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**SDS 930 COMPUTER  
EXAMINER DIAGNOSTIC SYSTEM  
TECHNICAL MANUAL**

SDS 90 00 97B      September 1965

**(Volume I)**



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## **INTRODUCTION**

### **GENERAL INFORMATION**

The SDS 930 Computer Examiner System is a complete diagnostic package that enables the operator to exercise and/or diagnose the memory and the computer main frame logic. For easy, convenient handling, the entire system is on one tape or on cards; its form is modular to facilitate expansion. The system consists of three main programs: Memory Diagnostic, Instruction Diagnostic, and The P and S Register Tester.

The Memory Diagnostic program tests memory, monitors the test for memory circuitry failure, and provides the user with pertinent information concerning the location and nature of the failure.

The Instruction Diagnostic tests the entire instruction set, exercises every gate and flip-flop pertaining to the instruction logic, monitors the tests, and provides pertinent information about the instruction in case of failure.

The P and S Register Tester determines whether the P Register and S Register operate properly over the entire addressing range.

Included in Section III under "Automatic Instruction Test Program" are detailed logic equation reference material, operating details, and detailed diagnostic constants for use in checking the multiply instruction (the Right Shift Adder) and the divide instruction (the BZO "eye-ball" circuit).

### **SYSTEM TAPE ORGANIZATION**

| The SDS 930 EXAMINER System is on one tape or on cards, as follows:

1. Memory Diagnostic
2. Instruction Diagnostic
3. P and S Register Tester

**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Catalog No. 304001B

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|                            |                                                                                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| IDENTIFICATION:            | Memory Diagnostic                                                                                                               |
| AUTHOR:                    | Resnick/Mulholland, SDS                                                                                                         |
| ACCEPTED:                  | August 23, 1965                                                                                                                 |
| COMPUTER<br>CONFIGURATION: | SDS 930                                                                                                                         |
| PURPOSE:                   | To exercise memory with a checkerboard memory word pattern; to monitor memory for errors and aid in diagnosing memory failures. |
| SUBROUTINES<br>REQUIRED:   | None                                                                                                                            |
| STORAGE:                   | All of memory                                                                                                                   |
| TIMING:                    | Not applicable                                                                                                                  |
| SOURCE<br>LANGUAGE:        | SYMBOL 8 Assembler                                                                                                              |
| LOADING<br>PROCEDURE:      | Self-loading, paper tape or cards. Clear memory before loading.                                                                 |

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**USE:****INTRODUCTION**

The SDS 930 Examiner Memory Diagnostic Program tests any core memory, 4096 through 32,768 words. The two versions of this diagnostic are "16k or less" and "over 16k." Operationally, both programs are similar. In performing the test, the program writes a regular checkerboard pattern to generate noise throughout memory (1's in "positive" cores and 0's in "negative" cores\*), then tests each memory word individually, inverts the word, tests again, and then restores the original word. If, during the testing process, the program detects an error, it can display the failing address and bit positions, aiding the operator in determining the circuitry that is malfunctioning. Also, the overflow light is turned on, and remains on, until the end of the half-cycle.

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\*Those cores inducing a positive polarity voltage into the sense winding are assumed to be positive cores, and the remainder negative cores.

USE: (cont.)

The program uses the breakpoint switches to provide various modes of program operation. See the next section, "Operating the Memory Diagnostic Program," for the mode discussion.

Special limits may be invoked at load time that may be used as a breakpoint option during execution. In the case of the "over 16k" version, new special limits may be invoked without reloading the program. During normal operation, the program tests all core memory above it ("16k or less" version) or all core other than resident 4k block of program ("over 16k" version). The program then moves itself to the upper end of core and tests all core below it ("16k or less" version), or all other core except the resident 4K block of program ("over 16k" version). When the program completes this cycle, it returns to lower core again and repeats the cycle with an "inverted" checkerboard pattern (0's in "positive" cores and 1's in "negative" cores). The ability to remain in one area and repeatedly test the remainder of core is a breakpoint option; the pattern will be inverted every second cycle in this mode. When special limits are used, the program will remain in the area that is not being tested. In the case of the "over 16k" version, the program moves only if the special start is in the first 4k block and/or the special limit is in the last 4k block of core. (If limits other than integer multiples of 128 are invoked, the program truncates the least significant 7 bits of the limits.)

### OPERATING THE MEMORY DIAGNOSTIC PROGRAM

If an "over 16k" computer is to be tested, use the fill procedure\* to load "over 16k" version over "16k or less" version (paper tape version).

1. During loading select breakpoint options as follows:

#### Breakpoint No. 1

SET - allows operator to change machine size, as displayed in the A Register (e.g., make 16k memory look as if it were only 12k or 8k, etc.).

A(9-23) - location plus one of last word in memory

B(9-23) - first location in memory, zero (do not change)

RESET - no effect

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\*See SDS 930 Computer Reference Manual, 90 00 64.

USE: (cont.)

Breakpoint No. 2

No effect

Breakpoint No. 3

SET – change limits to be tested, in multiples of 128 (e.g., normal limits – 0 to 030000, special limits – 0200 to 020000\*)

A(9-23) – location plus one of last word in memory

B(9-23) – first location of memory ("16k or less" version also has a NOP instruction in the A and B registers).

At this point the operator may change the lower and upper limits of memory by inserting the desired lower and upper limits in B and A, respectively. If special limits are to be used, the NOP instruction must be placed in these registers as well for the "16k or less" version.

RESET – No effect

Breakpoint No. 4

No effect

2. During running of the program select breakpoint options as follows:

Breakpoint No. 1

SET – repeat testing cycle in same area. Pattern will be inverted every second cycle.

RESET – normal testing cycle.

Breakpoint No. 2

SET – inhibit error halts

RESET – normal halts for errors.

Location of halts (both versions):

Low Memory – 0115

High Memory – 0X7715

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\*Leading 0 indicates octal number.

USE: (cont.)

Breakpoint No. 3

SET – special limits used (Do not set Bpt. 3 unless the program halts due to an error or to the setting of Bpt. 4).

RESET – normal limits used.

Breakpoint No. 4

SET – halt before each half-cycle. The A register contains the number of errors incurred. The operator may change the number at this time. Set Bpt. 3 if special limits are to be used.

In the "over 16k" version, if new machine size and/or special limits are desired, set Bpt. 1 (new machine size) and/or Bpt. 3 (new special limits) and branch to location 0404. Do this only if program is in low memory.

Location of halts (both versions):

Low Memory – 047

High Memory – 0X7647

RESET – No effect

CHECKERBOARD PATTERN MEMORY TEST

The checkerboard pattern consists of binary words of all 1's and words of all 0's. An example is:

| <u>Location</u> | <u>Contents</u> |
|-----------------|-----------------|
| 00000           | 77777777        |
| 00001           | 00000000        |
| 00002           | 77777777        |
| 00003           | 00000000        |
| .               | .               |
| .               | .               |
| .               | .               |

Shown in the form of X and Y address components, where a single digit represents a full word, this pattern is:

USE: (cont.)

|     |      |     |    |    |    |        |
|-----|------|-----|----|----|----|--------|
|     |      | Y → |    |    |    |        |
| X ↓ |      | 00  | 01 | 02 | 03 | ... 77 |
|     | 0000 | 1   | 0  | 1  | 0  | 0      |
|     | 0100 | 0   | 1  | 0  | 1  | 1      |
|     | 0200 | 1   | 0  | 1  | 0  | 0      |
|     | 0300 | 0   | 1  | 0  | 1  | 1      |
|     | .    |     |    |    |    | .      |
|     | .    |     |    |    |    | .      |
|     | .    |     |    |    |    | .      |
|     | 7700 | 0   | 1  | 0  | 1  | 1      |

The logical function that determines the pattern depends directly on the least significant bit of the X and Y sink addresses. Assuming that the address bits go from 9 through 23 in the C Register, the X sink bits and the Y sink bits are 15, 16, 17, and 21, 22, 23, respectively. This function is:

1. If address bit 17 is equal to address bit 23, the program fills the location with all 1-bits.
2. If address bit 17 is not equal to address bit 23, the program fills the location with all 0-bits.

Examples:

| <u>Address</u> | <u>Bit 17</u> | <u>Bit 23</u> | <u>Word Put in Location</u> |
|----------------|---------------|---------------|-----------------------------|
| 01000          | 0             | 0             | 77777777                    |
| 01001          | 0             | 1             | 00000000                    |
| 00304          | 1             | 0             | 00000000                    |
| 00503          | 1             | 1             | 77777777                    |

The program alternates the above pattern at the end of each memory testing cycle. The change occurs each time the memory area tested goes from lower memory to upper memory. Thus, a complete check of memory requires two complete test cycles. Setting Breakpoint 3 causes the pattern to change between each half of the test cycle.

## USE: (cont.)

The checkerboard pattern used in this program imposes the maximum noise on the output of the sense winding during reading or writing memory. The memory circuitry can detect such noise as information resulting in memory error.

ERROR CHECK

## 1. Error Halts in Program

If Breakpoint No.2 is RESET when an error is detected, the program halts and displays the error. The program halts in one of several locations depending on program placement and memory size. When the program is testing upper core, the error halt is location 0115. When testing lower core, the error halt location is 0X7715.

## 2. Use of Error Indications

Initially, if nothing loads into memory, check the power supply for proper power levels.

If the program loads and then detects errors during the operation, the operator can suspect the memory circuitry or memory adjustment.

When the operator determines the memory stack type — 4K, 8K and/or 16K — he can use the following to help determine the exact failure point.

X-Y Drivers/Sinks

When an error occurs, the C Register contains the error-word's location: C<sub>9</sub> through C<sub>23</sub>. These address bits correspond to the X, Y drivers and sinks according to the following tables.

USE: (cont.)

X Sinks

|              | C18 | C19 | C20 |
|--------------|-----|-----|-----|
| SRX0<br>SWX0 | 0   | 0   | 0   |
| SRX1<br>SWX1 | 0   | 0   | 1   |
| SRX2<br>SWX2 | 0   | 1   | 0   |
| SRX3<br>SWX3 | 0   | 1   | 1   |
| SRX4<br>SWX4 | 1   | 0   | 0   |
| SRX5<br>SWX5 | 1   | 0   | 1   |
| SRX6<br>SWX6 | 1   | 1   | 0   |
| SRX7<br>SWX7 | 1   | 1   | 1   |

Y Sinks

|              | C12 | C13 | C14 |
|--------------|-----|-----|-----|
| SRY0<br>SWY0 | 0   | 0   | 0   |
| SRY1<br>SWY1 | 0   | 0   | 1   |
| SRY2<br>SWY2 | 0   | 1   | 0   |
| SRY3<br>SWY3 | 0   | 1   | 1   |
| SRY4<br>SWY4 | 1   | 0   | 0   |
| SRY5<br>SWY5 | 1   | 0   | 1   |
| SRY6<br>SWY6 | 1   | 1   | 0   |
| SRY7<br>SWY7 | 1   | 1   | 1   |

USE: (cont.)

X Drivers

|      | C11 | C21 | C22 | C23 |
|------|-----|-----|-----|-----|
| DX0  | 0   | 0   | 0   | 0   |
| DX1  | 0   | 0   | 0   | 1   |
| DX2  | 0   | 0   | 1   | 0   |
| DX3  | 0   | 0   | 1   | 1   |
| DX4  | 0   | 1   | 0   | 0   |
| DX5  | 0   | 1   | 0   | 1   |
| DX6  | 0   | 1   | 1   | 0   |
| DX7  | 0   | 1   | 1   | 1   |
| DX10 | 1   | 0   | 0   | 0   |
| DX11 | 1   | 0   | 0   | 1   |
| DX12 | 1   | 0   | 1   | 0   |
| DX13 | 1   | 0   | 1   | 1   |
| DX14 | 1   | 1   | 0   | 0   |
| DX15 | 1   | 1   | 0   | 1   |
| DX16 | 1   | 1   | 1   | 0   |
| DX17 | 1   | 1   | 1   | 1   |

Y Drivers

|      | C10 | C15 | C16 | C17 |
|------|-----|-----|-----|-----|
| DY0  | 0   | 0   | 0   | 0   |
| DY1  | 0   | 0   | 0   | 1   |
| DY2  | 0   | 0   | 1   | 0   |
| DY3  | 0   | 0   | 1   | 1   |
| DY4  | 0   | 1   | 0   | 0   |
| DY5  | 0   | 1   | 0   | 1   |
| DY6  | 0   | 1   | 1   | 0   |
| DY7  | 0   | 1   | 1   | 1   |
| DY10 | 1   | 0   | 0   | 0   |
| DY11 | 1   | 0   | 0   | 1   |

|              |      |   |   |   |   |
|--------------|------|---|---|---|---|
| USE: (cont.) | DY12 | 1 | 0 | 1 | 0 |
|              | DY13 | 1 | 0 | 1 | 1 |
|              | DY14 | 1 | 1 | 0 | 0 |
|              | DY15 | 1 | 1 | 0 | 1 |
|              | DY16 | 1 | 1 | 1 | 0 |
|              | DY17 | 1 | 1 | 1 | 1 |

Z Inhibit Drivers

The Z Inhibit Drivers are functions of bit position and memory stack size. Number the bit positions in memory as M0 (most significant) through M23 (least significant) and M24 (parity).

used with 4K, 8K or 16K stacks when  $C_{10} C_{11} = 00$

$$Z0d0 = \overline{M0}$$

$$Z1d0 = \overline{M1}$$

.

.

.

$$Z23d0 = \overline{M23}$$

$$Z24d0 = \overline{M24} \text{ (parity)}$$

used with 8K or 16K stacks when  $C_{10} C_{11} = 01$

$$Z0d1 = \overline{M0}$$

$$Z1d1 = \overline{M1}$$

.

.

.

$$Z24d1 = \overline{M24} \text{ (parity bit)}$$

used with 16K stacks only when  $C_{10} C_{11} = 10$

$$Z0d2 = \overline{M0}$$

.

.

.

$$Z24d2 = \overline{M24} \text{ (parity bit)}$$

USE: (cont.)

used with 16K stacks only when  $C_{10} C_{11} = 11$ 

$$Z0d3 = \overline{M0}$$

$$\cdot$$

$$Z24d3 = \overline{M24} \text{ (parity bit)}$$

### Sense Amplifiers

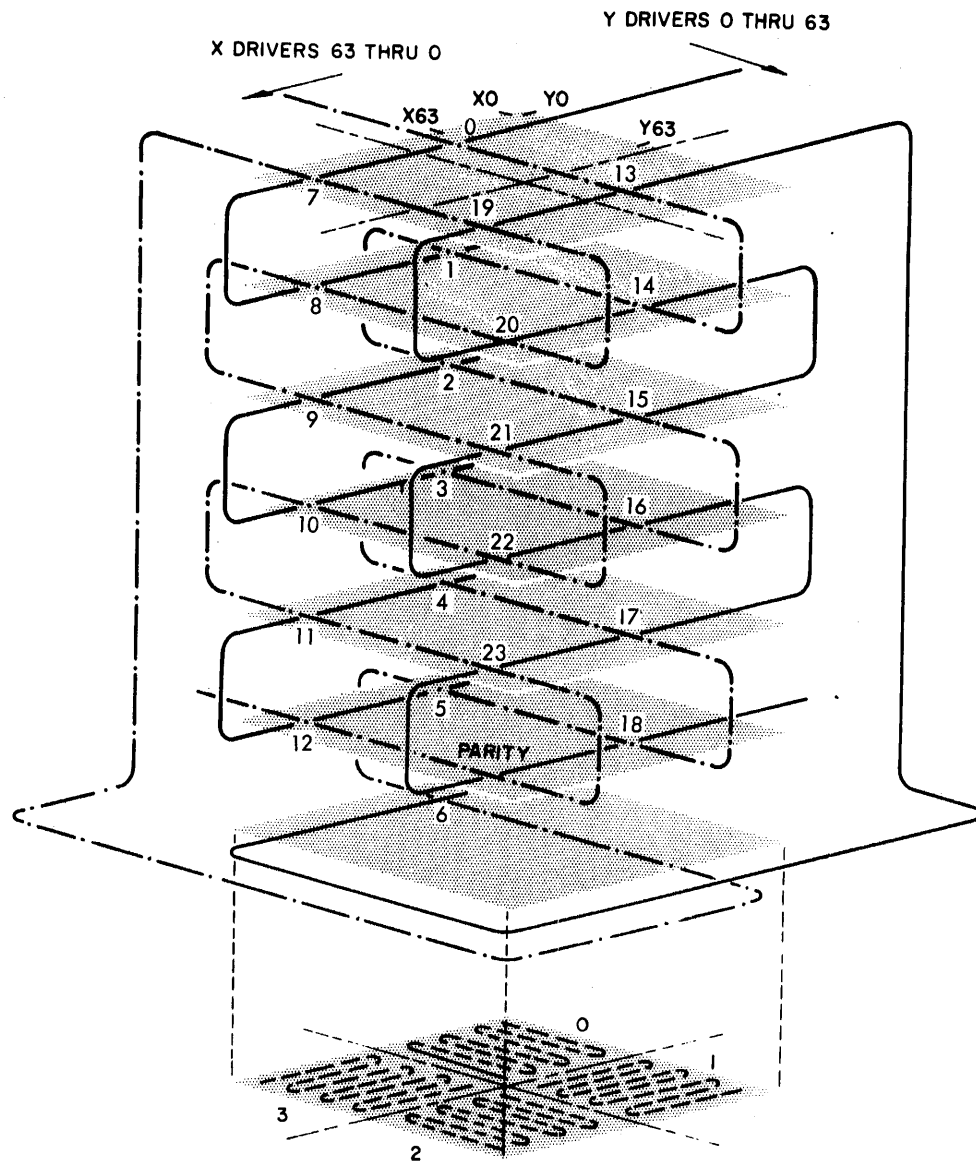
The Sense Amplifiers are functions of the following bit positions:

$$Md0 = M0$$

$$Md1 = M1$$

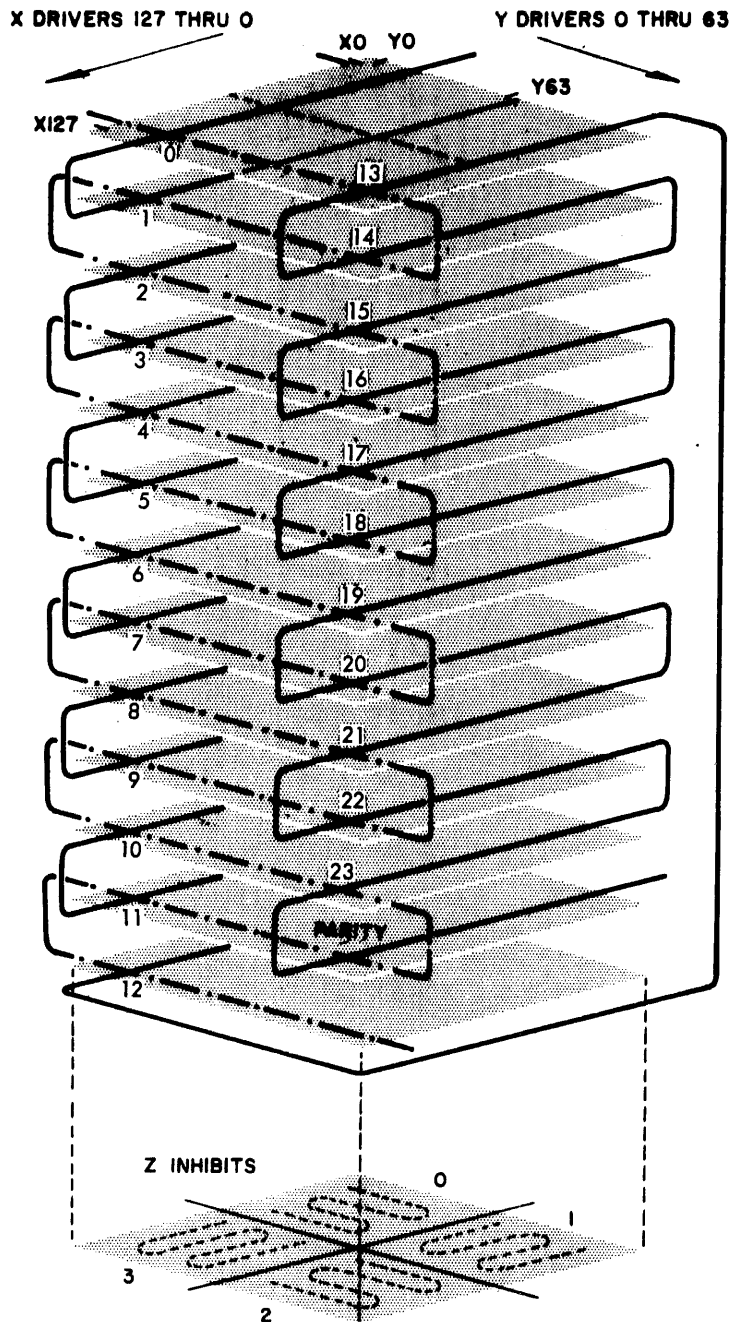
$$\cdot$$

$$Md24 = M24 \text{ (parity bit)}$$



Quadrant 0 is Y(0-63) X(0-63) Address 0000 - 7777 bits 0 - 6  
 Quadrant 1 is Y(0-63) X(0-63) Address 0000 - 7777 bits 13 - 18  
 Quadrant 2 is Y(0-63) X(0-63) Address 0000 - 7777 bits 19 - Parity  
 Quadrant 3 is Y(0-63) X(0-63) Address 0000 - 7777 bits 7 - 12

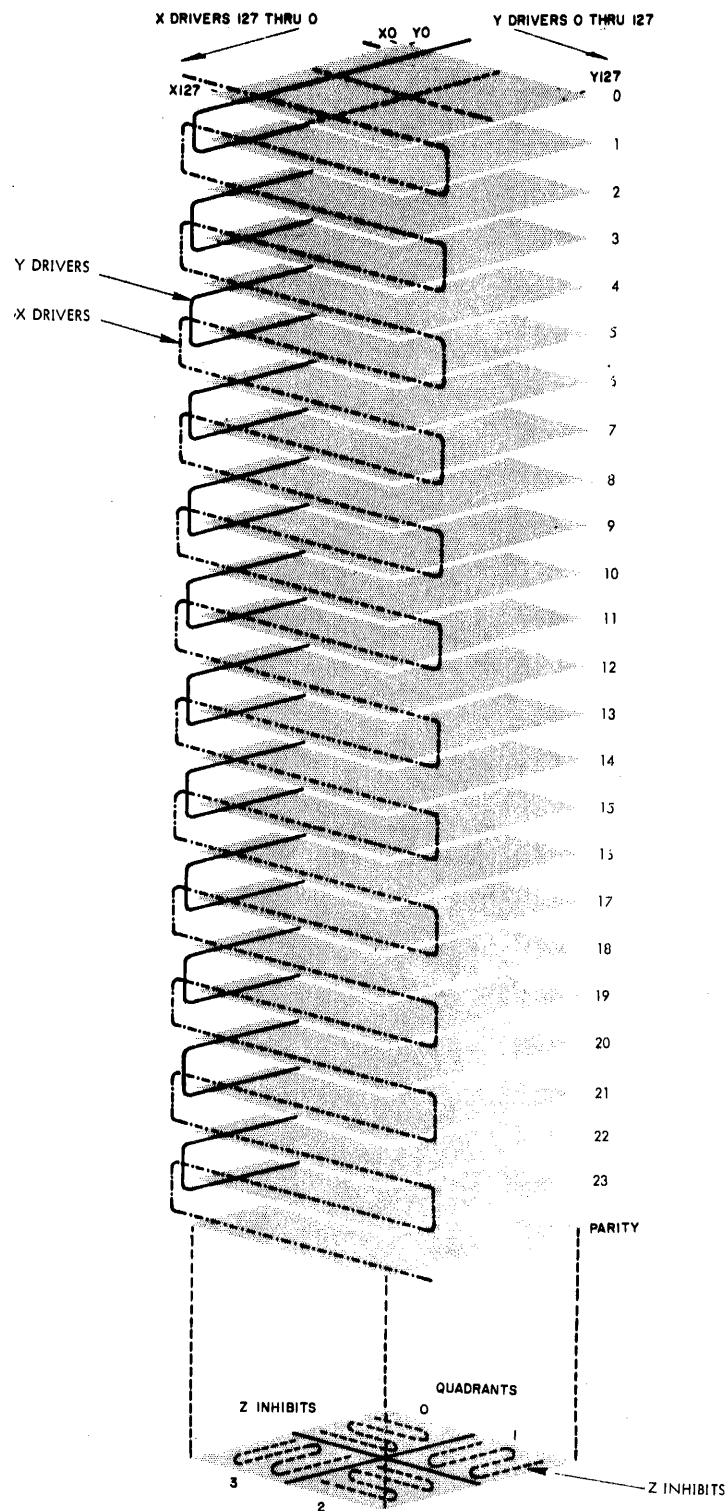
Figure 1. Memory Stack, 4K



|                                 |         |               |                  |
|---------------------------------|---------|---------------|------------------|
| Quadrant 0 is Y(0-63) X(0-63)   | Address | 0000 - 7777   | bits 0 - 12      |
| Quadrant 1 is (Y0-63) X(0-63)   | Address | 0000 - 7777   | bits 13 - Parity |
| Quadrant 2 is (Y0-63) X(64-127) | Address | 10000 - 17777 | bits 13 - Parity |
| Quadrant 3 is Y(0-63) X(64-127) | Address | 10000 - 17777 | bits 0 - 12      |

Z inhibit lines run parallel to the X drivers in Quadrants 0 and 2 and run parallel to the Y drivers in Quadrants 1 and 3.

The sense windings run diagonally by Quadrants.



Quadrant 0 is  $Y(0-63) \cdot X(0-63)$  Address 0000 - 7777

Quadrant 3 is  $Y(0-63) \cdot X(64-127)$  Address 10000 - 17777

Quadrant 1 is  $Y(64-127) \cdot X(0-63)$  Address 20000 - 27777

Quadrant 2 is  $Y(64-127) \cdot X(64-127)$  Address 30000 - 37777

Figure 3. Memory Stack, 16K

USE:  
(cont.)

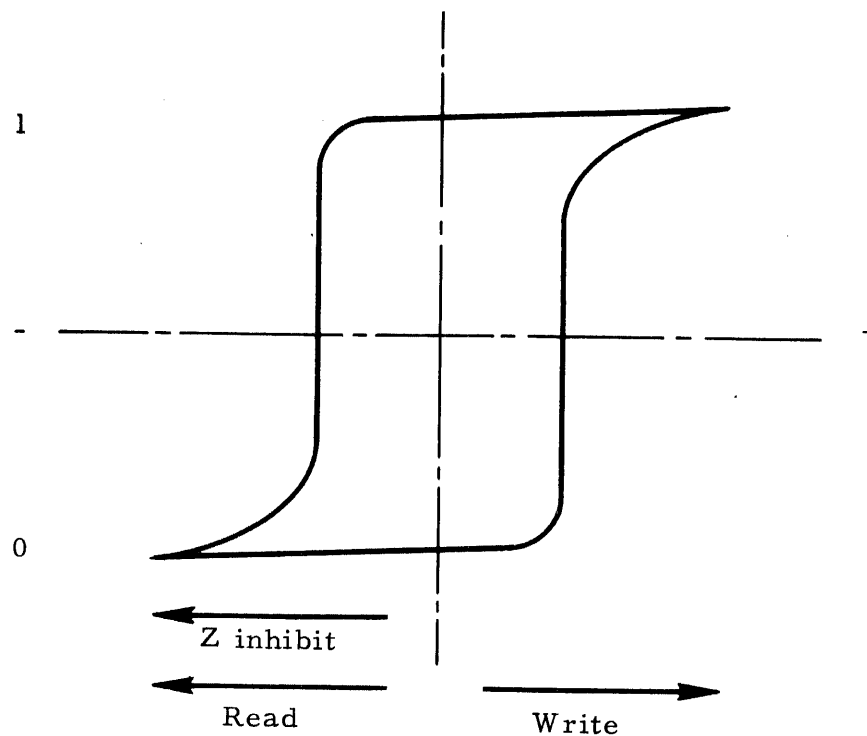


Figure 4. Current Flow

There are two switches, a read switch and a write switch, for each X and Y sink. The current flow in a read sink is equal to and opposite that in a write sink. The Z inhibit current is in the same direction as the read sink current.

If an address selects a core in a "one's" state, the X and Y read sinks combine two half-currents in the read direction and cause the core to change state. The change of state induces a voltage across the sense windings and sends a one-bit into the corresponding M register bit position. During the write cycle portion of the memory cycle, the X and Y write sinks restore the core to its original state by combining two half-currents in the write direction, causing the core to change state.

If, after the read phase and prior to the write phase of the memory cycle, an instruction changes a "one", read out of memory and into the M register, to a "zero" during the write cycle, the Z inhibit driver yields one half-current opposing the X and Y half-currents; therefore, no data is read back into core, which is a zero in memory. (A store instruction can cause such a change.)

USE: (cont.)

If, during the read phase, a "zero" is already in a core, the core does not change state when the two half-currents select it, and no change in potential occurs across the sense windings; this reads out a "zero". During the write phase of the memory cycle, the zero in the memory flip-flop triggers the Z inhibit driver and the core retains a "zero" state. However, if a "one" enters the memory flip-flop after the read but before the write, the Z inhibit driver does not trigger and the core changes to a "one's" state.

### MEMORY EXTENSION SYSTEM

Programs set the 930 Extend Memory Registers, EM3 and EM2, with an EOD instruction. Bits 16 and 17 select the register that the EOD changes; bits 18, 19, 20 and/or 21, 22, 23 contain the new contents for the registers.

|     |  |    |    |          |          |                                                  |
|-----|--|----|----|----------|----------|--------------------------------------------------|
| EOD |  | S3 | S2 | E M 3    | E M 2    | EOD Format                                       |
|     |  | 16 | 17 | 18 19 20 | 21 22 23 |                                                  |
| EOD |  | 0  | 0  | Ignored  | Ignored  | No register set                                  |
| EOD |  | 0  | 1  | Ignored  | X X X    | Set Bits XXX into EM2.                           |
| EOD |  | 1  | 0  | Y Y Y    | Ignored  | Set Bits YYY into EM3.                           |
| EOD |  | 1  | 1  | Y Y Y    | X X X    | Set Bits YYY into EM3.<br>Set Bits XXX into EM2. |

USE: (cont.)

The two most significant bits of an address, bits 10 and 11, determine the action of the Memory Extension; it reacts as follows:

Address bits 10 11

|   |   |                                   |
|---|---|-----------------------------------|
| 0 | 0 | Do not use Extend Memory Register |
|---|---|-----------------------------------|

|   |   |                                   |
|---|---|-----------------------------------|
| 0 | 1 | Do not use Extend Memory Register |
|---|---|-----------------------------------|

|   |   |                                                 |
|---|---|-------------------------------------------------|
| 1 | 0 | Use contents of EM2 as "fifth" digit of address |
|---|---|-------------------------------------------------|

|   |   |                                                 |
|---|---|-------------------------------------------------|
| 1 | 1 | Use contents of EM3 as "fifth" digit of address |
|---|---|-------------------------------------------------|

The following examples show the relationship between the setting of EM3 and EM2 and the leading address bits used in an instruction. The EOD sets the new value(s) in the register(s); the addresses show the effect of the value.

| EOD                                                 | New EM3 Value | New EM2 Value | Sample Address Written           | Actual Address Used              |
|-----------------------------------------------------|---------------|---------------|----------------------------------|----------------------------------|
| EOD 20300                                           | 0             | 0             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>0xxxx<br>0xxxx |
| EOD 20305                                           | 0             | 5             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>5xxxx<br>0xxxx |
| EOD 20354                                           | 5             | 4             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>4xxxx<br>5xxxx |
| EOD 20332                                           | 3             | 2             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx |
| This latter register setting is the normal setting. |               |               |                                  |                                  |

**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

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Catalog No. 304001

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|                            |                                                                                                                                                 |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| IDENTIFICATION:            | Memory Diagnostic                                                                                                                               |
| AUTHOR:                    | Richard S. Resnick, SDS                                                                                                                         |
| ACCEPTED:                  | August 28, 1964                                                                                                                                 |
| COMPUTER<br>CONFIGURATION: | Any SDS 930                                                                                                                                     |
| PURPOSE:                   | The program exercises memory with the worst-case memory word pattern; it monitors the memory for errors and aids in diagnosing memory failures. |
| PROGRAMMED<br>OPERATORS:   | None                                                                                                                                            |
| STORAGE:                   | All of memory                                                                                                                                   |
| TIMING:                    | N/A                                                                                                                                             |
| USE:                       | A. INTRODUCTION                                                                                                                                 |

The 930 Memory Diagnostic Program tests core memories of any size, 4096 through 32,768 words. In performing the test, the program writes a worst case pattern to generate noise throughout memory, and then tests each memory word individually. The worst case pattern is a checkerboard of words of all zeros and of all ones. If, during the testing process, the program detects an error, it can display the failing address and bit positions, aiding the operator in determining the circuitry which is malfunctioning.

The program uses the breakpoint switches to provide various modes of program operation. See Section B for the mode discussion.

For ease of troubleshooting, the program provides a "sync" bit on one word of the word testing loop. The operator can synchronize an oscilloscope on this bit to observe the action of continuously testing one word memory. An additional pulse generated by an EOM instruction external to the above-mentioned testing loop provides a broad sync loop.

USE: (cont.)

The program also provides the facility for observing "ringing" in the memory circuitry. During operation the program tests upper core, then moves itself to that area and tests lower core where it had been stored. When the program completes the lower core test (one test cycle), it returns to test upper core again (performs another test cycle). Depending on memory size--greater than or equal to 4K--the program tests different amounts of memory during the upper/lower parts of the test cycle. The operator also can select the portion of memory to be tested.

In each part of the cycle, the program covers the core area to be tested with the worst case pattern. Then the program accesses, inverts, tests, and restores to the test pattern each word in that area. The program inverts the worst case pattern between each repetition of the test cycle.

## B. OPERATING THE MEMORY DIAGNOSTIC PROGRAM

1. Load program by normal fill procedure.
2. Select program options as follows:

### Breakpoint No. 1

RESET position causes the program to test each word in sequence one time per test cycle.

SET position causes the program to test repeatedly the first erroneous word encountered.

### Breakpoint No. 2

RESET position causes computer to halt when it encounters an error. To continue, clear the halt.

SET position causes computer to continue (not halt) when it encounters an error.

### Error Indication

If Breakpoint No. 2 is RESET when the program encounters an error as it reads the inverted test word, the program displays the error as follows:

| <u>Register</u>     | <u>Meaning</u>                                    |
|---------------------|---------------------------------------------------|
| ( C <sub>9-23</sub> | The true 15-bit address capable of displaying 32K |

USE: (cont.)

|   |                                                           |
|---|-----------------------------------------------------------|
| B | The correct contents of the specified address             |
| X | The erroneous contents detected in the specified address. |

The discrepancies between (B) and (X) are the error positions. If a 1-bit appears in X in bit position  $i$  but not in B in that position, the failure is a bit picked up in position  $i$ . If a 1-bit appears in B in bit position  $j$  but not in  $\bar{X}$  in that position, the failure is a bit dropped from position  $j$ . This determines the bit positions that failed since the address uniquely determines the drive and sink circuitry.

## Breakpoint No. 3

During normal fill procedure

RESET position causes the normal fill to take place and causes the Memory Diagnostic program to be loaded and executed.

SET position causes the computer to halt and display:

The location plus one of the last word in memory in  $A_{(9-23)}$

The location of the first word in memory in  $B_{(9-23)}$

At this point the operator can change the lower and upper limits of memory by inserting the desired lower and upper limits in B and A, respectively.

During the running of the program

RESET position causes the Memory Diagnostic to use the actual lower and upper limits of the memory being tested.

SET position causes the Memory Diagnostic to use those limits provided during loading instead of the actual limits of the memory being tested.

By resetting Breakpoint 3, the program returns to the normal mode.

## Breakpoint No. 4

RESET position causes no action.

USE: (cont.)

| Breakpoint No. | SET                                                                                                                                                                                                                 | RESET                                                                                                                                                                                                                                                                                       |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1              | Repeated test of first erroneous word                                                                                                                                                                               | Test all words                                                                                                                                                                                                                                                                              |
| 2              | Continue on Error                                                                                                                                                                                                   | Halt on Error<br>Error Indication<br>$C_{9-23}$ = 15-bit address<br>$B_{9-23}$ = correct contents<br>$X$ = erroneous contents<br><br>1 in $X_i$ but not in $B_i$ implies<br>bit picked up in<br>position $i$<br><br>1 in $B_i$ but not in $X_i$ implies<br>bit dropped from<br>position $i$ |
| 3              | During Fill<br>Load and halt with display<br><br>$A_{9-23}$ = Location plus one<br>of last word in memory<br>$B_{9-23}$ = Location plus one<br>of first word in memory<br><br>To change limits, insert into A and B | During Fill<br>Load and run                                                                                                                                                                                                                                                                 |
|                | During Program Execution<br>Program uses limits provided at<br>load time                                                                                                                                            | During Program Execution<br>Program uses actual limits<br>of memory being tested                                                                                                                                                                                                            |
| 4              | Halt at each half-cycle<br>Display<br><br>$A$ = current 1's word<br>$B$ = current 0's word<br>$X$ = accumulation of errors                                                                                          | Ignore                                                                                                                                                                                                                                                                                      |

USE: (cont.)

SET position causes the program to halt before beginning each half of the test cycle and to display:

The current one's word in A

The current zero's word in B, and

The number of failures that have occurred in X (binary integer scaled at 23).

At this point, the operator can change any of the registers by clearing it and inserting the desired bit pattern. To obtain a count of errors for each half of the test cycle, clear X since the program continues to accumulate errors from cycle to cycle.

The computer halts at location 3 or at 7703/17703 depending on memory size and on the program's position when the Breakpoint is SET.

If SET, during the testing of upper memory, the computer halts at 3; if SET when testing lower memory, it halts at 7703 for a 4K core size, or at 17703 for a greater than 4K core size.

### C. WORST-CASE PATTERN MEMORY TEST

The worst-case pattern consists of a checkerboard pattern of binary words of all 1's and words of all 0's. An example is:

| <u>Location</u> | <u>Contents</u> |
|-----------------|-----------------|
| 00000           | 77777777        |
| 00001           | 00000000        |
| 00002           | 77777777        |
| 00003           | 00000000        |
| .               | .               |
| .               | .               |
| .               | .               |

Shown in the form of X and Y address components, where a single digit represents a full word, this pattern is:

USE: (cont.)

Y →

| X |      | 00 | 01 | 02 | 03 | . . . 77 |
|---|------|----|----|----|----|----------|
| ↓ | 0000 | 1  | 0  | 1  | 1  | 0        |
|   | 0100 | 0  | 1  | 0  | 1  | 1        |
|   | 0200 | 1  | 0  | 1  | 0  | 0        |
|   | 0300 | 0  | 1  | 0  | 1  | 1        |
|   | .    |    |    |    |    | .        |
|   | .    |    |    |    |    | .        |
|   | .    |    |    |    |    | .        |
|   | 7700 | 0  | 1  | 0  | 1  | 1        |

The logical function that determines the pattern is directly dependent on the least significant bit of the X and Y sink addresses. Assuming that the address bits go from 9 through 23 in the C Register, the X sink bits and the Y sink bits are 15, 16, 17, and 21, 22, 23, respectively. This function is:

1. If address bit 17 is equal to address bit 23, the program fills the location with all 1-bits.
2. If address bit 17 is not equal to address bit 23, the program fills the location with all 0-bits.

Examples:

| <u>Address</u> | <u>Bit 17</u> | <u>Bit 23</u> | <u>Word Put in Location</u> |
|----------------|---------------|---------------|-----------------------------|
| 01000          | 0             | 0             | 77777777                    |
| 01001          | 0             | 1             | 00000000                    |
| 00304          | 1             | 0             | 00000000                    |
| 00503          | 1             | 1             | 77777777                    |

The program alternates the above pattern at the end of each memory testing cycle. The change occurs each time the memory area tested goes from lower memory to upper memory. Thus, a complete check of memory requires two complete test cycles. Setting Breakpoint 3 causes the pattern to change between each half of the test cycle.

USE: (cont.)

The worst-case pattern used in this program imposes the maximum noise on the output of the sense winding during reading or writing memory. The memory circuitry can detect such noise as information resulting in memory error.

#### D. ERROR CHECK

##### 1. Error Halts in Program

If Breakpoint No. 2 is RESET when an error is detected, the program halts and displays the error. The program halts in one of several locations depending on program placement and memory size. When the program is testing upper core, the error halt is location 73<sub>8</sub>. When testing lower core in a machine with 4K, the error halt location is 7773<sub>8</sub>. When testing lower core in a machine with greater than 4K, the error halt location is 17773<sub>8</sub>.

##### 2. Error Checking Aids

The program provides a sync bit on one word in the test loop. With Breakpoint No. 1 SET, the operator can sync an oscilloscope on the sync bit. An EOM executed at the beginning of each half of the test cycle gives the operator a sync pulse on a larger loop. A right-cycle-48 executed once during each half of the test cycle turns memory off for six complete machine cycles; this allows the operator to observe "ringing" effects in memory and to observe its severity.

##### 3. Use of Error Indications

Initially, if nothing loads into memory, check the power supply for proper power levels.

If the program loads and then detects errors during the operation, the operator can suspect the memory circuitry or memory adjustment.

When the operator determines the memory stack type -- 4K, 8K and/or 16K -- he can use the following to help determine the exact failure point.

USE: (cont.)

X-Y Drivers/Sinks

When an error occurs, the C Register contains the error-word's location:  $C_9$  through  $C_{23}$ . These address bits correspond to the X, Y drivers and sinks according to the following tables:

|              | <u>X Sinks</u> |     |     |
|--------------|----------------|-----|-----|
|              | C21            | C22 | C23 |
| SRX0<br>SWX0 | 0              | 0   | 0   |
| SRX1<br>SWX1 | 0              | 0   | 1   |
| SRX2<br>SWX2 | 0              | 1   | 0   |
| SRX3<br>SWX3 | 0              | 1   | 1   |
| SRX4<br>SWX4 | 1              | 0   | 0   |
| SRX5<br>SWX5 | 1              | 0   | 1   |
| SRX6<br>SWX6 | 1              | 1   | 0   |
| SRX7<br>SWX7 | 1              | 1   | 1   |

|              | <u>Y Sinks</u> |     |     |
|--------------|----------------|-----|-----|
|              | C15            | C16 | C17 |
| SRY0<br>SWY0 | 0              | 0   | 0   |
| SRY1<br>SWY1 | 0              | 0   | 1   |
| SRY2<br>SWY2 | 0              | 1   | 0   |

USE: (cont.)

|      |              |     |     |     |
|------|--------------|-----|-----|-----|
|      | SRY3<br>SWY3 | 0   | 1   | 1   |
|      | SRY4<br>SWY4 | 1   | 0   | 0   |
|      | SRY5<br>SWY5 | 1   | 0   | 1   |
|      | SRY6<br>SWY6 | 1   | 1   | 0   |
|      | SRY7<br>SWY7 | 1   | 1   | 1   |
|      | C11          | C18 | C19 | C20 |
| DX0  | 0            | 0   | 0   | 0   |
| DX1  | 0            | 0   | 0   | 1   |
| DX2  | 0            | 0   | 1   | 0   |
| DX3  | 0            | 0   | 1   | 1   |
| DX4  | 0            | 1   | 0   | 0   |
| DX5  | 0            | 1   | 0   | 1   |
| DX6  | 0            | 1   | 1   | 0   |
| DX7  | 0            | 1   | 1   | 1   |
| DX10 | 1            | 0   | 0   | 0   |
| DX11 | 1            | 0   | 0   | 1   |
| DX12 | 1            | 0   | 1   | 0   |
| DX13 | 1            | 0   | 1   | 1   |
| DX14 | 1            | 1   | 0   | 0   |
| DX15 | 1            | 1   | 0   | 1   |
| DX16 | 1            | 1   | 1   | 0   |
| DX17 | 1            | 1   | 1   | 1   |

Y Drivers

|     |     |     |     |     |
|-----|-----|-----|-----|-----|
|     | C10 | C11 | C12 | C13 |
| DY0 | 0   | 0   | 0   | 0   |
| DY1 | 0   | 0   | 0   | 1   |

USE: (cont.)

|      |   |   |   |   |
|------|---|---|---|---|
| DY2  | 0 | 0 | 1 | 0 |
| DY3  | 0 | 0 | 1 | 1 |
| DY4  | 0 | 1 | 0 | 0 |
| DY5  | 0 | 1 | 0 | 1 |
| DY6  | 0 | 1 | 1 | 0 |
| DY7  | 0 | 1 | 1 | 1 |
| DY10 | 1 | 0 | 0 | 0 |
| DY11 | 1 | 0 | 0 | 1 |
| DY12 | 1 | 0 | 1 | 0 |
| DY13 | 1 | 0 | 1 | 1 |
| DY14 | 1 | 1 | 0 | 0 |
| DY15 | 1 | 1 | 0 | 1 |
| DY16 | 1 | 1 | 1 | 0 |
| DY17 | 1 | 1 | 1 | 1 |

Z Inhibit Drivers

The Z Inhibit Drivers are functions of bit position and memory stack size. Number the bit positions in memory as M0 (most significant) through M23 (least significant) and M24 (parity).

used with 4K; 8K or 16K stacks when  $C_{10} C_{11} = 00$

Z0d0 = M0

Z1d0 = M1

.

.

.

Z23d0 = M23

Z24d0 = M24 (parity)

used with 8K or 16K stacks when  $C_{10} C_{11} = 01$

Z0d1 = M0

Z1d1 = M1

.

.

.

Z24d1 = M24 (parity bit)

USE: (cont.)

used with 16K stacks only when  $C_{10} C_{11} = 10$

$$Z0d2 = M0$$

•  
•

$$Z24d2 = M24 \text{ (parity bit)}$$

used with 16K stacks only when  $C_{10} C_{11} = 11$

$$Z0d3 = M0$$

•  
•

$$Z24d3 = M24 \text{ (parity bit)}$$

#### Sense Amplifiers

The Sense Amplifiers are functions of the following bit positions:

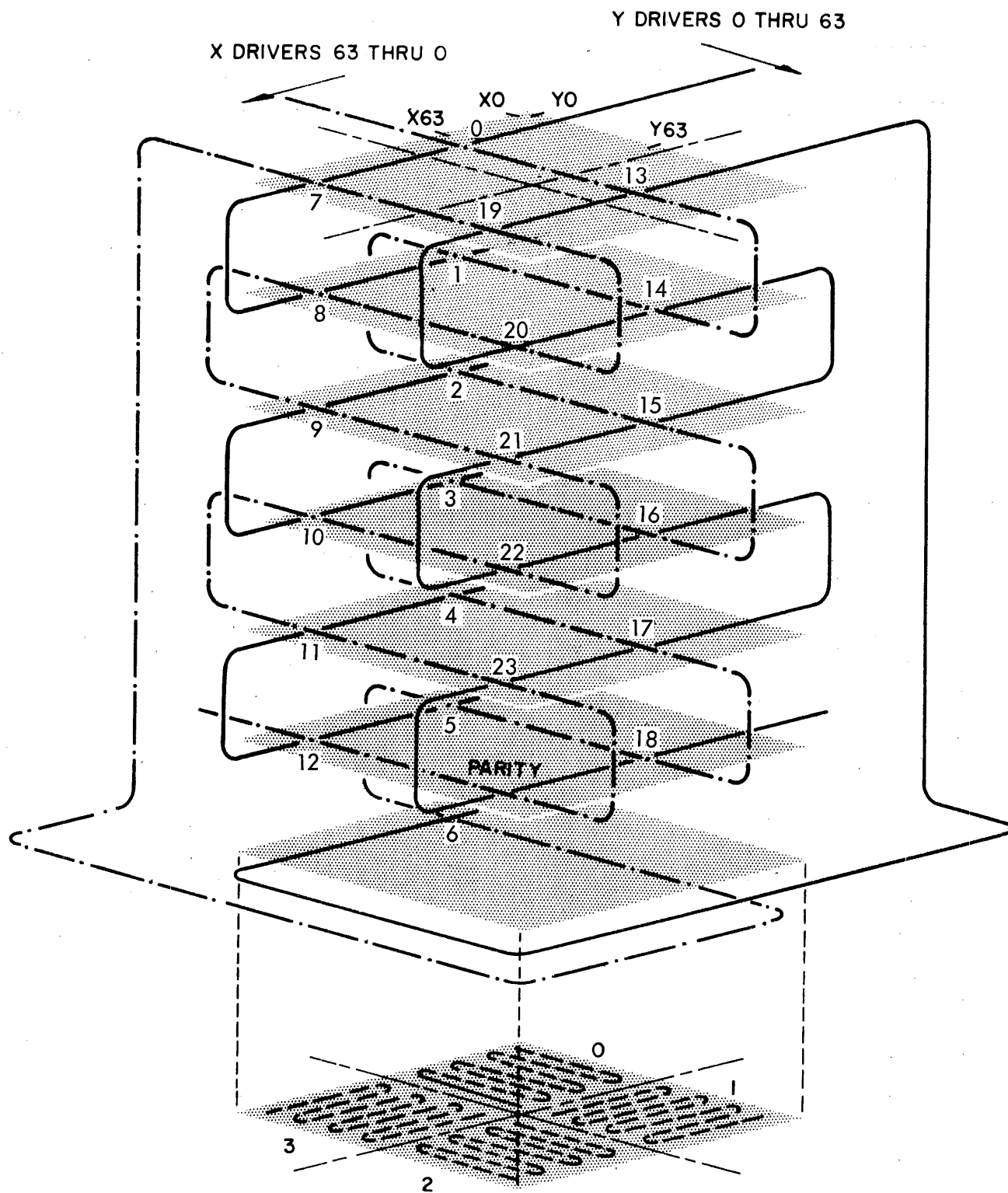
#### Sense Amplifiers

$$Md0 = M0$$

$$Md1 = M1$$

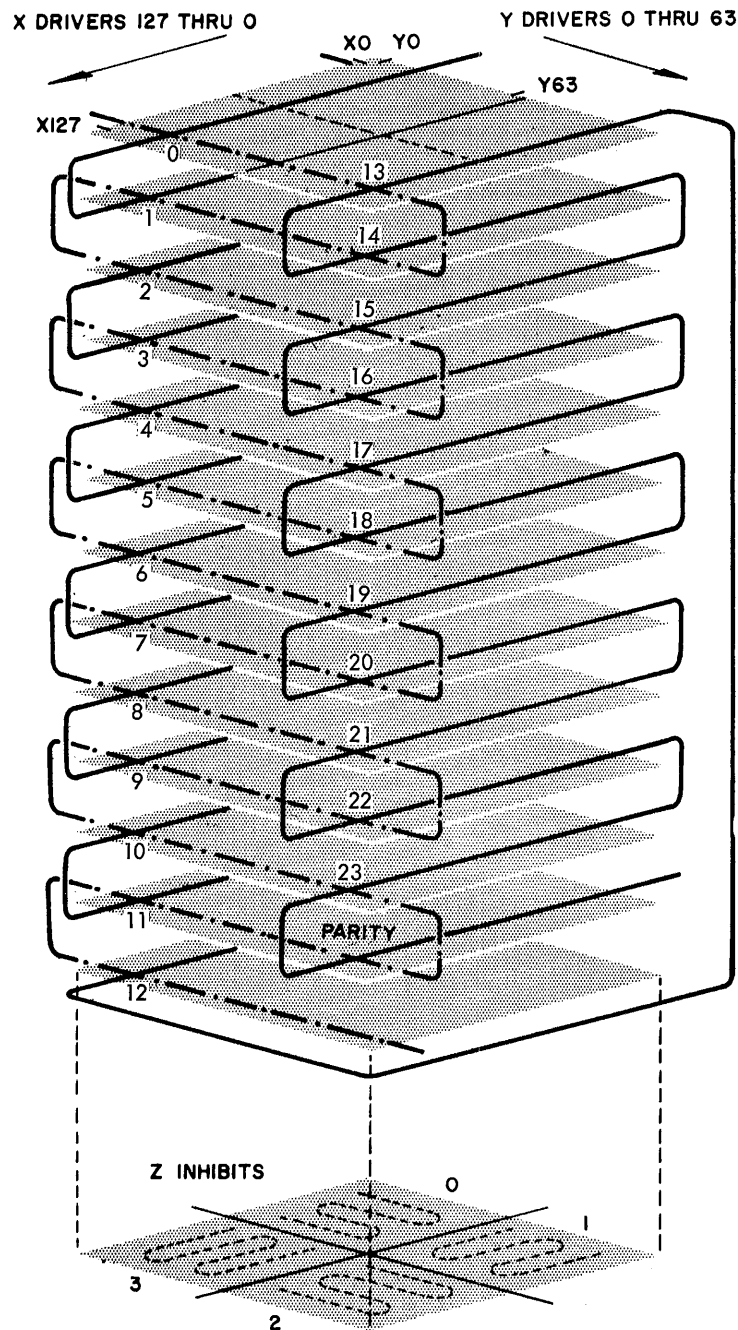
•  
•

$$Md24 = M24 \text{ (parity bit)}$$



Quadrant 0 is Y(0-63) X(0-63) Address 0000 - 7777 bits 0 - 6  
 Quadrant 1 is Y(0-63) X(0-63) Address 0000 - 7777 bits 13 - 18  
 Quadrant 2 is Y(0-63) X(0-63) Address 0000 - 7777 bits 19 - Parity  
 Quadrant 3 is Y(0-63) X(0-63) Address 0000 - 7777 bits 7 - 12

Figure 1. Memory Stack, 4K

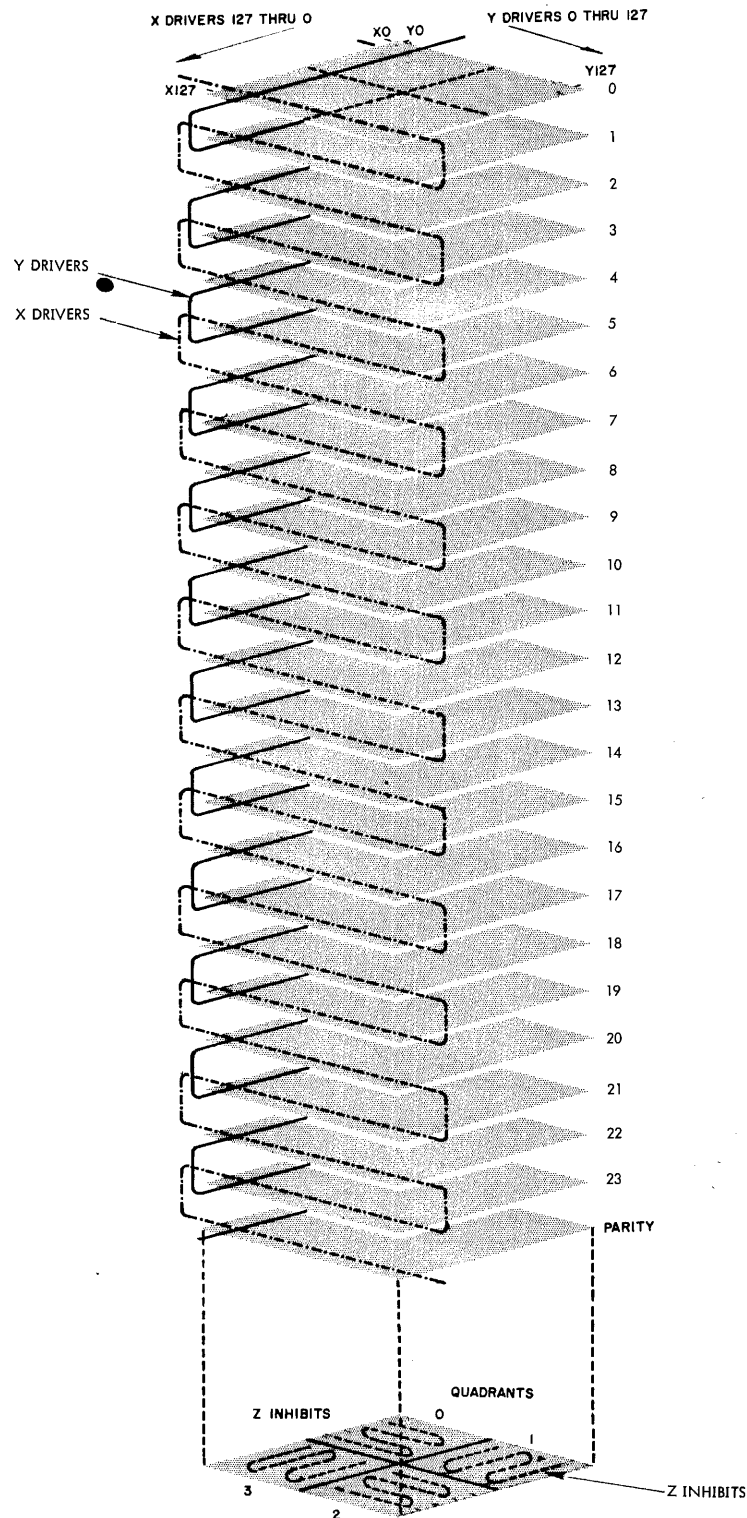


Quadrant 0 is Y(0-63) X(0-63) Address 0000 - 7777 bits 0 - 12  
 Quadrant 1 is Y(0-63) X(0-63) Address 0000 - 7777 bits 13 - Parity  
 Quadrant 2 is Y(0-63) X(64-127) Address 10000 - 17777 bits 13 - Parity  
 Quadrant 3 is Y(0-63) X(64-127) Address 10000 - 17777 bits 0 - 12

Figure 2. Memory Stack, 8K

Z inhibit lines run parallel to the X drivers in Quadrants 0 and 2 and run parallel to the Y drivers in Quadrants 1 and 3.

The sense windings run diagonally by Quadrants.



Quadrant 0 is  $Y(0-63) \cdot X(0-63)$  Address 0000 - 7777  
 Quadrant 3 is  $Y(0-63) \cdot X(64-127)$  Address 10000 - 17777  
 Quadrant 1 is  $Y(64-127) \cdot X(0-63)$  Address 20000 - 27777  
 Quadrant 2 is  $Y(64-127) \cdot X(64-127)$  Address 30000 - 37777

Figure 3. Memory Stack, 16 K

USE: (cont.)

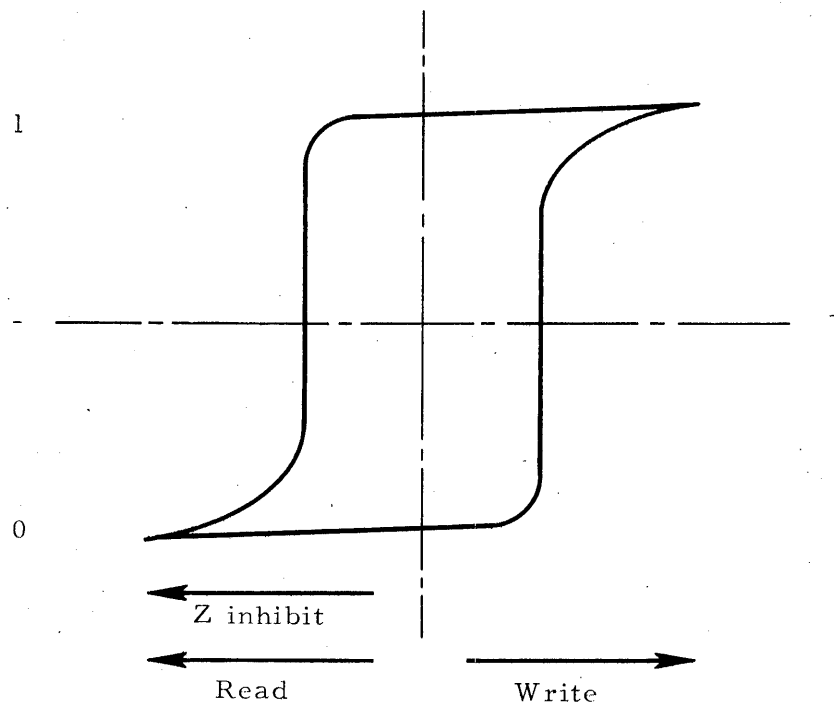


Figure 4. Current Flow

There are two switches, a read switch and a write switch, for each X and Y sink. The current flow in a read sink is equal to and opposite that in a write sink. The Z inhibit current is in the same direction as the read sink current.

If an address selects a core in a "one's" state, the X and Y read sinks combine two half-currents in the read direction and cause the core to change state. The change of state induces a voltage across the sense windings and sends a one-bit into the corresponding M Register bit position. During the write cycle portion of the memory cycle, the X and Y write sinks restore the core to its original state by combining two half-currents in the write direction, causing the core to change state.

If, after the read phase and prior to the write phase of the memory cycle, an instruction changes a "one", read out of memory and into the M Register, to a "zero" during the write cycle, the Z inhibit driver yields one half-current opposing the X and Y half-currents; therefore, no data is read back into core, which is a zero in memory. (A store instruction can cause such a change.)

USE: (cont.)

If, during the read phase, a "zero" is already in a core, the core does not change state when the two half-currents select it, and no change in potential occurs across the sense windings; this reads out a "zero". During the write phase of the memory cycle, the zero in the memory flip-flop triggers the Z inhibit driver and the core retains a "zero" state. However, if a "one" enters the memory flip-flop after the read but before the write, the Z inhibit driver does not trigger and the core changes to a "one's" state.

## E. MEMORY EXTENSION SYSTEM

Programs set the 930 Extend Memory Registers, EM3 and EM2, with an EOD instruction. Bits 16 and 17 select the register that the EOD changes; bits 18, 19, 20 and/or 21, 22, 23 contain the new contents for the registers.

|     |  |       |          |          |                                                  |
|-----|--|-------|----------|----------|--------------------------------------------------|
| EOD |  | S3 S2 | EM 3     | EM 2     | EOD Format                                       |
|     |  | 16 17 | 18 19 20 | 21 22 23 |                                                  |
| EOD |  | 0 0   | Ignored  | Ignored  | No register set                                  |
| EOD |  | 0 1   | Ignored  | X X X    | Set Bits XXX into EM2.                           |
| EOD |  | 1 0   | Y Y Y    | Ignored  | Set Bits YYY into EM3.                           |
| EOD |  | 1 1   | Y Y Y    | X X X    | Set Bits YYY into EM3.<br>Set Bits XXX into EM2. |

USE: (cont.)

The two most significant bits of an address, bits 10 and 11, determine the action of the Memory Extension; it reacts as follows:

|              |    |    |                                                 |
|--------------|----|----|-------------------------------------------------|
| Address bits | 10 | 11 |                                                 |
|              | 0  | 0  | Do not use Extend Memory Register               |
|              | 0  | 1  | Do not use Extend Memory Register               |
|              | 1  | 0  | Use contents of EM2 as "fifth" digit of address |
|              | 1  | 1  | Use contents of EM3 as "fifth" digit of address |

The following examples show the relationship between the setting of EM3 and EM2 and the leading address bits used in an instruction. The EOD sets the new value(s) in the register(s); the addresses show the effect of the value.

| EOD                                                 | New EM3 Value | New EM2 Value | Sample Address Written           | Actual Address Used              |
|-----------------------------------------------------|---------------|---------------|----------------------------------|----------------------------------|
| EOD 00300                                           | 0             | 0             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>0xxxx<br>0xxxx |
| EOD 00305                                           | 0             | 5             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>5xxxx<br>0xxxx |
| EOD 00354                                           | 5             | 4             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>4xxxx<br>5xxxx |
| EOD 00332                                           | 3             | 2             | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx | 0xxxx<br>1xxxx<br>2xxxx<br>3xxxx |
| This latter register setting is the normal setting. |               |               |                                  |                                  |

USE: (cont.)

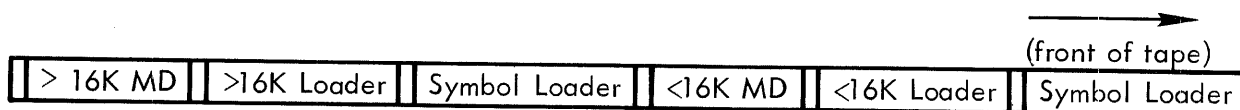
## F. MEMORY DIAGNOSTIC (MD) PROGRAM PARTICULARS

This program contains its own loader, which the standard loader loads into memory starting at location 200g. This loader loads MD into locations 0 through 177g, performs a checksum, and halts at P=204g if a checksum failure occurs.

The loader tests for memory size greater than 4K; if it finds the larger memory, the loader loads the appropriate "greater than 4K" routine as detailed in the next paragraph. If the memory is 4K, the loader responds to Breakpoint 3, and adjusts the pertinent program parameters. The loader then reads past the "greater than 4K" routine on the tape and transfers control to the Memory Diagnostic. MD stores the worst case pattern in memory from 200g through the last location in core. MD then tests each cell within the worst case pattern. The program then moves itself into locations 7600g through 7777g. MD writes the worst case pattern into locations 0 through 7600g and tests each cell. This represents one complete test cycle. The program then moves itself to locations 0 through 177g and repeats the cycle with the worst case pattern inverted.

If the MD loader finds a memory of more than 4K words, it reads a new loader into location 300g. This loader loads the "greater than 4K" MD into core at location 0 through 277g. The loader performs a checksum and halts with the P counter equal to 316g in case of checksum failure. The loader determines the exact memory size, responds to Breakpoint 3, adjusts pertinent parameters, and transfers to MD. MD stores the worst case pattern in memory from location 10000g through the last location in memory. MD tests each cell with the pattern. MD then writes a simple constant into locations 10000g through 17777g to nullify the worst case pattern and moves itself into locations 17500g through 17777g. The program writes the worst case pattern in lower core, locations 0 through 7777g, and tests each cell with the pattern. This represents one complete test cycle. MD then writes a simple constant into locations 0 through 7777g to nullify the worst case pattern and moves itself to locations 0 through 277g and repeats the cycle with the worst case pattern inverted.

## G. TAPE DESCRIPTION



**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Page 1 of

Catalog No. 304002

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**IDENTIFICATION:** Instruction Diagnostic

**AUTHOR:** R. Resnick, M. Mulholland

**ACCEPTED:** August 28, 1964

**COMPUTER  
CONFIGURATION:** SDS 930

**PURPOSE:** This program aids in diagnosing faulty computers by verifying proper execution of computer logic.

**PROGRAM  
OPERATORS:** N/A

**STORAGE:** 4096 words starting at Location 00000

**TIMING:** Approximately 53 milliseconds per pass when in the Automatic mode

**USE:** There are three reasons for testing the performance of a computer:

- Evaluation of the computer's performance,
- Detection of errors when the computer has failed, and
- Verification of the computer's performance.

This program provides for all three.

To test the computer's performance, it is necessary to perform:

- a Manual Test that involves the execution of a minimum number of specific instructions using the control console and comparing the resulting contents of the programmable registers with predetermined constants,
- a Semi-automatic Test, which uses a simple program principally consisting of those instructions tested during the Manual test; that executes a few more instructions and halts after each execution to let the operator inspect the registers for predetermined results, and
- an Automatic Test, which uses a complicated program containing those instructions tested during the previous two tests, that performs the remainder of the Instruction Repertoire, compares the results with predetermined constants and gives error indications when necessary.

USE: (cont.)

The Evaluation procedure involves all three tests and is used principally when there is no past history of the computer's performance as would be for a computer just off the assembly line. The Error Detection procedure involves the Semi-automatic and Automatic test and is used when a previously operative computer is suspected of having failed. The Verification procedure involves only the Automatic test and is used with Preventive Maintenance as well as for periodic computer reliability verification.

USE: (cont.)

## I. MANUAL INSTRUCTION TEST

The Manual Instruction Test is a procedure that the operator performs without the use of an internally stored program. The operator pre-sets the programmable registers, executes via the control console one of the five instructions to be tested, and compares the resulting constants in the registers with the list of predetermined constants. When these constants differ from the predetermined constants, an error (failure) has occurred.

In the case of an error, the operator should investigate it by observing via an oscilloscope, the circuitry operations during the execution of the instruction. Before using the oscilloscope,

- 1) raise the HOLD switch to hold the P Counter,
- 2) store the instruction being tested, with a 1-bit in bit 0, into the location currently displayed in the P Register,
- 3) raise the mode switch to RUN, and
- 4) observe the appropriate signal levels via the oscilloscope.

Note that the HOLD switch itself may be faulty.

The procedure tests the following instructions in the order given:

|                |                                             |    |
|----------------|---------------------------------------------|----|
| HLT            | Halt                                        | 00 |
| BRU            | Branch Unconditionally                      | 01 |
| BRX            | Increment Index and Branch (no branch case) | 41 |
| BRX            | Increment Index and Branch (branch case)    | 41 |
| LDX            | Load X                                      | 71 |
| Automatic Fill |                                             |    |

USE: (cont.)

The following gives the individual instruction test procedure:

A. HALT (00) TEST

1. Set mode switch to "IDLE," and press the START button.
2. Preset the registers as follows:

A = 77700070

B = 66611161

X = 55522252

P = 00000

C = 00000000

Overflow = reset

3. Set the mode switch to "RUN". The computer should wait (half light goes on.)
4. Set the mode switch to "IDLE" and check the registers for the following results:

A = 77700070

B = 66611161

X = 55522252

P = 00001

Overflow = reset

5. If an error occurs, follow the procedure outlined on the first page of the Manual Instruction Test program.

B. BRANCH UNCONDITIONALLY (01) TEST

1. Press the Start Button.
2. Preset the registers as follows:

A = 66611161

B = 55522252

USE: (cont.)

X = 44433343

P = 00000

C = 00107700

Overflow = reset

3. Set the mode switch to "STEP" and back to "IDLE".

4. Check the registers for the following results:

A = 66611161

B = 55522252

X = 44433343

P = 07700

Overflow = reset

5. If an error occurs, follow the procedure outlined on the first page of the Manual Instruction Test program.

C. INCREMENT INDEX AND BRANCH (41) TEST, BRANCH CASE

1. Press the start button.

2. Preset the registers as follows:

A = 55522252

B = 44433343

X = 33344434

P = 00000

C = 04107654

Overflow = reset

3. Set the mode switch to "STEP" and back to "IDLE".

4. Check the registers for the following results:

A = 55522252

B = 44433343

X = 33344435

P = 07654

Overflow = reset

5. If an error occurs, follow the procedure outlined on the first page of the Manual Instruction Test program.

USE: (cont.)

## D. INCREMENT INDEX AND BRANCH (41) TEST, NOT BRANCH CASE

1. Press the start button.
2. Preset the registers as follows:

A = 00077707

B = 11166616

X = 55522252

P = 00000

C = 04107654

Overflow = reset

3. Set the mode switch to "STEP" and back to "IDLE".
4. Check the registers for the following results:

A = 00077707

B = 11166616

X = 55522253

P = 00001

Overflow = reset

5. If an error occurs, follow the procedure outlined on the first page of the Manual Instruction Test program.

## E. AUTOMATIC FILL TEST

1. Press start button. Load reader with WIM Test, (or WIM test loop).
2. Preset the register as follows:

A = 44433343

B = 22255525

X = 77777777

P = 00000

C = 00000000

Overflow = reset

## USE: (Cont.)

3. Set the mode switch to "RUN". Raise paper tape fill switch and release.
4. The WIM test should load and then the computer should halt.
5. Set the mode switch to "IDLE" and check the registers for the following results:

A = 44433343

B = 22255525

X = 11111111

P = 00011

C = 77777777

Overflow = reset

6. If an error occurs refer to the Automatic Fill portion of the Peripheral Diagnostic Manual.

USE: (cont.)

## II. SEMI-AUTOMATIC INSTRUCTION TEST PROGRAM

The Semi-Automatic Instruction Test is a sequence of repeatable, program-controlled tests. As the program performs each test, it periodically halts, leaving preselected constants in all of the programmable registers. When the actual contents of these registers differ from the constants given in the test procedure, an error has occurred.

The operator is provided with the following breakpoint options:

- Breakpoint 1 Set = repeat the preceding test
- Breakpoint 1 Reset = normal operation
- Breakpoint 2 Set = bypass programmed halts
- Breakpoint 2 Reset = halt and inspect the registers during each test

Prior to loading:

- Breakpoint 4 Set = Load semi-automatic Instruction Program Test
- Breakpoint 4 Reset = Bypass Semi-automatic Instruction Test Program and load the Automatic Instruction Test Program

Upon completion of the Semi-automatic Instruction Test Program:

- Breakpoint 4 Set = Program to repeat Semi-automatic Instruction Test Program
- Breakpoint 4 Reset = Load Automatic Instruction Test Program

USE: (cont.)

The Breakpoint 1 option is available for all tests except the Breakpoint 1 tests.

The Breakpoint 2 option is available for all tests except the Breakpoint 2 tests.

A sync bit is provided in bit zero in all instructions being tested. With Breakpoints 1 and 2 set, the program repeatedly performs each test without halts; only the instruction being tested has a sync bit. This provides a means to synchronize an oscilloscope with the test loop to aid the operator in observing signal levels of any circuitry in question.

The program tests the following instructions in the order given:

| <u>Mnemonic<br/>Op Code</u> | <u>Test Case</u>                  | <u>Octal<br/>Op Code</u> |
|-----------------------------|-----------------------------------|--------------------------|
| BPT 1                       | BREAKPOINT NO. 1 TEST, reset case | 40                       |
| BPT 1                       | BREAKPOINT NO. 1 TEST, set case   | 40                       |
| BPT 2                       | BREAKPOINT NO. 2 TEST, reset case | 40                       |
| BPT 2                       | BREAKPOINT NO. 2 TEST, set case   | 40                       |
| BPT 3                       | BREAKPOINT NO. 3 TEST, reset case | 40                       |
| BPT 3                       | BREAKPOINT NO. 3 TEST, set case   | 40                       |
| BPT 4                       | BREAKPOINT NO. 4 TEST, reset case | 40                       |
| BPT 4                       | BREAKPOINT NO. 4 TEST, set case   | 40                       |
| LDX                         | LOAD X                            | 71                       |
| LDB                         | LOAD B                            | 75                       |
| LDA                         | LOAD A                            | 76                       |
| LDX*                        | LOAD X With Indirect Addressing   | 71                       |
| LDB*                        | LOAD B With Indirect Addressing   | 75                       |
| LDA*                        | LOAD A With Indirect Addressing   | 76                       |

|              |      |                                                                        |    |
|--------------|------|------------------------------------------------------------------------|----|
| USE: (cont.) | STB  | STORE B                                                                | 36 |
|              | STX  | STORE X                                                                | 37 |
|              | STB* | Store B With Indirect Addressing                                       | 36 |
|              | STX* | Store X With Indirect Addressing                                       | 37 |
|              | BRR  | RETURN BRANCH, Overflow Set                                            | 51 |
|              | OVT  | SKIP IF OVERFLOW NOT SET AND<br>RESET OVERFLOW, set case               | 40 |
|              | BRR  | RETURN BRANCH, Overflow not set                                        | 51 |
|              | BRR* | RETURN BRANCH, with Indirect<br>Addressing - Overflow not set          | 51 |
|              | BRX  | INCREMENT INDEX AND BRANCH<br>(no branch case)                         | 41 |
|              | OVT  | SKIP IF OVERFLOW NOT SET AND<br>RESET OVERFLOW, not set case           | 40 |
|              | BRX  | INCREMENT INDEX AND BRANCH<br>(branch case)                            | 41 |
|              | BRX* | INCREMENT INDEX AND BRANCH<br>for branch case with indirect addressing | 41 |
|              | SKE  | SKIP IF A EQUAL M FOR A = M case                                       | 50 |
|              | SKE  | SKIP IF A EQUAL M FOR A $\neq$ M case                                  | 50 |

The following gives the loading procedure, test entry procedure, and the individual instruction tests operation procedures.

A. LOAD PROGRAM

1. Set Breakpoint 4, reset Breakpoints 1, 2, and 3.
2. Perform normal fill procedure.
3. After the tape loads, the computer halts with P = 211.

B. ENTER PROGRAM

1. Reset all Breakpoints.
2. Put the mode switch in RUN to initiate the tests.

USE: (cont.)

## C. BREAKPOINT NO. 1 TEST (40) TEST

1. Program loops as long as Bpt 1 remains reset.
2. Setting Bpt 1 causes the program to halt. When it halts, move the mode switch to IDLE.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00220    |
| C        | = | 44020400 |
| Overflow | = | 0        |

3. Move the mode switch to RUN; the program then loops as long as Bpt 1 remains set.
4. Resetting Bpt 1 causes the program to halt. Move the mode switch to IDLE.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00223    |
| C        | = | 44020200 |
| Overflow | = | 0        |

5. Otherwise, move the mode switch to RUN. To repeat Bpt 1 test, place BRU 00214 in the C Register and move the mode switch to RUN.

## D. BREAKPOINT NO. 2 TEST (40) TEST

1. Program loops while Bpt 2 remains reset.
2. Setting Bpt 2 causes the program to halt. Move the mode switch to IDLE.

## USE: (cont.)

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00227    |
| C        | = | 44020200 |
| Overflow | = | 0        |

3. To repeat this test, set Bpt 1, reset Bpt 2, and move mode switch to RUN. Otherwise, reset Bpt 1 and move the mode switch to RUN; the program loops as long as Bpt 2 remains set.
4. Resetting Bpt 2 causes the program to halt. Move the mode switch to IDLE.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00234    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. To repeat this test, set Bpt 1, set Bpt 2, and move the mode switch to RUN. Otherwise, reset Bpt 1 and move the mode switch to RUN.

## E. BREAKPOINT NO. 3 TEST (40) TEST

1. The program loops as long as Bpt 3 remains reset.
2. Setting Bpt 3 causes the program to halt. Set Bpt 1 if a repeat of the test is desired. Move mode switch to IDLE.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00242    |
| C        | = | 44020100 |
| Overflow | = | 0        |

USE: (cont.)

3. To repeat this test, set Bpt 1, reset Bpt 3, and move mode switch to RUN. Otherwise, reset Bpt 1 and move mode switch to RUN; the program loops as long as Bpt 3 remains set.
4. Resetting Bpt 3 causes the program to halt. Move the mode switch to IDLE.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00247    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. To repeat this test, set Bpt 1, set Bpt 3 and move the mode switch to RUN. Otherwise, reset Bpt 1 and move mode switch to RUN.

## F. BREAKPOINT NO. 4 TEST (40) TEST

1. Program loops as long as Bpt 4 remains reset.
2. Setting Bpt 4 causes the program to halt. Move the mode switch to IDLE.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00255    |
| C        | = | 44020040 |
| Overflow | = | 0        |

3. To repeat this test, set Bpt 1, reset Bpt 4, and move mode switch to RUN. Otherwise, reset Bpt 1 and move the mode switch to RUN. The program loops as long as Bpt 4 remains set.
4. Resetting Bpt 4 causes the program to halt. Move mode switch to IDLE.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00252    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. To repeat this test, set Bpt 1, set Bpt 4, and move the mode switch to RUN. Otherwise, reset Bpt 1 and move mode switch to RUN.

In the following tests, set Bpt 2 if the operator wishes to inhibit halts for checking registers and erroneous branching and skipping. Set Bpt 1 if the operator wishes to repeat a particular test.

#### G. LOAD X (71) TEST

1. Upon entering this test, the computer halts. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 52525252 |
| B        | = | 25252525 |
| X        | = | 70707070 |
| P        | = | 00272    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2, and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

#### GG. LOAD X, (71) TEST, WITH INDIRECT ADDRESSING

1. Upon entering this test, the computer halts. Move the mode switch to IDLE and check the registers.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 40000001 |
| B        | = | 37777776 |
| X        | = | 70707070 |
| P        | = | 00302    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## H. LOAD B (75) TEST

1. Upon entering this test, the computer halts. Move mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 25252525 |
| B        | = | 70707070 |
| X        | = | 52525252 |
| P        | = | 00312    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## HH. LOAD B (75) TEST, WITH INDIRECT ADDRESSING

1. Upon entering this test, the computer halts. Move the mode switch to IDLE and check the registers.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 37777776 |
| B        | = | 40000001 |
| X        | = | 07070707 |
| P        | = | 00322    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise, proceed to the next test.

## I. LOAD A (76) TEST

1. Upon entering this test, the computer halts. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 70707070 |
| B        | = | 52525252 |
| X        | = | 25252525 |
| P        | = | 00332    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## II. LOAD A (76) TEST, WITH INDIRECT ADDRESSING

1. Upon entering this test, the computer halts. Move the mode switch to IDLE and check the registers.

USE: (cont.)

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 40000001 |
| B        | = | 37777776 |
| X        | = | 70707070 |
| P        | = | 00342    |
| C        | = | 04020400 |
| Overflow | = | 0        |

2. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
3. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## J. STORE B (36) TEST

1. Upon entering this test, the computer halts. Move the mode switch to IDLE, and check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 25255252 |
| B        | = | 77777777 |
| X        | = | 00000000 |
| P        | = | 00354    |
| C        | = | 07600750 |
| Overflow | = | 0        |

2. Move the mode switch to RUN
3. The computer halts again. Move the mode switch to IDLE and check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 77777777 |
| B        | = | 77777777 |
| C        | = | 00000000 |
| P        | = | 00360    |
| C        | = | 04020400 |
| Overflow | = | 0        |

USE: (cont.)

4. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
5. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to next test.

## JJ. STORE B (36) TEST, WITH INDIRECT ADDRESSING

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 11114444 |
| B        | = | 07070707 |
| X        | = | 70707070 |
| P        | = | 00372    |
| C        | = | 07600760 |
| Overflow | = | 0        |

2. Move the mode switch to RUN.
3. The computer halts again. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 07070707 |
| B        | = | 07070707 |
| X        | = | 70707070 |
| P        | = | 00376    |
| C        | = | 04020400 |
| Overflow | = | 0        |

4. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
5. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

USE: (cont.)

## K. STORE X (37) TEST

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 44441111 |
| B        | = | 10101010 |
| X        | = | 32323232 |
| P        | = | 00410    |
| C        | = | 07600754 |
| Overflow | = | 0        |

2. Move the mode switch to RUN.
3. The computer halts again. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 32323232 |
| B        | = | 10101010 |
| X        | = | 32323232 |
| P        | = | 00414    |
| C        | = | 04020400 |
| Overflow | = | 0        |

4. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
5. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## KK. STORE X (37) TEST, WITH INDIRECT ADDRESSING

1. Upon encountering the test, the computer halts. Move the mode switch to IDLE and check the registers.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 01014040 |
| B        | = | 00007777 |
| X        | = | 77770000 |
| P        | = | 00426    |
| C        | = | 07600765 |
| Overflow | = | 0        |

2. Move the mode switch to RUN.
3. The computer halts again. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 77770000 |
| B        | = | 00007777 |
| X        | = | 77770000 |
| P        | = | 00432    |
| C        | = | 04020400 |
| Overflow | = | 0        |

4. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
5. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## L. RETURN BRANCH (51) TEST, SET OVERFLOW CASE

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the P Register is 00443, the branch failed to occur. Set Bpts 1 and 2 and set up the oscilloscope. Move mode switch to RUN.
3. If correct branch occurs, check the registers.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 41111114 |
| B        | = | 14141414 |
| X        | = | 43434343 |
| P        | = | 00446    |
| C        | = | 04020400 |
| Overflow | = | 1        |

4. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
5. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the next test.

## M. OVERFLOW INDICATOR TEST AND RESET (40) TEST, SET CASE

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00461, the instruction skipped, when it should not have.
3. Set Bpts 1 and 2 and set up the oscilloscope. Move the mode switch to RUN.
4. If the PRegister is 00464, check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 12121212 |
| B        | = | 21212121 |
| X        | = | 01010101 |
| P        | = | 00464    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats. Otherwise proceed to the next test.

USE: (cont.)

## N. RETURN BRANCH (51) TEST, OVERFLOW NOT SET

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00475, the instruction failed to branch.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the correct branch occurs, check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 10101010 |
| B        | = | 01010101 |
| X        | = | 40000001 |
| P        | = | 00500    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## O. RETURN BRANCH (51) TEST, OVERFLOW NOT SET, WITH INDIRECT ADDRESSING

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00511, the instruction failed to branch.
3. Set Bpts 1 and 2 and set up the oscilloscope. Move mode switch to RUN.
4. If the correct branch occurs, check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 00000000 |
| B        | = | 70707070 |
| X        | = | 07070707 |
| P        | = | 00514    |
| C        | = | 04020400 |
| Overflow | = | 0        |

USE: (cont.)

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the next test.

P. INCREMENT INDEX AND BRANCH (41) TEST, FOR "NOT BRANCH" CASE

1. Upon completion of the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00526, the instruction branched when it should not have.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If there is no branch, check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 77777777 |
| B        | = | 00000000 |
| X        | = | 00100000 |
| P        | = | 00531    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the next test.

Q. OVERFLOW INDICATOR TEST AND RESET (40) TEST, FOR "NOT SET" CASE

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00531, the instruction failed to skip.
3. Set Bpts 1 and 2 and set up the oscilloscope.
4. If the instruction works properly, the computer halts. Move the mode switch to RUN.
5. If the PRegister is 00547, check the registers.

USE: (cont.)

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 07707707 |
| B        | = | 70070070 |
| X        | = | 77777777 |
| P        | = | 00547    |
| C        | = | 04020400 |
| Overflow | = | 0        |

6. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
7. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the next test.

#### R. INCREMENT INDEX AND BRANCH (41) TEST FOR BRANCH CASE

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the P register is 00560, the instruction failed to branch.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the branch occurs correctly, check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 77000077 |
| B        | = | 70777707 |
| X        | = | 00040001 |
| P        | = | 00563    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

USE: (cont.)

## S. INSTRUCTION INCREMENT INDEX AND BRANCH (41) TEST WITH INDIRECT ADDRESSING FOR BRANCH CASE

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the P register is 00574, the instruction failed to branch.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the branch occurs correctly, check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 37777776 |
| B        | = | 40000001 |
| X        | = | 70040007 |
| P        | = | 00577    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

## T. SKIP IF A EQUAL TO M (50) TEST FOR CASE A=M

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the P register is 00613, the instruction failed to skip.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the computer skips, check the registers.

## Correct Register Contents:

|   |   |          |
|---|---|----------|
| A | = | 00000000 |
| B | = | 00000000 |
| X | = | 77777776 |

USE: (cont.)

P = 00616  
C = 04020400  
Overflow = 0

5. If an error occurs, set Bpts 1 and 2 and set up the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the second case.
7. Now the program tests the second case. Upon reentering the test, the computer halts. Move the mode switch to IDLE and check the registers.
8. If the PRegister is 00613, the instruction failed to skip.
9. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
10. If the computer skips, check the registers.

## Correct Register Contents:

A = 77777777  
B = 77777777  
X = 77777777  
P = 00616  
C = 04020400  
Overflow = 0

11. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
12. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

U. SKIP IF A EQUAL TO M (50) TEST, FOR CASE A  $\neq$  M

1. Upon enetering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00634, the instruction skipped.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the computer doesn't skip, check the registers.

USE: (cont.)

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 40000000 |
| B        | = | 00000000 |
| X        | = | 77777776 |
| P        | = | 00637    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the second case.
7. Now the program tests the second case. Upon re-entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
8. If the PRegister is 00634, the instruction skipped.
9. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
10. If the computer doesn't skip, check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 00000000 |
| B        | = | 40000000 |
| X        | = | 77777777 |
| P        | = | 00637    |
| C        | = | 04020400 |
| Overflow | = | 0        |

11. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
12. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the next test.

V. SKIP IF A EQUAL TO M (50) TEST, FOR CASE  $A \neq M$ 

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00655, the instruction skipped.

USE: (cont.)

3. Set Bpts 1 and 2 and use oscilloscope. Move the mode switch to RUN.
4. If the computer doesn't skip, it halts. Move the mode switch to IDLE and check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 20000000 |
| B        | = | 00000000 |
| X        | = | 77777776 |
| P        | = | 00660    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the second case.
7. Now the program tests the second case. Upon reentering the test, the computer halts. Move the mode switch to IDLE and check the registers.
8. If the P Register is 00655, the instruction skipped.
9. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
10. If the computer doesn't skip, check the registers.

## Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 00000000 |
| B        | = | 20000000 |
| X        | = | 77777777 |
| P        | = | 00660    |
| C        | = | 04020400 |
| Overflow | = | 0        |

11. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
12. Move the mode switch to RUN. If Bpt 1 is set, the test repeats, otherwise proceed to the next test.

USE: (cont.)

W. SKIP IF A EQUAL TO M (50) TEST, FOR CASE  $A \neq M$ 

1. Upon entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
2. If the PRegister is 00676, the instruction skipped.
3. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
4. If the computer doesn't skip, it halts. Move the mode switch to IDLE and check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 10000000 |
| B        | = | 00000000 |
| X        | = | 77777776 |
| P        | = | 00701    |
| C        | = | 04020400 |
| Overflow | = | 0        |

5. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
6. Move the mode switch to RUN. If Bpt 1 is SET, the test repeats, otherwise proceed to the second case.
7. Now the program tests the second case. Upon re-entering the test, the computer halts. Move the mode switch to IDLE and check the registers.
8. If the PRegister is 00676, the instruction skipped.
9. Set Bpts 1 and 2 and use the oscilloscope. Move the mode switch to RUN.
10. If the computer doesn't skip, check the registers.

Correct Register Contents:

|          |   |          |
|----------|---|----------|
| A        | = | 00000000 |
| B        | = | 10000000 |
| X        | = | 77777777 |
| P        | = | 00701    |
| C        | = | 04020400 |
| Overflow | = | 0        |

USE: (cont.)

11. If an error occurs, set Bpts 1 and 2 and use the oscilloscope.
12. If Bpt 1 is set, move the mode switch to RUN; the test repeats.
13. If the operator wishes to repeat the entire Semi-automatic Instruction Diagnostic, set Bpt 4.
14. Move the mode switch to RUN. If Bpt 4 is reset, the program loads the Automatic portion of the Instruction diagnostic.

|       |            |    |   |                                                      |
|-------|------------|----|---|------------------------------------------------------|
|       |            | 1  | * |                                                      |
|       |            | 2  | * | LOADER FOR 930 SEMI-AUTOMATIC INSTRUCTION DIAGNOSTIC |
|       |            | 3  | * |                                                      |
|       | 00002      | 4  |   | ORG 2                                                |
| 00002 | 2 32 00012 | 5  |   | WIM 10.2                                             |
| 00003 | 2 41 00002 | 6  |   | BRX 2                                                |
| 00004 | 2 32 00176 | 7  |   | WIM 126                                              |
| 00005 | 2 32 00177 | 8  |   | WIM 127                                              |
| 00006 | 2 71 00010 | 9  |   | LDX 8                                                |
| 00007 | 2 01 00176 | 10 |   | BRU 126                                              |
| 00013 | 00077142   | 11 |   | BCT 77142                                            |
| 00011 | 00003000   | 12 |   | BCT 0                                                |
| 00012 | 00164      | 13 |   | BSS 116                                              |

USE: (cont.)

### III. AUTOMATIC INSTRUCTION TEST PROGRAM

The Automatic Instruction test is a "tight-looped" program that performs and tests those instructions not tested by the Manual or Semi-automatic Tests. The Instructions to be tested and all the data needed to perform the tests are in twelve word data blocks in memory. Each data block is associated with only one Instruction. The program, under index control, operates successively on each of the Data Blocks.

Each Data Block contains the register settings prior to performing the Instructions, and the resulting register settings after the Instruction execution. Appendix 3B contains a description of the Data Blocks.

The program operates on a Data Block by setting the registers with the proper data, executing the Instruction of the Data Block and comparing the resulting register contents against those in the Data Block. When an error occurs, the computer halts. Appendix 3B contains a description of the error halts.

The following breakpoint settings provide special operator control.

|                  |   |                                                                                                                  |
|------------------|---|------------------------------------------------------------------------------------------------------------------|
| Breakpoint 1 Set | = | Repeat the test now in progress                                                                                  |
| Reset            | = | Normal operation                                                                                                 |
| Breakpoint 2 Set | = | By-pass error halts                                                                                              |
| Reset            | = | Normal operation                                                                                                 |
| Breakpoint 3 Set | = | Halt after operating on each Data Block. The X Register contains the location of the Data Block just operated on |
| Reset            | = | Normal operation                                                                                                 |

A sync bit is provided in bit zero of all Instructions being tested. With Breakpoints 1 and 2 set, the program repeatedly performs each test without any halts; only the Instruction being tested has a sync bit. This provides a way to synchronize an oscilloscope with the test loop to aid the operator in observing signal levels of any circuitry in question.

## USE: (cont.)

Also provided to aid the operator in debugging is a description of each Instruction in terms of the logic equations which make up the Instruction logic. Using these descriptions along with program provided information when an error halt occurs, the operator can quickly localize the error.

The Data Blocks and their contents are shown on the program listings starting at octal location 130. The program tests the Instructions in the order their Data Blocks appear in the coding sheets.

Special handling of Multiply and Divide errors is described in Appendices 3C and 3D.

# APPENDIX 3A ERROR HALTS

Errors such as incorrect register contents, incorrect overflow indications, and incorrect skip performance are indicated by halts with Breakpoint 2 reset. The following defines the contents of the registers when such a halt occurs.

|                      |                                                                                     |
|----------------------|-------------------------------------------------------------------------------------|
| P register           | Location+1 of the error halt                                                        |
| A register           | Erroneous contents of the defined register after the instruction has been performed |
| B register           | Correct results of the defined register after the instruction has been performed    |
| X <sub>(10-23)</sub> | First location of data pertinent to instruction being tested                        |
| C <sub>(10-23)</sub> | Same as X Register for skip or not skip errors only                                 |

The following table defines the halt locations:

| <u>P Register</u> | <u>Definition of error</u>              | <u>Register in which data address is found</u> |
|-------------------|-----------------------------------------|------------------------------------------------|
| 26                | Failed to SKIP when SKIP should occur   | C                                              |
| 37                | SKIPPED when no SKIP should occur       | C                                              |
| 50                | A Register error →                      | X                                              |
| 56                | B Register error                        | X                                              |
| 64                | X Register error                        | X                                              |
| 72                | Memory Register error                   | X                                              |
| 77                | Overflowed when it should not occur     | X                                              |
| 105               | Failed to Overflow when it should occur | X                                              |

## APPENDIX 3B

### DATA BLOCKS

The Instruction Diagnostic is a tight-looped program that operates under Index Control on a field of data consisting of Data Blocks. These are 12-word blocks that contain the Instruction to be tested and all the data needed to perform the test of the Instruction. The following is a description of a Data Block (assume that the first location of the Block is B):

| <u>Location</u> | <u>Contents</u>                                                       |
|-----------------|-----------------------------------------------------------------------|
| B+10            | Address of Data Block with Indirect Address bit for indexing*         |
| +1              | Instruction                                                           |
| +2              | Original contents of A                                                |
| +3              | Resultant contents of A after performing Instruction                  |
| +4              | Original contents of B                                                |
| +5              | Resultant contents of B                                               |
| +6              | Original contents of X                                                |
| +7              | Resultant contents of X                                               |
| +8              | Original contents of memory (the operand)**                           |
| +9              | Resultant contents of memory                                          |
| +10             | Determines if SKIP should or should not occur***<br>(SKIP or NO SKIP) |
| +11             | Determines if overflow should or should not occur<br>(OVFLO or NOVLO) |

\*The Indirect address bit is necessary to allow X9=1 and force a BRX to branch. The last Data Block has no Ia bit and allows the BRX to fall through.

\*\*For those instructions in which an operand address has no meaning (e.g., Register exchange, shift, no-op, etc.), this word could contain an EOM which could be necessarily executed prior to performing the Instruction to be tested (e.g., it is necessary to perform an EOM prior to testing the BRTW instruction).

\*\*\*If the contents of this location are tagged with a "4", the overflow toggle will be set prior to performing the instruction to be tested.

### APPENDIX 3C

#### MULTIPLY AND THE RIGHT SHIFT ADDER

The following sets of constants allow the user to diagnose completely any Right Shift Adder and/or multiply problem. If a failure is suspected, the user should reset all breakpoints and load the tape using the Diagnostic load procedure beginning at the Automatic Instruction Diagnostic.

If the program halts at a multiply error halt, determine the pertinent constant set via Appendix 3A. Then set Breakpoints 1 and 2 and place the mode switch in RUN. This repeatedly performs the current test with the error halt inhibited. The user can now set up the oscilloscope and follow the test through each T-time to determine the exact circuit area

| TIME | A REGISTER | B REGISTER | FIGURE MUL 1<br>BC REGISTER | C REGISTER | A*M = | 77652714 | 03224436 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 74121733 | 0 00000000 | 00000000                    | 01305135   |       |          |          |   |
| T7   | 1 36050755 | 0 01305135 | 00000000                    | 01305135   | *     |          |          |   |
| T6   | 1 57024366 | 0 01047503 | 01000110                    | 01305135   | *     |          |          |   |
| T5   | 1 67412173 | 0 00023605 | 01000100                    | 01305135   |       |          |          |   |
| T4   | 1 73605075 | 0 01716077 | 00001000                    | 01305135   | *     |          |          |   |
| T3   | 1 75702436 | 0 01244564 | 01010010                    | 01305135   | *     |          |          |   |
| T2   | 1 36741217 | 0 00126276 | 01000000                    | 01305135   |       |          |          |   |
| T1   | 1 17360507 | 0 01750264 | 00010010                    | 01305135   | *     |          |          |   |
| TC   | 1 07570243 | 0 01275263 | 01000010                    | 01305135   | *     |          |          |   |
| TR   | 1 43674121 | 0 02433662 | 00010010                    | 01305135   | *     |          |          |   |
| TP   | 1 21736050 | 0 02525062 | 00001010                    | 01305135   | *     |          |          |   |
| T8   | 1 10757024 | 0 01253435 | 00000000                    | 01305135   |       |          |          |   |
| T7   | 1 44367412 | 0 00525616 | 00000000                    | 01305135   |       |          |          |   |
| T6   | 1 22173605 | 0 00252707 | 00000000                    | 01305135   |       |          |          |   |
| T5   | 1 51075702 | 0 01422470 | 00010010                    | 01305135   | *     |          |          |   |
| T4   | 1 24436741 | 0 00615230 | 00000010                    | 01305135   |       |          |          |   |
| T3   | 1 12217360 | 0 01603655 | 00010000                    | 01305135   | *     |          |          |   |
| T2   | 1 45107570 | 0 00705726 | 00000000                    | 01305135   |       |          |          |   |
| T1   | 1 22443674 | 0 00342753 | 00000000                    | 01305135   |       |          |          |   |
| TO   | 1 51221736 | 0 00161365 | 00000000                    | 01305135   |       |          |          |   |
| TR   | 1 64510757 | 0 00070572 | 00000000                    | 01305135   |       |          |          |   |
| TP   | 1 32244367 | 0 01331322 | 00010110                    | 01305135   | *     |          |          |   |
| T8   | 1 15122173 | 0 01065742 | 01000010                    | 01305135   | *     |          |          |   |
| T7   | 1 06451075 | 0 02337012 | 00001110                    | 01305135   | *     |          |          |   |
| T6   | 1 03224436 | 1 77542613 | 00110101                    | 76472642   | *     |          |          |   |
| TP   | 1 77652714 | 1 03224436 | 00110101                    | 76472642   |       |          |          |   |

| FIGURE MUL 2 |            |            |             |            | A*M = | 02200343 | 66100504 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T8           | 1 48666162 | 0 00000000 | 00000000    | 75176331   |       |          |          |   |
| T7           | 1 22733071 | 0 00000000 | 00000000    | 75176331   |       |          |          |   |
| T6           | 1 11355434 | 1 75176331 | 00000000    | 75176331   | *     |          |          |   |
| T5           | 1 44566616 | 1 76476554 | 00000000    | 75176331   |       |          |          |   |
| T4           | 1 22273307 | 1 77237266 | 00000000    | 75176331   |       |          |          |   |
| T3           | 1 11135543 | 1 64604064 | 10111000    | 75176331   | *     |          |          |   |
| T2           | 1 04456661 | 1 63483763 | 10110000    | 75176331   | *     |          |          |   |
| T1           | 1 42223330 | 1 82756222 | 10101100    | 75176331   | *     |          |          |   |
| T0           | 1 21113554 | 1 75327551 | 00100000    | 75176331   |       |          |          |   |
| TR           | 1 50445666 | 1 76513664 | 00100000    | 75176331   |       |          |          |   |
| TP           | 1 24222733 | 1 77205732 | 00100000    | 75176331   |       |          |          |   |
| T8           | 1 12111355 | 1 64637206 | 10101100    | 75176331   | *     |          |          |   |
| T7           | 1 08844566 | 1 63446474 | 10110000    | 75176331   | *     |          |          |   |
| T6           | 1 02422273 | 1 75666636 | 00000000    | 75176331   |       |          |          |   |
| T5           | 1 01211135 | 1 63020640 | 11110010    | 75176331   | *     |          |          |   |
| T4           | 1 00504456 | 1 63141655 | 10110000    | 75176331   | *     |          |          |   |
| T3           | 1 40242227 | 1 75424726 | 00100000    | 75176331   |       |          |          |   |
| T2           | 1 20121113 | 1 63747604 | 10100100    | 75176331   | *     |          |          |   |
| T1           | 1 10050445 | 1 82110273 | 11111000    | 75176331   | *     |          |          |   |
| T0           | 1 44824222 | 1 82605066 | 10101000    | 75176331   | *     |          |          |   |
| T8           | 1 22012111 | 1 75342033 | 00001000    | 75176331   |       |          |          |   |
| TP           | 1 51005044 | 1 63656746 | 10100000    | 75176331   | *     |          |          |   |
| T8           | 1 24402422 | 1 75767363 | 00000000    | 75176331   |       |          |          |   |
| T7           | 1 52201211 | 1 76773571 | 00000000    | 75176331   |       |          |          |   |
| T6           | 1 66100504 | 0 21577232 | 11001111    | 02602446   | *     |          |          |   |
| TP           | 1 02200343 | 0 66100504 | 11001111    | 02602446   |       |          |          |   |

| FIGURE MUL 3 |            |            |             |            | A*M = 01225457 06470510 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 76536132 | 0 00000000 | 00000000    | 40451332   |                           |  |  |
| T7           | 1 37257055 | 0 00000000 | 00000000    | 40451332   |                           |  |  |
| T6           | 1 17527426 | 1 40451332 | 00000000    | 40451332   | *                         |  |  |
| T5           | 1 07653613 | 1 60224555 | 00000000    | 40451332   | *                         |  |  |
| T4           | 1 43725705 | 1 30563510 | 00000110    | 40451332   | *                         |  |  |
| T3           | 1 21752742 | 1 14642242 | 00101000    | 40451332   | *                         |  |  |
| T2           | 1 10765361 | 1 46361521 | 00000000    | 40451332   | *                         |  |  |
| T1           | 1 44372570 | 1 23641102 | 00101100    | 40451332   | *                         |  |  |
| TC           | 1 22175274 | 1 51620001 | 00101100    | 40451332   | *                         |  |  |
| TR           | 1 51076536 | 1 64750440 | 00000000    | 40451332   | *                         |  |  |
| TP           | 1 24437257 | 1 72364220 | 00000000    | 40451332   | *                         |  |  |
| T8           | 1 12217527 | 1 35543442 | 00100000    | 40451332   | *                         |  |  |
| T7           | 1 05107653 | 1 16372153 | 01001000    | 40451332   | *                         |  |  |
| T6           | 1 42443725 | 1 07146717 | 01100100    | 40451332   | *                         |  |  |
| T5           | 1 61221752 | 1 04574731 | 00000010    | 40451332   | *                         |  |  |
| T4           | 1 70510765 | 1 42276350 | 00000010    | 40451332   | *                         |  |  |
| T3           | 1 34244372 | 1 21500422 | 00110100    | 40451332   | *                         |  |  |
| T2           | 1 16122175 | 1 50604251 | 00100000    | 40451332   | *                         |  |  |
| T1           | 1 47051076 | 1 24713456 | 00100000    | 40451332   | *                         |  |  |
| TC           | 1 23424437 | 1 52305627 | 00100000    | 40451332   | *                         |  |  |
| TR           | 1 51612217 | 1 25653245 | 00001000    | 40451332   | *                         |  |  |
| TP           | 1 64705107 | 1 12377454 | 01000000    | 40451332   | *                         |  |  |
| T8           | 1 32342443 | 1 05140150 | 01111010    | 40451332   | *                         |  |  |
| T7           | 1 15161221 | 1 03575722 | 00000100    | 40451332   | *                         |  |  |
| T6           | 1 06470510 | 0 70114456 | 11111001    | 37326445   | *                         |  |  |
| TP           | 1 01225457 | 0 06470510 | 11111001    | 37326445   |                           |  |  |

| FIGURE MUL 4 |            |            |             |            | A*M = 14411426 44633734 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 37124376 | 0 00000000 | 00000000    | 14665211   |                           |  |  |
| T7           | 0 17452177 | 0 00000000 | 00000000    | 14665211   |                           |  |  |
| T6           | 0 07625077 | 0 14665211 | 00000000    | 14665211   | *                         |  |  |
| T5           | 0 43712437 | 0 12117715 | 11100000    | 14665211   | *                         |  |  |
| T4           | 0 61745217 | 0 25364157 | 01011000    | 14665211   | *                         |  |  |
| T3           | 0 70762507 | 0 27753670 | 00110010    | 14665211   | *                         |  |  |
| T2           | 0 34371243 | 0 27616151 | 01101000    | 14665211   | *                         |  |  |
| T1           | 0 56174521 | 0 20124675 | 11110000    | 14665211   | *                         |  |  |
| T0           | 0 67076250 | 0 20373547 | 11010000    | 14665211   | *                         |  |  |
| TR           | 0 73437124 | 0 14571663 | 00010000    | 14665211   |                           |  |  |
| TP           | 0 75617452 | 0 06270731 | 00010000    | 14665211   |                           |  |  |
| T8           | 0 76707625 | 0 03130354 | 00010000    | 14665211   |                           |  |  |
| T7           | 0 37343712 | 0 15245377 | 01100000    | 14665211   | *                         |  |  |
| T6           | 0 57561745 | 0 06162577 | 01000000    | 14665211   |                           |  |  |
| T5           | 0 67670762 | 0 17256400 | 01100110    | 14665211   | *                         |  |  |
| T4           | 0 33734371 | 0 07167244 | 01000000    | 14665211   |                           |  |  |
| T3           | 0 15756174 | 0 10650733 | 10110000    | 14665211   | *                         |  |  |
| T2           | 0 46767076 | 0 00360355 | 10010000    | 14665211   |                           |  |  |
| T1           | 0 63373437 | 0 04174156 | 00000000    | 14665211   |                           |  |  |
| T0           | 0 31575617 | 0 16653204 | 00110100    | 14665211   | *                         |  |  |
| TR           | 0 14676707 | 0 13156753 | 11100000    | 14665211   | *                         |  |  |
| TP           | 0 46337343 | 0 26704576 | 00110000    | 14665211   | *                         |  |  |
| T8           | 0 23157561 | 0 27263400 | 01010110    | 14665211   | *                         |  |  |
| T7           | 0 11467670 | 0 20712055 | 10111000    | 14665211   | *                         |  |  |
| T6           | 0 44633734 | 0 14301426 | 00110000    | 63112566   |                           |  |  |
| TP           | 0 14411426 | 0 44633734 | 00110000    | 63112566   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL 5<br>BC REGISTER | C REGISTER | A*M = 72505325 45501024 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 55340547 | 0 00000000 | 00000000                    | 11177146   |                           |
| T7   | 1 26560263 | 0 11177146 | 00000000                    | 11177146   | *                         |
| T6   | 1 13270131 | 0 15566521 | 00110110                    | 11177146   | *                         |
| T5   | 1 45534054 | 0 17026452 | 01110010                    | 11177146   | *                         |
| T4   | 1 22656026 | 0 07057221 | 01000010                    | 11177146   |                           |
| T3   | 1 51327013 | 0 03027514 | 01000000                    | 11177146   |                           |
| T2   | 1 24553405 | 0 13102704 | 00110110                    | 11177146   | *                         |
| T1   | 1 12265602 | 0 16674544 | 00010010                    | 11177146   | *                         |
| T0   | 1 05132701 | 0 07332266 | 00010000                    | 11177146   |                           |
| TR   | 1 02455340 | 0 14650271 | 00110010                    | 11177146   | *                         |
| TP   | 1 41226560 | 0 06360130 | 00010010                    | 11177146   |                           |
| T8   | 1 20513270 | 0 03174050 | 00000010                    | 11177146   |                           |
| T7   | 1 10245534 | 0 01476020 | 00000010                    | 11177146   |                           |
| T6   | 1 04122656 | 0 00637014 | 00000000                    | 11177146   |                           |
| T5   | 1 02051327 | 0 00317406 | 00000000                    | 11177146   |                           |
| T4   | 1 01024553 | 0 11236741 | 00110010                    | 11177146   | *                         |
| T3   | 1 40412265 | 0 15652422 | 00110110                    | 11177146   | *                         |
| T2   | 1 20205132 | 0 17060313 | 01110110                    | 11177146   | *                         |
| T1   | 1 50102455 | 0 07074101 | 01000110                    | 11177146   |                           |
| T0   | 1 64041226 | 0 15125242 | 00110010                    | 11177146   | *                         |
| TR   | 1 32020513 | 0 06416525 | 00100000                    | 11177146   |                           |
| TP   | 1 55010245 | 0 14336310 | 00110110                    | 11177146   | *                         |
| T8   | 1 26404122 | 0 17312356 | 00110000                    | 11177146   | *                         |
| T7   | 1 13202051 | 0 07501167 | 00110000                    | 11177146   |                           |
| T6   | 1 45501024 | 1 61504224 | 11001101                    | 66600631   | *                         |
| TP   | 1 72505325 | 1 45501024 | 11001101                    | 66600631   |                           |

## FIGURE MUL 6

A\*M = 46133723 57100650 0

| TIME | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |
|------|------------|------------|-------------|------------|
| T8   | 0 37252204 | 0 00000000 | 00000000    | 45502225   |
| T7   | 0 17525102 | 0 00000000 | 00000000    | 45502225   |
| T6   | 0 07652441 | 0 00000000 | 00000000    | 45502225   |
| T5   | 0 03725220 | 1 45502225 | 00000000    | 45502225 * |
| T4   | 0 41752510 | 1 62641112 | 00000000    | 45502225   |
| T3   | 0 20765244 | 1 71320445 | 00000000    | 45502225   |
| T2   | 0 50372522 | 1 74550222 | 00000000    | 45502225   |
| T1   | 0 24175251 | 1 76264111 | 00000000    | 45502225   |
| TC   | 0 52076524 | 1 34634261 | 10000010    | 45502225 * |
| TR   | 0 65037252 | 1 52316134 | 10000000    | 45502225   |
| TP   | 0 32417525 | 1 61147056 | 10000000    | 45502225   |
| T8   | 0 15207652 | 1 31165644 | 11000010    | 45502225 * |
| T7   | 0 06503725 | 1 50072726 | 11000000    | 45502225   |
| T6   | 0 03241752 | 1 35137570 | 01000010    | 45502225 * |
| T5   | 0 01520765 | 1 56057670 | 01000010    | 45502225   |
| T4   | 0 00650372 | 1 24121165 | 11011000    | 45502225 * |
| T3   | 0 40324175 | 1 56454072 | 00001000    | 45502225   |
| T2   | 0 20152076 | 1 24720652 | 10010010    | 45502225 * |
| T1   | 0 10065037 | 1 56354321 | 00000010    | 45502225   |
| TC   | 0 44032417 | 1 24660371 | 10010010    | 45502225 * |
| TR   | 0 62015207 | 1 13036325 | 11000100    | 45502225 * |
| TP   | 0 71006503 | 1 17511437 | 00010000    | 45502225 * |
| T8   | 0 74403241 | 1 04352034 | 11001010    | 45502225 * |
| T7   | 0 36201520 | 1 03267647 | 11000000    | 45502225 * |
| T6   | 0 57100650 | 1 45133723 | 01000000    | 32275552   |
| TP   | 0 46133723 | 1 57100650 | 01000000    | 32275552   |

| FIGURE MUL 7 |            |            |             |            | A*M = 06437742 35001420 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 11565130 | 0 00000000 | 00000000    | 25453363   |                           |  |  |
| T7           | 0 04672454 | 0 00000000 | 00000000    | 25453363   |                           |  |  |
| T6           | 0 02335225 | 0 00000000 | 00000000    | 25453363   |                           |  |  |
| T5           | 0 01156513 | 0 00000000 | 00000000    | 25453363   |                           |  |  |
| T4           | 0 00467245 | 0 25453363 | 00000000    | 25453363   | *                         |  |  |
| T3           | 0 40233522 | 0 37270054 | 01011100    | 25453363   | *                         |  |  |
| T2           | 0 20115651 | 0 17130466 | 01010000    | 25453363   |                           |  |  |
| T1           | 0 10046724 | 0 25433516 | 10100100    | 25453363   | *                         |  |  |
| TC           | 0 04023352 | 0 16655607 | 00000100    | 25453363   |                           |  |  |
| TR           | 0 42011565 | 0 07326743 | 00000000    | 25453363   |                           |  |  |
| TP           | 0 61004672 | 0 20126644 | 11100100    | 25453363   | *                         |  |  |
| T8           | 0 30402335 | 0 14413362 | 00100000    | 25453363   |                           |  |  |
| T7           | 0 14201156 | 0 23610054 | 10111100    | 25453363   | *                         |  |  |
| T6           | 0 06100467 | 0 15740466 | 00010000    | 25453363   |                           |  |  |
| T5           | 0 03040233 | 0 23337516 | 11100100    | 25453363   | *                         |  |  |
| T4           | 0 01420115 | 0 33662262 | 10011010    | 25453363   | *                         |  |  |
| T3           | 0 00610046 | 0 46300010 | 01111110    | 25453363   | *                         |  |  |
| T2           | 0 00304023 | 0 23504440 | 00100010    | 25453363   |                           |  |  |
| T1           | 0 00142011 | 0 36355507 | 01000100    | 25453363   | *                         |  |  |
| TC           | 0 40061004 | 0 34131266 | 11111000    | 25453363   | *                         |  |  |
| TR           | 0 20030402 | 0 12410133 | 10111000    | 25453363   |                           |  |  |
| TP           | 0 50014201 | 0 01240455 | 10010000    | 25453363   |                           |  |  |
| T8           | 0 64006100 | 0 21177501 | 11000110    | 25453363   | *                         |  |  |
| T7           | 0 72003040 | 0 14077604 | 01000100    | 25453363   |                           |  |  |
| T6           | 0 35001420 | 0 06437742 | 00000000    | 52324414   |                           |  |  |
| TP           | 0 06437742 | 0 35001420 | 00000000    | 52324414   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL 8<br>8C REGISTER | C REGISTER | A*M = 04046712 32372146 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 72672751 | 0 00000000 | 00000000                    | 46470673   |                           |
| T7   | 1 35335364 | 1 46470673 | 00000000                    | 46470673   | *                         |
| T6   | 1 56556572 | 1 63234935 | 00000000                    | 46470673   |                           |
| T5   | 1 67267275 | 1 71516156 | 00000000                    | 46470673   |                           |
| T4   | 1 33533536 | 1 32237652 | 11100110                    | 46470673   | *                         |
| T3   | 1 15655657 | 1 51557761 | 10000010                    | 46470673   |                           |
| T2   | 1 46726727 | 1 36257567 | 01101100                    | 46470673   | *                         |
| T1   | 1 63353353 | 1 15150126 | 11111100                    | 46470673   | *                         |
| T0   | 1 31565565 | 1 11520306 | 10101100                    | 46470673   | *                         |
| TR   | 1 14672672 | 1 16300476 | 01101000                    | 46470673   | *                         |
| TP   | 1 06335335 | 1 47500637 | 00100000                    | 46470673   |                           |
| T8   | 1 43156556 | 1 21370102 | 11001110                    | 46470673   | *                         |
| T7   | 1 21467267 | 1 54174405 | 01000100                    | 46470673   |                           |
| T6   | 1 50633533 | 1 24066035 | 11101100                    | 46470673   | *                         |
| T5   | 1 64315665 | 1 14063241 | 11101110                    | 46470673   | *                         |
| T4   | 1 72146726 | 1 10062757 | 11100100                    | 46470673   | *                         |
| T3   | 1 75063353 | 1 40471327 | 10000100                    | 46470673   |                           |
| T2   | 1 76431565 | 1 22624406 | 10101100                    | 46470673   | *                         |
| T1   | 1 37214672 | 1 13742436 | 10101100                    | 46470673   | *                         |
| T0   | 1 17506335 | 1 41721657 | 10100000                    | 46470673   |                           |
| TR   | 1 48643156 | 1 22400512 | 11101110                    | 46470673   | *                         |
| TP   | 1 23721467 | 1 55640601 | 00000110                    | 46470673   |                           |
| T8   | 1 51750633 | 1 24310137 | 11101100                    | 46470673   | *                         |
| T7   | 1 64764315 | 1 14274302 | 11001110                    | 46470673   | *                         |
| T6   | 1 32372146 | 0 03035701 | 01010011                    | 31307104   | *                         |
| TP   | 1 04046712 | 0 32372146 | 01010011                    | 31307104   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE MUL 9<br>BC REGISTER | C REGISTER | A*M = | 10406001 | 20330000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 51007400 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T7   | 1 24403600 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T6   | 1 12201700 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T5   | 1 05100740 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T4   | 1 02440360 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T3   | 1 01220170 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T2   | 1 00510074 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| T1   | 1 00244036 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| TC   | 1 00122017 | 0 00000000 | 00000000                    | 64114650   |       |          |          |   |
| TR   | 1 00051007 | 1 64114650 | 00000000                    | 64114650   | *     |          |          |   |
| TP   | 1 00024403 | 1 56152174 | 00011000                    | 64114650   | *     |          |          |   |
| T8   | 1 00012201 | 1 43105246 | 10101100                    | 64114650   | *     |          |          |   |
| T7   | 1 00005100 | 1 41617733 | 10000100                    | 64114650   | *     |          |          |   |
| T6   | 1 40002440 | 1 64707715 | 00000100                    | 64114650   |       |          |          |   |
| T5   | 1 60001220 | 1 72343706 | 00000100                    | 64114650   |       |          |          |   |
| T4   | 1 30000510 | 1 75161703 | 00000100                    | 64114650   |       |          |          |   |
| T3   | 1 54000244 | 1 76470701 | 00000100                    | 64114650   |       |          |          |   |
| T2   | 1 66000122 | 1 77234300 | 00000100                    | 64114650   |       |          |          |   |
| T1   | 1 33000051 | 1 77516100 | 00000100                    | 64114650   |       |          |          |   |
| TC   | 1 15400024 | 1 53753750 | 10010000                    | 64114650   | *     |          |          |   |
| TR   | 1 06600012 | 1 51761764 | 10010000                    | 64114650   |       |          |          |   |
| TP   | 1 03300005 | 1 74774772 | 00000000                    | 64114650   |       |          |          |   |
| T8   | 1 01540002 | 1 52402145 | 10111100                    | 64114650   | *     |          |          |   |
| T7   | 1 40660001 | 1 61245422 | 10000100                    | 64114650   |       |          |          |   |
| T6   | 1 20330000 | 0 07305770 | 01100011                    | 13663127   | *     |          |          |   |
| TP   | 1 10406001 | 0 20330000 | 01100011                    | 13663127   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL10<br>BC REGISTER | A*M =<br>C REGISTER | 13604526 | 64505442 | 0 |
|------|------------|------------|-----------------------------|---------------------|----------|----------|---|
| T8   | 0 15447261 | 0 00000000 | 00000000                    | 33556341            |          |          |   |
| T7   | 0 06623530 | 0 33556341 | 00000000                    | 33556341            | *        |          |   |
| T6   | 0 43311664 | 0 15667160 | 00000000                    | 33556341            |          |          |   |
| T5   | 0 21544726 | 0 06733470 | 00000000                    | 33556341            |          |          |   |
| T4   | 0 10662353 | 0 03355634 | 00000000                    | 33556341            |          |          |   |
| T3   | 0 04331165 | 0 34234257 | 01111000                    | 33556341            | *        |          |   |
| T2   | 0 42154472 | 0 41230060 | 11111010                    | 33556341            | *        |          |   |
| T1   | 0 21066235 | 0 24150434 | 01010000                    | 33556341            |          |          |   |
| T0   | 0 10433116 | 0 45146597 | 01100000                    | 33556341            | *        |          |   |
| TR   | 0 44215447 | 0 22023267 | 01100000                    | 33556341            |          |          |   |
| TP   | 0 62106623 | 0 44127074 | 01101000                    | 33556341            | *        |          |   |
| T8   | 0 31043311 | 0 55262377 | 01010000                    | 33556341            | *        |          |   |
| T7   | 0 54421544 | 0 82603430 | 10110110                    | 33556341            | *        |          |   |
| T6   | 0 26210662 | 0 21345650 | 10000010                    | 33556341            |          |          |   |
| T5   | 0 13104331 | 0 14562720 | 00000010                    | 33556341            |          |          |   |
| T4   | 0 05442154 | 0 31747615 | 10100100                    | 33556341            | *        |          |   |
| T3   | 0 42621066 | 0 10723746 | 10100000                    | 33556341            |          |          |   |
| T2   | 0 21310433 | 0 00311763 | 10100000                    | 33556341            |          |          |   |
| T1   | 0 50544215 | 0 37782232 | 00011100                    | 33556341            | *        |          |   |
| T0   | 0 24262106 | 0 42447016 | 11101100                    | 33556341            | *        |          |   |
| TR   | 0 12131043 | 0 28663047 | 00001000                    | 33556341            |          |          |   |
| TP   | 0 45054421 | 0 45400364 | 01110000                    | 33556341            | *        |          |   |
| T8   | 0 22426210 | 0 56712433 | 00110100                    | 33556341            | *        |          |   |
| T7   | 0 51213104 | 0 27301255 | 00110000                    | 33556341            |          |          |   |
| T6   | 0 64505442 | 0 13504526 | 00100000                    | 44221436            |          |          |   |
| TP   | 0 13604526 | 0 64505442 | 00100000                    | 44221436            |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL11<br>BC REGISTER | C REGISTER | A*M = | 77163427 | 76765550 | G |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 03532233 | 0 00000000 | 00000000                    | 71205134   |       |          |          |   |
| T7   | 0 01655115 | 1 71205134 | 00000000                    | 71205134   | *     |          |          |   |
| T6   | 0 00726446 | 1 65707502 | 00000110                    | 71205134   | *     |          |          |   |
| T5   | 0 00353223 | 1 72743605 | 00000100                    | 71205134   |       |          |          |   |
| T4   | 0 40165511 | 1 66566076 | 00001000                    | 71205134   | *     |          |          |   |
| T3   | 0 20072644 | 1 64470563 | 00010010                    | 71205134   | *     |          |          |   |
| T2   | 0 50035322 | 1 72230275 | 00010000                    | 71205134   |       |          |          |   |
| T1   | 0 64016551 | 1 75110136 | 00010000                    | 71205134   |       |          |          |   |
| TC   | 0 32007264 | 1 67655103 | 00000110                    | 71205134   | *     |          |          |   |
| TR   | 0 55003532 | 1 73726405 | 00000100                    | 71205134   |       |          |          |   |
| TP   | 0 66401655 | 1 75753242 | 00000000                    | 71205134   |       |          |          |   |
| T8   | 0 33200726 | 1 67162655 | 01010000                    | 71205134   | *     |          |          |   |
| T7   | 0 55500353 | 1 73075326 | 01000000                    | 71205134   |       |          |          |   |
| T6   | 0 26640165 | 1 67233607 | 00010100                    | 71205134   | *     |          |          |   |
| T5   | 0 53320072 | 1 64726077 | 00001000                    | 71205134   | *     |          |          |   |
| T4   | 0 65550035 | 1 72353437 | 00000000                    | 71205134   |       |          |          |   |
| T3   | 0 72664016 | 1 66362743 | 00010010                    | 71205134   | *     |          |          |   |
| T2   | 0 75332007 | 1 73175365 | 00000000                    | 71205134   |       |          |          |   |
| T1   | 0 76555003 | 1 86673626 | 00010100                    | 71205134   | *     |          |          |   |
| TO   | 0 37266401 | 1 64546007 | 00001100                    | 71205134   | *     |          |          |   |
| TR   | 0 57633200 | 1 63460577 | 00010000                    | 71205134   | *     |          |          |   |
| TP   | 0 67655500 | 1 71634277 | 00000000                    | 71205134   |       |          |          |   |
| T8   | 0 73726640 | 1 74716137 | 00000000                    | 71205134   |       |          |          |   |
| T7   | 0 75753320 | 1 76347057 | 00000000                    | 71205134   |       |          |          |   |
| T6   | 0 76765550 | 1 77163427 | 00000000                    | 06572643   |       |          |          |   |
| TP   | 0 77163427 | 1 76765550 | 00000000                    | 06572643   |       |          |          |   |

| FIGURE MUL12 |            |            |             |            | A*M = 76723246 25616366 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 22541417 | 0 00000000 | 00000000    | 76106725   |                           |  |  |
| T7           | 0 11850007 | 1 76106725 | 00000000    | 76106725   | *                         |  |  |
| T6           | 0 44530303 | 1 65141277 | 10011000    | 76106725   | *                         |  |  |
| T5           | 0 62254141 | 1 64563054 | 10011010    | 76106725   | *                         |  |  |
| T4           | 0 31126060 | 1 64374757 | 10010000    | 76106725   | *                         |  |  |
| T3           | 0 54453030 | 1 76172367 | 00010000    | 76106725   |                           |  |  |
| T2           | 0 66225414 | 1 77071173 | 00010000    | 76106725   |                           |  |  |
| T1           | 0 73112606 | 1 77430476 | 00010000    | 76106725   |                           |  |  |
| T0           | 0 75445303 | 1 77610236 | 00010000    | 76106725   |                           |  |  |
| TR           | 0 36622541 | 1 65016034 | 11001010    | 76106725   | *                         |  |  |
| TP           | 0 17311260 | 1 65105347 | 10011000    | 76106725   | *                         |  |  |
| T8           | 0 47544530 | 1 76446163 | 00001000    | 76106725   |                           |  |  |
| T7           | 0 63662254 | 1 77223471 | 00000000    | 76106725   |                           |  |  |
| T6           | 0 71731126 | 1 77611634 | 00000000    | 76106725   |                           |  |  |
| T5           | 0 34754463 | 1 77644716 | 00000000    | 76106725   |                           |  |  |
| T4           | 0 16366225 | 1 65020264 | 11011010    | 76106725   | *                         |  |  |
| T3           | 0 07173112 | 1 65112453 | 10011010    | 76106725   | *                         |  |  |
| T2           | 0 43475445 | 1 76441621 | 00010010    | 76106725   |                           |  |  |
| T1           | 0 61636622 | 1 65322631 | 10011010    | 76106725   | *                         |  |  |
| T0           | 0 70717311 | 1 76855710 | 00000010    | 76106725   |                           |  |  |
| TR           | 0 34347544 | 1 65364675 | 10011000    | 76106725   | *                         |  |  |
| TP           | 0 56163662 | 1 76576736 | 00000000    | 76106725   |                           |  |  |
| T8           | 0 27071731 | 1 77277357 | 00000000    | 76106725   |                           |  |  |
| T7           | 0 53434754 | 1 65635404 | 10011110    | 76106725   | *                         |  |  |
| T6           | 0 25616366 | 1 76712246 | 00011000    | 01071000   |                           |  |  |
| TR           | 0 76723246 | 1 25616366 | 00011000    | 01071000   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL13<br>BC REGISTER | C REGISTER | A*M = 56603537 21726302 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 53451005 | 0 00000000 | 00000000                    | 33012655   |                           |
| T7   | 1 25624402 | 0 33012655 | 00000000                    | 33012655   | *                         |
| T6   | 1 52712201 | 0 15405326 | 00000000                    | 33012655   |                           |
| T5   | 1 25345100 | 0 31614320 | 10001110                    | 33012655   | *                         |
| T4   | 1 12562440 | 0 10706514 | 10000100                    | 33012655   |                           |
| T3   | 1 05271220 | 0 00343206 | 10000100                    | 33012655   |                           |
| T2   | 1 02534510 | 0 04161543 | 00000000                    | 33012655   |                           |
| T1   | 1 41256244 | 0 02070661 | 00000000                    | 33012655   |                           |
| TC   | 1 60522122 | 0 01034330 | 00000000                    | 33012655   |                           |
| TR   | 1 30253451 | 0 00416154 | 00000000                    | 33012655   |                           |
| TP   | 1 14125624 | 0 33211633 | 00010110                    | 33012655   | *                         |
| TA   | 1 46052712 | 0 15500751 | 00010010                    | 33012655   |                           |
| T7   | 1 63025345 | 0 06644360 | 00000010                    | 33012655   |                           |
| T6   | 1 31412562 | 0 36334741 | 00000110                    | 33012655   | *                         |
| T5   | 1 54605271 | 0 17156324 | 00000100                    | 33012655   |                           |
| T4   | 1 26302534 | 0 32471067 | 10011000                    | 33012655   | *                         |
| T3   | 1 53141256 | 0 11230033 | 10011000                    | 33012655   |                           |
| T2   | 1 65460527 | 0 00510415 | 10010000                    | 33012655   |                           |
| T1   | 1 72630253 | 0 37262053 | 00001010                    | 33012655   | *                         |
| TC   | 1 75314125 | 0 42643206 | 10001100                    | 33012655   | *                         |
| TR   | 1 36546052 | 0 50274710 | 10000110                    | 33012655   | *                         |
| TP   | 1 17263025 | 0 20136300 | 10000110                    | 33012655   |                           |
| T8   | 1 07531412 | 0 47061051 | 00011010                    | 33012655   | *                         |
| T7   | 1 43654605 | 0 23434020 | 00001010                    | 33012655   |                           |
| T6   | 1 21726302 | 1 55573536 | 01010001                    | 44765122   | *                         |
| TP   | 1 56603537 | 1 21726302 | 01010001                    | 44765122   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE MUL14<br>BC REGISTER | A*M = 77040237<br>C REGISTER | 52035164 0 |
|------|------------|------------|-----------------------------|------------------------------|------------|
| T8   | 0 15101573 | 0 00000000 | 00000000                    | 75556616                     |            |
| T7   | 0 06440675 | 1 75556616 | 00000000                    | 75556616 *                   |            |
| T6   | 0 03220336 | 1 63335115 | 11111010                    | 75556616 *                   |            |
| T5   | 0 41510157 | 1 75112042 | 01111010                    | 75556616                     |            |
| T4   | 0 20644067 | 1 64667233 | 10001010                    | 75556616 *                   |            |
| T3   | 0 50322033 | 1 63002737 | 11110000                    | 75556616 *                   |            |
| T2   | 0 64151015 | 1 63513166 | 10111010                    | 75556616 *                   |            |
| T1   | 0 72064406 | 1 62460604 | 11010110                    | 75556616 *                   |            |
| T0   | 0 35032203 | 1 75634346 | 00000000                    | 75556616                     |            |
| TR   | 0 16415101 | 1 63464771 | 11010010                    | 75556616 *                   |            |
| TP   | 0 47206440 | 1 63704116 | 10111100                    | 75556616 *                   |            |
| T8   | 0 23503220 | 1 75706407 | 00100100                    | 75556616                     |            |
| T7   | 0 51641510 | 1 76703243 | 00100000                    | 75556616                     |            |
| T6   | 0 64720644 | 1 77301521 | 00100000                    | 75556616                     |            |
| T5   | 0 72350322 | 1 77500650 | 00100000                    | 75556616                     |            |
| T4   | 0 35164151 | 1 77600324 | 00100000                    | 75556616                     |            |
| T3   | 0 16472064 | 1 64416760 | 11100010                    | 75556616 *                   |            |
| T2   | 0 07235032 | 1 76647374 | 00000000                    | 75556616                     |            |
| T1   | 0 03516415 | 1 77323576 | 00000000                    | 75556616                     |            |
| T0   | 0 01647206 | 1 64227405 | 11101110                    | 75556616 *                   |            |
| TR   | 0 40723503 | 1 76553246 | 00001000                    | 75556616                     |            |
| TP   | 0 20351641 | 1 64734731 | 10110010                    | 75556616 *                   |            |
| T8   | 0 50164720 | 1 63170176 | 11011000                    | 75556616 *                   |            |
| T7   | 0 24072350 | 1 75070477 | 01010000                    | 75556616                     |            |
| T6   | 0 52035164 | 1 76030237 | 01010000                    | 02221161                     |            |
| TP   | 0 77040237 | 1 52035164 | 01010000                    | 02221161                     |            |

| TIME | A REGISTER | B REGISTER | FIGURE MULIS<br>BC REGISTER | C REGISTER | A*M = 00066032 51624720 U |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 71042702 | 0 00000000 | 00000000                    | 77406364   |                           |
| T7   | 1 34421341 | 0 00000000 | 00000000                    | 77406364   |                           |
| T6   | 1 16210560 | 1 77406364 | 00000000                    | 77406364   | *                         |
| T5   | 1 07104270 | 1 77603172 | 00000000                    | 77406364   |                           |
| T4   | 1 03442134 | 1 77701475 | 00000000                    | 77406364   |                           |
| T3   | 1 41621056 | 1 77740636 | 00000000                    | 77406364   |                           |
| T2   | 1 20710427 | 1 77760317 | 00000000                    | 77406364   |                           |
| T1   | 1 50344213 | 1 66376423 | 11000110                    | 77406364   | *                         |
| TC   | 1 64162105 | 1 66175531 | 11010110                    | 77406364   | *                         |
| TR   | 1 72071042 | 1 66000204 | 11111100                    | 77406364   | *                         |
| TP   | 1 35034421 | 1 77444542 | 00000000                    | 77406364   |                           |
| T8   | 1 16416210 | 1 66220545 | 11010100                    | 77406364   | *                         |
| T7   | 1 47207104 | 1 77514222 | 00000100                    | 77406364   |                           |
| T6   | 1 23503442 | 1 77646151 | 00000000                    | 77406364   |                           |
| T5   | 1 51641621 | 1 77723064 | 00000000                    | 77406364   |                           |
| T4   | 1 24720710 | 1 66357716 | 11000100                    | 77406364   | *                         |
| T3   | 1 12350344 | 1 77567707 | 00000100                    | 77406364   |                           |
| T2   | 1 45164162 | 1 77673703 | 00000100                    | 77406364   |                           |
| T1   | 1 62472071 | 1 77735701 | 00000100                    | 77406364   |                           |
| TC   | 1 71235034 | 1 66354364 | 11011000                    | 77406364   | *                         |
| TR   | 1 34516416 | 1 77562572 | 00010000                    | 77406364   |                           |
| TP   | 1 16247207 | 1 77675275 | 00000000                    | 77406364   |                           |
| T8   | 1 47123503 | 1 66334012 | 11011110                    | 77406364   | *                         |
| T7   | 1 23451641 | 1 66160735 | 11010100                    | 77406364   | *                         |
| T6   | 1 51624720 | 0 77765021 | 00101011                    | 00371413   | *                         |
| TP   | 1 00066032 | 0 51624720 | 00101011                    | 00371413   |                           |

| FIGURE MUL16 |            |            |             |            | A*M = 03223757 67567714 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 17457571 | 0 00000000 | 00000000    | 06577626   |                           |  |  |
| T7           | 0 07627674 | 0 06577626 | 00000000    | 06577626   | *                         |  |  |
| T6           | 0 03713736 | 0 03277713 | 00000000    | 06577626   |                           |  |  |
| T5           | 0 41745757 | 0 01537745 | 00000000    | 06577626   |                           |  |  |
| T4           | 0 60762767 | 0 06346500 | 01111110    | 06577626   | *                         |  |  |
| T3           | 0 30371373 | 0 01316522 | 11111010    | 06577626   | *                         |  |  |
| T2           | 0 14174575 | 0 03702473 | 10111010    | 06577626   | *                         |  |  |
| T1           | 0 46076276 | 0 03674467 | 11011000    | 06577626   | *                         |  |  |
| T0           | 0 63037137 | 0 05272633 | 01010000    | 06577626   |                           |  |  |
| TR           | 0 71417457 | 0 01630133 | 10111010    | 06577626   | *                         |  |  |
| TP           | 0 74607627 | 0 02457207 | 11101100    | 06577626   | *                         |  |  |
| T8           | 0 76303713 | 0 03357761 | 11110010    | 06577626   | *                         |  |  |
| T7           | 0 77141745 | 0 04722512 | 10111110    | 06577626   | *                         |  |  |
| T6           | 0 37460762 | 0 04104537 | 11111000    | 06577626   | *                         |  |  |
| T5           | 0 57630371 | 0 06406657 | 00100000    | 06577626   |                           |  |  |
| T4           | 0 67714174 | 0 01732145 | 10111010    | 06577626   | *                         |  |  |
| T3           | 0 73746076 | 0 04711466 | 00110000    | 06577626   |                           |  |  |
| T2           | 0 35763037 | 0 02300633 | 00110000    | 06577626   |                           |  |  |
| T1           | 0 56771417 | 0 07773133 | 00011010    | 06577626   | *                         |  |  |
| T0           | 0 67374607 | 0 01471607 | 11110100    | 06577626   | *                         |  |  |
| TR           | 0 73576303 | 0 03777561 | 10101010    | 06577626   | *                         |  |  |
| TP           | 0 75677141 | 0 03527012 | 11111110    | 06577626   | *                         |  |  |
| T8           | 0 36737460 | 0 04007677 | 11110000    | 06577626   | *                         |  |  |
| T7           | 0 57357630 | 0 06447737 | 00000000    | 06577626   |                           |  |  |
| T6           | 0 67567714 | 0 03223757 | 00000000    | 71200151   |                           |  |  |
| TP           | 0 03223757 | 0 67567714 | 00000000    | 71200151   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL17<br>BC REGISTER | C REGISTER | A*M = 57066216 56071300 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 53075604 | 0 00000000 | 00000000                    | 31710530   |                           |
| T7   | 1 25436702 | 0 00000000 | 00000000                    | 31710530   |                           |
| T6   | 1 12617341 | 0 00000000 | 00000000                    | 31710530   |                           |
| T5   | 1 05307560 | 0 31710530 | 00000000                    | 31710530   | *                         |
| T4   | 1 02543670 | 0 14744254 | 00000000                    | 31710530   |                           |
| T3   | 1 01261734 | 0 06362126 | 00000000                    | 31710530   |                           |
| T2   | 1 00530756 | 0 03171053 | 00000000                    | 31710530   |                           |
| T1   | 1 40254367 | 0 01474425 | 00000000                    | 31710530   |                           |
| TC   | 1 60126173 | 0 31546742 | 01000000                    | 31710530   | *                         |
| TR   | 1 30053075 | 0 46173011 | 01001100                    | 31710530   | *                         |
| TP   | 1 54025436 | 0 54306574 | 01100000                    | 31710530   | *                         |
| T8   | 1 26012617 | 0 26503276 | 00100000                    | 31710530   |                           |
| T7   | 1 13005307 | 0 44211267 | 01001000                    | 31710530   | *                         |
| T6   | 1 45402543 | 0 53415663 | 01000000                    | 31710530   | *                         |
| T5   | 1 62601261 | 0 57116461 | 01001000                    | 31710530   | *                         |
| T4   | 1 71300530 | 0 51757360 | 10001000                    | 31710530   | *                         |
| T3   | 1 34540254 | 0 20767170 | 10001000                    | 31710530   |                           |
| T2   | 1 16260126 | 0 14373074 | 00001000                    | 31710530   |                           |
| T1   | 1 07130053 | 0 06175036 | 00001000                    | 31710530   |                           |
| TC   | 1 03454025 | 0 34707547 | 00100000                    | 31710530   | *                         |
| TR   | 1 41626012 | 0 47313313 | 01001100                    | 31710530   | *                         |
| TP   | 1 60713005 | 0 23145105 | 01001100                    | 31710530   |                           |
| T8   | 1 70345402 | 0 43773632 | 00000000                    | 31710530   | *                         |
| T7   | 1 34162601 | 0 21775715 | 00000000                    | 31710530   |                           |
| T6   | 1 56071300 | 1 56755105 | 00111111                    | 46067247   | *                         |
| TP   | 1 57066216 | 1 56071300 | 00111111                    | 46067247   |                           |

| FIGURE MUL18 |            |            |             |            | A*M = |  | 12145626 | 04303070 | 0 |
|--------------|------------|------------|-------------|------------|-------|--|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |  |          |          |   |
| T8           | 1 55617111 | 0 00000000 | 00000000    | 56055074   |       |  |          |          |   |
| T7           | 1 26707444 | 1 56055074 | 00000000    | 56055074   | *     |  |          |          |   |
| T6           | 1 13343622 | 1 67026436 | 00000000    | 56055074   |       |  |          |          |   |
| T5           | 1 05561711 | 1 73413217 | 00000000    | 56055074   |       |  |          |          |   |
| T4           | 1 42670744 | 1 43652573 | 10010010    | 56055074   | *     |  |          |          |   |
| T3           | 1 61334362 | 1 65721271 | 00010010    | 56055074   |       |  |          |          |   |
| T2           | 1 70556171 | 1 72754530 | 00000010    | 56055074   |       |  |          |          |   |
| T1           | 1 34267074 | 1 43333254 | 10110100    | 56055074   | *     |  |          |          |   |
| TC           | 1 16133436 | 1 65511566 | 00110000    | 56055074   |       |  |          |          |   |
| TR           | 1 07055617 | 1 72600673 | 00110000    | 56055074   |       |  |          |          |   |
| TP           | 1 43426707 | 1 43311321 | 10110110    | 56055074   | *     |  |          |          |   |
| T8           | 1 61613343 | 1 33665600 | 10000110    | 56055074   | *     |  |          |          |   |
| T7           | 1 30705561 | 1 37707730 | 00100110    | 56055074   | *     |  |          |          |   |
| T6           | 1 14342670 | 1 25050014 | 11011100    | 56055074   | *     |  |          |          |   |
| T5           | 1 06161334 | 1 56020446 | 01010000    | 56055074   |       |  |          |          |   |
| T4           | 1 03070556 | 1 67414223 | 00000000    | 56055074   |       |  |          |          |   |
| T3           | 1 41434267 | 1 73606111 | 00000000    | 56055074   |       |  |          |          |   |
| T2           | 1 60616133 | 1 43750030 | 10010110    | 56055074   | *     |  |          |          |   |
| T1           | 1 30307055 | 1 33745054 | 10100100    | 56055074   | *     |  |          |          |   |
| TC           | 1 14143426 | 1 37027452 | 01000110    | 56055074   | *     |  |          |          |   |
| TR           | 1 06061613 | 1 57037661 | 01000010    | 56055074   |       |  |          |          |   |
| TP           | 1 43030705 | 1 36064720 | 10010110    | 56055074   | *     |  |          |          |   |
| T8           | 1 21414342 | 1 31003400 | 10110110    | 56055074   | *     |  |          |          |   |
| T7           | 1 10606161 | 1 50445644 | 10000000    | 56055074   |       |  |          |          |   |
| T6           | 1 04303070 | 0 11144625 | 01001001    | 21722703   | *     |  |          |          |   |
| TP           | 1 12145626 | 0 04303070 | 01001001    | 21722703   |       |  |          |          |   |

| FIGURE MUL19 |            |            |             |            | A*M = 76276151 24566024 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 72447427 | 0 00000000 | 00000000    | 11470206   |                           |  |  |
| T7           | 1 35223613 | 0 11470206 | 00000000    | 11470206   | *                         |  |  |
| T6           | 1 16511705 | 0 15224301 | 01100010    | 11470206   | *                         |  |  |
| T5           | 1 47244742 | 0 10542342 | 10100010    | 11470206   | *                         |  |  |
| T4           | 1 23522361 | 0 00221165 | 10100000    | 11470206   |                           |  |  |
| T3           | 1 51651170 | 0 15540670 | 00100010    | 11470206   | *                         |  |  |
| T2           | 1 24724474 | 0 06620330 | 00100010    | 11470206   |                           |  |  |
| T1           | 1 12352236 | 0 03350150 | 00000010    | 11470206   |                           |  |  |
| TC           | 1 05165117 | 0 01564060 | 00000010    | 11470206   |                           |  |  |
| TR           | 1 02472447 | 0 11262232 | 01100010    | 11470206   | *                         |  |  |
| TP           | 1 01235223 | 0 16561327 | 00100000    | 11470206   | *                         |  |  |
| T8           | 1 40516511 | 0 10720751 | 10100010    | 11470206   | *                         |  |  |
| T7           | 1 60247244 | 0 21000576 | 01100000    | 11470206   | *                         |  |  |
| T6           | 1 30123522 | 0 10040277 | 01000000    | 11470206   |                           |  |  |
| T5           | 1 54051651 | 0 04420137 | 00000000    | 11470206   |                           |  |  |
| T4           | 1 66024724 | 0 13600255 | 00100010    | 11470206   | *                         |  |  |
| T3           | 1 73012352 | 0 05740122 | 00000010    | 11470206   |                           |  |  |
| T2           | 1 35405165 | 0 02760055 | 00000000    | 11470206   |                           |  |  |
| T1           | 1 56602472 | 0 12760224 | 00100010    | 11470206   | *                         |  |  |
| TC           | 1 27301235 | 0 05330116 | 00100000    | 11470206   |                           |  |  |
| TR           | 1 13540516 | 0 13204245 | 01100010    | 11470206   | *                         |  |  |
| TP           | 1 45660247 | 0 05142126 | 01000000    | 11470206   |                           |  |  |
| T8           | 1 22730123 | 0 14451251 | 00100010    | 11470206   | *                         |  |  |
| T7           | 1 51354051 | 0 17654736 | 00100000    | 11470206   | *                         |  |  |
| T6           | 1 24566024 | 1 65265040 | 11011111    | 66307571   | *                         |  |  |
| TP           | 1 76276151 | 1 24566024 | 11011111    | 66307571   |                           |  |  |

| FIGURE MUL20 |            |            |             |            | A*M = 71173165 72126104 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 36427241 | 0 00000000 | 00000000    | 70726342   |                           |  |  |
| T7           | 0 17213520 | 1 70726342 | 00000000    | 70726342   | *                         |  |  |
| T6           | 0 07505650 | 1 74353161 | 00000000    | 70726342   |                           |  |  |
| T5           | 0 43642724 | 1 76165470 | 00000000    | 70726342   |                           |  |  |
| T4           | 0 21721352 | 1 77072634 | 00000000    | 70726342   |                           |  |  |
| T3           | 0 10750565 | 1 77435316 | 00000000    | 70726342   |                           |  |  |
| T2           | 0 04364272 | 1 67534001 | 01011110    | 70726342   | *                         |  |  |
| T1           | 0 42172135 | 1 73262444 | 01010000    | 70726342   |                           |  |  |
| T0           | 0 21075056 | 1 66057564 | 01000000    | 70726342   | *                         |  |  |
| TR           | 0 10436427 | 1 73427672 | 00000000    | 70726342   |                           |  |  |
| TP           | 0 04217213 | 1 65531277 | 01011000    | 70726342   | *                         |  |  |
| T8           | 0 42107505 | 1 63107471 | 01100010    | 70726342   | *                         |  |  |
| T7           | 0 61043642 | 1 82021102 | 01011100    | 70726342   | *                         |  |  |
| T6           | 0 30421721 | 1 71414001 | 00001100    | 70726342   |                           |  |  |
| T5           | 0 54210750 | 1 64524702 | 01010100    | 70726342   | *                         |  |  |
| T4           | 0 26104364 | 1 72656301 | 00000100    | 70726342   |                           |  |  |
| T3           | 0 53042172 | 1 75327100 | 00000100    | 70726342   |                           |  |  |
| T2           | 0 25421075 | 1 76553400 | 00000100    | 70726342   |                           |  |  |
| T1           | 0 12610436 | 1 67103102 | 01111100    | 70726342   | *                         |  |  |
| T0           | 0 05304217 | 1 73005001 | 01101100    | 70726342   |                           |  |  |
| TR           | 0 42542107 | 1 66761302 | 00010100    | 70726342   | *                         |  |  |
| TP           | 0 21261043 | 1 63212143 | 01111000    | 70726342   | *                         |  |  |
| T8           | 0 50530421 | 1 62077723 | 01000100    | 70726342   | *                         |  |  |
| T7           | 0 64254210 | 1 61355353 | 01011000    | 70726342   | *                         |  |  |
| T6           | 0 72126104 | 1 70162165 | 01011000    | 07051435   |                           |  |  |
| TP           | 0 71173165 | 1 72126104 | 01011000    | 07051435   |                           |  |  |

| FIGURE MUL21 |            |            |             |            | A*M = 77004325 77001212 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 10150477 | 0 00000000 | 00000000    | 74104173   |                           |  |  |
| T7           | 0 04064237 | 1 74104173 | 00000000    | 74104173   | *                         |  |  |
| T6           | 0 42032117 | 1 62146160 | 10000110    | 74104173   | *                         |  |  |
| T5           | 0 21015047 | 1 61167227 | 10000100    | 74104173   | *                         |  |  |
| T4           | 0 50406423 | 1 60577646 | 10000100    | 74104173   | *                         |  |  |
| T3           | 0 24203211 | 1 60373056 | 10011100    | 74104173   | *                         |  |  |
| T2           | 0 12101504 | 1 50206152 | 10100110    | 74104173   | *                         |  |  |
| T1           | 0 05040642 | 1 74143021 | 00000110    | 74104173   |                           |  |  |
| T0           | 0 42420321 | 1 76061454 | 00000000    | 74104173   |                           |  |  |
| TR           | 0 21210150 | 1 63134711 | 10000110    | 74104173   | *                         |  |  |
| TP           | 0 50504064 | 1 75456300 | 00000110    | 74104173   |                           |  |  |
| T8           | 0 24242032 | 1 76627104 | 00000100    | 74104173   |                           |  |  |
| T7           | 0 12121015 | 1 77313402 | 00000100    | 74104173   |                           |  |  |
| T6           | 0 05050406 | 1 63641734 | 10010100    | 74104173   | *                         |  |  |
| T5           | 0 02424203 | 1 75724716 | 00000100    | 74104173   |                           |  |  |
| T4           | 0 01212101 | 1 62056572 | 11000010    | 74104173   | *                         |  |  |
| T3           | 0 00505040 | 1 61523374 | 10010100    | 74104173   | *                         |  |  |
| T2           | 0 00242420 | 1 74655536 | 00000100    | 74104173   |                           |  |  |
| T1           | 0 00121210 | 1 76326617 | 00000100    | 74104173   |                           |  |  |
| T0           | 0 40050504 | 1 77153347 | 00000000    | 74104173   |                           |  |  |
| TR           | 0 60024242 | 1 77465563 | 00000000    | 74104173   |                           |  |  |
| TP           | 0 70012121 | 1 77632671 | 00000000    | 74104173   |                           |  |  |
| T8           | 0 74005050 | 1 63011427 | 11010100    | 74104173   | *                         |  |  |
| T7           | 0 76002424 | 1 75000653 | 01010000    | 74104173   |                           |  |  |
| T6           | 0 77001212 | 1 76004325 | 01000000    | 03673604   |                           |  |  |
| TP           | 0 77004325 | 1 77001212 | 01000000    | 03673604   |                           |  |  |

| FIGURE MUL22 |            |            |             |            | A*M = |  | 65577047 | 53467714 | 0 |
|--------------|------------|------------|-------------|------------|-------|--|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |  |          |          |   |
| T8           | 1 81010463 | 0 00000000 | 00000000    | 25712202   |       |  |          |          |   |
| T7           | 1 33404231 | 0 25712202 | 00000000    | 25712202   | *     |  |          |          |   |
| T6           | 1 14202114 | 0 37657303 | 01000000    | 25712202   | *     |  |          |          |   |
| T5           | 1 46101046 | 0 17327541 | 01000000    | 25712202   |       |  |          |          |   |
| T4           | 1 63040423 | 0 07153660 | 01000000    | 25712202   |       |  |          |          |   |
| T3           | 1 31420211 | 0 21777132 | 10001000    | 25712202   | *     |  |          |          |   |
| T2           | 1 14610104 | 0 31602257 | 11110000    | 25712202   | *     |  |          |          |   |
| T1           | 1 46304042 | 0 10345127 | 11000000    | 25712202   |       |  |          |          |   |
| TC           | 1 63142021 | 0 00562453 | 10000000    | 25712202   |       |  |          |          |   |
| TR           | 1 71461010 | 0 21103427 | 11100000    | 25712202   | *     |  |          |          |   |
| TP           | 1 74630404 | 0 14001613 | 01100000    | 25712202   |       |  |          |          |   |
| T8           | 1 76314202 | 0 06440705 | 00000000    | 25712202   |       |  |          |          |   |
| T7           | 1 77146101 | 0 03220342 | 00000000    | 25712202   |       |  |          |          |   |
| T6           | 1 37463040 | 0 26422363 | 01000000    | 25712202   | *     |  |          |          |   |
| T5           | 1 57631420 | 0 13611171 | 00000000    | 25712202   |       |  |          |          |   |
| T4           | 1 67714610 | 0 05704474 | 00000000    | 25712202   |       |  |          |          |   |
| T3           | 1 33746304 | 0 02742236 | 00000000    | 25712202   |       |  |          |          |   |
| T2           | 1 15763142 | 0 01361117 | 00000000    | 25712202   |       |  |          |          |   |
| T1           | 1 46771461 | 0 00570447 | 00000000    | 25712202   |       |  |          |          |   |
| TC           | 1 63374630 | 0 25106425 | 01100000    | 25712202   | *     |  |          |          |   |
| TR           | 1 71576314 | 0 12003212 | 01100000    | 25712202   |       |  |          |          |   |
| TP           | 1 34677146 | 0 05441505 | 00000000    | 25712202   |       |  |          |          |   |
| T8           | 1 56337463 | 0 02620642 | 00000000    | 25712202   |       |  |          |          |   |
| T7           | 1 27157631 | 0 26222523 | 01000000    | 25712202   | *     |  |          |          |   |
| T6           | 1 53467714 | 1 65576746 | 00000101    | 52065575   | *     |  |          |          |   |
| TP           | 1 65577047 | 1 53467714 | 00000101    | 52065575   |       |  |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL23<br>BC REGISTER | C REGISTER | A*M = | 15523762 | 54111166 | U |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 62111173 | 0 00000000 | 00000000                    | 40344101   |       |          |          |   |
| T7   | 1 31044475 | 1 40344101 | 00000000                    | 40344101   | *     |          |          |   |
| T6   | 1 54422236 | 1 20426141 | 00100000                    | 40344101   | *     |          |          |   |
| T5   | 1 66211117 | 1 50253060 | 00000000                    | 40344101   |       |          |          |   |
| T4   | 1 33104447 | 1 24461531 | 00010000                    | 40344101   | *     |          |          |   |
| T3   | 1 55442223 | 1 12570755 | 00010000                    | 40344101   | *     |          |          |   |
| T2   | 1 66621111 | 1 05544467 | 00100000                    | 40344101   | *     |          |          |   |
| T1   | 1 73310444 | 1 02266334 | 01000000                    | 40344101   | *     |          |          |   |
| TC   | 1 35544222 | 1 41533156 | 00000000                    | 40344101   |       |          |          |   |
| TR   | 1 16662111 | 1 60655467 | 00000000                    | 40344101   |       |          |          |   |
| TP   | 1 47331044 | 1 30662734 | 00010000                    | 40344101   | *     |          |          |   |
| T8   | 1 23554422 | 1 54335356 | 00000000                    | 40344101   |       |          |          |   |
| T7   | 1 11666211 | 1 66156567 | 00000000                    | 40344101   |       |          |          |   |
| T6   | 1 44733104 | 1 33323374 | 00110000                    | 40344101   | *     |          |          |   |
| T5   | 1 22355442 | 1 55515576 | 00100000                    | 40344101   |       |          |          |   |
| T4   | 1 11166621 | 1 66606677 | 00100000                    | 40344101   |       |          |          |   |
| T3   | 1 44473310 | 1 33607430 | 00100010                    | 40344101   | *     |          |          |   |
| T2   | 1 22235544 | 1 55743610 | 00000010                    | 40344101   |       |          |          |   |
| T1   | 1 11116662 | 1 66761700 | 00000010                    | 40344101   |       |          |          |   |
| TC   | 1 04447331 | 1 73370744 | 00000000                    | 40344101   |       |          |          |   |
| TR   | 1 02223554 | 1 35030463 | 01110000                    | 40344101   | *     |          |          |   |
| TP   | 1 41111666 | 1 56060231 | 01010000                    | 40344101   |       |          |          |   |
| T8   | 1 60444733 | 1 67420114 | 00010000                    | 40344101   |       |          |          |   |
| T7   | 1 33222355 | 1 33150147 | 01010000                    | 40344101   | *     |          |          |   |
| T6   | 1 54111166 | 0 05423651 | 10100111                    | 37433676   | *     |          |          |   |
| TP   | 1 15523762 | 0 54111166 | 10100111                    | 37433676   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL24<br>BC REGISTER | C REGISTER | A*M = | 67201543 | 12433276 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 65503149 | 0 00000000 | 00000000                    | 32774725   |       |          |          |   |
| T7   | 1 32641461 | 0 32774725 | 00000000                    | 32774725   | *     |          |          |   |
| T6   | 1 55320630 | 0 47262277 | 01111000                    | 32774725*  | *     |          |          |   |
| T5   | 1 66550314 | 0 23175537 | 01000000                    | 32774725   |       |          |          |   |
| T4   | 1 73264146 | 0 11076657 | 01000000                    | 32774725   |       |          |          |   |
| T3   | 1 75532063 | 0 04037327 | 01000000                    | 32774725   |       |          |          |   |
| T2   | 1 76655031 | 0 34303470 | 01111010                    | 32774725   | *     |          |          |   |
| T1   | 1 37326414 | 0 40572165 | 11011000                    | 32774725   | *     |          |          |   |
| TC   | 1 57553206 | 0 24671472 | 00010000                    | 32774725   |       |          |          |   |
| TR   | 1 27665503 | 0 12330635 | 00010000                    | 32774725   |       |          |          |   |
| TP   | 1 53732641 | 0 37054233 | 01101010                    | 32774725   | *     |          |          |   |
| T8   | 1 65755320 | 0 42752446 | 10111000                    | 32774725   | *     |          |          |   |
| T7   | 1 32766550 | 0 25321623 | 00110000                    | 32774725   |       |          |          |   |
| T6   | 1 55373264 | 0 12514711 | 00100000                    | 32774725   |       |          |          |   |
| T5   | 1 66575532 | 0 05206344 | 00100000                    | 32774725   |       |          |          |   |
| T4   | 1 33276655 | 0 02543162 | 00000000                    | 32774725   |       |          |          |   |
| T3   | 1 15537326 | 0 33155316 | 01101100                    | 32774725   | *     |          |          |   |
| T2   | 1 06657553 | 0 15026107 | 01101100                    | 32774725   |       |          |          |   |
| T1   | 1 43327665 | 0 31747420 | 10101010                    | 32774725   | *     |          |          |   |
| TC   | 1 21553732 | 0 52710131 | 01111010                    | 32774725   | *     |          |          |   |
| TR   | 1 50665755 | 0 25700450 | 00110010                    | 32774725   |       |          |          |   |
| TP   | 1 24332766 | 0 44770155 | 01011000                    | 32774725   | *     |          |          |   |
| T8   | 1 52155373 | 0 22770466 | 00010000                    | 32774725   |       |          |          |   |
| T7   | 1 25066575 | 0 43274150 | 01101010                    | 32774725   | *     |          |          |   |
| T6   | 1 12433276 | 1 67171442 | 00010101                    | 45003052   | *     |          |          |   |
| TP   | 1 67201543 | 1 12433276 | 00010101                    | 45003052   |       |          |          |   |

| FIGURE MUL25 |            |            |             |            | A*M = 16425421 75165600 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 57411100 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T7           | 1 27604440 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T6           | 1 13702220 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T5           | 1 05741110 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T4           | 1 02760444 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T3           | 1 01370222 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T2           | 1 00574111 | 0 00000000 | 00000000    | 43610437   |                           |  |  |
| T1           | 1 00276044 | 1 43610437 | 00000000    | 43610437   | *                         |  |  |
| TC           | 1 40137022 | 1 61704217 | 00000000    | 43610437   |                           |  |  |
| TR           | 1 60057411 | 1 70742107 | 00000000    | 43610437   |                           |  |  |
| TP           | 1 70027604 | 1 37171472 | 01000010    | 43610437   | *                         |  |  |
| T8           | 1 34013702 | 1 57074631 | 01000010    | 43610437   |                           |  |  |
| T7           | 1 56005741 | 1 67036310 | 01000010    | 43610437   |                           |  |  |
| T6           | 1 27002760 | 1 37627807 | 00000100    | 43610437   | *                         |  |  |
| T5           | 1 53401370 | 1 57713603 | 00000100    | 43610437   |                           |  |  |
| T4           | 1 65600574 | 1 67745741 | 00000000    | 43610437   |                           |  |  |
| T3           | 1 72700276 | 1 73762760 | 00000000    | 43610437   |                           |  |  |
| T2           | 1 35340137 | 1 75771370 | 00000000    | 43610437   |                           |  |  |
| T1           | 1 16560057 | 1 31804123 | 11101110    | 43610437   | *                         |  |  |
| TC           | 1 47270027 | 1 24112144 | 01001010    | 43610437   | *                         |  |  |
| TR           | 1 23634013 | 1 15255016 | 01001110    | 43610437   | *                         |  |  |
| TP           | 1 51656005 | 1 02737401 | 10000110    | 43610437   | *                         |  |  |
| T8           | 1 64727002 | 1 00167273 | 11001010    | 43610437   | *                         |  |  |
| T7           | 1 72353401 | 1 44473131 | 00001010    | 43610437   |                           |  |  |
| T6           | 1 75165600 | 0 16316320 | 00110101    | 34167340   | *                         |  |  |
| TP           | 1 16425421 | 0 75165600 | 00110101    | 34167340   |                           |  |  |

| FIGURE MUL26 |            |            |             |            | A*M = 00764773 |  | 16360132 |
|--------------|------------|------------|-------------|------------|----------------|--|----------|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                |  |          |
| T3           | 0 15051535 | 0 00000000 | 00000000    | 02311421   |                |  |          |
| T7           | 0 06424656 | 0 02311421 | 00000000    | 02311421   | *              |  |          |
| T6           | 0 43212327 | 0 01144610 | 00000000    | 02311421   |                |  |          |
| T5           | 0 21505153 | 0 02773725 | 00000000    | 02311421   | *              |  |          |
| T4           | 0 50642465 | 0 03606373 | 00101000    | 02311421   | *              |  |          |
| T3           | 0 64321232 | 0 03254116 | 01001100    | 02311421   | *              |  |          |
| T2           | 0 32150515 | 0 01126407 | 01000100    | 02311421   |                |  |          |
| T1           | 0 55064246 | 0 03364664 | 00000000    | 02311421   | *              |  |          |
| TC           | 0 26432123 | 0 01572332 | 00000000    | 02311421   |                |  |          |
| TR           | 0 13215051 | 0 02106576 | 01100000    | 02311421   | *              |  |          |
| TP           | 0 05506424 | 0 03014610 | 01000110    | 02311421   | *              |  |          |
| T8           | 0 02643212 | 0 01006340 | 01000010    | 02311421   |                |  |          |
| T7           | 0 01321505 | 0 00003164 | 01000000    | 02311421   |                |  |          |
| T6           | 0 00550642 | 0 02712013 | 00001100    | 02311421   | *              |  |          |
| T5           | 0 40264321 | 0 01345445 | 00000000    | 02311421   |                |  |          |
| T4           | 0 60132150 | 0 02073243 | 01001000    | 02311421   | *              |  |          |
| T3           | 0 70055064 | 0 01435121 | 00001000    | 02311421   |                |  |          |
| T2           | 0 74026432 | 0 00615050 | 00001000    | 02311421   |                |  |          |
| T1           | 0 36013215 | 0 00307424 | 00000000    | 02311421   |                |  |          |
| TC           | 0 17005506 | 0 02454233 | 00001000    | 02311421   | *              |  |          |
| TR           | 0 47402643 | 0 01226515 | 00000000    | 02311421   |                |  |          |
| TP           | 0 63601321 | 0 02024667 | 01000000    | 02311421   | *              |  |          |
| T8           | 0 71700550 | 0 03723754 | 00000000    | 02311421   | *              |  |          |
| T7           | 0 34740264 | 0 01751766 | 00000000    | 02311421   |                |  |          |
| T6           | 0 16360132 | 0 00764773 | 00000000    | 75466356   |                |  |          |
| TP           | 0 00764773 | 0 16360132 | 00000000    | 75466356   |                |  |          |

| TIME | A REGISTER | B REGISTER | FIGURE MUL27<br>BC REGISTER | C REGISTER | A*M = 17312204 00443740 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 57330170 | 0 00000000 | 00000000                    | 42220642   |                           |
| T7   | 1 27554074 | 0 00000000 | 00000000                    | 42220642   |                           |
| T6   | 1 13666036 | 0 00000000 | 00000000                    | 42220642   |                           |
| T5   | 1 05733017 | 0 00000000 | 00000000                    | 42220642   |                           |
| T4   | 1 02755407 | 1 42220642 | 00000000                    | 42220642   | *                         |
| T3   | 1 01366603 | 1 23330163 | 00001000                    | 42220642   | *                         |
| T2   | 1 40873301 | 1 13774233 | 00001100                    | 42220642   | *                         |
| T1   | 1 60275540 | 1 07116317 | 01101100                    | 42220642   | *                         |
| T0   | 1 70136660 | 1 43007507 | 01100100                    | 42220642   |                           |
| TR   | 1 74057330 | 1 61043603 | 01000100                    | 42220642   |                           |
| TP   | 1 76027554 | 1 70021741 | 01000000                    | 42220642   |                           |
| T8   | 1 77013666 | 1 74410760 | 00000000                    | 42220642   |                           |
| T7   | 1 37408733 | 1 76204370 | 00000000                    | 42220642   |                           |
| T6   | 1 17602755 | 1 31322736 | 10000100                    | 42220642   | *                         |
| T5   | 1 07701366 | 1 22771251 | 00001010                    | 42220642   | *                         |
| T4   | 1 43740573 | 1 51374120 | 00001010                    | 42220642   |                           |
| T3   | 1 21760275 | 1 26716216 | 00101100                    | 42220642   | *                         |
| T2   | 1 10770136 | 1 15627301 | 00001110                    | 42220642   | *                         |
| T1   | 1 44374057 | 1 46713104 | 00001100                    | 42220642   |                           |
| T0   | 1 22176027 | 1 25586744 | 00000000                    | 42220642   | *                         |
| TR   | 1 11072013 | 1 14013124 | 01101100                    | 42220642   | *                         |
| TP   | 1 04437405 | 1 00666754 | 10000000                    | 42220642   | *                         |
| T8   | 1 02217602 | 1 06553120 | 00001110                    | 42220642   | *                         |
| T7   | 1 01107701 | 1 43265014 | 00001100                    | 42220642   |                           |
| T6   | 1 00443740 | 0 16202173 | 01110011                    | 35587135   | *                         |
| TP   | 1 17312204 | 0 00443740 | 01110011                    | 35557135   |                           |

| FIGURE MUL26 |            |            |             |            | A*M = 00355615 23630064 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 03005166 | 0 00000000 | 00000000    | 04737527   |                           |  |  |
| T7           | 0 01402473 | 0 00000000 | 00000000    | 04737527   |                           |  |  |
| T6           | 0 00601235 | 0 04737527 | 00000000    | 04737527   | *                         |  |  |
| T5           | 0 40300516 | 0 06206372 | 01111010    | 04737527   | *                         |  |  |
| T4           | 0 20140247 | 0 03547571 | 00000010    | 04737527   |                           |  |  |
| T3           | 0 50060123 | 0 05512327 | 01111100    | 04737527   | *                         |  |  |
| T2           | 0 64030051 | 0 07240332 | 01011010    | 04737527   | *                         |  |  |
| T1           | 0 32014024 | 0 00053200 | 11011110    | 04737527   | *                         |  |  |
| T0           | 0 15006012 | 0 04421144 | 00011000    | 04737527   |                           |  |  |
| TR           | 0 06403005 | 0 02214062 | 00001000    | 04737527   |                           |  |  |
| TP           | 0 03201402 | 0 05035150 | 01011010    | 04737527   | *                         |  |  |
| T8           | 0 01500601 | 0 02012060 | 01011010    | 04737527   |                           |  |  |
| T2           | 0 00040300 | 0 05340153 | 01011010    | 04737527   | *                         |  |  |
| T6           | 0 40320140 | 0 02164461 | 01000010    | 04737527   |                           |  |  |
| T5           | 0 60150060 | 0 01472234 | 00000000    | 04737527   |                           |  |  |
| T4           | 0 30064030 | 0 00635116 | 00000000    | 04737527   |                           |  |  |
| T3           | 0 14032014 | 0 00316447 | 00000000    | 04737527   |                           |  |  |
| T2           | 0 46015006 | 0 00147223 | 00000000    | 04737527   |                           |  |  |
| T1           | 0 63006403 | 0 00063511 | 00000000    | 04737527   |                           |  |  |
| T0           | 0 71403201 | 0 04760363 | 00011010    | 04737527   | *                         |  |  |
| TR           | 0 74601500 | 0 06223214 | 01111110    | 04737527   | *                         |  |  |
| TP           | 0 36300640 | 0 03555142 | 00001010    | 04737527   |                           |  |  |
| T8           | 0 17140320 | 0 01666065 | 00001000    | 04737527   |                           |  |  |
| T7           | 0 47460150 | 0 00733432 | 00000000    | 04737527   |                           |  |  |
| T6           | 0 23630064 | 0 00355615 | 00000000    | 73040250   |                           |  |  |
| TR           | 0 00355615 | 0 23630064 | 00000000    | 73040250   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL29<br>BC REGISTER | C REGISTER | A*M = 67532402 10014460 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 62761652 | 0 00000000 | 00000000                    | 24343434   |                           |
| T7   | 1 31370725 | 0 00000000 | 00000000                    | 24343434   |                           |
| T6   | 1 14574382 | 0 24343434 | 00000000                    | 24343434   | *                         |
| T5   | 1 06276165 | 0 12161616 | 00000000                    | 24343434   | *                         |
| T4   | 1 03137072 | 0 21333333 | 10101010                    | 24343434   | *                         |
| T3   | 1 41457435 | 0 14515151 | 00101010                    | 24343434   | *                         |
| T2   | 1 60627616 | 0 22642424 | 10010100                    | 24343434   | *                         |
| T1   | 1 30313707 | 0 15325252 | 00000000                    | 24343434   | *                         |
| TC   | 1 14145743 | 0 22015151 | 11101010                    | 24343434   | *                         |
| TR   | 1 46062761 | 0 31702424 | 10110100                    | 24343434   | *                         |
| TP   | 1 23031370 | 0 44340606 | 01010100                    | 24343434   | *                         |
| T8   | 1 11414574 | 0 22564343 | 00000000                    | 24343434   | *                         |
| T7   | 1 44606276 | 0 11272161 | 00000000                    | 24343434   | *                         |
| T6   | 1 62303137 | 0 04535070 | 00000000                    | 24343434   | *                         |
| T5   | 1 31141457 | 0 26811060 | 00111010                    | 24343434   | *                         |
| T4   | 1 14460627 | 0 37654460 | 00000010                    | 24343434   | *                         |
| T3   | 1 06230313 | 0 33261660 | 11010010                    | 24343434   | *                         |
| T2   | 1 03114145 | 0 46477360 | 00001010                    | 24343434   | *                         |
| T1   | 1 01446062 | 0 47673520 | 00010110                    | 24343434   | *                         |
| T0   | 1 00623031 | 0 23671614 | 00010100                    | 24343434   | *                         |
| TR   | 1 00311414 | 0 36203372 | 01101010                    | 24343434   | *                         |
| TP   | 1 00144606 | 0 16141171 | 01001010                    | 24343434   | *                         |
| T8   | 1 40062303 | 0 07460070 | 00001010                    | 24343434   | *                         |
| T7   | 1 20031141 | 0 27173074 | 01001000                    | 24343434   | *                         |
| T6   | 1 10014460 | 1 57422371 | 00110011                    | 53434343   | *                         |
| TP   | 1 67532402 | 1 10014460 | 00110011                    | 53434343   |                           |

| FIGURE MUL30 |            |            |             |            | A*M = | 06745073 | 46420734 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T8           | 0 32527245 | 0 00000000 | 00000000    | 10253726   |       |          |          |   |
| T7           | 0 15253522 | 0 10253726 | 00000000    | 10253726   | *     |          |          |   |
| T6           | 0 06525651 | 0 04125753 | 00000000    | 10253726   |       |          |          |   |
| T5           | 0 43252724 | 0 12225603 | 00101110    | 10253726   | *     |          |          |   |
| T4           | 0 61525352 | 0 05152345 | 00001000    | 10253726   |       |          |          |   |
| T3           | 0 70652555 | 0 02465562 | 00000000    | 10253726   |       |          |          |   |
| T2           | 0 34325272 | 0 11405517 | 00101100    | 10253726   | *     |          |          |   |
| T1           | 0 56152535 | 0 04642207 | 00001100    | 10253726   |       |          |          |   |
| T0           | 0 67065256 | 0 12574461 | 00001010    | 10253726   | *     |          |          |   |
| TR           | 0 73432527 | 0 05276634 | 00000000    | 10253726   |       |          |          |   |
| TP           | 0 35615253 | 0 12702234 | 00111010    | 10253726   | *     |          |          |   |
| T8           | 0 16706525 | 0 15650440 | 00011010    | 10253726   | *     |          |          |   |
| T7           | 0 07343252 | 0 16103542 | 01101010    | 10253726   | *     |          |          |   |
| T6           | 0 03561525 | 0 07401265 | 00101000    | 10253726   |       |          |          |   |
| T5           | 0 41670652 | 0 13014050 | 01101010    | 10253726   | *     |          |          |   |
| T4           | 0 20734325 | 0 05046420 | 01000010    | 10253726   |       |          |          |   |
| T3           | 0 10356152 | 0 13276132 | 00001010    | 10253726   | *     |          |          |   |
| T2           | 0 04167065 | 0 05537451 | 00000010    | 10253726   |       |          |          |   |
| T1           | 0 42073432 | 0 12022556 | 01111000    | 10253726   | *     |          |          |   |
| T0           | 0 21035615 | 0 05455667 | 00000000    | 10253726   |       |          |          |   |
| TR           | 0 50416706 | 0 12071651 | 01011010    | 10253726   | *     |          |          |   |
| TP           | 0 64207343 | 0 05430320 | 00011010    | 10253726   |       |          |          |   |
| T8           | 0 32103561 | 0 12073472 | 01001010    | 10253726   | *     |          |          |   |
| T7           | 0 15041670 | 0 15601167 | 00111000    | 10253726   | *     |          |          |   |
| T6           | 0 46420734 | 0 06744073 | 00001000    | 67524051   |       |          |          |   |
| TP           | 0 06745073 | 0 46420734 | 00001000    | 67524051   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL31<br>BC REGISTER | C REGISTER | A*M = 77401510 42064640 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 01242560 | 0 00000000 | 00000000                    | 63737373   |                           |
| T7   | 0 00521270 | 0 00000000 | 00000000                    | 63737373   |                           |
| T6   | 0 00250534 | 0 00000000 | 00000000                    | 63737373   |                           |
| T5   | 0 00124256 | 0 00000000 | 00000000                    | 63737373   |                           |
| T4   | 0 00052127 | 0 00000000 | 00000000                    | 63737373   |                           |
| T3   | 0 00025053 | 1 63737373 | 00000000                    | 63737373   | *                         |
| T2   | 0 40012425 | 1 54606060 | 01111110                    | 63737373   | *                         |
| T1   | 0 20005212 | 1 41676767 | 11010100                    | 63737373   | *                         |
| TC   | 0 50002505 | 1 64333333 | 01010100                    | 63737373   |                           |
| TR   | 0 64001242 | 1 55410100 | 01111110                    | 63737373   | *                         |
| TP   | 0 32000521 | 1 66240404 | 01010100                    | 63737373   |                           |
| T8   | 0 15000250 | 1 56453535 | 01010100                    | 63737373   | *                         |
| T7   | 0 46400124 | 1 67621616 | 00010100                    | 63737373   |                           |
| T6   | 0 23200052 | 1 73714747 | 00000000                    | 63737373   |                           |
| T5   | 0 51500025 | 1 75746363 | 00000000                    | 63737373   |                           |
| T4   | 0 64640012 | 1 51612464 | 11110100                    | 63737373   | *                         |
| T3   | 0 32320005 | 1 60341272 | 11010000                    | 63737373   |                           |
| T2   | 0 15150002 | 1 57413020 | 01111110                    | 63737373   | *                         |
| T1   | 0 06464001 | 1 67241054 | 01011000                    | 63737373   |                           |
| TC   | 0 03232000 | 1 57054311 | 01010110                    | 63737373   | *                         |
| TR   | 0 41515000 | 1 67022100 | 01010110                    | 63737373   |                           |
| TP   | 0 20646400 | 1 73015004 | 01000100                    | 63737373   |                           |
| T8   | 0 10323200 | 1 75006442 | 01000000                    | 63737373   |                           |
| T7   | 0 04151500 | 1 76003221 | 01000000                    | 63737373   |                           |
| T6   | 0 42064640 | 1 77401510 | 00000000                    | 14040404   |                           |
| TP   | 0 77401510 | 1 42064640 | 00000000                    | 14040404   |                           |

| FIGURE MUL32 |            |            |             | A*M =      | 00361521 | 66277232 | 0 |
|--------------|------------|------------|-------------|------------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |          |          |   |
| T8           | 1 76310175 | 0 00000000 | 00000000    | 66471421   |          |          |   |
| T7           | 1 37144076 | 1 66471421 | 00000000    | 66471421   | *        |          |   |
| T6           | 1 57462037 | 1 73234610 | 00000000    | 66471421   |          |          |   |
| T5           | 1 27631017 | 1 53107725 | 11100000    | 66471421   | *        |          |   |
| T4           | 1 53714407 | 1 50574373 | 10001000    | 66471421   | *        |          |   |
| T3           | 1 65746203 | 1 56667116 | 00101100    | 66471421   | *        |          |   |
| T2           | 1 32763101 | 1 45765520 | 10100010    | 66471421   | *        |          |   |
| T1           | 1 15371440 | 1 44423275 | 11101000    | 66471421   | *        |          |   |
| TC           | 1 46574620 | 1 66651136 | 00001000    | 66471421   |          |          |   |
| TR           | 1 23276310 | 1 73324057 | 00001000    | 66471421   |          |          |   |
| TP           | 1 51537144 | 1 75552427 | 00000000    | 66471421   |          |          |   |
| T8           | 1 64657462 | 1 76665213 | 00000000    | 66471421   |          |          |   |
| T7           | 1 72327631 | 1 77332505 | 00000000    | 66471421   |          |          |   |
| T6           | 1 75153714 | 1 55146663 | 11100000    | 66471421   | *        |          |   |
| T5           | 1 76465746 | 1 62023331 | 11100000    | 66471421   |          |          |   |
| T4           | 1 77232763 | 1 75451554 | 00000000    | 66471421   |          |          |   |
| T3           | 1 37515371 | 1 54215207 | 11101100    | 66471421   | *        |          |   |
| T2           | 1 57646574 | 1 50130554 | 11110000    | 66471421   | *        |          |   |
| T1           | 1 27723276 | 1 60410272 | 10110000    | 66471421   |          |          |   |
| TC           | 1 13751537 | 1 74240135 | 00010000    | 66471421   |          |          |   |
| TR           | 1 45764657 | 1 54515477 | 10100000    | 66471421   | *        |          |   |
| TP           | 1 62772327 | 1 50777250 | 10001010    | 66471421   | *        |          |   |
| T8           | 1 31375153 | 1 56761551 | 00110000    | 66471421   | *        |          |   |
| T7           | 1 54576465 | 1 45025205 | 11101100    | 66471421   | *        |          |   |
| T6           | 1 66277232 | 0 70351410 | 10010111    | 11306356   | *        |          |   |
| TP           | 1 00361521 | 0 66277232 | 10010111    | 11306356   |          |          |   |

| FIGURE MUL33 |            |            |             |            | A*M = 06361472 36302432 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 32300533 | 0 00000000 | 00000000    | 07664067   |                           |  |  |
| T7           | 0 15140255 | 0 07664067 | 00000000    | 07664067 * |                           |  |  |
| T6           | 0 46460126 | 0 02516012 | 11100110    | 07664067 * |                           |  |  |
| T5           | 0 23230053 | 0 05607041 | 00100010    | 07664067   |                           |  |  |
| T4           | 0 51514025 | 0 01527403 | 11100110    | 07664067 * |                           |  |  |
| T3           | 0 64646012 | 0 04177624 | 11000110    | 07664067 * |                           |  |  |
| T2           | 0 32323005 | 0 06477756 | 00000000    | 07664067   |                           |  |  |
| T1           | 0 15151402 | 0 02013746 | 11110110    | 07664067 * |                           |  |  |
| TC           | 0 06464601 | 0 05441727 | 00010100    | 07664067   |                           |  |  |
| TR           | 0 43232300 | 0 01400072 | 11111010    | 07664067 * |                           |  |  |
| TP           | 0 21515140 | 0 04244431 | 01000010    | 07664067   |                           |  |  |
| T8           | 0 50646460 | 0 02522210 | 00000010    | 07664067   |                           |  |  |
| T7           | 0 24323230 | 0 01251100 | 00000010    | 07664067   |                           |  |  |
| T6           | 0 12151514 | 0 00524444 | 00000000    | 07664067   |                           |  |  |
| T5           | 0 05064646 | 0 00252222 | 00000000    | 07664067   |                           |  |  |
| T4           | 0 02432323 | 0 00125111 | 00000000    | 07664067   |                           |  |  |
| T3           | 0 41215151 | 0 07636423 | 00100110    | 07664067 * |                           |  |  |
| T2           | 0 60506464 | 0 02533234 | 11110110    | 07664067 * |                           |  |  |
| T1           | 0 30243232 | 0 05611552 | 00110010    | 07664067   |                           |  |  |
| TC           | 0 14121515 | 0 02740661 | 00010010    | 07664067   |                           |  |  |
| TR           | 0 46050646 | 0 00140313 | 11110110    | 07664067 * |                           |  |  |
| TP           | 0 63024323 | 0 04424101 | 00100110    | 07664067   |                           |  |  |
| T8           | 0 71412151 | 0 01036163 | 11100010    | 07664067 * |                           |  |  |
| T7           | 0 74605064 | 0 04633054 | 10110110    | 07664067 * |                           |  |  |
| T6           | 0 36302432 | 0 06351462 | 00010010    | 70113710   |                           |  |  |
| TP           | 0 06361472 | 0 36302432 | 00010010    | 70113710   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL34<br>BC REGISTER | C REGISTER | A*M = 63723734 26006610 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 23402515 | 0 00000000 | 00000000                    | 54127724   |                           |
| T7   | 0 11601246 | 1 54127724 | 00000000                    | 54127724   | *                         |
| T6   | 0 04700523 | 1 66053752 | 00000000                    | 54127724   |                           |
| T5   | 0 02340251 | 1 47144601 | 00011110                    | 54127724   | *                         |
| T4   | 0 41160124 | 1 37505660 | 00111010                    | 54127724   | *                         |
| T3   | 0 20470052 | 1 57606334 | 00101000                    | 54127724   |                           |
| T2   | 0 10234025 | 1 67743556 | 00000000                    | 54127724   |                           |
| T1   | 0 04116012 | 1 47000503 | 01111110                    | 54127724   | *                         |
| TC   | 0 42047005 | 1 63044605 | 01000100                    | 54127724   |                           |
| TR   | 0 61023402 | 1 46141266 | 00011000                    | 54127724   | *                         |
| TP   | 0 30411601 | 1 63064133 | 00001000                    | 54127724   |                           |
| T8   | 0 54204700 | 1 45551371 | 00011010                    | 54127724   | *                         |
| T7   | 0 66102340 | 1 62660170 | 00011010                    | 54127724   |                           |
| T6   | 0 33041160 | 1 71334470 | 00000010                    | 54127724   |                           |
| T5   | 0 15420470 | 1 74556230 | 00000010                    | 54127724   |                           |
| T4   | 0 06610234 | 1 76267110 | 00000010                    | 54127724   |                           |
| T3   | 0 03304116 | 1 77133440 | 00000010                    | 54127724   |                           |
| T2   | 0 01542047 | 1 77455624 | 00000000                    | 54127724   |                           |
| T1   | 0 00661023 | 1 43745636 | 10011000                    | 54127724   | *                         |
| TC   | 0 00330411 | 1 31006233 | 11111010                    | 54127724   | *                         |
| TR   | 0 40154204 | 1 35166445 | 00011000                    | 54127724   | *                         |
| TP   | 0 60066102 | 1 56477622 | 00000000                    | 54127724   |                           |
| T8   | 0 30033041 | 1 67237711 | 00000000                    | 54127724   |                           |
| T7   | 0 54015420 | 1 47636660 | 00011010                    | 54127724   | *                         |
| T6   | 0 26006610 | 1 63713734 | 00010000                    | 23650053   |                           |
| TP   | 0 63723734 | 1 26006610 | 00010000                    | 23650053   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE MUL35<br>BC REGISTER | C REGISTER | A*M = | 10550561 | 33016416 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 52360411 | 0 00000000 | 00000000                    | 53323417   |       |          |          |   |
| T7   | 1 31170204 | 1 53323417 | 00000000                    | 53323417   | *     |          |          |   |
| T6   | 1 54474102 | 1 65551607 | 00000000                    | 53323417   |       |          |          |   |
| T5   | 1 66236041 | 1 72664703 | 00000000                    | 53323417   |       |          |          |   |
| T4   | 1 73117020 | 1 40655750 | 10080010                    | 53323417   | *     |          |          |   |
| T3   | 1 35447410 | 1 64326750 | 00000010                    | 53323417   |       |          |          |   |
| T2   | 1 16623604 | 1 72153374 | 00000000                    | 53323417   |       |          |          |   |
| T1   | 1 07311702 | 1 75065576 | 00000000                    | 53323417   |       |          |          |   |
| TC   | 1 03544741 | 1 76432677 | 00000000                    | 53323417   |       |          |          |   |
| TR   | 1 41662360 | 1 42530746 | 10010010                    | 53323417   | *     |          |          |   |
| TP   | 1 20731170 | 1 65250367 | 00010000                    | 53323417   |       |          |          |   |
| T8   | 1 50354474 | 1 72520173 | 00010000                    | 53323417   |       |          |          |   |
| T7   | 1 64166236 | 1 75254075 | 00000000                    | 53323417   |       |          |          |   |
| T6   | 1 72073117 | 1 76526036 | 00000000                    | 53323417   |       |          |          |   |
| T5   | 1 35035447 | 1 42576426 | 10000010                    | 53323417   | *     |          |          |   |
| T4   | 1 16416623 | 1 30512626 | 10110010                    | 53323417   | *     |          |          |   |
| T3   | 1 07207311 | 1 33634726 | 00000010                    | 53323417   | *     |          |          |   |
| T2   | 1 03503544 | 1 20231766 | 11010010                    | 53323417   | *     |          |          |   |
| T1   | 1 01641662 | 1 54510777 | 00010000                    | 53323417   |       |          |          |   |
| TC   | 1 40720731 | 1 66240377 | 00010000                    | 53323417   | *     |          |          |   |
| TR   | 1 60350354 | 1 46447506 | 00000110                    | 53323417   | *     |          |          |   |
| TP   | 1 30164166 | 1 63223607 | 00000100                    | 53323417   |       |          |          |   |
| T8   | 1 54072073 | 1 71511743 | 00000000                    | 53323417   |       |          |          |   |
| T7   | 1 66035035 | 1 47167370 | 01001010                    | 53323417   | *     |          |          |   |
| T6   | 1 33016416 | 0 00440460 | 10110101                    | 24454360   | *     |          |          |   |
| TP   | 1 10550561 | 0 33016416 | 10110101                    | 24454360   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL36<br>BC REGISTER | C REGISTER | A*M = | 30536721 | 76064526 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 44436405 | 0 00000000 | 00000000                    | 43154757   |       |          |          |   |
| T7   | 1 22217202 | 1 43154757 | 00000000                    | 43154757 * |       |          |          |   |
| T6   | 1 51107501 | 1 61466367 | 00000000                    | 43154757   |       |          |          |   |
| T5   | 1 64443640 | 1 33707042 | 00101110                    | 43154757 * |       |          |          |   |
| T4   | 1 32221720 | 1 55703065 | 00101000                    | 43154757   |       |          |          |   |
| T3   | 1 55110750 | 1 66701032 | 00101000                    | 43154757   |       |          |          |   |
| T2   | 1 26444364 | 1 73300015 | 00101000                    | 43154757   |       |          |          |   |
| T1   | 1 53222172 | 1 75500406 | 00100000                    | 43154757   |       |          |          |   |
| TC   | 1 25511075 | 1 76600203 | 00100000                    | 43154757   |       |          |          |   |
| TR   | 1 52644436 | 1 32414050 | 10101010                    | 43154757 * |       |          |          |   |
| TP   | 1 25322217 | 1 51246420 | 10000010                    | 43154757   |       |          |          |   |
| T8   | 1 12551107 | 1 33677163 | 00001010                    | 43154757 * |       |          |          |   |
| T7   | 1 45264443 | 1 10004744 | 11110110                    | 43154757 * |       |          |          |   |
| T6   | 1 22532221 | 1 13512375 | 00111010                    | 43154757 * |       |          |          |   |
| T5   | 1 51255110 | 1 00065451 | 11001110                    | 43154757 * |       |          |          |   |
| T4   | 1 64526444 | 1 44432260 | 00001010                    | 43154757   |       |          |          |   |
| T3   | 1 32253222 | 1 62215534 | 00000000                    | 43154757   |       |          |          |   |
| T2   | 1 15125511 | 1 71106656 | 00000000                    | 43154757   |       |          |          |   |
| T1   | 1 06452644 | 1 37517276 | 00101010                    | 43154757 * |       |          |          |   |
| TC   | 1 03225322 | 1 57607133 | 00101010                    | 43154757   |       |          |          |   |
| TR   | 1 41512551 | 1 67743051 | 00001010                    | 43154757   |       |          |          |   |
| TP   | 1 60645264 | 1 36036707 | 01100100                    | 43154757 * |       |          |          |   |
| T8   | 1 70322532 | 1 57457303 | 00000100                    | 43154757   |       |          |          |   |
| T7   | 1 74151255 | 1 67527501 | 00000100                    | 43154757   |       |          |          |   |
| T6   | 1 76064526 | 0 27536720 | 01000001                    | 34623020 * |       |          |          |   |
| TP   | 1 30536721 | 0 76064526 | 01000001                    | 34623020   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL37<br>BC REGISTER | A*M = 06521556 21500510 0<br>C REGISTER |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 0 12254114 | 0 00000000 | 00000000                    | 24474123                                |
| T7   | 0 05126046 | 0 00000000 | 00000000                    | 24474123                                |
| T6   | 0 02453029 | 0 00000000 | 00000000                    | 24474123                                |
| T5   | 0 01225411 | 0 24474123 | 00000000                    | 24474123 *                              |
| T4   | 0 40512604 | 0 36622174 | 00110000                    | 24474123 *                              |
| T3   | 0 20245302 | 0 17355076 | 00000000                    | 24474123                                |
| T2   | 0 10122541 | 0 07566437 | 00000000                    | 24474123                                |
| T1   | 0 44051260 | 0 27267332 | 01100010                    | 24474123 *                              |
| TC   | 0 22024630 | 0 13173551 | 01000010                    | 24474123                                |
| TR   | 0 51012254 | 0 05075660 | 01000010                    | 24474123                                |
| TP   | 0 24405126 | 0 02036734 | 01000000                    | 24474123                                |
| T9   | 0 12202453 | 0 01417356 | 00000000                    | 24474123                                |
| T7   | 0 05101225 | 0 24273602 | 01010110                    | 24474123 *                              |
| T6   | 0 02440512 | 0 36135060 | 01101010                    | 24474123 *                              |
| T5   | 0 01220245 | 0 17416034 | 00101000                    | 24474123                                |
| T4   | 0 00510122 | 0 23233531 | 11110010                    | 24474123 *                              |
| T3   | 0 40244051 | 0 15151650 | 01010010                    | 24474123                                |
| T2   | 0 20122024 | 0 23464053 | 10101000                    | 24474123 *                              |
| T1   | 0 50051012 | 0 15672425 | 00000000                    | 24474123                                |
| TC   | 0 64024405 | 0 06735212 | 00000000                    | 24474123                                |
| TR   | 0 32012202 | 0 27742620 | 00110010                    | 24474123 *                              |
| TP   | 0 15005101 | 0 13725314 | 00100000                    | 24474123                                |
| T8   | 0 06402440 | 0 21406661 | 11100010                    | 24474123 *                              |
| T7   | 0 43201220 | 0 14243334 | 01000000                    | 24474123                                |
| T6   | 0 21500510 | 0 06521556 | 00000000                    | 53303654                                |
| TP   | 0 06521556 | 0 21500510 | 00000000                    | 53303654                                |

| FIGURE MUL38 |            |            |             | A*M =      | 07204746 | 64342230 | 0 |
|--------------|------------|------------|-------------|------------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |          |          |   |
| T8           | 0 10310731 | 0 00000000 | 00000000    | 33534454   |          |          |   |
| T7           | 0 04144354 | 0 33534454 | 00000000    | 33534454   | *        |          |   |
| T6           | 0 02062166 | 0 15656226 | 00000000    | 33534454   |          |          |   |
| T5           | 0 01031073 | 0 06727113 | 00000000    | 33534454   |          |          |   |
| T4           | 0 40414435 | 0 36007011 | 01101110    | 33534454   | *        |          |   |
| T3           | 0 60206216 | 0 42170424 | 11010100    | 33534454   | *        |          |   |
| T2           | 0 30103107 | 0 25470252 | 00010000    | 33534454   |          |          |   |
| T1           | 0 14041443 | 0 45374571 | 01000010    | 33534454   | *        |          |   |
| TC           | 0 46020621 | 0 56622654 | 00110100    | 33534454   | *        |          |   |
| TR           | 0 23010310 | 0 52001732 | 11110110    | 33534454   | *        |          |   |
| TP           | 0 11404144 | 0 21444711 | 10000110    | 33534454   |          |          |   |
| T6           | 0 44602062 | 0 14622300 | 00000110    | 33534454   |          |          |   |
| T7           | 0 22301031 | 0 06311104 | 00000100    | 33534454   |          |          |   |
| T6           | 0 11140414 | 0 36670156 | 00011000    | 33534454   | *        |          |   |
| T5           | 0 04460206 | 0 17330467 | 00010000    | 33534454   |          |          |   |
| T4           | 0 42230103 | 0 07550233 | 00010000    | 33534454   |          |          |   |
| T3           | 0 61114041 | 0 36324561 | 01100010    | 33534454   | *        |          |   |
| T2           | 0 70446020 | 0 42346640 | 11000110    | 33534454   | *        |          |   |
| T1           | 0 34223010 | 0 25563364 | 00000000    | 33534454   |          |          |   |
| TC           | 0 16111404 | 0 12671572 | 00000000    | 33534454   |          |          |   |
| TR           | 0 07044602 | 0 05334675 | 00000000    | 33534454   |          |          |   |
| TP           | 0 43422301 | 0 02556336 | 00000000    | 33534454   |          |          |   |
| T8           | 0 21611140 | 0 34713523 | 00110110    | 33534454   | *        |          |   |
| T7           | 0 50704460 | 0 16301615 | 00110100    | 33534454   |          |          |   |
| T6           | 0 64342230 | 0 07104746 | 00100000    | 44243323   |          |          |   |
| TP           | 0 07204746 | 0 64342230 | 00100000    | 44243323   |          |          |   |

| FIGURE MUL39 |            |            |             |            | A*M = 05043667 76312562 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 16516613 | 0 00000000 | 00000000    | 13044513   |                           |  |  |
| T7           | 0 07247306 | 0 13044513 | 00000000    | 13044513   | *                         |  |  |
| T6           | 0 43523542 | 0 10466750 | 10000010    | 13044513   | *                         |  |  |
| T5           | 0 21651661 | 0 00233360 | 10000010    | 13044513   |                           |  |  |
| T4           | 0 10724730 | 0 17151207 | 00011100    | 13044513   | *                         |  |  |
| T3           | 0 44352354 | 0 07460143 | 00011000    | 13044513   |                           |  |  |
| T2           | 0 62165166 | 0 03634461 | 00000000    | 13044513   |                           |  |  |
| T1           | 0 71072473 | 0 01716230 | 00000000    | 13044513   |                           |  |  |
| T0           | 0 34435235 | 0 13703627 | 00110000    | 13044513   | *                         |  |  |
| TR           | 0 56216516 | 0 10041426 | 11011000    | 13044513   | *                         |  |  |
| TP           | 0 27107247 | 0 00424213 | 10001000    | 13044513   |                           |  |  |
| T8           | 0 53443523 | 0 17256210 | 00001010    | 13044513   | *                         |  |  |
| T7           | 0 25621651 | 0 12563223 | 10011000    | 13044513   | *                         |  |  |
| T6           | 0 52710724 | 0 24232624 | 00110000    | 13044513   | *                         |  |  |
| T5           | 0 25344352 | 0 12151312 | 00010000    | 13044513   |                           |  |  |
| T4           | 0 12562165 | 0 05060545 | 00010000    | 13044513   |                           |  |  |
| T3           | 0 45271072 | 0 15470775 | 00010000    | 13044513   | *                         |  |  |
| T2           | 0 62534435 | 0 06630376 | 00010000    | 13044513   |                           |  |  |
| T1           | 0 31256216 | 0 16364602 | 00000110    | 13044513   | *                         |  |  |
| T0           | 0 14527107 | 0 07172345 | 00000000    | 13044513   |                           |  |  |
| TR           | 0 46253443 | 0 16431675 | 00110000    | 13044513   | *                         |  |  |
| TP           | 0 63125621 | 0 12224441 | 10101010    | 13044513   | *                         |  |  |
| T8           | 0 71452710 | 0 24116337 | 00101000    | 13044513   | *                         |  |  |
| T7           | 0 74625344 | 0 12007557 | 00100000    | 13044513   |                           |  |  |
| T6           | 0 76312562 | 0 05043667 | 00000000    | 64733264   |                           |  |  |
| TP           | 0 05043667 | 0 76312562 | 00000000    | 64733264   |                           |  |  |

| FIGURE MUL40 |            |            |             |            | A*M = 02073303 11151642 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 03573443 | 0 00000000 | 00000000    | 22062173   |                           |  |  |
| T7           | 0 01675621 | 0 22062173 | 00000000    | 22062173   | *                         |  |  |
| T6           | 0 40736710 | 0 33013160 | 00100110    | 22062173   | *                         |  |  |
| T5           | 0 20357344 | 0 15445434 | 00000100    | 22062173   |                           |  |  |
| T4           | 0 10167562 | 0 06622656 | 00000000    | 22062173   |                           |  |  |
| T3           | 0 04073671 | 0 03311327 | 00000000    | 22062173   |                           |  |  |
| T2           | 0 42035734 | 0 23526646 | 00100100    | 22062173   | *                         |  |  |
| T1           | 0 21016756 | 0 11613363 | 00100000    | 22062173   |                           |  |  |
| T0           | 0 50407367 | 0 04745571 | 00000000    | 22062173   |                           |  |  |
| TR           | 0 64203573 | 0 24344767 | 00100100    | 22062173   | *                         |  |  |
| TP           | 0 72101675 | 0 34204526 | 00100100    | 22062173   | *                         |  |  |
| T8           | 0 35040736 | 0 30124406 | 10100100    | 22062173   | *                         |  |  |
| T7           | 0 16420357 | 0 10012243 | 10100000    | 22062173   |                           |  |  |
| T6           | 0 47210167 | 0 32027214 | 00100100    | 22062173   | *                         |  |  |
| T5           | 0 23504073 | 0 37035631 | 00100110    | 22062173   | *                         |  |  |
| T4           | 0 51642035 | 0 31430053 | 10111100    | 22062173   | *                         |  |  |
| T3           | 0 64721016 | 0 42642550 | 00100110    | 22062173   | *                         |  |  |
| T2           | 0 32350407 | 0 21361220 | 00000110    | 22062173   |                           |  |  |
| T1           | 0 15164203 | 0 32552647 | 00100100    | 22062173   | *                         |  |  |
| T0           | 0 46472101 | 0 37307456 | 00100100    | 22062173   | *                         |  |  |
| TR           | 0 23235040 | 0 31665752 | 10000110    | 22062173   | *                         |  |  |
| TP           | 0 11516420 | 0 10732721 | 10000110    | 22062173   |                           |  |  |
| T8           | 0 44647210 | 0 00355314 | 10000100    | 22062173   |                           |  |  |
| T7           | 0 22323504 | 0 04166506 | 00000100    | 22062173   |                           |  |  |
| T6           | 0 11151642 | 0 02073203 | 00000100    | 55716604   |                           |  |  |
| TP           | 0 02073303 | 0 11151642 | 00000100    | 55716604   |                           |  |  |

| FIGURE MUL41 |            |            |             |            | A*M = 77116344 |  | 30635022 | 0 |
|--------------|------------|------------|-------------|------------|----------------|--|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                |  |          |   |
| T8           | 0 34330013 | 0 00000000 | 00000000    | 77027673   |                |  |          |   |
| T7           | 0 16184008 | 1 77027673 | 00000000    | 77027673   | *              |  |          |   |
| T6           | 0 42066002 | 1 66432620 | 10011110    | 77027673   | *              |  |          |   |
| T5           | 0 23433001 | 1 77211614 | 00010100    | 77027673   |                |  |          |   |
| T4           | 0 11615400 | 1 66537531 | 10001110    | 77027673   | *              |  |          |   |
| T3           | 0 44706600 | 1 77257210 | 00001110    | 77027673   |                |  |          |   |
| T2           | 0 22343300 | 1 77527140 | 00001010    | 77027673   |                |  |          |   |
| T1           | 0 11161540 | 1 77653064 | 00001000    | 77027673   |                |  |          |   |
| T0           | 0 04470660 | 1 77725032 | 00001000    | 77027673   |                |  |          |   |
| TR           | 0 02234330 | 1 77752015 | 00001000    | 77027673   |                |  |          |   |
| TP           | 0 41116154 | 1 77765406 | 00000000    | 77027673   |                |  |          |   |
| T8           | 0 20447066 | 1 77772603 | 00000000    | 77027673   |                |  |          |   |
| T7           | 0 50223433 | 1 77775301 | 00000000    | 77027673   |                |  |          |   |
| T6           | 0 64111615 | 1 66715333 | 10111100    | 77027673   | *              |  |          |   |
| T5           | 0 72044706 | 1 66432000 | 10011110    | 77027673   | *              |  |          |   |
| T4           | 0 35022343 | 1 77211444 | 00010000    | 77027673   |                |  |          |   |
| T3           | 0 16411161 | 1 66537415 | 10001100    | 77027673   | *              |  |          |   |
| T2           | 0 47204470 | 1 66277031 | 10011110    | 77027673   | *              |  |          |   |
| T1           | 0 63502234 | 1 77133050 | 00011010    | 77027673   |                |  |          |   |
| T0           | 0 31641116 | 1 77481020 | 00011010    | 77027673   |                |  |          |   |
| TR           | 0 14720447 | 1 77620014 | 00011000    | 77027673   |                |  |          |   |
| TP           | 0 06350223 | 1 66733271 | 10011010    | 77027673   | *              |  |          |   |
| T8           | 0 43164111 | 1 66301733 | 10110100    | 77027673   | *              |  |          |   |
| T7           | 0 61472044 | 1 66223600 | 10011110    | 77027673   | *              |  |          |   |
| T6           | 0 30635022 | 1 77115344 | 00001000    | 00750104   |                |  |          |   |
| TP           | 0 77116344 | 1 30635022 | 00001000    | 00750104   |                |  |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL42<br>BC REGISTER | C REGISTER | A*M = 02675464 65657500 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 15470352 | 0 00000000 | 00000000                    | 06577220   |                           |
| T7   | 0 06634165 | 0 00000000 | 00000000                    | 06577220   |                           |
| T6   | 0 03316072 | 0 06577220 | 00000000                    | 06577220   | *                         |
| T5   | 0 01547035 | 0 03277510 | 00000000                    | 06577220   |                           |
| T4   | 0 00663416 | 0 07226064 | 01111000                    | 06577220   | *                         |
| T3   | 0 00331607 | 0 03157432 | 01000000                    | 06577220   |                           |
| T2   | 0 00154703 | 0 00556035 | 10111000                    | 06577220   | *                         |
| T1   | 0 40066341 | 0 02022636 | 11110000                    | 06577220   | *                         |
| TC   | 0 20033160 | 0 03144537 | 11110000                    | 06577220   | *                         |
| TR   | 0 50015470 | 0 05026257 | 01100000                    | 06577220   |                           |
| TP   | 0 64006634 | 0 02053127 | 01000000                    | 06577220   |                           |
| T8   | 0 72003316 | 0 01425453 | 00000000                    | 06577220   |                           |
| T7   | 0 75001547 | 0 00612625 | 00000000                    | 06577220   |                           |
| T6   | 0 76400663 | 0 06074532 | 01010000                    | 06577220   | *                         |
| T5   | 0 37200331 | 0 01131475 | 11110000                    | 06577220   | *                         |
| T4   | 0 57500154 | 0 03617056 | 10101000                    | 06577220   | *                         |
| T3   | 0 27640066 | 0 05747027 | 00001000                    | 06577220   |                           |
| T2   | 0 53720033 | 0 02763013 | 00001000                    | 06577220   |                           |
| T1   | 0 65750015 | 0 07061225 | 01110000                    | 06577220   | *                         |
| TC   | 0 72764006 | 0 02563732 | 10110000                    | 06577220   | *                         |
| TR   | 0 35372003 | 0 05235755 | 00100000                    | 06577220   |                           |
| TP   | 0 56575001 | 0 00245106 | 11111100                    | 06577220   | *                         |
| T8   | 0 27276400 | 0 02256323 | 11110000                    | 06577220   | *                         |
| T7   | 0 53537200 | 0 05563151 | 00010000                    | 06577220   |                           |
| T6   | 0 65657500 | 0 02675464 | 00000000                    | 71200557   |                           |
| TP   | 0 02675464 | 0 65657500 | 00000000                    | 71200557   |                           |

| FIGURE MUL43 |            |            |             |            | A*M = 03303112 44670636 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 47453333 | 0 00000000 | 00000000    | 73443035   |                           |  |  |
| T7           | 1 23625555 | 1 73443035 | 00000000    | 73443035   | *                         |  |  |
| T6           | 1 51712666 | 1 60264443 | 11000010    | 73443035   | *                         |  |  |
| T5           | 1 64745333 | 1 74532225 | 00000000    | 73443035   |                           |  |  |
| T4           | 1 72362555 | 1 61610147 | 10110000    | 73443035   | *                         |  |  |
| T3           | 1 75171266 | 1 67313010 | 01100110    | 73443035   | *                         |  |  |
| T2           | 1 36474533 | 1 73105440 | 01100010    | 73443035   |                           |  |  |
| T1           | 1 17236255 | 1 61545651 | 10000010    | 73443035   | *                         |  |  |
| TC           | 1 47517126 | 1 67225765 | 01100000    | 73443035   | *                         |  |  |
| TR           | 1 63647453 | 1 73152772 | 01000000    | 73443035   |                           |  |  |
| TP           | 1 31723625 | 1 61420322 | 10110110    | 73443035   | *                         |  |  |
| TH           | 1 14751712 | 1 67217242 | 01100010    | 73443035   | *                         |  |  |
| T7           | 1 06364745 | 1 73147525 | 01000000    | 73443035   |                           |  |  |
| T6           | 1 43172362 | 1 61426607 | 10100100    | 73443035   | *                         |  |  |
| T5           | 1 61475171 | 1 24653343 | 00000000    | 73443035   |                           |  |  |
| T4           | 1 70636474 | 1 61760516 | 10010100    | 73443035   | *                         |  |  |
| T3           | 1 34317236 | 1 74774207 | 00000100    | 73443035   |                           |  |  |
| T2           | 1 56147517 | 1 76376143 | 00000000    | 73443035   |                           |  |  |
| T1           | 1 67063647 | 1 62532016 | 10110100    | 73443035   | *                         |  |  |
| TC           | 1 33431723 | 1 60764074 | 10000010    | 73443035   | *                         |  |  |
| TR           | 1 15614751 | 1 67735077 | 00100000    | 73443035   | *                         |  |  |
| TP           | 1 46706364 | 1 66451464 | 01010010    | 73443035   | *                         |  |  |
| TH           | 1 23343172 | 1 73620636 | 00010000    | 73443035   |                           |  |  |
| T7           | 1 11561475 | 1 75714317 | 00000000    | 73443035   |                           |  |  |
| T6           | 1 44670636 | 0 72272001 | 11011111    | 04334742   | *                         |  |  |
| TP           | 1 03303112 | 0 44670636 | 11011111    | 04334742   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE MUL44<br>SC REGISTER | C REGISTER | A*M = | 05536742 | 02312574 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 32432635 | 0 00000000 | 00000000                    | 06664126   |       |          |          |   |
| T7   | 0 15213316 | 0 06664126 | 00000000                    | 06664126   | *     |          |          |   |
| T6   | 0 06506547 | 0 03332053 | 00000000                    | 06664126   |       |          |          |   |
| T5   | 0 43243263 | 0 07331143 | 01110010                    | 06664126   | *     |          |          |   |
| T4   | 0 61321531 | 0 02004503 | 11100110                    | 06664126   | *     |          |          |   |
| T3   | 0 70630554 | 0 03226423 | 11100010                    | 06664126   | *     |          |          |   |
| T2   | 0 74324326 | 0 05153215 | 01000000                    | 06664126   |       |          |          |   |
| T1   | 0 76152153 | 0 02065506 | 01000000                    | 06664126   |       |          |          |   |
| TO   | 0 37065065 | 0 07216761 | 01109010                    | 06664126   | *     |          |          |   |
| TR   | 0 57432432 | 0 02723412 | 10110110                    | 06664126   | *     |          |          |   |
| TP   | 0 27615215 | 0 05315641 | 00100010                    | 06664126   |       |          |          |   |
| T8   | 0 53706506 | 0 00462042 | 11011010                    | 06664126   | *     |          |          |   |
| T7   | 0 25743243 | 0 04635425 | 00000000                    | 06664126   |       |          |          |   |
| T6   | 0 52761521 | 0 00172730 | 11010010                    | 06664126   | *     |          |          |   |
| T5   | 0 25370650 | 0 02265406 | 11100100                    | 06664126   | *     |          |          |   |
| T4   | 0 12574324 | 0 05572443 | 00000000                    | 06664126   |       |          |          |   |
| T3   | 0 45275152 | 0 02575321 | 00000000                    | 06664126   |       |          |          |   |
| T2   | 0 52537055 | 0 01336550 | 00000000                    | 06664126   |       |          |          |   |
| T1   | 0 31257432 | 0 06333302 | 01110110                    | 06664126   | *     |          |          |   |
| TO   | 0 14527615 | 0 03511505 | 00110100                    | 06664126   |       |          |          |   |
| TR   | 0 46253706 | 0 07574020 | 01001010                    | 06664126   | *     |          |          |   |
| TP   | 0 23125743 | 0 03276414 | 01000000                    | 06664126   |       |          |          |   |
| T6   | 0 11452761 | 0 00713324 | 10110010                    | 06664126   | *     |          |          |   |
| T7   | 0 04625370 | 0 02275574 | 11000010                    | 06664126   | *     |          |          |   |
| T5   | 0 02312574 | 0 05536732 | 00000010                    | 71113651   |       |          |          |   |
| TP   | 0 05536742 | 0 02312574 | 00000010                    | 71113651   |       |          |          |   |

FIGURE MUL45  
BC REGISTER

A\*M = 07221555 20577040 0

| TIME | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |
|------|------------|------------|-------------|------------|
| T8   | 0 30556344 | 0 00000000 | 00000000    | 11334744   |
| T7   | 0 14267162 | 0 00000000 | 00000000    | 11334744   |
| T6   | 0 06133471 | 0 00000000 | 00000000    | 11334744   |
| T5   | 0 03055634 | 0 11334744 | 00000000    | 11334744 * |
| T4   | 0 01426716 | 0 04556362 | 00000000    | 11334744   |
| T3   | 0 00613347 | 0 02267171 | 00000000    | 11334744   |
| T2   | 0 40305563 | 0 12467330 | 00001110    | 11334744 * |
| T1   | 0 20142671 | 0 16560164 | 00011000    | 11334744 * |
| TC   | 0 10061334 | 0 10520336 | 10111100    | 11334744 * |
| TR   | 0 04030556 | 0 00214517 | 10100100    | 11334744   |
| TP   | 0 42014267 | 0 04146207 | 00000100    | 11334744   |
| T8   | 0 61006133 | 0 13317007 | 00101100    | 11334744 * |
| T7   | 0 70403055 | 0 16134707 | 01010100    | 11334744 * |
| T6   | 0 74201426 | 0 10716347 | 10101000    | 11334744 * |
| T5   | 0 76100613 | 0 00307563 | 10100000    | 11334744   |
| T4   | 0 77040305 | 0 15537535 | 00001100    | 11334744 * |
| T3   | 0 77420142 | 0 17104252 | 01111010    | 11334744 * |
| T2   | 0 37610061 | 0 07006521 | 01100010    | 11334744   |
| T1   | 0 57704030 | 0 15377110 | 00001110    | 11334744 * |
| TC   | 0 27742014 | 0 06577000 | 00001110    | 11334744   |
| TR   | 0 13761006 | 0 03277044 | 00001000    | 11334744   |
| TP   | 0 05770403 | 0 01537022 | 00001000    | 11334744   |
| T8   | 0 02774201 | 0 11104755 | 01110000    | 11334744 * |
| T7   | 0 41376100 | 0 16432222 | 00011110    | 11334744 * |
| T6   | 0 20577040 | 0 07211555 | 00010000    | 66443033   |
| IP   | 0 07221555 | 0 20577040 | 00010000    | 66443033   |

| TIME | A REGISTER | B REGISTER | FIGURE MUL46<br>BC REGISTER | C REGISTER | A*M = 04002564 42550272 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 11430455 | 0 00000000 | 00000000                    | 15330761   |                           |
| T7   | 0 04614226 | 0 15330761 | 00000000                    | 15330761   | *                         |
| T6   | 0 42306113 | 0 06554370 | 00000000                    | 15330761   |                           |
| T5   | 0 21143045 | 0 10516055 | 10101100                    | 15330761   | *                         |
| T4   | 0 50461422 | 0 25637347 | 00001100                    | 15330761   | *                         |
| T3   | 0 64230611 | 0 12717123 | 00001100                    | 15330761   |                           |
| T2   | 0 72114304 | 0 12670072 | 10011000                    | 15330761   | *                         |
| T1   | 0 35046142 | 0 01330435 | 10010000                    | 15330761   |                           |
| T0   | 0 56423061 | 0 04550216 | 00010000                    | 15330761   |                           |
| TR   | 0 27211430 | 0 17520060 | 00101010                    | 15330761   | *                         |
| TP   | 0 13504614 | 0 07610434 | 00100000                    | 15330761   |                           |
| T3   | 0 05642306 | 0 03744216 | 00000000                    | 15330761   |                           |
| T7   | 0 02721143 | 0 01762107 | 00000000                    | 15330761   |                           |
| T6   | 0 41350461 | 0 15221724 | 01100100                    | 15330761   | *                         |
| T5   | 0 20564230 | 0 14400773 | 10101000                    | 15330761   | *                         |
| T4   | 0 50272114 | 0 02240775 | 10000000                    | 15330761   |                           |
| T3   | 0 64135046 | 0 05120376 | 00000000                    | 15330761   |                           |
| T2   | 0 32056423 | 0 02450177 | 00000000                    | 15330761   |                           |
| T1   | 0 55027211 | 0 16554750 | 00000110                    | 15330761   | *                         |
| T0   | 0 26413504 | 0 14516311 | 10101100                    | 15330761   | *                         |
| TR   | 0 53205642 | 0 02207504 | 10100100                    | 15330761   |                           |
| TP   | 0 25502721 | 0 05143602 | 00000100                    | 15330761   |                           |
| T8   | 0 12641350 | 0 17711622 | 00101100                    | 15330761   | *                         |
| T7   | 0 05320564 | 0 07704351 | 00101000                    | 15330761   |                           |
| T6   | 0 42550272 | 0 03702564 | 00100000                    | 62447016   |                           |
| TP   | 0 04002564 | 0 42550272 | 00100000                    | 62447016   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE MUL47<br>BC REGISTER | C REGISTER | A*M = | 00006074 | 35126000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 75513000 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T7   | 1 36645400 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T6   | 1 17322600 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T5   | 1 07551300 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T4   | 1 03664540 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T3   | 1 01732260 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T2   | 1 00755130 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| T1   | 1 00366454 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| TC   | 1 00173226 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| TR   | 1 00075513 | 0 00000000 | 00000000                    | 77654641   |       |          |          |   |
| TP   | 1 00036645 | 1 77654641 | 00000000                    | 77654641   | *     |          |          |   |
| T8   | 1 40017322 | 1 66572161 | 11011000                    | 77654641   | *     |          |          |   |
| T7   | 1 60007551 | 1 77671470 | 00010000                    | 77654641   |       |          |          |   |
| T6   | 1 30003664 | 1 66514475 | 11101000                    | 77654641   | *     |          |          |   |
| T5   | 1 54001732 | 1 77606636 | 00100000                    | 77654641   |       |          |          |   |
| T4   | 1 26000755 | 1 77743317 | 00000000                    | 77654641   |       |          |          |   |
| T3   | 1 53000366 | 1 66535300 | 11101110                    | 77654641   | *     |          |          |   |
| T2   | 1 25400173 | 1 77616104 | 00101100                    | 77654641   |       |          |          |   |
| T1   | 1 12600075 | 1 66513343 | 11111000                    | 77654641   | *     |          |          |   |
| TC   | 1 45300036 | 1 66556722 | 11000100                    | 77654641   | *     |          |          |   |
| TR   | 1 22540017 | 1 77673311 | 00000100                    | 77654641   |       |          |          |   |
| TP   | 1 51260007 | 1 66501445 | 11111000                    | 77654641   | *     |          |          |   |
| T8   | 1 64530003 | 1 66551063 | 11011000                    | 77654641   | *     |          |          |   |
| T7   | 1 72254001 | 1 66445672 | 11100000                    | 77654641   | *     |          |          |   |
| T6   | 1 35126000 | 0 77708063 | 00101011                    | 00123136   | *     |          |          |   |
| TP   | 1 00006074 | 0 35126000 | 00101011                    | 00123136   |       |          |          |   |

| FIGURE MUL48 |            |            |             |            | A*M = 00404502 17747764 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 06431271 | 0 00000000 | 00000000    | 02371312   |                           |  |  |
| T7           | 0 03214534 | 0 02371312 | 00000000    | 02371312   | *                         |  |  |
| T6           | 0 01505256 | 0 01174545 | 00000000    | 02371312   |                           |  |  |
| T5           | 0 40643127 | 0 00476262 | 00000000    | 02371312   |                           |  |  |
| T4           | 0 20321453 | 0 02520443 | 00110000    | 02371312   | *                         |  |  |
| T3           | 0 50150625 | 0 03605533 | 00100000    | 02371312   | *                         |  |  |
| T2           | 0 64064312 | 0 03233167 | 01101000    | 02371312   | *                         |  |  |
| T1           | 0 72032145 | 0 01155073 | 01001000    | 02371312   |                           |  |  |
| TC           | 0 75015062 | 0 03350347 | 00110000    | 02371312   | *                         |  |  |
| TR           | 0 76406431 | 0 01520163 | 00110000    | 02371312   |                           |  |  |
| TP           | 0 77203214 | 0 02205303 | 01100100    | 02371312   | *                         |  |  |
| T8           | 0 77501506 | 0 01542501 | 00000100    | 02371312   |                           |  |  |
| T7           | 0 77640643 | 0 00661200 | 00000100    | 02371312   |                           |  |  |
| T6           | 0 37720321 | 0 02621052 | 00101000    | 02371312   | *                         |  |  |
| T5           | 0 17750150 | 0 03642337 | 00100000    | 02371312   | *                         |  |  |
| T4           | 0 47764064 | 0 01761157 | 00000000    | 02371312   |                           |  |  |
| T3           | 0 63772032 | 0 00770467 | 00000000    | 02371312   |                           |  |  |
| T2           | 0 71775015 | 0 00374233 | 00000000    | 02371312   |                           |  |  |
| T1           | 0 74776406 | 0 02467427 | 00100000    | 02371312   | *                         |  |  |
| TC           | 0 76377203 | 0 01273613 | 00000000    | 02371312   |                           |  |  |
| TR           | 0 77177501 | 0 02026217 | 01101000    | 02371312   | *                         |  |  |
| TP           | 0 77477640 | 0 03744011 | 00101010    | 02371312   | *                         |  |  |
| T8           | 0 77637720 | 0 01722400 | 00100010    | 02371312   |                           |  |  |
| T7           | 0 37717750 | 0 00711204 | 00100000    | 02371312   |                           |  |  |
| T6           | 0 17747764 | 0 00304502 | 00100000    | 75406465   |                           |  |  |
| TP           | 0 00404502 | 0 17747764 | 00100000    | 75406465   |                           |  |  |

| FIGURE MUL49 |            |            |             |            | A*M = 02216520 77651600 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 33330610 | 0 00000000 | 00000000    | 02521270   |                           |  |  |
| T7           | 0 15554304 | 0 00000000 | 00000000    | 02521270   |                           |  |  |
| T6           | 0 06666142 | 0 00000000 | 00000000    | 02521270   |                           |  |  |
| T5           | 0 03333061 | 0 00000000 | 00000000    | 02521270   |                           |  |  |
| T4           | 0 01555430 | 0 02521270 | 00000000    | 02521270   | *                         |  |  |
| T3           | 0 00666614 | 0 01250534 | 00000000    | 02521270   |                           |  |  |
| T2           | 0 00333306 | 0 00524256 | 00000000    | 02521270   |                           |  |  |
| T1           | 0 00155543 | 0 00252127 | 00000000    | 02521270   |                           |  |  |
| T0           | 0 40066661 | 0 02646243 | 00000100    | 02521270   | *                         |  |  |
| TR           | 0 60033330 | 0 03044351 | 01000100    | 02521270   | *                         |  |  |
| TP           | 0 70015554 | 0 01022124 | 01000100    | 02521270   |                           |  |  |
| T3           | 0 34006666 | 0 00011012 | 01000100    | 02521270   |                           |  |  |
| T2           | 0 16003333 | 0 00404445 | 00000000    | 02521270   |                           |  |  |
| T6           | 0 47001555 | 0 02723412 | 00000100    | 02521270   | *                         |  |  |
| T5           | 0 23400666 | 0 03072035 | 01001100    | 02521270   | *                         |  |  |
| T4           | 0 51600333 | 0 01035456 | 01000000    | 02521270   |                           |  |  |
| T3           | 0 24700155 | 0 03537017 | 00001100    | 02521270   | *                         |  |  |
| T2           | 0 52340066 | 0 03371237 | 01010100    | 02521270   | *                         |  |  |
| T1           | 0 65160033 | 0 01170557 | 01010000    | 02521270   |                           |  |  |
| T0           | 0 72470015 | 0 03521457 | 00100100    | 02521270   | *                         |  |  |
| TR           | 0 75234006 | 0 03431057 | 01001100    | 02521270   | *                         |  |  |
| TP           | 0 76516003 | 0 01214067 | 01001000    | 02521270   |                           |  |  |
| T8           | 0 77247001 | 0 03627623 | 00000100    | 02521270   | *                         |  |  |
| T7           | 0 77523400 | 0 03434141 | 01001100    | 02521270   | *                         |  |  |
| T6           | 0 77651600 | 0 01216420 | 01000100    | 75256507   |                           |  |  |
| TP           | 0 02216520 | 0 77651600 | 01000100    | 75256507   |                           |  |  |

| FIGURE MUL50 |            |            |             |            | A*M = 74002276 11743170 0 |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |
| T8           | 1 62512352 | 0 00000000 | 00000000    | 11445546   |                           |  |
| T7           | 1 31245165 | 0 00000000 | 00000000    | 11445546   |                           |  |
| T6           | 1 14522472 | 0 11445546 | 00000000    | 11445546   | *                         |  |
| T5           | 1 06251235 | 0 04622663 | 00000000    | 11445546   |                           |  |
| T4           | 1 43124516 | 0 13756077 | 00001000    | 11445546   | *                         |  |
| T3           | 1 61452247 | 0 05767437 | 00000000    | 11445546   |                           |  |
| T2           | 1 70625123 | 0 13330355 | 01111010    | 11445546   | *                         |  |
| T1           | 1 74312451 | 0 17665230 | 00001110    | 11445546   | *                         |  |
| TC           | 1 36145224 | 0 10370626 | 11010100    | 11445546   | *                         |  |
| TR           | 1 17062312 | 0 00670353 | 10010000    | 11445546   |                           |  |
| TP           | 1 47431245 | 0 04270165 | 00010000    | 11445546   |                           |  |
| T8           | 1 63614522 | 0 13505530 | 00100110    | 11445546   | *                         |  |
| T7           | 1 31706251 | 0 05602610 | 00100110    | 11445546   |                           |  |
| T6           | 1 14743124 | 0 13306016 | 01101100    | 11445546   | *                         |  |
| T5           | 1 06361452 | 0 05103447 | 01100000    | 11445546   |                           |  |
| T4           | 1 43170625 | 0 02001623 | 01100000    | 11445546   |                           |  |
| T3           | 1 61474312 | 0 12005457 | 01101000    | 11445546   | *                         |  |
| T2           | 1 70636145 | 0 05442227 | 00001000    | 11445546   |                           |  |
| T1           | 1 74317062 | 0 13266251 | 01001010    | 11445546   | *                         |  |
| TC           | 1 76147431 | 0 06133520 | 01000010    | 11445546   |                           |  |
| TR           | 1 37062614 | 0 14412312 | 00111110    | 11445546   | *                         |  |
| TP           | 1 17431706 | 0 06241501 | 00010110    | 11445546   |                           |  |
| T8           | 1 47614743 | 0 03124604 | 00000100    | 11445546   |                           |  |
| T7           | 1 23706351 | 0 12017000 | 01101110    | 11445546   | *                         |  |
| T6           | 1 11743170 | 1 63772275 | 10010001    | 66332231   | *                         |  |
| TP           | 1 74002276 | 1 11743170 | 10010001    | 66332231   |                           |  |

| TIME | A REGISTER | B REGISTER | FIGURE MULS1<br>BC REGISTER | C REGISTER | A*M = 40000000 00000000 |
|------|------------|------------|-----------------------------|------------|-------------------------|
| T8   | 1 43000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T7   | 1 23000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T6   | 1 13000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T5   | 1 04000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T4   | 1 02000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T3   | 1 01000000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T2   | 1 00400000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T1   | 1 00200000 | 0 00000000 | 00000000                    | 40000000   |                         |
| TC   | 1 00100000 | 0 00000000 | 00000000                    | 40000000   |                         |
| TR   | 1 00040000 | 0 00000000 | 00000000                    | 40000000   |                         |
| TP   | 1 00020000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T8   | 1 00010000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T7   | 1 00004000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T6   | 1 00002000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T5   | 1 00001000 | 0 00000000 | 00000000                    | 40000000   |                         |
| T4   | 1 00000400 | 0 00000000 | 00000000                    | 40000000   |                         |
| T3   | 1 00000200 | 0 00000000 | 00000000                    | 40000000   |                         |
| T2   | 1 00000100 | 0 00000000 | 00000000                    | 40000000   |                         |
| T1   | 1 00000040 | 0 00000000 | 00000000                    | 40000000   |                         |
| TC   | 1 00000020 | 0 00000000 | 00000000                    | 40000000   |                         |
| TR   | 1 00000010 | 0 00000000 | 00000000                    | 40000000   |                         |
| TP   | 1 00000004 | 0 00000000 | 00000000                    | 40000000   |                         |
| T8   | 1 00000002 | 0 00000000 | 00000000                    | 40000000   |                         |
| T7   | 1 00000001 | 0 00000000 | 00000000                    | 40000000   |                         |
| T6   | 1 00000000 | 0 37777777 | 00000001                    | 37777777   | *                       |
| TP   | 1 40000000 | 0 00000000 | 00000001                    | 37777777   |                         |

## APPENDIX 3D

## DIVIDE AND THE BZO "EYE-BALL CIRCUIT"

The following sets of constants allow the user to diagnose completely any BZO and/or divide problem. If a failure is suspected, the user should reset all breakpoints and load the tape using the Diagnostic load procedure beginning at the Automatic Instruction Diagnostic.

If the program halts at a divide error halt, determine the pertinent constant set via Appendix 3A. Then, set Breakpoints 1 and 2 and place the mode switch in RUN. This repeatedly performs the current test with the error halt inhibited. The user can now use the oscilloscope to follow the test through each T-time to determine the exact circuit area.

| TIME | A REGISTER | B REGISTER | FIGURE DIV 1<br>BC REGISTER | C REGISTER | A/M = 40000000 00000000 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 37777777 | 0 00000000 | 00000000                    | 37777777   |                           |
| T8   | 0 00000000 | 0 00000000 | 00000000                    | 40000000   |                           |
| T5   | 0 00000001 | 1 40000000 | 00000001                    | 40000000   |                           |
| T2   | 0 00000002 | 0 37777771 | 00000010                    | 37777777   |                           |
| TR   | 0 00000004 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T7   | 0 00000010 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T4   | 0 00000020 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T1   | 0 00000040 | 0 26666771 | 11111010                    | 37777777   | *                         |
| TP   | 0 00000100 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T6   | 0 00000200 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T3   | 0 00000400 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T0   | 0 00001000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T8   | 0 00002000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T5   | 0 00004000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T2   | 0 00010000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| TR   | 0 00020000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T7   | 0 00040000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T4   | 0 00100000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T1   | 0 00200000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| TP   | 0 00400000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T6   | 0 01000000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T3   | 0 02000000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T0   | 0 04000000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T8   | 0 10000000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T5   | 0 20000000 | 0 26666771 | 11111010                    | 37777777   | *                         |
| T2   | 0 40000000 | 0 77777702 | 00000100                    | 37777777   | *                         |
| TP   | 0 40000000 | 0 00000000 | 11111010                    | 37777777   | OF                        |

| FIGURE DIV 2 |            |            |             |            | A/M = 37777777 40000000 1 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 0 37777777 | 0 00000002 | 00000000    | 37777777   |                           |  |  |
| T8           | 0 00000002 | 0 00000000 | 00000000    | 40000000   |                           |  |  |
| T5           | 0 00000005 | 1 40000000 | 00000001    | 40000000   |                           |  |  |
| T2           | 0 00000012 | 0 37777771 | 00000010    | 37777777   |                           |  |  |
| TR           | 0 00000024 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T7           | 0 00000050 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T4           | 0 00000120 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T1           | 0 00000240 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| TP           | 0 00000500 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T6           | 0 00001200 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T3           | 0 00002400 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T0           | 0 00005000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T8           | 0 00012000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T5           | 0 00024000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T2           | 0 00050000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| TR           | 0 00120000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T7           | 0 00240000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T4           | 0 00500000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T1           | 0 01200000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| TP           | 0 02400000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T6           | 0 05000000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T3           | 0 12000000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T0           | 0 24000000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T8           | 0 50000000 | 0 26666771 | 11111010    | 37777777   | *                         |  |  |
| T5           | 0 20000000 | 0 26666772 | 11111010    | 37777777   | *                         |  |  |
| T2           | 0 40000000 | 0 77777704 | 00000100    | 37777777   | *                         |  |  |
| TP           | 0 40000000 | 0 00000001 | 11111010    | 37777777   | OF                        |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 3<br>BC REGISTER | A/M =<br>C REGISTER | 40000000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|---------------------|----------|----------|---|
| T8   | 0 37777777 | 0 00000000 | 00000000                    | 40000001            |          |          |   |
| T8   | 0 00000000 | 0 00000000 | 00000000                    | 40000001            |          |          |   |
| T5   | 0 00000001 | 1 40000001 | 00000000                    | 40000001            |          |          |   |
| T2   | 0 00000002 | 0 37777770 | 00000011                    | 37777776            |          |          |   |
| TR   | 0 00000004 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T7   | 0 00000010 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T4   | 0 00000020 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T1   | 0 00000040 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| TP   | 0 00000100 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T6   | 0 00000200 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T3   | 0 00000400 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T0   | 0 00001000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T8   | 0 00002000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T5   | 0 00004000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T2   | 0 00010000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| TR   | 0 00020000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T7   | 0 00040000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T4   | 0 00100000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T1   | 0 00200000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| TP   | 0 00400000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T6   | 0 01000000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T3   | 0 02000000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T0   | 0 04000000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T8   | 0 10000000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T5   | 0 20000000 | 0 26666770 | 11111011                    | 37777776            | *        |          |   |
| T2   | 0 40000000 | 0 77777702 | 00000100                    | 37777776            | *        |          |   |
| TP   | 0 40000000 | 0 00000000 | 11111001                    | 37777776            |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 4<br>BC REGISTER | C REGISTER | A/M = | 40000001 | 40000000 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 37777777 | 0 00000002 | 00000000                    | 40000001   |       |          |          |   |
| T8   | 0 00000002 | 0 00000000 | 00000000                    | 40000001   |       |          |          |   |
| T5   | 0 00000005 | 1 40000001 | 00000000                    | 40000001   |       |          |          |   |
| T2   | 0 00000012 | 0 37777770 | 00000011                    | 37777776   |       |          |          |   |
| TR   | 0 00000024 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T7   | 0 00000050 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T4   | 0 00000120 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T1   | 0 00000240 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TP   | 0 00000500 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T6   | 0 00001200 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T3   | 0 00002400 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T0   | 0 00005000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T8   | 0 00012000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T5   | 0 00024000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T2   | 0 00050000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TR   | 0 00120000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T7   | 0 00240000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T4   | 0 00500000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T1   | 0 01200000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TP   | 0 02400000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T6   | 0 05000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T3   | 0 12000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T0   | 0 24000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T8   | 0 50000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T5   | 0 20000000 | 0 26666771 | 11111011                    | 37777776   | *     |          |          |   |
| T2   | 0 40000000 | 0 77777704 | 00000100                    | 37777776   | *     |          |          |   |
| TP   | 0 40000000 | 0 00000001 | 11111011                    | 37777776   | OF    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 5<br>BC REGISTER | C REGISTER | A/M = | 60000000 | 60000001 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 40000000 | 0 00000002 | 00000000                    | 37777777   |       |          |          |   |
| T8   | 1 77777776 | 0 00000000 | 00000000                    | 40000000   |       |          |          |   |
| T5   | 1 77777775 | 1 40000001 | 00000001                    | 40000000   |       |          |          |   |
| T2   | 1 77777772 | 0 37777774 | 00000010                    | 37777777   |       |          |          |   |
| TR   | 1 77777764 | 0 26666700 | 11111110                    | 37777777   | *     |          |          |   |
| T7   | 1 77777750 | 0 26667710 | 11110110                    | 37777777   | *     |          |          |   |
| T4   | 1 77777720 | 0 26667730 | 11110110                    | 37777777   | *     |          |          |   |
| T1   | 1 77777640 | 0 26667070 | 11111010                    | 37777777   | *     |          |          |   |
| TP   | 1 77777500 | 0 26677170 | 11101010                    | 37777777   | *     |          |          |   |
| T6   | 1 77777200 | 0 26677370 | 11101010                    | 37777777   | *     |          |          |   |
| T3   | 1 77776400 | 0 26677770 | 11101010                    | 37777777   | *     |          |          |   |
| T0   | 1 77775000 | 0 26670770 | 11111010                    | 37777777   | *     |          |          |   |
| T8   | 1 77772000 | 0 26772770 | 11011010                    | 37777777   | *     |          |          |   |
| T5   | 1 77764000 | 0 26776770 | 11011010                    | 37777777   | *     |          |          |   |
| T2   | 1 77750000 | 0 26706770 | 11111010                    | 37777777   | *     |          |          |   |
| TR   | 1 77720000 | 0 27726770 | 10111010                    | 37777777   | *     |          |          |   |
| T7   | 1 77640000 | 0 27766770 | 10111010                    | 37777777   | *     |          |          |   |
| T4   | 1 77500000 | 0 27066770 | 11111010                    | 37777777   | *     |          |          |   |
| T1   | 1 77200000 | 0 37266770 | 01111010                    | 37777777   | *     |          |          |   |
| TP   | 1 76400000 | 0 37666770 | 01111010                    | 37777777   | *     |          |          |   |
| T6   | 1 75000000 | 0 30666770 | 11111010                    | 37777777   | *     |          |          |   |
| T3   | 1 72000000 | 0 32666770 | 11111010                    | 37777777   | *     |          |          |   |
| T0   | 1 64000000 | 0 36666770 | 11111010                    | 37777777   | *     |          |          |   |
| T8   | 1 50000000 | 0 46666770 | 11111010                    | 37777777   | *     |          |          |   |
| T5   | 1 20000000 | 0 66666770 | 11111010                    | 37777777   | *     |          |          |   |
| T2   | 1 40000001 | 1 77777700 | 00000100                    | 40000000   |       |          |          |   |
| TP   | 1 37777777 | 1 00000000 | 00000100                    | 40000000   | OF    |          |          |   |

| FIGURE DIV 6 |            |            |             |            | A/M =    |          |   |
|--------------|------------|------------|-------------|------------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER | 20000000 | 60000001 | 1 |
| T8           | 1 40000000 | 0 00000002 | 00000000    | 40000001   |          |          |   |
| T8           | 1 77777776 | 0 00000000 | 00000000    | 40000001   |          |          |   |
| T5           | 1 77777775 | 1 40000002 | 00000000    | 40000001   |          |          |   |
| T2           | 1 77777772 | 0 37777773 | 00000011    | 37777776   |          |          |   |
| TR           | 1 77777764 | 0 26666707 | 11111101    | 37777776   | *        |          |   |
| T7           | 1 77777750 | 0 26666717 | 11110101    | 37777776   | *        |          |   |
| T4           | 1 77777720 | 0 26666737 | 11110101    | 37777776   | *        |          |   |
| T1           | 1 77777640 | 0 26666777 | 11110101    | 37777776   | *        |          |   |
| TP           | 1 77777500 | 0 26667077 | 11111101    | 37777776   | *        |          |   |
| T6           | 1 77777200 | 0 26677277 | 11101101    | 37777776   | *        |          |   |
| T3           | 1 77776400 | 0 26677677 | 11101101    | 37777776   | *        |          |   |
| TC           | 1 77775000 | 0 26670677 | 11111101    | 37777776   | *        |          |   |
| T8           | 1 77772000 | 0 26772677 | 11011101    | 37777776   | *        |          |   |
| T5           | 1 77764000 | 0 26776677 | 11011101    | 37777776   | *        |          |   |
| T2           | 1 77750000 | 0 26706677 | 11111101    | 37777776   | *        |          |   |
| TR           | 1 77720000 | 0 27726677 | 10111101    | 37777776   | *        |          |   |
| T7           | 1 77640000 | 0 27766677 | 10111101    | 37777776   | *        |          |   |
| T4           | 1 77500000 | 0 27066677 | 11111101    | 37777776   | *        |          |   |
| T1           | 1 77200000 | 0 37266677 | 01111101    | 37777776   | *        |          |   |
| TP           | 1 76400000 | 0 37666677 | 01111101    | 37777776   | *        |          |   |
| T6           | 1 75000000 | 0 30666677 | 11111101    | 37777776   | *        |          |   |
| T3           | 1 72000000 | 0 32666677 | 11111101    | 37777776   | *        |          |   |
| TC           | 1 64000000 | 0 36666677 | 11111101    | 37777776   | *        |          |   |
| T8           | 1 60000000 | 0 46666677 | 11111101    | 37777776   | *        |          |   |
| T5           | 1 20000000 | 0 66666677 | 11111101    | 37777776   |          |          |   |
| T2           | 1 40000001 | 1 77777770 | 00000010    | 40000001   |          |          |   |
| TP           | 1 40000001 | 1 00000000 | 00000010    | 40000001   | 0F       |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 7<br>BC REGISTER | C REGISTER | A/M = 40000000 00000000 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 40000000 | 0 00000000 | 00000000                    | 00000000   |                           |
| T8   | 1 00000000 | 0 87777777 | 00000001                    | 77777777   | *                         |
| T5   | 1 00000000 | 0 77777700 | 00000100                    | 00000000   | *                         |
| T2   | 1 00000001 | 1 86667777 | 11110001                    | 77777777   | *                         |
| TR   | 1 00000003 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T7   | 1 00000007 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T4   | 1 00000017 | 1 86666677 | 11111101                    | 77777777   | *                         |
| T1   | 1 00000037 | 1 66666677 | 11111101                    | 77777777   | *                         |
| TP   | 1 00000077 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T6   | 1 00000177 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T3   | 1 00000377 | 1 86666677 | 11111101                    | 77777777   | *                         |
| T0   | 1 00000777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T8   | 1 00001777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T5   | 1 00003777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T2   | 1 00007777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| TR   | 1 00017777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T7   | 1 00037777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T4   | 1 00077777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T1   | 1 00177777 | 1 86666677 | 11111101                    | 77777777   | *                         |
| TP   | 1 00377777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T6   | 1 00777777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T3   | 1 01777777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T0   | 1 03777777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T8   | 1 07777777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T5   | 1 17777777 | 1 66666677 | 11111101                    | 77777777   | *                         |
| T2   | 1 37777777 | 1 77777770 | 00000010                    | 77777777   | *                         |
| TP   | 1 40000001 | 1 00000000 | 00000010                    | 77777777   | 0F                        |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 8<br>BC REGISTER | A/M = 37777777<br>C REGISTER | 00000000 0 |
|------|------------|------------|-----------------------------|------------------------------|------------|
| T8   | 0 37777776 | 0 00000002 | 00000000                    | 37777777                     |            |
| T8   | 0 00000002 | 0 77777777 | 00000000                    | 40000000                     |            |
| T5   | 0 00000004 | 0 26666665 | 11111110                    | 37777777                     |            |
| T2   | 0 00000011 | 1 37777772 | 00000001                    | 40000000                     |            |
| TR   | 0 00000023 | 1 37777766 | 00000001                    | 40000000                     |            |
| T7   | 0 00000047 | 1 37777756 | 00000001                    | 40000000                     |            |
| T4   | 0 00000117 | 1 37777736 | 00000001                    | 40000000                     |            |
| T1   | 0 00000237 | 1 37777676 | 00000001                    | 40000000                     |            |
| TP   | 0 00000477 | 1 37777576 | 00000001                    | 40000000                     |            |
| T6   | 0 00001177 | 1 37777376 | 00000001                    | 40000000                     |            |
| TR   | 0 00002377 | 1 37776776 | 00000001                    | 40000000                     |            |
| T0   | 0 00004777 | 1 37775776 | 00000001                    | 40000000                     |            |
| T8   | 0 00011777 | 1 37773776 | 00000001                    | 40000000                     |            |
| T5   | 0 00023777 | 1 37767776 | 00000001                    | 40000000                     |            |
| T2   | 0 00047777 | 1 37757776 | 00000001                    | 40000000                     |            |
| TR   | 0 00117777 | 1 37737776 | 00000001                    | 40000000                     |            |
| T7   | 0 00237777 | 1 37677776 | 00000001                    | 40000000                     |            |
| T4   | 0 00477777 | 1 37577776 | 00000001                    | 40000000                     |            |
| T1   | 0 01177777 | 1 37377776 | 00000001                    | 40000000                     |            |
| TP   | 0 02377777 | 1 36777776 | 00000001                    | 40000000                     |            |
| T6   | 0 04777777 | 1 35777776 | 00000001                    | 40000000                     |            |
| T3   | 0 11777777 | 1 33777776 | 00000001                    | 40000000                     |            |
| T0   | 0 23777777 | 1 27777776 | 00000001                    | 40000000                     |            |
| T8   | 0 47777777 | 1 17777776 | 00000001                    | 40000000                     |            |
| T5   | 0 17777777 | 1 77777777 | 00000001                    | 40000000                     |            |
| T2   | 0 37777777 | 1 77777770 | 00000010                    | 40000000                     |            |
| TP   | 0 37777777 | 1 00000000 | 00000010                    | 40000000                     |            |

| TIME | A REGISTER | B REGISTER | FIGURE DIV 9<br>BC REGISTER | C REGISTER | A/M = | 40000001 | 00000001 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 37777777 | 0 00000002 | 00000000                    | 40000000   |       |          |          |   |
| T8   | 0 00000002 | 0 77777777 | 00000000                    | 40000000   |       |          |          |   |
| T5   | 0 00000004 | 0 26666665 | 11111111                    | 37777777   |       |          |          |   |
| T2   | 0 00000011 | 1 37777774 | 00000000                    | 40000000   |       |          |          |   |
| TR   | 0 00000023 | 1 37777770 | 00000000                    | 40000000   |       |          |          |   |
| T7   | 0 00000047 | 1 37777760 | 00000000                    | 40000000   |       |          |          |   |
| T4   | 0 00000117 | 1 37777740 | 00000000                    | 40000000   |       |          |          |   |
| T1   | 0 00000237 | 1 37777700 | 00000000                    | 40000000   |       |          |          |   |
| TP   | 0 00000477 | 1 37777600 | 00000000                    | 40000000   |       |          |          |   |
| T6   | 0 00001177 | 1 37777400 | 00000000                    | 40000000   |       |          |          |   |
| T3   | 0 00002377 | 1 37777000 | 00000000                    | 40000000   |       |          |          |   |
| TC   | 0 00004777 | 1 37776000 | 00000000                    | 40000000   |       |          |          |   |
| T8   | 0 00011777 | 1 37774000 | 00000000                    | 40000000   |       |          |          |   |
| T5   | 0 00023777 | 1 37770000 | 00000000                    | 40000000   |       |          |          |   |
| T2   | 0 00047777 | 1 37760000 | 00000000                    | 40000000   |       |          |          |   |
| TR   | 0 00117777 | 1 37740000 | 00000000                    | 40000000   |       |          |          |   |
| T7   | 0 00237777 | 1 37700000 | 00000000                    | 40000000   |       |          |          |   |
| T4   | 0 00477777 | 1 37600000 | 00000000                    | 40000000   |       |          |          |   |
| T1   | 0 01177777 | 1 37400000 | 00000000                    | 40000000   |       |          |          |   |
| TP   | 0 02377777 | 1 37000000 | 00000000                    | 40000000   |       |          |          |   |
| T6   | 0 04777777 | 1 36000000 | 00000000                    | 40000000   |       |          |          |   |
| T3   | 0 11777777 | 1 34000000 | 00000000                    | 40000000   |       |          |          |   |
| TC   | 0 23777777 | 1 30000000 | 00000000                    | 40000000   |       |          |          |   |
| T8   | 0 47777777 | 1 20000000 | 00000000                    | 40000000   |       |          |          |   |
| T5   | 0 17777777 | 1 00000001 | 00000000                    | 40000000   |       |          |          |   |
| T2   | 0 37777777 | 0 00000002 | 00000000                    | 40000000   |       |          |          |   |
| TP   | 0 40000001 | 0 00000001 | 00000000                    | 40000000   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIVIO<br>BC REGISTER | C REGISTER | A/M = | 40000001 | 40000002 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 40000001 | 0 00000002 | 00000000                    | 37777777   |       |          |          |   |
| T8   | 1 77777776 | 0 77777777 | 00000000                    | 40000000   |       |          |          |   |
| T5   | 1 77777774 | 0 26666666 | 11111110                    | 37777777   |       |          |          |   |
| T2   | 1 77777771 | 1 97777775 | 00000001                    | 40000000   |       |          |          |   |
| TR   | 1 77777763 | 1 97777775 | 00000001                    | 40000000   |       |          |          |   |
| T7   | 1 77777747 | 1 97777775 | 00000001                    | 40000000   |       |          |          |   |
| T4   | 1 77777717 | 1 97777775 | 00000001                    | 40000000   |       |          |          |   |
| T1   | 1 77777637 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| TP   | 1 77777477 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T6   | 1 77777177 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T3   | 1 77776377 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T0   | 1 77774777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T8   | 1 77771777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T5   | 1 77763777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T2   | 1 77747777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| TR   | 1 77717777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T7   | 1 77637777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T4   | 1 77477777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T1   | 1 77177777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| TP   | 1 76377777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T6   | 1 74777777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T3   | 1 71777777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T0   | 1 63777777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T8   | 1 47777777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T5   | 1 17777777 | 1 37777775 | 00000001                    | 40000000   |       |          |          |   |
| T2   | 1 37777777 | 0 77777774 | 00000000                    | 40000000   |       |          |          |   |
| TP   | 1 40000001 | 0 40000002 | 00000000                    | 40000000   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV11<br>BC REGISTER | C REGISTER | A/M = 37777777 | 40000002 | 0 |
|------|------------|------------|-----------------------------|------------|----------------|----------|---|
| T8   | 1 40000001 | 0 00000002 | 00000000                    | 40000001   |                |          |   |
| T8   | 1 77777776 | 0 77777777 | 00000000                    | 40000001   |                |          |   |
| T5   | 1 77777774 | 0 26666665 | 11111111                    | 37777776   |                |          |   |
| T2   | 1 77777771 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TR   | 1 77777763 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T7   | 1 77777747 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T4   | 1 77777717 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T1   | 1 77777637 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TP   | 1 77777477 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T6   | 1 77777177 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T3   | 1 77776377 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TC   | 1 77774777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T8   | 1 77771777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T5   | 1 77763777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T2   | 1 77747777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TR   | 1 77717777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T7   | 1 77637777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T4   | 1 77477777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T1   | 1 77177777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TP   | 1 76377777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T6   | 1 74777777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T3   | 1 71777777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| TC   | 1 63777777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T8   | 1 47777777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T5   | 1 17777777 | 1 37777776 | 00000000                    | 40000001   |                |          |   |
| T2   | 1 37777777 | 0 77777774 | 00000000                    | 40000001   |                |          |   |
| TP   | 1 37777777 | 0 40000002 | 00000000                    | 40000001   |                |          |   |

| FIGURE DIV12 |            |            |             |            | A/M = | 40000000 | 00000000 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T8           | 1 40000001 | 0 00000000 | 00000000    | 37777777   |       |          |          |   |
| T8           | 1 00000000 | 0 77777777 | 00000001    | 40000000   | *     |          |          |   |
| T5           | 1 00000001 | 1 37777700 | 00000101    | 40000000   | *     |          |          |   |
| T2           | 1 00000002 | 0 26667771 | 11110010    | 37777777   | *     |          |          |   |
| TR           | 1 00000004 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T7           | 1 00000010 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T4           | 1 00000020 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T1           | 1 00000040 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| TP           | 1 00000100 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T6           | 1 00000200 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T3           | 1 00000400 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T0           | 1 00001000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T8           | 1 00002000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T5           | 1 00004000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T2           | 1 00010000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| TR           | 1 00020000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T7           | 1 00040000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T4           | 1 00100000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T1           | 1 00200000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| TP           | 1 00400000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T6           | 1 01000000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T3           | 1 02000000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T0           | 1 04000000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T8           | 1 10000000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T5           | 1 20000000 | 0 26666771 | 11111010    | 37777777   | *     |          |          |   |
| T2           | 1 40000000 | 0 77777702 | 00000100    | 37777777   | *     |          |          |   |
| TP           | 1 40000000 | 0 00000000 | 11111010    | 37777777   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV13<br>BC REGISTER | C REGISTER | A/M = | 40000000 | 00000000 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 40000001 | 0 00000000 | 00000000                    | 40000001   |       |          |          |   |
| T8   | 1 00000000 | 0 77777777 | 00000001                    | 40000001   | *     |          |          |   |
| T5   | 1 00000001 | 1 37777701 | 00000100                    | 40000001   | *     |          |          |   |
| T2   | 1 00000002 | 0 26666770 | 11110011                    | 37777776   | *     |          |          |   |
| TR   | 1 00000004 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T7   | 1 00000010 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T4   | 1 00000020 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T1   | 1 00000040 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TP   | 1 00000100 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T6   | 1 00000200 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T3   | 1 00000400 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TC   | 1 00001000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T8   | 1 00002000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T5   | 1 00004000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T2   | 1 00010000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TR   | 1 00020000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T7   | 1 00040000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T4   | 1 00100000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T1   | 1 00200000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TP   | 1 00400000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T6   | 1 01000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T3   | 1 02000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| TC   | 1 04000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T8   | 1 10000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T5   | 1 20000000 | 0 26666770 | 11111011                    | 37777776   | *     |          |          |   |
| T2   | 1 40000000 | 0 77777702 | 00000100                    | 37777776   | *     |          |          |   |
| TP   | 1 40000000 | 0 00000000 | 11111001                    | 37777776   | OF    |          |          |   |

| FIGURE DIV14 |            |            |            |          | A/M =    |  |  |
|--------------|------------|------------|------------|----------|----------|--|--|
| BC REGISTER  |            |            |            |          | 60000000 |  |  |
| TIME         | A REGISTER | B REGISTER | C REGISTER |          | 60000000 |  |  |
| T8           | 1 40000000 | 0 00000001 | 00000000   | 37777777 |          |  |  |
| T8           | 1 00000000 | 0 00000000 | 00000001   | 40000000 |          |  |  |
| T5           | 1 00000001 | 1 40000002 | 00000001   | 40000000 |          |  |  |
| T2           | 1 00000002 | 0 37777775 | 00000010   | 37777777 |          |  |  |
| TR           | 1 00000004 | 0 26666701 | 11111110   | 37777777 | *        |  |  |
| T7           | 1 00000010 | 0 26667711 | 11110110   | 37777777 | *        |  |  |
| T4           | 1 00000020 | 0 26667731 | 11110110   | 37777777 | *        |  |  |
| T1           | 1 00000040 | 0 26667071 | 11111010   | 37777777 | *        |  |  |
| TP           | 1 00000100 | 0 26677171 | 11101010   | 37777777 | *        |  |  |
| T6           | 1 00000200 | 0 26677371 | 11101010   | 37777777 | *        |  |  |
| T3           | 1 00000400 | 0 26677771 | 11101010   | 37777777 | *        |  |  |
| TC           | 1 00001000 | 0 26670771 | 11111010   | 37777777 | *        |  |  |
| T8           | 1 00002000 | 0 26772771 | 11011010   | 37777777 | *        |  |  |
| T5           | 1 00004000 | 0 26776771 | 11011010   | 37777777 | *        |  |  |
| T2           | 1 00010000 | 0 26706771 | 11111010   | 37777777 | *        |  |  |
| TR           | 1 00020000 | 0 27726771 | 10111010   | 37777777 | *        |  |  |
| T7           | 1 00040000 | 0 27766771 | 10111010   | 37777777 | *        |  |  |
| T4           | 1 00100000 | 0 27066771 | 11111010   | 37777777 | *        |  |  |
| T1           | 1 00200000 | 0 37266771 | 01111010   | 37777777 | *        |  |  |
| TP           | 1 00400000 | 0 37666771 | 01111010   | 37777777 | *        |  |  |
| T6           | 1 01000000 | 0 30666771 | 11111010   | 37777777 | *        |  |  |
| T3           | 1 02000000 | 0 32666771 | 11111010   | 37777777 | *        |  |  |
| TC           | 1 04000000 | 0 36666771 | 11111010   | 37777777 | *        |  |  |
| T8           | 1 10000000 | 0 46666771 | 11111010   | 37777777 | *        |  |  |
| T5           | 1 20000000 | 0 66666771 | 11111010   | 37777777 |          |  |  |
| T2           | 1 40000001 | 1 77777702 | 00000100   | 40000000 |          |  |  |
| TP           | 1 37777777 | 1 77777777 | 00000100   | 40000000 | OF       |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIVIS<br>BC REGISTER | C REGISTER | A/M = | 44000000 | 00000000 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 37777771 | 0 00000000 | 00000000                    | 40000010   |       |          |          |   |
| T8   | 0 00000000 | 0 00000001 | 00000000                    | 40000010   |       |          |          |   |
| T5   | 0 00000001 | 1 40000012 | 00000000                    | 40000010   |       |          |          |   |
| T2   | 0 00000002 | 0 37777703 | 00000111                    | 37777767   |       |          |          |   |
| TR   | 0 00000004 | 0 26667717 | 11110101                    | 37777767   | *     |          |          |   |
| T7   | 0 00000010 | 0 26667727 | 11110101                    | 37777767   | *     |          |          |   |
| T4   | 0 00000020 | 0 26667747 | 11110101                    | 37777767   | *     |          |          |   |
| T1   | 0 00000040 | 0 26667707 | 11111101                    | 37777767   | *     |          |          |   |
| TP   | 0 00000100 | 0 26677107 | 11101101                    | 37777767   | *     |          |          |   |
| T6   | 0 00000200 | 0 26677307 | 11101101                    | 37777767   | *     |          |          |   |
| T3   | 0 00000400 | 0 26670707 | 11110101                    | 37777767   | *     |          |          |   |
| TC   | 0 00001000 | 0 26771707 | 11010101                    | 37777767   | *     |          |          |   |
| T8   | 0 00002000 | 0 26773707 | 11010101                    | 37777767   | *     |          |          |   |
| T5   | 0 00004000 | 0 26777707 | 11010101                    | 37777767   | *     |          |          |   |
| T2   | 0 00010000 | 0 26707707 | 11110101                    | 37777767   | *     |          |          |   |
| TR   | 0 00020000 | 0 27727707 | 10110101                    | 37777767   | *     |          |          |   |
| T7   | 0 00040000 | 0 27767707 | 10110101                    | 37777767   | *     |          |          |   |
| T4   | 0 00100000 | 0 27087707 | 11110101                    | 37777767   | *     |          |          |   |
| T1   | 0 00200000 | 0 37267707 | 01110101                    | 37777767   | *     |          |          |   |
| TP   | 0 00400000 | 0 37667707 | 01110101                    | 37777767   | *     |          |          |   |
| T6   | 0 01000000 | 0 30667707 | 11110101                    | 37777767   | *     |          |          |   |
| T3   | 0 02000000 | 0 32667707 | 11110101                    | 37777767   | *     |          |          |   |
| TC   | 0 04000000 | 0 36667707 | 11110101                    | 37777767   | *     |          |          |   |
| T8   | 0 10000000 | 0 46667707 | 11110101                    | 37777767   | *     |          |          |   |
| T5   | 0 20000000 | 0 66667707 | 11110101                    | 37777767   | *     |          |          |   |
| T2   | 0 40000001 | 1 77777010 | 00001010                    | 40000010   |       |          |          |   |
| TP   | 0 37777777 | 1 00000010 | 00001010                    | 40000010   | OF    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV16<br>BC REGISTER | C REGISTER | A/M = | 50000000 | 00000000 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 37777720 | 0 00000000 | 00000000                    | 40000100   |       |          |          |   |
| T8   | 0 00000000 | 0 00000020 | 00000000                    | 40000100   |       |          |          |   |
| T5   | 0 00000001 | 1 40000140 | 00000000                    | 40000100   |       |          |          |   |
| T2   | 0 00000002 | 0 37777177 | 00001001                    | 37777677   |       |          |          |   |
| TR   | 0 00000004 | 0 26677177 | 11101101                    | 37777677   | *     |          |          |   |
| T7   | 0 00000010 | 0 26677377 | 11101101                    | 37777677   | *     |          |          |   |
| T4   | 0 00000020 | 0 26670777 | 11110101                    | 37777677   | *     |          |          |   |
| T1   | 0 00000040 | 0 26771777 | 11010101                    | 37777677   | *     |          |          |   |
| TP   | 0 00000100 | 0 26773777 | 11010101                    | 37777677   | *     |          |          |   |
| T6   | 0 00000200 | 0 26777777 | 11010101                    | 37777677   | *     |          |          |   |
| T3   | 0 00000400 | 0 26707777 | 11110101                    | 37777677   | *     |          |          |   |
| TC   | 0 00001000 | 0 27727777 | 10110101                    | 37777677   | *     |          |          |   |
| T8   | 0 00002000 | 0 27767777 | 10110101                    | 37777677   | *     |          |          |   |
| T5   | 0 00004000 | 0 27067777 | 11110101                    | 37777677   | *     |          |          |   |
| T2   | 0 00010000 | 0 37267777 | 01110101                    | 37777677   | *     |          |          |   |
| TR   | 0 00020000 | 0 37667777 | 01110101                    | 37777677   | *     |          |          |   |
| T7   | 0 00040000 | 0 30667777 | 11110101                    | 37777677   | *     |          |          |   |
| T4   | 0 00100000 | 0 32667777 | 11110101                    | 37777677   | *     |          |          |   |
| T1   | 0 00200000 | 0 36667777 | 11110101                    | 37777677   | *     |          |          |   |
| TP   | 0 00400000 | 0 46667777 | 11110101                    | 37777677   | *     |          |          |   |
| T6   | 0 01000000 | 0 66667777 | 11110101                    | 37777677   | *     |          |          |   |
| T3   | 0 02000001 | 1 37770200 | 00010100                    | 40000100   | *     |          |          |   |
| TC   | 0 04000002 | 0 26777477 | 11001001                    | 37777677   | *     |          |          |   |
| T8   | 0 10000004 | 0 26670777 | 11110101                    | 37777677   | *     |          |          |   |
| T5   | 0 20000010 | 0 26771777 | 11010101                    | 37777677   | *     |          |          |   |
| T2   | 0 40000020 | 0 77703170 | 00101010                    | 37777677   | *     |          |          |   |
| TP   | 0 37777760 | 0 00002000 | 11010101                    | 37777677   | 0F    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV17<br>BC REGISTER | C REGISTER | A/M = | 60000000 | 00000000 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 37777400 | 0 00000000 | 00000000                    | 40001000   |       |          |          |   |
| T8   | 0 00000000 | 0 00000400 | 00000000                    | 40001000   |       |          |          |   |
| T5   | 0 00000001 | 1 40002000 | 00000000                    | 40001000   |       |          |          |   |
| T2   | 0 00000002 | 0 37772777 | 00010001                    | 37776777   |       |          |          |   |
| TR   | 0 00000004 | 0 36773677 | 11011101                    | 37776777   | *     |          |          |   |
| T7   | 0 00000010 | 0 26707677 | 11101101                    | 37776777   | *     |          |          |   |
| T4   | 0 00000020 | 0 27717677 | 10101101                    | 37776777   | *     |          |          |   |
| T1   | 0 00000040 | 0 27737677 | 10101101                    | 37776777   | *     |          |          |   |
| TP   | 0 00000100 | 0 27777677 | 10101101                    | 37776777   | *     |          |          |   |
| T6   | 0 00000200 | 0 27077677 | 11101101                    | 37776777   | *     |          |          |   |
| T3   | 0 00000400 | 0 37277677 | 01101101                    | 37776777   | *     |          |          |   |
| TC   | 0 00001000 | 0 37677677 | 01101101                    | 37776777   | *     |          |          |   |
| T8   | 0 00002000 | 0 30677677 | 11101101                    | 37776777   | *     |          |          |   |
| T5   | 0 00004000 | 0 82677677 | 11101101                    | 37776777   | *     |          |          |   |
| T2   | 0 00010000 | 0 36677677 | 11101101                    | 37776777   | *     |          |          |   |
| TR   | 0 00020000 | 0 46677677 | 11101101                    | 37776777   | *     |          |          |   |
| T7   | 0 00040000 | 0 66677677 | 11101101                    | 37776777   | *     |          |          |   |
| T4   | 0 00100001 | 1 37702700 | 00100100                    | 40001000   | *     |          |          |   |
| T1   | 0 00200002 | 0 27774777 | 10010001                    | 37776777   | *     |          |          |   |
| TP   | 0 00400004 | 0 26707677 | 11101101                    | 37776777   | *     |          |          |   |
| T6   | 0 01000010 | 0 27717677 | 10101101                    | 37776777   | *     |          |          |   |
| T3   | 0 02000020 | 0 27737677 | 10101101                    | 37776777   | *     |          |          |   |
| TC   | 0 04000040 | 0 27777677 | 10101101                    | 37776777   | *     |          |          |   |
| T8   | 0 10000100 | 0 27077677 | 11101101                    | 37776777   | *     |          |          |   |
| T5   | 0 20000200 | 0 37277677 | 01101101                    | 37776777   | *     |          |          |   |
| T2   | 0 40000400 | 0 70771770 | 10010010                    | 37776777   | *     |          |          |   |
| TP   | 0 37777400 | 0 00400000 | 01101101                    | 37776777   | 0F    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV18<br>BC REGISTER | A/M = 40000000<br>C REGISTER 00000000 1 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 0 37777777 | 0 00000001 | 00000000                    | 40000001                                |
| T8   | 0 00000001 | 0 00000000 | 00000000                    | 40000001                                |
| T5   | 0 00000003 | 1 40000001 | 00000000                    | 40000001                                |
| T2   | 0 00000006 | 0 97777770 | 00000011                    | 37777776                                |
| TR   | 0 00000014 | 0 26666770 | 11111011                    | 37777776 *                              |
| T7   | 0 00000030 | 0 26666770 | 11111011                    | 37777776 *                              |
| T4   | 0 00000060 | 0 26666770 | 11111011                    | 37777776 *                              |
| T1   | 0 00000140 | 0 26666770 | 11111011                    | 37777776 *                              |
| TP   | 0 00000300 | 0 26666770 | 11111011                    | 37777776 *                              |
| T6   | 0 00000600 | 0 26666770 | 11111011                    | 37777776 *                              |
| T3   | 0 00001400 | 0 26666770 | 11111011                    | 37777776 *                              |
| T0   | 0 00003000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T8   | 0 00006000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T5   | 0 00014000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T2   | 0 00030000 | 0 26666770 | 11111011                    | 37777776 *                              |
| TR   | 0 00060000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T7   | 0 00140000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T4   | 0 00300000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T1   | 0 00600000 | 0 26666770 | 11111011                    | 37777776 *                              |
| TP   | 0 01400000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T6   | 0 03000000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T3   | 0 06000000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T0   | 0 14000000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T8   | 0 30000000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T5   | 0 60000000 | 0 26666770 | 11111011                    | 37777776 *                              |
| T2   | 0 40000000 | 0 77777703 | 00000100                    | 37777776 *                              |
| TP   | 0 40000000 | 0 00000000 | 11111001                    | 37777776 0F                             |

| TIME | A REGISTER | B REGISTER | FIGURE DIV19<br>BC REGISTER | A/M = 40000002<br>C REGISTER | 00000000 | 1 |
|------|------------|------------|-----------------------------|------------------------------|----------|---|
| T8   | 0 37777777 | 0 00000004 | 00000000                    | 40000001                     |          |   |
| T8   | 0 00000004 | 0 00000000 | 00000000                    | 40000001                     |          |   |
| T5   | 0 00000011 | 1 40000001 | 00000000                    | 40000001                     |          |   |
| T2   | 0 00000022 | 0 37777770 | 00000011                    | 37777776                     |          |   |
| TR   | 0 00000044 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T7   | 0 00000110 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T4   | 0 00000220 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T1   | 0 00000440 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| TP   | 0 00001100 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T6   | 0 00002200 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T3   | 0 00004400 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| TC   | 0 00011000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T8   | 0 00022000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T5   | 0 00044000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T2   | 0 00110000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| TR   | 0 00220000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T7   | 0 00440000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T4   | 0 01100000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T1   | 0 02200000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| TP   | 0 04400000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T6   | 0 11000000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T3   | 0 22000000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| TC   | 0 44000000 | 0 26666770 | 11111011                    | 37777776                     | *        |   |
| T8   | 0 10000000 | 0 26666771 | 11111011                    | 37777776                     | *        |   |
| T5   | 0 20000000 | 0 26666772 | 11111011                    | 37777776                     | *        |   |
| T2   | 0 40000000 | 0 77777706 | 00000100                    | 37777776                     | *        |   |
| TP   | 0 40000000 | 0 00000002 | 11111011                    | 37777776                     | 0F       |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV20<br>BC REGISTER | C REGISTER | A/M = 40000002 | 00000001 | 0 |
|------|------------|------------|-----------------------------|------------|----------------|----------|---|
| T8   | 0 17777777 | 0 00000002 | 00000000                    | 60000000   |                |          |   |
| T8   | 0 00000002 | 0 77777777 | 00000000                    | 60000000   |                |          |   |
| T5   | 0 00000004 | 0 06666665 | 11111111                    | 17777777   |                |          |   |
| T2   | 0 00000011 | 1 17777774 | 00000000                    | 60000000   |                |          |   |
| TR   | 0 00000023 | 1 17777770 | 00000000                    | 60000000   |                |          |   |
| T7   | 0 00000047 | 1 17777760 | 00000000                    | 60000000   |                |          |   |
| T4   | 0 00000117 | 1 17777740 | 00000000                    | 60000000   |                |          |   |
| T1   | 0 00000237 | 1 17777700 | 00000000                    | 60000000   |                |          |   |
| TP   | 0 00000477 | 1 17777600 | 00000000                    | 60000000   |                |          |   |
| T6   | 0 00001177 | 1 17777400 | 00000000                    | 60000000   |                |          |   |
| T3   | 0 00002377 | 1 17777000 | 00000000                    | 60000000   |                |          |   |
| T0   | 0 00004777 | 1 17776000 | 00000000                    | 60000000   |                |          |   |
| T8   | 0 00011777 | 1 17774000 | 00000000                    | 60000000   |                |          |   |
| T5   | 0 00023777 | 1 17770000 | 00000000                    | 60000000   |                |          |   |
| T2   | 0 00047777 | 1 17760000 | 00000000                    | 60000000   |                |          |   |
| TR   | 0 00117777 | 1 17740000 | 00000000                    | 60000000   |                |          |   |
| T7   | 0 00237777 | 1 17700000 | 00000000                    | 60000000   |                |          |   |
| T4   | 0 00477777 | 1 17600000 | 00000000                    | 60000000   |                |          |   |
| T1   | 0 01177777 | 1 17400000 | 00000000                    | 60000000   |                |          |   |
| TP   | 0 02377777 | 1 17000000 | 00000000                    | 60000000   |                |          |   |
| T6   | 0 04777777 | 1 16000000 | 00000000                    | 60000000   |                |          |   |
| T3   | 0 11777777 | 1 14000000 | 00000000                    | 60000000   |                |          |   |
| T0   | 0 23777777 | 1 10000000 | 00000000                    | 60000000   |                |          |   |
| T8   | 0 47777777 | 1 00000000 | 00000000                    | 60000000   |                |          |   |
| T5   | 0 17777777 | 1 00000001 | 00000000                    | 60000000   |                |          |   |
| T2   | 0 37777776 | 1 40000002 | 00000000                    | 17777777   |                |          |   |
| TP   | 0 40000002 | 0 00000001 | 00000011                    | 17777777   |                |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV21<br>BC REGISTER | A/M = 37777776<br>C REGISTER | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------------------------|----------|---|
| T8   | 1 00000001 | 0 00000000 | 00000000                    | 60000000                     |          |   |
| T8   | 1 00000000 | 0 77777776 | 00000001                    | 60000000                     |          |   |
| T5   | 1 00000000 | 0 06666665 | 11111111                    | 17777777                     |          |   |
| T2   | 1 00000001 | 1 17777774 | 00000000                    | 60000000                     |          |   |
| TR   | 1 00000003 | 1 17777770 | 00000000                    | 60000000                     |          |   |
| T7   | 1 00000007 | 1 17777760 | 00000000                    | 60000000                     |          |   |
| T4   | 1 00000017 | 1 17777740 | 00000000                    | 60000000                     |          |   |
| T1   | 1 00000037 | 1 17777700 | 00000000                    | 60000000                     |          |   |
| TP   | 1 00000077 | 1 17777600 | 00000000                    | 60000000                     |          |   |
| T6   | 1 00000177 | 1 17777400 | 00000000                    | 60000000                     |          |   |
| T3   | 1 00000377 | 1 17777000 | 00000000                    | 60000000                     |          |   |
| T0   | 1 00000777 | 1 17776000 | 00000000                    | 60000000                     |          |   |
| T8   | 1 00001777 | 1 17774000 | 00000000                    | 60000000                     |          |   |
| T5   | 1 00003777 | 1 17770000 | 00000000                    | 60000000                     |          |   |
| T2   | 1 00007777 | 1 17760000 | 00000000                    | 60000000                     |          |   |
| TR   | 1 00017777 | 1 17740000 | 00000000                    | 60000000                     |          |   |
| T7   | 1 00037777 | 1 17700000 | 00000000                    | 60000000                     |          |   |
| T4   | 1 00077777 | 1 17600000 | 00000000                    | 60000000                     |          |   |
| T1   | 1 00177777 | 1 17400000 | 00000000                    | 60000000                     |          |   |
| TP   | 1 00377777 | 1 17000000 | 00000000                    | 60000000                     |          |   |
| T6   | 1 00777777 | 1 16000000 | 00000000                    | 60000000                     |          |   |
| T3   | 1 01777777 | 1 14000000 | 00000000                    | 60000000                     |          |   |
| TC   | 1 03777777 | 1 10000000 | 00000000                    | 60000000                     |          |   |
| T8   | 1 07777777 | 1 00000000 | 00000000                    | 60000000                     |          |   |
| T5   | 1 17777777 | 1 60000000 | 00000000                    | 60000000                     |          |   |
| T2   | 1 37777776 | 1 40000000 | 00000000                    | 17777777                     |          |   |
| TP   | 1 37777776 | 0 00000000 | 00000001                    | 17777777                     |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV22<br>BC REGISTER | C REGISTER | A/M = | 37777774 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 60000002 | 0 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00000000 | 0 77777775 | 00000001                    | 60000000   |       |          |          |   |
| T5   | 1 00000000 | 0 06666663 | 11111111                    | 17777777   |       |          |          |   |
| T2   | 1 00000001 | 1 17777770 | 00000000                    | 60000000   |       |          |          |   |
| TR   | 1 00000003 | 1 17777760 | 00000000                    | 60000000   |       |          |          |   |
| T7   | 1 00000007 | 1 17777740 | 00000000                    | 60000000   |       |          |          |   |
| T4   | 1 00000017 | 1 17777700 | 00000000                    | 60000000   |       |          |          |   |
| T1   | 1 00000037 | 1 17777600 | 00000000                    | 60000000   |       |          |          |   |
| TP   | 1 00000077 | 1 17777400 | 00000000                    | 60000000   |       |          |          |   |
| T6   | 1 00000177 | 1 17777000 | 00000000                    | 60000000   |       |          |          |   |
| T3   | 1 00000377 | 1 17776000 | 00000000                    | 60000000   |       |          |          |   |
| T0   | 1 00000777 | 1 17774000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00001777 | 1 17770000 | 00000000                    | 60000000   |       |          |          |   |
| T5   | 1 00003777 | 1 17760000 | 00000000                    | 60000000   |       |          |          |   |
| T2   | 1 00007777 | 1 17740000 | 00000000                    | 60000000   |       |          |          |   |
| TR   | 1 00017777 | 1 17700000 | 00000000                    | 60000000   |       |          |          |   |
| T7   | 1 00037777 | 1 17600000 | 00000000                    | 60000000   |       |          |          |   |
| T4   | 1 00077777 | 1 17400000 | 00000000                    | 60000000   |       |          |          |   |
| T1   | 1 00177777 | 1 17000000 | 00000000                    | 60000000   |       |          |          |   |
| TP   | 1 00377777 | 1 16000000 | 00000000                    | 60000000   |       |          |          |   |
| T6   | 1 00777777 | 1 14000000 | 00000000                    | 60000000   |       |          |          |   |
| T3   | 1 01777777 | 1 10000000 | 00000000                    | 60000000   |       |          |          |   |
| T0   | 1 03777777 | 1 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 07777777 | 1 60000000 | 00000000                    | 60000000   |       |          |          |   |
| T5   | 1 17777776 | 0 57777777 | 00000001                    | 17777777   |       |          |          |   |
| T2   | 1 37777774 | 1 37777770 | 00000010                    | 17777777   |       |          |          |   |
| TP   | 1 37777774 | 0 00000000 | 11111101                    | 17777777   |       |          |          |   |

| FIGURE DIV23 |            |            |             |            | A/M = 37777770 00000000 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 60000004 | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00000000 | 0 77777773 | 00000001    | 60000000   |                           |  |  |
| T5           | 1 00000000 | 0 06666667 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00000001 | 1 17777780 | 00000000    | 60000000   |                           |  |  |
| TR           | 1 00000003 | 1 17777740 | 00000000    | 60000000   |                           |  |  |
| T7           | 1 00000007 | 1 17777700 | 00000000    | 60000000   |                           |  |  |
| T4           | 1 00000017 | 1 17777600 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00000037 | 1 17777400 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00000077 | 1 17777000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00000177 | 1 17776000 | 00000000    | 60000000   |                           |  |  |
| T3           | 1 00000377 | 1 17774000 | 00000000    | 60000000   |                           |  |  |
| T0           | 1 00000777 | 1 17770000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00001777 | 1 17760000 | 00000000    | 50000000   |                           |  |  |
| T5           | 1 00003777 | 1 17740000 | 00000000    | 60000000   |                           |  |  |
| T2           | 1 00007777 | 1 17700000 | 00000000    | 60000000   |                           |  |  |
| TR           | 1 00017777 | 1 17600000 | 00000000    | 60000000   |                           |  |  |
| T7           | 1 00037777 | 1 17400000 | 00000000    | 60000000   |                           |  |  |
| T4           | 1 00077777 | 1 17000000 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00177777 | 1 16000000 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00377777 | 1 14000000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00777777 | 1 10000000 | 00000000    | 60000000   |                           |  |  |
| T3           | 1 01777777 | 1 00000000 | 00000000    | 50000000   |                           |  |  |
| TC           | 1 03777777 | 1 60000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 07777776 | 0 57777777 | 00000001    | 17777777   |                           |  |  |
| T5           | 1 17777774 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 37777770 | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP           | 1 37777770 | 0 00000000 | 11111101    | 17777777   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV24<br>BC REGISTER | A/M = 37777760<br>C REGISTER 00000000 0 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 1 60000010 | 0 00000000 | 00000000                    | 60000000                                |
| T8   | 1 00000000 | 0 77777767 | 00000001                    | 60000000                                |
| T5   | 1 00000000 | 0 06666657 | 11111101                    | 17777777                                |
| T2   | 1 00000001 | 1 17777740 | 00000000                    | 60000000                                |
| TR   | 1 00000003 | 1 17777700 | 00000000                    | 60000000                                |
| T7   | 1 00000007 | 1 17777600 | 00000000                    | 60000000                                |
| T4   | 1 00000017 | 1 17777400 | 00000000                    | 60000000                                |
| T1   | 1 00000037 | 1 17777000 | 00000000                    | 60000000                                |
| TP   | 1 00000077 | 1 17776000 | 00000000                    | 60000000                                |
| T6   | 1 00000177 | 1 17774000 | 00000000                    | 60000000                                |
| T3   | 1 00000377 | 1 17770000 | 00000000                    | 60000000                                |
| T0   | 1 00000777 | 1 17760000 | 00000000                    | 60000000                                |
| T8   | 1 00001777 | 1 17740000 | 00000000                    | 60000000                                |
| T5   | 1 00003777 | 1 17700000 | 00000000                    | 60000000                                |
| T2   | 1 00007777 | 1 17600000 | 00000000                    | 60000000                                |
| TR   | 1 00017777 | 1 17400000 | 00000000                    | 60000000                                |
| T7   | 1 00037777 | 1 17000000 | 00000000                    | 60000000                                |
| T4   | 1 00077777 | 1 16000000 | 00000000                    | 60000000                                |
| T1   | 1 00177777 | 1 14000000 | 00000000                    | 60000000                                |
| TP   | 1 00377777 | 1 10000000 | 00000000                    | 60000000                                |
| T6   | 1 00777777 | 1 00000000 | 00000000                    | 60000000                                |
| T3   | 1 01777777 | 1 60000000 | 00000000                    | 60000000                                |
| T0   | 1 03777776 | 0 57777777 | 00000001                    | 17777777                                |
| T8   | 1 07777774 | 0 46666677 | 11111101                    | 17777777                                |
| T5   | 1 17777770 | 0 46666677 | 11111101                    | 17777777                                |
| T2   | 1 37777760 | 1 37777770 | 00000010                    | 17777777                                |
| TP   | 1 37777760 | 0 00000000 | 11111101                    | 17777777                                |

| FIGURE DIV25 |            |            |             |            | A/M = 37777740 |  | 00000000 | 0 |
|--------------|------------|------------|-------------|------------|----------------|--|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                |  |          |   |
| T0           | 1 60000020 | 0 00000000 | 00000000    | 60000000   |                |  |          |   |
| T0           | 1 00000000 | 0 77777757 | 00000001    | 60000000   |                |  |          |   |
| T5           | 1 00000000 | 0 06666637 | 11111101    | 17777777   |                |  |          |   |
| T2           | 1 00000001 | 1 17777600 | 00000100    | 60000000   |                |  |          |   |
| TR           | 1 00000003 | 1 17777600 | 00000000    | 60000000   |                |  |          |   |
| T7           | 1 00000007 | 1 17777400 | 00000000    | 60000000   |                |  |          |   |
| T4           | 1 00000017 | 1 17777000 | 00000000    | 60000000   |                |  |          |   |
| T1           | 1 00000037 | 1 17776000 | 00000000    | 60000000   |                |  |          |   |
| TP           | 1 00000077 | 1 17774000 | 00000000    | 60000000   |                |  |          |   |
| T6           | 1 00000177 | 1 17770000 | 00000000    | 60000000   |                |  |          |   |
| T3           | 1 00000377 | 1 17760000 | 00000000    | 60000000   |                |  |          |   |
| T0           | 1 00000777 | 1 17740000 | 00000000    | 60000000   |                |  |          |   |
| T8           | 1 00001777 | 1 17700000 | 00000000    | 60000000   |                |  |          |   |
| T5           | 1 00003777 | 1 17600000 | 00000000    | 60000000   |                |  |          |   |
| T2           | 1 00007777 | 1 17400000 | 00000000    | 60000000   |                |  |          |   |
| TR           | 1 00017777 | 1 17000000 | 00000000    | 60000000   |                |  |          |   |
| T7           | 1 00037777 | 1 16000000 | 00000000    | 60000000   |                |  |          |   |
| T4           | 1 00077777 | 1 14000000 | 00000000    | 60000000   |                |  |          |   |
| T1           | 1 00177777 | 1 10000000 | 00000000    | 60000000   |                |  |          |   |
| TP           | 1 00377777 | 1 00000000 | 00000000    | 60000000   |                |  |          |   |
| T6           | 1 00777777 | 1 60000000 | 00000000    | 60000000   |                |  |          |   |
| T3           | 1 01777776 | 0 57777777 | 00000001    | 17777777   |                |  |          |   |
| TC           | 1 03777774 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T8           | 1 07777770 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T5           | 1 17777760 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T2           | 1 37777740 | 1 37777770 | 00000010    | 17777777   |                |  |          |   |
| TP           | 1 37777740 | 0 00000000 | 11111101    | 17777777   |                |  |          |   |

| FIGURE DIV26 |            |            |             |            | A/M = 37777700 00000000 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 60000040 | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00000000 | 0 77777737 | 00000001    | 60000000   |                           |  |  |
| T5           | 1 00000000 | 0 06666577 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00000001 | 1 17777500 | 00000100    | 60000000   |                           |  |  |
| TR           | 1 00000003 | 1 17777400 | 00000000    | 60000000   |                           |  |  |
| T7           | 1 00000007 | 1 17777000 | 00000000    | 60000000   |                           |  |  |
| T4           | 1 00000017 | 1 17776000 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00000037 | 1 17774000 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00000077 | 1 17770000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00000177 | 1 17760000 | 00000000    | 60000000   |                           |  |  |
| T3           | 1 00000377 | 1 17740000 | 00000000    | 60000000   |                           |  |  |
| TC           | 1 00000777 | 1 17700000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00001777 | 1 17600000 | 00000000    | 60000000   |                           |  |  |
| T5           | 1 00003777 | 1 17400000 | 00000000    | 60000000   |                           |  |  |
| T2           | 1 00007777 | 1 17000000 | 00000000    | 60000000   |                           |  |  |
| TR           | 1 00017777 | 1 16000000 | 00000000    | 60000000   |                           |  |  |
| T7           | 1 00037777 | 1 14000000 | 00000000    | 60000000   |                           |  |  |
| T4           | 1 00077777 | 1 10000000 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00177777 | 1 00000000 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00377777 | 1 60000000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00777776 | 0 57777777 | 00000001    | 17777777   |                           |  |  |
| T3           | 1 01777774 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TC           | 1 03777770 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 07777760 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 17777740 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 37777700 | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP           | 1 37777700 | 0 00000000 | 11111101    | 17777777   |                           |  |  |

| FIGURE DIV27 |            |            |             |            | A/M = 37777600 |  | 00000000 | 0 |
|--------------|------------|------------|-------------|------------|----------------|--|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                |  |          |   |
| T0           | 1 60000100 | 0 00000000 | 00000000    | 60000000   |                |  |          |   |
| T0           | 1 00000000 | 0 77777677 | 00000001    | 60000000   |                |  |          |   |
| T5           | 1 00000000 | 0 06666477 | 11111101    | 17777777   |                |  |          |   |
| T2           | 1 00000001 | 1 17777300 | 00000100    | 60000000   |                |  |          |   |
| TR           | 1 00000003 | 1 17777000 | 00000000    | 60000000   |                |  |          |   |
| T7           | 1 00000007 | 1 17776000 | 00000000    | 60000000   |                |  |          |   |
| T4           | 1 00000017 | 1 17774000 | 00000000    | 60000000   |                |  |          |   |
| T1           | 1 00000037 | 1 17770000 | 00000000    | 60000000   |                |  |          |   |
| TP           | 1 00000077 | 1 17760000 | 00000000    | 60000000   |                |  |          |   |
| T6           | 1 00000177 | 1 17740000 | 00000000    | 60000000   |                |  |          |   |
| T3           | 1 00000377 | 1 17700000 | 00000000    | 60000000   |                |  |          |   |
| T0           | 1 00000777 | 1 17600000 | 00000000    | 60000000   |                |  |          |   |
| T8           | 1 00001777 | 1 17400000 | 00000000    | 60000000   |                |  |          |   |
| T5           | 1 00003777 | 1 17000000 | 00000000    | 60000000   |                |  |          |   |
| T2           | 1 00007777 | 1 16000000 | 00000000    | 60000000   |                |  |          |   |
| TR           | 1 00017777 | 1 14000000 | 00000000    | 60000000   |                |  |          |   |
| T7           | 1 00037777 | 1 10000000 | 00000000    | 60000000   |                |  |          |   |
| T4           | 1 00077777 | 1 00000000 | 00000000    | 60000000   |                |  |          |   |
| T1           | 1 00177777 | 1 60000000 | 00000000    | 60000000   |                |  |          |   |
| TP           | 1 00377776 | 0 87777777 | 00000001    | 17777777   |                |  |          |   |
| T6           | 1 00777774 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T3           | 1 01777770 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| TC           | 1 03777760 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T8           | 1 07777740 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T5           | 1 17777700 | 0 46666677 | 11111101    | 17777777   |                |  |          |   |
| T2           | 1 37777600 | 1 37777770 | 00000010    | 17777777   |                |  |          |   |
| TP           | 1 37777600 | 0 00000000 | 11111101    | 17777777   |                |  |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV28<br>BC REGISTER | A/M *<br>C REGISTER | 37777400 | 00000000 | 0 |
|------|------------|------------|-----------------------------|---------------------|----------|----------|---|
| T8   | 1 60000200 | 0 00000000 | 00000000                    | 60000000            |          |          |   |
| T8   | 1 00000000 | 0 77777577 | 00000001                    | 60000000            |          |          |   |
| T5   | 1 00000000 | 0 06666277 | 11111101                    | 17777777            |          |          |   |
| T2   | 1 00000001 | 1 17776700 | 00000100                    | 60000000            |          |          |   |
| TR   | 1 00000003 | 1 17776000 | 00000000                    | 60000000            |          |          |   |
| T7   | 1 00000007 | 1 17774000 | 00000000                    | 60000000            |          |          |   |
| T4   | 1 00000017 | 1 17770000 | 00000000                    | 60000000            |          |          |   |
| T1   | 1 00000037 | 1 17760000 | 00000000                    | 60000000            |          |          |   |
| TP   | 1 00000077 | 1 17740000 | 00000000                    | 60000000            |          |          |   |
| T6   | 1 00000177 | 1 17700000 | 00000000                    | 60000000            |          |          |   |
| T3   | 1 00000377 | 1 17600000 | 00000000                    | 60000000            |          |          |   |
| T0   | 1 00000777 | 1 17400000 | 00000000                    | 60000000            |          |          |   |
| T8   | 1 00001777 | 1 17000000 | 00000000                    | 60000000            |          |          |   |
| T5   | 1 00003777 | 1 16000000 | 00000000                    | 60000000            |          |          |   |
| T2   | 1 00007777 | 1 14000000 | 00000000                    | 60000000            |          |          |   |
| TR   | 1 00017777 | 1 10000000 | 00000000                    | 60000000            |          |          |   |
| T7   | 1 00037777 | 1 00000000 | 00000000                    | 60000000            |          |          |   |
| T4   | 1 00077777 | 1 60000000 | 00000000                    | 60000000            |          |          |   |
| T1   | 1 00177776 | 0 77777777 | 00000001                    | 17777777            |          |          |   |
| TP   | 1 00377774 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T6   | 1 00777770 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T3   | 1 01777760 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T0   | 1 03777740 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T8   | 1 07777700 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T5   | 1 17777600 | 0 46666677 | 11111101                    | 17777777            |          |          |   |
| T2   | 1 37777400 | 1 97777770 | 00000010                    | 17777777            |          |          |   |
| TP   | 1 37777400 | 0 00000000 | 11111101                    | 17777777            |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV29<br>BC REGISTER | C REGISTER | A/M = | 37777000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 60000400 | 0 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00000000 | 0 77777377 | 00000001                    | 60000000   |       |          |          |   |
| T5   | 1 00000000 | 0 06665677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00000001 | 1 17775700 | 00000100                    | 60000000   |       |          |          |   |
| TR   | 1 00000003 | 1 17774000 | 00000000                    | 60000000   |       |          |          |   |
| T7   | 1 00000007 | 1 17770000 | 00000000                    | 60000000   |       |          |          |   |
| T4   | 1 00000017 | 1 17760000 | 00000000                    | 60000000   |       |          |          |   |
| T1   | 1 00000037 | 1 17740000 | 00000000                    | 60000000   |       |          |          |   |
| TP   | 1 00000077 | 1 17700000 | 00000000                    | 60000000   |       |          |          |   |
| T6   | 1 00000177 | 1 17600000 | 00000000                    | 60000000   |       |          |          |   |
| T3   | 1 00000377 | 1 17400000 | 00000000                    | 60000000   |       |          |          |   |
| T0   | 1 00000777 | 1 17000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00001777 | 1 16000000 | 00000000                    | 60000000   |       |          |          |   |
| T5   | 1 00003777 | 1 14000000 | 00000000                    | 60000000   |       |          |          |   |
| T2   | 1 00007777 | 1 10000000 | 00000000                    | 60000000   |       |          |          |   |
| TR   | 1 00017777 | 1 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T7   | 1 00037777 | 1 60000000 | 00000000                    | 60000000   |       |          |          |   |
| T4   | 1 00077776 | 0 67777777 | 00000001                    | 17777777   |       |          |          |   |
| T1   | 1 00177774 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TP   | 1 00377770 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T6   | 1 00777760 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T3   | 1 01777740 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T0   | 1 03777700 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 07777600 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 17777400 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 37777000 | 1 37777770 | 00000010                    | 17777777   |       |          |          |   |
| TP   | 1 37777000 | 0 00000000 | 11111101                    | 17777777   |       |          |          |   |

| FIGURE DIV30 |            |            |             |            | A/M = | 37776000 | 00000000 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T8           | 1 60001000 | 0 00000000 | 00000000    | 60000000   |       |          |          |   |
| T8           | 1 00000000 | 0 77776777 | 00000001    | 60000000   |       |          |          |   |
| T5           | 1 00000000 | 0 06664677 | 11111101    | 17777777   |       |          |          |   |
| T2           | 1 00000001 | 1 17773700 | 00000100    | 60000000   |       |          |          |   |
| TR           | 1 00000003 | 1 17760000 | 00010000    | 60000000   |       |          |          |   |
| T7           | 1 00000007 | 1 17760000 | 00000000    | 60000000   |       |          |          |   |
| T4           | 1 00000017 | 1 17760000 | 00000000    | 60000000   |       |          |          |   |
| T1           | 1 00000037 | 1 17700000 | 00000000    | 60000000   |       |          |          |   |
| TP           | 1 00000077 | 1 17600000 | 00000000    | 60000000   |       |          |          |   |
| T6           | 1 00000177 | 1 17400000 | 00000000    | 60000000   |       |          |          |   |
| T3           | 1 00000377 | 1 17000000 | 00000000    | 60000000   |       |          |          |   |
| T0           | 1 00000777 | 1 16000000 | 00000000    | 60000000   |       |          |          |   |
| T8           | 1 00001777 | 1 14000000 | 00000000    | 60000000   |       |          |          |   |
| T5           | 1 00003777 | 1 10000000 | 00000000    | 60000000   |       |          |          |   |
| T2           | 1 00007777 | 1 00000000 | 00000000    | 60000000   |       |          |          |   |
| TR           | 1 00017777 | 1 60000000 | 00000000    | 60000000   |       |          |          |   |
| T7           | 1 00037776 | 0 57777777 | 00000001    | 17777777   |       |          |          |   |
| T4           | 1 00077774 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T1           | 1 00177770 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| TP           | 1 00877760 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T6           | 1 00777740 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T3           | 1 01777700 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T0           | 1 03777600 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T8           | 1 07777400 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T5           | 1 17777000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T2           | 1 37776000 | 1 37777770 | 00000010    | 17777777   |       |          |          |   |
| TP           | 1 37776000 | 0 00000000 | 11111101    | 17777777   |       |          |          |   |

| FIGURE DIV31 |            |            |             |            | A/M = 37774000 00000000 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 60002000 | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00000000 | 0 77775777 | 00000001    | 60000000   |                           |  |  |
| T5           | 1 00000000 | 0 06662677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00000001 | 1 17767700 | 00000100    | 60000000   |                           |  |  |
| TR           | 1 00000003 | 1 17750000 | 00010000    | 60000000   |                           |  |  |
| T7           | 1 00000007 | 1 17740000 | 00000000    | 60000000   |                           |  |  |
| T4           | 1 00000017 | 1 17700000 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00000037 | 1 17600000 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00000077 | 1 17400000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00000177 | 1 17000000 | 00000000    | 60000000   |                           |  |  |
| T3           | 1 00000377 | 1 16000000 | 00000000    | 60000000   |                           |  |  |
| T0           | 1 00000777 | 1 14000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00001777 | 1 10000000 | 00000000    | 60000000   |                           |  |  |
| T5           | 1 00003777 | 1 00000000 | 00000000    | 60000000   |                           |  |  |
| T2           | 1 00007777 | 1 60000000 | 00000000    | 60000000   |                           |  |  |
| TR           | 1 00017776 | 0 57777777 | 00000001    | 17777777   |                           |  |  |
| T7           | 1 00037774 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T4           | 1 00077770 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T1           | 1 00177760 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TP           | 1 00377740 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T6           | 1 00777700 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T3           | 1 01777600 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TC           | 1 03777400 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 07777000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 17776000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 37774000 | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP           | 1 37774000 | 0 00000000 | 11111101    | 17777777   |                           |  |  |

| TIME | FIGURE DIV32 |            |             |            | A/M = 37770000 00000000 0 |  |  |
|------|--------------|------------|-------------|------------|---------------------------|--|--|
|      | A REGISTER   | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8   | 1 60004000   | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8   | 1 00000000   | 0 77773777 | 00000001    | 60000000   |                           |  |  |
| T5   | 1 00000000   | 0 06656677 | 11111101    | 17777777   |                           |  |  |
| T2   | 1 00000001   | 1 17757700 | 00000100    | 60000000   |                           |  |  |
| TR   | 1 00000003   | 1 17730000 | 00010000    | 60000000   |                           |  |  |
| T7   | 1 00000007   | 1 17700000 | 00000000    | 60000000   |                           |  |  |
| T4   | 1 00000017   | 1 17600000 | 00000000    | 60000000   |                           |  |  |
| T1   | 1 00000037   | 1 17400000 | 00000000    | 60000000   |                           |  |  |
| TP   | 1 00000077   | 1 17000000 | 00000000    | 60000000   |                           |  |  |
| T6   | 1 00000177   | 1 16000000 | 00000000    | 60000000   |                           |  |  |
| T3   | 1 00000377   | 1 14000000 | 00000000    | 60000000   |                           |  |  |
| T0   | 1 00000777   | 1 10000000 | 00000000    | 60000000   |                           |  |  |
| T8   | 1 00001777   | 1 00000000 | 00000000    | 60000000   |                           |  |  |
| T5   | 1 00003777   | 1 60000000 | 00000000    | 60000000   |                           |  |  |
| T2   | 1 00007776   | 0 57777777 | 00000001    | 17777777   |                           |  |  |
| TR   | 1 00017774   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T7   | 1 00037770   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T4   | 1 00077760   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T1   | 1 00177740   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TP   | 1 00377700   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T6   | 1 00777600   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T3   | 1 01777400   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T0   | 1 03777000   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8   | 1 07776000   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5   | 1 17774000   | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2   | 1 37770000   | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP   | 1 37770000   | 0 00000000 | 11111101    | 17777777   |                           |  |  |



| TIME | A REGISTER | B REGISTER | FIGURE DIV34<br>BC REGISTER | A/M = 37740000<br>C REGISTER | 00000000 0 |
|------|------------|------------|-----------------------------|------------------------------|------------|
| T8   | 1 60020000 | 0 00000000 | 00000000                    | 60000000                     |            |
| T8   | 1 00000000 | 0 77757777 | 00000001                    | 60000000                     |            |
| T5   | 1 00000000 | 0 06626677 | 11111101                    | 17777777                     |            |
| T2   | 1 00000001 | 1 17677700 | 00000100                    | 60000000                     |            |
| TR   | 1 00000003 | 1 17670000 | 00010000                    | 60000000                     |            |
| T7   | 1 00000007 | 1 17400000 | 00000000                    | 60000000                     |            |
| T4   | 1 00000017 | 1 17000000 | 00000000                    | 60000000                     |            |
| T1   | 1 00000037 | 1 16000000 | 00000000                    | 60000000                     |            |
| TP   | 1 00000077 | 1 14000000 | 00000000                    | 60000000                     |            |
| T6   | 1 00000177 | 1 10000000 | 00000000                    | 60000000                     |            |
| T3   | 1 00000377 | 1 00000000 | 00000000                    | 60000000                     |            |
| TC   | 1 00000777 | 1 60000000 | 00000000                    | 60000000                     |            |
| T8   | 1 00001776 | 0 57777777 | 00000001                    | 17777777                     |            |
| T5   | 1 00003774 | 0 46666677 | 11111101                    | 17777777                     |            |
| T2   | 1 00007770 | 0 46666677 | 11111101                    | 17777777                     |            |
| TR   | 1 00017760 | 0 46666677 | 11111101                    | 17777777                     |            |
| T7   | 1 00037740 | 0 46666677 | 11111101                    | 17777777                     |            |
| T4   | 1 00077700 | 0 46666677 | 11111101                    | 17777777                     |            |
| T1   | 1 00177600 | 0 46666677 | 11111101                    | 17777777                     |            |
| TP   | 1 00377400 | 0 46666677 | 11111101                    | 17777777                     |            |
| T6   | 1 00777000 | 0 46666677 | 11111101                    | 17777777                     |            |
| T3   | 1 01776000 | 0 46666677 | 11111101                    | 17777777                     |            |
| TC   | 1 03774000 | 0 46666677 | 11111101                    | 17777777                     |            |
| T8   | 1 07770000 | 0 46666677 | 11111101                    | 17777777                     |            |
| T5   | 1 17760000 | 0 46666677 | 11111101                    | 17777777                     |            |
| T2   | 1 37740000 | 1 37777770 | 00000010                    | 17777777                     |            |
| TP   | 1 37740000 | 0 00000000 | 11111101                    | 17777777                     |            |

| TIME | A REGISTER | B REGISTER | FIGURE DIV35<br>BC REGISTER | C REGISTER | A/M = | 37700000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 60040000 | 0 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00000000 | 0 77737777 | 00000001                    | 60000000   |       |          |          |   |
| T5   | 1 00000000 | 0 06666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00000001 | 1 17577700 | 00000100                    | 60000000   |       |          |          |   |
| TR   | 1 00000003 | 1 17370000 | 00010000                    | 60000000   |       |          |          |   |
| T7   | 1 00000007 | 1 16000000 | 01000000                    | 60000000   |       |          |          |   |
| T4   | 1 00000017 | 1 16000000 | 00000000                    | 60000000   |       |          |          |   |
| T1   | 1 00000037 | 1 14000000 | 00000000                    | 60000000   |       |          |          |   |
| TP   | 1 00000077 | 1 10000000 | 00000000                    | 60000000   |       |          |          |   |
| T6   | 1 00000177 | 1 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T3   | 1 00000377 | 1 60000000 | 00000000                    | 60000000   |       |          |          |   |
| TC   | 1 00000776 | 0 57777777 | 00000001                    | 17777777   |       |          |          |   |
| T8   | 1 00001774 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 00003770 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00007760 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TR   | 1 00017740 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T7   | 1 00037700 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T4   | 1 00077600 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T1   | 1 00177400 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TP   | 1 00377000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T6   | 1 00776000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T3   | 1 01774000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TC   | 1 03770000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 07760000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 17740000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 37700000 | 1 37777770 | 00000010                    | 17777777   |       |          |          |   |
| TP   | 1 37700000 | 0 00000000 | 11111101                    | 17777777   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV36<br>BC REGISTER | C REGISTER | A/M = | 37600000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 60100000 | 0 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00000000 | 0 77677777 | 00000001                    | 60000000   |       |          |          |   |
| T5   | 1 00000000 | 0 06466677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00000001 | 1 17377700 | 00000100                    | 60000000   |       |          |          |   |
| TR   | 1 00000003 | 1 16770000 | 00010000                    | 60000000   |       |          |          |   |
| T7   | 1 00000007 | 1 15000000 | 01000000                    | 60000000   |       |          |          |   |
| T4   | 1 00000017 | 1 14000000 | 00000000                    | 60000000   |       |          |          |   |
| T1   | 1 00000037 | 1 10000000 | 00000000                    | 60000000   |       |          |          |   |
| TP   | 1 00000077 | 1 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T6   | 1 00000177 | 1 60000000 | 00000000                    | 60000000   |       |          |          |   |
| T3   | 1 00000376 | 0 57777777 | 00000001                    | 17777777   |       |          |          |   |
| TC   | 1 00000774 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 00001770 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 00003760 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00007740 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TR   | 1 00017700 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T7   | 1 00037600 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T4   | 1 00077400 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T1   | 1 00177000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TP   | 1 00376000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T6   | 1 00774000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T3   | 1 01770000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TC   | 1 03760000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 07740000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 17700000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 37600000 | 1 37777770 | 00000010                    | 17777777   |       |          |          |   |
| TP   | 1 37600000 | 0 00000000 | 11111101                    | 17777777   |       |          |          |   |

| FIGURE DIV37 |            |            |             |            | A/M = 37400000 00000000 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T0           | 1 00200000 | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00000000 | 0 77577777 | 00000001    | 60000000   |                           |  |  |
| T5           | 1 00000000 | 0 06266677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00000001 | 1 16777700 | 00000100    | 60000000   |                           |  |  |
| TR           | 1 00000003 | 1 15770000 | 00010000    | 60000000   |                           |  |  |
| T7           | 1 00000007 | 1 13000000 | 01000000    | 60000000   |                           |  |  |
| T4           | 1 00000017 | 1 10000000 | 00000000    | 60000000   |                           |  |  |
| T1           | 1 00000037 | 1 00000000 | 00000000    | 60000000   |                           |  |  |
| TP           | 1 00000077 | 1 60000000 | 00000000    | 60000000   |                           |  |  |
| T6           | 1 00000176 | 0 57777777 | 00000001    | 17777777   |                           |  |  |
| T3           | 1 00000374 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T0           | 1 00000770 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 00001760 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 00003740 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00007700 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TR           | 1 00017600 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T7           | 1 00037400 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T4           | 1 00077000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T1           | 1 00176000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TP           | 1 00374000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T6           | 1 00770000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T3           | 1 01760000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TC           | 1 03740000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 07700000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 17600000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 37400000 | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP           | 1 37400000 | 0 00000000 | 11111101    | 17777777   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV38<br>BC REGISTER | C REGISTER | A/M = 37000000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|----------------|----------|---|
| T8   | 1 60400000 | 0 00000000 | 00000000                    | 60000000   |                |          |   |
| T8   | 1 00000000 | 0 77377777 | 00000001                    | 60000000   |                |          |   |
| T5   | 1 00000000 | 0 05666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 00000001 | 1 15777700 | 00000100                    | 60000000   |                |          |   |
| TR   | 1 00000003 | 1 13770000 | 00010000                    | 60000000   |                |          |   |
| T7   | 1 00000007 | 1 07000000 | 01000000                    | 60000000   |                |          |   |
| T4   | 1 00000017 | 1 00000000 | 00000000                    | 60000000   |                |          |   |
| T1   | 1 00000037 | 1 60000000 | 00000000                    | 60000000   |                |          |   |
| TP   | 1 00000076 | 0 57777777 | 00000001                    | 17777777   |                |          |   |
| T6   | 1 00000174 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T3   | 1 00000370 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T0   | 1 00000760 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T8   | 1 00001740 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T5   | 1 00003700 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 00007600 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| TR   | 1 00017400 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T7   | 1 00037000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T4   | 1 00076000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T1   | 1 00174000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| TP   | 1 00370000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T6   | 1 00760000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T3   | 1 01740000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T0   | 1 03700000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T8   | 1 07600000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T5   | 1 17400000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 37000000 | 1 37777770 | 00000010                    | 17777777   |                |          |   |
| TP   | 1 37000000 | 0 00000000 | 11111101                    | 17777777   |                |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV39<br>BC REGISTER | C REGISTER | A/M = 36000000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|----------------|----------|---|
| T8   | 1 61000000 | 0 00000000 | 00000000                    | 60000000   |                |          |   |
| T8   | 1 00000000 | 0 76777777 | 00000001                    | 60000000   |                |          |   |
| T5   | 1 00000000 | 0 04666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 00000001 | 1 13777700 | 00000100                    | 60000000   |                |          |   |
| TR   | 1 00000003 | 1 07770000 | 00010000                    | 60000000   |                |          |   |
| T7   | 1 00000007 | 1 77000000 | 01000000                    | 60000000   |                |          |   |
| T4   | 1 00000017 | 1 00000000 | 00000000                    | 60000000   |                |          |   |
| T1   | 1 00000036 | 0 57777777 | 00000001                    | 17777777   | *              |          |   |
| TP   | 1 00000074 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T6   | 1 00000170 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T3   | 1 00000360 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T0   | 1 00000740 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T8   | 1 00001700 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T5   | 1 00003600 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 00007400 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| TR   | 1 00017000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T7   | 1 00036000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T4   | 1 00074000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T1   | 1 00170000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| TP   | 1 00360000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T6   | 1 00740000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T3   | 1 01700000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T0   | 1 03600000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T8   | 1 07400000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T5   | 1 17000000 | 0 46666677 | 11111101                    | 17777777   |                |          |   |
| T2   | 1 36000000 | 1 37777770 | 00000010                    | 17777777   |                |          |   |
| TP   | 1 36000000 | 0 00000000 | 11111101                    | 17777777   |                |          |   |

| FIGURE DIV40 |            |            |             |            | A/M = | 34000000 | 00000000 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T8           | 1 62000000 | 0 00000000 | 00000000    | 60000000   |       |          |          |   |
| T8           | 1 00000000 | 0 75777777 | 00000001    | 60000000   |       |          |          |   |
| T5           | 1 00000000 | 0 02666677 | 11111101    | 17777777   |       |          |          |   |
| T2           | 1 00000001 | 1 07777700 | 00000100    | 60000000   |       |          |          |   |
| TR           | 1 00000003 | 1 77770000 | 00010000    | 60000000   |       |          |          |   |
| TZ           | 1 00000007 | 1 57080000 | 01000000    | 60000000 * |       |          |          |   |
| T4           | 1 00000016 | 0 57777777 | 00000001    | 17777777   |       |          |          |   |
| T1           | 1 00000034 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| TP           | 1 00000070 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T6           | 1 00000160 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T3           | 1 00000340 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T0           | 1 00000700 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T8           | 1 00001600 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T5           | 1 00003400 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T2           | 1 00007000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| TR           | 1 00016000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T7           | 1 00034000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T4           | 1 00070000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T1           | 1 00160000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| TP           | 1 00340000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T6           | 1 00700000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T3           | 1 01600000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| TC           | 1 03400000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T8           | 1 07000000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T5           | 1 16000000 | 0 46666677 | 11111101    | 17777777   |       |          |          |   |
| T2           | 1 34000000 | 1 37777770 | 00000010    | 17777777   |       |          |          |   |
| TP           | 1 34000000 | 0 00000000 | 11111101    | 17777777   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV41<br>BC REGISTER | C REGISTER | A/M = | 30000000 | 00000000 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 64000000 | 0 00000000 | 00000000                    | 60000000   |       |          |          |   |
| T8   | 1 00000000 | 0 73777777 | 00000001                    | 60000000   |       |          |          |   |
| T5   | 1 00000000 | 0 76666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00000001 | 1 77777700 | 00000100                    | 60000000   | *     |          |          |   |
| TR   | 1 00000003 | 1 67770000 | 00010000                    | 60000000   | *     |          |          |   |
| T7   | 1 00000006 | 0 46777777 | 11000001                    | 17777777   |       |          |          |   |
| T4   | 1 00000014 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T1   | 1 00000030 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TP   | 1 00000060 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T6   | 1 00000140 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T3   | 1 00000300 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T0   | 1 00000600 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 00001400 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 00003000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 00006000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TR   | 1 00014000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T7   | 1 00030000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T4   | 1 00060000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T1   | 1 00140000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| TP   | 1 00300000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T6   | 1 00600000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T3   | 1 01400000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T0   | 1 03000000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T8   | 1 06000000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T5   | 1 14000000 | 0 46666677 | 11111101                    | 17777777   |       |          |          |   |
| T2   | 1 30000000 | 1 37777770 | 00000010                    | 17777777   |       |          |          |   |
| TP   | 1 30000000 | 0 00000000 | 11111101                    | 17777777   |       |          |          |   |

| FIGURE DIV42 |            |            |             |            | A/M = 20000000 00000000 0 |  |  |
|--------------|------------|------------|-------------|------------|---------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                           |  |  |
| T8           | 1 70000000 | 0 00000000 | 00000000    | 60000000   |                           |  |  |
| T8           | 1 00000000 | 0 67777777 | 00000001    | 60000000   |                           |  |  |
| T5           | 1 00000000 | 0 66666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00000001 | 1 57777700 | 00000100    | 60000000 * |                           |  |  |
| TR           | 1 00000002 | 0 46667777 | 11110001    | 17777777   |                           |  |  |
| T7           | 1 00000004 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T4           | 1 00000010 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T1           | 1 00000020 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TP           | 1 00000040 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T6           | 1 00000100 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T3           | 1 00000200 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T0           | 1 00000400 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 00001000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 00002000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 00004000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TR           | 1 00010000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T7           | 1 00020000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T4           | 1 00040000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T1           | 1 00100000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TP           | 1 00200000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T6           | 1 00400000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T3           | 1 01000000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| TC           | 1 02000000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T8           | 1 04000000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T5           | 1 10000000 | 0 46666677 | 11111101    | 17777777   |                           |  |  |
| T2           | 1 20000000 | 1 37777770 | 00000010    | 17777777   |                           |  |  |
| TP           | 1 20000000 | 0 00000000 | 11111101    | 17777777   |                           |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV43<br>BC REGISTER | C REGISTER | A/M = 20000000 00000000 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 60000000 | 0 00000000 | 00000000                    | 40000000   |                           |
| T8   | 1 00000000 | 0 87777777 | 00000001                    | 40000000   |                           |
| T5   | 1 00000000 | 0 66666677 | 11111101                    | 37777777   |                           |
| T2   | 1 00000001 | 1 87777700 | 00000100                    | 40000000   | *                         |
| TR   | 1 00000002 | 0 26667777 | 11110001                    | 37777777   | *                         |
| T7   | 1 00000004 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T4   | 1 00000010 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T1   | 1 00000020 | 0 26666677 | 11111101                    | 37777777   | *                         |
| TP   | 1 00000040 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T6   | 1 00000100 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T3   | 1 00000200 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T0   | 1 00000400 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T8   | 1 00001000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T5   | 1 00002000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T2   | 1 00004000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| TR   | 1 00010000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T7   | 1 00020000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T4   | 1 00040000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T1   | 1 00100000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| TP   | 1 00200000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T6   | 1 00400000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T3   | 1 01000000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T0   | 1 02000000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T8   | 1 04000000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T5   | 1 10000000 | 0 26666677 | 11111101                    | 37777777   | *                         |
| T2   | 1 20000000 | 0 77777770 | 00000010                    | 37777777   | *                         |
| TP   | 1 20000000 | 0 00000000 | 11111101                    | 37777777   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV44<br>BC REGISTER | C REGISTER | A/M = 51437240 67122325 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 44542115 | 1 71160352 | 00000000                    | 20100711   |                           |
| T8   | 1 06617426 | 1 13134751 | 00000000                    | 57677066   |                           |
| T5   | 1 15437055 | 1 75060700 | 11110111                    | 57677066   |                           |
| T2   | 1 33076133 | 1 63151000 | 11110111                    | 57677066   | *                         |
| TR   | 1 66174266 | 0 10642133 | 00001000                    | 20100711   |                           |
| T7   | 1 54370555 | 1 70375245 | 11010111                    | 57677066   |                           |
| T4   | 1 30761333 | 1 51601713 | 11110111                    | 57677066   | *                         |
| T1   | 1 61742666 | 0 65724761 | 00000000                    | 20100711   |                           |
| TP   | 1 43705554 | 0 73751654 | 00001000                    | 20100711   |                           |
| T6   | 1 07613330 | 0 07025442 | 01001000                    | 20100711   |                           |
| T3   | 1 17426661 | 1 77644162 | 00110011                    | 57677066   |                           |
| TO   | 1 37055542 | 0 17030277 | 01001000                    | 20100711   |                           |
| T8   | 1 76133305 | 1 17651554 | 00110111                    | 57677066   |                           |
| T5   | 1 74266613 | 1 06532531 | 11110111                    | 57677066   |                           |
| T2   | 1 70555427 | 1 06374563 | 11010011                    | 57677066   |                           |
| TR   | 1 61333057 | 1 05600357 | 11110101                    | 57677066   |                           |
| T7   | 1 42666137 | 1 04410127 | 11110101                    | 57677066   |                           |
| T4   | 1 05554277 | 1 02037447 | 11100101                    | 57677066   |                           |
| T1   | 1 13330577 | 1 75066306 | 11110101                    | 57677066   |                           |
| TP   | 1 26661377 | 1 63164074 | 11110011                    | 57677066   | *                         |
| T6   | 1 55542776 | 0 10670123 | 00001000                    | 20100711   |                           |
| T3   | 1 33305775 | 1 70351225 | 11110111                    | 57677066   |                           |
| TO   | 1 66613773 | 1 52731652 | 10110111                    | 57677066   | *                         |
| T8   | 1 55427766 | 0 66203650 | 00001010                    | 20100711   |                           |
| T5   | 1 33057754 | 0 74511452 | 00001000                    | 20100711   |                           |
| T2   | 1 66137730 | 1 71225124 | 00000000                    | 20100711   |                           |
| TP   | 1 11640050 | 0 63164415 | 00001000                    | 20100711   | 0F                        |

| TIME | A REGISTER | B REGISTER | FIGURE DIV45<br>BC REGISTER | C REGISTER | A/M = | 40241062 | 72603715 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 55440464 | 1 51761317 | 00000000                    | 12021725   |       |          |          |   |
| T8   | 1 26016462 | 1 10315366 | 00000000                    | 65756052   |       |          |          |   |
| T5   | 1 54035145 | 1 05500726 | 01110101                    | 65756052   |       |          |          |   |
| T2   | 1 30072313 | 1 72370021 | 11010111                    | 65756052   |       |          |          |   |
| TR   | 1 60164627 | 1 63756236 | 11000101                    | 65756052   | *     |          |          |   |
| T7   | 1 40251456 | 0 03755514 | 00001110                    | 12021725   |       |          |          |   |
| T4   | 1 00723135 | 1 64603423 | 11110101                    | 65756052   |       |          |          |   |
| T1   | 1 01646272 | 0 05640175 | 00011000                    | 12021725   |       |          |          |   |
| TP   | 1 03514565 | 1 70470344 | 11010101                    | 65756052   |       |          |          |   |
| T6   | 1 07231353 | 1 60157164 | 11000001                    | 65756052   | *     |          |          |   |
| T3   | 1 16462726 | 0 74357277 | 00001000                    | 12021725   |       |          |          |   |
| T0   | 1 35145654 | 0 02761413 | 00001110                    | 12021725   |       |          |          |   |
| T8   | 1 72313531 | 1 62613210 | 11110111                    | 65756052   |       |          |          |   |
| T5   | 1 64627262 | 0 71667560 | 10001010                    | 12021725   |       |          |          |   |
| T2   | 1 51456545 | 1 60437333 | 11100101                    | 65756052   | *     |          |          |   |
| TR   | 1 23135312 | 0 75210716 | 00110100                    | 12021725   |       |          |          |   |
| T7   | 1 46272624 | 0 04663751 | 00000010                    | 12021725   |       |          |          |   |
| T4   | 1 14565451 | 1 76415715 | 01110101                    | 65756052   |       |          |          |   |
| T1   | 1 31353122 | 0 01275751 | 10000010                    | 12021725   |       |          |          |   |
| TP   | 1 62726245 | 1 07441714 | 01110101                    | 65756052   |       |          |          |   |
| T6   | 1 45654513 | 1 06272005 | 01010101                    | 65756052   |       |          |          |   |
| T3   | 1 13531227 | 1 73552267 | 11010001                    | 65756052   |       |          |          |   |
| T0   | 1 27262457 | 1 76212532 | 01110101                    | 65756052   | *     |          |          |   |
| T8   | 1 56545136 | 0 00656303 | 10001110                    | 12021725   |       |          |          |   |
| T5   | 1 35312275 | 1 06425071 | 01110011                    | 65756052   |       |          |          |   |
| T2   | 1 72624573 | 0 17272104 | 00000100                    | 65756052   |       |          |          |   |
| TP   | 1 05153205 | 0 70242676 | 00000100                    | 65756052   | OF    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV46<br>BC REGISTER | A/M = 40000002<br>C REGISTER 77464736 1 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 1 56763275 | 0 02710031 | 00000000                    | 00727427                                |
| T8   | 1 75067750 | 0 20065053 | 00000000                    | 77050350                                |
| T5   | 1 72157721 | 1 37122477 | 00100001                    | 77050350                                |
| T2   | 1 64337643 | 1 65415451 | 10100101                    | 77050350                                |
| TR   | 1 50677506 | 0 73152744 | 01010010                    | 00727427                                |
| T7   | 1 21577214 | 0 70264350 | 01011010                    | 00727427                                |
| T4   | 1 43376430 | 0 62411367 | 01111000                    | 00727427                                |
| T1   | 1 06775060 | 0 47163376 | 01011010                    | 00727427                                |
| TP   | 1 15772140 | 0 20217433 | 01101010                    | 00727427                                |
| T6   | 1 33764301 | 1 31611456 | 10100001                    | 77050350                                |
| T3   | 1 67750602 | 0 03542555 | 01010010                    | 00727427 *                              |
| T0   | 1 57721405 | 1 00375623 | 10000101                    | 77050350                                |
| T8   | 1 37643013 | 1 17743121 | 00101101                    | 77050350                                |
| T5   | 1 77506027 | 1 27160714 | 10000101                    | 77050350                                |
| T2   | 1 77214057 | 1 65312303 | 10100101                    | 77050350                                |
| TR   | 1 76430136 | 0 73744430 | 00010010                    | 00727427                                |
| T7   | 1 75060274 | 0 67650520 | 01010010                    | 00727427                                |
| T4   | 1 72140570 | 0 61460600 | 01010110                    | 00727427                                |
| T1   | 1 64301360 | 0 45000240 | 01111010                    | 00727427                                |
| TP   | 1 50602740 | 0 14141140 | 01011010                    | 00727427                                |
| T6   | 1 21405701 | 1 21374671 | 10000001                    | 77050350                                |
| T3   | 1 43013603 | 1 51741034 | 10101101                    | 77050350                                |
| T0   | 1 06027406 | 0 44023612 | 01010110                    | 00727427                                |
| T8   | 1 14057014 | 0 12706263 | 00111010                    | 00727427                                |
| T5   | 1 30136031 | 1 15006036 | 10101101                    | 77050350                                |
| T2   | 1 60274063 | 0 52216276 | 00000000                    | 77050350                                |
| TP   | 1 17503715 | 0 52670641 | 00000000                    | 77050350 0F                             |

| TIME | A REGISTER | B REGISTER | FIGURE DIV47<br>BC REGISTER | C REGISTER | A/M = 77047436 24263720 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 00704547 | 0 35534245 | 00000000                    | 41254457   |                           |
| T8   | 0 35534245 | 0 42161226 | 00000000                    | 41254457   |                           |
| T5   | 0 73270512 | 0 32065774 | 11000001                    | 36523320   |                           |
| T2   | 0 66561224 | 0 34676213 | 10001101                    | 36523320   | *                         |
| TR   | 0 55342450 | 0 47211151 | 01111001                    | 36523320   | *                         |
| T7   | 0 32705120 | 0 56367645 | 01000001                    | 36523320   |                           |
| T4   | 0 65812240 | 0 64472034 | 11011001                    | 36523320   |                           |
| T1   | 0 53424500 | 0 21721313 | 10010101                    | 36523320   |                           |
| TP   | 0 27051201 | 1 24037400 | 01100110                    | 41254457   |                           |
| T6   | 0 56122403 | 1 13443677 | 00110000                    | 41254457   |                           |
| T3   | 0 34245007 | 1 60573146 | 10011110                    | 41254457   |                           |
| TC   | 0 70512016 | 0 17133054 | 01001001                    | 36523320   |                           |
| T8   | 0 61224035 | 1 01444502 | 00100110                    | 41254457   |                           |
| T5   | 0 42450073 | 1 44565074 | 00001010                    | 41254457   |                           |
| T2   | 0 05120166 | 0 47077531 | 01000001                    | 36523320   |                           |
| TR   | 0 12240354 | 0 56612504 | 00110101                    | 36523320   |                           |
| T7   | 0 24500730 | 0 63360732 | 11010001                    | 36523320   |                           |
| T4   | 0 51201660 | 0 26404106 | 01101101                    | 36523320   |                           |
| T1   | 0 22403541 | 1 10466066 | 10001010                    | 41254457   |                           |
| TP   | 0 45007303 | 1 02322543 | 00110110                    | 41254457   |                           |
| T6   | 0 12016607 | 1 46231176 | 00111010                    | 41254457   |                           |
| T3   | 0 24035416 | 0 42427734 | 11000001                    | 36523320   |                           |
| TC   | 0 50073034 | 0 55572112 | 10011101                    | 36523320   |                           |
| T8   | 0 20166070 | 0 01121747 | 11010001                    | 36523320   |                           |
| T5   | 0 40354161 | 1 65437377 | 00101000                    | 41254457   |                           |
| T2   | 0 00730342 | 1 53270777 | 00010000                    | 36523320   |                           |
| TP   | 0 77047436 | 0 24263720 | 11000101                    | 36523320   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV48<br>BC REGISTER | C REGISTER | A/M = 60202004 17350247 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 16657605 | 1 72043476 | 00000000                    | 41653276   |                           |
| T8   | 0 72043476 | 1 60533103 | 00000000                    | 41653276   |                           |
| T5   | 0 64107174 | 0 77302700 | 00110011                    | 36124501   |                           |
| T2   | 0 50216370 | 0 25141324 | 10011001                    | 36124501   |                           |
| TR   | 0 20434761 | 1 33177041 | 01001110                    | 41653276   |                           |
| T7   | 0 41071743 | 1 31183510 | 01100110                    | 41653276   |                           |
| T4   | 0 02163707 | 1 25372637 | 01010100                    | 41653276   |                           |
| T1   | 0 04347617 | 1 15650064 | 01011110                    | 41653276   |                           |
| TP   | 0 10717437 | 1 76315566 | 01100100                    | 41653276   |                           |
| T6   | 0 21637076 | 0 25157255 | 10001001                    | 36124501   |                           |
| T3   | 0 43476175 | 1 33113722 | 01100110                    | 41653276   |                           |
| TC   | 0 07174373 | 1 31273253 | 01010110                    | 41653276   |                           |
| T8   | 0 16370767 | 1 25451134 | 01011110                    | 41653276   |                           |
| T5   | 0 34761757 | 1 16717706 | 00100100                    | 41653276   |                           |
| T2   | 0 71743737 | 1 77603202 | 00110110                    | 41653276   |                           |
| TR   | 0 63707676 | 0 25742326 | 10011001                    | 36124501   |                           |
| T7   | 0 47617575 | 1 34571045 | 01011110                    | 41653276   |                           |
| T4   | 0 17437373 | 1 34257521 | 01000110                    | 41653276   |                           |
| T1   | 0 37076767 | 1 33302650 | 01110110                    | 41653276   |                           |
| TP   | 0 76175757 | 1 32670136 | 00011100                    | 41653276   |                           |
| T6   | 0 74373737 | 1 26455663 | 01000110                    | 41653276   |                           |
| T3   | 0 70767677 | 1 10706155 | 10101110                    | 41653276   |                           |
| TC   | 0 61757577 | 1 03661741 | 00010110                    | 41653276   |                           |
| T8   | 0 43737377 | 1 40337311 | 11100110                    | 41653276   |                           |
| T5   | 0 07676776 | 0 51113544 | 10110001                    | 36124501   |                           |
| T2   | 0 17575774 | 1 42447312 | 00000000                    | 36124501   |                           |
| TP   | 0 60202004 | 0 17350247 | 00001001                    | 36124501   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV49<br>BC REGISTER | C REGISTER | A/M = 35222771 02103136 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 21002075 | 0 00010113 | 00000000                    | 16152677   |                           |
| T8   | 0 00010113 | 0 02627176 | 00000000                    | 61625100   |                           |
| T5   | 0 00020227 | 1 66273474 | 01010001                    | 61625100   |                           |
| T2   | 0 00040456 | 0 64751761 | 10010110                    | 16152677   |                           |
| TR   | 0 00101134 | 0 07016751 | 01100110                    | 16152677   |                           |
| T7   | 0 00202271 | 1 01053242 | 01010001                    | 61625100   |                           |
| T4   | 0 00404563 | 1 65763606 | 00010001                    | 61625100   |                           |
| T1   | 0 01011346 | 0 61031205 | 11111110                    | 16152677   |                           |
| TP   | 0 02022714 | 0 72456421 | 10001110                    | 16152677   |                           |
| T6   | 0 04045631 | 1 56754362 | 00010001                    | 61625100   | *                         |
| T3   | 0 10113462 | 0 63022535 | 11101110                    | 16152677   |                           |
| TC   | 0 20227144 | 0 06311301 | 00111110                    | 16152677   |                           |
| T8   | 0 40456311 | 1 76662122 | 00010001                    | 61625100   |                           |
| T5   | 0 01134622 | 0 03636036 | 10101110                    | 16152677   |                           |
| T2   | 0 02271445 | 1 00413414 | 11110001                    | 61625100   |                           |
| TR   | 0 04563113 | 1 04064132 | 01010001                    | 61625100   |                           |
| T7   | 0 11346227 | 1 73715366 | 00100001                    | 61625100   |                           |
| T4   | 0 22714456 | 0 76104545 | 10101110                    | 16152677   |                           |
| T1   | 0 45631135 | 1 75230632 | 01010001                    | 61625100   | *                         |
| TP   | 0 13462272 | 0 02653256 | 10001110                    | 16152677   |                           |
| T6   | 0 27144565 | 1 06355054 | 01001001                    | 61625100   |                           |
| T3   | 0 56311353 | 1 77551232 | 01010001                    | 61625100   |                           |
| TC   | 0 34622727 | 1 62167567 | 01000001                    | 61625100   | *                         |
| T8   | 0 71445656 | 0 54421157 | 10111110                    | 16152677   |                           |
| T5   | 0 63113534 | 0 67336326 | 00101110                    | 16152677   |                           |
| T2   | 0 46227270 | 1 56076075 | 01001000                    | 16152677   |                           |
| TP   | 0 46227270 | 0 05612335 | 10111110                    | 16152677   | OF                        |

| FIGURE DIV50 |            |            |             |            | A/M =               |  |  |
|--------------|------------|------------|-------------|------------|---------------------|--|--|
| BC REGISTER  |            |            |             |            | 63420721 13535047 0 |  |  |
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                     |  |  |
| T8           | 0 11412441 | 1 75316651 | 00000000    | 47440035   |                     |  |  |
| T8           | 0 75316651 | 1 61052476 | 00000000    | 47440035   |                     |  |  |
| T5           | 0 72635522 | 0 72454037 | 00011101    | 30337742   |                     |  |  |
| T2           | 0 65473244 | 0 15401143 | 00111101    | 30337742   |                     |  |  |
| TR           | 0 63166511 | 1 72664546 | 10000000    | 47440035   |                     |  |  |
| T7           | 0 26355223 | 1 44111342 | 11100010    | 47440035 * |                     |  |  |
| T4           | 0 54732446 | 0 62751666 | 00011001    | 30337742   |                     |  |  |
| T1           | 0 31665114 | 0 75274411 | 01011111    | 30337742   |                     |  |  |
| TP           | 0 63552230 | 0 24142106 | 01011101    | 30337742   |                     |  |  |
| T6           | 0 47324461 | 1 11766444 | 10000010    | 47440035   |                     |  |  |
| T3           | 0 16651143 | 1 02315166 | 11100000    | 47440035   |                     |  |  |
| TC           | 0 35522307 | 1 66472301 | 10000110    | 47440035   |                     |  |  |
| T8           | 0 73244616 | 0 25414764 | 00110001    | 30337742   |                     |  |  |
| T5           | 0 66511435 | 1 12611700 | 10100110    | 47440035   |                     |  |  |
| T2           | 0 55223073 | 1 04264056 | 11000000    | 47440035   |                     |  |  |
| TR           | 0 32446167 | 1 71110162 | 11100010    | 47440035   |                     |  |  |
| T7           | 0 65114357 | 1 43060311 | 11000110    | 47440035 * |                     |  |  |
| T4           | 0 52230736 | 0 60470705 | 00010101    | 30337742   |                     |  |  |
| T1           | 0 24461674 | 0 71531757 | 00010001    | 30337742   |                     |  |  |
| TP           | 0 51143570 | 0 13632602 | 00011101    | 30337742   |                     |  |  |
| T6           | 0 22307361 | 1 66147634 | 11000010    | 47440035   |                     |  |  |
| T3           | 0 44616742 | 0 26646452 | 00011001    | 30337742   |                     |  |  |
| TC           | 0 11435705 | 1 14177154 | 11000010    | 47440035   |                     |  |  |
| T8           | 0 23073613 | 1 11736305 | 10100100    | 47440035   |                     |  |  |
| T5           | 0 46167427 | 1 03435047 | 10100000    | 47440035   |                     |  |  |
| T2           | 0 14357057 | 0 27272117 | 00000000    | 47440035   |                     |  |  |
| TP           | 0 63420721 | 0 13535047 | 00000000    | 47440035   |                     |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV51<br>BC REGISTER | C REGISTER | A/M = 76072766 74455603 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 77471243 | 0 15235633 | 00000000                    | 06455137   |                           |
| T8   | 1 62542146 | 0 71631375 | 00000000                    | 71322640   |                           |
| T5   | 1 45304314 | 0 61037022 | 11101110                    | 06455137   |                           |
| T2   | 1 12610630 | 0 62655314 | 10100110                    | 06455137   |                           |
| TR   | 1 25421460 | 0 63300107 | 11110100                    | 06455137   |                           |
| T7   | 1 53043140 | 0 77475545 | 00000010                    | 06455137   |                           |
| T4   | 1 26106300 | 0 75540462 | 10110010                    | 06455137   |                           |
| T1   | 1 54214601 | 1 84043724 | 01000101                    | 71322640   | *                         |
| TP   | 1 30431403 | 1 03422613 | 00010101                    | 71322640   |                           |
| T6   | 1 61063007 | 1 70307470 | 10101001                    | 71322640   |                           |
| T3   | 1 42146017 | 1 72343723 | 00000101                    | 71322640   | *                         |
| T0   | 1 04314036 | 0 62355100 | 11010110                    | 06455137   |                           |
| T8   | 1 10630074 | 0 64327557 | 11100000                    | 06455137   |                           |
| T5   | 1 21460170 | 0 71424465 | 10110010                    | 06455137   |                           |
| T2   | 1 43140361 | 1 74513732 | 00100101                    | 71322640   | *                         |
| TR   | 1 06300742 | 0 77075116 | 01010110                    | 06455137   |                           |
| T7   | 1 14601705 | 1 71534214 | 00001101                    | 71322640   | *                         |
| T4   | 1 31403612 | 0 61647761 | 10100010                    | 06455137   |                           |
| T1   | 1 63007424 | 0 61364011 | 11011110                    | 06455137   |                           |
| TP   | 1 46017050 | 0 62347372 | 11100010                    | 06455137   |                           |
| T6   | 1 14036120 | 0 65563134 | 10011010                    | 06455137   |                           |
| T3   | 1 30074240 | 0 71745447 | 10100000                    | 06455137   |                           |
| T0   | 1 60170501 | 1 75435756 | 00000001                    | 71322640   | *                         |
| T8   | 1 40361202 | 0 71440066 | 10111010                    | 06455137   |                           |
| T5   | 1 00742405 | 1 74644735 | 00000101                    | 71322640   | *                         |
| T2   | 1 01705012 | 1 71511074 | 00001000                    | 06455137   | *                         |
| TP   | 1 76072766 | 0 74455603 | 11110010                    | 06455137   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV52<br>BC REGISTER | C REGISTER | A/M = 56002562 61556456 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 62577375 | 0 14460725 | 00000000                    | 27440716   |                           |
| T8   | 1 63317054 | 0 65537463 | 00000000                    | 50337061   |                           |
| T5   | 1 46636130 | 0 72637055 | 10101010                    | 27440716   |                           |
| T2   | 1 15474261 | 1 85137134 | 01100101                    | 50337061   | *                         |
| TR   | 1 33170542 | 0 59036300 | 11101110                    | 27440716   |                           |
| T7   | 1 66361304 | 0 77637736 | 00100000                    | 27440716   |                           |
| T4   | 1 54742610 | 0 16237503 | 11101110                    | 27440716   |                           |
| T1   | 1 31705421 | 1 26130400 | 01110111                    | 50337061   |                           |
| TP   | 1 63613043 | 1 26030203 | 01010101                    | 50337061   |                           |
| T6   | 1 47426107 | 1 26437672 | 00000001                    | 50337061   |                           |
| T3   | 1 17054217 | 1 25326540 | 00110111                    | 50337061   |                           |
| TC   | 1 36130437 | 1 23324503 | 00110101                    | 50337061   |                           |
| T8   | 1 74261077 | 1 17320471 | 00110001                    | 50337061   |                           |
| T5   | 1 70542177 | 1 07310146 | 00110101                    | 50337061   |                           |
| T2   | 1 61304377 | 1 67377570 | 00000011                    | 50337061   |                           |
| TR   | 1 42610776 | 0 75337311 | 11101010                    | 27440716   |                           |
| T7   | 1 05421775 | 1 65337624 | 00100101                    | 50337061   | *                         |
| T4   | 1 13043772 | 0 72437560 | 10101010                    | 27440716   |                           |
| T1   | 1 26107765 | 1 55530341 | 00110101                    | 50337061   | *                         |
| TP   | 1 54217752 | 0 52141012 | 11001010                    | 27440716   |                           |
| T6   | 1 30437724 | 0 65744753 | 10000010                    | 27440716   |                           |
| T3   | 1 61077650 | 0 12351654 | 11001010                    | 27440716   |                           |
| TC   | 1 42177521 | 1 16254532 | 01010101                    | 50337061   |                           |
| T8   | 1 04377243 | 1 06000440 | 01110111                    | 50337061   |                           |
| T5   | 1 10776507 | 1 66550303 | 00010101                    | 50337061   |                           |
| T2   | 1 21775216 | 1 55340000 | 00001010                    | 27440716   |                           |
| TP   | 1 56002562 | 0 61556456 | 11101010                    | 27440716   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV53<br>BC REGISTER | C REGISTER | A/M = 04363677 30736776 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 03423023 | 0 22540776 | 00000000                    | 31222477   |                           |
| T8   | 0 22540776 | 0 52200324 | 00000000                    | 46555300   |                           |
| T6   | 0 45301774 | 0 55622247 | 00001100                    | 31222477   |                           |
| T2   | 0 12603770 | 0 64660306 | 00011110                    | 31222477   |                           |
| TR   | 0 25407760 | 0 02705423 | 00100110                    | 31222477   |                           |
| T7   | 0 53017741 | 1 44560566 | 10010001                    | 46555300   |                           |
| T4   | 0 26037702 | 0 62503746 | 00100110                    | 31222477   |                           |
| T1   | 0 54077604 | 0 76622523 | 00010110                    | 31222477   |                           |
| TP   | 0 30177410 | 0 86607056 | 00101110                    | 31222477   |                           |
| T6   | 0 60377021 | 1 13375654 | 11000001                    | 46555300   |                           |
| T3   | 0 40276043 | 1 16440033 | 01111001                    | 46555300   |                           |
| T0   | 0 01774107 | 1 75077371 | 11000001                    | 46555300   |                           |
| T8   | 0 03270217 | 1 52643264 | 10111001                    | 46555300   | *                         |
| T5   | 0 07760436 | 0 76152141 | 01001110                    | 31222477   |                           |
| T2   | 0 17741074 | 0 27540111 | 00011110                    | 31222477   |                           |
| TR   | 0 37702171 | 1 15077742 | 11000001                    | 46555300   |                           |
| T7   | 0 77604363 | 1 12644206 | 10111001                    | 46555300   |                           |
| T4   | 0 77410747 | 1 03407717 | 11100001                    | 46555300   |                           |
| T1   | 0 77021717 | 1 77764141 | 00011001                    | 46555300   |                           |
| TP   | 0 76043638 | 0 20114774 | 11100010                    | 31222477   |                           |
| T6   | 0 74107475 | 1 20106311 | 11101001                    | 46555300   |                           |
| T3   | 0 70217173 | 1 20163125 | 11011001                    | 46555300   |                           |
| T0   | 0 60436367 | 1 20045555 | 11100001                    | 46555300   |                           |
| T8   | 0 41074757 | 1 80060635 | 11010001                    | 46555300   |                           |
| T5   | 0 02171737 | 1 80686775 | 10100001                    | 46555300   |                           |
| T2   | 0 04363677 | 0 61678774 | 00000000                    | 46555300   |                           |
| TP   | 0 04363677 | 0 30736776 | 00000000                    | 46555300   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV54<br>BC REGISTER | A/M = 74520707<br>C REGISTER 47016161 0 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 1 74576514 | 1 82404733 | 00000000                    | 37111644                                |
| T8   | 1 25373046 | 1 44067417 | 00000000                    | 40666133                                |
| T5   | 1 52766114 | 0 47260672 | 00010010                    | 37111644                                |
| T2   | 1 25754230 | 0 45672441 | 10001010                    | 37111644                                |
| TR   | 1 63730460 | 0 62670766 | 10010000                    | 37111644                                |
| T7   | 1 27661140 | 0 14712511 | 10001110                    | 37111644                                |
| T4   | 1 57542301 | 1 11405575 | 01110001                    | 40666133                                |
| T1   | 1 37904603 | 1 65011420 | 01110111                    | 40666133                                |
| TP   | 1 76611406 | 0 03354026 | 10001100                    | 37111644                                |
| T6   | 1 75423015 | 1 66510300 | 01110111                    | 40666133                                |
| T3   | 1 73046032 | 0 06552667 | 10000000                    | 37111644                                |
| T0   | 1 66114065 | 1 75103602 | 01110111                    | 40666133                                |
| T8   | 1 54230152 | 0 23530463 | 10011010                    | 37111644                                |
| T5   | 1 30460325 | 1 27161212 | 01010111                    | 40666133                                |
| T2   | 1 61140653 | 1 20140771 | 01110011                    | 40666133                                |
| TR   | 1 42301527 | 1 02307130 | 01101011                    | 40666133                                |
| T7   | 1 04603257 | 1 47606436 | 00100001                    | 40666133                                |
| T4   | 1 11406536 | 0 46726632 | 10000110                    | 37111644                                |
| T1   | 1 23015274 | 0 64766540 | 10001010                    | 37111644                                |
| TP   | 1 46032570 | 0 20060164 | 11011000                    | 37111644                                |
| T6   | 1 14065361 | 1 22740404 | 00110101                    | 40666133                                |
| T3   | 1 30152743 | 1 06707345 | 00100001                    | 40666133                                |
| T0   | 1 60325707 | 1 56674047 | 00011001                    | 40666133                                |
| T8   | 1 40653616 | 0 64723765 | 10000000                    | 37111644                                |
| T5   | 1 01527434 | 0 20750517 | 10011100                    | 37111644                                |
| T2   | 1 03257071 | 0 61743436 | 00000000                    | 40666133                                |
| TP   | 1 74520707 | 0 47016161 | 00000000                    | 40666133                                |

| TIME | A REGISTER | B REGISTER | FIGURE DIV55<br>BC REGISTER | C REGISTER | A/M = | 41676363 | 31043510 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 33130202 | 0 14073355 | 00000000                    | 43107232   |       |          |          |   |
| T8   | 0 14073355 | 0 76237434 | 00000000                    | 43107232   |       |          |          |   |
| T5   | 0 30166732 | 0 20267535 | 11100101                    | 34670545   |       |          |          |   |
| T2   | 0 60355665 | 1 25056626 | 01010100                    | 43107232   |       |          |          |   |
| TR   | 0 40733553 | 1 17254007 | 00011100                    | 43107232   |       |          |          |   |
| T7   | 0 01667327 | 1 71651441 | 10010010                    | 43107232   |       |          |          |   |
| T4   | 0 03556657 | 1 46642354 | 00010000                    | 43107232   |       |          |          |   |
| T1   | 0 07335536 | 0 41314475 | 11101001                    | 34670545   | *     |          |          |   |
| TP   | 0 16673274 | 0 51623631 | 10100111                    | 34670545   |       |          |          |   |
| T6   | 0 35566570 | 0 77437441 | 01101011                    | 34670545   |       |          |          |   |
| T3   | 0 73355361 | 1 44300356 | 00110000                    | 43107232   | *     |          |          |   |
| T0   | 0 66732742 | 0 45610472 | 00101011                    | 34670545   |       |          |          |   |
| T8   | 0 55665704 | 0 47413744 | 01100011                    | 34670545   |       |          |          |   |
| T5   | 0 33553610 | 0 55017470 | 01101011                    | 34670545   |       |          |          |   |
| T2   | 0 67327420 | 0 60031747 | 11100001                    | 34670545   |       |          |          |   |
| TR   | 0 56657040 | 0 16053466 | 01101001                    | 34670545   |       |          |          |   |
| T7   | 0 35536101 | 1 71430301 | 10010110                    | 43107232   |       |          |          |   |
| T4   | 0 73274203 | 1 46200254 | 00010000                    | 43107232   | *     |          |          |   |
| T1   | 0 66570406 | 0 40210276 | 11101001                    | 34670545   |       |          |          |   |
| TP   | 0 55361014 | 0 56412234 | 01101111                    | 34670545   |       |          |          |   |
| T6   | 0 32742030 | 0 63016450 | 11101011                    | 34670545   |       |          |          |   |
| T3   | 0 65704060 | 0 24027607 | 01100101                    | 34670545   |       |          |          |   |
| TC   | 0 53610141 | 1 15356053 | 00011000                    | 43107232   |       |          |          |   |
| T8   | 0 27420303 | 1 75055351 | 01010010                    | 43107232   |       |          |          |   |
| T5   | 0 57040606 | 0 20742407 | 10101101                    | 34670545   |       |          |          |   |
| T2   | 0 36101415 | 0 61107211 | 01000010                    | 43107232   |       |          |          |   |
| TP   | 0 41676363 | 0 31043510 | 01000010                    | 43107232   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV56<br>BC REGISTER | C REGISTER | A/M = 72014004 13437770 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 04417370 | 1 21706720 | 00000000                    | 47574674   |                           |
| T8   | 0 71706720 | 1 54214264 | 00000000                    | 47574674   |                           |
| T5   | 0 63615640 | 0 60633654 | 00000001                    | 30203103   |                           |
| T2   | 0 47433500 | 0 71662636 | 00010001                    | 30203103   |                           |
| TR   | 0 17067200 | 0 23760872 | 00010011                    | 30203103   |                           |
| T7   | 0 36156401 | 1 66455272 | 11101010                    | 47574674   |                           |
| T4   | 0 74835002 | 0 27537707 | 00000001                    | 30203103   |                           |
| T1   | 0 70672006 | 1 16763415 | 10111100                    | 47574674   |                           |
| TP   | 0 61564013 | 1 15665027 | 10101100                    | 47574674   |                           |
| T6   | 0 43350027 | 1 12440043 | 11111110                    | 47574674   |                           |
| T3   | 0 06720057 | 1 06016113 | 11101110                    | 47574674   |                           |
| T0   | 0 15640137 | 1 75722232 | 10111110                    | 47574674   |                           |
| T8   | 0 33500277 | 1 53552570 | 10111010                    | 47574674   | *                         |
| T5   | 0 67200576 | 0 77742503 | 00010001                    | 30203103   |                           |
| T2   | 0 56401374 | 0 27120314 | 01010001                    | 30203103   |                           |
| TR   | 0 35002771 | 1 27754427 | 00101100                    | 47574674   |                           |
| T7   | 0 72005763 | 1 17627042 | 10101110                    | 47574674   |                           |
| T4   | 0 64013747 | 1 16354111 | 11101110                    | 47574674   |                           |
| T1   | 0 59027717 | 1 16626237 | 10101100                    | 47574674   |                           |
| TP   | 0 20057637 | 1 14342463 | 11111110                    | 47574674   |                           |
| T6   | 0 40137477 | 1 12613152 | 10111110                    | 47574674   |                           |
| T3   | 0 00277177 | 1 04344331 | 11101110                    | 47574674   |                           |
| T0   | 0 00576377 | 1 72607776 | 10100000                    | 47574674   |                           |
| T8   | 0 01374777 | 1 44303560 | 11111110                    | 47574674   | *                         |
| T5   | 0 02771776 | 0 53234663 | 00000001                    | 30203103   |                           |
| T2   | 0 05763774 | 1 46471540 | 00000010                    | 30203103   |                           |
| TP   | 0 72014004 | 0 13437770 | 00000001                    | 30203103   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV57<br>BC REGISTER | C REGISTER | A/M = 23676546 | 10403014 | 0 |
|------|------------|------------|-----------------------------|------------|----------------|----------|---|
| T8   | 0 12257538 | 1 23604361 | 00000000                    | 20517362   |                |          |   |
| T8   | 0 73604361 | 1 21840153 | 00000000                    | 57260415   |                |          |   |
| T5   | 0 67410742 | 0 03017601 | 01000110                    | 20517362   |                |          |   |
| T2   | 0 57021705 | 1 67217230 | 00101011                    | 57260415   |                |          |   |
| TR   | 0 36043612 | 0 76357065 | 01001000                    | 20517362   |                |          |   |
| T7   | 0 74107424 | 0 26487434 | 01000100                    | 20517362   |                |          |   |
| T4   | 0 70217051 | 1 06317606 | 10100101                    | 57260415   |                |          |   |
| T1   | 0 60435123 | 1 04217224 | 10101011                    | 57260415   |                |          |   |
| TP   | 0 41074247 | 1 07020000 | 01101111                    | 57260415   |                |          |   |
| T6   | 0 02170517 | 1 77422630 | 00100011                    | 57260415   |                |          |   |
| T3   | 0 04361236 | 0 17754064 | 00011000                    | 20517362   |                |          |   |
| T0   | 0 10742475 | 1 06132555 | 11100001                    | 57260415   |                |          |   |
| T8   | 0 21205173 | 1 05648761 | 10100011                    | 57260415   |                |          |   |
| T5   | 0 43612367 | 1 02173371 | 11001011                    | 57260415   |                |          |   |
| T2   | 0 07424757 | 1 75550412 | 10101011                    | 57260415   |                |          |   |
| TR   | 0 17051737 | 1 62703453 | 10100011                    | 57260415   | *              |          |   |
| T7   | 0 36123676 | 0 06516432 | 00010100                    | 20517362   |                |          |   |
| T4   | 0 74247575 | 1 64435671 | 10100011                    | 57260415   |                |          |   |
| T1   | 0 70517372 | 0 11702167 | 00111000                    | 20517362   |                |          |   |
| TP   | 0 61236765 | 1 73206764 | 10100011                    | 57260415   |                |          |   |
| T6   | 0 42475753 | 1 55075300 | 11001111                    | 57260415   | *              |          |   |
| T3   | 0 05173726 | 0 74604305 | 00110100                    | 20517362   |                |          |   |
| TC   | 0 12367654 | 0 11340374 | 01010000                    | 20517362   |                |          |   |
| T8   | 0 24757531 | 1 73100305 | 11101101                    | 57260415   |                |          |   |
| T5   | 0 51137263 | 1 67663421 | 00000011                    | 57260415   | *              |          |   |
| T2   | 0 23676546 | 1 87847065 | 00000000                    | 20517362   | *              |          |   |
| TP   | 0 23676546 | 0 10403014 | 01010100                    | 20517362   |                |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV58<br>BC REGISTER | A/M = 26077601<br>C REGISTER 60157300 1 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 1 42262332 | 0 30122704 | 00000000                    | 54202442                                |
| T8   | 1 47655074 | 0 11720107 | 00000000                    | 54202442                                |
| T5   | 1 17532171 | 1 27042651 | 01000010                    | 54202442                                |
| T2   | 1 37264363 | 1 54307104 | 00001100                    | 54202442 *                              |
| TR   | 1 76550746 | 0 53315745 | 01100001                    | 23575335                                |
| T7   | 1 75321714 | 0 54520242 | 00111011                    | 23575335                                |
| T4   | 1 72643630 | 0 54157054 | 01101011                    | 23575335                                |
| T1   | 1 65507460 | 0 55235400 | 01100111                    | 23575335                                |
| TP   | 1 53217140 | 0 57360550 | 01110011                    | 23575335                                |
| T6   | 1 26436300 | 0 64656670 | 00100011                    | 23575335                                |
| T3   | 1 55074600 | 0 74422137 | 01111001                    | 23575335                                |
| T0   | 1 32171400 | 0 16753536 | 00110101                    | 23575335                                |
| T8   | 1 64363001 | 1 02341030 | 10011110                    | 54202442                                |
| T5   | 1 50746003 | 1 20126743 | 11000000                    | 54202442                                |
| T2   | 1 21714007 | 1 56457341 | 00001010                    | 54202442 *                              |
| TR   | 1 43630016 | 0 50635257 | 10101001                    | 23575335                                |
| T7   | 1 07460034 | 0 64361076 | 01111001                    | 23575335                                |
| T4   | 1 17140070 | 0 26651423 | 00110111                    | 23575335                                |
| T1   | 1 36900160 | 0 10430525 | 11110101                    | 23575335                                |
| TP   | 1 74600341 | 1 17503016 | 00001100                    | 54202442                                |
| T6   | 1 71400703 | 1 03412677 | 10000000                    | 54202442                                |
| T3   | 1 63001607 | 1 73227131 | 10001110                    | 54202442                                |
| T0   | 1 46003417 | 1 52662145 | 10001000                    | 54202442 *                              |
| T8   | 1 14007036 | 0 60233640 | 11110011                    | 23575335                                |
| T5   | 1 30016074 | 0 05474057 | 01011001                    | 23575335                                |
| T2   | 1 60034171 | 0 15112130 | 00100010                    | 54202442                                |
| TP   | 1 60034171 | 0 71272720 | 00100010                    | 54202442 OF                             |

| TIME | A REGISTER | B REGISTER | FIGURE DIV59<br>BC REGISTER | C REGISTER | A/M = 40000215 77473026 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 66562553 | 1 54177240 | 00000000                    | 03070242   |                           |
| T8   | 1 23600540 | 1 06124762 | 00000000                    | 74707535   |                           |
| T5   | 1 47401301 | 1 00150471 | 11011011                    | 74707535   |                           |
| T2   | 1 17002603 | 1 16242732 | 01010011                    | 74707535   |                           |
| TR   | 1 36005407 | 1 22424433 | 11011011                    | 74707535   |                           |
| T7   | 1 74013017 | 1 53772645 | 10010001                    | 74707535   |                           |
| T4   | 1 70026036 | 0 42075757 | 11000000                    | 03070242   |                           |
| T1   | 1 60054074 | 0 21163171 | 10101010                    | 03070242   |                           |
| TP   | 1 40130171 | 1 56457130 | 01001011                    | 74707535   |                           |
| T6   | 1 00260362 | 0 32130545 | 10100000                    | 03070242   |                           |
| T3   | 1 00540744 | 0 07451554 | 00100000                    | 03070242   | *                         |
| T0   | 1 01301711 | 1 03222065 | 11011001                    | 74707535   |                           |
| T8   | 1 02603623 | 1 24365601 | 01010111                    | 74707535   |                           |
| T5   | 1 05407447 | 1 46672351 | 01011011                    | 74707535   |                           |
| T2   | 1 13017116 | 0 12676106 | 10001100                    | 03070242   |                           |
| TR   | 1 26036235 | 1 31475141 | 11011011                    | 74707535   |                           |
| T7   | 1 54074472 | 0 00204566 | 10100000                    | 03070242   | *                         |
| T4   | 1 30171165 | 1 14610002 | 01011111                    | 74707535   |                           |
| T1   | 1 60362353 | 1 27141753 | 01010011                    | 74707535   |                           |
| TP   | 1 40744727 | 1 54222406 | 01011101                    | 74707535   |                           |
| T6   | 1 01711656 | 0 35457451 | 00100010                    | 03070242   |                           |
| T3   | 1 03623535 | 1 67236677 | 01010001                    | 74707535   |                           |
| T0   | 1 07447272 | 0 63805742 | 00100100                    | 03070242   |                           |
| T8   | 1 17116564 | 0 42404346 | 10100000                    | 03070242   |                           |
| T5   | 1 35235350 | 0 20200156 | 10101000                    | 03070242   |                           |
| T2   | 1 74472721 | 0 60602334 | 00000000                    | 74707535   |                           |
| TP   | 1 03305057 | 0 47476622 | 00000000                    | 74707535   | OF                        |

| TIME | A REGISTER | B REGISTER | FIGURE DIV60<br>BC REGISTER | C REGISTER | A/M = 74660235 21636425 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 02377223 | 1 45265627 | 00000000                    | 46523256   |                           |
| T8   | 0 45265627 | 1 51122501 | 00000000                    | 46523256   |                           |
| T5   | 0 12553456 | 0 53411724 | 00110001                    | 31254521   |                           |
| T2   | 0 25327134 | 0 50417373 | 10101001                    | 31254521   |                           |
| TR   | 0 52656270 | 0 72414411 | 00101101                    | 31254521   |                           |
| T7   | 0 25534560 | 0 16407746 | 00100001                    | 31254521   |                           |
| T4   | 0 53271341 | 1 73732164 | 10011010                    | 46523256   |                           |
| T1   | 0 26562703 | 1 45421547 | 11010100                    | 46523256   | *                         |
| TP   | 0 55345606 | 0 66237237 | 00101001                    | 31254521   |                           |
| T6   | 0 32713414 | 0 05054122 | 01101101                    | 31254521   |                           |
| T3   | 0 65627031 | 1 52055614 | 11000110                    | 46523256   |                           |
| TC   | 0 53456062 | 0 77307372 | 00101001                    | 31254521   |                           |
| T8   | 0 27134144 | 0 20274400 | 10001111                    | 31254521   |                           |
| T5   | 0 56270311 | 1 26216470 | 01100010                    | 46523256   |                           |
| T2   | 0 34560623 | 1 14350457 | 11010000                    | 46523256   |                           |
| TR   | 0 71341447 | 1 10464304 | 11000110                    | 46523256   |                           |
| T7   | 0 62703117 | 1 01674207 | 10000100                    | 46523256   |                           |
| T4   | 0 45606237 | 1 61213065 | 11101010                    | 46523256   |                           |
| T1   | 0 13414476 | 0 15004614 | 01100101                    | 31254521   |                           |
| TP   | 0 27031175 | 1 72734000 | 10001110                    | 46523256   |                           |
| T6   | 0 56062373 | 1 43315476 | 11100000                    | 46523256   | *                         |
| T3   | 0 34144766 | 0 62207616 | 00100101                    | 31254521   |                           |
| TC   | 0 70311754 | 0 75063357 | 01011001                    | 31254521   |                           |
| T8   | 0 60623730 | 0 25344462 | 00101001                    | 31254521   |                           |
| T5   | 0 41447661 | 1 11636315 | 10000110                    | 46523256   |                           |
| T2   | 0 03117543 | 0 43474053 | 00001000                    | 46523256   |                           |
| TP   | 0 74660235 | 0 21636425 | 00000000                    | 46523256   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV61<br>BC REGISTER | C REGISTER | A/M = | 36063112 | 21326047 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 32272650 | 1 21430106 | 00000000                    | 31716246   |       |          |          |   |
| T8   | 0 71430106 | 1 00354402 | 00000000                    | 46061531   |       |          |          |   |
| T5   | 0 63060215 | 1 46712536 | 00100001                    | 46061531   |       |          |          |   |
| T2   | 0 46140432 | 0 47733435 | 00010110                    | 31716246   |       |          |          |   |
| TR   | 0 14301064 | 0 40615551 | 11010010                    | 31716246   |       |          |          |   |
| T7   | 0 30602150 | 0 54361500 | 01010110                    | 31716246   |       |          |          |   |
| T4   | 0 61404320 | 0 63671666 | 01010000                    | 31716246   |       |          |          |   |
| T1   | 0 43010640 | 0 02511713 | 01010110                    | 31716246   |       |          |          |   |
| TP   | 0 06021501 | 1 45225570 | 10100011                    | 46061531   |       |          |          |   |
| T6   | 0 14043202 | 0 63561640 | 01010010                    | 31716246   |       |          |          |   |
| T3   | 0 30106404 | 0 02271766 | 01010000                    | 31716246   |       |          |          |   |
| T0   | 0 60215011 | 1 44664405 | 10001101                    | 46061531   |       |          |          |   |
| T8   | 0 40432022 | 0 62461453 | 01010010                    | 31716246   |       |          |          |   |
| T5   | 0 01064044 | 0 70071305 | 11010110                    | 31716246   |       |          |          |   |
| T2   | 0 02150111 | 1 40264563 | 10000001                    | 46061531   | *     |          |          |   |
| TR   | 0 04320222 | 0 51467516 | 01000100                    | 31716246   |       |          |          |   |
| T7   | 0 10640444 | 0 56065672 | 01010010                    | 31716246   |       |          |          |   |
| T4   | 0 21501110 | 0 67001042 | 01111010                    | 31716246   |       |          |          |   |
| T1   | 0 43202220 | 0 11132362 | 01010010                    | 31716246   |       |          |          |   |
| TP   | 0 06404441 | 1 62365416 | 10001101                    | 46061531   |       |          |          |   |
| T6   | 0 15011102 | 0 15663474 | 01010010                    | 31716246   |       |          |          |   |
| T3   | 0 32022205 | 1 73540741 | 10110001                    | 46061531   |       |          |          |   |
| T0   | 0 64044413 | 1 45502435 | 10101001                    | 46061531   | *     |          |          |   |
| T8   | 0 50111026 | 0 64315233 | 01010110                    | 31716246   |       |          |          |   |
| T5   | 0 20222054 | 0 03560145 | 01011010                    | 31716246   |       |          |          |   |
| T2   | 0 40444131 | 0 01362332 | 10000000                    | 46061531   |       |          |          |   |
| TP   | 0 40444131 | 0 04571155 | 00000000                    | 46061531   | OF    |          |          |   |

| FIGURE DIV62 |            |            |             | A/M =      | 24741103 | 63724254 | 1 |
|--------------|------------|------------|-------------|------------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |          |          |   |
| T8           | 1 45641207 | 1 70677650 | 00000000    | 60336670   |          |          |   |
| T8           | 1 07100130 | 1 12475460 | 00000000    | 60336670   |          |          |   |
| T5           | 1 16200261 | 1 05421730 | 00110100    | 60336670   |          |          |   |
| T2           | 1 34400543 | 1 73512650 | 00110100    | 60336670   |          |          |   |
| TR           | 1 71001306 | 0 26006027 | 11101001    | 17441107   |          |          |   |
| T7           | 1 62002615 | 1 26544651 | 00010100    | 60336670   | *        |          |   |
| T4           | 1 44005432 | 0 04772022 | 10001011    | 17441107   |          |          |   |
| T1           | 1 10013065 | 1 11214657 | 01110100    | 60336670   |          |          |   |
| TP           | 1 20026153 | 1 04107526 | 01101100    | 60336670   |          |          |   |
| T6           | 1 40054327 | 1 72757244 | 00001100    | 60336670   |          |          |   |
| T3           | 1 00130656 | 0 74301010 | 11101011    | 17441107   |          |          |   |
| TC           | 1 00261535 | 1 73332632 | 00010100    | 60336670   | *        |          |   |
| T8           | 1 00543272 | 0 75346763 | 11000011    | 17441107   |          |          |   |
| T5           | 1 01306565 | 1 74243560 | 01011100    | 60336670   | *        |          |   |
| T2           | 1 02615352 | 0 01172647 | 11000001    | 17441107   |          |          |   |
| TR           | 1 05432725 | 1 04613310 | 00111100    | 60336670   |          |          |   |
| T7           | 1 13065653 | 1 71107610 | 01100100    | 60336670   |          |          |   |
| T4           | 1 26153526 | 0 73050727 | 11010001    | 17441107   |          |          |   |
| T1           | 1 54327255 | 1 70477450 | 00001100    | 60336670   | *        |          |   |
| TP           | 1 30656532 | 0 70542420 | 10100011    | 17441107   |          |          |   |
| T6           | 1 61535265 | 1 61033652 | 01010100    | 60336670   | *        |          |   |
| T3           | 1 43272552 | 0 53540024 | 10011011    | 17441107   |          |          |   |
| TC           | 1 06565324 | 0 56763172 | 10000011    | 17441107   |          |          |   |
| T8           | 1 15352650 | 0 64307505 | 11100011    | 17441107   |          |          |   |
| T5           | 1 32725520 | 0 02450333 | 10010011    | 17441107   |          |          |   |
| T2           | 1 65653241 | 0 25140600 | 00000110    | 60336670   |          |          |   |
| TP           | 1 65653241 | 0 65317434 | 00000000    | 60336670   | 0F       |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV63<br>BC REGISTER | A/M = 40000001<br>C REGISTER 74520140 1 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T0   | 1 62311602 | 1 23170133 | 00000000                    | 00753715                                |
| T0   | 1 04607646 | 1 14512260 | 00000000                    | 77024062                                |
| T5   | 1 11417515 | 1 20240522 | 10010101                    | 77024062                                |
| T2   | 1 23037233 | 1 57545420 | 00000111                    | 77024062                                |
| TR   | 1 46076466 | 0 37266177 | 01001000                    | 00753715                                |
| T7   | 1 14175154 | 0 00421204 | 01111110                    | 00753715 *                              |
| T4   | 1 20372331 | 1 72200612 | 10110101                    | 77024062                                |
| T1   | 1 60764663 | 1 23645600 | 10000111                    | 77024062 *                              |
| TP   | 1 41751547 | 1 76537605 | 10000101                    | 77024062 *                              |
| T6   | 1 03723317 | 1 04213677 | 10110001                    | 77024062 *                              |
| T3   | 1 07646637 | 1 27663562 | 00010101                    | 77024062                                |
| T0   | 1 17516477 | 1 46503520 | 10110111                    | 77024062                                |
| T8   | 1 37233176 | 0 38372377 | 01011000                    | 00753715                                |
| T5   | 1 75466375 | 1 63022750 | 11010111                    | 77024062                                |
| T2   | 1 75154772 | 0 70731050 | 00111010                    | 00753715                                |
| TR   | 1 72331764 | 0 62057056 | 01001000                    | 00753715                                |
| T7   | 1 64663750 | 0 46013042 | 01101010                    | 00753715                                |
| T4   | 1 51547720 | 0 16103032 | 01101010                    | 00753715                                |
| T1   | 1 23317641 | 1 25434167 | 10000001                    | 77024062                                |
| TP   | 1 46637503 | 1 62014342 | 10100101                    | 77024062                                |
| T6   | 1 15477206 | 0 64104014 | 01101010                    | 00753715                                |
| T3   | 1 33176414 | 0 52365765 | 01000000                    | 00753715                                |
| TC   | 1 66375030 | 0 26626667 | 01101000                    | 00753715                                |
| T8   | 1 54772061 | 1 46673531 | 10010111                    | 77024062                                |
| T5   | 1 31764142 | 0 35552412 | 01011010                    | 00753715                                |
| T2   | 1 63750305 | 0 75347044 | 00000000                    | 77024062                                |
| TP   | 1 14027473 | 0 41214356 | 00000000                    | 77024062 0F                             |

| FIGURE DIV64 |            |            |             |            | A/M. = 12231200 64527135 0 |  |  |
|--------------|------------|------------|-------------|------------|----------------------------|--|--|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |                            |  |  |
| T8           | 1 67745772 | 0 01721272 | 00000000    | 46770716   |                            |  |  |
| T8           | 1 76056506 | 0 57022723 | 00000000    | 46770716   |                            |  |  |
| T5           | 1 74135214 | 0 67044620 | 00010111    | 31007061   |                            |  |  |
| T2           | 1 70272430 | 0 07130644 | 00010101    | 31007061   |                            |  |  |
| TR           | 1 60565061 | 1 54271621 | 11001010    | 46770716   |                            |  |  |
| T7           | 1 41352142 | 0 03564444 | 00010101    | 31007061   |                            |  |  |
| T4           | 1 02724305 | 1 45261221 | 11101010    | 46770716   |                            |  |  |
| T1           | 1 05650612 | 0 65743443 | 00010101    | 31007061   |                            |  |  |
| TP           | 1 13521424 | 0 04726371 | 00010001    | 31007061   |                            |  |  |
| T6           | 1 27243051 | 1 57564672 | 01101010    | 46770716   |                            |  |  |
| T3           | 1 56506122 | 0 72552665 | 00010001    | 31007061   |                            |  |  |
| TO           | 1 35214244 | 0 16344536 | 00010101    | 31007061   |                            |  |  |
| T8           | 1 72430511 | 1 22621304 | 11101110    | 46770716   |                            |  |  |
| T5           | 1 65061223 | 1 45535747 | 11100000    | 46770716 * |                            |  |  |
| T2           | 1 52142446 | 0 66472770 | 00010011    | 31007061   |                            |  |  |
| TR           | 1 24305114 | 0 06204064 | 00011001    | 31007061   |                            |  |  |
| T7           | 1 50612231 | 1 52322060 | 11101010    | 46770716   |                            |  |  |
| T4           | 1 21424462 | 0 30045142 | 10010101    | 31007061   |                            |  |  |
| T1           | 1 43051145 | 1 46022414 | 01101010    | 46770716 * |                            |  |  |
| TP           | 1 06122312 | 0 47246032 | 00010101    | 31007061   |                            |  |  |
| T6           | 1 14244624 | 0 47533247 | 00010101    | 31007061   |                            |  |  |
| T3           | 1 30511450 | 0 40305701 | 10010101    | 31007061   |                            |  |  |
| TO           | 1 61223120 | 0 51633065 | 00010001    | 31007061   |                            |  |  |
| T8           | 1 42446240 | 0 54505136 | 00010101    | 31007061   |                            |  |  |
| T5           | 1 05114500 | 0 62231450 | 00010111    | 31007061   |                            |  |  |
| T2           | 1 12231200 | 1 44403342 | 00100000    | 31007061   |                            |  |  |
| TP           | 1 12231200 | 0 64527135 | 00010101    | 31007061   |                            |  |  |

| TIME | A REGISTER | B REGISTER | FIGURE DIV65<br>BC REGISTER | C REGISTER | A/M = | 40000001 | 64375304 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 1 50253200 | 1 83333102 | 00000000                    | 01160135   |       |          |          |   |
| T8   | 1 24444676 | 1 26344442 | 00000000                    | 76617642   |       |          |          |   |
| T5   | 1 51111575 | 1 42520746 | 11010001                    | 76617642   |       |          |          |   |
| T2   | 1 22223372 | 0 20341044 | 10101010                    | 01160135   |       |          |          |   |
| TR   | 1 44446765 | 1 57713772 | 00010001                    | 76617642   |       |          |          |   |
| T7   | 1 11115752 | 0 30727014 | 10101110                    | 01160135   |       |          |          |   |
| T4   | 1 22233724 | 0 03140305 | 00100100                    | 01160135   | *     |          |          |   |
| T1   | 1 44467651 | 1 74310654 | 11010001                    | 76617642   |       |          |          |   |
| TP   | 1 11157523 | 1 00460375 | 11011001                    | 76617642   | *     |          |          |   |
| T6   | 1 22337247 | 1 11751536 | 10011101                    | 76617642   |       |          |          |   |
| T3   | 1 44676517 | 1 31654230 | 11011111                    | 76617642   |       |          |          |   |
| T0   | 1 11575236 | 0 06432030 | 00101010                    | 01160135   | *     |          |          |   |
| T8   | 1 23372475 | 1 03075742 | 11010001                    | 76617642   |       |          |          |   |
| T5   | 1 46765173 | 1 26022540 | 01011011                    | 76617642   |       |          |          |   |
| T2   | 1 15752367 | 1 44676165 | 10011001                    | 76617642   |       |          |          |   |
| TR   | 1 33724756 | 0 32776401 | 00000110                    | 01160135   |       |          |          |   |
| T7   | 1 67651735 | 1 53504064 | 11111001                    | 76617642   |       |          |          |   |
| T4   | 1 57523672 | 0 52512200 | 00100110                    | 01160135   |       |          |          |   |
| T1   | 1 37247564 | 0 26504756 | 00100000                    | 01160135   |       |          |          |   |
| TP   | 1 75517351 | 1 43220576 | 11011001                    | 76617642   |       |          |          |   |
| T6   | 1 75236722 | 0 31543424 | 00100110                    | 01160135   |       |          |          |   |
| T3   | 1 72475645 | 1 51316033 | 11011101                    | 76617642   |       |          |          |   |
| T0   | 1 65173512 | 0 45736326 | 00100100                    | 01160135   |       |          |          |   |
| T8   | 1 52367224 | 0 15155102 | 00100110                    | 01160135   |       |          |          |   |
| T5   | 1 24756451 | 1 20341267 | 11011001                    | 76617642   |       |          |          |   |
| T2   | 1 51735123 | 0 62724550 | 00000010                    | 76617642   |       |          |          |   |
| TP   | 1 26042655 | 0 46425510 | 00000010                    | 76617642   | OF    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV66<br>BC REGISTER | C REGISTER | A/M = | 76212415 | 00414240 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 00312075 | 0 33376625 | 00000000                    | 70544122   |       |          |          |   |
| T8   | 0 33376625 | 0 71056217 | 00000000                    | 70544122   |       |          |          |   |
| T5   | 0 66775452 | 0 61367203 | 10001111                    | 07233655   |       |          |          |   |
| T2   | 0 55773124 | 0 61113406 | 11101101                    | 07233655   |       |          |          |   |
| TR   | 0 33766250 | 0 63664064 | 10001011                    | 07233655   |       |          |          |   |
| T7   | 0 67754520 | 0 66705747 | 10100101                    | 07233655   |       |          |          |   |
| T4   | 0 57731240 | 0 75247776 | 10000001                    | 07233655   |       |          |          |   |
| T1   | 0 37662501 | 1 02253011 | 01011110                    | 70544122   | *     |          |          |   |
| TP   | 0 77545203 | 1 76214364 | 01100000                    | 70544122   |       |          |          |   |
| T6   | 0 77312406 | 0 75063526 | 11001101                    | 07233655   |       |          |          |   |
| T3   | 0 76625015 | 1 04615571 | 00100010                    | 70544122   | *     |          |          |   |
| T0   | 0 75452033 | 1 01377525 | 01000000                    | 70544122   |       |          |          |   |
| T8   | 0 73124067 | 1 24433375 | 01110000                    | 70544122   |       |          |          |   |
| T5   | 0 66250156 | 0 22531540 | 10011111                    | 07233655   |       |          |          |   |
| T2   | 0 54520335 | 1 25041645 | 01010000                    | 70544122   | *     |          |          |   |
| TR   | 0 31240672 | 0 73356360 | 10001011                    | 07233655   |       |          |          |   |
| T7   | 0 62501565 | 1 76472004 | 01011100                    | 70544122   | *     |          |          |   |
| T4   | 0 45203352 | 0 76431066 | 10011001                    | 07233655   |       |          |          |   |
| T1   | 0 12406725 | 1 05640271 | 00010010                    | 70544122   | *     |          |          |   |
| TP   | 0 25015653 | 1 03264724 | 01000000                    | 70544122   |       |          |          |   |
| T6   | 0 52033527 | 1 00215772 | 01100000                    | 70544122   |       |          |          |   |
| T3   | 0 24067257 | 1 72377007 | 01001100                    | 70544122   |       |          |          |   |
| T0   | 0 50156536 | 0 65133063 | 11101011                    | 07233655   |       |          |          |   |
| T8   | 0 20335274 | 0 73623746 | 10100101                    | 07233655   |       |          |          |   |
| T5   | 0 40672571 | 1 77304230 | 01110010                    | 70544122   | *     |          |          |   |
| T2   | 0 01565363 | 1 70030401 | 11000100                    | 70544122   | *     |          |          |   |
| TP   | 0 76212415 | 1 00414240 | 10000000                    | 70544122   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV67<br>BC REGISTER | C REGISTER | A/M = | 37716231 | 06621435 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 34230727 | 0 24317475 | 00000000                    | 14254051   |       |          |          |   |
| T8   | 0 24317475 | 0 17754656 | 00000000                    | 63523726   |       |          |          |   |
| T5   | 0 50637173 | 1 12454452 | 11001011                    | 63523726   |       |          |          |   |
| T2   | 0 21476367 | 1 22656065 | 10001011                    | 63523726   |       |          |          |   |
| TR   | 0 43174757 | 1 40251012 | 11011111                    | 63523726   |       |          |          |   |
| T7   | 0 06371736 | 0 36710210 | 00110110                    | 14254051   |       |          |          |   |
| T4   | 0 14763675 | 1 51563566 | 10001001                    | 63523726   |       |          |          |   |
| T1   | 0 31747572 | 0 57525327 | 00100100                    | 14254051   |       |          |          |   |
| TP   | 0 63717364 | 0 43627027 | 10100100                    | 14254051   |       |          |          |   |
| T6   | 0 47636750 | 0 33022220 | 11110110                    | 14254051   |       |          |          |   |
| T3   | 0 17475720 | 0 24430632 | 00110100                    | 14254051   |       |          |          |   |
| T0   | 0 37173641 | 1 34024502 | 01001111                    | 63523726   |       |          |          | * |
| T8   | 0 76367503 | 1 55576344 | 00001011                    | 63523726   |       |          |          |   |
| T5   | 0 74757206 | 0 47542704 | 00110100                    | 14254051   |       |          |          |   |
| T2   | 0 71736414 | 0 23772062 | 10010000                    | 14254051   |       |          |          |   |
| TR   | 0 63575031 | 1 42527063 | 11001011                    | 63523726   |       |          |          |   |
| T7   | 0 47572062 | 0 33494142 | 10100100                    | 14254051   |       |          |          |   |
| T4   | 0 17364144 | 0 13444556 | 10100000                    | 14254051   |       |          |          | * |
| T1   | 0 36750311 | 1 22034252 | 11001011                    | 63523726   |       |          |          |   |
| TP   | 0 75720623 | 1 41515464 | 10101011                    | 63523726   |       |          |          |   |
| T6   | 0 73641446 | 0 97601144 | 00110100                    | 14254051   |       |          |          |   |
| T3   | 0 67503115 | 1 52345437 | 11001001                    | 63523726   |       |          |          |   |
| T0   | 0 57206232 | 0 52161052 | 11010100                    | 14254051   |       |          |          |   |
| T8   | 0 36414464 | 0 52536376 | 10100000                    | 14254051   |       |          |          |   |
| T5   | 0 75031150 | 0 51640745 | 10110100                    | 14254051   |       |          |          |   |
| T2   | 0 72062320 | 1 43721113 | 00001000                    | 14254051   |       |          |          |   |
| TP   | 0 72062320 | 0 76225116 | 01100100                    | 14254051   | OF    |          |          |   |

| FIGURE DIV68 |            |            |             | A/M =      | 11565411 | 20731660 | 0 |
|--------------|------------|------------|-------------|------------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |          |          |   |
| T8           | 0 06662624 | 0 92035730 | 00000000    | 26415534   |          |          |   |
| T8           | 0 32035730 | 0 60245020 | 00000000    | 51362243   |          |          |   |
| T5           | 0 64073660 | 0 86127614 | 01000100    | 26415534   |          |          |   |
| T2           | 0 50167540 | 0 74664365 | 10011000    | 26415534   |          |          |   |
| TR           | 0 20357301 | 1 62054116 | 01101101    | 51362243   | *        |          |   |
| T7           | 0 40736602 | 0 64747162 | 10001010    | 26415534   |          |          |   |
| T4           | 0 01675404 | 0 17335011 | 01001110    | 26415534   |          |          |   |
| T1           | 0 03573011 | 1 11156405 | 01100101    | 51362243   |          |          |   |
| TP           | 0 07366023 | 1 75017457 | 01100001    | 51362243   |          |          |   |
| T6           | 0 16754046 | 0 12644674 | 10010000    | 26415534   |          |          |   |
| T3           | 0 35730115 | 1 16013733 | 01100101    | 51362243   |          |          |   |
| T0           | 0 73660233 | 1 07802233 | 00110101    | 51362243   |          |          |   |
| T8           | 0 67540467 | 1 60706034 | 10101101    | 51362243   |          |          |   |
| T5           | 0 57301156 | 0 00423727 | 10010100    | 26415534   |          |          |   |
| T2           | 0 36602335 | 1 72342212 | 00110111    | 51362243   |          |          |   |
| TR           | 0 75404672 | 0 03531372 | 10011010    | 26415534   |          |          |   |
| T7           | 0 73011565 | 1 70666240 | 10001011    | 51362243   |          |          |   |
| T4           | 0 66023353 | 1 52030766 | 01110001    | 51362243   | *        |          |   |
| T1           | 0 54046726 | 0 44716403 | 10001110    | 26415534   |          |          |   |
| TP           | 0 30115654 | 0 57244753 | 01010010    | 26415534   |          |          |   |
| T6           | 0 60233530 | 0 66146472 | 01001010    | 26415534   |          |          |   |
| T3           | 0 40467260 | 0 74724731 | 10010010    | 26415534   |          |          |   |
| T0           | 0 01156541 | 1 62153146 | 01101001    | 51362243   | *        |          |   |
| T8           | 0 02335302 | 0 64145042 | 11001010    | 26415534   |          |          |   |
| T5           | 0 04672604 | 0 10721650 | 10010010    | 26415534   |          |          |   |
| T2           | 0 11565411 | 0 41663540 | 00000000    | 51362243   |          |          |   |
| TP           | 0 11565411 | 0 20731660 | 00000000    | 51362243   |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV69<br>BC REGISTER | C REGISTER | A/M = | 75175170 | 05337450 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 02425672 | 0 02176161 | 00000000                    | 42360576   |       |          |          |   |
| T8   | 0 02176161 | 0 45006470 | 00000000                    | 42360576   |       |          |          |   |
| T5   | 0 04374342 | 0 47424361 | 00010001                    | 35417201   |       |          |          |   |
| T2   | 0 10770704 | 0 44407145 | 101-01001                   | 35417201   |       |          |          |   |
| TR   | 0 21761610 | 0 66637515 | 00000001                    | 35417201   |       |          |          |   |
| T7   | 0 43743420 | 0 02006435 | 11110001                    | 35417201   |       |          |          |   |
| T4   | 0 07707041 | 1 60515563 | 10100110                    | 42360576   |       |          |          |   |
| T1   | 0 17616102 | 0 16042767 | 01010001                    | 35417201   |       |          |          |   |
| TP   | 0 37434205 | 1 70405456 | 10101100                    | 42360576   |       |          |          |   |
| T6   | 0 77070413 | 1 43575022 | 00001110                    | 42360576   | *     |          |          |   |
| T3   | 0 76161026 | 0 34703466 | 10110001                    | 35417201   |       |          |          |   |
| T0   | 0 74342054 | 0 47436350 | 00010011                    | 35417201   | *     |          |          |   |
| T8   | 0 70204130 | 0 44523144 | 10011001                    | 35417201   |       |          |          |   |
| T5   | 0 61610260 | 0 66607514 | 00100001                    | 35417201   |       |          |          |   |
| T2   | 0 43420540 | 0 02226434 | 11010001                    | 35417201   |       |          |          |   |
| TR   | 0 07041301 | 1 60755561 | 10100110                    | 42360576   |       |          |          |   |
| T7   | 0 16102602 | 0 17542763 | 00010001                    | 35417201   |       |          |          |   |
| T4   | 0 34205405 | 1 71605446 | 10101100                    | 42360576   |       |          |          |   |
| T1   | 0 70413013 | 1 45175002 | 01001110                    | 42360576   | *     |          |          |   |
| TP   | 0 61026026 | 0 41703426 | 10110001                    | 35417201   |       |          |          |   |
| T6   | 0 42054054 | 0 51436250 | 10010011                    | 35417201   |       |          |          |   |
| T3   | 0 04130130 | 0 70523744 | 10010001                    | 35417201   |       |          |          |   |
| TC   | 0 10260261 | 1 43547400 | 00101110                    | 42360576   | *     |          |          |   |
| T8   | 0 20540542 | 0 34130421 | 11010001                    | 35417201   |       |          |          |   |
| T5   | 0 41301304 | 0 47710245 | 00010001                    | 35417201   | *     |          |          |   |
| T2   | 0 02602610 | 1 17640515 | 00000000                    | 35417201   | *     |          |          |   |
| TP   | 0 75175170 | 0 05337450 | 11000001                    | 35417201   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV70<br>BC REGISTER | C REGISTER | A/M = | 15626505 | 12777521 | 0 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 11631731 | 0 22222044 | 00000000                    | 26570515   |       |          |          |   |
| T8   | 0 22222044 | 0 63041214 | 00000000                    | 51207262   |       |          |          |   |
| T5   | 0 44444110 | 0 64672145 | 10001000                    | 26570515   |       |          |          |   |
| T2   | 0 11110220 | 0 17256020 | 01101010                    | 26570515   |       |          |          |   |
| TR   | 0 22220441 | 1 11135242 | 01010101                    | 51207262   |       |          |          |   |
| T7   | 0 44441103 | 1 75511160 | 00011011                    | 51207262   |       |          |          |   |
| T4   | 0 11102206 | 0 11734070 | 10101010                    | 26570515   |       |          |          |   |
| T1   | 0 22204415 | 1 15271462 | 00010001                    | 51207262   |       |          |          |   |
| TP   | 0 44411033 | 1 03002320 | 01010111                    | 51207262   |       |          |          |   |
| T6   | 0 11022067 | 1 61224245 | 00010101                    | 51207262   |       |          |          |   |
| T3   | 0 22044156 | 0 60160421 | 11101010                    | 26570515   |       |          |          |   |
| T0   | 0 44110334 | 0 00233577 | 11100000                    | 26570515   |       |          |          |   |
| T8   | 0 10220671 | 1 73056551 | 01010111                    | 51207262   |       |          |          |   |
| T5   | 0 20441562 | 0 16665251 | 00101010                    | 26570515   |       |          |          |   |
| T2   | 0 41103345 | 1 06153724 | 01010101                    | 51207262   |       |          |          |   |
| TR   | 0 02206713 | 1 67547235 | 00010101                    | 51207262   |       |          |          |   |
| T7   | 0 04415626 | 0 75026301 | 11101110                    | 26570515   |       |          |          |   |
| T4   | 0 11033455 | 1 65456204 | 00010101                    | 51207262   | *     |          |          |   |
| T1   | 0 22067132 | 0 71644327 | 10101000                    | 26570515   |       |          |          |   |
| TP   | 0 44156265 | 1 54111030 | 01011111                    | 51207262   | *     |          |          |   |
| T6   | 0 10334552 | 0 50734010 | 10101010                    | 26570515   |       |          |          |   |
| T3   | 0 20671324 | 0 60562555 | 10100000                    | 26570515   |       |          |          |   |
| T0   | 0 41562650 | 0 07235047 | 01101000                    | 26570515   |       |          |          |   |
| T8   | 0 03345521 | 1 71073371 | 01010011                    | 51207262   |       |          |          |   |
| T5   | 0 06713242 | 0 02776511 | 10001010                    | 26570515   |       |          |          |   |
| T2   | 0 15626505 | 0 25777242 | 00000000                    | 51207262   |       |          |          |   |
| TP   | 0 15626505 | 0 12777521 | 00000000                    | 51207262   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV71<br>BC REGISTER | C REGISTER | A/M = 32021413 77402621 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 67352527 | 1 55464166 | 00000000                    | 77253076   |                           |
| T8   | 1 22313612 | 1 07700346 | 00000000                    | 77253076   |                           |
| T5   | 1 44627425 | 1 06053702 | 11000110                    | 77253076   |                           |
| T2   | 1 11457058 | 1 25373013 | 10010110                    | 77253076   |                           |
| TR   | 1 23136127 | 1 61251234 | 11010110                    | 77253076   |                           |
| T7   | 1 46274256 | 0 64266611 | 01001001                    | 00524701   |                           |
| T4   | 1 14570534 | 0 52273326 | 01011001                    | 00524701   |                           |
| T1   | 1 31361270 | 0 26334557 | 01001001                    | 00524701   |                           |
| TP   | 1 62742561 | 1 45046336 | 11100100                    | 77253076   |                           |
| T6   | 1 45705342 | 0 34031776 | 01010001                    | 00524701   |                           |
| T3   | 1 13612705 | 1 61356765 | 10000110                    | 77253076   |                           |
| T0   | 1 27425612 | 0 62452073 | 01011001                    | 00524701   |                           |
| T8   | 1 57053424 | 0 47662071 | 00011001                    | 00524701   |                           |
| T5   | 1 36127050 | 0 17202066 | 01111001                    | 00524701   |                           |
| T2   | 1 74256121 | 1 37071144 | 01010110                    | 77253076   |                           |
| TR   | 1 70534242 | 0 00726432 | 00001001                    | 00524701   | *                         |
| T7   | 1 61270505 | 1 70022055 | 11110110                    | 77253076   |                           |
| T4   | 1 42561213 | 1 71487341 | 10100110                    | 77253076   | *                         |
| T1   | 1 05342427 | 1 72442111 | 10110110                    | 77253076   | *                         |
| TP   | 1 12705057 | 1 74877430 | 10000110                    | 77253076   | *                         |
| T6   | 1 25612137 | 1 00542376 | 10110000                    | 77253076   | *                         |
| T3   | 1 53424277 | 1 10777762 | 10000110                    | 77253076   |                           |
| T0   | 1 27050577 | 1 30143153 | 11110110                    | 77253076   |                           |
| T8   | 1 56121376 | 0 02242447 | 01011001                    | 00524701   | *                         |
| T5   | 1 34242775 | 1 75772117 | 10010100                    | 77253076   |                           |
| T2   | 1 70505773 | 0 13704436 | 00100000                    | 77253076   |                           |
| TP   | 1 70505773 | 0 71775561 | 00100000                    | 77253076   | OF                        |

| FIGURE DIV72 |            |            |             |            | A/M = | 77421646 | 01563506 | 0 |
|--------------|------------|------------|-------------|------------|-------|----------|----------|---|
| TIME         | A REGISTER | B REGISTER | BC REGISTER | C REGISTER |       |          |          |   |
| T0           | 0 00156137 | 1 76543640 | 00000000    | 61144207   |       |          |          |   |
| T0           | 0 76543640 | 1 61322346 | 00000000    | 61144207   |       |          |          |   |
| T5           | 0 76307500 | 0 50477405 | 11001101    | 16633570   |       |          |          |   |
| T2           | 0 72617200 | 0 51734705 | 10100101    | 16633570   |       |          |          |   |
| TR           | 0 66436400 | 0 52625505 | 10100101    | 16633570   |       |          |          |   |
| T7           | 0 53075000 | 0 53406105 | 11101101    | 16633570   |       |          |          |   |
| T4           | 0 26172000 | 0 57041105 | 01011101    | 16633570   |       |          |          |   |
| T1           | 0 54364000 | 0 76757104 | 00001101    | 16633570   |       |          |          |   |
| TP           | 0 30750000 | 0 03573103 | 11001101    | 16633570   |       |          |          |   |
| T6           | 0 61220001 | 1 12434617 | 00100000    | 61144207   |       |          |          |   |
| T3           | 0 43640003 | 1 06335636 | 00100010    | 61144207   |       |          |          |   |
| T0           | 0 07500007 | 1 76137714 | 00100010    | 61144207   |       |          |          |   |
| T8           | 0 17200016 | 0 02222340 | 11111101    | 16633570   |       |          |          |   |
| T5           | 0 36400035 | 1 07723301 | 00110010    | 61144207   |       |          |          |   |
| T2           | 0 75000073 | 1 71122021 | 10111010    | 61144207   |       |          |          |   |
| TR           | 0 72000167 | 1 63522262 | 00110010    | 61144207   | *     |          |          |   |
| T7           | 0 64000356 | 0 55217255 | 11101101    | 16633570   |       |          |          |   |
| T4           | 0 50000734 | 0 52473425 | 11001101    | 16633570   |       |          |          |   |
| T1           | 0 20001670 | 0 75724745 | 10100101    | 16633570   |       |          |          |   |
| TP           | 0 40003561 | 1 75116313 | 00100010    | 61144207   | *     |          |          |   |
| T6           | 0 00007342 | 0 00267337 | 11001101    | 16633570   |       |          |          |   |
| T3           | 0 00016705 | 1 03625207 | 00100100    | 61144207   |       |          |          |   |
| T0           | 0 00035613 | 1 60716015 | 10101010    | 61144207   |       |          |          |   |
| T8           | 0 00073426 | 0 70661542 | 10010101    | 16633570   |       |          |          |   |
| T5           | 0 00167055 | 1 62627705 | 00100010    | 61144207   | *     |          |          |   |
| T2           | 0 00356132 | 1 45657632 | 00000000    | 16633570   | *     |          |          |   |
| TP           | 0 77421646 | 0 01563506 | 11011101    | 16633570   |       |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV73<br>BC REGISTER | C REGISTER | A/M = 36762602 74640044 0 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 1 56108526 | 1 41641171 | 00000000                    | 55427614   |                           |
| T8   | 1 36136610 | 1 77321065 | 00000000                    | 55427614   |                           |
| T5   | 1 74275420 | 0 10112235 | 11100101                    | 22350163   |                           |
| T2   | 1 70573041 | 1 17043401 | 01011110                    | 55427614   |                           |
| TR   | 1 61366103 | 1 15550037 | 00011000                    | 55427614   |                           |
| T7   | 1 42754207 | 1 00761603 | 10010110                    | 55427614   |                           |
| T4   | 1 08730417 | 1 76302433 | 01111010                    | 55427614   |                           |
| T1   | 1 13661036 | 0 11377261 | 10000011                    | 22350163   |                           |
| TP   | 1 27542075 | 1 17315370 | 01111010                    | 55427614   |                           |
| T6   | 1 57304173 | 1 16473614 | 00011000                    | 55427614   |                           |
| T3   | 1 36610367 | 1 02630245 | 10011000                    | 55427614   |                           |
| T0   | 1 75420757 | 1 72121326 | 11011000                    | 55427614   |                           |
| T8   | 1 73841737 | 1 83603461 | 10111010                    | 55427614   | *                         |
| T5   | 1 66103676 | 0 61101246 | 11100101                    | 22350163   |                           |
| T2   | 1 54207574 | 0 06752072 | 00001011                    | 22350163   |                           |
| TR   | 1 30417371 | 1 62345013 | 11011010                    | 55427614   |                           |
| T7   | 1 61036762 | 0 00204121 | 11100111                    | 22350163   |                           |
| T4   | 1 42075745 | 1 77237271 | 01001010                    | 55427614   |                           |
| T1   | 1 04173713 | 1 88027417 | 01101000                    | 55427614   | *                         |
| TP   | 1 10967626 | 0 56531111 | 00100111                    | 22350163   |                           |
| T6   | 1 20757454 | 0 57732527 | 00100101                    | 22350163   |                           |
| T3   | 1 41737130 | 0 52335543 | 10100101                    | 22350163   |                           |
| T0   | 1 03576260 | 0 67343674 | 00100001                    | 22350163   |                           |
| T8   | 1 07574540 | 0 71457655 | 10000101                    | 22350163   |                           |
| T5   | 1 17971301 | 1 80566540 | 10011010                    | 55427614   | *                         |
| T2   | 1 36762602 | 1 41357320 | 00000000                    | 22350163   | *                         |
| TP   | 1 36762602 | 0 74640044 | 01100101                    | 22350163   |                           |

| TIME | A REGISTER | B REGISTER | FIGURE DIV74<br>BC REGISTER | A/M = 74170301<br>C REGISTER 57266103 0 |
|------|------------|------------|-----------------------------|-----------------------------------------|
| T8   | 1 74711330 | 0 12011202 | 00000000                    | 32317176                                |
| T8   | 1 65766576 | 0 80547251 | 00000000                    | 45460601                                |
| T5   | 1 53755374 | 0 83625611 | 00010110                    | 32317176                                |
| T2   | 1 27732770 | 0 51702731 | 10110110                    | 32317176                                |
| TR   | 1 57665760 | 0 76335270 | 00010010                    | 32317176                                |
| T7   | 1 37553740 | 0 26221777 | 01010000                    | 32317176                                |
| T4   | 1 72327701 | 1 13043577 | 11101001                    | 45460601                                |
| T1   | 1 76682603 | 1 15771102 | 00001101                    | 45460601                                |
| TP   | 1 75537407 | 1 70344200 | 11101011                    | 45460601                                |
| T6   | 1 73277017 | 1 40572224 | 10001001                    | 45460601 *                              |
| T3   | 1 66576036 | 0 53675541 | 00010110                    | 32317176                                |
| T0   | 1 55374074 | 0 51122611 | 11010110                    | 32317176                                |
| T8   | 1 32770170 | 0 26574731 | 00010110                    | 32317176                                |
| T5   | 1 65760360 | 0 27721270 | 00010010                    | 32317176                                |
| T2   | 1 53740741 | 1 14242402 | 11101001                    | 45460601                                |
| TR   | 1 27201703 | 1 17367600 | 01000011                    | 45460601                                |
| T7   | 1 57603607 | 1 05337223 | 01101001                    | 45460601                                |
| T4   | 1 37407417 | 1 52460252 | 10101001                    | 45460601                                |
| T1   | 1 72017036 | 0 77651614 | 00010110                    | 32317176                                |
| TP   | 1 76036074 | 0 21082747 | 11010100                    | 32317176                                |
| T6   | 1 74074171 | 1 21526710 | 10100011                    | 45460601                                |
| T3   | 1 70170363 | 1 20035444 | 11101001                    | 45460601                                |
| T0   | 1 60360747 | 1 27655714 | 00100001                    | 45460601                                |
| T4   | 1 48741717 | 1 14313434 | 11101001                    | 45460601                                |
| T5   | 1 01703637 | 1 10411674 | 10100001                    | 45460601                                |
| T2   | 1 03607477 | 0 41223572 | 00000000                    | 45460601                                |
| TP   | 1 74170301 | 0 57266103 | 00000000                    | 45460601                                |

| TIME | A REGISTER | B REGISTER | FIGURE DIV75<br>8C REGISTER | C REGISTER | A/M = 37775613 00354702 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 37404050 | 0 81755437 | 00000000                    | 06174407   |                           |
| T8   | 0 31755437 | 0 31207441 | 00000000                    | 71603370   |                           |
| T5   | 0 63733077 | 1 53212472 | 01010001                    | 71603370   |                           |
| T2   | 0 47666176 | 0 36531566 | 00110010                    | 06174407   |                           |
| TR   | 0 17554375 | 1 66306665 | 01000101                    | 71603370   |                           |
| T7   | 0 37330772 | 0 54701353 | 10111010                    | 06174407   |                           |
| T4   | 0 75661764 | 0 50110345 | 10111010                    | 06174407   |                           |
| T1   | 0 75543750 | 0 46536332 | 00101010                    | 06174407   |                           |
| TP   | 0 73307720 | 0 13562304 | 10111010                    | 06174407   |                           |
| T6   | 0 66617641 | 1 30361121 | 11011101                    | 71603370   |                           |
| T3   | 0 55437502 | 0 00050044 | 11111010                    | 06174407   | *                         |
| TO   | 0 33077205 | 1 13145421 | 01000101                    | 71603370   |                           |
| T8   | 0 66176413 | 1 21116534 | 01000101                    | 71603370   |                           |
| T5   | 0 54375027 | 1 35030763 | 01010101                    | 71603370   |                           |
| T2   | 0 30772057 | 1 65705441 | 00000101                    | 71603370   |                           |
| TR   | 0 61764136 | 0 51707703 | 10100010                    | 06174407   |                           |
| T7   | 0 43750274 | 0 42103226 | 10111010                    | 06174407   |                           |
| T4   | 0 07720570 | 0 22824074 | 10101010                    | 06174407   |                           |
| T1   | 0 17641361 | 1 56255580 | 01000101                    | 71603370   |                           |
| TP   | 0 37502742 | 0 34627001 | 10101010                    | 06174407   |                           |
| T6   | 0 77205704 | 0 17754421 | 00100010                    | 06174407   | *                         |
| T3   | 0 76413611 | 1 21734353 | 10000101                    | 71603370   |                           |
| TC   | 0 75027423 | 1 54474421 | 01000101                    | 71603370   |                           |
| T8   | 0 72057046 | 0 91265644 | 10100010                    | 06174407   |                           |
| T5   | 0 64136114 | 0 00047130 | 11101010                    | 06174407   | *                         |
| T2   | 0 58274231 | 0 22310201 | 00010100                    | 71603370   | *                         |
| TP   | 0 58274231 | 0 11150140 | 00010000                    | 71603370   | 6F                        |

| TIME | A REGISTER | B REGISTER | FIGURE DIV76<br>BC REGISTER | A/M =<br>C REGISTER | 33747715 | 02416455 | 1 |
|------|------------|------------|-----------------------------|---------------------|----------|----------|---|
| T8   | 0 16141140 | 1 70702140 | 00000000                    | 07054017            |          |          |   |
| T8   | 0 70702140 | 1 07065121 | 00000000                    | 70723760            |          |          |   |
| T5   | 0 61604301 | 1 06075123 | 01001101                    | 70723760            |          |          |   |
| T2   | 0 43410603 | 1 06017331 | 01101101                    | 70723760            |          |          |   |
| TR   | 0 07021407 | 1 06164745 | 01000101                    | 70723760            |          |          |   |
| T7   | 0 16043017 | 1 06275074 | 01001001                    | 70723760            |          |          |   |
| T4   | 0 34106037 | 1 06417052 | 01101101                    | 70723760            |          |          |   |
| T1   | 0 70214077 | 1 07163206 | 01001101                    | 70723760            |          |          |   |
| TP   | 0 60430177 | 1 10273577 | 01001001                    | 70723760            |          |          |   |
| T6   | 0 41060377 | 1 12414261 | 01101101                    | 70723760            |          |          |   |
| T3   | 0 02140777 | 1 17155625 | 01001101                    | 70723760            |          |          |   |
| TC   | 0 04301777 | 1 30250534 | 01011101                    | 70723760            |          |          |   |
| T8   | 0 10603777 | 1 52466352 | 01001101                    | 70723760            |          |          |   |
| T5   | 0 21407776 | 0 26123135 | 10110010                    | 07054017            |          |          |   |
| T2   | 0 43017775 | 1 54301272 | 011111001                   | 70723760            |          |          |   |
| TR   | 0 06037772 | 0 52070576 | 10010010                    | 07054017            |          |          |   |
| T7   | 0 14077764 | 0 43255423 | 10000010                    | 07054017            |          |          |   |
| T4   | 0 30177750 | 0 25507075 | 10100010                    | 07054017            |          |          |   |
| T1   | 0 60377721 | 1 63331172 | 01011001                    | 70723760            |          |          |   |
| TP   | 0 40777642 | 0 57750376 | 00010010                    | 07054017            |          |          |   |
| T6   | 0 01777504 | 0 36714024 | 10101010                    | 07054017            |          |          |   |
| T3   | 0 03777210 | 0 15006007 | 10100100                    | 07054017            | *        |          |   |
| TC   | 0 07776421 | 1 42137176 | 01001001                    | 70723760            |          |          |   |
| T8   | 0 17275042 | 0 05254305 | 10100110                    | 07054017            |          |          |   |
| T5   | 0 37272105 | 1 22654712 | 01000101                    | 70723760            |          |          |   |
| T2   | 0 77764213 | 0 47531026 | 00001000                    | 70723760            |          |          |   |
| TP   | 0 77764213 | 0 23655013 | 00001000                    | 70723760            | 0F       |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV77<br>BC REGISTER | C REGISTER | A/M = 40607402 05140070 1 |
|------|------------|------------|-----------------------------|------------|---------------------------|
| T8   | 0 22130502 | 1 64012150 | 00000000                    | 71531776   |                           |
| T8   | 0 64012150 | 1 13662500 | 00000000                    | 71531776   |                           |
| T8   | 0 50024321 | 1 10276177 | 11001000                    | 71531776   |                           |
| T2   | 0 20050643 | 1 33227265 | 01101110                    | 71531776   |                           |
| TR   | 0 40121507 | 1 61311660 | 01101110                    | 71531776   |                           |
| T7   | 0 00243216 | 0 43263762 | 10010001                    | 06246001   |                           |
| T4   | 0 00506434 | 0 24725747 | 10110001                    | 06246001   |                           |
| T1   | 0 01215071 | 1 63524616 | 00101100                    | 71531776   |                           |
| TP   | 0 02432162 | 0 45611635 | 10110001                    | 06246001   |                           |
| T6   | 0 05064344 | 0 31001475 | 11110001                    | 06246001   |                           |
| T3   | 0 12150710 | 0 02461175 | 10010001                    | 06246001   | *                         |
| T0   | 0 24321621 | 1 16613262 | 00101110                    | 71531776   |                           |
| T8   | 0 50643443 | 1 26361652 | 01001110                    | 71531776   |                           |
| T6   | 0 21507107 | 1 47476633 | 01001110                    | 71531776   |                           |
| T2   | 0 43216216 | 0 27335707 | 00110001                    | 06246001   |                           |
| TR   | 0 06434435 | 1 40644517 | 10001100                    | 71531776   |                           |
| T7   | 0 15071072 | 0 27751437 | 00010001                    | 06246001   |                           |
| T4   | 0 32162165 | 1 40474776 | 11000100                    | 71531776   |                           |
| T1   | 0 64344352 | 0 21330175 | 10110001                    | 06246001   |                           |
| TP   | 0 50710725 | 1 54631263 | 00001110                    | 71531776   |                           |
| T6   | 0 21521652 | 0 37622760 | 00110011                    | 06246001   |                           |
| T3   | 0 43443525 | 1 60316650 | 11101110                    | 71531776   |                           |
| T0   | 0 07107252 | 0 61275742 | 10010001                    | 06246001   |                           |
| T8   | 0 15216524 | 0 60051707 | 11010001                    | 06246001   |                           |
| T5   | 0 34435250 | 0 60301621 | 10110001                    | 06246001   |                           |
| T2   | 0 71072520 | 1 50023444 | 01000000                    | 06246001   |                           |
| TP   | 0 06705260 | 0 76657624 | 00000001                    | 06246001   | 0F                        |

| TIME | A REGISTER | B REGISTER | FIGURE DIV78<br>BC REGISTER | C REGISTER | A/M = | 40000261 | 01341144 | 1 |
|------|------------|------------|-----------------------------|------------|-------|----------|----------|---|
| T8   | 0 32777271 | 1 57217524 | 00000000                    | 72121446   |       |          |          |   |
| T8   | 0 57217524 | 1 25120737 | 00000000                    | 72121446   |       |          |          |   |
| T5   | 0 36437251 | 1 44362235 | 00001110                    | 72121446   |       |          |          |   |
| T2   | 0 75076522 | 0 15514243 | 01111001                    | 05656331   |       |          |          |   |
| TR   | 0 72175245 | 1 27573157 | 00001000                    | 72121446   |       |          |          |   |
| T7   | 0 64372513 | 1 41411775 | 10100010                    | 72121446   |       |          |          |   |
| T4   | 0 50765226 | 0 20071344 | 11011001                    | 05656331   |       |          |          |   |
| T1   | 0 21752455 | 1 54325351 | 00001010                    | 72121446   |       |          |          |   |
| TP   | 0 43725132 | 0 35422273 | 01111001                    | 05656331   |       |          |          |   |
| T6   | 0 07652265 | 1 67307137 | 00101100                    | 72121446   |       |          |          |   |
| T3   | 0 17524552 | 0 54676727 | 10000101                    | 05656331   |       |          |          |   |
| TC   | 0 37251324 | 0 56344311 | 01110101                    | 05656331   |       |          |          |   |
| T8   | 0 76522650 | 0 34707355 | 10100001                    | 05656331   |       |          |          |   |
| T5   | 0 75245520 | 0 17664266 | 00011001                    | 05656331   | *     |          |          |   |
| T2   | 0 72513241 | 1 21613115 | 10101110                    | 72121446   |       |          |          |   |
| TR   | 0 65226503 | 1 55751011 | 00001110                    | 72121446   |       |          |          |   |
| T7   | 0 52455206 | 0 30572574 | 11010001                    | 05656331   |       |          |          |   |
| T4   | 0 25132414 | 0 00253624 | 11010101                    | 05656331   | *     |          |          |   |
| T1   | 0 52265031 | 1 14660210 | 00011110                    | 72121446   |       |          |          |   |
| TP   | 0 24552063 | 1 23603207 | 00101100                    | 72121446   |       |          |          |   |
| T6   | 0 51324147 | 1 31731254 | 10001010                    | 72121446   |       |          |          |   |
| T3   | 0 22650316 | 0 00432002 | 11111101                    | 05656331   | *     |          |          |   |
| TC   | 0 45520635 | 1 15427644 | 00000010                    | 72121446   |       |          |          |   |
| T8   | 0 13241473 | 1 25170177 | 00011000                    | 72121446   |       |          |          |   |
| T5   | 0 26503167 | 1 44523734 | 00000110                    | 72121446   |       |          |          |   |
| T2   | 0 55206356 | 1 11247010 | 00001100                    | 05656331   |       |          |          |   |
| TP   | 0 22571422 | 0 52402376 | 11010001                    | 05656331   | 0F    |          |          |   |

| TIME | A REGISTER | B REGISTER | FIGURE DIV79<br>BC REGISTER | A/M = 53203750<br>C REGISTER | 70027323 1 |
|------|------------|------------|-----------------------------|------------------------------|------------|
| T8   | 1 40751345 | 1 44374146 | 00000000                    | 27153034                     |            |
| T8   | 1 33403632 | 1 07653376 | 00000000                    | 50624743                     |            |
| T5   | 1 67007465 | 1 67342637 | 01011101                    | 50624743                     |            |
| T2   | 1 56017152 | 0 07072635 | 01010100                    | 27153034                     |            |
| TR   | 1 34036325 | 1 70021536 | 01011101                    | 50624743                     |            |
| T7   | 1 70074652 | 0 01130422 | 10110110                    | 27153034                     |            |
| T4   | 1 60171525 | 1 72325120 | 01001111                    | 50624743                     |            |
| T1   | 1 40363252 | 0 05727417 | 10100100                    | 27153034                     |            |
| TP   | 1 00746525 | 1 04673172 | 00011011                    | 50624743                     |            |
| T6   | 1 01715253 | 1 61434341 | 01001011                    | 50624743                     |            |
| T3   | 1 03632526 | 0 64145750 | 10100010                    | 27153034                     |            |
| T0   | 1 07465254 | 0 17666774 | 00000000                    | 27153034                     |            |
| T8   | 1 17152531 | 1 07371633 | 01011101                    | 50624743                     |            |
| T5   | 1 36325263 | 1 70621533 | 01011101                    | 50624743                     |            |
| T2   | 1 74652546 | 0 02530424 | 10110100                    | 27153034                     |            |
| TR   | 1 71525315 | 1 75325114 | 01001101                    | 50624743                     |            |
| T7   | 1 63252632 | 0 13727467 | 10100000                    | 27153034                     |            |
| T4   | 1 46525465 | 1 10673012 | 10011111                    | 50624743                     |            |
| T1   | 1 15253153 | 1 11434102 | 01001111                    | 50624743                     |            |
| TP   | 1 32526327 | 1 75616361 | 00101011                    | 50624743                     |            |
| T6   | 1 65254656 | 0 12701710 | 10110110                    | 27153034                     |            |
| T3   | 1 52531535 | 1 16640704 | 00010101                    | 50624743                     |            |
| T0   | 1 25263273 | 1 05346756 | 01000001                    | 50624743                     |            |
| T8   | 1 52546567 | 1 64531671 | 01011011                    | 50624743                     |            |
| T5   | 1 25315356 | 0 72450631 | 10010010                    | 27153034                     |            |
| T2   | 1 52632735 | 0 05141402 | 00000100                    | 50624743                     |            |
| TP   | 1 25145043 | 0 75317137 | 00000000                    | 50624743 0F                  |            |

**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Catalog No. 304003

**IDENTIFICATION:** P and S Register Tester

**AUTHOR:** M. Mulholland, SDS

**ACCEPTED:** August 28, 1964

**COMPUTER  
CONFIGURATION:** SDS 930

**PURPOSE:** To exercise the P and S Registers by storing and executing BRM's throughout memory. By comparing the "mark" of the BRM with an expected value, the program checks whether the computer stored the correct location. Therefore, the test checks whether the P and S registers functioned properly.

**STORAGE:** 0 - 221<sub>8</sub>, 146 locations

**SOURCE  
LANGUAGE:** SYMBOL 8

**LOADING  
PROCEDURE:** Load the P and S Register Tester into memory at the completion of the Automatic Instruction Diagnostic program using the normal fill procedure.

1. Set Bpt 3 if only one pass is desired through the memory. Set the mode switch to RUN.
2. The program stores BRM's throughout memory, starting at location 100<sub>8</sub>.
3. The computer executes the BRM's.
4. In case of an error, the computer halts; move mode switch to IDLE.  
The registers contain the following information.  
A = Expected location  
B = Actual location designated by "mark" of the BRM instruction just executed  
X = Which 4K bank, X = 0 through 7  
P = 0037  
C = 07100053

LOADING  
PROCEDURE:  
(cont.)

5. Set Bpt 1 if an error occurs. The computer will execute repeatedly the BRM just executed.
6. To inhibit the error halt, set Bpt 2.
7. Move the mode switch to RUN.
8. If Bpt 3 is set, the computer halts when it has executed all of the BRM's.
9. If the mode switch is set to RUN, the program reexecutes the set of BRM's.
10. If Bpt 3 is reset, the computer will loop through the program repeatedly until Bpt 3 is set.

|       |            |    |   |                                        |
|-------|------------|----|---|----------------------------------------|
|       |            | 1  | * |                                        |
|       |            | 2  | * | LOADER FOR P AND S REGISTERS EXERCISER |
|       |            | 3  | * |                                        |
|       | 00002      | 4  |   | ORG 2                                  |
| 00002 | 2 32 00012 | 5  |   | WIM 10.2                               |
| 00003 | 0 41 00002 | 6  |   | BRX 2                                  |
| 00004 | 0 32 00176 | 7  |   | WIM 126                                |
| 00005 | 0 32 00177 | 8  |   | WIM 127                                |
| 00006 | 0 71 00010 | 9  |   | LDX 8                                  |
| 00007 | 0 01 00176 | 10 |   | BRU 126                                |
| 00010 | 00077756   | 11 |   | OCT 77756                              |
| 00011 | 00000000   | 12 |   | OCT 0                                  |
| 00012 | 00164      | 13 |   | BSS 116                                |

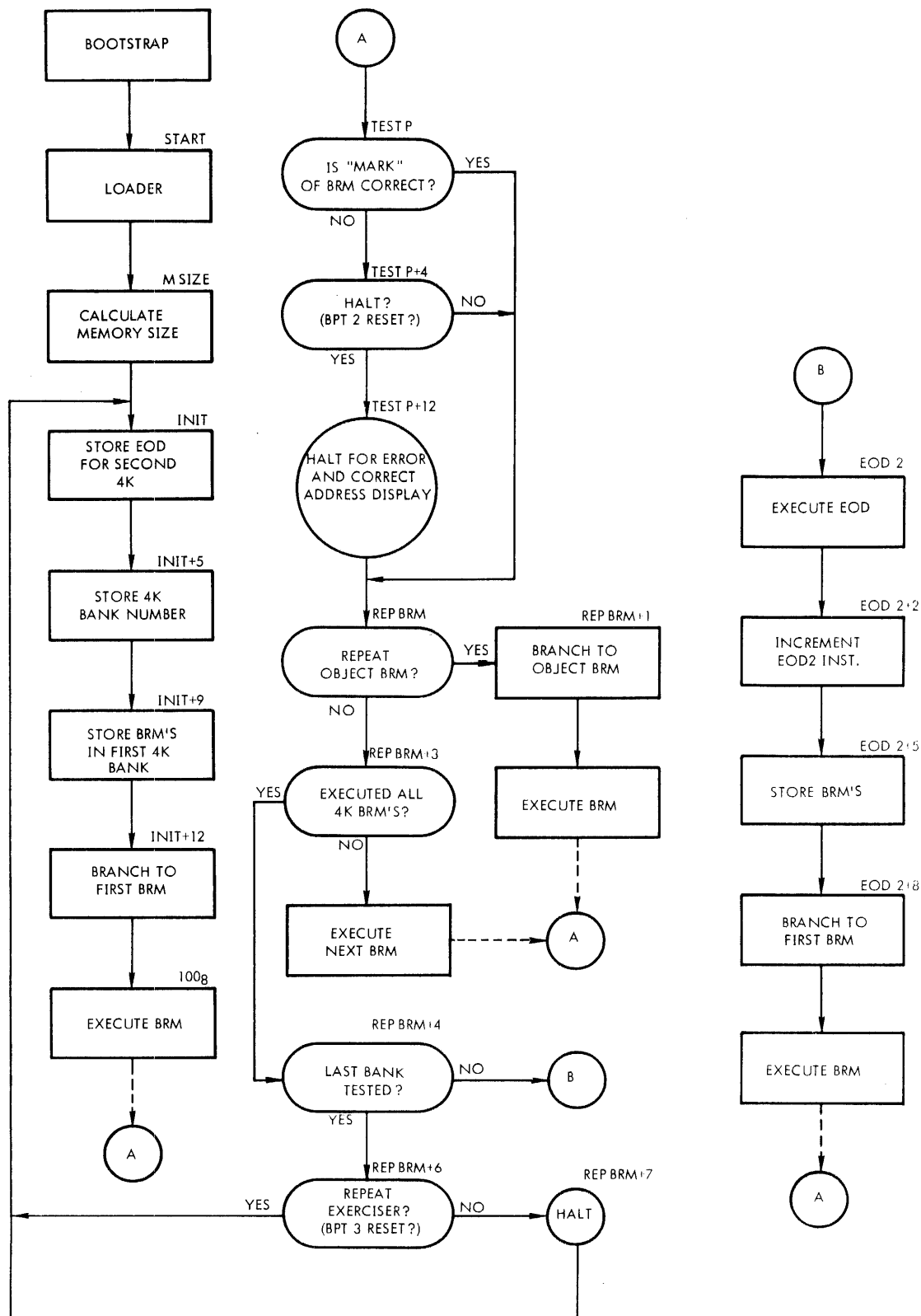
|       |            |    |       |                                        |
|-------|------------|----|-------|----------------------------------------|
|       |            | 1  | *     |                                        |
|       |            | 2  | *     | LOADER FOR P AND S REGISTERS EXERCISER |
|       |            | 3  | *     |                                        |
|       | 00002      | 4  |       | ORG 2                                  |
| 00002 | 2 32 00012 | 5  |       | WIM 10,2                               |
| 00003 | 0 41 00002 | 6  |       | BRX *-1                                |
| 00004 | 0 71 00011 | 7  |       | LDX 9                                  |
| 00005 | 2 32 04000 | 8  |       | WIM 2048,2                             |
| 00006 | 0 40 21000 | 9  |       | BRTW                                   |
| 00007 | 0 41 00005 | 10 |       | BRX *-2                                |
| 00010 | 0 01 04000 | 11 |       | BRU 2048                               |
| 00011 | 0 00 40000 | 12 |       | HLT* 0                                 |
|       |            | 13 | *     |                                        |
|       |            | 14 | *     |                                        |
|       |            | 15 | *     | CARD READER LOADER                     |
|       | 04000      | 16 |       | ORG 2048                               |
| 04000 | 0 71 00011 | 17 | LOAD  | LDX 9                                  |
| 04001 | 0 02 03606 | 18 |       | RCBW 1,4                               |
| 04002 | 2 32 00000 | 19 |       | WIM 0,2                                |
| 04003 | 0 40 21000 | 20 |       | BRTW                                   |
| 04004 | 0 41 04002 | 21 |       | BRX *-2                                |
| 04005 | 0 40 11006 | 22 | FILE  | CFTW 1                                 |
| 04006 | 0 01 04012 | 23 |       | BRU MSIZE                              |
| 04007 | 0 40 12006 | 24 |       | CRTW 1                                 |
| 04010 | 0 01 04005 | 25 |       | BRU FILE                               |
| 04011 | 0 01 04001 | 26 |       | BRU LOAD+1                             |
|       |            | 27 |       | PAGE                                   |
| 04012 | 0 76 04012 | 28 | MSIZE | LDA *                                  |
| 04013 | 0 61 04014 | 29 |       | MIN E0D1                               |
| 04014 | 0 06 20100 | 30 | E0D1  | E0D 64                                 |
| 04015 | 0 35 20000 | 31 |       | STA 8192                               |
| 04016 | 0 72 20000 | 32 |       | SKA 8192                               |
| 04017 | 0 01 04013 | 33 |       | BRU MSIZE+1                            |
| 04020 | 0 76 04014 | 34 |       | LDA E0D1                               |
| 04021 | 0 54 00063 | 35 |       | SUB =0620101                           |
| 04022 | 0 35 00077 | 36 |       | STA 63                                 |
| 04023 | 0 76 04025 | 37 |       | LDA ZERO                               |
| 04024 | 0 01 00000 | 38 |       | BRU 0                                  |

|       |            |    |      |      |          |                        |
|-------|------------|----|------|------|----------|------------------------|
| 04025 | 00000000   | 39 |      | PAGE |          |                        |
|       |            | 40 | ZERO | 0CT  | 0        |                        |
|       |            | 41 | E0D  | 0PD  | 620000   |                        |
| 04026 | 0 00 00000 | 42 |      | PZE  |          |                        |
| 04027 | 0 00 00000 | 43 |      | PZE  |          |                        |
| 04030 | 0 00 00000 | 44 |      | PZE  |          |                        |
| 04031 | 0 00 00000 | 45 |      | PZE  |          |                        |
| 04032 | 0 00 00000 | 46 |      | PZE  |          |                        |
| 04033 | 0 00 00000 | 47 |      | PZE  |          |                        |
| 04034 | 0 00 00000 | 48 |      | PZE  |          |                        |
| 04035 | 0 00 00000 | 49 |      | PZE  |          |                        |
| 04036 | 0 00 00000 | 50 |      | PZE  |          |                        |
| 04037 | 0 00 00000 | 51 |      | PZE  |          |                        |
|       |            | 52 |      | PAGE |          |                        |
|       | 00000      | 53 |      | ORG  | 0        |                        |
| 00000 | 0 75 00064 | 54 | INIT | LDB  | =07777   | MASK                   |
| 00001 | 0 35 00060 | 55 |      | STA  | WK2      |                        |
| 00002 | 0 76 00065 | 56 |      | LDA  | =0620210 | E0D FOR OVER 4K        |
| 00003 | 0 35 00015 | 57 |      | STA  | E0D2     |                        |
| 00004 | 0 76 00077 | 58 |      | LDA  | 63       |                        |
| 00005 | 0 35 00057 | 59 |      | STA  | WK1      |                        |
| 00006 | 0 06 20200 | 60 |      | E0D  | 128      |                        |
| 00007 | 0 71 00066 | 61 |      | LDX  | =070100  |                        |
| 00010 | 0 76 00061 | 62 |      | LDA  | BRM      | STORE BRM INSTRUCTIONS |
| 00011 | 2 35 10000 | 63 |      | STA  | 4096.2   | IN LOW 4K OF MEMORY    |
| 00012 | 0 41 00011 | 64 |      | BRX  | *-1      |                        |
| 00013 | 0 71 00067 | 65 |      | LDX  | =070101  |                        |
| 00014 | 0 01 00100 | 66 |      | BRU  | 64       |                        |
|       |            | 67 |      | PAGE |          |                        |
| 00015 | 0 00 00000 | 68 | E0D2 | PZE  |          | GREAT THAN 4K          |
| 00016 | 0 76 00070 | 69 |      | LDA  | =010     |                        |
| 00017 | 0 63 00015 | 70 |      | ADM  | E0D2     | INCREMENT BANK E0D     |
| 00020 | 0 71 00071 | 71 |      | LDX  | =070000  |                        |
| 00021 | 0 76 00061 | 72 |      | LDA  | BRM      | STORE BRM INSTRUCTION  |
| 00022 | 2 35 00000 | 73 |      | STA  | 0.2      | IN OVER 4K MEMORY      |
| 00023 | 0 41 00022 | 74 |      | BRX  | *-1      |                        |
| 00024 | 0 71 00071 | 75 |      | LDX  | =070000  |                        |
| 00025 | 2 41 00000 | 76 |      | BRX  | 0.2      |                        |

|       |            |     |        |      |          |                            |
|-------|------------|-----|--------|------|----------|----------------------------|
| 00026 | 0 00 00000 | 77  |        | PAGE |          |                            |
| 00027 | 0 46 00200 | 78  | TESTP  | PZE  |          |                            |
| 00030 | 0 54 00072 | 79  |        | CXA  |          | TEST REGISTERS             |
| 00031 | 0 70 00026 | 80  |        | SUB  | =1       |                            |
| 00032 | 0 40 20200 | 81  |        | SKM  | TESTP    | CORRECT                    |
| 00033 | 0 01 00045 | 82  |        | BPT  | 2        | NO                         |
| 00034 | 0 75 00026 | 83  |        | BRU  | REPBRM   | YES                        |
| 00035 | 0 37 00062 | 84  |        | LDB  | TESTP    | B CONTAINS ERROR ADDRESS   |
| 00036 | 0 71 00060 | 85  |        | STX  | SAVEX    |                            |
| 00037 | 0 66 20014 | 86  |        | LDX  | WK2      |                            |
| 00040 | 0 46 00340 | 87  |        | RCY  | 12       | MERGE                      |
| 00041 | 0 66 20014 | 88  |        | RCH  | 340      | BANK                       |
| 00042 | 0 00 00000 | 89  |        | RCY  | 12       | LOCATION                   |
| 00043 | 0 71 00062 | 90  |        | HLT  |          | A CONTAINS CORRECT ADDRESS |
| 00044 | 0 75 00064 | 91  |        | LDX  | SAVEX    |                            |
| 00045 | 0 40 20400 | 92  |        | LDB  | =07777   | MASK                       |
| 00046 | 2 01 37777 | 93  | REPBRM | BPT  | 1        | REPEAT BRM                 |
| 00047 | 2 41 00000 | 94  |        | BRU  | 16383.2  |                            |
| 00050 | 0 61 00060 | 95  |        | BRX  | 0.2      |                            |
| 00051 | 0 60 00057 | 96  |        | MIN  | WK2      |                            |
| 00052 | 0 01 00015 | 97  |        | SKR  | WK1      | LAST BANK                  |
| 00053 | 0 40 20100 | 98  |        | BRU  | E0D2     | NO                         |
| 00054 | 0 00 00000 | 99  |        | BPT  | 3        | YES-REPEAT ROUTINE         |
| 00055 | 0 76 00042 | 100 |        | HLT  |          | NO                         |
| 00056 | 0 01 00000 | 101 |        | LDA  | TESTP+12 |                            |
|       |            | 102 |        | BRU  | INIT     | YES                        |
|       |            | 103 |        | PAGE |          |                            |
| 00057 | 0 00 00000 | 104 | WK1    | PZE  |          |                            |
| 00060 | 0 00 00000 | 105 | WK2    | PZE  |          |                            |
| 00061 | 0 43 00026 | 106 | BRM    | BRM  | TESTP    |                            |
| 00062 | 0 00 00000 | 107 | SAVEX  | PZE  |          |                            |
|       |            | 108 | E0D    | 0PD  | 620000   |                            |
|       | 00000      | 109 |        | END  |          |                            |
| 00063 | 00620101   |     |        |      |          |                            |
| 00064 | 00007777   |     |        |      |          |                            |
| 00065 | 00620210   |     |        |      |          |                            |
| 00066 | 00070100   |     |        |      |          |                            |
| 00067 | 00070101   |     |        |      |          |                            |
| 00070 | 00000010   |     |        |      |          |                            |
| 00071 | 00070000   |     |        |      |          |                            |
| 00072 | 00000001   |     |        |      |          |                            |

|        |       |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|-------|
| REPBRM | 00045 | MSIZE | 04012 | SAVEX | 00062 | TESTP | 00026 |
| EOD1   | 04014 | EOD2  | 00015 | FILE  | 04005 | INIT  | 00000 |
| LOAD   | 04000 | ZERO  | 04025 | BRM   | 00061 | EOD   | 04067 |
| EOD    | 04026 | WK1   | 00057 | WK2   | 00060 |       |       |

# SDS 930 P & S REGISTER/TESTER



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**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Page 1 of 194

Catalog No. 594003B

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**IDENTIFICATION:** SDS 925/930 Rapid Access Data (RAD) Files Apocalyptic Diagnostic Program

**AUTHOR:** SDS

**DATE:** June 16, 1966

**COMPUTER CONFIGURATION:** Any SDS 925 or 930 Computer with one typewriter attached to the W-buffer, and one or more RAD files attached to any channel using interlace

**PURPOSE:** To provide the operator with a means of testing and checking out the SDS rapid access data files

**PROGRAMMED OPERATORS:** None

**SUBROUTINES REQUIRED:** None

**STORAGE:** The program nominally occupies  $3708_{10}$  locations from  $0000_8$  to  $7174_8$ . When operated, a minimum of  $4K_8$  locations are used

**SOURCE LANGUAGE:** METASYMBOL

**LOADING PROCEDURES:** Standard fill from paper tape or cards

## SECTION I

### METHOD OF OPERATION

#### 1.1 INITIATING THE PROGRAM

1.1.1 The program is supplied on paper tape or cards with a self-loading bootstrap.

1.1.2 To load the program, place the program medium (cards or paper tape) into the appropriate reader, reset all BREAKPOINT switches, and follow the standard fill procedure.

1.1.3 When the program is loaded, a message RAD APOCALYPTIC DIAGNOSTIC is typed to indicate that the program is now under operator control.

#### 1.2 OPERATING THE PROGRAM

1.2.1 By the input of the appropriate directives at the keyboard, the operator can initiate procedures that will check out the RAD file under test.

1.2.2 When the program is loaded and started normally, an initializer routine sets up certain run-time parameters to initial values. The initializer is not operated again when a restart is made; all run-time parameters retain the values they had before restart.

#### 1.3 REGAINING OPERATOR CONTROL

1.3.1 To regain operator control after the test program is activated, the operator sets BREAKPOINT switch 1 or moves the RUN-IDLE-STEP switch to IDLE, presses RESET or START, moves the switch to ~~STOP~~ and then to RUN. If the instruction in location 0001 is destroyed, he executes a BRU to location 0300. This will return control to the keyboard.

1.3.2 When a restart at 0300 is made, all parameters retain the values they had initially; the initializer is not operated again.

1.3.3 Recovery of operator control via any method other than described in paragraph 1.3.1 is not recommended.

#### 1.4 BREAKPOINT SWITCHES

1.4.1 BREAKPOINT switches exercise the following functions:

|              |       |                                                                                                   |
|--------------|-------|---------------------------------------------------------------------------------------------------|
| BREAKPOINT 1 | RESET | Continues sequence of operations                                                                  |
|              | SET   | Returns control to the typewriter in the immediate mode after the control line has been executed. |

---

|              |       |                                                                                                                                                                                                                                           |
|--------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BREAKPOINT 2 | RESET | In the interrupt test, keeps the sector address constant.                                                                                                                                                                                 |
|              | SET   | In the interrupt test, advances the sector address by 1. (After BREAKPOINT 2 is placed in a SET position, it is returned to the RESET position.)                                                                                          |
| BREAKPOINT 3 | RESET | In the compare function, allows bit summary typeout. In the interrupt test, continues sequence of operations. In the octal card read function, continues card read operation.                                                             |
|              | SET   | During the execution of the compare function, suppresses bit summary typeout. In the interrupt test, aborts testing and returns control to keyboard. In the octal card read function, aborts reading and returns control to the keyboard. |
| BREAKPOINT 4 | RESET | Allows all status and error messages to be output at the keyboard.                                                                                                                                                                        |
|              | SET   | Suppresses all message output except in those certain cases (specifically named in the directive descriptions) where typeout is not suppressible.                                                                                         |

## SECTION II

### PROGRAM DIRECTIVES

2.1 The following discussion assumes familiarity with the SDS 925/930 Diagnostic Control Program (catalog No. 004009) and the test language described therein.

2.2 The operator directs the operation of this program through the input of directives, each named by a unique mnemonic. These directives are entered at the keyboard or by card reader. Most directives have optional or required parameters that follow the mnemonic call, and optional iteration count or place marker identifiers that precede the mnemonic directive.

2.3 Functional directions fall into two categories:

a. Environmental directives, which permit the user to initialize and modify certain environmental parameters that affect subsequent operational directives.

b. Operational directives, which validate data transfer operations. Some of these directives directly perform data manipulation and comparison; others facilitate the task.

2.4 The directives associated with the program are described in paragraph 2.6 of this section.

2.5 Table 2-1 lists the directives of this RAD apocalyptic diagnostic program. The directives are arranged alphabetically by mnemonic name. The subparagraph reference after each mnemonic indicates the location of the detailed description.

Table 2-1. RAD Directives

| Directive | Class* | Function                        | Mode** | Paragraph |
|-----------|--------|---------------------------------|--------|-----------|
| ADR       | E      | Declare Device Starting Address | I      | 2.6.6     |
| BAK       | E      | Return To Starting Address      | I or C | 2.6.7     |
| C         | O      | Compare Data                    | I or C | 2.6.23    |
| CHN       | E      | Declare I/O Channel             | I      | 2.6.12    |
| CTR       | O      | Counter Control                 | I or C | 2.6.2     |
| DLY       | O      | Time Delay                      | I or C | 2.6.26    |
| ERR       | O      | Error Report                    | I or C | 2.6.4     |
| INT       | O      | Priority Interrupt Test         | I      | 2.6.16    |

\* \*\*See footnotes, page 5.

Table 2-1. RAD Directives (Cont.)

| <u>Directive</u> | <u>Class*</u> | <u>Function</u>                           | <u>Mode**</u> | <u>Paragraph</u> |
|------------------|---------------|-------------------------------------------|---------------|------------------|
| JMP              | U             | Jump To Location                          | I or C        | 2.6.27           |
| LEN              | E             | Set Record Length                         | I or C        | 2.6.11           |
| MARK             | O             | Mark Identify                             | I or C        | 2.6.28           |
| OCT              | U             | Octal Card Read                           | I             | 2.6.22           |
| PAT              | E             | Declare Test Pattern                      | I or C        | 2.6.14           |
| Q                | O             | Query Tests                               | I or C        | 2.6.25           |
| R                | O             | Read Record                               | I or C        | 2.6.20           |
| RNON             | O             | Read Record, Inhibit Band Incrementation  | I or C        | 2.6.21           |
| S                | E             | Move Device Address                       | I or C        | 2.6.8            |
| STOP             | O             | Stop Identify                             | I or C        | 2.6.29           |
| TDA              | O             | Type Device Address                       | I or C        | 2.6.10           |
| TRY              | E             | Declare Retry Count                       | I             | 2.6.5            |
| TYC              | O             | Type Counters                             | I or C        | 2.6.3            |
| TYP              | O             | Type I/O Buffer                           | I or C        | 2.6.13           |
| UNT              | E             | Declare Unit Environment                  | I             | 2.6.1            |
| UPA              | D             | Update Device Address                     | I or C        | 2.6.9            |
| W                | O             | Write Record                              | I or C        | 2.6.17           |
| WNON             | O             | Write Record, Inhibit Band Incrementation | I or C        | 2.6.18           |
| WSEQ             | O             | Write Sequentially                        | I or C        | 2.6.19           |
| XC               | O             | Declare Compare Timeout Mode              | I or C        | 2.6.24           |
| XPAT             | O             | Rotate Pattern                            | I or C        | 2.6.15           |

\* E = Environmental; O = Operational; U = Utility

\*\* I = Immediate; C = Control Line

## 2.6 DIRECTIVES USED WITH THE RAD APOCALYPTIC DIAGNOSTIC PROGRAM

In the following discussion, trailing parameters are referenced as  $P_1$ ,  $P_2$ ,  $P_3$ , etc.; and leading parameters are iteration counts,  $i$ , or place markers,  $m$ .

### 2.6.1 Directive: Declare Unit Environment (UNT)

**Purpose:** To establish the hardware environment to be tested and to specify the unit sequence in multiple-unit installations

**Parameters, Trailing:**  $P_1$  (octal), where  $0 \leq P_1 \leq 7$   
 $P_2$  (octal), where  $0 \leq P_2 \leq 4$   
 $P_3$  (octal), where  $0 \leq P_3 \leq 1$

**Parameters, Leading:** None allowed

**Mode:** Immediate only

**Format:** \$UNT,  $P_1$ ,  $P_2$ ,  $P_3$

Explanation:  $P_1$  specifies the unit assignment number (0 through 7),  $P_2$  specifies the number of basic (.5 million character) storage modules contained in the device (that is, the device capacity). This number is the last digit of the dash portion of the model number; -X4 shows 4 modules or a two-million character device. If a two-million character device is specified, two entries are made in the unit list (namely, two one-million character units). Eight is the maximum number of unit entries that can be made. When this limit is exceeded, a typeout occurs that indicates that the unit list is full. Any nonzero value for parameter  $P_3$  purges any previous entries in the unit list.

### 2.6.2 Directive: Counter Control (CTR)

**Purpose:** To provide the capability of setting, resetting, incrementing, decrementing, and testing the fifteen counters maintained within the RAD program. These counters may be tested individually or in combination. The first nine counters (1 through 9) are general-purpose counters that can only be modified by this directive. The last six counters (10 through 15) are modified internally by other functions in response to various conditions which occur. Table 2-2 contains a detailed description of each counter and its use.

Table 2-3 indicates the logical indicators (bits) used as entrance parameter  $P_1$  to specify which counters are operated upon.

|                          |                                                                                                                                                                                                                                                           |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parameters,<br>Trailing: | $P_1$ (octal), where $0 \leq P_1 \leq 77777$<br>$P_2$ (decimal), where $0 \leq P_2 \leq 9999$<br>$P_3$ (decimal), where $0 \leq P_3 \leq 2$<br>$P_4$ (decimal), where $0 \leq P_4 \leq 9999$ (maximum)<br>$P_5$ is alphabetic word TYPE or is not present |
| Parameters,<br>Leading:  | Place mark (m) allowed                                                                                                                                                                                                                                    |
| Mode:                    | Immediate or control line                                                                                                                                                                                                                                 |
| Format:                  | mCTR, $P_1$ , $P_2$ , $P_3$ , $P_4$ , $P_5$                                                                                                                                                                                                               |

Explanation:  $P_1$  specifies which counters are to be operated upon,  $P_2$  is the value of the operation,  $P_3$  indicates the operation, and  $P_4$  is the test value. Each bit of the 15-bit parameter  $P_1$  represents a counter (see table 2-2). In  $P_3$ , 0 equals set value, 1 equals increment by value, and 2 equals decrement by value. A counter tests true if the counter value is greater than  $P_4$  (the test value) or the counter is less than zero (negative). In both cases, the test takes place after the counter has been modified by  $P_2$  (the value of the operation), using the operation specified by  $P_3$  (set, increment, decrement). Each time a counter tests true, the counter's name and value are output on the console type-writer if parameter  $P_5$  contains the word TYPE.

The CTR directive may be preceded by a place mark parameter to provide conditional branching within the control line. If any counter specified by  $P_1$  tests true, the place mark branch is taken; if not, the control line continues in sequence.

**Example:** ..+ 4CTR,01011,1,1,12,TYPE . . . + 4.STOP,0001  
This indicates that counters 1, 4, and 10 are to be incremented by 1 and tested for value greater than 12. If any counter tests true, its name and value are typed, and control continues at place mark 4. Otherwise, the next directive in line is executed.

Table 2-2. RAD-Maintained Counters

| <u>Counter Name</u>  | <u>Counter Number</u> | <u>Use</u>                                                                                                                                                                                                                        |
|----------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Counter 1            | 1                     | General purpose                                                                                                                                                                                                                   |
| Counter 2            | 2                     | General purpose                                                                                                                                                                                                                   |
| Counter 3            | 3                     | General purpose                                                                                                                                                                                                                   |
| Counter 4            | 4                     | General purpose                                                                                                                                                                                                                   |
| Counter 5            | 5                     | General purpose                                                                                                                                                                                                                   |
| Counter 6            | 6                     | General purpose                                                                                                                                                                                                                   |
| Counter 7            | 7                     | General purpose                                                                                                                                                                                                                   |
| Counter 8            | 8                     | General purpose                                                                                                                                                                                                                   |
| Counter 9            | 9                     | General purpose                                                                                                                                                                                                                   |
| Record Counter       | 10                    | Shows the number of records that have passed since the last address declaration. This counter is unconditionally set to 1 when an ADR or UPA directive is executed, and is incremented by 1 each time the S directive is executed |
| Channel Errors-Read  | 11                    | Shows the number of channel errors that have occurred during read operations                                                                                                                                                      |
| Channel Errors-Write | 12                    | Shows the number of channel errors that have occurred during write operations                                                                                                                                                     |
| Coupler Errors-Read  | 13                    | Shows the number of coupler errors that have occurred during read operations                                                                                                                                                      |
| Coupler Errors-Write | 14                    | Shows the number of coupler errors that have occurred during write operations                                                                                                                                                     |
| Data Errors          | 15                    | Incremented by 1 for each data word that does not compare with the test pattern (see C directive).                                                                                                                                |

Table 2-3. Counter Logical Indicators (Bits)

| <u>Octal Value</u> | <u>Counter</u>       |
|--------------------|----------------------|
| 00001              | Counter 1            |
| 00002              | Counter 2            |
| 00004              | Counter 3            |
| 00010              | Counter 4            |
| 00020              | Counter 5            |
| 00040              | Counter 6            |
| 00100              | Counter 7            |
| 00200              | Counter 8            |
| 00400              | Counter 9            |
| 01000              | Record Counter       |
| 02000              | Channel Errors-Read  |
| 04000              | Channel Errors-Write |
| 10000              | Coupler Errors-Read  |
| 20000              | Coupler Errors-Write |
| 40000              | Data Errors          |

Note: Indicators are logically merged to operate on more than one counter. For example,  $P_1 = 77777$  would specify all counters.

---

**2.6.3 Directive: Type Counters (TYC)**

Purpose: To interrogate the 15 counters maintained within the program

Parameters, Trailing:  $P_1$  (octal), where  $0 \leq P_1 \leq 77777$

Parameters, Leading: None allowed

Mode: Immediate or control line

Format: TYC,  $P_1$

Explanation: Parameter  $P_1$  indicates the counters to be typed by placing a one bit into the bit position corresponding to the desired counter.

---

**2.6.4 Directive: Error Report (ERR)**

Purpose: To typeout the value of the five error counters

Parameters, Trailing:  $P_1$  (decimal), where  $0 \leq P_1 \leq 9999$

Parameters, Leading: None allowed

Mode: Immediate or control line

Format: ERR,  $P_1$

Explanation: Parameter  $P_1$  is the error report frequency. Every time the ERR directive is executed, an internal counter is incremented by 1 and then compared with the value specified by  $P_1$ . If this counter is greater than  $P_1$ , the value of the five error counters are output on the typewriter and the internal error frequency counter is reset to zero. If  $P_1$  is zero, the five error counters are set to zero.

---

**2.6.5 Directive: Declare Retry Count (TRY)**

Function: To cause an internal retry counter to be set at the value specified by parameter  $P_1$ . This counter is referenced when an error occurs during data transfers (see W and R directives, 2.6.17 and 2.6.20, respectively).

Parameters, Trailing:  $P_1$  (decimal), where  $0 \leq P_1 \leq 9999$

Parameters, Leading: None allowed

Mode: Immediate only

Format: \$TRY,  $P_1$

#### 2.6.6 Directive: Declare Device Starting Address (ADR)

Function: To establish the initial operating points in the RAD environment

Parameters, Trailing:  $P_1$  (octal), where  $0 \leq P_1 \leq 7$   
 $P_2$  (octal), where  $0 \leq P_2 \leq 7777$

Parameters, Leading: None allowed

Mode: Immediate only

Format: \$ADR,  $P_1$ ,  $P_2$

Explanation:  $P_1$  specifies the unit and  $P_2$  specifies the band and sector address on the unit. The  $P_2$  parameter initializes the two address counters maintained by this program. One counter is called starting device address; it can only be changed by this directive (ADR) and the UPA (Update Device Address) directive (see paragraph 2.6.9). The other counter is called the current device address. It is initialized by this directive (ADR) and by the Return to Starting Address (BAK) directive (paragraph 2.6.7); and incremented by the S (Move Device Address) directive (paragraph 2.6.8). All data transfer operations start at the address specified by the current device address counter. The program is initialized with unit 0, band 00 sector 00 as the starting device address.

#### Example:

|                                               |       |           |       |
|-----------------------------------------------|-------|-----------|-------|
|                                               | \$ADR | , 1, 3125 | CR    |
| Immediate mode                                | _____ | _____     | _____ |
| Directive                                     | _____ | _____     | _____ |
| Band 31 <sub>8</sub> , sector 25 <sub>8</sub> | _____ | _____     | _____ |
| starting address of unit 1                    | _____ | _____     | _____ |
| Carriage return (field separator)             | _____ | _____     | _____ |

**Error Message:** If the unit specified by P<sub>1</sub> does not exist in the RAD environment as defined by the UNT directive, an error message is typed. If the band address exceeds the capacity of the unit specified by P<sub>1</sub>, an error message is typed and a band and sector address of 00 00 is used.

#### 2.6.7 Directive: Return to Starting Address (BAK)

**Function:** To set the current device address equal to the starting device address

**Parameters, Trailing:** None allowed

**Parameters, Leading:** None allowed

**Mode:** Immediate or control line

**Format:** BAK

#### 2.6.8 Directive: Move Device Address (S)

**Function:** To cause the current device address to be incremented by an amount equal to the number of sectors required to contain the current record length as set by LEN (Set Record Length) directive (see paragraph 2.6.11). If the current device address is incremented past a unit address boundary as set by the UNT directive, the next unit in the unit list is selected as the current unit, and the band-sector address is set to 00 00.

**Parameters, Trailing:** None allowed

**Parameters, Leading:** Iteration counts (i) allowed

**Mode:** Immediate or control line

**Format:** iS

Explanation: The iteration count effectively moves the current device address by i (n) sectors, where (n) is the number of sectors needed to contain the current record length.

---

**2.6.9    Directive:    Update Device Address    (UPA)**

Function:        To cause the current device address to be initialized as the starting device address. When this directive is executed, the record counter is unconditionally set at 1.

Parameters,  
Trailing:        None allowed

Parameters,  
Leading:         None allowed

Mode:            Immediate or control line

Format:          UPA

**2.6.10   Directive:    Type Device Address    (TDA)**

Function:        To cause a typeout    RECORD STARTING ADDRESS UBBSS where U is the current unit number, BB is the current band address, and SS is the current sector address.

Parameters,  
Trailing:        None allowed

Parameters,  
Leading:         None allowed

Mode:            Immediate or control line

Format:          TDA

**2.6.11   Directive:    Set Record Length    (LEN)**

Function:        To establish the length of logical records for all data transfers and compare operations

Parameters,  
Trailing:         $P_1$  (decimal), where  $0 \leq P_1 \leq 4096$

Parameters,  
Leading:         None allowed

Mode:            Immediate or control line

Format: LEN,  $P_1$

Explanation: Parameter  $P_1$  is the desired length, expressed in words, where  $1 \leq P_1 \leq 4096$ . If  $P_1$  has a value of zero, the record length is set to 4096 words (1 band). If the program is to be run on a minimum configuration system (that is, 4K memory), then the limits are  $1 \leq P_1 \leq 128$  (namely, the record length is limited to 2 sectors). The program is initialized with the record length set to 64 words (1 sector).

2.6.12 Directive: Declare I/O Channel (CHN)

Function: To define the I/O channel associated with the RAD

Parameters, Trailing:  $P_1$  (alphabetic), where  $A \leq P_1 \leq H$

Parameters, Leading: None allowed

Mode: Immediate only

Format: \$CHN,  $P_1$

Explanation:  $P_1$  is the mnemonic identifier of this particular channel and is input in the form of a single alphabetic character, in the range A through H. Channels W and Y are represented by letters A and B, respectively. The program is initialized with channel A being assigned.

2.6.13 Directive: Type I/O Buffer (TYP)

Function: To cause the contents of the I/O buffer area to be typed at the console typewriter

Parameters, Trailing:  $P_1$  (decimal), where  $0 \leq P_1 \leq 4096$

Parameters, Leading: None allowed

Mode: Immediate or control line

Format: TYP,  $P_1$

Explanation: Parameter  $P_1$  determines the relative location within the buffer where the typing is to start. The relative location of the first word of the buffer is 1. If the parameter is 0 or blank, the standard value is set to 1. Words typed are preceded by their relative location within the buffer. The number of words typed out is equivalent to the length of the record read length. The unit-band-sector address at which the last data transfer was initiated is typed prior to the output of the data.

#### 2.6.14 Directive: Set Test Pattern (PAT)

Function: To set the test pattern for the write and compare operations

Parameters, Trailing:  $P_1$  (octal), where  $0 \leq P_1 \leq 77777777$   
 $P_2$  (decimal), where  $1 \leq P_2 \leq 8$

Parameters, Leading: None allowed

Mode: Immediate or control line

Format: PAT,  $P_1$ ,  $P_2$

Explanation: The desired test pattern is specified by parameter  $P_1$  as 1 to 8 octal digits. Parameter  $P_2$  specifies the number of octal digits input in  $P_1$ . The pattern generated for write and compare operations is based on the number of octal digits input in  $P_1$ . If the number of digits,  $N$ , is an even divisor of 8 (the number of octal digits in a 24-bit word), the pattern generated is cyclic every word; that is, every word in the pattern is the same. If  $N$  is not an even divisor of 8, however, the pattern is cyclic every  $N$ th word.

|          |             |                          |                |
|----------|-------------|--------------------------|----------------|
| Example: | PAT, 52, 2  | <u>PATTERN GENERATED</u> |                |
|          |             | <u>Word</u>              | <u>Pattern</u> |
|          |             | 1                        | 52525252       |
|          |             | 2                        | 52525252       |
|          |             | ⋮                        | ⋮              |
|          |             | ⋮                        | ⋮              |
|          | PAT, 543, 3 | 1                        | 54354354       |
|          |             | 2                        | 35435435       |
|          |             | 3                        | 43543543       |

PATTERN GENERATED

| <u>Word</u> | <u>Pattern</u> |
|-------------|----------------|
| 4           | 54354354       |
| ⋮           | ⋮              |

The program is initialized with a pattern of zeros.

2.6.15 Directive: Rotate Pattern (XPAT)

|                       |                                                                                                                                                                                                                                                                                            |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function:             | To cause the first word of the existing pattern to be rotated right the number of bit positions specified by parameter $P_1$ . The word obtained as a result of this shift is used in conjunction with the pattern digit count declared by the last PAT directive to define a new pattern. |
| Parameters, Trailing: | $P_1$ (decimal), where $0 \leq P_1 \leq 48$                                                                                                                                                                                                                                                |
| Parameters, Leading:  | None allowed                                                                                                                                                                                                                                                                               |
| Mode:                 | Immediate or control line                                                                                                                                                                                                                                                                  |
| Format:               | XPAT, $P_1$                                                                                                                                                                                                                                                                                |

2.6.16 Directive: Priority Interrupt Test (INT)

|                       |                                                                                                                                                            |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function:             | To test the optional priority interrupt available with the RAD for interrupt interval timing, multiple interrupt occurrence, and correct sector reporting. |
| Parameters, Trailing: | $P_1$ (octal), where $0 \leq P_1 \leq 7$<br>$P_2$ (octal), where $200 \leq P_2 \leq 277$<br>$P_3$ (octal), where $P_3$ is any zero or nonzero value        |
| Parameters, Leading:  | None allowed                                                                                                                                               |
| Mode:                 | Immediate only                                                                                                                                             |
| Format:               | \$INT, $P_1$ , $P_2$ , $P_3$                                                                                                                               |

Explanation: Parameter  $P_1$  specifies the unit to be tested (0 through 7). Parameter  $P_2$  specifies the interrupt link address,  $200_8$  through  $277_8$ . Parameter  $P_3$  is used to indicate the installation of the optional arming feature: zero indicates that it is not installed, any nonzero value indicates that it is installed.

Interrupt testing starts with sector 00 and advances sequentially through sector  $77_8$ .

The testing can only be done in the immediate mode. To abort testing set BREAKPOINT 3.

Error  
Messages:

If  $P_1$  unit is not in the RAD environment as previously defined by the UNT function, an error message is typed and control returns to the keyboard. If an error occurs in interrupt testing, it is reported on the typewriter and that sector is tested again. This continues until the sector interrupt is received correctly or BREAKPOINT 2 is set and reset, at which time the next sector in sequence is tested. A number of error typeouts can occur:

- a. INTERRUPT TIMING ERROR XX.XX indicates that an interrupt was received but was outside the allowable time limits (1 disc revolution per 35 ms), XX.XX represents the elapsed time in milliseconds from address POT to the interrupt occurrence.
- b. COUPLER SECTOR XXXX YYYY indicates that the sector address that was input in parallel (PIN) does not equal the sector address that was output in parallel (POT). XXXX is the expected sector address and YYYY is the sector address received.
- c. MULTIPLE INTERRUPTS XXXX occurs when more than one interrupt was received in two disc revolutions (70 milliseconds). XXXX is the number of interrupts received during the 70 ms after the disc-address POT operation.
- d. INTERRUPT NOT RECEIVED occurs when an interrupt is not received within 70 milliseconds after the address POT operation. If any sector fails to give an interrupt signal, the program does not loop on that sector but selects the next sector in sequence.

2.6.17 Directive: Write Record (W)

Function: To cause one record to be written on the RAD, starting at the current device address.

Parameters,  
Trailing:  $P_1$  (octal)

Parameters,  
Leading: Iteration counts (i) allowed

Mode: Immediate or control line

Format:  $iW, P_1$

Explanation: If Parameter  $P_1$  is zero or not present, an attempt is made to write over bands that are write-protected. If Parameter  $P_1$  is nonzero, any write-protected bands are skipped; when a write-protected band is encountered, an error message is typed.

Error  
Message: Errors are detected in the channel and the coupler and reported at the typewriter (if BREAKPOINT 4 is reset) before the retry counter is checked to determine whether to repeat the write operation. Iteration counts are not performed if the retry count is exhausted before the write is successfully completed.

If an error is detected, one or more of the following messages is typed:

WRITE ERROR CHANNEL ERROR

WRITE ERROR COUPLER ERROR

WRITE ERROR RECORD LENGTH ER NNNN XXXX

WRITE ERROR COUPLER SECTOR YYYY ZZZZ

In the typeouts above, NNNN is the expected word transfer count (the write record length), XXXX is the actual transfer count, YYYY is the expected sector address at completion of the data transfer, and ZZZZ is the received sector address. The error report is followed by a typeout of the current device address.

2.6.18 Directive: Write Record, Inhibit Band Incrementation (WNON)

Function: To serve as an alternative write function, identical to W, except that nonband incrementing EOM's are used.

Parameters,  
Trailing:  $P_1$  (octal)

Parameters,  
Leading: Iteration counts (i) allowed

Mode: Immediate or control line

Format: iWNON,  $P_1$

Explanation: (same as W directive, paragraph 2.6.17).

#### 2.6.19 Directive: Write Sequentially (WSEQ)

Function: To test the disc file's ability to perform gather write operations between adjacent sectors without the attendant loss of access time (1 disc revolution).

Due to the special nature of this test, certain restrictions are placed on its use:

- a. At least 8K words of memory are required.
- b. The test cannot operate in write-protected areas.
- c. If the disc file has the optional priority interrupt, and if the interrupt link address is not in the first special system interrupt group, then the priority interrupt module should be removed.
- d. Care should be exercised in choosing the initial starting address so that unit address boundaries will not be crossed.

Parameters,  
Trailing: None allowed

Parameters,  
Leading: Place mark (m) allowed

Mode: Immediate or control line

Format: mWSEQ

Explanation: When the test is run, the following sequence of operations will occur:

The current device address at the time the directive is executed is declared at the starting device address; starting at this address 4096 words of information (one band or 64 sectors) will be transferred to the disc. This information (consisting of the unit-band-sector address of the sector being written) is transferred, one sector at a time (that is, each sector gets its own address written). Extended mode I/O operation is used, with end-of-record interrupts occurring at the completion of each sector transfer. At this time, channel and coupler error indicators are checked and the next sector transfer operation is initiated.

After the write operation is completed (whether normal or aborted), the entire 4096 words are read back into the I/O buffer area for subsequent verification. (No provision is made for automatic verification; it is recommended that this directive be followed by a TYP directive to allow visual verification.)

The place mark branch will be taken if any errors are detected in the write operation.

Upon exit, the record length will be set to 4096 words.

Error  
Messages:

The following typeouts, all suppressible with BREAKPOINT 4, may occur:

a. INTERRUPT TIMING ERROR –

RECORD STARTING ADDRESS UBBSS

This occurs if the preceding sector failed to transfer in less than 20 milliseconds (that is, 1 disc revolution was lost). UBBSS is the unit-band-sector address of the sector following the one that failed, numerically one greater. (See timing chart, figure 2-1.)

b. CHANNEL ERROR

RECORD STARTING ADDRESS UBBSS

This timeout occurs if a channel error is detected during any transfer operation. UBBSS is the same as in step a.

c. COUPLER ERROR

RECORD STARTING ADDRESS UBBSS

This timeout occurs if a coupler error is detected during any transfer operation. UBBSS is the same as in step a.

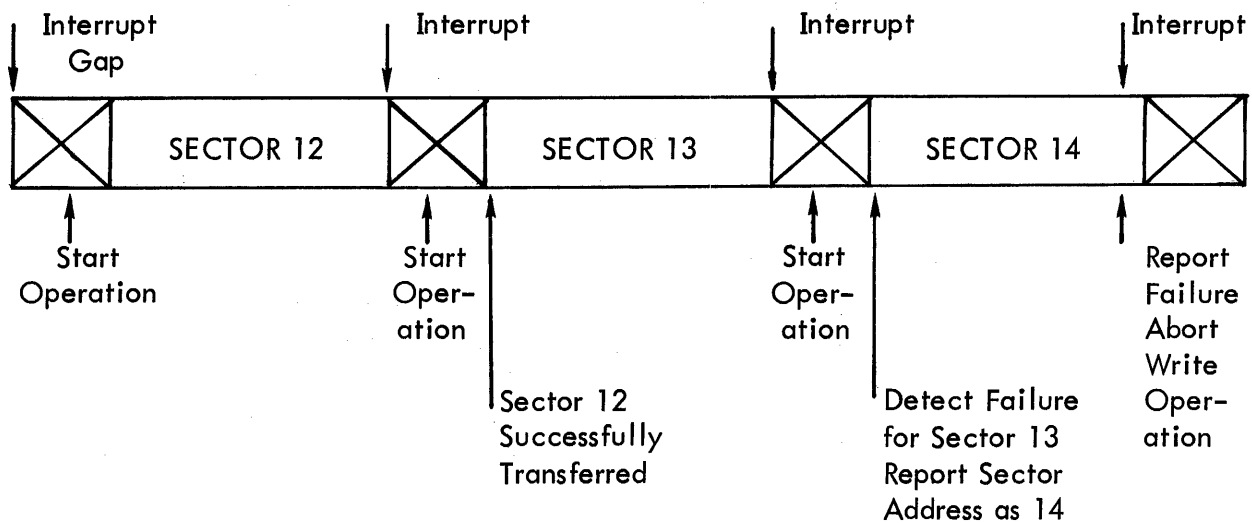


Figure 2-1. Timing Chart

If any of the errors are detected, the ongoing operation is completed (that is, the sector after the one that failed is transferred), the error is reported, and all further write operations are aborted.

#### 2.6.20 Directive: Read Record (R)

**Function:** To cause one record to be read from the RAD, starting at the current device address.

**Parameters, Trailing:**  $P_1$  (octal)

**Parameters, Leading:** Iteration counts (i) allowed

**Mode:** Immediate or control line

**Format:**  $iR, P_1$

Explanation: If  $P_1$  is zero or not present, write-protected bands are read. If parameter  $P_1$  is nonzero, write-protected bands are not read and an error message is typed to indicate a write-protected band is encountered.

**Error Messages:** Errors are detected in the channel and the coupler and are reported at the typewriter (if BREAKPOINT 4 is reset) before the try count is checked to determine whether or not to repeat the attempt to read correctly. Iteration counts are not performed if the retry count is exhausted before the read is successfully completed.

If an error is detected, the following messages may be typed:

READ ERRORS CHANNEL ERROR

READ ERRORS COUPLER ERROR

READ ERRORS RECORD LENGTH ER NNNN XXXX

READ ERRORS COUPLER SECTOR YYYY ZZZZ

In the above, NNNN is the expected word transfer count (read record length), XXXX is the actual transfer count, YYYY is the expected sector address at the completion of the data transfer, and ZZZZ is the received sector address. The error report is followed by a typeout of the current device address.

2.6.21 Directive: Read Record, Inhibit Band Incrementing (RNON)

Function: To serve as an alternate read operation, identical to the R directive, except that nonband-incrementing EOM's are used.

Parameters,  
Trailing:  $P_1$  (octal)

Parameters,  
Leading: Iteration count (i) allowed

Mode: Immediate or control line

Format: iRNON,  $P_1$

Explanation: (same as the R directive, paragraph 2.6.20).

2.6.22 Directive: Octal Card Read (OCT)

Function: To read cards from card reader 1 on the channel indicated by the CHN directive.

Parameters,  
Trailing: None allowed

Parameters,  
Leading: None allowed

Mode: Immediate only

Format: \$OCT

Explanation: The card format is as follows:

|                |     |          |     |          |       |          |   |
|----------------|-----|----------|-----|----------|-------|----------|---|
| 0              | 0 0 | 1 1      | 1 1 | 2 2      | 3     | 7        | 8 |
| 1              | 8 9 | 4 5      | 6 7 | 4 5      | 2 . . | 3        | 0 |
| unused address |     | 1st word |     | 2nd word |       | 8th word |   |

Up to eight locations may be altered by each card. These locations may be contiguous with the address named in columns 9 through 14. If a blank field or column 80 is passed, the program alters the named locations, then reads the next card. Leading zeros in each field must be punched. Cards will be read until the hopper is empty.

Another function of this directive is for patching purposes utilizing the JMP function (see paragraph 2.6.27).

Error Messages: An alphabetic or nonoctal digit in the address or data word fields or a channel error will result in an error typeout.

When the card reader is not ready, a message is typed. In order to resume the control line sequence of operations or to make the card reader ready to read more cards, BREAKPOINT 3 must be set and reset.

#### 2.6.23 Directive: Compare Data (C)

Function: To perform a word-for-word comparison of the I/O buffer area with the current test pattern as defined by the last PAT directive executed.

Parameters, Trailing: None allowed

Parameters, Leading: Place mark (m) allowed

Mode: Immediate or control line

Format: mC

Explanation: This comparison takes place on N words, where N is defined as the record read length expressed in words. In the event that the record read length is greater than the record write length (namely, the record write length is not modulo sector

length), then a word of zeros is used as the pattern compare word to verify that zeros were written past the record write length to the next sector boundary.

When the directive C is used in the control line, it may be preceded by a place mark parameter. If the place mark is present, the branch occurs when compare errors are detected; otherwise, control line execution continues in sequence.

Example: . . . + 5C . . . 5. STOP, 0

If any compare errors are detected, the place mark branch is taken and the next directive executed is the STOP directive (see paragraph 2.6.29) appearing at place mark 5. If all comparisons test all right, the next directive after 5C + is executed.

Error Messages: If a compare error is detected, the following message is typed (except for special case noted in paragraph 2.6.24):

```
COMPARE ERRORS @ AAAAA
N EEEEEEEE RRRRRRRR
```

In the above, AAAAA represents the unit-band-sector address at which the last data transfer took place, N is the relative location of the word in the I/O buffer, EEEEEEEE is the expected word pattern, and RRRRRRRR is the word received.

If any compare errors are detected after all comparisons are made, a bit summary typeout occurs in the following format:

```
SUMMARY AAAAA
BIT POS.      DROPPED      GAINED
    0          X          X
    .          .          .
    .          .          .
    .          .          .
   23          X          X
```

In the above, AAAAA represents the unit-band-sector address at which the last data transfer took place and X is the number of bits dropped or gained in a particular bit position.

Setting BREAKPOINT 4 suppresses the compare error typeout; setting BREAKPOINT 3 suppresses the bit summary typeout.

### 2.6.24 Directive: Declare Compare Typeout Mode (XC)

Function: To determine in which mode the compare typeout is to take place.

Parameters, Trailing:  $P_1$  (octal), where  $0 \leq P_1 \leq 1$

Parameters, Leading: None allowed

Mode: Immediate or control line

Format: XC,  $P_1$

Explanation:  $P_1$  specifies the compare error report made. If  $P_1 = 0$ , the normal mode is reported; if  $P_1 = 1$ , the inhibit mode prevails. The first compare error is reported in the normal manner but all subsequent compare error typeouts are suppressed. The breakpoint options as indicated in paragraphs 1.4.1 and 2.6.23 remain in effect.

### 2.6.25 Directive: Query Tests (Q)

Function: To request that certain tests be performed.

Parameters, Trailing:  $P_1$  (octal), where  $0 \leq P_1 \leq 77$

Parameters, Leading: Place mark (m) allowed

Mode: Immediate or control line

Format: mQ,  $P_1$

Explanation:  $P_1$  indicates which SKS (Skip If Signal Not Set) test or tests are to be performed. If any of the test results are true, the branch to place marker is taken. If a not-true condition prevails on all tests requested, the branch does not occur; the next directive in the control line sequence is executed instead.

Tests may be requested using the following values for  $P_1$ :

|                   | Parameter $P_1$ | SKS Test            | Typeout                      |
|-------------------|-----------------|---------------------|------------------------------|
| NOT SET FOR ERROR | 1               | Coupler Error       | CPLR. ERROR <sup>1</sup>     |
|                   | 2               | Write Protected     | WRITE PROTECTED <sup>1</sup> |
| SET FOR READY     | 4               | RAD Ready           | RAD READY <sup>2</sup>       |
| FOR NOT ACTIVE    | 10              | Channel Active      | CHANNEL ACTIVE <sup>2</sup>  |
| SET FOR COUNT     | 20              | Word Count = 0      | WD.COUNT=ZERO <sup>2</sup>   |
|                   | 40              | Channel Interrecord | CH INTERRECORD <sup>2</sup>  |

A zero or blank is used for  $P_1$  if a channel error test is desired. If an error exists, CHN.ERR AAAAA is typed and the place mark branch is taken. AAAAA is the unit-band-sector address at which the last data transfer took place.

A combination of tests may be requested by merging respective parameter values. For example,  $P_1 = 11$  would test for both channel error and channel active.

#### 2.6.26 Directive: Time Delay (DLY)

Function: To cause a time delay for the number of milliseconds specified by the trailing parameter.

Parameters, Trailing:  $P_1$  (decimal), where  $0 \leq P_1 \leq 9999$

Parameters, Leading: Iteration count (i) allowed

Mode: Immediate or control line

Format: iDLY,  $P_1$

Explanation:  $P_1$  specifies the number of milliseconds delay this directive provides. The maximum time delay allowed is 9.9999 seconds (namely, when  $P_1 = 9999$ ). If  $P_1$  is zero, a standard value of 35 ms (one disc revolution) is used. With a preceding iteration count, the delay is i ( $P_1$ ) milliseconds.

<sup>1</sup>Typeout suppressed in not-true condition

<sup>2</sup>Typeout preceded by a "not" in a not-true condition

---

**2.6.27 Directive:    Jump to Location (JMP)**

**Function:**            To interface the control program with user-supplied subroutines.

**Parameters,  
Trailing:**             $P_1$  (octal), memory address  
                          $P_2$  through  $P_{10}$  (octal)

**Parameters,  
Leading:**            Iteration counts (i) allowed

**Mode:**                Immediate or control line

**Format:**             iJMP,  $P_1$ ,  $P_2$  through  $P_{10}$

Explanation: Parameter  $P_1$  is the octal address of the user-supplied routine. This directive will execute a BRM instruction to this location. Parameters  $P_2$  through  $P_{10}$  may be used by the subroutine as entrance parameters.

Two returns are provided. The normal return is a BRR instruction directed to the location specified in  $P_1$ . This return allows any iteration count specified to be executed.

If, however, the contents of the location specified by  $P_1$  are increased by 1 (MIN) before the BRR instruction is executed, iteration is not allowed.

---

**2.6.28 Directive:    Mark Identify (MARK)**

**Function:**            To cause the word MARK XXXX to be typed at the console typewriter.

**Parameters,  
Trailing:**             $P_1$  (four alphanumeric characters)

**Parameters,  
Leading:**            Not allowed

**Mode:**                Immediate or control line

**Format:**             MARK,  $P_1$

Explanation:  $P_1$  specifies the four alphanumeric characters, XXXX, typed out on the typewriter. The typeout MARK XXXX is not suppressible.

2.6.29 Directive:     Stop Identify (STOP)

Function:            To cause a typeout STOP XXXX, and to cause the computer to halt. When the user clears the halt, the operation resumes at the next directive in the control line sequence.

Parameters,         $P_1$  (any four legal alphanumeric characters)  
Trailing:

Parameters,        None allowed  
Leading:

Format:            STOP,  $P_1$

Explanation:  $P_1$  specifies the four alphanumeric characters in the typeout STOP XXXX; XXXX are these characters. This typeout is not suppressible by any BREAKPOINT switch.

SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION

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Catalog No. 094017B

IDENTIFICATION: 900 Series Interrupt Arm-Disarm Feature Test Program

AUTHOR: A. Kliszewski

ACCEPTED: December 14, 1964

COMPUTER CONFIGURATION: Any 900 series computer with typewriter, 1 to 896 channels of system interrupts and the arm-disarm feature. Also required to perform the test is special module card #109745. When this card's input is connected to computer signal Rti, any PIN command should set all armed interrupts.

PURPOSE: To check out, thoroughly, the operation of the arm-disarm feature.

PROGRAMMED OPERATORS: None

STORAGE: Octal locations 001, 023-027, 031, 033, 100, 200-3163.

TIMING: About one minute per set of 32 channels when all are present and operating correctly.

USE: 1.0 Loading

Normal FILL procedure. The program is available on an absolute binary paper tape.

2.0 Control

The program may be restarted by moving the RUN-IDLE-STEP switch to IDLE, pressing START, then STEPPing once and RUNNING. Also, Breakpoint Switch #1 will, when set, return control to the input stage (restart all tests), from any test. During tests #3 and 4, Breakpoint Switch #2 will, if set, cause control to be transferred to the next test. Starting with Breakpoint Switch #4 set will transfer control to the diagnostic loop.

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USE: (Cont)

3.0 Input

- 3.1 As soon as the line "READY TO START TESTS..." is typed out, the computer is ready for input which consists of the interrupt group number N which is set into the A register, and M, the number of channels in the group to be tested, if  $M < 32$ , set into the B register, both in binary form. The groups consist of 32 interrupt channels each and are numbered sequentially 0-27 (0-33 octal).
- 3.2 Before proceeding with the tests, the special test cable must be connected to the Nth group of interrupts.
- 3.3 If the system tested comprises interrupt channels wired for single instruction execution, a simple modification to the program may be made from the console at this point. This consists of changing the BRM instruction in location numbered  $(177 + m)$  octal where m is the single instruction channel number ( $1 < m < 896$ ) to a MIN  $(1777 + m)$  instruction. If  $m = 1$ , test #7 in the program will not work without some modification.
- 3.4 To start the tests, clear the HALT.

4.0 Output

- 4.1 N and M are typed out immediately after the HALT has been cleared.
- 4.2 If no failures are detected during the tests, the only subsequent type out is a series of TEST i COMPLETE,  $i = 1, 2, \dots, 7$ .
- 4.3 Whenever a test has failed, timeout will identify the interrupt channel number (1 through 32) with the offending "COUNT" and the "PASS" number. The COUNT corresponds to the number of times the corresponding channel has been interrupted. The PASS number has meaning only in tests three and four which consist of M passes each.

METHOD:

The program generates that coding which constitutes the linkage and service for the interrupt channels:

|                |           |           |                             |
|----------------|-----------|-----------|-----------------------------|
| METHOD: (Cont) | Locations | 200-1777  | linkage                     |
|                |           | 2000-2037 | 32 counters                 |
|                |           | 2040-2177 | 32 counter incrementing     |
|                |           |           | interrupt service routines. |

This is done immediately after loading.

The tests are as follows:

- Test 1:    A. Disarm all 32 interrupts  
            B. Generate interrupts on all 32 channels  
            C. Check that all counters contain zero
- Test 2:    A. Arm all 32 interrupts  
            B. Generate interrupts  
            C. Check that all counters contain ones
- Test 3:    A. Selectively disarm ith channel  
            B. Generate interrupts  
            C. Check that counters 1 through i contain  
                zeros, counters i + 1 through 32 contain  
                ones  
            D. Clear counters  
            E. Do above for i = 1, 2, ..., 32 (i = pass  
                number)
- Test 4:    A. Selectively arm ith channel  
            B. Generate interrupts  
            C. Check that counters 1 through i contain ones  
                and counters i + 1 through 32 contain zeros  
            D. Clear counters  
            E. Do above for i = 1, 2, ..., 32
- Test 5:    A. Arm odd channels, disarm even ones  
                (simultaneously)  
            B. Generate interrupts  
            C. Check that odd counters contain ones, even  
                counters contain zeros
- Test 6:    A. Same as Test 5, but odd and even channels  
                have reverse roles

METHOD: (Cont)      Test 7:      Modify the first interrupt service routine to disarm channels 2 -32

- A. Arm all channels
- B. Generate interrupts
- C. Check that all counters contain ones (they should, since the disarm instruction was given after the interrupts attained waiting status)

The Diagnostic Loop: This is a loop consisting of AIR, POT (word selected by user), and PIN (to initiate interrupts).

The selected word is keyed into the A register when the program types = DIAGNOSTIC LOOP and halts.

Note: Counters are cleared at the beginning of all tests.

## SDS PROGRAM LIBRARY PROGRAM DESCRIPTION

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Catalog No. 000017C\*

IDENTIFICATION: Media Conversion Routine

AUTHOR: William Birney, SDS

ACCEPTED: April 29, 1965

COMPUTER CONFIGURATION: Any 4K SDS 910, 920, 925, or 930 with one or more peripheral devices attached to any buffer or channel and a console type-writer on the W buffer.

PURPOSE: To copy variable length records on binary or BCD cards, paper or magnetic tape, or typed input, to cards, paper or magnetic tape, typewriter or line printer.

PROGRAMMED OPERATORS: N/A

SUBROUTINES REQUIRED: Depending on the peripherals and channels involved in the conversion; one or more of the standard I/O handlers is required:

|       |          | <u>Buffered</u> | <u>Extended</u> | <u>Peripheral</u>     |
|-------|----------|-----------------|-----------------|-----------------------|
| PTYIO | Cat. No. | 020019          | 503001          | Typewriter/Paper Tape |
| CDRP  | "        | 030005          | 533002          | Card Read/Punch       |
| MTAPE | "        | 040004          | 540001          | Magnetic Tape         |
| PRINT | "        | 060005          | 563001          | Line Printer          |

STORAGE: Relocatable; requires 1140 (02164<sub>8</sub>) locations (not including I/O handlers), plus temporary record storage.

TIMING: N/A

SOURCE  
LANGUAGE: META-SYMBOL

\*This version of the routine can be used to perform conversions involving peripherals attached to a channel which is restricted to interlaced I/O, in addition to channels permitting buffered I/O (W and Y). Also, three more breakpoint control options (see 2.3.11), and an error halt when writing is attempted on a file-protected tape, have been added. Binary records can now be listed on a typewriter or line printer.

LOADING  
PROCEDURE:

The I/O handlers needed must be loaded with the routine itself. The version (buffered or extended mode) of each handler used depends on which computer is being used and which channel the peripheral device involved is attached to. When using a 910 or 920 computer, the buffered handlers must be used, regardless of whether either buffer is interlaced. When using a 925 or 930 computer, the extended mode handlers must be used for peripherals on channels C through H, and may be used for peripherals attached to interlaced channels A and B.

For example, if the media conversion involves a line printer on Channel D, the extended mode version of PRINT must be loaded. If the conversion involves a paper tape reader on the W buffer (925 or 930 only), the buffered version of PTYIO must be loaded unless that buffer has interlace capability, in which case either version of PTYIO will suffice. If the conversion does not involve, for example, cards, then neither version of CDRP need be loaded. Note that only one version of a handler may be loaded, so that it is not possible to perform both interlaced and non-interlaced I/O with peripherals using the same handler. For example, a conversion may not involve a typewriter on channel E and a paper tape unit on the Y buffer or a non-interlaced channel B.

If Media Conversion is loaded by the Monarch loader, the (buffered) handlers will normally be loaded automatically from the Monarch Library. Therefore the versions of the handlers required for the conversion(s) to be performed should be in the Monarch Library.

If Media Conversion is loaded by the Universal Binary Loader (UBL) instead of the Monarch Loader, the versions of the handlers required for the conversion(s) may be loaded prior to loading Media Conversion or immediately afterward. In the latter case, the UBL will expect to find the handlers in the Library provided (for details, see the UBL Program Description).

## USE: 1.0 MEDIA SPECIFICATION LIST

The program accepts an input list to the typewriter (unit 1, W buffer) and performs the specified conversion(s).

USE: (Cont.)

The list is of the form

$$D_1 U_1 C_1 - D_2 U_2 C_2, D_3 U_3 C_3, \dots, D_n U_n C_n.$$

 $D_1$  is input device

MTØ - MT1.

 $U_1$  is input unit number

/ CANCELS

 $C_1$  is input channel

SET BP1 FOR BINARY

 $D_i$  is output device

IDLE, RUN AFTER EDF

 $U_i$  is output unit number

2 ≤ i ≤ n SET BP2 TO STOP ON READ ERROR

 $C_i$  is output channel $D_i$  is a two-letter word:InputOutput

CR - card reader

card punch - CP

PR - paper tape reader

paper tape punch - PP

TY - typewriter

typewriter - TY

MT - magnetic tape

magnetic tape - MT

line printer - LP

When  $D_i$  (device) specifies CR, CP, PR, PP or LP, then  $U_i$  (unit) must be 1 or 2. When  $D_i$  specifies TY,  $U_i$  must be 1, 2 or 3. In either case, if  $U_i$  is omitted, it is assumed to be 1.  $U_i$  is either 0, 1, ..., 6 or 7 if MT is used, and may not be omitted.

$C_i$ , if present, is one of W or A, Y or B, C, D, E, F, G, H.  $C_i$  is assumed to be W if omitted.

Example of a legal list: MT1Y - CP2W, LP.

The program converts data from the form designated in  $D_1 U_1 C_1$  to the forms specified successively in  $D_2 U_2 C_2, \dots$ , and  $D_n U_n C_n$ . Each output triplet  $D_i U_i C_i$  ( $i > 2$ ) must be separated from the preceding one by a comma. The last must be followed by a period or a carriage return. Blanks in the list are ignored. Except for a slash (/), any character in the list which cannot logically follow the preceding ones causes an error message to be output to the console typewriter and cancellation of the entire list. A slash cancels the input list. In both cases the typewriter requests a new list.

USE: (Cont.)            Examples:    (a)    PR3W-MT2, LPY  
                                              (b)    PRW-MT2, LPY

Example (a) will not cause any conversion to take place since only units 1 and 2 of the paper-tape reader can exist. A list-error message will be printed by the typewriter.

Example (b) will cause a variable length record or records on paper tape unit 1 to be transmitted by means of the W Buffer to the computer and then to be recorded on magnetic tape unit 2 (W Buffer) and printed on line printer unit 1 (Y Buffer).

## 2.0    TRANSMISSION

### 2.1    Transmission Mode

All input/output data is assumed to be BCD (decimal) unless breakpoint switch 1 is set, in which case media conversion will take place in binary mode. The switch is tested before each paper tape, magnetic tape or card input or output operation, and therefore should not normally be moved until the entire list is executed or a halt for EOF (see below) occurs.

All media conversion is done in four characters/word mode. When the number of characters input is not a multiple of four, the following will take place:

- (a) Paper tape (BCD) or typewriter: the last word transmitted is padded with "60" codes. (On BCD paper tape or typewriter output, each "60" is converted to "12".)
- (b) Paper tape (binary): "0" codes are used for padding.
- (c) Magnetic tape: "0" codes are used for padding.

In BCD mode, "12" (blank) codes input from paper tape or typewriter are converted to "60" (b) codes, and "77" (##) codes are ignored. Each "60" is converted to a "12" on output from BCD paper tape or typewriter.

### 2.2    Transmission Errors

- 2.2.1 An error message is typed if any of the following errors occurs:

USE: (Cont.)

- (a) Magnetic tape - character or longitudinal parity error which remains after 11 reread attempts, or after 6 write attempts (2 attempts each on 3 sections of tape).
- (b) Typewriter, paper tape - parity error flip-flop set in buffer.
- (c) Line printer error, or card reader or card punch error.

The message is "Halt due to error in transmission".

After the message is printed, a halt occurs. If the error occurs during output of a record, clearing the halt resumes conversion. If the error occurs during input, clearing the halt has one of two effects depending on the setting of breakpoint 2. If breakpoint 2 is reset, the input information is ignored (no output takes place), and a new record is input. If breakpoint 2 is set, conversion resumes and the contents of the record in the input buffer are used for output. Thus if a card reader error halt occurs, breakpoint 2 should be reset and the card causing the difficulty should be discarded or replaced in the hopper, before the halt is cleared.

2.2.2 "Buffer error during typewriter input of list" is printed if such an error occurs during list input. In this case, a new list is requested.

2.2.3 It is recommended that records read from paper tape or written on magnetic tape (except end-of-file) contain in excess of two words, to prevent malfunction.

### 2.3 Details of Transmission

Input:

2.3.1 Input from cards or magnetic tape: records are transmitted until EOF or end-of-tape is reached. When EOF or end-of-tape is reached, an appropriate message is typed and one of two actions is taken by the operator when the machine halts:

- (a) The RUN switch is moved to IDLE, START button depressed, RUN switch moved to STEP, back to IDLE and to RUN, causing the program to request a new input list.
- (b) The RUN switch is moved to IDLE and back to RUN, causing the program to continue transmitting records until the next EOF is reached.

USE: (Cont.) 2.3.2 Input from typewriter: records (separated by CR, i.e., carriage return) are transmitted until breakpoint 4 is set. Code delete ("77" or ##) characters are ignored.

2.3.4 Input from paper tape:

- (a) BCD: As for magnetic tape; CR serves as EOR (end-of-record) and stop code plus gap as EOF. Records in a file should not be separated by gap. Code delete characters are ignored. Successive records are transmitted until EOF occurs or breakpoint 4 is set.
- (b) Binary: As for magnetic tape; gap serves as EOR. Successive records are transmitted until breakpoint 4 is set, or until an end-of-library record is punched on paper tape or cards. (An end-of-library record consists of the octal word 017170000.)

Output:

- 2.3.5 Magnetic tape: If input source is paper tape (BCD) or typewriter, the CR at the end of each record is suppressed, and "12" codes are converted to "60" codes. When any output magnetic tape is at end-of-tape following completed transmission of a record, an end-of-tape message is typed and a halt occurs. Action is then taken as in 2.3.1.
- 2.3.6 Cards: If input source is paper tape (BCD) or typewriter, the CR at the end of each record is suppressed, and "12" codes are converted to "60" codes. If a BCD (binary) input record exceeds 20 (40) words in length, it is divided into 20 (40) word segments for output on successive cards.
- 2.3.7 Typewriter: A CR is inserted at the end of each record input from magnetic tape or cards. If breakpoint 1 is set, binary input is assumed, and the record is unpacked. The output is in effect an octal listing of the binary record. If breakpoint 1 is reset, BCD input is assumed, and trailing blank words (four "60" characters) are suppressed, and "60" codes are converted to "12" codes. If a record (BCD or unpacked binary) exceeds 21 words in length, it is divided into 21 word segments for output on successive lines.

- USE: (Cont.) 2.3.8 Line printer: If input source is paper tape (BCD) or typewriter the CR at the end of each record is suppressed, and "12" codes are converted to "60" codes. If input was binary (breakpoint 1 set), the record is unpacked, and the output is in effect an octal listing of its contents. If an EOF occurs, the printer will upspace and print a blank line, which is to be disregarded. This enables the program to determine any error in printing the last line in the file.
- 2.3.9 Paper (BCD): A CR is inserted at the end of each record input from magnetic tape or cards. Trailing blank words (four "60" characters) are suppressed. Conversion of "60" codes to "12" codes takes place. A stop character is inserted after the last record in a file, and the first record in a file is preceded by gap.
- 2.3.10 Paper tape (binary): If breakpoint 3 is set, it is assumed that the input is in META-SYMBOL format. If input is from cards or magnetic tape, only the first logical record on each card or card image is output. The rest is deleted. (The length of a META-SYMBOL logical record is specified in bits 4-8 of the first word of the record.)
- 2.3.11 Caution: If a binary record input is listed on the typewriter or line printer, it is unpacked and therefore cannot subsequently be duplicated, for example, on magnetic tape.
- e.g., 1. CR - LP, CP with breakpoint 1 set. The contents of each card read will be unpacked and listed on the printer, and this unpacked record will be punched on binary cards. Thus the binary cards will contain garbage.
- e.g., 2. CR - CP, LP. with breakpoint 1 set. Each binary card will be duplicated, and then its contents will be unpacked and listed. Thus the conversion will be successful.
- 2.3.12 The accompanying tables show in detail the functions of the breakpoints and the mechanics of each possible conversion.

| USE: (Cont.) | <u>Breakpoint</u> | <u>Function when Reset</u>                      | <u>Function when Set</u>                                                                                           |
|--------------|-------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
|              | 1                 | BCD input/output                                | Binary input/output                                                                                                |
|              | 2                 | Delete output of record when input error occurs | Do not delete output of record when input error occurs                                                             |
|              | 3                 | Normal mode                                     | Delete data trailing each logical record on card or magnetic tape in META-SYMBOL format, when punching paper tape. |
|              | 4                 | Normal mode                                     | Halt before input of each record (paper tape or typewriter only).                                                  |

| Mode   | Device |        | End of Record |            | End of File |            | Line Length (Wds) | 1 | 2 | 3 | 4 |
|--------|--------|--------|---------------|------------|-------------|------------|-------------------|---|---|---|---|
|        | Input  | Output | In            | Out        | In          | Out        |                   |   |   |   |   |
| BCD    | MT     | TY     | gap           | carr. ret. | EOF record  |            | 21                | X |   |   | X |
| BIN    | MT     | TY     | gap           | CR         | EOF record  |            | 21                |   |   |   |   |
| BIN    | MT     | PP     | gap           | gap        | EOF record  |            |                   |   |   |   |   |
| BCD    | MT     | PP     | gap           | CR         | EOF record  | ## & gap   |                   | X |   |   | X |
| BCD    | MT     | LP     | gap           | upspace    | EOF record  | blank line | 33                |   |   |   |   |
| BIN    | MT     | LP     | gap           | upspace    | EOF record  | blank line | 33                |   |   |   |   |
| BIN    | MT     | CP     | gap           | next card  | EOF record  |            | 40                |   |   |   |   |
| BCD    | MT     | CP     | gap           | next card  | EOF record  |            | 20                |   |   |   |   |
| either | MT     | MT     | gap           | gap        | EOF record  | EOF rec.   |                   |   |   |   |   |
| (BCD)  | TY     | MT     | CR            | gap        |             |            |                   |   | X | X |   |
| (BCD)  | TY     | PP     | CR            | CR         |             |            |                   | X | X |   | X |
| (BCD)  | TY     | LP     | CR            | upspace    |             |            | 33                |   | X | X |   |
| (BCD)  | TY     | CP     | CR            | next card  |             |            | 20                |   | X | X |   |
| (BCD)  | TY     | TY     | CR            | CR         |             |            | (21)              | X | X |   | X |
| BIN    | PR     | MT     | gap           | gap        |             |            |                   |   |   |   |   |
| BCD    | PR     | MT     | CR            | gap        | ## & gap    | EOF rec.   |                   |   | X | X |   |
| BIN    | PR     | CP     | gap           | next card  |             |            | 40                |   |   |   |   |
| BCD    | PR     | CP     | CR            | next card  | ## & gap    |            | 20                |   | X | X |   |
| BIN    | PR     | PP     | gap           | gap        |             |            |                   |   |   |   |   |
| BCD    | PR     | PP     | CR            | CR         | ## & gap    | ## & gap   |                   | X | X |   | X |
| BCD    | PR     | LP     | CR            | upspace    | ## & gap    | blank line | 33                |   |   | X |   |
| BIN    | PR     | LP     | gap           | upspace    | ## & gap    |            | 33                |   |   |   |   |
| BCD    | PR     | TY     | CR            | CR         | ## & gap    |            | 21                | X | X |   | X |



## XDS PROGRAM LIBRARY PROGRAM DESCRIPTION

Catalog No: 851107-11A00

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REPT. HLL 8/1  
TYPE PIPS

p>IDENTIFICATION: Extended Mode I/O Test Program

AUTHOR: England/Vorgitch, XDS

ACCEPTED: September 30, 1965

COMPUTER  
CONFIGURATION: Any 925/930 computer with a typewriter attached to the W channel and a paper tape punch and reader on any interlaced communication channel. The W channel need not be interlaced for the typewriter.

PURPOSE: To test as many of the extended I/O operations as possible with paper tape. Given a communication channel that is known to be good then the program serves as a paper tape tester.

PROGRAMMED  
OPERATORS: None

SUBROUTINES  
REQUIRED: None

STORAGE: The program occupies 843<sub>10</sub> locations from 0177 to 01721 octal.

TIMING: N/A

SOURCE  
LANGUAGE: META-SYMBOL

LOADING  
PROCEDURE: The program is supplied on paper tape or cards with a self-loading bootstrap. Use the standard fill procedure.

USE: The program will load and address the typewriter for control. The program may be returned to the typewriter control at any time by using the START; STEP, RUN procedure.

USE: (Cont)

To select the reader and punch units to be used enter:

'CU' P to select punch and

'CU' R to select reader.

Where C is the channel number and may be any digits 0-7 and U is the unit, either 1 or 2. The reader and punch need not be on the same channel.

The test is started by entering the letter 'S.' Control of the test operation is then a function of the Breakpoint Switches. The following table summarizes the switch functions.

| <u>Switch</u> | <u>Reset</u>                                                                   | <u>Set</u>                                                                                 |
|---------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1             | Run in the normal mode as determined by the other switches.                    | Stop and return to keyboard control at the end of the current pass (either punch or read). |
| 2             | Continue to run the test selected by switch 3.                                 | Cycle test runs from punch to read to punch, etc.                                          |
| 3             | Selects punch mode.<br>(Used when switch 2 is reset or when starting the test) | Selects read mode.                                                                         |
| 4             | Stop and type diagnostic messages whenever an error occurs.                    | Do not stop and type on errors but continue to run.                                        |

When running cyclic tests from punch to read, etc., the tape from the punch should be inserted into the reader.

METHOD:

Punching

The program punches 4 blocks of 64 characters each in one pass. The characters form a counting sequence from 00 to 77<sub>8</sub>. The first block is started with leader and output with an IOSP. All punching is done in the one character per word mode. When the word count reaches zero an IOSD is loaded to punch a second block of 64 characters. No leader

## METHOD:(Cont)

is punched between the first and second blocks. This results in one physical block 128 characters long. Starting with leader two additional blocks of 64 characters are then punched with an IOSD.

At the conclusion of each output operation the channel address register is stored and compared with the expected value. If they do not agree the program types the expected and actual values.

The program tests the channel during the output operation to see if the channel should erroneously disconnect before the word count reaches zero.

Reading

Each of the four blocks is read with a different set of commands and counts so as to test as many operations as possible. After reading a block a general subroutine checks for input parity errors, channel end address agreement with expected, and the data read character by character. Error messages with block numbers will be typed in the event of any one of these tests failing.

The handling of each block is described below:

Block 1

The first block is one half of a 128 character physical block. Reading 1 character per word an IOSD with a count of 64 is used to read this block. The program checks to see if the count reaches zero and the channel becomes inactive at the same time.

Block 2

This is the second half of the first physical block and is read with an IOSD with a count of 65. The read should terminate because of the end of record. The program checks to see that the word count does not reach zero and the channel remains active after the CIT (interrecord test) instruction skips. The tape is finally stopped with a disconnect before the data is checked.

## METHOD: (Cont)

Block 3

Block 3 is a 64 character physical block. It is read with 2 channel commands. The first is an ISOP with a count of 32. If the count goes to zero before the channel disconnects then an IORP with a count of 33 is loaded. This should cause the interrecord indicator to be turned on at the end of the record. The count should not reach zero and the channel should remain active. The tape is again stopped with a disconnect before the data is checked.

Block 4

This is the third physical block of 64 characters and is read with an IORD with a count of 56. The program waits for the channel to be inactive then checks to see if the channel ignored the last eight characters. If the tape was erroneously stopped after the 56th character this will be visually discernible to the operator or will show up as a failure on the first block of the next read pass.

**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Page 1 of 22

Catalog No. 012013C\*

IDENTIFICATION: Utility and Debug Package (AID)

AUTHOR: J.A. Barnett, SDS

ACCEPTED: October 12, 1965

COMPUTER  
CONFIGURATION: Any 900 Series SDS computer with a console typewriter.

PURPOSE: Provide various utility routine and debugging aids for the programmer's use during on-line program checkout.

PROGRAMMED  
OPERATORS: None

SUBROUTINE  
REQUIRED: None

STORAGE: 5030g - Relocatable; 0-116 during loading.

TIMING: N/A

SOURCE  
LANGUAGE: META-SYMBOL

LOADING  
PROCEDURE: AID is available on either self-loading cards or paper tape.

1. Paper Tape:  
Paper tape copies of the package are loaded with Binary Input - Relocatable Paper Tape Loader, Catalog No. 000019. Use the standard FILL procedure. When the computer halts after reading a few inches of tape, place the address at which the package is to load in the A Register and clear the halt.
2. Cards:  
Card copies of the package are loaded with Binary Input - 2 Card Relocating Loader, Catalog No. 030007. To load the package into the 925/930, place the load address in the A Register and use the LOAD-FROM-CARDS switch. On the 910/920 place 03200002 in location 1, the load address

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\*Updated to provide DUMP output using the unbuffered Model 9372 Line Printer.

LOADING  
PROCEDURE  
(Cont.):

in the A Register, press START, 0203606 in the C Register and the RUN-IDLE-STEP switch in RUN.

When loading is complete the typewriter will be addressed for input of the first line. The loading process destroys the contents of locations 0 through 0116. The package itself occupies 50308 contiguous words starting at the location specified in the A Register.

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## PART I

## GENERAL INFORMATION

INTRODUCTION

AID is a package that embodies a group of commonly used utility programs and debugging aids. The package is intended as a helper for the programmer or engineer who is attempting to do on-line checkout of his program. Request for various functions are made by the user in the form of input lines. As an example, dumping of locations 100 through 200 would occur after the input of the following line: DUMP 100 TO 200. In general, an input line will consist of an action word (DUMP, LOAD, etc.) followed by a list of parameters. (See APPENDIX II for a Backus Normal Form description of the syntax of legal lines.)

Lines may be input from the typewriter, card reader or photo reader (see Assignment of the Control Media, page 9 ). An input line is terminated by one of the following conditions:

1. Encountering a carriage return (052 code '!'). If input is from cards, the remainder of the card is skipped; if input is from the photo reader, the reader is immediately disconnected. This allows the next character to be read without loss of data.
2. Reading 80 characters. Input is immediately disconnected and a carriage return is used as the 81st character (no data is lost on paper tape).
3. Encountering gap on paper tape.
4. End-of-file conditions on card reader causes control to return immediately to the typewriter.
5. If a channel error is encountered, the line being input is disregarded and control returns to the typewriter.
6. If a delete character (077 code '+++') is input, the line being input is ignored. On cards the remainder of the card is skipped, on paper tape the reader is disconnected. Except with card input, the next line is assumed to start with the next character input. With cards, input starts with the next card. Use of the delete character is not considered an error, but a convenience for the user to inhibit error messages.

7. Null lines (i.e., those consisting of blanks and carriage returns) are permissible. No action will be taken; they may be used as desired to space input. In a like manner, blank cards are ignored.

After a line has been input, it is checked for correctness. If an error is found, a message is typed out. No processing occurs until the entire line has been checked. Therefore, when an error message is typed, it is only necessary to re-enter the offending line in a corrected form. (See On-line Translator description for exception to this rule.)

### I/O DEVICES

Provisions are made for use of the following devices:

| <u>Mnemonic</u> | <u>Name</u>      | <u>Comment</u>                |
|-----------------|------------------|-------------------------------|
| TY              | typewriter       |                               |
| PR              | photo reader     |                               |
| PP              | paper tape punch |                               |
| CR              | card reader      |                               |
| CP              | card punch       | either buffered or unbuffered |
| LP              | line printer     |                               |

The devices are all assumed to be unit 1 on the W buffer and are addressed in a non-interlaced fashion. (The channel and unit assignments are assembly parameters and thus may be easily altered to fit the requirements of a particular installation.)

### FORMATS

All numerics entered are considered to be octal unless terminated by a decimal point (period).

Example:

$$100 = 100_8 = 64_{10}$$

$$100. = 144_8 = 100_{10}$$

Any numeric may be preceded by a + or - sign. If a numeric is used to specify a location it is computed, and its value mod  $2^{14}$  is used.

In the subsequent description, the following conventions will be used:

num      a 24 bit numeric quantity  
loc      a 14 bit address quantity

In several instances it is necessary to specify bounded regions of memory, i.e., DUMP 100 TO 200. The generic loc TO loc will be used to represent this type of entry. In all cases, the second location must be strictly greater than the first location; if not, an error message will be issued. A blank must separate the symbol 'TO' and both numerics enclosing it.

Certain sections of the package will accept Hollerith strings as input. A Hollerith string is a set of characters enclosed by single quote marks ('). The Hollerith information is packed 4 characters per word and left justifies in successively higher locations of memory. Blanks embedded in the Hollerith string are made into 060<sub>8</sub> codes.

Examples:

'A' = 21606060<sub>8</sub>  
'bbbA' = 60606021<sub>8</sub>  
'ABCDE' = 21222324<sub>8</sub> 25606060<sub>8</sub>

Caution: Neither a carriage return (052), delete character (077) nor a quote mark (014) are legitimate in a Hollerith field.

In all cases (other than the on-line translation or in Hollerith strings) blanks, commas, tabs and equal signs are treated identically. Further if one character of the four (say a blank) is sufficient to delimit a field, then several will work equally well. In other words multiple blanks, etc., are not significant when used to delimit a field.

Examples:

A,B ≡ A, ␣, = B  
A=B ≡ A, B ≡ A ␣ B

however

12. ≡ 12,.      A = B ≡ AB

i.e., delimiters may not be embedded in a field.

### COMMUNICATIONS LINKAGE

After loading is complete, a BRM to the package is put in cell 2. The user's program may communicate with the package via a BRM \*2. This will generate the necessary return linkage between the package and the user's program. The package may also be reached by placing a BRU 2 in the C Register. Further, the package may be entered by executing a BRU to the location used as the load address. If this latter method of entry is used, disregard the next paragraph.

Upon entry to the package the contents of all registers, the status of overflow indication and the conditions of the interrupt system (enabled, disabled) are saved. The W buffer status is then checked. If it is active, 1 second of time is counted off. After this, the buffer is unconditionally disconnected and the interrupt system disabled. If the buffer originally tested ready, then the interrupt system is immediately disabled. The stored values of the registers may be displayed or altered (see TYPE and STORE directive descriptions). To return control to the user's program, follow the procedure described as the GO directive. The package does not make use of any POP's.

### PACKAGE TABLE AREAS

When either the INSERT or SNAPSHOT directive is used, an entry is made in the ALTER-POINTS table. This is a table which is internal to the package and allows for twenty (20) such entries to be made. When an insert or snapshot is removed, the table entry assigned to it is opened for another entry to be made. The table overflow error message is issued when an attempt is made to have more than 20 inserts and snapshots in core simultaneously.

As snapshots and inserts are entered, information pertinent to them is put in the Package Table area. The current location of this area may be displayed using the TYPE directive or altered using the STORE directive. It is the user's responsibility to make sure he doesn't destroy his own program. If the ORG directive is used when entering an insert, the next available Package Table Locations is located somewhat after the ORGed location. See description of the REMOVE, INSERT, and SNAPSHOT directive for further information.

## PART II

## OPTIONS

ASSIGNMENT OF THE CONTROL MEDIA

Input lines are read from the control media. Upon the completion of loading and after the occurrence of any error, the typewriter is assigned as the control media. To assign the control media, one of the following lines should be entered:

|        |                                                          |
|--------|----------------------------------------------------------|
| C = TY | Read the next and subsequent lines from the typewriter   |
| C = PR | Read the next and subsequent lines from the photo reader |
| C = CR | Read the next and subsequent lines from the card reader  |

ASSIGNMENT OF PERIPHERAL DEVICES

Several of the options provided with the package will operate on more than one I/O device. The selection of the device is made by the user when a line of the following form is entered:

ASSIGN  $F_1, F_2 \dots$

where  $F_i$  is one of the following:

|         |                                                      |
|---------|------------------------------------------------------|
| BI = PR | subsequent loading takes place from the photo reader |
| BI = CR | subsequent loading takes place from the card reader  |
| BO = PP | subsequent binary output is on the paper tape punch  |
| BO = CP | subsequent binary output is on the card punch        |
| LO = TY | subsequent dumps are made on the typewriter          |
| LO = LP | subsequent dumps are made on the line printer        |

Example:

ASSIGN LO = LP, BI = PR

The above line causes subsequent dumps to occur on the line printer and subsequent loading to take place from the photo reader.

Point of Interest

After loading, the following assignments are automatically made and no ASSIGN line need be entered unless a different option is desired.

ASSIGN BI = PR, BO = PP, LO = TY

RESUME COMPUTATION DIRECTIVE

To restore the registers and indicators to their stored values, one of the following types of lines should be entered:

GO

GO loc

After the registers and indicators have been restored, computation will resume at the location specified by the stored value of the P register. If a numeric is used (as on the second line above), its value will be used instead as the transfer address.

Example:

GO 200

The above line will restore the A, B and X register, the overflow indicator and interrupt system, and then transfer to location 200.

LOAD DIRECTIVE

The package provides a resident loader for use with either absolute or relocatable programs that contain no POP's or External References or Definitions. The decks are input from the device specified as BI on the last ASSIGN line. To initiate loading, a line of the following type should be entered:

LOAD loc, GO

If the numeric (loc) is entered, it is used as the relocation bias. If not, the ending address + 1 of the last relocatable deck entered is used. If the symbol GO is entered, decks will be loaded until an end transfer card is input; if not, upon encountering any end card, control is immediately returned to user input. In any case, if an end transfer record is encountered during loading, the transfer address replaces the stored value of the P register and control returns to user input, i.e., the transfer is not taken until the GO directive is used.

## Examples:

## LOAD

Load one deck and return control to user input.

## LOAD 200

Load one deck and use 200 as the relocation bias.

## LOAD GO

Load until an end transfer record is encountered.

## LOAD 200, GO

Use 200 as the relocation bias and load decks until an end transfer record is met.

Point of Interest

Encountering an End of File on the card reader immediately terminates loading. The relocation bias is ignored when loading absolute decks.

DUMP DIRECTIVE

Selected portions of memory may be dumped in either octal or instruction format. Instruction format is a line containing the octal contents of 8 locations with the mnemonic op-code printed directly beneath the numeric. The output device is the one specified as LO in the previous ASSIGN line. In all cases, if an output line would be all 0's then it is not output.

To produce an octal dump, a line of one of the following types should be entered:

DUMP loc TO loc, loc TO loc, ....

or

DUMPO loc TO loc, loc TO loc, ...

To produce an instruction dump, a line of the following type should be entered:

DUMPI loc TO loc, loc TO loc, ...

Example:

DUMPI 1000 TO 3777, 500 TO 577

Will cause locations 1000 through 3777 and locations 500 through 577 to be dumped in instruction format.

#### Point of Interest

No matter what locations are given for a dump, the beginning address will be a multiple of 8 and the ending address will be a multiple of 8 plus 7, i.e., DUMP 5002 to 5010 will dump locations 5000 through 5017 inclusive.

#### BINARY PUNCH DIRECTIVE

Selected portions of memory and end transfer records may be punched out in the standard, absolute, binary format. The output will occur on the device specified as BO in the previous ASSIGN line. A line of the following type will cause this action:

PUNCH  $F_1, F_2, \dots$

Where  $F_i$  is one of the following

|            |                                                                                                                                                                                                                                         |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| loc to loc | Punches out all locations between the specified addresses.                                                                                                                                                                              |
| loc        | Punches out an end transfer record to the specified location. If this does not appear in the PUNCH statement an end record without a transfer address is punched. Further, a field of this type, if used, must be the last one entered. |

Examples:

PUNCH 107 TO 210, 300 TO 577, 120

The above line would cause location 107 through 210 inclusive, location 300 through 577 inclusive and an end transfer record to location 120 to be punched on the device specified as BO.

PUNCH 107 TO 210, 300 TO 577

Same as the above example except an end record without a transfer address is punched.

### PUNCH BOOTSTRAP DIRECTIVE

A bootstrap to load programs in the standard, absolute, binary format from paper tape may be punched out on paper tape. A line of the following form will cause this action:

BOOT

The above line will output the bootstrap on the paper tape punch. See Appendix IV for information on how to use the bootstrap.

### ALTER DIRECTIVE

The stored value of the registers and selected areas of memory may be set to values specified by the user. A line of the following type will cause this action:

STORE  $F_1, F_2, F_3, \dots$

where  $F_i$  is one of the following

|            |                                                                                                                     |
|------------|---------------------------------------------------------------------------------------------------------------------|
| A = num    | the numeric replaces the stored value of the A register                                                             |
| B = num    | the numeric replaces the stored value of the B register                                                             |
| P = loc    | the numeric replaces the stored value of the P register                                                             |
| X = num    | the numeric replaces the stored value of the X register                                                             |
| I = 1 or 0 | if the numeric equals 1, the stored interrupt flag is set to enable; the flag is set to disable if the numeric is 0 |
| O = 1 or 0 | if the numeric is 1, the stored overflow indicator is turned on; if 0, the indicator is turned off                  |

T = loc      the numeric becomes the value used as the Package  
Table Area location

loc = num      the numeric replaces the contents of the specified location

loc TO loc = num      the numeric replaces the contents of all memory  
locations specified between the two loc's

**Example:**

STORE 200 = 5, A = -1, 1000 TO 1400 = 0

The above line sets the stored value of the A register to -1, location 200 to 5  
and zeros cells 1000 through 1400 inclusive.

DISPLAY DIRECTIVE

The stored values of the registers along with selected areas of memory may be  
output on the typewriter. A line of the following form will cause this action:

TYPE F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub>, . . .

where F<sub>i</sub> is one of the following

|   |                                                                       |
|---|-----------------------------------------------------------------------|
| P | type out the value of the stored P register                           |
| A | type out the value of the stored A register                           |
| B | type out the value of the stored B register                           |
| X | type out the value of the stored X register                           |
| I | type 1 if the stored interrupt indicator is enabled, 0 if<br>disabled |
| O | type 1 if the stored overflow indicator is on, 0 if off               |

ALL      type out the stored value of all the registers and indicators

T        type out the Package Table Area location

loc      type out the contents of the location specified by this number

loc TO loc      type out the contents of all locations which lie between the  
first and second locations

ALT      type out the locations at which there is either a snapshot or insert

When memory locations are specified, the op-code will be typed along with the octal contents.

Example:

TYPE 200, A, B, P, 300 TO 310

The above line types out the stored values of the A, B and P registers, contents of location 200 and contents of location 300 through 310 inclusive.

#### DISPLAY IN BCD

Selected portions of memory may be typed out in BCD. A line of the following form causes this action:

TBCD loc TO loc, etc.

The locations specified are typed out, not more than 20 words per line. If several areas are specified, the typewriter is double spaced between them.

Example:

TBCD 105 TO 114, 306 TO 340

If the above line were entered, locations 105 through 114 and locations 306 through 340 inclusive would be output on the typewriter in BCD.

#### SEARCH DIRECTIVE

The package makes provisions for searching specified areas of core and typing out locations within those areas whose contents lie in a particular value range.

Input of a line in one of the following forms causes this action:

IN loc TO loc, F1, F2

The area searched is specified as 'loc TO loc'.

F1 is one of the following:

F1 = num      look for all locations in the specified area  
whose contents are C = num

F1 = num<sub>1</sub> TO num<sub>2</sub>      look for all locations in the specified  
area whose contents, C, satisfy  
 $\text{num}_1 \leq C \leq \text{num}_2$

F<sub>2</sub>, either a numeric or nothing, is entered. If no F<sub>2</sub> is  
given, it is assumed to be 77777777. F2 is used to mask  
the contents of the location as well as the value ranges  
before comparisons are made. As an example:

IN 100 TO 200, 1000, 37777

If the above line were input, locations 100 through 200  
inclusive would be searched for all locations whose address  
portion equalled 1000.

OUT loc TO loc, F1, F2

See above for use of loc TO loc and F2.

F1 is one of the following:

F1 = num      look for all locations in the specified area  
whose contents, C,  $\neq$  num.

F1 = num<sub>1</sub> TO num<sub>2</sub>      look for all locations in the specified  
area whose contents, C, satisfy  
 $C < \text{num}_1$  or  $C > \text{num}_2$

OUT 200 TO 300, 0 TO 100000, 7700000

If the above line were input, locations 200 through 300 inclusive would be searched for all locations whose OP codes were neither HLT's nor BRU's.

### ON-LINE TRANSLATOR DIRECTIVE

An on-line translator is provided in the package. In contradistinction to other operations in the package, commas, equal signs, blanks and tabs are not interchangeable. Blanks are disregarded as before but commas are significant. Therefore, it is recommended that lines be punctuated exactly as described below.

To initiate on-line translation, a line of the following type should be entered:

ORG loc

The location specified on the ORG line is the location at which the subsequent instruction is to be entered. As each line is entered the present value of the location counter is incremented and typed out (if input is from the typewriter).

If a line of the following type is entered:

ORG

Then the last value of the location counter is used. This is a convenience to expedite error recovery with the On-Line Translator.

The following directives are recognized:

1. RES num                      the numeric in the address field is added to the location counter.
2. ORG loc                      the location counter is set to the specified address.
3. DAT  $F_1, F_2, F_3$             where  $F_i$  is either a numeric or a Hollerith string. The numbers and Hollerith information are put into successively higher locations of memory and the location counter is incremented accordingly.

4. END or END loc      when an END directive is encountered, control is transferred back to the main body of the AID Package. If a location is specified, it replaces the stored value of the P register.
5. See Appendix 1 for the list of op-codes and their octal equivalent. With the mnemonics, relative and indirect addressing are done as in META-SYMBOL, e. g., \$+num means the present value of the location counter + the numeric. \*num or \*\$ means that this instruction is indirectly addressed.

Example:

|      |     |                      |                |             |          |
|------|-----|----------------------|----------------|-------------|----------|
|      | ORG | 1000                 |                |             |          |
| 1000 | LDX | 1100                 | 1001           | 07101100    |          |
| 1001 | LDA | 1101                 | 1001           | 07601101    |          |
| 1002 | BRU | \$+2                 | would generate | 1002        | 00101004 |
| 1003 | ADD | 1102                 | 1003           | 05501102    |          |
| 1004 | STA | 1200,2               | 1004           | 23501200    |          |
| 1005 | BRX | \$-2                 | 1005           | 04101003    |          |
|      | ORG | 1100                 |                |             |          |
| 1100 | DAT | -30,0,1              | 1100           | 77777750    |          |
|      |     |                      | 1101           | 00000000    |          |
|      |     |                      | 1102           | 00000001    |          |
|      | ORG | 2000                 |                |             |          |
| 2000 | DAT | 'THIS IS A TEST', -4 | 2000           | 63343162    |          |
|      |     |                      | 2001           | 60316260    |          |
|      |     |                      | 2002           | 21606325    |          |
|      |     |                      | 2003           | 62636060    |          |
|      |     |                      | 2004           | 77777774    |          |
| 2005 | EOM | 2641                 | 2005           | 00202641    |          |
| 2006 | LDX | 2005                 | 2006           | 07102005    |          |
| 2007 | MIW | 2005,2               | 2007           | 21202005    |          |
| 2010 | BRX | \$-1                 | 2010           | 04102007    |          |
| 2011 | EOM | 14000                | 2011           | 00214000    |          |
| 2012 | LDA | *100.                | 2012           | 07640144    |          |
| 2013 | STA | *\$+1                | 2013           | 03542013    |          |
| 2014 | HLT | 1                    | 2014           | 00000001    |          |
|      | END | 2005                 |                | PREG = 2005 |          |

INSERT DIRECTIVE

The package makes provision for patching a program by 'inserting' a sequence of code as described below. A line of the following type will cause this action:

```
INSERT    loc
```

Example:

| location | code |                              |
|----------|------|------------------------------|
| 1000     | LDA  | 100      memory before patch |
| 1001     | STA  | 101                          |
| 1002     | SKN  | 102                          |
| 1003     | BRU  | \$+2                         |

these lines are input:

```
INSERT    1002
          BRU    $+2
          DAT    1
          ADD    $-1
          STA    101
          MIN    102
          END
```

the following is the resultant code in memory

|      |     |      |                                                                     |
|------|-----|------|---------------------------------------------------------------------|
| 1000 | LDA | 100  |                                                                     |
| 1001 | STA | 101  |                                                                     |
| 1002 | BRU | T    |                                                                     |
| 1003 | BRU | \$+2 |                                                                     |
| :    |     |      |                                                                     |
| :    |     |      |                                                                     |
| T    | BRU | T+2  | T = first available locations in Package<br>Table Area (see page 8) |
| T+1  | DAT | 1    |                                                                     |
| T+2  | ADD | T+1  | inserted instructions                                               |
| T+3  | STA | 101  |                                                                     |
| T+4  | MIN | 102  |                                                                     |
| T+5  | SKN | 102  | original instruction                                                |
| T+6  | BRU | 1003 | linkage back to original program                                    |
| T+7  | BRU | 1004 | linkage back to original program                                    |

This example illustrates several important features of the insert action.

1. The insertions are placed in the first and successively higher Package Table Areas locations.
2. Relative addressing refers to the INSERT area.
3. The inserted instructions are executed before the original instruction.
4. An insertion may be made at any location including a transfer or skip. Note that two BRU's are placed after the original instruction.
5. The on-line translator is used.
6. If an ORG directive is used.
  - a. The user must provide the linkage (BRU) to the ORGed region himself.
  - b. The two BRUs back to the program will be generated immediately after the last instruction entered.
  - c. The locations after the second BRU will now be considered to be the first available locations for the next snapshot or insert. This is true even if ORG is the first instruction of the patch.
7. If an error occurs during the translator input, the original instruction will not be disturbed and no entry will be made in the Alter Points Table. Therefore, there is no need to reset the insert. If it is desired to continue making the insert, type I followed by a carriage return. This will save re-entering all instructions entered before the error.

See the description of the RESET directive for further information, also the section on use of the On-Line Translator.

#### SNAPSHOT DIRECTIVE

Dynamic snapshots can be made from any place in memory. To initiate this action a line of the following type should be entered.

SNAP loc, num, loc TO loc, loc TO loc, etc.

The first numeric specifies the location at which the snapshot is to take place. The second numeric specifies the number of times that the snapshot is to be done. The bounded areas are dumped on the typewriter.

The snapshot is made by replacing the original instruction with a BRU into the Package Table Area. The following sequence of events then takes place each time program control passes to the BRU:

1. The present values of the registers are saved.
2. The stored register values are typed out.
3. The specified regions of core are dumped on the typewriter.
4. The saved values of the registers are copied back to the register.
5. The original instruction is executed.
6. Control is transferred back to the user program.

The above steps are repeated each time that program control is transferred to the snapshot location. Upon entry a life counter is decremented. When the snapshot has been taken a number of times that equals the specified life count, the original instruction is put back in line and no further snapshots will be made at this location. Further, the Alter Points entry is erased. Program control is then transferred to the snapshot location which now contains the original instruction.

Example:

```
SNAP    300, 2, 360 TO 377
```

The above line will cause the registers to be typed along with a dump of locations 360 through 377 the next two times that program control passes to location 300.

#### Point of Interest

Read the description of the INSERT and REMOVE directives for further information on the handling of table space.

#### RESET DIRECTIVE

To remove inserts or snapshots from core a line of the following type should be entered:

REMOVE  $F_1, F_2, \dots$

where  $F_i$  is one of the following

S      remove all snapshot entries

I      remove all insertions

loc    remove the snapshot or insert that was made at this location

The corresponding Alter Point Entries are removed and made available for other uses and the original instruction is placed back in line.

Caution: Because of the way that snapshots and inserts are performed and removed, it is not advisable to have more than one of them active at any particular location.

## APPENDIX I

## OP CODES AND THEIR OCTAL EQUIVALENTS

| <u>OP Code</u> | <u>Octal</u> |
|----------------|--------------|
| HLT            | 0            |
| BRU            | 1            |
| EOM            | 2            |
| EOD            | 6            |
| MIY            | 10           |
| BPO            | 11           |
| MIN            | 12           |
| POT            | 13           |
| ETR            | 14           |
| MRG            | 16           |
| EOR            | 17           |
| NOP            | 20           |
| EXU            | 23           |
| YIM            | 30           |
| BPI            | 31           |
| WIM            | 32           |
| PIN            | 33           |
| STA            | 35           |
| STB            | 36           |
| STX            | 37           |
| SKS            | 40           |
| BRX            | 41           |
| BRM            | 43           |
| RCH            | 46           |
| SKE            | 50           |
| BRR            | 51           |
| SKB            | 52           |
| SKN            | 53           |
| SUB            | 54           |
| ADD            | 55           |
| SUC            | 56           |
| ADC            | 57           |
| SKR            | 60           |
| MDE            | 60           |
| MIN            | 61           |

## APPENDIX I (Continued)

| <u>OP Code</u> | <u>Octal</u> |
|----------------|--------------|
| XMA            | 62           |
| ADM            | 63           |
| MUL            | 64           |
| MUS            | 64           |
| DIV            | 65           |
| DIS            | 65           |
| SKM            | 70           |
| LDX            | 71           |
| SKA            | 72           |
| SKG            | 73           |
| SKD            | 74           |
| LDB            | 75           |
| LDA            | 76           |
| EAX            | 77           |

## APPENDIX I (Continued)

| Shift Mnemonic | Octal    |
|----------------|----------|
| RSH            | 06600000 |
| RCY            | 06620000 |
| LRSH           | 06624000 |
| LSH            | 06700000 |
| LCY            | 06720000 |
| NOD            | 06710000 |

## Register Change Mnemonics

|     |          |
|-----|----------|
| CLA | 04600001 |
| CLB | 04600002 |
| CLR | 04630003 |
| CAB | 04600004 |
| CBA | 04600010 |
| XAB | 04600014 |
| BAC | 04610012 |
| ABC | 04620005 |
| CLX | 24600000 |
| CXA | 04600200 |
| CAX | 04600400 |
| XXA | 04600600 |
| CBX | 04600020 |
| CXB | 04600040 |
| XXB | 04600060 |
| STE | 04600122 |
| LDE | 04600140 |
| XEE | 04600160 |
| CNA | 04601000 |

## Alternate Forms of the Directive

|   |                            |
|---|----------------------------|
| E | may be used instead of END |
| O | may be used instead of ORG |

## APPENDIX II

BACKUS NORMAL FORM DESCRIPTIONS OF LEGAL  
INPUT LINES

|           |    |                                                                 |
|-----------|----|-----------------------------------------------------------------|
| <NULL>    | := |                                                                 |
| <ALPHA>   | := | A/B/C/D/-----/X/Y/Z                                             |
| <NUMBER>  | := | 0/1/2/3/4/5/6/7/8/9                                             |
| <DECMAL>  | := | .                                                               |
| <PLUS>    | := | +                                                               |
| <MINUS>   | := | -                                                               |
| <HOLRTH>  | := | '                                                               |
| <DONE>    | := | !                                                               |
| <DLMIN>   | := | \$/)/*/Δ/(                                                      |
| <DLMOUT>  | := | / /=/, /#                                                       |
| <ILEGAL>  | := | √/:/>/?/[/</ /1/;///∞/‡                                         |
| <SIGN>    | := | <PLUS>/<MINUS>                                                  |
| <NUMERIC> | := | <NUMBER>/<NUMBER> <NUMERIC>                                     |
| <DEC>     | := | <NUMERIC> <DECMAL>                                              |
| <BCD>     | := | <DLM>/<SIGN>/<ILEGAL>/<NUMBER>/<DECMAL><br>/<ALPHA>/<BCD> <BCD> |
| <SYM>     | := | <ALPHA>/<ALPHA> <SYM>                                           |
| <DLM>     | := | <DLMIN>/<DLMOUT>                                                |
| <NUM>     | := | <NUMERIC>/<DEC>/<SIGN> <NUMERIC><br>/<SIGN> <DEC>               |
| <HOL>     | := | <HOLRTH> <BCD> <HOLRTH>                                         |
| <TRM>     | := | <DONE>                                                          |
| <TERM>    | := | <NULL>/<NUM>/<SYM>/<HOL>                                        |
| <STRING>  | := | <TERM>/<TERM> <DLM> <STRING>                                    |
| <LINE>    | := | <STRING> <TRM>                                                  |

## APPENDIX III

## SUMMARY OF LINE FORMATS

$$C = \begin{Bmatrix} \text{TY} \\ \text{PR} \\ \text{CR} \end{Bmatrix}$$

$$\text{ASSIGN BI} = \begin{Bmatrix} \text{PR} \\ \text{CR} \end{Bmatrix}, \quad \text{BO} = \begin{Bmatrix} \text{PP} \\ \text{CP} \end{Bmatrix}, \quad \text{LO} = \begin{Bmatrix} \text{TY} \\ \text{LP} \end{Bmatrix}$$

$$\text{GO } \{ \text{LOC} \}$$

$$\text{LOAD } \{ \text{RELOCATION BIAS} \}, \{ \text{GO} \}$$

$$\begin{Bmatrix} \text{DUMP} \\ \text{DUMPO} \\ \text{DUMPI} \end{Bmatrix} \text{ loc TO loc, ETC}$$

$$\text{PUNCH } \{ \text{loc TO loc} \}, \{ \text{TRANSFER ADDRESS} \}, \text{ ETC}$$

$$\text{STORE } \left\{ \begin{Bmatrix} \begin{Bmatrix} \text{T} \\ \text{A} \\ \text{B} \\ \text{P} \\ \text{X} \\ \text{I} \\ \text{O} \end{Bmatrix} \end{Bmatrix} = \text{num} \right\}, \{ \text{loc} = \text{num} \}, \{ \text{loc TO loc} = \text{num} \}, \text{ ETC}$$

$$\text{TYPE } \left\{ \begin{Bmatrix} \text{T} \\ \text{A} \\ \text{B} \\ \text{X} \\ \text{P} \\ \text{I} \\ \text{O} \\ \text{ALL} \\ \text{ALT} \end{Bmatrix} \right\}, \{ \text{loc} \}, \{ \text{loc TO loc} \}, \text{ ETC}$$

$$\text{ORG } \{ \text{loc} \}$$

## APPENDIX III (Continued)

Op Code  $\left\{ \ast \right\} \left\{ \begin{array}{c} \$\pm \text{num} \\ \text{loc} \end{array} \right\} \left\{ , \text{num} \right\}$

INSERT loc

I

SNAP loc, life,  $\left\{ \text{loc TO loc} \right\}$  , ETC

REMOVE  $\left\{ \text{loc} \right\}$  ,  $\left\{ S, \right\}$  ,  $\left\{ I \right\}$

$\left\{ \begin{array}{c} \text{IN} \\ \text{OUT} \end{array} \right\} \text{ loc TO loc , } \left\{ \begin{array}{c} \text{num} \\ \text{num TO num} \end{array} \right\} , \left\{ \text{mask} \right\}$

BOOT

TBCD loc TO loc , ETC

## APPENDIX IV

USE OF PAPER TAPE BOOTSTRAP OUTPUT BY THE BOOT DIRECTIVE

The bootstrap occupies locations 0, 2-53<sub>8</sub> and is used to load programs in the standard absolute binary format. The bootstrap is loaded with the FILL procedure. The breakpoints are interrogated during loading and cause the following action:

BP2

Breakpoint 2 set will cause the bootstrap to halt after it has loaded itself. This option is useful when the bootstrap and the object program are on physically different tapes. Clear the halt to continue loading.

BP1

Breakpoint 1 set will cause the bootstrap to halt each time that an end record is encountered. If the end record specifies a transfer address, the transfer will be taken when the halt is cleared. If no transfer address is on the end record, the bootstrap will attempt to load the next program when the halt is cleared.

HALTS

|           |                   |
|-----------|-------------------|
| P = 00007 | BP 2 Halt         |
| P = 00014 | Buffer Error Halt |
| P = 00043 | Checksum Error    |
| P = 00050 | BP1 Halt          |

The bootstrap will not load programs that contain POP definitions or external references and definitions.

## PROGRAM DESCRIPTION

Page 1 of 4

Catalog No. 034001(B)

IDENTIFICATION: Card Reader Test Program

AUTHOR: S. Vorgitch, SDS

ACCEPTED: May 26, 1964

COMPUTER  
CONFIGURATION: Any SDS 920 or SDS 910 with a typewriter, and SDS Model 9151 card reader.

PURPOSE: To provide an acceptance test for the SDS 9151 card reader.

PROGRAMMED  
OPERATORS: None

STORAGE: Octal locations 200-613 (268 words).

TIMING: Not applicable.

USE: The Card Reader Test Program consists of a self-loading paper tape and a special 64-card test deck. The card deck is sequentially numbered and must be in correct order to run the test.

To perform the card reader test, proceed as follows:

1. Load the program by normal Fill procedure. When the program is loaded the computer will halt.
2. Check the test deck for correct sequencing of cards.
3. Select either the binary or Hollerith test by means of Breakpoint Switch 1.  
  
BP 1 set: Hollerith read test  
  
BP 1 reset: Binary read test
4. Load the test deck and turn on the EOF ON indicator.
5. Clear the computer halt to start the test.

Normal Run

If the test deck reads through successfully one of the following messages will be typed out, depending on the mode selected: "Binary test complete" or "Hollerith

USE: (cont.)

test complete". The computer will then halt. At this time the test deck may be reloaded and the program repeated by clearing the halt.

Note: During the Hollerith read test, the VALIDITY CHECK light will be on continuously.

#### Error Indication

If an error occurs during the test, a message will be typed and the computer will halt. If an error halt occurs, the entire program must be restarted.

The following error messages are possible:

1. BIN check error:

The binary check character (52522525) read from columns 1 and 2 of the last card is not correct. The A register contains the pattern read from the card while the B register contains the value which should have been read.

2. HOL check error:

Either the Hollerith character (T) read from column 3 is not correct or a validity check has occurred while reading it. The A register contains the binary-coded value of the Hollerith character read from the card while the B register contains the value which should have been read.

3. IDN check error:

The identification number read from the last card does not sequentially follow that of the preceding card. The A register contains the sequence number read from the card while the B register contains the expected sequence number.

4. Error in column N: ( $8 \leq N \leq 71$ )

The information read from the particular card column is not correct. For the binary test, the A register contains the binary pattern read from the card, while the B register contains the pattern which should have been read. For the Hollerith test, the A register contains the Hollerith value read from the card, while the B register contains the binary pattern that should be in that card column.

USE: (cont.)

5. Error in column M: (M = 80\* or 81\*)

On each odd numbered card (columns 4 and 5) columns 72 through 80 are skipped using EOM 12006. Even numbered cards are read until an end of record interrupt (I2) is received. If the I2 occurs before column 80 or an I1 is received after column 80, the appropriate error note is printed.

6. Signal not present:

At certain places, the program tests for the presence of the following signals:

Card Reader ready to feed (SKS 12006)

Card Reader ready to read one column (SKS 14006)

The program will loop before continuing until the particular signal is received. Upon terminating the test, the Card Reader end-of-file signal (SKS 11006) is tested.

METHOD:

Each card in the test deck contains the following fields:

1. Binary check character (columns 1 and 2).
2. Hollerith check character (column 3).
3. Identification number (columns 4 and 5).
4. Test data (columns 8 through 71).

Columns 6, 7, and 72-80 are blank.

The test data contains every possible columnwise combination of punches arranged in ascending binary order. Column binary information is read from top to bottom, where the 12-row is the most significant bit and the 9-row is the least significant bit.

Each field on the card is read and interpreted for correctness as follows:

1. Columns 1 and 2 are read in the binary mode and form a check character whose octal value is 52522525.
2. Column 3 is read in the Hollerith mode and is the letter "T". The octal value is 63.

- METHOD: (cont.)
3. Columns 4 and 5 are read in Hollerith and converted to binary by the program to form the card identification number. This number is then checked for correct sequence.
  4. Binary test: Columns 8 through 71 are read in the binary mode, one column at a time. Each column is checked against an internal binary counter. Between columns, the W buffer is disconnected and the program waits for Card Reader ready (SKS 12006) before reading the next column.

Hollerith test: Columns 8 through 71 are read in the Hollerith mode, one column at a time. The octal value read from a particular column is used to select a binary pattern from a table. This value is compared with the internal binary counter pattern. The two patterns should match for non-valid Hollerith characters. The validity error signal should be set for non-valid Hollerith characters.



**XDS PROGRAM LIBRARY**  
**PROGRAM DESCRIPTION**

Catalog No. 851057-11A00  
394005

Page 1 of 3

IDENTIFICATION: Memory Lock-out and Power Fail-safe Test

AUTHOR: S.J. Vorgitch, Xerox Data Systems

ACCEPTED: December 2, 1965

COMPUTER  
CONFIGURATION: Any XDS 930 with Memory lock-out (manual or program  
controlled) / Power fail-safe

PURPOSE: To verify the operation of the memory lock-out/Power  
fail-safe options

PROGRAMMED  
OPERATORS: None

SUBROUTINES  
REQUIRED: None

STORAGE: 369 locations from 0100<sub>8</sub> to 0660<sub>8</sub>

TIMING: N/A

SOURCE  
LANGUAGE: META-SYMBOL

LOADING  
PROCEDURE: The program is supplied on self loading cards or paper  
tape. The Memory lock-out register must have been  
previously reset (start button or reset manual lock-out  
switches). After loading without error, the program will  
half with 0107<sub>8</sub> in the P register. At this time, the A  
register can be initialized with a starting random number  
and the Breakpoint Switches may be set. Location one is  
used for program recovery.

## USE: (Cont)

Breakpoint Switches have the following meaning:

| 1.0 | SWITCHES | SET                                                                                           | RESET                                                  |
|-----|----------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------|
| 1   |          | Do not use random numbers to fill memory. Use A register input at loading halt ( $p=0107_8$ ) | Use random numbers to fill memory                      |
| 2   |          | This machine has the Memory lock-out option.                                                  | This machine does not have the Memory lock-out option. |
| 3   |          | Perform Memory lock-out test.                                                                 | Perform Power fail-safe test.                          |
| 4   |          | Memory lock-out is manual.                                                                    | Memory lock-out is under program control.              |

## 2.0 ERROR INDICATION

For Memory lock-out (programmed and manual) the typewriter output is the only verification of proper operation.

For Power-fail save discrepancies are indicated by a type-out of the memory address that did not compare after power up. The program will then halt with  $P = 0572$ . The A register contains the data expected and the B register contains the data read out of memory. Clear the halt to continue comparing.

## METHOD:

After loading, memory size is computed. If required (B.P. 4 set) a note is printed requesting the operator to CLEAR ALL MANUAL SWITCHES. Location  $37_8$  is then loaded with a BRM to a power off subroutine and the program will halt to accept a random number seed and allow Breakpoint setting. After the idle-run sequence memory is filled with random number from  $01000_8$  to the end of memory. These numbers are then compared and B.P. 3 is tested. If reset, the sequence of filling and comparing is cycled until power off occurs. If B.P. 3 is set, a mask is generated with one bits corresponding to the maximum number of memory lock-out areas according to the memory size.

USE: (Cont)

If lock-out is manual (B.P. 4 set) the actual locked-out areas will be typed as the program attempts to write (STA) into all of memory. The switches can be changed at any time. Locations 0-511<sub>10</sub> (manual memory lock-out switch 1) should never be locked out.

In both the power fail-safe and the memory lock-out programs, B.P. 3 is interrogated. This permits going back and forth between the test programs.

**METHOD:**

Each functional routine is essentially independent of the others and attempts to accomplish its operation in as straight forward a manner as possible. The program attempts to prevent the tape from running off the reels in either direction. By using the write end of file operation, sections of the tape can be set off for further test without having to work from the beginning of the reel on every pass.

At the start of every routine, the status of the tape is tested and if the operation obviously cannot be accomplished the program does not attempt it. No reverse operation will be started if the tape is at the load point. No forward operation except write end of file will be started if the tape is on the end of reel marker. No write operation is attempted if the file protect is on.

All reading, spacing and searching operations will be unconditionally terminated when an end of file is encountered.

---

# SDS 900 SERIES PROGRAM LIBRARY

## PROGRAM DESCRIPTION

Page 1 of 8

Catalog No. 074001 B

---

REC START AT 01212

IDENTIFICATION: 42 KC Magnetic Tape Test Program, W Buffer

AUTHOR: A. W. England, SDS

ACCEPTED: May 4, 1964

COMPUTER  
CONFIGURATION: Any SDS 900 series with a typewriter and one or more magnetic tape units of any type except 9145 attached to the W buffer. The buffer must be interlaced.

PURPOSE: To provide a simple and easy means for initial checkout and testing of 42 KC magnetic tape units.

PROGRAMMED  
OPERATORS: None.

STORAGE: The program occupies 587 words from 400<sub>8</sub> to 1512<sub>8</sub>. It uses the HELP Word Output Subroutine located at 200<sub>8</sub>. The area from the end of the program to the end of memory may be used as input and interlaced output record image.

TIMING: The program is sufficiently fast to keep the tape operating at full speed for all operations.

USE: 1.0 LOADING

To load the program, insert the paper tape in the paper tape reader and follow the normal FILL procedure. When it is loaded, the light on the typewriter will indicate that the program is now under operator control.

1.1 REGAINING OPERATOR CONTROL

If at anytime the operator should lose control of the program he may return it to the keyboard mode by moving the RUN-IDLE-STEP switch to IDLE, pressing START, moving the switch to STEP and then to RUN. If for some reason location 0001 is destroyed he may execute a BRU to location 400 to return control to the keyboard.

2.0 CONTROL FUNCTIONS

The following list contains a call letter for the various control functions the program will perform. These may be typed anytime the light on the typewriter is lit.

USE: (cont.) 2.1 PARAMETER CONTROL

These functions cause the program to set up the various parameters for the tests which will follow.

2.1.1 P, Set Pattern

The previously typed 8 octal digits are set up as the pattern for writing operations.

2.1.2 L, Set Record Length

The previously typed octal number will be established as the record length for all subsequent test operations. For write operations it determines the number of words to be written. For read it determines the maximum number of words which will be stored in memory. The maximum length record is 7777<sub>8</sub> (4095). If a larger number is entered it will be reduced to this maximum.

2.1.3 U, Set Unit Number

The previously typed octal digit is used to identify the logical tape unit number which is to be tested. The program adjusts all tape unit addressing instructions accordingly.

2.1.4 C, Set Record Count

The record counter is incremented by one every time the program passes a record in the forward direction, and decremented by one for the reverse direction. After a rewind it is cleared to zero. This control function with the letter C is provided so that the user can reset this counter whenever he wishes to start a series of operations for which a count is needed. The previously typed 8 octal digits will be saved as the new record count.

2.1.5 Z, Set Parity

If the preceding digit is even the program converts all read and write EOM's to the BCD even parity mode. If the digit is odd it converts all read and write EOM's to the binary odd parity mode.

2.2 TAPE OPERATION CONTROL2.2.1 Breakpoint Functions

Breakpoints 1, 2 and 4 apply generally to all tape operations. Breakpoint 3 is used when writing.

USE: (cont.)

BP 1 RESET: Continuous operation. The operation will continue as long as this Breakpoint is RESET or until the end of tape is reached.

SET: Stop continuous operation. If initially SET do only one operation.

BP 2 RESET: Perform all operations without stopping between records.

SET: Stop after each record.

BP 3 RESET: Write normally.

SET: Write a continuous record as long as this Breakpoint is set.

BP 4 RESET: Stop if a read or write error occurs.

SET: Do not stop on a read or write error.

#### 2. 2. 2 W, Write

The previously set pattern will be written as a record of length indicated by the L function. Records will be continuously written as long as Breakpoint 1 is RESET. If Breakpoint 3 is SET one long continuous record will be written. If Breakpoint 4 is RESET and a write error occurs, the program will halt and print WRITE ERROR. If Breakpoint 4 is SET the error will not cause a stop. If the tape is situated on the end of tape marker the write routine will write a Tape Mark to signify end of file, then type END OF REEL, and return to keyboard.

#### 2. 2. 3 I, Write with Identification

This function is the same as Write except that the record count number is written as the first word of the record. This provides a unique identification word for each record. The record count word is inserted as the first word of the image so no additional words are added to the record.

#### 2. 2. 4 R, Read

The next record on the selected tape unit will be read into memory. If the record is longer than the preset record length, the program will skip the extra words. If the skip remainder of record operation is not functioning and additional I1 interrupts occur, the program will count these and print the count at the end

USE: (cont.)

of the record. As long as Breakpoint 1 is RESET the program will read records sequentially until an end of file or the end of tape is encountered. If Breakpoint 2 is SET, the program will stop the tape after each record; otherwise the tape will run without stopping.

If a read error occurs and Breakpoint 4 is RESET, the program will stop and type READ ERROR. If BP 4 is SET, the program continues.

2. 2. 5 B, Backspace

If the input number previous to the B is cleared to zero by a carriage return then the selected tape is backspaced one record at a time as long as Breakpoint 1 is RESET or until the load point or an end of file is encountered. If the input number previous to the B is non zero then it is decremented by one after each backspaced record and the backspacing operation is terminated when it reached zero. The counted backspace may also be stopped on Breakpoint 1, the load point, or an end of file. If Breakpoint 2 is reset, the spacing will proceed without stopping between records. If Breakpoint 2 is set, the tape will be stopped after each record spaced and then restarted to continue over the next one.

2. 2. 6 S, Space Forward

Space forward is the same as backspace except that it will also stop when the end of tape is reached.

2. 2. 7 X, Search-Forward

The selected tape is searched forward using the read-scan mode until a record is found whose first word is equal to the previously typed octal number. When the record is found it is read into memory. If an end of file or the end of tape is encountered before the record is found the tape is stopped.

2. 2. 8 Y, Search Reverse

The selected tape is scanned backward until a record is found whose first word (last word scanned over in reverse) is equal to the previously typed octal number. If an end of file or the load point is encountered before the record is found, the tape is stopped.

2. 2. 9 D, Rewind

The selected tape is started in a rewind and the program returns to keyboard control.

USE: (cont.)

2.2.10 E, Erase

This function is similar to write except that instead of writing information, it erases tape for a distance equal to the specified record length.

2.2.11 F, Write End of File

A tape mark is written on tape to indicate End of File. The record counter is not incremented by the operation. The operation may be executed even though the tape is on the end of tape conductive leader.

2.3 OUTPUT CONTROL

After the tape has been read or moved by some other operation, the results may be inspected using the following control characters.

2.3.1 N, Tape Record Count Number

The program will type the current contents of the record counter.

2.3.2 T, Type Record Read

If the number of words read was less than or equal to the preset length, the program will type: RECORD LENGTH < OR = LLLL, where LLLL represents the record length. If the number of words read exceeds the present record length, the program will type: RECORD LENGTH > LLLL.

After typing one of these messages the program will begin to type the record image in octal numbering each eighth word in octal. This output will continue until either Breakpoint 1 is SET or until the entire record is typed.

If Breakpoint 1 is SET when the T key is struck only the record length will be typed.

3.0 STATUS AND ERROR MESSAGES

The following messages will be typed by the program to inform the operator of the status of the tape operation:

## USE: (cont.) 3.1 WRITE ERROR

This indicates that the program detected a write error and Breakpoint 4 was RESET. The tape is stopped and the program returns to keyboard control after typing.

## 3.2 READ ERROR

This indicates that the program detected a read error and Breakpoint 4 was RESET. The tape is stopped and the program returns to keyboard control after typing.

## 3.3 SKIP REMAINDER OF RECORD ERRORS: nnnnnnnn

This indicates that the record read was longer than the preset record length and that when the program attempted to ignore the remainder of the record, it still received 11 interrupts. The number of interrupts is indicated by the octal number nnnnnnnn. Control returns to the keyboard after typing. This error stop may not be disabled by Breakpoint 4.

## 3.4 FILE PROTECT ON

This is typed whenever the user asks for a write or erase operation on a tape which has the file protect ring removed. After typing the program returns to keyboard control.

## 3.5 END OF REEL

This indicates that a forward operation has reached the end of tape.

## 3.6 LOAD POINT

This indicates that a reverse operation has reached the beginning of tape.

## 3.7 TAPE MARK

This indicates that a read, scan, or space operation has encountered an End of File record as indicated by the reading of a Tape Mark.

4.0 FUNCTION SUMMARY

In the calling sequence the small letter d is used to denote an octal digit.

USE: (cont.) 4. FUNCTION SUMMARY (cont.)Function Description

|                              |                 |
|------------------------------|-----------------|
| Clear digit accumulator      | Carriage Return |
| Set test pattern word        | dddddddP        |
| Set record length            | dddL            |
| Set logical tape unit number | dU              |
| Set record count number      | dddddddC        |
| Set to even parity (BCD)     | 0Z              |
| Set to odd parity (Binary)   | 1Z              |
| Write                        | W               |
| Write with record count ID   | I               |
| Read                         | R               |
| Backspace                    | B               |
| Backspace by count           | (octal count) B |
| Space forward                | S               |
| Space forward by count       | (octal count) S |
| Search forward and read      | dddddddX        |
| Search reverse               | dddddddY        |
| Rewind                       | D               |
| Erase                        | E               |
| Write end of file            | F               |
| Type record count number     | N               |
| Type record read             | T               |

IDENTIFICATION: Multi-Magnetic Tape System Exerciser

AUTHOR: A. W. England, SDS

ACCEPTED: 24 June 1964

COMPUTER  
CONFIGURATION: All 920, 925, and 930 systems, or any 910 systems with a typewriter, which have one to sixteen tape units attached to the W and/or Y buffers. No interlace is required and the tapes may be of any density and speed within the limitations of the buffer to which they are attached.

PURPOSE: This program is designed to exercise from one to sixteen tape units by first writing random numbers in random length records on all tapes under test and then reading these records back and comparing them with the numbers written. An attempt is made to tabulate and output all useful information concerning the errors made, if any, the mode of operation of each unit, and the number of passes over the tape.

STORAGE: The program occupies the first 1155 words of memory. The remaining memory may be used for test record storage.

TIMING: The program requires approximately 20 minutes to write or read a full reel (2400 feet) of tape.

USE:

- 1.0 LOADING  
Place tape in reader and FILL. When loading is complete the light on the typewriter will light if no loading error occurred.
- 2.0 KEYBOARD CONTROL  
When the keyboard light is on, the operator has control over the program. By actuating various keys he may set the test parameters, inspect results or start the exerciser test running.
- 2.1 REGAINING KEYBOARD CONTROL  
Control may be returned to the keyboard mode at any time by moving the RUN-IDLE-STEP switch to IDLE, pressing the START button, and moving the switch first to STEP then to RUN.

USE: (Cont)

### 3.0 CONTROL FUNCTIONS

The following list contains the call letters for the various functions which the program will perform. These may be typed anytime the typewriter light is lit.

#### 3.1 SELECT UNITS, "U" $u\phi$

The units to be exercised are selected by first typing the letter "U" followed by the several unit numbers separated by commas and finally a carriage return. After the last unit number followed by a comma is entered a carriage return must be given to terminate the unit select operation. Units on the W buffer are numbered 00-07 and on the Y buffer 10-17<sub>8</sub>.

#### 3.2 SET STARTING RANDOM NUMBER, "N" $\gamma\gamma\gamma\gamma N$

The initial random number is set by first typing the octal number desired (up to 8 digits) and then the letter N. The number being typed can be set to zero by typing a carriage return.

#### 3.3 SET MAXIMUM FILE LENGTH, "M" $1000 M$

The maximum number of records in the test file is set by typing the desired number of records in octal followed by the letter M. If the entire 2400 foot reel is to be written a maximum count of 10000<sub>8</sub> or greater should be sufficient.

#### 3.4 SET MAXIMUM RECORD LENGTH, "L" $40 L$

The maximum number of words in a record is set by typing the limit in octal followed by the letter L. If the specified maximum is less than or equal to 8 or greater than the maximum memory available then the maximum length is set equal to the memory available.

#### 3.5 MODE SELECT

The recording mode, either BCD or Binary is selected by typing the appropriate letter.

##### 3.5.1 Select Binary Mode, "B"

Typing the letter B will cause the appropriate EOM instructions to be converted to the binary mode of operation.

USE: (Cont)     3.5.2 Select BCD Mode, "D"

Typing the letter D will cause the EOM instructions to be set for BCD operation.

3.6 SELECT OUTPUT MEDIA

The output of the various messages and counters during the operation of the program can be on either the on-line typewriter or on paper tape for off-line listing. This is controlled by typing the appropriate letter before starting.

3.6.1 Select Typewriter Output, "T"

The typewriter is selected by typing the letter T.

3.6.2 Select Punch Output, "P"

The punch is selected by typing the letter P.

3.7 INITIATE TAPE OPERATION

After the appropriate parameters have been set the tape exercise operation may be initiated. There are three ways in which this may be done. If nothing has been recorded then the exercise must be begun with a START WRITE. However, once a file of information is written on tape and the program is stopped the other two starts can be used.

3.7.1 Start Write, "S"

To begin the exercise operation, type the letter S. The program will rewind all units and start to write a random number test file on the selected units.

3.7.2 Continue Operation, "C"

Once the exercise operation has been stopped with Breakpoint 1 (see section 4.1) it can be resumed from the point at which it was stopped by typing the letter C.

3.7.3 Restart Read, "R"

If during a read pass the program is stopped and the operator would like to reread the file from the beginning he can type the letter R to restart the read pass.

3.8 OUTPUT OPERATIONAL STATUS, "O"

The operator can inspect the status of the operation at anytime by stopping the program with Breakpoint 1 (see section 4.1) and typing the letter O. The program will then type out the status of the exercise operation as follows:

USE: (Cont)      3.8.1 Type of Pass

It types READ or WRITE depending on the type of pass in progress.

3.8.2 Mode of Operation

It then types the mode of operation, either BINARY or BCD.

3.8.3 Unit

The UNIT NO. of the tape unit currently being addressed is typed.

3.8.4 Program Counters

After this information the program will type a table of 17 counters each identified by a three or four character symbol. These symbols and their definitions follow:

MRC      Maximum Record Count. This is the octal number entered with the M key at the start of the exercise operation.

MRL      Maximum record length currently being used.

WRC      Write Record Count. If in a write pass this indicates the number of records written. In a read pass it indicates the total number written in the previous write pass.

RRC      Read Record Count. This indicates the number of records read during a read pass.

WPC      Write Pass Count. The number of write passes completed.

RPC      Read Pass Count. The number of read passes completed.

WEC      Write Error Count. The number of write errors that have occurred.

RWEC      Rewrite Error Count. This number of rewrite errors.

PREC      Permanent Read Error Count. The records that were read bad 10 times.

CPEC      Character Parity Error Count. The number of character parity errors that have occurred since the start of the exercise.

|             |                                        |                                                                                                                                                                                                                       |
|-------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| USE: (Cont) | LPEC                                   | Longitudinal Parity Error Count. The number of longitudinal parity errors that have occurred. For each read try only one character or longitudinal parity can be counted and character parity has priority.           |
|             | WCEC                                   | Word Count Error Counts. The number of word count errors that have occurred. A word count error occurs if the record read is longer or shorter than the record expected.                                              |
|             | CH1<br>CH2<br>CH3<br>CH4<br>CH5<br>CH6 | Errors in Channels 1-6. Channel 1 is the most significant bit, channel 6 the least. These counters are also output whenever a read error occurs if Breakpoint 2 is RESET. After a read error output they are cleared. |

#### 4.0 BREAKPOINT SWITCHES

The four Breakpoint switches are used to change the status of the program while it is running. These functions are as follows:

##### 4.1 BREAKPOINT 1

RESET: Normal

SET: Stop operation. After almost every tape operation there is a STOP point. If Breakpoint 1 is set the program will mark its place and return to the keyboard control mode. Operation can be continued by typing the letter C.

##### 4.2 BREAKPOINT 2

RESET: Output counters and messages whenever the normal output situation occurs.

SET: Skip the output of messages and counters. This will inhibit all output except the OUT OF SYNC message and the FILE PROTECT ON message.

##### 4.3 BREAKPOINT 3

RESET: At the end of a read pass go on to another write with new random numbers.

SET: At the end of a read pass go back and reread the same file again.

##### 4.4 BREAKPOINT 4

RESET: Run without halts.

SET: Halt on a write error or at the end of a read pass. Clearing these halts will allow the program to continue.

USE: (cont.)     5.0    MESSAGES

The program will type or punch status messages at various times in the operation of the exercise. These are described below:

5.1    END OF PASS

At the end of a write or read pass the output will be either WRITE or READ, PASS DONE. This is followed by a carriage return and the following two lines:

```
WRITES    READS    WRITE ERR REWRITES    BAD READS  
aaaaaaaaa bbbbbbbb ccccccc dddddddd eeeeeeee
```

where the a's represent the number of write passes in octal, the b's the number of read passes, the c's the number of write errors which have occurred, the d's the number rewrite errors, and the e's the number of records which were read erroneously 10 times.

5.2    REWRITE ERROR

If a write error is detected the program erases backward over the record and attempts to rewrite it. If this second attempt is also in error the program outputs the following counter titles:

```
WRITE PASS    RECORD NO.    WRITE ERRS    REWRITE ERRS
```

This is followed on the same line by the mode of operation (Binary or BCD) and the unit number. On the next line below the appropriate title it outputs the write pass count, the write record number count, the write error count and the rewrite error count. All counts are in octal.

5.3    READ ERROR

If a read error occurs, the program rereads the record nine more times and then outputs the read pass, record number, mode, and unit number. This is followed by a carriage return, the message, READ ERROR another carriage return and then nine, eight-octal-digit counters which represent the following quantities (from left to right): character parity error count, longitudinal parity error count, word count error count, errors in channel 1, channel 2, etc., to channel 6. On the next line the program outputs a good or bad message for each of the 10 reads. This consists of the letter G if the read was correct or B if the read was incorrect.

USE: (cont.)

For example:

B G G G B G G G G G

Indicates that the first and fifth reads were bad and all others were good.

#### 5.4 READ PASS OUT OF SYNC

The first word of every record is the number of records preceding it on the tape. When each record is read, the program compares this first word with the read record count. If they disagree the program backspaces and rereads the record a second time, if they still disagree then the difference between them is computed and the program spaces over as many records as necessary to position itself in front of the correct record. If the first word of this record does not agree with the read record count after two attempts the program ends the read pass and outputs the following. As in a read error it outputs the read pass count, read record number, mode, density and unit number. This is followed by this message:

```
READ PASS ABORT, OUT OF SYNC.  
aaaaaaaaa      bbbbbbbb
```

where the a's represent the first word of the first record read that did not agree with the read record count, and the b's represent the first word of the record read after spacing to what should have been the correct record. The program then goes to the end of read pass section where the end of pass output will be produced and from there on to another write or reread pass.

If a tape mark or the load point was encountered when spacing, the program terminates the read pass and outputs TAPE MARK before the other outputs. If it was the load point which was encountered it also outputs LOAD POINT. In either case the two words a and b will be the same since only one record was read.

#### 5.5 FILE PROTECT ON

Before the program attempts to write on a tape it tests the file protect for that unit. If the file protect should be on, the program outputs: FILE PROTECT ON (Mode) UNIT NO. n. and returns to the keyboard mode.

METHOD:

#### 1.0 WRITING

At the start of the write pass all units are rewound. The program then sets the tape control table for the lowest numbered unit and waits for it to be ready. As soon as this unit is ready a check is made to see if the tape is at

## METHOD: (cont.)

the loadpoint. If it is not, another rewind is given and the program waits until it is ready and at the load point. A three inch section of tape is erased before the first random number record is written. After writing this record on the first unit the control table is set to the next higher numbered unit and the record is written again. This continues until a record has been written on all units under test. The program then generates a new record of random numbers and starts writing this on all units.

## 1.1 WRITE ERROR

If a write error occurs the program erases backward to the front of this record and attempts to rewrite it. If this second attempt is also in error then the program outputs the rewrite error message. It then erases backward over the record again, erases it forward and attempts to write the record again on a new section of tape. An error here is considered a new write error and the process continues until a correct write is made.

## 1.2 END OF PASS

The write pass is concluded if one of two conditions occurs: Either the write record count reaches the maximum record count or an end of reel is encountered on any tape under test. When one of these occurs the program writes an end of file on all units and rewinds them. It then outputs the end of pass message and proceeds to the read pass.

2.0 READING

A read pass is similar to a write except that the program reads each record into memory and compares it with the random numbers which it regenerates for each read. The first record must be read starting from the load point. This insures that the tape is always positioned properly for the start of the pass.

## 2.1 READ ERRORS

When a read error occurs the program will always reread the record nine more times for a total of ten attempts regardless of whether or not a subsequent read was correct. It then outputs the results of these reads. Several conditions can cause a read error.

2.1.1 Character Parity Errors

The program counts a character parity error as any buffer error which occurs before the gap is reached.

## METHOD: (Cont)

2.1.2 Longitudinal Parity Error

If no character parity errors have occurred before the gap is reached and the buffer error is on after the tape stops, the program counts a longitudinal parity error.

2.1.3 Word Count Error

A word count error is defined as a record which was not of the length expected. The program tests for this in three ways. If more words than expected were read the read routine falls out of the loop too soon. The program also checks to see if the read loop should detect the end of record before expected. The third test is based on the fact that the program always writes records that consist of a multiple of four characters. Therefore, if the buffer contains anything other than zero at the end of the read an error has occurred.

## 2.2 READ SYNCHRONIZATION

When each record is read the first word is compared against the program record count. If they disagree it means that the program and tape are no longer synchronized. To guard against a read error causing the disagreement, the program backspaces and reads the record again. If they still disagree then the program computes the number of records to be spaced over in order to reach the desired record and moves to that point. It reads the new record and again checks the first word. If this word disagrees with the record count and a second read attempt does not correct the disagreement then the program aborts the read pass and outputs the appropriate message. If a tape mark or the load point is encountered while spacing to the correct position the pass is aborted without further read attempts.

## 2.3 END OF FILE

If the program should detect the buffer ready after the first word is read then a check for end of file is made. If the ready condition was caused by the reading of a tape mark then the read pass is complete and appropriate messages are output. If there is no tape mark character then the program assumes that the tape mark was read erroneously and terminates the read pass anyway and outputs an END OF FILE READ ERROR message.

METHOD: (Cont)

### 3.0 BCD MODE

In the BCD mode random numbers are generated and written the same as in binary. However, on the read pass all non compares between the generated number and the number from tape are checked to see if they are caused by the 12 to 00 conversion. This occurs because both the character 00 and the character 12 will be written on tape as a 12 but this character will always be read into memory as a 00.

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PROGRAM DESCRIPTION**

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Catalog No. 544001B

IDENTIFICATION: Extended Mode Multi-Magnetic Tape Exerciser

AUTHOR: S. J. Vorgitch, SDS

ACCEPTED: May 20, 1965

COMPUTER CONFIGURATION: Any SDS 925/930 system with 1 to 64 tape units attached to interlaced channels A through H. The typewriter on channel A(W) is used for control.

PURPOSE: The program is designed to exercise 1 to 64 magnetic tapes on channels A through H. The exercise operates under interrupt control in the extended mode using all four function codes and all SKS's and EOM's associated with the cahnnel and magnetic tape.

PROGRAMMED OPERATORS: None

STORAGE: The program occupies 1976 locations from 100g through 3770. The remainder of memory may be used for test record storage.

TIMING: The program requires approximately 10 to 15 minutes to write or read a full reel (2400 feet) or tape.

SOURCE LANGUAGE: META-SYMBOL

LOADING PROCEDURE: Self-loading

USE:

- 1.0 LOADING  
The program is loaded using the standard fill procedure. The typewriter will be addressed if no loading error occurred.
- 2.0 KEYBOARD CONTROL  
When the keyboard light is on, the operator has control over the program. By actuating various keys he may set the test parameters, inspect results or start the exerciser test running.

USE: (Cont)

## 2.1 REGAINING KEYBOARD CONTROL

Control may be returned to the keyboard mode at any time by moving the RUN-IDLE-STEP switch to IDLE, pressing the START button, and moving the switch first to STEP, then to RUN.

## 3.0 CONTROL FUNCTIONS

The following list contains the call letters for the various functions which the program will perform. These may be typed anytime the typewriter light is lit.

### 3.1 Select Units, "U"

*uφ, φ FOR SINGLE UNIT TEST*

The units to be exercised are selected by first typing the letter "U" followed by up to sixty-four unit numbers separated by comma's. After the last unit number is input with a comma, a carriage return will terminate unit selection. Units are numbered 0-7 for channel A, 10-17 for channel B, .... 70-77 for channel H.

### 3.2 Set Starting Random Number, "N"

The initial random number is set by typing the letter "N" followed by an octal number and entered with a carriage return.

### 3.3 Set Maximum File Length, "M"

The maximum file length is set by typing the letter "M" followed by an octal number and entered with a carriage return. Due to the writing technique used, the minimum file length is three records and the input maximum may be exceeded by three records.

### 3.4 Set Maximum Record Length, "L"

The maximum number of words in a record is set by typing the letter "L" followed by an octal number and entered with a carriage return. The minimum record length allowed by the program is four words. The maximum record length is determined within the program by the memory available.

USE: (Cont)

### 3.5 Select Mode, "B" or "D"

The recording mode can be set by typing a "B" for binary or a "D" for BCD.

### 3.6 Initiate Tape Operation

After the appropriate parameters have been set the tape exercise operation may be initiated. There are four ways in which this may be done. If nothing has been recorded then the exercise must begin with a START WRITE or if the tape unit(s) is in the test mode and not at load point the WRITE TEST may be used. However, once a file of information is written on tape and the program is stopped the other two starts can be used.

#### 3.6.1 Start Write, "S"

To begin the exercise operation, type the letter "S". The program will rewind all units and start to write a random number test file on the selected units.

#### 3.6.2 Continue Operation, "C"

Once the exercise operation has been stopped with Breakpoint 1 (see section 4.1) it can be resumed from the point at which it was stopped by typing the letter "C".

#### 3.6.3 Restart Read, "R"

If during a read pass the program is stopped and the operator would like to reread the file from the beginning he can type the letter R to restart the read pass.

#### 3.6.4 Write Test "K"

To perform in this mode the tape unit specified must be in the test mode and not at load point. The program will write random length, random number records until stopped with Breakpoint 1.

USE: (Cont)

### 3.7 Add or Remove a Unit From Test, "P"

If during a read or write pass the program is stopped with Breakpoint 1, a unit can be removed from the exercise by typing the letter "P" followed by a minus (-) and the unit number terminated with a carriage return. A unit can only be added to exercise prior to a write pass. This is accomplished by stopping the program after the read pass (B.P. 4) then setting B.P. 1 and clearing the halt. After the rewind the typewriter will be addressed. Type the letter P followed by a plus (+ or &) and the unit number and terminated with a carriage return.

### 3.8 Output Operational Status, "O"

The operator can inspect the status of the operation at anytime by stopping the program with Breakpoint 1 (see section 4.1) and typing the letter O. The program will then type out the status of the exercise operation indicated by section 3.8.1 - 3.8.4. Set Breakpoint 1 to terminate output and return control to the typewriter.

#### 3.8.1 Type of Pass

It types READ or WRITE depending on the type of pass in progress.

#### 3.8.2 Mode and Density

It then types the mode of operation, either BINARY or BCD and the tape density.

#### 3.8.3 Unit

The UNIT NO. of the tape unit currently being addressed is typed.

#### 3.8.4 Program Counters

After this information the program will type a table of 18 counters each identified by a three or four character symbol. These symbols and their definitions follow:

## USE: (Cont)

|      |                                                                                                                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MRC  | Maximum Record Count. This is the octal number entered with the M key at the start of the exercise operation.                                                                                               |
| CRN  | Current Record Number. Indicates record number just completed.                                                                                                                                              |
| MRL  | Maximum record length currently being used.                                                                                                                                                                 |
| WPC  | Write Pass Count. The number of write passes completed.                                                                                                                                                     |
| RPC  | Read Pass Count. The number of read passes completed.                                                                                                                                                       |
| WEC  | Write Error Count. The number of write errors that have occurred.                                                                                                                                           |
| RWEC | Rewrite Error Count. This number of rewrite errors.                                                                                                                                                         |
| PREC | Permanent Read Error Count. The records that were read bad 10 times.                                                                                                                                        |
| CPEC | Character Parity Error Count. The number of character parity errors that have occurred since the start of the exercise.                                                                                     |
| LPEC | Longitudinal Parity Error Count. The number of longitudinal parity errors that have occurred. For each read try only one character or longitudinal parity can be counted and character parity has priority. |
| WCEC | Write Count Error Count. The number of word count errors that have occurred. This is accomplished by "PINning" the channel and comparing with the expected record length.                                   |

USE: (Cont)

RCEC Read Count Error Count. The number of word count errors that have occurred. This is accomplished by "PINning" the channel and comparing with the expected record length.

CH1 Errors in Channels 1-6. Channel 1 is the  
CH2 most significant bit, channel 6 the least.  
CH3 These counters are also output whenever  
CH4 a read error occurs if Breakpoint 2 is  
CH5 RESET. After a read error output they  
CH6 are cleared.

### 3.9 Write Error Message Option

3.9.1 Type "X" to inhibit the write error message (5.2.1).

3.9.2 Type "Y" to restore the write error message.

### 4.0 BREAKPOINT SWITCHES

The breakpoints are used to change the status of the program while it is running. These functions are as follows:

#### 4.1 Breakpoint 1

Reset: Normal

Set: Stop operation. After almost every tape operation there is a STOP point. If Breakpoint 1 is set the program will mark its place and return to the keyboard control mode. Operation can be continued by typing the letter C.

#### 4.2 Breakpoint 2

Reset: Output counters and messages whenever the normal output situation occurs.

Set: Skip the output of messages and counters. This will inhibit all output except messages described in section 5.4 - 5.9.

USE: (Cont)

4.3 Breakpoint 3

Reset: At the end of a read pass go on to another write with new random numbers.

Set: At the end of a read pass go back and reread the same file again.

4.4 Breakpoint 4

Reset: Run without halts.

Set: Halt on a write error or at the end of a read or write pass. Clearing these halts will allow the program to continue.

5.0 MESSAGES

The program will type status messages at various times in the operation of the exercise. These are described below:

5.1 End of Pass

At the end of a write or read pass the output will be either WRITE or READ, PASS DONE. This is followed by a carriage return and the following two lines:

|          |          |           |          |           |           |
|----------|----------|-----------|----------|-----------|-----------|
| WRITES   | READS    | WRITE ERR | REWRITES | BAD READS | READ ERRS |
| aaaaaaaa | bbbbbbbb | cccccccc  | dddddddd | eeeeeeee  | ffffff    |

where the a's represent the number of write passes in octal, the b's the number of read passes, the c's the number of write errors which have occurred, the d's the number rewrite errors, the e's the number of records which were read erroneously 10 times, and the f's the number of erroneous reads.

5.2 Writing Errors5.2.1 Write Error

If a write error occurs and the message is not inhibited (3.9), the following line will be output

WRITE ERROR mode density uuuuuuu

where the u's represent the unit number.

USE: (Cont)

### 5.2.2 Rewrite Error

If a write error is detected the program erases backward over the record and attempts to rewrite it. If this second attempt is also in error the program outputs the write pass count, the write record number count, the write error count, the rewrite error count, and the number of parity errors. All counts are in octal.

### 5.3 Read Error

If a read error occurs, the record is re-read nine more times. During the reread, a "B" or "G" will be typed to indicate that the re-read was either Bad or Good. After nine re-reads a read error message is typed indicating on the first line the read pass number, the record number, the mode, density, and unit followed by a carriage return. Nine octal numbers are then typed which represent the number of character parity errors, the number of longitudinal parity errors, the number of read count errors and the number of tape channel errors. (CH1-CH6)

### 5.4 Unit N Aborted Record Sync Error

The first word of every record is a record number identification. This number is compared with the record number expected. If they disagree the tape is backspaced one record and re-read. If the record number is still in error, the tape is backspaced a maximum of 8 records looking for the last record read correctly. If successful the tape is spaced forward one record and the process is repeated. If the previous good record was not found or the recovery procedure failed a second time, that unit is declared out of synchronization and removed from the exercise.

### 5.5 Unit N Aborted Density Test Failure

If, while attempting to erase forward off the load point prior to the write pass, the program cannot ascertain the density of a unit the unit is removed from the test.

## USE: (Cont)

5.6 Unit N Aborted Non-Ready Condition

If during the course of program operation a unit does not come ready after approximately 5 minutes it is removed from the exercise.

5.7 Unit N Aborted Write Count Error

If, after a write operation, the results of PINning the channel do not compare with the expected address after two attempts, the unit is removed from the test.

5.8 Unit N Aborted Excessive Errors

Each unit under test is initialized to permit the typing of 200 error messages. If any unit exceeds this limit it is removed from the test. Type an "S" to reset the error counter and re-start the test.

5.9 All Units Removed From Test

If during program operation, the unit count is found to be zero due to program aborts or console removal (section 3.7) a message is typed and control is returned to the console.

## METHOD:

1.0 WRITING

At the beginning of the write pass all units under test are rewound and erased forward approximately 3.5 inches. A random length record of random numbers is generated within the program and is used to write 3 records on the first tape in the unit list. The whole record is first written using the function codes IOSP and IOSD. The first half of the generated record is then written to tape with the IORP function code. The third record is the last half of the generated record and is written with an IORD function code. This process is repeated for all units under test, after which, another record is generated and writing returns to the first tape in the unit list.

The IOSP arms both the zero word count and end of record interrupts, whereas the IOSD, IORP, and IORD only arm the end of record interrupt.

METHOD:  
(Cont)1.1 Write Error

If a write error occurs the program erases backward to the front of this record and attempts to rewrite it. If this second attempt is also in error then the program outputs the rewrite error message. It then erases backward over the record again, erases it forward and attempts to write the record again on a new section of tape. An error here is considered a new write error and the process continues until a correct write is made.

1.2 Write Count Error

After each write operation the channel is PINned and compared with the expected terminating address. If they differ an error note is typed indicating the mode, density, unit, channel and two octal numbers which represent the number of words written (result of PINning the channel) and the number of words attempted. After the note a space reverse is performed and a re-write is attempted. If unsuccessful the error note will again be printed followed by an abort message (see 5.7).

1.3 End of Pass

The write pass is concluded if one of two conditions occurs: Either the write record count reaches the maximum record count or an end of reel is encountered on any tape under test. When one of these occurs the program writes an end of file on all units and outputs the end of pass message. It then rewinds all units and proceeds to the read pass.

2.0 READING

A read pass is similar to a write except that the program reads each record into memory and compares it with the random numbers which it regenerates for each read. In addition, the proceed mode of reading is inhibited (IORF) such that the tape will stop and test ready before proceeding to the next read operation. The first record must be read starting from the load point. This insures that the tape is always positioned properly for the start of the pass.

METHOD:  
(Cont)2.1 Read Errors

When a read error occurs the program will always reread the record nine more times for a total of 10 attempts regardless of whether or not a subsequent read was correct. It concurrently outputs the results of these reads. Several conditions can cause a read error.

2.1.1 Character Parity Errors

The program counts a character parity error as any channel error which occurs before zero word count.

2.1.2 Longitudinal Parity Error

If no channel errors have occurred before the zero word count is reached and the channel error is on after the tape stops, the program counts a longitudinal parity error.

2.1.3 Data Compare Error

Any data word (except identifier) which does not compare with the word expected is considered cause for nine re-reads.

2.1.4 Read Count Error

After each read operation the channel is PINned and the results compared with the expected terminating address. If they differ the record is re-read nine times.

3.0 BCD MODE

In the BCD mode random numbers are generated and written the same as in binary. However, on the read pass all non compares between the generated number and the number from tape are checked to see if they are caused by the 12 to 00 conversion. This occurs because both the character 00 and the character 12 will be written on tape as a 12 but this character will always be read into memory as a 00.

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SDS 900 SERIES PROGRAM LIBRARY

PROGRAM DESCRIPTION

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Catalog No. 020012

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IDENTIFICATION: Paper Tape Reproducer Program

*No INTERLACE*

AUTHOR: A. W. England, SDS

ACCEPTED: 15 August 1963

COMPUTER  
CONFIGURATION: Any 910 or 920 with punch, reader, and typewriter.

PURPOSE: To reproduce paper tape.

PROGRAMMED  
OPERATORS: N/A

STORAGE: The program occupies  $270_{10}$  locations from  $200_8$  to  $616_8$ . The next 512 words are reserved for record table storage. The remainder of memory is used to hold the records of the tape to be reproduced.

TIMING: All operations proceed at the maximum rate of either the punch (60 characters per second) or the reader (300 characters per second).

USE: I. TO LOAD PROGRAM

- A. Insert tape in reader.
- B. With COMPUTE switch in IDLE press START button.
- C. Move COMPUTE switch to RUN.
- D. Set BP 1.
- E. Raise and lower FILL switch.

II. TO REPRODUCE A TAPE

A tape may be reproduced by first reading it, then verifying it, punching one or several copies of it, and finally verifying the copies. Each of these functions of the program will be described below. Upon

## USE: (Cont)

completion of each function, control will be returned to the operator via the typewriter, which is signified by the illuminated typewriter light and the presence of 000001 in the I/O address lights.

A function is initiated by typing one control letter; R, V, or P. The letter P may be preceded by a number to indicate the number of copies to be made.

Below is the procedure for reproducing tapes:

## A. Read

1. Place the tape to be reproduced in the reader.
2. RESET BP 1.
3. Type R.
4. When the tape runs out of the reader, SET BP 1.

## B. Verify

1. Place the tape to be verified in the reader.
2. Reset BP 1.
3. If there is only one copy to be verified or if there are several copies to be verified one at a time, RESET BP 2.
4. Type V. The tape will be read and verified. If an error is found, the reader will stop at the end of the copy and the program will type VERIFY ERROR.
5. If several copies are to be verified at once, SET BP 2 and type V.

When the tape runs out of reader or onto the the last length of trailer, SET BP 1.

## C. Punch

After the tape has been read and verified, it may be punched as follows:

USE: (Cont)

1. If the tape is to have a short leader RESET BP 3. If it is to have a long leader (for mounting on a reel) SET BP 3.
2. If the tape is to have a short trailer, RESET BP 4. If it is to have a long trailer (for mounting on a reel), SET BP 4.
3. If only one copy is to be made, RESET BP 2 and type P. When the copy has been punched the light will come on.
4. If more than one copy is to be punched, SET BP 2 and type a carriage return, then the number of copies to be made, and the letter P. The program will punch the desired number of copies and stop. If it appears that there is not sufficient paper tape to punch all the copies, BP 2 may be RESET and the program will stop after the copy it is then punching.

D. Verify New Tape

Follow procedure as outlined in B above.

III. ERRORS

A. Reading

1. If a Read error occurs, the program will stop the tape and type READ ERROR.
2. If the tape to be reproduced exceeds the capacity of memory, the program will stop the tape and type STORAGE FULL.
3. If the tape to be reproduced has more than 512 blocks on it, the program will stop the tape and type TABLE FULL.

B. Verifying

If a copy fails verification, the program will stop the tape after that copy and type VERIFY ERROR.

IV. BREAKPOINTS

| <u>BP NO.</u> | <u>RESET</u>  | <u>SET</u>   |
|---------------|---------------|--------------|
| 1             | Normal        | Stop         |
| 2             | One           | Many         |
| 3             | Short Leader  | Long Leader  |
| 4             | Short Trailer | Long Trailer |

## METHOD:

When a tape is read, the program records the gap length preceding the punched information and stores this in the record table. It also maintains the starting addresses of each record read. When Breakpoint 1 is set, the read is stopped and an end indicator is inserted in the table.

Verify is similar to read except that no attempt is made to verify the length of gaps. Each word of the record read from tape is compared with the corresponding word in memory. Any disagreement is indicated.

Punching utilizes the gap count generated during read to reproduce the proper length gaps between records. Each record is punched from memory with gaps as required. At the beginning and end of the tape the program punches either short (3 feet) or long (10 feet) leader depending on the settings of Breakpoints 3 and 4.

## SDS 900 SERIES PROGRAM LIBRARY

## PROGRAM LISTING

## Paper Tape Reproducer Program

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|       |            |       | LIST        | PAPER TAPE REPRODUCER |
|-------|------------|-------|-------------|-----------------------|
| 00200 | 0 71 00027 | BEGIN | LDX SC5     |                       |
| 00201 | 0 76 00026 |       | LDA SC4     |                       |
| 00202 | 2 35 00000 |       | STA 0.2     |                       |
| 00203 | 2 72 00000 |       | SKA 0.2     |                       |
| 00204 | 0 01 00207 |       | BRU *+3     |                       |
| 00205 | 2 77 34000 |       | EAX NEG2K.2 |                       |
| 00206 | 0 01 00201 |       | BRU *-5     |                       |
| 00207 | 0 37 00612 |       | STX LIMIT   |                       |
| 00210 | 0 76 00244 |       | LDA R8      |                       |
| 00211 | 0 35 00001 |       | STA 1       |                       |
| 00212 | 0 02 20004 | ENTER | DIR         |                       |
| 00213 | 0 02 00001 |       | E9M RKBW1   |                       |
| 00214 | 0 32 00012 |       | WIM T       |                       |
| 00215 | 0 76 00012 |       | LDA T       |                       |
| 00216 | 0 75 00255 |       | LDB C4      | 77                    |
| 00217 | 0 70 00252 |       | SKM R       |                       |
| 00220 | 0 01 00222 |       | BRU *+2     | N8T R                 |
| 00221 | 0 01 00256 |       | BRU READ    |                       |
| 00222 | 0 70 00253 |       | SKM P       |                       |
| 00223 | 0 01 00225 |       | BRU *+2     | N8T P                 |
| 00224 | 0 01 00373 |       | BRU PUNCH   |                       |
| 00225 | 0 70 00254 |       | SKM V       |                       |
| 00226 | 0 01 00230 |       | BRU *+2     | N8T V                 |
| 00227 | 0 01 00471 |       | BRU VERIFY  |                       |
| 00230 | 0 70 00247 |       | SKM CR      |                       |
| 00231 | 0 01 00233 |       | BRU *+2     | N8T CR                |
| 00232 | 0 01 00245 |       | BRU CLEAR   |                       |
| 00233 | 0 14 00255 | DIGIT | ETR C4      | ACCUMULATE DIGITS     |
| 00234 | 0 35 00012 |       | STA T       |                       |
| 00235 | 0 46 30003 |       | RCH 30003   |                       |
| 00236 | 0 76 00250 |       | LDA PCNT    |                       |
| 00237 | 0 67 00001 |       | LSH 1       |                       |
| 00240 | 0 55 00250 |       | ADD PCNT    |                       |
| 00241 | 0 67 00001 |       | LSH 1       |                       |
| 00242 | 0 55 00012 |       | ADD T       |                       |
| 00243 | 0 35 00250 |       | STA PCNT    |                       |
| 00244 | 0 01 00212 | R8    | BRU ENTER   |                       |
| 00245 | 0 46 30003 | CLEAR | RCH 30003   | CLEAR PCNT            |
| 00246 | 0 01 00243 |       | BRU *-3     |                       |
| 00247 | 00000052   | CR    | 9CT 52      |                       |
| 00250 | 0 00 00000 | PCNT  | PZE         |                       |
| 00251 | 0 00 00000 | RPCNT | PZE         |                       |
| 00252 | 00000051   | R     | 9CT 51      |                       |
| 00253 | 00000047   | P     | 9CT 47      |                       |
| 00254 | 00000065   | V     | 9CT 65      |                       |
| 00255 | 00000077   | C4    | 9CT 77      |                       |
| 00256 | 0 76 00575 | READ  | LDA R1      | SET INTERRUPTS        |
| 00257 | 0 75 00576 |       | LDB R2      | /                     |
| 00260 | 0 35 00031 |       | STA IIW     | /BRU C9NB             |

|       |            |         |       |                          |
|-------|------------|---------|-------|--------------------------|
| 00261 | 0 36 00033 | STB     | I2W   | /BRU I2RD                |
| 00262 | 0 76 00611 | LDA     | START | STARTING ADDRESS 8F STOR |
| 00263 | 0 35 00610 | STA     | ADDR  |                          |
| 00264 | 0 35 00616 | STA     | TBL   |                          |
| 00265 | 0 71 00574 | LUX     | TBLS  | TABLE SIZE T8 TBLC       |
| 00266 | 0 02 20002 | EIR     |       | ENABLE INTERRUPT         |
| 00267 | 0 02 03604 | E8M     | RPTW4 | START READER             |
| 00270 | 0 00 00000 | WAIT I1 | HLT   | WAIT I1                  |
| 00271 | 0 32 40610 | C8NB    | WIM*  | ADDR                     |
| 00272 | 0 61 00610 |         | MIN   | ADDR                     |
| 00273 | 0 76 00612 |         | LDA   | LIMIT                    |
| 00274 | 0 73 00610 |         | SKG   | ADDR                     |
| 00275 | 0 01 40323 |         | BRU*  | E3                       |
| 00276 | 0 01 40277 |         | BRU*  | **1                      |
| 00277 | 0 00 00270 |         | PZE   | WAIT I1                  |
| 00300 | 0 40 20010 | I2RD    | SKS   | SBEW                     |
| 00301 | 0 01 40321 |         | BRU*  | E1                       |
| 00302 | 0 32 00014 |         | WIM   | T+2                      |
| 00303 | 0 76 00014 |         | LDA   | T+2                      |
| 00304 | 0 72 00026 |         | SKA   | SC4                      |
| 00305 | 0 01 40321 |         | BRU*  | E1                       |
| 00306 | 0 41 00310 |         | BRX   | **2                      |
| 00307 | 0 01 40322 |         | BRU*  | E2                       |
| 00310 | 0 76 00610 |         | LDA   | ADDR                     |
| 00311 | 2 35 01616 |         | STA   | TBLE.2                   |
| 00312 | 0 76 00577 |         | LDA   | R3                       |
| 00313 | 0 35 00031 |         | STA   | I1W                      |
| 00314 | 0 76 00320 |         | LDA   | BIAS                     |
| 00315 | 0 02 03604 |         | E8M   | RPTW4                    |
| 00316 | 0 01 40317 |         | BRU*  | **1                      |
| 00317 | 0 00 00324 |         | PZE   | C8NT                     |
| 00320 | 77700000   | BIAS    | 8CT   | 77700000                 |
| 00321 | 0 00 00343 | E1      | PZE   | ERR1                     |
| 00322 | 0 00 00355 | E2      | PZE   | ERR2                     |
| 00323 | 0 00 00364 | E3      | PZE   | ERR3                     |
| 00324 | 0 55 00557 | C8NT    | AUD   | C1                       |
| 00325 | 0 40 20400 |         | SKS   | BPI                      |
| 00326 | 0 01 00336 |         | BRU   | ST8P                     |
| 00327 | 0 01 00324 |         | BRU   | **3                      |
| 00330 | 0 14 00560 | C8NA    | ETR   | C2                       |
| 00331 | 2 16 01616 |         | MRG   | TBLE.2                   |
| 00332 | 2 35 01616 |         | STA   | TBLE.2                   |
| 00333 | 0 76 00575 |         | LDA   | R1                       |
| 00334 | 0 35 00031 |         | STA   | I1W                      |
| 00335 | 0 01 00271 |         | BRU   | C8NB                     |
| 00336 | 2 76 01616 | ST8P    | LDA   | TBLE.2                   |
| 00337 | 0 16 00025 |         | MRG   | SC3                      |
| 00340 | 2 35 01616 |         | STA   | TBLE.2                   |
| 00341 | 0 02 00000 |         | E8M   | 0                        |
| 00342 | 0 01 00212 |         | BRU   | ENTER                    |

|       |            |       |     |        |                    |
|-------|------------|-------|-----|--------|--------------------|
| 00343 | 0 02 00000 | ERR1  | E8M | 0      |                    |
| 00344 | 0 02 20004 |       | DIR |        |                    |
| 00345 | 0 02 03641 |       | E8M | TYPW4  |                    |
| 00346 | 0 12 00562 |       | MIW | EM1    | CR REA             |
| 00347 | 0 12 00563 |       | MIW | EM1+1  | D SP ER            |
| 00350 | 0 12 00564 |       | MIW | EM1+2  | R8R CR             |
| 00351 | 0 02 14000 | T8P   | E8M | T8PW   |                    |
| 00352 | 0 40 21000 |       | SKS | SBRW   |                    |
| 00353 | 0 01 00352 |       | BRU | *-1    |                    |
| 00354 | 0 01 00212 |       | BRU | ENTER  |                    |
| 00355 | 0 02 00000 | ERR2  | E8M | 0      |                    |
| 00356 | 0 02 20004 |       | DIR |        |                    |
| 00357 | 0 02 03641 |       | E8M | TYPW4  |                    |
| 00360 | 0 12 00565 |       | MIW | EM2    | CR TAH             |
| 00361 | 0 12 00566 |       | MIW | EM2+1  | LE SP F            |
| 00362 | 0 12 00567 |       | MIW | EM2+2  | U LL CR            |
| 00363 | 0 01 00351 |       | BRU | T8P    |                    |
| 00364 | 0 02 20004 | ERR3  | DIR |        |                    |
| 00365 | 0 02 03641 |       | E8M | TYPW4  |                    |
| 00366 | 0 12 00570 |       | MIW | EM3    | CR ST8             |
| 00367 | 0 12 00571 |       | MIW | EM3+1  | R AGE              |
| 00370 | 0 12 00572 |       | MIW | EM3+2  | SP FUL             |
| 00371 | 0 12 00573 |       | MIW | EM3+3  | L . . CR           |
| 00372 | 0 01 00351 |       | BRU | T8P    |                    |
| 00373 | 0 76 00250 | PUNCH | LDA | PCNT   |                    |
| 00374 | 0 54 00024 |       | SUB | SC2    |                    |
| 00375 | 0 35 00251 |       | STA | RPCNT  |                    |
| 00376 | 0 76 00600 |       | LDA | R4     |                    |
| 00377 | 0 35 00424 |       | STA | SW1    | /                  |
| 00400 | 0 71 00574 |       | LUX | TBL5   |                    |
| 00401 | 2 76 01616 |       | LDA | TBLE.2 |                    |
| 00402 | 0 14 00027 |       | ETR | SC5    |                    |
| 00403 | 0 35 00610 |       | STA | ADDR   |                    |
| 00404 | 0 76 00614 |       | LDA | SLC    | SHORT LEADER COUNT |
| 00405 | 0 40 20100 |       | SKS | BP3    |                    |
| 00406 | 0 76 00613 |       | LDA | LLC    | LONG LEADER COUNT  |
| 00407 | 0 02 20004 |       | DIR |        |                    |
| 00410 | 0 14 00560 | C8NE  | ETR | C2     |                    |
| 00411 | 0 37 00012 |       | STX | T      |                    |
| 00412 | 0 02 01644 | L88P  | E8M | PPTW4  |                    |
| 00413 | 0 54 00561 |       | SUB | C3     |                    |
| 00414 | 0 72 00025 |       | SKA | SC3    |                    |
| 00415 | 0 01 00423 |       | BRU | SW1-1  |                    |
| 00416 | 0 71 00422 |       | LUX | PWC    |                    |
| 00417 | 0 35 00013 |       | STA | T+1    | KILL TIME          |
| 00420 | 0 41 00417 |       | BRX | *-1    |                    |
| 00421 | 0 01 00412 |       | BRU | L88P   |                    |
| 00422 | 00060000   | PWC   | 8CT | 60000  |                    |
| 00423 | 0 71 00012 |       | LUX | T      |                    |
| 00424 | 0 20 00000 | SW1   | N8P |        |                    |

|       |   |    |       |        |      |           |                 |
|-------|---|----|-------|--------|------|-----------|-----------------|
| 00425 | 2 | 76 | 01617 |        | LDA  | TABLE+1.2 |                 |
| 00426 | 0 | 14 | 00027 |        | ETR  | SC5       |                 |
| 00427 | 0 | 12 | 40610 | OUT    | MIW* | ADDR      |                 |
| 00430 | 0 | 61 | 00610 |        | MIN  | ADDR      |                 |
| 00431 | 0 | 73 | 00610 |        | SKG  | ADDR      |                 |
| 00432 | 0 | 01 | 00434 |        | BRU  | **2       |                 |
| 00433 | 0 | 01 | 00427 |        | BRU  | OUT       |                 |
| 00434 | 0 | 02 | 14000 |        | E8M  | T8PW      |                 |
| 00435 | 0 | 41 | 00436 |        | BRX  | **1       |                 |
| 00436 | 0 | 40 | 21000 |        | SKS  | SBRW      |                 |
| 00437 | 0 | 01 | 00436 |        | BRU  | *-1       |                 |
| 00440 | 2 | 53 | 01616 |        | SKN  | TABLE.2   |                 |
| 00441 | 0 | 01 | 00450 |        | BRU  | C8NF      |                 |
| 00442 | 0 | 76 | 00601 | C8NC   | LDA  | R5        | N8T D8NE        |
| 00443 | 0 | 35 | 00424 |        | STA  | SW1       | D8NE            |
| 00444 | 0 | 76 | 00614 |        | LDA  | SLC       | S(SW1) BRU C8ND |
| 00445 | 0 | 40 | 20040 |        | SKS  | BP4       |                 |
| 00446 | 0 | 76 | 00613 |        | LDA  | LLC       |                 |
| 00447 | 0 | 01 | 00410 |        | BRU  | C8NE      |                 |
| 00450 | 2 | 76 | 01616 | C8NF   | LDA  | TABLE.2   |                 |
| 00451 | 0 | 14 | 00027 |        | ETR  | SC5       |                 |
| 00452 | 0 | 35 | 00610 |        | STA  | ADDR      |                 |
| 00453 | 2 | 76 | 01616 |        | LDA  | TABLE.2   |                 |
| 00454 | 0 | 01 | 00410 |        | BRU  | C8NE      |                 |
| 00455 | 0 | 02 | 14000 | C8ND   | E8M  | T8PW      |                 |
| 00456 | 0 | 40 | 21000 |        | SKS  | SBRW      |                 |
| 00457 | 0 | 01 | 00456 |        | BRU  | *-1       |                 |
| 00460 | 0 | 40 | 20200 |        | SKS  | BP2       |                 |
| 00461 | 0 | 01 | 00463 |        | BRU  | **2       |                 |
| 00462 | 0 | 01 | 00212 |        | BRU  | ENTER     |                 |
| 00463 | 0 | 76 | 00251 |        | LDA  | RPCNT     |                 |
| 00464 | 0 | 54 | 00024 |        | SUB  | SC2       |                 |
| 00465 | 0 | 35 | 00251 |        | STA  | RPCNT     |                 |
| 00466 | 0 | 72 | 00025 |        | SKA  | SC3       |                 |
| 00467 | 0 | 01 | 00212 |        | BRU  | ENTER     |                 |
| 00470 | 0 | 01 | 00376 |        | BRU  | PUNCH+3   |                 |
| 00471 | 0 | 76 | 00602 | VERIFY | LDA  | R6        | BRU V1          |
| 00472 | 0 | 75 | 00603 |        | LDB  | R7        | BRU V2          |
| 00473 | 0 | 35 | 00031 |        | STA  | I1W       |                 |
| 00474 | 0 | 36 | 00033 |        | STB  | I2W       |                 |
| 00475 | 0 | 71 | 00574 | C8NTV  | LDX  | TRLS      |                 |
| 00476 | 0 | 46 | 30003 |        | RCH  | 30003     |                 |
| 00477 | 0 | 35 | 00615 |        | STA  | VFLG      | R(VFLG)         |
| 00500 | 2 | 76 | 01616 |        | LDA  | TABLE.2   |                 |
| 00501 | 0 | 72 | 00025 |        | SKA  | SC3       |                 |
| 00502 | 0 | 01 | 00543 |        | BRU  | VD8NE     |                 |
| 00503 | 0 | 14 | 00027 |        | ETR  | SC5       |                 |
| 00504 | 0 | 35 | 00610 |        | STA  | ADDR      |                 |
| 00505 | 0 | 75 | 00026 | VL88P  | LDB  | SC4       |                 |
| 00506 | 0 | 02 | 03604 |        | E8M  | RPTW4     |                 |

|       |            |       |      |                                     |        |
|-------|------------|-------|------|-------------------------------------|--------|
| 00507 | 0 02 20002 |       | EIR  |                                     |        |
| 00510 | 0 40 20400 | PAUSE | SKS  | BP1                                 |        |
| 00511 | 0 01 00212 |       | BRU  | ENTER                               |        |
| 00512 | 0 01 00510 |       | BRU  | *-2                                 |        |
| 00513 | 0 32 00016 | V1    | WIM  | T+4                                 |        |
| 00514 | 0 76 00016 |       | LDA  | T+4                                 |        |
| 00515 | 0 70 40610 |       | SKM* | ADDR                                |        |
| 00516 | 0 36 00615 |       | STB  | VFLG                                |        |
| 00517 | 0 61 00610 |       | MIN  | ADDR                                |        |
| 00520 | 0 01 40521 |       | BRU* | *+1                                 |        |
| 00521 | 0 00 00510 |       | PZE  | PAUSE                               |        |
| 00522 | 0 32 00016 | V2    | WIM  | T+4                                 |        |
| 00523 | 0 40 20010 |       | SKS  | SBEW                                |        |
| 00524 | 0 36 00615 |       | STB  | VFLG                                |        |
| 00525 | 0 76 00016 |       | LDA  | T+4                                 |        |
| 00526 | 0 72 00026 |       | SKA  | SC4                                 |        |
| 00527 | 0 36 00615 |       | STB  | VFLG                                |        |
| 00530 | 0 76 00610 |       | LDA  | ADDR                                |        |
| 00531 | 0 75 00027 |       | LDB  | SC6                                 |        |
| 00532 | 0 01 40533 |       | BRU* | *+1                                 |        |
| 00533 | 0 00 00534 |       | PZE  | *+1                                 |        |
| 00534 | 2 70 01617 |       | SKM  | TBLE+1.2                            |        |
| 00535 | 0 01 00540 |       | BRU  | V2A                                 |        |
| 00536 | 0 41 00500 |       | BRX  | C0NTV+3                             |        |
| 00537 | 0 01 00545 |       | BRU  | ERR4                                |        |
| 00540 | 0 76 00026 | V2A   | LDA  | SC4                                 |        |
| 00541 | 0 35 00615 |       | STA  | VFLG                                |        |
| 00542 | 0 01 00536 |       | BRU  | *-4                                 |        |
| 00543 | 0 53 00615 | VDONE | SKN  | VFLG                                |        |
| 00544 | 0 01 00554 |       | BRU  | VC0NT                               |        |
| 00545 | 0 02 20004 | ERR4  | DIR  |                                     |        |
| 00546 | 0 02 03641 |       | E0M  | TYPW4                               |        |
| 00547 | 0 12 00604 |       | MIW  | EM4                                 | CR VER |
| 00550 | 0 12 00605 |       | MIW  | EM4+1                               | IFY SP |
| 00551 | 0 12 00606 |       | MIW  | EM4+2                               | ERRB   |
| 00552 | 0 12 00607 |       | MIW  | EM4+3                               | R.. CR |
| 00553 | 0 01 00351 |       | BRU  | T0P                                 |        |
| 00554 | 0 40 20200 | VC0NT | SKS  | BP2                                 |        |
| 00555 | 0 01 00475 |       | BRU  | C0NTV                               |        |
| 00556 | 0 01 00212 |       | BRU  | ENTER                               |        |
| 00557 | 00000100   | C1    | 0CT  | 100                                 |        |
| 00560 | 37700000   | C2    | 0CT  | 37700000                            |        |
| 00561 | 00100000   | C3    | 0CT  | 00100000                            |        |
| 00562 | 52512521   | EM1   | 0CT  | 52512521.24122551.51465152          |        |
| 00565 | 52632122   | EM2   | 0CT  | 52632122.43251226.64434352          |        |
| 00570 | 52626346   | EM3   | 0CT  | 52626346.51212725.12266443.43333352 |        |
| 00574 | 77777000   | TBL6  | DEC  | -512                                |        |
| 00575 | 0 01 00271 | R1    | BRU  | C0NB                                |        |
| 00576 | 0 01 00300 | R2    | BRU  | I2RD                                |        |
| 00577 | 0 01 00330 | R3    | BRU  | C0NA                                |        |

|       |            |       |      |                                     |
|-------|------------|-------|------|-------------------------------------|
| 00600 | 0 20 00000 | R4    | NBP  |                                     |
| 00601 | 0 01 00455 | R5    | BRU  | CAND                                |
| 00602 | 0 01 00513 | R6    | BRU  | V1                                  |
| 00603 | 0 01 00522 | R7    | BRU  | V2                                  |
| 00604 | 52652551   | EM4   | BCT  | 52652551.31267012.25515146.51333352 |
| 00610 | 0 00 00000 | ADDR  | PZE  |                                     |
| 00611 | 0 00 01616 | START | PZE  | TABLE                               |
| 00612 | 0 00 00000 | LIMIT | PZE  |                                     |
| 00613 | 16000000   | LLC   | BCT  | 16000000                            |
| 00614 | 04400000   | SLC   | BCT  | 04400000                            |
| 00615 | 0 00 00000 | VFLG  | PZE  |                                     |
| 00616 | 0 00 00000 | TBL   | PZE  |                                     |
|       | 01616      | TABLE | EQU  | TBL+512                             |
|       | 03604      | RPTW4 | B00L | 03604                               |
|       | 20010      | SBEW  | B00L | 20010                               |
|       | 20400      | BP1   | B00L | 20400                               |
|       | 20200      | BP2   | B00L | 20200                               |
|       | 20100      | BP3   | B00L | 20100                               |
|       | 20040      | BP4   | B00L | 20040                               |
|       | 00023      | SC1   | B00L | 23                                  |
|       | 00024      | SC2   | B00L | 24                                  |
|       | 00025      | SC3   | B00L | 25                                  |
|       | 00026      | SC4   | B00L | 26                                  |
|       | 00027      | SC5   | B00L | 27                                  |
|       | 03641      | TYPW4 | B00L | 03641                               |
|       | 14000      | TBPW  | B00L | 14000                               |
|       | 21000      | SBRW  | B00L | 21000                               |
|       | 00012      | T     | B00L | 12                                  |
|       | 01644      | PPTW4 | B00L | 01644                               |
|       | 00001      | RKBW1 | B00L | 00001                               |
|       | 34000      | NEG2K | B00L | 34000                               |
|       | 00031      | I1W   | B00L | 31                                  |
|       | 00033      | I2W   | B00L | 33                                  |
|       | 00200      | END   |      | BEGIN                               |

SDS 900 SERIES PROGRAM LIBRARY  
PROGRAM DESCRIPTION

PUNCHED PPT LOADER  
NO INTERLACE

Page 1 of 2

Catalog No. 040003

REC REGION Q735

IDENTIFICATION: Paper Tape and Magnetic Tape Copier

AUTHOR: Reider D. Andersen and Philip H. Hartman, SDS

ACCEPTED: March 24, 1964

COMPUTER  
CONFIGURATION: Any 900 series computer with 4K memory and one  
magnetic tape unit

PURPOSE: To copy paper tape to magnetic tape and magnetic tape  
to paper tape.

PROGRAMMED  
OPERATORS: None

STORAGE: Locations 200<sub>g</sub> to 733<sub>g</sub> and 733<sub>g</sub> to end of memory for  
buffer area

TIMING: N/A

USE: I. LOADING

The program is loaded via the standard FILL procedure.  
Set the necessary Breakpoints before loading.

II. PROGRAM RESTART

Move the RUN-IDLE-STEP switch to IDLE, press START,  
move the switch to step and then to RUN. Or, BRU to  
location 200<sub>g</sub>.

III. OPERATION

|    | <u>Breakpoints Set</u> | <u>Operation</u>                                                                                       |
|----|------------------------|--------------------------------------------------------------------------------------------------------|
| A. | 1                      | Paper tape to magnetic tape<br>unit 1 (continued until halted).                                        |
| B. | 2                      | Magnetic tape unit 1 to paper<br>tape (continues until halted<br>or an End-of-File is<br>encountered). |

| USE: (Cont) | <u>Breakpoints Set</u> | <u>Operation</u>                                                                                            |
|-------------|------------------------|-------------------------------------------------------------------------------------------------------------|
| C.          | 1, 2                   | Verify Magnetic tape unit 1 and paper tape input (continues until halted or an End-of-File is encountered). |
| D.          | 1, 4                   | Same as A, but halts after each record.                                                                     |
| E.          | 1, 2, 4                | Same as C, but halts after each record.                                                                     |
| F.          | 2, 4                   | Same as B, but halts after each read and each punch output.                                                 |
| G.          | 1, 3, 4                | Backspace one record on Magnetic tape unit 1.                                                               |
| H.          | 1, 3                   | Backspace one file on Magnetic tape unit 1.                                                                 |
| I.          | 2, 3, 4                | Skip one record on Magnetic tape unit 1.                                                                    |
| J.          | 2, 3                   | Skip one file on Magnetic tape unit 1.                                                                      |
| K.          | 1, 2, 3                | Write an END-OF-FILE mark on Magnetic tape unit 1.                                                          |
| L.          | 1, 2, 3, 4             | Rewind Magnetic tape unit 1.                                                                                |

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SDS 900 SERIES PROGRAM LIBRARY  
PROGRAM DESCRIPTION

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Page 1 of 2

Catalog No. 094016

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IDENTIFICATION: Power Fail-Safe Interrupt Tester

AUTHOR: J. Gaines, SDS

ACCEPTED: 13 April 1964

COMPUTER CONFIGURATION: Any 910, 920, or 930

PURPOSE: To provide a program to test the Power Fail-Safe Interrupt System

PROGRAMMED OPERATORS: None

STORAGE: 323<sub>8</sub> locations

TIMING: N/A

USE: 1.0 This program gives the user the ability to go through a power OFF/ON cycle and provides a positive indication when an error occurs. The operation is as follows:

- 1.1 Set Breakpoint 2.
- 1.2 Load the paper tape by the normal FILL procedure.
- 1.3 The operator can proceed with an OFF/ON cycle at this point (i. e., turn computer OFF then ON). \* As far as the routine is concerned, there is no limit to the speed with which power can be turned off and on.
- 1.4 If an error that disrupts the program occurs during an OFF/ON cycle, the computer halts.

Clear the halt to return to the program which then awaits another OFF/ON cycle (paragraph 1.3).

\*Halting of the computer after setting Breakpoint 2 but prior to the OFF/ON cycle implies a memory failure independent of the Fail Safe interrupts. If such an error occurs, go to paragraph 1.5 a couple of seconds.

If the user suspects memory failure, he  
SDS Catalog No. 004007.

the Memory Tester Routine,

A slow off-on alternation of the most significant active bit in the P Register gives the user a simple visual indicator of whether the program is continuing to run properly.

- 1.5 To re-initialize, if it is necessary, branch to location 00001, set Breakpoint 2 and return to paragraph 1.3.

**METHOD:**

The program contains three parts: a power off routine, a power on routine, and a larger routine which forms the interrupted program during the OFF/ON cycle. This latter routine generates and tests random numbers endlessly.

**SDS PROGRAM LIBRARY  
PROGRAM DESCRIPTION**

Page 1 of 3

Catalog No. 394001

IDENTIFICATION: Model EJ-30 System Junction Box Digital Checkout Program

AUTHOR: A. Kliszewski, SDS

ACCEPTED: November 11, 1964

COMPUTER  
CONFIGURATION: SDS 930 computer with EJ-30 junction box, and an A/D converter.

Also required: special test cable (Part No. 110047).

PURPOSE: To checkout the digital portion of the EJ-30 junction box.

PROGRAMMED  
OPERATORS: BID

STORAGE: Octal locations: 12-15, 23-26, 100, 101, 172, 200-577,  
640-777

TIMING: Function of use.

USE: Loading is by FILL procedure.

Restart is by IDLE, START, STEP, RUN.

Breakpoint Control

BP1 and BP2 are interpreted together (binary coded) as the PIN input connector to which the test cable is connected.

One or both of them must be set at all times.

BP3 set causes the program to type out the number of successful loops completed and halt.

BP4 set causes the POT-PIN diagnostic routine to be entered.

USE: (Cont)

Error Indications

Two kinds of errors are detected:

- a. SKS errors (SKIP when no SKIP was expected or vice versa).
- b. PIN-POT errors (the word POTted out differs from the word PINned in).

Whenever an SKS error is detected, the program halts in the SKSERR subroutine. The SKS instruction which caused the error is in the A register. To continue as though no error had been detected, clear the HALT.

Whenever a PIN-POT error is detected, the program halts in the PIN ERR subroutine. The A register then contains the word POTted out, while the word PINned in is in the B register. To continue as though no error has been detected, clear the HALT.

PIN-POT Diagnostic Routine

This routine is entered when restarting the program with BP4 set. It halts to allow the user to set the A, B and X registers. It then performs the following:

POT out contents of A register to EJ-30 POT register,

PIN in the EJ-30 POT register through the appropriate connector,

Stall (based on contents of X register),

POT out contents of B register to EJ-30 POT register,

PIN in the EJ-30 POT register through the appropriate connector,

Stall,

Repeat the sequence indefinitely.

METHOD: If BP4 is set, only the PIN-POT diagnostic routine is executed.

Otherwise the program performs all the tests possible with the given connection. These include:

SKS tests if cable is connected to PIN input No. 1 or No. 2.

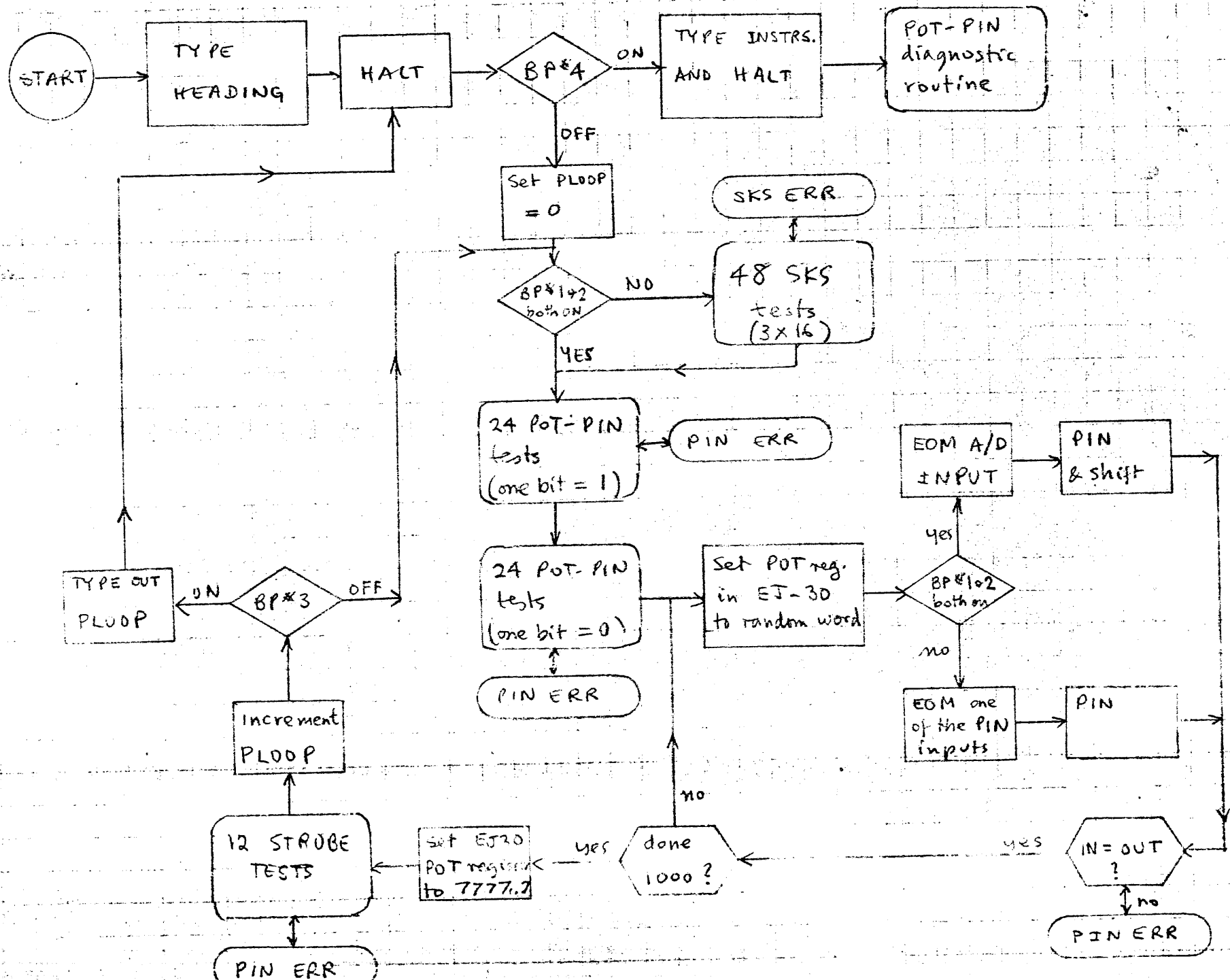
POT-PIN tests

POT-PIN test through ADC if cable is connected to PIN input No. 3

"Strobe" pulse tests

In the absence of errors, the program will keep repeating these tests until BP3 is set. It will then halt to allow the user to change connections.

# General Flow in the EJ-30 Test Program



C. 15 Dec  
11-2-64

EJ30 CHANGES SO  
TEST WILL WORK OK

---

| <u>DELETE</u> | OP014 | A 0 4 | J 24 | E 04 |
|---------------|-------|-------|------|------|
|               | OP015 | 4     | 24   | 04   |
|               | 1F060 | 4     | 24   | 14   |
|               | 2F060 | 4     | 24   | 15   |
|               | OALRT | 4     | 24   | 17   |
|               | OP014 | 3     | 14   | 25   |
|               | OP015 | 3     | 14   | 22   |

| <u>ADD</u> | 2F060 | 4 | 24 | 17 |
|------------|-------|---|----|----|
|            | 1AD14 | 4 | 18 | 34 |
|            | 1AD15 | 4 | 18 | 35 |
|            | 1AD14 | 3 | 14 | 25 |
|            | 1AD15 | 3 | 14 | 22 |

| <u>DELETE</u> | OT002  | 4 | 06 | 43 |
|---------------|--------|---|----|----|
|               | GROUND | 3 | 17 | 39 |

| <u>ADD</u> | PT001 | 4 | 06 | 43 |
|------------|-------|---|----|----|
|            | OP0T1 | 3 | 17 | 39 |

L. Israel  
26 Oct 1964

### EJ30 CLOSED-LOOP TEST

Part No. 110047 is a cable for use in a closed-loop test of the EJ30. Pins 20-43 at the "input" end of the cable are connected directly to pin 20-43 at the "output" end of the cable. Also, pins 1-12 at the "output" end are connected respectively to pins 20-31 on that same cable card, and pins 1-16 at the "input" end are connected respectively to pins 20-35 on that same cable card.

1. The "output" end of the cable should be plugged to A04J05 of the EJ30 (POT output register connector).
2. When the "input" end of the cable is plugged to A04J20 of the EJ30 (PIN input # 1), the POT register is fed back to the # 1 PIN inputs, and the high order 16 bits of the POT register are fed back (respectively) to SKS test lines 00-15.
3. When the "input" end of the cable is plugged to A04 J22 of the EJ30 (PIN input # 2), the POT register is fed back to the # 2 PIN inputs, and the high order 16 bits of the POT register are fed back (respectively) to SKS test lines 16-31.
4. When the "input" end of the cable is plugged to A04J24 of the EJ30 (PIN input # 3), the POT register is fed back to the # 3 PIN inputs, and bits 05-12 of the POT register are fed back to bit positions 16-23 of the ADC input word. The remainder of the bits in the ADC input word will float at "1" in the absence of any grounding.
5. Activating the EOM strobe pulses will respectively reset to "0" the high-order 12 bits of the POT register, without regard to the location to which the "input" end is plugged.

This cable, and the test with which it is used, are designed to operate properly with the interim version of the EJ30 used for Autonetics, NBS, Acetron. However, the design specifications for the final version of the EJ30 should be such that no changes in either the cable or the test are required.

The EJ30 closed-loop test will have the following broad characteristics:

1. Only the digital I/O portion of the EJ30 will be checked.
2. Breakpoint switches 1 and 2 will represent the PIN input connector to which the test cable is plugged (binary coded).
3. In order to make the test attractive as an acceptance test, the number of successful loops made on the entire test will be printed out (typewriter) after each pass, whenever breakpoint 3 is set.
4. For test purposes only, breakpoint 4 may be set, causing the following sequence of actions: set POT register to contents of A, PIN, stall based on positive-valued contents of index register (large positive is longest stall), POT contents of B, PIN, stall based on X, and repeat this sequence indefinitely.
5. The test will perform the following sequence of actions:
  - a. Reset POT register, check that no SKS tests are met.
  - b. Set POT register, check that all SKS tests are met.
  - c. Repeat a.
  - d. In turn, set POT register to each configuration which has only a single bit set, and check PIN input.
  - e. In turn, set POT register to each configuration which has only a single bit reset, and check PIN input.
  - f. Set POT register to a large number of pseudo-random configurations in sequence, and check PIN input each time.
  - g. Read in ADC input and check that data is as per specs; this should be in conjunction with test f.
  - h. Set POT register to ones and issue the proper commands for the EOM strobe pulses out of the EJ30; check that bits 0-11 of the POT register were reset.

Tests a, b, and c should be bypassed when breakpoints 1 and 2 are in state 11. Test g should be included only when breakpoints 1 and 2 are in state 01 or 10.

The tests should be repeated indefinitely, subject to previous qualifications, tallying the number of loops. If any error is detected, the program should halt, and the contents of A, B and X should contain sufficient diagnostic information to specifically pinpoint the error. For instance, the sign bit of A could specify PIN error or SKS error, while B and X could contain the expected and actual test patterns involved (obviously different).

