OPERATING MANUAL

MODEL 3325B
SYNTHESIZER/FUNCTION GENERATOR

Serial Number: ALL

IMPORTANT NOTICE

This manual applies to all instruments.Documentation changes required after the printing of this manual are shown on a manual change supplement which accompanies this manual.

WARNING

To prevent potential fire or shock hazard, do not expose instrument to rain or moisture.

Manual Part No. 03325-90014
Microfiche Part No. 03325-90214

8600 Soper Hill Road
Everett, Washington 98205-1298 U.S.A.

Printed: January 1988

Notice

Hewlett-Packard to Agilent Technologies Transition

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. To reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product name/number was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648 is now model number Agilent 8648.

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`http://www.agilent.com/find/assist`

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Printed in USA July 2004

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

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THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

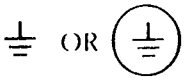
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

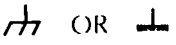
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line.)

Direct (power line.)

Alternating or direct current (power line.)

WARNING ***The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.***

CAUTION *The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.*

NOTE The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System

HP 3325B SYNTHESIZER/FUNCTION GENERATOR

in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment

HP 3325B SYNTHESIZER/FUNCTION GENERATOR

is in accordance with the Radio Interference Requirements of Directive FTZ 1046/1984. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still at the border of his premises.

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Table of Contents (con't)

Introduction

This operating manual contains information necessary to operate the Hewlett-Packard Model 3325B Synthesizer/Function Generator. This covers direct operation via the front panel as well as remote operation via the HP-IB or RS-232 interface. Also included with the HP 3325B is an installation manual that provides information and procedures to install and check the performance of the HP 3325B as well as a service manual to adjust, and service the HP 3325B.

- Operation Manual (Chapters 1, 2, 3)
- Installation Manual (Chapter 4, includes perfomance tests)
- Service Manual (Sections 5, 6, 7, 8)

This operating manual is divided into three chapters:

1. Operation and Reference
2. Remote Operation
3. General Information

The HP part number of this operating manual is listed on the title page along with the microfiche part number. The Microfiche part number can be used to order 4 × 6 microfilm transparencies of the operating manual. Each microfiche package also includes the latest manual change supplements for the operating manual.

Chapter 1

OPERATION AND REFERENCE

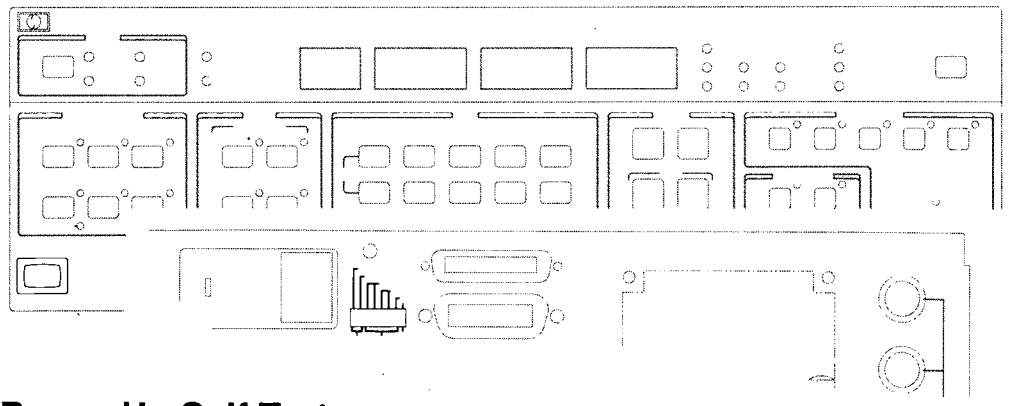
Chapter 1

OPERATION AND REFERENCE

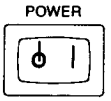
This chapter contains a description of the manual operation of the HP 3325B Synthesizer/Function Generator. The subdivisions in this chapter describe each major function of the HP 3325B. Chapter 2, "HP 3325B Remote Operation" contains a complete list of commands used for remote operation of the HP 3325B with a computer. Figure 1-1 identifies and describes the front and rear-panel controls, connectors, and indicators.

Caution *Prior to operating the HP 3325B, check that the fuse rating and line voltage setting are correct for the local ac power source. The Power Requirements section in "HP 3325B Installation" contains information for setting the line voltage and selecting the fuse.*

HP 3325B Turn-On and Warm-Up

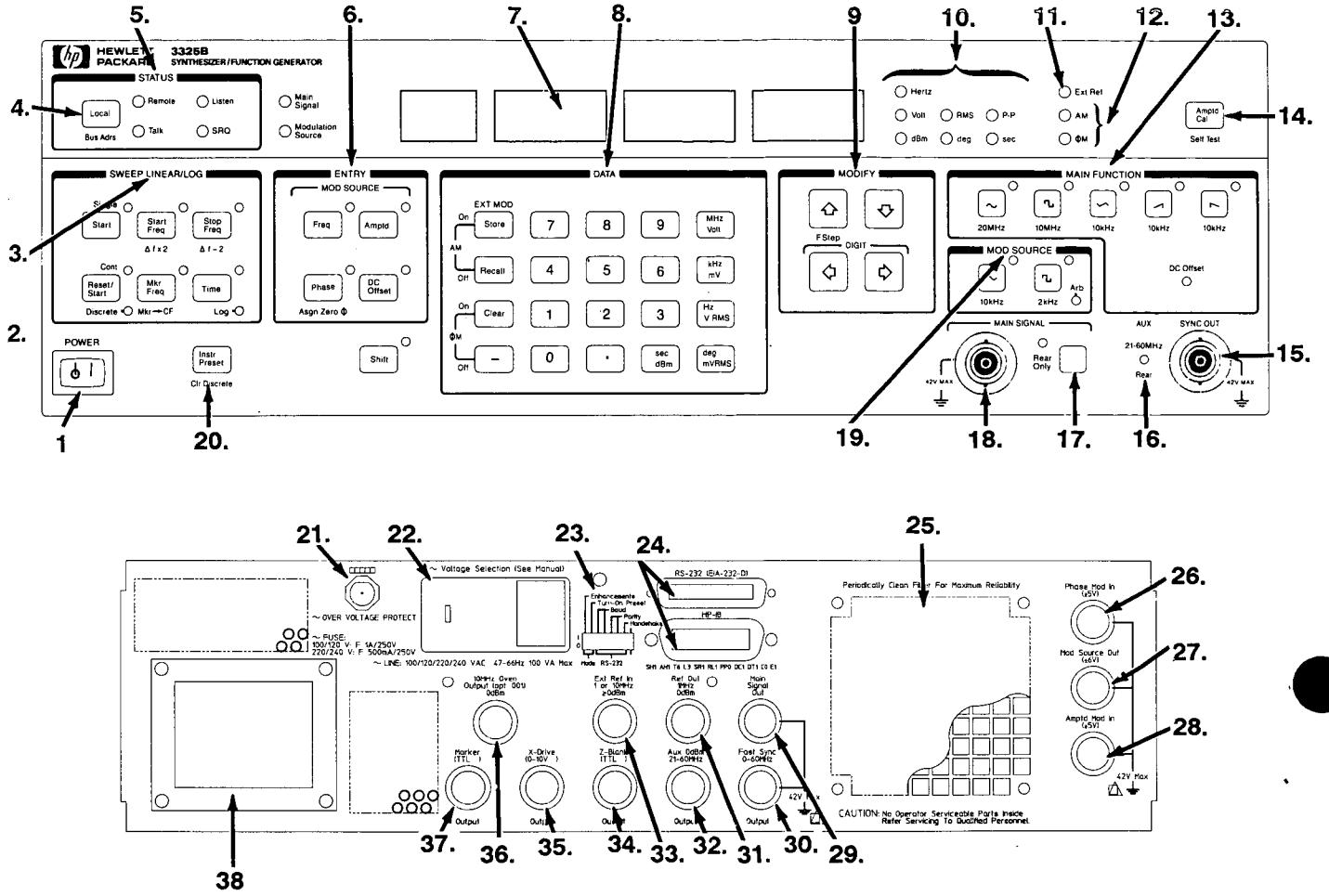


Turn-On and Power-Up Self Tests



Turn on the HP 3325B by pressing the I-side of the power switch. When turned on, power is applied to all of the HP 3325B circuits and the display shows "3325" followed by a list of the installed options. Then the HP 3325B initiates a series of self tests and calibrates internal circuits. When the ⏻-side of the Power key is pressed, the HP 3325B is placed in standby.

Note If Fail appears in the display, the HP 3325B has sensed a circuit failure or an amplitude calibration failure. If the Fail message appears in the display, send the instrument to qualified service personnel for repair.



1. **Power switch:** In the standby (⏻) position, power is applied to the oven (option 001), the HP-IB interface circuits external to the isolation barrier, and the high voltage output circuits (option 002), in addition to the power supply circuits.
2. **Blue [Shift] key**: Press the [Shift] key to access the key function labeled in blue.
3. **Sweep Linear/Log key group**: These are entry prefix keys for the sweep parameters, and the sweep start keys. When preceded by the [Shift] key, the sweep parameter keys control sweep modification functions and linear/log/discrete selection.
4. **[Local] key**: Returns HP 3325B from remote control to front-panel control unless local lockout has been programmed. When preceded by the [Shift] key, the HP 3325B HP-IB address is displayed.
5. **Status indicator group**: The indicators show the HP 3325B HP-IB status: Remote, Addressed to Listen, Addressed to Talk, and Request Service (SRQ).
6. **Entry key group**: These are the entry prefix keys for the main and modulation source signal parameters.
7. **Display**: Displays the value of the entry parameter selected, error codes, and self test results.
8. **Data key group**: This group includes the numeric data keys, the data suffix keys, the [Store] and [Recall] keys, and the entry [Clear] key. When preceded by the [Shift] key, the keys in the left column control the modulation functions.
9. **Modify Group**: The horizontal arrow keys select the digit to modify (indicated by the flashing digit), and the vertical arrow keys increment or decrement the digit. Preceding the up-arrow with the [Shift] key selects the frequency step parameter for display and modification.
10. **Units Indicators**: The indicators display the units of the value represented by the numeric display.

11. **Ext Ref Indicator**: The Ext Ref Indicator illuminates if an external reference or option 001 (internal 10 MHz oven reference) is connected to the rear-panel Ref In connector. The indicator flashes if the internal oscillator is not phase-locked to the external reference.
12. **Modulation Indicators**: The modulation indicators illuminate if amplitude or phase modulation is enabled.
13. **Main Function key group**: These keys select the main signal output function or dc-only.
14. **[Amptd Cal] key**: This key calibrates the amplitude and offset of the output signal. When preceded by the [Shift] key, it initiates an instrument self test.
15. **Sync Out**: A square wave synchronized output signal is available at this connector and rear-panel Fast Sync connector. This signal is synchronized with the output signal crossover point (zero volts or dc offset voltage). The front-panel sync output functions for frequencies below 21 MHz.

Caution *The maximum peak voltage that can be safely applied between chassis and outer conductor of any of the HP 3325B input or output signal connectors is ±42V.*

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16. **Aux 21-60 MHz Rear Indicator**: This indicator illuminates when the rear-panel Aux output is active.
17. **[Rear Only] key**: In standard instruments, this key switches the signal output from front-panel to rear-panel. The rear-panel output is active when the adjacent indicator illuminates. In instruments with the high voltage option (002), this key switches from normal to high voltage output. The adjacent indicator illuminates when the high voltage output is enabled. The key is labeled "40 V_{pp}, 40 mA, 0-1 MHz" for option 002. In option 002 instruments, no rear-panel signal output is provided.
18. **Main Signal output**: Standard output impedance is 50Ω. High voltage output option 002 output impedance is nominally < 1Ω at dc and < 10Ω at 1 MHz. Load impedance must be at least 500Ω. Standard and high-voltage outputs are fuse-protected.

Note If the standard instrument signal output is not terminated by an external 50Ω load, undesirable distortion may result, particularly at higher frequencies. Similar conditions may result if the high voltage output (option 002) is terminated by less than 500Ω.

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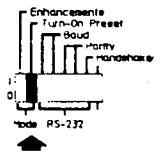
19. **Modulation Source key group**: These keys select the modulation signal function.
20. **[Instr Preset] key**: This key restores the HP 3325B to a predefined state (see table 1-1). When preceded by the [Shift] key, Instr Preset clears the discrete frequency sweep segments from memory.
21. **Circuit Breaker Reset Button:** Disconnects power supply from power line when the line voltage exceeds upper limit. See the Installation Manual for information on resetting the breaker and voltage limits.
22. **Voltage selection vs fuse used:** This module contains the line fuse and configures the HP 3325B for local line voltages. Refer to the HP 3325B Installation Manual for line fuse selection and line voltage configuration.
23. **Mode/RS-232 switch**: These switches enable the HP 3325B enhancements, turn-on configuration, and RS-232 characteristics.
24. **HP-IB/RS-232 connectors**: Remote control of the HP 3325B by an external controller is accomplished through these connectors.
25. **Fan Filter:** See "Instrument Cooling" in the Installation Manual for information concerning the fan and its filter.
26. **Phase Mod In**: Input connector for a phase modulating signal of ±5V maximum peak voltage.
27. **Mod Source Out**: Output connector for the internal modulation source.
28. **Amptd Mod In**: Input connector for an amplitude modulating signal of ±5V maximum peak voltage.
29. **Main Signal Out**: The output signal is switched to this connector by the front-panel [Rear Only] key. Instruments with the high voltage option 002 cannot switch the main signal to the rear-panel connector.
30. **Fast Sync**: A square wave synchronizing output signal is available at this connector. This signal is synchronized to (changes state at) the output signal crossover point (zero volts or dc offset voltage) and operates from 0 to 60 MHZ..
31. **Ref Out**: A 1 MHz signal from the HP 3325B reference circuits is available at this connector.
32. **Aux 0 dBm**: A signal is available at this output for frequencies between 19 MHz and 59 999 999.999 Hz.
33. **Ext Ref In**: This external frequency reference may be used to phase-lock the internal 30 MHz oscillator.
34. **Z-Blank**: A TTL-compatible output is present during a sweep operation.
35. **X-Drive**: This output ramps from 0V to 10V during a sweep-up.
36. **10 MHz Oven Output**: This signal is present only in instruments with option 001. Normally it is connected to the Ext Ref In connector (item 33) with a special connector (HP Part No. 1250-1499) supplied with option 001.
37. **Marker**: This TTL-compatible output goes low at the selected marker frequency during a sweep up, and high at completion of the sweep.
38. **Power Transformer**

Turn-On State



The initial state of the HP 3325B at power up is dependent upon the setting of the rear-panel Turn-On Preset switch. With the Turn-On Preset switch in the up (1) position, the turn-on state is the preset state described in "The Preset State and the Instr Preset Key." With the Turn-On Preset switch in the down (0) position (and the Enhancements switch in the up (1) position), the setup state in effect when power is removed is used as the turn-on state.

Enhancement Mode

Enhanced mode refers to the HP 3325A features that were improved to create the HP 3325B. In this mode all stored information is retained in nonvolatile memory. Stored information may be erased by overwriting the information in memory or by applying power with the green [Instr Preset] key depressed (memory clear).

HP 3325A (Compatibility) Mode

In this mode, stored information cannot be recalled after the power switch is set to the standby position.

Note See table 3-2 for a comparison of compatible and enhanced features.

Power-Down State/Turn-On Preset

The last operating state prior to removing power is also retained in nonvolatile memory. This operating state is restored by pressing the [Recall] key followed by the [−] (minus) key.

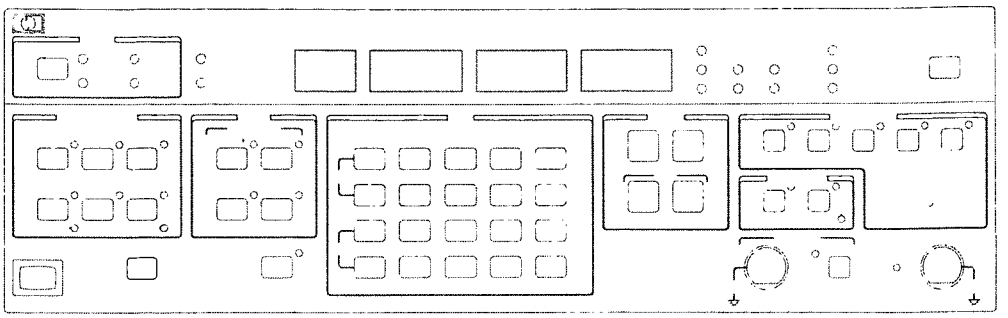
The setup state stored in the power-down memory can be selected as the turn-on state through the use of the Enhancements and Turn-On Preset switches. To allow the HP 3325B to restore the power-down state, set the Enhancements switch to the up (1) position, and the Turn-On Preset switch to the down position (0). Restoring the power-down state at turn-on is disabled by setting the Turn-On Preset switch in the up (1) position.

Warm-Up

Warm-up time is the amount of time the HP 3325B is connected to power. The HP 3325B without the high stability frequency reference (option 001) requires 30 minutes of warm-up time to meet all specifications. The HP 3325B with option 001 requires 15 minutes of warm-up time to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected from the HP 3325B with option 001 for more than 24 hours, up to 72 hours of warm-up time may be required to meet frequency specifications. The HP 3325B with option 001 requires 30 minutes of warm-up to meet other specifications.

Note Moving the power switch from the I position to the ⏾ position places the HP 3325B in standby. In standby, power is removed from all circuits except those that should be kept warm to minimize warm-up time.

The Preset State and the Instrument Preset Key



Instr Preset

Table 1-1 lists the *preset state* of the HP 3325B. This is a predefined state selected by pressing the green [Instr Preset] key. It is also the active state at power-up if the rear-panel Turn-On Preset switch is in the up (1) position. Instrument preset provides a convenient starting state for establishing an instrument setup. Instrument preset does not erase instrument states, modulation source ARB waveforms, or the discrete sweep table in internal memory.

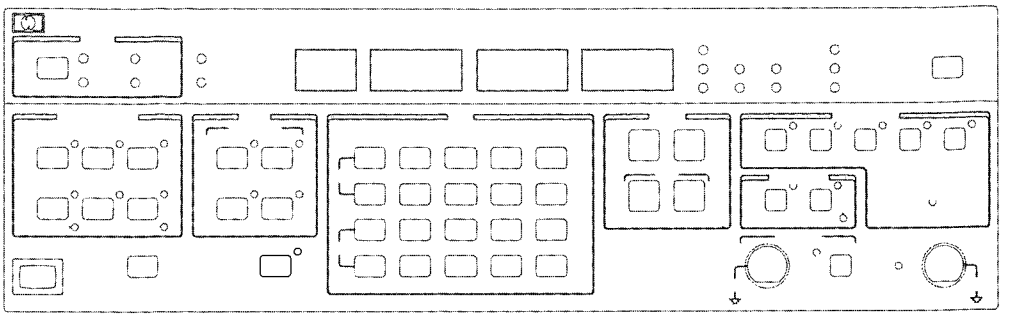
Table 1-1. HP 3325B Preset State

Key Group	Parameter	Preset State/Value
Status	Local	No effect
	Bus Adrs	No effect
Function	Sine wave	Enabled
Entry	Freq	1 kHz
	Amptd	0.001 V_{pp}
	Phase	0°
	DC Offset	0V
	Assign Zero Φ	–
	Mod Source Freq	1 Hz
	Mod Source Amptd	0.1 V_{pp}
Sweep Linear/Log	Sweep	Off
	Start Freq	1 MHz
	Stop Freq	10 MHz
	Mkr Freq	5 MHz
	Time	1 second
	Discrete Sweep/Log Sweep	Off

Table 1-1. HP 3325B Preset State (Cont'd)

Key Group	Parameter	Preset State/Value
Modulation	Ext Mod AM Ext Mod ΦM	Off Off
Modify	F Step	0.0 Hz
Mod Source	Mod Source	Off
Other Keys	[Shift]	Off
Signal	High Voltage Rear-Only	Off Disabled (Front-panel output)

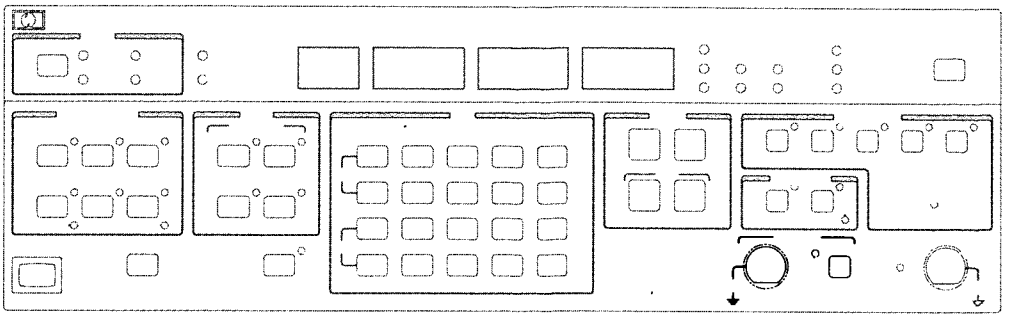
Shift Key



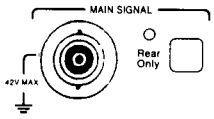
Some keys control two functions. The first function name appears on the key itself and is activated by pressing the key. If a key has another function, its name appears in blue below the key and it is activated by first pressing the blue [Shift] key. This manual may refer to shifted key names with or without reminding you to press the [Shift] key first. Always look for both names of a key when searching the front panel for a key name.

The indicator adjacent to the [Shift] key illuminates when the [Shift] key is pressed to indicate that the shifted key names may be selected.

Main Signal Output



Main Signal Output Connectors



The Main Signal is available at one of two BNC connectors located on the front and rear panels. The front-panel [Rear Only] key selects which of these two connectors has the main signal output. The active connector is indicated by the rear-only indicator; an illuminated rear-only indicator denotes that the rear-panel output is active.

Both outputs share the same ground and may be floated up to ±42 volts peak relative to earth ground.

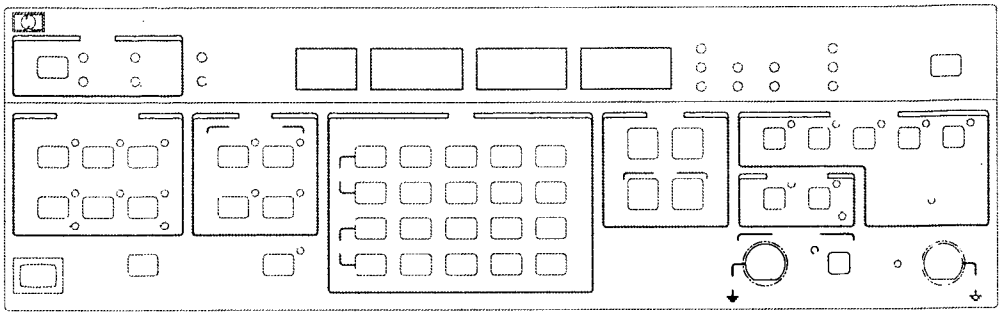
Caution *The maximum peak voltage (ac + dc) that can be safely applied between chassis and the outer conductor of the HP 3325B input and output connectors is ±42 volts peak.*

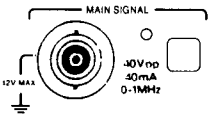
Note When the high voltage option (option 002) is installed, the key by the Main Signal output connector (labeled "40 V_{pp}, 40 mA, 0-1 MHz") controls the high voltage amplifier. On these instruments, the rear-panel Main Signal output connector is inactive.

The specifications for the Main Signal output impedance and return loss are:

Impedance:	50Ω ±1Ω from 0 to 10 kHz
Return Loss:	20 dB 10 kHz to 20 MHz except > 10 dB for > 3V, 5 MHz to 20 MHz
High Voltage (option 002):	< 2Ω at dc < 10Ω at 1 MHz

The High Voltage Option (option 002)





On instruments with the High Voltage Option (option 002)installed, the [40 V_{pp}] key enables or disables the high voltage output. The 40 V_{pp} indicator illuminates when the high voltage output is enabled. The high voltage option increases the available output voltage range to a maximum value of 40 V_{pp} (into a high impedance). Enabling the high voltage option reduces the maximum output frequency for the sine and square waves to 1 MHz, and decreases the output impedance (see Main Signal output). The output signal momentarily drops to zero volts when internal attenuator settings change.

Note

The rear-panel signal output is inactive (no internal signal connection) if the HP 3325B has the high voltage output (option 002) installed. Instructions in the Service Manual describe activation of the rear-panel signal output in one of two ways:

1. Disconnecting the front-panel signal output and placing the standard/high voltage output on the rear panel only, or

2. Disabling the high voltage output and enabling the standard front/rear output.

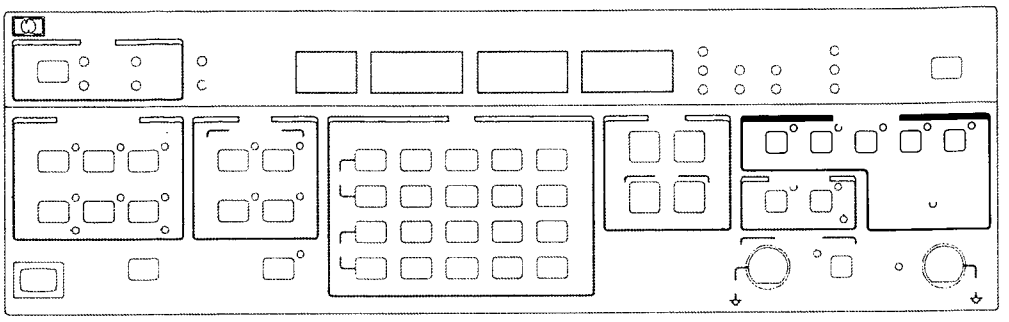
If one of these modifications is required, arrange for the work to be done by qualified service personnel.

The HP 3325B specifications apply when the external load resistance is > 500Ω and the total capacitance is < 500 pF. The same entry procedures and display features apply as for the standard configuration. Maximum and minimum amplitudes are listed in table 1-2.

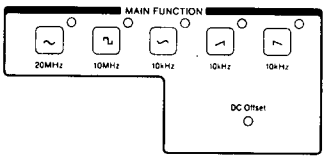
Table 1-2. High Voltage Amplitudes (option 002)

	V_{pp}		V_{rms}	
Function	**Max.**	**Min.**	**Max.**	**Min.**
Sine	40V	4 mV	14.14V	1.42 mV
Square	40V	4 mV	20.0V	2.0 mV
Triangle	40V	4 mV	11.55V	1.16 mV
± Ramp	40V	4 mV	11.55V	1.16 mV

Selecting the Output Function



The Main Function Keys and Indicators

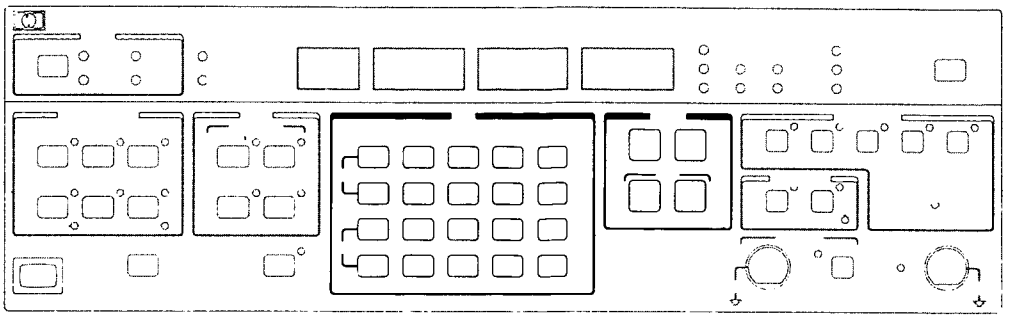


Pressing one of the five Main Function keys selects the function output of the HP 3325B. The indicator adjacent to a function key illuminates when that function is selected. Pressing the function key for the selected function a second time removes the ac component of the signal leaving only the selected dc offset (if any is entered). Removing the ac signal in this way, automatically displays dc offset and illuminates the dc offset entry indicator. Pressing the disabled function key again restores the ac signal. Unless a dc offset is entered, the output signal for each function is centered about zero volts.

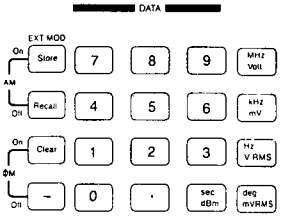
The DC Offset indicator illuminates when a non-zero dc offset exists.

Note The standard instrument signal output must be terminated by an external 50Ω load or sine wave distortion and square wave over-shoot may result, particularly at the higher frequencies (> 1 MHz). All specifications apply with a 50Ω load connected to the HP 3325B main signal output except where indicated (table 3-1, Specifications).

Data Entry And Modification



The Data Keys



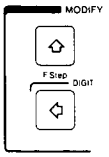
Entering setup values with the numeric keypad is a simple three step process:

1. Select a parameter to change.
2. Enter the desired value (most significant digit first).
3. End the entry with a units key.

For example, to change the output amplitude to 1 V_{rms}, press the [Amptd] (amplitude) key to display the current amplitude value. Press the [1] key in the numeric keypad, and press the [Hz / V RMS] units key to end the entry. For the example, the V_{rms} units from the [Hz / V RMS] units key is assigned to the data value. The HP 3325B assigns the units to the data value that corresponds to the parameter being changed. If an entered value exceeds the HP 3325B range limits, the HP 3325B ignores the entered value and displays an error message (refer to table 1-4). To cancel an incomplete data entry, press any key that requires the display for data entry (see table 1-3).

Table 1-3. Parameters Accepting Data Entry

Amptd	Mod Source Freq
Bus Adrs	Phase
DC Offset	Start Freq
F Step	Stop Freq
Freq	Store
Mkr Freq	Recall
Mod Source Amptd	Time



The value entered with the Data keys may be edited during data entry with the left-arrow key in the Modify key group. Each time the left-arrow key is pressed, the least-significant digit or decimal point is removed from the display. After the incorrect digits are removed from the display value, data entry can continue.

Clear Display

Pressing the [Clear] key (in the left column of the Data key group) clears the display to zero. This key is useful when an error is made while entering data.

Error Messages

If an attempt is made to enter or modify operating parameters beyond the HP 3325B capabilities, the new input is ignored and an error message and code is displayed. Table 1-4 lists the error messages and explanations of the errors.

Table 1-4. Error Messages

Error Code	Description
100	The value entered for the selected parameter exceeds the valid limits
200	The units key selected is improper for the selected parameter
201	The units key selected is improper for the selected parameter with high voltage option
300	The frequency entered is too high for the waveform function selected
400	The sweep time entered is too large for the frequency span (sweep span is too small)
401	The sweep time is too small for the frequency span.
500	Amplitude and dc offset values are incompatible
501	The dc offset is too large for amplitude
502	The amplitude is too large for the dc offset
503	Amplitude is too small
600	Sweep frequency improper
601	Sweep frequency too large for function
602	Sweep bandwidth too small
603	Log sweep start frequency too small
604	Log sweep stop frequency less than start frequency
605	Discrete sweep segment is empty
700	Unknown command
701	Illegal query
751	Key ignored front-panel key pressed while the HP 3325B is in remote (press LOCAL key)

Table 1-4. Error Messages (Cont'd)

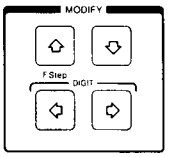
Error Code	Description
752	Key ignored front-panel key pressed while the HP 3325B is in local lockout
753	Feature disabled in compatibility mode
754	Attempt to recall a memory register that has not been stored since power up
755	Amplitude modulation not allowed on selected function
756	Modulation source arbitrary waveform memory register is empty
757	Too many modulation source arbitrary waveform points
758	Firmware (program) failure
800	A remote HP-IB or RS-232 command has a syntax error
801	Illegal digit for selection item
802	Illegal binary data block header
803	Illegal string, string overflow
810	RS-232 overrun – characters lost
811	RS-232 parity error
812	RS-232 frame error
900	Option not installed
-CAL-	Calibration in progress
PASS	A self test is successful
FAIL	A self test is unsuccessful – refer the HP 3325B to qualified service personnel for repair

Viewing Setup Parameters

Pressing a front-panel key which accepts data entry (such as the [Freq] or [Amptd] key) displays the current value of a setup parameter. Table 1-3 lists the front-panel keys which accept data entries. Pressing one of these keys does not alter the current setup values.

The units of the displayed parameter are indicated by an illuminated indicator at the right of the display. The indicators at the left of the display indicate whether the display value is associated with the Main Signal or the Modulation Source.

Modifying Parameter Values



The arrow keys in the Modify key group are used to modify the display value. The right and left-arrow keys select the digit for modification as indicated by the flashing digit. Pressing the right-arrow key selects the next least significant digit for modification; pressing the left-arrow key selects the next most significant digit for modification. To extinguish the flashing digit, press a right or left-arrow key until the flashing digit moves off the display.

The flashing digit is the least significant digit that is modified with the up- and down-arrow keys. The up-arrow key increments the value of the display, while the down-arrow decrements the value of the display. The up-and down-arrows modify the display value until the boundary limit is reached.

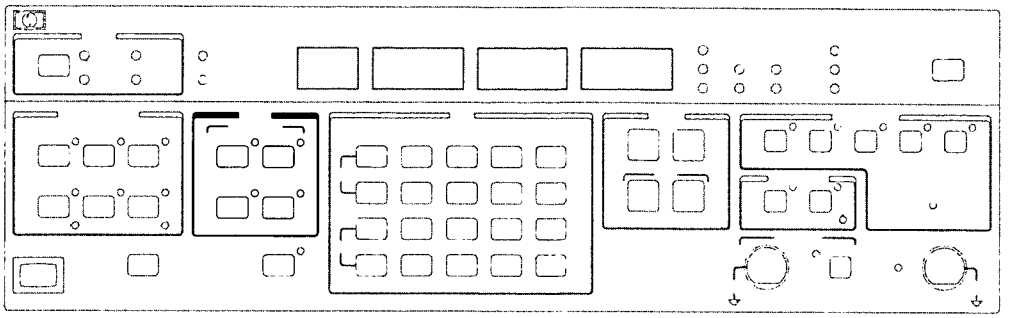
Frequency Step

The frequency step is how much change in the frequency parameter occurs when the up or down-arrow keys are pressed. The [F Step] (Frequency Step) key enables display, entry, or modification of the frequency step parameter. The [F Step] key is selected by pressing the blue [Shift] key prior to the up-arrow key. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the modify controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. During frequency step entry, the Hz units indicator is illuminated but the Frequency Entry indicator is extinguished.

The up-arrow and down-arrow keys increment and decrement the display by the F Step value when all the following are true:

1. The frequency step is non-zero (in the case of the main signal) or less than frequency resolution (for the modulation source)
2. A main signal or modulation source frequency value is displayed, and
3. No flashing digits appear in the display

The Entry Keys



Note An illuminated indicator adjacent to an entry key denotes it as the active entry parameter. For example, if the [Freq] entry key indicator is illuminated, it is not necessary to press that key before entering data.

Frequency

The [Freq] (Frequency) key enables display, entry, or modification of the frequency of the signal output. The indicator adjacent to the [Freq] key illuminates when the output frequency value is displayed. Frequency values are displayed in Hertz and changed with the numeric keypad and units keys or modified with the modify controls. The MHz, kHz, and Hz units allow convenient entry of frequency values.

Resolution of the frequency entry is 1 μHz for frequencies below 100 kHz, and 1 mHz for 100 kHz and above. At 100 kHz and above, 1 μHz resolution is possible through the use of the F Step parameter. Also, as a modify key is used to cross above the 100 kHz boundary, any μHz resolution value is maintained but not displayed. Frequency ranges are dependent upon the function selected and high voltage option (see table 1-5). During a frequency change, the main output signal is phase-continuous; that is, there are no phase discontinuities in the output waveform.

Table 1-5. Frequency Limits

Function	Main Signal
Sine	0 → 20 999 999.999 Hz
Square	0 → 10 999 999.999 Hz
Triangle, Ramps	0 → 10 999.999 999 Hz

Amplitude

The [Amptd] (amplitude) key enables display, entry, or modification of the amplitude of the signal output. The indicator adjacent to the [Amptd] key illuminates when an amplitude value is displayed. The displayed amplitude value is changed with the numeric keypad and units keys, or modified with the Modify keys. The Volt, mV, V RMS, mV RMS, and dBm units allow convenient entry of amplitude values. Amplitude values are displayed in Volts rms, Volts peak-to-peak (V_{pp}), or dBm as denoted by the indicators at the right of the display. The amplitude range is dependent upon selection of dc offset and the high voltage option (see table 1-6). The output signal is momentarily set at zero volts when internal attenuator settings change.

The HP 3325B units keys convert amplitude values to V_{pp}, V_{rms}, or dBm for any function. For example, if a sine wave amplitude of 10 V_{pp} is displayed, pressing the [V_{rms}] or [mV_{rms}] key displays the same amplitude as 3.536 V_{rms}, while pressing the [dBm] key displays the value as 23.98 dBm. When changing from one function to another, the last amplitude displayed is held constant.

Table 1-6. Amplitude Limits of AC Functions

	V_{pp}		V_{rms}		dBm (50Ω)	
Function	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
Sine	10V	1 mV	3.536V	0.354 mV	+23.98	−56.02
Square	10V	1 mV	5.000V	0.5 mV	+26.99	−53.01
Triangle	10V	1 mV	2.888V	0.289 mV	+22.22	−57.78
±Ramp	10V	1 mV	2.888V	0.289 mV	+22.22	−57.78

DC Offset

The [DC Offset] key enables display, entry, or modification of the dc offset of the signal output. The indicator adjacent to the [DC Offset] key illuminates when a dc offset value is displayed. The displayed dc offset value is changed with the numeric keypad and [Volt] or [mV] units key, or modified with the modify controls. The dc offset range is dependent upon amplitude and the high voltage option. Figure 1-2, and table 1-7 and 1-8 list the maximum output of the HP 3325B. The output signal momentarily drops to zero volts when internal attenuator settings change.

The DC Offset indicator in Main Function key block illuminates when a non-zero dc offset value exists.

AC with DC Offset

When dc offset is added to any ac function, there are minimum and maximum offset limits which must be observed. These limits are affected by the ac voltage and internal attenuator settings, listed in table 1-7. Figure 1-2 contains a set of graphs which show the approximate maximum dc offset permissible for a given ac peak-to-peak voltage. Resolution of a dc offset entry (with ac function) is determined by the resolution of the ac amplitude. The following equation may be used to determine maximum offset voltage:

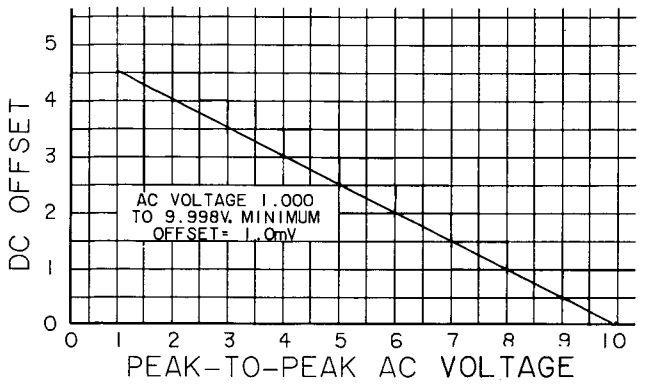
$$\text{Maximum dc offset} = (5 \div A) - (\text{Amptd} \div 2)$$

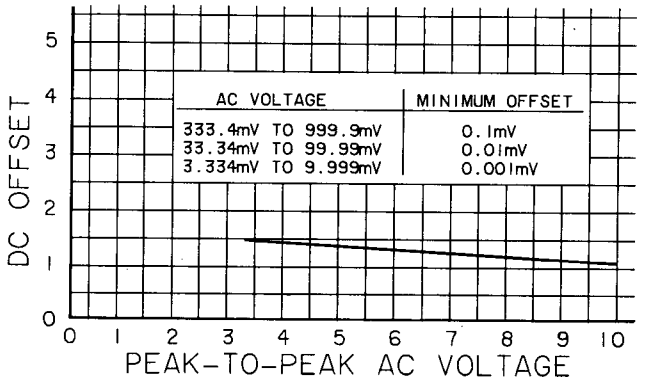
Where A = Attenuation factor (from table 1-7)
Amptd = Amplitude in V_{pp} of the ac function.

If a dc offset too large for the amplitude already programmed is entered or if the ac amplitude is increased beyond the level where the amplitude and offset are compatible, an error code between 500 and 503 appears in the display momentarily and the entry value is not accepted. The display then indicates the nearest acceptable value.

Table 1-7. Maximum DC Offset with any AC Functions

AC Amplitude Entry (peak-to-peak)		Maximum DC Offset (+ or −)	Minimum DC Offset Entry	Range	Attenuation Factor
1.000 mV	with	4.500 mV	0.001 mV	7	A = 1000
to					
3.333 mV	with	3.333 mV			
3.334 mV	with	14.99 mV	0.001 mV	6	A = 300
to					
9.999 mV	with	11.66 mV			
10.00 mV	with	45.00 mV	0.010 mV	5	A = 100
to					
33.33 mV	with	33.33 mV			
33.34 mV	with	149.9 mV	0.010 mV	4	A = 30
to					
99.99 mV	with	116.6 mV			
100.0 mV	with	450.0 mV	0.100 V	3	A = 10
to					
333.3 mV	with	333.3 mV			
333.4 mV	with	1.499V	0.100 V	2	A = 3
to					
999.9 mV	with	1.166 mV			
1.000 V	with	4.500 V	1.000 mV	1	A = 1
to					
9.998 mV	with	0.001 mV			





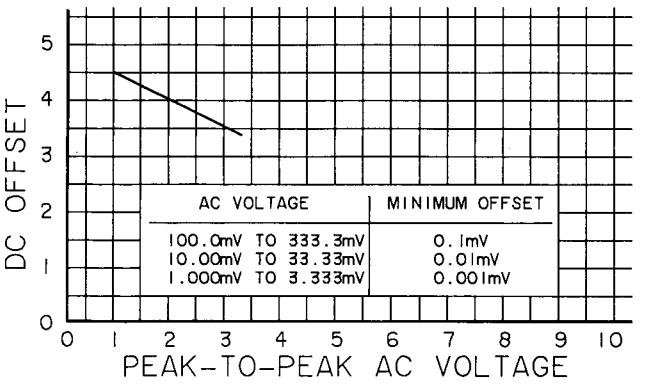


Figure 1-2. Maximum DC Offset with any AC Functions

DC Only

When the Main Function selections are disabled (all indicators extinguished), the HP 3325B automatically displays the DC Offset value and selects the [DC Offset] key for entry of DC Offset values. Without an ac function selected, the dc voltage output ranges from 0 mV to ± 5V, with four-digit resolution.

High Voltage Option

With the high voltage option enabled, the dc offset range is ±20 volts (ac + dc peak value or dc only). DC offset with the high voltage option is dependent on the ac amplitude. With the high voltage output (option 002) selected, the minimum and maximum permissible dc offset voltages may be determined by multiplying the amplitude and offset values in table 1-7 (and figure 1-2) by 4. The equation for determining maximum dc offset is:

Maximum dc Offset = (20 ÷A) − (Amptd ÷2)
Where A = Attenuator factor (from table 1-7)
Amptd = Amplitude in V_{pp} of the ac function.

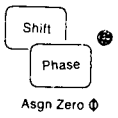
Note When the high voltage output is selected, minimum amplitude for dc only (no ac function) is 0.01 mV and maximum is 20.0V.

Phase

The [Phase] key enables display, entry, or modification for the phase of the Main Signal. The indicator adjacent to [Phase] key illuminates when a phase value is displayed. The displayed phase value is changed with the entry keys and [Deg] (degrees) units key, or modified with the modify controls. The phase display range is ±719.9° with a resolution of 0.1°. Phase values of ±1440° entered with the entry keys are accepted and the value is displayed modulo 720. For square wave frequencies below 25 kHz, phase changes greater than 25° may result in a phase shift ±180° from the desired amount.

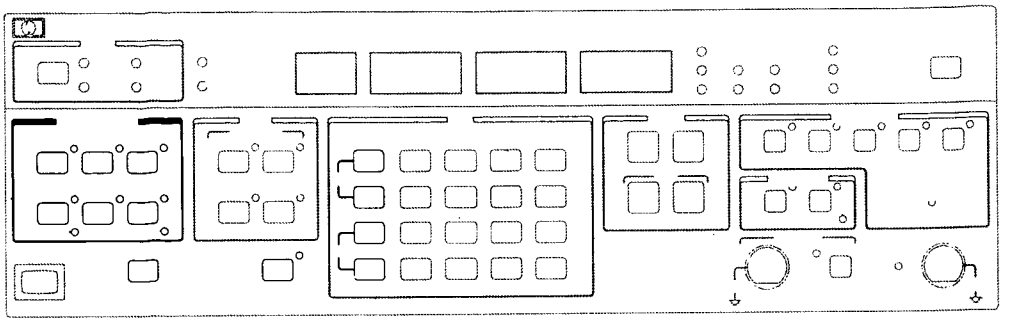
After entering a phase shift, the new phase may be assigned the zero-phase position; subsequent changes in phase are with reference to that value. To assign zero phase, press the blue [Shift] key followed by [Asgn Zero Φ] key.

Asgn Zero Φ



The [Asgn Zero Φ] (Assign Zero phase) key assigns a reference of zero degrees to the existing phase parameter of the Main Signal without changing the phase of the output waveforms. Subsequent changes in phase are with respect to that value. The [Asgn Zero Φ] key is selected by pressing the blue [Shift] key prior to the [Phase] key.

Frequency Sweeps



Introduction to Sweeps

The HP 3325B performs three kinds of sweeps: linear, log, and discrete. Linear sweeps of any function have sweep-time limits of 10 ms to 1000s and may be single or continuous. Single linear sweeps may be either up or down in frequency. Continuous sweeps move back and forth between the start and stop frequency in an up/down/up/down. . . fashion. The marker functions only during up-sweeps.

Log sweep times range from 1s to 1000s for single sweeps and from 0.1s to 1000s for continuous sweeps. Single log sweeps are up-only; they always start at the start frequency and sweep up to the stop frequency. The marker does not function during log sweeps.

Discrete sweeps allow the creation of custom sweep patterns. A discrete sweep consists of up to 100 linear sweeps or frequency steps (called segments). Each segment has four parameters: start frequency, stop frequency, sweep time, and marker frequency, which may be entered from the front panel or down-loaded from a computer. The marker functions as specified for each segment whether the sweep is up or down.

Single or continuous frequency sweeps are selectable with the [Start] and [Reset/Start] keys. Sweep parameters are entered with the [Start Freq] (start frequency), [Stop Freq] (stop frequency), and [Time] keys. The [Mkr → CF] (marker into center frequency), [Δf × 2], and [Δf ÷ 2] keys allow convenient modification of the sweep parameters. The [Mkr Freq] (marker frequency) key allows the rear-panel TTL level marker output signal to be specified.

Linear sweeps are phase-continuous over the full frequency range of the main output signal; that is, there are no phase discontinuities in the swept output waveform. When the HP 3325B is turned on, the sweep is off, the sweep mode is set to linear, and the parameters are set as follows:

Start Frequency	1 000 000.0 Hz
Stop Frequency	10 000 000.0 Hz
Marker Frequency	5 000 000.0 Hz
Time	1s

Note The marker frequency should be lower than the stop frequency by a sufficient amount to permit the marker pulse width to be approximately 400 μs.

To change any of the sweep parameters, press the appropriate Sweep Linear/Log entry key, then enter the desired data. To select log sweep, press the blue [Shift] key followed by the [Log] (Time) key to illuminate the log indicator. The sweep mode is linear unless the log or discrete indicators are illuminated. To select discrete sweep, press the [Shift] key and then the [Discrete] key. When a discrete sweep is selected, the discrete indicator is illuminated.

Start Frequency

The [Start Freq] (start frequency) key enables display, entry, or modification of the sweep start frequency for the main signal. The indicator adjacent to the [Start Freq] key illuminates when a start frequency value is displayed. The displayed frequency value may be changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. The upper frequency limit is established by the function selected.

Stop Frequency

The [Stop Freq] (stop frequency) key enables display, entry, or modification of the sweep stop frequency of the main signal. The indicator adjacent to the [Stop Freq] key illuminates when a stop frequency value is displayed. The displayed frequency value is changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. The upper frequency limit is established by the Main Function selected.

Time

The [Time] key enables display, entry, or modification of the sweep time for the Main Signal. The indicator adjacent to the [Time] key illuminates when a time value is displayed. The displayed time value is changed with the entry and units keys, or modified with the modify keys. The [SEC] units key ends entry of numeric values.

The maximum time per sweep (up or down) for all sweep modes is 1000 seconds, with a resolution of 0.01s for times ≥ 1s, and 0.001s for times < 1s.

Note The X-Drive output functions only when sweep time is < 100s. See the discussion, later in this chapter, on the marker, Z-blank, and X-drive rear-panel connectors.

Minimum times are:

Single Linear Sweep	0.010s
Continuous Linear Sweep	0.010s
Single Log Sweep	1.000s
Continuous Log Sweep	0.100s

Note When the enhancements are turned off, single log-sweep sweep time is increased by the processing time required between segments. The time increase (in seconds) is approximately equal to:

Time Increase = 0.045[10 log(stop freq. ÷ start freq.)]

Marker Frequency

The marker is a TTL-compatible signal on a rear-panel connector that goes low at the specified marker frequency during linear up-sweeps. It may also be used with discrete sweeps where it operates while sweeping up or down.

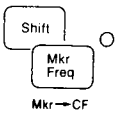
The [Mkr Freq] (marker frequency) key enables display, entry, or modification of the sweep marker frequency. The indicator adjacent to the [Mkr Freq] key illuminates when the marker frequency value is displayed. The displayed frequency value is changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz.

For a marker signal to be generated, the marker frequency may be set to any point within the sweep band to within approximately 400 μs of the stop frequency. If the marker frequency is set beyond this point, the stop frequency is automatically increased so that the marker pulse is approximately 400 μs wide. The following equation may be used to determine the approximate maximum marker frequency:

Max marker freq. = stop freq. − (0.0004 × bandwidth ÷ sweep time)

Note The marker signal is not generated on the down-sweep of a continuous sweep. See the discussion, later in this chapter, on the marker, Z-blank, and X-drive rear-panel outputs.

Mkr → CF



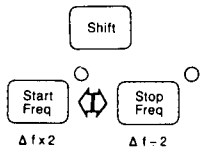
The [Mkr→CF] (marker into center frequency) key centers the sweep band on the frequency value of the marker parameter. The [Mkr→CF] key is selected by pressing the blue [Shift] key followed by the [Mkr Freq] key.

Reset/Start Sweep

The [Reset/Start] key performs three functions for the sweep operations:

1. If a continuous or single sweep is in progress, Reset/Start cancels the sweep. When a sweep is stopped, the current frequency appears in the display.
2. For single sweeps, the first press of the [Reset/Start] key resets the sweep to the start of the sweep.
3. After a single sweep is reset, pressing the [Reset/Start] key again starts the frequency sweep.

Δf×2, Δf÷2 (Modify Bandwidth)



In linear sweep mode, the [Δf×2] and [Δf÷2] keys may be used to double or halve the sweep bandwidth. If either the new sweep start or stop frequency exceeds the frequency limits, an error message is displayed. These two keys have no effect on discrete sweeps.

Single Sweep

The [Reset/Start] key resets the sweep the first time it is pressed. A single sweep starts the second time the [Reset/Start] key is pressed. An illuminated *Single* indicator denotes that a single linear sweep is in progress. A single sweep sweeps from the start frequency to the stop frequency over the specified sweep time.

Continuous Sweep

The [Start] key initiates a continuous (repetitive) sweep. The Cont indicator adjacent to [Start] key illuminates when a continuous sweep is in progress. Continuous sweeps move back and forth between the start and stop frequencies in an up/down/up/down. . . fashion. If the marker is active, it functions only during the up-sweep. Sweep parameters should be entered before starting a continuous sweep. See previous discussion on start and stop frequencies and sweep time.

Linear Frequency Sweeps

In linear mode, either continuous or single sweeps are available. Single sweep is from the start to stop frequency, where either the start or stop frequency may be the higher value.

To begin a single sweep:

1. Press [Reset/Start] to set output and display to the start frequency selected and reset the X-Drive ramp.

2. Press [Reset/Start] again to start the sweep.

The output signal frequency sweeps to the selected stop frequency and remains there. This frequency appears in the display.

Continuous linear sweeps alternate between up and down-sweeps. A continuous sweep begins when the [Start] key is pressed. The Cont indicator illuminates while the continuous sweep is active. Continuous sweeps may be stopped by pressing the [Start] key or by pressing [Reset/Start], [Freq], or [Phase] keys. With enhancements turned off, the sweep may stop when other parameters are changed. With enhancements turned on, the sweep does not stop for parameter changes that do not affect the sweep (i.e., amplitude or offset changes do not cause the sweep to stop). Pressing [Amptd Cal], [Self Test], [Asgn Zero Φ], or changing the function stops a continuous sweep. When a sweep stops, the display indicates the frequency at which the sweep stopped.

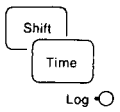
Linear Sweep Bandwidth

The maximum bandwidth is the full frequency range for the function selected. The minimum bandwidth for each function is as follows:

Sine	(10 mHz/s) × (sweep time)
Square	(5 mHz/s) × (sweep time)
Triangle	(0.5 mHz/s) × (sweep time)
Ramps	(1 mHz/s) × (sweep time)

For sweep bandwidths of less than 100 times the minimum bandwidth, bandwidth selected should be an integral multiple of the minimum bandwidth or sweep-time errors and stop-frequency errors will occur.

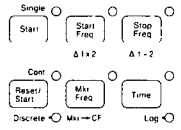
Log Frequency Sweep



In either single or continuous log sweep mode, the stop frequency must be higher than the start frequency and the sweep is up-only (continuous log sweep is a repetitive start-to-stop sweep, only). The minimum bandwidth for log sweep is one decade. Single log sweep is a line-segmented log approximation in one-tenth decade segments, and continuous log sweep is a two-segment-per-decade log approximation.

Note For narrow-band log sweeps, the actual stop frequency may be higher than the selected stop frequency. The error decreases as sweep time is increased. This error is minimized by activating enhancements.

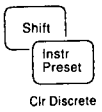
Discrete Frequency Sweep



Discrete sweeps consist of up to 100 linear sweeps (called segments) combined to form a custom sweep pattern. Parameters for each sweep segment consist of start frequency, stop frequency, sweep time, and marker frequency. These parameters are entered by programming a standard linear sweep and storing it into a discrete sweep segment as described in *Storing Discrete Sweep Segments.*

To perform a discrete frequency sweep, the HP 3325B sequences through the segment entries, performing the designated sweeps and skipping blank entries. The sequence is always from segment 00 to 99. For single sweep operation, the HP 3325B sequences through the elements each time the sweep is reset and started with the [Reset/Start] key. For continuous sweeps, the HP 3325B sequences through the segments repeatedly.

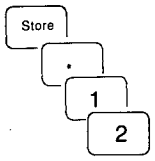
Clearing All Discrete Sweep Elements



The [Clr Discrete] (clear discrete) key empties all discrete sweep segments in nonvolatile memory. This should be done before entering new parameters. The [Clr Discrete] key is activated by pressing the blue [Shift] key and then the green [Instr Preset] key.

Storing Discrete Sweep Segments

Discrete sweep entries may be made whether the discrete sweep is active or not. Each sweep segment is a linear sweep; it may be considered a frequency step if the start frequency is the same as the stop frequency. The entries are saved in nonvolatile memory.

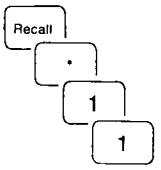


To store a discrete sweep segment:

1. Enter the start and stop frequencies, sweep time, and (optionally) the marker frequency as you would for any linear sweep.
2. Press the [Store] key.
3. Press the [.] key in the data group.
4. Enter a two-digit number by pressing numeric keys in the data group. Numbers between 1 and 9 should be preceded with a 0 (zero). No units or other terminating keystrokes are required. This number is the entry number in the discrete sweep segment list, the order of which determines the pattern of the discrete sweep. Segments may be saved in any order but are always executed sequentially from 00 to 99.

Discrete sweep segment entries may also be made by down-loading the parameters from a computer through one of the rear-panel interface connectors. In some cases, this is the preferred method of setting up discrete sweeps; especially if more than one pattern is used on a regular basis. See Chapter 2, Remote Operation, for more information.

Recalling Discrete Sweep Segments

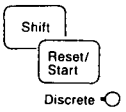


Discrete sweep parameters for any segment (start, stop, and marker frequency and sweep time) may be examined by recalling the discrete sweep segment entry and then pressing the key corresponding to the parameter of interest. To recall a discrete sweep segment:

1. Press the [Recall] key.
2. Press the [.] key.
3. Enter a two-digit number by pressing numeric keys in the data group. Numbers between 1 and 9 should be preceded by a 0 (zero). No units or other terminating keystrokes are required. This number is the entry number in the discrete sweep segment list, the order of which determines the pattern of the discrete sweep. If an empty segment is recalled the message "Error 605" is displayed.

The key sequence [Recall], [.], [1], [1] recalls the linear sweep segment previously stored in segment 11.

Enabling Discrete Sweeps



The [Discrete] key enables and disables discrete frequency sweeps. The [Discrete] key is activated by pressing the blue [Shift] key and then pressing the [Reset/Start] key. The Discrete indicator illuminates when a discrete frequency sweep is enabled.

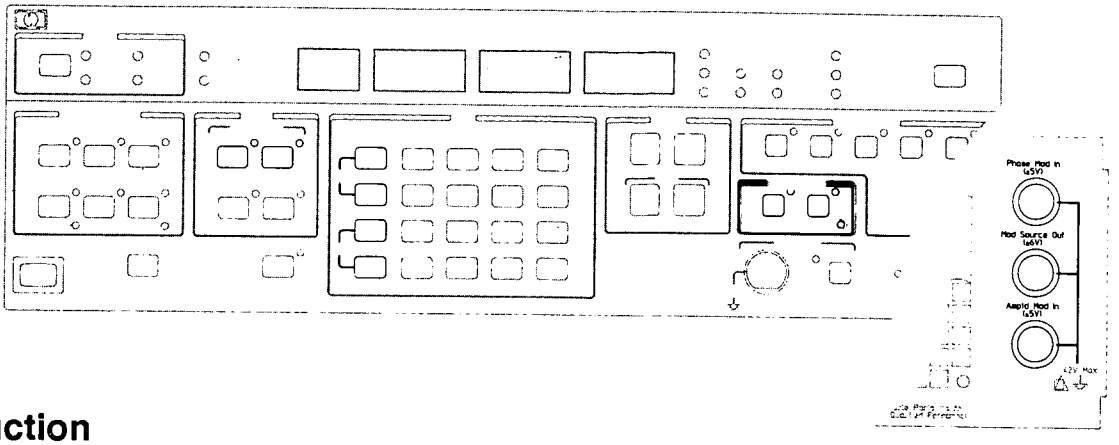
Single Discrete Sweeps

The [Reset/Start] key initiates a single discrete frequency sweep. The indicator adjacent to [Reset/Start] key illuminates when a single sweep is in progress. The [Reset/Start] key initiates a sweep from discrete frequency sweep segment 00 to 99, skipping empty segments. Pressing the [Reset/Start] key during a sweep stops the sweep and displays the present frequency. Pressing [Reset/Start] again resets the frequency to the start frequency of the first sweep segment.

Continuous Discrete Sweeps

When discrete sweep is selected, pressing the [Start] key initiates a continuous discrete frequency sweep. The indicator adjacent to [Start] key illuminates when a continuous sweep is in progress. Continuous discrete sweeps sequence through the segment table from 00 to 99, starting again at 00, repetitively. Pressing [Start] while a sweep is in progress stops the sweep.

Modulation

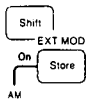


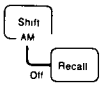
Introduction

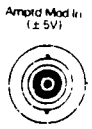
The Main Signal may be amplitude or phase-modulated by a signal connected to either of the two corresponding rear-panel connectors (Amptd Mod In or Phase Mod In). The signal may originate from another signal generator or the internal modulation source may provide the signal. After the connections are made to the rear-panel connectors, modulation of the Main Signal is controlled by the operator.

The Mod Source keys provide an independent sine wave, square wave, or arbitrary waveform signal through the rear-panel Mod Source Out connector. This signal may be used to modulate the Main Signal by connecting it to the rear-panel modulation input connector(s) and pressing the appropriate front-panel keys to activate modulation and control the Mod Source signal.

Amplitude Modulation





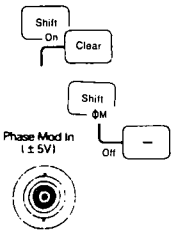


Amplitude modulation of the Main Signal is enabled by pressing the [AM On] ([Shift] [Store]) key which illuminates the AM indicator. Amplitude modulation is disabled by pressing the [AM Off] ([Shift] [Recall]) key which extinguishes the AM indicator, or by presetting the HP 3325B. The modulating signal is applied to the HP 3325B through the rear-panel Amptd Mod In connectors.

When amplitude modulation is enabled, the value entered for the amplitude of the Main Signal is the maximum value possible, or 100% modulation value. When no modulating signal is present or that signal is 0V, the amplitude of the Main Signal is half the entered value. (0V is considered to be 50% modulation.) A modulation input of approximately 5 V_{pk} results in 100% modulation. Modulation frequency may range from 0 to 400 kHz. If amplitude modulation is on when functions other than sine wave are selected, the output may be gated, depending on the level of the modulation input. Amplitude modulation should only by used with the sine wave function, and the modulation input should not exceed ±10 V_{pk}.

A dc voltage may be applied to the Amptd Mod input to control the HP 3325B output level, or a pulse may be used to gate the output. Approximately +5V cuts off the output signal, while approximately −5V doubles the output (maximum input is 10 V_{pp}). DC or pulse inputs should not exceed ±5 V_{pk}. The impedance of the Amptd Mod input is 10 kΩ (5 kΩ when AM is off).

Phase Modulation

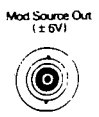


The [ΦM] (phase modulation) keys in the data group enable and disable phase modulation of the Main Signal. Phase modulation is enabled by pressing the [ΦM On] ([Shift] [Clear]) key, which illuminates the ΦM modulation indicator. Phase modulation is disabled by pressing the [ΦM Off] ([Shift] [−]) key, which extinguishes the ΦM modulation indicator, or by presetting the HP 3325B. The modulating signal is applied to the HP 3325B through the rear-panel Phase Mod In connector.

The phase modulation signal at the rear-panel Phase Mod Input connector should not exceed ±10 V_{pk}. The input impedance is 40 kΩ. The modulation signal frequency may be dc to 5 kHz. An input of ±5V results in the following approximate phase deviation (±170° per volt for the sine function):

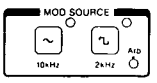
HP 3325B Function	Phase Deviation
Sine	±850°
Square	±425°
Triangle	±42.5°
±Ramp	±85°

Modulation Source

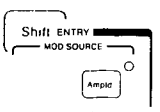


The modulation source provides a second independent signal source, available at the rear-panel Mod Source Out connector. This signal may be used to modulate the main signal by connecting the mod source out connector to the (amplitude or phase) input modulation connector(s) and then controlling main signal modulation and the mod source signal.

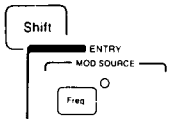
Note The Mod Source output signal should be connected to the Phase or Amplitude Modulation input connector with a BNC coaxial connector at the rear panel. There is no internal connection.



The modulation source is enabled by pressing the Mod Source sine wave or square wave key. The modulation source is disabled by pressing the Mod Source sine wave or square wave key adjacent to the illuminated Mod Source indicator to extinguish that indicator.



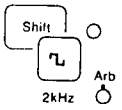
The Mod Source amplitude is entered by pressing the [Shift] key followed by the [Amptd] key. The Modulation Source indicator to the left of the display illuminates to indicate the display contains a modulation source value. Valid modulation source amplitudes range from 0.1 to 12 V_{pp} with 0.1V resolution. Amplitudes may be entered in either V_{pp} or V_{rms}.



The Mod Source Frequency is entered by pressing the [Shift] key followed by the [Freq] key. The Modulation Source indicator illuminates to indicate the display contains a modulation source value. The sine wave frequency values range from 0.1 Hz to 10 kHz with 2-digit resolution. The square wave frequency values range from 0.1 Hz to 2 kHz with 2-digit resolution. The modulation signal is momentarily disabled during modulation frequency changes.

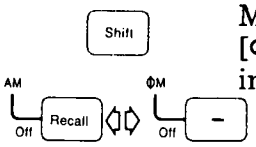
The Modulation Source is a free-running signal which is not phase-locked to the Main Signal output or External Reference input. It has no DC offset or phase parameters. The Modulation Source output is intended to drive high impedance inputs and should not be terminated in 50Ω. It may be connected to both modulation inputs at the same time but the extra loading may draw the output signal voltage down.

Arbitrary Waveforms



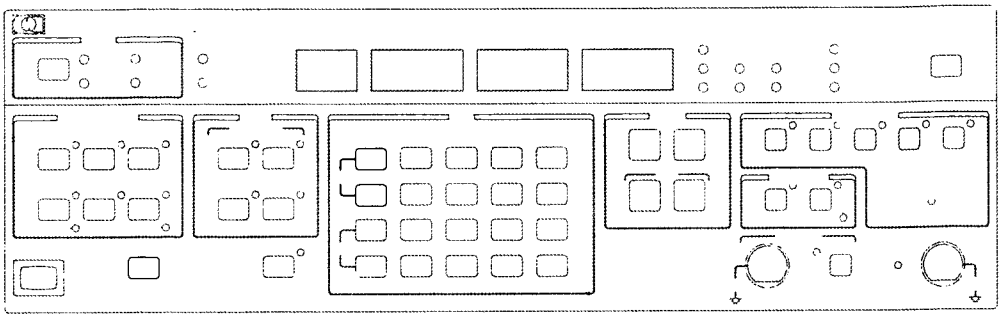
The modulation source may be programmed as an arbitrary waveform source by a computer via HP-IB or RS-232. Once programmed, the waveform is retained in nonvolatile memory and may be initiated from the front panel. Select the arbitrary waveform with the [Shift] Mod Source square wave key which illuminates the Arb indicator. The repetition rate of the arbitrary waveform is set with the [Shift] [Freq] key. Repetition rates range from 0.1 Hz to 10 kHz (the HP 3325B adjusts the value to compatible internal frequencies). The default waveform is dc (after memory is cleared).

Disabling Modulation



Modulation is disabled by pressing the [AM Off] ([Shift] [Recall]) key or [ΦM Off] ([Shift] [−]) key. The extinguished AM or ΦM modulation indicators provide a visual indication that modulation inputs are disabled.

Storing/Recalling Instrument States



Storing Instrument States

Store

The [Store] key, followed by a digit from 0 to 9, saves the current operating state in internal memory. The digit following the [Store] key specifies the memory location for storing the operating state. If two operating states are saved in the same memory location, the operating state saved first is overwritten. These states are not cleared by instrument preset; they are cleared by a memory clear (power up while pressing the preset key).

Note Any phase information stored is invalid when recalled because the instrument performs an amplitude calibration on Recall. The phase relationship between the output signal and the reference is not maintained when an amplitude calibration occurs.

Recalling Instrument States

Recall

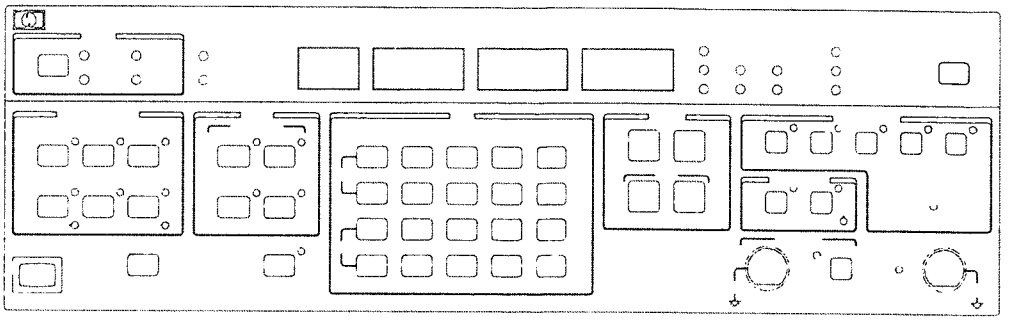
The [Recall] key, followed by a digit from 0 to 9, recalls an operating state saved in internal memory. The digits 0 to 9 select the memory location for the recall operation. Pressing [Recall] [−] recalls the state of the instrument just before it was last powered down.

Memory Clear

Instr Preset

Applying power to the HP 3325B with the green [Inst Preset] key depressed replaces the contents of all nonvolatile memory registers with the instrument preset state. All saved operating states (including power-down) are replaced with the instrument preset state, discrete frequency sweep elements are cleared, the arbitrary waveform registers are set to dc, the HP-IB address is set to 17, and the message "Fail 36" is displayed.

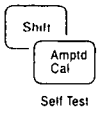
Calibration and Self Test



Amplitude Calibration

The [Amptd Cal] key initiates a calibration of the output signal each time the key is pressed. The Main Signal output amplitude changes to less than 4 mV_{pp} while the calibration is in progress. An amplitude and offset calibration is performed automatically whenever the function is changed and at instrument turn-on.

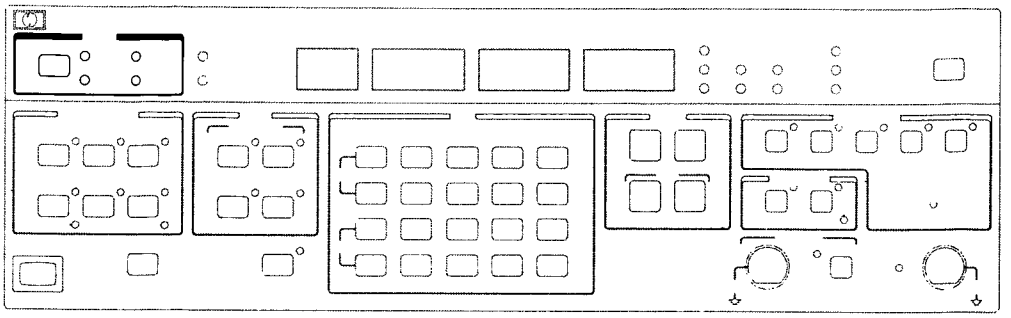
Self Test



A self test is initiated by pressing the blue [Shift] key prior to the [Amptd Cal] ([Self Test]) key. During a self test, all indicators and display segments briefly illuminate, -CAL- is displayed, and a series of internal tests is initiated. After each internal test, Pass or Fail and a number is displayed to indicate the test results. During a self test, the outputs are disabled.

Note If the message "Fail 21" through "Fail 29" is displayed momentarily after a self test, the HP 3325B should be sent to qualified service personnel for repair.

The HP-IB Status Keys/Indicators/Connector



The HP-IB (Hewlett-Packard Interface Bus) key and status indicators are used during remote operation. An overview of the HP-IB and a description of the HP 3325B HP-IB characteristics and commands is contained in Chapter 2.

Local

Local

The [Local] key removes the HP 3325B from remote (HP-IB or RS-232) operation if local lockout is not in effect. Remote operation is indicated by the illuminated Remote indicator.

○ Remote

The Remote indicator illuminates when the HP 3325B is operating under remote control. While in remote (and local lockout is not in effect), only the [Local] key is recognized.

○ Listen

The Listen indicator illuminates when the HP 3325B is addressed to listen over the HP-IB.

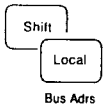
○ Talk

The Talk indicator illuminates when the HP 3325B is addressed to talk over the HP-IB.

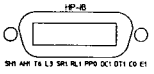
○ SRQ

The SRQ (service request) indicator illuminates when the HP 3325B has requested service (HP-IB only).

Bus Address

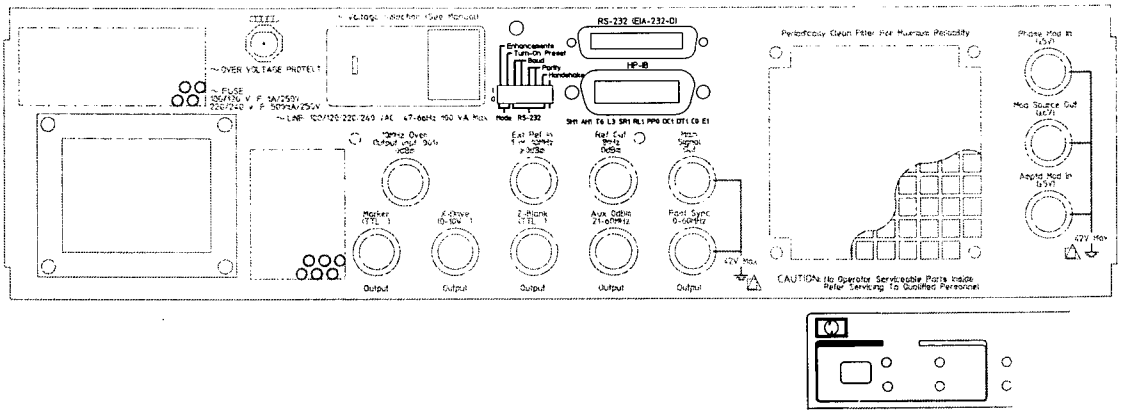


The [Bus Adrs] (bus address) key enables display or entry of the HP-IB address. The [Bus Adrs] key is selected by pressing the blue [Shift] key prior to the [Local] key. After selection of the [Bus Adrs] key, the HP-IB address is entered with the data entry keys or changed with the modify keys. For address values entered with the data entry keys, pressing any units key sets the address. The HP-IB address is an integer in the range of 0 to 31 and is retained in nonvolatile memory. Entering an address value of 31 places the HP 3325B in the listen-only mode and the HP 3325B displays LO rather than the address value.

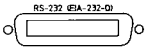


The HP 3325B is connected to other HP-IB devices through the rear-panel HP-IB connector.

The RS-232 Switches/Indicators/Connector

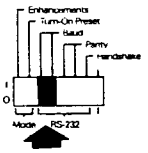


The RS-232 serial interface provides an alternate method (to the HP-IB) of remotely controlling the HP 3325B. Chapter 2 provides an overview of remote operation and contains a complete list of the remote operation commands.



The 25-pin female connector is configured as Data Terminal Equipment (DTE). Chapter 2 contains a description of the characteristics of the connectors. Five of the small switches on the rear panel configure the HP 3325B for operation with the serial RS-232 communications link.

Baud Rate



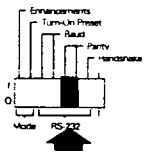
The Baud switches (switches 3 and 4) control the transmission speed (baud rate) of the RS-232 serial interface. Table 1-8 lists the available baud rates and switch settings for them. Whenever the baud switches are changed, the new rate value is displayed. For example, when switch 3 and 4 are placed in the down position, the HP 3325B displays "bAUd = 4800".

Table 1-8. RS-232 Baud Rate

Rate	Switch 3	Switch 4	Display Message
300*	up	up	bAUd = 300
1200	up	down	bAUd = 1200
2400	down	up	bAUd = 2400
4800	down	down	bAUd = 4800

** Factory setting*

Word Length/Parity



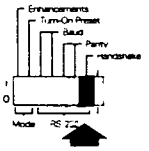
The Parity switches (switches 5 and 6) control the parity and word length of the serial data exchanged with the host computer. Table 1-9 lists the available word lengths and parity and corresponding switch settings. Whenever the parity switches are changed, the new parity value is displayed.

Table 1-9. RS-232 Word Length and Parity

Word Length	Parity	Switch 5	Switch 6
7 data bits *	Even	up	up
7 data bits	Odd	up	down
8 data bits	None	down	up
7 data bits	Zero	down	down

** Factory setting*

Handshaking



The Handshake switch (switch 7) sets the handshaking characteristics used to communicate with host computer. Table 1-10 lists the handshaking available and corresponding switch settings. Whenever the Handshake switch is changed, the new handshaking characteristics are displayed.

Table 1-10. RS-232 Handshaking

Handshaking	Switch 7	Display Message
Software (Xon/Xoff) *	up	HAnd = Soft
Hardware (DTR/RTS)	down	HAnd = dtr

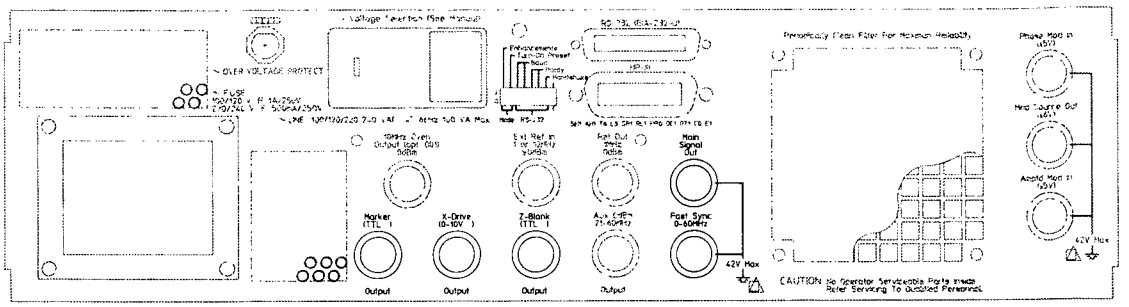
** Factory setting*

RS-232 Local/Remote

The [Local] key removes the HP 3325B from remote (HP-IB or RS-232) operation if local lockout is not in effect. Remote operation is indicated by the illuminated Remote indicator.

The Remote indicator illuminates when the HP 3325B is operating under HP-IB or RS-232 control. While in remote (and local lockout is not in effect), only the [Local] key is recognized.

Marker / Z-Blank (Pen Lift) / X-Drive Outputs



The Marker, Z-Blank, and X-Drive connectors provide outputs to drive an analog plotter or oscilloscope display during sweep operation.

Marker

The rear-panel Marker connector provides a TTL-level signal indicating when the sweep frequency reaches the value entered for the marker frequency.

Single/Continuous Linear Sweep

During a sweep up, the marker signal starts at a high level at the start frequency, drops to a low level at the selected marker frequency, and returns to the high level at the stop frequency. The marker output is disabled during a sweep down. If the marker value entered is out of the sweep span, no marker transition occurs.

Log Sweep

The marker is disabled during log sweeps.

Discrete Sweep

For discrete frequency sweeps, the marker goes to a high value at the start of each frequency segment, drops to a low level at the selected marker frequency and remains low until the start of the next sweep segment. Each of the sweep segments may have a different marker frequency. (See the discussion on discrete sweeps, earlier in this chapter, under Frequency Sweeps.) If the marker value entered is out of the sweep span of the segment, the marker output stays high during the duration of the sweep segment. The marker functions for up or down-sweeps when executing discrete sweeps. If the start, stop, and marker frequency parameters of a segment are equal, the marker output is low during the segment sweep time.

Z-Blank

The Z-Blank output drops low at the start of sweep and remains low until the end of a sweep. At the end of a sweep, the Z-Blank output signal goes to a high level and remains high until another sweep segment is initiated. The Z-Blank connector is located on the rear panel and the output is TTL-compatible. The Z-Blank low level is capable of sinking current from a positive voltage source through a pen-lift circuit or other device. When this output is low the maximum Z-Blank ratings are:

Maximum current sink: 200 mA
Allowable voltage range: 0 to +42V dc
Maximum power (voltage at output × current): 1 W

Single Linear Sweep

Z-Blank drops to a low level at the start of sweep and remains low until the end of a sweep. At the end, the Z-Blank output goes to a high level and remains high until the sweep is restarted.

Continuous Linear Sweep

Z-Blank drops to a low level during the sweep up, and goes to a high level for the sweep down.

Single Log Sweep

Z-Blank drops to a low level at the start frequency, and goes to a high level at the stop frequency and remains high until the sweep is restarted.

Continuous Log Sweep

Z-Blank drops to a low level at the start frequency, and momentarily goes to a high level at the stop frequency.

Discrete Frequency Sweep

Z-Blank drops low at the start of the first segment and stays low until the end of the last segment, when it returns to a high level. During continuous sweeps, Z-Blank remains high for approximately 400 μs.

X-Drive

During sweep operation, the rear-panel X-Drive connector provides a 0 to > 10 volt linear ramp proportional to the sweep time (ramps up). For sweep times of 100 seconds or more the X-drive output stays at 0 volts.

Note The X-Drive output has a nominal voltage of just over 10 volts at the end of a sweep to ensure compatibility with oscilloscopes with a horizontal sensitivity of 10 volts for full-screen deflection.

Single Linear Sweep

During a sweep, X-Drive Out increases linearly from 0 to > 10 volts from the start frequency to the stop frequency. At the end of a sweep, the output remains at approximately 10 volts until reset for the start of the next sweep. (Voltage drifts downward less than 10 mV/s.)

Continuous Linear Sweep

During the up sweep, X-Drive output signal increases linearly from 0 to > 10 volts. The output drops to 0 volts at the start of the down sweep and remains there during the down sweep.

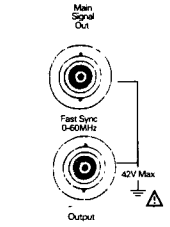
Log Sweep

X-Drive increases linearly from 0 to > 10 volts with the sweep segments.

Discrete Frequency Sweep

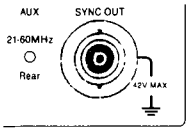
The X-Drive output is disabled during discrete sweeps.

Synchronization Outputs



A square wave with the frequency and phase of the main signal output is available at the front-panel Sync (synchronous) Out and rear-panel Fast Sync connectors. The Sync transition occurs at the signal zero-crossing or when the signal crosses the dc offset voltage.

The output impedance of Sync Out is approximately 50Ω with a frequency range matching the main signal output. When the Sync Out output is terminated in a 50Ω resistive load, the output levels are:

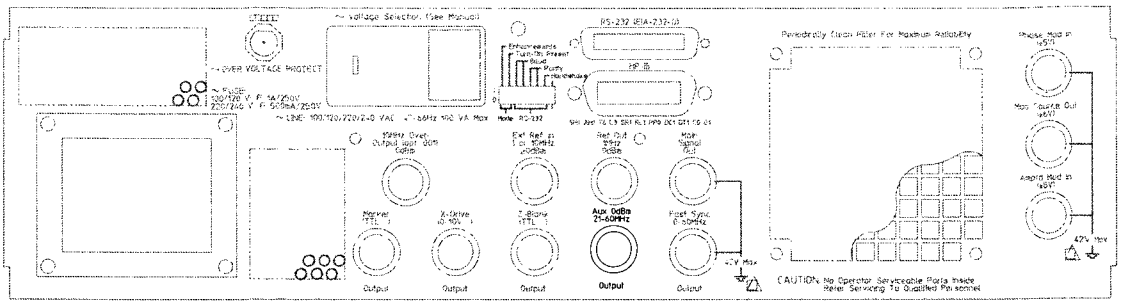


Front Sync	Rear Fast Sync
Low level < +0.2V	Low level < +0.5V
High level > +1.2V	High level > +1.5V

Note When the Sync output is connected to a high impedance load (≥ 1 MΩ), the voltage levels are approximately twice the values listed. Improper termination of a 50Ω system may cause ringing at the signal positive and negative transitions. It may be terminated into larger impedances, if necessary to drive TTL circuits to 60 MHz.

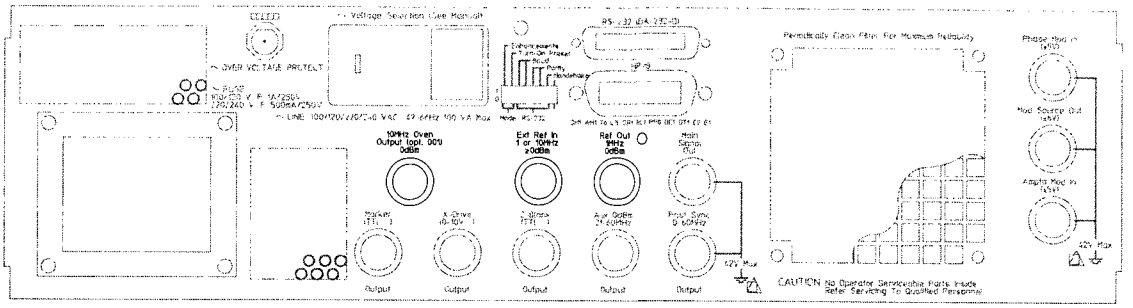
The rear-panel Fast Sync output impedance is approximately 50Ω with a frequency range extended to 60 MHz. The output levels for the Fast Sync connector may fall below the TTL minimums when terminated into 50Ω.

AUX 0 dBm 21–60 MHz Output (Extended Frequency)

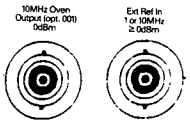


The rear-panel Aux 0 dBm 21–60 MHz connector supplies a signal when the HP 3325B frequency is set above 21 MHz. Once active, the frequency of this output ranges from 19 MHz to a maximum of 60 999 999.999 Hz. Frequencies below 19 MHz reactivate the main signal output connector. The auxiliary output is ac-coupled with a level approximately 0 dBm into 50Ω.

External Reference or Oven-Stabilized Frequency Option



10 MHz Oven Output (High-Stability Frequency Reference)

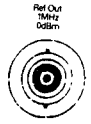


The 10 MHz oven output signal is available at a connector on the rear panel if the high-stability frequency reference (option 001) is installed. It is a 10 MHz temperature-stabilized crystal oscillator which connects to the HP 3325B frequency reference input by connecting the 10 MHz oven output connector to the External Ref In connector with a BNC-to-BNC adapter (HP part number 1250-1499). The 10 MHz oven signal has a level greater than 0 dBm (50Ω). The output signal is present whenever the HP 3325B is connected to a power source.

To reduce the warmup time and obtain maximum performance from an HP 3325B equipped with option 001, leave the HP 3325B connected to a power source. Power is supplied to option 001 whenever the HP 3325B is connected to a power source. An HP 3325B with option 001 requires 15 minutes of warmup time to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected for more than 24 hours, the HP 3325B may require up to 72 hours of warmup time to meet frequency specifications.

External Frequency Reference

The External Ref In connector phase-locks the HP 3325B to external frequency references. Phase-locking to an external frequency reference transfers the external reference's frequency accuracy and aging rate to the HP 3325B. The level of the frequency reference must be from 0 dBm to +20 dBm (50Ω). The frequency must be 10 MHz (±10 ppm) or a subharmonic down to 1 MHz (e.g., 1, 2, 3.33, 5, or 10 MHz). The front-panel Ext Ref indicator illuminates when the HP 3325B is connected to an external frequency reference. The Ext Ref indicator blinks if the HP 3325B is unable to synchronize to the reference. The 10 MHz oven output normally connects to the External Ref In connector if the high stability frequency reference (option 001) is installed.



The Ref Out 1 MHz connector supplies a 1 MHz square wave derived from the frequency reference of the HP 3325B. The square wave has a level greater than 0 dBm (50Ω) and can be used to phase-lock an analyzer or other instrumentation to the frequency reference of the HP 3325B.

Chapter 2

REMOTE OPERATION

Chapter 2
REMOTE OPERATION

This chapter contains two sections:

1. General information concerning the operation of the selected interface (either HP-IB or RS-232)
2. Interface commands specific to the HP 3325B.

The first is an overview of the Hewlett-Packard Interface Bus (HP-IB) and its relationship to the HP 3325B as well as a general description of the RS-232 interface. Both contain information that is general interface information, only; i.e., commands that might be used with any instrument.

The second section contains descriptions of commands used specifically for the HP 3325B.

Remote Operation via HP-IB

Description of the HP-IB

The HP-IB is a bus structure that links the HP 3325B to desktop computers, minicomputers, and other HP-IB controlled instruments to form automated measurement systems. The HP-IB is Hewlett-Packard's implementation of the IEEE Standard 488-1978 and ANSI Standard MC 1.1.

All of the active HP-IB interface circuits are contained within the various HP-IB controlled devices. The interconnecting cable is entirely passive and its role is limited to connecting the devices in parallel so that data can be transferred from one device to another.

Every participating device must be able to perform at least one of the following roles: talker, listener, or controller. A talker transmits data to other devices called listeners. Most devices can be both a talker and listener, but not at the same time. A controller manages the operation of the bus system by designating which device is to talk and which devices are to listen at any given time. The HP 3325B can be either a talker or a listener.

The full flexibility and power of the HP-IB is realized when a controller is added to the system. An HP-IB controller participates in the measurement by being programmed to automate, monitor, and coordinate instrument operation as well as process the measurement results. There may be more than one controller on the bus but only one can be active at a time. (Changing the active controller is accomplished with the *pass control* bus message.) One (and only one) of the controllers should be hard-wired as the *system controller*.

Capabilities of the HP-IB

Number of Interconnected Devices

Up to 15 devices, maximum, may be on one contiguous bus.

Interconnection Path/Maximum Cable Length

Star or linear bus network. Total transmission path length = 2 meters times number of devices, or 20 meters, whichever is less, with a maximum of 3 meters separating any two devices.

Message Transfer Method

Byte-serial, 8 bit-parallel, asynchronous data transfer using a 3-wire handshake.

Data Transfer Rate

One megabyte per second (maximum) over limited distances; actual data rate depends upon the capability of the slowest device involved in the transmission.

Address Capability

Primary addresses: 31 talk, 31 listen; secondary (2-byte) addresses: 961 talk, 961 listen. 1 talker and 14 listeners, maximum, at one time. The HP 3325B has only primary address capability. Table 2-2 lists the talk and listen HP-IB addresses.

Multiple Controller Capability

In systems with more than one controller, only one controller can be active at a time. The active controller can pass control to another controller but only the system controller can assume unconditional control. Only one system controller is allowed per system.

Interface Circuits

Driver and receiver circuits are TTL compatible.

Bus Structure

The HP-IB signal lines consist of eight data lines (DIO1–DIO8), five bus management lines, (explained in following text), and three handshake lines. This is shown in figure 2-1.

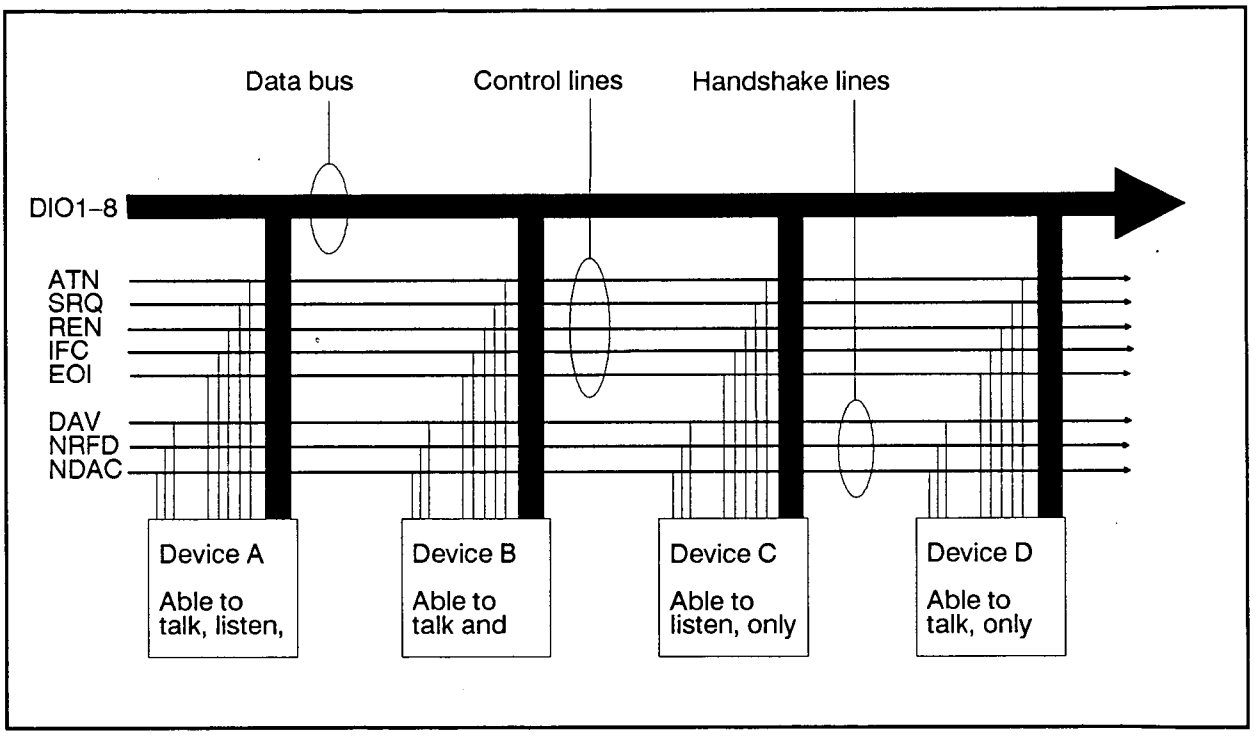


Figure 2-1. HP-IB Structure

HP-IB Management (Control) Lines

ATN — Attention. This line is used by the active controller to define how information on the data lines should be interpreted by other devices on the bus.

When ATN is low (true) the HP-IB is in the *command mode* and the data lines should be interpreted as *bus commands* (see "Bus Commands" later in this chapter). In the command mode the controller is active and all other devices are waiting for instructions. Also, devices on the HP-IB are addressed or unaddressed as listeners or talkers while the bus is in command mode.

When ATN is false the HP-IB is in *data mode* and the data lines should be interpreted as device-dependent commands. In the *data mode*, data and instructions are transferred between devices on the HP-IB. Instructions transferred to the instrument are called *device-dependent commands*. All the commands specifically for the HP 3325B fall into this category. The HP 3325B device-dependent commands configure the HP 3325B, initiate measurements, initiate data transfers, or define error-reporting conditions. These device-dependent commands are meaningless for other instruments. The HP 3325B device-dependent commands are listed later in this chapter under the heading "HP 3325B Remote Operation Command Set."

SRQ — Service Request. This line is set low (true) by any instrument requiring service. The controller should be programmed to respond to most service requests by polling the devices on the bus to determine which one initiated the request. The HP 3325B responds to a serial poll by putting its status byte on the data lines.

REN — Remote Enable. The system controller must set REN low and then address specific device(s) to listen before they can operate under remote control.

IFC — Interface Clear. Only the *system controller* can activate the IFC line. When IFC is set true (low), all devices on the bus become inactive.

EOI — End Or Identify. This line is used to indicate the end of a multiple-byte transfer sequence (in the *data mode*) or by the controller, in conjunction with ATN, to execute a parallel poll.

HP 3325B HP-IB Capability

The HP 3325B interfaces to the HP-IB as defined by IEEE Standard 488-1978. The interface functional subset which the HP 3325B implements is specified in table 2-1.

Table 2-1. HP 3325B HP-IB Capability

Code	Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker; serial poll; unaddressed to talk if addressed to listen; no talk-only
L3	Basic listener; unaddressed to listen if addressed to talk; listen-only
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT1	Device trigger capability
C0	No controller capability
E1	Driver electronics – open collector

Talk/Listen Addresses

Each HP-IB device has at least one talk and one listen address unless the device is either totally transparent or is a talk-only or listen-only device. Device addresses are used by the active controller in the *command mode* (ATN true) to specify the talker (via a talk address) and the listener(s) (via listen addresses). Only one device may be addressed to talk at a time.

The address of a device is usually preset at the factory but may be set to another value during system configuration. In the binary representation of the address, the device address is the decimal equivalent of the five least-significant bits of the address. (On HP-IB devices with selector switches, these are the five address switches.) The address can be from 0 to 31, inclusive. The sixth and seventh bits determine if the address is a talk or listen address, respectively. High-level HP-IB controllers typically configure these two bits automatically. Table 2-2 lists the HP-IB addresses if a controller requires the talk and listen addresses.

Table 2-2. HP-IB Addresses

Device Address	Binary Address	Address Characters Talk	Listen	
0	0000 0000	@	Space	
1	0000 0001	A	!	
2	0000 0010	B	"	
3	0000 0011	C	#	
4	0000 0100	D	$	
5	0000 0101	E	%	
6	0000 0110	F	&	
7	0000 0111	G	'	
8	0000 1000	H	(	
9	0000 1001	I	)	
10	0000 1010	J	*	
11	0000 1011	K	+	
12	0000 1100	L	,	
13	0000 1101	M	-	
14	0000 1110	N	.	
15	0000 1111	O	/	
16	0001 0000	P	0	
17	0001 0001	Q	1	(HP 3325B default address)
18	0001 0010	R	2	
19	0001 0011	S	3	
20	0001 0100	T	4	
21	0001 0101	U	5	(typically the controller)
22	0001 0110	V	6	
23	0001 0111	W	7	
24	0001 1000	X	8	
25	0001 1001	Y	9	
26	0001 1010	Z	:	
27	0001 1011	[	;	
28	0001 1100	\	<	
29	0001 1101	]	=	
30	0001 1110	^	>	

The talk and listen addresses fall within the printable ASCII character set. When a device receives one of these characters while ATN is true, it becomes addressed. The ASCII character "?" (ASCII 31) unaddresses all devices while ATN is true. The device address (set from the HP 3325B front panel) is used by HP-IB controllers, most of which automatically send the talk and listen address characters.

Viewing the HP 3325B HP-IB Address

The HP-IB address is stored in a nonvolatile memory location(there are no address switches). The address appears in the display when you press [Bus Adrs] key ([Shift] [Local]). The address message is removed from the display by pressing another key that requires the display.

Changing the HP-IB Address

Every device on the HP-IB must have a unique address. The HP 3325B address can be set at any address between 0 and 31, inclusive, and is stored in internal nonvolatile memory. When selecting an address, remember that the controller also has an address (usually 21).
To change the HP-IB address:

1. Press the blue [Shift] key followed by the [Local] key in the HP-IB Status block to display the HP-IB address.
2. Enter the address with the data entry keys or change it with the arrow keys.
3. Press any units key to enter the new address.

Notes

An address entry of 31 sets the HP 3325B to *listen only* and the message "Addr. = LO" appears in the display.

If you enter an address greater than 31, the message "Error 100" appears in the display (entry parameter out of range).

The HP-IB address is reset to 17 after a memory clear operation (hold down the Preset key and cycle power).

Bus Commands

The HP-IB interface system operates in one of two modes, controlled by the ATN bus management line: *command mode* (ATN true) or data mode (ATN false). (If an HP controller is used, the bus management lines are configured automatically and all necessary command strings are issued.)

Bus commands are issued while the HP-IB is in the command mode. These commands may instruct the instrument's HP-IB interface to control the instrument (like Clear or Trigger) but are more often used for bus management (Remote, Local, Polls, Service Request, Abort interface activity, or Pass Control). Bus commands are issued through the use of one of the five bus management lines or through the eight-bit data bus. The bus commands and the HP 3325B responses to them are described in the following:

Abort

The *abort* command (interface clear – IFC true) halts all HP-IB activity. The system controller assumes unconditional control of the bus. The HP 3325B responds by becoming unaddressed.

Clear

The clear command causes all devices addressed to listen to reconfigure themselves to a predefined device-dependent condition. The HP 3325B responds to the clear command (both the device clear, DCL, and selective device clear, SDC) by clearing the interface command buffer of any pending commands, clearing the error register, and resetting the instrument to the Preset state.

Clear Lockout/Set Local

The clear lockout/set local command removes all devices from the local lockout mode and returns the HP 3325B to local (front panel) control. The HP-IB is in the local mode because the REN bus management line is set false.

Local

The *local* command clears the remote command from the listening device and returns the listening device to local (front panel) control. If local lockout is not in effect, the HP 3325B responds by returning to front panel control. The Remote indicator on the front panel extinguishes if the HP 3325B is in Remote prior to the Local command.

Local Lockout

The *local lockout* command disables the Local front panel key to avoid operator interference. The HP 3325B front panel is locked out.

Parallel Poll

The *parallel poll* command is a controller operation used to obtain information from the devices under its control. The HP 3325B does not respond to this bus command.

Pass Control

The *pass control* command shifts system control from one controller to another. The HP 3325B does not respond to this command.

Remote

The *remote* command directs an instrument to take instructions from the HP-IB instead of the instrument's front panel. To implement the remote command, the controller must set the REN bus management line true. When the HP 3325B accepts the remote command, the Remote front panel indicator illuminates and the front panel is disabled except for the Local key which can return control of the instrument to the front panel if pressed. If the *local lockout* message is also issued, the mode cannot be changed from remote to local via the front panel [Local] key.

Serial Poll

The *serial poll* is issued by the active controller along with a specific address. If the address matches the address setting of the HP 3325B, it responds by putting its status byte on the data lines for the controller to read. The HP 3325B status byte consists of eight bits indicating the states of several operating parameters (refer to "The Status Byte").

Service Request

The *service request* (SRQ) bus management line is used by a device to indicate a need for attention from the controller. When the HP 3325B requires service (as is determined by the setting of the status byte mask) it issues an SRQ (pulls the SRQ line low), sets bit 6 of the status byte (see the "Status Byte"), and illuminates the front panel SRQ indicator. The SRQ is cleared by executing a serial poll of the HP 3325B. Bit 6, the require-service bit, is sometimes referred to as the status bit in connection with a poll. Bits 0, 1, 2, and 3 in the status byte may initiate an SRQ, depending on the setting of the status byte mask. The status byte may be masked to select which of the four bits cause the HP 3325B to issue the SRQ.

Trigger

The *group execute trigger* (GET) or *selective device trigger* (SDT) command causes all addressed instruments with HP-IB trigger capability to execute a predefined function simultaneously. The HP 3325B responds to the HP-IB trigger command by starting a single sweep, providing the HP 3325B is in the enhancements mode and the sweep was reset using the RSW command.

Masking The Status Byte

The HP 3325B MS and ESTB commands specify which bits in the status byte are enabled (to generate an SRQ). These commands are described under the HP 3325B Remote Control Command Set. Table 2-3 describes the HP 3325B status byte and lists the decimal value of each bit position.

The Status Byte

The status byte is an eight-bit word transmitted by the HP 3325B in response to a serial poll. The state of each bit indicates the status of an internal HP 3325B function. Table 2-3 describes the HP 3325B status byte bit positions and the events and conditions that set and reset each bit. A status bit is enabled (set) when the condition it represents changes from false to true. When a bit is enabled, bit 6 is also set and an SRQ is generated if the Boolean AND of the status byte and the status byte mask is not equal to zero. See the MS command and table 2-3 for more information on masking the status byte.

Table 2-3. HP 3325B Status Byte

Bit	Value	Description
B0	1	**ERR.** Program or front panel entry error. Use IER or ERR? to query for error number. Set when an error occurs. Cleared by a serial poll, QSTB?, or power on. Not cleared by HP-IB clear, *RST, ERR?, or IER commands.
B1	2	**STOP.** Sweep stopped; set by completion of a single sweep or by and command that stops a single sweep. Cleared by a serial poll, QSTB?, or starting a sweep. Not cleared by the HP-IB clear command, *RST command, or a single sweep reset.
B2	4	**START.** Sweep started. Set when a dingle or continuous sweep starts. Cleared by serial poll, QSTB?, completion of a single sweep, or any command that stops a sweep.
B3	8	**FAIL.** Hardware failure. Set by Self Test failure, Calibration failure, External Reference Unlock, Oscillator Unlocked, or Memory Lost conditions. Cleared by power-on, serial poll, and QSTB?. Not cleared by HP-IB clear or *RST.
B4	16	**Bit 4.** Always zero.
B5	32	**SWEEP.** Set when a sweep is in progress, clear when a sweep is not in progress. Cannot be configured to cause SRQ.
B6	64	**Require Service.** Set when the HP 3325B requires service (sent an SRQ). Its main function is to identify the instrument as having requested service when it is polled by the controller. It is set by the occurrence of an event which sets the ERR, STOP, START, or FAIL bits (if they are not masked; see the MS command and table 2-34). Cleared by a serial poll or QSTB? command, an HP-IB clear command, a *RST (reset) command, when the HP 3325B is preset (front panel), or when power is cycled. NOTE: this status bit is not set if one of the bits which sets it is set but masked, and is then unmasked. Recommend you poll after changing the mask.
B7	128	**BUSY.** Set while a command is being executed, clear when instrument is not busy. Cannot be configured to enable SRQ.

Remote Operation via RS-232 Interface

Description of the RS-232 Interface

The RS-232 interface provides a serial data communications link between the HP 3325B and controllers such as desktop computers.

Note	The RS-232C interface can be used when it is not possible or feasible to use the HP-IB. Never try to use both the RS-232 interface and HP-IB at the same time.

Serial data communication differs from the HP-IB in that serial data is transmitted one bit at a time while the HP-IB moves a byte (eight bits) at a time. The serial data format is shown in figure 2-2.

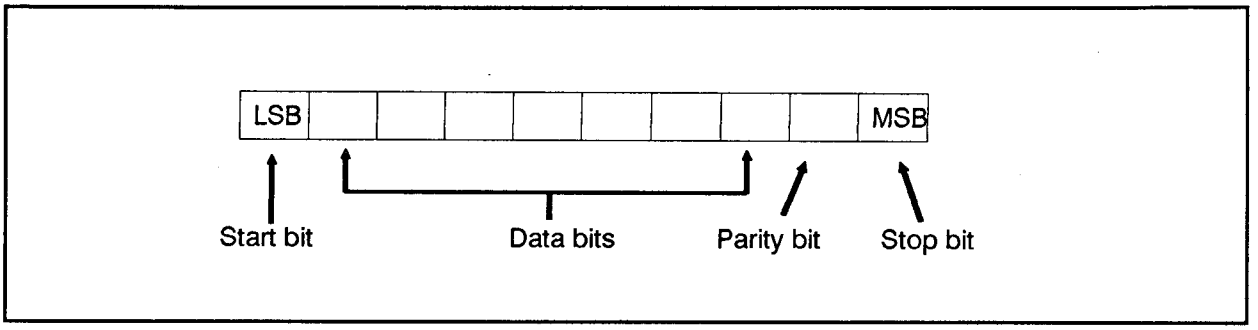


Figure 2-2. Serial Word Conifiguration

The HP 3325B RS-232 interface implements a subset of the signals defined in ANSI/EIA-232-D-1986 and CCITT V.24. The connector is a standard 25-pin female connector configured as Data Terminal Equipment (DTE). The HP 3325B sends and receives ASCII characters using an asynchronous format.

Table 2-4. RS-232 Connector Pin Assignments

Pin No.	Signal Name and Description
1	**Shield:** Connected to the HP 3325B chassis.
2	**BA or TXD (transmit data):** Bit-serial data transmitted from the HP 3325B.
3	**BB or RXD (receive data):** Bit-serial data received by the HP 3325B.
4	**CA or RTS (request to send):** An output from the HP 3325B that is usually +10V. If **hardware handshaking** is enabled, this signal changes to −10V when the HP 3325B buffer has room for less than 128 characters.
7	**AB or Signal Ground:** The reference potential for other signals. **Note:** *to prevent ground loops, the HP 3325B RS-232 interface circuits are isolated from earth ground and from signal ground.*
20	**CD or DTR (data terminal ready):** An output from the HP 3325B that is usually +10V. If **hardware handshaking** is enabled, this signal changes to −10V when the HP 3325B buffer has room for less than 128 characters.
	No other pins are connected.

The Cable

A standard printer cable should be used to connect the HP 3325B to another DTE device such as a computer or terminal. The printer cable switches the receive and send connections, as is necessary when a DTE device is connected to another DTE device. Use an HP 13242G to connect the HP 3325B to a controller with a 25-pin connector. Use an HP 24542G to connect to a 9-pin male connector as may be found on a serial interface in a desktop computer. Use an HP 92221P to connect to a 9-pin female connector as may be found on HP Series 9000/300 computers.

A standard modem cable should be used to connect the HP 3325B to a modem (HP 13242N).

Setting The Switches

Seven switches on the RS-232C rear panel determine the interface's baud rate, active handshake, and parity. All switches are set to the up position at the factory. New settings are recognized immediately displayed on the front panel when a switch setting is changed. The switch settings are defined in the following pages.

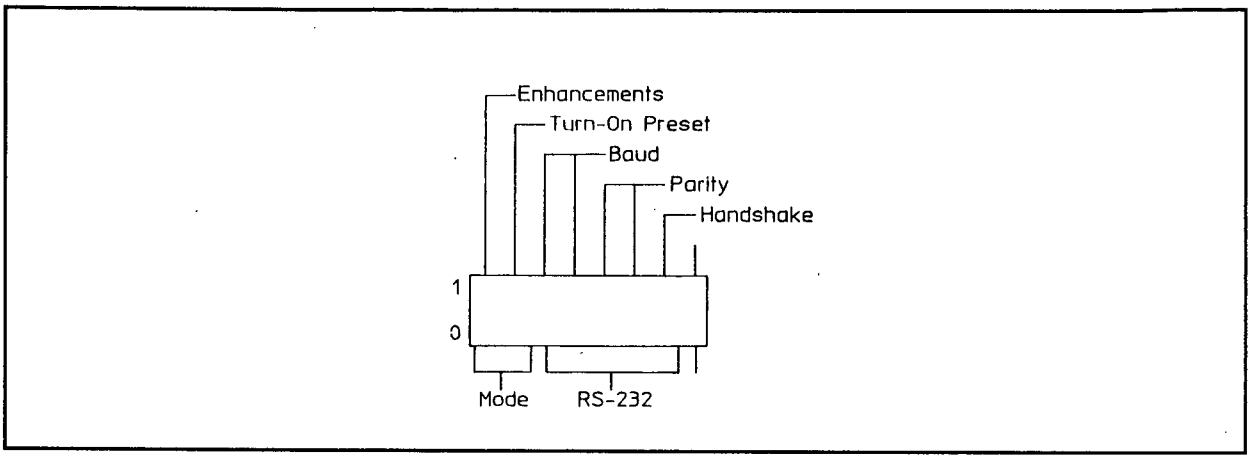


Figure 2-3. Rear-panel RS-232 switches

Mode Settings

Switches 1 and 2 select the enhancements/compatibility setting and the power-on state of the HP 3325B. These two switches are not directly tied to remote operation of the HP 3325B. They are explained here, in the remote control chapter, for the sake of completeness. They are explained again in Chapter 3, General Information.

Enhancements – Switch 1 determines the enhancement setting. *Enhancements* refers to capabilities that are improved on or added to those of the HP 3325A. When the enhancement mode is off, the HP 3325B is in the *compatible* mode. The enhancements mode may also be controlled with the ENH command as described later in this chapter.

Turn-On Preset – Switch 2 determines the turn-on settings. The choice is between the instrument preset state or the state of the instrument when it was last turned off.

Table 2-5. Mode Settings: switches 1 and 2

	Up	Down
Switch 1 – Enhancements	on	off
Switch 2 – Turn-on state	Preset	Turn-off state*

* *Requires that enhancements be on*

Baud Rate

Four different baud rates are available. These are selected by changing rear panel switches numbers three and four as shown in table 2-6. When a switch is changed the new baud rate is displayed on the front panel.

Table 2-6. Baud Rate Selection: switches 3 and 4

Baud Rate	Switch 3	Switch 4
300	up	up
1200	up	down
2400	down	up
4800	down	down

Word Length and Parity

Word length and parity are selected by setting switches five and six as shown in table 2-7.

Table 2-7. Switch settings for word length and parity: switches 5 and 6

Description	Switch 5	Switch 6
7 data bits, 1 parity bit, even parity	up	up
7 data bits, 1 parity bit, odd parity	up	down
8 data bits, no parity	down	up
7 data bits, 1 parity bit, parity bit always 0 (zero)	down	down

Handshake Selection

Handshaking, or *receive pacing*, is performed by the HP 3325B to prevent its character buffer from overflowing. Data is lost if it is sent to the HP 3325B when its data buffer is full. The data buffer can hold 256 characters. The handshaking may be accomplished with one of two different methods, selected with switch 7: *software handshake* or the *hardware handshake*.

When *software handshaking* is selected, the HP 3325B sends the Xoff character (decimal 19 or DC3) when there is room for less than 128 characters in its buffer. After sending Xoff the HP 3325B processes characters until there is room for 256 characters, when it sends the Xon character (decimal 17 or DC1) to indicate that it is ready for more characters.

The *hardware handshake* performs the same function using hardware connections to signal its readiness for data. Both the RTS (request to send) and DTR (data terminal ready) lines become false (−10V) when there is room for less than 128 characters in the character buffer. This handshake is not recommended when the HP 3325B is connected to a modem since dropping the DTR line may cause the modem to disconnect.

The HP 3325B uses receive handshaking, only. It does not respond when it receives the Xoff character and no hardware connection is made which would signal it to stop sending data. All data sequences sent by the HP 3325B are short enough that transmit pacing should not be necessary.

Table 2-8. Setting the Handshake: switch 7

Handshake description	Switch 7
Software (Xon/Xoff)	up
Hardware (DTR/RTS)	down

Remote and Local Functions

The first character of a remote command puts the HP 3325B in *Remote Mode* which causes the Remote LED to illuminate. The Talk and Listen LEDs are not used when using the RS-232 interface for remote control. When the HP 3325B receives the "LCL" command or the [Local] front-panel key is pressed, the HP 3325B returns to front-panel control.

Other remote-control commands that are useful for RS-232 operation are ECHO, RMT, *RST, and QSTB. These are described in more detail later in the chapter.

Note The RS-232 interface does not alert the controlling computer when the instrument issues a service request (SRQ), as the HP-IB does. We recommend checking the status byte periodically with the QSTB? command when the RS-232 interface is used for remote control.

HP 3325B Remote Operation Command Set

The commands for operating the HP 3325B with a computer controller are listed here. Some of these commands correspond to front-panel keystrokes; the rest are remote-only commands. Remote commands corresponding to front panel keys are described in Chapter 1.

The HP-IB Remote status light, located in the HP-IB Status block on the left side of the front panel, indicates whether the instrument is currently operating under *local* (front panel control) or *remote* control. Remote operation is accomplished only via commands transmitted through one of the two interface connectors located on the rear panel.

Note The Remote indicator on the HP 3325B can be used for a quick operational check of the remote interface. If you are using the HP-IB interface, refer to the controller operating manual for a description of the HP-IB Remote message. If you are using the RS-232 interface, send the RMT command. When this message is sent to the HP 3325B, the Remote indicator should illuminate. If this does not occur, check the cabling, the HP 3325B HP-IB address and the syntax of the controller statement (for HP-IB), or the baud rate, word length and parity settings (for RS-232).

Changing from local control to remote control does not alter the current operating state. Changing from local to remote control may be accomplished by issuing a remote command such as REMOTE (HP-IB) or RMT (RS-232).

Changing the HP 3325B from remote control to local control causes the HP 3325B to return to front panel control without changing the operating state. This may be accomplished by either pressing the [Local] key (if local lockout is not in effect), or by issuing a command remote command such as LOCAL (an HP-IB bus message) or LCL (an RS-232 command).

Command Syntax

The following conventions apply to the HP 3325B HP-IB commands:

- The HP 3325B accepts data in 7-bit ASCII code and ignores the 8th (parity) bit.
- All spaces and lower case alphabetic characters are ignored by the HP 3325B; they may be used to improve program readability.
- Under HP-IB control, two data transfer modes are available. Refer to the MD command for more detail. An asterisk or line feed is required to terminate a command string in data transfer mode 2.
- A semicolon can be used to separate commands (recommended but not required).
- Range values may be in integer, real, or exponential form. For positive values, only the first eleven digits of the mantissa are used. For negative values, only the first ten digits of the mantissa are used. Leading zeros before the decimal point are ignored.

The HP 3325B uses the following forms for remote commands:

Command Form	Example	Example Description
<mnemonic>	AC	Amplitude Calibrate
<mnemonic> <data>	FU2	Square wave function select
<mnemonic> <rangedata> <suffix>	AM1.2VO	Amplitude of 1.2 V_{pp}
<mnemonic>?	FR?	Interrogate frequency
<mnemonic>	IFR	Interrogate frequency

where:

- **<mnemonic>** is the HP-IB mnemonic
- **<suffix>** is an alphabetic code for units, function, or mode
- **<data>** is a numeric code for a function or mode
- **<range data>** is the value for an entry parameter
- **?** is used to interrogate the HP 3325B.

A program string for the HP 3325B may contain multiple HP-IB commands such as

"FU2 FR 1 MH AM 2 VO FR?"

Interrogating The HP 3325B For Setup Parameters

The value of a setup parameter is read over the HP-IB by sending the parameter HP-IB mnemonic followed by a question mark (?). For example, sending the mnemonic FR? sets up the HP 3325B to respond with the frequency value. HP-IB data is transmitted when the HP 3325B is addressed to talk. RS-232 data is transmitted 100 ms after the interrogation. Each interrogation response ends with the carriage return (ASCII 13) and line feed (ASCII 10) characters. Each interrogation may include command mnemonic and suffix, depending on the setting of the HEAD command.

Remote Operation via RS-232 Interface

Setup parameters include frequency, amplitude, offset, phase, sweep start frequency, sweep stop frequency, sweep marker frequency, sweep time, modulation source frequency, and modulation source amplitude.The current value for a setup parameter is displayed on the HP 3325B front panel if the corresponding HP-IB mnemonic is sent without data and a suffix. For example, sending the mnemonic AM displays the amplitude value but does not change the amplitude value.

The units for the displayed value of a setup parameter change to new units if the corresponding command mnemonic and new suffix are sent without data. For example, sending the mnemonic AM DB displays the current amplitude value in dBm. Sending the AM DB command does not change the amplitude value.

Note If the display is disabled with the DSP0 command, the requested value is not displayed.

Command Reference

Syntax Drawing Rules

All characters in circles or ovals are *terminal* symbols and must be sent exactly as shown. Items in boxes are *non-terminal* symbols; descriptions of these items are given following the syntax drawings. Spaces and lower case letters are ignored; they can be inserted to improve readability.

The *Response Format* tables specify what is returned by the instrument in response to a query. All responses are terminated with ‹carriage return› and ‹line feed› with the HP-IB EOI (bus management line) active. The "#" symbol represents one digit.

Definitions

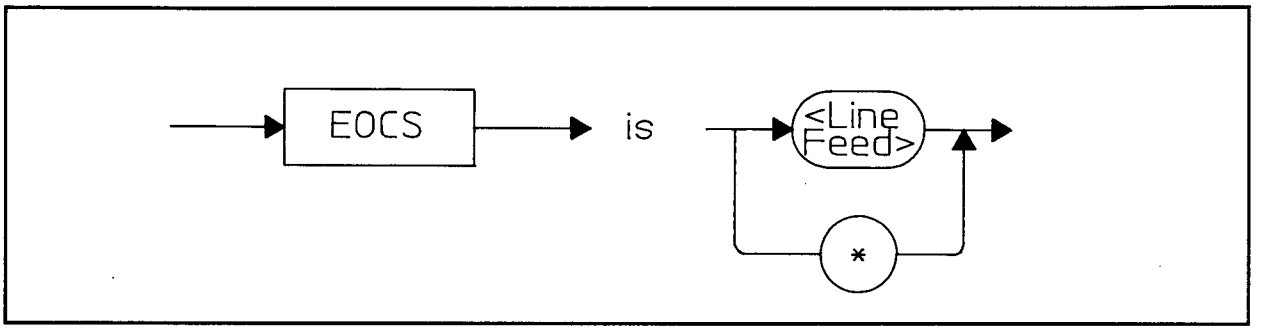


Figure 2-4. Definition of EOCS

The End-Of-Command-String character is used in Data Transfer Mode 2 (see the MD command). In data transfer mode 2, device-dependent commands are accepted and stored in an internal buffer and are not processed until the End-Of-Command-String (EOCS) character is received or the buffer is filled (48 bytes).

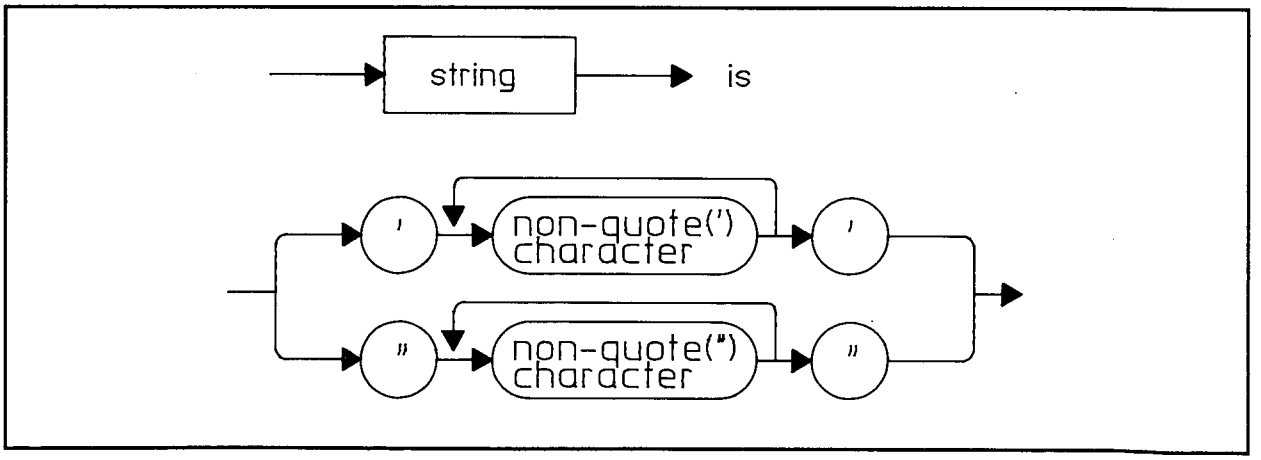


Figure 2-5. Definition of "String"

Strings can not include the End-Of-Command-String characters (* or ‹line feed›).

AC; Amplitude Calibration Command

The AC command performs an amplitude calibration. If calibration is not successful, the FAIL bit of the status register is set.

Command Availability

	AC
HP 3325B	Yes
HP 3325A	Yes

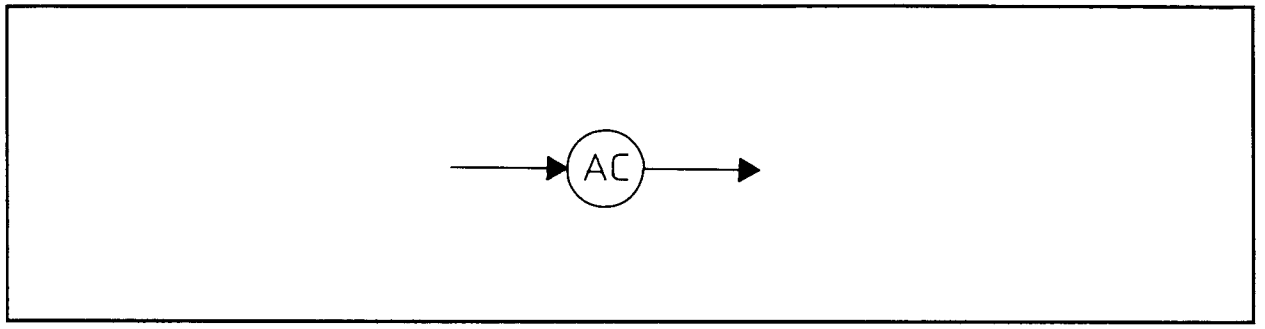


Figure 2-6. AC Syntax Diagram

AM; Amplitude Command

The AM command sets the amplitude of the main signal. Sending AM with no value or units displays the current amplitude. Sending AM and units without any value causes the current amplitude to be displayed in the new units. Issuing IAM or AM? causes the instrument to output its current amplitude. See MOAM to set the amplitude of the modulation source.

Instrument Preset value: 1.0 mV_{pp}

Command Availability

	AM	IAM	AM?	DV
HP 3325B	Yes	Yes	Yes	Yes
HP 3325A	Yes	Yes	No	No

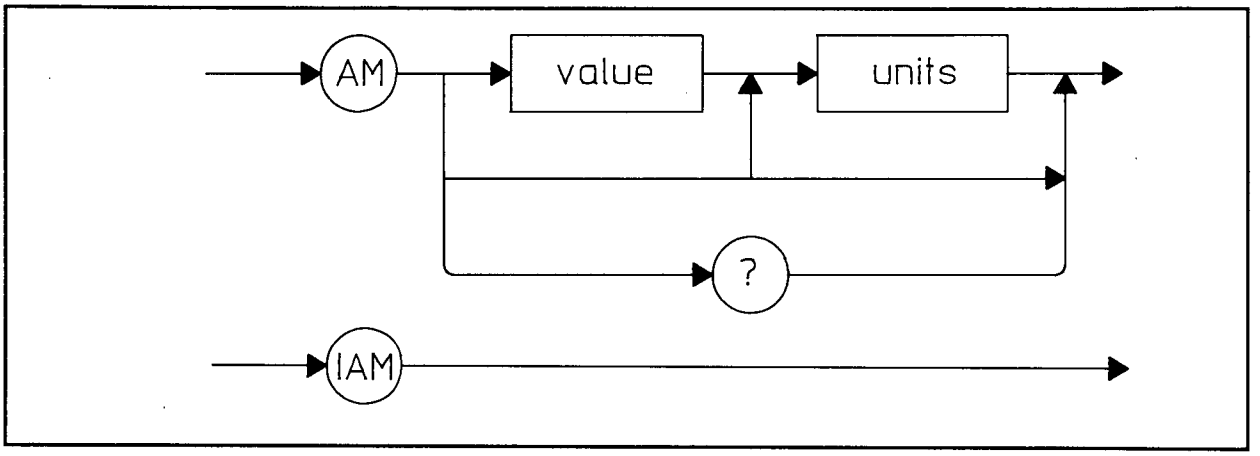


Figure 2-7. AM Syntax Diagram

Table 2-9. AM "value" Restrictions Given "units"

Value range	Units	Description	High Voltage"
0.001 →10.0 0.004 → 40.0	VO	V_{pp} On	Off
1.0 → 10000.0 4.0 → 40000.0	MV	mV_{pp} On	Off
0.000354 →3.53 0.00142 → 14.1	VR	V_{rms} On	Off
0.354 → 3530.0 1.42 → 14100.0	MR	mV_{rms} On	Off
−56.02 → 23.98 Illegal	DB	dBm	Off
−69.01 →10.97 −56.97 → 23.01	DV	dBV_{rms} On	Off

Table 2-10. AM? and IAM Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	AM#####.######VO	#####.######
VR or MR	AM#####.######VR	#####.######
DB or DV	AM−#######.###DB	−#######.###
DB or DV (special)	AM−#######.###DV	−#######.###

AP; Assign Zero Phase Command

The AP command assigns the current phase value to zero; subsequent changes in phase are referenced to that point.

Command Availability

	AP
HP 3325B	Yes
HP 3325A	Yes

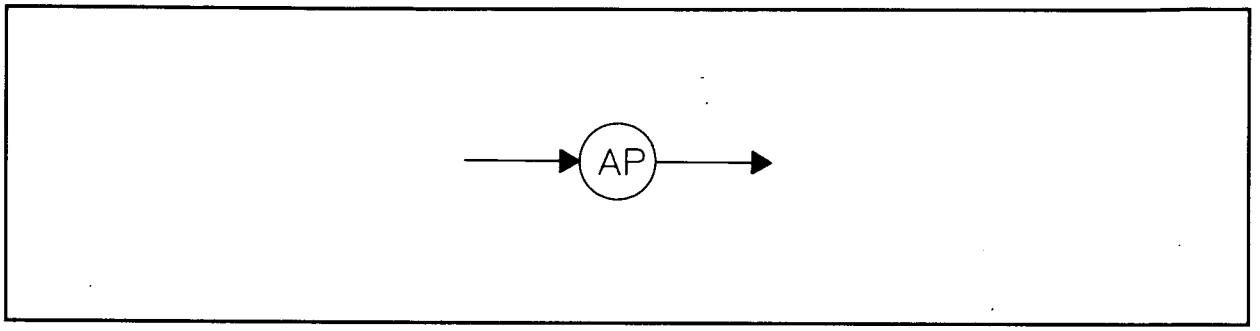


Figure 2-8. AP Syntax Diagram

CALM; Calibration Mode Command

The CALM command allows all functions to be calibrated once. In this mode, function changes are faster.

Instrument Power-on value: 0

Instrument Preset, HP-IB clear value: not changed.

Command Availability

	CALM
HP 3325B	Yes
HP 3325A	No

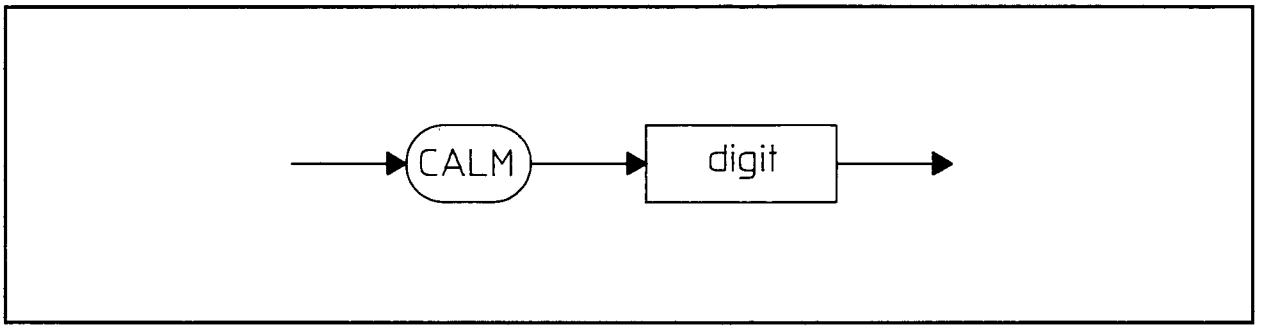


Figure 2-9. CALM Syntax Diagram

Digit	Meaning
0	Perform an Amplitude Calibration whenever the waveform function is changed.
1	Perform an Amplitude Calibration on all functions immediately, do not re-calibrate when waveform function is changed.

DCLR; Discrete Sweep Table Clear Command

The DCLR command clears all previously stored discrete sweep vectors.

Command Availability

	DCLR
HP 3325B	Yes
HP 3325A	No

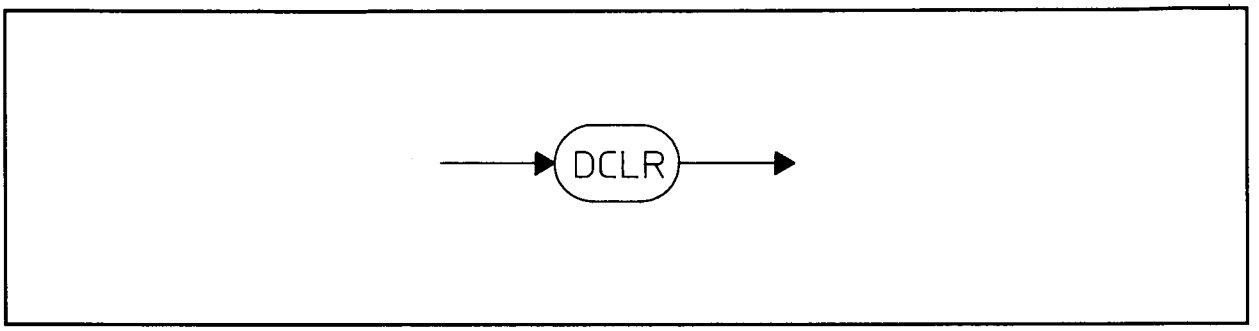


Figure 2-10. DCLR Syntax Diagram

DISP; Display On/Off Command

The DISP command and allows the display to be turned off. "DISP OFF" is displayed until the display is turned back on.

Instrument Power-on value: On

Instrument Preset, HP-IB clear value: not changed.

Command Availability

	DISP
HP 3325B	Yes
HP 3325A	No

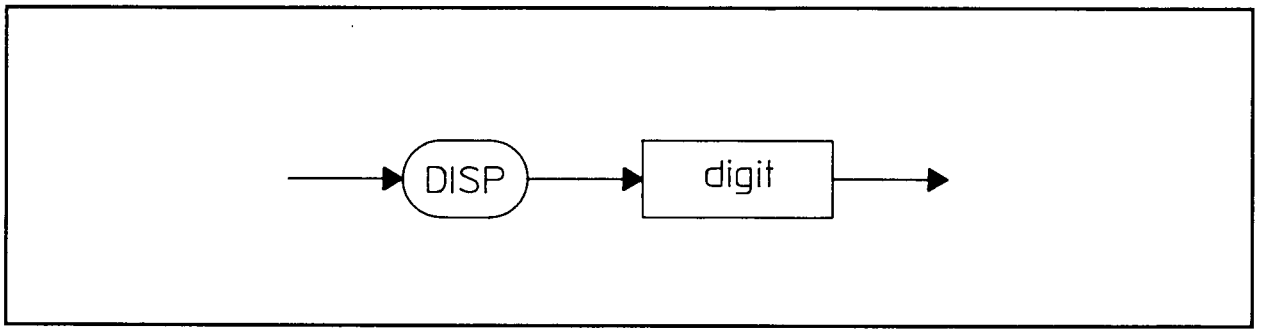


Figure 2-11. DISP Syntax Diagram

digit	Meaning
0	Display off.
1	Display on.

DRCL and DSTO; Discrete Sweep Store and Recall Commands

DRCL recalls the discrete sweep vector number specified by the two digits. Start frequency, stop frequency, marker frequency, and sweep time values are overwritten with the recalled values.

DSTO saves the current start frequency, stop frequency, marker frequency, and sweep time values in the discrete sweep vector number specified by the two digits.

Command Availability

	DRCL	DSTO
HP 3325B	Yes	Yes
HP 3325A	No	No

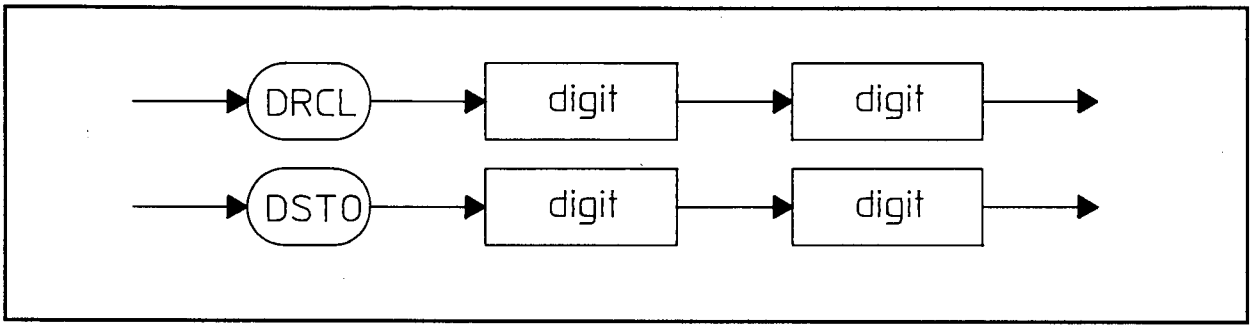


Figure 2-12. DRCL and DSTO Syntax Diagrams

DSP; Display String Command

The DSP command allows a message to be put in the instrument's display. Some alphabetic characters may be hard to distinguish when displayed in the 7-segment numeric displays.

Command Availability

	DSP
HP 3325B	Yes
HP 3325A	No

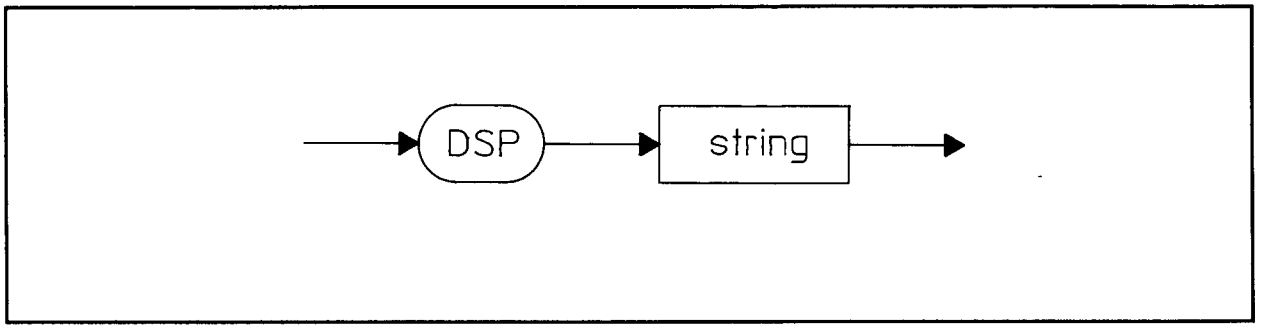


Figure 2-13. DSP Syntax Diagram

ECHO; RS-232 Echo-Control Command

The ECHO command enables echoing of in-bound RS-232 characters. This is useful when using a full-duplex terminal to program the HP 3325B. The carriage return character is echoed as <carriage return> and <line feed>.

Instrument Preset, HP-IB clear value: not changed

Instrument Power-on value: 0

Command Availability

	ECHO
HP 3325B	Yes
HP 3325A	No

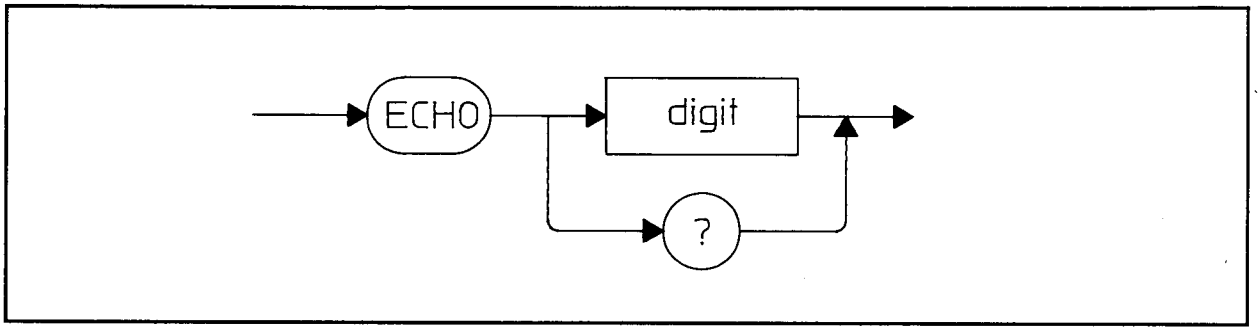


Figure 2-14. ECHO Syntax Diagram

digit	Meaning
0	Do not echo characters.
1	Echo characters.

Table 2-11. ECHO? Response Format

HEAD-on response	HEAD-off response
ECHO#	#

ENH; Enhancements Control Command

The ENH command selects between the *enhancements* mode and the *compatibility* mode. In the *enhancements* mode, new features of the HP 3325B are enabled. In the *compatibility* mode, some new features are disabled, but only those which may cause compatibility problems. Refer to Chapter 3, General Information, for a description of the differences in the two settings.

Instrument Preset, HP-IB clear value: not changed

Instrument Power-on value: rear-panel switch setting

Command Availability

	ENH
HP 3325B	Yes
HP 3325A	No

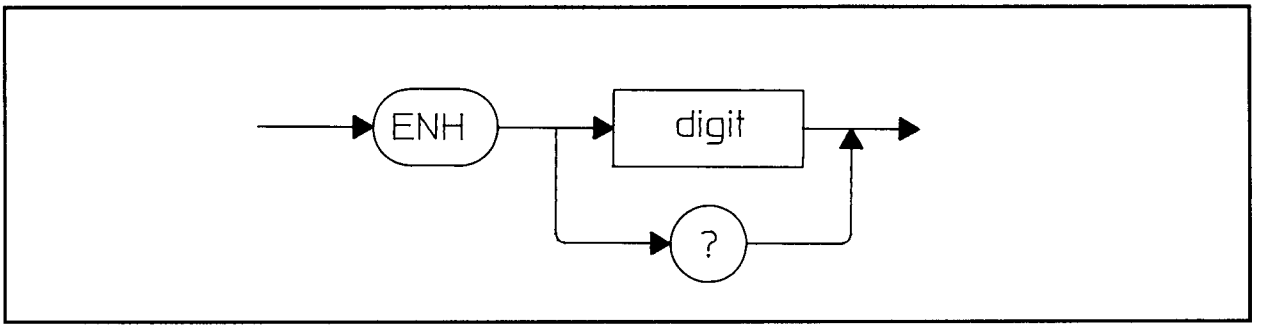


Figure 2-15. ENH Syntax Diagram

digit	Meaning
0	Select the compatibility mode.
1	Select the Enhancements mode.

Table 2-12. ENH? Response Format

HEAD-on response	HEAD-off response
ENH#	#

ERR? and IER; Error Query

These commands query the instrument for the most recent error code. The IER query returns a one-digit code. The ERR? query returns a three-digit code, the first digit of which is the same as the IER query; the other two digits provide more detail as described in table 2-51 later in this chapter. If no error occurred, 0 is returned. Issuing either command clears both error codes to 0.

Instrument Power-on: Clears any errors.

Instrument Preset, HP-IB Clear: Clears any errors.

Command Availability

	ERR?	IER
HP 3325B	Yes	Yes
HP 3325A	No	Yes

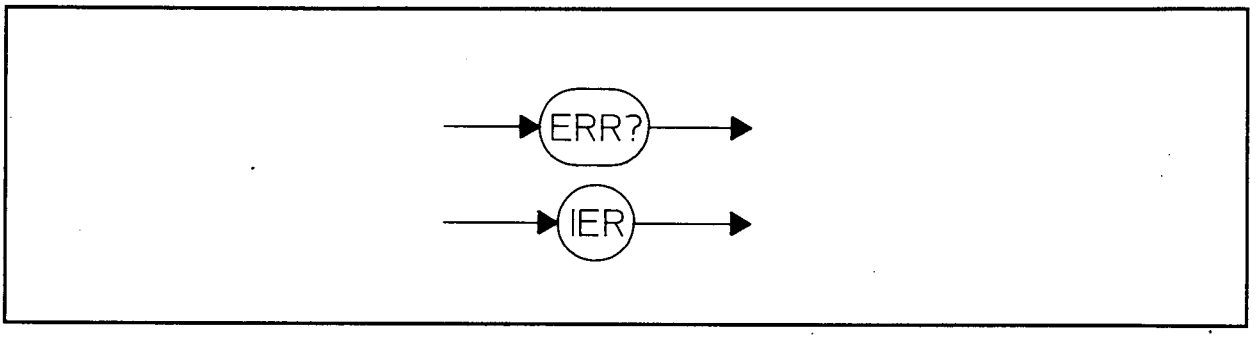


Figure 2-16. ERR Syntax Diagram

Table 2-13. ERR? and IER Response Formats

Command	HEAD-on response	HEAD-off response
ERR?	ERR###	###
IER	ER#	#

ESTB; Service Request Enable Command

The ESTB command is used to set the status byte mask. Four lists in the status byte are capable of causing a service request (SRQ). When they are enabled (unmasked). They may be enabled or masked in any combination as defined in the table 2-34. The MS Command accomplishes the same thing using alpha characters instead of decimal characters.

In the syntax diagram of Figure 2-17, **value** is a decimal number whose binary (base 2) equivalent represents the bits of the Status Register. The range of **value** is 0 thru 15.

Instrument Power-on value: 0 (all masked)

Instrument Preset, HP-IB-clear value: not changed

Command Availability

	ESTB	ESTB?
HP 3325B	Yes	Yes
HP 3325A	No	No

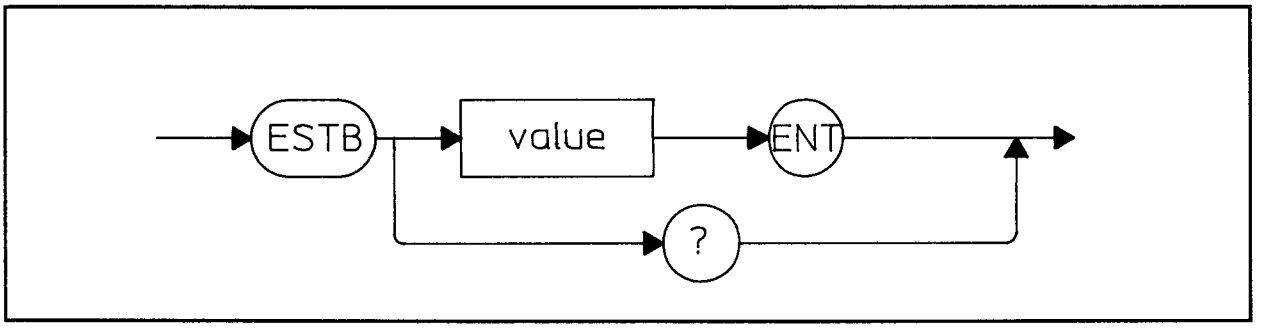


Figure 2-17. ESTB Syntax Diagram

Table 2-14. Status-Register Bits that can be enabled to cause SRQ

Bit	Value	Name	Description
0	1	ERR	Program or keyboard entry error.
1	2	STOP	Sweep stopped.
2	4	START	Sweep started.
3	8	FAIL	Hardware failure.

Table 2-15. ESTB? Response Format

HEAD-on response	HEAD-off response
ESTB###ENT	###

EXTR?; External Reference Locked Query

The EXTR? query returns 1 if the reference oscillator is locked to an external input, 0 if not.

Command Availability

	EXTR
HP 3325B	Yes
HP 3325A	No

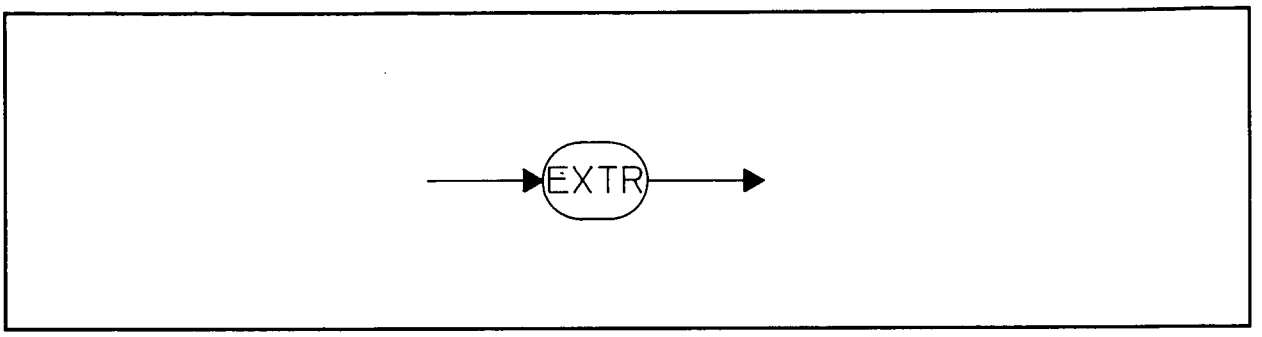


Figure 2-18. EXTR? Syntax Diagram

Table 2-16. EXTR? Response Format

HEAD-on response	HEAD-off response
EXTR#	#

FR; Frequency Command

The FR command sets the frequency. Sending FR with no value or units displays the current frequency. IFR and FR? cause the instrument to output its current frequency. See MOFR to set the frequency of the modulation source.

Instrument Preset value: 1000.0 Hz

Command Availability:

	FR	IFR	FR?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

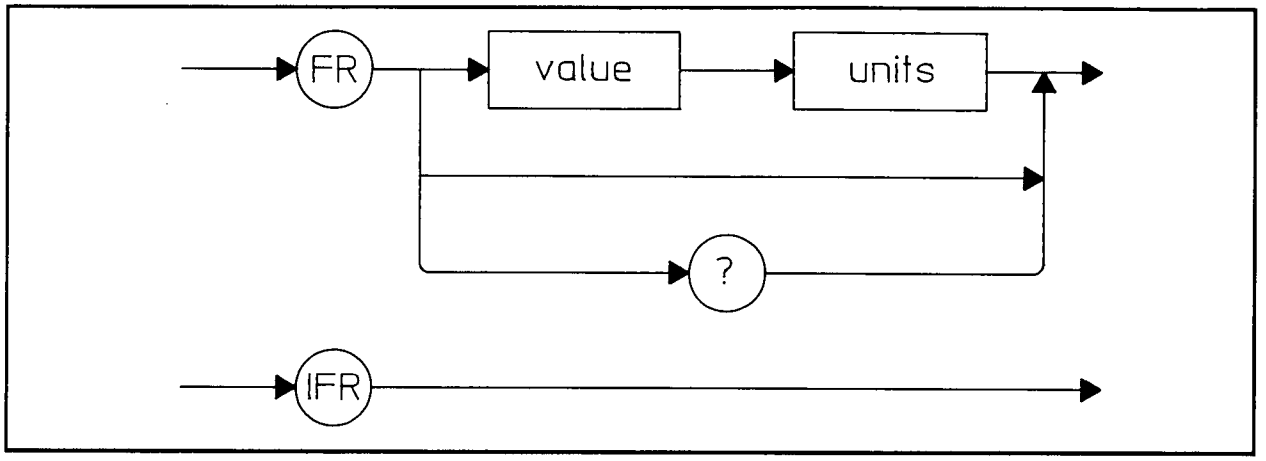


Figure 2-19. FR Syntax Diagram

Table 2-17. FR "value" Restrictions Given "units"

Units	Description	Range Restrictions for "value" (sine)
HZ	Hertz	0.0 → 60999999.999
KH	kHz	0.0 → 60999.999999
MH	MHz	0.0 → 60.999999

Table 2-18. FR? and IFR Response Format

μHz programmed	HEAD-on response	HEAD-off response
No	FR########.###HZ	########.###
Yes	FR#####.######HZ	#####.######

FU; Waveform Function Command

The FU command selects the waveform function for the main signal output.

Instrument Preset value: 1

Command Availability

	FU	IFU	FU?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

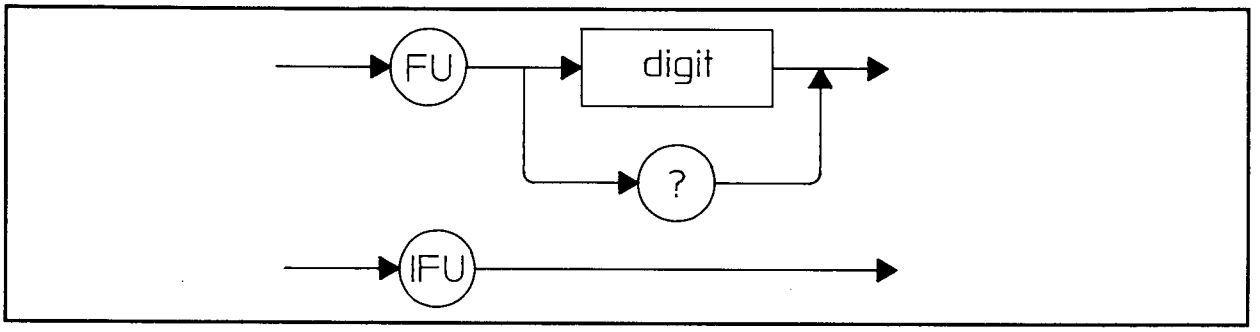


Figure 2-20. FU Syntax Diagram

Table 2-19. Waveform Selections for "digit"

digit	Waveform
0	Selects DC only.
1	Selects Sine wave
2	Selects Square wave.
3	Selects Triangle wave.
4	Selects Positive ramp.
5	Selects Negative ramp.

Table 2-20. FU? and IFU Response Format

HEAD-on response	HEAD-off response
FU#	#

HEAD; Response Header Control Command

The HEAD command enables or disables the alpha header (and units suffix) for query responses. With HEAD on, the response can be used to re-program the item. With HEAD off, only the numerics are sent which can make it easier to read into a numeric variable in a program.

Instrument Power-on value: 1.

Instrument Preset, HP-IB clear value: not changed.

Command Availability:

	HEAD
HP 3325B	Yes
HP 3325A	No

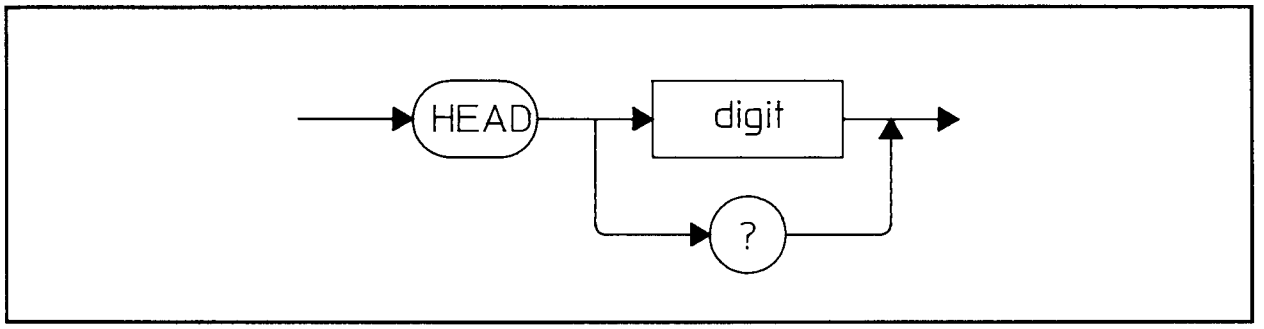


Figure 2-21. HEAD Syntax Diagram

"Digit"	Mode
0	Selects header OFF mode.
1	Selects header ON mode.

Table 2-21. HEAD? Response Format

HEAD-on response	HEAD-off response
HEAD#	#

HV; High Voltage Output Command

The HV command controls the High Voltage amplifier option for the main signal output.

Instrument Preset value: 1.

Command Availability

	HV	IHV	HV?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

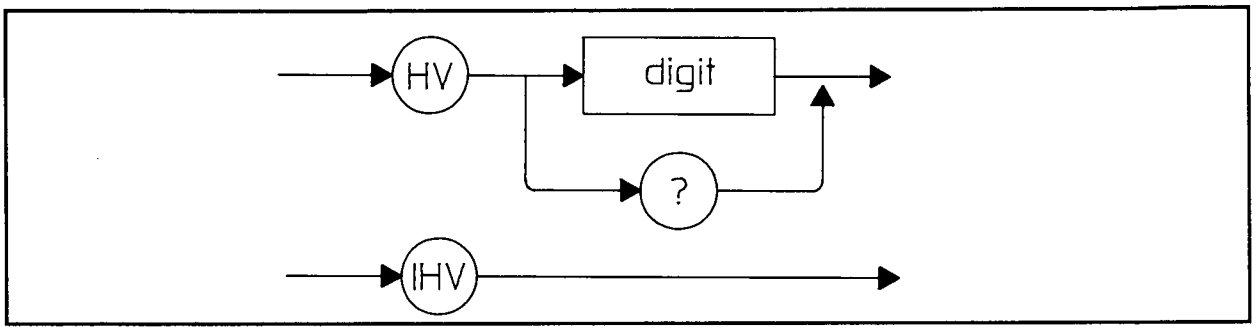


Figure 2-22. HV Syntax Diagram

digit	Meaning
0	Disable the high voltage amplifier.
1	Enable the high voltage amplifier.

Table 2-22. HV? and IHV Response Format

Option installed	HEAD-on response	HEAD-off response
Yes	HV#	#
No	RF#	#

ID?, *IDN?; Identification Query

This query returns the instrument manufacturer, model number, serial number, and firmware revision code.

Note In data transfer mode 2, an asterisk terminates a command string. Therefore use IDN?, without an asterisk, in data transfer mode 2.

Command Availability

	*IDN?	ID?
HP 3325B	Yes	Yes
HP 3325A	No	No

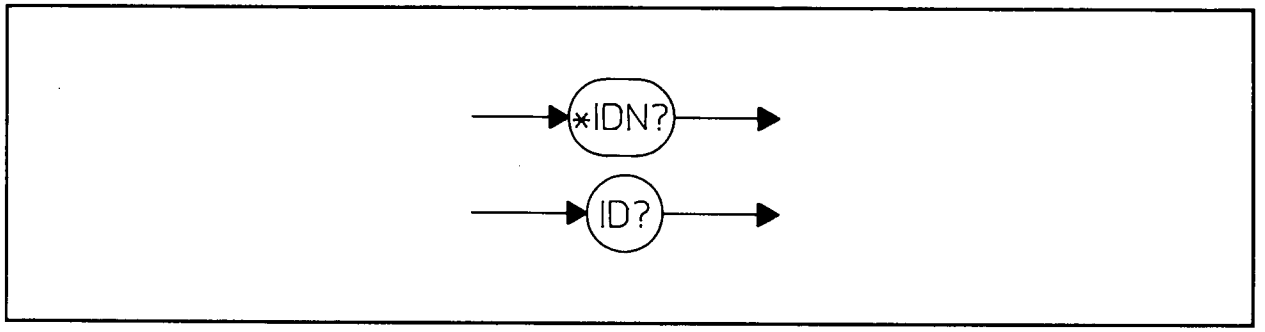


Figure 2-23. ID? and *IDN? Syntax Diagrams

Table 2-23. ID? and *IDN? Response Format

ID? response	*IDN? response
HP3325B	HEWLETT-PACKARD,3325B,2800A00000,2800

LCL; Local Command

The LCL command places the instrument in *local mode* and clears any local lockout. This command has the same effect as the HP-IB *local* bus command but can be issued when using the RS-232 interface.

Command Availability

	LCL
HP 3325B	Yes
HP 3325A	No

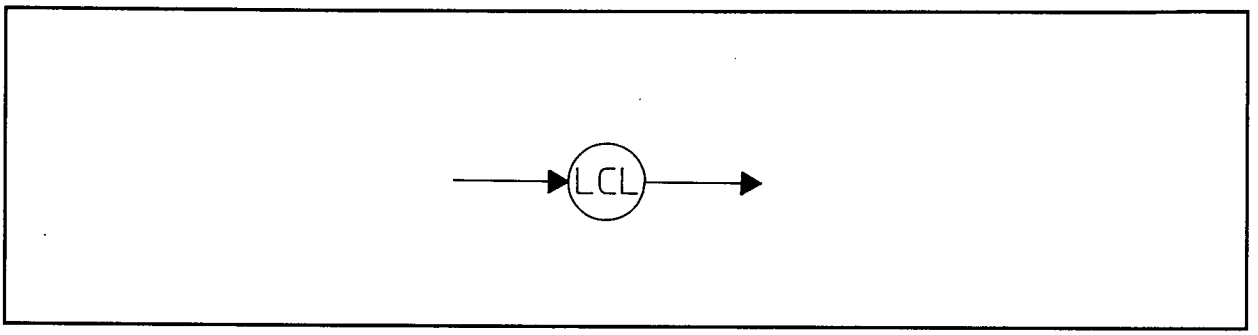


Figure 2-24. LCL Syntax Diagram

MA; Amplitude Modulation Command

The MA command enables and disables amplitude modulation of the main signal output. Amplitude modulation is only valid for sine waves.

Note If MA is enabled and no signal is applied to the AMPTD MOD input, the main signal amplitude is one half of its programmed value since 0 Volts corresponds to 50% modulation.

Instrument Preset value: 0.

Command Availability

	MA	IMA	MA?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

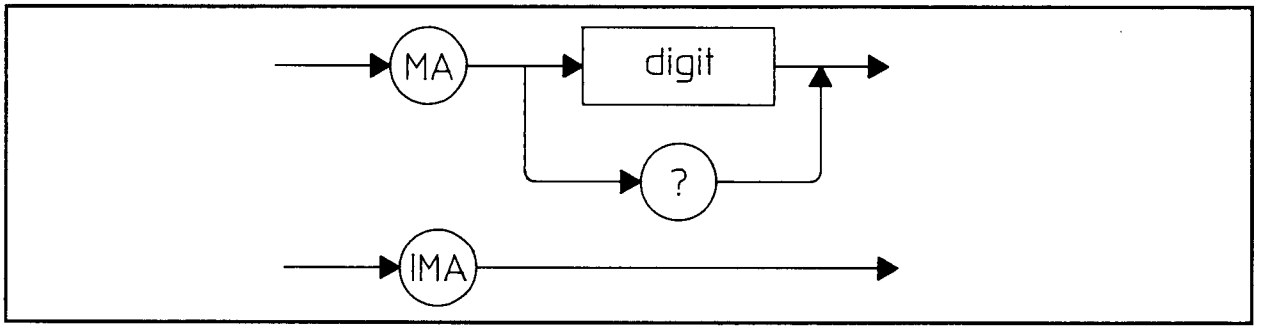


Figure 2-25. MA Syntax Diagram

"Digit	Meaning
0	Disable amplitude modulation.
1	Enable amplitude modulation.

Table 2-24. MA? and IMA Response Format

HEAD-on response	HEAD-off response
MA#	#

MD; Data Transfer Mode Command

The MD command selects the HP-IB data transfer mode. (This command has no effect when the RS-232 interface is used.) In mode 1, each device-dependent character is processed when received. No other communications are permitted on the bus until the entire HP 3325B program string has been accepted and all but the last character processed. In mode 2, device-dependent characters are accepted and stored in an internal buffer; they are not processed until the End-Of-Command-String (EOCS) character is received or the buffer is filled (48 bytes). Valid EOCS characters are the <line feed> character (ASCII decimal 10) or the asterisk (*) character (ASCII decimal 42).

Instrument Power-on, HP-IB Clear value: 1.

Instrument Preset value: not changed.

Command Availability

	MD	MD?
HP 3325B	Yes	Yes
HP 3325A	Yes	No

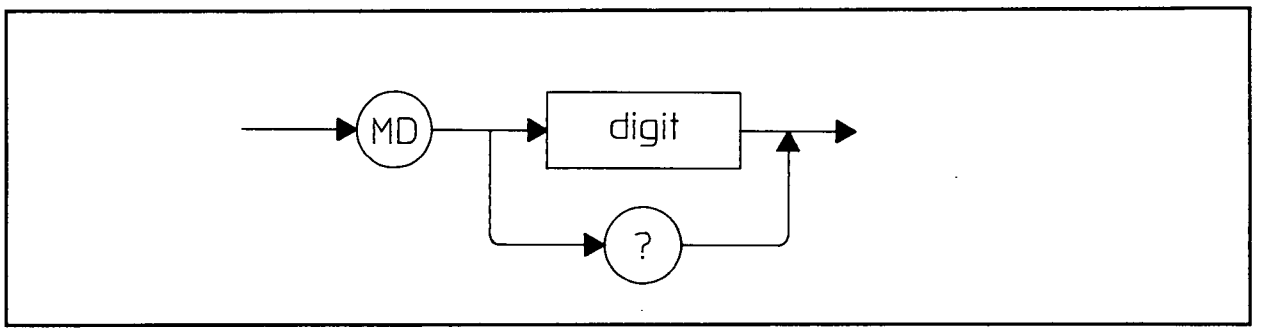


Figure 2-26. MD Syntax Diagram

Digit"	Meaning
1	Each character processed when received.
2	Characters buffered, EOCS starts processing.

Table 2-25. MD? and IMD Response Format

HEAD-on response	HEAD-off response
MD#	#

MF; Marker Frequency Command

The MF command sets the marker frequency. Sending MF with no value or units displays the current frequency. IMF and MF? cause the instrument to output its current frequency.

Instrument Preset value: 5.0 MHz

Command Availability

	MF	IMF	MF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

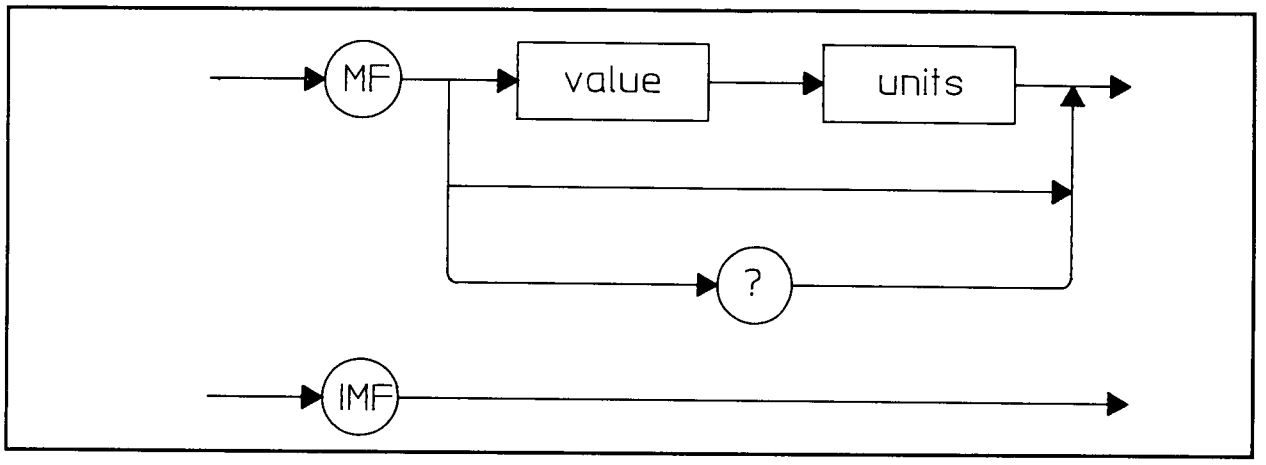


Figure 2-27. MF Syntax Diagram

Table 2-26. MF "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
HZ	Hertz	0.0 → 20999999.999
KH	kilo-Hz	0.0 → 20999.999999
MH	mega-Hz	0.0 → 20.999999999

Table 2-27. MF? and IMF Response Format

μ Hz programmed	HEAD-on response	HEAD-off response
No	MF########.###HZ	########.###
Yes	MF#####.######HZ	#####.######

MOAM; Modulation Source Amplitude Command

The MOAM command sets the amplitude of the modulation signal. Sending MOAM with no value or units displays the current amplitude. Sending MOAM and units without any value displays the current amplitude in the new units. MOAM? causes the instrument to output the current amplitude.

Instrument Preset value: 0.1 Vpp

Command Availability

	MOAM	MOAM?
HP 3325B	Yes	Yes
HP 3325A	No	No

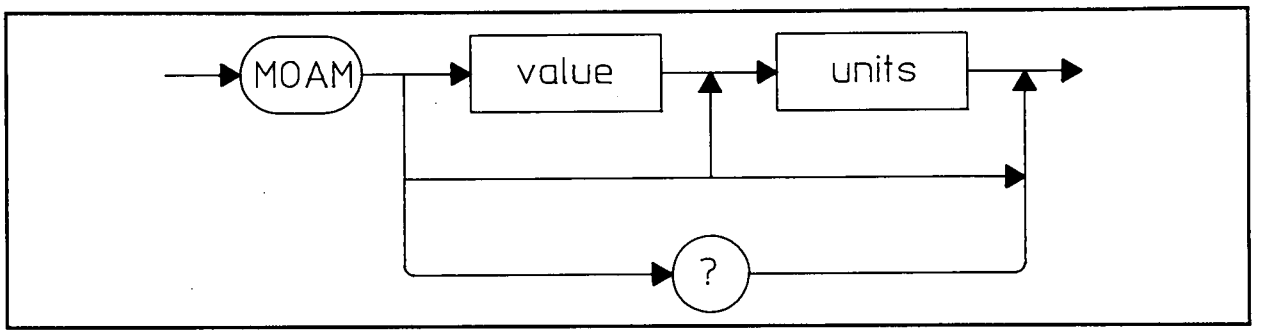


Figure 2-28. MOAM Syntax Diagram

Table 2-28. MOAM "value" Restrictions Given "units"

value range	units	Description
VO	V_{pp}	0.0 → 12.0
MV	mV_{pp}	0.0 → 12000.0
VR	V_{rms}	0.0 → 4.2
MR	mV_{rms}	0.0 → 4200.0

Table 2-29. MOAM? Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	MOAM#####.######VO	#####.######
VR or MR	MOAM#####.######VR	#####.######

MOAR; Write Modulation Source Arbitrary Waveform Data

The MOAR command defines an arbitrary waveform for the modulation source. From 1 to 4096 waveform sample points can be programmed. A value of 0 corresponds to 0.0 volts, and +1.0 corresponds to full scale which is half the MOAM voltage (since MOAM is in peak-to-peak). Issuing this command turns the modulation source off, so it should be followed with a MOFU3 command.

When using arbitrary waveforms, the MOFR command sets the frequency at which the entire waveform block is repeated. Only certain discrete frequencies are available and these depend on the number of entries in the waveform. The HP 3325B selects a frequency as near as possible to the value entered with the MOFR command.

Command Availability

	MOAR
HP 3325B	Yes
HP 3325A	No

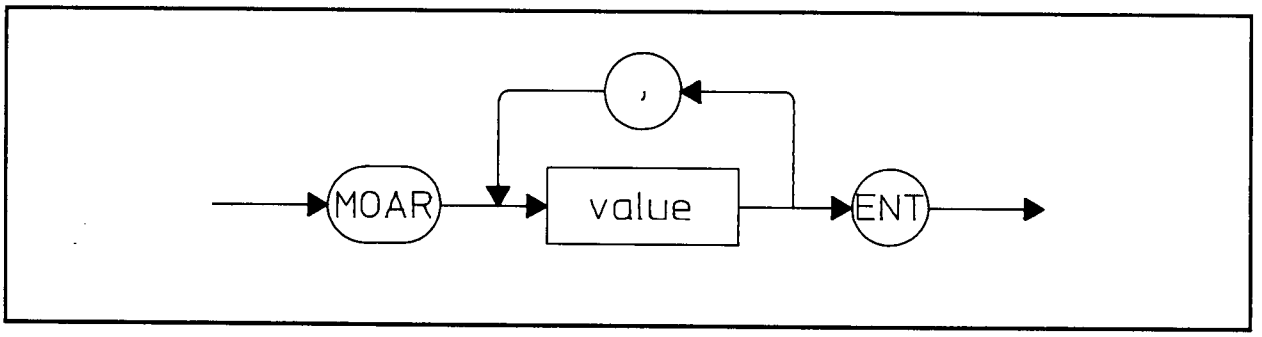
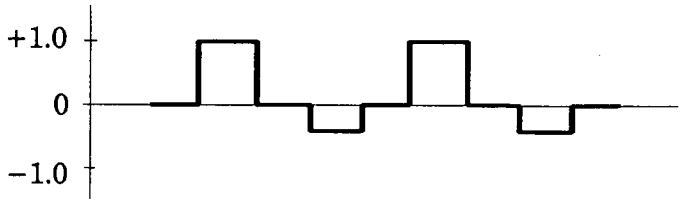


Figure 2-29. MOAR Syntax Diagram

Where *value* is a waveform sample whose value ranges from −1.0 to +1.0.

Example:

MOAR 1,0,- 0.4,0 ENT results in the following waveform:



MOFR; Modulation Source Frequency Command

The MOFR command sets the modulation source frequency. Sending MOFR with no value or units displays the current frequency. Issuing MOFR? causes the instrument to output its current frequency.

Notes

Only two digits of frequency resolution are available.

The timebase is not locked to the main signal or an external reference input.

Programming the frequency causes the signal to turn off momentarily.

Instrument Preset value: 1000.0 Hz

Command Availability

	MOFR	MOFR?
HP 3325B	Yes	Yes
HP 3325A	No	No

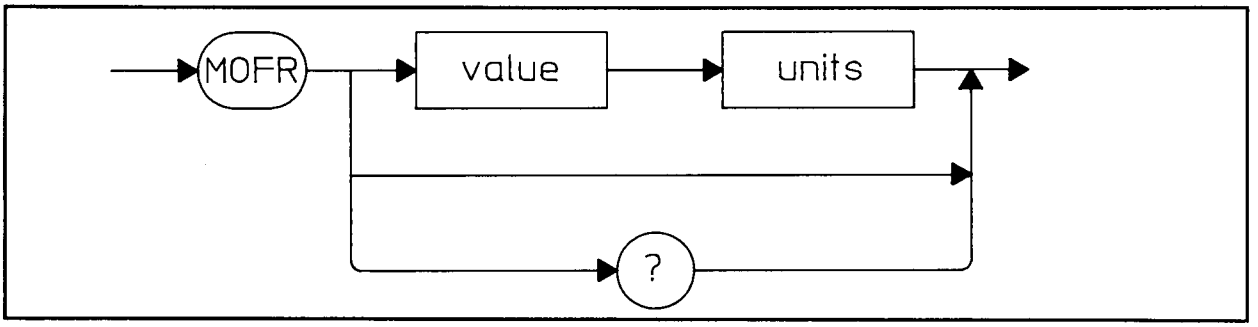


Figure 2-30. MOFR Syntax Diagram

Table 2-30. MOFR "value" Restrictions Given "units"

Value Range	Units	Description
0.0 → 10000.0	HZ	Hertz
0.0 → 10.0	KH	kilo-Hz
0.0 → 0.01	MH	mega-Hz

Table 2-31. MOFR? Response Format

HEAD-on response	HEAD-off response
MOFR########.###HZ	########.###

MOFU; Modulation Source Waveform Function Command

The MOFU command selects the waveform function for the modulation source output.

Instrument Preset value: 0.

Command Availability

	MOFR	MOFR?
HP 3325B	Yes	Yes
HP 3325A	No	No

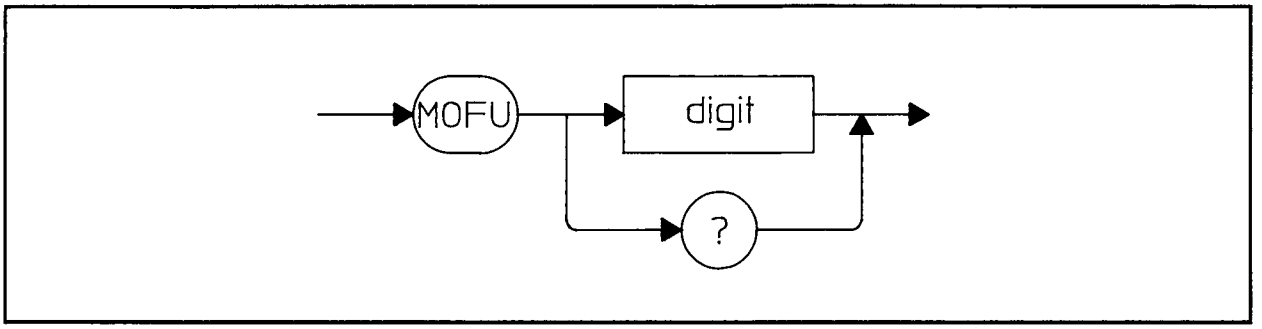


Figure 2-31. MOFU Syntax Diagram

"Digit"	Waveform
0	All functions off.
1	Selects Sine wave.
2	Selects Square wave.
3	Selects Arbitrary wave.

Table 2-32. MOFU? Response Format

HEAD-on response	HEAD-off response
MOFU#	#

MP; Phase Modulation Command

The MP command enables and disables phase modulation of the main signal output.

Instrument Preset value: 0.

Command Availability

	MP	IMP	MP?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

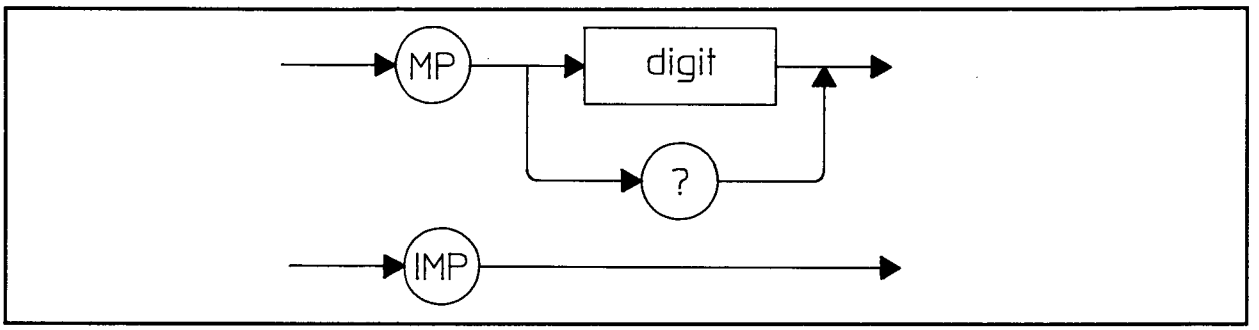


Figure 2-32. MP Syntax Diagram

"Digit"	Meaning
0	Disable phase modulation.
1	Enable phase modulation.

Table 2-33. MP? and IMP Response Format

HEAD-on response	HEAD-off response
MP#	#

MS; Status Byte Mask Command

The MS command is used to set the status byte mask. Four lists in the status byte are capable of causing a service request (SRQ) when they are enabled (unmasked). They may be enabled or masked in any combination as defined in table 2-34. The ESTB command accomplishes the same thing using decimal numbers instead of alphabetic characters.

Instrument Power-on value: @ (no bits enabled).

Instrument Preset, HP-IB Clear value: not changed.

Command Availability

	MS
HP 3325B	Yes
HP 3325A	Yes

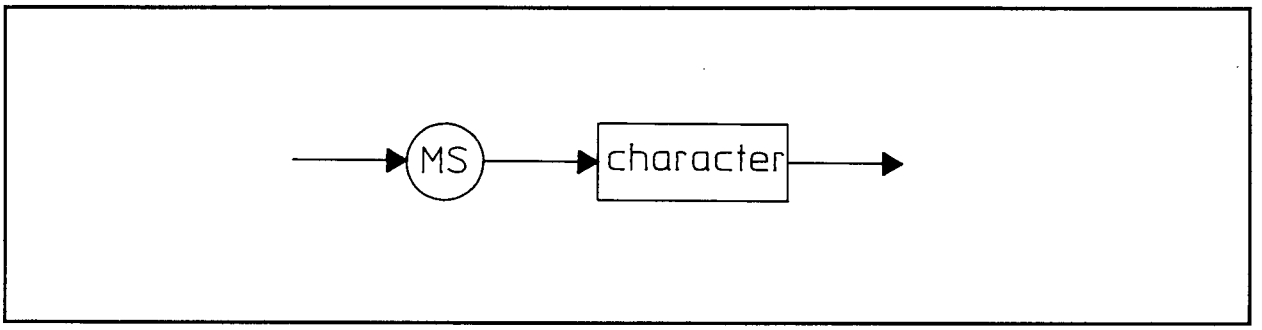


Figure 2-33. MS Syntax Diagram

Table 2-34. Status Byte Mask Characters

"character"	Status Bits FAIL	START	STOP	ERR
@	Mask	Mask	Mask	Mask
A	Mask	Mask	Mask	ENABLE
B	Mask	Mask	ENABLE	Mask
C	Mask	Mask	ENABLE	ENABLE
D	Mask	ENABLE	Mask	Mask
E	Mask	ENABLE	Mask	ENABLE
F	Mask	ENABLE	ENABLE	Mask
G	Mask	ENABLE	ENABLE	ENABLE
H	ENABLE	Mask	Mask	Mask
I	ENABLE	Mask	Mask	ENABLE
J	ENABLE	Mask	ENABLE	Mask
K	ENABLE	Mask	ENABLE	ENABLE
L	ENABLE	ENABLE	Mask	Mask
M	ENABLE	ENABLE	Mask	ENABLE
N	ENABLE	ENABLE	ENABLE	Mask
O	ENABLE	ENABLE	ENABLE	ENABLE

OF; DC Offset Command

The OF command sets the DC offset of the main signal. Sending OF with no value or units displays the current offset. When programming DC offset with an AC function, the DC offset range is further restricted by the AM setting and the resulting attenuator range. See the discussion in Chapter 1 under the heading "AC with DC Offset."

Instrument Preset value: 0.0 V_{pp}

Command Availability

	OF	IOF	OF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

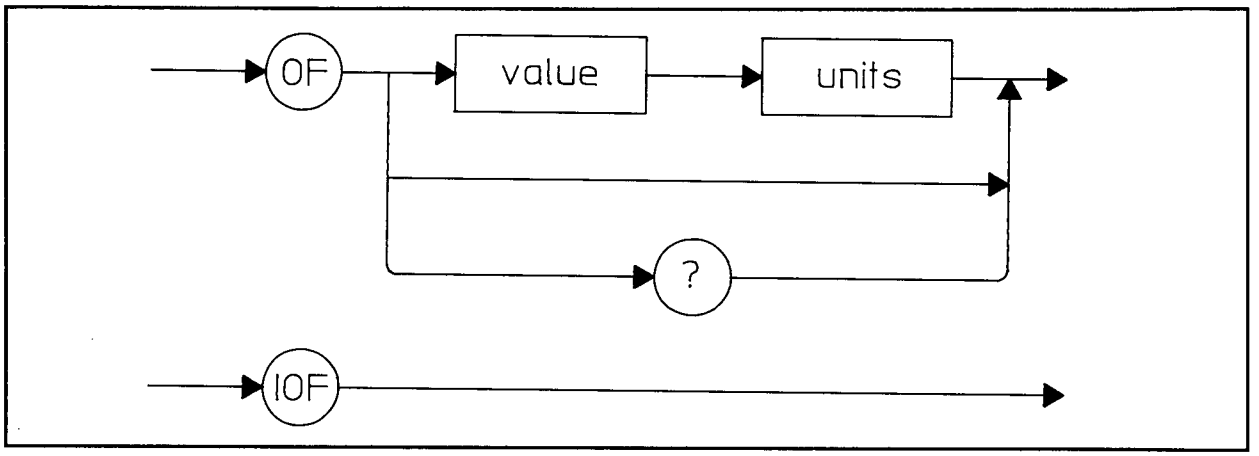


Figure 2-34. OF Syntax Diagram

Table 2-35. OF "value" Restrictions Given "units"

Units	Description	High Voltage	Value Range(DC only)
VO	Volts	Off	−5.0 → 5.0
		On	−20.0 → 20.0
MV	mVolts	Off	−5000.0 → 5000.0
		On	−20000.0 → 20000.0

Table 2-36. OF? and IOF Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	OF#####.######VO	#####.######

OPT?; Option Query Command

The OPT? query returns a list of the options installed in the instrument.

Command Availability

	OPT?
HP 3325B	Yes
HP 3325A	No

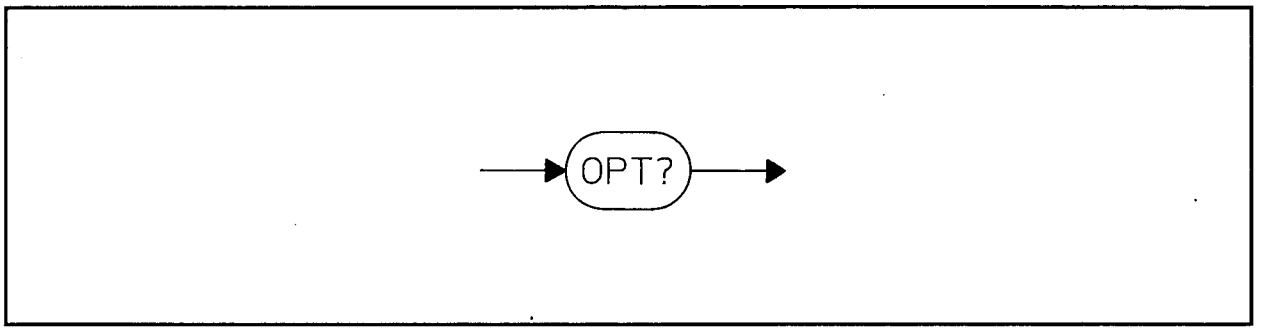


Figure 2-35. OPT? Syntax Diagram

Table 2-37. OPT? Response Format

Options installed	HEAD-on response	HEAD-off response
none	OPT0,0	0,0
Oven	OPT1,0	1,0
High Voltage	OPT0,2	0,2
Oven and High V.	OPT1,2	1,2

PH; Phase Command

The PH command sets the phase of the main signal. Sending PH with no value or units displays the current phase. Values outside the −720 to +720 range are treated as (value modulus 720).

Instrument Preset value: 0.0 Degrees

Command Availability

	PH	IPH	PH?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

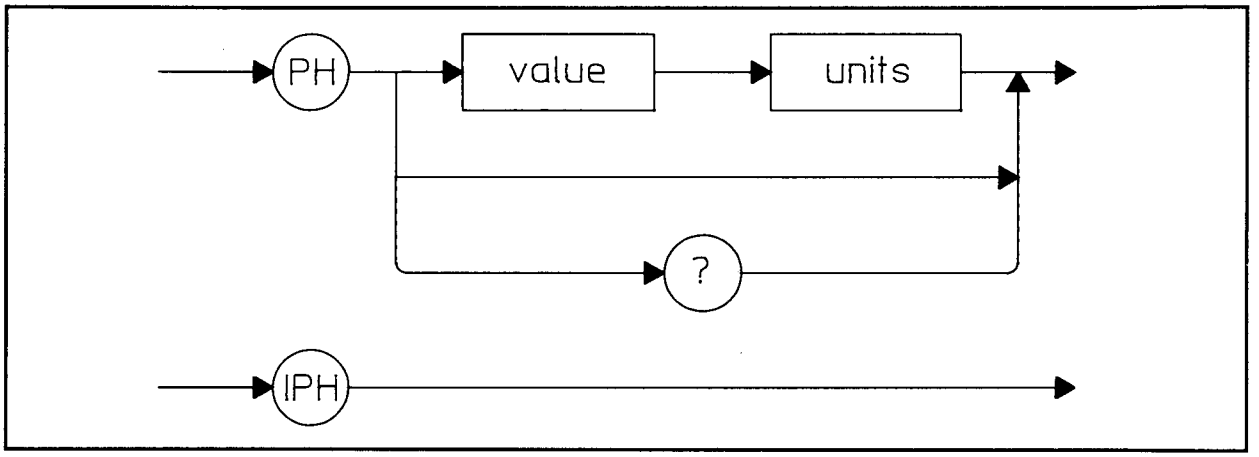


Figure 2-36. PH Syntax Diagram

Table 2-38. PH "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
DE	Degrees	−720.0 → 720.0

Table 2-39. IPH and PH? Response Format

HEAD-on response	HEAD-off response
PH########.###DE	########.###

QSTB; Query Status Byte (RS-232)

The QSTB? query command is used to upload the *status byte* over the RS-232 interface. The HP 3325B responds to this command by returning the contents of the status register in the form of an integer value ranging from 0 to 255. This integer, when converted to binary (base 2), represents the bits of the Status Register. This command reads the same register as the HP-IB *serial poll* and clears the ERR, STOP, START, FAIL and RQS bits of the status byte.

Command Availability

	QSTB?
HP 3325B	Yes
HP 3325A	No

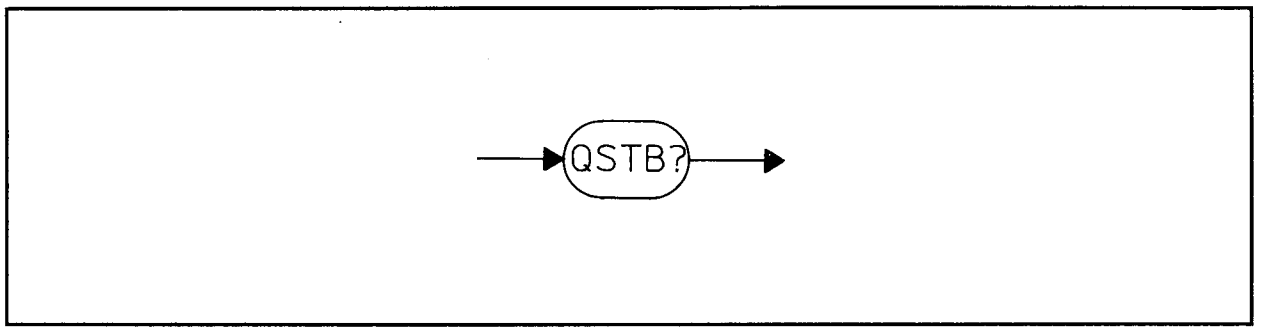


Figure 2-37. QSTB? Syntax Diagram

Table 2-40. Status Register Bit Coding

Bit	Value	Name	Description
0	1	ERR	Program or keyboard entry error.
1	2	STOP	Sweep stopped.
2	4	START	Sweep started.
3	8	FAIL	Hardware failure.
4	16	BIT4	Always zero.
5	32	SWEEP	Sweep in progress.
6	64	RQS	This corresponds to the HP-IB SRQ signal.
7	128	BUSY	Set while a command is being executed.

Table 2-41. QSTB? Response Format

HEAD-on response	HEAD-off response
QSTB###	###

RE; Recall State Command

The RE command recalls an instrument setup state from 1 of 11 memory locations. Locations 0 through 9 are programmed with the SR command. Memory location "–" is always the state when power is turned off.

Command Availability

	RE0 thru RE9	RE–
HP 3325B	Yes	Yes
HP 3325A	Yes	No

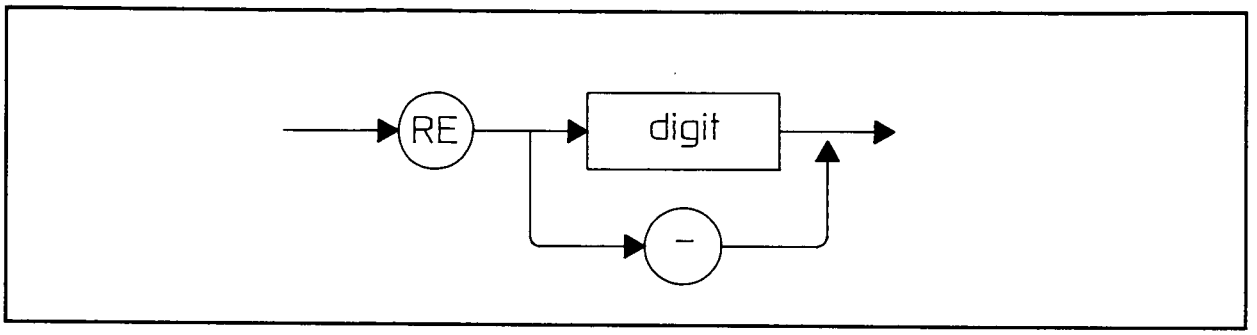


Figure 2-38. RE Syntax Diagram

"Digit"	Meaning
0 → 9	Recalls state stored in register 0 thru 9.
– (minus sign)	Recalls state at power-down.

RF; Rear or Front Signal Output Command

The RF command determines whether the main signal is present at the rear or front BNC connector.

Instrument Preset value: 1 (front).

Command Availability

	RF	IRF	RF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

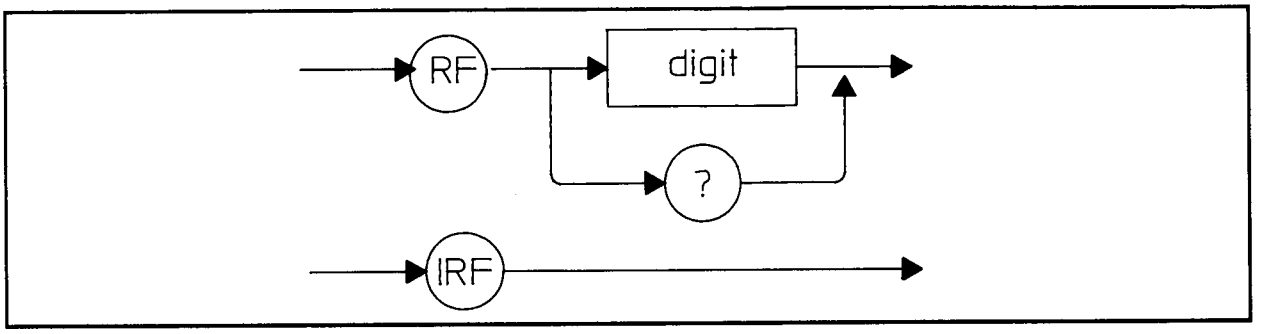


Figure 2-39. RF Syntax Diagram

"Digit"	Meaning
1	Front panel output.
2	Rear panel output.

Table 2-42. RF? and IRF Response Format

HV option	HEAD-on response	HEAD-off response
no	RF#	#
yes	HV#	#

RMT; Remote (with Local-Lockout) Command

The RMT command places the instrument in *remote* with *local lockout* mode. This command has the same effect as the HP-IB Local Lockout bus command but can be programmed using the RS-232 interface.

Command Availability

	RMT
HP 3325B	Yes
HP 3325A	No

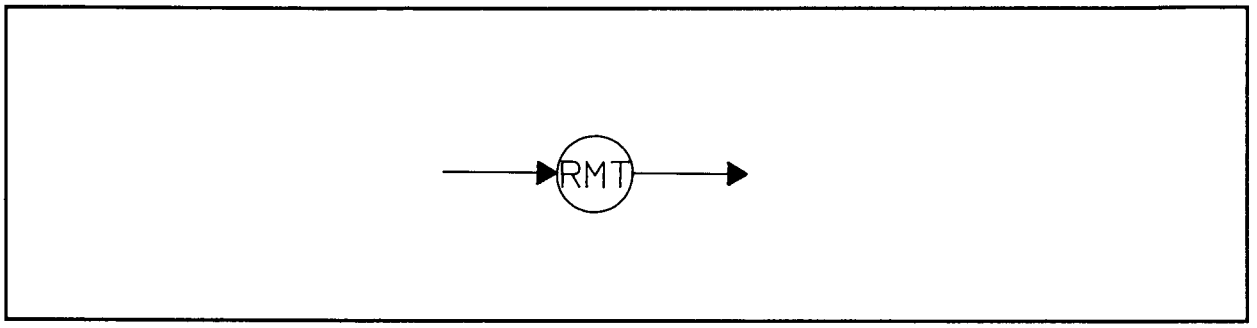


Figure 2-40. RMT Syntax Diagram

*RST; Reset Command

The *RST command resets the HP 3325B to the state in table 2-43. This command has the same effect as pressing the Instrument Preset key on the front panel and is similar to the HP-IB Device Clear command. *RST does not change the data transfer mode as does the Device Clear command.

Note In data transfer mode 2, an asterisk terminates a command string. Therefore, use RST without an asterisk, in data transfer mode 2.

Command Availability

	*RST
HP 3325B	Yes
HP 3325A	No

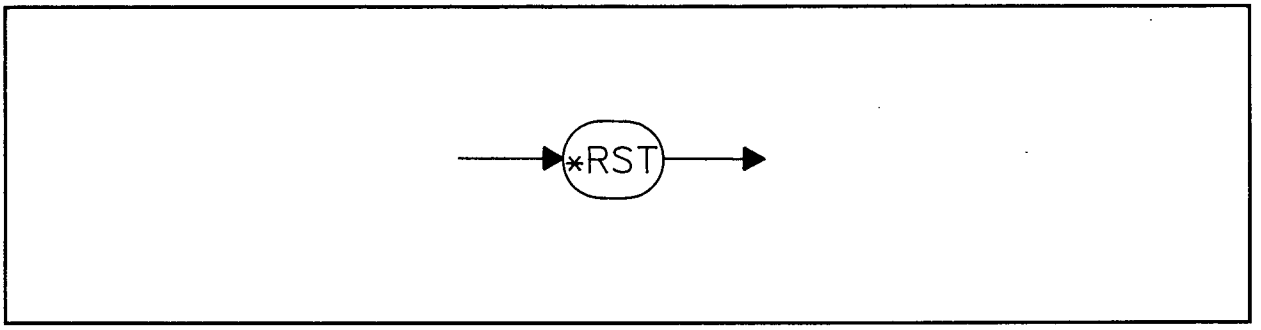


Figure 2-41. *RST Syntax Diagram

Table 2-43. Reset State

Item	Reset Value
Function	Sine
Frequency	1000.0 Hz
Amplitude	1.0 mV_{pp}
Offset	0.0 V
Phase	0.0°
Mod Source Function	Off
Mod Source Frequency	1000.0 Hz
Mod Source Amplitude	0.1 V_{pp}
Start Frequency	1.0 MHz
Stop Frequency	10.0 MHz
Marker Frequency	5 MHz
Sweep Time	1.0 Sec
High voltage	Off
Front/Rear output	Front
Amplitude Modulation	Off
Phase Modulation	Off
Sweep Mode	Linear
Status Byte (bits cleared)	0, 1, 2, 3, & 6

The *RST command does not alter:

- The 10 state storage registers
- HP-IB address
- HP-IB data transfer mode
- Status byte mask
- Enhancement/compatibility mode
- Calibration mode
- Head on/off
- Display on/off
- Echo on/off
- Discrete sweep table
- Modulation source arbitrary waveform data
- Serial number and elapsed time clock

RSW; Reset Single Sweep Command

The RSW command places the instrument in the sweep reset state. The output frequency returns to the Start Frequency and the next SS command starts a single sweep.

Command Availability

	RSW
HP 3325B	Yes
HP 3325A	No

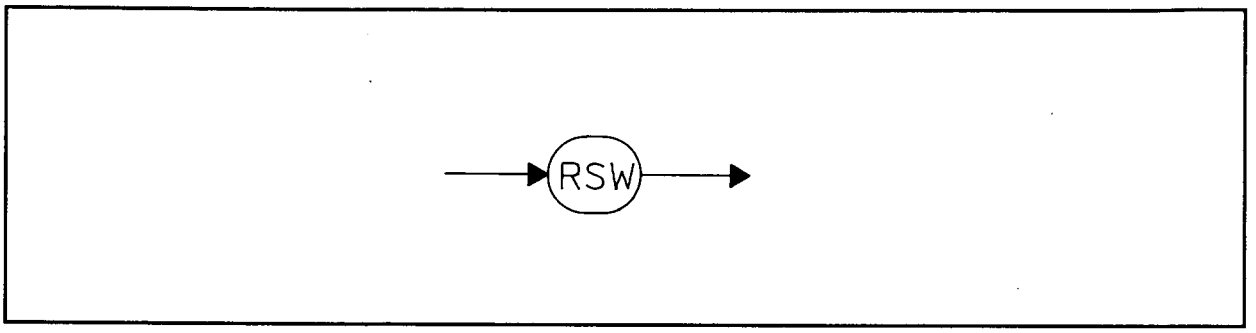


Figure 2-42. RSW Syntax Diagram

SC; Start Continuous Sweep Command

The SC command starts a continuous sweep. If the instrument is already sweeping, this command stops the sweep and does not restart it. FR can be used to stop a sweep.

Command Availability

	SC
HP 3325B	Yes
HP 3325A	Yes

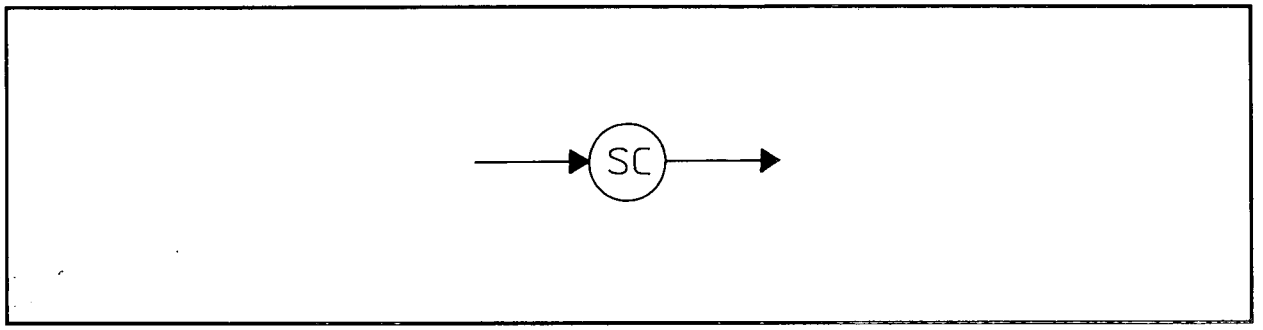


Figure 2-43. SC Syntax Diagram

SM; Sweep Mode Command

The SM command selects the sweep mode.

Instrument Preset value: 1.

Command Availability

	SM	ISM	SM?	SM3
HP 3325B	Yes	Yes	Yes	Yes
HP 3325A	Yes	Yes	No	No

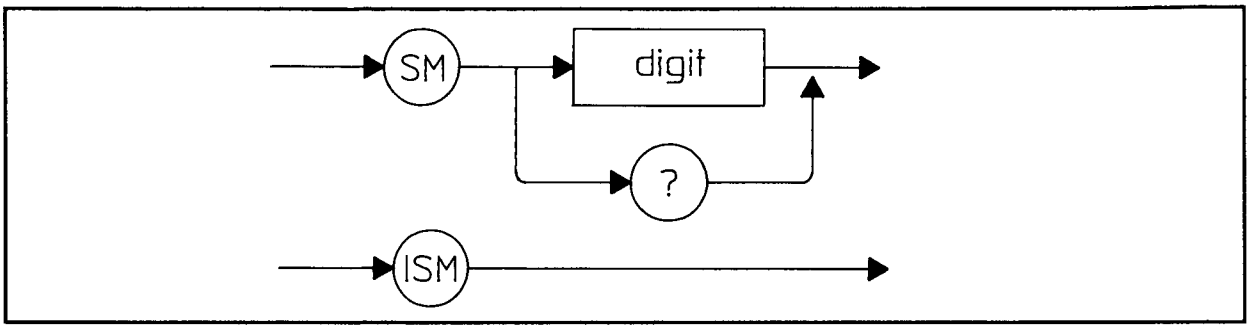


Figure 2-44. SM Syntax Diagram

"Digit"	Waveform
1	Selects Linear sweep mode.
2	Selects Logarithmic sweep mode.
3	Selects Discrete sweep mode.

Table 2-44. SM? and ISM Response Format

HEAD-on response	HEAD-off response
SM#	#

SP; Sweep Stop Frequency Command

The SP command sets the sweep stop frequency.

Instrument Preset value: 10.0 MHz

Command Availability

	SP	ISP	SP?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

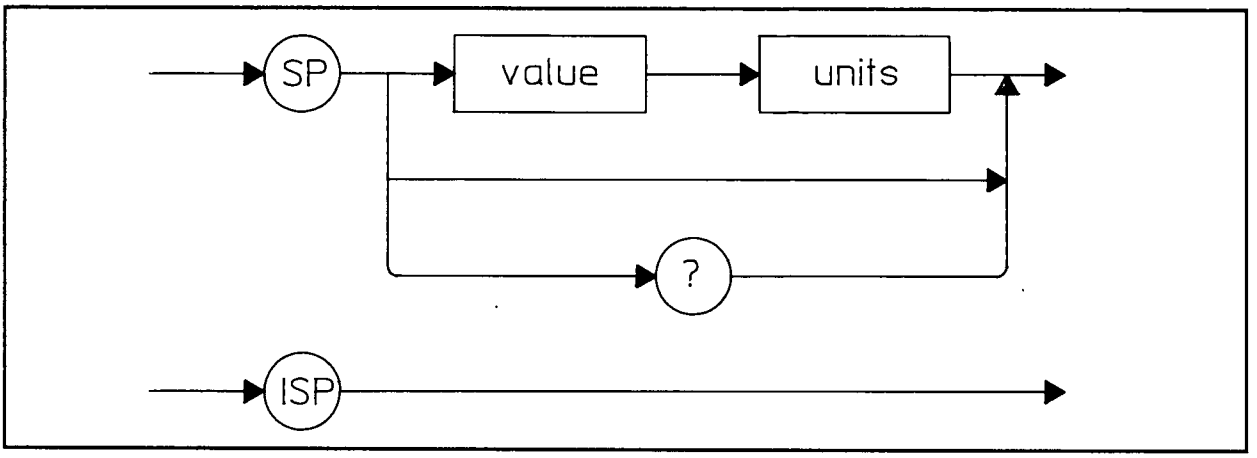


Figure 2-45. SP Syntax Diagram

Table 2-45. SP "value" Restrictions Given "units"

value range	units	Description
0.0 → 20999999.999	HZ	Hertz
0.0 → 20999.9999990	KH	kilo-Hz
0.0 → 20.999999999	MH	mega-Hz

Table 2-46. SP? and ISP Response Format

μHz programmed	HEAD-on response	HEAD-off response
no	SP########.###HZ	########.###
yes	SP#####.######HZ	#####.######

SR; Store State Command

The SR command stores the current instrument setup state in one of 10 memory locations.

Command Availability

	SR
HP 3325B	Yes
HP 3325A	Yes

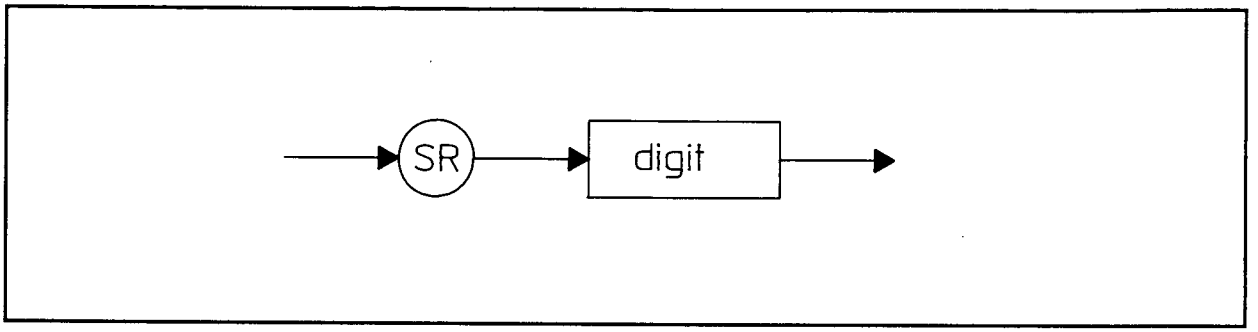


Figure 2-46. SR Syntax Diagram

"Digit"	Meaning
0 → 9	Stores state in location 0 thru 9.

SS; Start Single Sweep Command

The effect of the SS command depends on the state of the instrument. If the instrument is not sweeping and not in the sweep-reset state, then the SS command puts the instrument in the sweep-reset state at the sweep Start Frequency. If the instrument is already in the sweep-reset state, this command starts a single sweep. If the instrument is sweeping, this command stops the sweep and does not restart it.

Single sweeps can be started using the HP-IB Group Execute Trigger command. Before using the GET command, the HP 3325B must be in the enhancements mode and the sweep must be reset using the RSW command.

Command Availability

	SS
HP 3325B	Yes
HP 3325A	Yes

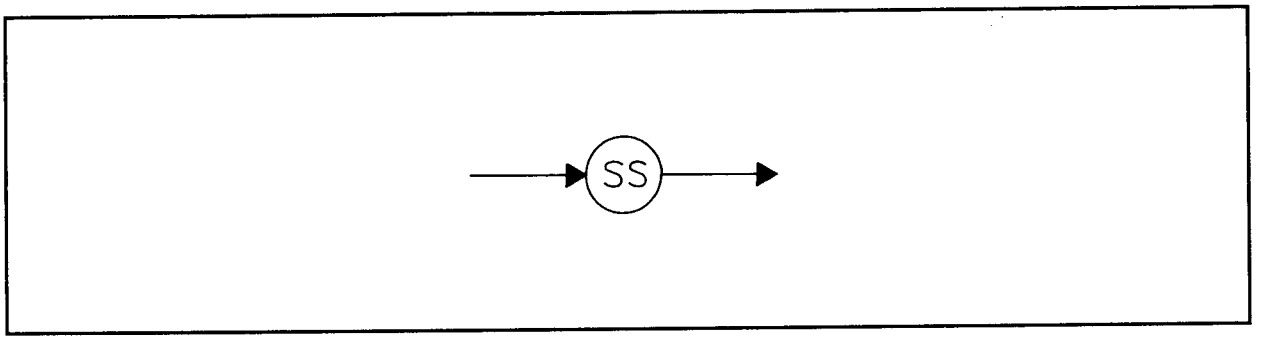


Figure 2-47. SS Syntax Diagram

ST; Sweep Start Frequency Command

The ST command sets the sweep start frequency.

Start Frequency Preset value: 1.0 MHz

Command Availability

	ST	IST	ST?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

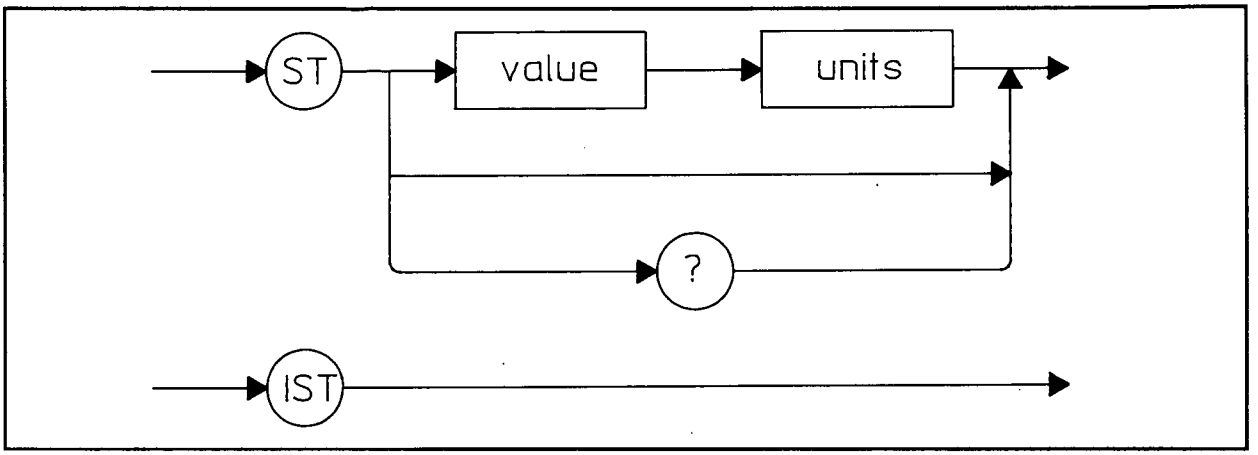


Figure 2-48. ST Syntax Diagram

Table 2-47. ST "value" Restrictions Given "units"

value range	units	Description
0.0 → 20999999.999	HZ	Hertz
0.0 → 20999.999999	KH	kilo-Hz
0.0 → 20.999999999	MH	mega-Hz

Table 2-48. ST? and IST Response Format

μHz programmed	HEAD-on response	HEAD-off response
no	ST########.###HZ	########.###
yes	ST#####.######HZ	#####.######

TI; Sweep Time Command

The TI command sets the sweep time. Sending TI with no value or units displays the current sweep time. ITI and TI? cause the instrument to output its current sweep time.

Instrument Preset value: 1.0 Sec

Command Availability

	TI	ITI	TI?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

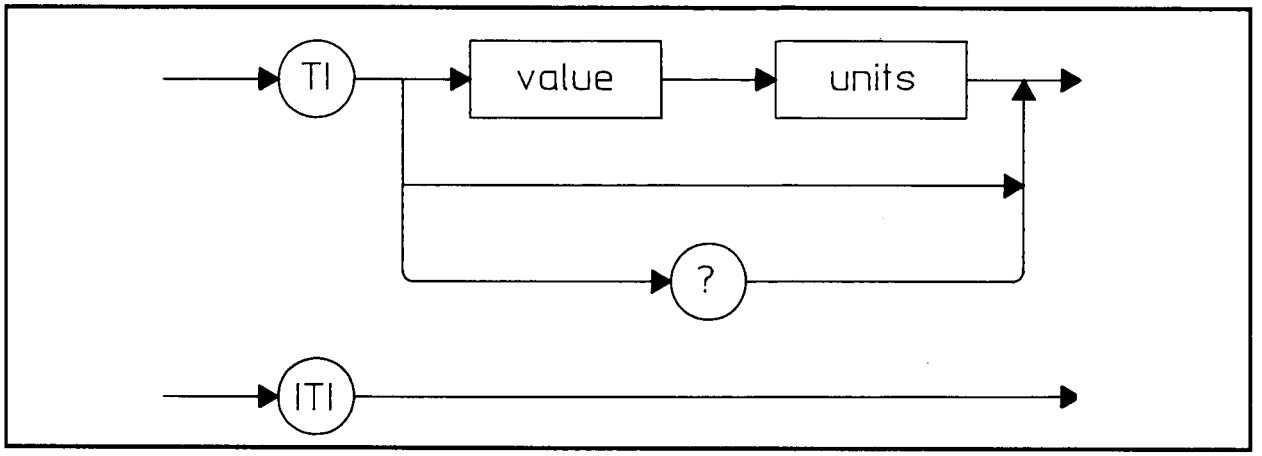


Figure 2-49. TI Syntax Diagram

Table 2-49. TI "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
SE	Seconds	0.0 → 1000

Table 2-50. TI? and ITI Response Format

HEAD-on response	HEAD-off response
TI########.###SE	########.###

Table 2-51. Error Messages

Code	Description
FAIL 010	Hardware failure, DAC range
FAIL 011	Bad checksum, low byte of ROM
FAIL 012	Bad checksum, high byte of ROM
FAIL 013	Machine data bus line stuck low
FAIL 014	Keyboard shift register test failed
FAIL 021	Signal too big during calibration
FAIL 022	Signal too small during calibration
FAIL 023	DC offset too positive during cal
FAIL 024	DC offset too negative during cal
FAIL 025	Unstable/ noisy calibration
FAIL 026	Calibration factor out of range: AC gain offset
FAIL 027	Calibration factor out of range: AC gain slope
FAIL 028	Calibration factor out of range: DC offset
FAIL 029	Calibration factor out of range: DC slope
FAIL 030	External ref unlocked
FAIL 031	Oscillator unlocked, VCO voltage too low
FAIL 032	Oscillator unlocked, VCO voltage too high
FAIL 033	HP-IB isolation circuits test failed self test
FAIL 034	HP-IB IC failed self test
FAIL 035	RS-232 test failed loop-back test
FAIL 036	Memory lost (battery dead)
FAIL 037	Unexpected interrupt
FAIL 038	Sweep-limit-flag signal failed self test
FAIL 039	Fractional-N IC failed self test
FAIL 040	Modulation Source failed self test
FAIL 041	Function-integrity-flag flip-flop always set
Error 100	Entry parameter out of bounds
Error 200	Invalid units suffix for entry
Error 201	Invalid units suffix with high voltage
Error 300	Frequency too large for function
Error 400	Sweep time too large (same as sweep rate too small)
Error 401	Sweep time too small
Error 500	Amplitude/offset incompatible
Error 501	Offset too big for amplitude
Error 502	Amplitude too big for offset
Error 503	Amplitude too small

Table 2-51. Error Messages (con't)

Code	Description
Error 600	Sweep frequency improper
Error 601	Sweep frequency too large for function
Error 602	Sweep bandwidth too small
Error 603	Log sweep start freq too small
Error 604	Log sweep stop frequency less than start frequency
Error 605	Discrete sweep element is empty
Error 700	Unknown command
Error 701	Illegal query
Error 751	Key ignored – in remote (press LOCAL)*
Error 752	Key ignored – local lockout*
Error 753	Feature disabled in compatibility mode
Error 754	Attempt to recall a register that has not been stored since power up. (Use enhancements mode)*
Error 755	Amplitude modulation not allowed on selected function (warning only)*
Error 756	Modulation source arbitrary waveform is empty
Error 757	Too many modulation source arbitrary waveform points
Error 758	Firmware failure
Error 759	Error while running XRUN routine
Error 800	Illegal character received
Error 801	Illegal digit for selection item
Error 802	Illegal binary data block header
Error 803	Illegal string, string overflow
Error 810	RS-232 overrun – characters lost
Error 811	RS-232 parity error
Error 812	RS-232 frame error
Error 900	Option not installed

* *These errors do not set the ERR bit in the status byte.*

HP 3325A Compatibility

For compatibility with existing programs, the HP 3325B supports all of the HP 3325A Synthesizer/Function Generator remote commands. Table 2-52 lists the HP 3325B mnemonics alphabetically and shows compatibility of each with the HP 3325A.

Table 2-52. Remote Command Compatibility

HP 3325B Command	HP 3325A Compatible?	Description
*	yes	End-of-string character
AC	yes	Amplitude Calibrate
AM	yes	Amplitude
AP	yes	Assign zero phase
CALM	no	Calibration mode
DB	yes	dBm (suffix)
DCLR	no	Discrete sweep clear
DE	yes	Degrees (suffix)
DISP	no	Display on/off
DRCL	no	Discrete sweep recall
DSP	no	Display string
DSTO	no	Discrete sweep store
DV	no	dBV_{rms} (suffix)
E	no	Exponent character
ECHO	no	Echo; for RS-232
ENH	no	Enhancements on
ENT	no	Enter, no units (suffix)
ER	yes	Error query, 1-digit code
ERR	no	Error query, 3-digit code
ESTB	no	Stat register mask (same as MS)
EXTR	no	Ext Ref query
FR	yes	Frequency
FU	yes	Function select
HEAD	no	Header on/off
HV	yes	High voltage
HZ	yes	Hertz (suffix)
ID	no	Identify, short
*IDN	no	Identify, long
KH	yes	Kilohertz (suffix)
LCL	no	Local, clear lockout (RS-232)
MA	yes	Amplitude modulation
MD	yes	Data transfer mode
MF	yes	Sweep marker frequency
MH	yes	Megahertz (suffix)
MOAM	no	Mod S amp
MOAR	no	Write arbitrary waveform

Table 2-52. Remote Command Compatibility (con't)

HP 3325B Command	HP 3325A Compatible?	Description
MOFR	no	Mod S frequency
MOFU	no	Mod S function
MP	yes	Phase modulation
MR	yes	mV_{rms} (suffix)
MS	yes	Status register mask (same as ESTB)
MV	yes	mV_{pp} (suffix)
OF	yes	DC offset entry
OPT	no	Option query
PH	yes	Phase entry
QSTB	no	Status register query
RE	yes	Recall state
RF	yes	Rear or front output selection
RMT	no	Remote with lockout (RS-232)
*RST	no	Reset (preset)
RSW	no	Reset single sweep
SC	yes	Start continuous sweep
SE	yes	Seconds (suffix)
SM	yes	Sweep mode selection
SP	yes	Sweep stop frequency entry
SR	yes	Store state selection
SS	yes	Start a single sweep
ST	yes	Sweep start frequency
TI	yes	Sweep time
VO	yes	V_{pp} (suffix)
VR	yes	V_{rms} (suffix)

Writing Compatible Programs

Backward Compatible with the HP 3325A

- Use only the two-letter HP 3325B command mnemonics such as FR. The three and four-letter mnemonics such as MOFR are not available on the HP 3325A.
- Do not separate commands with a semicolon.
- Use a leading **I** to interrogate setup parameters instead of a trailing **?**.
- Do not send values in scientific notation.

Programming Practices Compatible with IEEE 488.2

- Separate commands with a semicolon or line feed
- Use a trailing **?** to interrogate setup parameters instead of a leading **I**.
- Do not use data transfer mode 2.

Example Programs

HP-IB Interface Example Program

```
30  !
40  ! HP-BASIC Program to control the HP 3325B synthesizer.
50  !
60    ASSIGN @Hp3325 TO 717        !Select code and bus address
70                                 !usually 7 and 17
80    !
90    OUTPUT @Hp3325;"RST"         !reset the 3325B
100   !
110   Stat=SPOLL(@Hp3325)          !read status register
120   IF BIT(Stat,0) OR BIT(Stat,3) THEN PRINT "3325B has an error"
130   !
140   OUTPUT @Hp3325;"FR 123 KH; AM 1 VO"   !program freq and amptd
150   OUTPUT @Hp3325;"FR?"         !ask for frequency
160   ENTER @Hp3325;Freq           !read it back
170   PRINT "Frequency in Hz = ";Freq
180   !
190   LOCAL @Hp3325                !return front panel to local control
200   !
210   PRINT "Program done."
220 END
```

RS-232 Interface Example Program for HP-Vectra or IBM/PC

```
10  'HP Vectra BASIC program to control the 3325B Synthesizer.
20  '
30  'First open a communications file to the 3325B
40  'change COM1 to COM2 if needed.
50  OPEN "COM1:" AS #1
60  'OPEN defaults to 300 baud, 7 bits, parity EVEN
70  '
90  PRINT #1,"RST"               'send reset
100 PRINT #1,"HEAD 0"            'turn off heading in 3325B responses
110 '
120 PRINT #1,"QSTB?"             'ask for status register
130 INPUT #1, STAT               'read response from 3325B
150 IF (STAT AND (1+8)<>0) THEN PRINT "3325B has an error"
160 '
170 PRINT "Programming frequency and amplitude"
180 PRINT #1,"FR 123.4 KH; AM 1 VO"
190 PRINT #1,"FR?"               'ask for frequency
200 INPUT #1,FREQ                'read it back
210 PRINT "Frequency in Hz = ";FREQ
220 '
230 PRINT #1,"LCL"               'return front panel to local control
240 '
250 PRINT "Program done"
260 END
```

RS-232 Interface Example Program for HP Series 300

```
30  !
40  ! HP-BASIC Program to control the HP 3325B synthesizer using either
50  ! a HP98644, HP98626, or the build-in serial interface in
60  ! a Series-200 or Series-300 computer.
70  !
80  ! The connecting cable depends on the RS232 interface:
90  !    98644A interface:    use 13242G cable (25 pin M to 25 pin M).
100 !    Built-in interface:  use 92221P cable (9  pin M to 25 pin M).
110 !
120   ASSIGN @Hp3325 TO 9          !Select code for the serial interface,
130                                !usually 9 or 10
140   !
160   GOSUB Initialize_card
170   !
190   OUTPUT @Hp3325;"RST"         !reset the 3325B
200   !
210   OUTPUT @Hp3325;"QSTB?"       !ask for status register
220   ENTER @Hp3325;Stat           !read status from 3325B
240   IF BIT(Stat,0) OR BIT(Stat,3) THEN PRINT "3325B has an error"
250   !
260   OUTPUT @Hp3325;"FR 123 KH; AM 1 VO"   !program freq and amptd
270   OUTPUT @Hp3325;"FR?"         !ask for frequency
280   ENTER @Hp3325;Freq           !read it back
290   PRINT "Frequency in Hz = ";Freq
300   !
310   OUTPUT @Hp3325;"LCL"         !return front panel to local control
320   !
330   PRINT "Program done."
340   STOP
350   !
360   !-------------------------------------------
370 Initialize_card:   !
380    !
390    Isc=SC(@Hp3325)             !Get Interface select code.
400    !
410    Reset_=0                    !constants for CONTROL statements.
420    Baud=3
430    Parity_=4
440    !
450    ! All the RS232 switches on the 3325B rear panel should be
460    ! up. This sets baud=300, parity ON, parity EVEN.
470    !
480    CONTROL Isc,Reset_;1        !reset the card
490    CONTROL Isc,Baud;300        !set baud rate
500    CONTROL Isc,Parity_;16+8+0+2  !set parity
510  RETURN
520 END
```

Chapter 3

GENERAL INFORMATION

Chapter 3

GENERAL INFORMATION

Introduction

This chapter contains general information about the HP 3325B, including its performance specifications, safety considerations, instrument description, available options, supplied accessories, and available accessories.

Specifications

Instrument specifications are listed in table 3-1. The specifications are the performance standards or limits against which the instrument is tested.

Safety Considerations

This product is a safety class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings, instructions, cautions, and warnings to ensure safe operation.

This manual may have a yellow *manual change supplement* with it. This supplement contains information to correct errors and incorporate new information to keep the manual current. The supplement for this manual is identified by the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

Instrument Description

The HP 3325B Synthesizer/Function Generator produces sine wave, square wave, triangle waveforms, and positive and negative ramp waveforms from 1 μHz to a maximum frequency of 20 Mhz for sine wave and 10 Mhz for square wave and 10 kHz for the triangle and ramp functions. (The .999 extensions are assumed.) Frequency resolution is 1 μHz or eleven digits. Output amplitude is 1 mV_{pp} to 10 V_{pp}. The output amplitude level may be entered or displayed in V_{rms} or dBm (50Ω) as well as V_{pp}. Any function may have a dc offset of up to $\pm$4.5V or the output may be dc-only up to $\pm$5V. An optional high voltage output produces up to 40 V_{pp} into a load $\geq$ 500Ω, $\leq$ 500 pF.

The HP 3325B performs linear or log frequency sweeps in any of its waveforms at sweep times of 10 ms to 1000s for linear sweeps. Log sweep times are from 1s to 1000s for single sweeps and from 0.1s to 1000s for continuous sweeps. The direction of a single linear sweep may be up or down. A continuous sweep moves back and forth between the start and stop frequencies in an up/down/up/down/. . . fashion. Log sweeps always start at the start frequency and sweep up to the stop frequency. *Discrete sweep* is a feature which allows creation of custom sweep patterns.

Table 3-1. Specifications

FREQUENCY

Range:
Sine: 1 μHz to 20.999 999 999 MHz
Square: 1 μHz to 10.999 999 999 MHz
Triangle/Ramps: 1 μHz to 10.999 999 999 kHz
Resolution:
1 μHz, <100 kHz
1 mHz ≥100 kHz (1 μHz available, not displayed)
Accuracy:
$\pm 5 \times 10^{-6}$ of selected value, 20°C to 30°C, at time of calibration ,(Standard Instrument)

Stability:
$\pm 5 \times 10^{-6}$/year, 20°C to 30°C, standard (See also option 001, high stability frequency reference)
Warm-up Time:
20 minutes to within specified accuracy.

MAIN SIGNAL OUTPUT

(all waveforms)
Impedance:
50Ω ± 1Ω, 0–10 kHz
Return Loss:
>20 dB, 10 kHz to 20 MHz, except >10 dB for >3 V, 5 MHz to 20 MHz
Connector:
BNC; switchable to front or rear panel, non-switchable with option 002 except by internal cable change.
Floating:
Output may be floated up to 42V peak (AC + DC)

AMPLITUDE (all waveforms)

Resolution:
0.03% of full range or 0.01 dB (4 digits).
Range:
1 mV to 10 Vp-p in 8 amplitude ranges, 1–3–10 sequence. Ranges are 1 mV–2.999 mV, 3 mV–9.999 mV, 10 mV–29.99 mV, 30 mV–99.99 mV, .1 V–.2999 V, .3 V–.9999 V, 1V–2.999 V, 3 V–10V, (without DC offset).

Function	peak to peak	rms	dBm(50Ω)
Sine			
min.	1.000 mV	0.354 mV	−56.02
max.	10.00 V	3.536 V	+23.98
Square			
min.	1.000 mV	0.500 mV	−53.01
max.	10.00 V	5.000 V	+26.99
Triangle/ Ramps			
min.	1.000 mV	0.289 mV	−57.78
max.	10.00 V	2.887 V	+22.22

Accuracy: (with 0 Vdc offset)
Sine:

	.001 Hz	100 kHz	10 MHz	20 MHz
+23.98 dBm	± .1 dB	± .4 dB		
+13.52 dBm				± .6 dB
−16.02 dBm	± .2 dB	± .6 dB		
−56.02 dBm				± .9 dB

Square Wave:

	.001 Hz	100 kHz	10 MHz
10 Vp-p	± 1.0%	± 11.1%	
3 Vp-p			
1 mVp-p	± 2.2%	± 13.6%	

Triangle:

	.001 Hz	2 kHz	10 kHz
10 Vp-p	± 1.5%	± 5.0%	
3 Vp-p			
1 mVp-p	± 2.7%	± 6.2%	

Ramps:

	.001 Hz	500 kHz	10 kHz
10 Vp-p	± 1.5%	± 10%	
3 Vp-p			
1 mVp-p	± 2.7%	± 11.2%	

With DC offset, increase all sinewave tolerances by .2 dB and all function tolerances by 2%.

SINEWAVE SPECTRAL PURITY

Phase Noise:
− 60 dBc for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier) with option 001 installed.
Spurious:
All non-harmonically related output signals will be more than 70 dB below the carrier (−60 dBc with DC offset), or less than −90 dBm, whichever is greater.

WAVEFORM CHARACTERISTICS

Sinewave Harmonic Distortion:
Harmonically related signals will be less than the following levels relative to the fundamental:

Frequency Range	Harmonic Level
.1 Hz to 50 kHz	− 65 dBc
50 kHz to 200 kHz	− 60 dBc
200 kHz to 2 MHz	− 40dBc
2 MHz to 15 MHz	− 30 dBc
15 MHz to 20 MHz	− 25 dBc

Squarewave Characteristics:
Rise/fall time: ≤20 ns 10% to 90%, at full output.
Overshoot: ≤5% of peak to peak amplitude, at full output.at 1MHz.
Settling time: <1 μs to settle to within .05% of final value, tested at full output with no load, 10 Hz to 500 kHz.
Symmetry: ≤.02% of period + 3 ns.
Triangle/Ramp Characteristics:
Triangle/ramp linearity (10% to 90%, 10 kHz): ± .05% of full p-p output for each range.
Ramp retrace time: ≤3 μs, 90% to 10%.
Period variation for alternate ramp cycles: ≤1% of period.

DC OFFSET

Range:
DC only (no AC signal): 0 to ± 5.0 V/50Ω
DC + AC: Maximum DC offset ± 4.5 V on highest range; decreasing to ± 4.5 mV on lowest range.
Resolution: 4 digits
Accuracy:
DC only: ± .02 mV to ± 20 mV, depends on offset chosen.
DC + AC, to 1 MHz: ± .06 mV to ± 60 mV, depends on AC output level, ± .2 mV to ± 120 mV for ramps to 10 kHz.
DC + AC, 1 MHz to 20 MHz: ± 15 mV to ± 150 mV, depends on AC output level.

Table 3-1. Specifications (Cont'd)

PHASE OFFSET

Range:
±719.9° with respect to arbitrary starting phase, or assigned zero phase.
Resolution: 0.1°
Increment Accuracy: ±0.2°
Stability: ±1.0 degree of phase/°C

SINEWAVE AMPLITUDE MODULATION

Modulation Depth (at full output for each range):
0–100%
Modulation Frequency Range:
DC to 400 kHz (0–21 MHz carrier frequency)
Envelope Distortion:
– 30 dB to 80% modulation at 1 kHz, 0 VDC offset
Sensitivity:
±5 V peak for 100% modulation
Input Impedance: 10 kΩ
Connector: Rear panel BNC

PHASE MODULATION

Sine Function Range:
± 850°, ±5V input
Sine Function-Linearity:
±0.5%, best fit straight line
Squarewave Range: ±425°
Triangle Range: ±42.5°
Positive and Negative Ramps:
±85°
Modulation Frequency Range:
DC – 5 kHz
Input Impedance: >40 kΩ
Connector: Rear panel BNC

FREQUENCY SWEEP

Sweep Time:
Linear: 0.01s to 1000s
Logarithmic: 1s to 1000s single, 0.1s to 1000s continuous
Maximum Sweep Width:
Full frequency range of the main signal output for the waveform in use except minimum log start frequency is 1 Hz.
Minimum Sweep Width:

Function	Minimum sweep width	
	Sweep time .01 sec.	Sweep time 99.9 sec.
Sine:	.1 mHz	999.9 mHz
Square:	.05 mHz	499.5 mHz
Triangle:	.005 mHz	49.95 mHz
Ramps:	.01 mHz	99.99 mHz

Minimum log sweep width is 1 decade.
Phase Continuity:
Sweep is phase continuous over the full frequency range of the main output.
Discrete Sweep:
Number of segments: 100 maximum (Start and stop frequencies settable for each segment)
Time/segment: 0.01s to 1000s, 0.01s resolution

MODULATION SOURCE:

Frequency Range: Sine 0.1 Hz–10 kHz, Square 0.1 Hz–2 kHz
Frequency Resolution: 2 digits
Frequency Accuracy: Typically 0.1% (Sinewave)
Amplitude Range: 0.1 Vp-p to 12 Vp-p
Amplitude Resolution: 0.1 V
Amplitude Accuracy: Typically ± 200 mV
Impedance: Designed to drive ≥ 10 kOhm loads
Sinewave Purity: Typically better than – 34 dBc
Standard Waveforms: Sine, Square
Arbitrary Waveforms: Vertical resolution 256 points, horizontal resolution 4096 points, 300,000 samples/sec, 10 kHz maximum.
Output Location: Rear Panel BNC

AUXILIARY OUTPUTS

Auxiliary Frequency Output:
Frequency Range: 21 MHz to 60.999 999 999 MHz, underrange coverage to 19.000 000 001 MHz, frequency selection from front panel.
Amplitude: 0 dBm; output impedance: 50Ω
Connector: Rear panel BNC
Sync Output:
Square wave with $V_{high} \geq 1.2$ V, $V_{low} \leq 0.2$ V into 50Ω. Frequency range is the same as the main signal output for front panel sync and DC-60 MHz for rear panel sync.
Output impedance: 50Ω
Connector: BNC front and rear panels.
X-Axis Drive:
(0–100s sweeps only)
0 to +10 Vdc linear ramp proportional to sweep frequency; linearity, 10–90%, ±.1% of final value (applies for sweep widths which are integer multiples of the minimum sweep width).
Connector: Rear panel BNC.
Sweep Marker Output:
High to low TTL compatible voltage transition at keyboard selected marker frequency. (Linear sweep only.)
Connector: Rear panel BNC.
Z-Axis Blank Output:
TTL compatible voltage levels capable of sinking current from a positive source. Current 200 mA, voltage 45V, power dissipation 1 watt maximum.
1 MHz Reference Output:
0 dBm output for phase-locking additional instruments to the HP 3325B.
Connector: Rear panel BNC.
10 MHz Oven Output:
0 dBm internal high stability frequency reference output for phase-locking HP 3325B or other instruments (option 001 only).
Connector: Rear panel BNC.

Table 3-1. Specifications (Cont'd)

AUXILIARY INPUTS

Reference Input:

For phase-locking HP 3325B to an external frequency reference. Signal from 0 dBm to +20 dBm into 50Ω. Reference signal must be a subharmonic of 10 MHz from 1 MHz to 10 MHz.

Connector: Rear panel BNC. With option 001 this input may be jumpered to the 10 MHz reference output.

Amplitude Modulation Input:

See modulation specifications.

Phase Modulation Input:

See modulation specifications.

REMOTE CONTROL

Frequency Switching Time (to within 1 Hz exclusive of programming time:

≤10 ms for 100 kHz step; ≤25 msec for 1 MHz step; ≤70 msec for 20 MHz step.

Phase Switching Time (to within 90° of phase lock exclusive of programming time:

≤15 msec.

Amplitude Switching Time (to within amplitude specifications, exclusive of programming time): <30 ms.

HP-IB Interface Functions:

SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C0, E1

RS-232 Interface:

Subset of ANSI/EIA-232D-1986, CCITT V.24

Type: DTE, 25 pin female "D" connector

Baud Rate: 300-4800

OPTION 001 HIGH STABILITY FREQUENCY REFERENCE

Aging Rate:

$\pm 5 \times 10^{-8}$/week, after 72 hours continuous operation; $\pm 1 \times 10^{-7}$ mo., after 15 days continuous operation.

Warm-up time:

Reference will be within $\pm 1 \times 10^{-7}$ of final value 15 minutes after turn-on at 25°C for an off time of less than 24 hours.

OPTION 002 HIGH VOLTAGE OUTPUT

Frequency Range: 1 μHz to 1 MHz

Amplitude:

Range: 4.00 mV to 40.00 Vp-p in 8 ranges, 4-12-40 sequence, into 500Ω < 500 pF load. Ranges are four times the standard instrument ranges, without DC offset.

Accuracy: ±2% of full output for each range at 2 kHz.

Flatness: ±10% relative to programmed amplitude.

Sinewave Distortion:

Harmonically related signals will be less than the following levels (relative to the fundamental full output into 500Ω, load):

10 Hz–50 kHz: −65 dB

50 kHz–200 kHz: −60 dB

200 kHz–1 MHz: −40 dB

Square Wave Rise/Fall Time:

±125 ns, 10% to 90% at full output, with 500Ω, 500 pF load.

Square Wave Overshoot:

±10% of peak to peak amplitude with 500Ω, 500 pF load.

Output Impedance:

<2Ω at DC, <10Ω at 1 MHz

DC Offset:

Range: 4 times the specified range of the standard instrument.

Accuracy: ±(1% of full output for each range + 25 mV).

Maximum Output Current:

±20 mA peak

GENERAL

Operating Environment:

Temperature: 0°C to 55° C

Relative Humidity: 95%, 0°C to 40°C

Altitude: ≤15,000 ft.

Power:

100/120/220/240 V, +5%, −10%; 48 to 66 Hz; 90 VA, 120 VA with all options

Weight:

9 kg (20 lbs) net; 14.5 kg (32 lbs) shipping

Dimensions:

133.4 mm high × 425.5 mm wide × 498.5 mm deep (5¼" H × 16¾" W × 19⅝" D)

The HP 3325B is fully programmable through two separate computer interface connectors located on the rear panel. They are the Hewlett-Packard Interface Bus (HP-IB) and an RS-232 serial interface. A desktop computer can be configured and programmed to remotely operate the HP 3325B with either of these two interfaces. Interface information is in Chapter 2, Remote Operation.

New or Enhanced Features of the HP 3325B

The feature set of the HP 3325B is a superset of the HP 3325A features. The additional features and improvements are summarized in the following:

- Non-volatile memory added: battery backup provides power to the memory when the power switch is in the standby position or when the instrument is disconnected from line voltage.
- Modulation source added: a second source of sine wave, square wave, and arbitrary waveforms provides a signal which may be used to modulate the main signal. The output connector for this source is on the rear panel between the two modulation input connectors.
- RS-232 interface added: this serial interface offers an alternative to the HP-IB. Additional remote operation commands have been added to the command set to allow it to be used in the same manner as the HP-IB (i.e.; emulate the HP-IB bus commands).
- Frequency range of the rear-panel sync output extended to 60 MHz.
- Discrete sweep added: a sequence of up to 100 linear sweeps or frequency steps (called segments) offers the ability to create custom sweep patterns. Each segment is composed of a start frequency, stop frequency, sweep time, and marker frequency. Refer to Chapter 1, Operation and Reference, for more information on this feature.
- Additional front-panel conveniences such as a preset key, frequency entry increment and decrement (defined by a new F STEP key), and the use of the left-arrow key as a backspace during parameter entries.
- Over-voltage circuit breaker added: an over-voltage protection circuit provides added reliability and reduces maintenance.
- Extended self-test and diagnostic capabilities to reduce maintenance.

Compatibility with the HP 3325A

The HP 3325B enhancements were designed to improve upon the capabilities of the HP 3325A without sacrificing compatibility. In most cases the new features do not cause compatibility problems. Complete backward compatibility is achieved by turning off the enhancements switch (on the rear panel). This feature is also programmable. Table 3-2 shows a comparison of the HP 3325A features that have been enhanced and are controlled by the enhancements switch.

Table 3-2. Comparison of compatible and enhanced features relative to HP 3325A

Compatibility Mode	Enhancement Mode
Store/recall registers cleared when power is turned off.	Store/recall registers are non-volatile.
Programming times compatible with the HP 3325A.	Some items program faster.
Amplitude calibration time compatible with the HP 3325A.	Calibration is faster.
Frequency, time, and phase entries are truncated.	All entries are rounded.
Amplitude or offset entries stop a sweep.	Amplitude and offset values can be changed while sweeping without stopping the sweep.
Actual sweep time can vary significantly from value entered for very narrow-band sweeps.	Actual sweep time value deviates less from value entered.
Actual sweep stop-frequency can vary from value entered for very narrow-band sweeps.	Actual sweep stop-frequency value deviates less from entered value.
Continuous log sweeps always cover an integer number of decades.	Partial decades possible.
Log sweep momentarily pauses between sweeps.	Pause time between log sweep segments minimized.

Options

Table 3-3 lists the options available for the HP 3325B. These options are available when the instrument is ordered by specifying the option number, or are available for later installation by ordering the option part number.

Table 3-3. Options

HP 3325B Option	HP Part Number	Description
001	03325-88801	High Stability Frequency Reference
002	03325-88802	High Voltage Output
907	5061-0089	Front Handle Kit
908	5061-0077	Rack Flange Kit
909	5061-0083	Rack Mount Flange Kit with Handles

Accessories Supplied

Table 3-4 lists the accessories supplied with the HP 3325B. Additional Operating and Service manuals may be ordered through your HP Sales and Service Office.

Table 3-4. Accessories Supplied

Description	Quantity	HP Part Number
Operating Manual	1 ea.	03325-90014
Installation Manual	1 ea.	03325-90006
Service Manual	1 ea.	03325-90003

Accessories Available

Table 3-5 lists the accessories available for the HP 3325B. These accessories may be obtained through your HP Sales and Service Office.

Table 3-5. Accessories Available

Accessory	HP Part Number
Ground Isolator	15507A
50Ω Feed-Thru Termination	11048C
Transit Case	9211-2655

HP 3325B HP-IB and RS-232 PROGRAMMING CODES:

COMMANDS:

CODE	FUNCTION
AC	Amplitude Cal
AM	Amplitude
AP	Assign zero phase
CALM	Calibration mode (0-1).
DCLR	Discrete sweep clear.
DISP	Display (0-1).
DRCL	Discrete sweep recall (00-99).
DSP	Display a string (' ').
DSTO	Discrete sweep store (00-99).
ECHO	Echo for RS-232 (0-1).
ENH	Enhancements mode (0-1).
IER	Error query (1 digit).
ERR?	Error query (3 digits).
ESTB	Status reg. mask (also MS) (0-15)
EXTR?	Ext Ref query.
FR	Frequency
FU	Function Select (0-5).
HEAD	Query Header Enabled (0-1).
HV	High voltage (0-1).
ID?	Model Identify (short).
*IDN?	Model Identify (long).
LCL	Local, clear lockout.
MA	Amplitude modulation (0-1).

CODE	FUNCTION
MD	Data transfer mode (1-2).
MF	Sweep marker frequency
MOAM	Modulation Source amplitude
MOAR	Write arb waveform
MOFR	Modulation Source frequency
MOFU	Modulation Source function (0-3).
MP	Phase modulation (0-1).
MS	Status reg. mask (also ESTB) (@,A-O).
OF	DC Offset
OPT?	Option query.
PH	Phase
QSTB?	Status register query.
RE	Recallstate(−,0-9).
RF	Rear or front output (2-1).
RMT	Remote with lockout.
*RST	Reset (Preset).
RSW	Reset single sweep.
SC	Start continuous sweep.
SM	Sweep mode (1-3).
SP	Sweep stop frequency
SR	Store state (0-9).
SS	Reset or Start single sweep.
ST	Sweep start frequency
TE	Self Test
TI	Sweep time

Note that most commands may be followed by a question mark (?) to interrogate the related parameter.

DATA:

0 to 9	Digits
E	Exponent character
'xyz'	Alpha-numeric string
-	Minus sign
.	Decimal point

SUFFIX:

HZ	Hertz
KH	KHz
MH	MHz
MR	milli-Volts RMS
MV	milli-Volts p-p
VO	Volts p-p

VR	Volts RMS
DB	dBm
DV	dBVrms
DE	Degrees
SE	Seconds
ENT	Enter, no units
*	EOS character

STATUS BYTE:

BIT	VALUE	NAME	DESCRIPTION
0	1	ERR*	Program or keyboard entry error.
1	2	STOP*	Sweep stopped.
2	4	START*	Sweep started.
3	8	FAIL*	Hardware failure.
5	32	SWEEP	Sweeping.
6	64	RQS	Requested service
7	128	BUSY	3325 is busy.

** Only bits 0 to 3 may enable an SRQ.*

Bits which can be enabled to generate an SRQ and the arguments for MS and ESTB:

ARGUMENTS	FAIL	START	STOP	ERR
@,0	Mask	Mask	Mask	Mask
A, 1	Mask	Mask	Mask	ENABLE
B, 2	Mask	Mask	ENABLE	Mask
C, 3	Mask	Mask	ENABLE	ENABLE
D, 4	Mask	ENABLE	Mask	Mask
E, 5	Mask	ENABLE	Mask	ENABLE
F, 6	Mask	ENABLE	ENABLE	Mask
G, 7	Mask	ENABLE	ENABLE	ENABLE
H, 8	ENABLE	Mask	Mask	Mask
I, 9	ENABLE	Mask	Mask	ENABLE
J,10	ENABLE	Mask	ENABLE	Mask
K,11	ENABLE	Mask	ENABLE	ENABLE
L,12	ENABLE	Enable	Mask	Mask
M,13	ENABLE	Enable	Mask	ENABLE
N,14	ENABLE	Enable	ENABLE	Mask
O,15	ENABLE	Enable	ENABLE	ENABLE

(Example: MSI or ESTB9ENT cause an SRQ to be generated when an Error or Failure occurs. ESTB? returns the byte value of the mask.)

Hardware Failure Codes:

Fail	010	DAC range error
Fail	011	bad checksum, low byte of ROM
Fail	012	bad checksum, high byte of ROM
Fail	013	machine data bus line stuck low
Fail	014	keyboard shift register test failed
Fail	021	signal too big during calibration
Fail	022	signal too small during calibration
Fail	023	DC offset too positive during cal
Fail	024	DC offset too negative during cal
Fail	025	unstable/ noisy calibration
Fail	026	calibration factor out of range: AC gain offset
Fail	027	calibration factor out of range: AC gain slope
Fail	028	calibration factor out of range: DC offset
Fail	029	calibration factor out of range: DC slope
Fail	030	external ref unlocked
Fail	031	oscillator unlocked, VCO voltage too low
Fail	032	oscillator unlocked, VCO voltage too high
Fail	033	HP-IB isolation circuits failed self test
Fail	034	HP-IB IC failed self test
Fail	035	RS232 test failed loop-back test
Fail	036	memory lost (battery dead)
Fail	037	unexpected interrupt
Fail	038	sweep-limit-flag signal failed self test
Fail	039	Fractional-N IC failed self test
Fail	040	Modulation Source failed self test
Fail	041	function-integrity-flag flip-flop always set

Programming Error Codes:

Error	100	entry parameter out of bounds
Error	200	invalid units delimiter for entry
Error	201	invalid units delimiter with high voltage
Error	300	frequency too large for function
Error	400	sweep time too large, sweep rate too small.
Error	401	sweep time too small.
Error	500	amplitude/offset incompatible
Error	501	offset too big for amplitude
Error	502	amplitude too big for offset
Error	503	amplitude too small for offset
Error	600	sweep frequency
Error	601	sweep frequency too large for function
Error	602	sweep bandwidth too small
Error	603	log sweep start freq too small
Error	604	log sweep stop < start freq
Error	605	discrete sweep element is empty
Error	700	unknown command
Error	701	illegal query
Error	751	key ignored -- in remote (press LOCAL)
Error	752	key ignored -- local lockout
Error	753	feature disabled in compatibility mode
Error	754	attempt to recall a register that has not been stored since power up (use enhancements mode).
Error	755	amplitude modulation not allowed on selected function (warning only)
Error	756	modulation source arbitrary waveform is empty
Error	757	too many modulation source arbitrary waveform points
Error	758	firmware failure
		Error759 error while running XRUN routine
Error	800	illegal character received
Error	801	illegal digit for selection item
Error	802	illegal binary data block header
Error	803	illegal string, string overflow
Error	810	RS232 overrun -- characters lost
Error	811	RS232 parity error
Error	812	RS232 frame error
Error	900	option not installed

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Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States

California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows

New Jersey
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Paramus 07652

In Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
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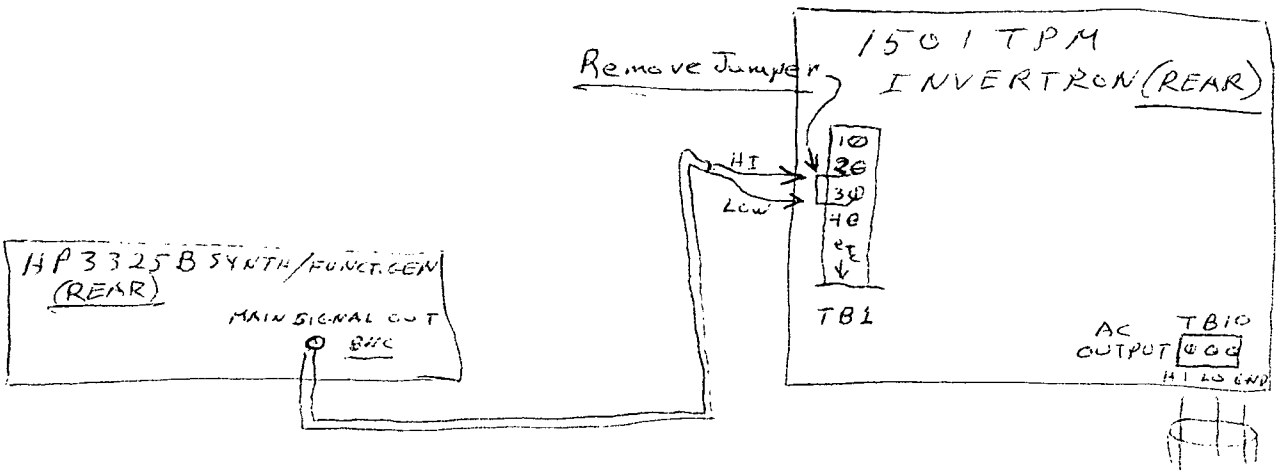
Case Postale 365
CH-1217 Meyrin

In All Other Locations
Hewlett-Packard Inter-Americas
3155 Porter Drive
Palo Alto, California 94304

A.C. OUTPUT CONNECTIONS
AND
CONNECTION FOR EXTERNAL FREQUENCY (and AMPLITUDE) DRIVE FOR 1501 TPM INVERTRON.



NOTE: If rear output is used as suggested above, make sure "Rear Only" switch on front panel is switched "ON" (Adjacent Indicator Light will be Lit).

WARNING! MAKE SURE THERE IS NO DC OFFSET ON FREQUENCY DRIVE SIGNAL.

USE #8 AWG FOR AC OUTPUT UP TO 10 FEET, FOR 45 AMPS LOAD, TO ASSURE MAX. LINE DROP OF 1.3 VOLTS.

M. Tobias 7/9/89

03325-90014

Printed in U. S. A.

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section contains information required to service the Model 3325 Synthesizer/Function Generator. This includes the theory of operation, block diagrams, troubleshooting procedures, and schematic diagrams. Most of the service information is divided into service groups, which are identified alphabetically. Each service group contains the schematic diagram, troubleshooting, and other pertinent information for a specific area of the instrument. A foldout functional block diagram follows Service Group O. The following circuits are included in the service groups:

Assembly	Circuit	Service Group
A3	VCO Buffer	D
A3	30 MHz Reference and Dividers	G
A3	Mixer	H
A8	High Voltage Output Opt 002	M
A9	High Stability Frequency Reference Opt 001	M
A12	Rear Panel Interface	B
A14	D/A Converter and Sample/Hold	I
A14	Function Circuits	J
A14	Output Amplifier and Level Comparator	K
A14	Relay Drivers	L
A14	Sweep Drive Circuits	N
A15	Display Driver	A
A21	Voltage Controlled Oscillator	D
A21	÷ NF Counter	E
A21	Fractional N Analog Circuits	F
A22	Fast Sync Converter	K
A22	Power Supplies	O
A23	Attenuator	L
A25	Keyboard	A
A26	Interface Circuits	B
A26	Control Circuits	C
A26	Modulation Source	N

Signature analysis information begins with Paragraph 8-139.

8-3. BASIS THEORY.

8-4. A simplified block diagram of the HP 3325B circuits is shown in Figure 8-1. In response to programming inputs from the keyboard or the interface circuits, the control circuits set the frequency, signal level, and output attenuation. The frequency synthesis circuits generate a sine wave at a frequency determined by digital information from the control circuits. This sine wave is applied to the function circuits where both the output function and signal level are determined, again by digital control. The signal level from the output amplifier can be tested in the level comparator to determine if a level correction is needed, thus providing an automatic amplitude calibration. If amplitude problems are encountered, it is important to disable this auto calibration. See section 8-114. Attenuator range is selected by the control circuits to provide (in conjunction with level control) the desired output signal amplitude. Program parameter data stored in the control circuits is transferred to the display when that parameter entry prefix key is pressed or the parameter prefix is programmed on the interface circuits.

8-5. THEORY OF OPERATION.

8-6. The following theory is a general description of each of the circuit blocks in the 3325 . A foldout functional block diagram of the 3325 follows Service Group O. Additional information on individual circuits may be found within the service groups. Figure 8-2 is a basic block diagram of the logic circuits, which interface with the processor (and with each other through the processor) to control the operation of the instrument. The Machine Data Bus, which consists of eight parallel lines labeled MD0 through MD7, is the principal means of data exchange between the control circuits and other parts of the instrument.

8-7. Keyboard and Display (Service Group A).

8-8. Keyboard Scan. Figure 8-3 is a block diagram of the Keyboard and Display circuits. To determine if a key has been pressed, a single high bit is shifted into the first position of the 16-bit register, and the four-line output of the keyboard matrix is read onto the machine data bus by the Read Keyboard clock signal. The high bit is then shifted one position in the register and the keyboard matrix output is read again. This process is repeated through the twelve input lines to the matrix. The high input bit is inverted by the keyboard buffers. A low level on one of the four matrix output lines indicates that a key has been pressed, and the control circuits initiate the proper action. After a low level has been detected, the control circuits look for a high level from the same key before the same action can be repeated. In other words, if the 5 key has been pressed, only one 5 will be processed even though the key is held through more than one keyboard scan cycle.

8-9. Numeric Display. The same high bit that is shifted through the 16-bit shift register to scan the keyboard enables one of the eleven numeric display digits in each of

the first eleven positions of the register. When a digit is enabled, eight bits of data (parallel) from the Machine Data Bus are entered in the 8-bit latch by a Write Keyboard Display Data clock signal. Each low bit in this data enables one of the eight current sources, which supplies current to the proper segment (or decimal point) of the enabled digit.

8-10. Annunciator Matrix. In each of the last five positions of the 16-bit shift register, the high bit that is being shifted through enables one of five sets of annunciators. Then another set of eight data bits is entered into the 8-bit latch. Each low bit in this data set also turns on one of the eight current sources, which supplies current to the proper annunciator.

8-11. Scan Cycle. Approximately 14 milliseconds are required for a complete scan of the Keyboard and Display. During each scan cycle, the events shown in Figure 8-3 happen concurrently.

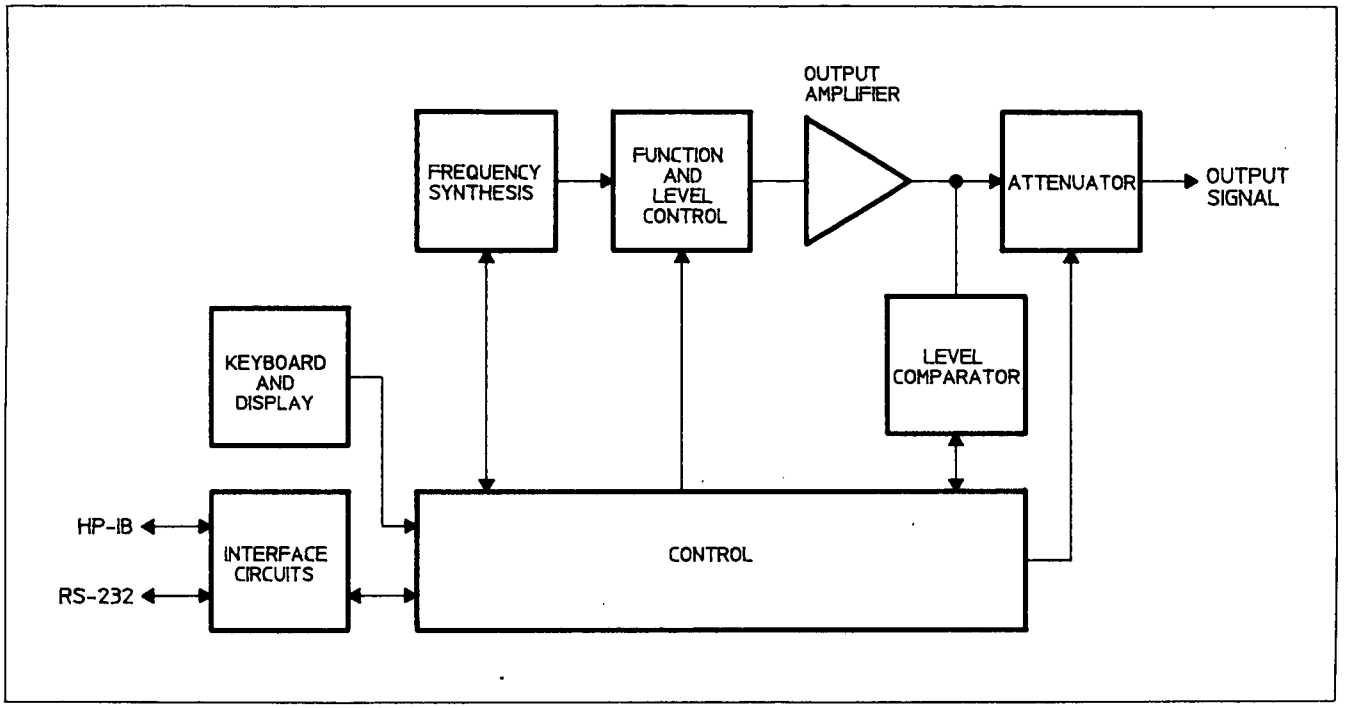


Figure 8-1. Simplified Block Diagram.

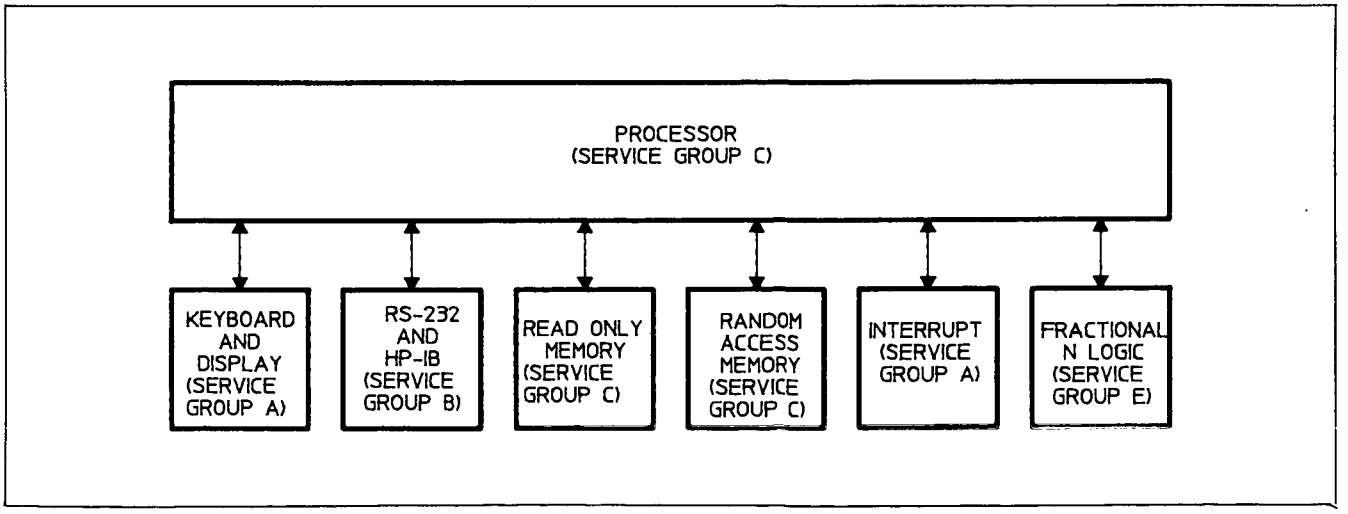


Figure 8-2. Basic Block Diagram, Logic Circuits.

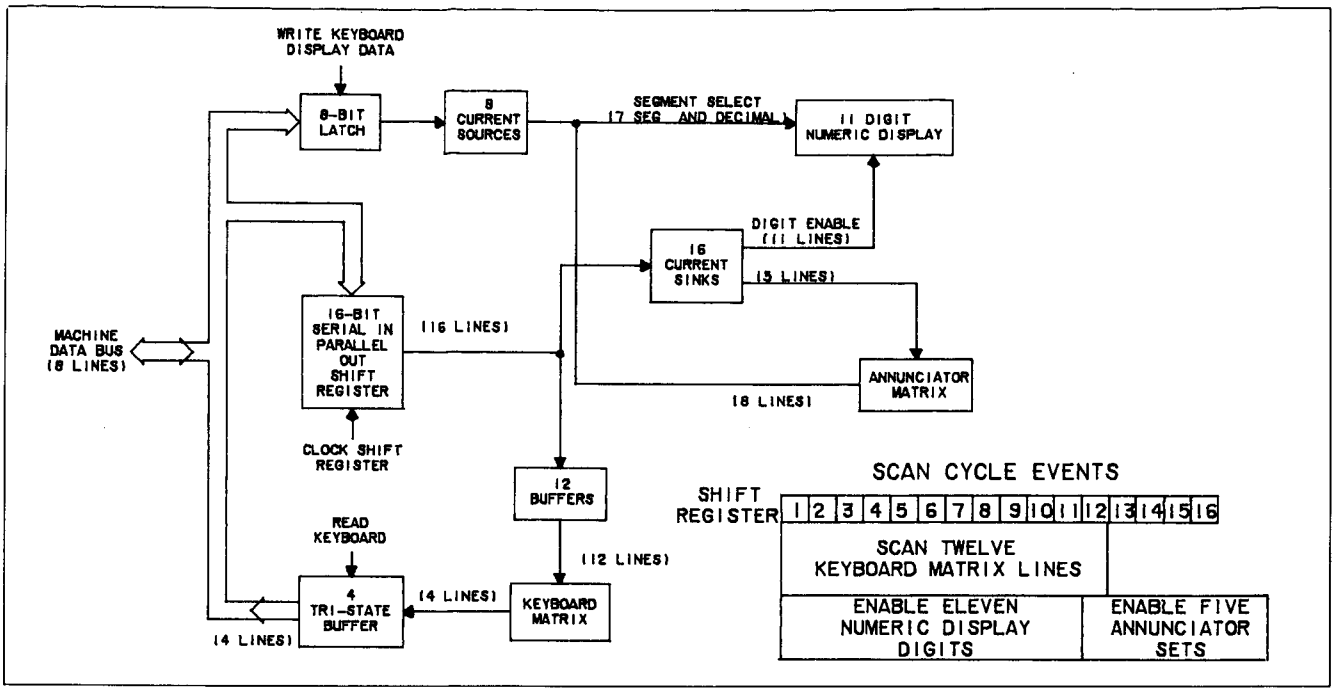


Figure 8-3. Keyboard and Display Block Diagram.

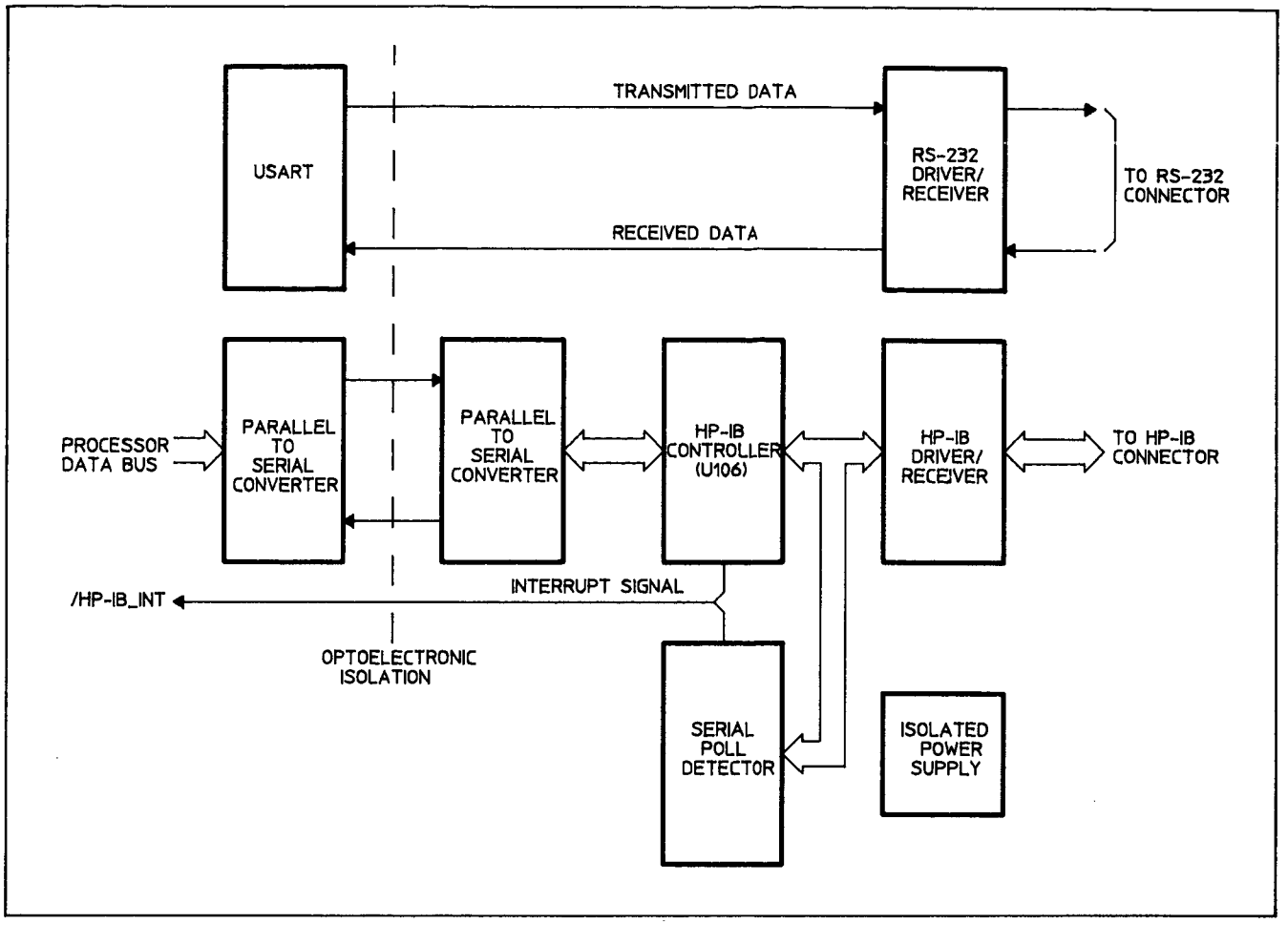


Figure 8-4. Basis Block Diagram of HP–IB and RS–232 Circuits.

8-12. HP-IB/RS-232 Circuits (Service Group B).

8-13. The HP-IB/RS-232 Circuits include the following:

- Isolated Power Supply
- Optoelectronic Isolation Interface
- HP-IB Controller
- Serial Poll Detector
- RS-232 Drivers and Receivers

Figure 8-4 is a basic block diagram of the HP-IB and RS-232 circuits.

8-14. Isolated Power Supply: Voltage regulator U150 provides +5 volt power to the isolated circuits. Optocoupler U151 and transistor Q151 disable the +5 volt supply when the HP 3325B is switched to standby.

8-15. Isolation Interface: The Isolation Interface circuits consist of shift registers U123, U125, U108, and U117 and of optocouplers U131 and U132. To transfer data from the processor to the HP-IB controller, U123 is parallel loaded with data, and the SHIFT signal is activated. SHIFTCLK (from /SHIFTCS) is clocked 8 times to shift the data through U131. Next U123 is loaded with the address of a register in the HP-IB controller, and the data is shifted 4 more times. The data is now in U117, and the register address is in U108. The SHIFT signal is deactivated, and the next SHIFTCLK writes the data to the HP-IB controller.

8-16. To transfer data from the HP-IB controller to the processor, U123 is parallel loaded with the register address, and the SHIFT signal is activated. SHIFTCLK is clocked 4 times to shift the data through U131 and into U108. The SHIFT signal is deactivated, and the next SHIFTCLK signal reads from the HP-IB controller and parallel loads U117. Data is clocked 8 times to move it through optocoupler U132 and into U123. The processor reads the data from U123.

8-17. HP-IB controller: U106 manages the HP-IB protocol. U103 and U104 buffer the HP-IB lines. When the HP 3325B is requested to listen or talk, or to transfer data in or out, the HP-IB controller interrupts the processor by activating HPIB_INT.

8-18. Serial Poll Detector: The Serial Poll Detector interrupts the processor when a serial poll occurs on the bus. This is necessary to maintain compatibility with the HP 3325A. U102 detects Serial Poll Enable and disables HP–IB commands (Serial Poll Enable and Serial Poll

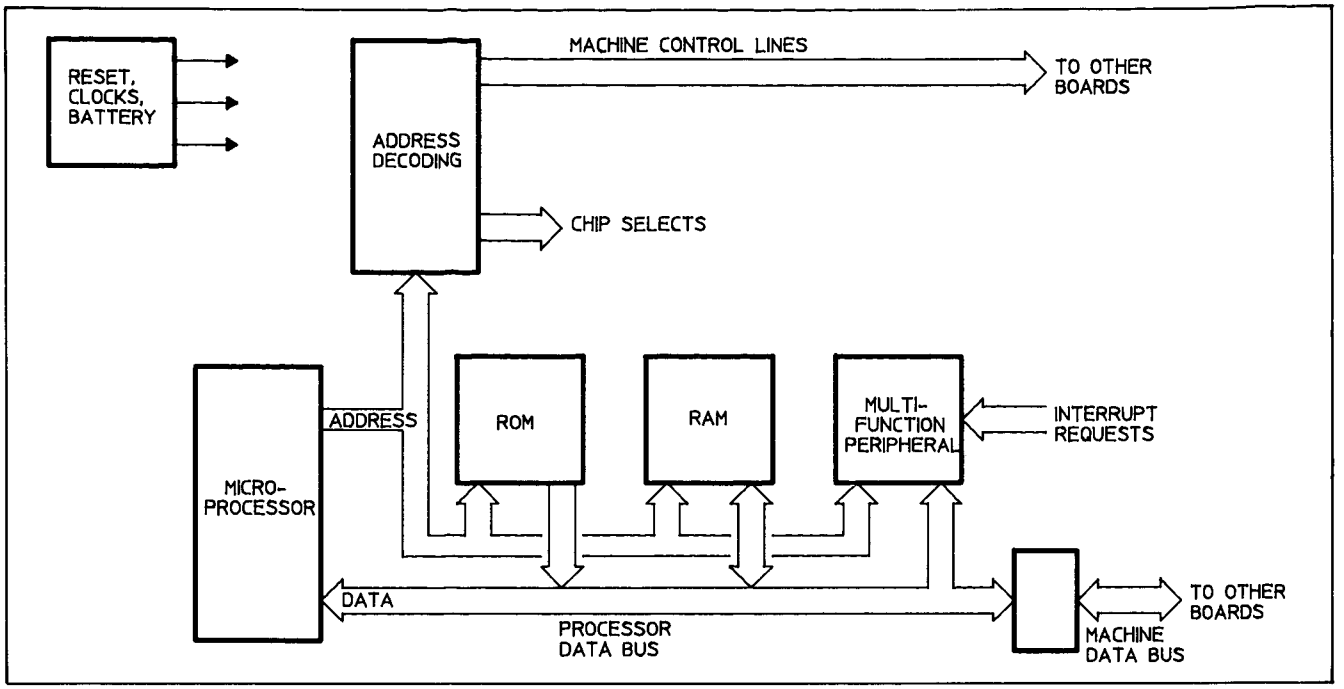


Figure 8-5. Basic Block Diagram of Control Circuits.

Disable). Serial Poll Enable sets U105A, and Serial Poll Disable clears it. When the serial poll byte is output to the HP-IB, U105B generates an interrupt to the processor.

8-19. RS-232 Driver/Receiver: The RS-232 Driver/Receiver (U170) translates TTL levels into RS-232 voltage levels. U170 contains charge-pump circuits that generate ± 10 volt supplies from the +5 volt supply.

8-20. Control Circuits (Service Group C).

8-21. The Control Circuits include the following:

- Microprocessor (Processor)
- Read Only Memory (ROM)
- Random Access Memory (RAM)
- Multi-Function Peripheral (MFP)
- Address Decoding
- Reset
- Clock

Figure 8-5 is a basic block diagram of the control circuits.

8-22. ROM and RAM circuits: The ROMs, U2 and U3, contain instructions that are read by the processor, U1. The RAMs, U6 and U7, provide storage for instrument state and other data.

8-23. Clock circuits: U99 generates a 19.6608 MHz clock. U98A divides this signal by 2 to make CLK10, which is used by the processor. U14A divides /CLK10 by 4 and by 16 to generate clock signals used by the MFP, U10 and by the Bus Error Detector, U14B.

8-24. Reset circuits: During power-up, U82 activates /RESET until the +5 volt supply stays above +4.85 volts for at least 2 seconds. When the supply is below 3.5 volts, U81 and Q81 activate /BTRY_ENABLE and transistors Q3 and Q4 function as a switch that opens to disconnect the non-volatile RAM supply (+5VB) from the +5 volt supply. Q2 is a switch that prevents the RAMs from being enabled when /BTRY_ENABLE is activated. During normal operation, both /RESET and /BTRY_ENABLE should be deactivated and +5VB should be greater than +4.5 volts. The processor can also activate /RESET if it is unable to execute instructions.

8-25. Address Decoding circuits: The processor outputs an address to the address bus at the beginning of each read or write cycle. AB21, the most significant address signal used, selects between the MFP and all other devices. When the MFP is not selected, U31 decodes address signals AB18 thru AB20 to select either ROM, RAM, machine data bus, or some other device. When the machine data bus is selected (/MDBS is activated), U33 and U34 further decode the address and activate one of the machine control lines. The MFP internally generates the Data Transfer Acknowledge (DTACK) signal that tells the processor when the read or write operation is complete. U14B generates a bus error timeout signal if DTACK did not occur. Read and write operations to everything else are terminated by the EEDTACK signal from U38.

8-26. Multi-Function Peripheral (MFP): This integrated circuit contains the following functional circuits:

An interrupt controller. All interrupts are prioritized by the MFP. The MFP activates /IRQ to interrupt the processor.

A Universal Synchronous/Asynchronous Receiver-Transmitter (USART). The USART is used for RS-232 communication.

Timer/counter **A** (1 of 4). This timer/counter divides the CLK2.5 clock to generate a periodic interrupt for the processor. The interrupt occurs at an 1800 Hz rate and signals the processor to scan the keyboard and update the digital-to-analog converters on the A14 assembly.

Timer/counter **B**. This timer/counter is used to time discrete sweep dwells.

Timer/counter **C**. This timer/counter generates the MODCLK signal for the modulation source.

Timer/counter **D**. This timer/counter generates the BAUD_CLOCK signal for the USART. The frequency of BAUD_CLOCK is 16 times the baud rate.

Eight Input/output pins. MODLOAD and SLC are output pins. HPIB_DATA is an input pin and /HPIB_INT and /SLF are interrupt inputs.

8-27 Fractional N Control. The Fractional N Control (see Service Group E) performs several functions vital to control of the HP 3325B.

a. It calculates the ÷ N and Pulse Remove data for the phase lock loop in the frequency synthesis circuits. (Explanation of the HP 3325B frequency synthesis begins with Paragraph 8-28.) This information is updated every 10 microseconds.

b. It increments or decrements the output frequency during a sweep function and outputs a Sweep Limit Flag when the start or stop frequency is reached. It also outputs a Sweep Limit Flag at the marker frequency during a sweep up.

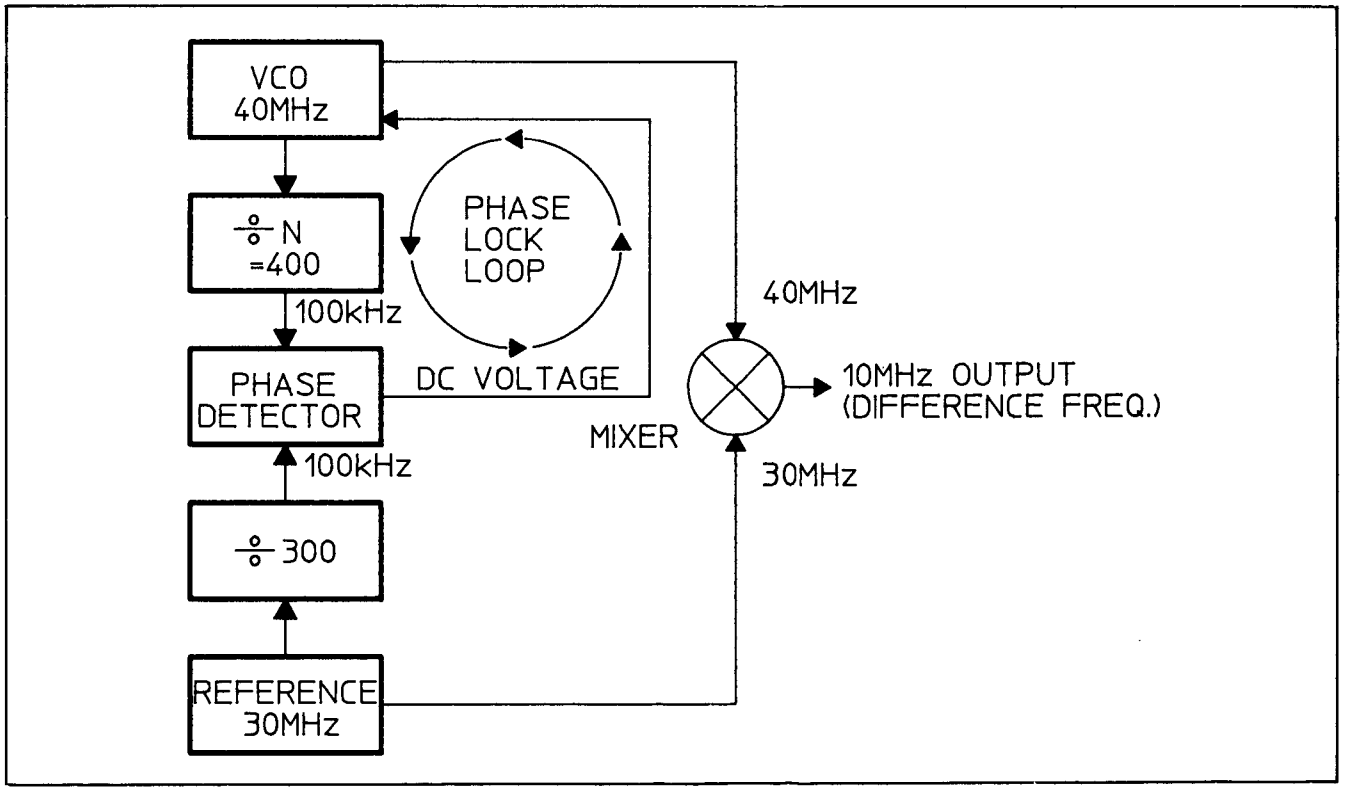


Figure 8-6. Phase Lock Loop.

8-28. Frequency Synthesis.

8-29. The Frequency Synthesis circuits are found in Service Group D, Voltage Controlled Oscillator; Service Group E, Fractional N Counter; and Service Group F, Fractional N Analog.

8-30. How does the HP 3325B generate a given frequency? Assume that the output desired is an even 10 MHz. A method for obtaining this frequency is illustrated in Figure 8-6. Basically, the HP 3325B uses this method.

8-31. The frequency of the VCO (Voltage Controlled Oscillator), in Figure 8-6, is controlled by the dc voltage out of the phase detector. This dc voltage reflects any phase change between the two detector input signals. Consequently, if the VCO frequency changes, the phase detector output changes to correct the VCO. This is known as a phase lock loop (PLL).

8-32. If we want to change the output from 10 MHz to 20 MHz, it is necessary merely to change the ÷ N number from 400 to 500. This obviously changes the divided VCO input to the phase detector to 80 kHz. The phase detector then uses the phase difference between its two inputs to change the VCO frequency to 50 MHz. This returns the phase detector input to 100 kHz, and the loop is again phase locked. It takes the 3325 about 50 milliseconds to make this change. The ÷ N number is determined by control circuits in response to front panel or remote programming.

8-33. The 3325B sine wave frequency range is essentially from zero to 20 MHz; consequently, the VCO frequency range is normally 30 MHz to 50 MHz. This dictates that the ÷ N number be a 3-digit integer between 300 and 500 (÷ N can be only three digits in the 3325A). For example, if ÷ N is 398, the VCO frequency is adjusted to 39.8 MHz (398 x 100 kHz) and the output is 9.8 MHz.

8-34. Now let us look at a more detailed diagram of the phase detector block (Figure 8-7). The control voltage to the VCO is the output of a Sample/Hold amplifier which samples the integrator output at the proper time and at regular intervals. Ideally, this voltage would be exactly the same at each sampling time and the VCO frequency would remain constant. Let us assume that this is true, and that the ÷ N number is 400. In this case, the output of the phase comparator would be a series of pulses of equal width. Each pulse turns on a current source which causes a given amount of charge to be placed on the integrator. At a specified time this voltage is stored on the Sample/Hold amplifier capacitor (Figure 8-7). The integrator output is illustrated in Figure 8-8. The charge slope is much greater than the discharge slope because the phase comparator current source has about ten times the magnitude of the bias current source.

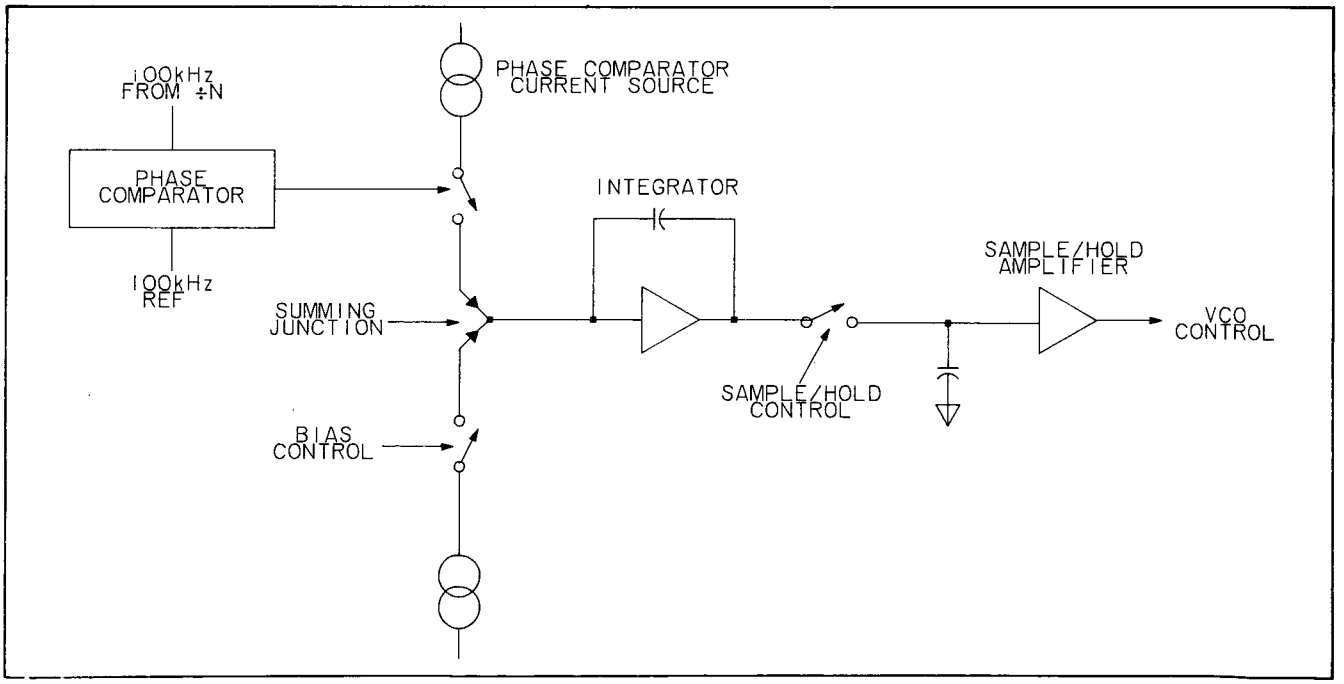


Figure 8-7. Phase Detector.

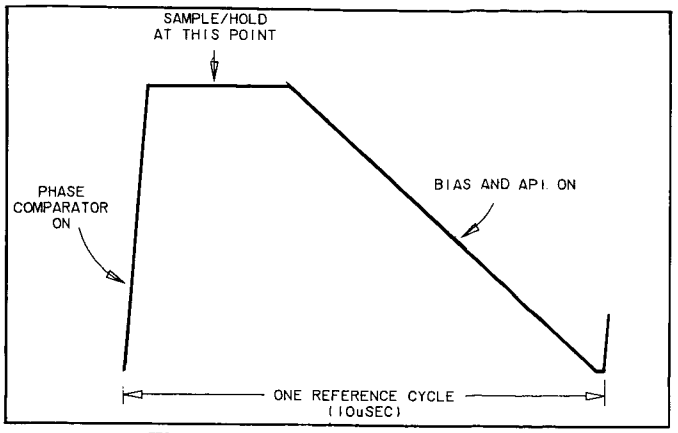


Figure 8-8. Integrator Output.

8-35. Immediately after a sample, the bias current source is turned on to discharge the integrator capacitor to the level it held before the phase comparator current was allowed to charge it. If this were not done, the charge would continue to accumulate to the limit permitted by the power supplies and remain at that level (nullifying the entire PLL scheme). The bias current is controlled by a pulse from the fractional N control IC.

8-36. Up to this point, we have considered only the situation where ÷ N is a whole number consisting of three digits. Now suppose an output of 10.04 MHz is desired. This would require the VCO frequency to be 40.04 MHz and the ÷ N number to be 400.4. (The number 400.4 is referred to as ÷ N.F. The number 400 is represented by N, and the fraction .4 may be called F, or the fractional N.) Since the existing phase lock system will not allow ÷ N to be four digits, some additional circuits are needed to make the VCO operate at a frequency of 40.04 MHz, and at the same time provide a signal to the phase comparator equal to 100 kHz. Two of these circuits are the digital-to-analog converter (DAC) and pulse remove blocks added in Figure 8-9.

8-37. If the VCO operated at 40.04 MHz and ÷ N were 400, then the divided VCO signal to the phase comparator would be 100.1 kHz and would be compared to the 100.0 kHz reference. This would result in an increasing phase comparator charge current to the integrator. To compensate for this increased charge, the discharge current from the bias source is adjusted by means of Analog Phase Interpolation (API) information from the fractional N control IC. The phase (frequency) difference between 40.04 MHz and 40.00 MHz is accumulated digitally in the control IC and applied through five lines to a digital-to-analog converter. The D/A output current is subtracted from the bias current to discharge the integrator to the proper level during each sampling period, effectively cancelling the increased charge from the phase comparator.

8-38. Only part of the problem is solved, however, because if the PLL were to continue operating in this manner, the phase comparator output would continue to increase beyond practical limits. To prevent this, a "pulse remove" technique is used. In effect, the accumulated phase difference (in the Control IC) causes the ÷N counter to count one extra cycle (÷401) each time the phase accumulator passes through unity. This has the effect of "removing" a cycle of VCO frequency, and the divided signal to the phase comparator is now an average of 100 kHz.

8-39. To accumulate the phase difference, the twelve least significant digits in a "frequency register" (contained in the Fractional N control IC) are added to

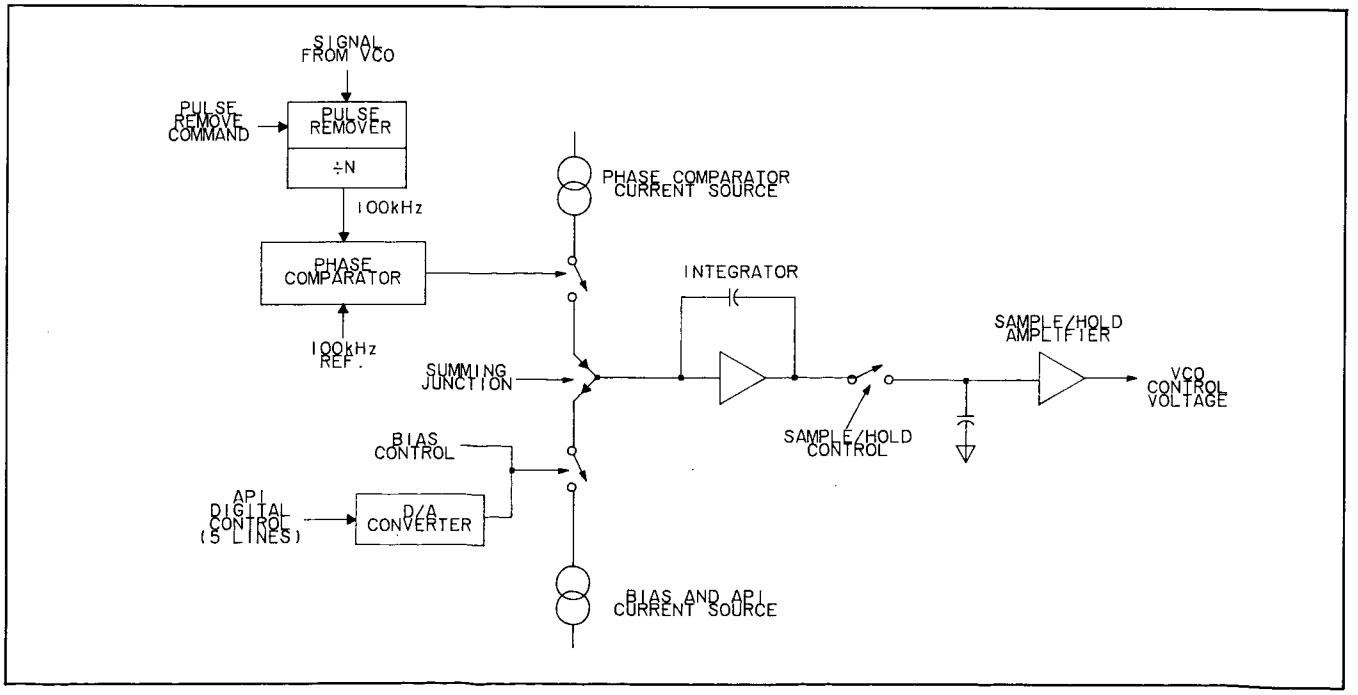


Figure 8-9. Addition of DAC and Pulse Remove Blocks.

the twelve digits in the phase accumulator, and the sum is stored again in the accumulator. This addition takes place every 10 microseconds (once for each cycle of the 100 kHZ reference). Figure 8-10 illustrates this process for the example we are using.

8-40. This example has used a fractional N of .4. If the output frequency were 10.004 MHz instead of 10.04 MHz, the fractional part would be .04, and both the phase comparator output and the phase accumulator content would increase at one-tenth the previous rate. As another example, if the output frequency were 10.09 MHz, the fractional N would be .9, and a pulse remove command would be required for 9 out of every 10 reference cycles.

8-41. Fractional N Counter. The ÷ N (Fractional N) counter consists basically of three presettable counters in series, shown in Figure 8-11. The counters for the two most significant digits (of the 3-digit ÷ N number) are decade counters. The least significant digit counter consists of a ÷ 5 counter and a ÷ 2 prescaler which can be made to divide by three as necessary. Presettable counters are used because ÷ N must be variable, as explained below.

8-42. The preset number that is loaded into the counter is BCD (binary coded decimal) form is the 9's complement of the ÷ N number. N is determined by the first three digits of the VCO frequency.

	Example 1	Example 2
Sine wave output	10 000 000.0 Hz	100 000.0 Hz
Reference frequency	30 000 000.0 Hz	30 000 000.0 Hz
VCO frequency	40 000 000.0 Hz	30 100 000.0 Hz
÷ N	40 0	30 1

To determine the 9's complement, ÷ N is subtracted from 999 in the fractional N control IC.

	999	999
÷ N	400	301
9's complement	599	698

8-43. The ÷ N counter begins at the preset number (599 in example 1), counts to 999 and then reloads the same number unless a new frequency has been programmed. One output pulse occurs for each time the counters reach 999; consequently, if 400 VCO cycles (599 to 999) are counted for every output pulse, VCO has been divided by 400. The output pulse is derived from the bias pulse issued by the fractional N control IC. To provide the proper stable phase relationship to the VCO signal, this

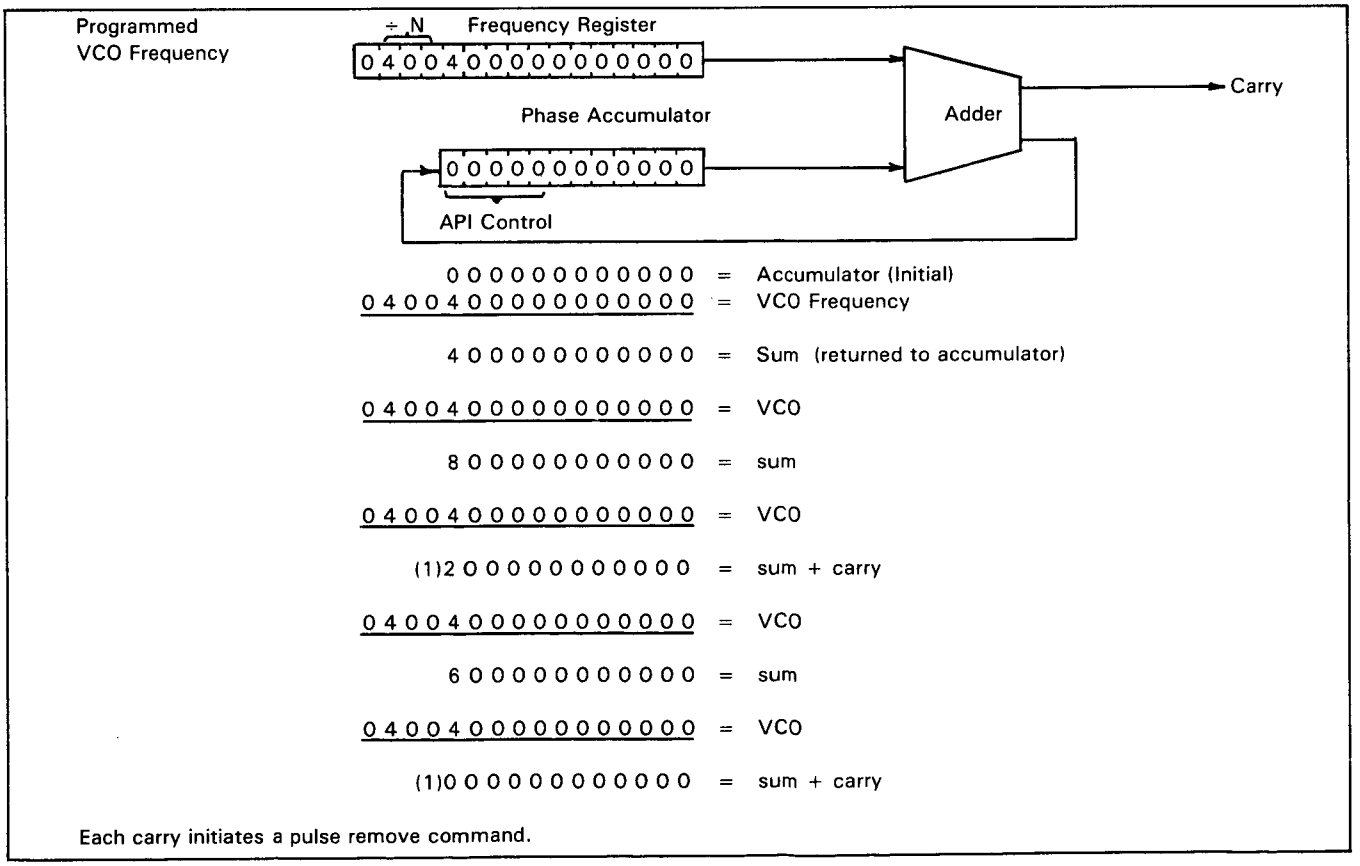


Figure 8-10. Phase Accumulation.

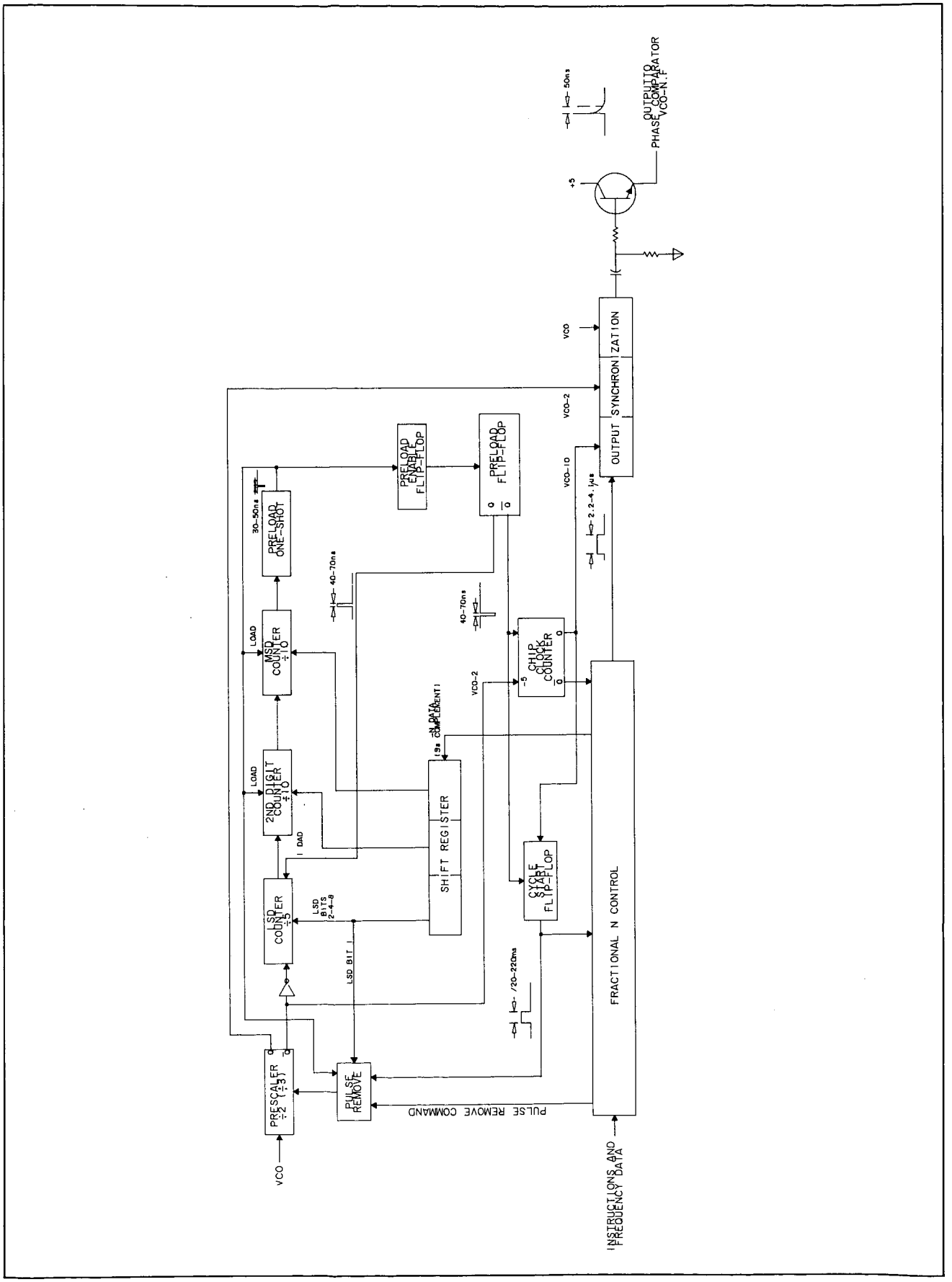


Figure 8-11. Divide by N Counter.

pulse is clocked first by VCO ÷ 10, then VCO ÷ 2, and finally by VCO.

8-44 In example 2, ÷ N is 301, so the counter must count 301 VCO cycles during each reference period. Normally only an even number of cycles could be counted because the least significant digit ÷ 5 counter is counting VCO ÷ 2 from the prescaler. Therefore, in order to count an odd number, the prescaler is forced to count one additional pulse during each reference period. To accomplish this, the pulse remove circuits are enabled when the least significant (BCD) bit of the least significant digit of the preset number is even, as is the case in example 2 (decimal 8 = binary 1000). Then the negative-going pulse from the preload one-shot changes the prescaler to ÷ 3 for one cycle. The pulse remove action associated with fractional N is independent of and in addition to the odd number count.

8-45. The chip clock counter output (Figure 8-11) is the prescaler output divided by five. The $\overline{Q}$ output from this counter goes to the fractional N control IC and is used to clock data in and out of the four shift registers within the IC. The counter Q output is used in the ÷ N.F counter output synchronization and to clock the cycle start flip-flop.

8-46. The cycle start flip-flop is set by the $\overline{Q}$ output from the preload flip-flop and is cleared by the next trailing edge of the chip clock signal. A cycle start pulse occurs at the time the ÷ N least significant digit is preloaded, which is once every reference period. Cycle start is used to initiate operations within the fractional N control IC. It is also used to set the pulse remove circuit when ÷ N is an odd number.

8-47. Reference Circuits (Service Group G).

8-48. Reference Oscillator. The Reference Oscillator is a 30 MHz crystal-controlled oscillator that can be synchronized to an external reference signal of 10 MHz or subharmonic of 10 MHz (minimum 1 MHz).

8-49. External Reference Phase Lock Loop. Figure 8-12 is a block diagram of the External Reference Phase Lock Loop. The external reference input is sent thorugh a squaring circuit, amplified, and then differentiated to provide a narrow positive pulse to the gate of a FET switch. This turns the switch on momentarily, sampling the instantaneous voltage of the sine wave at the FET switch source. This voltage is stored on the capacitor at the input of a Sample/Hold amplifier. The resulting dc output voltage from the S/H amplifier is applied to a varactor in the 30 MHz oscillator circuit to adjust the oscillator frequency.

8-50. When the 30 MHz oscillator is in phase with the external reference, the FET switch will sample the sine wave at exactly the same point each time and the S/H amplifier output voltage will remain constant. But if there is a change in phase relationship, the amplifier output voltage will change, correcting the oscillator frequency and restoring phase lock.

8-51. External Reference Detector. Whenever an external reference input is present, a detector circuit provides a logical "1" signal to the control circuits. This causes the front panel EXT REF indicator to light.

8-52. Unlock Detector. When the external reference loop is phase locked, the Sample/Hold amplifier output is a steady dc voltage. However, if the loop is not locked, this voltage will vary. The unlock detector is triggered by this varying voltage to provide a logical "1" to the control circuits. During an "unlock" condition, the front panel EXT REF indicator will flash on and off.

8-53. 30 MHz Reference Amplitude. Sine wave output amplitude and amplitude modulation are controlled by varying the amplitude of the 30 MHz Reference. Figure

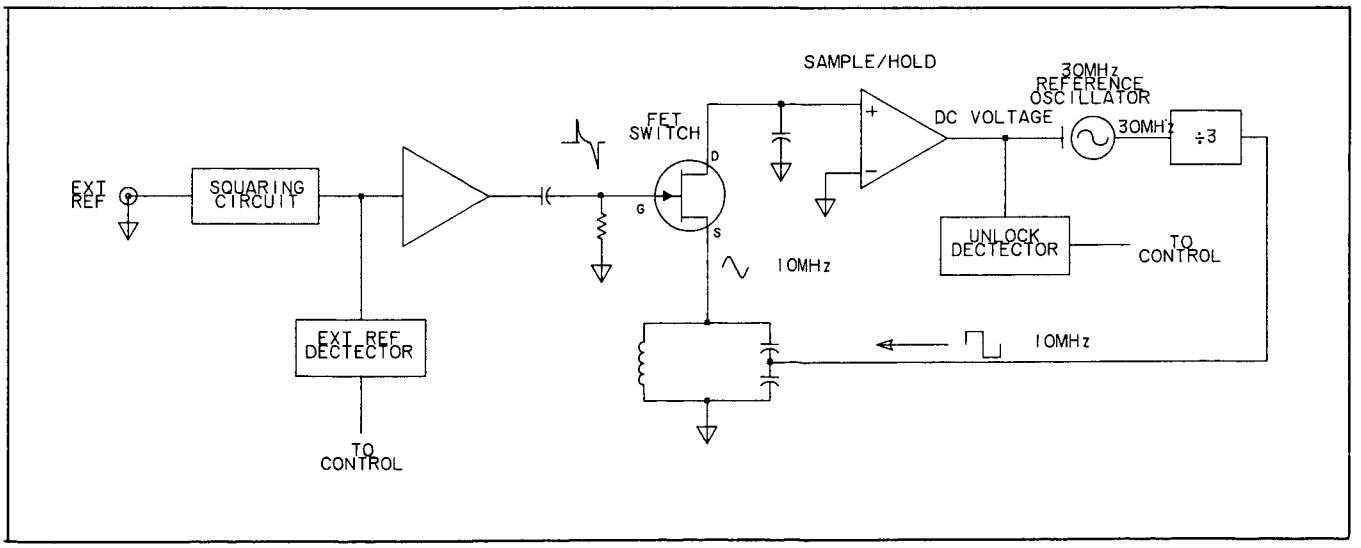


Figure 8-12. External Reference Phase Lock Loop Block Diagram.

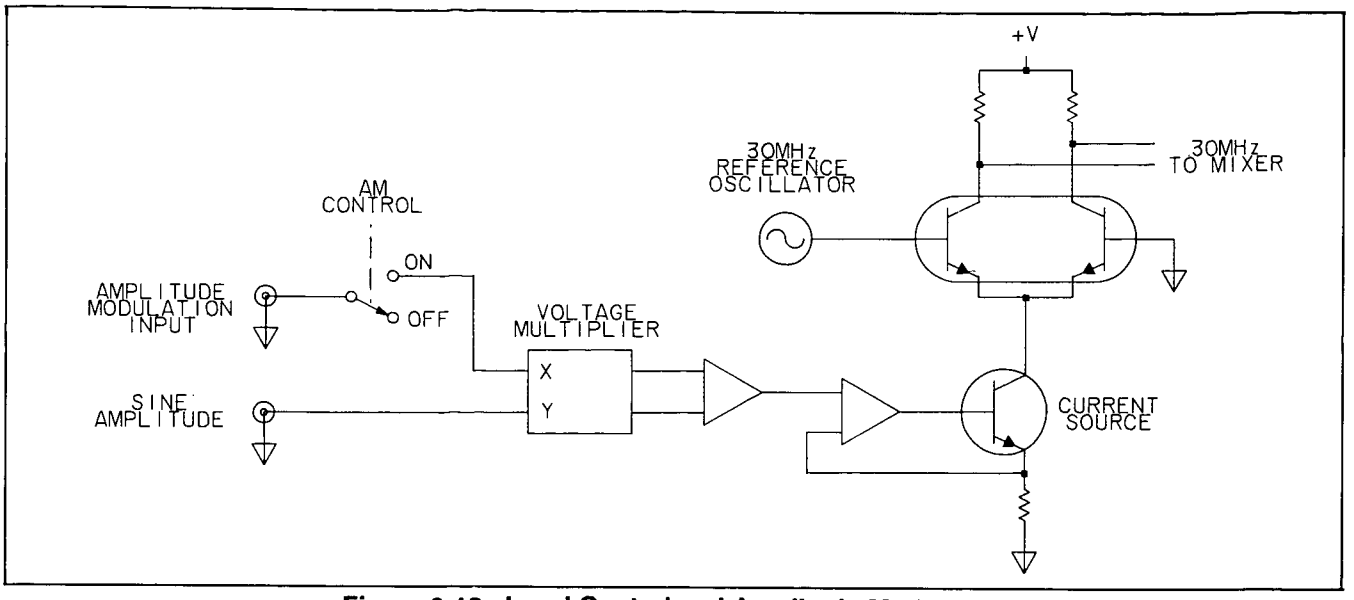


Figure 8-13. Level Control and Amplitude Modulation.

8-13 is a simplified diagram of the level control and amplitude modulation circuits. The reference signal amplitude is varied by controlling the current available from the current source (Figure 8-13), which in turn is controlled by the Sine Amplitude signal and/or the Amplitude Modulation input signal. When the AM Control switch is OFF, the X input to the voltage multiplier is constant, and the output level is controlled by the Sine Amplitude only. When the AM switch is ON, however, both the X and Y inputs influence the output. The output of the multiplier (V_o) is normally equal to .1XY, but because the multiplier output is connected to an operational amplifier input, this voltage cannot be measured. Use of the voltage multiplier in this circuit makes it possible to change the 3325 output (carrier) amplitude without affecting the percent of modulation, or to change the percent of modulation without affecting the carrier level. The output of the Level Control and Amplitude Modulation circuit goes to the Mixer, covered in Service Group H.

8-54. Reference Dividers. The 30 MHz Reference frequency is reduced through a series of dividers to provide the following signals:

10 MHz to the External Reference PLL
2 MHz to the D/A Converter (Service Group I)
1 MHz rear panel reference output
100 kHz reference to the Fractional N Phase Comparator (Service Group F)

For phase stability, the 100 kHz output is clocked first by 10 MHz, then by the 30 MHz reference signal. The 100 kHz signal is then differentiated to provide a narrow pulse to the Fractional N Phase Comparator.

8-55. Mixer (Service Group H).

8-56. The Mixer circuits are diagrammed in Figure 8-14. The 30 MHz reference is passed through a low pass filter and mixed with the 30-50 MHz signal from the VCO in a diode mixing circuit. The mixing circuit output is applied to a low pass filter to remove all but the difference frequency, which is amplified by a current amplifier. This signal then goes to the Function circuits (Paragraph 8-59).

8-57. D/A Converter (Service Group I).

8-58. The Digital-to-Analog (D/A) Converter supplies the analog voltages which control signal amplitude, dc offset, level comparator reference voltage, sweep X drive output, and correct for dc offset error. In addition, it supplies an auto zero voltage to its own current sources.

8-59. Preset Counters. Each of the four Preset Counters is a BCD counter that can be pre-loaded with a 4-digit binary number and then enabled to count from that point. In this application, they are set to count down. The counters are connected in two pairs, as illustrated by the least significant pair in Figure 8-15. Both counters are loaded at the same time, then the Least Significant Digit (LCD) Counter is enabled by the Counter and Current Source Enable Flip-Flop; and at the same time, the LSD Current Source is enabled to supply current to the DAC Integrator (see Figure 8-16). When the LSD Counter reaches zero, its Ripple Clock output enables the 3rd Digit Counter to count one clock pulse. If the preset number in the 3rd Digit Counter was greater than one, the LSD Counter continues to count, supplying an enable pulse to the 3rd Digit Counter each time it reaches zero. When the 3rd Digit Counter reaches zero, its Ripple Clock output changes the state of the Counter and Current Source flip-flop, disabling the LSD Counter and the Current Source.

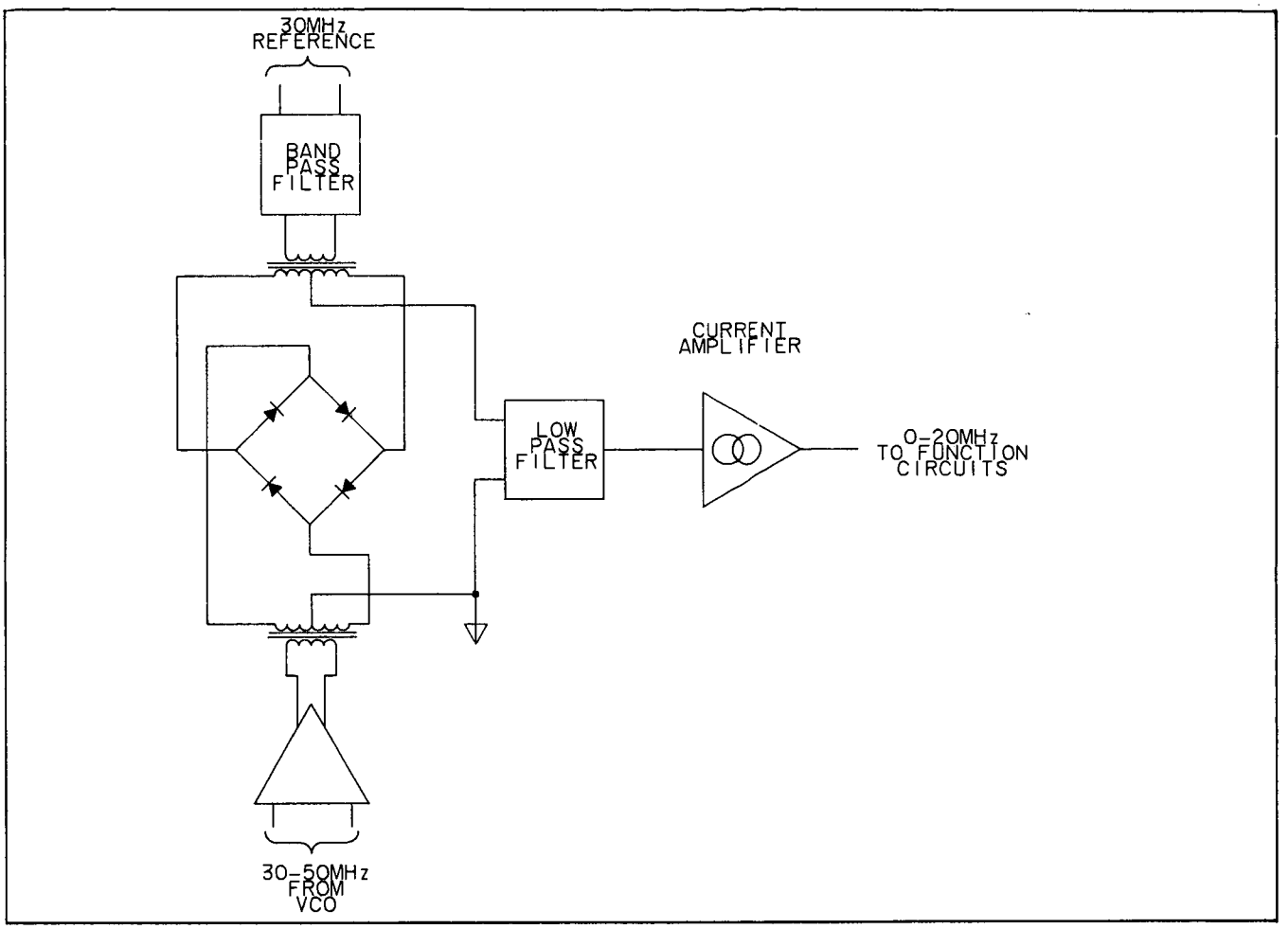


Figure 8-14. Mixer Diagram.

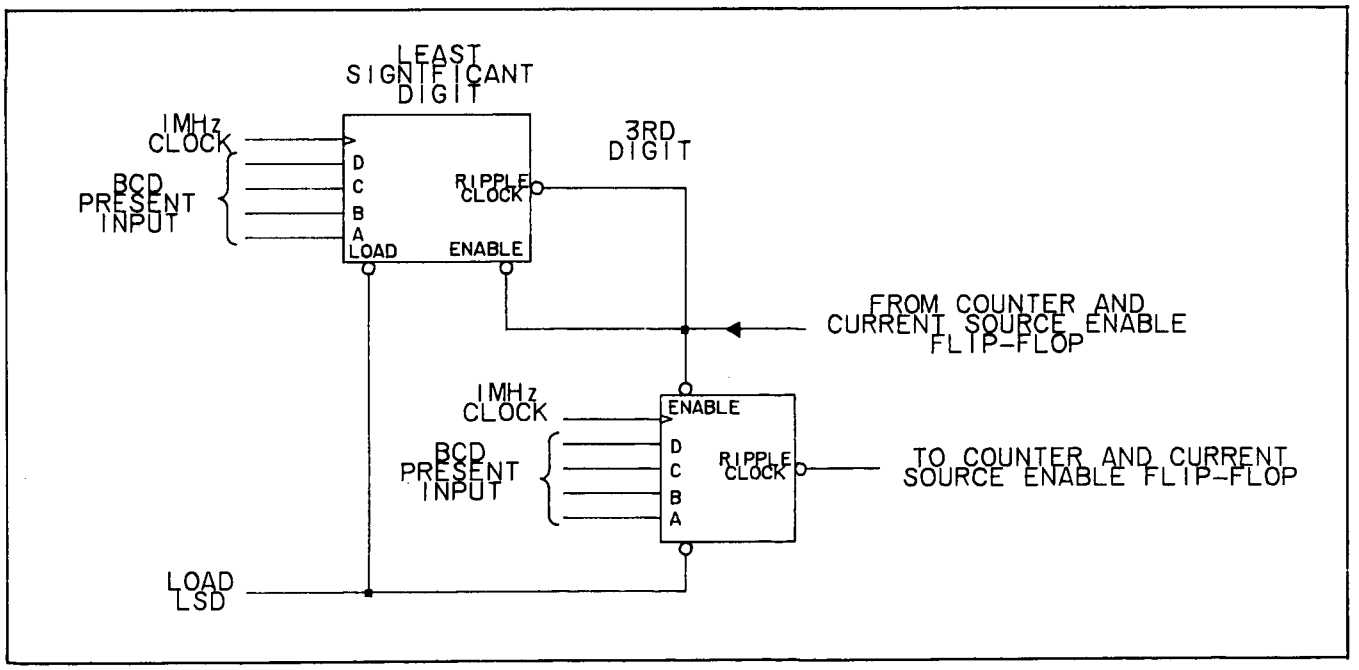


Figure 8-15. Preset Counters.

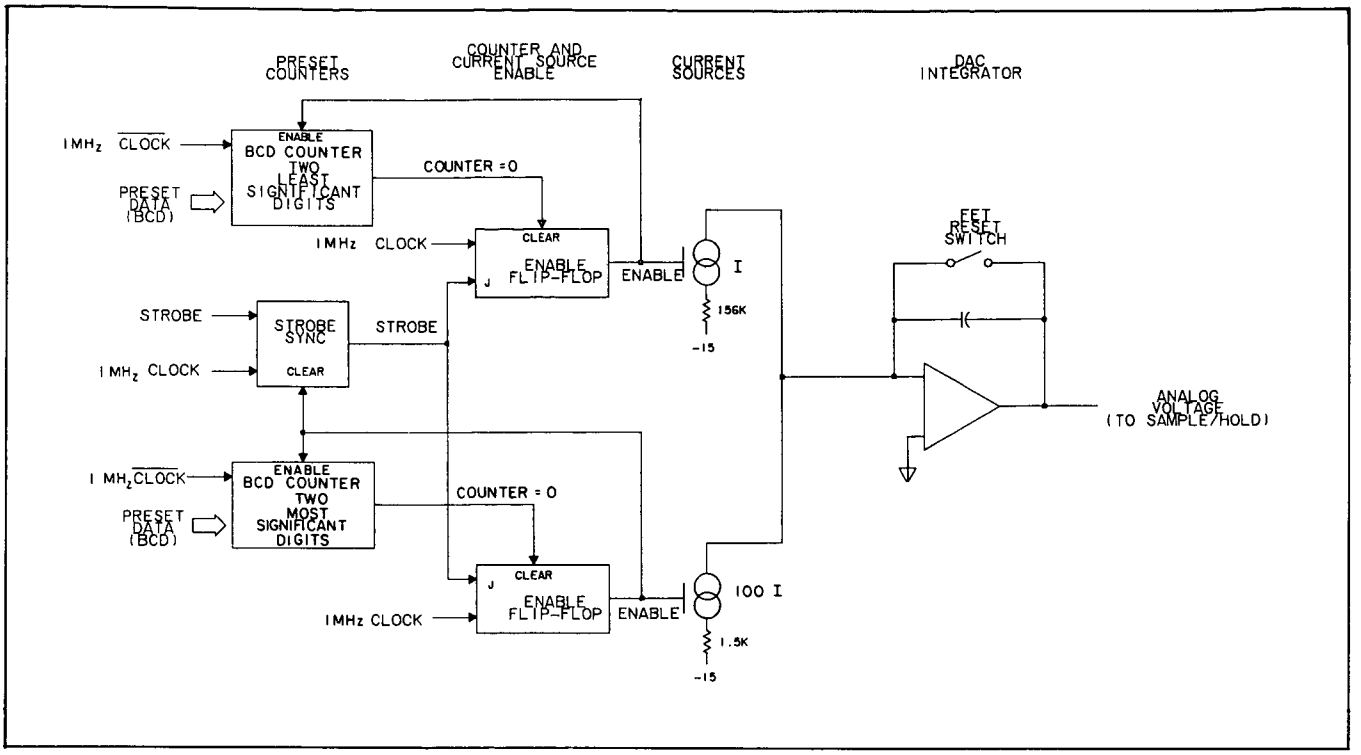


Figure 8-16. Digital-to-Analog Converter.

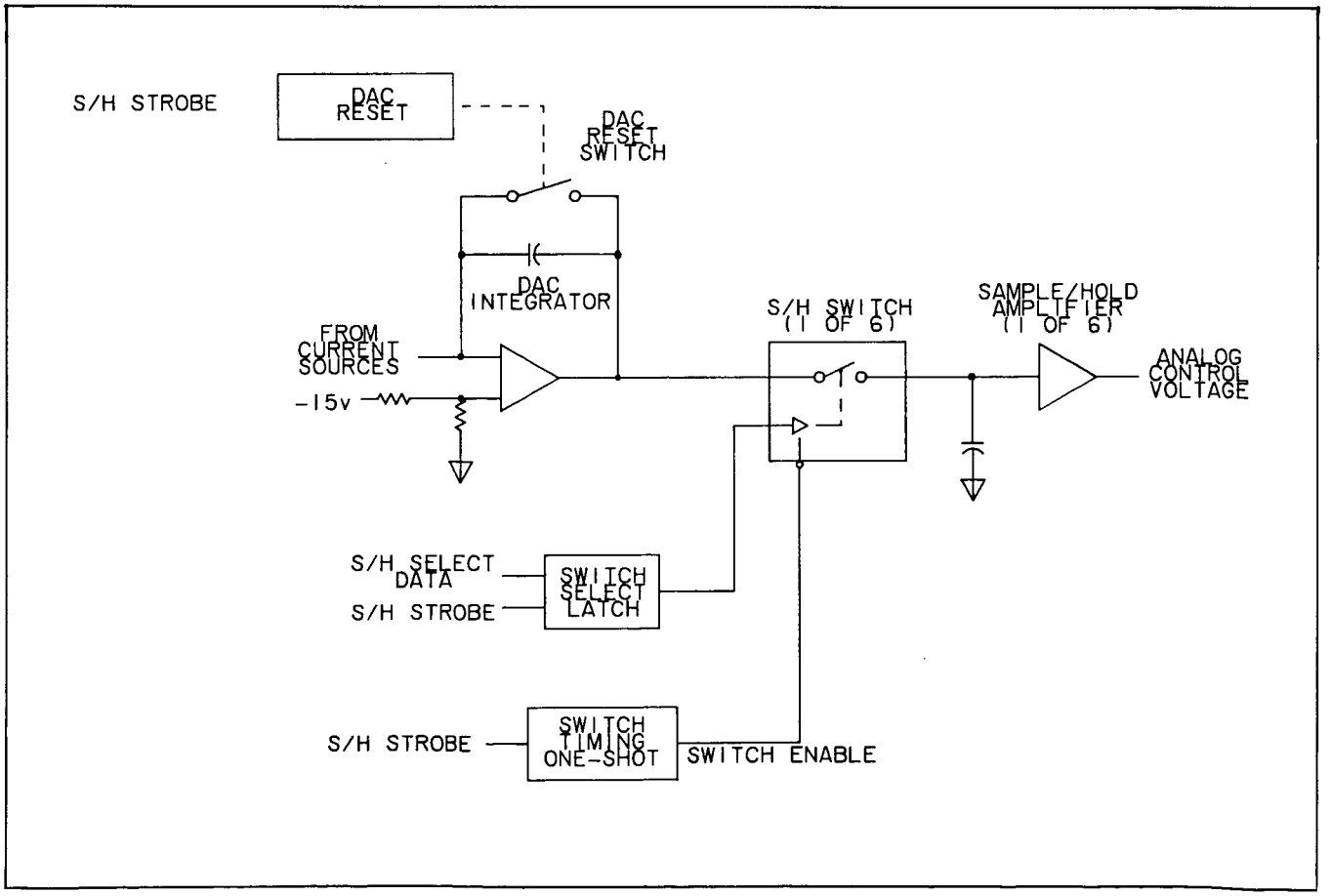


Figure 8-17. DAC Sample/Hold.

8-60. 4-Digit D/A Conversion. A simplified diagram of the D/A Converter is shown in Figure 8-16. The D/A Converter (DAC) Integrator output voltage is proportional to the four digits of BCD information that is loaded into the Preset Counters. The two current sources are enabled to supply constant current to the DAC Integrator for the length of time required for the Preset Counters to count down from the preset number to zero. The current resulting from the two most significant digits is proportionally 100 times that from the two least significant digits. For example, if the 4-digit preset number were 5555, the enable time would be the same for both current sources, but the current ratio would be 100 to 1.

8-61. DAC Sample / Hold Circuits. After the Preset Counters have finished counting and the current sources are disabled, the DAC Integrator output voltage must be transferred to the proper Sample / Hold Amplifier. Figure 8-17 is a simplified diagram of the DAC Sample/Hold circuits. The data that designates one of the six Sample/Hold Amplifiers is clocked into the latch by the S/H Strobe pulse. The S/H Strobe pulse also triggers a switch timing one-shot which enables the switches to close long enough to transfer the DAC Integrator voltage to the capacitor at the input to the S/H Amplifier.

8-62. DAC Reset. After the integrator output voltage has been transferred to the proper Sample / Hold Amplifier, the integrator is reset to zero by closing a FET switch across the integrator capacitor. The closing of this switch is timed by a one-shot which is triggered by the S/H Strobe pulse.

8-63. Function Circuits (Service Group J).

8-64. This section of the instrument provides the proper current to the operational output amplifier for each function. It includes a number of current sources, and the circuits which develop the square wave, triangle, and ramp functions from the sine wave. Function switching is accomplished by the enable signals shown in the block diagram, Figure 8-18.

8-65. Sine Wave. In sine function, the sine wave from the mixer passes through a current amplifier to the output amplifier. Sine wave amplitude is actually controlled in the level control circuits (see Paragraph 8-73), but the level control current is supplied from the amplitude control current source in this section.

8-66. Square Wave. The sine wave input is sent through a squaring circuit and then divided by two to produce the square wave output. Consequently, in the square wave function, the sine wave must be twice the output frequency, and the maximum output frequency is 10 MHz.

8-67. Triangle. To generate a triangle wave, the sine wave input is first put through the squaring circuit, then divided by 20 (÷10 and ÷2). The result is a square wave whose frequency is 1 MHz plus the programmed output frequency. This signal is phase compared to a 1 MHz reference in an exclusive OR gate. Because the output of the gate is high when one and only one input is high, the gate output is a series of pulses whose width varies in proportion to the phase difference between the two gate input signals. Figure 8-19 is a simplified illustration of this. The gate output drives a current amplifier (which inverts the signal) and the resulting current pulse signal is sent through a filter which shapes the triangle.

8-68. The triangle output frequency is the difference between the 1 MHz reference and the input frequency (from the mixer) divided by twenty. Consequently, the input frequency must be 20 MHz + (20 x output). To produce the maximum triangle output frequency of 10 kHz, for example, the input must be 20.2 MHz.

Output frequency	=	10 000 Hz
Reference	=	1 000 000 Hz
		1 010 000 Hz
	×	20
Input frequency	=	20 200 000 Hz

8-69. Positive and Negative Ramp. A ramp output is generated in the same manner as the triangle, except that when the phase difference between the 1 MHz reference and the input ÷20 has advanced 180°, the reference is inverted by the ramp reset circuits (Figure 8-18). Figure 8-20 illustrates the ramp generation process. Because the phase difference is allowed to advance only 180° instead of 360° as in triangle generation, the frequency of the "input ÷ 20" signal to the phase comparison gate must be 1 Mhz plus one-half the output frequency. For the maximum ramp output frequency of 10 kHz:

Output frequency	=	10 000 Hz
÷2	=	5 000 Hz
Reference	=	1 000 000 Hz
		1 005 000 Hz
	×	20
Input frequency	=	20 100 000 Hz

8-70. Ramp reset may be initiated either by the phase detector output (Figure 8-18) or by a + or – ramp reset signal from peak detectors at the output amplifier. Each reset pulse causes the reference signal to be inverted at the output of the ramp reset gate.

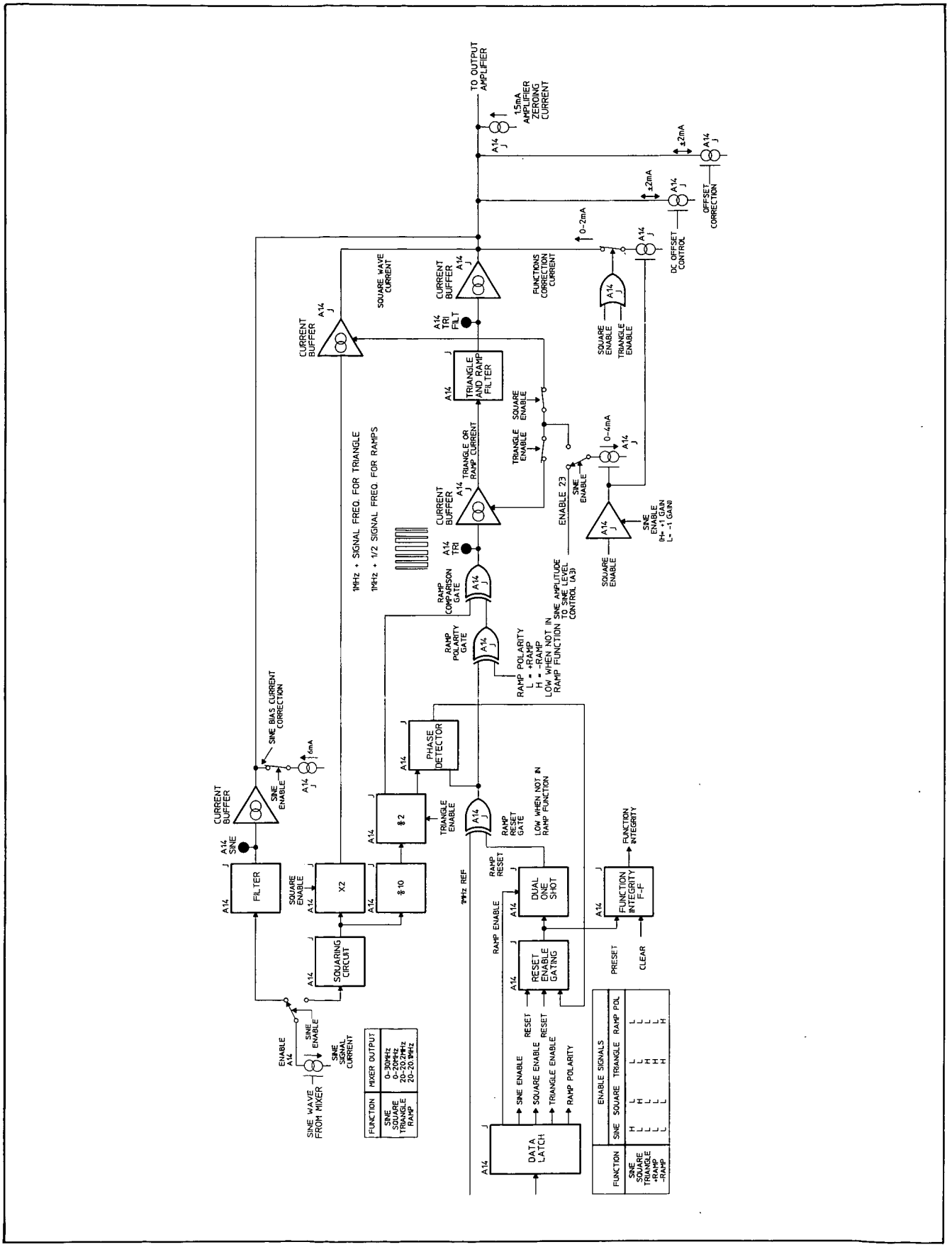


Figure 8-18. Enable Signals for Function Switching.

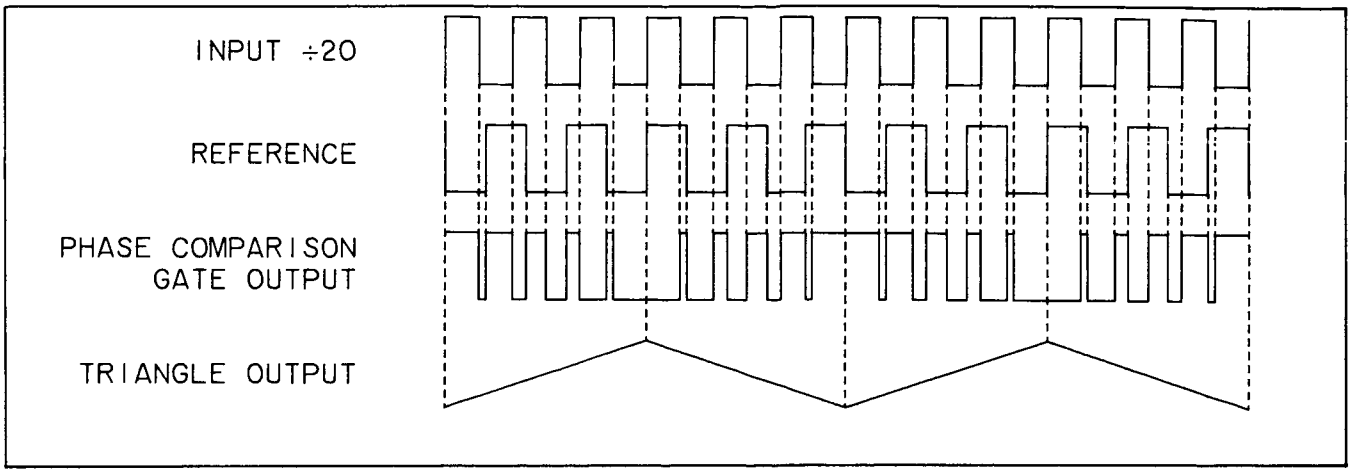


Figure 8-19. Simplified Illustration of Triangle Generation.

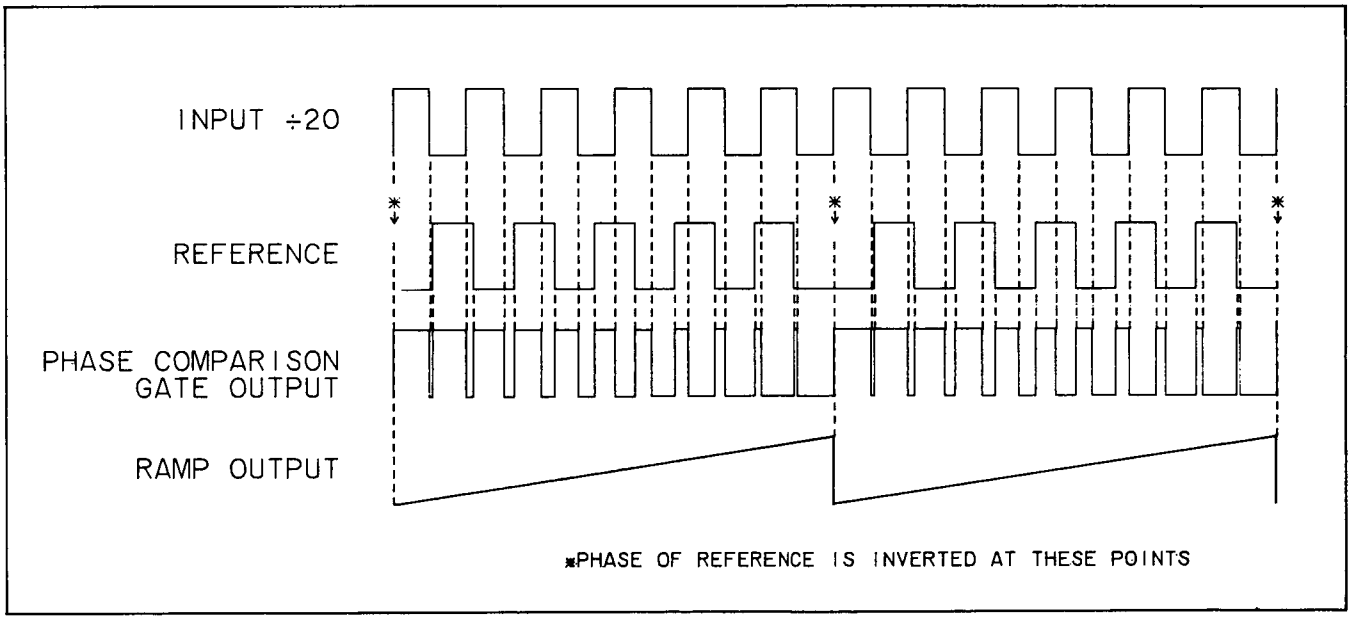


Figure 8-20. Simplified Illustration of Ramp Generation.

8-71. Ramp polarity is determined by the ramp polarity gate. If negative ramp is programmed, the reference signal is inverted by this gate.

8-72. Function Integrity Flag. If the ramp is being reset by the digital Phase Detector, the detector output sets the Function Integrity Flip-Flop, and the Function Integrity Flag (MD2) to the processor is high. If the ramp is being reset by the analog Level Comparator at the amplifier output (see Paragraph 8-78), the analog reset signal prevents the Function Integrity Flip-Flop from being set. The controller may reset the Function Integrity Flip-Flop. The Function Integrity Flag tells the processor which ramp reset method (analog or digital) is being used. This information is used by the processor in setting the correct reference level for the output Level Comparator. Ramps are reset by the digital Phase Detector at frequencies below 100 Hz, and by the analog output Level Comparator at frequencies of 100 Hz and higher.

8-73. Amplitude and Offset Control. The voltage output of the output amplifier is proportional to the current into its input summing junction. Consequently, signal amplitude can be controlled by varying the amount of current available from the current source which supplies the various functions. The amplitude control signal is a dc analog voltage from a D/A converter (see Paragraph 8-57) which receives its digital input from the controller.

8-74. Because the square wave, triangle, and ramp signals are generated by switching the unipolar amplitude

control current source on and off, the entire signal is above ground. These signals are centered about ground by a compensating current equal to one-half the signal amplitude. This current is labeled Functions Correction Current in Figure 8-18. After calibration, additional dc offset correction is added by the control circuits. This current is labeled Offset Correction in Figure 8-18.

8-75. Positive or negative dc offset can be programmed either with or without an ac signal. The offset current source is also controlled by a dc analog voltage from the D/A converter. The dc offset correction current source is also controlled by the D/A converter. The offset correction voltage is calculated from the results of the AMPTD CAL routine (see Paragraph 8-78).

8-76. Output Amplifier (Service Group K).

8-77. The Output Amplifier is an inverting operational amplifier that is designed for wide frequency response and low distortion. Its output stage is protected against excessive current by a 0.125 A fuse and against excessive voltage by diodes connected to the + and - 15 V supplies. Output resistance is 50 ohms.

8-78. Level Comparator and AMPTD CAL. During the amplitude calibration process (AMPTD CAL), the Level Comparator is used to determine the offset and signal amplitude errors of the 3325 output. To do this, the processor sets the signal amplitude to zero and varies the voltage of the "Level" input to the comparator to determine the dc offset in the amplifier output. The processor then sets the signal amplitude to 8 Vpp (with full attenuation) and proceeds to determine both the positive and negative peak voltages in a similar manner. From this information the processor computes the straight-line equations for the dc offset versus programmed amplitude and for the output amplitude versus programmed amplitude. Calibration FAIL codes 021 through 025 occur if the signal could not be adequately measured. The calibration constants then are reset to default values. Calibration FAIL codes 026 through 029 occur if the signal is successfully measured, but the processor determined that the calibration values were outside of recommended limits. In this case, the calibration values are left untouched.

8-79. The Level Comparator is also used to reset both the positive and negative-going ramps for frequencies of 100 Hz and higher. The "Level" voltage is set by the processor to the peak ramp voltage programmed. When the ramp and "Level" voltages are equal, a Ramp Reset pulse is generated by a one-shot and used to toggle a Ramp Reset flip-flop (see schematic in Service Group J). The ramp is then reset as explained in Paragraph 8-69.If the "Level" voltage is set incorrectly, the digital phase detector causes the ramp to be reset, and the Functional Integrity Flag to the processor to be high (see Paragraph 8-72). The processor then adjusts the "Level" voltage until the Level Comparator output resets the Function Integrity Flag, indicating that the ramp is being reset by the Level Comparator. This ramp "loop level" process is disabled when the frequency is being swept or modulation is enabled.

8-80. Sync Comparator and Driver. The amplifier output waveform is one input to the Sync Comparator and the other input is the DC Offset voltage level. If no dc offset has been programmed, the DC Offset voltage is zero and the comparator output changes at zero volts. This results in a Sync square wave whose transition occurs at zero volts crossing of the output signal. It follows, then, that the Sync signal transition occurs whenever the output signal crosses the DC Offset voltage, when an offset has been programmed. The Sync signal then is passed through buffer circuits to the front panel. The Sync signal is also passed through the FAST™ Sync Converter to the rear panel.

8-81. FAST Sync Converter. The FAST Sync Converter circuit on the Power Supply assembly combines the 19 to 60 MHz auxiliary signal generated on the A3 assembly with the 0 to 21 MHz sync signal generated on the A14 assembly. Only one of these inputs are active. The exclusive-or gating allows the active signal to pass through to the FAST Sync Output. A 0.25A fuse protects the FAST Sync circuitry from excessive current.

8-82. Q810 and Q820 act as amplifier and level shifter for the ac coupled 0.6 Vpp auxiliary signal. The resulting TTL signal is sent to U832 where it is gated with the TTL sync signal from the output amplifier. U830 is a 30Ω totem pole line driver capable of driving a standard 50Ω cable. The fast rise times normally require precise terminations, but the RC filter at the output slows the edges just enough to prevent undesirable reflections (e.g., ringing and double triggering) with open circuit terminations. Placing a 50Ω load on the output further improves reflection problems, but it decreases the signal amplitude to a level that may be just below valid TTL levels.

8-83. Attenuator (Service Group L).

8-84. Relay Drivers. Refer to the schematic diagram in Service Group L. Relay selection data is provided by the lines labeled K0 through K7 and is stored in the D flip-flops of A14U49. This information is obtained from the Machine Data Bus through A14U29 (see Service Group I). Seven of the relay driver circuits are contained in one integrated circuit package, and the eighth is a discrete transistor circuit. Current through the relay coils is limited by the Q77, Q78 circuit. Because latching relays are used, continuous current is not required. Therefore, after a relay has been switched, the driver can be turned off by the K0-K7 information. The D flip-flops are clocked at the proper time by a signal that is also decoded in A14U27 from the Machine Bus data.

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8-85. Attenuators Relays and Pads. Relay K1, K2, and K3 control the output signals attenuation. Table 8-1 shows the voltage ranges, both with and without dc offset and the relays and attenuation factors involved. The output relay, K4, switches the output to the front or rear panel in a standard instrument and switches the High Voltage amplifier in or out in Option 002 instruments.

Table 8-1. Attenuation and Voltage Ranges.

Range	Attenuation Factor	Attenuator Relay In	Amplitude (Peak-to-Peak, 50 Ω)		Maximum Offset (+ or −)	Minimum Offset (+ or −)	DC Only (+ or −)
			AC Only (No Offset)	AC (With Offset)			
1	1	None	10.00 V to 3.000 V	9.998 V to 1.000 V	0.001 V to 4.500 V	1.000 mV	4.500 V to 1.500 V
2	3	K3	2.999 V to 1.000 V	999.9 mV to 333.4 mV	1.166 V to 1.499 V	0.100 mV	1.499 V to 0.500 V
3	10	K2	999.9 mV to 300.0 mV	333.3 mV to 100.0 mV	333.3 mV to 450.0 mV	0.100 mV	499.9 mV to 150.0 mV
4	30	K2, K3	299.9 mV to 100.0 mV	99.99 mV to 33.34 mV	116.6 mV to 149.9 mV	0.010 mV	149.9 mV to 50.00 mV
5	100	K1	99.99 mV to 30.00 mV	33.33 mV to 10.00 mV	33.33 mV to 45.00 mV	0.010 mV	49.99 mV to 15.00 mV
6	300	K1, K3	29.99 mV to 10.00 mV	9.999 mV to 3.334 mV	11.66 mV to 14.99 mV	0.001 mV	14.99 mV to 5.000 mV
7	1000	K1, K2	9.999 mV to 3.000 mV	3.333 mV to 1.000 mV	3.333 mV to 4.500 mV	0.001 mV	4.999 mV to 1.500 mV
8	3000	K1,K2,K3	2.999 mV to 1.000 mV				1.499 mV to 0.001 mV

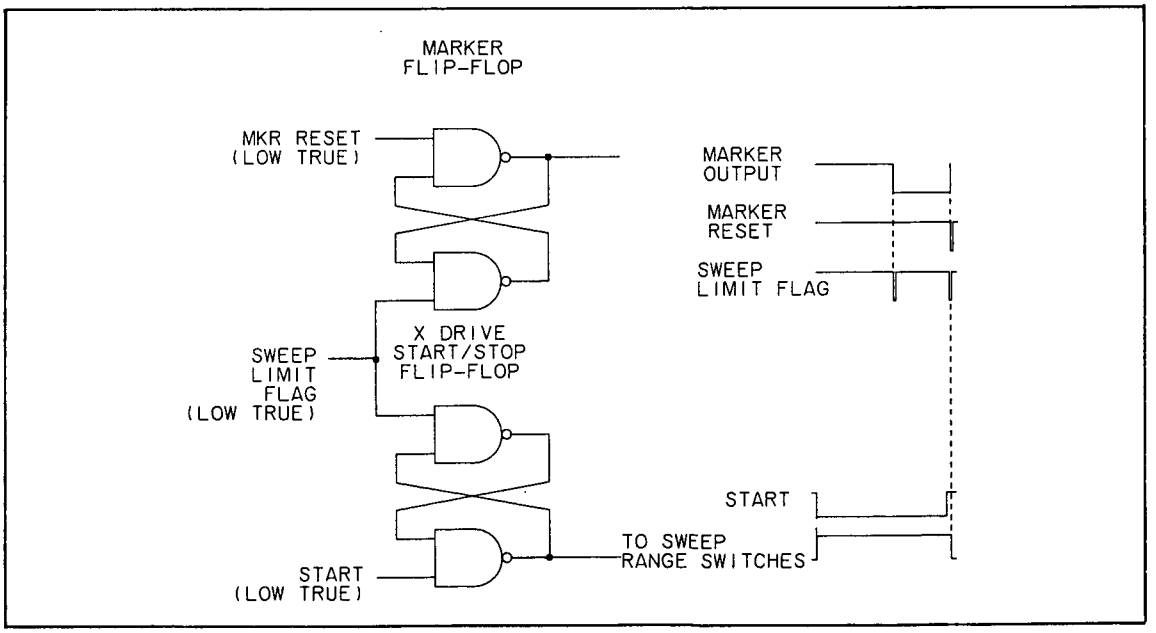


Figure 8-21. Marker and X Drive Start-Stop Flip-Flops.

8-86. Crystal Oven Option 001 (Service Group M).

8-87. AC power for the Crystal Oven is supplied by a separate winding on the instrument power transformer. Consequently, power is supplied to this assembly at any time ac power is applied to the instrument. A +15 V regulator provides dc power to the Crystal Oven. The oven output frequency is 10 MHz. It is capacitively coupled to the rear panel output connector.

8-88. High Voltage Output Option 002 (Service Group M).

8-89. The High Voltage Output Amplifier is non-inverting and has a gain of two. It is designed for operation over a bandwidth of 0 to 1 MHz. The output is current-protected by a 0.25 A fuse, and voltage-protected by diodes to the + and - 30 V supplies. Output resistance is essentially zero. Plus and minus 30 V regulators which supply power for this amplifier are a part of the option. Input power for these supplies is provided from a separate winding on the instrument power transformer; consequently, these supplies are on at any time ac power is connected to the instrument.

8-90. Sweep Drive Circuits (Service Group N).

8-91. The Sweep Drive Circuits provide three output signals that can be used in oscilloscope, plotter, and similar applications: Z Blank, Marker, and X Drive.

8-92. Z Blank. The Z Blank output voltage levels are TTL compatible. This signal goes low at the start of a linear or log single sweep, high at the end of the sweep, and remains high until the start of another sweep. For continuous sweep, Z Blank is low during sweep up and high during sweep down. The Z Blank output circuit is capable of sinking current through a relay or other device. The maximum ratings are:

Maximum current sink: 200 mA, fused at .25 A
Allowable voltage range: 0 V to +45 V dc
Maximum power (voltage at output x current): 1 W

8-93. Marker Output. A Marker output pulse occurs only during linear sweep up, either single or continuous sweep. The NAND gate flip-flop that produces this output is shown in Figure 8-21. The output is high at the start of a sweep up, then the Sweep Limit Flag input goes low at the Marker frequency, changing the flip-flop output to low. Immediately following a sweep up, the Marker Reset input goes low, resetting the flip-flop output to high.

8-94. X Drive. The output of the X Drive Start/Stop flip-flop (Figure 8-22) is set high by the low true Start signal and is returned to low by the Sweep Limit Flag pulse that occurs at the end of the sweep. The Start signal remains low until just before the end of sweep to prevent the Sweep Limit Flag pulse that sets the Marker flip-flop from also changing the X Drive flip-flop. The marker frequency and stop frequency points must be separated by approximately 400 microseconds to allow time

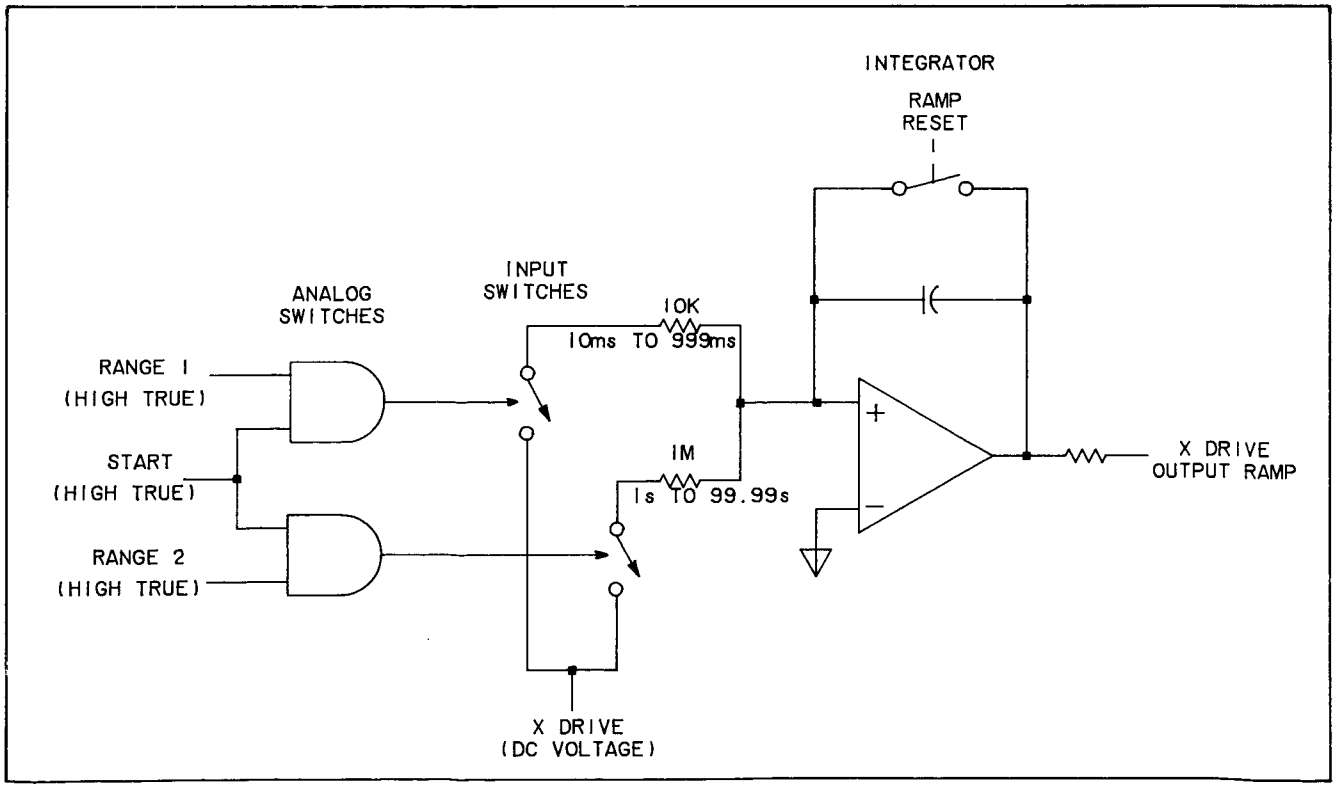


Figure 8-22. X Drive Ramp Output.

between the two Sweep Limit Flags for the control circuits and Fractional N IC to return the Start signal to high and process the information for the stop frequency.

8-95. The high output from the Start/Stop flip-flop is used to turn on one of two analog switches, depending upon which Range signal is high. Range 1 is high for sweep times of 0.01 second to 0.999 second, and Range 2 is high for times of 1 second to 99.99 seconds. As illustrated in Figure 8-22, each analog switch turns on a switch for the duration of the sweep, providing current to an integrator whose output is the X Drive ramp. The value of the current to the integrator depends upon the X Drive analog voltage and the resistance in the integrator input circuit. The resistances are fixed at 10 kΩ for Range 1 and 1 MΩ for Range 2. The value of the X Drive voltage is supplied from the Digital-to-Analog Converter (DAC) and Sample/Hold circuits (see Paragraph 8-57) and is calculated by the control circuits to provide the proper current to increase the X Drive Output Ramp from 0V to +10V during the sweep time selected.

8-96. Following a single sweep, the X Drive ramp remains essentially at 10V until reset prior to the start of another sweep. (This voltage will drift downward less than 10 mV/sec.) During continuous sweep, the ramp is reset at the start of sweep down. The reset switch is a FET connected across the integrator capacitor. The Ramp Reset pulse is initiated at the proper time by the control circuits.

8-97. Modulation Source Circuits (Service Group N)

8-98. The modulation source signal is generated by an 8-bit Digital-to-Analog Converter (DAC) from a waveform stored in the Modulation Waveform RAM. Figure 8-23 is a block diagram of these circuits.

8-99. Address Counter: U203, U204, and U206 form a 12-bit down counter that sequences through the addresses, and thus through the waveform stored in RAM U207. Each MODCLK clock cycle causes this counter to decrement. When the counter reaches 0, the /ZERO signal causes the counter to be re-loaded with the address stored in the Start Address Latches, U201 and U202. The Start Address Latch value determines the length of the waveform.

8-100. Digital-to-Analog Converters: DAC U209 converts the 8-bit waveform data into an analog current that is converted to a voltage by operational amplifiers U217A and U217B. U208 is a multiplying DAC that controls the amplitude. It multiplies the waveform by the amplitude value that U212 latched on to.

8-101. Loading the Waveform into RAM: The processor first activates MODLOAD, then writes the waveform into RAM. The processor address goes directly through the Start Address Latch and the RAM address counter in this mode. The highest address must be written last to initialize the Start Address Latch.

8-102. Modulation Source Frequency: Since the MODCLK signal is generated by dividing the processor clock by an integer, it can create only a limited set of frequencies (unlike the Fractional-N circuits on the A21 assembly). To overcome this limitation when sine waves are selected, the waveform RAM is loaded with more than 1 cycle of the waveform. For example, since multiples of 1 kHz are not available, 1 kHz sine waves are created by writing 10 cycles of a sine wave into 3072 points of the RAM, and clocking the system at 307200 Hz, which is available.

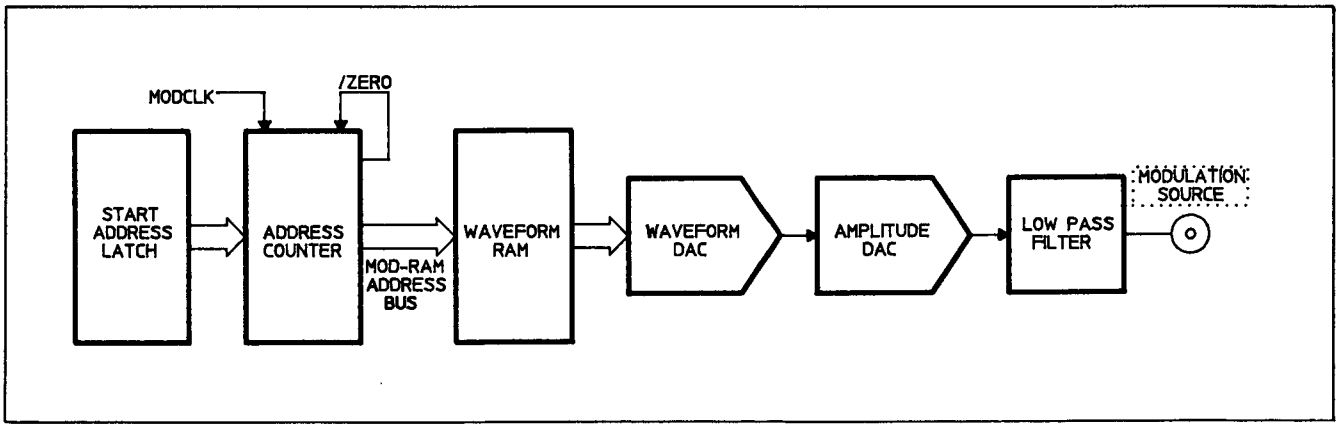


Figure 8-23. Modulation Source Block Diagram.

8-103. Power Supplies (Service Group O).

8-104. All three regulators, +5V, +15 and –15V (shown in the schematic diagram is Service Group O), are voltage and current controlled. Each regulator has a voltage sense connection. If the voltage at the load is too low, for example, this sense voltage feedback causes the regulator to adjust its output to the correct voltage. If the output current increases excessively (because of a short circuit, for example) the voltage drop across the current sensing resistance causes the active device in the current sensing circuit to limit the current through the series pass regulator.

8-105. When the front panel POWER switch is in the STANDBY (⏻) position, the three main power supply regulators are disabled. Power to the FAST Sync converter and Interface circuits is also disabled. However, power is still applied to the Oven Assembly (Option 001) and the High Voltage Output Amplifier (Option 002). These circuits have their own regulators, which are active at any time ac power is connected to the instrument.

8-106. When the POWER switch is in the STANDBY (⏻) position, as shown in the simplified schematic of Figure 8-24, a positive voltage is applied through the relay coil, K641, to the emitter of Q390. This biases Q390 into conduction. The current is limited by resistors R650, R390, and R391 so that the relay is not activated. Q301 is biased on by the current through Q390 to the point where it behaves in the same manner as it would if there was excessive current through the sensing resistor, R300. This causes the series pass regulator, Q300, to be turned off, disabling the –15V regulator. Because the +15V and –15V regulators are referenced to the –15V supply, they are also disabled.

8-107. When the POWER switch is set to ON (|), the emitter of Q390 is grounded which turns it off. Consequently, the –15V supply is not disabled. Also when the POWER switch is set to ON (|), relay K641 is activated which turns on the fan.

8-108. An over-voltage protection circuit in the unregulated +5V supply prevents the voltage from becoming high enough to damage the supply circuits. This circuit consists of an SCR (CR600) that is triggered if voltage across R601 becomes too great. (Refer to the Power Supply schematic, Service Group O.) When the SCR is triggered, it pulls current through the coil of the Relay Circuit Breaker (CB1) which disconnects the line voltage from the power supply. The Over Voltage Reset button on the rear panel must be pressed when this happens. Severe over voltages may cause the fuse to open as well.

8-109. The only voltage adjustment is R352 in the –15V regulator. This control also adjusts the +5V and +15V outputs because they are referenced to the –15V supply.

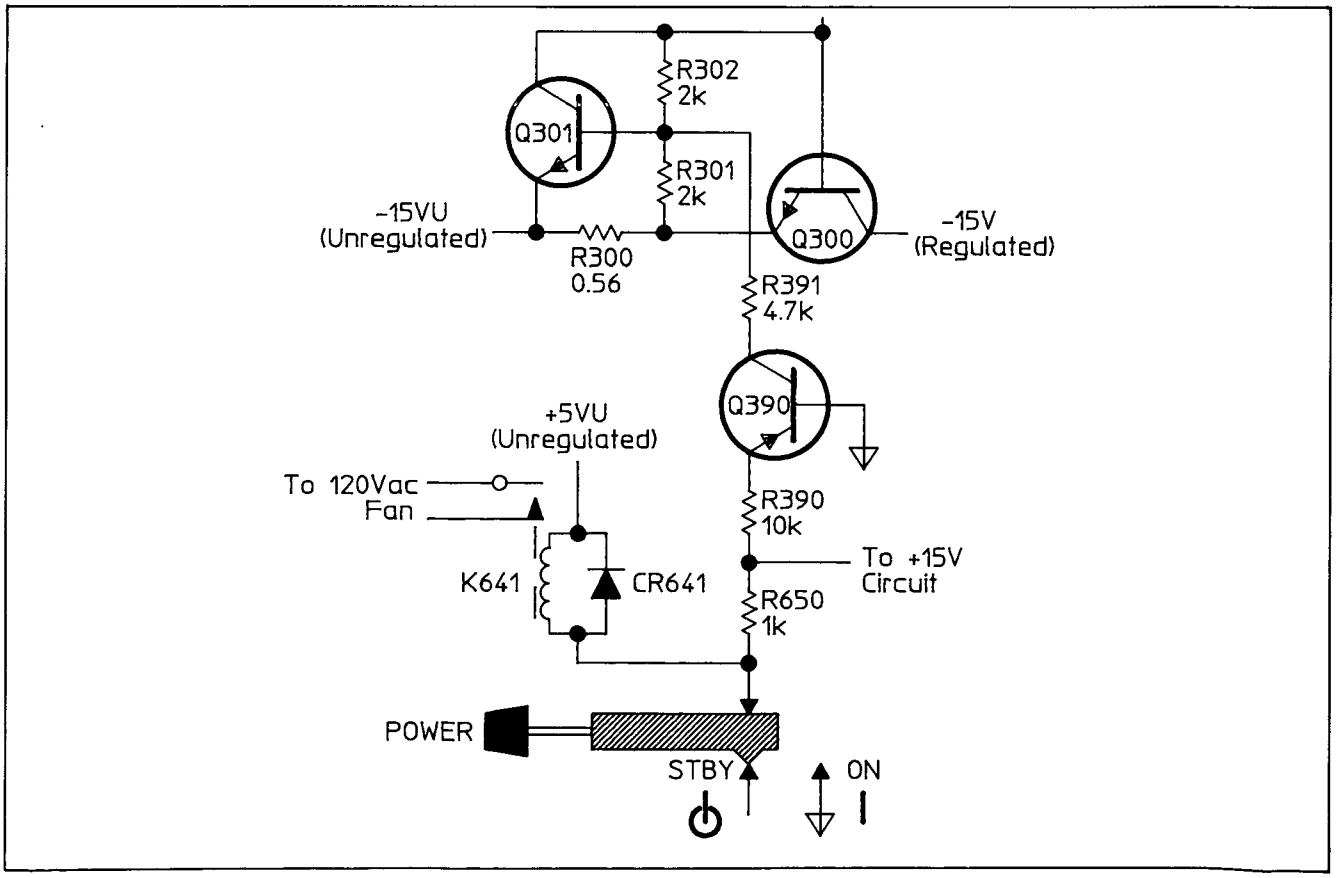


Figure 8-24. Power Supply Standby/On Circuit.

8-110. SINE AMPLITUDE CONTROL PATH.

8-111. Amplitude Control Circuitry.

8-112. The control of sine output amplitude involves a large amount of circuitry. The circuitry used is shown in Figure 8-25. Each block in this figure indicates the circuit board and schematic appropriate to that function. The process begins with the processor loading a number into the preset counters. For the length of time that it takes for these counters to count to zero, a current source is on and is charging up an integrator in the DAC. When the current source turns off, the integrator voltage is sampled and held. This D.C. voltage goes through a gain stage and a multiplier chip and establishes the bias on the 30MHz switch. This controls the level of the 30MHz reference signal to the mixer. From the mixer, a 0-20MHz signal is supplied to the function circuits, the output amplifier, the attenuator, and on to the instrument output. Through all these stages the signal's amplitude is controlled by the D.C. voltage to the 30MHz switch.

8-113. As seen in Figure 8-25, there exists a feedback path through the processor. Using a peak detector, the processor is able to sample the D.C. offsets and amplitude of the signal at the output of the Output Amplifier and compensate for errors by loading adjusted numbers into the Preset Counters.

8-114. Auto Calibration Disable (ACD).

8-115. When servicing the amplitude control path, it is imperative that the feedback path be eliminated before *troubleshooting begins.* This is performed by tying the ACD test point (on A14) to ground. This breaks the loop by preventing the processor from performing subsequent Auto Calibrations. *After tying ACD to ground, cycle power off, then on,* to erase from RAM all previous Auto Cal information.

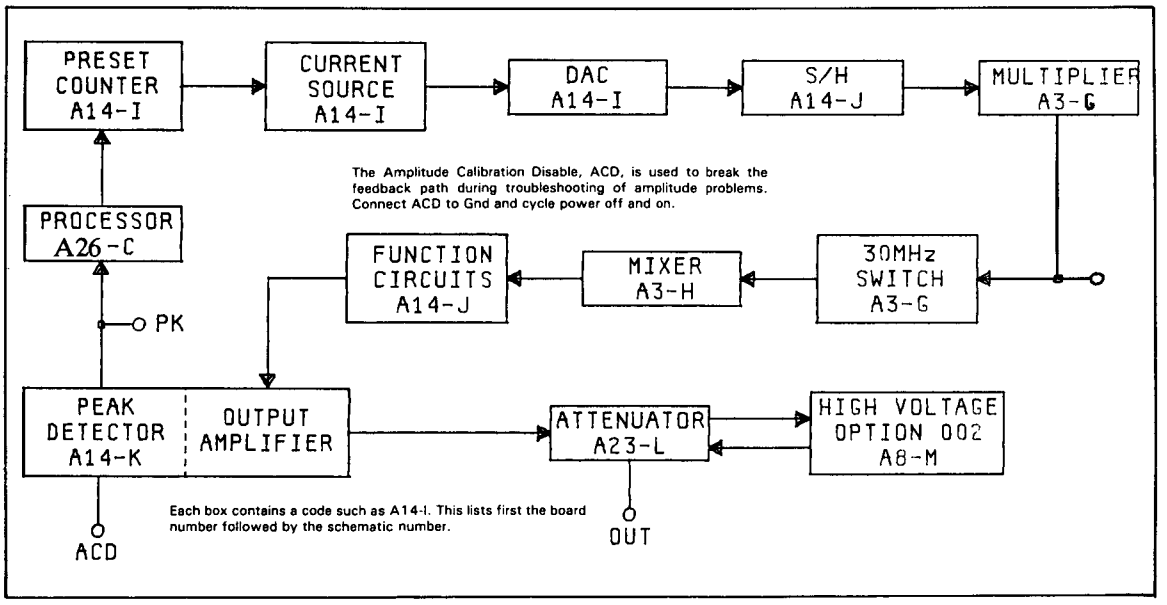


Figure 8-25. Sine Amplitude Control Path.

8-116. SERVICING INFORMATION.

8-117. Power Line Voltage Selection.

8-118. The line voltage selected for the HP 3325B is indicated on the line voltage selector. Instructions for setting the line voltage and changing the fuse are contained in the *HP 3325B Installation Manual.*

8-119. Fan Filter.

8-120. The fan filter must be inspected frequently and cleaned or replaced as necessary to permit the free flow of air through the instrument. To clean the fan filter, remove the four nuts that secure the filter retainer, remove the filter, flush with soapy water, rinse clean , and air dry.

8-121. Adapter Cable.

8-122. An adapter cable may be made as shown in Figure 8-26 that will aid in adjusting and troubleshooting the instrument. This cable has a phono plug at one end to connect to the phono jacks used as signal connectors on the printed circuit board. The BNC connector at the other end connects to the input of an oscilloscope or other test equipment.

8-123. TROUBLESHOOTING INFORMATION.

8-124. Service information is organized into service groups, which include schematic diagrams, block diagrams and troubleshooting information for specific areas of the instrument. Paragraph 8-2 contains an index of the circuits and the service groups in which they can be found.

8-125. Test Equipment Required.

8-126. Table 8-2 lists the test equipment needed to troubleshoot the HP 3325B. Any equipment that meets or exceeds the critical specifications may be substituted for the recommended model.

8-127. Adjustments Required After Repair.

8-128. Following repair of some circuits, certain adjustment procedures must be performed to assure proper operation of the instrument. These adjustments are shown in Table 8-3.

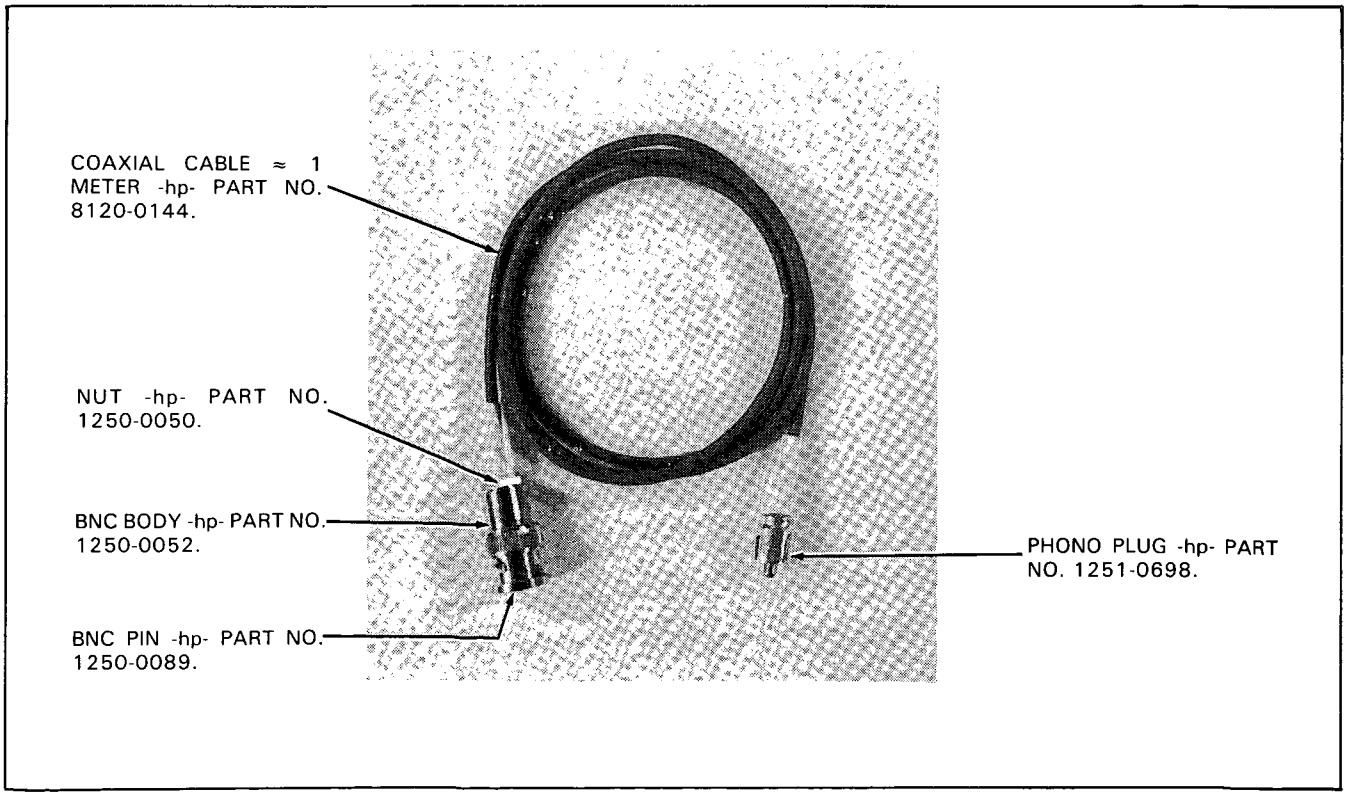


Figure 8-26. Adapter Cable.

Table 8-2. Test Equipment for Troubleshooting.

Instrument	Critical Specifications	Recommended Model	Use
Signature Analyzer	Signature: 4-digit hexadecimal Characters: 0 thru 9,A,C,F,H,P,U Threshold: Logic 1: +2.2 V Logic 0: +0.5 V Clock Frequency: ≥ 1.5 MHz	HP 5004A/5006A	Logic Circuit Troubleshooting
Pulse Generator	Pulse Rate: 500 kHz Pulse Width: ≤ 1 μs DC Offset: 1 V	HP 3312A	Logic Circuit Troubleshooting
Digital Multimeter 4 Digit	DC Function Ranges: 0.1 to 100V Accuracy: ±0.05% AC Function Ranges: .1 to 100 V Accuracy: ±0.5% Ohmmeter Ranges: 100 Ω to 1 MΩ Accuracy: ± 1%	HP 3455A/3478A	General Troubleshooting
Analog Oscilloscope 2 channel	Vertical Bandwidth: dc to 100 MHz Deflection: 0.01V to 5 V/div Horizontal Main Sweep: 50 ns to 0.5 s/div Delayed Sweep: 50 ns to 20 ms/div	HP 1740A/TEK 2245	General Troubleshooting
Electronic Counter	Frequency Measurement: to 20 MHz Accuracy: ± 2 counts Resolution: 8 digits	HP 5328A/5328B	÷ N Counter Troubleshooting
Oscilloscope Probe	Division Ratio: 10 to 1 Impedance: 1 MΩ, 12 pF	HP 10041A/10040A	General Troubleshooting
50-ohm Thruput Termination	Accuracy: ±0.2% Power Rating: 1W	HP 11048C	General Troubleshooting

8-129. Orientation of Components.

8-130. A square pad or outline is used on the printed circuit board to aid in orientation of certain components for replacement and in identification of connections.

Component	Square Pad Identifies
Integrated Circuit	Pin 1
Transistor	Emitter
FET Transistor	Source
Diode	Cathode
Electrolytic Capacitor	Positive Connection

8-131. Mnemonic Dictionary.

8-132. Most of the logic and data signals in the HP 3325B are identified on the schematic diagrams by a mnemonic, which is essentially an abbreviation of the signal name. Table 8-4 is a dictionary of the mnemonics used for the HP 3325B. All mnemonics are active high unless preceded by a / (slash) which indicates active low. Some schematics may use mnemonics that begin with **L** or **H** to designate active low or active high. Therefore **/WFS** is equivalent to **LWFS**.

8-133. Basic Troubleshooting Procedures.

8-134. Make sure all cables and connectors are firmly seated and that the ribbon cables from A26 to A21, A3, and A14 are properly aligned in their connectors. Look for burned or loose components. Also make sure the microcircuit packages that are mounted in sockets are firmly seated.

8-135. The flowchart of Figure 8-27 may be used to help isolate the trouble. Some symptoms that are identifiable from the display, outputs, or response to inputs or entries are given in Table 8-5, along with suggested areas to begin troubleshooting.

8-136. Primitive Power On Tests.

8-137. At power-on, the processor runs low-level self tests. Any error found during these tests are indicated by flashing LEDs on the Control assembly.

8-138. If the instrument did not respond normally at power-on, remove the top cover and watch LEDs CR141 through CR144 on the Control assembly as the POWER switch is set to the ON (|) position. As the tests are running, the LEDs sequence through the test codes. When a failure occurs, the LEDs blink OFF and ON ten times with the error code. Use Table 8-6 to interpret the error message.

8-139. Front Panel Special Functions.

8-140. From the front panel, the HP 3325B can perform self tests, display information, and set instrument states. These special functions are accessed by pressing **Shift, Deg, Self Test** followed by two digits. The self tests may isolate a problem to a circuit. The displayed information includes calibration values, installed options, switch settings, revision codes, elapsed time on, and instrument serial number. Adjustment and calibration modes can be enabled, and calibration modes and values can be cleared. Table 8-7 lists the front panel special functions.

8-141. Special Functions 60 through 66.

8-142. Special Functions 60 through 66 display the calibration values (correction factors) that control output level and dc offset. These constants are used to compute the DAC AMPL and OS1 test point values. These values are sent to the D/A converter to obtain the correct signal output. When you select one of these special functions, numbers appear in the format for the equation of a straight line, $y = A + Bx$ (A is the offset and B is the slope). On the display, the number for A appears on the left side and the number for B appears on the right side.

8-143. Initiating these special functions may help identify impending failures. These calibration constants are useful when used in conjunction with fail codes 021 to 029. If the instrument displays any of these fail codes, either a bad adjustment was made or a failure occurred in the functionally related circuitry.

8-144. Prior to initiating Special Function 60 to 66, the function being measured must be internally calibrated to obtain valid numbers. To internally calibrate a function you can simply enable that function, or you can run the internal self tests (Shift, Self Test) to calibrate all functions.

8-145. If fail codes 021 through 025 occur, the HP 3325B could not finish its calibration and the calibration constants were reset to their default values. In other words, the constants obtained by running Special Functions 60 to 66 will be at their default values (see Tables 8-8 and 8-9).

8-146. If fail codes 026 through 029 occur, the calibration constants were not reset to their default values. However, consider it a warning that the instrument may not meet all of its specifications or may have a marginal failure. Use Table 8-8 for the enabled function if either FAIL 026 or FAIL 027 occurs. Use Table 8-9 for the enabled function if FAIL 028 or 029 occurs.

Table 8-3. Adjustment Required After Repair.

Circuit Repaired	Service Group	Adjustments Required	Para. No.
Keyboard	A	None	
HP-IB/RS-232	B	None	
Control	C	None	
Voltage Controlled Oscillator	D	Voltage Controlled Oscillator	5-9
VCO Buffer	D	None	
÷N.F.Counter	E	None	
Fractional N Analog	F	Analog Phase Interpolation	5-10
30 MHz Oscillator	G	30 MHz Reference Oscillator	5-11
Sine Amplitude &	G	Amplitude Modulator	5-13
Amplitude Modulation		Sine Wave Gain-Offset	5-14
Mixer	H	Mixer Spurious Signal	5-20
D/A Converter & Sample/Hold	I	D/A Converter Gain and Offset	5-8
Function	J	Square wave Gain-Offset	5-14
		Ramp Stability	5-18
Ramp Gating	J	Ramp Stability	5-18
Output Amplifier	K	Amplifier Bias	5-17
		Amplitude Flatness	5-19
High Stability Reference	M	High Stability Frequency Reference	5-12
Sweep Range	N	X Drive	5-16
X Drive Integrator	N	X Drive	5-16
Power Supply	O	Power Supply	5-7

8-147. Performance Test Troubleshooting Guide.

8-148. If a performance test fails, an adjustment and/or circuit repair may be necessary to correct the problem. Some of the possible causes of failure are listed in Table 8-10. This is not an exhaustive list, it is only a guide that may assist you in isolating the problem to either a Service Group or an assembly. The table assumes there are no error codes occurring and that only a performance specification is out of range.

8-149. Logic Troubleshooting by Signature Analysis.

8-150. Because of the increased complexity of the logic circuits used to control many instruments, malfunctions in these circuits may be very difficult to locate. The concept of Signature Analysis is based on the fact that at a particular point in a circuit, the data pulses are predictable under specifically programmed conditions. An instrument such as the HP 5006A Signature Analyzer compresses the data at a given point during a controlled time span (window) and displays the resulting four-character signature. This signature indicates whether the correct data was present at the measurement point, and this information can be used to locate a defective component.

8-151. Signature Analysis does have its limitations. If a component connected to a bus fails, Signature Analysis may not run, or if it does run, all components on that bus may have incorrect signatures. Therefore, if Signature Analysis can not isolate the faulty component, use schematics, signal flow diagrams, and an oscilloscope to troubleshoot.

8-152. Three Signature Analysis (SA) tests are available for troubleshooting the Control assembly and the digital sections of other assemblies.

Kernel SA Test: Checks processor, address bus, and address decoding. Use this test to troubleshoot the Control assembly when the Primitive Power On Tests fail.

SA0 Test: Provides stable signatures for the processor data bus, chip select signals, machine data bus, machine control write signals, HP-IB circuits, function circuits, keyboard and display circuits. The processor, ROM, and address bus must be working for this test to run.

SA1 Test: Checks machine control read signals. The processor, ROM, and address bus must be working for this test to run.

8-153. Before starting a Signature Analysis test, check the Primitive Power On Tests (see Paragraph 8-136). Set up procedures and signatures are located in every Service Group that troubleshoots with Signature Analysis.

Table 8-4. Mnemonic Dictionary.

Mnemonic	Definition
+5VB	Non-volatile RAM Power Supply
+5V1	Isolated HP-IB Power Supply
AB1 through AB23	Processor Address Bus
AS	Address Strobe
ATN	HP-IB Attention
BAUD_CLOCK	Baud Rate *16 Clock
BERR	Bus Error
BTRY_ENABLE	Battery Enable
CE	Chip Enable
CLK.6	0.61440 MHz Clock
CLK2.5	2.45760 MHz Clock
CLK10	9.83040 MHz Clock
CSR	Clock Shift Register on Front Panel
DAV	HP-IB Data Valid
DB0 through DB15	Processor Data Bus
DIO1 through DIO8	HP-IB Data
DTR	RS-232 Data Terminal Ready
EC	External Clock to N.F IC
EEDTACK	Everything Else Data Transfer Acknowledge
EOI	HP-IB End-or-Identify
HPIBCS	HP-IB Chip Select
HPIB_DATA	Serial Data from HP-IB circuits
HPIB_INT	HP-IB Interrupt
IAC	Interrupt Acknowledge Bus Cycle
IFC	HP-IB Interface Clear
INV	Instruction Valid to N.F IC
IRQ	Interrupt Request from MFP to Processor
LDS	Lower Byte Data Strobe
LOAD_CNT	Load Max Count into Mod Source Addr Counter
LREAD	Lower Byte Read Strobe
LWRITE	Lower Byte Write Strobe
MA0 through MA11	Mod Source RAM Address Bus
MAN_RESET	Manual Reset
MD0 through MD7	Machine Data Bus 0-7
MDBS	Machine Data Bus Select
MFPCS	Multi-Function Peripheral Chip Select
MFPDTACK	MFP Data Transfer Acknowledge
MISCCS	Miscellaneous Latch Chip Select
MODAMPCS	Mod Source Amplitude Latch Chip Select
MODCLK	Modulation Source Clock
MODLOAD	Mod Source Load RAM
MODRAMCS	Mod Source RAM Chip Select
NDAC	HP-IB Not Data Accepted
NRFD	HP-IB Not Ready for Data
PMC	Phase Modulation Control
PR/W	Processor Read, not Write
PW/R	Processor Write, not Read
R/W	Read, not Write
RAD	Read Arithmetic Data from N.F IC
RAMCS	RAM Chip Select
REN	HP-IB Remote Enable
RESET	Power-on Reset
RESET_HPIB	HP-IB Reset
RFF	Read Function Flags
RKB	Read Keyboard Data
ROMCS	ROM Chip Select
RPBSW	Read Processor Board Switches
RPSW0 through RPBSW7	Rear Panel Switch Data Bus
RRPSW	Read Rear Panel Switches
RSS	Read Signal Source Data
RX	RS-232 Received data
SD0 through SD7	HP-IB Shifted Data Bus
SHIFT	HP-IB Shift Enable
SHIFTCLK	HP-IB Shift Clock
SHIFTCS	HP-IB Shift Clock Chip Select
SI	RS-232 Serial Data In
SLC	Sweep Limit Control to N.F
SLF	Sweep Limit Flag from N.F
SO	RS-232 Serial Data Out
SRQ	HP-IB Service Request
STBY	Standby
TX	RS-232 Transmitted Data
UDS	Upper Byte Data Strobe
UREAD	Upper Byte Read Strobe
UWRITE	Upper Byte Write Strobe
W/R	Write, not Read
WFD	Write Function Data to A14
WFS	Write Function Select to A14
WKD	Write Keyboard Data
WSS	Write Signal Source Data to A3
ZERO	Mod Source Addr Count = Zero

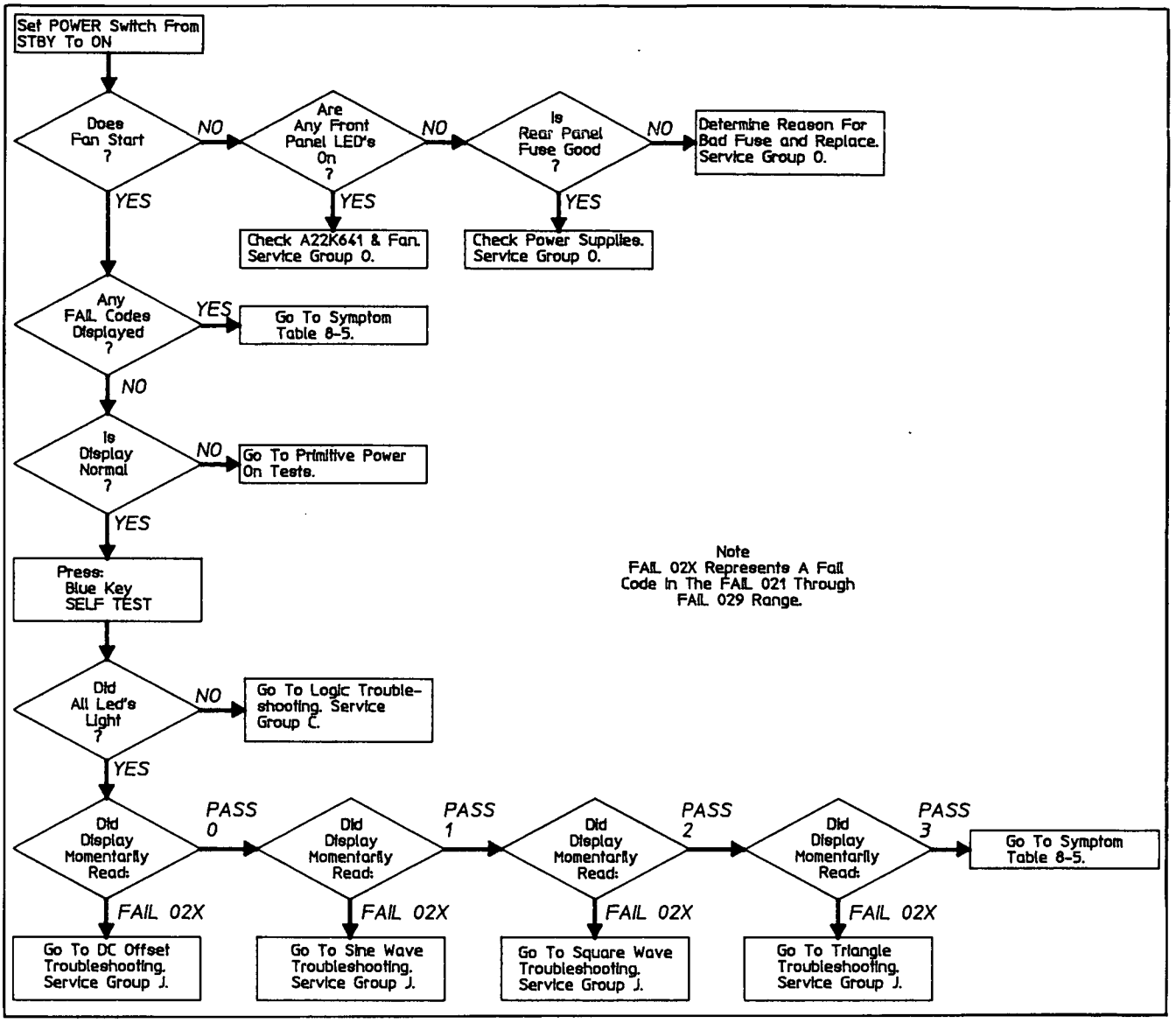


Figure 8-27. Basic Troubleshooting Procedure.

Table 8-5. Trouble Symptoms.

Symptoms	Troubleshooting Procedures	Symptoms	Troubleshooting Procedures
Display or Keyboard switch problems	Service Group A	Display reads FAIL 021 (signal too big during calibration)	Service Group K, J
No AUX output or incorrect frequency (Sine Function 21-60 MHz); front panel output normal.	Service Group D	Display reads FAIL 022 (signal too small during calibration)	Service Group K, J
Amplitude Modulation does not respond properly.	Service Group G	Display reads FAIL 023 (dc offset too positive during calibration)	Service Group K, J
Phase Modulation does not respond properly.	Service Group F	Display reads FAIL 024 (dc offset too negative during calibration)	Service Group K, J
Output amplitude incorrect for all functions.	Service Group L	Display reads FAIL 025 (unstable/noisy calibration)	Service Group K, J
No front panel display or annunciators.	If power supply voltages are correct (see Service Group O) go to Service Group C; if not, troubleshoot power supply, Service Group O.	Display reads FAIL 026 (calibration factor out of range: ac gain offset)	Service Group K, J
		Display reads FAIL 027 (calibration factor out of range: c gain slope)	Service Group K, J
Abnormal display characters (partial characters or all segments stay on), no response to front panel entries.	Service Group C	Display reads FAIL 028 (calibration factor out of range: dc offset)	Service Group K, J
Display appears normal, but no response to front panel entries.	Service Group C	Display reads FAIL 029 (calibration factor out of range: dc slope)	Service Group K, J
Instrument accepts entries but has no signal or sync outputs.	Service Group K	Display reads FAIL 030 (external eference unlocked)	Service Group G
No signal output; sync output correct.	Service Group L	Display reads FAIL 031 (oscillator unlocked, voltage too low)	Service Group D
Will not sweep frequency.	Service Group E	Display reads FAIL 032 (oscillator unlocked, voltage too high)	Service Group D
X Drive, Z Blank, or Marker signals incorrect.	Service Group N	Display reads FAIL 031 or 032 but oscillator circuits check good.	Service Group C SA0 Test
When External Reference or Option 001 is connected to rear panel REF IN, front panel EXT REF annunciator does not light or flashes on and off.	Service Group G	Display reads FAIL 033 (HP-IB isolation circuits test failed self test)	Service Group B
		Display reads FAIL 034 (HP-IB IC failed self test)	Service Group B
Output frequency incorrect.	Service Group G	Display reads FAIL 035 (RS-232 test failed loop-back test)	Service Group B
Control problems, or instrument "locks up" and will not accept entries	Service Group C SA0 or SA1	Display reads FAIL 036 (memory lost; dead battery)	Service Group C
Cannot perform SA0 or SA1	Service Group C Kernel SA Test	Display reads FAIL 037 (unexpected interrupt)	Service Group C
Display reads FAIL 010 (DAC range error)	Service Group K, J	Display reads FAIL 038 (sweep-limit-flag signal failed self test)	Service Group E
Display reads FAIL 011 (bad checksum, low byte of ROM)	Service Group C	Display reads FAIL 039 (Fractional-N IC failed self test)	Service Group E
Display reads FAIL 012 (bad checksum, high byte of ROM)	Service Group C	Display reads FAIL 040 (modulation source failed self test)	Service Group N
Display reads FAIL 013 (machine data bus line stuck low)	Service Group C	Display reads FAIL 041 (function-integrity-flag flip-flop always set)	Service Group J
Display reads FAIL 014 (Keyboard shift register test failed)	Service Group A, C		

Table 8-6. Primitive Power On Test Error Messages.

CR144	CR143	CR142	CR141	Indicates ...
○	○	○	○	All leds are turned on at start of testing.
☼	☼	☼	☼	Unknown problem, unable to test.
●	●	○	●	Running Low-byte and High-byte RAM tests. These tests write to and read from U6 and U7 on the Control assembly.
●	●	☼	●	Low-byte RAM test failed. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U6, U81, Q81, Q2, Q3, and Q4.
●	●	☼	☼	High-byte RAM test failed. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U7.
●	○	●	●	Running long RAM test. This test writes to and reads from all RAM addresses.
●	☼	●	●	Failed long RAM test. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U6 and U7.
●	○	●	○	Running ROM checksum test.
●	☼	●	☼	Low-byte ROM failed checksum. After blinking the LEDs, testing continues with the next test. On the Control assembly, check U2.
●	☼	☼	●	High-byte ROM failed checksum. After blinking the LEDs, testing continues with the next test. On the Control assembly, check U3.
●	○	○	○	Running MFP IC test. This test writes to and reads from U10 on the Control assembly.
●	☼	☼	☼	MFP IC test failed because incorrect data was received from U10. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U10.
☼	●	●	●	MFP IC test failed because no response was received from U10. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U10.
○	●	●	○	Running machine data bus test. This test does a read from the machine data bus.
☼	●	●	☼	Machine data bus test failed because a line was stuck low. After blinking the LEDs, testing continues with the next test. Set the power switch to STBY and unplug J1, J2, J3, J4, and J10 on the Control assembly. Ground the STBY test point to re-run the test. If the test fails, check U41 on the Control assembly. If the test passes, plug in one connector at a time and re-run the test to determine the assembly causing this test to fail.
○	●	○	●	Running Keyboard test. This test writes to and reads from the Keyboard assembly.
☼	●	☼	●	Keyboard test failed. After blinking the LEDs, testing continues with the next test. Set the power switch to STBY and unplug J10 on the Control assembly. Check the A15 assembly.
○	●	○	○	Running digital signature analysis test. On the Control assembly, return SA0 and SA1 on switch S100 to the NORMAL position and cycle power.
○	○	●	○	Special boot mode. On the Control assembly, return SPCO on switch S100 to the NORMAL position and cycle power.
○	○	○	●	Primitive power-on tests complete, initializing software.
●	●	●	●	Normal operation.

○=ON ●=OFF ☼=BLINKING

Table 8-7. Front Panel Special Functions.

To select a Special Function, press **Shift**, **Deg**, **Self Test** followed by two digits corresponding to the Special Function.

SPECIAL FUNCTION	DESCRIPTION
00	Self test. Same as pressing Shift, Self Test. Turns all front panel LEDs on, then off, then does amplitude calibrations on Sine, Square, and Triangle waveforms.
11	Power-on self test. Re-runs the power-on self tests. Same as running SPECIAL 12, 13, and 14. A successful test will not display any PASS indicators. Power must be cycled after running this test to restore HP-IB operation.
12	HP-IB circuits test. Writes data through the serial isolation path, then reads it back. Tests for stuck /HPIB_INT signal. Power must be cycled after running this test to restore HP-IB operation.
13	Fractional-N integrated circuit test. Writes data to A21 U19, executes a sweep, and reads data back. Tests for stuck SLC signal. Power must be cycled after running this test to restore operation.
14	Modulation Source test. Writes data to the modulation source waveform RAM, then reads it back. Modulation source function and amplitude must be reprogrammed after this test to restore operation.
20	Keyboard test. Lights all front panel LEDs. Pressing any key turns off one LED while the key is pressed. Press **Local** several times to quit.
21	HP-IB connector pins test. Front panel display continuously lists any HP-IB signals that are low. Disconnect all other HP-IB devices, and connect one HP-IB cable before starting this test. Short each pin of the HP-IB connector to pin 24, one at a time, while watching the display. **Pn 1** should appear when pin 1 is connected to pin 24. All pins should respond except pins 10, 12, and 18 through 24. Because the HP-IB is isolated, pins must be shorted to pin 24, not chassis or earth ground. Press **Local** to quit and cycle power to restore HP-IB operation.
22	RS-232 loop-back test. On the A26 Assembly, connect R173 to R175 at the ends nearest connector J100 before running this test. This test transmits several characters and expects to receive them back.
30	Displays (and output to HP-IB or RS232) the software revision code. The revision code is 4 digits, two for the year since 1960 and two for the week.
31	Displays the options installed.
32	Displays the elapsed time on in hours (also see Special Function 98).
34	Displays the rear panel switch setting as a value from 0 to 255. (The switch values are binary. Pin 1 in the up position represents 1.)
35	Displays the Control assembly switch setting as a value from 0 to 255. (The switch values are binary. Pin 1 in the NORMAL position represents 1.)
36	Displays the serial number (see the ZSER command).
50	Clears calibration values.
51	DC adjustment mode. Press local to quit.
52	Amplitude modulation adjustment mode (clears ARB waveform). Press local to quit.
53	Sine wave adjustment mode. Press local to quit.
54	Square wave adjustment mode. Press local to quit.
60	Displays calibration value for dc offset.
61	Displays calibration values for sine wave gain (as A, B in the equation $y = A + Bx$).
62	Displays calibration values for sine wave offset.
63	Displays calibration values for square wave gain.
64	Displays calibration values for square wave offset.
65	Displays calibration values for triangle wave gain.
66	Displays calibration values for triangle wave offset.
85	Restores normal calibration mode (CALM0).
95	Enables calibration mode 1 (CALM1). Calibrates all functions, then inhibits further calibration.
98	Displays **CLEAr Hr?**. The elapsed time counter is reset to 0 only if **Clear** is pressed.

Table 8-8. Typical Values for Amplitude Gain Corrections. (default values are shown in parentheses)

Special Test	Offset(A1)	Slope(B1)
61, Sine Wave	0±80 (0)	0.91±0.08 (0.8)
63, Square Wave	0±80 (0)	0.91±0.08 (0.8)
65, Triangle Wave	0±80 (0)	0.91±0.08 (0.8)

Table 8-9. Typical Values for Residual DC Corrections. (default values are shown in parentheses)

Special Test	Offset(A2)	Slope(B2)
60, DC Only	0±800 (0)	0.00 (0.00)
62, Sine wave	0±800 (0)	0±0.1 (0.00)
64, Square wave	0±800 (0)	-0.05±0.1 (0.00)
66, Triangle wave	0±800 (0)	-0.05±0.1 (0.00)

NOTE

Default values have no dc offset correction and the amplitudes are approximately 5% to 20% below normal. These values are obtained in one of three ways:

1. *By performing an ACAL disable (affects all functions).*
2. *If a FAIL 021-025 occurs for the particular function.*
3. *By turning on the HP 3325B without activating the function of concern.*

Table 8-10. Performance Test Troubleshooting Guide

Performance Test	Possible Cause of Failure
Harmonic Distortion	Suspect A3, A14, or A21.
Spurious Signals:	Check adjustment 5-20. If still bad, refer to Service Group H.
Mixer Spurs	
Fractional N Spurs	Check adjustment 5-10. If still bad, refer to Service Group F.
Integrated Phase Noise	Suspect A21.
AM Envelope Distortion	Check adjustments 5-13 and 5-14. If still bad, refer to Service Group G.
Square Wave Rise Time and Aberrations	Check adjustment 5-17. If still bad, refer to Service Group K.
Ramp Retrace Time	Refer to Service Group J.
Sync Output	Refer to Service Group K.
Square Wave Symmetry	Check adjustment 5-15. If still bad, refer to Service Group J.
Frequency Accuracy	Check adjustment 5-15. If still bad, refer to Service Group G.
Phase Increment Accuracy	Refer to Service Group F.
Phase Modulation Linearity	Refer to Service Groups E and F.
Amplitude Accuracy:	
Sine (< 100 kHz)	Check adjustments 5-13 and 5-14. If still bad, refer to Service Groups G, I, and J. Suspect the DAC (A14), amplitude control (A14), or sine amplitude and AM circuitry (A3).
Sine (> 100 kHz)	Check adjustment 5-17. If still bad, refer to Service Groups H and J. Suspect the 20 MHz LPF (A3) or the sine amplitude filter (A14).
Square, Triangle, Ramps	Check adjustment 5-15. If still bad, refer to Service Group J.
DC Offset Accuracy (DC only)	Check adjustment 5-8. If still bad, refer to Service Groups I, L, and O. Suspect the DAC (A14), attenuator (A23), or power supply (A22).
DC Offset Accuracy with AC Functions: Sine	Refer to Service Group H.
Square, Triangle, Ramps	Refer to Service Group J.
	Note: Having the mixer adjust more than 1/2 turn clockwise from stop can put the sine wave dc offset out of spec. It may be necessary to find the best compromise between the 2:1 spur and the amount of DC offset.
Triangle Linearity	Refer to Service Group J. Suspect the triangle filter circuitry.
X-Drive Linearity	Check adjustment 5-16. If still bad, refer to Service Group N.
Ramp Period Variation	Check adjustment 5-18. If still bad, refer to Service Group J.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3. ∇_E DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

   ∇_I DENOTES ISOLATED (I) OR SIGNAL(S) CIRCUIT GROUND.

   ∇_A DENOTES ANALOG CIRCUIT GROUND.

   ∇_D DENOTES DIGITAL CIRCUIT GROUND.

   ∇_B DENOTES HP-IB AND RS-232 BUS GROUND.

6. DENOTES ASSEMBLY.

7. DENOTES MAIN SIGNAL PATH.

8. DENOTES FEEDBACK PATH.

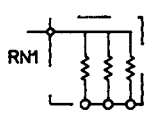
9. DENOTES FRONT PANEL MARKING.

10. DENOTES REAR PANEL MARKING.

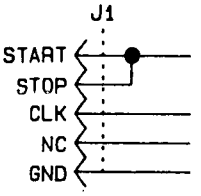
11. DENOTES SCREWDRIVER ADJUST.

12. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

13. ALL RELAYS ARE SHOWN DEENERGIZED.

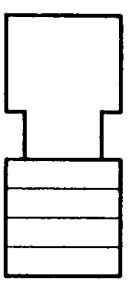
14. 

DENOTES RESISTOR PACK

15. 

DENOTES SIGNATURE ANALYSIS TESTING POINTS

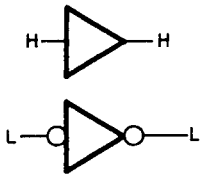
16. CONTROL BLOCK IS USED WHEN AN ARRAY OF RELATED LOGIC ELEMENTS SHARE COMMON CONTROL LINES



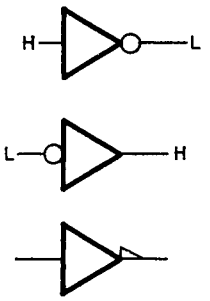
LOGIC ELEMENTS WITH COMMON CONTROL BLOCK

17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 PROBE. THE VOLTAGE LEVELS SHOWN FOR THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ±10% IN MEASUREMENTS SHOULD BE ALLOWED. ALL WAVEFORMS SHOWN WERE AC-COUPLED UNLESS OTHERWISE NOTED. DC VOLTAGE LEVELS OF WAVEFORM TEST POINTS ARE INDICATED SEPARATELY.

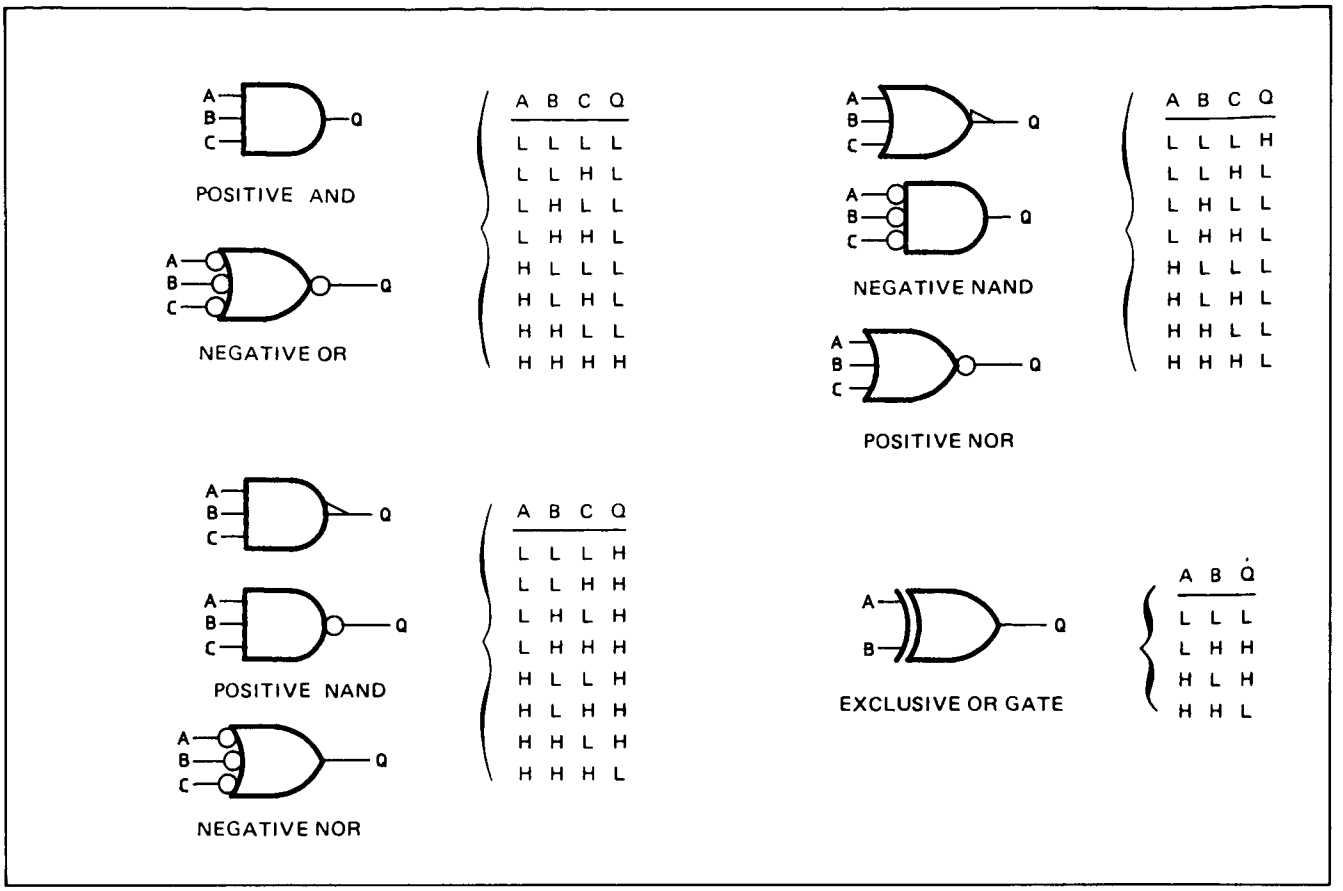
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A DVM. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ±10% SHOULD BE ALLOWED.

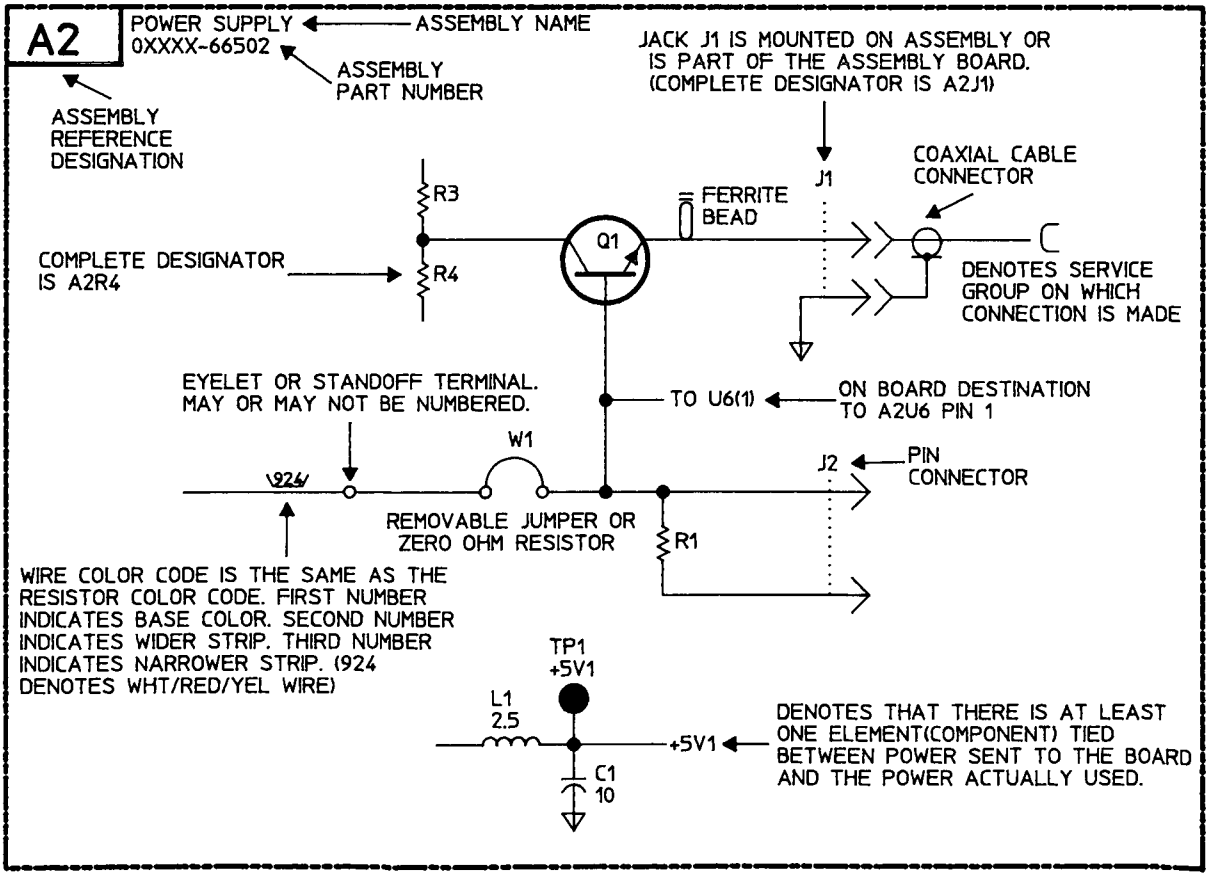


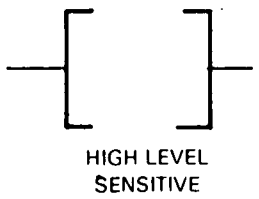
DENOTES BUFFER

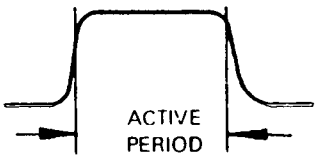


DENOTES INVERTER

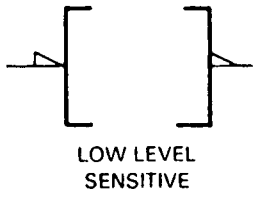

POSITIVE AND
NEGATIVE OR
NEGATIVE NAND
POSITIVE NOR
POSITIVE NAND
NEGATIVE NOR
EXCLUSIVE OR GATE
A B C Q
L L L L
L L H L
L H L L
L H H L
H L L L
H L H L
H H L L
H H H L
A B C Q
L L L H
L L H L
L H L L
L H H L
H L L L
H L H L
H H L L
H H H L
A B C Q
L L L H
L L H H
L H L H
L H H H
H L L H
H L H H
H H L H
H H H L
A B Q
L L L
L H H
H L H
H H L

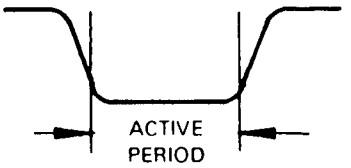

A2
POWER SUPPLY 0XXXX-66502
ASSEMBLY NAME
ASSEMBLY PART NUMBER
ASSEMBLY REFERENCE DESIGNATION
JACK J1 IS MOUNTED ON ASSEMBLY OR IS PART OF THE ASSEMBLY BOARD. (COMPLETE DESIGNATOR IS A2J1)
J1
COAXIAL CABLE CONNECTOR
R3
FERRITE BEAD
Q1
COMPLETE DESIGNATOR IS A2R4
R4
DENOTES SERVICE GROUP ON WHICH CONNECTION IS MADE
EYELET OR STANDOFF TERMINAL. MAY OR MAY NOT BE NUMBERED.
TO U6(1)
ON BOARD DESTINATION TO A2U6 PIN 1
W1
J2
PIN CONNECTOR
\924/
REMOVABLE JUMPER OR ZERO OHM RESISTOR
R1
WIRE COLOR CODE IS THE SAME AS THE RESISTOR COLOR CODE. FIRST NUMBER INDICATES BASE COLOR. SECOND NUMBER INDICATES WIDER STRIP. THIRD NUMBER INDICATES NARROWER STRIP. (924 DENOTES WHT/RED/YEL WIRE)
TP1
+5V1
L1
2.5
+5V1
C1
10
DENOTES THAT THERE IS AT LEAST ONE ELEMENT(COMPONENT) TIED BETWEEN POWER SENT TO THE BOARD AND THE POWER ACTUALLY USED.



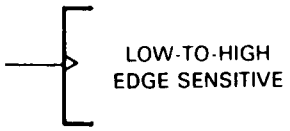


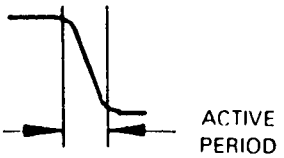
ACTIVE HIGH inputs and outputs - Indicated by the absence of the polarity indicator (▷).



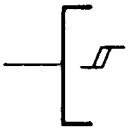


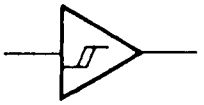
ACTIVE LOW inputs and outputs - Indicated by the presence of the polarity indicator (▷).



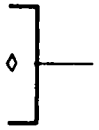


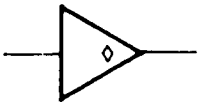
EDGE SENSITIVE (Dynamic) inputs - Indicated by the presence of the dynamic indicator symbol (>).



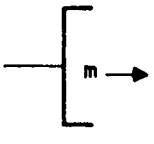


BI-THRESHOLD (Hysteresis) input (⊿) - Input takes on internal high state when external signal exceeds high threshold value. State is maintained until external signal falls below a lower threshold value.

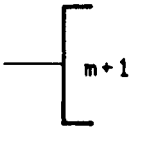




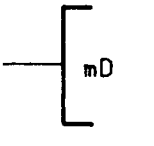
OPEN COLLECTOR output (◊) - Forms a part of a distributed connector.



SHIFT RIGHT (Down) input of register. m may be other qualifiers or dependency notation.



COUNT UP input of a counter. m may be other qualifiers or dependency notation.



DATA input. m may be other qualifiers or dependency notation.

Qualifying Symbols