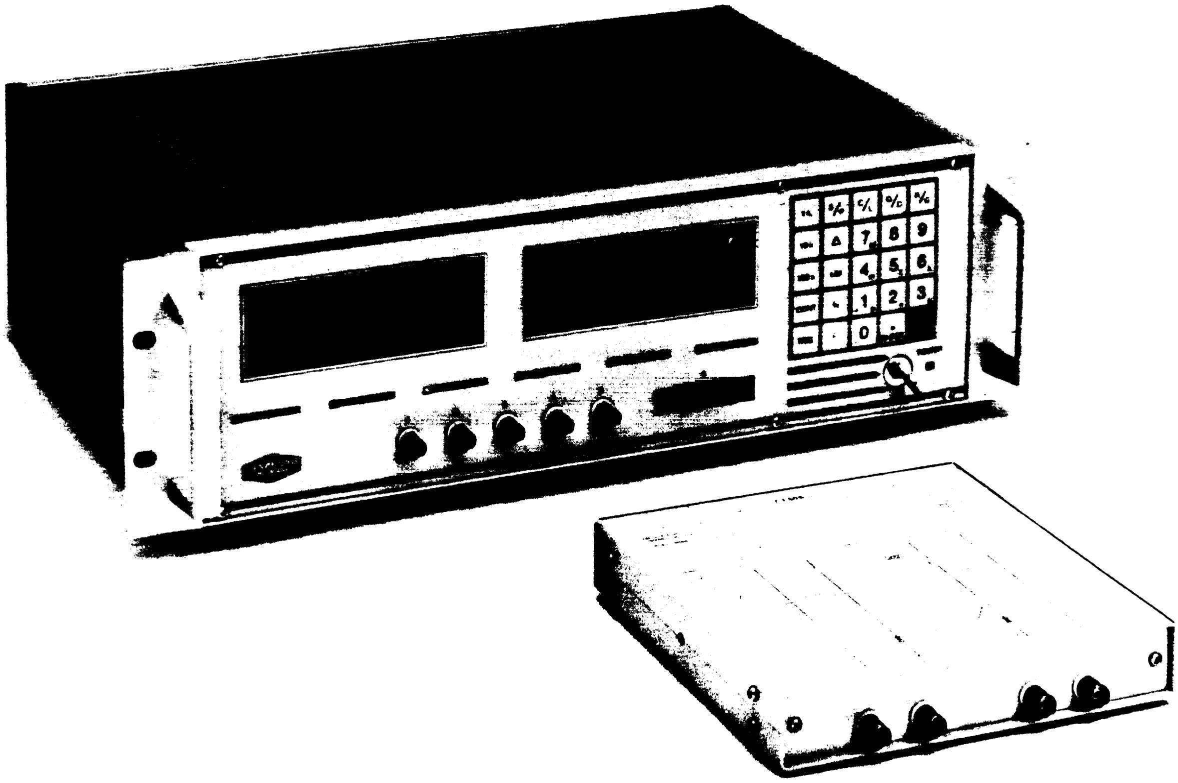
PRELIMINARY

INSTRUCTION MANUAL

DANBRIDGE
DENMARK



CLR TESTERS CT30 & CT30R

1988

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C T 3 0 O P E R A T I O N

CALIBRATION

Before any measurements are made with the CT30, it is necessary to calibrate i.e. Jig-Zero the set up. This will not only compensate for impedances in the jig, but also temperature-induced off-sets in the Bridge-module. Without calibration the measurements can be in error with several %. When capacitors greater than 33 nF are to be measured (at 100 kHz) a short-circuit calibration is also necessary. It is wise to repeat the calibration within the first hour of operation to compensate for warm-up drift.

The calibration code is:

[F] [TRIG] [ENTER].

for both open-circuit and short-circuit calibration.
After "[F] [TRIG]" the CT30 promts "C" - "*", because

[F] [TRIG] [CLR] removes both calibrations.

BASIC FUNCTION

The CT30 is basically an automatic bridge, which selects the most appropiate measuring range and decides the most likely parameter representation of the unknown component on the jig. If f.ex. a (bad) capacitor has a loss-factor a little higher than 1.0 at the selected measuring frequency, it is in fact more of a resistor than a capacitor. Consequently the CT30 will display the R_p (the parallel resistance) value as the primary parameter and the C_p value as the secondary value.

As this automatic function can be inconvenient for automatic sorting purposes, a number of locking modes are available, as will be described in detail later in this manual.
Just as an example, the [F] [8] [ENTER] code will select a capacitance lock, which will make the CT30 always show a capacitance value as the primary parameter.

CONTINUOUS & TRIG MODE

The CT30 does the measurements in two modes: CONTINUOUS and TRIGGED. There are some differences between the two modes as the first is intended for control, set-up and hand-measurements, and the second for automatic or semi-automatic measurements.

CONTINUOUS mode is selected by [CONT] and is the DEFAULT mode. In this mode a number of single measurements (default : 16) are averaged and presented at a moderate rate to ease the task of the operator. (The average number may be selected by [F] [4] ..., see later).

When the CT30 is to be programmed via the keyboard with Measuring Frequency, Nominal Value, Sorting Limits etc. it can only be done in Continuous Mode. The CT30 must also be set in "Local Control" when controlled via the interface bus (IEEE 488 or RS 232C) before keyboard set-up is possible.

TRIGGED mode is selected by [TRIG] (or a contact closure to the trig input on the rear-panel socket, or a trig-code over the interface bus). In this mode only keys modifying the front-panel display are active (see KEYS ACTIVE IN TRIG MODE) and the displays are only updated with each trig.

In TRIG mode, basically one single measurement is made and displayed, and the bridge then awaits the next trig signal, which can be accepted when the "TRIG READY" output-signal comes on. It is possible to trig so fast, that the displays are not updated, but the binning output over the rear panel socket will always be correct. Also the data transmission over the bus may be interrupted by a trig. This should be no problem if the bus is used to trigger the bridge, but if the hardware trig is used, care should be taken that it does not come too early.

The time taken to do one measurement after trig consists of three parts: Stabilization, measurement and calculation & (evt.) transmission.

STABILIZATION TIME

During stabilization after TRIG the bridge will seek the correct range, which normally may take a maximum of 20 mSec if range-lock is not used (see later). This time may be prolonged by charged capacitors or noise from contact bouncing ect. up to the limit, where no measurment is possible within the allotted time (the sorting equipment must move on). In this case the component is rejected as out of limits.

The normal stabilization time may be considerably reduced by using "range-lock". In case the measurements are made as deviation from a Nominal Value (△-mode), the bridge knows from this the expected range and locks that automatically, when the -mode is activated.

Even for absolute measurements it is possible to use range-lock. By inserting a Nominal Value and then, whithout activating the △-mode, calling the range-lock routine by: [F] [△] [9], the range lock is activated. The range-lock is deactivated by: [F] [△] [CLR].

In range-lock, one range-step away from the nominal range is allowed during the stabilization time, which will then be less than 5 mSec.

MEASURING TIME

The time for one measurement is 16 mSec. During this, the range detection circuit is monitored, and if a disturbance , f.ex. an attempt to change range, is detected within the first 4 mSec the measurement is restarted, but only three times, if the disturbance persists.
If the disturbance appears after the first 4 mSec, the measurement is abandoned.

CALCULATION TIME

The calculation time is from 5 to 9 mSec, dependent on the mode setting and the number of limits used. To this must be added the time for the data transmission over the bus (if used), which is usually less than 10 mSec for IEEE 488 (somewhat dependent on the bus controller). For the serial RS 232C it is much more and very dependent on the baud rate selected.

TOTAL TIME

So the total time for a single, trigged measurement with range-lock will be maximum 30 mSec and usually below 25 mSec, (not with RS 232C).

In double frequency measurements 21 mSec must be added (16 mSec measurement and 5 mSec switch-over and partial calculation between the two frequencies).

AVERAGE IN TRIG MODE

If, on an automatic sorting machine, more time is available per measurement it will be advantageous to average a number of single measurements.

In TRIG mode this is accomplished by [F] [4] [TRIG] which activate the averaging mode in TRIG mode.

Average in TRIG mode is deactivated by: [F] [4] [CONT].

The average number is set by the: [F] [4] [X] [X] routine.

The total measurement time will increment by 20 mSec for each single measurement added to the mumber to be averaged (40 mSec in double frequency).

The average number also sets the time available for the whole measurement. In noisy conditions, where some individual measurements are abandoned as invalid, the rest of the measurements will still be averaged. Under really bad conditions, f.ex. unreliable contact to the component under test the average program will attempt to get at least one measurement within the alloted time and in the locked range (or the neighbour range).

PARAMETER CONTROL

When measuring capacitors or inductances the following keys control the parameters measured:

[S/P] changes between serial and parallel representation.

[Q/D] changes between quality factor and tan delta as the secondary parameter.

[R/G] changes between resistance and conductance as the secondary parameter. Conductance can only be measured as G_p, PARALLEL mode.

When measuring resistors there is no parameter control. The secondary parameter will be either C_p or L_s according to the phase angle between the measuring voltage and -current.

In LIMIT mode (see later), when limits have been set up for the secondary parameter, these keys may become disabled if their use violates the specified limit parameters.

The DEFAULT mode is C_s-D and L_s-Q
(R is always ind DEFAULT mode: R_p-C_p or R_s-L_s).

[CLR] Resets the CT30 to the DEFAULT mode.

NOTE: It will also disable the $\triangle$-mode and LIMIT mode, as well as any Parameter-Lock modes, so that full control over the parameters is regained.

The $\triangle$, LIMIT and Parameter-Lock modes are easily reactivated and will again set the appropriate parameters.

MEASURING FREQUENCY

[1K] [10K] [100K]	the measuring frequency is selected by these keys, and is permanently indicated by the corresponding frontpanel LED.

DOUBLE FREQUENCY MEASUREMENTS

In this mode two full measurements are made in sequence at two different frequencies. The first measurement is made at the primary frequency "PFQ" and the second measurement at the secondary frequency "SFQ". The "PFQ" and "SFQ" can be freely selected, but cannot be the same.

To select a Double Frequency mode first select the "PFQ" (usually 1kHz):

["PFQ"] and then the sequence:

[F] ["SFQ"] [ENTER].

To exit the Double Frequency mode do:

[F] ["SFQ"] [CLR].

In double frequency measurements of f.ex. capacitors, a mix of parameter values (as f.ex. the capacitance value at 1 kHz and the lossfactors at 1 kHz and 100 kHz) are wanted. In case the ESR of a capacitor is high enough it may happen, that it dominates at the higher frequency making the component essentially a resistor (with some eqvivalent parallel capacitance), though it appears a capacitor at the lower frequency. In this case the double frequency measurements fail and an error-signal is issued.

The same phenomenon is seen when the jig is empty. When it is uncalibrated it usually has capacitance enough to show consistent values in Double Frequency mode. But if the jig is calibrated the CT30 is attempting to denote an infinite impedance. In fact, it attempts to decide the phase angle and hence the parameters, on the noise imput, and they will most likely not be the same at the two frequencies.

THE LOCK MODES

The automatic determination of the dominant parameter as the primary one can be annoying in automatic sorting, where limits are used. Normally in active LIMIT mode, when a component type, different from the one specified for the limits, is encountered, the limit detection is suspended for that component. To overcome this problem and also the problem with the parameter change in double frequency measurements, the Parameter-Lock modes are usefull. These are:

THE L/C LOCK:

[F] [C/L] [ENTER]	activates the L/C LOCK where the reactive term will always be the primary parameter.
[F] [C/L] [CLR]	deactivates the L/C LOCK.

THE RESISTANCE LOCK:

[F] [R/G] [ENTER]	activates the R LOCK, where the R_S/R_P term of a component will always be the primary parameter.
[F] [R/G] [CLR]	deactivates the R LOCK.

THE CAPACITANCE LOCK:

[F] [8] [ENTER] activates the C LOCK, where the reactive term will always be the primary and always denoted as a capacitor.
A high non-capacitve impedance will be shown as 00.00 pF and a low one as 9999 mF. This ensures that such a component will be rejected by the limit detection.

[F] [8] [CLR] deactivates the C LOCK.

NOTE: The general return to DEFAULT mode by [CLR] (see above) also disables the Lock modes.

An INDUCTANCE LOCK mode is available as an option.

NOMINAL VALUE SET-UP

To make deviation measurements or - as described above - to use the range-lock system, it is necessary to insert a Nominal Value of the components to be measured and sorted. The Nominal Value is only concerned with the primary parameter and consequently the secondary parameters as well as the serial/parallel representation can be set and changed during the course of measurements.

There are two ways of establishing a Nominal Value in the CT30, either by measuring a standard or to insert it by the keyboard (or the interface bus). The key-sequences are:

[△] If a Nominal Value is already in existance, it will be shown marked with a "△" and alternating signs. If it is acceptable, just exit with: [ENTER] and if not, that is, if it is to be erased or replaced by another value press [△] once more. This brings on the situation where no nominal value is in existence and the set up routine is called by the initial [△]. This is marked by the promt: "△" - "*" meaning:

[ENTER] exit without any Nominal Value, or

[△] start the establishing of a Nominal Value by keyboard, or

[TRIG] establish the Nominal Value by measuring the standard, connected to the jig.

If a standard is not connected, the error signal will be issued.

With a proper component (standard) on the jig, it will be measured by averaging 15 single measurements, and these measurements will be repeated untill:

[ENTER] which will establish the measurement as the Nominal Value and exit to RUN mode.

In case the [△] had been pressed, the by-keyboard-insertion routine starts with prompting "C" - "L" - "R" asking for the type of component. Then:

[R] selects resistance and

[C/L] selects initially C and thereafter changes between C and L.

After selection of the component type, the first digit place will flash a zero together with the leading decimal point, requesting insertion of a digit 0 - 9 or the DP. The next steps follow logically: When a digit has been entered, the next digit place will flash. There is complete freedom to format the value when entering it, but the software routine will transform the format to suitable engineering notation: f.ex. if .0100 nF has been entered, on recall for inspection it will appear as 10.00 pF.

When the decimal point is set, it can be overruled later: f.ex. 10. has been set, and the third digit place is flashing a zero, but 100.0 pF was intended. Just set a zero and then, when the fourth digit place is flashing, set the decimal point. If, on reflection, it should have been 10.00 pF after all, the [CLR] button is at hand. It will undo the last entry and thus allow corrections. It may be used repeatedly.

[△] will erase all, and the whole set-up procedure is restarted.

If the operator is in a hurry and wants to insert 1.000 nF, then, when the first digit, [1], has been set, [CONT] will do the rest i.e. set the decimal point and fill the rest of the places with zeroes. If the decimal point has already been set, [CONT] will just fill the empty digit places with zeroes.

When the value is set, the unit symbols will prompt, covering nine decades. F.ex. insertion of an inductance value will give the prompt: "µH" - "mH" - "H(-enry)".

A capacitance value will give the prompt:
"pF" - "nF" - "µF", but here "mF" is also available, though it is not shown in the prompt.

When the unit has been set (it may be reselected ad infinitum), the "IDLE" LED starts blinking, indicating the end of the set-up. Then:

[△] will restart the whole procedure.

[C/L] or [R/G] will erase the whole value, select a new parameter according to the key used and start prompting the first digit/ decimal point.

[CLR] will erase the unit entry and the last digit, and start prompting for a new one. Further use of the [CLR] will back-track right to the first digit.

[ENTER] will insert the entry as a Nominal Value in the memory, and exit to RUN mode.

The Nominal Value may be utilized to establish "range lock" (see above) by:

[F] [△] [9]   activate range lock.

[F] [△] [CLR]   deactivate range lock.

Without range lock the CT30 will go to range 1 whenever the jig is empty. It must then step through the ranges till it finds the correct one, when a new component is applied to the jig.

With range lock (which is only active in TRIG mode) it will stay in the indicated range, but allow measurement in the neighbouring ranges. Thus with a 10.00 nF Nominal Value, the possible measuring range will be approximately 400 pF to 400 nF. Outside this, a reject is made. Range lock greatly cuts down on the number of range steps per measurement, thus saving time and reducing wear and tear on the range switches. It is recommended to use range lock whenever possible.

Range lock is automatically established when deviation measurements are made.

THE △-MODE

[F] [△] [ENTER] activates deviation measurements with reference to an already established Nominal Value.

[F] [△] [CLR] deactivates △-mode.
NOTE: [CLR] in RUN mode will also deactivate the △-mode (see above).

The △-mode does not lock the **secondary** parameter setting or the selection of serial or parallel representation, so these settings are the operators choice (unless an active limit-set locks them !).

The △-mode cannot be activated, if the Nominal Value parameter is inconsistent with an active parameter lock, f.ex. a C Nominal Value and an active R lock. The opposite is also true: In △-mode with a C Nominal Value, the R lock cannot be set. But of course, the C lock can be set in △-mode with a C Nominal Value and that makes an important difference.

Normally a "wrong" component i.e. a resistor will just suspend the deviation measurement for the time being (and, if limits are active, a low + high reject will be issued). By using C lock this will not happen as the resistor will be read-out as either an infinite small or big capacitor, according to its size (more or less than 1 MΩ).

The Nominal Value can be inspected at any time in RUN mode, as described above, by pressing [△]. The Nominal Value will appear in the left-hand display, designated by a "△" and an alternating sign. It will remain there until reentered by [ENTER]. It may be modified in value by using the [CLR] button. When in Continuous mode, the RUN mode is suspended for the duration of the inspection/modification.

In TRIG mode the RUN mode is not suspended, but modification is not possible.

THE LIMIT SYSTEM

The CT30 can sort with up to 12 limits on the primary parameter and 4 limits on the secondary parameter. Secondary parameter limits are not possible on resistence measurements, because the secondary parameter (C_p or L_s) is automatically set in this case.

A set of limits, including secondary parameter limits, is called a Limit Vector. The "foreground" vector is defined as the set of limits immediately available, i.e. which may be activated/deactivated by [F] [LIM] [ENTER]/[CLR]. A "background" vector is stored in a protected area of the memory and must be called into the foreground to be utilized. Up to 5 Limit Vectors can be stored in background.

There are two basic types of limits:

Absolute Limits

Deviation Limits (on the primary parameter only)

The last type will, of course, only function in $\triangle$-mode, whereas the first type will function in both absolute- and $\triangle$-mode. Secondary parameter limits are always of the absolute type and will, when active, force the secondary parameter setting and disable the parameter selection keys, [S/P] [Q/D] [R/G] (see above).

Deviation limits are again of two types:

Absolute Deviation

Per Cent Deviation

The first type requires parameter compatibility with the Nominal Value, but the second type is rather universal, as it works on all components (C, L & R).

On the following pages are described in this order:

LIMIT SET-UP, ABSOLUTE LIMITS, DEVIATION LIMITS, SECONDARY LIMITS

LIMIT SORTING, BINNING DISPLAY

LIMIT INSPECTION AND EDITING

LIMIT STORING

LIMIT SET-UP

The procedure starts with:

[LIM] If a foreground vector already exists, this is brought into display, see "Limit Inspection". Here it is assumed that it is of no interest (it may have been saved, see "Limit Storing"), so we erase it by another [LIM] which brings us to the same situation, as if no foreground vector existed originally.

If the CT30 is in △-mode (i.e. was actually making deviation measurements, see above) it is now assumed, that the intention is to set up deviation limits and consequently the procedure starts on that (see "Deviation Limits").

If not in △-mode the left-hand display will be prompting "LIM" - "*" and retain the last shown parameter (C,L,R) in the last used S/P mode.

The right-hand display will show "LIM" and "00", indicating that the first (lowest numbered) limit is about to be created.

[*] Exits the set-up procedure and leave the foreground empty (no foreground limit vector).

[LIM] yes, we want to do a limit vector set-up.

The display will now show the "LIM" permanently and prompt "△" - "*" meaning:

[*] absolute limits are to be created.

[△] deviation limits are wanted.

ABSOLUTE LIMITS

The display will now prompt "C" - "L" - "R" asking for the parameter:

[R/G] absolute limits for resistance sorting.

[C/L] selects C initially and thereafter changes between L and C.

The leading decimal point and digit is now flashing, indicating that the value may now be entered. Before we do that, it should be noted that changing the S/P setting will not lock it, as this is a run-time decision (unless secondary parameter limits set up later on lock it).

Further, during set-up of limit "00", the parameter setting may be reselected at any time by [C/L], [R/G], which will cause the value input to be restarted with the first digit. We may also restart the whole procedure by [LIM].

Finally, if no primary parameter limits are wanted in this vector, but only limits on the secondary parameter, then:

[CONT] will jump to the secondary parameter limit set-up procedure, provided no digit (or decimal point) has been entered.

NOTE: In general for all primary limits, when the first digit and decimal point are flashing ".0" , [CONT] will terminate the primary limit set-up and proceed to the secondary parameter (see later)

Following the decimal point (DP)/digit prompts, the value is now entered. When the [*] key is used, the DP is frozen at that place, but a later [*] will override the first selection (as long as not all digits have been entered). If an error occurs the [CLR] button will backtrack the procedure and this may be carried right back to the first DP/digit.

(Even if the whole value, including the DP, has been erased by this backstepping, the "[CONT] jump" to the secondary limit set-up is no longer available. The use of this requires the procedure restart by [LIM]).

Though all the digit places must be entered it is not necessary to fill-in trailing zeroes each at a time. Just use:

[CONT] which sets the decimal point (if not previously set), sets the remaining digitplaces to zero and goes to the next step in the set-up procedure.

NOTE: When entering the limit values, it is necessary to keep in mind, that the limits must be increasing in value with the limit number, f.ex. in the sequence:
LIM 00: 9.000 nF, LIM 01: 8.000 nF, LIM 02: 10.000 nF, limit 01 will be ignored.

When the limit 00 value has been entered, the unit prompt will appear. The prompt covers the three usable units f.ex.: "pF" - "nF" - "µF". The unit is set by the appropiate key and the "IDLE" LED starts flashing, signalling that the limit is finished. The unit may still be reselected and the backtrack function by [CLR] as well as the parameter reselection and the procedure restart (by [LIM]), as described above, are still available.

When limit 00 is in all respects satisfactory, then:

[CONT] will store limit 00 away, update the limit number indication in the right-hand display to "LIM 01" and start prompting for the first DP/digit of that limit.

If instead of [CONT] we use:

[ENTER] the limit set-up procedure is terminated and a one-limit vector has been created, which is now the foreground vector.

But presumably more than one limit is required in the vector and we may put in the LIM "01" value in the same manner as for LIM "00". Now, however, we cannot change the parameter or the unit anymore.

[CLR] will backtrack as before.

[LIM] will restart the value input of this limit and the above mentioned "[CONT] jump" to the secondary limit set-up is now allowed.

[CONT] will auto-fill with trailing zeroes with or without setting the decimal point and go on to the next step, which is: Start setting-up the next limit (in this case LIM "02")

Remember, on the starting DP/digit prompt [CONT] means a jump to the secondary limit set-up. Whoever wants a limit with the value: .0000 ?

If the limit is set up without auto-fill by [CONT] then, when finished, the "IDLE" LED starts flashing and

[CONT] will start the set-up of the next limit.

[ENTER] will terminate the whole set-up procedure and exit to RUN mode.

DEVIATION LIMITS

When the limit set-up procedure has been called by "[LIM]", with the CT30 in active △-mode, it goes straight to deviation limit set-up. If not in active △-mode, but after the initial selection of the delta-limit set-up procedure by [LIM] [LIM] [△] as described above, the reaction of the procedure depends on whether a Nominal Value is in existence or not.

If it is, it will be flashed three times to remind the operator of its existence and value before going to the first step in the procedure. As the existing Nominal Value presumeably is the one to be used with the limit vector, about to be made, its parameters will be used for the limits.

If no Nominal Value exists, the set-up procedure will later ask for the parameters (C, L or R), but now proceed to the next step, where the right-hand display will show a "9" and prompt with "LIM" - "*". By:

[9] (or [LIM])	are symmetrical limits created, i.e. limits of the type +/-1%, +/-5%,..... When such limits are required, it is much easier to use this facility as in fact two limits are created at a time.
[ENTER]	are normal deviation limits to be made.

After selection of either normal or symmetrical △-limits the right-hand display will show "LIM" "00" and the left-hand display will prompt "%".

At this point the following keys will be active:

[ENTER]	exit the set-up procedure and return to RUN mode.
[LIM] or [CLR]	return to the "△" - "*" prompt in the initial part of the set-up procedure (see above).
[%]	selects %-deviation limits if pressed when the % shows in the display, else absolute deviation limits. Repeated [%] alternates between the two types.

If %△-limits are selected no further parameter entry is needed and the value-entry prompt for the first limit starts.

If absolute△-limits are selected, the parameter selection prompt: "C" - "L" - "R" will appear, if no Nominal Value exists. Otherwise the Nominal Value parameter is used (and displayed) and cannot be changed, and the procedure goes directly to the value-entry prompt for the first limit.

When the parameter setting is required then:

[R/G]	selects resistance as the primary parameter.
[C/L]	initially selects capacitance and thereafter changes bet ween inductance and capacitance.

and further, the following keys are active:

[ENTER]	exits the set-up procedure and returns to RUN mode.
[LIM] or [CLR]	restarts the whole limit set-up procedure.

When the parameter has been set, we go to the value entry of the first limit.

If symmetrical △-limits have been chosen, the prompt will be ".0" at the leading digit place. As both the + and - limit are made together, no sign entry is needed, and the numerical value can be entered directly.

If normal △-limits are made a sign is required and the first prompt will be: "+" - "-". In this case

[-] sets minus.

[+] sets plus. When the first + limit in the vector has been entered, the following limits must of necessity also be positive and "+" is thereafter automatically set.

When the sign has been set, the first decimal/digit prompt starts. If the sign-setting is wrong, then

[CLR] backsteps the procedure and restarts the sign prompt.

During the first value-entry prompt (sign or first digit) the following keys (besides the obvious) are available:

[LIM] backsteps the procedure to the prompt for symmetrical/non-symmetrical limits.

[CONT] jumps to the secondary parameter limit set-up procedure (but <u>only</u> during the sign-prompt and the <u>first</u> DP/digit prompt).

When entering the value of the limit(s) it should be remembered, that the limits must be entered in order of increasing (signed) value. Thus LIM 00: -10%, LIM 01: -5%, LIM 02: +5%, LIM 03: +10%..... is correct, but if now LIM 04 is set to +8%, it will never be detected in the limit sorting routine.

Symmetrical limits must also be ordered with increasing value, f.ex. LIM 00: +/-1%, LIM 01: +/-2%, LIM 02: +/-5%.......

The numerical value of LIM 00 is now entered following the decimal point (DP)/digit prompt. Whenever the DP is entered, it is frozen in that position, but a later entry will overrule the first one, except when the last (fourth) digit has been entered. During value entry the following keys are available:

[*] decimal point entry (not after the last digit).

[0-9] digit entry.

[CONT] sets the DP (if not previously entered) and fills the rest of the digit places with zeroes. Then it goes to the next step in the set-up procedure.

NOTE: with no digit or DP entered, [CONT] makes the procedure jump to the secondary parameter limit set-up.

[LIM] backsteps the set-up procedure to the symmetrical/non symmetrical limit type prompt.

[CLR] backtracks the value entry one step. (The backstepping may be carried right back to the first value prompt, but then the "[CONT] jump" to secondary limit set-up is no longer available (see above), [LIM] must be used).

After the value of LIM 00 has been entered, the unit prompt will appear, if absolute deviation limits are being made. This covers nine decades, f.ex. "pF" - "nF" - "µF". The unit is now entered and may be reselected. When the unit has been entered (for %△-limits there are of course no unit entry), the "IDLE" LED starts flashing, indicating that the LIM "00" set-up is finished.

Now the following keys are available:

[ENTER] which terminates the limit set-up procedure and goes back to RUN mode. A one-limit vector has now been created and placed in foreground.

[LIM] which restarts the set-up procedure at the symmetrical/non-symmetrical limit type prompt.

[CLR] which backsteps the procedure one step at a time.

[CONT] which inserts the LIM "00" in memory and proceeds to "LIM "01" set-up.

and in case we are making absolute △-limits, and no Nominal Value exists and consequently the parameter has been determined in the limit set-up:

[R/G] or [C/L] will change the parameter and restart the value input prompting.

When setting up the following limits the same procedure as above applies except that

[LIM] now restarts the value input of the present limit.

Of course, the parameter and unit are now frozen and cannot be changed.

If all the twelve possible primary limits have been entered then:

[CONT] will start the secondary parameter limit set-up.

Usually, not that many primary limits are needed, so when the last of the planned set has been entered:

[ENTER] will terminate the set-up, when secondary limits are not wanted, else

[CONT] [CONT] will jump to the secondary limit set-up.

This is equivalent to start the next primary limit by [CONT] and then, on the first value input prompt for this, use [CONT] once more to make the jump to the secondary limit set-up. If the last true limit was finished by the auto-fill [CONT], this counts as the first of the two [CONT]'s as it goes to the next limit set-up.

SECONDARY PARAMETER LIMITS.

Four limits on the secondary parameter may be included in the vector.

The secondary limit set-up procedure starts with showing "LIM 0" in the left-hand display and "LIM" in the right-hand display together with the parameter prompt. This is "d" - "R" for a primary C and "Q" - "R" for a primary L.

[ENTER] terminates the set-up procedure and returns to RUN mode. No secondary limits are made.

[CLR] starts a "LIM" - "*" prompt meaning:

- [LIM] yes, we want to set up secondary limits. Restarts the parameter prompt
- [ENTER] no, exit to RUN mode.

[Q/D] selects "Q" or "d".

[R/G] selects "R" or "G_p".

In case R is selected, the next step will be the "s" - "p" prompt and

[S/P] selects serial or parallel representation. This will be locked in RUN mode (and the [S/P] key disabled) when the limits are active.

When the parameter has been entered the value input prompt starts. In case tan delta, "d", has been selected, the decimal point is fixed in the leading position so the format of d will always be .xxxx.

The active keys during value entry are:

[*] decimal point (not for "d" and not when all digits have been entered, where it means: EXIT to RUN mode !). When the DP has been set, it may be overruled further on.

[0-9] digit input.

[CLR] backtracks one step at a time.

[LIM] restarts the "LIM" - "*" prompt (see above).

[Q/D] or [R/G] reselects the parameter and restarts the value entry.

[S/P] changes between serial and parallel representation, when R or G_p has been chosen.
As G_s is not allowed, G_p will change to R_s, by this key. The value entry is restarted.

[CONT] finishes the LIM 0 by setting the DP (if not already set) and fills in trailing zeroes.

When the value entry is finished, the unit prompt will start in case R or G_p has been selected. This will be either "Ω" - "KΩ" - "MΩ" or "µS" - "mS" - "S", during which we have the "[CLR]", "[LIM]" and parameter reselection function as described above.

When making Q or D limits (or when the unit has been entered for R or G_p), the "IDLE" LED is now flashing, indicating that the "LIM 0" set-up is finished. Then:

[ENTER] terminates the set-up procedure and returns to RUN mode.

[CONT] goes to LIM 1 set-up,

and [CLR], [LIM], [Q/D], [R/G] and [S/P] has the same functions as described above.

Entry of the next limits (LIM 1 - LIM 3) follows much the same procedure. The difference is:

[LIM] will restart the value entry of the indicated limit.

[CONT] will finish the limit with zeroes and go to the next limit,

and the parameter changes are no longer possible. When LIM 3 is finished, we may exit the set-up procedure by [CONT] [CONT] of which the first may be the auto-fill function. [ENTER] will also, as usual, terminate the set-up.

LIMIT SORTING

To utilize a foreground limit vector to sort components, it must be activated, i.e. the CT30 set in LIMIT mode.

[F] [LIM] [ENTER] activates the LIMIT mode.

If the vector contains deviation limits on the primary parameter, the △-mode will automatically be activated, provided, of course, that a Nominal Value is in existence. If not, the limits cannot work, and the error signal is issued.

[F] [LIM] [CLR] deactivates the LIMIT mode.

The LIMIT mode may be temporarily deactivated. This can happen automatically in RUN mode. If f.ex. a limit vector, with a C parameter specified, is active, and an inductance comes on the jig, the limit detection is suspended as meaningless, but the low <u>and</u> high rejects are issued as a warning.

When the LIMIT mode is deactivated by [F] [LIM] [CLR] the △-mode, if used, will <u>not</u> be deactivated automatically.

BINNING DESPLAY

Usually, the measured values are displayed on the CT30 front panel. But in LIMIT mode, the CT30 can display the BIN numbers, determined by the limit detection. The BIN numbers correspond to the pin numbers of the limit output socket, SC1, on the rear panel.

With normal (sequential) limits, the BIN numbers for a four-limit vector (primary parameter) are defined so:

```
      LIM 00        LIM 01        LIM 02        LIM 03
BIN 00   |   BIN 01   |   BIN 02   |   BIN 03   |   BIN 12
```

the BIN above the highest limit used (HIGH REJECT) is always designated BIN 12.

With symmetrical deviation limits the BIN numbering definition is for a two-limit vector:

```
      LIM 00        LIM 01
BIN 00   |   BIN 01   |   BIN 12
    +/- 1.000%    +/- 5.000%
```

with high and low reject designated BIN 12.

For the secondary parameter limits, the BIN numbering is:

```
      LIM 0        LIM 1        LIM 2        LIM 3
BIN 0   |   BIN 1   |   BIN 2   |   BIN 3   |   BIN 4
```

To display the BIN numbers on the frontpanel, the following RUN mode key codes apply:

[F] [LIM] [1]   display primary parameter binning alone.

[F] [LIM] [2]   display secondary parameter binning alone.

[F] [LIM] [3]   display both parameter binning.

[F] [LIM] [0]   display no binning.

Alle four codes will activate the LIMIT mode, if it is not already active.

SPECIAL BINNING IN DOUBLE FREQUENCY MODE.

In double frequency measurements, it is possible to redefine the secondary limits so, that LIM 0 is a go/nogo limit for the "PFQ" (primary frequency) second parameter and LIM 1 a go/nogo limit for the "SFQ" second parameter.

The BIN number definition is then:

```
     LIM 0                  LIM 1
BIN 0   |   BIN 1      BIN 2   |   BIN 3
|______PFQ______|      |______SFQ______|
```

LIM 2 and LIM 3 are ignored in this mode.

This "two go/nogo limit" mode is selected at RUN-time (in double frequency mode) by:

[F] [LIM] [4]   go/nogo limits on PFQ and SFQ second parameter,

and is deselected by:

[F] [LIM] [ENTER]   the LIMIT mode activation code.
or
[F] [LIM] [CLR]   the LIMIT mode deactivation code.

So this particular way of using the secondary parameter limits is a RUN mode decision and does not affect the set-up in any way, apart from considerations about their value.

When display of the secondary parameter binning has been chosen (by: [F] [LIM] [2]/[3]) the PFQ BIN number (0 or 1) will be shown to the left and the SFQ BIN number (2 or 3) to the right, in the right-hand display

LIMIT INSPECTION AND EDITING.

The foreground limit-vector may be inspected at any time in RUN mode. In Continuous mode the RUN mode is suspended during inspection. Also, during inspection, a particular limit in the vector may be called and subjected to alteration. This is not possible in TRIG mode, but inspection in this mode will not affect the measurements.

[LIM] displays the foreground limit vector.

If none exists, the limit set-up procedure is called, and the "LIM" - "*" prompt shows (see above).

The individual limits in the foreground vector are now shown in a slow sequence, with the value in the relevant display and the corresponding LIM number in the other one. When all the limits have been shown, the Nominal Value will show for a while, before the limits are shown anew. If, on this inspection, the vector is found satisfactory, just press:

[ENTER] terminates the display and returns to RUN mode.

If on the other hand, the vector is to be either erased or replaced, press:

[LIM] starts set-up procedure with the prompt "LIM" - "*".

Now as described above:

[ENTER] exits to RUN mode. (If in active $\triangle$-mode: [ENTER] [ENTER] as the prompt were for the symmetrical/ nonsymmetrical limits.)

[LIM] starts the set-up in earnest. (Or in $\triangle$-mode: [ENTER]/[9] and then [%]).

These are the only possible answers to the second [LIM] and both will erase the original vector. This is annoying, if one only wanted to inspect the vector and then, by accident, makes the second [LIM] !

In this case, exit with [ENTER], (but NOT a third [LIM], then the vetor is really lost !), and use:

[F] [LIM] [9] to rescue the "lost" vector. After the [F] [LIM] the right-hand display shows four "9" to remind of the "rescue" key.

The display of the vector is then resumed and

[ENTER] will exit to RUN mode with the vector in foreground.

If under inspection of a vector a closer look or perhaps some editing is wanted, a particular limit can be called. Press the limit's two-digit number, 00-15, where the last four (12-15) are the secondary parameter limits, and the limit will be shown in the usual format.

(Please, press the keys more firmly than usual, the display routine is a little slow in catching the key inputs).

One can now step through the limits in one's own good time, by using:

[CONT]

At the end of the vector, the Nominal Value is shown, if it exsists. Then [CONT] will again show the LIM 00.

A limit can always be selected by its number. If a particular limit needs modification or replacement of its value, then:

[CLR] backsteps into the limit value, starting the relevant DP/ digit prompts.

[LIM] restarts the entire value input to the limit.

If [LIM] is used on LIM 12 (LIM 0, the first of the secondary parameter limits), all the secondary limits are erased and the "LIM" - "*" prompt is started. The routine has transferred to the secondary limit set-up procedure, (see Limit Set-up).

If [LIM] is used on LIM 00, two possibilities exist: Either modify the value of LIM 00 and proceed in the inspection/edit routine, or by another [LIM], transfer to the set-up routine, described above.

If the set-up routine is exited immediately by [ENTER] (or [ENTER] [ENTER]), nothing has been changed in the limit vector.

The display routine is terminated by:

[ENTER] exit to RUN mode.

LIMIT STORING.

Up to five limit vectors may be stored in a background memory area, from where they may readily (one at a time) be called into the foreground. The background memory area is protected and cannot be easily erased, not even by the total reset by [F] [0] [0]. Only when after switch-on the memory test fails (for instance because of a bad memory back-up battery), will the background be cleared as the content is no longer reliable.

The background is called by:

[F] [LIM] [5]	call the background vector routine.

The right-hand display will now show either:

" 0 "	indicating that no background vectors exists or

or:

" 1 "..." 5 "	scrolling through the numbers 1-5, which indicates the background cells. Only the cells with a content are shown.

Now the keys are:

[CLR]	exit to RUN mode.
[1] ... [5]	call one of the five cells.

When a cell has been called, its number is shown and the "LIM" - "*" prompt comes on. Then:

[ENTER] stores the foreground vector in the indicated background cell. The cell number will flash three times. Then exit to RUN mode.

NOTE: This will fail if the cell is already occupied (or, of course, if there is no foreground vector !)

This guards against accidental destruction of the background vector. The cell must be positively cleared first.

[0] to start clearing the background cell. Now a zero shows and "C" - "*" prompts, meaning:

[CLR] [CLR] exit to RUN mode <u>without</u> doing anything.

[ENTER] exit to RUN mode with the selected background cell cleared.

[LIM] recalls the background vector in the selected cell to the foreground.

When the CT30 is in active LIMIT mode, the recalled vector will be activated if it is compatible with the component-on-jig or the Nominal Value in $\triangle$-mode.

When not in active LIMIT mode, the limit inspection routine is called to display the recalled vector.

In both cases an already existing foreground vector is replaced by the recalled vector, and therefore lost.

When the recalled vector is displayed with the inspection routine, it may be modified by using the Limit Editor. In any case, when we exit the display routine (by [ENTER]) the vector is copied back into the background cell, it was fetched from. This is indicated by the flashing of the cell number three times. (If we wish to modify the new foreground vector, without touching the background, we must first exit the display routine, and then call it again by [LIM]).

If a non-existent background vector is recalled, i.e. the selected cell is empty, then in active LIMIT mode nothing will happen, except a "Fault" signal. But if not in active LIMIT mode, the limit set-up routine is called automatically. If now a limit vector is created it will be stored in the selected cell on exit from the set-up routine.

THE CT30 FUNCTIONS

The CT30 posseses numerous facilities, most of them controlled by a key sequence, starting with the function-key [F].

THE RESET

[F] [0] [0] is the fundamental reset of the CT30.

All set-ups are cleared or returned to default settings, except the background limit vectors, which are only erased in case a memory fault is detected. The CT30 will start up in CONTINUOUS mode after this reset.

NOTE: the jig calibrations are also removed and must be redone.

[F] [0] [1] reads the communication status as defined by the two rear-panel switch banks: RS 232C and IEEE 488. The switches are also read at switch-on, but to avoid having to switch OFF/ON when the setting is modified, use this routine.

[F] [0] [2] calls a testprogram (exit by [F] [F]) with numerous test routines. The testprogramme is described in the Service Manual.

[F] [0] [3] [X] calls an optional "Personality Module" in the set-up control. The CT30 has so many possibilities, that some of the set-up procedures may seem complicated. If, for instance, a user always intend to use $\triangle$-mode and $\updownarrow\triangle$-limits, all the prompting for other modes may be cut out, greatly simplifying set-up. The standard modes are still available, when the "Personality" mode is not invoked.

DC BIAS

Up to +/- 3.5 VDC bias may be superimposed on the measuring signal.

[F] [2] calls the bias routine. The right-hand display shows the value in the format X X.X, where the first digit is the sign ("0" = "-" and "1" = "+") and the two other digits the value in Volts.

[CLR] erases the setting and prompts for a new sign and value, which must be entered (0 0.0 for no bias !). The decimal point should not be entered.

[ENTER] inserts the bias and exits to RUN mode.

DISPLAY CONTROL

[F] [3] [1] makes the left-hand display blank in RUN mode.

[F] [3] [2] makes the righ-hand display blank in RUN mode.

[F] [3] [3] makes both displays blank in RUN mode.

[F] [3] [0] resets to NORMAL (DEFAULT) display mode.

In double frequency mode the normal display mode is: The primary parameter measured at the primary frequency ("PFQ") to the left and the secondary parameter measured at the secondary frequency to the right.

[F] [3] [4] shows both parameters measured at PFQ.

[F] [3] [5] shows the secondary parameters measured at the PFQ to the left and at the SFQ to the right.

In △-mode, where normally the value of the deviation is shown,

[F] [3] [△] shows the absolute value of the primary parameter.

NB: This is strictly a display modification and the limit sorting or the bus transmissions are not affected !

[F] [3] [0] again resets to normal display mode.

AVERAGING MEASUREMENTS

The CT30 will always do averaging measurements in CONTINUOUS mode. The default number of single measurements per average value is 16. To modify that:

[F] [4]	the number of single measurements will show in the left-hand display with a blinking decimal point to indicate which digit may now be changed by:
[0-9]	up to 99 single measurements may be averaged.
[ENTER]	will exit to RUN mode at any time.

TRIGGED mode will, by default, make only one measurement at a time, but:

[F] [4] [TRIG]	will activate averaging in TRIG mode, and
[F] [4] [CONT]	will deactivate averaging in TRIG mode.

CHECK SUM

Each EPROM in the CT30 firmware is programmed so that it includes a checksum of the total information in the EPROM. These checksums are a unique identification of the firmware. By:

[F] [5]	is the five-digit checksum displayed for EPROM1. The EPROM number (1-6) is shown at the extreme left.
[1-6]	calls the individual EPROMs in the firmware set.
[ENTER]	exits to RUN mode.

THE PARAMETER LOCK

These lock modes are described earlier. To recapitulate:

[F] [8] [ENTER]   activates Capacitance-lock.

[F] [8] [CLR]   deactivates Capacitance-lock.

[F] [C/L] [ENTER]   activates LC-lock.

[F] [C/L] [CLR]   deactivates LC-lock.

[F] [R/G] [ENTER]   activates Resistance-lock.

[F] [R/G] [CLR]   deactivates Resistance-lock.

THE SOFTWARE KEY LOCK

To prevent unauthorized operation of the keyboard, a keylock may be used. To set the lock make:

[F] [9] [9]	and the right-hand display will show .0000.
[0-9]	put in a four digit lock code and **DONT FORGET THE CODE ...** the first digit cannot be zero. Then:
[ENTER]	exit to RUN mode with the keyboard locked.

Now the only active key is [F], so to unlock the CT30:

[F]	and the right-hand display will show rolling "eight"s for a short time to indicate the locked state. When the "eight"s stop rolling, the first digit place is indicated by the decimal point. Now, within two-three seconds, start:
[0-9]	to insert the lock-code, following the digit place indication.

And the keyboard is now open.

The lock code can now be erased by:

[F] [9] [CLR]	and a new code must be made to lock again.

Or the keyboard can be locked again, using the same code, by:

[F] [9] [ENTER].

The keyboard lock will not prevent the display control in TRIG mode.

KEYS ACTIVE IN TRIG MODE

These keys control what is displayed on the frontpanel and are active, even when the CT30 is under bus control.

[△]	will show the Nominal Value, if it exists.
[LIM]	will show the limits of the foreground vector sequentially (including the Nominal Value, if it exists).
[F] [3] [0-3]	display-blanking control as in Continuous mode.
[F] [3] [4-5]	special display in Double Frequency mode.
[F] [3] [△]	shows the absolute value of the primary parameter when in △-mode.
[F] [LIM] [0-3]	selects display of bin-numbers when in active Limit mode.
[CLR]	will reset the displays to normal or curtail the [F] ... sequences.

NOTE: Operation of these keys in TRIG mode will <u>not</u> interfere with the measurements or the set-up of the CT30.

Also note, that if the trigger is stopped the display will not be updated, and the effect of these keys only seen when a new trig is applied.

C T 3 0

IEEE and RS232 connections

4. REMOTE CONTROL

CT30 can be remotely controlled by means of the IEEE 488/IEC 625 bus interface or RS232C. All the keyboard functions are included in the bus interface.

The bit 3 in the rear panel switch SW90, selects either IEEE or RS232C:

MODE BIT:

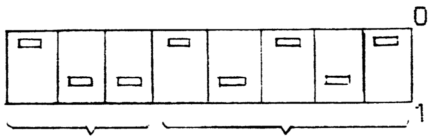
INTERFACE FUNCTION	TON	EOI	IEEE/ RS232	IEEE Mode
RS232C according to the RS232C control switch SW91	0	0	0	NO
SRQ after each measurement enabled by external trig or GET, DATA ON BUS when addressed to talk after	0	1	1	Talker/Listener with EOI
a SERIAL POLL sequence is performed by the bus controller	0	0	1	Talker/Listener without EOI
DATA ON BUS after each measurement enabled by external trig	1	1	1	Talker only
	1	0	1	Talker only without EOI

4.1 IEC 625/IEEE 488 Bus Interface.

IEEE Control Switch:

The IEEE control switch (SW90), located at the right-hand side of the rear panel, controls the data transmission capabilitie and sets the IEEE ADDRESS.

SW90



MODE BIT BUS ADDRESS

Set-up for Talker/Listener with END OF LINE termination (of each output string). Bus address >0A.

IEEE Interface Capabilities of CT30.

The list below show the sub-set of the IEEE interface used by the CT30. See Appendix C of IEEE Std. 488-1978 for a more detailed explanation.

Identification:	Function (description of capabilities):
SH1	Source Handshake.
AH1	Acceptor Handshake.
T5	Talker (Basic Talker, Serial Poll, Talk Only Mode, unaddressed to talk if addressed to listen).
L4	Listener (Basic Listener, unaddressed to listen if addressed to talk).
SR1	Service Request
RL2	Remote/Local
DC1	Device Clear
DT1	Device Trigger

Talker/Listener Mode.

The Remote Lamp on the front panel will light up as soon as the controller has taken control over the bus and addressed the CT30, and the keyboard will be inactive (unless a "go to local" is sent over the bus).

Remote Program Code:

The Device dependent messages for CT30 are listed in IEEE input code, Section 4.1.1.

Some commands requires some time to execute, (f. ex. J1) and the next CMD must be delayed accordingly. By sending E3 a SRQ for Done is send after eatch CMD execution.

Recall Status, Recall Reference VALUE and Store Reference VALUE are described in detail below.

Recall Status.

CT30 returns a service request and waits for the controller in charge to carry out a SERIAL POLL sequence after which, when adressed to talk, the CT30 sends a 16 bit flag loaded in hexadecimal, in two characters. The flag indicates the current mode of operation.

TRUE (1)	ON	ON			Q or D							ON		ON		
K-FLAG	TWO FRQ. MEAS.	DEVI-ATION △	AUTO / KEY	SERIAL / PARALLEL	Q/R	Q/D	R/G	X	△R	△C / △L	%	LIM MODE	△ LIM / ABS.	%	LIM R	LIM C / LIM L
FALSE (0)	OFF				R or G											
									DEVIATION MODE if ON				LIM MODE if ON			

ACTUAL FREQ.

F-FLAG																

1kHz 00
10kHz 01
100kHz 1(

Recall Reference VALUE:

CT30 returns a service request and waits for the controller in charge to carry out a SERIAL POLL sequence. The CT30 sends the selected reference value when addressed to talk after the SERIAL POLL sequence.

The output format is listed in Reference Value Output Codes, Section 4.1.2.

Store Reference VALUE:

CT30 waits for a 14 character string containing the reference data after receiving the Program Code. The input format is listed in Reference Value Input Codes, Section 4.1.3.

Service Request Status Byte:

CT30 sends SRQ when a measurement is completed and output data is available in the Talk and Listen Mode, or if the CT30 receives erroneous input strings.

NB: The bus controller has to perform a SERIAL POLL sequence *) in response to the SRQ in order to remove the CT30 interface from the SRQS State (Service Request State). The CT30 will not respond to any other bus commands before the SERIAL POLL sequence is performed, which is in accordance with the IEEE Standard.

*) (See Section 6.5.2. page 65 in "IEEE Standard Digital Interface for Programmable Instrumentation ANSI/IEEE Std. 488-1978", or in "IEC 625-1" chapter 40 Operational Sequences Section 40.2 Serial Poll).

Status Byte (sent out during Serial Poll).

	SRQ ON						ERROR	
0	1	0	0	0	0	0	0	DATA READY
0	1	0	0	0	0	0	1	syntax error in input string
0	1	0	0	0	0	1	1	RN, D1 or D2 received without a stored reference value
0	1	0	0	0	1	0	0	Command done
0	1	0	0	0	1	0	1	R 0-9 or L1 received without a stored reference value
0	1	0	0	0	1	1	1	L1 received with stored deviation limit, but without a NOM VAL, or deviation limits stored without a NOM VAL
0	1	0	0	1	0	0	1	R9 received without a stored reference value
0	1	0	0	1	1	0	1	Meas. error: (actual component unequal to DEV. or LIM. component
0	1	0	0	1	1	1	1	Non Digit character in value string
0	1	0	1	0	0	0	1	Double freq. meas. not activated prim. and sec. FRQ are equal

0	1	0	1	1	0	0	1	Jig Zero not possible
0	1	1	1	0	0	0	1	Double freq. Exit Meas. Error
0	1	1	1	0	1	1	1	R-LOCK not activated
0	1	1	1	1	0	0	1	LC-lock not activated

DATA Output Format:

The DATA output format is listed in Section 4.1.4 DATA Output Format.

The DATA are transmitted in 3 strings each terminated with a CRLF. The last string is terminated with an extra CRLF.

The first string contains the Main Parameter data. The second string contains the Secondary Parameter data, and the third string contains the Limit Parameters if specified.

In case of double frequency measurements extra strings may be added (16 characters each), containing the data on the Main Parameter and the Secondary Parameter on both PFQ (primary frequency) and SFQ (secondary frequency). These extra data strings are selected by means of the O code (see sec 4.1.1).

Examples of remote programming of the CT30 by means of device dependent messages:

A: Capacitance measurements with a nominal value of 1uF measured as series capacitance and loss factor (D) and per centage deviation. Set the Measuring Mode and store the nominal value plus the following limits:

-10 %, -2 %, 0 % +2 %, +10 % and +85 %.

STEP	PROGRAM CODE	INPUT STRING	NOTES
1	C S		Series Mode
2	S N	_ C P . 1 0 0 0 E - 0 5 CR LF	NOM VAL stored
3	S 0	P C - . 1 0 0 0 E + 0 2 CR LF	LIM 0 stored
4	S 1	P C - . 2 0 0 0 E + 0 1 CR LF	LIM 1 stored
5	S 2	P C - . 0 0 0 0 E + 0 1 CR LF	LIM 2 stored
6	S 3	P C + . 2 0 0 0 E + 0 1 CR LF	LIM 3 stored
7	S 4	P C + . 1 0 0 0 E + 0 2 CR LF	LIM 4 stored
8	S 5	P C + . 8 5 0 0 E + 0 2 CR LF	LIM 5 stored
9	B D		Loss factor selected for second parameter

B: As A, but with a 0.2 % limit on loss factor.

Omit step 1 (see above) and enter step 2 to 8 and continue with:

STEP	PROGRAM CODE	INPUT STRING	NOTES
10	S C	S D C . 0 0 2 0 E + 0 0 CR LF	LIM 12 stored

(Enter step 10 alone if step 1 to 9 in example A is entered previously, i.e.: It is always possible to add limits).

C: Resistor measurements with a nominal value of 2.15 kΩ and deviation limits: -100Ω, -20Ω, +21Ω and +150Ω.

STEP	PROGRAM CODE	INPUT STRING	NOTES
1	L 2		Delete previously stored NOM VAL and
2	D 3		limits, if any, else omit step 1 and 2.
3	S N	_ R _ . 2 1 5 0 E + 0 4 CR LF	NOM VAL stored
4	S 0	R R − . 1 0 0 0 E + 0 3 CR LF	LIM 0 stored
5	S 1	_ R − . 2 0 0 0 E + 0 2 CR LF	LIM 1 stored
6	S 2	_ R + . 2 1 0 0 E + 0 2 CR LF	LIM 2 stored
7	S 3	_ R + . 1 5 0 0 E + 0 3 CR LF	LIM 3 stored

D: Inductance measurements, measured as series inductance and Q, and absolute limits: +2 mH, +2.5 mH.

STEP	PROGRAM CODE	INPUT STRING	NOTES
1	L 2		See notes above
2	D 3		See notes above
3	C S		Series Mode
4	S 0	_ L + . 2 0 0 0 E − 0 2 CR LF	LIM 0 stored
5	S 1	_ L + . 2 5 0 0 E − 0 2 CR LF	LIM 1 stored
6	B Q		Q selected for secondary parameter.

4.1.1 IEEE Input Codes.

Default values after Device Clear is marked with *

	PROGRAM CODE	RESULT
<u>2. Parameter Setting</u>		
B Code	B Q	Sec. param. Q
	B D	Sec. param. D
	B R	Sec. param. R
	B G	Sec. param. G (only in parallel)
<u>Circuit Mode</u>		
C Code	C A	Auto Mode (Deviation, Limit and LC-Lock OFF) *
	C S	Series
	C P	Parallel
<u>Deviation</u>		
D Code	D 0	Deviation OFF
	D 1	Deviation ON absolute
	D 2	Deviation ON %
	D 3	Deviation OFF, delete nominal value *
<u>Error Output</u>		
E Code	E 0	Error message SRQ OFF
	E 1	Error message SRQ ON *
	E 2	SRQ after CMD. exe. (done) OFF *
	E 3	SRQ - " - ON
	E 4	SRQ on fail Comp. OFF *
	E 5	- - - - ON

Bias	sign value	
G Code	G 0 30	Bias -3.0 V min. value
	G 0 01	Bias -0.1 V
	G 0 00	Bias -0.0 V OFF *
	G 1 01	Bias +0.1 V
	G 1 30	Bias +3.0 V max value
Frequency		
F Code	F L	Shift to 1 kHz *
	F O	Shift to 10 kHz
	F R	Shift to 100 kHz
Recall Status		
K Code	K F	Return FREQUENCY FLAG F-flag
	K K	Return K-flag
Jig Compensation		
J Code	J 0	Jig compensation OFF *
	J 1	Create Jig Compensation and set Jig Compensation ON (delay next CMD. code 450 msec.)
Limit		
L Code	L 0	Limit OFF *
	L 1	Limit ON, Normal Display
	L 2	Limit OFF, DELETE Limits
	L 3	Primary LIM in left display (limit ON)
	L 4	Secondary LIM in right display (limit ON)
	L 5	Primary + secondary limit in displays

		Limit selection on sec. parameter by double Frq. measurements:
	L6	Limits on sec. Frq. only
	L7	GO/NOGO limits on both frequencies
<u>Measurement Mode</u>		
M Code	M 0	Continuous measurement
	M 1 L	Double freq. meas. Sec. freq. 1 kHz
	M 1 0	Double freq. meas. Sec. freq. 10 kHz
	M 1 R	Double freq. meas. Sec. freq. 100 kHz
	M 1 0	Double freq. meas. OFF
<u>Data Output Control</u>		
O Code	O 0	Standard output *
	O 1	- - - Lim. info
		Only in use by double Frq. measurements:
	O 2	PFQ data on 1.parameter + PFQ & SFQ data on 2. parameter + lim info
	O 3	PFQ data on 1.parameter + PFQ & SFQ data on 2. parameter - lim info
	O 4	PFQ & SFQ data on 1. parameter & 2. parameter + lim info
	O 5	PFQ & SFQ data on 1. parameter & 2. parameter - lim info

	0 6	Data transmission after TRIG ON *
	0 7	Data transmission after TRIG OFF
<u>Display Control</u>		
P Code	P 0	Normal display *
	P 1	Left display OFF
	P 2	Right display OFF
	P 3	Both displays OFF
<u>Component Lock</u>		
Q Code	Q 0	LC-lock OFF *
	Q 1	LC-lock ON
	Q 2	R-lock OFF *
	Q 3	R-lock ON
<u>Recall Reference Value</u>		
R Code	R N	Return Nominal Value
	R 0-F	Return Limit X (X = 0 - 15)
<u>Store Reference Value</u>		
S Code	S N	Store NOM VAL for Deviation Mode
	S 0-F	Store Limit X (X = 0 - 15)
<u>Single Measurement</u>		
T Code	T R	Perform a single measurement (TRIG).
<u>Measuring Voltage</u>		
V Code	V 0 0	1 VRMS standard *
	V 0 1	0.1 VRMS
	V x x	x.x VRMS (0.1 VRMS step)
	V 1 5	1.5 VRMS (max. value)

4.1.2 Reference Value Output Codes.

				OUTPUT CHARACTER CODES
1.character	Nominal value			Space
	LIM 0 - F	Serial		S
		Parallel		P
2.character		Measuring function:		
	Nominal value	Resistance	(Ω)	R
		Inductance	(H)	L
		Capacitance	(F)	C
	LIM 0 - B		%	P
		Resistance	(Ω)	R
		Inductance	(H)	L
		Capacitance	(F)	C
		△ R	(Ω)	W
		△ L	(H)	H
		△ C	(F)	F
	LIM C - F		Q	Q
		Loss factor	D	D
		Serial/paral. resist.	(Ω)	R
		Parallel conductance	($\frac{1}{\Omega}$)	G
3.character	Nominal value			Space
	LIM 0 - B	SIGN OF VALUE		+
				-
	LIM C - F			Space
4.character		Decimal point		.

5. - 8. character	Value in 4 DIGITS	
9.character	Nominal value LIM O - B LIM C - F (Q, R, G) (D)	E E E Space
10.character	Nominal value Sign of exponent LIM O - B - " - LIM C - F (Q, R, G) - " - LIM C - F (D)	 + - Space
11. - 12. character	Nominal value Exp. in 2 DIGITS LIM O - B - " - LIM C - F (Q, R, G) - " - LIM C - F (D)	 Space
13.character		CR
14.character		LF

4.1.3 Reference Value Input Codes.

			STRING CHARACTER CODES
1.character	Nominal value (NOM VAL)		Space
	LIM 0	Absolute limits	Space
		Deviation limits	R
		% limits	P
	LIM 1 - B	Absolute limits	Space
		Deviation limits	Space
		% limits	P
	LIM C - F	Serial Mode	S
		Parallel Mode	P
2.character	Nominal value	Component:	
		Resistance (Ω)	R
		Inductance (H)	L
		Capacitance (F)	C
	LIM 0 - B	LIM components:	
		Resistance (Ω)	R
		Inductance (H)	L
		Capacitance (F)	C
	LIM C - F	Q	Q
		Loss factor D	D
		Serial/paral. res.(Ω)	R
		Parallel conduct. ($\frac{1}{\Omega}$)	G
3.character	Nominal value	Relative deviation	Space
		% deviation	P
	LIM 0 - B	SIGN OF VALUE	+
			-
	LIM C - F	LIM components:	
		Inductance	L
		Capacitance	C

4.character	Decimal point	.
5. - 8. character	Value in 4 DIGITS	
9.character		E
10.character	Nominal value Sign of exponent LIM 0 - B - " - LIM C - F (Q, R, G) - " - LIM C - F (D) - " -	+ - +
11. - 12. character	Nominal value Exp. in 2 DIGITS LIM 0 - B - " - LIM C - F (Q, R, G) - " - (D) - " -	 0
13.character		CR
14.character		LF

4.1.4 DATA Output Format.

MAIN PARAMETER CODES → Mat1ƒ		OUTPUT CHARACTER CODES
1.character	Circuit Mode Serial Parallel	S P
2.character	Measuring frequency 1 kHz 10 kHz 100 kHz	L O R
3.character	Measuring function Resistance (Ω) Inductance (H) Capacitance (F) △R (Ω) △L (H) △C (F) %	R L C W H F P
4.character	Sign of value	+ -- Space
5.character		Space
6 character	Decimal point	•
7. - 10. character	Value in 4 DIGITS	
11.character		E

12.character	Sign of exponent	+ −
13. - 14. character	Exponent in 2 DIGITS	
15.character	End of line	CR
16.character		LF

SECONDARY PARAMETER CODES → Meol 2∅		OUTPUT CHARACTER CODES
17.character		Space
18.character		Space
19.character	Measuring function Q Loss factor D Serial/paral. resist. (Ω) Parallel conductance (1/Ω) Serial inductance (H) Parallel capacitance (F)	Q D R G L C
20.character	Sign of value	+ −
21.character		Space
22.character	Decimal point	•
23. - 26. character	Value in 4 DIGITS	
27.character		E

28.character	Sign of exponent	+ -
29. - 30. character	Exponent in 2 DIGITS	
31.character		CR
32.character		LF

LIMIT PARAMETERS => Meet 3ø		OUTPUT CHARACTER CODES
33.character	With Limit Set Up on Main Param.,	L
34.character	(N = Bin Number), else spaces.	I
35.character		M
36.character		N
37.character		N
38.character	Delimiter	,
39.character		Space
40.character	With Limit Set Up on SEC. Param.,	L
41.character	(N = Bin Number), else spaces.	I
42.character		M
43.character		Space
44.character		N
45.character		CR
46.character		LF

4.1.5 Operational IEEE/IEC Sequences.

Data Transfer:

ATN	BUS COMMANDS	NOTES
1	UNL	Inhibits all current listeners.
1	MLA	More than one address may be sent if multiple listeners are desired. Each address sent enables a specific device to receive future data bytes.
1	MTA	The address sent enables a specific device to send data as soon as ATN becomes 0.
0	(data on bus)	One or more bytes (device dependant message) sent by the currently enabled listener. *)
1	UNT	Disables last talker from sending data if ATN is set to 0.

*) **NB:** Bytes may be sent until the controller again sets ATN to 1, f. ex. in order to repeat the sequence. If the talker is sending a specific length record, it may optionally set EOI = 1, while sending the last byte.

<u>Serial Poll</u> (issued by controller usually whenever SRQ = 1 on the interface):

ATN	BUS COMMANDS	NOTES
1	UNL	Prevents other devices from listening to status sent (controller continues to listen without being addressed).
1	SPE	Puts interface into Serial Poll Mode during which all devices send status instead of data when enabled.
1	MTA	Enables a specific device to send status. Within this loop, devices should be sequentially enabled.
0	(SBN or SBA)	Status Byte sent by enabled device. If SBN was sent, loop should be repeated. If SBA was sent, the enabled device is identified as having sent SRQ over the interface and will automatically remove it.
	or	
1	SPD	Removes the interface from Serial Poll Mode.
1	UNT	Disables last talker from sending data if ATN is set 0.

NB: SBN means the SRQ bit in Status Byte is false, SBA means the SRQ bit is true.

4.1.6 List of Commands Sent by Controller (ATN = 1).

MNEMONIC	COMMAND	DATA BUS (DIO lines)							
		8	7	6	5	4	3	2	1
DCL	Device clear	-	0	0	1	0	1	0	0
GET	Group execute trigger	-	0	0	0	1	0	0	0
GTL	Go to local	-	0	0	0	0	0	0	1
MLA	My listen address	-	0	1	L	L	L	L	L
MTA	My talk address	-	1	0	T	T	T	T	T
SDC	Selected device clear	-	0	0	0	0	1	0	0
SPD	Serial poll disable	-	0	0	1	1	0	0	1
SPE	Serial poll enable	-	0	0	1	1	0	0	0
UNL	Unlisten	-	0	1	1	1	1	1	1
UNT	Untalk	-	1	0	1	1	1	1	1

NB: LLLLL specify the device dependent bits of the device's listen address (f. ex.: CT30 bus address).

TTTTT specify the device dependent bits of the device's talk address (f. ex.: CT30 bus address).

The DCL command requieres app. 1 sec of execution time. The CT30 is reset and all previously stored data are deleted.

If an E3 was received before the DCL, the CT30 sends a SRQ after execution, and the Status Byte contains an ASCII D for done.

4.1.7 Remote Programming Example (including the operational sequence).

The programme sequence is: Restart the CT30, select 1 kHz, serial mode and tan d as secondary parameter, make one measurement with data transfer from the CT30 to the controller, change the frequency to 10 kHz and make a second measurement with data transfer.

The controller should be programmed to be interrupted by SRQ on the bus (service request), perform a serial poll sequency (see above) read the status byte and take action accordingly.

First: Set SW 90 on the rear panel to talker/listener mode, and IEE, EOI (if used) and the wanted CT30 bus address.

NB: The CT30 bus address must be different from the controller's bus address.

Second: Press [F] [0] [1] on the CT30 keyboard (force the CT30 to read SW 90 (and SW 91)).

The CT30 is now ready for remote control by means of the IEEE/IEC interface. The following are the communications over the bus as they should be according to the IEEE/IEC protocol.

Set the REN-line true (Remote enable) this sets all devices on the bus in Remote State, the Remote lamp on the CT30 will light as soon as it is addressed.

ATN	BUS COMMANDS	NOTES
1		Attention line true (indicating bus commands).
1	DCL	Resets the CT30 and other devices on the bus.
1	UNL	Inhibits all current listeners.
1	MTA	My talk address (controller's bus address, i.e. the controller will act as talker when the ATN is set to 0).
1	MLA	My listener address (CT30's bus address).
0	(data on bus)	The controller sends C S B D F L (device dependent message, which performs the desired CT30 set-up).
1	GET	Trigger to the CT30.
1	UNL	

The CT30 will now measure for about 25 msec. The controller is meanwhile free to work (service other devices on the bus f. ex.) as it awaits the SRQ from the CT30. SRQ is the way, according to the protocol, devices on the bus get attention from the controller (physically it is a WIRED-OR line so the controller must find out which device is calling, which is performed by carrying out a serial poll sequence).

ATN	BUS COMMANDS	NOTES
1	UNL	May be omitted dependent on previous sequences.
1	SPE	Serial poll enable. The controller will now address the devices on the bus sequentially and read their status byte in order to detect which device has called for service (SRQ bit ON).
1	MTA	CT30 bus address.
0	(status byte on bus)	The CT30 reurns its status byte: >40 meaning data ready.
1	SPD	Serial poll disable (remember to re-enable the interrupt on SRQ in the controller, other devices might seek access).
1	UTN	Disable last talker from sending (CT30) if ATN is set to 0.
1	MLA	Controller bus address, i.e. the controller will act as listener when ATN is set to 0.
1	MTA	CT30 address.
0	(data on bus)	The CT30 sends the result of the measurement as a continuous string, (use EOI for termination indication or count the number of bytes (see Section 4.1.4)).

1	UTN	Disable last talker.
1	MTA	Controller address.
1	MLA	CT30 address.
0	(data on bus)	The controller sends F 0 (change frequency to 10 kHz).
1	GET	Trigger to the CT30 (orders the second measurement).
1	UNL	

The CT30 will now perform the second measurement and set SRQ = 1 after less than 25 msec. interrupting the controller which has to perform another serial poll sequency (see above) after which it will address the CT30 to talk in order to get the resulting data on the bus.

4.1.8 Demonstration Program for CT30 using HP85A with HPIB Interface.

```
10   REM TEST PROGRAM FOR CT30
20   REM THIS PROGRAM USES CT30 ON ADDRESS 10 AND HP1B
     INTERFACE SELECT 7
30   LET A=710
40   DIM A$ [100]
50   DIM B$ [20], C$ [20], D$ [20]
60   ENABLE INTR 7;8! SRQ
70   ON INTR 7 GO TO 320
80   REMOTE 7
90   CLEAR
100  DISP "MENU SELECTION:"
110  DISP "REQUEST MEASUREMENT: - MEAS"
120  DISP "LIST MENU: - HELP"
130  DISP "EXIT PRG.& GO TO LOCAL - EXIT"
140  DISP "CHARS TO CT30: ENTER CHARS"
150  INPUT A$
160  IF A$ = "MEAS" THEN GO TO 260
170  IF A$ = "HELP" THEN GO TO 90
180  IF A$ = "EXIT" THEN GO TO 280
190  IF LEN (A$)>2 THEN GO TO 230
200  OUTPUT A USING "#,AA": A$
210  PRINT USING "AA": A$
220  GO TO 150
230  OUTPUT A USING "14A": A$
240  PRINT USING "14A": A$
250  GO TO 150
260  TRIGGER A
270  GO TO 270
280  SEND 7: UNT LISTEN A-700
290  LOCAL 7
300  RESUME 7
```

```
310  GO TO 560
320  REM INTERRUPT
330  STATUS 7, 1; B
340  LET B = SPOLL (A)
350  ENABLE INTR 7; 8!
360  LET B$ = DTH$(B) & DTB$(B)
370  PRINT USING "K,K,K,K,K,K,X,K,K"; SERIAL POLL:",B,"d",B$
     [3,4],"h", B$ [13,16], B$ [17,20], "b"
380  IF B<>64 THEN GO TO 150
390  IF A$ = "KK" THEN GO TO 470
400  IF A$ = "KF" THEN GO TO 500
410  IF A$ [1,1] = "R" THEN GO TO 530
420  ENTER A; B$, C$, D$
430  PRINT B$
440  PRINT C$
450  PRINT D$
460  GO TO 150
470  ENTER A USING "#,#W"; B
480  PRINT USING "K,K"; "KFLAG="; DTH$(B)
490  GO TO 150
500  ENTER A USING "#,#W"; B
510  PRINT USING "K,K"; "FFLAG="; DTH$(B)
520  GO TO 150
530  ENTER A; B$
540  PRINT B$
550  GO TO 150
560  PRINT "PROGRAMME TERMINATED"
570  END
```

4.2 RS 232C Interface.

Transmission Format: V24 asynchronous data.

RS 232C Control Switch.

The RS 232C control switch (SW91), located in the middle of there rear panel, controls the data transmission capabilities.

SW91

OFF	1	OFF	ODD	OFF				0
TON	STOP BIT	PARITY	PARITY (ON)	SPLIT MODE				
ON	2	ON	EVEN	ON	BAUD RATE			1

Split Mode:

Receive Rate according to BAUD RATE setting

Transmission Rate 300 Baud	(ON)
Transmission Rate equal to Receive Rate	(OFF)

BAUD RATE SETTING	BAUD RATE
000	110 Baud
001	300 Baud
010	600 Baud
011	1200 Baud
100	2400 Baud
101	4800 Baud
110	9600 Baud
111	19200 Baud

DATA Input Format.

The data input format is equal to the IEEE input format, except for the control codes. See Section 4.1.1 for details.

N.B.: The CT30 will go to IDLE-state whenever it has received DATA from the Rs 232C interface (except MO, *T or *M) waiting for more data or an external trig.

Control Codes.

INPUT ORDERS	RESULT
*R	Go to remote control.
*L	Go to local control.
*T	Perform a single measurement.
*M	Perform continuous measurements.
*C	CLEAR. restart CT30 in Auto Mode and 1 kHz.

WARNING: ALL PREVIOUSLY STORED DATA ARE DELETED !

Data Transfer Control.

Set SC3 pin 20 (DTR) High (f. ex. connect pin 20 to pin 5 or 6, which are both connected by 3 kΩ to +12 V). The interface signal Printer Busy, Low (from -3 to -12 V), to SC3 pin 20 will cause the transmission in progress to stop.

The transmission will continue as soon as DTR returns to High, (+3 to +12 V).

The DTR pin is tied to -12 V by 21 kΩ internally and may be left unconnected if a "Busy" signal to stop transmission is not required.

Data Output Format.

4 characters in a continuous string (RETURN STATUS).
32 characters in a continuous string without limits.
46 characters in a continuous string with limits.

In case of double frequency measurements extra blocks of 16 characters each may be added containing data on 1. parameter and 2. parameter on both PFQ and SFQ (primary & secondary frequency). These extra blocks of data are selected by means of the O code (see sec. 4.1.1).
Each string is terminated with CR LF CR LF.

See Section 4.1.4 for details.

Fault Indication.

CT30 returns 2 characters terminated by CR LF CR LF:

*A	Syntax error in input string.
*C	RN, D1 or D2 received without a stored reference value.
*D	COMMAND DONE
*E	R 0 - 15 or L1 received without a stored reference value .
*G	L1 received with stored deviation limit, but without a nominal value, or deviation limits stored without a compatible nominal value, or LC-Lock ON and stored limits on Q or D.
*I	R12 received without a stored reference value.
*M	Measurement error 'WRONG' component (i.e. measured component not compatible with Nomval or Lim component in active Deviation or Lim Mode)
*O	Non Digit character in value string.
*Q	Double Frequency Measurement not activated. Primary and secondary frequencies are equal.
*Y	Jig ZERO not possible (Component on jig)
*q	Double Frequency EXIT, measurement ERROR.
*y	LC-Lock not activated (LIM on Q or D?).
*u	R-Lock not activated (LIM or DEV on L or C)

ADDITIONAL FEATURES IN THE NEW A-SOFTWARE FOR CT30

EXTERNAL TRIG MODE:

DISPLAYS ARE OPERATIONAL DURING TRIG

ALL F3 CODES ARE AVAILABLE.

F 3 1	BLANKING LEFT DISPLAY
F 3 2	BLANKING RIGHT DISPLAY
F 3 3	BLANKING BOTH DISPLAYS
F 3 0	NORMAL DISPLAYS

RELOAD

F 0 1 ENTER	CT30 WILL BE SET UP FOR DATA COMMUNICATION
F 0 1 CLR	DATA COMMUNICATION WILL BE CANCELLED

READ SETTING OF DATA COMMUNICATION SWITCHES

F 0 1 C/L	READ SETTING OF IEEE SWITCH (SW90)
F 0 1 R/G	READ SETTING OF RS232C SWITCH (SW 91)

LOCK MODE

F L/C	LC LOCK ON
F 8 0	C LOCK ON
F 8 1	L LOCK ON
F R/G	R LOCK ON
CLR	CANCEL LOCK MODE

88-04-08 EJ

SC1 (LIM OUTPUT)

	A	C	
NC	.	1 .	BIN 0
NC	.	2 .	BIN 1
NC	.	3 .	BIN 2
NC	.	4 .	BIN 3
NC	.	5 .	BIN 4
NC	.	6 .	BIN 5
NC	.	7 .	BIN 6
NC	.	8 .	BIN 7
NC	.	9 .	BIN 8
NC	.	10 .	BIN 9
NC	.	11 .	BIN 10
NC	.	12 .	BIN 11
NC	.	13 .	BIN 12
NC	.	14 .	NC
NC	.	15 .	NC
NC	.	16 .	TRIG READY
NC	.	17 .	NC
NC	.	18 .	COMMON +
NC	.	19 .	NC
NC	.	20 .	BIN 0----PFQ GO
NC	.	21 .	BIN 1---- - NOGO
NC	.	22 .	BIN 2----SFQ GO
NC	.	23 .	BIN 3---- - NOGO
NC	.	24 .	BIN 4
NC	.	25 .	MEAS END
NC	.	26 .	DATA READY
NC	.	27 .	TRIG
NC	.	28 .	COMMON +
NC	.	29 .	DIG GROUND
NC	.	30 .	DIG GROUND
NC	.	31 .	NC
NC	.	32 .	NC

(BIN 0 – BIN 3, pins 20–23:) Limits on both PFQ & SFQ on secondary parameter.

SC1A (CTRL)

NC	.9	1.	TRIG READY
NC	.10	2.	MEAS END
NC	.11	3.	DATA READY
NC	.12	4.	NC
NC	.13	5.	TRIG INPUT
NC	.14	6.	NC
TRANSMISSION ON/OFF	.15	7.	NC
		8.	SIGNAL GROUND

SC2 (RS232C)

NC	.14	1.	PROTECTIVE GROUND
NC	.15	2.	RECEIVE DATA INPUT
NC	.16	3.	TRANSMIT DATA OUTPUT
NC	.17	4.	NC
NC	.18	5.	PSEUDO CLEAR TO SEND OUTPUT
NC	.19	6.	DATA SET READY OUTPUT
DATA TERMINAL READY INPUT	.20	7.	SIGNAL GROUND
NC	.21	8.	REQUEST TO SEND OUTPUT
NC	.22	9.	NC
NC	.23	10.	NC
NC	.24	11.	NC
NC	.25	12.	NC
		13.	NC

SC3 (IEEE)

DIO 5	.13	1.	DIO 1
DIO 6	.14	2.	DIO 2
DIO 7	.15	3.	DIO 3
DIO 8	.16	4.	DIO 4
REN(24)	.17	5.	EOI(24)
GROUND(6)	.18	6.	DAV
GROUND(7)	.19	7.	NRFD
GROUND(8)	.20	8.	NDAC
GROUND(9)	.21	9.	IFC
GROUND(10)	.22	10.	SRQ
GROUND(11)	.23	11.	ATN
GND.LOGIC	.24	12.	SHIELD

SC8 (BRIDGE MODULE)

RE1F	.14	1.	RA1F
RE2F	.15	2.	RAOF
RE3F	.16	3.	-15V BAL
RE8F	.17	4.	+15V BAL
RE4F	.18	5.	+15V GEN
RE7F	.19	6.	-15V GEN
RE6F	.20	7.	ANALOG GROUND
RE5F	.21	8.	ANALOG GROUND
RE9F	.22	9.	ANALOG GROUND
CRU8 BIN9	.23	10.	ANALOG GROUND
NC	.24	11.	ANALOG GROUND
+5V	.25	12.	RA2F
		13.	+12V

SC9 (CT30R ONLY)

$\overline{\text{WE}}$	.20	1.	$\overline{\text{BLOCK 46}}$
D8	.21	2.	+15V
D9	.22	3.	INT14
D10	.23	4.	DIG GROUND
D11	.24	5.	$\overline{\text{OE}}$ KEY 1
D12	.25	6.	$\overline{\text{OE}}$ KEY
D13	.26	7.	INT13
D14	.27	8.	D15
Φ3	.28	9.	DBIN
CRU12H	.29	10.	+15V
CRU13H	.30	11.	CRU11H
A12	.31	12.	CRU13L
A13	.32	13.	CRU12L
A14	.33	14.	CRU11L
CRUOUT	.34	15.	CRU10L
CRU10H	.35	16.	$\overline{\text{RST1}}$
DIG GROUND	.36	17.	PH
NC	.37	18.	NC
		19.	NC

73722	CT30	RETTET / GODK.
	EXTERNAL CONNECTIONS	TEGNET 301088 BRAS