SECTION 2
OPERATION

2.1 FRONT PANEL CONTROLS AND INDICATORS

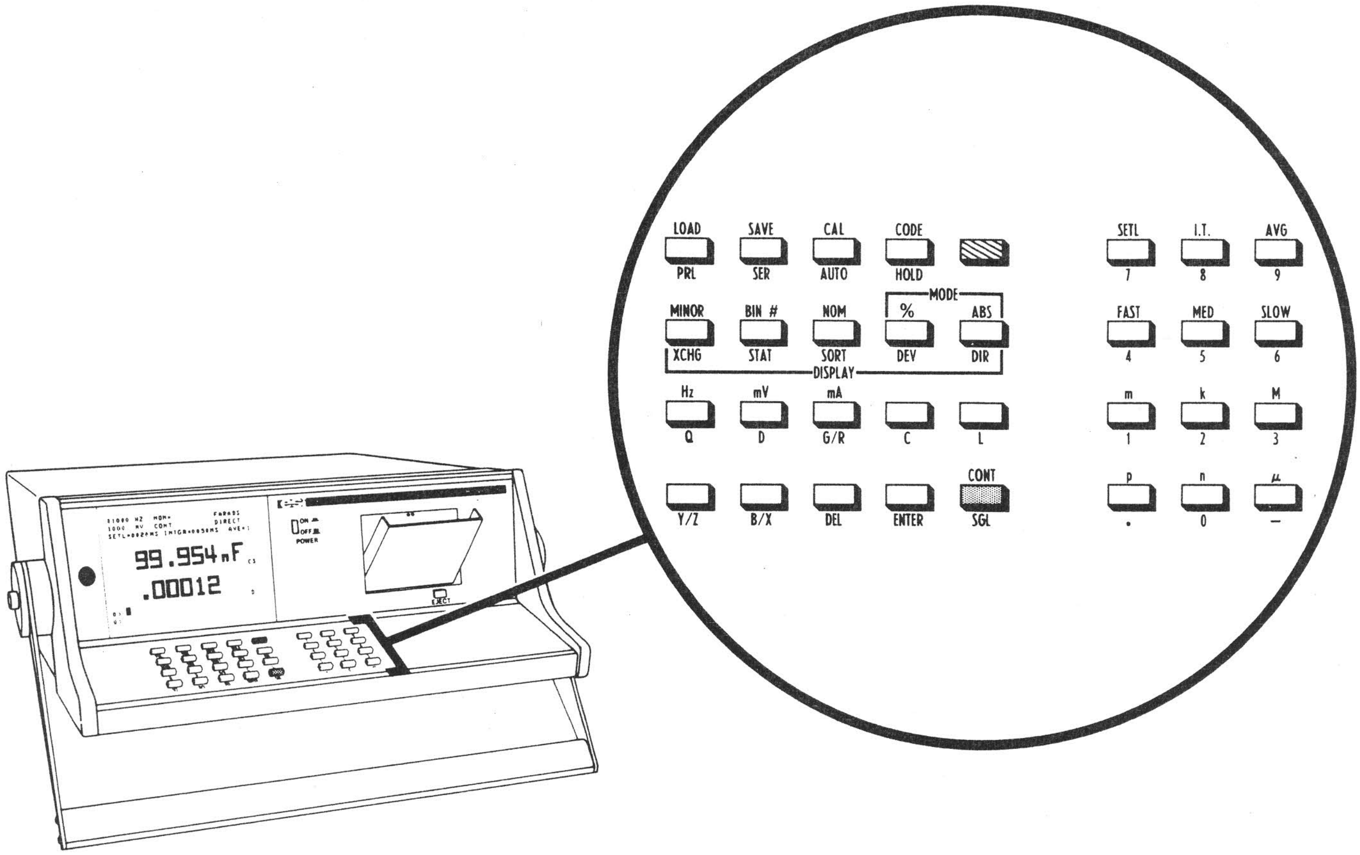


Figure 2-1. Model 2160 Front Panel

2.1.1 Keyboard and Key Definitions

The Model 2150/2160 keyboard has 32 keys to control all instrument operations. Many of the keys have labels for more than one function. The functions labeled in white are selected by pushing the key directly above it. Alternate functions, labeled in blue, are selected by pushing the blue key followed by the key directly below the desired function. The following list defines each key function.

Single measurement mode key makes one measurement and holds the displayed result. The BIN counter is updated for each measurement made (regardless of operational mode selected).

Continuous measurement mode key automatically starts a new measurement as soon as the present measurement is finished. BIN counters are not updated.

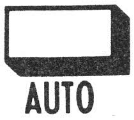
Series equivalent circuit key, in conjunction with the measurement function, selects the equivalent circuit element of the unknown component to be measured.

Parallel equivalent circuit key, in conjunction with the measurement function, selects the equivalent circuit element of the unknown component to be measured.

Zero correction key. Stores L, R, C, and G zero correction values to compensate for test fixture reactance (L and C) and loss (R and G) components. Prompts user to close and open test fixture for 5 range calibration process.

Range Hold key allows rapid checking of many components in the same range.

Measurement Controls (cont)



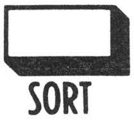
Auto key returns unit to autoranging mode. Autoranging is automatically selected when the instrument is first turned on.

Upper function key selects functions labeled in blue.

DISPLAY CONTROLS

Exchange key interchanges the top measurement display function with the bottom display function. One exchange takes place for each push of the key.

Status key toggles the display between binning (status) display format and the previous format. The display format changes once for each push of the key.



Sort key enters the instrument into the component sorting mode. Display indicates bin number or bin R (for reject) for each component measured. The Bin Counter is activated only in the SINGLE measurement mode.

DEV

Deviation (display) key enters the deviation measurement mode. After a nominal value is set, the top measurement display will indicate absolute or percent deviation from the nominal value.

DIR

Direct (display) key puts the instrument into normal (direct) display operation. Takes display out of: Auto LRC, GO/NO-GO, Deviation, and Status modes.

DEL

Delete key erases the last character entered; does not affect previously entered data.

Impedance Functions

Q

Quality Factor key selects the Q measurement function as the bottom display function.

D

Dissipation factor key selects D measurement function as the bottom display function.

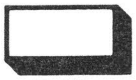
C

Capacitance function key selects F (farads -- units of capacitance) as the top display function.

L

Inductance function key selects H (henrys -- units of inductance) as the top display function.

Impedance Functions (cont)

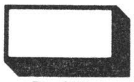


G/R

Conductance(G) / Resistance(R) function key selects S (siemens -- units of conductance) or Ω (ohms -- units of resistance) as the bottom display function. R_s is normally displayed in the series equivalent circuit mode, and R_p is displayed in parallel equivalent circuit mode. G_s can be selected by pressing the G/R key a second time while in series circuit mode. G_p can be selected by pressing the G/R key a second time while in parallel circuit mode.

Y/Z

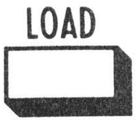
Admittance(Y) / Impedance(Z) function key selects either S (siemens -- units of admittance) or Ω (ohms -- units of impedance) as the top display function. Z is normally displayed in series and parallel equivalent circuit modes. Y is displayed in either mode by pressing the Y/Z key a second time.



B/X

Susceptance(B) / Reactance(X) function key selects either S (siemens -- units of susceptance) or Ω (ohms -- units of reactance) as the top display function. X_s is normally displayed in series equivalent circuit mode, and X_p is displayed in parallel equivalent circuit mode. B_s is displayed by pressing the B/X key a second time in series mode, while B_p is selected by pressing B/X a second time in parallel circuit mode.

Cassette Functions (2160 Only)

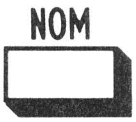


Load function key re-programs the instrument with measurement parameters stored on the cassette tape.

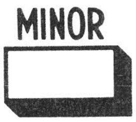
Save function key stores the instrument's parameters on the cassette tape.

Deviation and Limits Functions (a = numerical argument precedes key)

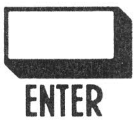
(a)**Bin number key** selects the bin for which limit values will be entered.



(a)**Nominal value key** is used to enter a comparison value for deviation or sorting measurements. Entering a nominal value resets all bin counts to zero (see Section 2.6.1 for more information).

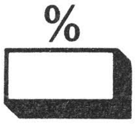


(a)**Minor limit key** is used to enter a maximum or minimum reject limit for the secondary function when programming limits for the sorting mode. For Q and siemen values, the entry will be a minimum limit. Entries for D and ESR will be maximum limits.

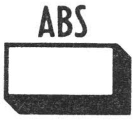


Enter key is used as a space bar.

Deviations and Limits Functions (cont)

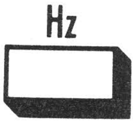


Percent mode key is used 1) to select percent DEViation display to show deviations from the nominal value, 2) to change STATUS page to set limits in percent.

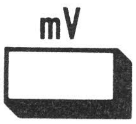


Absolute mode key is used 1) to select absolute DEViation display to show deviations from the nominal value, 2) to allow limits on STATUS page to be set as absolute values.

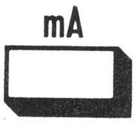
Test Frequency and Level (a = numerical argument precedes key)



(a)**Frequency key** enters a desired test frequency in hertz (Hz). Available frequencies below 10kHz are found by $F = 60kHz/N_1$ Where: N_1 is an integer $1 \leq N_1 \leq 3000$. Frequencies above 10kHz are found by $F = 300kHz/N_2$ Where: N_2 is an integer $2 \leq N_2 \leq 30$. See Section 2.5.1 for more details concerning test frequencies.

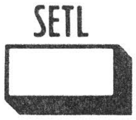


(a)**Test voltage level key** enters a test voltage from 5mV to 1500mV in 1mV steps.

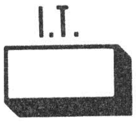


(a)**Test current level key** enters a test current from 0.1mA to 100mA in 0.1mA steps.

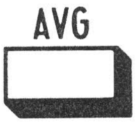
Measurement Time (a = numerical argument precedes key)



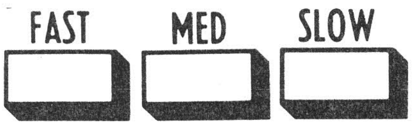
(a)**Settling time key** enters a time in milliseconds. After initiating a measurement, the instrument waits the selected time then starts the measurement. Settling times from 2ms to 1500ms can be entered in 1ms steps.



(a)**Integration time key** enters a time in milliseconds. This determines the number of test cycles performed on the device-under-test. Short integration times are less accurate than longer times and allow less measurement resolution. Integration times range from 2ms to 600ms (see Section 2.8.2 for more information.)



(a)**Average measurements key** enters the number of measurements (1 to 20) to be averaged for the result displayed.

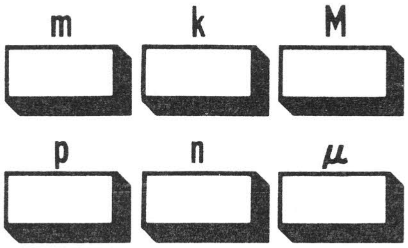


Fast, Medium, Slow keys choose preselected values of Settling Time, Integration Time, and number of measurements averaged.

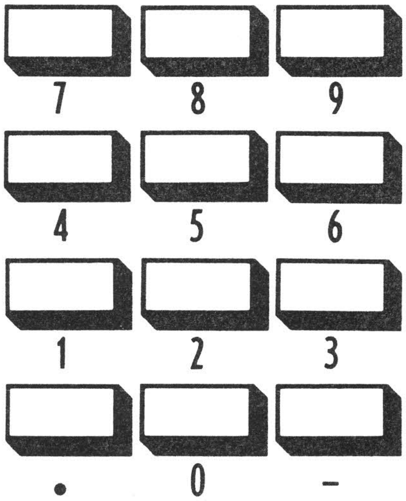
	SETL	I.T.	AVG
Fast	5ms	10ms	1
Medium	50ms	50ms	1
Slow	50ms	50ms	10

NOTE: Overall measurement speed is also dependent upon such factors as test frequency and display mode. See Section 2.8 for a complete description of measurement speed calculation.

Numerical and Unit Multiplier Keys

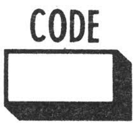


Multiplier prefix keys modify the basic units programmed. m = milli, k = kilo, M = mega, p = pico, n = nano, and u = micro.



Number keys are for keyboard entry of desired numerical arguments or data into the instrument.

Test Code Selection (a = numerical argument precedes key)



(a)**Code key** enables special functions not directly available on the VideoBridge keyboard. Pressing <blue> <CODE> displays the list of test code numbers and names on the CRT.

2.1.1.1 Test Codes

Test codes provide a means by which additional functions, not available directly on the keyboard, can be entered to further enhance the operation of the VideoBridge. Table 2-1 lists these functions and their programming codes. The procedure for programming the test code functions is as follows:

STEP 1. Push the number key or keys representing the desired function from the list in Table 2-1 (for negative test codes, press the minus sign, <->, before pressing the number key.)

STEP 2. Push the blue key.

STEP 3. Push the CODE key.

Example: Turn ON Bias (test code 1)

Push 

Table 2-1 is a list of these functions. All test codes apply to both the Model 2150 and Model 2160 unless otherwise stated. Numbers in parenthesis following a test code refer to the manual sections where further information may be found.

CAUTION

DO NOT USE NEGATIVE TEST CODES IF NOT LISTED. ILLEGAL ENTRIES MAY CAUSE INSTRUMENT MALFUNCTION ALONG WITH LOST OR ALTERED DATA. IF THE VIDEOBRIDGE BECOMES "HUNG UP", POWER MUST BE SHUT OFF TO RESET.

CAUTION

DO NOT ENTER TEST CODE 6 OR TEST CODE -6 WITHOUT ZRAM OPTION INSTALLED.

Table 2-1. Model 2150/2160 Test Code Functions

TEST CODE NO.	FUNCTION
CODE	Pushing <blue> <CODE> displays the list of test code names on the CRT display:

1	BIAS	15	BIN PRIORITY
2	RESET BINS	16	ANALOG BUSY
3	FORMAT TAPE	17	AUTO-LRC
4	PPM-D	18	(9) TO TAPE
5	RANGE HOLD	19	FILE NAME
6	Z-RAM	20	ALPHA KB
7	EDITION/BOOT	21	GO/NO-GO
8	HANDLER MODE	22	UN-CAL
9	KEYBOARDLOCK	23	GPIB/PET
10	OUTPUT CH-B	24	GPIB ADDR
11	STATUS>CH-B	25	GEN-REV
12	TAPE DIR.	26	BIN#+VALUE
13	LOAD SOURCE	27	MIN DIGITS
14	TAPE DELETE	28	---

(This table is continued on the following pages.)

Table 2-1. Model 2150/2160 Test Code Functions (cont)

TEST CODE NO.	FUNCTION
1 and -1	BIAS. Bias voltage is ON (capacitor measurements with voltage bias). To remove the bias voltage from the device-under-test use -1 CODE (2.10).
2	RESET BINS. All bin counters are set to zero--also clears counts in Non-Volatile Memory (2.7.5).
-2	RESET BINS. All bin counters and limits are set to zero--also clears limits and bin counters in Non-Volatile Memory (2.7.5).
3	FORMAT TAPE. Erases and formats cassette tapes--Model 2160 only (2.9.3).
4 and -4	PPM-D. 4 CODE enables dissipation factor display in parts per million (ppm). Half-sized zeroes appear to the right of significant digits to indicate proper ppm D value (e.g. .00012 D = 12o. ppm D). -4 CODE clears this mode (2.4.1).
5	RANGE HOLD (Automatic). The instrument will auto-range until it measures a part which is within 20 percent of a specified value, then enter the RANGE HOLD mode without further operator intervention. Value argument must be entered first. Percent limit is also selectable (2.5.3.1).

Table 2-1. Model 2150/2160 Test Code Functions (cont)

TEST CODE NO.	FUNCTION
6 and -6	Z-RAM. Memory Backup--when the Non-Volatile Memory option is installed, the VideoBridge saves set-up and bin count information during a line voltage failure or after a normal power down. Data storage is enabled by test code 6, and stored data is recalled by test code -6. DO NOT USE UNLESS NON-VOLATILE MEMORY OPTION IS INSTALLED (A.3).
7	EDITION. The screen readout will show the version number and date of the instrument's software. Also, installed RAM (Random Access Memory) capacity will be indicated as 4k for Model 2150 or 16k for Model 2160.
-7	BOOT. The instrument automatically returns to its power up conditions, which is useful for remote programming (2.3.2).
8	HANDLER MODE. Locks out the keyboard when handler interface option is installed. The display will read "NOW IN HANDLER MODE." The display is not active under this code. To de-activate this mode, temporarily ground Pin 21 of the Handler Interface rear panel connector (2.7.6, A.1).
-8	HANDLER MODE. Sets the VideoBridge to a special Handler routine displaying BIN number while locking the keyboard (2.7.6, A.1).

Table 2-1. **Model 2150/2160 Test Code Functions (cont)**

TEST CODE NO.	FUNCTION
9 and -9	KEYBOARD LOCK. 9 CODE locks all the keys except the SINGLE key. -9 CODE unlocks the keyboard. The keyboard may also be unlocked by one of the following methods: 1. Ground pin 21 on the Handler Interface rear panel connector. 2. Type "UNLOCK" through the GPIB Interface. 3. Type "UNLOCK" through Channel B of the RS-232C Interface (Appendix A).
10 and -10	OUTPUT CH-B. 10 CODE outputs measured results through Channel B of the RS-232C Interface at the end of each measurement cycle. -10 CODE clears the remote output command (A.2.1.2).
11	STATUS>CH-B. 11 CODE outputs status information from both the direct display and the status display of the VideoBridge through Channel B of the RS-232C Interface (A.2.9.1).
12	TAPE DIR. Displays the table of contents for a tape (2160 only). The filenames will be listed with the starting block to the left of the file-name (2.9.4.1).

Table 2-1. Model 2150/2160 Test Code Functions (cont)

TEST CODE NO.	FUNCTION
13	LOAD SOURCE. Load source code applications programs for Model 2160 (2.9.6.1).
14	TAPE DELETE. Deletes a specified file for Model 2160 only (2.9.6.2).
15 and -15	BIN PRIORITY. Redefines the binning priority when sorting capacitors. When a minor reject is detected, the VideoBridge makes an additional comparison to separate open-circuit parts into Bin 0 instead of Bin R. -15 CODE clears this mode (2.7.7).
16 and -16	ANALOG BUSY. The Analog Busy signal (or End of Conversion, EOC) is enabled for use with the Handler Interface Option. This mode allows the handler to advance to the next component for testing while calculations are still being made on the previous device-under-test. To clear this mode, use -16 CODE. Do not use 16 CODE unless Bin 11 limits have been set to zero (A.1.3).
17	AUTO LRC. The bridge will autorange and select the proper function for the component connected. Test frequency, test level, measurement speed, measurement mode (single or continuous) and equivalent circuit remain as programmed. To exit this mode, press any impedance measurement function key, any display mode key, or the HOLD key (2.3.2.)

Table 2-1. **Model 2150/2160 Test Code Functions (cont)**

TEST CODE NO.	FUNCTION
18	(9) TO TAPE. Saves keyboard lock (9 CODE) to tape on the Model 2160. To unlock the keyboard after the tape file has been loaded, use -9 CODE (2.9.5.3).
19	FILE NAME. Displays filename of last file loaded on the Model 2160. Upon entering this code, the VideoBridge will display: [FILE= filename] (2.9.6.4).
20 and -20	ALPHA KB. 20 CODE redefines the main VideoBridge keyboard to include full alphanumerics. To clear the alpha keyboard mode and return to the normal (default) keyboard mode, use -20 code (2.1.1.2)
21	GO/NO-GO. The GO/NO-GO mode displays PASS or FAIL symbols on the CRT display (2.7.8).
22 and -22	UN-CAL. Temporarily removes "CALIB" condition from present test setup. Zero correction offsets are recalled when either the test frequency or the test level for that setup is re-entered. -22 CODE permanently erases all stored zero offset values (2.3.5).
23 and -23	GPIB/PET. The SRQ line is reset when the VideoBridge is addressed as a talker. To clear this mode, use -23 CODE (A.2.16.3).

Table 2-1. Model 2150/2160 Test Code Functions (cont)

TEST CODE NO.	FUNCTION
24	GPIB ADDR. With the GPIB option installed, the instrument will display the address setting of the switches on the GPIB circuit card--P/N 46114 (A.2.8).
25 and -25	GEN-REV. Enables generator reversal for frequencies below 200Hz for noise reduction. -25 CODE (default condition at power-up) disables generator reversal below 200Hz, allowing faster measurement speeds. Entering FAST measurement mode also disables generator reversal (2.8, 3.3.1.1).
26 and -26	BIN # + VALUE. Top and bottom measurement values are displayed in small characters while in SORT mode. To clear this mode use -26 CODE (2.7.6).
27 and -27	MIN DIGITS. Allows the number of digits displayed to exceed limits normally applied by the VideoBridge. When preceded by a number between 1 and 6, this test code causes at least that number of digits to be displayed. -27 CODE programs 1 as the minimum digits displayed (1.1).
28	Not used.

2.1.1.2 Keyboard Overlay (2160 Only)

The Keyboard Overlay (P/N 55413) is used in conjunction with 20 CODE to redefine the main keyboard of the VideoBridge for full alphanumerics. The principal use of these characters is for entering names of cassette files. These names are listed on the tape directory (12 CODE) and are also used when storing and retrieving measurement data on the tape. For more information on using 20 CODE and the Keyboard Overlay to create tape file names, refer to section 2.9.5 of this manual.

> **NOTE:** The Keyboard Overlay is silkscreened on both sides. One side has the original keyboard functions. The other side has the new alphanumeric keyboard functions. Under normal operation, the overlay can be stored over the main keyboard with the original keyboard function face up. When the alternate keyboard function mode is selected, the overlay can be turned over to reveal the new alphanumeric functions. All discussion in this manual regarding the alternate keyboard function mode assumes the overlay is stored on the keyboard.

The Statistics and Analog applications programs use their own keyboard overlay. Each of these overlays is extended to fit over the 12 auxiliary keys as well as the main keyboard. When using STAT or ANALOG, these 12 keys on the righthand side of the keyboard are also redefined to display the appropriate applications program function.

STAT keyboard overlay--P/N 55410
ANALOG keyboard overlay--P/N 55412

The Alternate Keyboard layout
is as follows:

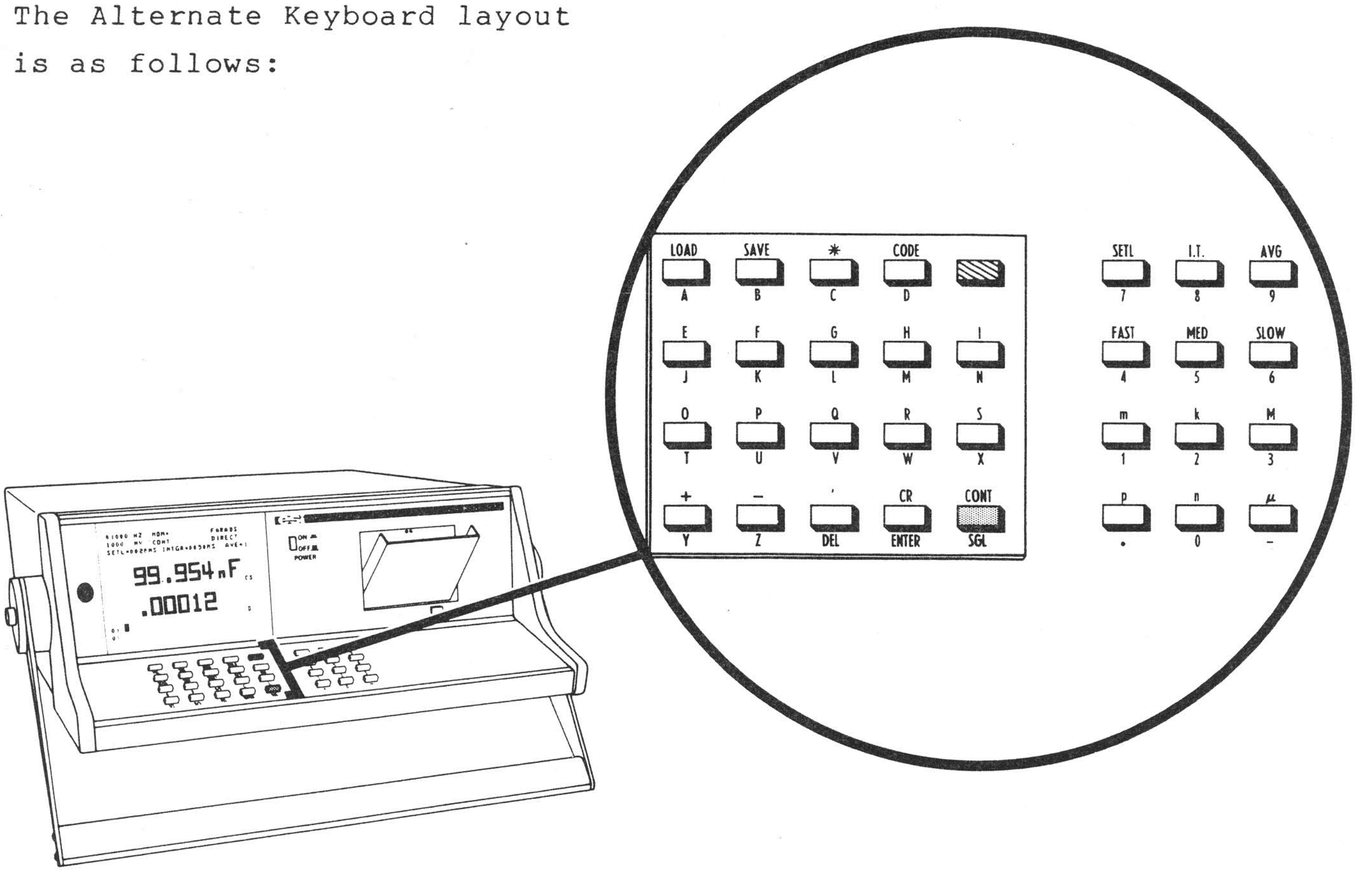


Figure 2-2. Model 2160 Front Panel with Overlay

Many keys on the keyboard have more than one function. A function labeled in white is selected by pushing the key directly above the label. An alternate function, labeled in blue, is selected by pushing the blue key followed by the key directly below the desired function. The following describes each key. (See Section 2.9.5)

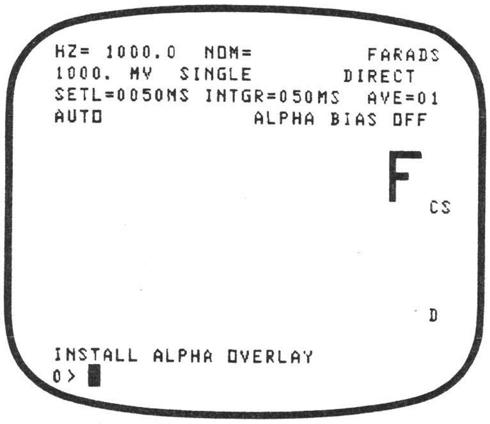
KEY	DEFINITION
A-Z	Letters for entering tape filenames. Each character is echoed on the CRT as it is entered.
+,-, *	Plus, minus, and asterisk keys for entering tape filenames. Each character is echoed on the CRT as it is entered.

KEY	DEFINITION
'	Apostrophe. This MUST precede the file name when loading a file from tape or saving a file onto tape.
<blue>	Upper function key selects functions labeled in blue.
CODE	Selects special instrument functions not available directly on the keyboard. (See Section 2.1.1.1 Test Codes in this Manual for more details.)
SAVE	Stores the instrument's parameters on cassette tape. File name must be preceded by the ' sign. (Refer to Section 2.9.5, Saving Parameters for more information.)
LOAD	Re-programs the instrument with measurement parameters stored on the cassette tape. File name must be preceded by the ' sign. (Refer to Section 2.9.6, Loading Parameter Programs for more information.)
CR	CARRIAGE RETURN. Terminates special commands.
CONT	CONTINUOUS measurement mode. Operates in the same manner described in Section 2.1.1 in this manual.
DEL	DELETE last entry. Operates in the same manner described in Section 2.1.1 in this manual.

KEY	DEFINITION
ENTER	ENTER key is used for spacing as described in Section 2.1.1 in this manual.
SGL	SINGLE measurement mode. Operates in the same manner described in Section 2.1.1 in this manual.

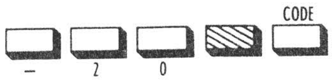
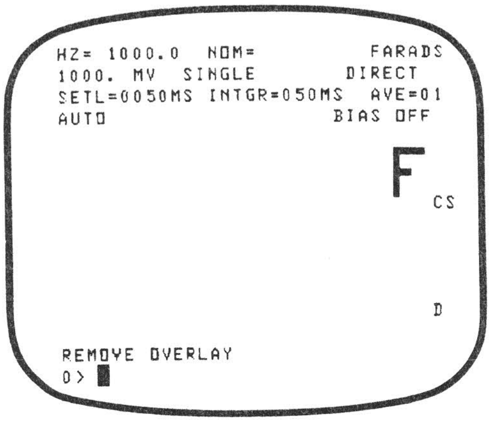
To enter the alternate keyboard function mode, push <2> <0> <blue> <CODE>. The CRT will indicate that the alpha keyboard overlay is now operational.

EXAMPLE:

Push	**Display**	**Comments**
		Indicates the ALPHA mode has been entered. Place the keyboard overlay alternate function side up.

To exit this mode and return to the original keyboard functions mode, push <-> <2> <0> <blue> <CODE> and follow the instructions on the CRT.

EXAMPLE:

Push	**Display**	**Comments**
		Place the keyboard overlay original function side up.

(For more information, refer to Section 2.9.5 Saving Parameters in this Manual.)

2.1.2 CRT Display

The 5-inch (diagonal) cathode-ray tube (CRT) presents a simultaneous display of those test parameters and measurement results that are most important to the operator. Models 2150/2160 feature two display formats--normal (direct) and binning (status).

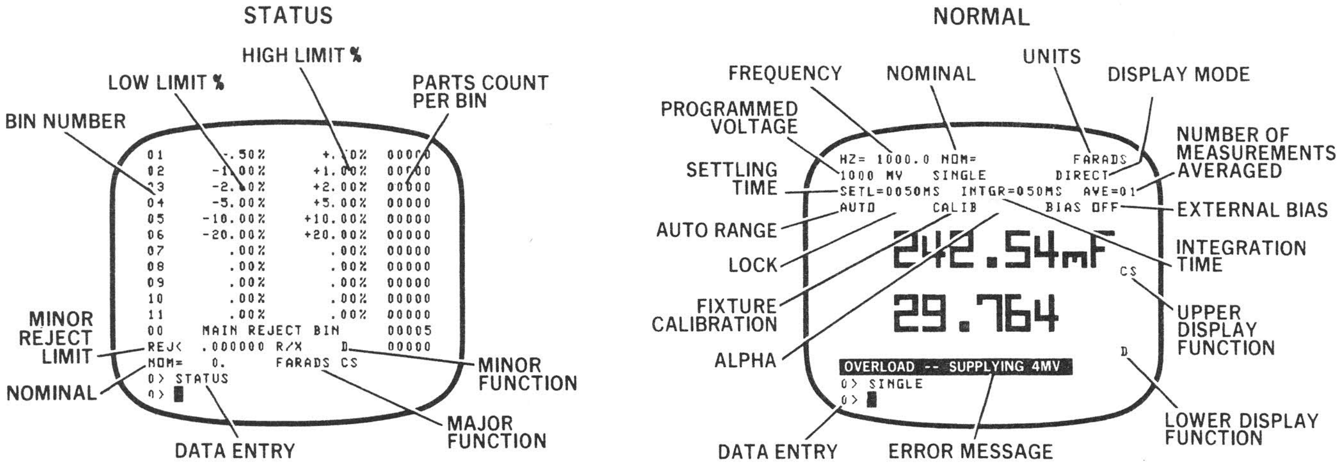


Figure 2-3. CRT Display Formats

Normal display format can be broken-down into three major areas:

1. Parameter field (top portion of CRT screen). It contains:
   - Test frequency in hertz (Hz)
   - Nominal value (when programmed)
   - Units of the top measurement display function
   - Test signal level in millivolts (mV) or milliamperes (mA)
   - Measurement mode -- continuous (CONT) or single (SINGLE)
   - Display mode -- Direct, Auto LRC, Deviation, GO/NO-GO, or Sort
   - Ranging mode -- Auto or Hold
   - Calibration (CALIB) indicator for test-lead or test fixture zero
   - Number of measurements averaged for each display
   - Settling time and integration time in milliseconds (ms)
   - BIAS ON/OFF, ALPHA keyboard overlay active, and keyboard LOCK

2. Measurement display (center portion of CRT screen). It contains:

- Two readings
- Unit multiplier and unit for each reading
- Function and equivalent circuit mode for each reading

3. Data entry (bottom portion of CRT screen). It contains:

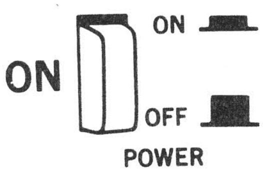
- Data entry lines that echo the last keyboard entries.
- Error message above data entry lines (see Section 2.11).

Status display is used when preparing for component sorting operation. It can be divided into two major areas--sorting limits and reject limit. For a more detailed explanation of the sorting operation and the status display see Section 2.7.1 in this manual.

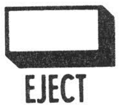
2.1.3 Cassette Tape Loader (2160 Only)

The cassette tape of the Model 2160 is a feature that adds to the overall versatility of the instrument. The cassette can be used as a mass storage device for test parameters, measurement information, or optional applications programs. It stores often used setups for later retrieval, so repeatedly making the same setup becomes unnecessary. For a more detailed explanation of the cassette tape loader, see Section 2.9 in this manual.

2.1.4 Other Front Panel Controls



Turns instrument power ON and OFF.



Opens Cassette Tape Loader door for direct access to cassette tapes. (Model 2160 only)

2.2 REAR PANEL

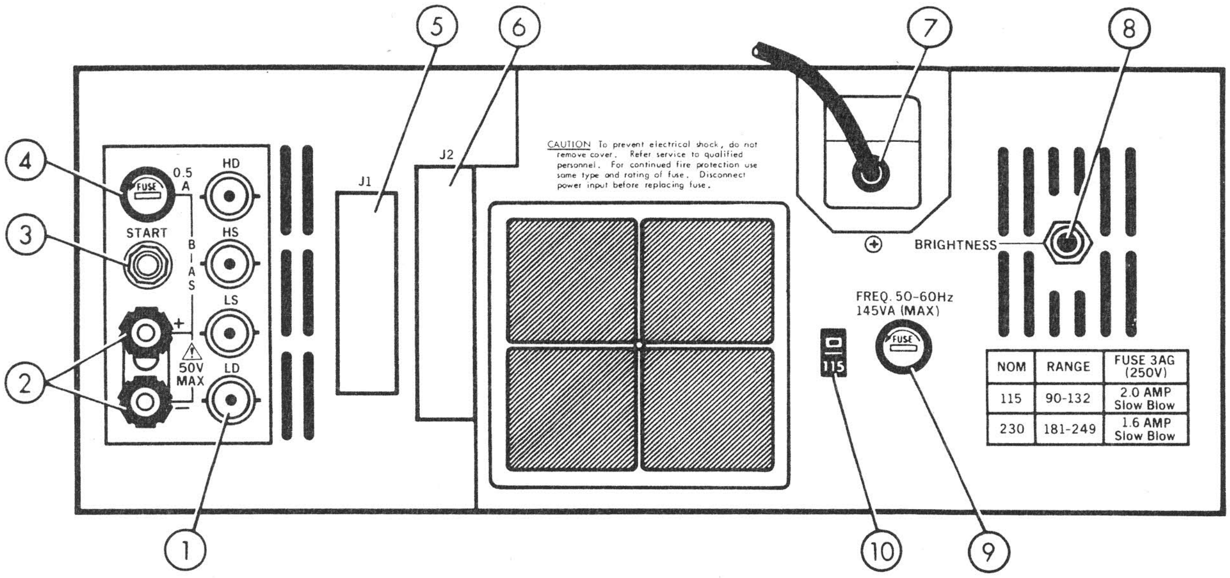


Figure 2-4. Rear Panel

2.2.1 Rear Panel Controls and Connectors

(1) HD, HS, LS, LD — Four BNC style connectors for making passively guarded, four-terminal-connection to the unknown.

WARNING

ELECTRICAL SHOCK HAZARD EXISTS WHEN BIAS SUPPLIES ARE CONNECTED TO THIS INSTRUMENT. WHEN EXTERNAL BIAS SUPPLIES ARE ATTACHED, THE BIAS VOLTAGES ARE PRESENT ON THE REAR PANEL BNC CONNECTORS. USE ONLY BIAS VOLTAGES UP TO +50VDC WITH EACH BIAS SUPPLY CURRENT LIMITED AT 100MA. DO NOT TOUCH, CONNECT, OR DISCONNECT THE MEASURED COMPONENT OR THE BNC CABLES WHILE BIAS VOLTAGES ARE APPLIED.

(2) BIAS Terminals — Two banana plug jacks (with removable strap link) provide connection of external bias supplies to the component being tested, up to 50VDC with bias supply current limited at 100mA. Bias supply polarity must match terminal indicators.

(3)	REMOTE START	A miniature phone jack style connector for remotely initiating measurements. (de-bounced switch contact closure for start.)
(4)	BIAS FUSE	A 0.5A 3AG fast blow fuse prevents damage to the instrument if a charged capacitor is connected to the input terminals or if excessive bias current is applied.
(5)	J1	An option inputs/outputs connector which allows connection to an interface option. Connector is present only when option is installed. Model 2160 has a standard RS-232C connector in this position.
(6)	J2	An option connector; outputs depend on option installed. Connector is present only when option is installed.
(7)	LINE POWER CORD	A standard 3-wire power cord for connection to nominal 115VAC at 48-66Hz or nominal 230VAC at 48-66Hz. (See Section 2.3.1 before using cord and connectors other than supplied.)
(8)	BRIGHTNESS CONTROL	Controls the brightness for characters displayed on the CRT.
(9)	POWER FUSE	The line power fuse used is 2.0A, 250V Slow-Blow for 115V operation and 1.6A, 250V Slow-Blow for 230V operation.
(10)	115/230 SWITCH	Selects the nominal line voltage.

2.3 INSTRUMENT SETUP

2.3.1 Power Requirements

The 2150/2160 requires a power source of 115VAC (90-132VAC) at 48/66Hz or 230VAC (180-250VAC) at 48/66Hz. Before turning the power ON, make sure the instrument is set to the proper line voltage and has the proper line fuse installed. The instrument contains a rear panel slide switch to select the nominal line voltage. See Figure 2-5 for proper line voltage settings.

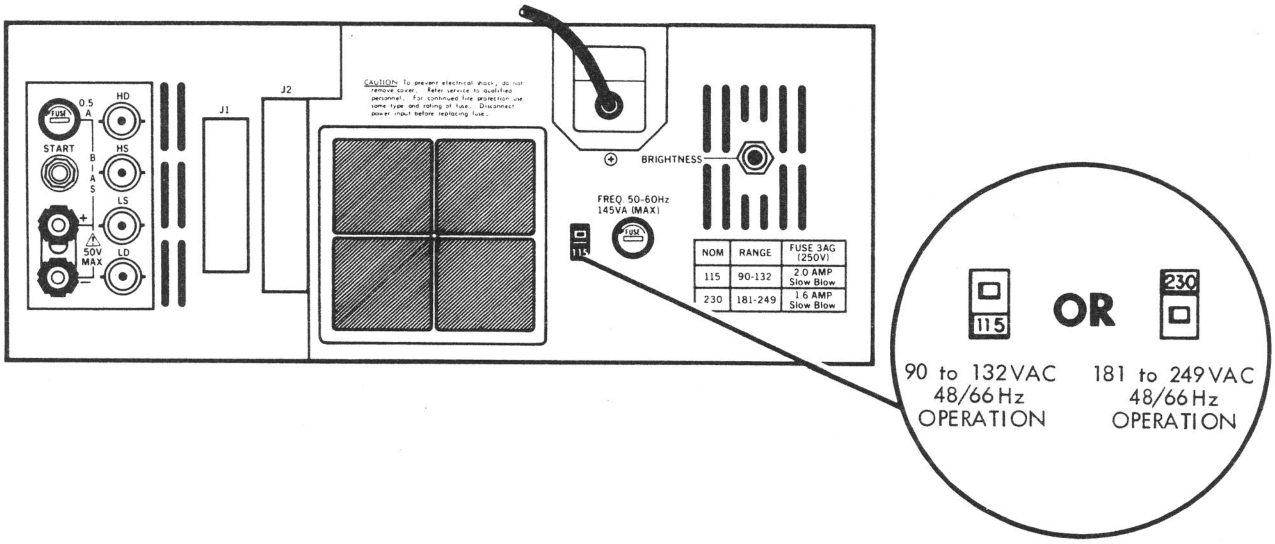


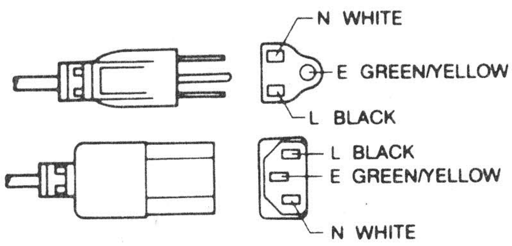
Figure 2-5. Line Voltage Settings

CAUTION

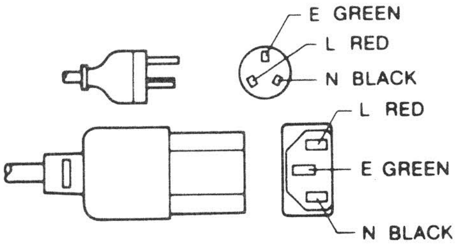
BECAUSE OF DIFFERING POWER REQUIREMENTS, INSTRUMENTS SHIPPED OUTSIDE THE UNITED STATES MAY REQUIRE A DIFFERENT POWER CORD CONNECTOR. WHEN PLACING A NEW CONNECTOR ON THE POWER CORD, CARE MUST BE TAKEN TO ASSURE ALL THREE WIRES (E,N,L) ARE CONNECTED PROPERLY. THE GREEN OR GREEN WITH YELLOW STRIPE WIRE IS ALWAYS CONNECTED TO EARTH GROUND (E). THE WHITE OR LIGHT BLUE WIRE IS CONNECTED TO THE NEUTRAL SIDE OF THE POWER LINE (N). THE BLACK OR BROWN WIRE IS CONNECTED TO THE HIGH SIDE OF THE POWER LINE (L). FIGURE 2-6 ILLUSTRATES THE AVAILABLE POWER CORD CONFIGURATIONS ACCORDING TO COUNTRY, INCLUDING THE STANDARD POWER CORD FURNISHED WITH THE INSTRUMENT.

WARNING

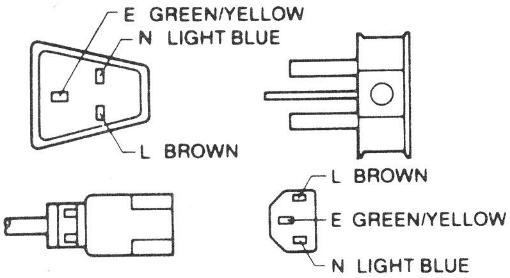
TO PREVENT POSSIBLE ELECTRICAL SHOCK OR DAMAGE TO THE INSTRUMENT, CHECK LOCAL ELECTRICAL STANDARDS BEFORE SELECTING A POWER CORD. THE INFORMATION PRESENTED HERE MAY NOT BE CORRECT FOR ALL LOCATIONS WITHIN THE REFERENCED AREAS.



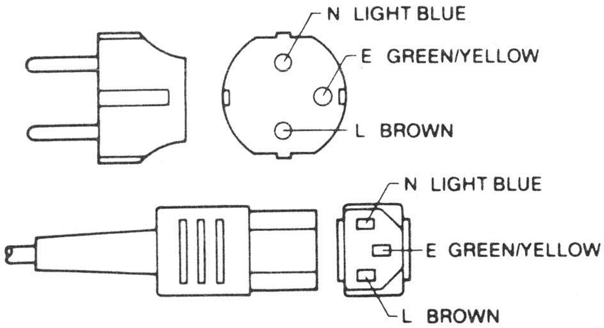
FURNISHED FOR COUNTRIES OTHER THAN LISTED BELOW



250V, 6A
NEW ZEALAND,
AUSTRALIA, ETC.



250V, 5A
GREAT BRITAIN,
SOUTH AFRICA, INDIA,
RHODESIA, SINGAPORE, ETC.



250 V, 6A
EAST/WEST EUROPE,
IRAN, ETC.

LEGEND
E: EARTH OR SAFETY GROUND
L: LINE OF ACTIVE CONDUCTOR
N: NEUTRAL OR IDENTIFIED CONDUCTOR

Figure 2-6. Power Cord Connectors

2.3.2 Applying Power

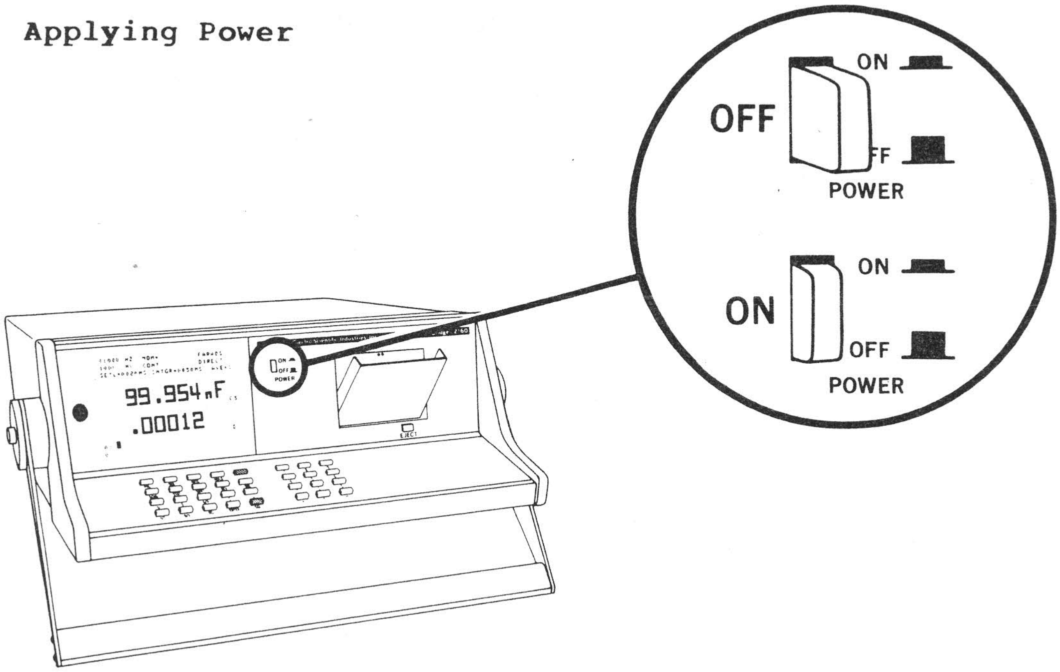


Figure 2-7. Power ON/OFF Switch

A front panel push-ON, push-OFF switch turns power ON and OFF (see Figure 2-7). When power is applied, the CRT display will illuminate in 15 seconds. Instrument warm-up time is 10 minutes. After initial turn-on, the bridge will automatically select the proper top display function and units for the component connected. The initial starting condition for other programmable parameters is:

Display Format	Direct
Display Mode	Auto LRC
Frequency	1000Hz
Nominal value	none
Test signal level	1000mV RMS
Measurement mode	Continuous
Settling time	50ms
Integration time	50ms
Measurements averaged	1
Binning limits 1 - REJ	+/- 0000%
SORT mode	%
Ranging mode	Auto

When the instrument is turned on, test code 17 (Auto LRC Mode) is enabled. The VideoBridge autoranges and determines whether the component being tested is an inductor, a resistor, or a capacitor and displays a series equivalent mode measurement in henrys, ohms or farads. Minor (loss) functions will be also be displayed according to the following:

1) L_s & Q,
2) R_s only (no minor),
3) C_s & D

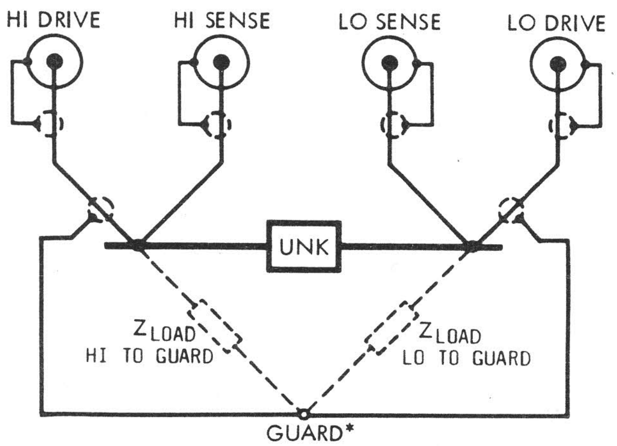
If there is no component connected to the test fixture or clips, the VideoBridge will display "OPEN" when it detects a $Z > 50M\Omega$, or "SHORT" when it detects a $Z < 20m\Omega$.

Auto LRC mode can be exited by pressing any impedance function key, any display mode key, or the HOLD key. If Auto LRC mode is re-entered, then test level, test frequency, measurement speed, and equivalent circuit remain as programmed and the VideoBridge returns to autoranging. The XCHG key is disabled in Auto LRC mode.

If a cassette tape is in place when power is applied to the Model 2160, the message [AUTOSTART TAPE SEARCH] and a blinking cursor will appear on the screen. This AUTOSTART feature initiates an automatic search of the cassette tape directory for a file that has been designated for loading upon the application of power. If the search for such a file is unsuccessful, the message [NO AUTOSTART FILE ON TAPE] will be displayed. If no cassette tape is installed or if the unit is a Model 2150, the power up conditions are the same as those previously described. (Refer to Section 2.9.5, Saving Parameters for additional information on the AUTOSTART feature.)

2.3.3 Connections to Unknown

Models 2150/2160 make four-terminal measurements with passive guarding. They provide separate shielded connection cables for current drive and voltage sense to the high and low side of the unknown. These cables are fully shielded to minimize the effects of stray capacitance. They are labeled HI DRIVE, HI SENSE, LO DRIVE, and LO SENSE. The shields around the HIGH and LOW DRIVE cables are connected to the GUARD point (see Figure 2-8). The total load impedance (Z) to the guard point must be greater than or equal to the impedance of the device under test. Drive and sense leads for both HIGH and LOW terminals must make separate connections to the unknown.



*Guard shields of HI and LO Drive cables must be connected at unknown end of test-leads.

Figure 2-8. Connection to Unknown

For accurate measurements of low impedance unknowns, separate drive and sense connections are necessary to prevent lead resistance from becoming a part of the measured unknown. Both drive and sense connections can be connected together to a single lead of the unknown (a 2-terminal measurement) if the lead is a small part of the unknown impedance ($R_{lead} < Z_{unk}/1000$ for <0.1% error). With proper connections as shown in Figure 2-8, cable length of 5 feet causes no loss of accuracy. Different cable lengths or special test conditions may result in accuracy loss.

Consult ESI factory for advice on your application.

2.3.4 Test-Leads vs Test-Fixtures

Certain measurement areas are more critical than others and require the use of a test-fixture rather than test-leads. Test-leads with KELVIN KLIPS are best used at frequencies below 1kHz or for higher frequency measurements where high accuracy is not needed (see note attached to KELVIN KLIPS). Changes in test-lead position change stray capacitance and/or inductance, making a true zero correction difficult to obtain.

At higher frequencies (above 1kHz), the need for a test-fixture becomes more and more important because test-lead (KLIP) spacing cannot be fixed as in a test-fixture. <u>If higher accuracy</u>, <u>high frequency measurements are needed</u>, <u>use a test-fixture</u>.

Also, if different test lead lengths are used (for example, changing from 5 foot leads to 3 foot leads), the high frequency trim may have to be re-adjusted. See Section 4.2 for more information on this trim.

2.3.5 Test Fixture Calibration

Measurement accuracy is enhanced by the 2150/2160's ability to correct for zero-offset errors caused by test-lead and test-fixture impedances (inductance, resistance, capacitance, etc.). These impedances appear in parallel or in series with the unknown component during measurement and add to the measured value. The zero calibration function measures these zero offset errors and stores them in memory. The stored value is automatically subtracted from each measured value.

The 2150/2160 can store offset measurements for four different combinations of settings for: test frequency, test signal, integration time, settling time and measurements averaged. Once these offsets have been measured for a given combination, the VideoBridge will retrieve them whenever that combination is re-entered. The word "CALIB" will be displayed to indicate that this combination has been calibrated.

If a fifth combination of settings is calibrated, the VideoBridge stores it and retains the three most recently used combinations already in memory. If five combinations in a row are entered, the VideoBridge will store them like a serial shift register. That is, the first combination entered will be overwritten by the fifth combination entered.

To temporarily suspend use of zero offset correction for a given combination that has been calibrated, enter test code 22. The VideoBridge makes a measurement without offset corrections, but still retains the calibration information for that combination. To clear this mode, re-enter the present test frequency. To permanently erase all existing zero calibration offsets, enter test code -22.

Zero calibration information is not stored on tape because the tape may be used in a different instrument, invalidating the corrections. A zero-calibrated file can be saved to tape. When it is loaded, the VideoBridge will initiate the calibration procedure. Zero calibration information may be stored on a permanent basis by use of optional Non-Volatile Memory. See Section A.3 for more information.

The VideoBridge does not support zero calibration by GPIB or RS-232C.

To ensure reliable calibration of zero offsets, follow these guidelines:

- maintain test lead spacing during and after calibration
- use a highly conductive material, such as low gauge wire, to close test leads in range 0 (don't clamp leads together).
- perform zero calibration at the speed (FAST, MED, SLOW or your own settings of I.T., SETL, AVG) at which measurements will be made.
- after pressing <blue> <CAL>, use only the <SGL> key to activate the calibration procedure.
- to calibrate while using external bias, enter test code 1 before pressing <blue> <CAL>.

The VideoBridge makes two types of zero calibration measurements -- Short-Circuit and Open-Circuit -- combined into one process:

1) For zero calibration of the lowest range (0), the lower data entry line will contain the message

CLOSE UNKNOWN - THEN PUSH "SGL"

Short the test leads and push <SGL>. The message will change to

CALIBRATING RANGE 0.

2) After calibration of range 0 has been completed, the lower data entry line will contain the message

OPEN UNKNOWN - THEN PUSH "SGL"

for zero calibration of ranges 1-4. Open the test leads and push <SGL>. The message will change to

CALIBRATING RANGE X,

where X represents each remaining range.

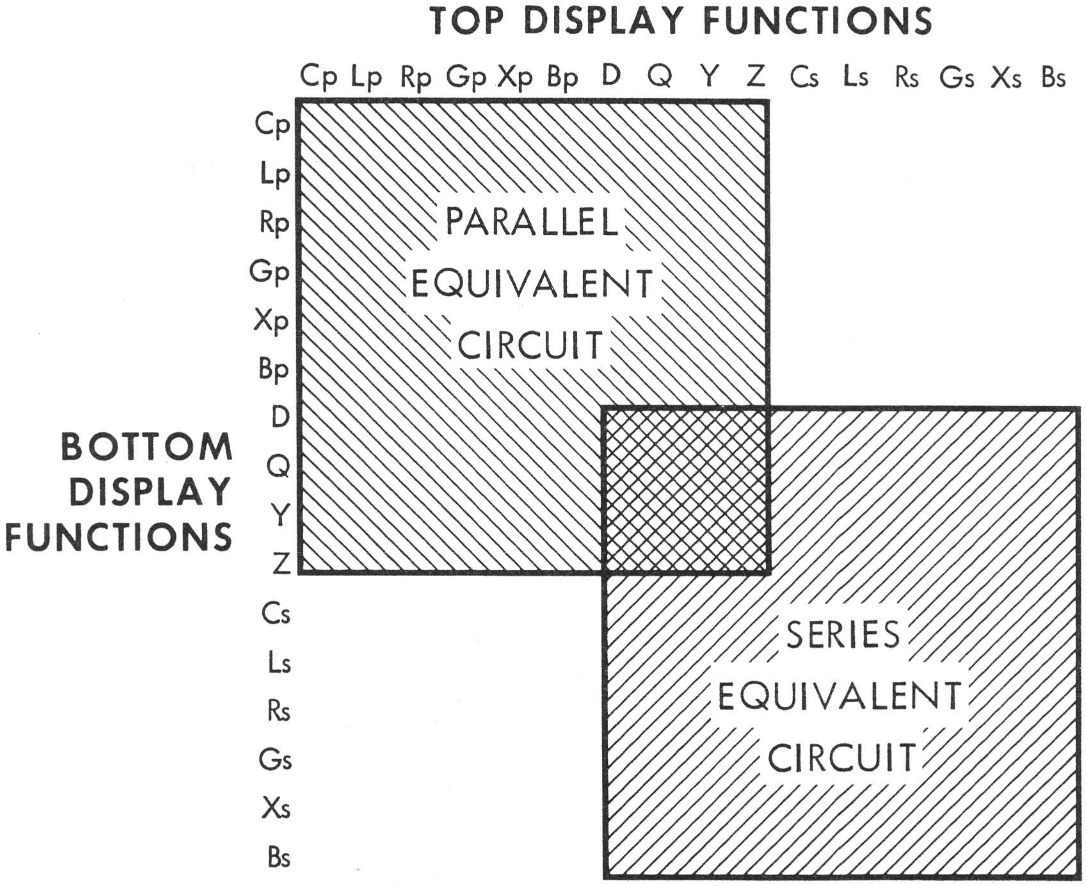
Each message will be followed by "OK" or "ERROR." If "OK", the VideoBridge will advance to the next range. If "ERROR," it will continue to calibrate the remaining ranges, but the range that failed will not be zero-corrected.

If all ranges calibrated were "OK," the VideoBridge will display "CALIB" on the bottom line of the parameter field. If "ERROR" was indicated on any range, [**CAL ?**] will appear in reverse video with no correction applied to the range that failed. If "ERROR" was indicated on all ranges, no message will appear and no correction will be applied to any range.

2.4 MEASUREMENT FUNCTIONS

The Model 2150/2160 will measure and display a variety of function combinations. The shaded areas of Table 2-2 show the functions that can be displayed simultaneously. Either selected function can be displayed as the top or the bottom function on the CRT screen. For a further explanation of programming measurement functions or exchanging their display positions, see Sections 2.4.1 and 2.4.2 in this manual.

Table 2-3. Measurement Functions



NOTE: Any top display can be displayed with any bottom display within the shaded areas.

2.4.1 Programming Measurement Functions

Measurement functions available with the Model 2150/2160 are: capacitance (C), inductance (L), resistance (R), dissipation factor (D), quality factor (Q), conductance (G), admittance (Y), impedance (Z), susceptance (B), and reactance (X). They are selected via the front panel keyboard by pressing the pushbutton for the desired function. The selected functions are displayed, one-above-the-other, on the CRT screen. Their position on the screen can be exchanged in direct mode at any time, i.e. Cs displayed above R can be exchanged to display R over Cs. Because of the versatility involved in displaying and positioning measurement displays and to assure the measurements are displayed as you want them, read the following precautions before programming measurement functions.

1. C, L, Y, Z, B, and X functions always replace the top measurement display on the CRT.

2. G, R, D, and Q functions always replace the bottom measurement display on the CRT.

3. G/R, B/X, and Y/Z functions are displayed in the parallel (PRL) and series (SER) equivalent circuit modes according to the following:

   Pressing the G/R, B/X, or Y/Z key displays resistance (Rs or Rp), reactance (Xs or Xp), or impedance (Z), in either circuit mode selected. Pressing the same key again displays conductance (Gs or Gp), susceptance (Bs or Bp), or admittance (Y).

4. Top and bottom measurement displays are exchanged using the XCHG key in DIRect display mode. This key does not work in Auto LRC, SORT, GO/NO-GO, or DEViation modes.

Figure 2-9 illustrates the initial measurement display with a capacitor connected. Measurement functions can be changed by pushing the desired function button, which takes the bridge out of Auto LRC. For best results, perform fixture calibration.

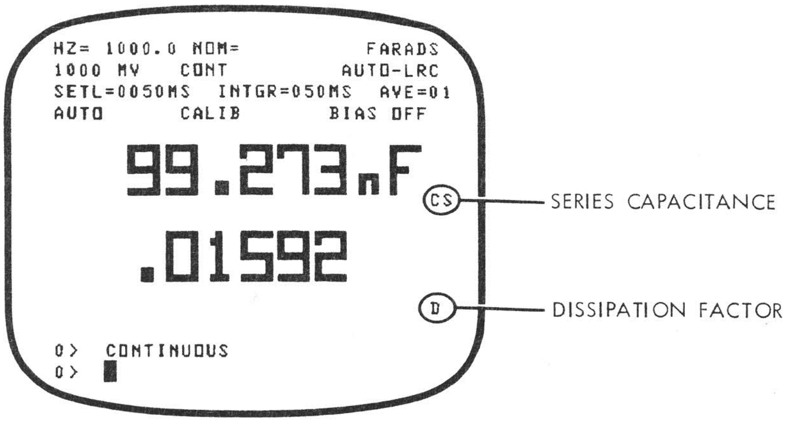
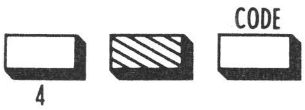
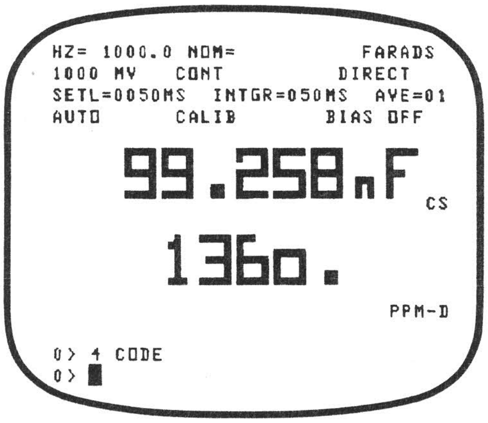


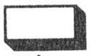
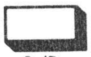
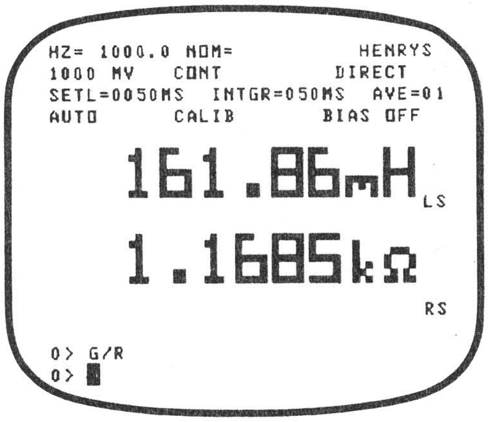
Figure 2-9. Measurement Display

Example: Display D measurement in parts per million (ppm).

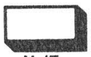
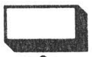
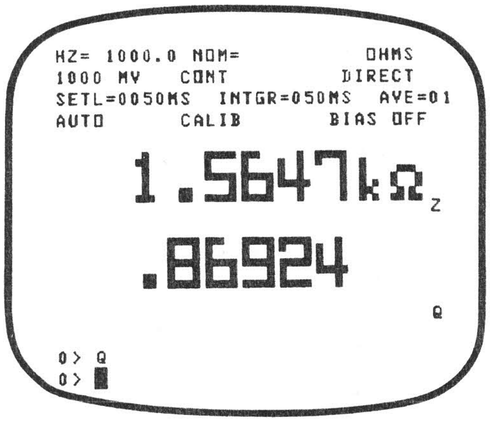
Push	Display	Comments
		Dissipation is changed from a decimal representation to parts per million. (Return to decimal format by entering -4 CODE.)

NOTE: Dissipation values may contain half-sized zeroes. They appear to the right of the last significant digit. Also, entering 4 CODE takes the VideoBridge out of Auto LRC mode.

Example: Measure series inductance (Ls) and resistance (Rs).

Push	Display	Comments
 		L key changes Cs to Ls in top display. G/R key changes D to R (series equivalent circuit) in bottom display.

Example: Measure impedance (Z) and quality factor (Q).

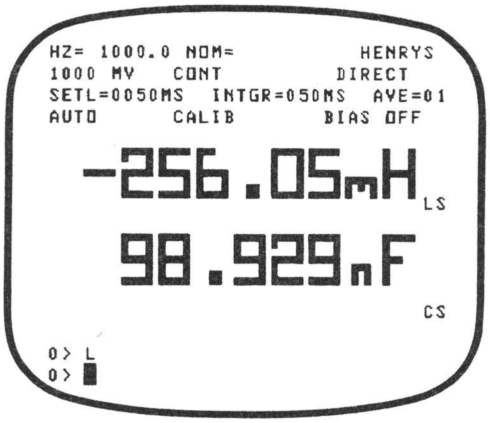
Push	Display	Comments
 		Y/Z key changes Ls to Z (series equivalent circuit) in top display. Q key changes R to Q in bottom display.

2.4.2 Exchanging Measurement Displays

The XCHG key exchanges the position of the two displayed measurements. Using the XCHG key allows two functions that normally appear in either the top or bottom display to be measured and displayed simultaneously.

Example: After turning instrument power ON, exit Auto LRC mode and set the instrument to measure and display Ls and Cs.

Push | **Display** | **Comments**



Exit Auto LRC mode.

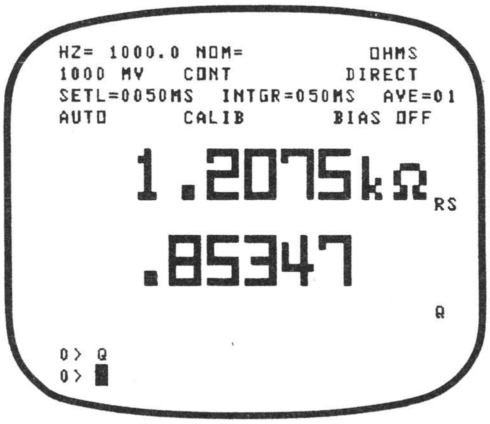
Move Cs to bottom display.

L key sets top display to series inductance.

Similarly, any two functions that normally appear in the bottom measurement display can also be displayed simultaneously.

Set the instrument to measure Rs and Q.

Push | **Display** | **Comments**



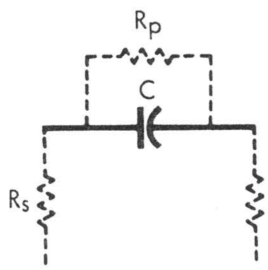
G/R key displays Rs (series equivalent circuit) in bottom display.

Exchange key moves Rs to top display.

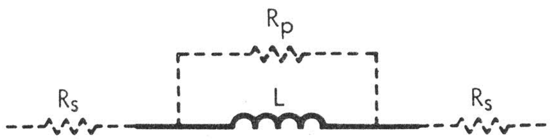
Q key selects Q in the bottom display.

2.4.3 Series and Parallel Equivalent Circuit

Capacitors, inductors, and resistors are inherently imperfect impedance components, i.e. they have series and parallel, reactive and resistive elements. The Model 2150/2160 measures the reactive and resistive elements of an impedance component. (The relationship of these reactive and resistive elements is often described in terms of their series or parallel equivalent circuits.) The 2150/2160's PRL (parallel) and SER (series) functions steer the measured reactive and resistive values to an algorithm that calculates values in terms of series or parallel equivalent circuit. Series and parallel equivalent circuit mode measurements will provide differing results. The magnitude of difference depends on the quality of the component being measured.



TYPICAL CAPACITOR



TYPICAL INDUCTOR

In determining which equivalent circuit mode to use, consider the following factors before making a selection.

1. What is the actual equivalent circuit of the capacitance being measured? This information should be available from the manufacturer's specifications. If not available, the equivalent circuit can be determined by a comparison of dissipation factor (D) value obtained at another frequency removed from the selected test frequency. If the test frequency goes up and the measured D decreases, then the unknown is most likely a parallel equivalent circuit. Likewise, if the test frequency goes down and the D decreases, the unknown is most likely a series equivalent circuit.

NOTE: The dissipation factor (D) of an inductor moves in the opposite direction from the D of a capacitor for a given change in frequency.

2. What is the end use for the component? The equivalent circuit used should provide the information most useful to determining the performance of a component in a particular application. For example, the information necessary for selecting a power supply bypass capacitor is obtained from the series equivalent circuit mode, while the information needed to select a capacitor for an LC resonant circuit is obtained from the parallel equivalent circuit mode.

3. Which equivalent circuit is most valuable to me? If no other information is available, the rule-of-thumb for selecting either series or parallel equivalent circuit mode is as follows:

Series equivalent circuit should be used when measuring components with a low impedance (basically large value capacitors, low value inductors) and parallel equivalent circuit for components with a high impedance (basically low value capacitors, high value inductors).

To convert a series equivalent circuit measurement to that of a parallel equivalent circuit use the formulas given in Figure 2-10. These formulas consider the effects of dissipation factor (D) with the measured value. (Dissipation factor (D) is always equal for both series and parallel equivalent circuits at a given frequency.)

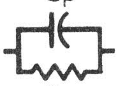
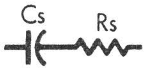
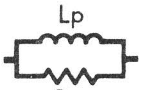
CIRCUIT MODE		DISSIPATION FACTOR	CONVERSION TO OTHER MODES
C	Cp  Rp	$D = \frac{1}{2\pi f C_p R_p} = \frac{1}{Q}$	$C_s = (1 + D^2) C_p$ $R_s = \frac{D^2}{1 + D^2} R_p$
	Cs Rs 	$D = 2\pi f C_s R_s = \frac{1}{Q}$	$C_p = \frac{1}{1 + D^2} C_s$ $R_p = \frac{1 + D^2}{D^2} R_s$
L	Lp  Rp	$D = \frac{2\pi f L_p}{R_p} = \frac{1}{Q}$	$L_s = \frac{1}{1 + D^2} L_p$ $R_s = \frac{D^2}{1 + D^2} R_p$
	Ls Rs 	$D = \frac{R_s}{2\pi f L_s} = \frac{1}{Q}$	$L_p = (1 + D^2) L_s$ $R_p = \frac{1 + D^2}{D^2} R_s$

Figure 2-10. Series and Parallel Equivalent Circuit Modes

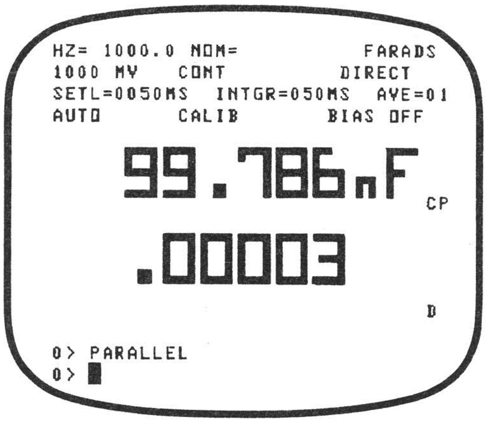
Where:

L = Inductance	Q = Quality factor
R = Resistance	X = Reactance
C = Capacitance	D = Dissipation factor
f = test frequency	

$$Q = \frac{X_s}{R_s} \qquad D = \frac{R_s}{X_s} \qquad X_s = \frac{1}{2\pi f C_s}$$

Series and parallel equivalent circuit modes are selected by pushing either the PRL (parallel) or the SER (series) keys.

Example: The 2150/2160 initially measures series equivalent circuit when power is applied. To change to parallel equivalent circuit mode:

Push	**Display**	**Comments**
		Cs is changed to Cp.

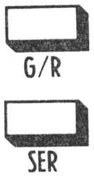
Three measurement functions are programmed in conjunction with the SER and PRL keys. They are Y/Z, G/R, and B/X. Each function can be displayed in either parallel or series mode. Impedance Z, resistance R, and reactance X, are displayed with the first press of the measurement function key. Reciprocal values admittance Y, conductance G, and susceptance B are displayed with the second key press. Subsequent key presses toggle the display of each reciprocal function.

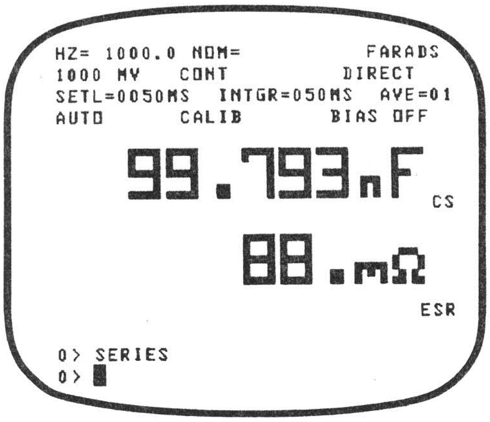
To display R_p, press the G/R key after selecting the parallel mode. X_p or Z can be displayed by pressing the B/X key or Y/Z key in the parallel mode. R_s, X_s, and Z can be similarly displayed by pressing the G/R, B/X, or Y/Z key in series mode.

G, B, or Y can be displayed in either equivalent circuit mode by pressing the G/R, B/X, or Y/Z key a second time.

Example: Change the displayed parameters to display series capacitance and resistance, then change the measurement mode to display series capacitance and conductance.

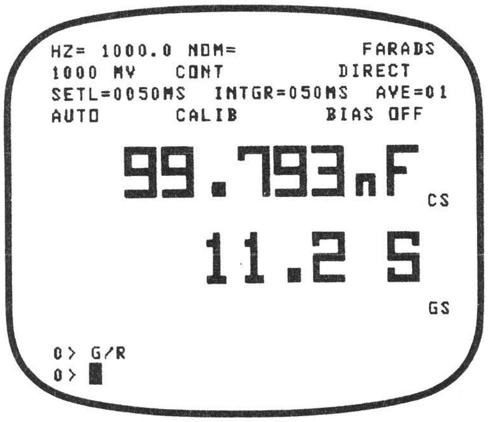
Push | **Display** | **Comments**





G/R key changes bottom window to R_S (series equivalent circuit).

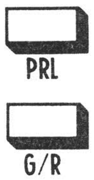
THEN



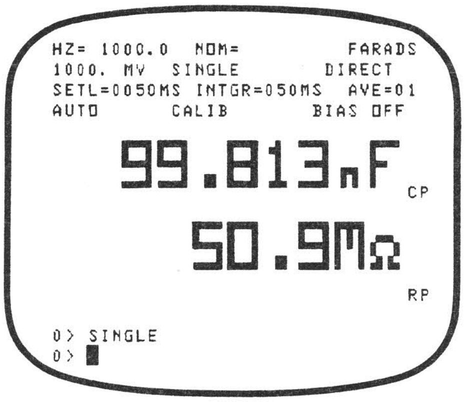
Change R to G by pressing <G/R> a second time.

Example: Enter parallel equivalent circuit mode by pushing the PRL key. Then push the G/R key to get R_p.

Push



Display



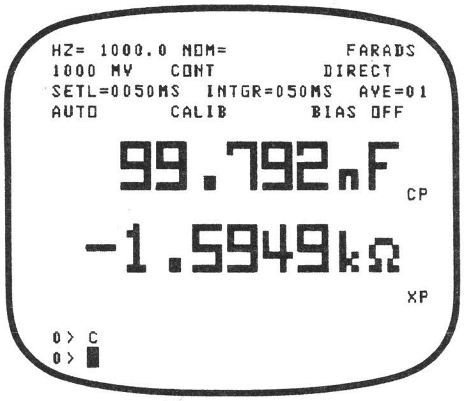
Comments

G/R, B/X, and Y/Z are "toggle" functions. Consecutive key presses alternate between the two functions on any key. (To get Gp, press <G/R> key a second time.

Use XCHG to get C, X_p.

Push

Display



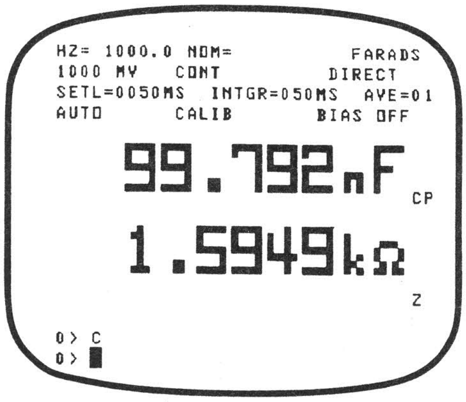
Comments

Push B/X, XCHG, C, to display C_p and X_p.

Use XCHG to get C, Z.

Push

Display



Comments

Push Y/Z, XCHG, C, to display C_p and Z.

2.5 TEST SIGNAL

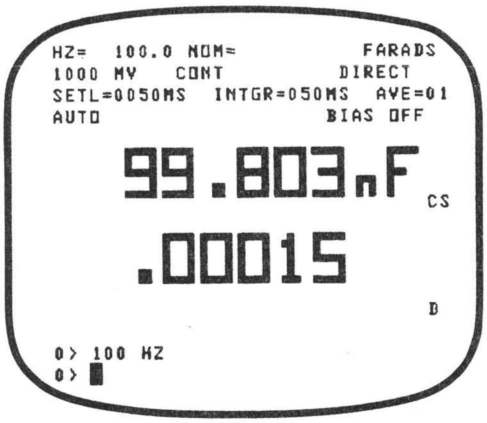
The test signal, applied to the device under test, is a sinusoidal waveform derived from a digital source. It is programmable both in frequency and in magnitude from either the front panel keyboard or remotely via an IEEE-488 or RS-232C interface bus. When power is applied, the instrument's frequency and voltage level initialize to 1000Hz and 1000mV RMS, respectively.

> **NOTE:** Because using voltage or current test signals at their low extremes produces a low signal-to-noise ratio, measurement accuracy at these low levels may be seriously derated. Also, fewer digits will be displayed per measurement.

2.5.1 Frequency

The Model 2150/2160 has over 3000 selectable test frequencies between 20Hz and 150kHz. All frequencies are accurate to within +/- 0.01%. When power is applied, the instrument's test frequency initializes to 1000Hz. All frequencies are entered directly in hertz (Hz).

Example: Set the instrument's test frequency to 100Hz.

Push	Display	Comments
		To allow the test signal to stabilize after a frequency change, wait 200ms before initiating a measurement.

The frequency selected is displayed on the CRT (top line -- small letters). The displayed frequency is the nearest available frequency greater than the selected value. The sine generator ROM of the 2150/2160 uses separate algorithms to generate test frequencies above and below 10,000Hz (except 12kHz, 15kHz, 20kHz, 30kHz, and 60kHz--which are generated by the "below 10,000Hz" algorithm).

Table 2-3 shows some of the commonly used frequencies below 10kHz. When F is at or below 10kHz, or when F is above 10kHz and yields an integral quotient when divided into 60,000, the following formula is used to determine which frequencies are available:

$$F = 60\text{kHz}/N_1$$

Where: N_1 is an integer $1 \leq N_1 \leq 3000$

Table 2-4. Test Frequencies Below 10kHz and Divisors of 60kHz Yielding Integral Quotients

N_1	Frequency (Hz)	N_1	Frequency (Hz)	N_1	Frequency (Hz)	N_1	Frequency (Hz)
1	60,000	12	5,000	80	750	500	120
2	30,000	15	4,000	100	600	600	100
3	20,000	20	3,000	120	500	1000	60
4	15,000	30	2,000	150	400	1200	50
5	12,000	40	1,500	200	300	1500	40
6	10,000	50	1,200	300	200	2000	30
10	6,000	60	1,000	400	150	3000	20

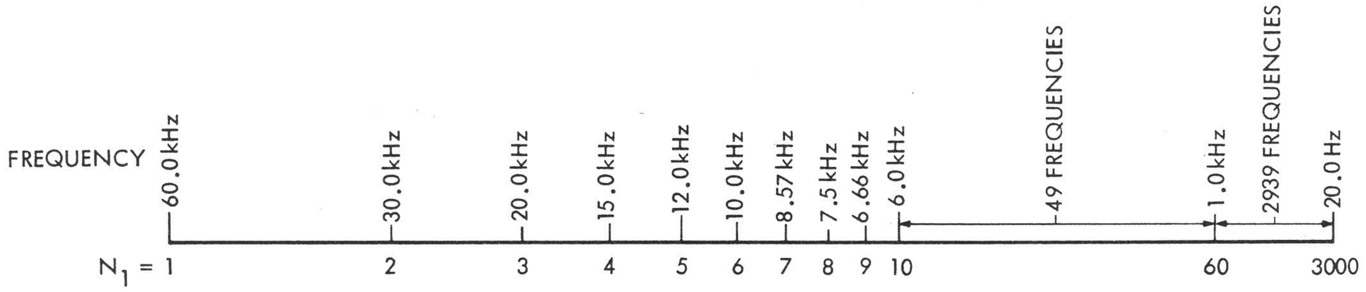


Table 2-4 shows the 23 available frequencies above 10,000Hz, determined by the following formula:

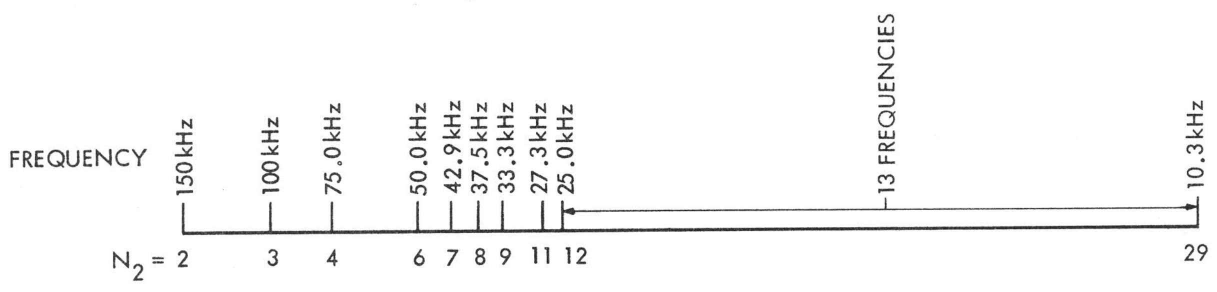
$$F = 300kHz/N_2$$

Where: N_2 is an integer $2 \leq N_2 < 30$ (excluding 5, 10, 15, 20, 25 which yield the frequencies already derived in Table 2-4).

Table 2-4. Test Frequencies Above 10kHz

N_2	Frequency (Hz)	N_2	Frequency (Hz)	N_2	Frequency (Hz)	N_2	Frequency (Hz)
2	150,000	11	27,273	19	15,789	28	10,714
3	100,000	12	25,000	21	14,286	29	10,345
4	75,000	13	23,077	22	13,636		
6	50,000	14	21,429	23	13,044		
7	42,857	15	20,000	24	12,500		
8	37,500	17	17,647	26	11,538		
9	33,333	18	16,667	27	11,111		

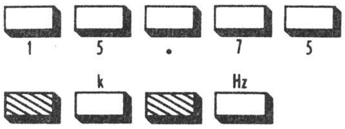
For further information on frequencies and the sine generator circuit, refer to Section 3.3.



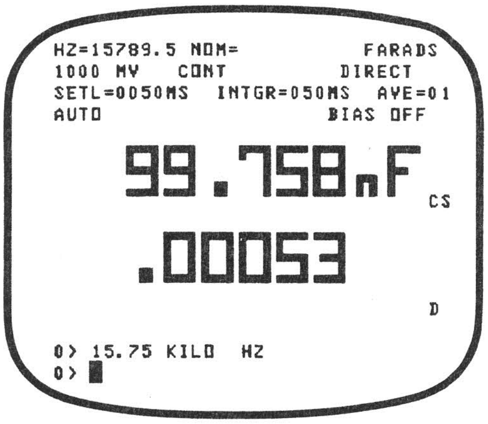
Any frequency entered between two available frequencies will automatically divert to the higher frequency.

Example: Set the test frequency to 15,750Hz.

Push



Display



Comments

Frequency (15.75kHz) automatically diverted to the closest higher frequency (15,789Hz).

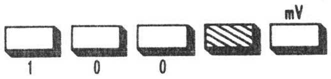
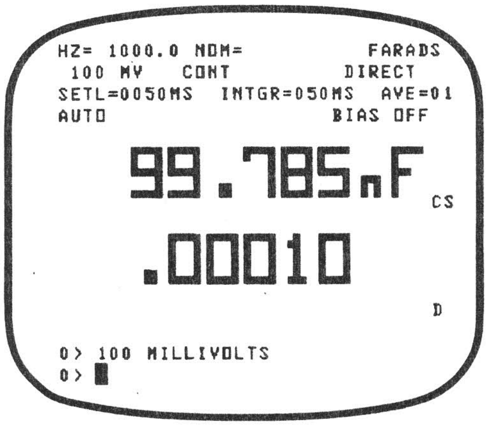
Notice in the examples above, as numbers are entered, they are echoed on the CRT. When the entry was terminated by pushing Hz, the 2150/2160 selected the closest, higher frequency available.

> **NOTE:** In the above examples, changing the test frequency removes the word "CALIB" from the display. Test fixture offset corrections are only valid at the frequency at which they are calibrated. For optimum measurement accuracy, zero offset calibration must be performed after changing to an uncalibrated test frequency/test signal combination.

2.5.2 Signal Levels

The test signal voltage level initializes to 1V RMS (1000mV) when instrument power is applied. The test signal level can be changed at any time to meet testing requirements. However, changing test signal level requires re-calibration of the test fixture. Voltage is programmable from 5mV to 1500mV RMS in 1mV steps. Current is programmable from 0.1mA to 100mA in 0.1mA steps.

Example: Set the amplitude of the test signal to 100mV RMS.

Push	Display	Comments
		To allow the test signal time to stabilize after a signal level change, wait 200ms before initiating a measurement.

To optimize measurement accuracy, care should be taken when selecting test signal levels. Measuring high impedance components at very low test voltages or very low impedances at very low current levels can cause measurements to be erratic due to a poor signal-to-noise ratio.

The test level vs. impedance charts (Tables 1-4, 2-5) in this manual are to be used as an aid to determining the optimum test signal level at a nominal frequency of 1kHz. <u>They do not indicate absolute instrument specifications</u>, due to the overwhelming number of test frequencies available.

Table 2-5. Test Level vs Impedance (typical at 1kHz)

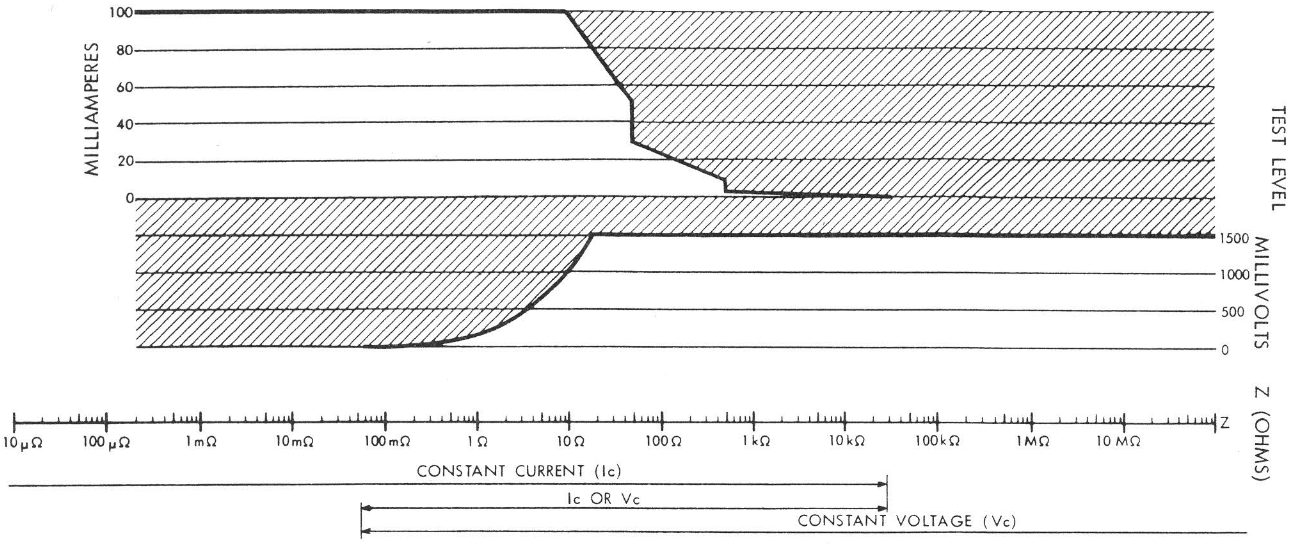


Table 2-5 shows typical test level limitations compared to the impedance of the component under test at 1kHz. The shaded areas indicate test signal levels not available for a given impedance.

Test currents can be programmed between 0.1mA and 100mA. For unknown impedances between 0 and 20 kilohms, set the test current directly. For unknown impedances over 20 kilohms, the test current is determined by dividing the voltage level by the unknown impedance.

For best measurement results, select a test signal level that will provide the best signal-to-noise ratio. High test signal levels are used for general component testing (capacitors, resistors, and certain inductors). Low test signal levels are used for testing devices requiring low operating-signal levels (semiconductor devices, inductors, and non-linear impedance devices).

Under certain conditions a test level can be programmed that the VideoBridge cannot supply. This is due to a mismatch occurring when a low impedance part is measured with a constant voltage or when a high impedance part is measured with constant current. When this happens, the instrument will supply a test signal less than the level programmed and display one of the following error messages:

[OVERLOAD ! -- SUPPLYING xx MV] for low impedance devices

OR

[OVERLOAD ! -- SUPPLYING xx MA] for high impedance devices

Where xx = the actual value of test signal level supplied by the VideoBridge.

In a voltage overload condition, the instrument will supply the voltage available at a maximum current of 100mA.

In a current overload condition, the instrument will supply the current available at a maximum voltage of 1500mV.

Measurements taken at these reduced signal levels are valid for that signal level. To clear the overload message, do one of the following:

1) re-enter a test signal level less than or equal to the amount displayed by the error message

2) for a voltage overload, change from voltage to current

3) for a current overload, change from current to voltage.

NOTE: To maintain measurement accuracy, test-lead or test-fixture calibration must be performed after changing to an uncalibrated test frequency/test signal combination.

2.5.3 Measurement Range

The Model 2150/2160 is basically a continuously ranging instrument (in AUTO range). Ranging is a transparent operation that makes the instrument appear to have only one range throughout its entire impedance measuring capabilities.

Actually, ranging is achieved by making an initial measurement before making the actual measurements for display. This initial measurement is made with very short integration times and is completely unaffected by the values programmed for measurement speed or test level. The sole purpose for this measurement is to determine the proper range resistor. This measurement is not displayed. With the proper range resistor selected, the instrument makes a measurement and displays the results. Range 4 is locked out above 10kHz.

Refer to Table 2-6 for ranging data.

Table 2-6. Model 2150/2160 Impedance Ranging Chart

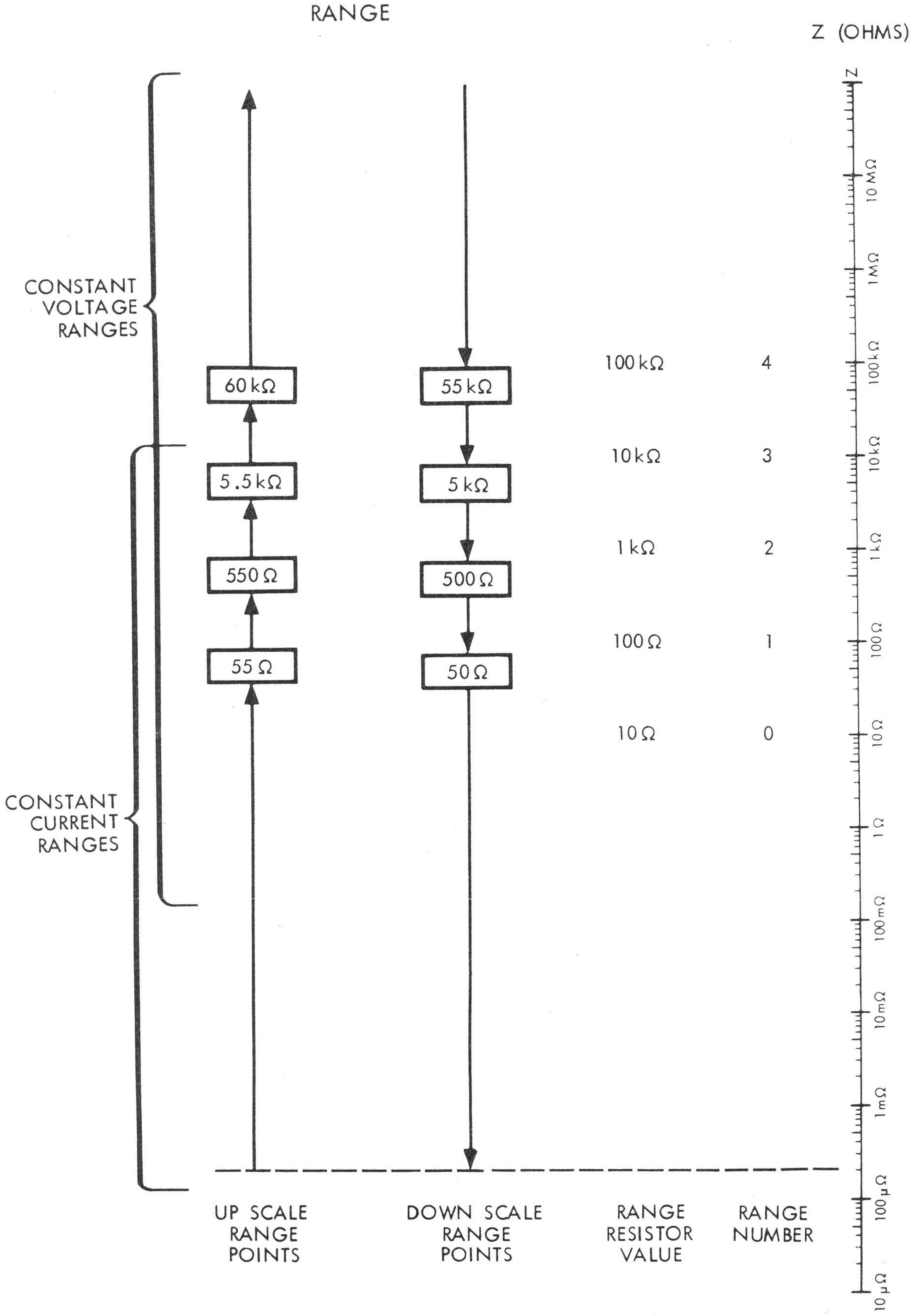
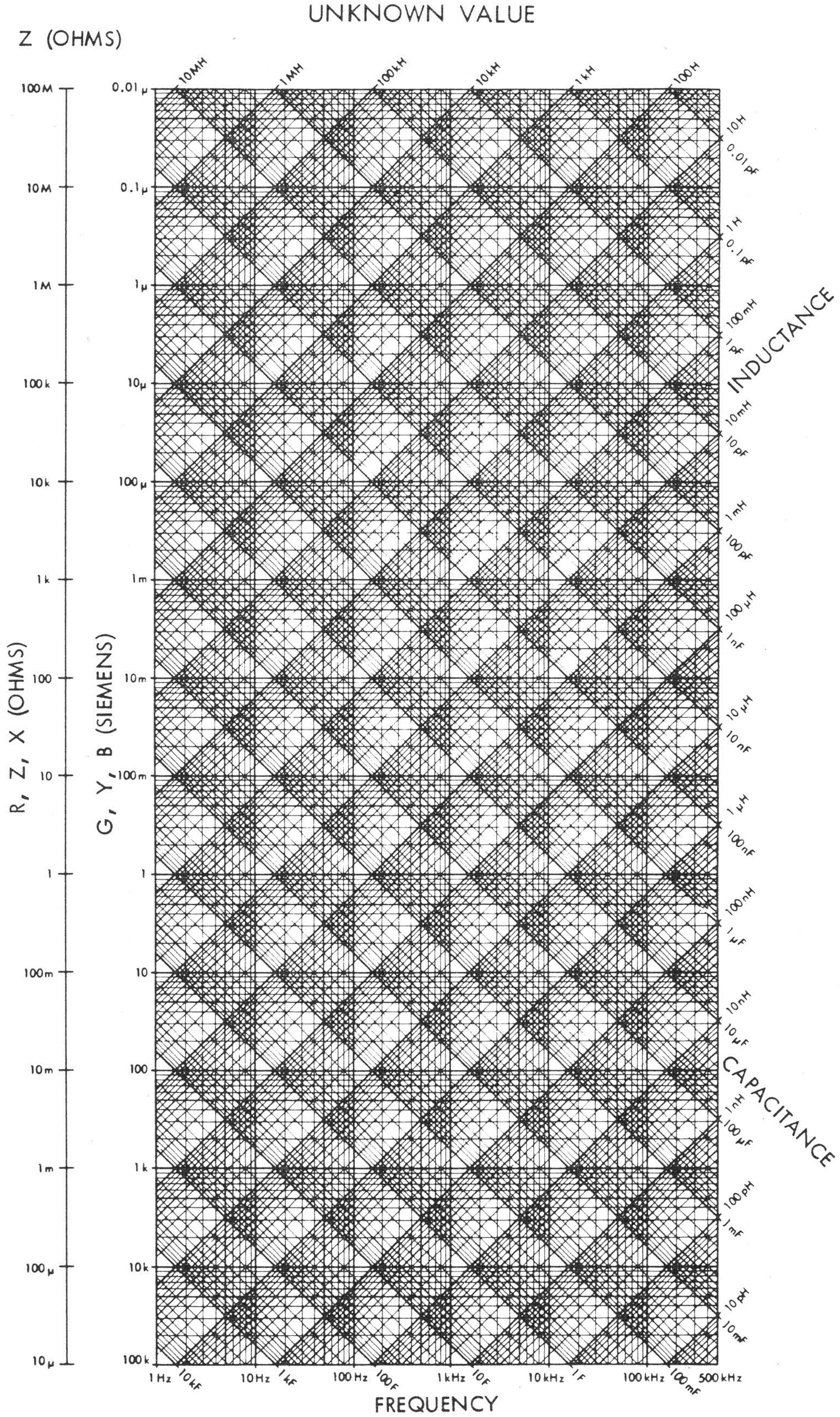


Table 2-7. Reactance Chart



To find the span of capacitance, inductance, or other measurement parameters for a particular impedance range (shown in Table 2-6) at a particular frequency use Table 2-7 as follows:

1. Find the impedance (Z) along the left margin of Table 2-7.

2. Find the operating frequency (Hz) at the bottom of Table 2-7.

3. Find the intersection of the horizontal impedance line and the vertical frequency line.

4. Find the closest diagonal line to the intersection.

5. Move down the diagonal line to the right or bottom margin to find the corresponding capacitance value. Move up the diagonal line to the right or top margin to find inductance. Resistance, conductance, admittance, susceptance, and reactance can be found in the two adjacent columns of the left margin.

2.5.3.1 Range Hold

When testing many components of the same value where speed is a prerequisite, the pre-measurement described in Section 2.5.3 can be eliminated by using range HOLD. (The range finding measurement takes a minimum of 60ms. Due to increased integration time, range finding measurements made at frequencies below 500Hz will take longer.)

RANGE HOLD can be set in either of two ways:

1. In the Manual-Hold Mode, described below,

   STEP 1. Connect a component to the test leads or fixture.

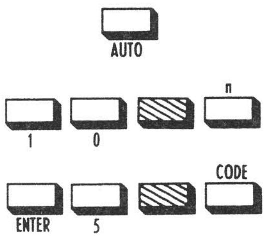
   STEP 2. Allow one measurement to be made, then push the HOLD button.

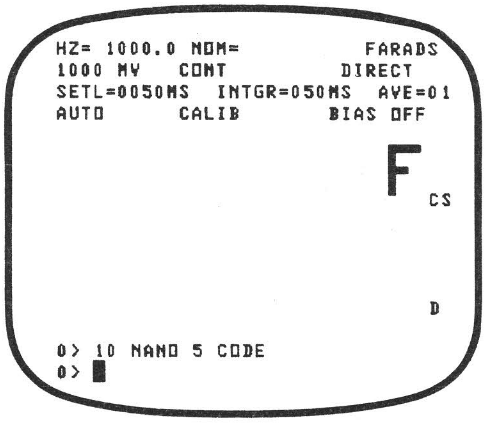
OR

2. Auto-Hold Mode via 5 CODE. This is for use with component handlers where it is inconvenient to place a part in the test fixture. Activate the Auto-Hold mode by entering the part value then pushing <5> <blue> <CODE>. This sets an internal control signal which is monitored during measurements. When a part is measured that is within +/-20% of the top measurement display value, the instrument changes from AUTO Ranging to the HOLD mode without operator intervention. This allows a handler to run until a part is present in the jaws. The VideoBridge then holds the range.

EXAMPLE:

Push **Display** **Comments**





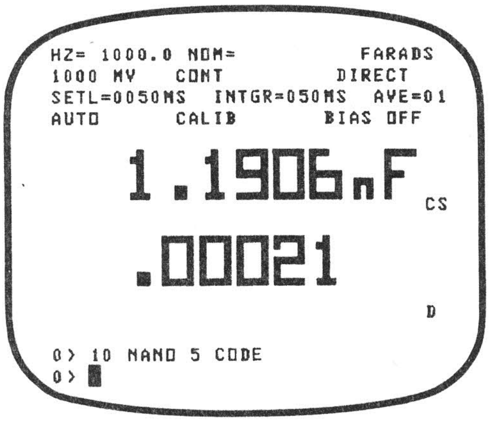
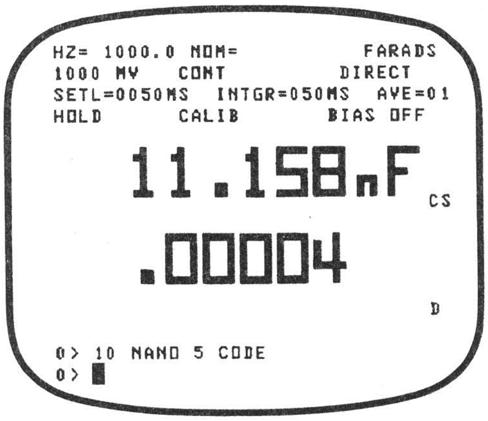
Set instrument to AUTOrange mode.

Sets AUTO-HOLD mode for 10nF.

NOTE: If the 20 percent limit is not convenient, this value can be changed. Enter the desired percentage (expressed as a positive decimal) when entering the part value:

<decimal specifier> <ENTER> <part value> <ENTER> <5> <blue> <CODE>

where <decimal specifier> is a numeric value representing the desired percent limit, i.e. <.><5> = 50%, <.><1> = 10%, <.><0><5> = 5%, etc. and <part value> is an entry such as 10nF in the above example.

Display	Comments
	Instrument begins measurement in AUTO mode.
	Instrument measures part that is within +/- 20% of the specified range value for the top measurement display and sets the HOLD mode accordingly.

NOTE: The 2150/2160 allows zero calibration while in Range Hold (eliminating the need to go to AUTO, zero the fixture or clips and re-enter Range Hold). To do this, the instrument leaves Range Hold, calibrates each range, and returns to Range Hold.

If a measurement is more than 100 times larger or smaller than the present range resistor, OUT OF RANGE will be displayed (ERROR ANALOG will be displayed on the highest or lowest range). Return to the continuous ranging mode by pushing the AUTO button.

(See Section 2.9 CASSETTE TAPE LOADER for information on saving RANGE HOLD as part of a parameter file.)

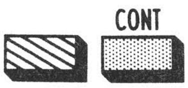
2.5.4 Continuous and Single Measurements

Continuous measurement mode is initially selected when instrument power is applied. In the Continuous mode the instrument makes 1 measurement and calculates the selected display value. Immediately after a measurement is completed, a new measurement is initiated. The continuous measurement mode is entered by pushing the blue key followed by the CONT key. In Autorange, the CRT display is updated once every 500 milliseconds when medium measurement speed is selected.

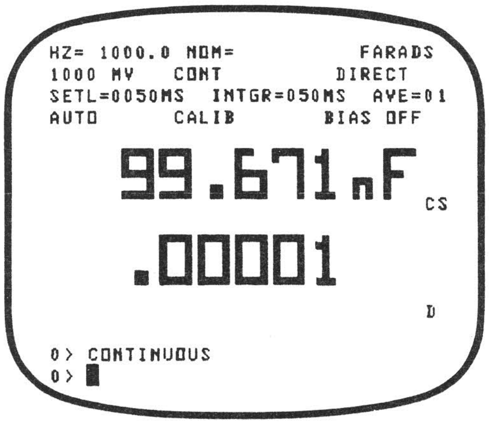
To perform single measurements, press the SGL button. The instrument will make one measurement and update the display. Single measurements can also be initiated via the rear panel remote start jack. Remote start requires a "de-bounced" switch or relay closure to ground to initiate a single measurement.

Example: Set the instrument to the continuous measurement mode.

Push



Display



Comments

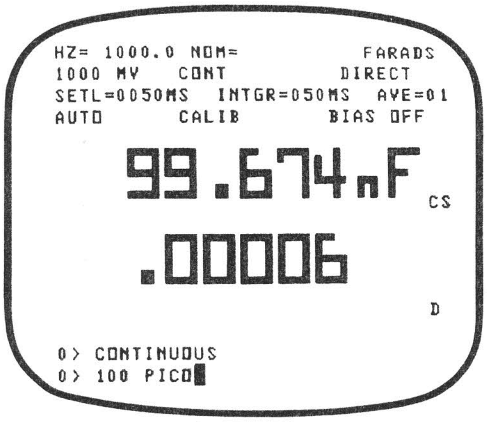
Selects continuous measurement mode.

To set the VideoBridge to single measurement mode, push the SGL key.

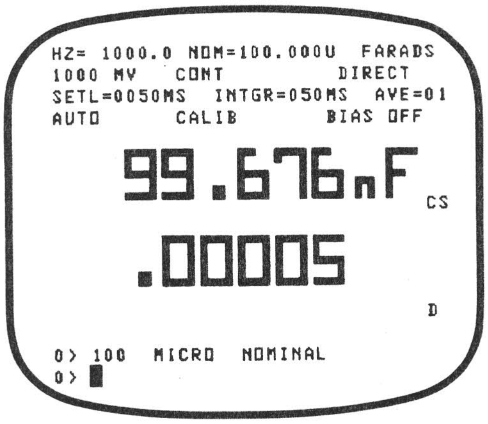
2.5.5 Delete

The DEL key removes the last character entered while programming data into the 2150/2160.

Example: Set the nominal value to 100uF.

Push	Display	Comments
		OOPS! Wrong prefix.
	0 > 100 PIC 0 > 100 PI 0 > 100 P 0 > 100	One character is erased for each push of the delete key.

Re-enter the correct data.

Push	Display	Comments
		Correct value is programmed.

If the entry has been terminated (by pushing the NOM button in this example), the DEL button will no longer remove the incorrect data. However, the correct data can be reprogrammed as a new entry.

2.6 DEVIATION MEASUREMENT

Two types of deviation measurement are possible with the Model 2150/2160; deviation as a percent of nominal or absolute deviation from a nominal in units. Deviation measurements can be made using either autoranging or range hold modes. In the autoranging mode, the 2150/2160 will change ranges to allow percent deviations from -100% to +999,999% of the preset nominal value (limited only by the number of digits displayed). In the range hold mode, the range of percent and absolute deviations are limited by the measurement ranges' upper and lower boundries. Deviation calculations require a small amount of time to complete, so measurement speed is decreased slightly.

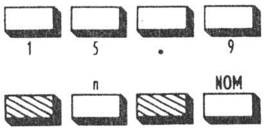
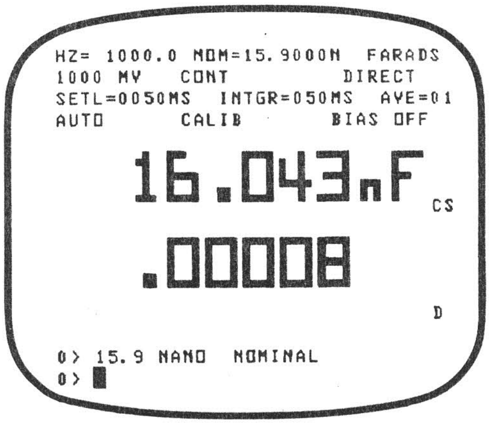
2.6.1 Nominal Value

To make deviation measurements or to sort into percent tolerance bins, a nominal value must first be set. A nominal value can be programmed at any time. It is programmed as a number with multiplier and assumes the units in the top measurement display. The nominal value is compared with the measured value. The comparison result is displayed as the top reading on the CRT (in deviation mode) or indicated as an appropriately binned part (in sort mode).

> **NOTE:** A non-zero nominal value must be set when using any of the following: deviation mode, % sort mode, 8 CODE, -8 CODE, or 21 CODE.

To set a nominal value, enter the desired value with multiplier (p,n,u,m,k,M) then push NOM VALUE. The entry takes the same units as selected for the top measurement display.

Example: Set a nominal value of 15.9nF.

Push	Display	Comments
		Nominal value takes on the units of the top displayed function.

NOTE: Only one nominal value can be set at a time. To store the present measurement as the nominal value, press

<0> <blue> <NOM> <blue> <NOM>

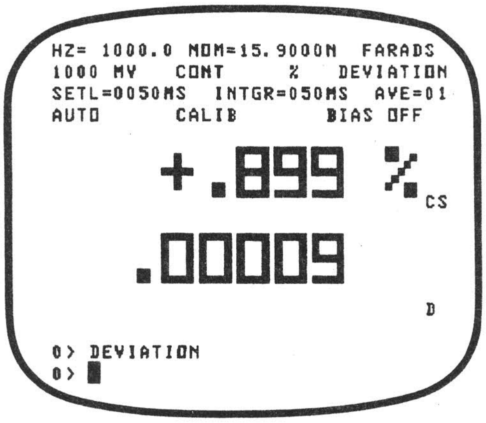
(or just <blue> <NOM> if the nominal value is already 0).

This is useful when making comparative measurements against a standard.

2.6.2 Deviation Mode

The deviation mode (DEV) compares the nominal value against the calculated value shown as the top measurement display. This top display is replaced by the comparison results--shown as either a percent or an absolute deviation. To enter the percent deviation mode, push <DEV>.

Example: Make deviation measurements using the nominal value set in the previous example.

Push	Display	Comments
		Enter deviation measurement mode. Deviation is the top displayed value.

NOTE: XCHG is disabled while in deviation mode.

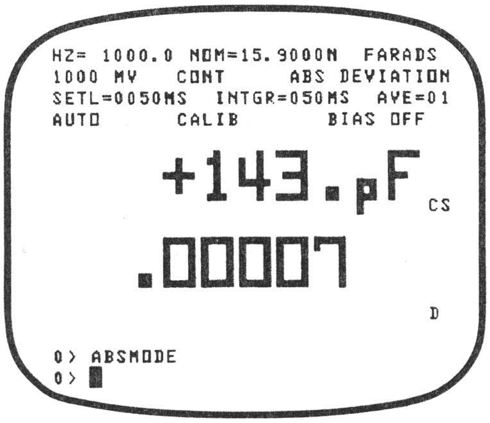
NOTE: Deviation is not available when Q and D are both displayed.

2.6.3 Absolute Deviation

The difference between the nominal value and the measured value (top reading) can be displayed as either absolute or percent deviation. Percent deviation is initially selected when power is applied. To display absolute deviation, push <blue> <ABS>.

Example: Continuing with the previous examples, the instrument was displaying percent deviations. Change to display absolute deviation.

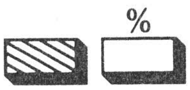
Push | **Display** | **Comments**

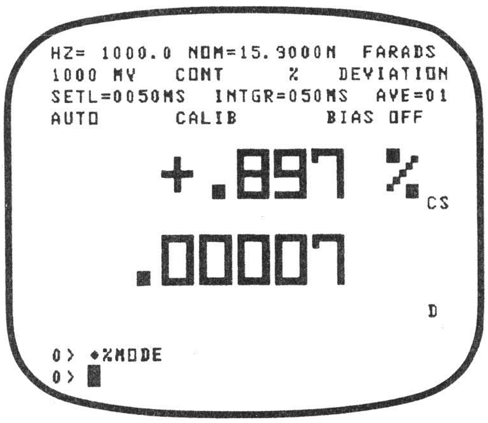


Display absolute deviation.

Example: Return to percent deviation mode.

Push | **Display** | **Comments**



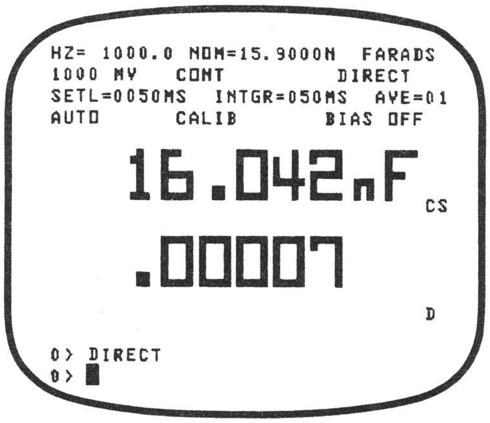


Display percent deviation.

2.6.4 Exit Deviation Mode

To exit from the deviation mode, push <DIR>. The instrument will revert to the direct (normal) display mode. The top measurement reading will again display the calculated value of the device under test.

Example: Continuing with the examples above, return to the direct measurement mode.

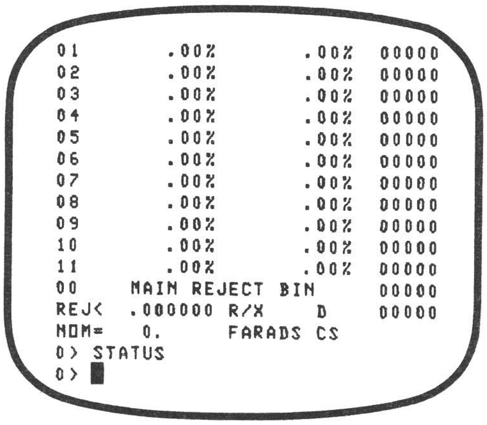
Push	Display	Comments
		Exit deviation mode.

2.7.1 Status Display

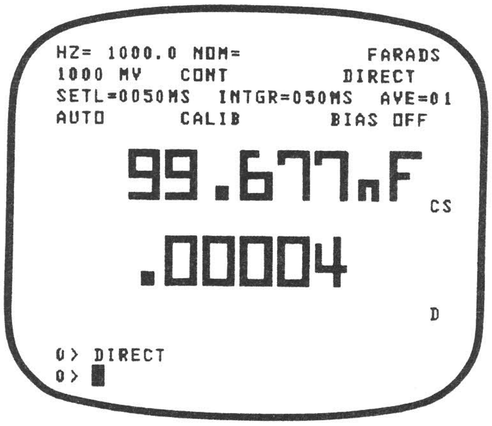
The Status display is used to set limits for SORT and GO/NO-GO displays. To enter this display, push <STAT> key. The status display consists of eleven accept bins (01-11), one main reject bin (00) and one loss element reject bin (REJ). Each bin has a lower limit value, an upper limit value, and a component counter. To switch from any display mode to the status display, push <STAT>. To switch back from status display to the previous display mode, push <STAT> again.

Example:

Push | **Display** | **Comments**



Status display format.



Return to previous measurement display.

The display also contains the programmed nominal value, units, and function for bins 0-11, and the units, component counter, and function for the reject limit. The priority for limits comparison is to compare a measured value first against the minor component limit, then against each individual bin limit from top to bottom on the display, i.e. REJ, 01-11, 00.

2.7.2 Programming Limits

Limits may be set in absolute units or as percent deviations from the nominal value. When instrument power is applied, the 2150/2160 is in the percent limits mode. Each bin is defined by an upper and a lower limit. If only one value is entered when selecting limits for a bin, the VideoBridge assigns the positive value of the entry as the upper limit and the negative value of the entry as the lower limit. If two different values are entered as limits for a bin, the lower value is assigned as the lower limit and the higher value is assigned as the upper limit.

> **NOTE:** Percent limits mode MUST have a nominal value set or else BIN 0 will always be selected. Absolute limits mode does not require a nominal value.

In either the absolute or percent mode, there are two methods of programming bin limits--"nested" and "sequential". In nested binning, the limits for each bin are set around the nominal value. Since the VideoBridge checks bins in order from 1 to 11, the span of limits must be increasingly larger for each succeeding bin. (Example: Bin 1 = -1%, 1%; Bin 2 = -2%, 2%; Bin 3 = -5%, 5%; etc.)

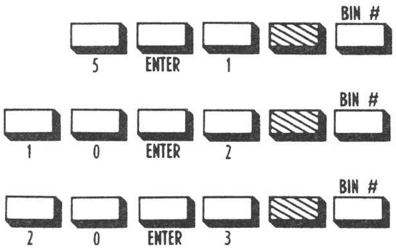
In sequential binning, the limits for each bin are not set around the nominal value. This method is more flexible and allows separation of high values from low values. (Example: Bin 1 = -5%, -3%; Bin 2 = -3%, 0%, Bin 3 = 0%, +5%; Bin 4 = +5%, +10%; etc.)

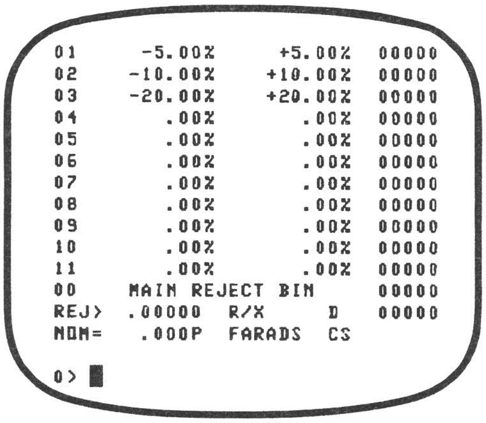
To set values for bins 0-11, push:
<number> (representing the first limit value), <ENTER>,
<number> (representing the second limit value), <ENTER>,
<number> (representing the bin in which the limit will be entered),
<blue> <BIN#>.

For nested binning, positive and negative values of the same percent value (i.e. +/- 1%) for any bin are entered by pushing <value> <ENTER> <desired bin #> <blue> <BIN #>.

Example: Set bins 1-3 for limits of +/- 5%, +/- 10%, +/- 20%.

Push | **Display** | **Comments**

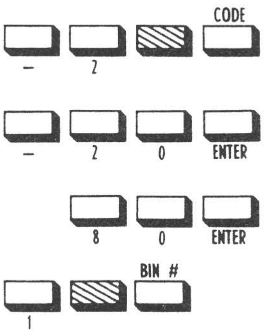


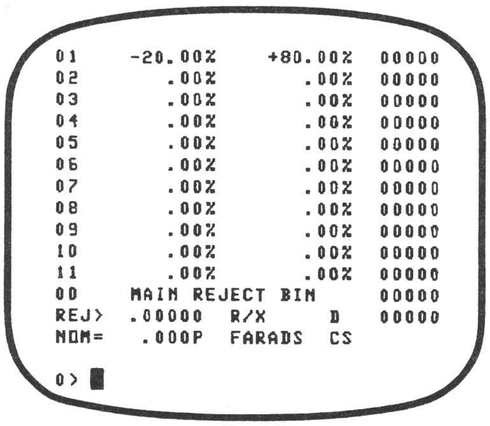


If only one value is entered per bin, the VideoBridge assumes symmetrical limits for that bin.

Example: Set bin 1 for limits of -20%, +80%.

Push | **Display** | **Comments**





Asymmetrical bin limits are entered in percent mode.

The preceeding examples used nested limits in percent mode.

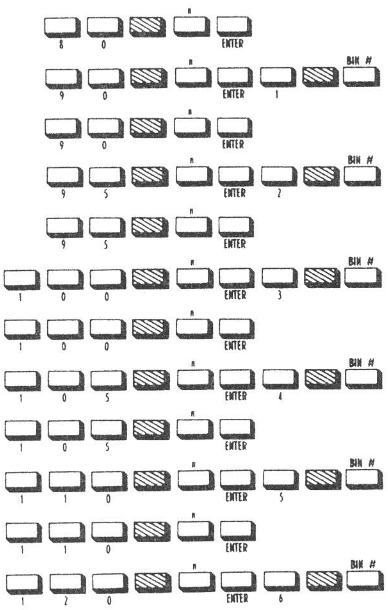
To program absolute value limits, push <blue> <ABS> to put the instrument in absolute mode.

Example: Set bins 1-6 for sequential limits above and below 100nF.

BIN 1 = 80-90nF BIN 2 = 90-95nF BIN 3 = 95-100nF

BIN 4 = 100-105nF BIN 5 = 105-110nF BIN 6 = 110-120nF.

Push | **Display** | **Comments**



```
01  80.0000N    90.0000N    00000
02  90.0000N    95.0000N    00000
03  95.0000N    100.000N    00000
04  100.000N    105.000N    00000
05  105.000N    110.000N    00000
06  110.000N    120.000N    00000
07      .000P       .000P   00000
08      .000P       .000P   00000
09      .000P       .000P   00000
10      .000P       .000P   00000
11      .000P       .000P   00000
00    MAIN REJECT BIN       00000
REJ> .00000   R/X       D   00000
NOM=    .000P  FARADS   CS

0>
```

Bins may be programmed in any order. Limit sequences for consecutive bins do not need to be adjacent. However, they should not overlap.

Remember to enter the units multiplier after each limit in absolute mode. No nominal value needs to be set in this mode.

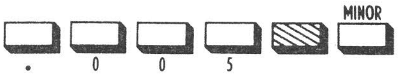
The minor reject limit (REJ) should be set before entering the SORT mode. It is a limit for the minor function (bottom measurement display when in direct display format). Reject limit is set as an absolute value for both absolute and percent mode. To program the reject limit, push:

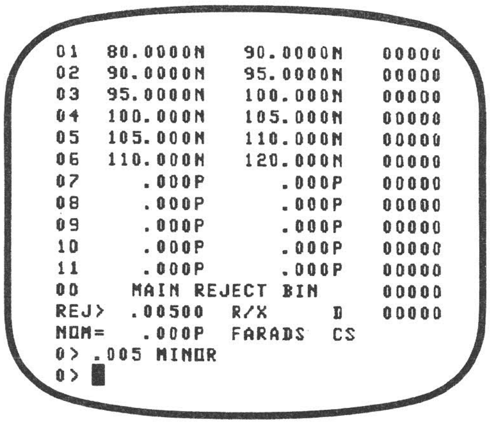
<number> (representing the limit of minor function)

<blue> <MINOR>.

Example: Set the maximum limit of D (minor parameter) to 0.005.

Push | **Display** | **Comments**





NOTE: If the minor reject limit is set at 0, the minor reject test is ignored.

NOTE: The reject limit is either a maximum or a minimum value depending on the measurement function of the bottom display on the CRT. Maximum or minimum is displayed as:

Rej > = Maximum Limit (all functions except G, B, Y, and Q)

Rej < = Minimum Limit (G, B, Y, and Q)

2.7.3 Bin Counters

Adjacent to each of the bins (0-11 and REJ) is a five-digit counter. The counter records the number of components that fall within the limits for each bin. During the sorting operation, the counter will record up to 65,225 parts for each bin. To view the counters and to stop the sorting operation, push the STAT key. To restart the sorting operation, push SORT. The bin counters for all bins (0-11 and REJ) are reset to zero by programming test code 2. Also, changing the nominal value also resets bins 0-11, while changing the minor reject limit resets bin REJ.

> **NOTE:** Bin counts are only incremented in the single measurement mode.

2.7.4 Sort Mode

Component sorting is always active in single measurement mode. To ensure accurate sorting to the desired bins, all test parameters and limit values must be set before entering the sort mode. When the SORT and SGL keys are pushed, the display indicates BIN number for each component measured (BIN R = minor reject). The appropriate Handler relay is activated if the Handler Interface is installed.

Activating the Handler relay allows testing the Handler setup before actual sorting begins. The Handler setup is checked by using the CONTINUOUS measurement mode. The CONTINUOUS measurement mode can be used to measure results without incrementing the bin count. Figure 2-12 is a sorting mode preparation check list.

> **NOTE:** The bin counter is always active when in the single measurement mode, regardless of the status of the sort mode. It is also active under other displays -- GO/NO-GO, % DEV, ABS DEV. If no bin limits are set when a component is measured in single mode, it will be binned as a major reject (BIN 0).

TEST PARAMETERS (Direct Display)

SET:

- [ ] Press <DIR>
- [ ] Top Display Function
- [ ] Bottom Display Function
- [ ] Frequency
- [ ] Signal Level
- [ ] Settling Time
- [ ] Integration Time
- [ ] Number of Averages
- [ ] Calibrate Clips/Fixture
- [ ] Range HOLD or Auto Range

(Settling Time, Integration Time, Number of Averages } [ ] Speed (FAST, MED, SLOW))

BINNING LIMITS (Status Display)

SET:

- [ ] Press <STAT>
- [ ] Major Limits for Bins 0 - 11
- [ ] Minor Reject Limit (REJ)
- [ ] Nominal Value (required for % mode)
- [ ] Select SORT or Handler Mode
- [ ] Press <SGL> to begin sorting

Figure 2-12. Sorting Mode Preparation Checklist

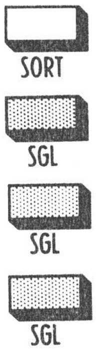
To enter the sort mode, push <SORT>. Entering the sort mode sets the instrument to the single measurement mode. Measurements are initiated by either pushing the SGL key or receiving a remote start signal.

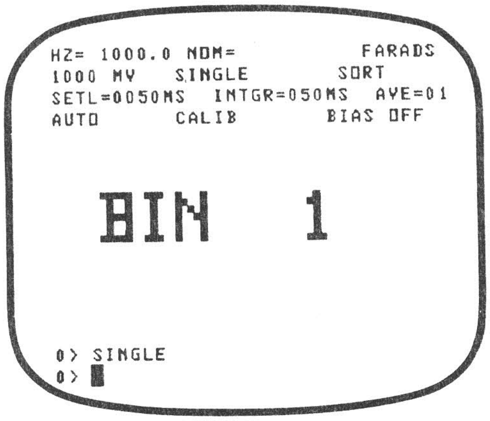
In SORT mode, the word BIN and a number are displayed. The number represents the bin into which the component was sorted. If the component exceeds the REJ limit, the display will read BIN R.

> **NOTE:** Programming test code 26 displays top and bottom display measurements along with BIN # while in SORT (see section 2.7.6).

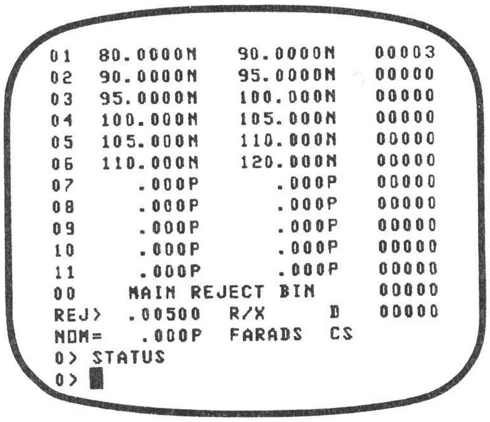
Example: Continuing with the preceding examples, enter the sorting mode and make several measurements.

Push | **Display** | **Comments**





Initiate sort mode measurements by pressing SGL key.



Check the status display and note bin counter totals. Adding totals from all bins indicates number of measurements taken.

To view the bin status, push STAT key. When the STAT key is pushed and the bin status is being displayed, the sorting function is still active. The nominal value and all limits are left intact. To return to the sorting display, push SORT key. The bin counters will continue to increment from their previous totals.

2.7.5 Component Sorting Example

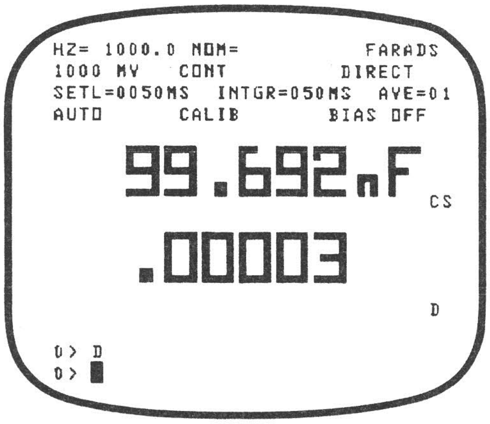
This example is to illustrate the concepts presented in this portion of the manual. It is a typical setup, starting from the instrument power ON condition. Sort 100nF capacitors into tolerance bands of +/- 1%, +/- 5%, +/- 10%, +/- 20% with a maximum limit on D of 0.005. Other test parameters include: frequency--1kHz, signal level--1000mV RMS, measurement speed--MED, test fixture--calibrated (CALIB).

After all parameters are programmed and the test fixture has been calibrated (see Section 2.3.5), the example will show how to start the sorting operation, stop sorting to look at the bin counters, and restart the sorting operation. The example will end by showing how to exit the sorting mode and return to direct mode.

Example:

Test Parameter Setup

Push | **Display** | **Comments**

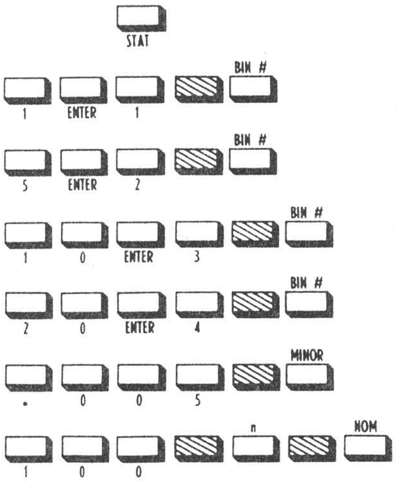


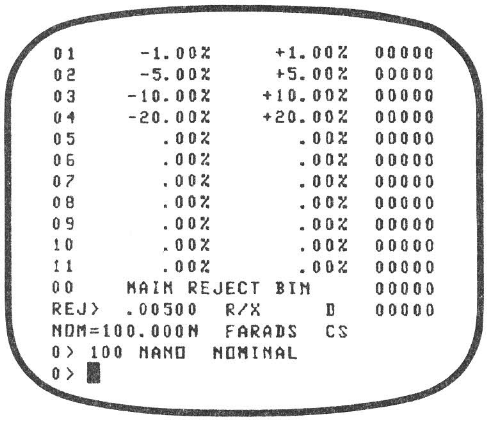
Go to direct display. Set measurement functions.

NOTE: In this example, test frequency, signal level, settling time, integration time, measurement averaging, and % mode did not need programming because the 2150/2160 initialized to these functions when power was applied.

Limits Setup

Push | **Display** | **Comments**

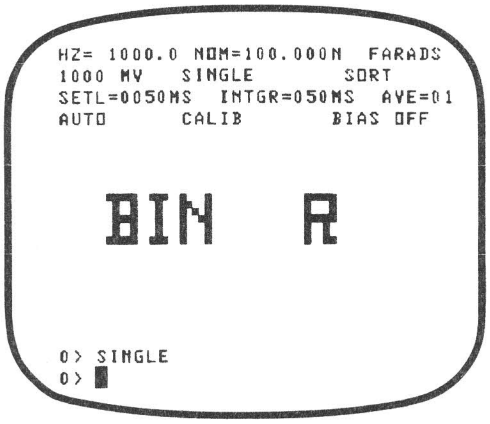




Limit values must be set in ascending order from Bin 1 to Bin 11. Within each bin, the VideoBridge will enter +/- per cent limits for each value entered.

Begin Sorting Operation

Push | **Display** | **Comments**



Components exceeding the minor reject limit will display BIN R.

View Bin Counters

Push	Display	Comments
STAT	(see display below)	Exit sort display. Note binning distribution. Remember that sorting is still active in this display.

```
01     -1.00%      +1.00%   00014
02     -5.00%      +5.00%   00011
03    -10.00%     +10.00%   00010
04    -20.00%     +20.00%   00013
05       .00%        .00%   00000
06       .00%        .00%   00000
07       .00%        .00%   00000
08       .00%        .00%   00000
09       .00%        .00%   00000
10       .00%        .00%   00000
11       .00%        .00%   00000
00    MAIN REJECT BIN       00000
REJ>  .00500   R/X     D    00001
NOM=100.000N  FARADS  CS
0> STATUS
0> █
```

Return to sort display and resume sorting

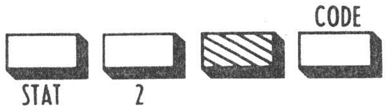
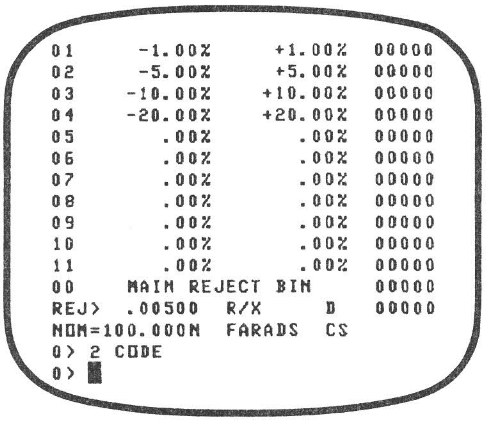
Push	Display	Comments
SGL	(see display below)	Re-enter sort mode and increment counters.

```
HZ= 1000.0 NOM=100.000N  FARADS
1000 MV    SINGLE        SORT
SETL=0050MS  INTGR=050MS  AVE=01
AUTO       CALIB        BIAS OFF

       BIN   2

0> SINGLE
0> █
```

Clear Bin Counters

Push	**Display**	**Comments**
		Return to status display. Enter 2 CODE to reset all bin counters to zero.

NOTE: To reset all counters to zero as well as clear all bin limits, program -2 CODE.

Component Sorting Summary:

- Consult the Sorting Mode Preparation Checklist in Figure 2-12 before sorting. If no limits are set, operating in SINGLE measurement mode will bin the part as a major reject.

- The bin counters only work in SINGLE measurement mode.

- Binning in percent mode requires a nominal value. Absolute value limits do not require that a nominal value be set.

- To clear all bin counts, program 2 CODE. To clear all bin counts and bin limits, program -2 CODE.

- The span of "nested" bin limits must widen as bin numbers increase. The higher the bin number, the wider the span of limits must be compared to the span of the previous bin.

- Bin counts are updated with Non-Volatile Memory (Section A.3).

2.7.6 Handler Mode

<8> <blue> <CODE> - Disables CRT display for use with the Handler Interface option and locks the keyboard. This code provides fastest VideoBridge measurement speed for handler operation. The display clears and shows "Now In Handler Mode". To deactivate 8 CODE, momentarily ground Pin 21 of the Handler Interface Card's rear panel connector. For more information on handler operation, see section A.1.

<-> <8> <blue> <CODE> - Displays the BIN number in large display characters, measured values in small characters and locks the keyboard for use with the Handler Interface option (see Figure 2-13). Display update increases measurement time by about 110ms compared to normal handler operation. Use of peripheral devices (such as a printer) also increases measurement time. Deactivate -8 CODE in the same manner as -8 CODE. Both 8 CODE and -8 CODE put the VideoBridge into SINGLE mode.

> **NOTE:** Neither 8 CODE nor -8 CODE can be saved in Non-Volatile Memory (see Section A.3).

<2> <6> <blue> <CODE> - When in SORT mode, 26 CODE displays the top and bottom display values in small characters (see Figure 2-13). The appropriate bin relay is activated if the Handler Interface is installed. The BUSY signal is not asserted in this mode. The keyboard is not locked under this mode. This mode is cleared by -26 CODE.

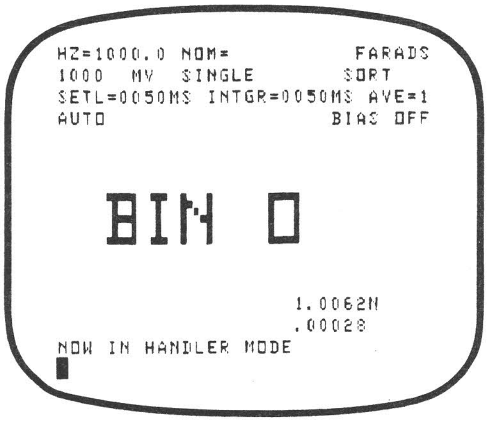


Figure 2-13. -8 CODE and 26 CODE Display Format

2.7.7 Binning Priority

Test Code 15 redefines the binning priority of the VideoBridge for capacitor testing.

NOTE:

NOTE:	MAJOR	as used in the following discussion means the primary, or reactive element of the unknown, C. The MAJOR value is the top display function.
	MINOR	as used in the following discussion means the secondary, or loss function of the unknown, D. The MINOR value is the bottom display function.

The normal (default at power up) bin priority selection is as follows:

REJ	Does part fail as a MINOR reject? If yes, select BIN REJ.
BINS 1-11	If no, does part's MAJOR value fall into an accept bin? If yes, select appropriate BIN.
BIN 0	If no, part fails as a MAJOR reject. Select BIN 0.

Under the above selection process, all High D parts are sorted as minor rejects. Since open-circuit parts will be measured as high D and low C, they would normally be binned as D rejects. 15 CODE provides an additional measurement on parts detected as D rejects rather than immediately binning them as Bin REJ. When 15 CODE is entered, the VideoBridge continues to test a D reject part against the bin limits. If the measured C value of the part does not fall within the limits of a programmed bin, it is sent to Bin 0 (MAJOR reject). If the measured C value of the part does fall within the limits of a programmed bin, it is sent to Bin REJ (MINOR reject).

Test Code 15 redefines binning priority to the following:

REJ	Does part fail as a MINOR reject? If yes, does part's MAJOR value fall into an accept bin? If yes, select Bin REJ. If no, select Bin 0.
BINS 1-11	If no, does part's MAJOR value fall into an accept bin? If yes, select appropriate BIN.
BIN 0	If no, part fails as a major reject. Select BIN 0.

To use, push <1><5> <blue> <CODE>. To clear this mode and return to normal bin selection priority, push <-> <1> <5> <blue> <CODE>.

NOTE: The status of 15 CODE is not indicated on the CRT.

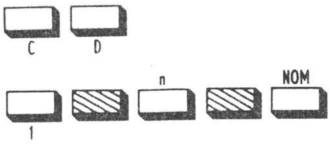
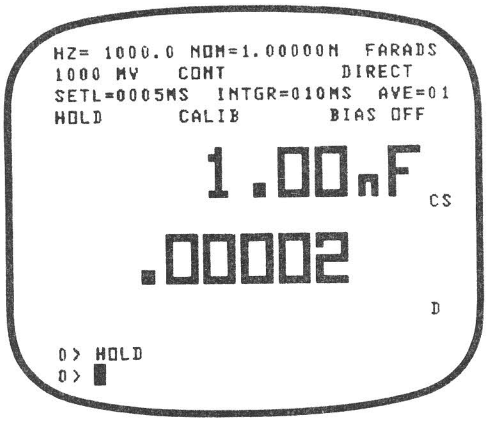
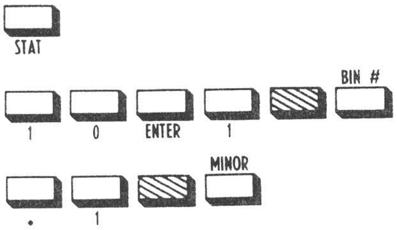
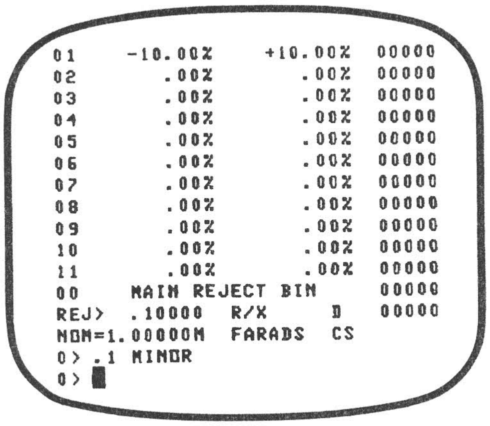
2.7.8 GO/NO-GO Mode

The GO/NO-GO mode takes advantage of the CRT display during hand sorting operations. When in the GO/NO-GO mode, the words "PASS" and "FAIL" appear on the CRT. If no minor limit is set, components which would normally fall into BIN 1 will cause the left side of the screen to illuminate under the word "PASS." If a minor limit is set, the component must pass both this limit and the Bin 1 limit for a "PASS" condition. All other BIN decisions will cause the right side of the screen to illuminate under the word "FAIL."

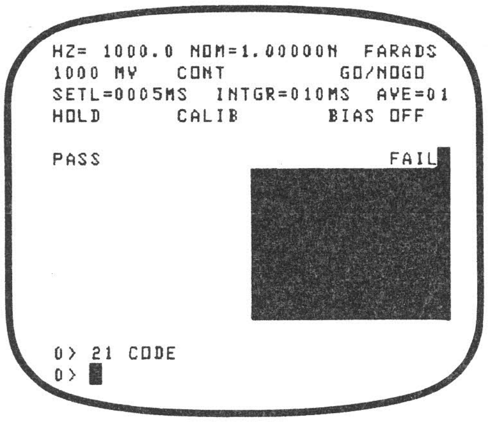
The GO/NO-GO mode operates in either CONTINUOUS or SINGLE measurement mode. However, the BIN counter is active only when in the SINGLE mode.

To enter the GO/NO-GO mode, push <2> <1> <blue> <CODE>. To exit this mode, enter any other measurement mode, e.g. DIRect, DEViation, SORT.

Example: From initial power up, set test parameters of: Nominal Value = 1nF, BIN 1 limits = +/- 10%, Dissipation reject limit = 0.1. Calibrate the test fixture. Connect a part of the value to be measured. Enter FAST and Range HOLD for maximum testing speed.

Push	Display	Comments
		Entering Range HOLD exits Auto LRC. Set nominal value to 1nF.
		Set BIN 1 to +/-10% of the nominal value and REJ > 0.1 D.

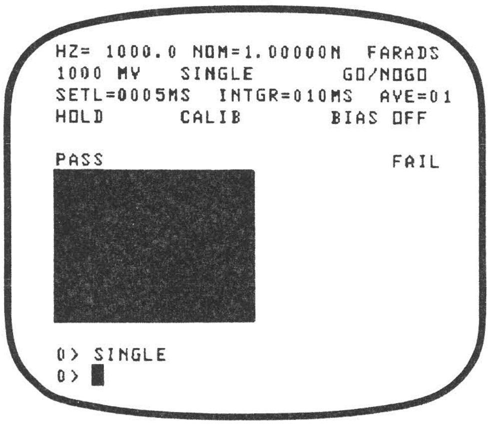
Push | **Display** | **Comments**



Enter GO/NO-GO mode. This setup condition is indicated by the words "GO/NO-GO", "PASS" and "FAIL" on the CRT display. "FAIL" will be indicated when no part is connected.

The GO/NO-GO mode is often used in continuous mode. However, to use bin counters, the SGL key or the footswitch must be pressed. Measure several parts by pressing <SGL>.

Push | **Display** | **Comments**

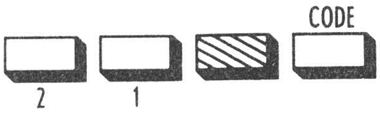


10 measurements are made in single mode, each indicating a PASS condition.

Push	Display	Comments
	(see display below)	Pressing the STAT key displays BIN STATUS counters.

```
01     -10.00%     +10.00%  00010
02        .00%        .00%  00000
03        .00%        .00%  00000
04        .00%        .00%  00000
05        .00%        .00%  00000
06        .00%        .00%  00000
07        .00%        .00%  00000
08        .00%        .00%  00000
09        .00%        .00%  00000
10        .00%        .00%  00000
11        .00%        .00%  00000
00     MAIN REJECT BIN      00000
REJ>  .10000   R/X      D   00000
NOM=1.00000N   FARADS   CS
0> STATUS
0> █
```

To continue testing with GO/NO-GO display, enter 21 CODE. The bin counters will continue to increment. To clear counters, enter 2 CODE before entering 21 CODE (see Section 2.7.5).

Push	Display	Comments
	(see display below)	Re-enter GO/NO-GO Mode.

```
HZ= 1000.0 NOM=1.00000N   FARADS
1000 MV    SINGLE        GO/NOGO
SETL=0005MS  INTGR=010MS  AVE=01
HOLD       CALIB        BIAS OFF

PASS                        FAIL






0> 21 CODE
0> █
```

Exit GO/NO-GO mode by selecting another display mode: SORT, DIRect, DEViation.

2.7.9 Outputs Connector Wiring

The order of outputs via the output connector on the Handler Interface card is listed in Table 2-8 (for more information on Handler Interface operation, see Section A.1).

Table 2-8. VideoBridge Outputs Connector Wiring

PIN NUMBER	FUNCTION
1	COMMON
2	BIN 0
3	BIN 1
4	BIN 2
5	BIN 3
6	BIN 4
7	BIN 5
8	BIN 6
9	BIN 7
10	BIN 8
11	BIN 9
16	BIN 10
17	BIN R
15	BIN 11 (EOC)
12*	+5V (SYSTEM) OUT
13*	SYSTEM GROUND
14	START IN
18	BUSY OUT
19	BUSY COM
20	START COM
21	KEYBOARD UNLOCK

*ESI recommends that Pin 12 (+5V OUT) and Pin 13 (SYSTEM GROUND) not be used. Noise introduced into the Model 2150/2160 through these connections may affect measurements results.

NOTE: Pin 17 is Bin R which is the REJ bin.

NOTE: Pin 15 (Bin 11) is used for the End of Conversion (EOC) signal when test code 16 is entered. THIS MAKES ONLY 10 ACCEPT BINS AVAILABLE INSTEAD OF 11. When the EOC feature is cleared (-16 CODE), Bin 11 is again available. Do not use 16 CODE unless Bin 11 limits have been set to zero.

2.8 MEASUREMENT SPEED

Overall Measurement Speed consists of three main parts: Measurement Time, Calculation Time, and Display Time.

In SINGLE mode, overall measurement speed is the sum of all times.

In CONTINUOUS mode, the calculation of the previous measurement is done during Measurement Time, which increases speed. Overall measurement speed is the larger of either [measurement time + 5ms] or [calculation + display time + 5ms].

Overall measurement speed can be found by using the formula:

Overall Measurement Speed = Measurement Time + Calculation Time + Display Time

Where: Measurement Time = [# of Sample Times + Settling Times] x # of Measurements Averaged

Calculation Time = 75ms

Display Time = 110ms Direct display
50ms Sorting display

All measurements and calculations are driven by various phases of the 7.68MHz clock signal from the motherboard. Test frequencies can interact with synchronizations of this clock and cause variations in several measurement speed elements: Settling Time, Integration Time, Tailoff Time, and Linelock Time.

These variations show up as discrepancies between values entered and values displayed (usually about 3-5ms). As a result, all stated measurement speeds are approximate--the methods and formulas for determining exact speeds are beyond the scope of this manual.

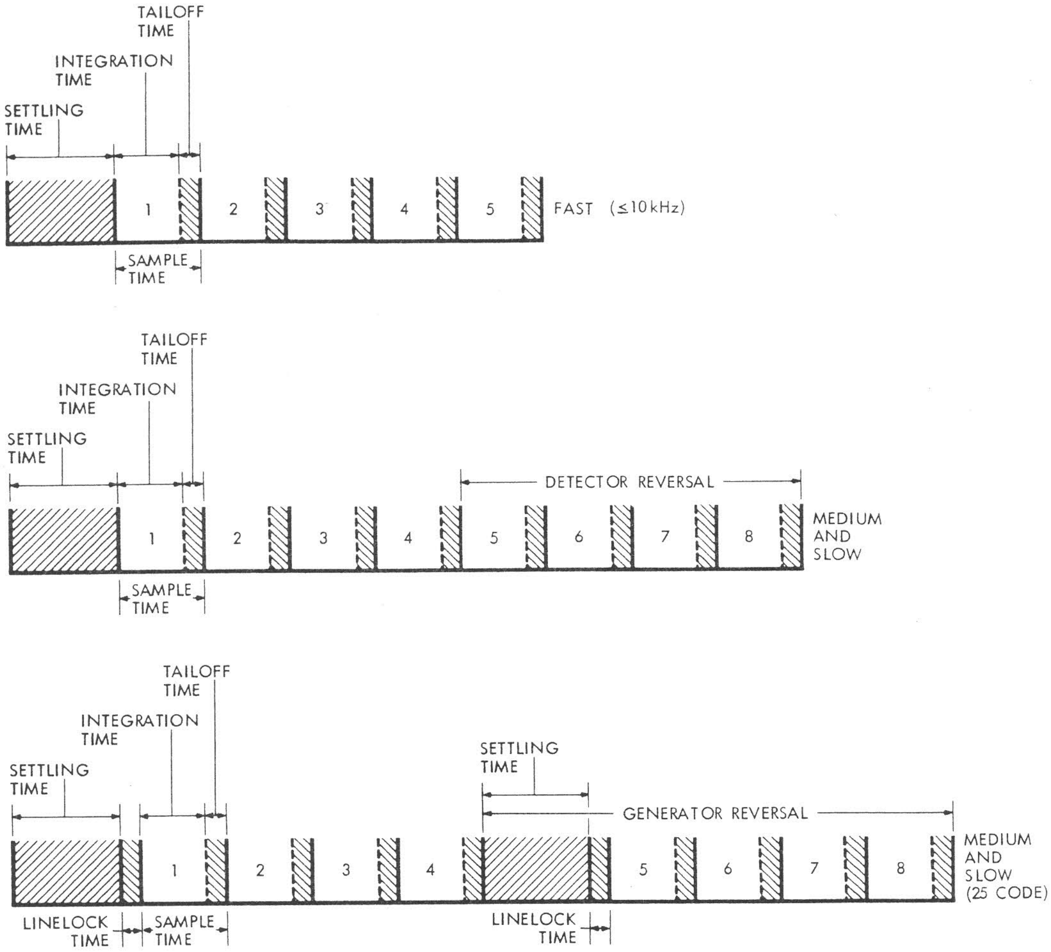


Figure 2-14. Detector and Generator Reversal Measurement Sequences

Settling Time is the time required for the analog voltage representing the unknown to settle to the desired accuracy. Settling times between 2ms and 1500ms can be programmed in 1ms steps. Settling time values are dependent on the type of component being tested and/or requirements of externally connected equipment. Typically, smaller impedances require longer settling times.

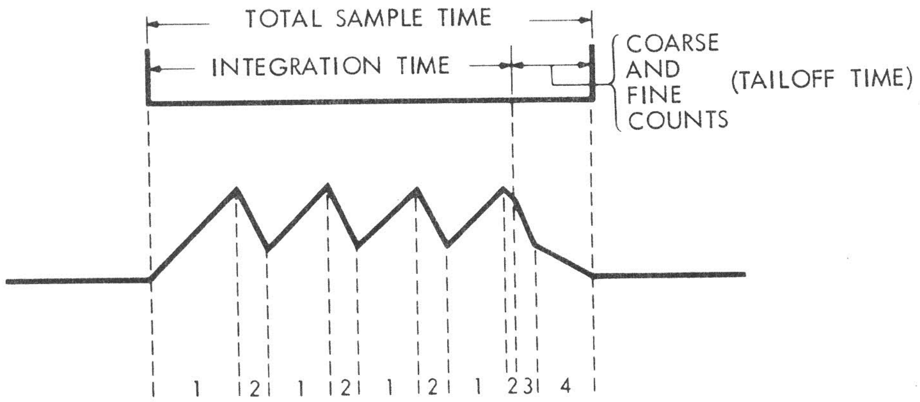
Integration Time is the combined periods of test frequency cycles during which the A/D converter is making the measurement. Integration time is one of three measurement time elements that can be programmed (Settling Time and Number of Averages are the others). Values for Integration Time may be programmed within the following range:

$$2\text{ms} \leq \text{I.T.} \leq 600\text{ms}$$

See Section 2.8.2 for more information on determining integration time.

Tailoff Time is the fixed portion of measurement time which is set at approximately 5ms. During tailoff time the A/D converter is brought to zero, and the coarse and fine counters are accumulating measurement data. Due to variations caused by the synchronization of internal timing, tailoff time can range from 4ms to 6ms (see Sample Time).

Sample Time is Integration time + 4ms of Tailoff time rounded to the next higher even number. For example, 27.5ms + 4ms = 31.5ms ⟶ 32ms.



1 = Integration on measured signal.

2 = Integration on mixture of measured and reference signal. Coarse counter sums these periods.

3 = Integration on reference signal only. Coarse counter sums this with previous periods.

4 = Integration on fine reference. Fine counter monitors this period adding its count to the coarse counter total (1 coarse count = 1024 fine counts).

Figure 2-15. Sample Time

Detector Reversal is the sinewave detector reversing polarity after the fourth sample time. The second series of measurements are made in the opposite polarity. These two series of measurements are algebraically added (i.e. (1-5) (2-6), (3-7), (4-8)), to cancel offset voltages in operational amplifiers and synchronized line related pickup. Neither linelock time nor additional settling time is required for this measurement method.

Generator Reversal (below 200Hz) is the sinewave generator reversing polarity after the fourth sample time with settling time and linelock time added before the first and fifth sample times. It is enabled by programming 25 CODE--the VideoBridge will perform generator reversal below 200Hz and switch to detector reversal at or above 200Hz. Cancellation of op amp offsets is the same as for detector reversal.

FAST Measurement Mode is enabled by pressing the <blue> and <FAST> keys. This puts the VideoBridge in its fastest preset measurement mode by performing an altogether different sample routine. The normal VideoBridge reversal routine compares the first four integration measurements of the unknown and standard against opposite polarity measurements of the unknown and standard. In FAST mode, the VideoBridge compares the first four measurements of the unknown and standard against a zero reference measurement (to ground). Measurements are subtracted from this reference instead of from opposite polarity measurements. This requires less time (five sample measurements are taken instead of eight -- see Figure 2-16), while still providing adequate offset cancellation.

> **NOTE:** Five measurements are taken only when the test frequency is at or below 10kHz. Above 10kHz, eight measurements are taken to improve the signal-to-noise ratio.

Linelock Time (generator reversal only) is the average time for the line frequency to reach the zero crossing point with a positive-going slope. Linelock time is added to settling time for test frequencies between 20Hz and 200Hz. Linelock time can vary, depending on the phase relationship at any given time of generator reversal to line frequency. Worst case is the period required for two complete line voltage cycles (one per half measurement sequence, or 33ms total at 60Hz). For test frequencies above 200Hz, linelock time is zero.

> **NOTE:** Linelock time for 50Hz line frequency is 20ms per half measurement (40ms for one full measurement sequence).

Measurement Time is the total time from start to end of a measurement sequence. For generator and detector reversal, integrations 5 through 8 are made with the generator/detector polarity reversed.

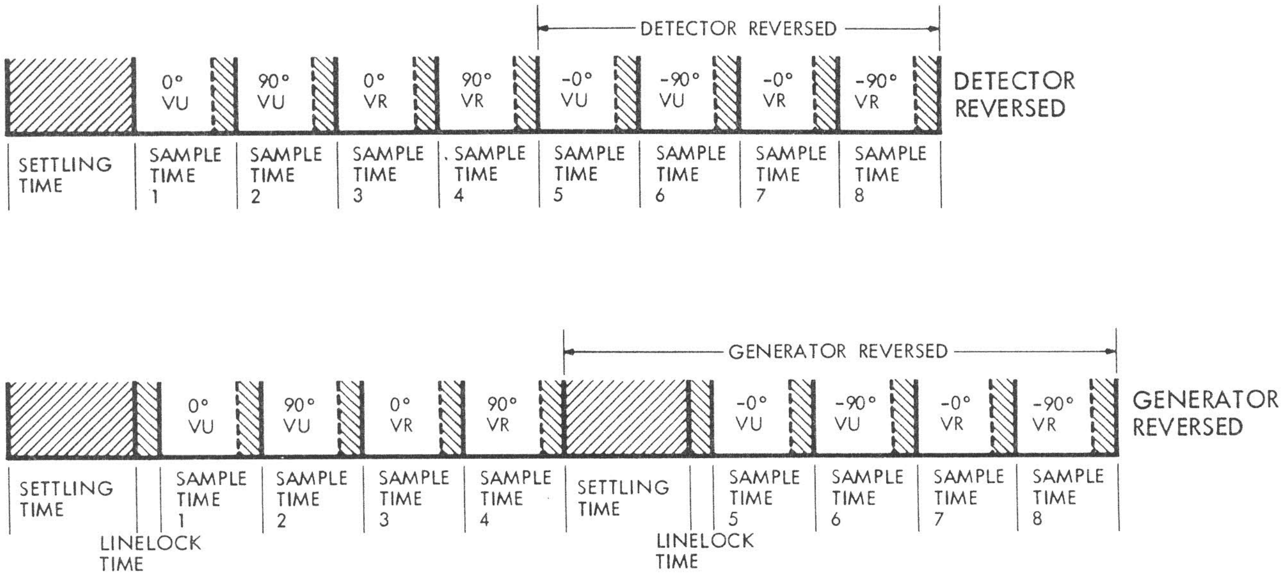


Figure 2-16. Measurement Cycles

Formula Summary

Generator Reversal	=	8(sample) + 2(settling) + 2(linelock)
Detector Reversal	=	8(sample) + 1(settling)
FAST (≤ 10kHz)	=	5(sample) + 1(settling)
Sample time	=	Integration time + tailoff
Tailoff time	=	4ms to 6ms per sample
Linelock time	=	16.7ms (60Hz line frequency)
	=	20ms (50Hz line frequency)

Measurement Averaging is n x (measurement time) Where: n is an integer between 1 and 20 (see Figure 2-17). Measurement averaging is the third measurement time element that is operator programmable (along with settling time and integration time). Averaging reduces noise in the readings by adding a selected number of measurement results and dividing by the number of measurements. The process is the same at any frequency.

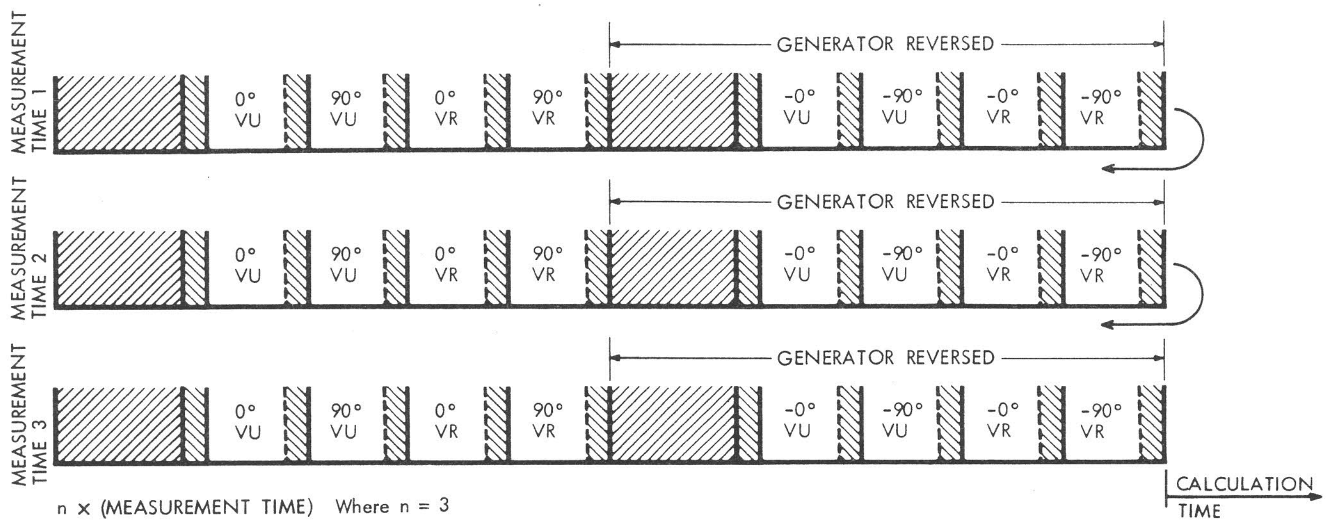


Figure 2-17. Measurement Averaging (Generator Reversal)

Where: VU = Voltage across unknown (device-under-test)
VR = Voltage across range resistor

Calculation Time is the time required to calculate display information from the raw measured data (approximately 75ms).

Display Time is the time required to display results on the CRT (approximately 110ms in DIRect, 50ms in SORT).

In addition, VideoBridge options (GPIB, RS-232C, Handler Interface) also affect Overall Measurement Speed:

For GPIB measurements, add 350ms per measurement in FAST and SLOW modes, 400ms in MEDium to standard VideoBridge measurement speeds.

For RS-232C measurements, use the baud rate set at the factory (9600) and range HOLD to achieve optimum measurement speeds.

The VideoBridge with Handler Interface option can be programmed to operate without display (test code 8). Eliminating display saves up to 110ms per measurement. By selecting FAST mode along with minimum Integration and Settling times of 2ms, the VideoBridge with Handler Interface can make up to 9 measurements per second. Refer to Section A.1 of this manual for more information on Handler Interface timing.

NOTE: All speeds listed are approximate. Specified times may vary by 3-5ms due to internal clock synchronization.

Meaningful determination of measurement speed depends on specifying the following conditions:

1) test frequency
2) integration time
3) settling time
4) number of averages
5) display mode
6) test signal
7) value of component-under-test
8) baud rate (if applicable)
9) FAST vs. MEDium vs. SLOW
10) single vs. continuous
11) range hold vs. auto range
12) bias on vs. bias off

FAST/MED/SLOW selection sets initial integration time, settling time, and number of averages. These may be used as is, or they may be reset to any desired level (see Section 2.8.1).

Table 2-9. Preset Measurement Speeds

	DIRECT	SORT and GO/NO-GO	HANDLER*
FAST	~4 measurements/second	~11 measurements/second	~6/second ~9/second**
MEDIUM	~2 measurements/second	~2 measurements/second	~2 measurements/second
SLOW	~5 seconds/measurement	~5 seconds/measurement	~5 seconds/measurement

*Single mode only, 8 CODE enabled
**2ms SETL, 2ms I.T., frequency ≥500 Hz

These measurement speeds are typical under the following conditions:

frequency = 1kHz
I.T. = determined by FAST/MED/SLOW
SETL = determined by FAST/MED/SLOW
AVG = determined by FAST/MED/SLOW
display mode = see table
test signal = 1000mV

value of component-under-test = 1nF
baud rate = 9600 (if using RS-232C)
FAST/MED/SLOW = see table
measurement mode = continuous (unless indicated as single)
ranging status = HOLD
bias = OFF

The following examples illustrate how to calculate measurement times under different test conditions.

Example: Speed for measuring a 1nF capacitor in single measurement mode, MEDium preset measurement time selected (SETL = 50ms, I.T. = 50ms, and AVG = 1), DIRect display mode, Range HOLD, bias OFF, 1000mV, 1kHz, is calculated as follows:

Integration time	=	50ms	
Tailoff time	= +	5ms	
SAMPLE TIME (TOTAL)	=	55ms x 8 = 440ms	
Linelock time	=	0ms	(frequency above 200Hz)
Settling time	= +	50ms	
(TOTAL)		50ms x 1 = 50ms	(Detector Rev.)
Measurement time	=	490ms	[8(55) + 1(50)]
Measurements averaged	= x	1	
Total Measurement time	=	490ms	
+ Calculation time	= +	75ms	
+ Display time	= +	110ms	(Normal display)
= Measurement speed	=	675ms	

Example: Conditions for fastest available measurement speed -- same as above except: FAST mode, SETL= 2ms, I.T.= 2ms, AVG = 1, handler interface with 8 CODE.

Integration time	=	2ms	
Tailoff time	= +	5ms	
SAMPLE TIME (TOTAL)	=	7ms x 5 = 35ms	
Linelock time	=	0	(frequency above 200Hz)
Settling time	= +	2ms	
(TOTAL)	=	2ms x 1 = 2ms	(Detector Rev.)
Measurement time	=	37ms	[35ms + 2ms]
Measurements averaged	= x	1	
Total Measurement time	=	37ms	
+ Calculation time	= +	75ms	
+ Display time	= +	0ms	(8 CODE, no display)
= Measurement speed	=	112ms = 9 measurements/second	

2.8.1 Programming Measurement Speed

Three pushbuttons program preset combinations of measurement time elements as FAST, MEDium, or SLOW. Each selection fixes a different combination of integration time, settling time, and number of measurement averages. However, any preset combination can be overridden by programming a different integration time, settling time and/or number of averages. MEDium speed is initially selected when power is applied.

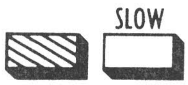
Table 2-10. Preset Measurement Parameters

	SETL	I.T.	AVG
Fast	5 ms	10 ms	1
Medium	50 ms	50 ms	1
Slow	50 ms	50 ms	10

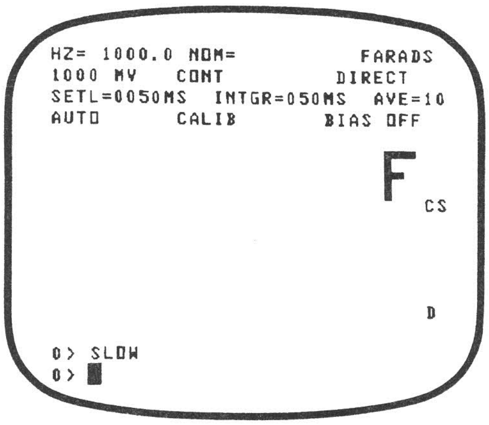
To program FAST, MEDium, or SLOW combinations, push the blue key followed by the FAST, MED, or SLOW key.

Example: Set the instrument to SLOW measurement speed.

Push



Display



Comments

Measurement speed is changed from MED to SLOW.

NOTE: Above 10kHz, FAST mode reverts to 8 integrations.

2.8.2 Programming Integration Time

Integration time (I.T.) is only a portion of the overall measurement time of the Model 2150/2160. It is the variable portion of sample time (described previously), that is based on the number of cycles of the test frequency. Integration time can be programmed to a maximum of 600ms and to a minimum of 2ms.

As a rule, minimum required integration time increases as test frequency decreases. Also, short integration times are less accurate than longer times and can cause less measurement resolution to be displayed. If an entered time does not allow the instrument to integrate on a number of complete measurement frequency cycles, it is automatically recalculated to the next larger integration time that does (see Table 2-11). This holds true when either integration time or test frequency is changed, or both.

To find the permissible integration times, use the formula:

I.T. = # of cycles * (period / 60)

where: # of cycles = CEILING [programmed I.T. * (60 / period)]

period = FLOOR [60,000/F] for F ≤ 10kHz or F = 12kHz, 15kHz, 20kHz, 30kHz, 60kHz.

period = FLOOR [300,000/F] for F > 10kHz (excluding 12kHz, 15kHz, 20kHz, 30kHz, 60kHz).

CEILING = a function where, if the value is a non-integer, round it to the next higher integer. If it is an integer, keep value.

FLOOR = a function where, if the value is a non-integer, round result to the next lower integer. If it is an integer, keep value.

Table 2-11. Integration Time Chart

FREQUENCY		MINIMUM INTEGRATION TIME
500Hz	=	2ms
400Hz	=	3ms
300Hz	=	4ms
200Hz	=	5ms
120Hz	=	16ms
100Hz	=	10ms
60Hz	=	17ms
50Hz	=	20ms
40Hz	=	25ms
30Hz	=	34ms
20Hz	=	50ms

To program integration time, push the numerical keys representing the desired integration time in milliseconds, then push the blue key followed by the I.T. key.

Example: Program integration time based on 10 cycles of the 500Hz test frequency.

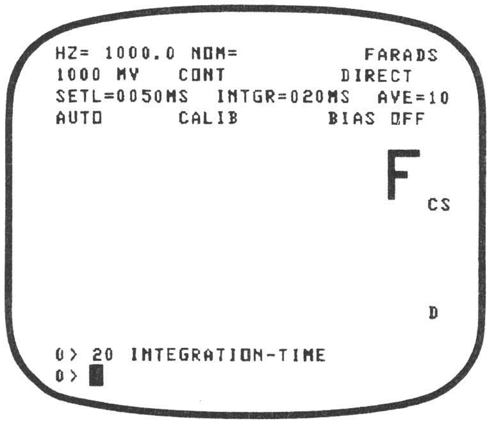
period = FLOOR [60,000/500] = 120

# of cycles = CEILING [20 * 60/120] = 10

I.T. = 10 * 120 / 60 = 20ms

Push

Display



Comments

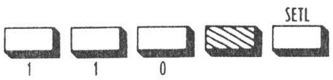
Integration time is entered in milli- seconds.

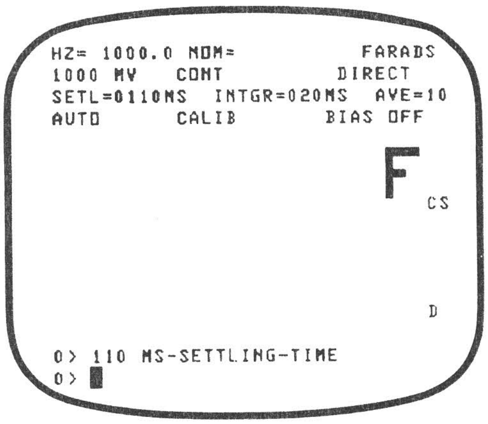
2.8.3 Programming Settling Time

Settling time, as described above (Section 2.8), is the time required for the analog voltage representing the unknown to settle to stated accuracy. When instrument power is applied, the settling time is at 50ms (MED speed). Settling times can be programmed between 2ms and 1500ms in 1ms steps. To program settling time, push the numerical keys that represent the settling time, in milliseconds, followed by the blue key and the SETL key.

Example: Set settling time to 110 milliseconds.

Push | **Display** | **Comments**





2.8.4 Programming Measurement Averaging

Measurements made where stray fields introduce noise can result in fluctuating readings. The 2150/2160 can reduce these fluctuations by averaging a specified number of measurements on one device-under-test. The noise is reduced by approximately the square root of the number of measurements averaged. As shown in Section 2.8, the total measurement time for averaging measurements is equal to:

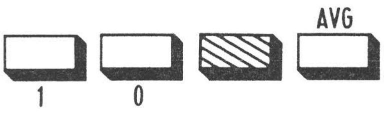
$$n \times (\text{Sample time})$$

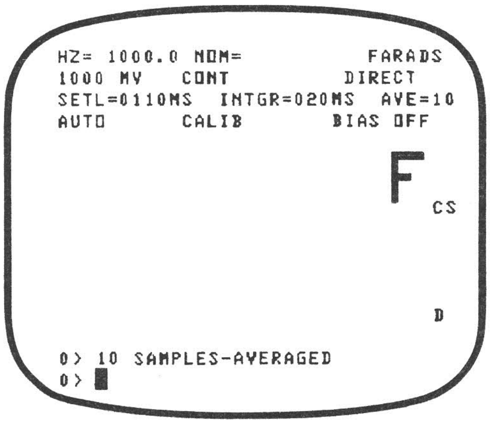
Where: n = an integer between 1 and 20

To program a selected number of measurements to be averaged, push the numerical keys representing the number of measurements to be averaged followed by the blue key and the AVG key.

Example: Average 10 measurements and display the results.

Push | **Display** | **Comments**





2.9 CASSETTE TAPE LOADER

The cassette tape loader is a non-volatile, mass storage unit that distinguishes the Model 2160 from the 2150. It uses a certified digital mini-cassette recording tape for saving and reloading instrument measurement-parameter setups. All measurement parameters, binning limits, and bin counter information can be saved, then reprogrammed at a later time. Using a cassette tape saves the time required to reload test parameters and limits at the start of a production run or after a power interruption. For greater efficiency, the Auto Start feature saves even more time and minimizes errors in setup by automatically loading a file at power up (see Section 2.9.5.1).

As stated in Section 2.3.5, zero offset corrections are not stored to tape. However, a setup that has been calibrated may be saved to tape. When that file is loaded, it automatically initiates a calibration, as if <blue> <CAL> were pressed.

Any cassette tape must be properly formatted for use in the 2160. Formatted tapes are available from ESI (P/N 55852) and can be used for immediate storage of data. Tapes can also be formatted by the 2160.

Applications Software Packages are also available for use with the 2160. The extended programming on these tapes analyzes measurement data and provides statistical evaluation or graphic display of results. The STATISTICS (P/N 55104) or ANALOG (P/N 55103) kits can be ordered with the Model 2160 or any time after purchase.

CAUTION

CASSETTE TAPE FUNCTIONS ARE NOT SUPPORTED BY WAY OF OPTIONAL REMOTE DEVICES--GPIB OR RS-232C. DO NOT ATTEMPT TO USE REMOTE COMMANDS TO CONTROL MODEL 2160 CASSETTE OPERATIONS.

2.9.1 Cassette Tape Installation

The mini-cassette tape is installed in the 2160's cassette tape loader as shown in Figure 2-18. To install:

STEP 1. Push the front panel button labeled EJECT. The cassette tape loader door will spring open.

STEP 2. Install tape by sliding cassette downwards as shown in Figure 2-18 (side A or B refers to whichever side is facing front).

STEP 3. Push the door closed.

STEP 4. The Model 2160 is ready to save or load parameter programs. (Tape must be properly formatted, see Section 2.9.3.)

> **NOTE:** Tape can be left in the tape loader when not in use. If Auto Start has been programmed, it will load at power up (see Section 2.9.5.1).

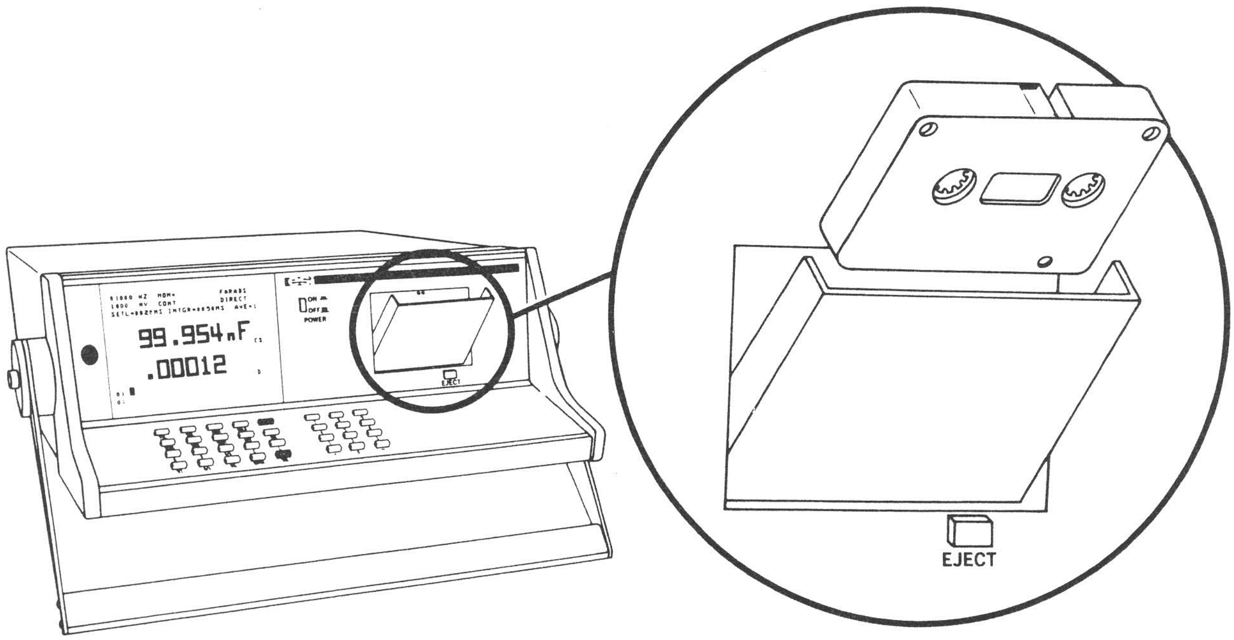


Figure 2-18. Cassette Tape Installation

2.9.2 Cassette Tape Loader Maintenance

To assure reliable data storage and playback, the recording and playback heads should be periodically checked and cleaned. The heads should be cleaned using a cotton tipped swab dipped in alcohol (see Figure 2-19). No other preventive maintenance or lubrication is required.

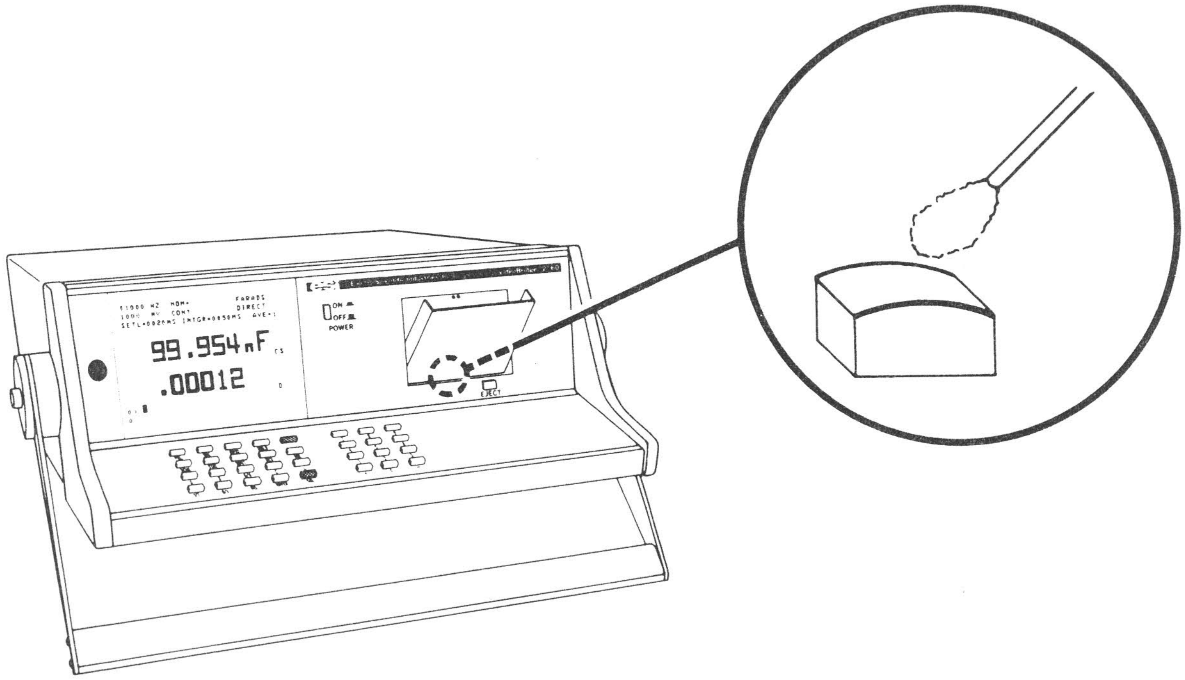


Figure 2-19. Cleaning Recording/Playback Heads

2.9.3 Cassette Tape Formatting

All blank tapes received from ESI have been formatted at the factory. Re-formatting a tape can be used as a method of tape erasure. However, it is recommended to bulk erase tapes before re-formatting due to tape deck variations between VideoBridges. Either a permanent magnet or AC field style tape eraser may be used.

CAUTION

FORMATTING A TAPE DESTROYS ANY AND ALL DATA WHICH MAY HAVE BEEN PREVIOUSLY SAVED ON THE TAPE.

The formatting sequence sets up 80 blocks per side of tape in which information can be stored. Each side must be formatted separately. The time required to format one side of a tape is approximately 7 minutes. To format a tape:

STEP 1. Place the new tape in the cassette drive unit.

STEP 2. Enter test code 3. The Model 2160 will echo the message: "MAKE TAPE - ENTER TO START."

STEP 3. Push the <ENTER> key to start the formatting process. Tape activity during the formatting process is indicated by a blinking cursor at the righthand side of the display screen. The following message is displayed: "BUSY - DO NOT DISTURB."

NOTE: If the cursor stops blinking while the tape is either moving slowly or is stopped, the tape is defective and should be discarded.

STEP 4. Completion of the formatting process will be indicated by the following message: "TAPE FORMATTED".

If any key besides <ENTER> or <SGL> is pressed to start formatting, the following message will result: "FUNCTION CANCELLED."

2.9.4 Tape File System

The tape structure is arranged in the following manner:

2 sides per tape

80 blocks per 50 foot tape side

256 bytes per block

6 blocks (minimum) per file entry

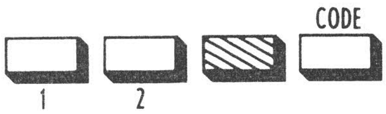
13 file entries per tape side (this is a maximum number and may be decreased by large files)

2.9.4.1 Tape Directory

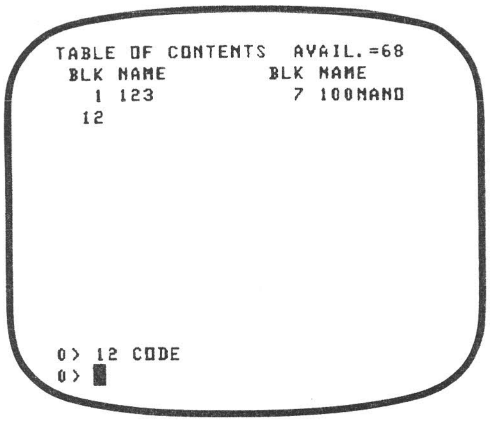
The Directory or Table Of Contents is a listing of all files on one side of the cassette tape. They are listed with the starting block to the left of the name. Use 12 CODE to display a Tape Directory.

EXAMPLE:

Push



Display



Comments

Table of Contents includes block number information and remaining space available (in blocks).

2.9.5 Saving Parameters

To save instrument parameters onto the cassette tape:

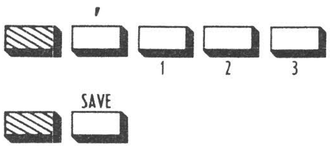
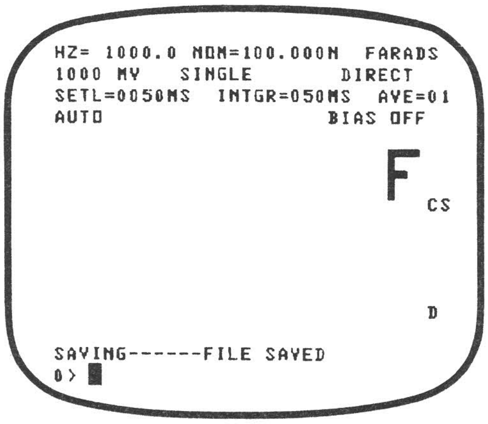
PUSH 

Where <filename> can be up to 10 characters long in any combination of letters, symbols, signs, numerals, or punctuation.

NOTE: A space cannot be used in naming a file.

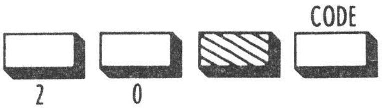
Alphanumeric entries can be entered with the Keyboard Overlay in conjunction with 20 CODE. (Refer to Section 2.1.1.2 in this Manual for additional details on the Keyboard Overlay.)

Example: Using the component sorting example in Section 2.7.5 of this manual, set up all test parameters and binning limits. Save this parameter program under the identification number 123.

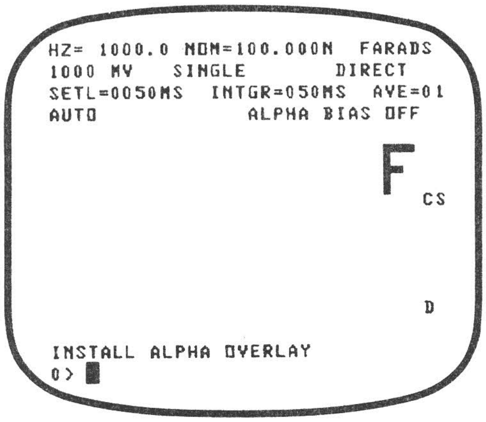
Push	Display	Comments
		Completion of the SAVE operation is signaled by "FILE SAVED" printed on the CRT. The tape directory will be displayed to verify the SAVE operation.

EXAMPLE 2: Using the same setup as in the above example, use the Keyboard Overlay and save the file under the filename of "100NANO".

Push



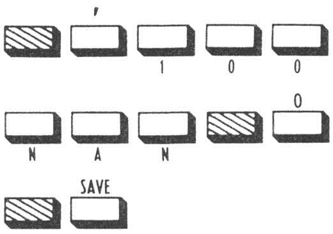
Display



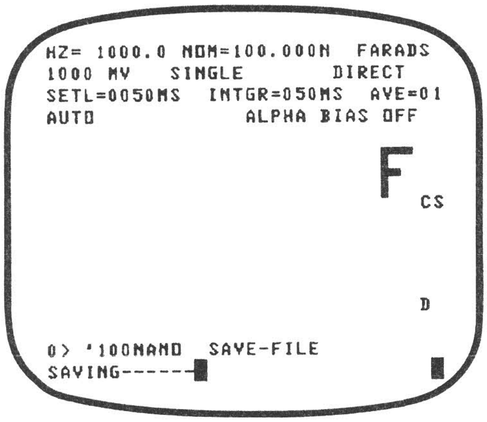
Comments

Place the keyboard overlay alternate function side up.

Push

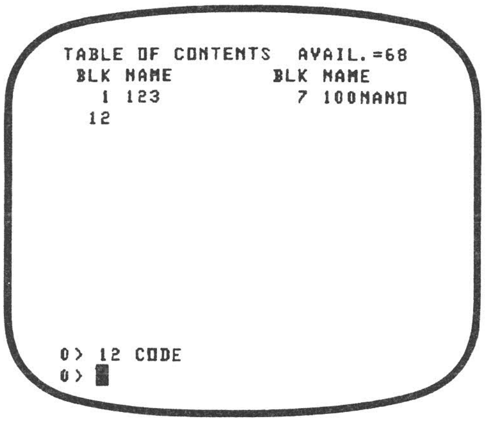


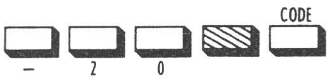
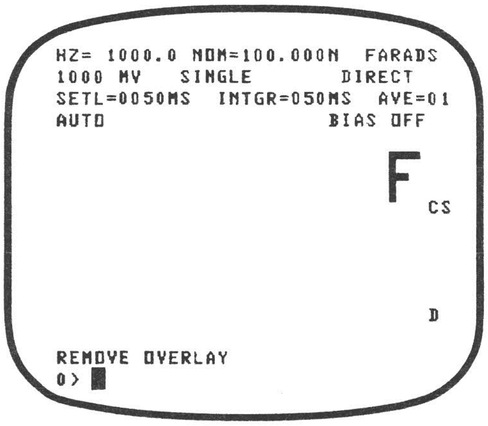
Display



Comments

Completion of the SAVE operation is signaled by [FILE SAVED] printed on the CRT.

Push	Display	Comments
		Examine the directory.

Push	Display	Comments
		Return to normal keyboard. Place the keyboard overlay with the original functions side up.

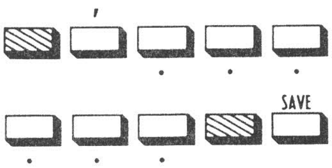
2.9.5.1 Autostart

To have a file automatically loaded when power is applied to the instrument, name the file <'......> when saving it. Whenever power is applied, the instrument will immediately search for this filename and upon finding it will load it automatically.

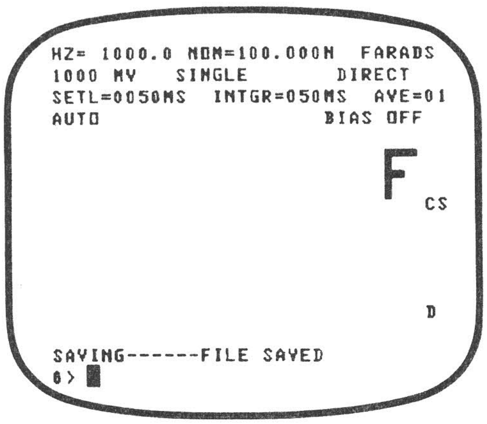
> **NOTE:** This file name must have exactly six decimal points to function properly.

Example: Using the component sorting example in Section 2.7.5 of this Manual, set up all test parameters and binning limits. Save this parameter program under the Autostart file name.

Push



Display



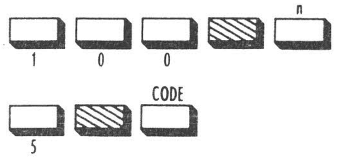
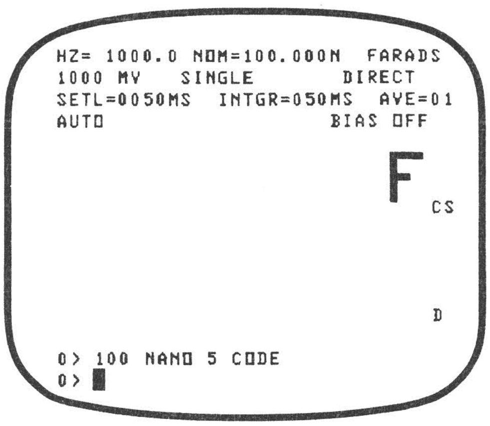
Comments

Completion of the SAVE operation is SIGNALED by [FILE SAVED] printed on the CRT. When power is applied to the instrument, this file will LOAD automatically.

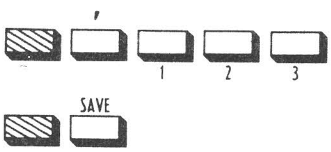
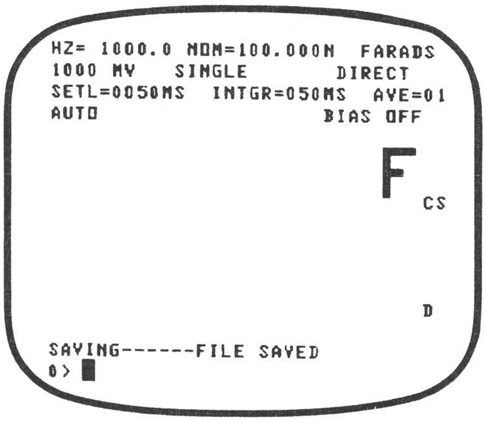
2.9.5.2 Save Range Hold

To save RANGE HOLD information, automatic Range Hold must be set as part of the SAVE-FILE command. Any attempt to save a file while in Range Hold will result in the following error message appearing on the screen: USE 5 CODE TO SAVE IN HOLD.

EXAMPLE:

Push	Display	Comments
		Automatic range hold is set for 100nF.

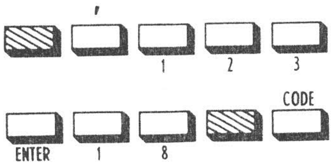
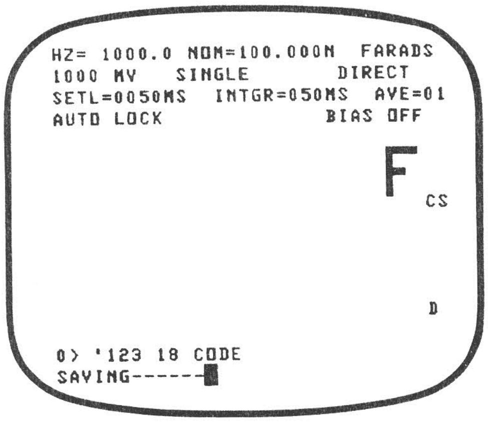
NOTE: When using 5 CODE, do not take a measurement before it has been saved to tape.

Push	Display	Comments
		File 123 is saved with the automatic range hold parameter set for 100nF. After file 123 is re-loaded, and a part is measured that is within +/-20% of the 100nF nominal, the instrument will go into the HOLD mode.

2.9.5.3 Keyboard Lock

The special Keyboard LOCK command, 9 CODE, can now be saved as part of a file with 18 CODE. This provision prevents any parameters from being inadvertently changed after the program is loaded.

EXAMPLE:

Push	Display	Comments
		Set up instrument parameters to be saved under filename 123. File 123 will set LOCK command when LOADed.

NOTE: When in this mode, the keyboard is locked except for the SGL key.

NOTE: To unlock the keyboard, push <-> <9> <blue> <CODE>.

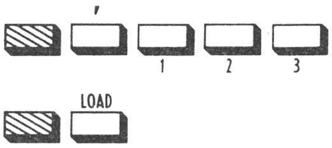
2.9.6 Loading Parameter Programs

Programs saved on the cassette tape can be retrieved at any time. To load the Model 2160 with a prestored program, push <blue> <'> <filename> <blue> <LOAD>. <filename> can be any combination of numerals (via VideoBridge Keyboard) or letters (via Keyboard Overlay).

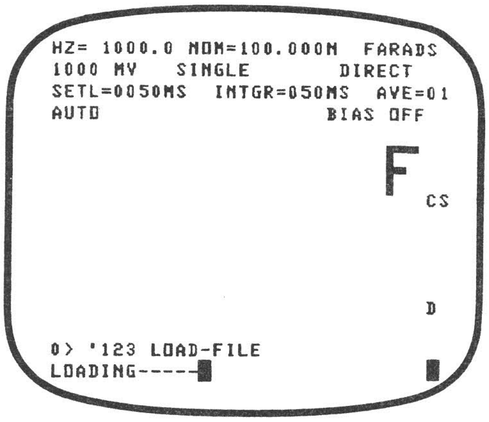
(Refer to Section 2.1.1.2 in this Manual for more information on the Keyboard Overlay.)

EXAMPLE:

Push

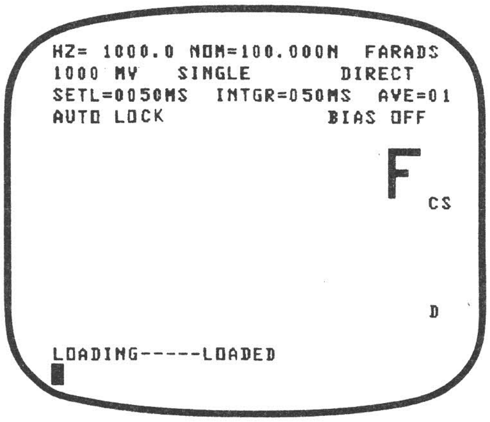


Display



Comments

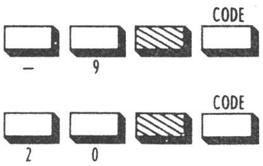
Load previously saved program. Completion of the loading operation is signaled by [LOADED] printed on the CRT (See next picture).



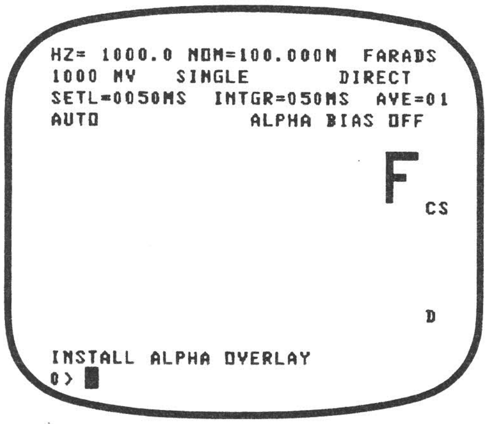
Program 123 is loaded with keyboard LOCKed since it was previously saved with the LOCK command, 18 CODE. (See Section 2.9.5.3.)

EXAMPLE: (ALPHANUMERICS)

Push



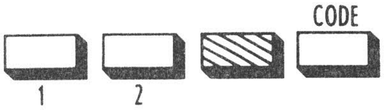
Display

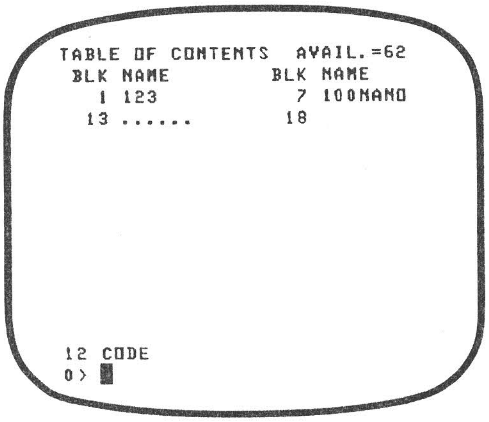


Comments

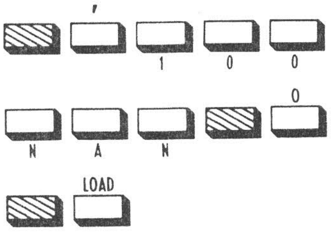
Unlock the keyboard, enable Alpha Overlay. Place the keyboard overlay alternate function side up.

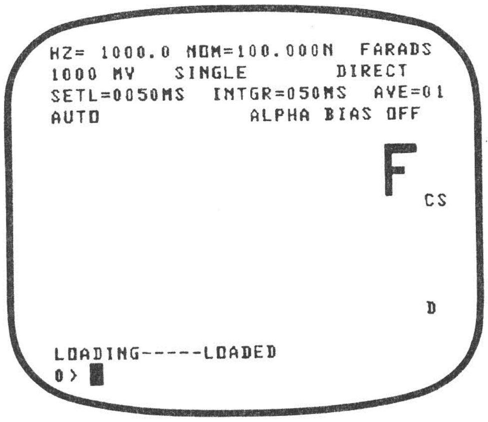
Push	Display	Comments





Examine the directory, choosing file "100NANO" for loading.





Load the file. Completion of the reloading operation is signaled by [LOADED] printed on the CRT.

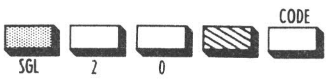
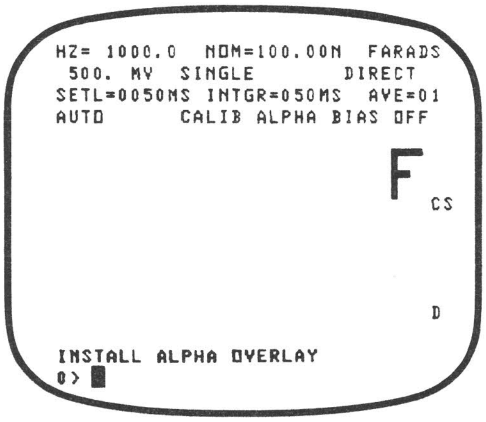
2.9.6.1 Load Applications Programs

ESI offers special applications software kits (e.g. STATISTICS, P/N 55104; ANALOG, P/N 55103) for testing applications such as statistics evaluation and graphics display capabilities. Application software source code is the original program code inscribed on the tape at the factory. These tapes are loaded by entering 13 CODE as described in the following example. Object code tapes are copies made by saving the source code onto blank, formatted cassettes. After an object code tape is made, it is loaded into the VideoBridge by using the LOAD key. DO NOT USE 13 CODE TO LOAD OBJECT CODE TAPES.

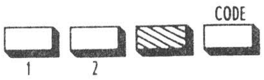
CAUTION

DO NOT ATTEMPT TO LOAD OBJECT CODE TAPES USING 13 CODE. THE INSTRUMENT WILL BECOME "HUNG UP" AND MUST HAVE POWER SHUT OFF TO RESET. THIS CAN CAUSE LOSS OF DATA.

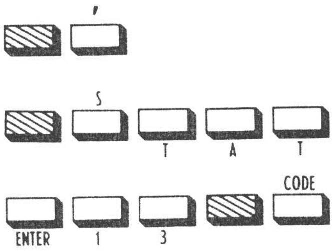
EXAMPLE: Insert the special Applications Software tape for statistics, then do the following:

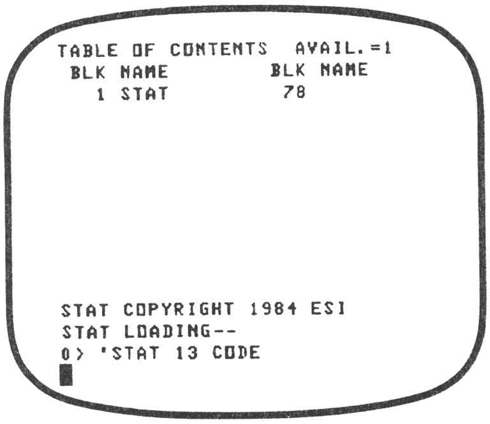
Push	Display	Comments
		Enter single test mode. Place the keyboard overlay alternate function side up.

Push | Display | Comments



Examine the directory.





Load the STAT Application Program. Tape activity is indicated by a blinking cursor along with the file-name displayed on the CRT.

Completion of the LOADING operation is signaled by the word [LOADED] printed on the CRT.

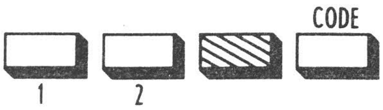
NOTE: For more information on the use of special Applications Software, consult the document provided with the particular Application Software package.

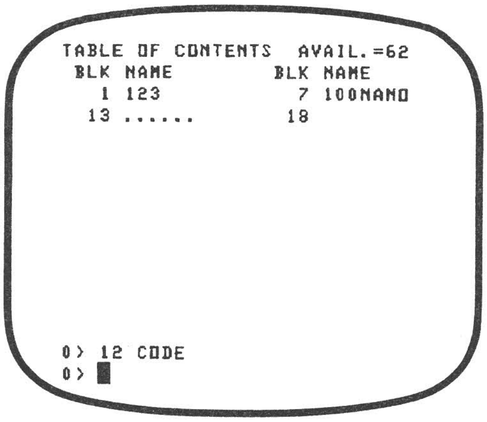
2.9.6.2 File Deletion

Delete a file with 14 CODE.

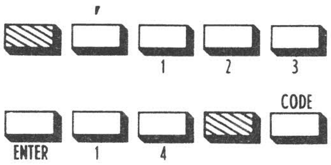
EXAMPLE:

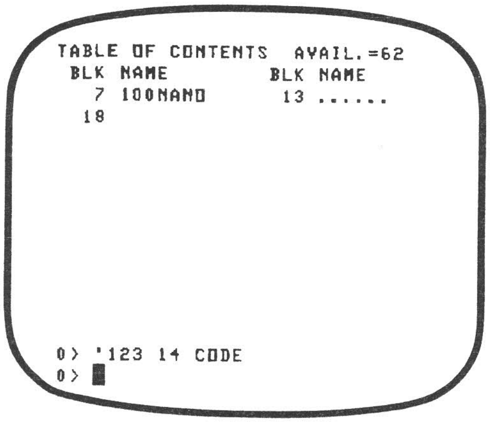
Push | **Display** | **Comments**





Examine the Directory, and select file 123 for deletion.



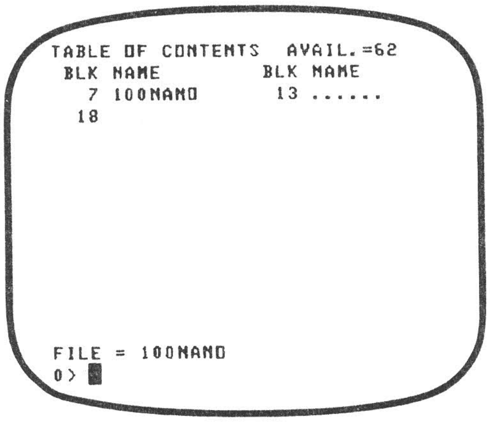


The CRT displays the new Directory after the DELETE operation.

2.9.6.3 File Loaded

Display the name of the file loaded from tape with 19 CODE.

EXAMPLE:

Push	**Display**	**Comments**
		Display prints [FILE=filename] on the CRT, where filename is the name of the last file loaded.

(Refer to Section 2.1.1.1 for additional information on the above test codes.)

2.9.7 Program Write-Protect

Important parameter programs can be protected from accidental erasure with the cassette write-protect feature, of which there are two types. One type features a swivel plug located at the top of each side of the cassette module (Figure 2-20). To protect recorded programs on Side A (which faces the operator upon insertion) from being overwritten, pivot the plug on Side B 1/2 turn clockwise to uncover the rectangular hole beneath it. Similarly, to protect Side B, pivot the plug on Side A. With the plug in this position, no additional data can be written over the existing programs on the opposite side of the tape with respect to the plug. To restore the tape to its unprotected state, simply pivot the plug counterclockwise back to its original position.

Cassettes with the other type of write-protect feature have a cross-shaped plug located on the top of each side of the module (Figure 2-20). To protect these cassettes from being overwritten, push out the cross-shaped plug. With the plug on Side B removed, no additional data can be written over the existing programs on side A. To protect Side B, push out the plug on Side A. Cassettes with the write-protect plug removed can be reprogrammed by placing a piece of cellophane tape over the write-protect hole.

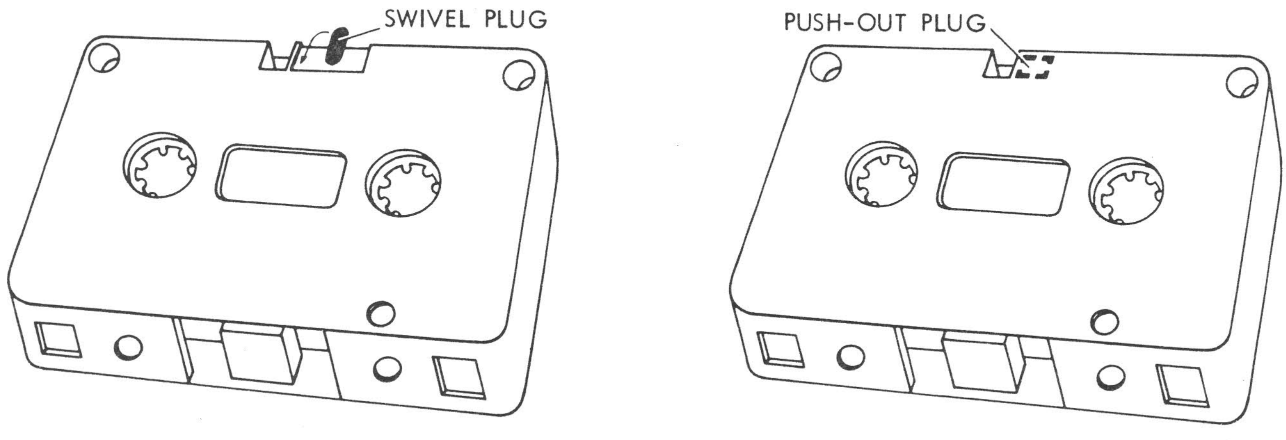


Figure 2-20. Swivel and Push-Out Write-Protect Features

Attempting to save data to a tape that has been write-protected will result in the error message: "WRITE PROTECTED".

2.9.8 Cassette Care

Careful handling procedures will extend the useful life of the mini-cassette tapes used with this instrument. Read the following precautions to extend the life of cassette tapes.

- Avoid direct sunlight, high temperatures, and moisture.
- Avoid touching the tape surface. This prevents transfer of any dirt from your fingers to recording and playback heads.
- Prevent tape breakage and stretching by removing any slack in the tape before putting the cassette into the recorder.
- Observe tape loader maintenance as described in section 2.9.2 of this manual. This will help keep tape surface clean.
- Do not store cassette tapes on or near magnetic fields or devices. Strong magnetic fields may destroy stored programs.

2.10 CAPACITANCE MEASUREMENTS WITH EXTERNAL DC BIAS (Codes 1 and -1)

A DC bias of up to +50V can be applied to the rear panel bias terminals (observe polarity). The Bias Voltage is not applied to the unknown until test code 1 is entered. Measurements with bias are available for capacitance only. Bias supply must have low ripple with internal current limit of 100mA and its output impedance must be less than 50mΩ. Leakage current through the unknown can be measured by sampling the current from the bias source to the bias terminals with a low impedance ammeter. If the bias source impedance is not low compared to the unknown, a bypass capacitor whose impedance is 1/5 of the range resistor at the operating frequency can be connected across the bias terminal posts.

WARNING

ELECTRICAL SHOCK HAZARD EXISTS WHEN A BIAS SUPPLY IS CONNECTED TO THIS INSTRUMENT. WHEN AN EXTERNAL BIAS SUPPLY IS ATTACHED, THE BIAS VOLTAGE IS PRESENT ON THE REAR PANEL BNC CONNECTORS. USE ONLY BIAS VOLTAGES UP TO 50VDC AND BIAS SUPPLIES CURRENT LIMITED AT 100mA. DO NOT TOUCH, CONNECT, OR DISCONNECT THE UNKNOWN COMPONENT OR BNC CABLES WHILE A BIAS VOLTAGE IS APPLIED.

A DC bias capability of +200V is available by ordering an SP5240 option. The SP5240 is identical to the 2150 and 2160 except for the extended bias capability. See Section A.4 for more information.

Use the following procedure when measuring DC-biased capacitors.

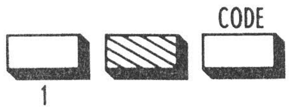
STEP 1. Loosen the black terminal caps and remove the shorting strap by pulling it up and pivoting it outward. The strap may be held in place by tightening the terminal caps.

STEP 2. Install bypass capacitor if needed (observe polarity).

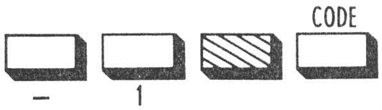
STEP 3. Connect the external biasing supply to the instrument's rear panel bias terminals (observe polarity).

STEP 4. Turn bias supply on and set to the proper bias setting.

STEP 5. Connect the unknown capacitor to the test leads. Observe proper polarity connection when testing electrolytic capacitors.

STEP 6. Turn the bias voltage on. PUSH 

STEP 7. Make the measurement.

STEP 8. Turn the bias voltage off. PUSH 

STEP 9. Wait five seconds and remove the measured capacitor from the test leads.

STEP 10. Repeat steps 5 through 9 for each component to be measured.

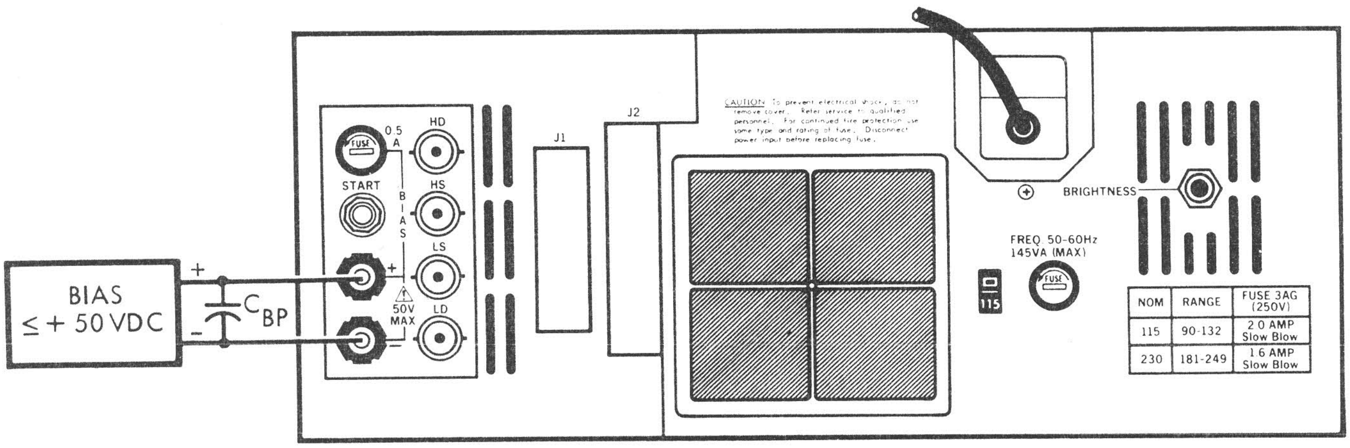


Figure 2-21. Capacitance Measurements with Bias

NOTE: When 1 CODE is entered, the instrument automatically uses 100ms settling time. After turning bias OFF by -1 CODE, settling time returns to the previously set amount.

2.11 ERROR MESSAGES

If an improper operation is attempted, the 2150/2160 responds by displaying an error message. Error messages are displayed at the bottom of the CRT screen (except CAL ?, ERROR ANALOG, ERROR CALC). All parameters entered prior to the improper operation remain unchanged. Following is a list of error messages that may appear during the programming and operation of this instrument. Included with each error message is a short explanation of probable causes for the message.

> **NOTE:** While in continuous measurement mode, temporary error conditions may occur if the device-under-test is connected during part of the measurement sequence. As a result, an error message may be momentarily displayed. This is normal and does not indicate instrument malfunction.

Programming and Operating Related Errors

ERROR ANALOG

This indicates that the input to the analog circuitry has been overloaded. The measurement is discarded, the part is binned as a D reject and the display reads "ERROR ANALOG" in large characters. Check for an overrange part if on range "HOLD". Reset to "AUTO" range and make another measurement.

ERROR Calc.

This indicates that the floating point capabilities of the micro-processor have been overloaded (e.g. the present data has overflowed its range or a divide-by-zero operation has been encountered). The measurement is discarded, the part is binned as a D reject, and the display reads "ERROR CALC". Re-check all measurement settings (such as an underrange value if on range "HOLD") and make another measurement.

OVERLOAD !--SUPPLYING XX MV for low impedance devices

OR

OVERLOAD !--SUPPLYING XX MA for high impedance devices

Where xx = the actual value of test signal level supplied by the VideoBridge.

If the impedance of the component being measured is too high for the current range or too low for the voltage range to supply the level specified on the screen, the appropriate message will appear on the bottom line of the display.

In a voltage overload condition, the instrument will supply the voltage available at a maximum current of 100mA.

In a current overload condition, the instrument will supply the current available at a maximum voltage of 1500mV.

The error message will show what current or voltage is being supplied to the component (see Section 2.5.2). The measurements taken are still valid, though only at the test signal level indicated by the message.

CAL ?

If the word "ERROR" was displayed after calibrating any range, this message will be displayed in the bottom line of the parameter field after calibration. This indicates that all ranges indicated as "OK" have their zero offsets stored, but one or more ranges were not calibrated properly. The message will also be displayed when that particular frequency/test level combination is recalled. No message will be displayed if all ranges failed calibration, and no calibration offsets are applied. To correct this condition, the zero calibration procedure must be performed again (see Section 2.3.5).

OUT OF RANGE

This message will be displayed when a measurement taken in RANGE HOLD is more than 100 times smaller or larger than the present range resistor. To correct this condition, re-enter AUTO RANGE. There will be no message if the VideoBridge is holding the highest range with very high unknowns or the lowest range with very low unknowns.

WRONG # OF ARGUMENTS

Any of the commands (mostly upper function key strokes) which take numerical arguments will display this message if insufficient numbers precede the word. For instance, programming <blue> Bin# will give a "Wrong # of Arguments" message because it requires the number of the bin being programmed and the limits for that bin. Start again.

PARAMETER STACK EMPTY

The VideoBridge recognizes the argument number as valid but it is improperly formatted or inappropriate to the command.

UNDEFINED

Occasionally a combination of keys will be pressed which result in the construction of a word which the instrument does not recognize. Pushing a number key, then a key which does not use a number ahead of it will result in something like "ldirect". The instrument will not recognize "ldirect" and the undefined message appears. Start again.

BIN 11 IN USE

Non-zero limits have been set for Bin 11. Analog Busy (EOC) function cannot be activated until Bin 11 limits are set to zero.

ANALOG-BUSY ACTIVE

Test code 16 has been entered. Bin 11 limits cannot be changed until -16 CODE is programmed.

FUNCTION CANCELLED

Another key besides <SGL> or <ENTER> was pressed while attempting to activate tape formatting or zero calibration.

SET NOMINAL VALUE

This message will result if an attempt is made to enter -8 CODE, 8 CODE, 21 CODE, % SORT mode, or DEViation mode without entering a nominal value.

DEV. ON Q/D NOT ALLOWED

The VideoBridge does not support a deviation calculation on minor functions Q and D. This message occurs if DEV is pressed with Q or D as the top display function.

Cassette Tape Related Errors (Model 2160 Only)

BAD TAPE - DISCARD

This error message says that the tape was not able to be formatted (3 CODE).

BAD READ

The tape file was not read properly during a LOAD operation from the tape. Re-enter file name and press <blue> <LOAD> again.

BAD WRITE

A problem was encountered while attempting a SAVE operation to the tape. Re-enter file name and press <blue> <SAVE> again.

NO TAPE IN PLACE

This message will appear when there is no cassette tape in the drive unit or when the LOAD or SAVE buttons are pushed on instruments without cassette capability.

WRITE PROTECTED

This message comes onto the screen if a SAVE or format command is tried on a cassette tape with its write protect opening uncovered (See Section 2.9.7).

TAPE JAMMED

When the cassette tape will not move forward or backward, this message appears on the screen. Remove the tape, re-insert, and try again.

USE 5 CODE TO SAVE IN HOLD

This message will result if an attempt is made to save a file while using manual range hold. Use the automatic range hold function described in Section 2.9.5.2 in this manual.

FILE DOES NOT EXIST

This message comes onto the screen if the VideoBridge has been directed to LOAD a file whose name is not listed in the directory.

2.11.1 Remote Output Error Codes

The following error codes are returned on remote output devices, such as GPIB and RS-232C Interface. See Section A.2 for more information on these VideoBridge options.

0	No Error	1	Can't Supply
2	Analog Error	3	Analog Error--Can't Supply
4	Calculation Error	5	Calculation Error--Can't Supply

NOTE: "Can't Supply" indicates inability to supply test signal current or voltage--whichever the VideoBridge has been programmed for.

"Analog Error" indicates the same fault condition as the "ERROR ANALOG" message on the CRT.

"Calculation Error" indicates the same fault condition as the "ERROR CALC" message on the CRT.