O W N E R ' S M A N U A L

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R A D I O S Y S T E M A N A L Y Z E R

5601-0085-01

NOTICE

The information contained in this document has been carefully reviewed and is believed to be accurate. However, no responsibility is assumed for inaccuracies.

References to product features in this document does not imply that those features are made available to this system. Options and accessories covered are available (subject to some option capability restrictions), and are included in the document to ensure the customer has received the latest information available on system operation.

REVISION PAGE

Cushman Electronics periodically reviews and revises the manuals published with our products. Interim changes are listed below to ensure our customers have the latest and most technically correct information on hand at all times.

MANUAL CHANGE NOTICE

INSTRUMENT AFFECTED:
EFFECTIVITY DATE:
INSTRUCTIONS:

INSTRUMENT AFFECTED:
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SECTION I - SHIPPING AND RECEIVING

1.01 INTRODUCTION

1.01.1 This section contains instructions for receiving, inspecting, unpacking, preparation for shipment, and the preparation for storage of Cushman Electronics equipment.

1.02 RECEIVING

1.02.1 Upon receipt, the shipping containers should be visually inspected for signs of external damage which might indicate damage to the contents, and such damage noted on the transporting agencies Receipt Invoice.

1.02.2 Carefully remove the equipment from the packing containers, and save the containers and packing material for future use. Visually examine the exterior of the unit on all sides for damage.

1.02.3 Any signs of damage seen should be documented as completely as possible to expedite the claims response (photographs are recommended). Claims made should be filed as quickly as possible with the responsible transporting agency.

1.03 PREPARATION FOR SHIPMENT

1.03.1 In the event factory service or repair is needed, contact the Cushman Electronics Customer Service Department for further service information or to make arrangements for shipment to the factory or Service Center. The factory address is:

Cushman Electronics, Inc.
Customer Service Department
1525 Atteberry Lane
San Jose, CA 95131

1.03.2 The following is a general guide for repackaging Cushman Electronics instruments for shipment. Use care when packaging to minimize the possibility of damage during shipment.

CAUTION

FEDERAL REGULATIONS PROHIBIT SHIPPING INSTRUMENTS WITH THE BATTERIES CONNECTED. ALWAYS DISCONNECT BATTERIES (IF INSTALLED) BEFORE SHIPPING ANY INSTRUMENT.

1.03.3 Before packing an instrument for shipment to the factory or regional Service Center for repair, attach a tag with the following information:

* Owner's name
* Model Number
* Serial Number
* Service/Repair Action Required

1.03.4 If the original container is to be used, place the instrument in the container as shown in Figure 1-1. If the original container is not available, one can be purchased from Cushman Electronics. Seal the container with packaging tape approved by the transporting agency.

1.03.5 If the original container and packing material are not used, proceed as follows:

a. Wrap the tagged instrument in plastic or heavy paper and place in an inner container.

b. Place packing material around all sides of the wrapped instrument.

c. Place the instrument and inner container in a heavy carton or wooden box and seal with strong (shipping or reinforced strapping) tape or metal bands.

1.03.6 Mark the shipping container as follows on at least two sides:

DELICATE
ELECTRONIC INSTRUMENT
FRAGILE

1.04 PREPARATION FOR STORAGE

1.04.1 If preparing the equipment for storage, the procedures of 1.03.3 or 1.03.4 above should be followed to ensure proper storage protection.

NOTE

If the optional 12Vdc battery is installed in the instrument battery compartment, the battery should be disconnected before shipment or storage. Federal Regulations prohibit shipping instruments with the batteries connected.

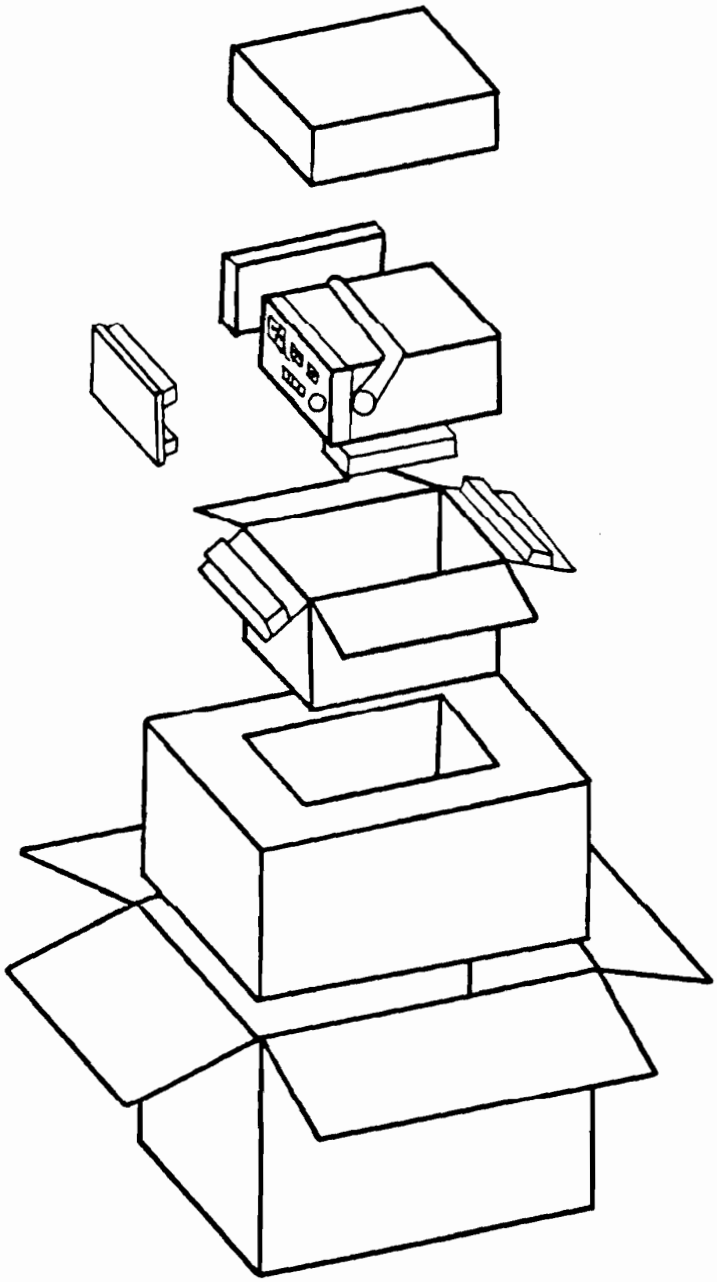


Figure 1-1. Typical CE-6000 Series Instrument Packaging

SECTION II - INSTALLATION

2.01 INTRODUCTION

2.01.1 This section contains information pertaining to installation requirements of the CE-6000 Series Radio System Analyzer. It covers environmental requirements, RF field interference, power source requirements, (optional) battery replacement, and Special Cautions for operating.

2.02 ENVIRONMENTAL REQUIREMENTS

2.02.1 CE-6000 Series instruments are designed to operate between 0°C and +55°C ambient temperature. In the field these temperatures can easily be exceeded if proper precautions are not taken. For instance, the internal temperature of a closed automobile trunk may exceed +65°C during summer daylight hours. Exceeding the upper or lower temperature limits for extended periods may not result in noticeable damage to the instrument, but may cause poor performance or actual malfunctioning.

2.02.2 Care should be taken not to block the cabinet's ventilation ports. Blocked air flow can cause the internal instrument temperature to rise to upper limits, again causing possible poor performance or malfunctioning.

2.02.3 Also, ambient humidity which exceeds a 90% maximum for an extended period of time can cause problems with accummulations of moisture in the instrument changing signal paths and component values.

2.03 RF FIELDS

2.03.1 When the CE-6000 Series instruments are used near one or more high power transmitters, adjacent channel interference may be encountered. If satisfactory measurements cannot be made with the antenna connected to the ANT INPUT connector, the transmitter to be monitored may have to be connected directly to the CE-6000 SIG GEN OUT/RF IN connector and its attenuator.

CAUTION

DON'T CONNECT "ANT IN" DIRECTLY TO THE TRANSMITTER OUTPUT IF TRANSMITTER LEVEL IS GREATER THAN 0 dBm.

MAXIMUM POWER INPUT IS 150 W. AN AUDIBLE ALARM WILL SOUND IF HIGH POWER LOAD TEMPERATURE EXCEEDS 75°C.

For further information, contact the Cushman Electronics Customer Service Department.

2.04 POWER REQUIREMENTS

2.04.1 The CE-6000 Series instruments can be operated from any one of the following sources:

* 115 Vac, +/-10%, 50-400 Hz, 80W (max)
* 230 Vac, +/-10%, 50-400 Hz, 80W (max)
* (Optional) External +11 to +15Vdc, 70W (max)
* (Optional) +12 Vdc Battery Pack

2.04.2 The instrument is fuse protected at the rear panel. The source voltage to be used is selected at the rear panel. A slide switch selects 115 or 230 Vac as applicable. A special adapter cable is used to provide +11 to +15 Vdc power from a motor vehicle DC power receptacle.

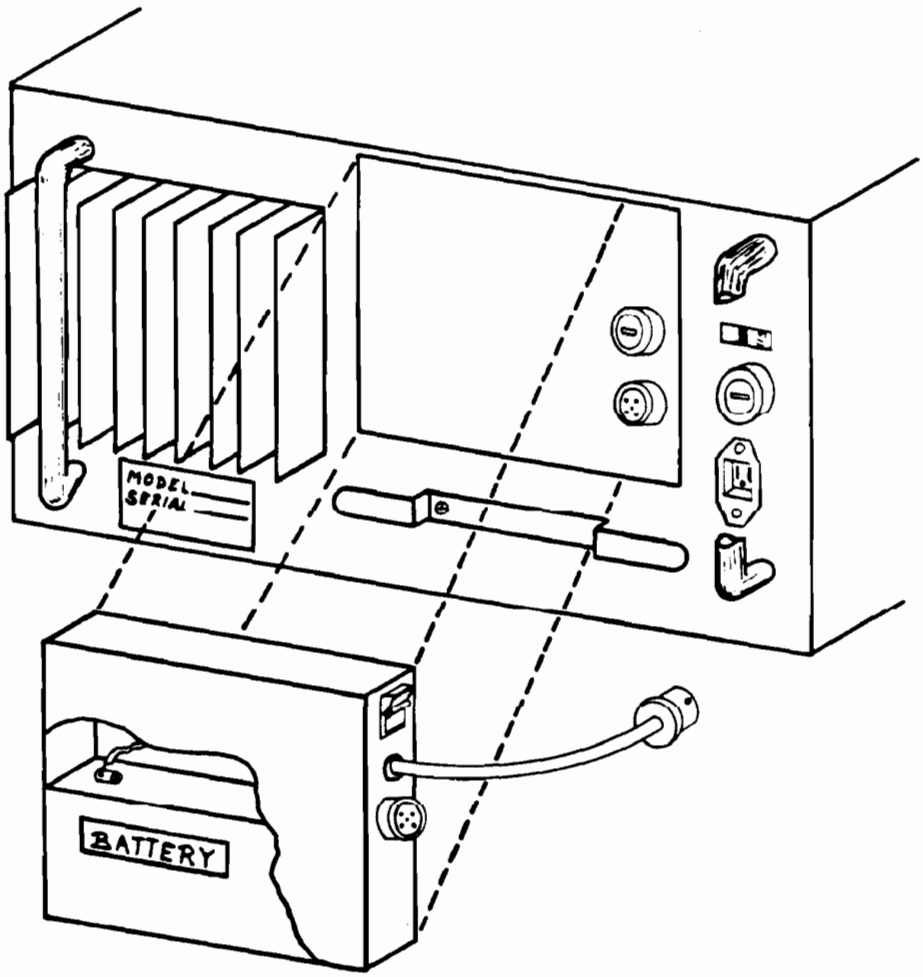


Figure 2-1. Battery Pack Installation and Removal

2.05 BATTERY PACK INSTALLATION AND REMOVAL (Figure 2-1)

2.05.1 Before the optional battery can be installed, the DC-DC Converter option must be installed, as it contains the circuits for dc operation. Both options are contained in CE-6000 option OP-01. If it is installed, the battery can be installed and removed as follows:

a. Make certain the instrument is disconnected from any AC or DC source.

b. Remove the rear panel battery compartment. Note that this compartment also contains the charging circuits for the unit.

c. Place the battery inside the battery compartment.

d. The optional +12 Vdc rechargeable battery has a connector and cable assembly attached to the battery terminals. Locate the harness connector inside the battery compartment (coming from the battery charging circuitry) and plug it into the battery connector.

e. Replace the battery compartment on the rear panel. Connect the DC interconnect cable on the side of the compartment to the CE-6000 rear panel DC input connector. External DC input is now to the DC connector on the side of the battery compartment. DC operation is selected by the EXT DC/BATT switch on the opposite side of the battery compartment.

f. To remove the battery, reverse Steps a.- e. above.

2.06 BATTERY CHARGING

2.06.1 The CE-6000 Series optional battery will charge as required while the instrument is connected to an external source of dc power. To ensure the battery is at full charge when using battery power for operation, it should be charged for at least 15 hours before using.

2.07 SPECIAL ACCESSORIES AND OPTIONS

2.07.1 OPTIONS

2.07.1.1 There are four basic versions of the CE-6000 Radio System Analyzer. They are the CE-6020, CE-6030, CE-6232, and CE-6488. Each version can be operated to its full capabilities immediately upon receipt. System capability can be increased with the addition of special accessories and options available from Cushman Electronics.

2.07.1.2 The basic CE-6000 Series Radio System Analyzer is a portable instrument designed to monitor and test the frequency characteristics of transceivers in the VHF/UHF range to 1000 MHz. It combines in one instrument the functions of a spectrum analyzer, RF signal generator, frequency comparator, audio generator and modulator, RF power meter, FM modulation deviation meter, % AM modulation meter, frequency error meter, oscilloscope, and SINAD receiver sensitivity meter. In addition, the basic instrument can be equipped with either an OP-07 IEEE-488 (CE-6488) or OP-09 RS-232C (the CE-6232) data bus option to provide a system interface capability.

2.07.1.3 The CE-6020 Radio System Analyzer includes the basic instrument capability plus OP-04 Tracking Generator (TG) option, and the Cable Fault Location function.

2.07.1.4 The CE-6030 Radio System Analyzer includes all functions of the CE-6020 instrument plus an Offset Frequency Generator (OP-03), and a Model 6408 Signal Center Encoder (OP-05).

2.07.1.5 Additional options available for the CE-6000 Series instruments include an oven-controlled crystal oscillator reference (OCXO) to replace the standard temperature-compensated crystal oscillator reference (TCXO), option OP-02, and a rechargeable batteryfor portable operation (option OP-01).

2.07.1.6 The purchase of a more basic instrument does not limit the overall CE-6000 capability. Any CE-6000 instrument can be updated at any time to include these additional capabilities, subject to some option capability restrictions. Contact Cushman Electronics for further information.

2.07.2 ACCESSORIES

2.07.2.1 Each CE-6000 Series instrument is shipped with an accessories package containing a telescoping whip antenna (which connects to the ANT IN connector), 74" coaxial cable, power cord, front cover, an owner's manual, and extender boards for maintenance. Other accessories available include a shipping trunk, a soft zippered cover with shoulder strap, and vehicular power cord.

SECTION III - OPERATING CONTROLS, CONNECTORS, AND INDICATORS

3.01 INTRODUCTION

3.01.1 Controls, connectors, and indicators of the CE-6000 Series equipment are shown in Figure 3-1 (Front Panel) and Figure 3-2 (Rear Panel). The functions of each are described in Tables 3-1 and 3-2.

TABLE 3-1

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
1	METER FUNCTION	Seven position switch for selecting desired function and scale.
2	ZERO ADJUST SCREW	For zeroing FUNCTION meter (power OFF)
3	FUNCTION Meter	Measures selected function: SINAD, PWR X1 and X10, %AM, and FM deviation from 1.5 to 15 kHz.
4	ANT IN	A fused signal input connector used to make measurements in the RECEIVE mode. Maximum input level of 0.5V peak/peak.
5	SIG LEVEL	LED lights when the selected RF signal level at ANT IN exceeds RECEIVE mode squelch level and can be measured.
6	SELECTIVITY	Selects IF bandwidth (NARROW, MEDIUM, or WIDE) for CE-6000 receive functions
7	SENSITIVITY/SQUELCH	Concentric switch sets dBm reference level (REF LEVEL dBm) to one of four detented positions (using the outside switch). Inside switch is a variable squelch adjustment.
8	HORIZ CAL	Detented potentiometer/switch used in conjunction with HORIZ/DIV switch to vary horizontal scale when out of the detented CAL position.
9	HORIZ POS	Adjusts left-to-right position of the CRT trace.
10	OFF/INTENSITY	ON/OFF switch for CRT display; when ON adjusts brightness of CRT trace.

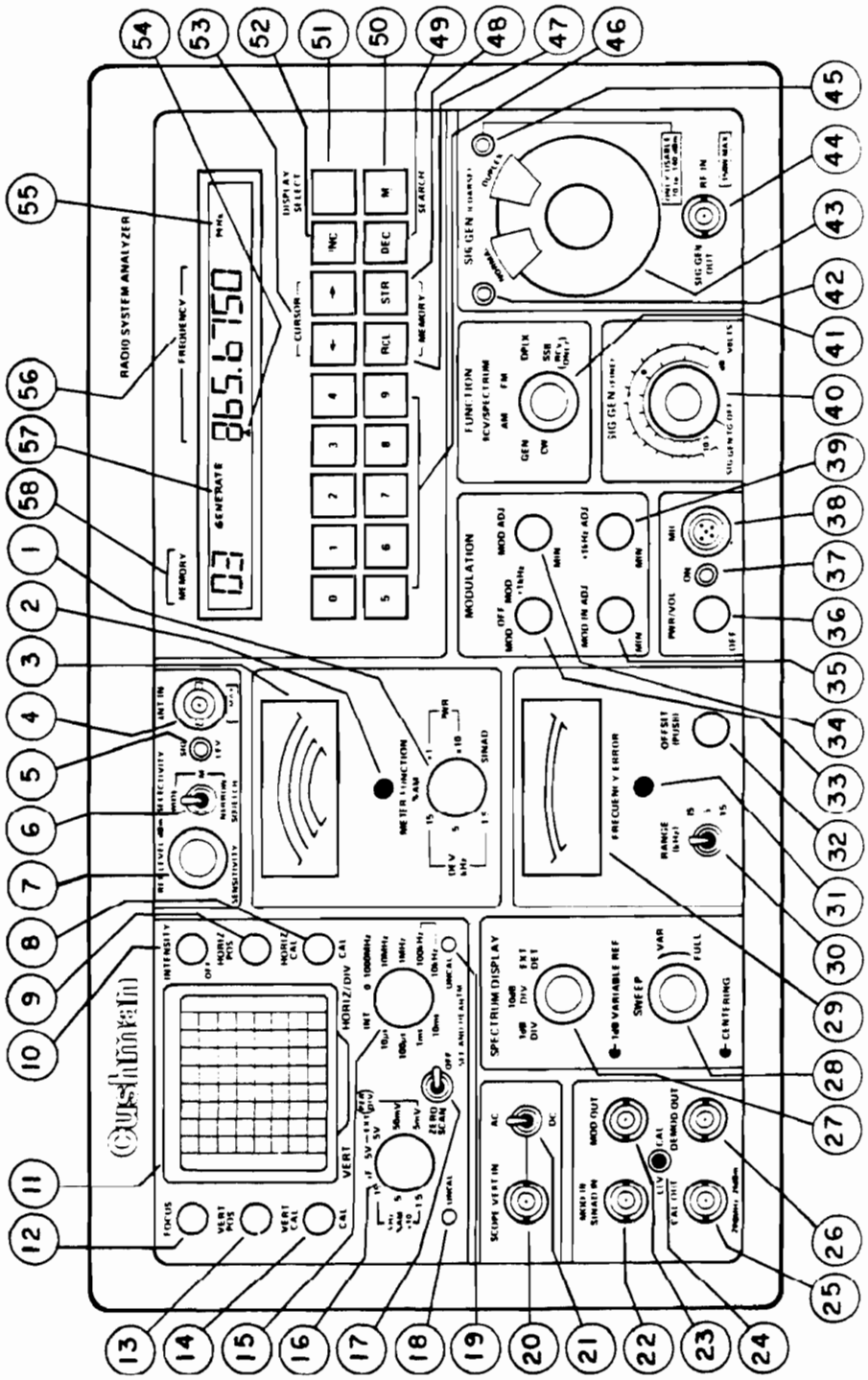


Figure 3-1. CE-6000 Series Front Panel Controls, Connectors, and Indicators

TABLE 3-1 (CONT'D)

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
11	CRT	In normal oscilloscope mode, displays modulated signals the CE-6000 Series instrument receives or generates; with external input to SCOPE VERT IN, can use as 500 kHz oscilloscope; in the SPECTRUM MONITOR mode, displays signal spectrums up to 1000 MHz over a 115 dB range. Automatic sync circuits lock the sweep to the incoming signal.
12	FOCUS	Adjusts sharpness of the CRT trace.
13	VERT POS	Controls vertical positioning of CRT display.
14	VERT CAL	Used in oscilloscope mode only. Varies vertical CRT scale between calibrated range selected on VERT control and its next lower range (when out of the CAL detent position).
15	HORIZ/DIV	Ten-position switch selects calibrated time base per division on oscilloscope display; in Spectrum Monitor, selects frequency per division.
16	VERT	Eight-position switch for selection of calibrated vertical sensitivities for CRT display.
17	ZERO SCAN	Stops Spectrum analyzer scan to allow use for accurate frequency selective measurements of signal strength. Has 2 kHz BW (for best resolution, a 10 kHz HORIZ/DIV setting is recommended).
18	UNCAL (Vert)	When lighted, LED indicates VERT CAL is not in the CAL (detented) position.
19	UNCAL (Horiz)	When lighted, LED indicates HORIZ CAL is not in the CAL (detented) position.
20	SCOPE VERT IN	Used when CRT is used as an external oscilloscope, or in a tracking scope mode. Provides vertical deflection for CRT external signal inputs.
21	AC/DC	Selects AC or DC coupling for signals input to the SCOPE VERT IN jack.

TABLE 3-1 (CONT'D)

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
22	MOD IN/SINAD IN	Input BNC for an external modulation source; also used to measure the 12 dB SINAD sensitivity of a receiver under test, with reading made on the CE-6000 FUNCTION meter.
23	MOD OUT	BNC jack makes the modulation signals available for external use.
24	LEV CAL	This screwdriver adjustment sets the Log Amplifier gain (used in Spectrum Monitor mode only).
25	CAL OUT	BNC output provides a precise internal 200 MHz signal at -20 dBm to be used for calibrating the CE-6000 Spectrum Monitor display, and troubleshooting when used in conjunction with other CE-6000 functions.
26	DEMOD OUT	Makes the recovered audio from the RF signal available for external use.
27	SPECTRUM DISPLAY/ 1 dB VARIABLE REF	This concentric switch/potentiometer provides for variation of the Spectrum Monitor display. The outer 3-position switch selects 1 or 10 dB/DIV, or an external detector (EXT DET). The inner potentiometer provides a calibration reference adjust for 1 dB/div setting.
28	SWEEP/CENTERING	Concentric switch/potentiometer allows variation of CRT sweep in 0-1000 MHz position. The center potentiometer is used to center sweep on display.
29	FREQUENCY ERROR	Meter displays frequency difference between received or generated signal and the frequency value contained in the CE-6000 FREQUENCY SELECT display.
30	RANGE (kHz)	Three-position switch selects 1.5, 5, and 15 kHz ranges for FREQUENCY ERROR meter display.
31	Zero Adjust Screw	Used to zero the FREQUENCY ERROR meter when instrument power is OFF. Adjusts the meter mechanical movement.

TABLE 3-1 (CONT'D)

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
32	OFFSET (PUSH)	When pressed, provides an offset to the generator output of up to -15 kHz (fully CCW) or +15 kHz (fully CW) from the value contained in the FREQUENCY SELECT display. Offset is "0" when the knob is in normal position.
33	MOD/OFF/MOD+1kHz	Three-position switch selects normal modulation (MOD), removes modulation (OFF), or adds 1 kHz to the modulation frequency (MOD + 1 kHz).
34	MOD ADJ	Adjusts modulation level of the audio oscillator for internal modulation or external audio output.
35	MOD IN ADJ	Adjusts audio input level to produce desired amount of modulation from an external source.
36	PWR VOL	Turns "ON" power to the CE-6000 when moved from the "OFF" position. Turning clockwise (CW) increases the volume of the demodulated signal.
37	ON	LED indicates that the PWR VOL switch has been moved from the "OFF" position and CE-6000 is "ON".
38	MIC	Connector provides for modulation from a microphone input; the mic. level is controlled by the MOD IN ADJ pot. Unit automatically switches to the GENERATE mode when microphone is keyed.
39	+ 1 kHz ADJ	Adjusts level of 1 kHz tone when the MODULATIONswitch is in "MOD + 1kHz".
40	SIG GEN (FINE)	Concentric switch/potentiometer. When moved clockwise out of OFF (detent) position, turns on RF Signal Generator (SIG GEN), and adjusts the SIG GEN OUT level within the 10 dB steps of the SIG GEN (COARSE) control. Inner scale is calibrated in dB level (+3 to -10) while outer scale is two scales; the inner side is calibrated 1-3, and the outer 1-10. Voltage level depends on SIG GEN (COARSE) setting.

TABLE 3-1 (CONT'D)

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
41	FUNCTION	Concentric switch selects CE-6000 unit functions. Outer switch selects Signal Generator (GEN), Receiver and Spectrum Monitor (RCV/SPECTRUM), and Duplex (DPLX) functions. Inner switch selects CW, AM, FM, and SSB (RCV only).
42	NORMAL (LED)	When lighted, the green LED indicates output level at the SIG GEN OUT port.
43	SIG GEN (COARSE)	RF output attenuator adjusts the SIG GEN OUT level in 10 dB steps from -120 to 0dBm (.3 uV to 300 mV rms).
44	SIG GEN OUT/RF IN	Connector for the RF Signal Generator output, or for the input signal whose power is to be measured. Automatically switches to PWR measurement function when signal input is detected at this connector (maximum of 150 W).
45	DUPLEX (LED)	Green LED lights when DUPLEX mode is selected at FUNCTION switch, and the DUPLEX level is -70 dBm to -140 dBm. Indicates a calibrated RF signal is available at SIG GEN OUT/RF IN while an input of up to 150 W is being measured at the Power Meter circuits.
46	FREQUENCY ENTRY	A ten-key pad numbered 0 - 9 which is used to enter the desired frequency.
47	MEMORY RCL	When pressed and released, the memory locations 00 - 69 can be recalled from memory and frequencies stored there displayed. Each memory cell can hold 3 frequencies: a 1-19999.9 Hz MOD TONE, and frequencies (to 999.9999 MHz) for the GENERATE and RECEIVE functions.
48	MEMORY STO	When pressed, stores frequency entered into frequency entry display in the selected memory cell for later recall and use.
49	DEC	Decreases (decrements) the memory cell or frequency number selected with the display cursor.

TABLE 3-1 (CONT'D)

CE-6000 SERIES FRONT PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
50	M	When pressed once, enables operator to select a memory cell for display. When pressed again, disables the memory select function.
51	DISPLAY SELECT	Selects the function of the frequency shown on the frequency entry display: GENERATE, RECEIVE, or MOD TONE.
52	INC	Increases (increments) the memory cell or frequency number selected with the display cursor.
53	CURSOR	Moves "cursor" on the frequency entry display in the direction of the arrow on the key pressed. Cursor can move to each digit of the frequency entry and memory cell location displays.
54	"cursor"	A small triangular marker which can be moved to each digit of the frequency and memory cell entry displays. Has automatic wrap-around at both high and low ends. Indicates the digit to be acted upon for frequency and memory cell entries.
55	MHz/UNLOCK/Hz	Information display which indicates the frequency displayed is in MHz or in Hz, or that there is an UNLOCK condition in one (or more) of the CE-6000 Phase Lock Loops.
56	FREQUENCY	Displays a seven digit frequency (in MHz) when GENERATE or RECEIVE function is selected, or a six digit frequency (in Hz) when MOD TONE is selected.
57	GENERATE/RECEIVE/ MOD TONE/ERROR	Lighted indicators which display the function selected for frequency entry or recall on the CE-6000. ERROR will illuminate for offsets over 11.999 MHz unless there is exactly 45 MHz between RECEIVE and GENERATE frequencies.
58	MEMORY	The two digit memory location (00-69) where frequencies are stored for later recall and operations.

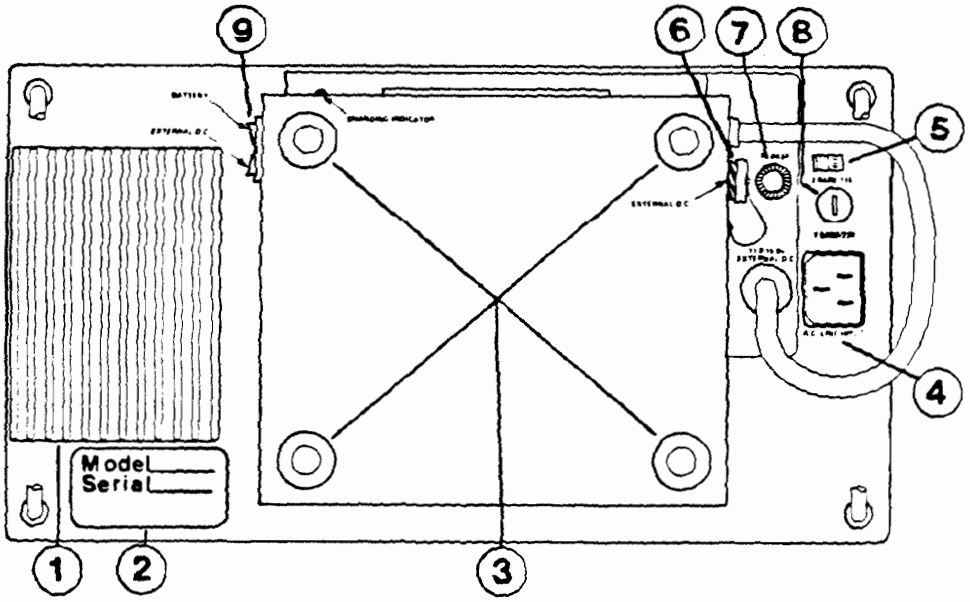


Figure 3-2. CE-6000 Series Rear Panel

TABLE 3-2

CE-6000 SERIES REAR PANEL CONTROLS, CONNECTORS, AND INDICATORS

NUMBER	FUNCTION	DESCRIPTION
1	RF LOAD	RF power load capable of dissipating up to 150W for more than 5 minutes.
2	ID Plate	Provides the MODEL number and SERIAL number information for the instrument.
3	Cord Rack	Storage rack for AC or DC power cord.
4	AC In	Connector for three conductor AC power cord to AC source voltage.
5	115/230	Slide switch to accommodate either a 115Vac or 230Vac power source.
6	EXTERNAL DC 11 TO 15V	Power cord connector for +11 to +15Vdc source voltage input.
7	FUSE	Fuse for DC power source (10.0 ASB)
8	FUSE	Fuse for AC power source (3.0 ASB for 115Vac; 1.5 ASB for 230Vac)
9	BATTERY/EXT DC	Rocker switch selects DC power source as being from internal battery or from an external +11 to +15Vdc source.

SECTION IV - OPERATION

4.01 INTRODUCTION

4.01.1 This section covers the operation of the CE-6000 Series Radio System Analyzer, and includes procedures for unit power source selection, turn-on, frequency selection, and testing of radio systems.

4.02 POWER SOURCE SELECTION

4.02.1 The CE-6000 Series Radio System Analyzer can operate with any one of the following input power sources:

* 115 Vac, +/-10%, 50 - 400 Hz
* 230 Vac, +/-10%, 50 - 400 Hz
* (Optional) External +11 to +15 Vdc Converter
* (Optional) +12 Vdc Battery Pack

4.02.2 The following procedures are used at the CE-6000 Rear Panel to select one of the above power sources for system operation:

4.02.2.1 115 or 230 Vac SOURCE

a. Move the 115/230 slide switch so the number visible on the switch corresponds to that of the source voltage.

b. Ensure that the 115/230Vac fuse installed is the correct rating for source voltage input (3.0 ASB if 115 Vac, or 1.5 ASB if 230 Vac).

c. Install three conductor AC power cord from the CE-6000 to input source voltage.

4.02.2.2 (Optional) EXTERNAL +11 to +15 Vdc SOURCE

a. Ensure that the fuse installed in the DC Converter panel is a 10AFB rating.

b. Install power cord from the CE-6000 External DC connector to the input source voltage.

NOTE

The CE-6000 Series instruments, if connected to an AC source, automatically switch to AC operation even if simultaneously connected to a DC power source.

4.02.2.3 (OPTIONAL) +12 Vdc BATTERY PACK

a. Set the BATTERY/EXT DC rocker switch (on the battery pack) to the BATTERY position.

b. Ensure that the fuse installed on the DC converter panel is a 10A FB rating.

c. Connect the power cord from the Battery Pack to the DC input connector on the CE-6000 rear panel.

4.03 SYSTEM TURN-ON AND WARM-UP

4.03.1 To turn on the CE-6000 Series Radio System Analyzer, ensure that the correct power source is selected at the CE-6000 rear panel. If the optional Battery Pack provides the source voltage, ensure that the battery has charged for at least 15 hours. This allows the battery to operate for its full 1/2 hour (nominal) capability.

NOTE

Very low ambient temperatures (when below $0^{o}C$) directly affect battery performance. The battery operational time can be reduced significantly if thebattery-operated CE-6000 has been exposed to low temperature for an extended period.

4.03.2 Turn the PWR VOL switch clockwise (CW) from "OFF" detent, and adjust the control for a comfortable listening level from the internal speaker.

4.03.3 When the PWR VOL switch is turned ON, all segments of the LCD display will be illuminated for 10 seconds (displays all "8's"). After 10 seconds, the LCD's will display the frequency stored in memory location 01, as determined by the position of the *FUNCTION* switch, and the cursor will move to the most significent digit (MSD) of the frequency display. This is the normal, or "Home" position of the cursor. See Figure 4-1.

4.03.4 The standard CE-6000 contains a TCXO (Temperature Compensated Crystal Oscillator) time base. Normal warm-up time for the TCXO is approximately 30 seconds, although very low ambient temperatures may require a longer warm-up period. If the optional Oven Controlled Crystal Oscillator (OCXO) is used, the CE-6000 will require no warm-up time if the unit has been plugged into its power source for longer than 1 1/2 hours.

4.04 FREQUENCY ENTRY INTO MEMORY

4.04.1 To enter new frequencies into memory, set the FUNCTION switch to *RCV, GEN, or DPLX as required.*

a. To set RCV frequencies, press and release the DISPLAY SELECT key until RECEIVE-MHz or MOD TONE function (as required) is illuminated on the Frequency Display. Then go to Steps d.-h. to enter the frequency.

b. To set GEN frequencies, press and release the DISPLAY SELECT key until the GENERATE-MHz or MOD TONE function (as required) is illuminated on the Frequency Display. Then go to Steps d.-h. to enter the frequency.

c. *To set DPLX, or split channel frequencies,* press and release the DISPLAY SELECT key to select (as required) the MOD TONE, RECEIVE-MHz, and GENERATE-MHz functions on the Frequency Display. As each desired function illuminates, go to Steps d.-h. and enter its frequency.

NOTE

Frequencies for RECEIVE and GENERATE are in MHz. The frequencies for MOD TONE are in Hz. Both the decimal point and cursor of the frequency display will shift to indicate the difference.

d. To set the frequency, move the cursor to the most significant digit (MSD) position of the frequency to be entered.

e. Press the 0 - 9 number keys of the display to enter the selected frequency. The cursor will automatically advance as each digit is entered.

f. When the last digit of the frequency is entered, press the STO key. The cursor will now move to the MEMORY portion of the display.

g. Press the 0 - 9 number keys of the display to enter the memory location (00 - 69) where the frequency is to be stored. Verify that the memory location is displayed and flashing.

NOTE

Verify the memory location entered is correct. Any entry to the memory location will overwrite its previous contents, which are destroyed.

h. Press the STO key again. The memory location will stop flashing, and the cursor will move back to the frequency field of the display. The frequency previously entered will now be stored in the selected memory location. Up to three frequencies can be stored in each memory location (one for RECEIVE-MHz, one for GENERATE-MHz, and one for MOD TONE-Hz).

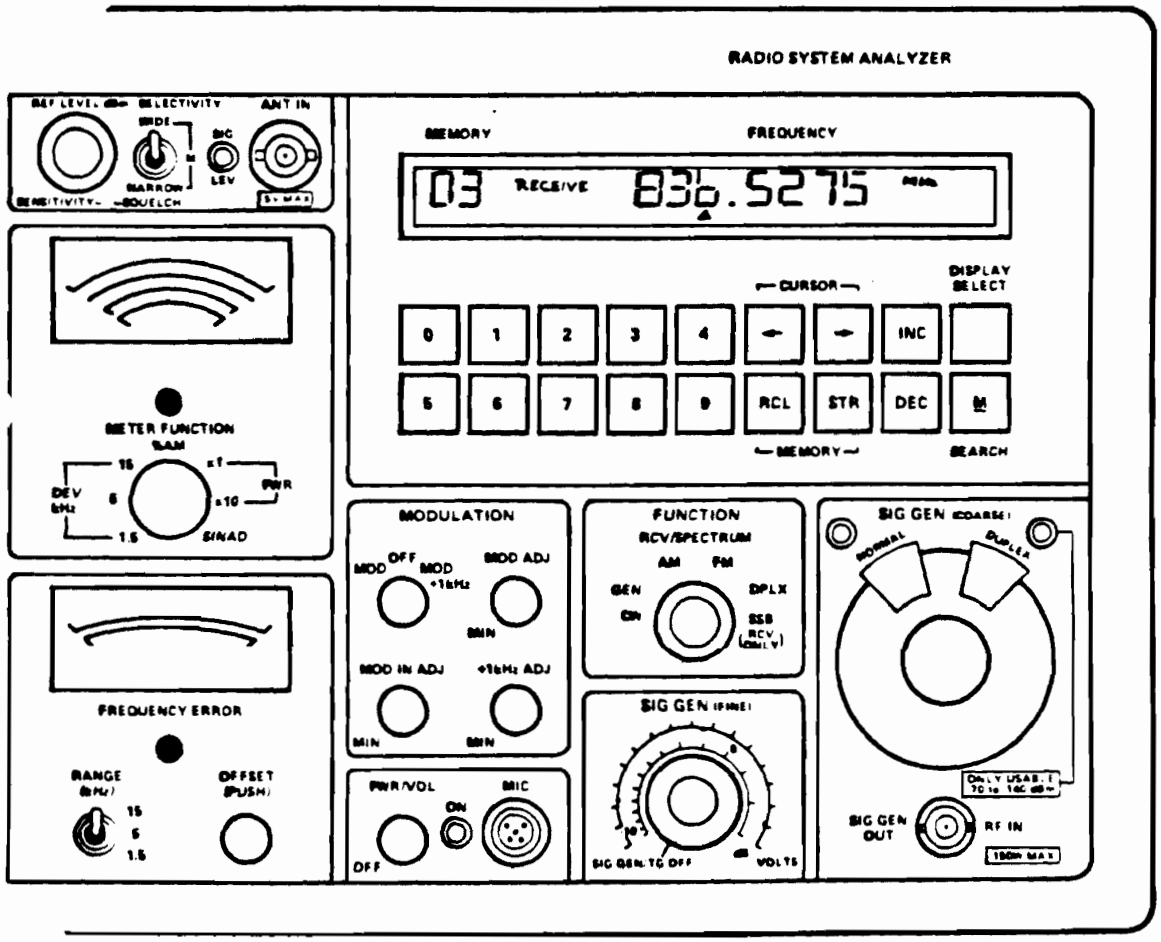


Figure 4-1. Frequency Entry Display and Controls

4.05 FREQUENCY RECALL

4.05.1 Frequencies entered into memory locations can be recalled for viewing on the Frequency Entry display by the following procedure:

a. Press the RCL (Recall) key. The cursor will move over to the memory location of the display.

b. Enter the memory location number to be recalled (00-69) on the 0 - 9 number keys of the display.

c. Frequencies stored in that memory location will appear in the Frequency Display of the CE-6000 depending upon which Display Function is selected. To select other DISPLAY FUNCTION's, press the DISPLAY SELECT key.

4.06 SCANNING MEMORY

4.06.1 All CE-6000 memory location frequencies may be scanned either individually, in groups, or in total by following these procedures:

a. Press and release the DISPLAY SELECT key until the desired Display Function (RECEIVE, GENERATE, or MOD TONE) is illuminated.

b. Press the M/SEARCH key. The cursor will move to the memory area of the Frequency Display.

c. On the 0 - 9 number keys of the Display, enter the number of the first memory location to be observed. The frequency stored at that location will be displayed.

d. To look at (scan) memory locations above the first location selected, press the INC key once for each location to be observed. To look below the first location, or to reverse the scan, press the DEC key.

e. To exit the memory scan, press the M/SEARCH key once again. The cursor will move back to the frequency area of the display.

4.07 TRANSMITTER/RECEIVER TESTING

4.07.1 The CE-6030 has three basic FUNCTIONS. It can GENERATE signals to verify radio receiver operation. It can RECEIVE signals from transmitters to check the transmitter functions. And it can perform a DUPLEX function, generating and receiving signals simultaneously. This allows it to test a repeater or other transceiver's response to known inputs.

4.07.2 Within each FUNCTION, there are different MODES of operation which allow the CE-6000 to measure results of the functions performed. The combinations of FUNCTIONS and MODES within one CE-6000 allow it to perform the functions of up to 12 separate laboratory and field instruments with no more than two cable interconnects.

4.07.3 GENERATE (GEN) FUNCTION (RECEIVER TESTING)

4.07.3.1 CW MODE (Squelch Level Test)

a. Refer to steps 4.03.1 - 4.03.4 and turn on the CE-6000. Set the FUNCTION (outer) switch to GEN, and inner switch to CW. Turn the MOD/OFF/MOD + 1kHz switch to OFF.

b. Enter the RF frequency of the receiver under test into the CE-6000 Frequency Entry display by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys. Refer to paragraph 4.04.1 for frequency entry.

c. Set the SIG GEN (COARSE) switch to the output level desired between .1 uV and 300 mV. For levels between the 10 dB switch increments, adjust the SIG GEN (FINE) control.

d. Connect the SIG GEN OUT/RF IN connector on the CE-6000 to the input of the receiver to be tested.

NOTE

The CE-6000 is protected against inadvertent transmitter keying by an automatic switching circuit which directs incoming RF on the SIG GEN OUT/RF IN connector to the Power Measuring Circuits.

e. Adjust the SIG GEN (COARSE) and SIG GEN (FINE) controls until the receiver under test just breaks squelch, and note the combined squelch level selected on the two controls.

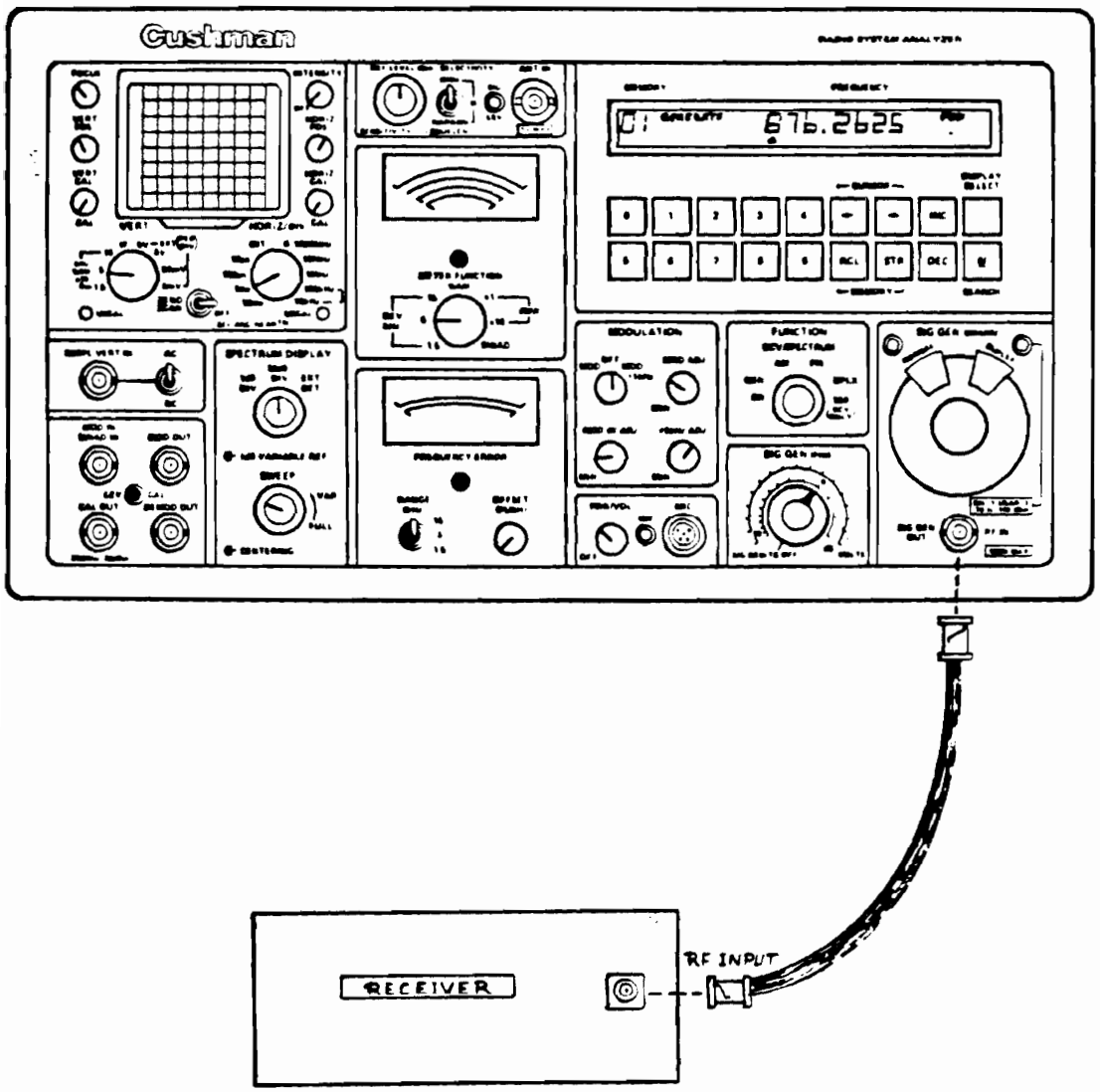


Figure 4-2. Receiver Testing Interconnect

4.07.3.2 AM MODE (Modulation Check)

a. Refer to steps 4.03.1 - 4.03.4 and turn on the CE-6000. Set the FUNCTION (outer) switch to GEN, and inner switch to AM. Turn the MOD/OFF/MOD + 1kHz switch to MOD.

b. Enter the RF frequency of the receiver under test into the CE-6000 Frequency Entry display by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys. Refer to step 4.04.1 for frequency entry.

c. If a modulation frequency is to be generated by the CE-6000, it can be selected by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys. Refer to step 4.04.1 for frequency entry.

d. For external modulation, connect an external signal source to the CE-6000 MOD IN/SINAD IN connector. Turn the MOD/OFF/MOD + 1kHz switch to OFF. Both the internal and external modulation signals will modulate the output RF if the MOD/OFF/MOD + 1kHz switch is in the MOD or MOD + 1kHz position.

e. The amount of AM modulation can be set from 0- >90 percent with the MOD ADJ control (for internal modulation), or MOD IN ADJ control (if external modulation). To set it to the level desired, place the METER FUNCTIONS switch to the %AM position and monitor the FUNCTIONS meter reading while adjusting the MOD ADJ control.

f. The modulating signal can also be monitored on the CE-6000 oscilloscope. Turn on the oscilloscope with the INTENSITY/OFF control. Set the VERT switch to the IF position, and adjust the INTEN and FOCUS controls for a sharp, clear trace on the CRT. Center the trace on the CRT with the VERT and HORIZ controls.

g. To simultaneously modulate the CE-6000 RF output with an audio frequency plus a constant known (1 kHz) frequency, place the MOD/OFF/MOD + 1kHz switch to the MOD + 1kHz position. The audio frequency is selected by the entry into the Frequency Display, while the 1 kHz is constantly applied. The 1 kHz modulation level can be changed by the + 1kHz ADJ control from 0 - 100 percent.

4.07.3.3 FM MODE (Modulation Check)

a. Refer to steps 4.03.1 - 4.03.4 and turn on the CE-6000. Set the FUNCTION (outer) switch to GEN, and inner switch to FM. Turn the MOD/OFF/MOD + 1kHz switch to MOD.

b. Enter the RF frequency of the receiver under test into the CE-6000 Frequency Entry display by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys (if necessary, refer to paragraph 4.04.1 for frequency entry.

c. If the modulation frequency is to be generated by the CE-6000, it can be selected by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys (if necessary, refer to paragraph 4.04.1 for frequency entry.

d. For external modulation, connect an external signal to the MOD IN/SINAD IN connector. Turn the MOD/OFF/MOD + 1kHz switch to the OFF position. Both the internal and external modulation signals will modulate the output RF if the MOD/OFF/MOD + 1kHz switch is left in the MOD or MOD + 1kHz positions.

e. The amount of FM modulation can be set from 0 - 15 kHz deviation by the MOD ADJ control (for internal modulation) or MOD IN ADJ control (if external modulation). To set it to the level desired, place the METER FUNCTIONS switch to the 15 kHz position (if less deviation is needed, better resolution can be achieved by using a lower frequency deviation position). Monitor the FUNCTIONS meter while adjusting the modulation to the desired FM frequency deviation. A modulating signal can also be monitored by turning on the oscilloscope as described in step 4.07.3.2 (f) and viewing the displayed signal.

f. To simultaneously modulate the CE-6000 output RF with an audio frequency plus a constant known frequency, place the MOD/OFF/MOD + 1kHz switch to the MOD + 1kHz position. The audio frequency is selected by the entry into the Frequency Display, while the 1 kHz is constantly applied. The 1 kHz modulation level can be changed by the 1 kHz ADJ control from 0 - 15 kHz frequency deviation.

4.07.3.4 12 dB SINAD SENSITIVITY

a. The SINAD measurement of receiver sensitivity is really a measurement of the quality of the output signal delivered to its speaker, and can be a useful tool in performing receiver alignment. To make SINAD measurements, make the following connections and control settings.

CAUTION

SOME RADIOS HAVE VOLTAGE ON THE SPEAKER LEADS. USE COUPLING CAPACITORS ON BOTH SPEAKER LEADS WHEN MAKING THE FOLLOWING RADIO CONNECTIONS.

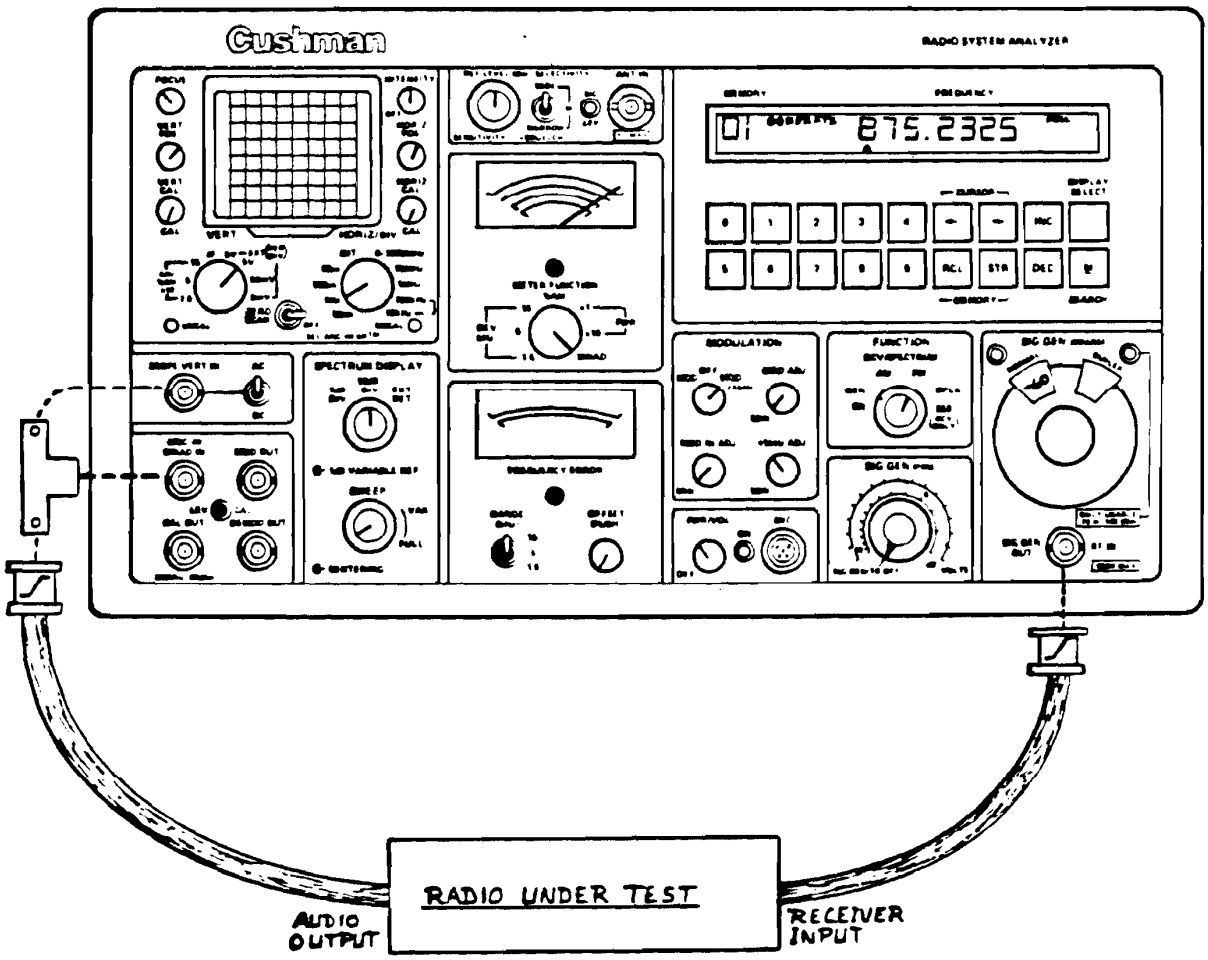


Figure 4-3. SINAD Measurement Interconnect

b. Connect the radio to the CE-6000 as shown in Figure 4-3, Sinad Measurement Interconnect.

c. Refer to steps 4.03.1 - 4.03.4, and turn on the CE-6000. Set the FUNCTION (outer) switch to GEN, and inner switch to AM or FM as needed for receiver modulation requirements.

d. Set the MOD/OFF/MOD + 1kHz switch to the MOD + 1kHz position, and turn the MOD IN adjust to minimum (fully counter-clockwise).

e. Set the METER FUNCTION switch to the 5kHz position.

f. Adjust the 1kHz ADJ potentiometer to 2/3 full system deviation as read on the FUNCTION meter (i.e., this would be 3.3 kHz for a narrow band FM radio with 5 kHz system deviation).

g. Set the SIG GEN (COARSE) attenuator to the -60 dBm position, and turn the SIG GEN (FINE) control to OFF.

h. Set the METER FUNCTION switch to the SINAD position.

i. Turn on the CE-6000 oscilloscope by moving the INTENSITY/OFF control from the OFF position. Adjust the INTENSITY and FOCUS controls for a sharp, clear trace on the CRT. Center the trace using the VERT POS and HORIZ POS controls. Set the VERT switch to .5V/DIV and HORIZ/DIV switch to 1 mS/DIV. Set the AC/DC switch to AC.

j. Monitor the CRT for a display of receiver noise. If not present, check the receiver SQUELCH setting.

k. Adjust the receiver VOLUME control so the CE-6000 FUNCTION METER pointer swings nearly full scale, and center it in the white box area. Take care not to overdrive the SINAD meter input.

l. Turn on the CE-6000 SIG GEN (FINE) control. Adjust both the SIG GEN (FINE) and SIG GEN (COARSE) levels until the FUNCTION METER pointer reads 12dB on the SINAD scale.

m. The SINAD sensitivity is the total of the SIG GEN (COARSE) and SIG GEN (FINE) control settings at the 12dB SINAD level.

4.07.4 RCV/SPECTRUM FUNCTION (TRANSMITTER TESTING)

INTRODUCTION

4.07.4.1 There are two methods of making measurements in the RECEIVE function of the CE-6000 unit. Transmitter output can be measured remotely, over the CE-6000 antenna, or by direct connection from the transmitter to the SIG GEN OUT/RF IN connector. The direct connection allows more tests to be made, and has automatic switching to protect the CE-6000 circuits. If the FUNCTION switch is in the GEN (signal generator) mode, any RF detected by the CE-6000 at the SIG GEN OUT/RF IN connector will cause it to automatically switch to the RECEIVE function.

4.07.4.2 CARRIER FREQUENCY/LEVEL MEASUREMENT

a. Refer to steps 4.03.1 - 4.03.4 and turn on the CE-6000. Set the FUNCTION switch to RCV/SPECTRUM (outer switch) and inner switch to AM, FM, CW, or SSB as required for transmitter under test.

b. If performing remote testing of a transmitter carrier frequency, connect CE-6000 antenna to its ANT IN connector. If performing local testing, connect the transmitter output (if 150 W or less) to CE-6000 SIG GEN OUT/RF IN.

CAUTION

DO NOT CONNECT TRANSMITTER OUTPUT DIRECTLY TO ANT IN CONNECTOR. MAXIMUM SIGNAL INPUT TO ANT IN IS 0 dBm.

c. Set SELECTIVITY switch to WIDE (if necessary, use NARROW or M to attain better adjacent channel selectivity while remembering that this reduces maximum deviation measurement capability).

d. Set the SENSITIVITY/SQUELCH (outer) switch to MAX (if the remote input is being received over the antenna), or REF LEVEL 0 dBm (if directly connected from transmitter output to SIG GEN OUT/RF IN). Set SQUELCH (inner control) so that the squelch is just open (critical position).

e. Set the METER FUNCTION switch to PWR (X10), and the RANGE (kHz) switch to 5 kHz.

f. Enter the RF frequency of the transmitter under test into the CE-6000 Frequency Entry display by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys. Refer to step 4.04.1 for frequency entry.

CAUTION

MAXIMUM POWER INPUT IS 150 W. AN AUDIBLE ALARM WILL SOUND IF THE HIGH POWER LOAD TEMPERATURE EXCEEDS 75°C.

g. Key transmitter. Adjust SENSITIVITY/SQUELCH control until the SIG LEV light just illuminates. The carrier frequency error is the difference between the CE-6000 frequency display and the transmitted frequency, and is displayed on the FREQUENCY ERROR meter. The RANGE (kHz) switch may be changed to better read frequency error on the meter.

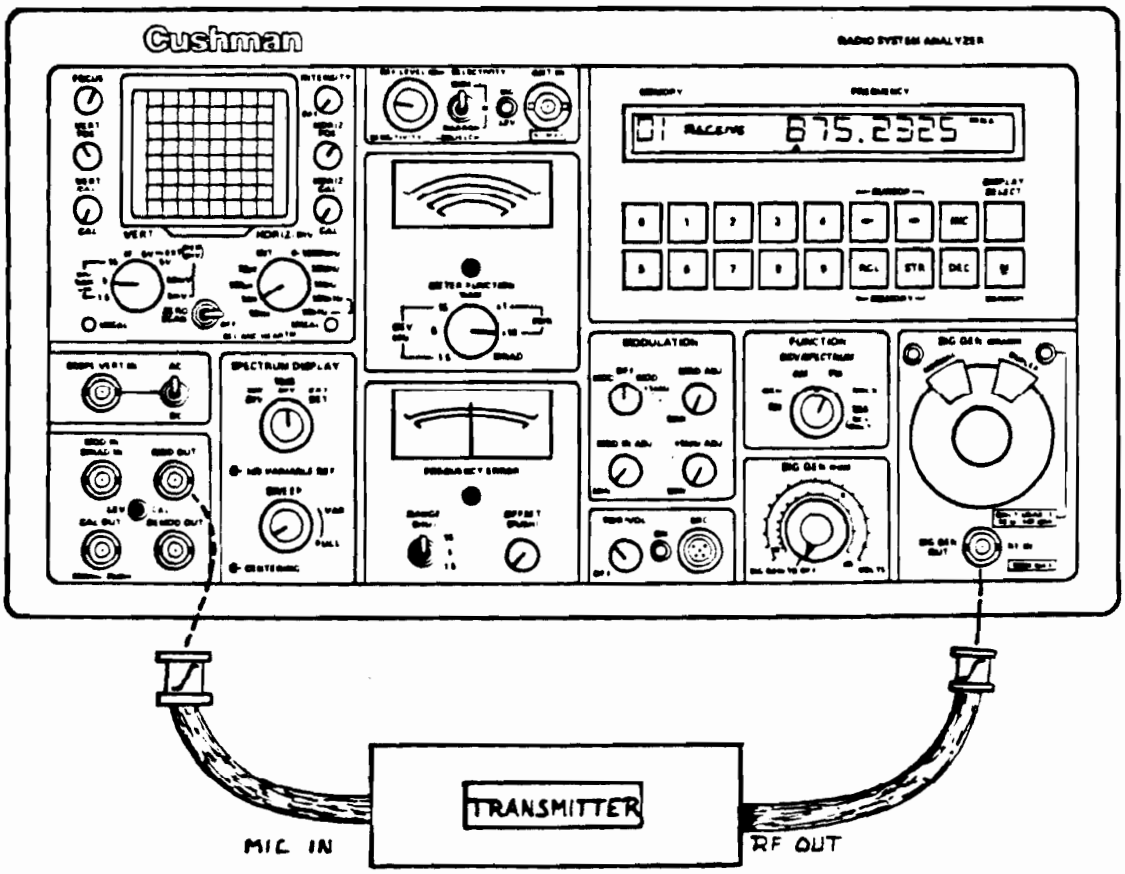


Figure 4 - 4. Transmitter Testing Interconnect (Closed Loop)

4.07.4.3 MEASURE TRANSMITTER OUTPUT POWER

Transmitter output power can be measured by repeating steps 4.07.4.2 (a - g) above and reading the output power level on the FUNCTION meter. Output power can be read in two switch positions: PWR X1 (0 - 15 W), or PWR X10 (0 - 150 W, the maximum level).

4.07.4.4 MEASURE TRANSMITTER FREQUENCY DEVIATION

a. If using the CE-6000 antenna for transmitter signal input, repeat 4.07.4.2 (a - e). Set METER FUNCTION switch to the lowest DEV kHz range which gives an on-scale reading of frequency deviation on the FUNCTION meter when the transmitter is keyed.

b. If the transmitter is directly connected to CE-6000 SIG GEN OUT/RF IN, repeat steps 4.07.4.2 (a - g). Turn on the oscilloscope by moving the INTENSITY/OFF control from the OFF position. Adjust the INTENSITY and FOCUS controls for a sharp, clear trace on the CRT. Center the trace on the CRT with the HORIZ POS and VERT POS controls.

c. Key transmitter and read FM deviation on the oscilloscope. Deviation peaks appear above and below the CRT center-line, and are read directly on the CRT through the scales marked there, (selected by the VERT control). The HORIZ control adjusts duration.

d. Adjust the VOL control for the desired level output of the demodulated FM through the speaker. The demodulated output is also available at the DEMOD OUT connector.

NOTE

The CE-6000 sensitivity allows it to measure FM or AM deviation when the antenna is connected to the ANT IN connector, and the Analyzer placed in close proximity to a properly loaded and keyed transmitter. Measurement is done just as shown in step 4.07.4.4 (a) above. Modulation can also be monitored on the oscilloscope while it is being measured on the FUNCTION meter.

4.07.4.5 MEASURE TRANSMITTER AM MODULATION

a. Repeat steps 4.07.4.4 (a) (except set METER FUNCTION switch to the % AM position), or 4.07.4.4 (b-c). The % AM modulation can be read directly from the FUNCTION meter or from the oscilloscope, as desired.

b. Adjust the VOL control for desired speaker level out. The demodulated signal is also available at the DEMOD OUT connector.

c. To analyze the modulation envelope of the AM transmitter on the oscilloscope, set the VERT switch to IF, and adjust the oscilloscope controls for best viewing.

4.08 OSCILLOSCOPE EXTERNAL OPERATION

a. The CE-6000 500 kHz oscilloscope can be used as a stand-alone instrument, apart from its usual RCV/SPECTRUM operation. The SCOPE VERT IN input is coupled through the AC/DC switch circuits, while the horizontal input is through the MOD IN/SINAD IN front panel connector.

b. Turn on the CE-6000 oscilloscope by moving the INTENSITY/OFF control clockwise from OFF. Adjust INTENSITY and FOCUS controls for a sharp, clear trace on the CRT. Center the trace using the VERT POS and HORIZ POS controls. Set the AC/DC switch for the type of input signal being measured. Use the VERT and HORIZ controls to set the amplitude and duration of the signal on the CRT.

CAUTION

PROLONGED DISPLAY OF A STATIONARY HIGH INTENSITY SIGNAL OR TRACE MAY DAMAGE THE CRT PHOSPHOR COATING. INTENSITY SHOULD BE SET NO HIGHER THAN NECESSARY FOR COMFORTABLE VIEWING.

c. Connect the input signal to the SCOPE VERT IN connector, and set the VERT control to the EXT (per div) 5mV - 5V position as required. Setthe HORIZ control to the 10 uS to 10 mS position which gives the best viewing.

d. If an external HORIZ input signal is needed for external oscilloscope operation, connect it to the MOD IN/SINAD IN connector. Set the HORIZ control to INT, and MOD/OFF/MOD + 1 kHz to OFF.

4.08.1 MEASURE MODULATION FREQUENCY (LISSAJOU)

a. Refer to steps 4.07.4.2 (a.- e.) to set up the CE-6000.

b. Turn on the CE-6000 oscilloscope by moving the INTENSITY/OFF control from the OFF position. Adjust the INTENSITY and FOCUS controls for a sharp, clear trace on the CRT.

c. Center the CRT trace with the VERT POS and HORIZ POS controls, and turn the HORIZ control to the INT TONE position.

d. Turn the MOD ADJ control until a circular or elliptical Lissajou pattern can be seen on the CE-6000 CRT.

e. Adjust the modulation frequency at the Frequency Entry display until the Lissajou pattern stops rotating and is steady. The modulation frequency of the input RF signal is that frequency selected on the Frequency Entry display.

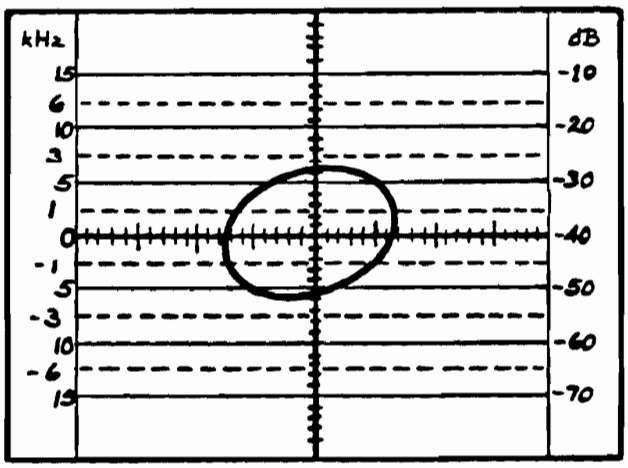


Figure 4 - 5. Example of Lissajou Pattern

4.09 SPECTRUM MONITOR OPERATION

4.09.1 Spectrum Monitor operation provides the capability of looking at a signal and determining its RF frequency, the receive level, adjacent frequencies which might cause interference, and modulation characteristics.

4.09.2 CALIBRATION

a. Refer to steps 4.03.1 - 4.03.4 and turn on the CE-6000. Set the FUNCTION (outer) switch to the RCV/SPECTRUM position (inner switch can be at any position).

c. Set the SIG GEN (FINE) control to OFF.

d. Switch the HORIZ/DIV switch to the 10 kHz position. The VERT switch can be in any position.

e. Set the SPECTRUM DISPLAY switch to the 10 dB/DIV position.

f. Enter 200.0000 MHz on the Frequency Entry display by using the frequency RCL function or by entering the frequency on the 0 - 9 number keys.

g. Set the SENSITIVITY switch to REF LEVEL -20 dBm. The level selected will be the level at the REF LEVEL 0 dB line on the CRT graticule, and subsequent readings of level will be from this reference. In this case, with the switch in the -20 dB position, the CRT REF LEVEL "0" dB line will be -20 dBm. Then the -10 dB line would be -30 dBm (-20 dBm plus the additional -10dBm), the -20 dB line would be -40 dBm, etc.

h. Connect the CE-6000 CAL OUT connector to the ANT IN connector. A 200 MHz signal should appear at the center of the CRT on the baseline trace, and extend upward to the REF LEVEL "0" dB line on the CRT. The signal amplitude can be adjusted by the recessed LEV CAL control on the front panel near the CAL OUT connector.

i. Set the SPECTRUM DISPLAY switch to 1 dB/DIV. Adjust the 1 dB VARIABLE REF control to put the trace exactly on the REF LEVEL "0" dB line on the CRT. Calibration of the Spectrum Monitor circuits is now complete.

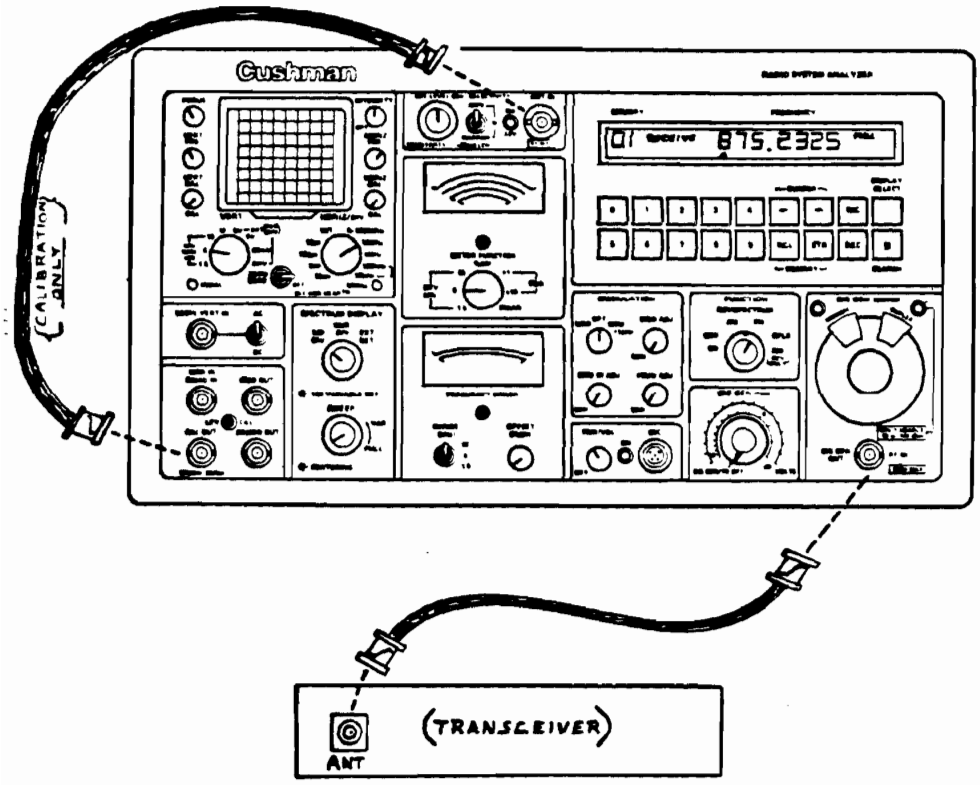


Figure 4 - 6. Spectrum Monitoring Interconnect

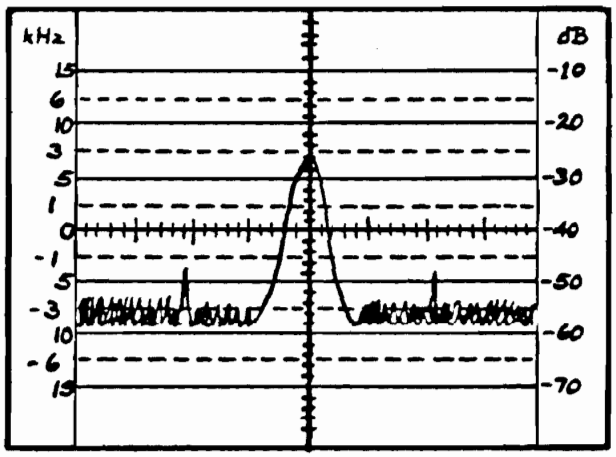


Figure 4 - 7. Typical Spectrum Display

4.09.3 SPECTRUM MONITORING

a. Repeat steps 4.09.2 (a - e).

b. Enter the RF frequency of the signal to be monitored into the CE-6000 Frequency Entry display by using the frequency RCL function, or by keying in the frequency on the 0 - 9 number keys. If necessary, refer to step 4.04.1.

c. Set the HORIZ/DIV scan width of the CRT to the 0 - 1000 MHz, 10 MHz, 1 MHz, 100 kHz, or 10 kHz position as desired for viewing. In the 0 - 1000 MHz scan width, each division of the CRT scale represents 100 MHz starting with 10 MHz at the left edge, and ending at the right edge with the CE-6000 maximum frequency of 1000 MHz. The input signals will appear on the scale at the position which corresponds to their frequency. In all other scan width positions, the CRT center will correspond to the CE-6000 tuned frequency. The divisions to right or left will be the value set by the HORIZ/DIV switch setting. For example, an input frequency of 300 MHz will appear at the CRT center of a unit tuned to that frequency. If the HORIZ/DIV switch is set to 10 MHz, then a signal two divisions to the left would be at 280 MHz (300 MHz - 20 MHz) while a signal two divisions to the right would be at 320 MHz (300 MHz + 20 MHz).

d. If the input signal is to be monitored off-the-air, (as it should be for low-powered transmitters), connect the monitor antenna to the ANT IN connector. Set the SENSITIVITY switch as required for an input signal on the CRT which extends from the baseline vertically to a point no higher than the top line of the CRT scale, and high enough to be easily seen.

e. If the monitor antenna input is not used, connect the transmitter output to the SIG GEN OUT/RF IN connector.

CAUTION

DO NOT CONNECT THE TRANSMITTER RF OUTPUT DIRECTLY TO THE ANT IN CONNECTOR. THE MAXIMUM SIGNAL INPUT TO THIS CONNECTOR IS 0 dBm.

f. If the frequency of an unknown signal is to be determined, it can be input to the CE-6000 Spectrum Monitoring circuits. The HORIZ/DIV switch is set to 0 - 1000 MHz. Determine the approximate frequency by the signal location on the baseline (100 MHz/DIV starting at 10 MHz and going from left to right on the CRT).

g. Enter this approximate frequency into the Frequency Entry display, and change the HORIZ/DIV switch to 10 MHz/DIV. The signal should appear near the center of the CRT.

h. Move the cursor on the Frequency Entry display to the 10 MHz digit position using the CURSOR arrow keys.

i. If the signal appears at left of CRT center, press the DEC key on the display. If it is to the right of center, press the INC key. Press and release the keys to move the signal to within 1/2 division of CRT center.

j. Change the HORIZ/DIV switch to the 1 MHz/DIV position. Move the cursor to the 1 MHz digit position using the CURSOR arrow keys.

k. Again press the INC or DEC keys to bring the signal to within 1/2 division of CRT center.

l. Change the HORIZ/DIV switch to 100 kHz/DIV, and move the cursor to the 100 kHz position. Again, center the signal within 1/2 division with INC and DEC keys.

NOTE

The CE-6000 activates its SEE and HEAR™ function when the HORIZ/DIV switch is in the 100 kHz or 10 kHz position. This enables the FREQUENCY ERROR and FUNCTION meters, and the audio circuits of the unit.

m. Adjust the PWR/VOL control to a comfortable audio level. Change the HORIZ/DIV switch to 10 kHz/DIV. Move the cursor to the 10 kHz position, and again center the signal within 1/2 division with the INC and DEC keys.

n. With the signal now centered on the CRT, its frequency can be read by adding the plus or minus error of the FREQUENCY ERROR meter to the Frequency Entry. And modulation on the signal can be read from the FUNCTION meter.

4.10 TRACKING GENERATOR OPERATION

4.10.1 The Tracking Generator function is used to make swept frequency measurements. It is available on the CE-6020 and CE-6030, and optionally available on the CE-6232 and CE-6488. There are no additional controls, connectors, or indicators for the Tracking Generator function. Controls and connectors are given additional functions as follows:

a. The SIG GEN OUT/RF IN connector is the Tracking Generator output when the FUNCTION switch is in the RCV/SPECTRUM position, the HORIZ/DIV switch is in the 10 MHz, 1 MHz, 100 kHz, or 10 kHz positions, and the SIG GEN (FINE) control is out of the OFF position.

b. The Tracking Generator output level is set by the SIG GEN (COARSE) and SIG GEN (FINE) controls.

c. All other controls, connectors, and indicators remain as described in Table 3-1.

4.10.2 SWEPT FREQUENCY MEASUREMENTS (10 dB/DIV)

a. Except for the frequency and output level settings, connections and settings given here are the same for all applications of Tracking Generator sweep operation. See Figure 4-8.

b. Set the FUNCTION switch to the RCV/SPECTRUM position. Enter the center frequency needed for the application into the Frequency Entry display (refer to step 4.04.1).

c. Set the HORIZ/DIV switch to the 10 MHz, 1 MHz, 100 kHz, or 10 kHz position as required for the application. These HORIZ/DIV switch settings set the Tracking Generator sweep ranges (for full CRT deflection) of 100 MHz, 10 MHz, 1 MHz, and 100 kHz, respectively.

d. Set the SENSITIVITY control switch to the approximate output level (0, -20dB, -40 dB, or MAX) needed from the Tracking Generator for the swept frequency application.

e. Place a double shielded coaxial cable (RG223 or RG142) on the CE-6000 SIG GEN OUT/RF IN connector. Place another coaxial cable on the ANT IN connector. Connect the two cables through a BNC barrel adapter as shown in Figure 4-9 for Swept Frequency Calibration.

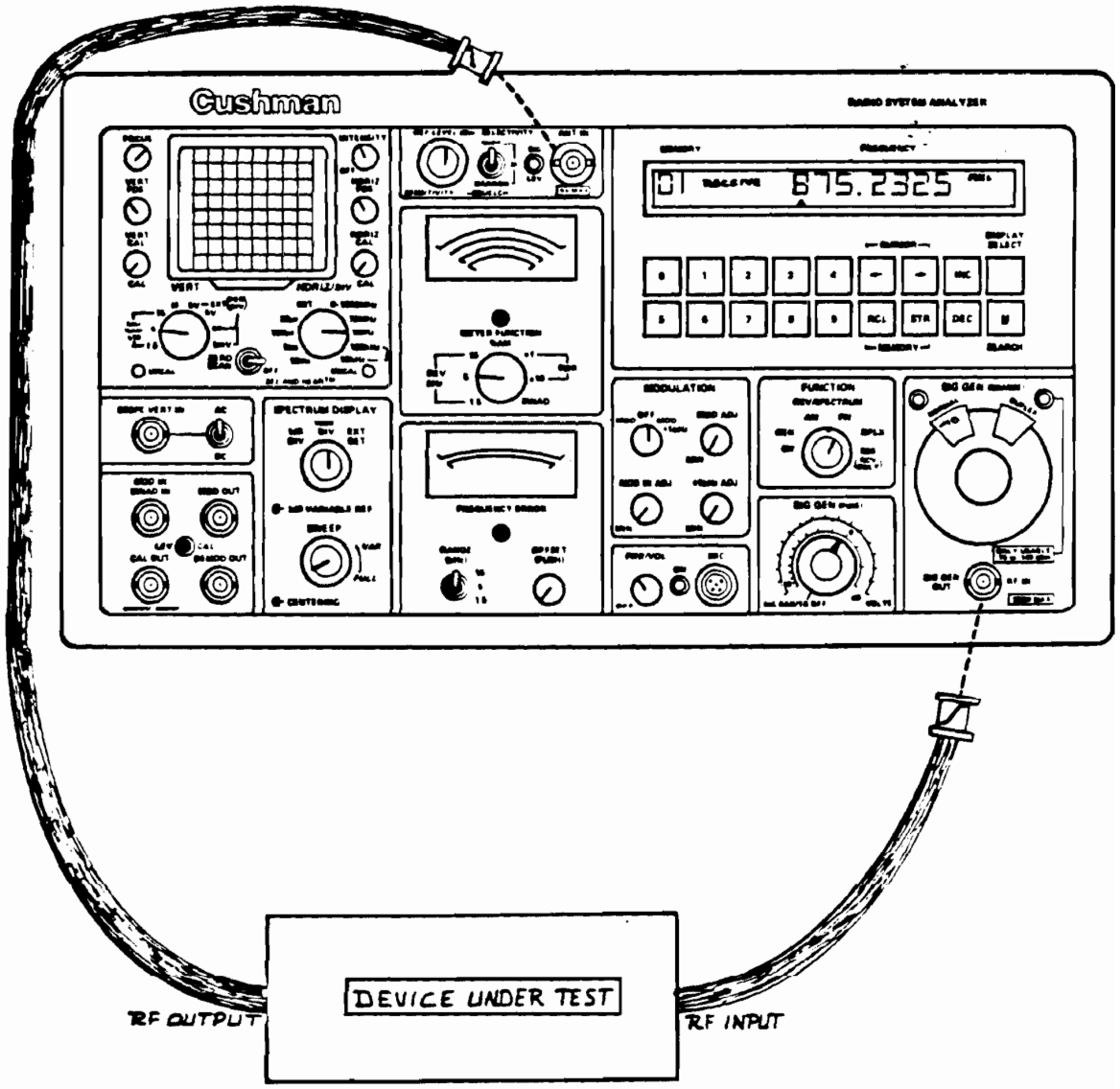


Figure 4-8. Tracking Generator Interconnect

f. Set the SIG GEN (COARSE) control to a level 10 dB higher than the SENSITIVITY switch setting. For example, if the SENSITIVITY switch is at -20 dB, set the SIG GEN (COARSE) control to -10 dB. Adjust the SIG GEN (FINE) control to approximately -10 dB to place the trace on the REF LEVEL 0 dB line of the CRT.

g. Remove the BNC barrel connector from between the two cables. Connect the cable from the SIG GEN OUT/RF IN connector to the input of the device under test, and connect its output to the cable from the ANT IN jack (refer to Figure 4-10 for Swept Frequency Alignment).

h. The trace on the CRT will outline the insertion loss of the device under test, and its frequency response around the selected center frequency.

4.10.3 SWEPT FREQUENCY MEASUREMENTS (1 dB/DIV)

a. To monitor the Tracking Generator output with greater resolution through the device under test, set the SPECTRUM DISPLAY switch to the 1 dB/DIV position.

b. Set the FUNCTION switch to the RCV/SPECTRUM position. Enter the center frequency needed for the application into the Frequency Entry display (refer to Step 4.04.1).

c. Set the HORIZ/DIV switch to 10 MHz, 1 MHz, 100 kHz, or 10 kHz as required for the application (to cover bandwidth of device under test).

d. Repeat the steps of 4.10.2 (d. - g.) above. Adjust the (inner) SPECTRUM DISPLAY control (1 dB VARIABLE REF) to set the trace at the same Log Ref graticule line as for the 10 dB setting (this calibrates the 1 dB to 10 dB). The trace on the CRT will outline the insertion loss of the device under test (in vertical 1 dB/DIV increments), and its frequency response around the selected center frequency (in increments corresponding to the setting of the HORIZ/DIV switch).

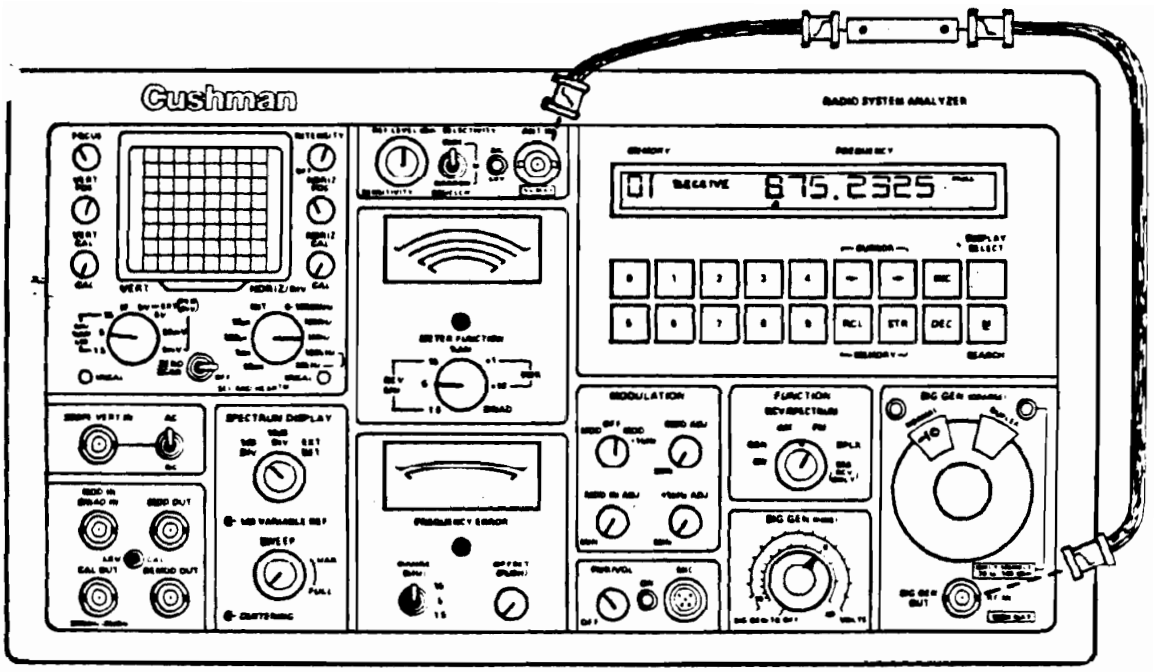


Figure 4-9. Swept Frequency Calibration Set-up

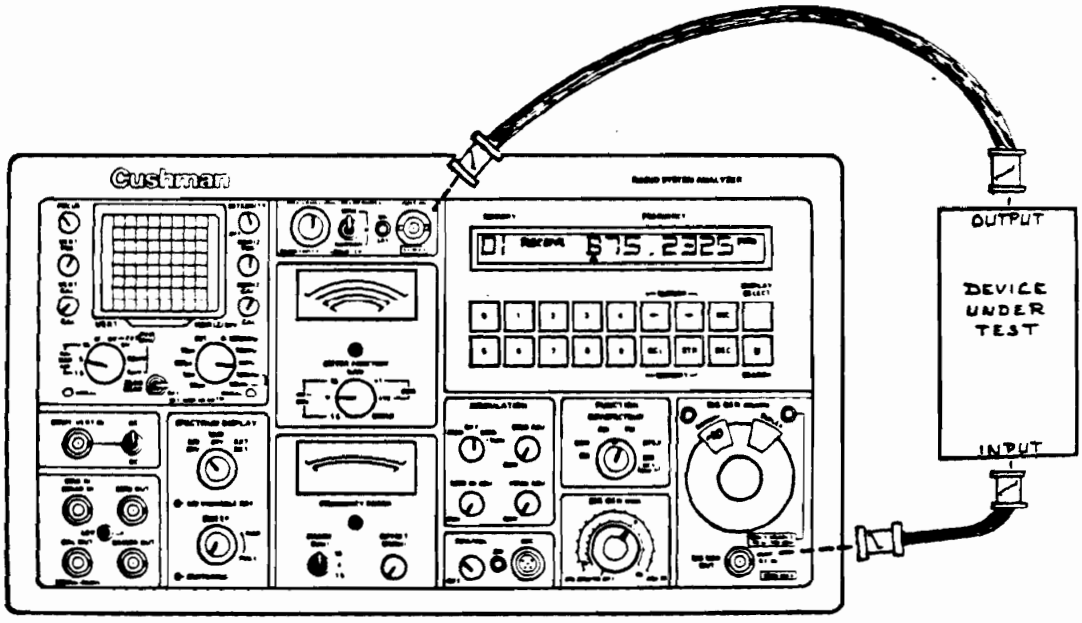


Figure 4-10. Swept Frequency Alignment Interconnect

4.11 OFFSET GENERATOR/DUPLEX OPERATION

4.11.1 Duplex operation is used when it is necessary to simultaneously transmit and receive on different frequencies. The function is standard on the CE-6030, and optionally available (under bus control) on the CE-6020, CE-6232 and CE-6488. A typical example of Duplex operation would be to set the FM modulation level of a repeater.

a. Set the VERT switch to 6 kHz, and the HORIZ/DIV switch to 1 mS. Set the METER FUNCTION switch to 5 kHz DEV. Set the RANGE (kHz) switch (for the FREQUENCY ERROR meter) to 1.5 kHz.

b. Set the FUNCTION (outer) switch to GEN, and the inner switch to FM.

c. Switch the SIG GEN (COARSE) control to -120 dBm, and SIG GEN (FINE) control to mid-range.

d. Turn the MOD/OFF/MOD + 1 kHz switch to MOD + 1 kHz. Turn the + 1 kHz ADJ control until a correct deviation level (see manufacturer's specifications for the repeater) is measured on the CE-6000 CRT and FUNCTION meter.

e. Change the FUNCTION (outer) switch to DPLX. Enter the repeater transmitter frequency into the Frequency Entry display RECEIVE display function, and the repeater receiver frequency into the GENERATE function. Refer to paragraph 4.04.1 for frequency entry.

f. Attach the CE-6000 antenna to the ANT IN connector (not needed if Single-cable Duplex option OP-08 is installed). Connect the SIG GEN OUT/RF IN connector to the duplexer input. Refer to Figure 4-11.

g. Set the SELECTIVITY switch to MEDIUM (M). Increase the SIG GEN (COARSE) and SIG GEN (FINE) control's output level until it keys the repeater transmitter, and the demodulated audio can be seen on the CRT (use only enough signal to unsquelch the receiver). If OP-08 is installed, the green DUPLEX LED above the SIG GEN (COARSE) control will light, indicating maximum output level is -70 dBm for single port duplex operation.

h. Adjust the repeater receiver audio bus output level until it is equal to the level set in paragraph 4.11.1 (d) above.

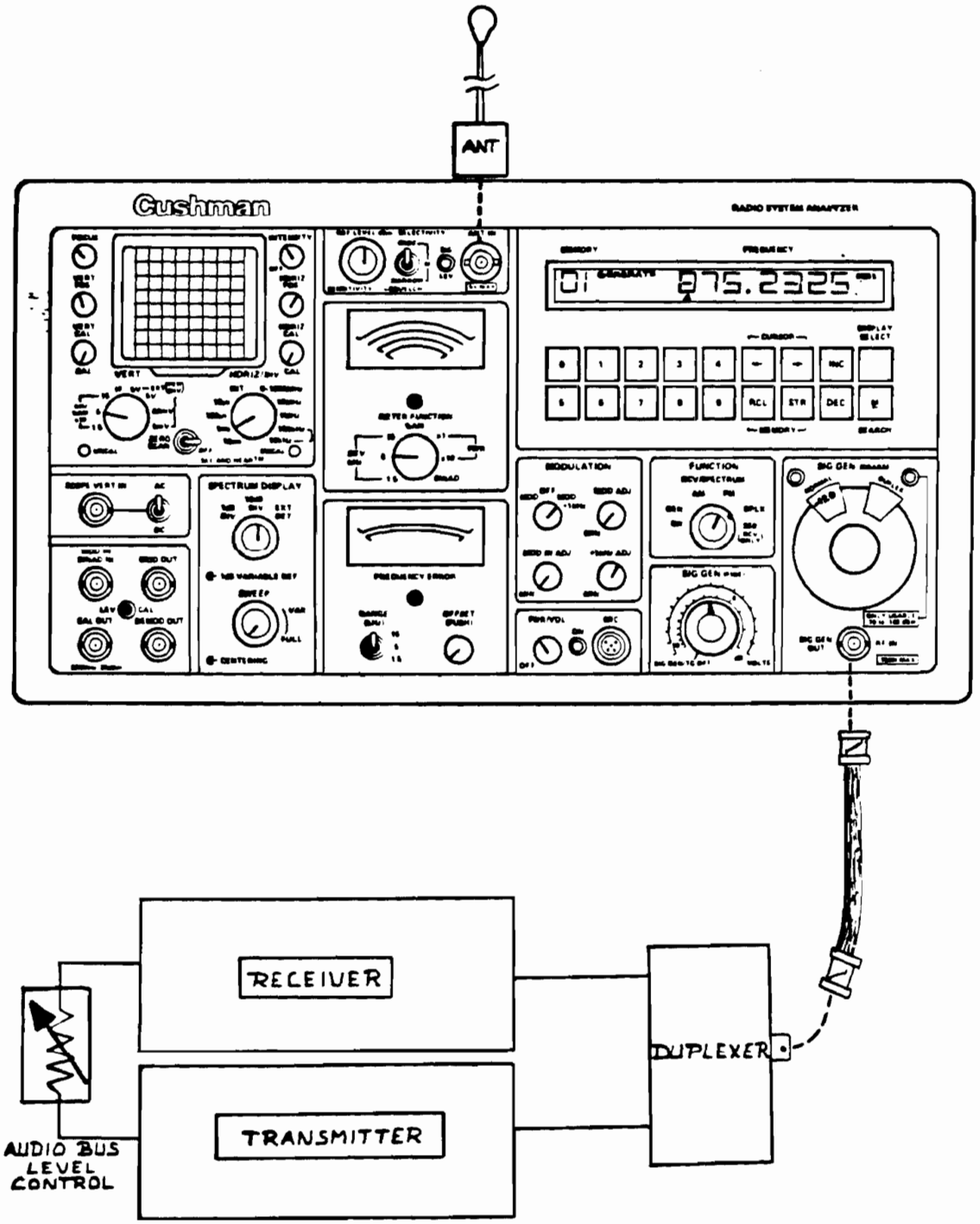


Figure 4-11. Repeater Duplex Test Set-up

4.12 CABLE FAULT LOCATION

4.12.1 This procedure is used to determine the distance to a high VSWR condition (a short or open) in a transmission line. The distance can be determined by calibrating the CE-6000 unit with a known length of cable of the same type as that to be tested. Cable Fault location is standard on the CE-6030, and is optionally available on the CE-6232 and CE-6488.

a. Connect an RG223 coaxial cable from the SIG GEN OUT/RF IN connector to one side of a BNC "Tee" connector at the ANT IN connector. See Figure 4-12.

b. Connect a known length of the cable to be tested (called a "Reference stub") to the other side of the ANT IN "Tee" connector.

c. Set the HORIZ/DIV switch to the 0 - 1000 MHz position. Switch the SPECTRUM DISPLAY switch to 10 dB/DIV, and the SWEEP control to VAR.

d. Set the SENSITIVITY switch REF LEVEL dBm switch to -20 dBm, and the SQUELCH control to minimum.

e. Turn the MOD/OFF/MOD + 1 kHz switch to OFF.

f. Set the FUNCTION (outer) switch to RCV/SPECTRUM.

g. Switch SIG GEN (COARSE) to -30 dBm, and SIG GEN (FINE) to 1 volt.

h. Adjust the SWEEP/CENTERING controls for one ripple across the CRT.

i. Remove the Reference stub from the ANT IN "Tee" connector, and connect the transmission line to be tested in its place. Refer to Figure 4-13.

j. Set the SPECTRUM DISPLAY switch to 1 dB/DIV and count the ripples on the CRT display. Multiplying the number of ripples by the length of the reference cable will give the length of the transmission line.

k. A short or open in the transmission line is displayed on the CRT as a deep, sharp change in the reference ripple display. By counting ripples to that point, and multiplying by the reference length, the short or open will be located in distance from the CE-6000.

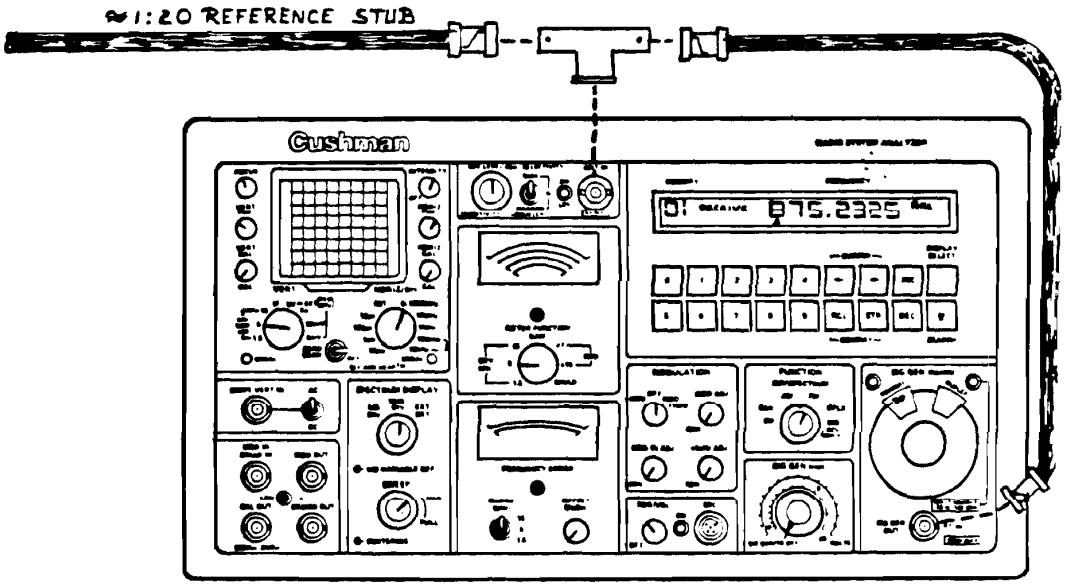


Figure 4-12. Cable Fault Calibration Set-Up

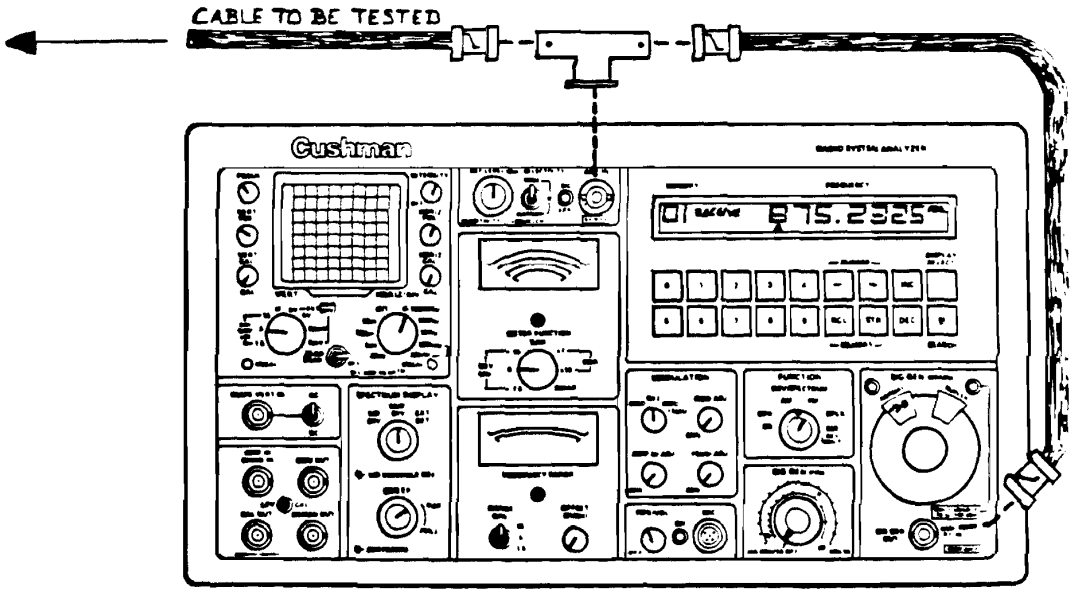


Figure 4-13. Cable Fault Location Test Set-up

SECTION V - PERFORMANCE VERIFICATION

5.01 INTRODUCTION

5.01.1 This section is intended only as a verification of CE-6000 Series Radio System Analyzer operation. The troubleshooting aids given are to assist only in determining if a problem is in the CE-6000 Series instrument, or external to it, and do not require any disassembly of the equipment.

5.01.2 If a problem has been localized to the CE-6000 Series equipment, contact the Cushman Electronics Customer Service Department for instructions on returning the unit to service. In California, call telephone number (408) 263-8100. Outside California, call (800) 538-7020.

5.01.3 If it becomes necessary to return equipment to Cushman Electronics, refer to the information contained in Section I of this manual for packing and shipment.

5.01.4 The only test equipment required to verify the 6000 Series equipment operation is another CE-6000 Series Radio System Analyzer. If not available, an equivalent RF Generator, Audio Generator, AM and FM demodulation meters, Frequency counter (1 Hz to 20 kHz), Frequency counter (10 MHz to 1000 MHz), SINAD meter, oscilloscope, and spectrum analyzer (HP 8555) may be used. Procedures will be described using another CE-6000 Series Radio System Analyzer for verification.

5.02 VISUAL INSPECTION

a. Verify that all CE-6000 Rear Panel controls and connectors are set for operation with the source voltage available, and that the correct fuses are installed and are not blown.

b. Verify that all Front Panel controls are set to the correct function for the test to be performed.

c. Verify that cabling interconnects have been made correctly, and that coaxial cables have correct impedance and operating specifications for the operation to be performed. Check cables for open or shorted conditions.

d. Turn on the CE-6000 Series Radio System Analyzer, using the procedures of SECTION IV, paragraphs 4.03 - 4.06. If any portion of the turn-on procedure fails to operate as described in those paragraphs, the problem is with the CE-6000.

NOTE

In the following procedures for localizing problems to the CE-6000 or an external source, it is assumed that the Visual Inspection procedures of paragraph 5.02 have been completed. No troubleshooting steps should be started without first completing the procedures for Visual Inspection.

5.03 RF SIGNAL GENERATOR VERIFICATION

a. Ensure that the Visual Inspection procedures of paragraph 5.02 have been completed.

b. On the CE-6000 to be verified (unit under test):

* Set the FUNCTION (outer) switch to GEN, and inner switch to CW.

* Switch the SIG GEN (COARSE) control to -10 dBm, and SIG GEN (FINE) to 0 dBm.

* Enter 90.0000 MHz into the Frequency Entry display using the 0 - 9 number keys. Refer to paragraph 4.04.1 if necessary.

* Set the MOD/OFF/MOD + 1 kHz switch to OFF

c. On the testing (reference) CE-6000:

* Calibrate the testing CE-6000 by attaching a cable from the CAL OUT connector to ANT IN. Enter 200.0000 MHz into the Frequency Entry Display using the 0 - 9 number keys (refer to paragraph 4.04.1). Set the testing CE-6000 SENSITIVITY control to -20 dBm, and SQUELCH to open. The CAL OUT signal should be seen on the CRT as a signal rising from the CRT baseline to the 0 dBm reference line. Adjust the LEV CAL control if necessary. Now, connect the cable from the reference CE-6000 ANT IN connector to SIG GEN OUT/RF IN of the CE-6000 under test. Refer to Figure 5-1.

* Set the FUNCTION (outer) switch to RCV/SPECTRUM and inner switch to CW. Turn the SIG GEN (FINE) control to OFF.

* Enter 90.0000 MHz into the Frequency Entry display using the 0 - 9 number keys (refer to paragraph 4.04.1).

* Set the METER FUNCTION control to 15 kHz Dev, and RANGE (kHz) to 15. Turn the oscilloscope

on, and set the INTENSITY and FOCUS for best viewing of CRT.

* Set the SPECTRUM DISPLAY switch to 10 dB/DIV.

d. Set the SENSITIVITY (outer) control for 0 dBm, and SQUELCH to open. The input signal from the CE-6000 to be verified should be at the -10 dB REF LEVEL line on the testing CE-6000 CRT. Step the SIG GEN (COARSE) control in 10 dB steps and verify that the signal tracks. If not, contact the Cushman Electronics Customer Service Department for instructions on repair of the unit.

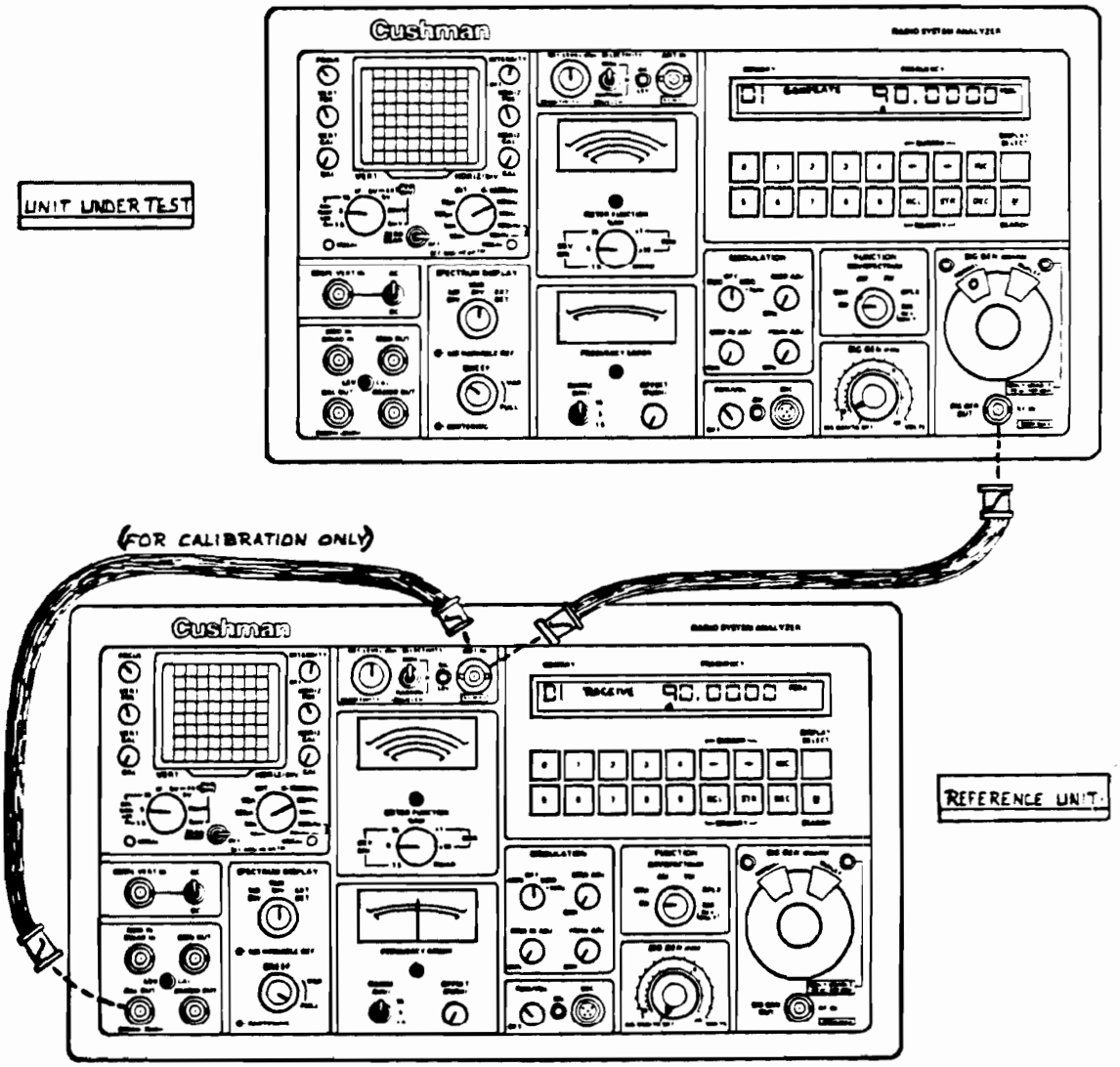


Figure 5-1. Signal Generator Verification Test Set-up

5.04 SIGNAL GENERATOR MODULATION VERIFICATION

a. Repeat the instructions of 5.03 (b) and (c) above. On the CE-6000 under test, move the MOD/OFF/MOD + 1 kHz switch to MOD, and adjust the MOD ADJ control for 5 kHz modulation on the FUNCTION meter with the METER FUNCTION control at 15 kHz DEV and FUNCTION (inner) switch set to FM.

b. On the testing (reference) CE-6000, switch the FUNCTION (inner) control to FM, and METER FUNCTION control to 15 kHz DEV. The reference CE-6000 unit should show 5 kHz deviation on the FUNCTION meter, and display the frequency deviation on the CRT. If not, contact the Cushman Electronics Customer Service Department for instructions on repair of the problem CE-6000 (unit under test).

5.05 RCV/SPECTRUM VERIFICATION

5.05.1 Ensure that paragraph 5.02 procedures for visual inspection have been completed. Testing verifies operation of CE-6000 Series instrument's RECEIVE functions of oscilloscope, Spectrum Monitoring, modulation, RF Level and Frequency measurement, and RF Power measurement.

NOTE

Many of the CE-6000 RECEIVE operations can be verified by the internal CALIBRATE signal, with no other test instrument required. Proceed as described below to test the unit, except tune the Frequency Entry Display to 200.0000 MHz, and connect the CAL OUT connector through a coax to the ANT IN connector. The signal measured will be at a -20 dBm level.

a. On the CE-6000 to be verified (unit under test):

* Switch the FUNCTION (outer) control to RCV/SPECTRUM, and (inner) switch to FM.

* Set VERT switch to 6 kHz, HORIZ/DIV to 1 mS, and SENSITIVITY to -20 dBm, or as needed.

* Set SQUELCH until it just opens, and set the SELECTIVITY switch to WIDE (for deviation).

* Enter 90.0000 MHz into the Frequency Entry display using the 0 - 9 numberkeys (refer to paragraph 4.04.1).

* Set the METER FUNCTION switch to 15 kHz DEV, the RANGE (kHz) switch to 15, and the SPECTRUM DISPLAY switch to 10 dB/DIV.

b. On the testing (reference) CE-6000:

* Set the FUNCTION switch (outer) to GEN, and (inner) switch to FM.

* Set SIG GEN (COARSE) to -20 dBm, and SIG GEN (FINE) to -10 dBm.

* Enter 90.0000 MHz into the Frequency Entry display using the 0 - 9 number keys (refer to paragraph 4.04.1).

* Switch the MOD/OFF/MOD + 1 kHz control to the MOD + 1 kHz position. Adjust the + 1 kHz ADJ potentiometer for 5 kHz output deviation.

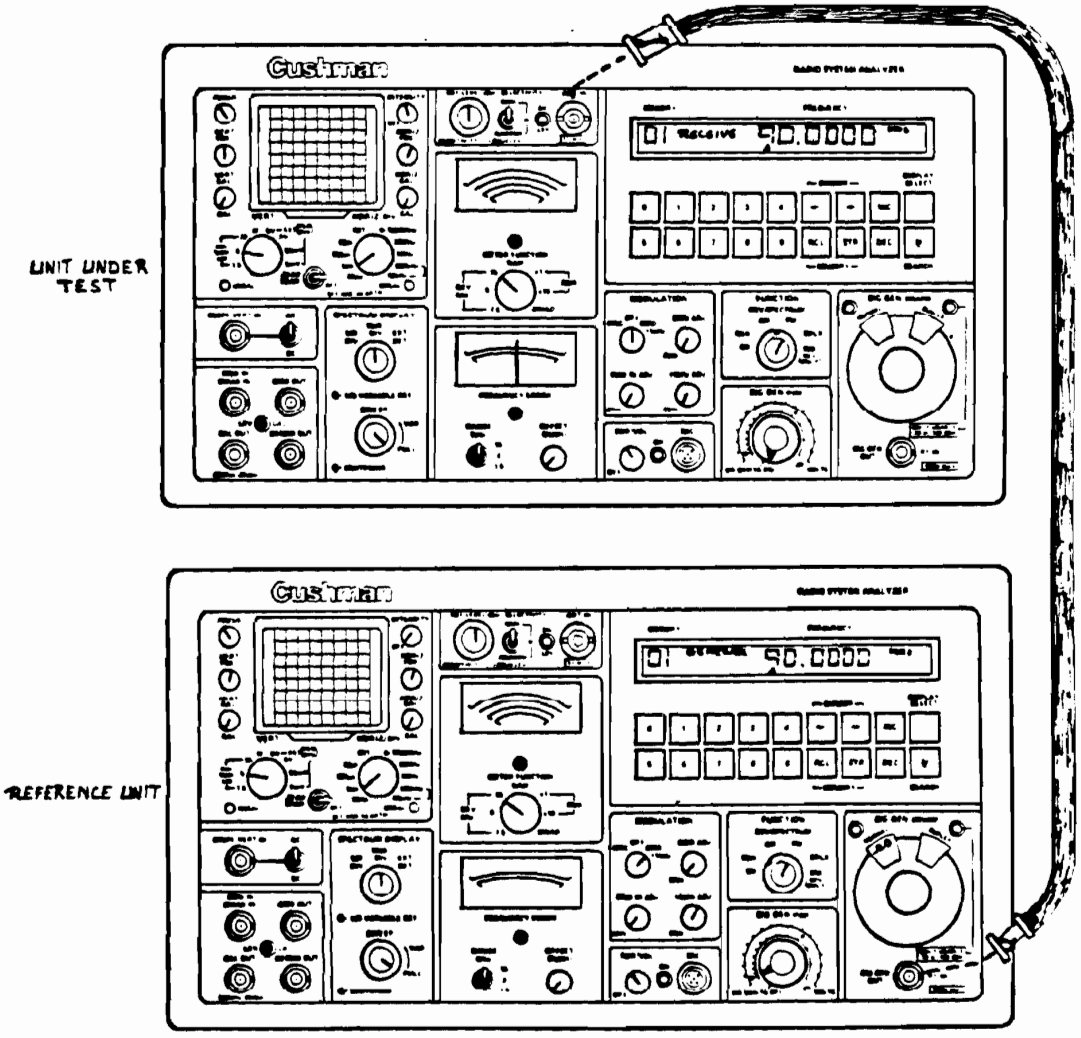


Figure 5-2. RCV/Spectrum Verification Set-Up

c. Connect a coax from the ANT IN of the CE-6000 unit under test to the testing CE-6000 SIG GEN OUT/RF IN connector (see Figure 5-2). Adjust the SQUELCH control until the SIG LEV LED just comes on.

d. The FREQUENCY ERROR meter of the CE-6000 under test should be within +/- 100 Hz error, while the FUNCTION METER shows a deviation of 5 kHz.

e. Monitor the oscilloscope of the CE-6000 under test. The signal should be a 1 kHz sine wave with a vertical amplitude to the 5 kHz deviation markings on the CRT graticule.

f. On the unit under test, move the HORIZ/DIV switch to 10 MHz/DIV. The Spectrum Display on the CRT should show a signal at CRT center rising to the -10 dB graticule line.

g. Change the HORIZ/DIV switch to 10 kHz. The signal should stay at CRT center at -10 dB, and sidebands should be seen rising 1 kHz away from the fundamental signal. All other signals should be >40 dB down from the fundamental.

h. Switch the FUNCTION switches (inner) of both the CE-6000's to AM and check the AM modulation of the CE-6000 under test.

i. If any of the tests of paragraphs c. through h. above are not correct, or cannot be performed, contact the Cushman Electronics Customer Service Department for unit repair instructions.

5.06 OFFSET GENERATOR (DUPLEX OPERATION) VERIFICATION

5.06.1 Ensure that the visual inspection procedures of paragraph 5.02 have been completed. Testing will verify operation of the CE-6000 Series equipment functions for offset generation and duplex operation.

a. On the CE-6000 to be verified (unit under test):

* Set the FUNCTION switch to DPLX/FM, and the MOD/OFF/MOD+1kHz switch to MOD.

* Enter 90.0000 MHz into the Frequency Entry display (GENERATE) memory using the 0 - 9 number keys. Enter 5.000 kHz into MOD TONE memory, and 94.0000 MHz into RECEIVE memory (refer to paragraph 4.04.1 if necessary).

* Set SIG GEN (COARSE) TO -70 dBm, and SIG GEN (FINE) to 0 dBm.

* Set SIG GEN (COARSE) TO -70 dBm, and SIG GEN (FINE) to 0 dBm.

b. On the testing (reference) CE-6000:

* Set FUNCTION switch (outer) to RCV/SPECTRUM, and inner switch to FM.

* Set SENSITIVITY switch to -40 dBm, and adjust SQUELCH until it just opens.

* Set SELECTIVITY switch for WIDE.

* Enter 94.0000 MHz into the Frequency Entry display using the 0 - 9 number keys. If necessary, refer to paragraph 4.04.1 for frequency entry.

* Set HORIZ/DIV switch to 1 MHz, and SPECTRUM DISPLAY to 10 dB/DIV.

c. Connect the SIG GEN OUT/RF IN connector of the CE-6000 unit under test to the ANT IN connector of the testing CE-6000.

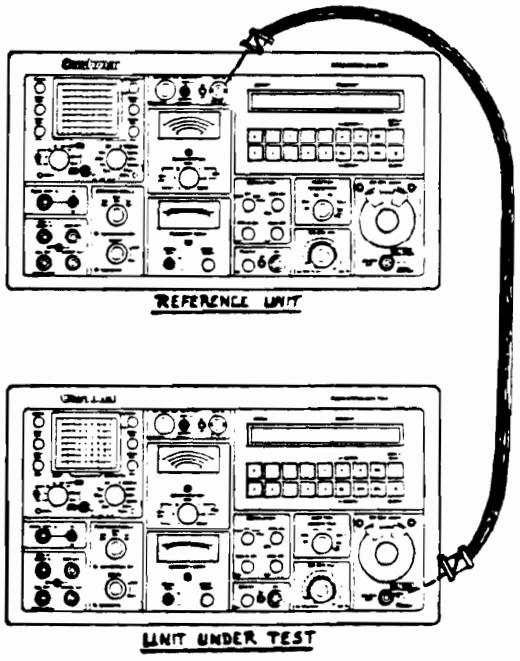


Figure 5-3. Offset Generator Function Verification

d. The testing CE-6000 should now have a spectrum display centered at 94.0000 MHz, and no higher than the -50 dB line of the CRT (-90 dBm). There should also be two sidebands (at 90.0000 MHz and 98.0000 MHz) at the -30 dB line (-70 dBm).

e. Change the testing CE-6000 frequency display to 90.0000 MHz and center the signal on the CRT with the SWEEP CENTERING control.

f. Change the HORIZ/DIV switch to 10 kHz. Observe that the GENERATE signal spectrum of the CE-6000 unit under test displays modulation sidebands of 5 kHz. Adjust the modulation output and verify the changes are made in the display.

g. If any of the Offset Generator tests cannot be performed, or are not correct, contact the Cushman Electronics Customer Service Department for unit repair instructions.

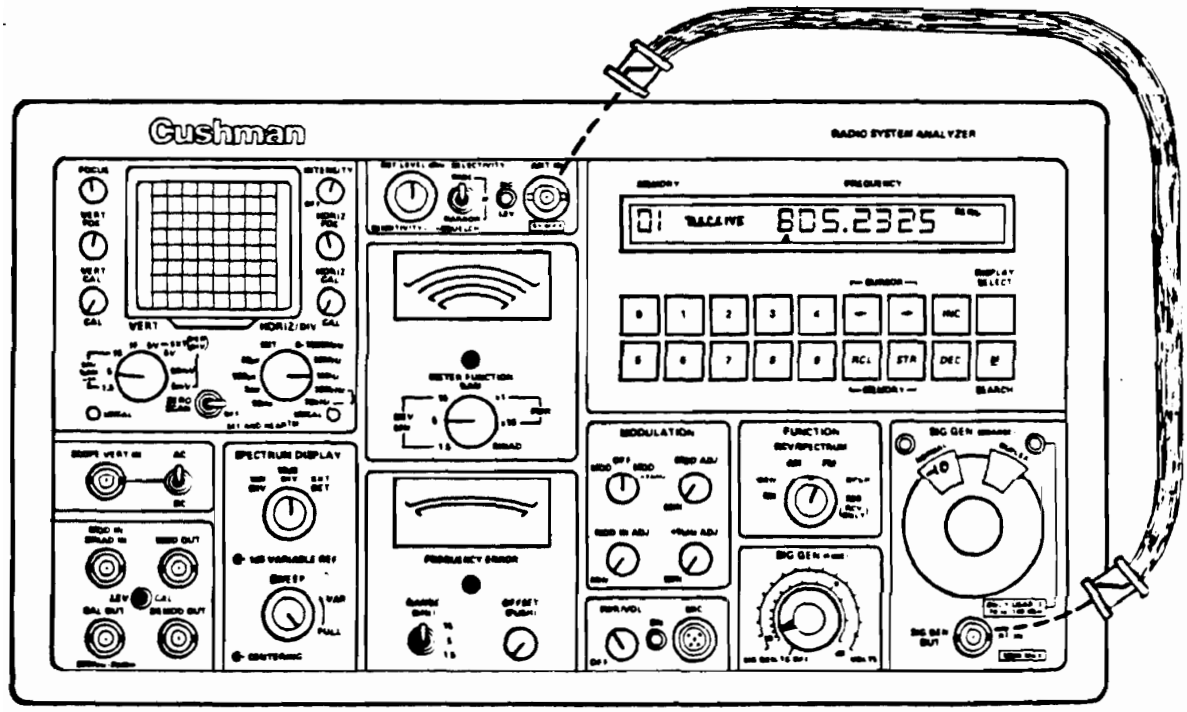


Figure 5-4. Tracking Generator Verification Set-Up

5.07 TRACKING GENERATOR VERIFICATION

5.07.1 Ensure that the visual inspection procedures of paragraph 5.02 have been completed. Testing will verify operation of the CE-6000 Series equipment Tracking Generator functions.

a. On the CE-6000 to be verified:

* Set the FUNCTION switch to RCV/SPECTRUM

* Set the HORIZ/DIV switch to 1 MHz

* Turn SENSITIVITY reference level to -20 dBm.

* Switch SPECTRUM DISPLAY to 10 dB/Div.

* Set SIG GEN (COARSE) to -10 dB, and SIG GEN (FINE) to -10 dB.

* Connect the SIG GEN OUT/RF IN connector to ANT IN as shown in Figure 5-4.

b. Adjust the SIG GEN (FINE) control to set trace to top of CRT graticule (0 dB line).

c. Increase the SIG GEN (COARSE) attenuation in -10 dB steps and verify that the trace drops down the CRT graticule by -10 dB steps, tracking the input level. Return the SIG GEN (COARSE) and SIG GEN (FINE) controls both to their -10 dB positions.

d. Change the SPECTRUM DISPLAY switch to 1 dB/DIV and adjust the 1 dB VARIABLE REF control to place the trace back to the top of the CRT graticule (the 0 dB line).

e. Change the SIG GEN (FINE) control in 1 dB steps, and verify the trace tracks the input level down the CRT graticule.

f. If any of the Tracking Generator tests cannot be performed as described, or are not correct, contact Cushman Electronics Customer Service Department for unit repair instructions.

5.08 CABLE FAULT LOCATION VERIFICATION CHECK

5.08.1 To verify operation of the Cable Fault Location function, repeat the steps of paragraph 4.12.1 with a piece of cable whose length and condition are known. Again, contact the Cushman Electronics Customer Service Department if there is any problem with the procedure, or the results are not correct.

SECTION VI - SPECIFICATIONS

Specifications for the CE-6000 Series Radio System Analyzer purchased are inserted here for reference, and are the latest release available of specifications for this product at the time of sale.

Maintenance procedures included in this manual are intended to verify system operation only, and should not be used to verify product specifications. In some instances, this requires special and laboratory type equipment not normally available in a field environment.

TABLE 6-1

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

MONITOR

FUNCTIONS
Frequency error, FM deviation, %AM, Power, SINAD, audio frequency (Lissajou), SSB

FREQUENCY
Range: 0.45 to 999.9999 MHz (usable to 50 kHz)
Accuracy: $\pm 1 \times 10^{-7} \pm$ (time base stability)

INPUTS
2 BNC connectors: high sensitivity (2uV) antenna input, and a high power input/output for direct connection of transceivers of up to 150 W transmitter power.

SENSITIVITY (NARROW SELECTIVITY)
FM: 2uV (0.6uV typical) for SINAD $\pm$10 dB; frequency $\geq$2.0 MHz
AM: 2uV typical for S/N = 10 dB; Frequency $\geq$ 10 MHz

SELECTIVITY/SQUELCH
Selects IF and audio 3 dB bandwidths: Narrow=22 kHz & 3 kHz; Medium=22 kHz & 21 kHz; Wide=220 kHz & 21 kHz
(Concentric controls adjust squelch and receiver sensitivity)

FREQUENCY ERROR METER
Zero centered meter reads offset from display frequency
Ranges: $\pm$1.5, $\pm$5, and +15 kHz
Resolution: 50 Hz

FM DEVIATION
FM peak deviation read simultaneously on meter and CRT
Ranges (meter and CRT): 1.5, 5, and 15 kHz peak
Accuracy: $\pm$5% of full scale on meter

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

AM MODULATION

% AM modulation read simultaneously on CRT display and calibrated meter.
Meter range: 0 to 100%
CRT Range: ±15%, ±50%, and ±150%
Accuracy: ±5% of meter scale

POWER METER

Range: 1W to 15W; 10W to 150W
Accuracy: ±10% full scale from 1-500 MHz; ±20% full scale from 500 - 1,000 MHz.
Frequency range: 1 - 1,000 MHz
Power handling: 150 watts for 5 minutes typical. Then thermal safety alarm sounds if load temperature reaches 25°C

SINAD METER

Range: 0 to 20 dB
Accuracy: 10, 12, and 20 dB SINAD ±1.5 dB
Frequency: 1,000 Hz

INTERNAL TONE

Connects MOD OUT to horizontal scope input to measure frequency of audio tones using Lissajou method.

FM RESIDUAL NOISE

≤100 Hz f_c ≥ 10 MHz, 20uV input, narrow selectivity

DEMOD OUT

Level: 2V peak-to-peak for 15 kHz FM deviation, typical

SIGNAL GENERATOR

FREQUENCY RANGE

.45 to 999.9999 MHz (usable to 10 kHz)

ACCURACY

FM, AM, CM: ±1 x 10^{-7} ± (time base stability)

VARIABLE FREQUENCY OFFSET

±15 kHz about dialed-in frequency with single knob control (push to activate)

LEVEL

Range: 0.1uV to 300 mV rms, continuous.
Accuracy: ±3 dB overall; ±2 dB typical for levels between 0.7uV to 100 mV.

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

MODULATION

FM Internal: Frequency, accuracy; refer to the audio synthesizer specifications.

Deviation: 1.5, 5, and 15 kHz peak deviation full scale ranges on meter and CRT.

Accuracy: ±5%

FM External Deviation:

Sine Wave: 30 Hz to 10 kHz, 15 kHz max. deviation

Square Wave: 5 Hz to 300 Hz, 3 kHz max. deviation

AM Internal: Frequency, accuracy; refer to the audio synthesizer specifications.

Range: 0 to 100% full-scale range on meter; ±15, ±50, and ±150% full-scale ranges on CRT.

AM External Frequency: 30 Hz to 10 kHz

Spurious Outputs

Harmonics (freq. ≥1 MHz): >30 dB_c (60 dB typical)

Non-harmonics: >35 dB_c (60 dB typical)

Residual FM: ≤100 Hz

SPECTRUM MONITOR

FREQUENCY RANGE

10 to 1,000 MHz (usable to 100 kHz)

DYNAMIC RANGE

+0 to -115 dB

RF ATTENUATOR

≥ 40 dB in 20 dB steps

DISPLAY RANGE

70 dB (10 dB/div.), and
8 dB (1 dB/div.)

VERTICAL OFFSET RANGE

> 20 dB (1 dB/div. only)

LOG SCALE LINEARITY

±1.5 dB from 0 to -60 dB (10 dB/div.)

±0.25 dB from 0 to 8 dB (1 dB/div.)

ABSOLUTE LEVEL ACCURACY

±4.5 dB (S/N ≥ 20 dB)

SCAN WIDTHS

Fixed: 10, 100 kHz/div.; 1, 10 MHz/div.; 0 - 1,000 MHz

Variable: 10 to > 350 MHz (for cable fault)

MINIMUM RESOLUTION

3 kHz for 2 equal signal levels

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

AUDIO SYNTHESIZER

FREQUENCY MODES
GEN: 0.1 Hz to 19,999.9 Hz
GEN + 1 kHz: Simultaneous 1 kHz tone + GEN frequency

ACCURACY
1 kHz: Time base stability

MOD OUT LEVEL RANGE
0 - 2V peak-to-peak into 1 K ohm typical. Separately adjustable controls for GEN frequency and 1 kHz tone.
Resolution: 0.1 Hz

OSCILLOSCOPE

FREQUENCY RANGE
DC to 500 kHz, 3 dB bandwidth (usable to 1 MHz)

CRT SCALE
8 divisions high x 10 divisions wide

VERTICAL SENSITIVITY (CALIBRATED)
5 mV/div., 50 mV/div., 0.5 V/div., 5.0 V/div (±5%)
Continuously adjustable between ranges

HORIZONTAL SWEEP RATE (CALIBRATED)
10 msec/div., 1 msec/div., 100 usec/div., 10 usec/div. (±5%) Continuously adjustable between ranges

EXTERNAL INPUTS
Vertical and horizontal inputs (horizontal through MOD IN connector)
Vertical input impedance: 1 megohm, ±5%, in parallel with 30 pF.

TRACKING GENERATOR (Optional for CE-6232 and CE-6488)
Swept frequency output is exactly equal to input frequency of Spectrum Monitor.

FREQUENCY RANGE
10 MHz to 999.9999 MHz (usable from 450 kHz)

SWEEP WIDTHS
Fixed: 100 kHz, 1 MHz, 10 MHz, 100 MHz, and 1,000 MHz
Variable: 10 MHz > 300 MHz

OUTPUT LEVEL
0.1 uV to 300 mV, continuous

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

OUTPUT
BNC Connector at SIG GEN OUT. Controlled by ON/OFF position on SIG GEN (FINE) attenuator control.

INTERNAL LEAKAGE
60 dB typical below 0 dB ref. on Spectrum Monitor (CRT) display, and SIG GEN (FINE) attenuator below -10 dB

DISPLAY MODE
Spectrum Monitor; External detector; oscilloscope

DISPLAY RANGE
60 dB typical on Spectrum Monitor with SIG GEN (FINE) attenuator control below -10 dB level.

DYNAMIC RANGE
>10 MHz: $\geq$ 100 dB, typical
455 kHz to 10 MHz: $\geq$70 dB, typical

OFFSET GENERATOR (Optional for CE-6020, CE-6232, CE-6488: Must be installed before option OP-08 can be incorporated). In DPLX mode, offset signal is generated simultaneously.

FREQUENCY RANGE
10 MHz to 999.9999 MHz offset from monitor receiver frequency.

FREQUENCY OFFSET
$\pm$0.10 to $\pm$11.999 MHz, and $\pm$45 MHz about the monitor frequency (Frequency > offset frequency)

RESOLUTION
1 kHz

OUTPUT LEVEL
0.1 uV to 300 mV (uncalibrated)

OUTPUT SPECTRUM
DSB suppressed carrier (2 signals of equal level above and below monitor display frequency).

CARRIER SUPPRESSION
Received frequency suppressed 20 dB min., 30 dB typical

MODULATION
AM; FM

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

IEEE-488 BUS

TRANSFER RATE: 2,500 bytes/second (Baud)

BUS MODES: Talker/Listener

BUS FUNCTIONS SUPPORTED:

Source Handshake	(SH)	Allows data transfer
Acceptor Handshake	(AH)	
Talker	(T)	Talker/Listener without
Listener	(L)	secondary addresses
Service Request	(SR)	Data available indicator
Remote/Local	(RL)	Allows controller to take over CE-6488 instrument.

INSTRUMENT BUS ADDRESS

Select resident memory location number 70; enter desired address (1-15) at CE-6488 front panel keyboard. Address is retained in memory until changed.

INSTRUMENT FUNCTIONS UNDER BUS CONTROL

Monitor	Signal Generator
Offset Generator	Audio Synthesizer

RS-232C INTERFACE BUS

TRANSFER RATE: 300 bytes/second (Baud); half duplex

BUS MODES: Talker/Listener

BUS FUNCTIONS SUPPORTED

Transmit Interrupt	(TI)	Allows data transfer
Talker	(T)	Talker/Listener without
Listener	(L)	secondary addresses.
Service Request	(SR)	Data available indicator
Remote/Local	(RL)	Allows controller to take over CE-6232 instrument

INSTRUMENT BUS ADDRESS

Select resident memory location number 70; enter desired address (1-15) at CE-6232 front panel keyboard. Address is retained in memory until changed.

INSTRUMENT FUNCTIONS UNDER BUS CONTROL

Monitor	Signal Generator
Offset Generator	Audio Synthesizer

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

GENERAL

WEIGHT
43 lbs. with top and bottom covers
38 lbs. without top and bottom covers

DIMENSIONS
Height: 8 1/4" Width: 15" Depth: 18"

POWER SOURCES
115/230 Vac (±10%), 50-400 Hz, 85 watts
External 11-15 Vdc at 7.5 amps. (Optional)
Self-contained battery pack and charger (Optional)

FREQUENCY STABILITY, TIME BASE
TCXO: 1×10^{-6} per year after 30 seconds; $\pm 3 \times 10^{-7}$ per month after 30 days.
Oven: (Optional) 2×10^{-7} per year after 25 minutes at 25°C.

FREQUENCY SELECTION
Microprocessor based, keyboard entry (with LCD display)
69 memory locations for RF and analog tone frequencies.

AUTOMATIC OVERLOAD PROTECTION
SIG GEN OUT/RF IN port automatically protected in SIG GEN mode against accidental transmitter keying for 150 watts maximum power for 5 minutes.

MICROPHONE INPUT
For optional Cushman microphone with built-in DTMF pad, or to connect Cushman's Model CE-6408 Signal Center Encoder.

TEMPERATURE OPERATING RANGE
0°C to +55°C (32°F to 131°F)

OPTIONS

OP-01: External 11-15 Vdc and Battery Pack/Charger (not available on units containing OP-07 or OP-09)

OP-02: OCXO Oven Controlled Oscillator

OP-03: Offset Generator (bus or local control. Included with the CE-6030)

OP-04: Tracking Generator (local control. Included with the CE-6020 and CE-6030)

OP-05: CE-6408 Signal Center Encoder (local control. Is included with the CE-6030)

TABLE 6-1 (cont'd)

CE-6000 SERIES RADIO SPECTRUM ANALYZER SPECIFICATIONS

OP-06: External 11 - 15 Vdc (less battery pack/charger) Not available on units containing OP-07 or OP-09.

OP-07: IEEE-488 Interface bus. Included in CE-6488 (not available for units equipped with OP-01 or OP-06.

OP-08: 150 watt Single-Cable Duplex (instrument must be equipped with OP-03)

OP-09: RS-232C Interface bus. Included in CE-6232 (not available for units containing OP-01 or OP-06).

ACCESSORIES

AK - 102	Accessory kit
1720-0002	Microphone with DTMF pad (included in AK-102)
5285-0020	Instrument mounted Accessory Pouch (recommended for CE-6408 Signal Center Encoder)
5287-0068	Fiberglass Carrying Trunk
5287-0069	Soft Protective Cover

MODEL CE-6408 SIGNAL CENTER

FREQUENCY RANGE:	
Single Tone Generator	0.1 to 3275 Hz
Multi-Frequency Tone Pairs	0.1 to 2100 Hz each
RESOLUTION	0.1 Hz
ACCURACY	$\pm$0.01%
ANALOG OUTPUT	
Wave Shape	Sinusoidal
Distortion	<1.0% at 1 kHz
Phase Jitter	$\leq 3.0^{o}$ p-p
Frequency Response (as measured at modular input)	+0.25, -1.0 dB
INTER-TONE TIMING	
Tone ON/OFF (Control and Delay Range)	0 - 64 seconds
Resolution	1 ms
Display	8 digit LCD

ADDENDUM TO CE-6000 SERIES OPTIONS

OPTION-12

CUSHMAN 6000's SIMULCAST OPTION

Frequency Error Meter has been replaced with a counter. Counter counts internal I.F. of the 6020/6030. Counter has one Hertz and 10 Hertz resolution. Zero frequency error is 30000 Hz and will display error from this frequency.

In addition, a digital Deviation Meter is installed below the Frequency Error Counter. This Deviation Meter measures the deviation of tone signal and is calibrated in dB. 0 dB is set at 1 kHz deviation.*

The Offset (push) Control and the Range (kHz) Switch are removed and no longer used. OP-02 also is installed with OP-12.

*As per Quintron Electronics specifications

SECTION VII

SIGNAL CENTER UNIVERSAL ENCODER

(OPTIONAL) MODEL CE-6408

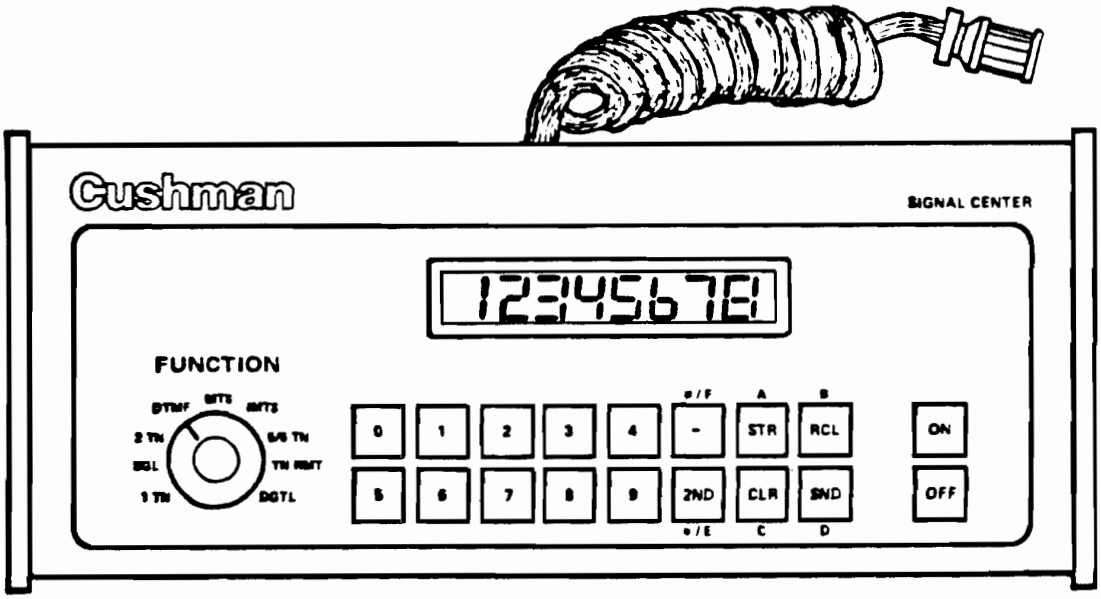


Figure 7-1. Cushman Model CE-6408 Signal Center

DESCRIPTION

7.0 The Cushman Model CE-6408 Signal Center is a dual microprocessor-controlled universal encoder that can generate tone and digital formats used for selective signalling over voice-grade communications channels. The front panel FUNCTION switch provides eight of the most common analog tone signalling formats (1 tone, two tone, single tone, DTMF, MTS, IMTS, 5/6 TONE, and tone remote), plus a digital position which allows the selection of digital-coded squelch (CDCSS), and POCSAG, NEC, and Motorola GOLAY digital pager address/display codes when the proper mode number is entered.

7.1 Each function selected generates a specific sequence of tones and data from a preprogrammed set of parameters stored in the CE-6408 memory. Or the user can reprogram the memory parameters for special purpose signalling requirements.

7.2 The Model CE-6408 Signal Center is standard with the Cushman CE-6030 Series 6000 Radio System Analyzer, and optionally available for the CE-6020, CE-6488, and CE-6232 units.

TABLE 7-1. MODEL CE-6408 CONTROLS and INDICATORS

NUMBER	CONTROL	FUNCTION
1	LCD Display	An 8-digit liquid crystal display (LCD). Displays selected register contents, or a selected tone sequence which is to be generated.
2	OFF/ON	Power ON/OFF switch for CE-6408.
3	Function	Switch positions select the following functions (signal level is controlled by adjusting the CE-6000 unit MOD IN ADJ): 1 TN - Provides continuous tone from .1 Hz to 3275 Hz. For generating CTCSS and other in-band tones. SGL - Single Tone 2805 Hz at 10 pps standard programming. Can be used for any single interrupted or continuous tone formats. 2 TN - Provides two-tone paging formats (standard and programmable). User can program frequencies for first and second tones, tone durations, inter-tone gap time, number of repeats, and delay time between repeated sequences. DTMF - Dual Tone Multi-Frequency format which is preprogrammed, but can be user programmed to other dual-tone pairs. MTS - (Mobile Telephone System). Format used for mobile telephone testing. IMTS - Improved Mobile TelephoneSystem. For mobile telephone testing. 5/6 TN - Provides all standard EIA 5 and 6 tone pager signalling formats, including preamble and dual address sequences. TN RMT - Provides the standard sequence to generate base station control and function tones necessary to fully emulate control point signalling. DGTL - Provides DPL, Motorola Golay, NEC and POCSAG digital paging formats when the proper mode number is selected.

TABLE 7-1. MODEL CE-6408 CONTROLS and INDICATORS (cont'd)

NUMBER	CONTROL	FUNCTION
4	Keyboard	Pushbutton switches to store (STO), recall (RCL), clear (CLR), and send (SND) selectively displayed tone sequences.
5	Microphone	Connector to allow microphone to be used simultaneously with Signal Center to test voice modulation.

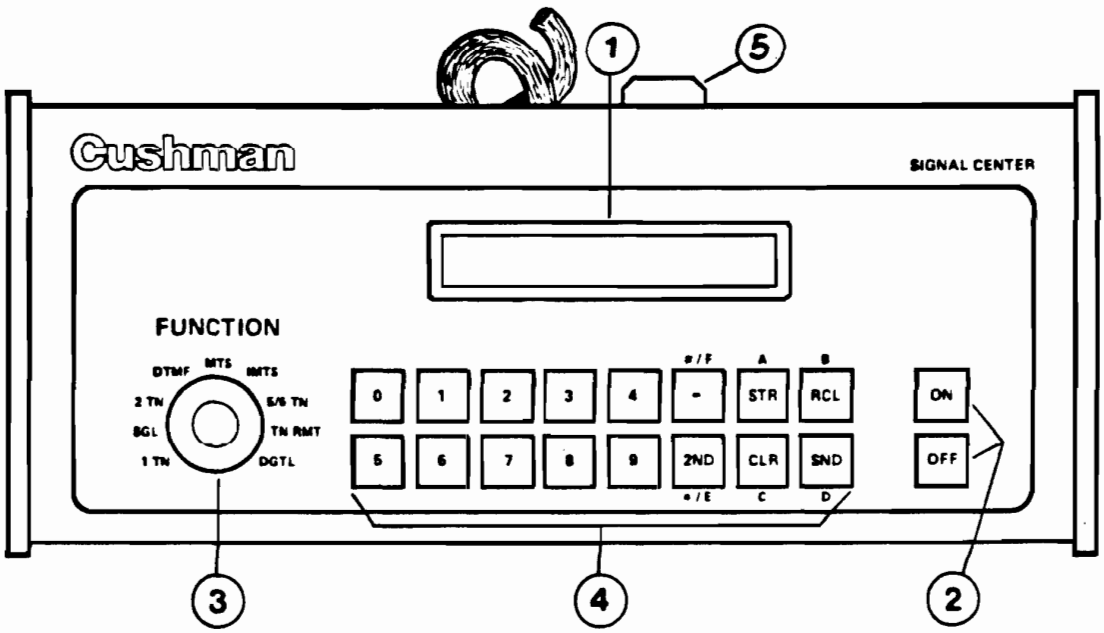


Figure 7-2. Model CE-6408 Signal Center Controls and Indicators

OPERATION

7.3 This section provides information for installing and operating the Model CE-6408 Signal Center with the Cushman CE-6000 Series Radio System Analyzer.

POWER-ON AND CHECKOUT

7.4 To turn on power and check out the Model CE-6408, perform the following:

a. Connect the CE-6408 Signal Center to the CE-6000 Series Radio System Analyzer MIC connector. (Note: a second microphone jack is supplied with the CE-6408 Signal Center if a microphone and signal encoding are needed simultaneously.

b. Press the ON key and observe the display for "CE6408d". If nothing appears, check the 1/4 Amp fuse in the rear panel fuse holder.

c. Set the FUNCTION switch to any one of the nine functions available.

d. Turn the FUNCTION switch to a different function; the display should now show only a single zero.

e. To control the level of the signal, adjust the CE-6000 Series Radio System Analyzer *MOD IN ADJ* control as required.

7.5 Verify that all of the keyboard keys are operational by performing the following tests:

a. Enter the digits "1" through "8" by pressing each of the corresponding digit keys on the keyboard. As each key is pressed its corresponding number should be entered into the display. The display should now read "1 2 3 4 5 6 7 8".

b. Press the CLR key to clear the display. Note that the display again shows a single zero.

c. Enter the digits "9" and "0" by pressing the corresponding keys. Then enter the DTMF digits (2nd) A, (2nd) B, (2nd) C, and (2nd) D by first pressing the "2nd" key (to select the key's second function) followed by the STO/A, RCL/B, CLR/C, and SND/D keys (respectively). The display should now read "9 0 A B C D".

d. Enter the DTMF characters "2nd *" and "2nd #" by pressing the "2nd /*" key two times for the "*" character, and then the "2nd" key followed by the "./#" key for the "#" character.Since the "2nd *" is displayed as "E", and the "2nd #" as "F", the display should now read "9 0 A B C D E F".

KEYBOARD BASICS

7.6 The following paragraphs describe in detail the use of the keyboard function keys.

7.6.1 The CE-6408 keyboard contains 16 operation keys. However, to fully utilize the power of the Model CE-6408 Signal Center, it is necessary to be able to enter 22 different operations - either data or commands. This means that 6 keys must perform more than one function. The six dual function keys are listed with their functions in Table 7-2.

a. To use the first function associated with a key, just press that key.

b. To use the second (2nd) function, press the "2nd" key followed by the key corresponding to the function desired. Refer to paragraphs 7.5 (c.) and (d.) above.

TABLE 7-2. DUAL FUNCTION KEYS

DUAL FUNCTION KEY	FIRST FUNCTION	SECOND FUNCTION
STO/A	STO - Store display data in a register.	Enter "A" character
RCL/B	RCL - Recall and display register contents.	Enter "B" character
CLR/C	CLR - Clear LCD display	Enter "C" character
SND/D	SND - Send sequence	Enter "D" character
2nd/*	2nd - Select 2nd function for next key pressed.	Enter "*" character Displayed as "E".
./#	. - Enter decimal point	Enter "#" character Displayed as "F".

ERROR MESSAGES

7.7 The message "ERROR - - - - " indicates that one of the following types of invalid keyboard operations was performed:

a. Attempt to store (STO) or recall (RCL) a function register that does not exist.

b. Sending a sequence (SND) before the cap-code or dialed digit information has been entered (for 5/6 tone and IMTS, Mode 2).

c. Storing a number (STO) that is larger than that allowed for frequency and timing parameters.

7.8 If an error message is displayed, press the CLR key and then enter the correct information.

PREPROGRAMMED FREQUENCY AND TIMING PARAMETERS

7.9 Each function that the Model CE-6408 is capable of generating has from 1 to 16 memory locations associated with it. Each memory location or register is designated by a number from 0 - 9, or the letters A, B, C, D, or the characters "*" or "#" (displayed as "E" and "F", respectively). The registers hold frequency and timing information to be used by the particular function selected when a sequence is generated. Each time the Model 6408 Signal Center is turned on, all registers are preprogrammed with the frequency and timing parameters most often used with each function. Refer to TABLE 7-3.

DISPLAYING PARAMETERS - RCL KEY

7.10 To display a register's contents for a particular function, first set the FUNCTION switch to that function. Then, using TABLE 7-3, determine the register number for the desired parameter. To display the parameter value, press the RCL key, followed by the key corresponding to the register number. The display will now show the register number (in the farthest left digit position), followed by the value stored in that register. If the register holds frequency information, a decimal point will also be displayed. Otherwise, the register holds timing or miscellaneous information which has no decimal point.

7.11 All frequency information is displayed in Hz with a resolution of 0.1 Hz. Timing information is displayed in milliseconds (ms), with a resolution of 1 ms. Therefore, one second will be displayed as "R 1000", where "R" is the register number.

TABLE 7-3. PREPROGRAMMED PARAMETERS

MANUAL SECTION	FUNCTION	DESCRIPTION	REGISTER NUMBER	PROGRAMMED VALUE
7.15	DTMF	Mode Number	0	0
		Tone On Time	1	100 ms
		Tone Off Time	2	100 ms
		MF Row Frequencies	3-6	0.0 Hz
		MF Column Frequencies	7-A	0.0 Hz
7.20	MTS	Frequency 1	1	600.0 Hz
		Frequency 2	2	1500.0 Hz
		Dial Pulse Width	3	100 ms
		Interdigit Time	4	500 ms
7.22	IMTS	Mode Number	0	1
		Idle Tone Frequency	1	2000.0 Hz
		Seize Tone Frequency	2	1800.0 Hz
		Dial Pulse-Break Time	3	50 ms
		Dial Pulse-Make Time	4	50 ms
		Interdigit Time	5	250 ms
		Delay Time before ANI	6	500 ms
7.26	ITN	Single Tone	-	0 Hz
7.27	SGL	Tone Frequency	1	2805.0 Hz
		Dial Pulse-Break Time	2	50 ms
		Dial Pulse-Make Time	3	50 ms
		Interdigit Time	4	250 ms
7.39	DGTL	Mode Number 0	0	134 Hz
		Mode Number 1	0	DPL
		Mode Number 2	0	MOT GOLAY
		Mode Number 3	0	NEC
		Mode Number 4	0	POCSAG
		Mode Number 0	1	NORMAL
		Mode Number 1	1	INVERTED CODE
		Mode Number 0	2	SEND ONCE
		Mode Number 1	2	SEND REPEATEDLY
7.28	2 TN	Number of 2-Tone Cycles	0	1
		First Tone Frequency	1	1000.0 Hz
		Second Tone Frequency	2	500.0 Hz
		First Tone On Time	3	1000 ms
		Intertone Gap Time	4	250 ms
		Second Tone On Time	5	2500 ms
		Delay Time Until Repeat	6	2000 ms

TABLE 7-3. PREPROGRAMMED PARAMETERS (cont'd)

MANUAL SECTION	FUNCTION	DESCRIPTION	REGISTER NUMBER	PROGRAMMED VALUE
7.31	5/6 TN	Digit 0 Frequency	0	600.0 Hz
		Digit 1 Frequency	1	741.0 Hz
		Digit 2 Frequency	2	882.0 Hz
		Digit 3 Frequency	3	1023.0 Hz
		Digit 4 Frequency	4	1164.0 Hz
		Digit 5 Frequency	5	1305.0 Hz
		Digit 6 Frequency	6	1446.0 Hz
		Digit 7 Frequency	7	1587.0 Hz
		Digit 8 Frequency	8	1728.0 Hz
		Digit 9 Frequency	9	1869.0 Hz
		Preamble On Time	A	633 ms
		Preamble Tone Frequency	B	600.0 Hz
		Digit Tone On Time	C	33 ms
		Dual Address Tone Freq.	D	2010.0 Hz
		Repeat Tone Frequency	* (E)	459.0 Hz
7.37	TN RMT	Guard Tone Frequency	0	2175.0 Hz
		Function Tone Frequency	1	1950.0 Hz
		High Level Guard Tone Burst Time	2	125 ms
		Function Tone Burst Time	3	40 ms

MODIFYING REGISTER INFORMATION - STO KEY

7.12 Any of the parameters stored in the registers listed in TABLE 7-3 can be modified by the following procedures:

a. Select the particular function to be modified.

b. Enter the new value of the parameter, using the keyboard, into the LCD display. If necessary, use the CLR key to clear mistakes and then enter the correct information.

NOTE

The CLR key clears the display only, and not the contents of the register. Register contents can only be modified by the STO (store) function.

c. With the desired information to be stored now displayed, press the STO key, followed by the key corresponding to the desired register number. The left-most digit of the display will now indicate the register in which the information was stored.

7.13 The following rules apply to storing data in registers:

a. If an attempt is made to store data in a register that does not exist for the function selected, the error message will be displayed.

b. Frequency information may not exceed 3275 Hz, and timing information may not exceed 64,000 ms (64 seconds).

c. Frequency information may be programmed with a resolution of 0.1 Hz. If a decimal point is not entered, it will be assumed to be located to the right of the last digit entered. If a decimal point is entered, then only one additional digit will be accepted.

EXAMPLE

TABLE 7-3 lists the single (SGL) tone frequency as 2805 Hz, and it is stored in register 1 under that (SGL) function. To modify it to generate a 2700 Hz tone instead, select the SGL function on the FUNCTION switch, and press the "2", "7", "0", and "0" (again) keys on the CE-6408 keyboard. Then press the "STO" and "1" keys. The display should now read "1 2700", and the Model CE-6408 should now be generating a 2700 Hz tone.

DIALED DIGIT OUTPULSING

7.14 Dialed digits may be outpulsed in a group of from 1 to 8 digits, or outpulsed individually (one at a time) for the DTMF, MTS, IMTS, and SGL functions.

a. To outpulse digits individually, first clear the display. Press the SND key and wait for the "-" (dash) to be displayed. Then, enter the digit to be outpulsed. A dash will again be displayed when the CE-6408 has completed outpulsing the digit. As soon as the dash appears, the unit is ready to accept another digit for outpulsing.

b. To outpulse groups of digits, first clear the display and then enter the group of digits. The first digit to be outpulsed is entered first. Then press the SND key to start the outpulsing, which outpulses the left most digit of the display first. The dash will again be displayed when all of the digits in the group are outpulsed. Once the dash is displayed, the user may press the RCL key (do not enter a register number) to recall the last group of digits outpulsed back into the display to be outpulsed once again by pressing the SND key. Or a new group of digits may be outpulsed, if desired, by entering the individual digits as before and again pressing the SND key.

USING THE MODEL CE-6408 SIGNAL CENTER FUNCTIONS

DTMF FUNCTION

7.15 The DTMF function is used to generate any of the standard tone pairs associated with the 16 DTMF digits using Mode 0, as well as custom user defined Multi-Frequency (MF) tone pairs using Mode 1. There are 11 registers associated with the DTMF function. The first 3 registers are preprogrammed with parameters on power-up, and are listed in TABLE 7-3 with their preprogrammed values. Registers 3 through A, which are used in Mode 1 only, contain all zeroes and must be programmed by the user with row and column frequency information.

7.16 The DTMF digits may be sent (outpulsed) as a group or individually. The rate at which the digits are sent depends on the information stored in registers 1 and 2. Each time a digit is outpulsed, the tone pair corresponding to the digit entered is generated for the amount of time specified in register 1, followed by a gap of no tone for the amount of time specified in register 2.

7.17 To select the standard DTMF tone pair frequencies, enter a zero in register 0 (i.e., select Mode 0). Registers 3 through A are not used in Mode 0, therefore the frequency information stored in these registers has no effect on the tone pair frequencies for standard DTMF generation.

7.18 To generate custom MF tone pairs, first store a 1 in register 0 (R0) to select the bank of user frequencies stored in registers 3 - A (R3 - RA). Then, program row frequencies in registers 3 - 6 (R3 - R6), and column frequencies in registers 7 - A (R7 - RA). The following TABLE 7-4 shows the relationship between the keyboard digits and the row and column frequency registers.

TABLE 7-4

(ROW)	R7	R8	R9	RA
R3	7	8	9	A
R4	4	5	6	B
R5	1	2	3	C
R6	*	0	#	D

(COLUMN)

7.19 The tone pair frequencies for a particular digit corresponds to the frequency stored in the two (row and column) registers associated with the digit in the above matrix. For example, the frequency pair associated with the digit 6 in the above matrix are the frequencies stored in R4 (the row) and R9 (the column) registers. NOTE: The largest frequency that may be generated in this mode is 2100.0 Hz.

EXAMPLE

Generate 2+2 signalling consisting of a 1500/800 Hz tone pair for 1 second, followed by a 900/750 Hz tone pair for 1 second.

STEP 1: Using the digit 1 for the first tone pair, and 5 for the second pair, (other digits could be used) we can determine that the row and column registers associated with digit 1 are (respectively) R5 and R7. Likewise, the registers associated with digit 5 are (respectively) R4 and R8.

STEP 2: Program the frequencies for digit 1 (the first tone pair) by storing 1500.0 in register R5 and 800.0 in R7.

STEP 3: Program the frequencies for digit 5 (the second tone pair) by storing 900.0 in register R4 and 750.0 in R8.

STEP 4: Program the tone duration times by storing 1000 in register R1 (1000 ms = 1 second), and the tone off time by storing 0 in R2 (no time between tones).

STEP 5: Generate the tone sequence by entering digits 1 and 5 into the CE-6408 and pressing SND. To send the same tone sequence again, press RCL and SND.

STEP 6: To send different frequencies, repeat STEPS 1 - 5 and enter the new frequencies instead of the frequencies of STEPS 2 and 3.

MTS (MOBILE TELEPHONE SYSTEM) FUNCTION

7.20 The MTS function is used to generate Mobile Telephone Service (MTS) 600/1500 Hz signalling at 10 pps. However, in this function the Model CE-6408 Signal Center is not limited to generating only the standard frequencies and timing associated with MTS. The user may change the two frequencies used, as well as the outpulsing rate. The MTS digits may be outpulsed in a group or individually. Table 7-5 is a list of the four registers associated with MTS signalling and their preprogrammed values.

TABLE 7-5

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Frequency 1	1	600.0 Hz
Frequency 2	2	1500.0 Hz
Dial Pulse Width	3	100 ms (10 pps)
Interdigit Time	4	500 ms

7.21 In the MTS function, pressing the SND key causes a clearing pulse to be generated before the digits in the display are outpulsed. The clearing pulse consists of 710 ms of frequency 1, followed by 710 ms of frequency 2. Each digit is separated by the interdigit time stored in register 4 (R4).

IMTS (IMPROVED MOBILE TELEPHONE SYSTEM)

7.22 This function is used to generate IMTS base-to-mobile, mobile-to-base, and general purpose FSK signalling. The type of signalling generated depends on the information stored in the 7 registers associated with the IMTS function. Table 7-6 lists these 7 registers and their preprogrammed values.

TABLE 7-6

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Mode Number	0	1
Idle Tone Frequency	1	2000.0 Hz
Seize Tone Frequency	2	1800.0 Hz
Dial Pulse-Break Time	3	50 ms
Dial Pulse-Make Time	4	50 ms
Interdigit Time	5	250 ms
Delay Time Before ANI	6	500 ms

7.23 The number stored in register 0 (R0) determines which type of signalling the CE-6408 Signal Center is to generate. For IMTS base-to-mobile signalling, a 1 must be stored in R0. Then, registers 2 through 5 determine the frequency and timing of the digits to be outpulsed. Also, the user can change these parameters to generate custom FSK type signalling. For IMTS mobile-to-base signalling, a 2 must be stored in R0. Using this mode, the user can either originate a call to an IMTS terminal or simulate a mobile's response to a call from an IMTS terminal. Registers 2 through 5 are not used in IMTS mode 2.

7.24 Since the Model CE-6408 Signal Center does not decode signalling from the IMTS terminal, it can't know when the terminal is ready to accept the mobile's ANI digits. To ensure that ANI is not sent before the terminal is ready, it is delayed before sending by the time stored in register 6 (R6).

7.25 There are two modes of IMTS operation on the CE-6408. Mode 1 is for base-to-mobile signalling, and Mode 2 is for mobile-to-base signalling.

Base-to-Mobile (Mode 1)

7.25.1 In IMTS Mode 1, the CE-6408 Signal Center will initially generate idle tone when the function is selected. To signal an IMTS mobile, enter the mobile's ANI digits (from 1 - 8) and press the SND

key. The ANI digits will then be outpulsed according to the timing parameters stored in R3 - R5. After all the digits have been outpulsed, a dash will be displayed. The user may then do one of the following:

a. Enter additional digits to be outpulsed, one at a time. Enter zeroes to simulate ringing to the mobile.

b. Press the RCL key to return to sending idle tone and recall the last ANI sent.

c. Press the CLR key to return to sending idle tone and clear the display.

Mobile-to-Base (Mode 2)

7.25.2 IMTS Mode 2 is used for testing the operation of IMTS Central Office terminal equipment. In this mode, the CE-6408 Signal Center may be used to simulate a call from an IMTS mobile or to simulate the mobile's response to a terminal originated call. In IMTS Mode 2, three of the keyboard keys take on a special meaning, as described below:

KEYBOARD DIGIT	NEW FUNCTION
2ND *	Send Acknowledge Tone
2nd #	Send Answer Tone
2nd D	Send Disconnect Tones

7.25.3 To simulate a call from a mobile to an IMTS terminal, a 2 must be stored in the register 0 (R0) of the IMTS function (must be in Mode 2). Enter the mobile unit's ANI digits (from 1 - 8 digits). While the digits are displayed, press the SND key. The CE-6408 Signal Center will generate a connect sequence, delay (wait) for the amount of time stored in R6, and then send the ANI which was displayed at 20pps (with parity).

7.25.4 When all the ANI digits have been outpulsed, a dash will be displayed. At this time, the user may simulate IMTS mobile dial pulsing by entering each digit, one at a time. Each time a digit is entered, it will be outpulsed and the dash again displayed to indicate that the CE-6408 is ready to accept the next digit.

7.25.5 While the dash is displayed, the user may (instead of simulating dial pulsing) press the RCL key to recall the last ANI sent. Or mobile disconnect signalling can be sent by entering the 2nd D character. After the disconnect tones are sent, the display will automatically recall the last ANI sent.

7.25.6 To simulate a mobile's response to an IMTS terminal call, first clear the display. When the IMTS terminal completes base-to-mobile signalling, send the mobile acknowledgement tone by entering the 2nd * character. Then press the 2nd # key to simulate mobile answer. Press the 2nd D key to send disconnect.

1TN (CONTINUOUS TONE)

7.26 To generate a CTSS, or continuous tone, select 1TN on the FUNCTION switch. Enter the desired frequency into the CE-6408 Signal Center display and press the SND key.

SGL (SINGLE FUNCTION)

7.27 The SGL (Single) function may be used for generating single tones (i.e., CTCSS tones), but is primarily used for single-tone interrupted signalling. Single-tone interrupted digits may be outpulsed in a group or individually. There are 4 registers associated with the SGL function, and they are listed with their preprogrammed values in Table 7-7.

TABLE 7-7

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Tone Frequency	1	2805.0 Hz
Dial Pulse-Break Time	2	50 ms
Dial Pulse-Make Time	3	50 ms
Interdigit Time	4	250 ms

7.27.1 When the SGL function is selected, a tone is generated at the frequency stored in register R1. To change the frequency, first clear the display, enter the new tone frequency, then press the STO and 1 keys. The CE-6408 Signal Center will now generate the new frequency being displayed.

2 TN (TWO - TONE FUNCTION)

7.28 The 2 TN (Two-Tone) function has 7 registers, and can generate 2-Tone sequential signalling. The registers and their preprogrammed values are listed in Table 7-8.

TABLE 7-8

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Number of 2-Tone Cycles	0	1
First Tone Frequency	1	1000.0 Hz
Second Tone Frequency	2	500.0 Hz
First Tone On Time	3	1000 ms
Intertone Gap Time	4	250 ms
Second Tone On Time	5	2500 ms
Delay Time Before Repeat	6	2000 ms

7.29 To send a Two-Tone sequence, first store the desired first and second tone frequencies in registers R1 and R2 (respectively). Press the SND key to generate the tone sequence according to the timing parameters stored in registers R3 - R5. If more than one sequence is to be generated, store the total number of cycles in R0 and the delay time between sequences in R6. Then press the SND key to start the cycle.

7.30 While the first tone is being generated, the display will read " 1". During the intertone gap, the display will be " 1-", and during the generation of the second tone, it displays " 1-2". If the value stored in R6 is greater than 1, the display will read " 1-2-" during the repeat delay period.

5/6 TONE FUNCTION

7.31 The 5/6 Tone function can generate sequences of froml to 8 tone bursts. There are 15 registers associated with the 5/6 Tone function, and they are listed in Table 7-9 with their preprogrammed values.

TABLE 7-9

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Digit 0 Frequency	0	600.0 Hz
Digit 1 Frequency	1	741.0 Hz
Digit 2 Frequency	2	882.0 Hz
Digit 3 Frequency	3	1023.0 Hz
Digit 4 Frequency	4	1164.0 Hz
Digit 5 Frequency	5	1305.0 Hz
Digit 6 Frequency	6	1446.0 Hz
Digit 7 Frequency	7	1587.0 Hz
Digit 8 Frequency	8	1728.0 Hz
Digit 9 Frequency	9	1869.0 Hz
Preamble On Time	A	633 ms
Preamble Tone Frequency	B	600.0 Hz
Digit Tone On Time	C	33 ms
Dual Address Tone Frequency	D	2010.0 Hz
Repeat Tone Frequency	* (E)	459.0 Hz

7.32 In the 5/6 Tone code plan, each digit in the cap-code of the pager represents a specific tone frequency. In the CE-6408 Signal Center, these digits (0 - 9) also correspond to the registers in which the decimal digits frequency is stored. Therefore, the tone frequencies sent are those stored in the registers corresponding to the cap-code.

NOTE

If the cap-code consists of 2 or more identical digits in a row, the code plan resumes, but the repeat tone frequency stored in R * will be automatically sent in place of the digits entered.

7.33 To signal a 5-Tone pager, simply enter the pager's five digit cap-code, as is, and press the SND key.

7.34 To signal the pager dual address, enter the same five digit cap-code, followed by 2nd D. Press the SND key.

7.35 To send a preamble tone before the address signalling, first press the 2nd B key. Then enter the five digit cap-code (i.e., the cap-code less the preamble digit). If a dual address is desired, now press the 2nd D key. Finally, to send the entire sequence, press the SND key.

NOTE

The preamble register (RB) must be programmed with the preamble frequency being used.

7.36 To program the preamble frequency in register RB, first determine the preamble digit from the cap-code. Then, use the CE-6408 Signal Center to determine the corresponding frequency for this digit by pressing the RCL key, followed by "P" (where P is the preamble digit). Then, while the frequency is being displayed, press STO and 2nd B to program the register RB with the preamble frequency to be generated.

TN RMT (TONE REMOTE) FUNCTION

7.37 The TN RMT function generates the tone sequence used in tone remote control of base station equipment. The TN RMT sequence consists of a burst of high-level guard tone (at 0 dBr), followed by a burst of function tone (also at 0 dBr),which is followed by low-level guard tone (-20 dBr transmit hold tone). There are 4 registers associated with the TN RMT function, and they are listed with their preprogrammed values in Table 7-10.

TABLE 7-10

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Guard Tone Frequency	0	2175.0 Hz
Function Tone Frequency	1	1950.0 Hz
High-Level Tone Burst Time	2	125 ms
Function Tone Burst Time	3	40 ms

7.38 To start the tone control sequence, press the SND key. The display will read " 1" while the high-level guard tone is being generated, followed by " 12" while the function tone is generated, followed by " 12-" while the low-level guard tone is generated.

NOTE

Low-level guard tone will continue to be sent until the CLR key is pressed.

DGTL (DIGITAL) FUNCTION

7.39 The DGTL (Digital) function allows the user to generate non-return-to-zero (NRZ) data sequences. The data sequence generated corresponds to the mode number stored in register 0 (R0) of the DGTL function. Table 7-11 contains a list of data sequences available:

TABLE 7-11

MODE #	DESCRIPTION
0	134 Hz Test Signal
1	Digital Coded Squelch (DCS) (continuous 23-bit word)
2	GOLAY Digital Display
3	NEC Digital Display
4	POCSAC Digital Display

7.40 Operation of each of the DGTL Modes is described in the following paragraphs.

134 Hz Test and Digital Coded Squelch (DCS)

7.40.1 Both Modes 0 and 1 are associated with testing DCS systems such as those manufactured by Motorola, E.F. Johnson, and Ferritronics. Mode 0 generates a test signal useful in setting an FM signal generator (if used) deviation. Mode 1 allows the user to generate actual 23-bit DCS data by simply entering the 3-digit octal DCS code.

7.40.2 Polarity control register (R1) determines if data is to be sent non-inverted (register R1 = 0), or inverted (R1 = 1). Normally, a 0 is automatically inserted.

7.40.3 Repeat register (R2) will send the bit stream repeatedly if there is a 1 in the register. Normally, a 0 (send once) is automatically stored in the register.

NOTE

A logical "1" in the bit stream will cause the carrier to shift in a positive direction (above 0) and logical "0" will cause it to shift negative (below 0) in a NRZ (Non-Return to Zero) system.

7.40.4 MODE 0 - The digital (NRZ) output may be input to an FM signal generator, or directly connected to the digital input of the DCS board under test. If a signal generator is used, the Mode 0 function (set by storing a 0 in R0) must be used first to set the proper FM deviation. Use the following procedure to set the signal generator deviation:

a. Select the UNIV function, and make sure that a 0 is stored in R0.

b. Press the SND key to generate the 134 Hz test signal.

c. Adjust the FM deviation to ±0.5 - ±1.0 kHz as viewed on CRT.

d. Press the CLR key to stop generation of the test signal.

NOTE

The keyboard will be locked (except for the CLR key) while the CE-6408 Signal Center is generating continuous data sequences. To halt data generation, and unlock the keyboard, either press the CLR key, or select another function.

7.40.5 MODE 1 - The following procedure is used to generate DCS data (i.e., a continuous sequence of the 23-bit code word).

a. Select the DGTL function, and make sure that a 1 is stored in R0 (to select Mode 1).

b. Enter the 3-digit octal DCS code number.

c. To send noninverted data, just press the SND key. To send inverted data, first enter a decimal point and then press the SND key.

d. To halt data generation, press the CLR key or select another function. Either of these actions will cause the CE-6408 Signal Center to send a 180 ms burst of 134 Hz turn-off code and then halt data generation.

NOTE

An error message indicates that either a digit in the DCS code was larger than 7, or more (or less) than 3 digits were entered for the code number.

7.40.6 MODE 2 - The Motorola GCS Paging Format is used with display pagers. To access display pagers, the user must enter 8 digits: 6 digits for the address, 1 digit for the function to be activated, and 1 digit to select tone only, tone/display, or tone/voice. The following procedure is used to signal Motorola digital pagers:

a. Rotate the function selector to DGTL.

b. Use Mode 0 to set the proper signal generator modulation deviation.

c. Store a 2 in register R0 to select Mode 2 (the Motorola Digital Paging Formats).

d. Enter the pager's 6 digit address

e. Enter the desired pager function code. See the Motorola Maintenance Manual for the pager under test.

Function Code	Output Address Format
1	W1 W2
2	W1 W2
3	W1 W2
4	W1 W2

f. Enter the Mode number:

Mode #	Type of Page
1	Tone only
2	Tone/Display
3	Tone/Voice

g. Press SND each time the page is to be transmitted.

7.40.7 MODE 3 - To test the NEC Display, proceed as follows:

a. Rotate the function selector to DGTL.

b. Use Mode 0 to set the proper signal generator modulation deviation.

c. Store a 3 in register R0 to select Mode 3 (NEC Display)

d. Enter the synchronization code digit (i.e., 1, 2, 3, or 4). The standard system uses a 1.

e. Enter the pager's 6 digit address.

f. Press SND each time the page is to be transmitted.

NOTE

The preprogrammed display message "8003434084" is sent to the pager.

7.40.8 MODE 4 - POCSAG is tested as follows:

a. Rotate the function selector to DGTL.

b. Use MODE 0 to set the proper signal generator modulation deviation.

c. Store a 4 in register R0 to select Mode 4 (POCSAG)

d. Enter the desired function code digit, 0, 1, 2, or 3 for their respective functions 1, 2, 3, or 4.

e. Enter the 6 digit (or last 6 of 7 digits) pager code.

f. Press SND each time the page is to be transmitted.

NOTE

The preprogrammed display message "48 43CCCCC" is sent to the pager.

SECTION VIII

SPECTRUM 6000 SERIES RADIO SYSTEM ANALYZER CE-6488 OPTION

GENERAL DESCRIPTION

8.1 The CE-6488 option for the Series 6000 Radio System Analyzer incorporates microprocessor based local control of the instrumentfor bench or on-site use, while providing an IEEE-488 bus operating system to allow the addition of a controller and peripherals for ease of radio testing.

8.2 By incorporating a computer as the controller for the CE-6488 Radio System Analyzer, stored programs can be used to provide fully automatic, computer controlled test routines for evaluating a radio's performance. Test results are easily evaluated from either the system display or hard-copy printer output. This results in faster testing, as well as more thorough and accurate testing of radio systems.

8.3 The CE-6488 option makes the Spectrum 6000 Series Radio System Analyzer family compatible with the IEEE Standard 488-1978 Interface Bus, which is also known as GPIB (the term we will use in this Manual), HP-IB, and IEC Bus. It has two modes of operation: Local and Remote.

8.4 In its Local mode, the instrument is completely under manual control. The microprocessor monitors the front panel control settings, and all the System 6000 instrument is programmable from the unit Front Panel.

8.5 In the Remote mode, the GPIB has access to all instrument functions except for power switch, volume control, and oscilloscope/spectrum monitor controls and display. The following controls and indicators are programmable through the GPIB:

SENSITIVITY switch	SQUELCH control
SELECTIVITY switch	FUNCTION meter
FREQUENCY ERROR meter	FREQ ERROR RANGE (kHz) switch
OFFSET ADJUST control	MODULATION SELECT switch
MOD ADJ control	MOD IN ADJ control
+1 kHz ADJ control	FUNCTION switch
SIG GEN ON/OFF switch	SIG GEN (FINE) control
GENERATE frequency	SIG GEN (COARSE) attenuator
RECEIVE frequency	MODULATION TONE frequency
(OPTIONAL) ZERO SCAN	

8.6 The microprocessor is the Series 6000 interface during both Local and Remote operation. The microprocessor always monitors instrumentation outputs which are displayed on the front panel, except for the oscilloscope CRT and its associated controls. Front panel displays are driven by the

microprocessor. None of the programmable front panel controls function while in the Remote mode.

8.7 There are 24 wires in the GPIB connector: eight wires for bus control, eight for bus data, and eight for ground. The data is byte serial bit parallel.

REQUIRED USER INTERACTION

8.8 For Remote operation, the Spectrum 6000 Series Radio System Analyzer user is required to:

a) Connect a GPIB cable to the GPIB controller

b) Enter desired GPIB address (Refer to paragraph 8.16.2).

c) Place the instrument in the Remote mode.

d) Write the desired programs which will run on the user's controller (refer to paragraph 8.17 for initialization routines using the HP-85 desk-top controller).

HARDWARE DESCRIPTION

8.9 The hardware needed to program the CE-6488 Radio System Analyzer (which contains the IEEE-488 option) is made up of two parts. The Standard hardware is incorporated in all Series 6000 Radio System Analyzers, and consists of an 8085 microprocessor, ROM, non-volatile RAM, keypad, LCD display and connectors to accept the GPIB section. It is used to control the Tone, Generate, and Receive frequencies, and provide non-volatile storage for up to 69 sets of frequencies.

8.10 The second part contains the necessary hardware to implement the GPIB option, and consists of four major parts:

a) An analog and digital interface to the Front Panel potentiometers, switches, and indicators which are remotely programmable over the GPIB.

b) An analog and digital interface to the instrumentation, corresponding to the Front Panel controls and indicators accessible by the GPIB.

c) A GPIB interface which has both talker and listener capability.

d) Additional ROM and RAM for use by the GPIB option software (as required).

8.11 The IEEE-488 option plugs into and is driven by the standard CE-6488 hardware.

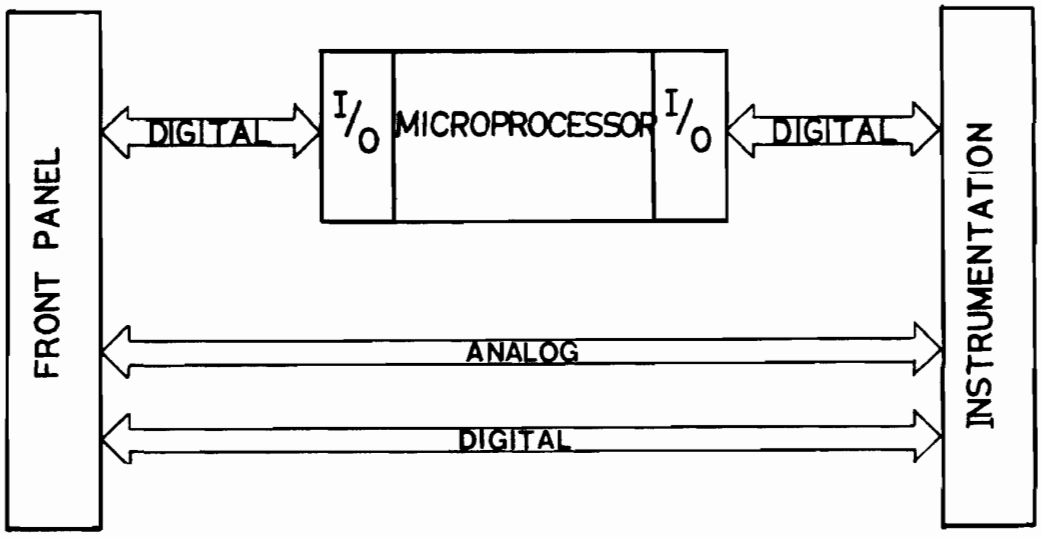


Figure 8-1. Standard Hardware Configuration

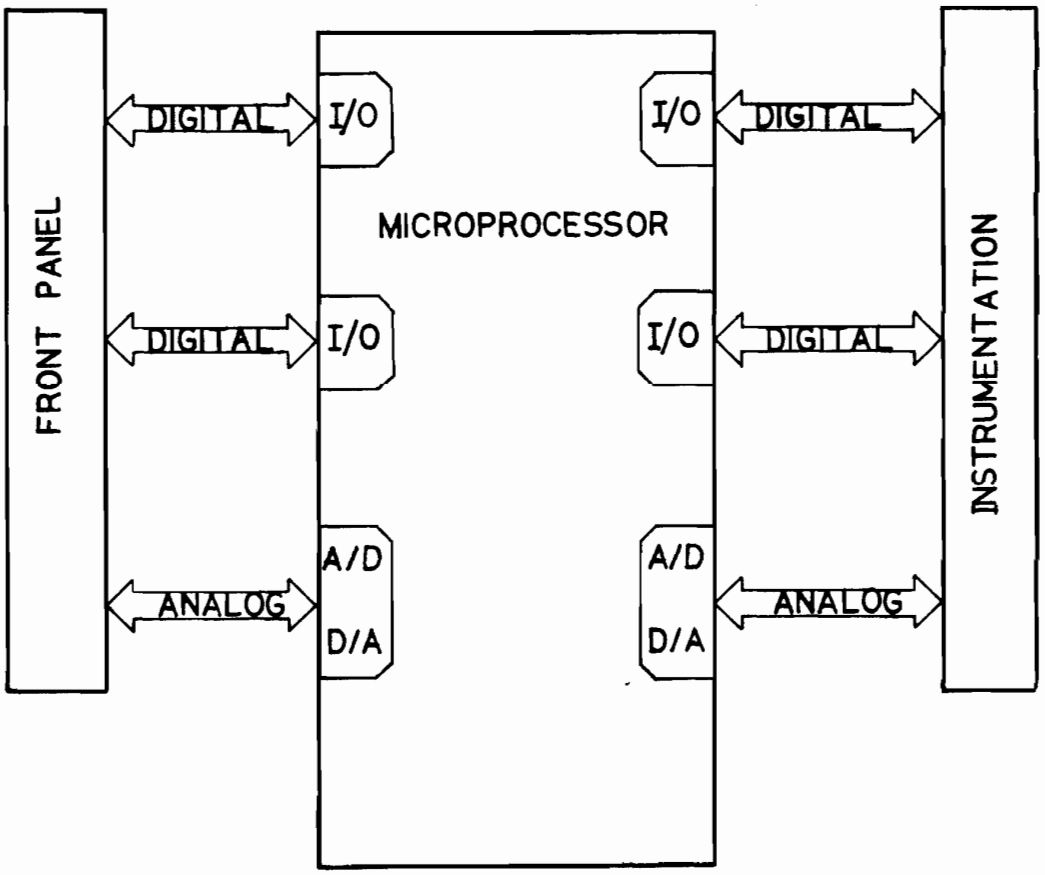


Figure 8-2. Incorporation of IEEE-488 Option Hardware

STANDARD HARDWARE DETAILED DESCRIPTION

8.12 Both the Standard and GPIB option hardware use the same 8085 microprocessor to control system operation.

8.13 Data entry is performed through an 18-key keypad on the Front Panel of the Series 6000 Radio System Analyzer. Ten of the keys are the numbers 0-9, and the other eight keys are for specialized functions. An LCD display is used to display the memory location, frequencies, and other special functions.

8.14 All interfaces to the Front Panel, instrumentation, and GPIB are true I/O ports instead of memory mapped I/O. The non-volatile RAM is implemented with low power, static devices and a battery backup. This allows data retention while the instrument is turned "OFF".

8.15 All memory and I/O decoding is done so that there is one address for each physical device. When reset, the 8085 microprocessor vectors to memory location 0. Therefore, the PROM starts at memory location 0.

IEEE-488 OPTION DESCRIPTION

8.16 The CE-6000 GPIB Option is a talker/listener Interface. Data to and from the CE-6000 is shown in Figure 1-3. Commands and responses have two parts: a control selector, and a numeric value or positional indicator. If the command requires a response (i.e., the second part of a command is a question mark), the instrument will read the requested value, do a service request, and return the data in response to a serial or parallel poll. No device trigger is necessary to start measurements.

8.16.1 Front Panel Controls - With the GPIB, Front Panel controls do not directly control instrumentation, but provide input to the microprocessor. The microprocessor acts as a switch to take input from the Front Panel or GPIB.

a) Keyboard - The keyboard consists of a set of 18 switches that can be read by, and a display which can be written into, the microprocessor. The switches are the numbers from 0-9, cursor control (typomatic type) keys, memory store and recall, display increment and decrement, and select and scan memory keys.

b) Switches and Adjustments - The switches used as inputs to the microprocessor are: SENSITIVITY, SELECTIVITY, METER FUNCTION, FREQUENCY ERROR RANGE, MODULATION, FUNCTION, and SIGNAL GENERATOR (COARSE). Adjustments used as inputs to the microprocessor are potentiometers that are measured by a switchable analog-to-digital (A/D) converter, and are: SQUELCH, FREQUENCY ERROR OFFSET, MOD ADJUST, MOD IN ADJUST, +1 kHz ADJUST, and SIGNAL GENERATOR (FINE).

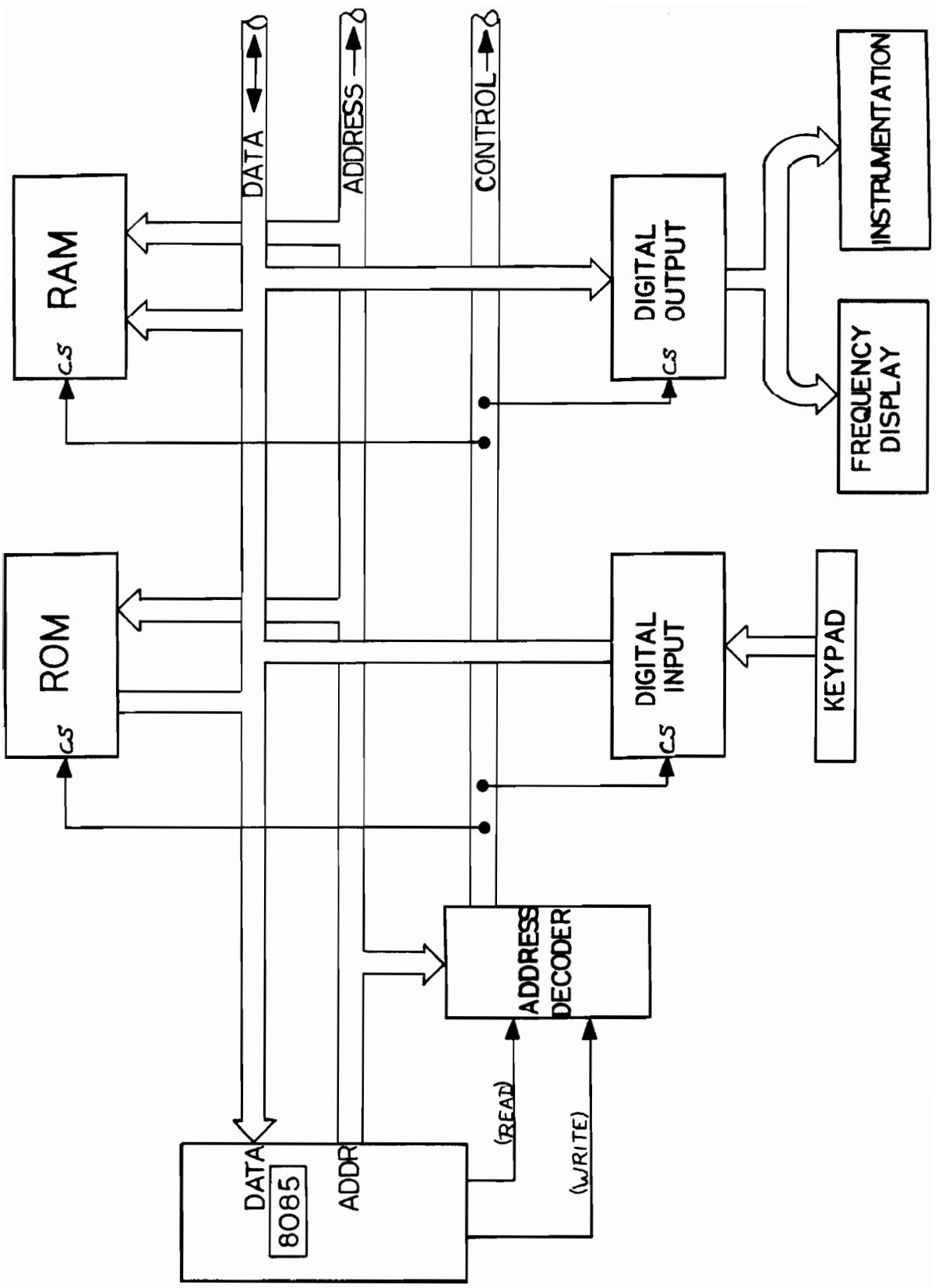


Figure 8-3. Standard CE-6000 Microprocessor Block Diagram

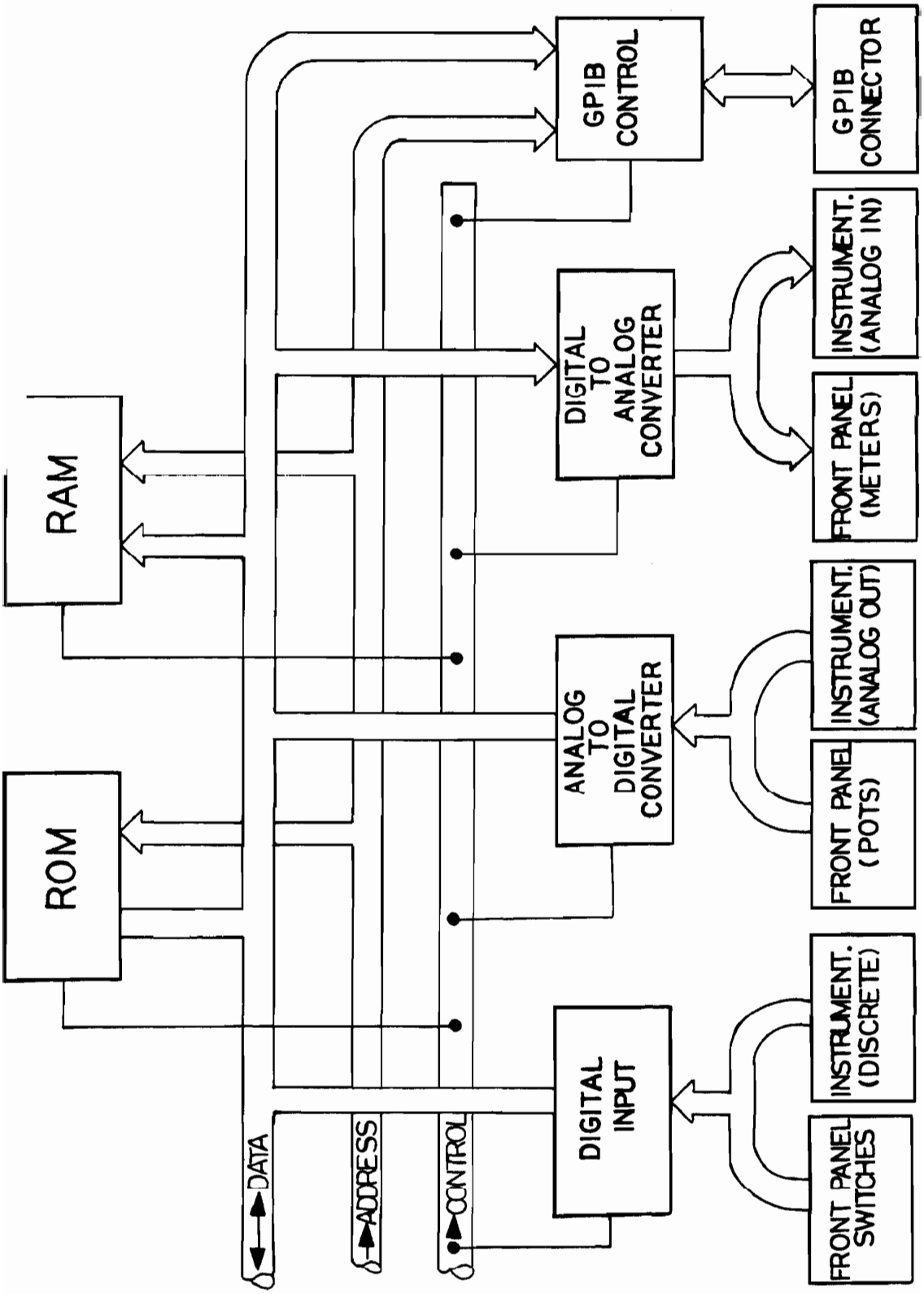


Figure 8-4. CE-6488 Microprocessor Block Diagram

c) Meters - Two meters are controlled by the microprocessor: the FUNCTION meter, and the FREQUENCY ERROR meter. As data is read out of the instrumentation, it is put into individual A/D's.

8.16.2 Bus Addresses - Bus addresses are saved as part of memory location 70 from the keyboard. The keyboard also enables the bus. Once it is enabled, it will go into Remote when the first interrupt from the GPIB is received. If the CE-6488 is to have a bus address for the first measurement (generally referred to as 701), then enter 0100000 into the display while the CE-6488 is in the Receive or Generate mode, Local control. Then store the displayed number into memory location 70.

8.16.3 GPIB Accessible Controls - The keyboard input, signal generator, function, modulation, frequency, meter function, sensitivity, and selectivity controls are controllable from the GPIB. These controls will not be altered unless specifically addressed. The format for each control is as follows:

CONTROL	FORMAT	DESCRIPTION
Generate Frequency	"GEN n.nnnnnn E+n"	Programs instrument to the specified frequency, and stores frequency in memory location "1".
Receive Frequency	"RCV n.nnnnnn E+n"	Programs instrument to the specified frequency, and stores frequency in memory location "1".
Modulation Tone	"TON n.nnnnnn E+n" (value range = 0 to 19.999 kHz)	Programs instrument to the specified frequency, and stores in memory location "1". If command received in Duplex mode, an error is sent to the Controller if Generate and Receive frequencies are not 45 MHz (exactly), or greater than 11.999 MHz.
Function Control	"FUN XXX" (where XXX can be RCV, GEN, or DPLX).	Allows major function of instrument to be selected. Setting will influence the keyboard inputs.
Modulation Type	"MTY XXX" (where XXX = CW, AM, FM, or SSB).	Selects modulation for RCV or Gen functions. Note SSB can be used only in RCV mode.

CONTROL	FORMAT	DESCRIPTION
SignalGen ON/OFF	"SIG XXX" (where XXX = ON or OFF)	ON/OFF switch on SIG GEN (FINE) controls output of signal generator.
Sig Gen (Coarse and Fine)	"SGC -n.nnn E+n"	Number's range is hardware dependent. Can go from 0 to -129 in 0.1 dB steps.
Modulation Select	"MOD XXX"	Where XXX can be MOD, OFF, or + 1 kHz.
Modulation Adjust	"MDA n.nn E+n"	Value can be from 0 - 255.
+1 kHz Adjust	"1kA n.nn E+n"	Value can be from 0 - 255.
Mod In Adjust	"MIA n.nn E+n"	Value can be from 0 - 255.
Sensitivity	"SEN XXX"	Where XXX can be MAX, -40, -20, or 0.
Squelch	"SQL n.nn E+n"	Value can be from 0 - 255.
Selectivity	"SEL X"	Where X can be W, M, or N.
Meter Select	"MSL XXXX"	Where XXXX can be 15k, 5k, 1.5k, %AM, Px1, Px10, or SINAD.
Frequency Error Range	"FER XX"	Where XX can be 1.5, 5, or 15.
Frequency Error Adjust	"FAD X.XXE+n"	Where X.XXE+n is 0 to 255 value number.
FunctionMeter	"MET?"	Format of the response is: "MET ± n.nn E+n". Range and meaning set by Meter Select control above.
Read Frequency Error Meter	"FRQ?"	Format of the response is: "FREQ ±X.XX E+n". Range of value set by Frequency Error range command above.
Read Zero Scan Log Amp	"FS?"	Format of the response is: "FS X.XX E±n". Range of the value is set by the Sensitivity command above.

8.16.4 To read RF and/or audio frequencies back from the CE-6488, or to return to Local (Front Panel) control, the following command sequence is used:

COMMAND	FORMAT	RESPONSE
Read GENERATE display frequency	GEN?	Format of the response is: "RF ±X.XXXXXX E+n"
Read RECEIVE display frequency	RCV?	Format of the response is: "RF ±X.XXXXXX E+n"
Read MODULATION TONE display frequency	TON?	Format of the response is: "TON ±X.XXXXX E+n"
Go to LOCAL	LOC	Returns control from GPIB to Front Panel

TABLE 8-1
GPIB COMMAND DICTIONARY

COMMAND	DEFINITION
1KA	1 kHz Adjust
FAD	Frequency Adjust
FER	Frequency Error Range
FRQ?	Read Frequency Error Meter
FS?	Read Zero Scan Log Amp Level
FUN	Function
GEN	Generate Frequency
GEN?	Read back GEN frequency
LOC	Go to Local Control
MDA	Modulation Adjust
MET?	Read Function Meter
MIA	Modulation In Adjust
MOD	Modulation
MSL	Meter Select
MTY	Modulation Type
RCV	Receive Frequency
RCV?	Read back RCV frequency
SEL	Selectivity
SEN	Sensitivity
SIG	Signal Generator ON/OFF
SGC	Signal Generator (Coarse)
SQL	Squelch
TON	Modulation Tone Frequency
TON?	Read back TON (Tone) frequency

8.16.5 The following is a typical command sequence using an HP-85 desk-top computer as a GPIB Controller for reading Function Meter (MET), Frequency Error Meter (FRQ), or the Zero Scan log amp level (FS):

COMMAND	RESPONSE
OUTPUT (U); FRQ? (or MET?, or FS?) (where U = bus address)	
X = SPOLL (U)	
DISP X	XX (if XX = 65, do the following)
ENTER U; A$	
DISP A$	XXX...X n.nn...n E±nn

INITIALIZATION PROGRAM

8.17 This section contains a group of subroutines that can be used to check the GPIB Bus and cabling interconnect when using the HP-85A desk-top controller. It allows setting any of the controls to initialize the CE-6488 from a turn-on, or reading the Function and Frequency Error meters.

8.17.1 The following program listing is for testing the GPIB interface card and device interconnect:

```
 10   PRINT "GPIB INTERFACE CARD AND
      DEVICE INTERCONNECT TEST"
 20   PRINT " "
 30   PRINT " "
 40   STATUS 7,0 ; A,B,C,D,E,F
 50   PRINT "Interface card status = ";A,B,C,D,E,F
 60   PRINT " "
 70   PRINT "-------------------------------------"
 80   PRINT " *** CARD STATUS SHOULD READ ***"
 90   PRINT " "
100   PRINT "Interface card status =   1"
110   PRINT " 0
       64"
120   PRINT " 0
       53"
130   PRINT " 160"
140   PRINT "-------------------------------------"
150   PRINT " "
160   S=7
170   SET TIMEOUT S;500
180   ON TIMEOUT S GOTO 270
190   FOR I-1 TO 15
```

```
200   DISP "SPOLL DEVICE ";I
210   S1=SPOLL(S*100+I)
220   PRINT "DEVICE ";I;" PRESENT"
230   NEXT I
240   PRINT USING 250
250   IMAGE 4/
260   STOP
270   ABORTIO 7
280   PRINT "DEVICE ";I;" NOT PRESENT"
290   GOTO 230
300   END
```

8.17.2 Initialization Program Variables:

```
A2 = Mod Adjust Potentiometer (Monitor)
A3 = +1 kHz Adjust Potentiometer (Monitor)
A4 = Mod In Adjust Potentiometer (Monitor)
A5 = Squelch Adjust (Monitor)
A6 = Frequency Error Adjust Pot (Monitor)

F1 = Log Amp Reading (optional zero scan)
F2 = Mod Tone Frequency (keyboard - Monitor)
F5 = Mod Tone Frequency (read back from Monitor)

L0 = Sig Gen ON/OFF (switch)     0 = OFF;  1 = ON
L1 = Sig Gen Level (Attenuator)

M1 = 1 = Duplex (Function Switch - Outer)
     2 = GEN
     3 = RCV

M2 = 1 = CW (Function Switch - Inner)
     2 = AM
     3 = FM
     4 = SSB

M3 = 0 = OFF (Mod Switch)
     1 = MOD
     2 = +1 kHz

M4 = 1 = 1.5K (Meter Function Switch)
     2 = 5K
     3 = 15K
     4 = %AM
     5 = Px1
     6 = Px10
     7 = SINAD

M5 = Function Meter Reading (Monitor)

M6 = Frequency Error Reading (Monitor)
```

R = Monitor Freq (Keyboard - Monitor)

R2 = 1 = 1.5 kHz Freq Error Range (Monitor)
2 = 5.0 kHz
3 = 15 kHz

R5 = Monitor Freq (read back from Monitor)

S2 = 0 = 0 dBm - RF Sensitivity Attenuator
1 = 20 dBm
2 = 40 dBm
4 = MAX Sensitivity

S3 = 1 = Narrow (Selectivity Switch)
2 = Medium
3 = Wide

T = Sig Gen Freq (Keyboard - Monitor)

T5 = Sig Gen Freq (read back from Monitor)

U = CE-6488 Bus Address

Z1 = Go to LOCAL

8.17.3 The following is a listing of initialization routines programmed into an HP-85A desk-top Controller:

```
10 ! CE6488 MAKE IT PROGRAM
20 !  T   -- SIG GEN FREQ.
24 !  T5  -- SIG GEN FREQ.READI
   NG
26 !  R   -- MONITOR FREQ.
28 !  R5  -- MONITOR FREQ.READI
   ND
30 !  A2  --  MOD ADJUST
34 !  A3  --  +1KHZ ADJUST
38 !  A4  --  MOD IN ADJUST
40 !  A5  --  SQUELCH ADJUST
42 !  A6  --  FREQUENCY ERROR A
   DJUST
46 !  F2  --  TONE FREQUENCY
48 !  F5  --  TONE FREQ. READIN
   G
50 !  L0  --  SIG GEN ON/OFF
52 !  L1  --  SIGNAL GEN LEVEL
56 !  Z1  --  GO TO LOCAL
100 !  M1  --  1 = DUPLX, 2 = GE
   N, 3 = RECEIVE
105 !  M2  --  1 = CW, 2 = AM, 3
    = FM, 4 = SSB
110 !  M3  --  0 = OFF, 1 = MOD,
    2 = +1KHZ
115 !  M4  --  1 = 1.5K, 2 = 5K,
    3 = 15K, 4 = %AM, 5 = PX1,
   6 = PX10, 7 = SINAD
120 !  M5 --  MAIN METER READING
125 !  M6  --  FREQ ERR METER RE
   ADING
130 !  F1  --  LOG AMP READING
135 !  R2  --  1 = .5, 2 = 5, 3
   = = 15 (FREQ ERR RANGE)
140 !  S2  --  0 = 0, 1 = -20, 2
    = -30, 3 = MAX (SENSITIVITY
   )
145 !  S3  --  1 = N, 2 = M, 3 =
    W (SELECTIVITY)
150 !  U  --  MONITOR GPIB ADDRE
   SS
155 !  A$  --  GENERAL USAGE BUF
   FER
200 ! PROGRAM PARTITIONING
205 !  0 - 999  --  COMMENTS AND
    DECLARATIONS
210 !  1000 - 5999  --  MAIN LIN
   E
215 !  6000 - 8999  --  SUBROUTI
   NES
220 !  9000 - 9999  --  6488 ROU
   TINES
250 !  U  --  MONITOR GPIB ADDRE
   SS
255 !  A$  --  GENERAL USAGE BUF
   FER
300 DIM A$[88]
400 ! THE FOLLOWING ARE VALUES F
   OR INPUT VARIABLES
405 M1=2 ! MODE 1 DUPLEX 2 GEN 3
    REC
```

```
410 T=45562500 ! GEN FREQ.
415 R=45062500 ! REC FREQ.
420 M2=2 ! FUNC SW 1=CW 2=AM 3=F
    M 4=SSB
425 F2=1000 ! MOD TONE FREQ
430 A2=0 ! MOD ADJ
435 A3=40 ! +1K ADJ
440 A4=0 ! MOD IN ADJ
445 A5=50 ! SQUELCH ADJ
450 A6=0 ! FREQ ERR ADJ
455 L0=0 ! SIG GEN ON/OFF 0=OFF
    1=ON
460 L1=0 ! SIG GEN LEVEL ADJ
465 S3=1 ! SEL SW 1=N 2=M 3=W
470 S2=0 ! SENS SW 0=0 1=-20 2=-
    40 3=MAX
475 M3=0 ! MOD SW 0=OFF 1=MOD 2=
    +1KHz
480 M4=4 ! METER FUN SW 1=1.5 2=
    5 3=15 4=%AM 5=PX1 6=PX10 7=
    SINAD
485 R2=1 ! FREQ ERR SW 1=1.5 2=5
     3=15KHz
500 U=701
505 IOBUFFER A$
510 REMOTE U
515 LOCAL LOCKOUT 7
520 GOSUB 9100
525 CLEAR
600 DISP "THE PROGRAM IS PAUSED!
     NOW TYPE OUTPUT STATMENTS A
    S DISCRIBED   IN MANUAL."
605 DISP "                -OR- "
610 DISP "TYPE LIST 1000 AND REA
    SSIGN VAL-UES TO VARIABLES T
    HEN PRESS RUN."
615 DISP "                -OR-"
620 DISP "BEGIN APPLICATIONS PRO
    GRAMING   STARTING ON LINE 2
    000."
5999 GOTO 9999
9000 !  9100  --  INITIALIZE INS
    TRUMENT
9005 !  9200  --  SEND XMIT FREQ
9010 !  9240  --  SEND RCV FREQ
9015 !  9280  --  SEND MOD TONE
9020 !  9320  --  SET GEN/REC MO
    DE
9025 !  9370  --  SET MOD MODE
9028 !  9413  --  SET SIG GEN ON
    /OFF
9030 !  9430  --  SET SIG GEN LE
    VEL
9035 !  9490  --  MOD SELECT
9040 !  9540  --  MOD ADJUST
9045 !  9580  --  +1KHZ ADJUST
9050 !  9620  --  MOD IN ADJUST
9055 !  9660  --  SENSITIVITY SE
    LECT
9060 !  9720  --  SQL ADJUST
```

```
9065 !  9760  --  FRQ ERROR ADJU
     ST
9070 !  9800  --  SELECTIVITY SE
     LECT
9075 !  9815  --  MAIN METER SEL
     ECT
9080 !  9842  --  FREQ ERROR SEL
     ECT
9085 !  9857  --  MAIN METER REA
     DING
9090 !  9869  --  FREQ ERROR REA
     DING
9093 !  9890  --  LOG AMP READIN
     G
9094 !  9900  --  GO TO LOCAL
9095 !  9910  --  READ BACK GEN
     FREQ.
9096 !  9920  --  READ BACK REC
     FREQ.
9097 !  9930  --  READ BACK TONE
      FREQ.
9100 GOSUB 9200
9102 GOSUB 9200
9105 GOSUB 9240
9110 GOSUB 9280
9115 GOSUB 9320
9120 GOSUB 9370
9122 GOSUB 9413
9125 GOSUB 9430
9130 GOSUB 9490
9135 GOSUB 9540
9140 GOSUB 9580
9145 GOSUB 9620
9150 GOSUB 9660
9155 GOSUB 9720
9160 GOSUB 9760
9165 GOSUB 9800
9170 GOSUB 9815
9175 GOSUB 9842
9180 RETURN
9200 GOSUB 9990
9210 OUTPUT U USING 9230 ; T
9220 RETURN
9230 IMAGE "GEN ",SD.DDDDDDE
9240 GOSUB 9990
9250 OUTPUT U USING 9270 ; R
9260 RETURN
9270 IMAGE "RCV ",SD.DDDDDDE
9280 GOSUB 9990
9290 OUTPUT U USING 9310 ; F2
9300 RETURN
9310 IMAGE "TON ",SD.DDDDDE
9320 GOSUB 9990
9330 IF M1=1 THEN OUTPUT U ;"FUN
      DPLX"
9340 IF M1=2 THEN OUTPUT U ;"FUN
      GEN"
9350 IF M1=3 THEN OUTPUT U ;"FUN
      RCV"
9360 RETURN
```

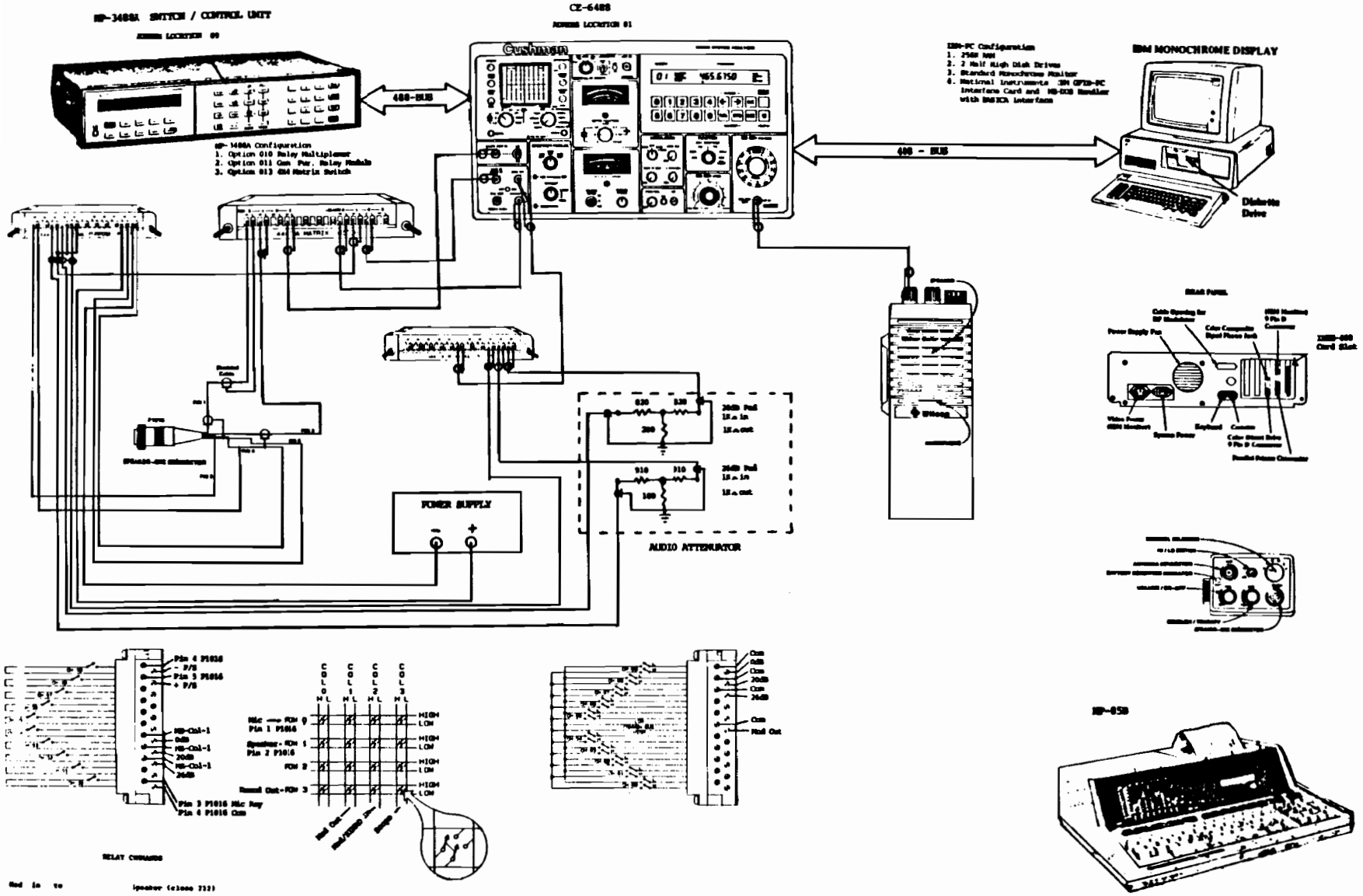
```
9370 GOSUB 9990
9380 IF M2=1 THEN OUTPUT U ;"MTY
      CW"
9390 IF M2=2 THEN OUTPUT U ;"MTY
      AM"
9400 IF M2=3 THEN OUTPUT U ;"MTY
      FM"
9410 IF M2=4 THEN OUTPUT U ;"MTY
      SSB"
9411 RETURN
9412 GOSUB 9990
9413 IF L0=1 THEN OUTPUT U ;"SIG
      ON"
9414 IF L0=0 THEN OUTPUT U ;"SIG
      OFF"
9416 RETURN
9430 GOSUB 9990
9440 OUTPUT U USING 9470 ; L1
9445 WAIT 500
9460 RETURN
9470 IMAGE "SGC -",D.DDDE
9490 GOSUB 9990
9500 IF M3=0 THEN OUTPUT U ;"MOD
      OFF"
9510 IF M3=1 THEN OUTPUT U ;"MOD
      MOD"
9520 IF M3=2 THEN OUTPUT U ;"MOD
      +1KHZ"
9530 RETURN
9540 GOSUB 9990
9550 OUTPUT U USING 9570 ; A2
9560 RETURN
9570 IMAGE "MDA ",SD.DDE
9580 GOSUB 9990
9590 OUTPUT U USING 9610 ; A3
9595 WAIT 100
9600 RETURN
9610 IMAGE "1KA ",SD.DDE
9620 GOSUB 9990
9630 OUTPUT U USING 9650 ; A4
9640 RETURN
9650 IMAGE "MIA ",SD.DDE
9660 GOSUB 9990
9670 IF S2=0 THEN OUTPUT U ;"SEN
      0"
9680 IF S2=1 THEN OUTPUT U ;"SEN
      -20"
9690 IF S2=2 THEN OUTPUT U ;"SEN
      -40"
9700 IF S2=3 THEN OUTPUT U ;"SEN
      MAX"
9710 RETURN
9720 GOSUB 9990
9730 OUTPUT U USING 9750 ; A5
9740 RETURN
9750 IMAGE "SQL ",SD.DDE
9760 GOSUB 9990
9770 OUTPUT U USING 9790 ; A6
9780 RETURN
9790 IMAGE "FAD ",SD.DDE
```

```
9800 GOSUB 9990
9803 IF S3=1 THEN OUTPUT U ;"SEL
     N"
9806 IF S3=2 THEN OUTPUT U ;"SEL
     M"
9809 IF S3=3 THEN OUTPUT U ;"SEL
     W"
9812 RETURN
9815 GOSUB 9990
9818 IF M4=1 THEN OUTPUT U ;"MSL
     1.5K"
9821 IF M4=2 THEN OUTPUT U ;"MSL
     5K"
9824 IF M4=3 THEN OUTPUT U ;"MSL
     15K"
9827 IF M4=4 THEN OUTPUT U ;"MSL
     %AM"
9830 IF M4=5 THEN OUTPUT U ;"MSL
     PX1"
9833 IF M4=6 THEN OUTPUT U ;"MSL
     PX10"
9836 IF M4=7 THEN OUTPUT U ;"MSL
     SINAD"
9839 RETURN
9842 GOSUB 9990
9845 IF R2=1 THEN OUTPUT U ;"FER
     1.5"
9848 IF R2=2 THEN OUTPUT U ;"FER
     5"
9851 IF R2=3 THEN OUTPUT U ;"FER
     15"
9854 RETURN
9857 WAIT 100
9858 OUTPUT U ;"MET?"
9859 GOSUB 9996
9860 ENTER U USING 9866 ; M5
9863 RETURN
9866 IMAGE 3X,SD.DDE
9869 OUTPUT U ;"FRQ?"
9870 GOSUB 9996
9872 ENTER U USING 9878 ; M6
9875 RETURN
9878 IMAGE 3X,SD.DDE
9881 GOSUB 9996
9884 ENTER U ; A$
9887 RETURN
9890 WAIT 100
9891 OUTPUT U ;"FS?"
9892 GOSUB 9996
9894 ENTER U USING 9898 ; F1
9896 RETURN
9898 IMAGE 3X,SD.DDE
9900 GOSUB 9990
9902 OUTPUT U USING 9906 ; Z1
9904 RETURN
9906 IMAGE "LOC"
9910 OUTPUT U ;"GEN?"
9912 GOSUB 9990
9914 ENTER U USING 9918 ; T5
9916 RETURN
```

```
9918 IMAGE 4X,SD.DDDDDDE
9920 OUTPUT U ;"RCV?"
9922 GOSUB 9996
9924 ENTER U USING 9928 ; R5
9926 RETURN
9928 IMAGE 4X,SD.DDDDDDE
9930 OUTPUT U ;"TON?"
9932 GOSUB 9996
9934 ENTER U USING 9938 ; F5
9936 RETURN
9938 IMAGE 3X,SD.DDDDDE
9990 IF (SPOLL(U) AND 63)=0 THEN
      9998
9991 ENTER U ; A$
9992 DISP A$;" ON UNIT ";U
9993 DISP "PUSH 'CONT' TO CONTIN
     UE"
9994 DISP "OR 'RUN' TO RESTART"
9995 PAUSE
9996 IF (SPOLL(U) AND 63)<>1 THE
     N 9998
9997 RETURN
9998 RETURN
9999 END
```

```
 10 PRINT "GPIB INTERFACE CARD A
    ND DEVICE  INTERCONNECT TEST
    "
 20 PRINT ""
 30 PRINT ""
 40 STATUS 7,0 ; A,B,C,D,E,F
 50 PRINT "Interface card status
     = ";A,B,C,D,E,F
 60 PRINT ""
 70 PRINT "----------------------
    -----------"
 80 PRINT " *** CARD STATUS SHO''
    LD READ ***"
 90 PRINT ""
100 PRINT "Interface card status
     =  1"
110 PRINT " 0
     64"
120 PRINT " 0
     53"
130 PRINT " 160"
140 PRINT "----------------------
    -----------"
150 PRINT ""
160 S=7
170 SET TIMEOUT S;500
180 ON TIMEOUT S GOTO 270
190 FOR I=1 TO 15
200 DISP "SPOLL DEVICE ";I
210 S1=SPOLL(S*100+I)
220 PRINT "DEVICE ";I;" PRESENT"
230 NEXT I
240 PRINT USING 250
250 IMAGE 4/
260 STOP
270 ABORTIO 7
280 PRINT "DEVICE ";I;" NOT PRES
    ENT"
290 GOTO 230
300 END
```

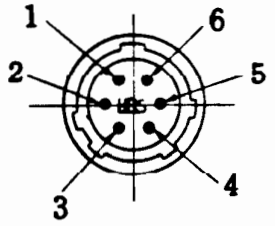
CE-6488S SYSTEM DIAGRAM



RELAY COMMANDS

Mod in to		Speaker (close 212)
Mod in to		Both (close 222)
Scope to		Speaker (close 213)
Scope to		Both (close 223)
Mod out to	0db	Mic (close 307, 304, 201)
Mod out to	20dB	Mic (close 309, 302, 201)
Mod out to	26dB	Mic (close 308, 303, 201)
Power Supply to radio		(close 108, 109)
Mic Key to radio		(close 108)

Contact Arrangement and Major Specification

Shell Size	
Voltage Withstanding	AC300V for a minute
Current Rating	2A
Insulation Resistance	MIN. 200MΩ at DC100V
Contact Resistance	MAX. 10mΩ at DC1A
Solder Pot Diameter	0.8mm
Applicable Cable Dia.	4.5–5.5mm

Note 1. The Contact Arrangement shown here is the mating surface of socket insert assembled in a receptacle. The contact number is shown 1 and 6 on the wiring side.

2. The Voltage Withstanding is the test value, so recommended voltage rating is a lower value than one-third of it.

SECTION IX

SPECTRUM 6000 SERIES RADIO SYSTEM ANALYZER
CE-6232 OPTION

GENERAL DESCRIPTION

9.1 The CE-6232 option for the Series 6000 Radio System Analyzer incorporates microprocessor based local control of the instrument for bench or on-site use, while providing an EIA Standard RS-232C compatible bus operating system to allow the addition of a controller and peripherals for ease of radio testing.

9.2 By incorporating a computer as the controller for the CE-6232 Radio System Analyzer, stored programs can be used to provide fully automatic, computer controlled test routines for evaluating a radio's performance. Test results are easily evaluated from either the system display or hard-copy printer output. This results in faster testing, as well as more thorough and accurate testing of radio systems.

9.3 The CE-6232 option makes the Spectrum 6000 Series Radio System Analyzer family compatible with the EIA Standard RS-232C Interface (August 1969). It uses a simple RS-232 interface. Only Receive Data, Transmit Data, and Signal Ground are used. The unit is wired for 300 baud, half duplex operation with one stop byte, no parity, and an eight bit byte. It has two modes of operation: Local and Remote interrupt.

9.4 In its Local mode, the instrument is completely under manual control. The microprocessor monitors the front panel control settings, and all of the System 6000 instrument is programmable from the unit Front Panel.

9.5 During Remote operation, the RS-232 has access to all instrument functions except for power switch, volume control, and oscilloscope controls and display. The following controls and indicators are programmable through the RS-232:

SENSITIVITY switch	SQUELCH control
SELECTIVITY switch	FUNCTION meter
FREQUENCY ERROR meter	FREQ ERROR RANGE (kHz) switch
OFFSET ADJUST control	MODULATION SELECT switch
MOD ADJ control	MOD IN ADJ control
+1 kHz ADJ control	FUNCTION switch
SIG GEN ON/OFF switch	SIG GEN (FINE) control
GENERATE frequency	SIG GEN (COARSE) attenuator
RECEIVE frequency	MODULATION TONE frequency
(OPTIONAL) ZERO SCAN	

9.6 The microprocessor in the Series 6000 instrument is its interface during both Local and Remote operation. The microprocessor always monitors instrumentation outputs which are displayed on the front panel, except for the oscilloscope CRT and its associated controls. Front panel displays are driven by the microprocessor. None of the programmable front panel controls function while in the Remote mode.

9.7 There are only three wires in the RS-232 connector: only pins 2 (Receive data), 3 (Transmit data), and 7 (Signal ground) are used.

REQUIRED USER INTERACTION

9.8 For Remote operation, the Spectrum 6000 Series Radio System Analyzer user is required to:

a) Connect a 3 wire cable to the RS-232 connector.

b) Write the desired programs which will run on the user's controller.

HARDWARE DESCRIPTION

9.9 The hardware needed to program the CE-6232 Radio System Analyzer (which contains the RS-232C option) is made up of two parts. The Standard hardware is incorporated in all Series 6000 Radio System Analyzers, and consists of an 8085 microprocessor, ROM, non-volatile RAM, keypad, LCD display and connectors to accept the RS-232 section. It is used to control the Tone, Generate, and Receive frequencies, and provide non-volatile storage for up to 69 sets of frequencies.

9.10 The second part contains the necessary hardware to implement the RS-232 option, and consists of four major divisions of parts:

a) An analog and digital interface to the Front Panel potentiometers, switches, and indicators which are remotely programmable over the RS-232 interface.

b) An analog and digital interface to the instrumentation, corresponding to the Front Panel controls and indicators accessible by the Controller.

c) An RS-232 interface which has both talker and listener capability.

d) Additional ROM and RAM for use by the RS-232 option software (as required).

9.11 The RS-232 option plugs into and is driven by the standard CE-6232 hardware.

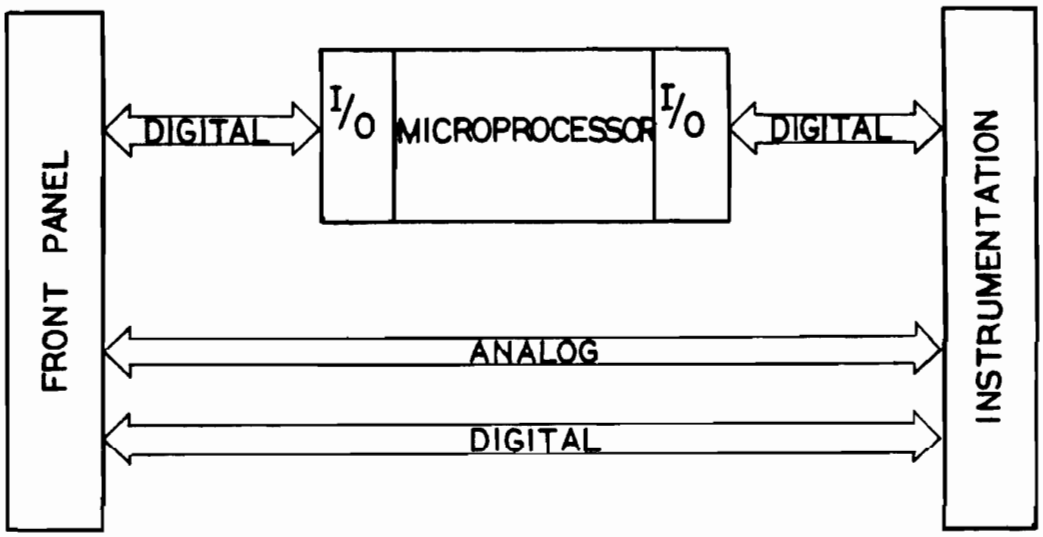


Figure 9-1. Standard Hardware Configuration

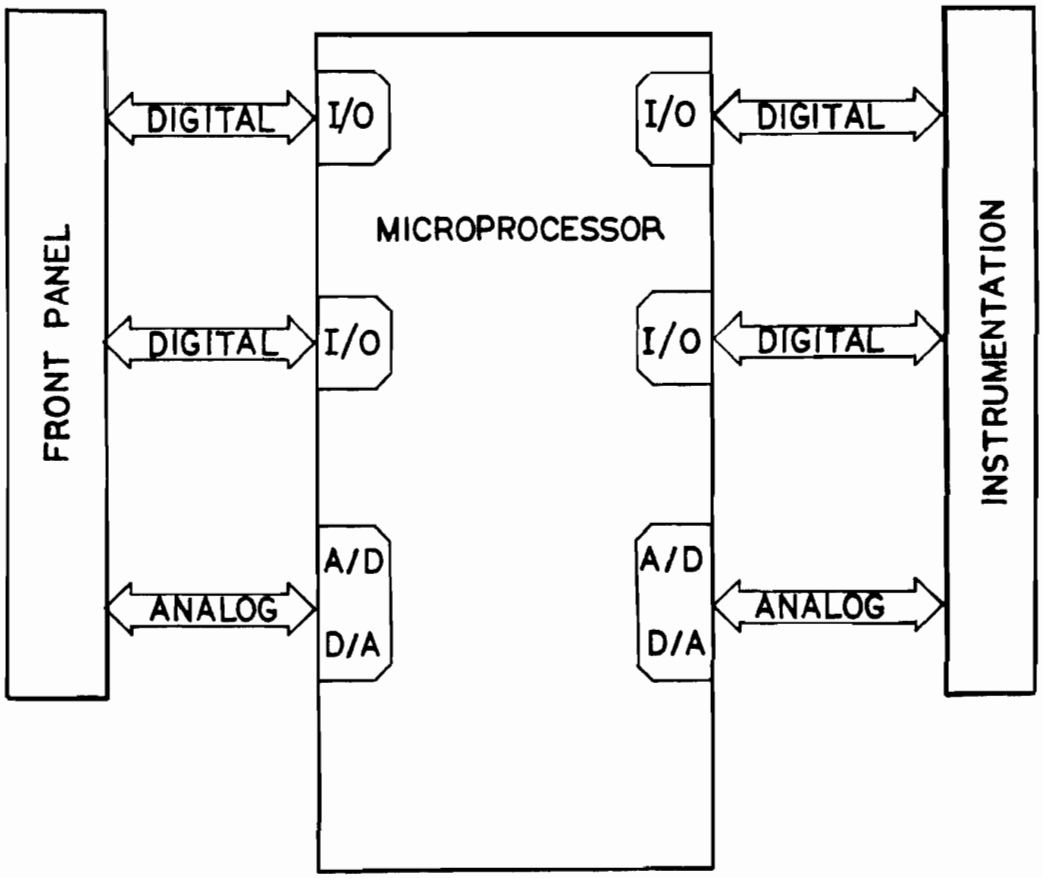


Figure 9-2. Incorporation of RS-232C Option Hardware

STANDARD HARDWARE DETAILED DESCRIPTION

9.12 Both the Standard and RS-232 option hardware use the same 8085 microprocessor to control system operation.

9.13 Data entry is performed through an 18-key keypad on the Front Panel of the Series 6000 Radio System Analyzer. Ten of the keys are the numbers 0-9, and the other eight keys are for specialized functions. An LCD display is used to display the memory location, frequencies, and other special functions.

9.14 All interfaces to the Front Panel, instrumentation, and RS-232 are true I/O ports instead of memory mapped I/O. The non-volatile RAM is implemented with low power, static devices and a battery backup. This allows data retention while the instrument is turned "OFF".

9.15 All memory and I/O decoding is done so that there is one address for each physical device. When reset, the 8085 microprocessor vectors to memory location 0. Therefore, the PROM starts at memory location 0.

RS-232 OPTION DESCRIPTION

9.16 The CE-6232 Option is a talker/listener Interface. Data to and from the CE-6000 is shown in Figure 1-3. Commands and responses have two parts: a control selector, and a numeric value or positional indicator. If the command requires a response (i.e., the second part of a command is a question mark), the instrument will read the requested value, do a service request, and return the data in response to a serial or parallel poll. No device trigger is necessary to start measurements.

9.16.1 Front Panel Controls - With the RS-232, Front Panel controls do not directly control instrumentation, but provide microprocessor input. The microprocessor acts as a switch to take input from the Front Panel or RS-232.

a) Keyboard - The keyboard consists of a set of 18 switches that can be read by, and a display which can be written into, the microprocessor. The switches are the numbers from 0-9, cursor control (typomatic type) keys, memory store and recall, display increment and decrement, and select and scan memory keys.

b) Switches and Adjustments - Switches used as inputs to the microprocessor are: SENSITIVITY, SELECTIVITY, METER FUNCTION, FREQUENCY ERROR RANGE, MODULATION, FUNCTION, and SIGNAL GENERATOR (COARSE). Adjustments used as inputs to the microprocessor are potentiometers measured by a switchable analog-to-digital (A/D) converter, and are: SQUELCH, FREQUENCY ERROR OFFSET, MOD ADJUST, MOD IN ADJUST, +1 kHz ADJUST, and SIGNAL GENERATOR (FINE).

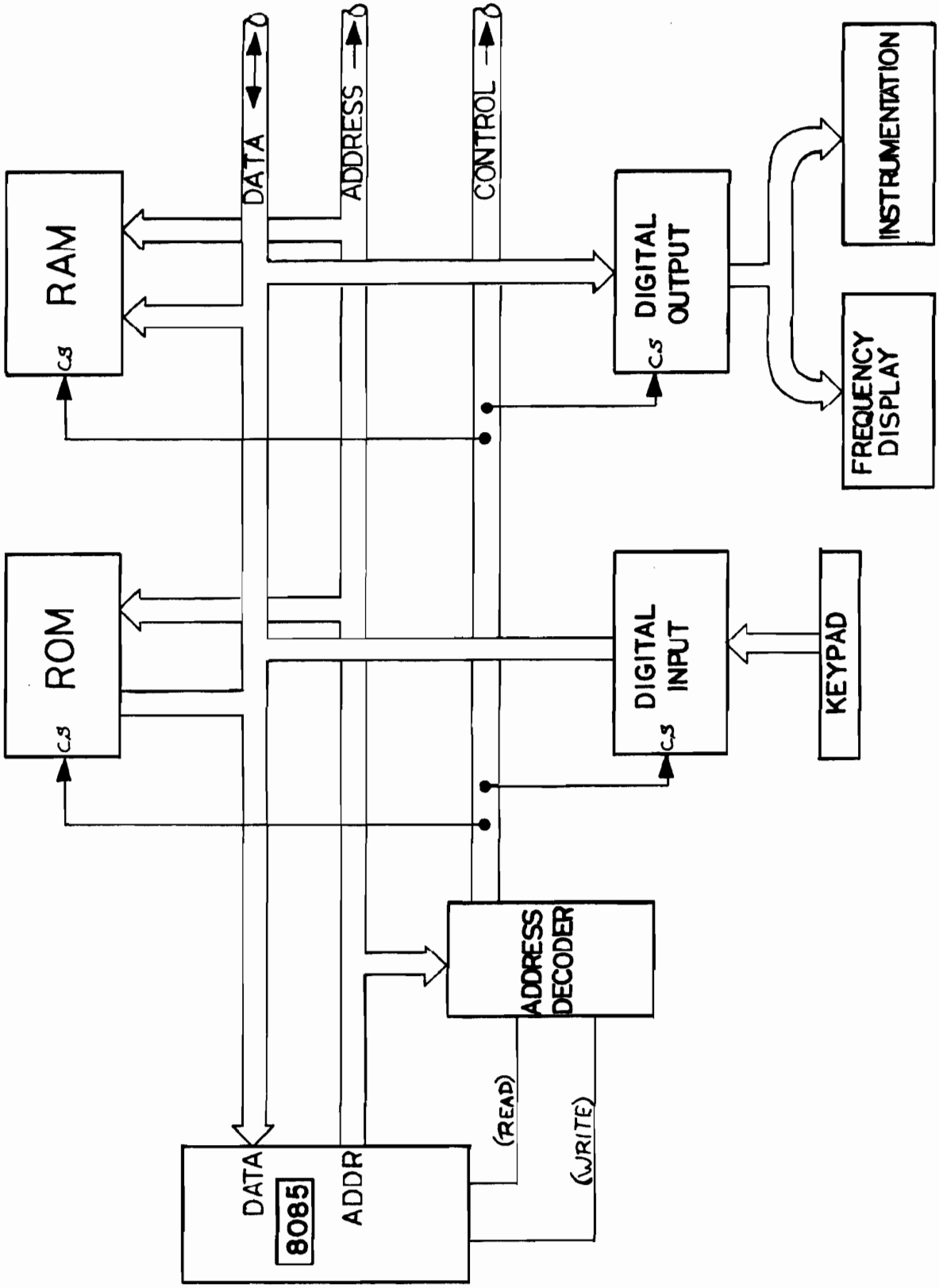


Figure 9-3. Standard CE-6000 Microprocessor Block Diagram

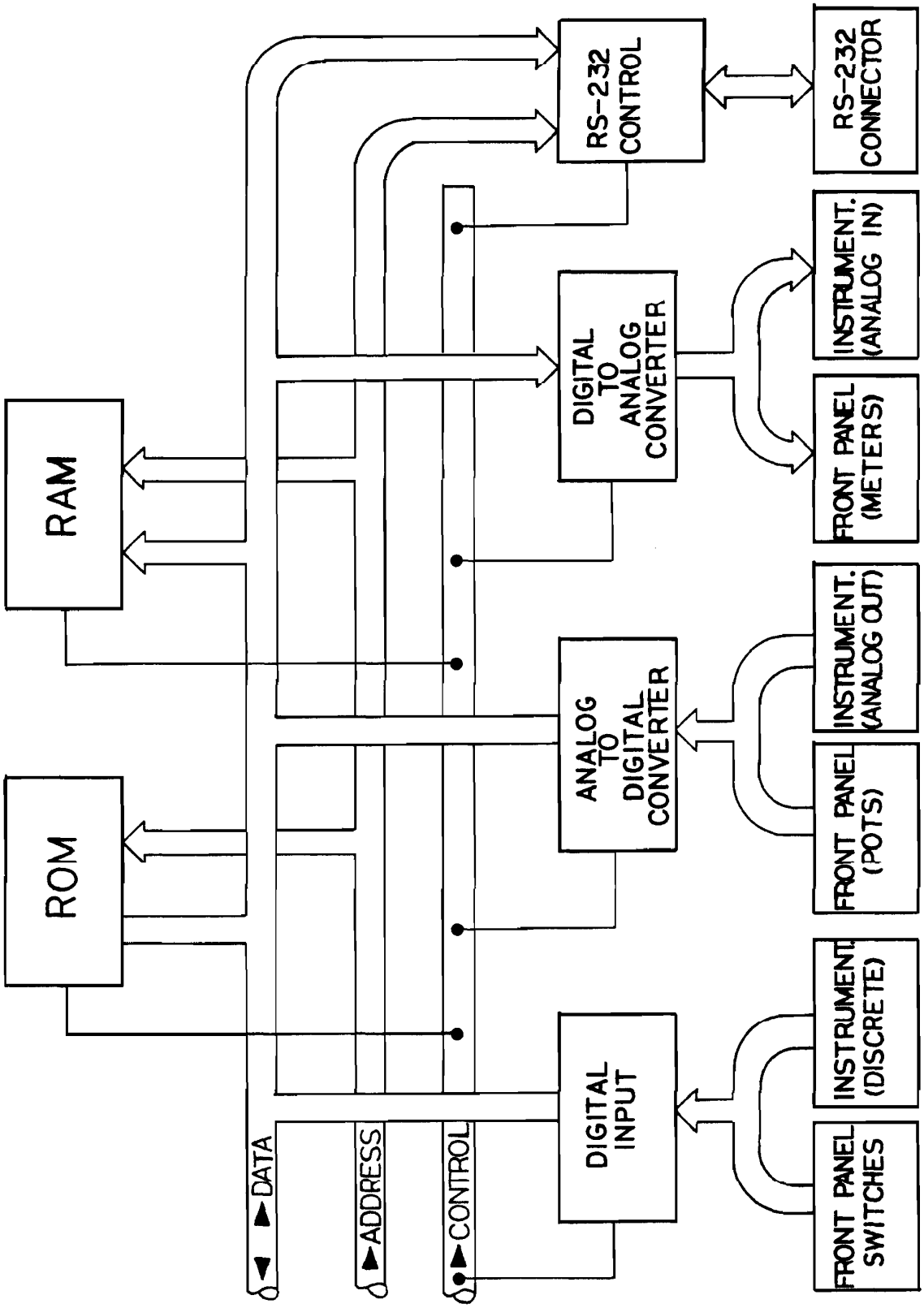


Figure 9-4. CE-6232 Microprocessor Block Diagram

c) Meters - Two meters are controlled by the microprocessor: the FUNCTION meter, and the FREQUENCY ERROR meter. As data is read out of the instrumentation, it is put into individual A/D's.

9.16.2 RS-232 Accessible Controls - The keyboard input, signal generator, function, modulation, frequency, meter function, sensitivity, and selectivity controls are controllable from the RS-232. These controls will not be altered unless specifically addressed. The format for each control is as follows:

CONTROL	FORMAT	DESCRIPTION
Generate Frequency	"GEN n.nnnnnn E+n"	Programs instrument to the specified frequency, and stores frequency in memory location "1".
Receive Frequency	"RCV n.nnnnnn E+n"	Programs instrument to the specified frequency, and stores frequency in memory location "1".
Modulation Tone	"TON n.nnnnnn E+n" (value range = 0 to 19.999 kHz)	Programs instrument to the specified frequency, and stores in memory location "1". If command received in Duplex mode, an error is sent to the Controller if Generate and Receive frequencies are not 45 MHz (exactly), or greater than 11.999 MHz.
Function Control	"FUN XXX" (where XXX can be RCV, GEN, or DPLX).	Allows major function of instrument to be selected. Setting will influence the keyboard inputs.
Modulation Type	"MTY XXX" (where XXX = CW, AM, FM, or SSB).	Selects modulation for RCV or Gen functions. Note SSB can be used only in RCV.
Signal Gen ON/OFF	"SIG XXX" (where XXX = ON or OFF)	ON/OFF switch on SIG GEN (FINE) controls output of signal generator.
Sig Gen (Coarse and Fine)	"SGC -n.nnn E+n"	Number's range is hardware dependent. Can go from 0 to -129 in 0.1 dB steps.
Modulation Select	"MOD XXX"	Where XXX can be MOD, OFF, or + 1 kHz.

CONTROL	FORMAT	DESCRIPTION
Modulation Adjust	"MDA n.nn E+n"	Value can be from 0 - 255.
+1 kHz Adjust	"1kA n.nn E+n"	Value can be from 0 - 255.
Mod In Adjust	"MIA n.nn E+n"	Value can be from 0 - 255.
Sensitivity	"SEN XXX"	Where XXX can be MAX, -40, -20, or 0.
Squelch	"SQL n.nn E+n"	Value can be from 0 - 255.
Selectivity	"SEL X"	Where X can be W, M, or N.
Meter Select	"MSL XXXX"	Where XXXX can be 15k, 5k, 1.5k, %AM, Px1, Px10, or SINAD.
Frequency Error Range	"FER XX"	Where XX can be 1.5, 5, or 15.
Frequency Error Adjust	"FAD X.XXE+n"	Where X.XXE+n is 0 to255 value number.
Function Meter	"MET?"	Format of the response is: "MET ± n.nn E+n". Range and meaning set by Meter Select control above.
Read Frequency Error Meter	"FRQ? "	Format of the response is: "FREQ ±X.XX E+n". Range of value set by Frequency Error range command above.
Read Zero Scan Log Amp	"FS?"	Format of the response is: "FS X.XX E±n". Range of the value is set by the Sensitivity command above.

9.16.3 The following is a typical command sequence from the RS-232 Controller for reading RF and Audio frequencies back from the CE-6232:

COMMAND	FORMAT	RESPONSE
Read GENERATE frequency	GEN?	Format of the response is: "RF ± n.nnnnnn E+n"
Read RECEIVE frequency	RCV?	Format of the response is: "RF ± n.nnnnnn E+n"
Read Mod Tone Frequency	TON?	Format of the response is: "TON ± n.nnnn E+n"
Go toLOCAL control	LOC	Return control to Front Panel

TABLE 9-1
RS-232 COMMAND DICTIONARY

COMMAND	DEFINITION
1KA	1 kHz Adjust
FAD	Frequency Adjust
FER	Frequency Error Range
FRQ?	Read Frequency Error Meter
FS?	Read Zero Scan Log Amp Level
FUN	Function
GEN	Generate Frequency
GEN?	Read back GEN frequency
LOC	Go to Local Control
MDA	Modulation Adjust
MET?	Read Function Meter
MIA	Modulation In Adjust
MOD	Modulation
MSL	Meter Select
MTY	Modulation Type
RCV	Receive Frequency
RCV?	Read back RCV frequency
SEL	Selectivity
SEN	Sensitivity
SIG	Signal Generator ON/OFF
SGC	Signal Generator (Coarse)
SQL	Squelch
TON	Modulation Tone Frequency
TON?	Read back TON frequency

ADDENDUM TO OPERATORS MANUAL

CE-6408 SIGNAL CENTER UNIVERSAL ENCODER
Firmware Version 1.10

SCOPE:

The following operators manual revsions apply to firmware version 1.10 for both the CE-408D module and the CE-6408 Signal Center:

1) Delete section 7.40.6 through 7.40.8 (as numbered in the manual for the Signal Center).

2) Replace the deleted sections with the following new sections regarding the operation of Motorola, NEC D3, and POCSAG signaling.

7.40.6 Motorola GSC (Mode 2)

The following procedure is used to signal Motorola digital pagers using the GSC format. These pagers include the Model BPR-2000 and the OPTRX. For this format each pager is assigned a 6 digit address or cap-code (The OPTRX may have two cap codes). For each cap-code the pager can be alerted in four different ways. In other words each address has 4 functions or sub addresses.

NOTE: In ALL cases where Motorola's Golay-sequential-Code (GSC) is to be encoded, the pagers cap-code consist of a 6 digit number. However, on some later model pagers, and in particular OPTRX pagers, a 7 digit address is printed on the pager. The seventh digit is known as the "Pager Function" and represents both the CE-6408 function digit (e.g. 1,2,3, or 4) and the CE-6408 mode digit (e.g., 1=tone only, 2=display, or 3=voice). To generate the correct signaling enter the first 6 digits (i.e. the pager's address) as is, and then use the following table to convert the Motorola Pager Function to the function and mode digits required by the CE-6408.

EXAMPLE:

A Motorola OPTRX pager has the address "1234565" printed on it. Using the following table, the correct eight digits for the CE-6408 are "12345612" which will cause a Data Display Page to be generated.

MOTOROLA PAGER FUNCTION	CE-6408 FUNCTION-MODE DIGIT	TYPE OF PAGE
1	1 - 3	Tone & Voice
2	2 - 3	Tone & Voice
3	3 - 3	Tone & Voice
4	4 - 3	Tone & Voice
5	1 - 2	Data Display
6	2 - 2	Data Display
7	3 - 2*	Data Display
8	4 - 2*	Data Display
9	1 - 1*	Tone Only
0	2 - 1*	Tone Only

NOTE: The Function-Mode digit combinations marked with an "*" are the only valid entries for the BPR-2000 pager.

The following procedure is used to signal Motorola GSC type pagers:

STEP 1: Rotate the selector switch to DGTL

STEP 2: Use Mode-0 to set the proper FM deviation to +/- 4.5 kHz if this has not already been done.

STEP 3: To select the Motorola GSC format store a "2" in the mode register R0 (The CE-6408 will remain in the Motorola GSC mode until another code is stored in R0. Therefore, it is not necessary to repeat this step before each test page).

STEP 4: Enter the pagers 6 digit cap code (include leading zeros.

STEP 5: Enter the desired pager function digit: (1,2,3 or 4).

STEP 6: Enter the "mode" number, either a 1,2 or 3 depending on the type of page you want the CE-6408 to generate. Entering a 1 causes the CE-6408 to send just the pager's address. Therefore, this type should be used only when the pager's Tone-Only functions are to be alerted. Entering a 2 causes the CE-6408 to send an address followed by the prestored display message "123456789-0" NOTE: For the OPTRX pager the test message is "A,49'F-P". This mode should be used only when alerting the pager's display functions. Entering a 3 causes the CE-6408 to send the pager's address followed by a speaker activation code used for Tone and Voice Paging.

STEP 7: Press the Send (SND) button each time the page is to be transmitted except where R2 has been programmed for repeat page.

7.40.7 NEC D3 DISPLAY (Mode 3)

STEP 1: Rotate the function selector to DGTL.

STEP 2: Use mode 0 to set the proper FM deviation if this has not already been done.

STEP 3: Store a 3 in R0 to select Mode 3 (The CE-6408 will remain in the NEC mode until another code is stored in R0).

STEP 4: Enter the one digit synchronization code i.e. 1,2,3 or 4. This code is pager dependent, however, most systems use sync. code "1".

STEP 5: Enter a "0" followed by the 6 digit pager address. There should now be a total of 8 digits in the display.

STEP 6: Press SND to start the page. The prestored display message is "1234567890".

7.40.8 POCSAG & NEC D4 (Mode 4)

STEP 1: Rotate the selector switch to DGTL.

STEP 2: Use mode 0 to set the FM deviation if this has not already been done.

STEP 3: Store a 4 in R0 to select mode 4 (The CE-6408 will remain in the POCSAG (Also NEC D4) mode until another code is stored in R0).

STEP 4: Enter the desired function code 1,2,3, or 4.

STEP 5: Enter the 7 digit pager address (include leading zeros). There should now be 8 digits in the display.

STEP 6: Press the SND button to start the page sequence. The prestored display message of "12345" is sent to the pager for all four functions of the address.

5/6 TONE FUNCTION

7.31 The 5/6 Tone function can generate sequences of from 1 to 8 tones bursts. Four different formats may be generated (i.e. US 5/6 Tone, and European ZVEI, CCIR & EEA) depending on what mode has been selected. There are 16 registers associated with the 5/6 Tone function and the contents of register "F" determines what format will be generated. When the encoder is first turned on the frequency and timing values listed in table 7-9A, which are for the US 5/6 Tone format, are automatically loaded into the 16 registers. To change to another format, all that is necessary is to store the format's mode designation digit in register "F" (only modes 1-4 are valid) and the other 15 registers are automatically modified.

7.32 In the 5/6 Tone code plan, each digit in the cap-code (i.e. the decoder's address) represents a specific tone frequency. In the CE-6408 Signal Center, these digits (0-9) also correspond to the registers in which the decimal digits frequency is stored. Therefore, the tone frequencies sent are those stored in the registers corresponding to the cap-code.

NOTE If the cap-code consists of 2 or more identical digits in a row, the repeat tone (stored in Register "E") is automatically sent when required.

TABLE 7-9A

DESCRIPTION	REGISTER #	PREPROGRAMMED VALUE
Digit 0 Freq.	0	600.0 Hz
Digit 1 Freq.	1	741.0 Hz
Digit 2 Freq.	2	882.0 Hz
Digit 3 Freq.	3	1023.0 Hz
Digit 4 Freq.	4	1164.0 Hz
Digit 5 Freq.	5	1305.0 Hz
Digit 6 Freq.	6	1446.0 Hz
Digit 7 Freq.	7	1587.0 Hz
Digit 8 Freq.	8	1728.0 Hz
Digit 9 Freq.	9	1869.0 Hz
Preamble On Time	A	690 ms
Preamble Tone Freq.	B	600.0 Hz
Digit Tone On Time	C	33 ms
Dual Address Tone Freq.	D	2010.0 Hz
Repeat Tone Freq.	E (*)	459.0 Hz
Mode (Format Selection)	F (#)	1

7.33 US 5/6 TONE

7.331 To signal a 5-Tone pager, simply enter the pager's five digit cap-code, as is, and press the SND key.

7.332 To signal the pager's dual address, enter the same five digit cap-code, followed by 2nd D. Press the SND key.

7.333 To send a preamble tone before the address signaling, first press the 2nd B key. Then enter the five digit cap-code (i.e. the cap-code less the preamble digit). If a dual address is desired, now press the 2nd D key. Finally, to send the entire sequence, press the SND key

NOTE The preamble register (RB) must be programmed with the preamble frequency being used.

7.334 To program the preamble frequency in register B (RB), first determine the preamble digit from the cap-code. Then, use the CE-6408 Signal Center to determine the corresponding frequency for this digit by pressing the RCL key, followed by "P" (where P is the preamble digit). Then, while the frequency is being displayed, press STO and 2nd B to program RB with the preamble frequency to generate.

7.34 European ZVEI, CCIR & EEA Formats

The formats ZVEI, CCIR and EEA may be generated by entering either a 2, 3 or 4 respectively in register F (RF). Whenever the CE6408 signal center detects a change in the contents of RF it automatically changes the frequency and timing parameters in register 0 to E for the format selected. Table 7-9B lists the register contents for the 3 European formats available.

TABLE 7-9B

REGISTER #	ZVEI	CCIR	EEA	UNITS
0	2400.0	1981.0	1981.0	Hz
1	1060.0	1124.0	1124.0	Hz
2	1160.0	1197.0	1197.0	Hz
3	1270.0	1275.0	1275.0	Hz
4	1400.0	1358.0	1358.0	Hz
5	1530.0	1446.0	1446.0	Hz
6	1670.0	1540.0	1540.0	Hz
7	1830.0	1640.0	1640.0	Hz
8	2000.0	1747.0	1747.0	Hz
9	2200.0	1860.0	1860.0	Hz
A	70	100	40	ms
B	2400.0	1981.0	1981.0	Hz
C	70	100	40	ms
D	2800.0	2400.0	1055.0	Hz
E(*)	2600.0	2110.0	2110.0	Hz
F(#)	2	3	4	Mode

7.35 The procedure for generating a ZVEI, CCIR or EEA signaling sequence is essentially the same as for the US 5/6 Tone format with the following exceptions:

7.351 The preamble feature should not be used i.e. preceding an address by the "B" digit. This will cause the frequency stored in RB to be sent for the amount of time stored in RA followed by a gap of 45 ms before the other digits in the address are sent. **NOTE:** In cases where it is necessary to extend the time of the first tone, simply enter that time in register A. The CE-6408 always sends the first digit of the address entered (ZVEI, CCIR or EEA only) for the amount of time stored in RA and the remaining digits for the amount of time stored in RC.

7.352 Register D contains the group call tone frequency and as in the US 5/6 Tone Format, register E holds the

repeat tone frequency.

EXAMPLE: To generate a group call to the addresses 12500 to 12599 enter 125DD. The CE-6408 will automatically insert the repeat tone where necessary, in this example the tones sent would be equivalent to entering 125DE.

USING THE CE-6488SH TRANSCEIVER INTERFACE

The HP3488 Transceiver Interface is supplied with the Cushman standard Mobile Radio Automated Test Equipment (MRATE) cable. This cable includes:

4 - BNC connectors to the CE-6488

1 - Dual Banana plug (shielded) to a DC power supply

1 - Cushman ATE standard 6 pin Radio interface connector (2535-0256) and one mating plug (2535-0255).

Connection of the MRATE cable:

BNC connectors to the CE-6488 - Each of these connectors is labled according to the matching jack on the CE-6488 front panel. All four connections are on the lower left corner of the CE-6488.

Dual Banana Plug - This shielded dual plug is for connecting to the proper DC power supply for operating the radio under test. Operating limits are 50 VDC Max, 2 Amps Max.

Radio Interface Connector - This six (6) pin connector contains the major signals required for testing a radio:

POWER (+DC Voltage)	pin 5
GROUND (-DC Voltage)	pin 4
Push-To-Talk (Transmit Enable)	pin 3
Microphone (Transmit Audio)	pin 1
Earphone (Receive Audio)	pin 2
No Connection	pin 6

Should the Cushman standard connector not fit your particular radio, it is a simple matter to make an interface cable:

1 - Obtain a mating test connector for your particular radio.

2 - Determine the corresponding pins on the mating connector to the ATE functions on the Cushman standard connector.

3 - Connect wires from the radio's mating connector to the six (6) pin plug (2535-0255) to transfer over the ATE functions.

4 - Label this new interface cable appropriately.

CE-6488SH

SHORT FORM INSTRUCTIONS

The CE-6488SH is shipped configured and tested to properly operate with the demo programs supplied:

STEPIT	A menu driven control program for the CE-6488. STEPIT does not operate the Transceiver Interface unit and, therefore, will not control the radio under test. All functions on the CE-6488 front panel subject to software control* are easily operated with STEPIT.
WILSON	An automated program for performance measurement and verification of a mobile radio.

To operate one of these programs, insert the program cassette into the HP-85A and type:

LOAD "STEPIT" <End of Line Key>

or

LOAD "WILSON" <End of Line Key>

When the cassette stops and the screen returns, press the *RUN key. This* starts the program. Follow all instructions presented on the screen while the program runs.

*Receive Frequency
Generate Frequency
Tone Frequency
Receive/Generate/Duplex
Measure Function
Modulation Type
Read Meters
Selectivity
Sensitivity
Squelch Level
Output Level
Modulation Levels
Local/Remote

Refer to the CE-6488 manual for further information on these commands and how to use them.

CE-6408 SIGNAL CENTER

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PREPROGARMMED PARAMETERS

FUNCTION	DESCRIPTION	REGISTER NUMBER	VALUE
DTMF:	Mode Number	0	0
	Tone On Time	1	100 ms
	Tone Off Time	2	100 ms
	MF Row Frequencies	3-6	0.0 Hz
	MF Column Frequencies	7-A	0.0 Hz
MTS:	Frequency 1	1	600.0 Hz
	Frequency 2	2	1500.0 Hz
	Dial Pulse Width	3	100 ms
	Interdigit Time	4	500 ms
IMTS:	Mode Number	0	1
	Idle Tone Frequency	1	2000.0 Hz
	Seize Tone Frequency	2	1800.0 Hz
	Dial Pulse-Break Time	3	50 ms
	Dial Pulse-Make Time	4	50 ms
	Interdigit Time	5	250 ms
	Delay Time Before ANI	6	500 ms
SINGLE:	Tone Frequency	1	2805.0 Hz
	Dial Pulse-Break Time	2	50 ms
	Dial Pulse-Make Time	3	50 ms
	Interdigit Time	4	250 ms
UNIVERASL:	Mode Number	0	0
2-TONE	Number of 2-TONE cycles	0	1
	First Tone Frequency	1	1000.0 Hz
	Second Tone Frequency	2	500.0 Hz
	First Tone On Time	3	1000 ms
	Intertone Gap Time	4	250 ms
	Second Tone On Time	5	2500 ms
	Delay Time Before Repeat	6	2000 ms
5/6 TONE	Digit 0 Frequency	0	600.0 Hz
	Digit 1 "	1	741.0 Hz
	Digit 2 "	2	882.0 Hz
	Digit 3 "	3	1023.0 Hz
	Digit 4 "	4	1164.0 Hz
	Digit 5 "	5	1305.0 Hz
	Digit 6 "	6	1446.0 Hz
	Digit 7 "	7	1587.0 Hz
	Digit 8 "	8	1728.0 Hz
	Digit 9 "	9	1869.0 Hz
	Preamble On Time	A	633 ms
	Preamble Tone Frequency	B	600.0 Hz
	Digit Tone On Time	C	33 ms
	Dual Address Tone Frequency	D	2010.0 Hz
	Repeat Tone Frequency	* (E)	459.0 Hz
TONE CONTROL:	Guard Tone Frequency	0	2175.0 Hz
	Function Tone Frequency	1	1950.0 Hz
	High Level Guard Tone Burst Time	2	125 ms
	Function Tone Burst Time	3	40 ms

1.0 GETTING ACQUAINTED - A Quick Look

1.1 Introduction

The CE-6408 Signal Center is a microcomputer controlled audio synthesizer capable of generating the tone and data formats used for selective signalling over voice grade communications channels. The most common tone signalling formats are easily selected by the front panel function switch. Each function or sequence is generated according to a preprogrammed set of frequency and timing parameters stored in the 6408 memory. The user may send a sequence using the preprogrammed parameters or change the parameters for special purpose signalling requirements. Data generation capabilities are provided in the UNIVERSAL function mode. In this function the user may select one of several formats by first entering the appropriate mode number.

This manual is divided into three sections. Section 1 provided basic information about the 6408. The purpose of this section is to introduce the user to the features of the 6408 while, at the same time, performing the initial power-up test and check out. Section 2 describes in detail the use of the keyboard function keys. Section 3 describes how to use the 6408 for each of the several function modes.

1.2 Power-Up

It is recommended that the instructions in this section be followed when the 6408 is first unpacked or when a problem is suspected, otherwise skip over this section. To test the 6408 first make sure that the function switch is

set to one of the eight functions available i.e. "DTMF" through "TONE CONTROL".

NOTE: The function switch will rotate clockwise past the tone control function. This is for selecting test functions used by the factory.

Then turn the OFF/ON-LEVEL control switch clockwise to the ON position and observe " 6408 " followed by a single letter indicating the software version installed in the 6408 . If nothing appears check the 1/4 amp fuse in the rear panel fuse holder. If the fuse is good consult the factory for further instructions. Next rotate the function switch to a different function. The display should now show only a single zero i.e. " 0". Verify that all of the keyboard keys are operational by performing the following tests.

1) Enter the digits "1" through "8" by pressing each of the corresponding digit keys on the keyboard. The display should now read "12345678".

2) Press the CLR key to clear the display and note that the display again shows a single zero.

3) Enter the digits "9" and "0" by pressing the corresponding keys and then enter the DTMF digits 2nd A, 2nd B, 2nd C and 2nd D by first pressing the 2nd key (to select the keys second function) followed by the corresponding digit key for each DTMF digit. The display should now read "90AbCd".

4) Enter the DTMF characters 2nd * and 2nd # by pressing the [*2nd] key two times, for the "*" character, and then the [*/2nd] key followed by the [#/.] key for the "#" character. NOTE, the 2nd * and 2nd # characters are displayed as "E" and "F" respectively. The display should now read "90AbCdEF".

5) Again press the CLR key to clear the display followed by the [#/.] key to enter a decimal point and observe that only a single decimal point is being displayed.

This completes the initial power-up check. If the 6408 did not perform as indicated consult the factory.

2.0 KEYBOARD BASICS

2.1 Error Messages

The error message "Error " indicates that one of the following types of invalid keyboard operations was performed by the user.

1) Attempt to store [STO] or recall [RCL] a function register that does not exist.

2) Sending a sequence [SND] before the cap-code or dialed digit information has been entered (for 5/6 tone and IMTS mode 2).

3) Storing a number [STO] that is larger than that allowed for frequency and timing parameters (see section 2.5).

If the error message should be displayed press the [CLR] key to clear the display and enter the correct information.

2.2 Dual Function Keys

The front panel keyboard contains 16 function keys. However, to fully utilize the power of the it is necessary to be able to enter 22 different functions, either data or commands. Therefore, 6 keys must perform more than one function. The 6 dual function keys are listed below.

DUAL FUNCTION KEY	FIRST FUNCTION	SECOND FUNCTION
[A/STO]	STO-Store display data in a register	Enter "A" character
[B/RCL]	RCL-Recall and display register contents	Enter "B" character
[C/CLR]	CLR-Clear Display	Enter "C" character
[D/SND]	SND-Send sequence	Enter "D" character
[*/2nd]	Select second function for next key pressed	Enter "*" character
[#/.]	Enter Decimal Point	Enter "#" character

To use the first function associated with a key - just press the key. To use the second function just press the [2nd] key followed by the key corresponding to the function desired.

EXAMPLE: Enter a "D" character: This requires 2 keyboard entries i.e. the [2nd] key followed by the [D] key. In future instructions this operation will be denoted "ENTER 2nd D.".

2.3 Preprogrammed Frequency & Timing Parameters

Each function the is capable of generating has from 1 to 16 memory locations associated with it. Each memory location or register is designated by a number from 0 to 9 or the letters A, B, C, D, or the characters "*" or "#". NOTE, the characters "*" and "#" are displayed as "E" and "F" respectively. The registers hold frequency and timing information which is used by the particular function selected when a sequence is generated. Each time the 6408 is turned on all of the registers are preprogrammed with the frequency and timing parameters most often used with each function. Table 1 is a list of each function and the registers associated with them along with the preprogrammed value of each parameter.

2.4 Displaying Parameters - [RCL] Key

To display a registers contents for a particular function first switch the function selector to the appropriate function desired. Then using Table 1 determine the register number for the desired parameter. To display the value of the parameter press the [RCL] key (for Recall register) followed by the key corresponding to the register number. The display will now show the register number, in the left most digit, followed by the value stored in that register. If the register holds

frequency information a decimal point will also be displayed, otherwise the register holds timing or misc. information.

All frequency information is displayed in units of hertz (Hz) with a resolution of 0.1 Hz while timing information is displayed in units of milleseconds (ms) with a resolution of 1 ms. Therefore, 1 second would be displayed as "R 1000" where R is the register number.

EXAMPLE: Determine what frequency would be sent when the SINGLE function is first selected.

STEP 1: Rotate the function selector to SINGLE

STEP 2: Table 1 indicates that 2805.0 Hz is the preprogrammed frequency for this function and is stored in register 1 (R1). This may be verified by pressing the [RCL] key followed by the [1] key to recall the information stored in R1. The display should now read "1 2805.0".

2.5 Modifying Register Information - [STO] Key

Any of the parameters listed in Table 1 may be modified by the following procedure:

1) Select the particular function desired.

2) Enter the new value of the parameter using the keyboard. If necessary use the [CLR] key to clear mistakes and then enter the correct information.

   NOTE: The contents of a register can only be modified by the store operation. The effect of the [CLR] key is to clear the display only, not the contents of the register.

3) With the desired information to be stored now displayed, press the [STO] key followed by the key corresponding to the desired register. The left most digit of the display will now indicate the register to which the information was stored.

The following rules apply to storing data in registers:

1) If an attempt is made to store data in a register that doesn't exist for the function selected the error message will be displayed.

2) Frequency information may not exceed 2775 Hz while timing information may not exceed 64000 i.e. 64 seconds.

3) Frequency information may be programmed with a resolution of 0.1 Hz. If a decimal point is not entered it will be assumed to be located to the right of the last digit entered. If a decimal point is entered than only one additional digit will be accepted.

EXAMPLE: (cont.)

The previous recall operation indicated that the SINGLE function was programmed to generate a tone on the frequency of 2805.0 Hz. However, it is desired to generate a 67.0 Hz CTCSS tone using this function. This may be done by entering [6] and then [7] followed by the two keys [STO] and [1]. The display should now read "1 67.0" and the 6408 should now be generating a 67.0 Hz tone.

2.6 Dialed Digit Outpulsing

Dialed digits may be outpulsed in a group, of from 1 to 8 digits, or outpulsed individually, one at a time, for the DTMF, MTS, IMTS, and SINGLE functions.

To outpulse digits individually first clear the display and then press the [SND] key and wait for the dash "-" to be displayed. Then enter the digit to be outpulsed. A dash will again be displayed when the outpulsing of the single digit has been completed. As soon as the dash appears the 6408 is ready to accept another digit for outpulsing.

To outpulse a group of digits first clear the display and then enter the group of digits, the first digit to be outpulsed is entered first. Then press the [SND] key to start the outpulsing, starting with the left most digit in the display. The dash will again be displayed when all of the digits in the

group have been outpulsed. Once the dash has been displayed the user may enter individual digits as before. Also, when the dash is being displayed the user may press the [RCL] key (DO NOT ENTER A REGISTER NUMBER) to recall the last group of digits outpulsed. The entire group may again be outpulsed by pressing the [SND] key again.

3.0 USING THE 6408 FUNCTIONS

3.1 DTMF

The DTMF function is used to generate any of the standard tone pairs associated with the 16 DTMF digits, using mode 0, as well as custom, user defined, multi-frequency (MF) tone pairs, using mode 1. There are 11 registers associated with the DTMF function. The first 3 registers are preprogrammed with parameters on power-up and are listed below along with their preprogrammed values. Registers 3 through A (R3 - RA) contain all zeros and must be programmed by the user with row and column frequency information (see section 3.1.2)

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
0	Mode Number	0
1	Tone On Time	100 ms
2	Tone Off Time	100 ms

The DTMF/MF digits may be sent (outpulsed) as a group or individually (see section 2.6 for outpulsing). The rate at which the digits are sent depends on the information stored in R1 and R2. Each time a digit is outpulsed the tone pair corresponding to the digit entered is generated for the amount of time specified in R1 followed by a gap, of no tone, for the amount of time specified in R2.

3.1.1 Standard DTMF Signalling

To select the standard DTMF tone pair frequencies enter a zero in R0, i.e. select mode 0. Registers 3 through A are not used in mode 0 and therefore, the frequency information stored in these registers has no effect on the tone pair frequencies for standard DTMF generation.

3.1.2 Custom MF Signalling

To generate custom MF tone pairs first store a 1 in R0 to select the bank of frequencies stored in R3 - RA. Then program row frequencies in R3 - R6 and column frequencies in R7 - RA. The following figure shows the relationship between the keyboard digits and the row and column frequency registers.

R3	7	8	9	A
R4	4	5	6	B
R5	1	2	3	C
R6	*	0	#	D
	R7	R8	R9	RA

The frequency of the tone pair for a particular digit corresponds to the frequency stored in the two registers (row and column) associated with the digit in the above matrix. The largest frequency that may be generated in this mode is 2100.0 Hz.

EXAMPLE: Generate 2+2 signalling consisting of a 1500/800 Hz tone pair for 1 second followed by a 900/750 Hz tone pair for 1 second.

STEP 1: Using the digits 1 and 5 for the first and second tone pairs respectively (others can be used) program

the row and colums registers for these digits.

STEP 2: Program the frequencies for digit 1 by storing 1500.0 in R5 and 800.0 in R7.

STEP 3: Program the frequencies for digit 5 by storing 900.0 in R4 and 750.0 in R8.

STEP 4: Program the digit on times by storing 1000 in R1 and 0 in R2 for no gap between tones.

STEP 5: Generate the tone sequence by entering the digits [1] [5] and press [SND]. To send the same tone sequence again press [RCL] and [SND].

3.2 MTS

The MTS function is used to generate Mobile Telephone Service (MTS) 600/1500 Hz signalling at 10 pps. However, in this function the 6408 is not limited to generating only the standard frequencies and timing associated with MTS. The user may change the two frequencies used as well as the outpulsing rate. MTS digits may be outpulsed in a group or individually (see section 2,6). The following is a list of the 4 registers associated with MTS signalling and their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
1	Frequency 1	600.0 Hz
2	Frequency 2	1500.0 Hz
3	Dial Pulse Width	100 ms (10 pps)
4	Interdigit Time	500 ms

In the MTS function, pressing the [SND] key causes a clearing pulse to be generated before the digits in the display are outpulsed. The clearing pulse consists of 710 ms of frequency 1 followed by 710 ms of frequency 2. Each digit is seperated by the interdigit space determined by the value

stored in R4. Pressing the [CLR] key causes a reset pulse to be generated followed by the removal of tone after 500 ms has elapsed.

3.3 IMTS

The IMTS function is used to generate IMTS base to mobile, mobile to base, and general purpose FSK signalling. The type of signalling generated depends on the information stored in the 7 registers associated with the IMTS function. The following is a list of the 7 registers and their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
0	Mode Number	1
1	Idle Tone Frequency	2000.0 Hz
2	Seize Tone Frequency	1800.0 Hz
3	Dial Pulse-Break Time	50 ms
4	Dial Pulse-Make Time	50 ms
5	Interdigit Time	250 ms
6	Delay Time Before ANI	500 ms

The number stored in register 0 (R0) determines which type of signalling is to be generated. For IMTS base to mobile signalling a "1" must be stored in R0. Then registers 2 through 5 determine the frequency and timing of the digits to be outpulsed. Also, the user can change these parameters to generate custom FSK type signalling. For IMTS mobile to base signalling a "2" must be stored in R0. Using this mode the user can either originate a call to an IMTS terminal or simulate a mobiles response to a call from an IMTS terminal. Registers 2 through 5 are not used in IMTS mode 2.

Since the 6408 doesn't decode signalling from the IMTS terminal it doesn't know when the terminal is ready to accept the mobiles ANI digits. To insure that ANI is not sent before the terminal is ready, the sending of ANI is delayed by the

amount of time stored in R6.

3.3.1 Base to Mobile Signalling (Mode 1)

In IMTS mode 1 the 6408® will initially generate idle tone when the function is selected. To signal an IMTS mobile enter the mobiles ANI digits (from 1 to 8) and press the [SND] key. The ANI digits will then be outpulsed according to the timing parameters stored in R3 - R5. After all the digits have been outpulsed a dash will be displayed. The user may then do one of the following:

1) Enter additional digits to be outpulsed, one at a time. (enter zeros to simulate ringing to the mobile)

2) Press the [RCL] key to return to sending idle tone and recall the last ANI sent.

3) Press the [CLR] key to return to sending idle tone and clear the display.

3.3.2 Mobile to Base Signalling (Mode 2)

IMTS mode 2 is used for testing the operation of IMTS central office terminal equipment. In this mode the CEC-10 may be used to simulate a call from an IMTS mobile or to simulate the mobiles response to a terminal originated call. In IMTS mode 2, three of the keyboard keys take on a special meaning as described below.

KEYBOARD DIGIT	NEW FUNCTION
2nd *	Send Acknowledge Tone
2nd #	Send Answer Tone
2nd D	Send Disconnect Tones

3.3.2.1 Mobile Originates the Call

To originate a call to an IMTS terminal, first make sure that a "2" is stored in R0 of the IMTS function. Then enter the mobile units ANI digits (from 1 to 8 digits). While the ANI digits are being displayed press the [SND]

key. The 6408 will generate a connect sequence, delay for the amount of time stored in R6, and then send the ANI dispalyed at 20 pps with parity.

When all of the ANI digits have been outpulsed a dash will be displayed. At this time the user may simulate IMTS mobile dial pulsing by entering each digit, one at a time. Each time a digit is entered it will be outpulsed and then a dash will be displayed again to indicate that The 6408 is ready to accept the next digit. Also, while the dash is being displayed the user may press the [RCL] key to recall the last ANI sent or enter the 2nd D character to send mobile disconnect signalling. After the disconnect tones are sent the display will automatically be updated with the last ANI sent.

3.3.2.2 Terminal Orignates the Call

To simulate a mobiles response to an IMTS call, first clear the display. As soon as the IMTS terminal completes the base to mobile signalling enter the 2nd * character to send the mobile acknowledment tone. Then to simulate mobile answer press the 2nd # key. As before, the 2nd D key may be pressed to send disconnect.

3.4 SINGLE

The SINGLE function is used for generating single tones e.g. CTCSS tones as well as single tone interrupted signalling. Single tone interrupted digits may be outpulsed in a group or individually (see section 2.6). There are 4 registers associated with the SINGLE function and they are listed below along with

their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
1	Tone Frequency	2805.0 Hz
2	Dial Pulse-Braek Time	50 ms
3	Dial Pulse-Make Time	50 ms
4	Interdigit Time	250 ms

As soon as the SINGLE function is selected a tone is generated on the frequency stored in R1. To Change the frequency, first clear the display and then enter the new tone frequency and then press the [STO] [1] keys. The will now be generating the new frequency being displayed.

3.5 2-TONE

The 2-TONE function is used to generate 2-tone sequential signalling. There are 7 registers associated with the 2-TONE function and they are listed below along with their preprogrammed values.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
0	Number of 2-tone cycles	1
1	First Tone Frequency	1000.0 Hz
2	Second Tone Frequency	500.0 Hz
3	First Tone On Time	1000 ms
4	Intertone Gap Time	250 ms
5	Second Tone On Time	2500 ms
6	Delay Time Before Repeat	2000 ms

To send a 2-TONE sequence first store the desired first and second tone frequencies in R1 and R2 respectively. Pressing the [SND] key will cause the tone sequence to be generated according to the timing parameters stored in R3 - R5. If more than one sequence is to be generated, store the total number of cycles in R0 and the delay time between sequences in R6. Then press the [SND] key to start the cycle.

While the first tone is being generated the display will

read " 1" followed by " 1-" during the intertone gap followed by " 1-2" during the generation of the second tone. If the value stored in R6 is greater than "1" the display will read " 1-2-" during the repeat delay period.

3.6 5/6 TONE

The 5/6 TONE function is capable of generation sequences of from 1 to 8 tone bursts. There are 15 registers associated with the 5/6 TONE function and they are listed below along with their preprogrammed values. The preprogrammed values are those used in the standard EIA 5/6 tone format. However, other formats may be generated by entering the decimal digit, dual address and repeat digit tone frequencies and timing in the appropriate registers.

REG. #	DESCRIPTION	PREPROGRAMMED VALUE
0	Digit 0 Frequency	600.0 Hz
1	Digit 1 "	741.0 Hz
2	Digit 2 "	882.0 Hz
3	Digit 3 "	1023.0 Hz
4	Digit 4 "	1164.0 Hz
5	Digit 5 "	1305.0 Hz
6	Digit 6 "	1446.0 Hz
7	Digit 7 "	1587.0 Hz
8	Digit 8 "	1728.0 Hz
9	Digit 9 "	1869.0 Hz
A	Preamble On Time	633 ms
B	Preamble Tone Frequency	600.0 Hz
C	Digit Tone On Time	33 ms
D	Dual Address Tone Frequency	2010.0 Hz
* (E)	Repeat Tone Frequency	459.0 Hz

In the 5/6 tone code plan each digit in the pager cap-code represents a specific tone frequency. In the 6408 these digits, 0 - 9, also correspond to the registers in which the decimal digits frequency is stored. Therefore, the tone frequencies sent are the ones stored in the registers corresponding to the cap-code. However, if the cap-code consists of 2 or more

identical digits in a row the repeat tone frequency, stored in R*, is automatically sent in place of the digits entered.

To signal a 5 tone pager simply enter the pagers 5 digit cap-code, as is, and press the [SND] key.

To signal the dual address for the pager enter the same 5 digit cap-code followed by 2nd D and press the [SND] key.

To send a preamble tone before the address signalling, first press the 2nd B key then enter the 5 digit cap code, i.e. the cap-code less the preamble digit, and then press the 2nd D key if the dual address is desired. Then press the [SND] key to send the entire sequence.

NOTE: The B register, i.e. RB, must be programmed with the preamble frequency being used.

To program the preamble frequency in RB, first determine, from the cap-code, the preamble digit. Then use the to determine the corresponding frequency for this digit by pressing the [RCL] key followed by [P] where P is the preamble digit. Then while the frequency is being displayed press [STO] and 2nd B to program the RB with the preamble frequency.

EXAMPLE: Send the dual address tone signalling corresponding to the cap-code 6/12344.

STEP 1: Here the preamble digit is 6 and the frequency corresponding to this digit is found by pressing [RCL] [6].

STEP 2: The preamble frequency is stored in RB by pressing [STO] 2nd B. The display should now read "b 1446.0".

STEP 3: Next program the 6408 to send the tone sequence for this cap-code by pressing 2nd B followed by 12344, followed by 2nd D. The display should now read " b12344d".

STEP 4: Press the [SND] key each time the tone sequence is to be generated.

3.7 TONE CONTROL

The TONE CONTROL function is capable of generating the tone sequence used in tone remote control of base station equipment. The TONE CONTROL sequence consists of a burst of high level guard tone (at 0 dBr) followed by a burst of function tone (at 0 dBr) followed by low level guard tone (transmit hold tone at -20 dBr). There are 4 registers associated with the TONE CONTROL function and they are listed below along with their preprogrammed values.

REG. #	DECRIPTION	PREPROGRAMMED VALUE
0	Guard Tone Frequency	2175.0 Hz
1	Function Tone Frequency	1950.0 Hz
2	High Level Guard Tone Burst Time	125 ms
3	Function Tone Burst Time	40 ms

To start the tone control sequence press the [SND] key. The display will read " 1" while the high level guard tone is being generated followed by " 12" while the function tone is being generated followed by " 12-" while the low level guard tone is being generated. Low level guard tone will continue to be sent until the [CLR] key is pressed.

3.8 UNIVERSAL

The UNIVERSAL function allows the user to generate None Return to Zero (NRZ) data sequences. The data output is at the BNC connector on the rear panel of the 6408 . The following is a list of the data sequences currently available in the UNIVERSAL function:

MODE #	DESCRIPTION
0	134 Hz Test Signal
1	DIGITAL CODED SQUELCH-Continuous 23 bit word

The data sequence generated depends on the mode number stored in register 0 (R0) of the UNIVERSAL function.

3.8.1 Digital Coded Squelch (DCS)

Both modes "0" and "1" are associated with testing DCS systems such as those made by Motorola, E.F. Johnson, and Ferritronics. Mode 0 generates a test signal useful in setting FM signal generator deviation, if one is used. Mode 1 allows the user to generate the actual 23 bit DCS data by simply entering the 3 digit octal DCS code. The data may be sent noninverted or inverted.

3.8.1.1 Mode 0

The digital (NRZ) output may be feed to a FM signal generator or directly connected to the digital input of the DCS board under test. If a signal genrerator is used, mode 0 must first be used to set the proper FM deviation, otherwise skip to section 3.8.1.2.

NOTE: The signal generator must employ direct FM, NOT PHASE MODULATION and the 6408 's data output must either be DC coupled to the modulator or coupled through a large capacitor ($\geq$ 25 uF) to insure proper modulation by the NRZ data which contains frequency components near DC.

The following procedure is used to set the signal generator deviation:

STEP 1: Select the UNIVERSAL function and make sure that a "0" is stored in R0.

STEP 2: Press the [SND] key to generate the 134 Hz test signal.

STEP 3: Adjust the FM deviation to ±0.5 - ±1.0 KHz.

STEP 4: Press the [CLR] key to halt generation of the test signal.

NOTE: The keyboard will be locked (except the [CLR] key) while the 6408 is generating continuous data sequences. To halt data generation, and unlock the keyboard, either press the [CLR] key or select another function.

3.8.1.2 Mode 1 - DCS Generation

The following procedure is used to generate DCS data i.e. a continuous sequence of the 23 bit code word.

STEP 1: Select the UNIVERSAL function and make sure that a "1" is stored in R0, i.e. to select mode 1.

STEP 2: Enter the 3 digit octal DCS code number.

STEP 3: To send noninverted data - just press the [SND] key. To send inverted data - first enter a decimal point and then press the [SND] key.

STEP 4: To halt data generation - press the [CLR] key or select another function. Either of these actions will cause the to send a 180 ms burst of 134 Hz turn off code and then halt data generation.

NOTE: The error message indicates that either a digit in the DCS code was larger than 7 or that more or less than 3 digits were entered for the code number.

3.9 DIGITAL PAGING

The following additional formats are provided in the UNIVERSAL function in the version B1 software as follows:

Mode #	Description
2	Motorola Golay Sequential Code (GSC)
3	NEC
4	POCSAG

Also, two additional registers are used for the above digital paging formats. Register 1 (R1) controls the polarity of the output TTL data. Normal data transmission takes place when a "0" is stored in R1 (the preprogrammed value). Storing a "1" in R1 causes the digital data to be sent INVERTED. Register 2 (R2) is used to control the number of repeats of the paging sequence. With a "0" stored in R2 the digital data is sent only once each time the SND button is pushed. With a "1" stored in R2, pressing the SND button causes the digital page to be repeated until the CLR button is pushed.

3.9.1 Motorola GSC

The following procedure is used to signal Motorola digital pagers using the Golay Sequential Code:

STEP 1: Rotate the function selector to UNIVERSAL

STEP 2: Use mode 0 to set the proper signal generator modulation deviation, see section 3.8.1.1

STEP 3: Store a 2 in R0 to select mode 2, i.e. Motorola GSC

STEP 4: Enter the pagers 6 digit address

STEP 5: Enter the desired pager function digit. See the Motorola maintenance manual for the type of pager under test to determine which functions are valid for tone only, tone/display and tone/voice.

STEP 6: Enter the desired mode number:

Mode Number	Type of Page
1	Tone Only (only address sent)
2	Tone/Display (The prestored display message "800 343-4084" is sent)
3	Tone/Voice (pagers voice output enabled)

The display should now read XXXXXXYZ
where XXXXXX is the pagers address, Y is the function code and Z is the mode number.

STEP 7: Press SND each time the page is to be transmitted.

3.9.2 NEC Digplay

STEP 1: Rotate the function selector to UNIVERSAL

STEP 2: Use mode 0 to set the proper signal qenerator modulation deviation, see section 3.8.1.1

STEP 3: Store a 3 in R0 to select mode 3, i.e. NEC Display

STEP 4: Enter the Syncronization code digit i.e. 1, 2, 3 or 4. The standard system uses a 1.

STEP 5: Enter the pagers 6 digit address.

STEP 6: Press SND each time the page is to be transmitted. NOTE: the prestored display message 8003434084" is sent to the pager.

3.9.3 POCSAG

STEP 1: Rotate the function selector to UNIVERSAL

STEP 2: Use mode 0 to set the proper signal qenerator modulation deviation, see section 3.8.1.1

STEP 3: Store a 4 in R0 to select mode 4, i.e. POCSAG

STEP 4: Enter the desired function code digit, 0, 1, 2 or 3 for the functions 1,2,3,4 respectively.

STEP 5: Enter the 6 digit (or last 6 of 7 digits) pager code.

STEP 6: Press SND each time the page is to be transmitted. NOTE: the prestored display message "48 43CCCCC" is sent to the pager.