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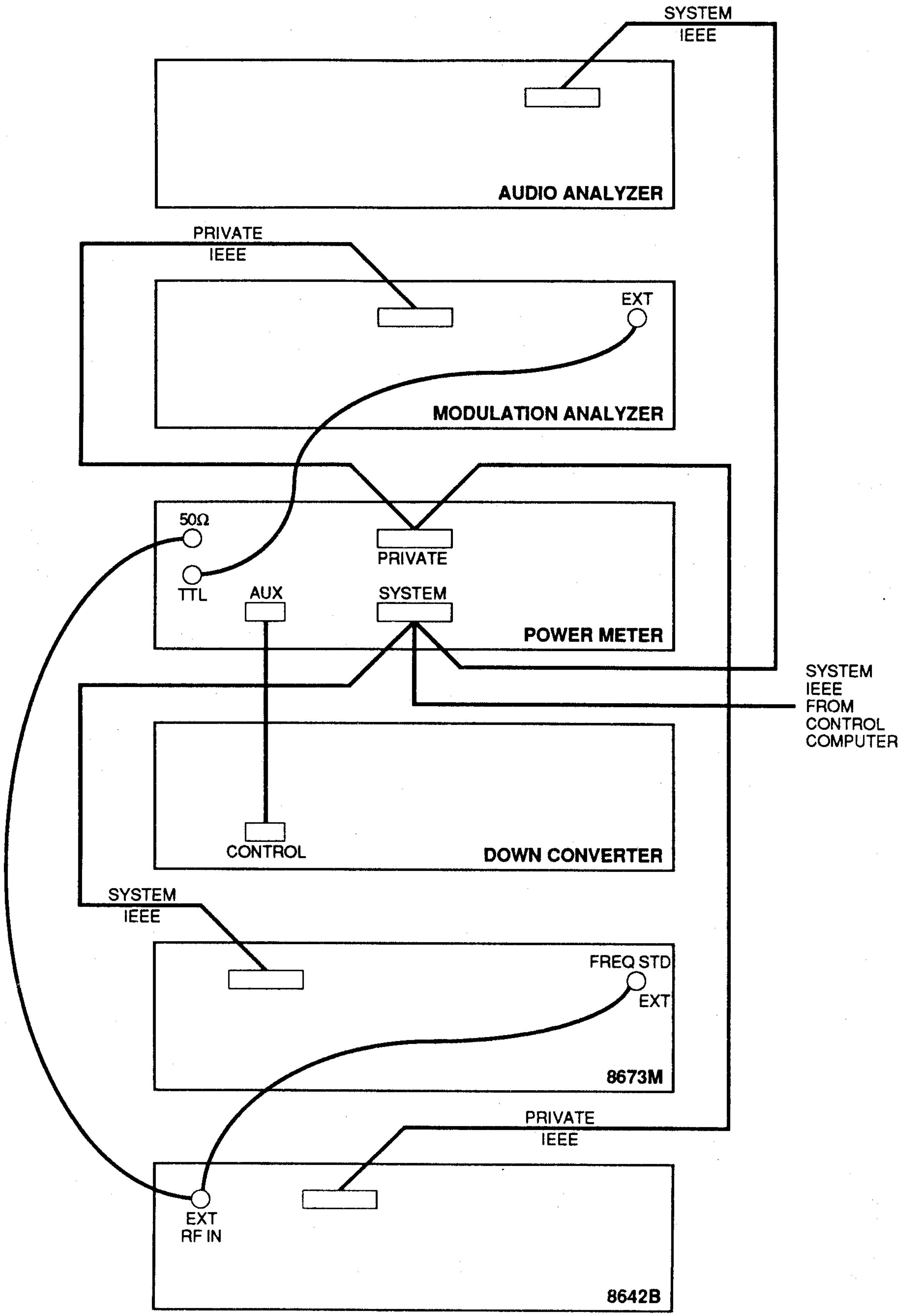

System Interconnect Diagram, Rear View.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides general information, installation information, operating instructions, theory of operation, performance tests, maintenance instructions, a parts list and schematic diagrams for the Model 8200-S/10 Modulation Analyzer. The Model 8200-S/10 is manufactured by Boonton Electronics Corporation, Randolph, New Jersey.

1-3. DESCRIPTION.

1-4. The Model 8200-S/10 is a versatile, precision, solid-state instrument with features and performance characteristics especially suitable for laboratory and industrial applications. It is a hardware variant of the Model 8200 and covers a frequency range of 100 kHz to 2.5 GHz. With the 4220-S/10, Comstron 9000S, SG1207/U, and SG1219/U the Model 8200-S/10 becomes a complete measuring receiver capable of operation to 18 GHz carrier frequencies, and able to perform level measurements to -127 dBm. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 8200-S/10. The result is a modulation analyzer that is easy and convenient to use, despite its flexibility. Among the outstanding features are:

a. Automatic or manual tuning and leveling. The Model 8200-S/10 can automatically acquire the largest signal present at the input connector and adjust its local oscillator and measurement channel gain to provide a calibrated display of amplitude, phase, or frequency modulation. Additionally, the operator can manually program carrier frequency to eliminate acquisition time. This may be accomplished using the front panel keys or remotely via the IEEE-488 bus.

b. Separate displays of all major functions. The Model 8200-S/10 has three separate displays to present simultaneously carrier frequency, carrier power or tuned level, modulation AM, FM, or PM, and program number or special function. Continuous display of IEEE-488 bus status is also presented.

c. Separate 455 kHz IF System. The 8200-S/10 contains a separate 455 kHz IF system for use with an external local oscillator and mixer to provide tuned level measurements from 0 to -127 dBm.

d. Low Residual Modulation. The exceptionally low modulation residuals provide excellent measurement accuracy with low noise sources. Direct residual measurements are possible using the Model 8200-S/10 with internal true rms detectors. In addition, active peak detectors insure exceptional baseband detection linearity so that residuals may be easily discounted for enhanced measurement accuracy.

1-5. The features described in the preceding paragraphs, together with those described in Table 1-1, make the Model 8200-S/10 particularly useful for design, production line, and field testing of FM and AM transmitters and signal generators. Because of its flexibility, the Model 8200-S/10 is also a good modulation analyzer for laboratory applications.

1-6. OPTIONS.

1-7. There are no options currently available for the Model 8200-S/10.

1-8. Inquiries regarding special applications of the Model 8200-S/10 to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

1-9. PERFORMANCE SPECIFICATIONS.

1-10. Performance specifications for the Model 8200-S/10 and the measuring receiver system are listed in Table 1-1.

1-11. OUTLINE DIMENSIONS.

1-12. Outline dimensions of the Model 8200-S/10 are shown in Figure 1-1.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

RF INPUT

Frequency Range	**: 500 kHz to 18 GHz for AM, FM, and PM.** **: 100 kHz to 18 GHz for untuned power.** **: 2.5 MHz to 18 GHz for tuned power.**
Level Range	**: -20 dBm to +19 dBm for AM, FM, and PM. **** **: -20 dBm to +30 dBm for untuned power.** **: -110 dBm to 0 dBm for tuned power, Frequency Range: 2.5 to 1000 MHz.** **: -100 dBm to 0 dBm for tuned power, Frequency Range: 1 to 18 GHz.** **: -127 dBm to 0 dBm for tuned power, Frf = 30 MHz.** **: -105 dBm to 0 dBm for tuned power, Frf = 2.0 GHz.** **: -100 dBm to 0 dBm for tuned power, Frequency Range: 2.5 to 1000 MHz. *** **: -75 dBm to 0 dBm for tuned power, Frequency Range: 1 to 18 GHz. *** *** 30 kHz measurement bandwidth, others 200 Hz bandwidth** **** Accurate AM indications will require additional attenuation ahead of mixer from 2 to 18 GHz. Maximum usable AM input without adapter pad is approximately -6 dBm.**
Input impedance	**: 50 ohms**
VSWR	**: 1.18 from 0 to -80 dBm level, Frequency Range: 100 kHz to 1 GHz.** **: 1.40 from -80 to -127 dBm level, Frequency Range: 100 kHz to 1 GHz.** **: 1.33 from 0 to -80 dBm level, Frequency Range: 1 GHz to 2 GHz.** **: 1.5 from -80 to -110 dBm, Frequency Range: 1 GHz to 2 GHz.** **: 1.25 for all levels, Frequency Range: 2 to 18 GHz, Untuned Power.** **: 1.28 for all levels, Frequency Range: 2 to 18 GHz, Tuned Power.**

FREQUENCY MODULATION

Measurement	**: +peak, -peak, peak average, and RMS.**
Rates	**: 30 Hz to 10 kHz, Frequency Range: 0.5 to 10 MHz.** **: 30 Hz to 200 kHz, Frequency Range: 10 MHz to 18 GHz.**
Range	**: 0 to 50 kHz peak, Frequency Range: 0.5 to 10 MHz.** **: 0 to 500 kHz peak, Frequency Range: 10 MHz to 18 GHz.**
Resolution	**: 1 Hz, 0 to 5 kHz deviation.** **: 10 Hz, 5 to 50 kHz deviation.** **: 100 Hz, 50 to 500 kHz deviation.**
Accuracy* **	**: 2% of reading, 20 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz.** **: 1% of reading, 50 Hz to 100 kHz rates, Frequency Range: 0.01 to 18 GHz.** **: 5% of reading, 20 Hz to 200 kHz rates, Frequency Range: 0.01 to 18 GHz.** *** peak residuals must be accounted for.** **** for RMS and +-3% of reading.**

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

Distortion	**: < 0.1% for deviations < 10 kHz, Frequency Range: 0.5 to 10 MHz.** **: < 0.1% for deviations < 100kHz, Frequency Range: 0.01 to 18 GHz.**
Residual FM*	**: < 8 Hz RMS @ 1300 MHz carrier, decreasing linearly with frequency.** **: < 1.7 Hz RMS at 100 MHz.** **: < 17 Hz RMS , Frequency Range: 1.3 to 6.2 GHz.** **: < 33 Hz RMS, Frequency Range: 6.2 to 12.4 GHz.** **: < 49 Hz RMS , Frequency Range: 12.4 to 18 GHz.** *** 30 Hz to 3 kHz measurement bandwidth.**
AM rejection	**: < 20 Hz peak deviation at 50% AM, 30 Hz to 3 kHz measurement bandwidth.**
AMPLITUDE MODULATION	
Measurement	**: + peak, -peak, peak average, and RMS.**
Rates	**: 30 Hz to 10 kHz for carriers from 0.5 to 10 MHz.** **: 30 Hz to 50 kHz for carriers from 10 MHz to 18 GHz.**
Range	**: 0 to 99.9%.**
Resolution	**: 0.01% from 0.00 to 50.00% AM.** **: 0.1% from 50.1 to 99.9% AM.**
Accuracy* **	**: 2% of reading, 50 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz.** **: 3% of reading, 20 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz.** **: 1% of reading, 50 Hz to 50 kHz rates, Frequency Range: 0.01 to 18 GHz.** *** peak residuals must be accounted for.** **** for RMS and + - 3% of reading.**
Distortion	**: 0.3% for depths of 50%, Frequency Range: 0.5 to1300 MHz.** **: 0.6% for depths of 95%, Frequency Range: 0.5 to1300 MHz.** **: 1.0% for depths of 50%, Frequency Range: 1300 MHz to 18 GHz.**
Residual AM	**: 0.02% RMS, 30 Hz to 3 kHz bandwidth.**
FM rejection	**: < 0.2% AM peak at 50 kHz deviation, Frequency Range: 10 to 1300 MHz.** **: < 0.2% AM peak at 5 kHz deviation, Frequency Range: 0.5 to 10 MHz.**
PHASE MODULATION	
Measurement	**: + peak, -peak, peak average, and RMS.**
Rates	**: 200 Hz to 20 kHz.**
Range	**: 0 to 150 RADS, Frequency Range: 0.5 to 10 MHz** **: 0 to 500 RADS, Frequency Range: 10 MHz to 18 GHz.**

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

Resolution*	**: 0.001 RAD, 0 to 5 RAD deviation.** **: 0.01 RAD, 5 to 50 RAD deviation.** **: 0.1 RAD, 50 to 500 RAD deviation.** *** Up to 1 kHz modulation rate. Above 1 kHz resolution is determined by the product of deviation and modulation rate.**
Accuracy* **	**: 4% of reading, 200 Hz to 20 kHz rates, Frf < 10 MHz.** **: 3% of reading, 200 Hz to 20 kHz rates, Frf > 10 MHz.** *** peak residuals must be accounted for.** **** for RMS and + - 3% of reading.**
Distortion	**: 0.1% at 75 RAD deviation, Frf <10 MHz.** **: 0.1% at 100 RAD deviation, Frf >10 MHz.**
Residual PM	**: < 0.1 RAD RMS, 30 Hz to 3 kHz bandwidth.**
AM rejection	**: < 0.02 RAD peak at 50 % AM.**
CARRIER FREQUENCY	
Range	**: ~~500~~ 100 kHz to 18 GHz.**
Resolution	**: 10 Hz for carriers <1000 MHz.** **: 100 Hz for carriers >1000 MHz.**
Sensitivity	**: 13 mV RMS from 150 kHz to 650 MHz.** **: 28 mV RMS from 650 MHz to 1300 Mhz.** **: 0.22mV RMS in the sensitive frequency mode.**
Accuracy	**: reference accuracy + - 3 counts, Frequency Range: 0.15 to 100 MHz.** **: reference accuracy + - 3 counts or 30 Hz whichever is greatest, Frequency Range: 100 MHz to 18 GHz.**
Reference	**: 10.0000 MHz, 1 X 10-9/day aging. (after 30 days)** **: 2 X 10-10/degree C temperature influence.** **: 6 X 10-10/5-10% change in line voltage** **: 1 X 10-9 short term stability. (1 second average)**
CARRIER POWER (untuned)	
Power Range	**: -20 to +30 dBm.**
Frequency Range	**: 100 kHz to 18 GHz.**
Linearity	**: +2,-4% from +30 to -20 dBm.** **: +-1% from +20 to -20 dBm.**

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

Cal Factor uncertainty	**: 2.3% , Frequency Range: 100 kHz to 2 GHz.** **: 6.9% , Frequency Range: 2 to 18 GHz.**
Cal Factor data	**: 18 points from 1 to 18 GHz for each sensor configuration, displayed on sensor.**
Maximum power	**: 100 watts pulse, not to exceed 2 watts average.**
Sensor switches	**: mechanical, 1 million operations minimum.**
CARRIER POWER (tuned)	
Frequency Range	**: 2.5 MHz to 18 GHz**
Power Range	**: 0 to -110 dBm, Frequency Range: 2.5 MHz to 1 GHz.** **: 0 to -100 dBm, Frequency Range: 1 to 18 GHz.** **: 0 to -127 dBm at 30 MHz.** **: 0 to -105 dBm at 2 GHz.**
Resolution	**: 0.01 dB**
Accuracy	**: 0.625 dBm rss at -110 dBm. *** **: 1.0 dBm rss from -110 to -127 dBm. *** **: 0.02 dB/10dB incremental accuracy.** *** includes mismatch errors, receiver and generator.**
POWER REFERENCE	
Frequency	**: 50 MHz.**
Accuracy	**: 0.7% initial accuracy.** **: + - 1.2% over 1 year.**
AUDIO FILTERS	
High-pass	**: < 10, 30, 300 and 3000 Hz, 3-pole butterworth, except < 10 which is gaussian.**
Low-pass	**: 3, 15, 20, 50, and 220 kHz.** **: 3 and 15 kHz, 3-pole Butterworth.** **: 50 and 220 kHz , 7-pole Butterworth.** **: 20 kHz, 3-pole Bessel.**
De-emphasis	**: 25, 50, 75, and 750 us.**
Accuracy	**: + - 4 % 3-dB corner and time constant.**
AM CALIBRATOR	**: internal, 50.00% depth, 0.1% accuracy.**
FM CALIBRATOR	**: internal, 83.33 deviation, 0.1% accuracy.**

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

POWER INPUT	
	: 103 to 130 volts, 50-60 Hz, single phase.
	: supplied with power cord, 6 feet long with NEMA 5-15P vinyl plug.
ENVIRONMENTAL	
Temperature	: 4 to 40 degrees C continuous, operating.
	: -55 degrees for 12 hours storage.
	: +60 degrees for 12 hours storage.
Humidity	: 0 to 90%.
Altitude	: 0 to 10,000 feet continuous, operating.
	: 40,000 feet for 12 hours, storage.
Shock	: 15 g half-sine for 11 milliseconds, vertical and horizontal.
Tilt drop	: 4 inch drop on each side, using the opposite side as a pivot.
Vibration	: 0.01 inch double amplitude + 0.006,-0.00 from 10 to 52 Hz.
	: frequency varying from 10 to 52 Hz and back in 5 minutes.
	: done on each axis(3).
SUPPLEMENTAL SPECIFICATIONS, TUNED LEVEL	
Relative Accuracy	: Summation of the following terms plus VSWR of generator and sensor.
Detector Linearity	: 0.02 dB/10dB change for synchronous detector.
	: 0.04 dB/10dB change for average detector.
IF range changes	: 0.02 dB/10 dB the first five range.
	: 0.05 dB/10dB for the last two ranges.
RF range changes	: 0.04 dB per range, 0.06 dB average power to tuned power transfer. Adapter pad is equivalent to one RF range.
Mixer linearity	: 0.2 dB for levels from 0 to -10 dBm, Frequency range: 2 to 18 GHz.
	: negligible below -10 dBm.
Noise error	: 0.2 dB for levels < -110 dBm, Frequency range: 2.5 to 1300 mHz.
	: 0.2 dB for levels < -90 dBm, Frequency range: 1.3 to 18 GHz.
Frequency Drift error	: +-0.05 dB per kHz.

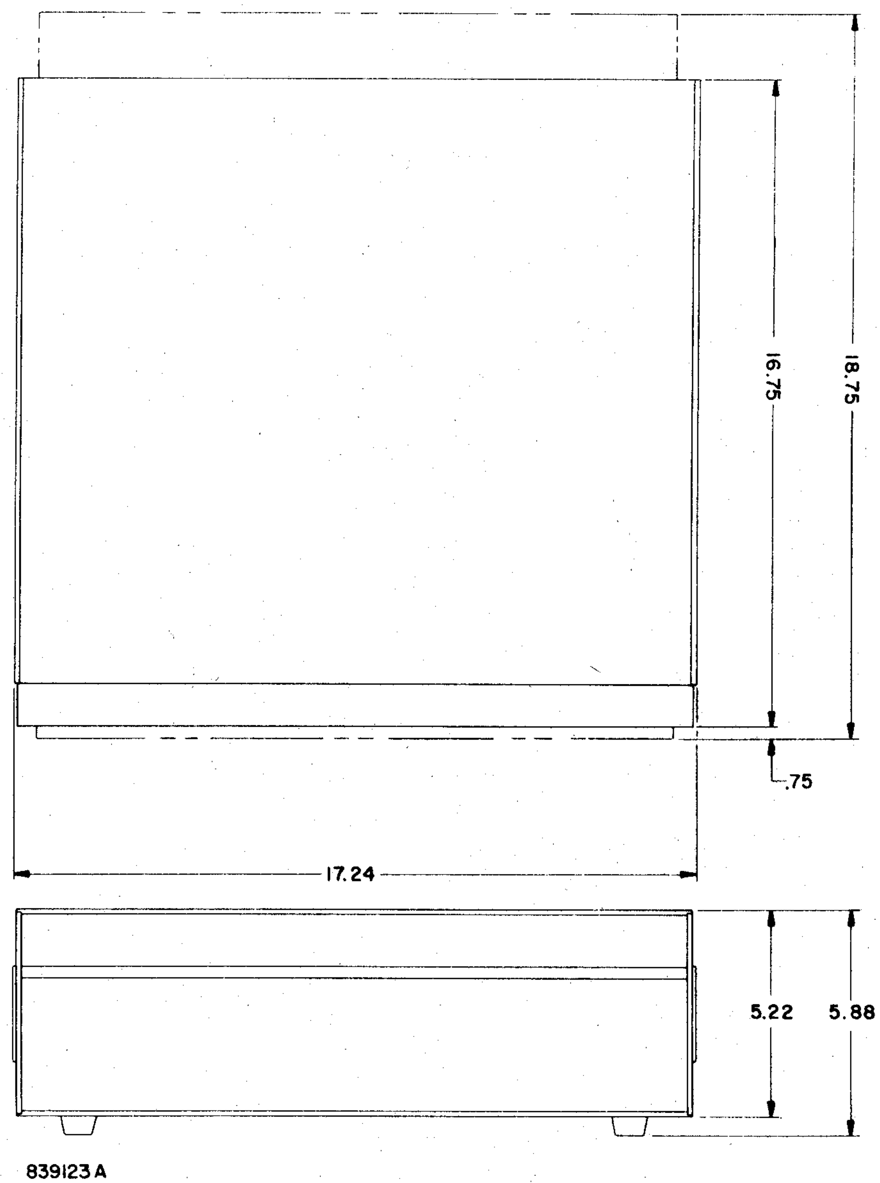

FIGURE 1-1 OUTLINE DIMENSIONS.

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SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains the installation instructions for the Model 8200-S/10 Modulation Analyzer. Included is information pertinent to unpacking, mounting, power requirements, line voltage selection, cable connections and initial inspection.

2-3. UNPACKING.

2-4. The Model 8200-S/10 is shipped complete and is ready to use upon receipt. Unpack the instrument from its shipping container and inspect it for damage that may have occurred during shipment. See Figure 2-1.

NOTE

Save the packing material and container for possible use in reshipment of the instrument.

2-5. MOUNTING.

2-6. For bench mounting, choose a clean, sturdy, uncluttered mounting surface. For rack mounting, an accessory kit 95005303A is supplied with the instrument that provides rack slides, mounting ears, and handles. The rack mounting kit also contains the required hardware and instructions.

2-7. The Model 8200-S/10 is intended to be configured into a measuring receiver system with the Model 4220-S/10 power meter/controller, the Comstron Model 9000S converter, an SG1207/U signal generator, and an SG1219/U signal generator. The preferred bench and rack mounting configuration is shown in Figure 2-2.

CAUTION

Always make certain that the line voltage selector switches are set to the correct positions most nearly corresponding to the voltage of the available a.c. power source, and that a fuse of the correct rating is installed in the fuse holder before connecting the Model 8200-S/10 to any a.c. power source.

2-8. Set the line voltage selector switches, located on the rear panel to the appropriate positions as indicated on the LINE VOLTAGE SELECT chart located next to the switches. Check that the line fuse is correct for the selected power source. The correct fuse is:

VAC +-10%	100 120	220 240	50 to 400 Hz
Fuse	3/4 ATD	3/8 ATD	80 VA

2-9. POWER FAIL PROTECTION.

2-10. If the line voltage drops more than 10% below nominal, a power fail protection circuit automatically isolates the internal random access memory and provides power from a lithium cell rated at 3.0 V and 160 mAh, with a life expectancy of more than five years. Simultaneously, the display is blanked and all internal processes stop. Normal operation resumes when nominal line voltage is restored. All conditions that existed before the loss of power, except the remote mode, will be re-established. If another

another power failure occurs during the restart process, the Model 8200-S/10 will discard the previous setup and perform an initialization restart.

2-11. CABLE CONNECTIONS.

2-12. Cable connections required depend on the use of the instrument. Cable connections that are required include:

a. **RF IN.** RF input, front panel, 50 ohm nominal impedance. Type N connector; to be connected to the Comstron 9000S frequency converter with semi-rigid cable assembly.

b. **EXT REF.** External 10 MHz counter reference, impedance and level requirements are TTL compatible, switching is automatic. Type BNC connector; to be connected to the Model 4220-S/10 REF OUT, TTL with a BNC cable.

c. **IEEE-488.** Private instrument bus connection. To be connected to the Model 4220-S/10 and SG1207/U. The SG1207/U is set to IEEE-488 bus address 19.

Optional cables that may be required include:

d. **AF OUT.** Audio output, front panel, 600 ohm impedance, 1 volt rms at 5000 counts on modulation display. Type BNC connector.

e. **AM OUT.** AM output, rear panel, 600 ohm source impedance, approximately 0.2 volts per +- 10 % AM. Type BNC connector.

f. **FM OUT.** FM output, rear panel, approximately 2 volts per +-100 kHz deviation, dc coupled, 600 ohm source impedance. Type BNC connector.

g. **IF OUT.** IF output, rear panel, 50 ohm nominal source impedance, 0 dBm level.

2-13. PRELIMINARY CHECK.

2-14. The preliminary check verifies that the Model 8200-S/10 is operational and should be performed before the instrument is placed into use.

2-15. Turn the system power ON. Wait several seconds then depress the INIT key. After the lamp test, the FREQUENCY/LEVEL display will contain the instrument firmware number and the other displays will contain dashes for a period of about three seconds. The carrier display will then change to the 'UNLOC' message and the [= = = =] message will appear in the modulation display. Refer to Section 3 for the meaning of any displayed error messages.

2-16. Depress the PRGM key. Depress the - and 1 keys to enter -1 into the SPCL/PRGM display. Depress the ENTER key to complete the entry. Now depress the RCL key. The carrier display should change to '-CAL-'. Observe the operation of the instrument. The Model 8200-S/10 is performing an internal calibration of the modulation detectors. As the calibration proceeds, the results of the calibration routines will appear in the modulation display window. The AM detector is calibrated first. The calibration point is 50.00%. If Error 40 appears in the carrier display window, a calibration fault has occurred and hardware maintenance is required.

2-17. The rms detector is calibrated next using the AM waveform. Error 41 is a calibration fault. Next comes the FM detector. The nominal indication is 83.3 kHz and error code 42 is the calibration fault. Finally, the PM detector is calibrated. The nominal indication is 90.8 RAD and the error code is 43.

2-18. After the calibration routine completes, the instrument will return to normal operation. If the calibration routine completes properly, the instrument is functional.

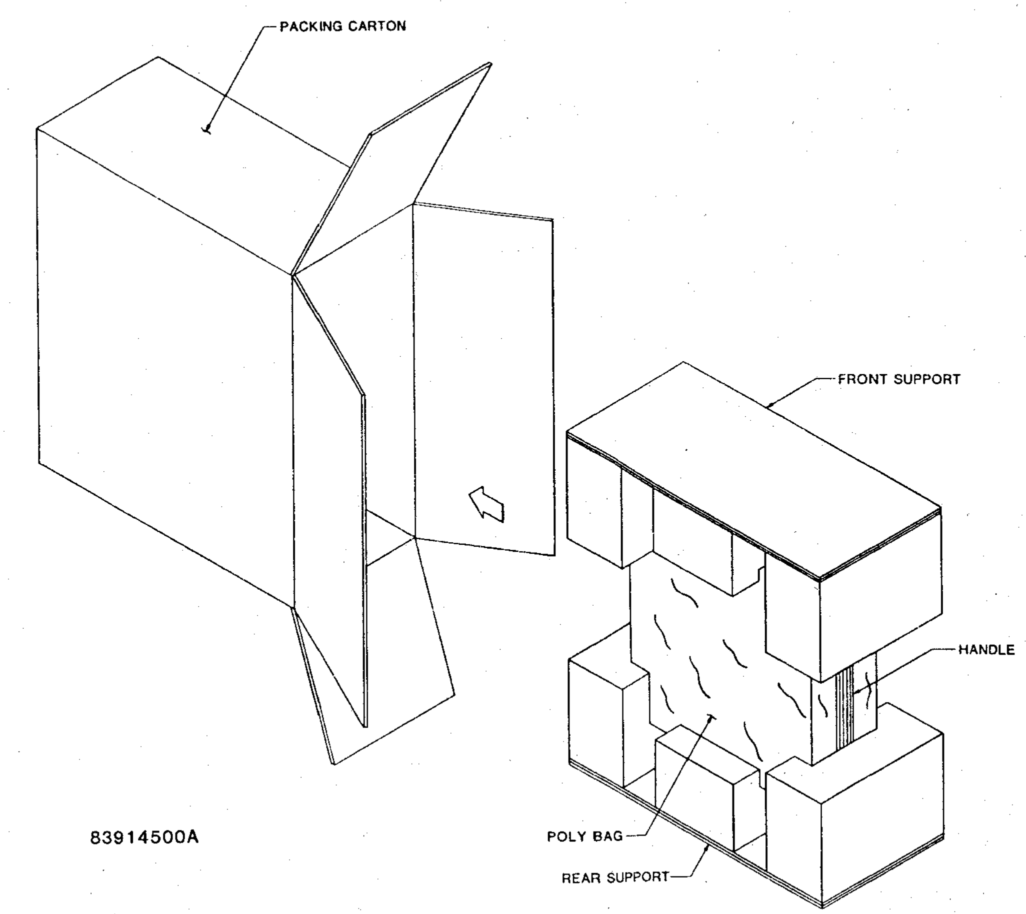

Figure 2-1. Packing and Unpacking Diagram.

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SECTION III
OPERATION

3-1. GENERAL.

3-2. This section contains complete operating information for the Model 8200-S/10 Modulation Analyzer when used in conjunction with the Model 4220-S/10 and Comstron 9000S as a Measuring Receiver system. Included are descriptions of the front and rear panel controls, displays, and connectors, option selections, and instructions for local and remote modes of operation. Additionally, typical measurement situations are described.

3-3. OPERATING CONTROLS, DISPLAYS, AND CONNECTORS.

3-4. The controls, indicators and connectors used during the operation of the Receiver are listed in Table 3-1 and shown in Figures 3-2 and 3-3.

3-5. GETTING STARTED.

3-6. Turn on the Receiver system and depress the LCL(INIT) key. After the display test, the FREQUENCY/LEVEL display will contain the 8200-S/10 firmware reference number and the other displays will contain dashes for about three seconds. The message 'UNLOC' will then appear in the carrier display window. The modulation display will contain the [= = = =] message and the SPCL/PRGM display will contain 99, the initialization program number. Refer to Table 3-10 for the meaning of any reported errors.

3-7. The front panel of the Model 8200-S/10 is organized for simple instrument operation. It consists of a display window and a separate keyboard area. The display area contains the FREQUENCY/LEVEL display, the MODULATION display, and BUS/PRGM display. The keys are organized as function keys, data keypad, and measurement control keys.

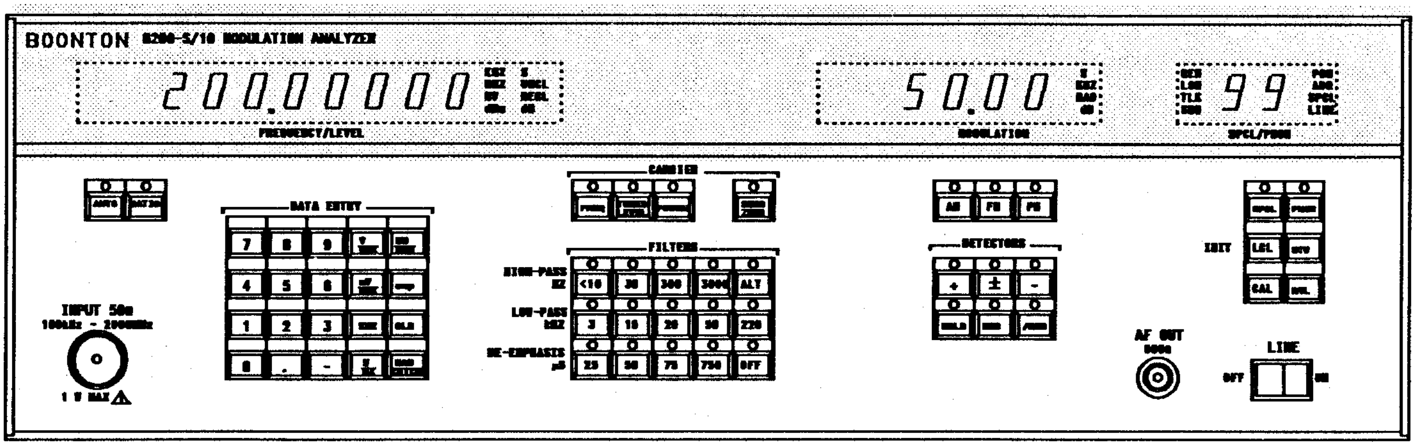

FIGURE 3-1. Instrument Displays

3-8. DISPLAYS. (Figure 3-1)

3-9. The left-most display is ten characters wide and is dedicated to measurements of carrier level and frequency. Units annunciators are mV and dBm for level and power, and MHz and kHz for frequency. Additionally, ratio units of % and dB are included as well as the RCAL and UCAL annunciators for tuned level measurements. This display is also used for error and status messages.

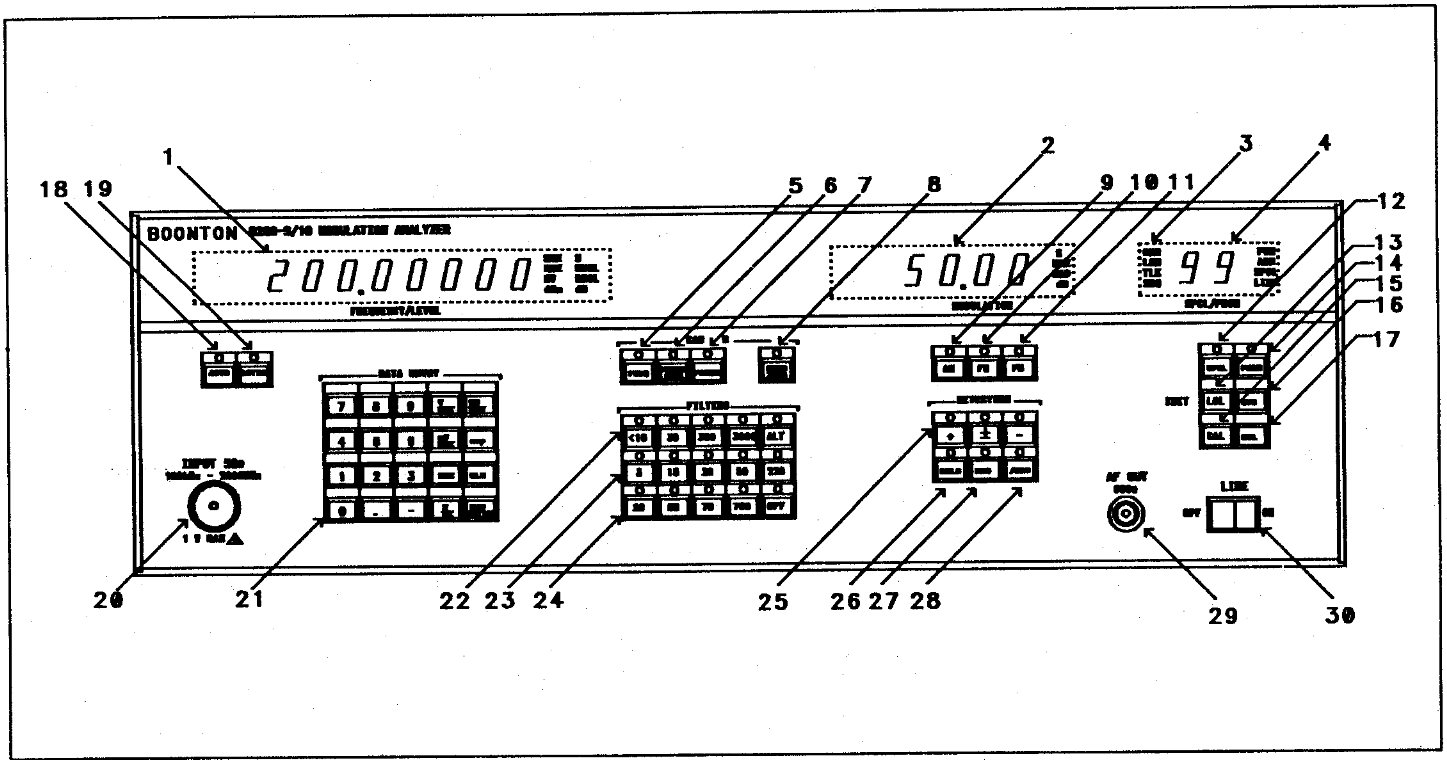

FIGURE 3-2. Model 8200-S/10, Front View.

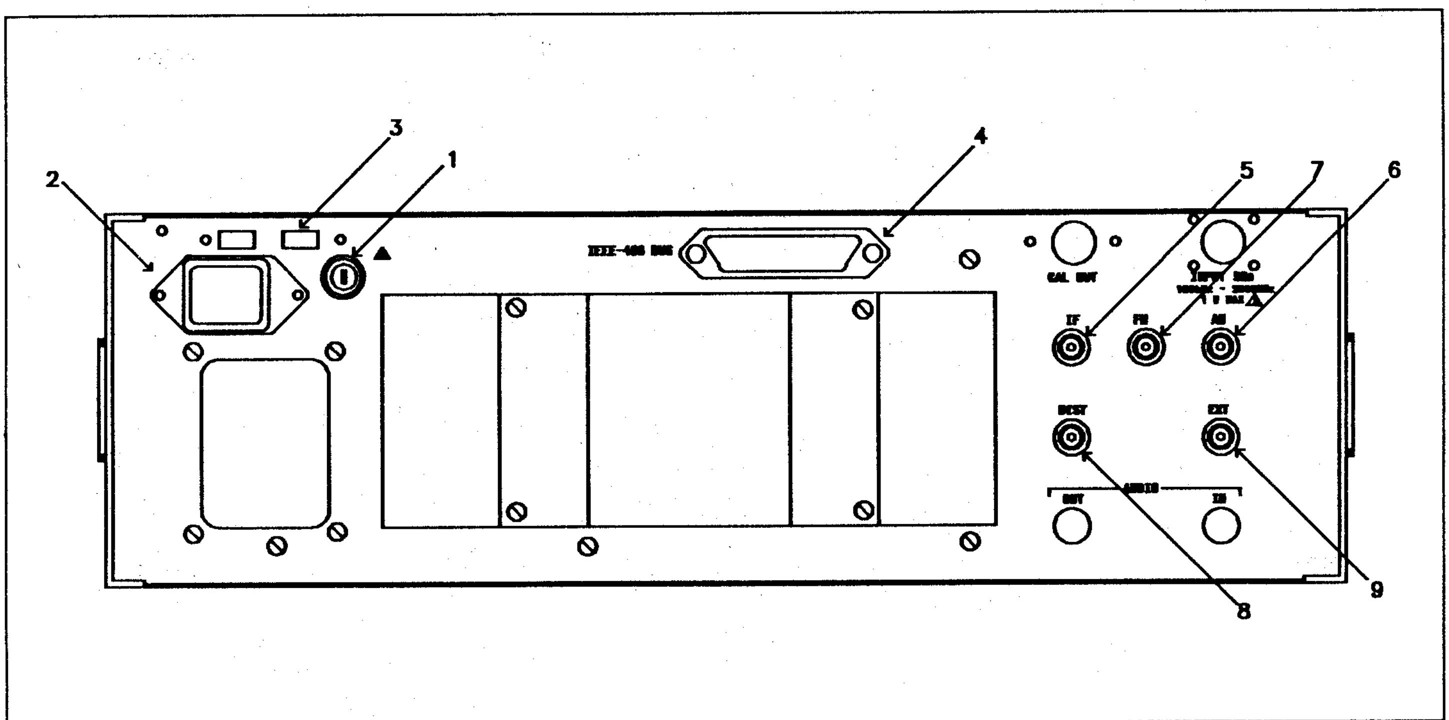

FIGURE 3-3. Model 8200-S/10, Rear View.

TABLE 3-1. CONTROLS, DISPLAYS, AND CONNECTORS.

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
FREQUENCY/LEVEL display	3-2,1	Displays carrier frequency in kHz or MHz, and RF level in dBm or mV. Alternately displays error codes and messages.
MODULATION display	3-2,2	Displays modulation in % AM, kHz FM deviation, RAD PM deviation. Also displays ratio in % or dB.
BUS Status display	3-2,3	Displays current IEEE-488 bus status; REM (remote enabled), LSN (listener addressed), TLK (talker addressed), and SRQ (service request active).
SPCL/PRGM display	3-2,4	Displays the current program number or active special function.
FREQ key	3-2,5	Selects carrier frequency as the active function. Use before setting carrier frequency or to activate carrier frequency display.
TUNED LEVEL key	3-2,6	Selects tuned level as the active function. Use before setting carrier level reference or to activate the tuned level display.
POWER key	3-2,7	Selects average power as the active function. Use before setting carrier power reference or to activate the average power display.
SENSOR ZERO key	3-2,8	Causes the average power sensor to be zeroed before a low level power measurement is made.
AM key	3-2,9	Selects AM modulation as the active function. Use before setting AM modulation reference for subsequent ratio measurement or to activate the AM modulation display.
FM key	3-2,10	Selects FM modulation as the active function. Use before setting FM modulation reference for subsequent ratio measurement or to activate the FM modulation display.
PM key	3-2,11	Selects PM modulation as the active function. Use before setting PM modulation reference for subsequent ratio measurement or to activate the PM modulation display.

TABLE 3-1. CONTROLS, DISPLAYS, AND CONNECTORS.

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
SPCL key	3-2,12	Selects special function as the active function. Use before selecting a special function.
LCL/INIT key	3-2,13	Causes instrument to "go-to-local" if local lockout is not active and remote is active, or initialize when the instrument is in the local state.
PRGM key	3-2,14	Selects instrument program as the active function. Use before selecting program number for store or recall.
CAL key	3-2,15	Causes the active function to be calibrated.
STO key	3-2,16	Stores the instrument setup at selected program number.
RCL key	3-2,17	Recalls instrument setup from selected program number.
AUTO key	3-2,18	Forces the display of the selected function to the measurement mode. Not active for the PRGM and SPCL functions.
RATIO key	3-2,19	Changes the active function display from absolute to relative. Units keys may be used to select displayed units.
RF IN connector	3-2,20	RF input connector, used to apply an external carrier signal.
DATA ENTRY keys		
0 - 9 keys	3-2,21	Numeric entry keys.
. key	3-2,21	Selects decimal point during data entry.
- key	3-2,21	Prefix for negative quantity.
V/GHz key	3-2,21	Selects volts or gigaherts units.
mV/MHz key	3-2,21	Selects millivolts or megaherts units.
kHz key	3-2,21	Selects kilohertz units.
%/Hz key	3-2,21	Selects percent or hertz units.
dB/dBm key	3-2,21	Selects log ratio or decibels referenced to 1 milliwatt.
EXP key	3-2,21	Enables scientific entry of data, (Exponent).
CLR key	3-2,21	Clears errors or current data entry.
RAD/ENTER	3-2,21	Selects radians or unitless number termination.

TABLE 3-1. CONTROLS, DISPLAYS, AND CONNECTORS.

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
High-pass Hz keys		
<10	3-2,22	Selects the < 10 Hz high-pass filter.
30	3-2,22	Selects the 30 Hz high-pass filter.
300	3-2,22	Selects the 300 Hz high-pass filter.
3000	3-2,22	Selects the 3000 Hz high-pass filter.
ALT	3-2,22	Selects the ALTernate filter group. (not in 8200-S/10)
Low-pass kHz keys		
3	3-2,23	Selects the 3 kHz low-pass filter.
15	3-2,23	Selects the 15 kHz low-pass filter.
20	3-2,23	Selects the 20 kHz low-pass filter.
50	3-2,23	Selects the 50 kHz low-pass filter.
220	3-2,23	Selects the 220 kHz low-pass filter.
De-emphasis uS keys		
25	3-2,24	Selects the 25 us de-emphasis filter.
50	3-2,24	Selects the 50 us de-emphasis filter.
75	3-2,24	Selects the 75 us de-emphasis filter.
750	3-2,24	Selects the 750 us de-emphasis filter.
OFF	3-2,24	Deselects the de-emphasis filters.
PEAK keys		
+ key	3-2,25	Selects + peak detector for display.
- key	3-2,25	Selects - peak detector for display.
± key	3-2,25	Selects peak average modulation display. The display is (+ peak (+) -peak)/2.
HOLD key	3-2,26	Alternate action key used to hold the greatest of the current or last modulation reading.
RMS key	3-2,27	Selects a true rms detector for modulation display.
√2RMS key	3-2,28	Selects a true rms detector for modulation display. The display is calibrated in rms for sine wave modulation.
AF OUT connector	3-2,29	Audio output connector, used to connect the demodulated signal to external test equipment.
LINE switch	3-2,30	Switches the instrument ac power supply ON or OFF.

TABLE 3-1. CONTROLS, DISPLAYS, AND CONNECTORS.

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
Fuseholder	3-3,1	Holds fuse for ac line protection.
Line connector	3-3,2	Permits connection of instrument to ac power supply.
Voltage Selector Switch	3-3,3	Permits the selection of various ac power supply voltages.
IEEE-488 bus connector	3-3,4	Provides a means for connecting the Model 8200-S/10 to the Model 4220-S/10 private instrument bus.
IF out connector	3-3,5	Provides a means for connecting the intermediate frequency signal to external test equipment.
AM out connector	3-3,6	Provides a means for connecting the demodulated AM signal to external test equipment.
FM out connector	3-3,7	Provides a means for connecting the demodulated FM signal to external test equipment.
DIST out connector	3-3,8	Provides a means for connecting bias to the 96400501A modulator for AM testing.
EXT REF connector	3-3,9	Provides a means for connecting an external 10.00 MHz frequency standard to the internal timebase circuits. Required for the Model 8200-S/10.

3-10. The center display is six characters wide and is used to display the measured modulation. Units annunciators are percent for AM and ratio, kHz for FM deviation, RAD for PM deviation, and dB for ratio measurements.

3-11. The right-most display is an entry only display which is two characters wide and is used to display special function or the current instrument program number. Units annunciators are PRGM for program number, SPCL for active special function, and ADRS for system IEEE-488 bus address. Also included is a line annunciator which indicates that ac power is applied.

3-12. To the immediate left of the BUS/PRGM display is the IEEE-488 status display. This display indicates REM when the Model 8200-S/10 is in the remote state, LSN when addressed as a listener, TLK when addressed as a talker, and SRQ when the Model 8200-S/10 has activated the IEEE-488 service request line.

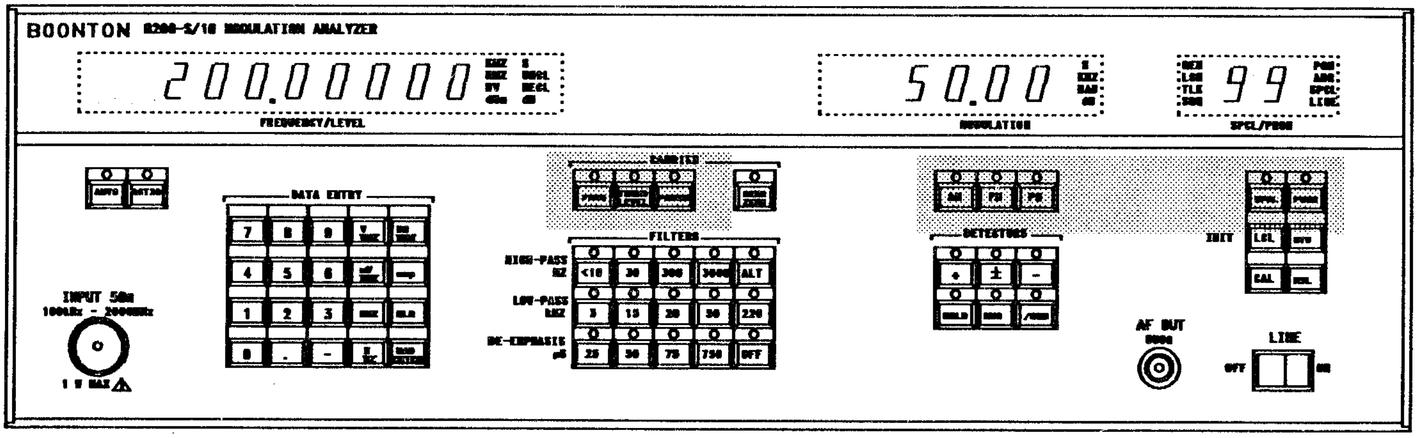

FIGURE 3-4. Function Keys.

3-13. FUNCTION KEYS. (Figure 3-4)

3-14. Most of the top row of illuminated switches are the function keys. These keys are used to select the parameter to be displayed and to enable the data keypad for subsequent data entry. The functions are FREQ, POWER, TUNED LEVEL, AM, FM, PM, SPCL, and PRGM. The LED in the switch of the selected function will be illuminated continuously. The LED in the switches of others will be off unless a measurement of that function is in progress, in which case the LED will flash during the measurement interval.

3-15. To select a function depress the desired function key. The units legends associated with that function will appear immediately to the right of the numeric display.

3-16. For example, select the carrier FREQ function. Then depress the 1 and V/GHZ keys. The display will now contain the number 1000.0000 and the active legend will be MHz.

3-17. Depress the FM function key. The LED in the carrier FREQ key will go out, and the LED in the FM key will light. Depress the 1, 0, and KHZ keys. The number 10.00 will now be displayed in the modulation display.

3-18. All other function keys operate in the same manner.

3-19. DATA KEYPAD. (Figure 3-5)

3-20. Operation of the data keypad is conventional. Select the carrier FREQ function and depress the [8] key. The carrier frequency display will indicate '8 and the units legend will go out. The tick mark (') indicates that the number displayed has not yet been entered. Continue by depressing the [2], [.], [1] and [5] keys and the MHZ key to enter the number. The display will

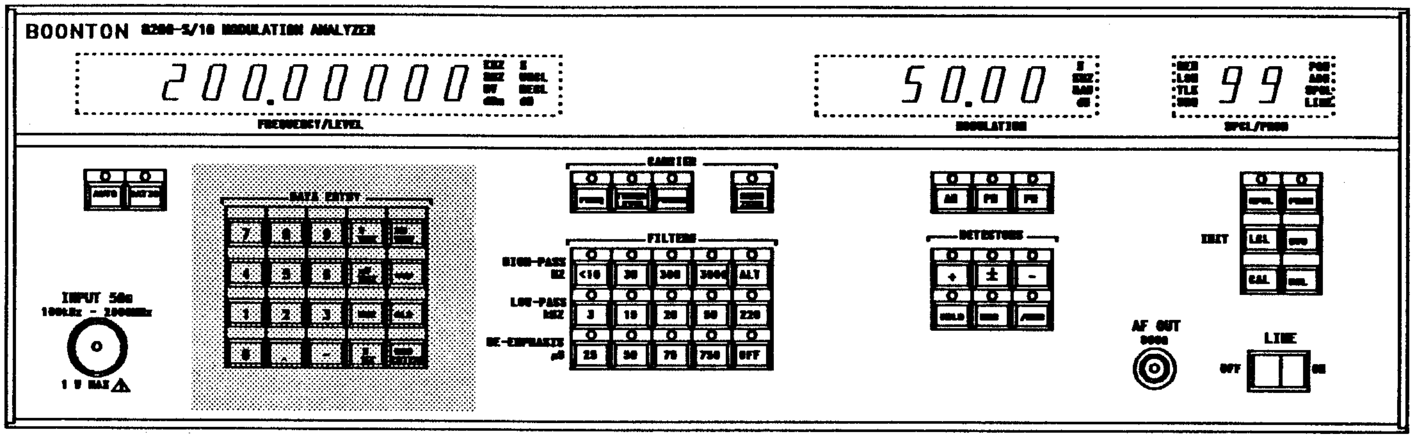

FIGURE 3-5. Data keypad.

now indicate 82.15000 MHz.

3-21. Note that it is not necessary to enter any trailing zeroes, nor is it necessary to depress the ENTER key if a units key is used. While this is the most efficient way to enter 82.15 MHz, it is equally valid to enter 82150 kHz, 82150000 Hz, 82.15 EXP 6 Hz, et cetera. If at any time prior to entry the wrong digit is entered, depress the CLR key to clear the input and restore the previous frequency display.

3-22. Depress the kHz key. The display will now contain 82150.00 and the annunciator will be kHz. The display program will rescale the number to the requested units if possible, otherwise the request is ignored. The GHz key is provided for convenience when entering frequency; however, the display will only indicate in MHz and kHz.

3-23. Depress the 1, EXP, 3, and MHz keys. The display should contain 1000.0000 MHz. The EXP key is included to allow scientific entry of data. Similarly, depressing 1, EXP, 6, and Hz, will result in a display of 1.00000 MHz. Other entry keys are used with other functions, and the ENTER key is used for unitless quantities, such as special function and program numbers.

3-24. The CLR key is used to recover from errors. Without changing function, depress the dBM key. The carrier display will now indicate Error 11. This means that an inconsistent units key has been depressed to terminate a data entry. Now depress the CLR key. The display will return to normal. All errors must be cleared by depressing the CLR key. A list of error codes is presented at the end of this section.

3-25. Depress the carrier TUNED LEVEL function key, then the 0 and dBM keys. The carrier display will now indicate 0.0 dBM. Now depress the mV/MHz key. The display will change to 223.6 mV. Carrier level may be entered in millivolts, volts, or dBm. The control program will recalculate or rescale numbers as required.

3-26. MEASUREMENT CONTROL KEYS. (Figure 3-6)

3-27. The measurement control keys consist of the groups of switches marked FILTERS and DETECTORS. These keys may be operated at any time and will affect only the MODULATION display. The filter switches are arranged as self-cancelling groups of four and five keys. Depressing any high-pass switch will cause the selected filter to be placed into the measurement channel and cancel any other selected high-pass filter. Similarly, depressing any low-pass filter will cause the selected filter to be placed into the measurement channel and cancel any other selected low-pass filter.

3-28. The maximum low-pass bandwidth selection is a function of carrier frequency. The control program will automatically adjust the low-pass filter cutoff frequency as required. The carrier breakpoints and low-pass bandwidths are:

Carrier	Filter
< 450 kHz	15 kHz max.
< 10 MHz	50 kHz max.
> 10 MHz	220 kHz max.

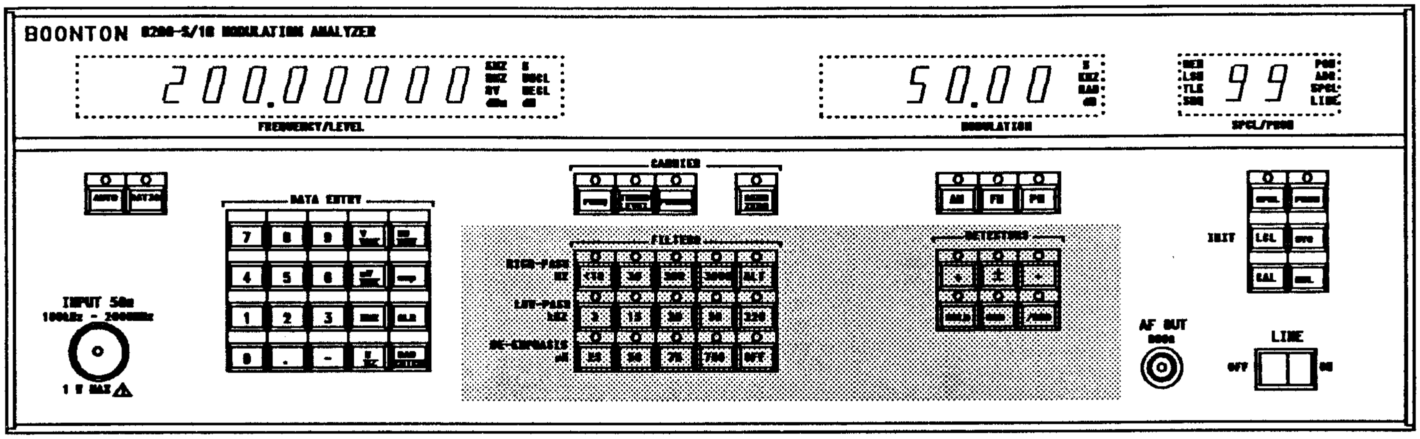

FIGURE 3-6. Measurement Control Keys.

3-29. The de-emphasis filters are normally available when measuring FM only. They are selected in the same manner as the high-pass and low-pass filters, but are automatically removed from the measurement channel when AM or PM modulation function is selected. The selected de-emphasis filter will be restored when the FM function is again selected. Additionally, the de-emphasis filters may be placed before or after the modulation display. This is accomplished be selecting SPCL 36 for pre-display and SPCL 37 for post-display operation. SPCL function 34 has been provided to allow selection of de-emphasis filters in the AM mode for test purposes. Similarly, SPCL function 35 has been included to cancel SPCL 34 without affecting other selected special functions.

3-30. The second group of measurement control keys is the DETECTOR switches. The peak detectors are normally used to measure modulation, however, precision rms detectors are included in the Model 8200-S/10. These detectors are used primarily to characterize noise residuals and complex or distorted modulation signals. The √2RMS key is used to select rms detection calibrated in peak for sinusoidal modulation. This is particularly useful when comparing peak and rms indications of noisy signals.

3-31. The Peak +, -, and ± keys and the RMS and √2RMS keys are arranged such that only one detector can be selected at a time.

3-32. The HOLD key is used to activate the hold detector mode. It is an alternate action key which can be used with any detector. In operation, as modulation measurements are made, the larger of the current measurement or the previous measurement becomes the displayed modulation. Depress the HOLD key to activate this mode, then depress the key again to cancel.

3-33. OTHER KEYS. (Figure 3-7)

3-34. The RATIO key is an alternate action key which changes the display from absolute to relative. In addition, the ratio measurement can be made relative to the current display or to a set value. Ratio can be displayed in percent or measurement units or dB for all functions except frequency. Frequency ratio can be displayed in kHz, MHz, or percent only.

3-35. The AUTO key is used to resume automatic operation of a particular function. It is active for the carrier FREQ, POWER, TUNED LEVEL, AM, FM, and PM functions. When numerical data is entered into a particular function window, the LED in the AUTO key will go out. This indicates that the selected function is not displaying a measured value. To resume measurement, depress the AUTO key. If carrier FREQ is the active function, depressing the AUTO key will always force the Model 8200-S/10 to reacquire the carrier signal.

3-36. The LCL(INIT) key is a dual function key. If the instrument is in the local IEEE-488 bus state and the key is depressed an initialization restart occurs. This is similar to a power on reset except that the current instrument status is lost and all selected special functions are returned to default settings. This does not include bus address or end-of-string selection. If the Model 8200-S/10 is remote enabled, and the local lockout bus state is not active, the instrument will return to front panel control.

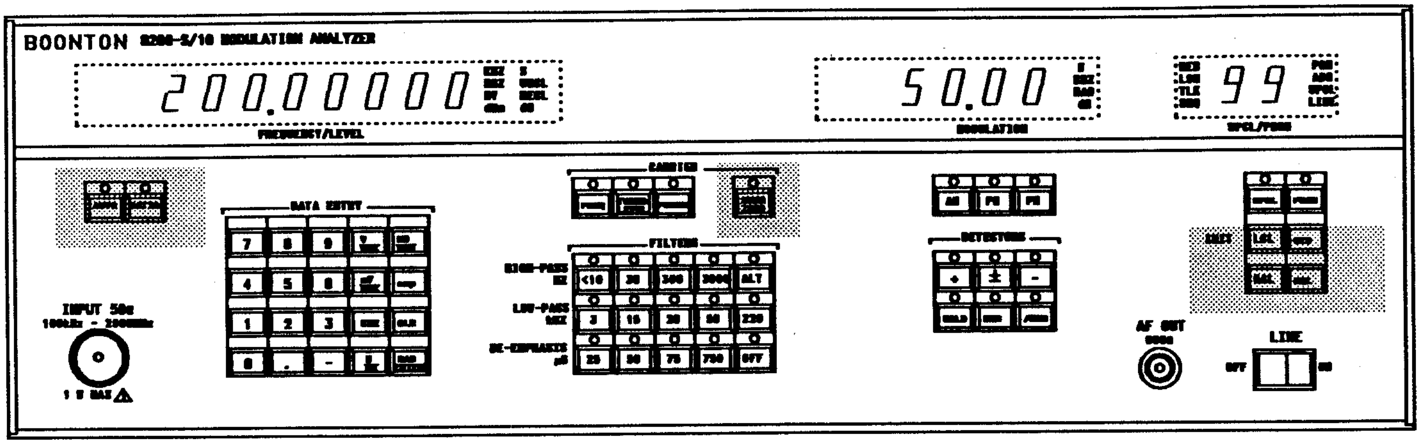

FIGURE 3-7. Other Keys.

3-37. The CAL key provides a means to calibrate the active function. This key is not active in the SPCL and PRGM functions. With the desired function active, depress this key. The calibration sequence will begin and the -CAL- message will appear in the FREQUENCY/LEVEL display. Calibration time varies depending on the selected function, but will usually be less than thirty seconds. Alternately, all of the modulation detectors and rms detector can be calibrated at one time by using recall-only stored program -1. See RECALL ONLY PROGRAMS below.

3-38. The SENSOR ZERO key provides a means to zero the average power detector. With the POWER function active, depress this key. The zeroing operation will begin and the FREQUENCY/LEVEL display will indicate the progress of the operation. Zeroing time varies depending on the operating power level, but will usually be less than twenty seconds.

3-39. The STO and RCL keys are used in conjunction with the PRGM function key to store and recall one of the 100 possible instrument control settings.

3-40. DISPLAYED MESSAGES.

3-41. When the Model 8200-S/10 unlocks, the carrier display will be overwritten with the 'UNLOC' message and the modulation display will be overwritten with the symbol [= = = =], which means display out of range. When a valid carrier is acquired, the FREQUENCY/LEVEL display will change to [= = = = = =], indicating frequency acquisition and that internal ranging is in progress. Finally the carrier frequency will be displayed.

3-42. The 'IFHI' and 'IFLO' messages appear in the modulation display for AM measurements only. These messages indicate that the intermediate frequency level is not within range to make an accurate AM measurement.

3-43. During calibration of any of the active functions the message '-CAL-' is written to the carrier display to indicate that a calibration sequence is in progress.

3-44. A normal error response is for the word 'Error' to appear in the carrier display followed by a number indicating the nature of the error. Error codes are tabulated in Table 3-10 along with a description of the error.

3-45. During normal operation of the Model 8200-S/10 the status of the private IEEE-488 bus is monitored. If the bus becomes inactive, the 'IEEE-488' message will appear in the FREQUENCY/LEVEL display. When bus activity resumes, the display will return to normal.

3-46. Other displayed messages are described in detail in the pertinent operation section.

3-47. SPECIAL FUNCTIONS.

3-48. Several of the Model 8200-S/10 operating features are internally programmable by selecting a SPCL function. These functions allow the operator to change measurement configuration, as well as change the hardware state of the instruments in the system. Some of the more useful SPCL functions are listed below, the others are included in Table 3-2.

3-49. SPCL 1, FREQUENCY OFFSET.

3-50. SPCL function 1 allows the operator to view or set the frequency offset mode of operation. This is the primary mode of operation of the instrument above 2 GHz. When SPCL 1 is entered, the operator keys in the frequency of the microwave local oscillator used for frequency conversion above 2 GHz. When the FREQ or AUTO key is depressed, subsequent display of carrier frequency will include this offset. Additionally, power measurements will include the saved calibration data for this frequency in the measurement. The local oscillator must be tuned to a frequency higher than the measured frequency.

3-51. SPCL 2, CANCEL FREQUENCY OFFSET.

3-52. SPCL function 2 allows the operator to cancel the frequency offset mode of operation without disturbing other selected special functions.

3-53. SPCL 3, SENSITIVE FREQUENCY MEASUREMENT.

3-54. SPCL function 3 allows the operator to change the FREQUENCY/LEVEL display from tuned level to frequency. This permits accurate frequency measurements at levels as low as -100 dBm. SPCL 3 also executes SPCL 6.

3-55. SPCL 4, CANCEL SENSITIVE FREQUENCY MEASUREMENT.

3-56. SPCL function 4 allows the operator to change the FREQUENCY/LEVEL display back to tuned level from sensitive frequency without disturbing other selected special functions. SPCL 4 also cancels SPCL 9.

3-57. SPCL 5, IF AVERAGE DETECTOR.

3-58. SPCL function 5 allows the operator to change the measurement detector for TUNED LEVEL measurement from synchronous to average. This detector, although not as sensitive as the synchronous detector, is useful for signals with moderate to high residual FM.

3-59. SPCL 6, IF SYNCHRONOUS DETECTOR.

3-60. SPCL function ~~5~~ 6 allows the operator to restore the measurement detector for TUNED LEVEL measurement to synchronous from average.

3-61. SPCL 7, 0.01 DB RESOLUTION FOR LOG MEASUREMENTS.

3-62. SPCL function 7 allows the operator to select a display resolution of 0.01 dB for power and ratio measurements in the dB mode. This is the default resolution for power and log ratio measurement display. SPCL 7 also sets ratio percent display to 0.1% resolution. Ratio measurements returned on the IEEE-488 bus are independent of SPCL settings and have a constant resolution of 0.001 dB or 0.01 %.

3-63. SPCL 8, 0.001 DB RESOLUTION FOR LOG MEASUREMENTS.

3-64. SPCL function 8 allows the operator to select a measurement resolution of 0.001 dB for power and ratio measurements in the dB mode. This function is useful when increased display resolution is required. SPCL 8 also sets ratio percent display to 0.01% resolution.

3-65. SPCL 9, NATIVE MODE LEVEL MEASUREMENT.

3-66. SPCL function 9 alters the operation of the TUNED LEVEL key to present the native mode level measurement. This measurement, although not as accurate as the normal tuned level measurement, is very fast and does not require an external local oscillator. The display is generated by measuring the output of the AM modulation detector and displaying the results in

TABLE 3-2. SPECIAL FUNCTIONS.

SPECIAL FUNCTION	PURPOSE
0	Reset all SPCL functions to defaults. Indicated by ♦
1	View or Set Frequency Offset Mode.
2	Disable Frequency Offset Mode.
3	Enable Sensitive Frequency Measurement.
4 ♦	Disable Sensitive Frequency Measurement.
5	Select IF average detector for Tuned Level Measurements.
6 ♦	Select IF synchronous detector for Tuned Level Measurements.
7 ♦	Set dB resolution to 0.01 dB for power and ratio measurements.
8	Set dB resolution to 0.001 dB for power and ratio measurements.
9	Native Mode tuned level measurement.
10	Enter System IEEE-488 bus address.
11	Set IEEE-488 end-of-string character.
12	Set IEEE-488 SRQ mask. See text.
13	Activate function hold display mode.
14	Toggle fast acquisition mode.
15	Set slow peak detector mode.
16 ♦	Cancel slow peak detector mode.
17	Display IF frequency for 3 seconds.
18	Display LO frequency for 3 seconds.
19	Toggle 1 Hz resolution in sensitive frequency measurement mode.
20	Set Frequency Converter to RF1 band.
21	Set Frequency Converter to RF2 band.
22	Set Frequency Converter to bypass mode.
23	Set Frequency Converter to -50 dB RF attenuation.
24	Set Frequency Converter to -10 dB RF attenuation.
25	Set Frequency Converter to +24 dB RF gain.
26 ♦	Set Frequency Converter to Auto ranging.
27	Empty.
28	Enable external timebase error reporting.
29	Disable external timebase error reporting.
30 ♦	Set Modulation Range to AUTO.
31	Set Modulation Range to 5.000 full scale.
32	Set Modulation Range to 50.00 full scale.
33	Set Modulation Range to 500.0 full scale.
34	Enable De-emphasis filters for AM measurements.
35 ♦	Disable De-emphasis filters for AM measurements.
36	Set De-emphasis mode to post-display.
37 ♦	Set De-emphasis mode to pre-display.
38 ♦	Disable IF frequency error reporting.
39	Enable IF frequency error reporting.

TABLE 3-2. SPECIAL FUNCTIONS CONTINUED.

SPECIAL FUNCTION	PURPOSE
40 ♦	Set IF attenuator to AUTO.
41	Set IF attenuator to 0 dB.
42	Set IF attenuator to +10 dB.
43	Set IF attenuator to +20 dB.
44	Set IF attenuator to +30 dB.
45	Set IF attenuator to +40 dB.
46	Set IF attenuator to +50 dB.
47	Set IF attenuator to +60 dB.
48	Set IF measurement time to 0.1 second.
49	Set IF measurement time to 1 second.
50	Set IF measurement time to 10 seconds.
51 ♦	Set IF measurement time to AUTO.
52	Forces display of Tuned Level Cal annunciators.
53	Restores nominal Tuned Level CalFactors at measurement frequency.
54	Restores nominal Tuned Level CalFactors at all frequencies.
55 ♦	Sets UNCAL annunciator temperature window at ± 1 degree C.
56	Sets UNCAL annunciator temperature window at ± 2 degrees C.
57	Empty.
58	Empty.
59	Empty.
60 ♦	4220-S/10 Auto Range.
61	4220-S/10 Range Hold.
62	Sensor select, power sensor.
63	Sensor select, RF1 band.
64	Sensor Select, RF2 band.
65	Turn 50 MHz power reference OFF.
66 ♦	Turn 50 MHz power reference ON.
67	Set Power Meter raw data mode.
68	Enter Sensor Ambient Temperature.
69	Empty.
70	Reserved.
71	Empty.
72	Empty.
73	Empty.
74	Empty.
75	Empty.
76	Empty.
77	Empty.
78	Reserved.
79	Empty.

TABLE 3-2. SPECIAL FUNCTIONS CONTINUED.

SPECIAL FUNCTION	PURPOSE
80 *	View/Set Sensor serial number.
81	View 4220-S/10 serial number.
82	View 8200-S/10 serial number.
83	View System serial number.
84	View Model 8200-S/10 firmware code.
85	View Model 4220-S/10 firmware code.
86 *	View Sensor high frequency calfactors.
87 *	View Sensor ac calfactors.
88	Activate automatic ac calibration using Model 2520.
89	Activate automatic dc calibration using Model 2510.
90	Activate local oscillator test program.
91	Activate DAC test program.
92	Activate A/D test program.
93	Activate counter test program.
94	Activate key test program.
95	Activate display test program.
96	Activate AGC system test program.
97	Display Calibrator frequency.
98	Enable Error 68 reporting .
99 ♦	Disable Error 68 reporting.
	* Clears average power 0 dBm calibration factors.

♦ See Special Function 0

dBm or millivolts. While this mode is active the units annunciator will flash. The mode is canceled by entering SPCL 4. Like other level displays the units keys will change the displayed units. Level accuracy in this mode is +- 1 dB to 520 MHz, +- 2 dB to 1500 MHz and +- 3 dB to 2000 MHz.

3-67. FRONT PANEL CONNECTORS, MODEL 8200-S/10.

3-68. The Model 8200-S/10 is normally supplied with two connectors on the front panel, RF IN, and AF OUT. These connectors are the most often used.

3-69. The RF IN connector is the means to apply a test signal to the Model 8200-S/10. It is a type N connector which is the preferred connector in this frequency range. The nominal input impedance at the RF IN is 50 ohms. The RF IN connector is designed to accept a fuse, although one is not installed in the 8200-S/10. A semi-rigid cable assembly attaches the RF IN connector to the RF OUT connector on the 9000S converter.

3-70. The AF OUT connector is a type BNC. The signal at this connector is a sample of the recovered modulation. As a result, the amplitude varies with modulation and modulation range settings and the signal is affected by the high- and low-pass filters and the de-emphasis networks. The nominal level is 1 volt into 600 ohms at 5000 counts on the modulation display. Source impedance is 600 ohms. Amplitude variations will also occur at the AF OUT connector with carrier level if the AM measurement mode is selected even though the modulation is constant. This happens because the Model 8200-S/10 uses a microprocessor controlled discrete AGC system rather than an analog one. The AM indication is not affected since the AM detector level is measured for each displayed AM indication.

3-71. FRONT PANEL CONNECTORS, MODEL 4220-S/10.

3-72. The Model 4220-S/10 has four connectors located on the front panel

3-73. The SENSOR connector is a two-pin type used to attach the diode detector located in the 51033-S/10 Sensor to the power meter circuitry. The SENSOR cable is one of four cables attached to the 51033-S/10.

3-74. The RELAY connector is a ten-pin type used to attach the RF relays and adapter pad sensor switch to the driver and comparator circuitry. The RELAY cable is one of four cables attached to the 51033-S/10.

3-75. The PWR REF connector provides a means for the operator to calibrate the 51033-S/10 average power sensor at 0 dBm, 50 mHz. The PWR REF output is controlled by the Model 8200-S/10 to operate when the CAL key is depressed in the POWER measurement mode.

3-76. The SYSTEM IEEE-488 connector provides a means for the operator to connect the unit-under-test to the system IEEE-488 control bus. This connector is electrically identical to the SYSTEM connector on the rear panel of the Model 4220-S/10.

3-77. FRONT PANEL CONNECTORS, MODEL 9000S.

3-78. There are five RF connectors located on the front panel of the Model 9000s.

3-79. The RF OUT connector is type N which is attached to the RF IN connector of the Model 8200-S/10. The signal frequency varies from 100 kHz to 2000 MHz, and the level from +19 to -130 dBm. The source impedance is 50 ohms nominal.

3-80. The LO2 IN connector is a type N and provides a means to attach a SG1219/U signal generator to be used as a local oscillator for Receiver measurements from 2 to 18 GHz. The input impedance is nominally 50 ohms.

3-81. The RF1 IN connector is a type N and is attached to the RF1 cable from the 51033-S/10 Sensor. The signal frequency range is [illegible] kHz to 2000 MHz and the nominal input impedance is 50 ohms.

100

3-82. The RF2 IN connector is a type N and is attached to the RF2 cable from the 51033-S/10 Sensor. The signal frequency range is 2 to 18 GHz and the nominal input impedance is 50 ohms.

3-83. The LO1 IN connector is a type N and provides a means to attach a **SG1219/U** signal generator to be used as a local oscillator for tuned level measurements from 2.5 MHz to 2 GHz. The input impedance is nominally 50 ohms.

3-84. REAR PANEL CONNECTORS, MODEL 8200-S/10

3-85. The most prominent connector on the rear panel of the Model 8200-S/10 is the IEEE-488 connector. This connector provides a means of incorporating the Model 8200-S/10 into the Measuring Receiver test system. This connector is used for the private bus connection to the Model 4220-S/10 and SG1207/U local oscillator. The Model 8200-S/10 is, however, accessible via the system bus. Complete instrument operation when connected to the IEEE-488 system bus is covered in subsequent paragraphs.

3-86. The connector marked IF OUT is a type BNC connector with a source impedance of 50 ohms which provides a sample of the frequency translated carrier signal. The nominal level is 0 dBm, and the frequency is determined by the carrier frequency as follows:

Carrier	**IF Frequency**
< 2 MHz	**same as carrier**
2 to 10 MHz	**346 kHz**
> 10 MHz	**1.211 MHz**

3-87. The connector marked AM OUT is a dc coupled sample of the output of the AM detector. This output is always active and has a small signal bandwidth of 220 kHz, corresponding to the 220 kHz filter setting on the front panel. Additional filtering may be required to use this signal if the carrier frequency is below 10 mHz. The nominal sensitivity is 0.2 volts peak-to-peak for 10% AM. The dc and ac portions of this signal can be used to calculate AM according to the following formula:

%AM	**= 100% X volts ac peak (Volts dc - offset)**

3-88. The offset in the above equation can be determined by depressing the carrier FREQ and V/MHZ keys and removing the RF IN connection, then noting the dc voltage at the AM OUT connector. Reapply the carrier signal and measure the ac and dc components. For example:

offset	**= +7 millivolts dc**
ac volts	**= 0.35volts rms**
	= 0.5 volts peak
dc volts	**= 1.008 volts**
% AM	**= 100% X 0.5 / (1.008 - .007) = 49.95%**

3-89. The connector marked FM OUT is a dc coupled sample of the output of the FM detector. This output is always active and has a small signal bandwidth of about 220 kHz, corresponding to the 220 kHz filter setting on the front panel. Additional filtering may be required to use this signal if the carrier frequency is below 10 MHz. The nominal sensitivity is 2 volts peak-to-peak for 100 kHz deviation. When the IF frequency is 1.211 MHz, the dc voltage will be approximately -1.3 volts, and at 346 kHz +7.6 volts. To determine the sensitivity at this connector, apply an unmodulated carrier at about 1 MHz. Note the dc voltage at the FM OUT connector and then change the frequency to 1.5 MHz. The sensitivity is:

volts dc @ 1.5 MHz - volts dc @ 1.0 mHz/0.5 MHz

For example:

volts dc at 1.5 MHz	**= -4.4**
volts dc at 1.0 MHz	**= +0.887**
sensitivity	**= [(-4.4) - (0.887)]/0.5**
	= -10.57 volts/MHz or
	= -1.057 volts/100kHz

Note

The sense of the recovered audio signal is reversed for carriers below 2 MHz. The control program automatically reverses the sense of the peak detectors below 2 MHz.

3-90. The connector marked DIST OUT is a test connector used in conjunction with modulator 96400501A to make AM flatness and distortion measurements. It is a dc voltage of +15 volts with a source impedance of about 3.3 kohms.

3-91. The connector marked EXT REF provides a means to connect a precision time-base reference to the counter circuits of the Model 8200-S/10. This input is TTL compatible, that is, the input circuit is a TTL gate with a termination network. Reference switching from internal to external is automatic when the external signal is present. This connector must be connected to the REF OUT connector of the Model 4220-S/10 for proper operation of the Model 8200-S/10. An error will be reported at power on if this signal is not present.

3-92. REAR PANEL CONNECTORS, MODEL 4220-S/10.

3-93. The REC OUT connector is a type BNC and provides a means to connect a chart recorder or voltmeter to the power meter. The chart recorder output is a dc level from 0 to 10 V that is proportional to power in dBm. The output is scaled at 1 V/10 dBm with full scale at 30 dBm. The output impedance is 9.09k, which gives the user the option of loading it with 1K, thereby reducing the full scale output to 1 V, however, resolution is maintained. The displayed power is used as the input to the chart recorder DAC so all calibration and zero offsets are included. The accuracy of the chart recorder is 1 percent in addition to the displayed power accuracy.

3-94. The SENSOR connector is electrically identical to the SENSOR connector on the front panel. It is provided for system applications where the Sensor is normally connected to a fixed measurement point.

3-95. The REF OUT, TTL is a type BNC connector and provides a TTL level 10 MHz frequency reference for the Receiver system. It is to be connected to the Model 8200-S/10 EXT REF connector and to the SG1207/U local oscillator.

3-96. The REF OUT, 50 OHM is a type BNC connector and provides a 10 MHz frequency reference signal for the SG1219/U local oscillator.

3-97. The AUX OUT connector is a type DB25 and provides a means of connecting the Model 4220-S/10 to the Model 9000S converter. Signal and impedance levels are TTL compatible.

3-98. The IEEE-488 connectors marked PRIVATE and SYSTEM are used to connect the 4220-S/10 to the Measuring Receiver system (PRIVATE) and to the workstation controller. (SYSTEM) The signals and impedance levels are compatible with IEEE-488.

3-99. REAR PANEL CONNECTORS, MODEL 9000S.

3-100. The J1, CONTROL connector on the rear panel of the Model 9000S is a type DB25 and is used to connect the Model 9000S to the Model 4220-S/10. Signal and impedance levels are TTL compatible.

3-101. 51033-S/10 SENSOR.

3-102. The 51033-S/10 Sensor has only one connector, the type N RF IN connector. This is a special connector designed to detect the presence of a low VSWR adapter pad which is permanently attached to the Sensor. The Sensor is configured with or without the adapter pad depending on the measurement and input level ranges. The adapter pad must be installed to meet specification for the following measurements:

- All untuned power measurements.
- Tuned power measurements from 0 to -80 dBm level, and 2.5 MHz to 2 GHz.
- Tuned power measurements from 0 to -100 dBm level, and 2 to 18 GHz.

- Modulation and frequency measurements above +19 dBm.

3-103. The adapter pad must be removed to meet specification for the following measurements:

- Tuned power measurements from -80 to -110 dBm level, and 2.5 MHz to 1 GHz.
- Tuned power measurements from -80 to -105 dBm level, and 1 to 2 GHz.
- Tuned power measurements from -110 to -127 dBm level at 30 MHz.
- All modulation and frequency measurements below 19 dBm.

3-104. As a general rule the adapter pad can remain installed if tuned level measurements are restricted to those greater than -110 dBm and modulation measurements are restricted to levels above -10 dBm.

3-105. MEASURING AND SETTING CARRIER FREQUENCY.

3-106. The Model 8200-S/10 uses a sampling technique to convert frequency. Using this technique it is necessary only that the sampling frequency (and consequently the local oscillator frequency) vary over one octave to convert frequencies over the operating range of the instrument. In practice, more than one octave is covered, but the details of operation remain the same. For any carrier frequency in the range of the instrument and any local oscillator frequency, an intermediate frequency signal will be produced which is between zero and one-half of the sampling rate. This signal is used to tune the local oscillator to the correct frequency. The problem is that the harmonic number of the local oscillator creating the intermediate frequency is not known. The relationship between the three different frequencies is:

Frf	**= N X Flo - Fif**
where Frf	**is the carrier frequency**
Flo	**is the local oscillator frequency**
Fif	**is the intermediate frequency**
and N	**is the harmonic number**

3-107. The unknown quantity in the equation is N. This can be determined by varying Flo and noting the change in Fif. The ratio of the change in Fif to the change in Flo is the harmonic number. See Theory of Operation for complete details of the operation of the frequency acquisition circuits.

3-108. When the Model 8200-S/10 acquires a carrier signal, the harmonic number is determined as described. The displayed carrier frequency is then calculated from the above expression and displayed.

3-109. To measure carrier frequency, first depress the carrier FREQ function key. If the AUTO key LED is not illuminated, depress the AUTO key. The 'UNLOC' message will appear and then the measured frequency will be displayed. At this point other functions may be selected or the frequency setting can be held by depressing one of the frequency units keys: V/GHz, mV/MHz, or kHz. Depressing AUTO again will cause the instrument to reacquire the carrier signal.

3-110. The frequency of operation of the Model 8200-S/10 can be established by manual entry using the data keypad. This operation does not imply any form of preselection or filtering, merely that automatic acquisition time can be eliminated. To manually enter the carrier, first depress the carrier FREQ key. Enter the operating frequency using the data keypad and terminate the number entry with one of the frequency units keys. For example, to set the Model 8200-S/10 to operate at 123.5 MHz, depress the [1], [2], [3], [.] and [5] keys, and then the mV/MHz key to complete the entry. The FREQUENCY/LEVEL display will now contain 123.50000 MHz and the LED in the AUTO key will be out.

3-111. Frequency can be entered using any consistent sets of units, as described above. Trailing zeroes are not required and the CLR key can be used to abort entry.

3-112. When the desired frequency measurement is above 2 GHz, the frequency offset mode is employed. In the frequency offset mode the operator enters the frequency of the external SG1219/U local oscillator into the carrier display using SPCL function 1. The same frequency is set into the SG1219/U and the difference frequency is actually read by the Model 8200-S/10. The offset is added to the display, so that the resulting frequency display is the actual microwave frequency. The SG1219/U should be set so that the frequency is no more than about 200 MHz above and no less than 10 MHz above the frequency to be measured. For example, if the frequency to be measured is 12.4 GHz, set the SG1219/U to 12.5 GHz. Some choices of local oscillator frequency may produce erratic or erroneous readings due to the presence of spurious mixing products. In this case an alternate frequency difference should be used.

3-113. If a sensitive frequency measurement is required, SPCL function 3 is used. In this mode of operation the tuned level measurement system is used to acquire the signal, and the normal power display is replaced with a frequency display. In this mode measurements can easily be made to -100 dBm carrier levels with update rates of 100 milliseconds. SPCL 19 can be used to increase measurement resolution to 1 Hz. The display resolution is limited to 1 Hz for frequencies below 1 GHz, however, the full resolution is available via the IEEE-488 bus. As with other frequency measurements, large amounts of FM deviation will obscure the measured results.

3-114. MEASURING AND SETTING CARRIER POWER.

3-115. The Model 8200-S/10 measures carrier power by means of a diode detector located in the 51033-S/10 Sensor. This detector is calibrated for use at frequencies from 100 kHz to 18 GHz, with and without a low VSWR adapter pad. The actual power measurement is made in the Model 4220-S/10 and the zero corrected result is sent to the Model 8200-S/10 over the private bus.

3-116. To measure carrier power, first set the carrier frequency, as described above, and depress the POWER key. If the AUTO led is not illuminated, depress the AUTO key to resume measurement. Before beginning measurements, the Sensor should be zeroed and calibrated. To zero the Sensor, depress the SENSOR ZERO key. The FREQUENCY/LEVEL display will indicate the progress of the zero operation by displaying a series of dashes. The number of dashes increase as the calibration completes. At the completion of the zero operation, connect the Sensor to the PWR REF connector on the front panel of the 4220-S/10 and depress the CAL key.

Note

If the adapter pad is to be used for subsequent measurements, zero and calibrate the Sensor with the adapter installed.

3-117. The calibration routine will take about 2 seconds to complete. The resulting measurement will be 0.00 dBm or about 223.6 millivolts.

3-118. A carrier power reference for ratio measurements can be set by entering the reference level into the FREQUENCY/LEVEL display while the POWER function is active. Enter the data in dBm or millivolts using the DATA keypad. The LED in the AUTO key will go out indicating that the displayed value is not a measurement. The RATIO key can be depressed at this point to make a relative measurement. To resume normal operation depress the RATIO key again to display the entered value and then the AUTO key to begin measurement.

3-119. If the input power is below about -30 dBm a series of dashes will appear in the FREQUENCY/LEVEL display at the lower segment of the LED display indicating a measurement underrange. Similarly, if the input power is above about +33 dBm a series of dashes will appear in the FREQUENCY/LEVEL display at the upper segment of the LED display indicating a measurement overrange.

3-120. SENSOR CALIBRATION.

3-121. Two types of calibration are used in the 4220-S/10: instrument calibration and sensor calibration. The instrument (less sensor) must be calibrated using a DC source. The procedures necessary to perform calibration are covered in maintenance section of the Model 4220-S/10 Manual. Sensor calibration theory is discussed below. Calibration data are stored in non-volatile memory. There are two types of sensor calibration--linearity and high-frequency.

3-122. 14-Point Linearity Data. The linearity data (also referred to as AC reference frequency linearity data) are supplied with the Sensor. This information is entered into non-volatile memory when the instrument is calibrated, however, SPCL function 87 is provided to permit the operator to re-enter this data if required. This program is an interactive procedure which displays

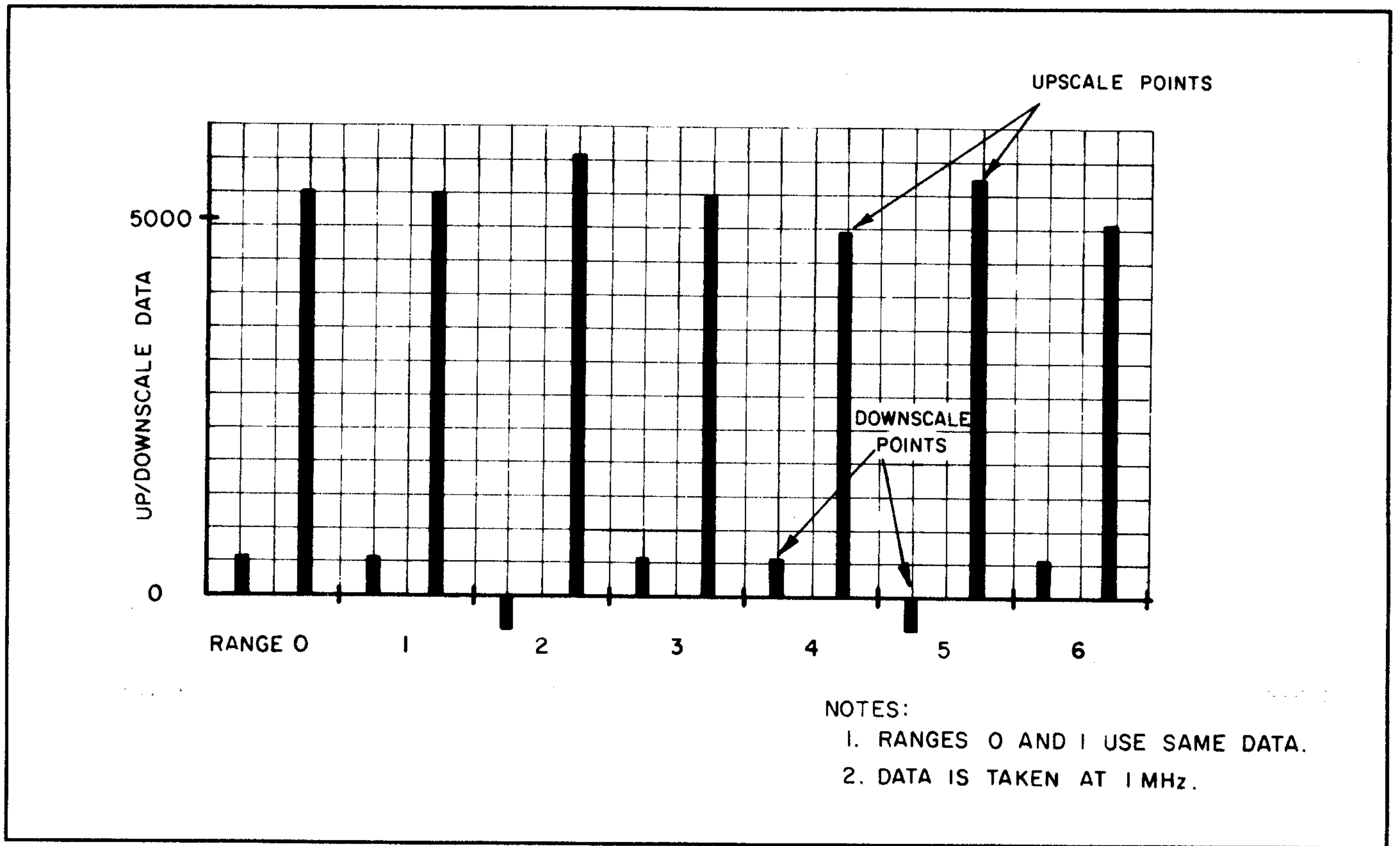

FIGURE 3-8. 14 Point Sensor Calibration.

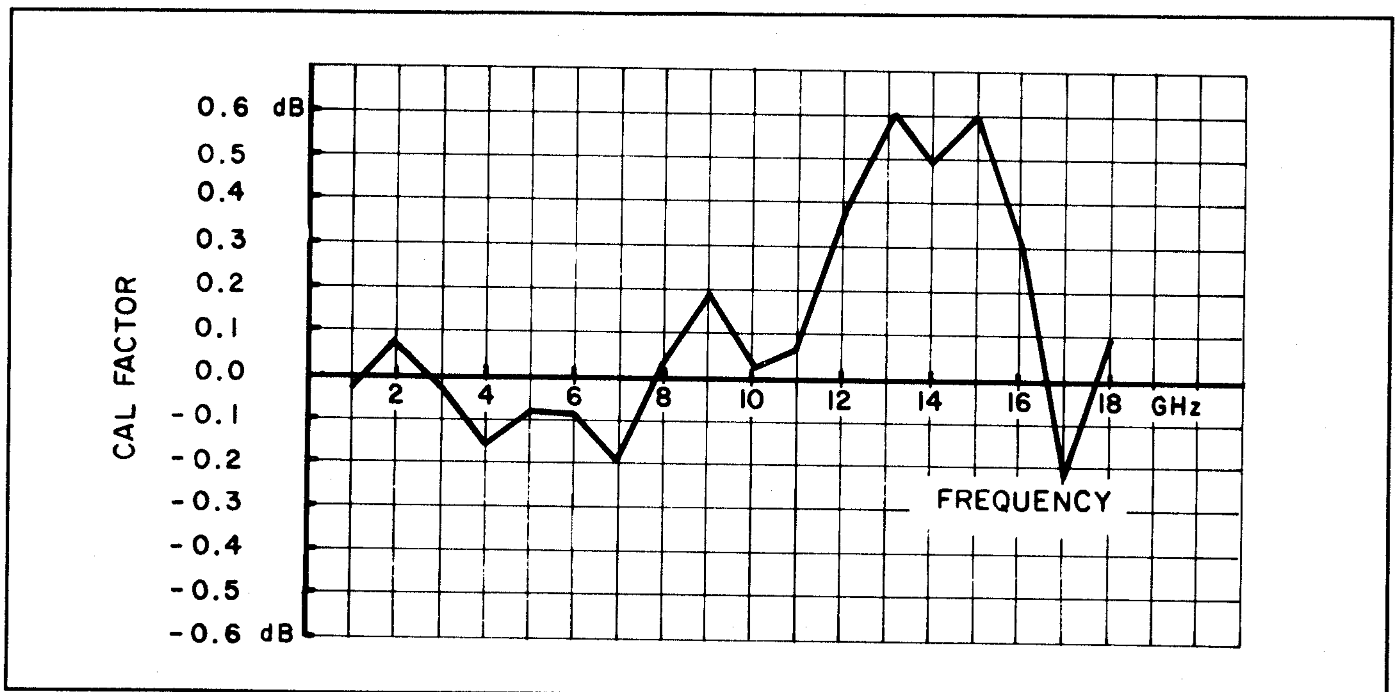

FIGURE 3-9. Typical High Frequency Sensor Calibration.

the calibration range and current data, and allows the operator to modify it. If the data point is correct, the ENTER key is depressed. If not, new data is entered using the DATA keypad. The routine is terminated when all of the data points are covered, or the LCL/INIT key is depressed. Additionally, if a Model 2520 is placed on the private bus, and set to bus address 20, SPCL function 88 will perform an automatic calibration. To use this SPCL function connect the 51033-S/10 Sensor, without adapter pad to the RF OUT connector of the Model 2520, set the BUS address of the Model 2520 to 20, and enter SPCL 88 on the model 8200-S/10. The -CAL- message will appear while the calibration is in progress. For the following discussion, refer to Figure 3-8.

3-123. At the reference frequency (50 MHz), the Sensor has two gain factors for each range: upscale and downscale. The upscale points are approximately 5000, which is a gain correction factor. The upscale point is determined during final test at about 70 percent of full scale. The downscale factor, a second-order correction, is determined at about 25 percent of full scale. Thus, since there are 7 internal power ranges in the Model 4220-S/10, there are 14 calibration points.

3-124. **High-Frequency Calibration Points.** In addition to linearity data, there are high-frequency points as shown in Figure 3-9. Calibration points covering the entire Sensor frequency range are supplied for each Sensor configuration.

3-125. Each 51033-S/10 Sensor operates over the frequency range of 100 kHz to 18 GHz. Eighteen calibration points are used, starting at 1 GHz and continuing to 18 GHz in 1-GHz steps. At frequencies below 1 GHz, no correction factor is applied.

3-126. During measurement, frequency points are linearly interpolated, or if a measurement frequency is entered outside the range of the Sensor, the highest or lowest data point is used as appropriate.

3-127. **High Frequency Data.** High frequency calibration factors also appear on the Sensor calibration label. They can be entered into the instrument by SPCL function 86. This program is an interactive procedure which displays the calibration frequency and data and allows the operator to modify it. If the data point is correct, the ENTER key is depressed. If not, new data is entered using the DATA keypad. The routine is terminated when all of the data points are covered, or the LCL/INIT key is depressed. Although the Sensor is intended to be used with the adapter pad, calibration data is also given for the 51033-S/10 without the pad. The data is stored internally as two different Sensors, Sensor #1 with the adapter pad and Sensor #2 without. The correct Sensor is identified before the calibration points are entered.

3-128. **ZEROING.**

POWER LEVEL	FILTER LENGTH
-40 dBm	2.8
-30 dBm	0.8
-20 dBm	0.3
-10 dBm	0.06

TABLE 3-3. Average Power Filter Lengths.

3-129. The automatic zeroing routine takes measurements on the bottom five ranges and applies them as correction factors on subsequent measurements. Offsets in the Sensor and input amplifiers are linearly corrected in the internal software. Offsets on the top ranges are below 0.02 percent of full scale and do not need correction.

3-130. Input power to the Sensor is removed automatically before the zeroing operation is executed. This is accomplished by switching out the detector in the 51033-S/10 Sensor.

3-131. For full accuracy at low signal levels, power must be removed from the Sensor several seconds before zeroing to allow the Sensor to settle. This is especially true if a large signal has been applied to the Sensor in the previous 20 seconds or so, because of the dielectric absorption of the capacitors in the diode Sensor. The 4220-S/10 waits anywhere from 2 to 25 seconds when the zero key is pressed before zeroing in order to account for typical decay conditions determined by the current power level. This condition is indicated by two centered dashes in the FREQUENCY/LEVEL display. As different ranges are zeroed, more dashes are added to the display until the operation is complete.

3-132. Zeroing should be done when the Sensor has drifted a significant amount with respect to the signal being measured. For large signals this may be once every several hours (if at all). For very small signals it is recommended that zeroing be done just before a measurement.

3-133. FILTERING AND NOISE.

3-134. The 4220-S/10 employs digital filtering, or averaging of measurements to reduce the noise floor of the instrument and to stabilize the measurements. The default filtering mode is referred to as auto-filtering. This mode uses a different, predefined value for each range, as shown in Table 3-3. These numbers are optimized for speed and noise under general conditions.

3-135. The technique is called digital pipeline filtering, which is also referred to as circular filtering or moving-average filtering. The displayed power is simply an equally weighted average of the last X seconds worth of samples, where X is the filter length in seconds. For purposes of noise and settling time, the time, rather than the number of samples is important. That is, if a 3-second filter is used, the noise is the same whether 60 or 600 samples are taken in that interval, providing that the samples are taken above a certain rate. Therefore, the 4220-S/10 filter selection is based on time rather than on the number of samples.

3-136. The amount of noise reduction that can be realized has no theoretical limitation, except that drift must be considered at filter lengths over 20 seconds. The digital filter has a bandwidth and rolloff curve just as any filter does. The bandwidth can be reduced arbitrarily. The effective noise bandwidth is 0.469/t, where t is the filter length. For example, with a filter length of 2.8 seconds the equivalent noise bandwidth is 0.17 Hz.

3-137. The filter is a simple integrator. Although it is not the best choice if one considers noise rejection versus bandwidth, it is the best compromise between noise rejection and settling time. It has the additional benefit that the ramp-like response is easy to interpret, and the display stops abruptly when filtering is complete.

3-138. MEASUREMENT TIME.

3-139. **Step Response.**The measurement time from a power input step is the sum of the instrument overhead time and the length of the digital filter, where the instrument overhead time is defined to be the delay due to the Sensor response and the data processing time. In theory, the total measurement time is a bit less than the arithmetic sum of the overhead time and the digital filter (it's the convolution of the two) but for most purposes the sum will do. Regardless of the overhead time or the digital filter length, the 8200-S/10 will continue to display readings at the measurement rate. As the Sensor and the digital filter settle, the readings will ramp up or down at that rate.

3-140. Instrument Overhead time includes final calibration, correction factors, communication across the private bus, and across the system IEEE-488 bus plus channel card measurement time of 20 milliseconds for each measurement.

3-141. HIGH-FREQUENCY ACCURACY.

3-142. Power measurements, particularly at high frequencies, have a considerable number of uncertainties that generally arise from high VSWR. If all power sources and power meters had impedances that were resistive and equal to the characteristic impedance of the measuring system, most problems would disappear. The incident, dissipated, and maximum available powers would all be equal, and the indicated power would differ only by the inefficiency of the power Sensor in converting all of the dissipated power to indicated power. Tuning eliminates most of the effects of VSWR, but it is cumbersome and is seldom done. The use of attenuator pads can mask imperfect VSWR, as can the use of a directional coupler to level the source and reduce its reflection coefficient to a value equal to the directivity factor of the coupler.

3-143. When the maximum VSWR of a power Sensor and an imperfect source are known, but the complex coefficients of both are not, the maximum positive and negative uncertainties of the measured power can be determined from Figure 3-10. For

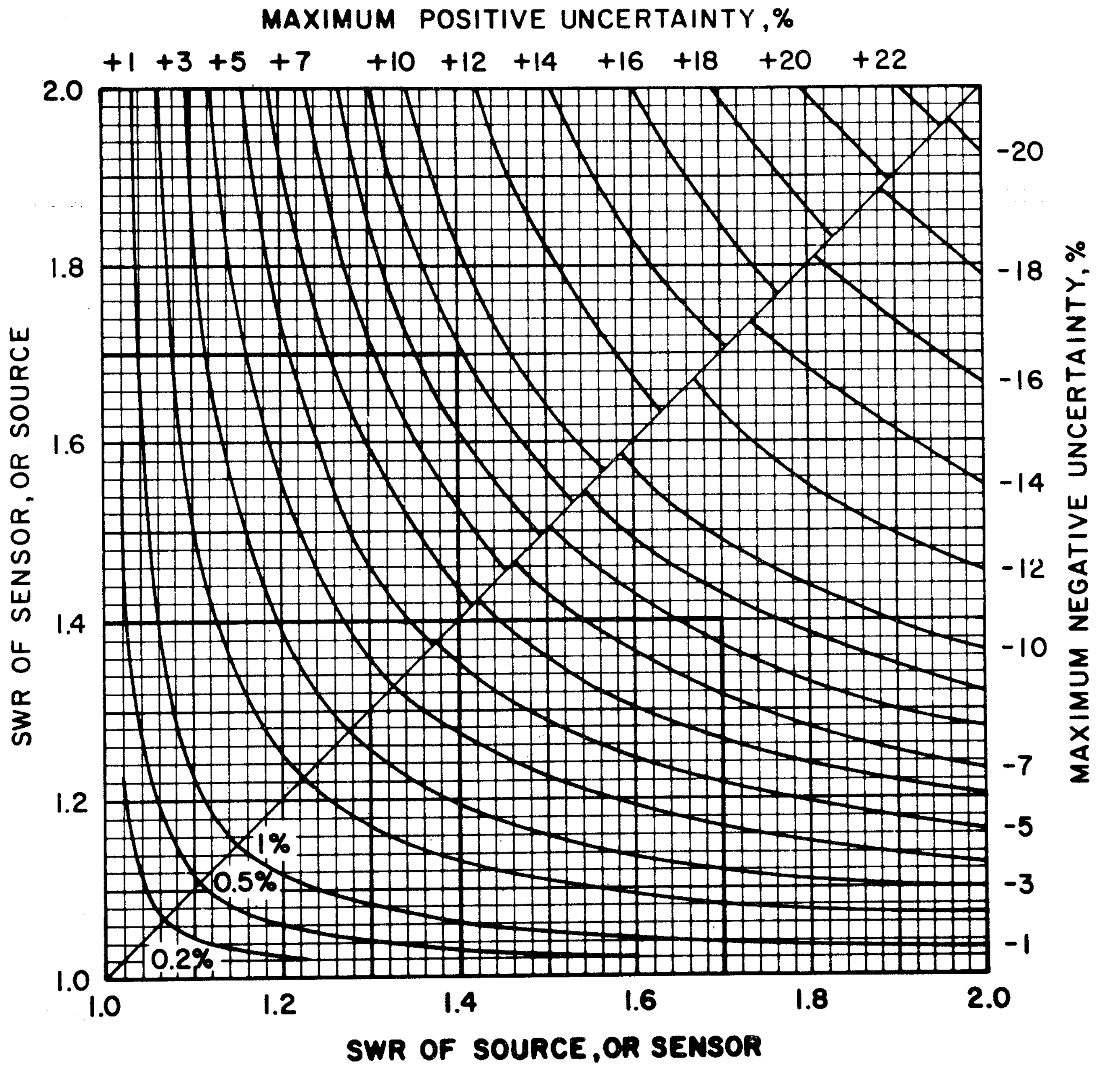

FIGURE 3-10. Mismatch Uncertainties Chart.

example, if the VSWR of the source is known to be 1.2:1 and the VSWR of the power Sensor is 1.25:1, we can see from Figure 3-10 that the measurement uncertainty is about 2 percent.

3-144. WAVEFORM SENSITIVITY.

3-145. The 51033-S/10 diode Sensor is RMS-responding below about +3 dBm with the adapter pad, and -7 dBm without the pad. That is, it can accurately convert signals with modulation, non-sinusoidal signals, and even pulses to an equivalent heating value without significant error. This is because the Sensors are dual-diode types, which respond in a square-law fashion at low and medium levels. At low levels the detector diodes do not turn on and off as switches, but rather behave as signal-dependent resistors. Even with no signal input, the diodes have a finite conductance, and the conductance is modulated on a cycle by cycle basis to produce DC output proportional to the incident power.

3-146. At power levels above +13 dBm with the Adapter pad and +3 dBm without the Adapter, the diodes operate as peak detectors. The 4220-S/10 is software-calibrated to calculate the RF power based on a shaping transfer function (RF to DC). However, only CW signals are displayed without error in this region, and in the transition region from +3 to +13 dBm with the Adapter and -7 to +3 dBm without the Adapter. CW refers to flat envelope waveforms such as FM, PM, etc.

3-147. MEASURING AND SETTING TUNED LEVEL.

3-148. To measure carrier TUNED LEVEL, first set the carrier frequency as described above, then depress the TUNED LEVEL key. If the AUTO key LED is not illuminated, depress the AUTO key. The FREQUENCY/LEVEL display is now indicating carrier tuned level. The units may be in dBm or millivolts. To change displayed units depress the desired units key and then the AUTO key. The action of depressing a level units key will override the automatic mode and hold the current level setting for subsequent ratio measurements. Depressing the AUTO key will resume measurement. Carrier level can be programmed manually in order to establish a reference for subsequent relative measurements. To program carrier tuned level manually, first depress the carrier TUNED LEVEL function key. The input level may be entered in units of power ratio (dBm) or voltage (mV or V). For example, to enter -16.5 dBm, depress the [-], [1], [6], [.], and [5] keys, followed by the dBm units key. The FREQUENCY/LEVEL display will now contain -16.5 dBm. To convert the input level in dBm to an equivalent voltage across the 50 ohm input impedance of the Sensor, depress the V/GHz or the mV/MHz keys. The resulting display will be in units of mV. In this example, the power level of -16.5 dBm will be converted to 33.45 mV. Depressing the dBm key will restore the -16.5 dBm indication. An input level may be entered in voltage units initially and displayed as a voltage level or a power ratio in dbm. Tuned level is stored internally in dBm, and converted to millivolts for display. Similarly, when level in millivolts is entered, it is first converted to dBm for storage, and then back to millivolts for display. As a result rounding to the nearest 0.1 dBm will cause the display to differ from the entered value.

3-149. TUNED LEVEL CALIBRATION.

3-150. Before calibrated Tuned Level measurements can be made, the following operating conditions must be established:

a. The Carrier Power measurement must be calibrated at the frequency of interest. This measurement provides the absolute reference for all tuned level measurements.

b. The Measuring Receiver must be properly tuned. The Measuring Receiver can be tuned manually or automatically. Manual tuning is accomplished by entering the carrier frequency, within +- 5 kHz, into the FREQUENCY/LEVEL display. Automatic tuning is accomplished by depressing the FREQ and AUTO keys and waiting for a stable frequency display before depressing the TUNED LEVEL key.

c. The Tuned Level calibration factors must be avaliable for all calibration points at the measurement frequency. Calibration factors are applied to the measurement whenever the RF signal path or the active IF detector is changed. This includes switching the RF attenuator steps, removing or replacing the Adapter pad or changing between synchronous and average detection. The calibration factors for Tuned Level measurements are created by comparison of two levels measured on adjacent RF ranges. The IF amplifier and attenuator provide a 10 dB range where adjacent RF ranges overlap and can be calibrated (Table 3-4). At levels where calibration is possible the RCAL annunciator will be illuminated. When the RCAL annunciator is illuminated, keep the input signal level constant, and depress the CAL key to create a calibration factor. If a measurement is made on an RF range for which a calibration factor has not been created, the UCAL annunciator will be illuminated. When the UCAL annunciator appears without RCAL, the calibration point can be found by increasing the signal level in approximately 5 dB increments until the RCAL annunciator illuminates.

d. The RF frequency and Measuring Receiver internal temperature must be within tolerance. When Tuned Level calibration is performed, the calibration factor is tagged with the RF frequency and the internal temperature of the Measuring Receiver. The RF frequency tolerance for accurate tuned level measurements is 10 MHz or 10% whichever is smaller. If the frequency is changed outside of the tolerance, new calibration factors for all RF signal paths are required. The temperature tolerance is +- 1 degree celsius. If the Measuring Receiver internal temperature changes more than the tolerance, the measurement is considered uncalibrated and recalibration at the RF1 calibration point (near 0 dBm) is needed.

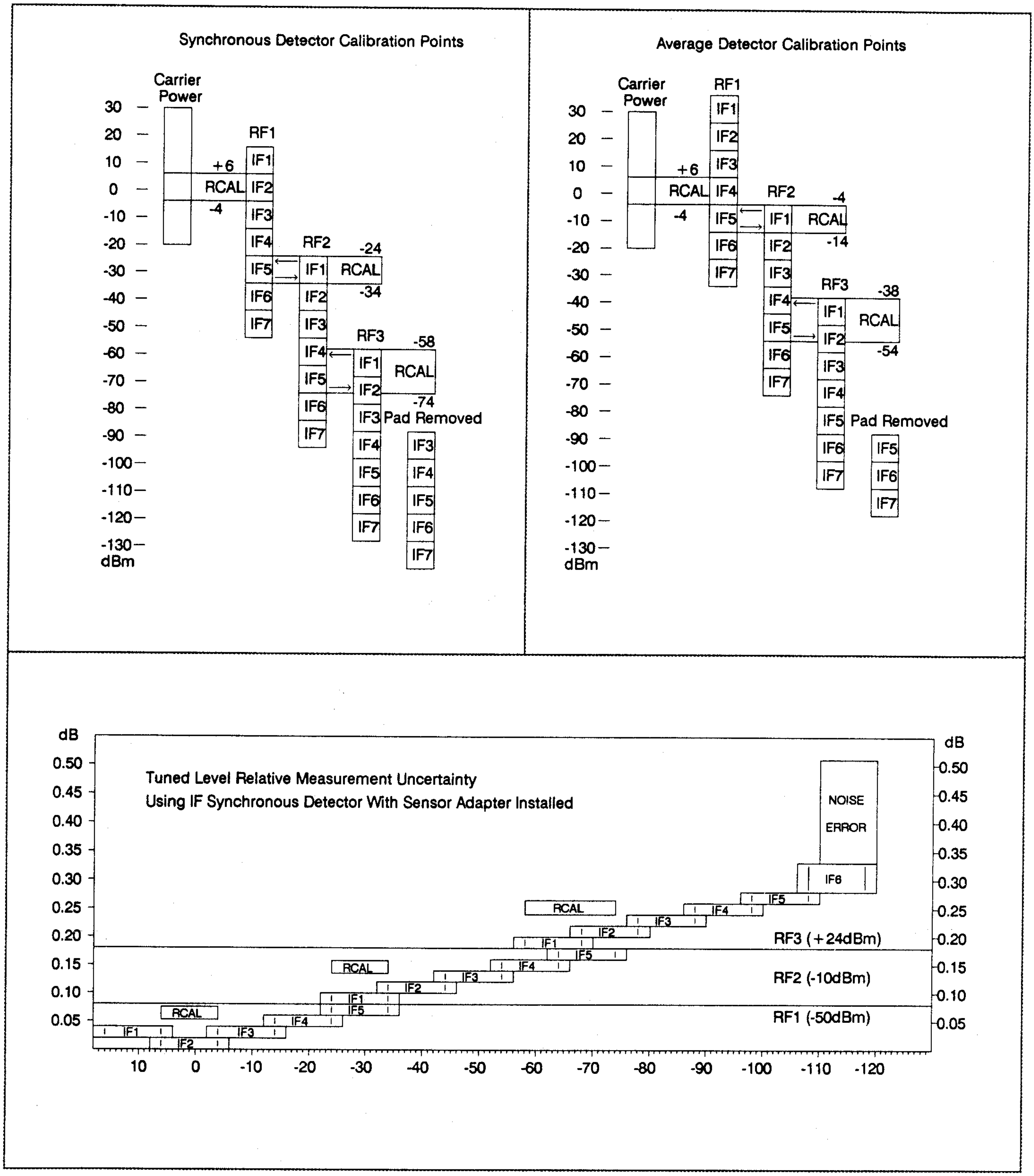

TABLE 3-4. Tuned Level Calibration and Accuracy.

3-151. Calibrating a Tuned Level Measurement. The following measurement scenario will illustrate how to create all of the required calibration factors at one measurement frequency.

a. Depress the INIT key to initialize the instrument.

b. Connect the sensor with the Adapter pad installed to the RF source. The signal level should be set to 0 dBm.

c. The frequency of the signal will appear in the FREQUENCY/LEVEL display. After the measurement settles depress the TUNED LEVEL key.

d. The synchronous detector is automatically selected when the Measuring Receiver is initialized. If desired, the average detector can be selected by entering SPCL 5.

e. After a few seconds the FREQUENCY/LEVEL display will contain the tuned level measurement. If the UCAL and RCAL legends are not displayed, calibration factors for the signal frequency already exist. If the UCAL legend is displayed without RCAL, the signal level should be adjusted to +5 dBm.

f. With the RCAL annunciator displayed, hold the input signal level constant and depress the TUNED LEVEL and CAL keys in sequence. The FREQUENCY/LEVEL display will indicate the - CAL - message for approximately 15 seconds. During calibration the Measuring Receiver creates a calibration factor for the first RF range (RF1) by comparing the Tuned Level measurement to the Carrier Power measurement.

g. If the Adapter pad will be removed for subsequent Tuned Level measurements, it must be calibrated at this time as follows, otherwise skip to step k.

h. Without changing the signal level, remove the adapter pad and connect the sensor to the RF source.

i. After a few seconds the FREQUENCY/LEVEL display will contain the tuned level measurement. If the UCAL and RCAL legends are not displayed, calibration factors for the Adapter pad already exist. If the UCAL and RCAL legends are displayed, depress the CAL key. The FREQUENCY/LEVEL display will indicate the - CAL - message for approximately 5 seconds. During the calibration the Measuring Receiver creates a calibration factor for the Adapter pad by comparing the Tuned Level measurement without the Adapter pad to the previous RF1 calibration measurement.

j. When the calibration sequence is complete, connect the sensor with the Adapter pad installed to the RF source.

k. As the signal level is stepped down, the RCAL legend will be displayed two more times at the point of overlap between the RF ranges (Table 3-4). When the RCAL legend is displayed, keep the input signal level constant and depress the CAL key. The FREQUENCY/LEVEL display will indicate the - CAL - message for approximately 5 seconds. During the calibration the Measuring Receiver creates a calibration factor for the current RF range by comparing Tuned Level measurements on adjacent RF ranges.

3-152. Table 3-4 also presents the expected measurement accuracy when the synchronous detector is used for level measurements down to -130 dBm. The accuracy data presented is a worst case summation of the incremental system errors, but relative to 0 dBm.

3-153. The control program in the Measuring Receiver stores calibration data in non-volatile memory. As more and more Tuned Level measurements are made the calibration memory fills. As a result, recalibration at RF2 and RF3 calibration points will be unnecessary as measurements are made at many different frequencies. However, if a complete recalibration at a particular frequency is desired for some reason, the RCAL and UCAL prompts can be enabled by entering SPCL 52. This will reset the internal calibration flags for this particular measurement frequency.

3-154. The TUNED LEVEL measurement uses signal averaging to present a stable reading at low power levels. Like the average power measurement, averaging time is set automatically by the control program based on internal range settings. For a complete discussion see FILTERING AND NOISE above. The measurement time can be set manually by selecting one of SPCL 48 through 51. See Table 3-2.

3-155. Because of the large dynamic range of TUNED LEVEL measurements, the FREQUENCY/LEVEL display is used to present measurement status during range changes and averaging. If the first RF range is active two centered dashes are presented in the display. As the RF ranges are changed, first four, and finally six dashes are presented. If all of the IF ranges are exhausted, eight dashes are presented. The [= = = = = = = =] message is presented while measurement averaging is in progress. The averaging time varies from 0.1 to 10 seconds. If no signal is present the display will alternate between "--------" and "[= = = = = = = =]". Depressing the TUNED LEVEL key will always force a new measurement average cycle to complete before the data is displayed.

3-156. SELECTING MODULATION MODE.

3-157. The Model 8200-S/10 can detect and display amplitude, frequency, or phase modulation. After the modulation mode is selected, subsequent instrument operation is very similar.

3-158. To select the AM measurement mode, first select carrier frequency and level as described above, then depress the modulation AM key. The modulation display will indicate the recovered AM modulation in %. The IFHI and IFLO messages are active in the AM mode and indicate that the carrier level is not adequate to make a calibrated measurement. The [= = = =] display indicates that the current measurement is out of range to be displayed, and will occur when autoranging is in progress or the display is overranged.

(See Para 3-105 & 3-1[illegible])

3-159. To select the FM measurement mode, first select carrier frequency and level as described above, then depress the modulation FM key. The modulation display will now indicate the recovered FM in kHz. The de-emphasis filters may be selected in the FM measurement mode. In addition, they may be placed before or after the modulation display. See above for a description of this option. The de-emphasis measurement control keys are mutually exclusive, that is depressing one of the keys will cancel the others. Depress the desired de-emphasis key. The AF OUT signal, and optionally the modulation display will now indicate modulation with the de-emphasis filter on. Depress the de-emphasis OFF key to cancel filter selection.

3-160. To select the PM measurement mode, first select carrier frequency and level as described above, then depress the modulation PM key. The modulation display will now indicate the recovered PM in RADians. The PM modulation mode is a special case of the FM mode. The modulation information is determined by integrating the output of the FM detector. This is mathematically consistent with the definition of frequency as the time rate of change of phase. The integration is only accurate over a selected range of frequencies so that accuracy specifications are relaxed and modulation bandwidth is decreased. Autoranging operation is also different in the PM measurement mode. The modulation range is determined by monitoring the recovered FM signal. This causes the displayed resolution to change based on phase deviation and modulation rate rather than just displayed deviation as in FM. For example, below a 1 kHz modulation rate, autoranging points are the same as they are for FM, 5199 and 499 counts, however, at a 5 kHz modulation rate the displayed autoranging points are 1040 and 99 counts. The displayed resolution continues to decrease with increasing modulation rate.

3-161. MEASUREMENT AND DISPLAY CONTROL.

3-162. After the modulation mode has been selected, recovered modulation can be additionally processed by using the measurement control keys and SPCL functions.

3-163. RANGE HOLD.

3-164. SPCL functions 30 through 33 are provided to eliminate autoranging when the magnitude of the recovered signal is known. This feature is also useful when decreased display resolution is desired. SPCL 30 is the default setting which adjusts the display resolution at 5199 and 499 counts. This provides the maximum displayed resolution for a given measurement.

3-165. SPCL functions 31-33 select one of three internal ranges. SPCL 31 selects the most sensitive range of 5.000 full-scale. If the recovered modulation exceeds 5.199 the [= = = =] message will overwrite the display. Similarly, SPCL 32 selects the 50.00 full-scale range and SPCL 33 selects the 500.0 full-scale range. Again, if the modulation exceeds the full scale value the [= = = =] display will result.

3-166. RATIO MEASUREMENTS.

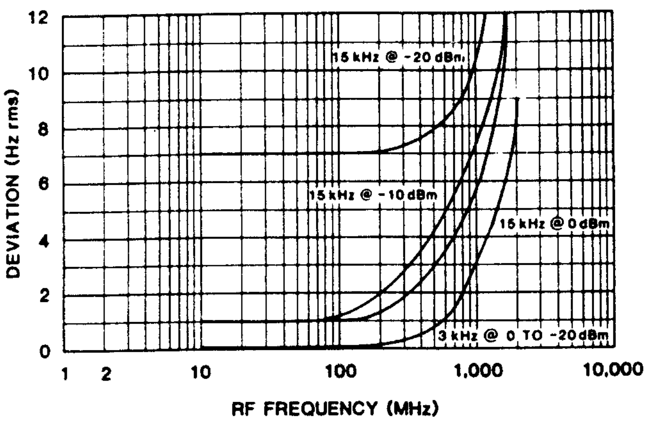

FIGURE 3-11. Residual FM, 3 and 15 kHz Filters.

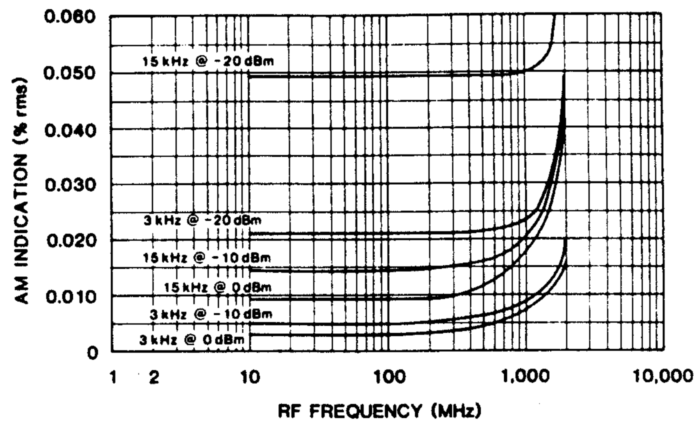

FIGURE 3-12. Residual AM, 3 and 15 kHz Filters.

3-167. The RATIO key is used to change displayed quantities from absolute to relative. RATIO can be displayed with respect to a previous measurement or a set value. The %, units, and dB keys are used to select the relative display units. If the RATIO key is depressed when the active function is in the measurement mode (LED in the AUTO key is illuminated), the current displayed reading becomes the reference for subsequent relative measurements. For example, if the current measurement is 25.00 kHz deviation and the RATIO key is depressed, and the % display is selected, the display will change to 100.0 and the units annunciators will be kHz and %. If the dB key is depressed the display will change to 0.00 (or optionally 0.000) and the annunciators will be kHz and dB. Note that if the active function is AM and the RATIO % display is selected, only the % annunciator will be displayed.

3-168. In our example, if the deviation now changes to 20.00 kHz, the display will change to 80.0 % or -1.91 dB depending on the units selection. Modulation readings can also be displayed relative to a set value of modulation. The value of the reference modulation is keyed into the modulation display using the data keypad before the RATIO mode is activated. The LED in the AUTO key will go off when the data entry is completed. For example, to establish a reference modulation of 40.00% AM depth, select the AM function and cancel the RATIO display if it is active. Enter 40% into the modulation display using the data keypad. Depress the RATIO key to measure AM with respect to 40.00%. The dB key may be depressed to change the displayed units to dB. Suppose that the actual modulation was 47.5%. In our example, the modulation display would indicate either 118.7% or 1.49 dB.

3-169. The RATIO display is a convenient way to alter displayed units. For example, incidental AM is often expressed as a ratio in dB of indicated AM with respect to 100%. To display incidental AM enter 100% as the reference modulation and select the dB RATIO measurement mode. Residual AM and FM and incidental FM may similarly be displayed with respect to a reference modulation.

3-170. Many other displays are possible by using the RATIO mode. Phase modulation may be displayed in degrees by entering 1.745 RAD as a reference and using the RATIO % measurement mode. Similarly, selecting the ratio of peak to rms will display the crest factor of the recovered modulation.

3-171. PEAK AND RMS DETECTORS.

3-172. When making modulation measurements, the desired result is normally the peak deviation or the peak or trough of amplitude modulation. The PEAK +, -, and ± keys provide this display. The + PEAK detector indicates the positive peak excursion of FM or PM deviation (increasing frequency or phase),and the peak of AM modulation. The - PEAK detector indicates the negative peak excursion of FM or PM deviation (decreasing frequency or phase), and the trough of AM modulation. The ± key indicates the arithmetic mean of the + and - peak key. The display in the PEAK ± mode is calculated by the display program from independent measurements of the + and - peaks.

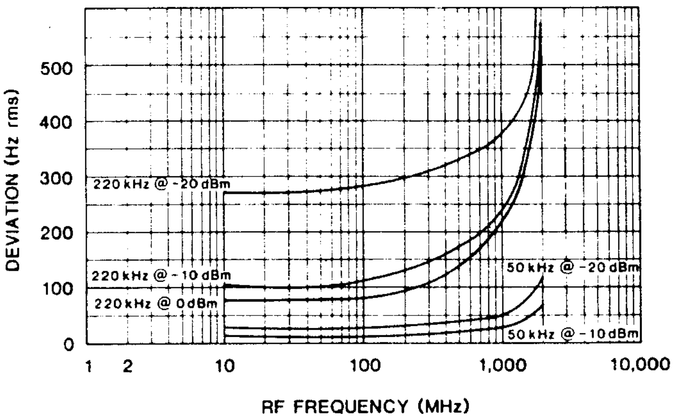

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FIGURE 3-13. Residual FM, 50 and 220 kHz Filters.

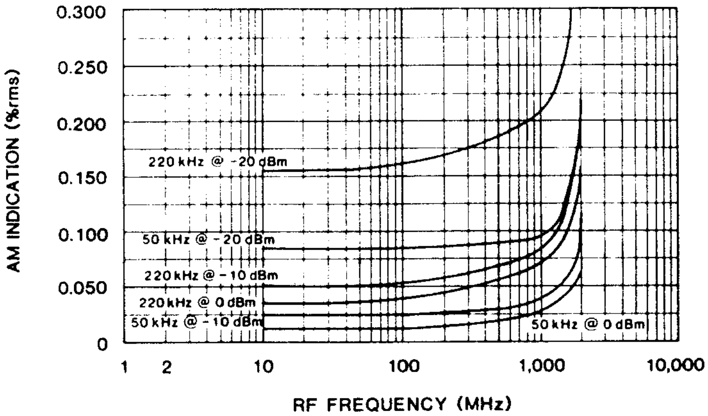

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FIGURE 3-14. Residual AM, 50 and 220 kHz Filters.

3-173. For most measurements there will be a difference in the positive and negative peaks. This is usually due to even order distortion of the recovered modulation signal. For FM modulation, the distortion would also be apparent in the carrier frequency display if the magnitude of the distortion is large enough. This asymmetry is also referred to as carrier shift. For AM a similar effect occurs, shifting the average carrier amplitude.

3-174. In any case some difference in peak readings is normal since the maximum on-scale resolution of the modulation display can be 1 part in 5000 or 0.02%.

3-175. Several measurement situations arise when peak indication is not very useful. The most often encountered of these is the measurement of noise residuals. Because the Model 8200-S/10 detectors and local oscillators have very low noise residuals, the instrument can be used to characterize noisy sources. Under these conditions, the RMS detectors should be used to give meaningful results.

3-176. Two RMS detector keys are provided, the RMS key and the √2RMS key. The keys differ only mathematically. Depressing the √2RMS key causes the control program to scale the actual rms detector output by the square root of 2, the crest factor for a sinewave; thus, the display is calibrated in peak for sinewave modulating signals. This is very useful for quantifying noise residuals on moderately noisy carriers.

3-177. Root-mean-square (RMS) voltage is obtained by summing the squares of the individual components of a waveform and then taking the square root of the result. Thermocouples, thermistors, and calorimeters are examples of rms detectors. The detector in the Model 8200-S/10 is a computing type of rms detector, that is, it takes the absolute value of the voltage, squares it, averages it, and finally takes the square root of the result.

3-178. When the measurement situation calls for display of residual modulation, the rms detector should be used. The noise of the carrier under test is combined with the residual noise of the Model 8200-S/10 circuits in very predictable manner. This allows the Model 8200-S/10 residuals to be easily discounted. For example, if the indicated residual FM is 25 Hz rms with a carrier at 1000 MHz and -10 dBM and with the 15 kHz low-pass filter selected, the residual noise of the carrier alone is simply the square root of difference of the square of 25 and 7.5 or 23.8 Hz rms. Residual AM and PM are handled in a similar manner. The residual responses of the Model 8200-S/10 are shown in Figures 3-11 through 3-14.

3-179. DETECTOR HOLD.

3-180. The detector HOLD key is useful in measurement situations where the long term modulation peak is desired. The HOLD key can be used with any of the detectors to display the larger of the previous or current measurement. To use the HOLD function, depress the HOLD key. The modulation display will change only if the measurement is greater than the one displayed. Depress the HOLD key again to cancel this measurement control mode.

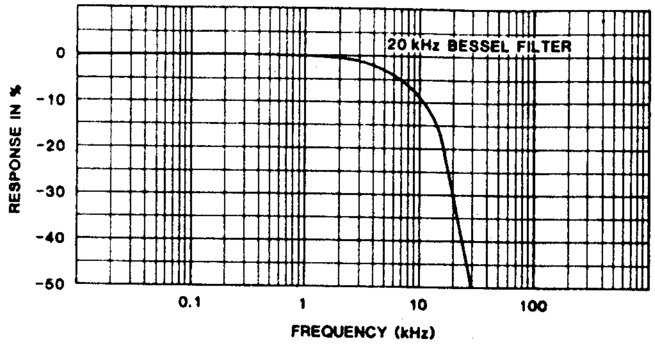

FIGURE 3-15. Response, 20 kHz Bessel Filter.

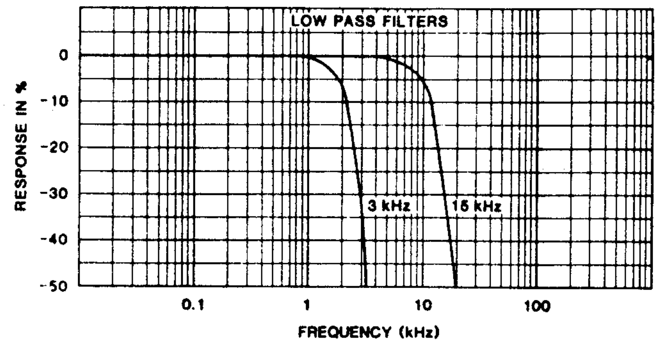

FIGURE 3-16. Response, 3 and 15 kHz Filters.

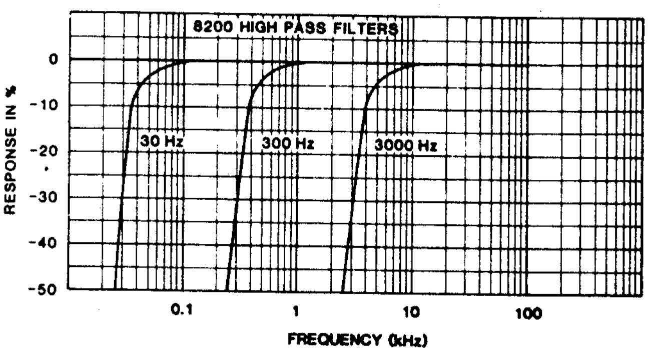

FIGURE 3-17. Response, High-pass Filters.

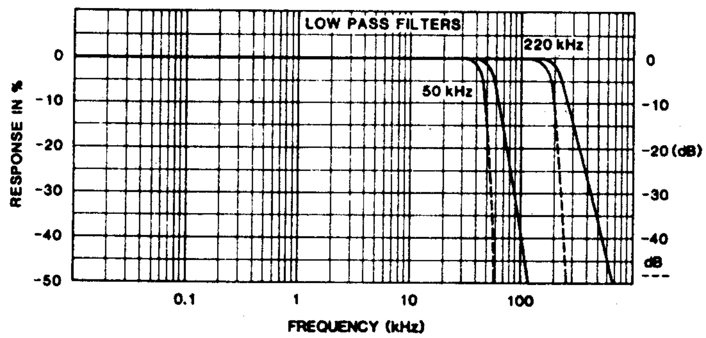

FIGURE 3-18. Response, 50 and 220 kHz Filters.

3-181. FILTERS.

3-182. The Model 8200-S/10 includes an array of low-pass, high-pass, and de-emphasis filters. These filters can be used to advantage to minimize measurement errors due to noise or to remove unwanted components of complex modulating waveforms.

3-183. The high-pass filters are all three-pole Butterworth designs except the < 10 Hz filter. The < 10 Hz filter is a Gaussian response controlled by the coupling capacitors on the Filter circuit board. The three dB corner is actually much less than 10 Hz. This filter is also specified to have less than 10 % droop with 5 Hz square wave modulation. The response of the high-pass filters is shown in Figure 3-17.

3-184. The low-pass filters are a combination of active and passive designs. The 3 and 15 kHz low-pass filters are three-pole Butterworth designs, the 20 kHz low-pass filter is a three-pole Bessel design, and the 50 and 220 kHz filters are seven-pole Butterworth designs. Low-pass filter response is shown in Figures 3-15, 3-16 and 3-18.

3-185. Filter selection is critical in maintaining accuracy of displayed modulation. All carriers applied to the RF IN connector of the Model 8200-S/10 will contain noise modulation sidebands. The magnitude of the noise can be determined by using rms detection as outlined above. Selection of the lowest low-pass filter possible based on the modulation frequency, will usually produce the most accurate indication. For example, if the modulation frequency is 1 kHz, the 3 kHz low-pass filter should be used.

3-186. If the modulation signal is a rectangular-wave (square or pulse) the 20 kHz low-pass filter should be used. This filter is a Bessel design which has controlled phase characteristics and very modest overshoot.

3-187. Filter selection is very important when measuring distortion. A reasonable distortion measurement should include at least the first three harmonics. For example, if a measurement of distortion is made on a modulating signal at 2.5 kHz, the 15 kHz low-pass should be used. High-pass selection will also affect distortion measurements. For example, when measuring the distortion of a 1 kHz modulating signal, if the 300 Hz high-pass is selected, the phase relationship of the fundamental signal, 1 kHz is changed with respect to the harmonics and a smaller or larger indicated distortion may result. Distortion measurements are made by connecting an audio analyzer such as the Boonton Model 1120 to the AF OUT connector.

3-188. PROGRAM STORE AND RECALL.

3-189. The Model 8200-S/10 contains an internal program memory which will hold 99 front panel setups. The programs represent the state of the instrument when the STO key is depressed. Storing and recalling program information is accomplished by depressing the PRGM key to activate the program function. Once the program function is active, the desired program number is entered into the display using the data keypad and the ENTER key. Depress the STO key to store the current instrument status or the RCL key to restore a previously saved instrument setting.

3-190. The internal memory of the Model 8200-S/10 is non-volatile, that is, when power is removed, the contents of the internal memory is not lost. In normal operation, the internal memory is never erased. New programs or changes are simply written over the old ones. It is possible, however, to erase the entire program memory by use of a test jumper located on the CPU circuit board. Erased programs cannot be recalled. After recalling a program, any panel setting may be changed. See Table 6-1 For Test Jumper Positions

3-191. RECALL ONLY PROGRAMS.

3-192. There are currently four recall only programs available in the Model 8200-S/10 firmware. Program number 99 is a setup program equivalent to the program installed when the INIT key is depressed. This program is installed during power up if a memory fault occurred on the previous power down. If an attempt is made to store a program at location 99, an error will result.

3-193. Program number minus 1 is the modulation detector calibration program. When recalled the -CAL- symbol will appear in the CARRIER display and detector calibration will begin. The calibration routine will take about 80 seconds to complete. The AM detector is calibrated first, followed by the RMS detector, the FM detector and finally the PM detector. If calibration errors occur, they will be displayed as the particular detector is being calibrated.

~~3-194. Program number minus 2 is the audio filter operational check program. Each filter position is checked for continuity and approximate response by applying the FM calibrator signal and selecting each filter in turn. Any errors that occur will be displayed as the particular filter is tested.~~

~~3-195. Program number minus 3 is used in conjunction with the Model 4220-S/10 power meter to test the power meter circuits. Power meter internal ranging and calibrator operation is tested. Any errors that occur will be displayed as they occur.~~ Delete

3-196. REMOTE OPERATION.

3-197. Any front-panel operation of the instrument with the exception of the LINE ON/OFF switch can be remotely controlled under direction of an IEEE-488 interface controller. IEEE-488 is a hardware standard which describes the communication and handshaking across an 8-bit parallel bus between a controller and up to 15 instruments.

3-198. **Setting the Bus Address.** To set the IEEE-488 bus address (MLTA), depress the SPCL key, enter 10, the special function to access the bus address setting program. The current bus address will be displayed, with the ADRS annunciator illuminated in the SPCL/PRGM display. Enter the address by means of the DATA ENTRY keypad and use the ENTER key to complete the entry. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented.

DISPLAY	Listen	Talk
L-CL	Line Feed.	Carriage Return, Line Feed.
C-CL	Carriage Return.	Carriage Return, Line Feed.
C-C	Carriage Return.	Carriage Return.
L-L	Line Feed.	Line Feed.
EOI	End-or-identify.	End-or-identify.

TABLE 3-5. IEEE-488 End-of-String Characters.

3-199. **Setting the End-of-String Character.** To set the IEEE-488 bus end of string character(s), depress the SPCL key, enter 11, the special function to access the end-of-string setting program. The current end-of-string character(s) will be displayed, in the FREQUENCY/LEVEL display. Select the desired characters by using the ENTER key to step through the possible selections, and a function key or INIT to select. The different character displays and their meanings are tabulated in Table 3-5. In any case, the Model 8200-S/10 always terminates on end-or-identify (EOI) true and always sends EOI true with the last character of every string.

3-200. **Entering the Remote Mode.** The instrument is put in the remote mode by addressing it as a listener with remote enable (REN) bus signal true. In the remote state the keyboard is disabled, except for the LCL/INIT key and the POWER ON/OFF switch. The REM status annunciator is illuminated.

3-201. **Returning to Local Mode.** The instrument may be returned to the local mode as follows:

a. The LCL/INIT key is depressed, provided local lockout (LLO) is not active.

b. The go-to-local (GTL) bus command is sent.

c. Remote enable (REN) is set false.

NOTE

The instrument must be placed in the remote mode for it to store and respond to data messages.

3-202. **Triggered Operation.** In the remote mode the instrument can be operated in the immediate mode (mnemonic MIM), or in the wait-for-trigger mode (MWT). The immediate mode is the default condition and results in the immediate response to mnemonic commands and settings. The wait-for-trigger mode causes data acquisition be deferred until a trigger is received. MWT This aids in synchronizing the instrument to other system components. The wait-for-trigger mode is set when the WT mnemonic is encountered in the input string. From that point on execution is delayed. No change will occur until one of the following events is encountered:

a. "Group-execute-trigger" (GET) is received.

b. The mnemonic MTR (trigger) is interpreted.

c. Any mnemonic following MIM (immediate) is interpreted.

NOTE

Event (c), above, or go-to-local terminates the wait-for-trigger mode and restores the immediate mode. The wait-for-trigger mode is not active in local operation.

3-203. Talk Operation. The instrument may be addressed as a talker without regard for remote/local mode. When the talker state is set by the bus controller, the instrument sends a character string which is determined by the current talk mode. One of four different talk modes is selected by sending the appropriate mnemonic with the Model 8200-S/10 addressed as a listener. The selected mode will remain in effect until changed.

3-204. Talk Status (MTS) Mode. In the MTS mode the error number and hardware status is returned as an ASCII string. The string is composed of:

error number followed by ASCII ','
hardware status byte followed by ASCII ','
tuned level calibration status byte followed by end-of-string.

If no error is pending the error number will be zero (0). The interpretation of the hardware status byte and the tuned level calibration byte is presented in Table 3-6. The MTS mode will automatically clear an error after the status is reported. This is the default talk mode after initialization of the instrument.

3-205. Talk Value (MTV) Mode. In the MTV mode the argument of the active function is returned as a number. All values returned are in basic units such as: Hz, dB, dBm, % etc. FM deviation is returned in kHz and level in millivolts.

3-206. Identify (MID) Mode. In the MID mode a string is returned that uniquely identifies the system hardware and firmware.

Hardware Status Byte

Bit Position	Meaning	Decimal value
0	RCAL active	1
1	UCAL active	2
2	Manual level set	4
3	Manual tune set	8
4	Active Display overranged	16
5	ALTernate Filter goup active	32
6	Unleveled	64
7	Unlocked	128

The instrument hardware state is the sum of the individual status bit weights.

Calibration Status Byte

Bit Position	Meaning	Decimal value
0	Average Detector active	1
1	0 dBm uncalibrated, Pad on	2
2	0 dBm uncalibrated, Pad off	4
3	-30 (-10) dBm step uncalibrated	8
4	-70 (-50) dBm step uncalibrated	16
5	Uncalibrated at present temperature	32
6	Adapter pad is not installed	64
7	Unused, always zero	128

The calibration status is the sum of the individual status bit weights.

TABLE 3-6. Status and Calibration, Bit assignments.

Bit Position	Function	Bus Code
0	Instrument Error.	1 MSQ
1	Zero Completed.	2 MSQ
2	Calibration Completed.	4 MSQ
3	Measurement Completed.	8 MSQ
4	Not used	
5	Not used	
6	Not used.	
7	Not used.	

More than one item can be selected by adding the corresponding bus codes.

TABLE 3-7. SRQ mask, Bit assignments.

COMMANDS		RESPONSE
Universal Command Group:		
	Device Clear (DCL)	Clear errors.
	Local Lockout (LLO)	Disable LCL/INIT key.
	Serial Poll Enable (SPE)	Set Talk mode for poll response.
	Serial Poll Disable (SPD)	Disable serial poll response..
Addressed Command Group:		
	Selected Device Clear (SDC)	Same as device clear.
	Go to Local (GTL)	Returns front panel control.
	Group Execute Trigger (GET)	Trigger a measurement.

TABLE 3-8. Bus Command Responses.

3-207. **Talk Program (MTP) Mode.** In the MTP mode a compressed parameter string of ASCII characters, the last of which is an ASCII ($), is returned. This string can be sent back to the instrument at any time to restore the exact state of all functions and settings which defined it, but it must be sent as a complete string without alteration. When the ($) character is encountered in the input buffer, the learn mode is automatically activated. While this form provides a compact and fast method to save and restore all settings, it bypasses much of the error control and must be used with caution.

3-208. **Using "Service Request" (SRQ).** The Service Request allows the Model 8200-S/10 to inform the controller that some special event has occurred. The instrument then expects the controller to perform a serial poll to find out what event has occurred. The events that can be selected to generate service requests are instrument error, measurement is ready, zeroing is completed, and calibration is completed. Each of these options can be individually enabled or disabled with the SRQ mask. The default settings for the mask are with all SRQ's disabled. They can only be enabled by setting the appropriate bits high in the SRQ mask over the bus with the MSQ mnemonic. In small systems only one instrument may be capable of using SRQ. In this situation there is no need to execute a serial poll since the identity of the requesting device is known. The error codes may be obtained directly form the talk error (MTE) mode. The SRQ line can then be cleared by sending the clear (MCL) command.

3-209. **Setting the SRQ mask.** Table 3-7 indicates the bit positions in the SRQ mask and what each bit enables/disables, and the corresponding bus configuration command.

3-210. **Bus Command Responses.** IEEE-488 bus commands are sent by the controller to all devices on the bus (Universal Command Group) or to addressed devices only (Addressed Command Group). The response of the instrument is listed in Table

TABLE 3-9. IEEE-488 BUS MNEMONICS.

BUS MNEMONIC	RESPONSE
Power Meter:	
PCP	Set receiver sensor to RF power.
PSI	Load sensor data.
PTI	Load sensor temperature data.
PSO	Read sensor data.
PTO	Send sensor temperature data.
PDI	Load dc calibration data.
PDO	Read dc calibration data.
PFI	Load sensor frequency data.
PFO	Read sensor frequency data.
PCN	Turn power reference ON.
PCF	Turn power reference OFF.
PSS	Select sensor.
PDS	Down Converter Status.
PRS	Power Meter Status.
PDC	Activate automatic calibration program. (Requires a Model 2510 on the private bus at address 10.)
PAC	Activate automatic calibration program. (Requires a Model 2520 on the private bus at address 20.)
PID	Sends a string which identifies the Model 4220-S/10.
PIT	Initialize the 4220-S/10 and 8200-S/10.
PGS	Send SG1207/U status.
PUN	Send 4220-S/10 Serial number.
PCD	Send 4220-S/10 calibration date.
Modulation Analyzer Functions:	
MFR	Carrier frequency, argument range: 100 kHz to 18 GHz.
MCP	Carrier power level, argument range: -20 to +33 dBm.
MTL	Carrier tuned level, argument range: ~~-130 to +33 dBm~~. -127 to +33 dbm
MAM	AM modulation, argument range: ~~0 to 200~~%. 0-99.9%
MFM	FM modulation, argument range: 0 to 500 kHz.
MPM	PM modulation, argument range: 0 to 500 RAD.
MSP	Special function, argument range: 0 to 99.
MPG	Program number, argument range -3 to 99.

TABLE 3-9. IEEE-488 BUS MNEMONICS CONTINUED.

BUS MNEMONIC	RESPONSE
Units:	
MGO	**Gigahertz offset for frequency entry.**
MDB	**dB for ratio, or dBm for level or power.**
MGH	**Gigahertz for frequency entry.**
MMH	**Megahertz for frequency entry.**
MKH	**Kilohertz for frequency entry.**
MHZ	**Hertz for frequency entry.**
MVO	**Volts for level or power entry.**
MMV	**Millivolts for level or power entry.**
MRA	**Radians for phase modulation entry.**
Display Control:	
MAU	**Activates the measurement mode, for the active function. Not active in PRGM and SPCL.**
MRP	**Activate relative measurements of the active function in percent.**
MRD	**Activate relative measurements of the active function in dB.**
MRX	**Turn OFF ratio mode.**
MWT	**Enable the wait-for-trigger talk mode.**
MIM	**Enable the immediate trigger talk mode.**
MTR	**Trigger a measurement, same as GET.**
MBL	**Blank Display and disable display updates.**
MUD	**Restore display and enable display updates.**
MPD	**Pre-display de-emphasis.**
MAD	**Post display de-emphasis.**
Filter Selections:	
MD1	**De-emphasis, 25 us.**
MD2	**De-emphasis, 50 us.**
MD3	**De-emphasis, 75 us.**
MD4	**De-emphasis, 750 us.**
MD5	**De-emphasis, OFF.**
MH1	**High-pass, <10 Hz.**
MH2	**High-pass, 30 Hz**
MH3	**High-pass, 300 Hz.**
MH4	**High-pass, 3000 Hz.**
MAL	**Alternate filters ON.**
MAX	**Alternate filters OFF.**
ML1	**Low-pass, 3 kHz.**
ML2	**Low-pass, 15 kHz.**
ML3	**Low-pass, 20 kHz.**
ML4	**Low-pass, 50 kHz.**
ML5	**Low-pass, 220 kHz.**

TABLE 3-9. IEEE-488 BUS MNEMONICS CONTINUED.

BUS MNEMONIC	RESPONSE
Detector Selection:	
MP1	**Peak +.**
MP2	**Peak ±.**
MP3	**Peak -.**
MRM	**RMS detector.**
MPR	**√2RMS detector.**
MPH	**Peak Hold ON.**
MPX	**Peak Hold OFF.**
Program Control:	
MST	**Store front panel setup.**
MRE	**Recall front panel setup.**
Calibration:	
MCA	**Calibrate the active function.**
MZR	**Zero the wideband power sensor.**
Set SRQ mask:	
MSQ	**See text.**
Test Function:	
MCH	**Execute self-check program.**
Cancel Errors:	
MCL	**Clear all errors.**
Talk modes:	
MTV	**Talk value, sends the value of the active function.**
MTP	**Talk program, sends a string representing the contents of the stored program followed by an ASCII $.**
MTS	**Talk status, sends the current error number.**
MID	**Sends a string which identifies the 8200-S/10 firmware.**
MTU	**Talk 8200 serial number.**
Special functions:	
MTA	**Set sensor Ambient temperature in degrees C.**
MF0	**Set sensitive frequency to 10 Hz resolution.**
MF1	**Set sensitive frequency to 1 Hz resolution.**
MFA	**Set fast frequency acquisition mode.**
MFN	**Reset fast frequency acquisition mode.**

3-8. All unlisted commands are ignored.

3-211. Program Function Mnemonics. Each front panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values, if appropriate, is analogous to manual front-panel operation. In addition, other program mnemonics are used for functions that are applicable only in remote operation. Table 3-9 lists all the program function mnemonics.

3-212. Number Formatting. Number formatting rules are as follows:

a. Fixed or floating formats are accepted.

b. The optional + or - sign may precede the mantissa and/or the exponent.

c. The optional radix point may appear at any position within the mantissa. A radix point in the exponent is ignored.

d. The optional "E" for exponent may be upper or lower case.

e. All ASCII characters below and including ";"(3Bh) are considered command delimiters. The ASCII characters " "(20h), ","(2Ch), ";"(3Bh), and ":"(3Ah) are considered numeric delimiters.

3-213. Data String Format. Data string formats are as follows:

a. The programming sequence is in natural order, that is, a function mnemonic is sent first followed by the argument, if appropriate.

b. The data strings sent to the instrument are case sensitive. This means lower case and upper case are not the same.

c. A primary function mnemonic sent without a following argument will make the specified function active.

d. The data string may not exceed 512 characters and may be terminated with LF, CR, and/or EOI.

e. Interpretation of the data string does not begin until the end-of-string character is received.

f. If units are unspecified for any argument, default units are automatically appended. The functions SPCL and PRGM always use default units.

g. If a unit mnemonic is sent without a corresponding argument, the display will reflect the change provided that the units are appropriate for the active function and the display can accommodate the rescaled number.

h. All commands over the bus must be separated by a delimiter. Valid delimiters are a blank space, number, comma (,), colon (:), or semicolon (;).

3-214. Data String Errors. Errors are detected during interpretation. The occurrence of an error will display the error code if the display is enabled, and will set SRQ true, if enabled. The error and SRQ can be cleared by a serial poll, a status request (MTS), or a clear error instruction (MCL). All errors cause previous valid parameters to be restored. No new input can be processed until an existing error is cleared.

3-215. Data String Examples. The following are examples of typical programming strings in HP BASIC:

OUTPUT 715; "MFR 123.456 MMH"	set carrier frequency to 123.456 MHz.
OUTPUT 715; "MFR 2.03 MGO"	set measurement frequency offset to 2.03 GHz.
OUTPUT 715; "MH1 ML2 MCP -5.43 MDB"	set high-pass < 10, low-pass 15, and carrier power to -5.43 dBm.

OUTPUT 715; "MPG 1 MRE"	set program to 1, then recall.
OUTPUT 715; "MRD"	select ratio, dB display for the active function.

3-216. **Reading Calibration values.** Calibration values are not normally accessible from the IEEE-488 bus, as the calibration process must necessarily stop all other operations and all communications. The values are accessible, however, by using the following program sequence

OUTPUT 715; "MAM MTV MWT MCA"	set AM, talk value, and wait for trigger; then calibrate.

The data is read back without sending a trigger. The first trigger command will update the measurement and overwrite the calibration data.

3-217. **Store and Recall Operation.** Store and Recall operation may be used to advantage with a bus controller. The instrument provides either temporary or long-term storage for control strings. This can be used to minimize bus traffic by storing several control setups at initialization and recalling them when needed with a simple string statements, such as:

OUTPUT 715; "MPG 23 MRE"

Since few controllers have power fail protection, the data in the instrument's non-volatile memory is the more secure.

3-218. **Calibration Data.** Power meter calibration data can be read or written to the power meter using the IEEE-488 bus.

3-219. PSI (datain). This command is used to send a portion of the Sensor calibration data in the form of a numeric data array. The following precautions should be observed when using this mode.

a. The data is protected by a bit switch in the 4220-S/10 on the control board. If switch position 5 is open, the data can be changed; if not, error 46 will be reported.

b. The data can be viewed or changed by SPCL 87.

c. There are two sets of data for each Sensor. One set is for the Sensor with the external 10 dB pad, the other set is for the the Sensor without the 10 dB pad. The correct Sensor configuration can be selected with the PSS (select sensor) command.

d. The data are the 14-point linearity data (AC reference frequency linearity data) for a selected Sensor and are placed in the Sensor data bank. This command complements the PSO (dataout) command over the bus and the PSO (dataout) command would normally be the source of the data string for this command.

Format: PSI Sensor type, Sensor serial number, U0,U1,U2,U3,U4,U5,U6,D0,D1,D2,D3,D4,D5,D6.

where:

Sensor type is 51033.

Sensor serial number is from 1 to 999999.

U0 through U6 are the Upscale gain factors (1000 to 10000, nominally 5000).

D0 through D6 are the downscale factors (-200 to +200).

e. Each numeric value must be separated by a valid delimiter.

f. Example:

OUTPUT 715;" PSI 5013,12345,5012,5003,5032,5013,4995,5005,4891,-20,-21,2,-3,-14,15,6"

3-220. PSO (dataout). This command is used to read calibration data. When executed, this command builds an array of numeric data in the talk buffer for transmission at the next talk request. The array consists of numeric data representing the 14 point linearity data (AC calibration data) for a selected Sensor. This command complements the PSI (datain) command over the bus and the PSI (datain) command would normally be the destination of the data string of this command.

Format: To the instrument in a listen string: PSO (dataout).

From the instrument in the next talk string: 51033, Sensor serial number, U0,U1,U2,U3,U4,U5,U6,D0,D1,D2,D3,D4,D5,D6.

where:

a. Each numeric value must be separated by a valid delimiter.

Example:

To the instrument in a listen string: PSO. From the instrument in the next talk string:

51013,12345,5023,5001,5012,5010,4997,5005,5003,10,13,-2,-23,14,-15,6.

3-221. PFI (freqin). This command is used to send Sensor high frequency calibration data for the 51033-S/10 Sensor in the form of an array. The following precautions should be observed.

a. The data is protected by a bitswitch in the 4220-S/10 on the control board. If switch position 5 is open the data can be changed. If not, an error will be reported.

b. This data can be viewed or changed by SPCL 86.

c. There are two sets of data for each Sensor. One set is for the Sensor with the external 10 dB pad. The other set is for the Sensor without the pad. The correct Sensor can be selected by the PSS (select Sensor) command.

d. The data are for the selected Sensor and are placed in the Sensor data bank.

e. Format: PFI DBCF1, DBCF2,... DBCF18

where: the frequency for each point 1-18 is implied.

DBCF is the dB Cal Factor from -3.00 to 3.00 dB in 0.01 dB increments.

f. Each numeric value must be separated by a valid delimiter.

g. Example:

OUTPUT 715;"PFI .09,.19,.03,-.17,-.54,-.58,-.52,-.33,-.12,-.07,.14,.22,.17,-.18,-.47,-.16,.25,-.25"

3-222. PFO (freqout). This command is used to read Sensor high frequency calibration data.

a. When executed, this command builds an array of numeric data in the talk buffer for transmission at the next talk request. The array consists of numeric data representing the dB Cal Factor information for a selected Sensor.

b. Format: To the instrument in a listen string: PFO; From the instrument in the next talk string:

DBCF1,DBCF2,DBCF3,... DBCF18

The frequency is implied by the location of the DBCF's position in the table.

DBCF is a dB Cal Factor for this group, from -3.00 to 3.00 dB in 0.01 dB increments; etc.

c. Example: PFO Instrument talks; .09,.19,.03, -.17,-.54,-.58,-.52,-.33,-.12, -.07,.14,.22,.17,-.18.-.47, -.16,.25,-.25

d. Each numeric value must be separated by a valid delimiter.

3-223. PDI. This command is used to send DC calibration data to the instrument in the form of an array.

a. The data are a gain constant for each range, and an ADZERO term which is a downscale adjustment. It is stored in non-volatile RAM.

b. Format: PDI G0,G1,G2,G3,G4,G5,G6,ADZERO

where: G0 through G6 are the gain constants for ranges 0 through 6, ranging from 4000 to 7500 (nominally 5000);

ADZERO is the downscale adjustment, ranging from -15 to 15, nominally 0.

c. Each numeric value must be separated by a valid delimiter.

d. Example:

OUTPUT 715;" PDI 5000,5001,5002,5003,5004,5005,5006,-1"

3-224. PDO (dcout). This command is used to read DC calibration data. When executed, this command builds an array of numeric data in the talk buffer for transmission at the next talk request. The array consists of a gain constant for each range, and an ADZERO term which is a downscale adjustment.

a. Format: To the instrument as a listen string: PDO; From the instrument in the next talk string:

G0,G1,G2,G3,G4,G5,G6,ADZERO

where:

G0 through G6 are the gain constants for ranges 0 through 6, ranging from 4000 to 7500 (nominally 5000, except range 6 which is 6635);

ADZERO is the downscale adjustment, ranging from -15 to 15, nominally 0.

b. Each numeric value must be separated by a valid delimiter.

c. Example:

To the instrument in a listen string: PDO. From the instrument in the next talk string:

5000,4889,5002,5029,5034, 4990,6645,-1

3-225. PTI (temperature data in). This command is used to send temperature calibration data to the instrument in the form of an array. The following precautions should be observed:

a. All data is lost when a cold initializaton of the 4220-S/10 is done.

b. The data is protected by a bitswitch on the 4220-S/10 control board. Switch position 5 must be open for calibration data to be received.

c. The data consists of 14 points of temperature data for each of 5 different temperatures.

d. Format: PDI TCF1, TCF2, ...,TCF70

where: TCF1 through TCF70 are the corection constants for each of four temperatures, ranging from +0.5 to -0.5.

e. Each numeric value must be separated by a valid delimiter.

f. Example:

OUTPUT 715;" PTI -.16, -.16, -.02, 0, .01, -.06, -.12, -.16, -.02, .01, -.01, -.04, -.13, -.12, -.16, -.16, -.01, 0, .01, -.06, -.12, -.16, -.03, .01, .01, -.04, -.12, -.12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -.16, -.16, -.04, -.01, 0, .07, .10, -.16, -.06, -.01, -.01, .03, .10, .10, -.10, -.10, -.05, -.01, .02, .15, .19, -.10, -.07, -.01, 0, .09, .20, .20

3-226. PTO (dcout). This command is used to read temperature calibration data. When executed, this command builds an array of numeric data in the talk buffer for transmission at the next talk request.

a. Format: To the instrument as a listen string: PTO; From the instrument in the next talk string:

TCF1, TCF2, ...,TCF70

where:

TCF1 through TCF70 are the correction constants for 14 points of temperature data for each of 5 different temperatures.

b. Example:

To the instrument in a listen string: PTO. From the instrument in the next talk string:

-.16, -.16, -.02, 0, .01, -.06, -.12, -.16, -.02, .01, -.01, -.04, -.13, -.12, -.16, -.16, -.01, 0, .01, -.06, -.12, -.16, -.03, .01, .01, -.04, -.12, -.12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -.16, -.16, -.04, -.01, 0, .07, .10, -.16, -.06, -.01, -.01, .03, .10, .10, -.10, -.10, -.05, -.01, .02, .15, .19, -.10, -.07, -.01, 0, .09, .20, .20

TABLE 3-10. INSTRUMENT ERROR CODES.

ERROR NUMBER	MEANING
1	Carrier Frequency entry out of range.
2	IF frequency out of range.
3	Tuned Level entry out of range.
4	Carrier Power entry out of range.
5	AM modulation entry out of range.
6	FM modulation entry out of range.
7	PM modulation entry out of range.
8	SPCL entry out of range.
9	PRGM entry out of range.
10	System IEEE-488 bus address out of range.
11	Units do not match active function.
12	Too many characters entered into display.
13	Requested Program is empty.
14	Program is recall only.
15	IEEE-488, non-existent mnemonic.
16	IEEE-488, input text buffer overflow.
17	IEEE-488 data string format error.
18	Power Meter, number out of range.
19	Power Meter, measurement underrange.
20	Power Meter, measurement overrange.
21	Power Meter, not ready error.
22	Power Meter, zero in progress.
23	Power Meter, DC calibration error.
24	Power Meter, Frequency/Cal Factor error.
25	Power Meter, Protected data error.
26	8200-S/10 to 4220-S/10 data transfer error.
27	Tuned Level carrier frequency out of range.
28	External timebase not connected to 8200-S/10.
29	Timebase Oven cold.
30	Oscillator setup error band 1. (Hardware)
31	Oscillator setup error band 2. (Hardware)
32	Oscillator setup error band 3. (Hardware)
33	Oscillator setup error band 4. (Hardware)
34	Frequency Counter self-check error.
35	Memory error, 8200-S/10.
36	Memory error, 4220-S/10 controller.
37	Memory error, 4220-S/10 channel card.
38	Battery error, 4220-S/10 controller.
39	Battery error, 4220-S/10 channel card.

TABLE 3-10. INSTRUMENT ERROR CODES CONTINUED.

ERROR NUMBER	MEANING
40	AM calibration fault. (Hardware)
41	RMS calibration fault. (Hardware)
42	FM calibration fault. (Hardware)
43	PM calibration fault. (Hardware)
44	Native mode level, calibration fault.
45	Power Meter, zero fault.
46	Power Meter, configuration fault (bitswitch settings).
47	Tuned Level calibration fault, Average detector.
48	Tuned Level calibration fault, Synchronous detector.
49	Tuned Level calibration fault, 0 dBm.
50	Tuned Level calibration fault, Adapter pad.
51	Tuned Level calibration fault, -50 dB 9000S converter range.
52	Tuned Level calibration fault, -10 dB 9000S converter range.
53	Tuned Level calibration fault, +24 dB 9000S converter range.
54	SG1207/U reporting error.
55	Power Meter, DC calibration data error.
56	Power Meter, channel card failure.
57	Power Meter, Timebase failure.
58	Converter, control circuit failure.
59	Converter, communications failure.
60	Private Bus, communications failure, 8200-S/10.
61	Private Bus, communications failure, SG1207/U @ address 19.
62	Private Bus, communications failure, 2510 @ address 10.
63	Private Bus, communications failure, 2520 @ address 20.
64	Power Meter, AC calibration error, remove adapter pad.
65	Power Meter, DC calibration fault.
66	Power Meter, AC calibration fault.
67	EEprom memory fault.
68	SPCL function not active for this measurement mode. See SPCL 98 and 99.
69	Inactive SPCL function.
70	Undefined System Error.
71	Undefined System Error.
72	Undefined System Error.
73	Undefined System Error.
74	Undefined System Error.
75	Undefined System Error.
76	Undefined System Error.
77	Undefined System Error.
78	Undefined System Error.
79	Undefined System Error.
80	Undefined System Error.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The Model 8200-S/10 is a versatile, solid-state, microprocessor controlled, modulation meter that covers the carrier frequency range of 100 kHz to 2 GHz, and with the 4220-S/10 and Comstron 9000S converter to 18 GHz. Recovered modulation is displayed on a six digit LED display, which provides a maximum resolution of 1 Hz deviation or .001 % AM. Operating modes, input frequency, input level, and reference levels can be keyed in through a front panel keyboard. An IEEE-488 interface enables remote programming of the instrument. Selected modes and values are displayed on an alphanumeric display and LED indicators. Input commands are processed by the internal microprocessor, and control signals developed by the microprocessor set up the internal circuits in accordance with the commands. The use of a microprocessor also enables storage of up to 99 complete sets of instrument setup data. Commonly used setups can be stored in non-volatile memory either through the keyboard or via the IEEE-488 interface; thereafter, the instrument front panel settings can be restored by keying in the program number assigned to the desired setup and depressing the RCL key or sending the MRE mnemonic on the bus.

4-3. OPERATIONAL BLOCK DIAGRAM. (See Figure 4-1.)

4-4. The measuring receiver consists of the Model 8200-S/10, which provides the AM, FM, PM, Frequency and Tuned Level measurement resources, the Model 4220-S/10 which provides the average power meter and the system IEEE-488 bus resources, and the Comstron Model 9000S which provides the two frequency converters required for frequency translation. Additionally, a SG1207/U signal generator is used for a local oscillator to drive the 9000S from 2.5 to 2000 MHz for tuned measurements, and a SG1219/U signal generator is used for a local oscillator to drive the 9000S for frequency translation from 2 to 18 GHz. The 51033-S/10 sensor is the means for connecting the measuring receiver to the generator under test.

4-5. The 51033-S/10 sensor is connected to the unit under test with or without a 10 dB adapter pad depending on the measurement to be made. For high levels or accurate power measurements the adapter pad is used. A contact closure in the sensor is used to detect the presence of the pad for automatic measurement adjustment and error checking. All other measurements are made without the pad. Calibration data supplied with the sensor is given with and without the pad.

4-6. Within the sensor the signal to be measured is connected to one of two RF inputs of the frequency converter or to a dual-diode power sensor depending on the measurement mode. For all measurements other than average power the signal is routed to the converter RF1 connector for carriers from 100 kHz to 2 GHz, and to the converter RF2 connector for frequencies above 2 GHz. Within the converter the frequency conversion circuitry is bypassed for all measurements except tuned level below 2 GHz. Above 2 GHz frequency conversion is used for all measurement modes.

4-7. Two local oscillators are used in the receiver system. An SG1207/U is used as a low-noise frequency conversion signal for tuned level measurements in the 2.5 MHz to 2000 MHz range. The SG1207/U is operated by the 4220-S/10 controller on a private IEEE-488 bus. The SG1219/U microwave ~~converter~~ generator is operated by the system controller for automatic operation in all modes from 2 to 18 GHz.

4-8. SIMPLIFIED OPERATION, MODEL 8200-S/10.(Figure 4-2.)

4-9. Control of instrument operation is exercised by a microprocessor that executes a fixed program resident in read-only memory (ROM). Timing of microprocessor operations is controlled by an 18.432 MHz clock. A random-access memory (RAM) provides storage capability for microprocessor data. To insure retention of data in storage, the non-volatile RAM is powered continuously from an internal 3-volt lithium battery.

4-10. The microprocessor communicates with the internal circuits through a data bus, an address bus, and an I/O printed circuit board. Command information is entered into the microprocessor through the front panel keyboard or an IEEE-488 interface. Test jumpers are provided for option selection and test purposes. Input data selection is displayed by means of a digital readout and LED indicators. The microprocessor stores and processes input data, and generates data and address

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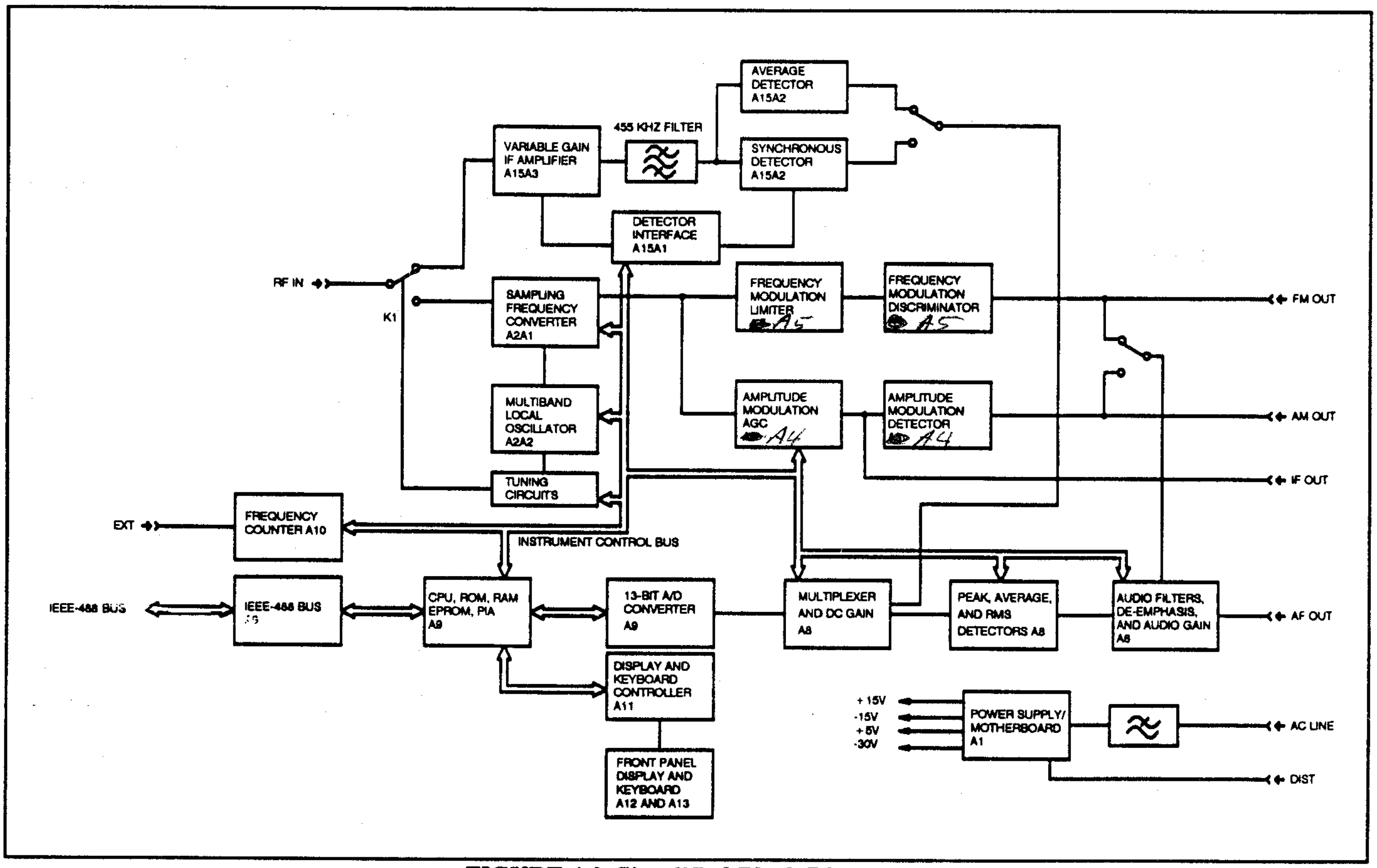


FIGURE 4-2. Simplified Block Diagram.

information to cause execution of commanded functions.

4-11. In the modulation measurement mode the carrier signal is first frequency translated to an intermediate frequency for processing. The intermediate frequency chosen is dependent on carrier frequency. Carriers above 10 MHz are converted to 1.211 MHz, carriers from 2 MHz to 10 MHz are converted to 346 KHz, and carriers below 2 MHz are not converted at all. Frequency translation is accomplished by means of a zero-order hold sampler. The sampler is fully bootstrapped to accept signals as high as 1 Volt rms, without overload.

4-12. A sampling impulse, generated from a tunable local oscillator, converts the RF signal to the appropriate IF signal. After filtering and buffering, the IF signal is processed by the AM and FM circuits. Additionally, the IF signal is processed by the tuning circuits to provide signals to the microprocessor to properly tune the local oscillator.

4-13. The FM modulation information is recovered by first amplitude limiting the IF signal to remove any AM information, and 'pulse-counting' the resulting signal to determine instantaneous frequency. A direct coupled output of the discriminator is connected to the FM OUT connector on the rear panel.

4-14. The amplitude modulation information is recovered by first setting the gain of the measurement channel to a convenient level for accurate measurement. The resulting signal is amplitude detected by a linear-active detector circuit. A direct coupled output of the detector is connected to the AM OUT connector on the rear panel.

4-15. The phase modulation information is recovered in the audio filter section by integrating the recovered FM signal.

4-16. The recovered audio signal from the AM or FM detectors is further processed by amplification and selectable filtering before being converted to dc for measurement. Audio detection consists of precision peak detectors and a true rms detector. The dc information from the audio detectors is digitized by a 13-bit A/D converter for subsequent digital processing and display.

4-17. Internal calibration circuits are operated by control program as required to establish calibration of the internal AM, FM, PM, and RMS detectors.

4-18. Counter/timebase circuits establish the clocks and reference frequencies for operation of the microprocessor and calibrator.

4-19. Power supply circuits convert the incoming line voltage into regulated dc operating voltages to power the instrument circuitry.

4-20. For tuned level measurements the modulation measurement circuits are bypassed by an RF switch at the RF IN connector and a 455 kHz IF signal from the frequency converter is connected to the tuned level measurement IF subsystem. This subsystem contains precision attenuators and a synchronous and average detectors to measure the amplitude of the input signal. The system is calibrated against the average power meter at high levels, and the resulting calibration factors transferred to the displayed level.

4-21. Average power measurements are made by a diode detector in the measuring receiver sensor and a single-card power meter in the Model 4220-S/10. Control information and power measurements are transferred bi-directionally over the private IEEE-488 bus.

4-22. THEORY OF OPERATION, RF CIRCUITS

4-23. The RF circuits convert the carrier input signal into a suitable IF signal for AM, FM, and PM measurements. See Figures 4-3 and ~~4-6~~ 8-7.

4-24. The carrier to be measured is applied to the front panel RF IN connector and via an RF switch to the RF assembly. The signal is attenuated ~~by a … dB pad, R1, R2, and R…~~, and appears at the sampling gate CR2. The attenuator provides some isolation and protection for the sampling circuit.

4-25. Simultaneously, a local oscillator signal is buffered by transistor Q1 and associated components and divided by two in U1. The resulting TTL signal is passed directly, or divided by 5 in U6, to a pulse forming circuit U2. Switching is accomplished by the band control line B2, and U3. The instrument control program operates the band switch to select the optimum operating band based on the RF frequency.

4-26. The pulse signal from U2 is further shaped and amplified by Q3 and Q13 to drive step-recovery diode CR4, through transformer T2. Initially CR4 is forward biased from the +5 volt supply through R22. The pulse signal from Q3 and Q13 drives CR4 into reverse conduction; however, CR4 does not "open" until all of its stored charge is depleted. At that instant the diode recovers and produces a large narrow pulse, which is coupled to the sampling bridge by T1, a balun transformer. The output of T1 is two nearly equal opposite-polarity pulses. If the two pulses were exactly equal, they would exactly cancel at the input and output of the bridge. Since such equality is never the case, however, R14 is required to balance the bridge on the various operating bands.

4-27. R6 is adjusted when the local oscillator signal is between 2 and 4 MHz for optimum sampler efficiency. R11 is adjusted when the local oscillator signal is between 10 and 20 Mhz.

4-28. The operation of the sampling gate is shown in simplified form in Figure 4-3. Each time the sampling gate is closed, by a short-duration pulse, the input capacitance of the sampler amplifier plus any stray capacitance is charged to a voltage that is less than the instantaneous RF input voltage. Before the next sample is taken, positive feedback from the sampler amplifier causes additional charge to be placed on this capacitance. Charge is added until the voltage at the output of the sampling amplifier is exactly equal to the RF input at the time when the sample was taken. This output is held constant until the next sample is taken. Successive samples are taken until the RF waveform is reconstructed at 1.211 MHz or 346 kHz, depending on the RF frequency. Additional feedback from the sampler amplifier maintains symmetrical reverse bias on the sampling gate.

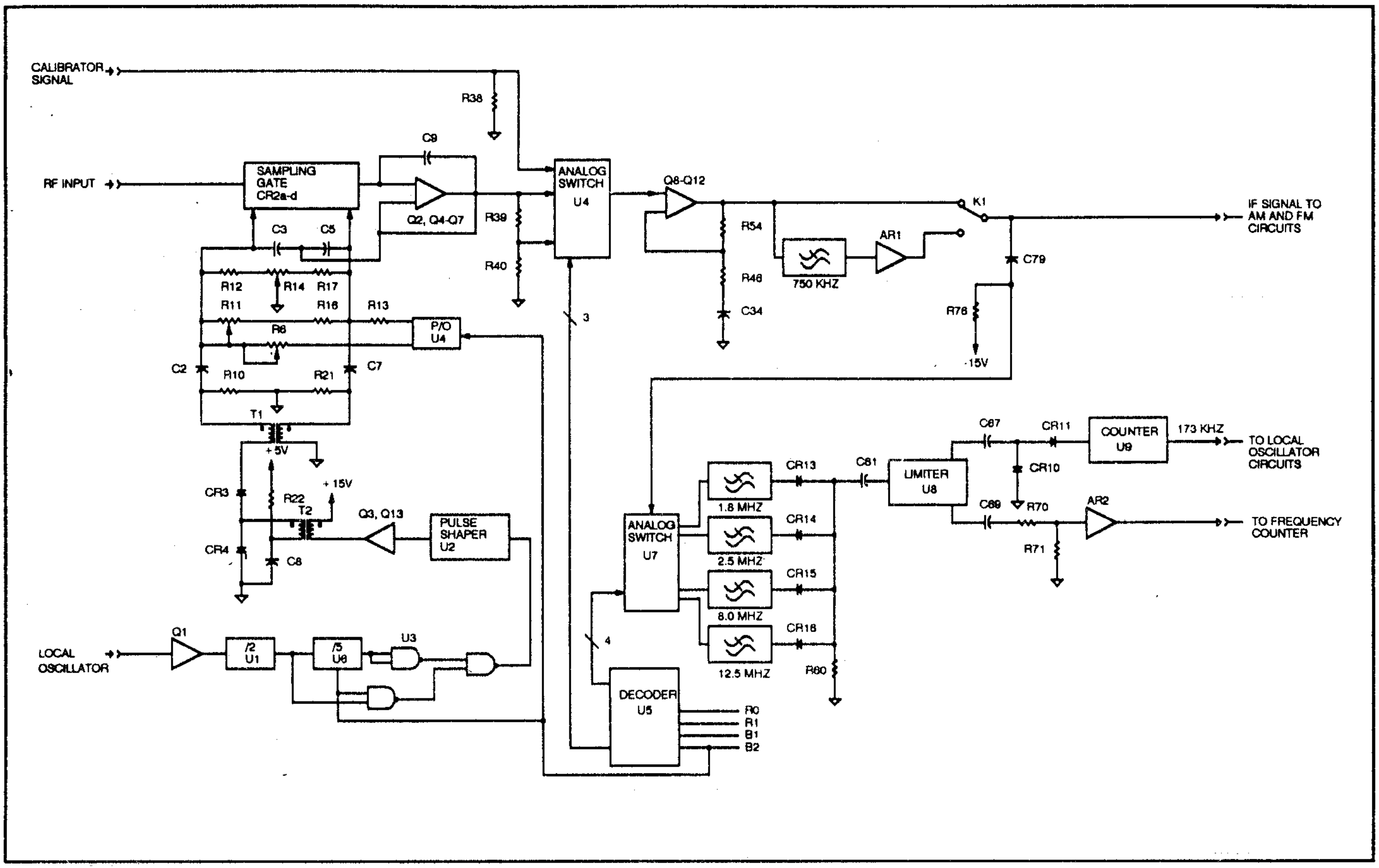


FIGURE 4-3. RF Circuits Block Diagram.

4-29. When the carrier frequency is between 100 kHz and 2 Mhz, the 1.211 MHz IF is selected and the local oscillator is set to about 18 MHz. Under these conditions, the input signal passes directly through the sampling bridge without conversion. The IF circuits then process the signal directly.

4-30. The sampler amplifier is composed of transistors Q2 and Q4-Q7 and associated components. The gain is fixed at less than one by a direct feedback connection. The stage has a low output impedance required to properly bootstrap the sampling bridge.

4-31. The output of the sampling amplifier is connected to a switched 10 times attenuator consisting of R39 and R40. Analog switch U4 is operated by the control program, via data decoder U5, to select the signal, the signal divided by 10, or the calibrator signal. The calibrator is connected to the IF circuits when the calibration program is operating, otherwise the attenuator outputs are selected. If the carrier level is greater than about 100 millivolts, the signal is attenuated 10 times.

4-32. An amplifier consisting of transistors Q8-Q12 and associated components is required to further amplify and buffer the IF signal. This stage has a gain of about 3.3, as determined by R54 and R46. When the 1.211 MHz IF is selected, relay K1 is operated to select the output of this stage. If the 346 kHz IF is being used, the signal is filtered by a 750 kHz low-pass filter consisting of L12, L14, C58, C62, and C64. Amplifier AR1 has a gain of two which compensates for the insertion loss of the filter. The output of AR1 then becomes the IF signal.

4-33. This signal is connected to the AM and FM boards for further processing, and to analog switch U7. U7 is operated by the control program, via data decoder U5, to select one of four low-pass filters. The filters, consisting of L2-L8, C38-C41, C46-49, and C51-54, are designed to reject the local oscillator signal and maintain a bandwidth of at least one-half of the sampling rate.

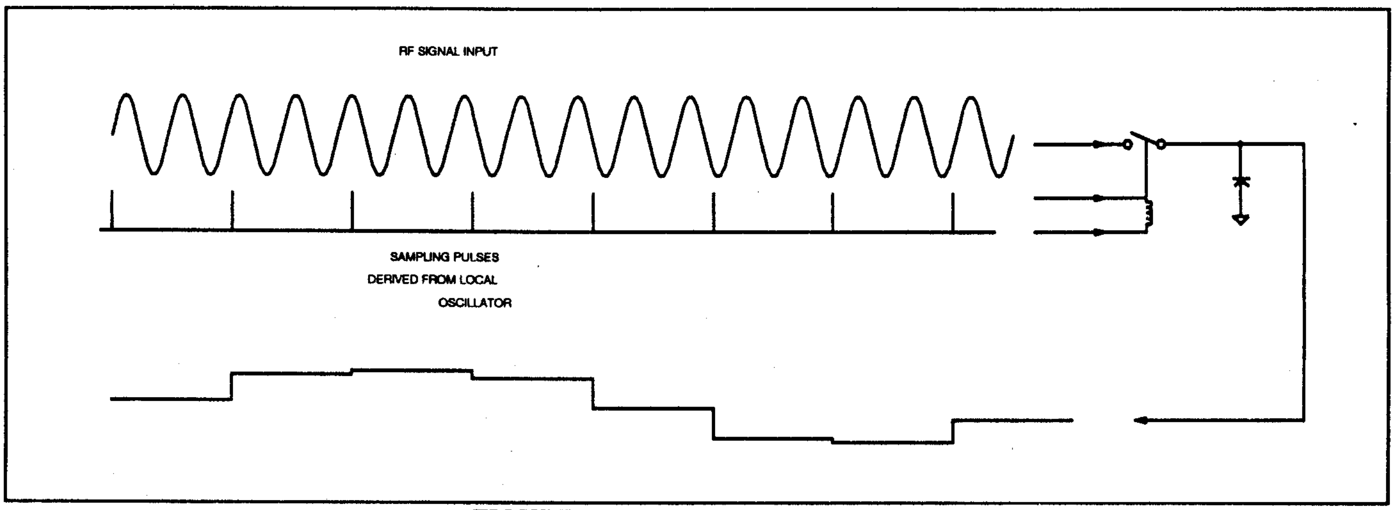


FIGURE 4-4. Sampling Gate Operation.

4-34. At any sampling frequency the carrier signal will be converted to a frequency between dc and one-half the sampling rate. Therefore, to insure proper signal discrimination, the filters must have a bandwidth of at least one-half of the sampling rate. The filter bandwiths are 1.8, 2.5, 8, and 12.5 MHz.

4-35. Diodes CR14-16 isolate the individual filters at the input of limiter U8. Diode bias is provided by R76 through U7. U8 limits the IF signal to remove any AM and generates square-wave outputs to drive U9, a TTL counter, and AR2, a buffer amplifier used to provide a sample of the IF signal for the frequency counter circuits.

4-36. The counter output signal is used to measure the IF signal frequency for tuning and RF frequency calculation.

4-37. Counter circuit U9 is programmed to divide by 2 or by 7 as determined by the state of control line B2. If B2 is a TTL high, the 10 to 20 MHz local oscillator is active and U9 is set to divide by 7. This converts the 1.211 MHz IF to 173 kHz. If B2 is a TTL low, the 2 to 4 MHz local oscillator is active and U9 is set to divide by 2. This converts the 346 kHz IF to 173 kHz. The 173 kHz signal is connected to the local oscillator circuits for further processing.

4-38. THEORY OF OPERATION, OSCILLATOR CIRCUITS

4-39. The local oscillator circuits provide the signals to operate the pulse generator circuits on the RF board. See Figures 4-5 and 8-9.

4-40. Four oscillators are operated individually to cover the band of frequencies from 20 to 40 MHz. The oscillators are designed and constructed to produce minimum residual FM. Since all oscillators function the same way, only one will be discussed in detail.

4-41. The lowest band is covered by an oscillator composed of Q1 and associated components. Transistor Q1 provides the gain required to sustain oscillations, while transformer T2 and capacitors C7 and C13 along with varactor diodes CR10-17 form the tuned circuit. Feedback is taken from a tap on T2 and connected to the source of Q1 through dc blocking capacitor C5. Diodes CR2 and CR3 provide output voltage amplitude control by rectifying the feedback and drain voltages and reverse biasing Q1, thus limiting stage operating current. Capacitor C1 bypasses the gate of Q1 at the frequency of oscillation. Resistor R1 is required to establish initial gate bias and inductor L4 provides a dc return for the source.

4-42. The output of the oscillator is connected through isolation resistor R7 and switching diode CR4 to buffer stages Q2 an Q5.

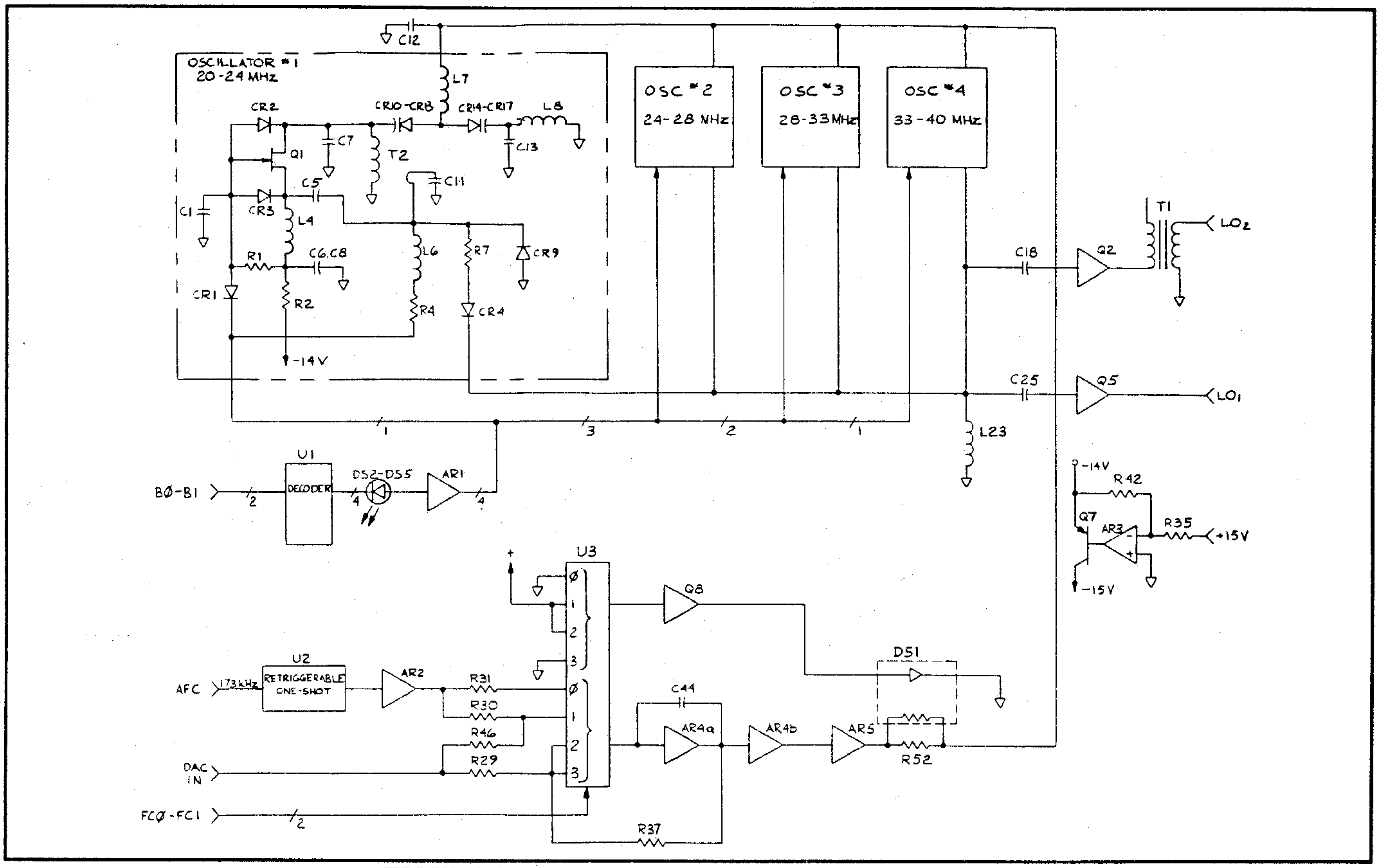


FIGURE 4-5. Local Oscillator Circuits Block Diagram.

4-43. Band switching is accomplishes by the control program via data decoder U1 and level shifter AR1. U1 is a one-of-four decoder which converts data lines B0 and B1 into individual select lines for the four oscillators. Diodes DS2 through DS5, and pull-up resistor array R54 couple the four TTL lines to level shifter AR1. The outputs of AR1 swing from about +13 to -13 volts.

4-44. When a band is selected, the LED associated with that band will be illuminated and the corresponding AR1 output will be at +13 volts. With +13 volts at the junction of CR1 and R4, CR1 becomes reverse biased, as does CR9. CR4 is forward biased, thus connecting the output of the selected oscillator to buffers Q2 and Q5.

4-45. When a band is not selected, the LED associated with that band will not be illuminated and the corresponding AR1 output will be at -13 volts. With -13 volts at the junction of CR1 and R4, CR1 becomes forward biased, as does CR9. CR4 is now reverse biased, thus disconnecting the output of the selected oscillator from buffers Q2 and Q5. Diode CR9 shunts the feedback path and stops the oscillator, while CR1 keeps the stage bias at the normal operating level.

4-46. Oscillator tuning is accomplished by varying the voltage at the junction of C12 and L7 from -5 to -25 volts. The four oscillators tune from 20 to 24, 24 to 28, 28 to 33, and 33 to 40 Mhz.

4-47. The 173 kHz IF signal from the RF board is connected to retriggerable one-shot U2. The period of U2 is determined by R15 and C23 to be 2.9 uS, the semi-period of the 173 kHz signal. The duty cycle of the waveform on pin 6 of U2 is then 50 % and the average value of the waveform is about 2.5 volts. Amplifier AR2 level-shifts the signal to make the average value about 0 volts dc. R19 adjusts the circuit for exactly 0 volts dc at 50 % duty cycle.

4-48. The output of AR2 is connected trough R30, R31, and analog switch U3 to integrator AR4a. The output of AR4a is connected through a level shifting circuit composed of AR4b, R43a, c, and d, and transistor Q9 to buffer stage AR5. The output

put of AR5 is the voltage used to tune all of the oscillators.

4-49. Additional connections to the integrator permit the control program to tune the oscillator using a digital-to-analog converter (DAC) located on the CPU board.

4-50. U3 is a dual switch array. The second section is used to operate a bypass circuit consisting of DS1 and Q8. This circuit operates to speed up acquisition by bypassing R52, a 1 megohm resistor, during search.

4-51. Frequency acquisition in the auto frequency mode proceeds as follows. The input carrier frequency is applied to the sampling bridge for frequency conversion. The subsequent IF frequency is somewhere between dc and one-half of the local oscillator frequency. The input signal to U2, the retriggerable one-shot, will produce an output waveform whose duty-cycle, and consequently average value will be proportional to frequency. The control program sets the U3 so as to connect the integrator to R30, providing a closed loop for frequency acquisition. The integrator will ramp until the input frequency to U2 is 173 kHz, corresponding to either a 1.211 or 346 kHz IF frequency.

4-52. The control program monitors the dc voltage at the output of the integrator and at the output of AR2 to determine if a valid IF has been established. If the integrator output is greater than + or -10 volts, the integrator is reset by connecting the junction of R37 and R39 to the input of AR4a. with the DAC IN input set to 0 volts. The band is changed and the integrator is released. This process continues until a valid IF is found.

4-53. When a valid IF signal is found, the control program changes the DAC IN dc level. This causes a current to flow through R46 which causes the IF frequency to change. The control program then measures the resulting IF frequency and the local oscillator frequency to determine the harmonic number.

4-54. Buffer stages Q2 and Q5 are grounded-base amplifiers used primarily to isolate the oscillator from influences generated by the circuits they drive. Output LO1 is the signal which drives the pulse generating circuits on the RF board and output LO2 drives a cable and the frequency counter circuits.

4-55. Amplifier AR3 and transistor Q7 re-regulate the -15 volt supply down to -14 volts to reduce power supply noise and ripple which improves the stability of the oscillator circuits.

4-56. THEORY OF OPERATION, FM CIRCUITS

4-57. The frequency modulation circuits recover the audio modulating signal from the frequency modulated carrier. See Figures 4-6 and 8-11.

4-58. The intermediate frequency signal from the RF circuits is connected through a 3 MHz, flat-phase, low-pass filter consisting of inductors L3 and L4 and capacitors C1 and C4-C7 to a 4-stage limiter. The limiter is composed of integrated amplifier arrays Q3 and Q8 and associated components. The stages are designed with small-signal feedback to minimize phase shift changes with level, thus minimizing incidental FM when the carrier contains large amounts of AM. The output of the limiter is connected to a pulse forming network consisting of Q13, R77, and R78, C48 and C49 and L8. This circuit creates a differentiated signal which drives U1b, a TTL flip-flop which is wired as an inverter to drive the FM detector.

4-59. The FM detector is a precision monostable multivibrator which operates as follows. Each positive transition of the signal at pin 11 of U1a (corresponding exactly to each cycle of the IF frequency) causes the signal at pin 8 of U1a to go low. Enhancement-mode FET Q1 is turned off, and the constant current source consisting of Q2, R2, R4, R11, R13, and CR1 charges C10 toward the positive supply rail. When the voltage reaches the value established at the base of Q5 by R30 and R28, transistor Q4 conducts and Q5 is turned off. This causes Q6 and Q7 to turn on which resets U1a. FET Q1 is turned on and capacitor C10 is discharged, completing the cycle.

4-60. The result of this operation is a a constant width pulse at a rate equal to the IF frequency. As the IF frequency varies, the duty cycle and consequently the average value of the waveform changes.

4-61. Enhancement-mode FET Q10 operates in parallel with Q1 to toggle current switch Q11 and Q12. The collector current of Q12 is a rectangular pulse with a duty cycle determined by the instantaneous IF frequency and an amplitude determined by a precision current generator consisting of AR2, Q9 and associated components. The 220 kHz low-pass filter consisting of

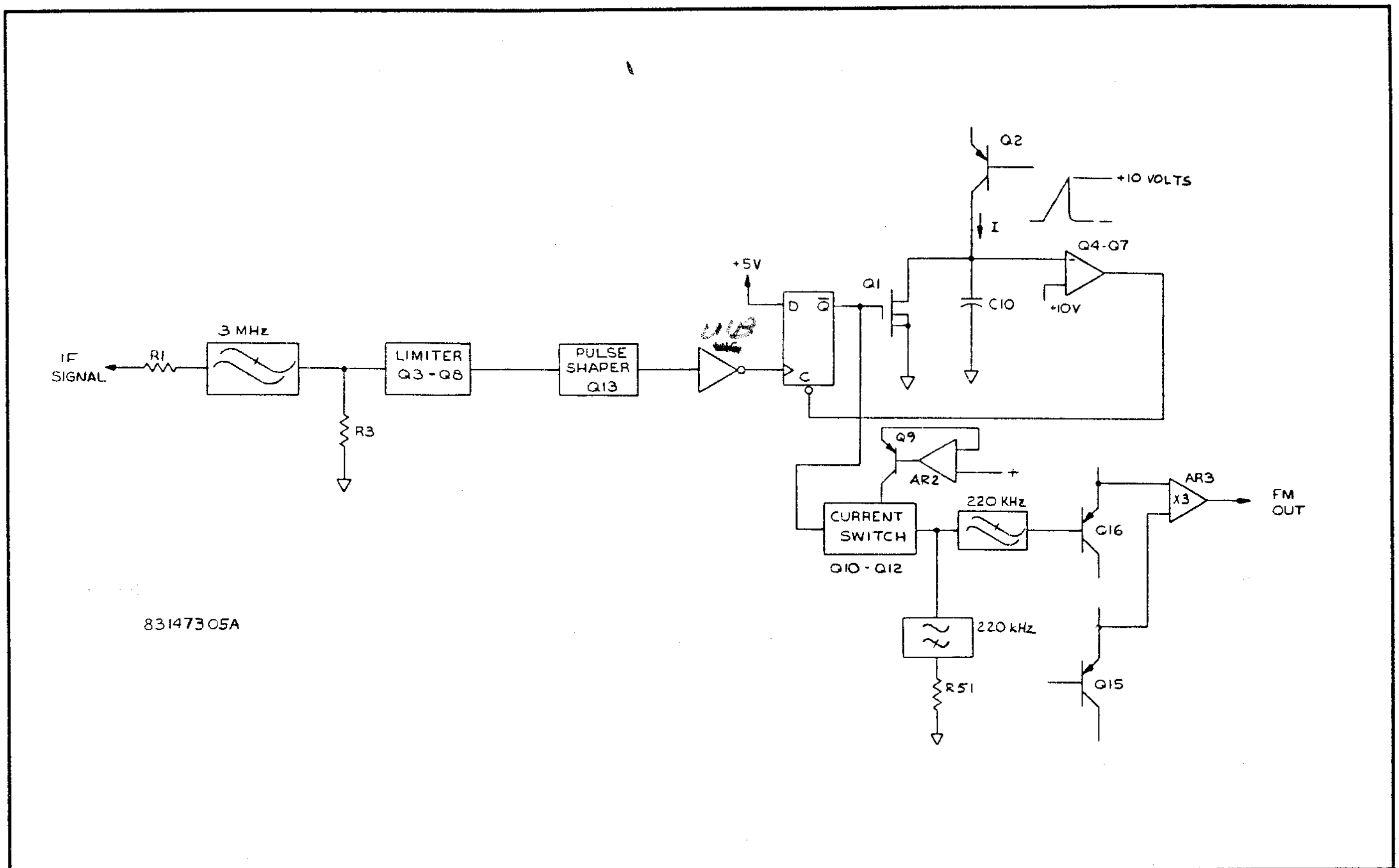


FIGURE 4-6. FM Circuits Block Diagram.

capacitors C36, C39, C42, and C41 and inductors L6, L9, and L10 removes the IF frequency components from the signal leaving only the modulation information.

4-62. A phase equalizer consisting of C27, C28, C32, C33, and L5 linearizes the filter phase response.

4-63. Transistors Q15 and Q16 and amplifier AR3 level shift and amplify the signal to drive the audio circuits.

4-64. Two on-board power supplies are required by the FM circuits. One is generated by Q14, R63, R71 and C35. This circuit isolates the -15 volt instrument supply. The other is a +5 volt supply generated by R14, R15, C12, and AR1. This supply powers the TTL circuits on the FM board.

4-65. THEORY OF OPERATION, AM CIRCUITS

4-66. The amplitude modulation circuits recover the audio modulating signal from the amplitude modulated carrier. Additionally, these circuits provide a dc signal which is proportional to the carrier level at the RF IN connector. See Figures 4-7 and 8-13.

4-67. The intermediate frequency signal from the RF circuits is connected through a 3 MHz, flat-amplitude, low-pass filter consisting of inductors L5 and L6, and capacitors C1, C7, and C10 to an input amplifier composed of Q3-Q6 and associated components. The gain from the input of the filter to the output of the amplifier is about 1.5, as determined by R1, R7, and R19. This stage is carefully compensated by R88, C62, R18, and C19 to provide very flat response from less than 100 kHz to greater than 2 MHz. A flat frequency response is required to maintain low incidental AM when the carrier contains large amounts of

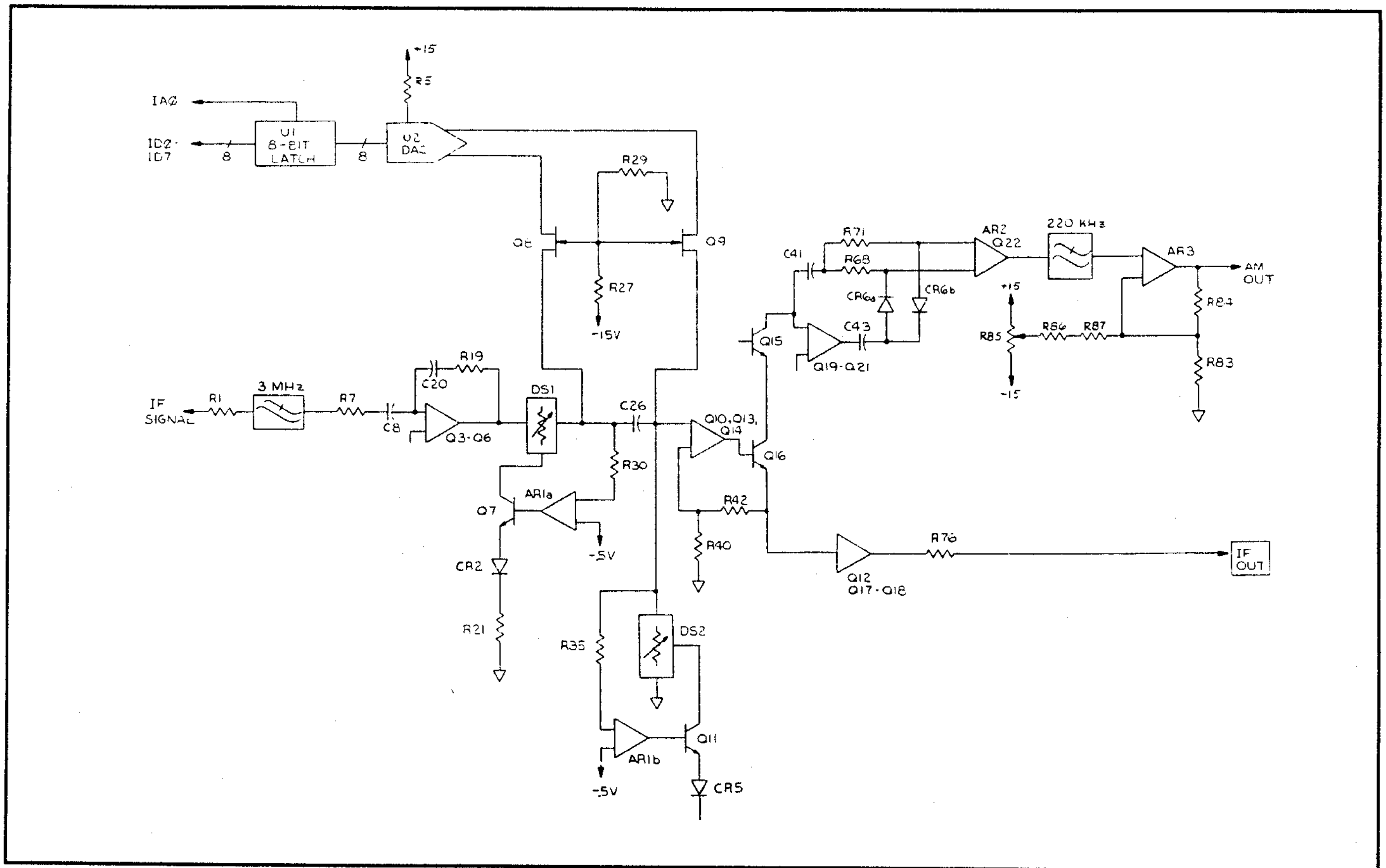


FIGURE 4-7. AM Circuits Block Diagram.

FM.

4-68. A programmable attenuator is required to keep the output of the AM detector within reasonable limits while the carrier level changes about 40 dB. The attenuator consists of two light dependent resistors (LDRs), two control loops, an 8-bit DAC and two isolating transistors.

4-69. Each of the two control loops operate as follows. A current flows through the variable resistance element of DS1 producing a voltage drop. This drop is monitored at one input to loop amplifier AR1a, while the other input is a reference voltage of about -0.5 volts. The output of AR1a is then the amplified difference between the reference and the drop across across DS1. This error voltage is coupled to the LED portion of DS1 through buffer Q7 in such a way as to reduce this difference to nearly zero. The result is that by adjusting the current through the LDR, the resistance can be set precisely.

4-70. The variable current is supplied by U2, an 8-bit DAC and isolating transistors Q8 and Q9. The current outputs of the DAC are differential, and proportional to the magnitude of the 8-bit digital data. When the most significant bit, B1 of U2 is high and all others are low, the two currents are nearly equal. The magnitude of this current is set by R5. Any other combination of bits will increase one current while decreasing the other. The two attenuator arms track the DAC current and thus produce an attenuation which is proportional to the digital data. The control program adjusts the digital data to adjust the dc output of the AM detector.

4-71. An amplifier consisting of transistors Q10 and Q13-Q16 increases the level of the attenuator output about 18 times as determined by R42 and R40. The input impedance of the stage is high to avoid loading the attenuator, and the output impedance is high to maximize the loop gain of the following stage, the AM detector.

4-72. The AM detector is a linear-active design, that is, the diode rectifiers are linearized by including them in the feedback path of a high gain amplifier. The amplifier consists of transistors Q19-Q21 and associated components. The stage is optimized for high gain and high output impedance to drive the non-linear feedback elements. The half-wave rectified voltages at the junctions if CR6a and CR6b and R68 and R71 are buffered by Q22a and Q22b and amplified by differential amplifier AR2. A 220 kHz, seven pole, low-pass filter consisting of inductors L10-L12 and capacitors C50-C56 removes IF frequency components from the signal, leaving only the modulation and dc components.

4-73. An additional gain of two is provided by AR3. Resistors R85-R87 provide a means to compensate for various offsets between the detector and the output of AR3.

4-74. An amplifier consisting of transistors Q12, Q17, and Q18 provides a sample of the leveled AM signal to the rear panel IF OUT connector.

4-75. THEORY OF OPERATION, FILTER CIRCUITS

4-76. The recovered modulation from the AM or FM circuits is further processed by the filter circuits. See Figures 4-8, 8-15, and 8-16.

4-77. Relay K1 is operated to select the output of the FM board for either FM or PM modulation, or the output of the AM board for AM modulation. Relays K2 and K3 are operated to select either an adjustable attenuator, or a 50 kHz, seven pole, low-pass filter as determined by the control program and the front panel low-pass filter selection. The 50 kHz filter is in the circuit for all low-pass filter selections except 220 kHz. The 220 kHz filters are located on the AM and FM boards.

4-78. Capacitors C15 and C16 remove any dc information from the signal before it is connected to a programmable attenuator consisting of R10, R11 and U3a. When the modulating signal is greater than 52.00 kHz, RAD, or %, the attenuator is selected.

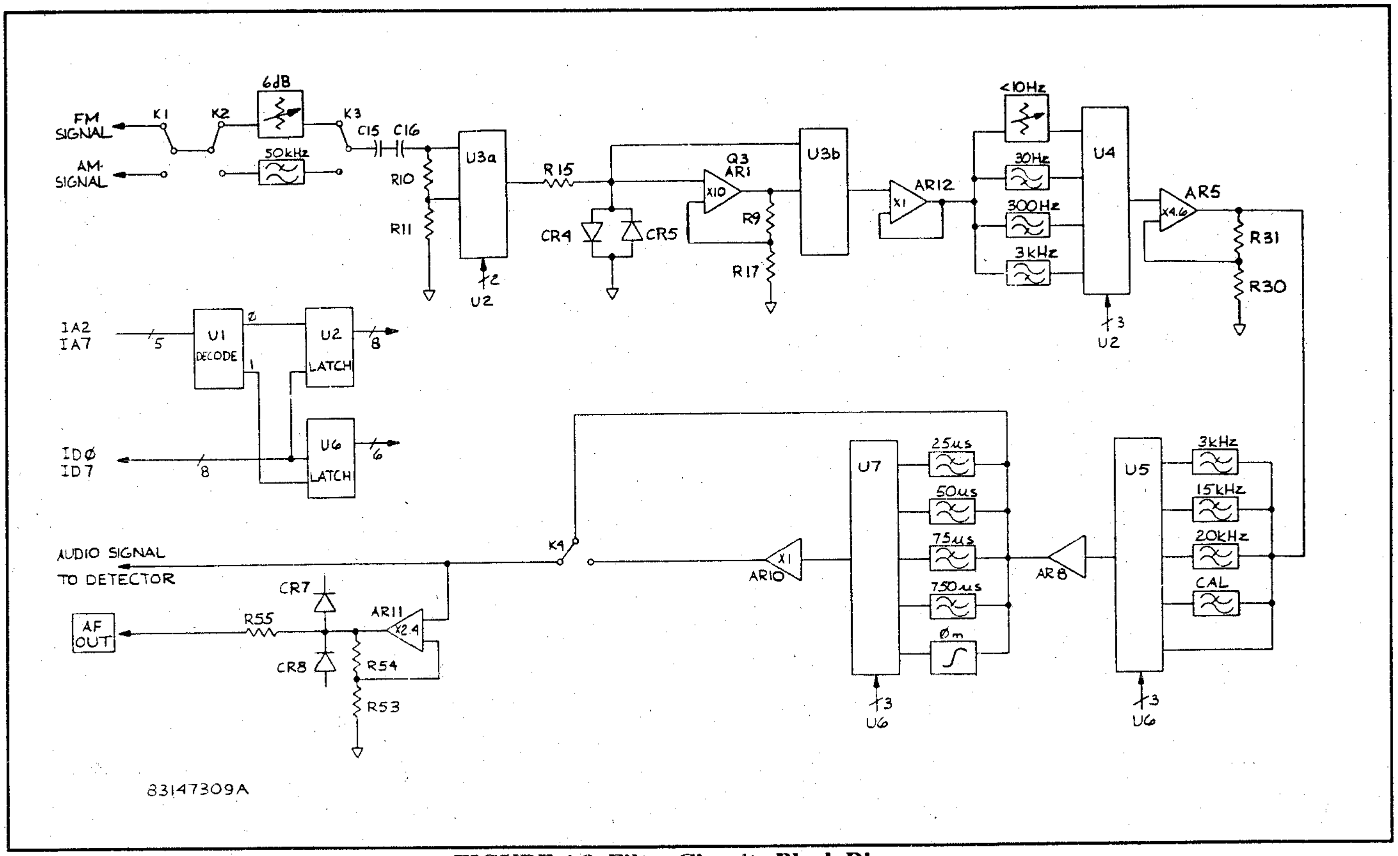


FIGURE 4-8. Filter Circuits Block Diagram.

CR4 and CR5 protect the following stages from severe overload during range switching. Transistors Q3a and Q3b buffer bipolar amplifier AR1 which has a gain of ten as determined by resistors R9 and R17. This stage is inserted in the signal path when the modulation is less than 5.200 kHz, [redacted], otherwise it is bypassed.

4-79. Unity-gain buffer AR12 drives the high-pass filter array. The filters are 3-pole Butterworth designs except for the < 10 Hz filter which is dc coupled at this point. Resistor R18 adjusts the insertion loss of the < 10 Hz position to equal that of the other active filters. The other filters are designed to cut off at 30, 300, and 3000 Hz. The control program operates analog multiplexer U4 based on the front panel high-pass filter selection.

4-80. Amplifier AR2 and associated components comprise the 30 Hz filter. Similarly AR3 and associated components comprise the 300 Hz filter, and AR4 and associated components comprise the 3000 Hz filter.

4-81. AR5 amplifies the signal about 4.6 times, as determined by R30 and R31 and drives a low-pass filter array. The 3 and 15 kHz filters are 3-pole Butterworth designs, and the 20 kHz filter is a 3-pole Bessel design. Additionally, a through position is provided for the 50 and 220 kHz filters, and a gaussian filter consisting of R34, R38, R40, C36, C38, and C41 is provided for calibration. Analog multiplexer U5 is operated by the control program based on the front panel switch setting or the carrier frequency to select the appropriate filter.

4-82. Unity-gain buffer AR8 drives the de-emphasis and phase modulation filters. The de-emphasis networks are single pole gaussian filters with cut frequencies of 212 Hz, 2.122 kHz, 3.183 kHz, and 6.366 kHz corresponding to the time constants of 750, 75, 50, and 25 microseconds respectively.

4-83. AR9a and b and associated components comprise the phase modulation filter. This filter is designed to have an insertion gain of unity at 1 kHz modulation frequency, and a response that approximates an ideal integrator over most of the audio frequency range.

4-84. Analog multiplexer U7 is operated by the control program to select the appropriate de-emphasis network as determined by the front panel de-emphasis switch setting. Additionally, the control program bypasses these networks in the AM measurement mode, and selects the phase modulation filter in the PM mode.

4-85. Unity-gain amplifier AR10 buffers the signal which is connected to the detector circuit board through relay K4. K4 is operated by the control program to select pre-display or post-display de-emphasis as determined by the selection of SPCL 34 or 35 or the de-emphasis mode as set via the IEEE-488 bus controller.

4-86. Amplifier AR11 increases the signal by about 2.4 times as determined by R53 and R54 to generate the front panel AF OUT signal. Resistor R55 determines the output impedance of 600 ohms and diodes CR7 and CR8 provide reverse power protection for AR11.

4-87. Digital control signals for the filter board are latched from the instrument control bus by octal latches U2 and U6. Strobe signals to operate the latches are generated by address decoder U1.

4-88. THEORY OF OPERATION, DETECTOR CIRCUITS

4-89. The recovered modulation signals from the filter board are converted to dc by the detector circuits. The detectors include plus and minus peak detectors, an rms detector, and an average detector. See Figures 4-9 and 8-18.

4-90. The recovered modulation signal is ac coupled to analog switch U1b through coupling network C36 and R5. U1b is operated by the control program to connect the peak detector circuits to the audio signal or a ground reference established by R11 and C6. Analog switch U1a is operated by the control program to connect R10 to ground when large overloads occur in the Filter circuits. This improves auto-zero recovery time.

4-91. The output of U1b is connected to the input of AR2d through an equalizer network consisting or R12 and 13 and C37 and 38. This network compensates for a slight decrease in peak detector efficiency at about 250 kHz. AR2d and AR2c are voltage followers cascaded to drive the positive peak detector. The output of AR2d also drives a precision inverter circuit consisting or AR2a and R55a-R55d which in turn drives the negative peak detector through voltage follower AR2b. This seemingly unnecessary symmetry is required because the full-scale resolution of the peak displays is 0.02%. The positive and negative peak

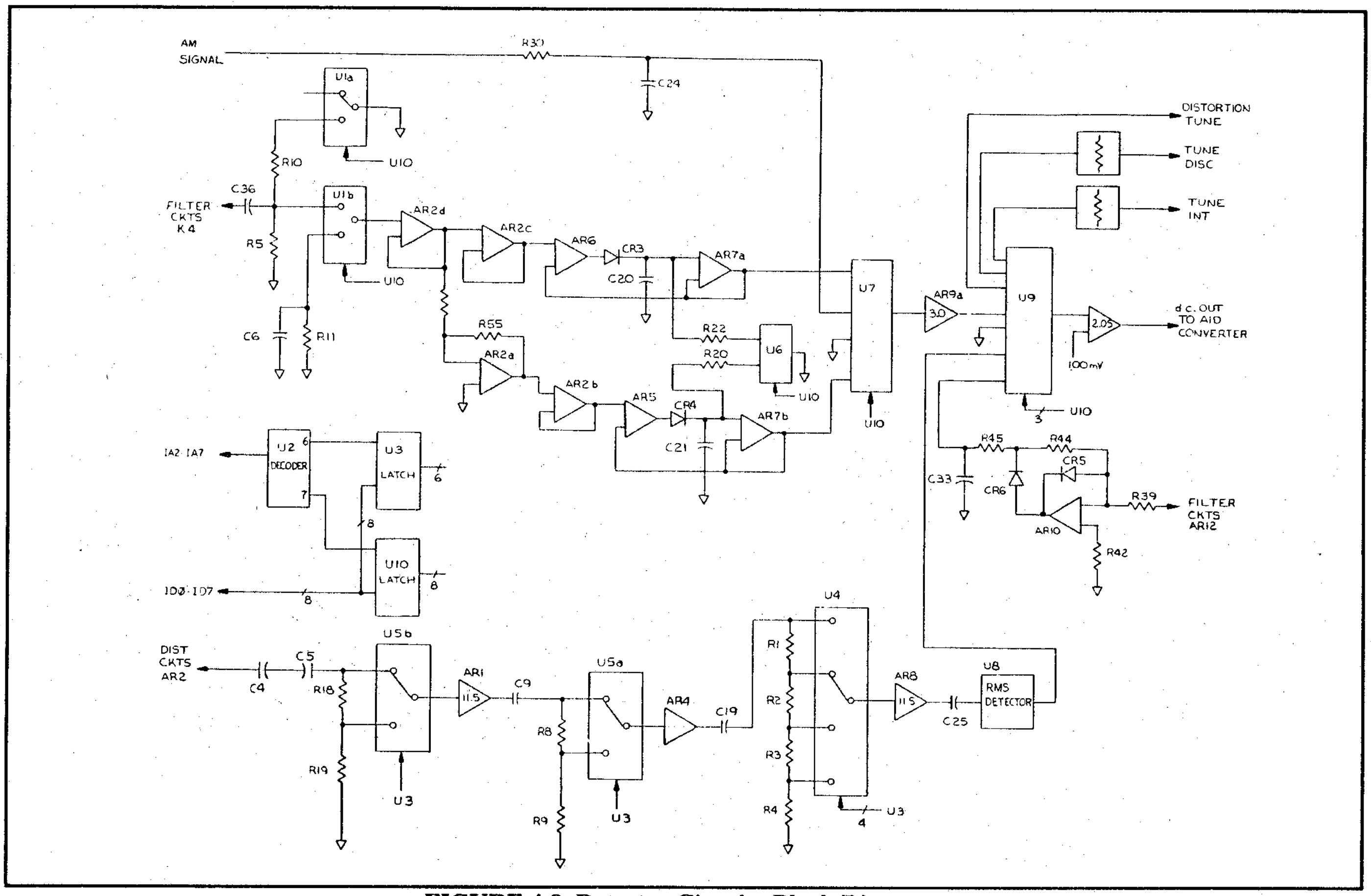


FIGURE 4-9. Detector Circuits Block Diagram.

detectors are identical circuits driven by audio signals that are 180 degrees out of phase.

4-92. Amplifier AR6 and AR7a and associated components are arranged as a positive peak detector. During the positive excursion of the audio signal, the output of AR6 is driven positive; C20 then charges through CR3. AR7a buffers the voltage across C20 and adds a small offset. When the output of AR7a reaches a value equal to the positive peak of the waveform plus a small increment, the output of AR6 goes negative and thus terminates the charging of C20. The output of AR7a is then equal to the positive peak of the audio signal.

4-93. The small offset created by R24 and R25 is required to insure that there is a net positive charge on C20 when the signal on pin 3 of AR6 is zero. Diode CR1 improves frequency response by limiting the voltage excursion at pin 6 of AR6 at about -0.7 volts in the negative direction.

4-94. The peak detector consisting of AR5 and AR7b and associated components operates in an identical manner, except that the audio signal at pin 3 of AR5 is inverted so that the positive output voltage at pin 7 of AR7b represents the negative peak of the audio waveform.

4-95. Analog switch U6, R20 and R22 are connected across peak detector capacitors C20 and 21 to reset the peak detectors during the various phases of the peak measurement cycle.

4-96. The measurement cycle proceeds as follows: The control program asserts the peak detector reset signal discharging capacitors C20 and C21. Analog switch U1b is set to connect the ground reference network R11 and C6 to the input of AR2d. After a short wait for transients to settle, the reset signal is removed and both peak detector outputs are measured. The measurements represent the zero input signal condition of the detectors. The reset signal is again asserted, and analog switch U1b is set to connect the audio input signal. The reset signal is again removed and both peak detectors are again measured. The measurement represents the output of the detectors including the input signal and offsets. The offsets are removed by the control program and the corrected measurement displayed on the front panel digital display. The measurement cycle is repeated by the control program as required. The peak average display is generated by adding the plus and minus peaks and dividing the result by two.

4-97. The outputs of the peak detectors and a dc signal from the AM detector are routed through an analog multiplexer, U7, to amplifier AR9a. The circuit gain is three, as determined by R43 and R37, which brings the full-scale output of the peak detectors and the nominal output of the AM detector to about three volts. This signal is connected through analog multiplexer , U9, to a second amplifier AR9b and associated components. This stage is designed to have a gain of about 2.04 and a dc offset of about 100 millivolts. Gain is required to increase the full-scale signal to about 6 volts for subsequent analog-to-digital conversion; the offset is required to insure that inputs near zero volts dc still produce a positive dc output. The output of AR9b is connected through the card-edge to the CPU board.

4-98. Several other signals are connected to multiplexer U9. A signal representing the output of the frequency acquisition integrator is attenuated and level shifted by resistors R33, R34, and R35. When the output of the integrator is +10 volts, the voltage at the pin 5 of U9 will be about 3.7 volts and when the output of the integrator is -10 volts, pin 5 will be about 0.58 volts. A second voltage from the frequency acquisition discriminator is attenuated and level shifted by R38, R40, and R41. For discriminator voltages between +3 and -3 volts, the voltage at pin 4 of U9 will vary between 3.2 and 0.8 volts respectively.

4-99. The signal on pin 6 of U9 is the dc signal from the separate 455 kHz IF system. This signal represents, at various times, the output of the average or synchronous detectors, or phase lock loop status, as determined by the control program. Pin 11 of U9 is grounded to provide a zero volt reference for the analog to digital converter. Two other inputs to U9 will be covered separately below.

4-100. A second audio signal is ac coupled by coupling network C4, C5, and R18 and R19 to analog switch U5b. This signal originates on the 455 kHz IF adapter board and represents an amplified version of the signal at the peak detectors. R18 and R19 divide the input signal by ten, so that the signal at pin 3 of AR1 is either the input signal or the signal divided by ten as determined by the setting of U5b. The stage gain of AR1 is set at 11.5 as determined by R6 and R7. Capacitor C7 provides high frequency compensation. Similarly, the output of AR1 is connected to an attenuator consisting of R8 and R9, analog switch U5a, and a second amplifier AR4. Diodes CR7-CR10 and resistors R57-R59 speed overload recovery of AR1 and AR4. AR4 is also configured for a gain of 11.5 and is ac coupled to an attenuator consisting of R1-R4 and analog switch U4. This attenuator is programmable for an attenuation of zero, six, fourteen, and twenty dB. Amplifier AR8 is configured for a gain of 11.5 and is ac coupled to rms detector U8.

4-101. The complete amplifier/attenuator chain is programmable for a gain change of 0 to 60 dB (1000 times) in steps of 6 or 8 dB. Gain is established as required by the control program to maintain the output of the rms detector between about 1 and 3 volts dc, corresponding to rms inputs of 1 to 3 volts respectively. Capacitor C26 determines the low frequency characteristics of the rms detector and is selected to maintain modest errors down to about 10 Hz. The output at pin 6 of U8 is connected to multiplexer U9 as one of the possible inputs to the analog to digital converter.

4-102. An average detector consisting of AR10 and associated components monitors the signal level at the input to the high-pass filter array. This detector is used to determine if an overload condition exists in the filter circuits, since the filters may attenuate an overrange signal before it is detected by the peak or rms detectors. This detector is also used for autoranging in the PM measurement mode.

4-103. The voltage at pin 2 of AR10 is nearly zero due to the high open loop gain of AR10. The voltage at the junction of C35 and R39 produces a current which also flows through R44, CR6, and CR5. If the current is sinusoidal, the current flows through R44 and CR6 on one half-cycle of the waveform, and through CR5 on the other half-cycle. The voltage at the junction of CR6 and R44 is the half-wave rectified and a dc voltage equal to the voltage peak divided by PI (3.14159) is produced. This voltage is connected to pin 10 of multiplexer U9 through filter R45 and C33. The filter removes the ac components from the rectified signal.

4-104. Octal latches U3 and U10 are used to store the control data from the instrument bus. The latch strobe signals are generated by address decoder U2 for instrument addresses 6 and 7.

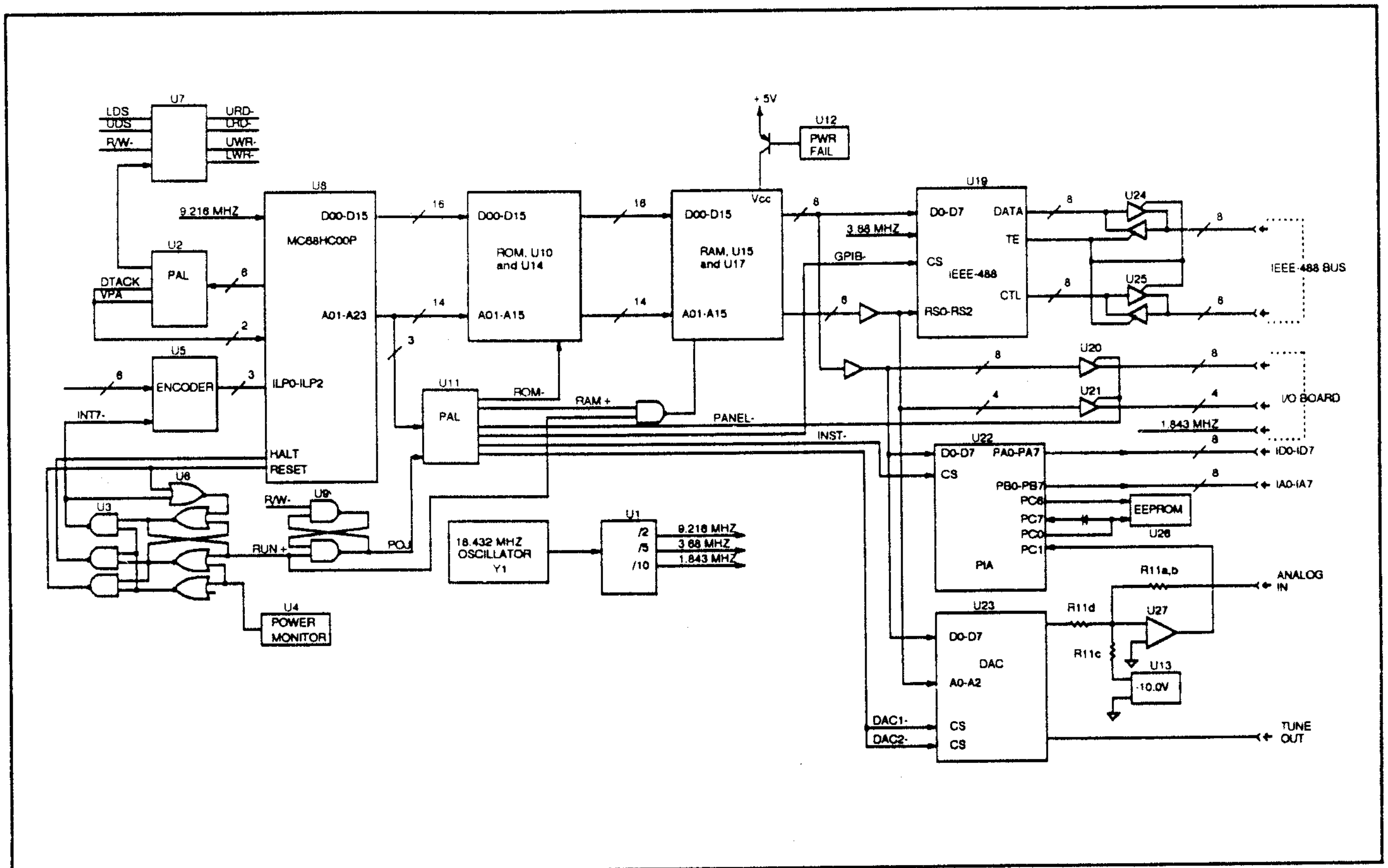


FIGURE 4-10. CPU Circuits Block Diagram.

4-105. Power supply decoupling is provided by L1, L2, C1, and C2. Additional supplies (+5 and -5 volts) are generated on board by AR3a and b, and resistors R27, R29, R31, and R32. Capacitors C10 and C13 provide additional filtering to reduce power supply noise.

4-106. THEORY OF OPERATION, CPU CIRCUITS

4-107. The CPU circuits provide the microprocessor control of all functions of the instrument. Additionally, the IEEE-488 microcontorller is located on this board as are the tuning DAC, the A/D converter and instrument interface circuits. See Figures 4-10 and 8-20.

4-108. The output of crystal oscillator Y1 is connected to U1, a dual bi-quinary counter used to generate the various timing signals required by the CPU and display circuits. The microprocessor clock signal, CLK is 9.21 MHz which is the frequency of Y1 divided by two. The timing of the IEEE-488 controller is generated by dividing the output of Y1 by five. The resulting signal, SCLK is 3.686 MHz. The 3.686 MHz signal is divided by two again to provide the PCLK signal for operation of the keyboard display controllers on the I/O board.

4-109. The 68000 microprocessor executes a control program stored in read-only-memory, (ROM) U10 and U14. Program variables and front panel setups are stored in random-access-memory, (RAM) U15 and U17. Instrumnent control is accomplished via peripheral interface adapter U22, and IEEE-488 communications is controlled by microcontroller U19 with buffers U24 and U25. Analog-to-digital conversion is accomplished by one-half of DAC U23 in conjunction with reference U13, comparator U27 and precision resistor array R11. The other half of U23 is used to tune the local oscillator circuits.

4-110. Local communications on the CPU board are via the high-speed CPU data bus D00 through D15 and address bus A01 through A17. Address lines A18 through A23 are not utilized. Memory space is partitioned by PAL U11 as follows:

Address	**Function**
00000-0FFFF	**ROM, U10 and U14**
10000-1FFFF	**RAM, U15 and U17**
20000-20FFF	**PIA, U22**
21000-21FFF	**A/D, conversion, U23A**
22000-22FFF	**D/A, conversion, U23B**
23000-23FFF	**I/O board, via U20 and U21**
24000-24FFF	**IEEE-488, U19**

4-111. U16 and U18 are required to isolate a portion of the devices on the address and data buses to meet the loading requirements of the microprocessor and memories.

4-112. During power-up, the +5 volt supply is monitored by supply supervisor U4 and the POR- control line is held low as long as the supply is below about 4.75 volts. U4 also pulls POR- low if, after normal power-up, the supply drops below 4.75 volts. Capacitor C1 is required to reduce the influence of transients on the +5 volt supply and C2 establishes the time that the POR- line is held low after the supply reaches normal levels. This delay insures proper microprocessor reset operation.

4-113. A flip-flop consisting of gates U6a and U6d is set by the high output of gate U6b, and the microprocessor RESET- and HALT- inputs are pulled low through gates U3b and U3c. The active reset signal is also supplied to peripheral circuits through gates U9b and U9c. After the +5 volt supply reaches its nominal value, signal POR- goes high, the HALT- and RESET- lines go high and flip-flop U6a/U6d is reset. This flip-flop activates the RUN+ signal to enable operation of the RAMs.

4-114. The RAM integrated circuits are powered from a non-volatile power supply consisting of U12, Q1 and battery BT1. If the +5 volt supply drops below the battery voltage of about 3 volts, U12 automatically transfers the RAM supplies to the battery. At the same time power supply supervisor U4 causes the POR- line to be pulled low. This in turn causes a microprocessor interrupt priority 7. (NMI) The control program is stopped and a RESET instruction is executed which resets all peripheral circuits, again sets latch U6a/U6d, and stops normal program activity. Control line POJ- is not used in normal operation of the instrument and can safely be ignored.

4-115. Analog-to-digital conversion is accomplished by the control program, one-half of DAC U23, comparator U27 and precision resistor array R11. The analog signal to be measured is connected to pins 3 and 4 of R11 which parallels two of the precision resistors and connects them to pin 2 of U27. Connected to the same point is one precision resistor of R11 which is connected to the -10.0 volt reference U13. A second resistor of R11 is connected to the VOA output of DAC U23. The control program successively sets data bits and tests the output of U27 via PIA U22. The progression is from most significant to least significant bit. If the comparator changes states, the bit is reset, otherwise is is left set. This successive approximation continues until 13 bits are tested.

4-116. Control of the local oscillator tuning is accomplished with one-half of DAC U23. The 16-bit digital word representing the desired output of U23 (-10 to +10 Volts) is simply written to U23 and the output taken from the VOB terminal.

4-117. U19 is the IEEE-488 interface microcontroller. All IEEE-488 operations are conducted by this circuit in conjunction with the microprocessor interrupt routines. These routines move data into and out of RAM buffers as required and control program flow in response to bus commands. When bus activity occurs, U19 sets the INT5- line low. The microprocessor reads the interrupt status registers to determine the nature of the interrupt and responds accordingly. All bus state transitions are controlled by U19, thus insuring compliance with IEEE-488 timing requirements.

4-118. THEORY OF OPERATION, COUNTER CIRCUITS

4-119. The counter circuits provide the frequency measurement functions for the Model 8200-S/10. Additionally, the calibration signals for internal detectors are generated on the counter circuit board. See Figures 4-11, 8-22, and 8-23.

4-120. A signal from 10.0 MHz crystal oscillator Y1 is divided by two by U20a, and by two again by U20b. The resulting 2.5 Mhz signal is connected to U22 for additional frequency division. The signal on pin 9 of U22 is 1.25 MHz and is used to generate the AM calibration signal. The signal on pin 15 of U22 is 1.221 kHz and is used to generate the AM and FM calibrator

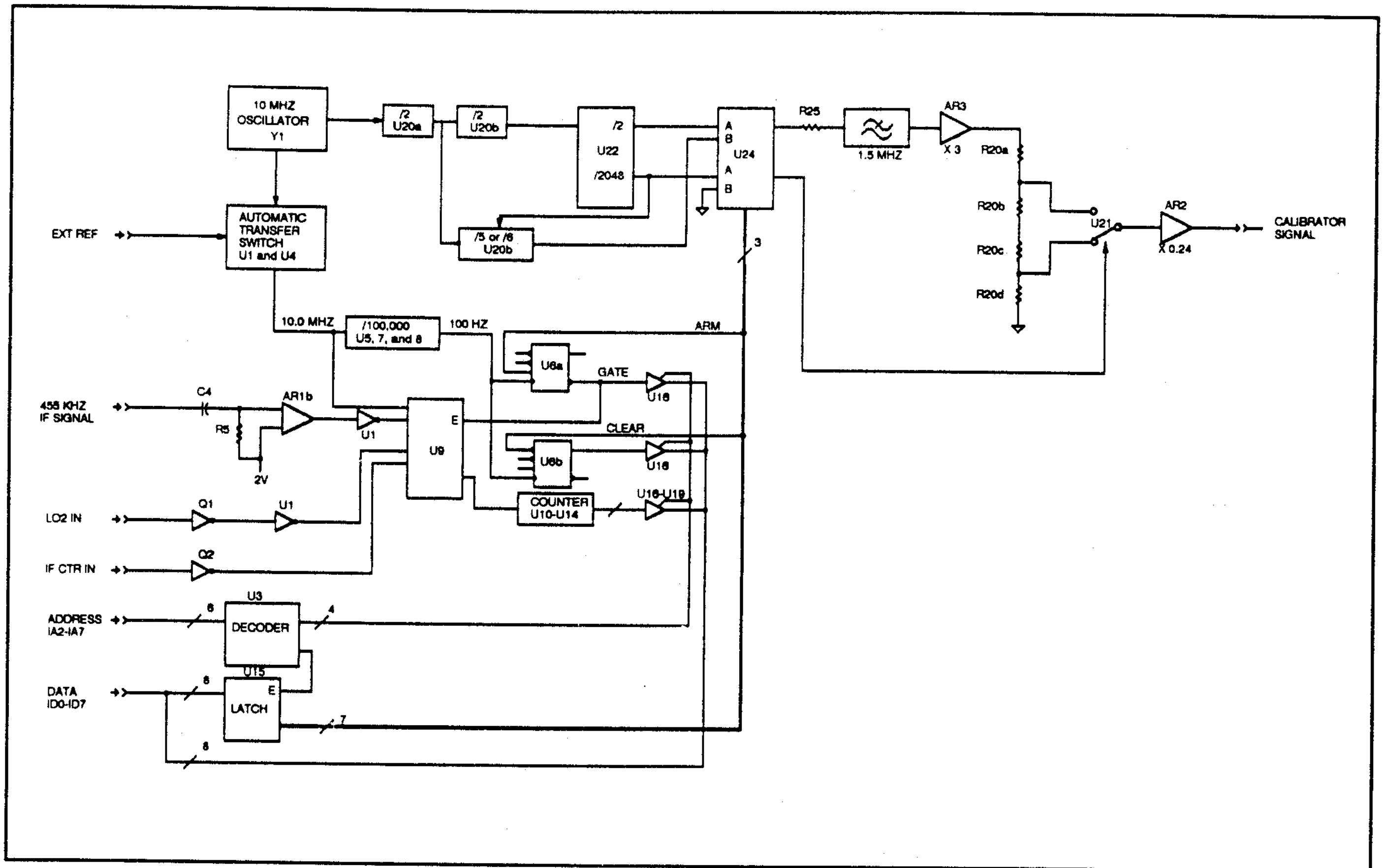


FIGURE 4-11. Counter Circuits Block Diagram.

modulation.

4-121. The 5 MHz signal from U20a is connected to the clock input of variable modulus counter U23 and the 1.221 kHz signal, inverted by U11c and non-inverted is connected to the preset inputs. The P1-P3 inputs of U23 are wired such that the counter divides by 5 or 6 depending on the level of the 1.221 kHz signal. Thus the counter output alternates between 1.0 and 833.33 kHz at a 1.221 kHz rate. The resulting signal has an average frequency of about 916 kHz and a peak deviation of + - 83.333 kHz. This signal is used to calibrate the FM and PM detectors.

4-122. The signal from the output of U23 is connected through data multiplexer U24 and resistor R25 to a filter circuit consisting of L5, L6, C17, C18, and C20. This filter removes harmonics from the signal before it is applied to the AM and FM detector circuits. AR3 amplifies the filter output signal three times as determined by R21 and R22 and drives precision divider R20a-R20d. When FM calibration is selected, analog switch U21 is set to select the signal at the junction of R20c and R20d. The output of U21 is connected to a buffer stage consisting of AR2, R29 and R30 and through R18 to the card-edge. C16, C22 and C23 provide proper compensation for amplifier AR2.

4-123. During AM calibration, one output of U24 is the 1.25 MHz signal from pin 9 of U22, and the other is the 1.211 kHz signal from U22 pin 15. The 1.25 MHz signal is filtered and amplified and applied to R20a-d. The signal at the junction of R20b and R20c is three fourths of the signal at the output of AR3. The signal at the junction of R20c and R20d is one fourth of the signal at the output of AR3. Equally important, the source impedance at both points is nearly identical. The ratio of the difference of the signals to the sum of the signals is exactly 0.5, corresponding to 50.00% AM. The two signals are switched to the output of U21 at a 1.221 kHz rate. The buffered signal is connected to the AM detector circuits during calibration. The control program takes into account switching asymmetry and switch dead time when calculating the actual AM of the calibrator.

4-124. The output of crystal oscillator Y1 is also connected to gate U4a. The other input of U4a is a signal derived from the EXT REF input. If an external reference signal is present, pin 8 of U1b will be alternating between TTL low and high levels. The low level signal will cause CR1 to become forward biased and thus bias pin 1 of U1c low. The output of U1c will be high, which will enable U4b. This will allow the external timebase signal to appear at pin 6 of U4c. Simultaneously, the output of U1c is inverted by U1e to disable U4a, disconnecting the internal timebase signal. When the external signal is removed, the internal timebase signal will appear at pin 6 of U4c.

4-125. This signal is divided down to 100 Hz by U5, U7, and U8 and is the gate used for all frequency measurements made by the Model 8200-S/10. The gate signal is used to clock d-latch U6a and U6b. The output of U6b is connected to the CPU board to provide an interrupt the microprocessor every 10 milliseconds.

4-126. A sample of the local oscillator signal at pin 30 of the edge connector is amplified to TTL levels by Q1 and associated components. U1f further shapes the signal which is applied to data selector U9.

4-127. A sample of the intermediate frequency at pin 32 of the edge-connector is similarly amplified by Q2 and associated components and connected directly to data selector U9.

4-128. A sample of the 455 kHz IF frequency at pin 34 of the edge-connector is converted to TTL levels by AR1b and associated components. Operating bias is supplied by diode DS2 and R4. The output of AR1b is connected to data selector U9 through buffer U1d and to the clock input of U2b.

4-129. The normal mode of measurement for this signal is by counting the number of zero-crossings of the signal in one second. The actual gate interval is controlled by the firmware by allowing a fixed number of 10 millisecond gate cycles to elapse before the arming signal on the D input of U6a is removed. Each gate cycle causes a microprocessor interrupt. The program counts the number of times an interrupt has occurred since U6 was armed. When the correct number of cycles is reached, the sequence is stopped. The residue in the counter chain is then read and the counter is reset.

4-130. Carrier frequency measurements are made by counting the local oscillator for N gate cycles, where N is the harmonic number used to generate the intermediate frequency. The intermediate frequency is then measured, and the difference is calculated as the carrier frequency. The expression relating the three frequencies is:

$$Frf = N X Flo - Fif$$

4-131. The output of U9 is the signal to be counted. The counter consists of U10, U12, U13, and U14. U10 and U12 are high speed binary dividers which are required to measure the local oscillator signal at 40 MHz. U13 and U14 are relatively slow speed CMOS 12-bit counters which always operate at less than 3 MHz. The counter has a total length of 28 bits which allows counting to greater than 260 MHz with a resolution of 1 Hz.

4-132. The outputs of the counters are connected to the instrument data bus via 3-state buffers U16-U19. The data is read by the microprocessor in 4, 8-bit bytes. In addition to the frequency information, the gate and external reference status signals are read.

4-133. U15 is an 8-bit latch which is used to store instrument data bus information when the counter board is addressed by the microprocessor. Address decoder U3 decodes instrument addresses 8 through 11 to operate the select lines for U15-U19.

4-134. THEORY OF OPERATION, I/O CIRCUITS

4-135. The I/O circuits provide an interface between the microprocessor and the front panel LED displays and keyswitches. See Figures 4-12, 8-25, and 8-26.

4-136. U2 and U3 are keyboard/display microcontrollers. Each circuit is capable of controlling up to 16 digits of display and a 64 key keyboard. The Model 8200-S/10 requires more than 16 display digits, so two circuits are required, however, less than 64 keys are used, so that only one of the keyboard interfaces is used. U2 operates 14 displays including the FREQUENCY/LEVEL display and legend and two digits of the MODULATION display. U3 operates 14 displays including 4 digits of the MODULATION display, the modulation legends, the SPCL/PRGM display and legends, the IEEE-488 legends, and the keyswitch LEDs on the keyboard. Additionally, U3 handles all keyboard switches. When a key is depressed, U3 activates the INT- line via U1

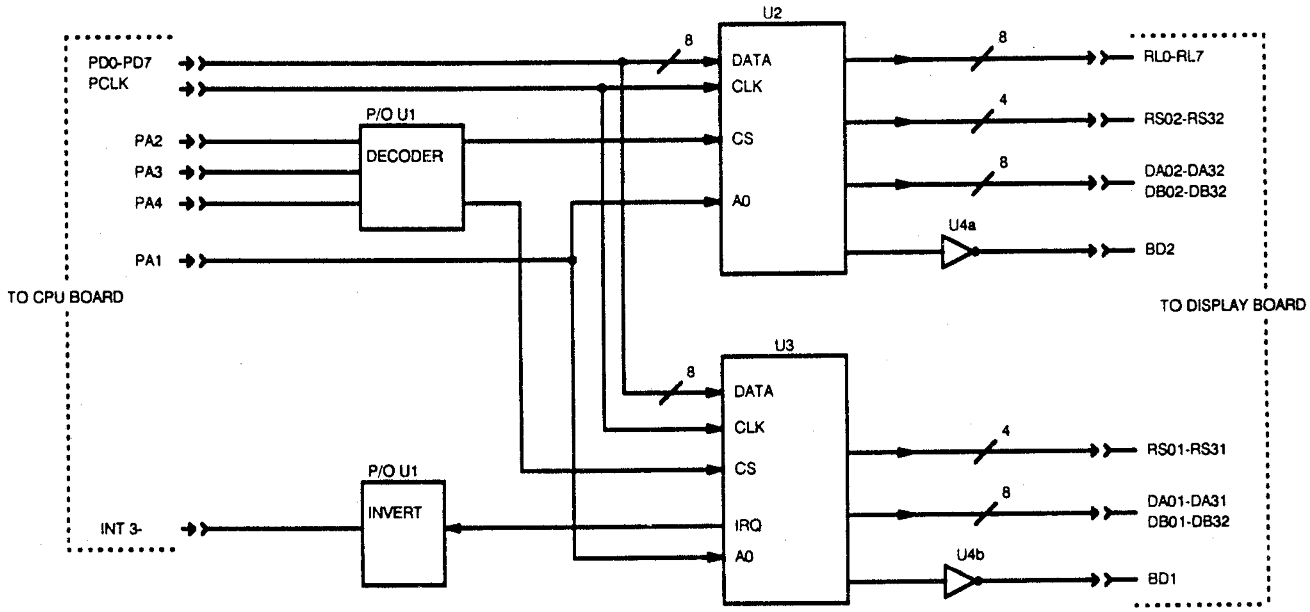


FIGURE 4-12. I/O Circuits Block Diagram.

to interrupt the microprocessor. The key closure is recognized by the control program by reading the data from U3 which releases the INT- line.

4-137. U1 is a dual decoder used to generate chip select signals from the address signals PA2-4. The two strobe signals at TP1 and 3 are used to select U2 and U3 respectively. One half of U1 is connected merely to invert the sense of the IRQ signal from U2 to the microprocessor. The panel interrupts are priority level 3. Signals from U2 and U3 are connected to the Display/keyboard via J3. LEDs DS1 and DS2 are activity indicators for the two five volt supplies present on the I/O board.

4-138. THEORY OF OPERATION, DISPLAY AND KEYBOARD CIRCUITS

4-139. The display and keyboard circuits provide the operator interface to the Model 8200-S/10 circuits. Key closures are detected and sent to the microprocessor which interprets them, and modifies the display LEDs appropriately. See Figures 4-12 and 8-26 through 8-30.

4-140. The software configurable display/keyboard microcontroller circuits U2 and U3 on the I/O circuit board are programmed to operate 16 display digits. All of the displays operated by U3 are connected to a common cathode driver bus which is generated by the signal lines DA01-DA31 and DB01-DB31. These signals are buffered by U1 and and U3 and connected to the display cathodes through current limiting resistors R1 and R2.

4-141. The signals RS01-RS31 are connected to a one-of-sixteen decoder consisting of U2 and U4. The sixteen decoder output lines are connected to buffers U5 and U6 where the interdigit blanking is applied by signal BD1-. The signals are then connected to the display anodes via driver circuits U7 and U8. Note that only 6 of the 8 available outputs of U8 are actually used. All segment decoding is done by the microprocessor so that no additional decoders are required.

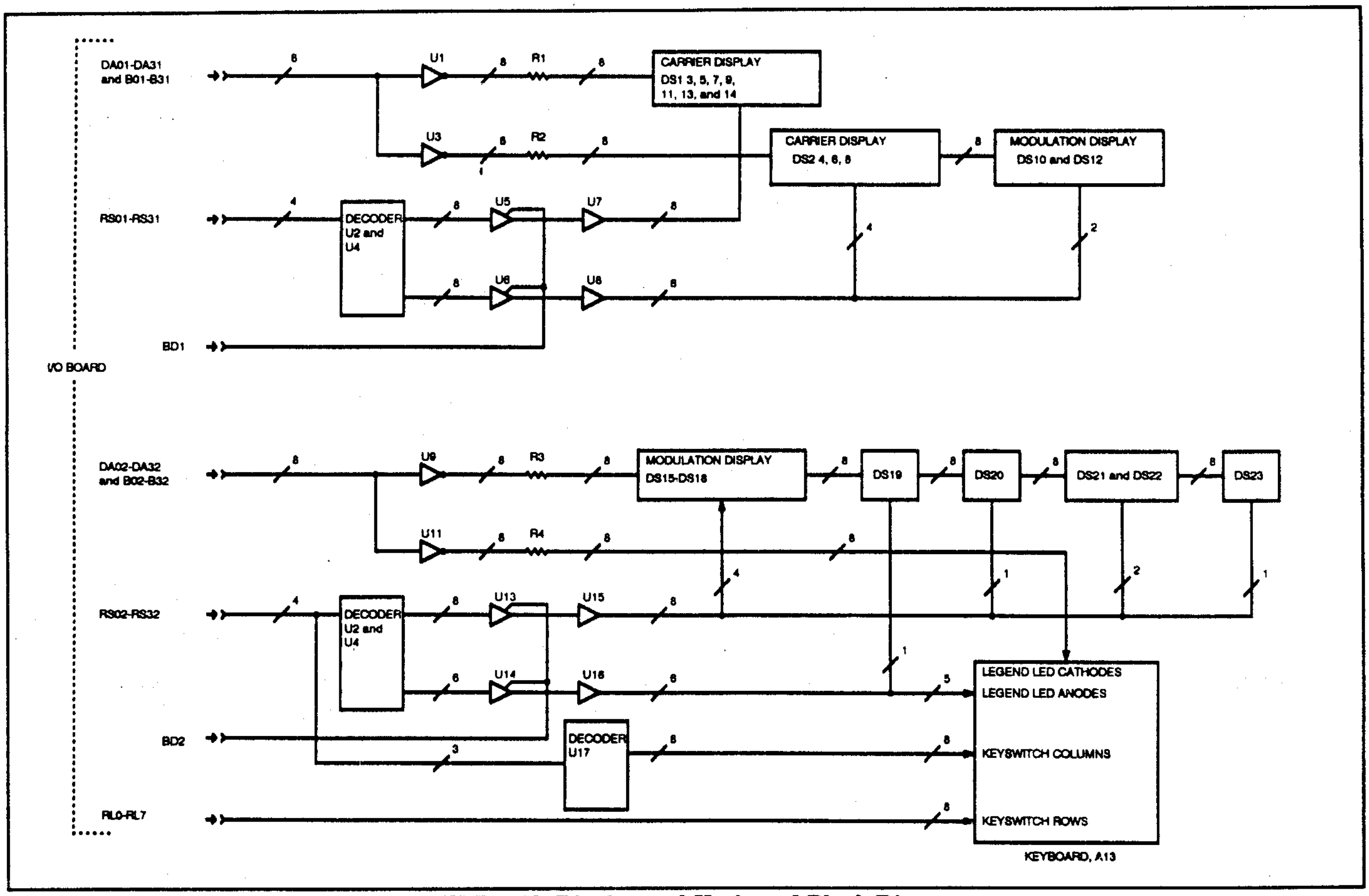


FIGURE 4-13. Display and Keyboard Block Diagram.

4-142. Similarly all of the displays operated by U2 are connected to a common cathode driver bus which is generated by the signal lines DA02-DA32 and B02-B33. These signals are buffered by U9 and connected to the display cathodes through current limiting resistor R3.

4-143. The signals RS02-RS32 are connected to a one-of-sixteen decoder consisting of U10 and U12. Fourteen of the sixteen decoder output lines are connected to buffers U13 and U14 where the interdigit blanking is applied by signal BD2-. The signals are then connected to the display anodes via driver circuits U15 and U16. Five of the buffered lines from U16 are connected through J5 to the keyboard to operate the keyswitch LEDs. The keyswitch LEDs are connected into five common anode groups with eight common cathode lines. Separate cathode drive lines are generated for the keyboard LEDs by U11 and R4.

4-144. A second decoder, U17 is connected to the RS02-RS22 lines to generate a one-of-eight select signal to drive the keyswitches on the keyboard. The signal lines RL0-RL7 are also connected to the keyswitches. The resulting keyswitch matrix can accommodate sixty-four switches, of which 56 are actually used.The time-division multiplexed signals from U17 are connected to the RL lines when a key is depressed. The keyboard controller, U2 on the I/O board, encodes the the key response based on which RL line was active during the time one of the outputs of U17 was active. Multiple keyswitch closures and key debouncing are handled by U2. Keyswitch closures cause microprocessor interrupts as described in the I/O circuits theory.

4-145. THEORY OF OPERATION, MOTHERBOARD/POWER SUPPLY

4-146. The motherboard circuitry provides the main interconnect for the operating circuits of the Model 8200. The motherboard contains the connectors for the plug-in boards, the regulated power supplies, the decoder and latch for the RF and oscillator circuits, and a latch and driver for RF relay K1. See Figures 4-14, 8-2, 8-3, and 8-4.

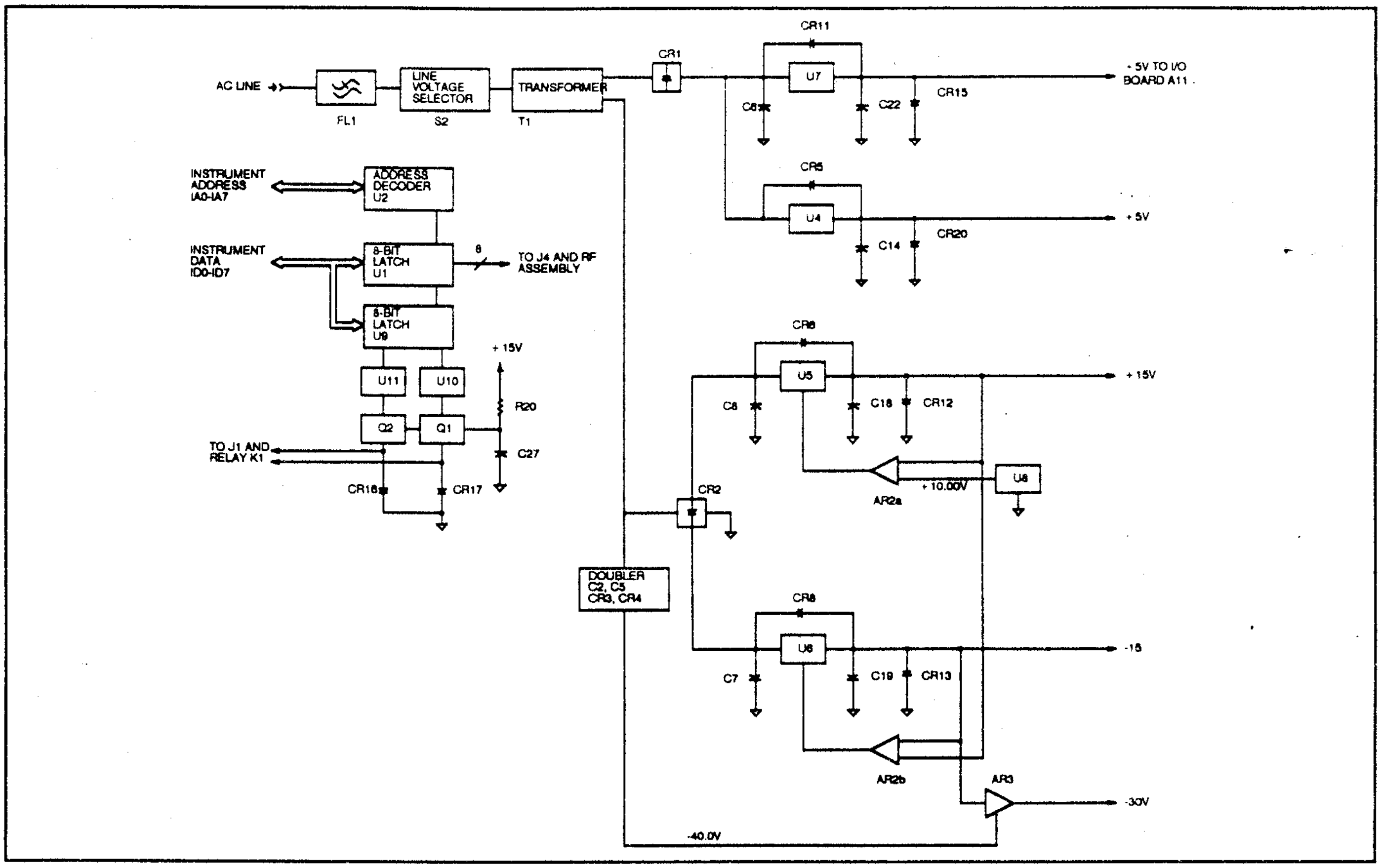


FIGURE 4-14. Motherboard/Power Supply Block Diagram.

4-147. The instrument data lines ID0-ID7 are connected to latch U1 which is operated by decoder U2. Information on the data lines is latched and connected to the RF circuitry to operate the tuning and conversion circuits.

4-148. The instrument data lines ID0-ID7 are also connected to latch U9 which is operated by decoder U2. Information on the data lines is latched on the rising edge of the signal from U2. The latched version of lines ID0 and ID1 are connected to analog switches U10 and U11 which operate FET relay drivers Q1 and Q2. The common output of the analog switch U10 is connected to the gate of Q1. When the data line ID0 goes high, the gate of Q1 is shorted to ground causing Q1 to turn on and discharge capacitor C27 into the coil of relay K1. Conversely, when ID0 goes low, the gate of Q1 is shorted to the +15 volt supply which turns Q1 off. U11 and Q2 operate in an identical fashion to operate the other coil of K1. Data lines ID0 and ID1 are operated by the control program to pulse the relay coils for approximately 15 milliseconds, which is sufficient to transfer the relay contacts. Resistor R20 supplies charging current to C27 between operations of K1.

4-149. Line power is connected to transformer T1 via line filter FL1, fuse F1, and line voltage selector switch S2. FL1 keeps internally generated rf signals from appearing on the power connecting cable, thus preventing unwanted electomagnetic radiation. Line switch S2 alters connections to the primary of T1 which allows the Model 8200-S/10 to be operated from line voltages from 100 to 240 volts.

4-150. One of the two secondary windings on T1 is connected through full-wave bridge CR1 to regulators U7 and U4. These three-terminal regulators generate 5 volt regulated voltages for the instrument logic circuits and the front panel display. A separate regulator, U7, is rovide for the display and I/O circuits in order to minimize internally generated switching noise.

4-151. Capacitor C6 provides the essential energy storage which reduces the ripple voltage at the inputs to U7 and U4. C14 and C22 provide local bypassing of the regulator circuits and diodes CR5, CR10, CR11 and CR15 protect the integrated regulators from reverse voltages.

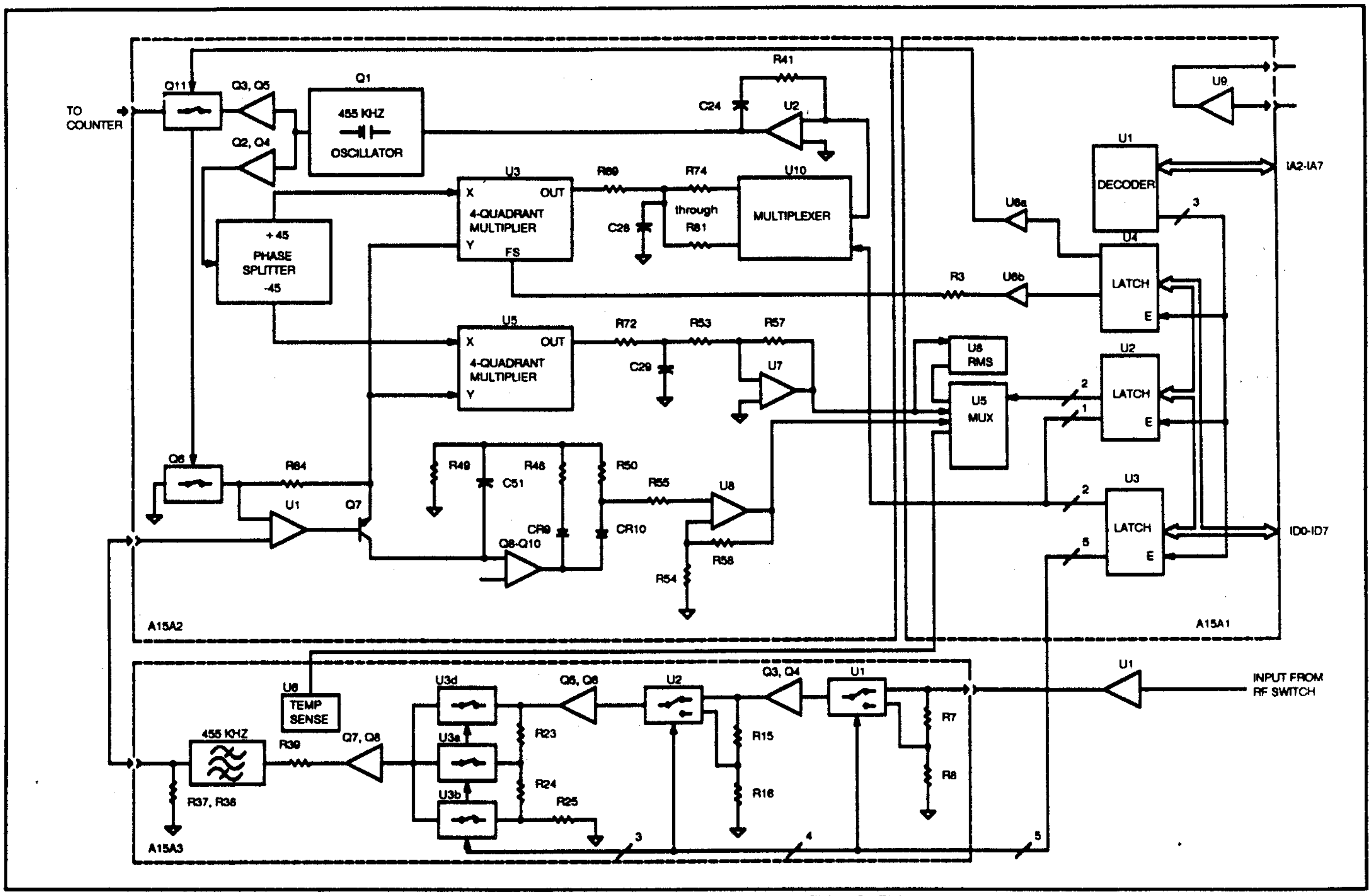


FIGURE 4-15. 455 KHz IF subsystem Block Diagram.

4-152. The other secondary winding of T1 is connected through full-wave bridge CR2 to regulators U5 and U6. These regulators are enclosed in feedback loops to improve regulation and increase the operating voltages from 5 to 15 volts. Capacitors C7 and C8 reduce input ripple voltage and CR6, CR12, CR28, and CR13 provide reverse voltage protection. Reference U8 is the primary reference for the power supply circuits. Precision resistors R7a, R7b, and R7e configure AR2a for a gain of +1.5. This converts the +10.00 volt reference into +15.00 volts. R7f and R7d configure AR2b for a gain of -1 which inverts the +15.00 volt supply into -15.00 volts. Zener diodes CR7 and CR9 are required to insure proper startup of the supply and are normally reverse biased when the supply is operating properly. C18 and C19 provide local bypassing to maintain loop stability as the supply loading changes.

4-153. A voltage doubler circuit consisting of C2, C3, CR3, and CR4 produces a dc output of about -40 volts at nominal line. This voltage is regulated to produce a -30 volt level required by the oscillator circuits. R7g and R7h configure AR3 for a gain of exactly +2 which amplifies the -15.00 volt supply to -30.00 volts.

4-154. As a troubleshooting convenience, each supply has an activity LED connected to its output. DS1-DS5 will normally be illuminated when the supplies are operating properly.

4-155. THEORY OF OPERATION, 455 KHZ IF SUB-SYSTEM

4-156. The 455 kHz IF sub-system operates in conjunction with an external low-noise oscillator and mixer to provide calibrated tuned level measurements from 0 to -127 dBm.

4-157. The 455 kHz signal from the frequency converter is connected via buffer amplifier U1 to a 20 dB switchable attenuator consisting of R7, R8 and switch U1. The position of the switch is determined by the control program based on the input level.

For a converter input level of 0 dBm, the level into amplifier U1 is about -40 dBm. U1 has a gain of approximately 10. Amplifier Q3, Q4, and associated components is configured for a gain of about 8 as determined by R12 and R14.

4-158. The output of this stage is connected to a second switchable 20 dB attenuator consisting of R15, R16 and switch U2. Amplifier Q5 and Q6 and associated components, is configured for a gain of about 10 as determined by R20 and R22.

4-159. The output of this stage is connected to a third switchable 20 dB attenuator consisting of R23, R24, R25, and switch U3. This attenuator consists of two independent 10 dB steps. Amplifier Q7 and Q8 and associated components, is configured for a gain of about 10 as determined by R30 and R32. The combination of the three attenuators provides gain changes of 0 to 60 dB in precise 10 dB steps. The total gain is sufficient to operate the detector stages at RF input levels as low as -130 dBm.

4-160. The last amplifier stage drives a 455 kHz band-pass filter consisting of inductors L1 through L5 and capacitors C13 through C21. This filter is designed for a bandwidth of about 30 kHz. Variable resistor R38 is adjusted for flat response over a 10 kHz band around 455 kHz. Temperature sensor U6 is located near the filter elements to monitor temperature changes. During the normal tuned level calibration sequence, the temperature sensor output is read and stored with the calibration factors. If a major change in temperature occurs, the control program will inform the operator of an uncalibrated reading.

4-161. The output of the filter is connected to a variable gain stage on the detector board. This stage is adjustable to remove the gain variations of the frequency converter circuits. Additionally, this stage is clamped by CR13 and CR14 to improve overload recovery time, and generates a current output at the collector of Q7 to drive the following linear-active-detector.

4-162. The linear-active-detector is similar to the circuit used to detect amplitude modulation. The stage consisting of Q8-Q10 and associated components is designed to have high loop gain and high output impedance to drive the non-linear feedback loop. The feedback current passes, on alternate half cycles, through either R48 and CR9 or R50 and CR10, thus, the voltage waveform at the junction of CR10 and R50 is half-wave rectified. The average value of this signal is equal to the peak AC voltage divided by PI (3.14159). The resulting DC voltage is filtered by R55 and C32 and buffered by U8 to drive the input of multiplexer A15A1U5.

4-163. The signal at the emitter of Q7 is connected to two four-quadrant multipliers, U3 and U5. Multiplier U3 provides phase sensitive detection to operate a phase lock loop, and U5 provides phase sensitive amplitude detection of the IF signal.

4-164. Oscillator Q1, and associated components, is designed to operate at about 455 kHz and is tuned by varying the voltage across varactor diodes CR3-CR8. Amplifier Q2 and Q4 buffers the oscillator output and drives a phase splitter consisting of T1, R25-R28, C19, and C20. This network is adjusted to provide two signals that are in phase quadrature. The two signals are connected to the X inputs of two multipliers. When two equal frequency inputs, X and Y of U3 are multiplied, the product (output) has signal components at twice the input frequency and DC. Additionally, if the phase relationship of the two inputs is exactly 90 degrees, the DC term is zero.

4-165. Since loop amplifier U2 has one of its inputs referenced to ground, the phase lock loop will operate with the X and Y inputs to U3 in phase quadrature. Multiplexer U10 and resistors R74 through R81 are connected so as to allow the bandwidth of the closed loop to be adjusted. The full-scale adjust input (FS) of U3 is used as a vernier adjustment of loop bandwidth. Loop bandwidth is held constant to provide predictable detection in the presence of large amounts of noise.

4-166. The second output of the phase splitter is connected to the X input of multiplier U5. Since this output is in quadrature with the phase lock loop reference, the dc output of this multiplier will be maximum, and equal to twice the peak AC signal divided by PI (3.14159). The DC output is filtered by R72 and C29 and amplified about 8.3 times by U7, as determined by R72, R53, and R57.

4-167. This DC signal, along with the signal from the average detector, and a signal from the temperature sensor, are input to multiplexer U5. The multiplexer is operated by the control program to measure the various signals during instrument tuned level measurements. An additional input is generated by RMS converter IC U8. This converter is placed in series with the synchronous detector output to compensate for the detuning of the phase lock when the signal-to-noise ratio at the input to the loop multiplier becomes poor. Noise detuning causes the average output of multiplier U5 to decrease. Placing an RMS converter in series with the output signal causes the DC output to increase as noise components increase.

4-168. Three 8-bit latches are connected to the instrument data bus, ID0-ID7. Decoder U1 selects the latches depending on the contents of the instrument address bus IA2-IA7. Latch U2 is selected when IA2 is high and IA3 and IA4 are low. Similarly, U3 is selected when IA2 and IA3 are high and IA4 is low. U4 is selected when IA2 and IA3 are low and IA4 is high. Line IA7 goes momentarily high, then low when data is written to the latches. The outputs of U4 are level shifted by comparators U6 to produce 0 to -15 volt logic swings. One output is used to opeate FET switch Q6 to increase stage gain for improved phase lock loop operation at very low levels. The other output is used to vary the full-scale level of multiplier U3, which acts as an adjustment of the phase lock loop bandwith.

4-169. The outputs of latch U3 are used to operate the gain switches and the auto zero switch. Those from U2 operate multiplexers U5 and U10 on command from the control program.

4-170. Amplifier stage U9 is included on the 455 kHz Detector Interface board to convert the 1 volt peak-to-peak signal at the input of the peak detectors to 1 volt RMS to operate the RMS converter on the Detector board, A8. The stage gain, 2.82, is determined by resistors R11 and R12.

SECTION V
PERFORMANCE TESTS

5-1. GENERAL

5-2. The following procedures verify the performance characteristics of the Measuring Receiver. Detailed tests against the requirements of MIS-35954/1 are included, however, testing beyond the requirements of MIS-35954/1 is included to verify operational features not included in the specification.

NOTE

A warm-up period of one hour is recommended before detailed testing is started.

5-3. EQUIPMENT REQUIRED

5-4. Equipment required is listed in Table 5-1. Any equipment which meets the critical specifications may be used for the recommended model.

NOTE

The following procedures assume that the recommended equipment is used. Procedural changes may be required if equipment substitution is made.

5-5. TEST RECORD

5-6. Each test table contains a test result block. As each test is completed, the results blocks are filled in.

5-7. CALIBRATION INTERVAL

5-8. The instrumentation should be tested to specification at least once per year.

5-9. INITIAL CALIBRATION

5-10. Initial calibration is performed before detailed performance checks and as the first step of the operational checks.

5-11. Procedure

1. Set the LINE ON/OFF switch to ON and depress the LCL/INIT key to initialize the system after the selfcheck program completes.

2. Select stored program -1, a recall only program, which executes all of the internal calibration routines, then depress the RCL key.

3. Any Calibration errors that are reported, indicate an operational failure.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT.

INSTRUMENT	CRITICAL SPECIFICATIONS	USAGE		MODEL
		PERFORMANCE EVALUATION	MAINTENANCE	
AM-FM Signal Generator	**Frequency Range:** 0.1 to 2000 MHz, **Level Range:** -50 to +19 dBm	X	X	**SG1207/U**
AM-FM Signal Generator	**Frequency Range:** 2-18 GHz, **Level Range:** -20 to +8 dBm	X	X	**SG1219/U**
Synthesizer, CW	**Frequency Range:** 650 and 1300 MHz **Residual FM** < 1Hz, 3 kHz BW **Residual AM** < -80 dBc, 3 kHz BW	X		**Adret Model 7100A**
Audio Analyzer	**Frequency Range:** 20 Hz to 20 kHz **Level Range** .6 mV to 6 V into 600 ohms **Distortion** < 0.05%	X	X	**Boonton 1120-S/1**
Test Oscillator	**Frequency Range:** 5Hz to 500 kHz **Level Range:** 0 to 3 V rms **Flatness:** +- 0.3 dB	X		**Tektronix Model SG502**
Spectrum Analyzer	**Frequency:** 1.2 MHz **Resolution BW:** 0.1 kHz **Frequency span:** 1 kHz	X		**HP Model 8566B**
Modulator	**Frequency:** 30 MHz **Flatness :** < 0.3%, 20 Hz to 220 kHz **Distortion:** < 0.15% at 90 % AM	X		**Boonton 96400501A**
Low-pass filter	5-pole response, 3dB corner, 50 MHz	X		**Mini-Circuits NLP-50**
RF Calibrator	**Frequency:** 30.0 MHz, crystal **Level Range:** -60 to +20 dBm **Accuracy:** 0.105 dB **Linearity: +- 0.004 dB/10 dB**	X	X	**Boonton Model 2520**

TABLE 5-1. RECOMMENDED TEST EQUIPMENT CONTINUED.

INSTRUMENT	CRITICAL SPECIFICATIONS	USAGE		MODEL
		PERFORMANCE EVALUATION	MAINTENANCE	
Variac/Line Monitor	20% variation about 100, 120, or 240 Volts	X		**Powerstat 3PN116B**
Milliwat Test Set	**Level Accuracy:** + - 0.015 dBm at 0.00 dBm	X		**Wandel and Golterman Model EPM-1 with TK-10 probe**
Certified Pads	10, 20, and 30 dB pads measured and certified by NBS	X		**Weinshel Model 1 -10, -20, and -30**
Certified Power Sensor	NBS Certified frequency response from 50 MHz to 18 GHz	X		**Hewlett-Packard Model 8481A H39 and 436 power meter**
Impedance Analyzer	**Frequency Range:** 100 kHz to 10 MHz. **Accuracy:** 50 ohms + - 5 %	X		**Hewlett-Packard Model 4194A**
Amplifier	1 dB compression point of +33 dBm 29 dB gain typical at 30 MHz.	X		**Mini Circuits** Model ZHL-1-2W
Network Analyzer	**Frequency Range:** 10 MHz to 18 GHz .	X		**PMI Model 1038-NS20/ 1038-NS207**
SWR Autotester	**Directivity : 38 dB**	X		**Wiltron Model 560-97NF50**
Time Standard	**Frequency : 10.000 MHz Stability 1 X10-10 per day**			**House Standard**
Power Calibrator	**Frequency Range:** 10 MHz to 18 GHz **Attenuation Range:** 0 to -100 dB, with precision 6 dB, + - 0.002 dB step.	X		**Argo Systems Model AS1210**
AM-FM Signal Generator	**Frequency Range:** 455 kHz to 30 MHz, **Level Range:** -80 to +19 dBm		X	**Boonton Model 1020**

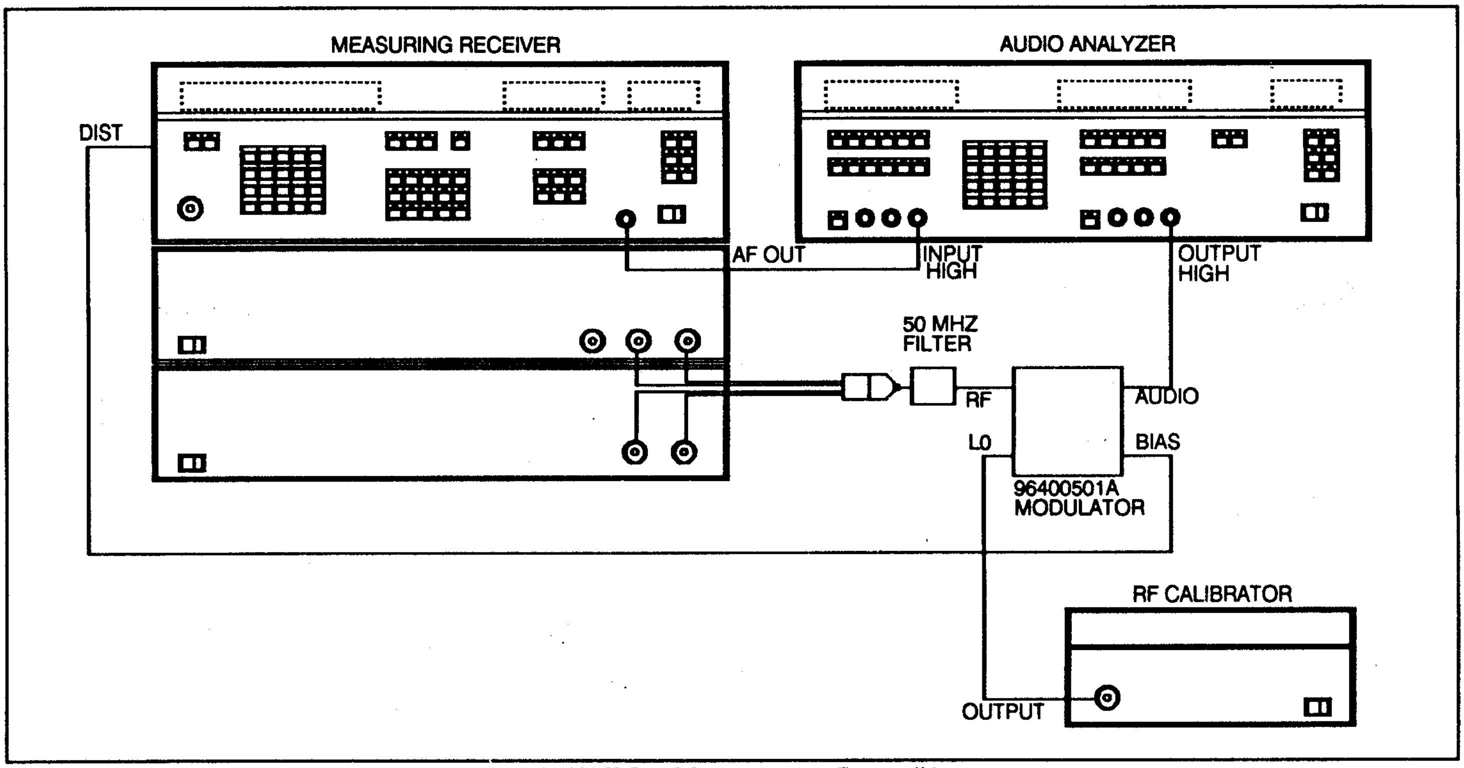


FIGURE 5-1. Measurement Setup #1.

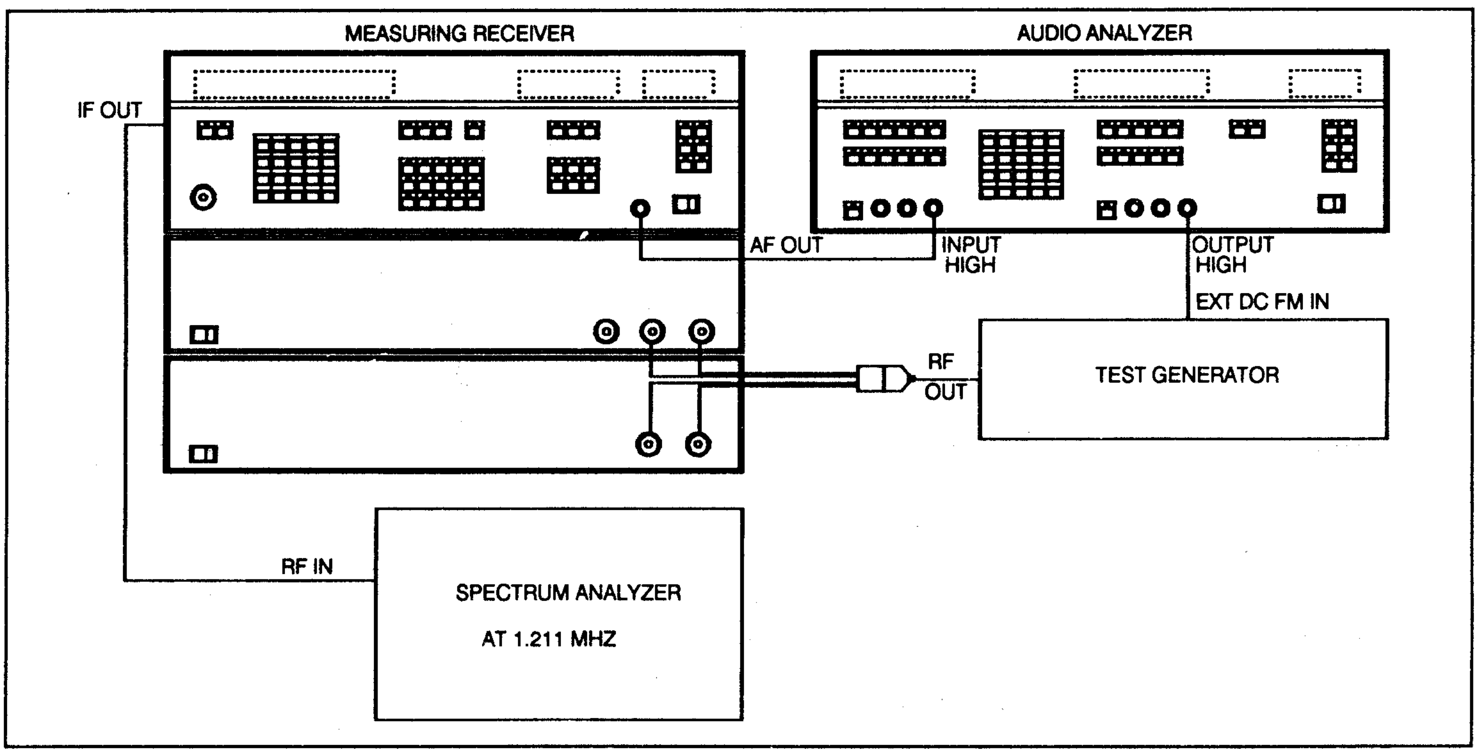


FIGURE 5-2. Measurement Setup #2.

PERFORMANCE TEST 1

AM MODULATION ACCURACY AND RESIDUALS

Specification	: +- 1%, 50 Hz to 50 kHz, Frf > 10 MHz
	: +- 2%, 50 Hz to 10 kHz, Frf < 10 MHz
	: +- 3%, 20 Hz to 10 kHz, Frf > 10 MHz
	: residual 0.02%, 3 kHz bandwidth
	: incidental FM 20 Hz peak at 50% AM, 3 kHz bandwidth
	: incidental PM 0.02 RAD at 50% AM, 3 kHz bandwidth

5-12. DESCRIPTION

5-13. The AM accuracy is verified first by using the internal calibrator which is 50.00% +- 0.1% at 1.220 kHz. The AM flatness is then tested by applying the output of a low-residual, wideband linear modulator to the input of the Receiver. The Audio Analyzer frequency is then varied, and a modulation RATIO change is noted. The audio frequency is then set to 1 kHz and the incidentals are checked at 50% AM. Finally, the Audio signal is removed from the modulator and the residual AM is measured.

5-14. PROCEDURE

1. Connect the equipment as shown in Figure 5-1.

2. Depress the LCL/INIT key to initialize the system.

3. Set the RF Calibrator to +10 dBm and turn the output ON.

4. Select the AM modulation mode and depress the CAL key. The calibration program will display the -CAL- message in the left display window and the AM indication in the MODULATION window. Record the Modulation indication.

5. Enter SPCL 15 to enable the slow detector mode. Select the <10 high-pass and 220 kHz low-pass filters, then adjust the Audio analyzer for an AM indication of about 47.00% at a 1 kHz rate and depress the Receiver RATIO and % keys to set a modulation reference.

NOTE

The following procedures assume that the Audio Analyzer Level flatness is better than 0.5%. This exceeds the MIS specification, however, the Model 1120 is typically 0.2%. This should be verified before continuing.

6. Set the Audio Analyzer to the test frequencies of Table 5-2 and record the ratio indication.

7. Set the Audio Analyzer to 1 kHz and adjust the LEVEL for an indication of 50 +-1% AM. Depress the RATIO key to disable this function.

8. Select the 30 Hz high-pass, the 3 kHz low-pass, and depress the FM modulation key. Increase or decrease the RF Calibrator level for a deviation null, then record the indication.

9. Depress the PM modulation key and record the indication.

10. Remove the Audio Analyzer connection to the Modulator, depress the AM and RMS detector keys and record the residual AM indication.

Table 5-2. AMPLITUDE MODULATION

FREQUENCY	FILTER SETTING	MINIMUM	ACTUAL	MAXIMUM
20 Hz	220 kHz	97.00	________	103.00
50 Hz	220 kHz	99.00	________	101.00
50 Hz	50 kHz	98.00	________	102.00
10 kHz	50 kHz	98.00	________	102.00
10 kHz	220 kHz	99.00	________	101.00
50 kHz	220 kHz	99.00	________	101.00
Incidental FM	30 Hz-3 kHz		________	20 Hz
Incidenal PM	30 Hz-3 kHz		________	0.02 RAD
Residual AM	30 Hz -3 kHz		________	0.02%

PERFORMANCE TEST 2

AUDIO FILTERS

Specification	: +- 4% corner accuracy
	: +- 4% time constant accuracy, de-emphasis

5-15. DESCRIPTION

5-16. Each audio filter of the Receiver is tested for corner accuracy by applying the output of a low-noise, wideband modulator to the input of the Receiver. The Receiver modulation RATIO measurement mode is used with a reference set at a midband frequency. The frequency of the Audio Analyzer is then set to the filter corner frequency and the relative amplitude measured and the results recorded.

5-17. PROCEDURE

1. Connect the equipment as in Fig. 5-1 and depress the LCL/INIT key to initialize the instrument.

2. On the Receiver enter SPCL 15 to enable the slow detector mode and SPCL 34 and 37 to enable de-emphasis filters in the AM measurement mode, then set the RF Calibrator to +10 dBm and ON.

3. Adjust the LEVEL of the Audio Analyzer for an indication of about 47.00% at 1 kHz.

4. Select the <10 high-pass and the 220 kHz low-pass filters, and depress the RATIO and % keys to establish a reference modulation.

5. Enter the Analyzer test frequency for each filter in Table 5-3, then depress the key to select the filter, and record the ratio indication.

6. For the 50 and 220 kHz filters, connect the Test Oscillator in place of the Audio Analyzer source in Figure 5-1.

7. Depress the RATIO key and adjust the Test Oscillator amplitude for an indication of about 47.00% AM at 1 kHz rate.

8. Select the 50 kHz low-pass filter, depress the RATIO key and increase the Test Oscillator frequency until the ratio indication is 70.7%. Read the Test Oscillator frequency on the Audio Analyzer and record.

9. Select the 220 kHz low-pass and continue to increase the Test Oscillator frequency until the ratio indication is again 70.7%. Record the Audio Analyzer frequency indication.

Table 5-3. AUDIO FILTERS

FILTER	SOURCE SETTING	MINIMUM	ACTUAL	MAXIMUM
<10Hz HP	30 Hz	99.50	________	100.50
30Hz HP	30 Hz	65.70	________	73.70
300Hz HP	300 Hz	65.70	________	73.70
3000Hz	3000 Hz	65.70	________	73.70
3 kHz	3 kHz	65.70	________	73.70
15 kHz	15 kHz	65.70	________	73.70
20 kHz	20 kHz	65.70	________	73.70
25 uS	6.366 kHz	65.70	________	73.70
50 uS	3.188 kHz	65.70	________	73.70
75 uS	2.122 kHz	65.70	________	73.70
750 uS	212.2 Hz	65.70	________	73.70
50 kHz	50 kHz approx.	48.0	________	52.0
220 kHz	220 kHz approx.	211.2	________	228.8

PERFORMANCE TEST 3

AMPLITUDE MODULATION, DISTORTION

Specification	: 0.3% for depths of 50%, Frf < 1300 MHz
	: 0.6% for depths of 95%, Frf < 1300 MHz
	: 1.0% for depth of 50%, Frf > 1300 MHz

5-18. DESCRIPTION

5-19. The Amplitude Modulation distortion is verified by applying the output of a low-residual, wideband, linear modulator to the input of the Receiver. The Audio Analyzer level is then adjusted for 50 and 95% depth and the recovered modulation distortion is displayed on the Audio Analyzer. Above 2 GHz AM distortion is verified by a simple system linearity measurement over a 10 dB dynamic range, roughly equivalent to 50% AM. The distortion is predominantly second harmonic and equal to 1/4 the change in slope of the Receiver front end. The AM detector linearity has been determined to be less than 0.08% at this point.

5-20. PROCEDURE

1. Depress the LCL/INIT key to initialize the system.

2. Connect the equipment as in Figure 5-1, and Select the Receiver AM modulation measurement mode.

3. Set the Audio Analyzer to 1 kHz and adjust the level for an AM indication of 50.00 +- 0.5%.

NOTE

For optimum measurement accuracy the displayed resolution should be 0.01%.

4. Select the Analyzer DIST mode with a 30 kHz low-pass filter. Record the distortion.

5. Adjust the Analyzer level for an AM indication of 95.0 +- 1% AM. Record the distortion.

6. Set the SG1219/U Generator to 10.0 GHz at about -10 dBm. Connect the Audio Analyzer source output to the AM IN and adjust the Analyzer level for 30% AM at a 1 kHz rate.

7. Connect the Receiver Sensor with the Adapter Pad installed to the generator RF OUT. Enter SPCL 1 to select the frequency offset operating mode, and enter 10.03 GHz as the offset. Depress FREQ to complete the entry.

NOTE

The modulation used in the following step is not critical. The number chosen is a compromise between a very small amount of AM, which gives the most accurate indication of the system linearity, and a large amount of AM which gives best signal-to-noise for measurement accuracy.

8. Set the SG1219/U local oscillator to 10.03 GHz at +8 dBm.

9. On the Receiver select AM measurement mode, and depress the RATIO and % keys after the reading settles.

10. Remove the Adapter Pad from the Sensor and record the ratio indication.

Table 5-4. AMPLITUDE MODULATION, DISTORTION

DEPTH	RF FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
50%	30 MHz		________	0.3%
95%	30 MHz		________	0.6%
(50%)	10 GHz	96.00	________	104.00

PERFORMANCE TEST 4

FM MODULATION ACCURACY AND INCIDENTAL AM

Specification	: +- 2%, 20 Hz to 10 kHz, Frf < 10 MHz
	: +- 1%, 50 Hz to 100 kHz, Frf > 10 MHz
	: +- 5%, 20 Hz to 200 kHz, Frf > 10 MHz
	: incidental AM 0.2% AM peak at 50kHz peak deviation Frf > 10 MHz
	: incidental AM 0.2% AM peak at 5 kHz peak deviation Frf < 10 MHz

5-21. DESCRIPTION

5-22. The FM accuracy is verified first by using the internal calibrator which is exactly 83.33 kHz +- 0.1% at a 1.220 kHz rate. The FM flatness is then tested by applying the FM modulated output of the test generator to the input of the Receiver. The Audio Analyzer frequency is then varied from 30 Hz to 5 kHz, and a modulation RATIO change is noted. Higher audio frequencies are tested by using Bessel null measurements at specific audio frequencies. The audio frequency is then set to 1 kHz and the incidental AM is checked at 50 kHz and 5 kHz deviation.

NOTE

The following procedure is used in lieu of Bessel null measurements. The Bessel zero technique is quite tedious at frequencies below about 1 kHz, as Spectrum Analyzer adjustment is difficult, and eighth order nulls, or higher, must be used to produce enough deviation for reasonable accuracy. The test generator used for the following tests is used over less than one two-hundredth of its modulation bandwidth, and can safely be assumed to be flat.

5-23. PROCEDURE

1. Connect the equipment as shown in Figure 5-2.

2. Depress the LCL/INIT key to initialize the system.

3. Set the Generator to 500 MHz, 0 dBm and EXT DC FM.

4. Adjust the Audio Analyzer source to 0.7 volts at 1 kHz, and Program the Generator for 50 kHz deviation.

5. Select the Receiver FM modulation mode and depress the CAL key. The calibration program will display the FM indication in the MODULATION window during the calibration program. Record the indication.

6. Enter SPCL 15 to enable the slow detector mode. Select the < 10Hz high-pass and 220 kHz low-pass filters, then adjust the Audio Analyzer LEVEL for an FM indication of about 47.00 kHz at a 1 kHz rate and depress the Receiver RATIO and % keys to set a modulation reference.

NOTE

The following procedures assume that the Audio Analyzer Level flatness is better than 0.5%. This exceeds the MIS specification, however, the Model 1120 is typically 0.2%. This should be verified before continuing.

7. Set the Audio Analyzer to 20, 50, 200, 500, and 1000 Hz and record the ratio indication.

8. Temporarily disconnect the Audio Analyzer from the Test Generator and adjust the Spectrum Analyzer for a full scale

indication of the unmodulated carrier. Reconnect the Audio Analyzer signal.

9. On the Receiver depress the RATIO key to disable this function, then adjust the Audio Analyzer frequency to 4.1583 kHz. Set the Generator to 10 kHz deviation.

10. Observe the Spectrum Analyzer display and, using the Audio Analyzer LEVEL STEP function, adjust for a carrier null of greater than 50 dB. This corresponds to a deviation of exactly 10.00 kHz +- 0.3%.

11. When the deviation reading settles, enter SPCL 32 to hold the modulation range, and temporarily disconnect the Audio Analyzer from the Generator. Subtract the residual reading from the deviation indication and record the difference.

12. Enter SPCL 30 to resume autoranging, then repeat the above procedure at 41.583 kHz and 100 kHz. Use SPCL 33 to hold range above 50 kHz deviation.

13. Replace the Audio Analyzer in the test setup with the Test Oscillator and perform the null at 200 kHz. Discount the residual indication as above and record the ratio indication.

14. Select the 30 Hz high-pass and the 3 kHz low-pass filters, and adjust the Test Oscillator for a deviation of 50 kHz peak at a 1 kHz rate. Select the AM modulation mode on the Receiver and record the indication.

15. Set the Generator for 0.5 MHz carrier frequency and change the FM deviation to 5.0 kHz. Record the Receiver AM indication.

Table 5-5. FREQUENCY MODULATION ACCURACY

FILTER	SOURCE FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
<10-220 kHz	20 Hz	95.00	________	105.00
<10-50 kHz	20 Hz	98.00	________	102.00
<10-220 kHz	50 Hz	99.00	________	101.00
<10-50 kHz	11.34 kHz	98.00	________	102.00
<10-220 kHz	43.56 kHz	99.00	________	101.00
<10-220 kHz	100 kHz	95.00	________	105.00
<10-220 kHz	200 kHz	190.00	________	210.00
CALIBRATION		82.5	________	84.1
INCIDENTAL @ 30 MHz			________	0.2%
INCIDENTAL @ 0.5 MHz			________	0.2%

PERFORMANCE TEST 5

FREQUENCY MODULATION, DISTORTION

Specification	: 0.1% for deviations < 10 kHz, Frf < 10 MHz
	: 0.1% for deviations < 100 kHz, Frf > 10 MHz

5-24. DESCRIPTION

5-25. The Frequency Modulation distortion is verified by applying the output of the Generator to the input of the Receiver. A small amount of FM deviation is applied to the carrier signal, and the Receiver local oscillator frequency is varied. The measurement determines the change of slope of the Frequency Modulation detector. The distortion components are then calculated and compared to the specifications. This technique is extremely sensitive and much easier than finding an FM source of sufficiently low distortion to make the test.

5-26. PROCEDURE

1. Depress the LCL/INIT key to initialize the system.

2. Enter SPCL 39 to disable IF frequency error reporting.

3. Connect Sensor to the RF output of the Generator. Set the Generator for 15.211 MHz, 0 dBm, and 3 kHz FM deviation at a 1 kHz rate.

4. Select the Receiver 300 Hz high-pass, 3 kHz low-pass, and the √2RMS detector. Enter 15.0 MHz into the Carrier Frequency display.

5. Select the Receiver FM modulation mode, and when the reading settles, depress the RATIO and % keys.

6. Using the DATA keypad, enter the carrier frequencies listed in Table 5-6. Record the ratio indication.

CAUTION

Do not change the Generator carrier frequency or FM deviation during this procedure, as large errors will result.

7. The change in indication is small and represents changes in the slope of the FM detector. The second harmonic term is dominant and equal to 1/4 of the change in slope. For example, if the indication at 14.5 MHz was 99.80% and the indication at 15.5 MHz was 100.00%, the slope change would be 0.2% for a + or - 500 kHz deviation. This would indicate a distortion of 0.05%. The difference between indications at 14.9 and 15.1 MHz should be less than 0.4% corresponding to 0.1% distortion for deviations of +- 100 kHz and carriers greater than 10 MHz. The difference between any two indications should be less than 0.4% corresponding to 0.1% distortion for deviations of +- 50 kHz for carriers below 2 MHz. The difference between 14.3 and 14.4 MHz should be less than 0.4% corresponding to 0.1% distortion for deviations of +- 50 kHz for carriers between 2 and 10 MHz.

Table 5-6. FM MODULATION DISTORTION.

FREQUENCY	DETECTOR OFFSET	MINIMUM	ACTUAL	MAXIMUM
14.50 MHz	0.500 MHz	-0.40	________	+0.4
14.60 MHz	0.600 MHz	-0.40	________	+0.4
14.70 MHz	0.700 MHz	-0.40	________	+0.4
14.80 MHz	0.800 MHz	-0.40	________	+0.4
14.90 MHz	0.900 MHz	-0.40	________	+0.4
15.00 MHz	1.000 MHz		Reference	
15.10 MHz	1.100 MHz	-0.40	________	+0.4
15.20 MHz	1.200 MHz	-0.40	________	+0.4
15.30 MHz	1.300 MHz	-0.40	________	+0.4
15.40 MHz	1.400 MHz	-0.40	________	+0.4
15.50 MHz	1.500 MHz	-0.40	________	+0.4
15.60 MHz	1.600 MHz	-0.40	________	+0.4
15.70 MHz	1.700 MHz	-0.40	________	+0.4
15.80 MHz	1.800 MHz	-0.40	________	+0.4
15.90 MHz	1.900 MHz	-0.40	________	+0.4
16.00 MHz	2.000 MHz	-0.40	________	+0.4

PERFORMANCE TEST 6

FM RESIDUALS, 3 kHz FILTER

Specification	: < 8 Hz rms at 1300 MHz
	: < 4 Hz rms at 650 MHz (linear decrease)
	: < 1.7 Hz rms at 100 MHz
	: < 17 Hz rms from 1.3 to 6.2 GHz
	: < 33 Hz rms from 6.2 to 12.4 GHz
	: < 49 Hz rms from 12.4 to 18 GHz

5-27. DESCRIPTION

5-28. The FM residual modulation is determined by applying the output of a low-noise Synthesizer to the input of the Receiver and noting the modulation indication using the RMS detector. For frequencies above 2 GHz, where frequency translation is used in the normal operation of the Receiver, the residual noise of the SG1219/U Generator used for the local oscillator is measured. For 100 MHz baseline noise the low-noise 100 MHz output of the SG1219/U Generator is used.

5-29. PROCEDURE

1. Depress the LCL/INIT key to initialize the system.

2. Connect the Sensor, using a suitable adapter, to the low-noise 100 MHz output on the rear panel of the SG1219/U Generator.

3. On the Receiver, Select the 30 Hz high-pass and 3 kHz low-pass filters, and the RMS detector. Record the FM deviation.

4. Connect the Sensor to the Synthesizer output, and set the Synthesizer to 650 MHz at 0 dBm. Record the FM deviation.

5. Increase the Synthesizer frequency to 1.3 GHz, and record the FM deviation.

6. Connect the Sensor to the SG1219/U Generator output, set the frequency to 6.2 GHz and level to 0 dBm.

7. Set the SG1219/U local oscillator to 6.3 GHz at +8 dBm.

8. On the Receiver, Enter SPCL 1 to enter the frequency offset of 6.3 GHz. Depress the FM key and read the residual FM.

NOTE

The method assumes that the two SG1219/U generators contribute equal amounts of noise, therefore, since the noise signals are combined in the RMS indication, each generator's contribution is 1 over the square root of 2 times the total.

9. Repeat steps 8, 9, and 10 for 12.4 and 18 GHz. At 18 GHz set the local oscillator at 17.9 GHz. Record the indication.

Table 5-7. FREQUENCY MODULATION, RESIDUALS.

SPECIAL	TEST FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
	100 MHz		______	1.7 Hz
	650 MHz		______	4 Hz
	1.300 GHz		______	8 Hz
1	6.200 GHz		______	17 Hz
1	12.40 GHz		______	33 Hz
1	18.00 GHz		______	49 Hz

PERFORMANCE TEST 7

PHASE MODULATION, ACCURACY AND FLATNESS

Specification	: +- 4% of reading Frf < 10MHz, 200 Hz to 20 kHz
	: +- 3% of reading Frf > 10 MHz, 200 Hz to 20 kHz

5-30. DESCRIPTION

5-31. Phase modulation is measured in the Receiver by integrating the output of the FM detector, as this is the mathematical relationship of phase and frequency. The PM accuracy is first verified by calibrating the phase detection system with the internal calibrator which is 90.78 RADS +- 1.0%. The detector flatness is then measured by applying known amounts of FM deviation and comparing the equivalent PM. PM deviation is equal to the FM deviation divided by the modulation rate.

5-32. PROCEDURE

1. Complete the FM system performance tests, this will verify FM flatness and FM and PM distortion, then connect the equipment as in Fig. 5-2, but omit the Spectrum Analyzer.

2. On the Receiver, select PM, PEAK ± detector, 30 Hz high-pass, and 50 kHz low-pass filters. Depress the CAL key to calibrate the PM detection system.

3. Set the Generator to 100 MHz, 0 dBm, and FM EXT DC.

4. Depress the Receiver FM key, set the Audio Analyzer source frequency to 1 kHz and adjust the LEVEL for a deviation of 50.00 kHz.

5. Depress the Receiver PM key and record the deviation.

6. Depress the Receiver FM key, set the Audio Analyzer source frequency to 200.0 Hz and adjust the LEVEL for a deviation of 50.00 kHz.

7. Depress the Receiver PM key and record the deviation.

8. Depress the Receiver FM key, the 300 Hz high-pass filter, set the Audio Analyzer source frequency to 20.0 kHz and adjust the LEVEL for a deviation of 50.00 kHz.

9. Depress the Receiver PM key and record the deviation.

10. Set the Generator to 1 MHz and repeat steps 4 through 8.

Table 5-8. PHASE MODULATION, ACCURACY AND FLATNESS.

CARRIER FREQUENCY	SOURCE SETTING	MINIMUM	ACTUAL	MAXIMUM
100 MHz	1 kHz	48.50	________	51.50
100 MHz	200.0 Hz	242.7	________	257.5
100 MHz	20.0 kHz	2.43	________	2.58
1 MHz	1 kHz	48.00	________	52.00
1 MHz	200.0 Hz	240.3	________	260.0
1 MHz	20.0 kHz	2.40	________	2.60

PERFORMANCE TEST 8

CARRIER FREQUENCY ACCURACY AND SENSITIVITY

Specification

: reference +- 3 counts Frf < 100 MHz
: reference +- 3 counts or 30 Hz whichever is greatest, Frf > 100 MHz
: sensitivity 13 mV rms, Frf < 650 MHz
: sensitivity 28 mV rms, Frf < 1300 MHz
: sensitivity 0.22 mV rms, manual mode

5-33. DESCRIPTION

5-34. Carrier frequency accuracy is measured by locking an SG1207/U generator to a timebase with 1 X 10-10 stability and known accuracy, then applying the output of the generator to the input of the Receiver. Frequency readings are taken at various frequencies and the indications recorded. The test also verifies the measurement sensitivity.

5-35. PROCEDURE

1. Connect the EXT REF input of the SG1207/U Generator to the output of the Time Standard timebase. (1 X 10-10 accuracy)
2. Connect the Sensor to the output SG1207/U Generator and set the frequency to 500 kHz and level to 13 mV.
3. On the Receiver enter SPCL 3 to activate sensitive frequency measurements, then depress the FREQ and AUTO keys.
4. Record the settled frequency reading, then without changing the generator frequency, depress the MHz and TUNED LEVEL keys. Reduce the Generator level to -60 dBm and record the settled frequency indication.
5. Increase the Generator level to 13 millivolts and set the frequency to 50 MHz. Depress the Receiver FREQ and AUTO keys and record the settled frequency indication.
6. Repeat step 4 at 50 MHz.
7. Repeat the above procedure at 650 and 1300 MHz, however, use a Generator level of 28 millivolts at 1300 MHz.

Table 5-9. CARRIER FREQUENCY ACCURACY AND SENSITIVITY

TEST LEVEL	FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
13mV	100.000000 MHz	99.99997	________	100.00003
13mV	650.000000 MHz	649.9997	________	650.0003
28mV	1300.00000 MHz	1299.9997	________	1300.0003
0.22mV	1300.00000 MHz	1299.9997	________	1300.0003

PERFORMANCE TEST 9

POWER REFERENCE

Specification	: 50 MHz, + - 0.5 MHz : 0.7% initial accuracy : + - 1.2% over 1 year

5-36. DESCRIPTION

5-37. The Milliwatt Test Set is first zeroed, and then connected to the Receiver 50 MHz power calibrator. The deviation from 0.00 dBm is noted. The Sensor is then connected to the 50 MHz power calibrator and the frequency is measured.

5-38. PROCEDURE

1. Connect the EPM-1 probe to the Milliwatt Test Set reference output with the range set to 0 dBm and resistance set to 50 ohms. Adjust the calibration control for a zero indication.

2. Connect the EPM-1 probe to the PWR REF output on the front panel of the 4220-S/10.

3. Record the deviation from 0.00 dBm in Table 5-10.

4. Connect the Sensor to the PWR REF output on the 4220-S/10 and select FREQ and AUTO to measure the calibrator frequency. Record the calibrator frequency in Table 5-10.

Table 5-10. POWER REFERENCE.

TEST	MINIMUM	ACTUAL	MAXIMUM
Accuracy	-0.05 dB	________	+0.05dB
Frequency	49.5 MHz	________	50.5 MHz

PERFORMANCE TEST 10

CARRIER POWER, UNTUNED

Specification
: Frequency Range 100 kHz to 18 GHz
: Power Range -20 to +30 dBm
: Linearity +2 -4% from +20 to +30 dBm
: Linearity +-1 % from -20 to +20 dBm
: Cal Factor uncertainty < 2.3%, Frf < 2 GHz
: Cal Factor uncertainty < 6.9%, Frf > 2 GHz

5-39. DESCRIPTION

5-40. The untuned power measurement is verified by applying the PWR REF output on the 4220-S/10 to the Sensor and calibrating the Receiver. Combinations of Certified Pads and an Amplifier are inserted into the measurement setup and the resulting displays noted. Frequency response is then checked by comparing the Receiver indication to that of an NBS traceable power sensor.

5-41. PROCEDURE

1. Connect the Receiver Sensor with Adapter Pad to the PWR REF output connector on the 4220-S/10.

2. Depress the LCL/INIT key to initialize the instrument.

3. Depress the POWER and the SENSOR ZERO keys..

4. After the zero operation completes, depress the CAL key.

5. Connect the Sensor to the RF Calibrator and set the RF Calibrator to 0 dBm and ON.

6. Insert the 10 dB Certified Pad in series with the measurement and note the indication. It should be the value of the pad +- 0.05 dB plus any residual indication from step 5.

7. Replace the 10 dB pad with the 20 dB Certified Pad and note the indication. It should be the value of the pad +- 0.05 dB plus any residual indication from step 5.

8. Disconnect the Sensor from the RF Calibrator and connect the probe of the Milliwatt Test Set through the 20 dB Certified Pad to the output of the RF Calibrator.

9. Set the RF Calibrator to +20 dBm and note the indication of the Milliwatt Test Set. The RF Calibrator output is equal to the value of the pad plus the indication of the Milliwatt Test Set.

10. Remove the pad and connect Sensor to the RF Calibrator output. The indication should be the value in step 9 +- 0.05 dB.

11. Disconnect the Sensor from the RF Calibrator and connect the RF Calibrator output to the input of the Amplifier. Connect the output of the Amplifier through the 30 dB Certified Pad to the Sensor input.

12. Adjust the RF Calibrator output level for a Receiver indication of about 0 dBm.

13. Remove the Sensor, connect the probe of the Milliwatt Test Set and note the indication. The level at the output of the Amplifier is the value of the pad plus the indication on the Milliwatt Test Set.

14. Remove the probe of the Milliwatt Test Set, connect the Sensor, and note the indication. It should be the value in step 13 +0.08 - 0.16 dB.

15. Connect the Certified Power Sensor to the output of the SG1207/U Generator. and set the generator to 1.0 GHz and 0 dBm.

16. Set the Reference Power Meter to the Watts mode and adjust the CAL FACTOR control to 100%. Calculate the corrected power indication as:

$$Pc = 10 \text{ LOG } [\text{ indication(mW) X } 100 / \text{CAL FACTOR } (\%)]$$

NOTE

Receiver Frequency Calibration Factors must have been installed before completing the following steps.

17. Without changing any settings, disconnect the Certified Power Sensor and connect the Receiver Sensor to the SG1207/U.

18. On the Receiver enter 1.0 GHz to set measurement frequency and select the POWER measurement. The maximum uncertainty is 0.2 dB (0.05 dB plus 0.15 db/2.3%).

19. Connect the Certified Power Sensor to the output of the SG1219/U Generator. Set the generator to 18 GHz and 0 dBm. Loosen and tighten the Connection several times until the maximum indication is achieved.

20. Step the Generator from 2 to 18 GHz in 1 GHz steps and record the indications.

21. Connect the Receiver Sensor to the output of the SG1219/U Generator. Set the generator to 18 GHz and 0 dBm. Loosen and tighten the Connection several times until the maximum indication is achieved.

22. Step the Generator from 2 to 18 GHz in 1 GHz steps, enter the test frequency into the Receiver FREQUENCY/LEVEL display, select POWER measurement and record the indications.

23. Calculate the error in indicated power as described above and record.

Table 5-11. UNTUNED POWER, ACCURACY/RESPONSE

FREQUENCY	POWER LEVEL	MINIMUM	ACTUAL	MAXIMUM
1 GHz	0 dBm	-0.2	________	+0.2
2 GHz	0 dBm	-0.34	________	+0.34
3 GHz	0 dBm	-0.34	________	+0.34
4 GHz	0 dBm	-0.34	________	+0.34
5 GHz	0 dBm	-0.34	________	+0.34
6 GHz	0 dBm	-0.34	________	+0.34
7 GHz	0 dBm	-0.34	________	+0.34
8 GHz	0 dBm	-0.34	________	+0.34
9 GHz	0 dBm	-0.34	________	+0.34
10 GHz	0 dBm	-0.34	________	+0.34
11 GHz	0 dBm	-0.34	________	+0.34
12 GHz	0 dBm	-0.34	________	+0.34
13 GHz	0 dBm	-0.34	________	+0.34
14 GHz	0 dBm	-0.34	________	+0.34
15 GHz	0 dBm	-0.34	________	+0.34
16 GHz	0 dBm	-0.34	________	+0.34
17 GHz	0 dBm	-0.34	________	+0.34
18 GHz	0 dBm	-0.34	________	+0.34
30 MHz	-10 dBm	-0.05	________	+0.05
30 MHz	-20 dBm	-0.05	________	+0.05
30 MHz	+20 dBm	-0.05	________	+0.05
30 MHz	+30 dBm	-0.08	________	+0.16

PERFORMANCE TEST 11

VSWR

Specification	
	: 1.18 from 0 to -80 dBm, Frf < 1 GHz
	: 1.40 from -80 to -127 dBm, Frf < 1 GHz
	: 1.33 from 0 to -80 dBm, Frf < 2 GHz
	: 1.50 from -80 to -110 dBm, Frf < 2 GHz
	: 1.28 for all levels, Frf between 2 and 18 GHz

5-42. DESCRIPTION

5-43. The Receiver VSWR is verified by measuring return loss of the Sensor in all specified frequency and amplitude ranges. Measurements are made using a Scalar Network Analyzer from 10 MHz to 18 GHz. For optional testing below 10 MHz, the Sensor input impedance is measured at several points and the VSWR is calculated.

5-44. PROCEDURE

1. Set up the Network Analyzer for a 10 MHz to 18 GHz sweep at a 0 dBm level, and calibrate the SWR autotester using the reference open and short to establish a return loss baseline.

2. Connect the Receiver Sensor, with Adapter Pad, to the test port of the SWR autotester and depress the POWER key to select average power. Record the minimum return loss from 0.01 to 18 GHz.

3. On the Receiver select SPCL 21 to select the converter RF2 band. Record the minimum return loss from 2 to 18 GHz.

4. Recalibrate the Analyzer at -10 dBm with a 10 MHz to 2.2 GHz sweep. On the Receiver select TUNED LEVEL, SPCL 20 to select the converter RF1 band, and SPCL 23 to select RF attenuation range 1. Record the minimum return loss from 0.01 to 1 GHz and from 1 to 2 GHz.

5. On the Receiver select SPCL 24 to select RF attenuation range 2. Record the minimum return loss from 0.01 to 1 GHz and from 1 to 2 GHz.

6. Remove the Adapter Pad from the Sensor and connect the Sensor to the SWR autotester. Enter SPCL 20 to select the RF1 band and SPCL 25 to select RF attenuation range 3. Record the minimum return loss from 0.01 to 1 GHz and from 1 to 2 GHz.

NOTE

The following procedure is optional as the Sensor impedance below 10 MHz is essentially the same as the DC resistance of the pads used in the Sensor.

7. Connect the Receiver Sensor, with the Adapter Pad to the measurement port of the Impedance Analyzer. Set the frequency to 2.5 MHz and the measurement level to 100 millivolts.

8. On the Receiver enter SPCL 20 to select the converter RF1 band, and SPCL 23 to select RF attenuation range 1.

9. Vary the Analyzer frequency from 2.5 to 10 MHz and record maximum impedance magnitude variation.

10. On the Receiver enter SPCL 24 to select of RF attenuation range 2 and repeat step 9. Record the impedance variation.

11. Decrease the analyzer test level to 10 millivolts, then remove the Adapter Pad from the Sensor and enter SPCL 25 on the Receiver to select RF attenuation range 3. Repeat step 9.

12. Connect the Receiver Sensor, with the Adapter Pad to the measurement port of the Impedance Analyzer. Set the frequency to 100 kHz and the measurement level to 100 millivolts.

13. On the Receiver depress the POWER key. Vary the Impedance Analyzer frequency from 100 kHz to 10 MHz and record maximum impedance magnitude variation.

Table 5-12. VSWR.

MEASUREMENT or SPCL Functions	FREQUENCY BAND	MINIMUM	ACTUAL	MAXIMUM
POWER	0.01-2 GHz	26.4 dB	________	
POWER	2-18 GHz	19.1 dB	________	
20, 23	0.01-1 GHz	21.6 dB	________	
20, 23	1-2 GHz	16.9 dB	________	
20, 24	0.01-1 GHz	21.6 dB	________	
20, 24	1-2 GHz	16.9 dB	________	
21	2-18 GHz	18.2 dB	________	
20, 25	0.01-1 GHz	15.6 dB	________	
20, 25	1-2 GHz	13.9 dB	________	
20, 23	0.1-10 MHz	42.4	________	59.0
20, 24	0.1-10MHz	42.4	________	59.0
20, 25	0.1-10 MHz	35.7	________	70.0

PERFORMANCE TEST 12

CARRIER POWER, TUNED

Specification	: Frequency Range 2.5 MHz to 18 GHz
	: Power Range 0 to -110 dBm, Frf < 1 GHz
	: Power Range 0 to -100 dBm, Frf < 18 GHz
	: Power Range 0 to -127 dBm, Frf = 30 MHz
	: Power Range 0 to -105 dBm, Frf = 2 GHz
	: Accuracy, 0.635 dBm rss -110 dBm
	: Accuracy, 1.0 dBm rss -110 to -127 dBm
	: Accuracy, 0.02 dB, incremental

5-45. DESCRIPTION

5-46. Tuned RF level measurements are relative, therefore, performance verification is easily made using accurate level changes. Ratiometric accuracy is assured if the detectors used are linear and the IF substitution attenuator is accurate. Pads certified at 30 MHz by NBS are used as accurate ratio standards to determine detector linearity and IF attenuator step accuracy. Detector linearity is measured first by applying a near full-scale signal to the Receiver and then inserting the 10 dB Certified Pad into the setup and noting the resulting reading. The IF attenuator step accuracy is measured next by applying a variable signal to the Receiver and then successively adding and removing the 10 dB Certified Pad to the setup, switching the IF attenuator, and noting the reading. The expected reading is compared to the actual reading and recorded. For performance testing at frequencies above 2 GHz the mixer linearity and RF integrity of the Receiver frequency converter is determined at 2, 5, 10, 15, and 18 GHz.

5-47. PROCEDURE

1. Connect the Receiver Sensor, with Adapter Pad, to the output of the RF Calibrator. Set the RF Calibrator to 0 dBm and ON.

2. On the Receiver depress the LCL/INIT key to initialize the instrument.

3. Enter SPCL 5 to select the average IF detector, select TUNED LEVEL, then depress the CAL key to calibrate the measurement.

4. After calibration completes, increase the RF Calibrator level to +6 dBm, enter SPCL 8 to select 0.001 dB resolution and SPCL 44 to hold the IF range setting.

5. When the reading settles depress the RATIO and DB keys.

6. Insert the 10 dB Certified Pad into the setup and note the ratio indication. Subtract the indication from the value of the Certified Pad and record the difference in Table 5-13.

7. Remove the Certified Pad, enter SPCL 6 to select the synchronous detector, and reset the RF Calibrator to 0 dBm. Select TUNED LEVEL, then depress the RATIO and CAL keys to calibrate the measurement.

8. After calibration completes, increase the RF Calibrator level to +16 dBm and enter SPCL 41 to hold the IF attenuator settings.

9. When the reading settles depress the RATIO and dB keys.

10. Insert the 10 dB Certified Pad into the setup and note the indication. Subtract the indication from the value of the Certified Pad and record the difference in Table 5-13.

11. Enter SPCL 42 to step the IF attenuator and note the indication.

12. Subtract the indication from the value of the Certified Pad and record the difference in Table 5-13.

13. Remove the 10 dB pad and reduce the RF Calibrator level by 10 dB. Select TUNED LEVEL, wait for a settled reading, and depress the RATIO key twice to establish a reference.

14. Insert the 10 dB Certified Pad into the setup, enter SPCL 43 to step the IF attenuator, and note the indication. Subtract the indication from the value of the Certified Pad and record the difference in Table 5-13.

15. Repeat steps 13 and 14 for SPCL 44 through 47.

16. Connect the Receiver Sensor to the SG1207/U Generator and set the level to +6 dBm and 30.0 MHz.

17. On the Receiver depress the FREQ and AUTO keys to acquire the signal, then depress the MHz key to hold the frequency.

18. Select TUNED LEVEL. When the reading settles, depress the RATIO and dB keys to set a level reference.

19. Vary the frequency of the SG1207/U Generator in 1 kHz increments over a +- 5 kHz range and note the change in level. Record the total amplitude deviation in Table 5-13.

20. On the Receiver enter SPCL 5 to select the average detector, then repeat steps 18 and 19. Ignore the UCAL and RCAL annunciators.

21. Connect the Receiver Sensor to the RF Power Calibrator, select SPCL 1 and enter 2.03 GHz as the frequency offset, enter SPCL 6 to select the synchronous detector.

22. Set the SG1219/U local oscillator to 2.03 GHz, +8 dBm level and remove all modulation.

23. Set the RF Power Standard to 0 dBm at 2 GHz at the wideband variable output, with a second SG1219/U as the RF source.

24. Select TUNED LEVEL. When the reading settles, depress the RATIO key twice to set a level reference.

25. Activate the precision 6 dB level step of the RF Power Calibrator and record the ratio indication. The ratio should be exactly 6.00 dB +- 0.2 dB

26. Step the RF Power Calibrator level to -50 dBm, reset the precision 6 dB step and depress the RATIO key twice to restore the level reference.

27. Activate the precision 6 dB level step of the RF Power Calibrator and record the ratio indication. The ratio should be 6.00 dB +-0.2 dB.

28. Repeat the above procedure for the levels and frequencies indicated in Table 5-14.

NOTE

The system measurement accuracy is the summation of the above measured detector linearity error, plus the IF range-to-range error, plus the RF range-to-range error, plus the frequency drift error, plus the noise error, plus the frequency converter mixer linearity error, and of course, one digit of display. Assuming that the detector linearity, IF attenuator, and mixer linearity terms meet the included specifications, the Receiver system will meet the 0.625 dB and 1 dB specifications.

29. Connect the Sensor, with Adapter Pad to the 50 MHz RF Calibrator on the 4220.

30. On the Receiver enter SPCL 2 to cancel the frequency offset mode and depress the POWER key. Zero and calibrate the measurement.

31. Connect the Sensor, with Adapter Pad, to the output of the Piston attenuator with a suitable adapter. Connect the input of the Piston attenuator to the output of the RF Calibrator using semi-rigid cable or triple shielded coaxial cable.

NOTE

When adjusting the piston attenuator, always approach the final setting in the same direction. For example, to set 0 dB attenuation, first set the attenuator to less than 0 dB, and then increase attenuation slowly until the counter reads exactly 0.00 dB.

32. On the Receiver depress the FREQ key, then set the RF Calibrator to +20 dBm and ON. Observing the above caution, set the piston attenuator to exactly 0 dB.

33. When the frequency reading settles, depress the MHz, and TUNED LEVEL keys, then depress the CAL key to calibrate the first RF range.

34. Remove the Adapter Pad and connect the Sensor to the output of the piston attenuator. When the TUNED LEVEL reading settles, depress the CAL key to calibrate the Adapter Pad. The absolute power indication should be 0 dBm +- 2.5 dB.

35. Reinstall the Adapter Pad and insert the 30 dB Certified Pad between the RF Calibrator and the Sensor. When the reading settles, depress the CAL key to calibrate the second RF range.

36. Insert the 10 dB Certified Pad between the RF Calibrator and the Sensor and adjust the piston attenuator to exactly 30 dB.

37. When the TUNED LEVEL reading settles, depress the CAL key to calibrate the third RF range.

38. Adjust the piston attenuator to exactly 70 dB and record the indication. The Receiver ratiometric measurement uncertainty at this point is:

(1) the uncertainty for each IF range traversed, 0.02 dB/range X 11 ranges, 0.22 dB.

(4) the uncertainty for each RF range calibration, 0.04 dB/range X 2 ranges, 0.08 dB.

(5) the uncertainty for detector linearity, 0.02 dB

Total: 0.32 dB worst case.

The absolute power measurement uncertainty is the above ratiometric error plus:

(1) the uncertainty of the two Certified Pads, 0.02 dB.

(2) the uncertainty of the piston attenuator at 70 dB, 0.05 dB.

(3) the uncertainty of the power to tuned level transfer, 0.005 dB.

(4) RF Calibrator uncertainty, 0.055 dB.

Total: 0.45 dB worst case.

39. Remove the Adapter Pad and adjust the piston attenuator to exactly 87 dB and record the indication. The measurement uncertainty at this point, -127 dBm, is the above uncertainty plus 0.02 dB for an additional IF range, plus 0.18 dB for added

noise, plus 0.04 dB for Adapter Pad calibration uncertainty. The total ratiometric uncertainty is then 0.56 dB and the absolute power uncertainty is 0.69 dB, worst case.

Table 5-13. TUNED POWER, LINEARITY/ACCURACY

SPCL FUNCTION	TEST LEVEL	MINIMUM	ACTUAL	MAXIMUM
44	+6 dBm	-0.04 dB	________	+0.04 dB
41	+16 dBm	-0.02 dB	________	+0.02 dB
42	+16 dBm	-0.02 dB	________	+0.02 dB
43	+6 dBm	-0.02 dB	________	+0.02 dB
44	-4 dBm	-0.02 dB	________	+0.02 dB
45	-14 dBm	-0.02 dB	________	+0.02 dB
46	-24 dBm	-0.05 dB	________	+0.05 dB
47	-34 dBm	-0.05 dB	________	+0.05 dB
IF FILTER RESPONSE				
SYNCHRONOUS DETECTOR		-0.25 dB	________	+0.25 dB
AVERAGE DETECTOR		-0.25 dB	________	+0.25 dB

Table 5-14. HIGH FREQUENCY, LINEARITY.

FREQUENCY	TEST LEVEL	MINIMUM	ACTUAL	MAXIMUM
2 GHz	0 dBm	-0.2 dB	________	+0.2 dB
2 GHz	-50 dBm	-0.1 dB	________	+0.1 dB
2 GHz	-100 dBm	-0.2 dB	________	+0.2 dB
5 GHz	0 dBm	-0.2 dB	________	+0.2 dB
5 GHz	-50 dBm	-0.1 dB	________	+0.1 dB
5 GHz	-94 dBm	-0.2 dB	________	+0.2 dB
10 GHz	0 dBm	-0.2 dB	________	+0.2 dB
10 GHz	-50 dBm	-0.1 dB	________	+0.1 dB
15 GHz	0 dBm	-0.2 dB	________	+0.2 dB
15 GHz	-50 dBm	-0.1 dB	________	+0.1 dB
15 GHz	-94 dBm	-0.2 dB	________	+0.2 dB
18 GHz	0 dBm	-0.2 dB	________	+0.2 dB
18 GHz	-50 dBm	-0.1 dB	________	+0.1 dB
18 GHz	-94 dBm	-0.2 dB	________	+0.2 dB

PERFORMANCE TEST 13

CALIBRATORS

Specification	: FM, 0.1% accuracy
	: AM, 0.1% accuracy

5-48. DESCRIPTION

5-49. Theory of operation of the calibrators is described, and the mathematical procedures used to determine the accuracy of the calibrators is disclosed. Since the calibrators are so precise, measurement verification of the stated accuracy is not practical. The following discussion presents the design constraints and the implied accuracy.

5-50. DISCUSSION

5-51. The internal calibrators of the Model 8200-S/10 provide modulation standards for AM and FM measurements; they are activated by the operator as required by the measurement.

NOTE

Based on the requirement of the MIS for an FM calibrator deviation of less than 100 kHz, the Model 8200 calibrator was modified to operate at 83.33 kHz rather than 125.0 kHz. The original design produces an intrinsically more accurate calibration due to dynamic range and quantizing effects in the measuring system. The modified calibrator deviation is just as accurate, however, this accuracy cannot be reliably transferred to the modulation measurement.

5-52. FM CALIBRATION

5-53. The calibration process consists of (1st) applying to the FM discriminator, in alternation, two accurately controlled frequencies; (2nd) measuring the resulting recovered modulation information; and (3rd) computing a correction factor for subsequent FM measurements. As an aid in following this discussion refer to Figure 8-25.

5-54. The input signal to pin 2 of U23 is the internal timebase frequency divided by two: 5.000 MHz +- 0.01%. The preset inputs, P1 through P4 are alternately programmed to divide by 5 or 6, depending on the sense of the signal on pins 3 and 4 of U23. This latter signal is generated by dividing the 5.00 MHz signal by 4096. The resulting signal is phase coherent with the other generated signals and at a frequency of 1.2207 kHz.

5-55. When the preset inputs of U23 are programmed to divide by 5, the resulting signal frequency is 1.000 MHz. Similarly, when the preset inputs are programmed to divide by 6, the resulting frequency is 833.3 kHz. The average frequency, therefore, is 916.67 kHz; the peak-to-peak deviation is 166.66 kHz, and the peak deviation is 83.33 kHz.

5-56. From the above discussion it is clear that the frequency deviation is precisely defined by the clock frequency. Additionally, since the modulation signal is phase coherent with the carrier frequency, switching from one carrier tone to the other is consistent.

5-57. In transferring the calibrator deviation to subsequent modulation measurement the primary limitation is the voltmeter resolution, in this case 1 part in 833 or 0.12%. FM noise is of little or no consequence, since the two frequencies are crystal controlled. The calibration program accumulates ten readings, and averages then to eliminate last-digit uncertainty.

5-58. Cross-correlation measurements using a Bessel null techniques indicate that the actual calibration uncertainty for 100 calibrations is close to 0.065% or one-half digit.

5-59. AM CALIBRATION

5-60. The operation of the AM calibrator is similar to that of the FM calibrator.

5-61. During AM calibration the a fixed divide by two output of U22 is used to generate the carrier frequency of 1.25 MHz. The TTL signal from U24 pin-7 is passed through a low-pass filter consisting of L5, L6 C17, C18, and C20. This filter removes harmonics of the TTL signal to produce a sine wave at the input of AR3.

5-62. Amplifier AR3 increases the signal level, but more importantly provides a very low output impedance to drive precision divider R20. The increased level also reduces the effects of charge injection in switch, U21.

5-63. The voltage divider comprising R20a through R20d is a precision resistor array. The absolute value of the resistors, however, is not as important as is the match between them. Thus, resistors R20a through R20d are guaranteed to a 0.05% match. Selecting the 3/4 and 1/4 voltage taps for the output insures that the source impedance for subsequent circuits is constant.

5-64. Analog switch U21 alternately switches between the 3/4 and 1/4 voltage taps at the 1.2207 kHz rate, thus producing an amplitude modulated signal with a depth of exactly 50%.

5-65. The effects of the inevitable variation in analog switch on resistance (U21) is obviated by inserting a 20 kohm resistor in series with the switch, thus reducing switch matching errors to less than 0.1%.

5-66. A possible source of error in transferring the calibrator AM accuracy to the measurement is the symmetry of the modulation waveform. The problem is addressed as follows: (In the following analysis, p+ indicates +peak and p- is -peak.)

$$\%p+ = (Emax - Eavg)/Eavg \times 100 \quad (1)$$
$$\%p- = (Eavg - Emin)/Eavg \times 100 \quad (2)$$
$$\text{peak average} = (p+ - p-)/2 \times 100 \quad (3)$$

Therefore, combining Eqs. 1, 2, and 3, for symmetrical modulation,

$$\%AM = (Emax - Emin)/(Emax + Emin) \times 100 \quad (4)$$

and for the above system:

$$\%AM = (3/4 - 1/4)/(3/4 + 1/4) \times 100$$
$$= 50.00$$

5-67. The above calculations assume that the modulation is symmetrical (i.e. perfectly so). Should that not be the case, a dc shift occurs and the plus and minus peaks are not equal. The calibrator program eliminates such an error by calculating AM as:

$$\%AM = (p+ + 3p-)/4 \quad (5)$$

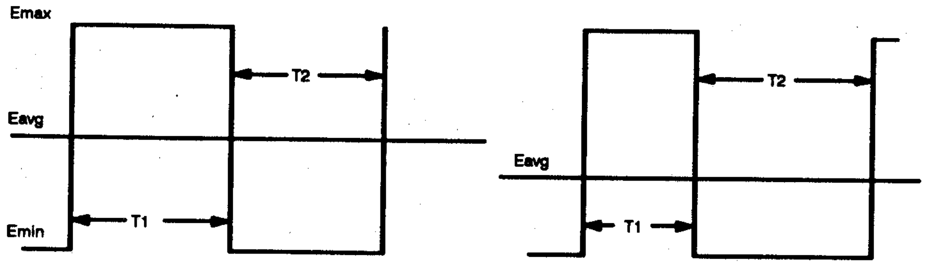
This expression is determined as follows:

Now, since the peak detectors are ac coupled (see figure for symbols),

$$(p+)(T1) - (p-)(t2) = 0 \quad (\text{0 volts dc} \quad) \quad (6)$$

And:

$$T1 + T2 = 1 \quad (7)$$
$$(p+)(T1) - (p-)(1-T1) = 0 \quad (8)$$



Now:

$$T1 = p-/(p+ + p-) \quad (9)$$

And in the 8200:

$$Eavg = Emin + (Emax - Emin)\, T1/(T1 + T2) \quad (10)$$

$$Emax = 3\, Emin \quad (11)$$

Combining Eqs. 7, 10, and 11:

$$Eavg = Emin + 2Emin\,(T1) \quad (12)$$
$$Eavg = Emin\,(1 + 2T1) \quad (13)$$

If symmetry is perfect:

$$T1 = 0.5 \text{ and } Eavg = 2Emin \quad (14)$$

If symmetry is less than perfect, the dc ratio error R (that is, Eq. 13 vs Eq. 14) will be:

$$R = (1 + 2T1)/2 \quad (15)$$

Combining Eqs. 9 and 15:

$$R = (p+ + 3p-)/(2\,(p+ + p-) \quad (16)$$

The uncorrected AM is

$$(p+ + p-)/2 \quad (17)$$

and corrected is

$$= (p+ + p-)/2 \times R \quad (18)$$
$$= (p+ + 3p-)/4 \quad (19)$$

5-68. Again, it should be noted that only ratios are involved in the above analysis. The absolute value of the voltages are not important to the method. As in the case of FM, the calibration program accumulates ten readings, and averages then to eliminate last digit uncertainty. The internal voltmeter can resolve the reading to 1 part in 5000 for a quantizing uncertainty of 0.02%. AM noise is of little consequence in determining calibrator depth since the original signal level is determined by TTL gates and the frequency of the carrier and modulation signals are crystal controlled.

5-69. Cross-correlation measurements using a specially calibrated Model 8200 indicate that the actual calibration uncertainty for 100 calibrations is approximately 0.15%.

SECTION VI
MAINTENANCE

6-1. INTRODUCTION.

6-2. This section contains maintenance and adjustment instructions for the Model 8200-S/10. Maintenance information for the Model 4220-S/10 and 9000S is covered in separate hardware manuals.

6-3. SAFETY REQUIREMENTS.

6-4. Although this equipment has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary located at the front of this manual or with specific warnings given throughout this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

6-5. REQUIRED TEST EQUIPMENT.

6-6. Test equipment required for maintenance and adjustments is listed with each procedure. For critical specifications see Table 5-1. Equipment of equivalent characteristics may be substituted for an item listed. An extender board is included in the Model 8200-S/10 to facilitate repair and adjustment of the plug-in circuit boards.

6-7. CLEANING PROCEDURE.

6-8. Painted surfaces can be cleaned with a commercial, spray-type window cleaner or with a mild soap and water solution.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in the instrument. Recommended cleaning agents are isopropyl alcohol, a solution of 1 part kelite and 20 parts water, or a solution of 1% mild detergent and 99% water.

6-9. MAJOR ASSEMBLY LOCATION.

6-10. See Figures 6-1 and 6-2 for the location of the major assemblies of the Model 8200-S/10. Coaxial connectors are identified by color coded heat shrink attached to the connectors.

6-11. REMOVAL OF MAJOR ASSEMBLIES AND PARTS.

6-12. Instrument Covers. To remove the instrument covers proceed as follows:

1. Disconnect all signal cables and the power cord from the Model 8200-S/10.

2. Remove the top cover by removing three No. 6 screws at the rear of the cover and lifting the cover up and to the rear.

3. Turn the instrument over and remove the bottom cover in a similar manner.

6-13. RF assembly covers. To remove the RF assembly covers, proceed as follows:

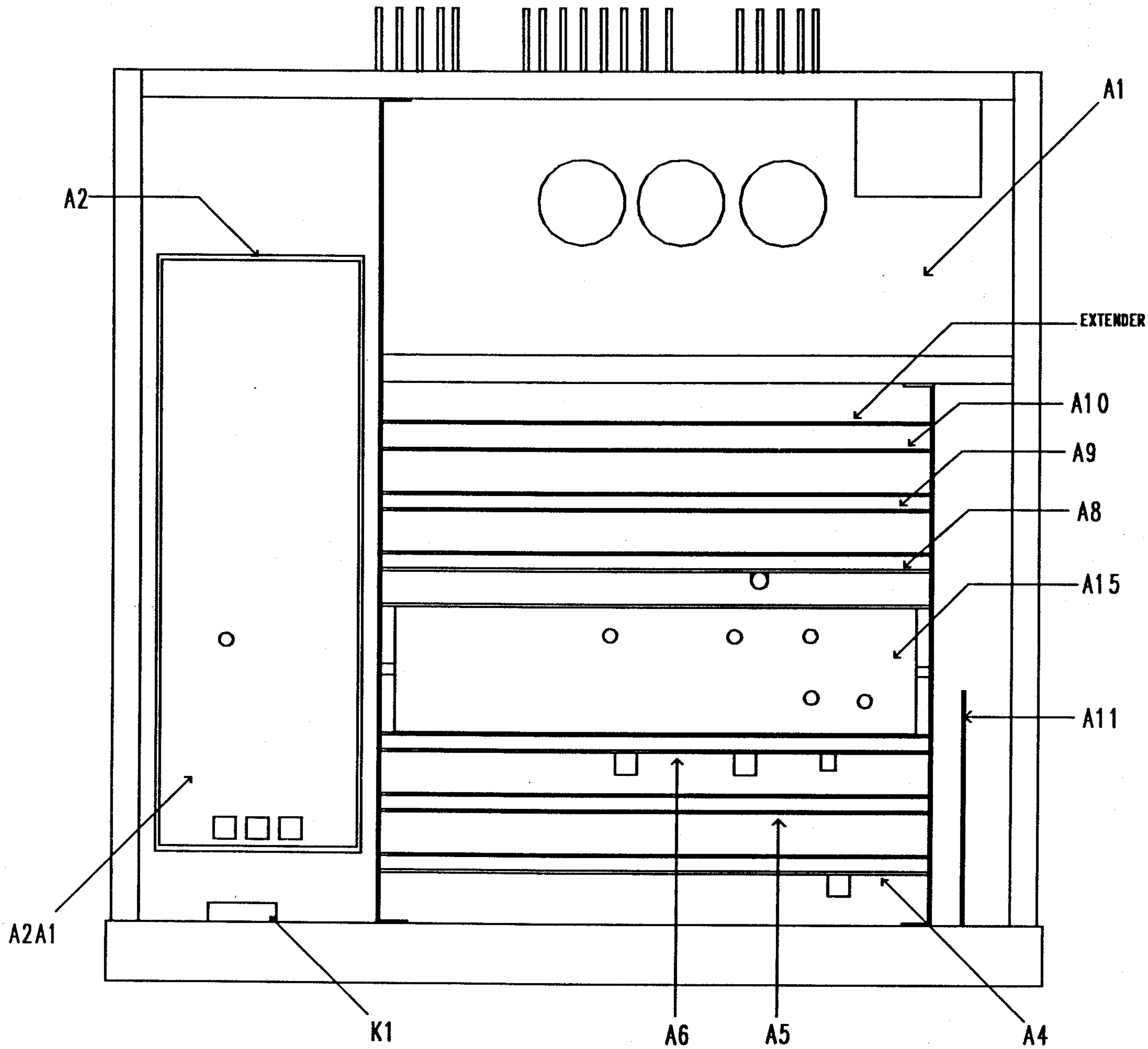


FIGURE 6-1. MAJOR ASSEMBLY LOCATION, TOP VIEW.

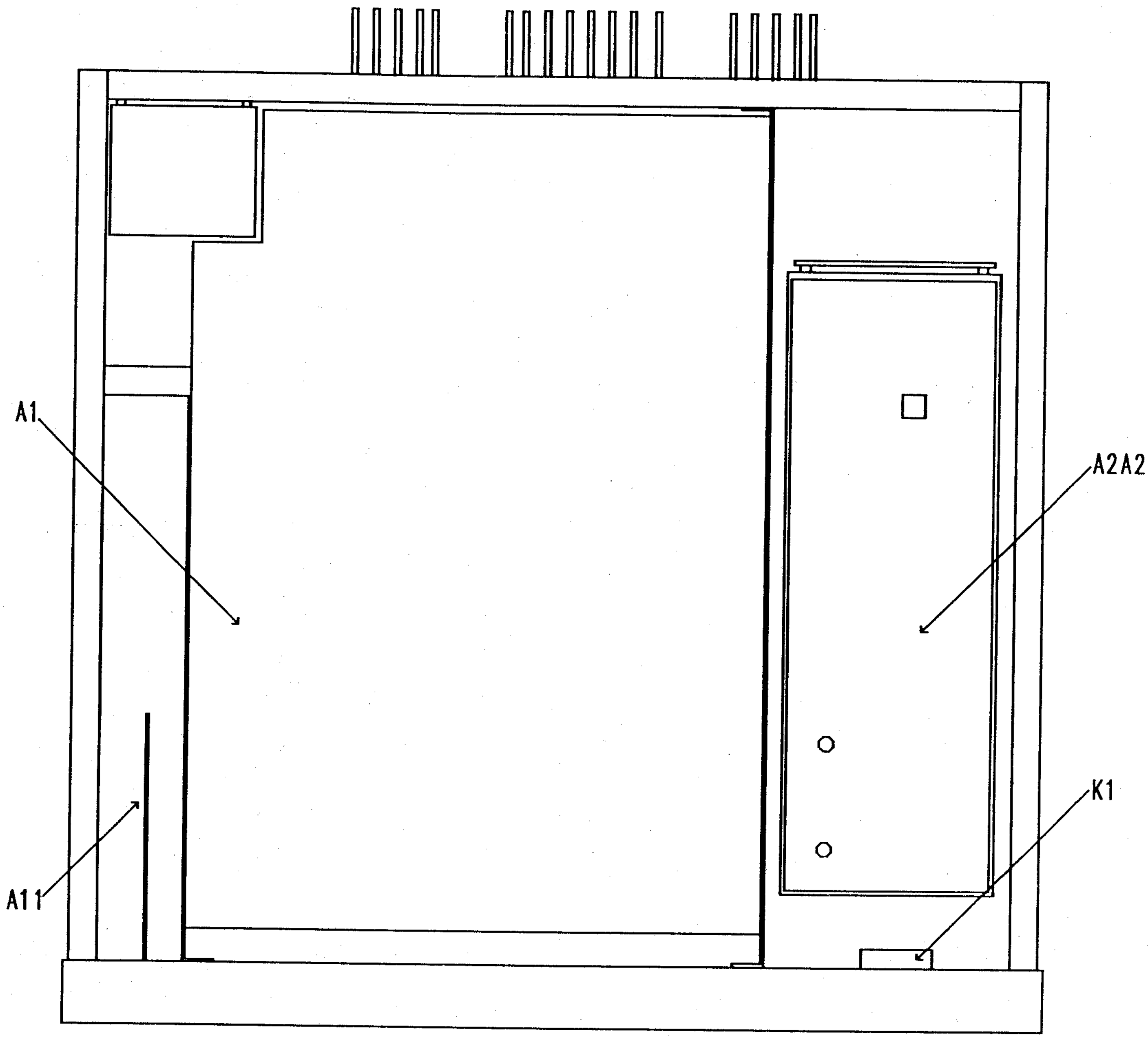


FIGURE 6-2. MAJOR ASSEMBLY LOCATION, BOTTOM VIEW.

1. Remove the instrument covers as described above.

2. Remove the No. 4 shipping screw in the RF assembly cover if it has not been removed previously.

3. Grasp the cover near the front and rear of the instrument.

4. Pull up on the cover at the rear of the instrument first, and then at the front. The cover should pull away easily.

5. Turn the instrument over and repeat the above procedure for the bottom cover.

6-14. RF Printed Circuit Board. To remove the RF printed circuit board, proceed as follows:

1. Remove the instrument and RF assembly covers as described above.

2. Remove the connectors from J3, J4, and J5 at the rear of the circuit board.

3. Remove the connector from J2 near the center of the board.

4. Remove 7 No. 4 screws and the hex spacer holding the circuit board to the RF casting.

CAUTION

Be careful in the following steps not to break the center pin of the RF in connector.

5. Use a small pair of pliers to pull up on TP1 to disengage J1 from the local oscillator board.

6. Carefully unsolder the center conductor of the input rf connector while pulling the circuit board toward the rear of the instrument.

7. Pull the circuit board up and away from the casting.

8. To replace the RF circuit board reverse the above procedure.

6-15. Oscillator Board. To remove the local oscillator board, proceed as follows:

1. Remove the instrument and RF assembly covers as described above.

2. Very carefully unsolder the wire from the center pin of the SMB connector at the front of the RF casting.

3. Remove the connectors from J1 and J2 at the rear of the circuit board.

4. Remove 9 No. 6 screws and one hex spacer holding the circuit board to the RF casting.

5. Use a small pair of pliers to gently pull up on TP4 to disengage P1 from the RF circuit board.

6. Pull the circuit board up and away from the RF casting.

7. To replace the Oscillator board reverse the above procedure.

6-16. Gaining Access to Display/keyboard. To gain access to the display and keyboard, proceed as follows:

1. Remove the instrument covers as described above.

2. Remove three No. 4 screws that hold the top trim extrusion and two grounding clips.

3. Grasp the trim strip by its edges and pull it away.

4. Remove the plastic display window.

CAUTION

Be careful not to scratch the the inner surface of the display window.

5. Turn the instrument over and remove three No. 4 screws that hold the bottom trim extrusion and two grounding clips.

6. Grasp the trim strip by its edges and pull it away.

7. Tilt the bottom of the front panel away from the instrument until all switches are clear; then, pull the front panel up to clear the center trim extrusion.

6-17. Gaining Access to 455 kHz IF boards. To gain access to the 455 kHz IF boards, proceed as follows:

1. Remove the instrument covers as described above.

2. Remove two No. 4 screws that hold the 455 kHz IF (A15) in the chassis.

3. Remove the RF connection at the left edge of the assembly.

4. Grasp the assembly with one hand, hold down the front of the instrument with the other and pull straight up.

NOTE

A board extraction tool may be required if the card-edge connector is too tight.

5. Remove the 14 No. 4 screws holding the front shield in place to expose the IF amplifier board, A15A3.

6. Turn the assembly over and remove the 16 No. 4 screws holding the rear shield in place to expose the IF Detector board, A15A2.

7. To replace the assembly, reverse the above procedure.

6-18. Changing Instrument Firmware. To change the instrument eproms, proceed as follows:

1. Remove all cable connections from the Model 8200-S/10, including the power cable.

2. Remove the instrument top cover as described above.

CAUTION

When replacing U10 and U14 observe that the orientation of pin 1 is away from the top of the CPU board. The three numbers on the replacement IC should match the numbers on the one being replaced.

3. Extract the CPU board, A9 (Blue Extractors) far enough to remove U10 and replace it with the new eprom.

4. Remove A9U14 and replace with the new eprom.

5. Install jumpers JP1 and JP2, then reseat the CPU board into the motherboard connector.

6. Before replacing the top instrument cover, connect the AC power supply and turn the LINE switch ON.

7. The new firmware number will appear in the CARRIER display.

8. Turn the instrument power off, extract the CPU board and remove jumpers JP1 and JP2. Replace the instrument cover.

9. Turn the instrument ON and recall program -1 to calibrate the Model 8200-S/10.

6-19. **Instrument Test Jumpers.** The Model 8200-S/10 CPU board has two test jumpers, JP1 and JP2, which are used as an aid in troubleshooting the instrument circuits. The jumper positions and related tests are listed below.

JP1 - JP2	ACTION
OFF-OFF	**Normal operation, no tests are done.**
ON-OFF	**Analog-to-digital converter test exercises the software A/D converter system.**
OFF-ON	**Counter chain test permits the counter circuit operation to be tested.**
ON-ON	**Erase variable memory and install nominal calibration factors. Used when a repair has been made on the CPU board or when new firmware is installed.**

TABLE 6-1. TEST JUMPERS.

6-20. **Removal of Detail Parts.** Careful attention has been paid in the design of the Model 8200-S/10 to maintainability. Most detail parts are readily accessible for inspection and replacement when the instrument covers and RF shields are removed. Solid-state circuit components, mounted on plug-in circuit boards, are used throughout the instrument. Standard printed circuit board maintenance techniques are used for removal and replacement of parts. Excessive heat must be avoided; a low wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

6-21. PRELIMINARY CHECKS.

6-22. **Visual checks.** If equipment malfunction occurs, perform a visual check of the Model 8200-S/10 before performing electrical tests. Visual checks often help to isolate the cause of a malfunction quickly and simply. Inspect the instrument for signs of damage caused by excessive shock, vibration, or overheating, such as broken wires, loose hardware and parts, loose electrical connections, electrical shorts, cold solder connections, or dirt or other foreign matter. Correct any problems discovered, then complete the operational checks to verify that the instrument is functional. If a malfunction persists or the instrument fails any of the operational checks, continue with the troubleshooting procedures below.

6-23. **Power Supply Check.** Improper operation of the Model 8200-S/10 may be caused by incorrect dc operating voltages. Before proceeding with any other electrical checks, perform the power supply checks in the Motherboard/Power Supply section.

6-24. TROUBLESHOOTING.

6-25. Instrument malfunction will generally be evident from front panel indications, or IEEE-488 bus responses. The problems will fall into two general categories; selective failure of one sub-system or catastrophic failure.

6-26. Selective failure of one section of the instrument or out of specification performance will be evident from manipulation of the front panel controls. For example, incorrect or erratic FM deviation indications would be evident from display readings only in the FM modulation mode, and the problem would most likely be associated with the FM circuit board, A4. However, similar performance on both AM and FM displays would indicate a problem on the Filter or Detector boards.

Display	Probable fault on
No display	A1 Motherboard/Power Supply or A11 I/O Board
Meaningless symbols	A9 CPU Board or A10 Counter Board
Error 30	A2A2 Oscillator Board, Q1
Error 31	A2A2 Oscillator Board, Q3
Error 32	A2A2 Oscillator Board, Q4
Error 33	A2A2 Oscillator Board, Q6
Error 34	A10 Counter Board
Error 40	AM Board
Error 41	Detector Board
Error 42	FM Board
Error 43	FM or Filter Board
Error 44	AM or RF Board

TABLE 6-2. HARDWARE ERROR DISPLAYS.

6-27. Catastrophic failures, on the other hand, would generally cause the Model 8200-S/10 to be completely inoperative. For instance, if the microprocessor was not operating properly, the displays would contain meaningless symbols and the keyboard would not be responsive.

6-28. Further isolation of the problem requires some understanding of the simplified block diagram. Read over the theory of operation section and then proceed with the troubleshooting section below. When the problem is localized to a specific assembly, refer to the service information for that assembly.

6-29. TROUBLE LOCALIZATION.

6-30. Many malfunctions are evident from the front panel display. See Table 6-2.

6-31. Other front panel indications might include erratic or incorrect displays or an inoperative keyboard. In each case the circuit board most closely associated with that display should be tested first.

6-32. TROUBLESHOOTING, MOTHERBOARD/POWER SUPPLY.

6-33. GENERAL. Procedures for checking the Motherboard circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-2, 8-3, and 8-4.

6-34. EQUIPMENT REQUIRED. The test equipment required for these tests is listed below. See Table 5-1 for critical specifications.

Oscilloscope.................................... HP 1740A
DC voltmeter .... Fluke 8840A

WARNING

Line voltages up to 240 volts AC may be encountered in the power supply circuits. To protect against electrical shock, observe suitable precautions when connecting and disconnecting test equipment, and when making voltage measurements.

Display LED	Circuit
DS1	-30V supply
DS2	+5V (display)
DS3	+5V (instrument)
DS4	+15V
DS5	-15V

TABLE 6-3. Power Supply LEDs.

6-35. **PROCEDURE.** With the instrument covers removed and power applied, observe DS1-DS5. These displays indicate if the supplies are operating normally. All of the LEDs should be about the same brightness. If not, troubleshoot the circuit associated with the incorrect display LED. The LED and associated circuits are:

NOTE

For the following oscilloscope measurements, use a high impedance probe.

6-36. **+5V Display (DS2).** The +5 volt display supply is a three terminal regulator, U7, and associated components. If the output voltage is incorrect check for shorted CR11, CR15, or C22. The regulator output can be isolated by disconnecting J4 on the I/O board.

6-37. **+5V Instrument (DS3).** The +5 volt instrument supply is a three terminal regulator, U4, and associated components. If the output voltage is incorrect check for shorted CR5, CR10, or C14. The regulator output can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing.

6-38. **+15V (DS4).** The +15 volt instrument supply is a three terminal regulator, U5, enclosed in a feedback loop consisting of AR2a and associated components. Proceed as follows:

1. If the dc voltage at the +15 volt bus is near ground a short circuit is the most likely problem. The supply can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing. This can be done one board at a time to isolate the defective circuit.

2. If the volatage at the +15 volt bus is low, but not zero, the problem may be with the -15 volt supply. See below.

3. In any case measure the dc voltage at the positive terminal of C8. The voltage should be +20 volts at nominal line. If not, check for defective CR2 or replace defective U5.

4. Measure the dc voltage at pin 6 of U8. The voltage should be +10 volts. If not, replace defective U8. Note that if the +15 supply voltage is less than 12 volts U8 will not operate properly.

5. Measure the dc voltage at pin 1 of AR2. The voltage should be +10 volts. If not, replace defective AR2, or check for shorted CR7.

6-39. **-15V (DS5).** The -15 volt instrument supply is a three terminal regulator, U6, enclosed in a feedback loop consisting of AR2b and associated components. Proceed as follows:

1. If the dc voltage at the -15 volt bus is near ground a short circuit is the most likely problem. The supply can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing. This can be done one board at a time to isolate the defective circuit.

2. If the voltage at the -15 volt bus is low, but not zero, the problem may be with the +15 volt supply.

3. In any case measure the dc voltage at the negative terminal of C10. The voltage should be -20 volts at nominal line. If not, check for defective CR2 or replace defective U6.

4. Measure the dc voltage at pin 6 of U8. The voltage should be +10 volts. If not, replace defective U8. Note: If the +15 supply voltage is less than 12 volts U8 will not operate properly.

5. Measure the dc voltage at pin 7 of AR2. The voltage should be -10 volts. If not, replace defective AR2, or check for shorted CR9.

6-40. -30V (DS1). The -30 volt instrument supply consists of a voltage doubler and operational amplifier AR3 and associated components. Proceed as follows:

1. If the dc voltage at pin 6 of AR3 is near ground a short circuit is the most likely problem. The supply can be isolated by disconnecting J4 at the RF housing.

2. Measure the dc voltage at the negative terminal of C3. The voltage should be -40 volts at nominal line. If not, check for defective CR3 or CR4 or replace defective AR3.

3. Measure the dc voltage at pin 3 of AR3. The voltage should be -15 volts. If not, troubleshoot the -15 volt supply.

5. Measure the dc voltage at pin 7 of AR3. The voltage should be -12 volts. If not, replace defective CR14.

6-41. LOGIC SIGNALS. Proper operation of the RF and Oscillator circuits depend on correct logic levels on the following control lines:

IA2-IA7 .... instrument address bus
ID0-ID7 ....instrument data bus

The instrument address lines are decoded by U2 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. In operation, data on the instrument bus is latched into octal latch U1, when address lines IA4 and IA5 are high, IA2, IA3, and IA6 are low, and strobe IA7 goes from high to low. Data is strobed into U9 under the same conditions except that IA2 is high.

To troubleshoot the logic circuits proceed as follows:

1. With the Model 8200-S/10 powered up normally, but with no RF input signal, depress the INIT key.

2. Use the oscilloscope to monitor the activity on the instrument data bus on pins 1-8 of the plug-in card connectors. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board.

3. Connect the oscilloscope to pin 6 of U2 and set the timebase to 0.5 mSEC/DIV.

4. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board.

5. Move the oscilloscope probe to pin 12 of U2. The signal should be as in the previous step, except that it is inverted. If not, replace defective U2.

6. The following table presents logic levels on various pins of U1 when the indicated data is keyed into the CARRIER or PRGM displays.

13. The signal at the junction of C7 and R20 should be as indicated in Figure 6-3A. Incorrect signals indicate defective sampling bridge or bridge bias circuits.

14. Move the oscilloscope probe to TP2. The signal should appear as in Figure 6-3C. If the signal is not as indicated, troubleshoot the sampler amplifier, Q2 and Q4-Q7 by dc and waveform measurements.

15. Connect the oscilloscope probe to TP3. The signal is the same as at TP2, but ten times smaller. (40 millivolts peak-to-peak) If not, replace defective U4.

16. Connect the oscilloscope probe to TP4. The signal is the same as that at TP3, but 3.6 times larger. (150 millivolts peak-to-peak) If the signal is not as indicated, troubleshoot the amplifier Q8-Q12 by dc and waveform measurements.

17. Connect the oscilloscope probe to A2J4 (center SMB connector). The signal is the same as that at TP4. If not, replace defective K1.

18. Change the generator frequency to 500 kHz and set the Model 8200-S/10 carrier FREQ to 9 MHz. The signal at A2J4 pin 1 should be about 150 millivolts peak-to-peak with a period of 2 microseconds. If not, replace defective AR1.

19. Move the oscilloscope probe to pin 1 of U8. The signal should be about 75 millivolts peak-to-peak. If not, replace defective U7 or troubleshoot filter L4, L8, C40, C48, C53.

20. Enter the following frequencies into the CARRIER FREQ display and observe the waveform on the indicated pins of U7. The signal is a 500 kHz signal as in step 18. Incorrect signals indicate defective U7 or decoder U5.

FREQUENCY	PIN
2 MHz	pin 2
9 MHz	pin 7
11 MHz	pin 15
18 MHz	pin 10

21. Probe the signals on pins 7 and 8 of U8. The signal should be a square wave about 3.5 volts peak-to-peak, with a 2 microsecond period. If not, replace defective U8.

22. Move the oscilloscope probe to pin 6 of AR2. The signal is a square wave as in step 21 with an amplitude of 600 millivolts. If not, replace defective AR2.

23. The signal on pin 2 of U9 is as in step 21 with an amplitude of about 2 volts peak-to-peak. If not, replace defective U9, shorted CR10, or open CR11.

24. The signal on pin 9 of U9 is a TTL waveform with a period of 14 microseconds. If not, replace defective U9.

25. Enter 2 MHz into the carrier FREQ display. The signal on pin 9 of U9 is a TTL waveform with a period of 4 microseconds. If not, replace defective U9.

6-46. LOGIC SIGNALS. Proper operation of the RF circuits depend on correct logic levels on the following control lines:

R0,R1..IF attenuation and calibration
B1,B2..band switching

The following table indicates the TTL logic levels and the associated function for control lines R0 and R1:

Logic Line	logic value	operation
R0-R1	low-low	no IF attenuation
	low-high	attenuate IF by 10
	high-low	not used
	high-high	calibrator signal

The following table indicates the TTL logic levels and the associated function for control lines B1 and B2:

Logic Line	logic value	operation
B1-B2	low-low	select filter U7,2 U9 divide by 7 U3, select /10
	low-high	select filter U7,7 U9 divide by 7 U3, select /10
	high-low	select filter U7,15 U9 divide by 2 U3, select /2
	high-high	select filter U7,10 U9 divide by 2 U3, select /2

Incorrect logic signals on the R0, R1, B1, or B2 lines indicate a problem on the mother board decoder U2 or latch U1, or the CPU board.

6-47. TROUBLESHOOTING, OSCILLATOR BOARD

6-48. GENERAL. Procedures for checking the oscillator board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-8 nad 8-9.

6-49. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
Signal Generator SG1207/U
DC voltmeter ....Fluke 8840A

6-50. PROCEDURE.

1. Measure the dc voltage at pin 16 of U3. The voltage should be approximately +5 volts. If not, the power supply circuits or the mother board connectors are defective.

2. Measure the dc voltage at pins 7 and 4 of AR2. The voltages should be +15 and -15 respectively. If not, the power supply circuits or the mother board connectors are defective.

3. Measure the dc voltage at TP3. The voltage should be -14.0 volts. If not, troubleshoot regulator AR3 and Q7 using dc measurements.

4. Enter 10 MHz into the carrier FREQ display. Observe that LED DS2 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

5. Measure the dc voltage at pin 7 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.

6. Connect the oscilloscope probe to the anode of CR4. The signal should be about 400 millivolts peak-to-peak with a period of 45 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q1 using dc and waveform measurements.

7. Select the CARRIER FREQ function and key 12 MHz into the display. Observe that LED DS3 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

8. Measure the dc voltage at pin 1 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

9. Connect the oscilloscope probe to the anode of CR21. The signal should be about 400 millivolts with a period of 37 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q3 using dc and waveform measurements.

10. Select the CARRIER FREQ function and key 15 MHz into the display. Observe that LED DS4 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

11. Measure the dc voltage at pin 8 of AR1. The level should be about +13 volts.If not, replace defective AR1 or U1.

12. Connect the oscilloscope probe to the anode of CR32. The signal should be about 400 millivolts with a period of 33 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q4 using dc and waveform measurements.

13. Select the CARRIER FREQ function and key 18 MHz into the display. Observe that LED DS5 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

14. Measure the dc voltage at pin 14 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

15. Connect the oscilloscope probe to the anode of CR43. The signal should be about 600 millivolts with a period of 26 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q6 using dc and waveform measurements.

16. Connect the oscilloscope probe to ungrounded end of L23. The signal should be about 500 millivolts with a period of 26 nanoseconds.If not, replace defective diode CR43.

17. Connect the oscilloscope probe to TP4. The signal should be about 800 millivolts with a period of 26 nanoseconds. If not, troubleshoot amplifier Q5 by dc and waveform measurements.

18. Move the oscilloscope to the LO2 SMB connector on the front of the RF casting. The signal should be 500 millivolts with a period of 26 nanoseconds. If not, troubleshoot amplifier Q2 by dc and waveform measurements, or replace defective T1, or check for shorted RF cable connecting to Motherboard.

19. Set the signal generator to 15 MHz CW and 0 dBm and connect the RF OUT to the RF IN of the Model 8200.

20. Depress the Model 8200-S/10 INIT key and then enter 15 MHz into the carrier FREQ Display.

21. Connect the oscilloscope probe to pin 3 of U2. The signal should be a TTL signal with a period of 6 microseconds. If not, the problem is associated with the RF circuit board.

22. Move the oscilloscope probe to pin 6 of U2. The signal should be a TTL signal with a period of 6 microseconds. Additionally, the time from the falling edge to the rising edge should be 3 microseconds. If not, replace defective U2 or check C23 and R15.

23. Move the oscilloscope probe to pin 6 of AR2. The signal should be a distorted TTL signal with a period of 6 microseconds and an average value of near zero volts. The oscilloscope must be dc coupled for this test. If not, replace defective AR2.

24. Enter SPCL 90 to activate the local oscillator test. The MODULATION display will indicate 0 -- LO.

25. Measure the dc voltage at the end of R29 nearest TP2. The voltage should be -10 volts. If not, the problem is on the CPU board or in the interconnecting cable.

26. The other end of R29 should be 0 volts dc. If not, U3 or AR4a is defective.

27. Measure the voltage at TP2. The voltage should be +10 volts. If not, U3 or AR4a is defective.

28. Measure the voltage at pin 3 of AR5. The voltage should be -5 volts. If not, AR4b or Q9 is defective.

29. Measure the voltage at pin 6 of AR5. The voltage should be -5 volts. If not, AR5 is defective.

NOTE

If all measurements to this point are correct, but trouble persists, the problem is with the logic circuits or U3 or possibly Q8 or DS1. Troubleshoot by dc voltage measurement or refer to logic signals troubleshooting below.

6-51. LOGIC SIGNALS. Proper operation of the oscillator circuits depend on correct logic levels on the following control lines:

FC0,FC1 .... oscillator tuning
B0,B1,B3 .... band switching

The following table indicates the logic levels and the associated function for control lines FC0 and FC1:

Logic Line	logic value	operation
FC0-FC1	low-low	frequency lock, DS1 off
	low-high	frequency lock, DS1 on
	high-low	set frequency, DS1 on
	high-high	set frequency, DS1 off

Logic Line	logic value	operation
B0,B1,B3	low-low-high	oscillator Q1 active, DS2 on
	low-high-high	oscillator Q3 active, DS3 on
	high-low-high	oscillator Q4 active, DS4 on
	high-high-high	oscillator Q6 active, DS5 on
	X - X -low	all oscillators inactive

X means don't care

Incorrect logic signals on the R0, R1, B0, B1, or B3 lines indicate a problem on Motherboard decoder U2, latch U1, or problems on the CPU board.

6-52. TROUBLESHOOTING, FM BOARD

6-53. GENERAL. Procedures for checking the FM circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-10 and 8-11.

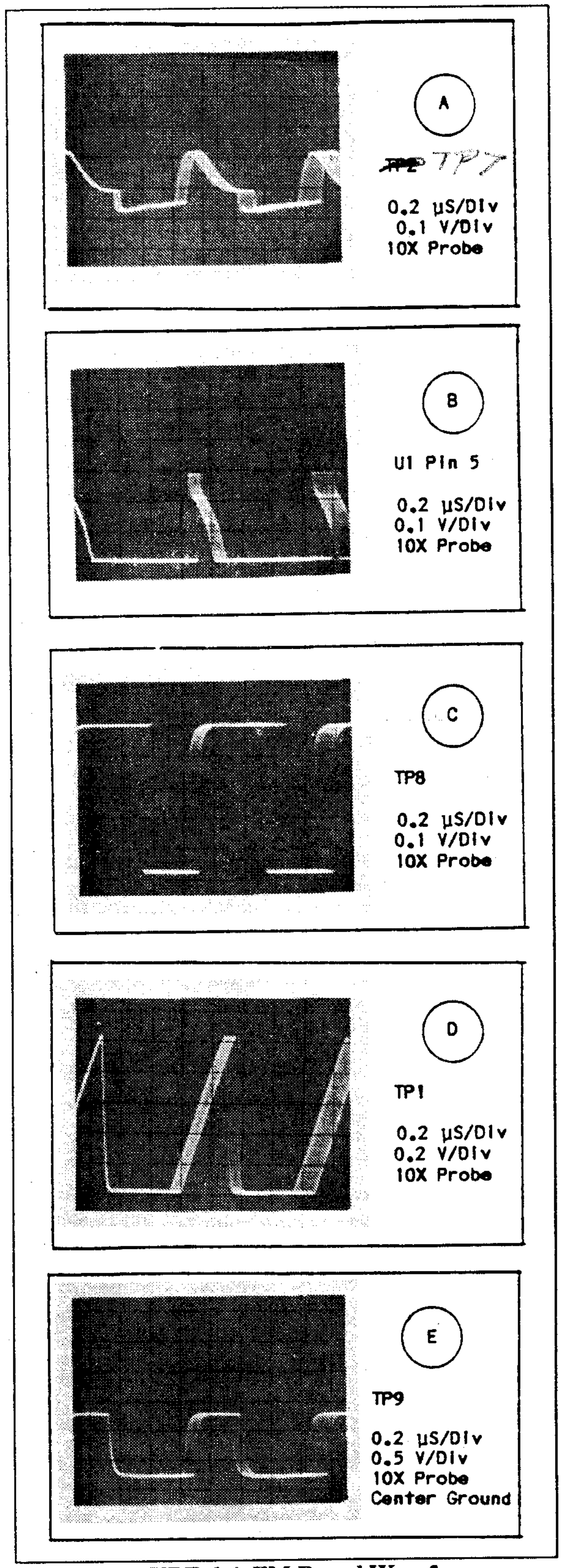


FIGURE 6-4. FM Board Waveforms.

6-54. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope ....HP 1740A
Signal Generator.............................SG1207/U
DC voltmeter....................................Fluke 8840A

6-55. PROCEDURE.

1. Turn off the instrument and remove the FM circuit board. (Brown extractors) Insert the FM board into the Extender board (Grey extractors), and plug the combination back into the FM board slot. Turn on the instrument power, wait for a normal power up sequence, then depress the INIT key.

2. Measure the dc voltage at pin 6 of AR1. The voltage should be approximately +5 volts. If not, troubleshoot the regulator circuit AR1 using dc measurements.

3. Repeat step 1. at pins 7 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not, the problem is in the power supply circuits or the Motherboard interconnect.

4. Measure the dc voltage at either end of L7. The voltage should be -12.5 volts. If not, troubleshoot regulator Q14 using dc measurements.

5. Set the signal generator to 15 MHz and 0 dBm with 50 kHz FM at a 1 kHz rate.

6. Connect the RF OUT of the generator to the RF IN of the Model 8200-S/10 and depress the FM function key.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.

7. Connect the oscilloscope probe to pin 2 of the edge connector. (also the right end of R1). The signal should be an FM modulated signal with an amplitude of about 150 millivolts peak-to-peak and a period of 0.83 microseconds. Some of the local oscillator signal will be present. If not, the problem is on the RF board or the interconnecting cables.

8. Move the oscilloscope probe to TP3. The signal should be as in step 7 except that the amplitude should be 75 millivolts peak-to-peak and the local oscillator signal should not be present. If not, check low-pass filter L3-L4, C1, and C4-C7 for open inductors or shorted capacitors.

9. Move the oscilloscope probe to TP2. The signal should be a clipped sinewave with an amplitude of 1 volt peak-to-peak. If not, troubleshoot limiter stages 1 and 2 (Q3) using dc and waveform measurements.

10. Move the oscilloscope probe to TP6. The signal should be a squarewave with an amplitude of 1 volt peak-to-peak. If not, troubleshoot limiter stages 3 and 4 (Q8) using dc and waveform measurements.

11. Move the oscilloscope probe to TP7. The signal should be as shown in Figure 6-4,A. If not, troubleshoot level shifter Q13 and associated components using dc and waveform measurements.

12. Move the oscilloscope probe to pin 5 of U1. The signal should be as shown in Figure 6-4,B. If not, replace defective U1.

13. Move the oscilloscope probe to TP8. The signal should be as shown in Figure 6-4,C. If not, troubleshoot comparator Q4-Q7 and current source Q2 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

14. Move the oscilloscope probe to TP1. The signal should be as shown in Figure 6-4,D. If not, troubleshoot comparator Q4-Q7 and current source Q2 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

15. Move the oscilloscope probe to TP9. The signal should be as shown in Figure 6-4,E. If not, troubleshoot current switch Q11 and Q12, or current source AR2 and Q9 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

16. Move the oscilloscope probe to TP11. The signal should be a sinewave with an amplitude of 300 millivolts peak-to-peak and a period of 1 millisecond. If not, check low-pass filter L5, L6, L9, L10, and C27, C28, C32, C33, C36, C39, C41, C42, and C44 for open inductors or shorted capacitors.

17. Move the oscilloscope probe to TP12. The signal should be a sinewave with an amplitude of 1 volts peak-to-peak and a period of 1 millisecond. If not, replace defective AR3, Q15 or Q16.

6-56. **LOGIC SIGNALS.**The operation of the FM circuits does not currently require interface to the control logic, however, instrument address line IA1 is dedicated to the FM circuits for future developments.

6-57. TROUBLESHOOTING, AM BOARD

6-58. GENERAL.

6-59. Procedures for checking the AM circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-12 and 8-13.

6-60. EQUIPMENT REQUIRED.

6-61. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
Signal Generator...........................SG1207/U
DC voltmeter.................................Fluke 8840A

6-62. PROCEDURE.

1. Turn off the instrument and remove the AM circuit board. (Black extractors) Insert the AM board into the Extender board (Grey extractors), and plug the combination back into the AM board slot. Turn on the instrument power, wait for a normal power up sequence, then depress the INIT key.

2. Measure the dc voltage at pin 20 of U1. The voltage should be approximately +5 volts. If not, the power supply circuits or the mother board connectors are defective.

3. Measure the dc voltage at pin 13 and pin 3 of U2. The voltages should be +15 and -15 volts respectively. If not, the power supply circuits or the mother board connectors are defective.

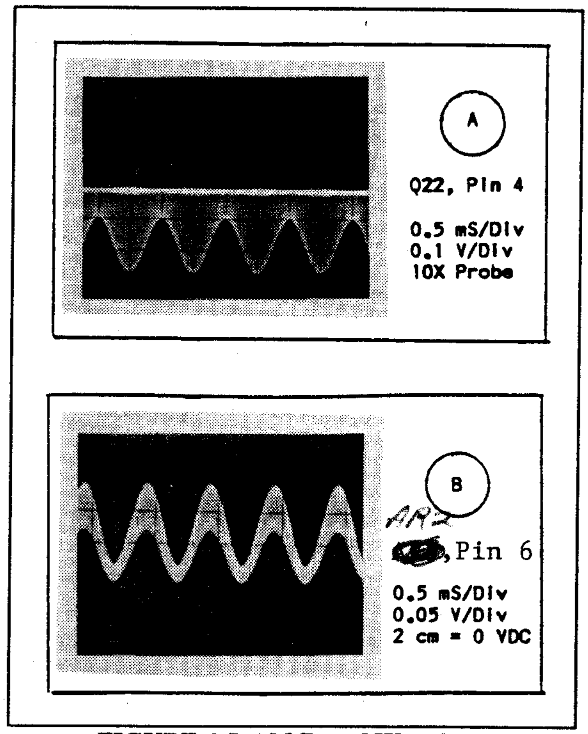


FIGURE 6-5. AM Board Waveforms.

4. Measure the dc voltage at either end of L7. The voltage should be +12 volts. If not, troubleshoot regulator Q1 and Q2 using dc measurements.

5. Set the signal generator to 15 MHz and 0 dBm with 50 % AM at a 1 kHz rate.

6. Connect the RF OUT of the generator to the RF IN of the Model 8200-S/10 and depress the AM function key.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.

7. Connect the oscilloscope probe to pin 2 of the edge connector. (also the right end of R1). The signal should be an amplitude modulated signal with an amplitude of about 200 millivolts peak- to-peak. The carrier period should be 0.83 microseconds and the modulation period should be 1 millisecond. Some local oscillator signal will be present. If not, The problem is on the RF board or the interconnecting cables.

8. Move the oscilloscope probe to TP1. The signal should be as in the previous step, except that the amplitude should be 350 millivolts peak-to-peak. Additionally, the local oscillator signal should not be present, and the dc level should be about 0 volts. If not, troubleshoot amplifier Q3-Q7 using dc and waveform measurements.

9. Move the oscilloscope probe to TP6. The signal should be as in the previous step, except that the amplitude should be 120 millivolts peak-to-peak and the dc level should be -0.5 volts. If not, proceed to logic signals troubleshooting for additional tests.

10. Move the oscilloscope probe to TP2. The signal should be as in the previous step, except that the amplitude should be 2.5 volts peak-to-peak. If not, troubleshoot feedback amplifier Q10 an Q13- Q16 using dc and waveform measurements.

11. Move the oscilloscope probe to pin 4 of Q22. The signal should be as shown in Figure 6-5,A. If not, troubleshoot active detector Q19-Q21 using dc and waveform measurements.

12. Move the oscilloscope probe to pin 8 of Q22. The signal should be as in the previous step, except it is inverted. If not, troubleshoot active detector Q19-Q21 using dc and waveform measurements.

13. Move the oscilloscope probe to pin 6 of AR2. The signal should be as shown in Figure 6-5,B. If not, troubleshoot buffer stage Q22 and AR2 using dc and waveform measurements.

14. Move the oscilloscope probe to pin 3 of AR3. The signal should be a 0.55 volt peak-to-peak sine wave with a period of 1 millisecond and a dc level of +0.5 volts. If not, check for open inductors or shorted capacitors in low-pass filter L10-L12 and C50-C56.

15. Move the oscilloscope probe to TP3. The signal should be as in the previous step, except that the amplitude should be 1.1 volt peak-to peak at a dc level of about 1 volt. If not, replace defective AR3.

16. Move the oscilloscope probe to the emitter lead of Q18. The signal should be an amplitude modulated signal with an amplitude of 2 volts peak-to-peak. The carrier period should be 0.83 microseconds and the modulation period should be 1 millisecond. If not, troubleshoot IF OUT buffer Q12 and Q17-Q18 using dc and waveform measurements.

6-63. LOGIC SIGNALS.

6-64. Proper operation of the AM agc circuits depend on correct logic levels on the following control lines:

IA0 ....agc latch strobe
ID0-ID7...instrument data bus

6-65. The instrument address line IA0 is dedicated to the AM board. In operation, data on the instrument data bus is latched into octal latch, U1, when IA0 makes the transition from high to low. The instrument data bus will contain the programming byte for agc digital-to-analog (DAC) at that time. To troubleshoot the logic and agc circuits proceed as follows:

1. With the Model 8200-S/10 powered up normally and no carrier signal connected, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 4-11 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the Model 8200-S/10 CARRIER FREQ to 15 MHz, and select SPCL 96 to activate the AGC test program.

4. Connect the oscilloscope probe to pin 12 of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be narrow positive pulses indicating an agc level change. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Enter SPCL 96 to activate the AGC attenuator test program. Enter 4.095 into the modulation display to set maximum attenuation. The levels on the B1-B8 pins (5-12) of U2 should be:

B1	B2	B3	B4	B5	B6	B7	B8
Low	Low	Low	Low	High	High	High	High

If the TTL levels are incorrect, U1 or U2 is defective.

7. Enter 0 into the modulation display to set minimum attenuation. The levels on the B1-B8 pins (5-12) of U2 are tabulated below.

B1	B2	B3	B4	B5	B6	B7	B8
High	High	High	High	High	Low	High	Low

If the TTL levels are incorrect, U1 or U2 is defective.

6-66. AGC ATTENUATOR.

6-67. The agc attenuator in the Model 8200-S/10 is a programmable L-pad whose series and shunt arm resistance is controlled by adjusting the current through a light dependent resistor while holding the dc voltage across the resistance constant. To troubleshoot the agc attenuator, proceed as follows:

1. Program the Model 8200-S/10 to 15 MHz CARRIER FREQ and 0 dBm carrier level.

2. Measure the dc voltage from TP6 to ground. The voltage should be -0.5 volts. If the indication is incorrect, troubleshoot the shunt arm control loop consisting of AR1b and Q11 and associated components by dc voltage measurements, or replace defective Q9.

3. Measure the dc voltage across R28. The voltage should be -0.5 volts. (+ 0.5 volts if the voltmeter polarity is reversed) If the indication is incorrect, troubleshoot the series arm control loop consisting of AR1a and Q7 and associated components by dc voltage measurements, or replace defective Q8.

6-68. TROUBLESHOOTING, FILTER BOARD

6-69. **GENERAL.** Procedures for checking the FILTER circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-14, 8-15, and 8-16.

6-70. **EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
Audio Analyzer...............................Boonton 1120
DC voltmeter ....Fluke 8840A

6-71. PROCEDURE.

1. Turn off the instrument and remove the FILTER circuit board. (Pink extractors) Insert the FILTER board into the Extender board (Grey extractors), and plug the combination back into the FILTER board slot. Extract the FM circuit board (Brown extractors) just far enough to disengage the circuit board connector. Turn the instrument ON and enter 15 Mhz into the CARRIER FREQ display.

2. Measure the dc voltage at pin 20 of U2. The voltage should be approximately +5 volts. If not the power supply circuits or the mother board connectors are defective.

3. Measure the dc voltage at pins 7 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not the power supply circuits or the mother board connectors are defective.

4. Set the audio analyzer source to 1 kHz and 600 millivolts.

5. Connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8200-S/10.

NOTE

For the following oscilloscope measurements, use a high impedance probe. TP7 may be used as a convenient ground terminal.

6. Connect the oscilloscope probe to pin 35 of the edge connector. The signal should be a sinewave signal with an amplitude of about 800 millivolts peak-to-peak and a period of 1 millisecond. If not, the problem is on the Motherboard.

7. Move the oscilloscope probe to TP1. The signal should be as in the previous step, except that the amplitude should be 400 millivolts peak-to-peak. If not, check for defective relay K1, K2, or K3, or open inductor L4, L5, L6, or shorted capacitor C9-C14.

8. Change the audio analyzer frequency to 50 kHz. The signal should be as in the previous step, except that the amplitude should be about 250 millivolts peak-to-peak. If not, troubleshoot defective 50 kHz low-pass filter L4-L6 and C9-C12 and C14.

9. Depress the Modulation analyzer 220 kHz low-pass filter key. The signal should be as in the previous step, except that the amplitude should be 0.4 volts peak-to-peak. If not, check for defective relay K1, K2, or K3, or defective attenuator R4-R6.

10. Move the oscilloscope probe to TP2. The signal should be as in the previous step, except that the amplitude should be 4 volts peak-to-peak. If not, check for defective U3 or amplifier AR1 and Q3, or proceed to logic troubleshooting for additional tests.

11. Move the oscilloscope probe to TP9. The signal should be as in the previous step, except that the amplitude should be 0.4 volts peak-to-peak. If not, check for defective U3 or amplifier AR12 or proceed to logic troubleshooting for additional tests.

12. Reduce the audio analyzer level to 60 millivolts. The Model 8200-S/10 should autorange and the signal at TP9 should be as in the previous step. If not, check for defective U3 or proceed to logic troubleshooting for additional tests.

13. Increase the audio analyzer level to 6 volts. The Model 8200 should autorange and the signal at TP9 should be as in the previous step. If not, check for defective U3 or proceed to logic troubleshooting for additional tests.

14. Move the oscilloscope probe to TP3 and set the audio analyzer frequency to 30 Hz. Depress the <10 Hz high-pass filter key. The signal should be 1.8 volts peak-to-peak with a period of 33 milliseconds. If not, check for defective U4 or amplifier AR5, or proceed to logic troubleshooting for additional tests.

15. Depress the 30 Hz high-pass key. The signal should be as in the previous step, except that the amplitude should be 1.3 volts peak-to-peak. If not, check for defective U4 or amplifier AR2, or proceed to logic troubleshooting for additional tests.

16. Change the audio analyzer frequency to 300 Hz and depress the 300 Hz high-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 3.3 milliseconds. If not, check for defective U4 or amplifier AR3, or proceed to logic troubleshooting for additional tests.

17. Change the audio analyzer frequency to 3000 Hz and depress the 3000 Hz high-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 0.33 milliseconds. If not, check for defective U4 or amplifier AR4, or proceed to logic troubleshooting for additional tests.

18. Change the audio analyzer frequency to 1 kHz and depress the 30 Hz high-pass key. Move the oscilloscope probe to TP4. The signal should be 1.8 volts peak-to-peak and the period should be 1 millisecond. If not, check for defective U5 or amplifier AR8, or proceed to logic troubleshooting for additional tests.

19. Change the audio analyzer frequency to 20 kHz and depress the 20 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 50 microseconds. If not, check for defective U5 or amplifier AR7, or proceed to logic troubleshooting for additional tests. 20. Change the audio analyzer frequency to 15 kHz and depress the 15 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 67 microseconds. If not, check for defective U5 or amplifier AR6a, or refer to logic signals troubleshooting for logic troubleshooting.

21. Change the audio analyzer frequency to 3 kHz and depress the 3 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 333 microseconds. If not, check for defective U5 or amplifier AR6b, or proceed to logic troubleshooting for additional tests.

22. Change the audio analyzer frequency to 1 kHz and depress the 50 kHz low-pass key. Move the oscilloscope probe to TP5. The signal should be 1.8 volts peak-to-peak and the period should be 1 millisecond. If not, check for defective U7 or amplifier AR10, or proceed to logic troubleshooting for additional tests.

23. Change the audio analyzer frequency to 6.366 kHz and depress the 25 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 157 microseconds. If not, check for defective U7 or filter R44, C49 or proceed to logic troubleshooting for additional tests.

24. Change the audio analyzer frequency to 3.183 kHz and depress the 50 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 314 microseconds. If not, check for defective U7 or filter R45, C50, or proceed to logic troubleshooting for additional tests.

25. Change the audio analyzer frequency to 2.122 kHz and depress the 75 uSEC de-emphasis key. The signal should be as 1.25 volts peak-to-peak and the period should be 471 microseconds. If not, check for defective U7 or filter R46, C51, or proceed to logic troubleshooting for additional tests.

26. Change the audio analyzer frequency to 212 Hz and depress the 750 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 4.7 milliseconds. If not, check for defective U7 or filter R47, C52, or proceed to logic troubleshooting for additional tests.

27. Change the audio analyzer frequency to 1 kHz and depress the de-emphasis OFF key. Note the amplitude of the signal, then depress the MODULATION PM key. The signal should remain the same. If not, check for defective U7 or amplifier AR9, or proceed to logic troubleshooting for additional tests.

28. Change the audio analyzer frequency to 2 kHz. The signal amplitude should decrease to one-half of that in step 27. If not, troubleshoot filter circuit AR9 and associated components.

29. Move the oscilloscope probe to pin 18 of the edge connector. The signal should be as in the previous step. If not, replace defective relay K4.

30. Move the oscilloscope probe to TP6. The signal should be as in the previous step, except that the amplitude should be 2.4 volts peak-to-peak. If not, replace defective AR11.

6-72. LOGIC SIGNALS. Proper operation of the FILTER circuits depend on correct logic levels on the following control lines:

IA2-IA7..instrument address bus
ID0-ID7..instrument data bus

The instrument addresss lines IA2-IA5 are decoded by U1 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals from the instrument data bus are transferred into octal latch, U2, when address lines IA2, IA3, IA4, and IA5 are low and IA7 goes from high to low. Similarly data is transferred into U6 when address IA2 is high and IA3-IA5 are low and IA7 goes from high to low.

To troubleshoot the logic circuits proceed as follows:

1. With the Model 8200-S/10 powered up normally and configured as above, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the audio analyzer level to 600 millivolts at 1 kHz and enter 15 MHz into the Model 8200-S/10 carrier FREQ display.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 15 of U1 and alternately depress the high-pass filter keys. The signal should be as in the previous step, except that the pulse is inverted. If not, replace defective U1.

7. Move the oscilloscope probe to pin 14 of U1 and alternately depress the low-pass filter keys. The signal should be as in the previous step. If not, replace defective U1.

8. Move the oscilloscope probe to pin 2 of U2. Alternately depress the MODULATION AM and FM keys. The signal should change from TTL high to low. If not, replace defective U2 or shorted Q1.

9. Move the oscilloscope probe to pin 5 of U2. Alternately depress the low-pass 220 and 50 keys. The signal should change from TTL high to low. If not, replace defective U2 or shorted Q2.

10. Enter the following SPCL functions and note the corresponding activity on pins 6 and 9 of U2.

SPCL	PIN 6	PIN 9
31	low	low
32	high	low
33	low	high

If the indications are incorrect, replace defective U2 or U3.

11. Operate the high-pass filter keys and note the corresponding activity on pins 12, 15 and 16 of U2.

KEY	PIN 12	PIN 15	PIN 16
<10	high	low	low
30	high	high	low
300	high	high	high
3000	high	low	high

If the indications are incorrect, replace defective U2 or U4.

12. Alternate the MODULATION FM and PM keys and observe the corresponding activity on pin 19 of U2.

KEY	PIN 19
FM	high
PM	low

If the indications are incorrect, replace defective U2 or Q4.

13. Operate the low-pass filter keys and note the corresponding activity on pins 9, 12, and 15 of U6.

KEY	PIN 9	PIN 12	PIN 15
3	high	low	high
15	high	low	low
20	low	low	high
50	high	high	high
220	high	high	high

If the indications are incorrect, replace defective U6 or U5.

14. Select the MODULATION FM function, operate the de-emphasis keys and note the corresponding activity on pins 2, 5, and 6 of U6.

KEY	PIN 2	PIN 5	PIN 6
25	low	low	low
50	high	low	high
75	high	low	low
750	high	low	high
OFF	low	high	low

If the indications are incorrect, replace defective U6 or U7. Note

6-73. TROUBLESHOOTING, DETECTOR BOARD

6-74. GENERAL. Procedures for checking the DETECTOR circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board Figures 8-17 and 8-18.

6-75. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
Audio Analyzer...............................Boonton 1120
Signal Generator SG1207/U
DC voltmeter ....Fluke 8840A

6-76. PROCEDURE.

1. Turn off the instrument and remove the DETECTOR circuit board. (Green extractors) Insert the DETECTOR board into the Extender board (Grey extractors), and plug the combination back into the DETECTOR board slot. Extract the FM circuit board (Brown extractors) just far enough to disengage the circuit board connector. Turn the instrument power ON, and enter 15 MHz into the carrier FREQ display.

2. Measure the dc voltage at pin 20 of U3. The voltage should be approximately +5 volts. If not the power supply circuits or the mother board connectors are defective.

3. Measure the dc voltage at pins 7 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not the power supply circuits or the mother board connectors are defective.

4. Measure the dc voltage at pins 7 and 1 of AR3. The voltages should be +5 and -5 volts respectively. If not, troubleshoot regulator AR3 using dc measurements.

5. Set the audio analyzer source to 1 kHz and 600 millivolts and connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8200-S/10. Set the signal generator to 15 MHz, CW, at 0 dBm and connect the generator RF OUT to the RF IN connector on the Model 8200-S/10.

NOTE

For the following oscilloscope measurements, use a high impedance probe. TP1 can be used as a ground terminal.

6. Connect the oscilloscope probe to pin 18 of the edge connector. The signal should be a sinewave with an amplitude of about 1.8 volts peak-to-peak and a period of 1 millisecond. If not, the problem is on the Filter board or the Motherboard interconnect.

7. Move the oscilloscope probe to TP5. The signal should be as in the previous step, except it is gated on and off about every 1.5 seconds. If not, check for defective switch U1, or amplifier AR2, or proceed to logic troubleshooting for additional tests.

8. Move the oscilloscope probe to TP7. The signal should be as in the previous step. If not, replace defective AR2.

9. Move the oscilloscope probe to TP8. The signal should be a low frequency rectangular waveform switching from ground to about + 0.8 volts at a 1.5 second rate. If not, check for defective switch U6, or amplifier AR6 or AR7, or proceed to logic troubleshooting for additional tests.

10. Move the oscilloscope probe to TP9. The signal should be as in the previous step. If not, check for defective switch U6, or amplifier AR5 or AR7, or proceed to logic troubleshooting for additional tests.

11. Measure the dc voltage at pin 1 of U7. The voltage should be 1 volt. If not, check filter R30 and C24, or the problem is on the AM board.

12. Move the oscilloscope probe to TP13. The signal should be as in Figure 6-6,A. If not, check for defective switch U7, or amplifier AR9, or proceed to logic troubleshooting for additional tests.

13. Measure the dc voltages at pins 19 and 20 of the edge connector. The voltages should be about 0.210 and -1.3 volts respectively. If not, the problem is on the RF board or in the interconnecting cable.

14. Measure the dc voltages at pins 4 and 5 of U9. The voltages should be about 2.1 and 1.9 volts respectively. If not, check the resistive attenuators R33-R35, and R38, R40 and R41, or replace defective U9.

15. Move the oscilloscope probe to TP14. The signal should be as in Figure 6-6,B. If not, check for defective switch U9, or amplifier AR9, or proceed to logic troubleshooting for additional tests.

16. Depress the $\sqrt{2}$RMS key and move the oscilloscope probe to pin 30 of the edge connector. The signal should be 5 volts peak-to-peak with a period of 1 millisecond. If not, the problem is on the Filter board.

17. Move the oscilloscope probe to pin 3 of AR1. The signal should be 0.5 volts peak-to-peak. If not, check for defective switch U5, or amplifier AR1, or proceed to logic troubleshooting for additional tests.

18. Move the oscilloscope probe to pin 6 of AR1. The signal should be 5.6 volts peak-to-peak. If not, check for defective switch U5, or amplifier AR1, or proceed to logic troubleshooting for additional tests. 19. Move the oscilloscope probe to pin 3 of AR4. The signal should be 0.56 volts peak-to-peak. If not, check for defective switch U5, or amplifier AR4, or refer to logic signals troubleshooting below.

20. Move the oscilloscope probe to pin 6 of AR4. The signal should be 6.6 volts peak-to-peak. If not, check for defective switch U4, or amplifier AR4, or proceed to logic troubleshooting for additional tests.

21. Move the oscilloscope probe to pin 3 of AR8. The signal should be 0.66 volts peak-to-peak. If not, check for defective switch U4, or amplifier AR8, or proceed to logic troubleshooting for additional tests.

22. Move the oscilloscope probe to TP10. The signal should be 7.6 volts peak-to-peak. If not, check for defective rms converter U8, or amplifier AR8, or or proceed to logic troubleshooting for additional tests.

23. Move the oscilloscope probe to TP11. The signal should be about 2.8 volts dc. If not, check for defective rms converter U8, or switch U9.

24. Move the oscilloscope probe back to TP10 and enter SPCL 32 to set the 50.00 modulation range. Set the audio analyzer to the following levels and observe the resulting waveforms. The '*' in front of the indication means that the voltage will be initially higher and then change to the indicated value.

Analyzer Level (millivolts)	Indication (volts peak-peak)
0	baseline noise
0.5	6
1	*6
2	*5
5	*6
10	*6
20	*5
50	*6
100	*6
200	*5
500	*6
1000	12.4

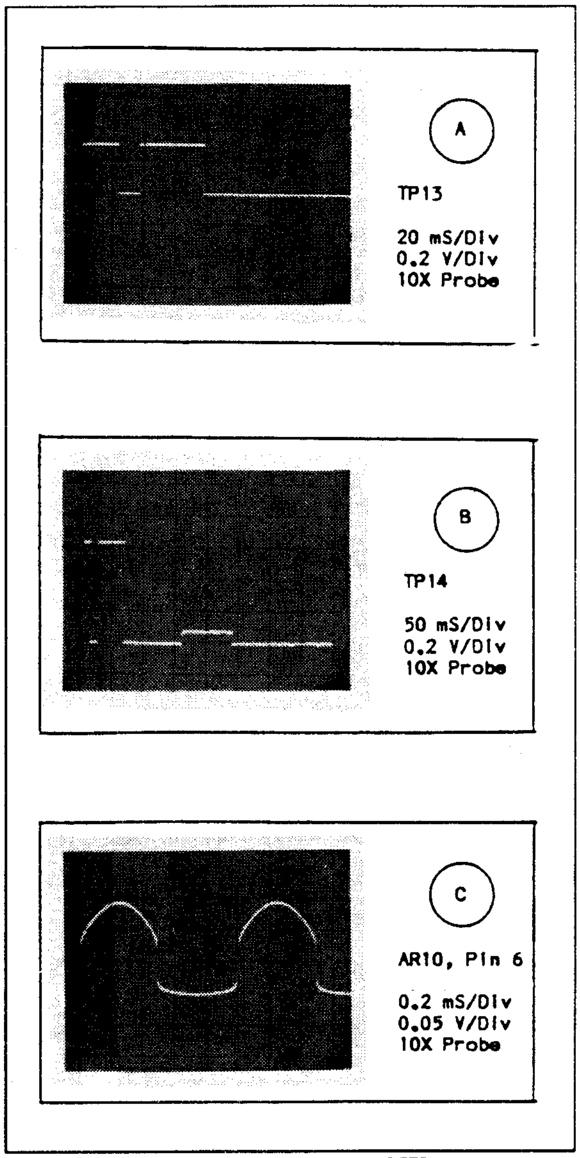


FIGURE 6-6. Detector Board Waveforms.

If the indications are incorrect, isolate the defective analog switch U5 or U4, or refer to logic signals troubleshooting below.

25. Set the audio analyzer to 600 millivolts and move the oscilloscope probe to pin 21 of the edge connector. The signal should be 380 millivolts peak-to-peak with a period of 1 millisecond. If not, the problem is on the Filter board.

26. Move the oscilloscope probe to pin 6 of AR10. The signal should be as in Figure 6-6,C. If not, replace defective AR10.

27. Move the oscilloscope probe to the cathode of CR6. The signal should be a half-wave rectified signal 380 millivolts peak with a period of 1 millisecond. If not, isolate defective component in average detector circuit using dc and waveform measurements.

28. Move the oscilloscope probe to pin 10 of U9 The voltage should be about 0.12 volts d3. If not, isolate defective component R45, C33, or U9.

6-77. LOGIC SIGNALS. Proper operation of the DETECTOR circuits depend on correct logic levels on the following control lines:

IA2-IA7..instrument address bus
ID0-ID7..instrument data bus

6-78. The instrument addresss lines IA2-IA5 are decoded by U2 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals on the instrument data bus are transferred into octal latch, U3, when addresses IA2 and IA5 are low, and IA3 and IA4 are high, and IA7 goes from high to low. Similarly data is transferred into U10 when address when IA5 is low and IA2-IA4 are high, and IA7 goes from high to low. To troubleshoot the logic circuits proceed as follows:

1. With the Model 8200-S/10-S/10 powered up normally and configured as in the troubleshooting section, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the audio analyzer level to 600 millivolts at 1 kHz, enter 15 MHz into the Model 8200-S/10 carrier FREQ display, and depress the RMS key.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 9 of U1 and change the audio analyzer level to 100, then 200, and back to 600 millivolts. The signal should be as in the previous step, except that the pulse is inverted. If not, replace defective U2.

7. Move the oscilloscope probe to pin 7 of U2. The signal should be as in the previous step. If not, replace defective U2.

8. Enter SPCL 32 to hold the 50.00 modulation range, then set the audio analyzer to the indicated levels, in millivolts, and note the activity on pins 2, 5, 6, 9, 12, and 15 of U3.

LEVEL	PIN 2	PIN 5	PIN 6	PIN 9	PIN 12	PIN 15
0	low	low	low	high	low	low
1	high	low	low	low	low	low
2	low	high	low	low	low	low
5	low	low	high	low	low	low
10	high	low	low	low	low	high
20	low	high	low	low	low	high
50	low	low	high	low	low	high
100	high	low	low	low	high	high
200	low	high	low	low	high	high

500	**low**	**low**	**high**	**low**	**high**	**high**
1000	**low**	**low**	**high**	**low**	**high**	**high**

If the indications are incorrect, replace defective U3.

9. Select the PEAK +- detector and move the oscilloscope probe to pin 5 of U10. The signal should be alternating between logic high and logic low with a period of about 1.5 seconds. If not, replace defective U10 or U1.

10. Move the oscilloscope probe to pin 6 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U6.

11. Move the oscilloscope probe to pin 9 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U7.

12. Move the oscilloscope probe to pin 12 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U7.

13. Move the oscilloscope probe to pin 15 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

14. Move the oscilloscope probe to pin 16 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

15. Move the oscilloscope probe to pin 19 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

16. Move the oscilloscope probe to pin 19 of U10. The signal should be a logic 0 (0 volts) If not, replace defective U10 or U1.

6-79. TROUBLESHOOTING, CPU BOARD

6-80. GENERAL. Procedures for checking the CPU circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-19 and 8-20. The CPU circuitry in the Model 8200-S/10 uses a 16-bit microprocessor in a bus-oriented system. Most of the high speed circuitry is contained on the CPU board and external signals are buffered. As a result failures of one or more peripheral circuits will generally identify the section to troubleshoot.

6-81. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications. Note that for several of the tests a logic probe could be substituted for the oscilloscope.

Oscilloscope....................................HP 1740A
DC voltmeter..................................Fluke 8840A
Logic Analyzer................................none specified

6-82. PROCEDURE.

CAUTION

When extracting or inserting the CPU board, be careful not to damage connector J2, J3, or the associated flat-cable wiring.

1. With the instrument power off, remove the CPU board (Blue Extractors). Insert the Extender board into the CPU slot and insert the CPU board into the extender board.

2. Measure the dc voltage from the ' + ' terminal of BT1 to ground. The voltage should be greater than 2.8 volts. If not, proceed to BATTERY REPLACEMENT below.

3. Turn on the instrument power and depress the INIT key if the keyboard is active.

4. Measure the dc voltage at pin 28 of U9. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L1 could cause the problem.

5. Measure the dc voltage at pins 8 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L1 could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection. A spring clip type ground connection is recommended.

6-83. CLOCK AND TIMING.

6. Connect the oscilloscope probe to pin 1 of U1. The signal should be a TTL level signal with a period of 54 nanoseconds (18.432 MHz). If not, replace defective Y1.

7. Move the oscilloscope to pin 3 of U1. The signal should be a TTL level signal with a period of 108 nanoseconds (9.21 MHz).If not, replace defective U1.

8. Move the oscilloscope to pin 6 of U1. The signal should be a TTL level signal with a period of 271 nanoseconds (3.68 MHz). If not, replace defective U1.

9. Move the oscilloscope to pin 13 of U1. The signal should be a TTL level signal with a period of 542 nanoseconds (1.84 MHz). If not, replace defective U1.

6-84. RESET and POWER FAIL.

10. Connect the oscilloscope to pin 5 of U4. The signal should be TTL logic high. If not, replace a defective U4, or U6.

11. Move the oscilloscope to pin 5 of U3. The signal should be TTL logic high. If not, replace defective U3 or U6.

12. Move the oscilloscope to pin 8 of U3. The signal should be TTL logic high. If not, replace defective U3 or U6.

13. Move the oscilloscope to pin 11 of U9. The signal should be TTL logic high. If not, replace defective U91 or U11.

14. Use a clip lead to momentarily short pin 5 of U4 to ground. Monitor the signal on pin 8 of U9. The signal should be TTL low when U4 pin 5 is ground. If not, replace defective U9.

15. Repeat the procedure but monitor the signal on pin 6 of U9. The signal should be TTL high. If not, replace defective U5.

6-85. CPU AND MEMORY.

16. If the microprocessor is halted LED DS2 will be illuminated. If this is the case a data bus fault has probably occurred. In this event a logic state analyzer is the most direct method of isolating the problem, however, parts substitution could be used as a last resort. The state of the data bus is tabulated below for the first several machine cycles. Refer to the manual for the particular logic analyzer for instructions for connecting to the DATA bus and clock signals. If data pattern errors occur the most likely problem is the eproms, however, DATA or ADDRESS bus shorts could also be the problem.

17. Remove the logic analyzer, turn off the instrument power and remove the CPU board far enough to install jumper, JP2.

18. Turn on instrument power and Monitor the activity on pins 1-4, 37-40, and 18-25 U22. The signal should be a TTL signal with a period of 47.5 milliseconds. If not replace defective U22 or isolate shorted instrument address or data bus line.

Address Bus(Hex)	D15————D00(Binary)
00000000	0000.0000.0000.0000
00000002	1000.1000.1000.1000
00000004	0000.0000.0000.0000
00000006	0000.0100.0000.0000
00000400	0010.0000.0011.1001
00000402	1010.1010.1010.1010
00000404	0101.0101.0101.0101
00000406	0010.0000.0011.1001
00000408	1111.1111.1111.1111
0000040A	0000.0000.0000.0000

6-86. A/D CONVERTER.

6-87. Proper operation of the CPU circuits is necessary for the correct operation of the A/D converter. The A/D conversion is a 13-bit successive approximation technique using a high performance 16-bit D/A converter in a software loop. To troubleshoot the A/D converter, proceed as follows:

19. Select SPCL 91 to activate the D/A converter test program.

20. Connect the oscilloscope to pin 5 of R11. The signal should be a slowly varying signal which moves from -10 to +10 volts. The oscilloscope should be dc coupled for this measurement. If not, replace defective U23.

21. Select SPCL 92 to activate the A/D measurement test program. Connect the oscilloscope probe to pin 5 of R11. The signal should be as shown in Figure 8-20,A. If not replace defective U23 or U27.

22. Move the oscilloscope probe to pin 7 of U21. The signal should be negative going TTL pulses about 1 microseconds wide occurring about every 35 microseconds. If not replace defective U27.

6-88. IEEE-488 CONTROLLER.

23. Connect the bus analyzer to the IEEE-488 bus connector on the rear panel of the Model 8200-S/10. Set the analyzer as follows:

REN	ON
MEMORY	OFF
COMP	OFF
TALK	active
EXECUTE	HALT
SRQ	0
EOI	0
ATN	0

24. Connect the oscilloscope probe to pin 9 of U24. Operate bus switch 1 on the analyzer alternately from 0 to 1. The signal should alternate between 0 and +3.5 volts. If not, the problem is in the connectors or cable connecting the bus analyzer to the CPU board.

25. Move the oscilloscope probe to pin 12 of U24 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U24 or U19.

27. Connect the oscilloscope probe to pin 2 of U25. Operate the REN switch on the analyzer alternately from 0 to 1. The signal should alternate between 0 and +3.5 volts. If not, the problem is in the connectors or cable connecting the bus analyzer to the CPU board.

28. Move the oscilloscope probe to pin 19 of U25 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U19 or U25.

29. Repeat the previous two steps for pins 3, 7, 8 and 18, 14, 13 of U25 using the bus analyzer IFC, EOI, and ATN switches. The results should be the same. If not, replace defective U19 or U25.

30. Select SPCL 97 to alternately activate the SRQ line.

31. Monitor the signal on pins 9 and 12 of U25. The signal should alternate between 0 and logic high. If not, replace defective U19 or U25.

32. Set the bus analyzer bus switches as follows:

8	7	6	5	4	3	2	1
0	1	0	1	0	0	1	0

33. Monitor the activity on pin 1 of U25 and activate the ATN line of the bus analyzer and depress the EXECUTE button. The signal should change from TTL high to low. If not, replace defective U19.

34. Monitor pin 21 of U25 and activate the bus analyzer IFC switch. Pin 1 should go high.If not, replace defective U25.

35. Set the bus analyzer bus switches as follows:

8	7	6	5	4	3	2	1
0	0	1	1	0	0	1	0

36. Set the REN switch ON, observe the signal on pin 39 of U19 and depress the EXECUTE key on bus analyzer. The signal should pulse low then return high. If not, troubleshoot the Display board.

6-89. Battery Replacement. To replace the lithium battery proceed as follows:

1. Remove the instrument top cover as described at the beginning of this section.

2. Carefully disconnect the flat cables from J2 and J3.

3. Extract the CPU board (Blue extractors) and place the board on a flat working surface with the components facing down.

4. Use a low-wattage soldering iron and a solder suction device to remove the solder from the two large circuit pads holding the battery. Remove and discard the old battery.

5. Insert the new battery into the circuit pads, observing polarity, and solder the connections.

6. Install jumpers JP1 and JP2, then replace the CPU board into the Motherboard slot. Reconnect the flat cables to J2 and J3.

7. Turn the Model 8200-S/10 ON and observe the FREQUENCY/LEVEL display until the firmware code number appears. This action clears the variable memory on the CPU board.

8. Turn off the Model 8200-S/10, extract the CPU board far enough to remove jumpers JP1 and JP2, then reseat the CPU board and replace the top cover.

6-90. TROUBLESHOOTING, COUNTER BOARD

6-91. GENERAL. Procedures for checking the COUNTER circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-21, 8-22, and 8-23.

6-92. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
DC voltmeter..................................Fluke 8840A

6-93. PROCEDURE.

1. Turn off the instrument and remove the Counter board. (Violet Extractors) Insert the Counter board into the Extender board (Grey extractors), and plug the combination back into the Counter board slot. Remove the EXT REF connection on the rear panel.

2. Turn on the instrument power and depress the INIT key if the keyboard is active.

3. Measure the dc voltage at pin 16 of U3. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L3 could cause the problem.

4. Measure the dc voltage at pins 8 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L3 could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection. A spring clip type ground connection is recommended.

6-94. GATE CIRCUITS.

1. Connect the oscilloscope probe to pin 3 of U20. The signal should be a TTL level signal with a period of 100 nanoseconds (10 MHz). If not, replace defective Y1 or check U20 or U14 for shorted pins.

2. Move the oscilloscope to pin 6 of U20. The signal should be a TTL signal with a period of 200 nanoseconds (5 MHz). If not, replace defective U20.

3. Move the oscilloscope to pin 9 of U20. The signal should be a TTL signal with a period of 400 nanoseconds (2.5 MHz). If not, replace defective U20.

4. Move the oscilloscope to pin 21 of the edge connector. The signal should be a dc level of about + 2.5 volts. If not, check for shorted EXT REF cable or defective U1.

5. Move the oscilloscope to pin 6 of U1. The signal should be TTL low logic level. If not, replace defective U1.

6. Move the oscilloscope to pin 8 of U1. The signal should be TTL high logic level. If not, replace defective U1 or check for shorted U4.

7. Move the oscilloscope to pin 2 of U1. The signal should be TTL low logic level. If not, replace defective U1 or check for shorted U4, C8, or open CR1.

8. Move the oscilloscope to pin 12 of U1. The signal should be TTL high logic level. If not, replace defective U1 or check for shorted U4.

9. Move the oscilloscope to pin 11 of U4. The signal should be a TTL signal with a period of 100 nanoseconds (10 MHz). If not replace defective U4.

10. Move the oscilloscope to pin 6 of U4. The signal should be as in the previous step. If not, replace defective U4 or check for shorted U5 or U9.

11. Move the oscilloscope to pin 7 of U5. The signal should be a TTL signal with a period of 10 microseconds (0.1 MHz). If not, replace defective U5.

12. Move the oscilloscope to pin 7 of U7. The signal should be a TTL signal with a period of 1 millisecond (1 kHz). If not, replace defective U7.

13. Move the oscilloscope to pin 9 of U8. The signal should be a TTL signal with a period of 10 milliseconds (0.1 kHz). If not, replace defective U8.

6-95. SOURCE SIGNALS.

1. Set the signal generator to 15 MHz, 0 dBm, and CW.

2. Connect the RF OUT of the generator to the RF IN of the Model 8200-S/10. Key 15 MHz into the CARRIER FREQ display. (Ignore any frequency setting errors which may occur).

3. Connect the oscilloscope probe to pin 30 of the edge connector. The signal should be a sinewave with an amplitude of about 500 millivolts peak-to-peak with a period of 26 nanoseconds. If not, the problem is in the oscillator circuits or the interconnecting cable.

4. Move the oscilloscope probe to pin 11 of U1. The signal should be as in the previous step except that the amplitude should be 3 volts peak-to-peak. If not, replace defective Q1 or check for shorted C6, CR2, or U1.

5. Move the oscilloscope probe to pin 10 of U1. The signal should be as in the previous step except that the amplitude should be 3.5 volts peak-to-peak. If not, replace defective U1 or check for shorted U9.

6. Move the oscilloscope probe to pin 32 of the edge connector. The signal should be about 700 millivolts peak-to-peak with a period of 800 nanoseconds. If not, the problem is in the RF circuits or the interconnecting cable.

7. Move the oscilloscope probe to pin 3 of U9. The signal should be as in the previous step except that the amplitude should be 3.5 volts peak-to-peak. If not, replace defective Q2 or check for shorted C5 or U9.

8. Set the generator frequency to 455 kHz and select the TUNED LEVEL carrier function. Move the oscilloscope probe to pin 34 of the edge connector. The signal should be about 2.2 volts peak-to-peak with a period of 2.2 microseconds. If not, the problem is in the 455 kHz IF circuits or the Motherboard interconnect.

9. Move the oscilloscope probe to pin 7 of AR1. The signal should be as a square wave with an amplitude of 5 volts peak-to-peak and a period of 2.2 microseconds. If not, replace defective AR1 or check for shorted U1 or U2.

10. Move the oscilloscope probe to pin 4 of U1. The signal should be as in the previous step except that the signal swings should be TTL. If not, replace defective U1 or check for shorted U9.

6-96. COUNTER CHAIN, DECODER, and BUS BUFFERS.

1. Disconnect the Generator signal and depress the INIT key on the front panel of the Model 8200-S/10.

2. Use the oscilloscope to monitor the activity on the instrument data lines ID0-ID7 on pins 1-8 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Select SPCL 93 to activate the counter test program.

4. Connect the oscilloscope to the indicated pin of U3. The strobe signal should be a negative going TTL pulse. If not, check the activity on the instrument address bus IA2-IA7 on pins 11-16 of the edge connector. The correct signals are tabulated below. If these signals are not correct, the problem is on the CPU board, otherwise replace defective U3. State of instrument address lines IA2-IA5 while IA6 is high and the corresponding strobe signal.

IA2	IA3	IA4	IA5	Strobe(U3)
low	low	low	high	pin 15
high	low	low	high	pin 14
low	high	low	high	pin 13
high	high	low	high	pin 12

State of instrument address lines IA2-IA5 while IA7 is high and the corresponding strobe signal.

IA2	IA3	IA4	IA5	Strobe(U3)
high	high	low	high	pin 7

5. Connect the oscilloscope to pin 11 of U10. The signal should be TTL composite signal consisting of one waveform with a period of 25 nanoseconds gated off temporarily about every 2.5 seconds. If not, replace defective U9 or U10.

6. Connect the oscilloscope to pin 13 of U10. The signal should be negative TTL pulse signal occurring about every 2.5 seconds indicating proper counter reset action. If not, check bus buffer U15 by monitoring pins 9 and 8 for activity. If these signals are not correct, the problem is most likely on the CPU board.

7. Move the oscilloscope probe to pin 2 of U11. The signal should be as in the previous step, except the pulse is positive going. If not, replace defective U11 or check for shorted U14.

8. Move the oscilloscope probe to pin 9 of U10. The signal should be TTL composite signal consisting of one waveform with a period of 50 nanoseconds gated off temporarily every 2.5 seconds. If not, replace defective U10 or check for shorted U19.

9. Move the oscilloscope probe to pin 5 of U10. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U10 or check for shorted U19.

10. Move the oscilloscope probe to pin 5 of U12. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U12 or check for shorted U19.

11. Move the oscilloscope probe to pin 9 of U12. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U12 or check for shorted U19.

12. Repeat the above step for pins 9, 7, 6, 5, 3, 2, 4, 13, 12, 14, 15, and 1 of U14. In each case the higher frequency signal component should reduce in frequency by a factor of two for each pin. If not, replace defective U14, or check for shorted U19 or U18.

13. Repeat the above step for pins 9, 7, 6, 5, 3, 2, 4, 13, 12, 14, and 15 of U13. In each case the higher frequency signal component should reduce in frequency by a factor of two for each pin. If not, replace defective U13, or check for shorted U16 or U17.

14. If all of the above checks are correct, but the counter still does not operate properly, the problem is with the bus buffers U16-U19. Isolate the problem by interchanging or replacing the buffers one at a time.

6-97. CALIBRATOR CIRCUITS.

1. Connect the oscilloscope probe to pin 9 of U22. The signal should be a TTL waveform with a period of 800 nanoseconds (1.25 MHz). If not, replace defective U22.

2. Move the oscilloscope probe to pin 15 of U22. The signal should be a TTL waveform with a period of 800 microseconds. (1.221 kHz). If not, replace defective U22.

3. Move the oscilloscope probe to pin 12 of U11. The signal should be as in the previous step. If not, replace defective U11 or check for shorted U24.

4. Move the oscilloscope probe to pin 11 of U23. The signal should be a complex TTL waveform with two distinct frequency components. Synchronize the oscilloscope on the negative slope of the signal and adjust the timebase to 0.2 uSEC/DIV. The display should show one signal with a period of 4 divisions and one with a period of 5 divisions. If not, replace defective U23 or check for shorted U24.

5. The signals on pins 2 and 14 of U24 control the output signals on pins 7 and 9. The logic levels and corresponding outputs are tabulated below.

Pin numbers:

2	14	7	9
low	low	low	low
low	high	1.25 MHz	1.221 kHz
high	low	1.0/1.25 MHz	high
high	high	low	low

When the calibration routine is activated, the progression is from line 1 to line 2 to line 3 of the above table. Execute the calibration routine by recalling program number -1 and observe the results. The signals should be as indicated. If not, replace defective U24 or bus buffer U15.

6. Execute the calibration routine by recalling program number -1. The initial phase of calibration is the AM detector calibration. The signals indicated in the following tests are measured during this initial phase. If the tests are not completed in the time required for one AM calibration cycle, depress the INIT key and then recall program -1 to resume AM calibration.

7. Connect the oscilloscope to pin 3 of AR3. The signal should be a sinewave with an amplitude of 2 volts peak-to-peak and a period of 800 nanoseconds. If not, isolate the defective component in low-pass filter L5-L6, and C17, C18, and C20 by waveform measurements.

8. Move the oscilloscope to pin 6 of AR3. The signal should be a sinewave with an amplitude of 6.4 volts peak-to-peak and a period of 800 nanoseconds. If not, replace defective AR3.

9. Move the oscilloscope to pin 2 of U20. The signal should be as in the previous step, except the amplitude should be 4.8 volts peak-to-peak. If not, replace defective R20 or U21.

10. Move the oscilloscope to pin 15 of U20. The signal should be as in the previous step, except the amplitude should be 1.6 volts peak-to-peak. If not, replace defective R20 or U21.

11. Move the oscilloscope to pin 1 of U21. The signal should be a TTL waveform with a a period of 800 microseconds. If not, check for shorted C19 or open R26 or shorted U21.

12. Move the oscilloscope to pin 3 of U21. The signal should be a sinewave with a period of 800 nanoseconds amplitude modulated by a squarewave with a period of 800 microseconds. The carrier amplitude should have two distinct levels, 1.6 and 4.8 volts peak-to-peak. If not, replace defective U21.

13. Move the oscilloscope to pin 6 of AR2. The signal should be as in the previous step, except the amplitude should be 0.4 and 1.2 volts peak-to-peak. If not, replace defective AR2.

14. If the above tests are all correct, but the problem persists, the trouble is with the RF circuits, or the interconnecting cable.

6-98. TROUBLESHOOTING, I/O BOARD

6-99. GENERAL. Procedures for checking the I/O circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-24 and 8-25.

6-100. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope.................................... HP 1740A
DC voltmeter .... Fluke 8840A

6-101. PROCEDURE.

1. With the instrument power off, remove the top and bottom covers.

2. Remove the right side strap handle by removing two 6-32 screws holding the handle covers, and three 6-32 screws holding the handle extrusion.

3. Turn on the instrument power and depress the INIT key if the keyboard is active.

4. Measure the dc voltage at pin 40 of U3. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or defective power connector, J2 could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection.

6-102. ADDRESS DECODER.

1. Connect the oscilloscope probe to pin 1 of U1. The signal should be a series of negative going TTL pulses indicating board selection. If not, the problem is on the CPU board or the interconnecting wiring.

2. Move the oscilloscope to pins 2 and 3. Observe a TTL signal indicating activity on the CPU address bus. If not, the problem is on the CPU board or the interconnecting wiring.

3. Move the oscilloscope to TP1. The signal should be a negative going TTL pulse indicating chip select activity for U2. If not, replace defective U1.

4. Move the oscilloscope to TP3. The signal should be a negative going TTL pulse indicating chip select activity for U3. If not, replace defective U1.

6-103. DISPLAY/KEYBOARD CONTROLLERS.

1. Connect the oscilloscope probe to pin 3 of U3. The signal should be a TTL logic waveform with a period of 400 nanoseconds. If not, the problem is on the CPU board or the interconnecting wiring.

2. Move the oscilloscope probe to pin 9 of U3. The signal should be a TTL low dc level indicating proper reset circuit operation. If not, the problem is on the CPU board or the interconnecting wiring.

3. Move the oscilloscope probe to pin 21 of U3. The signal should be a TTL logic waveform indicating proper operation of the CPU A1 address line. If not, the problem is on the CPU board oth the interconnecting wiring.

4. Move the oscilloscope probe to pins 10 and 11 of U3. The signal should be a TTL logic waveform indicating proper operation of the CPU read and write lines. If not, the problem is on the CPU board oth the interconnecting wiring.

5. Move the oscilloscope probe to pin 22 of U3. The signal should be a negative going TTL pulse indicating read and write activity. If not, the problem is in the decoder section. See above.

6. Move the oscilloscope probe to pin 22 of U2. The signal should be as in the previous step. If not, the problem is in the decoder section. See above.

7. Enter 1 GHz into the CARRIER FREQ display and monitor the activity on pins 23-35 of U3. The signals should be TTL logic waveforms indication proper multiplexing of the display information. If not, replace defective U3 or check for shorted connections in J3.

NOTE

The I/O board may be removed if necessary to isolate a defective J3 or Display board.

8. Repeat the measurements of step 7 on U2. The results should be the same. If not, replace defective U2 or proceed as in the previous step.

9. Move the oscilloscope probe to pin 38 of U2 and hold down the 3 kHz low-pass key. The signal should be a negative going TTL pulse indicating correct operation of the keyboard decoder. If not, the problem is on the display or keyboard.

10. Repeat the previous step with the following pins and keys:

U2 pin number	key depressed
39	15kHz
1	20 kHz
2	50 kHz
5	220 kHz
6	HOLD
7	RMS
8	√2RMS

6-104. TROUBLESHOOTING, DISPLAY/KEYBOARD

6-105. GENERAL. Procedures for checking the DISPLAY/KEYBOARD circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-26 through 8-30.

6-106. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope .... HP 1740A
DC voltmeter .... Fluke 8840A

6-107. PROCEDURE.

1. With the instrument power off, remove the top and bottom covers. Extract the CPU (blue extractors) far enough to install jumper JP1, then reseat the CPU board.

2. Remove the display and front panels as described above to gain access to the display and keyboards.

3. Turn the instrument power ON. The instrument should power up normally, and then illuminate all displays, annunciators, and keyswitch LEDs. If any of the display segments or individual LEDs are not illuminated the associated display or switch LED is most likely defective. Groups of displays with missing segments or groups of keyswitch LEDs not illuminated indicates a defective driver or decoder.

4. Turn the instrument power OFF and remove the keyboard by removing eight 6-32 screws and gently pulling the board away from the display board.

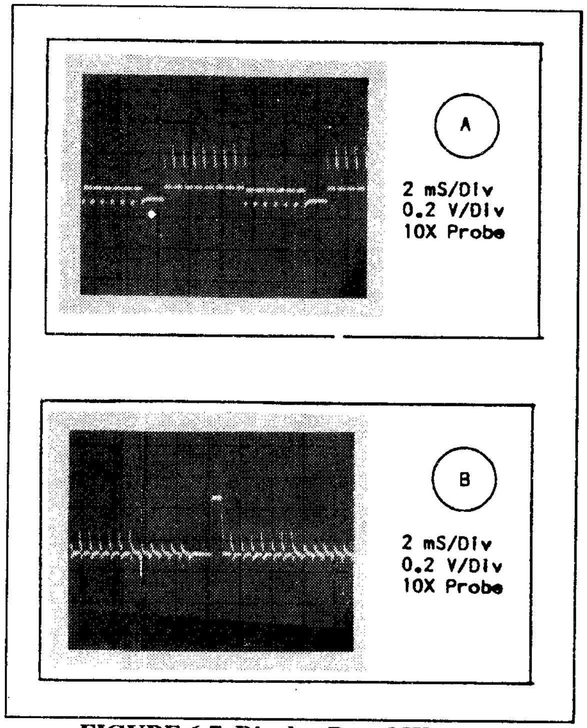


FIGURE 6-7. Display Board Waveforms.

5. Turn the instrument power ON and measure the dc voltage at pin 20 of U13. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or defective power connector, J4 on the I/O board could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection.

6-108. FREQUENCY/LEVEL AND MODULATION (LEFT 2 DIGITS) DISPLAYS.

1. Connect the oscilloscope probe to pins 1 through 8 of U1 and verify that the segment drive signals are active. If not, the problem is on the I/O board or connector P3.

2. Move the oscilloscope to pins 11-18 of U1. The signal should appear as in Figure 6-7,A. If not, replace defective U1.

3. Repeat the measurements of the previous step on U3. The results should be the same. If not, replace defective U3.

4. Move the oscilloscope probe to pin 1 of of U2. The signal should be a TTL squarewave with a period of 1.3 milliseconds, indicating correct operation of the display controllers on the I/O board. If the signal is not present, the problem is on the I/O board or the connector P3.

5. Repeat the previous step for pins 2, 3, and 5 or U2. The signal is similar with a period of 2.5, 5, and 10 milliseconds respectively. If the signals are not present, the problem is on the I/O board or the connector P3.

6. Move the oscilloscope to pin 15 of U2. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 10 milliseconds. If not, replace defective U2.

7. Repeat the previous step for pins 7, and 9 through 14 of U2. The results should be the same. If not, replace defective U2.

8. Repeat the previous step for pins 7, and 9 through 15 of U4. The results should be the same. If not, replace defective U4.

9. Move the oscilloscope to pin 18 of U5. The signal should be as in the previous step. If not, replace defective U5.

10. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, and 16 of U5. The results should be the same. If not, replace defective U5.

11. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, 16, and 18 of U24. The results should be the same. If not, replace defective U24.

12. Move the oscilloscope to pin 1 of U5. The signal should be a negative going TTL pulse 150 microseconds wide occurring every 0.64 milliseconds, indicating correct operation of the display controller blanking signal on the I/O board. If not, the problem is on the I/O board or connector, P3.

13. Move the oscilloscope to pin 18 of U7. The signal should be as in Figure 6-7,B. If not, replace defective U7.

14. Repeat the previous step for pins 11 through 17 of U7. The results should be the same. If not, replace defective U7.

15. Repeat the previous step for pins 13 through 18 of U8. The results should be the same. If not, replace defective U8.

6-109. MODULATION, SPCL/PRGM, AND KEYSWITCH LEDS.

1. Connect the oscilloscope probe to pins 1 through 8 of U9 and verify that the segment drive signals are active. If not, the problem is on the I/O board or connector P3.

2. Move the oscilloscope to pins 11-18 of U9. The signal should appear as in Figure 6-7,A. If not, replace defective U9.

3. Repeat the previous step using U11. The results should be the same. If not, replace defective U11.

4. Move the oscilloscope probe to pin 1 of of U10. The signal should be a TTL squarepwave with a period of 1.3 milliseconds, indicating correct operation of the display controllers on the I/O board. If the signal is not present, the problem is on the I/O board or the connector P3.

5. Repeat the previous step for pins 2, 3, and 5 or U10. The signal is similar with a period of 2.5, 5, and 10 milliseconds respectively. If the signals are not present, the problem is on the I/O board or the connector P3.

6. Move the oscilloscope to pin 15 of U10. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 10 milliseconds. If not, replace defective U10.

7. Repeat the previous step for pins 7, and 9 through 14 of U10. The results should be the same. If not, replace defective U10.

8. Repeat the previous step for pins 7, and 9 through 15 of U12. The results should be the same. If not, replace defective U12.

9. Move the oscilloscope to pin 18 of U13. The signal should be as in the previous step. If not, replace defective U13.

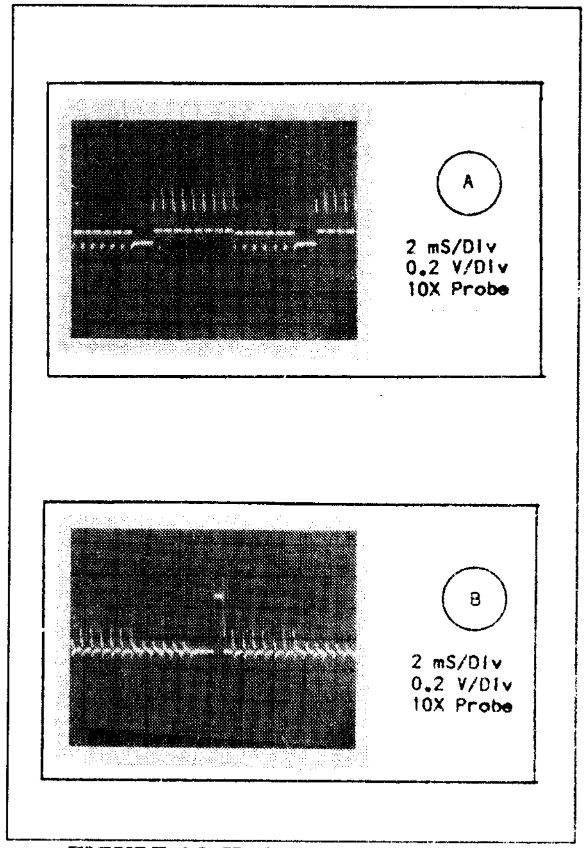


FIGURE 6-8. Keyboard Board Waveforms.

10. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, and 16 of U13. The results should be the same. If not, replace defective U13.

11. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, 16, and 18 of U14. The results should be the same. If not, replace defective U14.

12. Move the oscilloscope to pin 1 of U13. The signal should be a negative going TTL pulse 150 microseconds wide occurring every 0.64 milliseconds, indicating correct operation of the display controller blanking signal on the I/O board. If not, the problem is on the I/O board or connector, P3.

13. Move the oscilloscope to pin 18 of U15. The signal should be as in Figure 6-7,B. If not, replace defective U15.

14. Repeat the previous step for pins 11 through 17 of U15. The results should be the same. If not, replace defective U15.

15. Repeat the previous step for pins 11, and 14 through 18 of U16. The results should be the same. If not, replace defective U16.

16. Replace the keyboard, but do not replace the mounting hardware at this time.

6-110. KEYBOARD.

1. Connect the oscilloscope probe to pins 1 through 8 of J1 and verify that the segment drive signals are similar to Figure 6-8,A. If not, the problem, is on the Display board or connector J1.

2. Move the oscilloscope to pins 9-13 of J1. The signal should be a appear as in Figure 6-8,B. If not, the problem is on the Display board or connector J1.

3. Move the oscilloscope to pins 1 through 8 of J2. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 5 milliseconds. If not, the problem is on the Display board or connector J2.

4. Move the oscilloscope to pin 13 of J2 and depress the PRGM key. The signal should be as in the previous step while the key is depressed. If not, the keyswitch is defective.

5. Refer to the schematic diagram for the keyboard and observe the signals on the RL lines as the keyswitches are operated. When none of the keyswitches is depressed, the RL lines should be at TTL high. When the switches are depressed the strobe signal described in the previous steps should be present.

6. Replace the keyboard mounting hardware and reassemble the front panel and display windows.

6-111. TROUBLESHOOTING, 455 KHZ IF SYSTEM

6-112. GENERAL. Procedures for checking the 455 KHZ IF circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-31 through 8-37.

6-113. EQUIPMENT REQUIRED. The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope....................................HP 1740A
DC voltmeter..................................Fluke 8840A
Signal Generator............................SG1207/U

6-114. PROCEDURE.

1. With the instrument power off, remove the top and bottom covers. Remove the two #4 screws holding the 455 kHz IF assembly housing.

2. Without disconnecting the RF cable at the left of the housing, carefully remove the housing from the instrument and remove the front and rear cover shields. Place the assembly on the extender board and reseat the assembly in the mother-board connector.

3. Set the Test generator to 455 kHz at -50 dBm and connect the RF OUT to the RF IN connector of the Model 8200-S/10.

4. Turn the instrument power ON. After the power sequence completes, select TUNED LEVEL.

5. Measure the dc voltage at pin 20 of A15A1U4. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open inductor A15A1L3 could cause the problem.

6. Measure the dc voltage at pins 7 and 4 of A15A1U9. The voltage should be +15 and -15 volts respectively. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open inductors A15A1L1 or L2 could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection.

6-115. IF AMPLIFIER, A15A3.

7. Connect the oscilloscope probe to A15A3, TP2. TP8 can be used as a convenient ground point. The signal should be a sinewave, about 200 millivolts peak-to-peak, with a period of 2.2 microseconds. If not, replace defective amplifier U1 or check for open or shorted RF cables. Additionally, RF switch S1, located on the front panel could be defective.

8. Move the oscilloscope to A15A3, TP3 and enter SPCL 41 to hold the IF attenuator range. The signal should be as in the previous step, except the amplitude is 180 millivolts. If not, replace defective U1, or troubleshoot amplifier Q3 and Q4 using DC and waveform measurememts.

9. Enter SPCL 43. The signal should be as in the previous step, except the amplitude should be about 1.8 volts peak-to-peak. If not, replace defective U1, or proceed to logic troubleshooting for additional tests.

10. Move the oscilloscope probe to A15A3, TP4. The signal should be as in the previous step. If not, replace defective U2, or troubleshoot amplifier Q5 and Q6 using DC and waveform measurememts.

11. Decrease the input level to -50 dBm and enter SPCL 45. The signal should be as in the previous step. If not, replace defective U2, or proceed to logic troubleshooting for additional tests.

12. Move the oscilloscope probe to A15A3, TP5. The signal should be as in the previous step, except the amplitude should be 0.6 volts peak-to-peak. If not, replace defective U30, or troubleshoot amplifier Q7 and Q8 using DC and waveform measurememts.

13. Enter SPCL 46. The signal should be as in the previous step, except the amplitude should be about 1.8 volts peak-to-peak. If not, replace defective U30, or proceed to logic troubleshooting for additional tests.

14. Decrease the input signal to -60 dBm and enter SPCL 47. The signal should be as in the previous step. If not, replace defective U30, or proceed to logic troubleshooting for additional tests.

15. Move the oscilloscope probe to A15A3, TP6. The signal should be as in the previous step. If not, check for shorted C13 or C21, or open C14, C16, C18, or C20, or open L1-L5.

6-116. IF DETECTOR BOARD.

16. Move the oscilloscope probe to A15A2, TP3. Temporarily short either end of A15A2, L9 to the ungrounded end of R29. Decrease the input level to -70 dBm. The signal should be as in the previous step, except the amplitude should be about 3.5 volts peak-to-peak. If not, troubleshoot amplifier U1 and Q7 using DC and waveform measurememts.

17. Decrease the input level to -80 dBm. Move the oscilloscope to the junction of CR10 and R50. The signal should be half-wave rectified with a period of 2.2 microseconds and an amplitude of 4.5 volts peak-to-peak. If not, troubleshoot active-detector Q8-Q10 using DC and waveform measurememts.

18. Move the oscilloscope to pin A15A2, TP6. The signal should be about 3 volts DC. If not, replace defective U8, or check for shorted C32.

19. Move the oscilloscope probe to A15A2, TP7. The signal should be a sinewave, 2 volts peak-to-peak, with a period of 2.2 microseconds. If not, troubleshoot oscillator Q1 and associated components using DC and waveform measurememts.

20. Move the oscilloscope probe to A15A2, TP1. The signal should be a sinewave, 3.7 volts peak-to-peak, with a period of 2.2 microseconds. If not, troubleshoot amplifier Q2 and associated components using DC and waveform measurememts, or replace defective U3.

21. Move the oscilloscope probe to A15A2, TP2. The signal should be as in the previous step. If not, troubleshoot amplifier Q2 and associated components using DC and waveform measurememts, or replace defective U4.

22. Move the oscilloscope probe to A15A2U3, pin 12. The signal should be a sinewave, 0.5 volts peak-to-peak, with a period of 1.1 microseconds The DC level should be zero volts. If not, replace defective U3.

23. Move the oscilloscope probe to A15A2, TP4. The signal should be a DC level between +10 and -10 volts. If not, replace defective U2.

24. Move the oscilloscope probe to A15A2U5, pin 12. The signal should be a sinewave, 0.5 volts peak-to-peak, with a period of 1.1 microseconds riding on a DC level of about -3 volts. If not, replace defective U5.

25. Enter SPCL 40 and allow the TUNED LEVEL reading to settle. Move the oscilloscope probe to A15A2, TP5. The signal should be a DC level of about +4 volts. If not, replace defective U7.

26. Move the oscilloscope probe to A15A2, TP8. The signal should be a sinewave, 0.45 volts peak-to-peak with a period of 2.2 microseconds. IF not, troubleshoot amplifier Q3 and associated components using DC and waveform measurements.

23. Disconnect the input signal and remove the temporary connection between L9 and R29. The sinewave signal at TP8 should disappear.

6-117. LOGIC SIGNALS. Proper operation of the 455 kHz IF circuits depend on correct logic levels on the following control lines:

IA2-IA7 ....instrument address bus
ID0-ID7 ....instrument data bus

6-118. The instrument addresss lines IA2-IA5 are decoded by A15A1, U1 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals on the instrument data bus are transferred into octal latch, U2, when addresses IA2, IA4, and IA5 are low, and IA3 is high, and IA7 goes from high to low. Similarly data is transferred into U3 when address when IA4 and IA5 are low and IA2 andIA3 are high, and IA7 goes from high to low.Data is transferred into U4 when address IA4 is high and IA2, IA3, and IA5 are low, and IA7 goes from high to low. To troubleshoot the logic circuits proceed as follows:

1. With the Model 8200-S/10-S/10 powered up normally and configured as in the troubleshooting section, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the Test Generator to -30 dBm at 455 kHz. SPCL 41 and SPCL 23.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 2 of U4 and temporarily remove the 455 kHz input signal. The signal should change from a TTL low to high. If not, replace defective U4.

7. Move the oscilloscope probe to pin 2 of U6 and repeat the previous step. The signal should change from -15 volts to zero volts. If not, replace defective U6.

8. Move the oscilloscope probe to pin 1 of U6. The signal should be at -15 volts. If not, replace defective U6.

9. Enter the following SPCL functions and observe the signals on pins 2, 5, 6, 9, and 12 of U3.

SPCL	PIN 2	PIN 5	PIN 6	PIN 9	PIN 12
41	high	high	high	low	high
42	high	high	low	high	high
43	high	high	high	low	low
44	high	high	low	high	low
45	low	high	high	low	low
46	low	high	low	high	low
47	low	low	high	high	low (may change if ranging is operating)

If the indications are incorrect, replace defective U3.

10. Enter the following SPCL functions and observe the signals on pins 2, and 5 of U2.

SPCL	PIN 2	PIN 5
5	high	high
6	high	low

11. Observe the signals on pins 15, 16, and 19 of U3 while reducing the imput signal level slowly over a 10 dB range. All of the pins should show a change of TTL level during the level change. If not replace defective U3.

6-119. ADJUSTMENTS.

6-120. The instrument adjustments are listed below. The adjustment sequence is not critical, however, the RF adjustments would normally be done first.

6-121. RF board Adjustments. There are four adjustments associated with the RF circuit board. These are:

ADJUSTMENT	PURPOSE
R14	sampling bridge balance
R11	sampling bridge bias, low bands
R6	sampling bridge bias, high bands

Adjustment	Circuit Board
Sampler balance, R14	RF Board
Sampler bias, R11	RF Board
Sampler bias, R6	RF Board
Flatness, C78	RF Board
Oscillator, T2	Oscillator Board
Oscillator, T3	Oscillator Board
Discriminator, R19	Oscillator Board
AM detector, R85	AM Board
220 kHz gain, R5	Filter Board
DC balance, R13	Filter Board
< 10Hz gain, R18	Filter Board
RMS response, C23	Detector Board
IF filter response, L1-L5	IF Amplifier Board
IF filter slope, C40	IF Amplifier Board
IF filter Flatness, R38	IF Amplifier Board
IF Oscillator Frequency, L3	IF Detector Board
IF Detector Gain, R21	IF Detector Board
IF Phase Adjust, R26	IF Detector Board
IF PLL offset Adjust, R83	IF Detector Board

C78 ....IF flatness

6-122. Equipment Required. The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

Oscilloscope..................................HP 1740A
Signal Generator SG1207/U
Power Meter ....Boonton 4200
Low-pass Filter..............................Mini-Circuits NLP-50

6-123. Procedure.

1. Connect the power meter to the RF IN connector of the Model 8200-S/10 and set the CARRIER FREQ to 11.0 MHz. Adjust R14 for a minimum power indication.

2. Set the signal generator to 9.9 MHz, +10 dBm, and about 100 kHz deviation at a 1 kHz rate. Set AM modulation to OFF.

3. Depress the INIT key and enter 9.9 MHz into the carrier FREQ display. Select the 300 Hz high-pass, 3 kHz low-pass, and de-emphasis OFF filters.

4. Connect the generator, through the low-pass filter, to the RF IN connector of the Model 8200.

5. Adjust the generator deviation for a Model 8200-S/10 indication of 100 +- 5 kHz deviation.

6. Set the oscilloscope to 0.05 V/DIV and 0.5 mSEC/DIV and connect the Model 8200-S/10 AF OUT to the vertical input of the oscilloscope using a shielded BNC cable.

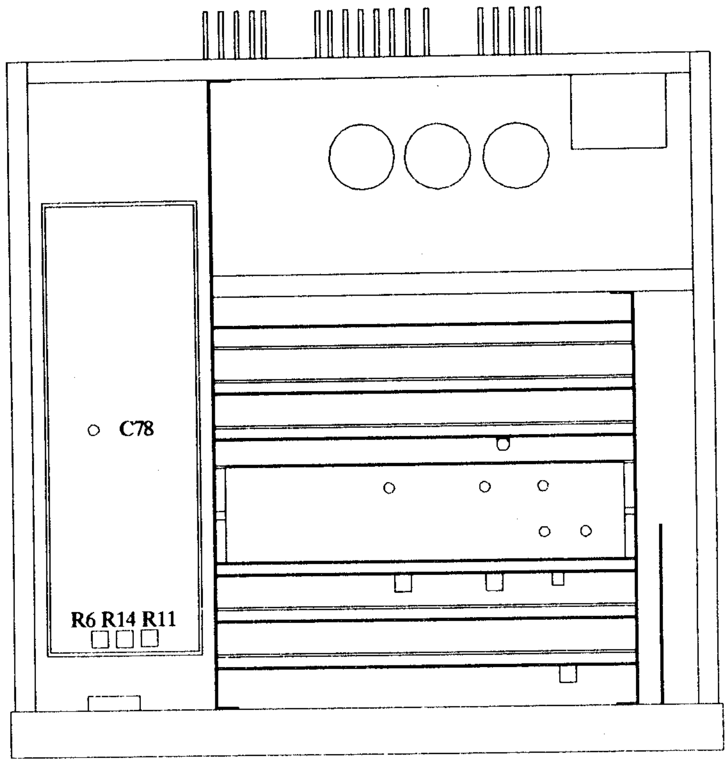
7. Depress the MODULATION AM key and adjust R11 for minimum peak-to-peak deflection on the oscilloscope.

8. Change the generator and Model 8200-S/10 frequency to 18.5 Mhz.

9. Adjust C78 for minimum peak-to-peak deflection on the oscilloscope.

10. Change the generator and Model 8200-S/10 frequency to 10.02 Mhz.

11. Adjust R6 for minimum peak-to-peak deflection on the oscilloscope. Note R6 may be at or near one end when the deflection is minimum.



6-124. Oscillator Board Adjustments. There are three adjustments on the Oscillator circuit board. These are:

ADJUSTMENT	PURPOSE
T2	Oscillator 1 tuning
T3	Oscillator 2 tuning
R19	Discriminator centering

6-125. Equipment Required. The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

Signal Generator	SG1207/U
DC voltmeter	Fluke 8840A

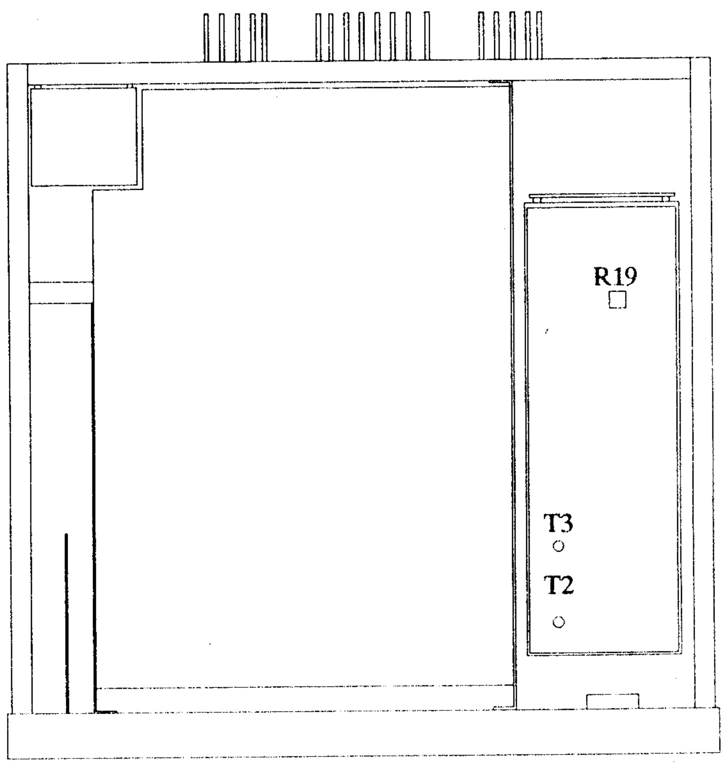
6-126. Procedure.

1. Select SPCL 90 to activate the local oscillator test program. Depress the CLR key until the modulation display reads " 0 -- LO" .

2. Use a nonmetallic screw driver to adjust the slug in T2 until the CARRIER display indicates 19.9 +- 0.05 MHz.

3. Depress the CLR key until the modulation display reads " 1 -- LO".

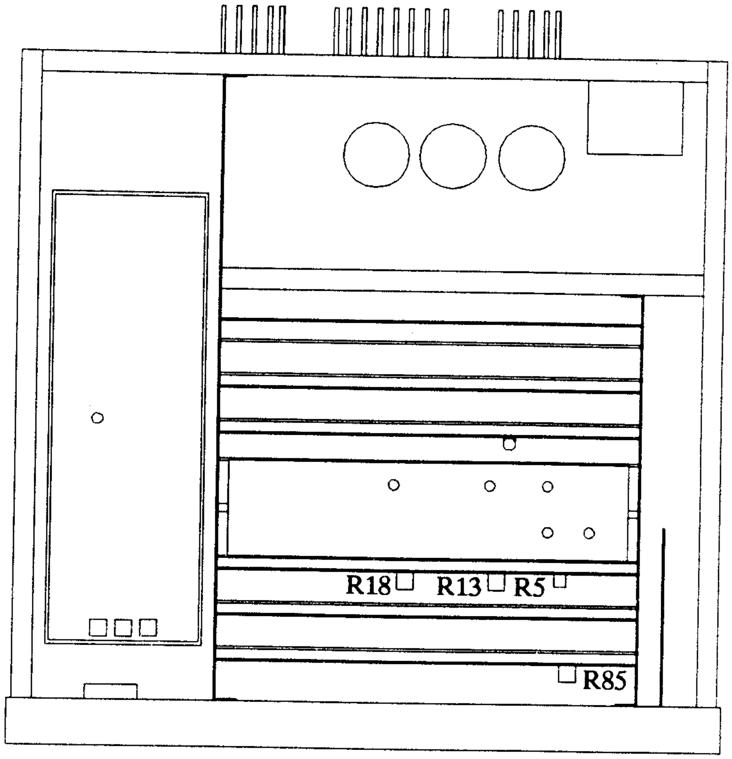
4. Use a nonmetallic screw driver to adjust the slug in T3 until the CARRIER display indicates 23.8 +- 0.05 MHz.



5. Depress the LCL/INIT key, enter 15 MHz into the carrier FREQ display, and connect the signal generator RF OUT to the Model 8200-S/10 RF IN connector.

6. Set the generator frequency to 1.211 MHz CW and 0 dBm.

7. Monitor the dc voltage at TP1 and adjust R19 for an indication of 0 +- 0.02 volts.



6-127. AM Board Adjustments.

6-128. One adjustment is required on the AM circuit board. R85, the AM detector offset control. It is adjusted to remove dc offsets from the circuitry between the active detector and the AM OUT signal.

6-129. Equipment Required.

6-130. No additional equipment is required to make the adjustment.

6-131. Procedure.

1. Power on the Model 8200-S/10 and depress the INIT key.

2. Enter 15 MHz into the carrier FREQ display, 50 kHz into the modulation display, and enter SPCL 9 to activate the native mode level display, and then depress the TUNED LEVEL key.

3. Observe the CARRIER display and adjust R85 full clockwise, and then counter-clockwise for an indication of - 70.8 dBm. Note that the indication will jump in approximately 1 dB increments during the adjustment.

6-132. Filter Board Adjustments. There are three adjustments on the FILTER circuit board. These are:

ADJUSTMENT	PURPOSE
R5	220 kHz low-pass gain
R13	AR1 dc balance adjust
R18	high-pass gain

6-133. Equipment Required. The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

Audio Analyzer	Boonton 1120
DC voltmeter	Fluke 8840A

6-134. Procedure.

1. With the instrument power off, remove the Filter board (Pink extractors) from the instrument, place it on the extender card (Grey extractors) and return the combination to the Filter board slot.

2. Extract the FM board (Brown extractors) only far enough to disconnect the card-edge connector.

3. Set the audio analyzer to 60 millivolts at a 1 kHz rate.

4. Connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8200-S/10.

5. Turn on the instrument power and depress the INIT key. Enter 15 MHz into the carrier FREQ display and SPCL 33 to hold the 500.0 modulation range.

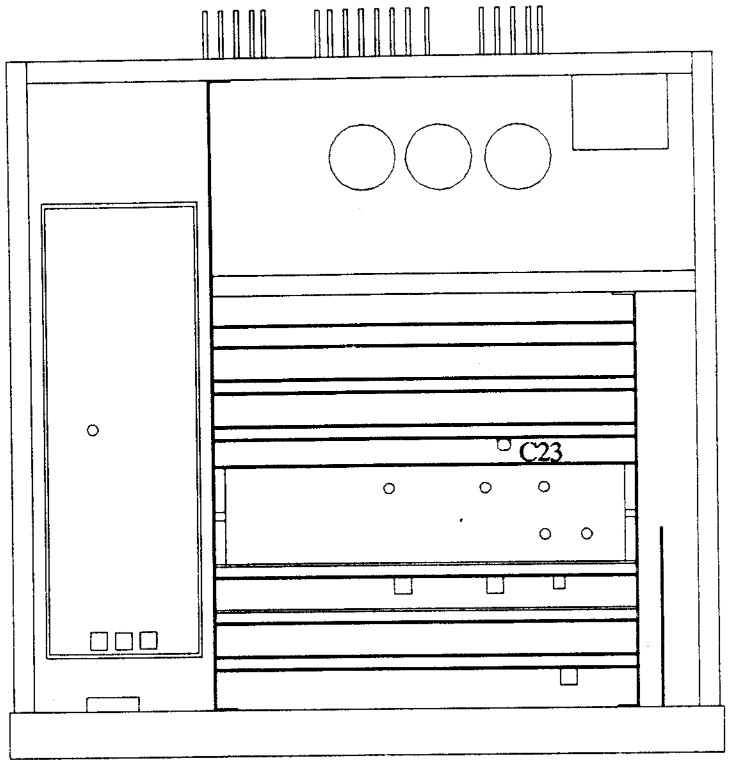
6. Connect the voltmeter to TP2 and adjust R13 for an indication on 0.0 +- 0.002 volts.

7. Select the MODULATION FM function and enter SPCL 30 to enable modulation autoranging. Increase the audio analyzer source level to 600 millivolts.

8. Connect the audio analyzer HIGH input to pin 35 of the edge connector and select the audio analyzer LEVEL display. Select the Model 8200-S/10 50 kHz low-pass filter and wait for a settled reading on both instruments.

9. Select the RATIO function on both instruments. The displays should both indicate 100.0%.

10. Depress the Model 8200-S/10 220 kHz low-pass key and adjust R5 until the ratio indication on the Model 8200-S/10 display and the audio analyzer agree.



11. Select the < 10 high-pass filter and adjust R18 for the same indication as in the previous step.

12. Turn the instrument power OFF and replace the Filter board in the Motherboard connector.

6-135. Detector Board Adjustments. There is one adjustment on the DETECTOR circuit board. This is:

ADJUSTMENT ....PURPOSE
C23 ....RMS detector frequency response

6-136. Equipment Required. The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

Audio Analyzer................................Boonton 1120
DC voltmeter....................................Fluke 8840A

6-137. Procedure.

1. With the instrument power off, extract the FM board (Brown extractors) only far enough to disconnect the card-edge connector.

3. Set the audio analyzer to 600 millivolts at a 1 kHz rate.

4. Connect the audio analyzer source to the FM OUT connector on the rear panel of the Model 8200-S/10.

5. Turn on the instrument power and depress the INIT key.

6. Enter 15 MHz into the carrier FREQ display, and select the 220 kHz low-pass filter. When the MODULATION display settles, select the RATIO % display mode.

7. Set the audio analyzer to 100 kHz and note the MODULATION RATIO indication.

8. Change the audio analyzer frequency back to 1 kHz and select the √2RMS detector. Depress the RATIO key twice to restore the 100.0 % indication.

9. Set the audio analyzer to 100 kHz and adjust C23 until the ratio indication on the Model 8200-S/10 display is 100.0%.

10. Turn the instrument power OFF and remove the audio analyzer connection. Reseat the FM board into the motherboard connector.

6-138. IF Amplifier Board Adjustments. There are seven adjustments on the IF Amplifier circuit board. These are:

ADJUSTMENT	PURPOSE
C40	IF filter slope adjust
R38	IF filter flatness adjust
L1-L5	IF filter response adjust

6-139. Equipment Required. The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

Test Generator	Boonton Model 1020/21/30
Oscilloscope	HP 1740, with 10X probe

6-140. Procedure.

1. Connect the Test Generator MOD OSC out to the channel B input of the Oscilloscope, DC couple channel B and adjust the sensitivity to 1 V/div.

2. Connect the Receiver Sensor, with the Adapter Pad installed, to the output of the Test Generator and set the Test Generator to 30 MHz center frequency at 6 dBm.

3. On the 8200-S/10 recall program location 99 to initialize the instrument.

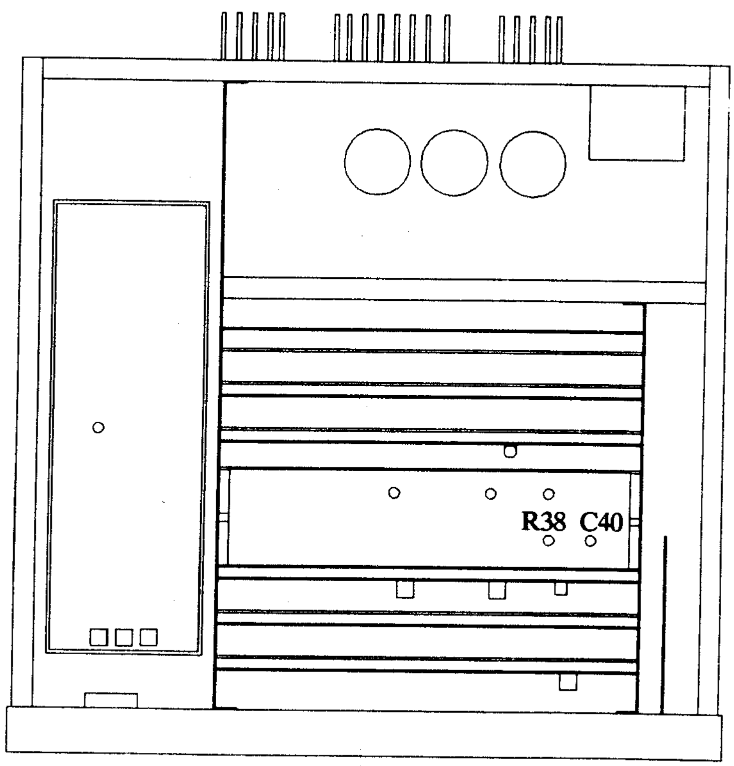
4. After the carrier frequency is displayed and settles select TUNED LEVEL and enter SPCL 44.

5. Set the Test Generator to sweep + - 25 kHz.

6. Connect the channel A input of the Oscilloscope to A15A3 IF Amplifier Board, TP5 using the 10X probe and adjust the sensitivity to 500 mV/div.

7. Remove the jumper, JP1 from J16 and connect to J12.

8. Adjust L1 for a peak 1 division to the right of the center marker. Refer to Fig. 6-9,A.



9. Remove the jumper, JP1 from J12 and connect to J13.

10. Adjust L2 for a null 0.2 divisions to the right of the center marker. Refer to Fig 6-9,B.

11. Remove the jumper, JP1 from J13 and connect to J14.

12. Adjust L3 for a peak 0.2 divisions to the right of the center marker. Refer to Fig 6-9,C.

13. Remove the jumper, JP1 from J14 and connect to J15.

14. Adjust L4 for a null 0.2 divisions to the right of the center marker. Refer to Fig 6-9,D.

15. Remove the jumper, JP1 from J15 and connect to J16.

16. Adjust C40, filter slope, such that the adjustment slot is perpendicular to the circuit board.

17. Connect the channel A input of the Oscilloscope to A15A1 Detector Interface Board, TP2 using the 10X probe, adjust the sensitivity to 50 mV/div and AC couple the input.

18. Set the Test Generator to sweep +- 5 kHz.

19. Alternately adjust R38 and L5 for pass-band ripple of less than 1 division (<1%).

6-141. IF Detector Board Adjustments.

6-142. There are four adjustments on the IF Detector circuit board. These are:

L3	**Oscillator frequency adjust**
R21	**Detector gain adjust**
R26	**IF phase adjust**
R83	**Loop offset adjust**

6-143. Equipment Required. The equipment required to make the adjustments is listed below.

Test Generator	**Boonton Model 1020/21/30**
DC voltmeter	**Fluke 8840A**
Wave Analyzer	**HP 3581A**

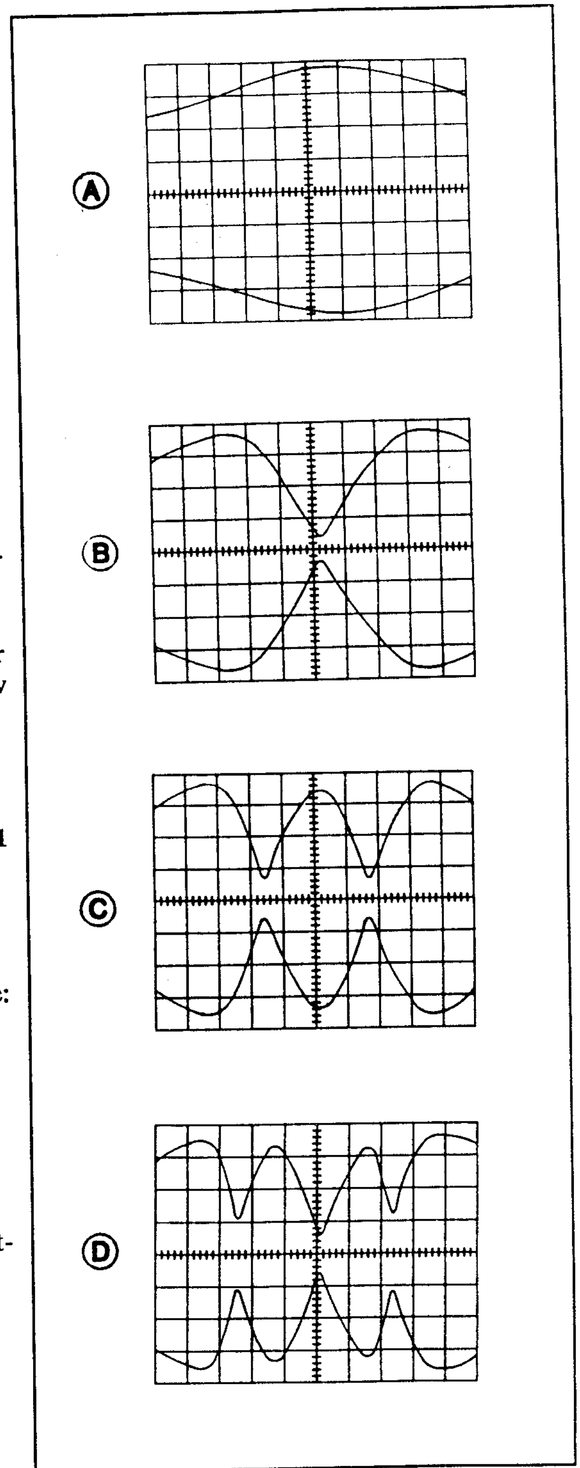


FIGURE 6-9. IF Amplifier Board Waveforms.

6-144. Procedure.

1. Set the LINE switch on the 8200-S/10 to OFF, remove the IF assembly from the card cage and remove the shield covering the IF Detector Board.

2. Install the extender card in the card slot for the IF assembly, install the IF assembly on the extender card and set the LINE switch on the 8200-S/10 to ON.

3. Connect the DC Voltmeter to IF Detector PWA TP4, set the measurement mode to DC level and select the 20 volt range.

4. Set the Test Generator to 30.000 MHz and 0 dBm and connect the Receiver Sensor, with the Adapter Pad installed, to the Test Generator RF OUT connector.

5. On the 8200-S/10 recall program location 99 to initialize the instrument.

6. After the carrier frequency measurement settles depress the TUNED LEVEL key, enter SPCL 3 to select the sensitive frequency mode and SPCL 44 to hold the IF level range.

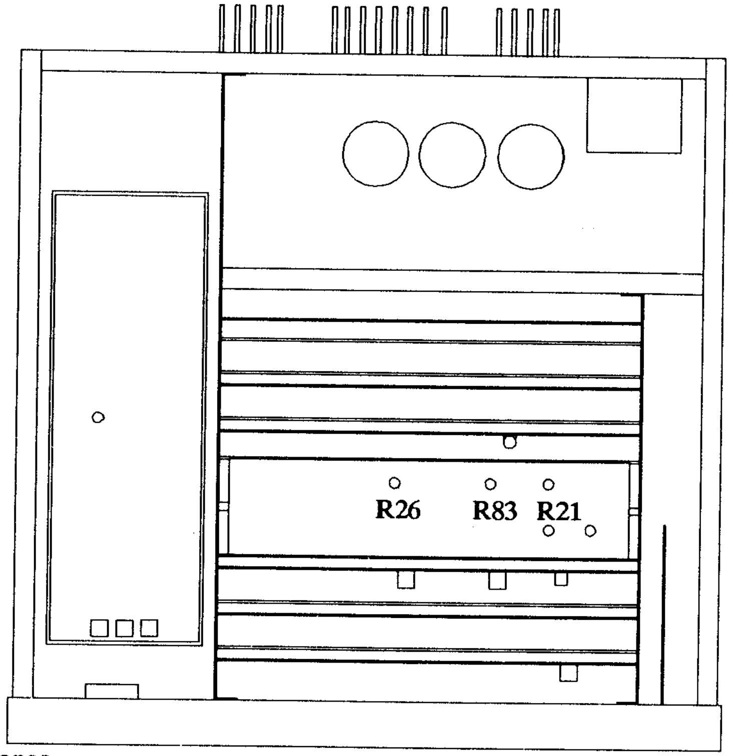
7. Set the Test Generator to 29.998 MHz. Note the DVM measurement and slowly adjust L3 for a level of 0 +- 0.5 volts.

8. Set the Test Generator to 30.000 MHz.

9. After the 30.000 MHz frequency reading settles, set the Test Generator to RF OFF, note the carrier frequency measurement and adjust R83 for a frequency drift rate of < 10 Hz/sec.

10. If the DVM measurement exceeds +- 10 volts, set the Test Generator to RF ON until the carrier frequency display indicates 30.000 MHz and repeat step 9.

11. Set the Test Generator to RF ON, 0.5 rad of phase modulation at a modulation rate of 200 Hz.



12. On the 8200-S/10 enter SPCL 6 to select the synchronous IF detector and SPCL 42 to hold the IF level range.

13. Connect the wave analyzer to TP5 and set the wave analyzer controls as follows:

Frequency..200 Hz
Bandwidth..10 Hz
Scale..90 dB
Input ....Sensitivity 0 dB

14. Note the wave analyzer indication and adjust R26 for a null which exceeds 70 dB.

15. Disconnect the DVM and wave analyzer and connect the Receiver Sensor to the PWR REF connector on the Model 4220-S/10.

16. On the 8200-S/10 recall program location 99 to initialize the instrument.

17. After the carrier frequency measurement settles depress the TUNED LEVEL and CAL keys.

18. After the calibration is complete depress the RATIO and DB keys.

19. Enter special function 48 to set 100 mS averaging rate and SPCL 53 to restore nominal calibration factors.

20. Note the display and adjust R21 for a level indication of 0.00 +- 0.1 dB.

SECTION VII
PARTS LIST

7-1. INTRODUCTION.

7-2. The replaceable parts for the Model 8200-S/10 are listed in Table 7-2. The replaceable parts list contains the reference symbol, description, manufacturer, and both the BEC and manufacturer part numbers. Table 7-1 lists the manufacturer's federal supply code numbers.

TABLE 7-1. MANUFACTURERS FEDERAL SUPPLY CODE NUMBERS.

00213	Nytronics
00241	Fenwall Electronics
01121	Allen Bradley
01295	Texas Instruments
02114	Ferroxcube Corp.
02735	RCA Solid State Division
03888	Pyrofilm (KDI)
03911	Clairex Corporation
04222	AVX Ceramics Company
04713	Motorola Semiconductor
04901	Boonton Electronics Corporation
06383	Panduit Corporation
06665	Precision Monolithics
06776	Robinson Nugent, Inc.
07263	Fairchild Semiconductor
11961	Semicon
13812	Dialco Division of Amperex
13919	Burr Brown Corporation
14655	Cornell-Dubilier
14674	Corning Glass
14752	Electro Cube, Inc.
15542	Mini Circuits Labs.
17117	Electronics Molding Co.
17856	Siliconix, Inc.
18324	Signetics Corporation
19505	Applied Eng'r. Products
19701	Mepco Electra
20307	Arco - Micronics
24226	Gowanda Electronics
27014	National Semiconductor
27264	Molex, Inc.
27735	F-Dyne Electronics
28480	Hewlett-Packard Corporation
31313	Components Corporation
31781	EDAC
31918	ITT Schadow, Inc.
32293	Intersil, Inc.
32575	AMP
33883	RMC
34371	Harris Semiconductor
50316	Minis Systems Inc.
51406	Murata Corporation of America
51640	Analog Devices, Inc.
54420	Dage - MTI
54426	Buss Fuses
54473	Panasonic
55153	Dielectric Labs Inc.
56289	Sprague Electric Company
57582	Kahgan Electronics Corporation
59474	Jeffers Electronics Inc.
59660	Tusonix
61637	Kemet - Union Carbide
64537	Pyrofilm (KDI)
71450	CTS Corporation
73138	Beckman Instruments, Helipot Division
81654	Monitor Products
82389	Switchcraft
91293	Johanson
91637	Dale Electronics
95077	Solitron Microwave
95348	Gordos Corporation
95721	Quality Components Corporation
98291	Sealectro Corporation
S4217	United Chemicon, Inc.
TOSH	Toshiba America, Inc.

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
	08256802A REV: A* '8200-S10' PRE CAL ASSY MODEL: 8200-S10				
A1	PWA '8200-S10' MOTHER	04901	08251902A	1	08251902A
A2	'8200-S10' RF HOUSING ASSY	04901	08250501A	1	08250501A
A4	PWA '8200' FM	04901	08252201A	1	08252200A
A5	PWA '8200' AM	04901	08251300B	1	08251300B
A6	PWA '8200' FILTER	04901	08251401A	1	08251400B
A8	PWA '8200' DETECTOR	04901	08251000B	1	08251000B
A9	PWA '8220' CPU	04901	08262000A	1	08262000A
A10	PWA '8200-S10' COUNTER	04901	08251601A	1	08251601A
A11	PWA '8200-S10' I/O	04901	08257500A	1	08257500A
A12	PWA '8200-S10' DISPLAY	04901	08257600A	1	08257600A
A13	PWA '8200-S10' KEYBOARD	04901	08251702A	1	08251702A
A14	PWA EXTENDER 36 PIN	04901	08252300A	1	08252300A
A15	'8200-S10' 455kHz IF HSG ASSY	04901	08257000A	1	08257000A
A22	'8200-S10' FRAME ASSY	04901	08256803A	1	08256803A
A23	'8200-S10' REAR PANEL ASSEMBLY	04901	08250703A	1	08250703A
A25	'8200-S10' FRONT PANEL ASSEMBLY	04901	08253002A	1	08253002A
U1	MODULAR AMPLIFIER	04901	99700100A	1	99700100A
W2	CABLE ASSY COAX RG316/U 19.25L	04901	572215000	1	572215000
W3	CABLE ASSY COAX RG316/U 19.25L	04901	572213000	1	572213000
W4	CABLE ASSY COAX RG316/U 17.25L	04901	572214000	1	572214000
W5	CABLE ASSY COAX RG316/U 18.50L	04901	572212000	1	572212000
W6	CABLE ASSY COAX RG316/U 9.75L	04901	572206000	1	572206000
W7	CABLE ASSY FLAT 24CKT 9.00L	04901	92017600A	1	92017600A
W8	CABLE ASSY FLAT 26 CKT 11.00 L	04901	92017800A	1	92017800A
W22	CABLE ASSY COAX RG405/U 8.25L	04901	57225600A	1	57225600A

A1

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
	08251902A REV: A* PWA '8200-S10' MOTHER				
AR2	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR3	IC 356P OP AMP	04713	LF356N	1	535040000
AR4	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2-3	CAP EL 220uF 20% 50V	S4217	SM-50-VB-220	2	283359000
C4-5	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104 M25V	2	224364000
C6	CAP EL 26000uF 20% 16V	56289	622D263M016AC2A	1	283340000
C7	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104 M25V	1	224364000
C8	CAP EL 4500uF 20% 35V	56289	622D452M035AA2A	1	283339000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C10	CAP EL 4500uF 20% 35V	56289	622D452M035AA2A	1	283339000
C11	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C13	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C14	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C15	CAP MICA 270pF 5% 50V	57582	KD5271J101	1	205045000
C16	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104 M25V	1	224364000
C18-19	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	2	283293000
C21	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C22	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C24	CAP CER 0.01uF 20% 500V	33883	BGP Z5U W/FDCL	1	224271000
C25	CAP TANT 10uF 10% 35V	56289	196D106X903PE4	1	283353000
C27	CAP EL 2200uF -10% +50% 35V	57582	KSMM-2200-35	1	283351000
CR2	DIODE BRIDGE FWLD-50	11961	FWLA-50	1	532028000
CR3-6	DIODE SIG 1N4001	04713	1N4001	4	530151000
CR7	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	1	530146000
CR8	DIODE SIG 1N4001	04713	1N4001	1	530151000
CR9	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	1	530146000
CR10-13	DIODE SIG 1N4001	04713	1N4001	4	530151000
CR14	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	1	530146000
CR15-17	DIODE SIG 1N4001	04713	1N4001	3	530151000
DS1-5	LED YELLOW DIFF 5082-4684	28480	HLMP-1401	5	536034000
J1	CONN M 03 CKT ST .1CT	06383	MFSS100-3-C-A	1	477364000
J2-3	HEADER 3 PIN STRAIGHT .156 SPA	06383	HPSS156-3-C	2	477343000
J4	SOCKET IC 24 PIN	06776	ICN-246-S4-G	1	473043000
J4	CONN M 24 CKT HDR DBL ROW .1C	06776	NSH-24DB-S2-TG	1	47742224A
J6-10	CONNECTOR "SMB"	19505	209	5	477317000
J12-15	CONNECTOR "SMB"	19505	209	4	477317000
Q1-2	TRANS FET 2N7016 PWRMOS P-CHAN	17856	2N7016	2	52816300A
R5	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R7	RES NETWORK 10K .1% 1.5W 16pin	73138	698-3R10KD	1	345010000
R9	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R10-11	RES MF 600 OHM 0.25% 1/8W	64537	PME55-T2	2	324215000
R14	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R15-16	RES MF 1.65K 1% 1/4W	19701	5043ED1K650F	2	341321000
R17-18	RES MF 6.81K 1% 1/4W	19701	5043ED6K810F	2	341380000
R19	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	1	341465000
R19	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R20	RES MF 150.00 OHM 0.1% 1W	91637	CMF70-150 OHM	1	32678100A
R21	RES MF 3.74K 1% 1/4W	19701	5043ED3K740F	1	341355000
U1	IC 74HCT273	01295	SN74HCT273N	1	534377000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
U2	IC 74HCT138 1 OF 8 DECODER	01295	74HCT138N	1	534375000
U8	IC REF-01CP VOLTAGE REFERENCE	06665	REF-01CP	1	535116000
U9	IC 74HCT273	01295	SN74HCT273N	1	534377000
U10-11	IC 419 ANALOG SWITCH	17856	DG-419-DJ	2	53452400A
W1	CABLE ASSY WIRE 22GA 2C 6.50L	04901	571206000	1	571206000
W2	CABLE ASSY WIRE 24GA 3C 4.50L	04901	571203000	1	571203000
W3	CABLE ASSY WIRE 24GA 3C 4.50L	04901	571204000	1	571204000
W4	CABLE ASSY WIRE 24GA 3C 6.50L	04901	571205000	1	571205000
W5	CABLE ASSY WIRE 22GA 3C 15.00L	04901	571207000	1	571207000
W6	CABLE ASSY WIRE 22GA 2C 11.00L	04901	571208000	1	571208000
W7	CABLE ASSY COAXIAL	04901	572106000	1	572106000
XA4-6	CONNECTOR 36 PIN	31781	306-036-521-102	3	479338000
XA8-10	CONNECTOR 36 PIN	31781	306-036-521-102	3	479338000
XA15	CONNECTOR 36 PIN	31781	306-036-521-102	1	479338000
XAR2-3	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU1	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU8	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU9	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU10-11	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000

A2

08250501A REV: A* '8200-S10' RF HOUSING ASSY

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A2A1	PWA '8200-S10' RF	04901	08251201A	1	08251201A
A2A2	PWA '8200' OSCILLATOR	04901	08251101A	1	08251100B
A2A3	PWA '8200' CONNECTOR	04901	08252500A	1	08252500A
FL1-15	CAP FT 3000pF 100V	32575	859617-1	15	227123000
J1	CONNECTOR SMA	95077	SF-2950-606	1	479440000
J2-5	CONNECTOR "SMB" 50 OHM	19505	2019-7511-000	4	477305000
A2W1	CABLE ASSY WIRE 24GA 8C VAR. L	04901	571198000	1	571198000
A2W2	CABLE ASSY WIRE 24GA 5C 3.50L	04901	571199000	1	571199000
A2W3	CABLE ASSY WIRE 24GA 2C 5.25L	04901	571195000	1	571195000
A2W4	CABLE ASSY WIRE 24GA 2C 9.0L	04901	571196000	1	571196000
A2W5	CABLE ASSY WIRE 24GA 9C 5.0L	04901	571197000	1	571197000

A2A1

08251201A REV: A* PWA '8200-S10' RF

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
AR2	IC 356P OP AMP	04713	LF356N	1	535040000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2	CAP MICA 12pF 5% 300V	57582	KD5120J301	1	205005000
C3	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C4	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C5	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C6	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C7	CAP MICA 12pF 5% 300V	57582	KD5120J301	1	205005000
C8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C9	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C10	CAP CER CHIP 680pF 10% 50V	61637	C1210C681K5XAH	1	224377000
C11	CAP CER CHIP 270pF 10% 50V	61637	C1210C271K5XAC	1	224388000
C12	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C13	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C14	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C15	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C16	CAP MICA 680pF 5% 300V	57582	KD15681J301	1	200112000
C17	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C18-20	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C21	CAP MICA 270pF 5% 50V	57582	KD5271J101	1	205045000
C22	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C23-24	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C25	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C28-30	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C31	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C32	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C33	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C34-37	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	4	224268000
C38-39	CAP MICA 270pF 5% 50V	57582	KD5271J101	2	205045000
C40-41	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	2	205018000
C42-43	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C44	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C45	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C46-47	CAP MICA 390pF 5% 500V	57582	KD15391J501	2	200108000
C48-49	CAP MICA 75pF 5% 300V	57582	KD5750J301	2	205043000
C50	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C51-52	CAP MICA 270pF 5% 50V	57582	KD5271J101	2	205045000
C53-54	CAP MICA 51pF 5% 300V	57582	KD5510J301	2	205020000
C55-56	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C57	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C58	CAP MICA 300pF 1% 50V	57582	KD5301F101	1	205051000
C59	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C60	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C61	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C62	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C63	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C64	CAP MICA 300pF 1% 50V	57582	KD5301F101	1	205051000
C65	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C66	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C67	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C68	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C69-71	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C73-74	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C76	CAP CER CHIP 220pF 10% 50V	61637	CX1210C221K5XAC	1	224220000
C77	CAP CER CHIP 270pF 10% 50V	61637	C1210C271K5XAC	1	224388000
C78	CAP VAR CER 3-10pF 250V	91293	9372	1	281014000
C79	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C80	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C81	CAP MICA 270pF 5% 50V	57582	KD5271J101	1	205045000
CR1	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
CR2A	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR2B	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR2C	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR2D	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR3	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
CR4	DIODE SIG 5082-0180	28480	5082-100	1	530168000
CR5	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
CR6-16	DIODE SIG 1N914	01295	1N914	11	530058000
J1	CONNECTOR 50 OHM	19505	225	1	479387000
J2	HEADER 2 PIN RT ANGLE	06383	HFAS100-2-C	1	477367000
J3	HEADER 10 PIN STRAIGHT	06383	HPSS100-10-C	1	477381000
J4	CONNECTOR 2 PIN STRAIGHT	27264	22-10-2021	1	477361000
J5	HEADER 5 PIN STRAIGHT .1 SPACE	06383	HPSS100-5-C	1	477382000
K1	RELAY SPDT FORM "C" 5V DIP	95348	835C-1	1	471034000
L1	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L2	INNDUCTOR 68uH 10%	24226	10/682	1	400411000
L3	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L4	INDUCTOR 7.5 uH 10%	24226	10M751K	1	400433000
L5	INDUCTOR 15uH 10%	24226	10M152K	1	400373000
L6	INDUCTOR 68uH 10%	24226	10/682	1	400411000
L7	INDUCTOR 39uH 10%	24266	10/392	1	400387000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
L8	INDUCTOR 7.5 uH 10%	24226	10M751K	1	400433000
L9	INDUCTOR 15uH 10%	24226	10M152K	1	400373000
L10-11	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L12	INDUCTOR 150uH 5%	59474	1315-16J	1	400415000
L13	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
L14	INDUCTOR 150uH 5%	59474	1315-16J	1	400415000
L15	INDUCTOR VK200/20-4B	02114	VK-200-20/4B	1	400409000
Q1	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q2	TRANS FET 2N4416 N-CHAN	04713	2N4416	1	528072000
Q3	TRANS NPN 2N3866	04713	2N3866	1	528116000
Q4	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q5-6	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q7	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q8	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q9	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q10-11	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q12	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q13	TRANS NPN 2N3866	04713	2N3866	1	528116000
Q14	TRANS PNP 2N4403	04713	2N4403	1	528122000
R3	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R5	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R6	RES VAR 50K 10% 0.5W	73138	72PR50K	1	311393000
R7	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R8	RES COMP 6.8K 5% 1/8W	01121	BB6825	1	331102000
R9-10	RES COMP 100 OHM 5% 1/8W	01121	BB1015	2	331058000
R11	RES VAR 50K 10% 0.5W	73138	72PR50K	1	311393000
R12	RES COMP 6.8K 5% 1/8W	01121	BB6825	1	331102000
R13	RES COMP 10K 5% 1/8W	01121	BB1035	1	331106000
R14	RES VAR 10K 10% 0.5W	73138	72PR10K	1	311328000
R15	RES CHIP 100 OHM 5% 1/2W	50316	WA-7PS-101JS	1	339999000
R16	RES COMP 5.1K 5% 1/8W	01121	BB5125	1	331099000
R17	RES COMP 6.8K 5% 1/8W	01121	BB6825	1	331102000
R18	RES CHIP 100 OHM 5% 1/2W	50316	WA-7PS-101JS	1	339999000
R19	RES COMP 6.8K 5% 1/8W	01121	BB6825	1	331102000
R20-21	RES COMP 100 OHM 5% 1/8W	01121	BB1015	2	331058000
R22	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R23	RES COMP 1K 5% 1/8W	01121	BB1025	1	331082000
R24	RES MF 3.92K 1% 1/4W	19701	5043ED3K920F	1	341357000
R25	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R26	RES COMP 20K 5% 1/8W	01121	BB2035	1	331113000
R27	RES MF 33.2 OHM 1% 1/4W	19701	5034ED33R20F	1	341150000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R28	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R29	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R30	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R31	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R32	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R33-35	RES COMP 47 OHM 5% 1/8W	01121	BB4705	3	331050000
R36	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R37	RES COMP 100 OHM 5% 1/8W	01121	BB1015	1	331058000
R38	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R39	RES MF 900 OHM 0.1% 1/8W	64537	PME55-T2	1	324235000
R40	RES MF 100 OHM 0.1% 1/8W	64537	PME55-T2	1	324118000
R41	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R42	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R43	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R44	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R45	RES MF 3.92K 1% 1/4W	19701	5043ED3K920F	1	341357000
R46	RES MF 392 OHM 1% 1/4W	19701	5043ED392R0F	1	341257000
R47	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R48	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R49	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R50	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R51	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R52	RES MF 15.0 OHM 1% 1/4W	19701	5043ED15R00F	1	341117000
R53	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R54	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R55	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R56	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R58	RES MF 432 OHM 1% 1/4W	19701	5043ED432R0F	1	341261000
R60	RES COMP 510 OHM 5% 1/8W	01121	BB5115	1	331075000
R63	RES MF 365 OHM 1% 1/4W	19701	5043ED365R0F	1	341254000
R64	RES MF 432 OHM 1% 1/4W	19701	5043ED432R0F	1	341261000
R65	RES MF 825 OHM 1% 1/4W	19701	5043ED825R0F	1	341288000
R66-69	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	4	341300000
R70	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R71	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R72	RES MF 39.2K 1% 1/4W	19701	5043ED39K20F	1	341457000
R73	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R74	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R75-76	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	2	341329000
R77	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
T1	TRANSFORMER BAL T1-1-X65	15542	T1-1	1	410089000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
T2	TRANSFORMER RF PULSE	04901	41009000B	1	41009000B
U1	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
U2	IC 74S00 POS NAND-GATE	01295	SN74S00N	1	534082000
U3	IC 74FOOPC NAND GATE	07263	74F00PC	1	534366000
U4	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U5	IC 74LS139 DECODE/MULTPXR	01295	SN74LS139N	1	534188000
U6	IC 74LS290 DEC CTR	01295	SN74LS290N	1	534328000
U7	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U8	IC 1355P OP AMP	04713	MC1355P	1	535038000
U9	IC 74LS163 4 BIT COUNTER	01295	SN74LS163AN	1	534279000
XAR1-2	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XK1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XQ2	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XU1-3	SOCKET IC 14 PIN	06776	ICN-143-S3-G	3	473019000
XU4-5	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU6	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU8	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU9	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

A2A2

08251100B REV: CC PWA '8200' OSCILLATOR

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC 324N QUAD OP AMP	27014	LM324N	1	535068000
AR2-3	IC 356P OP AMP	04713	LF356N	2	535040000
AR4	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR5	IC 356P OP AMP	04713	LF356N	1	535040000
C1	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000
C2	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C3-4	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C5	CAP MICA 150pF 5% 100V	57582	KD5151J101	1	205009000
C6	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C7	CAP CER 22pF 2% 500V	55153	C17AH220G4TXL	1	224384000
C8	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C9	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C10	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C11	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C12	CAP MPC 1.0uF 10% 50V	14752	652A-1-A-105K	1	234152000
C13	CAP CER 360pF 5% 200V	14752	C17AH361J6TXL	1	224387000
C14	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C15	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C16	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C17	CAP CER 10pF 2% 500V	55153	C17AH100G4TXL	1	224383000
C18	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C19	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C20	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C21	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C22	CAP CER 300pF 5% 200V	55153	C17AH301J6TXL	1	224386000
C23-24	CAP MICA 250pF 5% 50V	57582	KD251J101	2	205037000
C25	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C27	CAP CER 3.3pF +-0.25pF 500V	55153	C17AH3R3C4TXL	1	224381000
C28	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C29-31	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C32	CAP CER 220pF 2% 200V	55153	C17AH221G6TXL	1	224385000
C33	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C34	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000
C35	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C36	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C37-38	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C39	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C40	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C41	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C42	CAP CER CHIP 1.2pF 0.1pF 500V	55153	C17AH1R2B4TXL	1	22439100A
C43	CAP EL 100uF 20% 25V	S42217	SM-25-VB-100-M	1	283334000
C44	CAP MPC 1.0uF 10% 50V	14752	652A-1-A-105K	1	234152000
C45	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	1	205018000
C46	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C47	CAP CER 220pF 2% 200V	55153	C17AH221G6TXL	1	224385000
C48	CAP TANT 10uF 10% 35V	56289	196D106X903PE4	1	283353000
C49	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C50	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C51	CAP CER 5.0pF +-0.25pF 100V	59660	0835305P3K0509C	1	22439000A
CR1	DIODE SIG 1N914	01295	1N914	1	530058000
CR2-3	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR4	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR9	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR10-17	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	8	530770000
CR18	DIODE SIG 1N914	01295	1N914	1	530058000
CR19-20	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
CR21	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR22-24	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	3	530770000
CR25	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR26-28	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	3	530770000
CR29	DIODE SIG 1N914	01295	1N914	1	530058000
CR30-31	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR32	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR33-34	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	2	530770000
CR35	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR36-37	DIODE SIG 1N914	01295	1N914	2	530058000
CR38-39	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	2	530770000
CR40	DIODE SIG 1N914	01295	1N914	1	530058000
CR41-42	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR43	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR44-45	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	2	530770000
CR46	DIODE PIN 5082-3188	28480	5082-3188	1	530165000
CR47-48	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	2	530770000
DS1	PHOTO MOD CLM6500	03911	CLM6500	1	325016000
DS2-5	LED RED DIFF 5082-4684	28480	HLMP-1301	4	536024000
J1	HEADER 10 PIN STRAIGHT	06383	HPSS100-10-C	1	477381000
J2	HEADER PIN STRAIGHT .1 SPACE	06383	HPSS100-5-C	1	477382000
L1-3	INDUCTOR 5.6uH 10%	24226	15/561	3	400308000
L4	INDUCTOR 0.82uH 10%	59474	4425-5K	1	400293000
L5	INDUCTOR 330 uH 10%	24226	10/333	1	400442000
L5	INDUCTOR 330 uH 10%	24226	10/333	1	400442000
L6	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L7	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L8	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L9	INDUCTOR 0.82uH 10%	59474	4425-5K	1	400293000
L11	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L12	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L13	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L14	INDUCTOR 0.82uH 10%	59474	4425-5K	1	400293000
L16	.INDUCTOR 39uH 10%	24266	10/392	1	400387000
L17	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L18	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L19	INDUCTOR 4.7uH 10%	24226	10/471	1	400384000
L20	INDUCTOR 0.82uH 10%	59474	4425-5K	1	400293000
L22-23	INDUCTOR 39uH 10%	24266	10/392	2	400387000
L24	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
L25	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L26	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
P1	CONNECTOR "SMA" 50 OHM	98291	52-051-0000	1	477304000
Q1	TRANS FET 2N4416 N-CHAN	04713	2N4416	1	528072000
Q2	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q3-4	TRANS FET 2N4416 N-CHAN	04713	2N4416	2	528072000
Q5	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q6	TRANS FET 2N4221A N-CHAN	17856	2N4221A	1	528063000
Q7	TRANS PNP 2N4403	04713	2N4403	1	528122000
Q8	TRANS NPN 2N4401	04713	2N4401	1	528121000
Q9	TRANS PNP 2N4403	04713	2N4403	1	528122000
R1	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R2	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R3	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R4	RES MF 1.21K 1% 1/4W	19701	5043ED1K210F	1	341308000
R5	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R6	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R7	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R8	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000
R9	RES MF 909 OHM 1% 1/4W	09701	5043ED909R0F	1	341292000
R10	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R11	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R12	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R13	RES MF 1.21K 1% 1/4W	19701	5043ED1K210F	1	341308000
R14	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R15	RES MF 24.9K 1% 1/4W	19701	RN55D-2492-F	1	341438000
R16	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
R17	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R18	RES MF 8.25K 1% 1/4W	19701	5043ED8K250F	1	341388000
R19	RES VAR 5K 10% 0.5W	73138	72PR5K	1	311308000
R20	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R21	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R22-23	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	2	341368000
R24	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R25	RES MF 1.21K 1% 1/4W	19701	5043ED1K210F	1	341308000
R26	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R27	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R28	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R29	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R30	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R31	RES MF 392K 1% 1/4W	19701	5043ED392K0F	1	341557000
R32	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000
R33	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R34	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R35	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R36	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R37	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R38	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R39	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R40	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R41	RES MF 1.10K 1% 1/4W	19701	5043ED1K100F	1	341304000
R42	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R43	RES NETWORK 10K 0.5% 1/2W	73138	694-3-R10K-D	1	345041000
R44	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R45	RES MF 1.21K 1% 1/4W	19701	5043ED1K210F	1	341308000
R46	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R47	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R48	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R51	RES MF 133 OHM 1% 1/4W	19701	5043ED133R0F	1	341212000
R52	RES MF 1.00M 1% 1/4W	14674	5043ED1M000F	1	341600000
R53	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R54	RES NETWORK 470 OHM 2% 1.1W	71450	750-81-R470	1	345018000
R55	RES MF 1.62K 1% 1/4W	19701	5043ED1K620F	1	341320000
T1	TRANSFORMER RF T4-1-X65	15542	T4-1	1	410087000
T2-4	OSC TRANSFORMER	04901	400431000	3	400431000
T5	OSC TRANSFORMER	04901	400430000	1	400430000
U1	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U2	IC 74LS122 MONOSTABLE MULTIVBT	01295	SN74LS122N	1	534280000
U3	IC 4052B MULTIPLEXER	02735	CD4052BE	1	534140000
XAR1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XAR2-5	SOCKET IC 8 PIN	06776	ICN-083-S3-G	4	473041000
XDS1/1	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XDS1/2	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XQ1	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XQ3-4	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	2	473051000
XQ6	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU3	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A2A3					
	08252500A REV: AB PWA '8200' CONNECTOR				
J1	SOCKET IC 24 PIN	06776	ICN-246-S4-G	1	473043000
A4					
A4	08252200A REV: EC PWA '8200' FM				
AR1	IC 301A OP AMP	27014	LM301AN	1	535012000
AR2	IC 356P OP AMP	04713	LF356N	1	535040000
AR3	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
C1	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000
C2-3	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C4	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C5	CAP MICA 91pF 5% 300V	14655	CD5FC910J	1	205021000
C6	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C7	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
C8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C9	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C10	CAP MICA 100pF 1% 500V	14655	CD15FD101F	1	200045000
C11	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C12	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C13	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C14-15	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	2	224269000
C16	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C17	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C18	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C19	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C20-21	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C22-23	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	2	224269000
C24	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C25	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C26	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C27	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	1	200015000
C28	CAP MICA 36pF 5% 300V	14655	CD5EC360J	1	205003000
C29	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	1	200015000
C30-31	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	2	224269000
C32	CAP MICA 680pF 5% 300V	57582	KD15681J301	1	200112000
C33	CAP MICA 500pF 1% 500V	14655	CD15FD501F	1	200123000
C34	CAP TANT 100uF 20% 20V	56289	196D107X0020TE4	1	283313000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C35	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C36	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C37-38	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C39	CAP MICA 330pF 5% 50V	14655	CD5FY331J	1	205029000
C40	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C41	CAP MICA 330pF 5% 50V	14655	CD5FY331J	1	205029000
C42	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C43	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C44	CAP MICA 200pF 1% 100V	14655	CD5FA201F	1	205041000
C45	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C46-47	CAP TANT 100uF 20% 20V	56289	196D107X0020TE4	2	283313000
C48	CAP MICA 27pF 5% 300V	14655	CD5EC270J	1	205008000
C49	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C50	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C51	CAP MICA 130pF 5% 100V	14655	CD5FA131J	1	205011000
C52	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C53-54	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
CR1-3	DIODE SIG 1N914	01295	1N914	3	530058000
L1-2	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L3	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L4	INDUCTOR 15uH 10%	59474	4445-4K	1	400302000
L5	INDUCTOR 750uH 5%	24226	19/753J	1	400443000
L6	COIL ASSY 902uH (ALT.-000)8200	04901	40043901A	1	40043901A
L7	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
L8	INDUCTOR 120uH 10%	24226	10/123	1	400413000
L9	COIL ASSY 1450uH (ALT-000)8200	04901	40044001A	1	40044001A
L10	COIL ASSY 902uH (ALT.-000)8200	04901	40043901A	1	40043901A
L11	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
Q1	TRANS FET SD215EE N-CHAN	17856	SD215DE	1	528120000
Q2	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q3	IC 3054 OP AMP	02735	CA3054	1	535111000
Q4-5	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q6	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q7	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q8	IC 3054 OP AMP	02735	CA3054	1	535111000
Q9	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q10	TRANS FET SD215DE N-CHAN	17856	SD215DE	1	528120000
Q11-13	TRANS PNP 2N3906	04713	2N3906	3	528076000
Q14-16	TRANS PNP 2N4403	04713	2N4403	3	528122000
R1	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R2	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R3	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R4	RES MF 2.61K 1% 1/4W	19701	5043ED2K619F	1	341340000
R5-7	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	3	341268000
R8-9	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R10	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R11	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R12	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R13	RES MF 750 OHM 1% 1/4W	19701	5043ED750R0F	1	341284000
R14	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R15	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R16	RES MF 681 OHM 1% 1/4W	19701	5043ED681R0F	1	341280000
R17	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R18-19	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R20	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R21	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R22	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R23-24	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R25-26	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R27	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R28	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R29	RES MF 681 OHM 1% 1/4W	19701	5043ED681R0F	1	341280000
R30	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R31	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R32-34	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	3	341268000
R35-36	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R37-39	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	3	341268000
R40-41	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R42	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R43	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R44	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R45	RES MF 3.92K 1% 1/4W	19701	5043ED3K920F	1	341357000
R46	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R47-48	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R49-50	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R51	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R52	RES MF 182 OHM 1% 1/4W	19701	RN55D-1820-F	1	341225000
R53-54	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	2	341250000
R55-56	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R57-58	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R59	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R60	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R61	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R62	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R63	RES MF 3.74K 1% 1/4W	19701	5043ED3K740F	1	341355000
R64	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R65-66	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R67	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R68	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R69	RES MF 221 OHM 1% 1/4W	19701	5043ED221R0F	1	341233000
R70	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R71	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R72	RES MF 9.09K 1% 1/4W	19701	5043ED9K090F	1	341392000
R73	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R74	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R75	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R76	RES MF 5.62K 1% 1/4W	19701	5043ED5K620F	1	341372000
R77	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R78	RES MF 432 OHM 1% 1/4W	19701	5043ED432R0F	1	341261000
R79	RES MF 68.1 OHM 1% 1/4W	19701	5043ED68R10F	1	341180000
R80-83	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	4	341350000
R84-85	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R86	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R87-88	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	2	341350000
R89	RES MF 681 OHM 1% 1/4W	19701	5043ED681R0F	1	341280000
U1	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
XAR1-3	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000
XQ1	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XQ2	SOCKET TRANSISTOR 3 CIR TO-18	EMC	7003-265-5	1	47307800A
XQ3	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XQ4-7	SOCKET TRANSISTOR 3 CIR TO-18	EMC	7003-265-5	4	47307800A
XQ8	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XQ9	SOCKET TRANSISTOR 3 CIR TO-18	EMC	7003-265-5	1	47307800A
XQ10	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XQ11-13	SOCKET TRANSISTOR 3 CIR TO-18	EMC	7003-265-5	3	47307800A
XU1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000

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TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR2	IC 318N OP AMP	27014	LM318N	1	535031000
AR3	IC 356P OP AMP	04713	LF356N	1	535040000
C1	CAP MICA 100pF 1% 300V	14655	CD5FC101F	1	205039000
C2	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C3	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C4	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C5	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C6	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C7	CAP MICA 180pF 1% 100V	14655	CD5FA181F	1	205040000
C8	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C9	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C10	CAP MICA 100pF 1% 300V	14655	CD5FC101F	1	205039000
C11-12	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C13	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C14	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C15	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C16-18	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	3	283336000
C19	CAP MICA 470pF 5% 300V	14655	CD15-471J03	1	200028000
C20-21	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	2	283216000
C22	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C23	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C24	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C25	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C26	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C27	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C28	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C29	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C30	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C31	CAP COMP 0.27pF 10% 500V	95721	TYPE MC	1	218006000
C32	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C33	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C34	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C35	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C36	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C37	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C38-39	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C40	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C41	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C42	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C43	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C44	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C45	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
C47	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C48	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
C50	CAP MICA 300pF 1% 50V	57582	KD5301F101	1	205051000
C51	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C52	CAP MICA 300pF 5% 50V	14655	CD5FY301J	1	205026000
C53	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C54	CAP MICA 300pF 5% 50V	14655	CD5FY301J	1	205026000
C56	CAP MICA 300pF 1% 50V	57582	KD5301F101	1	205051000
C57	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C58	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C59-60	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C61	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C62	CAP MICA 75pF 5% 300V	57582	KD5750J301	1	205043000
CR1-5	DIODE SIG 1N914	01295	1N914	5	530058000
CR6a-6b	DIODE 5082-2815 MATCHED PAIR	28480	5082-2815	1	53091100A
DS1-2	PHOTO MOD CLM6500	03911	CLM6500	2	325016000
L1-3	INDUCTOR 5.6uH 10%	24226	15/561	3	400308000
L4	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L5-6	INDUCTOR 47uH 5%	24226	15/472J	2	400320000
L7-8	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L9	INDUCTOR 1800uH 5%	59474	1312-25J	1	400434000
L10	COIL ASSY 902uH (ALT.-000)8200	04901	40043901A	1	40043901A
L11	COIL ASSY 1450uH (ALT-000)8200	04901	40044001A	1	40044001A
L12	COIL ASSY 902uH (ALT.-000)8200	04901	40043901A	1	40043901A
Q1	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q2	TRANS NPN 2N3053	04713	2N3053	1	528123000
Q3-4	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q5-6	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q7	TRANS NPN 2N4401	04713	2N4401	1	528121000
Q8-10	TRANS FET 2N4416 N-CHAN	04713	2N4416	3	528072000
Q11	TRANS NPN 2N4401	04713	2N4401	1	528121000
Q12	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q13-14	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q15-17	TRANS NPN 2N3904	04713	2N3904	3	528071000
Q18-20	TRANS PNP 2N3906	04713	2N3906	3	528076000
Q21	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q22	TRANS NPD 5564	27014	NPD5564	1	528148000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R1	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R2	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R3	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R4-5	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	2	341417000
R6	RES MF 562 OHM 1% 1/4W	19701	5043ED562R0F	1	341272000
R7	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R8	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R9	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R10	RES MF 5.36K 1% 1/4W	19701	5043ED5K360F	1	341370000
R11	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R12	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R13	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R14	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R15	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R16	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R17	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R18	RES MF 75.0 OHM 1% 1/4W	19701	5043ED75R00F	1	341184000
R19	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R20-21	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	2	341165000
R22	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R23	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R24	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R25	RES MF 9.31K 1% 1/4W	19701	5043ED9K310F	1	341393000
R26	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R27	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	1	341467000
R28	RES MF 75.0K 1% 1/4W	19701	5043ED75K00F	1	341484000
R29	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R30	RES MF 499K 1% 1/4W	19701	5043ED499K0F	1	341567000
R31	RES MF 267K 1% 1/4W	19701	5043ED267K0F	1	341541000
R32	RES MF 9.31K 1% 1/4W	19701	5043ED9K310F	1	341393000
R33	RES MF 75.0K 1% 1/4W	19701	5043ED75K00F	1	341484000
R34	RES MF 267K 1% 1/4W	19701	5043ED267K0F	1	341541000
R35	RES MF 499K 1% 1/4W	19701	5043ED499K0F	1	341567000
R36	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R37	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R38	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R39	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R40-41	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R42	RES MF 9.09K 1% 1/4W	19701	5043ED9K090F	1	341392000
R43	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R44	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R45	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R46	RES MF 11.0K 1% 1/4W	19701	5043ED11K00F	1	341404000
R47-48	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	2	341165000
R49	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R50	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R51	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R52	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R53-54	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R55	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R56	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R57	RES MF 8.25K 1% 1/4W	19701	5043ED8K250F	1	341388000
R58	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R59	RES MF 1.62K 1% 1/4W	19701	5043ED1K620F	1	341320000
R60	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R61	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
R62	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R63	RES MF 8.25K 1% 1/4W	19701	5043ED8K250F	1	341388000
R64-65	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	2	341165000
R66-67	RES MF 221 OHM 1% 1/4W	19701	5043ED221R0F	2	341233000
R68	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R69	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R70	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R71	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R72	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R73	RES MF 9.09K 1% 1/4W	19701	5043ED9K090F	1	341392000
R74	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R75	RES MF 9.09K 1% 1/4W	19701	5043ED9K090F	1	341392000
R76	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R77-79	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R80	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R81	RES MF 12.7K 1% 1/4W	19701	5043ED12K70F	1	341410000
R82	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R83-84	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R85	RES VAR 100K 10% 0.5W	73138	72XWR100K	1	311377000
R86	RES MF 301K 1% 1/4W	19701	5043ED301K0F	1	341546000
R87	RES COMP 4.7M 5% 1/4W	01121	CB4755	1	343665000
R88	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
TP1-5	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	5	48330600A
U1	IC 74HCT273	01295	SN74HCT273N	1	534377000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
U2	D/A CONVERTER DAC-08EP	06665	DAC-08EP	1	421037000
XDS1/1	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XDS1/2	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XDS2/1	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XDS2/2	SOCKET STRIP 2 PIN	04901	473074000	1	473074000
XU1	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000

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REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
AR2-4	IC 310N OP AMP	27014	LM310N	3	535035000
AR5	IC 357N OP AMP	27014	LF357N	1	535096000
AR6	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR7-8	IC 310N OP AMP	27014	LM310N	2	535035000
AR9	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR10	IC 310N OP AMP	27014	LM310N	1	535035000
AR11	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
AR12	IC 356P OP AMP	04713	LF356N	1	535040000
C1-2	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C3	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C4	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C5	CAP MICA 820pF 5% 300V	14655	CD15FC821J03	1	200110000
C6	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C7	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C8	CAP MICA 180pF 1% 100V	14655	CD5FA181F	1	205040000
C9	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
C10-11	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	2	234142000
C12	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C13	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C14	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
C15-16	CAP TANT 100uF 20% 10V	56289	196D107X0010PE4	2	283291000
C17	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C18	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C19-20	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	2	234139000
C21	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	1	234142000
C22-23	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	2	234139000
C24	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	1	234142000
C25-26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C27-28	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	2	234142000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C29	CAP MPC 0.047uF 2% 50V	14752	652A-1-A473G	1	234144000
C30	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C31	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C32	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C33	CAP MICA 240pF 1% 500V	00853	D10FD241F	1	200124000
C34	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C35	CAP MICA 200pF 2% 500V	14655	CD15FD201G	1	200053000
C36	CAP MICA 100pF 1% 300V	14655	CD5FC101F	1	205039000
C37	CAP MICA 120pF 1% 50V	20307	DM5-FY121F	1	205050000
C38	CAP MICA 100pF 1% 300V	14655	CD5FC101F	1	205039000
C39	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C40	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
C41	CAP MICA 75pF 1% 300V	20307	DM5-EC750F	1	205056000
C42-43	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C44-45	CAP MICA 1000pF 1% 100V	51406	DM15-102F	2	200113000
C46-47	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C48	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C49-51	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	3	234142000
C52	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C53	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	1	234142000
C54-55	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	2	234139000
C56	CAP MICA 22pF 5% 300V	14655	CD5CC220J	1	205036000
C57	CAP MICA 150pF 5% 100V	57582	KD5151J101	1	205009000
C58	CAP MICA 5.0pF 10% 300V	14655	CD5CC050D	1	205000000
CR1-3	DIODE SIG 1N914	01295	1N914	3	530058000
CR4-5	DIODE SIG FDH-300	07263	FDH300	2	530052000
CR6-8	DIODE SIG 1N914	01295	1N914	3	530058000
K1-4	RELAY SPDT FORM "C" 5V DIP	95348	835C-1	4	471034000
L1-3	INDUCTOR 5.6uH 10%	24226	15/561	3	400308000
L4	COIL ASSY (2270 uH) '8200'	04901	400437000	1	400437000
L5	COIL ASSY (3641 uH) '8200'	04901	400438000	1	400438000
L6	COIL ASSY (2270 uH) '8200'	04901	400437000	1	400437000
Q1-2	TRANS PNP 2N4403	04713	2N4403	2	528122000
Q3	TRANS NPD 5564	27014	NPD5564	1	528148000
Q4	TRANS PNP 2N4403	04713	2N4403	1	528122000
R1	RES MF 562 OHM 1% 1/4W	19701	5043ED562R0F	1	341272000
R2	RES MF 619 OHM 1% 1/4W	19701	5043ED619R0F	1	341276000
R3	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R4	RES MF 576 OHM 1% 1/4W	19701	5043ED576R0F	1	341273000
R5	RES VAR 50 OHM 10% 0.5W	73138	82PAR50	1	311369000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R6	RES MF 590 OHM 1% 1/4W	19701	5043ED590R0F	1	341274000
R7	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R8	RES MF 619 OHM 1% 1/4W	19701	5043ED619R0F	1	341276000
R9-10	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	2	324354000
R11	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	1	324241000
R12	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R13	RES VAR 1K 10% 0.5W	73138	72XWR1K	1	311340000
R14	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R15	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R17	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	1	324241000
R18	RES VAR 100 OHM 10% 0.5W	73138	72XWR100	1	311306000
R19	RES MF 121 OHM 1% 1/4W	19701	5043ED121R0F	1	341208000
R20	RES MF 26.7K 1% 1/4W	19701	5043ED26K70F	1	341441000
R21	RES MF 105K 1% 1/4W	19701	5043ED105K0F	1	341502000
R22	RES MF 2.67K 1% 1/4W	19701	5043ED2K670F	1	341341000
R23	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R24	RES MF 2.61K 1% 1/4W	19701	5043ED2K619F	1	341340000
R25	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R26	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R27	RES MF 536K 1% 1/4W	19701	RN55D-5363-F	1	341570000
R28	RES MF 53.6K 1% 1/4W	19701	5043ED53K60F	1	341470000
R29	RES MF 1.13K 1% 1/4W	19701	5043ED1K130F	1	341305000
R30	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R31	RES MF 3.65K 1% 1/4W	19701	5043ED3K650F	1	341354000
R32	RES MF 26.7K 1% 1/4W	19701	5043ED26K70F	1	341441000
R33	RES MF 182K 1% 1/4W	19701	5043ED182K0F	1	341525000
R34	RES MF 80.00K 0.1% 1/4W	03888	PME55-T9	1	32592000A
R35	RES MF 11.5K 1% 1/4W	19701	5043ED11K50F	1	341406000
R36	RES MF 16.5K 1% 1/4W	19701	5043ED16K50F	1	341421000
R37	RES MF 73.2K 1% 1/4W	19701	5043ED73K20F	1	341483000
R38	RES MF 80.00K 0.1% 1/4W	03888	PME55-T9	1	32592000A
R39	RES MF 4.87K 1% 1/4W	19701	5043ED4K870F	1	341366000
R40	RES MF 80.00K 0.1% 1/4W	03888	PME55-T9	1	32592000A
R41	RES MF 9.76K 1% 1/4W	19701	5043ED9K760F	1	341395000
R42	RES MF 48.7K 1% 1/4W	19701	5043ED48K70F	1	341466000
R43	RES MF 5.76K 1% 1/4W	19701	5043ED5K760F	1	341373000
R44	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R45	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R46-47	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	2	341384000
R48	RES MF 243K 1% 1/4W	19701	5043ED243K0F	1	341537000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R49	RES MF 3.920K 0.1% 1/8W	64537	PME55-T2	1	324311000
R50	RES MF 56.2K 0.1% 1/8W	64537	PME55-T2	1	324448000
R51	RES MF 11.5K 1% 1/4W	19701	5043ED11K50F	1	341406000
R52	RES MF 48.7K 1% 1/4W	19701	5043ED48K70F	1	341466000
R53	RES MF 1.54K 1% 1/4W	19701	5043ED1K540F	1	341318000
R54	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R55	RES MF 600 OHM 0.25% 1/8W	64537	PME55-T2	1	324215000
U1	IC 74HCT138 1 OF 8 DECODER	01295	74HCT138N	1	534375000
U2	IC 74HCT273	01295	SN74HCT273N	1	534377000
U3	IC 6208 4 CHAN DIF MULTPXR	32293	IH6208CPE	1	534266000
U4-5	IC 6108 CMOS CHAN MULTPXR	32293	IH6108CPE	2	534265000
U6	IC 74HCT273	01295	SN74HCT273N	1	534377000
U7	IC 6108 CMOS CHAN MULTPXR	32293	IH6108CPE	1	534265000
XAR1-12	SOCKET IC 8 PIN	06776	ICN-083-S3-G	12	473041000
XQ3	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU3-5	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU6	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

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08251000B REV: EE PWA '8200' DETECTOR

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
AR2	IC TL074CN OP AMP QUAD	01295	TL074CN	1	535082000
AR3	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR4	IC HA3-2625-5-M OP AMP	34371	HA3-2625-5	1	53511900A
AR5-6	IC 3080E OP AMP	02735	CA3080E	2	535091000
AR7	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR8	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
AR9	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
AR10	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
C1	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C2	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C3	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C4-5	CAP TANT 100uF 20% 10V	56289	196D107X0010PE4	2	283291000
C6	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C7	CAP MICA 5.0pF 10% 300V	14655	CD5CC050D	1	205000000
C8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C9	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C10-11	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C12	CAP EL 47uF 20% 50V	S4217	SM50VB47	1	283358000
C13	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C14-15	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C16	CAP MICA 5.0pF 10% 300V	14655	CD5CC050D	1	205000000
C17-18	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C19	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C20-21	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	2	234139000
C23	CAP VAR CER 5.1-50pF 250V GRN	52769	GKR50000	1	281006000
C24	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C25	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C26	CAP TANT 2.2uF 20% 35V	61637	T368B225M035 ASC2513	1	283317000
C27-30	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	4	224268000
C31	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C32-34	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C35	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C36	CAP TANT 100uF 20% 10V	56289	196D107X0010PE4	1	283291000
C37	CAP CER 0.022uF 10% 50V	61637	C052K223K5X5CA	1	224302000
C38	CAP MICA 12pF 5% 300V	57582	KD5120J301	1	205005000
C39	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
CR1-2	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR3-4	DIODE SIG FDH-300	07263	FDH300	2	530052000
CR5-10	DIODE SIG 1N914	01295	1N914	6	530058000
L1-3	INDUCTOR 5.6uH 10%	24226	15/561	3	400308000
R1	RES MF 5.000K 0.1% 1/8W	64537	PME55-T2	1	324326000
R2	RES MF 3.000K 0.1% 1/8W	64537	PME55-T2	1	324300000
R3-4	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	2	324241000
R5	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R6	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R7	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R8	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R9	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	1	324241000
R10	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R11	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R12	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R13	RES MF 75.0K 1% 1/4W	19701	5043ED75K00F	1	341484000
R14	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R15	RES MF 11.0K 1% 1/4W	19701	5043ED11K00F	1	341404000
R16	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R17	RES MF 11.0K 1% 1/4W	19701	5043ED11K00F	1	341404000
R18	RES MF 9.000K 0.1% 1/4W	64537	PME55-T2	1	324354000
R19	RES MF 1.000K 0.1% 1/8W	03888	PME55-T2	1	324241000
R20	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R21	RES MF 22.1K 1% 1/4W	19701	RN55D-2212-F	1	341433000
R22	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R23	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R24	RES MF 22.1K 1% 1/4W	19701	RN55D-2212-F	1	341433000
R25	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R26	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R27	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R28	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R29	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R30	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	1	341465000
R31	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R32-33	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R34	RES MF 12.1K 1% 1/4W	19701	5043ED12K10F	1	341408000
R35	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R36-38	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R39	RES MF 2.67K 1% 1/4W	19701	5043ED2K670F	1	341341000
R40	RES MF 33.2K 1% 1/4W	19701	5043ED33K20F	1	341450000
R41	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R42	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R43	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R44	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R45	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R46	RES MF 750K 1% 1/4W	19701	5043ED750K0F	1	341584000
R47	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R48	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R49	RES MF 10.5K 1% 1/4W	19701	5043ED10K50F	1	341402000
R50-52	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	3	341350000
R53	RES MF 750K 1% 1/4W	19701	5043ED750K0F	1	341584000
R54	RES MF 2.43K 1% 1/4W	19701	RN55D-2431-F	1	341337000
R55	RES NETWORK 10K 0.5% 1/2W	73138	694-3-R10K-D	1	345041000
R56	RES COMP 2.0M 5% 1/4W	01121	CB2055	1	343629000
R57-59	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
U1	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U2	IC 74HCT138 1 OF 8 DECODER	01295	74HCT138N	1	534375000
U3	IC 74HCT273	01295	SN74HCT273N	1	534377000
U4	IC 13202N 4 NOR OPEN SW	27014	LF13202N	1	534252000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
U5	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U6-7	IC 4052B MULTIPLEXER	02735	CD4052BE	2	534140000
U8	IC AD536 TRUE RMS/DC CONV	51640	AD536AJD	1	535105000
U9	IC 6108 CMOS CHAN MULTPXR	32293	IH6108CPE	1	534265000
U10	IC 74HCT273	01295	SN74HCT273N	1	534377000
XAR1	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XAR2	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XAR3-10	SOCKET IC 8 PIN	06776	ICN-083-S3-G	8	473041000
XU1-2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU3	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU4-7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	4	473042000
XU8	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU9	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU10	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000

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08262000A REV: AB PWA '8200-S/10' CPU

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
BT1	CELL LITHIUM 3V	54473	BR2325-1HB	1	556007000
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2	CAP TANT 4.7uF 10% 10V	56289	196D475X9010HA1	1	283226000
C3-9	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	7	224268000
C10	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C11-14	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	4	224268000
C15	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C16-18	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	3	283293000
CR1-2	DIODE SIG 1N914	01295	1N914	2	530058000
DS1-3	LED YELLOW DIFF 5082-4684	28480	HLMP-1401	3	536034000
J1	CONN M 40 CKT HDR DBL ROW .1CT	06776	NSH-40DB-S2-TG	1	47742240A
J2-3	CONN M 26 CKT HDR DBL ROW .1CT	06776	NSH-26DB-S2-TG	2	47742226A
JP1-2	SHUNT 2 CIRCUIT	27264	15-38-1024	2	483253000
L1	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
L2	INDUCTOR VK200/20-4B	02114	VK-200-20/4B	1	400409000
L3	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
Q1	TRANS PNP 2N4403	04713	2N4403	1	528122000
R1	RES NETWORK 3.3K 2% 1.5W 10pin	71450	750-101-R3.3K	1	345030000
R2	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R3	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R4-5	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	2	341250000
R6	RES MF 1.21K 1% 1/4W	19701	5043ED1K210F	1	341308000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R7-9	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	3	341350000
R10	RES NETWORK 3.3K 2% 0.9W 6pin	71450	750-61-R3.3K	1	34504500A
R11	RES NETWORK 10K 0.5% 1/2W	73138	694-3-R10K-D	1	345041000
R12	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
U1	IC 74LS390 DU DEC CTR	01295	SN74LS390N	1	534329000
U2	IC PLS157 PAL BLANK	18324	PLS157	1	53449100A
U3	IC 74HCT03 QUAD 2 INPUT NAND	18324	74HCT03N	1	53444212A
U4	IC 7705 SUPPLY VOLTAGE SUPVR	01295	TL7705ACP01295	1	53442200A
U5	IC 74LS148 8 TO 3 LINE ENCODER	01295	SN74LS148N	1	534234000
U6	IC 74HCT02 QUAD 2 INPUT NOR	18324	74HCT02N	1	53444211A
U7	IC 74F139 DUAL 1 OF 4 DECODER	07263	74F139PC	1	53448000A
U8	IC 68HC000CP	HITAC	68HC000CP-10	1	53449200A
U9	IC 74LS00 2 INP POS NAND	01295	SN74LSOON	1	534167000
U10	PROM 27C256 BLANK	01295	TMS27C256-1JL	1	53441200A
U11	IC PEEL153 PAL PROGRAMMED	04901	53454900A	1	53454900A
U12	IC 7673 AUTO BATTERY BACKUP SW	32293	ICL7673CPA	1	53448500A
U13	IC AD581JH VOLT REF	51640	AD581JH	1	535053000
U14	PROM 27C256 BLANK	01295	TMS27C256-1JL	1	53441200A
U15	IC TC 55257 PL-10	TOSH	TC55257APL-10	1	53449400A
U16	IC 74LS541 OCTAL BUFFER	01295	SN74LS541N	1	534381000
U17	IC TC 55257 PL-10	TOSH	TC55257APL-10	1	53449400A
U18	IC74LS245 OCT BUS TRANSCEIVER	01295	SN74LS245N	1	53437200A
U19	IC 9914ANL IEEE BUS PROCESSOR	01295	TMS9914ANL	1	534288000
U20	IC 74LS367 HEX BUFF DRVR	01295	SN74LS367N	1	534257000
U21	IC74LS245 OCT BUS TRANSCEIVER	01295	SN74LS245N	1	53437200A
U22	IC 82C55 INTERFACE	34371	CP82C55A	1	53441100A
U23	IC DAC725JP DUAL D/A CONVERTER	13919	DAC725JP	1	53514500A
U24	IC 75160 IEEE BUS TRANSCEIVER	01295	SN75160BN	1	534286000
U25	IC 75161 IEEE BUS TRANSCEIVER	01295	SN75161BN	1	534287000
U26	IC X24C16	XICOR	X24C16-P	1	53449500A
U27	IC 311N OP AMP COMPARATOR	27014	LM311N	1	535034000
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU3	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU4	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU5	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU6	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU7	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU8	SOCKET IC 68 PIN CHIP CARRIER	32575	641749-2	1	47308168A
XU9	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
XU10	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000
XU11	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU12	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU14-15	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	2	473044000
XU16	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU17	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000
XU18	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU19	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU20	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU21	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU22	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU23	SOCKET IC 28 PIN	06776	ICN-286-S4-TG	1	473044000
XU24-25	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
XU26-27	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XY1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
Y1	OSC CRYSTAL 18.432 MHz TTL DIP	NDK	TD1100C18.432	1	54790502A

A10

08251601A REV: A* PWA '8200-S10' COUNTER

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
AR1	IC TL372CP OP AMP	01295	TLC372CP	1	535118000
AR2	IC HA3-2544C-5 VIDEO AMPLIFIER	34371	HA3-2544C-5	1	53515300A
AR3	IC 318N OP AMP	27014	LM318N	1	535031000
C1-2	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C3	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C4	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C5	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C6	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C7	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C8	CAP MICA 250pF 5% 50V	57582	KD251J101	1	205037000
C9-15	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	7	224268000
C17	CAP MICA 300pF 5% 50V	14655	CD5FY301J	1	205026000
C18	CAP MICA 560pF 1% 300V	14655	CD15FC561F	1	200091000
C19	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C20	CAP MICA 300pF 5% 50V	14655	CD5FY301J	1	205026000
C21	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C22	CAP MICA 3.0pF +-0.5pF 300V	14655	CD5CC030D	1	205013000
CR1	DIODE SIG 1N914	01295	1N914	1	530058000
CR2	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
DS1-2	LED RED DIFF 5082-4684	28480	HLMP-1301	2	536024000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
L1-2	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L3	INDUCTOR VK200/20-4B	02114	VK-200-20/4B	1	400409000
L5-6	INDUCTOR 82uH 5%	59474	1315-10J	2	400318000
Q1	TRANS NPN MPS6507	04713	MPS6507	2	528070000
Q2	TRANS NPN 2N3904	04713	2N3904	2	528071000
R1	RES MF 221 OHM 1% 1/4W	19701	5043ED221R0F	1	341233000
R2	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R3	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000
R4	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R5	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R6	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R7	RES MF 56.2 OHM 1% 1/4W	19701	5043ED56R20F	1	341172000
R8-9	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	2	341200000
R10-11	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R12	RES MF 30.1K 1% 1/4W	19701	5043ED30K10F	1	341446000
R13	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R14	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R15	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R16	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R17	RES MF 681 OHM 1% 1/4W	19701	5043ED681R0F	1	341280000
R18	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R19	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R20	RES NETWORK 500 OHM 0.5% 0.5W	73138	694-3-R500D	1	345035000
R21	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R22-23	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R24-25	RES MF 464 OHM 1% 1/4W	19701	5043ED464R0F	2	341264000
R26	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R29	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R30	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
U1	IC 74F04 HEX INVERTER	07263	74F04PC	1	534395000
U2	IC 74LS74 FLIP FLOP	01295	SN74LS74N	1	534157000
U3	IC 74HCT138 1 OF 8 DECODER	01295	74HCT138N	1	534375000
U4	IC 74LS00 2 INP POS NAND	01295	SN74LSOON	1	534167000
U5	IC 74LS490 DUAL DEC COUNTER	18324	N74LS490N	1	534238000
U6	IC 74LS74 FLIP FLOP	01295	SN74LS74N	1	534157000
U7	IC 74LS490 DUAL DEC COUNTER	18324	N74LS490N	1	534238000
U8	IC 74LS290 DEC CTR	01295	SN74LS290N	1	534328000
U9	IC 74F151PC	07263	74F151PC	1	534374000
U10	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000
U11	IC 4049A HEX BUFF	02735	CD4049AE	1	534172000
U12	IC 74F74PC DUAL D FLIP FLOP	07263	74F74PC	1	534367000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
U13-14	IC 4040B COUNTER/DIVIDER	02735	CD4040BE	2	534275000
U15	IC 74HCT273	01295	SN74HCT273N	1	534377000
U16-19	IC 74HCT244	01295	74HCT244	4	534376000
U20	IC 74LS74 FLIP FLOP	01295	SN74LS74N	1	534157000
U21	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U22	IC 4040B COUNTER/DIVIDER	02735	CD4040BE	1	534275000
U23	IC 74LS163 4 BIT COUNTER	01295	SN74LS163AN	1	534279000
U24	IC 74LS153 4-1 LINE DATA SEL	01295	SN74LS153N	1	534278000
XU15-19	SOCKET IC 20 PIN	06776	ICN-203-S3-G	5	473065000
Y1	OSC CRYSTAL 10 MHz TTL DIP	81654	970-10.0 MHz	1	54790506A
A11					
	08257500A REV: AB PWA '8200-S10' I/O				
C1	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C2-4	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
DS1-2	LED RED DIFF HLMP-6620	28480	HLMP-6620	2	536026000
J1	CONN M 26 CKT HDR DBL ROW .1CT	06776	NSH-26DB-S2-TG	1	47742226A
J2	CONNECTOR HEADER 2 PIN RT ANG	06383	HPAS156-2-C	1	477385000
J3	CONN F 50 CKT DBL ROW .1CT	32575	102585-3	1	479439000
J4	HEADER 5 PIN RT ANGLE	06383	HPAS156-5-C or D	1	477341000
R1-2	RES NETWORK 3.3K 2% 1.5W 10pin	71450	750-101-R3.3K	2	345030000
U1	IC 74F139 DUAL 1 OF 4 DECODER	07263	74F139PC	1	53448000A
U2-3	IC 82C79P-2 KEYBD/DISP INTERFACE	TOSH	TM82C79P-2	2	53454700A
U4	IC 74HCT04 HEX INVERTER	02735	CD74HCT04E	1	53444213A
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2-3	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	2	473052000
XU4	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
A12					
	08257600A REV: AA PWA '8200-S10' DISPLAY				
C1-2	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C3-4	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C5	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C6	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
DS1-5	DISPLAY NUMERIC 5082-7651	28480	5082-7651-S02	5	536811000
DS6	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	1	536027000
DS7	DISPLAY NUMERIC 5082-7651	28480	5082-7651-S02	1	536811000
DS8	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	1	536027000
DS9-18	DISPLAY NUMERIC 5082-7651	28480	5082-7651-S02	10	536811000
DS19-20	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	2	536027000
DS21-22	DISPLAY NUMERIC 5082-7651	28480	5082-7651-S02	2	536811000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
DS23	LED LIGHT BAR MOD HLMP-2620	28480	HLMP-2620	1	536027000
P1-2	CONNECTOR 20 PIN STRAIGHT	27264	22-03-2201	2	477397000
P3	CONN M 50 CKT HDR DBL ROW .1CT	32575	102692-4	1	477384000
R1-4	RES NETWORK 22 OHM +-2 OHM 2W	01121	316B-220	4	345034000
U1	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U2	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U3	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U4	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U5-6	IC 74HCT244	01295	74HCT244	2	534376000
U7-8	IC UDN2585A	56289	UDN2585A	2	534392000
U9	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U10	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U11	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U12	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
U13-14	IC 74HCT244	01295	74HCT244	2	534376000
U15-16	IC UDN2585A	56289	UDN2585A	2	534392000
U17	IC 74LS138 DECDR/MPX	01295	SN74LS138N	1	534246000
XDS1-5	SOCKET IC 14 PIN	06776	ICN-143-WB-G	5	473066000
XDS6	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XDS7	SOCKET IC 14 PIN	06776	ICN-143-WB-G	1	473066000
XDS8	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XDS9-18	SOCKET IC 14 PIN	06776	ICN-143-WB-G	10	473066000
XDS19-20	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	2	473047000
XDS21-22	SOCKET IC 14 PIN	06776	ICN-143-WB-G	2	473066000
XDS23	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XU1	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	1	473045000
XU2	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XU3	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	1	473045000
XU4	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XU5-6	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
XU7-9	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	3	473045000
XU10	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XU11	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	1	473045000
XU12	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000
XU13-14	SOCKET IC 20 PIN	06776	ICN-203-S3-G	2	473065000
XU15-16	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	2	473045000
XU17	SOCKET IC 16 PIN	06776	ICN-163-WB-TG	1	473047000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A13					
	08251702A REV: A* PWA '8200-S10' KEYBOARD				
J1-2	CONNECTOR 20 PIN	27264	22-02-2205	2	479399000
S1	SWITCH PUSH BUTTON W/LED	31918	200480	1	465293000
S2-3	SWITCH PUSH BUTTON W/O LED	31918	200330	2	465294000
S4-9	SWITCH PUSH BUTTON W/LED	31918	200480	6	465293000
S10-11	SWITCH PUSH BUTTON W/O LED	31918	200330	2	465294000
S12-16	SWITCH PUSH BUTTON W/LED	31918	200480	5	465293000
S19-21	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S22-25	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S26-28	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S29-32	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S33-35	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S36-39	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S40-42	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S44-47	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S48-50	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S52-55	SWITCH PUSH BUTTON W/O LED	31918	200330	4	465294000
S56-58	SWITCH PUSH BUTTON W/LED	31918	200480	3	465293000
S60-61	SWITCH PUSH BUTTON W/LED	31918	200480	2	465293000
A15					
	08257000A REV: AA '8200-S10' 455kHz IF HSG ASSY				
A15W1	CABLE ASSY COAX RG405/U 7.75 L	04901	57226100A	1	57226100A
A15A1	PWA '8200-S10' DET INTERFACE	04901	08257700A	1	08257700A
A15W2	CABLE ASSY COAX RG405/UL	04901	57226200A	1	57226200A
A15A2	PWA '8200-S10' IF DETECTOR	04901	08257300A	1	08257300A
A15W3	CABLE ASSY WIRE 24GA 1C 2.50L	04901	57125500A	1	57125500A
A15A3	PWA '8200-S10' IF AMPLIFIER	04901	08257400A	1	08257400A
C1-24	CAP FT 3000pF 100V	32575	859617-1	24	227123000
J1	CONNECTOR SMA	19505	60-0939-090	1	479367000
A15A1					
	08257700A REV: AB PWA '8200-S10' DET INTERFACE				
C1-3	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	3	283334000
C4	CAP TANT 6.8uF 10% 35V	61637	196D685X9035KA1	1	283217000
C5-8	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	4	224264000
C9	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C10-11	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000
J1-16	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	16	479333000
J17	CONNECTOR "SMB"	19505	209	1	477317000
L1-2	INDUCTOR 5.6uH 10%	24226	15/561	2	400308000
L3	INDUCTOR VK200/20-4B	02114	VK-200-20/4B	1	400409000
R1	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R2	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R3	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R10	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R11	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R12	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R13	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	1	341467000
U1	IC 74HCT138 1 OF 8 DECODER	01295	74HCT138N	1	534375000
U2-4	IC 74HCT273	01295	SN74HCT273N	3	534377000
U5	IC 6108 CMOS CHAN MULTPXR	32293	IH6108CPE	1	534265000
U6	IC 339 QUAD COMPARATOR	27014	LM339N	1	535018000
U8	IC AD536 TRUE RMS/DC CONV	51640	AD536AJD	1	535105000
U9	IC 356B OP AMP	27014	LF356BN	1	535052000
XU1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU2-4	SOCKET IC 20 PIN	06776	ICN-203-S3-G	3	473065000
XU5	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU6, 8	SOCKET IC 14 PIN	06776	ICN-143-S3-G	2	473019000
XU9	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
A15A2					
	08257300A REV: AA	PWA '8200-S10' IF DETECTOR			
C1	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C4-5	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000
C6	CAP MICA 390pF 5% 500V	57582	KD15391J501	1	200108000
C7	CAP MICA 2200pF 5% 500V	57582	KD19222J501	1	200525000
C8	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C9	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C10	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C11	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C12	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C13-15	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	3	224264000
C16	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C17-18	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C19	CAP MICA 680pF 1% 300V	14655	CD15FC681F03	1	200015000
C20	CAP MICA 120pF 5% 100V	14655	CD5FC121J	1	205022000
C21-23	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	3	224264000
C24	CAP MPC 1.0uF 10% 50V	14752	652A-1-A-105K	1	234152000
C25-27	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	3	224264000
C28-29	CAP MICA 1500pF 1% 100V	57582	SD15-152F101	2	20013100A
C31	CAP MPC 0.33uF 5% 50V	27735	MPC53-.33-50-5	1	234143000
C32	CAP CER 100 pF 5% 300V	14655	CD15FD101F	1	205039000
C33-34	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C35-51	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	17	224264000
CR1-2	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR3-8	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	6	530760000
CR9-10	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR13-14	DIODE SIG FDH-300	07263	FDH-300	2	530052000
CR15	DIODE ZENER 1N5241B 11V 5%	04713	1N5241B	1	530082000
J1-2	CONNECTOR "SMB"	19505	209	2	477317000
J3-23, 25-27	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	24	479333000
L1	INDUCTOR 2.2mH	00213	WEE2200	1	400141000
L2	INDUCTOR 68mH 10%	00213	SWD 68000	1	400419000
L3	COIL ASSY (280 uH) '8200-S10'	04901	40045100A	1	40045100A
L4	INDUCTOR 150uH 10%	24226	10/153	1	400418000
L8-9	INDUCTOR 2.2mH	00213	WEE2200	2	400141000
L10	INDUCTOR 470uH 5%	00213	WEE-470	1	400116000
Q1	TRANS FET 2N4221A N-CHAN	27014	2N4221A	1	528063000
Q2-3	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q4-5	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q6	TRANS FET J108	17856	J-108	1	52815600A
Q7	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q8-9	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q10	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q11	TRANS FET J108	17856	J-108	1	52815600A
R1	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R2	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R5	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R6-7	RES MF 3.74K 1% 1/4W	19701	5043ED3K740F	2	341355000
R8	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R9	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R10	RES MF 825 OHM 1% 1/4W	19701	5043ED825R0F	1	341288000
R11	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R12	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R13	RES MF 825 OHM 1% 1/4W	19701	5043ED825R0F	1	341288000
R14-15	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	2	341367000
R16	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R18	RES MF 604 OHM 1% 1/4W	19701	5043ED604R0F	1	341275000
R19	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R20	RES MF 100 OHM 1% 1/4W	19701	5043ED243R0F	1	341200000
R21	RES VAR 500 OHM 10% 0.5W	73138	72XWR500	1	311357000
R22	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R23	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R24	RES MF 7.15K 1% 1/4W	19701	5043ED7K150F	1	341382000
R25	RES MF 432 OHM 1% 1/4W	19701	5043ED432R0F	1	341261000
R26	RES VAR 500 OHM 10% 0.5W	73138	72XWR500	1	311357000
R28	RES MF 412 OHM 1% 1/4W	19701	5043ED412ROF	1	341259000
R29	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R30	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R31	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R32	RES MF 1.00k OHM 1% 1/4W	19701	5043ED432R0F	1	341300000
R33	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R35	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R36	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R37	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R38	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R39	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R40	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R41	RES MF 31.6K 1% 1/4W	19701	5043ED100K0F	1	341448000
R42-43	RES MF 316 OHM 1% 1/4W	19701	5043ED316R0F	2	341248000
R46	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R47	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R48	RES MF 2.00K 1% 1/4W	19701	5043ED3K010F	1	341329000
R49	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R50	RES MF 2.00K 1% 1/4W	19701	5043ED3K010F	1	341329000
R53	RES MF 4.02K 1% 1/4W	19701	5043ED4K020F	1	341358000
R54	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R55	RES COMP 1.0M 5% 1/4W	01121	CB1055	1	343600000
R57	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R58	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R61	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R62	RES MF 1.58K 1% 1/4W	19701	5043ED1K580F	1	341319000
R63	RES MF 5.49K 1% 1/4W	19701	5043ED5K490F	1	341371000
R64	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R65	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R66	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R67	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R69	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R70	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R72	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R73	RES COMP 2.0M 5% 1/4W	01121	CB2055	1	343629000
R74	RES MF 17.4K 1% 1/4W	19701	5043ED17K40F	1	341423000
R75	RES MF 14.0K 1% 1/4W	19701	5043ED14K00F	1	341414000
R76	RES MF 11.5K 1% 1/4W	19701	5043ED11K50F	1	341406000
R77	RES MF 9.09K 1% 1/4W	19701	5043ED9K090F	1	341392000
R78	RES MF 7.15K 1% 1/4W	19701	5043ED7K150F	1	341382000
R79	RES MF 5.76K 1% 1/4W	19701	5043ED5K760F	1	341373000
R80	RES MF 4.42K 1% 1/4W	19701	5043ED4K420F	1	341362000
R81	RES MF 3.57K 1% 1/4W	19701	5043ED3K570F	1	341353000
R82	RES COMP 1.0M 5% 1/4W	01121	CB2055	1	343600000
R83	RES VAR 25K 10% 0.5W	73138	72XWR25K	1	311385000
R84	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
T1	TRANSFORMER TTI-6-X65	15542	TT1-6 STYLE X65	1	41009401A
U1	IC HA3-2625-5-A OP AMP	34371	HA3-2625-5-A	1	53511901A
U2	IC OP-07EP OP AMP	06665	OP-07EP	1	535110000
U3	IC MPY634KP 4 QUAD ANALOG MULT	13919	MPY634KP	1	53451900A
U5	IC MPY634KP 4 QUAD ANALOG MULT	13919	MPY634KP	1	53451900A
U7-8	IC OP-07EP OP AMP	06665	OP-07EP	2	535110000
U10	IC 6108 CMOS CHAN MULTPXR	32293	IH6108CPE	1	534265000
XU1-2	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU3	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU5	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU7-8	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU10	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A15A3					
	08257400A REV: PWA '8200-S10' IF AMPLIFIER				
C1	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C5-6	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000
C7	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C8-9	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000
C10	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C11-12	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	2	224264000
C13	CAP MICA 3100pF 0.5% 500V	57582	KD19312E501	1	200521000
C14	CAP MICA 240pF 5% 50V	14655	CD5FY241J	1	205025000
C15	CAP MICA 3100pF 0.5% 500V	57582	KD19312E501	1	200521000
C16	CAP MICA 120pF 5% 100V	14655	CD5FC121J	1	205022000
C17	CAP MICA 3100pF 0.5% 500V	57582	KD19312E501	1	200521000
C18	CAP MICA 130pF 5% 100V	14655	CD5FA131J	1	205011000
C19	CAP MICA 3100pF 0.5% 500V	57582	KD19312E501	1	200521000
C20	CAP MICA 160pF 5% 50V	14655	CD5FA161J	1	205004000
C21	CAP MICA 3100pF 0.5% 500V	57582	KD19312E501	1	200521000
C22	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C23-24	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	2	283334000
C26-38	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	13	224264000
C39	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C40	CAP VAR CER 5.1-50pF 250V GRN	52769	GKR50000	1	281006000
C41	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C42	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C43	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	283334000
C44	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C45	CAP EL 100uF 20% 25V	S4217	SM-25-VB-100-M	1	228334000
C46	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
CR2-4	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	3	530174000
J1	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	1	479333000
J2	CONNECTOR "SMB"	19505	209	2	477317000
J3, 5-11	SOCKET SPRING COMPONENT LEAD	32575	1-332070-7	8	479333000
J12-16	CONNECTOR 2 PIN STRAIGHT	27264	22-10-2021	5	477361000
L1-5	COIL ASSY (40 uH) '8200-S10'	04901	40045000A	5	40045000A
P1	SHUNT 2 CIRCUIT	27264	15-38-1024	1	483253000
Q3	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q4	TRANS PNP 2N4403	04713	2N4403	1	528122000
Q5	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q6	TRANS PNP 2N4403	04713	2N4403	1	528122000

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
Q7	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q8	TRANS PNP 2N4403	04713	2N4403	1	528122000
R7	RES MF 900 OHM 0.02% 1/8W	91637	PTF56900R0BCT16	1	324236000
R8	RES MF 100 OHM 0.02% 1/8W	91637	PTF56100R0BCT16	1	324117000
R9	RES MF 90.9 OHM 1% 1/4W	19701	5043ED90R90F	1	341192000
R10	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R11	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R12	RES MF 75.0 OHM 1% 1/4W	19701	5043ED75R00F	1	341184000
R13	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R14	RES MF 562 OHM 1% 1/4W	19701	5043ED562R0F	1	341272000
R15	RES MF 900 OHM 0.02% 1/8W	91637	PTF56900R0BCT16	1	324236000
R16	RES MF 100 OHM 0.02% 1/8W	64537	PTF56100R0BCT16	1	324117000
R17	RES MF 90.9 OHM 1% 1/4W	19701	5043ED90R90F	1	341192000
R18	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R19	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R20	RESMF 61.9 OHM 1% 1/4W	19701	5043ED61R90F	1	341176000
R21	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R22	RES MF 562 OHM 1% 1/4W	19701	5043ED562R0F	1	341272000
R23	RES MF 683.8 OHM 0.02% 1/4W	91637	PTF56683R8BCT16	1	324224000
R24	RES MF 216.2 OHM 0.02% 1/4W	91637	PTF56216R2BCT16	1	324165000
R25	RES MF 100 OHM 0.02% 1/8W	91637	PTF56100R0BCT16	1	324117000
R26	RES MF 215 OHM 1% 1/4W	19701	5043ED215R0F	1	341232000
R27	RES MF 127 OHM 1% 1/4W	19701	5043ED127R0F	1	341210000
R28	RES MF 499 OHM 1% 1/4W	19701	5043ED499R0F	1	341267000
R29	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R30	RESMF 61.9 OHM 1% 1/4W	19701	5043ED61R90F	1	341176000
R31	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R32	RES MF 562 OHM 1% 1/4W	19701	5043ED562R0F	1	341272000
R33	RES MF 806 OHM 1% 1/4W	19701	5043ED806R0F	1	341287000
R37	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R38	RES VAR 1K 10% 0.5W	73138	72XWR1K	1	311340000
R39	RES MF 221 OHM 1% 1/4W	19701	5043ED221R0F	1	341233000
R40	RES MF 10.00K 0.1% 1/8W	91637	CMF55-1002-B-T2	1	32593100A
R41	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R42	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
RT1	THERMISTOR 1.0K DISK RDL LEADS	00241	JB31J1	1	32501700A
U1-2	IC 419 ANALOG SWITCH	17856	DG-419-DJ	2	53452400A
U3	IC 13201N ANALOG SWITCH	27014	LF13201N	1	535106000
U6	IC 592 TEMPERATURE TRANSDUCER	51640	AD592AN	1	53514700A

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A23					
	08250703A REV: A* '8200-S10' REAR PANEL ASSEMBLY				
A27	HEAT SINK ASSY	04901	08250800B	1	08250800B
F1	FUSE 0.75 AMP 250V MDL SLO BLO	54426	MDL-3/4	1	545533000
FL1	FILTER LINE	56289	3JX5421A	1	439004000
J5-9	CONN COAX BNC	54420	UG-625B/U	5	479123000
S2	SWITCH DUAL SLIDE DPDT-DPDT	82389	47206LFR	1	465279000
T1	TRANSFORMER POWER	04901	44609600A	1	44609600A
W9	CABLE ASSY FLAT 24CKT 14.75 L	04901	92017700A	1	92017700A
W10	CABLE ASSY WIRE 22GA 3C 14.00L	04901	57121701A	1	57121701A
W12	CABLE ASSY COAX RG316/U 18.25L	04901	57223608A	1	57223608A
W13	CABLE ASSY COAX RG316/U 25.75L	04901	57223610A	1	57223610A
W14	CABLE ASSY COAX RG316/U 26.00L	04901	57223609A	1	57223609A
W15	CABLE ASSY COAX RG316/U 20.25L	04901	57223612A	1	57223612A
W17	CABLE ASSY WIRE 24GA 4C 7.75L	04901	57120100B	1	57120100B
W19-20	CABLE ASSY WIRE 20GA 1C 10.50L	04901	57121801A	2	57121801A
A24					
	08250401A REV: A* '8200-S10' SUB PANEL ASSY				
A12	PWA '8200-S10' DISPLAY	04901	08257600A	1	08257600A
A28	POWER SWITCH ASSY	04901	082531000	1	082531000
C1	CAP MICA 430pF 1% 500V	14655	CD15FD431F03	1	200037000
C2	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
J2	CONNECTOR RF FUSE ASSY	04901	082042000	1	082042000
J3	CONNECTOR "SMB" 50 OHM	19505	2019-7511-000	1	477305000
K1	SWITCH SPDT MICROWAVE	04901	46503300A	1	46503300A
L1	INDUCTOR ASSY 330 uH	04901	400441000	1	400441000
W1	CABLE ASSY COAX .141	04901	57225500A	1	57225500A
W21	CABLE ASSY WIRE 24GA 3C 17.5 L	04901	57125400A	1	57125400A
W23	CABLE ASSY COAX .141	04901	57225400A	1	57225400A
A25					
	08253002A REV: A* '8200-S10' FRONT PANEL ASSY MODEL: 8200-S10				
A13	PWA '8200-S10' KEYBOARD	04901	08251702A	1	08251702A
A24	'8200-S10' SUB PANEL ASSY	04901	08250401A	1	08250401A

TABLE 7-2. Model 8200-S/10 Parts List Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A27					
	08250800B REV: C* HEAT SINK ASSY				
C9	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C20	CAP CER 0.01uF 20% 500V	33883	BGP Z5U W/FDCL	1	224271000
C26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
CR1	DIODE BRIDGE SDA-980-1	11961	SDA-980-1	1	532030000
U4	IC 323K REGULATOR	27014	LM323K	1	535024000
U5	IC UA7805UC VOLT REG	07263	uA7805UC	1	53511700A
U6	IC UA79M05AUC VOLT REG	07263	uA79MO5AUC	1	535093000
U7	IC UA7805UC VOLT REG	07263	uA7805UC	1	53511700A
W18	CABLE ASSY WIRE 22GA 3C 5.00L	04901	57121703A	1	57121703A
XU4	SOCKET TRANSISTOR PWR TO-3	06776	MP-3452G	1	47308000A
A28					
	082531000 REV: CA POWER SWITCH ASSY MODEL: 8200				
J1	CONN COAX BNC	54420	UG-625B/U	1	479123000
S1	SWITCH ROCKER DPDT	13812	572-2121-0103-010	1	465286000
W16	CABLE ASSY WIRE 24GA 4C 16.25L	04901	57120000B	1	57120000B

SECTION VIII
SCHEMATIC DIAGRAMS

TABLE 8-1. LIST OF SCHEMATIC DIAGRAMS.

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