INSTRUCTION MANUAL

MODEL 8211
MODULATION METER

BOONTON

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of this instrument. Failure to comply with these precautions, or with specific warnings elsewhere in this manual, violates safety standards of design, manufacture, and intended use of the instrument. Boonton Electronics assumes no liability for the customer's failure to comply with these requirements.

THE INSTRUMENT MUST BE GROUNDED

To minimize shock hazard the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor, three-prong power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to a two-contact adapter with the (green) grounding wire firmly connected to an electrical ground at the power outlet.

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

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

DO NOT SERVICE OR ADJUST ALONE

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modification of the instrument. Return the instrument to Boonton Electronics for repair to ensure that the safety features are maintained.

SAFETY SYMBOLS

This safety requirement symbol (located on the rear panel) has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, paragraph 5.3, which directs that the instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available, and that the switch on the rear panel is set to the applicable operating voltage.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond the CAUTION sign until the indicated conditions are fully understood and met.

WARNING

The WARNING sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Indicates dangerous voltages.

JUNE 1994

CERTIFICATION

Boonton Electronics Corporation certifies that this instrument has been inspected by our Quality Assurance Department, and found to conform to our standards for quality of workmanship and performance.

Boonton Electronics Corporation further certifies that its calibration is directly traceable to the National Institute of Standards and Technology, to the extent of its current services, through standards certified at periodic intervals.

The system under which calibration was performed conforms to the present requirements of MIL-STD-45622A Calibration System Requirements. Records of the certification standards are maintained and may be inspected upon request.

WARRANTY

Boonton Electronics Corporation warrants this product (to the original purchaser) free from defects in material and workmanship and to operate within applicable specifications for a period of one year from the date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

Boonton Electronics Corporation will repair, or at our option, replace any of our products that are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return normal ground transportation during the first three months of this warranty. *

There will be no charge for parts, labor, or return normal ground transportation during the fourth through twelfth month of this warranty. *

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

**For overseas shipments, there will be no-charge for air freight during these specific time periods.*

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Boonton products.

For any assistance, contact your Boonton Representative, Distributor, or the Applications Engineering Department of Boonton Electronics Corporation. The factory address, FAX, TWX, and phone numbers can be found on the title page and manual update insert at the front of this manual.

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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, parts list and schematic diagrams for the Model 8211 Modulation Meter. The Model 8211 is manufactured by Boonton Electronics Corporation, Randolph, New Jersey.

1-3. DESCRIPTION

1-4. The Model 8211 is a precise, versatile, solid-state instrument with features and performance characteristics especially suited to laboratory and industrial applications. It covers a frequency range of 2 MHz to 1.5 GHz. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 8211. The result is a modulation meter that is easy and convenient to use, despite its flexibility. Among the outstanding features:

- **Automatic tuning and leveling.** The Model 8211 can automatically acquire the largest signal present at the RF IN connector and adjust its local oscillator and measurement channel gain to provide a calibrated display of amplitude or frequency modulation.
- **Internal Calibration.** The Model 8211 contains precision AM and FM calibrators that can be activated from the front panel to calibrate the modulation detectors.
- **Low Residual Modulation.** Low modulation residuals provide excellent measurement accuracy with low noise sources. Additionally, active peak detectors insure exceptional baseband detection linearity so that residuals may be easily discounted for enhanced measurement accuracy.
- **IEEE-488 Bus Interface.** The Model 8211 is supplied with an IEEE-488 interface. This interface allows connection to remote computers and other instruments.

1-5. The features described in the preceding paragraphs, with those described in TABLE 1-1, make the Model 8211 particularly useful for design, production line, and field testing of FM and AM transmitters and signal generators. Because of its flexibility, the Model 8211 is also a good modulation analyzer for laboratory applications.

1-6. ITEMS FURNISHED. The instrument is supplied complete with power cord. For making measurements the connection of various cables will be called for, depending upon the operating mode of the Model 8211. Required cable connections are discussed in SECTION II.

1-7. OPTIONS

-01 **30 kHz Low-pass Filter**. The 15 kHz low-pass filter is replaced by a 30 kHz filter. See TABLE 1-1.

-02 **50 kHz Low-pass Filter**. The 15 kHz low-pass filter is replaced by a 50 kHz filter. See TABLE 1-1.

1-8. ACCESSORIES. Boonton part number 950027 is a rack-mounting kit that permits a Model 8211 to be mounted in a standard 19-inch rack configuration. (Not supplied).

1-9. Inquiries regarding special applications of the Model 8211 to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

1-10. PERFORMANCE SPECIFICATIONS

1-11. Performance specifications for Model 8211 are listed in TABLE 1-1.

1-12. OUTLINE DIMENSIONS

1-13. Outline dimensions of Model 8211 are shown in FIGURE 1-1.

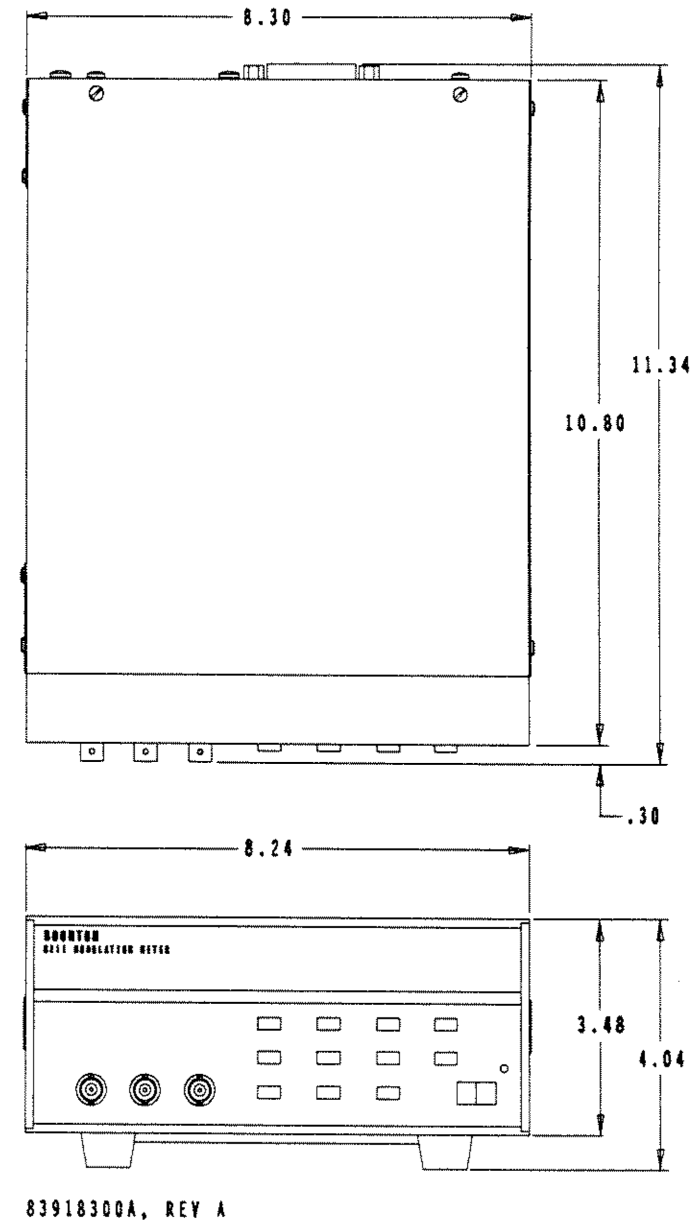

Figure 1-1. OUTLINE DIMENSIONS.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

RF INPUT

Frequency Range	: 2 MHz to 1.5 GHz.
Tuning	: Automatic.
Carrier Level	: 10 millivolts to 1 volt, Frequency < 520 MHz. : 30 millivolts to 1 volt, Frequency < 1500 MHz.
Maximum Input	: 1 watt (7 V rms).
Input Impedance	: 50 ohms nominal.

FREQUENCY MODULATION

Measurement	: +peak, -peak, and peak average.
Rates	: < 20 Hz to 15 kHz.
Range	: 0 to 150 kHz peak.
Resolution	: 10 Hz, 0 to 15.00 kHz deviation. : 100 Hz, 15.0 to 150.0 kHz deviation.
Accuracy(1)	: 1% of reading, 50 Hz to 5 kHz. : 2% of reading, 20 Hz to 7.5 kHz.
Distortion	: < 0.25% for deviations < 75 kHz.
Residual FM	: < 150 Hz rms at 1500 MHz carrier, decreasing linearly with frequency to a floor of < 5 Hz rms, with 3 kHz filter. : < 200 Hz rms at 1500 MHz carrier, decreasing linearly with frequency to a floor of < 15 Hz rms, with 15 kHz filter.
Incidental FM	: < 100 Hz peak deviation at 50% AM, 1 kHz modulation rate, with 3 kHz filter.

AMPLITUDE MODULATION

Measurement	: +peak, -peak, and peak average.
Rates	: < 20 Hz to 15 kHz.
Range	: 0 to 99.9%.
Resolution	: 0.01% from 0.00 to 15.00% AM. : 0.1% from 15.0 to 150.0% AM.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

Accuracy		10% to 90%, AM.	<10 % & >90% AM.
	from 50 Hz to 5 kHz.	1% of reading.	3% of reading.
	from 20 Hz to 7.5 kHz.	2 % of reading.	6% of reading.
Distortion	: <0.5% for depths up to 90%.		
Residual AM(2)	: 0.15% rms with 3 kHz filter. : 0.25% rms with 15 kHz filter.		
Incidental AM	: <1.0% AM peak at 100 kHz peak deviation.		
AUDIO FILTERS			
Low-pass	: 3 and 15 kHz, 3-pole Butterworth.		
De-emphasis	: 750 μs.		
Accuracy	: ± 4 % for 3 dB corner and time constant.		
AM CALIBRATOR	: internal, 33.33% depth, 0.25% accuracy.		
FM CALIBRATOR	: internal, 46.08 kHz deviation, 0.1% accuracy.		
GENERAL			
IEEE-488	: Complies with IEEE-488-1978. Implements AH1, SH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, and E1.		
Power Requirements	: 100, 120, 220, or 240 volts, 50-400 Hz, single phase, approx. 24 VA.		
Operating Temperature	: 0 to 55 degrees C.		
Dimensions	: 8.6 inches (21.8 cm) wide, 4.1 inches (10.3 cm) high, 11.0 inches (27.8 cm) deep.		
Weight	: 7 lbs (3.18 kg).		
SUPPLEMENTAL SPECIFICATIONS			
AF OUT(3)	: Uncalibrated, approx. 1 V into 600 ohms at 1000 counts on display. Source impedance 600 ohms.		
IF OUT(3)	: Approximately 300 to 360 mV into 600 ohms, frequency 400 kHz nominal. Source impedance 600 ohms.		

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

MODEL 8211 OPTION -01

AUDIO-FREQUENCY RESPONSE

Filters — The 15 kHz low-pass filter is replaced by a 30 kHz low-pass filter; corner accuracy ± 4%.

FREQUENCY MODULATION

Deviation Accuracy — : 1% of reading for modulation frequencies between 50 Hz and 10 kHz.
: 2% of reading, 20 Hz to 15 kHz.

Modulation Bandwidth — : <20 Hz to 30 kHz.

Residual FM — : <400 Hz rms at 1.5 GHz, decreasing linearly with frequency to a floor of <25 Hz rms, with 30 kHz filter.

AMPLITUDE MODULATION

Accuracy		10% to 90%, AM.	<10 % & >90% AM.
	from 50 Hz to 10 kHz.	1% of reading.	3% of reading.
	from 20 Hz to 15 kHz.	2 % of reading.	6% of reading.

Modulation Bandwidth — <30 Hz to 30 kHz.

Residual AM (2) — : <0.35% AM rms for input levels above 100 mV rms, with 30 kHz filter.

MODEL 8211 OPTION -02

AUDIO-FREQUENCY RESPONSE

Filters — The 15 kHz low-pass filter is replaced by a 50 kHz low-pass filter; corner accuracy ± 4%.

FREQUENCY MODULATION

Deviation Accuracy(1) — 1% of reading for modulation frequencies between 50 Hz and 16.7 kHz.
2% of reading, 20 Hz to 25 kHz.

Modulation Bandwidth — <20 Hz to 50 kHz.

Residual FM — : <950 Hz, rms at 1.5 GHz, decreasing linearly with frequency to a floor of <55 Hz rms, with 50 kHz filter.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

AMPLITUDE MODULATION

Depth Accuracy(1)		10% to 90%, AM.	< 10% & 90% AM.
	from 50 Hz to 16.7 kHz.	1% of reading.	3% of reading.
	from 20 Hz to 25 kHz.	2 % of reading.	6% of reading.

Modulation Bandwidth < 20 Hz to 50 kHz.

Residual AM (2) : < 0.55% AM rms for input levels above 100 mV rms, with 50 kHz filter.

NOTES

(1) Peak residual must be accounted for.
(2) Level > 100 millivolts, Frf < 520 MHz.
Above 520 MHz, residual increases linearly with frequency.
(3) These specifications are for application purposes and, although typical, are not warranted.

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains the installation instructions for the Model 8211 Modulation Meter. Included is information pertinent to unpacking, mounting, power requirements, line voltage selection, cable connections and initial inspection.

2-3. UNPACKING

2-4. The Model 8211 is shipped complete and is ready to use upon receipt. Unpack the instrument from its shipping container and inspect it for damage. See FIGURE 2-1. If the contents are incomplete or the instrument shows signs of damage, notify Boonton Electronics and the carrier.

NOTE

Save the packing material and container for possible use in reshipment of the instrument, or for carrier inspection in case of shipping damage.

2-5. MOUNTING

2-6. For bench mounting, choose a clean, sturdy and uncluttered mounting surface. For rack mounting, an accessory package (Model Number 950027) is available; it consists of two angle-mounting brackets, two flat plates, four binder-head screws, and four lockwashers. To rack mount an 8211, proceed as follows:

NOTE

If necessary, the feet and tilt bail may be removed from the cover to clear any adjacent rack-mounted units.

- The 8211 has one extrusion at each end of the front panel. On the outside surfaces of these extrusions, where they join the cabinet, are two strips of pressure-sensitive tape. Remove or perforate these tape strips to expose the tapped mounting holes for the rack-mounting brackets.
- Refer to the drawing in the accessory's package for the proper orientation of the two mounting brackets.
- Mount the Model 8211 in the rack, with standard rack-mounting screws, through slotted holes in the angle brackets.

CAUTION

Always make certain that the line voltage selector is set to the correct position most nearly corresponding to the voltage of the available AC power source, and that a fuse of the correct rating is installed before connecting the Model 8211 to any AC power source.

2-7. To set the line voltage selector, located in the rear panel line connector assembly to the appropriate position:

- Remove all rear panel connections to the instrument.
- Remove the fuse drawer using a small flat-blade screwdriver.
- Remove the voltage selector insert and rotate until the correct voltage indication appears in the window of the fuse drawer.

- Install the voltage selector insert, install the correct fuse in the fuse drawer, and replace the fuse drawer.

- The correct fuse for the selected power source is 1/4 ATD for 100 and 120 volts, and 1/8 ATD for 220 and 240 volts.

2-8. POWER FAIL PROTECTION

2-9. If the line voltage drops more than 10% below nominal, a power fail protection circuit automatically isolates the internal random access memory. Backup power is provided by a lithium cell rated at 3.0 V and 160 mAh, with a life expectancy of more than five years.

2-10. CABLE CONNECTIONS

2-11. Cable connections required depend on the use of the instrument. Cable connections that may be required include:

- RF IN. RF input, front panel, 50 ohms nominal impedance. Type BNC connector.

- Audio output, front panel, 600 ohms impedance, 1 volt rms at 1000 counts on modulation display. Type BNC connector.

- IF output, front panel, 600 ohms nominal source impedance, 300 to 360 millivolts rms.

- Instrument bus connection. Connector compatible with IEEE-488-1975.

2-12. PRELIMINARY CHECK

2-13. The preliminary check verifies that the Model 8211 is operational and should be performed before the instrument is placed into use.

2-14. Turn the instrument power ON. After a brief lamp test, the display will contain the instrument firmware code for about three seconds. The instrument will then execute a self-check program. Finally, display will change to the '----' message that indicates that the instrument is unlocked. Refer to SECTION III for the meaning of any other displayed messages.

2-15. Depress the SHIFT and CAL keys. The display should change to the 'CAL' message. Observe the operation of the instrument. The Model 8211 is performing an internal calibration of the AM detector. As the calibration proceeds, the results of the calibration process will appear in the display window. The calibration point is 33.3 % AM. If CC1 appears in the display window, a calibration fault has occurred and hardware maintenance is required.

2-16. The 'CAL' message will reappear and FM calibration will begin. The nominal indication is 46.1 kHz and condition code 2 is the calibration fault.

2-17. After the calibration routine completes, the instrument will return to normal operation. If the calibration routine completes properly, the instrument is functional.

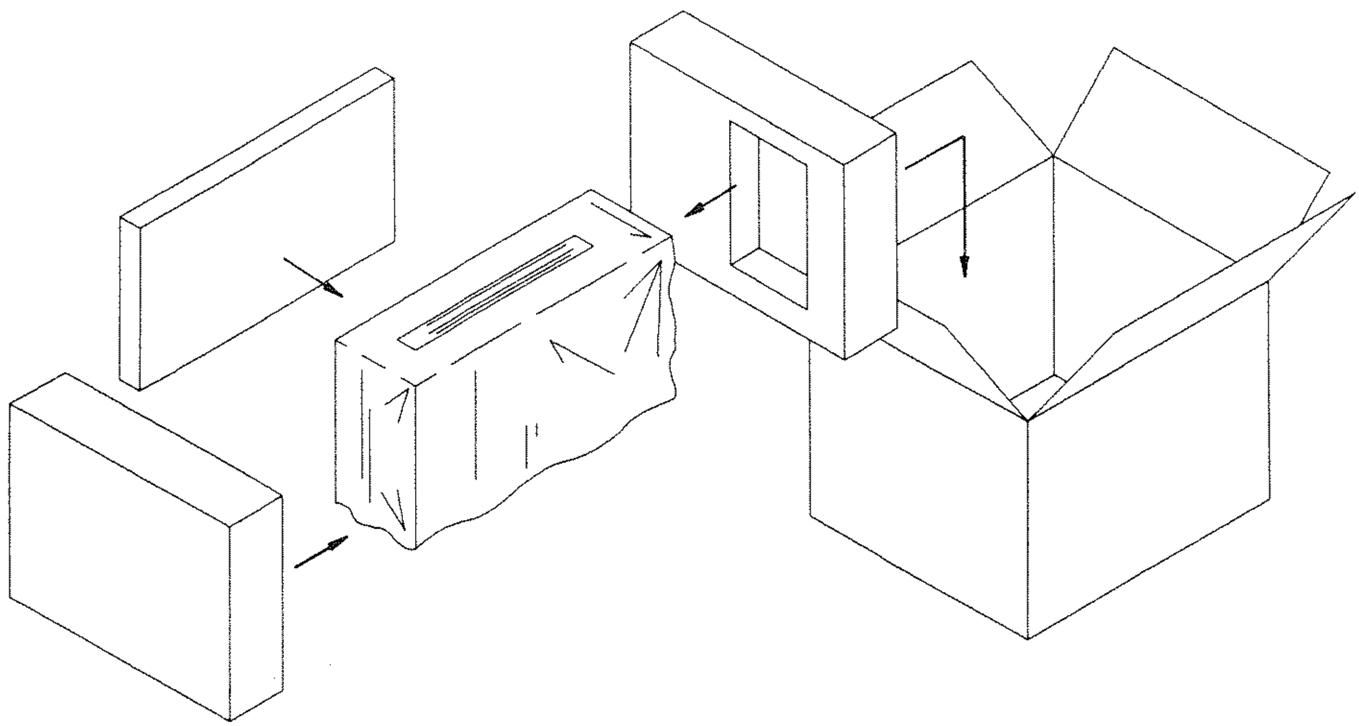

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FIGURE 2-1. PACKING AND UNPACKING DIAGRAM.

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SECTION III
OPERATION

3-1. GENERAL

3-2. This section contains complete operating information for the Model 8211 Modulation Meter. Included are descriptions of the front and rear panel controls, displays, and connectors, 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 instrument are listed in TABLE 3-1 and shown in FIGURES 3-2 and 3-3.

3-5. GETTING STARTED

3-6. Turn on the instrument power. After a short lamp test the display will contain the Modle 8211 firmware code for about three seconds. A self-check sequence will then begin. The message 'ch' will appear in the display followed by a number from 1 to 8 representing the check being performed. If a fault occurs, the message 'Er' followed by the self-check number will appear in the display. Refer to TABLE 3-7 for the meaning of any reported errors. The message '----' will then appear.

3-7. The front panel of the Model 8211 is organized for simple instrument operation. It consists of a display window with LED displays and a separate keyboard area. The display area contains the modulation display, the FILTER annunciators, and the REMOTE/ADRS and FUNCTION legends. The keyswitches are organized as filter keys and measurement control keys.

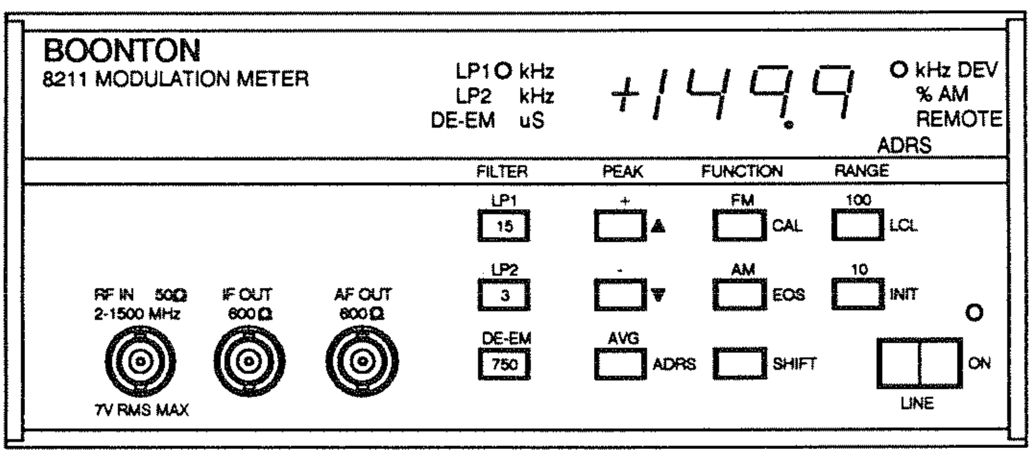


FIGURE 3-1. INSTRUMENT DISPLAYS.

3-8. DISPLAYS (FIGURE 3-1)

3-9. The seven-segment display is three and one-half digits wide and is used for all measurements and messages.

3-10. To the left of the seven-segment display is a group of three annunciators that show the currently selected filter.

3-11. To the right of the seven-segment display is a group of annunciators that indicate the currently selected modulation function, and the IEEE-488 bus status. The REMOTE/ADRS annunciator is illuminated continuously when the Model 8211 is in the remote state, and flashes when it is an active talker, but not remote.

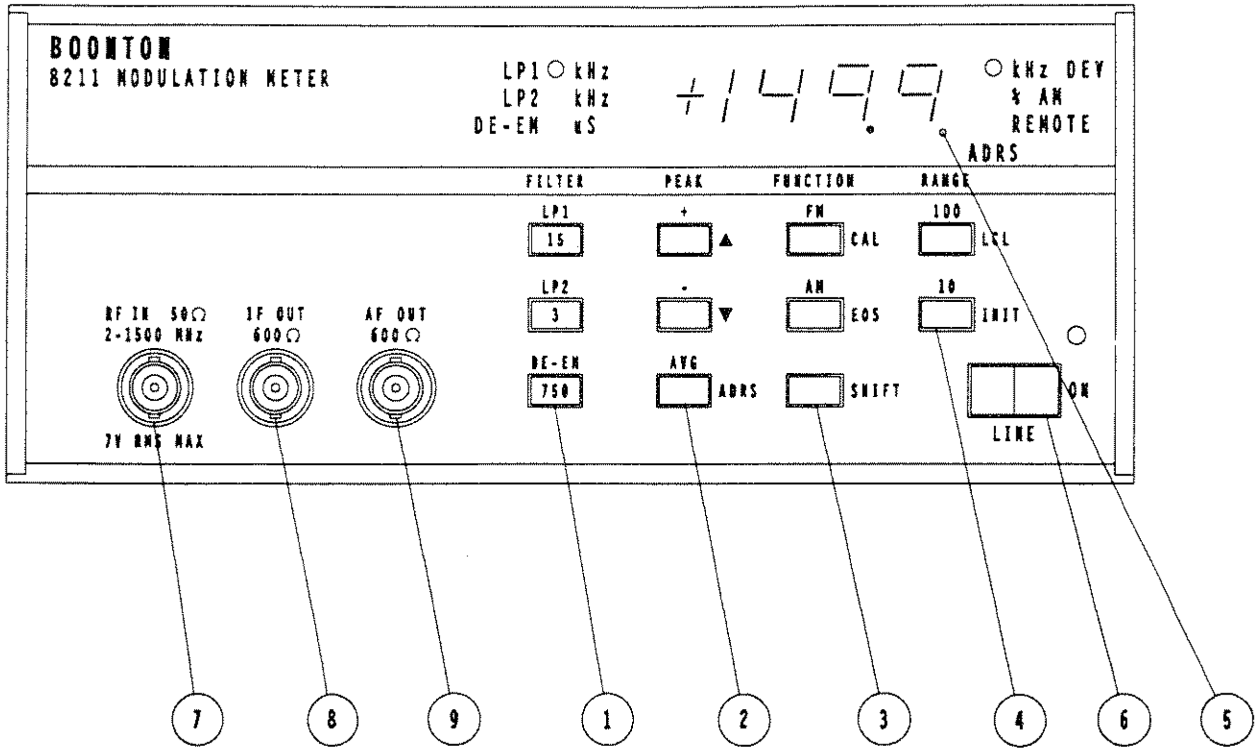


FIGURE 3-2. MODEL 8211, FRONT VIEW.

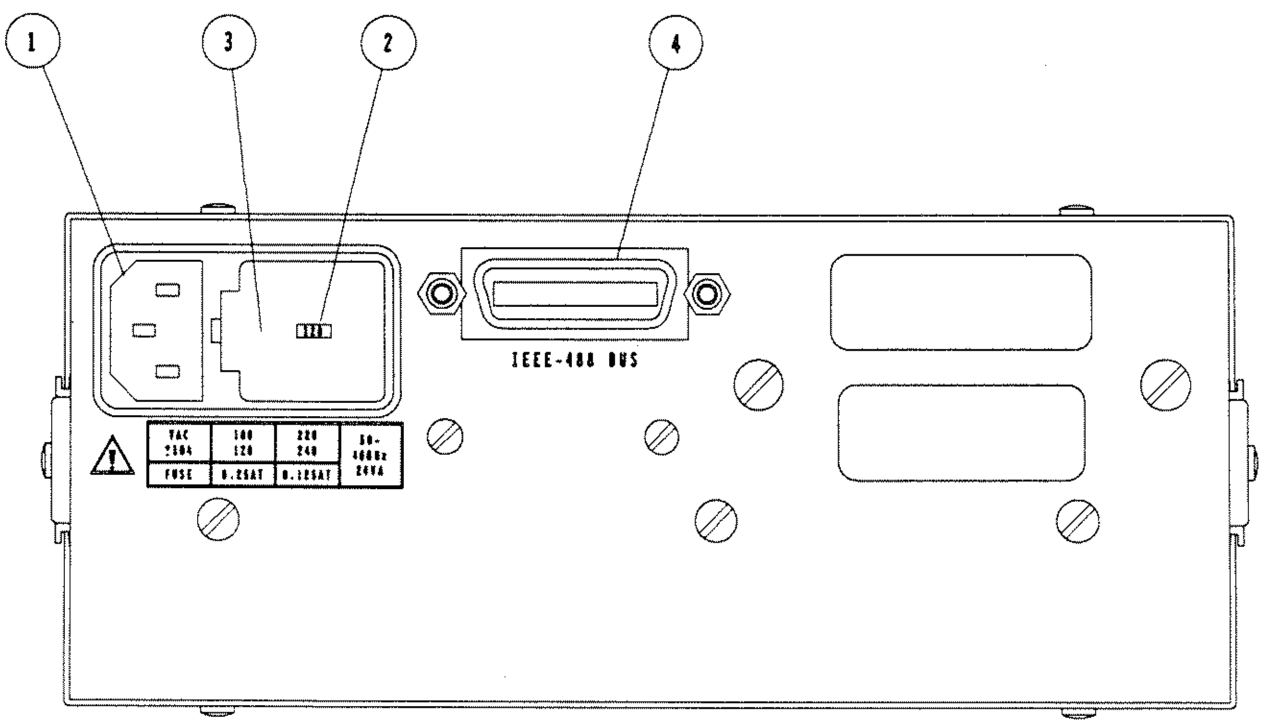


FIGURE 3-3. MODEL 8211, REAR VIEW.

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

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
Filter Keys		
LP1 Key	3-2, 1	Selects the low-pass filter 1. Cutoff as marked on the button.
LP2 Key	3-2, 1	Selects the low-passs filter 2. Cutoff as marked on the button.
DE-EM Key	3-2, 1	Selects de-emphasis filter as marked on the button.
PEAK Keys		
+ Key	3-2, 2	Selects + peak detector for display. This key is redefined as up-arrow for certain functions.
- Key	3-2, 2	Selects - peak detector for display. This key is redefined as down-arrow for certain functions.
AVG Key	3-2, 2	Selects peak average modulation display. The display is (+peak (+) -peak)/2. Depressing SHIFT and then the AVG key, activates the IEEE-488 bus address selection program. (ADRS) Arrow keys are active.
Function Keys		
FM Key	3-2, 3	Selects frequency modulation as the active measurement function. Depressing SHIFT and then the FM key, causes the modulation detectors to be calibrated. (CAL)
AM Key	3-2, 3	Selects amplitude modulation as the active measurement function. Depressing SHIFT and then the AM key, activates the IEEE-488 end-of-string selection program. (EOS) Arrow keys are active.
SHIFT Key	3-2, 3	Enables alternate key function selection.
Range Keys		
100 Key	3-2, 4	Selects the least senstive modulation range. Full-scale is 150.0 and resolution is 0.1. If the IEEE-488 bus state is remote, depressing this key causes the Model 8211 to 'go-to-local' if local lockout is not active and remote is active.

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

CONTROL, INDICATOR or CONNECTOR	FIGURE and INDEX NO.	FUNCTION
10 Key	3-2, 4	Selects the most senstive modulation range. Full-scale is 15.00 and resolution is 0.01. Depressing SHIFT and then the 10 key, causes the instrument to reset to a preset state (INIT).
DISPLAY		
Seven Segment	3-2, 5	Displays modulation in % AM, kHz FM deviation, error codes and status messages.
LP1 kHz	3-2, 5	Indicates low-pass filter 1 is selected.
LP2 kHz	3-2, 5	Indicates low-pass filter 2 is selected.
DE-EM uS	3-2, 5	Indicates de-emphasis filter is selected.
kHz DEV	3-2, 5	Indicates that FM modulation display is selected.
% AM	3-2, 5	Indicates that AM modulation display is selected.
REMOTE/ ADRS	3-2, 5	Displays IEEE-488 bus status; remote enabled (lighted), addressed (flashing), or local (dark).
LINE Switch	3-2, 6	Switches the instrument ac power supply ON or OFF.
RF IN Connector	3-2, 7	RF input connector, used to apply an external carrier signal.
IF OUT Connector	3-2, 8	Provides a means for connecting the intermediate frequency signal to external test equipment.
AF OUT Connector	3-2, 9	Audio output connector, used to connect the demodulated signal to external test equipment.
Line Connector	3-3, 1	Permits connection of instrument to ac power supply.
Voltage Selector Switch	3-3, 2	Permits the selection of various ac power supply voltages.
Fuseholder	3-3, 3	Holds fuse for ac line protection.
IEEE-488 Bus Connector	3-3, 4	Provides a means for connecting the modulation meter to an IEEE-488 compatible bus.

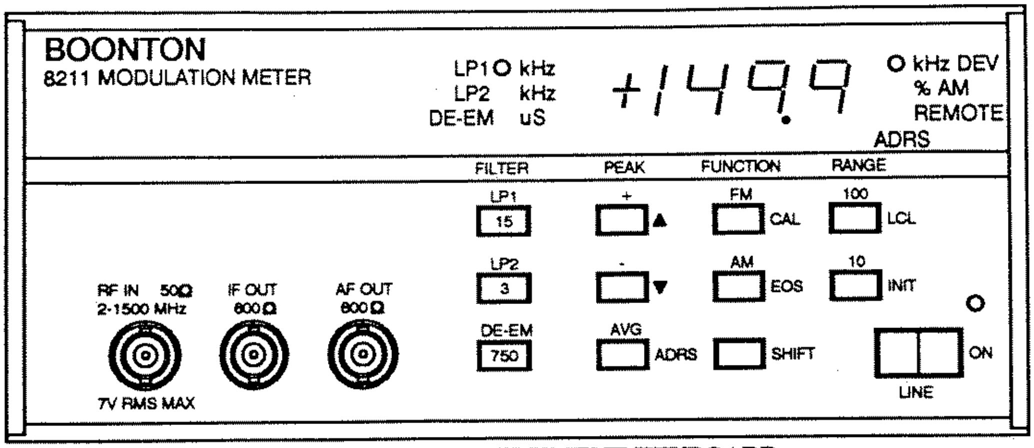


FIGURE 3-4. INSTRUMENT KEYBOARD.

3-12. FILTER KEYS (FIGURE 3-4)

3-13. The keyswitches under the FILTER legend are used to select post detection filtering. There are two low-pass filters, LP1 and LP2, and a de-emphasis filter. Only one filter can be selected at a time, however, the de-emphasis filter can be set to affect the displayed reading or not, depending on internal jumper selection. The de-emphasis filter always affects the AF OUT signal.

3-14. To select a different measurement filter, depress the desired FILTER key. The legend associated with that filter will appear to the left of the numeric display. Depress the LP1 FILTER key. The LP1 legend next to the LED display will light. Now depress the LP2 key. The LP2 legend will light and the LP1 legend will go out.

3-15. PEAK KEYS (FIGURE 3-4)

3-16. The PEAK keys are used to select one of three different detection modes. The PEAK + display indicates the positive frequency excursion of an FM signal or the positive peak of an AM signal. Similarly, the PEAK - display indicates the negative frequency excursion of an FM signal or the trough of an AM signal. The PEAK AVG display is the arithmetic mean of the + and - peaks, that is, (PEAK + + PEAK -)/2. The PEAK +, -, and AVG keys are arranged such that only one detector can be selected at a time.

3-17. FUNCTION KEYS (FIGURE 3-4)

3-18. The keyswitches under the FUNCTION legend are the FUNCTION keys. The FUNCTION keys select the measurement detector, AM or FM. Only one measurement function can be active at a time.

3-19. To select a measurement function, depress the desired FUNCTION key. The units legends associated with that function will appear immediately to the right of the numeric display. Depress the FM function key. The kHz DEV legend next to the LED display will light. Now depress the AM key. The legend will change to % AM.

3-20. RANGE KEYS (FIGURE 3-4)

3-21. The RANGE keys control the resolution and full-scale limit of the modulation display. When the 10 key is depressed, the maximum reading is 15.00 and the resolution 0.01. When the 100 key is depressed, the maximum reading is 150.0 and the resolution is 0.1.

3-22. SHIFTED KEYS

3-23. The SHIFT key provides access to other functions in the local IEEE-488 bus state. However, when the instrument is remote, the keyboard is inactive except the LCL key. The shifted keyboard state is assumed when the instrument is remote, so that only the LCL key is depressed to return to local state. Transition to the local bus state will occur only if local lockout is not true.

3-24. The SHIFT-CAL key provides a means to calibrate the modulation detectors. Depress the SHIFT-CAL key. The calibration sequence will begin and the 'CAL' message will appear in the display. AM calibration is done first, then FM. Calibration time will be less than fifty seconds.

3-25. When the SHIFT-INIT key is depressed an initialization restart occurs. This is similar to a power up reset except that the current instrument status is lost. This does not include bus address or end-of-string selection.

3-26. The other shifted keys are discussed in detail in the REMOTE operation portion of this section.

3-27. DISPLAYED MESSAGES

3-28. When the Model 8211 unlocks, the display will be overwritten with the '----' message. When a valid carrier is acquired, the display will temporarily show the ' -- ' display indicating that level adjustment is in process, then the selected modulation display will appear.

3-29. If the 'IFHI' and 'IFLO' messages appear in the display, the intermediate frequency level is not within range to make accurate AM measurements.

3-30. Depressing the SHIFT-CAL key will cause the 'CAL' message to be written to the display. This indicates that a calibration sequence is in progress.

3-31. A normal error response is for the 'CC' message to appear in the display followed by a number indicating the nature of the error. Error codes are tabulated in TABLE 3-7, along with a description of the error.

3-32. Other displayed messages are described in detail in the following paragraphs.

3-33. FRONT PANEL CONNECTORS

3-34. The Model 8211 is supplied with three connectors on the front panel, RF IN, IF OUT, and AF OUT.

3-35. The RF IN connector is the means to apply a test signal to the Model 8211. The nominal input impedance at the RF IN is 50 ohms. The Model 8211 is designed to accept signals up to one watt (7 Vrms) without damage.

3-36. The connector marked IF OUT is a type BNC connector with a source impedance of 600 ohms. This signal is a sample of the frequency translated carrier signal. The nominal level is 300 to 360 millivolts, and the frequency is approximately 400 kHz.

3-37. 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. The signal is also affected by the high-pass and low-pass filters and the de-emphasis networks. The nominal level is 1 volt into 600 ohms at 1000 counts on the modulation display. Source impedance is 600 ohms. Amplitude variations will occur at the AF OUT connector with carrier level, if the AM measurement mode is selected. This occurs even though the modulation is constant because the Model 8211 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.

3-38. REAR PANEL CONNECTORS

3-39. The only signal connector on the rear panel of Model 8211 is the IEEE-488 connector. This connector provides a means of incorporating the Model 8211 into an automatic test system. Complete instrument operation, when connected to the IEEE-488 bus, is covered in later paragraphs.

3-40. SELECTING MODULATION MODE

3-41. The Model 8211 can detect and display amplitude or frequency modulation. After the modulation mode is selected, subsequent instrument operation is very similar.

3-42. To select the AM measurement mode, first apply a carrier signal with AM modulation, then depress the 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 modulation display is overranged.

3-43. To select the FM measurement mode, first apply a carrier signal with FM modulation, then depress the FM key. The modulation display will now indicate the recovered FM in kHz. The [=] display indicates that the modulation display is overranged.

3-44. MEASUREMENT AND DISPLAY CONTROL

3-45. After the modulation mode has been selected, recovered modulation can be processed further by using the measurement control keys.

3-46. PEAK DETECTORS

3-47. When making modulation measurements, the desired result is normally the peak deviation or the peak or trough of amplitude modulation. The PEAK +, -, and AVG keys provide this display. The + PEAK detector indicates the positive peak excursion of FM deviation (increasing frequency), and the peak of AM modulation. The - PEAK detector indicates the negative peak excursion of FM deviation (decreasing frequency), and the trough of AM modulation. The AVG key changes the display to indicate the arithmetic mean of the + and - peak detectors. The display in the PEAK AVG mode is calculated by the display program from independent measurements of the + and - peaks.

3-48. 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 if the magnitude of the distortion is large enough. This asymmetry is also called carrier shift. For AM a similar effect occurs, shifting the average carrier amplitude.

3-49. 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 1500, or 0.07%.

3-50. FILTERS

3-51. The Model 8211 includes two low-pass filters and one de-emphasis filter. These filters can be used to minimize measurement errors due to noise, or to remove unwanted components of complex modulation signals.

3-52. The 3 and 15 kHz low-pass filters are three-pole Butterworth designs.

3-53. Filter selection is critical in maintaining accuracy of displayed modulation and distortion. All carriers applied to the RF IN connector of the Model 8211 will contain noise modulation sidebands. Selection of the lowest cut-off, low-pass filter, based on the modulation frequency, will usually produce the most accurate indication.

3-54. Filter selection is also 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 at 2.5 kHz, the 15 kHz low-pass should be used.

3-55. APPLICATION NOTES

3-56. The following paragraphs describe some typical applications for the Model 8211. However, the use of the Model 8211 is not restricted to these applications.

3-57. FM MEASUREMENTS

3-58. High-accuracy FM measurements are possible with the Model 8211, for modulating frequencies from less than 30 Hz to 15 kHz, and deviations up to 300 kHz p-p. To achieve maximum accuracy, the signal level applied to the RF IN connector should be greater than 100 mV, rms. Such signal levels reduce residual FM in the Model 8211 to a minimum value. To further reduce residuals, the minimum measurement-bandwidth consistent with the modulation frequency should be used. For instance: for measurements at a 400 Hz modulation rate, the 3 kHz low-pass filter should be used.

3-59. Typical residuals for the Model 8211 are plotted in FIGURES 3-5 through 3-8; audio response curves are plotted in FIGURES 3-9 through 3-12. Because the audio detectors in the 8211 are true peak-responding, the residual noise is added to the recovered signal being measured. Peak-detector response to a signal plus noise is not linear, and depends on the carrier-to-noise ratio and the modulation waveshape. In most measurement situations involving sinusoidal modulation, noise suppression is approximately 30%.

3-60. For example, if the peak residual indicated without modulation is 100 Hz, and 10 kHz deviation is added, the resulting display would be 10.07. (Since the 0.7 multiplier is an approximate value, there will be variation. However, the use of that figure guarantees that the resulting display will always be within specification.) The assumption made is that the noise is gaussian and that the carrier-to-noise ratio exceeds 20 dB.

3-61. True rms measurements of the recovered audio signal will provide a more precise indication of modulation in the presence of large amounts of noise.

3-62. AM MEASUREMENTS

3-63. The Model 8211 makes fast, accurate measurements of amplitude modulation. Optimum accuracy is achieved with input signal levels between -10 and + 10 dBm, and the minimum bandwidth consistent with the modulation frequency. As with FM, noise suppression does occur, and a 0.7 multiplier is used to subtract added noise.

3-64. SPURIOUS RESPONSES

3-65. Most frequency-translating devices rely on a non-linear circuit element to produce the multiplication required for frequency translation. This non-linearity produces spurious mixing products, which "cross over" the desired IF. In contrast, the Model 8211 converts frequency by using a sampler, which is very linear and produces few spurious responses in the usual sense.

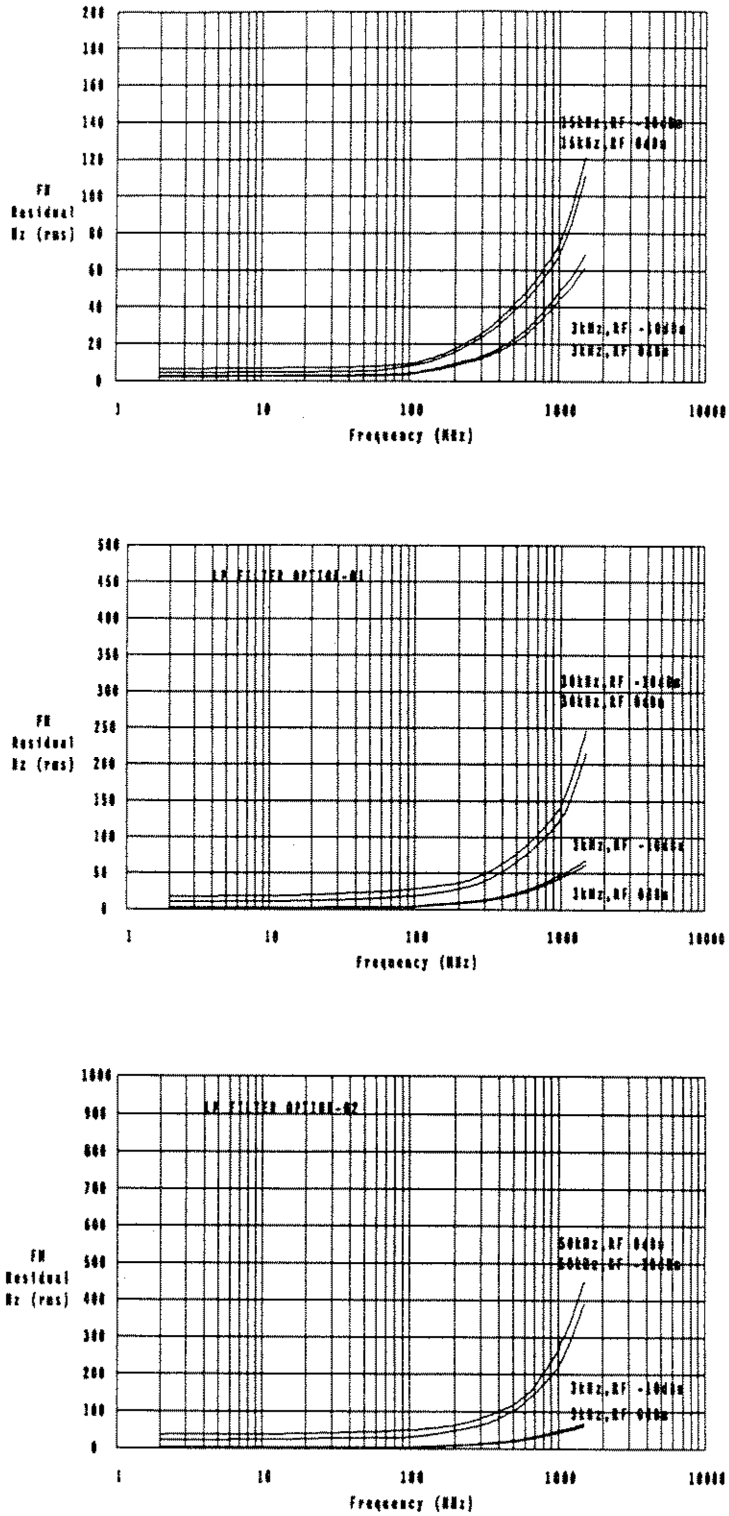


FIGURE 3-5. RESIDUAL FM, 0 AND -10 dBm.

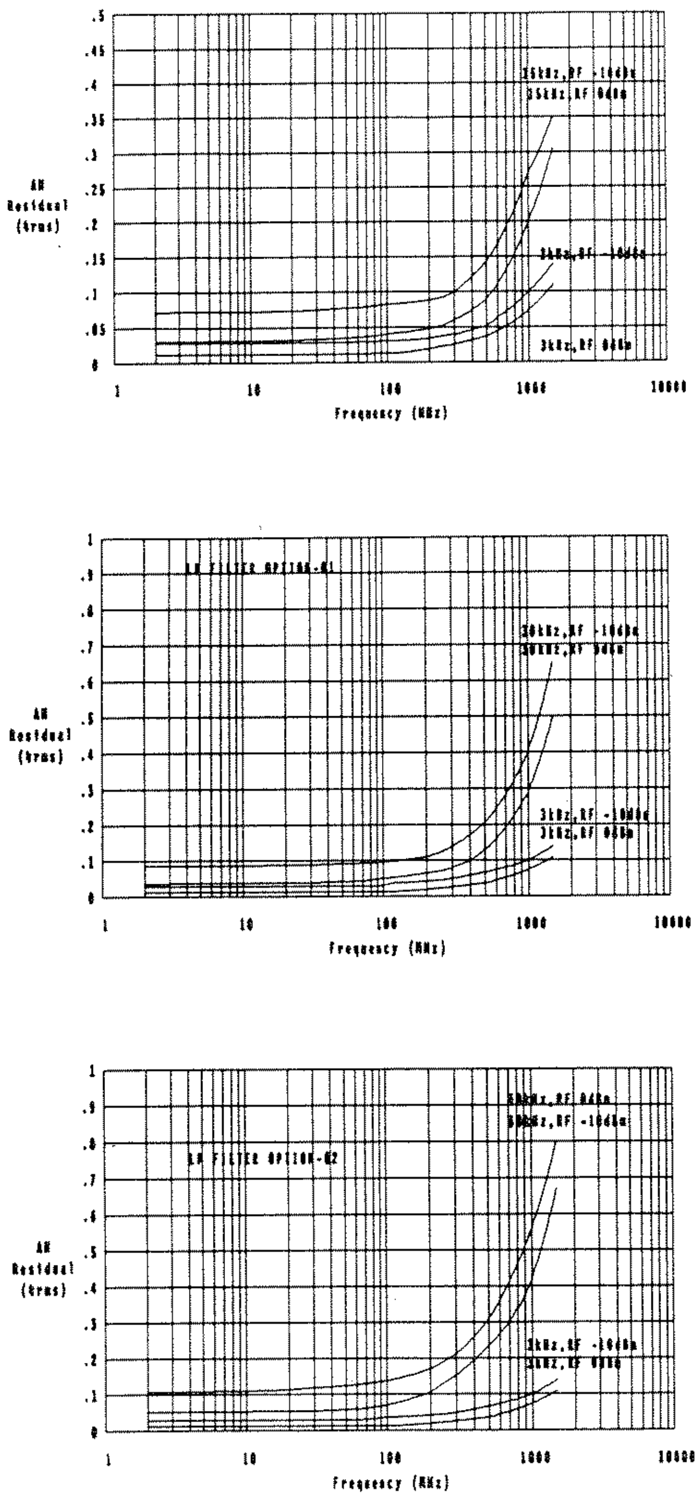


FIGURE 3-6. RESIDUAL AM, 0 AND -10 dBm.

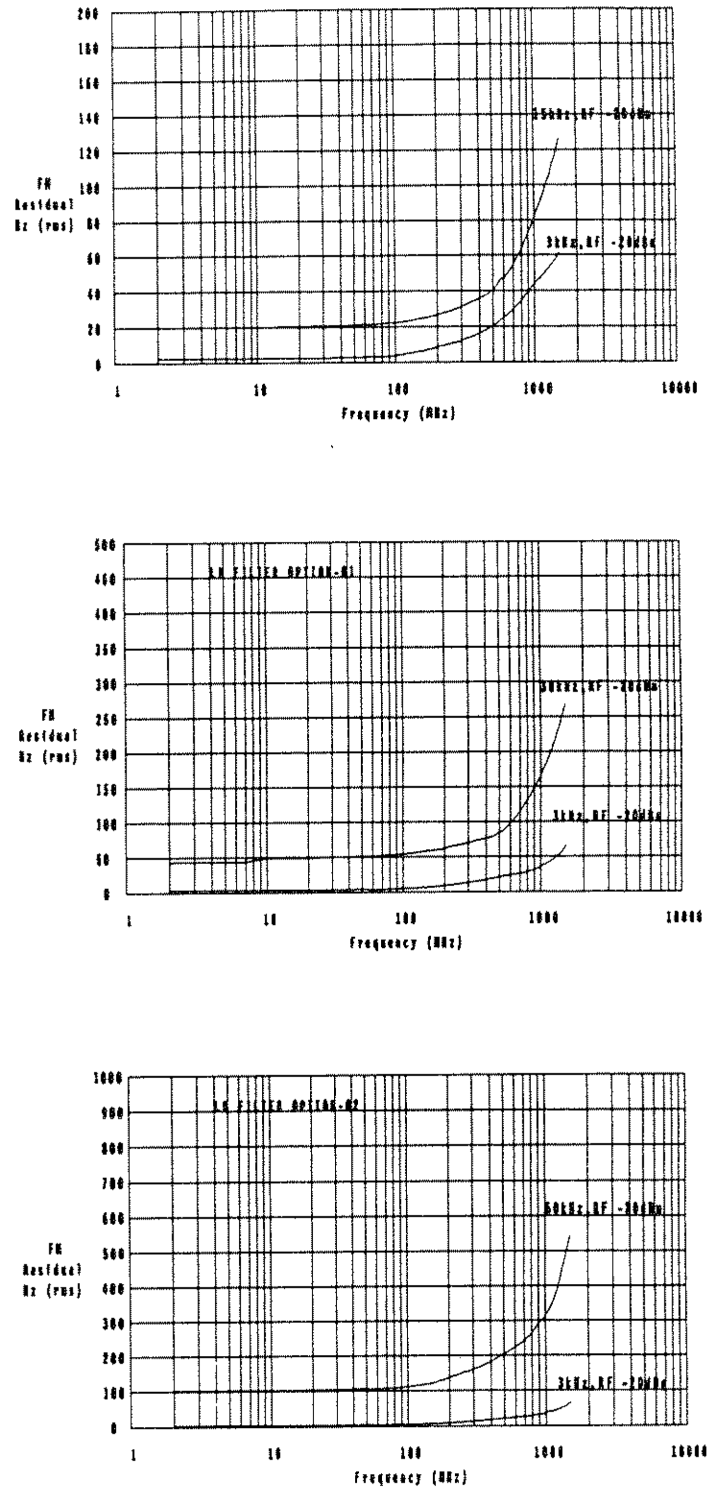


FIGURE 3-7. RESIDUAL FM, -20 dBm.

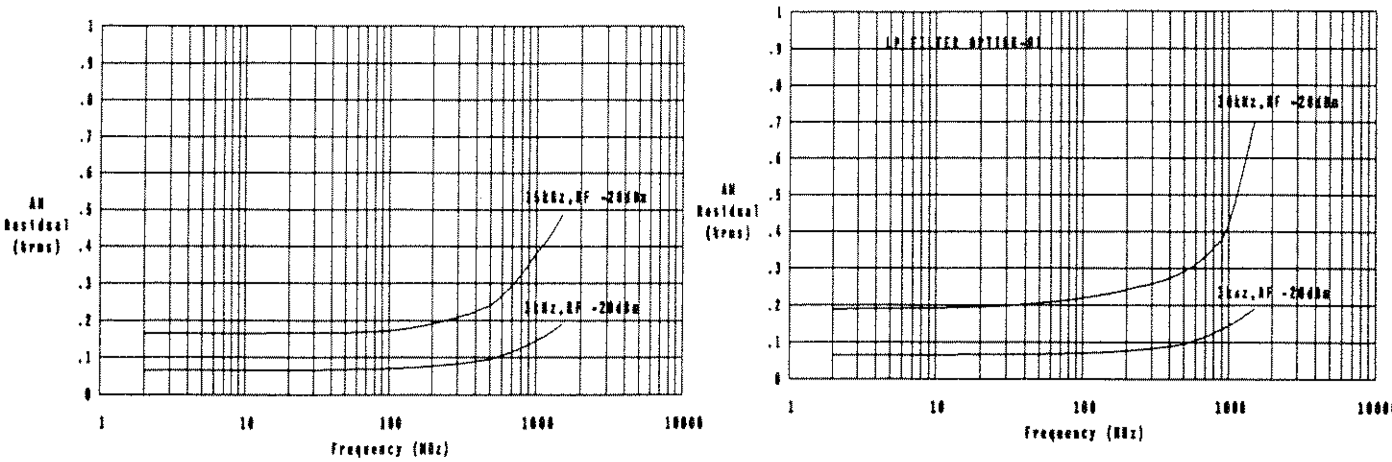


FIGURE 3-8. RESIDUAL AM, -20 dBm.

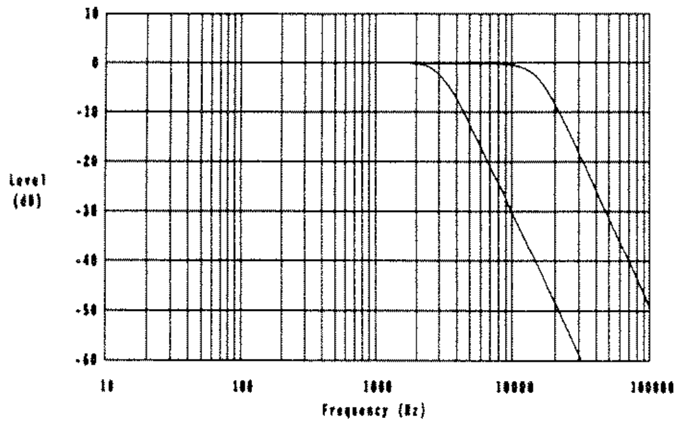


FIGURE 3-9. RESPONSE, 3 AND 15 kHz FILTERS.

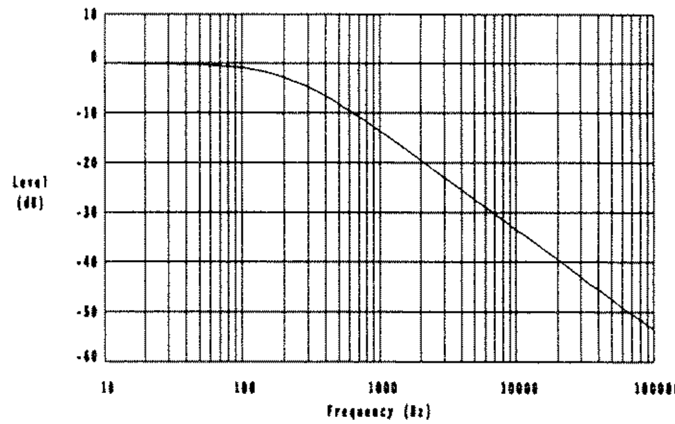


FIGURE 3-10. RESPONSE, DE-EMPHASIS FILTER.

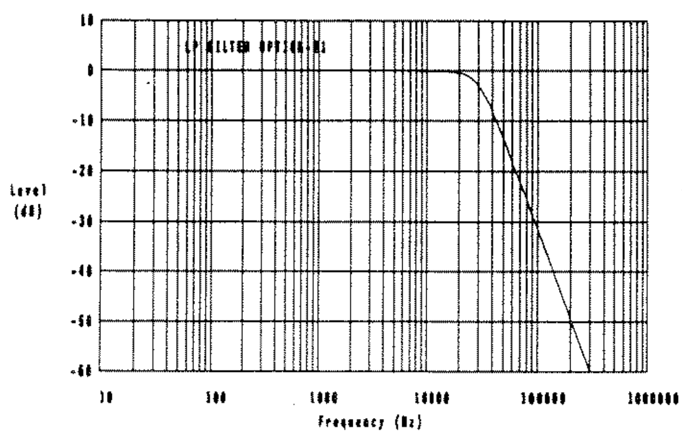


FIGURE 3-11. RESPONSE, OPTION -01, 30 kHz FILTER.

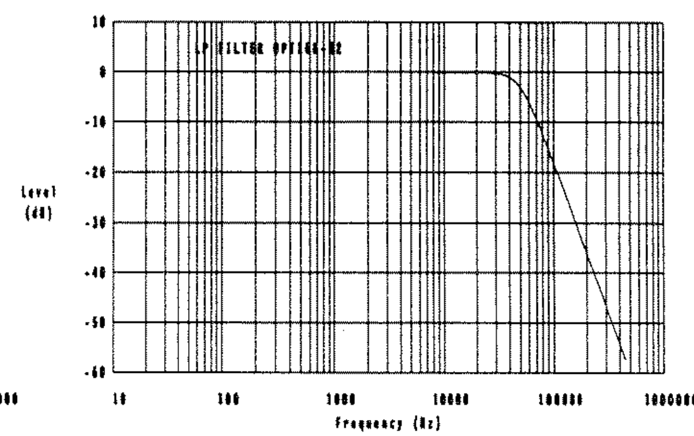


FIGURE 3-12. RESPONSE, OPTION -02, 50 kHz FILTER.

3-66. There are, however, a few points to remember when applying a sampling instrument like the Model 8211. If the input signal contains significant harmonic power above the third harmonic, an IF beat can occur and thus produce unwanted AM and FM indications.

3-67. Signals that are not harmonically related can interfere if, when they are mixed with any local-oscillator harmonic, the resulting sum frequency or difference frequency appears near the Model 8211's intermediate frequency.

3-68. For example, assume two input signals--the larger at 100 MHz, the smaller at 501.6 MHz. The local oscillator might be at 2.5014 MHz so that its 40th harmonic (100.4 MHz), when mixed with the 100 MHz signal, produces a 414 kHz IF. However, the 200th harmonic of 2.5104 MHz is 502.07 MHz--that converts the 501.6 MHz carrier to 414 kHz also. Since the two signals are not phase coherent, a low-frequency beat will occur at the IF and produce spurious AM and FM indications. The offending input signal should be filtered to eliminate this interference.

3-69. EXTENDED CARRIER RANGE

3-70. Although carrier level requirements are not specified, the response of the frequency converter in the Model 8211 extends well beyond 1500 MHz. Of course input sensitivity decreases and AM and FM residuals increase with increasing frequency. Sensitivity from 1500 to 2000 MHz is typically less than 100 millivolts. Residual FM increases linearly with input frequency.

3-71. ADDITIONAL APPLICATIONS

3-72. Information about other applications for the Model 8211 will be found in Boonton Electronics' Application Note #19: High Accuracy AM-FM Measurements with the Boonton 82AD Modulation Meter. This application note is available free upon request from Boonton Electronics.

3-73. REMOTE OPERATION

3-74. Any front-panel operation of the instrument, except the LINE ON/OFF switch, can be remotely controlled under direction of an IEEE-488 interface controller. IEEE-488 is a hardware standard that describes the communication and handshaking across an 8-bit parallel bus between a controller and up to 15 instruments.

3-75. **SETTING THE BUS ADDRESS.** To set the IEEE-488 bus address (MLTA), depress the SHIFT-ADRS key. The current bus address will be displayed. Select the desired address using the arrow keys. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented.

3-76. **SETTING THE END-OF-STRING CHARACTER.** To set the IEEE-488 bus end of string character(s), depress the SHIFT-EOS key to start the end-of-string setting program. The current end-of-string character(s) will be displayed. Select the desired characters by using the arrow keys to step through the possible selections. Selection is automatic. The different character displays and their meanings are tabulated in TABLE 3-2. In any case, the Model 8211 always terminates on end-or-identify (EOI) true and always sends EOI true with the last character of every string.

TABLE 3-2. IEEE-488 END-OF-STRING CHARACTERS.

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.

3-77. 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 key and the POWER ON/OFF switch. The REMOTE/ADRS status annunciator is illuminated continuously.

3-78. RETURNING TO LOCAL MODE. The instrument may be returned to the local mode as follows:

- The LCL key is depressed, provided local lockout (LLO) is not active. The 'LCL' message will be displayed briefly.
- The go-to-local (GTL) bus command is sent.
- 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.

3-79. TRIGGERED OPERATION. In the remote mode the instrument can be operated in the immediate mode (mnemonic IM), or in the wait-for-trigger mode (WT). The immediate mode is the default condition and results in the immediate response to talk requests. The wait-for-trigger mode causes data acquisition be deferred until a trigger is received. 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:

- "Group-execute-trigger" (GET) is received.
- The mnemonic TR (trigger) is interpreted.
- Any mnemonic following IM (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.

3-80. TALK OPERATION. The instrument may be addressed as a talker without regard for remote/local state. 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 8211 addressed as a listener. The selected mode will remain in effect until changed.

3-81. TALK ERROR (TE) MODE. The TE mode returns two ASCII coded bytes separated by a comma. The bytes represent the error status of the instrument. The first byte is the current condition code, the second is the self-test pass/fail results. Both bytes are normally zero. TABLE 3-7 presents the returned codes and its meaning. All errors will automatically be cleared after the status is reported. Talk Status (TE) is the default talk mode after initialization of the instrument.

3-82. TALK FUNCTION (TF) MODE. The TF mode returns a two-character string, in HEX notation, representing the state of the hardware and display functions. The bit assignments are arranged to allow for string or byte oriented decoding. The bit assignments and meanings are presented in TABLE 3-3.

3-83. TALK VALUE (TV) MODE. In the TV mode the argument of the active function is returned. AM is returned in %, FM in kHz.

3-84. IDENTIFY (ID) MODE. In the ID mode a string identifying the instrument and firmware revision is returned. A typical response is "Boonton Model 8211, November 12,1993 rev AA". This includes the model number and firmware date.

TABLE 3-3. HARDWARE STATUS, BIT ASSIGNMENTS.

FUNCTION	BINARY WORD	ASCII STRING
		0 4
Unlocked	0	
Unleveled	0	
Display overrange	0	
Calibration Fault	0	
AM display active	0	
FM display active	1	
IF LEVEL active	0	
Not Used	0	

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

3-85. USING "SERVICE REQUEST" (SRQ). The "Service Request" allows the Model 8211 to inform the system 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 Bus Syntax Error, Measurement is Ready, Calibration is Completed, Instrument Unleveled, or Unlocked. 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. Valid mask numbers are 0 to 63 inclusive. 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 nature of the request is known. Error codes may be obtained directly form the Talk Error (TE) mode. The TE response will automatically clear the SRQ.

3-86. SETTING THE SRQ MASK. TABLE 3-4 indicates the bit positions in the SRQ mask, what each bit enables/disables, and the corresponding bus configuration command. Note that the numeric argument follows the SQ mnemonic.

TABLE 3-4. SRQ MASK BIT ASSIGNMENTS.

Bit Position	Function	Bus Code
0	Condition Code Error.	SQ 1
1	Calibration Completed.	SQ 2
2	Measurement Completed.	SQ 4
3	Unleveled.	SQ 8
4	Unlocked.	SQ 16
5	Self-check Error.	SQ 32
6	Reserved for future use.	SQ 64
7	Reserved for future use.	SQ 128

More than one item can be selected by adding the corresponding bit positions.

3-87. 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 3-5. All unlisted commands are ignored.

TABLE 3-5. BUS COMMAND RESPONSES.

COMMANDS		RESPONSE
Universal Command Group:		
	Device Clear (DCL).	Clear errors.
	Local Lockout (LLO).	Disable SHIFT-LCL 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.

3-88. **PROGRAM FUNCTION MNEMONICS.** Each front-panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values is analogous to manual front panel operation. In addition, other program mnemonics are used for functions that are applicable only in remote operation. TABLE 3-6 lists all the program function mnemonics.

3-89. **NUMBER FORMATTING.** Number formatting rules are as follows:

- Fixed or floating formats are accepted.
- The optional + or - sign may precede the mantissa or the exponent.
- The optional radix point may appear at any position within the mantissa. A radix point in the exponent is ignored.
- The optional "E" for exponent may be upper or lower case.
- All ASCII characters that have hexadecimal values of 0 to 23, and 25 to 2B, are ignored.

3-90. **DATA STRING FORMAT.** Data string formats are as follows:

- The programming sequence is in natural order, that is, a function mnemonic is sent first followed by the argument, if appropriate.
- All ASCII characters that have hexadecimal values of 0 to 23, and 25 to 2C, are ignored. The ASCII ($), hexadecimal 24, is reserved. Lower case letters are automatically converted to upper case.
- A primary function mnemonic, sent without a following argument, will make the specified function active.
- The data string may not exceed 256 characters and may be terminated with LF, CR, or EOI, depending on the end-of-string setting.
- Interpretation of the data string does not begin until the end-of-string character is received.

3-91. **DATA STRING ERRORS.** Errors are detected during interpretation. The occurrence of an error will set the syntax bit in the SRQ byte and will set SRQ true, if enabled. The error and SRQ can be cleared by a status request (TE), or a clear error instruction (CL). All errors cause existing valid parameters to be restored. No new input can be processed until a pending error is cleared.

3-92. DATA STRING EXAMPLES. The following are examples of typical programming strings in HP BASIC:

- OUTPUT 715; "AM F2 " Set functon to AM and Filter to LP2.
- OUTPUT 715; "TV" Set talk mode to talk value.
- OUTPUT 715; "WT SQ 16" Set wait-for-trigger mode, SRQ mask to enable SRQ on unlock event.

3-93. READING BACK CALIBRATION VALUES. Calibration data is normally transient. It exists only during the calibration process. There are occasions, however, when this data is required. To capture this data, the instrument should be programmed to the wait-for-trigger(WT) mode. Select the appropriate function and send the TV and CA mnemonics to activate calibration with the talk value mode selected. When calibration completes, the value read back is the calibration data for that function.

- OUTPUT 715; "FMTV" Set measurement to FM, and talk mode to talk value.
- OUTPUT 715; "WT CA" Set trigger mode to wait-for-trigger, and calibrate detectors.
- ENTER 715; A$ Read back calibration data.
- OUTPUT 715; "AM" Set measurement to AM.
- ENTER 715; A$ Read back calibration data.

TABLE 3-6. IEEE-488 BUS MNEMONICS.

BUS MNEMONIC	RESPONSE
Function Control:	
AM	Select AM modulation display.
FM	Select FM modulation display.
SQ	SRQ mask, argument range 0 to 63.
Display Control:	
WT	Enable the wait-for-trigger talk mode.
IM	Enable the immediate-trigger talk mode.
TR	Trigger a measurement, same as GET.
BL	Blank Display and disable display updates.
UD	Restore display and enable display updates.
Filter Selections:	
F1	Low-pass filter 1, usually 3 kHz.
F2	Low-pass filter 2, usually 15 kHz, optionally 30 or 50 kHz.
F3	De-emphasis, 750 us.

TABLE 3-6. IEEE-488 BUS MNEMONICS.

BUS MNEMONIC	RESPONSE
Detector Selection:	
P1	Peak +.
P2	Peak -.
P3	Peak AVG.
Range Selection:	
R1	Set modulation range 100.
R2	Set modulation range 10.
Special Operators:	
IP	Instrument preset.
CH	Execute self-check program.
CL	Clear errors.
CA	Calibrate the modulation detectors.
Talk Modes:	
TV	Talk value, sends the value of the active function.
TE	Talk error, sends the condition code, and self-check error bytes.
TF	Talk function, sends a string representing the current hardware status.
ID	Identify, sends a string identifying the Model 8211.

TABLE 3-7. INSTRUMENT ERROR AND CONDITION CODES.

DISPLAY	MEANING	BUS ERROR CODE
CC1	AM calibration fault. (Hardware)	1
CC2	FM calibration fault. (Hardware)	2
CC3	IEEE-488, non-existent mnemonic.	3
CC4	IEEE-488 data string format error.	4
CC5	IEEE-488, input text buffer overflow.	5
ER1	IEEE-488 interface fault.	1*
ER2	Random Access Memory fault.	2
ER3	Firmware checksum fault.	4
ER4	PIA, U12 fault.	8
ER5	PIA, U14 fault.	16
ER6	IF Circuits, AGC.	32
ER7	RF Circuits, AFC.	64
ER8	AF Circuits.	128
	* More than one error is represented by sums of these values.	

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

4-2. The Model 8211 is a compact, microprocessor controlled, modulation meter that covers the carrier frequency range of 2 MHz to 1.5 GHz. Operation is fully automatic. The Model 8211 tunes to the largest carrier present at input connector and adjusts measurement channel gain for calibrated display of modulation. Recovered modulation is displayed on a three and one-half digit LED display, which provides a maximum resolution of 10 Hz deviation or .01 % AM. A standard 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. Control signals developed by the microprocessor set up the internal circuits in accordance with the commands.

4-3. FUNCTIONAL BLOCK DIAGRAM (FIGURE 4-1)

4-4. Control of instrument operation is exercised by a microprocessor that executes a fixed program in read-only-memory (ROM). Timing of microprocessor operations is controlled by an 3.686 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.

4-5. The microprocessor communicates with the internal circuits via latched interface adapters. Command information is entered into the microprocessor through the front-panel keyboard or an IEEE-488 interface. 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 information to cause execution of commanded functions.

4-6. The carrier signal to be measured is first frequency translated to a 400 kHz intermediate frequency for processing. Frequency translation is accomplished by means of a zero-order hold sampler which is fully bootstrapped to accept signals as high as 2 volts rms, without overload.

4-7. 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 IF circuits. Additionally, the IF signal is processed by the tuning circuits to provide signals to the microprocessor. This properly tunes the local oscillator.

4-8. The frequency modulation information is recovered by amplitude limiting the AM detector signal to remove any AM information, and 'pulse-counting' the resulting signal to determine instantaneous frequency.

4-9. 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 sample of the amplitude controlled IF signal is connected to the IF OUT connector on the front panel.

4-10. 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 positive and negative peak detectors. The dc information from the detectors is digitized by a 12-bit A/D converter for digital processing and display.

4-11. Internal calibration circuits are operated by control program as required to establish calibration of the internal AM and FM detectors.

4-12. Power supply circuits convert the incoming line voltage into regulated operating voltages to power the instrument circuitry.

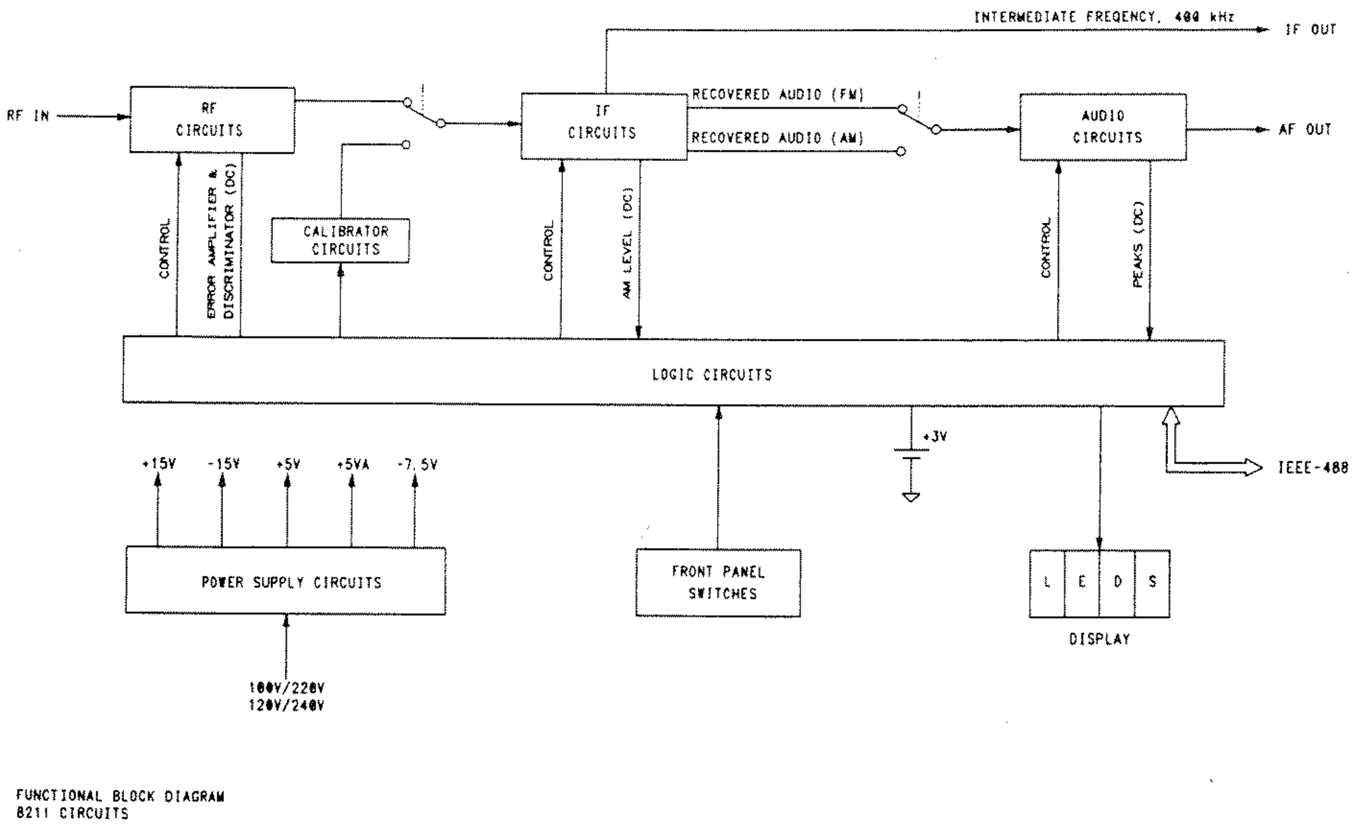


FIGURE 4-1. FUNCTIONAL BLOCK DIAGRAM.

4-13. THEORY OF OPERATION, RF CIRCUITS

4-14. The RF circuits convert the carrier input signal into a suitable intermediate frequency (IF) signal for AM and FM measurements. See FIGURES 4-2 and 8-3.

4-15. The carrier to be measured is applied to the front-panel RF IN connector, J1. The signal is passed through connectors J2 and P1 to a 3 dB pad, which consists of R2-R4, and appears at the sampling gate CR2a-CR2d. The attenuator provides some isolation and protection for the sampling circuit.

4-16. 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 (and 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 initial RF input. This output is held constant until the next sample is taken. Successive samples are taken until the RF waveform is reconstructed at 400 kHz. Additional feedback from the sampler amplifier maintains symmetrical reverse bias on the sampling gate. R10 adjusts the bias magnitude, and R14 adjusts the bridge balance.

4-17. The sampler amplifier is composed of transistors Q2-Q6 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.

4-18. The output of the sampling amplifier is connected to a switchable 20 dB attenuator, consisting of R34, R35, and U4a. The attenuation is selected by the control program whenever the RF input level exceeds approximately 100 mV. Amplifier U5 increases the signal level about four times before it is coupled to the IF circuits. The output of U5 is connected also to a switchable low-pass filter composed of U5b, L6, L7, L9, L10, C36, C37, C42, C43, C45 and C46. This filter eliminates most of the

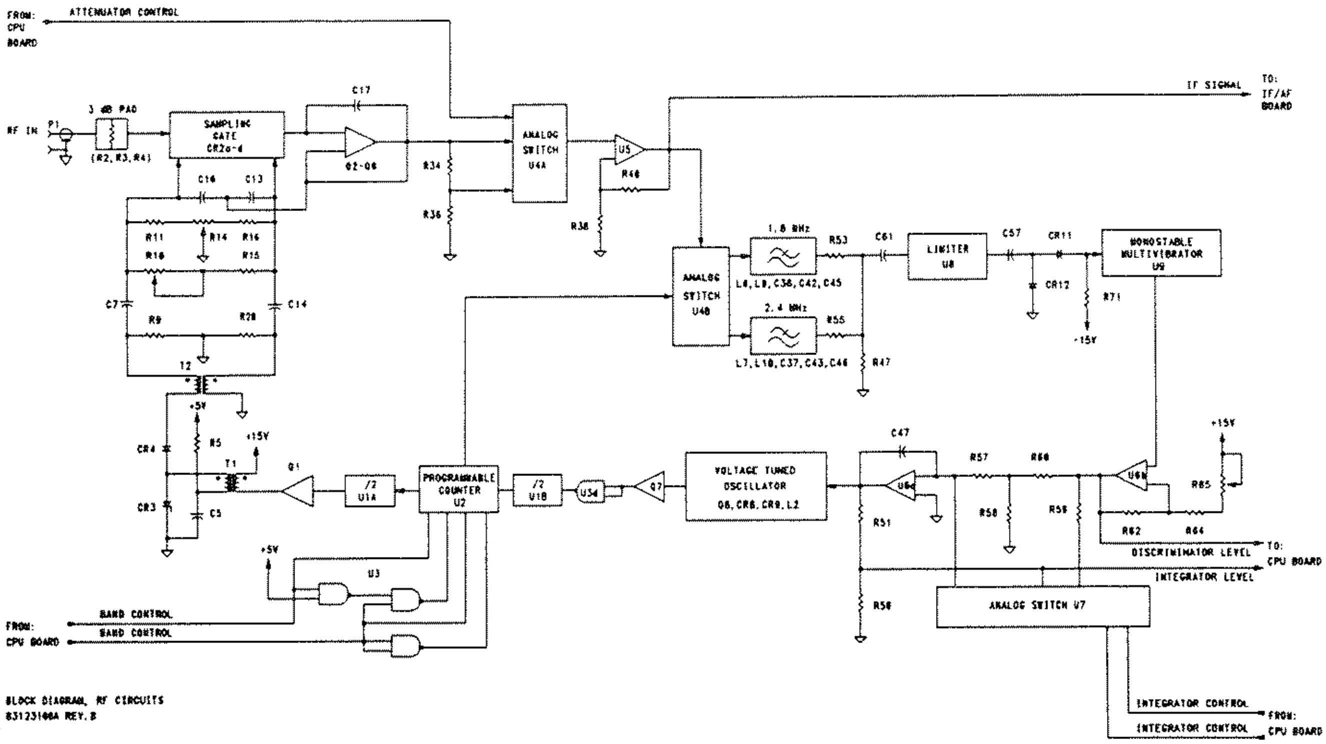


FIGURE 4-2. RF CIRCUITS BLOCK DIAGRAM.

local-oscillator signal at the input of the limiting amplifier U8. A level-shift circuit, which consists of CR11, CR12, C57 and R71, translates the limited IF signal to TTL levels so as to operate U9 -- a monostable multivibrator. The duty cycle, and thus the average value, is proportional to frequency. R64 sets the operating level of U6b to 0 volts, dc, when the intermediate frequency is 400 kHz.

4-19. The output of U6b is connected to integrating amplifier U6a through a voltage divider formed by R58, R60. This attenuation is needed to preserve low-frequency FM response at high carrier frequencies. CMOS switch U7 can be programmed to "dump" the integrator or to by-pass the input voltage divider on command from the logic circuits. The output of the integrator is resistively coupled to the varactor diodes CR9 and CR10.

4-20. The local oscillator, composed of FET Q8 and associated components, is voltage-tuned. The frequency is determined by a tuned circuit consisting of L2 and varactor diodes CR9 and CR10. As the voltage at the output of U6a varies from + 11 to -11 volts, the oscillator's frequency changes from less than 30 MHz to approximately 40 MHz. Level shifter Q7 increases the signal to TTL-compatible levels to drive both U3d (a buffer), and U1b (a divide-by-two stage). U2 and U3a-c are configured as a programmable counter, able to divide by four, by five, or by six, as controlled by the logic circuitry. By successively changing the divide modulus, three overlapping bands (extending together over one octave), are generated.

4-21. The sampling pulses are generated by the step-recovery diode CR3, amplifier Q1, and transformer T1. Initially, diode CR3 is forward biased from the + 5 volt supply through R5. U1a generates a narrow pulse from the output of the counter. This pulse, amplified by Q1, drives the step-recovery diode into reverse conduction, however, CR3 does not "open" until all of its stored charge is depleted. Then the diode recovers and produces a large narrow pulse, which is coupled to the sampling bridge through T2, a balun transformer. The output of T2 is two nearly equal opposite-polarity pulses. If the two pulses were exactly equal and opposite, they would cancel one another at the input and output of the sampling bridge. Since such equality is never the case, however, R14 is adjusted to null the bridge-input signal--and thereby the signal fed out of the RF IN connector.

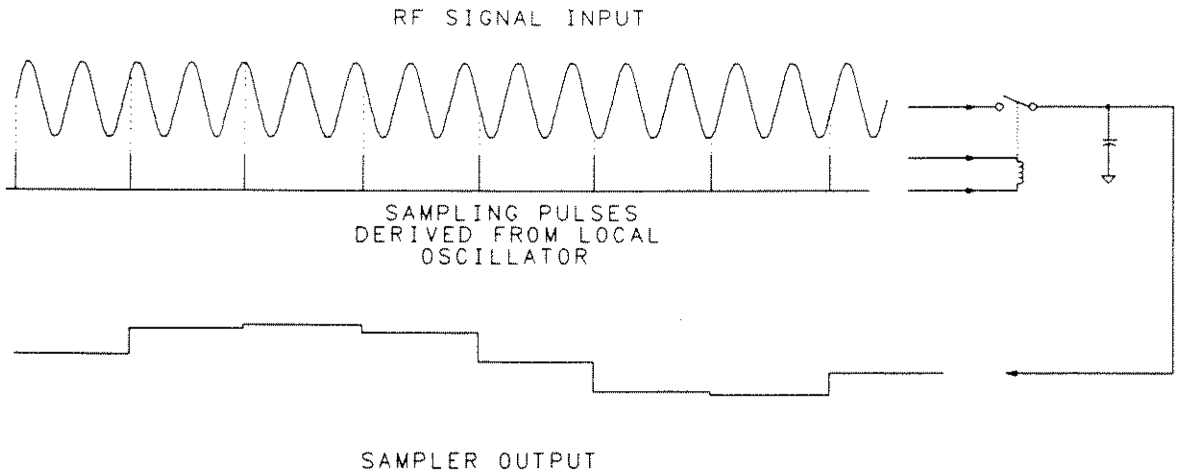


FIGURE 4-3. SAMPLING GATE OPERATION.

4-22. Frequency acquisition occurs in the following manner: If no carrier is present at the input (RF IN), the discriminator level indicates that the frequency is high. The integrator ramps toward the negative supply rail until it has exceeded 11 volts. Then the integrator is reset to 0 volts, the integrator attenuator is by-passed, and the count-modulus of the band counter is changed. This process continues until a carrier signal is applied to the RF IN connector.

4-23. When a carrier is applied, an IF signal will be produced at a frequency that is between 0 and 1/2 of the sampling rate. This signal is hard-limited, then applied to a discriminator which, in turn, causes the integrator to move toward one or the other of the supply rails (depending on whether the IF is high or is low). If a valid 400 kHz IF is produced, the integrator stops, and the by-pass of the integrator attenuator is removed. If no valid IF occurs, the integrator output will eventually exceed either + 11 or -11 volts. Then the integrator will be reset, and the band-counter modulus will be either increased or decreased. In this way, all possible input frequencies can be made to produce a valid IF.

4-24. The capture performance of the system is determined principally by the limiter's gain and the bandwidth of the sampler. Weaker signals at the RF input (non-harmonically related to the signal of interest) will be suppressed, since the largest signal present will drive the limiter to a low-gain state. These weaker signals will appear as FM sidebands at the output of the limiter.

4-25. THEORY OF OPERATION, IF CIRCUITS

4-26. The IF circuits recover the AM and FM signals from the frequency-shifted input signal. These circuits also provide a sample IF signal to the front-panel IF OUT connector; in addition, for AM measurements, they provide a dc signal proportional to the IF level. Refer to FIGURES 4-4, 8-5, and 8-7.

4-27. The 400 kHz IF signal from the RF circuits is connected to amplifier U2 through a low-pass filter that consists of inductors L1 through L3, capacitors C1-C2, and resistors R3, R4, and R6. Variable resistor R6 reduces the filter's amplitude-response variations, which are due to component tolerances. It is adjusted to give minimum AM indication when an FM signal is applied. Amplifier U2 has a closed-loop gain of approximately four, as determined by R3, R4, R6, and R8. The signal is then connected to calibrator switch U3, and ac coupled to DAC U4. The gain of the DAC is determined by the digital byte appearing at inputs B1-B8. The logic circuitry varies this byte to maintain the dc output of the AM detector between 0.5 and 0.6 volts. The amplifier that consists of U5, Q3, and associated components, increases the IF level and provides the high output impedance necessary for driving the linear active detector circuit. The signal at the emitter of Q3 is buffered by U8 and routed to the IF OUT connector.

4-28. The active detector circuit, which comprises transistors Q4 through Q6, diode CR6-CR7, and associated components, converts the input current into two half-wave-rectified signals. The circuitry of Q4-Q6 yields maximum gain and a high output impedance for driving the feedback network. The two half-wave-rectified signals at the outputs of CR6 and CR7 are added to complete the feedback path.

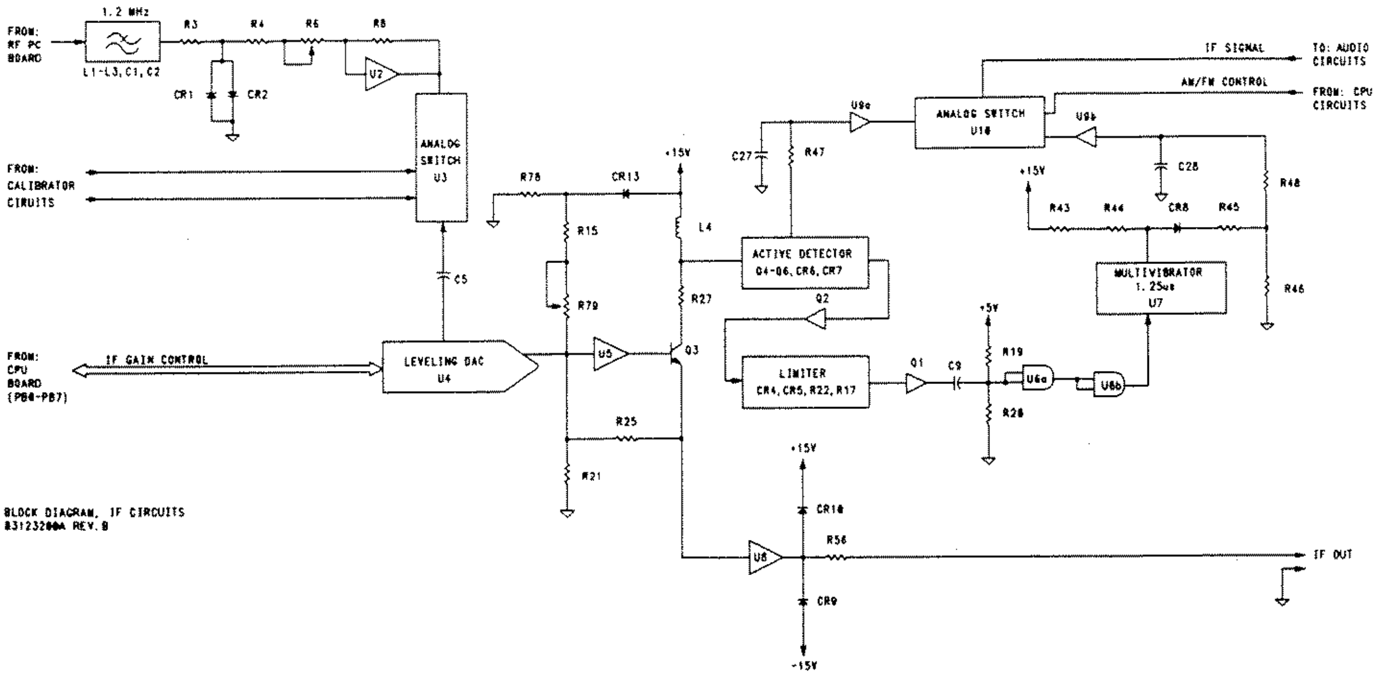


FIGURE 4-4. IF CIRCUITS BLOCK DIAGRAM.

4-29. The output at detector diode CR7 is a signal that contains a dc component proportional to IF level, and an ac component proportional to modulation depth. This signal is lightly filtered by R47 and C27, and amplified by U9a. The output of U9a is connected to the AM-FM switch U14.

4-30. A portion of the linear active detector's output is coupled to a limiter circuit via impedance transformer Q2 and associated components. The limiter, consisting of CR4, CR5, R22 and R17, removes most of the AM from the IF signal. The resulting signal is amplified to TTL levels by amplifier Q1, then differentiated by C9, R19 and R20. The TTL gates U6a and U6b amplify the differentiated signal into a narrow TTL pulse to drive U7, a monostable multivibrator.

4-31. The period of the signal at the output of U7 is approximately 2.5 microseconds. The network consisting of R43-R46 and CR8 confines the peak-to-peak amplitude of U7's output to 4 volts. As the intermediate frequency changes, the duty cycle of the multivibrator (and consequently the average value of the waveform) changes proportionally.

4-32. The signal is lightly filtered by R48 and C28, then amplified and level-shifted by U9b. The signal is routed to the AM-FM switch U10, and to the audio circuits.

4-33. THEORY OF OPERATION, AF CIRCUITS

4-34. The audio circuits process the recovered modulation signal supplied from the AM or the FM detector circuits determined by the front-panel FUNCTION switch selection. The recovered signal is filtered and converted to a dc level, which is then measured. The result is presented on the front-panel LED display. Refer to FIGURES 4-5, 8-5, and 8-7.

4-35. The signal from the output of the AM-FM switch U10, is filtered by active filter U9c and associated components. This filter is part of a three-pole 60 kHz filter, which removes most of the IF component from the recovered signal. The filtered signal impedance to drive a precision divider A3R7a, b and c. The signal is kept at a high level to reduce charge injection errors in switch, A3U3.

4-68. The voltage divider comprising R7a through R7d is a precision resistor array. The absolute value of the resistors is not as important as the match between them. Thus R7a though R7d are matched to 0.1%.

4-69. Maintaining this voltage divider at a constant impeadance minimizes the loading effect of attenuator A3R11-R12.

4-70. Analog switch U3 alternately switches between 2/3 and 1/3 voltage taps at the 900 Hz rate, thus producing an amplitude modulated signal with a depth of exactly 33.33%.

4-71. A possible source of error in transferring the calibrator AM accuracy to the measurement in the symmetry of the modulation waveform. The problem is addressed as follows: (in the following p+ indicates +peak and p- is the -peak).

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

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

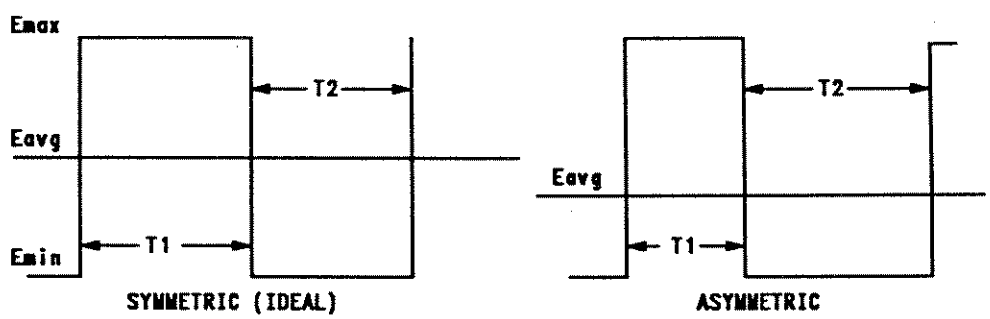
$$\%AM = (Emax-Emin)/(Emax+Emin) \times 100 \qquad (4)$$

and for the above system:

$$\%AM = (3/2 - 1/3)/(2/3 + 1/3) \times 100$$
$$= 33.33$$

4-72. The above calculations assume that the modulation is symmetrical. Should that not be the case, a dc shift occurs. The plus and minus peaks are not equal. The calibrator program eliminates such an error by calculating the AM as:

$$\%AM = (p+ + 2p-)/3 \qquad (5)$$



This expression is determined as follows:

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

$$(p+)(T1)-(p-)(T2) = 0 \qquad (6)$$

And:

$$T1 + T2 = 1 \qquad (7)$$
$$(p+)(T1)-(p-)(1-T1) = 0 \qquad (8)$$
$$T1 = p-/(p+ + p-) \qquad (9)$$

Now:

$$Eavg = Emin + (Emax - Emin)\ T1/(T1 + T2) \quad (10)$$

And in the Modulation Meter:

$$Emax = 2Emin \quad (11)$$

Combining Eqs. 7, 10, and 11:

$$Eavg = Emin + Emin(T1) \quad (12)$$
$$Eavg = Emin(1 + T1) \quad (13)$$

If symmetry is perfect:

$$Eavg = Emin(1.5) \quad (14)$$

If symmetry is less than perfect, the dc ratio error, R (that is, Eq. 13 vs. Eq. 14), will be:

$$R = (1 + T1)/1.5 \quad (15)$$

Combining Equations 9 and 15:

$$R = (p+\ 2p-)/1.5(p+\ +\ p-) \quad (16)$$

The uncorrected AM is:

$$= (p+\ +\ p-)/2 \quad (17)$$

The corrected AM is then:

$$= ((p+\ +\ p-)/2) \times R \quad (18)$$
$$= (p+\ +\ 2p-)/3 \quad (19)$$

4-73. Again, it should be noted that only the ratios are involved in the above analysis. The absolute value of the voltages are not important to the method. As in FM, the calibration program accumulates ten readings and averages them to eliminate last digit uncertainty. The internal voltmeter can resolve 1 part in 333 or 0.3%. AM noise is of little consequence in determining calibrator depth. The original signal level is determined by logic gates and the frequency of the carrier and modulation signals are crystal controlled.

4-74. Cross-correlation measurements, using a specially calibrated Modulation Analyzer, indicate the actual calibration uncertainty for 100 calibration is approximately 0.2% or 2/3 of a digit.

TABLE 5-3. AUDIO FILTERS.

FILTER	SOURCE SETTING	MINIMUM	ACTUAL	MAXIMUM
LP2	3 kHz	65.70	________	73.70
LP1	15 kHz	65.70	________	73.70
DE-EM	212.2 Hz	65.70	________	73.70
Option -01				
LP1	30 kHz	65.70	________	73.70
Option -02				
LP1	50 kHz	65.70	________	73.70

PERFORMANCE TEST 3

AMPLITUDE MODULATION, DISTORTION

Specification : 0.3% for depths of 90%

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 Modulation Meter. The Audio Analyzer level is then adjusted for 90% and the recovered modulation distortion indicated on the the Audio Analyzer DISTORTION display.

5-20. PROCEDURE

- Depress the SHIFT-INIT key to initialize the Modulation Analyzer.
- Connect the equipment as in FIGURE 5-1. Note that the power supply is set to 10 +- 1 volts.
- Select the Model 8211 AM modulation measurement mode and the LP2 low-pass filter.
- Set the Audio Analyzer to 500 Hz and adjust the level for an AM indication of 90.0 +- 0.5%.
- Select the Audio Analyzer DISTORTION measurement and record the indication.

TABLE 5-4. AMPLITUDE MODULATION, DISTORTION.

DEPTH	RF FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
90%	30 MHz		________	0.3%

PERFORMANCE TEST 4

FM MODULATION ACCURACY AND INCIDENTAL AM

Specification	: +- 1%, 50 Hz to 5 kHz
	: +- 2%, 20 Hz to 7.5 kHz
	: incidental AM 1.0% AM peak at 100kHz peak deviation

5-21. DESCRIPTION

5-22. The FM accuracy is verified by using the internal calibrator which is exactly 46.1 kHz +- 0.1% at a 900 Hz rate. The FM flatness is then tested by applying the FM modulated output of the Test Generator to the input of the Modulation Meter. The Audio Analyzer frequency is then varied from 20 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 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

- Connect the equipment as shown in FIGURE 5-2.
- Depress the SHIFT-INIT key to initialize the Modulation Meter.
- Set the Test Generator to 500 MHz, 0 dBm and EXT DC FM.
- Adjust the Audio Analyzer Source to 0.7 volts at 1 kHz, and program the Test Generator for 50 kHz deviation.
- Select the Model 8211 FM modulation mode and depress the SHIFT-CAL key. The calibration program will display the FM indication during the calibration program. Record the indication.
- Select the LP1 low-pass filter.
- Adjust the Audio Analyzer LEVEL for an FM indication of 50.0 kHz at a 1 kHz rate.

NOTE

The following procedures assume that the Audio Analyzer Level flatness is better than 0.2%. This should be verified before continuing.

- Set the Audio Analyzer to 30, 100, and 500 Hz and record the indication.
- 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.

- Adjust the Audio Analyzer and Test Generator for the rate and deviation indicated in TABLE 5-5 for the appropriate instrument option.
-

NOTE

Always approach the null from a deviation significantly less than the required deviation to insure that the null is the first (M = 2.4048).

- Observe the Spectrum Analyzer display and, using the Audio Analyzer LEVEL STEP function, adjust for a carrier null of greater than 50 dB.
- Temporarily disconnect the the Audio Analyzer from the test generator. Subtract the residual reading from the deviation indication and record the difference.
- Repeat the above procedure at the second rate and deviation in TABLE 5-5.
- Set the Signal Generator to 30 MHz at 0 dBm and adjust the Audio Analyzer for a deviation of 100 kHz at a 1 kHz rate.
- Select the LP2 low-pass filter, RANGE 10, AM modulation display, and record the indication.

TABLE 5-5. FREQUENCY MODULATION ACCURACY.

FILTER	RATE	MINIMUM	ACTUAL	MAXIMUM
LP1	30 Hz	49.5	______	50.5
LP1	100 Hz	49.5	______	50.5
LP1	500 Hz	49.5	______	50.5
FILTER	**RATE (DEVIATION)**	**MINIMUM**	**ACTUAL**	**MAXIMUM**
LP1	5 kHz(12 kHz)	11.90	______	12.14
LP1	7.5 kHz(18 kHz)	17.7	______	18.4
Option -01				
LP1	10 kHz(24 kHz)	23.8	______	24.3
LP1	15 kHz(36 kHz)	35.4	______	36.8
Option -02				
LP1	16.67 kHz(40 kHz)	39.7	______	40.5
LP1	25 kHz(60 kHz)	58.9	______	61.3
CALIBRATION			______	
INCIDENTAL @ 30 Mhz			______	1.0%

PERFORMANCE TEST 5

FREQUENCY MODULATION, DISTORTION

Specification : 0.25% for deviations < 75 kHz

5-24. DESCRIPTION

5-25. The Frequency Modulation distortion is verified by applying a carrier signal from the Test Generator to the RF input of the Modulation Meter. The FM deviation is set to 75 kHz and the Audio Analyzer distortion is noted.

5-26. PROCEDURE

- Depress the SHIFT-INIT key to initialize the Modulation Meter.
- Set the Test Generator for 100.00 MHz, 0 dBm, and external FM deviation.
- Set the Audio Analyzer SOURCE for 75 kHz peak deviation at a 1 kHz rate.
- Record the Audio Analyzer DISTORTION display.

TABLE 5-6. FREQUENCY MODULATION, DISTORTION.

DEVIATION	RF FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
75 kHz	100 MHz		________	0.25%

PERFORMANCE TEST 6

FM RESIDUALS, LP1 and LP2 FILTERS

Specification	: < 150 Hz rms at 1500 MHz, 3 kHz bandwidth
	: < 75 Hz rms at 750 MHz, 3 kHz bandwidth (linear decrease)
	: < 5 Hz rms at 30 MHz, 3 kHz bandwidth (floor)
	: < 200 Hz rms at 1500 MHz, 15 kHz bandwidth
	: < 100 Hz rms at 650 MHz, (linear decrease)15 kHz bandwidth
	: < 15 Hz rms at 30 MHz, 15 kHz bandwidth (floor)

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 Modulation Meter and noting the Audio Analyzer LEVEL indication, which is rms responding.

5-29. PROCEDURE

- Depress the SHIFT-INIT key to initialize the Modulation Analyzer.
- Connect output of the Synthesizer to the RF IN connector of the Model 8211. Set the Synthesizer to 30 MHz and 0 dBm. Select the Audio Analyzer LEVEL display, and when the reading settles, record the level indication.
- Change the low-pass filter setting to LP2 and record the indication.
- Change the Synthesizer frequency to 750 MHz and record the indication.
- Change the low-pass filter setting to LP1 and record the indication.
- Change the Synthesizer frequency to 1500 MHz and record the indication.
- Change the low-pass filter setting to LP2 and record the indication.

TABLE 5-7. FREQUENCY MODULATION, RESIDUALS.

FILTER	TEST FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
LP2	30 MHz		______	1 mV
LP1	30 MHz		______	3 mV
LP2	750 MHz		______	15 mV
LP1	750 MHz		______	20 mV
LP2	1500 MHz		______	30 mV
LP1	1500 MHz		______	40 mV

TABLE 5-8. FREQUENCY MODULATION RESIDUALS, -01 Option.

FILTER	TEST FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
LP2	30 MHz		______	1 mV
LP1	30 MHz		______	5 mV
LP2	750 MHz		______	15 mV
LP1	750 MHz		______	40 mV
LP2	1500 MHz		______	30 mV
LP1	1500 MHz		______	80 mV

TABLE 5-9. FREQUENCY MODULATION RESIDUALS, -02 Option.

FILTER	TEST FREQUENCY	MINIMUM	ACTUAL	MAXIMUM
LP2	100 MHz		______	1 mV
LP1	100 MHz		______	11 mV
LP2	750 MHz		______	15 mV
LP1	750 MHz		______	95 mV
LP2	1500 MHz		______	30 mV
LP1	1500 MHz		______	190 mV

PERFORMANCE TEST 7

CARRIER LEVEL

Specification : 10 millivolts to 1 volt, Frequency <520 MHz
: 30 millivolts to 1 volt, Frequency <1500 MHz

5-30. DESCRIPTION

5-31. The RF level range is verified by applying the output of the Signal Generator at a known level and frequency to the RF IN of the Modulation Meter. Correct operation is noted.

5-32. PROCEDURE

- Connect the equipment as in FIGURE 5-2.
- Depress the SHIFT-INIT key to initialize the instrument.
- Set the Signal Generator to 2.0 Mhz and -27 dBm (10 millivolts). The instrument should properly acquire the signal and display residual modulation.
- Change the generator level to +13 dBm (1 volt). The instrument should properly acquire the signal and display residual modulation.
- Repeat the procedure for the frequencies and levels listed in TABLE 5-10.

TABLE 5-10. CARRIER LEVEL.

FREQUENCY	LEVEL	MINIMUM	ACTUAL	MAXIMUM
2.0 MHz	-27 dBm		________	-27 dBm
2.0 MHz	+13 dBm	+13 dBm	________	
520 MHz	-27 dBm		________	-27 dBm
520 MHz	+13 dBm	+13 dBm	________	
1500 MHz	-17 dBm		________	-17 dBm
1500 MHz	+13 dBm	+13 dBm	________	

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SECTION VI
MAINTENANCE

6-1. INTRODUCTION

6-2. This section contains maintenance and adjustment instructions for the Model 8211.

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.

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 8211.

6-11. REMOVAL OF MAJOR ASSEMBLIES AND PARTS

6-12. INSTRUMENT COVERS

To remove the instrument covers proceed as follows:

- Disconnect all signal cables and the power cord from the Model 8211.
- Remove the top cover by removing two No. 4 screws at the rear of the cover, and lifting the cover up and to the rear.
- Turn the instrument over and remove the bottom cover in a similar manner.

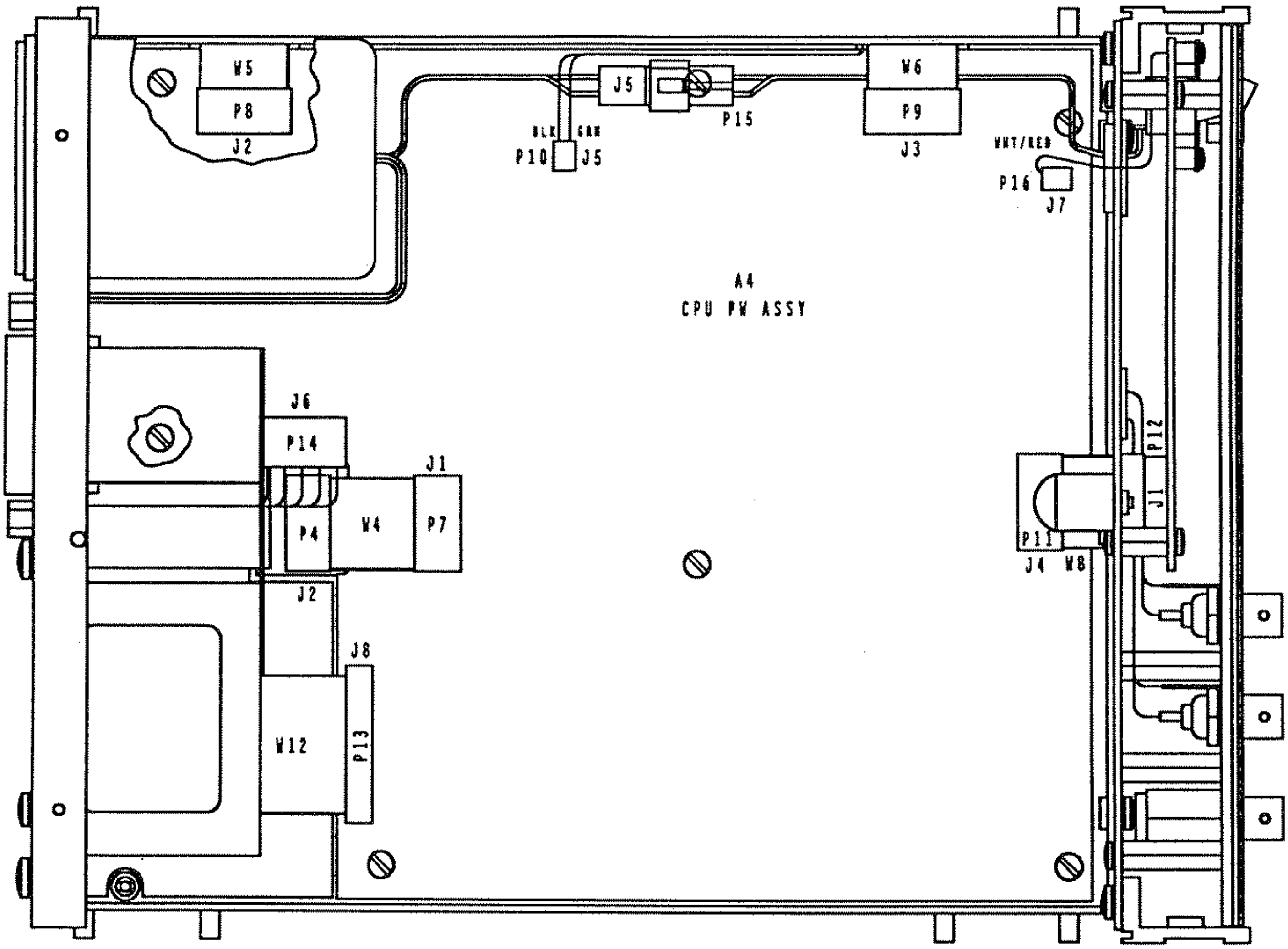


FIGURE 6-1. MAJOR ASSEMBLY LOCATION, TOP VIEW.

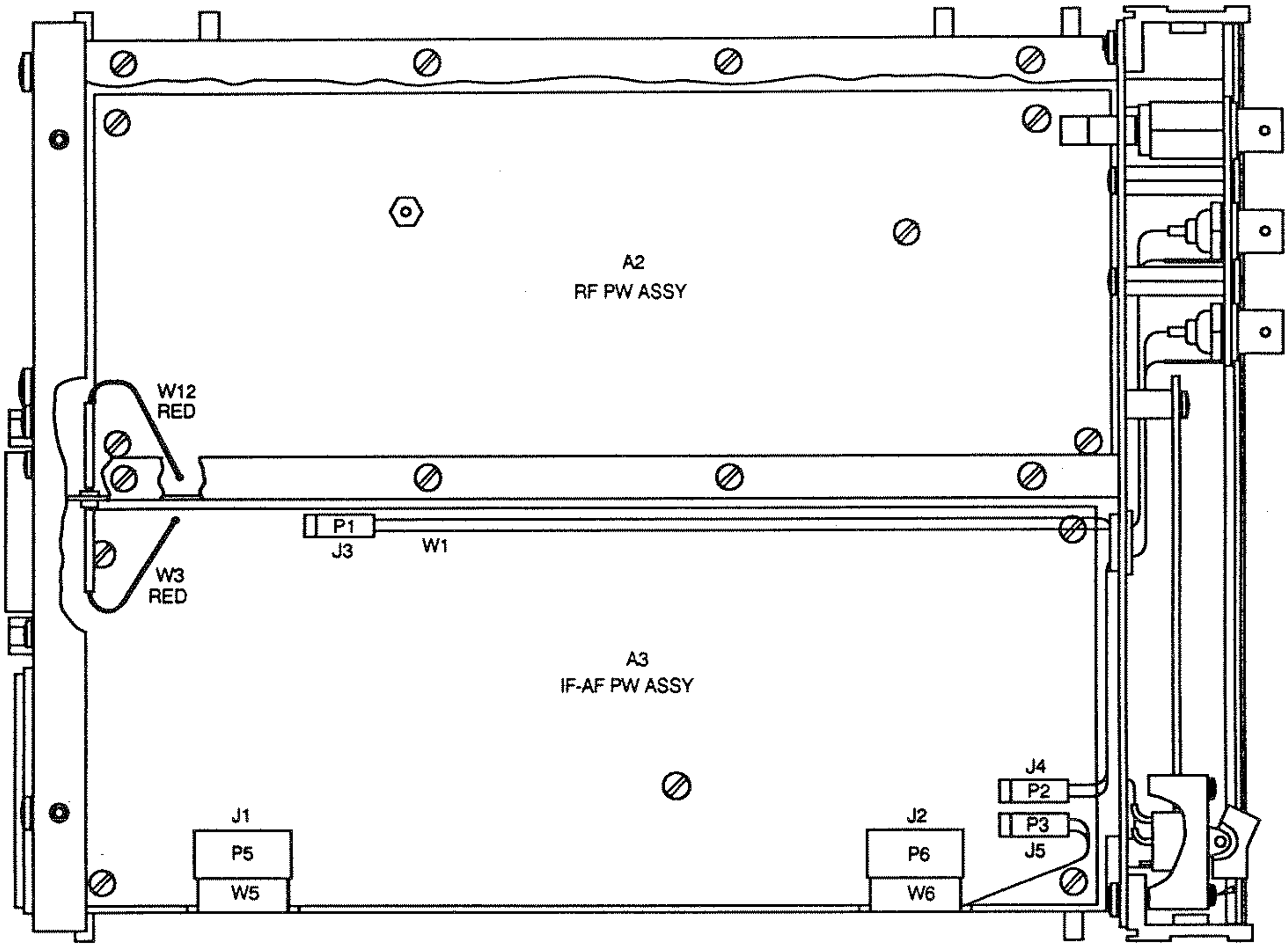


FIGURE 6-2. MAJOR ASSEMBLY LOCATION, BOTTOM VIEW.

6-13. RF ASSEMBLY COVER

To remove the RF assembly cover, proceed as follows:

- Remove the instrument covers as described above.
- Remove nine No. 4 screws that secure the RF assembly cover.
- Push the cover toward the rear of the instrument and lift the front upward.
- Pull the cover toward the front of the instrument and remove it.

6-14. RF PRINTED CIRCUIT BOARD

To remove the RF printed circuit board, proceed as follows:

- Remove the instrument and RF assembly cover as described above.
- Remove the IF signal connection at the rear of the circuit board.
- Turn the instrument over and disconnect ribbon connector A1P4.

CAUTION

Be careful in the following steps not to break the center pin of the RF connector.

- Remove five No. 4 screws and one hex spacer holding the circuit board to the chassis.
- Pull the circuit board toward the rear of the instrument to disengage the RF connector.
- Pull the circuit board up and away from the chassis.
- To replace the RF circuit board reverse the above procedure.

6-15. IF/AF BOARD

To remove the IF/AF board, proceed as follows:

- Remove the instrument covers as described above.
- Remove the IF connection at the rear of the circuit board.
- Remove both two-pin connectors at the front edge of the circuit board; disconnect the two-pin connector at the right edge of the circuit board.
- Remove five No. 4 screws holding the circuit board and lift out the board.
- To replace the IF/AF board reverse the above procedure.

6-16. REAR PANEL ASSEMBLY

To remove the Rear Panel Assembly, proceed as follows:

- Remove the instrument covers as described above.
- Disconnect the power connector A1P14.
- Disconnect the power switch connector A1P15 from A1J5.
- Remove three No. 6 screws securing the rear panel to the chassis.
- Remove two No. 4 screws securing the rear panel to the power supply heat sink.
- Pull the rear panel away from the chassis.

6-17. DIGITAL CIRCUITS AND POWER SUPPLY BOARD

To remove the Digital Circuits and Power Supply board, proceed as follows:

- Remove the instrument covers as described above.
- Disconnect four ribbon connectors A1P7, A1P8, A1P9, and A1P11, and A1P12 from J8.
- Disconnect pin connector A1P13.
- Disconnect two-pin connector A1P10.
- Remove the rear panel assembly (see above).
- Revove seven No. 4 screws holding the circuit board, and lift the board out of the chassis.
- To replace the board reverse the above procedure.

6-18. GAINING ACCESS TO DISPLAY BOARD

To gain access to the display board, proceed as follows:

- Remove the instrument covers as described above.
- Remove three No. 4 screws that hold the top trim extrusion and grounding clip.
- Grasp the trim strip by its edges and pull it away.
- Remove the plastic display window.

CAUTION

Be careful not to scratch the the inner surface of the display window.

- Turn the instrument over and remove three No. 4 screws that hold the bottom trim extrusion and grounding clip.
- Grasp the trim strip by its edges and pull it away.

- 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.

6-19. CHANGING INSTRUMENT FIRMWARE

To change the instrument eprom, proceed as follows:

- Remove all cable connections from the Model 8211, including the power cable.
- Remove the instrument top cover as described above.

CAUTION

When replacing A4U8 observe that the orientation of pin 1 is toward the left edge of the board. The three numbers on the replacement IC should match the numbers on the one being replaced.

- Remove A4U8 and replace with the new eprom.
- Before replacing the top instrument cover, set positions 4, 5, 6, and 7 of test switch A4S1 to the closed position, and connnect the ac power supply. Turn the LINE switch ON.
- The new firmware code will appear in the display. Wait several seconds until the '....' message appears.
- Turn the instrument power off, reset all positions of A4S1 to the open position.
- Turn the instrument ON. The Model 8211 will automatically recalibrate the modulation detectors after the self-check completes.

TABLE 6-1. TEST SWITCH SETTINGS.

POSITION 1 2 3 4 5 6 7 8	ACTION(TESTS)
0 0 0 0 0 0 0 0	Normal instrument operation.
0 0 0 0 0 0 x 0	Enables manual operation of carrier acquisition circuits. (Oscillator, Bandswitching, Integrator)
0 0 0 0 0 x 0 0	Enables manual operation of automatic gain control circuits. (Automatic Gain control)
0 0 0 0 0 x x 0	Operates measurement circuits without a carrier.(Audio, peak detectors, voltmeter)
0 0 0 0 x 0 0 0	View and edit detector calibration variables. (Calibrators)
0 0 0 0 x 0 x 0	Normal operation that bypasses self-check. (All)
0 0 0 0 x x 0 0	Operates instrument and display interface in endless loop. (A4U12 and A4U14)
0 0 0 0 x x x 0	Activates a A/D converter in endless loop. (Voltmeter)
0 0 0 x 0 0 0 0	Operates self-test in endless loop. (All)
0 0 0 x x x x 0	Initializes instrument and installs default calibration data.

6-20. INSTRUMENT TEST SWITCH The Model 8211 Digital/Power Supply board has a multiposition switch that is used as an aid in troubleshooting the instrument circuits. The switch settings and related tests are listed in TABLE 6-1. Open is indicated by '0' and closed by 'x'.

6-21. REMOVAL OF DETAIL PARTS Careful attention has been paid in the design of the Model 8211 to maintainability. Most detail parts are readily accessible for inspection and replacement when the instrument covers and RF shield are removed. Solid-state circuit components, mounted on circuit boards, are used throughout the instrument. Standard printed circuit board maintenance techniques are used for removal and replacememt 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.

TABLE 6-2. HARDWARE ERROR DISPLAYS.

Display	Probable Fault On
No Display.	A4, Power Supply Circuits or A5 Display Board.
Meaningless Symbols.	A4 , Logic Circuits.
CC 1	A4, Logic Circuits or A3, Calibrator Circuits.
CC 2	A4, Logic Circuits or A3, Calibrator Circuits.
ER 1	A4, Logic Circuits, GPIB.
ER 2	A4, Logic Circuits, U13.
ER 3	A4, Logic Circuits, U8.
ER 4	A4, Logic Circuits, U12.
ER 5	A4, Logic Circuits, U14.
ER 6	A3, IF Circuits, U4.
ER 7	A2, RF Circuits.
ER 8	A3, Audio Circuits.

6-22. PRELIMINARY CHECKS

6-23. **VISUAL CHECKS.** If equipment malfunction occurs, perform a visual check of the Model 8211 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. Damage may be broken wires, loose hardware and parts, loose electrical connections, electrical shorts, cold solder connections, dirt or other foreign matter. Correct any problems discovered, then complete the performance tests to verify that the instrument is functional. If a malfunction persists or the instrument fails any of the performance tests, continue with the troubleshooting procedures below.

6-24. **POWER SUPPLY CHECK.** Improper operation of the Model 8211 may be caused by incorrect dc operating voltages. Before proceeding with any other electrical checks, perform the power supply checks in the POWER SUPPLY CIRCUITS portion of this section.

6-25. TROUBLESHOOTING

6-26. 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.

6-27. 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. The problem would most likely be associated with the IF circuits on the IF/AF circuit board, A3. Similar performance on both AM and FM displays would indicate a problem in the AF circuits.

6-28. Catastrophic failures would generally cause the Model 8211 to be completely inoperative. For instance, if the microprocessor was not operating properly, the displays would be blank or contain meaningless symbols, and the keyboard would not be responsive.

6-29. Further isolation of the problem requires some understanding of the simplified block diagram. Read over the theory of operation section and proceed with the troubleshooting section below. When the problem is localized to a specific assembly, refer to the service information for that assembly.

Test Point	Circuit
TP6	+15V supply
TP7	-15V supply
TP8	-7.5V supply
TP9	+5VA(analog)
U15 , pin 22	+5V(logic)

TABLE 6-3. POWER SUPPLY TEST POINTS.

6-30. TROUBLE LOCALIZATION

6-31. Many malfunctions are evident from the front-panel display. See TABLE 6-2.

6-32. 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.

6-33. TROUBLESHOOTING, POWER SUPPLY CIRCUITS

6-34. **GENERAL.** Procedures for checking the POWER SUPPLY circuits 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.

6-35. **EQUIPMENT REQUIRED.** The equipment required includes: (See TABLE 5-1 for critical specifications).

Oscilloscope .... HP 1740A
Multimeter .... 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 epuipment, and when making voltage measurements.

6-36. **PROCEDURE.** With the instrument covers removed and power applied, measure the dc voltages on TP6-Tp9. The voltage at each point should be as indicated in TABLE 6-3.

NOTE

For the following oscilloscope measurements, use a high impedance probe. TP-11 can be used as a convenient ground.

6-37. **+5V Logic (U5-pin 22).** The +5 volt logic supply is a three-terminal regulator, U27, and associated components. If the output voltage is incorrect check for shorted CR11, CR15 or C22.

6-38. **+5VA Analog (TP9).** The +5 volt analog supply is a three terminal regulator, U26, enclosed in a feedback loop consisting of U30D and associated components. Proceed as follows:

- If the dc voltage at the +5VA volt bus is near ground, a short circuit is the most likely problem. The supply can be isolated by disconnecting A1P7 or A1P9. Disconnect one at a time to isolate problems on other circuit boards.

- Measure the voltage on pin 14 of U30. The voltage should be approximately 0 Vdc . If not, check the +15 and -15 volt supplies. See below.

- In any case measure the dc voltage and ripple at the positive terminal of C38 (TP12). The voltage should be +8.7 Vdc with 500 millivolts of ripple at nominal line. If not, check for defective CR6 or replace defective U26.

- Measure the dc voltage at pin 3 of U26. The voltage should be +5.0. If not, replace defective U26, or check for defective U30 or U31.

- Measure the dc voltage at pin 14 of U30. The voltage should be about 0 Vdc. If not, replace defective U30, or check for shorted CR13.

6-39. +15V (TP6). The +15 volt instrument supply is a three-terminal regulator, U28, enclosed in a feedback loop. This consists of U30A and associated components. Proceed as follows:

- 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 disconnecting A1P7 or A1P9. Disconnect one at a time to isolate problems on other circuit boards.

- If the voltage at the +15 volt bus is low, but not zero, the problem may be with the -15 volt supply. See below.

- Measure the dc voltage and ripple at the positive terminal of C42 (TP13). The voltage should be +18 Vdc with 750 millivolts of ripple at nominal line. If not, check for defective CR7 or replace defective U28.

- Measure the dc voltage at pin 6 of U31. The voltage should be +10 volts. If not, replace defective U31. If the +15 supply voltage is less than 12 volts U31 will not operate properly.

- Measure the dc voltage at pin 1 of U30A. The voltage should be +10 volts. If not, replace defective U30, or check for shorted CR10.

6-40. -15V (TP7). The -15 volt instrument supply is a three-terminal regulator, U29, enclosed in a feedback loop. This consists of U30B and associated components. Proceed as follows:

- 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 disconnecting A1P7 or A1P9 one connector at a time. This isolates problems on other circuit boards.

- If the voltage at the -15 volt bus is low, but not zero, the problem may be with the +15 volt supply. See above.

- Measure the dc voltage and ripple at the negative terminal of C10 (TP14). The voltage should be -18 Vdc with 750 millivolts of ripple at nominal line. If not, check for defective CR7 or replace defective U29.

- Measure the dc voltage at pin 6 of U31. The voltage should be +10 volts. If not, replace defective U31. If the +15 supply voltage is less than 12 volts, U31 will not operate properly.

- Measure the dc voltage at pin 7 of U30B. The voltage should be -10 volts. If not, replace defective U30, or check for shorted CR12.

6-41. -7.5 (TP7). The -7.5 volt instrument supply consists of an operational amplifier U30C and associated components. Proceed as follows:

- If the dc voltage at the -7.5 volt bus is near ground, a short circuit is the most likely problem. The supply can be isolated by disconnecting A1P7 or A1P9 one connector at a time. This will isolate problems on other circuit boards.

- Measure the dc voltage at pin 10 of U30C. The voltage should be -7.5 volts. If not, troubleshoot the -15 volt supply or replace defective U30.

6-42. TROUBLESHOOTING, LOGIC CIRCUITS

6-43. GENERAL. Procedures for checking the LOGIC circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, FIGURES 8-8 and 8-9. The CPU circuitry in the Model 8211 uses an 8-bit microprocessor in a bus-oriented system. The high-speed circuitry is contained on the Digital/Power Supply board and external signals are buffered. As a result, failures of one or more peripheral circuits will generally identify the section to troubleshoot.

6-44. EQUIPMENT REQUIRED. The test equipment required is listed below. See TABLE 5-1 for critical specifications. For several of the tests, a logic probe could be substituted for the oscilloscope.

Oscilloscope.............................. HP 1740A
Multimeter................................ Fluke 8840A
Logic Analyzer.......................... none specified

6-45. PROCEDURE.

- With the instrument power off, 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.
- Turn on the instrument power and depress the SHIFT-INIT key if the keyboard is active.
- Measure the dc voltage at pin 28 of U8. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors could cause the problem.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a short ground connection.

6-46. CLOCK AND TIMING

- Connect the oscilloscope probe to pin 6 of U7. The signal should be a TTL level signal with a period of 271 nanoseconds (3.6864 MHz). If not, replace defective Y1.
- Move the oscilloscope to pin 9 of U3. The signal should be a CMOS level signal with a period of 542 nanoseconds (1.8432 MHz).If not, replace defective U3.
- Move the oscilloscope to pin 1 of U3. The signal should be a CMOS level signal with a period of 1.1 milliseconds (900 MHz). If not, replace defective U3.

6-47. RESET and POWER FAIL

- Connect the oscilloscope to pin 15 of U15. The signal should be TTL logic high. If not, replace a defective U15.
- Move the oscilloscope to pin 16 of U15. The signal should be TTL logic low. If not, replace defective U15.

6-48. CPU AND MEMORY

- If the microprocessor data bus is inactive, a data or address bus problem is indicated. In this event a logic state analyzer is the most direct method of isolating the problem. Parts substitution should be used as a last resort. The state of the data bus is tabulated below for the first several machine bus cycles. Refer to the manual for the particular logic analyzer for instructions in connecting the DATA bus and clock signals. If data pattern errors occur, the most likely problem is the eprom U8. DATA or ADDRESS bus shorts could also be the problem.

Address Bus (Hex)	D7-----D0 (Binary)
0000	1100.0011
0001	1000.0000
0002	0000.0000
0080	0011.0001
0081	1000.0000
0082	1011.0000
0083	1101.1101
0084	0010.0001
0085	0000.0000
0086	1011.0001

- Remove the logic analyzer, turn off the instrument power and set positions 5 and 6 of test switch A4S1 to the closed position.
- Turn instrument power ON and monitor the activity on pins 1-4, 37-40, and 18-25 U14. The signal should alternate between TTL high and low. If not, replace defective U14 or isolate shorted instrument control lines.
- Reset all positions of A4S1 to the open position. Cycle instrument power.

6-49. IEEE-488 CONTROLLER

- Connect the bus analyzer to the IEEE-488 connector on the rear-panel of the Model 8211. Set the analyzer as follows:

REN	ON
MEMORY	OFF
COMP	OFF
TALK	active
EXECUTE	HALT
SRQ	0
EOI	0
ATN	0

- Connect the oscilloscope probe to pin 9 of U19. 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 the cable connecting the bus analyzer to the CPU board.
- Move the oscilloscope probe to pin 12 of U19 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U18 or U19.
- Repeat the previous two steps for pins 2-8 and 19-13 of U19 using bus analyzer switches 2-8. The results should be the same. If not, replace defective U18 or U19.
- Connect the oscilloscope probe to pin 2 of U20. 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 the cable connecting the bus analyzer to the CPU board.
- Move the oscilloscope probe to pin 19 of U20 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U18 or U20.
- Repeat the previous two steps for pins 3, 7, 8 and 18, 14, 13 of U20 using the bus analyzer IFC, EOI, and ATN switches. The results should be the same. If not, replace defective U18 or U20.

- Turn off the instrument power, and set positions 5 and 6 of A4S1 to the closed position.
- 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.
- Reset all positions of A4S1 to the open position, depress the SHIFT-INIT key, and set the bus analyzer bus switches as follows:

8	7	6	5	4	3	2	1
0	1	0	1	0	0	1	0

- Monitor the activity on pin 1 of U20 and activate the ATN line of the bus analyzer and depress the EXECUTE button. When the ATN switch is set false, the signal should change from TTL low to high and the front panel ADRS annunciator should flash. If not, replace defective U18.
- Monitor pin 1 of U20 and activate the bus analyzer IFC switch. Pin 1 should go low and the ADRS annunciator should go out. If not, replace defective U18 or U20.
- Set the bus analyzer bus switches as follows:

8	7	6	5	4	3	2	1
0	0	1	1	0	0	1	0

- Set the REN switch ON and ATN true. Depress the EXECUTE key on bus analyzer. The front panel REMOTE annunciator should illuminate. If not, replace defective U18 or U20, or proceed to Display board troubleshooting.

6-50. **BATTERY REPLACEMENT.** To replace the lithium battery proceed as follows:

- Remove the instrument top cover as described at the beginning of this section.
- Carefully clip one of the leads from the battery to the circuit board.
- Bend the battery up to gain access to the other lead. Clip it as well.
- Use a low-wattage soldering iron and a solder suction device to remove the solder from the two large circuit pads holding the battery leads. Properly dispose of the old battery.
- Insert the new battery into the circuit pads, observing polarity. Carefully solder the connections.
- Set positions 4, 5, 6, and 7 of test switch A4S1 to the closed position.
- Turn the Model 8211 ON and observe the display until the '...." message appears. This action clears the variable memory.
- Turn off the Model 8211, reset all positions of A4S1 to the open position and replace the top cover. Turn the instrument ON. The modulation detectors will be recalibrated automatically.

6-51. TROUBLESHOOTING, RF CIRCUITS

6-52. GENERAL. Procedures for checking the RF circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, FIGURES 8-2 and 8-3.

6-53. EQUIPMENT REQUIRED. The test equipment required is listed below. See TABLE 5-1 for critical specifications.

Oscilloscope............................... HP 1740A
Signal Generator .... Boonton 102E-19
Multimeter................................ Fluke 8840A

6-54. PROCEDURE

- With the power OFF, set position 7 of test switch A4S1 to a closed position. Turn power ON.

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.

6-55. OSCILLATOR

- Connect the oscilloscope probe to A2TP1. The signal should be an RF signal between 26 and 38 MHz, and the amplitude should exceed 0.6 volts peak-to-peak. If not, isolate defective component in oscillator circuit A2Q8 - A2CR10 using dc and waveform measurements.

- Connect the oscilloscope to the collector of A2Q7. The signal should be 2 volts peak-to-peak , between 26 and 38 MHz. If not, replace defective A2Q7 or A2CR7.

- Connect the oscilloscope to pin 8 of U3. The signal should be a TTL signal between 26 and 38 MHz. If not, replace defective A2U3.

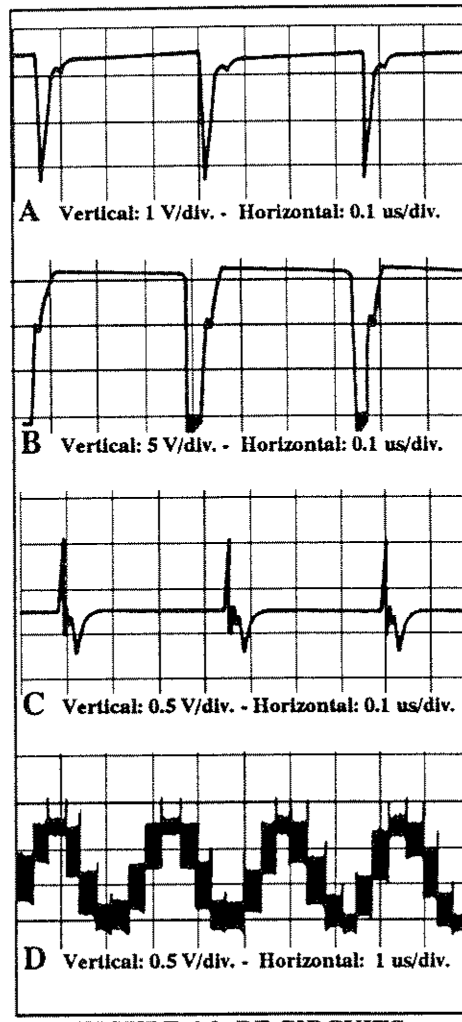


FIGURE 6-3. RF CIRCUITS, WAVEFORMS.

- Connect the oscilloscope to pin 9 of U1. The signal should be a TTL signal between 13 and 19 MHz. If not, replace defective A2U1.

- Connect the oscilloscope to pin 3 of U1. The signal should be a TTL signal at about 4 MHz. If not, replace defective A2U2, U3, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the LP2 key. The signal should be a TTL signal; the frequency should decrease from that in the previous step. If not, replace defective A2U2, U3, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the DE-EM key. The signal should be a TTL signal; the frequency should decrease from that in the previous step. If not, replace defective A2U2, U3, or refer to LOGIC CIRCUITS troubleshooting below.

- Connect the oscilloscope to pin 6 of U1. The signal should be as waveform A, FIGURE 6-3. If not, replace defective A2U1, or open R13 or C15.

6-56. PULSE GENERATOR

- Connect the oscilloscope to the collector of A2Q1. The signal should be as waveform B, FIGURE 6-3. If not, replace defective A2CR1, A2Q1, A2R1, or replace A2T1 or A2CR3.
- Connect the oscilloscope probe to the junction of A2R8 and A2C7. The signal should be waveform C, FIGURE 6-3. An incorrect signal indicates defective A2C7, A2R8, A2R9, A2R20, or replace A2T2 or A2CR4.
- Connect the oscilloscope probe to the junction of A2R19 and A2C14. The signal should be as in previous step, but reversed polarity. An incorrect signal indicates defective A2R19 or A2C14.

6-57. RF INPUT AND SAMPLER

- Set the signal generator to 2.4 MHz CW at +10 dBm and connect the RF OUT to the Model 8211 RF IN connector.
- Connect the oscilloscope probe to the junction of A2R12 and A2CR2b. The signal should be about 1.4 volts peak-to-peak with a period of 400 nanoseconds. Some of the local oscillator signal may be present. Incorrect signals indicate defective input connector, A2C3 or A2R3.
- Connect the oscilloscope to the junction of A2C23 and A2R32. Depress the DE-EM key. The signal should be approximately 400 kHz, 1.4 volts peak-to-peak with a 2.8 MHz signal added. See waveform D, FIGURE 6-3. No signal indicates a defective local oscillator, defective CR2, or troubleshoot amplifier Q2-Q6 using waveform measurements.
- Move the oscilloscope probe to pin 1 of U4. This should be about 5 Vdc. If not, replace defective ribbon cable W4, or defective A2U4, or check LOGIC CIRCUITS troubleshooting below.
- Move the oscilloscope probe to pin 6 of U5. Depress the 10 RANGE key. The signal should be approximately 400 kHz, 600 millivolts peak-to-peak, with a 2.8 MHz signal added. If not, replace defective A2U5 or A2U4, or refer to LOGIC CIRCUITS troubleshooting below.

6-58. FREQUENCY CONTROL CIRCUITS

- Move the oscilloscope probe to the pin 8 of A2U4. Depress the DE-EM key and the PEAK + key. The signal should be approximately 5 Vdc. If not, check for defective A2U4 or refer to FREQUENCY CONTROL, DIGITAL below.
- Move the oscilloscope probe to the junction of A2L9 and A2R53. Depress the 100 RANGE key. The signal should be 300 to 500 kHz, 2.5 volts peak-to-peak, with a 2.8 MHz signal added. If not, replace A2U4, open A2L6 or open A2L9.
- Depress the LP2 key. The signal should be a small residual of the signal in the previous step. If not, replace defective A2U4 or refer to LOGIC CIRCUITS troubleshooting below.
- Move the oscilloscope probe to the junction of A2L10 and A2R55. Change the Test Generator frequency to 2.9 MHz. The signal should be 300 to 600 kHz, 2.5 volts peak-to-peak, with a 3.3 MHz signal added. If not, replace defective A2U4 or open A2L7 or A2L10.
- Move the oscilloscope probe to pin 14 of U8. The signal should be as in previous step, except attenuated 10 times. If not, check for open A2C48.
- Move the oscilloscope probe to pin 8 of U8. Set the Test Generator to 2.4 MHz and depress the DE-EM key. The signal should be a 300 to 500 kHz sqarewave, 3.5 volts peak-to-peak with a 12 Vdc component. If not, replace defective A2CR12 or A2U8.
- Move the oscilloscope probe to pin 3 of U9. Vary the Test Generator frequency until the waveform frequency is 400 kHz. The signal should be a 400 kHz sqarewave, approximately -0.5 to +2 volts. If not, check for open A2C57, A2CR12, A2CR11, or replace defective A2U9.

- Move the oscilloscope probe to pin 6 of U9. The signal should be TTL rectangular wave with a semi-period of 2.5 microseconds. If not, replace defective A2U9 or check for open A2R70 or A2C58.

- Move the oscilloscope probe to pin 7 of U6. Depress the PEAK - key. The signal should be a 400 kHz squarewave, 5.5 volts peak-to-peak. If not, replace defective A2U6 or check for open A2R65, or refer to LOGIC CIRCUITS troubleshooting below.

- Move the oscilloscope probe to pin 1 of U6. Depress the LP2 and PEAK + keys. The signal should be 0.0 Vdc approximately. If not, replace defective A2U6 or A2U7, or check for open A2R51, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the PEAK - and DE-EM keys, then vary the Test Generator frequency about 50 kHz above and below the initial setting. The ac ripple should be less than 400 millivolts peak-to-peak; the dc voltage will move above and below the baseline as the Test Generator frequency is changed. If not, replace defective A2U7, or check for open A2C47, or refer to LOGIC CIRCUITS troubleshooting below.

- Reset the Test Generator frequency until the dc level is again 0 Vdc. Depress the PEAK AVG key, then offset the Test Generator frequency 100 kHz. Initially, the signal should be 0.0 Vdc, and then drift approximately ± 2.4 volts. If not, replace defective A2C47, A2U7, or A2U6, or refer to LOGIC CIRCUITS troubleshooting below.

6-59. OSCILLATOR, DIGITAL

- 30. Move the oscilloscope probe to pin 2 of U3. Depress the LP1 key. The signal should be 5 Vdc approximately. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the LP2 key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the DE-EM key. The signal should be approximately 5 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Move the oscilloscope probe to pin 4 of U3. Depress the LP1 key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the LP2 key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the DE-EM key. The signal should be approximately 5 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

6-60. FREQUENCY CONTROL, DIGITAL

- Move the oscilloscope probe to pin 10 of U7. Depress the PEAK + key. The signal should be approximately 5 Vdc. If not, replace A2U7, or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the PEAK - key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the PEAK AVG key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Move the oscilloscope probe to pin 11 of U7. The signal should be approximately 0.0 Vdc. If not, replace A2U7, or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the PEAK - key. The signal should be approximately 5 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Depress the PEAK + key. The signal should be approximately 0.0 Vdc. If not, replace or repair W4 cable, or refer to LOGIC CIRCUITS troubleshooting below.

6-61. TROUBLESHOOTING, IF CIRCUITS

6-62. GENERAL. Procedures for checking the IF circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, FIGURES 8-4 and 8-5.

6-63. EQUIPMENT REQUIRED. The test equipment required is listed below. See TABLE 5-1 for critical specifications.

Oscilloscope .... HP 1740A
Signal Generator..................... Boonton 102E-19
Multimeter .... Fluke 8840A

6-64. PROCEDURE

- With the instrument power OFF, set position 5 of test switch A4S1 to the closed position. Turn instrument power ON.

NOTE

For the following oscilloscope measurements, use a high impedance probe with a very short ground connection.

- Connect the oscilloscope probe to pin 3 of U1. Depress the AM key. The signal should be 460 kHz and 1.9 volts peak-to-peak. If not, replace or repair W5, or refer to CALIBRATOR CIRCUITS troubleshooting.

- Move the oscilloscope probe to pin 6 of U1. The signal should be the same, except that the amplitude is doubled. If not, replace defective A3U11.

- Move the oscilloscope probe to pin 1 or 16 of U3. The signal should be a TTL signal at a frequency of 900 Hz. If not, replace or repair W5, or refer to CALIBRATOR CIRCUITS troubleshooting.

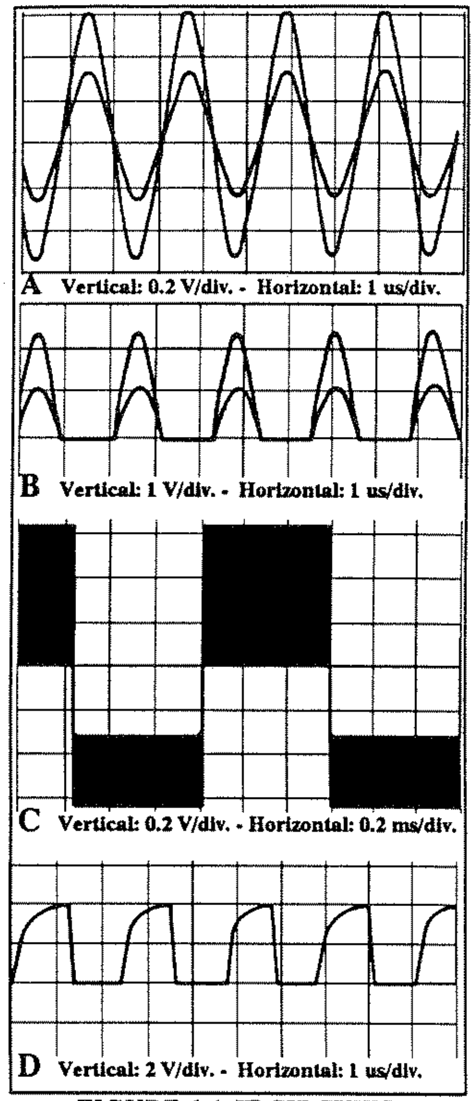


FIGURE 6-4. IF CIRCUITS, WAVEFORMS.

- Depress the FM key. The signal should be at TTL high. If not, refer to CALIBRATOR CIRCUITS troubleshooting.

- Move the oscilloscope probe to pin 6 of U3. Depress the AM key. The signal should be a 460 kHz sinewave modulated at a 900 Hz rate, 1.15 volts peak-to-peak. See FIGURE 6-4, waveform A. If not, replace defective A3U3, or check A3R7a through A3R7c.

- Move the oscilloscope probe alternately to pins 5 through 12 of U4. Pins 7 through 9 should be TTL high, all others should be low. If not, replace or repair W5, or refer to CALIBRATOR CIRCUITS troubleshooting.

- Move the oscilloscope probe to pin 4 of U4. The signal should be a 460 kHz sinewave modulated at a 900 Hz rate, 540 millivolts peak-to-peak. See FIGURE 6-4, waveform A. If not, isolate defective component by voltage or waveforma measurements. Check for open A3CR13, A3C4, A4C5, A3C6, A3R79, or replace A3U4.

- Move the oscilloscope probe to pin 6 of U5. The signal should be the same, except approximately 2.6 volts peak-to-peak. If not, isolate defective component by voltage or waveform measurements.

- Move the oscilloscope probe to the junction of A3C23 and A3CR6. The signal should be the same, except approximately 5.2 volts peak-to-peak. If not, isolate defective component by voltage or waveform measurements. Check for open A3C19, A3C22, A3C18, A3CR6, or A3CR7.

- Move the oscilloscope probe to the junction of A3R41 and A3CR7. The signal should be the same, except half-wave rectified, approximately 2.3 volts peak-to-peak. See FIGURE 6-4, waveform B. If not, isolate defective component by voltage or waveform measurements. Check for open A3C19, A3C22, A3C18, A3CR6, or A3CR7.

- Move the oscilloscope probe to pin 11 of U10. The signal should be 5 Vdc. If not, repair W6 cable, or refer to LOGIC CIRCUITS troubleshooting below.

- Move the oscilloscope probe to pin 8 of U9. The signal should be a 900 Hz squarewave with added 460 kHz sawtooth, approximately 1.3 volts peak-to-peak. See FIGURE 6-4, waveform C. If not, replace A3C27, A3R47, or A3U9.

- Move the oscilloscope probe to pin 3 of U10. The signal should be the same as previous step. If not, replace defective A3U10.

- Move the oscilloscope probe to pin 6 of U8. The signal should be a 460 kHz sinewave modulated at a 900 Hz rate, 2.6 volts peak-to-peak. If not, check for shorted A3CR9, A3CR10, or replace A3U8.

- Move the oscilloscope probe to the IF OUT connector. The signal should be the same as previous step. If not, replace defective A1P1, A1 W1, or A1J3.

- Move the oscilloscope probe to the collector of A3Q1. The signal should be a 460 kHz TTL squarewave. See FIGURE 6-4, waveform D. If not, isolate defective component by waveform or voltage measurement. Check A3Q1, A3Q2, A3CR3, A3CR4, and A3CR5.

- Move the oscilloscope probe to pin 1 of U7. The signal should be a TTL pulse about 0.9 microseconds wide. If not, check for defective timing components A3C20 and A3R33, or replace defective A3U7.

- Move the oscilloscope probe to pin 13 of U10. Depress the FM key. The signal should be a 460 kHz sawtooth, +0.5 to -2 volts. If not, isolate defective components by waveform and voltage measurements. Check for open A3C28, or refer to LOGIC CIRCUITS troubleshooting.

- Set position 6 of test switch S1-7 to the closed position, and position 5 open. Turn instrument power OFF, then ON. The front-panel display should contain 12.8. If not, refer to LOGIC CIRCUITS troubleshooting.

- Connect the oscilloscope probe to the junction of A4R27 and A4C28. Depress and hold the down arrow key until the display reads 2.0. The signal should be about 0.4 Vdc. If not, check for defective A1P5, A1W5, A1P8, A4R20, A4C15, or A4U20.

- Adjust scope so that the trace is positioned near the bottom of the display and set vertical senstitvity to 0.5 V/DIV. Depress and hold the up arrow key. The signal should change smoothly, without noticable steps, to about 4.2 Vdc. If not, repair or replace defective A3J1, A1P5, A1W5, A1P8, A4J2, or replace defective A3U4, or refer to LOGIC CIRCUITS troubleshooting.

- Set position 6 of test switch A4S1 to the open position. Turn instrument power OFF, then ON. Set the Test Generator to 30 MHz, -10 dBm, and 50% AM at a 1 kHz rate. Connect the oscilloscope probe to the junction of A3L3, and A3R3. The signal should be a 400 kHz sinewave with AM, 0.82 Volts peak-to-peak. If not, troubleshoot the IF filter circuit using waveform measurements.

- Move the oscilloscope probe to pin 6 of U2. The signal should be the same as previous step, except amplitude is 3.5 volts peak-to-peak. If not, troubleshoot input amplifier circuit using voltage and waveform measurements.

- Move the oscilloscope probe to pin 8 of U3. The signal should be TTL high. If not, check for defective W5, or replace defective U3, or refer to LOGIC CIRCUITS troubleshooting.

- Move the oscilloscope probe to pin 16 of U3. The signal should be TTL low. If not, check for defective W5, or replace defective U3, or refer to LOGIC CIRCUITS troubleshooting.

- Increase Test Generator level to + 13 dBm. Display should indicate 'IFHI'. If not, the problem is in RF, AF or LOGIC CIRCUITS.

- Decrease Test Generator level to -30 dBm. Display should indicate 'IFLO'. If not, the problem is in RF, AF or LOGIC CIRCUITS.

6-65. TROUBLESHOOTING, AF CIRCUITS

6-66. GENERAL. Procedures for checking the AF circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, FIGURES 8-7 and 8-8.

6-67. EQUIPMENT REQUIRED. The test equipment required is listed below. See TABLE 5-1 for critical specifications.

Oscilloscope............................ HP 1740A
Audio Analyzer........................ Boonton 1120
Multimeter............................... Fluke 8840A

6-68. PROCEDURE

- With the instrument power OFF, disconnect A1P1 from A3J3 and connect to A3TP1. Remove A3U10 from socket, and set positions 6 and 7 of test switch A4S1 to the closed position. Set the Audio Analyzer for 1 kHz at 106 millivolts and connect the HIGH output of the Analyzer to the IF OUT connector. Turn instrument power ON.

NOTE

For the following oscilloscope measurements, use a high impedance probe.

- Connect the oscilloscope probe to pin 13 of U11. Depress and RANGE 10 key. The signal should be a 1 kHz sinewave 300 millivolts peak-to-peak. If not, isolate defective component in the filter circuit A3U9c by waveform measurement. Refer to AF CIRCUITS, DIGITAL, if necessary.

- Change the Audio Analyzer frequency to about 72 kHz (104 kHz for Option -02). The signal should be a sinewave about 210 millivolts peak-to-peak. If not, isolate defective component in the filter circuit A3U9c by waveform measurement. Refer to AF CIRCUITS, DIGITAL, if necessary.

- Change the Audio Analyzer frequency back to 1 kHz. Connect the oscilloscope probe to pin 3 of U11. The signal should be a 1 kHz sinewave about 300 millivolts peak-to-peak. If not, replace defective A3U11. Refer to AF CIRCUITS, DIGITAL, if necessary.

- Depress the RANGE 100 key. The signal should be a 1 kHz sinewave about 30 millivolts peak-to-peak. If not, replace defective A3U11 or A3R59. Refer to AF CIRCUITS, DIGITAL, if necessary.

- Depress the RANGE 10 key. Connect the oscilloscope probe to pin 14 of U9. The signal should be a 1 kHz sinewave about 3.3 volts peak-to-peak. If not, replace defective A3U9, A3R61, or A3R63. Check for open decoupling capacitors.

- Connect the oscilloscope probe to pin 12 of U13. The signal should be a 1 kHz sinewave about 3.3 volts peak-to-peak. If not, replace defective A3U12, or A3U13. Check other components in U12a circuit.

- Change the Audio Analyzer frequency to 5 kHz. The signal should be a 5 kHz sinewave about 3.3 volts peak-to-peak. If not, replace defective A3U12 or A3U13. Check other components in U12a circuit.

- Change the Audio Analyzer frequency to 15 kHz (30 kHz for Option -01, 50 kHz for Option -02). The signal should be a sinewave about 2.3 volts peak-to-peak. If not, check A3R71 or A3C47.

- Change the Audio Analyzer frequency to 750 Hz. Connect the oscilloscope to pin 14 of U13. The signal should be a 750 Hz sinewave about 3.3 volts peak-to-peak. If not, replace defective A3U12 or A3U13. Also check other components in U12b circuit.

- Change the Audio Analyzer frequency to 3 kHz. The signal should be a 3 kHz sinewave about 2.4 volts peak-to-peak. If not, replace defective A3R68 or A3C44.

- Change the Audio Analyzer frequency to 50 Hz. Connect the oscilloscope to pin 15 of U13. The signal should be a 50 Hz sinewave about 3.3 volts peak-to-peak. If not, check for defective A3R69 or A3C45.

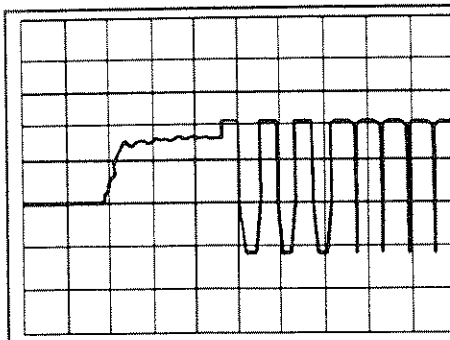
- Change the Audio Analyzer frequency to 212 Hz. The signal should be a 212 Hz sinewave about 2.4 volts peak-to-peak. If not, replace defective A3R69 or A3C45.

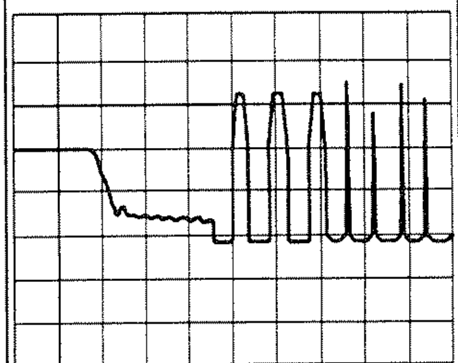
- Change the Audio Analyzer frequency to 5 kHz. Connect the oscilloscope to pin 11 of U13. The signal should be a 5 kHz sinewave about 2.4 volts peak-to-peak. If not, replace defective A3U13, or check for open/shorted capacitor, or open resistor.

- Change the Audio Analyzer frequency to 1 kHz. Depress the LP1 key. Connect the oscilloscope to pin 1 of A3J4. The signal should be a 1 kHz sinewave about 8.4 volts peak-to-peak. If not, replace defective A3U14. Check other components in A3U14 circuit.

- Connect the oscilloscope probe to pin 3 of U15. Depress the LP2 key. The signal should be a 1 kHz sinewave, squarewave modulated, about 3.3 volts peak-to-peak. If not, isolate defective component in A3U12-A3U15 circuit by waveform and voltage measurement.

- Connect the oscilloscope probe to pin 1 of A3J5. Depress the DE-EM key. The signal should be the same as the previous step, except 670 millivolts peak-to-peak. If not, replace defective A3U12, or check for shorted cable W7.


A Vertical: 0.5 V/div. - Horizontal: 10 ms/div.


B Vertical: 0.5 V/div. - Horizontal: 10 ms/div.

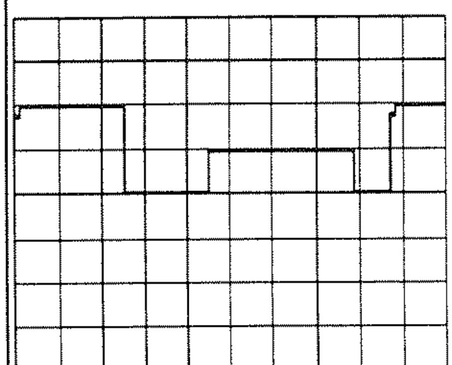

C Vertical: 0.5 V/div. - Horizontal: 50 ms/div.

FIGURE 6-5. AF CIRCUITS, WAVEFORMS.

- Depress the LP1 key. Connect the oscilloscope to the AF OUT connector. The signal should be a 1 kHz sinewave about 8.4 volts peak-to-peak. If not, replace defective A1P2, A1W2, or A1J4.

- Connect the oscilloscope probe to pin 1 of A4J5. The signal should be a 1 kHz sinewave, squarewave modulated, about 3.3 volts peak-to-peak. If not, replace defective W7 cable.

- Connect the oscilloscope probe to pin 10 of A4U23. The signal should be a CMOS signal. If not, refer to LOGIC CIRCUITS troubleshooting.

- Using a second probe, connect the oscilloscope to pin 6 of A4U25. Set trigger to CHAN A. Connect the Audio Analyzer HIGH input to the AF OUT connector and adjust the Audio Analyzer SOURCE for an ANALYZER indication of 2 Vrms at 50 Hz. The signal should be waveform A, FIGURE 6-5. If not, isolate defective components by waveform and voltage measurement. Check A4U22, A4U21, A4U23, or open A4CR4 or CR5.

- Connect the second oscilloscope probe to pin 6 of A4U24. The signal should be waveform B, FIGURE 6-5. If not, isolate defective components by waveform and voltage measurement. Check A4U22, A4U21, A4U24, or A4CR2 or CR3.
- Connect the oscilloscope probe to pin 3 of A4U22. The signal should be as waveform C, FIGURE 6-5. If not, replace defective A4U22, or refer to LOGIC CIRCUITS troubleshooting.
- Replace A3J3 and install A3U10.

6-69. AF CIRCUITS, VOLTMETER

- Turn instrument power OFF, set positions 5, 6, and 7 of test switch A4S1 to the closed position. Short pins 1 and 2 of A4JMP4.
- Check the logic levels on pins 9, 10, and 11 of A4U22. All pins should be near 5 Vdc. If not, refer to LOGIC CIRCUITS troubleshooting.
- Measure the dc voltage at the junction of A4R27 and A4C28. The voltage should be approximately 1.3 Vdc. If not, check for open pin 2 of cable W6.
- Move voltmeter probe to pin 3 of A4U22. The voltage should be approximately 1.3 Vdc. If not, replace A4U22.
- Move voltmeter probe to pin 7 of A4U10. The voltage should be approximately 2.8 Vdc. If not, replace A4U10.
- Open all positions of A4S1, then close positions 4 and 7 to bypass the self-check. Turn the power OFF then ON.

6-70. AF CIRCUITS, DIGITAL

- Connect the oscilloscope probe to pin 11 of A3U10. Depress the FM key. The signal should be CMOS logic low. If not, check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Depress the AM key. The signal should change to CMOS logic high. If not, check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Connect the oscilloscope probe to pin 11 of A3U11. Depress the RANGE 100 key. The signal should be CMOS logic high. If not, replace defective A3U11, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Depress the RANGE 10 key. The signal should change to CMOS logic low. If not, replace defective A3U11, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Connect the oscilloscope probe to pin 10 of A3U11. Turn instrument power OFF then ON. The signal should be CMOS logic low, then logic high when power is switched ON. If not, replace defective A3U11, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Connect the oscilloscope probe to pin 10 of A3U13. Depress, in turn, the LP1, LP2, and DE-EM keys. The CMOS logic signal should change from low to high to low as the keys are pressed. If not, replace defective A3U13, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Connect the oscilloscope probe to pin 9 of A3U13. Depress, in turn, the LP1, LP2, and DE-EM keys. The CMOS logic signal should change from low to low to high as the keys are pressed. If not, replace defective A3U13, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.
- Connect the oscilloscope probe to pin 9 of A3U15. A CMOS logic signal that changes from low to high at a low frequency. If not, replace defective A3U15, or check for defective A3J2, A1P6, A1W6, A1P9, or refer to LOGIC CIRCUITS troubleshooting.

6-71. TROUBLESHOOTING, CALIBRATOR CIRCUITS

6-72. GENERAL. Procedures for checking the calibrator circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, FIGURES 8-4, 8-5, 8-9 and 8-10.

6-73. EQUIPMENT REQUIRED. The test equipment required is listed below. See TABLE 5-1 for critical specifications.

Oscilloscope...............................HP 1740A

6-74. PROCEDURE

- Turn the instrument power OFF and set position 5 of test switch A4S1 to the closed position. Connect the oscilloscope probe to pin 9 of A4U3. The signal should be a TTL waveform with a period of 542 nanoseconds (1.84 MHz). If not, replace defective U3 or Y1.
- Move the oscilloscope probe to pin 15 of U3. The signal should be a TTL waveform with a period of 0.55 milliseconds. (1800 Hz). If not, replace U3.
- Move the oscilloscope probe to pin 18 of U4. 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 0.5 uSEC/DIV. The display should show one signal with a period of 4.4 divisions and one with a period of 5.4 divisions. If not, replace defective U4.
- The signals on pins 4 and 5 of U4 control the output signals on pins 17 and 18. The logic levels and corresponding outputs are tabulated below. Depress the AM key for line 2 and the FM key for line 3.

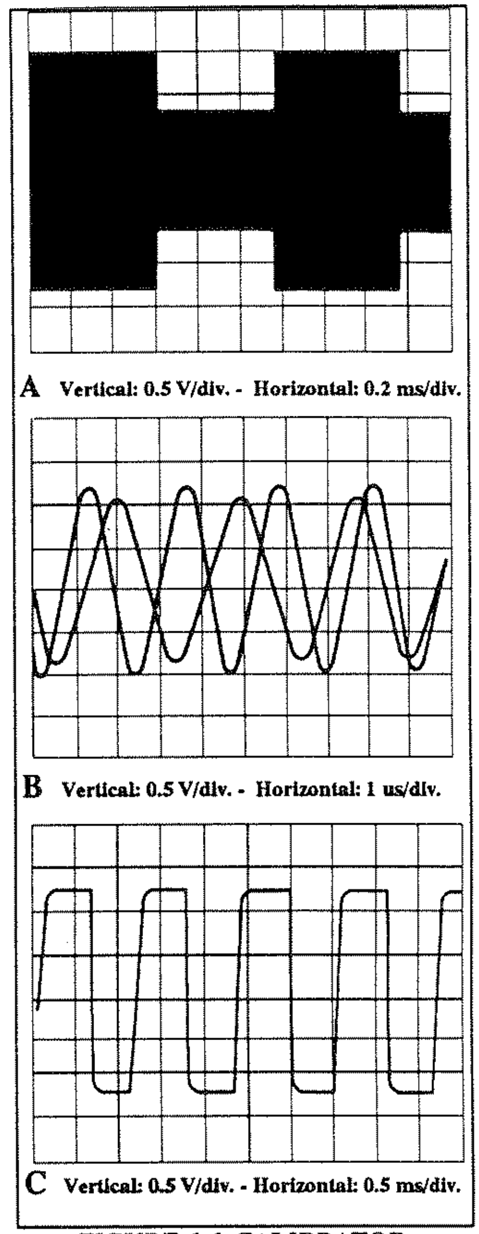


FIGURE 6-6. CALIBRATOR, WAVEFORMS.

Pin numbers:

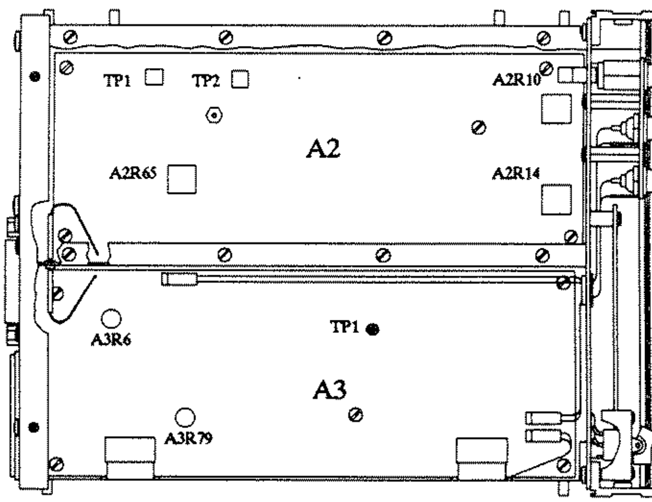
4	5	18	17
low	low	low	low
low	high	460 kHz	900 Hz
high	low	368/460 kHz	high
high	high	low	low

- Move the oscilloscope probe to pin 3 of A3U1. Depress the AM key. The signal should be a sine wave with an amplitude of 1.9 volts peak-to-peak and a period of 2.2 microseconds. If not, check for open A4L1-L2, A4C20-22, A4C24, or defective W5, or replace A3U1.
- Move the oscilloscope probe to pin 6 of A3U1. The signal should be as in the previous step, except the amplitude should be 3.8 volts peak-to-peak. If not, replace defective U1.
- Move the oscilloscope to the IF OUT connector. The signal should be waveform A, FIGURE 6-6. If not, refer to IF CIRCUITS troubleshooting above.
- Depress the FM key. The signal should be waveform B, FIGURE 6-6. If not, refer to IF CIRCUITS troubleshooting above or replace defective A4U4.

- Move the oscilloscope probe to the AF OUT connector. Depress the AM key. The signal should be waveform C, FIGURE 6-6. If not, refer to IF CIRCUITS troubleshooting above or AF CIRCUITS troubleshooting.
- Turn OFF instrument power and open all positions of A4S1.

6-75. ADJUSTMENTS. There are five adjustments associated with Model 8211 circuit operation. These are:

ADJUSTMENT	PURPOSE
A2R14	sampling bridge balance
A2R10	sampling bridge bias
A2R65	IF frequency centering
A3R6	IF frequency response
A3R79	IF gain centering



6-76. EQUIPMENT REQUIRED. The equipment required to make the adjustments is listed below. See TABLE 5-1 for critical specifications.

Oscilloscope	HP 1740A
Signal Generator	Boonton 102E

6-77. PROCEDURE

- Connect the oscilloscope input to the RF IN connector of the Modulation Meter with a shielded cable. Set the oscilloscope for 50 ohm input impedance, 5 mV/DIV vertical, and 0.2 uS /DIV timebase, and adjust A2R14 for a minimum indication.
- Set the signal generator to 2 MHz, 0 dBm, and about 100 kHz deviation at a 1 kHz rate. Set AM modulation to OFF and connect the generator to the modulation meter RF IN.
- Connect the oscilloscope to the AF OUT, then depress the AM, LP2, and RANGE 10 keys.
- Adjust A2R10 for minimum indication on the oscilloscope.
- Change the Test Generator frequency to 3.5 MHz. Wait until the IF frequency settles. Adjust A3R6 for minimum indication.
- Repeat steps 2 through 5 until the adjustment of either control increases the indication.
- Set the generator frequency to 400 kHz CW and 0 dBm.
- Monitor the dc voltage at pin 7 of A2U6, and adjust A2R65 for an indication of 0 + - 0.02 volts.
- Change the Test Generator level to approximately -29.5 dBm and turn off all modulation..
- If the Modulation Meter display indicates 'IFLO', slowly adjust A3R79 until a normal modulation display appears.

SECTION VII
PARTS LIST

7-1. INTRODUCTION

7-2. The replaceable parts for the Model 8211 are listed in TABLE 7-2. The replaceable parts list contains the reference symbol, description, manufacturer, and both the Boonton and manufacturer part numbers. TABLE 7-1 lists the manufacturer's federal supply code numbers.

TABLE 7-1. MANUFACTURERS FEDERAL SUPPLY CODE NUMBERS.

00853	Sangamo Electronics	31918	ITT Schadow, Inc.
01121	Allen Bradley	32575	AMP
01295	Texas Instruments	32997	Bourns
02114	Ferroxcube Corp.	33297	NEC
02735	RCA Solid State Division	33883	RMC
04222	AVX Ceramics Company	50316	Mini Systems Inc.
04713	Motorola Semiconductor	51406	Murata Corporation of America
04901	Boonton Electronics Corporation	51640	Analog Devices, Inc.
06383	Panduit Corporation	52464	OKI
06665	Precision Monolithics	54420	Dage - MTI
06776	Robinson Nugent, Inc.	54426	Buss Fuses
07263	Fairchild Semiconductor	54473	Panasonic
13812	Dialco Division of Amperex	56289	Sprague Electric Company
14655	Cornell-Dubilier	56708	Zilog, Inc.
14752	Electro Cube, Inc.	57582	Kahgan Electronics Corporation
15542	Mini Circuits Labs.	59474	Jeffers Electronics Inc.
17117	Electronics Molding Co.	61637	Kemet - Union Carbide
17856	Siliconix, Inc.	61935	Schurter
18324	Signetics Corporation	64537	Pyrofilm (KDI)
19505	Applied Eng'r. Products	71279	Cambridge Thermionics
19701	Mepco Electra	71450	CTS Corporation
20307	Arco - Micronics	73138	Beckman Instruments, Helipot Division
24226	Gowanda Electronics	75378	CTS Knight
27014	National Semiconductor	98291	Sealectro Corporation
27264	Molex, Inc.	S4217	United Chemicon, Inc.
27777	Varo Semiconductor	TOSH	Toshiba America, Inc.
28480	Hewlett-Packard Corporation	MAXI	Maxim Inc.
31313	Components Corporation	EPSO	Epson Inc.

TABLE 7-2. MODEL 8211 PARTS LIST.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
	MODEL 8211 MODULATION METER	04901	99402700A	1	99402700A
A1	REV: BB FRAME ASSY '8211'	04901	08271000A	1	08271000A
A2	PWA RF '8210/8211'	04901	08210801L	1	08210801L
A3	PWA '8210' IF-AF	04901	08210901J	1	08210901J
A4	PWA CPU '8211'	04901	08270100A	1	08270100A
A5	PWA DISPLAY 8211	04901	08211003A	1	08211003A
A6	'8210' CONN ASSY LINE SW	04901	08211501A	1	08211501A
A7	CHASSIS UNIT ASSY	04901	08211501A	1	08211400A
A8	'8210' SUB PANEL ASSY	04901	08210301A	1	08210301A
A9	REAR PANEL ASSY 8211	04901	08270500A	1	08270500A
W4-6	CABLE ASSY FLAT 16CKT 3.00L	04901	92006500A	3	92006500A
W7	CABLE ASSY WIRE 24GA 2C 8.25L	04901	57116100A	1	57116100A
W8	CABLE ASSY FLAT 16CKT 3.00L	04901	92006500A	1	92006500A
A2	PWA RF '8210/8211'	04901	08210801L	1	08210801L
C1	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C2	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C3	CAP CER CHIP 0.01uF 20% 50V	61637	C1210C103M5XAH	1	224210000
C4	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C5	CAP CER CHIP 680pF 10% 50V	61637	C1210C681K5XAH	1	224377000
C6	CAP CER 0.01uF 100V	33883	BT Z5U	1	224119000
C7	CAP MICA 100pF 1% 500V	14655	CD15FD101F	1	200045000
C8	CAP CER 0.01uF 100V	33883	BT Z5U	1	224119000
C9	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C10	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
C11	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C12	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C13	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
C15	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C17	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C18	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C19	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C20	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C21	CAP MICA 270pF 5% 50V	57582	KD5271J101	1	205045000
C22-26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	5	224268000
C27	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C28	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	1	205018000
C29	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C30	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C31	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C32	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	1	283334000
C33	CAP MICA 10pF 5% 300V	14655	CD5CC100J	1	205002000
C34	CAP MICA 22pF 5% 300V	14655	CD5EC220J	1	205036000
C35	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C36-37	CAP MICA 270pF 5% 50V	57582	KD5271J101	2	205045000
C38	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C39	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C40	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C41	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C42-43	CAP MICA 390pF 5% 500V	57582	KD15391J501	2	200108000
C44	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	1	283334000
C45-46	CAP MICA 270pF 5% 50V	57582	KD5271J101	2	205045000
C47	CAP MPC 1.0uF 10% 50V	14752	652A-1-A-105K	1	234152000
C48	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C50-51	CAP CER CHIP 0.1uF 10% 50V	51406	GRM422X7R10450VPB	2	224136000
C53	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C57	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
C58	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C59	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C60	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C61-63	CAP CER CHIP 0.1uF 10% 50V	51406	GRM422X7R10450VPB	3	224136000
C64	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	1	205018000
C65	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
CR1	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
CR2	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR3	DIODE SIG 5082-0180	28480	5082-100	1	530168000
CR4	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
CR5-6	DIODE SIG 1N914	01295	1N914	2	530058000
CR7-8	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	2	530174000
CR9-10	DIODE VARACTOR MV2115 SEL ITF	04713	MV2115	2	530760000
CR11-12	DIODE SIG 1N914	01295	1N914	2	530058000
CR13	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	1	530174000
J2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
L1	INDUCTOR 33uH 5%	59474	4465-2K	1	400310000
L2	INDUCTOR 0.72uH	04901	40041700A	1	40041700A
L3	INDUCTOR 4.7uH 10%	59474	4425-14K	1	400292000
L4	INDUCTOR 4.7uH 10%	24226	10/471	1	400384000
L5	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
L6	INDUCTOR 68uH 10%	24226	10/682	1	400411000
L7	INDUCTOR 39uH 10%	24266	10/392	1	400387000
L8	INDUCTOR 5.6uH 10%	24226	15/561	1	400308000
L9	INDUCTOR 68uH 10%	24226	10/682	1	400411000
L10	INDUCTOR 39uH 10%	24266	10/392	1	400387000
P1	CONNECTOR RIGHT ANGLE RF	98291	52-054-0000-220	1	479336000
P17	CONNECTOR PIN	71279	450-3367-01-03-00	1	479417000
Q1	TRANS NPN 2N3866	04713	2N3866	1	528116000
Q2	TRANS FET 2N4416 N-CHAN	17856	2N4416	1	528072000
Q3	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q4-5	TRANS NPN 2N3904	04713	2N3904	2	528071000
Q6	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q7	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
Q8	TRANS FET 2N4416 N-CHAN	17856	2N4416	1	528072000
Q9-10	TRANS NPN 2N3904	04713	2N3904	2	528071000
R1	RES MF 33.2 OHM 1% 1/4W	19701	5043ED33R20F	1	341150000
R2	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R3	RES CHIP 18 OHM 5% 1/2W	50316	WA-7PG-180JS	1	339996000
R4	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R5	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R6	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R7	RES MF 6.81K 1% 1/4W	19701	5043ED6K810F	1	341380000
R8-9	RES COMP 100 OHM 5% 1/8W	01121	BB1015	2	331058000
R10	RES VAR 50K 10% 0.5W	73138	72PR50K	1	311393000
R11	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R12	RES COMP 200 OHM 5% 1/8W	01121	BB2015	1	331065000
R13	RES MF 33.2 OHM 1% 1/4W	19701	5043ED33R20F	1	341150000
R14	RES VAR 10K 10% 0.5W	73138	72PR10K	1	311328000
R15	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R16	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R17	RES COMP 200 OHM 5% 1/8W	01121	BB2015	1	331065000
R18	RES MF 6.81K 1% 1/4W	19701	5043ED6K810F	1	341380000
R19-20	RES COMP 100 OHM 5% 1/8W	01121	BB1015	2	331058000
R21	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R22	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R23	RES MF 3.92K 1% 1/4W	19701	5043ED3K920F	1	341357000
R24	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R25	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R26	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R27	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R28	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R29	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R30	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R31	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
R32	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	1	341133000
R33	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R34	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
R35	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R36	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R37	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R38	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R39	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R40	RES MF 3.01K 1% 1/4W	19701	5043ED3K010F	1	341346000
R41	RES MF 357 OHM 1% 1/4W	19701	5043ED357R0F	1	341253000
R42	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R43	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R44	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	1	341465000
R45	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	1	341429000
R46	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	1	341465000
R47	RES MF 90.9K 1% 1/4W	19701	5043ED90K90F	1	341492000
R48	RES COMP 47 OHM 5% 1/8W	01121	BB4705	1	331050000
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 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R52	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R53	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R54-55	RES COMP 510 OHM 5% 1/8W	01121	BB5115	2	331075000
R56	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R57	RES MF 200K 1% 1/4W	19701	5043ED200K0F	1	341529000
R58	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R59	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R61	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R62	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R63A-D	RES NETWORK 3.3K 2% 0.9W 6pin	71450	750-61-R3.3K	1	34504500A
R64	RES MF 8.25K 1% 1/4W	19701	5043ED8K250F	1	341388000
R65	RES VAR 5K 10% 0.5W	73138	72PR5K	1	311308000
R66	RES COMP 13K 5% 1/8W	01121	BB1335	1	331109000
R67-68	RES COMP 6.8K 5% 1/8W	01121	BB6825	2	331102000
R69	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
R70	RES MF 24.3K 1% 1/4W	19701	5043ED24K30F	1	341437000
R71	RES MF 39.2K 1% 1/4W	19701	5043ED39K20F	1	341457000
R72-73	RES COMP 200 OHM 5% 1/8W	01121	BB2015	2	331065000
R75-76	RES COMP 330 OHM 5% 1/8W	01121	BB3315	2	331070000
R77	RES MF 33.2 OHM 1% 1/4W	19701	5043ED33R20F	1	341150000
R78-79	RES COMP 100 OHM 5% 1/8W	01121	BB1015	2	331058000
R80	RES COMP 820 OHM 5% 1/8W	01121	BB8215	1	331080000
R81	RES MF 3.3K 5% 1/8W	54473	ERD-10-T-J-332	1	335750000
R82-83	RES COMP 1K 5% 1/8W	01121	BB1025	2	331082000
R84-85	RES COMP 220 OHM 5% 1/8W	01121	BB2215	2	331066000
T1	XFORMER RF (PULSE)	04901	41009000B	1	41009000B
T2	XFORMER RF (BALANCE)(T1-1-X65)	15542	T1-1	1	410089000
TP1-2	CONN M 2 CKT ST .1CT	27264	22-10-2021	2	477361000
U1	IC 74ALS74 DUAL FLIP FLOP	01295	SN74ALS74N	1	534281000
U2	IC 74LS163 4 BIT COUNTER	01295	SN74LS163AN	1	534279000
U3	IC 74LS00 2 INP POS NAND	01295	SN74LSOON	1	534167000
U4	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U5	IC 357N OP AMP	27014	LF357N	1	535096000
U6	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
U7	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	1	534209000
U8	IC 10116P TRIP LINE REC P-DIP	04713	MC10116FN	1	53467001A
U9	IC 74LS122 MONOSTABLE MULTIVBT	01295	SN74LS122N	1	534280000
XQ2	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XQ8	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	1	473051000
XU1	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU3	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
XU4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU5-6	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000
XU7-8	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU9	SOCKET IC 14 PIN	06776	ICN-143-S3-G	1	473019000
A3	PWA '8210' IF-AF	04901	08210901J	1	08210901J
C1	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
C2	CAP MICA 240pF 1% 500V	00853	D10FD241F	1	200124000
C3	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C4	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C5	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
C6	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	1	283334000
C7	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C8	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
C9	CAP MICA 150pF 5% 100V	57582	KD5151J101	1	205009000
C10	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C11	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C12	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
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% 25V	51406	DD312E10Y5P104M25V	1	224364000
C17	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C18	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C19	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C20	CAP MICA 39pF +-0.5pF 300V	57582	KD50390F301	1	205049000
C21	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C22	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C23	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C24	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C25-26	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	2	283334000
C27-28	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	2	205018000
C29	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C30	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C31-32	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C33-34	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	2	283334000
C35	CAP MICA 500pF 1% 500V	14655	CD15FD501F	1	200123000
C36	CAP MICA 120pF 1% 50V	20307	DM5-FY121F	1	205050000
C37	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C38-39	CAP MICA 1000pF 1% 100V	51406	DM15-102F	2	200113000
C40	CAP MICA 240pF 1% 500V	00853	D10FD241F	1	200124000
C41	CAP MICA 200pF 2% 500V	14655	CD15FD201G	1	200053000
C42	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C43	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C44	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	1	234142000
C45	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C46	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C47	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	1	234142000
C48	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C49-50	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	2	224364000
C51	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C52	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C53	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
CR1-2	DIODE SIG 1N914	01295	1N914	2	530058000
CR3-7	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	5	530174000
CR8-13	DIODE SIG 1N914	01295	1N914	6	530058000
CR14-15	DIODE SIG 1N914	01295	1N914	2	530058000
J1-2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
J3-5	HEADER 2 PIN RT ANGLE	06383	HFAS100-2-C	3	477367000
L1	INDUCTOR 100uH 5%	59474	1315-12J	1	400295000
L2	INDUCTOR 91uH 5%	59474	1315-11J	1	400416000
L3	INDUCTOR 20uH 5%	59474	4445-6J	1	400258000
L4	INDUCTOR 150uH 5%	59474	1315-16J	1	400415000
L5	INDUCTOR VK200/20-4B	02114	VK-200-20/4B	1	400409000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
L6-9	INDUCTOR 5.6uH 10%	24226	15/561	4	400308000
P16	CONNECTOR PIN	71279	450-3367-01-03-00	1	479417000
Q1	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q2	TRANS PNP 2N3906	04713	2N3906	1	528076000
Q3	TRANS NPN 2N3904	04713	2N3904	1	528071000
Q4-5	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q6	TRANS NPN 2N3904	04713	2N3904	1	528071000
R1	RES COMP 330 OHM 5% 1/8W	01121	BB3315	1	331070000
R2	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R3	RES MF 221 OHM 1% 1/4W	19701	5043ED221R0F	1	341233000
R4	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 100 OHM 10% 0.5W	32997	3329H-1-101	1	311406000
R7	RES NETWORK 500 OHM 0.5% 0.5W	73138	694-3-R500D	1	345035000
R8	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R9	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R10	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R11-12	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R13	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R14	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R15	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R16	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R17	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000
R18	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R19	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R20	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R21	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R22	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	1	341265000
R23	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	1	341317000
R24	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R25	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R26	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R27	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R28	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R29	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	1	341200000
R30	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R31	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R32	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R33	RES MF 39.2K 1% 1/4W	19701	5043ED39K20F	1	341457000
R34	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R35-36	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	2	341265000
R37	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R38	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R39	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	1	341376000
R40	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R41	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R42	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R43	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R44	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R45	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R46	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R47-48	RES MF 52.3K 1% 1/4W	19701	5043ED52K30F	2	341469000
R50-52	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R53	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	1	341417000
R55	RES MF 30.1K 1% 1/4W	19701	5043ED30K10F	1	341446000
R56	RES MF 604 OHM 1% 1/4W	19701	5043ED604R0F	1	341275000
R57	RES MF 13.3K 1% 1/4W	19701	5043ED13K30F	1	341412000
R58	RES MF 8.87K 1% 1/4W	19701	5043ED8K870F	1	341391000
R59	RES MF 9.000K 0.1% 1/4W	64537	PME55-T9	1	324354000
R60	RES MF 1.000K 0.1% 1/8W	64537	PME55-T9	1	324241000
R61	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R62	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R63	RES MF 26.7K 1% 1/4W	19701	5043ED26K70F	1	341441000
R64	RES MF 182K 1% 1/4W	19701	5043ED182K0F	1	341525000
R65	RES MF 16.9K 1% 1/4W	19701	5043ED16K90F	1	341422000
R66	RES MF 73.2K 1% 1/4W	19701	5043ED73K20F	1	341483000
R67	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R68	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R69	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	1	341384000
R70	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R71	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R72	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	1	341468000
R73	RES MF 1.54K 1% 1/4W	19701	5043ED1K540F	1	341318000
R74	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R75	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
R76	RES MF 604 OHM 1% 1/4W	19701	5043ED604R0F	1	341275000
R77	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R78	RES MF 511K 1% 1/4W	19701	5043ED511K0F	1	341568000
R79	RES VAR 1K 10% 0.5W	32997	3329H-1-102	1	311404000
TP1	CONN M 2 CKT ST .1CT	27264	22-10-2021	1	477361000
U1	IC 356P OP AMP	27014	LF356N	1	535907000
U2	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
U3	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U4	D/A CONVERTER DAC-08EP	06665	DAC-08EP	1	421037000
U5	IC 5534AN OP AMP	18324	NE5534AN	1	535061000
U6	IC 74LS00 2 INP POS NAND	01295	SN74LSOON	1	534167000
U7	IC 74121 MULTIVIBRATOR TI ONLY	01295	SN74121N	1	534038000
U8	IC 356P OP AMP	27014	LF356N	1	535907000
U9	IC TL074CN OP AMP QUAD	01295	TL074CN	1	535082000
U10-11	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	2	534209000
U12	IC TL074CN OP AMP QUAD	01295	TL074CN	1	535082000
U13	IC 4052B MULTIPLEXER	02735	CD4052BE	1	534140000
U14	IC 356P OP AMP	27014	LF356N	1	535907000
U15	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	1	534209000
XU2	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XU6-7	SOCKET IC 14 PIN	06776	ICN-143-S3-G	2	473019000
XU10	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A4	PWA CPU '8211'	04901	08270100A	1	08270100A
BT1	CELL LITHIUM 3V	54473	BR2325-1HB	1	556007000
C1	CAP TANT 56uF 10% 6V	56289	196D566X9006KA1	1	283228000
C2-3	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C7-8	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	2	224268000
C10-17	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	8	224268000
C18	CAP MICA 1000pF 1% 100V	51406	DM15-102F	1	200113000
C19	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C20	CAP MICA 1100pF 5% 100V	14655	CD15-112J	1	200111000
C21	CAP MPC 0.002uF 2% 50V	14752	652A-1-A-202G	1	234140000
C22	CAP MICA 1100pF 5% 100V	14655	CD15-112J	1	200111000
C23	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C24	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
C25	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C26	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C27	CAP MICA 300pF 5% 50V	14655	CD5FY301J	1	205026000
C29	CAP TANT 1.0uF 10% 35V	56289	199D105X9035AA2	1	283216000
C30-31	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C32-33	CAP PE 0.1uF 10% 100V	19701	719A1CA104PK101SA	2	234080000
C34-35	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C38-40	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C41	CAP EL 4700uF 20% 16V	S4217	SM-16-VB-4700M	1	283352000
C42-43	CAP EL 2200uF 20% 35V	57582	KSM-2200-35	2	283351000
C44-46	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	3	224270000
C47-49	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	3	283293000
C50	CAP TANT 0.47uF 20% 35V	56289	196D474X0035KA1	1	283324000
C51	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	1	283293000
CR2	DIODE SIG FDH-300	27014	FDH300	1	530052000
CR3	DIODE SIG 1N914	01295	1N914	1	530058000
CR4	DIODE SIG FDH-300	27014	FDH300	1	530052000
CR5	DIODE SIG 1N914	01295	1N914	1	530058000
CR6-7	DIODE BRIDGE VM-18	27777	VM-18	2	532031000
CR8-9	DIODE SIG 1N4001	04713	1N4001	2	530151000
CR10	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	1	530146000
CR11	DIODE SIG 1N4001	04713	1N4001	1	530151000
CR12	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	1	530146000
CR13-18	DIODE SIG 1N4001	04713	1N4001	6	530151000
J5	CONN M 02 CKT ST POLZ .1CT	06383	MPSS100-2-A	1	47740702A
J6	HEADER 5 PIN STRAIGHT	06383	MPSS156-5-D	1	477345000
J7	CONN M 02 CKT ST .1CT	06383	MFSS100-2-A	1	47742002A
J8	CONN M 24 CKT HDR DBL ROW .1CT	06776	NSH-24DB-S2-TG	1	47742224A
L1-L2	INDUCTOR 150uH 5%	59474	1315-16J	2	400415000
L3-L4	INDUCTOR 100uH 10%	59474	1310-16J	2	400295000
R1	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	1	341300000
R2-3	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	2	341400000
R4	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
R5-7	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R9	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R10	RES MF 3.32K 1% 1/4W	19701	5043ED33K20F	1	341350000
R12	RES MF 11.0K 1% 1/4W	19701	5043ED11K00F	1	341404000
R13	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R14	RES MF 4.22K 1% 1/4W	19701	5043ED4K220F	1	341360000
R15	RES MF 63.4K 1% 1/4W	19701	5043ED63K40F	1	341477000
R16	RES MF 68.1K 1% 1/4W	19701	5043ED68K10F	1	341480000
R17	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R18-19	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	2	341433000
R20	RES MF 11.0K 1% 1/4W	19701	5043ED11K00F	1	341404000
R22-23	RES MF 750K 1% 1/4W	19701	5043ED750K0F	2	341584000
R24	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	1	341433000
R26	RES MF 5.62K 1% 1/4W	19701	5043ED5K620F	1	341372000
R28	RES MF 33.2K 1% 1/4W	19701	5043ED33K20F	1	341450000
R29	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R30	RES MF 2.49K 1% 1/4W	19701	5043ED2K490F	1	341338000
R31	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R32	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R33	RES MF 33.2K 1% 1/4W	19701	5043ED33K20F	1	341450000
R34	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	1	341433000
R35	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	1	341229000
R36-37	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R38	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	1	341433000
R39	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
R40	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	1	341433000
R41	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R43	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	1	341246000
R44	RES MF 750 OHM 1% 1/4W	19701	5043ED750R0F	1	341284000
RN1	RES NETWORK 3K/6.2K 2% 2.7W	73138	L105-5-R3K/6.2K	1	345031000
RN2	RES NETWORK 10K 2% 1.5W	71450	750-101-R3.3K	1	345023000
RN3-4	RES NETWORK 10K 2% 1.5W	71450	750-101-R10K	2	345038000
RN5	RES NETWORK 3.3K 2% 2W 8pin	71450	750-81-R3.3K	1	345017000
RN6	RES NETWORK 22 OHM +-2 OHM 2W	01121	316B-220	1	345034000
RN7	RES NETWORK 10K .1% 1.5W 16pin	73138	698-3R10KD	1	345010000
S1	SWITCH SLIDE DIP SPST X 7	75378	206-7-LP	1	46530007A
TP4-5	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	2	48330600A
T11	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	1	48330600A
TP15	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	1	48330600A
U3	IC 4040B COUNTER/DIVIDER	02735	CD4040BE	1	534275000
U4	IC PAL CALIBRATOR (18CV8)	04901	53473300A	1	53473300A
U5	IC 191 12 BIT SAMP ADC LOW PWR	MAXIM	MAX191	1	53473000A
U7	IC Z80 MICROPRCS 6 MHz CMOS	56708	Z84C00-06PE	1	53440906A
U8	IC PROGRAMMER 27C256	04901	53473400A	1	53473400A
U9	IC PAL MEM DECODER (18CV8)	04901	53473100A	1	53473100A
U10	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
U11	IC PAL I/O DECODER (18CV8)	04901	53473200A	1	53473200A
U12	IC 71055 INTERFACE	52464	MSM82C55A-5RS	1	53441100A
U13	IC TC 55257 PL-10	TOSHI	TC55257APL-10	1	53449400A
U14	IC 71055 INTERFACE	52464	MSM82C55A-5RS	1	53441100A

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
U15	IC 691 MICRO SUPERVISORY CKT	MAXIM	MAX691A	1	53472900A
U16	IC UDN2983A SOURCE DRIVER	56289	UDN2983A	1	534255000
U17	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U18	IC 9914ANL IEEE BUS PROCESSOR	01295	TMS9914ANL	1	534288000
U19	IC 75160 IEEE BUS TRANSCEIVER	01295	SN75160BN	1	534286000
U20	IC 75161 IEEE BUS TRANSCEIVER	01295	SN75161BN	1	534287000
U21	IC TL072CP DUAL OP AMP	01295	TL072CP	1	535092000
U22	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	1	534209000
U23	IC 4052B MULTIPLEXER	02735	CD4052BE	1	534140000
U24-25	IC 3080E OP AMP	02735	CA3080E	2	535091000
U26-28	IC UA7805UC VOLT REG	07263	uA7805UC	2	53511700A
U29	IC 79M05 VOLT REG	07263	uA79MO5AUC	1	535093000
U30	IC 324N QUAD OP AMP	27014	LM324N	1	535068000
U31	IC REF-01CP VOLTAGE REFERENCE	06665	REF-01CP	1	535116000
XJ1-4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	4	473042000
XU4	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU5	SOCKET IC 24 PIN DIP 300 MIL	32575	2-641932-4	1	47308824A
XU7	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU8	SOCKET IC 28 PIN	06776	ICN-286-S4-G	1	473044000
XU9	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU11	SOCKET IC 20 PIN	06776	ICN-203-S3-G	1	473065000
XU12	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU13	SOCKET IC 28 PIN	06776	ICN-286-S4-G	1	473044000
XU14	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
XU18	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	1	473052000
Y1	CRY OSC 3.6864 MHz 14 PIN DIP	EPSON	SG51K3.6864	1	54705000A
A5	PWA DISPLAY 8211	04901	08211003A	1	08211003A
CR1	LED YELLOW DIFF 5082-4684	28480	HLMP-1401	1	536034000
CR2-7	LED RED DIFF 5082-4684	28480	HLMP-1301	6	536024000
CR8-11	DIODE SIG 1N914	01295	1N914	4	530058000
DS1	DISPLAY NUMERIC 5082-7656 ONLY	28480	5082-7656-SO2	1	536812000
DS2-4	DISPLAY NUMERIC 5082-7651	28480	5082-7651-S02	3	536811000
J1	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
P13	CONN F 02 CKT .1 SP 24 AWG	06383	CE100F-24-2-C	1	479418000
S1-11	SWITCH PUSHBUTTON SPST	31918	220075 Type D7	11	465287000
XDS1-4	SOCKET IC 14 PIN	06776	ICN-143-S3-G	4	473019000
A6	'8210' CONN ASSY LINE SW	04901	08211501A	1	08211501A
P15	CONN HOUSING 4 PIN	27264	03-06-2043	1	477306000
S2	SWITCH ROCKER DPDT	13812	572-2121-0103-010	1	465286000
A8	'8210' SUB PANEL ASSY	04901	08210301A	1	08210301A
J2	CONNECTOR "SMB" 50 OHM	19505	2019-7511-000	1	477305000
J3-4	CONN F COAX BNC	54420	UG-625B/U	2	479123000
W1	CABLE ASSY WIRE 24GA 2C 11.50L	04901	57116200B	1	57116200B
W2	CABLE ASSY WIRE 24GA 2C 6.75L	04901	57116000A	1	57116000A

TABLE 7-2. MODEL 8211 PARTS LIST Continued.

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MFGR PART NO.	QTY	BEC PART NO.
A9	REAR PANEL ASSY 8211	04901	08270500A	1	08270500A
C36-37	CAP CER 0.001uF 20% 1000V	33883	B W/FDCL	2	224229000
F1	FUSE 1/4A (0.25A) 250V SLO-BLO	54426	MDL-1/4A	1	545511000
P14	CONNECTOR 5 CIRCUIT	06383	CE156F24-5-C	1	479394000
T1	TRANSFORMER POWER	04901	44610100A	1	44610100A
J1	POWER MODULE	61935	KE16.5100.105	1	47748000A
FH1	FUSE DRAWER	61935	4305.0017	1	48212000A
J1	VOLTAGE SELECTOR INSERT	61935	4305.0048.01	1	48336900A

SECTION VIII
SCHEMATIC DIAGRAMS

TABLE 8-1. LIST OF SCHEMATIC DIAGRAMS.

Figure		Page
FIGURE 8-1.	Main Frame Schematic Diagram.	8-3
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FIGURE 8-15.	Display/Keyboard A12, Schematic Diagram.	8-17

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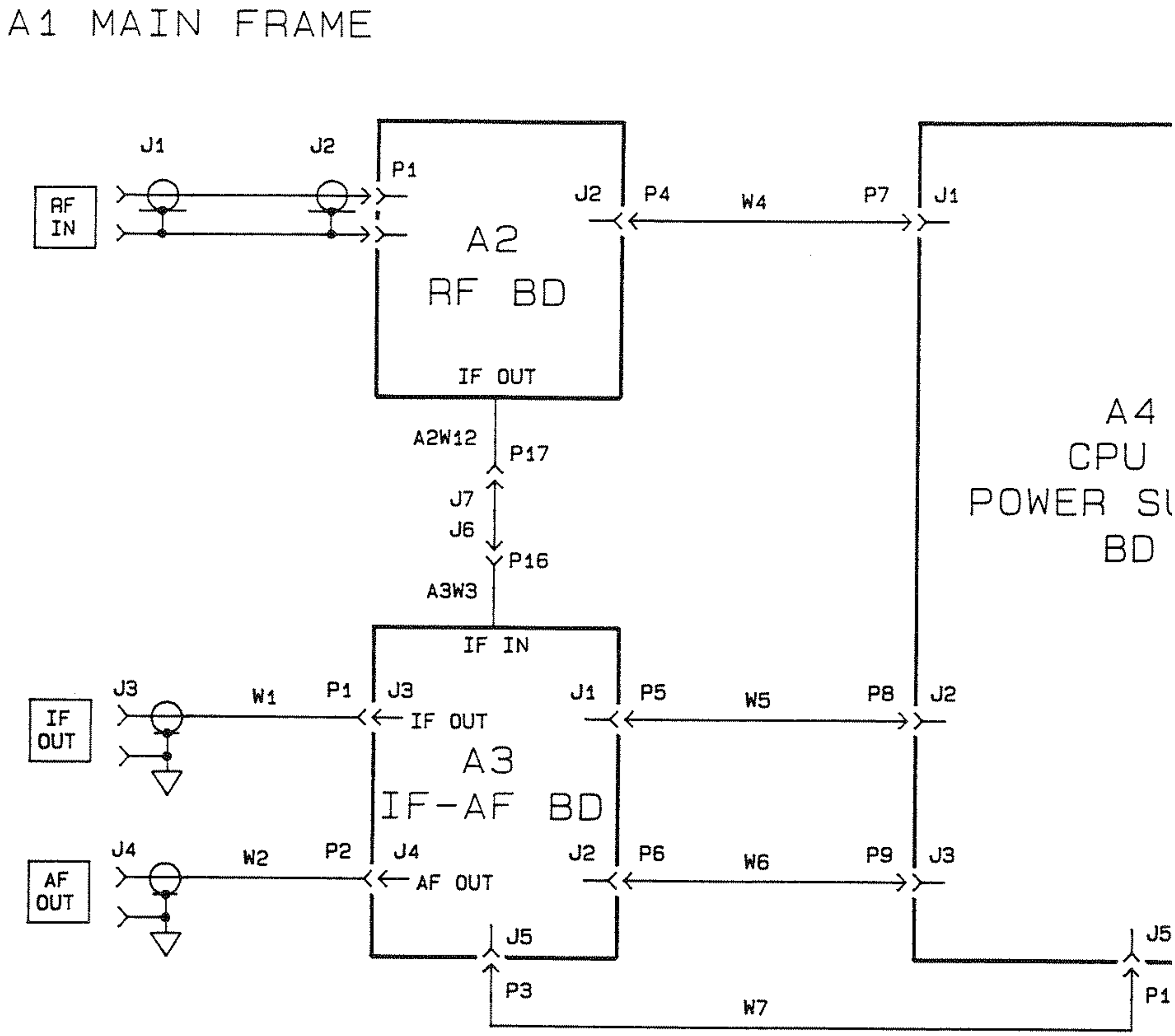
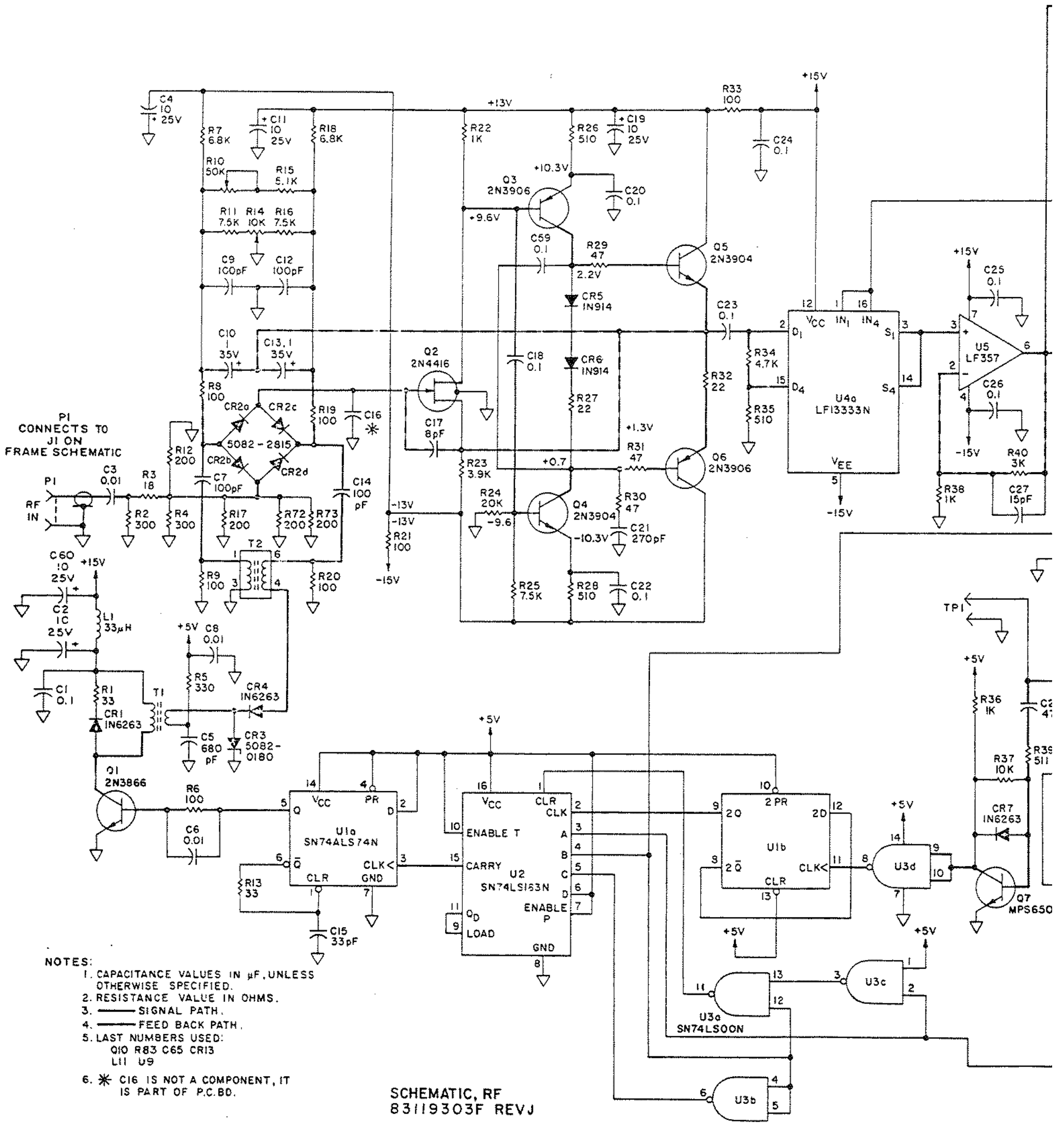
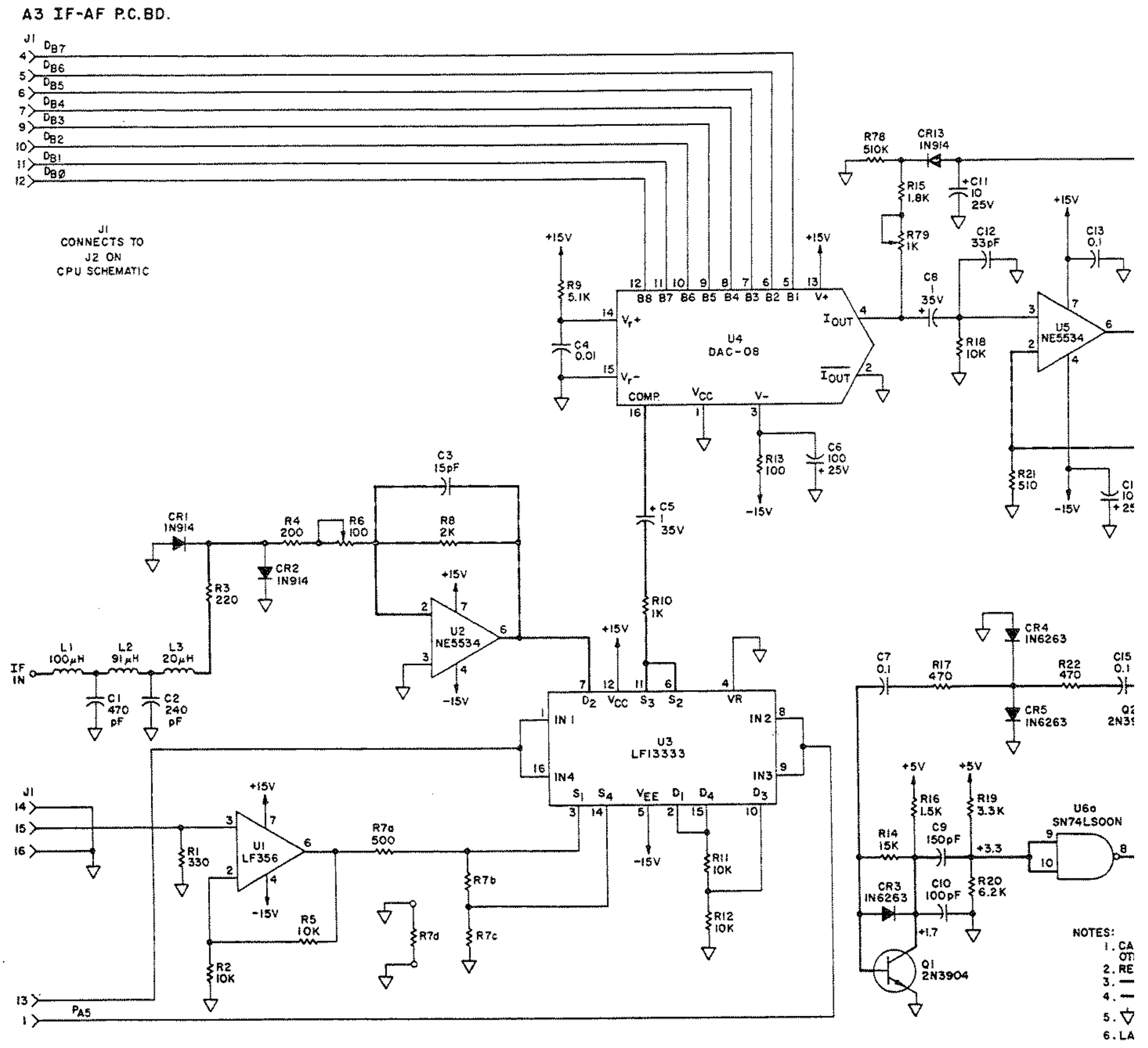


SCHEMATIC, MAIN FRAME
83119309A REV B

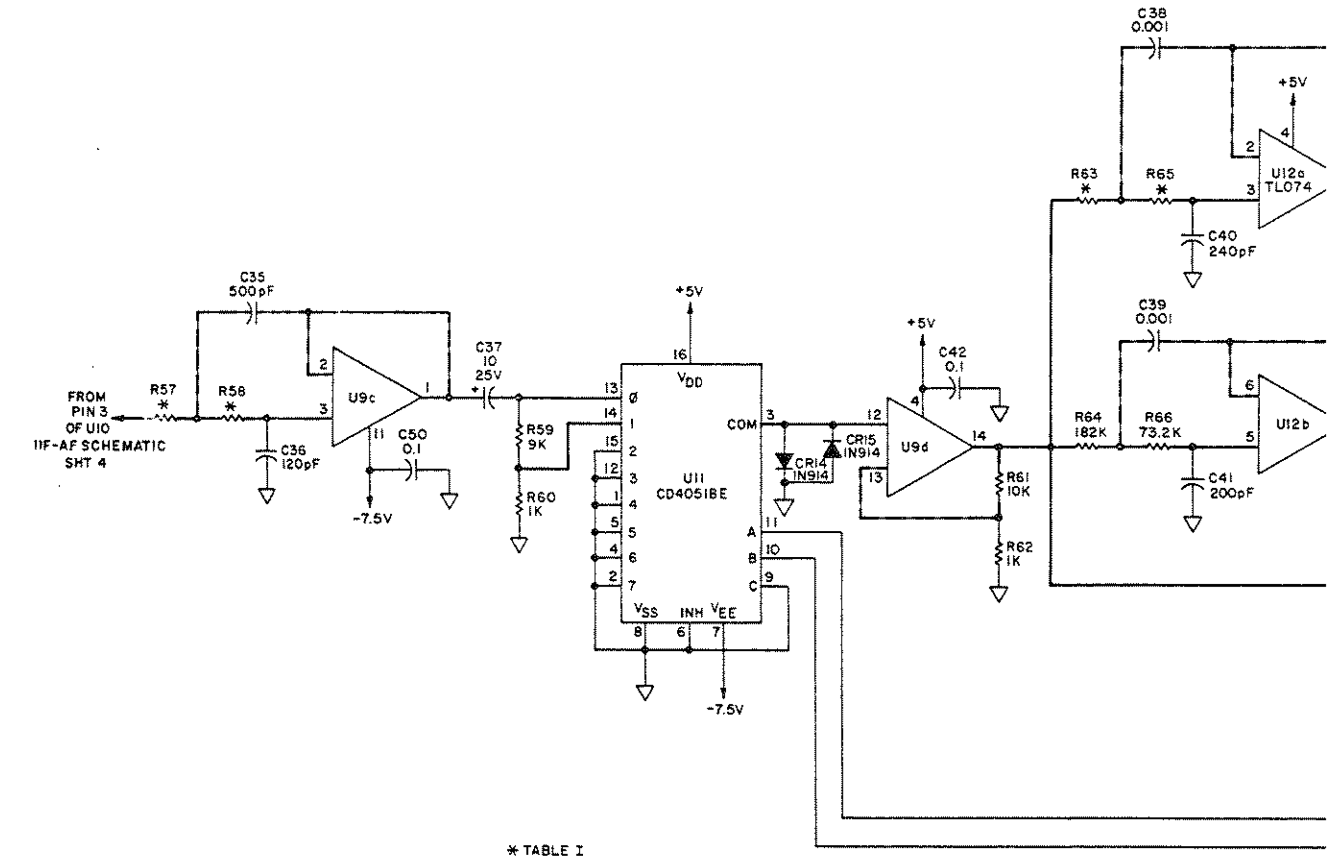
A2 RF P.C.BD.


P1 CONNECTS TO J1 ON FRAME SCHEMATIC
RF IN
Q1 2N3866
Q2 2N4416
Q3 2N3906
Q4 2N3904
Q5 2N3904
Q6 2N3906
Q7 MPS650
5082-2815
U1a SN74ALS74N
U2 SN74LS163N
U1b
U3a SN74LS00N
U3b
U3c
U3d
U4a LF13333N
U5 LF357
T1
T2
TP1
+15V
+13V
+5V
-15V
-13V
NOTES:
1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUE IN OHMS.
3. SIGNAL PATH.
4. FEED BACK PATH.
5. LAST NUMBERS USED: Q10 R83 C65 CR13 L11 U9
6. ✳ C16 IS NOT A COMPONENT, IT IS PART OF P.C.BD.
SCHEMATIC, RF
83119303F REVJ



SCHEMATIC, IF-AF
83119304A REV. F

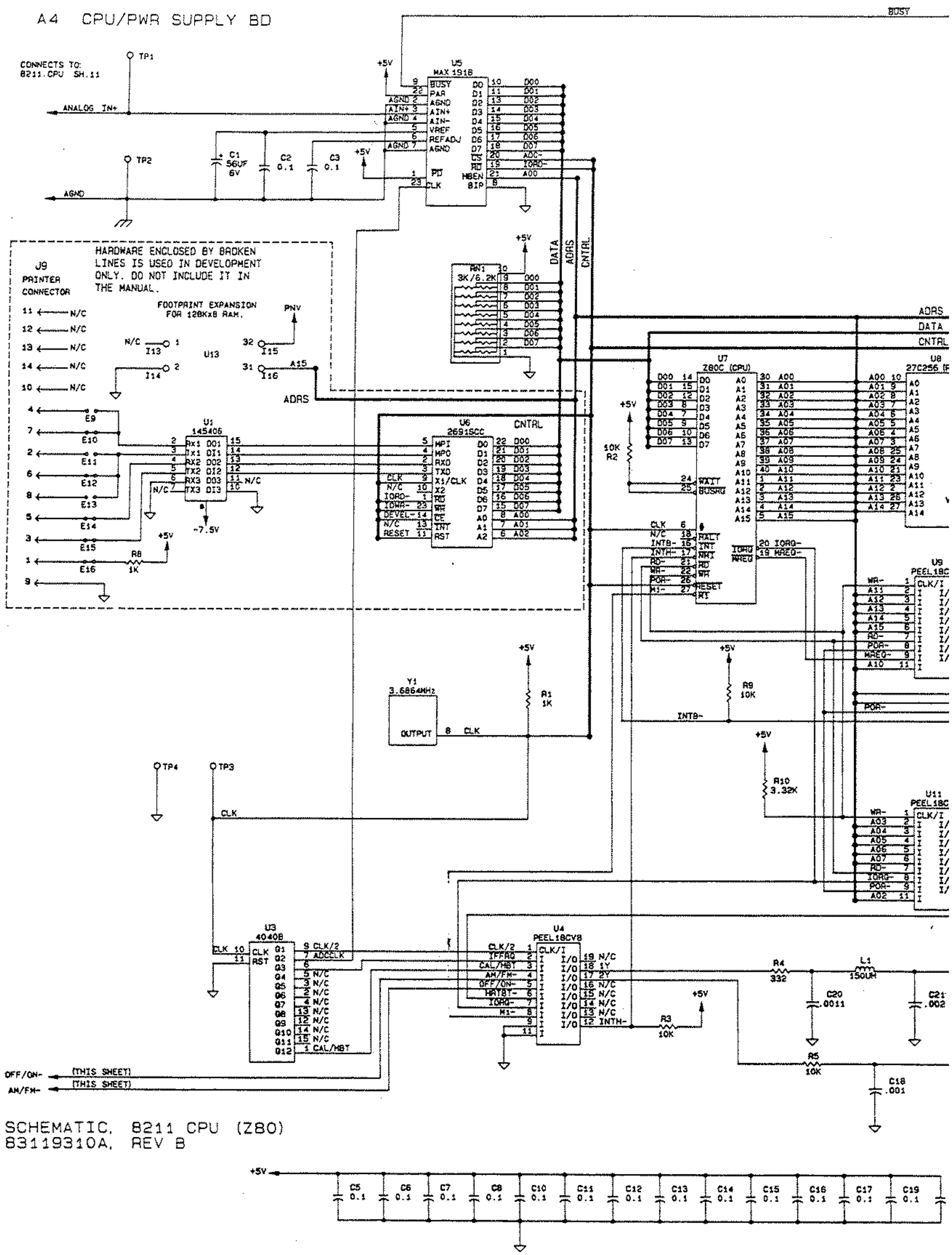
A3 IF-AF P.C.BD.



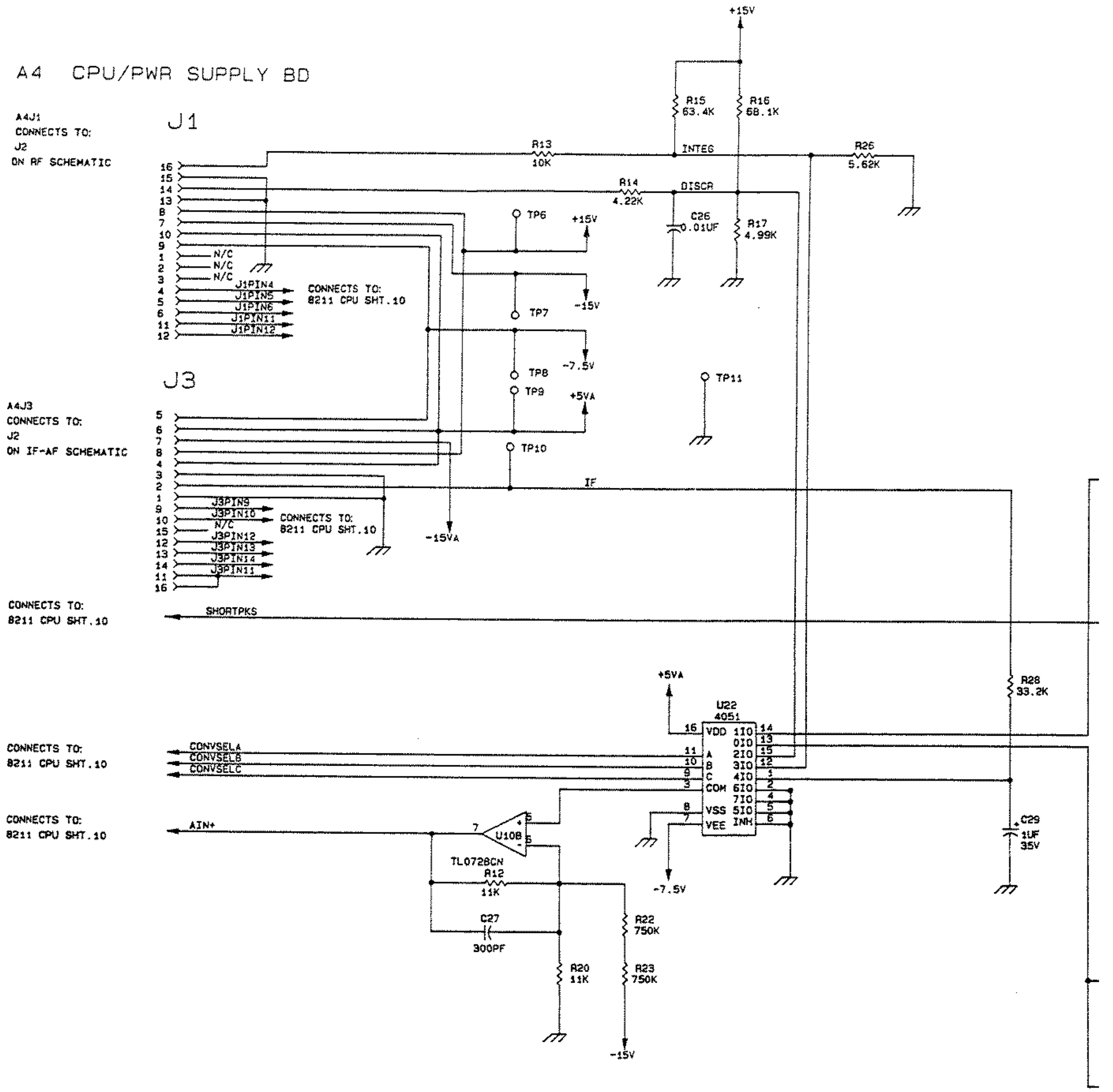
* TABLE I

REF DES.	8210	8210-01	8210-S/1	8211	8211-01	8211-02
R57	13.3K	13.3K	10K	13.3K	13.3K	10K
R58	8.87K	8.87K	6.81K	8.87K	8.87K	6.81K
R63	26.7K	12.7K	7.32K	26.7K	12.7K	7.32K
R65	16.9K	8.25K	4.99K	16.9K	8.25K	4.99K
R71	1K	499	287	1K	499	287

SCHEMATIC IF-AF
83119305A REV. G

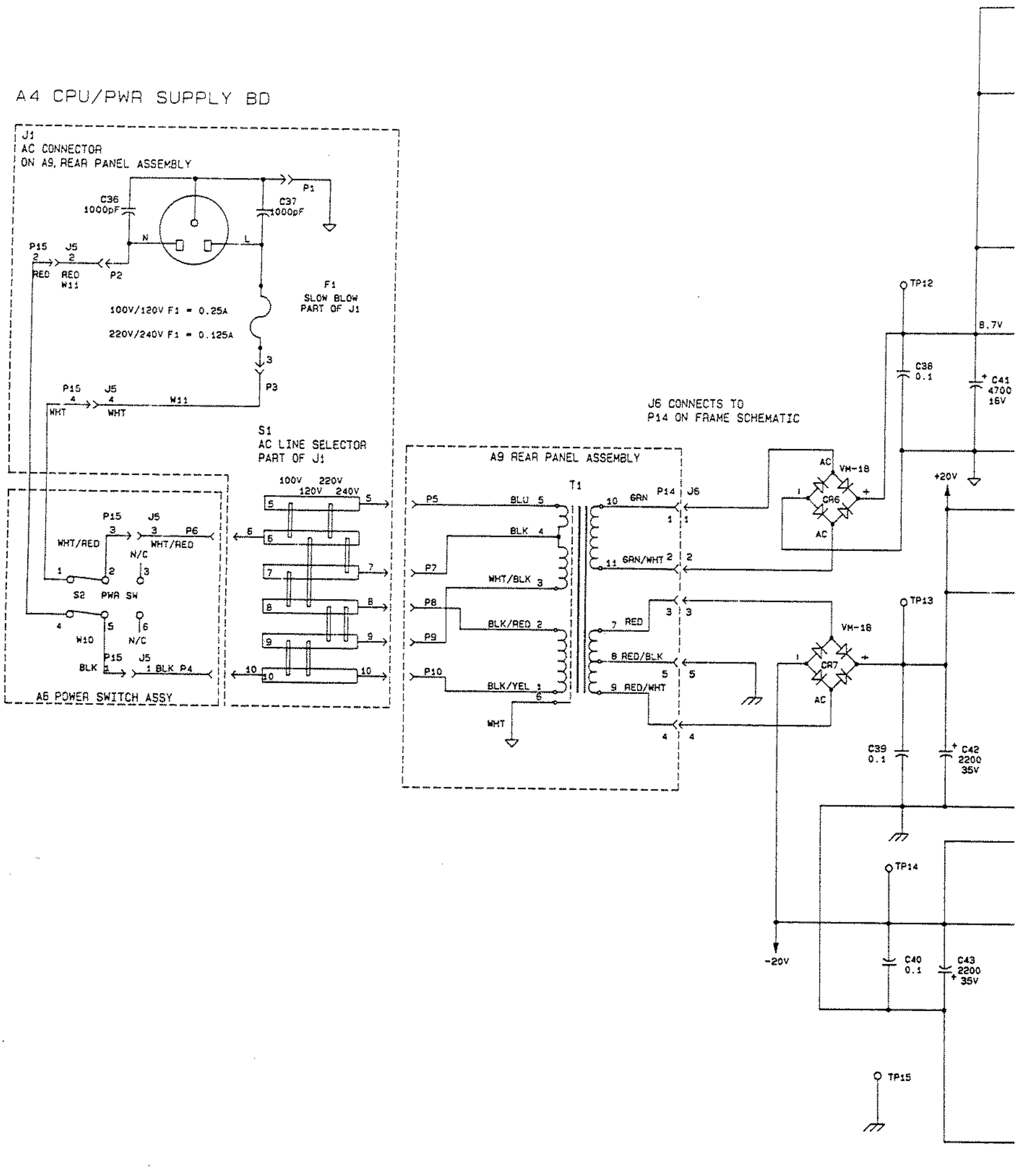


A4 CPU/PWR SUPPLY BD
CONNECTS TO: 8211 CPU SH.11
ANALOG IN+
AGND
TP1
TP2
TP3
TP4
U5 MAX 191B
C1 56UF 6V
C2 0.1
C3 0.1
HARDWARE ENCLOSED BY BROKEN LINES IS USED IN DEVELOPMENT ONLY. DO NOT INCLUDE IT IN THE MANUAL.
J9 PRINTER CONNECTOR
FOOTPRINT EXPANSION FOR 128Kx8 RAM.
U1 145406
U6 2691SCC
U7 Z80C (CPU)
U8 27C256
U9 PEEL18C
U11 PEEL18C
RN1 3K/6.2K
DATA
ADRS
CNTRL
BUSY
Y1 3.6864MHz
OUTPUT
R1 1K
R2 10K
R8 1K
R9 10K
R10 3.32K
U3 4040B
U4 PEEL18CV8
R3 10K
R4 332
R5 10K
L1 150UH
C18 .001
C20 .0011
C21 .002
OFF/ON- (THIS SHEET)
AM/FM- (THIS SHEET)
SCHEMATIC, 8211 CPU (Z80)
83119310A, REV B



SCHEMATIC, 8211 CPU (DETECTORS)
83119311A, REV.B

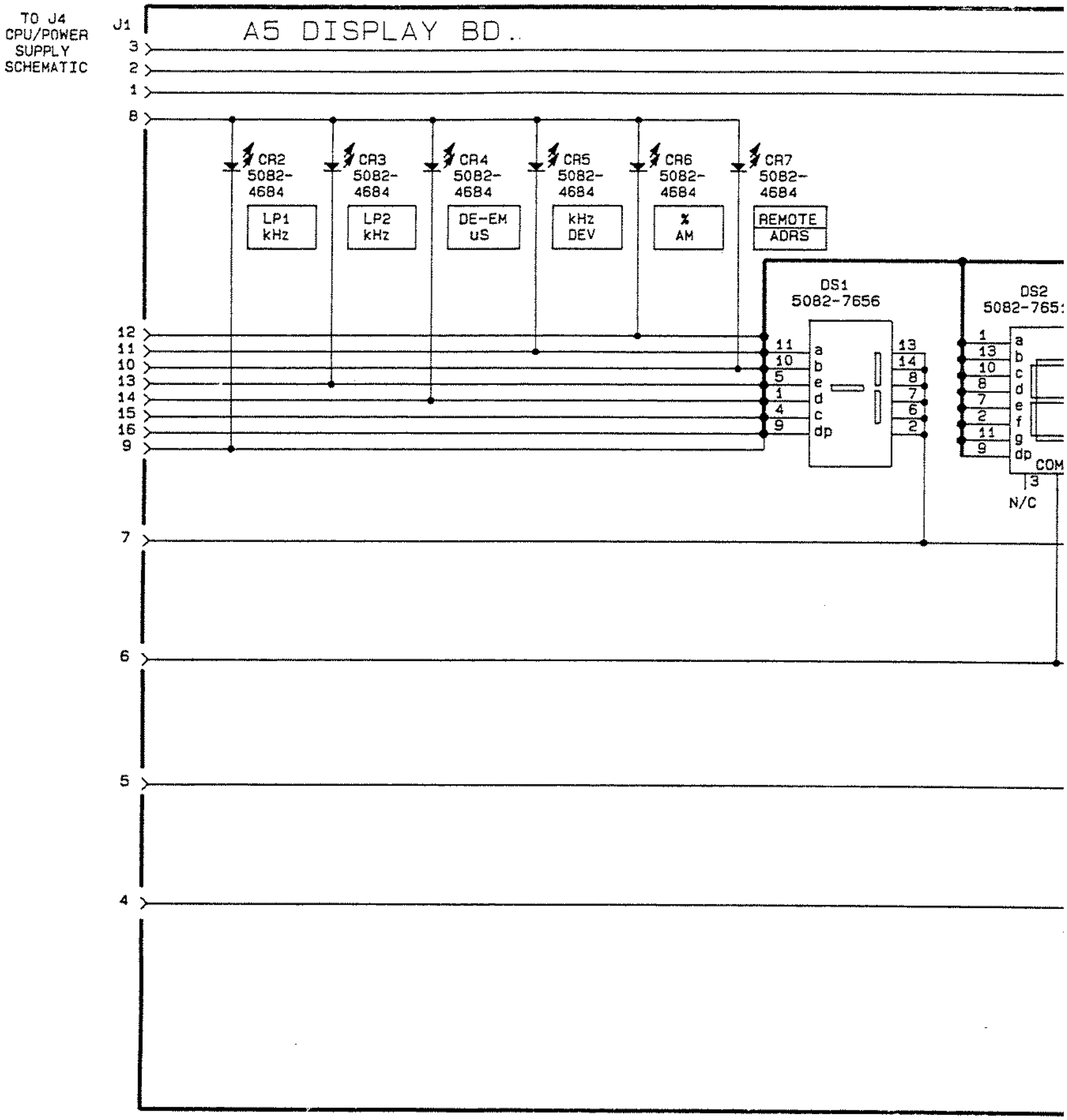
NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED ON THIS SHEET C35, CR4 J5, R39, TP11, U25
4. NUMBERS NOT USED: C28, R18, R19, R21, R24, R25 R27



SCHEMATIC, 8211 CPU POWER SUPPLY

83119312A, REV.B

NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED ON THIS SHEET C51, CR18, J6, LP10, P15, S2, TP20, U31
4. NUMBERS NOT USED: C36, C37, P11, P12, P13, R42



SCHEMATIC, DISPLAY
83119313A REV A

NOTES:

1. * 30

2. * 50

3.

WARRANTY

Boonton Electronics Corporation (BEC) warrants its products to the original Purchaser to be free from defects in material and workmanship for a period of one year from date of shipment for instrument, and for one year from date of shipment for probes, power sensors and accessories. BEC further warrants that its instruments will perform within all current specifications under normal use and service for one year from date of shipment. These warranties do not cover active devices that have given normal service, sealed assemblies which have been opened or any item which has been repaired or altered without BEC's authorization.

BEC's warranties are limited to either the repair or replacement, at BEC's option, of any product found to be defective under the terms of these warranties.

There will be no charge for parts and labor during the warranty period. The Purchaser shall prepay shipping charges to BEC or its designated service facility and shall return the product in its original or an equivalent shipping container. BEC or its designated service facility shall pay shipping charges to return the product to the Purchaser. The Purchaser shall pay all shipping charges, duties and taxes if a product is returned to BEC from outside of the United States.

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