BOONTON

BOONTON ELECTRONICS CORPORATION

INSTRUCTION MANUAL

MODEL 8210

F.M.-A.M. MODULATION METER

Valuetronics International, Inc.
1-800-552-8258
MASTER COPY

This Manual applies to instruments with serial numbers 408 and above.

INSTRUCTION MANUAL
MODEL 8210
F.M.-A.M. MODULATION METER

This Manual applies to instruments with serial numbers 406 and above.

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Printed in U.S.A.

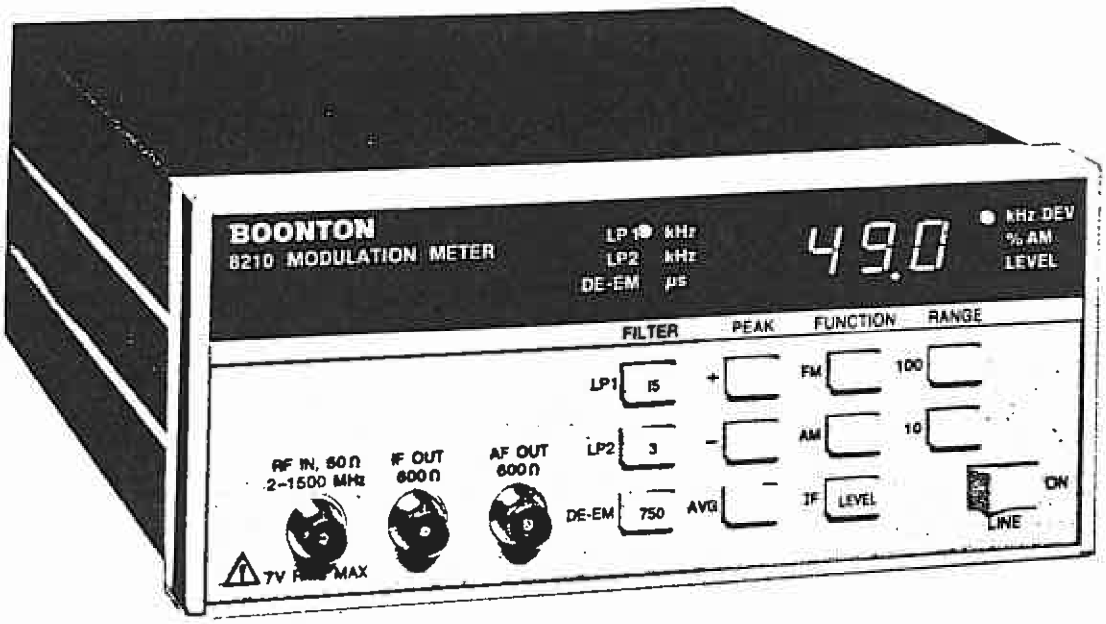

Figure 1-1. Model 8210 F.M.-A.M. Modulation Meter

8210-1182

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T A B L E   O F   C O N T E N T S

SECTION 1 - INTRODUCTION

SECTION II - INSTALLATION AND OPERATION

SECTION III - THEORY OF OPERATION

SECTION IV - MAINTENANCE AND ADJUSTMENT

SECTION IV - MAINTENANCE AND ADJUSTMENT (Continued)

SECTION V - PARTS LIST

SECTION VI - SCHEMATIC DIAGRAMS

APPENDIX A - CALIBRATOR OPERATION

LIST OF ILLUSTRATIONS

Figure **Page**

LIST OF TABLES

S E C T I O N I

GENERAL INFORMATION

1-1. SAFETY NOTICE

The Model 8210 is furnished with a three-conductor power cable and three-prong plug so that, when the plug is inserted in a properly polarized a.c. power receptacle, the instrument is grounded. The instrument depends upon such connection to ground for equipment and operator safety.

*** * * WARNING * * ***

> To avoid the possibility of electrical shock, before anything is connected to this instrument, and before you use this instrument,
> make certain that its power cable is plugged into a mating a.c. receptacle that has a grounded ("earthed") contact.

Never defeat the instrument's protective grounding. For example: Do not use an extension power cable if it is not equipped with a ground conductor; do not plug the instrument into an a.c. receptacle that does not provide a high-quality earth ground. If only a two-terminal a.c. power receptacle is available, use a three-prong-to-two-prong adapter and connect the ground wire of the adapter to the power-receptacle ground. Do not use such an adapter if the ground wire cannot be grounded.

1-2. Description

The Model 8210 Modulation Meter, manufactured by Boonton Electronics Corporation, is a versatile, solid-state instrument that measures and displays the deviation of frequency-modulated signals or the percentage modulation of amplitude-modulated signals over a carrier range of 2 MHz to 1.5 GHz. Both the a.m. and f.m. detectors of the 8210 are true peak-responding at all levels. Thus they conform to the basic definition of modulation depth or deviation. In addition, because the detectors are true peak-responding, the effect of any system noise will be accurately included in the measured value. Among the features of the Model 8210 are:

a. Fully Automatic Tuning and Leveling. The Model 8210 will automatically acquire the largest signal present at the input connector and adjust its local oscillator, and the gain of its measurement channel, to provide a fully calibrated display of amplitude modulation or frequency modulation.

b. Internal Calibration. When the LEVEL key is depressed at power on, the 8210 calibrates both its a.m. and its f.m. detector.

c. Digital Display. The 8210 presents recovered modulation on a 3-1/2 digit display, providing exceptional resolution and accuracy for modulation measurements.

d. Pushbutton Operation. Selection of all operational parameters is made by means of pushbuttons, thus allowing fast measurement setup.

e. Low Residual Modulation. The 8210's exceptionally low residual modulation permits accurate measurements of low noise sources. Direct residual measurements are possible if an external r.m.s. detector is used.

The Model 8210 is intended for both laboratory and field application. It will also be especially useful in the design of, and for production-line and field-testing of, f.m. and a.m. transmitters and signal generators.

1-3. 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 8210. Required cable connections are discussed in paragraph 2.1d.

1-4. OPTIONS AND ACCESSORIES

Option -01: With this operation, the 15 kHz low-pass filter is replaced by a 30 kHz low-pass filter. See Specifications, below, for details.

Option -S/1: With this operation, the 15 kHz low-pass filter is replaced by a 50 kHz low-pass filter. See Specifications, below, for details.

Accessory 95401501B:
This is a rack-mounting kit (not supplied as standard), for mounting a single 8210 to left or right of center.

1-5. ENVIRONMENTAL DATA, OPERATING AND STORAGE
Temperature: Operating, 0 to +55oC. Storage, -55oC to +75oC.

1-6. SPECIFICATIONS
R.F. INPUT:

Carrier Frequency Range	2 MHz to 1.5 GHz
Tuning	Automatic
Sensitivity	10 mV, R.M.S., 2 MHz to 520 MHz 30 mV, R.M.S., 520 MHz to 1.5 GHz
Level Set	Automatic for levels up to 1 V
Maximum Safe Input	7 V, R.M.S.
Input Impedance	50 ohms, nominal

FREQUENCY MODULATION:

Maximum Deviation	150 kHz, peak
Deviation Ranges	10 and 100 kHz, full scale
Deviation Accuracy Standard:	1% of reading for modulation frequencies, between 50 Hz and 5 kHz. 2% of reading, 5 kHz to

	7.5 kHz.
8210-01:	1% of reading for modulation frequencies between 50 Hz and 10 kHz 2% of reading, 10 kHz to 15 kHz.
8210-S/1:	1% of reading for modulation frequencies between 50 Hz and 15 kHz 2% of reading, 15 kHz to 25 kHz.
	NOTE: Peak residuals must be accounted for to obtain the above accuracies.
Modulation Bandwidth	
Standard:	<30 Hz to 15 kHz
8210-01:	<30 Hz to 30 kHz
8210-S/1:	<30 Hz to 50 kHz
Residual F.M.	
Standard:	<150 Hz RMS at 1.5 GHz decreasing linearly to a floor of <5 Hz RMS, with 3 kHz LP filter. <200 Hz RMS at 1.5 GHz decreasing linearly to a floor of <15 Hz RMS, with 15 kHz LP filter.
	NOTE: RF level > 100 mV.
8210-01:	<400 Hz RMS at 1.5 GHz decreasing linearly to a floor of <25 Hz RMS with 30 kHz LP filter. <150 Hz RMS at 1.5 GHz decreasing linearly to a floor of <5 Hz RMS with 3 kHz LP filter.
8210-S/1:	<950 Hz RMS at 1.5 GHz decreasing linearly to a floor of <55 Hz RMS with 50 kHz LP filter. <150 Hz RMS at 1.5 GHz decreasing linearly to a floor of <5 Hz RMS with 3 kHz LP filter.
A.M. Rejection	<100 Hz deviation at 50% a.m. (modulation frequency <1 kHz) 3 kHz low-pass filter.

AMPLITUDE MODULATION

Modulation-Depth Ranges	10% and 100%, full scale
Depth Accuracy	

	Modulation Frequncy	Accuracy	
		10% - 90% AM	<10% & >90% AM
Standard:	50 Hz to 5 kHz 5 kHz to 7.5 kHz	1% of Reading 2% of reading	3% of reading 6% of reading
8210-01:	50 Hz to 10 kHz 10 kHz to 15 kHz	1% of reading 2% of reading	3% of reading 6% of reading
8210-S/1:	50 Hz to 15 kHz 15 kHz to 25 kHz	1% of reading 2% of reading	3% of reading 6% of reading

NOTE: Peak residuals must be accounted for to obtain the above accuracies. Carrier Frequency <520 MHz; r.f. level between -10 and +10 dBm.

Modulation Bandwidth

Standard:	<30 Hz to 15 kHz
8210-01:	<30 Hz to 30 kHz
8210-S/1:	<30 Hz to 50 kHz

Residual A.M.

Standard: <0.15% AM RMS for input levels >100 mV RMS, 3 kHz LP filter. <0.25% AM RMS for input levels >100 mV RMS, 15 kHz LP filter.

8210-01: <0.35% AM RMS for input levels >100 mV RMS, 30 kHz LP filter. <0.15% AM RMS for input levels >100 mV RMS, 3 kHz LP filter.

8201-S/1: <0.5% AM RMS for input levels >100 mV RMS, 50 kHz LP filter. <0.15% AM RMS for input levels >100 mV RMS, 3 kHz LP filter.

NOTE: Carrier frequency <520 MHz; above 520 MHz residuals increase linearly with frequency.

F.M. Rejection: Less than 1.0% a.m., peak, at 100 kHz peak modulation.

AUDIO-FREQUENCY RESPONSE

Filters

Standard: 3 kHz LP, 15 kHz LP, and 750 us de-emphasis. De-emphasis can be either before or after the display (jumper selected).

8210-01: 3 kHz LP, 30 kHz LP, and 750 us de-emphasis. De-Emphasis can be either before or after the display (jumper selected).

8210-S/1: 3 kHz LP, 50 kHz LP, and 750 us de-emphasis. De-emphasis can be either

	before or after the dispaly (jumper selected).
Audio Distortion Standard & 8210-01:	<0.25% THD for 75 kHz peak deviation. <0.5% THD for 90% AM.
8210-S/1:	<0.5% THD for 75 kHz peak deviation. <0.5% THD for 90% AM.
Output Level	1 V RMS nominal into 600 ohms at 1000 counts on display for FM, 1 to 1.2 V RMS for AM.
DISPLAY	
Modulation	LED display, 1000 counts plus 50% overrange; true peak, positive peak, negative peak, or peak-average indications.
Annunciators	Display of settings of mode switch and of filter. Digital display indicates level-high, level-low and unlocked conditions.
I.F. OUTPUT	
Frequency	400 kHz, nominal.
Level	300 to 360 mV, nominal, into 600 ohm load
POWER REQUIREMENTS	100, 120, 220, or 240 volts, a.c., +/- 10%, 50 to 400 Hz; 24 VA.
DIMENSIONS	103 mm high x 218 wide x 278 deep (4.1 in. x 8.6 x 11.0)
WEIGHT	3.18 kg (7.0 lbs.), approximately
Recommended Calibration Internal	12 Months

OPTIONAL MODEL 8210-01

This model is the same as the standard Model 8210 except as follows:

AUDIO-FREQUENCY RESPONSE	
Filters	The 15 kHz low-pass filter is replaced by a 30 kHz low-pass filter; corner accuracy is +/- 4%.
FREQUENCY MODULATION	
Deviation Accuracy	1% of reading for modulation frequencies between 50 Hz and 10 kHz. 2% of reading, 10 kHz to 15 kHz.
Modulation Bandwidth	<30 Hz to 30 kHz

Residual F.M.
(R.F. Level >100 mV)

With 30 kHz low-pass filter: <400 Hz, r.m.s., at 1.5 GHz, decreasing linearly to a floor of <25 Hz, r.m.s.

With 3 kHz low-pass filter: <150 Hz, r.m.s., at 1.5 GHz, decreasing linearly to a floor of <5 Hz, r.m.s.

AMPLITUDE MODULATION

Depth Accuracy

Modulation Frequency	Accuracy	
	10% - 90% A.M.	<10% & >90% A.M.
50 Hz to 10 kHz	1% of reading	3% of reading
10 kHz to 15 kHz	2% of reading	6% of reading

NOTE: Peak residuals must be accounted for to obtain the above accuracies.

Carrier frequency <520 MHz; r.f. level between -10 and +10 dBm.

Modulation Bandwidth

<30 Hz to 30 kHz

Residual A.M.

With 30 kHz low-pass filter: Less than 0.35% a.m., r.m.s., for input levels above 100 mV, r.m.s.

With 3 kHz low-pass filter: Less than 0.15% a.m., r.m.s., for input levels above 100 mV, r.m.s.

NOTE: Carrier frequency <520 MHz; above 520 MHz residuals increase linearly with frequency.

SECTION II

INSTALLATION & OPERATION

2-1. INSTALLATION

a. Unpacking. The 8210 is shipped complete and ready for use. Unpack the equipment from the shipping container and inspect it for any damage that may have occurred during shipment. Check that all connectors and switches operate without binding.

NOTE: Save the packing material and container for possible use in reshipment of the 8210. See Figure 2-10 (p. 2-14) for the repacking method.

b. Mounting. For bench mounting, choose a clean, sturdy and uncluttered mounting surface. For rack mounting, an accessory package (Model Number 95401501B) is available; it consists of two angle-mounting brackets, two flat plates, four binder-head screws, and four lockwashers. To rack mount an 8210, proceed as follows:

1. The 8210 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.

2. Refer to the drawing in the accessory's package for the proper orientation of the two mounting brackets.

3. Mount the 8210 in the rack with standard rack-mounting screws through the slotted holes in the angle brackets.

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

c. Power Requirements. The 8210 can be operated on a.c. power sources of 100, 120, 220 or 240 volts, 50 to 400 Hz, single phase. The power required is 24 VA at 120 or 240 volts, a.c.

CAUTION

Before connecting the 8210 to an a.c. power source, see that the voltage-selector switches on the rear panel are set for the available line voltage and that a fuse of the proper rating is in the instrument's fuse holder: 0.25 A for 100 or 120 Vac; 0.125 A for 220 or 240 Vac -- either fuse to be type MDL Slo-Blo.

d. Cable Connections. Depending on the operating mode of the 8210, various cables will have to be connected to it; these cables are not supplied with the instrument. Connections that may be required are:

1. R.F. Input. The RF IN connector of the 8210 is a type BNC. The input impedance is 50 ohms, nominal.

2. I.F. Output. The 8210's i.f. output is available at the front-panel BNC marked IF OUT. The level varies between 300 and 360 mVrms; the source impedance is 600 ohms, nominal.

3. A.F. Output. The recovered audio signal appears at the front-panel BNC connector labeled AF OUT. For FM, the level is approximately 1 Vrms, into 600 ohms at 1000 counts on the digital display. For AM, the level is 1 to 1.2 Vrms.

2-2. OPERATING CONTROLS, INDICATORS AND CONNECTORS

All controls, indicators and connectors used during operation of the 8210 are shown in Figures 2-1 and 2-2. They are described in Table 2-1, below.

Table 2-1. Operating Controls, Indicators, and Connectors

ITEM	FIGURE	INDEX #	FUNCTION
FILTER switches	2-1	1	Select low-pass or de-emphasis filters.
PEAK switches	2-1	2	Select display of + peak, - peak or peak average.
FUNCTION switches	2-1	3	Select AM, FM or LEVEL display functions
RANGE switches	2-1	4	Select desired full-scale modulation range
LED display	2-1	5	Indicates Modulation or i.f. level -- as determined by the FUNCTION switch setting
LINE switch	2-1	6	Turns line power on and off
RF IN connector	2-1	7	Input signal connection point
IF OUT connector	2-1	8	Allows connection of 8210's i.f. signal to external circuits
AF OUT connector	2-1	9	Allows connection of 8210's recovered audio signal to external circuits.
Power connector	2-2	1	Input connector for a.c. power cable
Line-voltage switches	2-2	2	Permit selection of appropriate a.c. operating voltage
Fuse holder	2-2	3	Contains replaceable line fuse

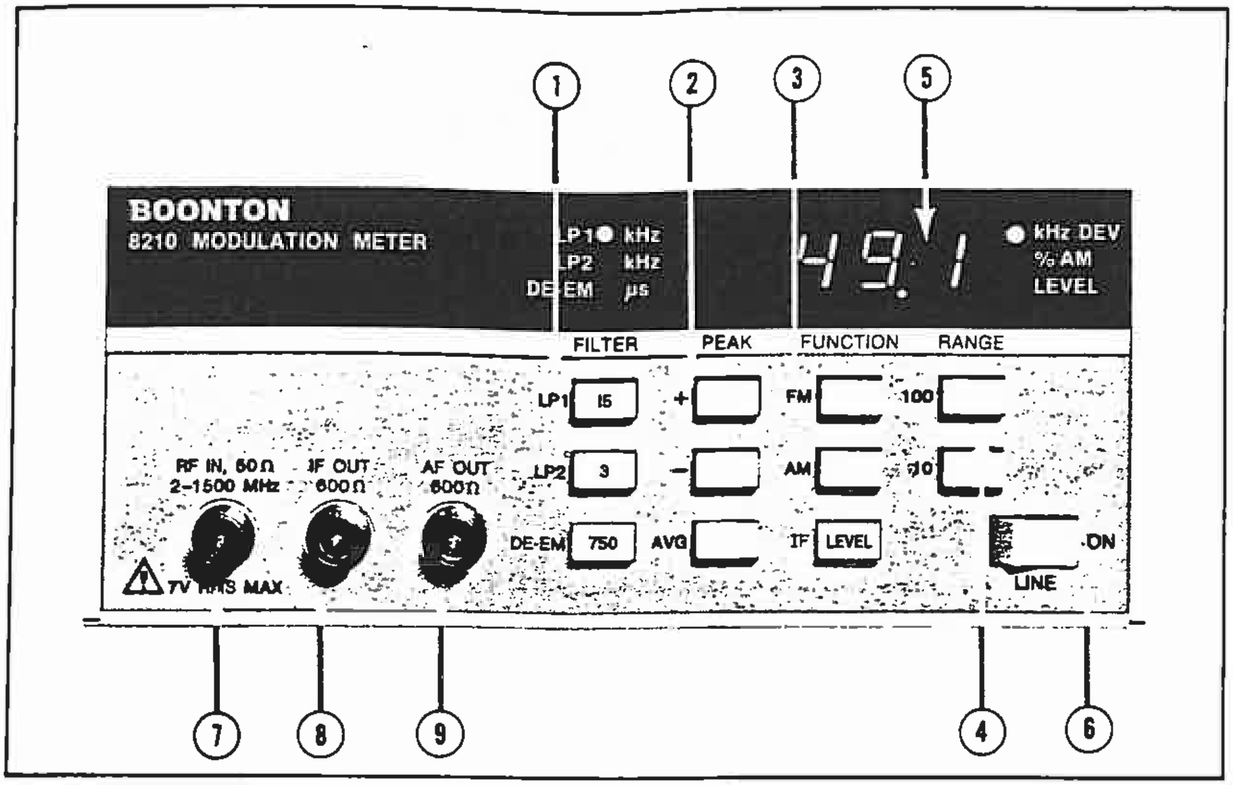


Figure 2-1. Model 8210, Front View

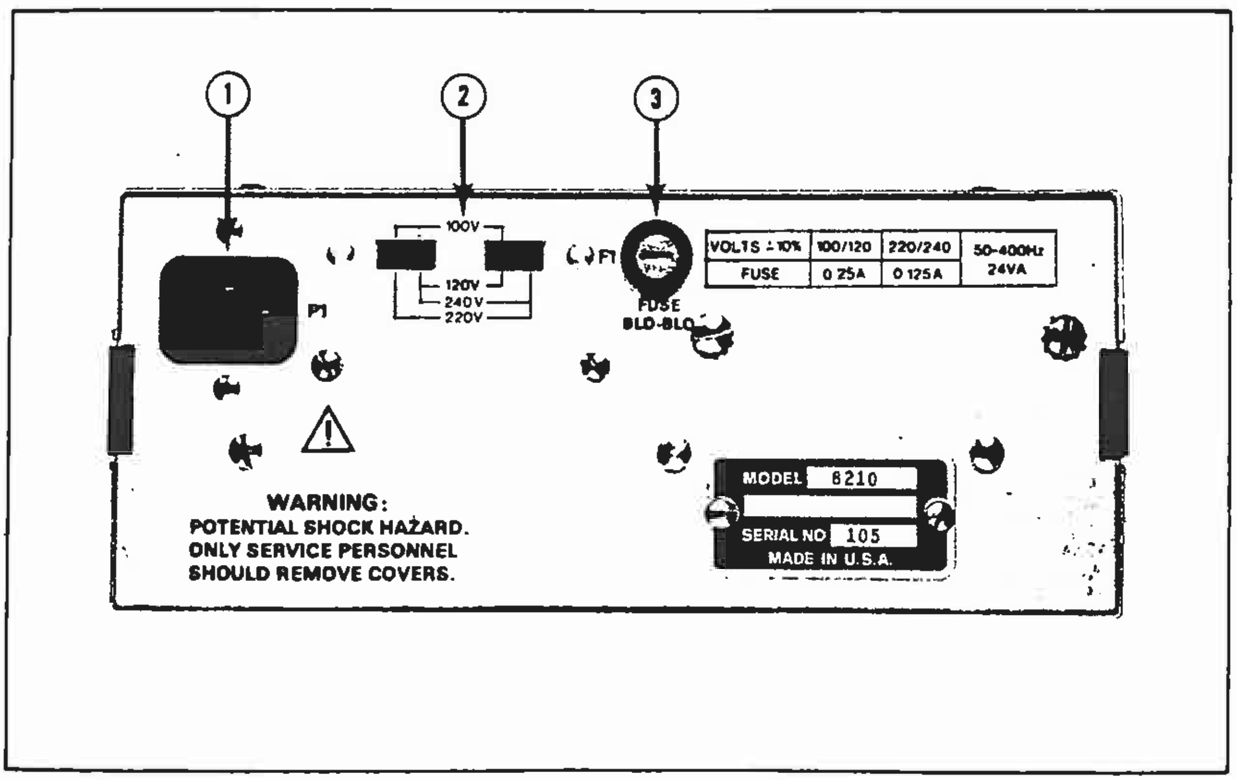


Figure 2-2. Model 8210, Rear View

2-3. PRELIMINARY CHECK

NOTE: The following preliminary check procedure is intended only to ensure that all circuits are operating. If a detailed performance check against specifications is desired, refer to subsection 2-6.

Before using the Model 8210, perform a preliminary check as follows:

a. Set the LINE switch to the "on" position and depress the LEVEL key. The LED display should indicate "CAL", which means that the calibration sequence has begun. After about 30 seconds, a series of dashes should appear on the LED display, indicating an unlocked condition.

b. Apply a 100 mV (r.m.s.) unmodulated test signal, at a frequency between 2 and 520 MHz, to the RF IN connector of the 8210. The LED display on the 8210 should now indicate residual modulation. Note that two dashes on the LED indicate that the 8210 is executing an a.g.c. cycle.

c. Reduce the test signal to 5 mV. The display should indicate "IFLO".

d. Increase the test signal to 1.5 V. The display now should read "IFHI".

e. Decrease the test signal to approximately 0 dBm. The display should read as in Step (b).

f. In turn, depress the three FILTER switches, and see that the associated annunciators indicate the switch selection correctly.

g. Repeat Step (f) for the FUNCTION switches.

h. Depress in turn the three PEAK switches. A plus sign (+) will be shown for the + PEAK switch, a minus sign (-) for the - PEAK, and no sign when the AVG switch is depressed.

i. Depress in turn the RANGE switches. The decimal-point indication of the display should move to left or right as each switch is depressed.

j. Connect an oscilloscope to the 8210's IF OUT connector. Set the scope so that it displays the 400 kHz i.f. signal of the 8210.

k. Modulate the test signal with approximately 50% a.m. Depress the AM FUNCTION switch, the 100 RANGE switch, and the 15 kHz FILTER switch. The display should indicate approximately 50% a.m.

l. Remove the amplitude modulation, and frequency-modulate the test signal with approximately 50 kHz peak deviation. Depress the FM FUNCTION switch. The display should indicate approximately 50 kHz deviation.

2-4. APPLICATION NOTES

The following paragraphs describe some typical applications for the Model 8210. The use of the 8210 is not restricted to these applications, however.

a. F.M. Measurements. High-accuracy f.m. measurements are possible with the 8210, 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, r.m.s. Such signal levels reduce residual f.m. in the 8210 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.

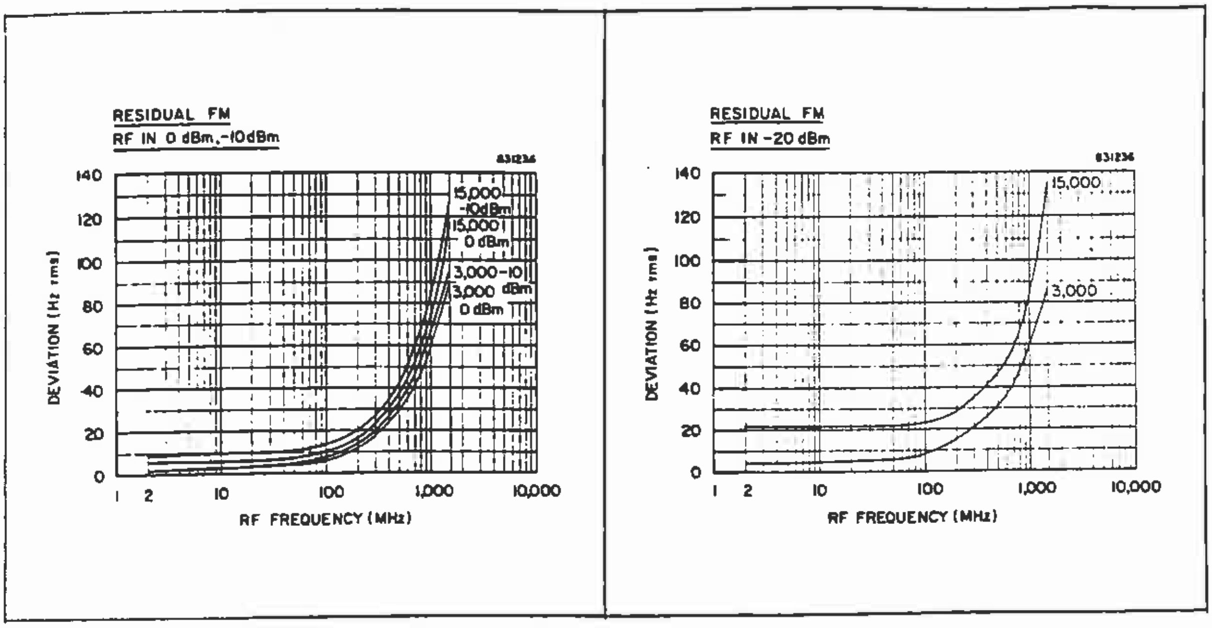


Figure 2-3. Residual F.M., Typical

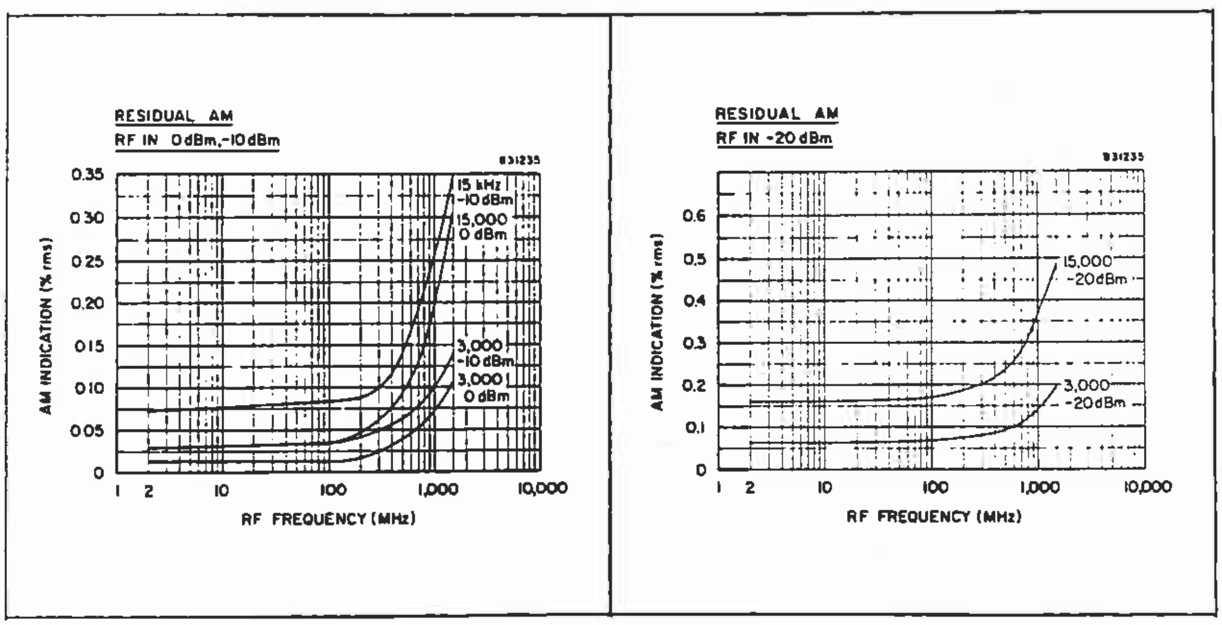


Figure 2-4. Residual A.M., Typical

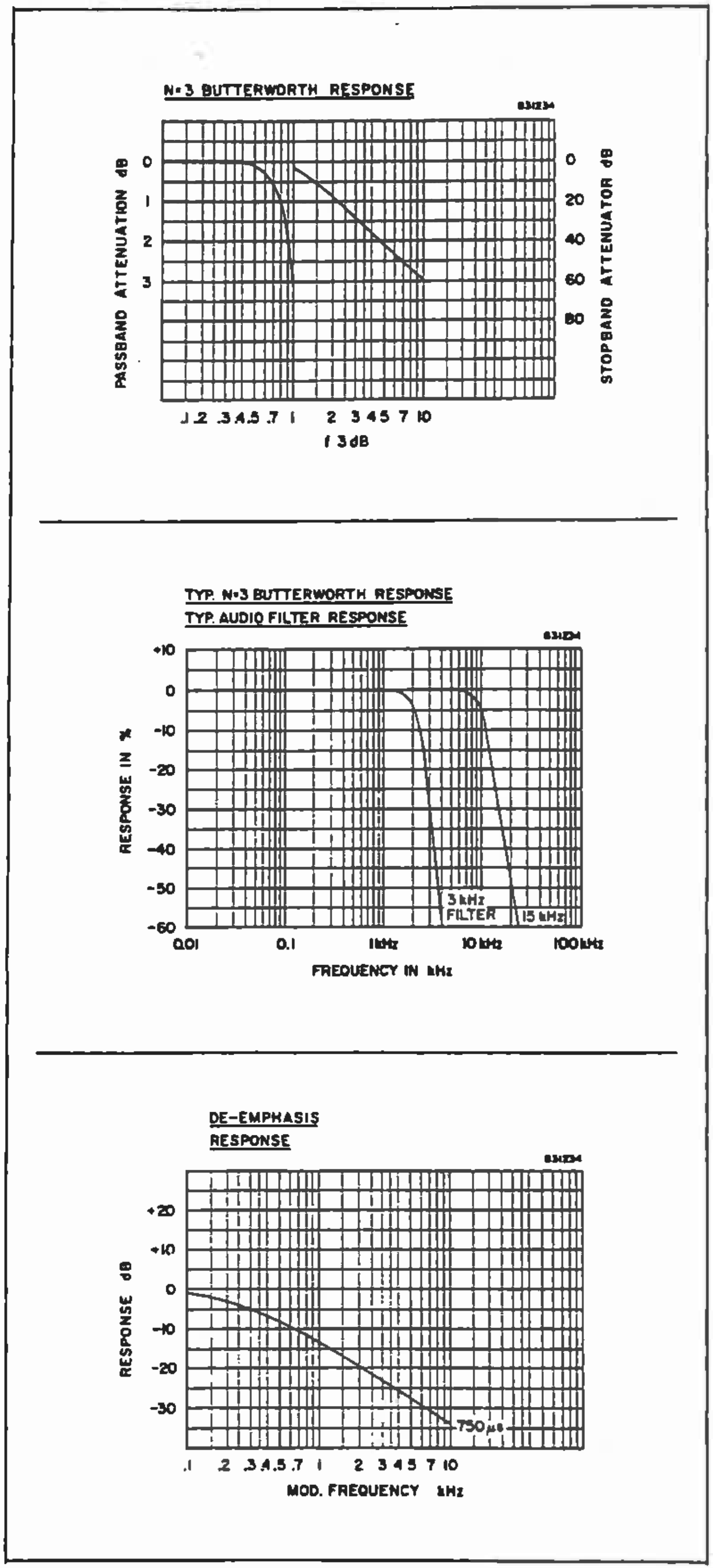


Figure 2-5. Audio Response, Typical

2-4a, Continued.

Typical residuals for the 8210 are plotted in Figures 2-3 and 2-4; audio response curves are plotted in Figure 2-5. Because the audio detectors in the 8210 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 is a function of the carrier to noise ratio and the modulation waveshape. In most measurement situations involving sinusoidal modulation, noise suppression is approximately 30%.

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 the carrier-to-noise ratio exceeds 20 dB.

True r.m.s. measurements of the recovered audio signal will provide a more precise indication of modulation in the presence of large amounts of noise.

b. A.M. Measurements. The 8210 makes possible fast, accurate indications of amplitude modulation. Optimum accuracy is achieved with input signal levels between -10 and +10 dBm (for lowest residuals), and the minimum bandwidth consistent with the modulation frequency. As discussed above for f.m., noise suppression does occur, and the 0.7 multiplier is used to subtract added noise.

c. Spurious Responses. 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 tend to "cross over" the desired i.f. and change its character. In contrast, the 8210 converts frequency by using a sampler, which is very linear and which produces few spurious responses in the usual sense.

There are, however, a few points to remember when applying a sampling instrument like the 8210. If the input signal contains significant harmonic power above the third harmonic, an i.f. beat can occur and thus produce unwanted a.m. and f.m. indications.

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 8210's intermediate frequency.

EXAMPLE: Assume two input signals - the larger at 100 MHz, the smaller at 501.6 MHz. The local oscillator might be at 2.51 MHz so that its 40th harmonic (100.4 MHz), when mixed with the 100 MHz signal, produces a 400 kHz i.f. However, the 200th harmonic of 2.51 MHz is 502 MHz - which converts the 501.6 MHz carrier to 400 kHz also. Since the two signals are not phase coherent, a low-frequency beat will occur at the i.f. and product spurious a.m. and f.m. indications. The offending input signal should be filtered in order to eliminate this interference.

d. Additional Applications. Information relevant to further applications of the 8210 will be found in Boonton Electronics' Application Note #19:

High Accuracy AM-FM Measurements with the Boonton 82AD Modulation Meter.

The Application Note is available free upon request to Boonton Electronics.

Inquiries regarding application of the 8210 to specific customer requirements are invited. Please direct any such inquiries to the Applications Engineering Department of Boonton Electronics Corporation

2-5. OPERATING INSTRUCTIONS
The operation of the Model 8210 is essentially automatic, requiring only that the operator select the proper display function and baseband filter. Paragraphs 2-5a and 2-5b summarize operating steps for a.m. and f.m. measurements, respectively.

a. A.M. Measurements

1. Set the LINE switch to ON, and connect to the RF IN connector the r.f. signal that is to be measured.

   NOTE: If a calibration cycle is desired, depress the LEVEL key while the firmware date is displayed.

2. Select the desired measurement bandwidth. Use the minimum bandwidth consistent with the modulation frequency.

3. Depress the appropriate PEAK switch, as determined by the amplitude modulation measurement to be made.

4. Depress the AM FUNCTION switch and the 100 RANGE switch.

5. Read the percentage of a.m. modulation from the LED display. The 10 RANGE may be selected if the modulation is less that 15%.

b. F.M. Measurements. Operation of the Model 8210 for f.m. measurements is basically the same as for a.m., except for the selection of Function and Filter. For f.m. measurements, depress the FM FUNCTION switch and the appropriate RANGE and PEAK switches.

Either a low-pass filter or the 750 us de-emphasis filter may be selected for the measurement. The de-emphasis filter may be placed before or after the modulation display, according to an internal jumper selection. Units shipped from the factory are normally wired for de-emphasis before the display.

c. Level Function. The "Level" function is included in the Model 8210 to indicate the relative a.m. -detector operating point; it is required only when an external indicator is used for making an a.m. measurement When the 8210 is operating properly, depressing LEVEL should always result in a number between 0.95 and 11.5 on its digital display. If the reading on the external indicator is now multiplied by 10.00, then divided by the Level indication, the external indicator will be properly scaled.

The LEVEL pushbutton serves another purpose. If a calibration operation is desired, depress the LEVEL key while the firemware date is displayed at power on. If a malfunction occurs during calibration, a condition code (the letters "cc", followed by a number), will appear on the digital display. It means that proper calibration could not be accomplished. (Refer to Section IV for the meaning of each condition code). Depressing the LEVEL pushbutton releases the error condition, and measurements can be made. Note, however, that the detector that malfunctioned will not be properly calibrated.

In addition, the LEVEL button is utilized in several of the test routines provided for troubleshooting the 8210. These routines are described in detail in Section IV.

2-6. PERFORMANCE VERIFICATION

The following tests may be performed when the Model 8210 is first received. Thereafter, performance verification should be needed only after repair to the instrument.

> NOTE: In these verification procedures, some settings or results are followed by data in parentheses. These parenthetical entries apply to instruments with the -01 Option installed.

a. Test Equipment Required. Table 2-2 lists all test equipment required for verification of performance of the 8210. Other models of test equipment that meet or exceed the Critical Specifications may be used instead.

Table 2-2. Recommended Test Equipment for Performance Verification

EQUIPMENT	CRITICAL SPECIFICATIONS	SUGGESTED MODEL
Signal Generator	AM/FM, 0.01 to 520 MHz, -30 to + 10 dBm level. T.H.D. <0.05% at 75 kHz deviation at 100 MHz	Boonton Elec. 102E-19 & HP 8642
Signal Generator	C.W., 1.5 GHz, -30 to +7 dBm	HP 8660C/86603A & 8642
Crystal-Controlled Source or Synthesizer	<3 Hz residual f.m. at 500 MHz in 15 kHz bandwidth	Ailtech 460 & H-P 8642
Voltmeter	True r.m.s., 10 mV full-scale sensitivity, 100 kHz bandwidth	Boonton Elec. 93AD
Double-Balanced Mixer	+7 dBm, l.o. Range of l.o & r.f.: 0.5 - 500 MHz	Mini-Circuits ZAD-1
Audio Oscillator	Range: 20 Hz - 20 kHz <0.1% t.h.d.	Boonton 1120 & HP 204C
Resistor	10 k ohm, 1/4 W, 5%	Allen Bradley
Resistor	620 ohm, 1/4/ W, 5%	AB-EB
Power Supply	+ 10 V, d.c.	Power Designs 5015T
Capacitor	1000 uF, 6 w.v.d.c.	-----
Distortion Analyzer:	Range: 20 Hz - 20 kHz Resolution: 0.1% t.h.d.	Boonton 1120 & Radiometer BKF10

b. R.F. Input Sensitivity.

1. Connect the 8210 and test equipment as shown in Figure 2-6.

2. Depress the switches of the 8210 as indicated in Figure 2-6.

3. Apply a 10 MHz, 10 mVrms signal from the Model 102E-19 signal generator to the RF IN connector of the 8210. The 8210 should indicate "lock" and adequate signal level for a measurement.

4. Change the r.f. input to 500 MHz. Indications should be the same as in Step 3.

5. Connect the Model 8660C signal generator to the RF IN connector of the 8210. Set the signal generator's controls to provide an r.f. input of 30 mV, r.m.s., at 1500 MHz. Indications as in Step 3.

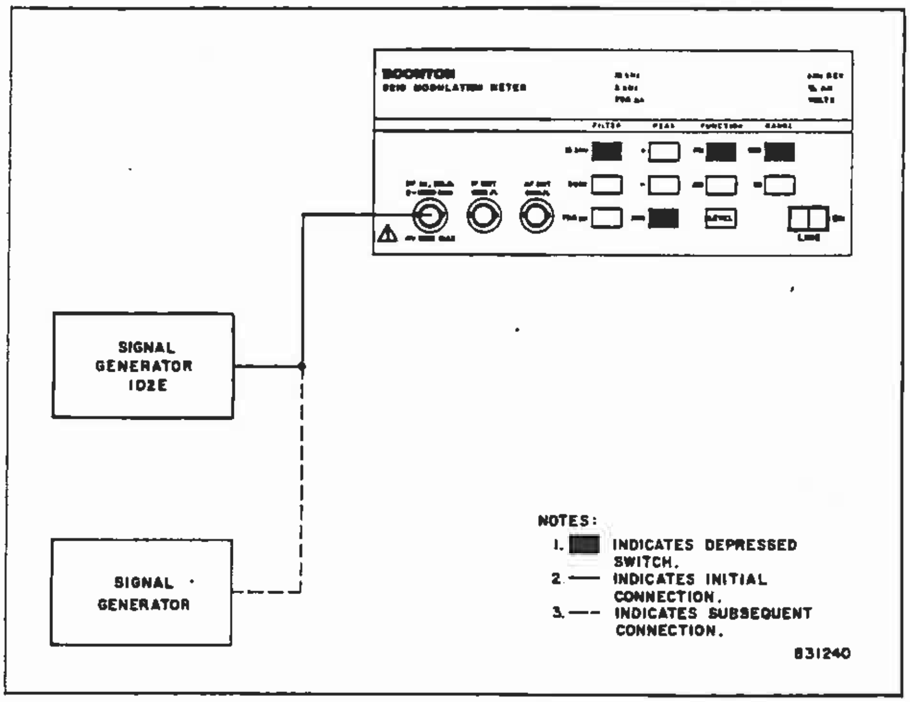


Figure 2-6. Test Setup: R.F. Input Sensitivity

c. Deviation Accuracy. Verification of the deviation accuracy of the 8210 is not usually required. If there is any doubt as to the operation of the internal calibrators, refer to Section IV for maintenance instructions, or to Appendix A for operation of the calibrators.

d. Residual F.M.

1. Connect the 8210 and test equipment as shown in Figure 2-7.

2. Apply the 500 MHz signal, at 0 dBm, from the test source to the RF IN connector of the 8210.

3. Depress the switches of the 8210 as indicated in Figure 2-7.

4. Connect the r.m.s. voltmeter (without 600 ohm termination) to the AF OUT connector on the 8210.

5. Set the voltmeter for 100 kHz bandwidth and 30 mV full-scale sensitivity. The voltmeter should indicate less than 13.3 mV (26.6 mV).(S/1 - 44.3 mV) NOTE: Set Voltmeter to 100 mV F.S. Sensitivity.

6. Depress the 8210's 3 kHz FILTER switch. The voltmeter should read less than 10 mV.

NOTE: The display of the 8210 indicates true peak deviation; therefore the display's readings will always be two to three times higher than the r.m.s. readings of the voltmeter.

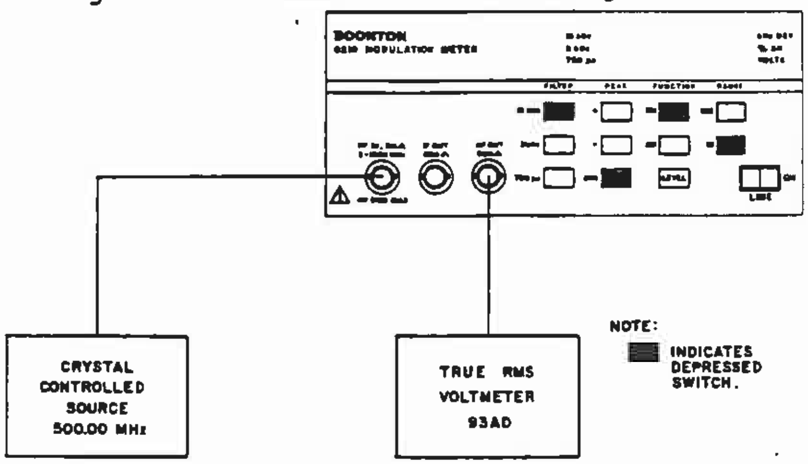


Figure 2-7. Test Setup: Residual F.M. and Residual A.M.

e. Residual A.M.

1. Connect the equipment as shown in Figure 2-7.

2. Set the 8210's controls as indicated, but select the AM FUNCTION.

3. Set the voltmeter to 100 kHz bandwidth and 100 mV sensitivity.

4. The voltmeter should indicate less than 50 mV (70 mV). (S/1 ?)

5. Set the 8210's FILTER to 3 kHz, and voltmeter sensitivity to 30 mV.

6. The voltmeter should indicate less than 30 mV.

f. A.M. Rejection.

1. Connect the 8210 and test equipment as shown in Figure 2-8.

2. Set the 8210's controls as shown in Figure 2-8.

3. Apply a 30 MHz signal, at 0 dBm, from the generator to the mixer.

4. Adjust the power-supply output voltage to +10 V d.c. Adjust the audio source for approximately 50% indicated a.m. at a 1

kHz rate.

5. Change the 8210's FUNCTION to FM.

6. Vary the r.f. level between 0 and +10 dBm for a deviation null. The display should indicate less than 100 Hz peak f.m. (Residual noise modulation must be subtracted).

g. A.M. Audio Distortion. NOTE: Step 2-6f, the A.M. Rejection check, should be completed before performing this verification. Leave the equipment set up as in Figure 2-8.

1. Adjust the audio oscillator for 90% a.m. at a 1 kHz rate.

2. The distortion analyzer should indicate less than 0.5%.

3. Vary the audio oscillator frequency from 50 Hz to 10 kHz.

4. The distortion should be less than 0.5% at all frequencies.

h. Audio-Frequency Response, 15 kHz. NOTE of Step 2-6g applies here also.

1. Depress the AM FUNCTION button.

2. Adjust the frequency of the audio oscillator to 1 kHz; adjust its amplitude for an indication of 60.0% a.m.

3. While maintaining a constant audio-oscillator amplitude, vary the modulation frequency between 50 Hz and 5 kHz (10 kHz). (S/1 - 16.7 kHz)

4. The indicated a.m. should be between 59.4% and 60.6% for all modulation frequencies.

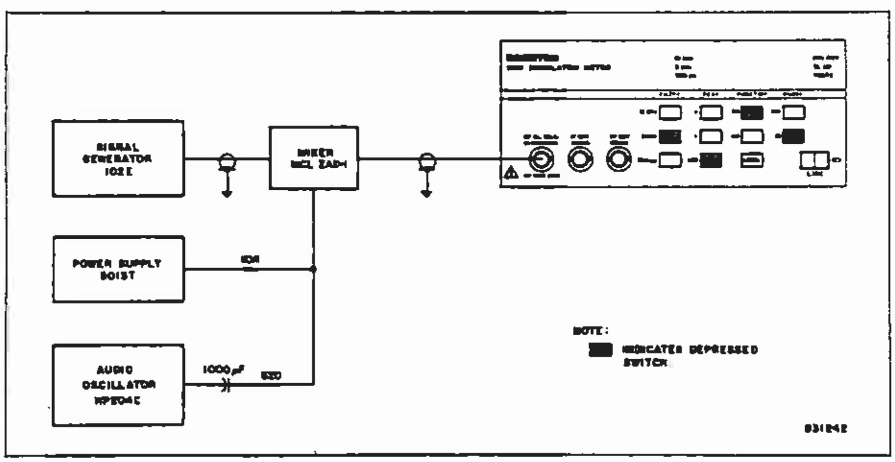


Figure 2-8. Test Setup: A.M. Rejection, A.M. Frequency Response, And A.M. Audio Distortion

5. Increase the frequency to 7.5 kHz (15 kHz)(S/1 25 kHz). The indicated a.m. should be between 58.8% and 61.2%.

6. Increase the frequency to 15.0 kHz (30 kHz)(S/1 50 kHz). The indicated a.m. should be between 40.4% and 44.3%.

i. F.M. Audio Distortion.

1. Connect the 8210 and test equipment as shown in Figure 2-9.

2. Set the controls of the 8210 as shown.

3. Set the signal generator to 100 MHz, 0 dBm, and external f.m.

4. Adjust the level of the audio oscillator for 75 kHz peak deviation at a 1 kHz rate.

5. The indicated distortion should be less than 0.25%.

6. Repeat Step 4 for modulation rates of 50 Hz and 10 kHz.

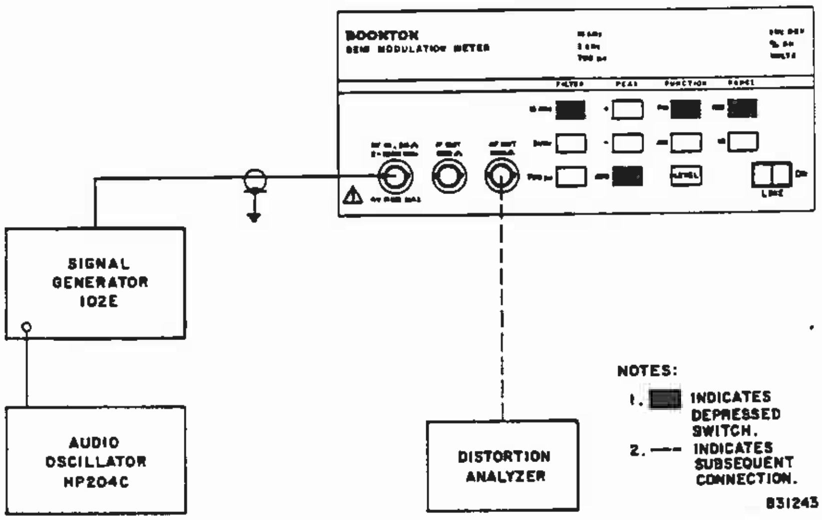


Figure 2-9. Test Setup: F.M. Audio Distortion and F.M. Rejection

j. F.M. Rejection.

1. Connect the equipment as shown in Figure 2-9.

2. Set the controls of the 8210 as indicated.

3. Adjust the audio oscillator's frequency to 1 kHz; adjust its amplitude for a 100 kHz peak deviation.

4. Change the 8210's FUNCTION to AM and its RANGE to 10.

5. The display should indicate less than 1.0%, peak.

k. Audio-Frequency Response, 3 kHz.

1. Connect the equipment as in Figure 2-9.

2. Set the 8210's controls as shown.

3. Adjust the audio oscillator's frequency to 300 Hz, then adjust its amplitude until the 8210 reads 100.0 kHz.

4. Without changing the audio oscillator's level, adjust its

frequency to exactly 3.00 kHz.

5. The Model 8210 display should indicate between 67.5 and 73.8 kHz.

l. Audio-Frequency Response, 750 us De-emphasis.

1. Connect the equipment as in Figure 2-9.

2. Set the 8210's controls as shown.

3. Adjust the audio oscillator's frequency to 212.2 Hz, then adjust its amplitude until the 8210's display indicates 100.0 kHz.

4. Change the 8210's FILTER to 750 us.

5. The display should read between 68.0 and 73.5 kHz deviation.

m. A.M. Depth Accuracy. Verification of the a.m. depth accuracy of the 8210 is not required. If there is any doubt as to the operation of the internal calibrators, refer to Section IV for maintenance instructions, or to appendix A for operation of the calibrators.

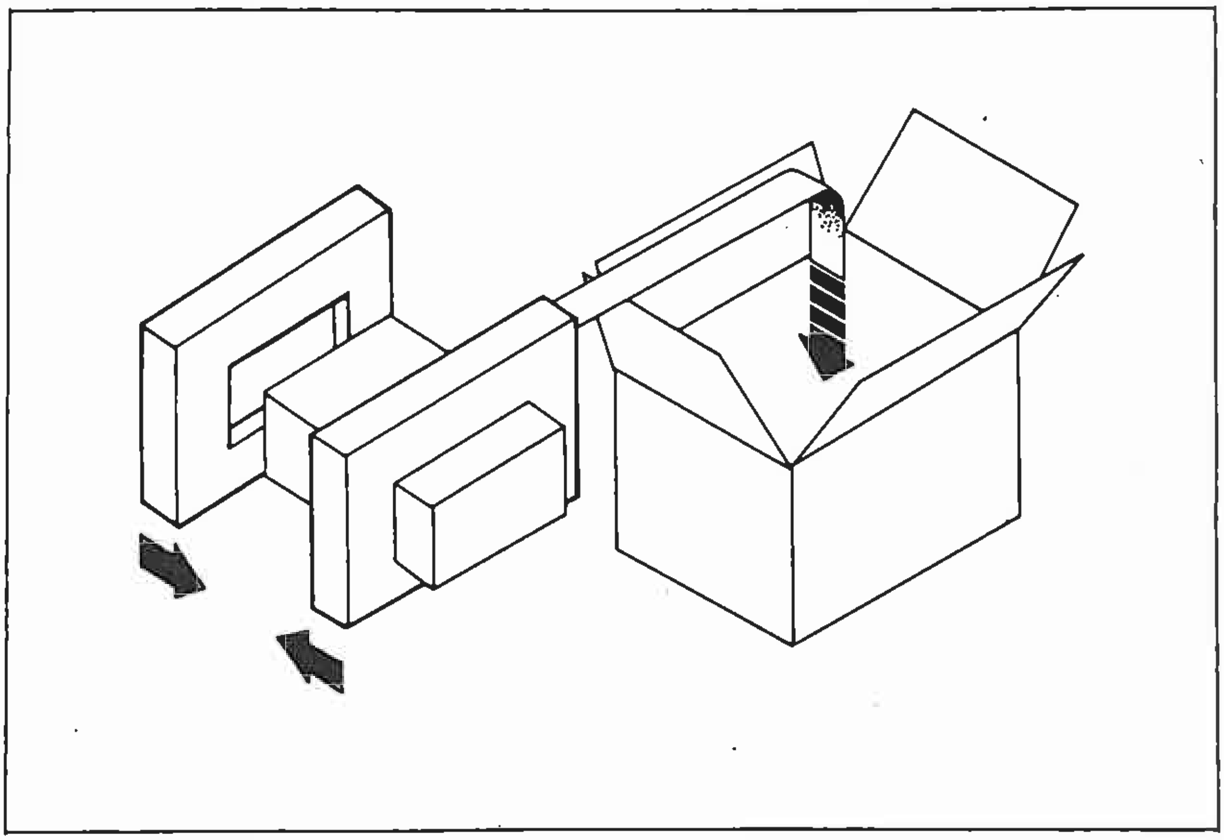


Figure 2-10. Packing Diagram.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

The 8210 is a compact, microprocessor-controlled, internally calibrated AM/FM modulation meter that covers the carrier frequency range of 2 MHz to 1.5 GHz. Amplitude modulation or frequency modulation is displayed on a four-digit LED display that provides a maximum resolution of 0.01% a.m. or 10 Hz deviation. Signal acquisition, display operation, calibration, and instrument control is accomplished using a microprocessor.

Operation of the 8210 is fully automatic. The largest signal present at the RF IN connector is converted to a 400 kHz intermediate frequency, which is adjusted to a convenient level for a.m. measurements. The modulation depth of a.m. signals is equal to the peak amplitude of the recovered audio signal divided by the d.c. level of the a.m. detector. The deviation of an f.m. signal is equal to the peak amplitude of the recovered signal. The recovered modulation is converted into a proportional d.c. level, then into a digital display, by microprocessor-controlled detectors and an analog-digital (A-D) converter.

3-2. Circuits: General Discussion.

For this discussion the circuits of the 8210 are grouped by function, as follows: r.f., i.f., calibrator, a.f., logic, and power-supply circuits. Refer to Figure 3-1, a simplified block diagram of the 8210.

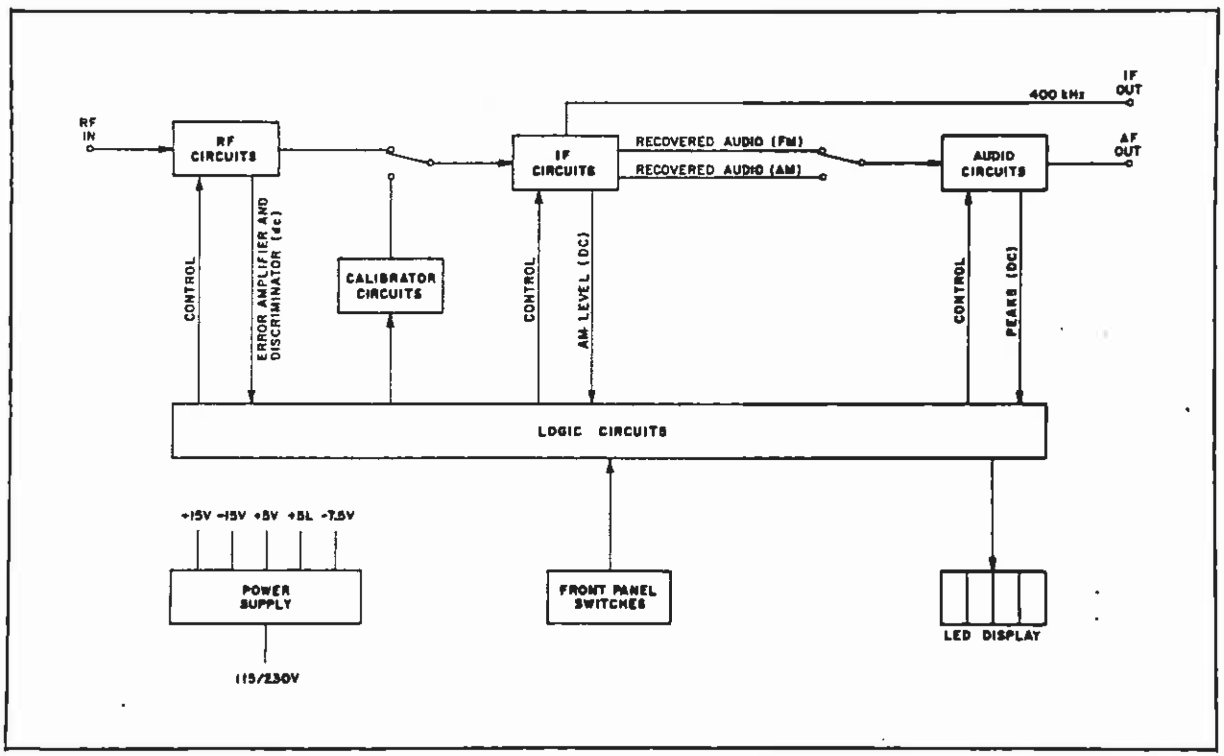


Figure 3-1. Simplified Block Diagram

a. R.F. Circuits. The r.f. input signal to be measured is applied to the r.f. circuits through the front-panel RF IN connector. This signal passes through a fixed 3 dB pad to a zero-order hold sampler. The sampler is fully bootstrapped to accept signals as large as 1 V, r.m.s., without overload.

3-2a, Continued.

A sampling pulse, generated from a tunable local oscillator, converts the r.f. signal into an i.f. signal at approximately 400 kHz. The i.f. signal is passed to the i.f. circuits and also through a filter to a limiter, a discriminator, and an error amplifier. Automatic frequency control is accomplished by these circuits in conjunction with the microprocessor.

b. I.F. Circuits. The i.f. signal from the sampler is filtered and amplified, then coupled to a.m. and f.m. detectors through a digital-to-analog (D-A) converter configured as a variable-gain element. The logic circuitry adjusts the converter so as to maintain a convenient d.c. level at the output of the a.m. detector. The last-mentioned is a linear active detector, which recovers the amplitude modulation of the i.f. and provides a d.c. signal proportional to the i.f. level. A portion of the a.m. detector output signal is used to drive a monostable multivibrator, which detects the f.m. modulation of the i.f. signal. Both a.m. and f.m. signals are amplified and applied to the a.f. circuits through a switch. During calibration, the signal from the r.f. circuits is disconnected from, and the calibrator signal is connected to, the i.f. circuits.

c. Calibrator Circuits. The calibrator circuits consist of a variable-modulus counter circuit and a precision attenuator. The variable-modulus counter is alternately programmed to divide the output of a 3.579 MHz crystal-controlled oscillator by eight or by ten. The resulting signal has an average frequency of 402 kHz, approximately, and a peak deviation of 44.74 kHz. This signal is used to calibrate the f.m. detector. In addition, a fixed-frequency signal is applied to a switchable attenuator, which is alternately programmed to attenuate by two-thirds and by one-third. The signal from the attenuator has an amplitude variation of two to one, and therefore is equivalent to a signal with 33.33% a.m.

d. A.F. Circuits. The recovered audio signal from the a.m. or the f.m. detector (as determined by the FUNCTION switch), is filtered by an active-filter circuit to remove i.f. components. Baseband processing circuitry, in the form of selectable low-pass filters, additional gain, and precision peak detectors -- all under the control of the logic circuitry -- convert the recovered signal into a digital display.

e. Logic Circuits. The logic circuits consist of a central processing unit (CPU), read-only memory (ROM), random-access memory (RAM), peripheral interface adapters (PIA), and a digital-to-analog converter (DAC). The CPU operates under control of a microprogram, stored in ROM, to monitor the frequency control, level control, peak-detector circuits, and the front-panel switches. In addition, the CPU controls and updates the front-panel displays, and operates all internal control circuits.

f. Power-Supply Circuits. The power-supply circuits convert the a.c. line voltage into well regulated d.c. voltages. Five power-supply voltages are used to operate the circuits in the 8210: +15, -15, -7.5, and separate +5 supplies for the analog and for the digital circuits.

3-3. CIRCUITS: DETAILED DISCUSSION.

a. R.F. Circuits. The r.f. circuits convert the r.f. input signal that is to be measured into a 400 kHz i.f. signal. With the assistance of a microprocessor, a local oscillator signal is generated and controlled so as to maintain this intermediate frequency. (Refer to Figure 3-2, a detailed block diagram of the r.f. circuits).

1. The input signal applied to the front-panel RF IN connector, J1, is passed through connectors J2 and P1 to a fixed 3 dB pad, which consists of R2-R4. This pad reduces the r.f. level, and improves the impedance match to the incoming signal. The output of the pad is connected to a sampling gate consisting of diodes CR2a-CR2d. The sampling gate and sampler amplifier, consisting of transistors Q2 through Q6 and associated components, constitute a zero-order hold sampler.

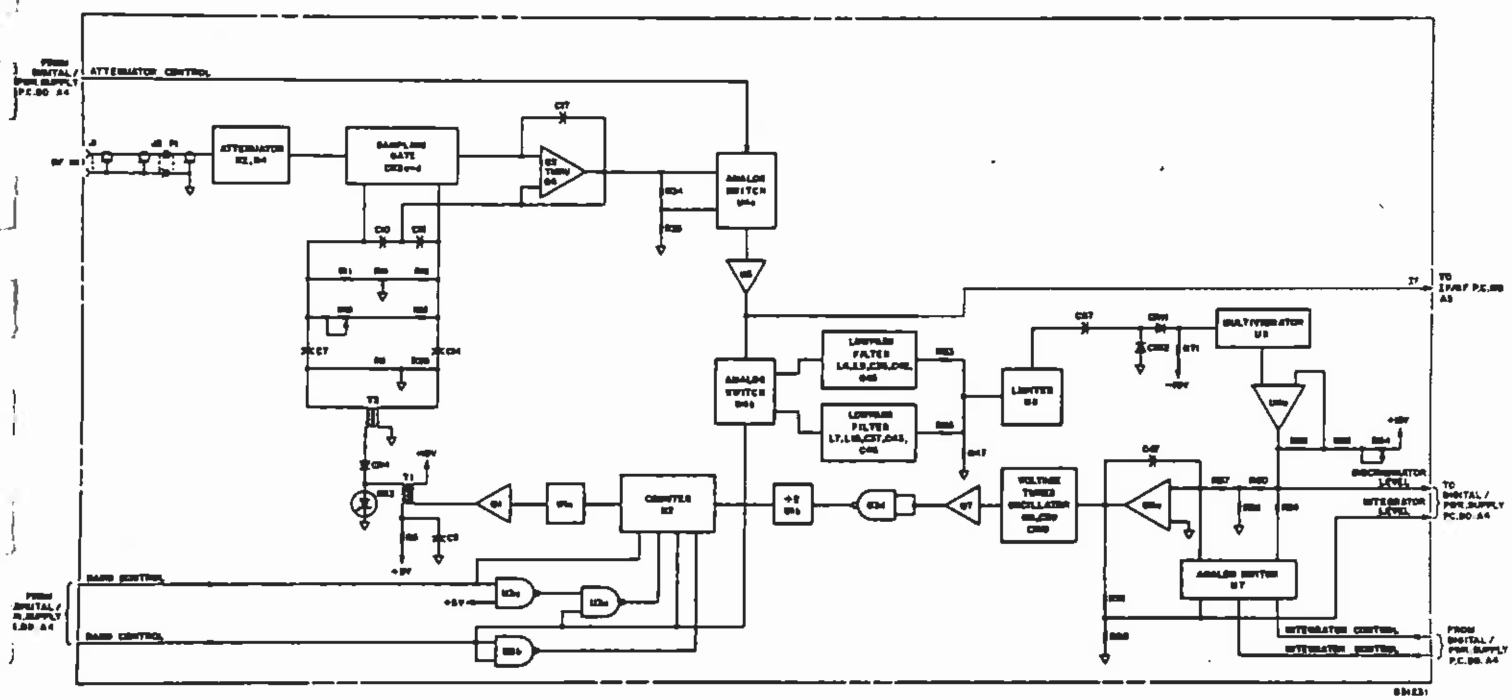


Figure 3-2. R.F. Circuits: Detailed Block Diagram.

2. The operation of the sampling gate is shown in simplified form in Figure 3-3. Each time the sampling gate is closed, by a short-duration pulse, the input capacitance of the sampler amplifier plus any stray capacitance is charged to a voltage that is less than the instantaneous r.f. 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 output voltage of the sampler amplifier is equal to the r.f. input at the time the sample was taken. This output voltage is held constant until the next sample is taken. Successive samples are taken until the r.f. 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.

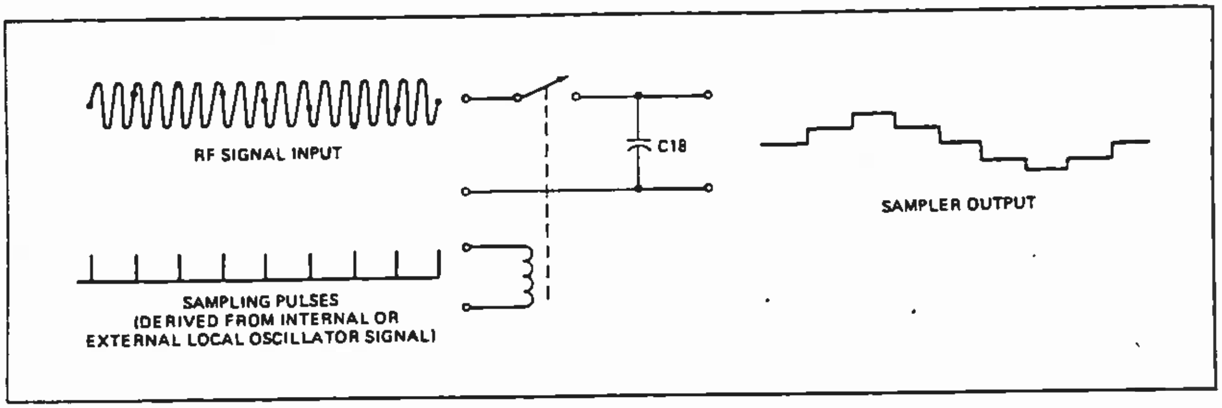


Figure 3-3. Sampling Gate: Simplified Operation

3. The output of the sampler 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 r.f. input level exceeds approximately 100 mV. Amplifier U5 increases the signal level about four times before it is coupled to the i.f. circuits. The output of U5 is connected also to a switchable low-pass filter composed of U4b, L6, L7, L9, L10, C36, C37, C42, C43, C45, and C46. This filter eliminates most of the 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 i.f. signal to TTL levels in order 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 zero volts, d.c., when the intermediate frequency is 400 kHz.

4. 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 f.m. response at high carrier frequencies. CMOS switch U7 can be programmed to "dump" the integrator or to bypass 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.

5. 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.

6. 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. At that time 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.

7. 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. At that time 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.

8. When a carrier is applied, an i.f. signal will be produced at a frequency that is between zero and one-half 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 i.f. is high or is low. If a valid 400 kHz i.f. is produced the integrator stops, and the by-pass of the integrator attenuator is removed. If no valid i.f. 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 i.f.

9. The capture performance of the system is determined principally by the limiter's gain and the bandwidth of the sampler. Weaker signals at the r.f. 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 f.m. sidebands at the output of the limiter.

b. I.F. Circuits. The i.f. circuits recover the a.m. and f.m.

signals from the frequency-shifted input signal. These circuits also provide a sample i.f. signal to the front-panel IF OUT connector; in addition, for a.m. measurements, they provide a d.c. signal proportional to the i.f. level. (Refer to Figure 3-4, a detailed block diagram of the i.f. circuits).

1. The 400 kHz i.f. signal from the r.f. 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 so as to give minimum a.m. indication when an f.m. signal is applied. Amplifier U2 has a closed-loop gain of four (approximately), as determined by R3, R4, R6 & R8. The signal is then connected to calibrator switch U3, and a.c.-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 in order to maintain the d.c. output of the a.m. detector between 0.5 and 0.6 volts. The amplifier that consists of U5, Q3, and associated components, increases the i.f. 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.

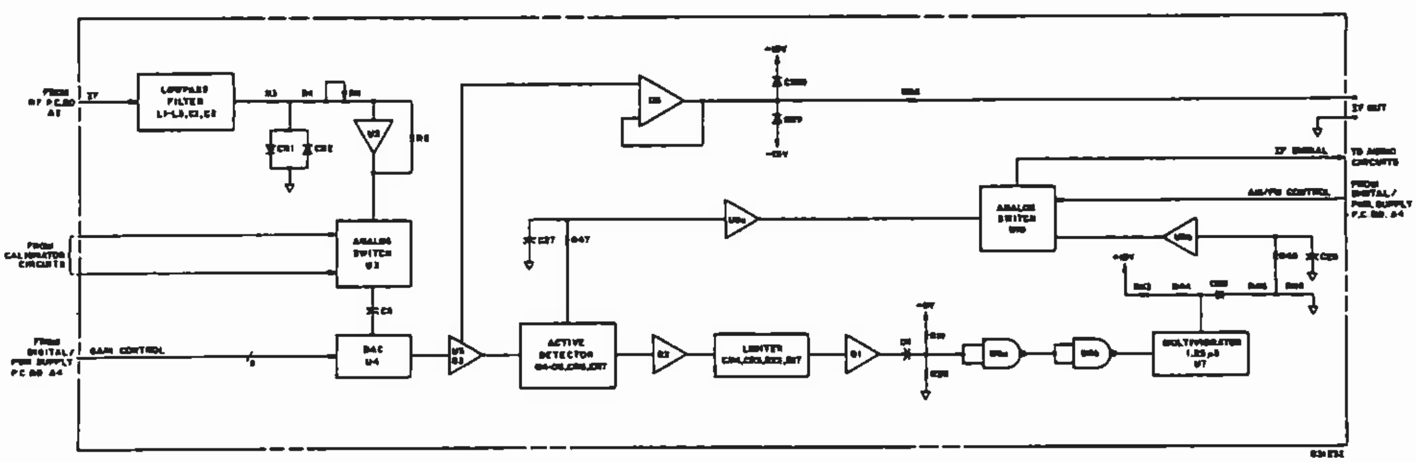


Figure 3-4. I.F. Circuits: Detailed Block Diagram

2. The active detector circuit, which comprises transistors Q4 through Q6, diodes 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.

3. The output at detector diode CR7 is a signal that contains a d.c. component proportional to i.f. level, and an a.c. 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 a.m.-f.m. switch U10.

4. 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 &R17, removes most a.m. from the i.f. 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.

5. The period of U7 is 1.25 us, approximately. The network consisting of R43-R46 and CR8 confines the peak-to-peak amplitude of U7's output to four volts. As the intermediate frequency changes, the duty cycle of the multivibrator--and consequently the average value of the waveform--changes proportionally.

6. The signal is lightly filtered by R48 and C28, then amplified and level-shifted by U9b. The signal is routed to the a.m.-f.m. switch U10, and to the audio circuits.

c. Calibrator Circuits. The calibrator circuits provide the reference calibration signals for the 8210's a.m. and f.m. detectors. See Figure 3-5. (In addition to the circuit description given below, technical information on design and operation of the calibrator circuits appears in Appendix A.)

1. The 1.79 MHz signal from U5a, pin 8, is connected to the clock input of synchronous counter U9. The counter is configured to self-load its data inputs at the end of each count cycle. By varying the input data with an 874 Hz signal from U1f, pin 2, the divide modulus is changed from four to five. The signal that results synchronously switches from 357.9 to 447.4 kHz, producing an average frequency of 402.6 kHz and deviation of 89.48 kHz, p-p. This signal is used to calibrate the f.m. discriminator. The signal is connected to data selector U12, along with a signal at 447.4 kHz from U3, pin 6, and an 874 Hz signal from U1f, pin 2. The outputs of the data selector are controlled by the signals from U16, pins 39 and 17. During the calibration cycle U16, pin 17 is "low"; pin 36 is set "high" for a.m. calibration, and "low" for f.m. calibration.

2. When the calibration routine initially selects AM FUNCTION, the outputs of the data selector are the signal from U3, and the 874 Hz signal from U1f, pin 2. The 447.4 kHz signal is

routed through a low-pass filter consisting of L1, L2, C6, C8 and C10 to the i.f. circuits. This signal is amplified (x2)

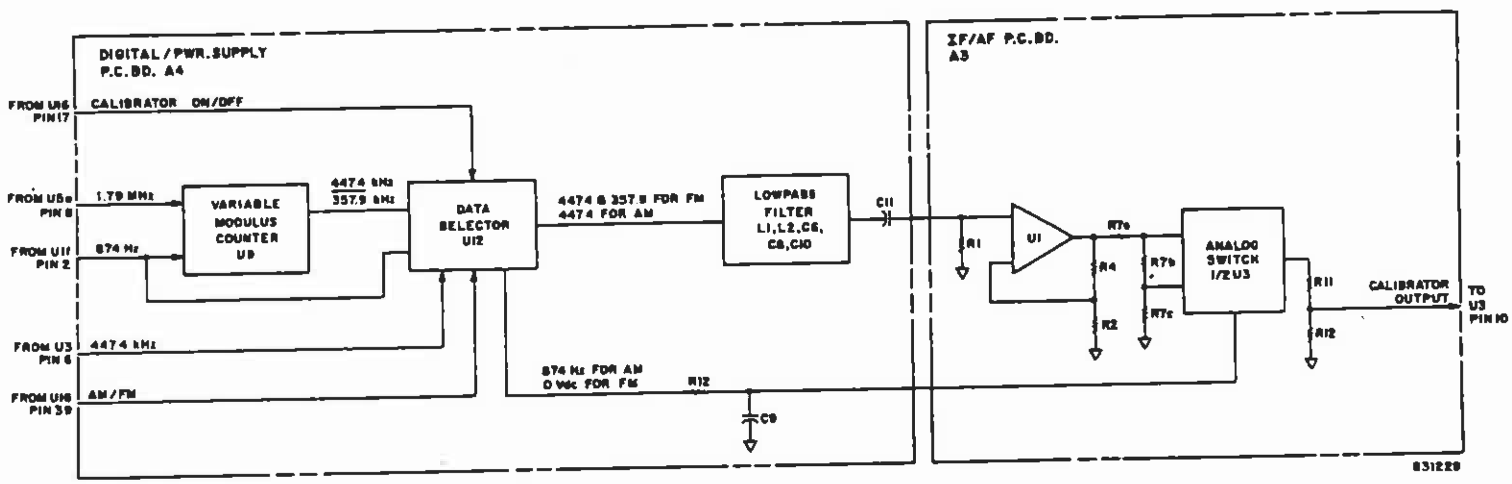


Figure 3-5. Calibrator Circuits: Detailed Block Diagram

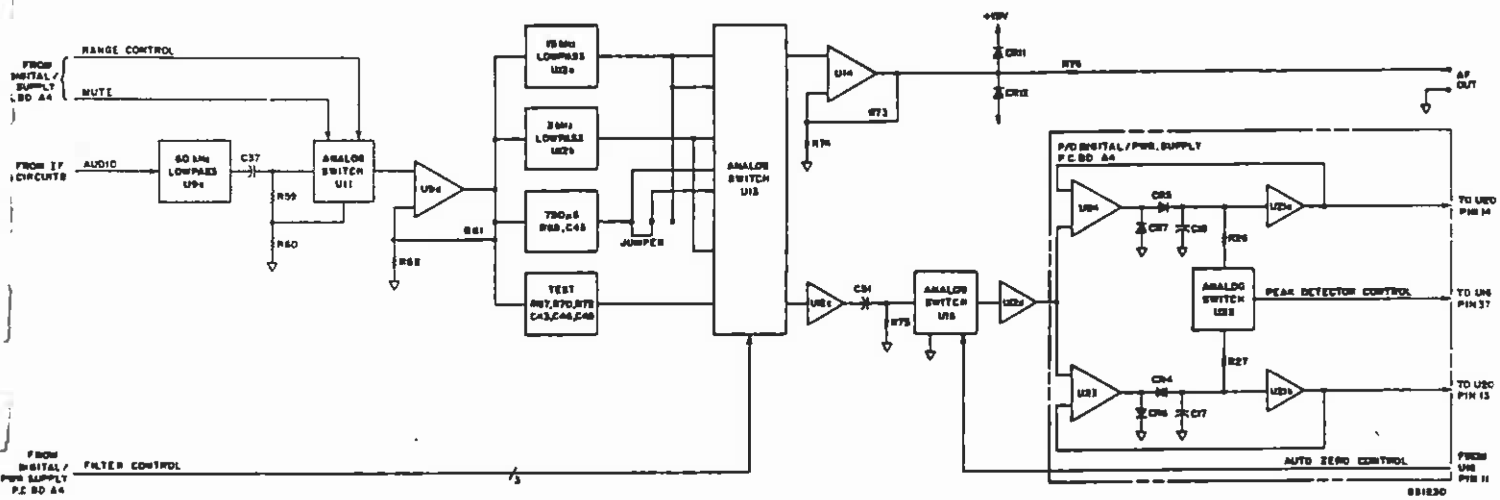


Figure 3-6. A.F. Circuits: Detailed Block Diagram

by A3U1 and applied to the voltage divider A3R7. The analog switch A3U3 is controlled by the 874-Hz signal from A4U12 so as to switch between two taps of the divider. The voltage ratio is exactly two, therefore the equivalent a.m. is 33.33%. This signal is coupled through an attenuator (R11 and R12) and the second half of switch A3U3 to the i.f. circuitry.

d. A.F. Circuits. The audio circuits process the recovered modulation signal supplied from the a.m. or the f.m. detector circuits--as determined by the front-panel FUNCTION switch. The recovered signal is filtered and converted to a d.c. level, which is then measured; the result is presented on the front-panel LED display. Refer to Figure 3-6.

1. The signal from the output of the a.m.-f.m. switch U10, is filtered by active filter U9c and associated components. This filter is part of three-pole 60 kHz filter, which removes most of the i.f. component from the recovered signal. The filtered signal is then a.c. coupled to a 20 dB attenuator: R59, R60. CMOS switch U11 selects either the signal, or the attenuated signal, as determined by the front-panel RANGE switch. Additionally, the logic circuitry can program U11 to disconnect the recovered signal in order to prevent audio-circuit overload when the instrument is unlocked.

2. The signal is then amplified (x11) by U9d and is coupled to the 15 kHz filter, the 3 kHz filter, and the 750 us de-emphasis network. U12a and associated components form the 15 kHz filter; U12b and associated components for the 3 kHz filter. Both are three-pole Butterworth types. The 750 us de-emphasis network is a single RC section: R69, C45. A jumper circuit is provided to give the option of connecting the de-emphasis network either before or after the measuring circuits.

3. CMOS switch U13 selects one of the three filters, as determined by the front-panel FILTER switch. In addition, the logic circuitry can program U13 to select--during calibration--a filter consisting of R67, R70, R72, C43, C46 and C48. One of the outputs of U13 is amplified (x 2.5) by U14 and routed to the front-panel AF OUT connector. The other output is buffered by voltage-follower U12c and a.c. coupled to U15, an auto-zero switch. U15 is operated by the logic circuitry to disconnect the recovered signal for a period of time adequate to determine the output of the peak detectors with no input. The switch is then closed, and the modulation signals are connected through buffer U12d to the peak detectors.

4. The positive-peak detector consists of U24, U21a, CR5, CR7 and C18. During the positive excursion of the modulating signal, the output of U24 is driven positive; C18 then charges through CR5. U21a buffers the voltage across C18, and adds a small offset. When the output of U21a reaches a value equal to the peak of the waveform plus a small increment, the output of U24 goes negative and thus terminates the charging. The voltage at the output of U21a is then equal to the positive peak of the modulating signal.

5. Similarly, U23, U21b, CR4, CR6 and C17 constitute a negative-peak detector. In addition, U22 provides a means for resetting both detectors for auto-zero measurements.

e. Logic Circuits. The logic circuits generate all control and display functions in the 8210. The logic circuits consist of a CPU, 8192 bytes of ROM, 2048 bytes of non-volatiile RAM, two PIA's, a DAC, and several IC gates and drivers.

The CPU, U8, is controlled by a program stored in ROM (U11). Temporary program variables and subroutine return addresses are stored in RAM (U13). The control functions of the 8210 are directed by U16, a PIA; keyboard and display functions are directed by the PIA U17. See Figures 3-7 and 3-8.

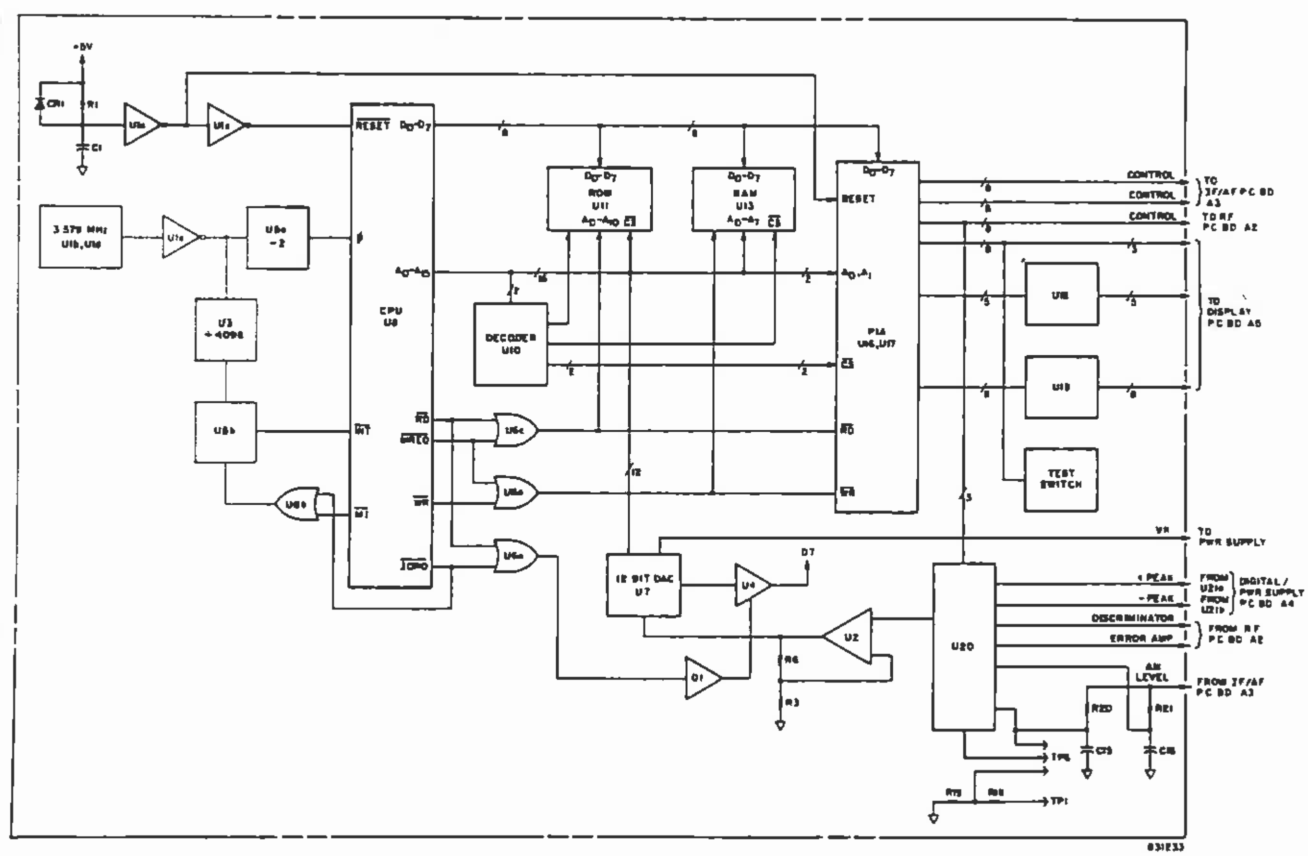


Figure 3-7. Logic Circuits: Detailed Block Diagram

1. The control program initializes the RAM and PIA circuits and checks the status of the test switch during the power-up sequence. The display is then enabled, and interrupt processing of the keyboard and the display begins. As each digit of the display is updated, each row of keys is tested simultaneously, and any key closures are detected. The firmware code is then displayed then, the main program loop begins. The latter places the highest priority on successful frequency acquisition, then on establishing the proper i.f. level, and finally on measuring the recovered signal. The program checks level and frequency each time through the main loop, so i.f. errors are detected immediately. When proper operating parameters are established, the recovered signal is processed.

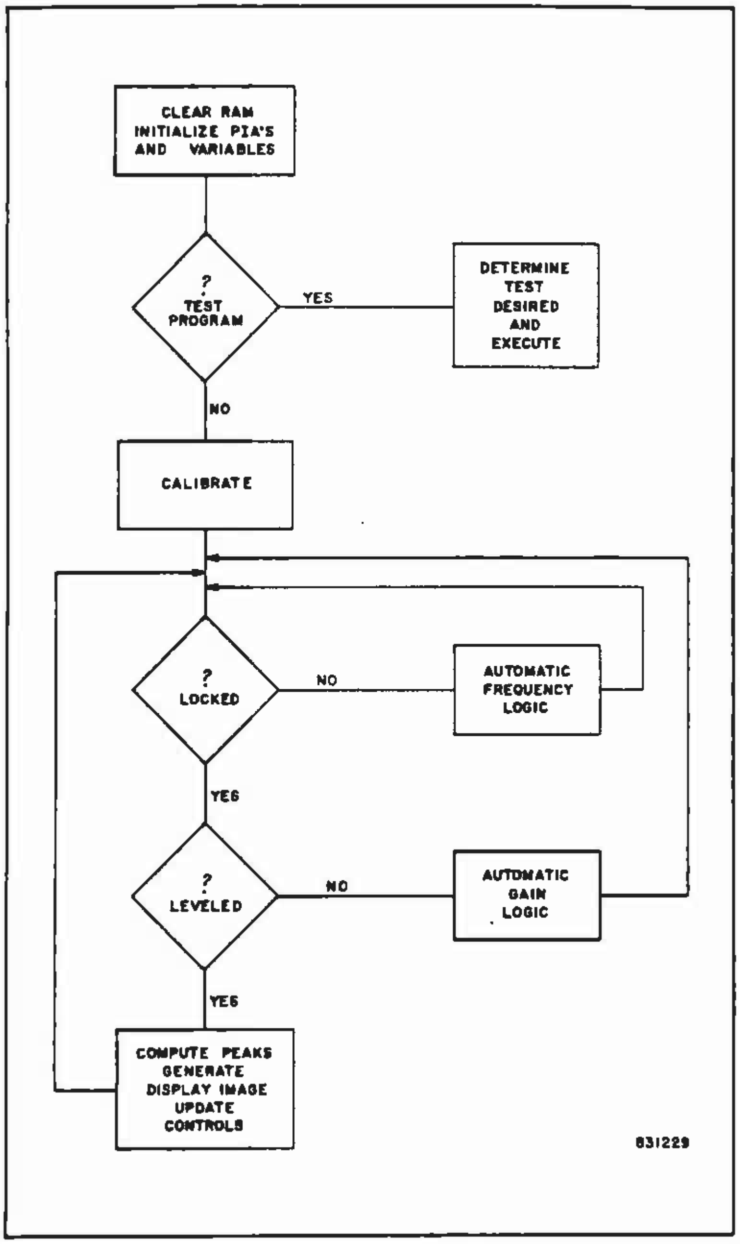


Figure 3-8. Program Flow Diagram

2. The program executes an auto-zero cycle each time a measurement is made. The audio signal is turned off, the peak detectors are reset and released, and both detectors are read. The information is stored temporarily. The peak detectors are reset, audio is turned on, and the detectors are released. They are read again and the "zero" information is subtracted. The display is then updated with the data determined by the setting of the front-panel PEAK switch.

3. All d.c. voltage measurements are made by the successive approximation A-D converter consisting of U7, U4, Q4, and associated components. The successive trial values are software generated, and sent to the 12-bit DAC (U7) via the address bus of the CPU. An I-O read cycle (signaled by IORQ = RD = LO) returns the comparison (made by U4) of the DAC value and the input d.c. signal on data line D7. A complete conversion requires 12 successive tests to converge within 1 LSB. U2 serves as a fixed-gain buffer to isolate U20, the CMOS multiplexer,

from the A-D converter circuits low input impedance.

4. The CMOS multiplexer, U20, is operated by the program to select various voltages from the 8210's circuits. Both peak detectors are connected to it, as are the outputs of the integrator and the discriminator from the r.f. circuits, and the d.c. level from the a.m. detector. The a.m. detector output is filtered by R21 and C16 to provide one a.m. level input and by R20 and C15 to provide another. The two a.m. detector inputs are used during i.f. level setting and a.m. depth measurements: the moderately filtered one for testing the level, the heavily filtered one for computing a.m.

5. U1b, U1d, and U1e constitute a crystal-controlled oscillator, with the 3.58 MHz crystal frequency divided by a factor of two by U5a. The output of U5a is connected to the clock input of the CPU. The 3.58 MHz signal is also divided by a factor of 4096 by U3, to generate the 1.1 ms interrupt signal. U5b is clocked by this signal going high, which activates the INT line of the CPU and causes an interrupt to occur. The CPU recognizes the interrupt; it acknowledges by setting lines IORQ and M1 low. Thus U5b is reset, and the interrupt condition is cleared. The interrupt program updates the display and interrogates the keyboard, then returns to the main program.

6. U10 decodes the address lines to enable the IC's of ROM, RAM, and PIA. The program ROM is located from address 0 to FFF hex; the RAM is located at addresses 2000 to 27FF hex; the display PIA, IC7, is located at address 4000 hex; and the control PIA, IC6 is located at address 6000 hex.

7. A circuit composed of U1a, U1c, R1, C1 and CR1 resets the CPU and PIA IC's at power-up.

8. Non-volatile operation of A4U13 is controlled by U31. This circuit switches the Vcc connection of A4U13 from the +5L supply to the battery supply, BT1, when the +5L supply falls below the battery voltage. Additionally, U31 inhibits the chip enable signal at pin 18 of A4U13 when the +5L supply drops below 4.75 volts. This action insures that the RAM contents will not change when power is removed.

f. Power-Supply Circuits. The power-supply circuits provide d.c. operating power for all other circuits of the instrument. Regulated output voltages of +15, -15, +5(L), +5, and -7.5 volts are provided. The power supplies are designed to operate from a 100, 120, 220, or 240 volt (nominal) a.c. power source. Refer to Figures 6-2 and 6-7.

1. Power is applied to the primary windings of power transformer T1 through the power connector P1, line fuse F1, line-voltage selector switch S1, and the front-panel LINE switch. S1 is set by the user in accordance with the available a.c. power source.

2. Two separate secondary windings of T1 supply a.c. voltages to the rectifier circuits, through connector J6. Bridge rectifier CR8 and capacitor C23 generate an unregulated d.c. output, which supplies power to U26 (a five volt, three-terminal regulator). CR10 and CR15 protect the regulator from reverse voltages during power-on and power-off

transients. C26 and C33 improve the transient response of the regulator. The unregulated output of CR8 also is connected to a second regulator, U25, which is enclosed in the feedback loop of U29c. This connection produces a precision +5 volt supply for the analog circuitry of the 8210.

3. The reference output of U7 (Figure 6-5) is filtered by R31b and C34, and applied to pin 3 of U29a. This provides a reference for the generation of the +15 volt supply. R31 is actually an array of eight matched 10K ohm resistors, three of which are connected in series between +15 volts and ground. Since the junction of R31a and R31c is connected to pin 2 of U29a, the feedback loop will cause the voltage at this point to be +10.00 volts within the offset of U29a. Consequently, the voltage at the junction of R31c and R31e will be +5.00 volts. This voltage becomes the reference for U29c, which generates the precision +5 volt supply.

4. The -15 volt supply is generated by U28 and U29b, and associated components. A sample of the regulated output voltage of the supply, developed by the resistive divider composed of R31d and R31f, is compared to ground. Error voltages are amplified by U29b, and are coupled to regulator U28 in order to adjust the output voltage so as to reduce the error. In this manner the -15 volt supply is made to track the +15 volt supply.

5. One additional supply voltage is generated; its components are a resistive divider (R31h and R31g), and U29d. The latter is connected as a voltage follower in order to buffer the -7.5 volts at pin 5.

6. All regulators are protected from reverse bias by diodes both from their outputs to ground, and from their outputs to inputs.

7. Capacitors at input and output terminals improve the transient response of the supplies.

8. Diodes CR12, CR14, and CR16 ensure proper start-up of the supplies.

SECTION IV
MAINTENANCE AND ADJUSTMENT

4-1. INTRODUCTION
This section contains maintenance and adjustment instructions for the Model 8210. Symptomatic and systematic troubleshooting procedures for localizing a malfunction are given, as well.

4-2. TEST EQUIPMENT REQUIRED
The test equipment that is required for maintenance and adjustment of the Model 8210 is listed in Table 4-1, below. Other models of test equipment that meet or exceed the Critical Specifications may be used instead.

Table 4-1. Required Test Equipment for Maintenance and Adjustment

EQUIPMENT	CRITICAL SPECIFICATIONS	SUGGESTED MODEL
Signal Generator	AM/FM 0.01 to 520 MHz -30 to +10 dBm.	Boonton Electronics 102E-19
Oscilloscope	100 MHz Bandwidth. 5 mV Sensitivity.	Hewlett-Packard 1740A
Audio Oscillator	20 Hz to 75 kHz. Constant level of 110 mV, with low distortion.	Boonton 1120 & HP 204C
A.C. Voltmeter	10 mV to 2 V. Accuracy 1%, 50 Hz to 1 kHz.	Boonton Electronics 93AD
Digital D.C. Voltmeter	100 mV to 20 V. Accuracy 0.15% at 15 V.	Data Precision 1350
Frequency Counter	20 Hz to 5 MHz. Sensitivity 100 mV.	Data Precision 5740 & Fluke 8840
Signature Analyzer	> 3.5 MHz Operating Frequency	Hewlett-Packard 5004A

4-3. LOCATION OF MAJOR ASSEMBLIES
See Figures 4-1 and 4-2 for the location of the major assemblies of this instrument.

4-4. REMOVAL OF MAJOR ASSEMBLIES AND PARTS
a. Instrument Covers.

1. Disconnect all signal cables and the power cord from the 8210.

2. Remove two #4-40 screws securing the top cover at the rear panel.

3. Remove the cover by lifting up and toward the rear of the unit.

4. Turn the instrument over and remove the two #4-40 screws securing the bottom cover.

5. Remove the bottom over as in Step 3.

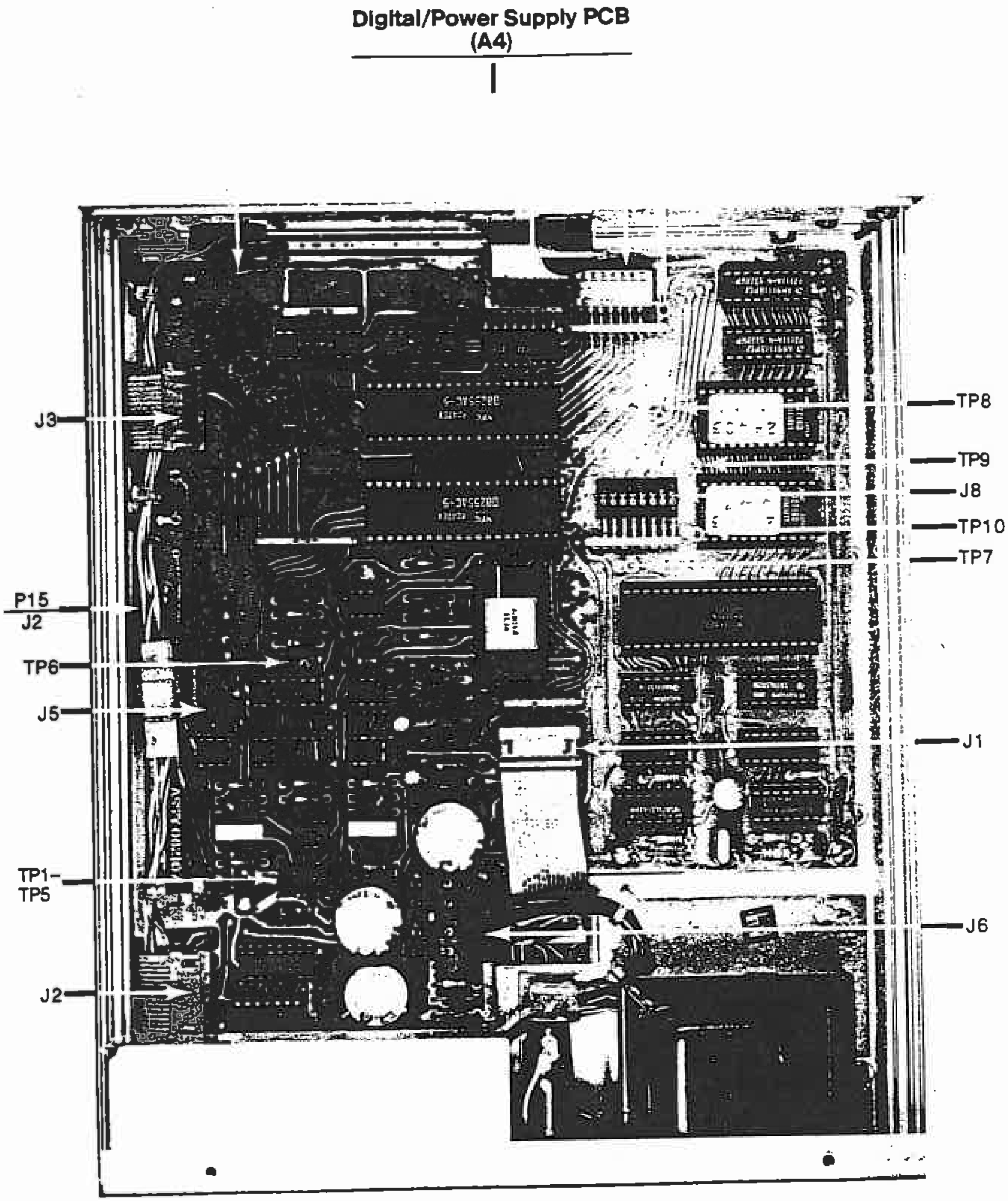


Figure 4-1. Model 8210: Top View with Covers Removed

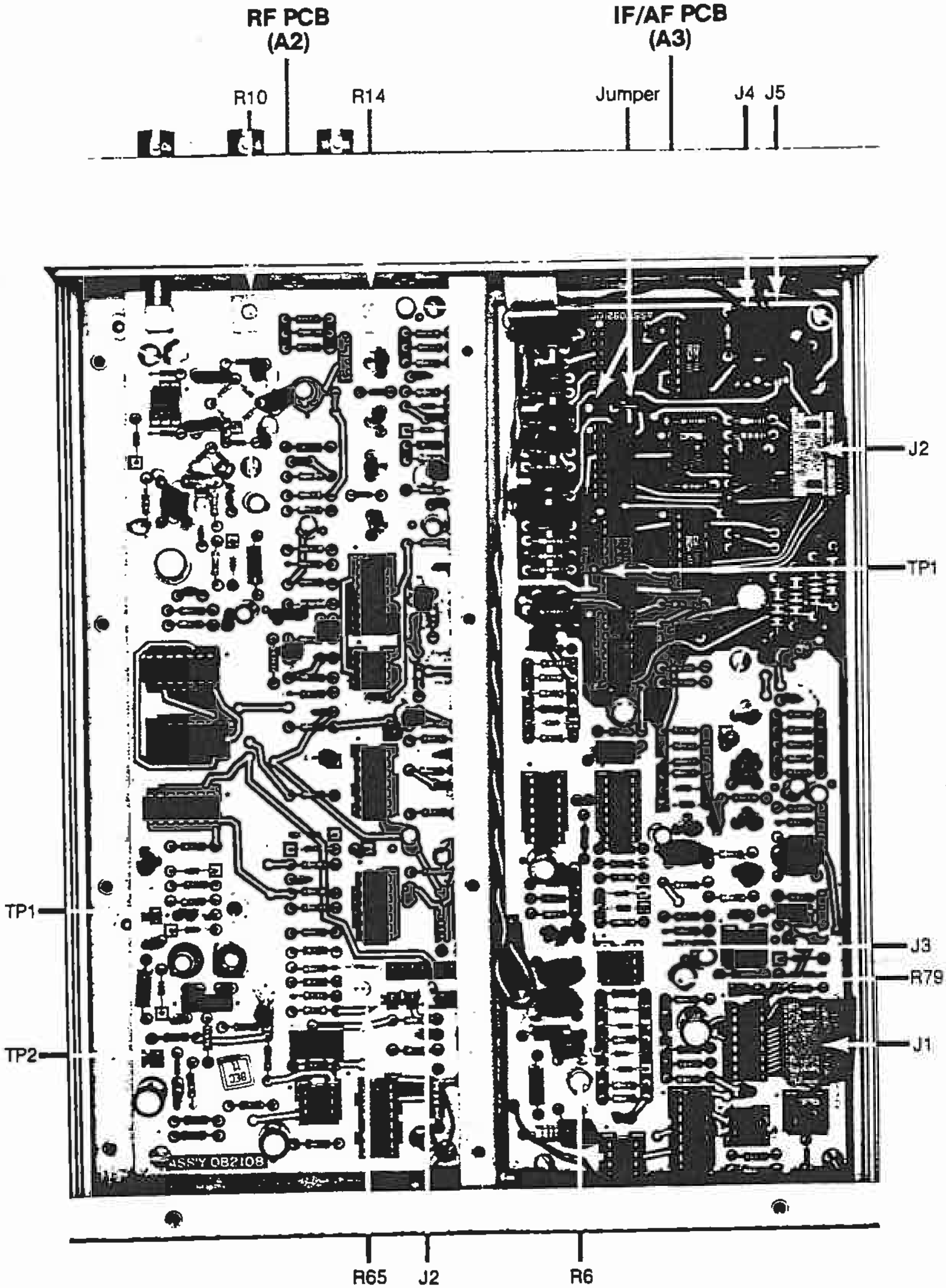


Figure 4-2. Model 8210: Bottom View with Covers Removed

4-4. Continued

b. R.F.-Assembly Cover.

1. Remove the 8210's covers as in paragraph 4-4a.

2. Place the instrument on a smooth working surface, with the bottom side up.

3. Remove the nine #4-40 screws that secure the R.F. Assembly cover.

4. Push the cover toward the rear of the instrument and lift the front of the cover upwards.

5. Pull the cover toward the front of the instrument and remove it.

c. R.F. Circuit Board.

1. Remove the instrument's covers (para. 4-4a).

2. Remove the cover of the r.f. assembly (para. 4-4b).

3. Remove the i.f. connection at the r.f. circuit board.

4. Turn the instrument over and disconnect ribbon connector A1P4.

5. Remove the five #4-40 screws and the one hex standoff securing the circuit board.

6. Carefully slide the circuit board toward the rear of the instrument to disengage the r.f. input connector.

7. Lift the circuit board out of the instrument.

d. I.F./A.F. Circuit Board.

1. Remove the instrument covers (para. 4-4a.)

2. Remove the i.f. connection at the rear of the i.f.-a.f. circuit board.

3. Disconnect both ribbon connectors on the left edge of the circuit board.

4. Disconnect 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.

5. Remove the five #4-40 screws securing the circuit board, and lift out the board.

e. Rear-Panel Assembly.

1. Remove the instrument covers (para. 4-4a.)

2. Disconnect the power connector, A1P14.

3. Disconnect the power-switch connector, A1P15.

4. Remove three #6-32 screws securing the rear panel to the chassis.

5. Remove two #4-40 screws securing the rear panel to the power-supply heat sink.

6. Pull the rear panel away from the chassis.

f. Digital circuits and Power-Supply Board.

1. Remove the instrument covers (para. 4-4a.)

2. Disconnect the four ribbon connectors A1P7, A1P8, A1P9 and A1P11.

3. Disconnect pin connector A1P13.

4. Disconnect two-pin connector A1P10.

5. Remove the rear-panel assembly (para. 4-4e).

6. Remove seven #4-40 screws securing the circuit board, and lift the board out of the chassis.

g. Display Circuit Board (Access or Removal).

1. Remove the instrument covers (para. 4-4a.)

2. Remove three #4-40 screws securing the top trim-strip extrusions and grounding clip.

3. Grasp the trim strip by its edges and pull it away from the instrument's frame.

4. Carefully remove the plexiglass display window.

5. Turn the instrument over and remove the bottom trim-strip extrusion as in Steps 2 and 3 above.

6. Tilt the bottom of the front trip panel away from the instrument until all switches are cleared, then put the front panel up and out to clear the center trip extrusion.

NOTE: This completes the procedure for gaining access to the Display Circuit Board. If it is necessary to remove the board, carry on as follows:

7. Disconnect the ribbon-cable connector from the rear of the board.

8. Disconnect the power-switch connector, A1P15.

9. Disconnect the power-indicator connector, A1P13.

10. Remove the two #4 flat-head screws securing the center trim extrusion. Lift out the extrusion.

11. Remove the four #4-40 screws securing the circuit board, and lift the board out of the instrument.

4-5. REMOVAL OF DETAIL PARTS.

In the design of the 8210, much thought was given to maintainability. Most detail parts are readily available for checking and replacement once the instrument's covers and shields are removed. Solid-state components, on plated-through circuit boards, are used throughout the instrument. Sockets are used for all active components except for the power-supply regulators. Standard printed-circuit-board maintenance techniques are required for the removal and replacement of parts. Excessive heat must be avoided; a low-wattage soldering iron, together with suitable heat sinks, should be used for soldering and unsoldering operations.

4-6. PRELIMINARY CHECKS.

a. Visual Check. If equipment malfunction occurs, perform a visual check of the 8210 before performing electrical tests. Visual checks often help to isolate, quickly and simply, the cause of a malfunction. Inspect for signs of damage caused by excessive shock or vibration, such as: broken wires, loose hardware, and loose electrical connections. Then check for signs of overheating, which may be caused by an electrical short-circuit of an accumulation of dirt and other foreign matter.

Correct any problems discovered through the visual check. If the trouble persists, proceed with the electrical checks.

b. Power-Supply Check. Improper operation of the 8210 may be caused by incorrect d.c. operating voltages. Before proceeding with any other electrical checks, perform the power-supply checks given in Table 4-2.

* * * * * * * * * * * * * * * * WARNING * * * * * * * * * * * * * * * *

Line voltages up to 240 volts, a.c., may be encountered in the power supply circuits. To protect against electrical shock, observe suitable precautions when connecting and disconnection test equipment, and when making voltage measurements.

Table 4-2. Power-Supply Checks

STEP	PROCEDURE	NORMAL INDICATION
1.	Set the LINE switch to ON. Using a digital voltmeter, measure the d.c. voltage at the +15 V supply rail, A4TP5.	14.75 to 15.25 V
2.	Using a digital voltmeter, measure the d.c. voltage at the -15 V supply rail, A4TP2.	-14.75 to -15.25 V
3.	Using a digital voltmeter, measure the d.c. voltage at the +5 V supply rail, A4TP4.	4.90 to 5.10 V
4.	Using a digital voltmeter, measure the d.c. voltage at the -7.5 V supply rail, A4TP3.	-7.33 to -7.68 V
5.	Using the digital voltmeter, measure the d.c. voltage of the +5 (L) supply (pin 24,A4U11).	4.75 to 5.25 V
6.	Using an oscilloscope, measure the a.c. ripple at the +15, -15, +5 and -7.5 V supply rails.	Less than 1 mV, Peak-to-Peak.

In case of abnormal indications, refer to Table 4-11, a systematic troubleshooting chart for the power supplies.

4-7. TROUBLESHOOTING.

a. Concepts. Logical trouble-localization involves three major procedures:

1. Symptomatic troubleshooting, used to localize the cause of a malfunction to a major circuit group.
2. Systematic troubleshooting within the affected circuit group, used to localize the cause to a specific circuit or stage; and,
3. Voltage measurements, waveform analysis, or signature analysis -- all used to isolate the defective part.

b. Symptomatic Troubleshooting: Discussion. The design of the Model 8210 facilitates symptomatic troubleshooting. Various "condition codes" are displayed both as a guide to proper operation and to localize a malfunction to a major circuit group (see Table 4-3). Moreover, certain circuit groups can be switched in and out of operation by an internal seven-position Test Switch (refer to Tale 4-4). With a grasp of the detailed block diagrams (Figures 3-1 through 3-8), and of the function of each position of the Test Switch, along with manipulation of the front-panel controls, the user is well on the path to localizing the cause of a malfunction to one or more of the major circuit groups. In addition, a variety of symptoms is listed in Table 4-5, together with the probable causes of the malfunctions.

c. Systematic Troubleshooting: Discussion. Once you have localized the cause of a malfunction to a major circuit group, refer to the appropriate Systematic Troubleshooting Chart (Tables 4-6 through 4-11). These charts give instructions to help further localize a cause of malfunction to a particular stage or even to the component of that stage likely to be causing the trouble.

d. Measurements and Analysis: Discussion. The 8210 uses both analog and digital circuitry. Tables 4-6 through 4-11, information on the schematic diagrams (Figures 6-1 through 6-7), and waveform data in Table 4-12, are intended to assist in troubleshooting the analog circuits. Frequently this will suffice--without having to look into the digital circuitry. In case the tests in the analog portions have not solved the problem, some of the troubleshooting tables continue with tests (still using an oscilloscope and voltmeter), for the digital portions of the circuits.

However, the digital circuitry of the 8210 uses a microprocessor in a bus-oriented system. In such circuits, d.c. and a.c. measuring instruments are not always adequate to isolating problems, and a new technique, called signature analysis, has been developed. The troubleshooting chart of the 8210's logic circuits accordingly has tests that utilize an oscilloscope, and also has tests that call for signature analysis.

A complete discussion of signature analysis is beyond the scope of this manual; however, a brief description will aid in understanding its use in maintenance of the 8210.

Long, complex data streams are present in any microprocessor bus-oriented system. In signature analysis, with the system operating at normal speed, these data streams are compressed into concise, easy-to-interpret readouts (signatures) measured at pertinent data nodes. By choosing the appropriate measuring periods, or windows, signatures become unique: one, and only one, signature occurs at any given node of the instrument in normal operation.

Using a test device known as a signature analyzer you can therefore proceed through the instrument in an orderly fashion: you compare the signature you find at each specified node to the signature that the instrument's manufacturer tells you ought to be at that node, until an improper signature is obtained. Generally, at that point it is possible for you to deduce which component is the most probable cause of the malfunction.

Table 4-3. Condition-Code Displays

DISPLAY	MEANING
CAL	Instrument in Calibration (takes approximately 30 seconds)
cc1	8210 has failed to calibrate properly the a.m. channel.
cc2	8210 has failed to calibrate properly the f.m. channel.
----	8210 is unlocked, due to improper r.f.-input frequency or level or to a malfunction in the r.f. circuits.
--	8210 is in unleveled state, due to low modulation frequency or to a malfunction in the i.f. circuits.
IFLO	R.F. input too low in amplitude, or there is a malfunction in the r.f. circuits.
IFHI	R.F. input too high in amplitude, or there is a malfunction in the r.f., i.f., or a.f. circuits.
dSP	The panel Meter is over-ranged.

Table 4-4. Troubleshooting Test-Switch Chart

SWITCH POS.	FUNCTION	AID IN TROUBLESHOOTING THE FOLLOWING CIRCUITS
1	Disables the automatic frequency lock loop.	a. Oscillator b. Band-Switching c. Attenuator d. Discriminator e. Integrator f. Logic
2	Disables the automatic gains control loop.	a. Automatic gain control b. Logic
3	Disables the frequency control loop and the auto-zero circuit.	a. Audio b. Peak Detector c. Voltmeter
4	Operates data-acquisition circuits in an endless loop.	a. Voltmeter b. Logic
5	LED Test: enables the display (lights all segments), decimal points & annunciators.	a. Logic; ports A, B & C of U17 and associated buffers b. Display circuit-board assembly.

Table 4-4. Troubleshooting Test-Switch Chart, (continued)

SWITCH POS.	FUNCTION	AID IN TROUBLESHOOTING THE FOLLOWING CIRCUITS
5 Plus LEVEL	Tests I/O port of U16. Loads three output ports with hex 55 or hex AA, depending upon PEAK setting.	a. Logic; ports A, B & C of U16-used for logic control of r.f., i.f. a.f. and calibrator circuits.
6	8210 displays month and year of the installed program	a. Facilitates testing (signature analysis) of special or updated versions. b. Aids in ordering correct spare PROMS.
7	Operates calibrator circuits in an endless loop.	a. Calibrator b. I.F. c. A.F.

Table 4-5. Symptomatic Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE OF MALFUNCTION
After power-on, and depressing the LEVEL key while the firmware date is displayed instrument fails to display CAL.	One of the Test Switches (A4S1) is on; or defective logic circuits (refer to Table 4-9).
During Calibration cycle, 8210 displays cc1.	Defective calibrator circuits (see Table 4-10); or defective i.f. circuits (refer to Table 4-7).
During calibration cycle, 8210 displays cc2.	Defective i.f. circuits (refer to Table 4-7).
The 8210 fails to exit from CAL mode.	Defective logic circuits (refer to Table 4-9).
Instrument fails to lock.	Defective r.f. circuits (Table 4-6)
8210 locks but fails to level properly.	Defective i.f. circuits (refer to Table 4-7).
8210 displays IFLO when proper signal is applied to RF IN.	Defective i.f. circuits (refer to Table 4-7).
8210 displays IFHI when proper signal is applied to RF IN.	Defective i.f. circuits (refer to Table 4-7).
A.M. incorrect or inoperative.	Defective r.f. circuits (Table 4-6) Defective a.f. circuits (Table 4-8)
F.M. incorrect or inoperative.	Defective a.f. circuits (Table 4-8)

Table 4-5. Symptomatic Troubleshooting Chart (continued)

SYMPTOM	PROBABLE CAUSE OF MALFUNCTION
One or more low-pass filters inoperative.	Defective a.f. circuits (refer to Table 4-8).
One or more peak indications incorrect.	Defective a.f. circuits (refer to Table 4-8).
One or more panel switches inoperative.	Defective logic circuits (refer to Table 4-9).
One or more switch annunciators inoperative.	Defective logic circuits (refer to Table 4-9).
All digital panel-meter displays incorrect or inoperative	Defective logic circuits (refer to Table 4-9).
8210 does not range properly	Defective a.f. circuits (Table 4-8)
AF output missing or incorrect.	Defective a.f. circuits (Table 4-8)
IF output missing or incorrect.	Defective i.f. circuits (Table 4-7)

Table 4-6. Systematic TroubLeshooting Chart: R.F. Circuits

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
* * * * * * * * * * * *		OSCILLATOR CIRCUITS	* * * * * * * * * *
1.	Power off. Set Test Switch (A4S1) Pos. #1 to "on". Remove r.f. cover & turn power on. Connect 'scope to A2TP1.	R.F. signal between 26 & 38 MHz, > 1 V, p-p	Isolate defective component in oscillator circuit A2Q8 A2CR10.
2.	Connect 'scope to collector of A2Q7.	TTL signal between 26 & 38 MHz.	Replace A2Q7 or A2CR7.
3.	Connect 'scope to pin 8 of IC A2U3d.	TTL signal between 26 & 38 MHz.	Replace A2U3.
4.	Connect 'scope to pin 9 of A2U1.	TTL signal between 13 & 19 MHz.	Replace A2U1.
5.	Connect 'scope to pin 3 of A2U1. Depress +PEAK button.	TTL signal, approx. 4 MHz.	Replace A2U2, A2U3; or malfunction in logic circuits. (steps 28-33)
6.	Depress 3 kHz button.	TTL signal; frequency should decrease.	Same as in Step 5.

Table 4-6. Systematic Troubleshooting Chart: R.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
* * * * * * * * *	OSCILLATOR CIRCUITS (continued)	* * * * * * *	
7.	Depress the 750 us button.	TTL signal; frequency should decrease.	Same as in Step 5.
8.	Connect 'scope to pin 6 of A2U1.	See Waveform 1, in Table 4-12.	Replace A2U1; or check for open A2R13, A2C15.
* * * * * * * * * * * *	PULSE GENERATOR	* * * * * * * * * * * *	
9.	Connect 'scope to Collector of A2Q1.	See Waveform 2, in Table 4-12.	Check for open A2CR1, A2Q1, A2R1; or replace A2T1 or A2CR3.
10	Connect 'scope to junction of A2R8 and A2C7.	See Waveform 3, in Table 4-12.	Check for open A2C7 A2R8, A2R9, A2R20; replace A2T2 or A2CR4.
11	Connect 'scope to junction of A2C14 and A2R19.	Same as in step 10 but with reversed polarity.	Check for open A2C14, A2R19.
* * * * * *	RF INPUT, SAMPLER, AND SAMPLING AMPLIFIER	* * * * * * *	
12	Connect 'scope to junction of A2R12 and A2CR2b. Connect a 2.4 MHz, +7 dBm signal to RF IN connector.	2.4 MHz signal approximately 1.4 V peak-to-peak.	Check for open A2C3 or A2R3.
13	Connect 'scope to junction of A2C23 and A2R32. Depress the 750 us button.	Approximately 400 kHz, 1.4 V, p-p, with a 2.8 MHz signal added. See Waveform 4, in Table 4-12.	Isolate defective component in sampler or sampling amplifier by d.c. voltage and waveform measurements.
14	Connect 'scope to pin 1, A2U4.	Approximately 5 V, d.c.	Defective 16 conductor ribbon cable W4, (or pin connections); or defective A2U4; or malfunction in logic circuit (Table 4-9).
15	Connect 'scope to pin 6 of A2U5. Depress 10 RANGE button.	Approximately 400 kHz, with a 2.8 MHz signal added; approximately 600 mV, peak-to-peak.	Replace A2U5 or A2U4; refer to Table 4-9.

Table 4-6. Systematic Troubleshooting Chart: R.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
* * * * * * *	AUTOMATIC FREQUENCY-LOCK-LOOP CIRCUITS	* * * * * * *	
16	Connect 'scope to pin 8 of A2U4. Depress the 750 us and the +PEAK button	Approximately 5 V, d.c.	Check for open pin 4 in 16-conductor ribbon cable W4; or replace A2U4; or refer to Steps 34-39.
17	Connect 'scope to junction of A2L9 & A2R53. Depress the 100 RANGE pushbutton	300 to 500 kHz, with a 2.8 MHz signal added; approximately 2.5 V, peak-to-peak.	Check A2L6 or A2L9 for open circuit; or bad A2U4.
18	Depress the 3 kHz button.	Very small residual of signal in Step 17.	Replace A2U4, or see Table 4-9.
19	Connect 'scope to junction of A2L10 & A2R55. Change frequency of generator to about 2.9 MHz.	300 to 600 kHz, with a 3.3 MHz signal added; approximately 2.5 V, peak-to-peak.	Check A2L7 or A2L10 for open circuit; or bad A2U4.
20	Connect 'scope to pin 14 of A2U8.	Same as Step 19, but attenuated by 20 dB.	Check for open A2C48.
21	Connect 'scope to pin 8 of A2U8. Set generator frequency to 2.4 MHz. Depress the 750 us button.	300 to 500 kHz square wave, about 3.5 V, p-p, on top of approx. 12 V, d.c.	Check A2CR12 for short circuit; or replace A2U8.
22	Connect 'scope to pin 3 of A2U9. Set i.f. to about 400 kHz by varying generator's frequency above or below 2.4 MHz.	400 kHz square wave, approximately -0.5 to +2 volts.	Check for open A2C57, A2CR12, A2CR11; or replace A2U9.
23	Connect 'scope to pin 6 of A2U9.	TTL signal, with pulse about 2.5 us wide.	Check for open A2R70, A2C58; or replace A2U9.
24	Connect 'scope to pin 7 of A26U. Depress -PEAK button	400 kHz square wave, approximately 5.5 V, peak-to-peak.	Check for open A2R65. Replace A2U6. Refer to Steps 34-39.
25	Connect 'scope to pin 1 of A2U6. Depress the 3 kHz and +PEAK buttons.	0 volts, d.c., approx.	Replace A2U7 or A2U6; check for open A2R51. Refer to Steps 34-39.

Table 4-6. Systematic Troubleshooting Chart: R.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
*** * * * AUTOMATIC FREQUENCY-LOCK-LOOP CIRCUITS (continued) * * * ***			
26	Depress the -PEAK & 750 us buttons. Vary generators frequency about 50 kHz above and below the initial setting.	A.C. ripple < 400 mV, p-p. DC voltage will move below & above the baseline as the frequency of the r.f. signal is changed.	Check for open A2C47. Replace A2U7. Refer to Steps 34-39.
27	Reset generator's frequency for 0 V at pin 1 of A2U6. Press the AVG button. Offset the generator frequency by 100 kHz.	Initially, 0 V, d.c., then slowly drifting to approximately +/- 2.4 volts, d.c.	Defective A2C47; or replace A2U7 or A2U6. Refer to Steps 34-39.
*** * * * * * DIGITAL PORTION: OSCILLATOR BANDSWITCHING * * * * * ***			
28	Connect 'scope to pin 2 of A2U3. Depress 15 kHz button.	5 volts, d.c.	Repair or replace W4 cable, or refer to Table 4-9.
29	Depress the 3 kHz filter button.	0 volts, d.c.	Same as Step 28.
30	Depress the 750 us filter button.	5 volts, d.c.	Same as Step 28.
31	Connect 'scope to pin 4 of A2U3. Depress 15 kHz button.	0 volts, d.c.	Same as Step 28 or replace defective A2U4.
32	Depress the 3 kHz filter button.	0 volts, d.c.	Same as Step 31.
33	Depress the 750 us filter button.	5 volts, d.c.	Same as Step 31.
*** DIGITAL PORTION: AUTOMATIC FREQUENCY-LOCK-LOOP SWITCHING LOGIC ***			
34	Connect 'scope to pin 10 of A2U7. Depress +PEAK button.	5 volts, d.c.	Check for open circuit in W4 cable; replace A2U7; or check malfunction in logic circuits (see Table 4-9).

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

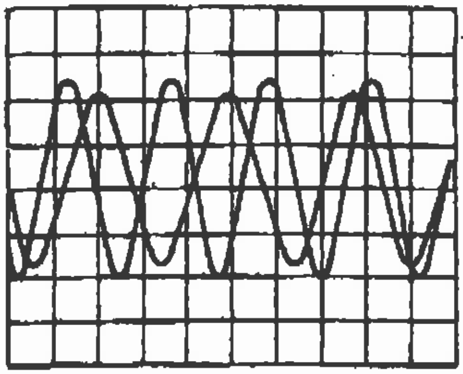
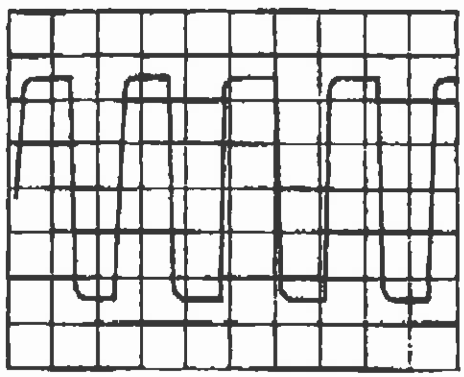
FIG #	REFERENCE TABLE	STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
16	4-10	12		Vertical: 0.5 V/division. Horizontal: 1 ms/division.
17	4-10	13		Vertical: 0.5 V/division. Horizontal: 0.5 ms/division.

Table 4-6. Systematic Troubleshooting Chart: R.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
* DIGITAL PORTION: AUTOMATIC FREQUENCY-LOCK-LOOP SWITCHING LOGIC * (continued)			
35	Depress the -PEAK button.	0 volts, d.c.	W4 cable may have a short circuit; or look for malfunction in the logic circuits (see Table 4-9).
36	Depress the AVG button.	0 volts, d.c.	Same as Step 34 or 35.
37	Connect 'scope to pin 11 of A2U7.	0 volts, d.c.	Same as Step 34 or 35.
38	Depress the -PEAK button.	5 volts, d.c.	Same as Step 34 or 35.
39	Depress the +PEAK button.	0 volts, d.c.	Same as Step 34 or 35.

Table 4-7. Systematic Troubleshooting Chart: I.F. Circuits

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
1.	Power Off. Set Test Switch (A4S1) Pos. #7 "on". Power on. Do NOT press LEVEL button.		
2.	Connect 'scope to pin 3 of A3U1. Depress the AM button.	447.4 kHz sine wave, approximately 1.9 V peak-to-peak.	Open pin 15 in W5, the 16-conductor ribbon cable; or malfunction in calibrator circuits (see table 4-10, Steps 1-9).
3.	Connect 'scope to pin 6 of A3U1.	Same as Step 2, but doubled in amplitude.	Replace A3U1.
4.	Connect 'scope to pin 1 or pin 16 of A3U3.	874 Hz TTL signal	Open pin 13 in the cable; or check for a malfunction in calibrator circuits (Table 4-10, Steps 2 and 5).
5.	Depress FM button.	TTL logic 1.	Malfunction in calibrator circuits (see Table 4-10, step 8).
6.	Depress AM button. Connect 'scope to pin 6 of A3U3.	447 kHz sine wave, audio-modulated at an 874 Hz rate; 1.15 V, p-p. See Waveform 5, Table 4-12.	Check for defective A3R7a through A3R7c or defective A3U3.
7.	Connect 'scope in turn to pins 5 through 12 of A3U4.	On pin 6, a TTL high; on all others, TTL low.	Defective W5 cable; or malfunction in logic circuits (Table 4-9).
8.	Connect 'scope to pin 4 of A3U4.	Same waveform as in Step 6; approximately 540 mV, p-p. (Depends upon setting of A3R79).	Isolate defective component by voltage or waveform measurements. Check for open A3CR13, A3C4, A3C5, A3C6, A3R79; or replace A3U4.
9.	Connect 'scope to pin 6 of A3U5.	Same as Step 6, but amplified to approx. 2.85 V, peak-to-peak.	Isolate defective component by voltage or waveform measurements.

Table 4-7. Systematic Troubleshooting Chart: I.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
10	Connect 'scope to the junction of A3C23 and A3CR6.	Same as Step 6, but amplified to approx. 5.7 V, peak-to-peak.	Isolate defective component by voltage or waveform measurements. Check for open A3C19, A3C22, A3C18, A3CR6, or A3CR7.
11	Connect 'scope to the junction of A3CR7 and A3R41.	The above waveform, halfwave rectified; 2.3 V, p-p. See Waveform 6, Table 4-12.	Same as Step 10.
12	Connect 'scope to pin 11 of A3U10.	5 volts, d.c.	Defective 16 conductor ribbon cable W6 (or pin connections); or malfunctions in logic circuits (Table 4-9)
13	Connect 'scope to pin 8 of A3U9.	874 Hz square wave & added 447 kHz sawtooth; about 1.3 V, p-p. See Waveform 7, Table 4-12.	Defective A3C27, A3R47; or replace A3U9.
14	Connect 'scope to pin 3 of A3U10.	Same as Step 13.	Replace defective A3U10.
15	Connect 'scope to pin 6 of A3U8.	Same as Step 9.	Defective A3U8; "short" in A3CR9 or A3CR10.
16	Connect 'scope to IF OUT connector.	Same as Step 9.	Defective A1P1, A1W1, or A13.
17	Connect 'scope to collector of A3Q1; set timebase of 'scope to 1 us/div.	447 kHz TTL signal. See Waveform 8 in Table 4-12.	Isolate defective component by voltage or waveform measurements. Suspect A3Q1, A3Q2, A3CR3, A3CR4, or A3CR5.
18	Connect 'scope to pin 1 of A3U7. Time-Base at 0.5 us/div.	A pulse: width about 2.1 to 2.4 us; amplitude 5 V, p-p.	Width: check timing components A3C20, A3R33; or replace A3U7. Amplitude: check A3R43 through A3R46.

Table 4-7. Systematic Troubleshooting Chart: I.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
19	Connect 'scope to pin 13 of A3U10. Depress FM pushbutton.	447 kHz sawtooth; -0.5 to -2 volts, p-p.	Isolate defective component by voltage or waveform measurements. Check for open A3C28; or bad logic circuits (see Table 4-9).
20	Set Test-Switch Pos. #7 "off", #2 "on". Power "off", then "on".	12.8 appears on the front-panel display.	Malfunction in logic circuits (Table 4-9)
21	Connect 'scope to junction of A4R20 & A4C15; set for d.c. and V. Sensitivity @ 0.05 V per div. Hold depressed 3-PEAK button until 8210 displays 1.9 or 2.0.	Approximately 0.25 V, d.c.	Open A3R77; or defect in A1P5, A1W5, A1P8, A4R20, A4C15 or A4U20.
22	Adjust V. Position on 'scope so trace nears bottom of screen. Hold depressed +PEAK pushbutton of 8210.	Rise in d.c. voltage should be smooth (no "steps"), to about 3.5 V, d.c.	Defective A3J1, A1P5, A1W5, A1P8, A4J2, or A3U4; or defective logic circuits (see Table 4-9)
23	Set Pos. #2 on Test Switch (A4S1) "off". Turn power off, then on. Allow completion of the calibration cycle. To RF IN apply a 30 MHz, -10 dBm signal with 50% 1 kHz a.m. Connect the 'scope to the junction of A3L3 and A3R3.	400 kHz sine wave with a.m.; amplitude approx. 0.82 V, peak-to-peak.	Problem in the i.f. filter circuit. Use waveform measurements to isolate the problem.
24	Connect 'scope to pin 6 of A3U2.	Same as Step 23, but amplitude increased to about 3.5 V, p-p.	Isolate defective component in circuit of input amplifier, using voltage and waveform measurements

Table 4-7. Systematic Troubleshooting Chart: I.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
25	Connect 'scope to pin 8 or 9 of A3U3.	A TTL high.	Defective 16 conductor ribbon cable W5 (or pin connecttions) or malfunction in logic circuits (Table 4-9); or replace defective A3U3.
26	Connect 'scope to 6 or 11 of A3U3.	A TTL low.	
27	Increase level of generator to more than +13 dBm.	Display shows IFHI.	Defect in circuits of: a.f. (see Table 4-8); r.f. (Table 4-6); or logic (Table 4-9).
28	Reduce generator's level to -40 dBm.	Display shows IFLO.	Same as Step 27.

Table 4-8. Systematic Troubleshooting Chart: A.F. Circuits

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
1.	(a) Power "off". (b) Disconnect A1P1 from A3J3 and connect it to A3TP1.* (c) Remove A3U10. (d) Set Pos. #3 on Test Switch (A4S1) to "on". (e) Set a.f. oscillator for 1 kHz, 106 mV, r.m.s. (f) Apply the a.f. signal to the IF OUT connector (A1J3). (g) Turn power "on". *Early 8210's do not have A3TP1. On these, omit (b) and change (f) as follows: Apply the a.f. signal to pin 3 of the A3U10 socket. Other steps unchanged. NOTE: "INDICATIONS" in this table are approximate.		
2.	Depress the front-panel 10 RANGE push-button. Connect 'scope to pin 13 of A3U11.	1 kHz sine wave; 300 mV, peak-to-peak	Isolate defective component in the filter circuit A3U9c by waveform measurements. See also Steps 33-40.
3.	Set a.f. oscillator to about 72 kHz.	72 kHz sine wave; 210 mV (approx.), p-p	Same as Step 2.
4.	Set a.f. oscillator to 1 kHz. Connect 'scope to pin 3, A3U11.	1 kHz sine wave; 300 mV, peak-to-peak.	Defective A3U11; or see Steps 33-40.

Table 4-8. Systematic Troubleshooting Chart: A.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
26	Check the logic on 9, 10 & 11 of A4U20.	All high.	Malfunction in logic circuits. See Table 4-9, Steps 49 and 50.
27	Connect d.c. voltmeter to junction of A4R20 and A4C15.	Indicated d.c. voltage should be approx. 1 V.	Check for open circuit at pin 2 of cable W6 (16-conductor cable)
28	Move VM probe to pin 3 of A4U20.	Same as Step 27.	Replace defective A4U20.
29	Move VM probe to pin 6 of A4U2.	Indicated d.c. voltage 2.4 to 2.47 volts.	Replace defective A4U2.
30	Connect 'scope to pin 6, A4U6. Adjust trigger level of 'scope for stationary display.	TTL signal; period approximately 1.5 us.	Malfunction in logic circuits. Replace level of defective A4U6 or A4Q4.
31	Connect 'scope to collector of A4Q4. Adjust trigger level for stationary display.	Similar to Step 30, but signal swings from +12 to +14 volts.	Replace defective A4Q4 or A4U4.
32	Set 'scope for d.c., V. Sens. @ 0.2V/div. & 0.05 us/div. Connect probe to pin 2 of A4U4. Set trigger level for a stationary display.	Approximately 0.6 V, d.c.	Check for open diode A4CR2, or malfunction in logic circuits (see Table 4-9, Steps 1-14); or replace A4U4 or A4U7.
33	Remove short from pin 1 & 2, A4TP6.	D.C. voltage will go negative.	Same as Step 32.
* * * * * * * * * DIGITAL PORTION A.F. CIRCUITS * * * * * * * * *			
34	Connect 'scope to pin 11 of A3U10. Depress the FM FUNCTION pushbutton.	CMOS low.	Defective A3J2, A1P6, A1W6, A1P9; or logic circuit malfunction (refer to Table 4-9)
35	Depress the AM FUNCTION pushbutton.	CMOS high.	Same as Step 34, or defective A3U10.
36	Connect 'scope to pin 11, A3U11. Depress 100 RANGE button.	CMOS high.	Same as Step 34, or defective A3U11.

Table 4-8. Systematic Troubleshooting Chart: A.F. Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
* * * * * * * DIGITAL	PORTION A.F. CIRCUITS	(continued) * * * * *	
37	Depress 10 RANGE.	CMOS low.	Same as Step 34.
38	Connect 'scope to pin 10, A3U11. Power off, then on quickly.	Normal CMOS "low" will move toward "high" as power is switched on.	Same as Step 36.
39	Connect 'scope to pin 10 of A3U13. Depress in turn: 15 kHz pushbutton; 3 kHz pushbutton; 750 us pushbutton.	 CMOS low. CMOS high. CMOS low.	 Same as Step 34. As above or bad A3U13. Same as Step 34.
40	Connect 'scope to pin 9 of A3U13. Depress in turn: 15 kHz pushbutton; 3 kHz pushbutton; 750 us pushbutton.	 CMOS low. CMOS low. CMOS high.	 Same as Step 34. Same as Step 34. As above or bad A3U13.
41	Connect 'scope to pin 9 of A3U15.	CMOS logic signal	Same as Step 34, or defective A3U15.

Table 4-9. Systematic Troubleshooting Chart: Logic Circuits

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
1.	Connect 'scope to Pin 16 of A4U8.	TTL high.	Replace A4U13.
2.	Connect 'scope to pin 2 of A4U31.	Voltage greater than 2.2 volts d.c.	Replace BT1.
3.	Compare signals on pins 5 and 6 of A4U31.	Same signal.	Replace A4U13.
4.	Connect 'scope to pin 10 of A4U1.	3.579 MHz TTL logic signal.	Replace A4U1, A4Y1, or A4C2.
5.	Connect 'scope to pin 8 of A4U1.	Same as Step 1.	Replace A4U5.
6.	Connect 'scope to pin 6 of A4U8.	1.789 MHz TTL signal.	Replace A4U5 or AU9.

Table 4-9. Systematic Troubleshooting Chart: Logic Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
7.	Connect 'scope to pin 1 of A4U3.	Approximately 874 Hz CMOS logic signal.	Replace A4U3.
8.	Connect 'scope to pin 6 of A4U3.	447.35 kHz CMOS logic signal.	Replace A4U3 or A4U12.
9.	Connect 'scope to pin 26 of A4U8.	TTL high.	Replace A4U1, or check for shorted A4C1.
10	Power off. Remove jumper A4J8. Connect signature analyzer per Table 4-9a. Power on. Run signature-analysis test of the address bus.	See Table 4-9a.	Defective A4U8, or a "short" in circuitry.
11	Connect 'scope in turn to data bus lines D0-D7 of A4U8.	TTL signals on all lines.	Same as Step 7.
12	Connect 'scope in turn to remaining pins of A4U8.	TTL signals on pins 19, 21, 27 & 28. Pins 17, 18, 20, 22, 24 and 25 are TTL high.	Same as Step 7.
13	Connect 'scope to pin 8 of A4U6.	TTL logic signal.	Defective A4U6, or a "short" in circuitry.
14	Connect signature analyzer per Table 4-9b and run test on the decoder:A4U10	See Table 4-9b.	Defective A4U10, or a "short" in circuitry.
15	Connect signature analyzer per Table 5-9c; test PROM A4U11.	See Table 4-9c.	Defective A4U11, or a "short" in circuitry.
16	This step deleted 12/83.		
17	Replace number A4J8. Connect 'scope to pin 18 of A4U8.	TTL high.	Replace A4U13 or A4U6.
18	Connect 'scope to pin 33 of A4U5.	TTL logic signal, about 874 Hz.	Defective A4U1, or a "short" in circuitry

Table 4-9. Systematic Troubleshooting Chart: Logic Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
19	Connect 'scope to pin 6 of A4U5.	TTL logic signal, 1.15 ms period.	Replace A4U5, A4U6, or A4U8.
20	Connect 'scope to pin 6 of A4U6.	TTL logic signal.	Replace A4U6 or A4Q4.
21	Connect 'scope to pin 8 of A4U6.	TTL logic signal.	Defective A4U6, or "short" in circuitry.
22	Connect 'scope to pin 35 of A4U16.	TTL low.	Replace A4U1.
23	Connect 'scope to pin 35 of A4U17.	TTL low.	Same as Step 19.
24	Connect 'scope in turn to pins 18 through 22 of A4U17.	TTL logic signal.	Replace A4U17 or A4U18; or check for a "short" in circuitry.
25	Connect 'scope in turn to pins 11 through 15 of A4U18.	Same as in Step 21.	Defective A4U18, or a "short" in circuitry; or defective A4R16.
26	Connect 'scope to pin 4 of A4U17.	TTL low.	Defective A4U17, or "short" in circuitry.
27	Depress the 15 kHz pushbutton.	See Waveform 12 in Table 4-12.	Check for open circuit: 16-conductor cable W8 (and its connections); also, A4CR8 & A4S8.
28	Depress the +PEAK pushbutton.	Same as in Step 24.	As above: W8 (etc), A4CR9, A4S9.
29	Depress the FM pushbutton.	Same as in Step 24.	As above: W8 (etc), A4CR10, A4S10.
30	Depress the 100 RANGE pushbutton.	Same as in Step 24.	As above: W8 (etc), A4CR11, A4S11.
31	Connect 'scope to pin 3 of A4U17.	TTL low.	Defective A4U17, or a "short" in circuitry.
32	Depress the 3 kHz pushbutton.	Same as in Step 24.	Replace A4U17 check for open circuit in W8 (and its connections), or in A4S4.

Table 4-9. Systematic Troubleshooting Chart: Logic Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
33	Depress the -PEAK pushbutton.	Same as in Step 24.	Check for open circuit in W8 (etc), & A4S5.
34	Depress the AM pushbutton.	Same as in Step 24.	As above: W8 (etc), A4S6.
35	Depress the 10 RANGE pushbutton.	Same as in Step 24.	As above: W8 (etc), A4S7.
36	Connect 'scope to pin 2 of A4U17.	TTL low.	Replace A4U17; check "short" in circuitry.
37	Depress the 750 us pushbutton.	Same as in Step 24.	Check for open circuit: W8 (etc), A4S1.
38	Depress the AVG pushbutton.	Same as in Step 24.	As above: W8 (etc), A4S2.
39	Depress the LEVEL pushbutton.	Same as in Step 24.	As above: W8 (etc) A4S3.
40	Set "on", one at a time, each position of Test Switch, A4S1; as each one is turned on, connect 'scope in turn to pins 3 through 9 of A4R14.	Same as in Step 24, on each pin, as each Test Switch position is turned "on".	Replace A4U17, A4S1 or A4R14.
41	Set Test Switch Pos. #5 to "on". Turn power off, then on.	All display segments and legends "on".	Continue Steps 39-43. (If "Indication" is good, jump to Step 44.
42	Connect 'scope in turn to pins 1 through 8 of A4U19.	See Waveform 13 in Table 12.	Replace defective A4U17 or A4U19.
43	As above, pins 11 through 18.	See Waveform 14 in Table 4-12.	Defective A4U19, or a "short" in circuitry.
44	Connect 'scope in turn to pins 9 through 16 of A5J1.	Same as in Step 40.	Check for "open" in W8 (etc); or replace LED A4CR2 through A4CR7.

Table 4-9. Systematic Troubleshooting Chart: Logic Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
45	Connect 'scope in turn to pins 14 of A4DS1, A4DS2, A4DS3, A4DS4.	Same as in Step 24.	Check for open circuit in W8 (etc).
46	Visually inspect display for missing segments or decimal points.	Same as in Step 38.	If the same segment is out on A4DS2 through A4DS4, check for open circuit. If outage is not common, replace faulty display(s).
47	Depress the LEVEL pushbutton.		
48	Depress the +PEAK button. Connect the 'scope in turn to pins PA0 through PA7, A4U16.	A0 A1 A2 A3 A4 A5 A6 A7 1 0 1 0 1 0 1 0	Replace A4U16 or A4U10; or check for a "short" in circuitry.
49	Depress the -PEAK button. Connect the 'scope in turn to pins PA0 through PA7, A4U16.	0 1 0 1 0 1 0 1	Same as in Step 45.
50	Connect the 'scope in turn to pins PB0 through PB7 of A4U16.	Same as in Step 46.	Defective A4U16; or a "short" in circuitry.
51	Depress the +PEAK button. Connect the 'scope in turn to pins PB0 through PB7, A4U16.	Same as in Step 45.	Same as in Step 47.
52	Connect the 'scope in turn to pins PC0 through PC7 of A4U16.	Same as in Step 45.	Replace A4U16 or A4U20; or check for a "short" in circuitry.
53	Depress the -PEAK button. Connect the 'scope in turn to pins PC0 through PC7, A4U16.	Same as in Step 46.	Same as above.
54	Set Test Switch Pos. #5 "off". Power off. Power on.	Instrument is returned to operating condition.	

Table 4-9a . Signature-Analysis Chart: Address Field

PROCEDURE: Power off. Remove jumper A4J8, located on the Power-Supply-and-Digital-Circuits board. Set the Signature Analyzer's controls, and connect it, as shown below. Turn the 8210 "on".

SIGNATURE ANALYZER SWITCH SETTINGS & CABLE-CONNECTION POINTS:

Function	Switch Setting	Cable Connection
START	_┌‾	Pin 5 of A4U8 (TP7)
STOP	‾┐_	Pin 20 of A4U7 (TP7)
CLOCK	‾┐_	Pin 8 of A4U6 (TP8)

SIGNATURE ANALYZER PROBE CONNECTIONS:

Item	Test Point: Pin on A4U8	Correct Signature	Item	Test Point: Pin on A4U8	Correct Signature
Common	29	0000	A7	37	A3C1
Vcc	11	755U	A8	38	7707
A0	30	H335	A9	39	577A
A1	31	C113	A10	40	HH86
A2	32	7050	A11	1	89F1
A3	33	0772	A12	2	AC99
A4	34	C4C3	A13	3	PCF3
A5	35	AA08	A14	4	1180
6	36	7211	A15	5	755U

Table 4-9b. Signature-Analysis Chart: Decoder Circuit

PROCEDURE: Same as in Table 4-9a.

SIGNATURE ANALYZER SWITCH SETTINGS & CABLE-CONNECTION POINTS:

Function	Switch Setting	Cable Connection
START	_┌‾	Pin 5 of A4U8 (TP7)
STOP	‾┐_	Pin 20 of A4U7 (TP7)
CLOCK	_┌‾	Pin 8 of A4U6 (TP8)

SIGNATURE ANALYZER PROBE CONNECTIONS:

Item	Test Point: Pin on A4U10	Correct Signature	Item	Test Point: Pin on A4U10	Correct Signature
Common	8	0000	CS2	3	868C
+5 v	16	755U	CS3	4	970C
CS0	1	1817			
CS1	2	7FF8			

Table 4-9c. Signature-Analysis Chart: PROM A4U11 (June, 1983)*

PROCEDURE: Same as in Table 4-9a.

SIGNATURE ANALYZER SWITCH SETTING & CABLE-CONNECTION POINTS:

Function	Switch Setting	Cable Connection
START	‾|_	Pin 1 of A4U10 (TP9)
STOP	_|‾	Pin 1 of A4U10 (TP9)
CLOCK	_|‾	Pin 8 of A4U6 (TP8)

SIGNATURE ANALYZER PROBE CONNECTIONS:

NOTE: PROM A4U11 MAY BE EITHER OF TWO TYPES: 2732, OR 2764.

Item	Type 2732 Test Point: Pin on A4U11	Correct Signature	Item	Type 2764 Test Point: Pin on A4U13	Correct Signature
Common	12	0000	Common	14	0000
+5 V	24	P254	+5 V	28	P254
D0	9	9738	D0	11	A10F
D1	10	76AA	D1	12	20CU
D2	11	663H	D2	13	1P4P
D3	13	6FFU	D3	15	F64A
D4	14	2CUH	D4	16	A1C7
D5	15	UHC1	D5	17	9056
D6	16	P56U	D6	18	7PF0
D7	17	U75P	D7	19	17H4

* To determine date of PROM: Set Pos. #6 of the Test Switch (A4S1) to "on". Turn power off, then on. The date of the PROM will appear on the 8210's display. Reset the Test Switch (all positions "off").

Table 4-10. Systematic Troubleshooting Chart: Calibrator Circuits

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
1.	Power off. Set Pos. #7 of Test Switch (A4S1) "on". Power on. Depress LEVEL button. Connect 'scope to pin 2 of A4U9.	1.79 MHz TTL logic signal.	Replace A4U9, or bad logic circuits (see Table 4-9).
2.	Connect 'scope to pin 3 of A4U9.	TTL signal, at about 874 Hz.	Replace A4U9 of A4U12 or defective logic circuits. (See Table 4-9).
3.	Connect 'scope to pin 9 of A4U9.	TTL signal, switching from 357.9 to 447.4 kHz an 874 Hz rate.	Replace A4U9.
4.	Connect 'scope to pin 4 of A4U12.	TTL signal, 447.4 kHz	Replace A4U12, or bad logic circuits (See Table 4-9).
5.	Connect 'scope to pin 12 of A4U12.	TTL signal, 874 Hz.	Same as in Step 2.
6.	Connect 'scope to pin 7 of A4U12. Depress the AM button.	TTL signal, 447.4 kHz.	Replace A4U12, or bad logic circuits (Table 4-9, Steps 44-50).
7.	Connect 'scope to pin 9 of A4U12.	TTL signal, 874 Hz.	Same as in Step 6.
8.	Depress FM button.	TTL high.	Same as in Step 6.
9.	Connect 'scope to pin 3 of A3U1. Depress the AM button.	Sine wave, 447.4 kHz; approximately 1.9 V, peak-to-peak.	Check for open A4L1, A4L2, A4C8, A4C10, A4C11 or 16-conductor cable W5 (or its connections); or replace defective A3U1.
10	Connect 'scope to pin 6 of A3U1.	Same as in Step 9, but doubled in amplitude.	Replace defective A3U1.
11	Connect 'scope to IF OUT connector.	See Waveform 15, Table 4-12.	Bad i.f. circuits. Refer to Table 4-7 Steps 4-9, and 15.
12	Depress FM button.	See Waveform 16, Table 4-12.	Replace A4U9; or bad i.f. circuits (See Table 4-7).

11/20/1995 17:03 17085824329 VALUETRONICS PAGE 02
FROM TEST LAB COMPANY TO 17085824329 P.01

4-8. ADJUSTMENT AND ALIGNMENT PROCEDURES

This subsection lists all required adjustments and alignment procedures. Note, however, that adjustment is not a substitute for troubleshooting; be certain that all other possible caused of equipment malfunction have been eliminated before making adjustments.

Connect the equipment, and depress the switches, as shown in Figure 4-3.

a. I.F. Adjustment.

1. Remove the r.f. assembly cover (Para. 4-4b).

2. Set the output frequency of the signal generator to 100 MHz, c.w., and the output level to 0 dBm.

3. Adjust potentiometer A3R65 for a reading of 400 kHz, +/- 5 kHz, on the frequency counter.

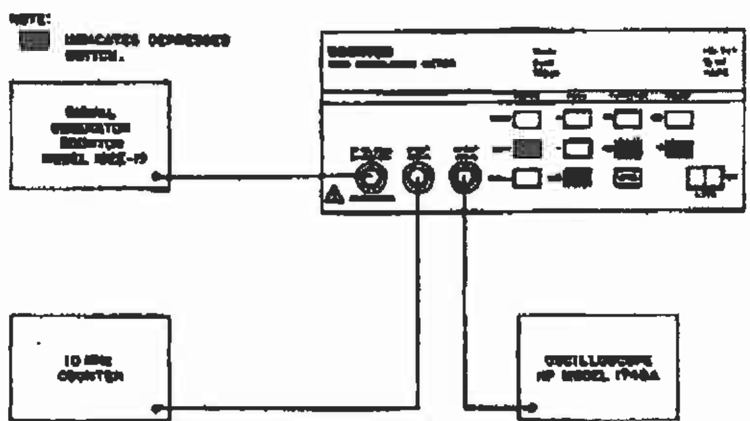


Figure 4-3. Test Setup: Adjustment and Alignment

b. R.F. Efficiency and F.M. Rejection.

1. Replace the r.f. assembly cover.

2. Set the oscilloscope to 0.05 V/division and 1 ms/division.

3. Set the signal generator to 2 MHz, 0 dBm. Apply 100 kHz deviation at a 1 kHz rate. Let the i.f. to settle to within +/- 5 kHz of 400 kHz (or, disconnect the 8210's r.f. input, then reconnect it).

4. Adjust potentiometer A2R10 for a minimum indication on the 'scope.

5. Set 102E-19's r.f. to 3.5 MHz. Wait until i.f. is 400 kHz +/- 5 kHz.

6. Adjust potentiometer A3R6 for a minimum indication on the 'scope.

7. Repeat Steps 4-8b (3) through 4-8b (6) until the adjustment of either potentiometer increases the indication on the oscilloscope.

c. R.F. Sensitivity Adjustment (except in early models; see Note, below)

1. Set the 1028-19 to 2 MHz, approx. -29.5 dBm. Remove all modulation.

2. If the 8210 displays IFLO, slowly adjust potentiometer A3R79* until a numeric display (i.e., a display of residual modulation) appears.
*NOTE: Early model 8210's do not have potentiometer A3R79.

d. R.F. Balance Adjustment.

1. Disconnect the r.f. input to the 8210.

2. Disconnect the 'scope from AF OUT and connect it to RF IN.

3. Set the 'scope to 0.005 V/div., 50 ohm input, and 0.5 us/div.

4. Adjust potentiometer A2R14 for a minimum indication on the 'scope.

Table 4-12. Systematic Troubleshooting: Waveforms

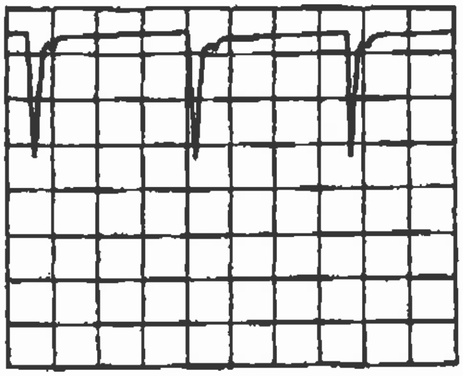
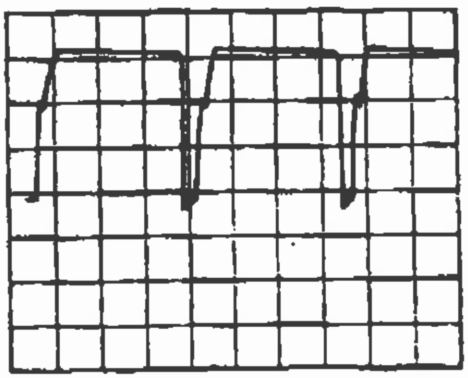
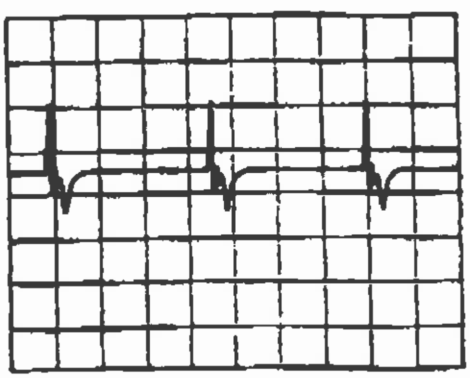
FIG #	REFERENCE TABLE	REFERENCE STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
1	4-6	8		Vertical: 1 V/division, d.c. Horizontal: 0.1 us/division.
2	4-6	9		Vertical: 5 V/division, d.c. Horizontal: 0.1 us/division.
3	4-6	10		Vertical: 0.5 V/div., a.c. Horizontal: 0.1 us/division.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

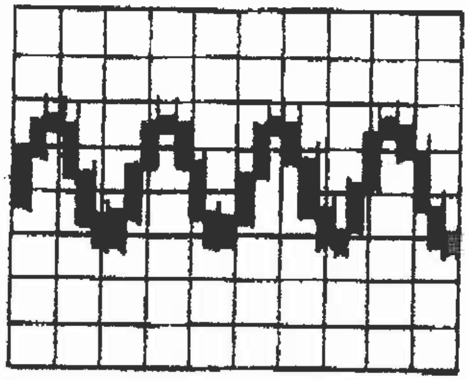
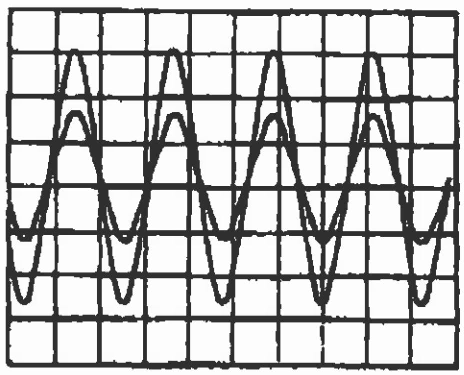
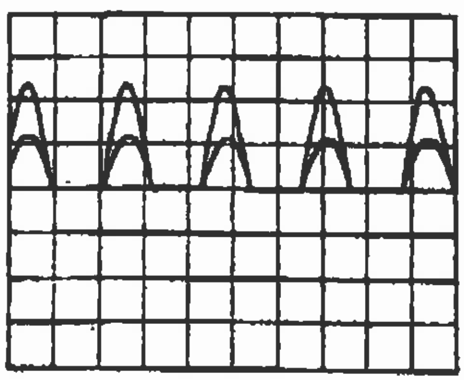
FIG #	REFERENCE TABLE	REFERENCE STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
4	4-6	13		Vertical: 0.5 V/Division. Horizontal: 1 us/division.
5	4-7	6		Vertical: 0.2 V/division. Horizontal: 1 us/division.
6	4-7	11		Vertical: 1 V/division, d.c. Horizontal: 1 us/division.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

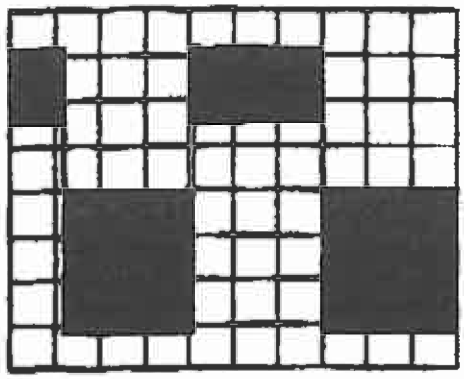
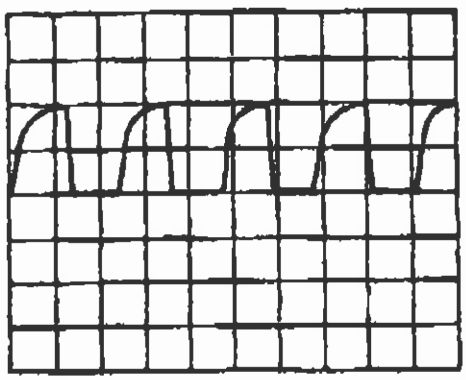
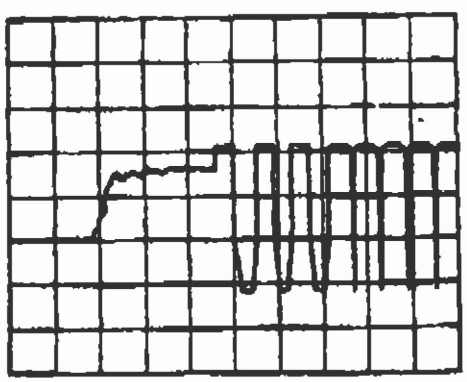
FIG #	REFERENCE TABLE	REFERENCE STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
7	4-7	13		Vertical: 0.2 V/division. Horizontal: 0.2 ms/division.
8	4-7	17		Vertical: 1 V/division, d.c. Horizontal: 1 us/division.
9	4-8	22		Vertical/Channel A 5 V/division, d.c. Channel-A probe to pin 10 of A4U22. Trigger on A. Negative Trigger. Vertical/Channel B: 0.5 V/division, d.c. Display Channel B. Horizontal: Uncalibrated, 10 ms-per division.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

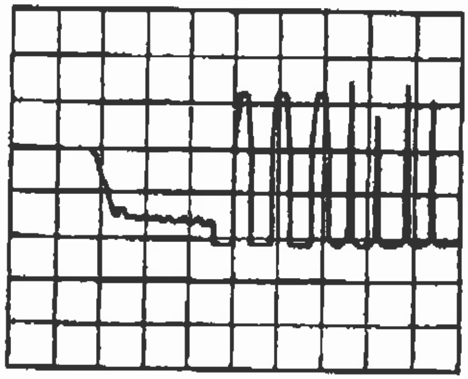
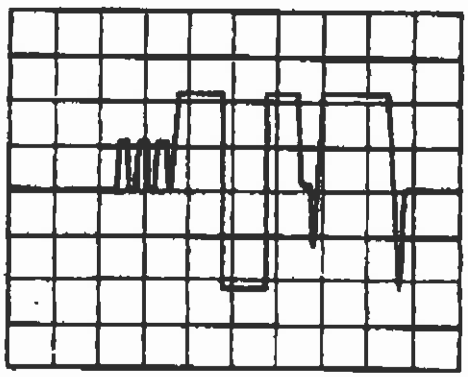
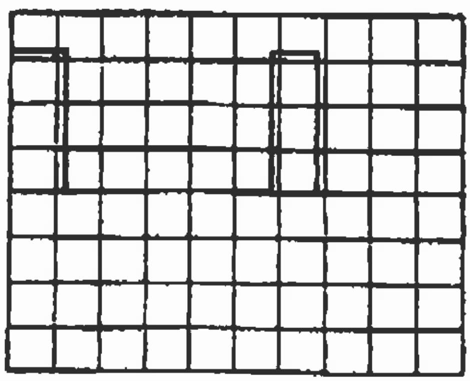
FIG #	REFERENCE TABLE	REFERENCE STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
10	4-8	23		Vertical/Channel A: 5 V/division, d.c. Channel-A probe to pin 10 of A4U22. Trigger on Channel A. Negative Trigger. Vertical/Channel B: 0.5 V/division, d.c. Display Channel B. Horizontal: Uncalibrated, 10 ms per division.
11	4-8	24		Vertical/Channel A: 5 V/division, d.c. Channel-A probe to pin 10 of A4U22. Trigger on Channel A. Negative trigger. Vertical/Channel B: 0.5 V/division, d.c. Display Channel B. Horizontal: Uncalibrated, 20 ms per division
12	4-9	24		Vertical: 1 V/division, d.c. Horizontal: 1 ms/division.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

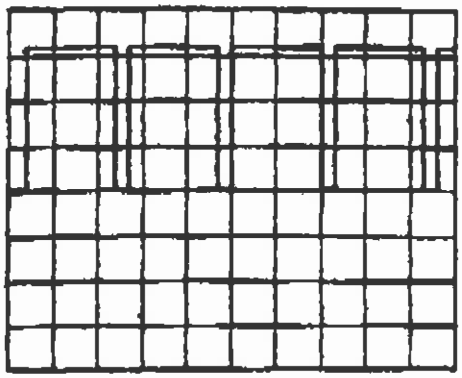
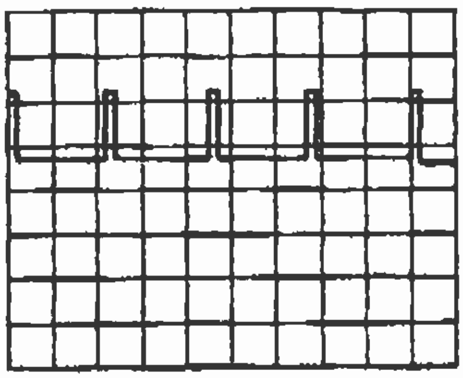
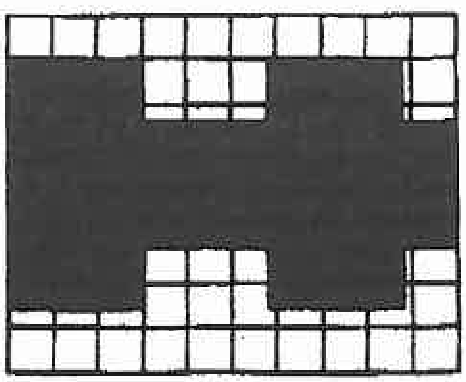
FIG #	REFERENCE TABLE	REFERENCE STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
13	4-9	39		Vertical: 1 V/division, d.c. Horizontal: 0.5 ms/division.
14	4-9	40		Vertical: 1 V/division, d.c. Horizontal: 0.5 ms/division.
15	4-10	11		Vertical: 0.5 V/division. Horizontal: 0.2 ms/division.

Table 4-10. Systematic Troubleshooting Chart: Calibrator Circuits (continued)

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
13	Connect 'scope to AF OUT connector. Depress the AM button.	874 Hz, 2.5 V, p-p. See Waveform 17, Table 4-12.	Bad i.f. circuits refer to Table 4-7 Steps 4 - 10); or bad a.f. circuits (refer to Table 4-8, Steps 1 through 6, and 14 through 16).

Table 4-11. Systematic Troubleshooting Chart: Power Supply

	PROCEDURE	INDICATION	IF INDICATION IS ABNORMAL
1.	(Line Voltage = 120) Connect 'scope to the junction of A4CR8 and A4C23.	8.55 to 9.45 V, d.c.; approximately 350 mV, peak-to-peak.	Isolate defective component by voltage or waveform measurements.
2.	Connect 'scope to the junction of A4CR9 & A4C24.	19.0 to 21.0 V; ripple approximately 350 mV, peak-to-peak.	Same as above.
3.	Connect 'scope to the junction of A4CR9 & A4C25.	-19 to -21 V; ripple approximately 800 mV, peak-to-peak.	Same as above.
4.	Connect voltmeter to pin 4, 6, or 8 of A4U7.	9.9 to 10.1 V, d.c.	Check A4C34 for circuit; or defective A4U29, A4U7.
5.	Connect VM & 'scope to the junction of A4CR18 and A4C35.	14.75 to 15.25 V; ripple less than 1 mV, peak-to-peak.	Isolate defective component by voltage measurements.
6.	Connect VM & 'scope to the junction of A4CR19 and A4C36.	-14.75 to -15.25 V; ripple less than 1 mV, peak-to-peak.	Same as Step 5.
7.	Connect VM & 'scope to pin 7 of A4U29.	7.33 to 7.68 V; ripple less than 1 mV, peak-to-peak.	Same as Step 5.
8.	Connect VM & 'scope to the junction of A4CR15 and A4C33.	4.75 to 5.25 V; ripple less than 1 mV, peak-to-peak.	Same as Step 5.
9.	Connect VM & 'scope to the junction of A4CR17 and A4C32.	4.90 to 5.10 V; ripple less than 1 mV, peak-to-peak.	Same as Step 5.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

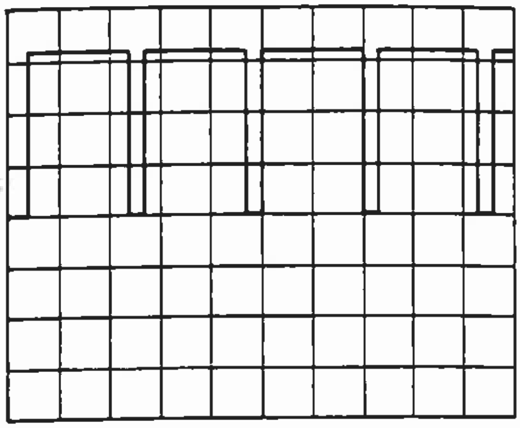
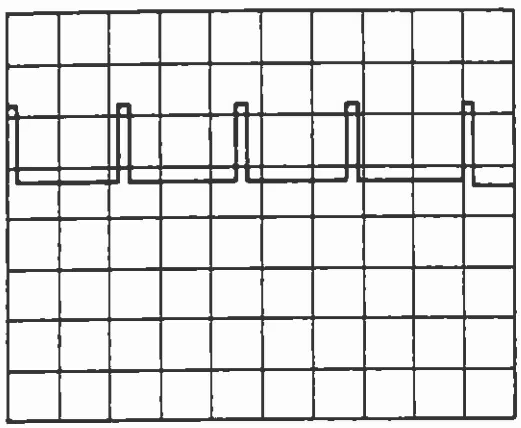
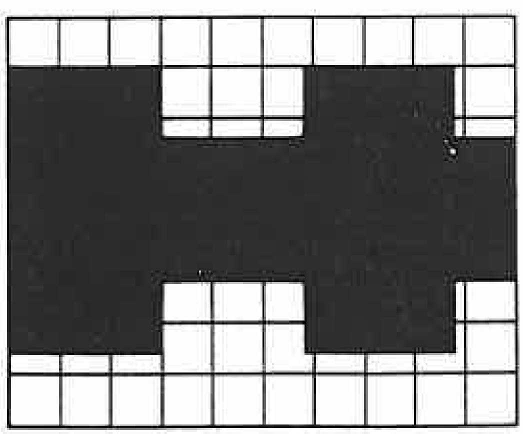
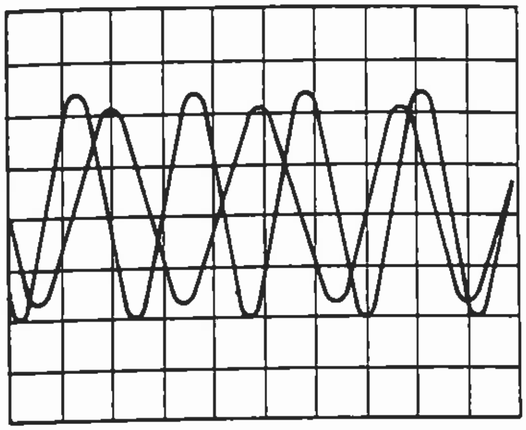
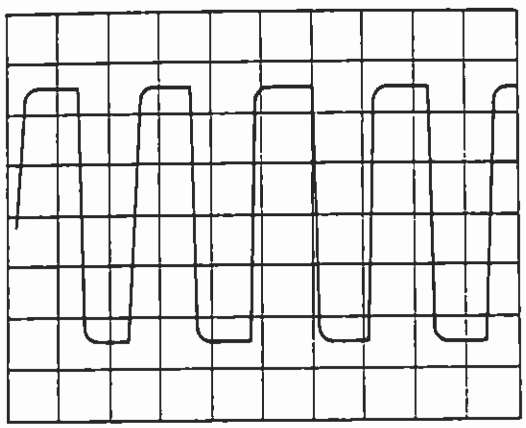
FIG #	REFERENCE TABLE	STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
13	4-9	39		Vertical: 1 V/division, d.c. Horizontal: 0.5 ms/division.
14	4-9	40		Vertical: 1 V/division, d.c. Horizontal: 0.5 ms/division.
15	4-10	11		Vertical: 0.5 V/division. Horizontal: 0.2 ms/division.

Table 4-12. Systematic Troubleshooting: Waveforms (continued)

FIG #	REFERENCE TABLE	STEP	WAVEFORM	'SCOPE SETTINGS & SIGNAL CONDITIONS
16	4-10	12		Vertical: 0.5 V/division. Horizontal: 1 ms/division.
17	4-10	13		Vertical: 0.5 V/division. Horizontal: 0.5 ms/division.

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

Table 5-2, Replaceable Parts, identifies the manufacturers of components by five-digit groups taken from the Federal Supply Code for Manufacturers. A list of the applicable code groups and manufacturers is given in Table 5-1.

The Table of Replaceable Parts begins with major assemblies, including PC boards complete with all their parts, followed by miscellaneous parts and components not mounted on PC boards. Then all the components of the individual assemblies (including PC boards) are listed.

To simplify ordering, please note the following:

A. When ordering a component or an assembly, the BEC Part Number is all that we need. However, part numbers can suffer changes during transmission and it is safer to include also a brief description. Examples:
   1. BEC Part #2000050: Mica Capacitor, 470 pF, 1%, 500 V.
   2. BEC Part #10249: Oscillator PC Board Assembly.

B. The number printed on a PC board is not an assembly number; it is the number for the bare board, alone. To order a complete assembly--the board with all its components installed -- specify it by the BEC Part Number given in the Assemblies Section of this table.

C. Unless otherwise identified, the number on a schematic diagram or on a parts-location diagram is not an assembly number; it is the number for just the diagram itself.

Table 5-1. Applicable Federal Supply Code Numbers for Manufacturers

00853	Sangamo Electric	28480	Hewlett-Packard Corp.
01121	Allen Bradley Company	31918	ITT Schadow, Inc.
01295	Texas Instruments	00779	AMP
02735	RCA Solid State Division	32997	Bourns Inc., Trimpot
03888	Pyrofilm KDI	33883	RMC
04222	AVX Ceramics Company	34335	Advanced Micro Devices
04713	Motorola Semiconductor	34649	Intel Corporation
04901	Boonton Electronics	50316	Mini-Systems, Inc.
06383	Panduit Corporation	51406	Murata Corp. of America
06665	Precision Monolithics	51640	Analog Devices, Inc.
06776	Robinson Nugent, Inc.	52464	OKI
07047	Milton Ross	54420	Dage
07263	Fairchild Semiconductor	54426	Buss Fuses
13812	Amperex, Dialight Div.	56289	Sprague Electric Company
14752	Electro Cube, Inc.	56708	Zilog, Inc.
17117	Electronic Molding	57582	Kahgan Electronics Corp.
19505	Applied Engineer Products	59474	Jeffers Electronics, Inc.
19701	Mepco Electra	61637	Union Carbide - Kemet
20307	Arco - Micronics	71279	Cambridge Thermionics
24226	Gowanda Electronics	71450	CTS Corporation
27014	National Semiconductor	73138	Beckman, Helipot Division
27264	Molex, Inc.	91168	Elmenco
27735	F-Dyne Electronics	95402	Electro Dynamics
27777	Varo Semiconductors	98291	Sealectro Corp
	S4217 United Chemicon, Inc.		

08210201A **'8210' FRAME ASSEMBLY**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
A1	'8210' FRAME ASSY	04901	08210201A	1	08210201A
A2	PWA '8210' RF	04901	08210801K	1	08210801K
A3	PWA '8210' IF-AF	04901	08210901J	1	08210901J
A4	PWA '8210' DIGITAL & PWR SUPLY	04901	08210702A	1	08210702A
A5	PWA '8210' DISPLAY	04901	08211001E	1	08211001E
A6	'8210' CONNECTOR ASSY LINE SW	04901	08211501A	1	08211501A
A7	'8210' CHASSIS UNIT ASSY	04901	08211400A	1	08211400A
A8	'8210' SUB PANEL ASSY	04901	08210301A	1	08210301A
A9	'8210' REAR PANEL ASSY	04901	08210403A	1	08210403A
W4-6,8	CABLE ASSY FLAT 16CKT 3.00L	04901	92006500A	4	92006500A
W7	CABLE ASSY WIRE 24GA 2C 8.25L	04901	57116100A	1	57116100A

08210403A **'8210' REAR PANEL ASSEMBLY**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1-2	CAP CER 0.001uF 20% 1000V	33883	B W/FDCL	2	224229000
F1	FUSE 0.25A 250V MDL SLO BLO	54426	MDL-1/4A	1	545511000
J5(W10)	CONN HOUSING 4 PIN	27264	03-06-1043	2	479340000
P14	CONNECTOR 5 CIRCUIT	06383	CE156F24-5-C	1	479394000
T1	TRANSFORMER POWER	04901	44610100A	1	44610100A

08210702A **PWA '8210' DIGITAL & POWER SUPPLY**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
BT1	CELL LITHIUM COIN	54473	BR-2325 LITHIUM	1	556008000
C1,3-4,11	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	4	283336000
C2	CAP MICA 51pF 5% 300V	57582	KD5510J301	1	205020000
C5,7,12-14	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	5	224364000
C6,10	CAP MICA 1100pF 5% 100V	14655	CD15-112J	2	200111000
C8	CAP MPC 0.002uF 2% 50V	14752	652A-1-A-202G	1	234140000
C9,29-31	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	4	224270000
C15,32	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	2	283293000
C16	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
C17-18	CAP PE 0.1uF 10% 100V	19701	719A1CA104PK101SA	2	234080000
C19	CAP EL 100uF 20% 25V	S4217	SM-25-VB-10-M	1	283334000
C20	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C23	CAP EL 4700uF -10% +50% 16V	S4217	SM-16-VB-4700M	1	283352000
C24-25	CAP EL 2200uF 20% 35V	57582	KSM-2200-35	2	283351000
C26-28	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	3	224364000
C33	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	1	283334000
C34,36	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	2	283293000

(continued) 08210702A PWA '8210' DIGITAL & POWER SUPPLY
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C35	CAP TANT .47uFd 35V	56289	196D106X0025KA1	1	283324000
C37	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
CR1-3,6-7	DIODE SIG 1N914	01295	1N914	5	530058000
CR4-5	DIODE SIG FDH-300	27014	FDH300	2	530052000
CR8-9	DIODE BRIDGE VM-18	27777	VM-18	2	532031000
CR10-11,13	DIODE SIG 1N4001	04713	1N4001	3	530151000
CR12,14	DIODE ZENER 1N5242B 12V 5%	04713	1N5242B	2	530146000
CR15-20	DIODE SIG 1N4001	04713	1N4001	6	530151000
CR21	DIODE SIG 1N914	01295	1N914	1	530058000
J1-4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	4	473042000
J5	CONN M 2 CKT ST .1CT	27264	22-10-2021	1	477361000
J6	HEADER 5 PIN STRAIGHT	06383	MPSS156-5-D	1	477345000
J7	CONNECTOR PIN (M)	98291	229-1086-000-550	1	477240000
J8	SHUNT 8 CIRCUIT	32575	435704-8	1	483226000
L1-2	INDUCTOR 150uH 5%	59474	1315-16J	2	400415000
L3	INDUCTOR 39uH 10%	24266	10/392	1	400387000
Q1	TRANS NPN 2N3904	04713	2N3904	1	528071000
R1,22	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	2	341433000
R3,12,30	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R4,7-8,10	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	4	341300000
R5	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	1	341365000
R6	RES MF 14.3K 1% 1/4W	19701	5043ED14K30F	1	341415000
R9	RES NETWORK 10K 2% 1.5W	71450	750-101-R10K	1	345038000
R11	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R13-14	RES NETWORK 3.3K 2% 1.5W 10pin	71450	750-101-R3.3K	2	345030000
R15-16	RES NETWORK 3.3K 2% 2W 8pin	71450	750-81-R3.3K	2	345017000
R17	RES NETWORK 22 OHM +-2 OHM 2W	01121	316B-220	1	345034000
R18	RES MF 909K 1% 1/2W	91637	RN60D9093F	1	342592000
R19-20	RES MF 100K 1% 1/4W	19701	5043ED100K0F	2	341500000
R21	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	1	341465000
R23-24	RES MF 200 OHM 1% 1/4W	19701	5043ED200R0F	2	341229000
R25	RES MF 33.2K 1% 1/4W	19701	5043ED33K20F	1	341450000
R26-27	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	2	341300000
R28-29	RES MF 22.1K 1% 1/4W	19701	5043ED22K10F	2	341433000
R31	RES NETWORK 10K .1% 1.5W 16pin	73138	698-3R10KD	1	345010000
R32	RES MF 909 OHM 1% 1/4W	19701	5043ED909R0F	1	341292000
R33	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	1	341329000
R34	RES MF 357 OHM 1% 1/4W	19701	5043ED357R0F	1	341253000
R35	RES MF 750 OHM 1% 1/4W	19701	5043ED750R0F	1	341284000
R36	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R37	RES MF 4.99K 1% 1/4W	19701	5043ED4K990F	1	341367000
R38	RES MF 49.9K 1% 1/4W	19701	5043ED49K90F	1	341467000
R39	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	1	341400000
S1	SWITCH SLIDE DIP SPST X 7	75378	206-7-LP	1	46530007A
TP1-5	CONN M 05 CKT ST .1CT	06383	MFSS100-5-C-A	6	477365000
TP6	CONN M 03 CKT ST .1CT	06383	MFSS100-3-C-A	1	477364000
TP7-10	TERMINAL WIRE LOOP TEST POINT	31313	TP-103-02	4	48330600A
U1	IC 74LS04 HEX INVERTER	01295	SN74LS04N	1	534155000
U2	IC 356P OP AMP	04713	LF356N	1	535907000

(continued) 08210702A **PWA '8210' DIGITAL & POWER SUPPLY**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
U3	IC 4040B COUNTER/DIVIDER	02735	CD4040BE	1	534275000
U4	IC 311N OP AMP-COMPARATOR	27014	LM311N	1	535905000
U5	IC 74LS74 FLIP FLOP	01295	SN74LS74N	1	534157000
U6	IC 74LS32 QUAD 2 INPUT OR	01295	SN74LS32N	1	534168000
U7	D/A CONVERTER 565	51640	AD565AJD	1	421034000
U8	IC Z80-CPU-PS	56708	Z80-CPU-PS	1	534159000
U9	IC 74LS163 4 BIT COUNTER	01295	SN74LS163AN	1	534279000
U10	IC 74LS42 4-10 DECODER	01295	SN74LS42N	1	534210000
U11	PROM 8210 A4-U11 DIG/PWR PWA	04901	53444300B	1	53444300B
U12	IC 74LS153 4-1 LINE DATA SEL	01295	SN74LS153N	1	534278000
U13	IC MSM5128-20-RS RAM 2K X 8	52464	MSM5128-20-RS	1	534304000
U16-17	IC 8255APC PERIPH INTERFACE	34335	AM8255APC	2	534171000
U18	IC UDN2983A SOURCE DRIVER	52769	UDN2983A	1	534255000
U19	IC ULN2803A TRANSISTOR ARRAY	56289	ULN2803A	1	534274000
U20	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	1	534209000
U21	IC TL072CP DUAL OP AMP	01295	TL072CP	2	535092000
U22	IC 4052B MULTIPLEXER	02735	CD4052BE	1	534140000
U23-24	IC 3080E OP AMP	02735	CA3080E	1	535091000
U29	IC 324N QUAD OP AMP	27014	LM324N	1	535068000
U30	IC LM10CLN OPAMP/VOLT REF 8DIP	27014	LM10CLN	1	53512200A
U31	IC DS1210 RAM CONTROLLER	0B0A9	DS1210	1	53514300A
XJ8	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000
XQ1	SOCKET TRANSISTOR 3 PIN	07047	90363-202	1	473046000
XU1,5-6,29	SOCKET IC 14 PIN	06776	ICN-143-S3-G	4	473019000
XU2,4,21	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000
XU3,9-10	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU7,13	SOCKET IC 24 PIN	06776	ICN-246-S4-G	2	473043000
XU8,16-17	SOCKET IC 40 PIN	06776	ICN-406-S4-TG	3	473052000
XU11	SOCKET IC 28 PIN	06776	ICN-286-S4-G	1	473044000
XU12,20,22	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU18-19	SOCKET IC 18 PIN	06776	ICN-183-S3-TG	2	473045000
XU23-24,30	SOCKET IC 8 PIN	06776	ICN-083-S3-G	3	473041000
XBT1	BATTERY HOLDER	25441	BH-906	1	483263000
Y1	CRYSTAL 3.579545 MHz	95402	MQC035A	1	547035000

08210801L **PWA '8210' RF**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1,18,20	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C2,4,11,19	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	4	283336000
C3	CAP CER CHIP 0.01uF 20% 50V	61637	C1210C103M5XAH	1	224210000
C5	CAP CER CHIP 680pF 10% 50V	61637	C1210C681K5XAH	1	224377000
C6,8	CAP CER 0.01uF 100V	33883	BT Z5U	2	224119000
C7,14	CAP MICA 100pF 1% 500V	14655	CD15FD101F	2	200045000
C9,12,58	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	3	205006000

(continued) 08210801L PWA '8210' RF
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C10,13,57	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	3	283216000
C15	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C17	CAP MICA 8.0pF 10% 300V	57582	KD5080D301	1	205001000
C21,36-37	CAP MICA 270pF 5% 50V	57582	KD5271J101	3	205045000
C22-26	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	5	224268000
C27	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C28,64	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	2	205018000
C29	CAP CER 0.001uF 10% 100V	04222	SR151C102KAA	1	224270000
C30,35,40	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	3	283336000
C31,39,41	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	3	224269000
C32,44	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	2	283334000
C33	CAP MICA 10pF 5% 300V	14655	CD5CC100J	1	205002000
C34	CAP MICA 22pF 5% 300V	14655	CD5CC220J	1	205036000
C38,48,53	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	3	283293000
C42-43	CAP MICA 390pF 5% 500V	57582	KD15391J501	2	200108000
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
C50-51	CAP CER CHIP 0.1 uF 10% 50V	51406	GRM422X7R104K50VPB	2	234136000
C52, 55,59	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C60	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	1	283336000
C61-63	CAP CER CHIP 0.1 uF 10% 50V	51406	GRM422X7R104K50VPB	3	234136000
C65	CAP TANT 1.0 uF 10% 35V ONLY	56289	196D105X9035HA1	1	283216000
CR1,4,7-8	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	4	530174000
CR2	DIODE 5082-2815 MATCHED QUAD	28480	5082-2815	1	530903000
CR3	DIODE SIG 5082-0180	28480	5082-100	1	530168000
CR5-6	DIODE SIG 1N914	01295	1N914	2	530058000
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
L5,8,11	INDUCTOR 5.6uH 10%	24226	15/561	3	400308000
L6,9	INDUCTOR 68uH 10%	24226	10/682	2	400411000
L7,10	INDUCTOR 39uH 10%	24266	10/392	2	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
Q2,8	TRANS FET 2N4416 N-CHAN	04713	2N4416	2	528072000
Q3,6	TRANS PNP 2N3906	04713	2N3906	2	528076000
Q4-5, 9-10	TRANS NPN 2N3904	04713	2N3904	4	528071000
Q7	TRANS NPN MPS-6507	04713	MPS6507	1	528070000
R1,13, 77	RES MF 33.2 OHM 1% 1/4W	19701	5043ED33R20F	3	341150000
R2,4	RES MF 301 OHM 1% 1/4W	19701	5043ED301R0F	2	341246000
R3	RES CHIP 18 OHM 5% 1/2W	50316	WA-7FG-180JS	1	339996000
R5	RES MF 332 OHM 1% 1/4W	19701	5043ED332R0F	1	341250000
R6,21,33	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	3	341200000
R7,18	RES MF 6.81K 1% 1/4W	19701	5043ED6K810F	2	341380000

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
R8-9,19-20	RES COMP 100 OHM 5% 1/8W	01121	BB1015	4	331058000
R10	RES VAR 50K 10% 0.5W	73138	72PR50K	1	311393000
R11,16,25	RES MF 7.50K 1% 1/4W	19701	5043ED7K500F	3	341384000
R12,17	RES COMP 200 OHM 5% 1/8W	01121	BB2015	2	331065000
R14	RES VAR 10K 10% 0.5W	73138	72PR10K	1	311328000
R15,51	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	2	341368000
R22,36,38,50	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	4	341300000
R23	RES MF 3.92K 1% 1/4W	19701	5043ED3K920F	1	341357000
R24,45	RES MF 20.0K 1% 1/4W	19701	5043ED20K00F	2	341429000
R26,28	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R27,32	RES MF 22.1 OHM 1% 1/4W	19701	5043ED22R10F	2	341133000
R29,31,48	RES COMP 47 OHM 5% 1/8W	01121	BB4705	3	331050000
R30	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	1	341165000
R34,69	RES MF 4.75K 1% 1/4W	19701	5043ED4K750F	2	341365000
R35,39	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	2	341268000
R37,49,56	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
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
R44,46	RES MF 47.5K 1% 1/4W	19701	5043ED47K50F	2	341465000
R47	RES MF 90.9K 1% 1/4W	19701	5043ED90K90F	1	341492000
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 510 OHM 5% 1/8W	01121	BB5115	2	331075000
R57,60	RES MF 200K 1% 1/4W	19701	5043ED200K0F	2	341529000
R58,61,67	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R59,62	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	2	341329000
R63A-D	RES NETWORK 3.3K 2% 0.9W	71450	750-61-R3.3K	1	34514500A
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
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
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

(continued) 08210801L **PWA '8210' RF**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
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	04713	MC10116P	1	53467001A
U9	IC 74LS122 MONOSTABLE MULTIVBT	01295	SN74LS122N	1	534280000
XQ2,8	SOCKET TRANSISTOR 4 PIN	17117	7004-265-5	2	473051000
XU1,3,9	SOCKET IC 14 PIN	06776	ICN-143-S3-G	3	473019000
XU4,7,8	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU5-6	SOCKET IC 8 PIN	06776	ICN-083-S3-G	2	473041000

08210901J **PWA '8210' IF-AF**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
C1	CAP MICA 470pF 1% 500V	14655	CD15FD471F03	1	200050000
C2,40	CAP MICA 240pF 1% 500V	00853	D10FD241F	2	200124000
C3	CAP MICA 15pF 5% 300V	14655	CD5CC150J	1	205035000
C4	CAP CER 0.01uF 10% 100V	04222	SR201C103KAA	1	224269000
C5,8	CAP TANT 1.0uF 10% 35V ONLY	56289	196D105X9035HA1	2	283216000
C6,25-26	CAP EL 100uF 20% 25V	S4217	SM-25-VB-101M	3	283334000
C7,15,18	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	3	224364000
C9	CAP MICA 150pF 5% 100V	57582	KD5151J101	1	205009000
C10,43,46	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	3	205006000
C11,14,17	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	3	283336000
C12	CAP MICA 33pF 5% 300V	20307	DM5-EC330J	1	205010000
C13,22,29	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	3	224268000
C19,24	CAP EL 10uF 20% 25V	S4217	SM-25-VB-10-M	2	283336000
C20	CAP MICA 39pF +-0.5pF 300V	57582	KD50390F301	1	205049000
C21,37,51	CAP TANT 10uF 20% 25V	56289	196D106X0025KA1	3	283293000
C23	CAP CER 1.0uF 20% 50V	04222	SR305E105MAA	1	224264000
C27-28	CAP MICA 47pF 5% 300V	20307	DM5-EC470J	2	205018000
C30,49-50	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	3	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% 100V	14655	CD5FC121J	1	205050000
C38-39	CAP MICA 1000pF 1% 100V	51406	DM15-102F	2	200113000
C41	CAP MICA 200pF 2% 500V	14655	CD15FD201G	1	200053000
C42	CAP CER 0.1uF 20% 50V	04222	SR215E104MAA	1	224268000
C44,47	CAP MPC 0.01uF 2% 50V	14752	652A-1A-103G	2	234142000
C45	CAP MPC 0.1uF 2% 50V	14752	652A-1-A-104G	1	234139000
C48	CAP MICA 100pF 5% 300V	20307	DM5-FC101J	1	205006000
C52	CAP CER 0.1uF 20% 25V	51406	DD312E10Y5P104M25V	1	224364000
C53	CAP MICA 20pF 5% 300V	14655	CD5CC200J	1	205017000
CR1-2,8-13	DIODE SIG 1N914	01295	1N914	8	530058000
CR3-7	DIODE HSCH1001 (1N6263)	28480	HSCH-1001	5	530174000
CR14-15	DIODE SIG 1N914	01295	1N914	2	530058000
J1-2	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000

(continued) 08210901J PWA '8210' IF-AF
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
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
L6-9	INDUCTOR 5.6uH 10%	24226	15/561	4	400308000
P16	CONNECTOR PIN	71279	450-3367-01-03-00	1	479417000
Q1,3,6	TRANS NPN 2N3904	04713	2N3904	3	528071000
Q2,4-5	TRANS PNP 2N3906	04713	2N3906	3	528076000
R1	RES COMP 330 OHM 5% 1/8W	01121	BB3315	1	331070000
R2,5,11-12	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	4	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
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
R8,26,38	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	3	341329000
R9	RES MF 5.11K 1% 1/4W	19701	5043ED5K110F	1	341368000
R10,27,46	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	3	341300000
R13,29	RES MF 100 OHM 1% 1/4W	19701	5043ED100R0F	2	341200000
R14,30,32	RES MF 15.0K 1% 1/4W	19701	5043ED15K00F	3	341417000
R15	RES MF 1.82K 1% 1/4W	19701	5043ED1K820F	1	341325000
R16,23	RES MF 1.50K 1% 1/4W	19701	5043ED1K500F	2	341317000
R17,22	RES MF 475 OHM 1% 1/4W	19701	5043ED475R0F	2	341265000
R18,40,42	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	341400000
R19	RES MF 3.32K 1% 1/4W	19701	5043ED3K320F	1	341350000
R20,31,39	RES MF 6.19K 1% 1/4W	19701	5043ED6K190F	3	341376000
R21	RES MF 511 OHM 1% 1/4W	19701	5043ED511R0F	1	341268000
R24,28,34	RES MF 47.5 OHM 1% 1/4W	19701	5043ED47R50F	3	341165000
R25	RES MF 2.21K 1% 1/4W	19701	5043ED2K210F	1	341333000
R33	RES MF 39.2K 1% 1/4W	19701	5043ED39K20F	1	341457000
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
R41,44,77	RES MF 2.00K 1% 1/4W	19701	5043ED2K000F	3	341329000
R43	RES MF 243 OHM 1% 1/4W	19701	5043ED243R0F	1	341237000
R45	RES MF 150 OHM 1% 1/4W	19701	5043ED150R0F	1	341217000
R47-48	RES MF 52.3K 1% 1/4W	19701	5043ED52K30F	2	341469000
R50-52,61	RES MF 10.0K 1% 1/4W	19701	5043ED10K00F	3	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
R56,76	RES MF 604 OHM 1% 1/4W	19701	5043ED604R0F	2	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
R62,74,71	RES MF 1.00K 1% 1/4W	19701	5043ED1K000F	3	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

(continued) 08210901J **PWA '8210' IF-AF-**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
R67,70,72	RES MF 51.1K 1% 1/4W	19701	5043ED51K10F	3	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
R73	RES MF 1.54K 1% 1/4W	19701	5043ED1K540F	1	341318000
R75	RES MF 100K 1% 1/4W	19701	5043ED100K0F	1	341500000
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
U1,8,14	IC 356P OP AMP	04713	LF356N	3	535907000
U2,5	IC 5534AN OP AMP	18324	NE5534AN	2	535061000
U3	IC 13333 ANALOG SWITCH LF	27014	LF13333N	1	535095000
U4	D/A CONVERTER DAC-08EP	06665	DAC-08EP	1	421037000
U6	IC 74LS00 2 INP POS NAND	01295	SN74LSOON	1	534167000
U7	IC 74121 MULTIVIBRATOR TI ONLY	01295	SN74121N	1	534038000
U9,12	IC TL074CN OP AMP QUAD	01295	TL074CN	2	535082000
U10-11,15	IC 4051B MULTIPLEXER RCA ONLY	02735	CD4051BE	3	534209000
U13	IC 4052B MULTIPLEXER	02735	CD4052BE	1	534140000
XU1-2,5,8	SOCKET IC 8 PIN	06776	ICN-083-S3-G	4	473041000
XU3-4	SOCKET IC 16 PIN	06776	ICN-163-S3-G	2	473042000
XU6-7,9,12	SOCKET IC 14 PIN	06776	ICN-143-S3-G	4	473019000
XU10-11,13	SOCKET IC 16 PIN	06776	ICN-163-S3-G	3	473042000
XU14	SOCKET IC 8 PIN	06776	ICN-083-S3-G	1	473041000
XU15	SOCKET IC 16 PIN	06776	ICN-163-S3-G	1	473042000

08211001E **PWA '8210' DISPLAY**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
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(W9)	CONNECTOR PIN FEMALE	27264	02-06-1231	2	479320000
S1-11	SWITCH PUSHBUTTON SPST	31918	220075 Type D7	11	465287000
XDS1-4	SOCKET IC 14 PIN	06776	ICN-143-S3-G	4	473019000

08211501A **'8210' CONNECTOR ASSEMBLY LINE SW**
MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
P15	CONN HOUSING 4 PIN	27264	03-06-2043	1	477306000
S2	SWITCH ROCKER DPDT	13812	572-2121-0103-010	1	465286000

08211600B **'8210' CONNECTOR ASSEMBLY**

MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
J2	CONNECTOR "SMB" 50 OHM	19505	2019-7511-000	1	477305000
J3-4	CONN 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

08211901B **'8210' HEAT SINK ASSEMBLY**

MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
U25,27	IC 78M05CT VOLT REG	04713	MC78M05CT	2	535046000
U26	IC UA7805UC VOLT REG	07263	uA7805UC	1	53511700A
U28	IC UA79M05AUC VOLT REG	07263	uA79MO5AUC	1	535093000

96300101A **FUSE KIT 220V 0.125A**

MODEL: 8210

REFERENCE DESIGNATOR	DESCRIPTION	FED. CODE	MANUFACTURER PART NUMBER	QTY	BEC PART NUMBER
F1	FUSE 0.125A 250V MDL SLO BLO	54426	MDL-1/8 SLO BLO	1	545516000
FH1	FUSE CARRIER BLACK 5mm x 20mm	SCHUR	FEK031.1663S	1	482115000

SECTION VI

SCHEMATIC DIAGRAMS

6-1. TABLE OF CONTENTS

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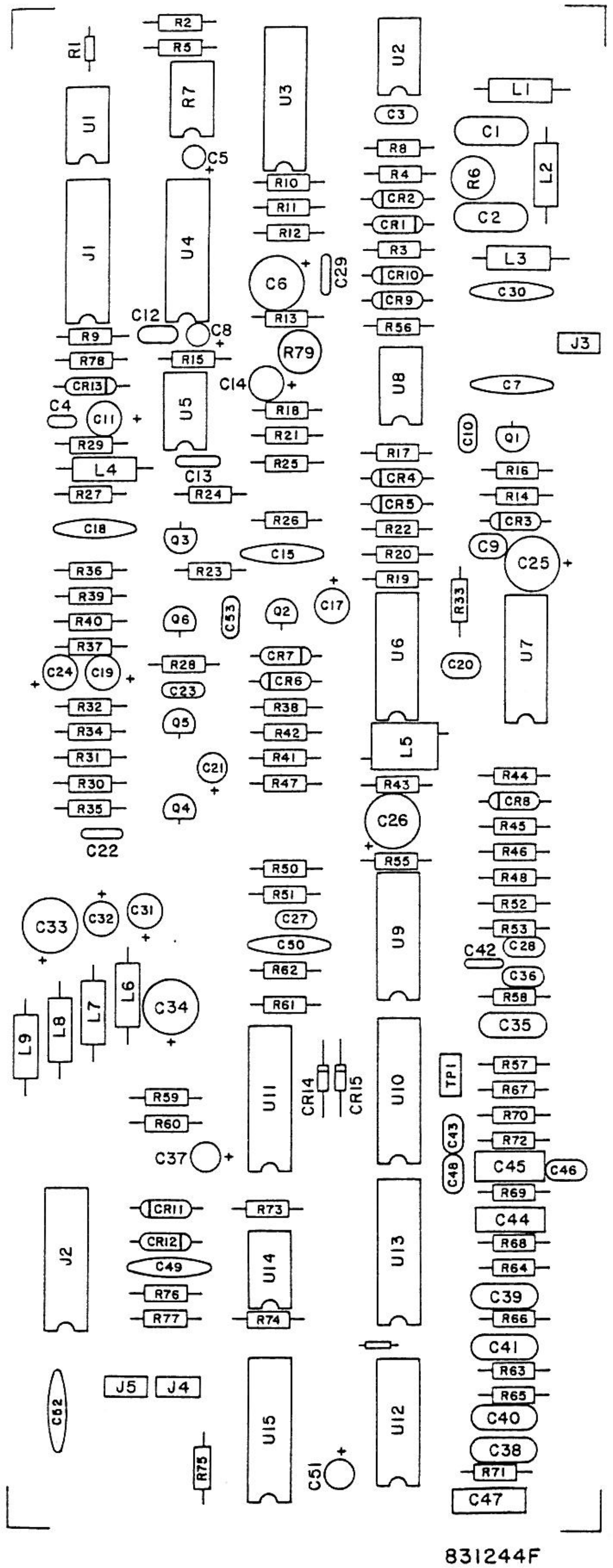


I.F.-A.F. Board, Parts Location Diagram (D831244D)

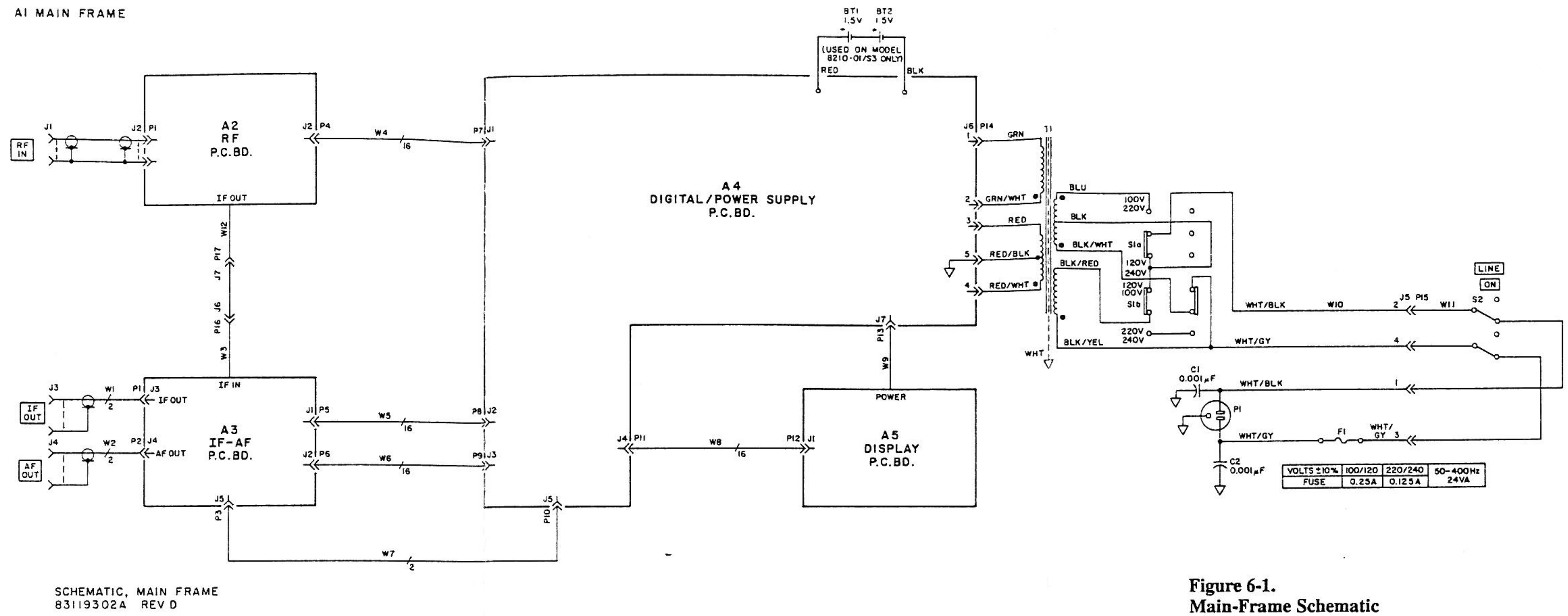
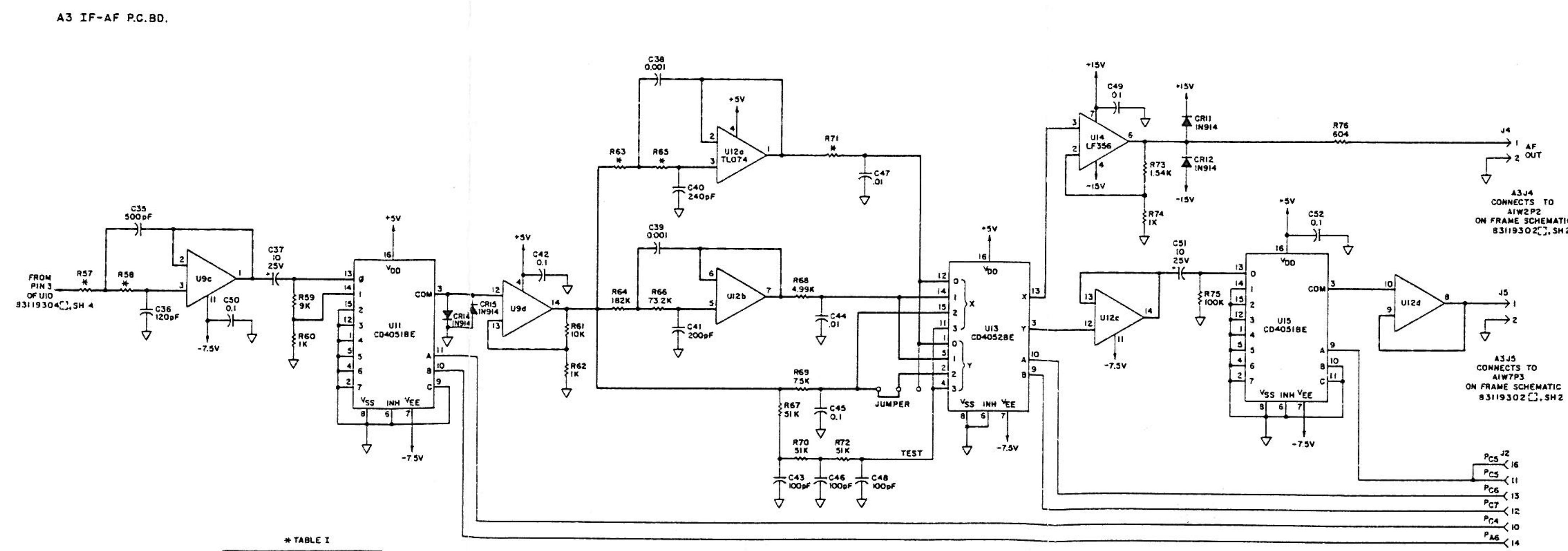


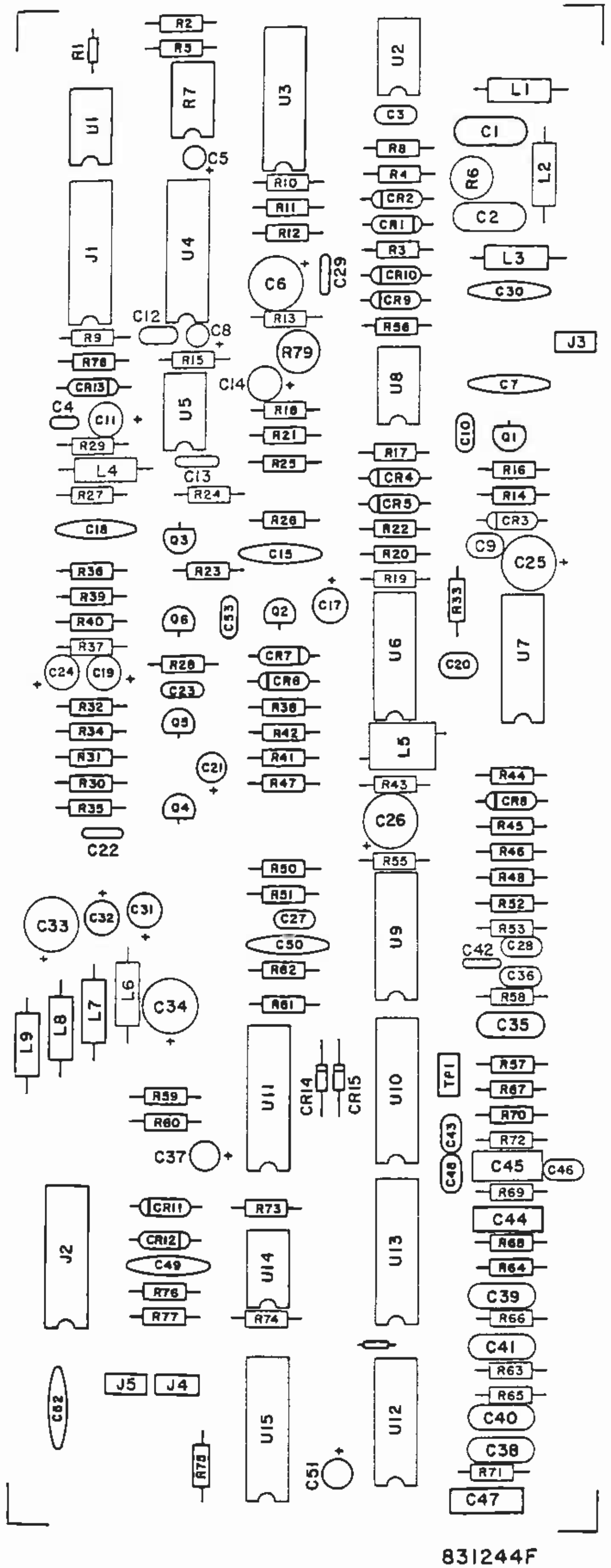
Figure 6-1.
Main-Frame Schematic (E831193C) Sheet 1 of 4



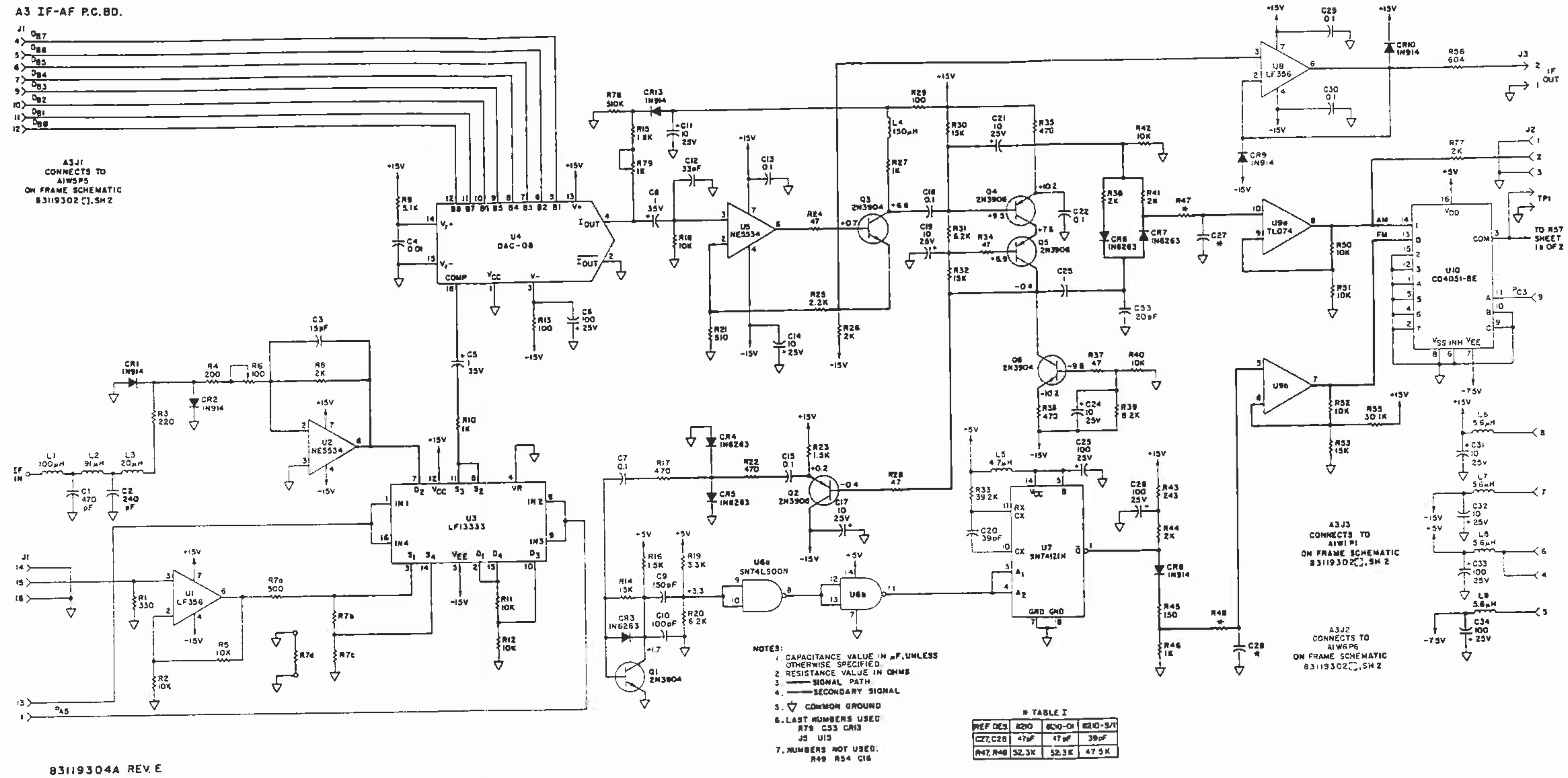
* TABLE I

REF DES.	8210	8210-01	8210-S/1
R57	13.3K	13.3K	10K
R58	8.87K	8.87K	6.81K
R63	26.7K	12.7K	7.32K
R65	16.9K	8.25K	4.99K
R71	1K	499	301

Figure 6-2.
I.F.-A.F. Board Schematic (E831193C) Sheet 3b of 4



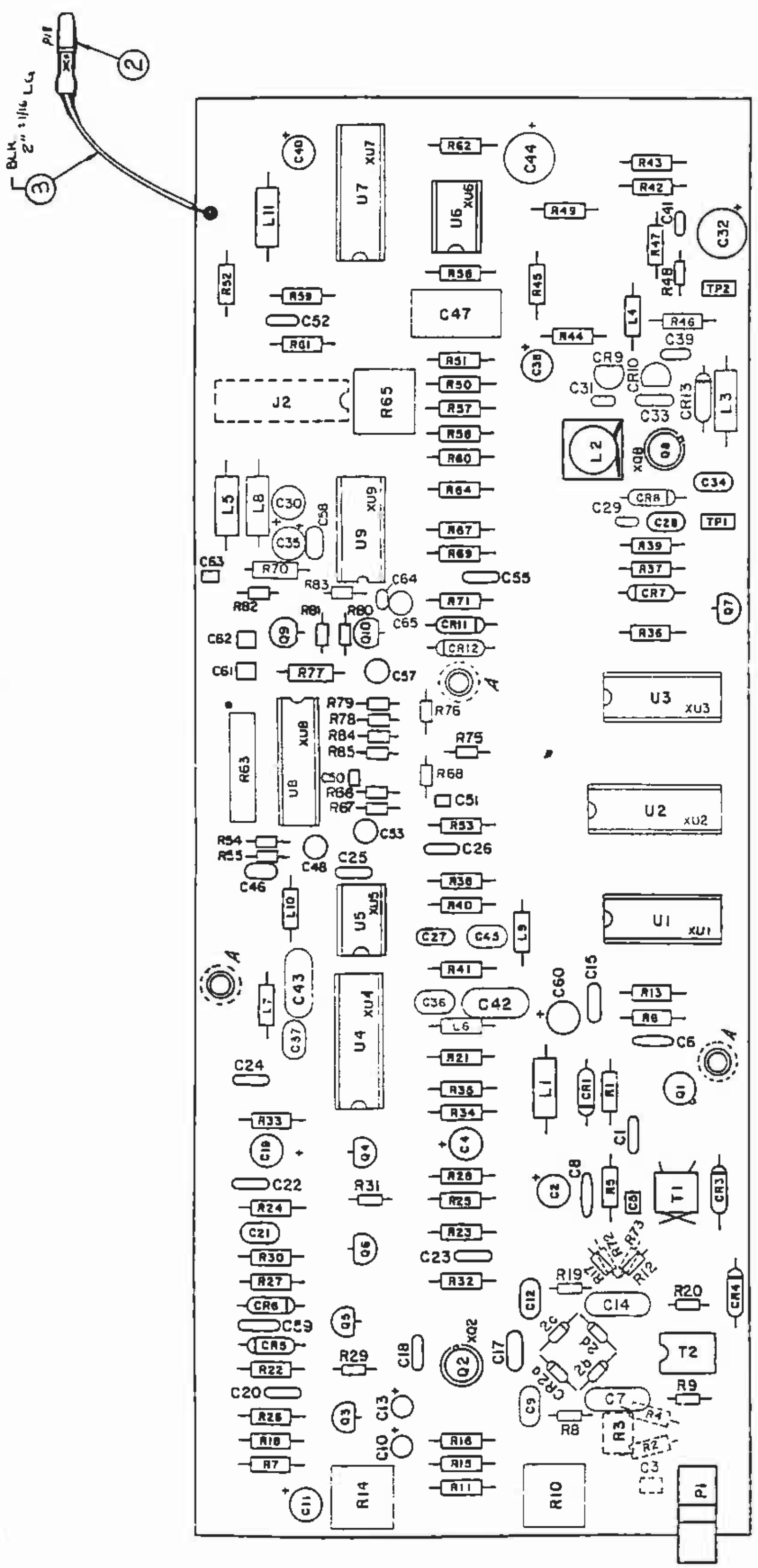
I.F.-A.F. Board, Parts-Location Diagram (D831244D)



* TABLE I

REF DES	8210	8210-01	8210-S/1
C27,C28	47pF	47pF	39pF
R47,R48	52.3K	52.3K	47.5K

Figure 6-3.
I.F.-A.F. Board Schematic (E831193D) Sheet 3a of 4



R.F. Board Parts Location Diagram (D831245H)

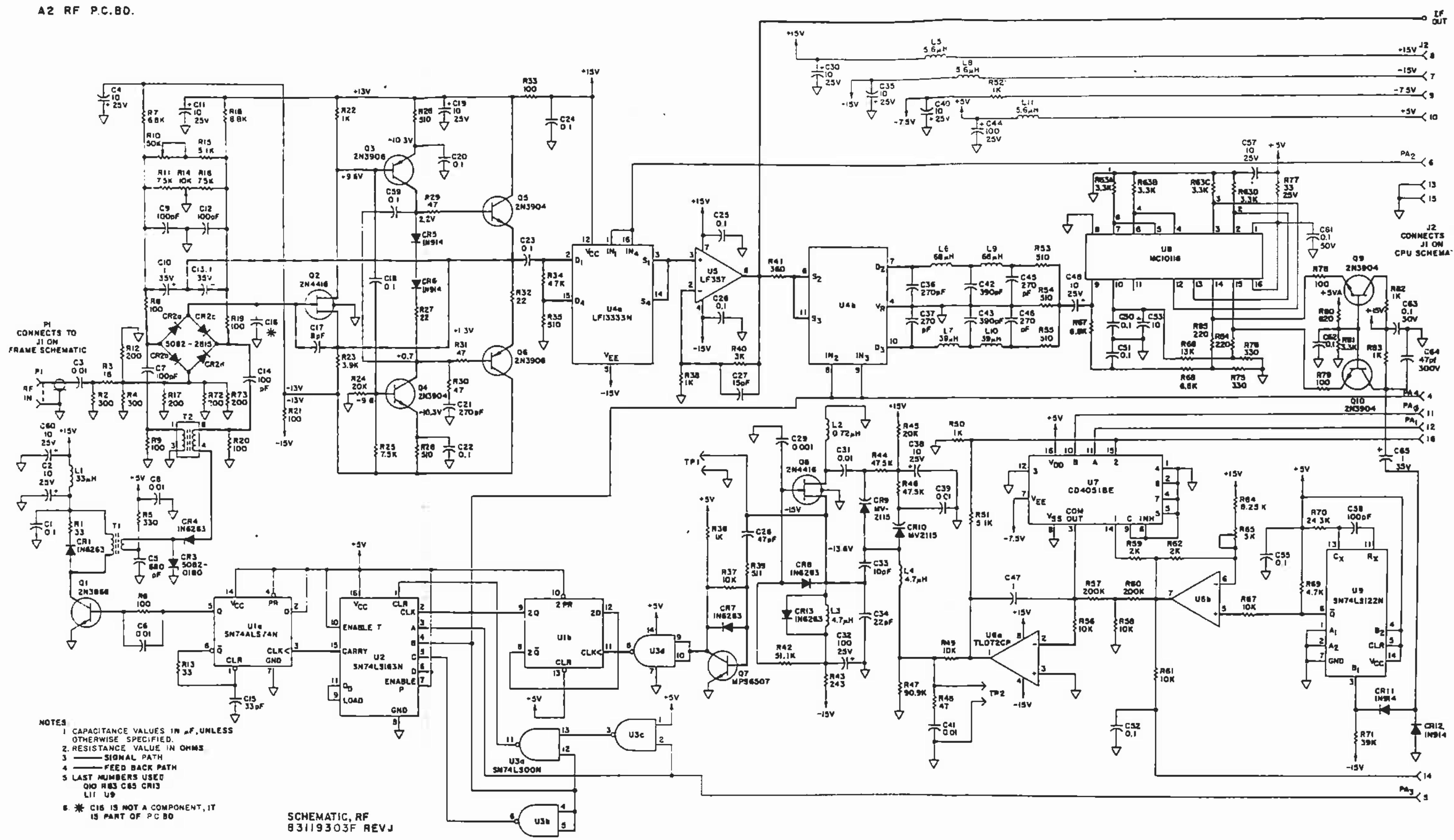
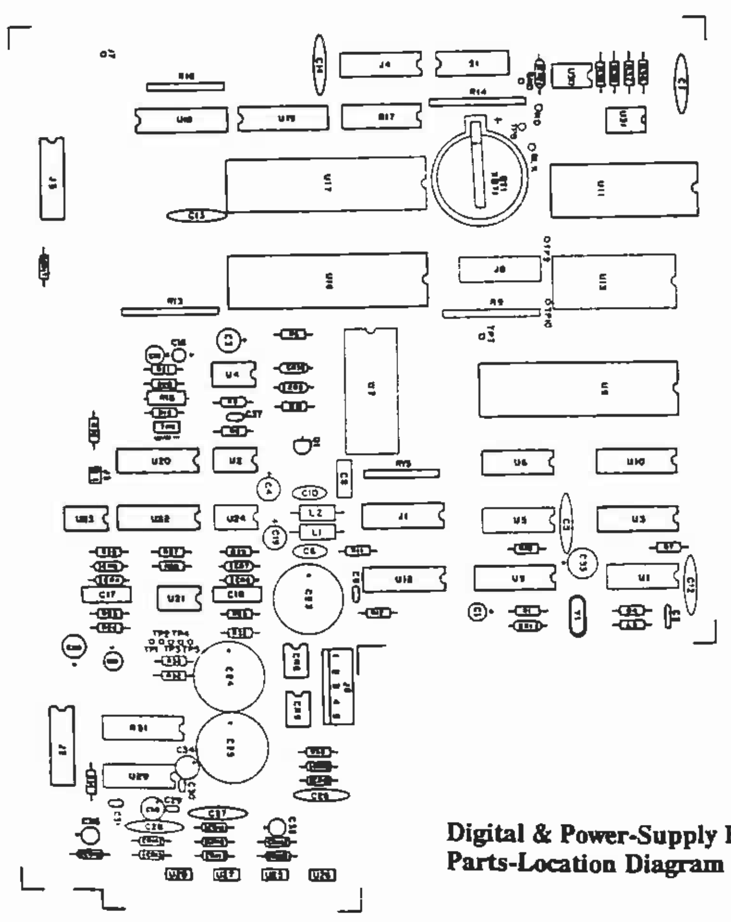
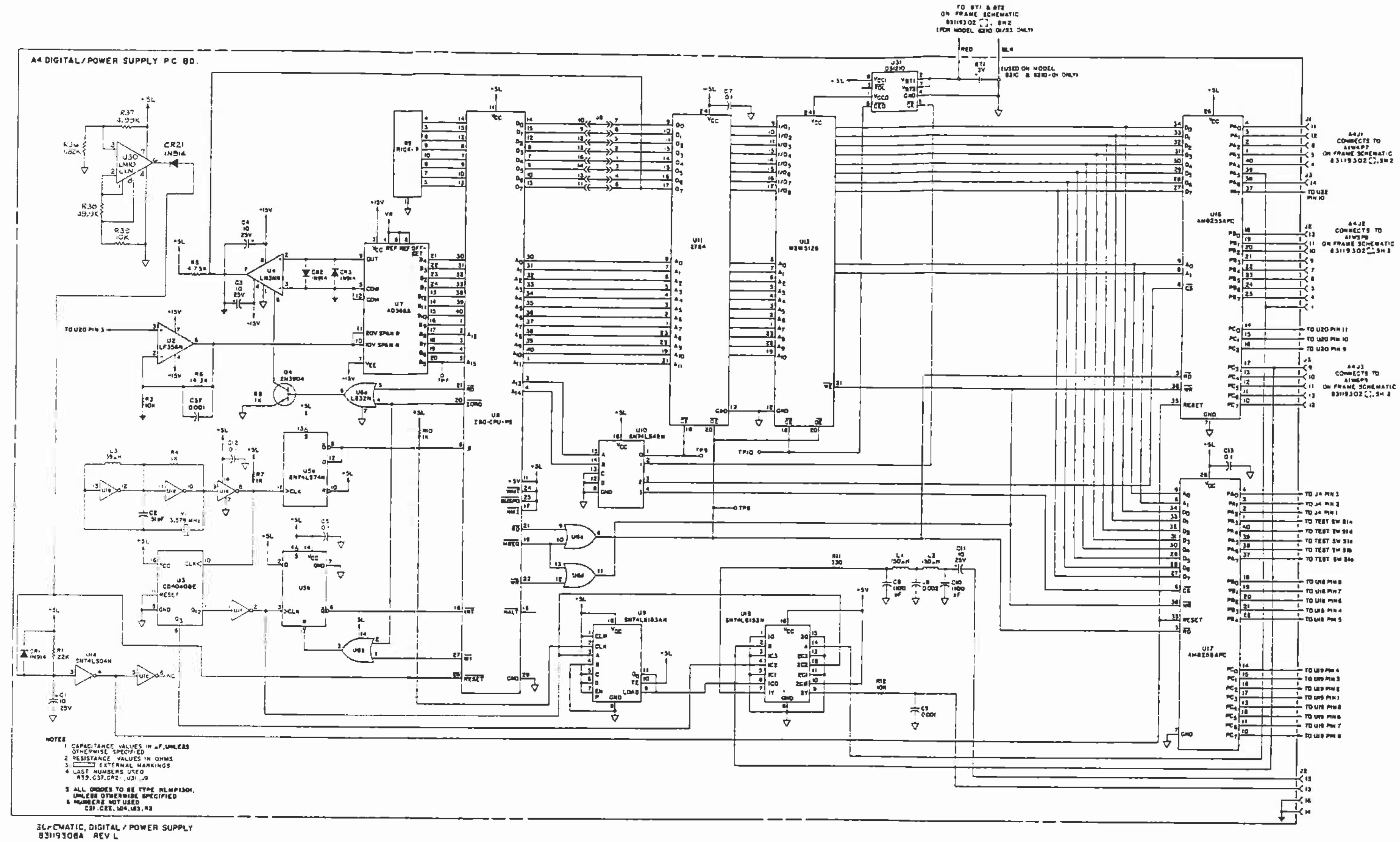


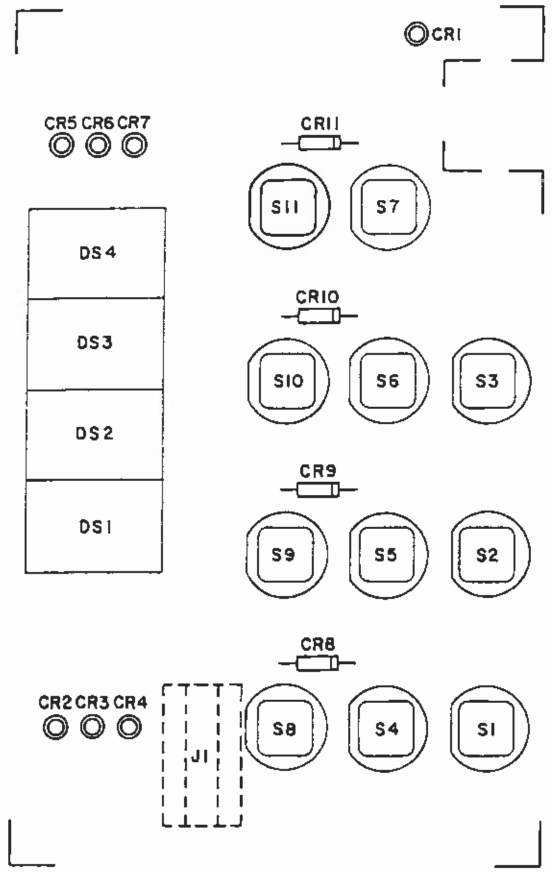
Figure 6-4.
R.F. Board Schematic (E831193J) Sheet 2 of 4





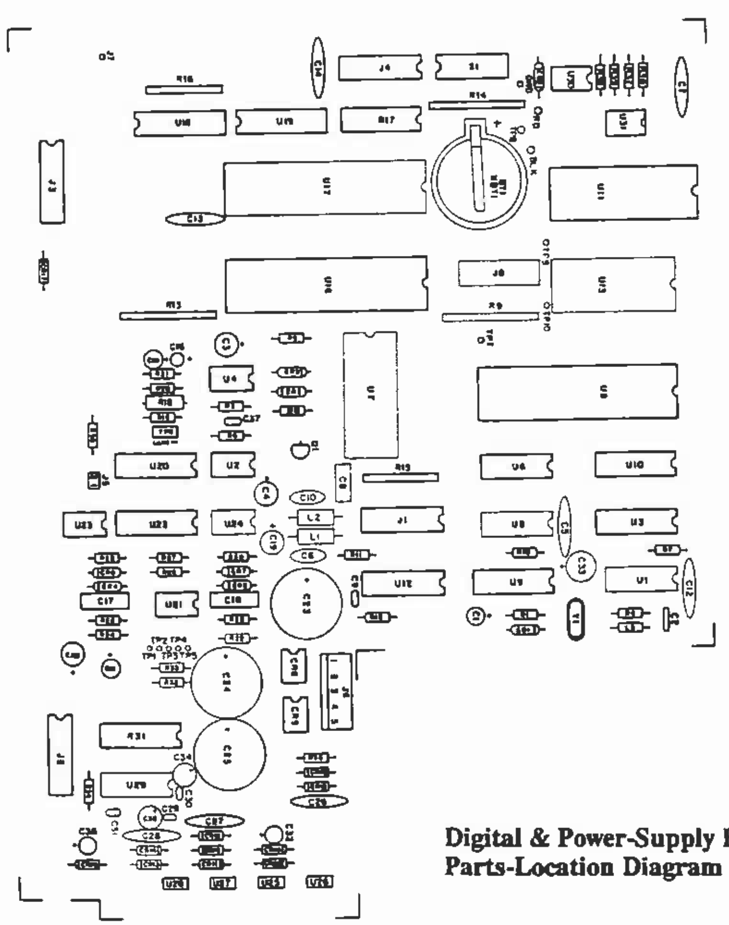
Digital & Power-Supply Board Parts-Location Diagram (D831248F)

Figure 6-5.
Digital & Power-Supply Board Schematic (R831193F) Sheet 4a of 4



831250A

Digital Board Parts-Location Diagram (C831250A)



Digital & Power-Supply Board Parts-Location Diagram (D831248F)

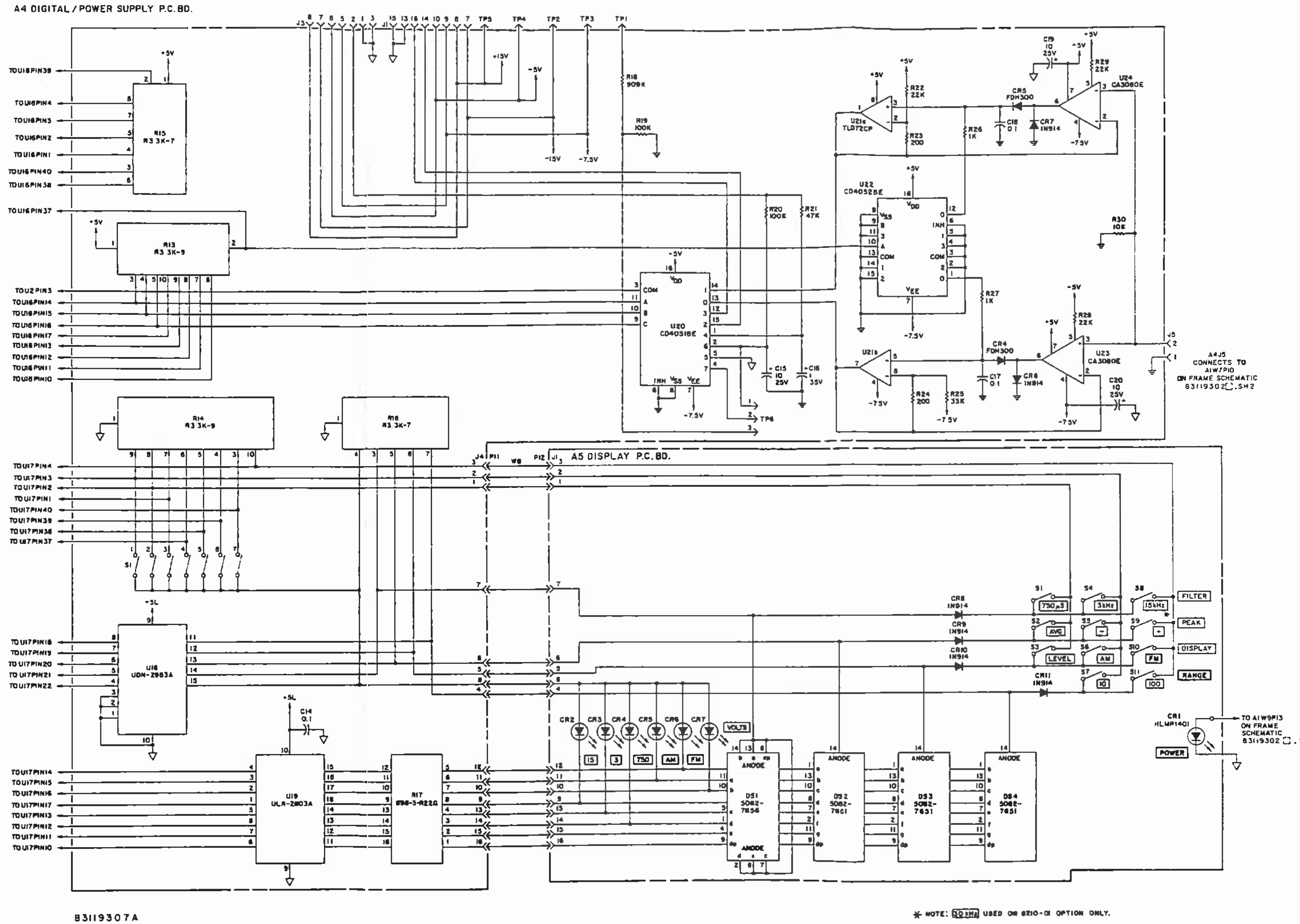
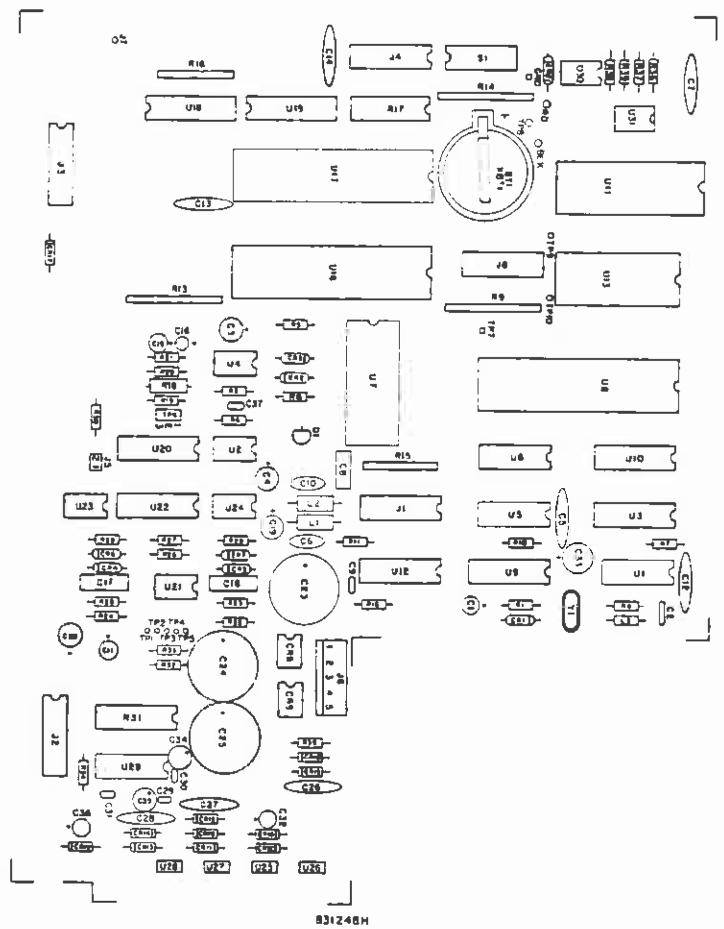


Figure 6-6.
Digital & Power-Supply Board Schematic (E831193D) Sheet 4b of 4



Digital & Power-Supply Board
Parts-Location Diagram (D831248F)

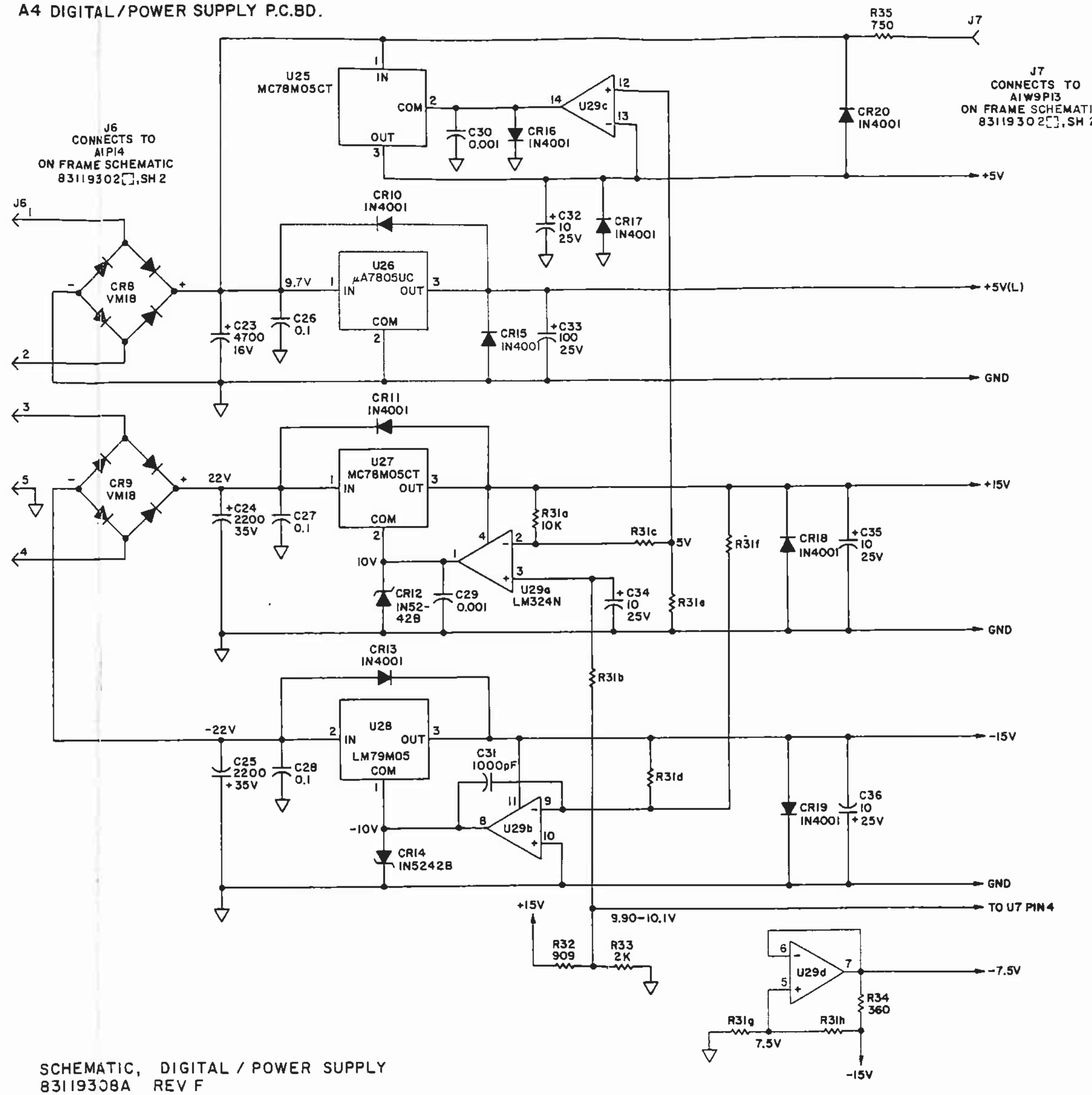


Figure 6-7.
Digital & Power-Supply Board Schematic (D8311930) Sheet 4c of 4

APPENDIX A

CALIBRATOR OPERATION

A-1. INTRODUCTION
The internal calibrators of the Model 8210 provide modulation standards for a.m. and f.m. measurements; they are activated when the level key is depressed while the firmware code is being displayed after the instrument is initially turned on. This section of the manual provides technical information concerning the operation and design of the calibrators.

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

1. The input signal to pin 2 of A4U9 is the microprocessor's crystal-oscillator signal divided by two: 1.79 MHz. The preset inputs, A-D, of A4U9 are alternately programmed to be 12 (decimal) or 13 (decimal), depending upon the sense of the signal on pin 3 of A4U9. This latter signal is generated by dividing the 3.58 MHz crystal-oscillator frequency by 4096. The resulting frequency is 874 Hz.

2. When the preset inputs are programmed to decimal 12, five clock cycles (i.e., at 1.79 MHz) are required to cause the counter to overflow. The QD output then goes low, which reloads the preset inputs. Under these conditions, the counter is dividing the signal by a factor of five, resulting in an output frequency of 357.9 kHz. Similarly, when the preset inputs are programmed to decimal 13 the counter divides by four. The resulting frequency is then 447.4 kHz. The "average" frequency, therefore, is 402.6 kHz. The peak-to-peak deviation of 89.5 kHz and peak deviation is 44.75 kHz.

3. To verify the accuracy of the f.m. calibrator, it is required only that the microprocessor's clock frequency be measured accurately. (Naturally, counter U9 must be operating properly as well). Manual verification of the two (programmed) frequencies can be performed by lifting pin 2 of A4U9, shortening it alternately to +5 V and to ground, and measuring the resulting frequencies.

4. The calibration program accumulates ten readings, and averages them to eliminate the last-digit uncertainty. The voltmeter, however, can resolve the actual deviation only to 1 part in 447. Thus the worst-case quantizing error is +/- 0.22%. F.M. noise is of little or no consequence in determining calibrator deviation, since the two frequencies are crystal controlled and the r.f. circuitry is bypassed for calibration.

5. Cross-correlation measurements using a Bessel null technique indicate that the actual calibration uncertainty for 100 calibrations is close to +/- 0.11%, or one-half digit. (When employing Bessel null correlation, care

should be taken to use a carrier with the lowest possible noise--and to take noise residuals into account--while keeping audio distortion to less than 0.1%).

b. A.M. Calibrator. The operation of the a.m. calibrator is similar to that of the f.m. calibrator. Refer to Figure 3-5.

1. During a.m. calibration the count modulus of A4U9 is fixed at four. The resulting frequency, 447.5 kHz, is low-pass filtered by A4L1, L2, C6, C8 and C10 to remove harmonics. The signal's amplitude is not critical since the a.g.c. system is used to normalize the a.m. detector output.

2. The filtered signal is routed to the i.f./a.f. circuit board via C11, which removes any d.c. component, and thence to the input of buffer U1. Amplifier U1 increases the level of the signal, and more importantly, provides a very low output impedance to drive the voltage divider consisting of A3R7a, b, and c. The signal is kept at a high level in its passage through A3U3 in order to reduce the effects of switching transients and feed-through. The attenuator consisting of R11 & R12 reduces the signal to the correct level after modulation.

3. The voltage divider comprising A3R7a, b, c, is a precision-resistor array. The absolute value of the resistors, however, is not as important as is the match between them. Thus, resistors R7b and R7c are guaranteed to a +/- 0.1% match with R7a.

   Maintaining this voltage divider at a constant impedance minimized the loading effect of attenuator A3R11-R12.

4. The voltage at the junction of A3R7a and R7b is two-thirds of the output voltage of A3U1; the voltage at the junction of R7b and R7c is one-third. The ratio of these two voltages is 2:1. The equivalent a.m. percentage is then derived as follows:

NOTE:
p+ = +Peak
p- = -Peak

$$\% \; p+ = \frac{E_{max} - E_{avg}}{E_{avg}} \times 100 \qquad (1)$$

$$\% \; p- = \frac{E_{avg} - E_{min}}{E_{avg}} \times 100 \qquad (2)$$

$$\text{Peak Average } \% = \frac{p+ - p-}{2} \times 100 \qquad (3)$$

Therefore, combining Eqa. 1, 2 & 3, for symmetrical modulation,

$$\text{a.m.} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} \times 100 \qquad (4)$$

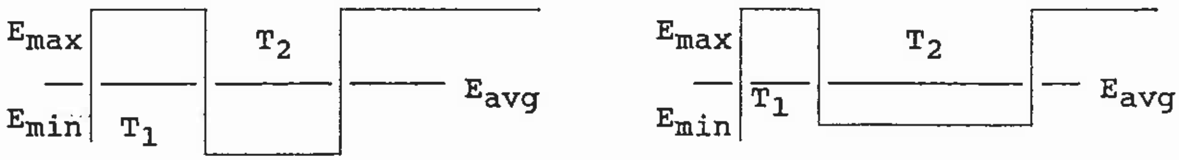
And for a 2:1 ration, $= \frac{2 - 1}{2 + 1} \times 100$

$= 33.33\%$

5. The above equations assume that the modulation is symmetrical (i.e. perfectly so). Should that not be the case, a d.c. shift occurs and the plus and minus peaks are not symmetrical. The calibrator program eliminates such an error by calculating a.m. as:

$$\text{peak average} = \frac{p+ + 2p-}{3} \qquad (5)$$

This expression is determined as follows;



Symmetric (Ideal) Modulation   Asymmetric Modulation

Calibrator Modulation Signal

Now, since the peak detectors are a.c. coupled,

$$(p+)(T_1) - (p-)(T_2) = 0 \quad \text{(0 volts, d.c.)} \qquad (6)$$

And:

$$T_1 + T_2 = 1 \qquad (7)$$

$$(p+)(T_1) - (p-)(1 - T_1) = 0 \qquad (8)$$

$$T_1 = \frac{p-}{p+ + p-} \qquad (9)$$

Now:

$$E_{avg} = E_{min} + (E_{max} - E_{min}) \frac{T_1}{T_1 + T_2} \qquad (10)$$

And in the 8210:
[see Para. A-2B(4)]

$$E_{max} = 2E_{min} \qquad (11)$$

Combining Eqs. 7, 10 & 11:

$$E_{avg} = E_{min} + E_{min}\,(T_1) \qquad (12)$$

$$E_{avg} = E_{min}\,(1 + T_1) \qquad (13)$$

If symmetry is perfect: $E_{avg} = E_{min}\,(1.5)$ (14)

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

$$R = (1 + T_1)/1.5 \qquad (15)$$

Combining Eqs. 9 & 15:

$$R = \frac{p+ + 2\,p-}{1.5\,(p+ + p-)} \qquad (16)$$

The incorrect a.m., (E_{avg} normalized to 1):

$$= \frac{p+ + p-}{2} \qquad (17)$$

The corrected a.m. is then:

$$= \frac{p+ + p-}{2} \times R \qquad (18)$$

And, from Eqs. 16 & 18,

$$= \frac{p+ + 2p-}{3} \qquad (19)$$

6. It should be noted that only the ratio of the two modulating levels is important--not their absolute values. The two a.m. levels can be measured at the AF OUT connector by manually operating the IC analog switch A3U3 as follows:

   a. With power off, set Pos. #7 of Test Switch A4S1 "on".

   b. Power on. Connect a voltmeter to the AF OUT connector.

   c. Connect a clip lead from pin 1 or 16 of A3U3 to ground. (These pins are resistively isolated, so no harm will occur in grounding them).

   d. Depress the AM FUNCTION button and measure the AF OUT voltage.

   e. Disconnect the clip lead from ground and connect it to +5 volts (pin 14 of A3U6).

   f. Measure the AF OUT voltage.

   The ratio of the two voltages should be exactly 2:1, within +/- 0.1% (The voltmeter should be able to resolve a 0.1% error at 447.4 kHz; a thermocouple type is suggested).

   The procedure given above is not intended to be a performance test; it is included only to satisfy one who is curious as to the operation of the calibrator.

7. The calibration program accumulates ten readings, and averages them to eliminate the last-digit uncertainty in the scaling operation. The voltmeter, however, can resolve the reading only to 1 part in 333. Therefore, the worst-case quantification error is +/- 0.3%. A.M. noise is of little consequence in determining calibrator depth since the level is determined by TTL gates before filtering, and the frequency is crystal-controlled. Actual noise levels are less than 1 part in 3333.

8. Cross-correlation measurements using a specially calibrated Model 82AD FM/AM Modulation Meter (Boonton Electronics Model) indicate that the actual calibration uncertainty for 100 calibrations is approximately +/- 0.15%.

c. Audio Processing. During calibration, a three-pole Gaussian filter is used to remove high-frequency signal components. The filter time-constants are selected so as to provide the required filtering without affecting the absolute peak values of the recovered signal. The use of a Gaussian filter ensures that there will be no overshoot on the recovered audio signal.

d. R.F. Circuitry. The Model 8210's r.f. circuitry is designed to have exceptional linearity so that a.m. performance is not degraded. As noted earlier, however, the r.f. circuits are not included in the modulation-calibration process. Consequently, during a.m. measurements, errors can occur if there is a malfunction in the r.f. section. These errors will usually be obvious to the user.

For f.m. measurements, the bypassing of r.f. circuitry during modulation calibration does not present a problem, since frequency modulation is the same before and after frequency conversion.

WARRANTY

Boonton Electronics Corporation 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 instruments, probes, power sensors and accessories. Boonton Electronics 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 Boonton's authorization.

Boonton's warranties are limited to either the repair or replacement, at Boonton'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 Boonton or its designated service facility and shall return the product in its original or an equivalent shipping container. Boonton 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 Boonton from outside of the United States.

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