# MODEL 8201
# MODULATION ANALYZER
# INSTRUCTION MANUAL

**BOONTON**

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DATE 4/92

# IMPORTANT NOTICE
## DECEMBER 28, 1994

INSTRUCTION MANUAL-ADDENDUM: MODEL 8201

*Instruction manual addenda are issued to adapt the manual to changes and improvements made after its printing. Please review the following pages and insert into your manual and discard the old pages.*

**Thank you for selecting Boonton Electronics for your Test and Measurement needs.**

**SECTION 7, TABLE 7-2,** page 7-28

Change U4 Part number to 534366000

**SECTION 8, FIGURE 8-23,** page 8-27

Change U4 to SN74F00

# IMPORTANT NOTICE
## MARCH 6, 1995

INSTRUCTION MANUAL-ADDENDUM: MODEL 8201

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**Page 4-3** Figure 4-2: RF Circuits Block Diagram.

Replace CR11 with a wire.

**Page 6-12**

On line number 23 change "2 volts" to "4.5 volts" and omit text ", or open CR11".

**Page 7-5** Table 7-2: Model 8201 Parts List.

Change Reference Designator "CR6-16" to "CR6-9,12-16" and change the quantity on that line to "9".

Add the following information for CR10:

| | | | | |
|---|---|---|---|---|
| DIODE HSCH1001 (1N6263) | 28480 | HSCH-10001 | 1 | 530174000 |

**Page 7-7** Table 7-2: Model 8201 Parts List.

Change the information for R72 as follows:

| | | | | |
|---|---|---|---|---|
| RES MF 110K 1% 1/4W | 19701 | 5043ED110K0F | 1 | 341504000 |

**Page 8-10** Figure 8-6: RF Board A2A1, Parts Location.

Replace CR11 with a wire.

**Page 8-11** Figure 8-8: RF Board A2A1, Schematic Diagram.

Replace CR11 with a wire. Omit reference designator "CR11" and the value "1N914".

Change the value of CR10 to "1N6263".

Change the value of R72 to "110K".

# IMPORTANT NOTICE

## DECEMBER 1, 1995

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Page 1-6 Table 1-1 General Information

Add the following:

Ventilation Requirements:
1 1/2 inch clearance after installation, top,side, and rear

Temperature:
Non-Operating: -40 to 75 degrees C

Altitude:
Operating: 10,000 FT
Non-Operating: 15,000 FT

Humidity:
95% (non-condensing)

Battery Type:
Refer to page 7-25

Installation Category:
Designed for IEC Installation (overvoltage) Category 2

CE MARK: Declares Conformity to European Community (EC) Council Directives : 89/336/EEC//93/68/EEC, 73/23/EEC//93/68/EEC & Standards : EN55011, EN50082-1, EN61010-1

Page 2-1 Line Voltage Select Chart

Change 3/4ATD & 3/8 ATD to 3/4A T & 3/8A T

# IMPORTANT NOTICE

February 27, 2008

OPERATION AND MAINTENANCE MANUAL-ADDENDUM: MODEL 8201

Operation and Instruction manual addenda are issued to adapt the manual to changes and improvements made after this printing. Please review the following text and retain with your manual for future reference. These changes will be applied in the next printing of the manual.

**Thank you for selecting BOONTON ELECTRONICS for your Test and Measurement needs.**

Page 7-2 "**A1 PWA '8201' MOTHER** "
REFERENCE: 224270000
REMOVE C11.

Page 7-2 "**A1 PWA '8201' MOTHER** "
REFERENCE: 205045000
ADD REFERENCE DESIGNATOR C26 WITH C15.
CHANGE QUANTITY FROM 1 TO 2.

Page 7-3 "**A1 PWA '8201' MOTHER** "
REFERENCE: 341246000
ADD REFERENCE DESIGNATOR R21 WITH R5.
CHANGE QUANTITY FROM 1 TO 2.

Page 8-4 "**Figure 8-2. Mother Board A1, Parts Location.**"
REPLACE WITH DRAWING 082519B

Page 8-5 "**Figure 8-3. MotherBoard A1, Schematic Diagram Sheet 1.**"
REPLACE WITH DRAWING 83136230A REV. C
DRAWING 83136230A REV. C INCLUDES THE FOLLOWING CHANGES;

1) REMOVE C11
2) ADD 301 OHM RESISTOR FROM AR2 PIN1 TO CATHODE OF CR7
3) ADD 270 pF CAPACITOR FROM AR2 PIN 1 TO AR2 PIN 2

# SAFETY SUMMARY

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

### THE INSTRUMENT MUST BE GROUNDED

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

### DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE

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

### KEEP AWAY FROM LIVE CIRCUITS

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

### DO NOT SERVICE OR ADJUST ALONE

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

### DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

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

### SAFETY SYMBOLS

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

**CAUTION**

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

**WARNING**

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

Indicates dangerous voltages.

APRIL 1992

# Table of Contents


**Paragraph** **Page**

## SECTION I - GENERAL INFORMATION

1-1. INTRODUCTION. . . . . 1-1
1-3. DESCRIPTION. . . . . 1-1
1-6. OPTIONS. . . . . 1-1
1-8. PERFORMANCE SPECIFICATIONS. . . . . 1-2
1-10. OUTLINE DIMENSIONS. . . . . 1-2

## SECTION II - INSTALLATION

2-1. INTRODUCTION. . . . . 2-1
2-3. UNPACKING. . . . . 2-1
2-5. MOUNTING. . . . . 2-1
2-8. POWER FAIL PROTECTION. . . . . 2-1
2-10. CABLE CONNECTIONS. . . . . 2-2
2-12. PRELIMINARY CHECK. . . . . 2-2
2-18. OPTIONAL FILTERS. . . . . 2-2

## SECTION III - OPERATION

3-1. INTRODUCTION. . . . . 3-1
3-3. OPERATING CONTROLS, DISPLAYS, AND CONNECTORS. . . . . 3-1
3-5. GETTING STARTED. . . . . 3-1
3-8. DISPLAYS. (Figure 3-1) . . . . . 3-1
3-14. FUNCTION KEYS. (Figure 3-4) . . . . . 3-8
3-20. DATA KEYPAD. (Figure 3-5) . . . . . 3-9
3-27. MEASUREMENT CONTROL KEYS. (Figure 3-6) . . . . . 3-9
3-37. OTHER KEYS. (Figure 3-7) . . . . . 3-11
3-42. DISPLAYED MESSAGES. . . . . 3-11
3-49. SPECIAL FUNCTIONS. . . . . 3-12
3-51. SPCL 0, CLEAR ALL SPECIALS. . . . . 3-12
3-53. SPCL 1-4, MODULATION RANGE SETTINGS. . . . . 3-12
3-55. SPCL 5, ENABLE SLOW PEAK DETECTOR MODE. . . . . 3-12
3-57. SPCL 6, DISABLE SLOW PEAK DETECTOR MODE. . . . . 3-12
3-59. SPCL 7, SET PRE-DISPLAY DE-EMPHASIS. . . . . 3-12
3-61. SPCL 8, SET POST-DISPLAY DE-EMPHASIS. . . . . 3-12
3-63. SPCL 9-10, SET/RESET DE-EMPHASIS IN AM. . . . . 3-14
3-65. SPCL 11, 0.001 DB RESOLUTION FOR LOG MEASUREMENTS. . . . . 3-14

| Paragraph | Page |
|---|---|
| 3-67. SPCL 12, 0.01 DB RESOLUTION FOR LOG MEASUREMENTS. | 3-14 |
| 3-69. SPCL 30, MODULATION DETECTOR CALIBRATION. | 3-14 |
| 3-71. FRONT PANEL CONNECTORS. | 3-14 |
| 3-75. REAR PANEL CONNECTORS. | 3-14 |
| 3-83. MEASURING AND SETTING CARRIER FREQUENCY. | 3-15 |
| 3-90. MEASURING AND SETTING CARRIER LEVEL. | 3-16 |
| 3-95. SELECTING MODULATION MODE. | 3-17 |
| 3-100. MEASUREMENT AND DISPLAY CONTROL. | 3-17 |
| 3-102. RATIO MEASUREMENTS. | 3-17 |
| 3-108. PEAK AND RMS DETECTORS. | 3-18 |
| 3-117. DETECTOR HOLD. | 3-19 |
| 3-119. FILTERS. | 3-20 |
| 3-129. AUDIO FREQUENCY AND DISTORTION. | 3-22 |
| 3-137. PROGRAM STORE AND RECALL. | 3-22 |
| 3-140. RECALL ONLY PROGRAM. | 3-23 |
| 3-142. REMOTE OPERATION. | 3-23 |
| 3-144. SETTING THE BUS ADDRESS. | 3-23 |
| 3-145. SETTING THE END-OF-STRING CHARACTER. | 3-23 |
| 3-146. ENTERING THE REMOTE MODE. | 3-23 |
| 3-147. RETURNING TO LOCAL MODE. | 3-23 |
| 3-148. TRIGGERED OPERATION. | 3-24 |
| 3-149. TALK OPERATION. | 3-24 |
| 3-150. TALK STATUS (TS) MODE. | 3-25 |
| 3-151. TALK FUNCTION (TF) MODE. | 3-25 |
| 3-152. TALK VALUE (TV) MODE. | 3-25 |
| 3-153. TALK PROGRAM (TP) MODE. | 3-25 |
| 3-154. IDENTIFY (ID) MODE. | 3-25 |
| 3-155. USING "SERVICE REQUEST" (SRQ). | 3-25 |
| 3-156. SETTING THE SRQ MASK. | 3-25 |
| 3-157. BUS COMMAND RESPONSES. | 3-25 |
| 3-158. PROGRAM FUNCTION MNEMONICS. | 3-25 |
| 3-159. NUMBER FORMATTING. | 3-26 |
| 3-160. DATA STRING FORMAT. | 3-26 |
| 3-161. DATA STRING ERRORS. | 3-26 |
| 3-162. DATA STRING EXAMPLES. | 3-27 |
| 3-163. READING BACK CALIBRATION VALUES. | 3-27 |

## SECTION IV - THEORY OF OPERATION

| | |
|---|---|
| 4-1. INTRODUCTION. | 4-1 |
| 4-3. FUNCTIONAL BLOCK DIAGRAM. (Figure 4-1.) | 4-1 |
| 4-16. THEORY OF OPERATION, RF CIRCUITS. | 4-2 |
| 4-32. THEORY OF OPERATION, OSCILLATOR CIRCUITS. | 4-5 |
| 4-50. THEORY OF OPERATION, FM CIRCUITS. | 4-6 |
| 4-59. THEORY OF OPERATION, AM CIRCUITS. | 4-8 |
| 4-69. THEORY OF OPERATION, FILTER CIRCUITS. | 4-9 |
| 4-82. THEORY OF OPERATION, DISTORTION ANALYZER. | 4-11 |
| 4-93. THEORY OF OPERATION, DETECTOR CIRCUITS. | 4-12 |

| Paragraph | Page |
|---|---|
| 4-112. THEORY OF OPERATION, CPU CIRCUITS. | 4-15 |
| 4-124. THEORY OF OPERATION, COUNTER CIRCUITS. | 4-16 |
| 4-138. THEORY OF OPERATION, I/O CIRCUITS. | 4-18 |
| 4-142. THEORY OF OPERATION, DISPLAY AND KEYBOARD CIRCUITS. | 4-18 |
| 4-149. THEORY OF OPERATION, MOTHERBOARD/POWER SUPPLY. | 4-20 |
| 4-158. THEORY OF OPERATION, OPTIONAL FILTER BOARD. | 4-21 |
| 4-165. THEORY OF OPERATION, OPTIONAL 50 MHZ CALIBRATOR. | 4-22 |

## SECTION V - PERFORMANCE TESTS

| | |
|---|---|
| 5-1. INTRODUCTION. | 5-1 |
| 5-3. EQUIPMENT REQUIRED. | 5-1 |
| 5-5. TEST RECORD. | 5-1 |
| 5-7. CALIBRATION INTERVAL. | 5-1 |
| 5-9. INITIAL CALIBRATION. | 5-1 |
| 5-11. PROCEDURE. | 5-1 |
| 5-12. DESCRIPTION, PERFORMANCE TEST 1. | 5-5 |
| 5-14. PROCEDURE. | 5-5 |
| 5-15. DESCRIPTION, PERFORMANCE TEST 2. | 5-7 |
| 5-17. PROCEDURE. | 5-7 |
| 5-18. DESCRIPTION, PERFORMANCE TEST 3. | 5-9 |
| 5-20. PROCEDURE. | 5-9 |
| 5-21. DESCRIPTION, PERFORMANCE TEST 4. | 5-10 |
| 5-23. PROCEDURE. | 5-10 |
| 5-24. DESCRIPTION, PERFORMANCE TEST 5. | 5-12 |
| 5-26. PROCEDURE. | 5-12 |
| 5-27. DESCRIPTION, PERFORMANCE TEST 6. | 5-14 |
| 5-29. PROCEDURE. | 5-14 |
| 5-30. DESCRIPTION, PERFORMANCE TEST 7. | 5-15 |
| 5-32. PROCEDURE. | 5-15 |
| 5-33. DESCRIPTION, PERFORMANCE TEST 8. | 5-17 |
| 5-35. PROCEDURE. | 5-17 |
| 5-36. DESCRIPTION, PERFORMANCE TEST 9. | 5-18 |
| 5-38. PROCEDURE. | 5-18 |
| 5-39. DESCRIPTION, PERFORMANCE TEST 10. | 5-20 |
| 5-41. PROCEDURE. | 5-20 |
| 5-42. DESCRIPTION, PERFORMANCE TEST 11. | 5-21 |
| 5-44. PROCEDURE. | 5-21 |
| 5-45. DESCRIPTION, PERFORMANCE TEST 12. | 5-23 |
| 5-47. DISCUSSION. | 5-23 |
| 5-49. FM CALIBRATION. | 5-23 |
| 5-56. AM CALIBRATION. | 5-23 |
| 5-67. DESCRIPTION, PERFORMANCE TEST 13. | 5-26 |
| 5-69. PROCEDURE. | 5-26 |
| 5-70. DESCRIPTION, PERFORMANCE TEST 14. | 5-30 |
| 5-72. PROCEDURE. | 5-30 |

**Paragraph** **Page**

## SECTION VI - MAINTENANCE


6-1. INTRODUCTION. . . . . 6-1
6-3. SAFETY REQUIREMENTS. . . . . 6-1
6-5. REQUIRED TEST EQUIPMENT. . . . . 6-1
6-7. CLEANING PROCEDURE. . . . . 6-1
6-9. MAJOR ASSEMBLY LOCATION. . . . . 6-1
6-11. REMOVAL OF MAJOR ASSEMBLIES AND PARTS. . . . . 6-1
6-12. INSTRUMENT COVERS. . . . . 6-1
6-13. RF ASSEMBLY COVERS. . . . . 6-4
6-14. RF PRINTED CIRCUIT BOARD. . . . . 6-4
6-15. OSCILLATOR BOARD. . . . . 6-4
6-16. GAINING ACCESS TO DISPLAY/KEYBOARD. . . . . 6-5
6-17. CHANGING INSTRUMENT FIRMWARE. . . . . 6-5
6-18. INSTRUMENT TEST JUMPERS. . . . . 6-5
6-19. REMOVAL OF DETAIL PARTS. . . . . 6-5
6-20. PRELIMINARY CHECKS. . . . . 6-6
6-21. VISUAL CHECKS. . . . . 6-6
6-22. POWER SUPPLY CHECK. . . . . 6-6
6-23. TROUBLESHOOTING. . . . . 6-6
6-28. TROUBLE LOCALIZATION. . . . . 6-6
6-31. TROUBLESHOOTING, MOTHERBOARD/POWER SUPPLY. . . . . 6-7
6-32. GENERAL. . . . . 6-7
6-33. EQUIPMENT REQUIRED. . . . . 6-7
6-34. PROCEDURE. . . . . 6-7
6-36. +5V DISPLAY (DS2). . . . . 6-7
6-37. +5V INSTRUMENT (DS3). . . . . 6-8
6-38. +15V (DS4). . . . . 6-8
6-39. -15V (DS5). . . . . 6-8
6-40. -30V (DS1). . . . . 6-8
6-41. LOGIC SIGNALS. . . . . 6-9
6-43. TROUBLESHOOTING, RF BOARD . . . . . 6-10
6-44. GENERAL. . . . . 6-10
6-45. EQUIPMENT REQUIRED. . . . . 6-10
6-46. PROCEDURE. . . . . 6-10
6-47. LOGIC SIGNALS. . . . . 6-12
6-49. TROUBLESHOOTING, OSCILLATOR BOARD . . . . . 6-13
6-50. GENERAL. . . . . 6-13
6-51. EQUIPMENT REQUIRED. . . . . 6-13
6-52. PROCEDURE. . . . . 6-13
6-53. LOGIC SIGNALS. . . . . 6-14
6-55. TROUBLESHOOTING, FM BOARD . . . . . 6-15
6-56. GENERAL. . . . . 6-15
6-57. EQUIPMENT REQUIRED. . . . . 6-15
6-58. PROCEDURE. . . . . 6-15
6-59. LOGIC SIGNALS. . . . . 6-17
6-61. TROUBLESHOOTING, AM BOARD . . . . . 6-17

| Paragraph | Page |
|---|---|
| 6-62. GENERAL. | 6-17 |
| 6-63. EQUIPMENT REQUIRED. | 6-17 |
| 6-64. PROCEDURE. | 6-17 |
| 6-65. LOGIC SIGNALS. | 6-18 |
| 6-68. AGC ATTENUATOR. | 6-19 |
| 6-70. TROUBLESHOOTING, FILTER BOARD | 6-19 |
| 6-71. GENERAL. | 6-19 |
| 6-72. EQUIPMENT REQUIRED. | 6-19 |
| 6-73. PROCEDURE. | 6-19 |
| 6-74. LOGIC SIGNALS. | 6-21 |
| 6-76. TROUBLESHOOTING, DISTORTION ANALYZER BOARD | 6-23 |
| 6-77. GENERAL. | 6-23 |
| 6-78. EQUIPMENT REQUIRED. | 6-23 |
| 6-79. PROCEDURE. | 6-23 |
| 6-80. LOGIC SIGNALS. | 6-25 |
| 6-82. TROUBLESHOOTING, DETECTOR BOARD | 6-26 |
| 6-83. GENERAL. | 6-26 |
| 6-84. EQUIPMENT REQUIRED. | 6-26 |
| 6-85. PROCEDURE. | 6-26 |
| 6-86. LOGIC SIGNALS. | 6-28 |
| 6-89. TROUBLESHOOTING, CPU BOARD | 6-30 |
| 6-90. GENERAL. | 6-30 |
| 6-91. EQUIPMENT REQUIRED. | 6-30 |
| 6-92. PROCEDURE. | 6-30 |
| 6-93. CLOCK AND TIMING. | 6-30 |
| 6-94. RESET and POWER FAIL. | 6-31 |
| 6-95. CPU AND MEMORY. | 6-31 |
| 6-96. A/D CONVERTER. | 6-31 |
| 6-98. IEEE-488 CONTROLLER. | 6-32 |
| 6-99. BATTERY REPLACEMENT. | 6-33 |
| 6-101. TROUBLESHOOTING, COUNTER BOARD | 6-33 |
| 6-102. GENERAL. | 6-33 |
| 6-103. EQUIPMENT REQUIRED. | 6-33 |
| 6-104. PROCEDURE. | 6-33 |
| 6-105. GATE CIRCUITS. | 6-34 |
| 6-106. SOURCE SIGNALS. | 6-34 |
| 6-107. COUNTER CHAIN, DECODER, AND BUS BUFFERS. | 6-35 |
| 6-108. CALIBRATOR CIRCUITS. | 6-36 |
| 6-109. TROUBLESHOOTING, I/O BOARD | 6-37 |
| 6-110. GENERAL. | 6-37 |
| 6-111. EQUIPMENT REQUIRED. | 6-37 |
| 6-112. PROCEDURE. | 6-37 |
| 6-113. ADDRESS DECODER. | 6-38 |
| 6-114. DISPLAY/KEYBOARD CONTROLLERS. | 6-38 |
| 6-115. TROUBLESHOOTING, DISPLAY/KEYBOARD | 6-39 |
| 6-116. GENERAL. | 6-39 |
| 6-117. EQUIPMENT REQUIRED. | 6-39 |
| 6-118. PROCEDURE. | 6-39 |
| 6-119. FREQUENCY/LEVEL AND AUDIO DISPLAYS. | 6-40 |

Paragraph Page


6-120. MODULATION, SPCL/PRGM, AND KEYSWITCH LEDS. . . . 6-40
6-121. KEYBOARD. . . . 6-41
6-122. ADJUSTMENTS. . . . 6-42
6-124. RF BOARD ADJUSTMENTS. . . . 6-42
6-125. Equipment Required. . . . 6-42
6-126. Procedure. . . . 6-42
6-127. OSCILLATOR BOARD ADJUSTMENTS. . . . 6-43
6-128. Equipment Required. . . . 6-43
6-129. Procedure. . . . 6-43
6-130. AM BOARD ADJUSTMENTS. . . . 6-43
6-131. Equipment Required. . . . 6-43
6-132. Procedure. . . . 6-43
6-133. DISTORTION ANALYZER BOARD ADJUSTMENTS. . . . 6-44
6-134. Equipment Required. . . . 6-44
6-135. Procedure. . . . 6-44
6-136. DETECTOR BOARD ADJUSTMENTS. . . . 6-45
6-137. Equipment Required. . . . 6-45
6-138. Procedure. . . . 6-45
6-139. OPTIONAL FILTER BOARD AJUSTMENTS. . . . 6-45
6-140. Equipment Required. . . . 6-46
6-141. Procedure. . . . 6-46
6-142. OPTIONAL 50 MHZ CALIBRATOR ADJUSTMAENT. . . . 6-47
6-143. Equipment Required. . . . 6-47
6-144. Procedure. . . . 6-47


## SECTION VII - PARTS LIST


7-1. INTRODUCTION. . . . 7-1


## SECTION VIII - SCHEMATIC DIAGRAMS

# List of Tables


| Table | Page |
|---|---|
| TABLE 1-1. PERFORMANCE SPECIFICATIONS. | 1-3 |
| TABLE 3-1. CONTROLS, DISPLAYS, AND CONNECTORS. | 3-3 |
| TABLE 3-2. SPECIAL FUNCTIONS. | 3-13 |
| TABLE 3-3. IEEE-488 END-OF-STRING CHARACTERS. | 3-23 |
| TABLE 3-4. HARDWARE STATUS, BIT ASSIGNMENTS. | 3-24 |
| TABLE 3-5. SRQ MASK, BIT ASSIGNMENTS. | 3-25 |
| TABLE 3-6. IEEE-488 BUS COMMAND RESPONSES. | 3-26 |
| TABLE 3-7. IEEE-488 BUS MNEMONICS. | 3-28 |
| TABLE 3-8. INSTRUMENT ERROR CODES. | 3-31 |
| TABLE 5-1. RECOMMENDED TEST EQUIPMENT. | 5-2 |
| TABLE 5-2. AMPLITUDE MODULATION | 5-6 |
| TABLE 5-3. AUDIO FILTERS | 5-8 |
| TABLE 5-4. AMPLITUDE MODULATION, DISTORTION | 5-9 |
| TABLE 5-5. FREQUENCY MODULATION ACCURACY | 5-11 |
| TABLE 5-6. FM MODULATION DISTORTION. | 5-13 |
| TABLE 5-7. FREQUENCY MODULATION, RESIDUALS. | 5-14 |
| TABLE 5-8. PHASE MODULATION, ACCURACY AND FLATNESS. | 5-16 |
| TABLE 5-9. DISTORTION ANALYZER ACCURACY. | 5-16 |
| TABLE 5-10. CARRIER LEVEL ACCURACY. | 5-19 |
| TABLE 5-11. FREQUENCY ACCURACY AND SENSITIVITY. | 5-20 |
| TABLE 5-12. VSWR. | 5-22 |
| TABLE 5-13. CCITT BANDPASS FILTER. | 5-27 |
| TABLE 5-14. C-MESSAGE BANDPASS FILTER. | 5-28 |
| TABLE 5-15. CCIR BANDPASS FILTER. | 5-29 |
| TABLE 5-16. POWER REFERENCE ACCURACY. | 5-30 |
| TABLE 6-1. TEST JUMPERS. | 6-6 |
| TABLE 6-2. HARDWARE ERROR DISPLAYS. | 6-7 |
| TABLE 6-3. POWER SUPPLY LEDs. | 6-8 |
| TABLE 7-1. MANUFACTURERS FEDERAL SUPPLY CODE NUMBERS. | 7-1 |
| TABLE 7-2. MODEL 8201 PARTS LIST. | 7-2 |
| TABLE 8-1. LIST OF SCHEMATIC DIAGRAMS. | 8-1 |

# List of Figures

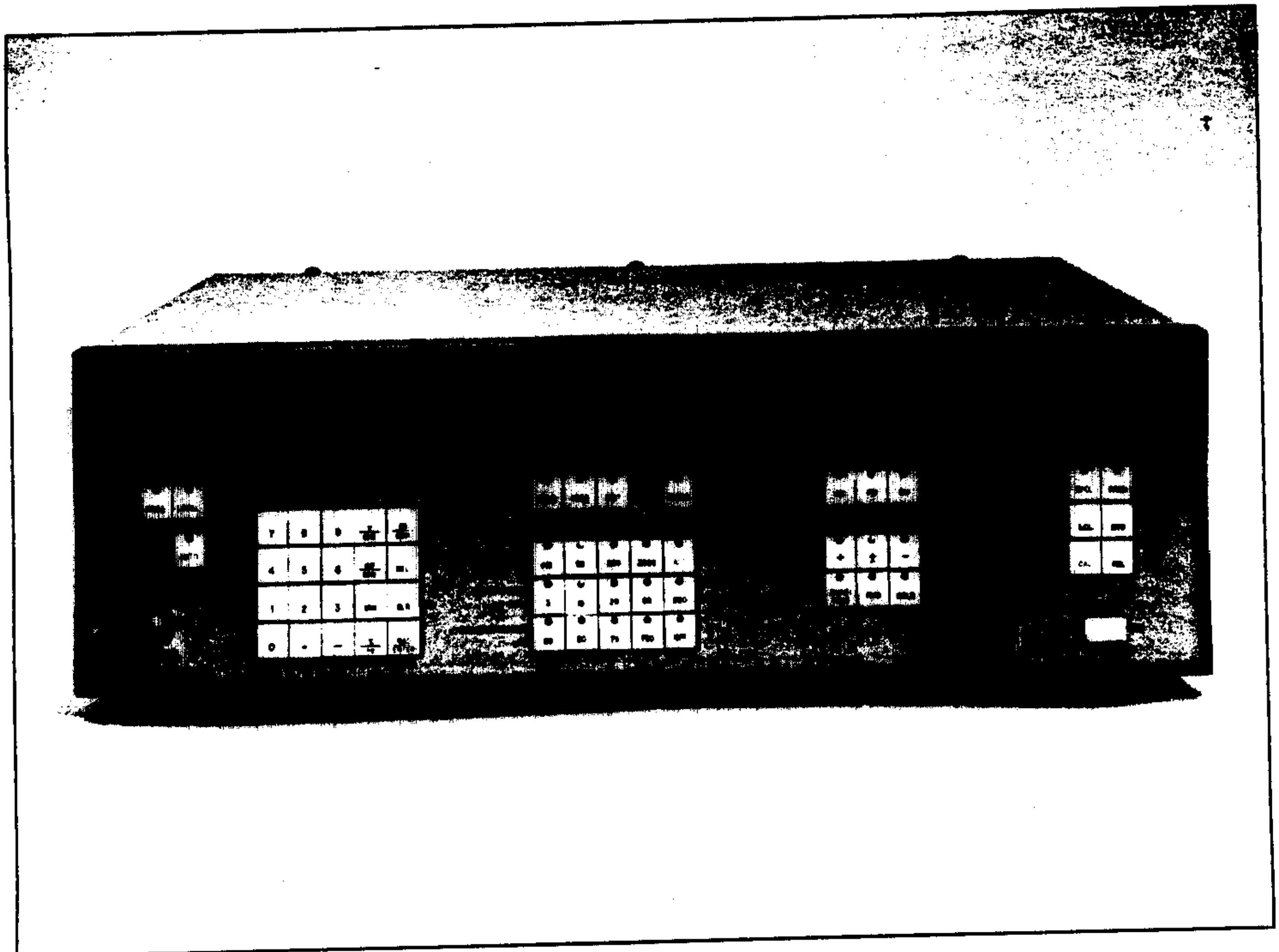

**Figure** **Page**

FIGURE 1-1 OUTLINE DIMENSIONS. . . . . . . . . . . . . . . . . . . . . . . . . 1-2
FIGURE 2-1. PACKING AND UNPACKING DIAGRAM. . . . . . . . . . . . . . . 2-4
FIGURE 2-2. OPTIONAL FILTER INSTALLATION. . . . . . . . . . . . . . . . . 2-5
FIGURE 3-1. INSTRUMENT DISPLAYS . . . . . . . . . . . . . . . . . . . . . . 3-1
FIGURE 3-2. MODEL 8201, FRONT VIEW. . . . . . . . . . . . . . . . . . . . . 3-2
FIGURE 3-3. MODEL 8201, REAR VIEW. . . . . . . . . . . . . . . . . . . . . . 3-2
FIGURE 3-4. FUNCTION KEYS. . . . . . . . . . . . . . . . . . . . . . . . . . 3-8
FIGURE 3-5. DATA KEYPAD. . . . . . . . . . . . . . . . . . . . . . . . . . . 3-9
FIGURE 3-6. MEASUREMENT CONTROL KEYS. . . . . . . . . . . . . . . . . 3-10
FIGURE 3-7. OTHER KEYS. . . . . . . . . . . . . . . . . . . . . . . . . . . 3-11
FIGURE 3-8. TYPICAL LEVEL RESPONSE. . . . . . . . . . . . . . . . . . . . 3-16
FIGURE 3-9. RESIDUAL FM, 3 and 15 kHz FILTERS. . . . . . . . . . . . . . 3-19
FIGURE 3-10. RESIDUAL AM, 3 and 15 kHz FILTERS. . . . . . . . . . . . . 3-19
FIGURE 3-11. RESIDUAL FM, 50 and 220 kHz FILTERS. . . . . . . . . . . . 3-19
FIGURE 3-12. RESIDUAL AM, 50 and 220 kHz FILTERS. . . . . . . . . . . . 3-19
FIGURE 3-13. RESPONSE, 20 kHz BESSEL FILTER. . . . . . . . . . . . . . . 3-20
FIGURE 3-14. RESPONSE, 3 and 15 kHz FILTERS. . . . . . . . . . . . . . . 3-20
FIGURE 3-15. RESPONSE, HIGH-PASS FILTERS. . . . . . . . . . . . . . . . 3-20
FIGURE 3-16. RESPONSE, 50 and 220 kHz FILTERS. . . . . . . . . . . . . . 3-20
FIGURE 3-17. RESPONSE, CCITT BANDPASS FILTER. . . . . . . . . . . . . . 3-21
FIGURE 3-18. RESPONSE, CCIR BANDPASS FILTER. . . . . . . . . . . . . . 3-21
FIGURE 3-19. RESPONSE, C-MESSAGE BANDPASS FILTER. . . . . . . . . . . 3-21
FIGURE 3-20. RESPONSE, HIGH-PASS FILTERS. . . . . . . . . . . . . . . . 3-21
FIGURE 4-1. FUNCTIONAL BLOCK DIAGRAM. . . . . . . . . . . . . . . . . . 4-2
FIGURE 4-2. RF CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . . . . 4-3
FIGURE 4-3. SAMPLING GATE OPERATION. . . . . . . . . . . . . . . . . . . 4-4
FIGURE 4-4. LOCAL OSCILLATOR CIRCUITS BLOCK DIAGRAM. . . . . . . . . 4-5
FIGURE 4-5. FM CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . . . . 4-7
FIGURE 4-6. AM CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . . . . 4-8
FIGURE 4-7. FILTER CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . 4-10
FIGURE 4-8. DISTORTION ANALYZER BLOCK DIAGRAM. . . . . . . . . . . . 4-11
FIGURE 4-9. DETECTOR CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . 4-13
FIGURE 4-10. CPU CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . . 4-15
FIGURE 4-11. COUNTER CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . 4-17
FIGURE 4-12. I/O CIRCUITS BLOCK DIAGRAM. . . . . . . . . . . . . . . . . 4-19
FIGURE 4-13. DISPLAY AND KEYBOARD BLOCK DIAGRAM. . . . . . . . . . . 4-20
FIGURE 4-14. MOTHERBOARD/POWER SUPPLY BLOCK DIAGRAM. . . . . . . . 4-21
FIGURE 5-1. MEASUREMENT SETUP #1. . . . . . . . . . . . . . . . . . . . 5-4
FIGURE 5-2. MEASUREMENT SETUP #2. . . . . . . . . . . . . . . . . . . . 5-4
FIGURE 5-2. MEASUREMENT SETUP #3. . . . . . . . . . . . . . . . . . . . 5-22
FIGURE 6-1. MAJOR ASSEMBLY LOCATION, TOP. . . . . . . . . . . . . . . . 6-2
FIGURE 6-2. MAJOR ASSEMBLY LOCATION, BOTTOM. . . . . . . . . . . . . . 6-3
FIGURE 6-3. RF BOARD WAVEFORMS. . . . . . . . . . . . . . . . . . . . . 6-11
FIGURE 6-4. FM BOARD WAVEFORMS. . . . . . . . . . . . . . . . . . . . . 6-15

# List of Figures(Cont.)

**Figure** **Page**

FIGURE 6-5. AM BOARD WAVEFORMS. . . . . . 6-17
FIGURE 6-6. DISTORTION ALALYZER WAVEFORMS. . . . . . 6-24
FIGURE 6-7. DETECTOR BOARD WAVEFORMS. . . . . . 6-26
FIGURE 6-8. CPU BOARD WAVEFORM. . . . . . 6-31
FIGURE 6-9. DISPLAY BOARD WAVEFORMS. . . . . . 6-39
FIGURE 8-1. MAIN FRAME SCHEMATIC DIAGRAM. . . . . . 8-3
FIGURE 8-2. MOTHER BOARD A1, PARTS LOCATION. . . . . . 8-4
FIGURE 8-3. MOTHER BOARD A1, SCHEMATIC DIAGRAM, SHEET 1. . . . . . 8-5
FIGURE 8-4. MOTHER BOARD A1, SCHEMATIC DIAGRAM, SHEET 2. . . . . . 8-7
FIGURE 8-5. RF HOUSING A2, SCHEMATIC DIAGRAM. . . . . . 8-9
FIGURE 8-6. RF BOARD A2A1, PARTS LOCATION. . . . . . 8-10
FIGURE 8-7. RF BOARD A2A1, SCHEMATIC DIAGRAM. . . . . . 8-11
FIGURE 8-8. OSCILLATOR BOARD, A2A2 PARTS LOCATION. . . . . . 8-12
FIGURE 8-9. OSCILLATOR BOARD, A2A2 SCHEMATIC DIAGRAM. . . . . . 8-13
FIGURE 8-10. FM BOARD A4, PARTS LOCATION. . . . . . 8-14
FIGURE 8-11. FM BOARD A4, SCHEMATIC DIAGRAM. . . . . . 8-15
FIGURE 8-12. AM BOARD A5, PARTS LOCATION. . . . . . 8-16
FIGURE 8-13. AM BOARD A5, SCHEMATIC DIAGRAM. . . . . . 8-17
FIGURE 8-14. FILTER BOARD A6, PARTS LOCATION. . . . . . 8-18
FIGURE 8-15. FILTER BOARD A6, SCHEMATIC DIAGRAM. . . . . . 8-19
FIGURE 8-16. DISTORTION ANALYZER A7, PARTS LOCATION. . . . . . 8-20
FIGURE 8-17. DISTORTION ANALYZER A7, SCHEMATIC DIAGRAM. . . . . . 8-21
FIGURE 8-18. DETECTOR BOARD A8, PARTS LOCATION. . . . . . 8-22
FIGURE 8-19. DETECTOR BOARD A8, SCHEMATIC DIAGRAM. . . . . . 8-23
FIGURE 8-20. CPU BOARD A9, PARTS LOCATION. . . . . . 8-24
FIGURE 8-21. CPU BOARD A9, SCHEMATIC DIAGRAM. . . . . . 8-25
FIGURE 8-22. COUNTER BOARD A10, PARTS LOCATION. . . . . . 8-26
FIGURE 8-23. COUNTER BOARD A10, SCHEMATIC DIAGRAM, SHEET 1. . . . . . 8-27
FIGURE 8-24. COUNTER BOARD A10, PARTS LOCATION. . . . . . 8-28
FIGURE 8-25. COUNTER BOARD A10, SCHEMATIC DIAGRAM, SHEET 2. . . . . . 8-29
FIGURE 8-26. I/O BOARD A11, PARTS LOCATION. . . . . . 8-30
FIGURE 8-27. I/O BOARD A11, SCHEMATIC DIAGRAM. . . . . . 8-31
FIGURE 8-28. DISPLAY BOARD A12 PARTS LOCATION. . . . . . 8-32
FIGURE 8-29. DISPLAY BOARD A12 SCHEMATIC DIAGRAM, SHEET 1. . . . . . 8-33
FIGURE 8-30. DISPLAY BOARD A12 PARTS LOCATION. . . . . . 8-34
FIGURE 8-31. DISPLAY BOARD A12 SCHEMATIC DIAGRAM, SHEET 2. . . . . . 8-35
FIGURE 8-32. KEYBOARD A13 PARTS LOCATION. . . . . . 8-36
FIGURE 8-33. KEYBOARD A13 SCHEMATIC DIAGRAM. . . . . . 8-37
FIGURE 8-34. OPTIONAL FILTER BOARD A15 PARTS LOCATION. . . . . . 8-38
FIGURE 8-35. OPTIONAL FILTER BOARD A15 SCHEMATIC DIAGRAM. . . . . . 8-39
FIGURE 8-36. OPTIONAL FILTER, CCITT, SCHEMATIC AND PARTS LOCATION. . . . 8-40
FIGURE 8-37. OPTIONAL FILTER, CCIR, SCHEMATIC AND PARTS LOCATION. . . . 8-41
FIGURE 8-38. OPTIONAL FILTER, C-MSG, SCHEMATIC AND PARTS LOCATION. . . . 8-42
FIGURE 8-39. OPTIONAL 50 MHz CALIBRATOR A3 PARTS LOCATION. . . . . . 8-43
FIGURE 8-40. OPTIONAL 50 MHz CALIBRATOR A3 SCHEMATIC DIAGRAM. . . . . . 8-44



**8201 Modulation Analyzer**

# SECTION I
# GENERAL INFORMATION

## 1-1. INTRODUCTION.

1-2. This manual provides general information, installation information, operating instructions, theory of operation, performance tests, maintenance instructions, a parts list and schematic diagrams for the Model 8201 Modulation Analyzer. The Model 8201 is manufactured by Boonton Electronics Corporation, Randolph, New Jersey.

## 1-3. DESCRIPTION.

1-4. The Model 8201 is a versatile, precision, solid-state instrument with features and performance characteristics especially suitable for laboratory and industrial applications. It covers a frequency range of 100 kHz to 2.5 GHz. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 8201. The result is a modulation analyzer that is easy and convenient to use, despite its flexibility. Among the outstanding features are:

☐ **Automatic tuning and leveling.** The Model 8201 can automatically acquire the largest signal present at the input connector and adjust its local oscillator and measurement channel gain to provide a calibrated display of amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM). Additionally, the operator can select the display of carrier level in millivolts or dBm. This may be accomplished using the front panel keys or remotely via the IEEE-488 bus.

☐ **Separate displays of all major functions.** The Model 8201 has four separate displays to present simultaneously carrier frequency or level, audio frequency, distortion percent, or distortion SINAD, modulation AM, FM, or PM, and program number or SPCL function. Continuous display of IEEE-488 bus status is also presented.

☐ **Internal Distortion Analyzer.** The Model 8201 includes a fully automatic audio distortion analyzer. The results can be displayed in percent or dB SINAD.

☐ **Low Residual Modulation.** The exceptionally low modulation residuals provide excellent measurement accuracy with low noise sources. Direct residual measurements are possible using the Model 8201 with internal true rms detectors. In addition, active peak detectors insure exceptional baseband detection linearity so that residuals may be easily discounted for enhanced measurement accuracy.

1-5. The features described in the preceding paragraphs, together with those described in Table 1-1, make the Model 8201 particularly useful for design, production line, and field testing of AM, FM, and PM transmitters and signal generators. Because of its flexibility, the Model 8201 is also a good modulation analyzer for laboratory applications.

## 1-6. OPTIONS.

-01 **Avionics Calibration.** Additional tests are made to insure the augmented avionics AM specifications. (Table 1-1)

-02 **Rear panel RF IN connector.** The RF IN connector is installed on the rear panel of the Model 8201.

-03 **CCITT filter.** A CCITT bandpass filter is added to the baseband processing circuits.

-05 **Power Reference.** A 50 MHz, 0 dBm calibrator is added to the rear panel of the Model 8201.

-07 **Audio loop-thru.** Circuitry is added to the baseband processing circuits to permit the use of custom external filters.

-08 **CCIR filter.** A CCIR bandpass filter is added to the baseband processing circuits.

-09 **C-MESSAGE filter.** A C-MESSAGE bandpass filter is added to the baseband processing circuits.

1-7. Inquiries regarding special applications of the Model 8201 to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

## 1-8. PERFORMANCE SPECIFICATIONS.

1-9. Performance specifications for the Model 8201 are listed in Table 1-1.

## 1-10. OUTLINE DIMENSIONS.

1-11. Outline dimensions of the Model 8201 are shown in Figure 1-1.

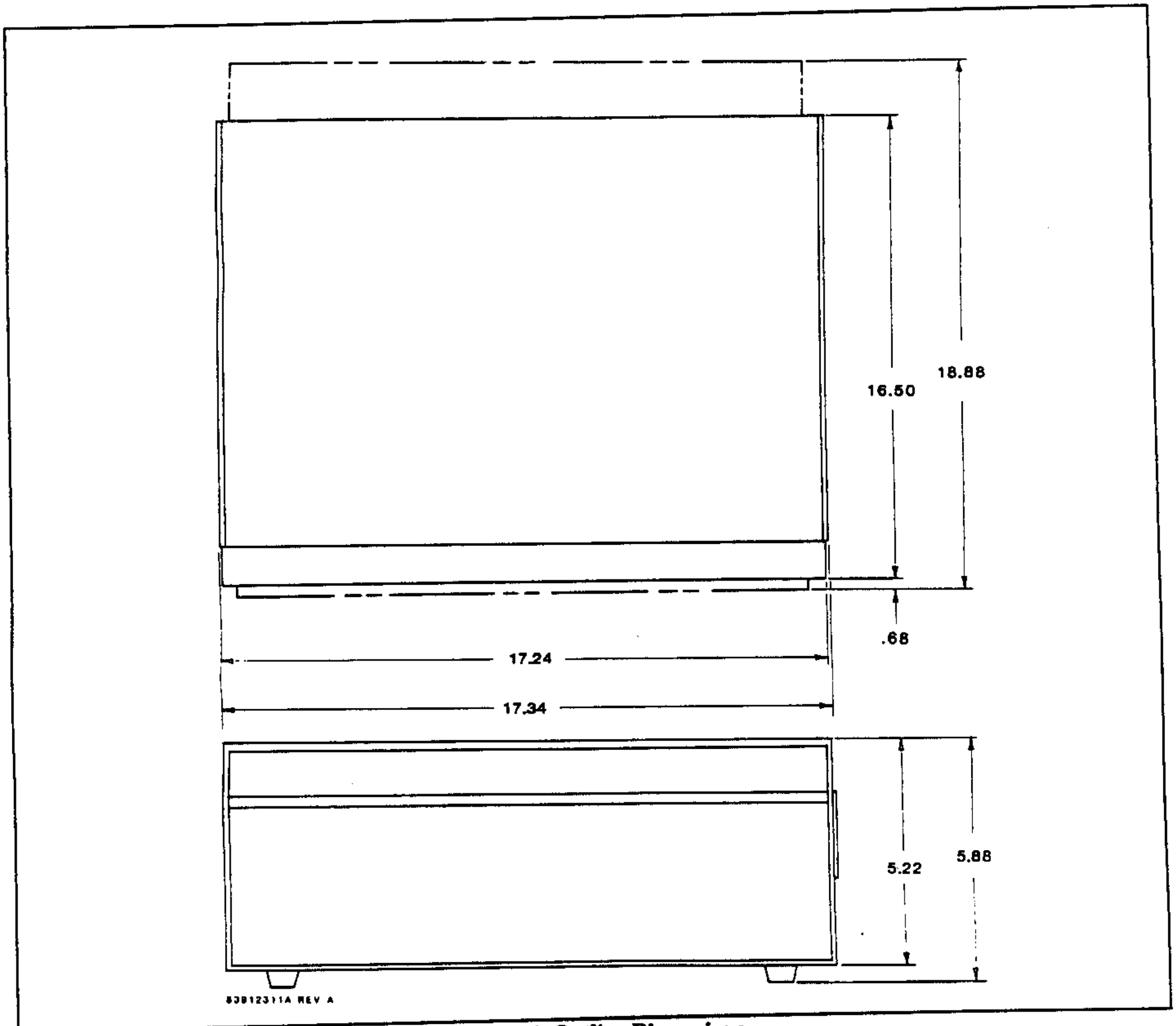



**Figure 1-1. Outline Dimensions.**

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

| | |
|---|---|
| **RF INPUT** | |
| Frequency Range | : 100 kHz to 2.5 GHz |
| Tuning (8) | : Automatic, typical acquisition time one second, or manual from keyboard or IEEE-488 bus. |
| Sensitivity | : 10 mV, Frequency Range: 100 kHz to 520 MHz.<br>: 15 mV, Frequency Range: 520 MHz to 1000 MHz.<br>: 28 mV, Frequency Range: 1000 MHz to 1500 MHz.<br>: 50 mV, Frequency Range: 1500 MHz to 2500 MHz. |
| Maximum Input (8) | : 1 watt ( 7 V rms, +30 dBm ) |
| Maximum Safe Input (8) | : 40 Vdc, 35 Vac ( 25 W for source SWR < [illegible] ) |
| Level Set (8) | : Automatic, typical acquisition time one second for levels up to 7 V, or manual from keyboard or IEEE-488 bus. |
| Input Impedance | : 50 ohms nominal. |
| VSWR | : < 1.50, Frequency Range: 100 kHz to 2.0 GHz.<br>: < 1.80, Frequency Range: 2.0 GHz to 2.5 GHz. |
| **FREQUENCY MODULATION** | |
| Measurement | : +peak, -peak, peak average, quasi-peak, and rms. |
| Rates | : 20 Hz to 15 kHz, Frequency Range: 0.2 to 0.5 MHz.<br>: 20 Hz to 50 kHz, Frequency Range: 0.5 MHz to 10 MHz.<br>: 20 Hz to 220 kHz, Frequency Range: 10 MHz to 2.5 GHz. |
| Range(6) | : 0 to carrier(kHz)/10 kHz peak, Frequency Range: 0.2 to 0.5 MHz.<br>: 0 to 150 kHz peak, Frequency Range: 0.5 to 10 MHz.<br>: 0 to 500 kHz peak, Frequency Range: 10 MHz to 2.5 GHz. |
| Resolution(7) | : 1 Hz, 0.000 to 5.000 kHz deviation.<br>: 10 Hz, 5.00 to 50.00 kHz deviation.<br>: 100 Hz, 50.0 to 500.0 kHz deviation. |
| Accuracy(1) (2) | : 1% of reading, 30 Hz to 5 kHz rates, Frequency Range: 0.2 to 0.5 MHz.<br>: 2% of reading, 5 kHz to 7.5 kHz, Frequency Range: 0.2 to 0.5 MHz.<br>: 1% of reading, 30 Hz to 15 kHz, Frequency Range: 0.5 to 10 MHz.<br>: 2% of reading, 15 kHz to 30 kHz, Frequency Range: 0.5 to 10 MHz.<br>: 1% of reading, 30 Hz to 100 kHz, Frequency Range: 0.01 to 2.5 GHz.<br>: 2% of reading, 100 kHz to 150 kHz, Frequency Range: 0.01 to 2.5 GHz. |
| Distortion | : < 0.1% for deviations < 30 kHz, Frequency Range: 0.2 to 0.5 MHz.<br>: < 0.1% for deviations < 75 kHz, Frequency Range: 0.5 to 10 MHz.<br>: < 0.1% for deviations < 100kHz, Frequency Range: 0.01 to 2.5 GHz. |
| Residual FM (3 kHz low-pass) | : < 15 Hz RMS at 2000 MHz carrier, decreasing linearly with frequency.<br>: < 1 Hz RMS at 100 MHz.( floor ) |
| Residual FM (15 kHz low-pass) | : < 30 Hz RMS at 2000 MHz carrier, decreasing linearly with frequency.<br>: < 2 Hz RMS at 100 MHz.( floor ) |
| Incidental FM | : < 20 Hz peak deviation at 50% AM, 30 Hz to 3 kHz measurement bandwidth. |

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

**AMPLITUDE MODULATION**

| | |
|---|---|
| Measurement | : + peak, -peak, peak average, quasi-peak, and rms. |
| Rates | : 20 Hz to 15 kHz, Frequency Range: 0.1 to 0.5 MHz. |
| | : 20 Hz to 50 kHz, Frequency Range: 0.5 to 10 MHz. |
| | : 20 Hz to 220 kHz, Frequency Range: 10 MHz to 2.5 GHz. |
| Range | : 0 to 99.9%. |
| Resolution | : 0.001% from 0.000 to 5.000% AM. |
| | : 0.01% from 5.00 to 50.00% AM. |
| | : 0.1% from 50.1 to 99.9% AM. |
| Accuracy(1) (2) | : 1% of reading, 30 Hz to 5 kHz, Frequency Range: 0.1 to 0.5 MHz. |
| | : 2% of reading, 30 Hz to 7.5 kHz, Frequency Range: 0.1 to 0.5 MHz. |
| | : 1% of reading, 30 Hz to 15 kHz, Frequency Range: 0.5 to 10 MHz. |
| | : 2% of reading, 30 Hz to 30 kHz, Frequency Range: 0.5 to 10 MHz. |
| | : 1% of reading, 30 Hz to 100 kHz, Frequency Range: 0.01 to 2.5 GHz. |
| | : 2% of reading, 30 Hz to 150 kHz, Frequency Range: 0.01 to 2.5 GHz. |
| Distortion | : < 0.3% for depths up to 90% |
| Residual AM(3) | : 0.02% RMS, 30 Hz to 3 kHz bandwidth. |
| | : 0.05% RMS, 30 Hz to 15 kHz bandwidth. |
| Incidental AM (3 kHz low-pass) | : < 0.2% AM peak at 5 kHz deviation, Carrier Frequency < 10 MHz. |
| | : < 0.2% AM peak at 50 kHz deviation, Carrier Frequency > 10 MHz. |

**PHASE MODULATION**

| | |
|---|---|
| Measurement | : + peak, -peak, peak average, quasi-peak, and rms. |
| Rates | : 100 Hz to 15 kHz, Frequency Range: 0.2 to 0.5 MHz. |
| | : 20 Hz to 50 kHz, Frequency Range: 0.5 to 10 MHz. |
| | : 20 Hz to 100 kHz, Frequency Range: 10 MHz to 2.5 GHz. |
| Range(4) | : 0 to CARRIER(kHz)/10 RAD peak, Frequency Range: 0.2 to 0.5 MHz. |
| | : 0 to 150 RAD peak, Frequency Range: 0.5 to 10 MHz. |
| | : 0 to 500 RAD peak, Frequency Range: 10 MHz to 2.5 GHz. |
| Resolution(5) | : 0.001 RAD, 0.000 to 5.000 RAD deviation. |
| | : 0.01 RAD, 5.00 to 50.00 RAD deviation. |
| | : 0.1 RAD, 50.0 to 500.0 RAD deviation. |
| Accuracy(1) (2) | : 3% of reading, 200 Hz to 7.5 kHz, Frequency Range: 0.2 to 0.5 MHz. |
| | : 3% of reading, 200 Hz to 30 kHz, Frequency Range: 0.5 MHz to 2.5 GHz. |

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

| | |
|---|---|
| **Distortion** | : < 0.1% for deviations < 30 RAD, Frequency Range: 0.2 to 0.5 MHz.<br>: < 0.1% for deviations < 75 RAD, Frequency Range: 0.5 to 10 MHz.<br>: < 0.1% for deviations < 100 RAD, Frequency Range: 0.01 to 2.5 GHz. |
| **Residual PM** | : < 0.1 RAD RMS at 2 GHz decreasing linearly with frequency.<br>: < 0.005 RAD RMS at 100 MHz. ( floor ) |
| **Incidental PM** | : < 0.02 RAD peak at 50 % AM, 30 Hz to 3 kHz bandwidth. |
| **CARRIER FREQUENCY** | |
| **Range** | : 100 kHz to 2.5 GHz. |
| **Resolution** | : 10 Hz, Frf < 1000 MHz.<br>: 100 Hz, Frf > 1000 MHz. |
| **Accuracy** | : reference accuracy ± 3 digits. |
| **Reference** | : 10.0000 MHz, 1 X 10-6/year aging.<br>: 1 X 10-6/degree C temperature influence, from 0 to 50 degrees C. |
| **CARRIER LEVEL** | |
| **Range*** | : -47.0 ( -27.0) to +30.0 dBm, Frequency Range: 0.1 to 520 MHz.<br>: -37.0 (-17.0) to +30.0 dBm, Frequency Range: 520 to 1500 MHz.<br>: -33.0 (-13.0) to +30.0 dBm, Frequency Range: 1500 to 2500 MHz.<br>* With carrier frequency set. ( ) values in automatic mode. |
| **Frequency Range** | : 100 kHz to 2500 MHz. |
| **Resolution** | : 0.01 dB or 0.1 millivolts. |
| **Accuracy** | : ± 1 dB, Frequency Range: 0.1 to 520 MHz.<br>: ± 2.0 dB, Frequency Range: 520 to 1500 MHz.<br>: ± 3.0 dB, Frequency Range: 1500 to 2500 MHz. |
| **AUDIO FREQUENCY** | |
| **Range** | : 10 Hz to 220 kHz. |
| **Resolution** | : 0.1 Hz from 10 Hz to 1 kHz.<br>: 1 Hz from 1 kHz to 10 kHz.<br>: 10 Hz from 10 kHz to 100 kHz.<br>: 100 Hz above 100 kHz. |
| **Accuracy** | : reference accuracy ± 1 count. |

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

| | |
|---|---|
| **AUDIO DISTORTION/SINAD** | |
| Frequency Range | : 20 Hz to 20 kHz. |
| Tuning | : Automatic if modulation frequency is within range, or manual from keyboard or IEEE-488 bus. |
| Distortion Range | : 0.01 TO 100% THD or 0 to 80 dB SINAD. |
| Resolution | : 0.01%, Range: 0.01 TO 9.99%.<br>: 0.1%, Range: 10.0 TO 99.9%.<br>: 0.01 dB, Range: 0 TO 80 dB SINAD. |
| Accuracy | : ± 10% or ± 1 dB SINAD. Residual modulation must be accounted for in distortion measurements. |
| Residual Distortion | : < 0.1 % or 60 dB SINAD. |
| **AUDIO FILTERS** | |
| High-pass | : <10 Hz gaussian, less than 10 % droop with 5 Hz square wave.(8)<br>: 30, 300 and 3000 Hz, 3-pole Butterworth. |
| Low-pass | : 3 and 15 kHz, 3-pole Butterworth.<br>: 20 kHz, 3-pole Bessel.<br>: 50 and 220 kHz, 7-pole Butterworth. |
| De-emphasis | : 25, 50, 75, and 750 μs. |
| Accuracy | : ± 4 % 3 dB corner and time constant. |
| **AM CALIBRATOR** | : internal, 50.00% depth, 0.1% accuracy. |
| **FM CALIBRATOR** | : internal, 125.0 kHz deviation, 0.1% accuracy. |
| **PM CALIBRATOR** | : internal, 136.3 RAD deviation, 1% accuracy. |
| **GENERAL** | |
| Power Requirements | : 100, 120, 220, or 240 volts, ± 10%, 50-400 Hz, single phase, approx. 65 VA. |
| Operating Temperature | : 0 to 55 degrees C. |
| Dimensions | : 17.25 inches (43.8 cm) wide,<br>5.75 inches (14.6 cm) high,<br>18.75 inches (47.6 cm) deep |
| Weight | : 28 lbs (12.7 kg) |
| Accessories Included | : rack mounting hardware. |

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

**SUPPLEMENTAL SPECIFICATIONS**

| | |
|---|---|
| AF OUT (8) | : Uncalibrated, approx. 1 V into 600 ohms at 5000 counts on display. Source impedance 600 ohms. |
| IF OUT (8) | : Approximately 0 dBm into 50 ohms.<br>: Frequency 1.21 MHz nominal for carriers from 10 to 2500 MHz, 346 kHz for carriers from 2 to 10 MHz, and 100 kHz to 2 MHz for carriers below 2 MHz.<br>: Source impedance 50 ohms. |
| AM OUT (8) | : DC coupled, 0.02 volts peak-to-peak per 1% AM depth. Source impedance 600 ohms. |
| FM OUT (8) | : DC coupled, 2 volts peak-to-peak per ± 100 kHz deviation. Source impedance 600 ohms. |
| DIST OUT (8) | : Uncalibrated, approximately 1 V rms into 600 ohms at 5000 counts on display. Source impedance 600 ohms. |
| REF IN (8) | : TTL compatible for external timebase. Switching is automatic. |
| IEEE-488 (8) | : Complies with IEEE-488-1978. Implements AH1, SH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, and E1. |
| Stereo Separation (8) | : > 48 dB, 50 Hz to 15 kHz, < 10 to 220 kHz bandwidth. |

**AVIONICS AM CALIBRATION ( optional )**

| | |
|---|---|
| Accuracy | : ± 0.7%, 20 to 40% AM, at 30 Hz to 3 kHz rates, < 10 to 15 kHz filters. |
| Flatness | : ± 0.4% for constant AM between 20 and 40%, and 90 and 150 Hz rates. |

**POWER REFERENCE ( optional )**

| | |
|---|---|
| Frequency | : 50 MHz, ± 1%. |
| Power Accuracy | : 0.7% initial accuracy.<br>: ± 1.2% over 1 year. |

**CCITT FILTER ( optional )**

: bandpass filter, CCITT recommendation P.53.

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

**CCIR FILTER ( optional )**
: bandpass filter, CCIR recommendation 468-3(DIN 45404).

**C-MSG FILTER ( optional )**
: bandpass filter, Bell System Technical Reference 41009.

**AUDIO LOOP THRU ( optional )**

| | |
|---|---|
| Frequency range | : < 10 Hz to > 220 kHz. |
| Input impedance | : 1 Megohm, shunted by approximately 50 pF. |
| Output impedance | : 600 ohms |

NOTES

| | |
|---|---|
| (1) | Peak residuals must be accounted for. |
| (2) | For rms add ± 1% of reading.<br>For quasi-peak add ± 6% of reading, 20 Hz to 20 kHz. |
| (3) | Level > 100 millivolts, carrier frequency < 520 MHz.<br>Above 520 MHz, residuals increase linearly with frequency. |
| (4) | Up to 1 kHz modulation rate. Above 1 kHz range decreases linearly with modulation frequency. |
| (5) | Up to 1 kHz modulation rate. Above 1 kHz resolution is determined by the product of deviation and modulation rate. |
| (6) | With 750 us de-emphasis, and pre-display selected, the deviation is limited to 50 kHz peak. |
| (7) | Display resolution is ten times greater with 750 $\mu$s de-emphasis, and pre-display selected. |
| (8) | These specifications are for application purposes and, although typical, are not warranted. |

# SECTION II
# INSTALLATION

## 2-1. INTRODUCTION.

2-2. This section contains the installation instructions for the Model 8201 Modulation Analyzer, and field installable options. Included is information pertinent to unpacking, mounting, power requirements, line voltage selection, cable connections and initial inspection.

## 2-3. UNPACKING.

2-4. The Model 8201 is shipped complete and is ready to use upon receipt. Unpack the instrument from its shipping container and inspect it for damage. See Figure 2-1. If the contents are incomplete or the instrument shows signs of damage, notify Boonton Electronics and the carrier.

**NOTE**

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

## 2-5. MOUNTING.

2-6. For bench mounting, choose a clean, sturdy, uncluttered mounting surface. For rack mounting, the accessory kit supplied with the instrument (08253301A) contains mounting ears, hardware, and instructions for attaching the ears to the Model 8201. The kit also contains line fuses, RF fuses, and an open end wrench for replacing the RF fuses.

**CAUTION**

*Always make certain that the line voltage selector switches are set to the correct positions most nearly corresponding to the voltage of the available AC power source, and that a fuse of the correct rating is installed in the fuse holder before connecting the Model 8201 to any AC power source.*

2-7. Set the line voltage selector switches, located on the rear panel, to the appropriate positions as indicated on the LINE VOLTAGE SELECT chart located next to the switches. Check that the line fuse is correct for the selected power source. The correct fuse is:

| | | | |
|---|---|---|---|
| VAC<br>+ -10% | 100<br>120 | 220<br>240 | 50 to<br>400 Hz |
| Fuse | 3/4 ATD | 3/8 ATD | 65 VA |

## 2-8. POWER FAIL PROTECTION.

2-9. If the line voltage drops more than 10% below nominal, a power fail protection circuit automatically isolates the internal random access memory. Backup power is provided by a lithium cell rated at 3.0 V and 160 mAh, with a life expectancy of more than five years. Simultaneously, the display is blanked and all internal processes stop. Normal operation resumes when nominal line voltage is restored. All conditions that existed before the loss of power, except the remote mode, will be re-established. If another power failure occurs during the restart process, the Model 8201 will discard the previous setup and perform an initialization restart.

## 2-10. CABLE CONNECTIONS.

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

a. **RF IN.** RF input, front panel, 50 ohms nominal impedance. Type N connector.

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

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

d. **FM OUT.** FM output, rear panel, 600 ohms source impedance, approximately 2 volts per + -100 kHz deviation. Type BNC connector.

e. **IF OUT.** IF output, rear panel, 50 ohms nominal source impedance, 0 dBm level.

f. **DIST OUT.** Distortion monitor output, rear panel, 600 ohms nominal impedance.

g. **EXT REF.** External 10 MHz counter reference, impedance and level requirements are TTL compatible, switching is automatic. BNC connector. 0 dBm level.

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

## 2-12. PRELIMINARY CHECK.

2-13. The preliminary check verifies that the Model 8201 is operational and should be performed before the instrument is placed into use.

2-14. Turn the instrument power ON. Wait several seconds then depress the INIT key. The FREQUENCY/LEVEL display will contain the instrument firmware number and the other displays will contain dashes for a period of about three seconds. The FREQUENCY/LEVEL display will then change to indicate self test progress, and finally the 'UNLOC' message will be displayed . Refer to Section 3 for the meaning of any displayed error messages.

2-15. Depress the SPCL key and enter 30 into SPCL/PRGM display using the DATA keypad. Depress the ENTER key to complete the entry. The FREQUENCY/LEVEL display should change to the '-CAL-'message. Observe the operation of the instrument. The Model 8201 is performing an internal calibration of the modulation detectors. As the calibration proceeds, the results of the calibration routines will appear in the modulation display window. The AM detector is calibrated first. The calibration point is 50.00%. If Error 20 appears in the FREQUENCY/LEVEL display window, a calibration fault has occurred and hardware maintenance is required.

2-16. The RMS detector is calibrated next using the AM waveform. Error 23 is a calibration fault. Next comes the FM detector. The nominal indication is 125.0 kHz and error code 21 is the calibration fault. Finally, the PM detector is calibrated. The nominal indication is 136.3 RAD and the error code is 22.

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

## 2-18. OPTIONAL FILTERS.

2-19. Installation of the optional filters requires that the instrument cover(s) be removed. Refer to Section VI for safety precautions and disassembly details, and Figure 2-2 for filter board assembly details.

2-20. Audio Loop Thru Option -07. Remove all power and signal connections and remove the instrument top and bottom covers. Proceed as follows:

- Thread W16 (blue) coaxial cable assembly through the AUDIO OUT connector hole in the rear panel of the Model 8201.
- Slide the 3/8 washer and nut over the cable, and secure the BNC connector to the rear panel.
- Thread W17 (yellow) coaxial cable assembly through the AUDIO IN connector hole in the rear panel, and secure as above.
- Route both cables through the large openings in the sheet metal as shown in Figure 2-2.
- Snap the SMC connector on W17 (yellow) onto J1 of Filter option A15.
- Snap the SMC connector on W16 (blue) onto J2 of Filter option A15.
- Dress the two cables toward the left side of the circuit card-cage.
- Move the 2-circuit shunt from pins 8 and 9 to pins 7 and 8 of J3.
- If no other filters are to be installed, place the A15 Option board into the card guides and seat into the XA15 connector on the Motherboard. Note: The A15 option assembly is inserted directly behind the A9 (pink extractors) assembly.

2-21. Options -03, 08, and 09. Remove all power and signal connections and remove the instrument top cover. Proceed as follows:

- Insert the optional filter assembly(ies) into the appropriate mating connectors. Circuit board A15 is marked to indicate the proper location for each of the optional filters.
- Secure the optional filter assembly(ies) to the A15 assembly using two #4-40 machine screws provided.
- Place the A15 Option board into the card guides and seat into the XA15 connector on the Motherboard. Note: The A15 option assembly is inserted directly behind the A9 (pink extractors) assembly.
- Before replacing the top cover, complete performance test 13 to verify optional filter performance, as slight adjustment of the nominal insertion gain may be required.
- Replace the instrument top cover.

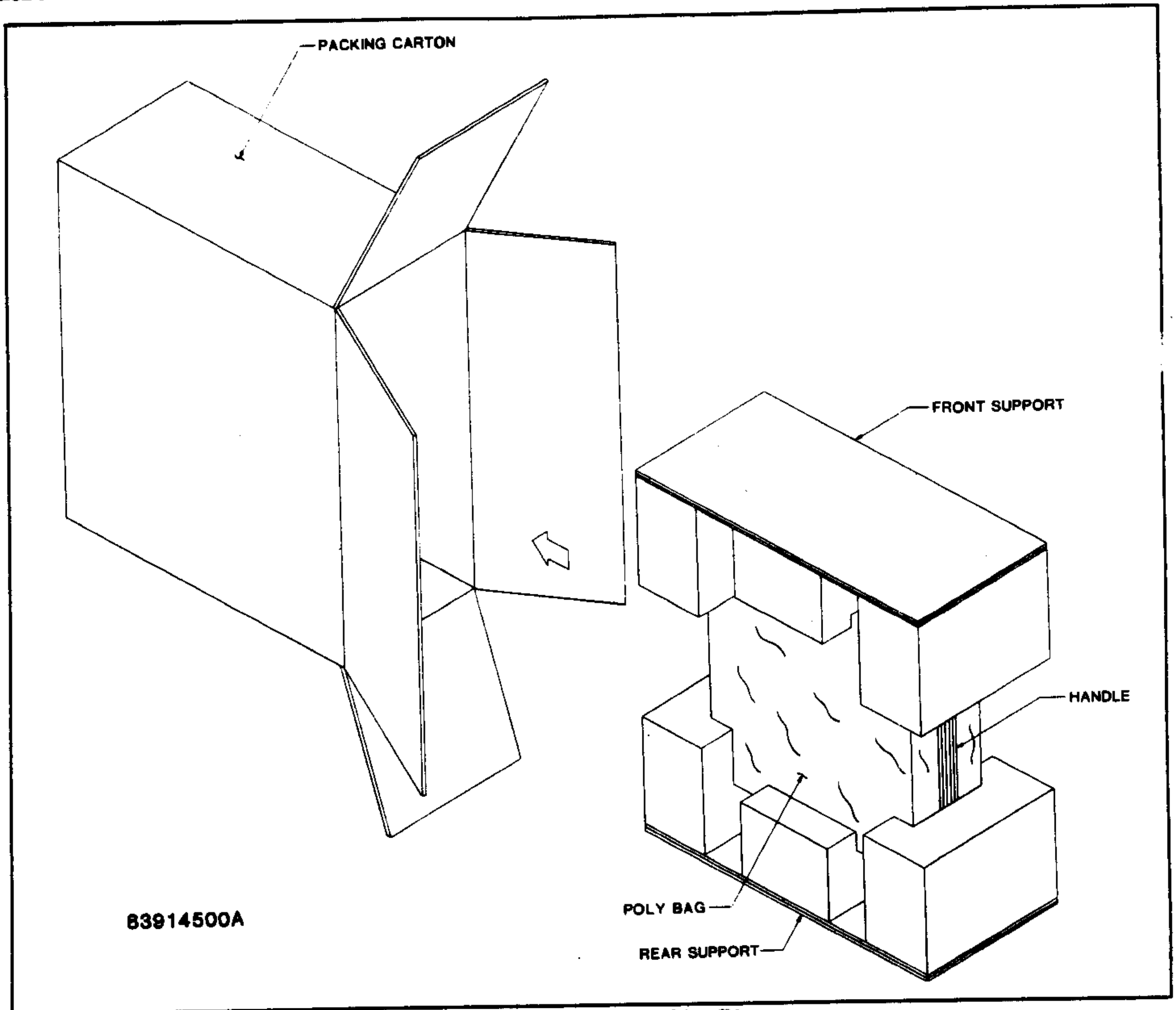



**Figure 2-1. Packing and Unpacking Diagram.**

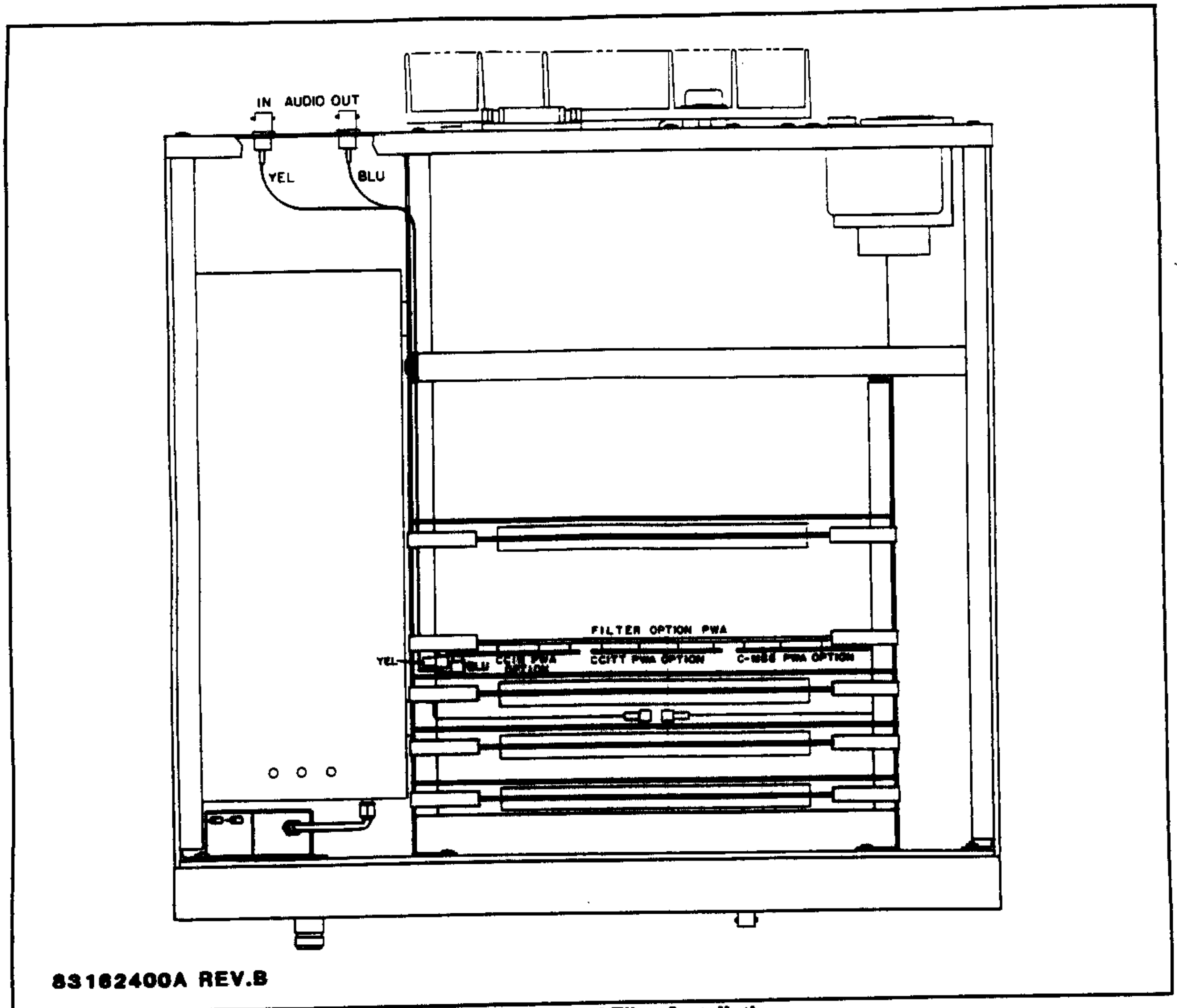



**Figure 2-2. Optional Filter Installation.**

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# SECTION III
# OPERATION

## 3-1. INTRODUCTION.

3-2. This section contains complete operating information for the Model 8201 Modulation Analyzer. Included are descriptions of the front and rear panel controls, displays, and connectors, option selections, and instructions for local and remote modes of operation. Additionally, typical measurement situations are described.

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

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

## 3-5. GETTING STARTED.

3-6. Turn on the instrument and depress the LCL(INIT) key. After a short lamp test, the FREQUENCY/LEVEL display will contain the 8201 firmware reference number and the other displays will contain dashes for about three seconds. The message 'UNLOC' will then appear in the FREQUENCY/LEVEL display window. The audio and modulation displays will contain the [= =] message and the SPCL/PRGM display will contain 99, the initialization program number. Refer to Table 3-7 for the meaning of any reported errors.

3-7. The front panel of the Model 8201 is organized for simple instrument operation. It consists of a display window and a separate keyboard area. The display area contains the FREQUENCY/LEVEL display, the AUDIO display, the MODULATION display, and the SPCL/PRGM display. The keys are organized as function keys, data keypad, and measurement control keys.

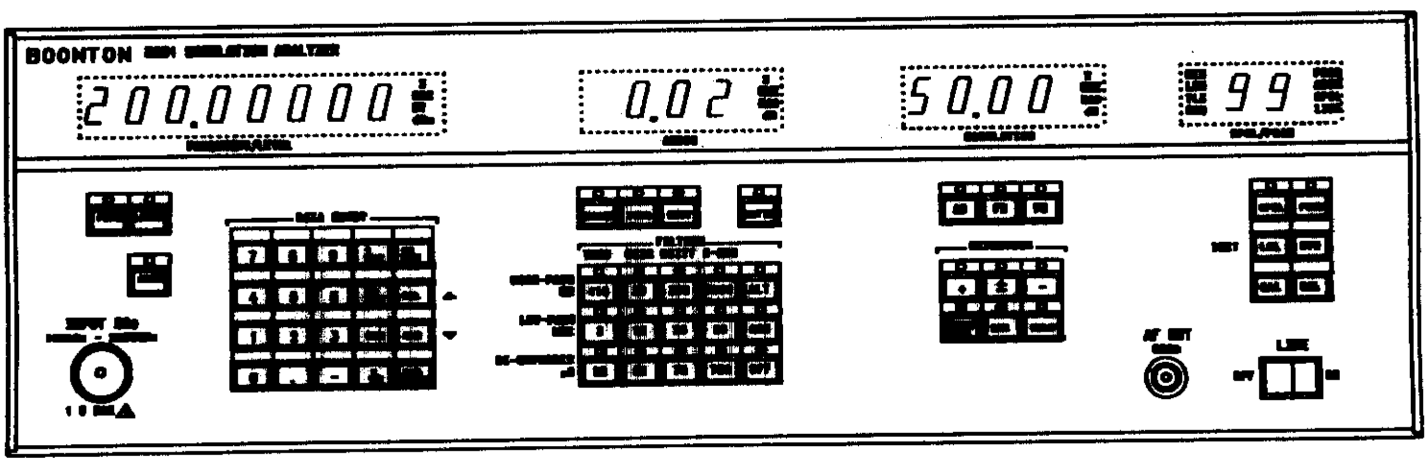


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FIGURE 3-1. Instrument Displays

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

3-9. The FREQUENCY/LEVEL display is eight characters wide and displays measurements of carrier level and frequency. Units annunciators are mV and dBm for level, MHz for frequency, and % for ratio. This display is also used for error and status messages.

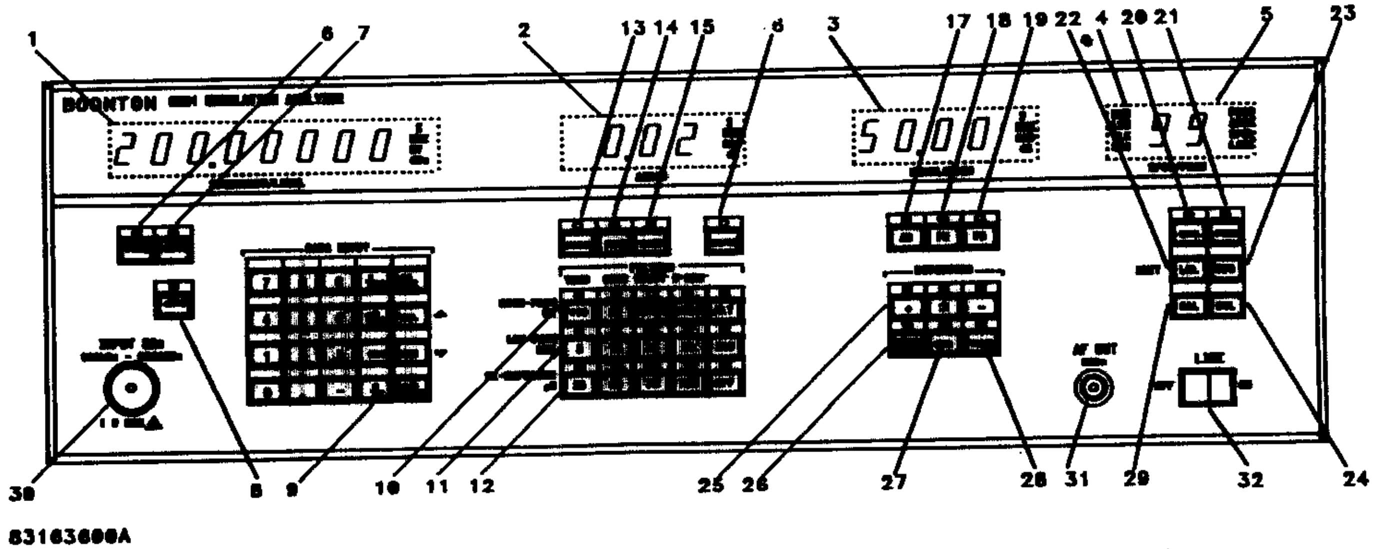


FIGURE 3-2. Model 8201, Front View.

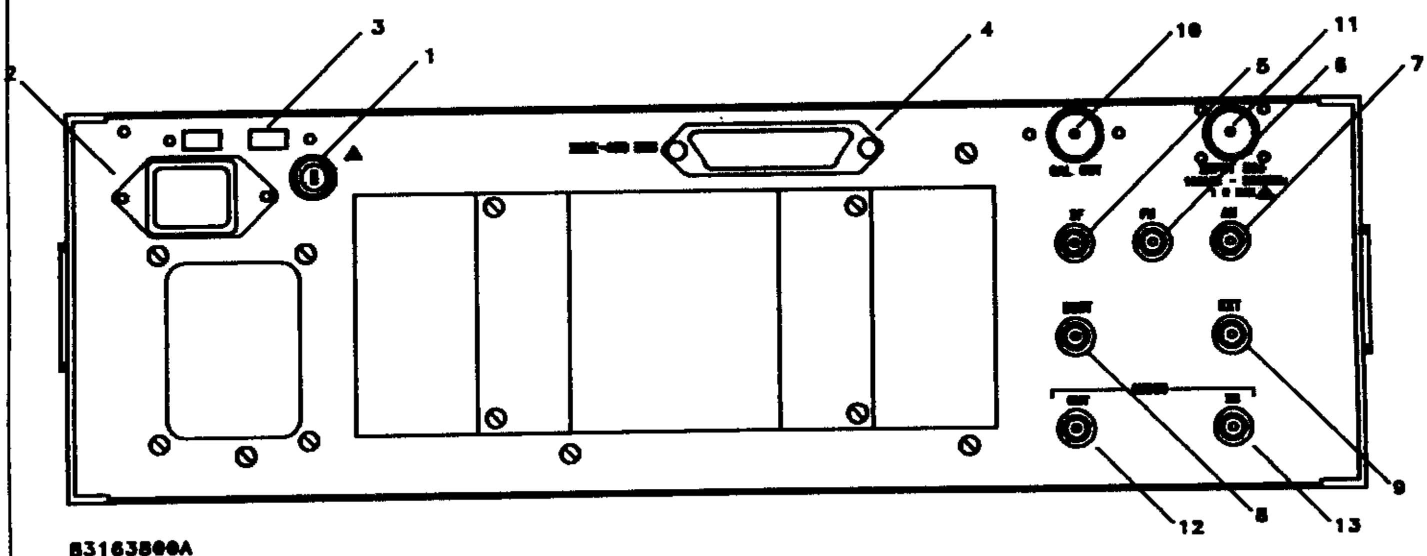


FIGURE 3-3. Model 8201, Rear View.

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

| CONTROL, INDICATOR or CONNECTOR | FIGURE and INDEX NO. | FUNCTION |
|---|---|---|
| FREQUENCY/LEVEL display | 3-2,1 | Displays carrier frequency in kHz or MHz, and RF level in dBm or mV. Alternately displays error codes and messages. |
| AUDIO display | 3-2,2 | Displays modulation frequency in Hz or kHz and distortion in % or dB SINAD. |
| MODULATION display | 3-2,3 | Displays modulation in % AM, kHz FM deviation, and RAD PM deviation. Also displays ratio in % or dB. |
| BUS Status display | 3-2,4 | Displays current IEEE-488 bus status; REM (remote enabled), LSN (listener addressed), TLK (talker addressed), and SRQ (service request active). |
| SPCL/PRGM display | 3-2,5 | Displays the current program number or selected special function. |
| FREQ key | 3-2,6 | Selects carrier frequency as the active function. Use before setting carrier frequency or to activate carrier frequency display. |
| LEVEL key | 3-2,7 | Selects carrier level as the active function. Use before setting carrier level or to activate the level display. |
| AUTO key | 3-2,8 | Forces the selected function to the measurement mode. Not active for the PRGM and SPCL functions. |
| DATA ENTRY keys | | |
| 0 - 9 keys | 3-2,9 | Numeric entry keys. |
| . key | 3-2,9 | Selects decimal point during data entry. |
| - key | 3-2,9 | Prefix for negative quantity. |
| V/GHz key | 3-2,9 | Selects volts or gigahertz units. |
| mV/MHz key | 3-2,9 | Selects millivolts or megahertz units. |
| kHz key | 3-2,9 | Selects kilohertz units. |
| %/Hz key | 3-2,9 | Selects percent or Hertz units. |
| dBm key | 3-2,9 | Selects decibels referenced to 1 milliwatt. |
| DEL(↑) key | 3-2,9 | Deletes the last entered digit, or increments parameter. |
| CLR(↓) key | 3-2,9 | Clears errors or current data entry, or decrements parameter. |
| RAD/ENTER | 3-2,9 | Selects radians or unitless number termination. |

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

| CONTROL, INDICATOR or CONNECTOR | FIGURE and INDEX NO. | FUNCTION |
|---|---|---|
| High-pass Hz keys | | |
| < 10/THRU | 3-2,10 | Selects the < 10 Hz high-pass or THRU bandpass filter. |
| 30/CCIR | 3-2,10 | Selects the 30 Hz high-pass or CCIR bandpass filter. |
| 300/CCITT | 3-2,10 | Selects the 300 Hz high-pass or CCITT bandpass filter. |
| 3000/C-MSG | 3-2,10 | Selects the 3000 Hz high-pass or C-MSG bandpass filter. |
| ALT | 3-2,10 | Toggles filter selection from high-pass to bandpass. |
| Low-pass kHz keys | | |
| 3 | 3-2,11 | Selects the 3 kHz low-pass filter. |
| 15 | 3-2,11 | Selects the 15 kHz low-pass filter. |
| 20 | 3-2,11 | Selects the 20 kHz low-pass filter. |
| 50 | 3-2,11 | Selects the 50 kHz low-pass filter. |
| 220 | 3-2,11 | Selects the 220 kHz low-pass filter. |
| De-emphasis uS keys | | |
| 25 | 3-2,12 | Selects the 25 us de-emphasis filter. |
| 50 | 3-2,12 | Selects the 50 us de-emphasis filter. |
| 75 | 3-2,12 | Selects the 75 us de-emphasis filter. |
| 750 | 3-2,12 | Selects the 750 us de-emphasis filter. |
| OFF | 3-2,12 | Deselects the de-emphasis filters. |
| SINAD key | 3-2,13 | Selects SINAD audio distortion measurement. |
| FREQ (audio) | 3-2,14 | Selects audio frequency as the active function. Use before setting audio frequency for SINAD measurements, or to activate the audio frequency display. |
| DIST key | 3-2,15 | Selects audio distortion measurement. |
| RATIO key | 3-2,16 | Alternate action key. Changes the active display from absolute to relative. Units keys may be used to select displayed units. |
| AM key | 3-2,17 | Selects AM modulation as the active function. Use before setting AM modulation reference for subsequent ratio measurement, or to activate the AM modulation display. |
| FM key | 3-2,18 | Selects FM modulation as the active function. Use before setting FM modulation reference for subsequent ratio measurement, or to activate the FM modulation display. |

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

| CONTROL, INDICATOR or CONNECTOR | FIGURE and INDEX NO. | FUNCTION |
|---|---|---|
| PM key | 3-2,19 | Selects PM modulation as the active function. Use before setting PM modulation reference for subsequent ratio measurement, or to activate the PM modulation display. |
| SPCL key | 3-2,20 | Selects special function as the active function. Use before selecting special function. |
| PRGM key | 3-2,21 | Selects instrument program as the active function. Use before selecting program number for store or recall. |
| LCL/INIT key | 3-2,22 | Causes instrument to "go-to-local" if local lockout is not active and remote is active, or initialize when the instrument is in the local state. |
| STO key | 3-2,23 | Stores the instrument setup at selected program number. |
| RCL key | 3-2,24 | Recalls instrument setup from selected program number. |
| PEAK keys | | |
| + key | 3-2,25 | Selects + peak detector for display. |
| - key | 3-2,25 | Selects - peak detector for display. |
| ± key | 3-2,25 | Selects peak average modulation display. The display is ( + peak ( + ) -peak )/2. |
| QUASI-PEAK key | 3-2,26 | Selects CCIR 386-3 peak detector for display. The display is peak responding, calibrated in rms. |
| RMS key | 3-2,27 | Selects a true rms detector for modulation display. |
| HOLD key | 3-2,28 | Alternate action key used to display the greater of the current or last modulation reading. |
| CAL key | 3-2,24 | Causes the selected function to be calibrated. Active for carrier LEVEL, AM, FM, and PM. |

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

| CONTROL, INDICATOR or CONNECTOR | FIGURE and INDEX NO. | FUNCTION |
|---|---|---|
| RF IN connector | 3-2,30 | RF input connector, used to apply an external carrier signal. |
| AF OUT connector | 3-2,31 | Audio output connector, used to connect the demodulated signal to external test equipment. |
| LINE switch | 3-2,32 | Switches the instrument ac power supply ON or OFF. |
| Fuseholder | 3-3,1 | Holds fuse for ac line protection. |
| Line connector | 3-3,2 | Permits connection of instrument to ac power supply. |
| Voltage Selector Switch | 3-3,3 | Permits the selection of various ac power supply voltages. |
| IEEE-488 bus connector | 3-3,4 | Provides a means for connecting the Model 8201 to a system control bus. |
| IF out connector | 3-3,5 | Provides a means for connecting the intermediate frequency signal to external test equipment. |
| FM out connector | 3-3,6 | Provides a means for connecting the demodulated FM signal to external test equipment. |
| AM out connector | 3-3,7 | Provides a means for connecting the demodulated AM signal to external test equipment. |
| DIST out connector | 3-3,8 | Provides a means for connecting the distortion analyzer signal output to external test equipment. |
| EXT REF connector | 3-3,9 | Provides a means for connecting an external 10.00 MHz frequency standard to the internal timebase circuits. |

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

| CONTROL, INDICATOR or CONNECTOR | FIGURE and INDEX NO. | FUNCTION |
|---|---|---|
| Optional: CAL OUT connector | 3-3,10 | Provides a means for connecting the optional 50 MHz, 0 dBm calibrator to the Model 8201 for level calibration. |
| RF IN connector | 3-3,11 | Optional RF input connector, used to apply an external carrier signal. |
| AUDIO OUT connector | 3-3,12 | Provides a means for connecting the modulation signal to external filters or processing circuits. |
| AUDIO IN connector | 3-3,13 | Provides a means for connecting an external audio signal to the internal baseband processing circuits. |

3-10. The AUDIO display is four characters wide and displays the measured audio frequency or distortion. Units annunciators are Hz and kHz for frequency, and percent and dB for distortion.

3-11. The MODULATION ·lay is four characters w· · and displays the measured modulation. Units annunciators are percent for AM and ratio, ki r FM deviation, RAD for PM deviation, and dB for ratio measurements.

3-12. The SPCL/PRGM display is an entry only display which is two characters wide and displays selected special function, or the current instrument program number. Units annunciators are PRGM for program number, SPCL for special function, and ADRS for IEEE-488 bus address. Also included is a LINE annunciator which indicates that ac power is applied.

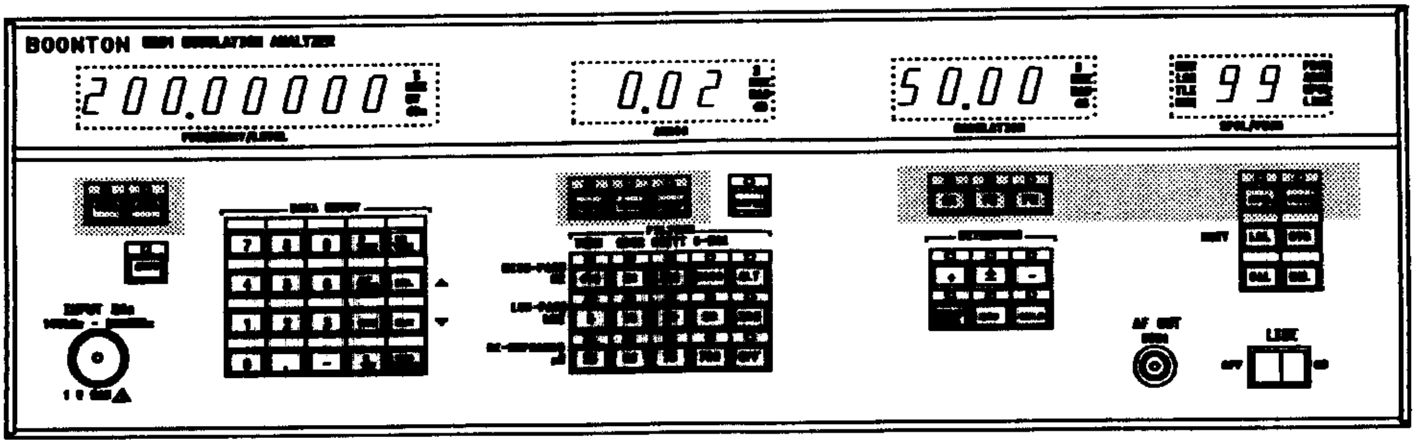

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FIGURE 3-4. Function Keys.

3-13. To the immediate left of the SPCL/PRGM display is the IEEE-488 status display. This display indicates REM when the Model 8201 is in the remote state, LSN when addressed as a listener, TLK when addressed as a talker, and SRQ when the Model 8201 has activated the IEEE-488 service request line.

3-14. **FUNCTION KEYS. (Figure 3-4)**

3-15. The top row of illuminated switches are the function keys. These keys are used to select the parameter to be displayed and to enable the data keypad for subsequent data entry. The functions are carrier FREQ, carrier LEVEL, audio SINAD, audio FREQ, audio DIST, AM, FM, PM, SPCL, and PRGM. The LED in the switch of the selected function will be illuminated continuously; the others will be off unless a measurement of that function is in progress. In this case the LED will flash during the measurement interval.

3-16. To select a function depress the desired function key. The units legends associated with that function will appear immediately to the right of the numeric display.

3-17. For example, select the carrier FREQ function and depress the 1 and V/GHZ keys. The display will now contain the number 1000.0000 and the active legend will be MHz.

3-18. Depress the FM function key. The LED in the carrier FREQ key will go out, and the LED in the FM key will illuminate. Depress the 1, 0, and kHz keys. The number 10.00 will now be displayed in the modulation display.

3-19. All other function keys operate in the same manner, except that data cannot be entered when the DIST or SINAD functions are selected.

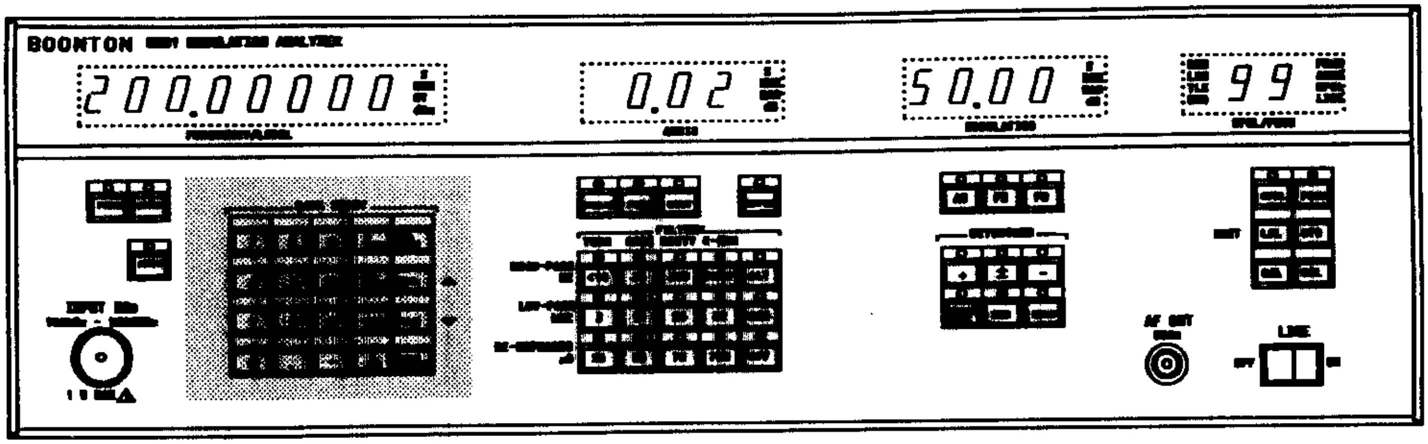


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FIGURE 3-5. Data keypad.

### 3-20. DATA KEYPAD. (Figure 3-5)

3-21. Operation of the data keypad is conventional. Select the carrier FREQ function and depress the [8] key. The carrier frequency display will indicate '8 and the units legend will go out. The tick mark (') indicates that the number displayed has not yet been entered. Continue by depressing the [2], [.], [1] and [5] keys and the MHZ key to enter the number. The display will now indicate 82.15000 MHz.

3-22. Note that it is not necessary to enter any trailing zeroes, nor is it necessary to depress the ENTER key if a units key is used. While this is the most efficient way to enter 82.15 MHz, it is equally valid to enter 82150 kHz, 82150000 Hz, et cetera. If at any time before entry the wrong digit is entered, depress the DEL key to clear the digit, or depress the CLR key to clear all input and restore the previous frequency display.

3-23. The kHz and GHz keys are provided for convenience when entering frequency; however, the display will only indicate in MHz. Similarly, the V key can be used for entering input level; however the display will indicate in millivolts.

3-24. The ENTER key is used for unitless quantities, such as special function and program numbers.

3-25. The CLR key is used to recover from errors. Without changing function, depress the dBM key. The FREQUENCY/LEVEL display will now indicate Error 9 or 11. This means that an inconsistent units key has been depressed to terminate a data entry. Depress the CLR key. The display will return to normal. A list of error codes is presented in Table 3-7, at the end of this section.

3-26. Depress the carrier LEVEL function key, then the 0 and dBm keys. The FREQUENCY/LEVEL display will now indicate 0.00 dBm. Depress the mV/MHz key. The display will change to 223.6 mV. Carrier level may be entered in millivolts, volts, or dBm. The control program will recalculate or rescale numbers as required.

3-27. The DEL and CLR keys are also labeled as up- and down-arrow keys for scrolling through SPCL function menus.

### 3-28. MEASUREMENT CONTROL KEYS. (Figure 3-6)

3-29. The measurement control keys consist of the groups of switches marked FILTERS and DETECTORS. These keys may be operated at any time and will affect the MODULATION and AUDIO displays. The filter switches are arranged as self-cancelling groups of four and five keys. Depressing any high-pass switch will cause the selected filter to be placed into the measurement channel and cancel any other selected high-pass filter. Similarly, depressing any low-pass filter will cause the selected filter to be placed into the measurement channel and cancel any other selected low-pass filter.

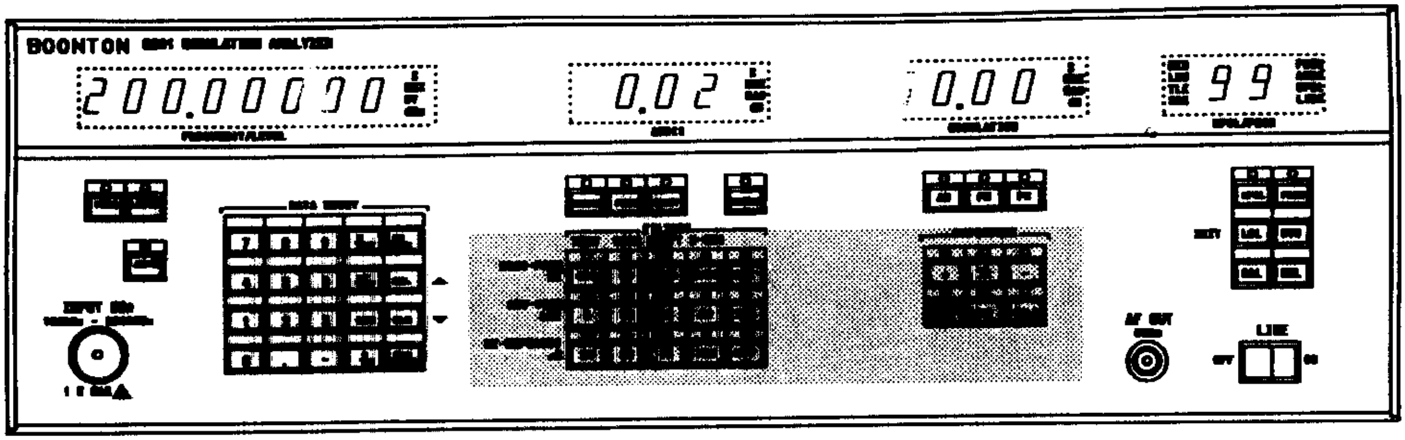

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FIGURE 3-6. Measurement Control Keys.

3-30. The maximum low-pass bandwidth selection is a function of carrier frequency. The control program will automatically adjust the low-pass filter cutoff frequency as required. The carrier breakpoints and low-pass filters are:

| Carrier | Filter |
|---|---|
| < 500 kHz | 15 kHz max. |
| < 10 MHz | 50 kHz max. |
| > 10 MHz | 220 kHz max. |

3-31. The de-emphasis filters are normally available when measuring FM only. They are selected in the same manner as the high-pass and low-pass filters, but are automatically removed from the measurement channel when AM or PM modulation function is selected. The selected de-emphasis filter will be restored when the FM function is again selected. Additionally, the de-emphasis filters may be placed before or after the modulation display. This is accomplished by selecting SPCL function 7 for pre-display and SPCL function 8 for post-display de-emphasis. SPCL function 9 permits the de-emphasis filters to be selected in the AM measurement function. This is useful for performance verification of the filter 3 dB points.

3-32. The ALT key is active if optional filters are installed in the Model 8201. Optional filters available are:

| | |
|---|---|
| THRU | **Permits connection of external filters in the audio path.** |
| CCIR | **CCIR recommendation 468-3 bandpass filter.** |
| CCITT | **CCITT recommendation P.53 bandpass filter.** |
| C-MSG | **Bell System Technical Reference 41009 bandpass filter.** |

Any or all of these filters can be installed at one time, however, the A15 option board is required with any of the filters. The ALT key will activate the filters marked above the corresponding high-pass key, if the filters are installed. Error 19 will be displayed if an optional filter is not installed and the key is depressed.

3-33. The second group of measurement control keys is the DETECTOR switches. The peak detectors are normally used to measure modulation, however, precision rms detectors are included in the Model 8201. These detectors are used primarily to characterize noise residuals and complex or distorted modulation signals. Two detectors are provided. The normal function of the RMS key is to select an rms calibrated display; however, SPCL function 18 can be executed to change the RMS key to select rms detection calibrated in peak for sinusoidal modulation. This is particularly useful when comparing peak and rms indications of noisy signals. A quasi-peak detector, compatible with CCIR 368-3, is available for use with the CCIR filter option. This detector is always available, whether the optional filter is installed or not.

3-34. The Peak +, -, and ± keys, the RMS key, and the QUASI-PEAK key are arranged such that only one detector can be selected at a time.

3-35. The HOLD key is used to activate the hold detector mode. It is an alternate action key which can be used with any detector. In operation, as modulation measurements are made, the larger of the current measurement or the previous measurement

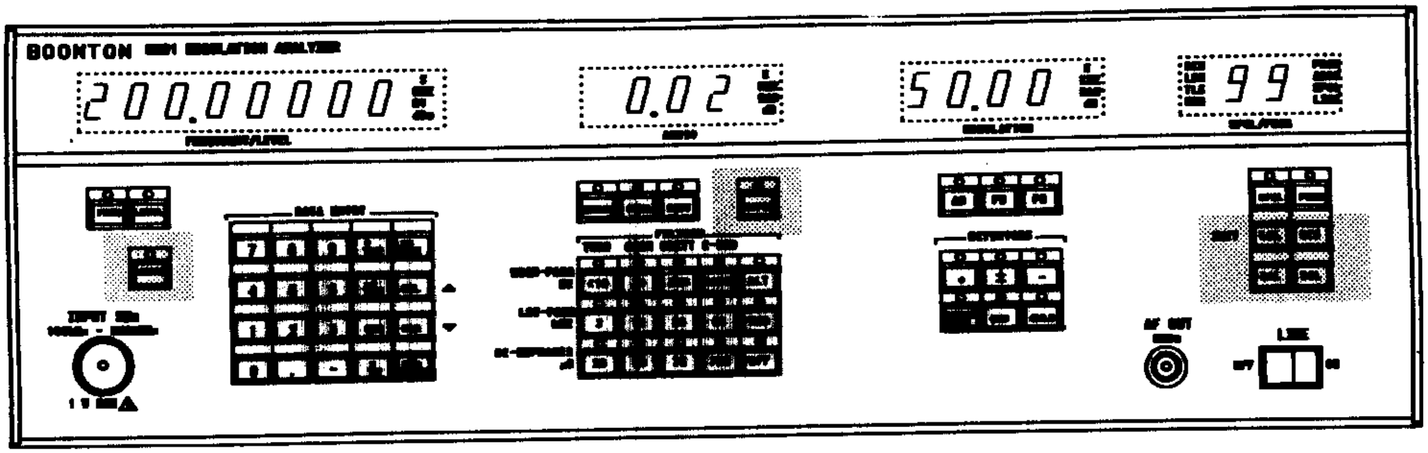


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FIGURE 3-7. Other Keys.

becomes the displayed modulation. Depress the HOLD key to activate this mode, then depress the key again to cancel.

### 3-36. OTHER KEYS. (Figure 3-7)

3-37. The RATIO key is an alternate action key which changes the active display from absolute to relative. In addition, the ratio measurement can be made relative to the current display, or to a set value. Ratio can be displayed in percent, measurement units, or dB by using the %, units, and dB keys in the data keypad.

3-38. The AUTO key is used to resume automatic operation of a particular function. It is active for the carrier FREQ, carrier LEVEL, audio FREQ, AM, FM, and PM functions. When numerical data is entered into a particular function window, the LED in the AUTO key will go out. This indicates that the selected function is not displaying a measured value. To resume measurement, depress the AUTO key. If carrier FREQ is the active function, depressing the AUTO key will always force the Model 8201 to reacquire the carrier signal.

3-39. The LCL(INIT) key is a dual function key. If the Model 8201 is in the local IEEE-488 bus state and the key is depressed an initialization restart occurs. This is similar to a power on reset except that the current instrument status is lost. This does not include bus address or end-of-string selection. If the Model 8201 is remote enabled, and the local lockout bus state is not active, the instrument will return to front panel control.

3-40. The STO and RCL keys are used with the PRGM function key to store and recall one of the 100 possible instrument control settings.

3-41. The CAL key is used to calibrate the active function. It is active for carrier LEVEL, AM, FM, and PM modulation.

### 3-42. DISPLAYED MESSAGES.

3-43. When the Model 8201 unlocks, the FREQUENCY/LEVEL display will be overwritten with the 'UNLOC' message and the AUDIO and MODULATION displays will be overwritten with the [ = = ] symbol, which means display out of range. When a valid carrier is acquired, the displays will return to normal.

3-44. The 'IFHI' and 'IFLO' messages appear in the modulation display and indicate that the intermediate frequency level is not within range to make an accurate measurement. SPCL functions 13 and 14 allow the operation of these messages to be modified.

3-45. When the CAL key is depressed, or during the execution of SPCL function 30, the message '-CAL-' is written to the FREQUENCY/LEVEL display to indicate that a calibration sequence is in progress.

3-46. A normal error response is for the word 'Error' to appear in the FREQUENCY/LEVEL display followed by a number indicating the nature of the error. Error codes are tabulated in Table 3-7 along with a description of the error.

3-47. The message 'SELFCHK', followed by a changing digit, appears in the FREQENCY/LEVEL display at power on, and indicates that a hardware check is in progress. Any error messages displayed indicate a hardware problem. See Table 3-8 for the meaning of any reported errors.

3-48. Other displayed messages are described in detail in the pertinent operation section.

## 3-49. SPECIAL FUNCTIONS.

3-50. Several of the Model 8201 operating features are internally programmable by selecting a SPCL function. These functions allow the operator to change measurement configuration, as well as change the hardware state of the instrument. Some of the more useful SPCL functions are listed below, the others are included in Table 3-2.

### 3-51. SPCL 0, CLEAR ALL SPECIALS.

3-52. SPCL function 0 allows the operator to reset any active SPCL functions. The instrument special status is returned to the defaults indicated in Table 3-2.

### 3-53. SPCL 1-4, MODULATION RANGE SETTINGS.

3-54. SPCL functions 1 through 4 permit the operator to select the modulation display range. This is useful for speeding up measurements where modulation may be removed temporarily, or in situations where the modulation range is known. This feature is also useful when decreased display resolution is desired. SPCL 1 is the default function which is autorange. The others are:

| | |
|---|---|
| **SPCL 2** | **5.000 full-scale** |
| **SPCL 3** | **50.00 full-scale** |
| **SPCL 4** | **500.0 full-scale** |

### 3-55. SPCL 5, ENABLE SLOW PEAK DETECTOR MODE.

3-56. SPCL function 5 is provided to slow the response of the peak detectors for modulation signal frequencies below 200 Hz. The detectors are optimized for signal frequencies greater than 200 Hz for maximum measurement speed. Below 200 Hz additional filtering is required.

### 3-57. SPCL 6, DISABLE SLOW DETECTOR MODE.

3-58. SPCL function 6 allows the operator to cancel SPCL 5. This is the default setting.

### 3-59. SPCL 7, SET PRE-DISPLAY DE-EMPHASIS.

3-60. SPCL function 7 allows the operator to change the de-emphasis filter location from post-display to pre-display. This means that the de-emphasis filters will affect the displayed modulation readings as well as the AF OUT signal. This is useful for comparison of receiver de-emphasis networks to the precision network used in the Model 8201.

### 3-61. SPCL 8, SET POST-DISPLAY DE-EMPHASIS.

3-62. SPCL function 8 allows the operator to change the de-emphasis filter location from pre-display to post-display. This means that the de-emphasis filters will not affect the displayed modulation readings, but will affect the AF OUT signal. This is the default setting for the de-emphasis filters.

TABLE 3-2. SPECIAL FUNCTIONS.

| SPECIAL FUNCTION | PURPOSE |
|---|---|
| 0 | Reset all SPCL functions to defaults. Indicated by ♦ |
| 1 ♦ | Set Modulation Range to AUTO. |
| 2 | Set Modulation Range to 5.000 full-scale. |
| 3 | Set Modulation Range to 50.00 full-scale. |
| 4 | Set Modulation Range to 500.0 full-scale. |
| 5 | Set slow peak detector mode. |
| 6 ♦ | Cancel slow peak detector mode. |
| 7 | Set de-emphasis to Pre-display. |
| 8 ♦ | Set de-emphasis to Post-display. |
| 9 | Enable de-emphasis for AM measurements. |
| 10 ♦ | Disable de-emphasis for AM measurements. |
| 11 | Set dB resolution to 0.001 dB for ratio measurements. |
| 12 ♦ | Set dB resolution to 0.01 dB for ratio measurements. |
| 13 ♦ | Enable IFHI and IFLO messages for FM measurements. |
| 14 | Disable IFHI and IFLO messages for FM measurements. |
| 15 | Set IEEE-488 end-of-string character. |
| 16 | Set IEEE-488 SRQ mask. See text. |
| 17 | Set IEEE-488 bus address. |
| 18 | Set RMS key to √2RMS. |
| 19 ♦ | Reset RMS key to RMS. |
| 20 | Set 750 uS de-emphasis gain to 1. |
| 21 ♦ | Set 750 uS de-emphasis gain to 10. |
| 22 | Activate function hold display mode. |
| 23 | Toggle fast acquisition mode. |
| 24 | Display IF frequency. |
| 25 | Display LO frequency. |
| 26 | Display calibrator frequency. |
| 27 | Reserved. |
| 28 | View firmware code. |
| 29 | View instrument serial number. |
| 30 | Execute complete detector calibration. |
| 31 | Enable 8200 error code reporting. |
| 32 ♦ | Enable 8201 error code reporting. |
| 33 | Activate key test routine. |
| 34 | Activate Display test routine. |
| 35 | Activate AGC test routine. |
| 36 | Activate COUNTER test routine. |
| 37 | Activate LOCAL OSCILLATOR test routine. |
| 38 | Activate DAC test routine. |
| 39 | Activate A/D test routine. |
| 40-49 | Reserved. |
| 50-99 | ACCESSABLE ONLY WITH A9JP1 INSTALLED. See Section VI. |

### 3-63. SPCL 9-10, SET/RESET DE-EMPHASIS IN AM.

3-64. SPCL func[illegible] alters the operation of the de-emphasis filters such that the filters are active for AM and modulation measurements. [illegible]eans that the de-emphasis filters will affect AF OUT signal and, optionally, the displayed modulation readings in the [illegible]odulation measurement mode as well as the FM mode. This is useful for performance testing of de-emphasis time c[illegible]stants. SPCL 10 restores FM only operation.

### 3-65. SPCL 11, 0.001 DB RESOLUTION FOR LOG MEASUREMENTS.

3-66. SPCL function 11 allows the operator to select a measurement resolution of 0.001 dB for ratio measurements in the dB mode. This function is useful when increased display resolution is desired.

### 3-67. SPCL 12, 0.01 DB RESOLUTION FOR LOG MEASUREMENTS.

3-68. SPCL function 12 allows the operator to select a display resolution of 0.01 dB for ratio measurements in the dB mode. This is the default resolution for power and log ratio measurement display.

### 3-69. SPCL 30, MODULATION DETECTOR CALIBRATION.

3-70. SPCL function 30 is the modulation detector calibration program. When executed the -CAL- message will appear in the FREQUENCY/LEVEL display and detector calibration will begin. The calibration routine will take about 80 seconds to complete. The AM detector is calibrated first, followed by the rms detector, the FM detector and finally the PM detector. If calibration errors occur, they will be displayed as the particular detector is being calibrated.

### 3-71. FRONT PANEL CONNECTORS.

3-72. The Model 8201 is normally supplied with two connectors on the front panel, RF IN, and AF OUT. These connectors are the most often used. Optionally, the RF IN connector can be placed on the rear panel.

3-73. The RF IN connector is the means to apply a test signal to the Model 8201. It is a type N connector which is the preferred connector in this frequency range. The nominal input impedance at the RF IN is 50 ohms (SWR $< 1.5$). The RF IN connector is designed to accept a fuse, although one is not installed since the Model 8201 is designed to accept inputs of 40 volts dc, or 35 volts ac without damage. A protection circuit automatically disconnects ac inputs exceeding about +32 dBm. The carrier level response is shown in Figure 3-8.

3-74. The AF OUT connector is a type BNC. The signal at this connector is a sample of the recovered modulation. As a result, the amplitude varies with modulation and modulation range settings and the signal is affected by the high-pass and low-pass filters and the de-emphasis networks. The nominal level is 1 volt into 600 ohms at 5000 counts on the modulation display. Source impedance is 600 ohms. Amplitude variations will also occur at the AF OUT connector with carrier level if the AM measurement mode is selected even though the modulation is constant. This happens because the Model 8201 uses a microprocessor controlled discrete AGC system rather than an analog one. The AM indication is not affected since the AM detector level is measured for each displayed AM indication.

### 3-75. REAR PANEL CONNECTORS.

3-76. The most prominent connector on the rear panel of the Model 8201 is the IEEE-488 connector. This connector provides a means of incorporating the Model 8201 into an automatic test system. Complete instrument operation when connected to the IEEE-488 bus is covered in later paragraphs.

3-77. The connector marked IF OUT is a type BNC connector with a source impedance of 50 ohms which provides a sample of the frequency translated carrier signal. The nominal level is 0 dBm, and the frequency is determined by the carrier frequency as follows:

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

3-78. The connector marked AM OUT is a dc coupled sample of the output of the AM detector. This output is always active and has a small signal bandwidth of 220 kHz, corresponding to the 220 kHz filter setting on the front panel. Additional filtering may be required to use this signal if the carrier frequency is below 10 MHz. The nominal sensitivity is 0.2 volts peak-to-peak for 10% AM. The dc and ac portions of this signal can be used to calculate AM according to the following formula:

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

3-79. The offset in the above equation can be determined by depressing the carrier FREQ and V/MHZ keys and removing the RF IN connection, then noting the dc voltage at the AM OUT connector. Reconnect the carrier signal and measure the ac and dc components. For example:

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

3-80. The connector marked FM OUT is a dc coupled sample of the output of the FM detector. This output is always active and has a small signal bandwidth of about 220 kHz, corresponding to the 220 kHz filter setting on the front panel. Additional filtering may be required to use this signal if the carrier frequency is below 10 MHz. The nominal sensitivity is 2 volts peak-to-peak for 100 kHz deviation. When the IF frequency is 1.211 MHz, the dc voltage will be approximately -1.3 volts, and at 346 kHz +7.6 volts. To determine the sensitivity at this connector, apply an unmodulated carrier at about 1 MHz. Note the dc voltage at the FM OUT connector and then change the frequency to 1.5 MHz. The sensitivity is:

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

**For example:**

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

## Note

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

3-81. The connector marked DIST OUT is a sample of the audio signal with the fundamental frequency component removed. The source impedance is 600 ohms. The level is proportional to the distortion indication and is approximately 10 millivolts rms into 600 ohms at 1% distortion. The signal is useful in determining the character of the distortion products of a demodulated signal.

3-82. The connector marked EXT REF provides a means to connect a precision timebase reference to the counter circuits of the Model 8201. This input is TTL compatible, that is, the input circuit is a TTL gate with a termination network. Reference switching from internal to external is automatic when the external signal is present.

### 3-83. MEASURING AND SETTING CARRIER FREQUENCY.

3-84. The Model 8201 uses a sampling technique to convert frequency. Using this technique it is necessary only that the sampling frequency (and as a result the local oscillator frequency) vary over one octave to convert frequencies over the operating range of the instrument. In practice, more than one octave is covered, but the details of operation remain the same. For any carrier in the operating range of the instrument and any local oscillator frequency, an intermediate frequency signal will be produced which is between zero and one-half of the sampling rate. This signal is used to tune the local oscillator to the correct frequency. The problem is that the harmonic number of the local oscillator creating the intermediate frequency is not known. The relationship between the three different frequencies is:

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

3-85. The unknown quantity in the equation is N. This can be determined by varying Flo and noting the change in Fif. The ratio of the change in Fif to the change in Flo is the harmonic number. See Theory of Operation for complete details of the operation of the frequency acquisition circuits.

3-86. When the Model 8201 acquires a carrier signal, the harmonic number is determined as described. The displayed carrier frequency is then calculated from the above expression and displayed.

3-87. To measure carrier frequency, first depress the carrier FREQ function key. If the AUTO key LED is not illuminated, depress the AUTO key. The 'UNLOC' message will appear and then the measured frequency will be displayed. At this point other functions may be selected or the frequency setting can be held by depressing one of the frequency units keys: V/GHz, mV/MHz, or kHz. Depressing AUTO again will cause the instrument to reacquire the carrier signal.

3-88. The frequency of operation of the Model 8201 can be established by manual entry using the data keypad. This operation does not imply any form of preselection or filtering, merely that automatic acquisition time can be eliminated. To enter the carrier frequency depress the carrier FREQ key and enter the operating frequency using the data keypad. Terminate the number entry with one of the frequency units keys. For example, to set the Model 8201 to operate at 123.5 MHz, depress the [1], [2], [3], [.] and [5] keys, and then the mV/MHz key to complete the entry. The FREQUENCY/LEVEL display will now contain 125.50000 MHz and the LED in the AUTO key will be out.

3-89. Frequency can be entered using any consistent sets of units, as described above. Trailing zeroes are not required and the CLR key can be used to abort entry.

### 3-90. MEASURING AND SETTING CARRIER LEVEL.

3-91. The Model 8201 measures carrier level by monitoring the DC output of the AM detector. By knowing the setting of the internal attenuators, this level can be referred to the input connector. Absolute adjustments are made in the displayed value to account for the frequency response of the sampling frequency converter. As a result, it is always necessary for the control program to know the carrier frequency to display the carrier level correctly. The typical frequency corrected response is shown in Fig 3-8.

3-92. To measure carrier level, first set the carrier frequency, as described above, and depress the LEVEL key. If the AUTO led is not illuminated, depress the AUTO key to resume measurement. The FREQUENCY/LEVEL display is now indicating carrier level. The units may be in dBm or millivolts. To change displayed units, depress the desired units key and then the AUTO key. The action of depressing a units key will override the automatic mode and hold the current level setting. Depressing the AUTO key will resume measurement.

3-93. The carrier LEVEL measurement can be calibrated by depressing the CAL key, with the carrier LEVEL function active. To calibrate the measurement, connect the RF IN connector to a signal with a known level, such as the optional 50 MHz power calibrator, and enter the level into the carrier LEVEL display.

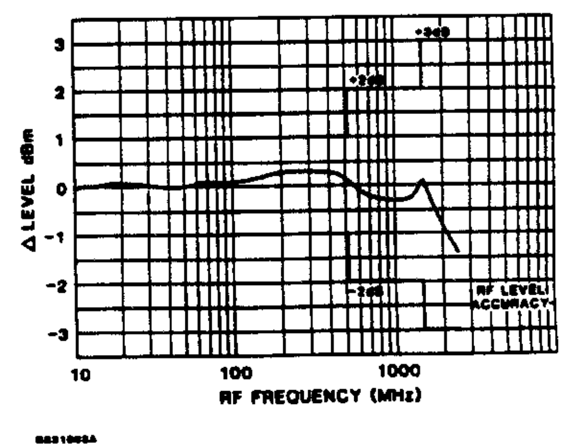


**Figure 3-8 Typical Level Response**

Depress the CAL key. The calibration routine will take about 3 seconds to complete. The resulting measurement will be the entered value, or an error will be displayed if the input signal is not within 2 dB of the entered value.

3-94. Carrier LEVEL can be set manually in order to eliminate acquisition time. To program carrier LEVEL, first depress the carrier LEVEL function key. For example, to enter -16.5 dBm, depress the [-], [1], [6], [.], and [5] keys, followed by the dBm units key. The FREQUENCY/LEVEL display will now contain -16.5 dBm. To convert the input level in dBm to an equivalent voltage across the 50 ohm input impedance of the sensor, depress the V/GHz or the mV/MHz keys. The resulting display will be in units of mV. In this example, the power level of -16.5 dBm will be converted to 33.45 mV. Depressing the dBm key will restore the -16.5 dBm indication. An input level may be entered in voltage units initially and displayed as a voltage level or a power ratio in dBm.

## 3-95. SELECTING MODULATION MODE.

3-96. The Model 8201 can detect and display amplitude, frequency, or phase modulation. After the modulation mode is selected, subsequent instrument operation is very similar.

3-97. To select the AM measurement mode, first select carrier frequency and level as described above, then depress the modulation AM key. The modulation display will indicate the recovered AM modulation in %. The IFHI and IFLO messages are active in the AM mode and indicate that the carrier level is not adequate to make a calibrated measurement. The [= =] display indicates that the current measurement is out of range to be displayed, and will occur when autoranging is in progress or the display is overranged.

3-98. To select the FM measurement mode, first select carrier frequency and level as described above, then depress the modulation FM key. The modulation display will now indicate the recovered FM in kHz. The de-emphasis filters may be selected in the FM measurement mode. In addition, they may be placed before or after the modulation display. See above for a description of this option. The de-emphasis filter keys are mutually exclusive, that is depressing one of the keys will cancel the others. Depress the desired de-emphasis key. The AF OUT signal, and optionally the modulation display, will now indicate modulation with the de-emphasis filter on. Depress the de-emphasis OFF key to cancel filter selection.

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

## 3-100. MEASUREMENT AND DISPLAY CONTROL.

3-101. After the modulation mode has been selected, recovered modulation can be additionally processed by using the measurement control keys.

## 3-102. RATIO MEASUREMENTS.

3-103. The RATIO key is used to change displayed values from absolute to relative. RATIO can be displayed with respect to a previous measurement or a set value. The %/Hz, units, and dB/dBm keys in the data keypad toggle the relative display between linear (%), units, and logarithmic (dB).

3-104. If the RATIO key is depressed when the active function is in the measurement mode (LED in the AUTO key is illuminated), the current displayed reading becomes the reference for subsequent relative measurements. For example, if the current measurement is 25.00 kHz deviation and the RATIO key is depressed, and the % display is selected, the display will change to 100.0 and the units annunciators will be kHz and %. If the dB key is depressed the display will change to 0.00 and the annunciators will be kHz and dB. Note that if the active function is AM and the RATIO % display is selected, only the %

annunciator will be displayed.

3-105. In our example, if the deviation now changes to 20.00 kHz, the display will change to 80.0 % or -1.9 dB depending on the selection of the % or dB rati Modulation readings can also be displaye ive to a set value of modulation. The value of the reference modulation is ke d into the modulation display using the da ad before the RATIO mode is activated. The LED in the AUTO key will go off when the data entry is completed. For ex , to establish a reference modulation of 40.00% AM depth, select the AM function and cancel the RATIO display if it is active. Enter 40% into the modulation display using the data keypad. Depress the RATIO key to measure AM with respect to 40.00%. The dB key may be depressed to change the displayed units to dB. Suppose that the actual modulation was 47.5%. In our example, the modulation display would indicate either 118.7% or 1.5 dB.

3-106. The RATIO display is a convenient way to alter displayed units. For example, incidental AM is often expressed as a ratio in dB of indicated AM with respect to 100%. To display incidental AM, enter 100% as the reference modulation and select the dB RATIO measurement mode. Residual AM and FM and incidental FM may similarly be displayed with respect to a reference modulation. Carrier frequency will be displayed as MHz, or % frequency shift with respect to a measured, or set frequency.

3-107. Many other displays are possible by using the RATIO mode. Phase modulation may be displayed in degrees by entering 1.745 RAD as a reference and using the RATIO % measurement mode.

**3-108. PEAK AND RMS DETECTORS.**

3-109. When making modulation measurements, the desired result is normally the peak deviation or the peak or trough of amplitude modulation. The PEAK +, -, and ± keys provide this display. The + PEAK detector indicates the positive peak excursion of FM or PM deviation (increasing frequency or phase), and the peak of AM modulation. The - PEAK detector indicates the negative peak excursion of FM or PM deviation (decreasing frequency or phase), and the trough of AM modulation. The ± key indicates the arithmetic mean of the + and - peak key. The display in the PEAK ± mode is calculated by the display program from independent measurements of the + and - peaks.

3-110. For most measurements there will be a difference in the positive and negative peaks. This is usually due to even order distortion of the recovered modulation signal. For FM modulation, the distortion would also be apparent in the carrier frequency display if the magnitude of the distortion is large enough. This asymmetry is also called carrier shift. For AM a similar effect occurs, shifting the average carrier amplitude.

3-111. In any case some difference in peak readings is normal since the maximum on-scale resolution of the modulation display can be 1 part in 5000, or 0.02%.

3-112. Several measurement situations arise when peak indication is not very useful. The most often encountered of these is the measurement of noise residuals. Because the Model 8201 detectors and local oscillators have very low noise residuals, the instrument can be used to characterize noisy sources. Under these conditions, the rms detectors should be used to give meaningful results.

3-113. Two rms detectors are provided, RMS and √2RMS. The detectors differ only mathematically. Selecting SPCL function 18 causes the RMS key to be redefined as √2RMS. This causes the control program to scale the actual rms detector output by the square root of 2, the crest factor for a sinewave; thus, the display is calibrated in peak for sinewave modulation signals. This is very useful for quantifying noise residuals on moderately noisy carriers.

3-114. Root-mean-square (rms) voltage is obtained by summing the squares of the individual components of a waveform and then taking the square root of the result. Thermocouples, thermistors, and calorimeters are examples of rms detectors. The detector in the Model 8201 is a computing type of rms detector, that is, it takes the absolute value of the voltage, squares it, averages it, and finally takes the square root of the result.

3-115. When the measurement situation calls for display of residual modulation, the rms detector should be used. The noise of the carrier under test is combined with the residual noise of the Model 8201 circuits in very predictable manner. This allows the Model 8201 residuals to be easily discounted. For example, if the indicated residual FM is 25 Hz rms with a carrier at 1000 MHz and -10 dBm and with the 15 kHz low-pass filter selected, the residual noise of the carrier alone is simply the square root of the difference of the square of 25 and 7.5 or 23.8 Hz rms. Residual AM and PM are handled in a similar manner. The residual

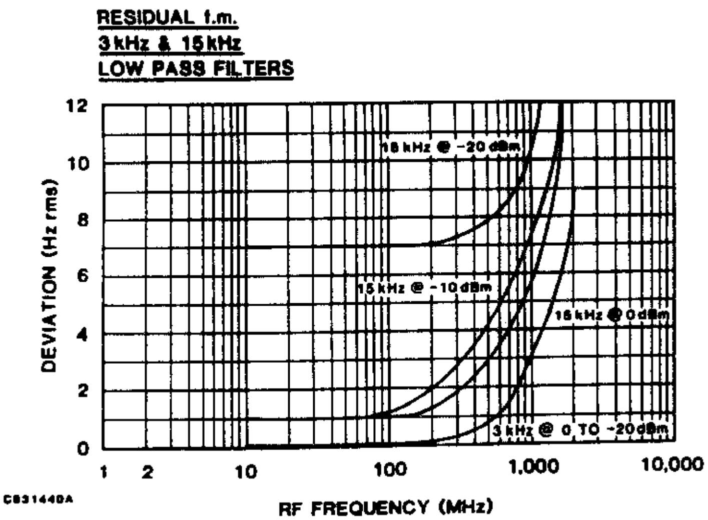


FIGURE 3-9. Residual FM, 3 and 15 kHz Filters.

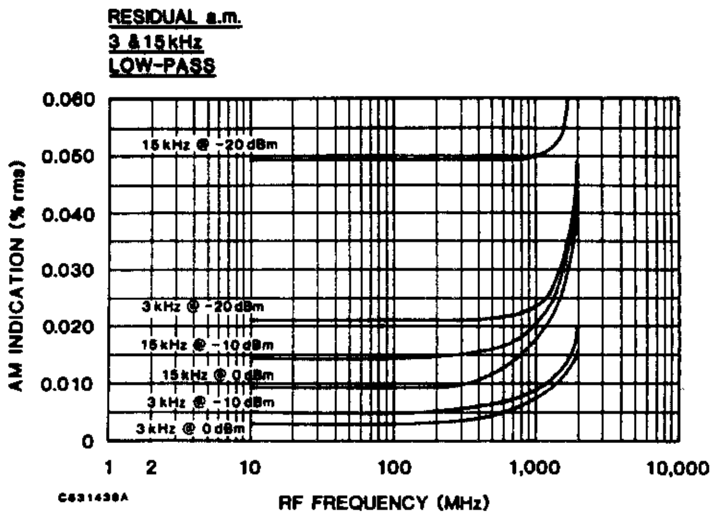


FIGURE 3-10. Residual AM, 3 and 15 kHz Filters.

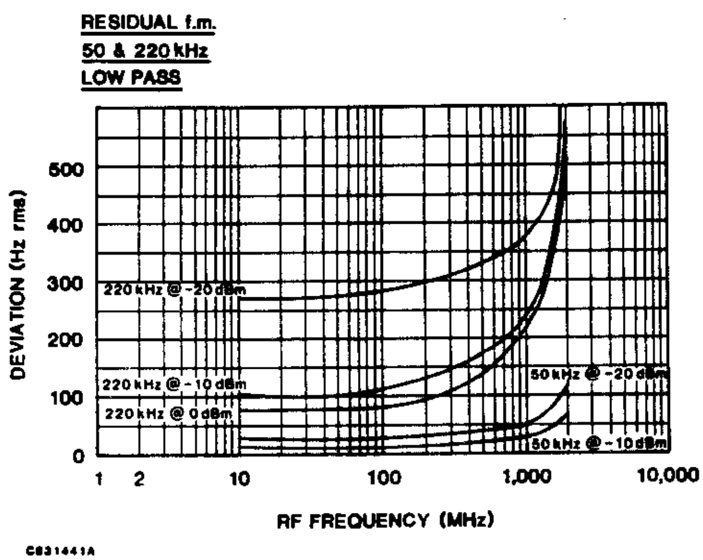


FIGURE 3-11. Residual FM, 50 and 220 kHz Filters.

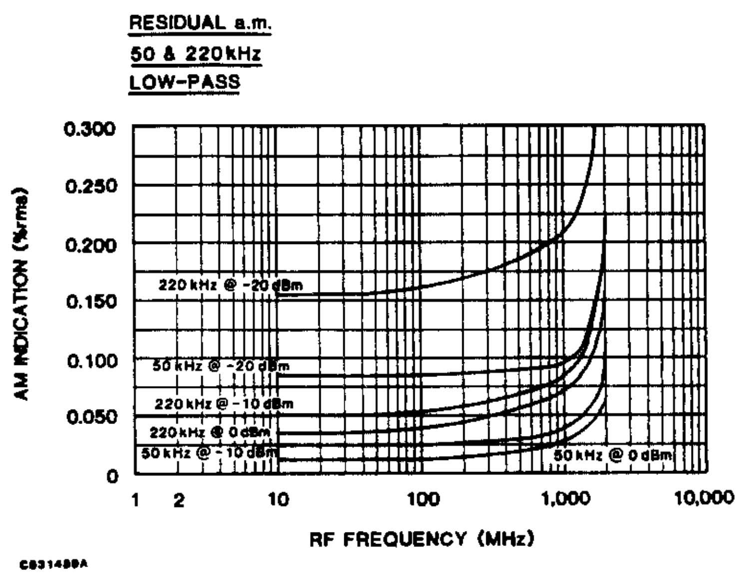


FIGURE 3-12. Residual AM, 50 and 220 kHz Filters.

responses of the Model 8201 are shown in Figures 3-9 through 3-12.

3-116. The QUASI-PEAK detector is included for measurements compatible with CCIR recommendation 468-3. This detector is most useful for measurements using the CCIR bandpass filter, however, it can be used for other measurements as well. Note that the detector indicates the peak value calibrated in rms.

### 3-117. DETECTOR HOLD.

3-118. The detector HOLD key is useful in measurement situations where the long term modulation peak is desired. The HOLD key can be used with any of the detectors to display the larger of the previous or current measurement. To use the HOLD function, depress the HOLD key. The modulation display will change only if the measurement is greater than the one displayed. Depress the HOLD key again to cancel this measurement control mode.

### 3-119. FILTERS.

3-120. The Model 8201 includes an array of low-pass, high-pass, and de-emphasis filters. These filters can be used to advantage to minimize measurement errors due to noise, or to remove unwanted components of complex modulation signals.

3-121. The high-pass filters are all three-pole Butterworth designs except the < 10 Hz filter. The < 10 Hz filter is a Gaussian response controlled by the coupling capacitors on the Filter circuit board. The three dB corner is much less than 10 Hz. This filter is also specified to have less than 10 % droop with 5 Hz square wave modulation. The response of the high-pass filters is shown in Figure 3-15.

3-122. The low-pass filters are a combination of active and passive designs. The 3 and 15 kHz low-pass filters are three-pole Butterworth designs, the 20 kHz low-pass filter is a three-pole Bessel design, and the 50 and 220 kHz filters are seven-pole Butterworth designs. Low-pass filter response is shown in Figures 3-13, 3-14 and 3-16.

3-123. Filter selection is critical in maintaining accuracy of displayed modulation and distortion. All carriers applied to the RF IN connector of the Model 8201 will contain noise modulation sidebands. The magnitude of the noise can be determined by

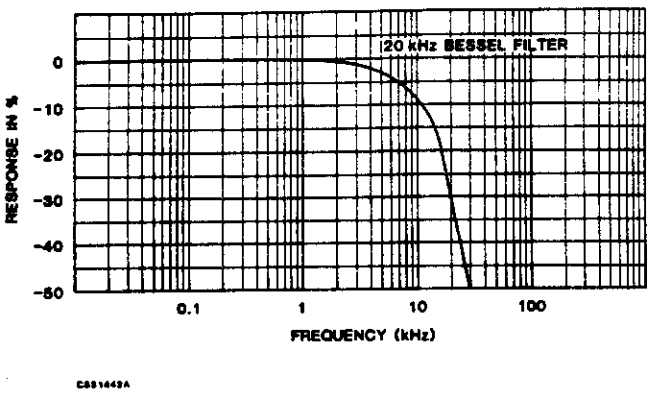


FIGURE 3-13. Response, 20 kHz Bessel Filter.

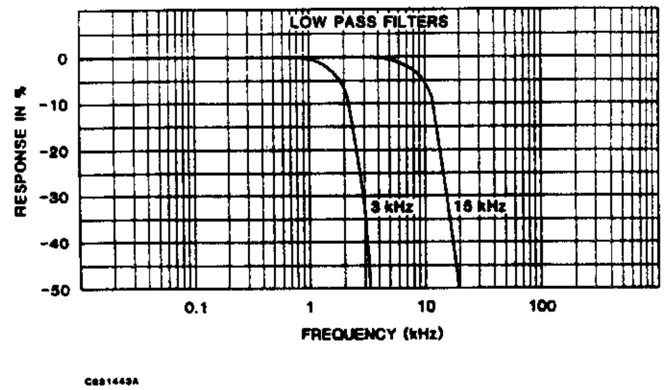


FIGURE 3-14. Response, 3 and 15 kHz Filters.

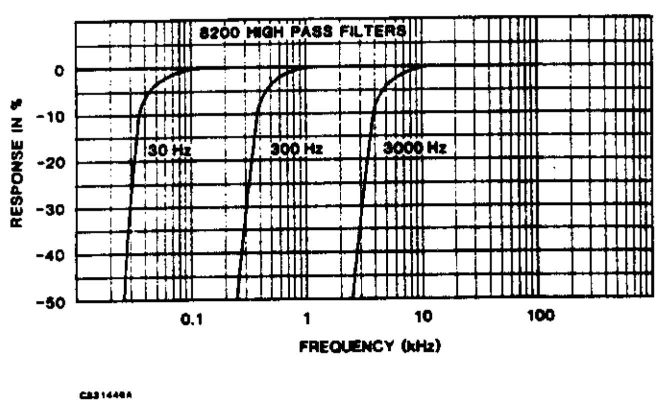


FIGURE 3-15. Response, High-pass Filters.

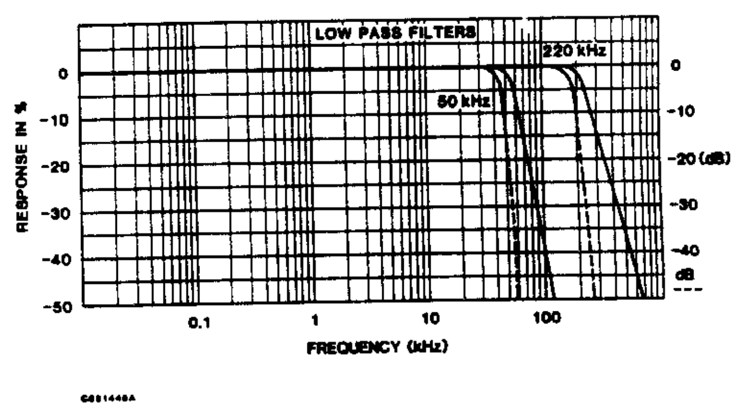


FIGURE 3-16. Response, 50 and 220 kHz Filters.

using rms detection as outlined above. Selection of the lowest low-pass filter possible based on the modulation frequency, will usually produce the most accurate indication. For example, if the modulation frequency is 1 kHz, the 3 kHz low-pass filter should be used.

3-124. If the modulation signal is a squarewave or pulse, the 20 kHz low-pass filter should be used. This filter is a Bessel design which has controlled phase characteristics and modest overshoot.

3-125. Filter selection is very important when measuring distortion. A reasonable distortion measurement should include at least the first three harmonics. For example, if a measurement of distortion is made at 2.5 kHz, the 15 kHz low-pass should be used. High-pass selection will also affect distortion measurements. For example, when measuring distortion at 1 kHz with the 300 Hz high-pass is selected, the phase relationship of the fundamental signal, 1 kHz, is changed with respect to the harmonics and a smaller or larger indicated distortion may result.

3-126. As an option, the Model 8201 can be configured with CCITT, CCIR, or C-MESSAGE bandpass filters. These filters are required by various specifying authorities to quantify noise residuals in voice grade telephone or radio-telephone systems. Any one, or all of these filters can be installed in the Model 8201. The responses of these filters are shown in Figures 3-17, 3-18, and 3-19.

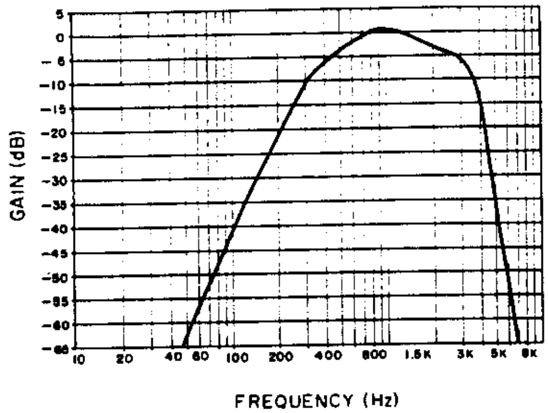


FIGURE 3-17. Response, CCITT Bandpass Filter.

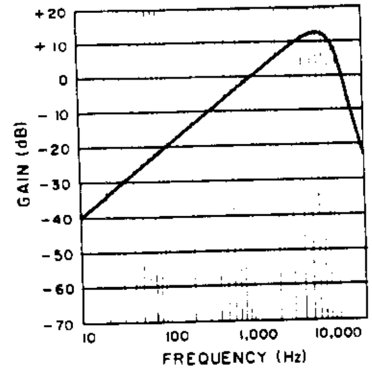


FIGURE 3-18. Response, CCIR Bandpass Filter.

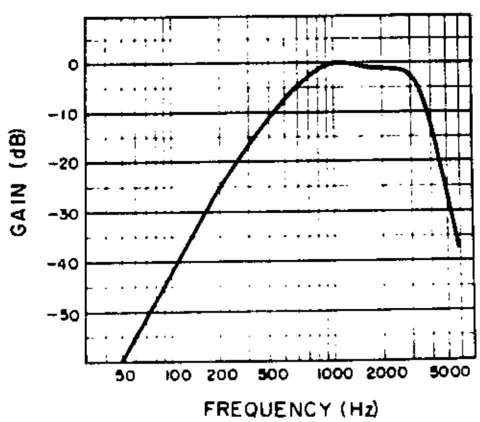


FIGURE 3-19. Response, C-MESSAGE Bandpass Filter.

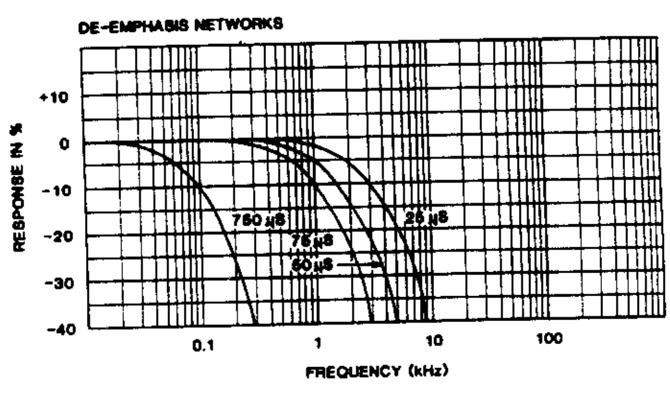


FIGURE 3-20. Response, De-emphasis Filters.

3-127. For situations requiring proprietary or unusual filter shapes, a loop thru filter option can be installed. This option permits external circuitry to be placed between the AM and FM detectors and the baseband detectors. Any circuit or system capable of accepting a 1.0 volt peak-to-peak signal from a 600 ohm source, and able to drive 1 megohm in shunt with about 50 picofarads can be used. Both input and output circuits are protected against over-voltage and static discharge. The frequency response of the loop thru path extends from less than 10 Hz to greater than 220 kHz.

3-128. The de-emphasis filters were described above, The response of the de-emphasis filters is shown in Figure 3-20.

3-129. **AUDIO FREQUENCY AND DISTORTION.** After the modulation mode and measurement control functions have been determined, the recovered modulation can be further processed. The AUDIO display can be used to display audio frequency or distortion.

3-130. To measure audio frequency depress the FREQ key under the AUDIO display. The AUDIO display will indicate the frequency of the recovered modulation. Display resolution is determined automatically by the control program. For frequencies below 100 Hz, the resolution is 0.1 Hz, decreasing in decade steps to 100 Hz at 100 kHz modulation frequency.

3-131. The AUDIO display can also be used to display distortion. The internal audio distortion analyzer is automatically adjusted by the control program if the modulation frequency is between 20 Hz and 20 kHz. For frequencies outside this range, or during range changes, the [ = = ] symbol is displayed. The '----' symbol is displayed if the rms detectors are being used for modulation measurements.

3-132. To measure distortion in percent, depress the DIST key under the AUDIO display. The [ = = ] symbol will appear until the internal analyzer is tuned, and then the measured distortion will be displayed.

3-133. When the key marked SINAD is depressed, the distortion will be displayed in dB. SINAD is an acronym for Signal plus Noise and Distortion. The measurement made is the ratio of signal plus noise and distortion to noise and distortion expressed in decibels. The SINAD display has a higher resolution at low distortion readings because of the logarithmic display, however, it is normally used for adjusting receiver sensitivity at indications of about -12 dB. When the SINAD ratio is very low, the distortion analyzer can be tuned manually, by entering the audio frequency into the AUDIO display using the DATA keypad. The LED in the AUTO key will be out when audio frequency is set. Depressing the AUTO key will resume audio frequency measurement.

3-134. As indicated above, filter selection is very important when measuring distortion. Using a wider low-pass bandwidth than necessary will cause a higher distortion indication because of additional noise, and conversely, using a lower low-pass filter than necessary will cause a lower distortion indication because of attenuation of the harmonic components.

3-135. Some care should be taken when comparing Model 8201 distortion indications to those of instruments connected to the AF OUT connector. Most distortion analyzers use average rather than rms detection to indicate distortion. Average detectors read noise about 11 percent, or 1.1 dB lower than an rms detector. As a result, this type of instrument gives an optimistic indication when most of the residual signal is noise.

3-136. The DIST OUT connector on the rear panel of the Model 8201 can be used to assess the nature of the distorting signal. If the dominant component of the DIST OUT signal is noise, then the front panel indication is not representing harmonic distortion, but the residual noise.

3-137. **PROGRAM STORE AND RECALL.**

3-138. The Model 8201 contains an internal program memory which will hold 99 front panel setups. The programs represent the state of the instrument when the STO key is depressed. Storing and recalling program information is accomplished by depressing the PRGM key to activate the program function. Once the program function is active, the desired program number is entered into the display using the data keypad and the ENTER key. Depress the STO key to store the current instrument status or the RCL key to restore a previously saved instrument setting.

3-139. The internal memory of the Model 8201 is non-volatile, that is, when power is removed, the contents of the internal memory are not lost. In normal operation, the internal memory is never erased. New programs or changes are simply written over the old ones. It is possible, however, to erase the entire program memory by use of test jumpers A9JP1 and A9JP2. See section VI. Erased programs cannot be recalled. After recalling a program, any panel setting may be changed.

### 3-140. RECALL ONLY PROGRAM.

3-141. Program number 99 is a setup program equivalent to the program installed when the INIT key is depressed. This program is installed during power up if a memory fault occurred on the previous power down. If an attempt is made to store a program at location 99, an error will result.

### 3-142. REMOTE OPERATION.

3-143. Any front panel operation of the instrument except for the LINE ON/OFF switch can be remotely controlled under direction of an IEEE-488 interface controller. IEEE-488 is a hardware standard which describes the communication and handshaking across an 8-bit parallel bus between a controller and up to 15 instruments.

3-144. **Setting the Bus Address.** To set the IEEE-488 bus address (MLTA), depress the SPCL key, and enter 17, the special function to set the bus address. The current bus address will be displayed, with the ADRS annunciator illuminated in the SPCL/PRGM display. Select the desired address with the data keypad. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented. The bus address function will remain active until the SPCL function is changed or the PRGM key is depressed.

3-145. **Setting the End-of-String Character.** To set the IEEE-488 bus end of string character(s), depress the SPCL key, and enter 15, the special function to access the end-of-string setting program. The current end-of-string character(s) will be displayed, in the FREQUENCY/LEVEL display. Select the desired characters by using the DEL and CLR (arrow) keys to step through the possible selections. Selection is automatic. The different character displays and their meanings are tabulated in Table 3-3. In any case, the Model 8201 always terminates on end-or-identify (EOI) true and always sends EOI true with the last character of every string. The display is cleared when another function key or ENTER is depressed.

| DISPLAY | LISTEN | TALK |
|---|---|---|
| CL-CL | Line Feed. | Carriage Return, Line Feed. |
| C-CL | Carriage Return. | Carriage Return, Line Feed. |
| C-C | Carriage Return. | Carriage Return. |
| L-L | Line Feed. | Line Feed. |
| EOI | End-or-identify. | End-or-identify. |

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

3-146. **Entering the Remote Mode.** The instrument is put in the remote mode by addressing it as a listener with remote enable (REN) bus signal true. In the remote state the keyboard is disabled, except for the LCL/INIT key and the POWER ON/OFF switch. The REM status annunciator is illuminated.

3-147. **Returning to Local Mode.** The instrument may be returned to the local mode as follows:

- ☐ The LCL/INIT key is depressed, provided local lockout (LLO) is not active.
- ☐ The go-to-local (GTL) bus command is sent.
- ☐ Remote enable (REN) is set false.

## NOTE

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

**3-148. Triggered Operation.** In the remote mode the instrument can be operated in the immediate mode (mnemonic IM), or in the wait-for-trigger mode (WT). The immediate mode is the default condition and results in the immediate response to talk requests. The wait-for-trigger mode causes data acquisition be deferred until a trigger is received. This aids in synchronizing the instrument to other system components. The wait-for-trigger mode is set when the WT mnemonic is encountered in the input string. From that point on execution is delayed. No change will occur until one of the following events is encountered:

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

## NOTE

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

**3-149. Talk Operation.** The instrument may be addressed as a talker without regard for remote/local mode. When the talker state is set by the bus controller, the instrument sends a character string which is determined by the current talk mode. One of four different talk modes is selected by sending the appropriate mnemonic with the Model 8201 addressed as a listener. The selected mode will remain in effect until changed.

| Function/Status | Binary Word | ASCII string |
|---|---|---|
| | | 0 C A 4 |
| Manual Tuning Set | 0 | |
| Manual Level Set | 0 | |
| Manual Range Set | 0 | |
| Alternate Filter Set | 0 | |
| Unlocked | 1 | |
| Unleveled | 1 | |
| Manual audio tuning | 0 | |
| Audio Display overrange | 0 | |
| **Active Displays** | | |
| Distortion | 1 | |
| Sinad | 0 | |
| Carrier Level | 1 | |
| Carrier Frequency | 0 | |
| PM | 0 | |
| FM | 1 | |
| AM | 0 | |
| Audio Frequency | 0 | |

TABLE 3-4. Hardware Status, Bit assignments.

**3-150. Talk Status (TS) Mode.** If an error is pending, the error code will be returned, otherwise a zero is returned. The TS mode will automatically clear an error after the status is reported. Talk Status (TS) is the default talk mode after initialization of the instrument.

**3-151. Talk Function (TF) Mode.** The TF mode returns a four character string, in HEX notation, representing the state of the hardware and display functions. The bit assignments are arranged to allow for string or byte oriented decoding. The bit assignments and meanings are presented in Table 3-4.

**3-152. Talk Value (TV) Mode.** In the TV mode the argument of the active function is returned. All values returned are in basic units such as: Hz, dB, dBm, % etc. FM deviation is returned in kHz, and carrier level in millivolts.

**3-153. Talk Program (TP) Mode.** In the TP mode a six digit number is returned that uniquely identifies the instrument firmware.

**3-154. Identify (ID) Mode.** In the ID mode a string containing the instrument identification and serial number is returned. A typical response is:

**"Boonton Model 8201, SN: 999, April 12,1991"**

which includes the model number, the serial number, and the firmware date.

**3-155. Using "Service Request" (SRQ).** The Service Request allows the Model 8201 to inform the system controller that some special event has occurred. The instrument then expects the controller to perform a serial poll to find out what event has occurred. The events that can be selected to generate service requests are instrument error, measurement is ready, and calibration is completed. Each of these options can be individually enabled or disabled with the SRQ mask. The default settings for the mask are with all SRQ's disabled. They can only be enabled by setting the appropriate bits high in the SRQ mask over the bus followed by the SQ mnemonic or manually using SPCL function 16. In small systems only one instrument may be capable of using SRQ. In this situation there is no need to execute a serial poll since the nature of the request is known. Error codes may be obtained directly form the talk error (TS) mode. The SRQ line can then be cleared by sending the clear (CL) command.

**3-156. Setting the SRQ mask.** Table 3-5 indicates the bit positions in the SRQ mask, what each bit enables/disables, and the corresponding bus configuration command. Note that the numeric argument precedes the SQ mnemonic.

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

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

**TABLE 3-5. Bus Command Responses.**

**3-157. Bus Command Responses.** IEEE-488 bus commands are sent by the controller to all devices on the bus (Universal Command Group) or to addressed devices only (Addressed Command Group). The response of the instrument is listed in Table 3-6. All unlisted commands are ignored.

**3-158. Program Function Mnemonics.** Each front panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values, if appropriate, is analogous to manual front panel operation. In addition, other program mnemonics are used for functions that are applicable only in remote operation. Table 3-7 lists the program function mnemonics.

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

**TABLE 3-6. Bus Command Responses.**

3-159. **Number Formatting.** Number formatting rules are as follows:

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

3-160. **Data String Format.** Data string formats are as follows:

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

3-161. **Data String Errors.** Errors are detected during interpretation. The occurrence of an error will display the error code if the display is enabled, and will set SRQ true, if enabled. The error and SRQ can be cleared by a status request (TS), or a clear error instruction (CL). All errors cause existing valid parameters to be restored. No new input can be processed until a pending error is cleared.

**3-162. Data String Examples.** The following are examples of typical programming strings in HP BASIC:

- ☐ OUTPUT 715; "SP 25" set SPCL function to 25 and execute it.
- ☐ OUTPUT 715; "H2L2" set high-pass to 30 Hz, and low-pass to 15 kHz.
- ☐ OUTPUT 715; "RD" select ratio, dB display for the active function.
- ☐ OUTPUT 715; "2 SQ" enable SRQ on calibration complete.
- ☐ OUTPUT 715; "FMTV" set measurement to FM, and talk mode to talk value.
- ☐ OUTPUT 715; "AM CA" set measurement to AM, and calibrate AM detector.
- ☐ OUTPUT 715; "A2 TS" set alternate filter 2 (CCIR), and talk mode to talk status.

**3-163. Reading Back Calibration Values.** Calibration data is normally transient. It exists only during the calibration process. There are ocassions, however, when this data is required. In order to capture this data, the instrument should be programmed to the wait-for-trigger(WT) mode. Select the appropriate function and send the TV and CA mnemonics to activate calibration with the talk value mode selected. When calibration completes, the value read back is the calibration data.

- ☐ OUTPUT 715; "FMTV" set measurement to FM, and talk mode to talk value.
- ☐ OUTPUT 715; "WT CA" set trigger mode to wait-for-trigger, and calibrate FM detector.
- ☐ ENTER 715; A$ read back calibration data.
- ☐ OUTPUT 715; "IM" restore immediate trigger mode.

TABLE 3-7. IEEE-488 BUS MNEMONICS.

| BUS MNEMONIC | RESPONSE |
|---|---|
| **Function Control:** | |
| FR | Carrier frequency, argument range: 100 kHz to 2.5 GHz. |
| RL | Carrier level, argument range: -47 to +30 dBm.( 1 mV to 7 V) |
| SI | SINAD, no argument allowed. |
| AF | Audio Frequency, argument range: 10 Hz to 20 kHz. |
| DN | Distortion, no argument allowed. |
| AM | AM modulation, argument range: 0 to 100%. |
| FM | FM modulation, argument range: 0 to 500 kHz. |
| PM | PM modulation, argument range: 0 to 500 RAD. |
| SP | Special Function, argument range 0 to 99. |
| PG | Program number, argument range 0 to 99. |
| **Number Termination:** | |
| DB | dB for ratio, or dBm for level. |
| GH | Gigahertz for frequency entry. |
| MH | Megahertz for frequency entry. |
| KH | Kilohertz for frequency entry. |
| HZ | Hertz for frequency entry. |
| VO | Volts for level entry. |
| MV | Millivolts for level entry. |
| RA | Radians for phase modulation entry. |
| **Display Control:** | |
| AU | Activates the measurement mode, for the active function. Not active in SPCL or PRGM. |
| RP | Activate relative measurements of the active modulation function in percent. |
| RD | Activate relative measurements of the active modulation function in dB. |
| RX | Turn OFF ratio mode. |
| WT | Enable the wait-for-trigger talk mode. |
| IM | Enable the immediate trigger talk mode. |
| TR | Trigger a measurement, same as GET. |
| BL | Blank Display and disable display updates. |
| UD | Restore display and enable display updates. |
| **Filter Selections:** | |
| D1 | De-emphasis, 25 us. |
| D2 | De-emphasis, 50 us. |
| D3 | De-emphasis, 75 us. |
| D4 | De-emphasis, 750 us. |
| D5 | De-emphasis, OFF. |

TABLE 3-6. IEEE-488 BUS MNEMONICS CONTINUED.

| BUS MNEMONIC | RESPONSE |
|---|---|
| H1 | High-pass, < 10 Hz. |
| H2 | High-pass, 30 Hz |
| H3 | High-pass, 300 Hz. |
| H4 | High-pass, 3000 Hz. |
| A1 | Optional THRU filter. |
| A2 | Optional CCIR filter. |
| A3 | Optional CCITT filter. |
| A4 | Optional C-MSG filter. |
| L1 | Low-pass, 3 kHz. |
| L2 | Low-pass, 15 kHz. |
| L3 | Low-pass, 20 kHz. |
| L4 | Low-pass, 50 kHz. |
| L5 | Low-pass, 220 kHz. |
| Detector Selection: | |
| P1 | Peak +. |
| P2 | Peak ±. |
| P3 | Peak -. |
| QP | Quasi-peak detector. |
| RM | RMS detector. |
| PR | √2RMS detector. |
| PH | Peak Hold ON. |
| PX | Peak Hold OFF. |
| Program Control: | |
| ST | Store front panel setup. |
| RE | Recall front panel setup. |
| Test Function: | |
| CH | Execute self-check program. |
| Cancel Errors: | |
| CL | Clear all errors. |
| Talk modes: | |
| TV | Talk value, sends the value of the active function. |
| TL | Talk program, sends a string representing the contents of the stored program followed by an ASCII $. |
| TS | Talk status, sends the current error number. |
| TP | Sends a string which identifies the 8201 firmware. |
| TF | Talk function, sends a string representing the current hardware status. |
| ID | Sends a string which identifies the 8201. |

TABLE 3-6. IEEE-488 BUS MNEMONICS CONTINUED.

| BUS MNEMONIC | RESPONSE |
|---|---|
| **Special Control codes:** | |
| **R0 or SP 1** | **Set modulation range to auto. ( same as SP 1 )** |
| **R1 or SP 2** | **Set modulation range 1, 0.000 to 5.000. ( same as SP 2 )** |
| **R2 or SP 3** | **Set modulation range 2, 5.00 to 50.00. ( same as SP 3 )** |
| **R3 or SP 4** | **Set modulation range 3, 50.0 to 500.0. ( same as SP 4 )** |
| **PD or SP 7** | **Force de-emphasis mode to pre-display.** |
| **AD or SP 8** | **Force de-emphasis mode to post-display.** |
| **CA** | **Calibrate the active function.** |
| **SQ** | **Set SRQ mask, argument range 0 to 7. See text.** |
| **EI** | **Enable SRQ interrupts. (8200 compatible)** |
| **DI** | **Disable SRQ interrupts. (8200 compatible)** |

TABLE 3-8. INSTRUMENT ERROR CODES.

| ERROR NUMBER | | MEANING |
|---|---|---|
| **Operation:** | | |
| 01 (01) | | Carrier Frequency entry out of range. |
| 02 (05) | | Carrier Level entry out of range. |
| 03 (03) | | Audio Frequency entry out of range. |
| 04 (06) | | AM modulation entry out of range. |
| 05 (12) | | FM modulation entry out of range. |
| 06 (21) | | PM modulation entry out of range. |
| 07 (07) | | SPCL function entry out of range. |
| 08 (10) | | PRGM entry out of range. |
| 09 (11) | | Units do not match active function. |
| 10 (15) | | Too many characters entered into display. |
| 11 (50) | | SPCL function requires A9J1 installed. |
| 12 (51) | | SPCL function not active. |
| 13 (13) | | Requested Program is empty. |
| 14 (22) | | Program is recall only. |
| 15 (14) | | IEEE-488 bus address out of range. |
| 16 (16) | | IEEE-488, non-existent mnemonic. |
| 17 (17) | | IEEE-488 data string format error. |
| 18 (18) | | IEEE-488, input text buffer overflow. |
| **Calibration:** | | |
| 20 (40) | | AM calibration fault. |
| 21 (42) | | FM calibration fault. |
| 22 (43) | | PM calibration fault. |
| 23 (41) | | RMS detector calibration fault. |
| 24 (24) | | Average detector calibration fault. |
| 25 (25) | | Quasi-peak detector calibration fault. |
| 26 (44) | | Carrier Level calibration fault. |
| 27 (27) | | < 10 Hz filter calibration fault. |
| 28 (28) | | 220 kHz filter calibration fault. |
| **Hardware:** | | |
| 30 (30) | | Oscillator setup error band 1. |
| 31 (31) | | Oscillator setup error band 2. |
| 32 (32) | | Oscillator setup error band 3. |
| 33 (33) | | Oscillator setup error band 4 |
| 34 (36) | | Frequency Counter self-check error. |
| 35 (52) | | Memory error, ROM. |
| 36 (53) | | Memory error, RAM. |
| 37 (37) | | Memory error, EEPROM |
| 38 (38) | | GPIB interface fault. |
| 39 (39) | | Instrument interface fault. |
| NOTE: | | Numbers in () indicate value returned in 8200 error mode. |

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# SECTION IV
# THEORY OF OPERATION

## 4-1. INTRODUCTION.

4-2. The Model 8201 is a versatile, solid-state, microprocessor controlled, modulation analyzer that covers the carrier frequency range of 100 kHz to 2.5 GHz. Recovered modulation is displayed on a four digit LED display, which provides a maximum resolution of 1 Hz deviation, or 0.001 % AM. Operating modes, input frequency, input level, and reference levels can be keyed in through a front panel keyboard. An IEEE-488 interface enables remote programming of the instrument. Selected modes and values are displayed on an alphanumeric display and LED indicators. Input commands are processed by the internal microprocessor, and control signals developed by the microprocessor set up the internal circuits in accordance with the commands. The use of a microprocessor also enables storage of up to 99 complete sets of instrument setup data. Commonly used setups can be stored in non-volatile memory either through the keyboard or via the IEEE-488 interface; thereafter, the instrument front panel settings can be restored by keying in the program number assigned to the desired setup and depressing the RCL key or sending the RE mnemonic on the bus.

## 4-3. FUNCTIONAL BLOCK DIAGRAM (Figure 4-1).

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

4-5. The microprocessor communicates with the internal circuits through a data bus, an address bus, and an I/O printed circuit board. Command information is entered into the microprocessor through the front panel keyboard or an IEEE-488 interface. Special functions are provided for option selection and test purposes. Input data selection is displayed by means of a digital readout and LED indicators. The microprocessor stores and processes input data, and generates data and address information to cause execution of commanded functions.

4-6. The carrier signal is first frequency translated to an intermediate frequency for processing. The intermediate frequency chosen is dependent on carrier frequency. Carriers above 10 MHz are converted to 1.211 MHz, carriers from 2 MHz to 10 MHz are converted to 346 kHz, and carriers below 2 MHz are not converted at all. Frequency translation is accomplished by means of a zero-order hold sampler. The sampler is fully bootstrapped to accept signals as high as 2 Volts rms, without overload.

4-7. A sampling impulse, generated from a tunable local oscillator, converts the RF signal to the appropriate IF signal. After filtering and buffering, the IF signal is processed by the AM and FM circuits. Additionally, the IF signal is processed by the tuning circuits to provide signals to the microprocessor to properly tune the local oscillator.

4-8. The frequency modulation information is recovered by first amplitude limiting the IF signal to remove any AM information, and 'pulse-counting' the resulting signal to determine instantaneous frequency. A direct coupled output of the discriminator is connected to the FM OUT connector on the rear panel.

4-9. The amplitude modulation information is recovered by first setting the gain of the measurement channel to a convenient level for accurate measurement. The resulting signal is amplitude detected by a linear-active detector circuit. A direct coupled output of the detector is connected to the AM OUT connector on the rear panel.

4-10. The phase modulation information is recovered in the audio filter section by integrating the recovered FM signal.

4-11. The recovered audio signal from the AM or FM detectors is further processed by amplification and selectable filtering before being converted to dc for measurement. Audio detection consists of precision peak detectors, a quasi-peak detector, and a true rms detector. The dc information from the audio detectors is digitized by a 13-bit A/D converter for digital processing

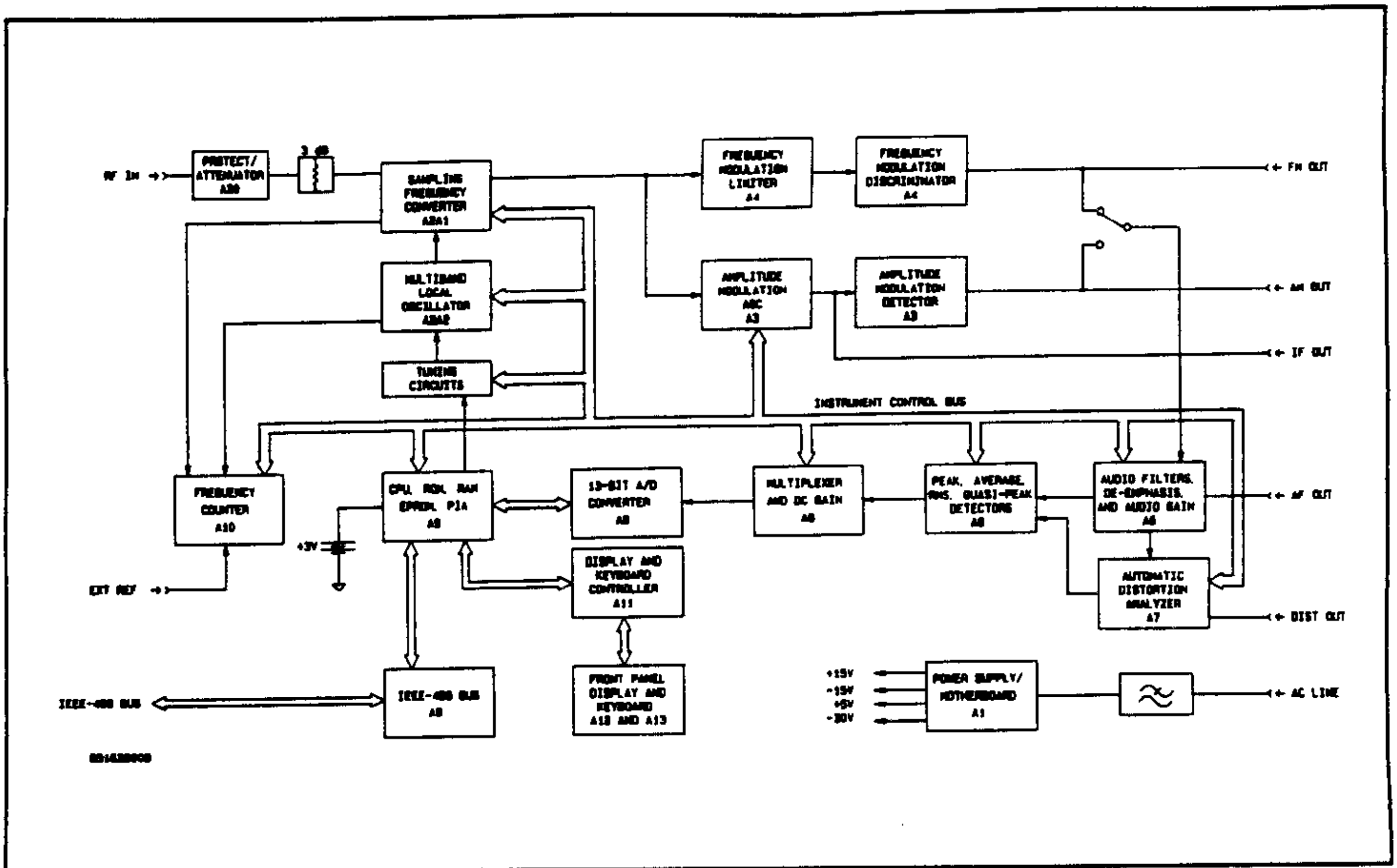



**FIGURE 4-1. Functional Block Diagram.**

and display.

4-12. The audio signal is also processed by a fully automatic distortion analyzer. This analyzer operates in conjunction with the control program to provide continuous readout of the recovered audio distortion for baseband frequencies from 20 Hz to 20 kHz.

4-13. Internal calibration circuits are operated by control program as required to establish calibration of the internal AM, FM, PM, quasi-peak, and rms detectors.

4-14. Counter/timebase circuits establish the clocks and reference frequencies for operation of the frequency counter and calibrator.

4-15. Power supply circuits convert the incoming line voltage into regulated dc operating voltages to power the instrument circuitry.

## 4-16. THEORY OF OPERATION, RF CIRCUITS.

4-17. The RF circuits convert the carrier input signal into a suitable IF signal for AM, FM, and PM measurements. See Figures 4-2 and 8-7.

4-18. The carrier to be measured is applied to the front panel RF IN connector. The signal passes through overload protection module A30, and is attenuated by AT1, a 3 dB pad, before it appears at sampling gate CR2. The attenuator provides some isolation and protection for the sampling circuit. The protection module includes a switchable 20 dB pad which is activated for input levels above +20 dBm.

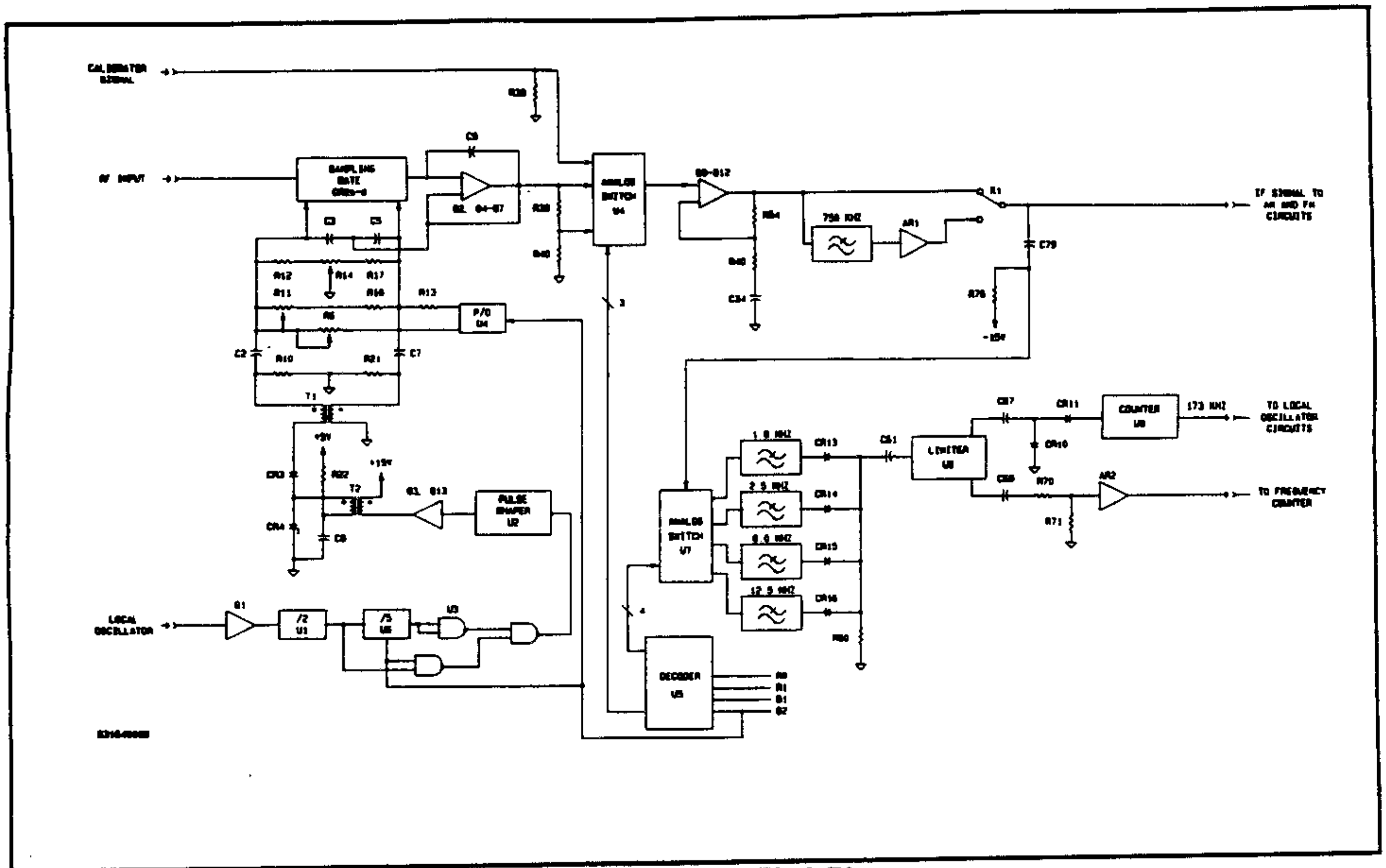


**FIGURE 4-2. RF Circuits Block Diagram.**

4-19. Simultaneously, a local oscillator signal is buffered by transistor Q1 and associated components and divided by two in U1. The resulting TTL signal is passed directly, or divided by 5 in U6, to a pulse forming circuit U2. Switching is accomplished by U3, and band control line B2. The instrument control program operates the band switch to select the proper operating band based on the RF frequency.

4-20. The pulse signal from U2 is further shaped and amplified by Q3 and Q13 to drive step-recovery diode CR4, through transformer T2. Initially CR4 is forward biased from the +5 volt supply through R22. The pulse signal from Q3 and Q13 drives CR4 into reverse conduction; however, CR4 does not "open" until all of its stored charge is depleted. At that instant the diode recovers and produces a large narrow pulse, which is coupled to the sampling bridge by T1, a balun transformer. The output of T1 is two nearly equal opposite polarity pulses. If the two pulses were exactly equal, they would exactly cancel at the input and output of the bridge. Since such equality is never the case, however, R14 is required to balance the bridge on the various operating bands.

4-21. R6 is adjusted when the local oscillator signal is between 2 and 4 MHz for optimum sampler efficiency. R11 is adjusted when the local oscillator signal is between 10 and 20 MHz.

4-22. The operation of the sampling gate is shown in simplified form in Figure 4-3. Each time the sampling gate is closed, by a short-duration pulse, the input capacitance of the sampler amplifier plus any stray capacitance is charged to a voltage that is less than the instantaneous RF input voltage. Before the next sample is taken, positive feedback from the sampler amplifier causes additional charge to be placed on this capacitance. Charge is added until the voltage at the output of the sampling amplifier is exactly equal to the RF input when the sample was taken. This output is held constant until the next sample is taken. Successive samples are taken until the RF waveform is reconstructed at 1.211 MHz or 346 kHz, depending on the RF frequency. Additional feedback from the sampler amplifier maintains symmetrical reverse bias on the sampling gate.

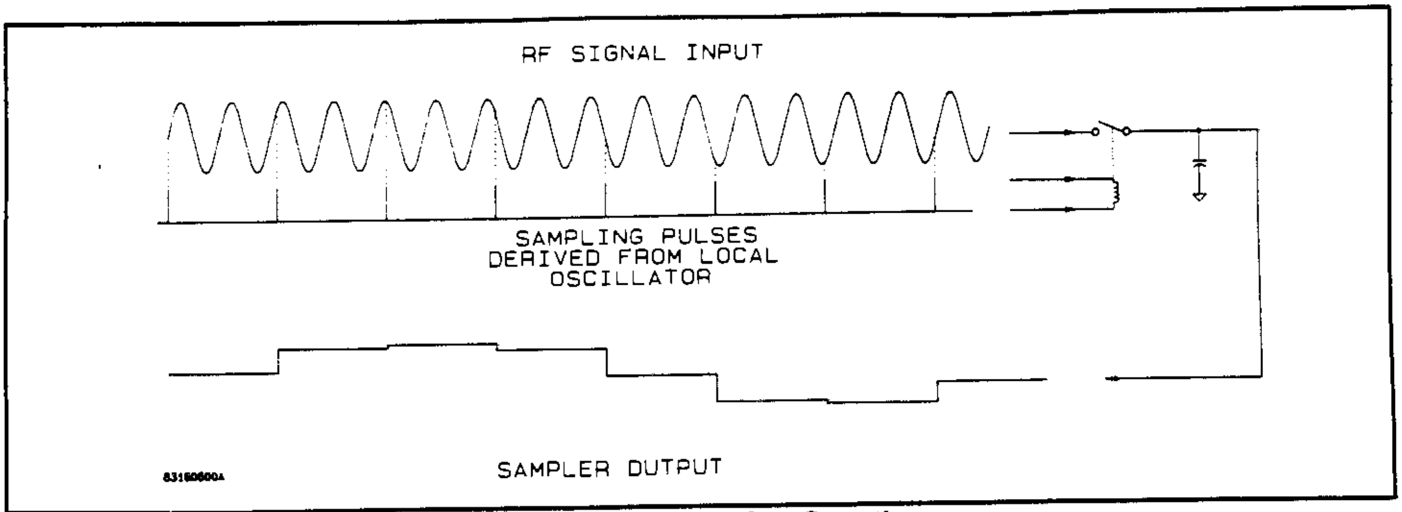



**FIGURE 4-3. Sampling Gate Operation.**

4-23. When the carrier frequency is between 100 kHz and 2 MHz, the 1.211 MHz IF is selected and the local oscillator is set to about 18 MHz. Under these conditions, the input signal passes through the sampling bridge without conversion. The IF circuits then process the signal directly.

4-24. The sampler amplifier is composed of transistors Q2 and Q4-Q7 and associated components. The gain is fixed at less than one by a direct feedback connection. The stage has a low output impedance required to properly bootstrap the sampling bridge.

4-25. The output of the sampling amplifier is connected to a switched 10 times attenuator consisting of R39 and R40. Analog switch U4 is operated by the control program, via data decoder U5, to select the signal, the signal divided by 10, or the calibrator signal. The calibrator is connected to the IF circuits when the calibration program is operating, otherwise the attenuator outputs are selected. If the carrier level is greater than about 100 millivolts, the signal is attenuated 10 times.

4-26. An amplifier consisting of transistors Q8-Q12 and associated components is required to amplify and buffer the IF signal. This stage has a gain of about 3.3, as determined by R54 and R46. When the 1.211 MHz IF is selected, relay K1 is operated to select the output of this stage. If the 346 kHz IF is being used, the signal is filtered by a 750 kHz low-pass filter consisting of L12, L14, C58, C62, and C64. Amplifier AR1 has a gain of two which compensates for the insertion loss of the filter. The output of AR1 then becomes the IF signal.

4-27. This signal is connected to the AM and FM boards for further processing, and to analog switch U7. U7 is operated by the control program, via data decoder U5, to select one of four low-pass filters. The filters, consisting of L2-L9, C38-C41, C46-49, and C51-54, are designed to reject the local oscillator signal and maintain a bandwidth of at least one-half of the sampling rate.

4-28. At any sampling frequency the carrier signal will be converted to a frequency between dc and one-half the sampling rate. Therefore, to insure proper signal discrimination, the filters must have a bandwidth of at least one-half of the sampling rate. The filter bandwidths are 1.8, 2.5, 8, and 12.5 MHz.

4-29. Diodes CR13-CR16 isolate the individual filters at the input of limiter U8. Diode bias is provided by R76 through U7. U8 limits the IF signal to remove any AM and generates square wave outputs to drive U9, a TTL counter, and AR2, a buffer amplifier used to provide a sample of the IF signal for the frequency counter circuits.

4-30. The counter output signal is used to measure the IF signal frequency for tuning and RF frequency calculation.

4-31. Counter circuit U9 is programmed to divide by 2 or by 7 as determined by the state of control line B2. If B2 is a TTL high, the 10 to 20 MHz local oscillator is active and U9 is set to divide by 7. This converts the 1.211 MHz IF to 173 kHz. If B2 is a TTL low, the 2 to 4 MHz local oscillator is active and U9 is set to divide by 2. This converts the 346 kHz IF to 173 kHz. The 173 kHz signal is connected to the local oscillator circuits for further processing.

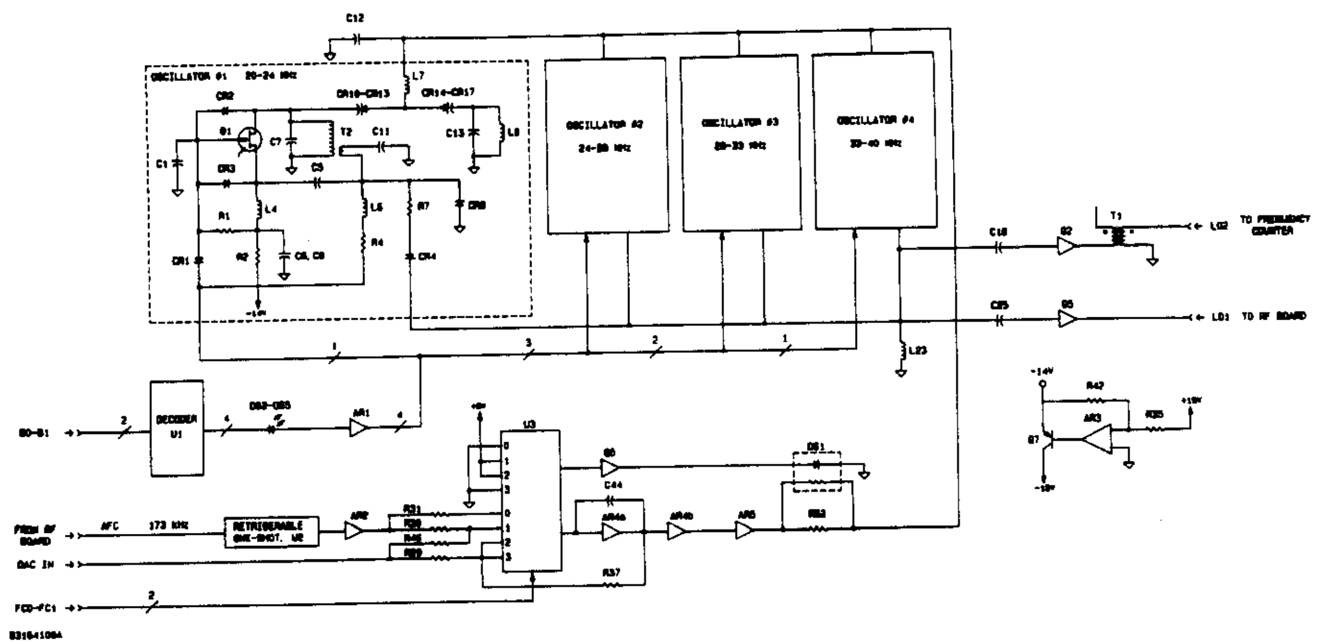


FIGURE 4-4. Local Oscillator Circuits Block Diagram.

## 4-32. THEORY OF OPERATION, OSCILLATOR CIRCUITS.

4-33. The local oscillator circuits provide the signals to operate the pulse generator circuits on the RF board. See Figures 4-5 and 8-9.

4-34. Four oscillators are operated individually to cover the band of frequencies from 20 to 40 MHz. The oscillators are designed and constructed to produce minimum residual FM. Since all oscillators function the same way, only one will be discussed in detail.

4-35. The lowest band is covered by an oscillator composed of Q1 and associated components. Transistor Q1 provides the gain required to sustain oscillations, while transformer T2 and capacitors C7 and C13 along with varactor diodes CR10-17 form the tuned circuit. Feedback is taken from the secondary winding of T2 and connected to the source of Q1 through dc blocking capacitor C5. Diodes CR2 and CR3 provide output voltage amplitude control by rectifying the feedback and drain voltages and reverse biasing Q1, thus limiting stage operating current. Capacitor C1 bypasses the gate of Q1 at the frequency of oscillation. Resistor R1 is required to establish initial gate bias and inductor L4 provides a dc return for the source.

4-36. The output of the oscillator is connected through isolation resistor R7 and switching diode CR4 to buffer stages Q2 and Q5.

4-37. Band switching is accomplished by the control program via data decoder U1 and level shifter AR1. U1 is a one-of-four decoder which converts data lines B0 and B1 into individual select lines for the four oscillators. Diodes DS2 through DS5, and pull-up resistor array R54 couple the four TTL lines to level shifter AR1. The outputs of AR1 swing from about + 13 to -13 volts.

4-38. When a band is selected, the LED associated with that band will be illuminated and the corresponding AR1 output will be at +13 volts. With +13 volts at the junction of CR1 and R4, CR1 becomes reverse biased, as does CR9. CR4 is forward biased, thus connecting the output of the selected oscillator to buffers Q2 and Q5.

4-39. When a band is not selected, the LED associated with that band will not be illuminated and the corresponding AR1 output will be at -13 volts. With -13 volts at the junction of CR1 and R4, CR1 becomes forward biased, as does CR9. CR4 is now reverse biased, thus disconnecting the output of the selected oscillator from buffers Q2 and Q5. Diode CR9 shunts the feedback path and stops the oscillator, while CR1 keeps the stage bias at the normal operating level.

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

4-41. The 173 kHz IF signal from the RF board is connected to retriggerable one-shot U2. The period of U2 is determined by R15 and C23 to be 2.9 uS, the semi-period of the 173 kHz signal. The duty cycle of the waveform on pin 6 of U2 is then 50 % and the average value of the waveform is about 2.5 volts. Amplifier AR2 shifts the dc level of the signal to make the average value about 0 volts dc. R19 adjusts the circuit for exactly 0 volts dc at 173 kHz.

4-42. The output of AR2 is connected trough R30, R31, and analog switch U3 to integrator AR4a. The output of AR4a is connected through a level shifting circuit composed of AR4b, R43a, c, and d, and transistor Q9 to buffer stage AR5. The output of AR5 is the voltage used to tune all the oscillators.

4-43. Additional connections to the integrator permit the control program to tune the oscillator using a digital-to-analog converter (DAC) located on the CPU board.

4-44. U3 is a dual switch array. The second section is used to operate a bypass circuit consisting of DS1 and Q8. This circuit operates to speed up acquisition by bypassing R52, a 1 megohm resistor, during search.

4-45. Frequency acquisition in the automatic tuning mode proceeds as follows. The input carrier frequency is applied to the sampling bridge for frequency conversion. The resulting IF frequency is somewhere between dc and one-half of the local oscillator frequency. The input signal to U2, the retriggerable one-shot, will produce an output waveform whose duty cycle, and thus average value will be proportional to frequency. The control program configures U3 so as to connect the integrator to R30, providing a closed loop for frequency acquisition. The integrator will ramp until the input frequency to U2 is 173 kHz, corresponding to either a 1.211 or 346 kHz IF frequency.

4-46. The control program monitors the dc voltage at the output of the integrator and at the output of AR2 to determine if a valid IF has been established. If the integrator output is greater than + or -10 volts, the integrator is reset by connecting the junction of R29 and R37 to the input of AR4a. with the DAC IN input set to 0 volts. The band is changed and the integrator is released. This process continues until a valid IF is found.

4-47. When a valid IF signal is found, the control program changes the DAC IN dc level. This causes a current to flow through R46 which causes the IF frequency to change. The control program then measures the resulting IF frequency and the local oscillator frequency to determine the harmonic number.

4-48. Buffer stages Q2 and Q5 are grounded base amplifiers used primarily to isolate the oscillator from influences generated by the circuits they drive. Output LO1 is the signal which drives the pulse generating circuits on the RF board and output LO2 drives a cable and the frequency counter circuits.

4-49. Amplifier AR3 and transistor Q7 regulate the -15 volt supply down to -14 volts to reduce power supply noise and ripple which improves the stability of the oscillator circuits.

## 4-50. THEORY OF OPERATION, FM CIRCUITS.

4-51. The frequency modulation circuits recover the audio signal from the frequency modulated carrier. See Figures 4-5 and 8-11.

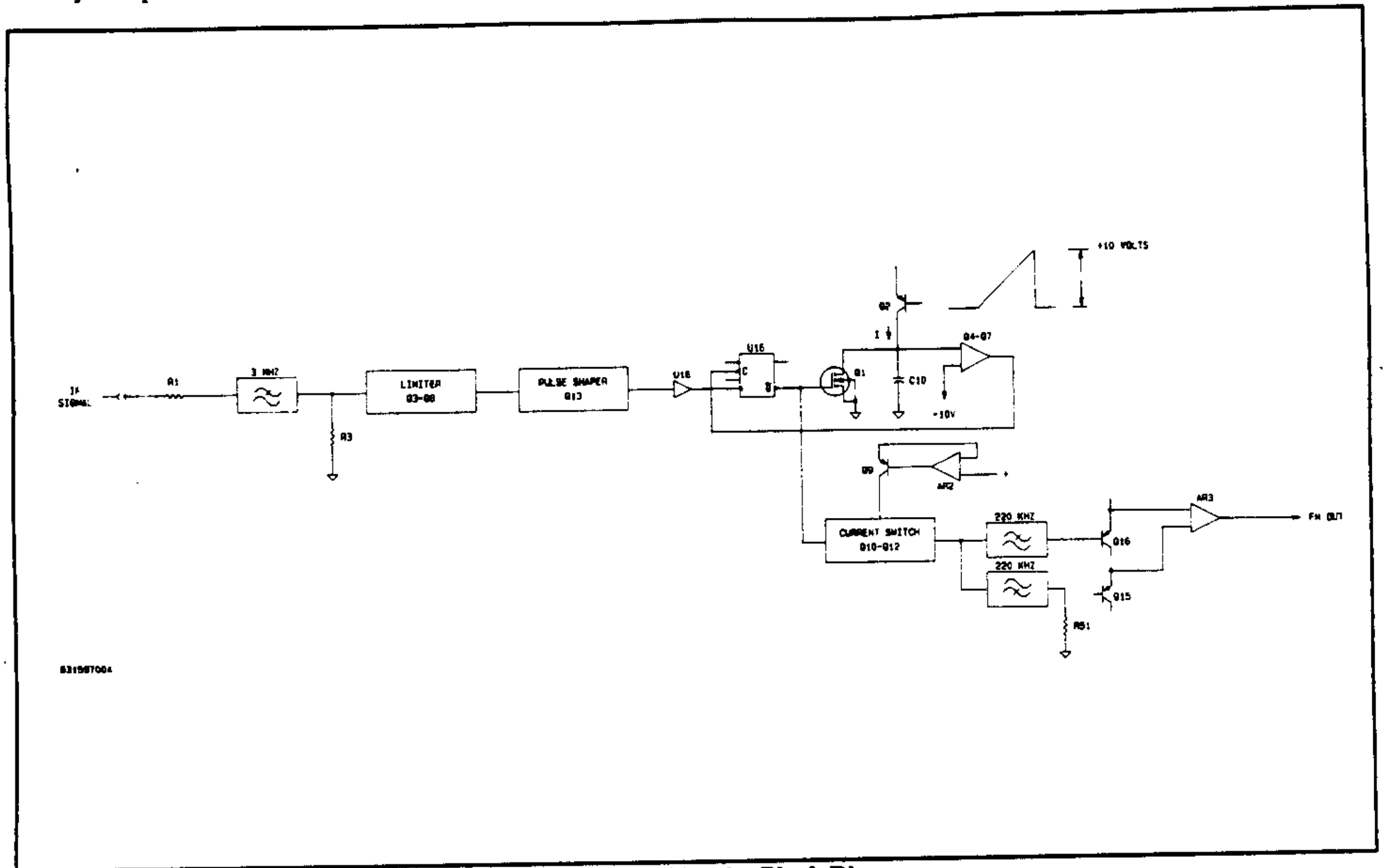



**FIGURE 4-5. FM Circuits Block Diagram.**

4-52. The intermediate frequency signal from the RF circuits is connected through a 3 MHz, flat-phase, low-pass filter consisting of inductors L3 and L4 and capacitors C1 and C4-C7 to a 4-stage limiter. The limiter is composed of integrated amplifier arrays Q3 and Q8 and associated components. The stages are designed with small signal feedback to minimize phase shift changes with level, thus minimizing incidental FM when the carrier contains large amounts of AM. The output of the limiter is connected to a pulse forming network consisting of Q13, R77, and R78, C48 and C49 and L8. This circuit creates a differentiated signal which drives U1b, a TTL flip-flop, which is wired as an inverter to drive the FM detector.

4-53. The FM detector is a precision monostable multivibrator which operates as follows. Each positive transition of the signal at pin 11 of U1a (corresponding exactly to each cycle of the IF frequency) causes the signal at pin 8 of U1a to go low. Enhancement mode FET Q1 is turned off, and the constant current source consisting of Q2, R2, R4, R11, R13, and CR1 charges C10 toward the positive supply rail. When the voltage reaches the value established at the base of Q5 by R30 and R28, transistor Q4 conducts and Q5 is turned off. This causes Q6 and Q7 to turn on which resets U1a. FET Q1 is turned on and capacitor C10 is discharged, completing the cycle.

4-54. The result of this operation is a constant width pulse at a rate equal to the IF frequency. As the IF frequency varies, the duty cycle and thus the average value of the waveform changes.

4-55. Enhancement mode FET Q10 operates in parallel with Q1 to toggle current switch Q11 and Q12. The collector current of Q12 is a rectangular pulse with a duty cycle determined by the instantaneous IF frequency and an amplitude determined by a precision current generator consisting of AR2, Q9 and associated components. The 220 kHz low-pass filter consisting of capacitors C36, C39, C41, and C42 and inductors L6, L9, and L10 removes the IF frequency components from the signal leaving only the modulation information.

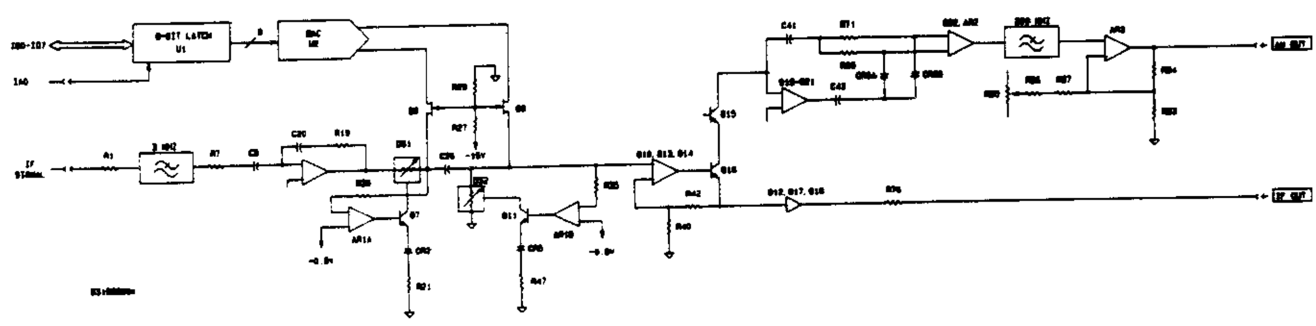



**FIGURE 4-6. AM Circuits Block Diagram.**

4-56. A phase equalizer consisting of C27, C28, C32, C33, L5, and R51 linearizes the filter phase response.

4-57. Transistors Q15 and Q16 and amplifier AR3 level shift and amplify the signal to drive the audio circuits.

4-58. Two local power supplies are required by the FM circuits. One is generated by Q14, R63, R70, R71 and C35. This circuit isolates the -15 volt instrument supply. The other is a +5 volt supply generated by R14, R15, C12, and AR1. This supply powers the TTL circuits on the FM board.

## 4-59. THEORY OF OPERATION, AM CIRCUITS.

4-60. The amplitude modulation circuits recover the audio signal from the amplitude modulated carrier. Additionally, these circuits provide a dc signal which is proportional to the carrier level at the RF IN connector. See Figures 4-6 and 8-13.

4-61. The intermediate frequency signal from the RF circuits is connected through a 3 MHz, flat-amplitude, low-pass filter consisting of inductors L5 and L6, and capacitors C1, C7, and C10 to an input amplifier composed of Q3-Q6 and associated components. The gain from the input of the filter to the output of the amplifier is about 1.5, as determined by R1, R7, and R19. This stage is carefully compensated by R88, C62, R18, and C19 to provide very flat response from less than 100 kHz to greater than 2 MHz. A flat frequency response is required to maintain low incidental AM when the carrier contains large amounts of FM.

4-62. A programmable attenuator is required to keep the output of the AM detector within reasonable limits while the carrier level changes about 40 dB. The attenuator consists of two light dependent resistors ( LDRs), two control loops, an 8-bit DAC and two isolating transistors.

4-63. Each of the two control loops operate as follows. A current flows through the variable resistance element of DS1 producing a voltage drop. This drop is monitored at one input to loop amplifier AR1a, while the other input is a reference voltage of about -0.5 volts. The output of AR1a is then the amplified difference between the reference and the drop across DS1. This error voltage is coupled to the LED portion of DS1 through buffer Q7 in such a way as to reduce this difference to nearly zero. The result is that by adjusting the current through the LDR, the resistance can be set precisely.

4-64. The variable current is supplied by U2, an 8-bit DAC and isolating transistors Q8 and Q9. The current outputs of the DAC are differential, and proportional to the magnitude of the 8-bit digital data. When the most significant bit, B1 of U2 is high and all others are low, the two currents are nearly equal. The magnitude of this current is set by R5. Any other combination of bits will increase one current while decreasing the other. The two attenuator arms track the DAC current and thus produce an attenuation which is proportional to the digital data. The control program adjusts the digital data to adjust the dc output of the AM detector.

4-65. An amplifier consisting of transistors Q10 and Q13-Q16 increases the level of the attenuator output about 18 times as determined by R42 and R40. The input impedance of the stage is high to avoid loading the attenuator, and the output impedance is high to maximize the loop gain of the following stage, the AM detector.

4-66. The AM detector is a linear-active design, that is, the diode rectifiers are linearized by including them in the feedback path of a high gain amplifier. The amplifier consists of transistors Q19-Q21 and associated components. The stage is optimized for high gain and high output impedance to drive the nonlinear feedback elements. The half-wave rectified voltages at the junctions if CR6a and CR6b and R68 and R71 are buffered by Q22a and Q22b and amplified by differential amplifier AR2. A 220 kHz, seven pole, low-pass filter consisting of inductors L10-L12 and capacitors C50-C54, and C56 removes IF frequency components from the signal, leaving only the modulation and dc components.

4-67. An additional gain of two is provided by AR3. Resistors R85-R87 provide a means to compensate for various offsets between the detector and the output of AR3.

4-68. An amplifier consisting of transistors Q12, Q17, and Q18 provides a sample of the leveled AM signal to the rear panel IF OUT connector.

## 4-69. THEORY OF OPERATION, FILTER CIRCUITS.

4-70. The recovered modulation from the AM or FM circuits is further processed by the filter circuits. See Figures 4-7, and 8-15.

4-71. Relay K1 is operated to select the output of the FM board for either FM or PM modulation, or the output of the AM board for AM modulation. Relays K2 and K3 are operated to select either an attenuator, or a 50 kHz, seven pole, low-pass filter as determined by the control program and the front panel low-pass filter selection. The 50 kHz filter is in the measurement path for all low-pass filter selections except the 220 kHz filters. The 220 kHz filters are located on the AM and FM boards.

4-72. Capacitors C15 and C16 remove any dc information from the signal before it is connected to a programmable attenuator consisting of R10, R11 and U3a. When the modulation signal is greater than 52.00 kHz, RAD, or %, the attenuator is selected. CR4 and CR5 protect the following stages from severe overload during range switching. Buffer amplifier AR1 has a gain of ten as determined by resistors R9 and R17. This stage is inserted in the signal path when the modulation is less than 5.200 kHz, RAD, or %, otherwise it is bypassed.

4-73. Unity gain buffer AR12 drives the high-pass filter array. The filters are 3-pole Butterworth designs except for the < 10 Hz filter which is dc coupled at this point. Resistors R19 and R26 set the insertion loss of the < 10 Hz position to equal that of the other active filters. The other filters are designed to cut off at 30, 300, and 3000 Hz. The control program operates analog multiplexer U4 based on the front panel high-pass filter selection.

4-74. Amplifier AR2 and associated components comprise the 30 Hz filter. Similarly AR3 and associated components comprise the 300 Hz filter, and AR4 and associated components comprise the 3000 Hz filter.

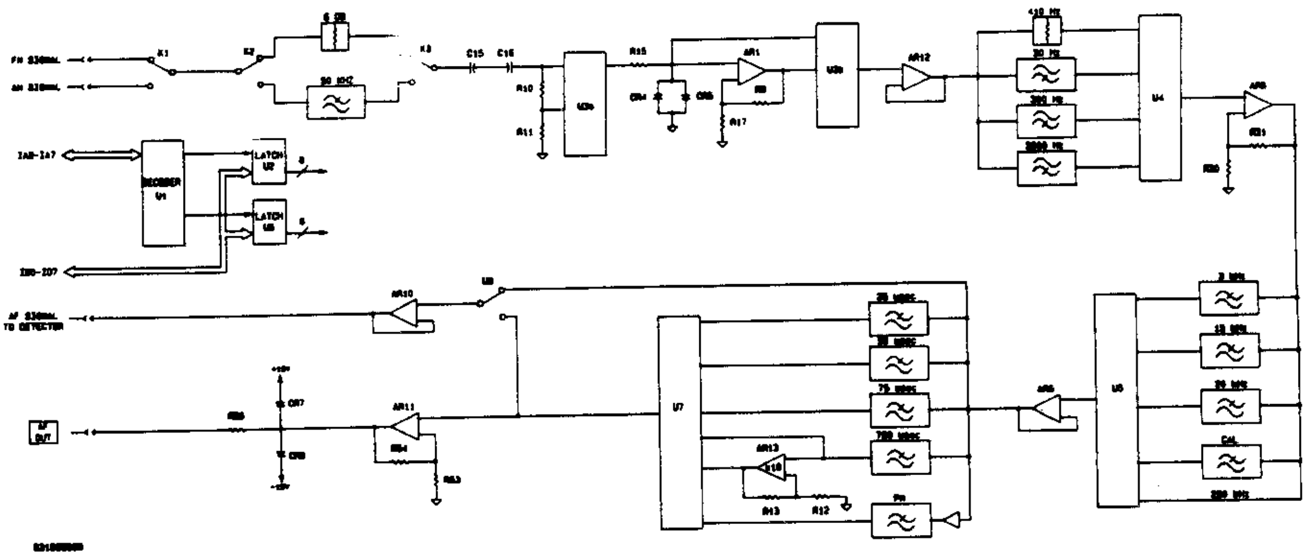


**FIGURE 4-7. Filter Circuits Block Diagram.**

4-75. AR5 amplifies the signal about 4.6 times, as determined by R30 and R31 and drives a low-pass filter array. The 3 and 15 kHz filters are 3-pole Butterworth designs, and the 20 kHz filter is a 3-pole Bessel design. Additionally, a thru position is provided for the 50 and 220 kHz filters, and a gaussian filter consisting of R34, R38, R40, C36, C38, and C41 is provided for calibration. Analog multiplexer U5 is operated by the control program based on the front panel switch setting or the carrier frequency to select the appropriate filter.

4-76. Unity gain buffer AR8 drives the de-emphasis and phase modulation filters. The de-emphasis networks are single pole gaussian filters with cut frequencies of 212 Hz, 2.122 kHz, 3.183 kHz, and 6.366 kHz corresponding to the time constants of 750, 75, 50, and 25 microseconds respectively.

4-77. AR9a and b and associated components comprise the phase modulation filter. This filter is designed to have an insertion gain of unity at 1 kHz modulation frequency, and a response that approximates an ideal integrator over most of the audio frequency range.

4-78. Analog multiplexer U7 is operated by the control program to select the appropriate de-emphasis network as determined by the front panel de-emphasis switch setting. Additionally, the control program bypasses these networks in the AM measurement mode, and selects the phase modulation filter in the PM mode.

4-79. Unity gain amplifier A10 buffers the signal which is connected to the detector circuit board through analog switch U8. U8 is operated by the control program to select pre-display or post-display de-emphasis as determined by SPCL functions 7 or 8, or the de-emphasis mode as set via the IEEE-488 bus controller.

4-80. Amplifier AR11 increases the signal by about 2.4 times as determined by R53 and R54 to generate the front panel AF OUT signal. Resistor R55 determines the output impedance of 600 ohms and diodes CR7 and CR8 provide reverse power protection for AR11.

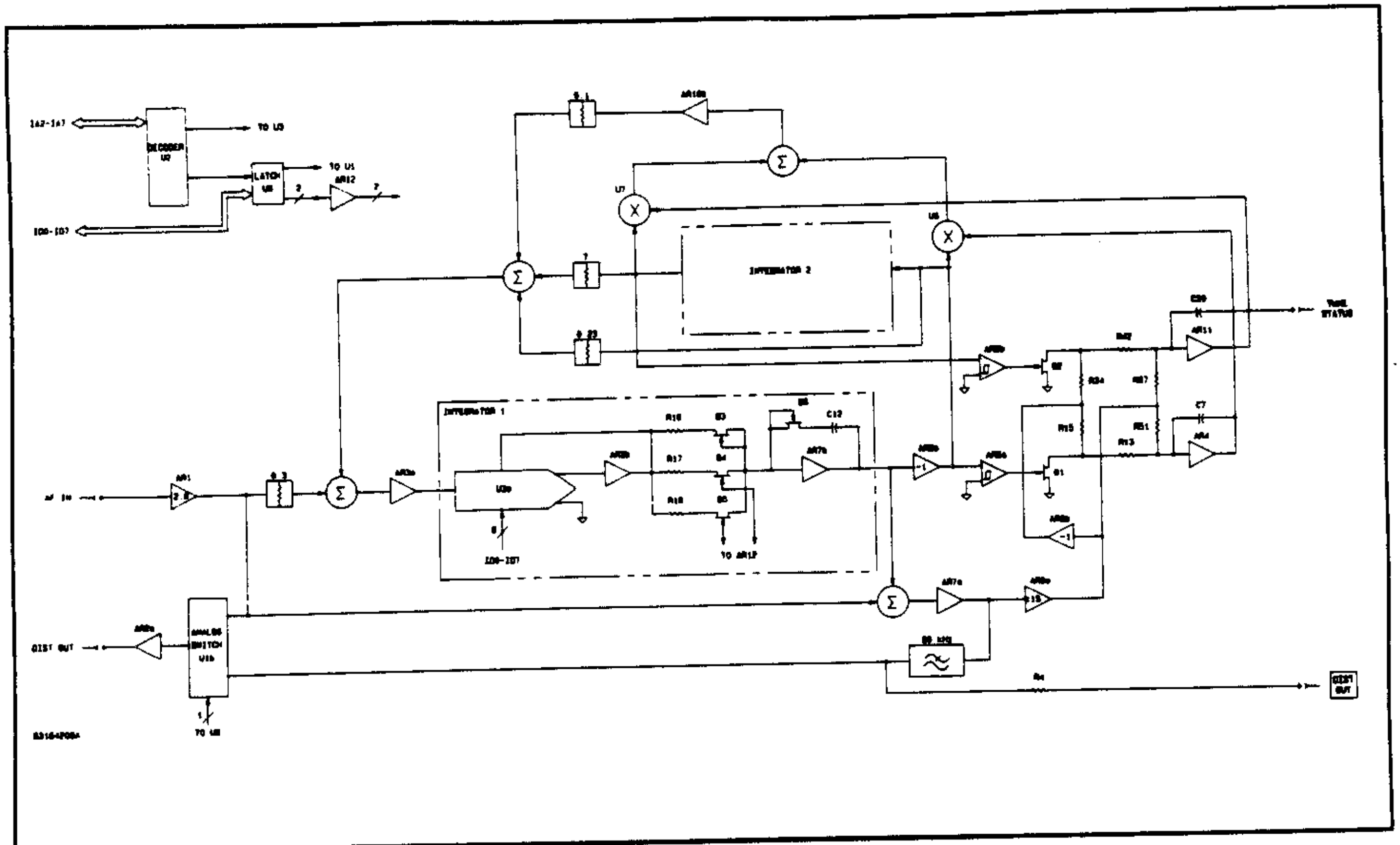


**FIGURE 4-8. Distortion Analyzer Block Diagram.**

4-81. Digital control signals for the filter board are latched from the instrument control bus by octal latches U2 and U6. Strobe signals to operate the latches are generated by address decoder U1.

## 4-82. THEORY OF OPERATION, DISTORTION ANALYZER

4-83. The distortion analyzer is an automatically tuned and balanced state-variable notch filter. The circuits operate in conjunction with the filter and detector circuits to produce a display of audio distortion in % or dB SINAD. See Figures 4-8 and 8-17.

4-84. The audio signal to be measured is applied to amplifier AR1 through ac coupling network C28 and R1. AR1 is configured for a gain of 2.82 as determined by R3 and R2. The signal is then connected to the notch generating circuits.

4-85. The notch filter consists of a state variable bandpass filter and a balance amplifier AR7a. The bandpass filter is tuned to the incoming audio signal by the control program. The output of the bandpass filter is subtracted from the input signal leaving only the harmonics and residual noise at the output of AR7a. Fine adjustment of the notch center frequency and the amplitude of the bandpass output is accomplished by two control loops which operate to reduce the in-phase and quadrature components of the signal at the output of the balance amplifier.

4-86. The individual integrators in the filter are identical, so only one will be described in detail. The output signal from summing amplifier AR3a is connected to the reference input of multiplying digital-to-analog converter (DAC) U3a. The gain from the reference input of the DAC to the output of amplifier AR3b is proportional to the digital data on the D0-D7 inputs. The output of AR3b drives resistors R16-R18 and transistor switches Q3-Q5 which are connected to the inverting input of AR7b. Integrating capacitor C12 is connected from the output of AR7b to the inverting input, completing the integrator circuit. Transistors Q6 and Q3 are always conducting and are used to reduce the residual distortion of the integrator stages. Transistors Q4 and Q5 may be turned on by the control program to change the integrator time constant in decade steps. Frequency range breakpoints are at 250 and 2500 Hz. Coarse tuning on each band is accomplished by changing the digital data inputs to the DAC. The tuning range is about one decade from 25 Hz to 250 Hz, in 1 Hz steps on the lowest band. The circuit values are adjusted such that when the digital data is 25 decimal, the frequency is about 25 Hz. Similarly, when the digital data is 250 decimal, the frequency is about 250 Hz.

4-87. The signal at the output of AR7a is amplified an additional 15 times by AR9a. The gain is determined by R30 and R31. Additionally, AR9b inverts the amplified signal to provide an out of phase signal used to generate a full-wave rectified signal for the tune and balance integrators. The rectifiers operate as follows: While switch Q2 is shorted to ground, a current flows in resistor R57. When switch Q2 opens twice as much current, of the opposite phase, flows in R42. Since the currents in R57 and R42 are 180 degrees out of phase, the net current flow is in the same direction as when Q2 is closed. The result is a full-wave rectified current. This produces a voltage at the output of integrator AR11 which drives four quadrant multiplier U7. The current output at Pin 4 of U7 is proportional to the product of the dc voltage at the output of the integrator AR11 and the ac voltage TP4. This current is summed back into the notch summing amplifier AR3a to cancel balance and tuning errors.

4-88. The notch output signal is filtered by an 80 kHz active low-pass filter consisting of amplifier AR2b, C2, C8, C15, R37, R49, and R50. This signal is connected through 600 ohm resistor R4 to the DIST OUT connector on the rear panel, and through switch U1b and buffer AR2a to the rms detector circuits.

4-89. Switch U1b is operated by the control program to monitor the input signal and the notch signal alternately. The ratio of these signals, times 100 is the distortion in percent. SINAD ratio is calculated by the control program and displayed in dB.

4-90. A tune status output signal is generated by attenuating and level shifting the dc output of the tune integrator. This signal is used by the control program to determine that the notch is properly tuned.

4-91. Decoder U2 generates data latch strobes for the circuits on the distortion analyzer board. A portion of octal latch U8 is used to store range data for the distortion analyzer.

4-92. Comparator AR12 is used to shift the TTL logic signal levels at the outputs to U8 to 15 volt logic signals to operate the FET range switches in the notch filter.

### 4-93. THEORY OF OPERATION, DETECTOR CIRCUITS.

4-94. The recovered modulation signals from the filter board are converted to dc signals by the detector circuits. The detectors include plus and minus peak detectors, an rms detector, a quasi-peak detector, and an average detector. See Figures 4-9 and 8-19.

4-95. The recovered modulation signal is ac coupled to analog switch U1 through coupling network C36 and R5. U1 is operated by the control program to connect the peak detector circuits to the audio signal or a ground reference established by R11 and C6.

4-96. The output of U1 is connected to the input of U13d through an equalizer network consisting or R12 and R13 and C37 and 38. This network compensates for a slight decrease in peak detector efficiency at about 250 kHz. U13d and U13c are voltage followers cascaded to drive the positive peak detector. The output of U13d also drives a precision inverter circuit consisting or U13a and R55a-R55d which in turn drives the negative peak detector through voltage follower U13b. This seemingly unnecessary symmetry is required because the full-scale resolution of the peak displays is 0.02%. The positive and negative peak detectors are identical circuits driven by audio signals that are 180 degrees out of phase.

4-97. Amplifier U15 and U19a and associated components are arranged as a positive peak detector. During the positive excursion of the audio signal, the output of U15 is driven positive; C20 then charges through CR3. U19a buffers the voltage across C20 and adds a small offset. When the output of U19a reaches a value equal to the positive peak of the waveform plus a small increment, the output of U15 goes negative and thus terminates the charging of C20. The output of U19a is then equal to the positive peak of the audio signal.

4-98. The small offset created by R24 and R25 is required to insure that there is a net positive charge on C20 when the signal on pin 3 of U15 is zero. Diode CR1 improves frequency response by limiting the voltage excursion at pin 6 of U15 at about -0.7 volts in the negative direction.

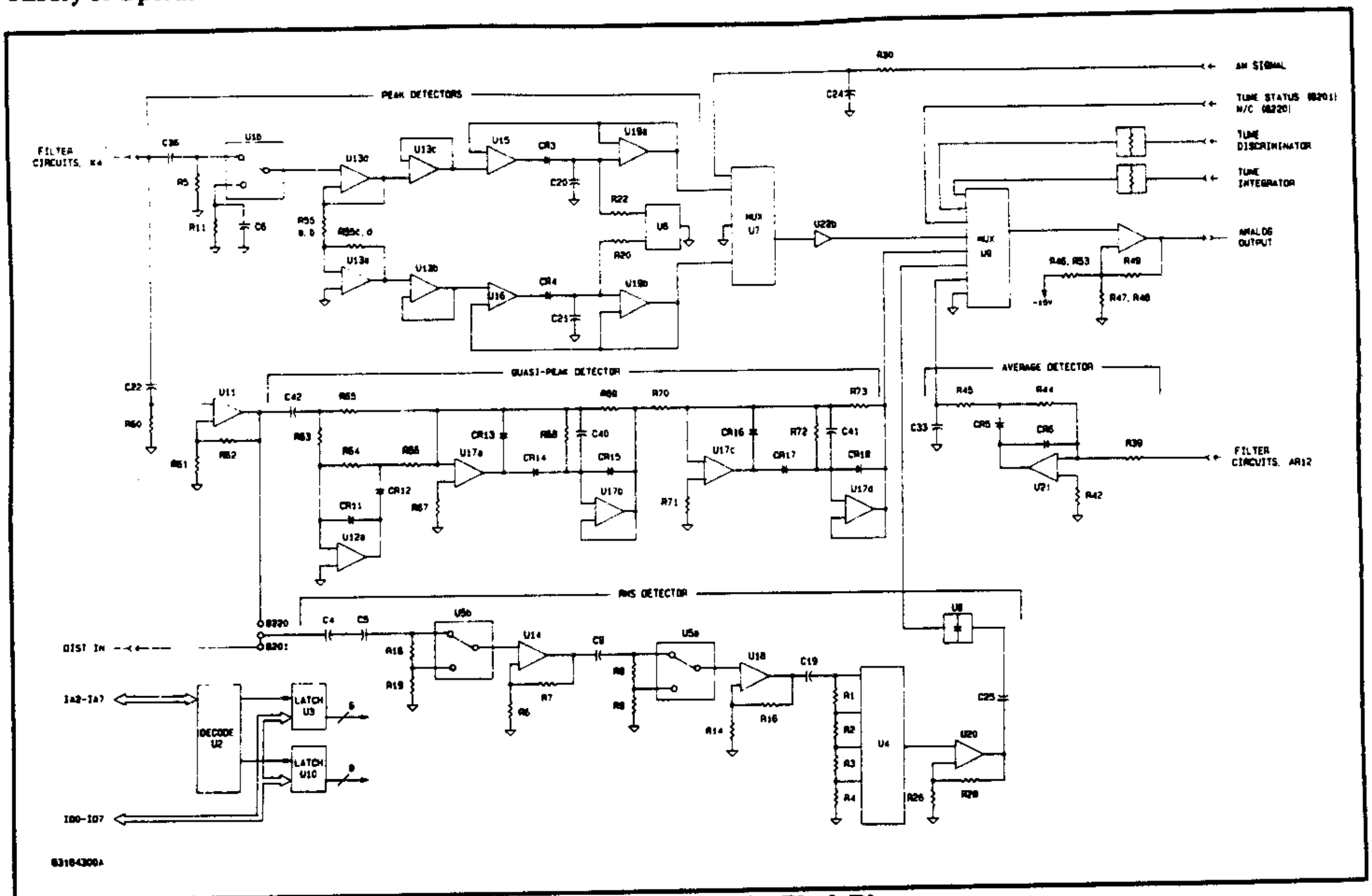



**FIGURE 4-9. Detector Circuits Block Diagram.**

4-99. The peak detector consisting of U16 and U19b and associated components operates in an identical manner, except that the audio signal at pin 3 of U16 is inverted, so that the positive output voltage at pin 7 of U19b represents the negative peak of the audio waveform.

4-100. Analog switch U6, R20 and R22 are connected across capacitors C20 and 21 to reset the peak detectors during the various phases of the peak measurement cycle.

4-101. The measurement cycle proceeds as follows: The control program asserts the peak detector reset signal discharging capacitors C20 and C21. Analog switch U1 is set to connect the ground reference network R11 and C6 to the input of U13d. After a short wait for transients to settle, the reset signal is removed and both peak detector outputs are measured. The measurements represent the zero input signal condition of the detectors. The reset signal is again asserted, and analog switch U1 is set to connect the audio input signal. The reset signal is again removed and both peak detectors are again measured. The measurement represents the output of the detectors including the input signal and offsets. The offsets are removed by the control program and the corrected measurement displayed on the front panel digital display. The measurement cycle is repeated by the control program as required. The peak average display is generated by adding the plus and minus peaks and dividing the result by two.

4-102. The outputs of the peak detectors and a dc signal from the AM detector are routed through an analog multiplexer, U7, to amplifier U22b. The circuit gain is three, as determined by R43 and R37, which brings the full-scale output of the peak detectors and the nominal output of the AM detector to about three volts. This signal is connected through analog multiplexer, U9, to a second amplifier U22a and associated components. This stage is designed to have a gain of about 2.04 and a dc offset of about 100 millivolts. Gain is required to increase the full-scale signal to about 6 volts for later analog-to-digital conversion; the offset is required to insure that inputs near zero volts still produce a positive dc output. The output of U22a is connected through the card edge to the CPU board.

4-103. Several other signals are connected to multiplexer U9. A signal representing the output of the frequency acquisition integrator is attenuated and level shifted by resistors R33, R34, and R35. When the output of the integrator is +10 volts, the voltage at the pin 5 of U9 will be about 3.7 volts and when the output of the integrator is -10 volts, pin 5 will be about 0.58 volts. A second voltage from the frequency acquisition discriminator is attenuated and level shifted by R38, R40, and R41. For discriminator voltages between +3 and -3 volts, the voltage at pin 4 of U9 will vary between 3.2 and 0.8 volts respectively.

4-104. The signal on pin 6 of U9 is a signal representing the tuning status of the distortion analyzer circuits. This signal is used to determine that the tuning integrator output voltage is within normal operating range. Pin 7 of U9 is grounded to provide a zero volt reference for the analog to digital converter. Three other inputs to U9 will be covered separately below.

4-105. A second audio signal is ac coupled by coupling network C4, C5, and R18 and R19 to analog switch U5. This signal originates on the distortion analyzer board and represents an amplified version of the signal at the peak detectors. R18 and R19 divide the input signal by ten, so that the signal at pin 3 of U14 is either the input signal, or the signal divided by ten, as determined by the setting of U5. The stage gain of U14 is set at 11.5 as determined by R6 and R7. Capacitor C7 provides high frequency compensation. Similarly, the output of U14 is connected to an attenuator consisting of R8 and R9, analog switch U5, and a second amplifier U18. Diodes CR7-CR10 and resistors R57-R59 speed overload recovery of U14 and U18. U18 is also configured for a gain of 11.5 and is ac coupled to an attenuator consisting of R1-R4 and analog switch U4. This attenuator is programmable for an attenuation of zero, six, fourteen, or twenty dB. Amplifier U20 is configured for a gain of 11.5 and is ac coupled to rms detector U8.

4-106. The complete amplifier/attenuator chain is programmable for a gain change of 0 to 60 dB (1000 times) in steps of 6 or 8 dB. Gain is established as required by the control program to maintain the output of the rms detector between about 1 and 3 volts dc, corresponding to rms inputs of 1 to 3 volts respectively. Capacitor C26 determines the low frequency characteristics of the rms detector and is selected to maintain modest errors down to about 10 Hz. The output at pin 6 of U8 is connected to multiplexer U9 as one of the possible inputs to the analog to digital converter.

4-107. An average detector consisting of U21 and associated components monitors the signal level at the input to the high-pass filter array. This detector is used to determine if an overload condition exists in the filter circuits, since the filters may attenuate an overrange signal before it is detected by the peak or rms detectors. This detector is also used for autoranging in the PM measurement mode.

4-108. The voltage at pin 2 of U21 is nearly zero due to the amplifier's high open loop gain. The voltage at the junction of C35 and R39 produces a current which also flows through R44, CR6, and CR5. If the current is sinusoidal, the current flows through R44 and CR5 on one half-cycle of the waveform, and through CR6 on the other half-cycle. The voltage at the junction of CR5 and R44 is thus half-wave rectified, and a dc voltage equal to the voltage peak divided by PI (3.14159) is produced. This voltage is connected to pin 10 of multiplexer U9 through filter R45 and C33. The filter removes the ac components from the rectified signal.

4-109. The quasi-peak detector consists of amplifiers U12a, and U17a-U17d and associated components. This circuitry is designed to meet the requirements of CCIR 468-3. U12a, CR11, CR12, and associated components are configured as an absolute value circuit. The output signal at the junction of R65 and R66 is a full-wave rectified current. U17a and U17b and associated components form a peak detector with a charge time of 2 milliseconds, and a decay time of 400 milliseconds. U17c and U17d and associated components form a peak detector with a charge time of 200 milliseconds, and a decay time of 600 milliseconds. The circuits are cascaded to meet the timing requirements of CCIR 468-3. The output is connected to pin 11 of multiplexer U9.

4-110. Octal latches U3 and U10 are used to store the control data from the instrument bus. The latch strobe signals are generated by address decoder U2.

4-111. Power supply decoupling is provided by L1, L2, C1, and C2. Additional supplies ( +5 and -5 volts) are generated on board by U23a and b, and resistors R27, R29, R31, and R32. Capacitors C10 and C13 provide filtering to reduce power supply noise.

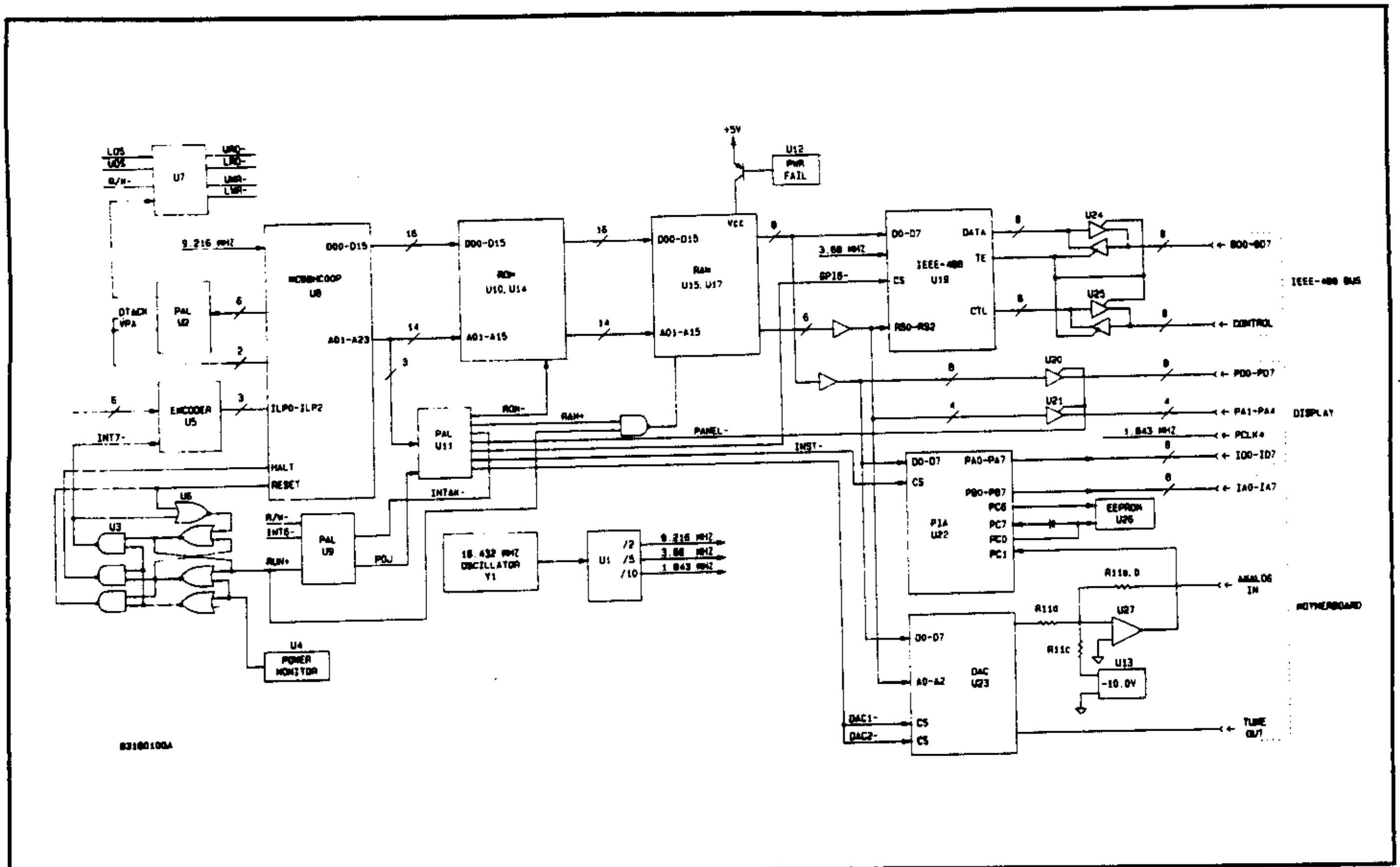


**FIGURE 4-10. CPU Circuits Block Diagram.**

## 4-112. THEORY OF OPERATION, CPU CIRCUITS.

4-113. The CPU circuits provide the microprocessor control of all functions of the instrument. Additionally, the IEEE-488 microcontroller is located on this board as are the tuning DAC, the A/D converter and instrument interface circuits. See Figures 4-10 and 8-21.

4-114. The output of crystal oscillator Y1 is connected to U1, a dual bi-quinary counter used to generate the various timing signals required by the CPU and display circuits. The microprocessor clock signal, CLK is 9.21 MHz which is the frequency of Y1 divided by two. The timing of the IEEE-488 controller is generated by dividing the output of Y1 by five. The resulting signal, SCLK is 3.686 MHz. The 3.686 MHz signal is divided by two again to provide the PCLK signal for operation of the keyboard display controllers on the I/O board.

4-115. The 68000 microprocessor executes a control program stored in read-only-memory, (ROM) U10 and U14. Program variables and front panel setups are stored in random-access-memory, (RAM) U15 and U17. Instrument control is accomplished via peripheral interface adapter U22, and IEEE-488 communications is controlled by microcontroller U19 with buffers U24 and U25. Analog-to-digital conversion is accomplished by one-half of DAC U23 in conjunction with reference U13, comparator U27 and precision resistor array R11. The other half of U23 is used to tune the local oscillator circuits.

4-116. Local communications on the CPU board are via the high-speed CPU data bus D00 through D15 and address bus A01 through A17. Address lines A18 through A23 are not utilized. Memory space is partitioned by PAL U11 as follows:

| Address | Function |
|---|---|
| 00000-0FFFF | ROM, U10 and U14 |
| 10000-1FFFF | RAM, U15 and U17 |
| 20000-20FFF | PIA, U22 |

**21000-21FFF ....................................A/D, conversion, U23A**
**22000-22FFF ....................................D/A, conversion, U23B**
**23000-23FFF ....................................I/O board, via U20 and U21**
**24000-24FFF ....................................IEEE-488, U19**

4-117. U15 and U18 are required to isolate a portion of the devices on the address and data buses to meet the loading requirements of the microprocessor and memories.

4-118. During power-up, the +5 volt supply is monitored by supply supervisor U4 and the POR- control line is held low as long as the supply is below about 4.75 volts. U4 also pulls POR- low if, after normal power-up, the supply drops below 4.75 volts. Capacitor C1 is required to reduce the influence of transients on the +5 volt supply and C2 establishes the time that the POR- line is held low after the supply reaches normal levels. This delay insures proper microprocessor reset operation.

4-119. A flip-flop consisting of gates U6a and U6d is set by the high output of gate U6b, and the microprocessor RESET- and HALT- inputs are pulled low through gates U3b and U3c. The active reset signal is also supplied to peripheral circuits through programmable logic array (PAL) U9. After the +5 volt supply reaches its nominal value, signal POR- goes high, the HALT- and RESET- lines go high and flip-flop U6a/U6d is reset. This flip-flop activates the RUN+ signal to enable operation of the RAMs.

4-120. The RAM integrated circuits are powered from a non-volatile power supply consisting of U12, Q1 and battery BT1. If the +5 volt supply drops below the battery voltage of about 3 volts, U12 automatically transfers the RAM supplies to the battery. At the same time power supply supervisor U4 causes the POR- line to be pulled low. This in turn causes a microprocessor interrupt priority 7, (NMI). The control program is stopped and a RESET instruction is executed which resets all peripheral circuits, again sets latch U6a/U6d, and stops normal program activity. Control line POJ- is not used in normal operation of the instrument and can safely be ignored.

4-121. Analog-to-digital conversion is accomplished by the control program, one-half of DAC U23, comparator U27 and precision resistor array R11. The analog signal to be measured is connected to pins 3 and 4 of R11 which parallels two of the precision resistors and connects them to pin 2 of U27. Connected to the same point is one precision resistor of R11 which is connected to the -10.0 volt reference U13. A second resistor of R11 is connected to the VOA output of DAC U23. The control program successively sets data bits and tests the output of U27 via PIA U22. The progression is from most significant to least significant bit. If the comparator changes states, the bit is reset, otherwise is is left set. This successive approximation continues until 13 bits are tested.

4-122. Control of the local oscillator tuning is accomplished with one-half of DAC U23. The 16-bit digital word representing the desired output of U23 (-10 to +10 Volts) is simply written to U23 and the output taken from the VOB terminal.

4-123. U19 is the IEEE-488 interface microcontroller. All IEEE-488 operations are conducted by this circuit in conjunction with the microprocessor interrupt routines. These routines move data into and out of RAM buffers as required and control program flow in response to bus commands. When bus activity occurs, U19 sets the INT5- line low. The microprocessor reads the interrupt status registers to determine the nature of the interrupt and responds accordingly. All bus state transitions are controlled by U19, thus insuring compliance with IEEE-488 timing requirements.

## 4-124. THEORY OF OPERATION, COUNTER CIRCUITS.

4-125. The counter circuits provide the frequency measurement functions for the Model 8201. Additionally, the calibration signals for internal detectors are generated on the counter circuit board. See Figures 4-11, 8-23, and 8-25.

4-126. A signal from 10.0 MHz crystal oscillator Y1 is divided by two by U20a, and by two again by U20b. The resulting 2.5 Mhz signal is connected to U22 for additional frequency division. The signal on pin 9 of U22 is 1.25 MHz and is used to generate the AM calibration signal. The signal on pin 15 of U22 is 1.221 kHz and is used to generate the AM and FM calibrator modulation. For a complete discussion of calibrator operation, refer to Section 5, Performance Test 12.

4-127. The output of crystal oscillator Y1 is also connected to gate U4a. The other input of U4a is a signal derived from the EXT REF input. If an external reference signal is present, pin 8 of U1b will be alternating between TTL low and high levels.

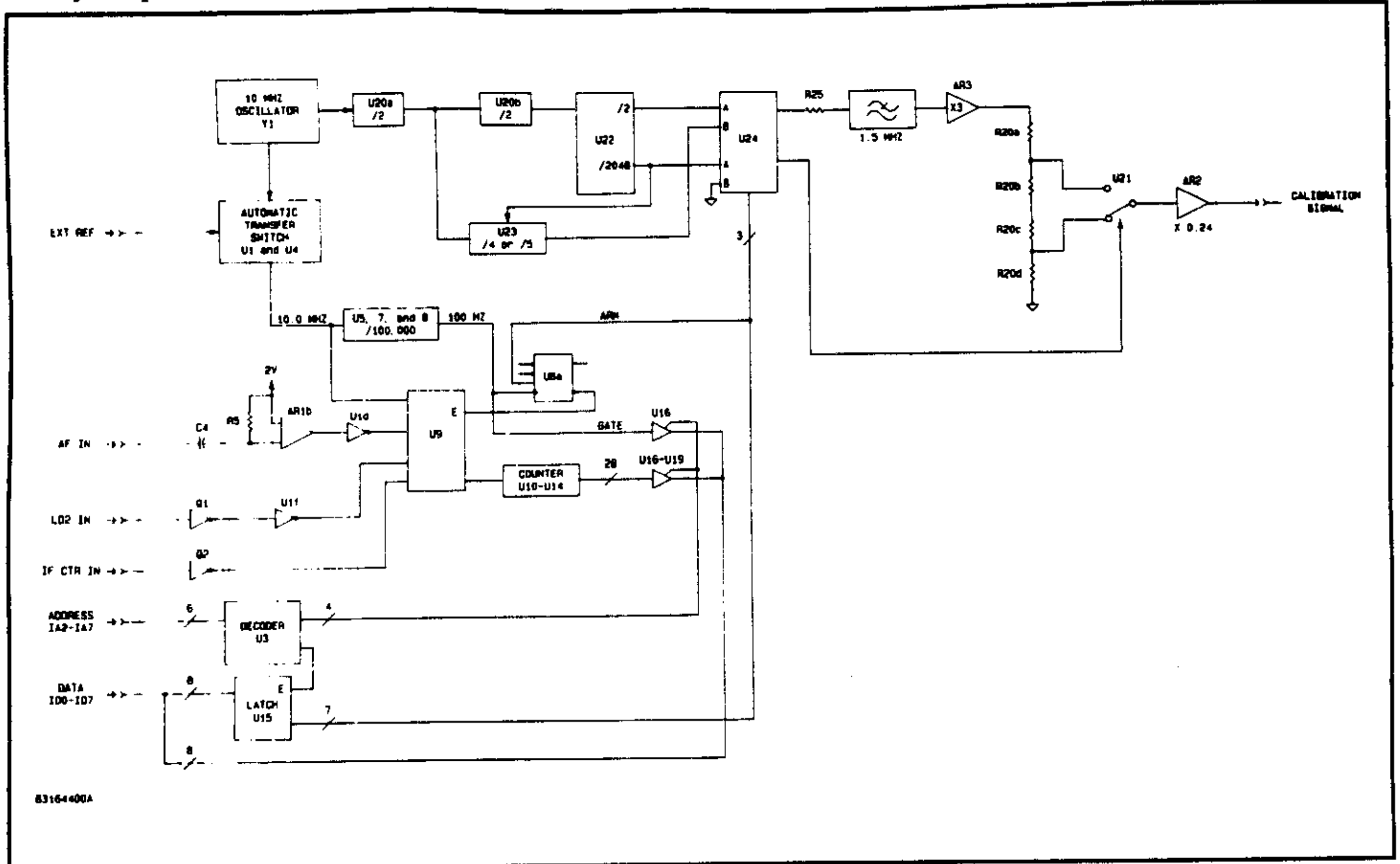



**FIGURE 4-11. Counter Circuits Block Diagram.**

The low level signal will cause CR1 to become forward biased and thus bias pin 1 of U1c low. The output of U1c will be high, which will enable U4b. This will allow the external timebase signal to appear at pin 6 of U4c. Simultaneously, the output of U1c is inverted by U1e to disable U4a, disconnecting the internal timebase signal. When the external signal is removed, the internal timebase signal will appear at pin 6 of U4c.

4-128. This signal is divided down to 100 Hz by U5, U7, and U8 and is the gate used for all frequency measurements made by the Model 8201. The gate signal is used to clock d-latch U6a and U6b, and an interrupt latch on the CPU circuit board, to interrupt the microprocessor every 10 milliseconds.

4-129. A sample of the local oscillator signal at pin 30 of the edge connector is amplified to TTL levels by Q1 and associated components. U1f further shapes the signal which is applied to data selector U9.

4-130. A sample of the intermediate frequency at pin 32 of the edge connector is similarly amplified by Q2 and associated components and connected directly to data selector U9.

4-131. A sample of the audio frequency signal at pin 34 of the edge connector is converted to TTL levels by AR1b and associated components. Operating bias is supplied by diode DS2 and R4. The output of AR1b is connected to data selector U9 through buffer U1d and to the clock input of U2b.

4-132. U2a and U2b are configured to synchronize one cycle of the audio signal to the interrupt cycle of the microprocessor. The control program arms the gate latch U6a by setting the D input high. On the rising edge of the 10 millisecond gate signal the Q output of U6a goes high. This clocks the high level D input of U2a to its Q output. The rising edge of the audio signal then transfers this high level to the Q output of U2b and allows the 10 MHz reference signal to pass through U4d to data selector U9. When the Q output of U2b goes high, the Q- output goes low and resets U2a. This clears the D input of U2b so that on the next positive transition of the audio signal the Q output goes low and disables the counting sequence. This mode of measurement is used for audio frequencies below 1 kHz.

4-133. When the audio frequency exceeds 1 kHz, the measurement is made by counting the number of zero crossings of the signal in one second. The actual gate interval is controlled by the firmware by allowing a fixed number of 10 millisecond gate cycles to elapse before the arming signal on the D input of U6a is removed. Each gate cycle causes a microprocessor interrupt. The program counts the number of times an interrupt has occurred since U6 was armed. When the correct number of cycles is reached, the sequence is stopped. The residue in the counter chain is then read and the counter is reset.

4-134. Carrier frequency measurements are made by counting the local oscillator for N gate cycles, where N is the harmonic number used to generate the intermediate frequency. The intermediate frequency is then measured, and the difference is calculated as the carrier frequency. The expression relating the three frequencies is:

$$Frf = N \times Flo - Fif$$

4-135. The output of U9 is the signal to be counted. The counter consists of U10, U12, U13, and U14. U10 and U12 are high speed binary dividers which are required to measure the local oscillator signal at 40 MHz. U13 and U14 are relatively slow speed CMOS 12-bit counters which always operate at less than 3 MHz. The counter has a total length of 28 bits which allows counting to greater than 260 MHz with a resolution of 1 Hz.

4-136. The outputs of the counters are connected to the instrument data bus via 3-state buffers U16-U19. The data is read by the microprocessor in 4, 8-bit bytes. Besides the frequency information, the gate and external reference status signals are read.

4-137. U15 is an 8-bit latch which is used to store instrument data bus information when the counter board is addressed by the microprocessor. Address decoder U3 decodes instrument addresses 8 through 11 to operate the select lines for U15-U19.

## 4-138. THEORY OF OPERATION, I/O CIRCUITS.

4-139. The I/O circuits provide an interface between the microprocessor and the front panel LED displays and keyswitches. See Figures 4-12, and 8-27.

4-140. U2 and U3 are keyboard/display microcontrollers. Each circuit is capable of controlling up to 16 digits of display and a 64 key keyboard. The Model 8201 requires more than 16 display digits, so two circuits are required, however, less than 64 keys are used, so that only one of the keyboard interfaces is used. U2 operates 14 displays including the FREQUENCY/LEVEL display and legends, and the AUDIO display and legends. U3 operates 14 displays including the MODULATION display, the modulation legends, the SPCL/PRGM display and legends, the IEEE-488 legends, and the keyswitch LEDs on the keyboard. Additionally, U2 handles all keyboard switches. When a key is depressed, U2 activates the INT- line via U1 to interrupt the microprocessor. The key closure is recognized by the control program by reading the data from U2 which releases the INT- line.

4-141. U1 is a dual decoder used to generate chip select signals from the address signals PA2-4. The two strobe signals at TP1 and 3 are used to select U2 and U3 respectively. One half of U1 is connected merely to invert the sense of the IRQ signal from U2 to the microprocessor. The panel interrupts are priority level 3. Signals from U2 and U3 are connected to the Display/keyboard via J3. LEDs DS1 and DS2 are activity indicators for the two, five volt supplies present on the I/O board.

## 4-142. THEORY OF OPERATION, DISPLAY AND KEYBOARD CIRCUITS.

4-143. The display and keyboard circuits provide the operator interface to the Model 8201 circuits. Key closures are detected and sent to the microprocessor which interprets them. The microprocessor then modifies the display LEDs appropriately. See Figures 4-13 and 8-29 through 8-33.

4-144. The software config[illegible]ble display/keyboard microcontroller circuits A11U2 and A11U3 on the I/O circuit board are programmed to operate 16 [illegible]lay digits. All the displays operated by A11U3 are connected to a common cathode driver bus which is generated by the s[illegible] lines DA01-DA31 and DB01-DB31. These signals are buffered by U1 and U3 and connected to the display cathodes thro[illegible]h current limiting resistors R1 and R2.

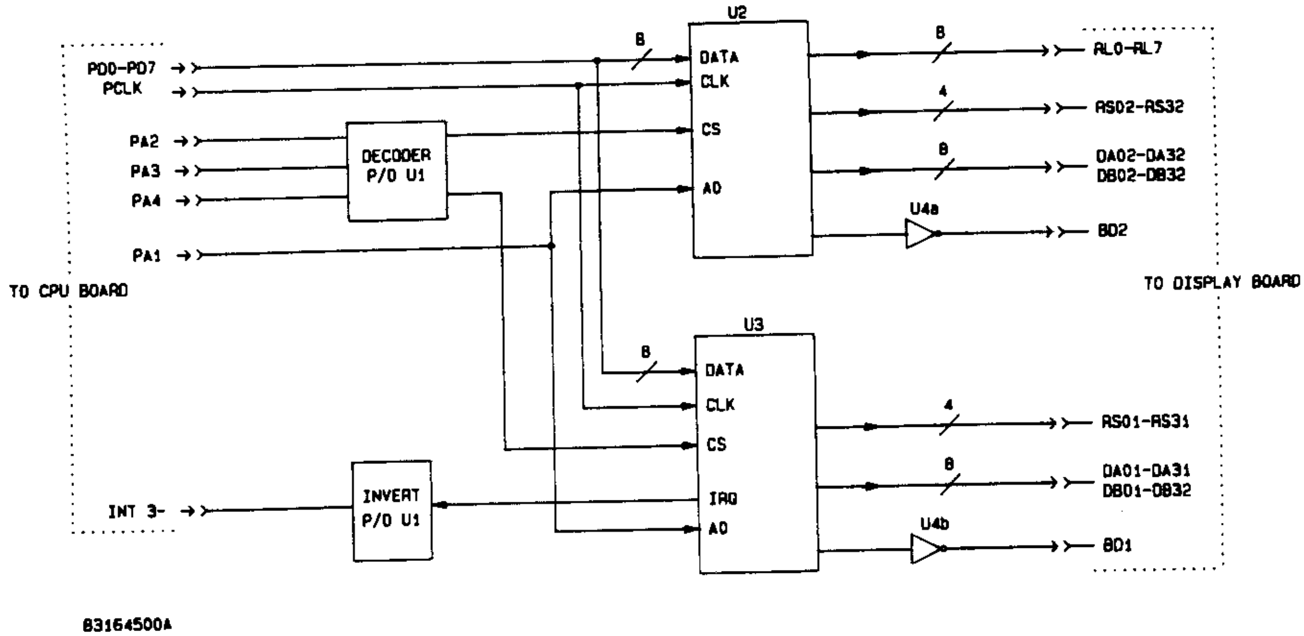



FIGURE 4-12. I/O Circuits Block Diagram.

4-145. The signals RS01-RS31 are connected to a one-of-sixteen decoder consisting of U2 and U4. The sixteen decoder output lines are connected to buffers U5 and U6 where the interdigit blanking is applied by signal BD1-. The signals are then connected to the display anodes via driver circuits U7 and U8. Note that only 6 of the 8 available outputs of U8 are used. All segment decoding is done by the microprocessor so that no additional decoders are required.

4-146. Similarly all the displays operated by A11U2 are connected to a common cathode driver bus which is generated by the signal lines DA02-DA32 and B02-B32. These signals are buffered by U9 and connected to the display cathodes through current limiting resistor R3.

4-147. The signals RS02-RS32 are connected to a one-of-sixteen decoder consisting of U10 and U12. Fourteen of the sixteen decoder output lines are connected to buffers U13 and U14 where the interdigit blanking is applied by signal BD2-. The signals are then connected to the display anodes via driver circuits U15 and U16. Five of the buffered lines from U16 are connected through J5 to the keyboard to operate the keyswitch LEDs. The keyswitch LEDs are connected into five common anode groups with eight common cathode lines. Separate cathode drive lines are generated for the keyboard LEDs by U11 and R4.

4-148. A second decoder, U17 is connected to the RS02-RS22 lines to generate a one-of-eight select signal to drive the keyswitches on the keyboard. The signal lines RL0-RL7 are also connected to the keyswitches. The resulting keyswitch matrix can accommodate sixty-four switches, of which 57 are used. The time division multiplexed signals from U17 are connected to the RL lines when a key is depressed. The keyboard controller, U2 on the I/O board, encodes the key response based on which RL line was active during the time one of the outputs of U17 was active. Multiple keyswitch closures and key debouncing are handled by U2. Keyswitch closures cause microprocessor interrupts as described in the I/O circuits theory.

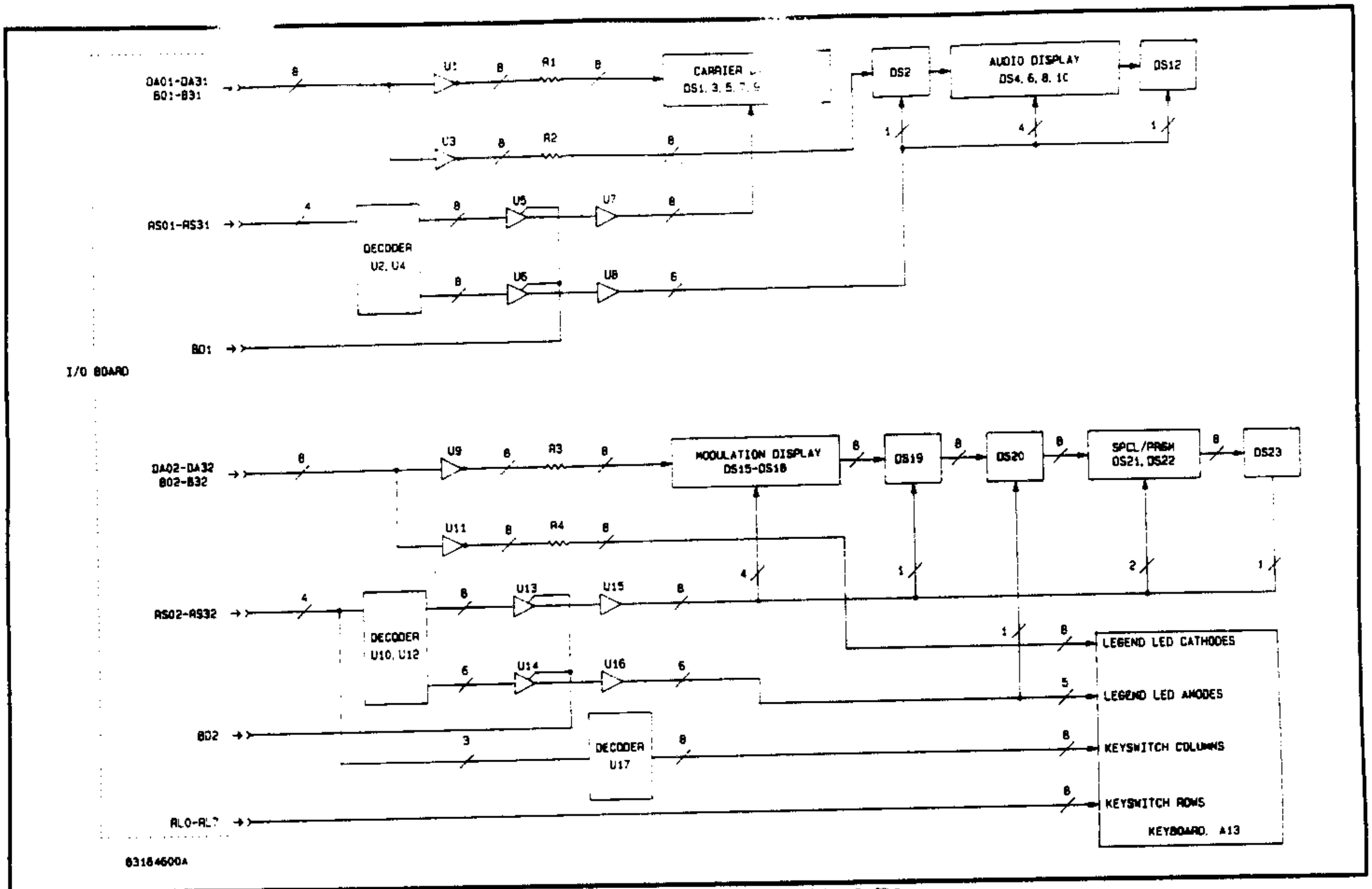



FIGURE 4-13. Display and Keyboard Block Diagram.

## 4-149. THEORY OF OPERATION, MOTHERBOARD/POWER SUPPLY

4-150. The motherboard circuitry provides the main interconnect for the operating circuits of the Model 8201. The motherboard contains the connectors for the plug-in boards, the regulated power supplies, the decoder and latch for the RF and oscillator circuits, and the power fail circuitry. See Figures 4-14, 8-3, and 8-4.

4-151. The instrument data lines ID0-ID7 are connected to latches U1 and U9 which are selected by decoder U2. Information on the data lines is latched into U1, and connected to the RF circuitry to operate the tuning and conversion circuits. ID0 is latched into U9 to operate analog switch U10 and switch Q1 to drive overload protect/attenuator module A30, for carrier inputs greater than +20 dBm.

4-152. Line power is connected to transformer T1 via line filter FL1, fuse F1, and line voltage selector switch S2. FL1 keeps internally generated RF signals from appearing on the power connecting cable, thus preventing unwanted electromagnetic radiation. Line switch S2 alters connections to the primary of T1 which allows the Model 8201 to be operated from line voltages from 100 to 240 volts.

4-153. One of the two secondary windings on T1 is connected through full-wave bridge CR1 to regulators U7 and U4. These three terminal regulators generate 5 volt regulated voltages for the instrument logic circuits and the front panel display. A separate regulator, U7, is used for the display and I/O circuits in order to minimize internally generated switching noise.

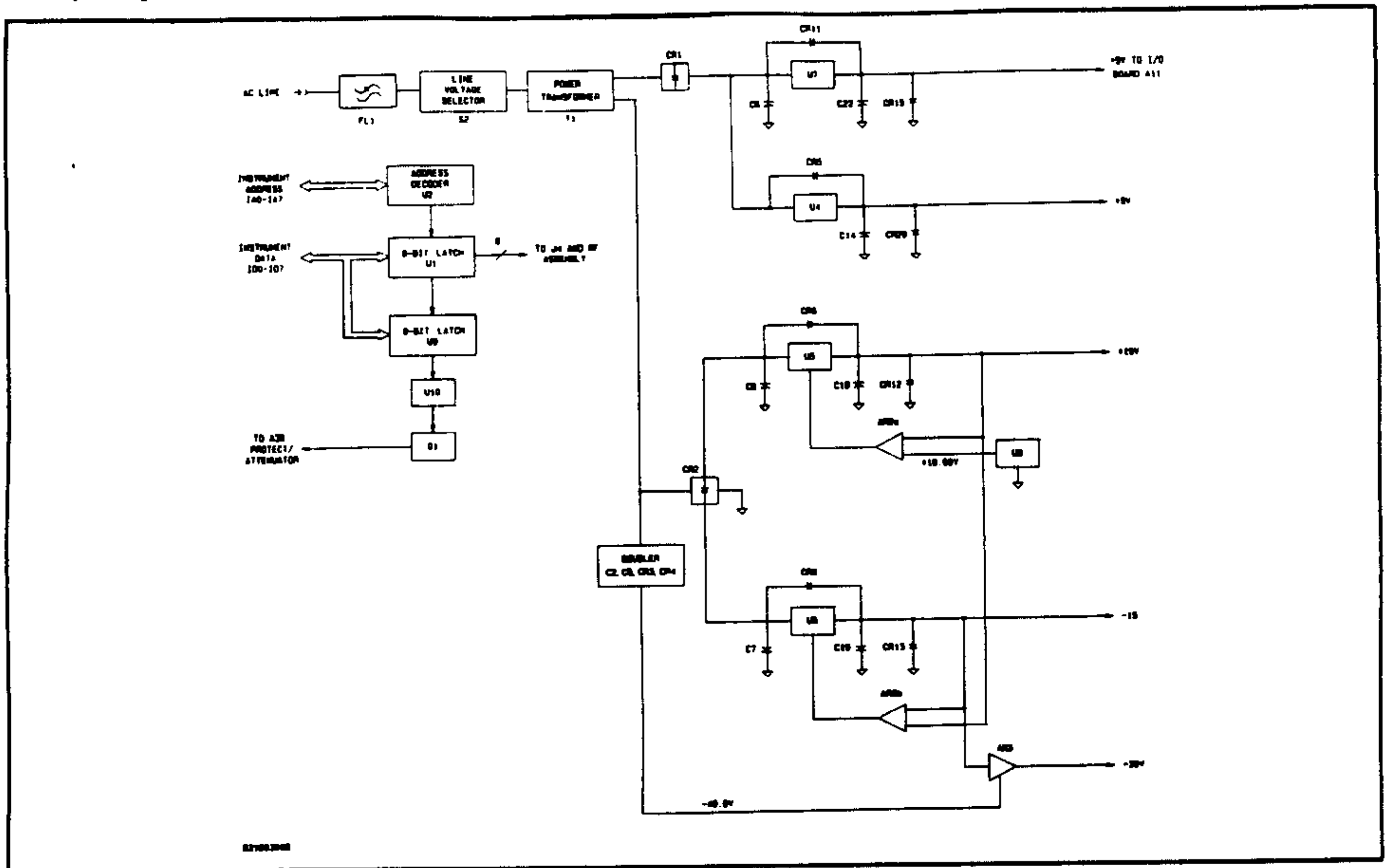


**FIGURE 4-14. Motherboard/Power Supply Block Diagram.**

4-155. The other secondary winding of T1 is connected through full-wave bridge CR2 to regulators U5 and U6. These regulators are enclosed in feedback loops to improve regulation and increase the operating voltages from 5 to 15 volts. Capacitors C8 and C10 reduce input ripple voltage and CR6, CR8, CR12, and CR13 provide reverse voltage protection. Reference U8 is the primary reference for the power supply circuits. Precision resistors R7a, R7b, and R7d configure AR2a for a gain of +1.5. This converts the +10.00 volt reference into +15.00 volts. R7e and R7f configure AR2b for a gain of -1 which inverts the +15.00 volt supply into -15.00 volts. Zener diodes CR7 and CR9 are required to insure proper startup of the supply and are normally reverse biased when the supply is operating properly. C18 and C19 provide local bypassing to maintain loop stability as the supply loading changes.

4-156. A voltage doubler circuit consisting of C2, C3, CR3, and CR4 produces a dc output of about -40 volts at nominal line. This voltage is regulated to produce a -30 volt level required by the oscillator circuits. R7g and R7h configure AR3 for a gain of exactly +2 which amplifies the -15.00 volt supply to -30.00 volts.

4-157. As a troubleshooting convenience, each supply has an activity LED connected to its output. DS1-DS5 will normally be illuminated when the supplies are operating properly.

## 4-158. THEORY OF OPERATION, OPTIONAL FILTER BOARD

4-159. The optional filter board, A15, permits three different bandpass filters, and external input connectors to be inserted into the Filter Circuits signal path. Any or all of these options can be installed at one time. See Figures 8-34 through 8-39.

4-160. A signal from the Filter Circuits, A6AR12, is connected via P1, pin 21 to the input pins 12, 22, and 32 of the three optional bandpass filters. This signal is also connected through R2, which establishes a 600 ohm source impedance, and J2 to the rear panel AUDIO OUT connector. Diodes CR1 and CR2 provide reverse power protection.

4-161. The AUDIO IN signal from the rear panel appears at J1. R1 establishes the 1 Megohm input impedance, and R3, CR3, and CR2 provide input over-voltage protection. C1 improves high frequency response. This signal, and the outputs from the three optional filter boards are connected to analog multiplexer U3, a dual 4 input mulitplexer. The multiplexer is operated by the control program based on the front panel selection of alternate filter.

4-162. Amplifier U4a is a unity gain buffer which is necessary to provide the last stage of the CCITT filter circuit. U4b is connected to an array of variable and fixed resistors which determine the gain of each selected filter. R5, R6, R10, and R13 are adjusted for nominal gain at the reference frequency for the selected filter.

4-163. A ground connection from each filter assembly (pins 14, 24, and 34) and a 2-circuit jumper between pins 7 and 8 of J3 provide a means of identifying which filter options are installed. These lines are pulled to +5 volts by R4. If one of the filter assemblies is not installed, the signal line associated with that assembly will be at +5 volts. Conversely, if the assembly is installed, the line will be pulled to ground. At power-up the control software checks the state of these lines via programmable array U2, and determines which filters are present.

4-164. U1 is an 8-bit latch which is operated by the control program to select one of the four possible filter connections.

## 4-165. THEORY OF OPERATION, OPTIONAL 50 MHZ CALIBRATOR CIRCUITS.

4-166. The 50 MHz calibrator circuits provide an accurate output signal to calibrate the Model 8201 carrier LEVEL measurement. See Figure 8-40.

4-167. The output signal is generated by oscillator Q1 and associated components. The circuit oscillates at approximately 50 MHz as controlled by C11, L2 and adjustable capacitor, C12. The circuit is adjusted until the frequency is 50 + - 0.5 MHz. The signal at the junction of C9 and L2 is rectified by CR2 and connected to operational amplifier AR1. A second input to AR1 is provided by precision reference IC1 through adjustable divider R7, R4, and R1 and compensation diode CR1. The error voltage between pins 2 and 3 of AR1 is amplified and applied to varactor CR3, which forms part of a voltage variable divider. This variable signal is connected to the base of Q1 to complete the oscillator feedback loop. The circuit is an automatic gain control which maintains the output voltage at exactly 0.223 volts as determined by the setting of R4.

4-168. Capacitors C9 and C10 provide impedance matching, and R15 determines the output resistance. Inductor L3 is provided to compensate the slightly capacitive output impedance.

# SECTION V
# PERFORMANCE TESTS

## 5-1. INTRODUCTION.

5-2. The following procedures verify the performance characteristics of the Modulation Analyzer. Detailed tests against specification are included to verify all operational features, including options.

**NOTE**

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

## 5-3. EQUIPMENT REQUIRED.

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

**NOTE**

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

## 5-5. TEST RECORD.

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

## 5-7. CALIBRATION INTERVAL.

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

## 5-9. INITIAL CALIBRATION.

5-10. Initial calibration is performed before detailed performance testing to insure that all detectors are functioning properly.

## 5-11. PROCEDURE.

1. Set the LINE ON/OFF switch to ON and depress the LCL/INIT key to initialize the instrument, after the selfcheck program completes.
2. Select SPCL function 30, which calibrates the modulation detectors.
3. Any errors reported during calibration, indicate an operational failure.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT.

| INSTRUMENT | CRITICAL SPECIFICATIONS | USAGE | | MODEL |
|---|---|---|---|---|
| | | PERFORMANCE EVALUATION | MAINTENANCE | |
| AM-FM Signal Generator | **Frequency Range:** 0.01 to 1000 MHz, **Level Range:** -50 to +19 dBm | X | X | Boonton Model 1021 |
| Synthesizer, CW | **Frequency Range:** 0.01 to 1300 MHz **Residual FM** < 1Hz, 3 kHz BW **Residual AM** < -80 dBc, kHz BW | X | X | Adret Model 7100A |
| Audio Analyzer | **Frequency Range:** 20 Hz to 20 kHz **Level Range** .6 mV to 6 V into 600 ohms **Distortion** < 0.05% | X | X | Boonton Model 1120 |
| Test Oscillator | **Frequency Range:** 5Hz to 500 kHz **Level Range:** 0 to 3 V rms **Flatness:** +- 0.3 dB | X | | Tektronix Model SG502 |
| Spectrum Analyzer | **Frequency:** 1.2 MHz **Resolution BW:** 0.1 kHz **Frequency span:** 1 kHz | X | | HP Model 8566B |
| Modulator | **Frequency:** 30 MHz **Flatness :** < 0.3%, 20 Hz to 220 kHz **Distortion:** < 0.15% at 90 % AM | X | | Boonton 96400501A |
| Low-pass filter | 5-pole response, 3dB corner, 50 MHz | X | X | Mini-Circuits NLP-50 |
| RF Calibrator | **Frequency:** 30.0 MHz, crystal **Level Range:** -60 to +20 dBm **Accuracy:** 0.105 dB | X | X | Boonton Model 2520 |
| DC Power Supply | **Range:** 0.00 to 10.0 volts. | X | | Power Designs Model 5015T |
| Multimeter | **Range:** 0.001 to 100 volts, dc. | | X | Fluke Model 8840A |

TABLE 5-1. RECOMMENDED TEST EQUIPMENT CONTINUED.

| INSTRUMENT | CRITICAL SPECIFICATIONS | USAGE | | MODEL |
|---|---|---|---|---|
| | | PERFORMANCE EVALUATION | MAINTENANCE | |
| **Variac/Line Monitor** | 20% variation about 100, 120, or 240 Volts | X | | **Powerstat 3PN116B** |
| **Power Meter** | **Frequency Range:** 10 MHz to 1.3 GHz. **Accuracy:** ± 0.5 dB | X | X | **Boonton Model 4220** |
| **Network Analyzer** | **Frequency Range:** 10 MHz to 2 GHz. | X | | **PMI Model 1038-NS20/ 1038-NS207** |
| **SWR Autotester** | **Directivity:** 38 dB | X | | **Wiltron Model 560-97NF50** |
| **RF Millivoltmeter ♦** | **Frequency Range:** 100 kHz to 10 MHz. **Accuracy:** ± 2% | X | | **Boonton Model 9200** |
| **Precision resistor ♦** | **Value:** 50.00 ohms ± 0.1% | X | | **Mepco PME-55** |
| **Oscilloscope** | **Frequency Range:** DC to 100 MHz. 0.005 to 50 volts with 10X probes | | X | **Hewlett-Packard Model 1740A** |
| **Bus Analyzer** | **Real time display of IEEE-488 bus activity.** | | X | **Hewlett-Packard Model 59401A** |
| **Milliwatt Test Set ♦** | **Level Accuracy:** ± 0.015 dBm at 0 dBm. | X | | **Wandel and Golterman EPM-1 with TK-10 probe** |
| **Time Standard** | **Frequency:** 10.0000 MHz **Stability:** $1 \times 10^{-10}$ per day | X | | **House Standard** |
| **Wave Analyzer** | **Resolution:** 3 Hz bandwidth at 1 kHz. **Dynamic Range:** > 100 dB | | X | **Hewlett-Packard Model 3581A** |

**♦ This equipment is required only if calibrator option is installed or for optional VSWR tests.**

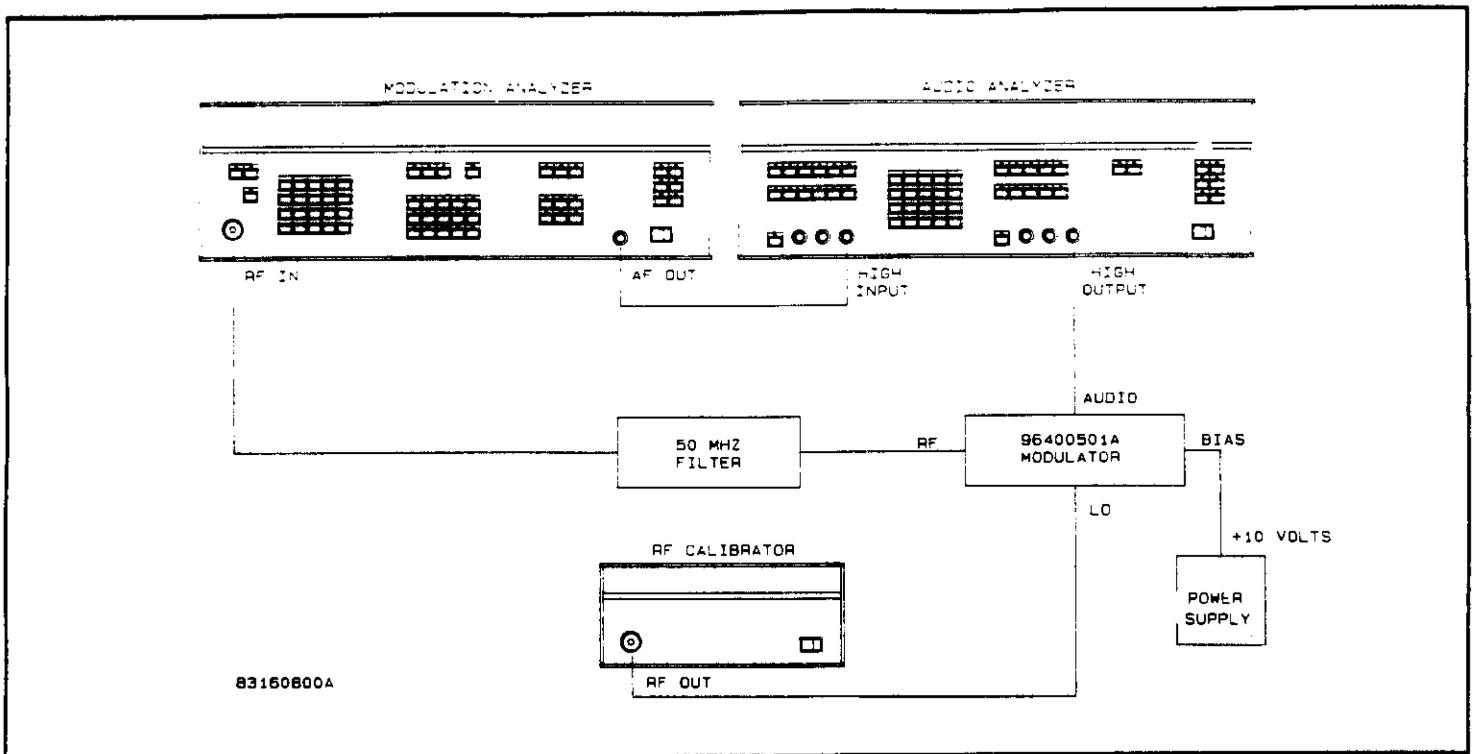



FIGURE 5-1. Measurement Setup #1.

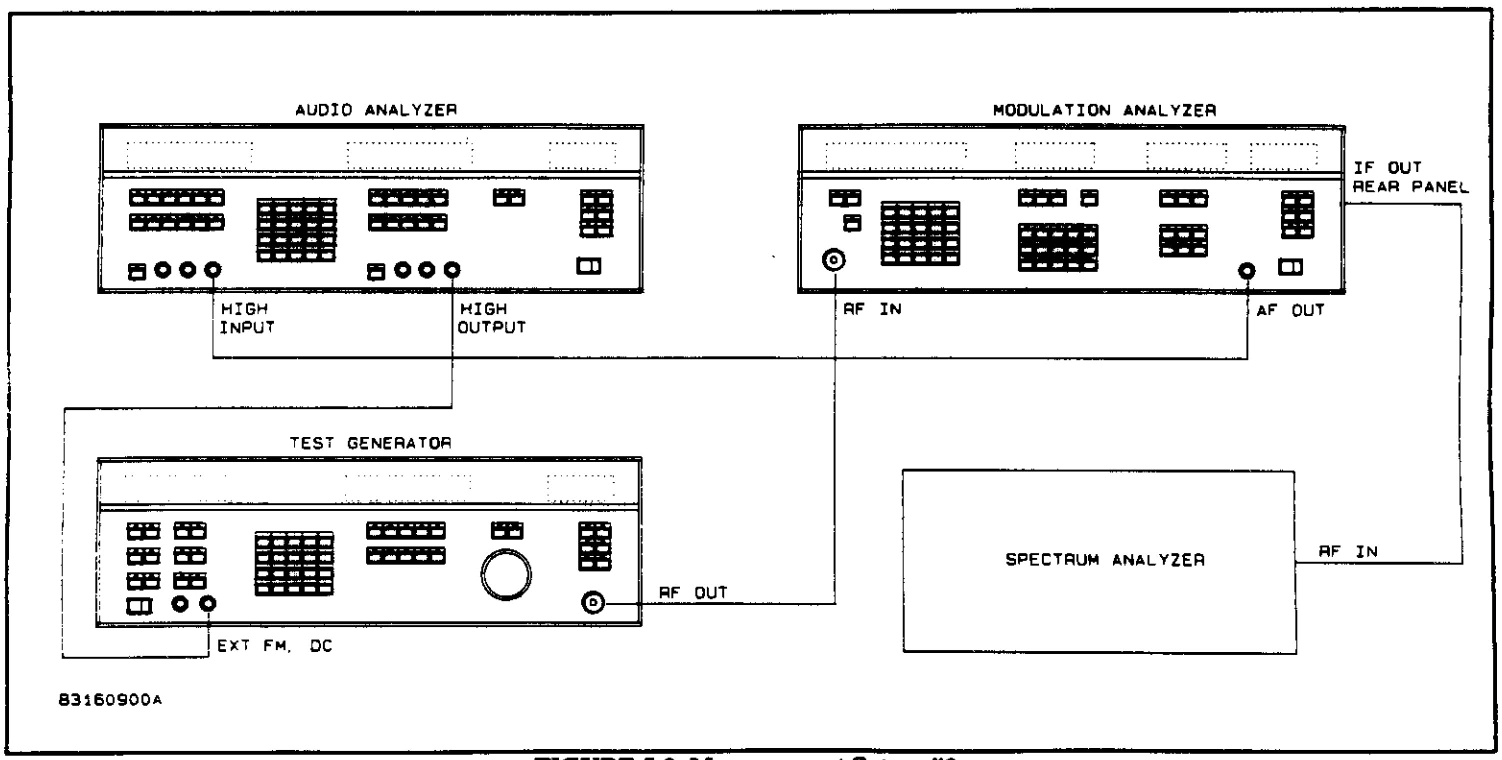



FIGURE 5-2. Measurement Setup #2.

# PERFORMANCE TEST 1

# AM MODULATION ACCURACY AND RESIDUALS

**Specification**

: ± 1%, 30 Hz to 5 kHz, Frf 0.1 to 0.5 MHz
: ± 2%, 30 Hz to 7.5 kHz, Frf 0.1 to 0.5 MHz
: ± 1%, 30 Hz to 15 kHz, Frf 0.5 to 10 MHz
: ± 2%, 30 Hz to 30 kHz, Frf 0.5 to 10 MHz
: ± 1%, 30 Hz to 100 kHz, Frf > 10 MHz
: ± 2%, 30 Hz to 150 kHz, Frf > 10 MHz
: residual 0.05%, 15 kHz bandwidth, level > 100 millivolts
: residual 0.02%, 3 kHz bandwidth, level > 100 millivolts
: incidental FM 20 Hz peak at 50% AM, 3 kHz bandwidth
: incidental PM 0.02 RAD at 50% AM, 3 kHz bandwidth

## 5-12. DESCRIPTION.

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

## 5-14. PROCEDURE.

1. Connect the equipment as shown in Figure 5-1. Note that the power supply is set to 10.0 ± 1 volts.

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

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

4. Select the AM modulation mode and depress the CAL key. The calibration routine will display the -CAL- message in the FREQUENCY/LEVEL window and the AM indication in the MODULATION window. Record the modulation indication.

5. Select the <10 high-pass and 220 kHz low-pass filters, and SPCL function 5 to enable the slow detector mode.

6. Adjust the Audio Analyzer for an AM indication of about 47.00% at a 1 kHz rate and select the Modulation Analyzer percent RATIO display mode.

### NOTE

*The following procedures assume that the Audio Analyzer Level flatness is better than 0.5%. This should be verified before continuing.*

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

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

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

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

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

12. Select the 15 kHz low-pass filter and record the indication.

Table 5-2. AMPLITUDE MODULATION

| FREQUENCY | FILTER SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 30 Hz | 220 kHz | 99.00 | ______ | 101.00 |
| 100 Hz | 220 kHz | 99.00 | ______ | 101.00 |
| 10 kHz | 220 kHz | 99.00 | ______ | 101.00 |
| 50 kHz | 220 kHz | 99.00 | ______ | 101.00 |
| 100 kHz | 220 kHz | 99.00 | ______ | 101.00 |
| 150 kHz | 220 kHz | 98.00 | ______ | 102.00 |
| Incidental FM | 30 Hz-3 kHz | | ______ | 20 Hz |
| Incidenal PM | 30 Hz-3 kHz | | ______ | 0.02 RAD |
| Residual AM | 30 Hz -3 kHz | | ______ | 0.02% |
| Residual AM | 30 Hz -15 kHz | | ______ | 0.05% |

# PERFORMANCE TEST 2

# AUDIO FILTERS

| | |
|---|---|
| **Specification** | : ± 4% corner accuracy |

## 5-15. DESCRIPTION.

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

## 5-17. PROCEDURE.

1. Connect the equipment as in Fig. 5-1. Note that the power supply is set to 10.0 ± 1 volts.

2. Depress the LCL/INIT key to initialize the instrument, then execute SPCL functions 7 and 9 to set pre-display de-emphasis, on AM.

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

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

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

6. Set the Audio Analyzer test frequency for each high-pass filter in Table 5-3, then depress the key to select the filter, and record the ratio indication.

7. Select the <10 Hz high-pass filter and set the Audio Analyzer test frequency for each de-emphasis filter in Table 5-3. Depress the key to select the filter, and record the ratio indication.

8. Turn the de-emphasis filters off, select the 30 Hz high-pass filter. Set the Audio Analyzer test frequency for each low-pass filter in Table 5-3 except the 50 and 220 kHz, then depress the key to select the filter. Record the ratio indication.

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

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

11. Select the 50 kHz low-pass filter, depress the RATIO key and increase the Test Oscillator frequency until the ratio indication is 70.7%. Record the audio FREQ display indication.

12. Select the 220 kHz low-pass and continue to increase the Test Oscillator frequency until the ratio indication is again 70.7%. Record the audio FREQ display indication.

Table 5-3. AUDIO FILTERS

| FILTER | SOURCE SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| **High-pass:** | | | | |
| < 10Hz | 30 Hz | 99.50 | ________ | 100.50 |
| 30Hz | 30 Hz | 67.50 | ________ | 73.70 |
| 300Hz | 300 Hz | 67.50 | ________ | 73.70 |
| 3000Hz | 3000 Hz | 67.50 | ________ | 73.70 |
| **De-emphasis:** | | | | |
| 25 uS | 6.366 kHz | 67.50 | ________ | 73.70 |
| 50 uS | 3.188 kHz | 67.50 | ________ | 73.70 |
| 75 uS | 2.122 kHz | 67.50 | ________ | 73.70 |
| 750 uS | 212.2 Hz | 67.50 | ________ | 73.70 |
| **Low-pass:** | | | | |
| 3 kHz | 3 kHz | 67.50 | ________ | 73.70 |
| 15 kHz | 15 kHz | 67.50 | ________ | 73.70 |
| 20 kHz | 20 kHz | 67.50 | ________ | 73.70 |
| 50 kHz | 50 kHz approx. | 48.00 | ________ | 52.00 |
| 220 kHz | 220 kHz approx. | 211.2 | ________ | 228.8 |

# PERFORMANCE TEST 3

# AMPLITUDE MODULATION, DISTORTION

**Specification** : 0.3% for depths of 90%,

## 5-18. DESCRIPTION.

5-19. The amplitude modulation distortion is verified by applying the output of a low-residual, wideband, linear modulator to the input of the Modulation Analyzer. The Audio Analyzer level is then adjusted for 90% and the recovered modulation distortion is displayed using the internal distortion analyzer which has to be verified before this test.

## 5-20. PROCEDURE.

1. Depress the LCL/INIT key to initialize the Modulation Analyzer.
2. Connect the equipment as in Figure 5-1, and select the Modulation Analyzer AM modulation measurement mode.
3. Set the Audio Analyzer to 1 kHz and adjust the level for an AM indication of 90.0 ± 0.5%.
4. Select the audio DIST mode and record the indicated distortion.

Table 5-4. AMPLITUDE MODULATION, DISTORTION

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

# PERFORMANCE TEST 4

# FM MODULATION ACCURACY AND INCIDENTAL AM

| | |
|---|---|
| **Specification** | : ± 1%, 30 Hz to 5 kHz, Frf 0.2 to 0.5 MHz<br>: ± 2%, 30 Hz to 7.5 kHz, Frf 0.2 to 0.5 MHz<br>: ± 1%, 30 Hz to 15 kHz, Frf 0.5 to 10 MHz<br>: ± 2%, 30 Hz to 30 kHz, Frf 0.5 to 10 MHz<br>: ± 1%, 30 Hz to 100 kHz, Frf > 10 MHz<br>: ± 2%, 30 Hz to 150 kHz, Frf > 10 MHz<br>: incidental AM 0.2% AM peak at 50kHz peak deviation Frf > 10 MHz<br>: incidental AM 0.2% AM peak at 5 kHz peak deviation Frf < 10 MHz |

**5-21. DESCRIPTION.**

**5-22.** The FM accuracy is verified by using the internal calibrator which is exactly 125.0 kHz ± 0.1% at a 1.220 kHz rate. The FM flatness is then tested by applying the FM modulated output of the Test Generator to the input of the Modulation Analyzer. The Audio Analyzer frequency is then varied from 30 Hz to 5 kHz, and a modulation RATIO change is noted. Higher audio frequencies are tested by using Bessel null measuremnents at specific audio frequencies. The audio frequency is then set to 1 kHz and the incidental AM is checked at 50 kHz and 5 kHz deviation.

## NOTE

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

**5-23. PROCEDURE.**

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

2. Depress the LCL/INIT key to initialize the Modulation Analyzer.

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

4. Adjust the Audio Analyzer Source to 0.7 volts at 1 kHz, and program the Test Generator for 50 kHz deviation.

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

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

## NOTE

*The following procedures assume that the Audio Analyzer Level flatness is better than 0.5%. This should be verified before continuing.*

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

8. Temporarily disconnect the Audio Analyzer from the Test Generator and adjust the Spectrum Analyzer for a full scale indication of the unmodulated carrier. Reconnect the Audio Analyzer signal.

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

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

11. When the deviation reading settles, select SPCL function 3 to hold the 50.00 modulation range, and temporarily disconnect the the Audio Analyzer from the test generator. Subtract the residual reading from the deviation indication and record the difference.

12. Select SPCL function 1 to resume autoranging, then repeat the above procedure at 41.583 kHz and 100 kHz.

13. Replace the Audio Analyzer in the test setup with the test oscillator and perform the null at 150 kHz. Discount the residual indication as above and record the ratio indication.

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

15. Change the test generator frequency to 5 MHz, and adjust the Test Oscillator for a deviation of 5 kHz peak at a 1 kHz rate. Select the AM modulation measurement of the Modulation Analyzer and record the indication.

Table 5-5. FREQUENCY MODULATION ACCURACY

| FILTER | SOURCE FREQUENCY | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| < 10-220 kHz | 30 Hz | 99.00 | ________ | 101.00 |
| < 10-220 kHz | 100 Hz | 99.00 | ________ | 101.00 |
| < 10-220 kHz | 500 Hz | 99.00 | ________ | 101.00 |
| < 10-220 kHz | 1000 Hz | | Reference | |
| < 10-50 kHz | 4.1583 kHz | 9.90 | ________ | 10.10 |
| < 10-220 kHz | 41.583 kHz | 99.00 | ________ | 101.00 |
| < 10-220 kHz | 100 kHz | 238.1 | ________ | 242.9 |
| < 10-220 kHz | 150 kHz | 353.5 | ________ | 367.9 |
| CALIBRATION | | 123.8 | ________ | 126.3 |
| INCIDENTAL @ 500 MHz | | | ________ | 0.2% |
| INCIDENTAL @ 5 MHz | | | ________ | 0.2% |

# PERFORMANCE TEST 5

# FREQUENCY MODULATION, DISTORTION

| | |
|---|---|
| **Specification** | : 0.1% for deviations < 30 kHz, Frf 0.2 to 0.5 MHz |
| | : 0.1% for deviations < 75 kHz, Frf 0.5 to 10 MHz |
| | : 0.1% for deviations < 100 kHz, Frf > 10 MHz |

## 5-24. DESCRIPTION.

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

## 5-26. PROCEDURE.

1. Depress the LCL/INIT key to initialize the Modulation Analyzer.

2. Connect the RF output of the Test Generator to Modulation Analyzer RF IN connector. Set the Generator for 15.211 MHz, 0 dBm, and 3 kHz FM deviation at a 1 kHz rate.

3. Select the 300 Hz high-pass, 3 kHz low-pass, and the RMS detector. Execute SPCL 18 to select the √RMS detector, and enter 15.0 MHz into the FREQUENCY/LEVEL display.

4. Select the FM modulation mode, and when the reading settles, depress the RATIO and %/Hz keys.

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

### CAUTION

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

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

Table 5-6. FM MODULATION DISTORTION.

| FREQUENCY | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|
| 14.10 MHz | -0.40 | ________ | +0.4 |
| 14.20 MHz | -0.40 | ________ | +0.4 |
| 14.30 MHz | -0.40 | ________ | +0.4 |
| 14.40 MHz | -0.40 | ________ | +0.4 |
| 14.50 MHz | -0.40 | ________ | +0.4 |
| 14.60 MHz | -0.40 | ________ | +0.4 |
| 14.70 MHz | -0.40 | ________ | +0.4 |
| 14.80 MHz | -0.40 | ________ | +0.4 |
| 14.90 MHz | -0.40 | ________ | +0.4 |
| 15.00 MHz | | Reference | |
| 15.10 MHz | -0.40 | ________ | +0.4 |
| 15.20 MHz | -0.40 | ________ | +0.4 |
| 15.30 MHz | -0.40 | ________ | +0.4 |
| 15.40 MHz | -0.40 | ________ | +0.4 |
| 15.50 MHz | -0.40 | ________ | +0.4 |
| 15.60 MHz | -0.40 | ________ | +0.4 |
| 15.70 MHz | -0.40 | ________ | +0.4 |
| 15.80 MHz | -0.40 | ________ | +0.4 |
| 15.90 MHz | -0.40 | ________ | +0.4 |
| 16.00 MHz | -0.40 | ________ | +0.4 |

# PERFORMANCE TEST 6

# FM RESIDUALS, 3 and 15 kHz FILTERS

**Specification**
: < 15 Hz rms at 2000 MHz, 3 kHz bandwidth
: < 7.5 Hz rms at 1000 MHz, 3 kHz bandwidth ( linear decrease )
: < 1 Hz rms at 100 MHz, 3 kHz bandwidth ( floor )
: < 30 Hz rms at 2000 MHz, 15 kHz bandwidth
: < 15 Hz rms at 1000 MHz, ( linear decrease )15 kHz bandwidth
: < 2 Hz rms at 100 MHz, 15 kHz bandwidth ( floor )

## 5-27. DESCRIPTION.

5-28. The FM residual modulation is determined by applying the output of a low-noise Synthesizer to the input of the Modulation Analyzer and noting the modulation indication using the rms detector.

## 5-29. PROCEDURE.

1. Depress the LCL/INIT key to initialize the Modulation Analyzer.

2. Connect output of the Synthesizer to the RF IN connector of the Modulation Analyzer. Set the Synthesizer to 2 GHz and 0 dBm. Depress the RMS key, and when the reading settles, record FM deviation.

3. Change the low-pass filter setting to 3 kHz and record the FM deviation.

4. Change the Synthesizer frequency to 1000 MHz and record the FM deviation.

5. Change the low-pass filter setting to 15 kHz and record the FM deviation.

6. Change the Synthesizer frequency to 100 MHz and record the FM deviation.

7. Change the low-pass filter setting to 3 kHz and record the FM deviation.

Table 5-7. FREQUENCY MODULATION, RESIDUALS.

| FILTER | TEST FREQUENCY | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 15 | 2000 MHz | | | 30 Hz |
| 3 | 2000 MHz | | | 15 Hz |
| 3 | 1000 MHz | | | 7.5 Hz |
| 15 | 1000 MHz | | | 15 Hz |
| 15 | 100 MHz | | | 2 Hz |
| 3 | 100 MHz | | | 1 Hz |

# PERFORMANCE TEST 7

# PHASE MODULATION, ACCURACY AND FLATNESS

| | |
|---|---|
| **Specification** | : ± 3% 200 Hz to 7.5 kHz, Frf 0.2 to 0.5 MHz<br>: ± 3% 200 Hz to 30 kHz, Frf > 0.5 MHz |

## 5-30. DESCRIPTION.

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

## 5-32. PROCEDURE.

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

2. Select PM, PEAK ± detector, 30 Hz high-pass, and 50 kHz lowpass filters. Depress the CAL key to calibrate the PM measurement.

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

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

5. Depress the Modulation Analyzer PM key and record the deviation.

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

7. Depress the Modulation Analyzer PM key and record the deviation.

8. Depress the Modulation Analyzer FM key, the 300 Hz high-pass filter, set the Audio Analyzer Source frequency to 30.0 kHz and adjust the LEVEL for a deviation of 50.00 kHz.

9. Depress the Modulation Analyzer PM key and record the deviation.

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

| CARRIER FREQUENCY | SOURCE SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 100 MHz | 1 kHz | 48.50 | ________ | 51.50 |
| 100 MHz | 200.0 Hz | 242.7 | ________ | 257.5 |
| 100 MHz | 30.0 kHz | 1.62 | ________ | 1.72 |

Table 5-9. DISTORTION ANALYZER, ACCURACY.

| AUDIO ANALYZER | TEST OSCILLATOR | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 1 kHz | 2 kHz | -39.0 | ________ | -41.0 |
| 20 Hz | 40 Hz | -39.0 | ________ | -41.0 |
| 20 kHz | 40 kHz | -39.0 | ________ | -41.0 |

# PERFORMANCE TEST 8

# DISTORTION ANALYZER

| | |
|---|---|
| **Specification** | : ± 10% or 1 dB SINAD<br>: residual distortion < 0.1% ( 60 dB SINAD ) |

## 5-33. DESCRIPTION.

5-34. The distortion analyzer is tested by applying a synthetically generated distortion reference signal to the Modulation Analyzer FM and audio circuits. This signal is generated by accurately combining the outputs of two audio sources with levels set exactly 40 dB apart to obtain a calibrated distortion indication.

## 5-35. PROCEDURE.

1. Set the output impedance of the Audio Analyzer and the Audio generator to 50 ohms and connect them together using a 'TEE' connector to the EXT FM input of the Test Generator.

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

3. Connect the Test Generator output to the Modulation Analyzer RF IN connector.

4. Depress the LCL/INIT key to initialize the Modulation Analyzer.

5. Set the Audio Analyzer LEVEL to 0 volts ( OFF ) and the Audio Generator to 1 kHz and about 0.7 volts.

6. Adjust the Audio Generator LEVEL until the MODULATION display indicates about 45.00 kHz, then depress the Modulation Analyzer RATIO key to set a reference.

7. Turn OFF the Audio generator and adjust the Audio Analyzer level until the indication is 100.0 % at 2 kHz rate.

8. Turn on the Audio generator and reduce the level of of the Audio Analyzer exactly 100 times ( -40 dB ).

9. Depress the Modulation Analyzer SINAD key and record the settled reading.

10. Depress < 10 Hz high-pass key and repeat the procedure at 20 Hz ( Audio Analyzer at 40 Hz ).

11. Depress 50 kHz low-pass key and repeat the procedure at 20 kHz ( Audio Analyzer at 40 kHz ).

# PERFORMANCE TEST 9

# CARRIER LEVEL

| | |
|---|---|
| **Specification** | : ± 1 dB, 0.1 to 520 MHz, -47 to +30 dBm |
| | : ± 2 dB, 520 to 1500 MHz, -37 to +30 dBm |
| | : ± 3 dB, 1500 to 2500 MHz, -33 to +30 dBm |

### 5-36. DESCRIPTION.

5-37. The carrier LEVEL measurement is verified by applying the output of the RF Calibrator to the RF IN of the Modulation Analyzer and calibrating the measurement. The RF calibrator is then used to verify performance at 30 MHz. An accurate power meter is then used to verify the accuracy at other frequencies.

### 5-38. PROCEDURE.

1. On the Modulation Analyzer, depress the LCL/INIT key to initialize the system.

2. Connect the RF Calibrator output to the RF IN connector of the Modulation Analyzer and set the RF Calibrator to 0 dBm and ON.

3. Enter 0 dBm into the carrier LEVEL display, then depress the CAL key to calibrate the measurement.

4. When the calibration routine completes, depress the carrier FREQ and MHZ keys to hold the frequency setting.

5. Depress the carrier LEVEL key and record the indications for the RF Calibrator levels listed in Table 5-10.

6. Connect the Reference Power Meter sensor to the output of the Test Generator using the same cable that is used to connect the Generator to the Modulation Analyzer.

7. Set the Test Generator to 1000 MHz and to the Test levels indicated in Table 5-10. Record the indications.

## NOTE

*Start the procedure at the highest level to insure that the Modulation Analyzer properly acquires the signal before depressing the MHZ key.*

8. Without changing any settings, disconnect the Reference Power Meter and connect the Test Generator to the Modulation Analyzer.

9. On the Modulation Analyzer depress the carrier FREQ and AUTO keys to acquire the signal. When the frequency reading settles, depress the MHZ key to hold the measurement frequency.

10. Depress the LEVEL key and record the indications at the indicated test levels.

11. Repeat the procedure at 2000 MHz.

Table 5-10. CARRIER LEVEL ACCURACY.

| FREQUENCY | TEST LEVEL | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 30 MHz | 0 dBm | | REFERENCE | |
| 30 MHz | -47.0 dBm | -48.0 | ________ | -46.0 |
| 30 MHz | -10.0 dBm | -11.0 | ________ | -9.0 |
| 30 MHz | +10.0 dBm | +9.0 | ________ | +11.0 |
| 30 MHz | +19.0 dBm | +18.0 | ________ | +20.0 |
| | | | | |
| 1000 MHz | 0 dBm | -2.0 | ________ | +2.0 |
| 1000 MHz | -37.0 dBm | -39.0 | ________ | -35.0 |
| 1000 MHz | -10.0 dBm | -12.0 | ________ | -8.0 |
| 1000 MHz | +10.0 dBm | +8.0 | ________ | +12.0 |
| 1000 MHz | +19.0 dBm | +17.0 | ________ | +21.0 |
| | | | | |
| 2000 MHz | 0 dBm | -3.0 | ________ | +3.0 |
| 2000 MHz | -33.0 dBm | -36.0 | ________ | -30.0 |
| 2000 MHz | -10.0 dBm | -13.0 | ________ | -7.0 |
| 2000 MHz | +10.0 dBm | +7.0 | ________ | +13.0 |

# PERFORMANCE TEST 10

# FREQUENCY ACCURACY AND SENSITIVITY

| | |
|---|---|
| **Specification** | : reference ± 3 counts Frf < 100 MHz<br>: reference ± 3 counts or 30 Hz whichever is greatest, Frf > 100 MHz<br>: sensitivity 10 mV rms, Frf < 520 MHz<br>: sensitivity 15 mV rms, Frf < 1000 MHz<br>: sensitivity 28 mV rms, Frf < 1500 MHz<br>: sensitivity 50 mV rms, Frf > 1500 MHz |

## 5-39. DESCRIPTION.

5-40. Carrier frequency accuracy is measured by locking the Test Generator to a timebase with 1 X 10-10 stability and known accuracy, then applying the output of the generator to the input of the Modulation Analyzer. Frequency readings are taken at various frequencies and levels and the indications recorded. The test also verifies the measurement sensitivity, and audio frequency accuracy, as the same counter and timebase are used.

## 5-41. PROCEDURE.

1. Connect the EXT REF input of the Test Generator to the output of the Metrology Standard timebase.

2. Connect the Test Generator output to the Modulation Analyzer RF IN connector and set the frequency to 500 kHz and level to 10 mV. Record the settled reading.

3. Increase the Test Generator frequency to 520 MHz. Record the settled reading.

4. Increase the Test Generator frequency to 1000 MHz, and increase the level to 15 millivolts. Record the settled reading.

5. Increase the Test Generator frequency to 1500 MHz, and increase the level to 28 millivolts. Record the settled reading.

5. Increase the Test Generator frequency to 2000 MHz, and increase the level to 50 millivolts. Record the settled reading.

Table 5-11. CARRIER FREQUENCY ACCURACY AND SENSITIVITY

| TEST LEVEL | FREQUENCY | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|---|
| 10mV | .500000 MHz | .49997 | ________ | .50003 |
| 10mV | 520.00000 MHz | 519.9997 | ________ | 520.0003 |
| 15mV | 1000.00000 MHz | 999.9997 | ________ | 1000.0003 |
| 28mV | 1500.00000 MHz | 1499.9997 | ________ | 1500.0003 |
| 50mV | 2000.00000 MHz | 1999.9997 | ________ | 2000.0003 |

# PERFORMANCE TEST 11

# VSWR

| | |
|---|---|
| **Specification** | : < 1.5 from 100 kHz to 2.0 GHz.<br>: < 1.8 from 2.0 to 2.5 GHz. |

## 5-42. DESCRIPTION.

5-43. The Modulation Analyzer VSWR is verified by measuring return loss. Measurements are made using a Scalar Network Analyzer from 10 MHz to 2.5 GHz. For optional testing below 10 MHz, the sensor input impedance is measured at several points and the VSWR is calculated.

## 5-44. PROCEDURE.

1. Set up the Scalar Analyzer for a 10 MHz to 2.5 GHz sweep at a 0 dBm level, and calibrate the SWR autotester using the reference open and short to establish a return loss baseline.

2. Connect SWR autotester test port to the RF IN connector of the Modulation Analyzer, and connect the SWR autotester to the Scalar Analyzer sweep generator with a short low VSWR cable.

3. Enter 100 MHz into the carrier FREQ display to keep the Modulation Analyzer local oscillator frequency constant, and record the minimum return loss from 0.01 to 2.5 GHz.

### NOTE

*The following procedure is optional as the Modulation Analyzer input impedance below 10 MHz is essentially the same as the DC resistance of the input protection pad and termination.*

4. Connect the equipment as in Figure 5-3, page 5-22.

5. Set the voltmeter to display the ratio of the two channels, and vary the generator frequency from 0.1 to 10 MHz at 0 dBm and record maximum amplitude variation in Table 5-12. This variation represents the impedance variation at the RF IN connector. A ratio of -7.96 dB represents 33.3 ohms resistance, and -4.43 dB represents 75 ohms.

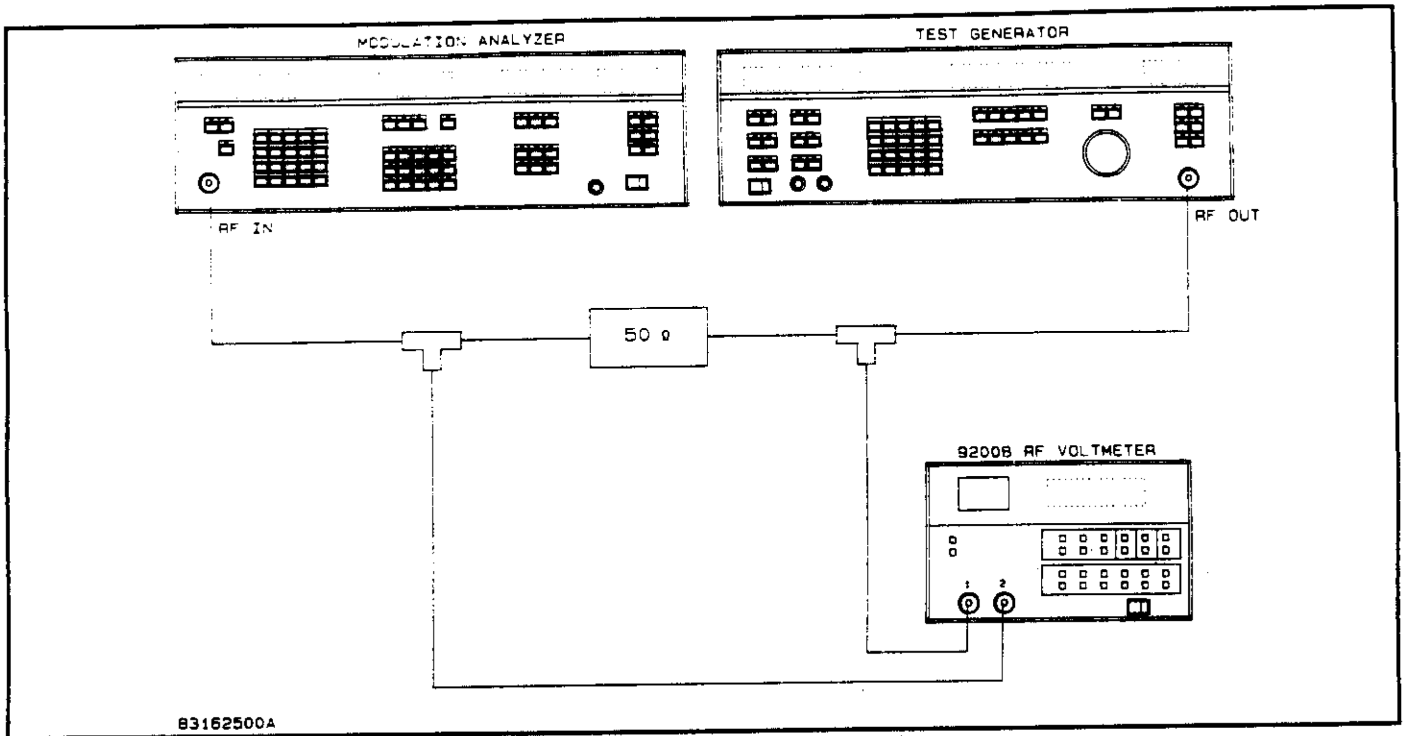



**FIGURE 5-3. Measurement Setup #3.**

Table 5-12. VSWR

| FREQUENCY RANGE | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|
| 2.0 GHz - 2.5 GHz | 10.9 dB | ________ | |
| 10 MHz - 2.0 GHz | 13.9 dB | ________ | |
| 100 kHz - 10 MHz | -7.96 dB | ________ | -4.43 dB * |

*VSWR AND IMPEDANCE: VSWR = 1.5, RHO = 0.2, Zmax = 75 ohms, Zmin = 33.3 ohms

# PERFORMANCE TEST 12

# CALIBRATORS

| | |
|---|---|
| **Specification** | : FM, 0.1% accuracy<br>: AM, 0.1% accuracy |

## 5-45. DESCRIPTION.

5-46. The theory of operation of the calibrators is described in detail, and the mathematical procedures used to determine the accuracy of the calibrators is disclosed. Since the calibrators are so precise, measurement verification of the stated accuracy is not practical. The following discussion presents the design constraints and the implied accuracy.

## 5-47. DISCUSSION.

5-48. The internal calibrators of the Modulation Analyzer provide modulation standards for AM and FM measurements; they are activated by the operator as required by the measurement.

## 5-49. FM CALIBRATION.

5-50. The calibration process consists of (1st) applying to the FM discriminator, in alternation, two accurately controlled frequencies; (2nd) measuring the resulting recovered modulation information; and (3rd) computing a correction factor for subsequent FM measurements. As an aid in following this discussion refer to Figure 8-25.

5-51. The input signal to pin 2 of U23 is the internal timebase frequency divided by two: 5.000 MHz ± 0.01%. The preset inputs, P0 through P3 are alternately programmed to divide by 4 or 5, depending on the sense of the signal on pins 3 and 4 of U23. This latter signal is generated by dividing the 5.00 MHz signal by 4096. The resulting signal is phase coherent with the other generated signals and at a frequency of 1.2207 kHz.

5-52. When the preset inputs of U23 are programmed to divide by 5, the resulting signal frequency is 1.000 MHz. Similarly, when the preset inputs are programmed to divide by 4, the resulting frequency is 1.2500 MHz. The average frequency, therefore, is 1.125 MHz; the peak-to-peak deviation is 250 kHz, and the peak deviation is 125.0 kHz.

5-53. From the above discussion it is clear that the frequency deviation is precisely defined by the clock frequency. Additionally, since the modulation signal is phase coherent with the carrier frequency, switching from one carrier tone to the other is consistent.

5-54. In transferring the calibrator deviation to subsequent modulation measurement the primary limitation is the voltmeter resolution, in this case 1 part in 1250 or 0.08%. FM noise is of little or no consequeuce, since the two frequencies are crystal controlled. The calibration program accumulates ten readings, and averages then to eliminate last-digit uncertainty.

5-55. Cross-correlation measurements using a Bessel null techniques indicate that the actual calibration uncertainty for 100 calibrations is close to 0.04% or one-half digit.

## 5-56. AM CALIBRATION.

5-57. The operation of the AM calibrator is similar to that of the FM calibrator.

5-58. During AM calibration the fixed divide by two output of U22 is used to generate the carrier frequency of 1.25 MHz. The TTL signal from U24 pin-7 is passed through a low-pass filter consisting of L5, L6 C17, C18, and C20. This filter removes harmonic ·f the TTL signal to produce a sinewave at the input of AR3.

5-59. Ar ·r AR3 increases the signal level, but more importantly provides a very low output impedance to drive precision divider R. The increased level also reduces the effects of charge injection in switch, U21.

5-60. The voltage divider comprising R20a through R20d is a precision resistor array. The absolute value of the resistors, however, is not as important as is the match between them. Thus, resistors R20a through R20d are guaranteed to a 0.05% match. Selecting th 3/4 and 1/4 voltage taps for the output insures that the source impedance for subsequent circuits is constant.

5-61. Analog switch U21 alternately switches between the 3/4 and 1/4 voltage taps at the 1.2207 kHz rate, thus producing an amplitude modulated signal with a depth of exactly 50%.

5-62. The effects of the inevitable variation in analog switch on resistance (U21) is obviated by inserting a 20 kohm resistor in series with the switch, thus reducing switch matching errors to less than 0.1%.

5-63. A possible source of error in transferring the calibrator AM accuracy to the measurement is the symmetry of the modulation waveform. The problem is addressed as follows: (In the following analysis, p+ indicates +peak and p- is -peak.)

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

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

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

and for the above system:

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

5-64. The above calculations assume that the modulation is symmetrical (i.e. perfectly so). Should that not be the case, a dc shift occurs and the plus and minus peaks are not equal. The calibrator program eliminates such an error by calculating AM as:

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

This expression is determined as follows:

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

$$(p+)(T1) - (p-)(T2) = 0 \quad (0 \text{ volts dc}) \quad (6)$$

And:

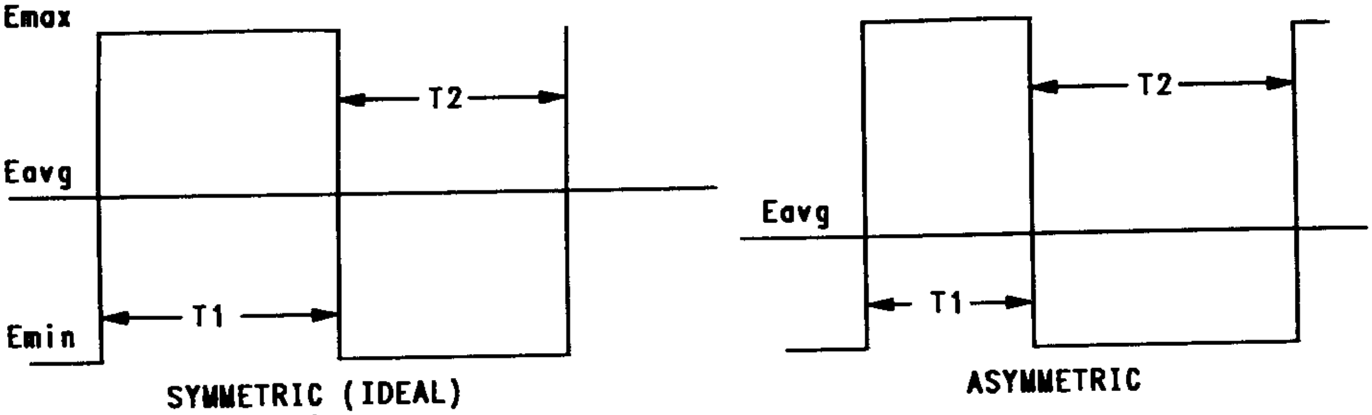
$$T1 + T2 = 1 \quad (7)$$
$$(p+)(T1) - (p-)(1-T1) = 0 \quad (8)$$
$$T1 = p-/(p+ + p-) \quad (9)$$

Now:

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

And in the Modulation Analyzer:

$$Emax = 3\, Emin \quad (11)$$




Combining Equs. 7, 10, and 11:

$$\text{Eavg} = \text{Emin} + 2\text{Emin}\,(\text{T1}) \quad (12)$$
$$\text{Eavg} = \text{Emin}\,(1 + 2\text{T1}) \quad (13)$$

If symmetry is perfect:

$$\text{T1} = 0.5 \text{ and Eavg} = 2\text{Emin} \quad (14)$$

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

$$R = (1 + 2\text{T1})/2 \quad (15)$$

Combining Eqs. 9 and 15:

$$R = (p+ \; + 3p-)/(2\,(p+ \; + p-) \quad (16)$$

The uncorrected AM is

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

and corrected is

$$= (p+ \; + p-)/2 \times R \quad (18)$$
$$= (p+ \; + 3p-)/4 \quad (19)$$

5-65. Again, it should be noted that only ratios are involved in the above analysis. The absolute value of the voltages are not important to the method. As in the case of FM, the calibration program accumulates ten readings, and averages then to eliminate last digit uncertainty. The internal voltmeter can resolve the reading to 1 part in 5000 for a quantizing uncertainty of 0.02%. AM noise is of little consequence in determining calibrator depth since the original signal level is determined by TTL gates and the frequency of the carrier and modulation signals are crystal controlled.

5-66. Cross-correlation measurements using a specially calibrated Modulation Analyzer indicate that the actual calibration uncertainty for 100 calibrations is approximately 0.15%.

# PERFORMANCE TEST 13

# OPTIONAL FILTERS

| | |
|---|---|
| **Specification** | : See Tables 5-13, 5-14, and 5-15. |

## 5-67. DESCRIPTION.

5-68. Each optional filter is tested for passband gain accuracy by applying the output of a low-noise, wideband modulator to the input of the Modulation Analyzer. The Audio Analyzer Level RATIO measurement mode is used with a reference set at a specific frequency. The frequency of the Audio Analyzer is then varied, and the relative amplitude measured and the results recorded.

## 5-69. PROCEDURE.

1. Connect the equipment as in Fig. 5-1. Note that the power supply is set to 10 ± 1 volts.

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

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

4. Depress the AM and RMS keys, and execute SPCL 18 to select the √RMS detector.

5. Adjust the LEVEL of the Audio Analyzer Source for an indication of about 47.00% at the reference frequency from Tables 5-13 through 5-15 for the selected filter.

6. Depress the Audio Analyzer LEVEL, RATIO, and dB keys to establish a 0 dB reference level.

7. Select the appropriate optional filter(s), enter the Audio Analyzer test frequencies from Tables 5-13 through 5-15 for the selected filter, and record the RATIO indication.

8. Repeat the above procedure for each installed filter.

Table 5-13. CCITT BANDPASS FILTER.

| SOURCE SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|
| 800 Hz | | REFERENCE | |
| 50 Hz | -65.0 | ______ | -61.0 |
| 100 Hz | -43.0 | ______ | -39.0 |
| 200 Hz | -23.0 | ______ | -19.0 |
| 300 Hz | -11.6 | ______ | -9.6 |
| 400 Hz | -7.3 | ______ | -5.3 |
| 800 Hz | -0.2 | ______ | +0.2 |
| 1000 Hz | 0.0 | ______ | +2.0 |
| 1200 Hz | -1.0 | ______ | +1.0 |
| 1600 Hz | -2.7 | ______ | -0.7 |
| 2000 Hz | -4.0 | ______ | -2.0 |
| 3000 Hz | -6.6 | ______ | -4.6 |
| 3500 Hz | -10.5 | ______ | -6.5 |
| 4000 Hz | -18.0 | ______ | -12.0 |
| 5000 Hz | -39.0 | ______ | -33.0 |

Table 5-14. C-MESSAGE BANDPASS FILTER.

| SOURCE SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|
| 1000 Hz | | REFERENCE | |
| 60 Hz | -57.7 | ________ | -53.7 |
| 100 Hz | -44.5 | ________ | -40.5 |
| 200 Hz | -27.0 | ________ | -23.0 |
| 300 Hz | -17.5 | ________ | -15.5 |
| 400 Hz | -12.4 | ________ | -10.4 |
| 800 Hz | -2.5 | ________ | -0.5 |
| 1000 Hz | -0.2 | ________ | +0.2 |
| 1200 Hz | -1.2 | ________ | +0.8 |
| 1500 Hz | -2.0 | ________ | 0.0 |
| 2500 Hz | -2.4 | ________ | -0.4 |
| 3000 Hz | -3.5 | ________ | -1.5 |
| 3500 Hz | -9.6 | ________ | -5.6 |
| 4000 Hz | -17.5 | ________ | -11.5 |
| 5000 Hz | -31.5 | ________ | -25.5 |

Table 5-15. CCIR BANDPASS FILTER.

| SOURCE SETTING | MINIMUM | ACTUAL | MAXIMUM |
|---|---|---|---|
| 1000 Hz | | REFERENCE | |
| 31.5 Hz | -30.0 | ______ | -28.0 |
| 63 Hz | -24.9 | ______ | -22.9 |
| 100 Hz | -20.8 | ______ | -18.8 |
| 200 Hz | -14.3 | ______ | -13.3 |
| 400 Hz | -8.3 | ______ | -7.3 |
| 800 Hz | -2.4 | ______ | -1.4 |
| 1000 Hz | -0.5 | ______ | +0.5 |
| 2000 Hz | +5.1 | ______ | +6.1 |
| 3150 Hz | +8.5 | ______ | +9.5 |
| 4000 Hz | +10.0 | ______ | +11.0 |
| 5000 Hz | +11.2 | ______ | +12.2 |
| 6300 Hz | +12.0 | ______ | +12.4 |
| 7100 Hz | +11.8 | ______ | +12.2 |
| 8000 Hz | +11.0 | ______ | +11.8 |
| 9000 Hz | +9.7 | ______ | +10.5 |
| 10.0 kHz | +7.7 | ______ | +8.5 |
| 12.5 kHz | -1.0 | ______ | +1.0 |
| 14.0 kHz | -6.3 | ______ | -4.3 |
| 16.0 kHz | -12.7 | ______ | -10.7 |
| 20.0 kHz | -23.2 | ______ | -21.2 |
| 31.5 kHz | none | ______ | -40.7 |

# PERFORMANCE TEST 14

# OPTIONAL POWER REFERENCE

| | |
|---|---|
| **Specification** | : 50 MHz, +- 0.5 MHz<br>: 0.7% initial accuracy<br>: +- 1.2% over 1 year |

### 5-70. DESCRIPTION.

5-71. The Milliwatt Test Set is first zeroed, and then connected to the Modulation Analyzer 50 MHz power calibrator. The deviation from 0.00 dBm is noted. Then the 50 MHz power calibrator output is connected to the Modulation Analyzer RF IN and the frequency is measured.

### 5-72. PROCEDURE.

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

2. Connect the EPM-1 probe to the PWR REF output on the rear panel of the Modulation Analyzer.

3. Record the deviation from 0.00 dBm in Table 5-16.

4. Connect the PWR REF output on the Modulation Analyzer to the RF IN connector with a suitable cable and select FREQ and AUTO to measure the frequency. Record the calibrator frequency in Table 5-16.

Table 5-16. POWER REFERENCE.

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

# SECTION VI
# MAINTENANCE

**6-1. INTRODUCTION.**

6-2. This section contains maintenance and adjustment instructions for the Model 8201 Modulation Analyzer.

**6-3. SAFETY REQUIREMENTS.**

6-4. Although this equipment has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary located at the front of this manual or with specific warnings given throughout this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

**6-5. REQUIRED TEST EQUIPMENT.**

6-6. Test equipment required for maintenance and adjustments is listed with each procedure. For critical specifications see Table 5-1. Equipment of equivalent characteristics may be substituted for an item listed. An extender board is included in the Model 8201 to facilitate repair and adjustment of the plug-in circuit boards.

**6-7. CLEANING PROCEDURE.**

6-8. Painted surfaces can be cleaned with a commercial, spray-type window cleaner or with a mild soap and water solution.

**CAUTION**

*Avoid the use of chemical cleaning agents which might damage the plastics used in the instrument. Recommended cleaning agents are isopropyl alcohol, a solution of 1 part kelite and 20 parts water, or a solution of 1% mild detergent and 99% water.*

**6-9. MAJOR ASSEMBLY LOCATION.**

6-10. See Figures 6-1 and 6-2 for the location of the major assemblies of the Model 8201. Coaxial connectors are identified by color coded heat shrink attached to the connectors.

**6-11. REMOVAL OF MAJOR ASSEMBLIES AND PARTS.**

6-12. **Instrument Covers.** To remove the instrument covers proceed as follows:

1. Disconnect all signal cables and the power cord from the Model 8201.

2. Remove the top cover by removing three No. 6 screws at the rear of the cover and lifting the cover up and to the rear.

3. Turn the instrument over and remove the bottom cover in a similar manner.

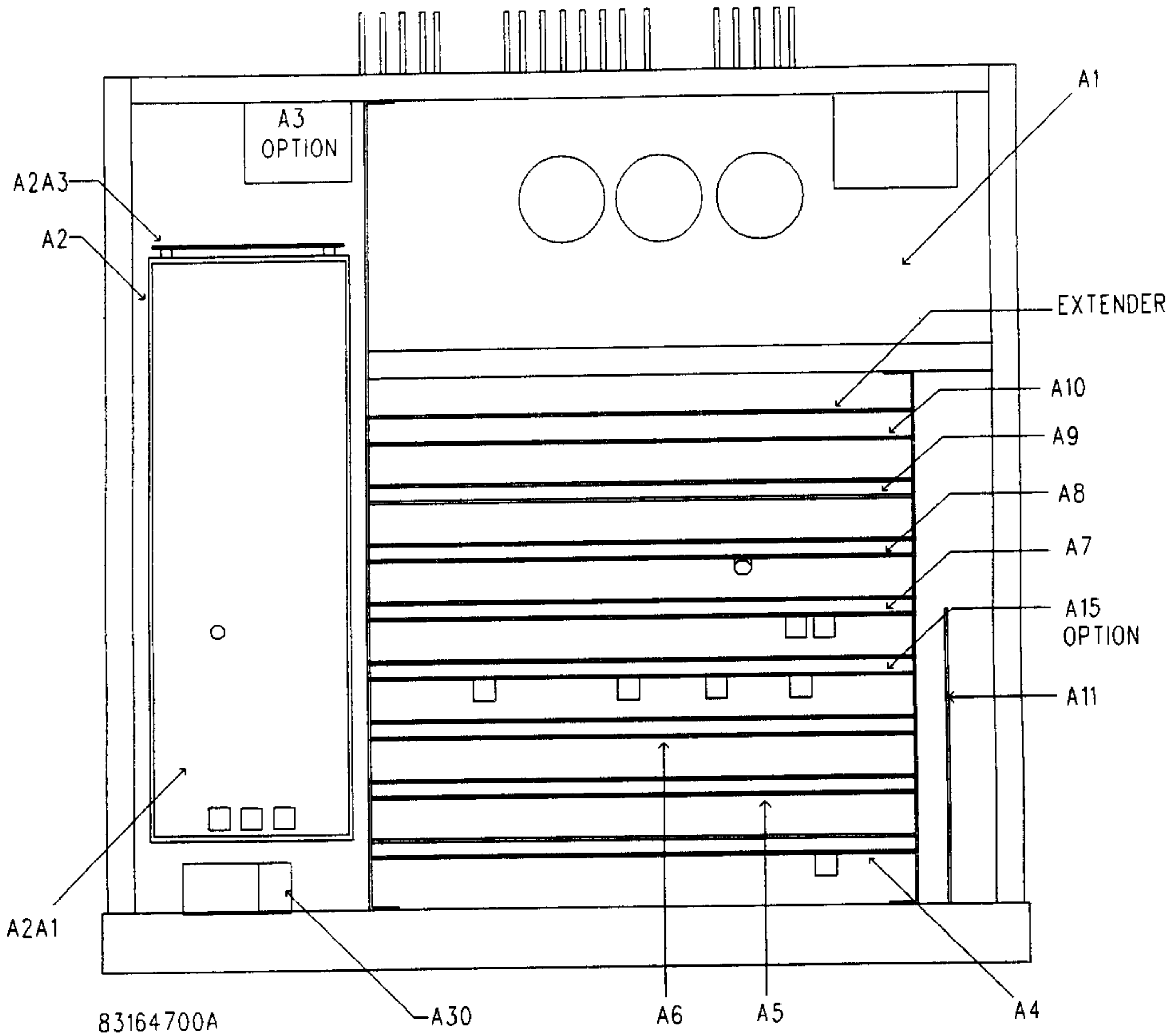



**FIGURE 6-1. MAJOR ASSEMBLY LOCATION, TOP VIEW.**

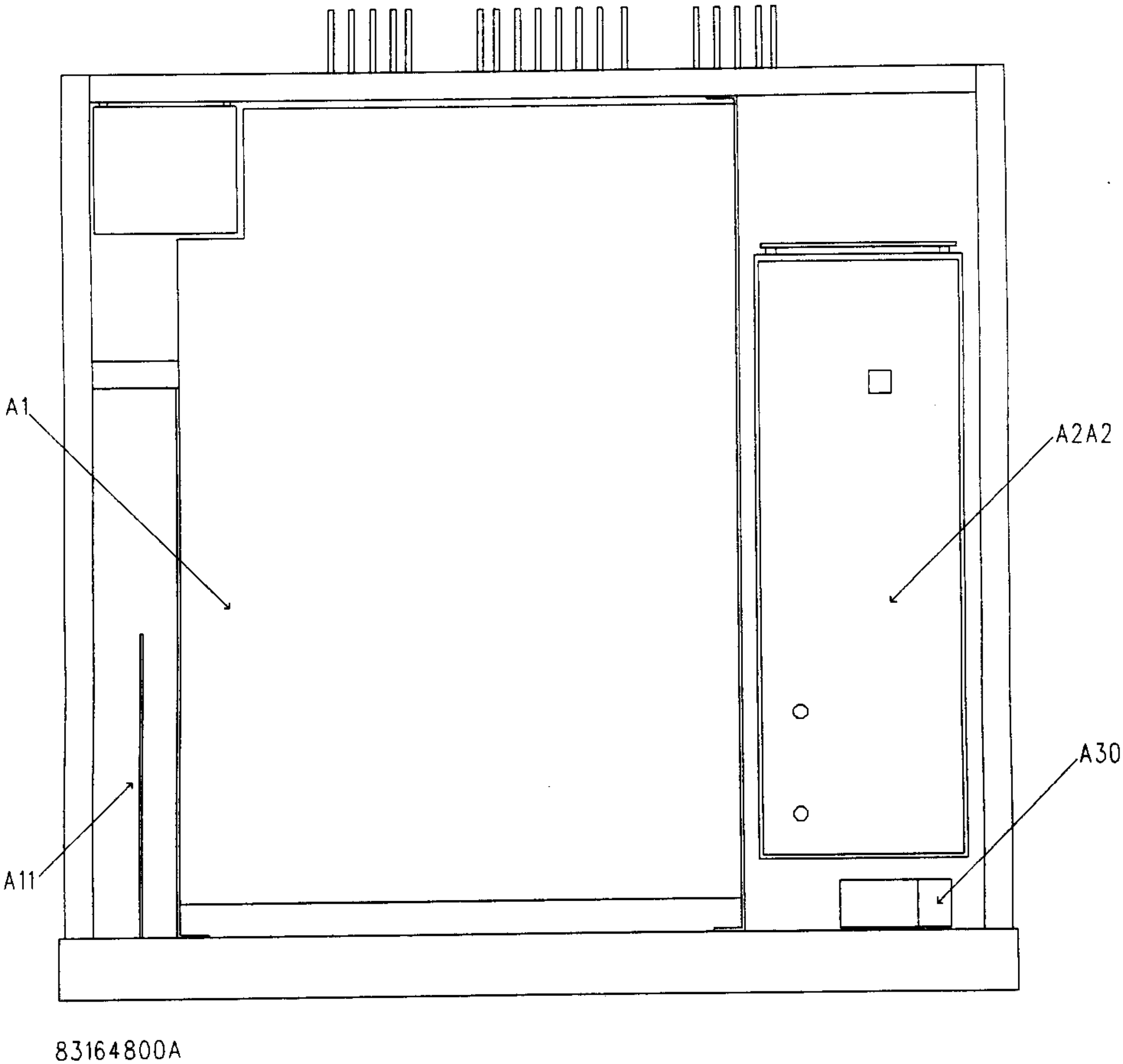



**FIGURE 6-2. MAJOR ASSEMBLY LOCATION, BOTTOM VIEW.**

**6-13. RF assembly covers.** To remove the RF assembly covers, proceed as follows:

1. Remove the ins covers as described above.

2. Remove the No. 4 snipping screw in the RF assembly cover if it has not been removed previously.

3. Grasp the cover near the front and rear of the instrument.

4. Pull up on the cover at the rear of the instrument first, and then at the front. The cover should pull away easily.

5. Turn the instrument over and repeat the above procedure for the bottom cover.

**6-14. RF Printed Circuit Board.** To remove the RF printed circuit board, proceed as follows:

1. Remove the instrument and RF assembly covers as described above.

2. Remove the connectors from J3, J4, and J5 at the rear of the circuit board.

3. Remove the connector from J2 near the center of the board.

4. Remove 7 No. 4 screws and the hex spacer holding the circuit board to the RF casting.

**CAUTION**

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

5. Use a small pair of pliers to pull up on TP1 to disengage J1 from the local oscillator board.

6. Carefully unsolder the center conductor of the input RF connector while pulling the circuit board toward the rear of the instrument.

7. Pull the circuit board up and away from the casting.

8. To replace the RF circuit board reverse the above procedure.

**6-15. Oscillator Board.** To remove the local oscillator board, proceed as follows:

1. Remove the instrument and RF assembly covers as described above.

2. Very carefully unsolder the wire from the center pin of the SMB connector at the front of the RF casting.

3. Remove the connectors from J1 and J2 at the rear of the circuit board.

4. Remove 9 No. 6 screws and one hex spacer holding the circuit board to the RF casting.

5. Use a small pair of pliers to gently pull up on TP4 to disengage P1 from the RF circuit board.

6. Pull the circuit board up and away from the RF casting.

7. To replace the Oscillator board reverse the above procedure.

**6-16. Gaining Access to Display/keyboard.** To gain access to the display and keyboard, proceed as follows:

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

**CAUTION**

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

5. Turn the instrument over and remove three No. 4 screws that hold the bottom trim extrusion and two grounding clips.
6. Grasp the trim strip by its edges and pull it away.
7. Tilt the bottom of the front panel away from the instrument until all switches are clear; then, pull the front panel up to clear the center trim extrusion.

**6-17. Changing Instrument Firmware.** To change the instrument eproms, proceed as follows:

1. Remove all cable connections from the Model 8201, including the power cable.
2. Remove the instrument top cover as described above.

**CAUTION**

*When replacing U10 and U14 observe that the orientation of pin 1 is away from the top of the CPU board. The three numbers on the replacement IC should match the numbers on the one being replaced.*

3. Extract the CPU board, A9 (Blue Extractors) far enough to remove U10 and replace it with the new eprom.
4. Remove A9U14 and replace with the new eprom.
5. Install jumpers JP1 and JP2, then reseat the CPU board into the motherboard connector.
6. Before replacing the top instrument cover, connect the AC power supply and turn the LINE switch ON.
7. The new firmware number will appear in the CARRIER display, followed by a 'CLEAR' message..
8. Turn the instrument power off, extract the CPU board and remove jumpers JP1 and JP2. Replace the instrument cover.
9. Turn the instrument ON and enter SPCL 30 to calibrate the Model 8201.

**6-18. Instrument Test Jumpers.** The Model 8201 CPU board has two test jumpers, JP1 and JP2, which are used as an aid in troubleshooting the instrument circuits. The jumper positions and related tests are listed below.

**6-19. Removal of Detail Parts.** Careful attention has been paid in the design of the Model 8201 to maintainability. Most detail parts are readily accessible for inspection and replacement when the instrument covers and RF shields are removed. Solid-state circuit components, mounted on plug-in circuit boards, are used throughout the instrument. Standard printed circuit board

| JP1 - JP2 | ACTION |
|---|---|
| OFF-OFF | Normal operation, no tests are done. |
| ON-OFF | Enable SPCL functions for test and calibration. |
| OFF-ON | Activate Tests. Exercises the software A/D converter system, instrument interface, and GPIB SRQ line. |
| ON-ON | Erase variable memory and install nominal calibration factors. Used when a repair has been made on the CPU board or when new firmware is installed. |

TABLE 6-1. TEST JUMPERS.

maintenance techniques are used for removal and replacement of parts. Excessive heat must be avoided; a low wattage soldering iron and suitable heat sinks should be used for all soldering and unsoldering operations.

## 6-20. PRELIMINARY CHECKS.

6-21. **Visual checks.** If equipment malfunction occurs, perform a visual check of the Model 8201 before performing electrical tests. Visual checks often help to isolate the cause of a malfunction quickly and simply. Inspect the instrument for signs of damage caused by excessive shock, vibration, or overheating, such as broken wires, loose hardware and parts, loose electrical connections, electrical shorts, cold solder connections, or dirt or other foreign matter. Correct any problems discovered, then complete the operational checks to verify that the instrument is functional. If a malfunction persists or the instrument fails any of the operational checks, continue with the troubleshooting procedures below.

6-22. **Power Supply Check.** Improper operation of the Model 8201 may be caused by incorrect dc operating voltages. Before proceeding with any other electrical checks, perform the power supply checks in the Motherboard/Power Supply section.

## 6-23. TROUBLESHOOTING.

6-24. Instrument malfunction will generally be evident from front panel indications, or IEEE-488 bus responses. The problems will fall into two general categories; selective failure of one sub-system or catastrophic failure.

6-25. Selective failure of one section of the instrument or out of specification performance will be evident from manipulation of the front panel controls. For example, incorrect or erratic FM deviation indications would be evident from display readings only in the FM modulation mode, and the problem would most likely be associated with the FM circuit board, A4. However, similar performance on both AM and FM displays would indicate a problem on the Filter or Detector boards.

6-26. Catastrophic failures, on the other hand, would generally cause the Model 8201 to be completely inoperative. For instance, if the microprocessor was not operating properly, the displays would contain meaningless symbols and the keyboard would not be responsive.

6-27. Further isolation of the problem requires some understanding of the simplified block diagram. Read over the theory of operation section and then proceed with the troubleshooting section below. When the problem is localized to a specific assembly, refer to the service information for that assembly.

## 6-28. TROUBLE LOCALIZATION.

6-29. Many malfunctions are evident from the front panel display. See Table 6-2.

6-30. Other front panel indications might include erratic or incorrect displays or an inoperative keyboard. In each case the circuit board most closely associated with that display should be tested first.

| Display | Probable fault on |
|---|---|
| No display | A1 Motherboard/Power Supply or A12 Display Board |
| Meaningless symbols | A9 CPU Board |
| Error 20 | A5 AM Board |
| Error 21 | A4 FM Board |
| Error 22 | A4 FM or A6 Filter Board |
| Error 23-25 | A8 Detector Board |
| Error 26 | A5 AM or A2A1 RF Board |
| Error 27,28 | A6 Filter Board |
| Error 30-33 | A2A2 Oscillator Board |
| Error 34 | A2A2 Oscillator Board |
| Error 35-39 | A9 CPU Board |

TABLE 6-2. HARDWARE ERROR DISPLAYS.

## 6-31. TROUBLESHOOTING, MOTHERBOARD/POWER SUPPLY.

6-32. **GENERAL.** Procedures for checking the Motherboard circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-2, 8-3, and 8-4.

6-33. **EQUIPMENT REQUIRED.** The test equipment required for these tests is listed below. See Table 5-1 for critical specifications.

**Oscilloscope................................HP 1740A**
**DC voltmeter ................................Fluke 8840A**

**WARNING**

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

## 6-34. PROCEDURE.

6-35. With the instrument covers removed and power applied, observe DS1-DS5. These displays indicate if the supplies are operating normally. All of the LEDs should be about the same brightness. If not, troubleshoot the circuit associated with the incorrect display LED. The LED and associated circuits are:

**NOTE**

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

6-36. **+5V Display (DS2).** The +5 volt display supply is a three terminal regulator, U7, and associated components. If the output voltage is incorrect check for shorted CR11, CR15, or C22. The regulator output can be isolated by disconnecting J4 on the I/O board.

| LED | Circuit |
|---|---|
| DS1 | -30V supply |
| DS2 | +5V (display) |
| DS3 | +5V (instrument) |
| DS4 | +15V |
| DS5 | -15V |

**TABLE 6-3. Power Supply LEDs.**

**6-37. +5V Instrument (DS3).** The +5 volt instrument supply is a three terminal regulator, U4, and associated components. If the output voltage is incorrect check for shorted CR5, CR10, or C14. The regulator output can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing.

**6-38. +15V (DS4).** The +15 volt instrument supply is a three terminal regulator, U5, enclosed in a feedback loop consisting of AR2a and associated components. Proceed as follows:

1. If the dc voltage at the +15 volt bus is near ground a short circuit is the most likely problem. The supply can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing. This can be done one board at a time to isolate the defective circuit.

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

3. In any case measure the dc voltage at the positive terminal of C8. The voltage should be +20 volts at nominal line. If not, check for defective CR2 or replace defective U5.

4. Measure the dc voltage at pin 6 of U8. The voltage should be +10 volts. If not, replace defective U8. Note that if the +15 supply voltage is less than 12 volts U8 will not operate properly.

5. Measure the dc voltage at pin 1 of AR2. The voltage should be +10 volts. If not, replace defective AR2, or check for shorted CR7.

**6-39. -15V (DS5).** The -15 volt instrument supply is a three terminal regulator, U6, enclosed in a feedback loop consisting of AR2b and associated components. Proceed as follows:

1. If the dc voltage at the -15 volt bus is near ground a short circuit is the most likely problem. The supply can be isolated by extracting all of the plug-in boards and disconnecting J4 at the RF housing. This can be done one board at a time to isolate the defective circuit.

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

3. In any case measure the dc voltage at the negative terminal of C10. The voltage should be -20 volts at nominal line. If not, check for defective CR2 or replace defective U6.

4. Measure the dc voltage at pin 6 of U8. The voltage should be +10 volts. If not, replace defective U8. Note: If the +15 supply voltage is less than 12 volts U8 will not operate properly.

5. Measure the dc voltage at pin 7 of AR2. The voltage should be -10 volts. If not, replace defective AR2, or check for shorted CR9.

**6-40. -30V (DS1).** The -30 volt instrument supply consists of a voltage doubler and operational amplifier AR3 and associated components. Proceed as follows:

1. If the dc voltage at pin 6 of AR3 is near ground a short circuit is the most likely problem. The supply can be isolated by disconnecting J4 at the RF housing.

2. Measure the dc voltage at the negative terminal of C3. The voltage should be -40 volts at nominal line. If not, check for defective CR3 or CR4 or replace defective AR3.

3. Measure the dc voltage at pin 3 of AR3. The voltage should be -15 volts. If not, troubleshoot the -15 volt supply.

5. Measure the dc voltage at pin 7 of AR3. The voltage should be -12 volts. If not, replace defective CR14.

## 6-41. LOGIC SIGNALS.

6-42. Proper operation of the RF and Oscillator circuits depend on correct logic levels on the following control lines:

**IA2-IA7 .............................................. instrument address bus**
**ID0-ID7 ..............................................instrument data bus**

The instrument address lines are decoded by U2 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. In operation, data on the instrument bus is latched into octal latch U1, when address lines IA4 and IA5 are high, IA2, IA3, and IA6 are low, and strobe IA7 goes from high to low. Data is strobed into U9 under the same conditions except that IA2 is high.

To troubleshoot the logic circuits proceed as follows:

1. With the Model 8201 powered up normally, but with no RF input signal, depress the INIT key.

2. Use the oscilloscope to monitor the activity on the instrument data bus on pins 1-8 of the plug-in card connectors. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board.

3. Connect the oscilloscope to pin 6 of U2 and set the timebase to 0.5 mSEC/DIV.

4. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board.

5. Move the oscilloscope probe to pin 12 of U2. The signal should be as in the previous step, except that it is inverted. If not, replace defective U2.

6. The following table presents logic levels on various pins of U1 when the indicated data is keyed into the CARRIER or PRGM displays.

| **Pin numbers** | **15-16-12** |
|---|---|
| **logic level** | **data entered** |
| **low-low-high** | **Enter -20 dBm into carrier LEVEL display.** |
| **low-high-high** | **Enter +10 dBm into carrier LEVEL display.** |
| **high-low-high** | **not used** |
| **high-high-low** | **SPCL 30** |

| **Pin numbers** | **19-2-5** |
|---|---|
| **logic level** | **data entered** |
| **low-low-low** | **2.0 MHz FREQ** |
| **high-low-low** | **2.2 MHz FREQ** |

| | |
|---|---|
| **low-high-low** | **2.5 MHz FREQ** |
| **high-high-low** | **3.2 MHz FREQ** |
| **low-low-high** | **10.1 MHz FREQ** |
| **high-low-high** | **12.0 MHz FREQ** |
| **low-high-high** | **15.0 MHz FREQ** |
| **high-high-high** | **18.0 MHz FREQ** |

7. Depress the carrier FREQ and AUTO keys and observe the signals on pins 6 and 9 of U2. The signal should be TTL logic waveforms indicating proper operation of the frequency acquisition circuits. If not, replace defective U2, or check for wiring shorts between the motherboard and the RF casting assembly.

8. Move the oscilloscope probe to pin 19 of U9. Enter +26 dBm, and then 0 dBm into the carrier LEVEL display. The signal should change from TTL low to high. If not, replace defective U9.

9. Move the oscilloscope probe to pin 1 of U10. The signal should be as in the previous step except that it is inverted and is 15 volts peak-to-peak. If not, replace defective U10.

10. Move the oscilloscope probe to the circuit pad connected to J1, pin 1. (pin 1 is nearest R20). The signal should be as in the previous step except that it is again inverted. If not, replace defective Q1.

11. If steps 8-10 are correct, but A30 does still not operate properly, replace defective A30, or check for open or shorted wiring.

**6-43. TROUBLESHOOTING, RF BOARD.**

**6-44. GENERAL.** Procedures for checking the RF circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-6 and 8-7.

**6-45. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope .................................... HP 1740A**
**Signal Generator ............................ Boonton 1021**
**DC voltmeter .................................... Fluke 8840A**

**6-46. PROCEDURE.**

1. Set the signal generator to 15 MHz CW at 0 dBm and connect the RF OUT to the Model 8201 RF IN connector.

2. Select the carrier FREQ function and key 15 MHz into the display.

## NOTE

*For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.*

3. Connect the oscilloscope probe to the RF input connector, A2J1 on the circuit board, and measure the incoming signal. The signal should be about 400 millivolts peak-to-peak with a period of 67 nanoseconds. Some of the local oscillator signal may be present. Incorrect signals indicate defective input connectors, A30 module, or cables.

4. Connect the oscilloscope to TP1. The signal should be about 700 millivolts peak-to-peak with a period of 33 nanoseconds. No signal indicates a defective local oscillator board.

5. Move the oscilloscope to pin 11 of U1. The signal should be about 3.5 volts peak-to-peak with a period of 33 nanoseconds. If not, replace defective Q1 or U1.

6. Move the oscilloscope to pin 9 of U1. The signal will be a TTL signal with a period of 67 nanoseconds. Some ringing and overshoot is normal. If not, replace defective U1.

7. Use the oscilloscope probe to trace the TTL signal to pin 8 and pin 6 of U3. If not, replace defective U3.

8. Move the oscilloscope probe to pin 3 of U2. This should be a negative going TTL pulse about 12 nanoseconds wide with a period of 62 nanoseconds. If not, replace defective U2.

9. Move the oscilloscope probe to the collector (case) of Q3 or Q13. The signal should be a negative going pulse about 12 volts peak-to-peak. If not, replace defective Q3 or Q13.

10. Move the oscilloscope probe to the anode of CR4. The signal should be as shown in Figure 6-3,D. If not, check for defective T2 or replace defective CR4.

11. The signals at pins 1 and 6 of T1 should be nearly equal amplitude, opposite polarity pulses between .7 and 1.1 volts peak with a 100 MHz oscilloscope bandwidth. If not, replace defective T1 or open CR3.

12. The signal at the junction of C2 and R9 should be as indicated in Figure 6-3,B. Incorrect signals indicate defective sampling bridge or bridge bias circuits.

13. The signal at the junction of C7 and R20 should be as indicated in Figure 6-3,A. Incorrect signals indicate defective sampling bridge or bridge bias circuits.

14. Move the oscilloscope probe to TP2. The signal should appear as in Figure 6-3,C. If the signal is not as indicated, troubleshoot the sampler amplifier, Q2 and Q4-Q7 by dc and waveform measurements.

15. Connect the oscilloscope probe to TP3. The signal is the same as at TP2, but ten times smaller. ( 40 millivolts peak-to-peak ) If not, replace defective U4.

16. Connect the oscilloscope probe to TP4. The signal is the same as that at TP3, but 3.6 times larger. ( 150 millivolts peak-to-peak ) If the signal is not as indicated, troubleshoot the amplifier Q8-Q12 by dc and waveform measurements.

17. Connect the oscilloscope probe to A2J4 (center SMB connector). The signal is the same as that at TP4. If not, replace defective K1.

18. Change the generator frequency to 500 kHz and set the Model 8201 carrier FREQ to 9 MHz. The signal at A2J4 pin 1 should be about 150 millivolts peak-to-peak with a period of 2 microseconds. If not, replace defective AR1.

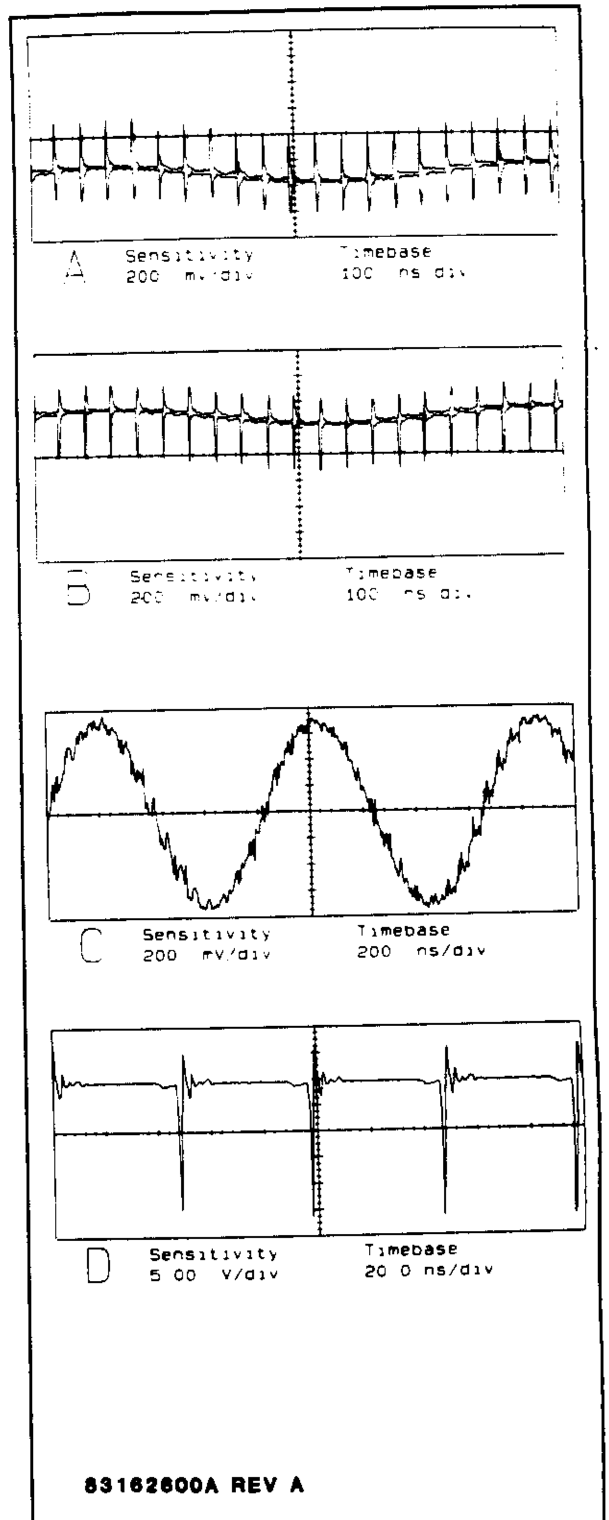



FIGURE 6-3. RF Board Waveforms.

19. Move the oscilloscope probe to pin 1 of U8. The signal should be about 75 millivolts peak-to-peak. If not, replace defective U7 or troubleshoot filter L3, L7, C39, C47, C52.

20. Enter the following frequencies into the carrier FREQ display and observe the waveform on the indicated pins of U7. The signa[illegible] a 500 kHz signal as in step 18. Incorrect signals indicate defective U7 or decoder U5.

| FREQUENCY | PIN |
|---|---|
| 2 MHz | pin 2 |
| 9 MHz | pin 7 |
| 11 MHz | pin 15 |
| 18 MHz | pin 10 |

21. Probe the signals on pins 7 and 8 of U8. The signal should be a square wave about 3.5 volts peak-to-peak, with a 2 microsecond period. If not, replace defective U8.

22. Move the oscilloscope probe to pin 6 of AR2. The signal is a square wave as in step 21 with an amplitude of 600 millivolts. If not, replace defective AR2.

23. The signal on pin 2 of U9 is as in step 21 with an amplitude of about 2 volts peak-to-peak. If not, replace defective U9, shorted CR10, or open CR11.

24. The signal on pin 9 of U9 is a TTL waveform with a period of 14 microseconds. If not, replace defective U9.

25. Enter 2 MHz into the carrier FREQ display. The signal on pin 9 of U9 is a TTL waveform with a period of 4 microseconds. If not, replace defective U9.

### 6-47. LOGIC SIGNALS.

6-48. Proper operation of the RF circuits depend on correct logic levels on the following control lines:

**R0,R1..................................................IF attenuation and calibration**
**B1,B2..................................................band switching**

The following table indicates the TTL logic levels and the associated function for control lines R0 and R1:

| Logic Line | logic value | operation |
|---|---|---|
| R0-R1 | low-low | no IF attenuation |
| | low-high | attenuate IF by 10 |
| | high-low | not used |
| | high-high | calibrator signal |

The following table indicates the TTL logic levels and the associated function for control lines B1 and B2:

| Logic Line | logic value | operation |
|---|---|---|
| B1-B2 | low-low | select filter U7,2 U9 divide by 7 U3, select /10 |
| | low-high | select filter U7,7 U9 divide by 7 U3, select /10 |
| | high-low | select filter U7,15 U9 divide by 2 U3, select /2 |
| | high-high | select filter U7,10 U9 divide by 2 U3, select /2 |

Incorrect logic signals on the R0, R1, B1, or B2 lines indicate a problem on the motherboard decoder U2 or latch U1, or the CPU board.

**6-49. TROUBLESHOOTING, OSCILLATOR BOARD.**

**6-50. GENERAL.** Procedures for checking the oscillator board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-8 and 8-9.

**6-51. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope....................................HP 1740A**
**Signal Generator ............................Boonton 1021**
**DC voltmeter ....................................Fluke 8840A**

**6-52. PROCEDURE.**

1. Measure the dc voltage at pin 16 of U3. The voltage should be approximately +5 volts. If not, the power supply circuits or the motherboard connectors are defective.

2. Measure the dc voltage at pins 7 and 4 of AR2. The voltages should be +15 and -15 respectively. If not, the power supply circuits or the motherboard connectors are defective.

3. Measure the dc voltage at TP3. The voltage should be -14.0 volts. If not, troubleshoot regulator AR3 and Q7 using dc measurements.

4. Enter 10 MHz into the carrier FREQ display. Observe that LED DS2 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

5. Measure the dc voltage at pin 7 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

## NOTE

*For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.*

6. Connect the oscilloscope probe to the anode of CR4. The signal should be about 400 millivolts peak-to-peak with a period of 45 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q1 using dc and waveform measurements.

7. Select the carrier FREQ function and key 12 MHz into the display. Observe that LED DS3 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

8. Measure the dc voltage at pin 1 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

9. Connect the oscilloscope probe to the anode of CR21. The signal should be about 400 millivolts with a period of 37 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q3 using dc and waveform measurements.

10. Select the carrier FREQ function and key 15 MHz into the display. Observe that LED DS4 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

11. Measure the dc voltage at pin 8 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

12. Connect the oscilloscope probe to the anode of CR32. The signal should be about 400 millivolts with a period of 33 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q4 using dc and waveform measurements.

13. Select the carrier FREQ function and key 18 MHz into the display. Observe that LED DS5 is illuminated. If not, proceed to logic signals troubleshooting for additional tests.

14. Measure the dc voltage at pin 14 of AR1. The level should be about +13 volts. If not, replace defective AR1 or U1.

15. Connect the oscilloscope probe to the anode of CR43. The signal should be about 600 millivolts with a period of 26 nanoseconds. If the indication is incorrect, troubleshoot oscillator Q6 using dc and waveform measurements.

16. Connect the oscilloscope probe to ungrounded end of L23. The signal should be about 500 millivolts with a period of 26 nanoseconds. If not, replace defective diode CR43.

17. Connect the oscilloscope probe to TP4. The signal should be about 800 millivolts with a period of 26 nanoseconds. If not, troubleshoot amplifier Q5 by dc and waveform measurements.

18. Move the oscilloscope to the LO2 SMB connector on the front of the RF casting. The signal should be 500 millivolts with a period of 26 nanoseconds. If not, troubleshoot amplifier Q2 by dc and waveform measurements, or replace defective T1, or check for shorted RF cable connecting to Motherboard.

19. Set the signal generator to 15 MHz CW and 0 dBm and connect the RF OUT to the RF IN of the Model 8201.

20. Depress the Model 8201 INIT key and then enter 15 MHz into the carrier FREQ Display.

21. Connect the oscilloscope probe to pin 3 of U2. The signal should be a TTL signal with a period of 6 microseconds. If not, the problem is associated with the RF circuit board.

22. Move the oscilloscope probe to pin 6 of U2. The signal should be a TTL signal with a period of 6 microseconds. Additionally, the time from the falling edge to the rising edge should be 3 microseconds. If not, replace defective U2 or check C23 and R15.

23. Move the oscilloscope probe to pin 6 of AR2. The signal should be a distorted TTL signal with a period of 6 microseconds and an average value of near zero volts. The oscilloscope must be dc coupled for this test. If not, replace defective AR2.

24. Enter SPCL 37 to activate the local oscillator test. The MODULATION display will indicate 0 -- LO.

25. Measure the dc voltage at the end of R29 nearest TP2. The voltage should be -10 volts. If not, the problem is on the CPU board or in the interconnecting cable.

26. The other end of R29 should be 0 volts dc. If not, U3 or AR4a is defective.

27. Measure the voltage at TP2. The voltage should be +10 volts. If not, U3 or AR4a is defective.

28. Measure the voltage at pin 3 of AR5. The voltage should be -5 volts. If not, AR4b or Q9 is defective.

29. Measure the voltage at pin 6 of AR5. The voltage should be -5 volts. If not, AR5 is defective.

## NOTE

*If all measurements to this point are correct, but trouble persists, the problem is with the logic circuits or U3 or possibly Q8 or DS1. Troubleshoot by dc voltage measurement or refer to logic signals troubleshooting below.*

### 6-53. LOGIC SIGNALS.

6-54. Proper operation of the oscillator circuits depend on correct logic levels on the following control lines:

**FC0,FC1.........................................oscillator tuning**
**B0,B1,B3........................................ band switching**

The following table indicates the logic levels and the associated function for control lines FC0 and FC1:

| Logic Line | logic value | operation |
|---|---|---|
| FC0-FC1 | low-low | frequency lock, DS1 off |
| | low-high | frequency lock, DS1 on |
| | high-low | set frequency, DS1 on |
| | high-high | set frequency, DS1 off |

| Logic Line | logic value | operation |
|---|---|---|
| B0,B1,B3 | low-low-high | oscillator Q1 active, DS2 on |
| | low-high-high | oscillator Q3 active, DS3 on |
| | high-low-high | oscillator Q4 active, DS4 on |
| | high-high-high | oscillator Q6 active, DS5 on |
| | X - X -low | all oscillators inactive |

X means don't care

Incorrect logic signals on the FC0, FC1, B0, B1, or B3 lines indicate a problem on Motherboard decoder U2, latch U1, or problems on the CPU board.

**6-55. TROUBLESHOOTING, FM BOARD.**

**6-56. GENERAL.** Procedures for checking the FM circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-10 and 8-11.

**6-57. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope......................................HP 1740A**
**Signal Generator .............................Boonton 1021**
**DC voltmeter ....................................Fluke 8840A**

**6-58. PROCEDURE.**

1. Turn off the instrument and remove the FM circuit board. (Brown extractors) Insert the FM board into the Extender board (Grey extractors), and plug the combination back into the FM board slot. Turn on the instrument power, wait for a normal power up sequence, then depress the INIT key.

2. Measure the dc voltage at pin 6 of AR1. The voltage should be approximately +5 volts. If not, troubleshoot the regulator circuit AR1 using dc measurements.

3. Repeat step 1. at pins 7 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not, the problem is in the power supply circuits or the Motherboard interconnect.

4. Measure the dc voltage at either end of L7. The voltage should be -12.5 volts. If not, troubleshoot regulator Q14 using dc measurements.

5. Set the signal generator to 15 MHz and 0 dBm with 50 kHz FM at a 1 kHz rate.

6. Connect the RF OUT of the generator to the RF IN of the Model 8201 and depress the FM function key.

## NOTE

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

7. Connect the oscilloscope probe to pin 2 of the edge connector. (also the right end of R1). The signal should be an FM modulated signal with an amplitude of about 150 millivolts peak-to-peak and a period of 0.83 microseconds. Some of the local oscillator signal will be present. If not, the problem is on the RF board or the interconnecting cables.

8. Move the oscilloscope probe to TP3. The signal should be as in step 7 except that the amplitude should be 75 millivolts peak-to-peak and the local oscillator signal should not be present. If not, check low-pass filter L3-L4, C1, and C4-C7 for open inductors or shorted capacitors.

9. Move the oscilloscope probe to TP2. The signal should be a clipped sinewave with an amplitude of 1 volt peak-to-peak. If not, troubleshoot limiter stages 1 and 2 (Q3) using dc and waveform measurements.

10. Move the oscilloscope probe to TP6. The signal should be a squarewave with an amplitude of 1 volt peak-to-peak. If not, troubleshoot limiter stages 3 and 4 (Q8) using dc and waveform measurements.

11. Move the oscilloscope probe to TP7. The signal should be as shown in Figure 6-4,A. If not, troubleshoot level shifter Q13 and associated components using dc and waveform measurements.

12. Move the oscilloscope probe to pin 5 of U1. The signal should be as shown in Figure 6-4,B. If not, replace defective U1.

13. Move the oscilloscope probe to TP8. The signal should be as shown in Figure 6-4,C. If not, troubleshoot comparator Q4-Q7 and current source Q2 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

14. Move the oscilloscope probe to TP1. The signal should be as shown in Figure 6-4,D. If not, troubleshoot comparator Q4-Q7 and current source Q2 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

15. Move the oscilloscope probe to TP9. The signal should be as shown in Figure 6-4,E. If not, troubleshoot current switch Q11 and Q12, or current source AR2 and Q9 using dc and waveform measurements. Additionally, check for defective Q1 or Q10.

16. Move the oscilloscope probe to TP11. The signal should be a sinewave with an amplitude of 300 millivolts peak-to-peak and a period of 1 millisecond. If not, check low-pass filter L5, L6, L9, L10, and C27, C28, C32, C33, C36, C39, C41, C42, and C44 for open inductors or shorted capacitors.

17. Move the oscilloscope probe to TP12. The signal should be a sinewave with an amplitude of 1 volts peak-to-peak and a period of 1 millisecond. If not, replace defective AR3, Q15 or Q16.

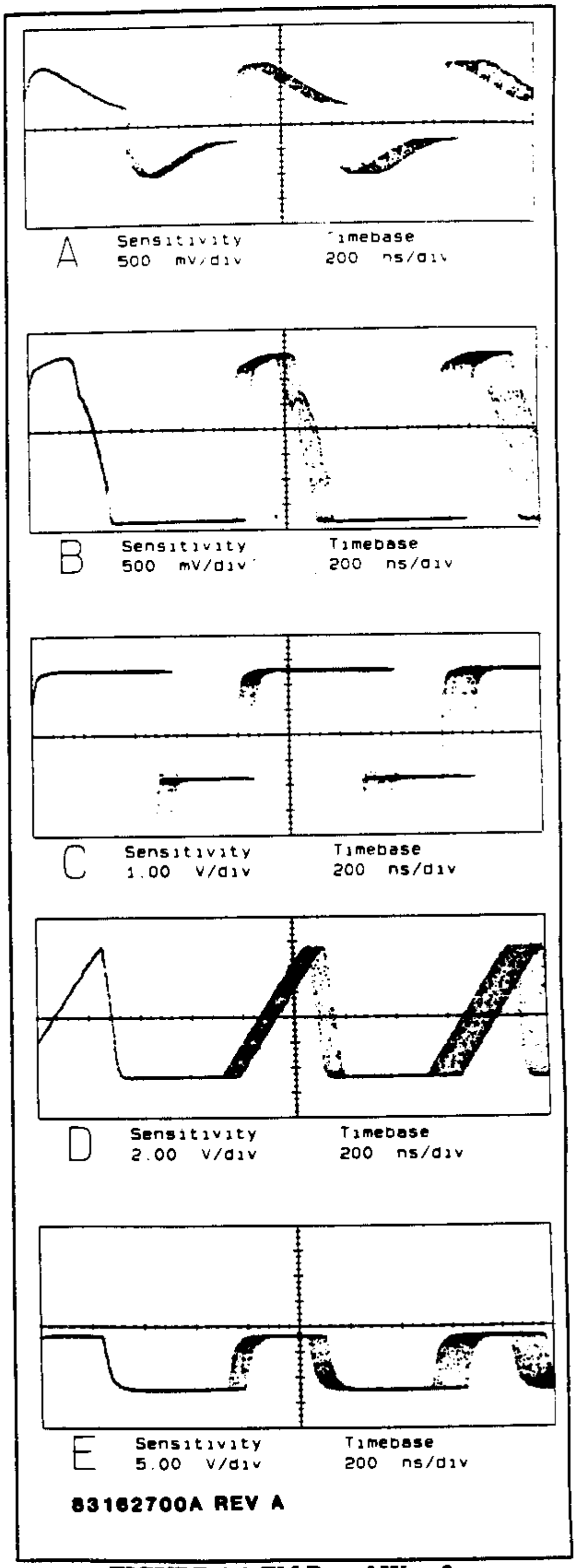



FIGURE 6-4. FM Board Waveforms.

### 6-59. LOGIC SIGNALS.

6-60. The operation of the FM circuits does not require interface to the control logic, however, instrument address line IA1 is dedicated to the FM circuits for future developments.

### 6-61. TROUBLESHOOTING, AM BOARD.

6-62. **GENERAL.** Procedures for checking the AM circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-12 and 8-13.

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

**Oscilloscope....................................HP 1740A**
**Signal Generator ............................Boonton 1021**
**DC voltmeter ..................................Fluke 8840A**

### 6-64. PROCEDURE.

1. Turn off the instrument and remove the AM circuit board. (Black extractors) Insert the AM board into the Extender board (Grey extractors), and plug the combination back into the AM board slot. Turn on the instrument power, wait for a normal power up sequence, then depress the INIT key.

2. Measure the dc voltage at pin 20 of U1. The voltage should be approximately +5 volts. If not, the power supply circuits or the motherboard connectors are defective.

3. Measure the dc voltage at pin 13 and pin 3 of U2. The voltages should be +15 and -15 volts respectively. If not, the power supply circuits or the motherboard connectors are defective.

4. Measure the dc voltage at either end of L7. The voltage should be +12 volts. If not, troubleshoot regulator Q1 and Q2 using dc measurements.

5. Set the signal generator to 15 MHz and 0 dBm with 50 % AM at a 1 kHz rate.

6. Connect the RF OUT of the generator to the RF IN of the Model 8201 and depress the AM function key.

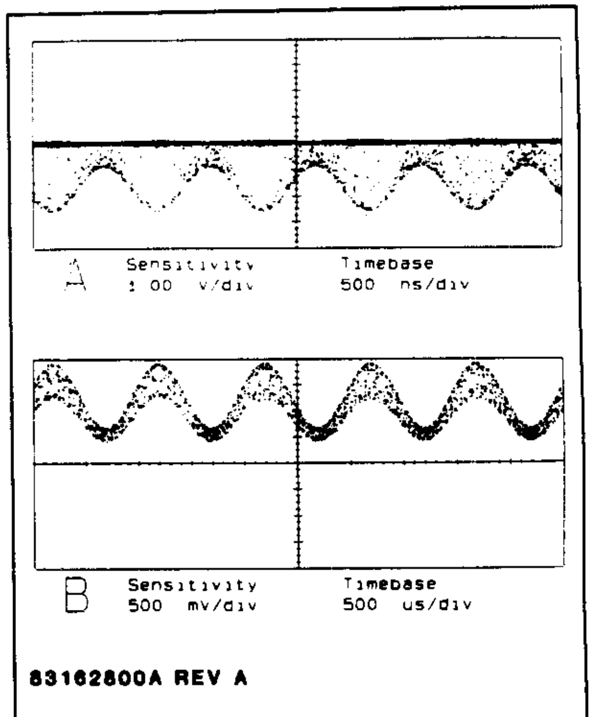



**FIGURE 6-5. AM Board Waveforms.**

## NOTE

*For the following oscilloscope measurements, use a high impedance probe with a very short ground connection. A spring clip type ground connection is recommended.*

7. Connect the oscilloscope probe to pin 2 of the edge connector. (also the right end of R1). The signal should be an amplitude modulated signal with an amplitude of about 200 millivolts peak- to-peak. The carrier period should be 0.83 microseconds and the modulation period should be 1 millisecond. Some local oscillator signal will be present. If not, The problem is on the RF board or the interconnecting cables.

8. Move the oscilloscope probe to TP1. The signal should be as in the previous step, except that the amplitude should be 350 millivolts peak-to-peak. Additionally, the local oscillator signal should not be present, and the dc level should be about 0 volts. If not, troubleshoot amplifier Q3-Q7 using dc and waveform measurements.

9. Move the oscilloscope probe to TP6. The signal should be as in the previous step, except that the amplitude should be 120 millivolts peak-to-peak and the dc level should be -0.5 volts. If not, proceed to logic signals troubleshooting for additional tests.

10. Move the oscilloscope probe to TP2. The signal should be as in the previous step, except that the amplitude should be 2.5 volts peak-to-peak. If not, troubleshoot feedback amplifier Q10 and Q13- Q16 using dc and waveform measurements.

11. Move the oscilloscope probe to pin 4 of Q22. The signal should be as shown in Figure 6-5,A. If not, troubleshoot active detector Q19-Q21 using dc and waveform measurements.

12. Move the oscilloscope probe to pin 8 of Q22. The signal should be as in the previous step, except it is inverted. If not, troubleshoot active detector Q19-Q21 using dc and waveform measurements.

13. Move the oscilloscope probe to pin 6 of AR2. The signal should be as shown in Figure 6-5,B. If not, troubleshoot buffer stage Q22 and AR2 using dc and waveform measurements.

14. Move the oscilloscope probe to pin 3 of AR3. The signal should be a 0.55 volt peak-to-peak sine wave with a period of 1 millisecond and a dc level of +0.5 volts. If not, check for open inductors or shorted capacitors in low-pass filter L10-L12 and C50-C56.

15. Move the oscilloscope probe to TP3. The signal should be as in the previous step, except that the amplitude should be 1.1 volt peak-to peak at a dc level of about 1 volt. If not, replace defective AR3.

16. Move the oscilloscope probe to the emitter lead of Q18. The signal should be an amplitude modulated signal with an amplitude of 2 volts peak-to-peak. The carrier period should be 0.83 microseconds and the modulation period should be 1 millisecond. If not, troubleshoot IF OUT buffer Q12 and Q17-Q18 using dc and waveform measurements.

**6-65. LOGIC SIGNALS.**

6-66. Proper operation of the AM agc circuits depend on correct logic levels on the following control lines:

**IA0 ....................................................agc latch strobe**
**ID0-ID7...........................................instrument data bus**

6-67. The instrument address line IA0 is dedicated to the AM board. In operation, data on the instrument data bus is latched into octal latch, U1, when IA0 makes the transition from high to low. The instrument data bus will contain the programming byte for agc digital-to-analog (DAC) at that time. To troubleshoot the logic and agc circuits proceed as follows:

1. With the Model 8201 powered up normally and no carrier signal connected, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 4-11 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the Model 8201 carrier FREQ to 15 MHz, and select SPCL 35 to activate the AGC test program.

4. Connect the oscilloscope probe to pin 12 of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be narrow positive pulses indicating an agc level change. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Enter SPCL 35 to activate the AGC attenuator test program. Enter 15 into the modulation display to set maximum attenuation. The levels on the B1-B8 pins (5-12) of U2 should be:

| B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 |
|---|---|---|---|---|---|---|---|
| Low | Low | Low | Low | High | High | High | High |

If the TTL levels are incorrect, U1 or U2 is defective.

7. Enter 250 into the modulation display to set minimum attenuation. The levels on the B1-B8 pins (5-12) of U2 are tabulated below.

| B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 |
|---|---|---|---|---|---|---|---|
| High | High | High | High | High | Low | High | Low |

If the TTL levels are incorrect, U1 or U2 is defective.

**6-68. AGC ATTENUATOR.**

6-69. The agc attenuator in the Model 8201 is a programmable L-pad whose series and shunt arm resistance is controlled by adjusting the current through a light dependent resistor while holding the dc voltage across the resistance constant. To troubleshoot the agc attenuator, proceed as follows:

1. Program the Model 8201 to 15 MHz carrier FREQ and 0 dBm carrier level.

2. Measure the dc voltage from TP6 to ground. The voltage should be -0.5 volts. If the indication is incorrect, troubleshoot the shunt arm control loop consisting of AR1b and Q11 and associated components by dc voltage measurements, or replace defective Q9.

3. Measure the dc voltage across R28. The voltage should be -0.5 volts. ( + 0.5 volts if the voltmeter polarity is reversed) If the indication is incorrect, troubleshoot the series arm control loop consisting of AR1a and Q7 and associated components by dc voltage measurements, or replace defective Q8.

**6-70. TROUBLESHOOTING, FILTER BOARD.**

6-71. **GENERAL.** Procedures for checking the FILTER circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-14, 8-15, and 8-16.

6-72. **EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope....................................HP 1740A**
**Audio Analyzer...............................Boonton 1120**
**DC voltmeter...................................Fluke 8840A**

**6-73. PROCEDURE.**

1. Turn off the instrument and remove the FILTER circuit board. (Pink extractors) Insert the FILTER board into the Extender board (Grey extractors), and plug the combination back into the FILTER board slot. Extract the FM circuit board (Brown extractors) just far enough to disengage the circuit board connector. Turn the instrument ON and enter 15 MHz into the carrier FREQ display.

2. Measure the dc voltage at pin 20 of U2. The voltage should be approximately + 5 volts. If not the power supply circuits or the motherboard connectors are defective.

3. Measure the dc voltage at pins 7 and 4 of AR1. The voltages should be + 15 and -15 volts respectively. If not the power supply circuits or the motherboard connectors are defective.

4. Set the audio analyzer source to 1 kHz and 600 millivolts.

5. Connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8201.

## NOTE

*For the following oscilloscope measurements, use a high impedance probe. TP7 may be used as a convenient ground terminal.*

6. Connect the oscilloscope probe to pin 35 of the edge connector. The signal should be a sinewave signal with an amplitude of about 800 millivolts peak-to-peak and a period of 1 millisecond. If not, the problem is on the Motherboard.

7. Move the oscilloscope probe to TP1. The signal should be as in the previous step, except that the amplitude should be 400 millivolts peak-to-peak. If not, check for defective relay K1, K2, or K3, or open inductor L4, L5, L6, or shorted capacitor C9-C12 or C14.

8. Change the audio analyzer frequency to 50 kHz. The signal should be as in the previous step, except that the amplitude should be about 250 millivolts peak-to-peak. If not, troubleshoot defective 50 kHz low-pass filter L4-L6 and C9-C12 and C14.

9. Depress the modulation analyzer 220 kHz low-pass filter key. The signal should be as in the previous step, except that the amplitude should be 0.4 volts peak-to-peak. If not, check for defective relay K1, K2, or K3, or defective attenuator R4-R6.

10. Move the oscilloscope probe to TP2. The signal should be as in the previous step, except that the amplitude should be 4 volts peak-to-peak. If not, check for defective U3 or amplifier AR1, or proceed to logic troubleshooting for additional tests.

11. Move the oscilloscope probe to TP9. The signal should be as in the previous step, except that the amplitude should be 0.4 volts peak-to-peak. If not, check for defective U3 or amplifier AR12 or proceed to logic troubleshooting for additional tests.

12. Reduce the audio analyzer level to 60 millivolts. The Model 8201 should autorange and the signal at TP9 should be as in the previous step. If not, check for defective U3 or proceed to logic troubleshooting for additional tests.

13. Increase the audio analyzer level to 6 volts. The Model 8201 should autorange and the signal at TP9 should be as in the previous step. If not, check for defective U3 or proceed to logic troubleshooting for additional tests.

14. Move the oscilloscope probe to TP3 and set the audio analyzer frequency to 30 Hz. Depress the < 10 Hz high-pass filter key. The signal should be 1.8 volts peak-to-peak with a period of 33 milliseconds. If not, check for defective U4 or amplifier AR5, or proceed to logic troubleshooting for additional tests.

15. Depress the 30 Hz high-pass key. The signal should be as in the previous step, except that the amplitude should be 1.3 volts peak-to-peak. If not, check for defective U4 or amplifier AR2, or proceed to logic troubleshooting for additional tests.

16. Change the audio analyzer frequency to 300 Hz and depress the 300 Hz high-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 3.3 milliseconds. If not, check for defective U4 or amplifier AR3, or proceed to logic troubleshooting for additional tests.

17. Change the audio analyzer frequency to 3000 Hz and depress the 3000 Hz high-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 0.33 milliseconds. If not, check for defective U4 or amplifier AR4, or proceed to logic troubleshooting for additional tests.

18. Change the audio analyzer frequency to 1 kHz and depress the 30 Hz high-pass key. Move the oscilloscope probe to TP4. The signal should be 1.8 volts peak-to-peak and the period should be 1 millisecond. If not, check for defective U5 or amplifier AR8, or proceed to logic troubleshooting for additional tests.

19. Change the audio analyzer frequency to 20 kHz and depress the 20 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 50 microseconds. If not, check for defective U5 or amplifier AR7, or proceed to logic troubleshooting for additional tests.

20. Change the audio analyzer frequency to 15 kHz and depress the 15 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 67 microseconds. If not, check for defective U5 or amplifier AR6a, or refer to logic signals troubleshooting for logic troubleshooting.

21. Change the audio analyzer frequency to 3 kHz and depress the 3 kHz low-pass key. The signal should be 1.3 volts peak-to-peak and the period should be 333 microseconds. If not, check for defective U5 or amplifier AR6b, or proceed to logic troubleshooting for additional tests.

22. Change the audio analyzer frequency to 1 kHz and depress the 50 kHz low-pass key. Move the oscilloscope probe to TP5. The signal should be 1.8 volts peak-to-peak and the period should be 1 millisecond. If not, check for defective U7 or amplifier AR10, or proceed to logic troubleshooting for additional tests.

23. Change the audio analyzer frequency to 6.366 kHz and depress the 25 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 157 microseconds. If not, check for defective U7 or filter R44, C49 or proceed to logic troubleshooting for additional tests.

24. Change the audio analyzer frequency to 3.183 kHz and depress the 50 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 314 microseconds. If not, check for defective U7 or filter R45, C50, or proceed to logic troubleshooting for additional tests.

25. Change the audio analyzer frequency to 2.122 kHz and depress the 75 uSEC de-emphasis key. The signal should be as 1.25 volts peak-to-peak and the period should be 471 microseconds. If not, check for defective U7 or filter R46, C51, or proceed to logic troubleshooting for additional tests.

26. Change the audio analyzer frequency to 212 Hz and depress the 750 uSEC de-emphasis key. The signal should be 1.25 volts peak-to-peak and the period should be 4.7 milliseconds. If not, check for defective U7 or filter R47, C52, or proceed to logic troubleshooting for additional tests.

27. Change the audio analyzer frequency to 1 kHz and depress the de-emphasis OFF key. Note the amplitude of the signal, then depress the MODULATION PM key. The signal should remain the same. If not, check for defective U7 or amplifier AR9, or proceed to logic troubleshooting for additional tests.

28. Change the audio analyzer frequency to 2 kHz. The signal amplitude should decrease to one-half of that in step 27. If not, troubleshoot filter circuit AR9 and associated components.

29. Move the oscilloscope probe to pin 18 of the edge connector. The signal should be as in the previous step. If not, replace defective relay K4.

30. Move the oscilloscope probe to TP6. The signal should be as in the previous step, except that the amplitude should be 2.4 volts peak-to-peak. If not, replace defective AR11.

### 6-74. LOGIC SIGNALS.

6-75. Proper operation of the FILTER circuits depend on correct logic levels on the following control lines:

**IA2-IA7 ............................................instrument address bus**
**ID0-ID7 ............................................instrument data bus**

The instrument address lines IA2-IA5 are decoded by U1 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals from the instrument data bus are transferred into octal latch, U2, when address lines IA2, IA3, IA4, and IA5 are low and IA7 goes from high to low. Similarly data is transferred into U6 when address IA2 is high and IA3-IA5 are low and IA7 goes from high to low.

To troubleshoot the logic circuits proceed as follows:

1. With the Model 8201 powered up normally and configured as above, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the audio analyzer level to 600 millivolts at 1 kHz and enter 15 MHz into the Model 8201 carrier FREQ display.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 15 of U1 and alternately depress the high-pass filter keys. The signal should be as in the previous step, except that the pulse is inverted. If not, replace defective U1.

7. Move the oscilloscope probe to pin 14 of U1 and alternately depress the low-pass filter keys. The signal should be as in the previous step. If not, replace defective U1.

8. Move the oscilloscope probe to pin 2 of U2. Alternately depress the MODULATION AM and FM keys. The signal should change from TTL high to low. If not, replace defective U2 or shorted Q1.

9. Move the oscilloscope probe to pin 5 of U2. Alternately depress the low-pass 220 and 50 keys. The signal should change from TTL high to low. If not, replace defective U2 or shorted U9.

10. Enter the following SPCL functions and note the corresponding activity on pins 6 and 9 of U2.

| SPCL | PIN 6 | PIN 9 |
|---|---|---|
| 2 | low | low |
| 3 | high | low |
| 4 | low | high |

If the indications are incorrect, replace defective U2 or U3.

11. Operate the high-pass filter keys and note the corresponding activity on pins 12, 15 and 16 of U2.

| KEY | PIN 12 | PIN 15 | PIN 16 |
|---|---|---|---|
| <10 | high | low | low |
| 30 | high | high | low |
| 300 | high | high | high |
| 3000 | high | low | high |

If the indications are incorrect, replace defective U2 or U4.

12. Alternately depress the FM and PM keys and observe the corresponding activity on pin 19 of U2.

| KEY | PIN 19 |
|---|---|
| FM | high |
| PM | low |

If the indications are incorrect, replace defective U2 or U4.

13. Operate the low-pass filter keys and note the corresponding activity on pins 9, 12, and 15 of U6.

| KEY | PIN 9 | PIN 12 | PIN 15 |
|---|---|---|---|
| 3 | high | low | high |

| | | | |
|---|---|---|---|
| 15 | high | low | low |
| 20 | low | low | high |
| 50 | high | high | high |
| 220 | high | high | high |

If the indications are incorrect, replace defective U6 or U5.

14. Select the MODULATION FM function, operate the de-emphasis keys and note the corresponding activity on pins 2, 5, and 6 of U6.

| KEY | PIN 2 | PIN 5 | PIN 6 |
|---|---|---|---|
| 25 | low | low | low |
| 50 | low | low | high |
| 75 | high | low | low |
| 750 | high | high | low |
| OFF | low | high | low |

If the indications are incorrect, replace defective U6 or U7.

## 6-76. TROUBLESHOOTING, DISTORTION ANALYZER BOARD.

6-77. **GENERAL.** Procedures for checking the DISTORTION ANALYZER circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-16 and 8-17.

6-78. **EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope....................................HP 1740A**
**Audio Analyzer...............................Boonton 1120**
**DC voltmeter ...................................Fluke 8840A**

## 6-79. PROCEDURE.

1. Turn off the instrument and remove the DISTORTION ANALYZER circuit board. (Yellow extractors) Insert the DISTORTION ANALYZER board into the Extender board (Grey extractors), and plug the combination back into the DISTORTION ANALYZER board slot. Extract the FM circuit board (Brown extractors) just far enough to disengage the circuit board connector. Turn the instrument ON and enter 15 MHz into the carrier FREQ display.

2. Measure the dc voltage at pin 20 of A7U8. The voltage should be approximately +5 volts. If not the power supply circuits or the motherboard connectors are defective.

3. Measure the dc voltage at pins 7 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not the power supply circuits or the motherboard connectors are defective.

4. Set the audio analyzer source to 1 kHz and 600 millivolts.

5. Connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8201.

## NOTE

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

6. Depress the audio FREQ key and enter 1 kHz into the AUDIO display.

7. Remove the feedback jumper J1 from the header P1.

8. Connect the oscilloscope probe to the edge connector, pin 18. The signal should be a sinewave with and amplitude of about 1.8 volts peak-to-peak, and a period of 1 millisecond. If not, the problem is on the FILTER board, A6.

9. Move the oscilloscope probel to AR1 pin 6. The signal should be as in the previous step, except that the amplitude should be 4.8 volts peak-to-peak. If not, replace defective AR1.

10. Move the oscilloscope probe to AR3, pin 1. The signal should be as in the previous step. Additionally, the dc level should be near zero volts.

11. Temporarily short TP4 to ground. If the dc level returns to zero volts, the problem is between TP2 and TP4, otherwise the problem is between AR3a and TP2. If the signal is okay, proceed to step 14.

12. If the problem is between TP2 and TP4, temporarily short TP2 to ground. The voltage on AR8, pin 7 should be near zero volts. If not, replace defective U3 or AR8, or proceed to logic troubleshooting for additional tests.

13. If the problem is between AR3 and TP2, temporarily short AR3, pin 3 to ground. The voltage on AR3, pins 1 and 7 should be near zero volts. If not, replace defective U3 or AR3, or proceed to logic troubleshooting for additional tests.

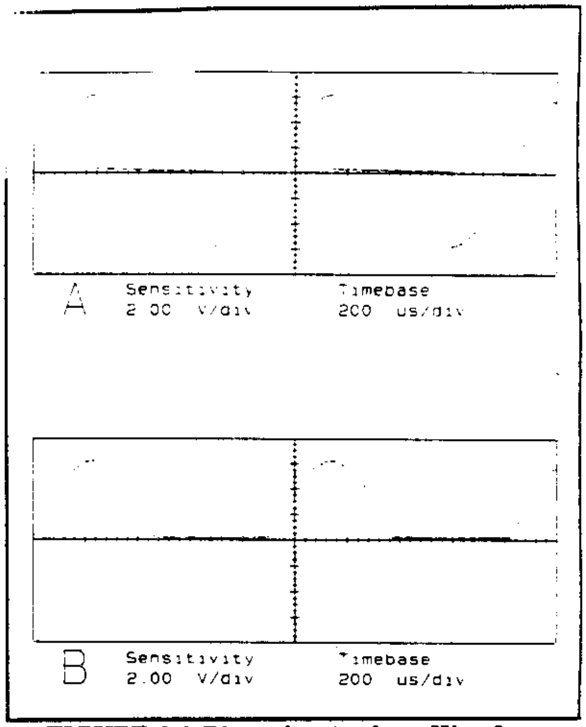



**FIGURE 6-6. Distortion Analyzer Waveforms.**

14. Move the oscilloscope probe to TP2. The signal should be 4.5 volts peak-to-peak with a period of 1 millisecond. If not, check for defective Q4, Q6, or amplifier AR7b, or proceed to logic troubleshooting for additional tests.

15. Move the oscilloscope probe to TP4. The signal should be as in the previous step. If not, check for defective Q8, Q10, or amplifier AR10a, or proceed to logic troubleshooting for additional tests.

16. Move the oscilloscope probe to AR5, pin 1. The signal should be a 15 volt peak-to-peak squarewave, and the period should be 1 millisecond. If not, replace defective Q1 or AR5.

17. Move the oscilloscope probe to AR5, pin 7. The signal should be a 15 volt peak-to-peak squarewave, and the period should be 1 millisecond. If not, replace defective Q2 or AR5.

18. Change the audio analyzer frequency to 1.1 kHz, 200 millivolts and move the oscilloscope probe to TP3. The signal should be one-half cycle of a sinewave, 7 volts peak for 450 microseconds, and zero volts for 450 microseconds as shown in Figure 6-6, waveform A. If not, check for defective Q2 or amplifier AR9.

19. Move the oscilloscope probe to TP1. The signal should be one-half cycle of a cosinewave, 14 volts peak-to-peak for 450 microseconds, and zero volts for 450 microseconds as shown in Figure 6-6, waveform B. If not, check for defective Q1 or amplifier AR5.

21. Change the audio analyzer frequency to 1 kHz. Connect the oscilloscope probe to AR11, pin 6. Temporarily replace jumper J1. The dc level should be between +10 and -10 volts. If not, check for defective U7 AR10b, or AR11.

22. Change the audio analyzer frequency to 2 kHz, 600 millivolts, and move the oscilloscope probe to AR2, pin 7. The signal should be a sinewave 4.5 volts peak-to-peak and the period should be 0.5 milliseconds. If not, replace defective AR2.

23. Move the oscilloscope probe to U1, pin 7 or 10. The signal should be as in the previous step. If not, check for defective U1 or AR2 or proceed to logic troubleshooting for additional tests.

24. Change the audio analyzer frequency to 1 kHz and depress the RMS detector key. Allow time for one measurement.

25. Connect the oscilloscope probe to U1 pin 7 or 10. The signal should be a sinewave 4.5 volts peak-to-peak and the period should be 1 millisecond. If not, check for defective U1 or AR2, or proceed to logic troubleshooting for additional tests.

26. Depress the audio FREQ key, the AUTO key, the + - PEAK key and the DIST key. Set the audio analyzer frequency to 100 Hz.

27. Connect the oscilloscope probe to AR2, pin 1. The signal should initially be 4.5 volts peak-to-peak, then the fundamental should be notched out, indicating proper operation of the tuning circuits. If not, check for defective Q3 or Q7, or proceed to logic troubleshooting for additional tests.

28. Change the audio analyzer frequency to 5 kHz. The signal should initially be 4.5 volts peak-to-peak, then the fundamental should be notched out, indicating proper operation of the tuning circuits. If not, check for defective Q4 or Q8, or proceed to logic troubleshooting for additional tests.

## 6-80. LOGIC SIGNALS.

**6-81.** Proper operation of the DISTORTION ANALYZER circuits depend on correct logic levels on the following control lines:

**IA2-IA7 ..........................................instrument address bus**
**ID0-ID7 ..........................................instrument data bus**

The instrument address lines IA2-IA5 are decoded by U1 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals from the instrument data bus are transferred into dual 8-bit DAC, U3, when address lines IA2, IA4, and IA5 are low, IA3 is high, and IA7 goes from high to low. Similarly data is transferred into U5 and U8 when address IA4 and IA2 are high and, IA3, and IA5 are low and IA7 goes from high to low.

To troubleshoot the logic circuits proceed as follows:

1. With the Model 8201 powered up normally and configured as above, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the audio analyzer level to 600 millivolts at 1 kHz and enter 15 MHz into the Model 8201 carrier FREQ display.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 13 of U2, depress the audio FREQ key, and successively enter 1, 2, and then 3 kHz into the display. The signal should be as in the previous step, except that the pulse is inverted. If not, replace defective U2.

7. Depress the DIST key and connect the oscilloscope probe to the following pins of U8 with the audio analyzer set for the indicated frequencies. The TTL levels should be as indicated.

| FREQ | PIN 5 | PIN 6 |
|---|---|---|
| 0.1 kHz | low | low |
| 1 kHz | high | low |
| 10 kHz | low | high |

If the levels are not as indicated, replace defective U8.

8. Connect the oscilloscope pro: e to the following pins of AR12 with the audio analyzer set for the indicated frequencies. The voltage levels should be as ındicated.

| FREQ | PIN 1 | PIN 7 |
|---|---|---|
| 0.1 kHz | -15 | -15 |
| 1 kHz | -15 | 0 |
| 10 kHz | 0 | -15 |

If the levels are not as indicated, replace defective AR12.

## 6-82. TROUBLESHOOTING, DETECTOR BOARD.

**6-83. GENERAL.** Procedures for checking the DETECTOR circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board Figures 8-17 and 8-18.

**6-84. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope ....................................HP 1740A**
**Audio Analyzer ...............................Boonton 1120**
**Signal Generator............................Boonton 1021**
**DC voltmeter...................................Fluke 8840A**

**6-85. PROCEDURE.**

1. Turn off the instrument and remove the DETECTOR circuit board. (Green extractors) Insert the DETECTOR board into the Extender board (Grey extractors), and plug the combination back into the DETECTOR board slot. Extract the FM circuit board (Brown extractors) just far enough to disengage the circuit board connector. Turn the instrument power ON, and enter 15 MHz into the carrier FREQ display.

2. Measure the dc voltage at pin 20 of U3. The voltage should be approximately +5 volts. If not the power supply circuits or the motherboard connectors are defective.

3. Measure the dc voltage at pins 7 and 4 of U14. The voltages should be +15 and -15 volts respectively. If not the power supply circuits or the motherboard connectors are defective.

4. Measure the dc voltage at pins 7 and 1 of U23. The voltages should be +5 and -5 volts respectively. If not, troubleshoot regulator U23 using dc measurements.

5. Set the audio analyzer source to 1 kHz and 600 millivolts and connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8201. Set the signal generator to 15 MHz, CW, at 0 dBm and connect the generator RF OUT to the RF IN connector on the Model 8201.

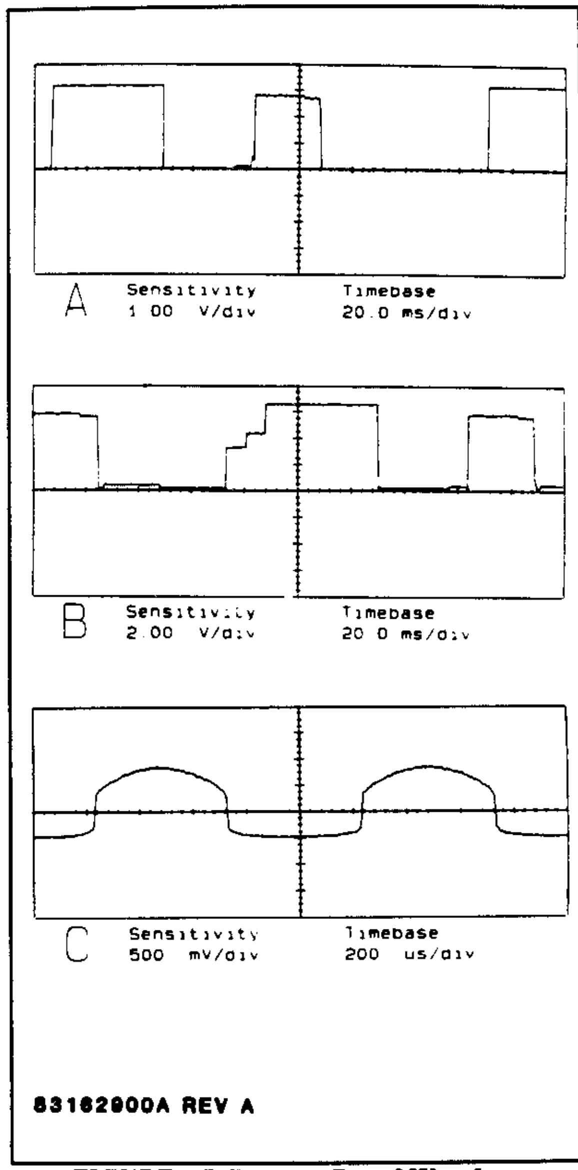



**FIGURE 6-7. Detector Board Waveforms.**

## NOTE

*For the following oscilloscope measurements, use a high impedance probe. TP1 can be used as a ground terminal.*

6. Connect the oscilloscope probe to pin 18 of the edge connector. The signal should be a sinewave with an amplitude of about 1.8 volts peak-to-peak and a period of 1 millisecond. If not, the problem is on the Filter board or the Motherboard interconnect.

7. Move the oscilloscope probe to TP5. The signal should be as in the previous step, except it is gated on and off about every 1.5 seconds. If not, check for defective switch U1, or amplifier U13, or proceed to logic troubleshooting for additional tests.

8. Move the oscilloscope probe to TP7. The signal should be as in the previous step. If not, replace defective U13.

9. Move the oscilloscope probe to TP8. The signal should be a low frequency rectangular waveform switching from ground to about + 0.8 volts at a 1.5 second rate. If not, check for defective switch U6, or amplifier U15 or U19, or proceed to logic troubleshooting for additional tests.

10. Move the oscilloscope probe to TP9. The signal should be as in the previous step. If not, check for defective switch U6, or amplifier U16 or U19, or proceed to logic troubleshooting for additional tests.

11. Measure the dc voltage at pin 1 of U7. The voltage should be 1 volt. If not, check filter R30 and C24, or the problem is on the AM board.

12. Move the oscilloscope probe to TP13. The signal should be as in Figure 6-6,A. If not, check for defective switch U7, or amplifier U22, or proceed to logic troubleshooting for additional tests.

13. Measure the dc voltages at pins 19 and 20 of the edge connector. The voltages should be about 0.210 and 0.319 volts respectively. If not, the problem is on the RF board or in the interconnecting cable.

14. Measure the dc voltages at pins 4 and 5 of U9. The voltages should be about 2.1 and 2.2 volts respectively. If not, check the resistive attenuators R33-R35, and R38, R40 and R41, or replace defective U9.

15. Move the oscilloscope probe to TP14. The signal should be as in Figure 6-6,B. If not, check for defective switch U9, or amplifier U22, or proceed to logic troubleshooting for additional tests.

16. Depress the RMS key and move the oscilloscope probe to pin 30 of the edge connector. The signal should be 5 volts peak-to-peak with a period of 1 millisecond. If not, the problem is on the Filter board.

17. Move the oscilloscope probe to pin 3 of U14. The signal should be 0.5 volts peak-to-peak. If not, check for defective switch U5, or amplifier U14, or proceed to logic troubleshooting for additional tests.

18. Move the oscilloscope probe to pin 6 of U14. The signal should be 5.6 volts peak-to-peak. If not, check for defective switch U5, or amplifier U14, or proceed to logic troubleshooting for additional tests.

19. Move the oscilloscope probe to pin 3 of U18. The signal should be 0.56 volts peak-to-peak. If not, check for defective switch U5, or amplifier U18, or refer to logic signals troubleshooting below.

20. Move the oscilloscope probe to pin 6 of U18. The signal should be 6.6 volts peak-to-peak. If not, check for defective switch U5, or amplifier U18, or proceed to logic troubleshooting for additional tests.

21. Move the oscilloscope probe to TP3. The signal should be 0.66 volts peak-to-peak. If not, check for defective switch U4, or amplifier U20, or proceed to logic troubleshooting for additional tests.

22. Move the oscilloscope probe to TP10. The signal should be 7.6 volts peak-to-peak. If not, check for defective rms converter U8, or amplifier U20, or or proceed to logic troubleshooting for additional tests.

23. Move the oscilloscope probe to TP11. The signal should be about 2.8 volts dc. If not, check for defective rms converter U8, or switch U9.

24. Move the oscilloscope probe back to TP10 and enter SPCL 3 to set the 50.00 modulation range. Set the audio analyzer to the following levels and observe the resulting waveforms. The '*' in [illegible] of the indication means that the voltage will be initially higher and then change to the indicated value.

| Analyzer Level (millivolts) | Indication (volts peak-peak) |
|---|---|
| 0 | baseline noise |
| 0.5 | 6 |
| 1 | *6 |
| 2 | *5 |
| 5 | *6 |
| 10 | *6 |
| 20 | *5 |
| 50 | *6 |
| 100 | *6 |
| 200 | *5 |
| 500 | *6 |
| 1000 | 12.4 |

If the indications are incorrect, isolate the defective analog switch U5 or U4, or refer to logic signals troubleshooting below.

25. Set the audio analyzer to 600 millivolts and move the oscilloscope probe to pin 21 of the edge connector. The signal should be 380 millivolts peak-to-peak with a period of 1 millisecond. If not, the problem is on the Filter board.

26. Move the oscilloscope probe to pin 6 of U21. The signal should be as in Figure 6-6,C. If not, replace defective U21.

27. Move the oscilloscope probe to the cathode of CR5. The signal should be a half-wave rectified signal 380 millivolts peak with a period of 1 millisecond. If not, isolate defective component in average detector circuit using dc and waveform measurements.

28. Move the oscilloscope probe to pin 10 of U9 The voltage should be about 0.12 volts dC. If not, isolate defective component R45, C33, or U9.

## 6-86. LOGIC SIGNALS.

6-87. Proper operation of the DETECTOR circuits depend on correct logic levels on the following control lines:

**IA2-IA7..............................................instrument address bus**
**ID0-ID7..............................................instrument data bus**

6-88. The instrument address lines IA2-IA5 are decoded by U2 to produce latch strobes. IA7 is a write strobe and IA6 is a read strobe. Logic signals on the instrument data bus are transferred into octal latch, U3, when addresses IA2 and IA5 are low, and IA3 and IA4 are high, and IA7 goes from high to low. Similarly data is transferred into U10 when address when IA5 is low and IA2-IA4 are high, and IA7 goes from high to low. To troubleshoot the logic circuits proceed as follows:

1. With the Model 8201-S/10 powered up normally and configured as in the troubleshooting section, depress the INIT key.

2. Use the oscilloscope to monitor activity on the instrument data lines ID0-ID7 on pins 1-7 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Set the audio analyzer level to 600 millivolts at 1 kHz, enter 15 MHz into the Model 8201 carrier FREQ display, and depress the RMS key.

4. Connect the oscilloscope probe to pin 16 (IA7) of the edge connector and set the timebase to 0.5 mSEC/DIV.

5. The signal should be a narrow positive pulse indicating a write operation to the instrument circuits. If the signal is incorrect, the problem is on the CPU board or the Motherboard interconnect.

6. Move the oscilloscope probe to pin 19 of U2 and change the audio analyzer level to 100, then 200, and back to 600 millivolts. The signal should be as in the previous step, except that the pulse is inverted. If not, replace defective U2.

7. Move the oscilloscope probe to pin 18 of U2. The signal should be as in the previous step. If not, replace defective U2.

8. Enter SPCL 3 to hold the 50.00 modulation range, then set the audio analyzer to the indicated levels, in millivolts, and note the activity on pins 2, 5, 6, 9, 12, and 15 of U3.

| LEVEL | PIN 2 | PIN 5 | PIN 6 | PIN 9 | PIN 12 | PIN 15 |
|---|---|---|---|---|---|---|
| 0 | low | low | low | high | low | low |
| 1 | high | low | low | low | low | low |
| 2 | low | high | low | low | low | low |
| 5 | low | low | high | low | low | low |
| 10 | high | low | low | low | low | high |
| 20 | low | high | low | low | low | high |
| 50 | low | low | high | low | low | high |
| 100 | high | low | low | low | high | high |
| 200 | low | high | low | low | high | high |
| 500 | low | low | high | low | high | high |
| 1000 | low | low | high | low | high | high |

If the indications are incorrect, replace defective U3.

9. Select the PEAK + - detector and move the oscilloscope probe to pin 5 of U10. The signal should be alternating between logic high and logic low with a period of about 1.5 seconds. If not, replace defective U10 or U1.

10. Move the oscilloscope probe to pin 6 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U6.

11. Move the oscilloscope probe to pin 9 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U7.

12. Move the oscilloscope probe to pin 12 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U7.

13. Move the oscilloscope probe to pin 15 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

14. Move the oscilloscope probe to pin 16 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

15. Move the oscilloscope probe to pin 19 of U10. The signal should be similar to the previous step. If not, replace defective U10 or U9.

16. Move the oscilloscope probe to pin 2 of U10. The signal should be a logic 0 ( 0 volts) If not, replace defective U10 or U1.

### 6-89. TROUBLESHOOTING, CPU BOARD.

**6-90. GENERAL.** Procedures for checking the CPU circuit board are given below. Test p· · and other measurement points are indicated on the schematic diagram and circuit board overlay Figures 8-22 and 8-23. T: 'PU circuitry in the Model 8201 uses a 16-bit microprocessor in a bus-oriented system. Most of the high speed circuitry is contained on the CPU board and external signals are buffered. As a result, failures of one or more peripheral circuits will generally identify the section to troubleshoot.

**6-91. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications. Note that for several of the tests a logic probe could be substituted for the oscilloscope.

**Oscilloscope........................................HP 1740A**
**DC voltmeter........................................Fluke 8840A**
**Logic Analyzer....................................none specified**

**CAUTION**

*When extracting or inserting the CPU board, be careful not to damage connector J2, J3, or the associated flat-cable wiring.*

### 6-92. PROCEDURE.

1. With the instrument power off, remove the CPU board (Blue Extractors). Insert the Extender board into the CPU slot and insert the CPU board into the extender board.

2. Measure the dc voltage from the ' + ' terminal of BT1 to ground. The voltage should be greater than 2.8 volts. If not, proceed to BATTERY REPLACEMENT below.

3. Turn on the instrument power and depress the INIT key if the keyboard is active.

4. Measure the dc voltage at pin 28 of U10. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L2 could cause the problem.

5. Measure the dc voltage at pins 8 and 4 of U27. The voltages should be +15 and -15 volts respectively. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L1 or L3 could cause the problem.

**NOTE**

*For the following oscilloscope measurements, use a high impedance probe with a short ground connection. A spring clip type ground connection is recommended.*

### 6-93. CLOCK AND TIMING.

6. Connect the oscilloscope probe to pin 1 of U1. The signal should be a TTL level signal with a period of 54 nanoseconds (18.432 MHz). If not, replace defective Y1.

7. Move the oscilloscope to pin 3 of U1. The signal should be a TTL level signal with a period of 108 nanoseconds (9.21 MHz). If not, replace defective U1.

8. Move the oscilloscope to pin 6 of U1. The signal should be a TTL level signal with a period of 271 nanoseconds (3.68 MHz). If not, replace defective U1.

9. Move the oscilloscope to pin 13 of U1. The signal should be a TTL level signal with a period of 542 nanoseconds (1.84 MHz). If not, replace defective U1.

## 6-94. RESET and POWER FAIL.

10. Connect the oscilloscope to pin 5 of U4. The signal should be TTL logic high. If not, replace a defective U4, or U6.

11. Move the oscilloscope to pin 5 of U3. The signal should be TTL logic high. If not, replace defective U3 or U6.

12. Move the oscilloscope to pin 8 of U3. The signal should be TTL logic high. If not, replace defective U3 or U6.

13. Move the oscilloscope to pin 19 of U9. The signal should be TTL logic high. If not, replace defective U9 or U11.

14. Use a clip lead to momentarily short pin 5 of U4 to ground. Monitor the signal on pin 11 of U9. The signal should be TTL low when U4 pin 5 is ground. If not, replace defective U9.

15. Repeat the procedure but monitor the signal on pin 9 of U9. The signal should be TTL high. If not, replace defective U9.

## 6-95. CPU AND MEMORY.

16. If the microprocessor is halted LED DS2 will be illuminated. If this is the case a data bus fault has probably occurred. In this event a logic state analyzer is the most direct method of isolating the problem, however, parts substitution could be used as a last resort. The state of the data bus is tabulated below for the first several machine cycles. Refer to the manual for the particular logic analyzer for instructions for connecting to the DATA bus and clock signals. If data pattern errors occur the most likely problem is the eproms, however, DATA or ADDRESS bus shorts could also be the problem.

| Address Bus(Hex) | D15————D00(Binary) |
|---|---|
| 00000000 | 0000.0000.0000.0000 |
| 00000002 | 1000.1000.1000.1000 |
| 00000004 | 0000.0100.0000.0000 |
| 00000400 | 0010.0000.0011.1001 |
| 00000402 | 1010.1010.1010.1010 |
| 00000404 | 0101.0101.0101.0101 |
| 00000406 | 0010.0000.0011.1001 |
| 00000408 | 1111.1111.1111.1111 |
| 0000040A | 0000.0000.0000.0000 |
| 0000040C | 0100.1110.1111.1001 |

17. Remove the logic analyzer, turn off the instrument power and remove the CPU board far enough to install jumper, JP2.

18. Turn on instrument power and Monitor the activity on pins 1-4, 37-40, and 18-25 U22. The signal should be a TTL signal with a period of 47.5 milliseconds. If not replace defective U22 or isolate shorted instrument address or data bus line.

## 6-96. A/D CONVERTER.

6-97. Proper operation of the CPU circuits is necessary for the correct operation of the A/D converter. The A/D conversion is a 13-bit successive approximation technique using a high performance 16-bit D/A converter in a software loop. To troubleshoot the A/D converter, proceed as follows:

19. Select SPCL 38 to activate the D/A converter test program.

20. Connect the oscilloscope to pin 15 of U23. The signal should be a slowly varying signal which moves from -10 to +10 volts. The oscilloscope should be dc coupled for this measurement. If not, replace defective U23.

21. Select SPCL 39 to activate the A/D measurement test program. Connect the oscilloscope probe to pin 5 of R11. The signal should be as shown in Figure 6-8. If not replace defective U23 or U27.

22. Move the oscilloscope probe to pin 7 of U27. The signal should be negative going TTL pulses about 1 microseconds wide occurring about every 35 microseconds. If not replace defective U27.

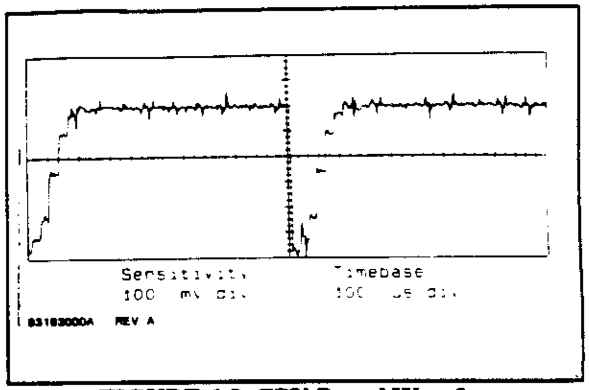


FIGURE 6-8. CPU Board Waveform.

## 6-98. IEEE-488 CONTROLLER.

23. Connect the bus analyzer to the IEEE-488 bus connector on the rear panel of the Model 8201. Set the analyzer as follows:

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

24. Connect the oscilloscope probe to pin 9 of U24. Operate bus switch 1 on the analyzer alternately from 0 to 1. The signal should alternate between 0 and +3.5 volts. If not, the problem is in the connectors or cable connecting the bus analyzer to the CPU board.

25. Move the oscilloscope probe to pin 12 of U24 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U24 or U19.

26. Repeat the previous two steps for pins 2-8 and 19-13 of U24 using bus analyzer switches 2-8. The results should be the same. If not, replace defective U24 or U19.

27. Connect the oscilloscope probe to pin 2 of U25. Operate the REN switch on the analyzer alternately from 0 to 1. The signal should alternate between 0 and +3.5 volts. If not, the problem is in the connectors or cable connecting the bus analyzer to the CPU board.

28. Move the oscilloscope probe to pin 19 of U25 and repeat the previous step. The signal should alternate between 0 and +5 volts. If not, replace defective U19 or U25.

29. Repeat the previous two steps for pins 3, 7, 8 and 18, 14, 13 of U25 using the bus analyzer IFC, EOI, and ATN switches. The results should be the same. If not, replace defective U19 or U25.

30. Set the bus analyzer bus switches as follows:

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

31. Monitor the activity on pin 1 of U25 and activate the ATN line of the bus analyzer and depress the EXECUTE button. The signal should change from TTL high to low. If not, replace defective U19.

32. Monitor pin 1 of U25 and activate the bus analyzer IFC switch. Pin 1 should go high.If not, replace defective U25.

33. Set the bus analyzer bus switches as follows:

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

36. Set the REN switch ON, observe the signal on pin 39 of U19 and depress the EXECUTE key on bus analyzer. The signal should pulse low then return high. If not, troubleshoot the Display board.

**6-99. BATTERY REPLACEMENT.**

6-100. To replace the lithium battery proceed as follows:

1. Remove the instrument top cover as described at the beginning of this section.

2. Carefully disconnect the flat cables from J2 and J3.

3. Extract the CPU board (Blue extractors) and place the board on a flat working surface with the components facing down.

4. Use a low-wattage soldering iron and a solder suction device to remove the solder from the two large circuit pads holding the battery. Remove and discard the old battery.

5. Insert the new battery into the circuit pads, observing polarity, and solder the connections.

6. Install jumpers JP1 and JP2, then replace the CPU board into the Motherboard slot. Reconnect the flat cables to J2 and J3.

7. Turn the Model 8201 ON and observe the FREQUENCY/LEVEL display until the firmware code number and the 'CLEAR' message is displayed. This action clears the variable memory on the CPU board.

8. Turn off the Model 8201, extract the CPU board far enough to remove jumpers JP1 and JP2, then reseat the CPU board and replace the top cover.

**6-101. TROUBLESHOOTING, COUNTER BOARD.**

6-102. **GENERAL.** Procedures for checking the COUNTER circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-24 through 8-27.

6-103. **EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope......................................HP 1740A**
**DC voltmeter ...................................Fluke 8840A**

**6-104. PROCEDURE.**

1. Turn off the instrument and remove the Counter board (Violet Extractors). Insert the Counter board into the Extender board (Grey extractors), and plug the combination back into the Counter board slot. Remove the EXT REF connection on the rear panel.

2. Turn on the instrument power and depress the INIT key if the keyboard is active.

3. Measure the dc voltage at pin 16 of U3. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L3 could cause the problem.

4. Measure the dc voltage at pins 8 and 4 of AR1. The voltages should be +15 and -15 volts respectively. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or open L1 or L2 could cause the problem.

## NOTE

*For the following oscilloscope measurements, use a high impedance probe with a short ground connection. A spring clip-type ground connection is recommended.*

### 6-105. GATE CIRCUITS.

1. Connect the oscilloscope probe to pin 3 of U20. The signal should be a TTL level signal with a period of 100 nanoseconds (10 MHz). If not, replace defective Y1 or check U20 or U4 for shorted pins.

2. Move the oscilloscope to pin 6 of U20. The signal should be a TTL signal with a period of 200 nanoseconds (5 MHz). If not, replace defective U20.

3. Move the oscilloscope to pin 9 of U20. The signal should be a TTL signal with a period of 400 nanoseconds (2.5 MHz). If not, replace defective U20.

4. Move the oscilloscope to pin 21 of the edge connector. The signal should be a dc level of about + 2.5 volts. If not, check for shorted EXT REF cable or defective U1.

5. Move the oscilloscope to pin 6 of U1. The signal should be TTL low logic level. If not, replace defective U1.

6. Move the oscilloscope to pin 8 of U1. The signal should be TTL high logic level. If not, replace defective U1 or check for shorted U4.

7. Move the oscilloscope to pin 2 of U1. The signal should be TTL low logic level. If not, replace defective U1 or check for shorted U4, C8, or open CR1.

8. Move the oscilloscope to pin 12 of U1. The signal should be TTL high logic level. If not, replace defective U1 or check for shorted U4.

9. Move the oscilloscope to pin 11 of U4. The signal should be a TTL signal with a period of 100 nanoseconds (10 MHz). If not replace defective U4.

10. Move the oscilloscope to pin 6 of U4. The signal should be as in the previous step. If not, replace defective U4 or check for shorted U5 or U9.

11. Move the oscilloscope to pin 7 of U5. The signal should be a TTL signal with a period of 10 microseconds (0.1 MHz). If not, replace defective U5.

12. Move the oscilloscope to pin 7 of U7. The signal should be a TTL signal with a period of 1 millisecond (1 kHz). If not, replace defective U7.

13. Move the oscilloscope to pin 9 of U8. The signal should be a TTL signal with a period of 10 milliseconds (0.1 kHz). If not, replace defective U8.

### 6-106. SOURCE SIGNALS.

1. Set the signal generator to 15 MHz, 0 dBm, and 45 kHz deviation at a 1 kHz rate.

2. Connect the RF OUT of the generator to the RF IN of the Model 8201. Key 15 MHz into the carrier FREQ display. (Ignore any frequency setting errors which may occur).

3. C[illegible]ct the oscilloscope probe to pin 30 of the edge connector. The signal should be a sinewave with an amplitude of ab[illegible]0 millivolts peak-to-peak with a period of 26 nanoseconds. If not, the problem is in the oscillator circuits or the interco[illegible]ing cable.

4. Move the oscilloscope probe to pin 11 of U1. The signal should be as in the previous step except that the amplitude should be 3 volts peak-to-peak. If not, replace defective Q1 or check for shorted C6, CR2, or U1.

5. Move the oscilloscope probe to pin 10 of U1. The signal should be as in the previous step except that the amplitude should be 3.5 volts peak-to-peak. If not, replace defective U1 or check for shorted U9.

6. Move the oscilloscope probe to pin 32 of the edge connector. The signal should be about 700 millivolts peak-to-peak with a period of 800 nanoseconds. If not, the problem is in the RF circuits or the interconnecting cable.

7. Move the oscilloscope probe to pin 3 of U9. The signal should be as in the previous step except that the amplitude should be 3.5 volts peak-to-peak. If not, replace defective Q2 or check for shorted C5 or U9.

8. Move the oscilloscope probe to pin 34 of the edge connector. The signal should be about 2.2 volts peak-to-peak with a period of 1 millisecond. If not, the problem is on the FILTER board, A6 or the Motherboard interconnect.

9. Move the oscilloscope probe to pin 7 of AR1. The signal should be as a square wave with an amplitude of 5 volts peak-to-peak and a period of 1 millisecond. If not, replace defective AR1 or check for shorted U1 or U2.

10. Move the oscilloscope probe to pin 4 of U1. The signal should be as in the previous step except that the signal swings should be TTL. If not, replace defective U1 or check for shorted U9.

11. Set the signal generator modulation rate to 10 kHz. Enter SPCL function 3 to hold the modulation range setting, then depress the audio FREQ key.

12. Connect the oscilloscope probe alternately to pin 2, 6 and 9 of U6. The signal should be a pair of negative TTL pulses occuring about every 1.2 seconds. If not, refer to A9, CPU board troubleshooting.

13. Move the oscilloscope probe to pin 5 of U2. The signal should be as in the previous step except that the pulses are positive going. If not, replace defective U2 or U4.

14. Move the oscilloscope probe to pin 5 of U9. The signal should be a composite TTL signal. One signal has a period of 100 microseconds and is gated by a signal with a period of 100 milliseconds. If not, replace defective U9 or U10.

### 6-107. COUNTER CHAIN, DECODER, and BUS BUFFERS.

1. Disconnect the Generator signal and depress the INIT key on the front panel of the Model 8201.

2. Use the oscilloscope to monitor the activity on the instrument data lines ID0-ID7 on pins 1-8 of the edge connector. All of the data lines should show activity and normal TTL levels. If not, the problem is on the CPU board or the Motherboard interconnect.

3. Select SPCL 36 to activate the counter test program.

4. Connect the oscilloscope to the indicated pin of U3. The strobe signal should be a negative going TTL pulse. If not, check the activity on the instrument address bus IA2-IA7 on pins 11-16 of the edge connector. The correct signals are tabulated below. If these signals are not correct, the problem is on the CPU board, otherwise replace defective U3. State of instrument address lines IA2-IA5 while IA6 is high and the corresponding strobe signal.

| IA2 | IA3 | IA4 | IA5 | Strobe(U3) |
|---|---|---|---|---|
| low | low | low | high | pin 15 |
| high | low | low | high | pin 14 |
| low | high | low | high | pin 13 |
| high | high | low | high | pin 12 |

State of instrument address lines IA2-IA5 while IA7 is high and the corresponding strobe signal.

| IA2 | IA3 | IA4 | IA5 | Strobe(U3) |
|---|---|---|---|---|
| high | high | low | high | pin 7 |

5. Connect the oscilloscope to pin 11 of U10. The signal should be TTL composite signal consisting of one waveform with a period of 25 nanoseconds gated off temporarily about every 2.5 seconds. If not, replace defective U9 or U10.

6. Connect the oscilloscope to pin 13 of U10. The signal should be negative TTL pulse signal occurring about every 2.5 seconds indicating proper counter reset action. If not, check bus buffer U15 by monitoring pins 9 and 8 for activity. If these signals are not correct, the problem is most likely on the CPU board.

7. Move the oscilloscope probe to pin 2 of U11. The signal should be as in the previous step, except the pulse is positive going. If not, replace defective U11 or check for shorted U13 or U14.

8. Move the oscilloscope probe to pin 9 of U10. The signal should be TTL composite signal consisting of one waveform with a period of 50 nanoseconds gated off temporarily every 2.5 seconds. If not, replace defective U10 or check for shorted U19.

9. Move the oscilloscope probe to pin 5 of U10. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U10 or check for shorted U19.

10. Move the oscilloscope probe to pin 5 of U12. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U12 or check for shorted U19.

11. Move the oscilloscope probe to pin 9 of U12. The signal should be similar to the previous step, except the high frequency component of the signal is divided by two. If not, replace defective U12 or check for shorted U19.

12. Repeat the above step for pins 9, 7, 6, 5, 3, 2, 4, 13, 12, 14, 15, and 1 of U14. In each case the higher frequency signal component should reduce in frequency by a factor of two for each pin. If not, replace defective U14, or check for shorted U19 or U18.

13. Repeat the above step for pins 9, 7, 6, 5, 3, 2, 4, 13, 12, 14, 15, and 1 of U13. In each case the higher frequency signal component should reduce in frequency by a factor of two for each pin. If not, replace defective U13, or check for shorted U16 or U17.

14. If all of the above checks are correct, but the counter still does not operate properly, the problem is with the bus buffers U16-U19. Isolate the problem by interchanging or replacing the buffers one at a time.

### 6-108. CALIBRATOR CIRCUITS.

1. Connect the oscilloscope probe to pin 9 of U22. The signal should be a TTL waveform with a period of 800 nanoseconds (1.25 MHz). If not, replace defective U22.

2. Move the oscilloscope probe to pin 15 of U22. The signal should be a TTL waveform with a period of 800 microseconds. (1.221 kHz). If not, replace defective U22.

3. Move the oscilloscope probe to pin 12 of U11. The signal should be as in the previous step. If not, replace defective U11 or check for shorted U24.

4. Move the oscilloscope probe to pin 11 of U23. The signal should be a complex TTL waveform with two distinct frequency components. Synchronize the oscilloscope on the negative slope of the signal and adjust the timebase to 0.2 uSEC/DIV. The display should show one signal with a period of 4 divisions and one with a period of 5 divisions. If not, replace defective U23 or check for shorted U24.

5. The signals on pins 2 and 14 of U24 control the output signals on pins 7 and 9. The logic levels and corresponding outputs are:

| 2 | 14 | 7 | 9 |
|---|---|---|---|
| low | low | low | low |
| low | high | 1.25 MHz | 1.221 kHz |
| high | low | 1.0/1.25 MHz | high |
| high | high | low | low |

When the calibration routine is activated, the progression is from line 1 to line 2 to line 3 of the above table. Execute the calibration routine by executing SPCL function 30, and observe the results. The signals should be as indicated. If not, replace defective U24 or bus buffer U15.

6. The initial phase of calibration is the AM detector calibration. The signals indicated in the following tests are measured during this initial phase. If the tests are not completed in the time required for one AM calibration cycle, depress the INIT key and then execute SPCL function 30 to resume AM calibration.

7. Connect the oscilloscope to pin 3 of AR3. The signal should be a sinewave with an amplitude of 2 volts peak-to-peak and a period of 800 nanoseconds. If not, isolate the defective component in low-pass filter L5-L6, and C17, C18, and C20 by waveform measurements.

8. Move the oscilloscope to pin 6 of AR3. The signal should be a sinewave with an amplitude of 6.4 volts peak-to-peak and a period of 800 nanoseconds. If not, replace defective AR3.

9. Move the oscilloscope to pin 2 of U21. The signal should be as in the previous step, except the amplitude should be 4.8 volts peak-to-peak. If not, replace defective R20 or U21.

10. Move the oscilloscope to pin 15 of U21. The signal should be as in the previous step, except the amplitude should be 1.6 volts peak-to-peak. If not, replace defective R20 or U21.

11. Move the oscilloscope to pin 1 of U21. The signal should be a TTL waveform with a a period of 800 microseconds. If not, check for shorted C19 or open R26 or shorted U21.

12. Move the oscilloscope to pin 3 of U21. The signal should be a sinewave with a period of 800 nanoseconds amplitude modulated by a squarewave with a period of 800 microseconds. The carrier amplitude should have two distinct levels, 1.6 and 4.8 volts peak-to-peak. If not, replace defective U21.

13. Move the oscilloscope to pin 6 of AR2. The signal should be as in the previous step, except the amplitude should be 0.4 and 1.2 volts peak-to-peak. If not, replace defective AR2.

14. If the above tests are all correct, but the problem persists, the trouble is with the RF circuits, or the interconnecting cable.

### 6-109. TROUBLESHOOTING, I/O BOARD.

6-110. **GENERAL.** Procedures for checking the I/O circuit board are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-28 and 8-29.

6-111. **EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

Oscilloscope .................................... HP 1740A
DC voltmeter .................................... Fluke 8840A

### 6-112. PROCEDURE.

1. With the instrument power off, remove the top and bottom covers.

2. Remove the right side strap handle by removing two 6-32 screws holding the handle covers, and three 6-32 screws holding the handle extrusion.

3. Turn on the instrument power and depress the INIT key if the keyboard is active.

4. Measure the dc voltage at pin 40 of U3. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or defective power connector, J2 could cause the problem.

## NOTE

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

### 6-113. ADDRESS DECODER.

1. Connect the oscilloscope probe to pin 1 of U1. The signal should be a series of negative going TTL pulses indicating board selection. If not, the problem is on the CPU board or the interconnecting wiring.

2. Move the oscilloscope to pins 2 and 3. Observe a TTL signal indicating activity on the CPU address bus. If not, the problem is on the CPU board or the interconnecting wiring.

3. Move the oscilloscope to TP1. The signal should be a negative going TTL pulse indicating chip select activity for U2. If not, replace defective U1.

4. Move the oscilloscope to TP3. The signal should be a negative going TTL pulse indicating chip select activity for U3. If not, replace defective U1.

### 6-114. DISPLAY/KEYBOARD CONTROLLERS

1. Connect the oscilloscope probe to pin 3 of U3. The signal should be a TTL logic waveform with a period of 400 nanoseconds. If not, the problem is on the CPU board or the interconnecting wiring.

2. Move the oscilloscope probe to pin 9 of U3. The signal should be a TTL low dc level indicating proper reset circuit operation. If not, the problem is on the CPU board or the interconnecting wiring.

3. Move the oscilloscope probe to pin 21 of U3. The signal should be a TTL logic waveform indicating proper operation of the CPU A1 address line. If not, the problem is on the CPU board or the interconnecting wiring.

4. Move the oscilloscope probe to pins 10 and 11 of U3. The signal should be a TTL logic waveform indicating proper operation of the CPU read and write lines. If not, the problem is on the CPU board or the interconnecting wiring.

5. Move the oscilloscope probe to pin 22 of U3. The signal should be a negative going TTL pulse indicating read and write activity. If not, the problem is in the decoder section. See above.

6. Move the oscilloscope probe to pin 22 of U2. The signal should be as in the previous step. If not, the problem is in the decoder section. See above.

7. Enter 1 GHz into the carrier FREQ display and monitor the activity on pins 23-35 of U3. The signals should be TTL logic waveforms indication proper multiplexing of the display information. If not, replace defective U3 or check for shorted connections in J3.

## NOTE

*The I/O board may be removed if necessary to isolate a defective J3 or Display board.*

8. Repeat the measurements of step 7 on U2. The results should be the same. If not, replace defective U2 or proceed as in the previous step.

9. Move the oscilloscope probe to pin 38 of U2 and hold down the 3 kHz low-pass key. The signal should be a negative going TTL pulse indicating correct operation of the keyboard decoder. If not, the problem is on the display or keyboard.

10. Repeat the previous step with the following pins and keys:

| U2 pin number | key depressed |
|---|---|
| 39 | 15kHz |
| 1 | 20 kHz |
| 2 | 50 kHz |
| 5 | 220 kHz |
| 6 | QUASI-PEAK |
| 7 | RMS |
| 8 | HOLD |

**6-115. TROUBLESHOOTING, DISPLAY/KEYBOARD.**

**6-116. GENERAL.** Procedures for checking the DISPLAY/KEYBOARD circuits are given below. Test points and other measurement points are indicated on the schematic diagram and circuit board overlay, Figures 8-30 through 8-35.

**6-117. EQUIPMENT REQUIRED.** The test equipment required is listed below. See Table 5-1 for critical specifications.

**Oscilloscope.................................HP 1740A**
**DC voltmeter...............................Fluke 8840A**

**6-118. PROCEDURE.**

1. With the instrument power off, remove the top and bottom covers. Extract the CPU (blue extractors) far enough to install jumper JP2, then reseat the CPU board.

2. Remove the display and front panels as described above to gain access to the display and keyboards.

3. Turn the instrument power ON. The instrument should power up normally, and then illuminate all displays, annunciators, and keyswitch LEDs. If any of the display segments or individual LEDs are not illuminated the associated display or switch LED is most likely defective. Groups of displays with missing segments or groups of keyswitch LEDs not illuminated indicates a defective driver or decoder.

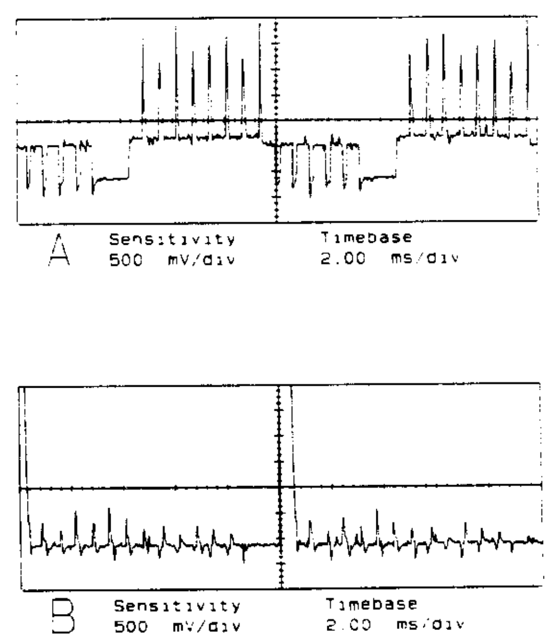



**FIGURE 6-9. Display Board Waveforms.**

4. Turn the instrument power OFF and remove the keyboard by removing eight 6-32 screws and gently pulling the board away from the display board.

5. Turn the instrument power ON and measure the dc voltage at pin 20 of U13. The voltage should be +5 volts. If not, the problem is most likely in the power supply circuits, however, shorted bypass capacitors or defective power connector, J4 on the I/O board could cause the problem.

## NOTE

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

## 6-119. FREQUENCY/LEVEL AND AUDIO DISPLAYS.

1. Connect the oscilloscope probe to pins 1 through 8 of U1 and verify that the segment drive signals are active. If not, the problem is on the I/O board or connector P3.

2. Move the oscilloscope to pins 11-18 of U1. The signal should appear as in Figure 6-7,A. If not, replace defective U1.

3. Repeat the measurements of the previous step on U3. The results should be the same. If not, replace defective U3.

4. Move the oscilloscope probe to pin 1 of of U2. The signal should be a TTL squarewave with a period of 1.3 milliseconds, indicating correct operation of the display controllers on the I/O board. If the signal is not present, the problem is on the I/O board or the connector P3.

5. Repeat the previous step for pins 2, 3, and 5 or U2. The signal is similar with a period of 2.5, 5, and 10 milliseconds respectively. If the signals are not present, the problem is on the I/O board or the connector P3.

6. Move the oscilloscope to pin 15 of U2. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 10 milliseconds. If not, replace defective U2.

7. Repeat the previous step for pins 7, and 9 through 14 of U2. The results should be the same. If not, replace defective U2.

8. Repeat the previous step for pins 7, and 9 through 15 of U4. The results should be the same. If not, replace defective U4.

9. Move the oscilloscope to pin 18 of U5. The signal should be as in the previous step. If not, replace defective U5.

10. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, and 16 of U5. The results should be the same. If not, replace defective U5.

11. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, 16, and 18 of U6. The results should be the same. If not, replace defective U6.

12. Move the oscilloscope to pin 1 of U5. The signal should be a negative going TTL pulse 150 microseconds wide occurring every 0.64 milliseconds, indicating correct operation of the display controller blanking signal on the I/O board. If not, the problem is on the I/O board or connector, P3.

13. Move the oscilloscope to pin 18 of U7. The signal should be as in Figure 6-7,B. If not, replace defective U7.

14. Repeat the previous step for pins 11 through 17 of U7. The results should be the same. If not, replace defective U7.

15. Repeat the previous step for pins 13 through 18 of U8. The results should be the same. If not, replace defective U8.

## 6-120. MODULATION, SPCL/PRGM, AND KEYSWITCH LEDS.

1. Connect the oscilloscope probe to pins 1 through 8 of U9 and verify that the segment drive signals are active. If not, the problem is on the I/O board or connector P3.

2. Move the oscilloscope to pins 11-18 of U9. The signal should appear as in Figure 6-8,A. If not, replace defective U9.

3. Repeat the previous step using U11. The results should be the same. If not, replace defective U11.

4. Move the oscilloscope probe to pin 1 of of U10. The signal should be a TTL squarewave with a period of 1.3 milliseconds, indicating correct operation of the display controllers on the I/O board. If the signal is not present, the problem is on the I/O board or the connector P3.

5. Repeat the previous step for pins 2, 3, and 6 of U10. The signal is similar with a period of 2.5, 5, and 10 milliseconds respectively. If the signals are not present, the problem is on the I/O board or the connector P3.

6. Move the oscilloscope to pin 15 of U10. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 10 milliseconds. If not, replace defective U10.

7. Repeat the previous step for pins 7, and 9 through 14 of U10. The results should be the same. If not, replace defective U10.

8. Repeat the previous step for pins 7, and 9 through 15 of U12. The results should be the same. If not, replace defective U12.

9. Move the oscilloscope to pin 18 of U13. The signal should be as in the previous step. If not, replace defective U13.

10. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, and 16 of U13. The results should be the same. If not, replace defective U13.

11. Repeat the previous step for pins 3, 5, 7, 9, 12, 14, 16, and 18 of U14. The results should be the same. If not, replace defective U14.

12. Move the oscilloscope to pin 1 of U13. The signal should be a negative going TTL pulse 150 microseconds wide occurring every 0.64 milliseconds, indicating correct operation of the display controller blanking signal on the I/O board. If not, the problem is on the I/O board or connector, P3.

13. Move the oscilloscope to pin 18 of U15. The signal should be as in Figure 6-9,B. If not, replace defective U15.

14. Repeat the previous step for pins 11 through 17 of U15. The results should be the same. If not, replace defective U15.

15. Repeat the previous step for pins 11, and 14 through 18 of U16. The results should be the same. If not, replace defective U16.

16. Replace the keyboard, but do not replace the mounting hardware at this time.

**6-121. KEYBOARD.**

1. Connect the oscilloscope probe to pins 1 through 8 of J1 and verify that the segment drive signals are similar to Figure 6-9,A. If not, the problem, is on the Display board or connector J1.

2. Move the oscilloscope to pins 9-13 of J1. The signal should be a appear as in Figure 6-9,B. If not, the problem is on the Display board or connector J1.

3. Move the oscilloscope to pins 1 through 8 of J2. The signal should be a negative going TTL pulse about 0.6 milliseconds wide occurring every 5 milliseconds. If not, the problem is on the Display board or connector J2.

4. Move the oscilloscope to pin 13 of J2 and depress the PRGM key. The signal should be as in the previous step while the key is depressed. If not, the keyswitch is defective.

5. Refer to the schematic diagram for the keyboard and observe the signals on the RL lines as the keyswitches are operated. When none of the keyswitches is depressed, the RL lines should be at TTL high. When the switches are depressed the strobe signal described in the previous steps should be present.

6. Replace the keyboard mounting hardware and reassemble the front panel and display windows.

**6-122. ADJUSTMENTS.**

6-123 The instrument adjustment procedure is described below. The adjustment order is not critical, however, the following sequence is recommended.

6-124. **RF board Adjustments.** There are four adjustments associated with the RF circuit board. These are:

| ADJUSTMENT | PURPOSE |
|---|---|
| R14 | sampling bridge balance |
| R11 | sampling bridge bias, low bands |
| R6 | sampling bridge bias, high bands |
| C78 | IF flatness |

6-125. **Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

| | |
|---|---|
| Low-pass Filter | Mini-Circuits NLP-50 |
| Oscilloscope | HP 1740A |
| Signal Generator | Boonton 1021 |
| Power Meter | Boonton 4200 |

6-126. **Procedure.**

1. Connect the power meter to the RF IN connector of the Model 8201 and set the carrier FREQ to 11.0 MHz. Adjust R14 for a minimum power indication.

2. Set the signal generator to 9.9 MHz, +10 dBm, and about 100 kHz deviation at a 1 kHz rate. Set AM modulation to OFF.

3. Depress the INIT key and enter 9.9 MHz into the carrier FREQ display. Select the 300 Hz high-pass, 3 kHz low-pass, and de-emphasis OFF filters.

4. Connect the generator, through the low-pass filter, to the RF IN connector of the Model 8201.

5. Adjust the generator deviation for a Model 8201 indication of 100 +- 5 kHz deviation.

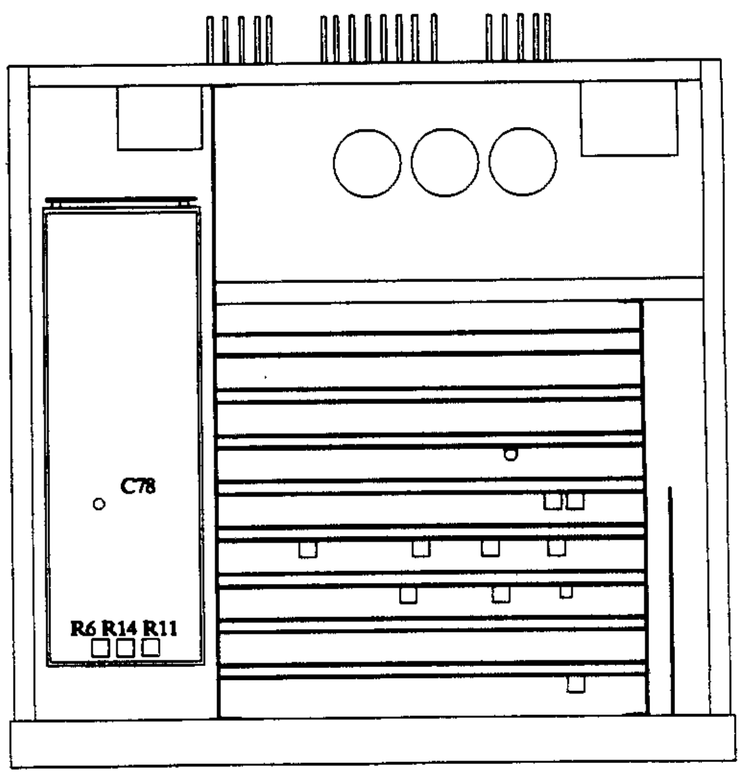
6. Set the oscilloscope to 0.05 V/DIV and 0.5 mSEC/DIV and connect the Model 8201 AF OUT to the vertical input of the oscilloscope using a shielded BNC cable.

7. Depress the AM key and adjust R11 for minimum peak-to-peak deflection on the oscilloscope.

8. Change the generator and Model 8201 frequency to 18.5 MHz.

9. Adjust C78 for minimum peak-to-peak deflection on the oscilloscope.

10. Change the generator and Model 8201 frequency to 10.02 MHz.



11. Adjust R6 for minimum peak-to-peak deflection on the oscilloscope. Note R6 may be at or near one end when the deflection is minimum.

6-127. **Oscillator Board Adjustments.** There are three adjustments on the Oscillator circuit board. These are:

| ADJUSTMENT | PURPOSE |
|---|---|
| T2 | Oscillator 1 tuning |
| T3 | Oscillator 2 tuning |
| R19 | Discriminator centering |

6-128. **Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

| | |
|---|---|
| Signal Generator | Boonton 1021 |
| DC voltmeter | Fluke 8840A |

6-129. **Procedure.**

1. Select SPCL 37 to activate the local oscillator test program. Depress the DEL( ↑ ) key until the modulation display reads " 0 -- LO".

2. Use a nonmetallic screw driver to adjust the slug in T2 until the FREQUENCY/LEVEL display indicates 19.9 +- 0.05 MHz.

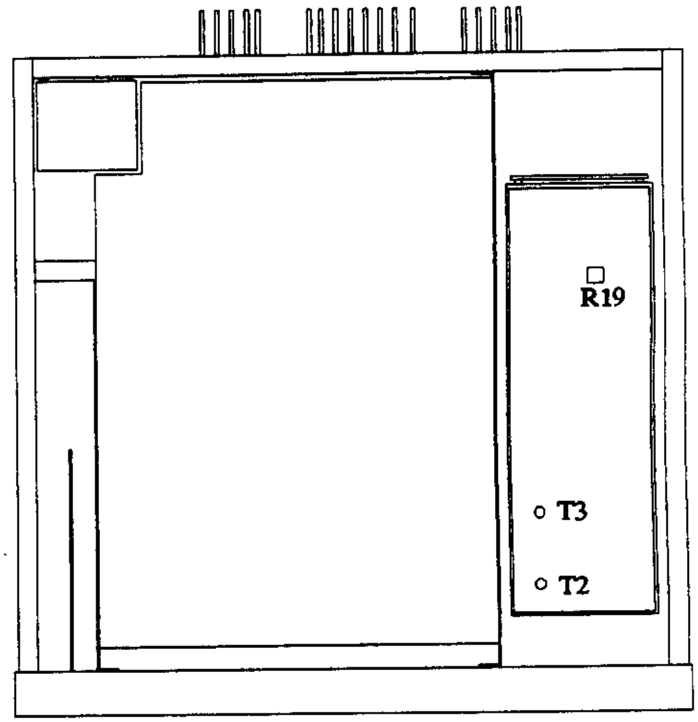
3. Depress the DEL( ↑ ) key until the modulation display reads " 1 -- LO".

4. Use a nonmetallic screw driver to adjust the slug in T3 until the FREQUENCY/LEVEL display indicates 23.8 +- 0.05 MHz.

5. Depress the LCL/INIT key, enter 15 MHz into the carrier FREQ display, and connect the signal generator RF OUT to the Model 8201 RF IN connector.

6. Set the generator frequency to 1.211 MHz CW and 0 dBm.

7. Monitor the dc voltage at TP1 and adjust R19 for an indication of 0 +- 0.02 volts.




83165600A

6-130. **AM Board Adjustments.** There is one adjustment on the AM circuit board. This is:

| ADJUSTMENT | PURPOSE |
|---|---|
| R85 | AM detector offset |

6-131. **Equipment Required.** No additional equipment is required to make the adjustment.

6-132. **Procedure.**

1. Power on the Model 8201 and depress the INIT key.

2. Enter 15 MHz into the carrier FREQ display and depress the LEVEL key.

3. Observe the CARRIER display and adjust R85 full clockwise, and then counter-clockwise for an indication of - 70.8 dBm. Note that the indication will jump in approximately 1 dB increments during the adjustment.

6-133. **Distortion Analyzer Board Adjustments.** There are two adjustments on the DISTORTION ANALYZER circuit board. These are:

**ADJUSTMENT ............................PURPOSE**
**R11 ................................................Balance offset**
**R44 ................................................Tune offset**

6-134. **Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

**Audio Analyzer ............................Boonton 1120**
**Wave Analyzer ..............................HP3581A**

6-135. **Procedure.**

1. With the instrument power off, extract the FM board (Brown extractors) only far enough to disconnect the card-edge connector.

2. Set the audio analyzer source to 600 millivolts at a 1 kHz rate.

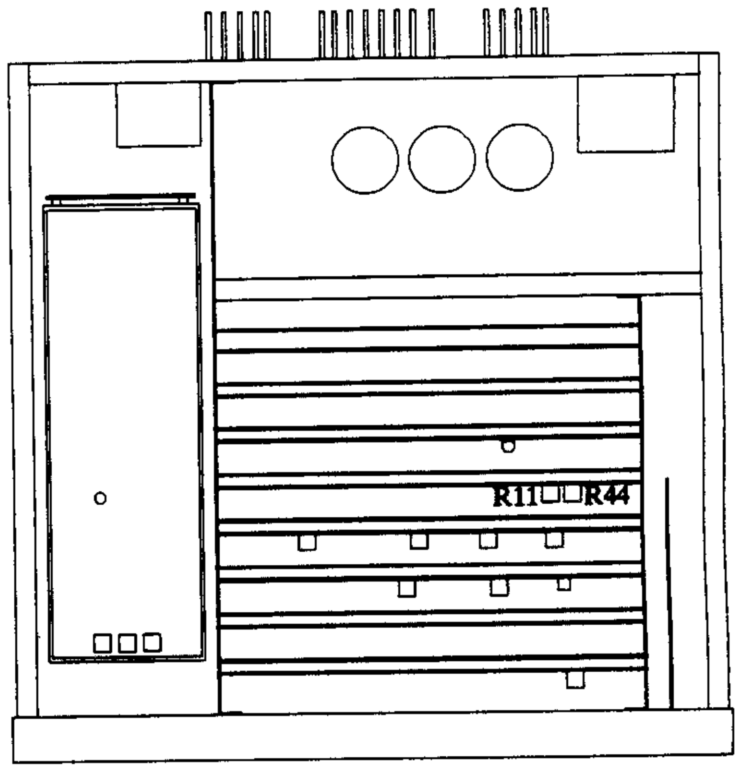
3. Connect the audio analyzer source output to the FM OUT connector on the rear panel of the Model 8201.

4. Turn on the instrument power and depress the INIT key.

5. Enter 15 MHz into the carrier FREQ display and depress the DIST key.

6. Connect the wave analyzer to the DIST OUT connector on the rear panel of the Model 8201.

7. Set the wave analyzer controls as follows:




| | |
|---|---|
| SCALE: | 90 dB |
| FREQUENCY: | 1000 Hz |
| AMPLITUDE REF LEVEL: | NORMAL |
| INPUT SENSITIVITY: | -60 dB |
| SWEEP MODE: | OFF |
| RESOLUTION BANDWIDTH: | 3 Hz |

8. Observe the wave analyzer, and alternately adjust R11 and R44 for a minimum indication. The null should be greater than 100 dB (-60 dB reference plus a -40 dB scale indication).

9. Turn the instrument power OFF and install the FM board into the appropriate Motherboard connector.

R85

**6-136. Detector Board Adjustments.** There is one adjustment on the DETECTOR circuit board. This is:

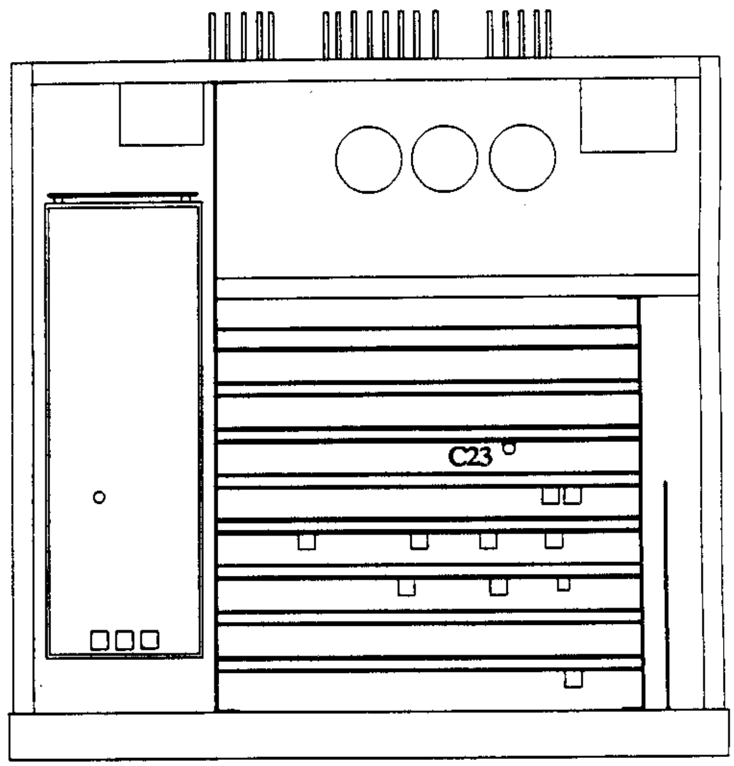
| ADJUSTMENT | PURPOSE |
|---|---|
| C23 | RMS detector frequency response |

**6-137. Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

| | |
|---|---|
| Audio Analyzer | Boonton 1120 |
| DC voltmeter | Fluke 8840A |

**6-138. Procedure.**

1. With the instrument power off, extract the FM board (Brown extractors) only far enough to disconnect the card-edge connector.




3. Set the audio analyzer to 600 millivolts at a 1 kHz rate.

4. Connect the audio analyzer source to the FM OUT connector on the rear panel of the Model 8201.

5. Turn on the instrument power and depress the INIT key.

6. Execute SPCL function 18, enter 15 MHz into the carrier FREQ display, and select the 220 kHz low-pass filter. When the MODULATION display settles, select the RATIO % display mode.

7. Set the audio analyzer to 100 kHz and note the modulation ratio indication.

8. Change the audio analyzer frequency back to 1 kHz and select the RMS detector. Depress the RATIO key twice to restore the 100.0 % indication.

9. Set the audio analyzer to 100 kHz and adjust C23 until the ratio indication on the Model 8201 display is 100.0%.

10. Turn the instrument power OFF, remove the audio analyzer connection, and reseat the FM board into the motherboard connector.

**6-139. Optional Filter Board Adjustments.** There are four adjustments on the OPTIONAL FILTER circuit board. These are:

| ADJUSTMENT | PURPOSE |
|---|---|
| R5 | LOOP-THRU filter gain adjust |
| R8 | CCITT bandpass filter gain adjust |
| R10 | CCIR bandpass filter gain adjust |
| R13 | C-MESSAGE bandpass filter gain adjust |
| R11 | CCIR response |

**6-140. Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

**Audio Analyzer ..............................Boonton 1120**

**6-141. Procedure.**

1. With the instrument power off, extract the FM board (Brown extractors) only far enough to disconnect the card-edge connector.

2. Set the audio analyzer to 600 millivolts at a 1 kHz rate.

3. Connect the audio analyzer source to the FM OUT connector on the rear panel of the Model 8201.

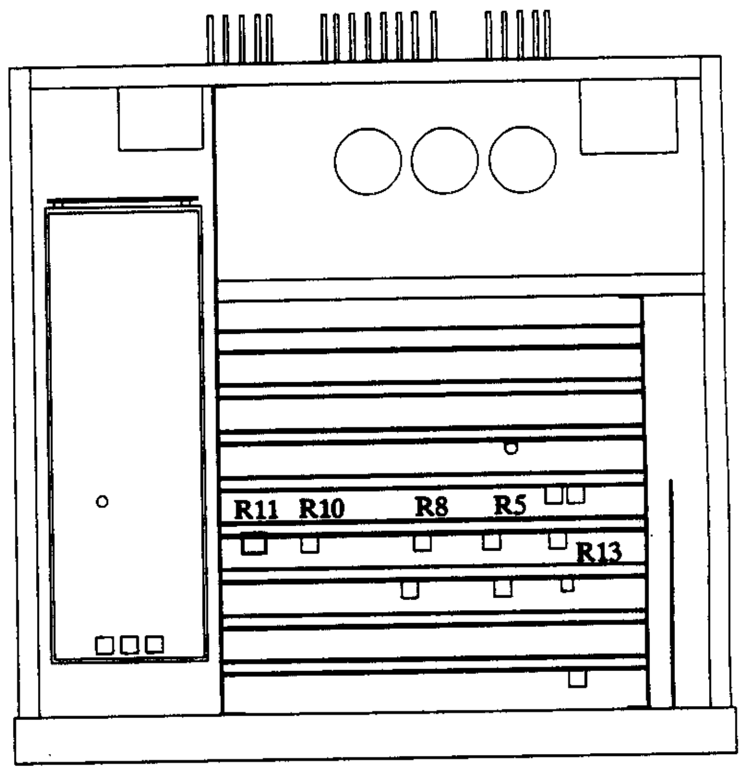
4. Turn on the instrument power and depress the INIT key.

5. Execute SPCL function 18, enter 15 MHz into the FREQUENCY/LEVEL display and select the 220 kHz low-pass filter, and the RMS detector.

6. When the MODULATION display settles, set the audio analyzer to 1 kHz ( 800 Hz for CCITT ), and select the RATIO % display mode.

6. Depress the ALT and appropriate high-pass key to select the filter.

7. Adjust R5 for THRU, R8 for CCITT, R10 for CCIR, or R13 for C-MESSAGE for an indication of 100.0 %.




**NOTE**

*Complete the following steps for the CCIR filter only.*

8. Depress the RATIO key on the Modulation Analyzer to disable this function.

9. Set the audio analyzer to 6.300 kHz and adjust the Analyzer Source LEVEL for an indication of about 49 kHz deviation with the CCIR filter active.

10. Depress the Modulation Meter RATIO and dB/dBm keys to establish a 0.0 dB reference.

11. Change the Analyzer Source frequency to 1.000 kHz, then adjust R11 on the CCIR filter board for an indication of -12.20 +- 0.05 dB.

12. Change the Analyzer Source frequency back to 6.300 kHz. If the display is not 0.00 +- 0.05 dB, repeat steps 9 through 13.

**6-142. Optional 50 MHz Calibrator Adjustment.** There is one adjustment on the 50 MHZ CALIBRATOR assembly. This is:

**ADJUSTMENT................................PURPOSE**
**R4.....................................................Output power level adjust**

**6-143. Equipment Required.** The equipment required to make the adjustments is listed below. See Table 5-1 for critical specifications.

**Milliwatt Test Set ...........................W&G EPM-1 with TK-10**

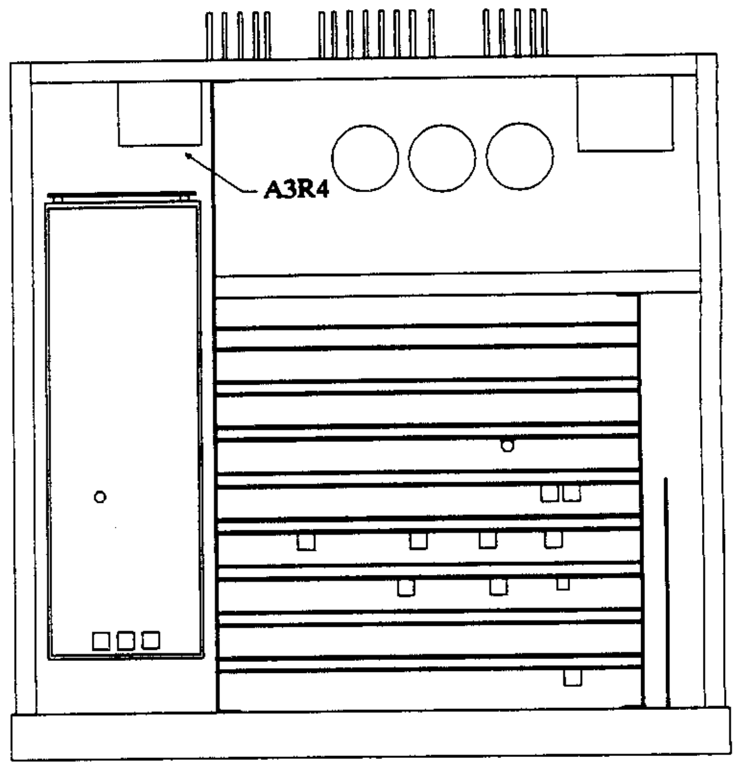
**6-144. Procedure.**

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

2. Power on the Modulation Analyzer and allow at least 30 minutes for warmup.

3. Connect the EPM-1 probe to the PWR REF output on the rear panel of the Modulation Analyzer.

3. Adjust R4 until the Milliwatt Test Set indicates 0.0 dBm.



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# SECTION VII
# PARTS LIST

## 7-1. INTRODUCTION.

7-2. The replaceable parts for the Model 8201 are listed in Table 7-2. The replaceable parts list contains the reference symbol, description, manufacturer, and both the BEC and manufacturer part numbers. Table 7-1 lists the manufacturer's federal supply code numbers.

**TABLE 7-1. MANUFACTURERS FEDERAL SUPPLY CODE NUMBERS.**

| | | | |
|---|---|---|---|
| 00853 | Sangamo Electronics | 31935 | Siemens |
| 00213 | Nytronics | 31918 | ITT Schadow, Inc. |
| 00241 | Fenwall Electronics | 32293 | Intersil, Inc. |
| 01121 | Allen Bradley | 32575 | AMP |
| 01295 | Texas Instruments | 32997 | Bourns |
| 02114 | Ferroxcube Corp. | 33297 | NEC |
| 02735 | RCA Solid State Division | 33883 | RMC |
| 03888 | Pyrofilm (KDI) | 34078 | Midwest Microwave |
| 03911 | Clairex Corporation | 34371 | Harris Semiconductor |
| 04222 | AVX Ceramics Company | 4S177 | International Manufacturing Services |
| 04713 | Motorola Semiconductor | 50316 | Minis Systems Inc. |
| 04901 | Boonton Electronics Corporation | 51406 | Murata Corporation of America |
| 06383 | Panduit Corporation | 51640 | Analog Devices, Inc. |
| 06665 | Precision Monolithics | 54420 | Dage - MTI |
| 06776 | Robinson Nugent, Inc. | 54426 | Buss Fuses |
| 07263 | Fairchild Semiconductor | 54473 | Panasonic |
| 11961 | Semicon | 55153 | Dielectric Labs Inc. |
| 13812 | Dialco Division of Amperex | 56289 | Sprague Electric Company |
| 13919 | Burr Brown Corporation | 57582 | Kahgan Electronics Corporation |
| 14655 | Cornell-Dubilier | 59474 | Jeffers Electronics Inc. |
| 14674 | Corning Glass | 59660 | Tusonix |
| 14752 | Electro Cube, Inc. | 60395 | XICOR |
| 15542 | Mini Circuits Labs. | 61637 | Kemet - Union Carbide |
| 15546 | Centralab | 61935 | Schurter |
| 17117 | Electronics Molding Co. | 64537 | Pyrofilm (KDI) |
| 17856 | Siliconix, Inc. | 71450 | CTS Corporation |
| 18324 | Signetics Corporation | 73138 | Beckman Instruments, Helipot Division |
| 19505 | Applied Eng'r. Products | 81654 | Monitor Products |
| 19701 | Mepco Electra | 82389 | Switchcraft |
| 20307 | Arco - Micronics | 91293 | Johanson |
| 24226 | Gowanda Electronics | 91637 | Dale Electronics |
| 24253 | Pomona | 95077 | Solitron Microwave |
| 24931 | Specialty Connector | 95348 | Gordos Corporation |
| 27014 | National Semiconductor | 95721 | Quality Components Corporation |
| 27264 | Molex, Inc. | 98291 | Sealectro Corporation |
| 27735 | F-Dyne Electronics | S4217 | United Chemicon, Inc. |
| 28480 | Hewlett-Packard Corporation | TOSH | Toshiba America, Inc. |
| 29996 | American Technical Ceramics | HITAC | Hitachi America, Inc. |
| 31313 | Components Corporation | NDK | NDK Inc. |
| 31781 | EDAC | ARMT | Aromat Corporation |

TABLE 7-2. Model 8201 Parts List.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| | 99402300A REV: A* MODEL 8201 | | | | |
| A1 | PWA '8201' MOTHER | 04901 | 08251903A | 1 | 08251903A |
| A2 | '8200' RF HOUSING ASSY | 04901 | 08250502A | 1 | 08250502A |
| A3 | 50 MHZ CALIBRATOR ASSY | 04901 | 08254200A | 1 | 08254200A |
| A4 | PWA '8200' FM | 04901 | 08252200A | 1 | 08252200A |
| A5 | PWA '8200' AM | 04901 | 08251300B | 1 | 08251300B |
| A6 | PWA '8201' FILTER | 04901 | 08265300A | 1 | 08265300A |
| A7 | PWA '8201' DISTORTION ANALYZER | 04901 | 08252001A | 1 | 08252001A |
| A8 | PWA '8201' DETECTOR | 04901 | 08262201A | 1 | 08262201A |
| A9 | PWA '8201' CPU | 04901 | 08262101A | 1 | 08262101A |
| A10 | PWA '8200' COUNTER | 04901 | 08251600B | 1 | 08251600B |
| A11 | PWA '8200-S/10' I/O | 04901 | 08257500A | 1 | 08257500A |
| A12 | PWA '8200' DISPLAY | 04901 | 08251800B | 1 | 08251800B |
| A13 | PWA '8201' KEYBOARD | 04901 | 08251703A | 1 | 08251703A |
| A14 | PWA EXTENDER 36 PIN | 04901 | 08252300A | 1 | 08252300A |
| A15 | PWA OPTIONAL FILTER | 04901 | 08262400A | 1 | 08262400A |
| A22 | '8201' FRAME ASSY | 04901 | 08265103A | 1 | 08265103A |
| A23 | '8201' REAR PANEL ASSEMBLY | 04901 | 08250704A | 1 | 08250704A |
| A25 | '8201' SUB PANEL ASSEMBLY | 04901 | 08265500A | 1 | 08265500A |
| A30 | PROTECT/ATTN HOUSING | 04901 | 08265700A | 1 | 08265700A |
| AT1 | ATTENUATOR 3dB PAD 444-3 | 34078 | 444-3 | 1 | 56202300A |
| W1 | CABLE ASSY SEMIFLEX SMA | 04901 | 57231604A | 1 | 57231604A |
| W2 | CABLE ASSY COAX RG316/U 19.25L | 04901 | 572215000 | 1 | 572215010 |
| W3 | CABLE ASSY COAX RG316/U 19.25L | 04901 | 572213000 | 1 | 572213000 |
| W4 | CABLE ASSY COAX RG316/U 17.25L | 04901 | 572214000 | 1 | 572214000 |
| W5 | CABLE ASSY COAX RG316/U 18.50L | 04901 | 572212000 | 1 | 572212000 |
| W6 | CABLE ASSY COAX RG316/U 9.75L | 04901 | 572206000 | 1 | 572206000 |
| W7 | CABLE ASSY FLAT 24 CKT 9.00 L | 04901 | 92017600A | 1 | 92017600A |
| W8 | CABLE ASSY FLAT 26 CKT 18.50L | 04901 | 92019400A | 1 | 92019400A |

## A1

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| 08251903A | REV: PWA '8201' MOTHER | | | | |
| A1W1 | CABLE ASSY WIRE 22GA 2C 6.500L | 04901 | 571206000 | 1 | 571206000 |
| A1W6 | CABLE ASSY WIRE 22GA 2C 11.00L | 04901 | 571208000 | 1 | 571208000 |
| AR2 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR3 | IC 356P OP AMP | 04713 | LF356N | 1 | 535040000 |
| C1 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C2-3 | CAP EL 220uF 20% 50V | S4217 | SM-50-VB-220 | 2 | 283359000 |
| C4-5 | CAP CER 0.1uF 20% 25V | 51406 | DD312E10Y5P104M25V | 2 | 224364000 |
| C6 | CAP EL 26000uF 20% 16V | 56289 | 622D263M016AC2A | 1 | 283340000 |
| C7 | CAP CER 0.1uF 20% 25V | 51406 | DD312E10Y5P104M25V | 1 | 224364000 |
| C8 | CAP EL 4500uF 20% 35V | 56289 | 622D452M035AA2A | 1 | 283339000 |
| C10 | CAP EL 4500uF 20% 35V | 56289 | 622D452M035AA2A | 1 | 283339000 |
| C11 | CAP CER 0.001uF 10% 100V | 04222 | SR151C102KAA | 1 | 224270000 |
| C13 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C14 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C15 | CAP MICA 270pF 5% 50V | 57582 | KD5271J101 | 1 | 205045000 |
| C16 | CAP CER 0.1uF 20% 25V | 51406 | DD312E10Y5P104M25V | 1 | 224364000 |
| C18-19 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 2 | 283293000 |
| C21 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C22 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C24 | CAP CER 0.01uF 20% 500V | 33883 | BGP Z5U W/FDCL | 1 | 224271000 |
| C25 | CAP TANT 10uF 10% 35V | 56289 | 196D106X903PE4 | 1 | 283353000 |
| CR2 | DIODE BRIDGE FWLD-50 | 11961 | FWLA-50 | 1 | 532028000 |
| CR3-6 | DIODE SIG 1N4001 | 04713 | 1N4001 | 4 | 530151000 |
| CR7 | DIODE ZENER 1N5242B 12V 5% | 04713 | 1N5242B | 1 | 530146000 |
| CR8 | DIODE SIG 1N4001 | 04713 | 1N4001 | 1 | 530151000 |
| CR9 | DIODE ZENER 1N5242B 12V 5% | 04713 | 1N5242B | 1 | 530146000 |
| CR10-13 | DIODE SIG 1N4001 | 04713 | 1N4001 | 4 | 530151000 |
| CR14 | DIODE ZENER 1N5242B 12V 5% | 04713 | 1N5242B | 1 | 530146000 |
| CR15 | DIODE SIG 1N4001 | 04713 | 1N4001 | 1 | 530151000 |
| DS1-5 | LED YELLOW DIFF 5082-4684 | 28480 | HLMP-1401 | 5 | 536034000 |
| J1 | CONN M 03 CKT ST .1CT | 06383 | MFSS100-3-C-A | 1 | 477364000 |
| J2-3 | HEADER 3 PIN STRAIGHT .156 SPA | 06383 | HPSS156-3-C | 2 | 477343000 |
| J4 | CONN M 24 CKT HDR DBL ROW .1CT | 06776 | NSH-24DB-S2-TG | 1 | 47742224A |
| J6-15 | CONNECTOR "SMB" | 19505 | 209 | 10 | 477317000 |
| J16-18 | CONN M 05 CKT ST POLZ .1CT | 06383 | HPSS100-5-C | 3 | 477382000 |
| Q1 | TRANS FET 2N7016 PWRMOS P-CHAN | 17856 | 2N7016 | 1 | 52816300A |
| R5 | RES MF 301 OHM 1% 1/4W | 19701 | 5043ED301R0F | 1 | 341246000 |
| R7 | RES NETWORK 10K .1% 1.5W 16pin | 73138 | 698-3R10KD | 1 | 345010000 |
| R9 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R10-11 | RES MF 600 OHM 0.25% 1/8W | 64537 | PME55-T2 | 2 | 324215000 |
| R14 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R15-16 | RES MF 1.65K 1% 1/4W | 19701 | 5043ED1K650F | 2 | 341321000 |
| R17-18 | RES MF 6.81K 1% 1/4W | 19701 | 5043ED6K810F | 2 | 341380000 |
| R19 | RES MF 47.5K 1% 1/4W | 19701 | 5043ED47K50F | 1 | 341465000 |
| R20 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| U1 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U2 | IC 74HCT138 1 OF 8 DECODER | 01295 | 74HCT138N | 1 | 534375000 |
| U8 | IC REF-01CP VOLTAGE REFERENCE | 06665 | REF-01CP | 1 | 535116000 |
| U9 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U10 | IC 419 ANALOG SWITCH | 17856 | DG-419-DJ | 1 | 53452400A |
| XA4-10 | CONNECTOR 36 PIN | 31781 | 306-036-521-102 | 6 | 479338000 |
| XA15 | CONNECTOR 36 PIN | 31781 | 306-036-521-102 | 1 | 479338000 |
| XAR2-3 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XU1 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU2 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU8 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 1 | 473041000 |
| XU9 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU10 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 1 | 473041000 |

## A2

| | 082505000 | REV: D* | '8200' RF HOUSING ASSY | | A2 |
|---|---|---|---|---|---|
| A2A1 | PWA '8201' RF | 04901 | 08251202A | 1 | 08251202A |
| A2A2 | PWA '8200' OSCILLATOR | 04901 | 08251100B | 1 | 08251100B |
| A2A3 | PWA '8200' CONNECTOR | 04901 | 08252500A | 1 | 08252500A |
| A2W1 | CABLE ASSY WIRE 24GA 8C VAR. L | 04901 | 571198000 | 1 | 571198000 |
| A2W2 | CABLE ASSY WIRE 24GA 6C 3.50L | 04901 | 571199000 | 1 | 571199000 |
| A2W3 | CABLE ASSY WIRE 24GA 2C 5.25L | 04901 | 571195000 | 1 | 571195000 |
| A2W4 | CABLE ASSY WIRE 24GA 2C 9.0L | 04901 | 571196000 | 1 | 571196000 |
| A2W5 | CABLE ASSY WIRE 24GA 9C 5.0L | 04901 | 571197000 | 1 | 571197000 |
| FL1-15 | CAP FT 3000pF 100V | 32575 | 859617-1 | 15 | 227123000 |
| J1 | CONNECTOR SMA | 95077 | SF-2950-606 | 1 | 479440000 |
| J2-5 | CONNECTOR "SMB" 50 OHM | 19505 | 2019-7511-000 | 4 | 477305000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| **A2A1** | | | | | |
| | 08251200B REV: F* | PWA '8200' RF | | | |
| AR1 | IC 5534AN OP AMP | 18324 | NE5534AN | 1 | 535061000 |
| AR2 | IC 356P OP AMP | 04713 | LF356N | 1 | 535040000 |
| C1 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C2 | CAP MICA 12pF 5% 300V | 57582 | KD5120J301 | 1 | 205005000 |
| C3 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C4 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C5 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C6 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C7 | CAP MICA 12pF 5% 300V | 57582 | KD5120J301 | 1 | 205005000 |
| C8 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C9 | CAP MICA 8.0pF 10% 300V | 57582 | KD5080D301 | 1 | 205001000 |
| C10 | CAP CER CHIP 680pF 10% 50V | 61637 | C1210C681K5XAH | 1 | 224377000 |
| C11 | CAP CER CHIP 270pF 10% 50V | 61637 | C1210C271K5XAC | 1 | 224388000 |
| C12 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C13 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C14 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C15 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C16 | CAP MICA 680pF 5% 300V | 57582 | KD15681J301 | 1 | 200112000 |
| C17 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C18-20 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| C21 | CAP MICA 270pF 5% 50V | 57582 | KD5271J101 | 1 | 205045000 |
| C22 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C23-24 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C25 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C26 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C28-30 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| C31 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C32 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C33 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C34-37 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 4 | 224268000 |
| C38-39 | CAP MICA 270pF 5% 50V | 57582 | KD5271J101 | 2 | 205045000 |
| C40-41 | CAP MICA 47pF 5% 300V | 20307 | DM5-EC470J | 2 | 205018000 |
| C42-43 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C44 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C45 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C46-47 | CAP MICA 390pF 5% 500V | 57582 | KD15391J501 | 2 | 200108000 |
| C48-49 | CAP MICA 75pF 5% 300V | 57582 | KD5750J301 | 2 | 205043000 |
| C50 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C51-52 | CAP MICA 270pF 5% 50V | 57582 | KD5271J101 | 2 | 205045000 |
| C53-54 | CAP MICA 51pF 5% 300V | 57582 | KD5510J301 | 2 | 205020000 |
| C55-56 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C57 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C58 | CAP MICA 300pF 1% 50V | 57582 | KD5301F101 | 1 | 205051000 |
| C59 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C60 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 1 | 224269000 |
| C61 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C62 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C63 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C64 | CAP MICA 300pF 1% 50V | 57582 | KD5301F101 | 1 | 205051000 |
| C65 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C66 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C67 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C68 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C69-71 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| C73-74 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C76 | CAP CER CHIP 220pF 10% 50V | 61637 | CX1210C221K5XAC | 1 | 224220000 |
| C77 | CAP CER CHIP 270pF 10% 50V | 61637 | C1210C271K5XAC | 1 | 224388000 |
| C78 | CAP VAR CER 3-10pF 250V | 91293 | 9372 | 1 | 281014000 |
| C79 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C80 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C81 | CAP MICA 270pF 5% 50V | 57582 | KD5271J101 | 1 | 205045000 |
| CR1 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 1 | 530174000 |
| CR2A | DIODE 5082-2815 MATCHED QUAD | 28480 | 5082-2815 | 1 | 530903000 |
| CR2B | DIODE 5082-2815 MATCHED QUAD | 28480 | 5082-2815 | 1 | 530903000 |
| CR2C | DIODE 5082-2815 MATCHED QUAD | 28480 | 5082-2815 | 1 | 530903000 |
| CR2D | DIODE 5082-2815 MATCHED QUAD | 28480 | 5082-2815 | 1 | 530903000 |
| CR3 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 1 | 530174000 |
| CR4 | DIODE SIG 5082-0180 | 28480 | 5082-100 | 1 | 530168000 |
| CR5 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 1 | 530174000 |
| CR6-16 | DIODE SIG 1N914 | 01295 | 1N914 | 11 | 530058000 |
| J1 | CONNECTOR 50 OHM | 19505 | 225 | 1 | 479387000 |
| J2 | HEADER 2 PIN RT ANGLE | 06383 | HFAS100-2-C | 1 | 477367000 |
| J3 | HEADER 10 PIN STRAIGHT | 06383 | HPSS100-10-C | 1 | 477381000 |
| J4 | CONN M 2 CKT ST .1CT | 27264 | 22-10-2021 | 1 | 477361000 |
| J5 | HEADER 5 PIN STRAIGHT .1 SPACE | 06383 | HPSS100-5-C | 1 | 477382000 |
| K1 | RELAY SPDT FORM "C" 5V DIP | 95348 | 835C-1 | 1 | 471034000 |
| L1 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L2 | INDUCTOR 68uH 10% | 24226 | 10/682 | 1 | 400411000 |
| L3 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L4 | INDUCTOR 7.5 uH 10% | 24226 | 10M751K | 1 | 400433000 |
| L5 | INDUCTOR 15uH 10% | 24226 | 10M152K | 1 | 400373000 |
| L6 | INDUCTOR 68uH 10% | 24266 | 10/682 | 1 | 400411000 |
| L7 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L8 | INDUCTOR 7.5 uH 10% | 24226 | 10M751K | 1 | 400433000 |
| L9 | INDUCTOR 15uH 10% | 24226 | 10M152K | 1 | 400373000 |
| L10-11 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 2 | 400308000 |
| L12 | INDUCTOR 150uH 5% | 59474 | 1315-16J | 1 | 400415000 |
| L13 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| L14 | INDUCTOR 150uH 5% | 59474 | 1315-16J | 1 | 400415000 |
| L15 | INDUCTOR VK200/20-4B | 02114 | VK-200-20/4B | 1 | 400409000 |
| Q1 | TRANS NPN MPS-6507 | 04713 | MPS6507 | 1 | 528070000 |
| Q2 | TRANS FET 2N4416 N-CHAN | 04713 | 2N4416 | 1 | 528072000 |
| Q3 | TRANS NPN 2N3866 | 04713 | 2N3866 | 1 | 528116000 |
| Q4 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q5-6 | TRANS NPN 2N3904 | 04713 | 2N3904 | 2 | 528071000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| Q7 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q8 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| Q9 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q10-11 | TRANS NPN 2N3904 | 04713 | 2N3904 | 2 | 528071000 |
| Q12 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q13 | TRANS NPN 2N3866 | 04713 | 2N3866 | 1 | 528116000 |
| Q14 | TRANS PNP 2N4403 | 04713 | 2N4403 | 1 | 528122000 |
| R1 | RES CHIP 300 OHM 5% 1/2W | 50316 | WA-7PG-301-J-S | 1 | 339995000 |
| R2 | RES CHIP 18 OHM 5% 1/2W | 50316 | WA-7PG-180JS | 1 | 339996000 |
| R3 | RES MF 200 OHM 1% 1/4W | 19701 | 5043ED200R0F | 1 | 341229000 |
| R4 | RES CHIP 300 OHM 5% 1/2W | 50316 | WA-7PG-301-J-S | 1 | 339995000 |
| R5 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R6 | RES VAR 50K 10% 0.5W | 73138 | 72PR50K | 1 | 311393000 |
| R7 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R8 | RES COMP 6.8K 5% 1/8W | 01121 | BB6825 | 1 | 331102000 |
| R9-10 | RES COMP 100 OHM 5% 1/8W | 01121 | BB1015 | 2 | 331058000 |
| R11 | RES VAR 50K 10% 0.5W | 73138 | 72PR50K | 1 | 311393000 |
| R12 | RES COMP 6.8K 5% 1/8W | 01121 | BB6825 | 1 | 331102000 |
| R13 | RES COMP 10K 5% 1/8W | 01121 | BB1035 | 1 | 331106000 |
| R14 | RES VAR 10K 10% 0.5W | 73138 | 72PR10K | 1 | 311328000 |
| R15 | RES CHIP 100 OHM 5% 1/2W | 50316 | WA-7PS-101JS | 1 | 339999000 |
| R16 | RES COMP 5.1K 5% 1/8W | 01121 | BB5125 | 1 | 331099000 |
| R17 | RES COMP 6.8K 5% 1/8W | 01121 | BB6825 | 1 | 331102000 |
| R18 | RES CHIP 100 OHM 5% 1/2W | 50316 | WA-7PS-101JS | 1 | 339999000 |
| R19 | RES COMP 6.8K 5% 1/8W | 01121 | BB6825 | 1 | 331102000 |
| R20-21 | RES COMP 100 OHM 5% 1/8W | 01121 | BB1015 | 2 | 331058000 |
| R22 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 1 | 341250000 |
| R23 | RES COMP 1K 5% 1/8W | 01121 | BB1025 | 1 | 331082000 |
| R24 | RES MF 3.92K 1% 1/4W | 19701 | 5043ED3K920F | 1 | 341357000 |
| R25 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R26 | RES COMP 20K 5% 1/8W | 01121 | BB2035 | 1 | 331113000 |
| R27 | RES MF 33.2 OHM 1% 1/4W | 19701 | 5034ED33R20F | 1 | 341150000 |
| R28 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 1 | 341384000 |
| R29 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R30 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R31 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R32 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R33-35 | RES COMP 47 OHM 5% 1/8W | 01121 | BB4705 | 3 | 331050000 |
| R36 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R37 | RES COMP 100 OHM 5% 1/8W | 01121 | BB1015 | 1 | 331058000 |
| R38 | RES COMP 47 OHM 5% 1/8W | 01121 | BB4705 | 1 | 331050000 |
| R39 | RES MF 900 OHM 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324235000 |
| R40 | RES MF 100 OHM 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324118000 |
| R41 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R42 | RES COMP 47 OHM 5% 1/8W | 01121 | BB4705 | 1 | 331050000 |
| R43 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R44 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R45 | RES MF 3.92K 1% 1/4W | 19701 | 5043ED3K920F | 1 | 341357000 |
| R46 | RES MF 392 OHM 1% 1/4W | 19701 | 5043ED392R0F | 1 | 341257000 |
| R47 | RES MF 20.0K 1% 1/4W | 19701 | 5043ED20K00F | 1 | 341429000 |
| R48 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 1 | 341384000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R49 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R50 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R51 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R52 | RES MF 15.0 OHM 1% 1/4W | 19701 | 5043ED15R00F | 1 | 341117000 |
| R53 | RES COMP 47 OHM 5% 1/8W | 01121 | BB4705 | 1 | 331060000 |
| R54 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R55 | RES COMP 47 OHM 5% 1/8W | 01121 | BB4705 | 1 | 331050000 |
| R56 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R58 | RES MF 432 OHM 1% 1/4W | 19701 | 5043ED432R0F | 1 | 341261000 |
| R60 | RES COMP 510 OHM 5% 1/8W | 01121 | BB5115 | 1 | 331075000 |
| R63 | RES MF 365 OHM 1% 1/4W | 19701 | 5043ED365R0F | 1 | 341254000 |
| R64 | RES MF 432 OHM 1% 1/4W | 19701 | 5043ED432R0F | 1 | 341261000 |
| R65 | RES MF 825 OHM 1% 1/4W | 19701 | 5043ED825R0F | 1 | 341288000 |
| R66-69 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 4 | 341300000 |
| R70 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R71 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R72 | RES MF 39.2K 1% 1/4W | 19701 | 5043ED39K20F | 1 | 341457000 |
| R73 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R74 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R75-76 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 2 | 341329000 |
| R77 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| T1 | TRANSFORMER BAL T1-1-X65 | 15542 | T1-1 | 1 | 410089000 |
| T2 | TRANSFORMER RF PULSE | 04901 | 41009000B | 1 | 41009000B |
| TP1-6 | TERMINAL WIRE LOOP TEST POINT | 31313 | TP-103-02 | 6 | 48330600A |
| U1 | IC 74F74PC DUAL D FLIP FLOP | 07263 | 74F74PC | 1 | 534367000 |
| U2 | IC 74S00 POS NAND-GATE | 01295 | SN74S00N | 1 | 534082000 |
| U3 | IC 74FOOPC NAND GATE | 07263 | 74F00PC | 1 | 534366000 |
| U4 | IC 13201N ANALOG SWITCH | 27014 | LF13201N | 1 | 535106000 |
| U5 | IC 74LS139 DECODE/MULTPXR | 01295 | SN74LS139N | 1 | 534188000 |
| U6 | IC 74LS290 DEC CTR | 01295 | SN74LS290N | 1 | 534328000 |
| U7 | IC 13201N ANALOG SWITCH | 27014 | LF13201N | 1 | 535106000 |
| U8 | IC 1355P OP AMP | 04713 | MC1355P | 1 | 535038000 |
| U9 | IC 74LS163 4 BIT COUNTER | 01295 | SN74LS163AN | 1 | 534279000 |
| XAR1-2 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XK1 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XQ2 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 1 | 473051000 |
| XU1-3 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 3 | 473019000 |
| XU4-5 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 2 | 473042000 |
| XU6 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU7 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU8 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU9 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |

## A2A2

| | 08251100B REV: DC | PWA '8200' OSCILLATOR | | | A2A2 |
|---|---|---|---|---|---|
| AR1 | IC 324N QUAD OP AMP | 27014 | LM324N | 1 | 535068000 |
| AR2-3 | IC 356P OP AMP | 04713 | LF356N | 2 | 535040000 |
| AR4 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR5 | IC 356P OP AMP | 04713 | LF356N | 1 | 535040000 |
| C1 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 1 | 205037000 |
| C2 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C3-4 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C5 | CAP MICA 150pF 5% 100V | 57582 | KD5151J101 | 1 | 205009000 |
| C6 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C7 | CAP CER 22pF 2% 500V | 55153 | C17AH220G4TXL | 1 | 224384000 |
| C8 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C9 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C10 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C11 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C12 | CAP MPC 1.0uF 10% 50V | 14752 | 652A-1-A-105K | 1 | 234152000 |
| C13 | CAP CER 360pF 5% 200V | 14752 | C17AH361J6TXL | 1 | 224387000 |
| C14 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 1 | 205037000 |
| C15 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C16 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C17 | CAP CER 10pF 2% 500V | 55153 | C17AH100G4TXL | 1 | 224383000 |
| C18 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 1 | 224269000 |
| C19 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C20 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C21 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C22 | CAP CER 300pF 5% 200V | 55153 | C17AH301J6TXL | 1 | 224386000 |
| C23-24 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 2 | 205037000 |
| C25 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 1 | 224269000 |
| C26 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C27 | CAP CER 3.3pF +-0.25pF 500V | 55153 | C17AH3R3C4TXL | 1 | 224381000 |
| C28 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C29-31 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| C32 | CAP CER 220pF 2% 200V | 55153 | C17AH221G6TXL | 1 | 224385000 |
| C33 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C34 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 1 | 205037000 |
| C35 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C36 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C37-38 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C39 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C40 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C41 | CAP CER 0.001uF 10% 100V | 04222 | SR151C102KAA | 1 | 224270000 |
| C42 | CAP CER CHIP 1.2pF 0.1pF 500V | 55153 | C17AH1R2B4TXL | 1 | 22439100A |
| C43 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C44 | CAP MPC 1.0uF 10% 50V | 14752 | 652A-1-A-105K | 1 | 234152000 |
| C45 | CAP MICA 47pF 5% 300V | 20307 | DM5-EC470J | 1 | 205018000 |
| C46 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C47 | CAP CER 220pF 2% 200V | 55153 | C17AH221G6TXL | 1 | 224385000 |
| C48 | CAP TANT 10uF 10% 35V | 56289 | 196D106X903PE4 | 1 | 283353000 |
| C49 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C50 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C51 | CAP CER 5.0pF +-0.25pF 100V | 59660 | 0835-306-P3K0-509C | 1 | 22439000A |
| CR1 | DIODE SIG 1N914 | 01295 | 1N914 | 1 | 530058000 |
| CR2-3 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR4 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR9 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR10-17 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 8 | 530770000 |
| CR18 | DIODE SIG 1N914 | 01295 | 1N914 | 1 | 530058000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| CR19-20 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR21 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR22-24 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 3 | 530770000 |
| CR25 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR26-28 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 3 | 530770000 |
| CR29 | DIODE SIG 1N914 | 01295 | 1N914 | 1 | 530058000 |
| CR30-31 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR32 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR33-34 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 2 | 530770000 |
| CR35 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR36-37 | DIODE SIG 1N914 | 01295 | 1N914 | 2 | 530058000 |
| CR38-39 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 2 | 530770000 |
| CR40 | DIODE SIG 1N914 | 01295 | 1N914 | 1 | 530058000 |
| CR41-42 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR43 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR44-45 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 2 | 530770000 |
| CR46 | DIODE PIN 5082-3188 | 28480 | 5082-3188 | 1 | 530165000 |
| CR47-48 | DIODE VARACTOR MV2115 SEL ITF | 04713 | MV2115 | 2 | 530770000 |
| DS1 | PHOTO MOD CLM6500 | 03911 | CLM6500 | 1 | 325016000 |
| DS2-5 | LED RED DIFF 5082-4684 | 28480 | HLMP-1301 | 4 | 536024000 |
| J1 | HEADER 10 PIN STRAIGHT | 06383 | HPSS100-10-C | 1 | 477381000 |
| J2 | HEADER 5 PIN STRAIGHT .1 SPACE | 06383 | HPSS100-5-C | 1 | 477382000 |
| L1-3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 3 | 400308000 |
| L4 | INDUCTOR 0.82uH 10% | 59474 | 4425-5K | 1 | 400293000 |
| L5 | INDUCTOR 330 uH 10% | 24226 | 10/333 | 1 | 400442000 |
| L6 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L7 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L8 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L9 | INDUCTOR 0.82uH 10% | 59474 | 4425-5K | 1 | 400293000 |
| L11 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L12 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L13 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L14 | INDUCTOR 0.82uH 10% | 59474 | 4425-5K | 1 | 400293000 |
| L16 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L17 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L18 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L19 | INDUCTOR 4.7uH 10% | 24226 | 10/471 | 1 | 400384000 |
| L20 | INDUCTOR 0.82uH 10% | 59474 | 4425-5K | 1 | 400293000 |
| L22-23 | INDUCTOR 39uH 10% | 24266 | 10/392 | 2 | 400387000 |
| L24 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L25 | INDUCTOR 39uH 10% | 24266 | 10/392 | 1 | 400387000 |
| L26 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| P1 | CONNECTOR "SMA" 50 OHM | 98291 | 52-051-0000 | 1 | 477304000 |
| Q1 | TRANS FET 2N4416 N-CHAN | 04713 | 2N4416 | 1 | 528072000 |
| Q2 | TRANS NPN MPS-6507 | 04713 | MPS6507 | 1 | 528070000 |
| Q3-4 | TRANS FET 2N4416 N-CHAN | 04713 | 2N4416 | 2 | 528072000 |
| Q5 | TRANS NPN MPS-6507 | 04713 | MPS6507 | 1 | 528070000 |
| Q6 | TRANS FET 2N4221A N-CHAN | 27014 | 2N4221A | 1 | 528063000 |
| Q7 | TRANS PNP 2N4403 | 04713 | 2N4403 | 1 | 528122000 |
| Q8 | TRANS NPN 2N4401 | 04713 | 2N4401 | 1 | 528121000 |
| Q9 | TRANS PNP 2N4403 | 04713 | 2N4403 | 1 | 528122000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R1 | RES MF 51.1K 1% 1/4W | 19701 | 5043ED51K10F | 1 | 341468000 |
| R2 | RES MF 243 OHM 1% 1/4W | 19701 | 5043ED243R0F | 1 | 341237000 |
| R3 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R4 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R5 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R6 | RES MF 1.82K 1% 1/4W | 19701 | 5043ED1K820F | 1 | 341325000 |
| R7 | RES MF 150 OHM 1% 1/4W | 19701 | 5043ED150R0F | 1 | 341217000 |
| R8 | RES MF 475 OHM 1% 1/4W | 19701 | 5043ED475R0F | 1 | 341265000 |
| R9 | RES MF 909 OHM 1% 1/4W | 09701 | 5043ED909R0F | 1 | 341292000 |
| R10 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R11 | RES MF 51.1K 1% 1/4W | 19701 | 5043ED51K10F | 1 | 341468000 |
| R12 | RES MF 243 OHM 1% 1/4W | 19701 | 5043ED243R0F | 1 | 341237000 |
| R13 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R14 | RES MF 150 OHM 1% 1/4W | 19701 | 5043ED150R0F | 1 | 341217000 |
| R15 | RES MF 24.9K 1% 1/4W | 19701 | RN55D-2492-F | 1 | 341438000 |
| R16 | RES MF 4.75K 1% 1/4W | 19701 | 5043ED4K750F | 1 | 341365000 |
| R17 | RES MF 51.1K 1% 1/4W | 19701 | 5043ED51K10F | 1 | 341468000 |
| R18 | RES MF 8.25K 1% 1/4W | 19701 | 5043ED8K250F | 1 | 341385000 |
| R19 | RES VAR 5K 10% 0.5W | 73138 | 72PR5K | 1 | 311308000 |
| R20 | RES MF 243 OHM 1% 1/4W | 19701 | 5043ED243R0F | 1 | 341237000 |
| R21 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R22-23 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 2 | 341368000 |
| R24 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R25 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R26 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R27 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R28 | RES MF 150 OHM 1% 1/4W | 19701 | 5043ED150R0F | 1 | 341217000 |
| R29 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R30 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 1 | 341368000 |
| R31 | RES MF 392K 1% 1/4W | 19701 | 5043ED392K0F | 1 | 341557000 |
| R32 | RES MF 475 OHM 1% 1/4W | 19701 | 5043ED475R0F | 1 | 341265000 |
| R33 | RES MF 1.82K 1% 1/4W | 19701 | 5043ED1K820F | 1 | 341325000 |
| R34 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R35 | RES MF 15.0K 1% 1/4W | 19701 | 5043ED15K00F | 1 | 341417000 |
| R36 | RES MF 51.1K 1% 1/4W | 19701 | 5043ED51K10F | 1 | 341468000 |
| R37 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R38 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R39 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R40 | RES MF 243 OHM 1% 1/4W | 19701 | 5043ED243R0F | 1 | 341237000 |
| R41 | RES MF 1.10K 1% 1/4W | 19701 | 5043ED1K100F | 1 | 341304000 |
| R42 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R43 | RES NETWORK 10K 0.5% 1/2W | 73138 | 694-3-R10K-D | 1 | 345041000 |
| R44 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R45 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R46 | RES MF 51.1K 1% 1/4W | 19701 | 5043ED51K10F | 1 | 341468000 |
| R47 | RES MF 150 OHM 1% 1/4W | 19701 | 5043ED150R0F | 1 | 341217000 |
| R48 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R51 | RES MF 133 OHM 1% 1/4W | 19701 | 5043ED133R0F | 1 | 341212000 |
| R52 | RES MF 1.00M 1% 1/4W | 14674 | 5043ED1M000F | 1 | 341600000 |
| R53 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R54 | RES NETWORK 470 OHM 2% 1.1W | 71450 | 750-81-R470 | 1 | 345018000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R55 | RES MF 1.62K 1% 1/4W | 19701 | 5043ED1K620F | 1 | 341320000 |
| T1 | TRANSFORMER RF T4-1-X65 | 15542 | T4-1 | 1 | 410087000 |
| T2-4 | OSC TRANSFORMER | 04901 | 400431000 | 3 | 400431000 |
| T5 | OSC TRANSFORMER | 04901 | 400430000 | 1 | 400430000 |
| U1 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| U2 | IC 74LS122 MONOSTABLE MULTIVBT | 01295 | SN74LS122N | 1 | 534280000 |
| U3 | IC 4052B MULTIPLEXER | 02735 | CD4052BE | 1 | 534140000 |
| XAR1 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XAR2-5 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 4 | 473041000 |
| XDS1/1 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XDS1/2 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XQ1 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 1 | 473051000 |
| XQ3-4 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 2 | 473051000 |
| XQ6 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 1 | 473051000 |
| XU1 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU2 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU3 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |

## A2A3

08252500A REV: AB PWA '8200' CONNECTOR

| | | | | | |
|---|---|---|---|---|---|
| J1 | SOCKET IC 24 PIN | 06776 | ICN-246-S4-G | 1 | 473043000 |

## A4

08252200A REV: F* PWA '8200' FM

| | | | | | |
|---|---|---|---|---|---|
| AR1 | IC 301A OP AMP | 27014 | LM301AN | 1 | 535012000 |
| AR2 | IC 356P OP AMP | 27014 | LF356N | 1 | 535040000 |
| AR3 | IC 5534AN OP AMP | 18324 | NE5534AN | 1 | 535081000 |
| C1 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 1 | 205037000 |
| C2-3 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C4 | CAP MICA 8.0pF 10% 300V | 57582 | KD5080D301 | 1 | 205001000 |
| C5 | CAP MICA 91pF 5% 300V | 14655 | CD5FC910J | 1 | 205021000 |
| C6 | CAP MICA 8.0pF 10% 300V | 57582 | KD5080D301 | 1 | 205001000 |
| C7 | CAP MICA 20pF 5% 300V | 14655 | CD5CC200J | 1 | 205017000 |
| C8 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C9 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C10 | CAP MICA 100pF 1% 500V | 14655 | CD15FD101F | 1 | 200045000 |
| C11 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C12 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C13 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C14-15 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 2 | 224269000 |
| C16 | CAP MICA 33pF 5% 300V | 20307 | DM5-EC330J | 1 | 205010000 |
| C17 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C18 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C19 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C20-21 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C22-23 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 2 | 224269000 |
| C24 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C25 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C26 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C27 | CAP MICA 680pF 1% 300V | 14655 | CD15FC681F03 | 1 | 200015000 |
| C28 | CAP MICA 36pF 5% 300V | 14655 | CD5EC360J | 1 | 205003000 |
| C29 | CAP MICA 680pF 1% 300V | 14655 | CD15FC681F03 | 1 | 200015000 |
| C30-31 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 2 | 224269000 |
| C32 | CAP MICA 680pF 5% 300V | 57582 | KD15681J301 | 1 | 200112000 |
| C33 | CAP MICA 500pF 1% 500V | 14655 | CD15FD501F | 1 | 200123000 |
| C34 | CAP TANT 100uF 20% 20V | 56289 | 196D107X0020TE4 | 1 | 283313000 |
| C35 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C36 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C37-38 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C39 | CAP MICA 330pF 5% 50V | 14655 | CD5FY331J | 1 | 205029000 |
| C40 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C41 | CAP MICA 330pF 5% 50V | 14655 | CD5FY331J | 1 | 205029000 |
| C42 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C43 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C44 | CAP MICA 200pF 1% 100V | 14655 | CD5FA201F | 1 | 205041000 |
| C45 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C46-47 | CAP TANT 100uF 20% 20V | 56289 | 196D107X0020TE4 | 2 | 283313000 |
| C48 | CAP MICA 27pF 5% 300V | 14655 | CD5EC270J | 1 | 205008000 |
| C49 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 1 | 224269000 |
| C50 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C51 | CAP MICA 130pF 5% 100V | 14655 | CD5FA131J | 1 | 205011000 |
| C52 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C53-54 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C55 | CAP MICA 20pF 5% 300V | 14655 | CD5CC200J | 1 | 205017000 |
| CR1-3 | DIODE SIG 1N914 | 01295 | 1N914 | 3 | 530058000 |
| L1-2 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 2 | 400308000 |
| L3 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L4 | INDUCTOR 15uH 10% | 59474 | 4445-4K | 1 | 400302000 |
| L5 | INDUCTOR 750uH 5% | 24226 | 19/753J | 1 | 400443000 |
| L6 | COIL ASSY 902uH (ALT.-000)8200 | 04901 | 40043901A | 1 | 40043901A |
| L7 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| L8 | INDUCTOR 120uH 10% | 24226 | 10/123 | 1 | 400413000 |
| L9 | COIL ASSY 1450uH (ALT-000)8200 | 04901 | 40044001A | 1 | 40044001A |
| L10 | COIL ASSY 902uH (ALT.-000)8200 | 04901 | 40043901A | 1 | 40043901A |
| L11 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| Q1 | TRANS FET SD215EE N-CHAN | 17856 | SD215DE | 1 | 528120000 |
| Q2 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q3 | IC 3054 ARRAY | 02735 | CA3054 | 1 | 535111000 |
| Q4-5 | TRANS NPN 2N3904 | 04713 | 2N3904 | 2 | 528071000 |
| Q6 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q7 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| Q8 | IC 3054 ARRAY | 02735 | CA3054 | 1 | 535111000 |
| Q9 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q10 | TRANS FET SD215EE N-CHAN | 17856 | SD215DE | 1 | 528120000 |
| Q11-13 | TRANS PNP 2N3906 | 04713 | 2N3906 | 3 | 528076000 |
| Q14-16 | TRANS PNP 2N4403 | 04713 | 2N4403 | 3 | 528122000 |
| R1 | RES MF 475 OHM 1% 1/4W | 19701 | 5043ED475R0F | 1 | 341265000 |
| R2 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R3 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R4 | RES MF 2.61K 1% 1/4W | 19701 | 5043ED2K619F | 1 | 341340000 |
| R5-7 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 3 | 341268000 |
| R8-9 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R10 | RES MF 2.21K 1% 1/4W | 19701 | 5043ED2K210F | 1 | 341333000 |
| R11 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R12 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R13 | RES MF 750 OHM 1% 1/4W | 19701 | 5043ED750R0F | 1 | 341284000 |
| R14 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R15 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R16 | RES MF 681 OHM 1% 1/4W | 19701 | 5043ED681R0F | 1 | 341280000 |
| R17 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R18-19 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R20 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R21 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R22 | RES MF 200 OHM 1% 1/4W | 19701 | 5043ED200R0F | 1 | 341229000 |
| R23-24 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 2 | 341268000 |
| R25-26 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R27 | RES MF 2.21K 1% 1/4W | 19701 | 5043ED2K210F | 1 | 341333000 |
| R28 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R29 | RES MF 681 OHM 1% 1/4W | 19701 | 5043ED681R0F | 1 | 341280000 |
| R30 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R31 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R32-34 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 3 | 341268000 |
| R35-36 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R37-39 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 3 | 341268000 |
| R40-41 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R42 | RES MF 2.21K 1% 1/4W | 19701 | 5043ED2K210F | 1 | 341333000 |
| R43 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R44 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R45 | RES MF 3.92K 1% 1/4W | 19701 | 5043ED3K920F | 1 | 341357000 |
| R46 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R47-48 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 2 | 341268000 |
| R49-50 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R51 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R52 | RES MF 182 OHM 1% 1/4W | 19701 | RN55D-1820-F | 1 | 341225000 |
| R53-54 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 2 | 341250000 |
| R55-56 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 2 | 341268000 |
| R57-58 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R59 | RES MF 2.21K 1% 1/4W | 19701 | 5043ED2K210F | 1 | 341333000 |
| R60 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R61 | RES MF 499 OHM 1% 1/4W | 19701 | 5043ED499R0F | 1 | 341267000 |
| R62 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R63 | RES MF 3.74K 1% 1/4W | 19701 | 5043ED3K740F | 1 | 341355000 |
| R64 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R65-66 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R67 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R68 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 1 | 341250000 |
| R69 | RES MF 221 OHM 1% 1/4W | 19701 | 5043ED221R0F | 1 | 341233000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R70 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R71 | RES MF 499 OHM 1% 1/4W | 19701 | 5043ED499R0F | 1 | 341267000 |
| R72 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| R73 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R74 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R75 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R76 | RES MF 5.62K 1% 1/4W | 19701 | 5043ED5K620F | 1 | 341372000 |
| R77 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R78 | RES MF 432 OHM 1% 1/4W | 19701 | 5043ED432R0F | 1 | 341261000 |
| R79 | RES MF 68.1 OHM 1% 1/4W | 19701 | 5043ED68R10F | 1 | 341180000 |
| R80-83 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 4 | 341350000 |
| R84-85 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 2 | 341300000 |
| R86 | RES MF 1.82K 1% 1/4W | 19701 | 5043ED1K820F | 1 | 341325000 |
| R87-88 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 2 | 341350000 |
| R89 | RES MF 681 OHM 1% 1/4W | 19701 | 5043ED681R0F | 1 | 341280000 |
| U1 | IC 74F74PC DUAL D FLIP FLOP | 07263 | 74F74PC | 1 | 534367000 |
| XAR1-3 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 3 | 473041000 |
| XQ1 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 1 | 473051000 |
| XQ2 | SOCKET TRANSISTOR 3 CIR TO-18 | EMC | 7003-265-5 | 1 | 47307800A |
| XQ3 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XQ4-7 | SOCKET TRANSISTOR 3 CIR TO-18 | EMC | 7003-265-5 | 4 | 47307800A |
| XQ8 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XQ9 | SOCKET TRANSISTOR 3 CIR TO-18 | EMC | 7003-265-5 | 1 | 47307800A |
| XQ10 | SOCKET TRANSISTOR 4 PIN | 17117 | 7004-265-5 | 1 | 473051000 |
| XQ11-13 | SOCKET TRANSISTOR 3 CIR TO-18 | EMC | 7003-265-5 | 3 | 47307800A |
| XU1 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |

**A5**

**08251300B REV: CB PWA '8200' AM**

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| AR1 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR2 | IC 318N OP AMP | 27014 | LM318N | 1 | 535031000 |
| AR3 | IC 356P OP AMP | 27014 | LF356N | 1 | 535040000 |
| C1 | CAP MICA 100pF 1% 300V | 14655 | CD5FC101F | 1 | 205039000 |
| C2 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C3 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C4 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C5 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C6 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C7 | CAP MICA 180pF 1% 100V | 14655 | CD5FA181F | 1 | 205040000 |
| C8 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C9 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C10 | CAP MICA 100pF 1% 300V | 14655 | CD5FC101F | 1 | 205039000 |
| C11-12 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C13 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C14 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C15 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C16-18 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 3 | 283336000 |
| C19 | CAP MICA 470pF 5% 300V | 14655 | CD15-471J03 | 1 | 200028000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C20-21 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 2 | 283216000 |
| C22 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C23 | CAP CER 0.01uF 10% 100V | 04222 | SR201C103KAA | 1 | 224269000 |
| C24 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C25 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 1 | 234139000 |
| C26 | CAP CER 1.0uF 20% 50V | 04222 | SR305E105MAA | 1 | 224264000 |
| C27 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C28 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 1 | 234139000 |
| C29 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C30 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C31 | CAP COMP 0.27pF 10% 500V | 95721 | TYPE MC | 1 | 218006000 |
| C32 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C33 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C34 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C35 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C36 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C37 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C38-39 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C40 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C41 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C42 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C43 | CAP CER 1.0uF 20% 50V | 04222 | SR305E105MAA | 1 | 224264000 |
| C44 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C45 | CAP MICA 20pF 5% 300V | 14655 | CD5CC200J | 1 | 205017000 |
| C47 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C48 | CAP MICA 20pF 5% 300V | 14655 | CD5CC200J | 1 | 205017000 |
| C50 | CAP MICA 300pF 1% 50V | 57582 | KD5301F101 | 1 | 205051000 |
| C51 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C52 | CAP MICA 300pF 5% 50V | 14655 | CD5FY301J | 1 | 205026000 |
| C53 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C54 | CAP MICA 300pF 5% 50V | 14655 | CD5FY301J | 1 | 205026000 |
| C56 | CAP MICA 300pF 1% 50V | 57582 | KD5301F101 | 1 | 205051000 |
| C57 | CAP MICA 15pF 5% 300V | 14655 | CD5CC150J | 1 | 205035000 |
| C58 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C59-60 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C61 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C62 | CAP MICA 75pF 5% 300V | 57582 | KD5750J301 | 1 | 205043000 |
| CR1-5 | DIODE SIG 1N914 | 01295 | 1N914 | 5 | 530058000 |
| CR6a-6b | DIODE 5082-2815 MATCHED PAIR | 28480 | 5082-2815 MATCH PAIR | 1 | 53091100A |
| DS1-2 | PHOTO MOD CLM6500 | 03911 | CLM6500 | 2 | 325016000 |
| L1-3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 3 | 400308000 |
| L4 | INDUCTOR 33uH 5% | 59474 | 4465-2K | 1 | 400310000 |
| L5-6 | INDUCTOR 47uH 5% | 24226 | 15/472J | 2 | 400320000 |
| L7-8 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 2 | 400308000 |
| L9 | INDUCTOR 1800uH 5% | 59474 | 1312-25J | 1 | 400434000 |
| L10 | COIL ASSY 902uH (ALT.-000)8200 | 04901 | 40043901A | 1 | 40043901A |
| L11 | COIL ASSY 1450uH (ALT-000)8200 | 04901 | 40044001A | 1 | 40044001A |
| L12 | COIL ASSY 902uH (ALT.-000)8200 | 04901 | 40043901A | 1 | 40043901A |
| Q1 | TRANS PNP 2N3906 | 04713 | 2N3906 | 1 | 528076000 |
| Q2 | TRANS NPN 2N3053 | 04713 | 2N3053 | 1 | 528123000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| Q3-4 | TRANS PNP 2N3906 | 04713 | 2N3906 | 2 | 528076000 |
| Q5-6 | TRANS NPN 2N3904 | 04713 | 2N3904 | 2 | 528071000 |
| Q7 | TRANS NPN 2N4401 | 04713 | 2N4401 | 1 | 528121000 |
| Q8-10 | TRANS FET 2N4416 N-CHAN | 04713 | 2N4416 | 3 | 528072000 |
| Q11 | TRANS NPN 2N4401 | 04713 | 2N4401 | 1 | 528121000 |
| Q12 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| Q13-14 | TRANS PNP 2N3906 | 04713 | 2N3906 | 2 | 528076000 |
| Q15-17 | TRANS NPN 2N3904 | 04713 | 2N3904 | 3 | 528071000 |
| Q18-20 | TRANS PNP 2N3906 | 04713 | 2N3906 | 3 | 528076000 |
| Q21 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| Q22 | TRANS NPD 5564 | 27014 | NPD5564 | 1 | 528148000 |
| R1 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R2 | RES MF 2.49K 1% 1/4W | 19701 | 5043ED2K490F | 1 | 341338000 |
| R3 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R4-5 | RES MF 15.0K 1% 1/4W | 19701 | 5043ED15K00F | 2 | 341417000 |
| R6 | RES MF 562 OHM 1% 1/4W | 19701 | 5043ED562R0F | 1 | 341272000 |
| R7 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R8 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R9 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R10 | RES MF 5.36K 1% 1/4W | 19701 | 5043ED5K360F | 1 | 341370000 |
| R11 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 1 | 341384000 |
| R12 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 1 | 341368000 |
| R13 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R14 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 1 | 341250000 |
| R15 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R16 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R17 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R18 | RES MF 75.0 OHM 1% 1/4W | 19701 | 5043ED75R00F | 1 | 341184000 |
| R19 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R20-21 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 2 | 341165000 |
| R22 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R23 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R24 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R25 | RES MF 9.31K 1% 1/4W | 19701 | 5043ED9K310F | 1 | 341393000 |
| R26 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R27 | RES MF 49.9K 1% 1/4W | 19701 | 5043ED49K90F | 1 | 341467000 |
| R28 | RES MF 75.0K 1% 1/4W | 19701 | 5043ED75K00F | 1 | 341484000 |
| R29 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R30 | RES MF 499K 1% 1/4W | 19701 | 5043ED499K0F | 1 | 341567000 |
| R31 | RES MF 267K 1% 1/4W | 19701 | 5043ED267K0F | 1 | 341541000 |
| R32 | RES MF 9.31K 1% 1/4W | 19701 | 5043ED9K310F | 1 | 341393000 |
| R33 | RES MF 75.0K 1% 1/4W | 19701 | 5043ED75K00F | 1 | 341484000 |
| R34 | RES MF 267K 1% 1/4W | 19701 | 5043ED267K0F | 1 | 341541000 |
| R35 | RES MF 499K 1% 1/4W | 19701 | 5043ED499K0F | 1 | 341567000 |
| R36 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R37 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R38 | RES MF 3.01K 1% 1/4W | 19701 | 5043ED3K010F | 1 | 341346000 |
| R39 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R40-41 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 2 | 341268000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R42 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| R43 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R44 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R45 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R46 | RES MF 11.0K 1% 1/4W | 19701 | 5043ED11K00F | 1 | 341404000 |
| R47-48 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 2 | 341165000 |
| R49 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R50 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R51 | RES MF 3.01K 1% 1/4W | 19701 | 5043ED3K010F | 1 | 341346000 |
| R52 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R53-54 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 2 | 341268000 |
| R55 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R56 | RES MF 22.1 OHM 1% 1/4W | 19701 | 5043ED22R10F | 1 | 341133000 |
| R57 | RES MF 8.25K 1% 1/4W | 19701 | 5043ED8K250F | 1 | 341388000 |
| R58 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R59 | RES MF 1.62K 1% 1/4W | 19701 | 5043ED1K620F | 1 | 341320000 |
| R60 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R61 | RES MF 4.75K 1% 1/4W | 19701 | 5043ED4K750F | 1 | 341365000 |
| R62 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R63 | RES MF 8.25K 1% 1/4W | 19701 | 5043ED8K250F | 1 | 341388000 |
| R64-65 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 2 | 341165000 |
| R66-67 | RES MF 221 OHM 1% 1/4W | 19701 | 5043ED221R0F | 2 | 341233000 |
| R68 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R69 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R70 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R71 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R72 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R73 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| R74 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R75 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| R76 | RES MF 47.5 OHM 1% 1/4W | 19701 | 5043ED47R50F | 1 | 341165000 |
| R77-79 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 3 | 341400000 |
| R80 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R81 | RES MF 12.7K 1% 1/4W | 19701 | 5043ED12K70F | 1 | 341410000 |
| R82 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R83-84 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R85 | RES VAR 100K 10% 0.5W | 73138 | 72XWR100K | 1 | 311377000 |
| R86 | RES MF 301K 1% 1/4W | 19701 | 5043ED301K0F | 1 | 341546000 |
| R87 | RES COMP 4.7M 5% 1/4W | 01121 | CB4755 | 1 | 343665000 |
| R88 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| TP1-5 | TERMINAL WIRE LOOP TEST POINT | 31313 | TP-103-02 | 5 | 48330600A |
| U1 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U2 | D/A CONVERTER DAC-08EP | 06665 | DAC-08EP | 1 | 421037000 |
| XDS1/1 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XDS1/2 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XDS2/1 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XDS2/2 | SOCKET STRIP 2 PIN | 04901 | 473074000 | 1 | 473074000 |
| XU1 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| **A6** | | | | | |
| 08265300A | REV: A* | | PWA '8201' FILTER | | |
| AR1 | IC OP37EP OP AMP | 06665 | OP37EP | 1 | 53521400A |
| AR2-4 | IC 310N OP AMP | 27014 | LM310N | 3 | 535035000 |
| AR5 | IC 357N OP AMP | 27014 | LF357N | 1 | 535098000 |
| AR6 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR7-8 | IC 310N OP AMP | 27014 | LM310N | 2 | 535035000 |
| AR9 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR10 | IC 310N OP AMP | 27014 | LM310N | 1 | 535035000 |
| AR11 | IC 5534AN OP AMP | 18324 | NE5534AN | 1 | 535061000 |
| AR12 | IC 356P OP AMP | 27014 | LF356N | 1 | 535040000 |
| AR13 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| C1-2 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C3 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C4 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C5(SEL) | CAP MICA 820pF 5% 300V | 14655 | CD15FC821J03 | 1 | 200110000 |
| C5 | CAP MICA 910pF 5% 100V | 57582 | KD15911J101 | 1 | 200125000 |
| C6 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C7 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C8 | CAP MICA 180pF 1% 100V | 14655 | CD5FA181F | 1 | 205040000 |
| C9 | CAP MICA 470pF 1% 500V | 14655 | CD15FD471F03 | 1 | 200050000 |
| C10-11 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 2 | 234142000 |
| C12 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C13 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C14 | CAP MICA 470pF 1% 500V | 14655 | CD15FD471F03 | 1 | 200050000 |
| C15-16 | CAP TANT 100uF 20% 10V | 56289 | 196D107X0010PE4 | 2 | 283291000 |
| C17 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C18 | CAP MICA 7pF 5% 300V | 14655 | CD5CC070J | 1 | 205030000 |
| C19-20 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 2 | 234139000 |
| C21 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 1 | 234142000 |
| C22-23 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 2 | 234139000 |
| C24 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 1 | 234142000 |
| C25-26 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C27-26 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 2 | 234142000 |
| C29 | CAP MPC 0.047uF 2% 50V | 14752 | 652A-1-A473G | 1 | 234144000 |
| C30 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C31 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C32 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C33 | CAP MICA 240pF 1% 500V | 00853 | D10FD241F | 1 | 200124000 |
| C34 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C35 | CAP MICA 200pF 2% 500V | 14655 | CD15FD201G | 1 | 200053000 |
| C36 | CAP MICA 100pF 1% 300V | 14655 | CD5FC101F | 1 | 205039000 |
| C37 | CAP MICA 120pF 1% 50V | 20307 | DM5-FY121F | 1 | 205050000 |
| C38 | CAP MICA 100pF 1% 300V | 14655 | CD5FC101F | 1 | 205039000 |
| C39 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 1 | 200113000 |
| C40 | CAP MICA 470pF 1% 500V | 14655 | CD15FD471F03 | 1 | 200050000 |
| C41 | CAP MICA 75pF 1% 300V | 20307 | DM5-EC750F | 1 | 205056000 |
| C42-43 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C44-45 | CAP MICA 1000pF 1% 100V | 51406 | DM15-102F | 2 | 200113000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C46-47 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C48 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C49-51 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 3 | 234142000 |
| C52 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 1 | 234139000 |
| C53 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 1 | 234142000 |
| C54-55 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 2 | 234139000 |
| C56 | CAP MICA 22pF 5% 300V | 14655 | CD5CC220J | 1 | 205036000 |
| C57 | CAP MICA 150pF 5% 100V | 57582 | KD5151J101 | 1 | 205009000 |
| C58 | CAP MICA 5.0pF 10% 300V | 14655 | CD5CC050D | 1 | 205000000 |
| CR1-3 | DIODE SIG 1N914 | 01295 | 1N914 | 3 | 530058000 |
| CR4-5 | DIODE SIG FDH-300 | 07263 | FDH300 | 2 | 530052000 |
| CR7-8 | DIODE SIG 1N914 | 01295 | 1N914 | 3 | 530058000 |
| K1-3 | RELAY DUAL FORM "C" 12V | ARMT | TQ2E-12V | 3 | 47106100A |
| L1-3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 3 | 400308000 |
| L4 | COIL ASSY 2270 uH | 04901 | 40043701A | 1 | 40043701A |
| L5 | COIL ASSY 3641 uH | 04901 | 40043801A | 1 | 40043801A |
| L6 | COIL ASSY 2270 uH | 04901 | 40043701A | 1 | 40043701A |
| Q1 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| R1 | RES MF 562 OHM 1% 1/4W | 19701 | 5043ED562R0F | 1 | 341272000 |
| R2 | RES MF 619 OHM 1% 1/4W | 19701 | 5043ED619R0F | 1 | 341276000 |
| R3 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 1 | 341384000 |
| R4 | RES MF 619 OHM 1% 1/4W | 19701 | 5043ED619R0F | 1 | 341276000 |
| R6 | RES MF 619 OHM 1% 1/4W | 19701 | 5043ED619R0F | 1 | 341276000 |
| R7 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 1 | 341384000 |
| R8 | RES MF 619 OHM 1% 1/4W | 19701 | 5043ED619R0F | 1 | 341276000 |
| R9-10 | RES MF 9.000K 0.1% 1/4W | 64537 | PME55-T2 | 2 | 324354000 |
| R11-12 | RES MF 1.000K 0.1% 1/8W | 03888 | PME55-T2 | 1 | 324241000 |
| R13 | RES MF 9.000K 0.1% 1/4W | 64537 | PME55-T2 | 2 | 324354000 |
| R15 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R17 | RES MF 1.000K 0.1% 1/8W | 03888 | PME55-T2 | 1 | 324241000 |
| R19 | RES MF 26.7 OHM 1% 1/4W | 19701 | 5043ED026R7F | 1 | 341141000 |
| R20 | RES MF 26.7K 1% 1/4W | 19701 | 5043ED26K70F | 1 | 341441000 |
| R21 | RES MF 105K 1% 1/4W | 19701 | 5043ED105K0F | 1 | 341502000 |
| R22 | RES MF 2.67K 1% 1/4W | 19701 | 5043ED2K670F | 1 | 341341000 |
| R23 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R24 | RES MF 2.61K 1% 1/4W | 19701 | 5043ED2K610F | 1 | 341340000 |
| R25 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R26 | RES MF 6.19K 1% 1/4W | 19701 | 5043ED6K190F | 1 | 341376000 |
| R27 | RES MF 536K 1% 1/4W | 19701 | RN55D-5363-F | 1 | 341570000 |
| R28 | RES MF 53.6K 1% 1/4W | 19701 | 5043ED53K60F | 1 | 341470000 |
| R29 | RES MF 1.13K 1% 1/4W | 19701 | 5043ED1K130F | 1 | 341305000 |
| R30 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R31 | RES MF 3.65K 1% 1/4W | 19701 | 5043ED3K650F | 1 | 341354000 |
| R32 | RES MF 26.7K 1% 1/4W | 19701 | 5043ED26K70F | 1 | 341441000 |
| R33 | RES MF 182K 1% 1/4W | 19701 | 5043ED182K0F | 1 | 341525000 |
| R34 | RES MF 80.00K 0.1% 1/8W | 64537 | PME55-T9 | 1 | 32592000A |
| R35 | RES MF 11.5K 1% 1/4W | 19701 | 5043ED11K50F | 1 | 341406000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R36 | RES MF 16.5K 1% 1/4W | 19701 | 5043ED16K50F | 1 | 341421000 |
| R37 | RES MF 73.2K 1% 1/4W | 19701 | 5043ED73K20F | 1 | 341483000 |
| R38 | RES MF 80.00K 0.1% 1/8W | 64537 | PME55-T9 | 1 | 32592000A |
| R39 | RES MF 4.67K 1% 1/4W | 19701 | 5043ED4K670F | 1 | 341366000 |
| R40 | RES MF 80.00K 0.1% 1/8W | 64537 | PME55-T9 | 1 | 32592000A |
| R41 | RES MF 9.76K 1% 1/4W | 19701 | 5043ED9K760F | 1 | 341395000 |
| R42 | RES MF 48.7K 1% 1/4W | 19701 | 5043ED48K70F | 1 | 341466000 |
| R43 | RES MF 5.76K 1% 1/4W | 19701 | 5043ED5K760F | 1 | 341373000 |
| R44 | RES MF 2.49K 1% 1/4W | 19701 | 5043ED2K490F | 1 | 341338000 |
| R45 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R46-47 | RES MF 7.50K 1% 1/4W | 19701 | 5043ED7K500F | 2 | 341384000 |
| R48 | RES MF 243K 1% 1/4W | 19701 | 5043ED243K0F | 1 | 341537000 |
| R49 | RES MF 3.920K 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324311000 |
| R50 | RES MF 56.2K 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324448000 |
| R51 | RES MF 11.5K 1% 1/4W | 19701 | 5043ED11K50F | 1 | 341406000 |
| R52 | RES MF 48.7K 1% 1/4W | 19701 | 5043ED48K70F | 1 | 341466000 |
| R53 | RES MF 1.54K 1% 1/4W | 19701 | 5043ED1K540F | 1 | 341318000 |
| R54 | RES MF 2.21K 1% 1/4W | 19701 | 5043ED2K210F | 1 | 341333000 |
| R55 | RES MF 600 OHM 0.25% 1/8W | 64537 | PME55-T2 | 1 | 324215000 |
| R56 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R57-58 | RES MF 243 OHM 1% 1/4W | 19701 | 5043ED243R0F | 1 | 341237000 |
| U1 | IC 74HCT138 1 OF 8 DECODER | 01295 | 74HCT138N | 1 | 534375000 |
| U2 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U3 | IC 6208 4 CHAN DIF MULTPXR | 32293 | IH6208CPE | 1 | 534266000 |
| U4-5 | IC 6108 CMOS CHAN MULTPXR | 32293 | IH6108CPE | 2 | 534265000 |
| U6 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U7 | IC 6108 CMOS CHAN MULTPXR | 32293 | IH6108CPE | 1 | 534265000 |
| U8-9 | IC ANALOG SWITCH DG419 | 17856 | DG419 | 2 | 53452400A |
| XAR1-13 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 13 | 473041000 |
| XU8-U9 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XU1 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU2 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU3-5 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 3 | 473042000 |
| XU6 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU7 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |

## A7

| 08252001A | REV: A | PWA '8200' DISTORTION ANALYZER |
|---|---|---|

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| AR1 | IC 356P OP AMP | 04713 | LF356N | 1 | 535040000 |
| AR2 | IC 5532A DUAL OP AMP 8 DIP | 01295 | NE5532AP | 1 | 53512100A |
| AR3 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR4 | IC OP-07EP OP AMP | 06665 | OP-07EP | 1 | 535110000 |
| AR5 | IC 393 OP AMP | 27014 | LM393N | 1 | 535107000 |
| AR7-8 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 2 | 535092000 |
| AR9 | IC 5532A DUAL OP AMP 8 DIP | 01295 | NE5532AP | 1 | 53512100A |
| AR10 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| AR11 | IC OP-07EP OP AMP | 06665 | OP-07EP | 1 | 535110000 |
| AR12 | IC 393 OP AMP | 27014 | LM393N | 1 | 535107000 |
| C1 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| C2 | CAP MICA 250pF 1% 50V | 14655 | CD5FY251F | 1 | 205034000 |
| C3-6 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 4 | 224268000 |
| C7 | CAP MPC 0.22uF 2% 50V | 14752 | 652A-1-A224G | 1 | 234167000 |
| C8 | CAP MICA 75pF 5% 300V | 57582 | KD5750J301 | 1 | 205043000 |
| C9 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C12 | CAP MICA 1000PF 1% 50V | 51406 | DM15-102F | 1 | 200113000 |
| C13-14 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C15 | CAP MICA 500pF 1% 500V | 14655 | CD15FD501F | 1 | 200123000 |
| C16 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C17 | CAP TANT 100uF 20% 10V | 56289 | 196D107X0010PE4 | 1 | 283291000 |
| C19 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C20 | CAP MPC 0.22uF 2% 50V | 14752 | 652A-1-A224G | 1 | 234167000 |
| C21-22 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C23 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C24 | CAP MICA 1000PF 1% 50V | 51406 | DM15-102F | 1 | 200113000 |
| C25-26 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C27 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C28 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| CR1-2 | DIODE SIG 1N914 | 01295 | 1N914 | 2 | 530058000 |
| CR4-5 | DIODE SIG 1N5713 | 28480 | 1N5713 | 2 | 530161000 |
| J1 | CONN M 2 CKT ST .1CT | 27264 | 22-10-2021 | 1 | 477361000 |
| L1-2 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 2 | 400308000 |
| L3 | INDUCTOR VK200/20-4B | 02114 | VK-200-20/4B | 1 | 400409000 |
| P1 | SHUNT 2 CIRCUIT | 27264 | 15-38-1024 | 1 | 463253000 |
| Q1-10 | TRANS FET 2N5653 | SEMI, | 2N5653 | 10 | 528058000 |
| R1 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R2 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R3 | RES MF 1.82K 1% 1/4W | 19701 | 5043ED1K820F | 1 | 341325000 |
| R4 | RES MF 600 OHM 0.25% 1/8W | 64537 | PME55-T2 | 1 | 324215000 |
| R5 | RES MF 33.2K 1% 1/4W | 19701 | 5043ED33K20F | 1 | 341450000 |
| R6 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R7-8 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R9 | RES NETWORK 100K 2% 1.5W | 71450 | 750-61-R100K | 1 | 345032000 |
| R10 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R11 | RES VAR 10K 10% 0.5W | 73138 | 72XWR10K | 1 | 311348000 |
| R12 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R13 | RES MF 48.7K 1% 1/4W | 19701 | 5043ED48K70F | 1 | 341466000 |
| R14 | RES MF 10.0 OHM 1% 1/4W | 19701 | 5043ED10R00F | 1 | 341100000 |
| R15 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R16 | RES MF 619K 1% 1/4W | 19701 | RN55D-6193-F | 1 | 341576000 |
| R17 | RES MF 6.19K 1% 1/4W | 19701 | 5043ED6K190F | 1 | 341376000 |
| R18 | RES MF 68.1K 1% 1/4W | 19701 | 5043ED68K10F | 1 | 341480000 |
| R19 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R20 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R23-24 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R26 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 1 | 341368000 |
| R27 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R28 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 1 | 341368000 |
| R29 | RES MF 15.0K 1% 1/4W | 19701 | 5043ED15K00F | 1 | 341417000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R30 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R31 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R32 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R33 | RES MF 150K 1% 1/4W | 19701 | 5043ED150K0F | 1 | 341517000 |
| R34 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R35 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R36 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R37 | RES MF 14.0K 1% 1/4W | 19701 | 5043ED14K00F | 1 | 341414000 |
| R38 | RES MF 619K 1% 1/4W | 19701 | RN55D-6193-F | 1 | 341576000 |
| R39 | RES MF 6.19K 1% 1/4W | 19701 | 5043ED6K190F | 1 | 341376000 |
| R40 | RES MF 68.1K 1% 1/4W | 19701 | 5043ED68K10F | 1 | 341480000 |
| R41 | RES MF 10.0 OHM 1% 1/4W | 19701 | 5043ED10R00F | 1 | 341100000 |
| R42 | RES MF 48.7K 1% 1/4W | 19701 | 5043ED48K70F | 1 | 341466000 |
| R43 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R44 | RES VAR 10K 10% 0.5W | 73138 | 72XWR10K | 1 | 311348000 |
| R45 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R46 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R48 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R49 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R50 | RES MF 2.43K 1% 1/4W | 19701 | RN55D-2431-F | 1 | 341337000 |
| R51 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R52 | RES MF 3.01K 1% 1/4W | 19701 | 5043ED3K010F | 1 | 341346000 |
| R53-54 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R55 | RES MF 12.7K 1% 1/4W | 19701 | 5043ED12K70F | 1 | 341410000 |
| R56 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R57 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R58 | RES NETWORK 100K 2% 1.5W | 71450 | 750-61-R100K | 1 | 345032000 |
| R59-64 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 6 | 341500000 |
| R65 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R66 | RES MF 4.32K 1% 1/4W | 19701 | 5043ED4K320F | 1 | 341361000 |
| R67 | RES MF 681 OHM 1% 1/4W | 19701 | 5043ED681R0F | 1 | 341280000 |
| TP1-4 | TERMINAL WIRE LOOP TEST POINT | 31313 | TP-103-02 | 4 | 48330600A |
| U1 | IC 13333 ANALOG SWITCH LF | 27014 | LF13333N | 1 | 535095000 |
| U2 | IC 74HCT138 1 OF 8 DECODER | 01295 | 74HCT138N | 1 | 534375000 |
| U3 | IC 7528 CMOS 8 BIT DAC | 51640 | AD7528JN | 1 | 535108000 |
| U6-7 | IC 4200ANB RC | 07933 | RC4200ANB | 2 | 535083000 |
| U8 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| XAR1-5 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 5 | 473041000 |
| XAR7-12 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 6 | 473041000 |
| XU1-2 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 2 | 473042000 |
| XU3 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU6-7 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XU8 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| **A8** | | | | | |
| 08262201A | REV: AA | PWA '8201' DETECTOR | | | |
| C1 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C2 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| C3 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C4-5 | CAP TANT 100uF 20% 10V | 56289 | 196D107X0010PE4 | 2 | 283291000 |
| C6 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C7 | CAP MICA 5.0pF 10% 300V | 14655 | CD5CC050D | 1 | 205000000 |
| C8 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C9 | CAP TANT 56uF 10% 6V | 56289 | 196D566X9006KA1 | 1 | 283228000 |
| C10-11 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C12 | CAP EL 47uF 20% 50V | S4217 | SM50VB47 | 1 | 283358000 |
| C13 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C14-15 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C16 | CAP MICA 5.0pF 10% 300V | 14655 | CD5CC050D | 1 | 205000000 |
| C17-18 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C19 | CAP TANT 56uF 10% 6V | 56289 | 196D566X9006KA1 | 1 | 283228000 |
| C20-21 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 2 | 234139000 |
| C22 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 1 | 283336000 |
| C23 | CAP VAR CER 5.1-50pF 250V GRN | 52769 | GKR50000 | 1 | 281006000 |
| C24 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C25 | CAP TANT 56uF 10% 6V | 56289 | 196D566X9006KA1 | 1 | 283228000 |
| C26 | CAP TANT 2.2uF 20% 35V | 61637 | T368B225M035ASC2513 | 1 | 283317000 |
| C27-30 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 4 | 224268000 |
| C31 | CAP CER 0.001uF 10% 100V | 04222 | SR151C102KAA | 1 | 224270000 |
| C32-34 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| C35 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C36 | CAP TANT 100uF 20% 10V | 56289 | 196D107X0010PE4 | 1 | 283291000 |
| C37 | CAP CER 0.022uF 10% 50V | 61637 | C052K223K5X5CA | 1 | 224302000 |
| C38 | CAP MICA 12pF 5% 300V | 57582 | KD5120J301 | 1 | 205005000 |
| C39 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C40-41 | CAP MPC 1.0uF 10% 50V | 14752 | 652A-1-A-105K | 2 | 234152000 |
| C42 | CAP TANT 56uF 10% 6V | 56289 | 196D566X9006KA1 | 1 | 283228000 |
| CR1-2 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR3-4 | DIODE SIG FDH-300 | 07263 | FDH300 | 2 | 530052000 |
| CR5-10 | DIODE SIG 1N914 | 01295 | 1N914 | 6 | 530058000 |
| JP1 | WIRE BARE SOLID 24 AWG | 04901 | 920148240 | 1 | 920148240 |
| L1-3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 3 | 400308000 |
| R1 | RES MF 5.000K 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324326000 |
| R2 | RES MF 3.000K 0.1% 1/8W | 64537 | PME55-T2 | 1 | 324300000 |
| R3-4 | RES MF 1.000K 0.1% 1/8W | 03888 | PME55-T2 | 2 | 324241000 |
| R5 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R6 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R7 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R8 | RES MF 9.000K 0.1% 1/4W | 64537 | PME55-T2 | 1 | 324354000 |
| R9 | RES MF 1.000K 0.1% 1/8W | 03888 | PME55-T2 | 1 | 324241000 |
| R11 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R12 | RES MF 301 OHM 1% 1/4W | 19701 | 5043ED301R0F | 1 | 341246000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R13 | RES MF 75.0K 1% 1/4W | 19701 | 5043ED75K00F | 1 | 341484000 |
| R14 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R15 | RES MF 11.0K 1% 1/4W | 19701 | 5043ED11K00F | 1 | 341404000 |
| R16 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R17 | RES MF 11.0K 1% 1/4W | 19701 | 5043ED11K00F | 1 | 341404000 |
| R18 | RES MF 9.000K 0.1% 1/4W | 64537 | PME55-T2 | 1 | 324364000 |
| R19 | RES MF 1.000K 0.1% 1/8W | 03888 | PME55-T2 | 1 | 324241000 |
| R20 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R21 | RES MF 22.1K 1% 1/4W | 19701 | RN55D-2212-F | 1 | 341433000 |
| R22 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R23 | RES MF 200 OHM 1% 1/4W | 19701 | 5043ED200R0F | 1 | 341229000 |
| R24 | RES MF 22.1K 1% 1/4W | 19701 | RN55D-2212-F | 1 | 341433000 |
| R25 | RES MF 200 OHM 1% 1/4W | 19701 | 5043ED200R0F | 1 | 341229000 |
| R26 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R27 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R28 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R29 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R30 | RES MF 47.5K 1% 1/4W | 19701 | 5043ED47K50F | 1 | 341465000 |
| R31 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R32-33 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R34 | RES MF 12.1K 1% 1/4W | 19701 | 5043ED12K10F | 1 | 341408000 |
| R35 | RES MF 2.49K 1% 1/4W | 19701 | 5043ED2K490F | 1 | 341338000 |
| R36-38 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 3 | 341400000 |
| R39 | RES MF 2.67K 1% 1/4W | 19701 | 5043ED2K670F | 1 | 341341000 |
| R40 | RES MF 33.2K 1% 1/4W | 19701 | 5043ED33K20F | 1 | 341450000 |
| R41 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R42 | RES MF 2.49K 1% 1/4W | 19701 | 5043ED2K490F | 1 | 341338000 |
| R43 | RES MF 20.0K 1% 1/4W | 19701 | 5043ED20K00F | 1 | 341429000 |
| R44 | RES MF 4.99K 1% 1/4W | 19701 | 5043ED4K990F | 1 | 341367000 |
| R45 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R46 | RES MF 750K 1% 1/4W | 19701 | 5043ED750K0F | 1 | 341584000 |
| R47 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R48 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R49 | RES MF 10.5K 1% 1/4W | 19701 | 5043ED10K50F | 1 | 341402000 |
| R50 | RES NETWORK 3.3K 2% 2W | 73138 | 694-3-R10K-D | 1 | 345017000 |
| R53 | RES MF 750K 1% 1/4W | 19701 | 5043ED750K0F | 1 | 341584000 |
| R54 | RES MF 2.43K 1% 1/4W | 19701 | RN55D-2431-F | 1 | 341337000 |
| R55 | RES NETWORK 10K 0.5% 1/2W | 73138 | 694-3-R10K-D | 1 | 345041000 |
| R56 | RES COMP 2.0M 5% 1/4W | 01121 | CB2055 | 1 | 343629000 |
| R57-59 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 3 | 341400000 |
| R60 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R61 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R62 | RES MF 1.82K 1% 1/4W | 19701 | 5043ED1K820F | 1 | 341325000 |
| R63-64 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R65 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R66 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R67 | RES MF 499 OHM 1% 1/4W | 19701 | 5043ED499R0F | 1 | 341267000 |
| R68 | RES MF 402K 1% 1/4W | 19701 | 5043ED402K0F | 1 | 341558000 |
| R69 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R70 | RES MF 49.9K 1% 1/4W | 19701 | 5043ED499K0F | 1 | 341467000 |
| R71 | RES MF 38.3K 1% 1/4W | 19701 | 5043ED38K30F | 1 | 341456000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R72 | RES MF 619K 1% 1/4W | 19701 | 5043ED619K0F | 1 | 341576000 |
| R73 | RES MF 200K 1% 1/4W | 19701 | 5043ED200K0F | 1 | 341529000 |
| U1 | IC 13333 ANALOG SWITCH LF | 27014 | LF13333N | 1 | 535095000 |
| U2 | IC PEEL DETECTOR 8220 | 04901 | 53469600A | 1 | 53469600A |
| U3 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U4 | IC 13202N 4 NOR OPEN SW | 27014 | LF13202N | 1 | 534252000 |
| U5 | IC 13333 ANALOG SWITCH LF | 27014 | LF13333N | 1 | 535095000 |
| U6-7 | IC 4052B MULTIPLEXER | 02735 | CD4052BE | 2 | 534140000 |
| U8 | IC AD536 TRUE RMS/DC CONV | 51640 | AD536AJD | 1 | 535105000 |
| U9 | IC 6108 CMOS CHAN MULTPXR | 32293 | IH6108CPE | 1 | 534265000 |
| U10 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U11 | IC 356P OP AMP | 27014 | LF356N | 1 | 535040000 |
| U12 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| U13 | IC TL074CN OP AMP QUAD | 01295 | TL074CN | 1 | 535082000 |
| U14 | IC HA3-2625-5 OP AMP | 34371 | HA3-2625-5 | 1 | 53511900A |
| U15-16 | IC 3080E OP AMP | 02735 | CA3080E | 2 | 535091000 |
| U17 | IC TL074CN OP AMP QUAD | 01295 | TL074CN | 1 | 535082000 |
| U18 | IC HA3-2625-5 OP AMP | 34371 | HA3-2625-5 | 1 | 53511900A |
| U19 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 1 | 535092000 |
| U20 | IC 5534AN OP AMP | 18324 | NE5534AN | 1 | 535061000 |
| U21 | IC 5534AN OP AMP | 18324 | NE5534AN | 1 | 535061000 |
| U22-23 | IC TL072CP DUAL OP AMP | 01295 | TL072CP | 2 | 535092000 |
| XU1 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU2-3 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 2 | 473065000 |
| XU4-7 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 4 | 473042000 |
| XU8 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU9 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU10 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU11-12 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XU13 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU14-16 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 3 | 473041000 |
| XU17 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU18-23 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 6 | 473041000 |

**A9**

| 08262101A | REV: A | PWA '8201' CPU | | | |
|---|---|---|---|---|---|
| BT1 | CELL LITHIUM 3V | 54473 | BR2325-1HB | 1 | 556007000 |
| C1 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C2 | CAP TANT 4.7uF 10% 10V | 56289 | 196D475X9010HA1 | 1 | 283226000 |
| C3-9 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 7 | 224268000 |
| C10 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 1 | 283293000 |
| C11-14 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 4 | 224268000 |
| C15 | CAP EL 100uF 20% 25V | 54217 | SM-25-VB-101M | 1 | 283334000 |
| C16-18 | CAP TANT 10uF 20% 25V | 56289 | 196D106X0025KA1 | 3 | 283293000 |
| C19 | CAP MICA 330pF 5% 50V | 14655 | CD5FY331J | 1 | 205029000 |
| CR1-2 | DIODE SIG 1N914 | 01295 | 1N914 | 2 | 530058000 |
| CR3 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 1 | 530174000 |
| DS1 | LED YELLOW DIFF 5082-4684 | 28480 | HLMP-1401 | 1 | 536034000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| DS2 | LED RED DIFF HLMP-6620 | 28480 | HLMP-6620 | 1 | 536026000 |
| J1 | CONN M 40 CKT HDR DBL ROW .1CT | 06776 | NSH-40DB-S2-TG | 1 | 47742240A |
| J2-3 | CONN M 26 CKT HDR DBL ROW .1CT | 06776 | NSH-26DB-S2-TG | 2 | 47742226A |
| JP1-3 | SHUNT 2 CIRCUIT | 27264 | 15-38-1024 | 3 | 483253000 |
| L1 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| L2 | INDUCTOR VK200/20-4B | 02114 | VK-200-20/4B | 1 | 400409000 |
| L3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 1 | 400308000 |
| Q1 | TRANS PNP 2N4403 | 04713 | 2N4403 | 1 | 528122000 |
| R1 | RES NETWORK 3.3K 2% 1.5W 10pin | 71450 | 750-101-R3.3K | 1 | 345030000 |
| R2 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R3 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R4-5 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 2 | 341250000 |
| R6 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R8 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R10 | RES NETWORK 3.3K 2% 0.9W 8pin | 71450 | 750-81-R3.3K | 1 | 34504500A |
| R11 | RES NETWORK 10K 0.5% 1/2W | 73138 | 694-3-R10K-D | 1 | 345041000 |
| R12 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R13 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| U1 | IC 74LS390 DU DEC CTR | 01295 | SN74LS390N | 1 | 534329000 |
| U2 | IC PAL V3 DTACK '8220' | 04901 | 53459900A | 1 | 53459900A |
| U3 | IC 74HCT03 QUAD 2 INPUT NAND | 18324 | 74HCT03N | 1 | 53444212A |
| U4 | IC 7705 SUPPLY VOLTAGE SUPVR | 01295 | TL7705ACP | 1 | 53442200A |
| U5 | IC 74LS148 8 TO 3 LINE ENCODER | 01295 | SN74LS148N | 1 | 534234000 |
| U6 | IC 74HCT02 QUAD 2 INPUT NOR | 18324 | 74HCT02N | 1 | 53444211A |
| U7 | IC 74F139 DUAL 1 OF 4 DECODER | 07263 | 74F139PC | 1 | 53448000A |
| U8 | IC 68HC000CP | HITAC | HD68HC000CP-10 | 1 | 53449200A |
| U9 | IC PEEL PROG CPU '8220' | 04901 | 53456400A | 1 | 53456400A |
| U10 | IC EPROM PROG 8201 (II) | 04901 | 53469800A | 1 | 53469800A |
| U11 | IC PEEL 153 PROG '8201/20' | 04901 | 53454900B | 1 | 53454900B |
| U12 | IC 7673 AUTO BATTERY BACKUP SW | 32293 | ICL7673CPA | 1 | 53448500A |
| U13 | IC AD581JH VOLT REF | 51640 | AD581JH | 1 | 535053000 |
| U14 | IC EPROM PROG 8201 (I) | 04901 | 53469700A | 1 | 53469700A |
| U15 | IC TC 55257 PL-10 | TOSH | TC55257APL-10 | 1 | 53449400A |
| U16 | IC 74LS541 OCTAL BUFFER | 01295 | SN74LS541N | 1 | 534381000 |
| U17 | IC TC 55257 PL-10 | TOSH | TC55257APL-10 | 1 | 53449400A |
| U18 | IC74LS245 OCT BUS TRANSCEIVER | 01295 | SN74LS245N | 1 | 53437200A |
| U19 | IC 9914ANL IEEE BUS PROCESSOR | 01295 | TMS9914ANL | 1 | 534288000 |
| U20 | IC 74LS367 HEX BUFF DRVR | 01295 | SN74LS367N | 1 | 534257000 |
| U21 | IC74LS245 OCT BUS TRANSCEIVER | 01295 | SN74LS245N | 1 | 53437200A |
| U22 | IC 82C55 INTERFACE | 34371 | CP82C55A | 1 | 53441100A |
| U23 | IC DAC725JP DUAL D/A CONVERTER | 13919 | DAC725JP | 1 | 53514500A |
| U24 | IC 75160 IEEE BUS TRANSCEIVER | 01295 | SN75160BN | 1 | 534286000 |
| U25 | IC 75161 IEEE BUS TRANSCEIVER | 01295 | SN75161BN | 1 | 534287000 |
| U26 | IC EEPROM X24C16 2Kx8 | 60395 | X24C16-P | 1 | 53449500A |
| U27 | IC 311N OP AMP COMPARATOR | 27014 | LM311N | 1 | 535034000 |
| XJP3 | CONN M 2 CKT ST .1CT | 27264 | 22-10-2021 | 1 | 477361000 |
| XJP1/2 | CONN M 04 CKT HDR DBL ROW .1CT | 06776 | NSH-04DB-S2-TG | 1 | 47742204A |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| XU1 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU2 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU3 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU4 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 1 | 473041000 |
| XU5 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU6 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU7 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU8 | SOCKET IC 68 PIN CHIP CARRIER | 32575 | 641749-2 | 1 | 47308168A |
| XU9 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU10 | SOCKET IC 28 PIN | 06776 | ICN-286-S4-TG | 1 | 473044000 |
| XU11 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU12 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 1 | 473041000 |
| XU13 | SOCKET TRANSISTOR 3 CIR TO-18 | 06776 | SD-5173-N | 1 | 47307800A |
| U14-15 | SOCKET IC 28 PIN | 06776 | ICN-286-S4-TG | 2 | 473044000 |
| XU16 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU17 | SOCKET IC 28 PIN | 06776 | ICN-286-S4-TG | 1 | 473044000 |
| XU18 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU19 | SOCKET IC 40 PIN | 06776 | ICN-406-S4-TG | 1 | 473052000 |
| XU20 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU21 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 1 | 473065000 |
| XU22 | SOCKET IC 40 PIN | 06776 | ICN-406-S4-TG | 1 | 473052000 |
| XU23 | SOCKET IC 28 PIN | 06776 | ICN-286-S4-TG | 1 | 473044000 |
| XU24-25 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 2 | 473065000 |
| XU26-27 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| XY1 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| Y1 | CRYSTAL OSC 18.432 MHz TTL DIP | NDK | TD1100C18.432 | 1 | 54790502A |

## A10

| 08251600B | REV: E* | PWA '8200' COUNTER |
|---|---|---|

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| AR1 | IC TL372CP OP AMP | 01295 | TLC372CP | 1 | 535118000 |
| AR2 | IC HA3-2625-5 OP AMP | 34371 | HA3-2625-5 | 1 | 53511900A |
| AR3 | IC 318N OP AMP | 27014 | LM318N | 1 | 535031000 |
| C1-2 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C3 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C4 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C5 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C6 | CAP CER 0.001uF 10% 100V | 04222 | SR151C102KAA | 1 | 224270000 |
| C7 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C8 | CAP MICA 250pF 5% 50V | 57582 | KD251J101 | 1 | 205037000 |
| C9-15 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 7 | 224268000 |
| C16 | CAP MICA 10pF 5% 300V | 14655 | CD5WCC100J | 1 | 205002000 |
| C17 | CAP MICA 300pF 5% 50V | 14655 | CD5FY301J | 1 | 205026000 |
| C18 | CAP MICA 560pF 1% 300V | 14655 | CD15FC561F | 1 | 200091000 |
| C19 | CAP CER 0.001uF 10% 100V | 04222 | SR151C102KAA | 1 | 224270000 |
| C20 | CAP MICA 300pF 5% 50V | 14655 | CD5FY301J | 1 | 205026000 |
| C21 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C22 | CAP MICA 3.0pF +-0.5pF 300V | 14655 | CD5CC030D | 1 | 205013000 |
| C23 | CAP MICA 100pF 1% 300V | 14655 | CD5FC101F | 1 | 205039000 |
| CR1 | DIODE SIG 1N914 | 01295 | 1N914 | 1 | 530058000 |
| CR2 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 1 | 530174000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| DS1-2 | LED RED DIFF 5082-4684 | 28480 | HLMP-1301 | 2 | 536024000 |
| L1-2 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 2 | 400306000 |
| L3 | INDUCTOR VK200/20-4B | 02114 | VK-200-20/4B | 1 | 400409000 |
| L5-6 | INDUCTOR 82uH 5% | 59474 | 1315-10J | 2 | 400318000 |
| Q1 | TRANS NPN MPS-6507 | 04713 | MPS6507 | 1 | 528070000 |
| Q2 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| R1-2 | RES MF 332 OHM 1% 1/4W | 19701 | 5043ED332R0F | 2 | 341250000 |
| R3 | RES MF 475 OHM 1% 1/4W | 19701 | 5043ED475R0F | 1 | 341265000 |
| R4 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R5 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R6 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R7 | RES MF 56.2 OHM 1% 1/4W | 19701 | 5043ED56R20F | 1 | 341172000 |
| R8-9 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 2 | 341200000 |
| R10-11 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 2 | 341400000 |
| R12 | RES MF 30.1K 1% 1/4W | 19701 | 5043ED30K10F | 1 | 341446000 |
| R13 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R14 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R15 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R16 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R17 | RES MF 681 OHM 1% 1/4W | 19701 | 5043ED681R0F | 1 | 341280000 |
| R18 | RES MF 511 OHM 1% 1/4W | 19701 | 5043ED511R0F | 1 | 341268000 |
| R19 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R20 | RES NETWORK 500 OHM 0.5% 0.5W | 73138 | 694-3-R500D | 1 | 345035000 |
| R21 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R22-23 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 2 | 341300000 |
| R24-25 | RES MF 464 OHM 1% 1/4W | 19701 | 5043ED464R0F | 2 | 341264000 |
| R26 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R29 | RES MF 20.0K 1% 1/4W | 19701 | 5043ED20K00F | 1 | 341429000 |
| R30 | RES MF 4.75K 1% 1/4W | 19701 | 5043ED4K750F | 1 | 341365000 |
| U1 | IC 74F04 HEX INVERTER | 07263 | 74F04PC | 1 | 534395000 |
| U2 | IC 74LS74 FLIP FLOP | 01295 | SN74LS74N | 1 | 534157000 |
| U3 | IC 74HCT138 1 OF 8 DECODER | 01295 | 74HCT138N | 1 | 534375000 |
| U4 | IC 74LS00 2 INP POS NAND | 01295 | SN74LSOON | 1 | 534167000 |
| U5 | IC 74LS490 DUAL DEC COUNTER | 18324 | N74LS490N | 1 | 534238000 |
| U6 | IC 74LS74 FLIP FLOP | 01295 | SN74LS74N | 1 | 534157000 |
| U7 | IC 74LS490 DUAL DEC COUNTER | 18324 | N74LS490N | 1 | 534238000 |
| U8 | IC 74LS290 DEC CTR | 01295 | SN74LS290N | 1 | 534328000 |
| U9 | IC 74F151PC | 07263 | 74F151PC | 1 | 534374000 |
| U10 | IC 74F74PC DUAL D FLIP FLOP | 07263 | 74F74PC | 1 | 534367000 |
| U11 | IC 4049A HEX BUFF | 02735 | CD4049AE | 1 | 534172000 |
| U12 | IC 74F74PC DUAL D FLIP FLOP | 07263 | 74F74PC | 1 | 534367000 |
| U13-14 | IC 4040B COUNTER/DIVIDER | 02735 | CD4040BE | 2 | 534275000 |
| U15 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U16-19 | IC 74HCT244 | 01295 | 74HCT244 | 4 | 534376000 |
| U20 | IC 74LS74 FLIP FLOP | 01295 | SN74LS74N | 1 | 534157000 |
| U21 | IC 13333 ANALOG SWITCH LF | 27014 | LF13333N | 1 | 535095000 |
| U22 | IC 4040B COUNTER/DIVIDER | 02735 | CD4040BE | 1 | 534275000 |
| U23 | IC 74LS163 4 BIT COUNTER | 01295 | SN74LS163AN | 1 | 534279000 |
| U24 | IC 74LS153 4-1 LINE DATA SEL | 01295 | SN74LS153N | 1 | 534278000 |
| XU1-2 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 2 | 473019000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| XU3 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU4 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU5 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU6 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU7 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU8 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU9 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU10 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU11 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU12 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU13-14 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 2 | 473042000 |
| XU20 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| XU21-24 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 4 | 473042000 |
| Y1 | OSC CRYSTAL 10 MHz | 27802 | CO-251-B16 | 1 | 547904000 |
| **A11** | | | | | |
| 08257500A | REV: BB | PWA '8200-S10' I/O | | | |
| C1 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| C2-4 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 3 | 224268000 |
| DS1-2 | LED RED DIFF HLMP-6620 | 28480 | HLMP-6620 | 2 | 536026000 |
| J1 | CONN M 26 CKT HDR DBL ROW .1CT | 06776 | NSH-26DB-S2-TG | 1 | 47742226A |
| J2 | CONNECTOR HEADER 2 PIN RT ANG | 06383 | HPAS156-2-C | 1 | 477365000 |
| J3 | CONN F 50 CKT DBL ROW .1CT | 32575 | 102585-3 | 1 | 479439000 |
| J4 | HEADER 5 PIN RT ANGLE | 06383 | HPAS156-5-C or D | 1 | 477341000 |
| R1-2 | RES NETWORK 3.3K 2% 1.5W 10pin | 71450 | 750-101-R3.3K | 2 | 345030000 |
| U1 | IC 74F139 DUAL 1 OF 4 DECODER | 07263 | 74F139PC | 1 | 53446000A |
| U2-3 | IC 82C79P-2 KEYBD/DISP INTERFACE | TOSH | TM82C79P-2 | 2 | 53454700A |
| U4 | IC 74HCT04 HEX INVERTER | 02735 | CD74HCT04E | 1 | 53444213A |
| XU1 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU2-3 | SOCKET IC 40 PIN | 06776 | ICN-406-S4-TG | 2 | 473052000 |
| XU4 | SOCKET IC 14 PIN | 06776 | ICN-143-S3-G | 1 | 473019000 |
| **A12** | | | | | |
| 08251800B | REV: CB | PWA '8200' DISPLAY | | | |
| C1-2 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C3-4 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 2 | 283334000 |
| C5 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| C6 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-100-M | 1 | 283334000 |
| DS1 | DISPLAY NUMERIC 5082-7651 | 28480 | 5082-7651-S02 | 1 | 536811000 |
| DS2 | LED LIGHT BAR MOD HLMP-2620 | 28480 | HLMP-2620 | 1 | 536027000 |
| DS3-11 | DISPLAY NUMERIC 5082-7651 | 28480 | 5082-7651-S02 | 9 | 536811000 |
| DS12 | LED LIGHT BAR MOD HLMP-2620 | 28480 | HLMP-2620 | 1 | 536027000 |
| DS13-18 | DISPLAY NUMERIC 5082-7651 | 28480 | 5082-7651-S02 | 6 | 536811000 |
| DS19-20 | LED LIGHT BAR MOD HLMP-2620 | 28480 | HLMP-2620 | 2 | 536027000 |
| DS21-22 | DISPLAY NUMERIC 5082-7651 | 28480 | 5082-7651-S02 | 2 | 536811000 |
| DS23 | LED LIGHT BAR MOD HLMP-2620 | 28480 | HLMP-2620 | 1 | 536027000 |
| P1-2 | CONNECTOR 20 PIN STRAIGHT | 27264 | 22-03-2201 | 2 | 477397000 |
| P3 | CONN M 50 CKT HDR DBL ROW .1CT | 32575 | 102692-4 | 1 | 477384000 |
| R1-4 | RES NETWORK 22 OHM +-2 OHM 2W | 01121 | 316B-220 | 4 | 345034000 |

TABLE 7-2. Model 8201 Pa ist Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| U1 | IC ULN2803A TRANSISTOR ARRAY | 56289 | ULN2803A | 1 | 534274000 |
| U2 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| U3 | IC ULN2803A TRANSISTOR ARRAY | 56289 | ULN2803A | 1 | 534274000 |
| U4 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| U5-6 | IC 74HCT244 | 01295 | 74HCT244 | 2 | 534378000 |
| U7-8 | IC UDN2585A | 56289 | UDN2585A | 2 | 534392000 |
| U9 | IC ULN2803A TRANSISTOR ARRAY | 56289 | ULN2803A | 1 | 534274000 |
| U10 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| U11 | IC ULN2803A TRANSISTOR ARRAY | 56289 | ULN2803A | 1 | 534274000 |
| U12 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| U13-14 | IC 74HCT244 | 01295 | 74HCT244 | 2 | 534378000 |
| U15-16 | IC UDN2585A | 56289 | UDN2585A | 2 | 534392000 |
| U17 | IC 74LS138 DECDR/MPX | 01295 | SN74LS138N | 1 | 534246000 |
| XDS1 | SOCKET IC 14 PIN | 06776 | ICN-143-WB-G | 1 | 473066000 |
| XDS2 | SOCKET IC 16 PIN | 06776 | ICN-163-WB-TG | 1 | 473047000 |
| XDS3-11 | SOCKET IC 14 PIN | 06776 | ICN-143-WB-G | 9 | 473066000 |
| XDS12 | SOCKET IC 16 PIN | 06776 | ICN-163-WB-TG | 1 | 473047000 |
| XDS13-16 | SOCKET IC 14 PIN | 06776 | ICN-143-WB-G | 6 | 473066000 |
| XDS19-20 | SOCKET IC 16 PIN | 06776 | ICN-163-WB-TG | 2 | 473047000 |
| XDS21-22 | SOCKET IC 14 PIN | 06776 | ICN-143-WB-G | 2 | 473066000 |
| XDS23 | SOCKET IC 16 PIN | 06776 | ICN-163-WB-TG | 1 | 473047000 |
| XU1 | SOCKET IC 18 PIN | 06776 | ICN-183-S3-TG | 1 | 473045000 |
| XU3 | SOCKET IC 18 PIN | 06776 | ICN-183-S3-TG | 1 | 473045000 |
| XU5-6 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 2 | 473065000 |
| XU7-9 | SOCKET IC 18 PIN | 06776 | ICN-183-S3-TG | 3 | 473045000 |
| XU11 | SOCKET IC 18 PIN | 06776 | ICN-183-S3-TG | 1 | 473045000 |
| XU13-14 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 2 | 473065000 |
| XU15-16 | SOCKET IC 18 PIN | 06776 | ICN-183-S3-TG | 2 | 473045000 |
| **A13** | | | | | |
| 08251703A | REV: A* | PWA '8201' KEYBOARD | | | |
| J1-2 | CONNECTOR 20 PIN | 27264 | 22-02-2205 | 2 | 479399000 |
| S1 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 1 | 465293000 |
| S2-3 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 2 | 465294000 |
| S4-9 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 6 | 465293000 |
| S10-11 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 2 | 465294000 |
| S12-17 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 6 | 465293000 |
| S19-21 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S22-25 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 4 | 465294000 |
| S26-28 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S29-32 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 4 | 465294000 |
| S33-35 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S36-39 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 4 | 465294000 |
| S40-42 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S44-47 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 4 | 465294000 |
| S48-50 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S52-55 | SWITCH PUSH BUTTON W/O LED | 31918 | 200330 | 4 | 465294000 |
| S56-58 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 3 | 465293000 |
| S60-61 | SWITCH PUSH BUTTON W/LED | 31918 | 200480 | 2 | 465293000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR. PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| **A23** | | | | | |
| 08250704A | REV: A* | '8201' REAR PANEL ASSY | | | |
| A27 | '8220' HEAT SINK ASSY | 04901 | 08250803A | 1 | 08250803A |
| C3 | CAP MICA 680pF 5% 300V | 57582 | KD15681J301 | 1 | 200112000 |
| F1 | FUSE 0.75 AMP 250V MDL SLO BLO | 54426 | MDL-3/4 | 1 | 545533000 |
| FL1 | FILTER LINE | 56289 | 3JX5421A | 1 | 439004000 |
| J5-9 | CONN COAX BNC | 54420 | UG-625B/U | 5 | 479123000 |
| T1 | TRANSFORMER POWER | 04901 | 44609600B | 1 | 44609600B |
| S2 | SWITCH DUAL SLIDE DPDT-DPDT | 82389 | 47206LFR | 1 | 465279000 |
| W9 | CABLE ASSY FLAT 24 CKT 14.75 L | 04901 | 92017700A | 1 | 92017700A |
| W10 | CABLE ASSY WIRE 22GA 3C 14.00L | 04901 | 57121701A | 1 | 57121701A |
| W11 | CABLE ASSY COAX RG316/U 22.50L | 04901 | 57223611A | 1 | 57223611A |
| W12 | CABLE ASSY COAX RG316/U 18.25L | 04901 | 57223608A | 1 | 57223608A |
| W13 | CABLE ASSY COAX RG316/U 25.75L | 04901 | 57223610A | 1 | 57223610A |
| W14 | CABLE ASSY COAX RG316/U 28.00L | 04901 | 57223609A | 1 | 57223609A |
| W15 | CABLE ASSY COAX RG316/U 20.25L | 04901 | 57223612A | 1 | 57223612A |
| W17 | CABLE ASSY WIRE 24GA 4C 7.75L | 04901 | 57120100B | 1 | 57120100B |
| W19-20 | CABLE ASSY WIRE 20GA 1C 10.50L | 04901 | 57121801A | 2 | 57121801A |
| XF1B | FUSE CARRIER GRAY 1/4 x 1-1/4 | 61935 | FEK031.1666 | 1 | 482114000 |
| XF1A | FUSE HOLDER | 61935 | FEU031.1673 | 1 | 482117000 |
| **A25** | | | | | |
| 08266500A | REV: AA | '8201' SUB PANEL ASSY | | | |
| A12 | PWA '8200' DISPLAY | 04901 | 08251800B | 1 | 08251800B |
| A13 | PWA '8201' KEYBOARD | 04901 | 08251703A | 1 | 08251703A |
| A28 | POWER SWITCH ASSY | 04901 | 082531000 | 1 | 082531000 |
| C1 | CAP MICA 430pF 1% 500V | 14655 | CD15FD431F03 | 1 | 200037000 |
| C2 | CAP MICA 470pF 1% 500V | 14655 | CD15FD471F03 | 1 | 200050000 |
| J2 | CONNECTOR RF FUSE ASSY | 04901 | 082042000 | 1 | 082042000 |
| J3 | CONNECTOR "SMB" 50 OHM | 19505 | 2019-7511-000 | 1 | 477305000 |
| L1 | INDUCTOR ASSY 330 uH | 04901 | 400441000 | 1 | 400441000 |
| **A27** | | | | | |
| 08250803A | REV: A* | '8220' HEAT SINK ASSY | | | |
| A27W2 | CABLE ASSY WIRE 24GA 5C 4.50L | 04901 | 57127401A | 1 | 57127401A |
| A27W3 | CABLE ASSY WIRE 24GA 5C 4.50L | 04901 | 57127402A | 1 | 57127402A |
| A27W4 | CABLE ASSY WIRE 24GA 5C 6.50L | 04901 | 57127403A | 1 | 57127403A |
| C9 | CAP TANT 1.0uF 10% 35V ONLY | 56289 | 196D105X9035HA1 | 1 | 283216000 |
| C20 | CAP CER 0.01uF 20% 500V | 33883 | BGP Z5U W/FDCL | 1 | 224271000 |
| C26 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 1 | 224268000 |
| CR1 | DIODE BRIDGE 15A 50V | 11961 | SDA-980-1 | 1 | 532030000 |
| U4 | IC 323K REGULATOR | 27014 | LM323K | 1 | 535024000 |
| U5 | IC UA7805UC VOLT REG | 07263 | uA7805UC | 1 | 53511700A |
| U6 | IC UA79M05AUC VOLT REG | 07263 | uA79MO5AUC | 1 | 535093000 |
| U7 | IC UA7805UC VOLT REG | 07263 | uA7805UC | 1 | 53511700A |
| W18 | CABLE ASSY WIRE 22GA 3C 5.00L | 04901 | 57121703A | 1 | 57121703A |

TABLE 7-2. Model 8201 Parts List Con'.aued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| XU4 | SOCKET TRANSISTOR PWR TO-3 | 06776 | MP-3452G | 1 | 47306000A |
| **A28** | | | | | |
| 082531000 | REV: CA | '8200' POWER SWITCH ASSY | | | |
| J1 | CONN COAX BNC | 54420 | UG-625B/U | 1 | 479123000 |
| S1 | SWITCH ROCKER DPDT | 13812 | 572-2121-0103-010 | 1 | 465286000 |
| W16 | CABLE ASSY WIRE 24GA 4C 16.15L | 04901 | 57120000B | 1 | 57120000B |
| **A3, OPTION** | | | | | |
| 08254200A | REV: AA | '8200' CALIBRATOR ASSY | | | |
| C6 | CAP FT 1000pF 20% 500V | 59660 | 2499-003-X5S0102M | 1 | 227105000 |
| J10 | CONNECTOR TYPE "N" | 24253 | 4889 | 1 | 47945500A |
| 04313101A | REV: A* | PWA '4300' 50 MHz GENERATOR; Model: 4200A,S17 | | | |
| AR1 | IC 301A OP AMP | 27014 | LM301AN | 1 | 535012000 |
| C1 | CAP CER 470pF 10% 500V | 33883 | TYPE JF | 1 | 224219000 |
| C2 | CAP MICA 100pF 5% 300V | 20307 | DM5-FC101J | 1 | 205006000 |
| C3 | CAP EL 10uF 20% 25V | 54217 | SM-25-VB-10-M | 1 | 283336000 |
| C4 | CAP VAR CER 3.5-18pF 250V | 91293 | 9373 | 1 | 281011000 |
| C5 | CAP CER 1000pF 10% 600V | 16546 | CE-102 | 1 | 224310000 |
| C7 | CAP EL 10uF 20% 25V | 54217 | SM-25-VB-10-M | 1 | 283336000 |
| C8 | CAP CER 0.01uF 100V | 33883 | BT Z5U | 1 | 224119000 |
| C9 | CAP MICA 36pF 5% 300V | 14655 | CD5EC360J | 1 | 205003000 |
| C10 | CAP MICA 200pF 5% 100V | 14655 | CD5FA201J | 1 | 205024000 |
| C11 | CAP MICA 10pF 5% 300V | 14655 | CD5WCC100J | 1 | 205002000 |
| C12 | CAP VAR CER 3.5-18pF 250V | 91293 | 9373 | 1 | 281011000 |
| CR1-2 | DIODE HSCH1001 (1N6263) | 28480 | HSCH-1001 | 2 | 530174000 |
| CR3 | DIODE MV-1650 | 04713 | MV1650 | 1 | 530762000 |
| L1 | INDUCTOR 4.7uH 10% | 24226 | 10/471 | 1 | 400384000 |
| L2 | INDUCTOR 0.56uH 10% | 24226 | 10/560 | 1 | 400382000 |
| L3 | INDUCTOR 0.033uH 10% | 04901 | 400386000 | 1 | 400386000 |
| Q1 | TRANS NPN 2N3904 | 04713 | 2N3904 | 1 | 528071000 |
| R1 | RES MF 1.50K 1% 1/4W | 19701 | 5043ED1K500F | 1 | 341317000 |
| R2-3 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 2 | 341500000 |
| R4 | RES VAR 1K 10% 0.5W | 32997 | 3299X-1-102 | 1 | 311410000 |
| R6 | RES MF 100K 1% 1/4W | 19701 | 5043ED100K0F | 1 | 341500000 |
| R7 | RES MF 2.43K 1% 1/4W | 19701 | RN55D-2431-F | 1 | 341337000 |
| R8-9 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 2 | 341300000 |
| R10 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R11 | RES MF 5.11K 1% 1/4W | 19701 | 5043ED5K110F | 1 | 341368000 |
| R12 | RES MF 1.21K 1% 1/4W | 19701 | 5043ED1K210F | 1 | 341308000 |
| R13 | RES MF 1.30K 1% 1/4W | 19701 | 5043ED1K300F | 1 | 341311000 |
| R14 | RES MF 75.0 OHM 1% 1/4W | 19701 | 5043ED75R00F | 1 | 341184000 |
| R15 | RES MF 50.00 OHM 0.1% 1/4W | 64537 | PME55-T9 | 1 | 325916000 |
| U1 | IC AD581JH VOLT REF | 51640 | AD581JH | 1 | 535053000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| **A15, OPTION** | | | | | |
| 08262400A | REV: AB | PWA '8220' FILTER OPTION | | | |
| C1 | CAP MPC 0.022uF 2% 50V | 14752 | 652A-1-A223G | 1 | 234166000 |
| C2-3 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C4 | CAP EL 100uF 20% 25V | S4217 | SM-25-VB-101M | 1 | 283334000 |
| CR1-2 | DIODE SIG 1N914 | 01295 | 1N914 | 2 | 530058000 |
| CR3-4 | DIODE SIG FDH-300 | 07263 | FDH300 | 2 | 530052000 |
| J1-2 | CONNECTOR "SMB" | 19505 | 209 | 2 | 477317000 |
| J3 | CONN M 09 CKT ST POLZ .1CT | 06383 | HPSS100-9-C | 1 | 477374000 |
| L1-3 | INDUCTOR 5.6uH 10% | 24226 | 15/561 | 3 | 400308000 |
| P11-40 | SOCKET SPRING COMPONENT LEAD | 32575 | 1-332070-7 | 30 | 479333000 |
| R1 | RES MF 1.00M 1% 1/4W | 19701 | 5043ED1M000F | 1 | 341600000 |
| R2 | RES MF 600 OHM 0.25% 1/8W | 64537 | PME55-T9 | 1 | 324215000 |
| R3 | RES MF 475K 1% 1/4W | 19701 | 5043ED475K0F | 1 | 341565000 |
| R4 | RES NETWORK 3.3K 2% 0.9W 8pin | 71450 | 750-61-R3.3K | 1 | 34504500A |
| R5 | RES VAR 2K 10% 0.5W | 73138 | 72XWR2K | 1 | 311347000 |
| R6 | RES MF 1.00K 1% 1/4W | 19701 | 5043ED1K000F | 1 | 341300000 |
| R7 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R8 | RES VAR 2K 10% 0.5W | 73138 | 72XWR2K | 1 | 311347000 |
| R9 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R10 | RES VAR 2K 10% 0.5W | 73138 | 72XWR2K | 1 | 311347000 |
| R11 | RES MF 9.31K 1% 1/4W | 19701 | 5043ED9K310F | 1 | 341393000 |
| R12 | RES MF 15.0K 1% 1/4W | 19701 | 5043ED15K00F | 1 | 341417000 |
| R13 | RES VAR 2K 10% 0.5W | 73138 | 72XWR2K | 1 | 311347000 |
| R14 | RES MF 4.87K 1% 1/4W | 19701 | 5043ED4K870F | 1 | 341366000 |
| R15 | RES MF 4.02K 1% 1/4W | 19701 | 5043ED4K020F | 1 | 341358000 |
| R16 | RES MF 2.00K 1% 1/4W | 19701 | 5043ED2K000F | 1 | 341329000 |
| R17 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| U1 | IC 74HCT273 | 01295 | SN74HCT273N | 1 | 534377000 |
| U2 | IC PEEL PROG FILTER OPT '8220' | 04901 | 53458700A | 1 | 53458700A |
| U3 | IC 6208 4 CHAN DIF MULTPXR | 32293 | IH6208CPE | 1 | 534266000 |
| U4 | IC 356P OP AMP | 04713 | LF356N | 1 | 535040000 |
| XU1-2 | SOCKET IC 20 PIN | 06776 | ICN-203-S3-G | 2 | 473065000 |
| XU3 | SOCKET IC 16 PIN | 06776 | ICN-163-S3-G | 1 | 473042000 |
| XU4 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 1 | 473041000 |
| 97403101A | REV: A- | OPT AUDIO LOOP-THRU, -07 OPTION | | | |
| A15 | PWA '8220' FILTER OPTION | 04901 | 08262400A | 1 | 08262400A |
| J11-12 | CONN COAX BNC | 54420 | UG-625B/U | 2 | 479123000 |
| W16 | CABLE COAXIAL ASSY (BLUE) | 04901 | 57223616A | 1 | 57223616A |
| W17 | CABLE COAXIAL ASSY (YELLOW) | 04901 | 57223617A | 1 | 57223617A |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| 11204000A | REV: AA | PWA CCITT BANDPASS FILTER, -03 OPTION | | | |
| C1 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 1 | 234142000 |
| C2 | CAP MICA 1000pF 5% 100V | 14655 | CD15FA102J | 1 | 200506000 |
| C3-4 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C5-6 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C7 | CAP MPC 0.01uF 2% 50V | 14752 | 652A-1A-103G | 1 | 234142000 |
| C8 | CAP MPC 0.0047uF 2% 50V | 14752 | 652A-1-A472G | 1 | 23417300A |
| C9 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 1 | 234139000 |
| C10 | CAP MICA 560pF 1% 300V | 14655 | CD15FC561F | 1 | 200091000 |
| C11 | CAP MPC 0.047uF 2% 50V | 14752 | 652A-1-A473G | 1 | 234144000 |
| C12 | CAP MPC 0.022uF 2% 50V | 14752 | 652A-1-A223G | 1 | 234166000 |
| C13 | CAP MPC 0.047uF 2% 50V | 14752 | 652A-1-A473G | 1 | 234144000 |
| C14-16 | CAP MPC 0.1uF 2% 50V | 14752 | 652A-1-A-104G | 3 | 234139000 |
| J1-10 | TERMINAL .040 OD .270 LG .062M | 98291 | 229-1071-230 | 10 | 510038000 |
| R1 | RES MF 23.2K 1% 1/4W | 19701 | 5043ED23K20F | 1 | 34143500A |
| R2 | RES MF 15.0K 1% 1/4W | 19701 | 5043ED15K00F | 1 | 341417000 |
| R3 | RES MF 1.15K 1% 1/4W | 19701 | 5043ED1K150F | 1 | 341306000 |
| R4 | RES MF 2.15K 1% 1/4W | 19701 | 5043ED2K150F | 1 | 341332000 |
| R5 | RES MF 26.1K 1% 1/4W | 19701 | 5043ED26K10F | 1 | 341440000 |
| R6 | RES MF 9.09K 1% 1/4W | 19701 | 5043ED9K090F | 1 | 341392000 |
| R7 | RES MF 6.04K 1% 1/4W | 19701 | 5043ED6K040F | 1 | 341375000 |
| R8 | RES MF 5.62K 1% 1/4W | 19701 | 5043ED5K620F | 1 | 341372000 |
| R9 | RES MF 6.04K 1% 1/4W | 19701 | 5043ED6K040F | 1 | 341375000 |
| R10 | RES MF 4.53K 1% 1/4W | 19701 | 5043ED4K530F | 1 | 341363000 |
| R11 | RES MF 100 OHM 1% 1/4W | 19701 | 5043ED100R0F | 1 | 341200000 |
| R12 | RES MF 26.1K 1% 1/4W | 19701 | 5043ED26K10F | 1 | 341440000 |
| R13 | RES MF 14.3K 1% 1/4W | 19701 | 5043ED14K30F | 1 | 341415000 |
| R14 | RES MF 1.10K 1% 1/4W | 19701 | 5043ED1K100F | 1 | 341304000 |
| R15 | RES MF 5.76K 1% 1/4W | 19701 | 5043ED5K760F | 1 | 341373000 |
| U1-2 | IC 5532A DUAL OP AMP 8 DIP | 01295 | NE5532AP | 2 | 53512100A |
| XU1-2 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| 11203700A | REV: BA | PWA CCIR WGHTING FILTER, -08 OPTION | | | |
| C1 | CAP MICA 1500pF 1% 100V | 57582 | SD15-152F101 | 1 | 20013100A |
| C2 | CAP MPC 0.0047uF 1% 50V | 14752 | 652A-1A-472F | 1 | 23418100A |
| C3 | CAP MICA 1500pF 1% 100V | 57582 | SD15-152F101 | 1 | 20013100A |
| C4-5 | CAP MPC 0.0047uF 1% 50V | 14752 | 652A-1A-472F | 2 | 23418100A |
| C6-8 | CAP MICA 1500pF 1% 100V | 57582 | SD15-152F101 | 3 | 20013100A |
| C9-10 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C11-12 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| J1-10 | TERMINAL .040 OD .270 LG .062M | 98291 | 229-1071-230 | 10 | 510038000 |
| R1 | RES MF 10.0K 1% 1/4W | 19701 | 5043ED10K00F | 1 | 341400000 |
| R2 | RES MF 5.62K 1% 1/4W | 19701 | 5043ED5K620F | 1 | 341372000 |
| R3 | RES MF 27.4K 1% 1/4W | 19701 | 5043ED27K40F | 1 | 341442000 |
| R4-5 | RES MF 5.62K 1% 1/4W | 19701 | 5043ED5K620F | 2 | 341372000 |

TABLE 7-2. Model 8201 Parts List Continued.

| REFERENCE DESIGNATOR | DESCRIPTION | FED. CODE | MFGR PART NO. | QTY | BEC PART NO. |
|---|---|---|---|---|---|
| R6 | RES MF 392 OHM 1% 1/4W | 19701 | 5043ED392R0F | 1 | 341257000 |
| R7-9 | RES MF 5.62K 1% 1/4W | 19701 | 5043ED5K620F | 3 | 341372000 |
| R10 | RES MF 20.0K 1% 1/4W | 19701 | 5043ED20K00F | 1 | 341429000 |
| R11 | RES VAR 2K 10% 0.5W | 73138 | 72XWR2K | 1 | 311347000 |
| U1-2 | IC 5532A DUAL OP AMP 8 DIP | 01295 | NE5532AP | 2 | 53512100A |
| XU1-2 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |
| 11207000A | REV: BB | PWA C-MSG FILTER, -09 OPTION | | | |
| C1-4 | CAP MPC 0.022uF 2% 50V | 14752 | 652A-1-A223G | 4 | 234166000 |
| C5-8 | CAP MPC 0.0022uF 2% 50V | 14752 | 653A-1-A222G | 4 | 234165000 |
| C9-10 | CAP CER 0.1uF 20% 50V | 04222 | SR215E104MAA | 2 | 224268000 |
| C11-12 | CAP EL 10uF 20% 25V | S4217 | SM-25-VB-10-M | 2 | 283336000 |
| C13 | CAP MPC 0.22uF 2% 50V | 14752 | 652A-1-A224G | 1 | 234167000 |
| J1-10 | TERMINAL .040 OD .270 LG .062M | 98291 | 229-1071-230 | 10 | 510038000 |
| R1 | RES MF 20.0K 1% 1/4W | 19701 | 5043ED20K00F | 1 | 341429000 |
| R2 | RES MF 33.2K 1% 1/4W | 19701 | 5043ED33K20F | 1 | 341450000 |
| R3 | RES MF 3.32K 1% 1/4W | 19701 | 5043ED3K320F | 1 | 341350000 |
| R4 | RES MF 19.1K 1% 1/4W | 19701 | 5043ED19K10F | 1 | 341427000 |
| R5 | RES MF 8.25K 1% 1/4W | 19701 | 5043ED8K250F | 1 | 341388000 |
| R6 | RES MF 95.3K 1% 1/4W | 19701 | 5043ED95K30F | 1 | 341494000 |
| R7 | RES MF 3.65K 1% 1/4W | 19701 | 5043ED3K650F | 1 | 341354000 |
| R8 | RES MF 110K 1% 1/4W | 19701 | 5043ED110K0F | 1 | 341504000 |
| R9 | RES MF 13.3K 1% 1/4W | 19701 | 5043ED13K30F | 1 | 341412000 |
| U1-2 | IC 5532A DUAL OP AMP 8 DIP | 01295 | NE5532AP | 2 | 53512100A |
| XU1-2 | SOCKET IC 8 PIN | 06776 | ICN-083-S3-G | 2 | 473041000 |

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# SECTION VIII
# SCHEMATIC DIAGRAMS

TABLE 8-1. SCHEMATIC INDEX.


| Figure | Page |
|---|---|
| Figure 8-1. Main Frame Schematic Diagram. | 8-3 |
| Figure 8-2. Mother Board A1, Parts Location. | 8-4 |
| Figure 8-3. Mother Board A1, Schematic Diagram, Sheet 1. | 8-5 |
| Figure 8-4. Mother Board A1, Schematic Diagram, Sheet 2. | 8-7 |
| Figure 8-5. RF Housing A2, Schematic Diagram. | 8-9 |
| Figure 8-6. RF Board A2A1, Parts Location. | 8-10 |
| Figure 8-7. RF Board A2A1, Schematic Diagram. | 8-11 |
| Figure 8-8. Oscillator Board, A2A2 Parts Location. | 8-12 |
| Figure 8-9. Oscillator Board, A2A2 Schematic Diagram. | 8-13 |
| Figure 8-10. FM Board A4, Parts Location. | 8-14 |
| Figure 8-11. FM Board A4, Schematic Diagram. | 8-15 |
| Figure 8-12. AM Board A5, Parts Location. | 8-16 |
| Figure 8-13. AM Board A5, Schematic Diagram. | 8-17 |
| Figure 8-14. Filter Board A6, Parts Location. | 8-18 |
| Figure 8-15. Filter Board A6, Schematic Diagram. | 8-19 |
| Figure 8-16. Distortion Analyzer A7, Parts Location. | 8-20 |
| Figure 8-17. Distortion Analyzer A7, Schematic Diagram. | 8-21 |
| Figure 8-18. Detector Board A8, Parts Location. | 8-22 |
| Figure 8-19. Detector Board A8, Schematic Diagram. | 8-23 |
| Figure 8-20. CPU Board A9, Parts Location. | 8-24 |
| Figure 8-21. CPU Board A9, Schematic Diagram. | 8-25 |
| Figure 8-22. Counter Board A10, Parts Location. | 8-26 |
| Figure 8-23. Counter Board A10, Schematic Diagram, Sheet 1. | 8-27 |
| Figure 8-24. Counter Board A10, Parts Location. | 8-28 |
| Figure 8-25. Counter Board A10, Schematic Diagram, Sheet 2. | 8-29 |
| Figure 8-26. I/O Board A11, Parts Location. | 8-30 |
| Figure 8-27. I/O Board A11, Schematic Diagram. | 8-31 |
| Figure 8-28. Display Board A12 Parts Location. | 8-32 |
| Figure 8-29. Display Board A12 Schematic Diagram, Sheet 1. | 8-33 |
| Figure 8-30. Display Board A12 Parts Location. | 8-34 |
| Figure 8-31. Display Board A12 Schematic Diagram, Sheet 2. | 8-35 |
| Figure 8-32. Keyboard A13 Parts Location. | 8-36 |
| Figure 8-33. Keyboard A13 Schematic Diagram. | 8-37 |
| Figure 8-34. Optional Filter Board A15 Parts Location. | 8-38 |
| Figure 8-35. Optional Filter Board A15 Schematic Diagram. | 8-39 |
| Figure 8-36. Optional Filter, CCITT, Schematic and Parts Location. | 8-40 |
| Figure 8-37. Optional Filter, CCIR, Schematic and Parts Location. | 8-41 |
| Figure 8-38. Optional Filter, C-MSG, Schematic and Parts Location. | 8-42 |
| Figure 8-39. Optional 50 MHz Calibrator A3 Parts Location. | 8-43 |
| Figure 8-40. Optional 50 MHz Calibrator A3 Schematic Diagram. | 8-44 |

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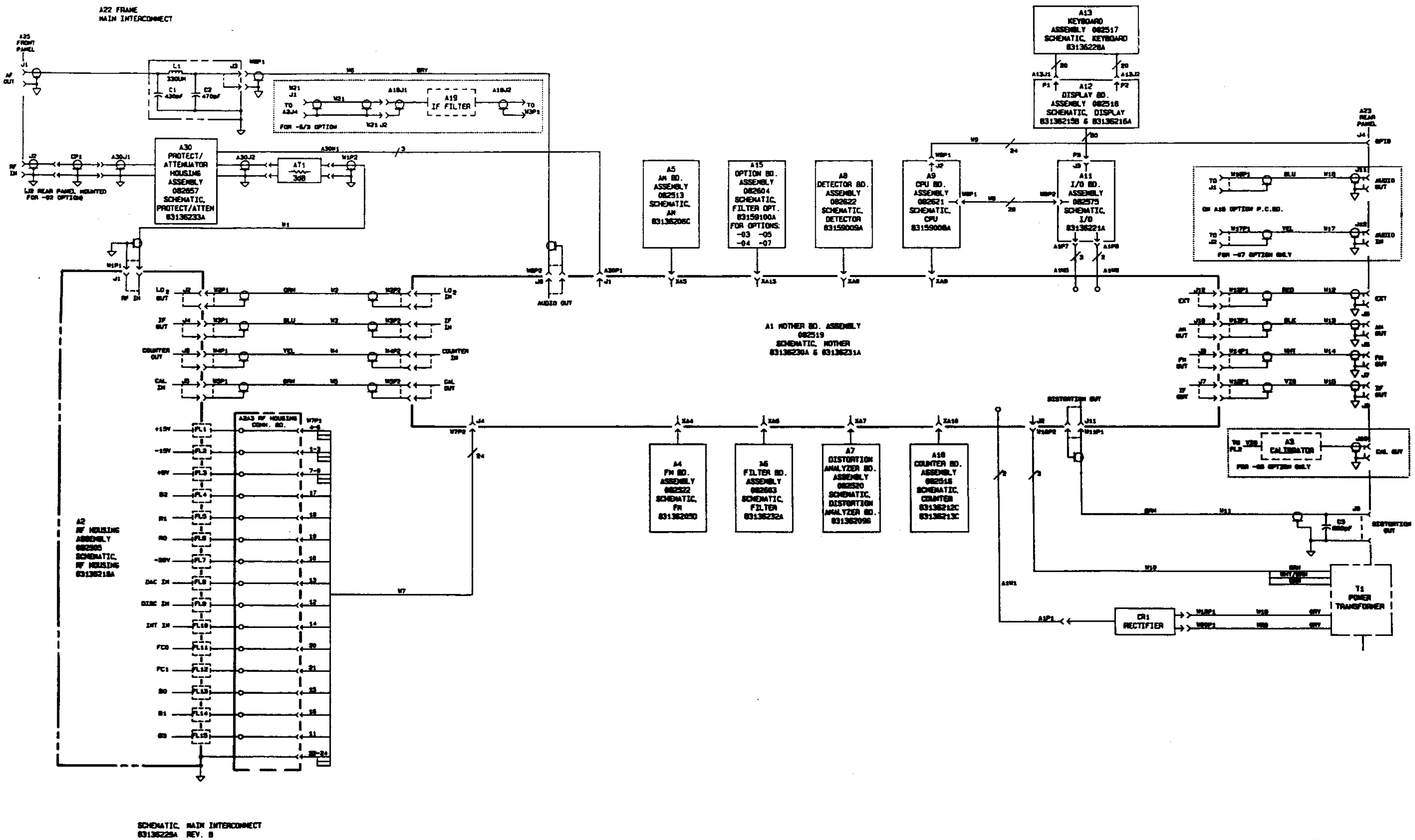
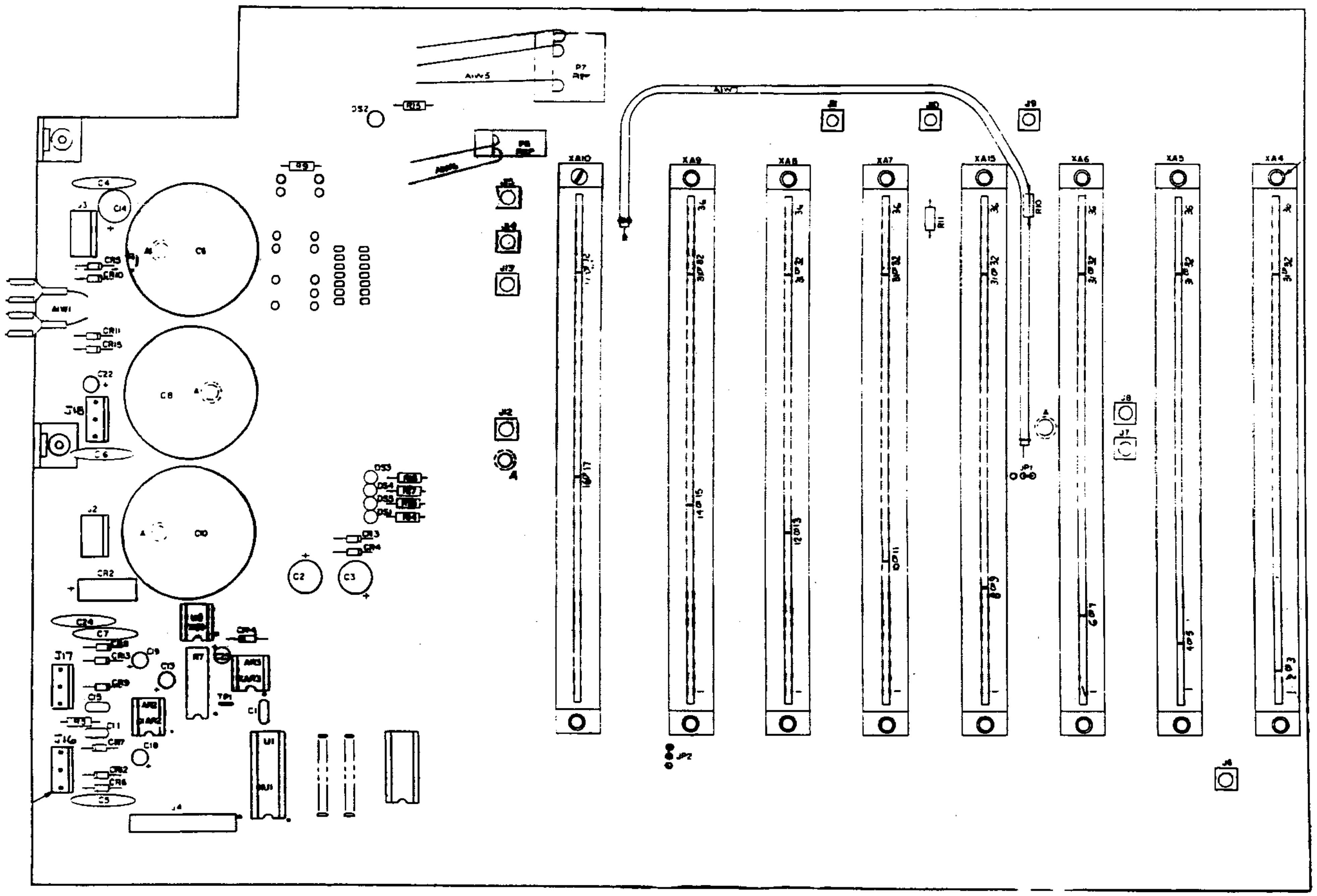



**Figure 8-1. Main Frame Schematic.**




082519A SHT. 3

Figure 8-2. Mother Board A1, Parts Location.

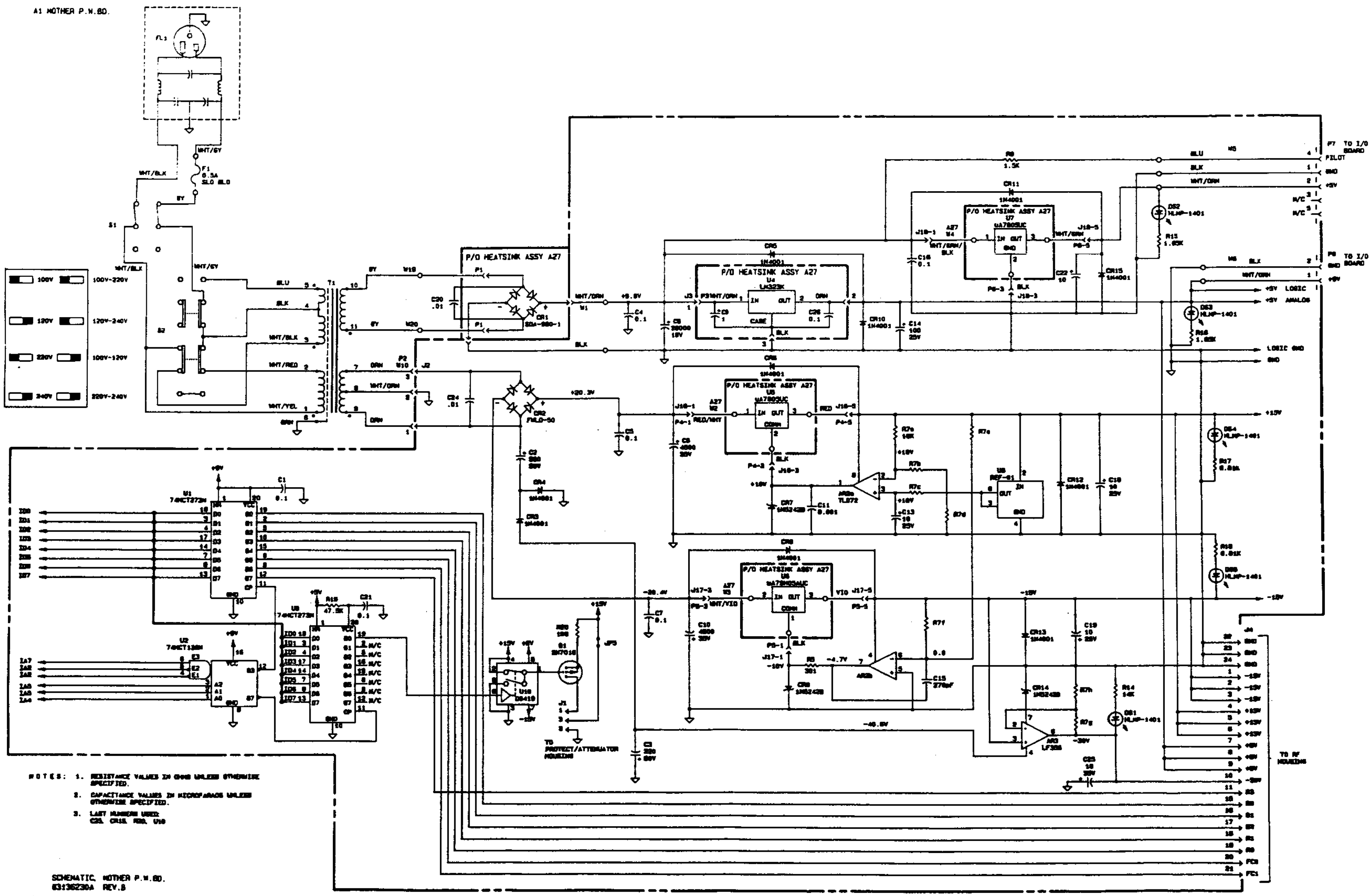



Figure 8-3. Motherboard A1, Schematic Diagram Sheet 1.

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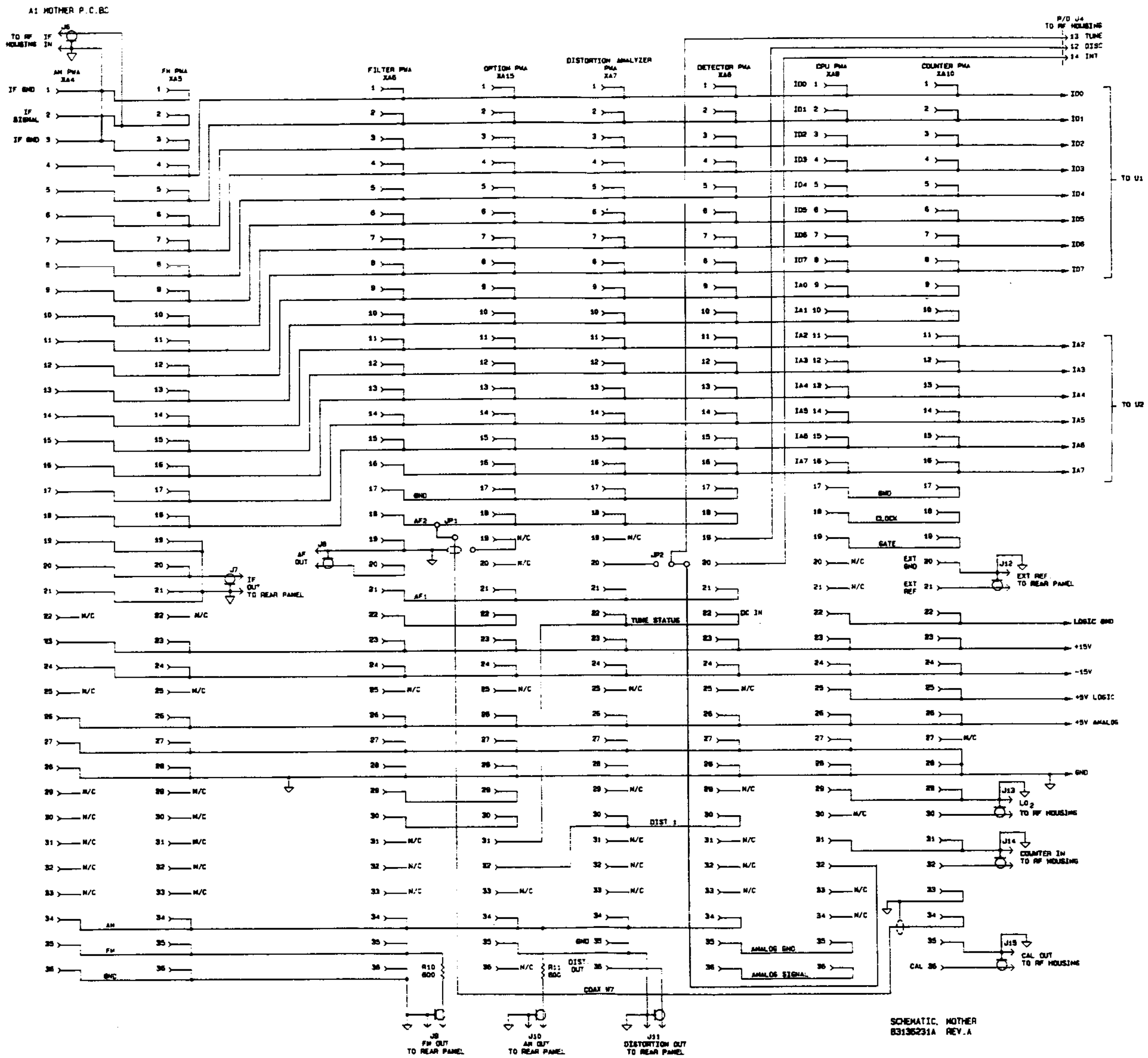

**Figure 8-4. Motherboard A1, Schematic Diagram Sheet 2.**

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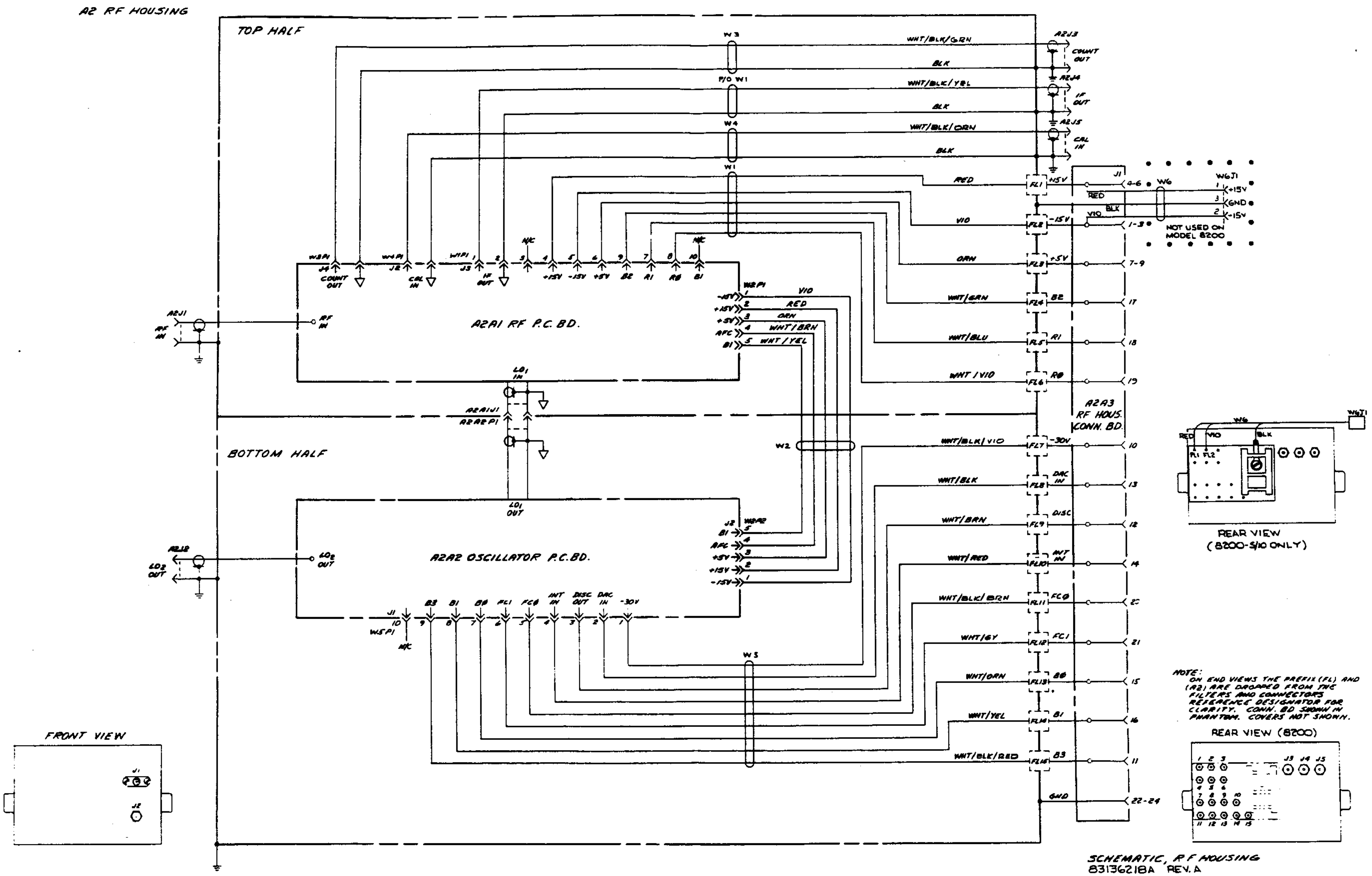
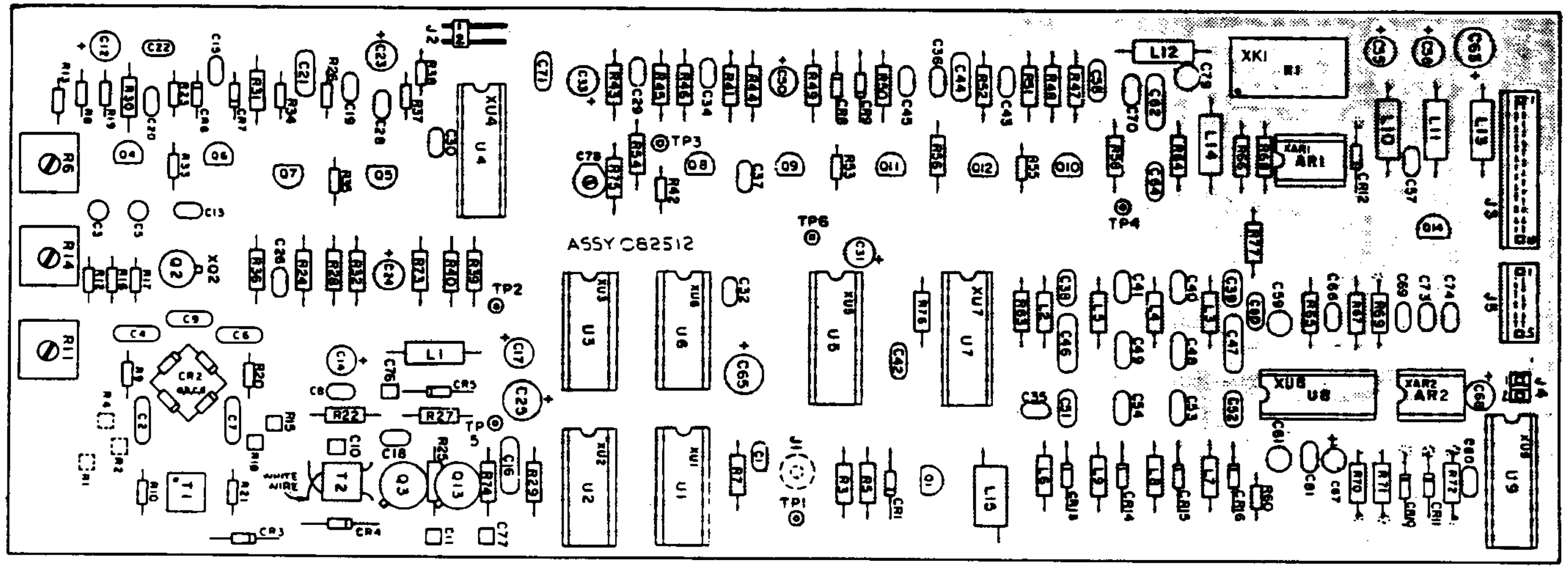



Figure 8-5. RF Housing A2, Schematic Diagram.




082512F

Figure 8-6. RF Board A2A1, Parts Location.

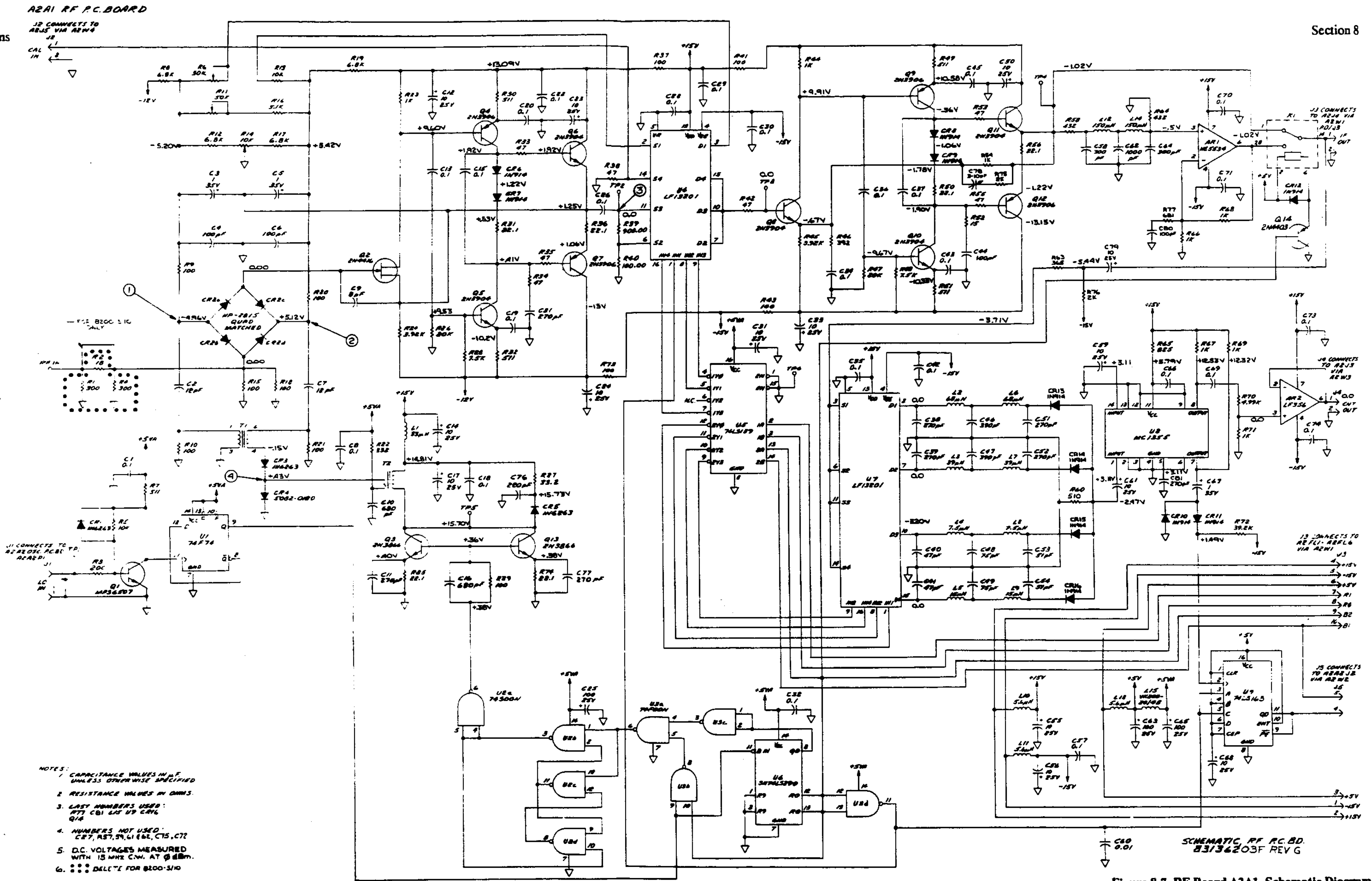
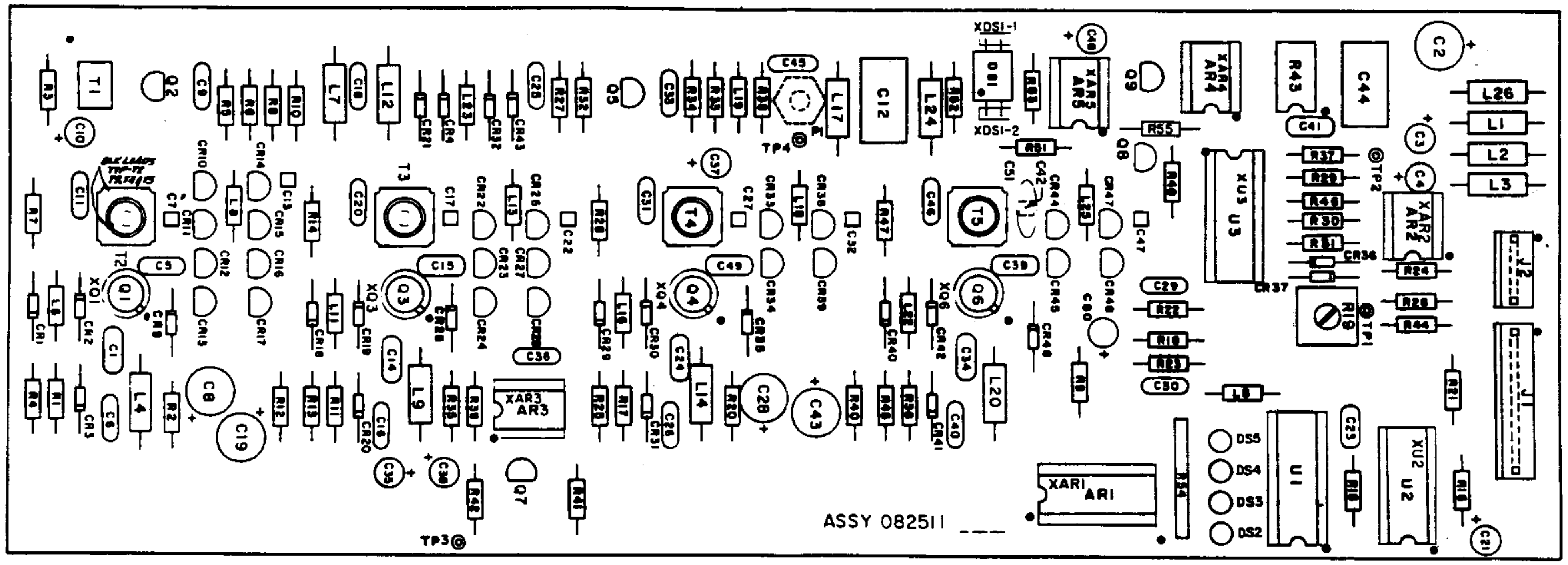


**Figure 8-7. RF Board A2A1, Schematic Diagram.**




082511C

Figure 8-8. Oscillator Board A2A2, Parts Location.

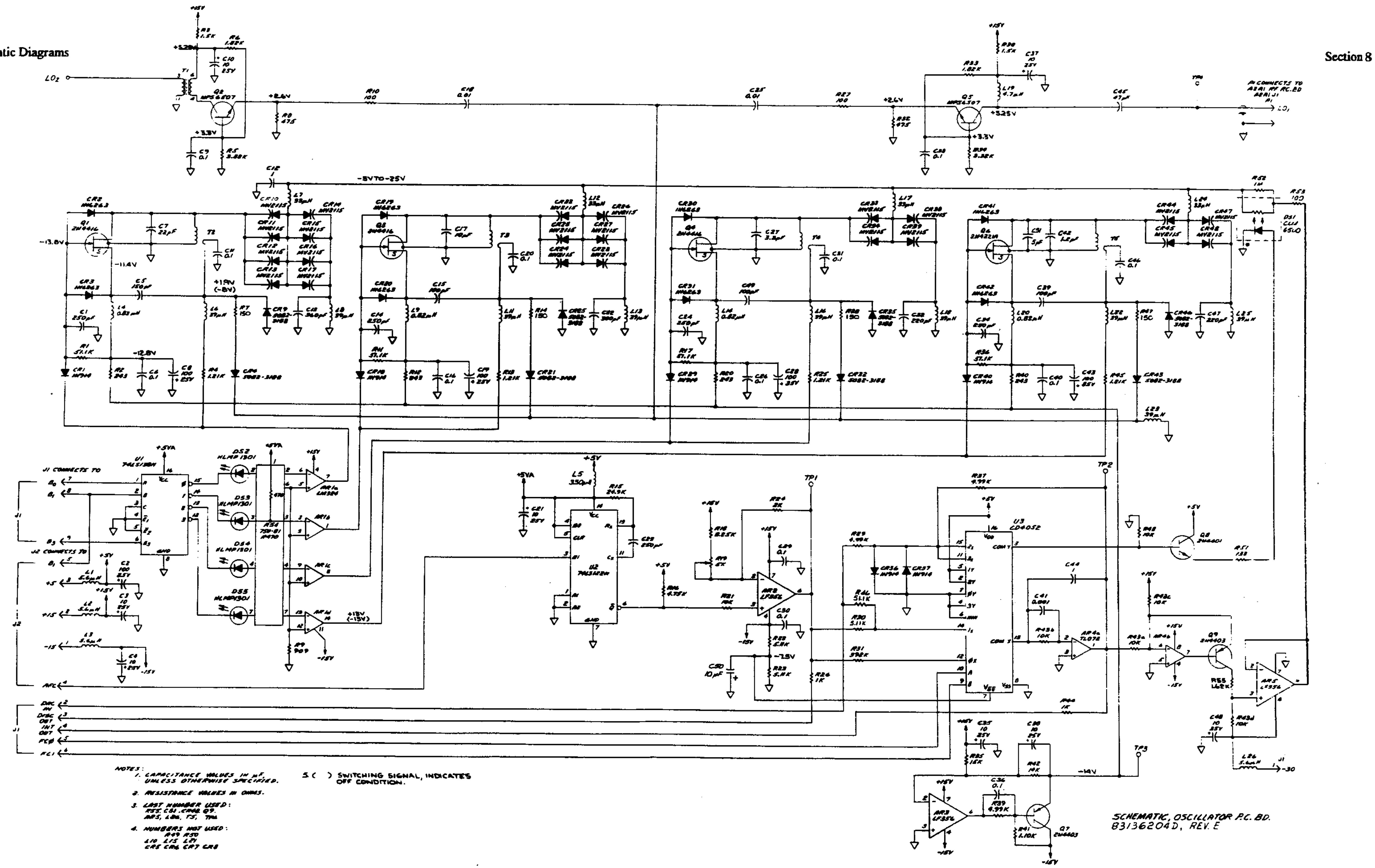
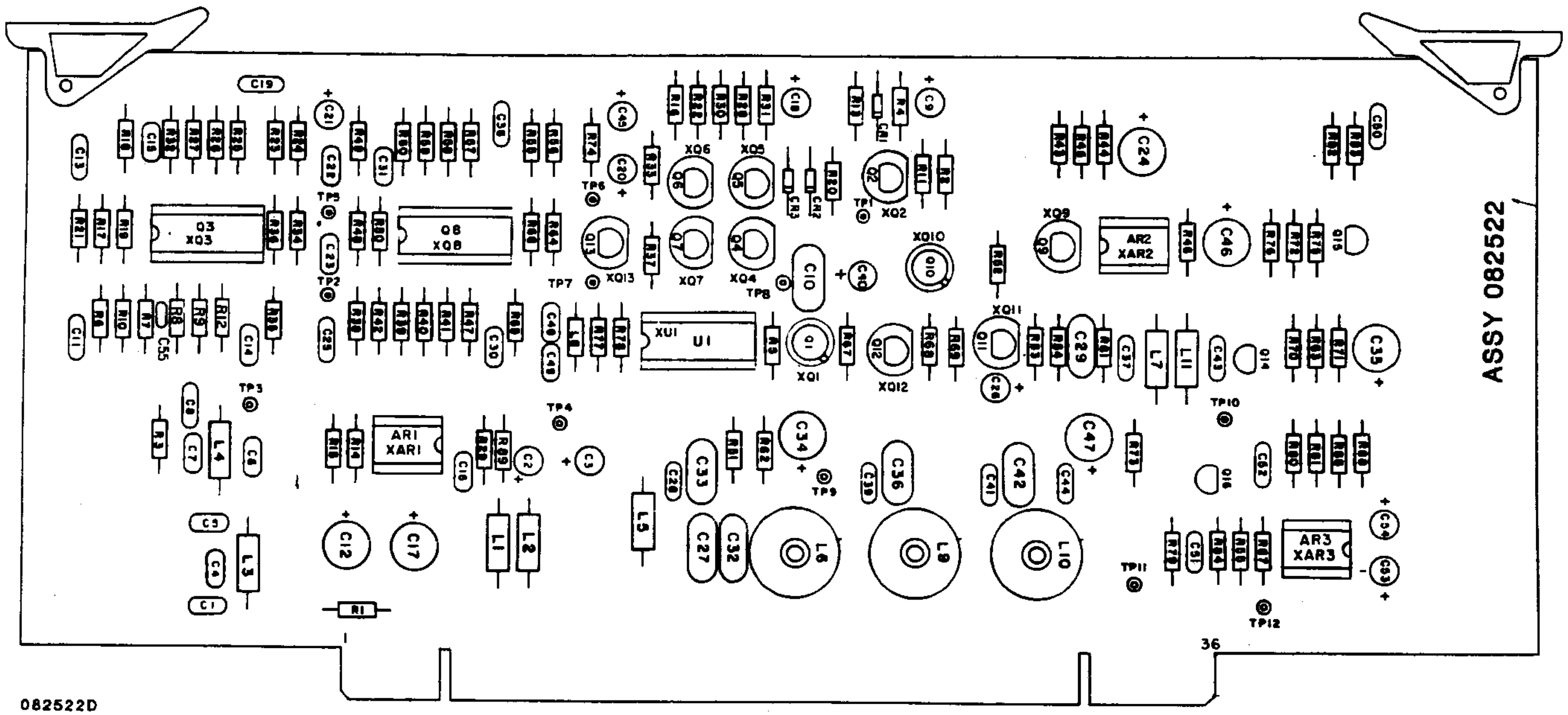
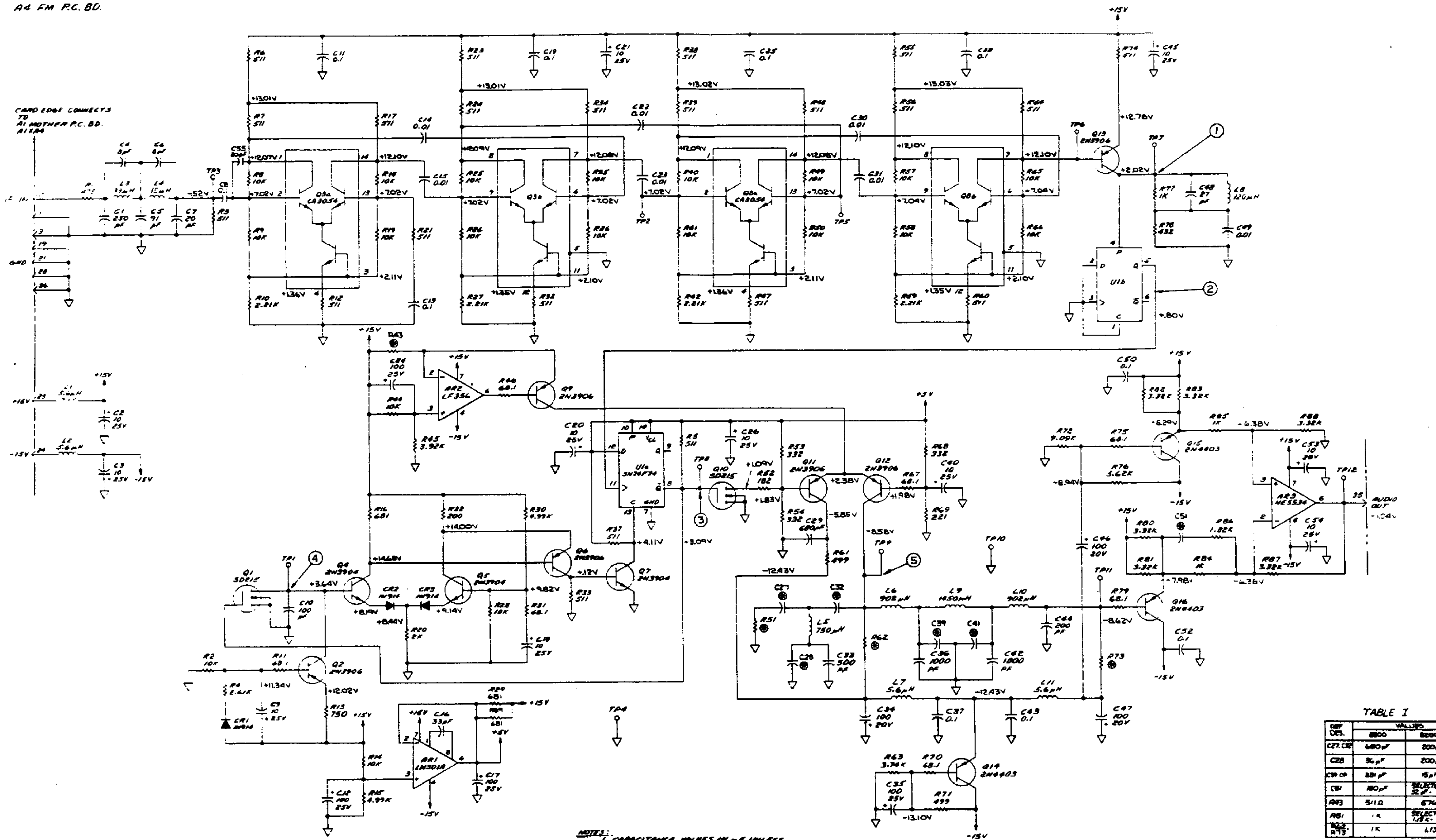



**Figure 8-9. Oscillator Board A2A2, Schematic Diagram.**




082522D

Figure 8-10. FM Board A4, Parts Location.




NOTES:
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED: R89, C54, Q16, TP12, L11
4. D.C. MEASURMENTS MADE WITH 15 MHz C.W. AT ±48.50 kHz DEV. AT 1 kHz RATE.
5. ● SEE TABLE I FOR VALUES.

TABLE I

| REF DES. | VALUES | |
|---|---|---|
| | 8800 | 8800 -4/10 |
| C27, C32 | 680 pF | 200 pF |
| C28 | 36 pF | 200 pF |
| C39 C41 | 331 pF | 15 pF |
| C51 | 180 pF | SELECTED 32 pF - 100 pF |
| R43 | 511 Ω | 576 Ω |
| R51 | 1 K | SELECTED 1.13 K - 3.01 K |
| R62, R73 | 1 K | 1.13 K |

**Figure 8-11. FM Board A4, Schematic Diagram.**

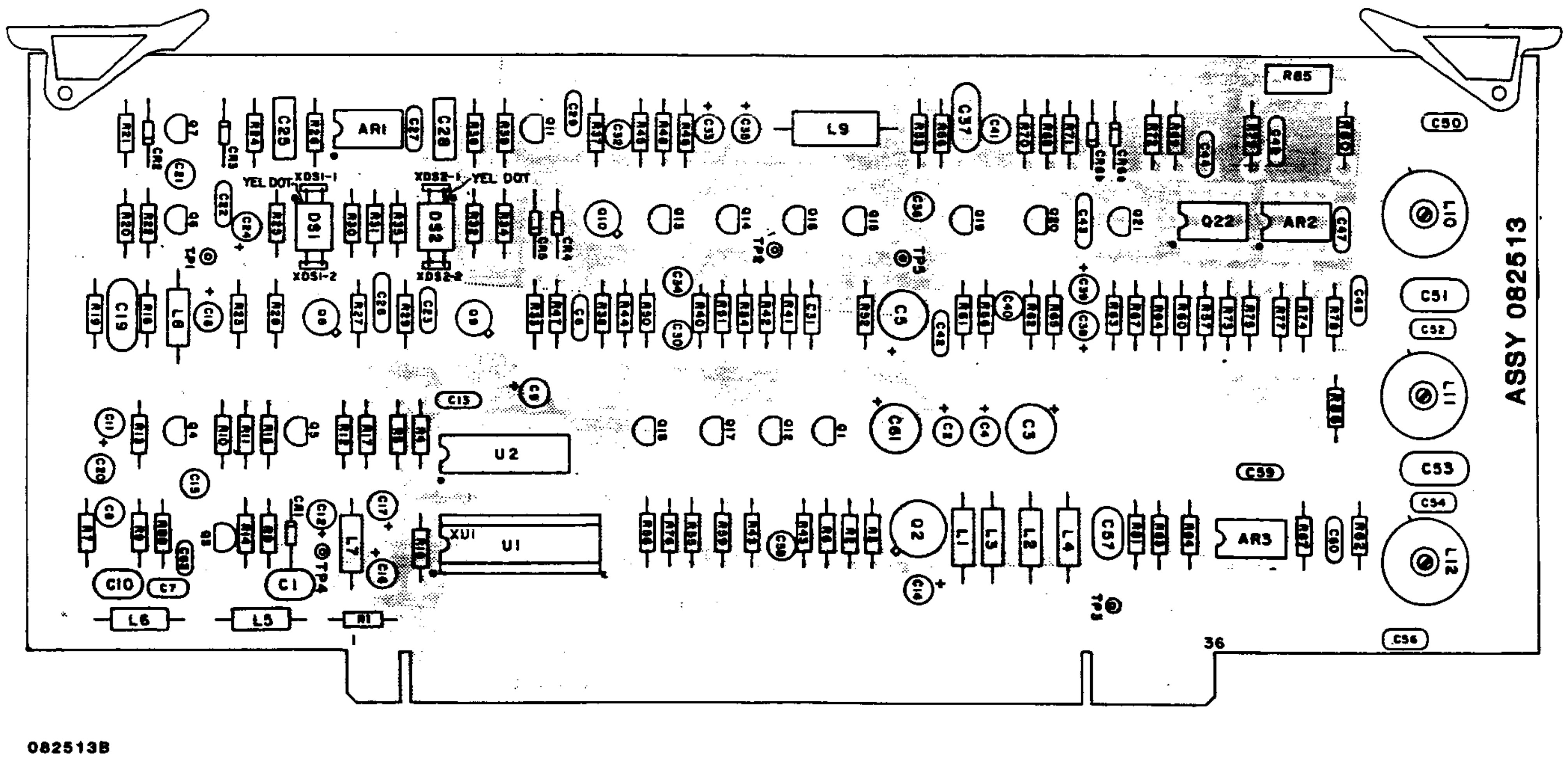



Figure 8-12. AM Board A5, Parts Location.

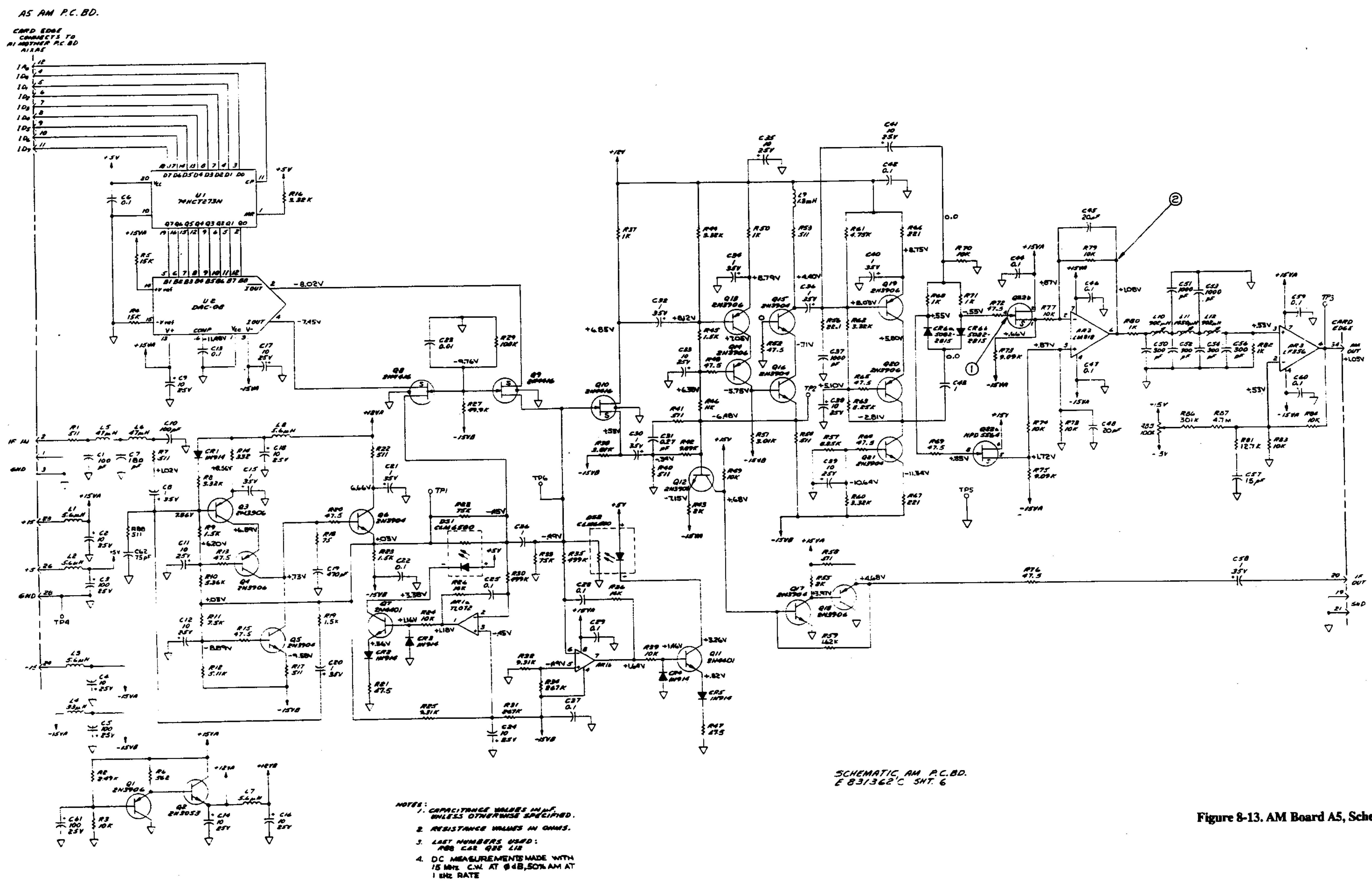



Figure 8-13. AM Board A5, Schematic Diagram.

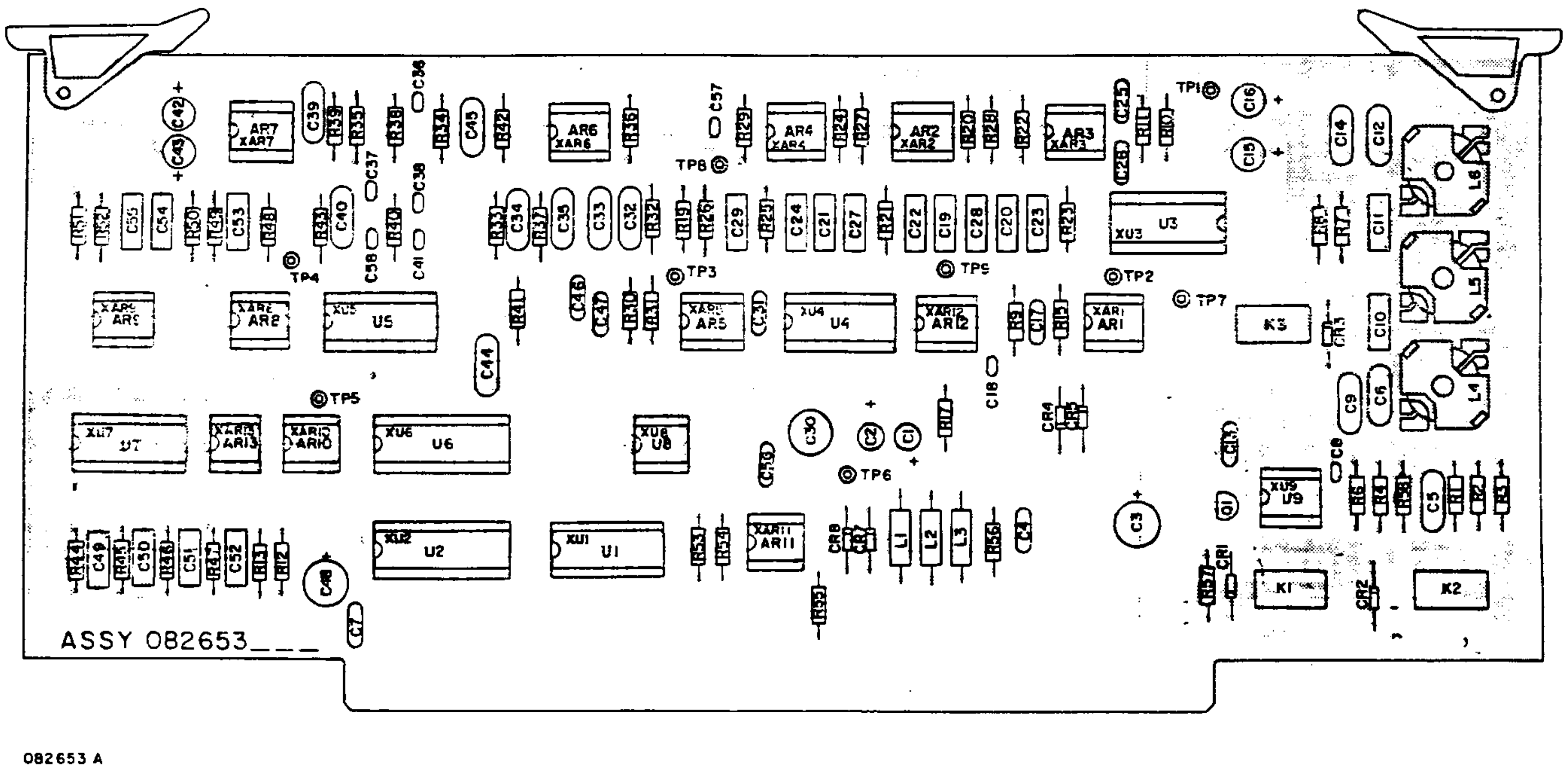
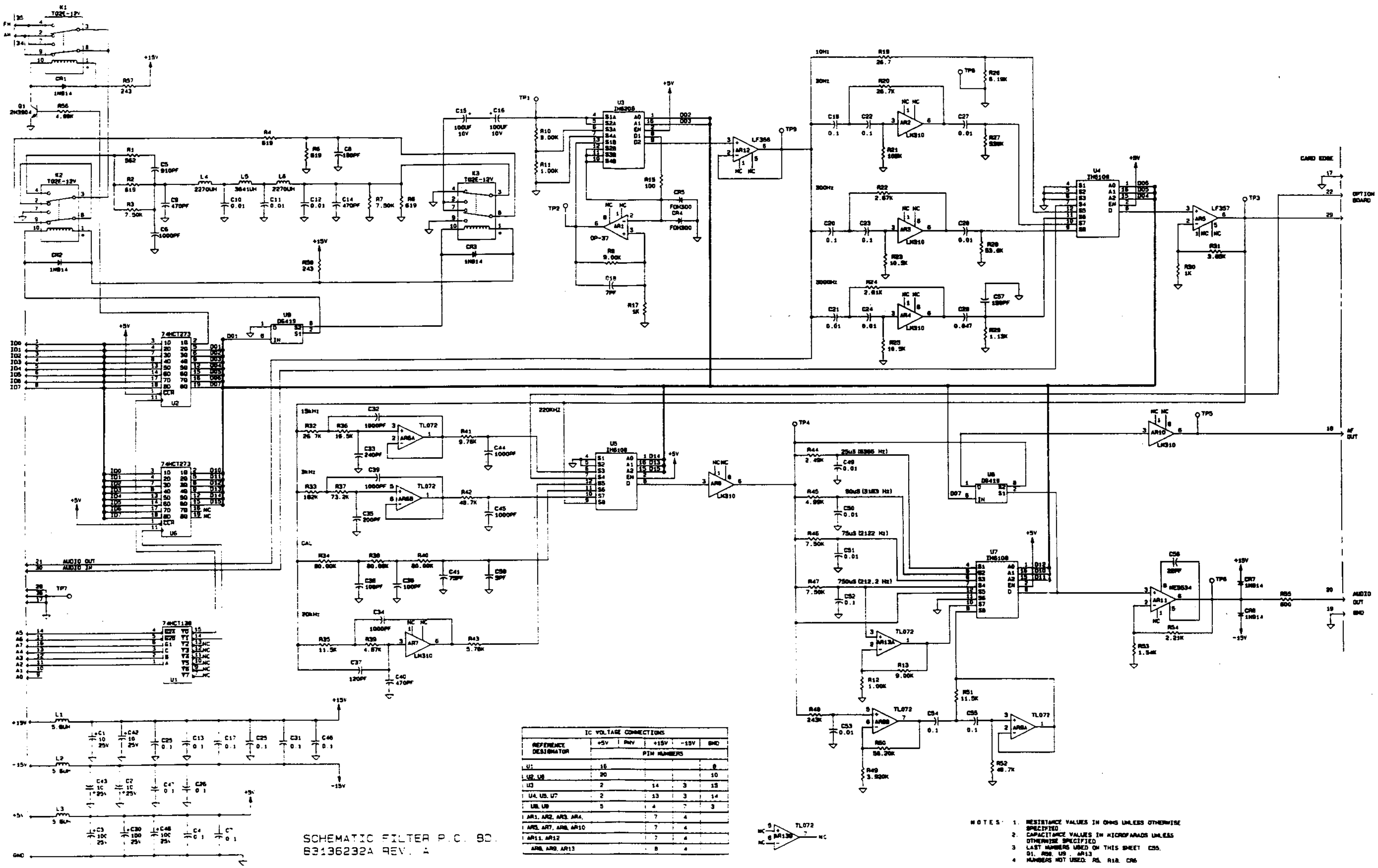


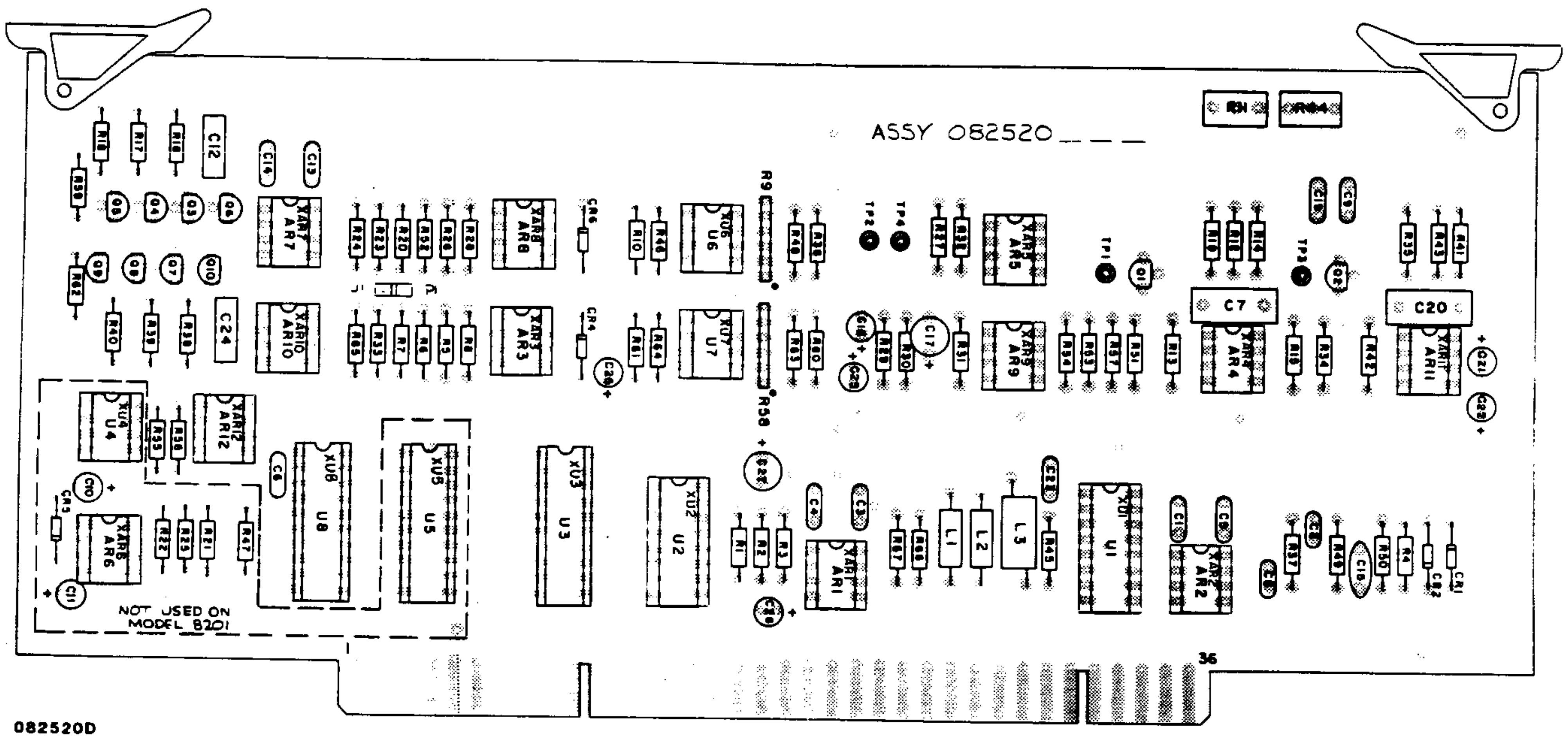

Figure 8-14. Filter Board A6, Parts Location.




| IC VOLTAGE CONNECTIONS | | | | | |
|---|---|---|---|---|---|
| REFERENCE DESIGNATOR | +5V | PWV | +15V | -15V | GND |
| | PIN NUMBERS | | | | |
| U1 | 16 | | | | 8 |
| U2, U6 | 20 | | | | 10 |
| U3 | 2 | | 14 | 3 | 15 |
| U4, U5, U7 | 2 | | 13 | 3 | 14 |
| U8, U9 | 5 | | 4 | 7 | 3 |
| AR1, AR2, AR3, AR4, | | | 7 | 4 | |
| AR5, AR7, AR8, AR10 | | | 7 | 4 | |
| AR11, AR12 | | | 7 | 4 | |
| AR6, AR9, AR13 | | | 8 | 4 | |

NOTES:
1. RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCE VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. LAST NUMBERS USED ON THIS SHEET C55, Q1, R58, U9, AR13
4. NUMBERS NOT USED: R5, R18, CR6

**Figure 8-15. Filter Board A6, Schematic Diagram.**




NOTE:

1.MARK FINAL ASSY PART NUMBER WITH 1/8 HIGH BLACK CHARACTERS. REFER TO MANUFACTURING ORDER FOR COMPLETE PART NUMBER

**Figure 8-16. Distortion Analyzer, A7 Parts Location.**

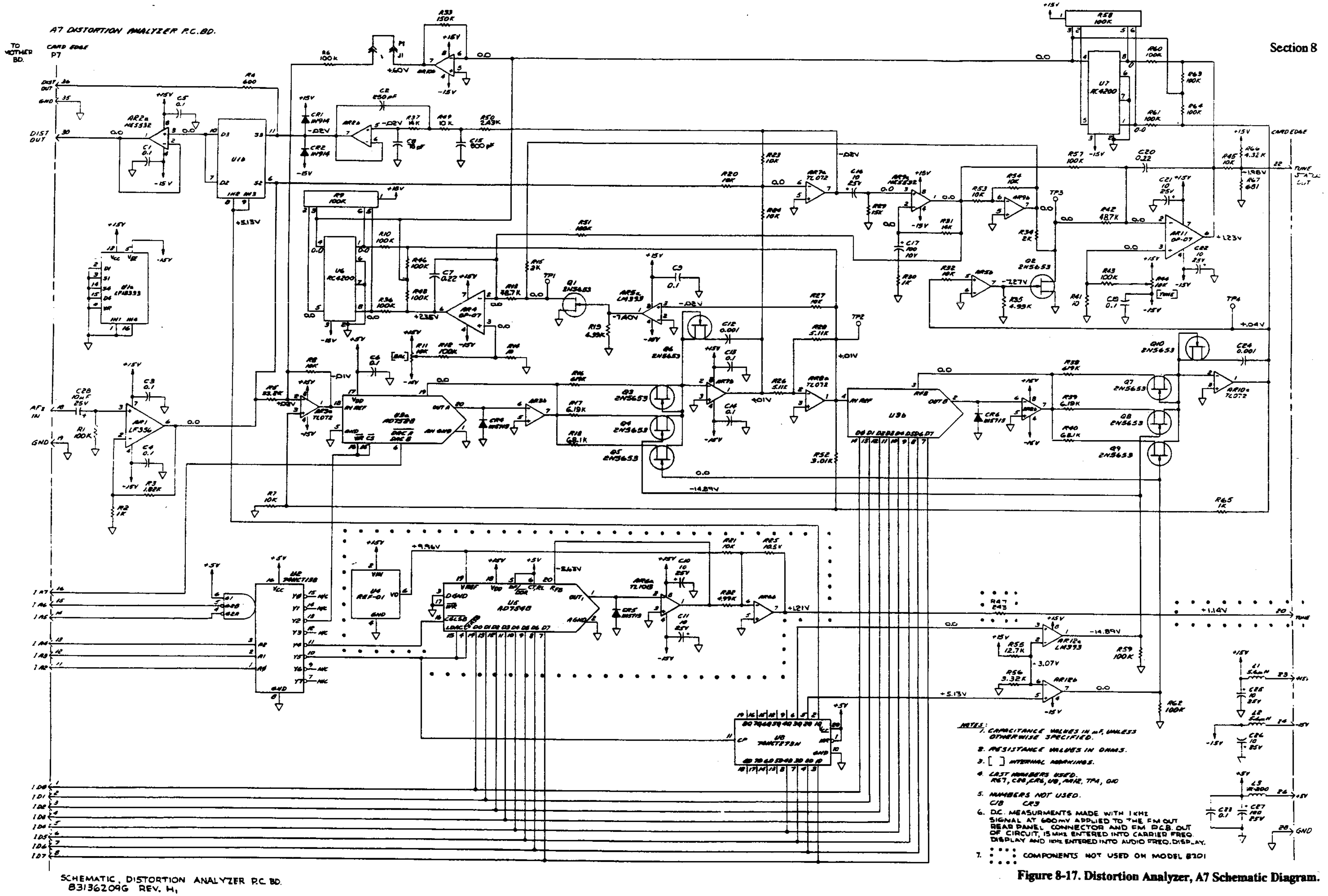
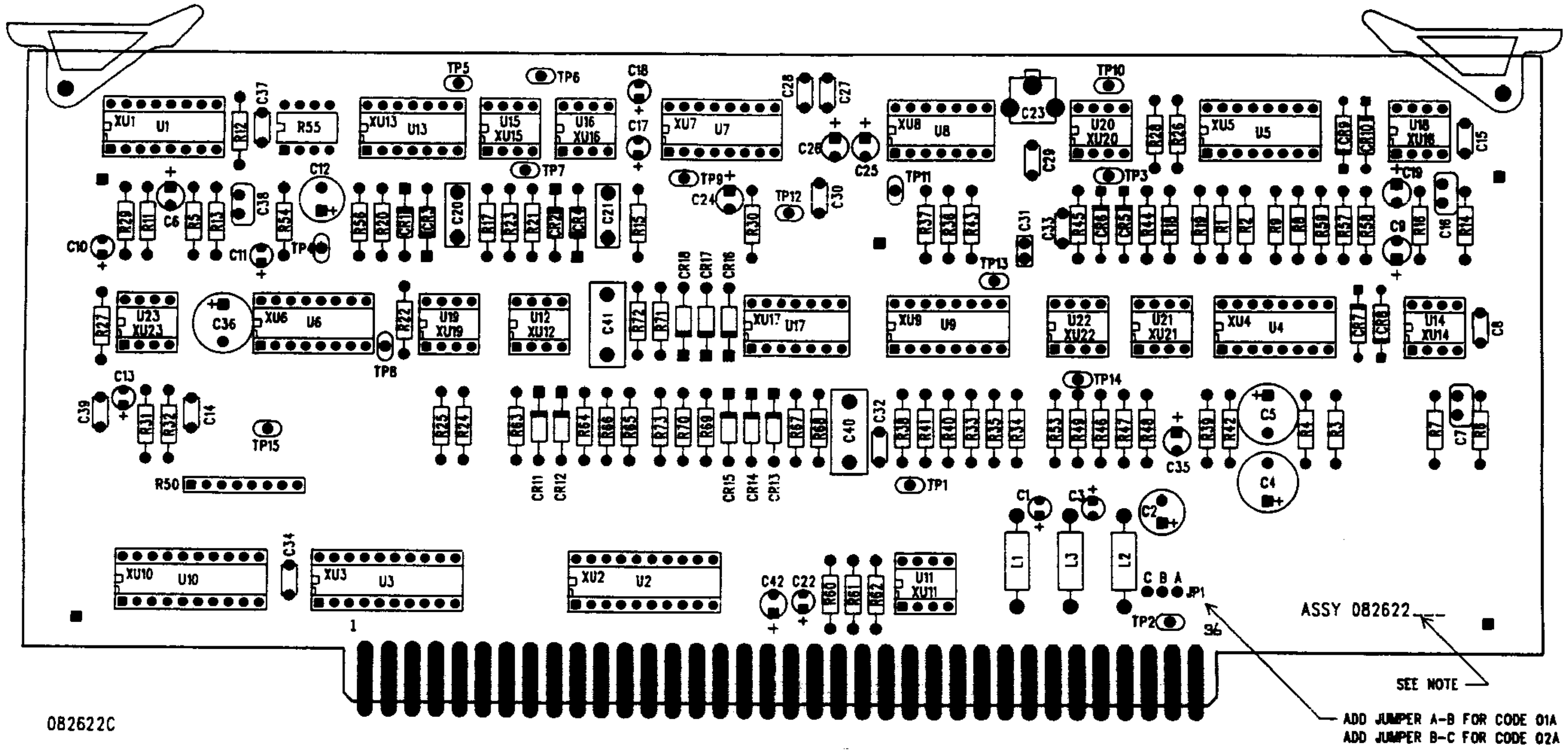
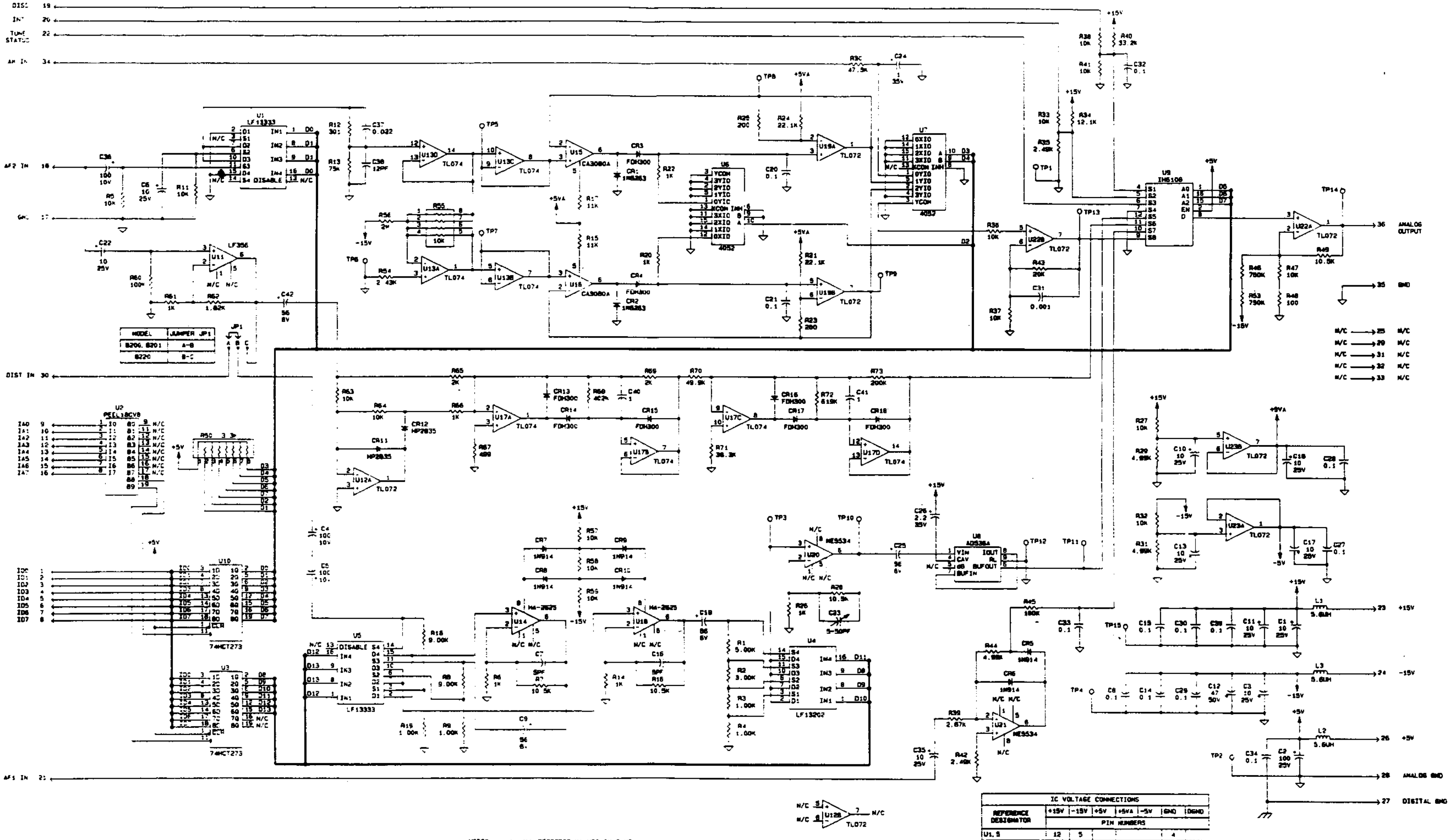



**Figure 8-17. Distortion Analyzer, A7 Schematic Diagram.**




| BEC CODE | MODEL | REMARKS |
|---|---|---|
| 00C | COMMON ASSY | |
| 01A | 8201 | ADD APPROPRIATE JUMPER (JP1) |
| 02A | 8220 | |

**Figure 8-18. Detector Board A8, Parts Location.**



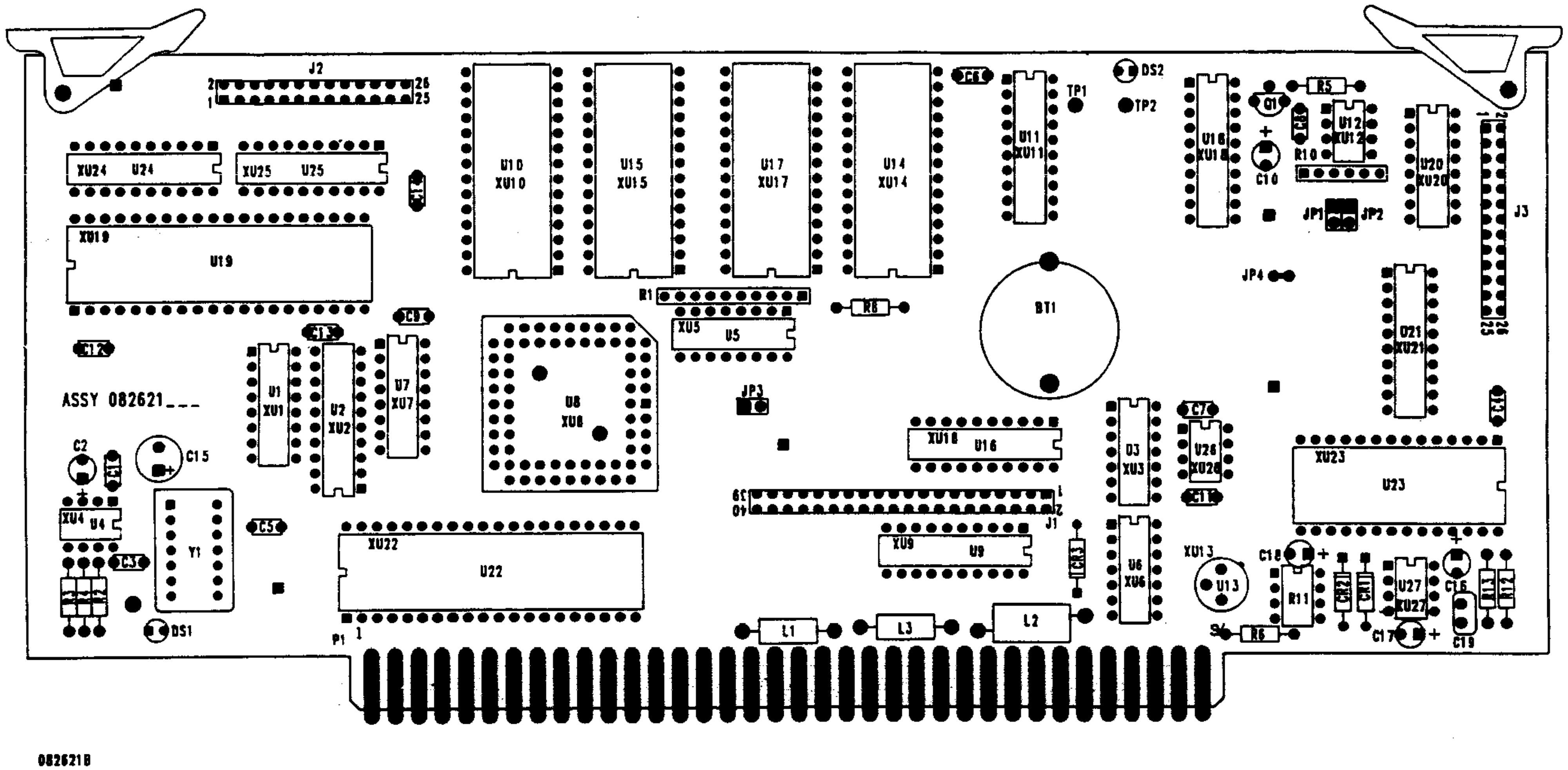
SCHEMATIC 8220 DETECTOR PWB
83159009A REV C

NOTES
1. ALL RESISTOR VALUES IN OHMS
2. ALL CAPACITOR VALUES IN UF UNLESS OTHERWISE SPECIFIED
3. LAST NUMBERS USED C42 CR18 JP1 L3 R73 U23 TP15
4. NUMBERS NOT USED R10 R51 R52

IC VOLTAGE CONNECTIONS

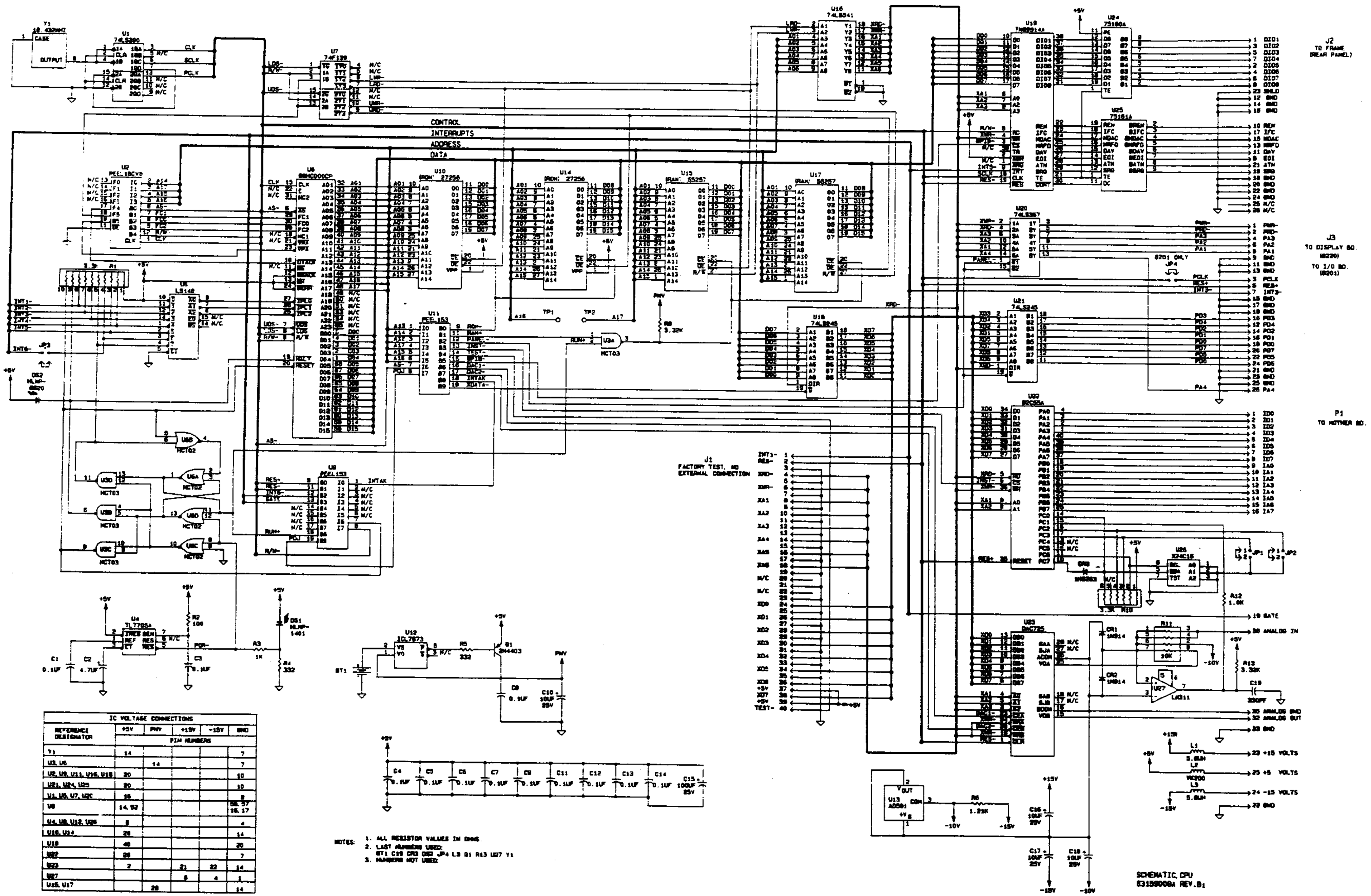
| REFERENCE DESIGNATOR | +15V | -15V | +5V | +5VA | -5V | GND | DGND |
|---|---|---|---|---|---|---|---|
| | PIN NUMBERS | | | | | | |
| U1, 5 | 12 | 5 | | | | 4 | |
| U11, 14, 18, 20, 21 | 7 | 4 | | | | | |
| U13, 17 | 4 | 11 | | | | | |
| U15, 16 | | | | 7 | 4 | | |
| U6, 7 | | | | 16 | 7 | 8 | |
| U19 | | | | 8 | 4 | | |
| U9 | 13 | 3 | | | | 14 | |
| U12, 22, 23 | 8 | 4 | | | | | |
| U2, 3, 10 | | | 20 | | | | 10 |
| U8 | 14 | 3 | | | | 10 | |
| U4 | 13 | 4 | | | | 5 | |

**Figure 8-19. Detector Board A8, Schematic Diagram.**




| PART NUMBER | MODEL | REMARKS |
|---|---|---|
| 08262100A | 8220 | U10 & U14 ARE VARIABLE |
| 08262101A | 8201 | |

**Figure 8-20. CPU Board A9, Parts Location.**



| IC VOLTAGE CONNECTIONS | | | | | |
|---|---|---|---|---|---|
| REFERENCE DESIGNATOR | +5V | PWV | +15V | -15V | GND |
| | PIN NUMBERS | | | | |
| Y1 | 14 | | | | 7 |
| U3, U6 | | 14 | | | 7 |
| U2, U9, U11, U16, U18 | 20 | | | | 10 |
| U21, U24, U25 | 20 | | | | 10 |
| U1, U5, U7, U20 | 16 | | | | 8 |
| U8 | 14, 52 | | | | 56, 57 16, 17 |
| U4, U9, U12, U26 | 8 | | | | 4 |
| U10, U14 | 28 | | | | 14 |
| U19 | 40 | | | | 20 |
| U22 | 26 | | | | 7 |
| U23 | 2 | | 21 | 22 | 14 |
| U27 | | | 8 | 4 | 1 |
| U15, U17 | | 28 | | | 14 |

NOTES:
1. ALL RESISTOR VALUES IN OHMS.
2. LAST NUMBERS USED:
BT1 C19 CR3 DS2 JP4 L3 Q1 R13 U27 Y1
3. NUMBERS NOT USED:

SCHEMATIC CPU
E3159009A REV.B1

**Figure 8-21. CPU Board A9, Schematic Diagram.**

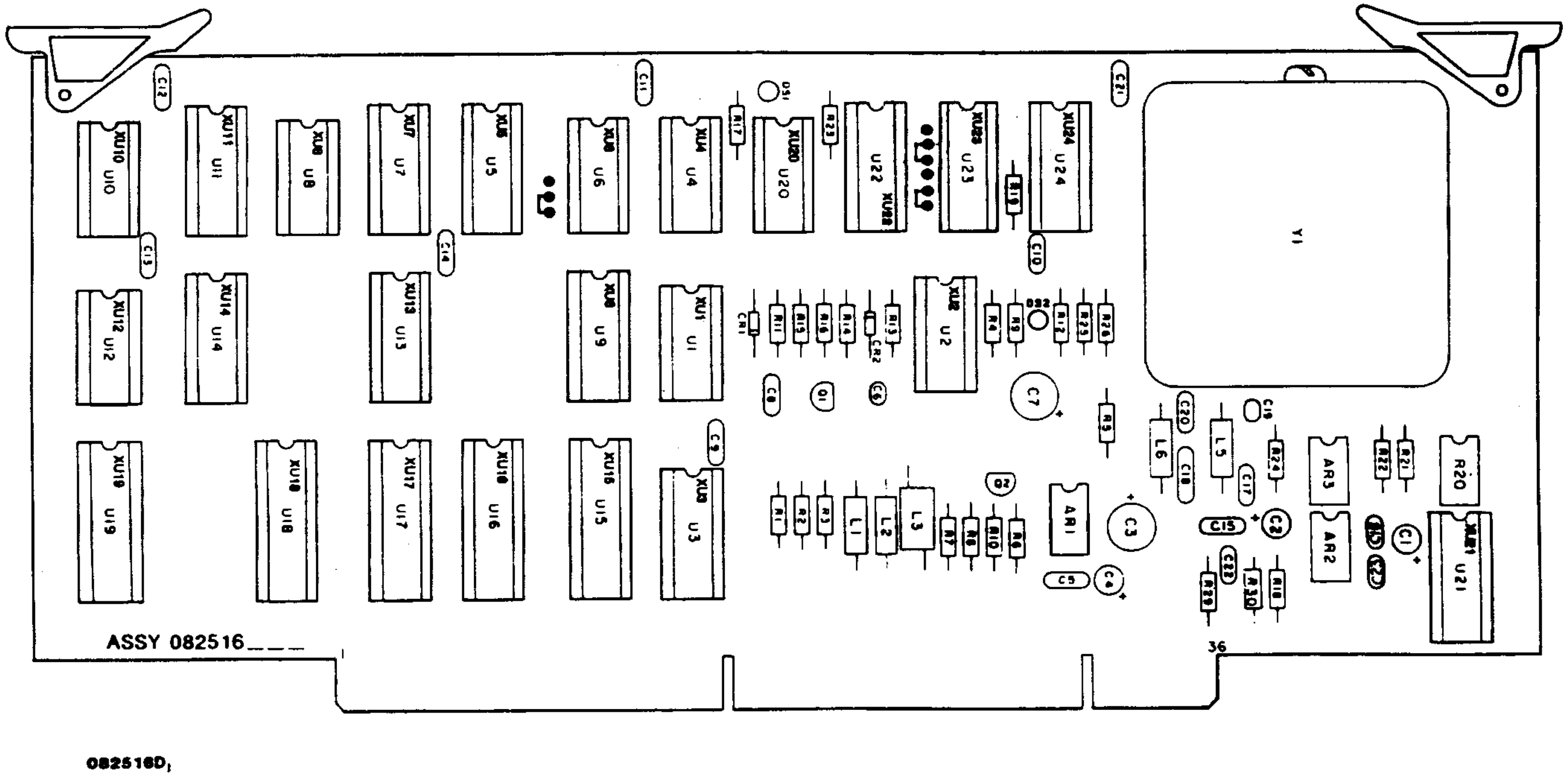



Figure 8-22. Counter Board A10, Parts Location.

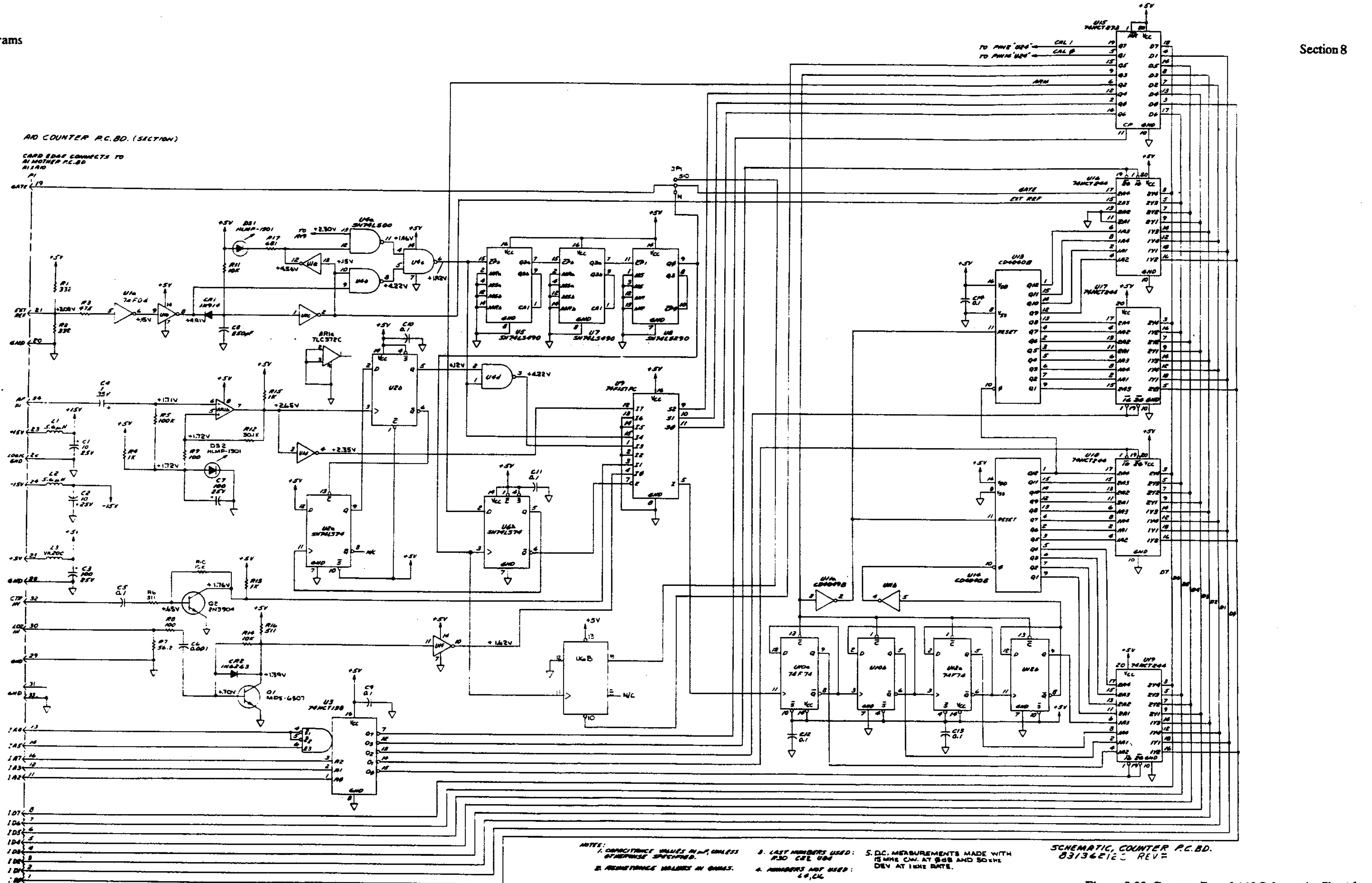
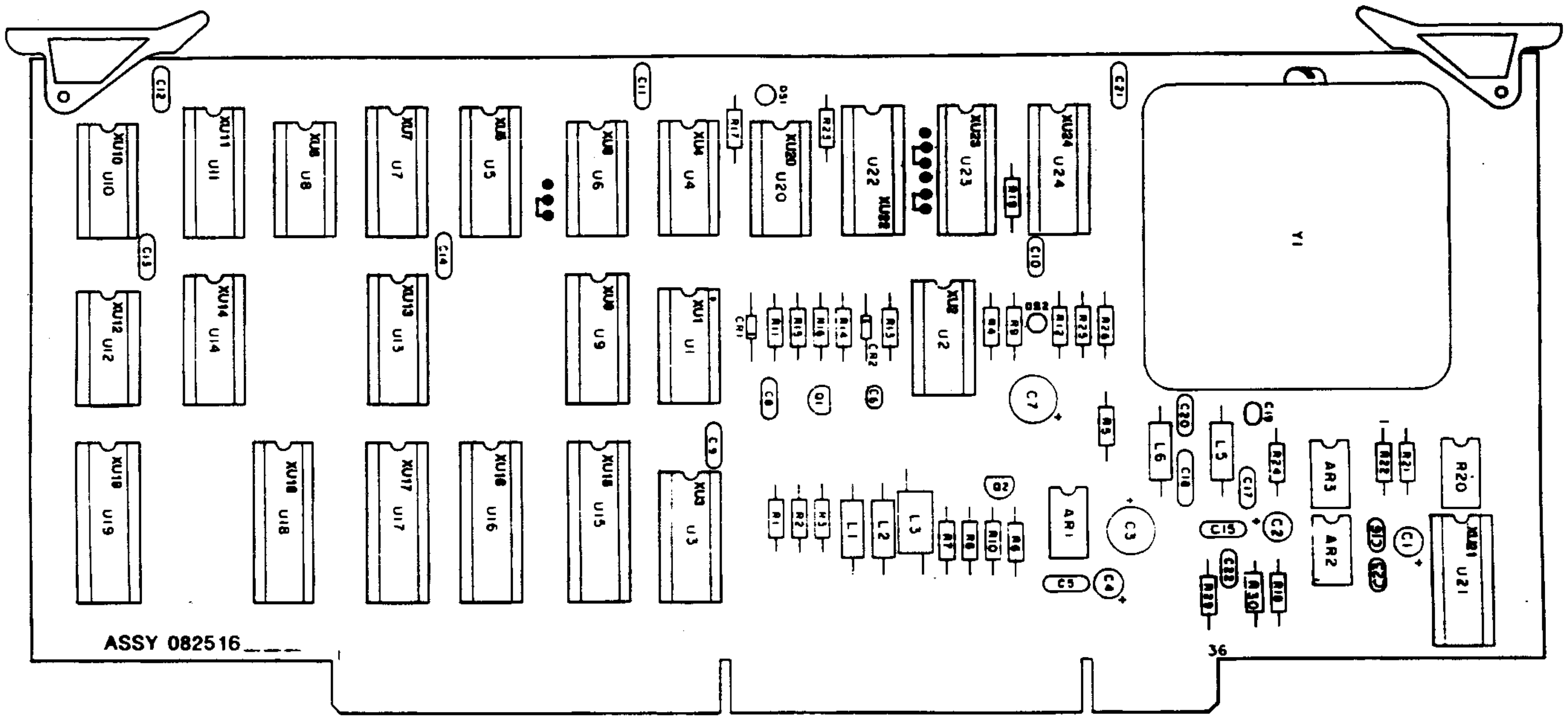



**Figure 8-23. Counter Board A10 Schematic, Sheet 1.**




082516D

Figure 8-24. Counter Board A10, Parts Location.

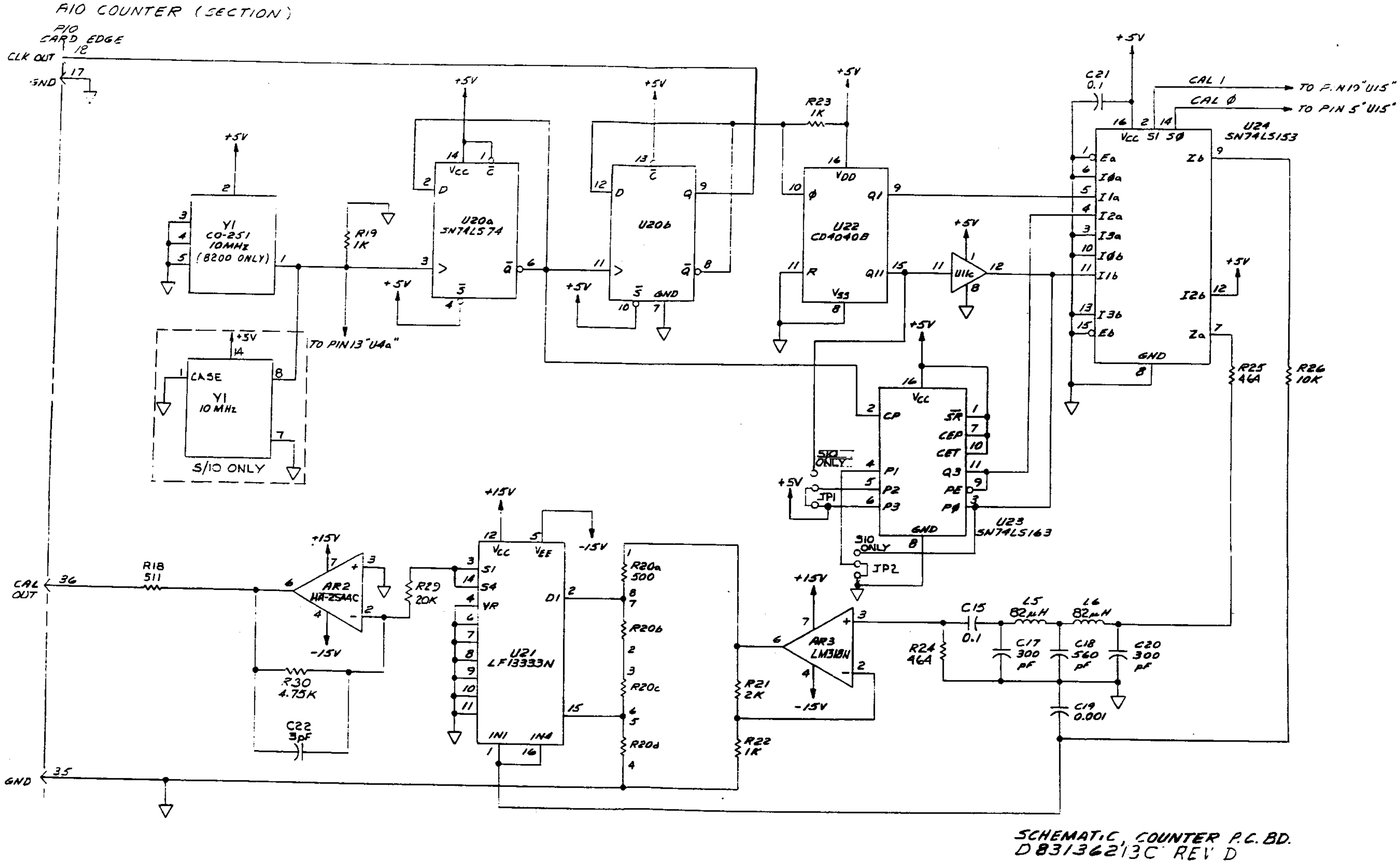



**Figure 8-25. Counter Board A10 Schematic, Sheet 2.**

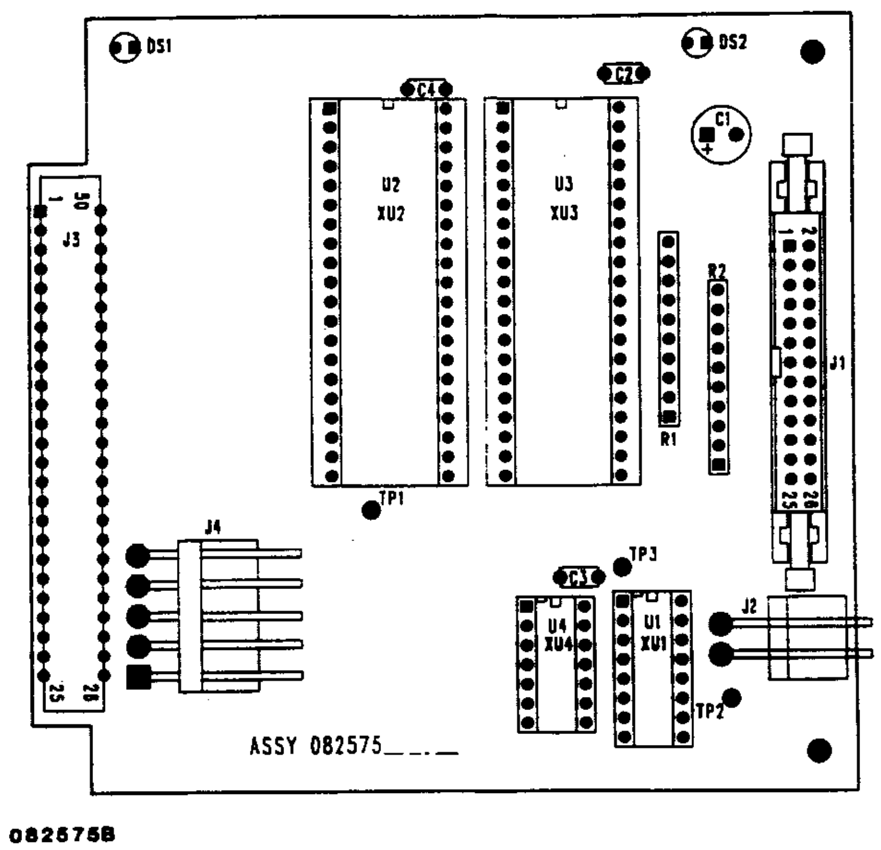
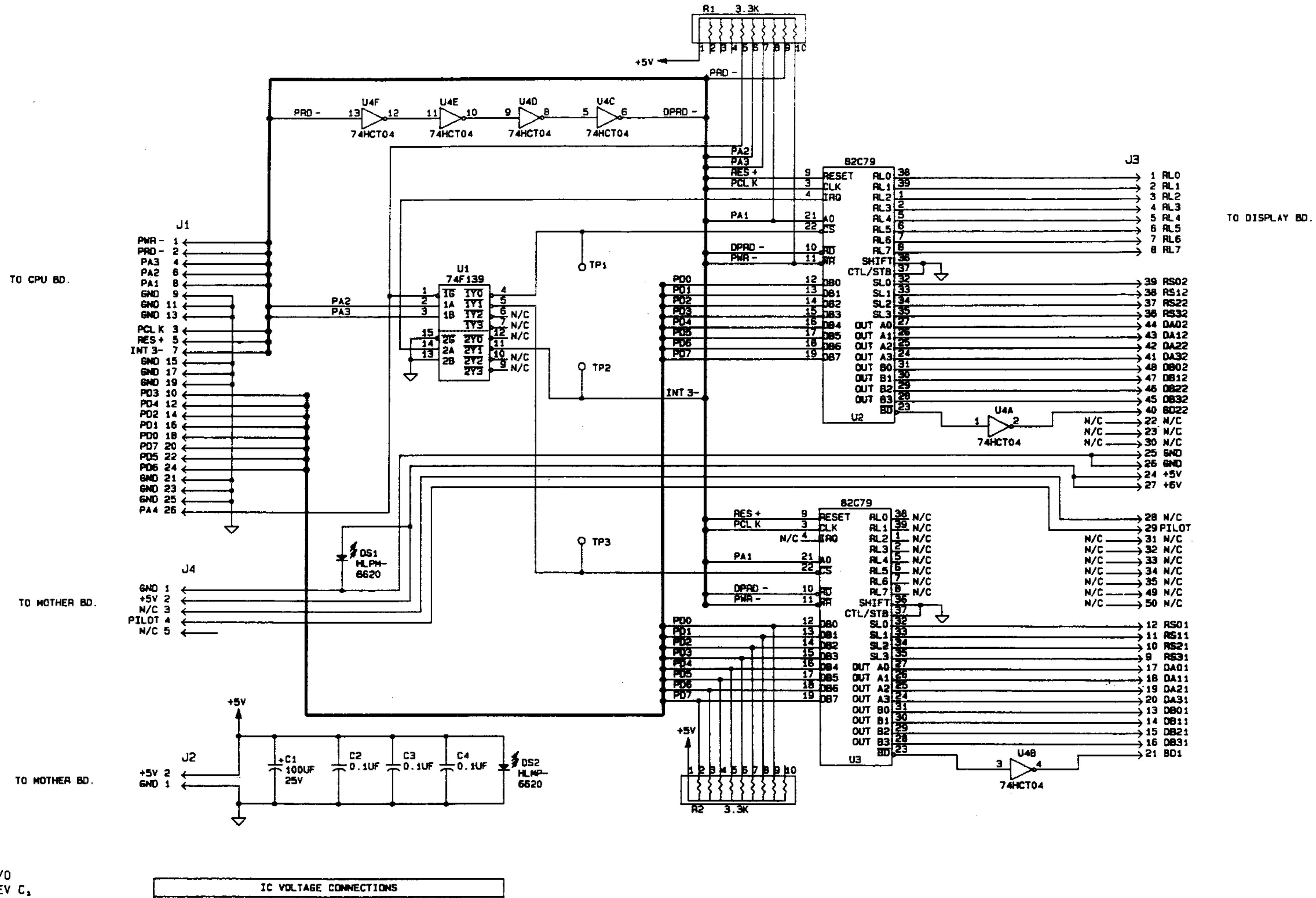


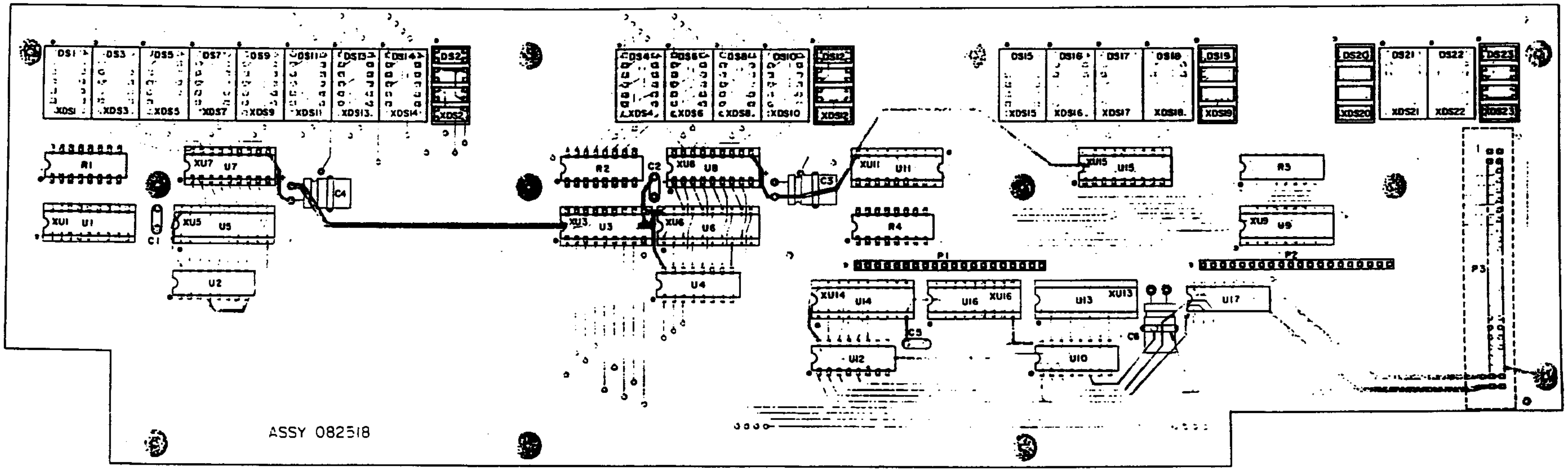

**Figure 8-26. I/O Board A11, Parts Location.**




| IC VOLTAGE CONNECTIONS | | | | | |
|---|---|---|---|---|---|
| REFERENCE DESIGNATOR | +5V | -5V | +15V | -15V | GND |
| | PIN NUMBERS | | | | |
| U1 | 16 | | | | 8 |
| U2, U3 | 40 | | | | 20 |
| U4 | 14 | | | | 7 |

NOTES:
1. ALL RESISTOR VALUES IN OHMS.
2. LAST NUMBERS USED:
   C4 DS2 R2 U4
3. NUMBERS NOT USED:

**Figure 8-27. I/O Board A11, Schematic Diagram.**




082518B

**Figure 8-28. Display Board A12, Parts Location.**

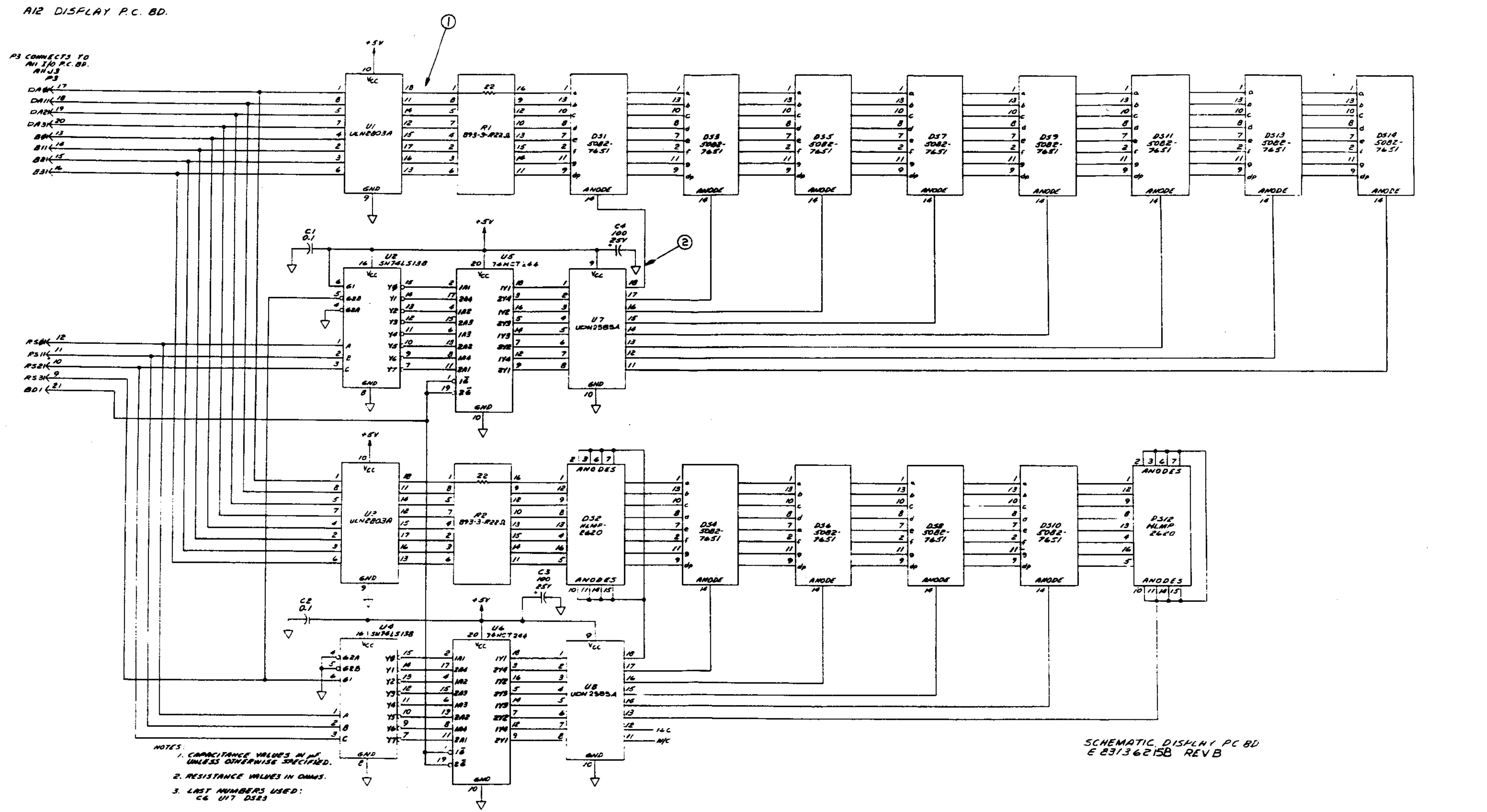
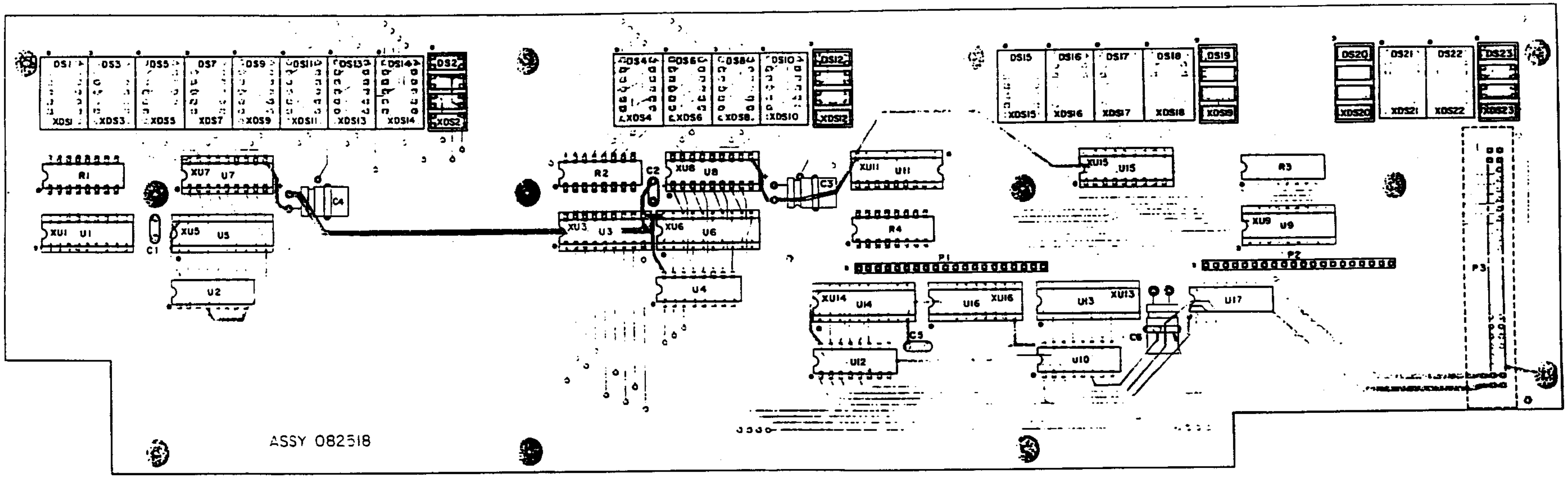



Figure 8-29. Display Board A12 Schematic, Sheet 1.




082518B

Figure 8-30. Display Board A12, Parts Location.

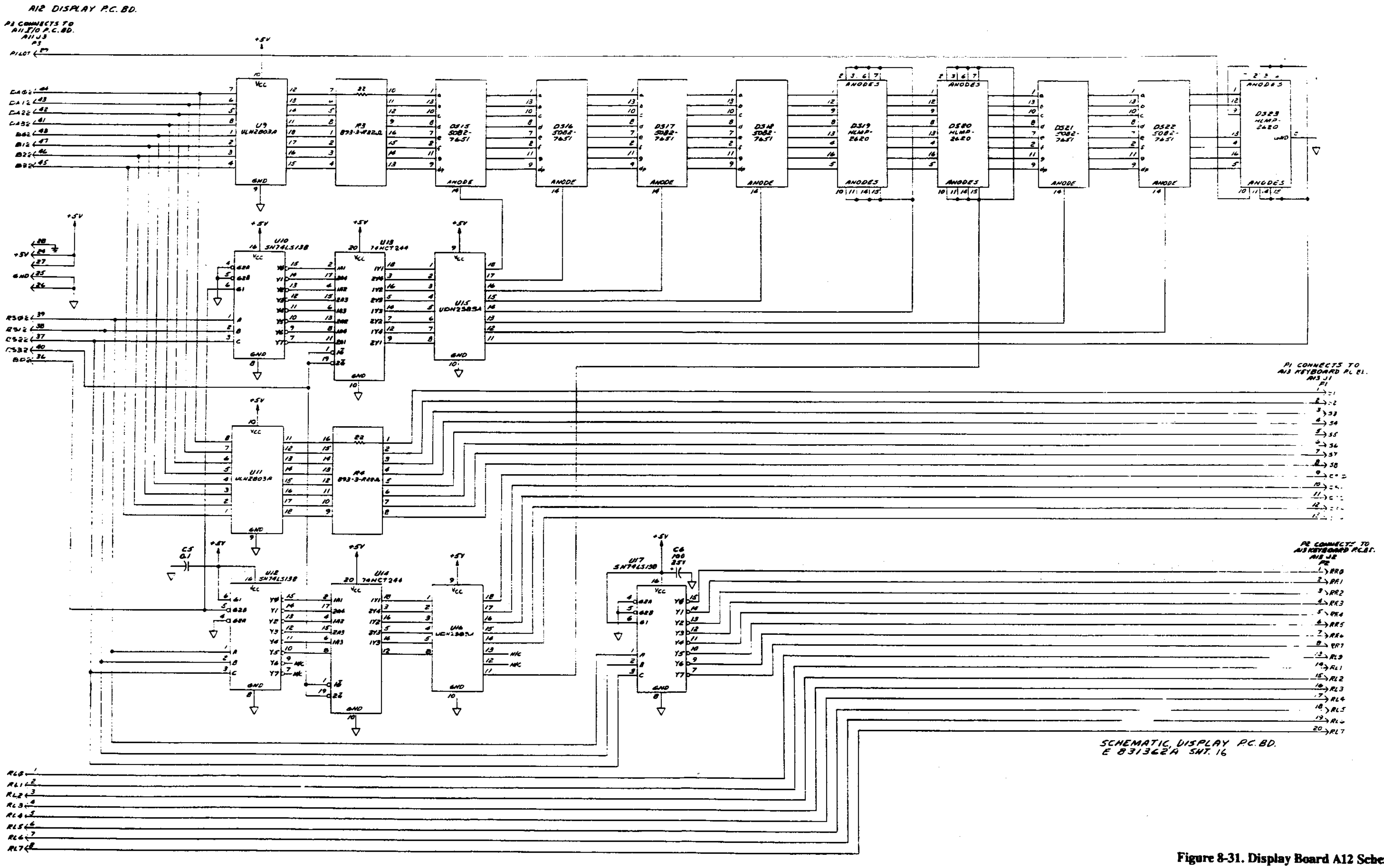
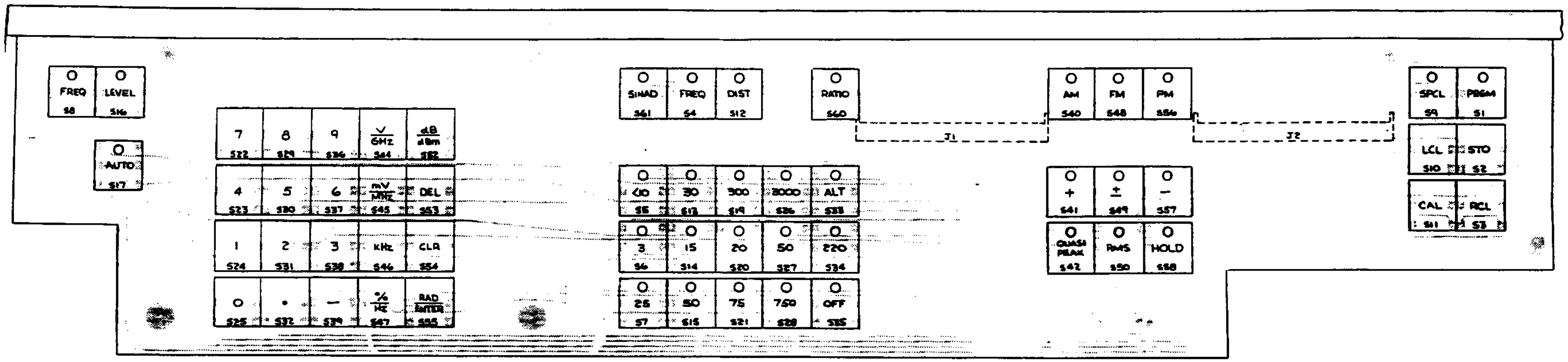



Figure 8-31. Display Board A12 Schematic, Sheet 2.




082517A SHT.3

Figure 8-32. Keyboard A13, Parts Location.

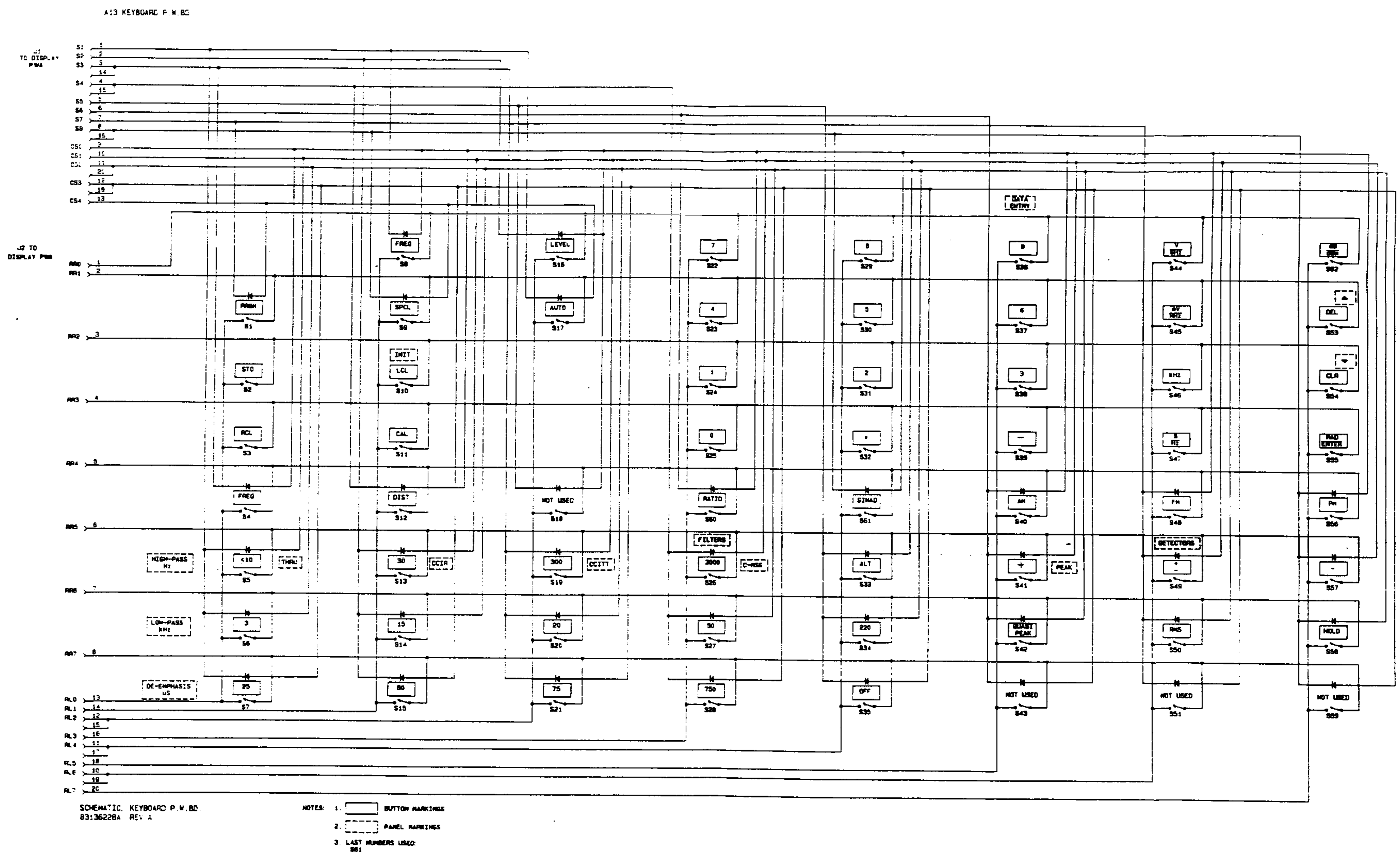
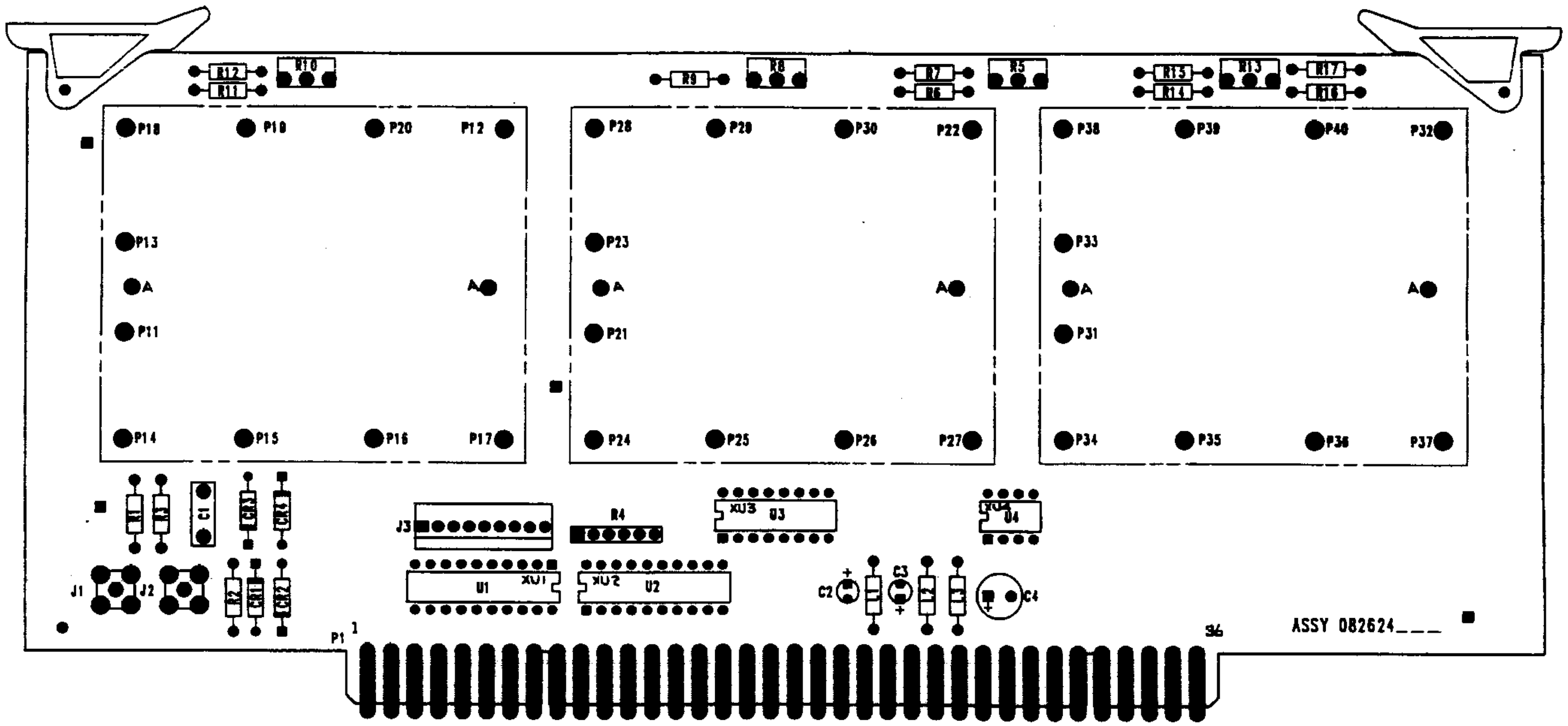
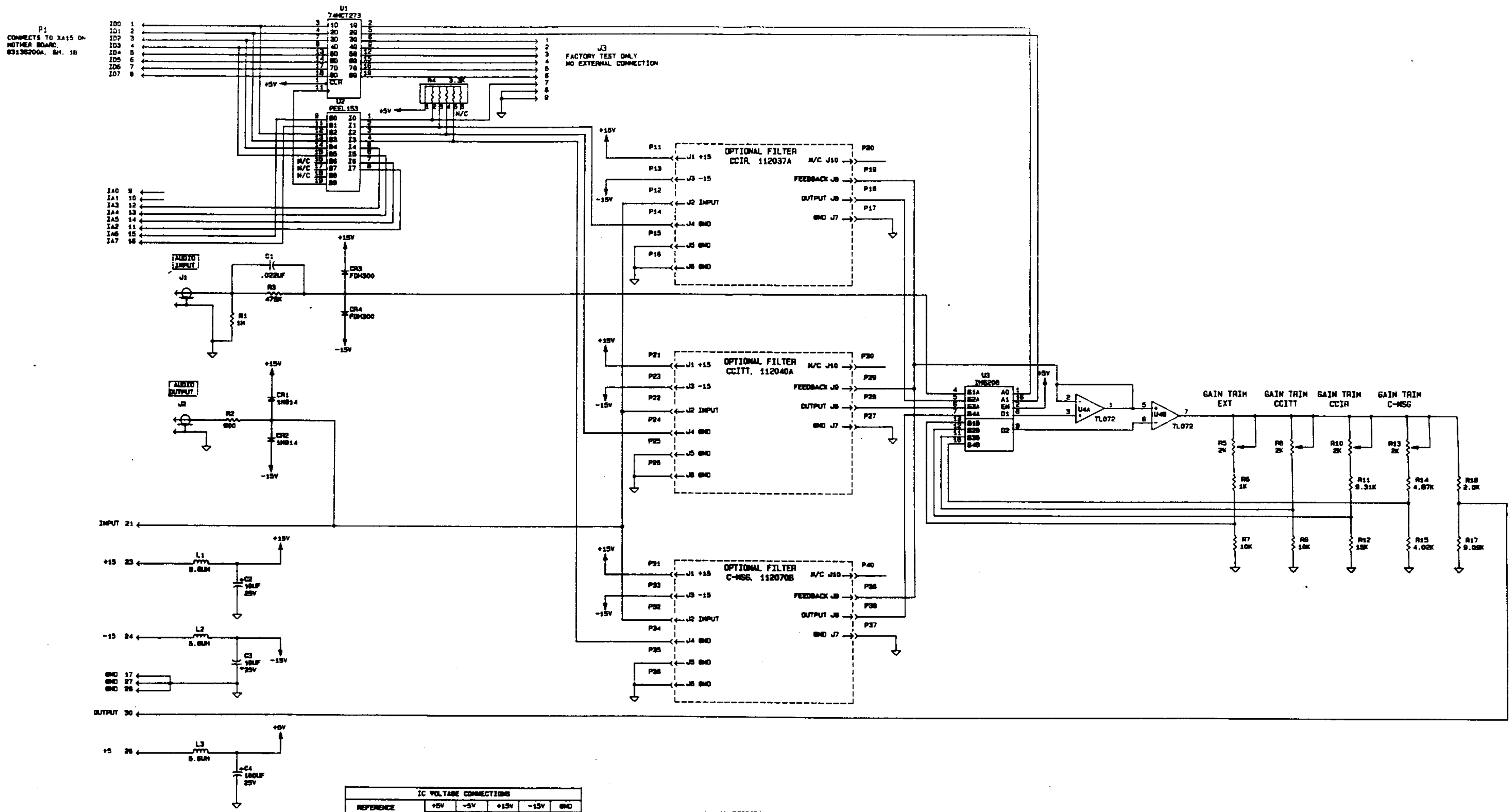



**Figure 8-33. Keyboard A13, Schematic Diagram.**



082624B

Figure 8-34. Option Board A15, Parts Location.

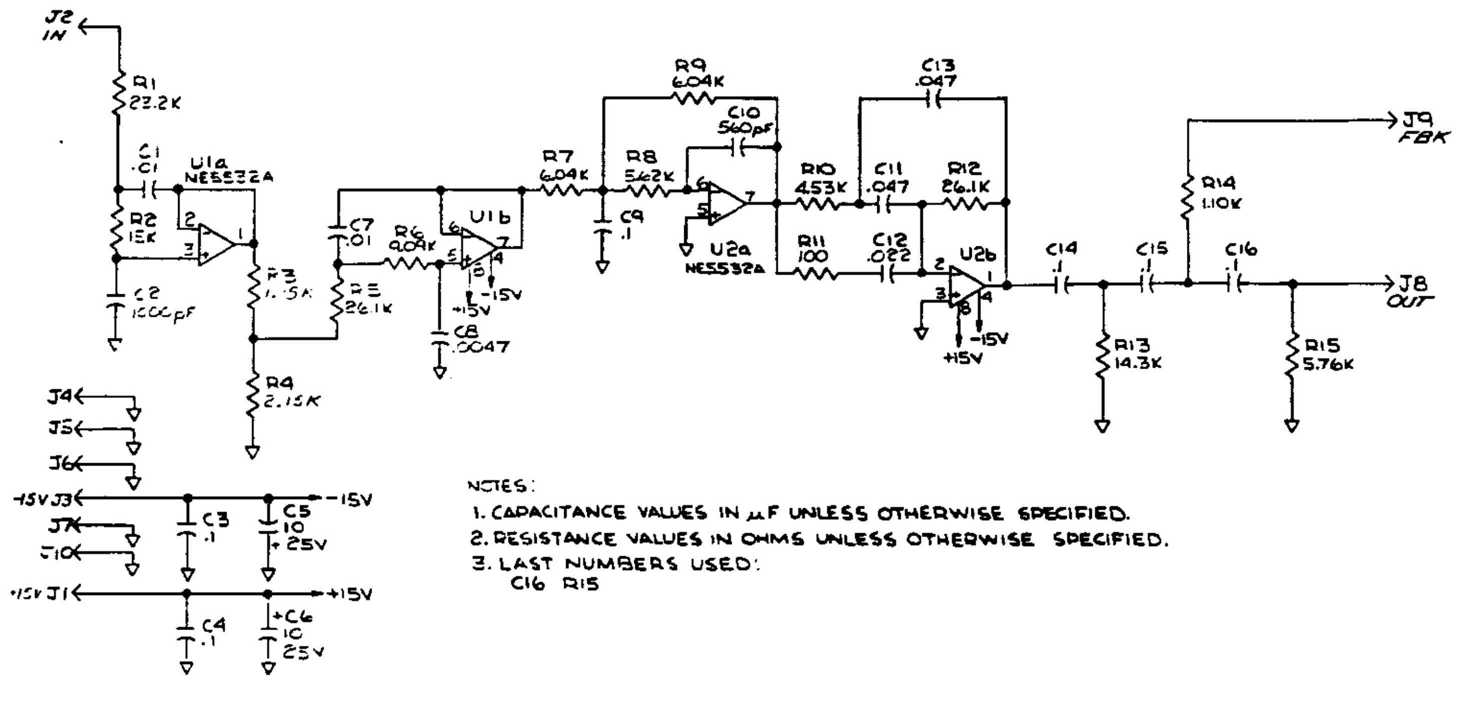



| IC VOLTAGE CONNECTIONS | | | | | |
|---|---|---|---|---|---|
| REFERENCE DESIGNATOR | +5V | -5V | +15V | -15V | GND |
| | PIN NUMBERS | | | | |
| U1, U2 | 20 | | | | 10 |
| U3 | | | 14 | 3 | 15 |
| U4 | | | 8 | 4 | |
| | | | | | |
| | | | | | |

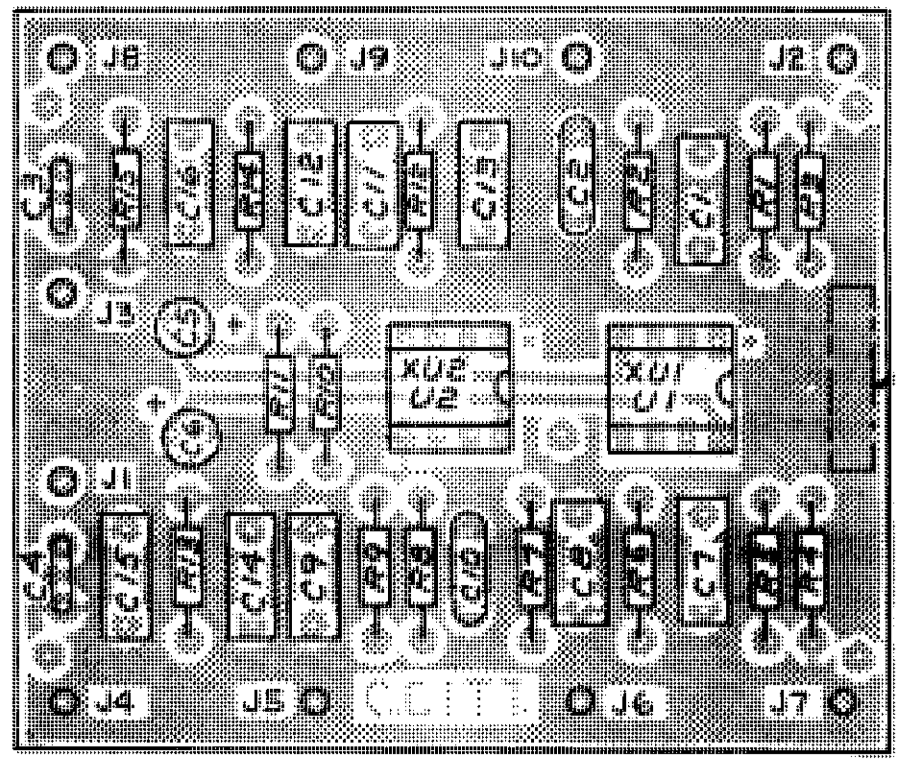
NOTES:
1. ALL RESISTOR VALUES IN OHMS.
2. LAST NUMBERS USED:
C4 CR4 L3 R17 U4
3. NUMBERS NOT USED:
J4-J6

SCHEMATIC, FILTER OPTION
83158100A, REV.B

**Figure 8-35. Option Board A15, Schematic Diagram.**

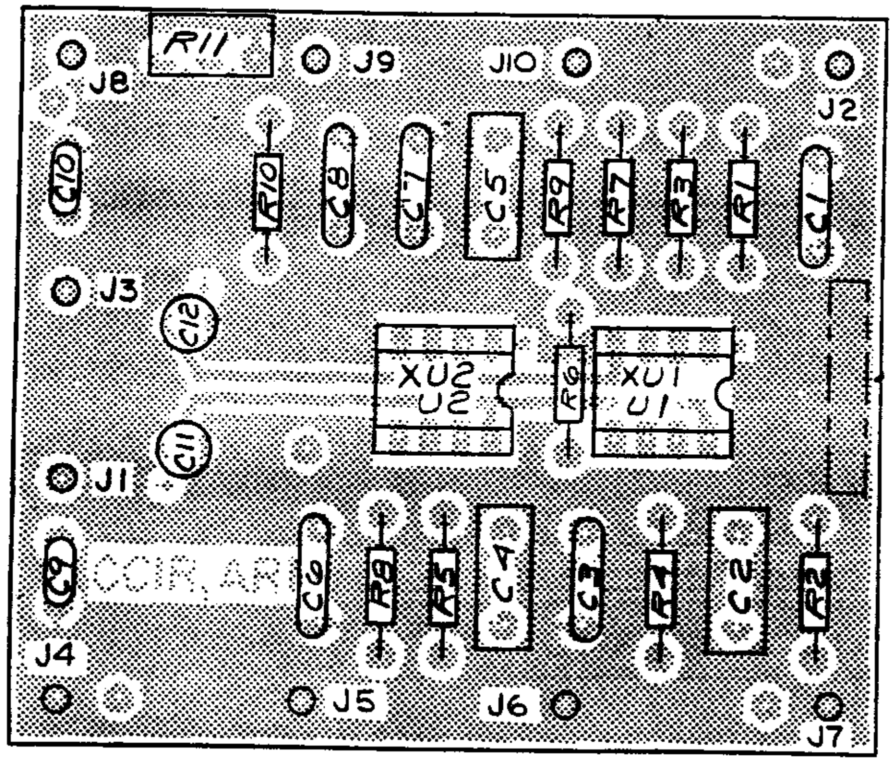



83151403A REV A

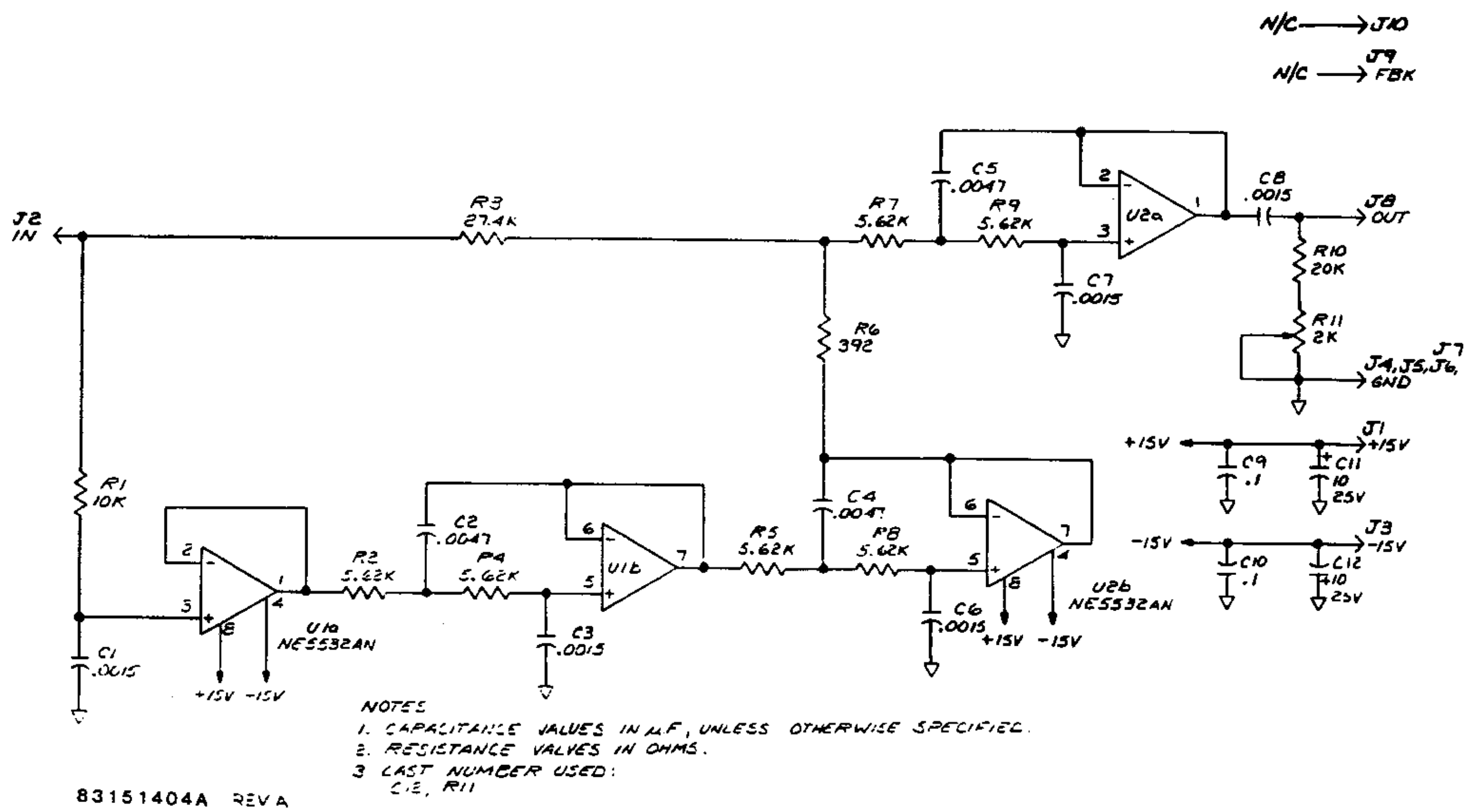



112040A

**Figure 8-36. CCITT Filter, Parts Location/Schematic.**



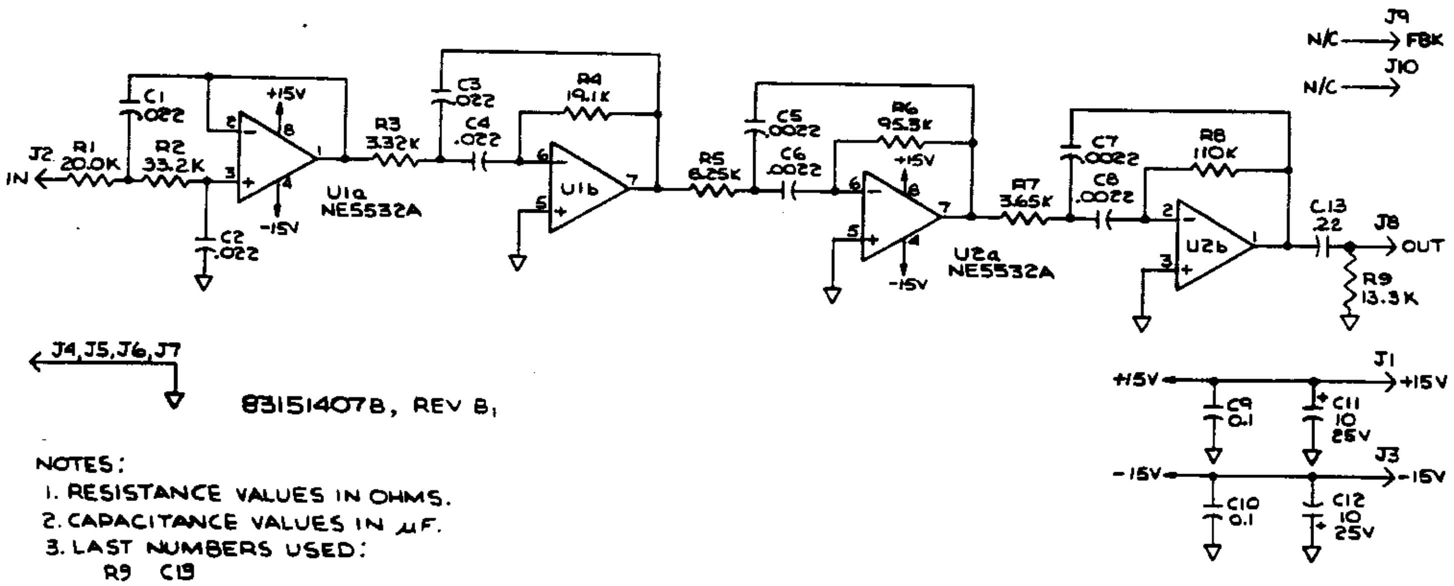

112037A

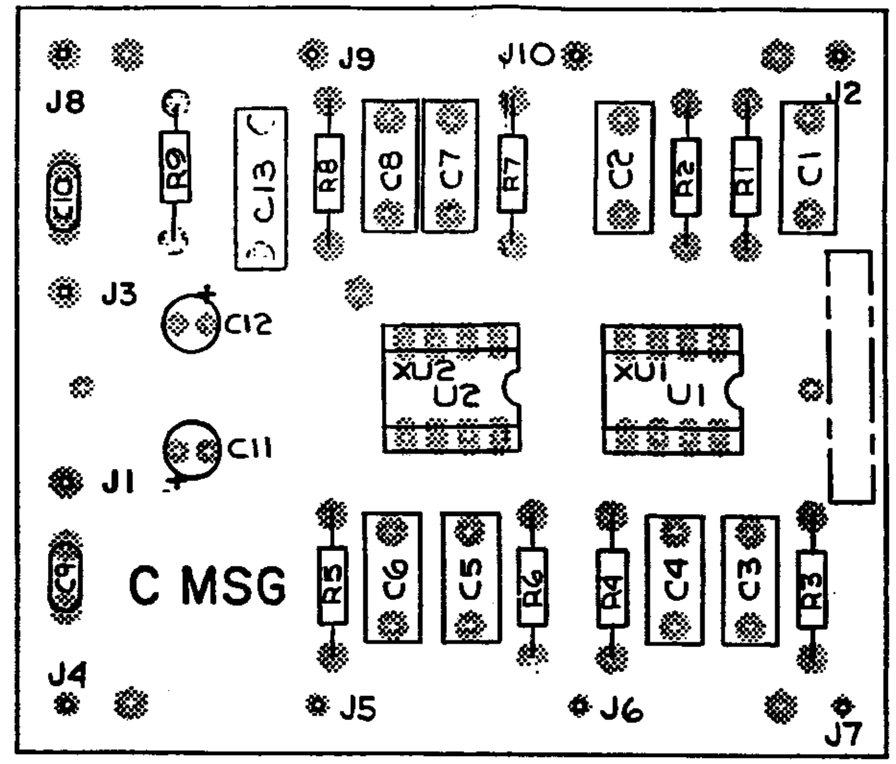



NOTES
1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALVES IN OHMS.
3 LAST NUMBER USED:
C12, R11

83151404A REV A

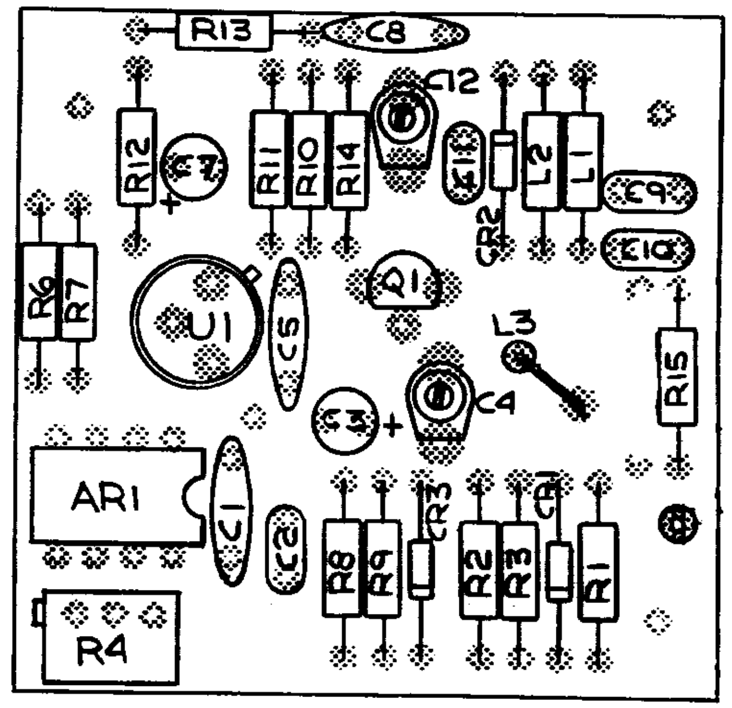
Figure 8-37. CCIR Filter, Parts Location/Schematic.



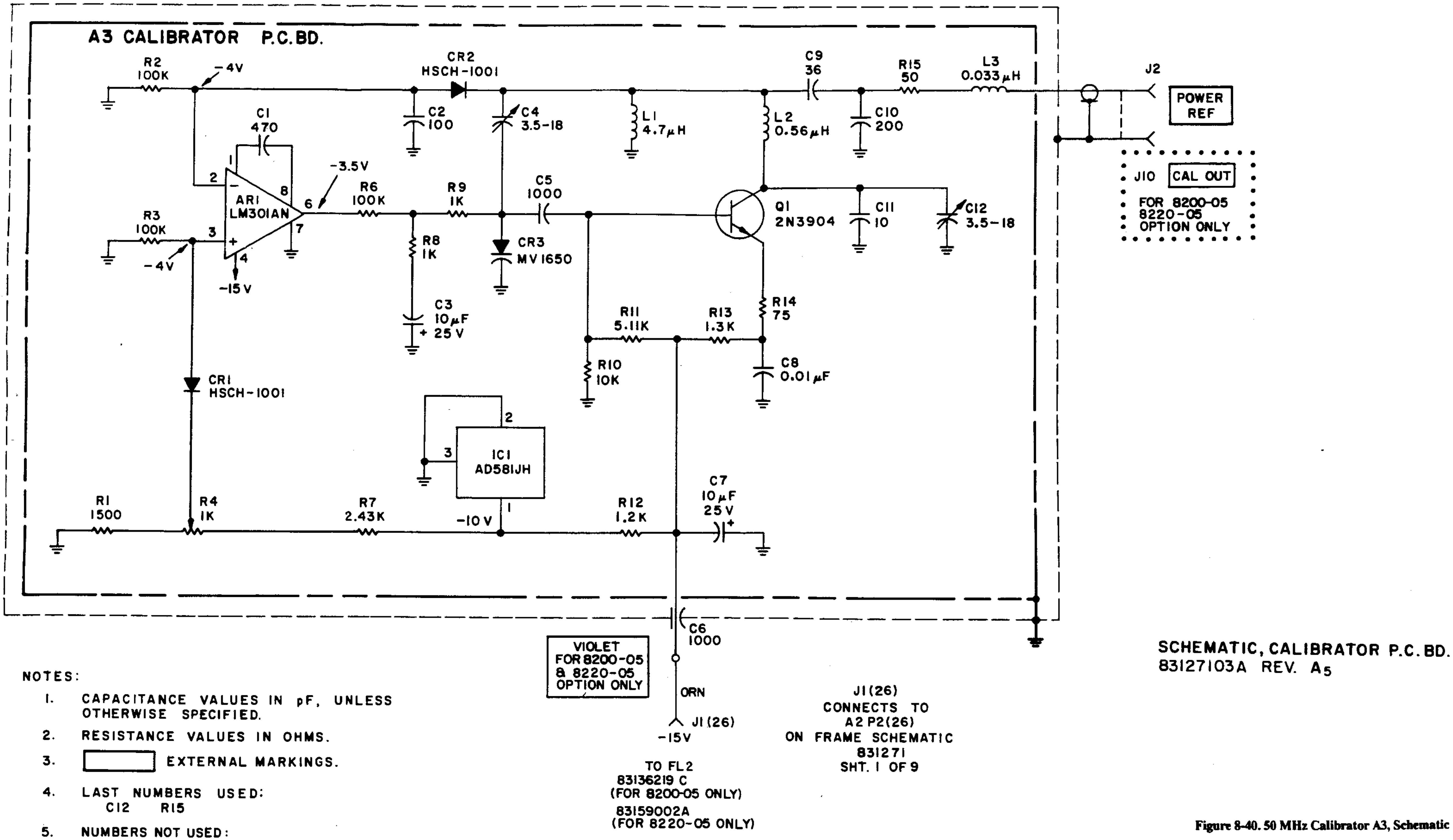

112070B

Figure 8-38. C-Message Filter Parts Location/Schematic




043131A

Figure 8-39. 50 MHz Calibrator A3, Parts Location.




NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. [box] EXTERNAL MARKINGS.
4. LAST NUMBERS USED: C12 R15
5. NUMBERS NOT USED: R5 J1(26) (8200-05 & 8220-05 ONLY)

Figure 8-40. 50 MHz Calibrator A3, Schematic Diagram

# WARRANTY

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

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

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

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BEC shall not be liable to any incidental or consequential damages, as defined in Section 2-715 of the Uniform Commercial Code, in connection with the products covered by the foregoing warranties.

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