**SERIAL NUMBERS**

**This manual applies directly to model 6060A Signal Generators with serial numbers 3650000 and up.**

**NOTE**

**This manual documents the Model 6060A and its assemblies at the revision levels identified in Section 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating information in Section 7A for older assemblies.**

# 6060A

*SYNTHESIZED RF SIGNAL GENERATOR*

## Instruction Manual

P/N 704841
January 1985


FLUKE ®

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

**John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206**

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**6060A Synthesized Signal Generator**

# Section 1
# Introduction and Specifications

## 1-1. INTRODUCTION

The 6060A Synthesized Signal Generator (referred to as the Generator or instrument) is a fully-programmable, precision, synthesized signal generator. The Generator is designed for applications that require good modulation, frequency accuracy, and output level performance with moderate spectral purity. It is well suited for testing a wide variety of RF components and systems including filters, amplifiers, mixers, and radios, particularly on-channel radio testing.

## 1-2. UNPACKING THE GENERATOR

This shipping container should include a 6060A Signal Generator, an Operator Information Card, a Getting Started Manual, an Instruction Manual, a line power cord, and a BNC dust cap (for the 10 MHz IN/OUT connector). Any accessories ordered for the Generator are shipped in a separate container.

Section 2, Installation and Operation, gives instructions on inspecting your new Generator, and what to do if the instrument arrives with shipping damage. Reshipment information is also included.

## 1-3. SAFETY

This instruction manual contains information, warnings, and cautions that should be followed to ensure safe operation and to maintain the Generator in a safe condition.

The Generator is designed primarily for indoor use, and it may be operated in temperatures from 0°C to and 50°C without degradation of its safety.

**WARNING**

**TO AVOID ELECTRIC SHOCK, USE A POWER CORD THAT HAS A THREE-PRONG PLUG. IF YOU DO NOT USE A PROPER POWER CORD, THE 6060A CASE CAN DEVELOP AN ELECTRICAL POTENTIAL ABOVE EARTH GROUND.**

**CAUTION**

**To avoid damage to the 6060A, check that the rear panel line voltage selection card and fuse are correct for the line voltage in your area. The correct line voltage and fuse combinations are:**

| LINE VOLTAGE | FUSE |
|---|---|
| 100/120V ac, ±10%, 47 Hz to 63 Hz | 1.5 AMP |
| 220/240V ac, ±10%, 47 Hz to 63 Hz | .75 AMP |

**CAUTION**

**If your Generator does not have Option -870 Reverse Power Protection, do not allow an input over 1/8 watt of sustained power to the RF OUTPUT. Such input could damage the Generator.**

## 1-4. OPERATOR INFORMATION CARD

The Operator Information Card has an adhesive backing so it may be affixed to the top of the Generator in bench applications or to the operator console in remote applications. A copy of the card is located at the end of Section 8 of this manual as a convenient reference or for duplication.

## 1-5. GENERATOR DESCRIPTION

Fundamental features of the Generator are as follows:

0.1-MHz to 1050-MHz frequency range in 10-Hz steps

+13-dB to −137-dBm level range in 0.1-dB steps

AM and FM, internal or external

Internal 400-Hz and 1000-Hz modulation oscillator

Relative frequency and amplitude

Volts/dBm conversion

Store/recall memory

Master/slave for frequency, amplitude, and modulation step (IEEE-488 Interface controlled.)

Fluorescent display

5 1/4-inches high, rack mountable

## 1-6. Controller Functions

The Controller microprocessor controls all operator interface functions, performs background operations such as status checks, and updates (strobes) the front panel displays. Whether you are using local control with the front panel, or remote control with the IEEE-488 Interface option, the microprocessor provides self test and diagnostic capability. Economical instrument performance is achieved by using software compensation EPROMs and accuracy-enhancement circuitry.

## 1-7. LOCAL CONTROL

The value of the basic output parameters of the Generator, i.e., amplitude, frequency, or modulation can be controlled in three ways:

Direct numeric entry

Incrementing or decrementing the bright digit

Step-up or step-down entry where the step size can be operator programmed

Other controls provide selection of the POWER ON/OFF, RF OUTPUT ON/OFF, MODULATION ON/OFF, internal/external frequency reference, and STATUS.

## 1-8. DISPLAY FIELD

The programmed values of modulation, frequency, and amplitude are displayed in the three display fields.

## 1-9. REMOTE-CONTROL PROGRAMMING

The Option -488 IEEE-488 Interface allows the Generator to be remotely controlled with any IEEE-488 bus controller. The instrument can also be used on the IEEE-488 bus without a controller in a listen-only or talk-only mode by selecting the appropriate Generator rear panel IEEE-488 switch settings.

All instrument controls can be remotely controlled except the POWER ON/OFF and the rear panel REF INT/EXT switches. The Option -488 IEEE-488 Interface provides additional commands not available with local control, such as data transfer and individual control of internal I/O control bits.

The Option -488 IEEE-488 Interface allows two Generators to track amplitude, frequency, or modulation in a master/slave configuration when using the front panel step-up and step-down entries on one of the instruments. For instance, frequency tracking is convenient for tests involving mixers, and amplitude tracking is useful for two-tone intermodulation testing.

### 1-10. Frequency

The specified frequency range is 0.1 to 1050 MHz. The frequency is synthesized from a 10-MHz reference and provides an output resolution of 10 Hz over the entire frequency range. The relative frequency mode allows the frequency to be programmed in relation to a center frequency or an offset frequency. This is convenient for testing filters and mixers. The output frequency stability and accuracy depends on the reference, whether that reference is internal or external.

### 1-11. Reference

The internal frequency reference is either a 10-MHz ambient crystal oscillator, or the Option -130 High Stability Reference. With the rear panel REF INT/EXT switch set to INT, the Generator output frequency is synthesized from the internal 10-MHz crystal oscillator reference, and the internal oscillator (timebase) TTL signal is available at the 10 MHz IN/OUT connector.

The Generator can be operated from an external 10-MHz timebase by setting the rear panel REF INT/EXT switch to EXT and applying a TTL timebase signal to the 10 MHz IN/OUT connector.

With the Option -131 Sub-Harmonic Reference installed and the REF INT/EXT switch set to EXT, the Generator can be operated from an external 1-, 2-, 2.5-, 5-, or 10-MHz, 0.3V to 4V peak-to-peak sine or square-wave reference applied to the REF IN connector. In either position of the INT/EXT switch, the selected reference is available as a 10-MHz TTL signal at the rear panel 10 MHz OUT connector.

### 1-12. Amplitude

The Generator has a specified signal level range from +13 to -137 dBm with programming limits of +19 and -147.4 dBm. This corresponds to specified terminated voltages of 1V to 0.03 uV and limits of 2V to 0.01 uV, respectively. The maximum usable signal level is approximately +17 dBm. The level entry can be in dBm or volts, or it can be converted from one to the other. In addition, the relative amplitude mode allows you to account for cascaded gain or loss, or to display the level (in dB) relative to 1 uV or 1 mV.

### 1-13. Modulation

Both internal and external amplitude modulation and frequency modulation capability is available. The internal modulation oscillator is selectable between 400 Hz and 1000 Hz. AM depths of 0% to 99% are available in 1% steps. FM deviation ranges of 1 kHz, 10 kHz, and 100 kHz are available in steps of 1 Hz, 10 Hz, and 100 Hz, respectively.

### 1-14. OPTIONS AND ACCESSORIES

The following options are available for the Generator:

Option -130 High-Stability (Ovened) Reference
Option -131 Sub-Harmonic Reference (1-, 2-, 2.5-, 5-, and 10-MHz)
Option -488 IEEE Interface
Option -570 Non-Volatile (Store/Recall) Memory ( 50 locations)
Option -651 Low-Rate FM (External only)
Option -830 Rear RF OUT and MOD IN Connectors
Option -870 Reverse Power Protection (50W protection)

Section 6 provides more detailed information on the options.

The following accessories are included with each Generator:

The following accessories are available for the Generator:

| DESCRIPTION | ACCESSORY NO. |
|---|---|
| Rack Mount Kit. Includes M05-205-600 (5 1/4-inch Rack Mount Ears) and M00-280-610 (24-inch Rack Slides) | Y6001 |
| IEEE-488 Shielded Cable, 1 meter | Y8021 |
| IEEE-488 Shielded Cable, 2 meters | Y8022 |
| IEEE-488 Shielded Cable, 4 meters | Y8023 |
| Coaxial Cable, 50 ohms, 3 feet, BNC (m) both ends | Y9111 |
| Coaxial Cable, 50 ohms, 6 feet, BNC (m) both ends | Y9112 |

### 1-15. RECOMMENDED TEST EQUIPMENT

The test equipment recommended for the performance tests, calibration adjustments, and troubleshooting are listed in Table 4A-1. This equipment is assumed to be calibrated to the manufacturer's specifications. If the recommended test equipment is not available, equivalent test equipment can be substituted.

### 1-16. MNEMONICS

The mnemonics used on the schematics, block diagrams, wiring diagrams, truth tables, and in the text, are listed in Figure 8-1.

### 1-17. SIGNAL GENERATOR SPECIFICATIONS

Unless otherwise noted, the following performance is guaranteed over the specified environmental and ac power line conditions 20 minutes after turn-on. Table 1-1 lists the Generator specifications.

**Table 1-1. Signal Generator Specifications**

Warranted performance, 20 minutes after turn-on within operating temperature range.

FREQUENCY (8 1/2-Digit Display)

| | |
|---|---|
| RANGE | 0.1 MHz to 1050.0 MHz in 3 bands; 0.1 MHz to 244.99999 MHz, 245 MHz to 511.99999 MHz, 512 MHz to 1050 MHz. |
| RESOLUTION | 10 Hz. |
| ACCURACY | Same as reference (See REFERENCE). |
| REFERENCE (Internal) | The unit operates on an internal free-air 10-MHz crystal oscillator, < ±0.5ppm/month and < ±5ppm for 25°C, ±25°C. Internal reference signal (10-MHz TTL) available at rear connector. |
| REFERENCE (External) | Accepts 10-MHz TTL signal. |

AMPLITUDE (3 1/2-Digit Display)

| | |
|---|---|
| RANGE (Indicated) | +13 (+13 peak on AM) to -137 dBm; (Autoranging 6-dB step attenuator). |
| RESOLUTION | 0.1 dB (< 1% or 1 nV in volts). |
| ACCURACY | ±1.5 dB at and above 0.4 MHz; below 0.4 MHz ± 2 dB at or above -100 dBm and ± 3 dB below -100 dBm. |
| SOURCE SWR | < 1.5 below 1 dBm and at or above 0.4 MHz; < 2.0 elsewhere. |

SPECTRAL PURITY (CW ONLY)

| | |
|---|---|
| SPURIOUS | <-60 dBc for offsets greater than 10 kHz. Fixed frequency spurs are <-60 dBc or <-140 dBm whichever is larger.<br><br>NOTE<br><br>DBc refers to decibels relative to the carrier frequency, or in this case, relative to the signal level. |
| HARMONICS | < -30 dBc. |
| RESIDUAL FM (rms in 0.3-kHz to 3-kHz Band) | < 13 Hz for 245 MHz to 512 MHz; < 27 Hz elsewhere. |
| RESIDUAL FM (rms in 0.05-kHz to 15-kHz Band) | < 30 Hz for 245 MHz to 512 MHz; < 60 Hz elsewhere. |

**Table 1-1. Signal Generator Specifications (cont)**

| | |
|---|---|
| RESIDUAL AM (in 0.05-kHz to 15-kHz Band) | < -60 dBc. |
| **AMPLITUDE MODULATION (2-Digit Display)** | |
| DEPTH RANGE | 0% to 99%. |
| RESOLUTION | 1%. |
| ACCURACY | ±(2% + 4% of setting) for internal rates, for depths 90% or less and peak amplitude of +13 dBm or less. |
| DISTORTION | < 1.5% total harmonic distortion (THD) to 30% AM, < 3% to 70% AM, < 5% to 90% AM at internal rates. |
| BANDWIDTH (3dB) | 20 Hz to 30 kHz. |
| INCIDENTAL FM | < $0.3f_m$ for internal rates and 30% AM. |
| **FREQUENCY MODULATION (3-Digit Display)** | |
| DEVIATION RANGES | 100 Hz to 999 Hz, 1 kHz to 9.99 kHz, and 10 kHz to 99.9 kHz. |
| MAXIMUM DEVIATION | Lesser of 99.9 kHz and $2f_m f_o$ above 245 MHz, or $2f_m$ $(f_o + 800)$ below 245 MHz, where $f_o$ is in MHz; $(f_o - 100)/3$ kHz, below 0.4 MHz ($f_o$ in kHz). |
| RESOLUTION | 3 digits. |
| ACCURACY | ±7% for rates of 0.3 kHz to 20 kHz (0.3 to 1 kHz for $f_o$ < 0.4 MHz) and > 100-Hz deviation. |
| DISTORTION | < 1% THD for rates of 0.3 kHz to 20 kHz (0.3 to 1 kHz for $f_o$ < 0.4 MHz) and > 100-Hz deviation. |
| BANDWIDTH (3dB) | 0.02 kHz to 100 kHz; unspecified for $f_o$ < 0.4 MHz. |
| INCIDENTAL AM | < 1% AM at 1-kHz rate, for the maximum deviation or 50 kHz, whichever is less. |
| **MODULATION SOURCE** | |
| INTERNAL | 0.4 kHz or 1 kHz, ±3% for 20°C to 30°C; add ±0.1%/°C outside this range. |
| EXTERNAL | ±5V max.; 1V peak provides indicated modulation index. Nominal input impedance is 600 ohms. |

**Table 1-1. Signal Generator Specifications (cont)**

| | |
|---|---|
| MODES | Any combination of internal AM, internal FM, external AM, and external FM. Modulation may also be disabled. The nominal input impedance with both external AM and external FM enabled is 560 ohms. |
| GENERAL | |
| TEMPERATURE | |
| Operating | 0°C to 50°C (32°F to 122°F). |
| Non-Operating | -40°C to 75°C (-40°F to 167°F). |
| HUMIDITY RANGE | |
| Operating | 95% to 30°C, 75% to 40°C, 45% to 50°C. |
| ALTITUDE | |
| Operating | Up to 10,000 ft. |
| VIBRATION | |
| Non-Operating | 5 Hz to 15 Hz at 0.06 inch, 15 Hz to 25 Hz at 0.04 inch, and 25 Hz to 55 Hz at 0.02 inch, double amplitude (DA). |
| SHOCK | |
| Non-Operating | Bench handling per MIL T 28800C Class 5, Style E. |
| ELECTROMAGNETIC COMPATIBILITY | The radiated emissions induce < 3 uV (< 1 uV of the Generator's output signal) into a 1-inch diameter, 2-turn loop, 1-inch from any surface as measured into a 50-ohm receiver. |

Also complies with the following standards:

CE03 of MIL-STD-461B (Power and interconnecting leads), 0.015 MHz to 50 MHz.

RE02 of MIL-STD-461B (14 kHz to 10 GHz).

FCC Part 15 (j), class A.

CISPR 11.

| | | | |
|---|---|---|---|
| SIZE | Width | Height | Depth |
| | 43 cm | 13.3 cm | 50.8 cm |
| | 17 in | 5.25 in | 20 in |

| | |
|---|---|
| POWER | 100, 120, 220, 240V ac ±10%, 47 to 63 Hz, < 180 VA (< 15 VA, with Option -130 installed, and the Generator turned off (standby). |
| WEIGHT | < 15.7 kg (35 lbs). |

**Table 1-1. Signal Generator Specifications (cont)**

6060A OPTION -130 HIGH STABILITY REFERENCE

| | |
|---|---|
| AGING RATE | $< \pm 5 \times 10^{-10}$/day, after 21 days. |
| TEMPERATURE STABILITY | $< \pm 2 \times 10^{-10}/^{\circ}C$ (Oven remains powered in standby). |

6060A OPTION -131 SUB-HARMONIC REFERENCE

| | |
|---|---|
| INPUT | 1, 2, 2.5, 5, or 10 MHz at 0.3 to 4V p-p, sine wave or square wave, into 50-ohm nominal impedance. |

6060A OPTION -488 IEEE INTERFACE (IEEE-488-1978 STD)

| | |
|---|---|
| INTERFACE FUNCTIONS | SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1, C0, and E2. |

6060A OPTION -570 NON-VOLATILE MEMORY

50 instrument states are retained for 2 years (typically), even without ac line power applied.

6060A OPTION -870 REVERSE POWER PROTECTION

| | |
|---|---|
| PROTECTION LEVEL | Up to 50 watts from a 50-ohm source, 0.1 MHz to 1050 MHz. Withstands up to 50V dc. Protection is not provided when the Generator is off. |

6060A OPTION -651 LOW RATE EXTERNAL FM

| | |
|---|---|
| MAXIMUM DEVIATION | 9.99 kHz. |
| DROOP | < 15% on a 10-Hz square wave. |
| BANDWIDTH (3dB) | 0.5 Hz to 100 kHz (typical). |
| MAX DC INPUT | $\pm$10 mV. |
| INCIDENTAL AM | < 1% AM at 1-kHz rate and deviation < 10 kHz. |

SUPPLEMENTAL CHARACTERISTICS

The following characteristics are provided to assist in the application of the Generator and to describe the typical performance that can be expected.

| | |
|---|---|
| FREQUENCY SWITCHING SPEED | < 100 mS to be within 100 Hz. |
| AMPLITUDE SWITCHING SPEED | < 100 mS to be within 0.1 dB. |
| AMPLITUDE RANGE | Programmable to +19 dBm and -147.4 dBm, usable to +17 dBm. Fixed-range, selected by special function, allows for more than 12 dB of vernier without switching the attenuator. |

**Table 1-1. Signal Generator Specifications (cont)**

| | |
|---|---|
| NOISE (at 20-kHz offset) ........ | <-113 dBc/Hz (except <-107 dBc/Hz below 245 MHz and above 512 MHz). |
| RESIDUAL FM (rms in 0.3 to 3 kHz) | Approximately a linear function of output frequency between the following typical band-edge values:<br><br>15 Hz at 0.1 MHz to 20 Hz at 244.99999 MHz.<br><br>6 Hz at 245 MHz to 10 Hz at 511.99999 MHz.<br><br>12 Hz at 512 MHz to 20 Hz at 1050 MHz. |
| EXTERNAL MODULATION ............. | Annunciators indicate when a 1V peak signal is applied, ±2%, over a 0.02-kHz to 100-kHz band. |
| IEEE-488 ....................... | All controls except the power switch and the internal/external reference switch are remotely programmable via IEEE-488 Interface (Std 488-1978). All status including the option complement are available remotely. The Store/Recall memory data may be transferred via an external controller. In talk-only, the appropriate commands are generated when the front panel step-up and step-down entries are made to control another 6060A, 6070A, or 6071A. (6070/71A only have FREQUENCY STEP.) |

# Section 2
# Installation and Operation

## 2-1. INTRODUCTION

This section describes how to install and operate the Generator. This section contains information for an initial inspection, setting up the instrument, and local and remote operation.

## 2-2. INITIAL INSPECTION

The Generator is shipped in a special protective container that should prevent damage during shipment. Check the shipping order against the contents of the container, and report any damage or short shipment to the place of purchase or the nearest Fluke Technical Service Center. Instructions for inspection and claims are included on the shipping container.

If reshipment of the Generator is necessary, please use the original shipping container. If the original container is not available, use a container that provides adequate protection during shipment. It is recommended that the Generator be surrounded by at least three inches of shock-absorbing material on all sides of the container. Do not use loose fill to pad the shipping container. Loose fill allows the Generator to settle to one corner of the shipping container, which could result in the Generator being damaged during shipment.

## 2-3. SETTING UP THE GENERATOR

The following paragraphs describe how to set up the Generator for operation. This information includes: line power requirements, line voltage selection procedures, fuse replacement procedures, and rack mounting instructions.

### 2-4. Line Power Requirements

The Generator uses a line voltage of 100 or 120V ac rms (± 10%) with a 1.5A fuse; or 220V or 240V ac (± 10%) with a 0.75A fuse. The line frequency must be between 48 to 63 Hz. The power consumption of the instrument is <180 VA with a full option complement.

### 2-5. Line Voltage and Fuse Selection

**CAUTION**

**Verify that the intended line power source matches the line voltage setting of your Generator before plugging in the line power cord.**

Refer to Figure 2-1 to set the line voltage of the Generator to match your available source. Figure 2-1 also shows how to replace the line fuse of the Generator. The correct fuse value for each of the four line voltages is listed on a plate attached to the rear panel of the Generator.

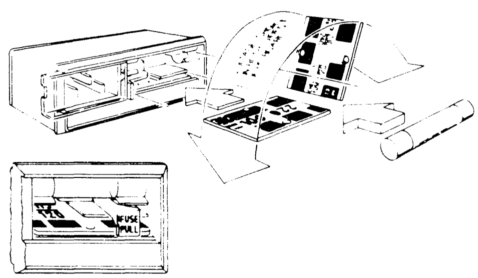


Figure 2-1. Fuse/Filter/Line Voltage Selection Assembly

## 2-6. IEEE-488 Address

If the IEEE-488 Interface option is installed, the IEEE-488 address can be selected using the switches located next to the IEEE-488 connector on the rear panel. Talk-only and listen-only modes can also be selected on this switch.

## 2-7. RACK OR BENCH MOUNTING THE GENERATOR

**CAUTION**

**Allow at least 3 inches of clearance behind and on each side of the Generator to ensure proper air circulation. Clean the fan filter regularly. Determine the cleaning interval by the type of environment.**

**To meet the specified radiated emissions, the IEEE-488 connector must be terminated with a shielded IEEE-488 cable, such as a Fluke Y8021.**

The Generator normally operates on an internal reference oscillator. However, if desired, the Generator can be operated on an external reference by setting the rear panel REF INT/EXT switch to EXT and connecting the external reference to the 10 MHz IN/OUT connector. Use the REF IN connector if the Generator has the Sub-Harmonic Reference option.

**CAUTION**

**When operating on the internal reference, a 10-MHz TTL signal is present at the 10 MHz IN/OUT connector on the rear panel. To meet the specified radiated emissions, this connector must be terminated with a BNC non-shorting dust cap. A dust cap, JF 478982, is supplied with the Generator. If a cable is connected, it must be a double-shielded coaxial cable such as RG-223 terminated in a TTL load.**

**CAUTION**

**Output spectral degradation occurs if the Generator is operated on internal reference with an external reference signal applied.**

The Generator may be placed directly on a work bench or mounted in a standard (24-inch deep) equipment rack. Use the Fluke Y6001 Rack Mount Kit for mounting the Generator on an equipment rack. Instructions for installing the Generator with the Rack Mount Kit are provided in the kit. The outside dimensions of the Generator are shown in Figure 2-2. The Rack Mount Kit is composed of the following parts:

5-1/4-inch Rack Adapter, P/N M05-205-600
24-inch Rack Slides, P/N M00-280-610

## 2-8. GENERAL OPERATING INFORMATION

The following paragraphs contain general information on the operation of the Generator. This includes all the information required to familiarize the you with the instrument and the differences between local and remote operation.

### 2-9. Familiarization

Figure 2-3 shows the front panel controls, indicator, and connectors and Table 2-1 describes the features.

Figure 2-4 shows the rear panel controls, connectors, and switches and Table 2-2 describes the features.

### 2-10. Local Verses Remote Operation

There are two modes of controlling the output of the Generator. One mode uses the keys on the front panel; this is called local operation. The other mode is available when the IEEE-488 Interface option has been installed, and an IEEE-488 controller is used to control the Generator. This is referred to as remote operation. An overview of local control is presented first. The next heading, Operating Reference Material, is divided into two parts. The first part covers local and remote control operations that have similar entry methods. The second part, Remote Operation, contains information on commands or descriptions that pertain only to remote operations.

### 2-11. Power-On Sequence

When the Generator is turned on, a power-on sequence is started. During the power-on sequence, the microprocessor tests the analog circuitry, the program ROM, the scratch-pad RAM, and the front panel displays. The front panel displays are tested by lighting all segments for a brief period at the same time the rest of the self tests are performed.

If any of the self tests fail, an error code is displayed. If the operator initiates any front panel entry before the power-on sequence is completed, the self test is aborted, and the Generator is placed in the Instrument Preset State [RCL] [9][8]. In addition, the RF output is turned on. Table 2-3 lists the Instrument Preset State. If the Non-Volatile Memory Option is installed, the Generator is set to the state it was in when turned off. Power-on instrument settings that relate to the optional IEEE-488 Interface are described in the Remote Operation paragraphs in this section.

### 2-12. Changing Output Parameters

The four parameters of the Generator (i.e., frequency, amplitude, amplitude modulation (AM), and frequency modulation (FM)) may be changed by one of three methods:

FUNCTION-DATA-UNIT
Bright-Digit Edit
Step Entry

These different methods all accomplish the same result but use different approaches. The reason for this apparent redundancy is to reduce the chance of error during complex test procedures that require continuously resetting parameters or in those cases when a test is partly under remote control and only some of the parameters require changes.

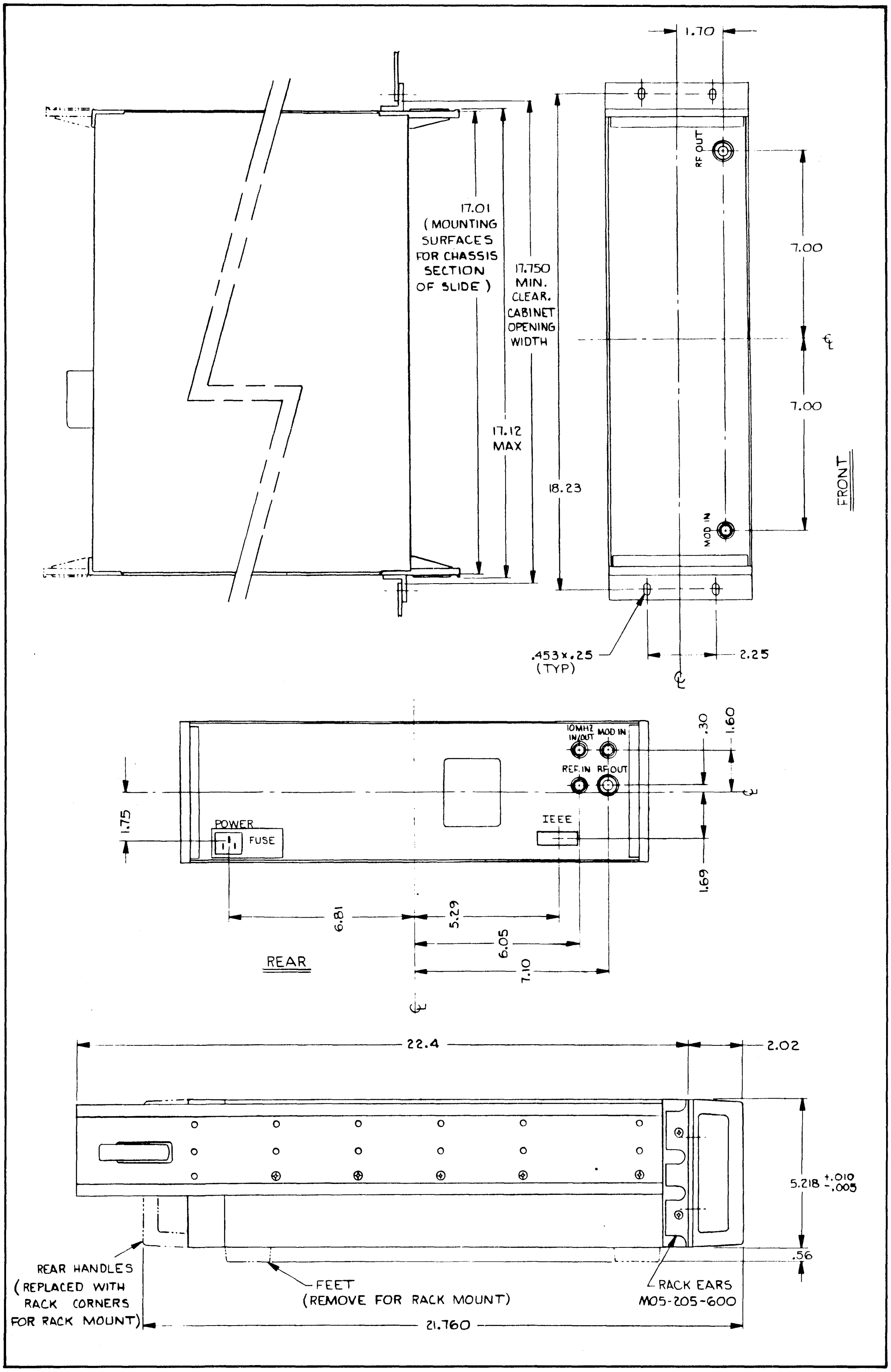



**Figure 2-2. 6060A Outside Dimensions**

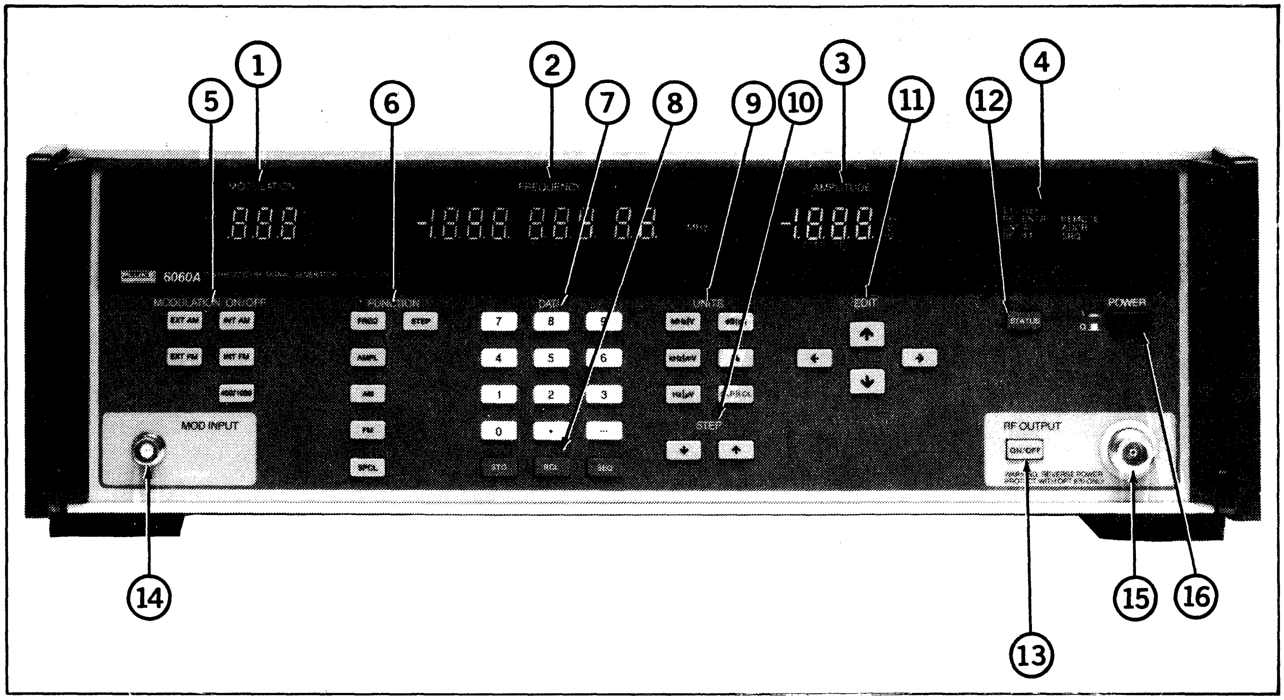



**Figure 2-3. Front Panel Controls, Indicators, and Connectors**

**Table 2-1. Front Panel Controls, Indicators, and Connectors**

| | |
|---|---|
| (1) MODULATION DISPLAY FIELD | A three-digit display, with associated indicators used to display the AM depth, FM deviation, source of modulation signal, and modulation frequency. |
| INT AM | Indicates that the internal modulation oscillator signal is amplitude modulating the Generator. |
| EXT AM | Indicates that the Generator is amplitude modulated by the signal connected to the MOD INPUT connector. |
| INT FM | Indicates that the internal modulation oscillator signal is frequency modulating the Generator. |
| EXT FM | Indicates that the Generator is frequency modulated by the signal connected to the MOD INPUT connector. |
| STEP | Indicates that the Step [↑] or [↓] keys (Step Entry) affect the current Modulation display value. |
| % | Indicates that the value displayed is the AM Depth in percent. |
| kHz DEV | Indicates that the value displayed is the FM Deviation in kHz. |
| 400 Hz | Indicates that the internal modulating frequency is 400 Hz. |
| 1000 Hz | Indicates that the internal modulating frequency is 1000 Hz. |
| EXT HI | Indicates that the external modulation signal is more than 2% above the nominal 1V peak requirement for calibrated operation. |
| EXT LO | Indicates that the external modulation signal is more than 2% below the nominal 1V peak input requirement. |

**Table 2-1. Front Panel Controls, Indicators, and Connectors (cont)**

| | | |
|---|---|---|
| (2) | FREQUENCY DISPLAY FIELD | An 8 1/2-digit display, with two indicators used to display the output frequency of the Generator. Also used to display the special function code, status error codes, or the memory location being stored or recalled, as well as relative and actual frequency, when 'REL' is lit, and step frequency. |
| | STEP | Indicates that the Step [↑] or [↓] keys (Step Entry) affect the output frequency. |
| | REL | Indicates that the displayed frequency is relative to a reference frequency. |
| (3) | AMPLITUDE DISPLAY FIELD | A 3 1/2- (and sign) digit display, with six indicators, used to display the output amplitude of the Generator into a 50-ohm load. |
| | STEP | Indicates that the Step [↑] or [↓] keys (Step Entry) affect the output amplitude. |
| | REL | Indicates that the displayed amplitude is relative to a reference amplitude. |
| | dBm | Indicates that the output amplitude is in decibels relative to one milliwatt. |
| | V | Indicates that the output amplitude is in volts. |
| | uV | Indicates that the output amplitude is in microvolts. |
| | mV | Indicates that the output amplitude is in millivolts. |
| (4) | STATUS DISPLAY FIELD | The status display field is composed of 11 indicators used to denote the current status of the Generator or instrument entry. |
| | EXT REF | Indicates that the rear panel REF switch is in the EXT (external) position. |
| | REJ ENTRY | Lights when an invalid entry is made. |
| | UNCAL | Lights when a parameter entry is outside its specified range. This indicator flashes when any of the internal DAC's are over or under-flow or when any abnormal operation is detected. |
| | RF OFF | Lights when the RF OUTPUT is disabled. |
| | REMOTE | Lights when the Generator is in the remote (IEEE-488 Interface) mode of operation. |
| | ADDR | Lights when the Generator is addressed to listen or talk. |
| | SRQ | Lights when the Generator has asserted the IEEE-488 SRQ signal. |
| (5) | MODULATION ON/OFF | Used to select type, source, and frequency of modulation. With the exception of the [400/1000] key, these keys operate as independent push-on/push-off switches for the given function. Any combination is allowed. |
| | INT AM | Enables internal amplitude modulation at the frequency annunciated by the '400/1000' Hz indicator. |

**Table 2-1. Front Panel Controls, Indicators, and Connectors (cont)**

| | | |
|---|---|---|
| | INT FM | Enables internal frequency modulation at the frequency annunciated by the '400/1000' Hz indicator. |
| | EXT AM | Enables external amplitude modulation using the signal applied to the MOD INPUT connector. |
| | EXT FM | Enables external frequency modulation using the signal applied to the MOD INPUT connector. |
| | 400/1000 | Alternately sets the internal modulation oscillator's frequency to 400 or 1000 Hz. Selected frequency is displayed only when INT AM or INT FM is enabled. |
| 6 | FUNCTION | With the exception of the [STEP] and [SPCL] keys, these keys operate as interlocked switches that select the parameter to be entered or edited. For the [FREQ], [AMPL], [AM], and [FM] FUNCTION keys, the bright digit appears in the corresponding display of the selected function. |
| | FREQ | Selects the frequency parameter of the Generator to be programmed by using the DATA, EDIT, or STEP entry keys. |
| | AMPL | Selects the amplitude parameter of the Generator to be programmed by using the DATA, EDIT, or STEP entry keys. |
| | AM | Selects the amplitude modulation (AM) parameter of the Generator to be programmed by using the DATA, EDIT, or STEP entry keys. |
| | FM | Selects the frequency modulation (FM) parameter of the Generator to be programmed by using the DATA, EDIT, or STEP entry keys. |
| | SPCL | Enables the special function mode. Special functions are called up by a two-digit code, that is entered by using the DATA keys. Refer to the paragraphs on Special Function in this section for a detailed description and a list of the special functions. |
| | STEP | After one of the four parameter functions has been selected for programming, pressing this key allows you to program a step-wise change to that parameter. The step increase or decrease is then performed every time the STEP [↑] or [↓] keys are pressed. |
| 7 | DATA | A ten-digit (plus sign and decimal key) keypad used for entering a parameter's value, the special function code, or a memory recall/store location. |
| 8 | Memory | |
| | STO | Used with the DATA keys to store the current instrument state in a memory location. Memory locations 01 through 07 are available (01 through 50 with the Non-Volatile Memory option installed). |
| | RCL | Used with the DATA keys to recall an instrument state from a memory location. Memory locations 01 through 07 (01 through 50 with the optional Non-Volatile Memory) are available for operator-stored states; memory location 98 contains the Instrument Preset State (see Table 2-3.) |

**Table 2-1. Front Panel Controls, Indicators, and Connectors (cont)**

| | |
|---|---|
| SEQ | Sequentially recalls, in increasing location order, the instrument states stored in memory. While the [SEQ] key is pressed, successive memory locations are displayed. When the key is released, the location last displayed is recalled. |
| (9) UNITS | These keys, with the exception of [CLR/LCL], serve as the terminating keystroke of a function entry, thereby causing the Generator to be programmed. The amplitude units keys are also used during Amplitude Units Conversion entries. |
| MHz\|V | Used with the [FREQ], [FM], and [AMPL] function keys to program the numerical DATA entries in terms of megahertz (frequency or frequency modulation) or volts (amplitude). |
| dB(m) | Used with the [AMPL] function key to program the numerical DATA entries in terms of decibels per milliwatt. |
| kHz\|mV | Used with the [FREQ], [FM], and [AMPL] function keys to program the numerical DATA in terms of kilohertz (frequency or frequency modulation) or millivolts (amplitude). |
| % | Used with the [AM] function key to program the numerical DATA entries in terms of percentage AM depth. |
| Hz\|uV | Used with the [FREQ], [FM], and [AMPL] function keys to program the numerical DATA in terms of hertz (frequency or frequency modulation) or microvolts (amplitude). |
| CLR\|LCL | When the Generator is in local operation, this key is used to clear the current entry and returns the Generator to the previous state. When the instrument is in remote operation, this key is used to return local control. |
| (10) STEP | These two keys work in conjunction with the STEP Function key. These keys repeat while they remain pressed. |
| [↑] | After a parameter is set to the step function mode, and the 'STEP' indicator appears in the display field, this key increments the parameter by the step value previously programmed. |
| [↓] | After a parameter is set to the step function mode, and the 'STEP' indicator appears in the display field, this key decrements the parameter by the step value previously programmed. |
| (11) EDIT | These keys are used to position the bright digit within a display field and to increase or decrease the bright digit value. All four keys repeat while they remain pressed. The function keys are used to move the bright digit to the desired display field. |
| [↑] | Increases the bright-digit value. |
| [←] | Moves the bright digit one digit to the left. |
| [↓] | Decreases the bright-digit value. |
| [→] | Moves the bright digit one digit to the right. |

**Table 2-1. Front Panel Controls, Indicators, and Connectors (cont)**

| | | |
|---|---|---|
| (12) | STATUS | A push and hold key that displays the Uncal and Reject Entry status codes in the MODULATION, FREQUENCY, and AMPLITUDE display fields. |
| (13) | ON/OFF | A push-on/push-off key (with a corresponding 'RF OFF' indicator in the STATUS display filed) that enables or disables the output of the Generator. |
| (14) | Connector | A BNC connector for input of a 1V peak, external modulation signal. |
| (15) | Connector | A standard RF connector at the output of the Generator. |
| (16) | POWER | A push-on/push-off detent switch that applies line power to the Generator. |

## 2-13. Function Entry

Changing an instrument parameter with the FUNCTION-DATA-UNIT entry method of consists of:

Selecting the Function to be changed
Entering the new numerical value of the parameter
Selecting the Units of the numerical value (megahertz, millivolts, etc).

The command syntax for function entries is:

Select Function -- Enter Data -- Select Unit

1. Select one of the four parameters using the FUNCTION keys. The bright digit appears in the corresponding display field. The presence of the bright digit in the display field indicates that the value of the selected parameter is ready to be programmed or changed.

2. Enter the data with the DATA keys. The numerics appear in the appropriate display field.

3. Select a UNIT key. This gives the data its absolute value, and causes the microprocessor to internally program the Generator to the new state.

For the amplitude and frequency functions, the entered data programs the displayed value. If the relative mode is enabled, the displayed value may be different from the actual output value.

Once a function is selected, that parameter or feature remains in the active programming mode until a new function is selected. Data for a selected parameter must be followed by a unit value and must be within the range specified for the function. The display field flashes and, the 'REJ ENTRY' status indicator flashes if the entered data is not within the specified range. A rejected entry does not affect the output of the Signal Generator. The output of the Generator remains at its previous values until a new value is accepted.

A function entry may be terminated at any time by the [CLR|LCL] key or by selecting another function.

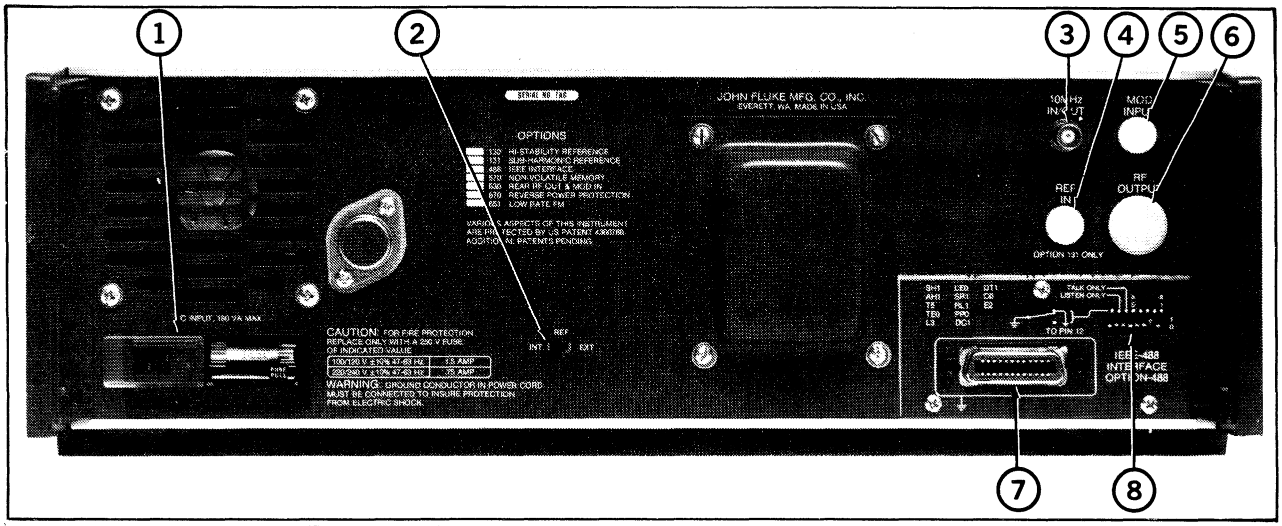



Figure 2-4. Rear Panel Controls, Connectors, and Switches

Table 2-2. Rear Panel Controls, Connectors, and Switches

| | | |
|---|---|---|
| 1 | AC INPUT | Permits operation from 100, 120, 220, or 240V ac. The number visible through the window on the selector card indicates the nominal line voltage to which the Generator must be connected. The line voltage is selected by orienting the selector card appropriately. A 1 1/2-ampere fuse is required for 100/120V operation and a 3/4-ampere fuse is required for 220/240V operation. |
| 2 | REF INT/EXT | Permits selection of the Generator frequency reference. When set to INT, the Generator operates on the internal reference, which is either the standard oscillator or the high-stability oscillator if the High-Stability Reference is installed. In either case, the internal 10-MHz reference signal is available at the 10 MHZ IN/OUT connector as a TTL level. When set to EXT, the Generator reference is the 10-MHz TTL signal applied to the external 10 MHZ IN/OUT connector. |
| 3 | 10 MHZ IN/OUT | 10 MHZ IN/OUT connector (BNC) provides a 10-MHz TTL signal when the Generator is operating on the internal reference, or accepts a 10-MHz TTL signal when operating on external reference.<br>If the Sub-Harmonic option is installed, then the REF IN connector is added and the 10 MHZ IN/OUT connector is relabeled 10 MHZ OUT. |
| 4 | REF IN | Connector (BNC) is present only with the Sub-Harmonic reference option to accept a 1-, 2-, 2.5-, 5-, or 10-MHz, 0.3 to 4V p-p sine or square wave signal into nominally 50 ohms. |
| 5 | MOD INPUT | Connector (BNC) is present only with the REAR RF OUT and MOD IN option to accept a 1V peak external modulation signal. |
| 6 | RF OUTPUT | Connector (type N) is present only with the REAR RF OUT and MOD IN option to provide the Generator output signal. |
| 7 | IEEE-488 CONNECTOR | Present only with the IEEE-488 Interface option to allow remote operation of the Generator via the IEEE-488 bus. |
| 8 | IEEE-488 ADDRESS SWITCH | Present only with the IEEE-488 Interface option and allows the selection of the Generator bus address. |

**Table 2-3. Instrument Preset State**

| FUNCTION | SETTING |
|---|---|
| Frequency | 300.00000 MHz |
| Frequency Step | 1.00000 MHz |
| Amplitude | -10.0 dBm |
| Amplitude Step | 1 dB |
| Modulation Rate | 1000 Hz |
| AM Depth | 30% |
| AM Depth Step | 1% |
| FM Deviation without/with Option -651 | 5.0/.5 kHz |
| FM Deviation Step without/with Option -651 | 100/10 Hz |
| Modulation Display | AM Depth |
| Bright-Digit Location | Frequency Bright Digit |
| Frequency Bright-Digit Position | 1 MHz |
| Amplitude Bright-Digit Position | 1 dBm |
| AM Bright-Digit Position | 1% |
| FM Bright-Digit Position without/with Option -651 | 10/1 Hz |
| Special Functions | 20,30,70,80,90 |
| INT AM | Off |
| EXT AM | Off |
| INT FM | Off |
| EXT FM | Off |
| Step Function | Frequency Step |

## 2-14. Bright-Digit Edit Operation

Changing an instrument parameter by the edit entry method is the fastest way to make vernier (incremental) changes to one of the four parameters. The EDIT keys are used with the four parameter FUNCTION keys to position the bright digit in the desired display field and then increase or decrease the bright-digit value.

The command syntax for bright-digit edit entries is:

Select Display Field -- Position Bright Digit -- Change Bright-Digit Value

1. Use one of the four FUNCTION keys to position the bright digit in the appropriate display field.

2. Use the [ → ] or [ ← ] EDIT keys to position the bright digit to the desired resolution, and use the [ ↑ ] or [ ↓ ] EDIT keys to increase or decrease the value of the bright digit.

The position of the bright digit within a display field is maintained when the bright digit is moved from one display field to another.

The repeat rate of the [ ↑ ] or [ ↓ ] EDIT keys may be changed to a faster or slower rate (a medium repeat rate is the default) with a special function code. Refer to the paragraphs on Special Function and the reference pages in this section for the method and code.

## 2-15. Step Operation

Changing parameters by the Step Entry method allows you to preset step-wise increments of a parameter then change that parameter (by the amount programmed in the step function) [ ↑ ] or [ ↓ ] with a single keystroke.

The command syntax for step entries is:

Select Step Function -- Enter Data -- Select Units -- Change Parameter

1. Select the parameter to be changed step-wise using one of the FUNCTION key.
2. Press the [STEP] key to enable the Step function.
3. Program the step amount using the DATA and UNIT keys.
4. The parameter value can now be changed, up or down by the programmed step amount by using the [ ↑ ] or [ ↓ ] STEP keys.

While the [STEP] key is pressed, the display field of the selected parameter shows the step amount. The 'STEP' indicator is lit in the display field currently affected by the [STEP] key.

The repeat rate of the [↑] or [v] STEP [redacted] keys may be changed to a faster or slower rate (a medium repeat rate is the default) with a Special Function code. Refer to the paragraphs on Special Functions and the reference material for the method and code.

A step entry is ignored when the result of that step entry would cause the value of the parameter to exceed its programmable limit.

### 2-16. Status and Clear Entries

The Status entry allows you to interrogate the Generator for an explanation of uncalibrated or rejected entry operation ('UNCAL' or 'REJ ENTRY') indicator is lit. Refer to the paragraphs on Status and Clear Entry in the reference section for a complete list of status codes.

The [CLR|LCL] key may be used to clear a partial DATA entry or clear the flashing 'REJ ENTRY' indicator.

### 2-17. RF Output On/Off

The RF OUTPUT [ON/OFF] key allows the operator to enable or disable the RF output of the Generator. This feature is useful in zeroing a power meter, finding the noise floor of a system, or determining the presence or source of an unknown signal.

On power-up, the RF output of the Generator is enabled. Pressing the RF OUTPUT [ON/OFF] key disables the output of the Generator and causes the 'RF OFF' indicator (in the STATUS display field) to light. If the Non-Volatile Memory option is installed, the RF ON/OFF status on power-up assumes the state it was in when the Generator was turned off.

### 2-18. Modulation On/Off and Rate

The MODULATION ON/OFF keys allow you to select any combination of modulation or no modulation. The MODULATION display field indicates what combination of modulation has been selected. Each modulation key is a push-on push-off type (except the [400/1000] key).

The [400/1000] key toggles the internal modulation oscillator between 400 and 1000 Hz. The '400 Hz' and '1000 Hz' indicators are lit only when INT AM or FM modulation is enabled.

### 2-19. Memory

Memory entry using the [STO] key allows you to save up to seven complete front panel settings for later recall. If the Non-Volatile Memory option is installed, the capacity for front panel settings is increased to 50.

The command syntax for memory operations follows. No memory location needs to be specified for the sequence operation.

Select Memory Function -- Enter Memory Location

To store the current front panel setting, press the [STO] key (located below the DATA keys). The last memory location stored or recalled is displayed in the FREQUENCY display field. Next, use the DATA keys to enter the two-digit memory location code. The location code must contain both digits (e.g., 01, 02, ...07). The two-digit code appears in the FREQUENCY display field as it is entered.

To recall a front panel setting, press the [RCL] key (located below the DATA keys). The last memory location stored or recalled is displayed in the FREQUENCY display field. Next, use the DATA keys to enter the memory location code of the desired front panel setting. Remember, the location code must contain both digits of the memory location code.

Memory location 98 contains the Instrument Preset State that can be recalled at any time.

The [SEQ] key allows the front panel settings stored in memory to be sequentially recalled. This process is activated by pressing the [SEQ] key at any time. When the [SEQ] key is pressed, the memory location code of the currently recalled setting appears in the FREQUENCY display field, and the location is recalled. When the last memory location is reached (07 for standard instruments, 50 with the Non-Volatile Memory option), the [SEQ] key starts over at 01. The [SEQ] key repeats while pressed.

### 2-20. Special Function

Special Function Entries allow the operator to enable several special operating functions in the Generator. For example, special functions allow the operator to change the repeat rate of the STEP and EDIT keys, start the self tests, display the results of the power-up self tests, display the IEEE-488 address, enable relative and fixed-range features, and disable or enable special attenuation features. A complete list of the special functions available are presented in Table 2-4.

The command syntax for special function entries is as follows:

Select Special Function -- Enter Special Function Code

The special function is selected by pressing the [SPCL] key. The special function code is entered using the DATA keys.

## 2-21. OPERATING REFERENCE MATERIAL

This reference section describes local and remote operation for each Generator function. The functions are arranged in alphabetical order. For each function, the syntax of the command, allowable data ranges, and other information is presented.

### 2-22. Amplitude and Frequency Entry

The following information describes how to control the carrier frequency and amplitude by the FUNCTION-DATA-UNIT entry sequence. This method applies to both normal and relative operations. The frequency display is a fixed-point display in MHz. The amplitude display is fixed point while displaying dBm but is floating point when displaying voltage units.

The RF OUTPUT [ON/OFF] must be enabled for the Generator to produce an output (see the reference material on RF OUTPUT ON/OFF Entry).

Table 2-4. Special Functions

| SPECIAL FUNCTION | OPERATION |
|---|---|
| 00 | Clears all currently set special functions. |
| 02 | Initiates self tests. |
| 03 | Display test. This test is detailed in Section 4D. |
| 04 | Key test. This test is detailed in Section 4D. |
| 07 | Set SRQ if IEEE-488 Interface option is installed. |
| 08 | Reset SRQ if IEEE-488 Interface option is installed. |
| 09 | Display instrument software revision level. Information appears in the MODULATION and FREQUENCY display fields for approximately 3 seconds or until another key is pressed. |
| 10 | Display IEEE-488 mode and address in decimal form if the IEEE-488 Interface option is installed. |
| 11 | Display self-test results. Zeros in the display fields indicate that the self tests have passed. See Section 4D for details of the self-test display. |
| 12 | Turn on displays. |
| 13 | Turn off all displays. All other functions still operate. |
| 14 | Initialize memory locations to Instrument Preset State. 'Sto' appears in the FREQUENCY display field for 3 seconds. If during this time, the [STO] key is pressed, all memory locations are initialized. |
| 15 | Latch test. This test is detailed in Section 4D. |
| 20 | Disable Relative Frequency. See reference page on Relative Function. |
| 21 | Enable Relative Frequency. See reference page on Relative Function. |
| 30 | Disable Relative Amplitude. See reference page on Relative Function. |
| 31 | Enable Relative Amplitude. See reference page on Relative Function. |
| 70 | Set repeat rate for EDIT and STEP keys to medium. |
| 71 | Set repeat rate for EDIT and STEP keys to fast. |
| 72 | Set repeat rate for EDIT and STEP keys to slow. |
| 80 | Enable Amplitude correction. Normal operation. |
| 81 | Disable Amplitude correction. If level accuracy is not critical, level correction circuitry can be disabled for improved programming speed. Level accuracy may be up to 7 dB low. |
| 82 | Disable attenuator correction. Useful as a troubleshooting tool. RF input to attenuator is flat. |
| 83 | Program alternate 24 dB attenuation. See Section 4D. |
| 84 | Program alternate 24 dB attenuation. See Section 4D. |
| 85 | Program alternate 24 dB attenuation. See Section 4D. |
| 86 | Program alternate 24 dB attenuation. See Section 4D. |
| 90 | Disable Amplitude Fixed Range. See reference material on Amplitude Fixed Range. |
| 91 | Enable Amplitude Fixed Range. See reference material on Amplitude Fixed Range. |

## Command Syntax

Select Function -- Enter Data -- Select Unit

## Summary

| | COMMAND | RANGE | RESOLUTION | NOTES |
|---|---|---|---|---|
| Set Frequency | | | | |
| Local: | [FREQ] -- DATA -- [MHz\|V]<br>[kHz\|mV]<br>[Hz\|uV] | 0.1 to 1050 MHz | 10 Hz | 1,2 |
| Remote: | "FR" -- float -- "GZ"<br>"MZ"<br>"KZ"<br>"HZ" | 0.1 to 1050 MHz | 10 Hz | 1,3 |
| Set Amplitude | | | | |
| Local: | [AMPL] -- DATA -- [dB(m)]<br>[MHz\|V]<br>[kHz\|mV]<br>[Hz\|uV] | -137 to +13 dBm<br>0.03 uV to 1 V | 0.1 dBm<br>3 digits | 2,4,5 |
| Remote: | "AP" -- float -- "DB"<br>"V"<br>"MV"<br>"UV"<br>"NV" | -137 to +13 dBm<br>0.03 uV to 1 V | 0.1 dBm<br>3 digits | 3,4,5 |

## Example

Set Frequency to 10.7 MHz and Amplitude to –7.5 dBm.

```
Local:  [FREQ] [1] [0] [.] [7] [MHz|V]
        [AMPL] [-] [7] [.] [5] [dB(m)]

Remote: "FR10.7MZ,AP-7.5DB"
```

## Notes

1. Frequency ranging occurs at 245 and 512 MHz.

2. FUNCTION ([FREQ] or [AMPL]) remains selected until another FUNCTION or [STEP], [STO], [RCL], or [SPCL] is pressed.

3. float equals floating-point number.

4. Amplitude uncalibrated range from –147.4 to –137.1 dBm and from +13.1 to +19 dBm.

5. Amplitude ranging occurs at 1/2V, 1/4V, 1/8V, ... $1/2^{23}$ V with AM off and 1/4V, 1/8V, 1/16V, ... $1/2^{24}$ V with AM on.

Related Operations

Amplitude Fixed Range
Bright-Digit Edit Entry
Relative Function
Step Entry

### 2-23. Amplitude Fixed Range

The following information describes how to use the Fixed-Range special function. This special function fixes the current amplitude range (holds the currently selected step of the Step Attenuator). This function allows monotonic and nontransient level control over a limited range around those levels where the Step Attenuator normally autoranges. This level control may be accomplished with the Bright-Digit Edit Entry only.

The level vernier in fixed range has at least 12 dB of range.

Command Syntax

Select Fixed Range -- Enable or Disable

Summary

| | COMMAND | NOTES |
|---|---|---|
| Enable Fixed Range | | |
| Local: | [SPCL] [9] -- [1] | 1 |
| Remote: | "SP" "9" -- "1" | |
| Disable Fixed Range | | |
| Local: | [SPCL] [9] -- [0] | 2 |
| Remote: | "SP" "9" -- "0" | |

Example

Set the Generator for monotonic and nontransient amplitude control (Bright-Digit Edit only) over the range of the vernier level control below 0.25V.

Local: [AMPL] [.] [2] [5] [MHz|V] [SPCL] [9] [1]

Remote: "AP.25V,SP91"

Notes

1. The amplitude range is fixed only for Bright-Digit Edit operations. Other methods of changing the amplitude cause the step attenuator to autorange if necessary.

2. With amplitude fixed range disabled, amplitude ranging occurs at 1/2V, 1/4V, 1/8V, ... $1/2^{23}$ V with AM off and 1/4V, 1/8V, 1/16V, ... $1/2^{24}$ V with AM on.

Related Operations

Bright-Digit Edit Entry
Relative Function

## 2-24. Amplitude Units Conversion

The following information describes how to convert the displayed amplitude level from dBm to volts and volts to dBm. The output of the Generator does not change during these operations.

Command Syntax

Select Amplitude Function -- Select Unit

Summary

```
                          COMMAND                  NOTE

    Convert dBm to volts

        Local:  [AMPL] -- [MHz|V]                  1
                          [kHz|mV]
                          [Hz|uV]

        Remote: "AP"   -- "V"                      1
                          "MV"
                          "UV"
                          "NV"

    Convert volts to dBm

        Local:  [AMPL] -- [dB(m)]

        Remote: "AP"   -- "DB"
```

Example

Change the displayed amplitude of –10.0 dBm to its voltage equivalent.

```
Local:  [AMPL] [MHz|V]

Remote: "APV"
```

Note

1. Any voltage unit is accepted since the microprocessor automatically selects the units appropriate for the value being displayed.

Related Operations

Relative Function

## 2-25. Bright-Digit Edit Entry

The following information describes how to use a Bright-Digit Edit Entry to change an instrument parameter. The output frequency, amplitude and the modulation indices can be modified with this entry method.

The RF OUTPUT [ON/OFF] must be enabled for the Generator to produce an output. (See the reference material on RF OUTPUT [ON/OFF] Entry.)

Command Syntax

Select Display Field -- Position Bright Digit -- Change Bright-Digit Value

## Summary

| | | COMMAND | NOTES |
|---|---|---|---|
| Edit Frequency | | | |
| | Local: | [FREQ] -- EDIT [←]/[→] -- EDIT [↑]/[↓] | 1,2 |
| | Remote: | "FB" -- float "GZ" "MZ" "KZ" "HZ" -- "KF" float | 3,4,5 |
| Edit Amplitude | | | |
| | Local: | [AMPL] -- EDIT [←]/[→] -- EDIT [↑]/[↓] | 1,2 |
| | Remote: | "AB" -- float "DB" "V" "MV" "UV" "NV" -- "KA" float | 3,4,5 |
| Edit FM Deviation | | | |
| | Local: | [FM] -- EDIT [←]/[→] -- EDIT [↑]/[↓] | 1,2 |
| | Remote: | "DB" -- float "GZ" "MZ" "KZ" "HZ" -- "KD" float | 3,4,5 |
| Edit AM Depth | | | |
| | Local: | [AM] -- EDIT [←]/[→] -- EDIT [↑]/[↓] | 1,2 |
| | Remote: | "PB" -- float "PC" -- "KP" float | 3,4,5 |

## Example 1

Edit the displayed amplitude of 9.7 dBm to 10.0 dBm.

Local: Put the bright digit in the amplitude display by pressing [AMPL]. Select the least significant digit in that display by pressing EDIT [→] until the bright digit is on that digit. Increase the value of that digit by pressing EDIT [↑] three times.

Remote: "AB.1DB,KA3"

## Example 2

Edit the displayed FM Deviation from 5.0 kHz to 3.0 kHz.

Local: Put the bright digit in the FM display by pressing [FM]. Select the 1-kHz digit by pressing the EDIT [→] or EDIT [←] until the bright digit is on that digit. Decrease the value of that digit by pressing EDIT [↓] twice.

Remote: "DB1KZ,KD-2"

Notes

1. The bright-digit field remains selected until another display field is selected.

2. The bright-digit position is maintained for each of the four functions so that the bright digit can be moved from one display to another and back without losing its position in that previous display field.

3. float equals floating-point number.

4. In remote, the bright digit is positioned within a display field using a decade value and associated unit. Minus signs are ignored.

5. In remote, the bright digit is moved to the corresponding field and is increased or decreased by the signed integer following the "KF,KA,KD,KP" messages. The generic edit command "KB" may also be used to edit up or down the current bright-digit position. Positive integers do not require a sign.

Related Operations

Relative Function
Amplitude Fixed Range

## 2-26. Memory Entry

The following information describes how to use the memory function to store and recall front panel settings. The standard Generator has seven memory locations for storing settings that are lost if the power is turned off. With the Non-Volatile Memory option, the Generator has 50 memory locations that are retained for 2 years with the power off.

The sequence feature allows the operator to recall successive memory locations.

Command Syntax

Select Memory Function -- Enter Memory Location

Summary

| | COMMAND | NOTES |
|---|---|---|
| Store | | |
| Local: | [STO] -- [n] [n] | 1,2,3 |
| Remote: | "ST" -- int | 1,4 |
| Recall | | |
| Local: | [RCL] -- [n] [n] | 1,2,3 |
| Remote: | "RC" -- int | 1,4 |
| Sequence | | |
| Local: | [SEQ] | 5,6 |
| Remote: | "SQ" | 5 |

Example

Recall the Instrument Preset State (located in memory location 98). Change the frequency parameter to 302 MHz, then store the new front panel setting in memory location 06.

```
Local:  [RCL] [9][8]   EDIT [↑] [↑]  [STO] [0][6]

Remote: "RC98,KF2,ST6"
```

Notes

1. The memory locations available for operator use are 01 through 07. With the Non-Volatile Memory option, the available locations are 01 through 50. Additionally, the following special memory locations are available:

   Memory location 00 contains a backup-memory location. After a recall (or sequence) operation it contains the last front panel setting. After a store operation, it contains the data in the stored memory location before the store operation. Thus, a recall operation can be reversed by recalling location 00.

   Memory location 98 contains the Instrument Preset State.

   Memory location 99 contains the ~~the~~ present instrument state.

2. In local control, two data digits must be entered to specify the memory location. The recall or store is performed when the second digit is released.

3. The last memory location specified (used for sequence operations) is displayed while the [STO] or [RCL] button is pressed.

4. int equals unsigned integer.

5. The sequence operation recalls the next higher memory location, starting from the last memory location stored or recalled. No memory location need to be specified. When the highest location is reached, the sequence starts over again at location 01.

6. While [SEQ] is pressed, the next memory location number is displayed and the memory location is recalled. This key is repeating.

## 2-27. Modulation Entry

The following information describes how to preset the modulation index (AM depth or FM deviation), internal modulation rate (400 or 1000 Hz), and how to select the modulation source (internal and/or external).

The FUNCTION-DATA-UNIT method of selecting the modulation index is summarized in the following command syntax. The indices may also be modified using Bright-Digit Edit or Step Entry. Since there is only one modulation display, the modulation index displayed is determined by the last modulation FUNCTION key pressed.

Command Syntax

Select Function -- Enter Data -- Select Unit

## Summary

| | COMMAND | RANGE | RESOLUTION | NOTES |
|---|---|---|---|---|
| Set AM Depth | | | | |
| Local: | [AM] -- DATA -- [%] | 0 to 99% | 1% | 1,2 |
| Remote: | "AM" -- float -- "PC" | 0 to 99% | 1% | 1,3 |
| Set FM Deviation | | | | |
| Local: | [FM] -- DATA -- [MHz\|V]<br>[kHz\|mV]<br>[Hz\|uV] | 0.1 to 99.9 kHz | 3 digits | 1,4 |
| Remote: | "FM" -- float -- "GZ"<br>"MZ"<br>"KZ"<br>"HZ" | 0.1 to 99.9 kHz | 3 digits | 1,3,4 |

## Summary

| | COMMAND | NOTES |
|---|---|---|
| Select Modulation Rate | | |
| Local: | [400/1000] | 5 |
| Remote: | "MR" "0" or "1" | 6 |

## Summary

| | COMMAND | NOTES |
|---|---|---|
| Enable or Disable Modulation | | |
| Local: | [INT AM]<br>[INT FM]<br>[EXT AM]<br>[EXT FM] | 7,8 |
| Remote: | "AI" "0" or "1"<br>"FI" "0" or "1"<br>"AE" "0" or "1"<br>"FE" "0" or "1" | 9 |

## Example

Set the FM deviation to 5 kHz, the modulation rate to 400 Hz, and internally modulate the carrier.

Local: [FM] [5] [kHz] [INT FM] [400/1000]

Remote: "FM5KZ,MR0,FI1"

Notes

1. This operation does not change the Generator output unless the corresponding modulation is enabled.

2. Uncalibrated if peak amplitude exceeds +13 dBm or if AM depth exceeds 90% and AM is enabled.

3. float equals floating-point number.

4. Uncalibrated if FM is enabled and FM deviation is below 100 Hz or above (frequency -100 kHz)/3. ~~If the Low-Rate FM option is installed, the range of FM deviation is 0.01 to 9.99 kHz. With this option, the uncalibrated deviation range is below 10 Hz or above (frequency - 100 kHz)/30.~~

5. Toggles between 400 or 1000 Hz only. An indicator shows selected rate only if internal modulation is on.

6. "0" selects a modulation rate of 400 Hz; "1" selects 1000 Hz.

7. These are ON/OFF operations; any combination is allowed.

8. Two indicators 'EXT HI' and 'EXT LO' are lit when external modulation is on to indicate that the external modulation signal is 2% above or 2% below the nominal 1V peak input requirement.

9. "0" turns the modulation source off; "1" turns it on.

Related Operations

Bright-Digit Edit Entry
Step Entry

## 2-28. Relative Function

The following paragraphs describe how to change frequency and amplitude using the Relative mode. There are two steps:

1. Setting the reference

2. Changing the parameter relative to that reference

Setting the reference is done by setting the parameter to the desired value and then enabling the relative mode for that parameter. This causes the 'REL' indicator to light and the displayed value to be zero in the corresponding display. The Generator output does not change during these operations. In the relative mode, the usual means of changing the parameter may be used; i.e., FUNCTION-DATA-UNIT, Step, or Bright-Digit Edit Entry.

In the relative frequency mode, the actual frequency is the sum of the reference and the displayed frequency. The actual frequency may be displayed by pressing the [FREQ] key.

In the relative amplitude mode, the actual amplitude is the sum of the reference and the displayed amplitude when the reference and the displayed quantities have the same units. However, with mixed units (volts and dB), the actual amplitude is the voltage value scaled by the dB value. The actual amplitude may be displayed by pressing the [AMPL] key.

Command Syntax

Select Relative Function -- Enable or Disable

Summary

| | COMMAND | NOTE |
|---|---|---|
| Frequency | | |
| Local: | [SPCL] [2] — [0] or [1] | 1 |
| Remote: | "SP" "2" -- "0" or "1" | 1 |
| Amplitude | | |
| Local: | [SPCL] [3] — [0] or [1] | 1 |
| Remote: | "SP" "3" -- "0" or "1" | 1 |

Example

Set the amplitude to –15 dB$\mu$V; i.e., 15 dB below 1 microvolt.

Local: [AMPL] [1] [Hz|uV] [SPCL] [3] [1] [AMPL] [-] [1] [5] [dB(m)]

Remote: "AP1UV,SP31,AP-15DB"

Note

1. 1 enables the relative function; 0 disables the relative function.

Related Operations

Amplitude and Frequency Entry
Bright-Digit Edit Entry
Step Entry

## 2-29. RF OUTPUT ON/OFF Entry

The following information describes how to enable the output of the Generator using the RF OUTPUT [ON/OFF] key and the corresponding remote code.

Command Syntax

RF Output On/Off

Summary

| | COMMAND | NOTE |
|---|---|---|
| RF Output On | | |
| Local: | RF [ON/OFF] when 'RF OFF' is on | 1 |
| Remote: | "RO1" | 1 |
| RF Output Off | | |
| Local: | RF [ON/OFF] when 'RF OFF' is off | |
| Remote: | "RO0" | |

Notes

1. Turning the RF Output on resets the optional RPP circuitry if it has tripped.

### 2-30. Special Function Entry

The following information describes how to use the Special Function Entry to use the special operating functions of the Signal Generator. Table 2-4 lists the special functions available.

In addition to the Special Functions, there are three permanent use memory locations. Locations 00, 98, and 99 contain the backup, preset, and present instrument states, respectively. See paragraph 2-26 for more details.

The special function code is a two-digit number. The first digit indicates the classification of the special function, and the second digit specifies the particular special function.

The special function is executed when the second special function code digit is entered. There are ten classes of special functions. The special functions in the 0(n) and 1(n) class cause an action to be performed. Classes 2(n) through 9(n) cause an instrument state to change. The status of classes 2(n) through 9(n) appears (left to right) in the frequency display field when the [SPCL] key is pressed.

Command Syntax

Select Special Function -- Enter Special Function Code

| | COMMAND | NOTE |
|---|---|---|
| Local: | [SPCL] -- [n] [n] | |
| Remote: | "SP" -- int | 1 |

Example

Change the repeat rate of the EDIT and STEP keys to slow.

```
Local:  [SPCL] [7] [2]

Remote: "SP72"
```

Note

1. int equals unsigned integer.

Related Operations

Fixed Range
Relative Function

### 2-31. Status and Clear Entry

The Status entry allows you to interrogate the Generator for an explanation of either uncalibrated operation ('UNCAL' indicator is lit) or rejected entry operation (the 'REJ ENTRY' indicator in lit).

When either the 'UNCAL' or 'REJ ENTRY' indicator is lit, press and hold the [STATUS] key to display the Uncalibrated or Rejected Entry Error Code Message. These messages provide detailed information on the nature of the uncalibrated or rejected entry condition. Table 2-5 contains a list and explanation of all the Uncalibrated Error Code Messages. Table 2-6 contains a list and explanation of all the Rejected Entry Error Code messages.

**Table 2-5. UNCAL Error Codes**

| CODE | DESCRIPTION |
|---|---|
| 000 000 000 = | Indicates no UNCAL conditions |
| 001 000 000 = | FM deviation < 100 Hz (< 10 Hz with Option -651) |
| 002 000 000 = | FM deviation > (freq -100 kHz)/3 |
| *004 000 000 = | Excess FM deviation, main or reference PLL unlocked |
| 020 000 000 = | AM depth > 90% |
| *000 010 000 = | Main or reference PLL unlocked |
| 000 000 001 = | Level vernier below calibrated range or level < -137 dBm |
| 000 000 002 = | Peak (AM) amplitude > +13 dBm |
| *000 000 004 = | Amplitude unleveled |
| *000 000 010 = | Fixed-range level vernier at 0 |
| *000 000 020 = | Fixed-range level vernier at full scale |
| *000 000 040 = | RPP tripped |
| 000 000 100 = | Level below -137 dBm |
| 000 000 200 = | Level correction disabled |
| *000 000 400 = | RF output off |

**Table 2-6. REJect ENTRY Codes**

| CODE | DESCRIPTION |
|---|---|
| 001 000 000 = | FM deviation not between 0 and 99.9 kHz (9.99 kHz with Option -651) |
| 002 000 000 = | FM deviation Step not between 0 and 99.9 kHz (9.99 kHz with Option -651) |
| 004 000 000 = | AM depth not between 0 and 99% |
| 010 000 000 = | AM depth step not between 0 and 99% |
| 020 000 000 = | IEEE-488 command syntax error |
| 040 000 000 = | IEEE-488 input value out of range |
| 100 000 000 = | Special function requires IEEE option |
| 200 000 000 = | IEEE edit or step operation beyond allowed range |
| 000 001 000 = | Frequency not between 0.1 and 1050 MHz |
| 000 004 000 = | Frequency step not between 0 and 1050 MHz |
| 000 040 000 = | Invalid memory location |
| 000 100 000 = | Invalid data in memory |
| 000 200 000 = | Special function not allowed |
| 000 000 001 = | Output amplitude not between 10 nV and 2V |
| 000 000 002 = | Insufficient resolution for units conversion |
| 000 000 004 = | Units conversion to volts not allowed with reference in volts |
| 000 000 010 = | Units conversion to dB not allowed with reference in volts |
| 000 000 020 = | Amplitude step not between 0 and 166 dB or 0 and 1999V |
| 000 000 040 = | Units conversion on amplitude step not allowed |
| 000 000 100 = | Amplitude step and current amplitude display not in same units |

The [CLR LCL] key may be used to clear a partial DATA entry or clear the flashing 'REJ ENTRY' indicator. Press the [STATUS] key while an 'UNCAL' indication exists to display the Uncal Error Codes in three fields:

Flashing codes (denoted by *) indicate abnormal operation or aberrated output. Non-flashing codes indicate operation outside specified range.

Press the [STATUS] key while the 'REJ ENTRY' indication exists to display the Reject Entry error codes:

## 2-32. Step Entry

The following information describes how to use the Step Entry function to change an instrument parameter. The RF OUTPUT [ON/OFF] must be enabled for the Generator to produce an output. (See the reference material on RF OUTPUT [ON/OFF] Entry.)

Command Syntax

Select Step Function -- Enter Data -- Select Units -- Change Parameter

Summary

```
                   COMMAND          RANGE            RESOLUTION      NOTES

Frequency

    Local:  [FREQ][STEP]--DATA --[MHz|V]  --STEP [↑]/[↓]
                                 [kHz|mV]
                                 [Hz|uV]
                           0 to 1050 MHz   10 Hz

    Remote: "FS"          --float--"GZ"    --"FU"/"FD"
                                 "MZ"
                                 "KZ"
                                 "HZ"
                           0 to 1050 MHz   10 Hz             1,2

Amplitude

    Local: [AMPL][STEP]--DATA --[dB(m)]  -- STEP [↑]/[↓]
                                [MHz|V]
                                [kHz|mV]
                                [Hz|uv]
                           0 to 166 dB     0.1 dB
                           0 nV to 999 V   3 digits

    Remote: "LS"         --float--"DB"     --"LU"/"LD"
                                "V"
                                "MV"
                                "UV"
                                "NV"
                           0 to 166 dB     0.1 dB            1,2
                           0 nV to 999V    3 digits          1,2

FM deviation

    Local:  [FM][STEP]   --DATA --[MHz|V]  -- STEP [↑]/[↓]
                                 [kHz|mV]
                                 [Hz|uV]
                           0 to 99.9kHz    3 digits          3
```

```
    Remote: "DS"        --float--"GZ"     --"DU"/"DD"
                                 "MZ"
                                 "KZ"
                                 "HZ"
                           0 to 99.9kHz    3 digits        1,2,3

AM depth

    Local:  [AM][STEP]  —DATA --[%]       -- STEP [↑]/[↓]
                           0 to 99%        1%

    Remote: "PS"        —float—"PC"       —"PU"/"PD"
                           0 to 99%        1%              1,2
```

Example

Recall the Instrument Preset State: [RCL] [9] [8]. Step the displayed frequency of 300 MHz, in 10-MHz steps, to 270 MHz.

```
Local:  [FREQ]   [STEP]   [1] [0] [MHz|V]   [↓] [↓] [↓]STEP

Remote: "FS10MZ,FD,FD,FD"
```

Notes

1. float equals floating-point number.

2. Entering the step size from IEEE-488 does not select the step function. For example, "FS10MZ" does not select the step function; "FD" or "FU". The generic step up/down commands "SU" and "SD" may be used to step the current step function. must be used to select the frequency step function.

3. If the Low-Rate FM option is installed, the range of FM deviation steps is 0 to 9.99 kHz.

Related Operations

Relative Function

## 2-33. REMOTE OPERATION (IEEE-488 INTERFACE)

The following paragraphs describe how to operate the Generator using the IEEE-488 Interface option. This option allows you to program the Generator and operate instrument functions via the IEEE-488 bus (with the exception of the front panel POWER switch and the rear panel REF INT/EXT switch). The IEEE-488 Interface option also provides additional programming features not accessible from the front panel.

The rest of this section is divided into two parts: the first part describes how to set up the Generator for operation on the IEEE-488 bus and gives some typical programming examples. The first part also includes a complete list of the programming commands recognized by the Generator software.

The second part describes the implementation of the IEEE-488 interface and programming features that are accessible only from the IEEE-488 Interface. The second part includes typical timing data, provided as an aid to system programmers. This information can assist in writing programs that have greater speed and efficiency.

The Generator can be used with any IEEE-488 controller in the normal addressed mode. The following two additional modes are available for operation without a controller:

Listen-only mode
Talk-only mode

In the listen-only mode, the Generator responds to all data messages on the IEEE-488 bus. In the talk-only mode, the Generator sends commands on the IEEE-488 bus to program another 6060A Generator (or a 607xA with some restrictions).

### 2-34. Setting Up the IEEE-488 Interface

Figure 2-5 shows a 6060A Signal Generator connected to a 1722A via the IEEE-488 bus.

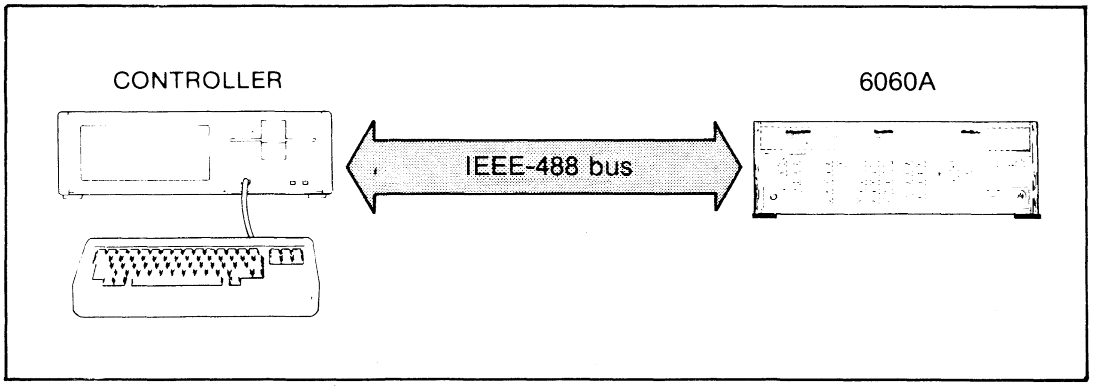



**Figure 2-5. 6060A Signal Generator Connected to a 1722A**

Use the following procedure to set up the Generator with the IEEE-488 Interface option:

1. Connect a standard IEEE-488 cable between the Generator and the IEEE-488 device.

*NOTE*

*The IEEE-488 Interface signal SHIELD (pin 12) can be disconnected (when using an IEEE-488 cable with a metallic hood) from instrument ground. To do this, use the left most address switch (as viewed from the rear panel).*

2. Select the IEEE-488 address and mode as follows:

   a. For control of the Generator with a controller, set both the LISTEN ONLY and TALK ONLY switches to 0 (down). Set switches a1 through a5 to the desired address. For example, for an address of 1, set switches a2, a3 a4, and a5 to 0 (down), and set switch a1 to 1 (up).

   b. For talk-only operation, set the TALK ONLY switch to 1 (up).

   c. For listen-only operation, set the LISTEN ONLY switch to 1 (up) and the TALK ONLY switch to 0 (down).

3. Verify the address and mode:

a. Press the [SPCL] and the [1][0] keys. Verify that the selected address appears in decimal in the Frequency display field.

b. If the talk-only mode or listen-only mode has been selected, "to" or "lo" appears to the left of the address in the Frequency display field.

*NOTE*

*The address switches are continuously monitored except when in remote. The TALK ONLY and LISTEN ONLY switches are only read when the Generator is powered on.*

### 2-35. Programming Commands

After the address and mode have been set, the Generator can be programmed by an IEEE-488 controller or from another Generator. Tables 2-7 and 2-8 and the programming examples following them provide the basic information on how to program the Generator.

More details about the commands can be found in two places. Commands that are available from the front panel are described in the first part of this section. Those commands that are only available from the IEEE-488 Interface are described in the Commands Descriptions paragraphs later in this section of the manual.

Table 2-7 is an index for the IEEE-488 Commands used in Table 2-8. This index is a list of the command headers according to function. Table 2-8 lists all the remote commands that are recognized by the Generator. The commands are listed alphabetically by function.

### 2-36. Programming Examples

The following three examples show how to use the IEEE-488 bus and use a variety of controllers to program the Generator. In the first example, a Fluke 1722A Controller is used to program the Generator. In the second example, two Generators are configured to track each other in frequency. In the third example, a 1722A is used to program the Generator with the frequency step up controlled by the trigger command.

**Table 2-7. Index of IEEE-488 Commands**

| FUNCTION | COMMAND HEADERS |
|---|---|
| Amplitude Entry | AP, SP3x, RA, SP8x, SP9x |
| Binary Learn Commands | LI, LM |
| Clear Commands | CB, CE, CL |
| Edit Entry | AB, DB, FB, PB, KB, KA, KD, KF, KP |
| Frequency Entry | FR, SP2x, RF |
| Interface Mode Commands | EM, RM, TM, VM, UM, @ |
| Interrogate Commands | ID, IE, II, IO, IR, IT, IU, IV |
| Memory Entry | RC, ST, SQ |
| Modulation Entry | AM, AE, AI, FM, FE, FI, MR, MF |
| Monitor Commands | IB, OB, OD, RB, RW, DW, WB, WW, XA, XB, XD, XR |
| RF ON/OFF Entry | RO |
| Special Function Entry | SP |
| SRQ Commands | IM, SM, XF |
| Step Entry | FS, LS, PS, DS, SU, SD, FU, FD, LU, LD, PU, PD, DU, DD |
| Trigger Commands | CT, TR |

**Table 2-8. IEEE-488 Commands**

| COMMAND USE | COMMAND HEADER | COMMAND NUMERIC | COMMAND SUFFIX | COMMENTS |
|---|---|---|---|---|
| AMPLITUDE ENTRY | | | | |
| Program Amplitude | AP | float | <br><br>V<br>MV<br>UV<br>NV<br>DB | Program displayed amplitude<br>in units of:<br>volts<br>millivolts<br>microvolts<br>nanovolts<br>dB or dBm |
| Convert Amplitude Units | AP | none | <br>V<br>MV<br>UV<br>NV<br>DB | Change amplitude units to:<br>volts<br>volts<br>volts<br>volts<br>dB ~~or dBm~~ |
| Relative Amplitude | SP | 30/31 | none | Disable/enable relative amplitude operation |
| Relative Amplitude | RA | 0/1 | | disable/enable relative amplitude operation. |
| Level Correction | SP | 80<br>81<br>82 | none | Enable all level correction.<br>Disable all level correction.<br>Disable attenuator correction. |
| Amplitude Fixed Range | SP | 90/91 | none | Disable/enable amplitude fixed-range operation. |
| BINARY LEARN COMMANDS | | | | |
| Store a Front Panel Setup | LI | int | string | The Generator stores the string into the memory location specified by int. See the Command Description paragraph for decoding the learn string. |
| Send a Front Panel Setup | LM | int | none | The Generator responds with the contents of the memory location specified by int. See the Command Descriptions paragraph for decoding the learn string. |
| CLEAR COMMANDS | | | | |
| Clear IEEE-488 Output Buffer | CB | none | none | Clears IEEE-488 output buffer. |
| Clear error | CE | none | none | Clears the IEEE-488 rejected entry status. |
| Device Clear | CL | none | none | Clears the instrument state. |
| EDIT ENTRY | | | | |
| Position Amplitude | AB | float | V<br>MV | Position the bright digit in the AMPLITUDE display with the stated resolution. For |

Table 2-8. IEEE-488 Commands (cont)

| | | | | |
|---|---|---|---|---|
| Bright Digit | | | UV<br>NV<br>DB | example, enter "AB10MV" for 10 mV resolution. |
| Position FM Bright Digit | DB | float | GZ<br>MZ<br>KZ<br>HZ | Position the bright digit in the FM Display with the stated resolution. For example, enter "DB1KZ" for 1-kHz resolution. |
| Position Frequency Bright Digit | FB | float | GZ<br>MZ<br>KZ<br>HZ | Position the bright digit in the FREQUENCY display with the stated resolution. For example, enter "FB1MZ" for 1-MHz resolution. |
| Position AM Bright Digit | PB | float | PC | Position the bright digit in the AM display with the stated resolution. For example, enter "PB1PC" for a 1% resolution. |
| Edit | KB | float | none | Edit the current bright digit by float counts. |
| Edit Amplitude | KA | float | none | Move the bright digit to the AMPLITUDE display and edit amplitude by float counts. |
| Edit FM | KD | float | none | Move the bright digit to the FM display and edit FM by float counts. |
| Edit Frequency | KF | float | none | Move the bright digit to the FREQUENCY display and edit frequency by float counts. |
| Edit AM | KP | float | none | Move the bright digit to the AM display and edit AM by float counts. |
| FREQUENCY ENTRY | | | | |
| Frequency Programming | FR | float | <br>GZ<br>MZ<br>KZ<br>HZ | Program displayed frequency in units of:<br>gigahertz<br>megahertz<br>kilohertz<br>hertz |
| Relative Frequency | SP | 20/21 | none | Disable/enable relative frequency operation. |
| Relative Frequency | RF | 0/1 | none | Alternate programming command for disable/enable relative frequency operation. |
| INTERFACE MODE COMMANDS | | | | |
| Error Mode | EM | 0/1 | none | Disable/enable the clear error mode. If disabled, the IEEE-488 error status is cleared only when interrogated. If enabled, the error status is cleared when a new message is processed. |

Table 2-8. IEEE-488 Commands (cont)

| | | | | |
|---|---|---|---|---|
| Record Mode | RM | 0/1 | none | Disable/enable the record mode. If disabled, the message unit is a command. If enabled, a message unit is a record. The message unit is the smallest group of characters that the Generator processes. |
| Record Terminator Mode | TM | 0/1 | none | Selects the LF/CR character as the record terminator. The record terminator is used on input in the record mode and is sent following all output. |
| Output Valid Mode | VM | 0/1 | none | Disable/enable the output valid mode. In the output valid mode, the Generator waits to process commands until the RF output has become valid. |
| Unbuffered Mode | UM | 0/1 | none | Disable/enable the unbuffered mode. If disabled, all input is buffered. If enabled, only one message unit is buffered. |
| "@" Modes | @ | int | none | The "@" command may be used as an alternate method of programming interface modes. |
| INTERROGATE COMMANDS | | | | |
| Instrument Identification | ID | none | none | The Generator responds with its model number, for example, "6060A". |
| Elapsed Time Indicator | IE | none | none | If the Non-Volatile Memory option is installed, the Generator responds with the total operating time since the Generator was manufactured. |
| Interface Modes | II | none | none | Interrogate the interface modes selected. The Generator responds with an unsigned integer. |
| Option Loading | IO | none | none | Interrogate the option loading. The Generator responds with the message: d1, d2, d3<br>d1 is the instrument code.<br>d2 is the digital and synthesizer options.<br>d3 is the output options.<br>See the Interrogate Commands paragraphs for details. |
| Rejected Entry | IR | none | none | Interrogates the rejected entry error codes. The Generator responds with three octal fields: "AAAAA,BBBBB,CCCCC". See Table 2-6 for a list of rejected entry error codes. |
| Self Test | IT | none | none | Interrogates the results of the self tests. The Generator responds with the self-test results. See Section 4D for self-test codes. |

**Table 2-8. IEEE-488 Commands (cont)**

| | | | | |
|---|---|---|---|---|
| UNCAL | IU | none | none | Interrogates the uncalibrated output error codes. The Generator reponds with three octal fields: "AAAAA,BBBBB,CCCCC". See Table 2-5 for a list of uncal error codes. |
| Software Version | IV | none | none | Interrogate the software version. The Generator responds with the status message: "Vxx.x" where x's are decimal digits representing the current software revision level. |
| MEMORY ENTRY | | | | |
| Recall | RC | int | none | Recall the front panel setup stored at the memory location specified by int. |
| Store | ST | int | none | Store the current front panel setup at the memory location specified by int. |
| Sequence | SQ | none | none | Sequence (recall) to the next higher memory location. |
| MODULATION ENTRY | | | | |
| Program AM | AM | float | PC | Program AM depth in percent. |
| External AM | AE | 0/1 | none | Disable/enable external AM modulation. |
| Internal AM | AI | 0/1 | none | Disable/enable internal AM modulation. |
| Program FM | FM | float | <br>GZ<br>MZ<br>KZ<br>HZ | Program FM deviation in units of:<br>gigahertz<br>megahertz<br>kilohertz<br>hertz |
| External FM | FE | 0/1 | none | Disable/enable external FM modulation. |
| Internal FM | FI | 0/1 | none | Disable/enable internal FM modulation. |
| Program Mod Freq | MR | 0/1 | none | Program modulation frequency to 400 Hz/1000 Hz. |
| Program | MF | float | <br>GZ<br>MZ<br>KZ<br>HZ | Program modulation frequency in units of:<br>gigahertz<br>megahertz<br>kilohertz<br>hertz |
| MONITOR COMMANDS | | | | |
| Input Bit | IB | none | BIT Desig-nator | Respond with the value of the designated hardware bit. |
| Output Bit | OB | 0/1 | BIT Desig-nator | Set the designated hardware bit to 0 or 1. |

Table 2-8. IEEE-488 Commands (cont)

| | | | | |
|---|---|---|---|---|
| Output Dac | OD | int | DAC Desig-nator | Set the value of the designated hardware DAC to the value specified by int. |
| Read Byte | RB | int | none | Read the value of the addressed byte. The Generator responds with an unsigned integer. |
| Read Word | RW | int | none | Read the value of the addressed word. The Generator responds with an unsigned integer. |
| Define Write Address | DW | int | none | Defines the address to be used by the write byte/word commands. |
| Write Byte | WB | int | none | Write int into the address specified with the define write address command. |
| Write Word | WW | int | none | Write int into the address specified with the define write address command. |
| Read Attenuation | XA | none | none | Read the current attenuation. The Generator responds with an unsigned integer. |
| Write Attenuation | XB | none | none | Change attenuation to 6dB times the unsigned integer. The integer can be 0 to 23. |
| Set Frequency Direct | XD | float | GZ<br>MZ<br>KZ<br>HZ | Set the frequency hardware directly to the specified synthesizer frequency. |
| RF Output | XR | 0/1 | none | "XR0" programs all attenuation. "XR1" restores attenuation to its previous state. |
| RF ON/OFF ENTRY | | | | |
| RF Output | RO | 0/1 | none | Turn RF output off/on. |
| SPECIAL FUNCTION ENTRY | | | | |
| Special Functions | SP | 00<br>02<br>03<br>04<br>07/08<br>09<br>10<br>11<br>12/13<br>14<br>15<br>20/21<br>30/31<br>70<br>71<br>72<br>80<br>81<br>82<br>83-86<br>90/91 | | Clears all special functions<br>Initiates self test<br>Display check<br>Key check<br>Set/reset SRQ<br>Display S/W rev and instr ID<br>Display IEEE-488 address<br>Display self-test results<br>Turn on/off display<br>Initialize memory<br>Latch test<br>Disable/enable relative freq<br>Disable/enable relative ampl<br>Medium key repeat rate<br>Fast key repeat rate<br>Slow key repeat rate<br>Enable all level correction<br>Disable all level correction<br>Disable attenuator correction<br>Program alternate 24dB attens<br>Disable/enable ampl fixed ring |

**Table 2-8. IEEE-488 Commands (cont)**

| | | | | |
|---|---|---|---|---|
| SRQ COMMANDS | | | | |
| Interrogate SRQ Mask | IM | none | none | Interrogate the SRQ mask. The Generator responds with the decimal value of the SRQ mask. |
| Set SRQ | SM | int | none | The SRQ mask is set to int. |
| Local Operation Alert Mode | XF | 0/1 | none | Disable/enable a mode to set SRQ each time a local entry is made. This SRQ is enabled by setting the front panel bit in the SRQ mask. |
| STEP ENTRY | | | | |
| Program FREQ STEP Size | FS | float | <br>GZ<br>MZ<br>KZ<br>HZ | Program frequency step size in units of:<br>gigahertz<br>megahertz<br>kilohertz<br>hertz |
| Program AMPL STEP Size | LS | float | <br>V<br>MV<br>UV<br>NV<br>DB | Program amplitude step size in units of:<br>volts<br>millivolts<br>microvolts<br>nanovolts<br>dB or dBm |
| Program AM STEP Size | PS | float | PC | Program AM step size in percent. |
| Program FM STEP Size | DS | float | <br>GZ<br>MZ<br>KZ<br>HZ | Program FM step size in units of:<br>gigahertz<br>megahertz<br>kilohertz<br>hertz |
| Step Up/Down | SU/SD | none | none | Step the currently selected step function up/down one step. |
| Step Up/Down Frequency | FU/FD | none | none | Change the current step function to frequency and step frequency up/down one step. |
| Step Up/Down Amplitude | LU/LD | none | none | Change the current step function to amplitude and step amplitude up/down one step. |
| Step Up/Down AM | PU/PD | none | none | Change the current step function to AM and step AM up/down one step. |
| Step Up/Down FM | DU/DD | none | none | Change the current step function to FM and step FM up/down one step. |
| TRIGGER COMMANDS | | | | |
| Configure Trigger | CT | string | none | Configures the trigger. Each time a trigger command or a group execute trigger interface message is received, the Generator executes the string of commands. The string record must end with a record terminator. |

**Table 2-8. IEEE-488 Commands (cont)**

| | | | | |
|---|---|---|---|---|
| Trigger | TR | none | none | Trigger command. Equivalent to the group execute interface message. Upon processing the trigger command, the Generator executes the string, which has been preprogrammed with the configure trigger command. |

## 2-37. PROGRAMMING EXAMPLE 1

Use the following procedure to program the Generator with a Fluke 1722A Instrument Controller to this state:

| | |
|---|---|
| Frequency | 210 MHz |
| Amplitude | 6 dBm |
| Modulation Freq. | 1000 Hz |
| FM | 5 kHz |
| Internal FM | ON |
| AM | 15% |
| External AM | ON |

1. Connect the Generator to the Controller with an IEEE-488 cable.
2. Set the address switch of the Generator as follows (as viewed from the rear of the instrument):

   00000010

3. Enter the following program into the Controller:

```
1   ! Fluke 1722A BASIC program to control a 6060A.
2   ! The Address of the 6060A is 2.
3   A% = 2%
10  ! Clear the 6060A so that it is in a known state.
15  INIT PORT 0
20  REMOTE @A% \ CLEAR @A%
100 ! SET THE 6060A.
110 PRINT @A%, "FR210MZ,AP6DB,MR1,FM5KZ,FI1,AM15PC,AE1"
999 END
```

4. Run the program by typing on the Controller "RUN <RETURN>".

## 2-38. PROGRAMMING EXAMPLE 2

The 6060A Signal Generator can be connected to an other 6060A Signal Generator in a master-slave configuration. In the following example, two Generators are configured to track each other in frequency. This configuration may be used to track frequency, amplitude, AM, or FM.

1. Connect two 6060A Signal Generators together with an IEEE-488 cable.
2. Set the rear panel address switch of the first Generator (talker) as follows:

   00100000

3. Set the rear panel address switch of the second Generator (listener) as follows:

   01000000

4. Manually program the talker Generator as follows:

| FUNCTION | VALUE | KEY SEQUENCE |
|---|---|---|
| Frequency | 210 MHz | [FREQ] [2] [1] [0] [MHz\|V] |
| Step Function | Frequency | [FREQ] [STEP] |
| Frequency Step | 1.25 kHz | [1] [.] [2] [5] [kHz\|mV] |

5. Manually program the listener Generator as follows:

| FUNCTION | VALUE | KEY SEQUENCE |
|---|---|---|
| Frequency | 195 MHz | [FREQ] [1] [9] [5] [MHz\|V] |
| Step Function | Frequency | [FREQ] [STEP] |
| Frequency Step | 1.24 kHz | [1] [.] [2] [4] [kHz\|mV] |

6. On the talker Generator, press the [ ↑ ] STEP or [ ↓ ] STEP keys. Each time the key is pressed, the frequency of both Generators increases or decreases by 1.24 kHz (the Frequency Step) at frequencies 15 MHz apart.

Different functions on each Generator can be programmed to track in the master-slave configuration. In other words, while the master Generator can be programmed to step increase 25 kHz FM, the Slave Generator can be programmed to step 25% AM.

*NOTE*

*To use the step function feature for other functions, change the step function on the Generators to the desired functions.*

## 2-39. PROGRAMMING EXAMPLE 3

In the following example, the Generator is programmed by a Fluke 1722A Controller (via the IEEE-488 bus) to the same state as in Programming Example 1. Additionally, the frequency step size is set to 1.24 kHz, and the trigger buffer is programmed to execute the step up command when the trigger command is received. The SRQ mask of the Generator is set to generate an SRQ when the RF output has settled and the Generator is ready for more input from the bus.

The program then enters a loop where it waits for the ready SRQ, sends the GET (group execute trigger) interface message to step up the frequency, and waits again. At this time you should do the following:

1. Connect the Generator to the Controller with an IEEE-488 cable.

2. Set the rear panel address switch of the Generator as follows:

   00000111

3. Enter the following program into the Controller:

```
1   ! Fluke 1722A BASIC program to control a 6060A.
2   ! The address of the 6060A is 7.
3   A% = 7%
10  ! Clear the 6060A so that it is in a known state.
15  INIT PORT 0
20  REMOTE @A% \ CLEAR @A%
100 ! Set the 6060A.
110 PRINT @A%, "FR210MZ,AP6DB,MR1,FM5KZ,FI1,AM15PC,AE1"
120 ! Set the frequency step, output valid mode,
121 ! and configure the trigger buffer.
130 PRINT @A%, "FS1.24KZ,VM1,CTSU"
140 ! Set the SRQ mask to enable "output valid" SRQ
150 PRINT @A%, "SM16"
160 ! Wait for above commands to finish processing
170 WAIT 1000 \ S% = SPL (A%)
180 ! Trigger the first step up
190 TRIG @A%
300 ! Wait for SRQ
310 ON SRQ GOTO 800
320 WAIT FOR SRQ
800 OFF SRQ
810 ! Check the serial poll response
820 S% = SPL(A%)
830 IF (S% AND 64%+16%) < > 80% THEN PRINT S%;" Bad Serial Poll Response"
840 ! Trigger the next step up
850 TRIG @A%
860 ! Resume operation-- waiting for next SRQ
870 RESUME 300
999 END
```

4. Run the program by typing on the Controller "RUN <RETURN>".

## 2-40. Interface Functions

The Generator implements a subset of interface functions defined by the IEEE Standard 488-1978. Table 2-9 summarizes the interface functions implemented. This section describes the operation of the Generator in response to interface messages associated with each interface function.

**Table 2-9. IEEE-488 Interface Functions List**

| FUNCTION | DESCRIPTION |
|---|---|
| SH1 | Complete source handshake capability |
| AH1 | Complete acceptor handshake capability |
| T5 | Basic talker, Talk only, Serial poll, Unaddressed if MLA |
| TE0 | No extended talker capability |
| L3 | Basic listener, Listen only, Unaddressed if MTA |
| LE0 | No extended listener capability |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local capability |
| PP0 | No parallel poll capability |
| DC1 | Complete device clear capability |
| DT1 | Complete device trigger capability |
| C0 | No controller capability |
| E2 | Tri-state drivers |

## 2-41. Address Mode

In the address mode, the Generator may be operated from local (using the Front Panel keys) or from remote (using the IEEE-488 Interface). The following paragraphs describe the operation of the Generator in both states and transitions between the states.

The available IEEE-488 messages and their descriptions for the address mode of operation are presented in Table 2-10.

## 2-42. LOCAL OPERATION

The Generator powers up in the local mode. When in local mode, the following conditions are present:

The front panel indicator 'REM', is not lit.

Device trigger (GET), device clear (DCL), and selected device clear (SDC) interface messages are ignored.

All device dependent messages are ignored.

If the data output was requested while the Generator was in the remote mode, the data output of a talker may be sent.

## 2-43. GOING FROM LOCAL TO REMOTE

The Generator switches from local to remote when the "my listen address message" (MLA) is received, and the Remote Enable (REN) signal is true.

**Table 2-10. IEEE-488 Address Mode Message Descriptions**

| MESSAGE | DESCRIPTION |
|---|---|
| pon<br>Power-On | |
| Talker Operation | When powered up, the Generator generates a Power-On message (pon) and clears its output buffer. The Generator is not addressed to talk when powered up. |
| Listener Operation | The Generator is not addressed to listen when the power is turned on. |
| Service Request Operation | The state of the Service Request (SRQ) signal on pon is determined by the SRQ mask. If the Non-volatile Memory option is installed, the SRQ mask is the same as when the power was removed. Therefore, if the SRQ mask enables the power on, output valid, or ready SRQs, the SRQ signal will be true during pon. If the Non-Volatile Memory option is not installed, the SRQ signal will not be true. |
| MTA<br>My Talk Address | |
| Talker Operation | The Generator is addressed to talk upon receipt of the MTA message. The front panel 'ADDR' indicator is lit while the Generator is addressed to talk. |
| Listener Operation | The Generator unlistens when the MTA message is received. |
| MLA<br>My Listen Address | |
| Talker Operation | The Generator untalks when the MLA message is received. |
| Listener Operation | The Generator is addressed to listen when the MLA message is received. The front panel 'ADDR' indicator of the Generator is lit while the Generator is addressed to listen. |
| Data | |
| Talker Operation | The Generator sends data to the IEEE-488 bus only when requested by a programming data message. Message formats are described in the Command Description paragraphs. An End of Record (EOR) character is sent with EOI asserted following all outputs. The EOR character is either a carriage return or a line feed, depending on the setting of the terminator mode. The parity bit is always zero. Multiple output requests are buffered until the buffer is full. Processing of programming data messages is stopped until the buffer is no longer full. The buffer can be cleared with the Clear Buffer command ("CB"). The buffer is also cleared on power up (pon), with a Clear Command ("CL"), or with a Device Clear interface message (DCL or SDC). |
| Listener Operation | Command syntax, error processing, and input buffer overflow are described in the paragraphs on Command Processing. Refer to Table 2-8 for a list of IEEE-488 commands that are recognized by the Generator. |

Table 2-10. IEEE-488 Address Mode Message Descriptions (cont)

| MESSAGE | DESCRIPTION |
|---|---|
| IFC<br>Interface Clear | |
| Talker Operation | The Generator untalks and unlistens when the IFC message is received. |
| Listener Operation | The Generator unlistens and untalks when the IFC message is received. |
| OTA<br>Other Talk Address | |
| Talker Operation | The Generator untalks when the OTA message is received. |
| SPE<br>Serial Poll Enable | |
| Talker Operation | After receiving the SPE message, the Generator responds with the serial poll status byte, if addressed to talk. |
| SPD<br>Serial Poll Disable | |
| Talker Operation | After receiving the SPD message, the Generator resumes normal talk operation. |
| ULA<br>Unlisten Address | |
| Listener Operation | The Generator unlistens when the ULA message is received. |
| RSV<br>Request Service | |
| Service Operation | The front panel SRQ indicator is lit when the rsv message is sent. The Generator may request service for several reasons. Each reason for service request can be individually masked with the set mask command ("SM"). The service request mask can be interrogated with the interrogate mask command ("IM"). |
| DCL<br>Device Clear | |
| Clear Operation | The DCL message is ignored when in local. When the DCL message is received (during remote operation) the Generator is cleared. Any characters in the input buffer are cleared followed by the same operation as the clear command ("CL"). The operation of the DCL message is identical to the operation of the selected device clear (SDC) message. The cleared state of the Generator is described in the paragraphs on Power-On Conditions. |

**Table 2-10. IEEE-488 Address Mode Message Descriptions (cont)**

| MESSAGE | DESCRIPTION |
|---|---|
| SDC Selected Device Clear | |
| Clear Operation | The SDC message is ignored during local operation. When the SDC message is received (during remote operation), the Generator is cleared. Any characters in the input buffer are cleared followed by the same operation as the clear command ("CL"). The operation of the SDC message is identical to the operation of the device clear (DCL) message. The cleared state of the Generator is described in the paragraphs on Power-On Conditions. |
| GET Group Execute Trigger | |
| Trigger Operation | The GET message is ignored during local operation. When the GET message is received (during remote operation), the Generator executes a command string that has been preprogrammed with the Configure Trigger command ("CT"). The operation of the GET message is identical to the operation of the Trigger ("TR") command. |
| Undefined IEEE-488 Commands | |
| | All undefined IEEE-488 commands are acknowledged by the Generator handshake sequence, but no action is taken. |

## 2-44. REMOTE OPERATION

When in the remote mode, the following conditions are present:

The front panel REM indicator is lit.

Device trigger (GET), device clear (DCL), and selected device clear (SDC) interface messages are processed.

All device-dependent messages are processed during the remote mode.

## 2-45. GOING FROM REMOTE TO LOCAL

The Generator switches from remote to local mode in one of the following ways: The IEEE-488 Go To Local (GTL) message is received, the remote enable signal REN is false, or a Return To Local (RTL) message is generated by pressing the front panel [CLR|LCL] key (if the Generator is not in the local lockout mode).

The Generator enters the local lockout mode when the Local Lockout message (LLO) is received. The Generator exits the local lockout mode to the local mode when REN is false.

When switching from remote to local, unprocessed commands in the input buffer are processed until the input buffer is cleared or a front panel entry is made. Switching to local has no effect on the contents of the output buffer.

### 2-46. Talk-Only Mode

Figure 2-6 shows two 6060A connected together with the IEEE-488 Bus.

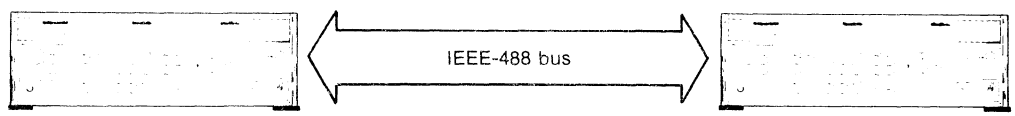



**Figure 2-6. 6060A IEEE-488 Bus Connected to a 6060A IEEE-488 Bus**

To select the talk-only mode, set the TALK ONLY address switch to 1 (up). If the talk-only address switch and the listen-only address switch are set to 1, the talk-only mode is selected.

In the talk-only mode, the listener, remote/local, service request, device clear, and device trigger interface functions do not apply.

If the talk-only mode is selected, the Generator is always addressed to talk and the front panel 'ADDR' indicator is always lit. The Step Up ("SU") or Step Down ("SD") message is sent when the [ ↑ ] STEP or [ ↓ ] STEP front panel keys are pressed. This output is not buffered and if no listener is connected to the IEEE-488 Interface, no output will be sent. A carriage return followed by line feed (with the EOI signal true) are always sent as the end of record.

### 2-47. Listen-Only Mode

To select the listen-only mode, set the LISTEN ONLY address switch to 1 (up). If the talk-only address switch and the listen-only address switch are set to 1, the talk-only mode is selected.

If the listen-only mode is selected, the Generator is always addressed to listen, and the front panel 'ADDR' indicator is always lit. The Generator listens and responds to all data messages on the IEEE-488 Interface. The response to data messages is the same as in the addressed mode of operation except that requests for talker output are ignored.

In the listen-only mode, the talker, remote/local, service request, device clear, and device trigger interface functions do not apply.

### 2-48. Command Syntax

The Generator IEEE-488 bus commands alphabet consists of the letters A through Z (upper and lower case letters are treated equally), digits 0 through 9, and the following special characters:

@ . , ; + - CR LF

Spaces, tabs characters, and the parity bit are ignored.

The IEEE-488 commands for the Generator consist of the following three parts:

Header
Numeric
Suffix

The header is always required, but the numeric and suffix may be optional. This rule gives the following four possible combinations:

⟨HEADER⟩
⟨HEADER⟩ ⟨NUMERIC⟩
⟨HEADER⟩ ⟨NUMERIC⟩ SUFFIX⟩
⟨HEADER⟩ ⟨SUFFIX⟩

Multiple commands may be separated with one of the end of string (EOS) characters ";" or ",". Use of EOS characters facilitates recovery in the event of a syntax error and will also enhance readability.

## 2-49. COMMAND HEADER SYNTAX

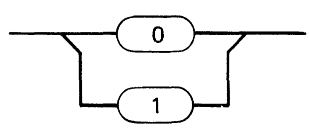
The command header is a two alpha-character string. A list of the IEEE-488 command headers used on the Generator is presented in Table 2-8. The header determines the syntax of the numeric and suffix as listed in the table.

## 2-50. NUMERIC DATA SYNTAX

There are four types of numeric data: Boolean, unsigned integer, floating point, and trigger string. The following paragraphs describes each of the four numeric data formats. A syntax diagram is included for each format.

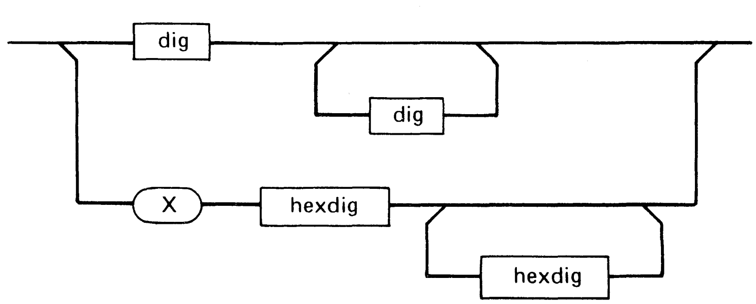
1. Boolean

   Boolean numeric data must be either a "0" or a "1". All other characters will result in a syntax error.



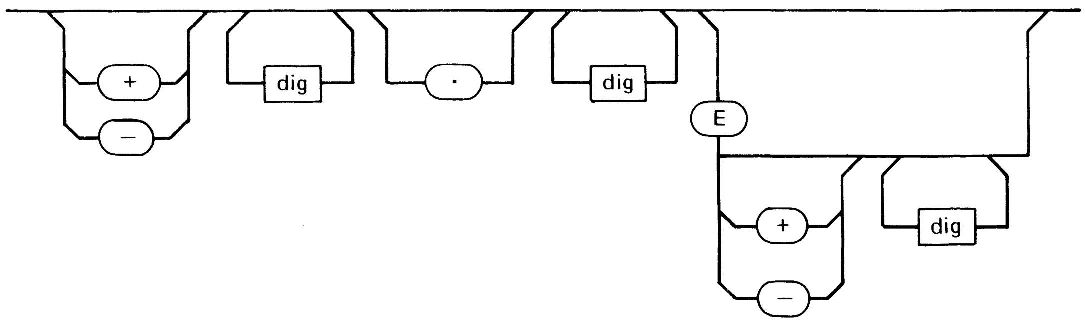

2. Unsigned Integer

   Unsigned integers may be specified in decimal or in hexadecimal. Any number of decimal digits are accepted. However, values greater than 65,535 are rejected. Hexadecimal numbers are preceded by an "X". Only 4 hexadecimal digits are accepted. Specifying a number in hexadecimal for the read word and read byte commands causes the response to be sent in hexadecimal. Decimal digits may be the numerals 0 through 9. Hexedecimal digits may be the hexadecimal digits 0 through F.



3. Floating Point

The floating-point numeric data format is the most flexible format. Digits may be the numerals 0 through 9. Any number of digits are accepted for both the number and the exponent. However, numbers greater than 2,147,483,629 are truncated, and exponents greater than 32,749 are rejected.

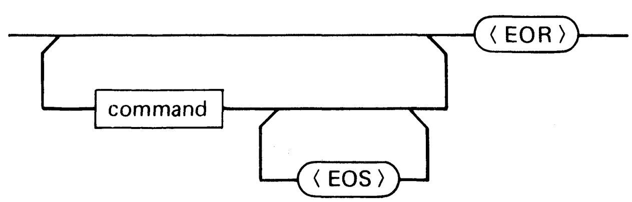



4. Trigger String

The trigger string numeric data is a string of Generator commands terminated with an EOR. The string may be up to 71 characters not including the EOR. Commands in the string are not checked for validity until the trigger string is executed with the trigger command.

EOR is the end of record character. This character is selectable with the terminator mode command. "TM0" selects the linefeed character. "TM1" selects the carriage return character. The IEEE-488 interface signal EOI asserted with any other character is also considered an end of record.

EOS is an end of string character, use either ";" or ",".




## 2-51. SUFFIX SYNTAX

Suffixes are always one or two alpha-characters. Certain suffixes are used to scale the numeric (the same as the front panel UNITS keys). Other suffixes mnemonically designate hardware components. The five types of suffixes are described in Table 2-11.

## 2-52. Command Descriptions

The following paragraphs describe the remote IEEE-488 Interface operating commands that are not accessible from the front panel of the Generator. IEEE-488 Interface commands that are accessible from the front panel of the Generator are described earlier in this section.

**Table 2-11. Suffix Types**

| SUFFIX TYPE | SUFFIX | MNEMONIC | EQUIVALENT EXPONENT |
|---|---|---|---|
| Frequency and FM | GZ | gigahertz | 9 |
| | MZ | megahertz | 6 |
| | KZ | kilohertz | 3 |
| | HZ | hertz | 0 |
| Amplitude | V | volts | 0 |
| | MV | millivolts | -3 |
| | UV | microvolts | -6 |
| | NV | nanovolts | -9 |
| | DB | dBm or dB | 0 |
| AM | PC | percent | 0 |
| DAC/BIT Designators | DAC and BIT designators are two alpha-character mnemonics that refer to hardware dacs and bits. Refer to the paragraphs on Monitor Commands for a complete list of designators. | | |
| Learn Suffix | A learn suffix is a string of ASCII characters that contain coded memory location contents. Refer to the paragraphs on Binary Learn Commands for decoding of the learn string. | | |

## 2-53. BINARY LEARN COMMANDS

Front panel setups are stored in the memory of the Generator in a packed binary format. The binary learn commands are used to transfer this binary data between an IEEE-488 controller and the Generator. These commands allow you to minimize the amount of programming commands needed to program the entire instrument state. The binary learn commands are:

"LM" Learn Memory
"LI" Learn Interface

The syntax for the Learn Memory ("LM") command is as follows:

"LM" Memory Location Code

The Generator responds to the "LM" command with a string of 64 ASCII characters followed by an <EOR> (end of record character). This string represents the front panel settings (in a packed binary format) that were stored in the memory location specified.

*NOTE*

*The <EOR>, end of record character, is sent with EOI asserted. "TM0" selects the linefeed character, and "TM1" selects the carriage return character.*

Example

IEEE-488 Command: "LM98"

Response:

"BOABAAAAPPJMAAAKAAAAAAAABBOBKKAAAAAPECEAA BPEAAABDAEEBBAGBLKKMPAC"⟨EOR⟩

Refer to Figure 2-7 for information on how to decode this learn string.

The syntax for the Learn Interface "LI" Command is as follows:

"LI" Memory Location Code: Learn String

The Generator stores the learn string in the memory location designated by the memory location code. If the memory location specified is 99, the instrument is programmed to the data sent in the learn string.

Example

To program the Generator to the Instrument Preset State:

"LI99BOABAAAAPPJMAAAKAAAAAAAABBOBKKAAAAAPECEAABPE AAABDAEEBBAGBLKKMPAC"

Note that the binary learn string in this example is the same as the learn string returned from memory location 98 which contains a record of the Instrument Preset State.

Instructions:

1. Convert the hexadecimal number to a signed decimal number as follows:

   a. Multiply the most significant hexadecimal digit by 16.

   b. Add the next significant digit to the value obtained in Step a.

   c. Multiply the sum of Step b by 16, and add in the next hexadecimal digit until the least significant hexadecimal digit has been added.

*NOTE*

*If the hexadecimal number started with an 8 through F, the number is negative. Preform Step d for negative numbers.*

   d. Subtract, 16 from the number raised to the power of the number of digits.

Example of Instruction 1:

To convert hexadecimal number 1E:

(1 * 16) + 14 = 30

(Since the most significant digit is 1, the number is not negative.)

| Character Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | B | O | A | B | A | A | A | A | P | P | J | M | A | A | A | K | A | A |

| 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | A | A | A | A | A | B | B | O | B | K | D | A | A | A | A | A | P | E | C | E | A | A |

| 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | P | E | A | A | G | B | D | A | E | E | B | B | A | G | B | L | K | K | M | P | A | C |

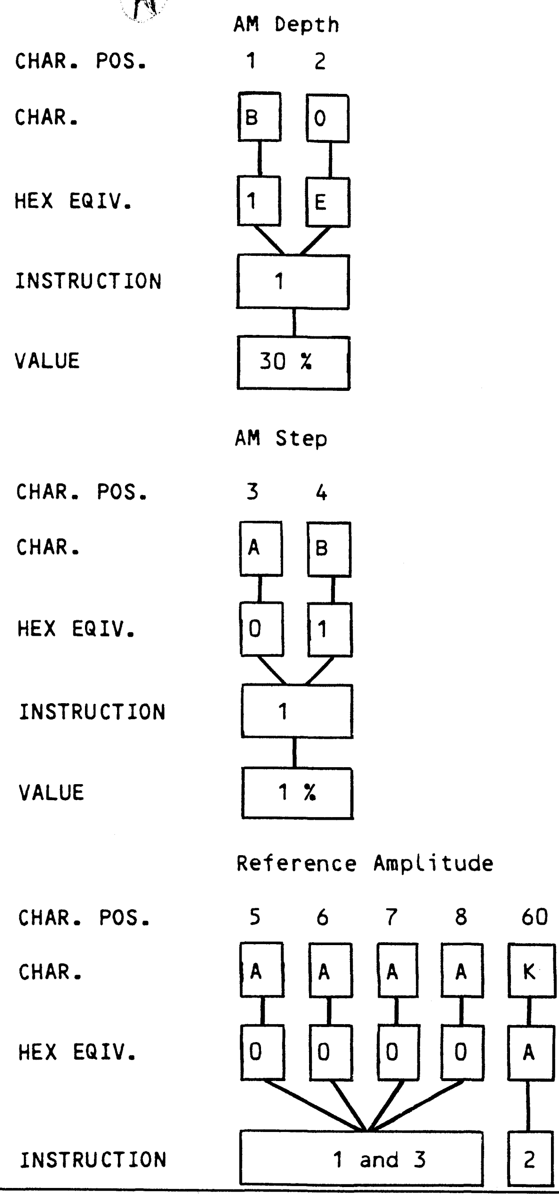



Figure 2-7. Learn String Example

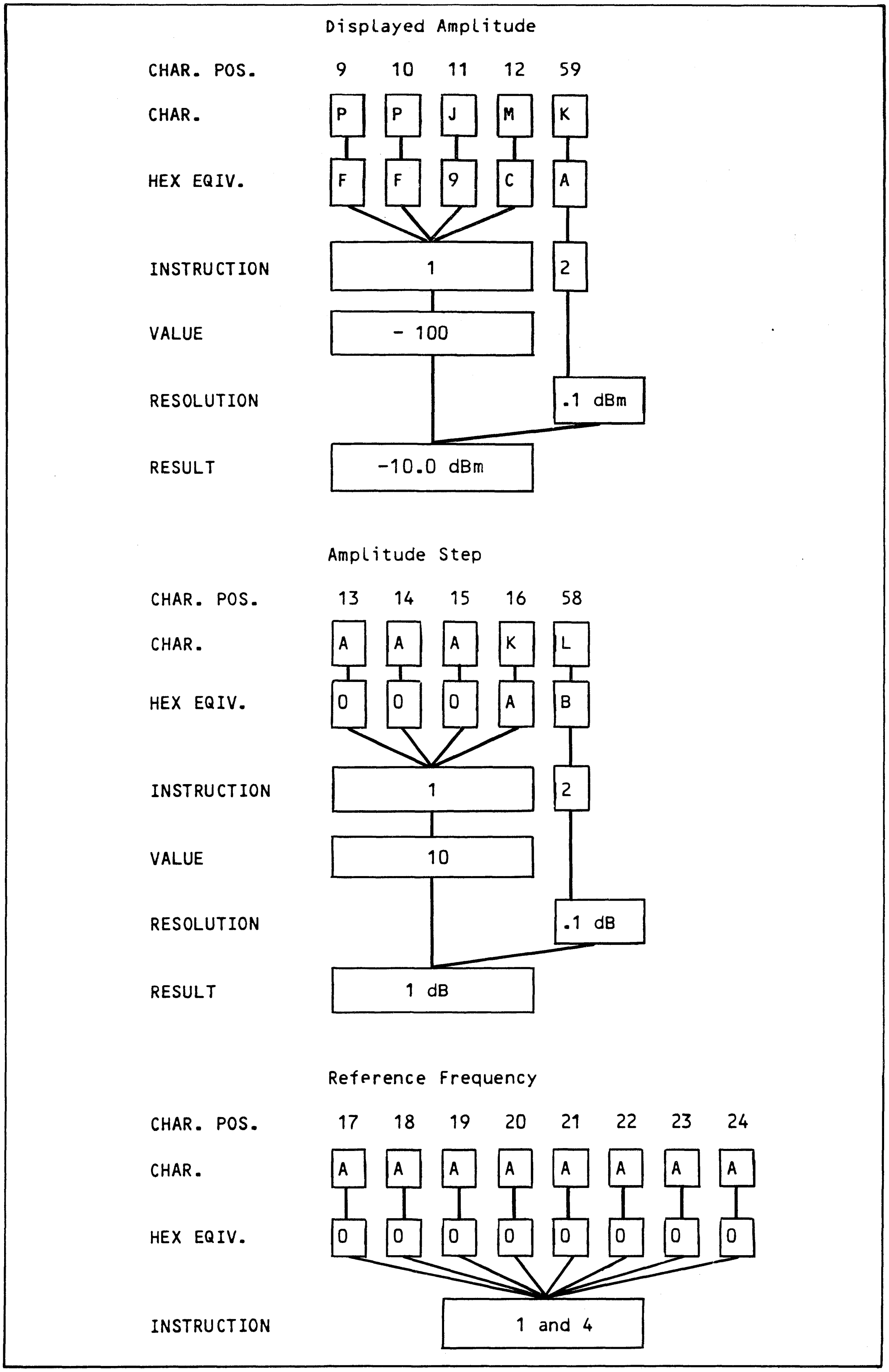



**Figure 2-7. Learn String Example (cont)**

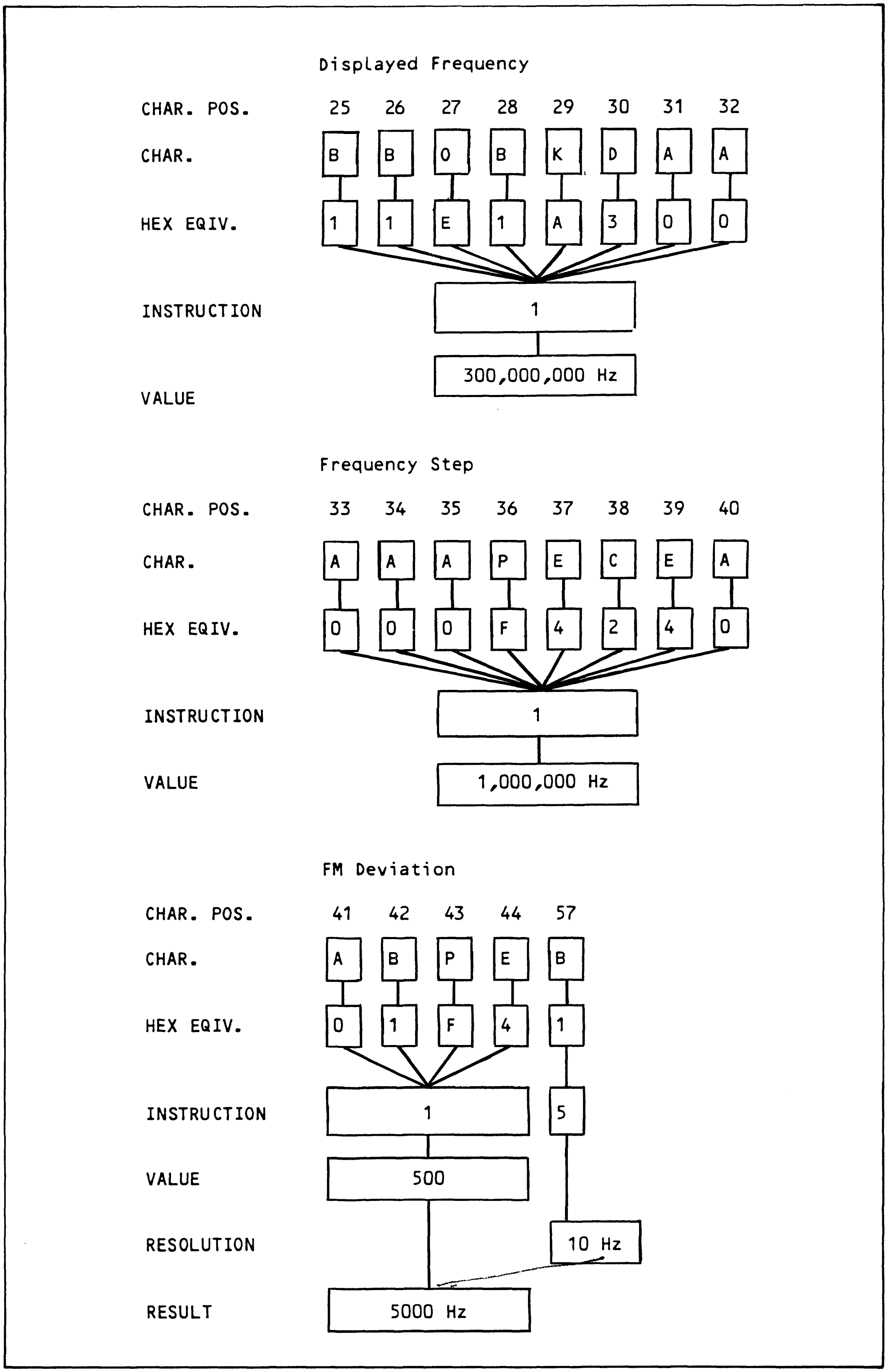



**Figure 2-7. Learn String Example (cont)**

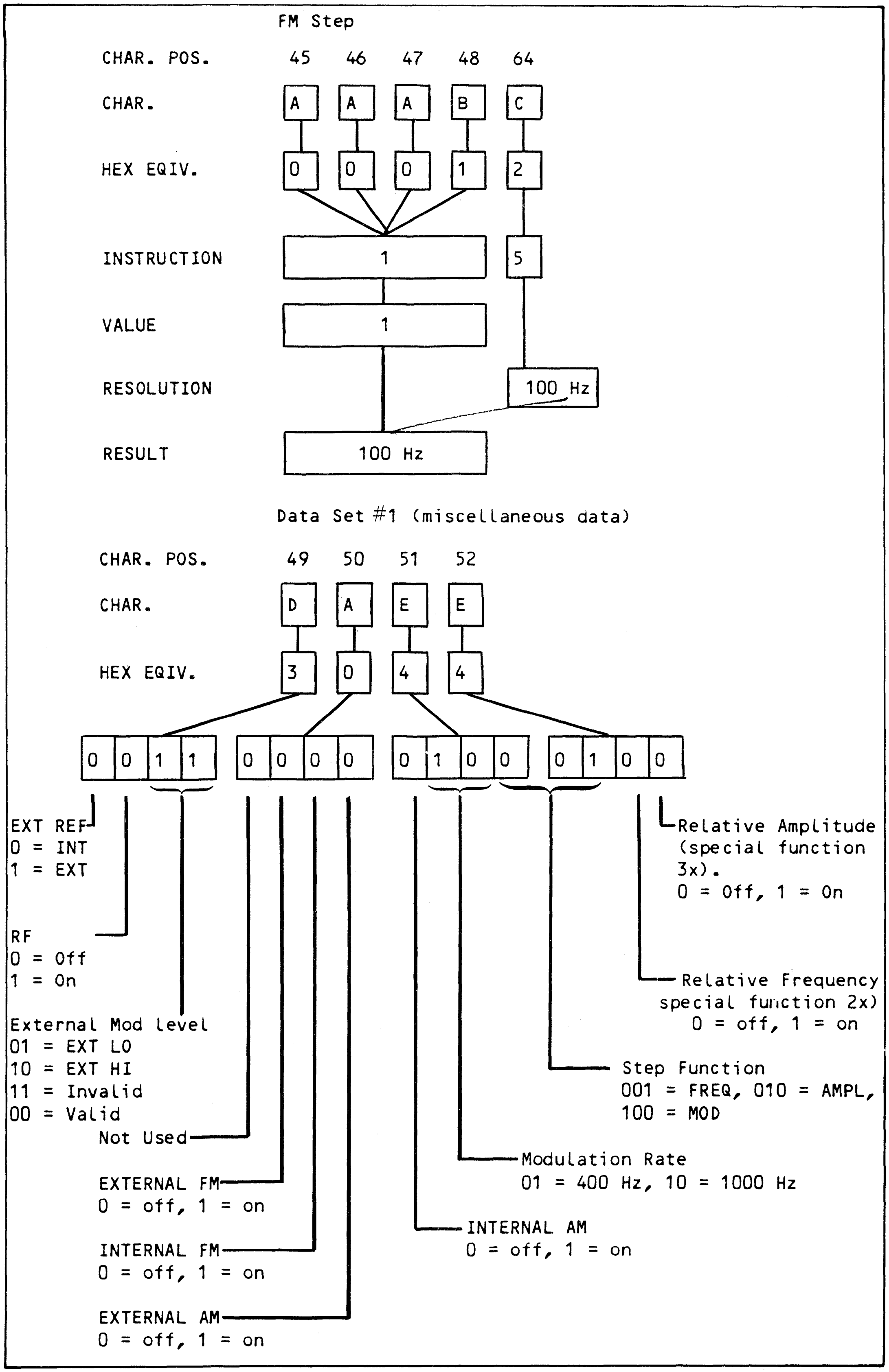



**Figure 2-7. Learn String Example (cont)**

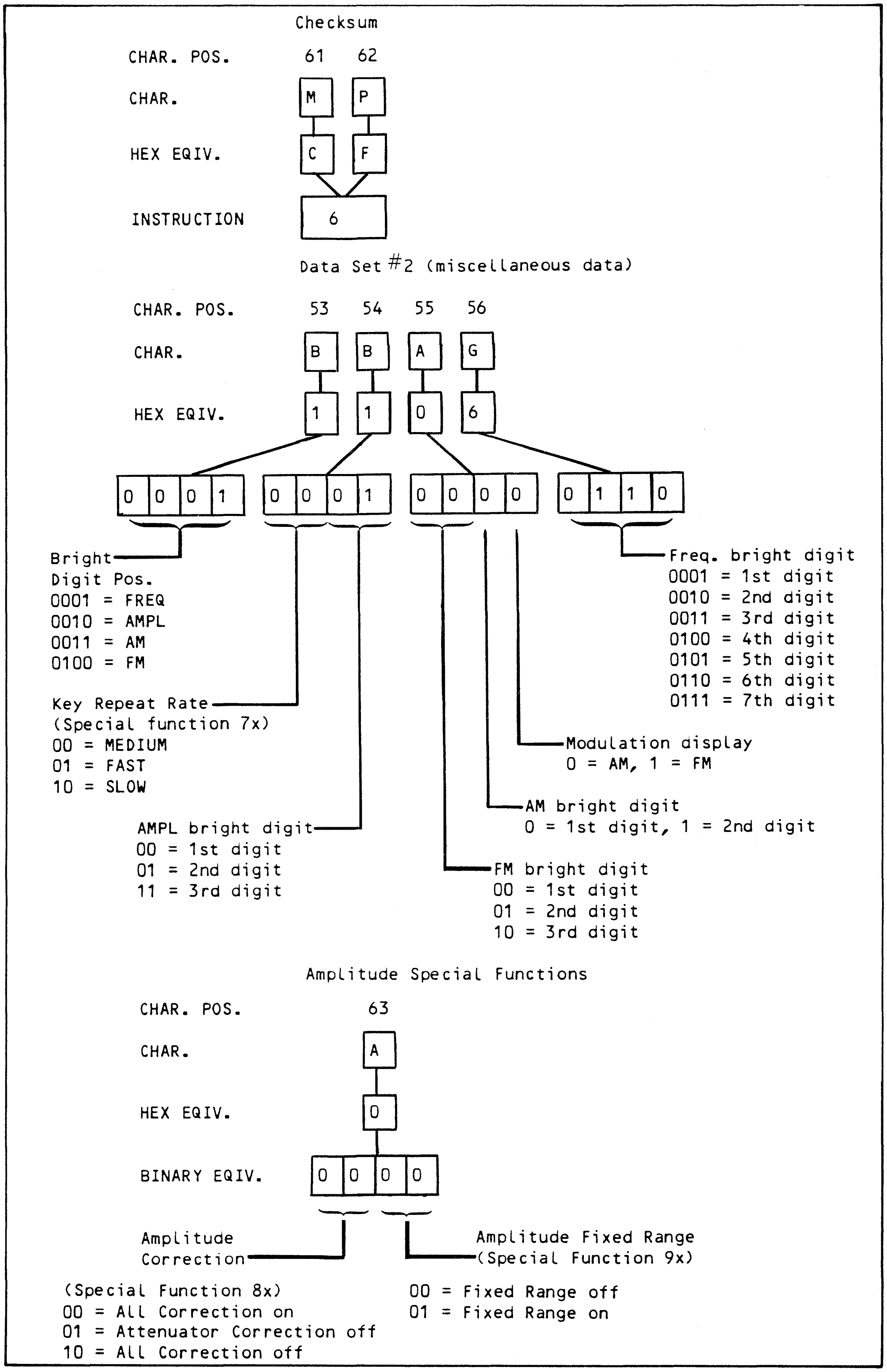



**Figure 2-7. Learn String Example (cont)**

To convert hexadecimal number FF9C:

(((((15 * 16) + 15) * 16) + 9) * 16) + 12 = 65436

(Since the most significant digit is F, the number is negative.)

Using Step d; 16 4 = 65536, 65436 – 65536 = –100. The signed decimal equivalent to FF9C is –100.

2. Amplitude quantities have a number and a resolution associated with them. This applies to the Displayed Amplitude, Reference Amplitude, and Amplitude Step.

   Use the following procedure to identify the resolution of an amplitude quantity:

   a. If the resolution is A or B (hexadecimal), the resolution of the number is 0.1 dBm or 0.1 dB units.

Example:

The Displayed Amplitude (in this figure) is –100 with a resolution of

   a. The actual displayed amplitude is –10.0 dBm.

   b. If the stored resolution is 0 through 9 (hexadecimal), the amplitude quantity is in volts. To convert the number to the actual amplitude in nanovolts, multiply the amplitude number by the power of ten represented by the resolution.

      Example: An Amplitude Step of 12, with a resolution of 6 would be an actual amplitude step of 12,000,000 nV or 12 mV.

3. If the Relative Amplitude mode is off, the data stored in the reference amplitude location is not used.

4. If the Relative Frequency mode is off, the data stored in the reference frequency location is not used.

5. FM and FM Step quantities have a number and a resolution associated with them. To convert the number to the FM quantity in Hz, multiply the number by the power of ten represented by the resolution. If the Low-Rate FM option is installed, the FM quantity, adjusted by the resolution, has a resolution of 0.1 Hz.

   Example: The FM number (in this figure) is 500, with a resolution of 10 Hz. The actual FM deviation is 5000 Hz.

6. The checksum data is calculated by adding the data in the learn string, two hexadecimal digits at a time. The total, including the checksum, should add up to a number whose least significant two hexadecimal digits are 01.

*NOTE*

*The memory location code must be an unsigned integer indicating the memory location to be learned. Memory location 99 refers to the current instrument settings. Memory location 98 refers to the Instrument Preset State as listed in Table 2-3.*

The characters in the learn string correspond to each Generator function. A description of how to interpret the characters in the learn string is given in Figure 2-7. Table 2-12 shows the conversion from the learn string to the hexadecimal character.

**Table 2-12. Learn Character to Hexadecimal Conversion**

| LEARN CHARACTER | HEXADECIMAL EQUIVALENT | DECIMAL EQUIVALENT |
|---|---|---|
| A | 0 | 0 |
| B | 1 | 1 |
| C | 2 | 2 |
| D | 3 | 3 |
| E | 4 | 4 |
| F | 5 | 5 |
| G | 6 | 6 |
| H | 7 | 7 |
| I | 8 | 8 |
| J | 9 | 9 |
| K | A | 10 |
| L | B | 11 |
| M | C | 12 |
| N | D | 13 |
| O | E | 14 |
| P | F | 15 |

## 2-54. CLEAR COMMANDS

The following IEEE-488 clear commands are recognized by the Generator:

"CB" Clear IEEE-488 input buffer
"CE" Clear IEEE-488 rejected entry error status
"CL" Clear instrument

The "CB" command can be used to clear the Generator output buffer. The output buffer is also cleared on power up, with the "CL" clear Generator command, or by the SDC and DCL clear interface messages.

The "CE" command can be used to explicitly clear the error status. The error status is also cleared when it is interrogated with the "IR" command, or the "CL" clear Generator command, or the SDC and DCL clear.

The "CL" command is used to clear the instrument state. The same actions are performed with the SDC and DCL clear interface messages. (In addition, the input buffer is cleared with the clear interface messages.) The following IEEE-488 commands are performed with the clear Generator command: "RC98, RO1, CE, CB, RM0, TM0, EM0, VM0, UM0, SM192, SP08, XF0, DW0, CT"<EOR>.

## 2-55. INTERFACE MODE COMMANDS

Interface Mode commands are used to configure the Generator for different modes of IEEE-488 interface operation. Since the Generator knows when its RF output has settled, it can be configured to synchronize itself with the Controller. This eliminates WAIT statements in the program, which are normally used to allow time for the output of the controlled device to settle. Table 2-13 lists the Interface Mode Commands.

Table 2-13. Interface Mode Commands

| COMMAND | DESCRIPTION | COMMAND STATUS |
|---|---|---|
| "EM" | Error Mode | 1 = on, 0 = off |
| "RM" | Record Mode | 1 = on, 0 = off |
| "TM" | Select Terminator | 1 = CR, 0 = LF |
| "UM" | Unbuffered Mode | 1 = on, 0 = off |
| "VM" | Valid Mode | 1 = on, 0 = off |

The error mode selects when the IEEE-488 rejected entry status is cleared. If turned on, the error status is cleared when a new message is processed. If turned off, the status is cleared only when interrogated with the "IR" (interrogate rejected entry) command or when explicitly cleared with the "CE" (clear error command).

The record mode selects whether the message unit is a record or a command. When turned on, the message unit is a record. When turned off, the message unit is a command.

The terminator mode selects the character used as the record terminator. The terminator character is not used for command processing unless the record mode is enabled. When turned on, the record terminator CR (carriage return) is used. If turned off, the record terminator LF (line feed) is used. The record terminator character is the last character in all IEEE-488 messages sent from the Generator.

The unbuffered mode selects when messages from the IEEE-488 interface are processed. When turned on, messages are read from the IEEE-488 interface only when the microprocessor is ready to process them. In this mode, the input buffer will contain a maximum of one message. (A message may be one command or one record, depending on the setting of the record mode.) When turned off, messages are read from the IEEE-488 interface to the input buffer of the Generator at the fastest rate. In this mode, the input buffer may contain up to 80 characters.

The valid mode selects when messages are processed by the Generator microprocessor. When turned on, processing of a new message is begun only after the RF output has settled and become valid. When turned off, a new message is processed immediately after the completion of the previous message.

The interface modes can also be programmed using the command, "@" n (where n is an integer). The interface modes are set to the value of n where n is the sum of the codes for the desired modes. The integer codes for the interface modes that can be programmed using the "@" n commands are as follows:

| | |
|---|---|
| Terminator Mode | = 1 |
| Record Mode | = 2 |
| Valid Mode | = 4 |
| Unbuffered Mode | = 8 |
| Error Mode | = 16 |

For example, to select the record mode and valid mode, the command is "@" 6.

Interface Mode Example

In this example, the RF output of Generator is connected to a circuit that is being measured by a voltmeter. The output of the Generator must be settled before the voltmeter is given it's command to make a measurement.

A Fluke 1722A program might look something like:

```
PRINT @1, "CL,TM1,RM1,VM1,UM1"   ! initialize the 6060, select modes
PRINT @1, "FR100MZ,AP-25DB"      ! program the 6060
PRINT @2, "?"                    ! trigger the voltmeter
INPUT @2, R$                     ! get the reading
```

The entire record is transferred into the Generator before processing begins. In this example, processing begins when the record terminator CR is received. The following character (LF in this case) will not be received into the Generator until the entire record is processed and the output has settled. No wait statement is needed between setting up the Generator and taking the measurement because the Generator will not handshake the LF character until its output has settled.

*NOTE*

*A record is a string of characters separated by ⟨EOR⟩. A message is the smallest group of characters that the Generator can process when programmed from the IEEE-488 interface.*

*NOTE*

*The output valid state of the Generator occurs 45 ms after any hardware has been changed.*

## 2-56. INTERROGATE COMMANDS

Interrogate commands allow the status of the Generator to be given over the IEEE-488 interface. These commands consist of headers only. The interrogate commands available on the IEEE-488 interface are:

"ID" Give Instrument ID
"IE" Elapsed Time Indicator
"II" Interface Mode Status
"IO" Option Loading
"IR" IEEE-488 Rejected Entry Status
"IT" Self-Test Results
"IU" UNCAL (uncalibrated) Status
"IV" Software Revision Level

When the "ID" command is sent, the Generator responds with its instrument model number (and end of record character) as in "6060A"⟨EOR⟩.

The "IE" elapsed time indicator command works only on Generators with the Non-Volatile Memory Option. When the "IE" command is sent, the Generator reponds with a 10-digit integer followed by the ⟨EOR⟩ character. The 10-digit integer indicates the time the instrument has been in operation since it was manufactured. To convert the time into minutes, multiply the integer by 0.67.

The "II" command interrogates the current selection of interface modes. A 5-digit integer followed by the ⟨EOR⟩ character is the sum of the modes selected as follows:

Terminator mode= 1
Record mode = 2
Valid mode = 4
Unbuffered mode= 8
Error Mode = 16

The "IO" command interrogates the Generator for its option complement. The returned record contains three integers, separated by commas, that indicates configuration of options. For the 6060A, the first number is always 3, which indicates that the Generator being interrogated is in fact a 6060A. The two remaining numbers are the sum of the option related numbers as follows:

2nd Number

1 = -570 Non-Volatile Memory Option
2 = -131 Sub-Harmonic Reference Option
4 = -130 High-Stability Reference Option
8 = -651 Low-Rate FM Option

3rd Number

1 = -870 RPP Option
2 = -830 Rear Output Option

For example, 352 would indicate a 6060A with options -570, -131, and -830.

The "IR" command interrogates the Generator for rejected entry error status. (See Table 2-6 for a list of rejected entry codes.) The returned record is the sum of errors that have been detected while processing IEEE-488 commands. The status is cleared when interrogated with the "IR" command. The status can also be explicitly cleared with the "CE" command and is also cleared on the "CL" command and the clear interface messages DCL and SDC.

The "IT" command interrogates the Generator for the self-test results. Table 2-14. lists the self-test error codes. The self tests are performed on the Generator power-up and can also be initiated with special function 02.

The self-test results are reported in four fields which are explained in the table. Any non-zero code indicates that some tests failed. Further details of the self-test results are listed in the Service Section. Table 2-14. shows the self-test error codes.

The "IU" command interrogates the Generator for the UNCAL entry status. (See Table 2-5 for a list of the UNCAL Error Codes.)

The "IV" command interrogates the Generator for its current software revision level. The returned record is similar to the following:

"V1.0" <EOR>.

This means that the software revision level is Version 1.0.

**Table 2-14. Self-Test Error Codes**

```
        MOD        FREQ         AMPL
        aaa     -bbb     ccc     ddd

aaa = Modulation (AM and FM) test results
-   = If displayed, indicates the self test did not complete
bbb = Frequency test results
ccc = Digital test results
ddd = Amplitude test results
```

## 2-57. MONITOR COMMANDS

The Generator monitor commands are intended for troubleshooting and maintenance procedures. They allow the instrument hardware to be programmed to states not normally possible with the regular programming commands.

**CAUTION**

**The output of the Generator is not guaranteed if the Generator hardware has been changed with these monitor commands.**

There are three types of monitor commands: Input/Output, Read/Write, and Hardware Control. Table 2-15 lists the Input/Output types of monitor commands. Table 2-16 lists the Read/Write types of monitor commands. Table 2-17 lists the Hardware Control types of monitor commands.

## 2-58. SRQ COMMANDS

The Generator asserts the SRQ bus management line on the IEEE-488 interface bus whenever the Generator requires service. The Controller can then perform a serial poll to determine the need for service. The set mask command is used to designate those needs that require service. The SRQ commands are as follows:

"SM" Set SRQ Mask
"IM" Interrogate SRQ Mask
"XF" Local Operation Alert Mode

The SRQ mask is set to the sum of the reason values listed in Table 2-18. These reason values correspond to the allowable reasons that will be requiring service. The SRQ Mask is set by the following command sequence:

"SM" Sum of Reasons

The Generator asserts SRQ when one of the allowed reasons becomes true. The serial poll response is the sum of those values for reasons that are currently true, independent of the setting of the SRQ mask. For example, if the rejected entry SRQ is enabled with "SM2" and a rejected entry occurs, the serial poll response will indicate that the Generator generated the SRQ (value of 64) and that a rejected entry occurred (value of 2). In addition, other values may be set. The default SRQ mask is 192.

The "IM" command interrogates the current SRQ mask, and an integer is returned.

The "XF" command enables a mode that causes an SRQ to be generated any time the Generator processes an entry. In this mode, a front panel SRQ is generated (i.e., the serial poll response indicates that a front panel SRQ is the cause of the SRQ). This mode is enabled and disabled with its own command, not through the Set SRQ Mask commands (as are all other SRQs). The Alert Mode is enabled/disabled as follows:

"XF0" = Alert Mode off, "XF1" = Alert Mode on.

## 2-59. TRIGGER COMMANDS

The Generator has the ability to preprogram a command string of arbitrary Generator programming commands. This command string is executed whenever the trigger command "TR" or the IEEE-488 group execute trigger interface message (GET) is received. This method of programming the Generator can be used when a long string of commands is to be sent to the Generator over and over. The programming time is shortened by the time required to transmit the string of characters from the controller to the Generator.

**Table 2-15. Input/Output Monitor Commands**

| COMMAND NAME | COMMAND | VALUE | DESIGNATOR | NAME | LOCATION |
|---|---|---|---|---|---|
| Read Input Bit | "IB" | | "EX" | exrefl | A2A7, U11-13 |
| | | | "HS" | hsoptl | A2A7, U11-14 |
| | | | "IE" | ieinl | A2A7, U11-7 |
| | | | "LF" | lrfm | A2A7, U40-13 |
| | | | "MH" | mlevhi | A2A7, U40-8 |
| | | | "ML" | mlevlo | A2A7, U40-3 |
| | | | "NV" | nvinl | A2A7, U11-8 |
| | | | "RO" | roptl | A2A7, U40-17 |
| | | | "RP" | rppl | A2A7, U11-3 |
| | | | "RT" | rptrpl | A2A7, U11-4 |
| | | | "SR" | shrefl | A2A7, U40-18 |
| | | | "TQ" | trseql | A2A7, U40-4 |
| | | | "UK" | unlok | A2A7, U11-17 |
| | | | "UV" | unlvl | A2A7, U11-18 |
| | | | "XA" | extra-a | A2A7, U40-14 |
| | | | "XB" | extra-b | A2A7, U40-7 |
| Set Output Bit | "OB" | 0 or 1 | "CL" | clr | A2A7, U17-16 |
| | | | "EA" | extam | A2A4, U308-19 |
| | | | "EF" | extfm | A2A4, U308-16 |
| | | | "FE" | fmen | A2A1, U19-19 |
| | | | "FP" | front-panel | A2A7, U17-9 |
| | | | "HO" | haocth | A2A4, U305-5 |
| | | | "HT" | het | A2A4, U305-9 |
| | | | "IA" | intam | A2A4, U308-15 |
| | | | "IF" | intfm | A2A4, U308-12 |
| | | | "LP" | mid | A2A4, U305-6 |
| | | | "MA" | rmux0 | A2A1, U32-5 |
| | | | "MB" | rmux1 | A2A1, U32-2 |
| | | | "MF" | mf400l | A2A4, U308-9 |
| | | | "MG" | module-gate | A2A7, U17-6 |
| | | | "MS" | trmodl | A2A1, U32-15 |
| | | | "NE" | nven | A2A7, U17-5 |
| | | | "PU" | pulse | A2A4, U308-6 |
| | | | "RI" | rinh | A2A1, U32-9 |
| | | | "RR" | rprst | A2A7, U17-2 |
| | | | "SE" | shen | A2A1, U32-12 |
| | | | "SH" | shet | A2A1, U32-16 |
| | | | "TO" | tbout | A2A4, U305-2 |
| | | | "TS" | tbsyn | A2A1, U32-19 |
| | | | "XO" | xoenl | A2A1, U32-6 |
| | | | "YA" | extra-a | A2A7, U17-19 |
| | | | "YB" | extra-b | A2A7, U17-15 |
| | | | "YC" | extra-c | A2A7, U17-12 |
| Set Output DAC | "OD" | (integer value) | (DAC | location) | |
| | | 0-255 | "AM" | AM dac | n.a. |
| | | 0-127 | "AT" | attenuator | A2A7, U27-5, 6, 9, 12, 15, 16, 19 |
| | | 0-1023 | "FM" | FM dac | A2A4, U403-6 through 13 |
| | | 0-7 | "FR" | FM range | A2A1, U19-12,15,16 |
| | | 0-1023 | "KN" | kn dac | A2A1, U27-4 through 13 |
| | | 0-1023 | "KV" | kv dac | A2A1, U29-4 through 13 |
| | | 0-4095 | "LE" | level dac | A2A4, U303-4 through 15 |
| | | 0-255 | "TC" | temp.comp.dac | n.a. |

**Table 2-16. Read/Write Monitor Commands**

| COMMAND NAME | COMMAND SYNTAX | NOTES |
|---|---|---|
| Read byte | "RB" memory location | 1 |
| Read word | "RW" memory location | 1 |
| Define write address | "DW" memory location | 2 |
| Write byte | "WB" value | 2 |
| Write word | "WW" value | 2 |

Notes

1. The Generator responds to these commands with the value of the byte or word in the memory location addressed. The memory location must be an unsigned integer. The value returned is followed by an <EOR>. If the memory location is specified in hexadecimal, then the value is returned in hexadecimal preceded by an "X".

2. The Define Write Address command specifies the write address used with the Write Byte and Write Word commands. When the Write Byte and Write Word commands are used, the specified data will be written to that write address.

**Table 2-17. Hardware Control Monitor Commands**

| COMMAND NAME | COMMAND SYNTAX | NOTES |
|---|---|---|
| Read attenuation | "XA" | 1 |
| Set attenuation | "XB" integer | 1 |
| Set synthesizer frequency | "XD" floating point decimal "MZ" | 2 |
| RF on/off | "XR" "0" or "1" | 3 |

Notes

1. The current settings of the Attenuator can be read or set. The attenuation is a number from 0 to 23 where the number specifies the multiple of 6-dB attenuation. Zero indicates no attenuation, and 23 is the maximum attenuation. Only the attenuators are changed with the "XB" command. The value of the attenuation will be output on the "XA" command as an unsigned integer followed by <EOR>.

2. The "XD" command can be used to program the Generator to the specified frequency. Only the synthesizer circuits on the Synthesizer PCB is programmed. No offset is added, no filters are programmed, no VCO compensation is calculated, and no level correction is calculated.

3. "XR0" programs all attenuation, and "XR1" restores the attenuator to its previous state.

The trigger commands are as follows:

"CT" Configure Trigger
"TR" Execute Trigger Buffer

The configure trigger command is followed by a string of any Generator programming commands up to 71 characters in length. The validity of the programming commands is not checked until the trigger buffer is executed. The power-on value of the trigger string is null (nothing).

**Table 2-18. SRQ Mask and Status Values**

| VALUE | REASON | TRUE | FALSE |
|---|---|---|---|
| 1 | Ready | Input buffer is empty and no commands are being processed. | Input buffer is not empty or commands are being processed. |
| 2 | Rejected Entry | IEEE-488 rejected entry; error code is not zero. | IEEE-488 rejected entry error; code is zero. |
| 4 | Uncalibrated | RF output is not calibrated. (Front panel 'UNCAL' indiciator is ~~not~~ lit.) | RF output is ~~not~~ calibrated. (Front panel 'UNCAL' indiciator is not lit.) |
| 8 | Power on | Instrument has powered up. | Special function 08. |
| 16 | Output valid | RF output is settled. | RF output is not settled. |
| 32 | Not Used | | |
| 64 | RQS | SRQ mask ANDed with currently set values is not zero. | Reason for SRQ goes away or serial poll is performed. |
| 128 | Front panel | Special function 07. | Special function 08. |

The trigger command causes execution of the trigger buffer, which has been preprogrammed with the configure trigger command "CT". The trigger buffer can also be executed by sending the IEEE-488 group execute trigger interface message (GET).

## 2-60. Command Processing

The following paragraphs describe how IEEE-488 commands are processed by the Generator. Command processing is a term for how commands are executed and how errors are handled.

### 2-61. COMMAND EXECUTION

The execution of the IEEE-488 commands depends on the selection of interface modes with one exception: if an IEEE-488 input is buffered and the buffer becomes full, command execution starts and no further input is accepted until there is room in the input buffer. For more details, refer to the paragraphs on Interface Modes.

### 2-62. ERROR HANDLING

The Generator detects two types of errors while processing IEEE-488 commands: syntax errors and processing errors. All errors are accumulated until the error status is interrogated or is explicitly cleared. The IEEE-488 rejected entry status is interrogated with the "IR" command. The error status is cleared with one of the following commands:

"CE" Clear Error Command
"CL" Clear Command
DCL or SDC Clear Interface Messages

The error status is also cleared on power-up.

The SRQ mask can be set to assert SRQ when an error is detected. The SRQ is unasserted when the error status is cleared.

Syntax errors are commands that do not have the correct syntax for the specified header. For example, "FE5" is a syntax error because the external FM command requires a Boolean numeric field. Unrecognized headers are also syntax errors. An IEEE-488 syntax error causes all commands from the point of the error up to the next string terminator or record terminator to be ignored.

Processing errors are commands that are syntactically valid, but the requested value is outside the range of programmable values. For example, "FR99GZ" is syntactically correct, but the Generator cannot be programmed to a frequency of 99 gigahertz. Command processing continues with the next command.

## 2-63. Timing Data

The programming time can be broken down into four groups: transfer of commands to Generator, command parsing time, software programming time, and instrument settling time.

The total programming time depends on the selection of the interface modes. In some modes, programming steps are performed in parallel and can increase throughput. This section gives some typical timing data for the above four programming steps and describes how the interface modes affect their relative timing.

### 2-64. TRANSFER OF COMMANDS TO GENERATOR

The maximum rate of transfer is 0.4 to 0.5 ms per character. With most IEEE-488 controllers, all characters sent with a single output or print statement is transferred together at the maximum rate. The total time to transfer commands to the Generator is obtained by multiplying the number of characters by the rate of transfer.

### 2-65. COMMAND-PARSING TIME

Command-parsing time is the sum of the time required to process the header, the numeric, and the suffix. Some commands do not have numerics or suffixes. Table 2-19 gives the typical time it takes to process the different components of a command.

### 2-66. SOFTWARE PROGRAMMING TIME

The minimum time required to process a command is 20 ms. Most of the commands that do not program the hardware (such as storing step values) are programmed in 20 ms. Table 2-20 gives the typical time value for programming the different functions in the Generator.

### 2-67. INSTRUMENT-SETTLING TIME

Commands that do not change the state of the hardware (such as programming step values) have no settling time after the software-processing time.

For all other Generator parameters, except frequency and recall, the instrument has settled by the time the software-programming time is up, so no additional instrument-settling time is required.

Worst case frequency changes (including recalls) typically settle within 35 ms after the software-programming time. If level correction is disabled, this settling time is increased to 45 ms. Small frequency changes (not crossing a band) typically settle by the time the software-programming time is up, so no additional instrument-settling time is required.

**Table 2-19. Command-Parsing Time**

| COMMAND COMPONENT | TIME |
|---|---|
| Header | 2 ms |
| Boolean Numeric | 1 ms |
| Unsigned Integer Numeric | 2 ms + 1 ms per character |
| Floating-Point Numeric | 2 ms + 1 ms per character |
| Trigger-String Numeric | 10 ms + 0.5 ms per character |
| Suffix | 1 to 1.5 ms |
| Learn-Interface Suffix | 35 ms |

**Table 2-20. Typical Programming Time of the Generator Functions**

| FUNCTION | TIME (IN ms) | NOTES |
|---|---|---|
| Frequency | 55 | 1, 2, 3, 4 |
| Amplitude in Volts | 50 | 1, 2, 4, 5 |
| Amplitude in dBm | 90 | 1, 2, 4, 5 |
| AM Depth | 45 | 2, 4 |
| FM Deviation | 30 | 4 |
| Modulation Frequency | 25 | |
| Enable/Disable AM | 55 | 2 |
| Enable/Disable FM | 25 | |
| Recall 98 | 185 | 6, 5 |
| RF Output On | 45 | 2 |
| RF Output Off | 30 | |

Notes

1. May take up to 5 ms longer if the relative mode is enabled.
2. Can save 10 ms if all level correction is disabled with special function 81.
3. Add 20 ms when frequency changes from greater than or equal to 245 MHz to less than 245 MHz. Subtract 20 ms from frequency hardware-settling time in this case.
4. Edits and steps may take up to 5 ms longer than the programming function directly.
5. Add 45 ms when the Attenuator settings change.
6. Recalls vary considerably depending on the stored data. Maximum is approximately 250 ms.

## 2-68. TIMING OPTIMIZATION

Timing depends upon the interface modes selected. Read the paragraphs on Interface Mode Commands for a complete description of the interface modes.

The transfer of commands from the IEEE-488 controller to the Generator can never be processed in parallel with anything else. The transfer of commands usually happens simultaneously, regardless of which interface mode is selected.

The parsing of the command and programming the new instrument state is performed one message unit at a time. The record mode selects a command or a record as the message unit. The record mode off ("RM0") is slower since there is extra processing between message units, and the message unit is smaller.

If the valid mode is enabled, the processing of message units is delayed until the Generator has settled from the previous message. If the output of the Generator does not need to be settled between programming strings, the valid mode should be turned off to speed up processing. If the output does not need to be settled between commands, but needs to be settled between records, enable the valid mode and the record mode. The instrument processes commands within the record as fast as possible and wait for the output to settle only between records.

## 2-69. Power-on Conditions

The power-on conditions of the Generator depend on whether or not the IEEE-488 Interface Option is installed. The power-on state also depends on whether or not the Option -570 Non-Volatile Memory is installed. Table 2-21 lists the instrument parameters at power-on with the IEEE-488 Option installed, and with and without the Non-Volatile Memory Option. The remote clear commands can be used to reset all parameters except the last memory location and the remote/local state.

**Table 2-21. IEEE-488 Power-On State**

| INSTRUMENT PARAMETER | WITHOUT OPTION -570 | WITH OPTION -570 | NOTES |
|---|---|---|---|
| Memory location parameters | 98 | same as power off | 1 |
| RF on/off | on | same as power off | |
| Last memory location | 0 | same as power off | 2 |
| Remote/local state | local | local | |
| IEEE output buffer | cleared | cleared | |
| IEEE input buffer | cleared | cleared | |
| Valid mode | off | same as power off | |
| Record terminator | LF | same as power off | |
| Unbuffered mode | off | same as power off | |
| Record mode | off | same as power off | |
| SRQ mask | 192 | same as power off | |
| Trigger configuration | cleared | same as power off | |
| SRQ interface signal | unasserted | may be asserted | 3 |

Notes

1. The contents of memory location 98 (Instrument Preset State) is listed in Table 2-3.
2. The last memory location is used for sequence operations.
3. If the SRQ mask has the power on, output valid, or ready SRQ enabled, the SRQ interface signal is asserted on power-on.

# Section 3
# Theory of Operation

## 3-1. INTRODUCTION

This section of the manual describes the theory of operation for the Generator. There are four major headings:

General Description
Functional Description
Software Operation
Detailed Circuit Descriptions

The General Description briefly explains the functions and components of the three major modules of the Generator. The Functional Description covers the main output parameters, amplitude, frequency, and modulation. The Software Operation section describes the software and how it affects the hardware. The Circuit Description is a comprehensive explanation of the operation of each circuit assembly.

## 3-2. GENERAL DESCRIPTION

The Generator has three major sections. The front section includes the keyboard and display for local control. The module section includes the frequency, level, modulation, and control circuits. The rear section includes the power supply, cooling fan, and assorted external connectors.

### 3-3. Front Section

The front section of the Generator provides the operator interface. It includes the primary controls, connectors, and indicators of the Generator. All front panel keys and displays (except the power switch that controls the power supply directly) are monitored and handled by the Controller in the module section.

### 3-4. Module Section

The module section is a multi-compartmented, shielded enclosure that includes the circuits that generate the instrument stimulus functions: frequency, modulation, and amplitude. The Controller (which is not shielded) is also located here. The Controller governs the Generator operation and at power-on determines if any options are installed by checking the option status bits. The optional Sub-Harmonic Reference, Low-Rate FM, and Non-Volatile Memory are also located in this section of the instrument.

### 3-5. Rear Section

The rear section includes the power supply, the cooling fan, various external connectors, the IEEE-488 Interface and the High-Stability Reference Options.

The power supply is a linear design providing two +15V, -15V, +5V, +37V, +18V, and 6V ac to the Generator. All the power supplies are series-pass regulated except the 6V ac filament supply and the +18V supply, which provides power to the Attenuator relays and optional Reverse Power Protector (RPP) relays. A fuse/filter/line-voltage selector allows the Generator to operate from any common supply voltage.

The ac fan is powered from a 120-volt winding on the power supply transformer regardless of the position of the line voltage selector. The fan operates only when line power is available and the front panel POWER switch is ON.

The Option -130 High-Stability Reference operates whenever the instrument is plugged into an active ac outlet, regardless of the position of the instrument POWER switch.

## 3-6. FUNCTIONAL DESCRIPTION

The following paragraphs describe the key output parameters of the Generator: level, amplitude modulation, frequency, and frequency modulation.

### 3-7. Level

Level control is provided by two separate circuits, a step attenuator and a vernier level DAC. The 6.02 dB per step Attenuator (A2A6 or optional Attenuator/RPP, A2A5) provides coarse control. Fine level control is provided by a vernier level DAC that varies the automatic level control voltage (ALC). The microprocessor automatically controls the step attenuator and the vernier level DAC. The microprocessor also applies level correction to compensate for the Generator frequency response.

Each Generator has level correction data for the Output and Attenuator assemblies, stored in the Output and Attenuator calibration EPROMs. The EPROMs are located on the Controller assembly. The correction data is based on measurements of each assembly during calibration of the Generator at the factory.

This microprocessor level correction data is applied only to the vernier level DAC; it does not affect the coarse level control provided by the Attenuator. In other words, all Generators have the same attenuator pads inserted at a selected level even though the correction data is different for each Generator.

To improve level accuracy in relation to temperature, the Generator uses a software temperature compensation technique. This technique uses data that is the same for all Generators regardless of the options installed.

### 3-8. Amplitude Modulation

The output of the level DAC is the ALC loop control voltage. The Generator output signal is amplitude modulated by varying this control voltage with the modulating signal. A 1V peak modulating signal from the internal modulation oscillator or from the external MOD INPUT connector is applied to the AM DAC, a multiplying D-to-A Converter. The multiplying factor of this DAC, corresponding to the programmed percentage of modulation, is factored by the Controller.

The modulation signal from the AM DAC is summed with a fixed dc reference voltage. The composite signal (dc plus modulation) is applied to the LEVEL DAC, a level control-multiplying DAC. The multiplying factor for this DAC is also handled by the Controller and corresponds to the programmed signal level. The multipling factor also includes the level correction information stored in the calibration EPROMs.

The operation of the ALC loop causes the amplitude of the RF signal to conform to this varying control voltage, thus amplitude modulating the Generator output.

### 3-9. Frequency

The 0.1-MHz to 1050-MHz frequency coverage is divided into the following three bands:

| | |
|---|---|
| Low-band | 0.1 MHz to 245 MHz |
| Mid-band | 245 MHz to 512 MHz |
| High-band | 512 MHz to 1050 MHz |

The high and mid bands are derived directly from a voltage-controlled oscillator (VCO) followed by a binary divider that is part of the main phase-locked loop (PLL).

This PLL synthesizes the 245- to 512-MHz band using a modified N-divider loop with a single-sideband mixer (SSB) in the feedback path. The reference frequency for the loop is 1 MHz, which would normally provide 1-MHz steps in a conventional N-divider loop. However, this Generator provides 0.02-MHz steps by using a modified N-divider circuit with pulse deletion controlled by a rate multiplier.

Additional resolution is gained by introducing a signal from the sub-synthesizer circuit into the main PLL through the SSB mixer in the feedback path. This signal provides internal frequency steps of 5 Hz. The sub-synthesizer consists of a 14-bit rate multiplier followed by a divide-by-1000.

Control of the synthesizer frequency ($F_s$) is such that later (effective) doubling or heterodyning produces the high and low frequency bands for the desired Generator output frequency. Also, since the main PLL bandwidth varies with the programmed frequency (due to N changing and variations in the VCO tuning coefficient), the Controller uses compensation to program the phase detector gain via the KN DAC to maintain constant loop bandwidth. By keeping the loop bandwidth constant, loop stability and modulation transfer is controlled, thus ensuring accurate, wideband FM.

### 3-10. Frequency Modulation

Frequency modulation is achieved by applying the modulation signal simultaneously to the PLL VCO and the Phase Detector. Both are necessary because modulating either the VCO or the Phase Detector alone results in FM with a high-pass filter characteristic, or phase modulation with a low-pass filter characteristic. The filter characteristic cutoff frequencies are equal to the PLL bandwidth.

The modulating signal applied to the VCO and the Phase Detector is adjusted in amplitude by the KV DAC to compensate for variations in the VCO tuning coefficient. This compensation is done automatically by the Controller using factory calibration data measured on the VCO in each Generator. This compensation data is stored in the VCO Calibration EPROM.

By integrating the modulation signal applied to the Phase Detector and simultaneously applying the modulation signal to the VCO, the two effects are complementary and result in a flat FM response.

### 3-11. SOFTWARE OPERATION

The Generator software is executed on a Texas Instruments TMS 9995 microprocessor in the A2A7 Controller assembly. The instrument program is stored in 40K-bytes of ROM, two scratch pad RAM, 2K-bytes off-chip and 250- bytes on-chip RAM. Three 2K-byte EPROMs contain the individual Generator calibration data. The software provides the following general functions:

- Interfaces with the front panel keys and the IEEE-488 Interface to provide access to the Generator functions.

- Configures the Generator functional blocks to produce the required output and then applies linearization and compensation data to optimize the instrument performance and resolution.

- Implements a set of self test and diagnostic functions.

### 3-12. User Interface

The Generator software is implemented with a simple operating system that allows several tasks to operate in a round-robin fashion on a equal priority basis. Input and output to the front panel and to the IEEE-488 Interface option, however, execute at a higher priority and are handled as interrupt routines.

At power-on, the software performs an instrument self test and initializes both the RAM and the Generator hardware. Three tasks are continuously in operation:

Service task
Key task
IEEE-488 task

The service task checks the status signals. The key task and IEEE-488 task process user input. A fourth task is activated only when needed to process certain UNCAL (uncalibrated) or REJ ENTRY (rejected entry) conditions that cause the instrument STATUS display to flash.

### 3-13. Amplitude Control

Amplitude is programmed using a 23-step (6.02 dB per step) attenuator assembly and a 12-bit vernier level DAC. The level DAC settings depend on a combination of the programmed output level and amplitude correction data.

The amplitude correction data compensates for level inaccuracies and is a function of the Generator frequency. Correction factors are stored in the Output and the Attenuator Calibration EPROMs. Each Output and Attenuator assembly comes with a matched calibration EPROM. The assemblies may be replaced under the Module Exchange Program with only minor adjustments needed after installing the replacements.

### 3-14. Attenuators

One 6-dB, one 12-dB, and five 24-dB sections of the Attenuator are programmed in combination to provide course level control. The indicated voltages at which the Attenuator changes ranges are $2^{-m}$ volts, where

m = 1, 2, 3, ...23 for non-AM, or

m = 2, 3, ,4, ...24 for AM operation

Table 4D-15 lists the Attenuator sections programmed for various displayed levels.

### 3-15. Level DAC

The level DAC setting (LEV 0 through 9) is calculated from the Generator output level. If level correction is enabled, the level DAC setting is further modified by the data stored in the Output and Attenuator calibration EPROMs.

To minimize level transients that could damage external circuitry, the following sequence is used in programming the Attenuators and the level DAC when the Attenuator setting is changed:

1. The level DAC is programmed to zero.

2. The new Attenuator setting is programmed.

3. After a 15-ms wait to allow the Attenuators to settle, the LEVEL DAC is programmed to the new setting.

### 3-16. Temperature Compensation

The temperature compensation DAC (TC DAC) data is stored in the Generator software as a function of the output frequency ($F_o$). This data is the same for each Generator.

### 3-17. Reverse Power Protector Option

The optional Reverse Power Protector (RPP) A2A5 (if installed) protects the Generator from damaging voltages applied to the RF OUTPUT connector. The status line RPTRPL indicates whether the RPP circuitry has tripped. If the RPP trips, the RF output is programmed off, and the RF OFF indicator flashes. The RPP circuitry is reset by the operator turning the RF OUTPUT on. This causes the Controller to reset the RPP by toggling RPRSTL, and programming the RF on.

### 3-18. Frequency Reference Control

Programming of the frequency reference control bits depends on the setting of the INT/EXT reference switch as well as whether the High-Stability Reference or the Sub-Harmonic Reference options are installed.

### 3-19. Frequency Control

The output frequency ($F_o$) is programmable with 10-Hz resolution. The minimum calibrated output frequency is 0.1 MHz, and the maximum calibrated output frequency is 1050 MHz. The filter and band control bits are programmed in five bands and are determined by the output frequency ($F_o$). For each band, a synthesizer frequency ($F_s$) is determined.

The programming data of the KV and KN DACs are calculated from the synthesizer frequency ($F_s$) and the instrument-specific VCO Calibration EPROM data. The KV DAC settings on the high and low bands are one half the settings on the mid-band to compensate for the effective doubling of the FM deviation that occurs on the high and low bands.

### 3-20. Modulation On/Off

The four modulation modes are:

Internal AM
External AM
Internal FM
External FM

The modulation modes can be programmed separately or in any combination. The AM depth and FM deviation DACs are always programmed regardless of whether or not modulation is enabled. When enabling or disabling modulation, only the modulation control bits are programmed. Table 4D-17, Modulation ON/OFF Control, lists the control states for each modulation choice.

### 3-21. Modulation Frequency

The two internal modulation frequencies of 400 Hz and 1000 Hz are programmed with a single control bit MF400L. Table 4D-18 Modulation Frequency Control lists the MF400L control states.

### 3-22. Amplitude Modulation

The Generator allows amplitude modulation depth programming from 0 to 99% with 1% resolution. However, the maximum calibrated AM depth is 90%. Programming an AM depth greater than 90% causes the 'UNCAL' indicator to light. When the combination of signal amplitude and programmed AM depth exceeds +13 dBm peak, the 'UNCAL' indicator lights to warn you the output level is no longer guaranteed. Amplitude modulation depth is programmed using the 8-bit AM DAC, with a setting of 200 on the AM DAC corresponding to 100% AM modulation of the output frequency.

### 3-23. Frequency Modulation

Frequency modulation (FM) is programmable with three digits of resolution in the three decade ranges. Table 4D-12, FM Ranges, lists the three ranges.

### 3-24. FM Deviation

The FM DAC is a 10-bit DAC programmed to the FM deviation in Hz divided by the resolution. Table 4D-13 lists the settings of the FM DAC.

### 3-25. Self Test

At power-on, the Generator automatically self tests its digital and analog circuits. If the Generator fails any self test, the test results are automatically displayed as error codes. Several special functions are available for additional tests. (See section 4D-16.) Also, the Generator microprocessor continuously monitors two status signals, UNLVL (unleveled) and UNLOK (unlocked).

The self tests can also be invoked by using the [SPCL] [0][2] keys. The results of the self test can be displayed in the four display fields with [SPCL] [1][1] keys and can also be transmitted using the optional IEEE-488 Interface.

Self tests 1 through 5 are digital checks that indicate the general functionality of the Controller assembly. Self tests 6 through 10 use the two status signals UNLVL and UNLOK to test the general functionality of the RF circuitry.

During the self-test sequence all attenuators are programmed ON (maximum attenuation) to prevent unwanted signals at the output. In addition, the Generator is programmed to the internal frequency reference because the self tests fail if there is no reference supplied.

The self-test error codes and descriptions are listed in Section 4D. A brief description of the different Generator self tests are described in the following:

Test 1. The Generator RAM is verified by writing data to each memory location and checking that the same data can be read back. Both the off-chip RAM and the on-chip RAM are tested in this way.

Test 2. The data in each word of the two instrument software EPROMs is successively summed and rotated by two. The result of this procedure is compared with a checksum for each EPROM.

Test 3. The data in each of the three calibration EPROMs (VCO, Output, and Attenuator) is summed and compared with a checksum.

Test 4. The IEEE-488 (if installed) is verified by the microprocessor writing data to the IEEE-488 chip and then by reading it back to see if the response is the one expected. The operator is given a report only if the test fails.

Test 5. If Non-Volatile Memory is installed, each memory location of the Non-Volatile RAM is checked with a checksum.

Test 6. The low-pass filters on the Output assembly are tested by setting the frequency at the top of each of the four half-octave non-HET bands and verifying that the output is leveled. Then, the frequency is set above the cutoff frequency, and the output is checked to see if the output is unleveled.

Test 7. The synthesizer operation is verified by programming the Generator to a normal operating frequency and checking to see that the instrument is locked. The Generator is then programmed to a synthesizer frequency below 225 MHz and then above 550 MHz and is checked to see that the instrument becomes unlocked. Finally, all frequency reference circuitry is turned off and checked to see that the Generator becomes unlocked.

Test 8. The Generator PLL operation is verified by forcing a large change in frequency. When this is done, the Generator should become unlocked and then lock again.

Test 9. Frequency modulation is verified by overmodulating the carrier and then checking the unlocked indicator. This is done by programming internal FM on and programming the KV DAC to a higher than normal value.

Test 10. Amplitude modulation is verified by overmodulating the carrier and then checking the unleveled indicator. This is done by programming a high output level and programming INT AM on with a high AM depth.

### 3-26. Service Special Functions

There are two special function self tests for the front panel indicators and keys. These special function self tests are described in the following:

1. The front panel displays are checked any time by pressing the [SPCL] [0][3] keys. When this is done the microprocessor lights all display segments. This test is terminated by pressing any key on the instrument.

2. Check the normally open front panel keys by pressing the [SPCL] [0][4] keys. Now, each key pressed has its row and column address displayed in the center of the FREQUENCY display field. The special function is exited by pressing the [CLR/LCL] key.

### 3-27. Status Signals

Six status signals indicate the Generator option complement, and these status bits are interrogated at power-on self test as follows:

HSOPTL = 0 indicates Option -130 High-Stability Reference is installed.

SHREFL = 0 indicates Option -131 Sub-Harmonic Reference is installed.

IEINL = 0 indicates Option -488 IEEE-488 Interface is installed.

NVINL = 0 indicates the Option -570 Non-Volatile Memory is installed.

LRFML = 0 indicates the Option -651 Low-Rate FM is installed.

ROPTL = 0 indicates Option -830 rear panel RF OUTPUT and MOD IN connectors is installed.

RPPL = 0 indicates Option -870 Reverse Power Protector is installed.

The status of the rear panel REF EXT/INT reference switch is continuously monitored with the EXREFL bit. The state of this bit is used by the Controller to display the 'EXTREF' indicator on the front panel and to program the reference source.

The RF output of the Generator is considered calibrated whenever the 'UNCAL' indicator is off. The 'UNCAL' indicator is lit, but not flashing, whenever the calibrated limit of the Generator is exceeded. However, the RF output is still considered usable.

The 'UNCAL' indicator flashes when the output of the instrument is considered unusable. This is the result of a severe overrange condition or when one of the following analog status signals becomes active.

RPTRPL = 0 indicates that the optional-870 RPP circuitry has tripped. If this occurs, the RF output is programmed off to provide additional protection to the instrument. The 'RF OFF' and 'UNCAL'indicators flash to indicate that RPP has tripped.

UNLOKL = 0 indicates one of several conditions. The Synthesizer or the reference circuits could be out-of-lock. If FM is on, it could indicate FM over-modulation. The 'UNCAL' indicator flashes for any of these circumstances.

UNLVLL = 0 indicates that the output is unleveled. This could also be the result of amplitude over-modulation. With this condition, the 'UNCAL' indicator flashes.

## 3-28. DETAILED CIRCUIT DESCRIPTIONS

This section contains the detailed circuit descriptions for the following assemblies:

A1 Front Section

- A1A1 Display Assembly
- A1A2 Switch Assembly

A2 Module Section

- A2A1 Synthesizer Assembly
- A2A2 VCO Assembly
- A2A4 Output Assembly
- A2A6 Attenuator Assembly
- A2A7 Controller Assembly

A3 Rear Section

- A3A1 Power Supply Assembly

## 3-29. FRONT SECTION, A1

The Generator front section, A1, consists of the Display PCA A1A1, the Switch PCA A1A2, and the Elastomer switches mounted in a sheet metal housing. The front section also includes the display lens, the POWER ON/OFF switch, and the MOD INPUT connector.

## 3-30. Display PCA, A1A1

The Display PCA A1A1 provides a readout of the programmed modulation, frequency, amplitude parameters, and status information. This displayed information and the bright digit are controlled by the Controller, A2A7, under the direction of the instrument software. The display is comprised of two vacuum fluorescent displays and their associated control circuitry. The two displays are refreshed as four groups of eight display fields (usually a digit) each. The four groups share the digit (grid) strobes but have individual segment (anode) strobes.

### 3-31. DATA COMMUNICATIONS

Display data is sent through a byte-wide bidirectional data bus from the Controller A2A7 and is latched by U1 through U5 on the display board. Latch select signals DIGL, SEG1L, SEG2L, SEG3L, and SEG9L determine which latch receives the data. Level shifting buffer drivers U6 through U10 interface the TTL latches directly to the +37V anodes of the vacuum fluorescent displays.

### 3-32. DISPLAY FILAMENT VOLTAGE

The 6.0V ac filament voltage for the display is derived from a center-tapped winding on the power supply transformer, T1. The ac filament voltage is biased at +6.2V above ground by circuitry on the power supply board A3A1, to provide a cutoff potential for the displays.

### 3-33. BRIGHT-DIGIT EFFECT

The bright-digit effect is achieved by providing three extra refresh cycles (strobes) to the specified digit. Grid current-limiting resistor R3 provides uniform digit brightness by controlling electron depletion from the display cathode filaments.

### 3-34. SWITCHBOARD INTERFACE

The digit strobe data latched by U1 is buffered by open collector inverters U13 and U15, and strobes the front panel switch matrix. The switch columns are strobed in unison with the eight display fields. The switch matrix status is read by the tri-state buffer U14.

### 3-35. DISPLAY BLANKING

Monostable U11 and NOR gate U12 clear the display if new field or segment strobes are not received. This protects the display if the microprocessor stops refreshing. The display can be blanked manually by pressing [SPCL] [1][3] which sets the signal CLRL and the output of U11 low, thus clearing latches U2 through U5. To restore the display, press [SPCL] [1][2].

### 3-36. MODULATION-LEVEL INDICATOR

The external modulation-level indicator warns the operator when the modulation signal is not set to 1V peak ($\pm$ 2% typically). The external modulation signal is compared in the dual-comparator, U16, with internal references of 0.98 and 1.02V. Two status bits, MLEVLO and MLEVH1, are at the output of the 0.5 second dual one-shot, U17. If either of these reference voltages are exceeded, the two status bits are sensed by the Generator Controller that controls the 'EXT HI' and 'EXT LO' indicators in the MODULATION display field.

## 3-37. Switch PCB, A1A2

All the front panel control keys, except the POWER ON/OFF switch, consist of an Elastomer membrane sandwiched between the Switch PCB A1A2 and the front panel sheet metal housing. The Switch PCB consists of a 6-by-8 matrix of open switch contact pads. When a key is pressed, a conductive pad on the back of the Elastomer membrane connects a set of contact pads. The Controller software senses what row and column of the matrix are connected when a key is pressed.

## 3-38. MODULE SECTION, A2

The module section consists of a cast module frame with gasketed covers and includes the following electrical assemblies:

A2A1, Synthesizer
A2A2, VCO
A2A4, Output
A2A6, Attenuator (or A2A5, Attenuator/RPP)
A2A7, Controller

### 3-39. Synthesizer PCA, A2A1

The Synthesizer PCA provides frequency control and modulation of the Signal Generator output. The Synthesizer assembly is located on the top side of the Module Section A2. Together with VCO A2A2 and a 10-MHz reference frequency, the Synthesizer assembly simultaneously generates a high-band signal that spans 490 to 1050 MHz and a mid-band signal that spans 245 to 512 MHz.

The high-band and mid-band signals are coupled to the Output A2A4. Here, heterodyning extends the Generator frequency coverage down to 0.1 MHz.

The Synthesizer assembly consists of the following functional circuits that are described in the following paragraphs:

10-MHz Reference
Main PLL
FM Processing
800/40 MHz PLL
Sub-Synthesizer

#### 3-40. 10-MHZ REFERENCE

The 10-MHz Reference circuitry allows internal or external signals to function as the Generator reference. The Generator reference is normally the internal 10-MHz crystal oscillator. If Option -130 High-Stability Oscillator is installed, that oscillator becomes the Generator reference.

The internal 10-MHz crystal oscillator (XO) is a crystal, Y1, and an FET transistor Q26. The frequency is adjusted by C153. The oscillator signal from Q26 is buffered by Q27, converted to TTL by U54, and sent to multiplexer U55A. When the internal oscillator is disabled, the input (U54 pin 13) is pulled up at the same time the bias current for Q26 is disabled. The A section of this multiplexer decides whether the internal 10-MHz X.O., the external reference, or Option -130 High-Stability Reference is selected for the Generator reference.

The output of multiplexer U55 is sent to the 800/40-MHz loop-phase detector, the main loop-phase detector via divide-by-10 U58, and Option -131 Sub-Harmonic Reference (if installed). Multiplexer U55B sends the signal to the rear panel if the REF INT/EXT switch is set to INT.

The rear panel 10 MHz IN/OUT connector serves two functions.

1. When the rear panel REF INT/EXT switch is set to INT, the 10-MHz reference signal from the X.O. is the Generator's reference.

   If Option -130 High-Stability Oscillator is installed, its signal is the Generator's reference, and it is available at the rear panel 10 MHz IN/OUT connector.

2. When the rear panel REF INT/EXT switch is set to EXT, an external 10-MHz TTL signal applied to this connector becomes the Generator reference.

   If Option -131 Sub-Harmonic Reference is installed, a separate BNC connector labeled REF IN is installed on the rear panel. The existing 10 MHz IN/OUT connector is relabeled 10 MHz OUT.

## 3-41. MAIN PHASE-LOCK LOOP

The main phase-lock loop (PLL) is a fractional divider PLL with a single-sideband mixer (SSB) in the feedback path. The oscillator for this loop is a separate PCA, the A2A2 VCO. All the remaining PLL circuitry is on the synthesizer PCA A2A1.

The key signals to the main PLL are the 1-MHz reference signal from the 10- MHz Reference circuit, the 245-MHz to 512-MHz signal from the binary divider, and the 20-kHz to 40-kHz signal from the sub-synthesizer circuit. The fractional division technique provides 20-kHz frequency resolution.

The SSB mixer, in conjunction with the sub-synthesizer, provides additional 5-Hz resolution at the Generator frequency (Fs). This corresponds to 10-Hz resolution on the high band.

The main PLL consists of the VCO, the binary divider, the SSB mixer, the triple-modulus prescaler, the N-Divider, the phase detector, and the loop amplifier. All but the VCO are described in the following paragraphs. The VCO is discussed in paragraphs 3-48.

### 3-42. Binary Divider And Single-Sideband Mixer

The 490-MHz to 1050-MHz signal from the VCO via J107 is coupled to the binary divider, U1. Regulator Q1 provides +5V for the divider. One output of U1 is coupled to the Output PCA, A2A4 through J104. The other output is amplified by Q2 and Q3. This signal is split into two quadrature (90° phase difference) signals by 3-dB coupler, U6.

This signal, and two other audio quadrature signals from U10, are summed in the double-balanced mixers U7 and U8 to produce two double-sideband suppressed-carrier signals. Because of the phase relationship of the outputs of the mixers, the summing of the two composite signals (in resistor network R21 and R22) results in the upper-sideband component being suppressed. The predominate remaining signal is the lower-sideband signal.

The lower-sideband signal, spanning 245 MHz to 512 MHz in 20-kHz steps, is amplified by U9 and applied to the N-Divider where it is divided down to 1 MHz.

### 3-43. N-Divider

The main components of the N-Divider are:

Triple-Modulus Prescaler (divide by 20/21/22) U18, U19, and U20
N-Divider Custom Gate Array U17

The triple-modulus prescaler, Figure 3-1, consists of a divide by 10/11 (U20), divide by 2 (U18A), synchronizing flip-flop (U18B), and quad NOR gates (U19). If all the inputs (E1, E2, E3, E4, and E5) to the 10/11 divider are low, the prescaler divides by 11, and the total division to the output (U20 pin 7) is 22. If any of the inputs are high, it divides by 10, and the total division is 20.

If inputs E1 and E3 are low, the modulus of the 10/11 divider is controlled by the output of the following divide by 2 (U18A). Consequently, the prescaler divides by 10 half the time and by 11 the other half, resulting in a divide by 21. U20 contains the ECL to TTL converter. U18B synchronizes the changing of the modulus with the clocking of the subsequent stages. The N-divider is clocked by the composite prescaler output U18A.

The operation of the triple-modulus prescaler is shown in Figure 3-1. The prescaler operates in conjunction with the N-divider gate array shown in Figure 3-2.

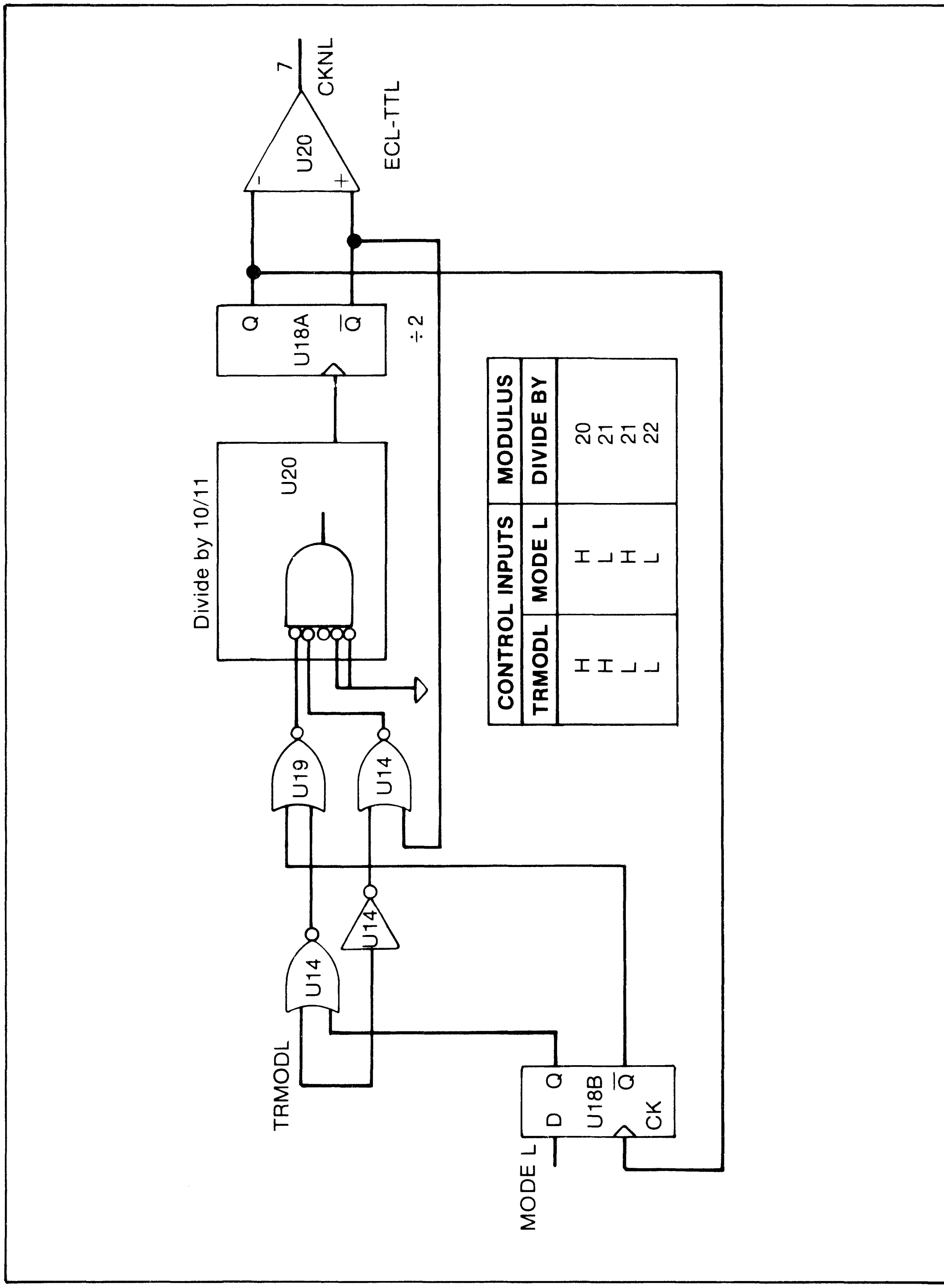



Figure 3-1. Triple-Modulus Prescaler Operation

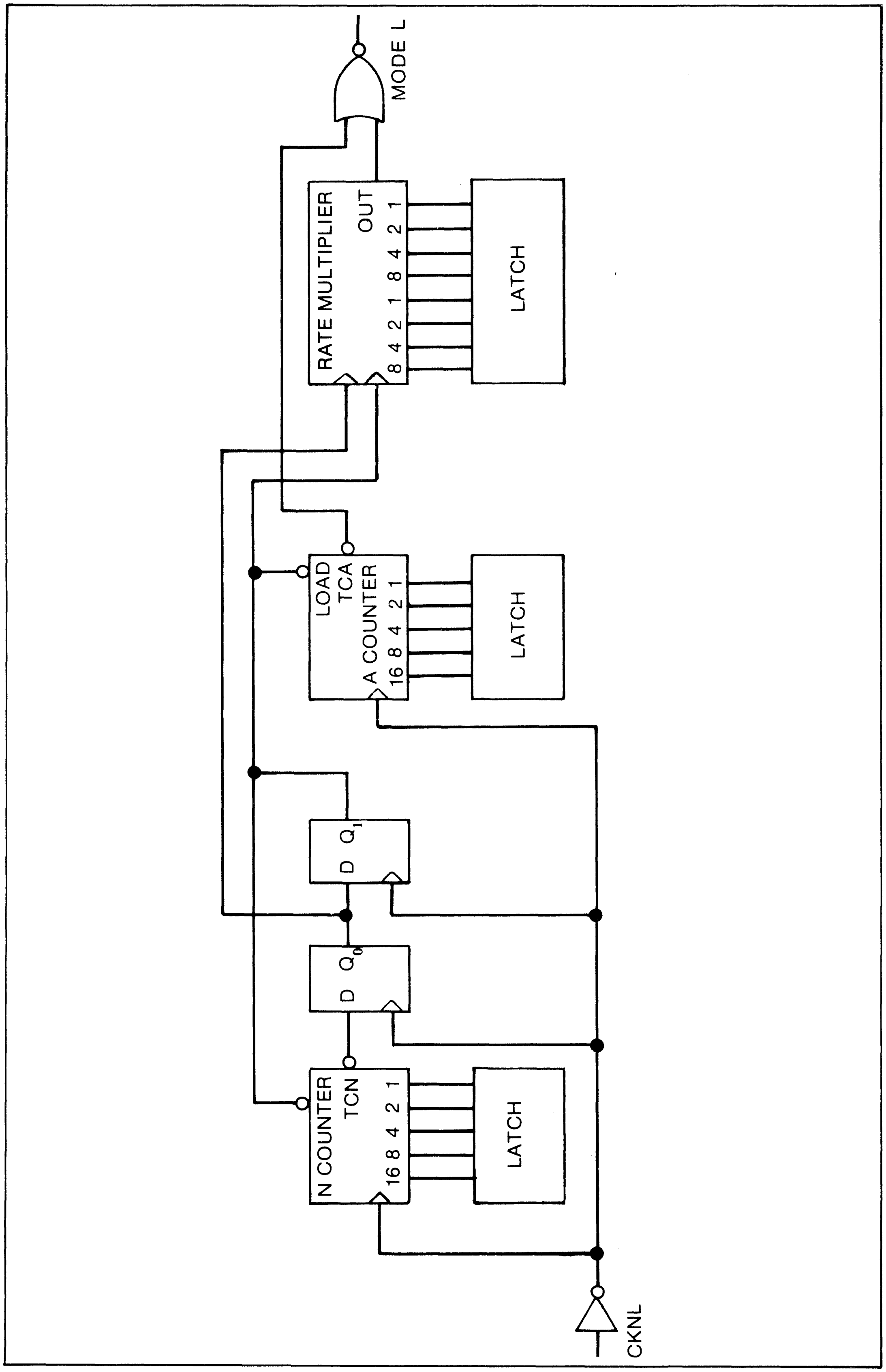



**Figure 3-2. N-Divider Operation**

The N-Divider gate-array contains two 5-bit binary counters (A and N), a BCD two-decade rate multiplier, and latches to interface to the microprocessor. The operation of the N and A counters is as follows:

At the beginning of a count cycle, a number is loaded into the A and N counters. The A counter is not at its terminal count, so the output is high, and the mode line (MODE L) is low. This causes the prescaler to divide by 21 (or 22, TRMODL = low). The mode line stays low for 31-A counts, where A is the programmed number. The mode line goes high, and the prescaler divides by 20 (or 21, TRMODL = low) for 31-N counts.

The total division is:

$$(P+1)*(31-A) + P*((31-N)-(31-A)) \text{ or } P*(31-N) + (31-A)$$

On the 31st count, the counters are reinitialized. Figure 3-3 shows the timing for the A-counter programmed to 26, and the N-counter programmed to 18. Only the CKNL and MODE L signals shown in Figure 3-2 are accessible at U17, pin 6, and 22, respectively. Figure 3-3 show the N-Divider timing diagram.

The N-Divider gate array includes a two-decade rate multiplier that produces the fractional part of the division. It produces a pulse train with a programmed number of pulses for a 100-cycle frame of the 1-MHz N-divider output.

The programmed number ranges between zero and 98 in steps of two, corresponding to 20-kHz steps at the mid-band output frequency. The flip-flops in the rate multiplier get setup on count 29, and on count 30, a pulse may or may not be present depending on the programming of the rate multiplier. This is the shaded pulse in the timing diagram, Figure 3-3.

Irregularly spaced rate-multiplier pulses cause the mode line to go low, and the prescaler divides by P+1 at a rate equal to the rate multiplier programming. At a division of 255, the N and A counters are normally programmed to 15. This means the divider is always dividing by 21; consequently, there is no place to slip in the rate-multiplier pulses.

It might be noted that a 20/21 dual-modulus prescaler will not allow division from 245 to 525 without holes. For example 252 is 12 frames of 20 and 12 frames of 21. Consequently, there is no place to slip in the rate-multiplier pulses. It is not possible to divide by 253.

By using a triple-modulus prescaler, these problems are solved. Continuing with the above example number of 252, 252 is 12 frames of 21 and 0 frames of 22. The deleter functions by allowing the prescaler to divide by 22 at a rate equal to the rate-multiplier frequency. Number 253 is 11 frames of 21 and 1 frame of 22. A software algorithm determines whether to operate in the 20/21 mode (TRMODL =1) or 21/22 mode (TRMODL =0).

The frequency at the output of the divider is $(F_o/2 - F_s - F_d)/N$; where $F_o$ is the VCO output frequency, $F_s$ is the sub-synthesizer frequency, and $F_d$ is the fractional-division frequency.

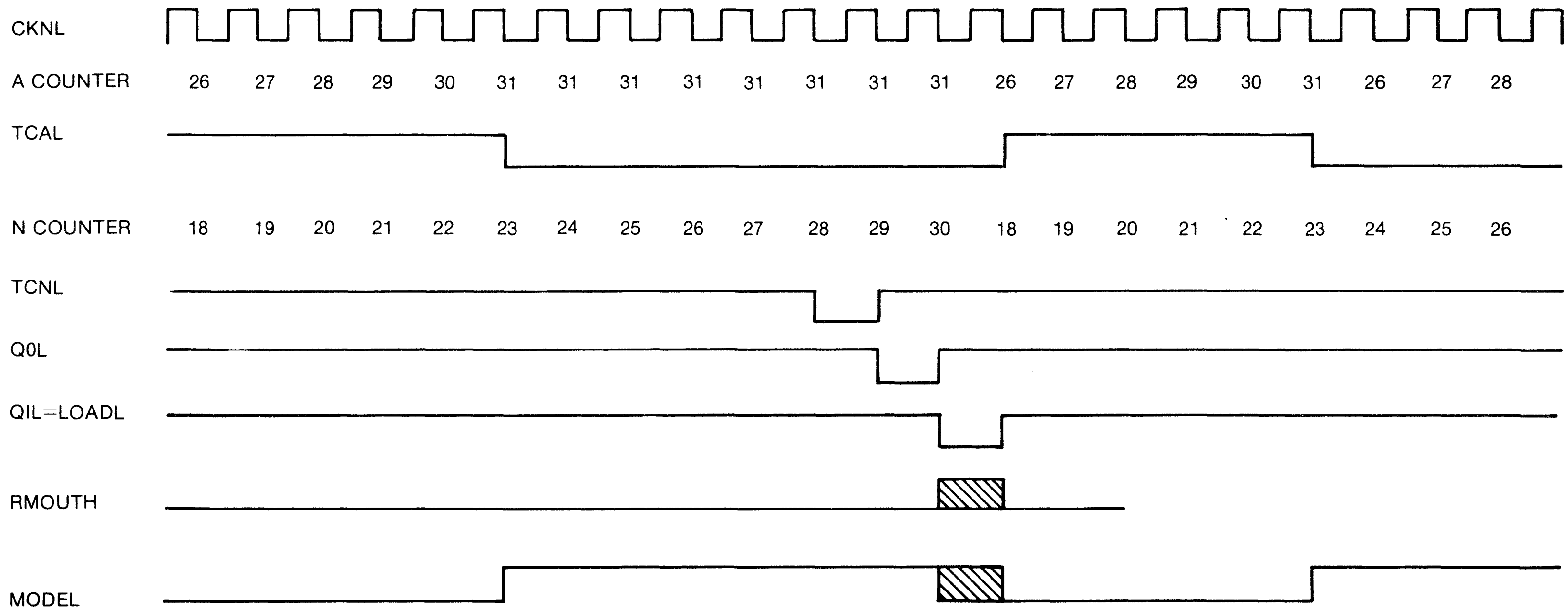



Figure 3-3. N-Divider Timing Diagram

### 3-44. Phase Detector

The 1-MHz reference signal from divide-by-10 U58, and the 1-MHz signal from the N-divider U17 are connected to a digital phase-frequency detector (U43, U44, U45). If the N-divider output is greater than the reference frequency, the level at TP38 is high. When the output of the level shifter Q16 is above ground, then CR12 is turned off. This allows current from Q19 to flow through CR13 into the integrator, decreasing the voltage at the integrator output, U48 Pin 6, which then lowers the frequency of the VCO until the reference and the N-divider output are the same frequency.

Similarly, if the N-divider output frequency is below the reference, TP39 is low, and the voltage at the output of level shifter Q17 is below ground, turning off CR15 and allowing current from R108 to flow through CR14 out of the integrator. This raises the voltage at the output of the integrator, which raises the VCO frequency. The phase-frequency detector is designed so that if the phase between the reference and N-Divider output slips more than two cycles in either direction, the corresponding phase-detector output is high or low. This provides twice the integrator current during acquisition as a conventional phase-frequency detector.

R107 provides a small bias current to the integrator to bias the phase detector at approximately 2.5 radians; consequently, the down-pump is normally always on. If the up-pump comes on, indicating an over-modulation condition, the pulses are detected by the one-shot, U47 that produces the UNLOK status that is then sensed by the Controller.

For flat FM response, it is necessary for the PLL bandwidth to be constant at all VCO frequencies. Two factors cause the loop bandwidth to change: the VCO tuning coefficient (Kv) and the divider ratio (N).

During calibration of the VCO, the Kv is measured at many frequencies across the band, and compensation data is stored in the VCO Calibration EPROM. The instrument software uses this data along with N to control the PLL bandwidth in a compensating manner. The PLL bandwidth is controlled by changing the current to the down-pump via the KN DAC, U27, and the voltage-to-current converter, U46, Q18, and Q19.

### 3-45. Loop Amplifier

The loop amplifier-integrator consists of operational amplifier U48, C118 and R91. Capacitors C121 and C119 filter the 1-MHz reference. The output of the integrator is connected to a multi-pole LC filter (R92, C123, C99, C124, C126, C125, L49, L50, and R93) that attenuates the delete rate (20 and 40 kHz) and reference 1-MHz spurs.

Diodes CR9 and CR10 stabilize the loop during switching. The filter is buffered by the Darlington emitter-follower Q20, which is biased at 10 mA by Q21. Additional lead/lag compensation is provided by R99, R101, and C131. Proper termination for the filter is provided by R93 and Q22. The voltage for the loop amplifier is regulated to approximately +30V by Q15.

Amplifier U49 is a precision clamp to keep the VCO frequency above a minimum value for oscillation, and below a maximum above which the N-divider would not divide correctly. The photoisolator U50 detects when the clamp is active, indicating an out-of-lock condition. This signal is ORed with the signal from one-shot U47 and sent to the microprocessor as the UNLOK status.

### 3-46. FM PROCESSING

To provide FM accuracy, the FM signal FMV from the Output board is first processed by the KV DAC (U28, and U29) to compensate for the VCO tuning coefficient. The KV DAC setting is proportional to 1/Kv, where Kv is the tuning coefficient. This correction is stored in the VCO Calibration EPROM on the Controller board. For output frequencies above 512 MHz and below 245 MHz, the KV DAC setting is halved to account for the effective frequency doubling that occurs on these bands.

Range switching is provided by resistors R77, R78, R79, and FETs Q10, Q11, and Q12. Comparator U42 converts TTL levels to 0V (on), and -15V (off) required by the FETs. U41A buffers the range switch, and in conjunction with R82, provides an overall FM adjustment. At this point, the audio signal splits into two paths. The path that connects to the integrator, U41, is for modulation frequencies inside the loop bandwidth.

The path that sums with the VCO control voltage at J103 is for frequencies outside the loop bandwidth. U41D is an active high-pass filter that compensates for the non-ideal integrator and the ac coupling to the VCO tuning port.

The output of U41D is summed with the VCO control voltage via R88 and C117. FET Q13 allows the FM to be turned off. The audio signal is also processed by integrator U41A, R85, R86, and C115. The audio signal is ac coupled into the phase-detector integrator via R89, R90, C116, and FET Q14. (Resistor R90 adjusts the low frequency FM gain). This integrator makes the phase modulation produced at the Phase Detector appear as FM.

### 3-47. 800/40 MHz PLL

When the Signal Generator is operated in the low-band, the 800-MHz oscillator is locked to the 10-MHz Reference and provides a local oscillator for the heterodyne circuit on the Output PCA. It also provides a 40-MHz signal to the sub-synthesizer clock generator.

The 800-MHz VCO is connected to the divide-by-four, U61, followed by a divide-by-five, U62 and U63, providing 40 MHz to the sub-synthesizer clock generator through selector U64. When the Signal Generator is not in the low-band, the 800-Hz oscillator and the first divide-by-four are disabled by turning off Q28 (HET).

The 40-MHz Oscillator consisting of U64, L66, and CR24, is selected by U64. The 40-Hz balanced ECL signal from U64 drives the two-phase clock generator. A self-biased gate, U65, converts ECL to TTL. U66 divides the 40-MHz signal by four to produce a 10-MHz signal that is compared against the 10-MHz reference in the phase detector U59 and U65.

Op-amp U60, resistor network Z9, and C181, C185, C186, and C201 integrate the phase detector pulses to produce a dc control voltage for the 800-MHz VCO and the 40-MHz VCO.

### 3-48. 800-MHz VCO

The 800-MHz VCO is a low noise, limited range, voltage-controlled oscillator for the 800-MHz PLL. The basic oscillator uses two active devices operating as negative resistance elements, coupled symmetrically to a resonator made up of a varactor and an adjustable capacitor. Each device is followed by an amplifier and isolation pad. This provides two coherent outputs of +5 dBm to the PLL and 0 dBm to the output A2A4 assembly.

The oscillator transistors Q32 and Q35 are biased at 13 mA by R182 and R191. The voltage at the collectors of Q32 and Q35 is typically +2.5V. The two 6-dB amplifiers Q33 and Q37 are biased so that the voltage at their emitters is about +0.3V, and the voltage at their bases is about +1V with the collectors at +6.5V.

The PLL control voltage from U60 provides the tuning voltage for the varactor CR27. The adjustable capacitor C206 is set to provide +16V on the varactor to optimize the VCO noise characteristic. The output attenuators consisting of R186, R187, R189, R197, R198, and R200 provide isolation between the outputs. The VCO signal is coupled to the output assembly A2A4 by a through-the-plate coaxial connector P108 at the 0 dBm level. The other VCO signal is connected to the divider U61 to provide the feedback for the PLL.

### 3-49. SUB-SYNTHESIZER

The sub-synthesizer consists of the clock generator, U34, 35, Q4, Q5, the gate-array, U33, the divide by 500, U15, and U16, and the low-pass filter L11 and L17. Internal to the sub-synthesizer gate-array, U33, are a divide-by-two, a 3 1/2 decade-rate multiplier, and associated latches.

The balanced 40-MHz ECL clock signal is converted to TTL in Q4 and Q5, and converted to a two-phase 20-MHz clock in U34, U35.

An enable output of each section allows multiple sections to be cascaded. The input frequency to the rate-multiplier is 20-MHz. The output frequency can be programmed from zero to 19.995 MHz in 5-kHz steps. This signal is ORed with the other phase of the 20-MHz clock to produce 20 MHz to 39.995 MHz at U33 pin 1. This is divided by two in the gate-array, by ten in U15, and again by 50 in U16 to produce 20 kHz to 39.995 kHz in 5-Hz steps. This TTL signal at TP11 is filtered by L11, L17, and C41, C42, C48, C50, and C51. Op-amp, U10 forms an active quadrature generator, and the output pins 14 and 8 are offset by 90°. These two signals are the 20-kHz to 40-kHz inputs for the Main PLL single-sideband mixer.

### 3-50. VCO PCA, A2A2

The VCO PCA A2A2 is the heart of the main PLL. It produces the signal that is further processed to become the Signal Generator output. The VCO assembly is located in a bottom side compartment of the Module section A2.

The VCO tunes over a frequency range of 490 MHz to 1050 MHz with a control voltage range of +2V to +18V. The basic oscillator circuit uses two active devices operating as negative resistance elements. Coupled symmetrically to a resonator, each active device is followed by a 6-dB amplifier and a 15-dB isolator pad that provides two coherent but isolated signals at about 0 dBm.

One signal is sent to the Output A2A4 assembly, and the other to the Synthesizer A2A1 assembly. To suppress harmonics, two tuned trap filters are placed between the negative resistance devices and amplifiers Q2 and Q4.

The oscillator transistors Q1 and Q3 are biased at 13 mA by the FET current sources Q5 and Q6. The voltage at the collectors of Q1 and Q3 are typically set at +6V. The two 6-dB amplifiers Q2 and Q4 are biased so that the voltage at their emitters is about +0.3V and at their bases about +1V, with the collectors at about +6.5V.

The PLL control voltage from the Synthesizer assembly A2A1 at P102 provides the tuning voltage for varactors CR1 and CR2. This voltage also controls varactors CR3 and CR4 with resistors R6, R4, R18, R19, and R20. These varactors, in conjunction with their lead inductance and C1 and C32, make up a shunt trap filter at twice the VCO frequency to suppress the in-band second harmonic at both VCO outputs to typically less than -10 dBc.

The output attenuators consisting of R13, R14, R15, R27, R28, and R29 provide the isolation between the two VCO outputs at P103 and P104. C23 and C30, in series with the printed board inductors, form out-of-band trap filters for approximately 1.4 GHz. These filters further suppress the out-of-band harmonics.

C23 couples the VCO signal to the Synthesizer assembly by a through-the-plate coaxial connector P104. The other VCO signal is connected to the Output assembly A2A4 by a plug-in capacitor, A2C1. This plug-in capacitor allows either VCO or the Output PCB to be removed independently from the module A2 assembly without the use of a soldering iron.

### 3-51. Output PCA, A2A4

The Output PCA accepts RF signals from the Synthesizer and the VCO circuits and command signals from the Controller. The output circuit provides a 0.1-MHz to 1050-MHz RF signal to the Attenuator.

The functions of the Output assembly are to reduce harmonic distortion components in the RF signal, control RF signal amplitude, introduce AM, and generate the low (heterodyne) frequency band 0.1 MHz to 245 MHz though mixing. It also generates a modulation signal to provide internal AM and FM, and provides a digital interconnect path between the Controller and Synthesizer.

#### 3-52. RF PATH

The RF path begins with the two RF signals from the VCO and the Synthesizer assemblies. The SPDT bandswitch circuit selects between the 512-MHz to 1050-MHz signal at P106 and the 245-MHz to 512-MHz signal at P107. The selected signal is applied to buffer amplifier Q101 and Q102.

The 245-to 512-MHz signal directly generates the 245-to 512-MHz mid-band output signal. The 512-MHz to 1050-MHz signal generates the 512-MHz to 1050-MHz high-band output signal directly and the 0.1-MHz to 245-MHz low-band output signal by mixing with an 800-MHz LO signal.

The buffer amplifier Q101 and Q102 is a common-base, common-emitter cascade circuit with 7-dB gain. The three cascaded filter circuits that follow the buffer amplifier consist of combinations of discrete components and printed filters that suppress harmonics in the Generator RF output signal.

The first section of the circuit is a printed 1100-MHz low-pass filter. The second section is switched into the RF path via PIN diodes CR106 through CR110 by asserting MIDL when the Generator is operated in the mid-band (245 to 512 MHz). PIN diodes CR114 through CR116 select capacitors C119, C121, and C123 whenever HAOCTH is asserted to change the section cutoff frequency from 512 to 350 MHz. The third section provides harmonic filtering for the two higher bands, 512 MHz to 730 MHz, and 730 MHz to 1050 MHz. PIN diodes CR111 through CR113 select capacitors C112 through C114 to change the cutoff frequency from 1050 MHz to 730 MHz whenever HAOCTH is not asserted.

The amplitude modulator consists of PIN diodes CR117 through CR120 and associated components and follows the switchable filters in the signal path. The modulator is a voltage-controlled variable attenuator that provides AM and output level control. Modulator control voltage is determined by the leveling-loop circuitry. The leveling loop is described later in this section.

Q209, Q211, Q213, and associated components follow the modulator in the signal path and form a three-stage, 20-dB gain, 245-MHz to 1050-MHz amplifier. This amplifier drives a 3-dB power splitter that consists of resistors R253 through R255 and associated printed transmission lines.

One power splitter output drives the leveling-loop detector diode CR202. The other output goes to the HET band switch that includes PIN diodes CR203 through CR210 and biasing components. In the 245-MHz to 1050-MHz position, the signal passes through diodes CR204 through CR209 to the output amplifier Q215. This low-distortion output amplifier has 6-dB gain and output capability of 15 dBm.

For low-band operation (0.1 MHz to 245 MHz), the signal from the power splitter is routed through CR203 to an adjustable attenuator, R224 through R229, and then to the RF port of U201 (a double-balanced mixer). The signal frequency at the mixer RF port varies from 800.1 MHz to 1045 MHz. The 800-MHz local oscillator (LO) signal for the mixer comes from the Synthesizer assembly through P108 and is amplified by Q207. This fixed-tuned amplifier has 13 dB of gain and provides a 10-dBm signal at the mixer LO port.

The mixer 0.1-MHz to 245-MHz output signal is passed through a diplexing low-pass filter (C219 through C230, R230, R231) that suppresses unwanted mixer spurious products while maintaining a 50-ohm load at the mixer IF port. The filtered IF signal is amplified by a three-stage IF amplifier Q202, Q204, Q206 and associated components.

The IF amplifier gain increases with frequency and is nominally 35 dB at 0.1 MHz and 37 dB at 245 MHz. This gain characteristic compensates for the increasing loss with frequency of the mixer and the diplexing low-pass filter. The output of the IF amplifier passes through a 245-MHz low-pass filter (C216, C217, C218 and printed inductors) and PIN diode CR210 to the output amplifier. The +15V power supply for the LO and IF amplifiers is switched off by Q301 when the instrument is operating in the 245-MHz to 1050-MHz band to avoid introducing spurious products in the instrument output.

### 3-53. LEVELING LOOP

The leveling loop accepts the unleveled 245-MHz to 1050-MHz signal from the switchable low-pass filters and generates a leveled signal at the power splitter output that feeds the HET band switch. The leveled signal is proportional to the leveling loop control voltage that is generated by the level-control circuit. The signal amplitude at the other output of the power splitter is detected by a Schottky detector diode, CR202.

This diode generates a temperature-dependent dc voltage, which is a non-linear function of the applied RF voltage, so temperature compensation and linearization are necessary. The detector diode signal is low-pass filtered by L217 and C253, and is offset by the voltage across temperature-compensating diode CR126. Q104, Q105 and associated components form a current source circuit that provides bias current for CR126 and CR202.

The offset detector diode voltage at U101B pin 3 is linearized by amplifier U101B and its associated feedback components. Potentiometer R144 provides detector linearity adjustment. Thus, the voltage at U101B pin 1 is proportional to the RF voltage at detector diode CR202.

This voltage is divided and applied to the loop integrator amplifier at U101A pin 6. This amplifier drives the modulator through emitter follower Q103 and through the action of the ALC loop, maintaining the voltage level at U101A pin 6 equal to that on pin 5. Pin 5 voltage is a function of the leveling loop control voltage applied to R140. R140, R141, CR127, and CR128 form an additional detector linearizing network that is active for low RF levels. Amplitude modulation is achieved by summing an appropriately scaled modulation signal with the dc leveling loop control voltage applied to R140.

The amplitude modulator consists of PIN diodes CR117 through CR120, resistors R121, R122, and capacitors C137 and C138. Attenuation through the modulator is a function of bias current through the PIN diodes. This current is provided by the modulator linearizer circuit (R123 through R129, R148, R149, C139 through C143, and CR121).

Modulator attenuation is thus approximately proportional to the modulator control voltage at the emitter of Q103. Proportionality is required to maintain constant leveling loop bandwidth as modulator attenuation varies. Minimum attenuation is obtained with a modulator control voltage of 10V, while maximum attenuation is obtained with 0V.

Comparator U310A and associated components form an unleveled indicator circuit. The comparator senses the modulator control voltage at the emitter of Q103. This voltage is normally less than +11V, and the comparator output is high. If the modulator control voltage exceeds +11V, the modulator attenuation is at a minimum, and the leveling loop becomes inoperative (unleveled). This condition could be due to a fault or some abnormal operation such as over-modulation. In this case, the comparator output (UNLVLL) goes low. The Controller senses this low and causes the front panel 'UNCAL' indicator to flash and displays an unleveled status if interrogated.

## 3-54. LEVEL CONTROL

The instrument output level is set by the level-control circuit. Inputs to this audio signal processing circuit are the internal and external modulation signals, a dc reference voltage, and the digital control commands. The circuit output is the leveling loop control voltage that provides vernier level control of the Generator output. Digitally encoded level, modulation depth, and temperature-compensation information are provided by the Controller.

Selection of the internal or external modulating signal, or no modulation, is made by analog switches U401C, U401D, and Op-amp U402B. The selected, buffered modulation signal at U402B pin 1 is applied to pin 4 of U301, a dual 8-bit DAC. U301, with U302D, acts as a digitally programmed variable attenuator and is labeled AM DAC.

Binary AM depth control information from the Controller is applied to DAC U301. The output at U302D pin 14 is the modulation signal scaled to the programmed AM depth. This ac signal is summed by op-amp U302B with a dc reference voltage provided by CR403. The output at U302B pin 7 is called the 1+AM signal. This signal provides the desired AM depth when scaled by the LVL DAC and applied to the leveling loop. AM depth adjustment is provided by potentiometer R421.

The instrument RF output amplitude is temperature compensated in a frequency-dependent manner as follows. The 1+AM signal is applied to pin 18 of dual 8-bit DAC U301, the DAC B reference input. The DAC output, at U405D pin 14, is the 1+AM signal attenuated by an RF frequency-dependent factor provided by the Controller using constants stored in the Generator firmware. This voltage is applied to a resistor/thermistor network that includes R303, R305, R306, and RT301.

The network output is the 1+AM signal attenuated by an RF frequency and temperature-dependent factor, and is applied to summing op-amp U302C. The 1+AM signal is also applied to this summing amplifier. Thus, the voltage at U302C pin 8 is the temperature-compensated and scaled 1+AM signal.

This signal is applied to the reference input of Level DAC U303. This 12-bit DAC, with op-amp U302A, latches U304, U305, controls the Output assembly RF output amplitude. The DAC output voltage, at U302A pin 1, is the temperature-compensated 1+AM signal multiplied by a factor proportional to the 12-bit level control number provided by the Controller. This voltage is the leveling loop control voltage. The Generator RF output level adjustment is provided by potentiometer R311, and DAC offset voltage adjustment is provided by potentiometer R309.

### 3-55. MODULATION OSCILLATOR

The modulation oscillator generates a leveled sine wave of 400 Hz or 1 kHz and is the modulation source for the internal AM and FM functions. The oscillator is a level-controlled Wien-Bridge type and consists of op-amps U405A, U405B. Frequency is determined by the series RC time constant of the components between pins 5 and 7 of U405B and by the parallel RC time constant of the components from U405 pin 5 to ground. The modulation frequency control line, MF400L, originating at the latch U308, selects either 400-Hz or 1-kHz operation, and is selected by switching resistors with JFETs Q401 and Q403.

The amplitude of oscillation is controlled by an ALC loop that varies the resistance on U405B pin 6 to ground. This resistance comprised of R412 and the drain resistance of Q402, is nominally 2K ohms. The oscillator signal amplitude is sensed by rectifier CR401. The average current through CR401 is made equal to the reference current in R416 by integrator-amplifier U405A. Level adjustment is set by potentiometer R419. Temperature compensation is provided by R417, R418, and CR402.

### 3-56. FM DEVIATION CONTROL

The FM modulation signal source and deviation control circuits are on the Output assembly. Analog switches U401A, U401B, and op-amp U402A select the internal or external modulating signal, or no modulation. The selected and buffered modulating signal at U402A pin 7 is applied to FM DAC U403. This DAC provides fine control of the FM deviation. (The coarse control FM circuitry is part of the Synthesizer assembly). The output of the DAC, at U405C pin 8, is the modulation signal multiplied by a factor proportional to the 8-bit FM deviation control provided by the Controller.

## 3-57. Attenuator PCA, A2A6

The Attenuator PCA A2A6 consists of an Attenuator PCA, A2A6A1, in a metal housing mounted on the top side of the A2 module section to form a shielded enclosure. The Relay Driver PCA, A2A6A5, is included in this assembly.

The Attenuator assembly controlled by the microprocessor provides coarse control of the Signal Generator output level. The high-level signal from the Output PC assembly, A2A4, is applied to the Attenuator which provides 0 dB to 138 dB of attenuation, in 6-dB steps, to this signal before it goes to the Generator RF OUTPUT connector.

If the Generator is equipped with the Reverse Power Protector option, the standard Attenuator A2A6 assembly is replaced with the Attenuator/RPP A2A5 assembly. For a description of this option, refer to Section 6 paragraph 870-1 in this manual.

Compensation data peculiar to the particular attenuator in each Generator is stored in the Attenuator calibration EPROM located on the Controller PCA, A2A8. The instrument program uses this data to correct for the combined deviations of the attenuator sections in use. For more details on level correction, refer to paragraph 3-13, Amplitude Control.

The Attenuator Assembly provides an attenuation range from 0 dB to 138 dB in 6-dB steps and consists of seven independently cascaded 50-ohm attenuation sections, a 6-dB, a 12-dB, and five 24-dB sections. Each section consists of a DPDT relay and a three-resistor attenuator pad.

One relay position (when power is applied to the relay provides a straight path for the RF signal, and the other position (no power applied to the relay) inserts the attenuator pad into the RF signal path. All seven relays are inside individual shielded compartments in the Attenuator housing.

The control of the Attenuator relays is latched via U27, the open-collector drivers U30 and U31 on the Controller PCA A2A8 and transistor drivers on the A2A6A5 Relay Driver PCA (or the A2A5A5 Relay Driver/RPP control PCA). For calibration and troubleshooting purposes, special functions 83 through 86 allow the direct selection of four of the five 24-dB attenuators. The other 24-dB attenuator is selected by programming the appropriate level (-12 dBm).

## 3-58. Controller PCA, A2A7

The Controller, under the direction of the instrument software, handles the data interface between the front panel, remote interface, and Generator functions. The Controller is located in a top side compartment of the module section, A2.

The Controller printed circuit assembly consists of the following functional groups:

- Microprocessor and its interface circuitry
- Attenuator control interface
- Front panel interface
- IEEE-488 Interface
- Memory ICs and addressing circuitry
- Module I/O circuitry
- Reset circuit
- Status and control latches

### 3-59. MICROPROCESSOR

The heart of the Controller assembly is U1, a TMS9995 16/8 bit microprocessor. The digital system clock signal is generated by an oscillator comprised of gates from U5 and crystal U41. When enabled, bidirectional buffer U4 provides additional drive current to the data bus operation; when it is disabled, it isolates the microprocessor from the system data bus. Buffers U33, U34, and U10 provide extra drive current to the microprocessor address and control signals.

### 3-60. ATTENUATOR CONTROL INTERFACE

The attenuator control signals are latched by U27. Darlington drivers U30 and U31 control the Relay Drivers A2A6A5 (or A2A5A5) PCA.

### 3-61. FRONT PANEL INTERFACE

Data is transferred to and from the front panel circuitry through tri-state bidirectional data buffer U18. This buffer is active when a front panel latch is addressed and the buffer control signal from U17 is low; otherwise, it is in the high-impedance state. The front panel latch select lines are decoded by U36. To reduce RF emissions from the Generator, low-pass filters comprised of the following components are used on the following signals:

| SIGNALS | COMPONENTS |
|---|---|
| Signal CLRL | R6 and C51 |
| Latch select SEG1L | R7 and C53 |
| Latch select SEG2L | R8 and C54 |
| Latch select SEG3L | R9 and C55 |
| Latch select SEG9L | R10 and C56 |
| Latch select DIGL | R11 and C57 |

In addition, capacitors C58 and C59 bypass the display filament supplies. LC filters comprised of L1 and C50, and L2 and C52 are used on the +5 volt and +37 volt supplies to the front panel circuitry.

### 3-62. IEEE-488 INTERFACE

Tri-state bidirectional buffer U2 buffers the data bus to the optional IEEE-488 assembly, A3A3. Address and control lines to the option are buffered by tri-state buffer U3. These buffers are in the high-impedance state when the option is not addressed.

The active low interrupt signal IEINTL from the IEEE-488 option is connected to the level four interrupt on the microprocessor. When the option is not present, IEINTL is pulled up to the inactive state. R1 and C22 form a low-pass filter to suppress digital emissions from the Generator.

### 3-63. MEMORY

The microprocessor uses a 2K-byte RAM (U25) to store program variables. A 32K- and an 8K-byte EPROM (U21 and U22) contain the microprocessor instructions and constant data. Three 2K-byte Calibration EPROMs (U23, U24, U26) contain calibration data for the VCO, Output, and Attenuator or optional Attenuator/RPP assemblies, respectively. Decoders U20 and U14 decode the individual chip selects for the memory ICs.

### 3-64. MODULE I/O

Control data is transferred to the RF circuitry (located in the Module Section, A2) through a byte wide unidirectional data bus. This data is retained on the RF circuit boards in latches. Select lines BSEL0L, BSEL1L, and address lines BAB2 through BAB0 are decoded into individual latch enables on the various RF circuit boards. Tri-state buffers U15 and U16 on the data and address lines provide extra drive current and allow these signals to float when inactive.

Flip-flop U42 gates the module I/O select pulse from U8 with the system clock to delay the leading edges of BSEL0L and BSEL1L to provide adequate latch setup times. D-flip-flop U9 latches address lines BAB2 through BAB0 to provide adequate latch hold times.

### 3-65. RESET

Comparator U7 and its associated circuitry generate the active low reset signal to the TMS9995. The reset signal is generated on power-up or if the +5V supply drops below +5V.

At power-up, R5 and C4 provide a slow-rising reset signal to the microprocessor, and the output of U7 is ignored. When the +5V supply is up, a reference voltage is set at U7 pin 2, the negative terminal. This reference voltage is one diode drop below the voltage at the positive terminal (pin 3). When power is lost, the voltage at the positive terminal falls below the reference voltage held by C3, and the output of U7 is immediately pulled low.

### 3-66. STATUS AND CONTROL

Tri-state buffers U11 and U40 read the three hardware fault detector status signals, UNLVL, UNLOKL and RPTRPL, the seven option status signals HSOPTL, SHREFL, IEINL, RPPL, LRFML, ROPTL, and NVINL, and the status of the REF INT/EXT switch. Control and buffer enable signals are latched by U17.

## 3-67. REAR SECTION, A3

The rear panel section consists of a fuse/filter/line-voltage selector switch A3FL1, a transformer A3T1, a Power Supply PCA A3A1, and a fan, A3B1. The line-selector switch accommodates four line voltages, 100/120/220/240 volts, selected by the orientation of a pullout PCB.

The transformer A3T1, with its two primary windings, accepts these four voltages and produces the necessary five secondary voltages. The power supply PCA A3A1 rectifies, filters, and regulates these secondary voltages to produce the dc voltages required by the

Generator. The 120V ac fan A3B1 is connected to the line selector switch so that it always has the correct voltage, 120V ac (nominal) connection.

*NOTE*

*The power supply for Option -130 High-Stability Reference is separate. It has an automatic change over switch for different input line voltages.*

### 3-68. Power Supply PCA, A3A1

The bridge rectifiers in the power supply are used in either a bridge or full-wave center-tapped configuration with capacitor input filters. Table 3-1 lists the rectifier configurations as well as the component designations for the various supplies.

The two +15V, the -15V, and the +5V supplies use conventional three-terminal IC regulators with internal current-limiting and temperature protection. All three 15V regulators have reverse voltage protection diodes CR3, 4, and 8.

The +37V regulator voltage is adjustable via R3. A 6.2V supply is developed from the +37V supply through resistor R4 and zener diode CR7 and is applied to the center tap of the 6V ac filament supply. This provides grid bias for the front panel displays. All regulators (except +37V) have their common reference terminals brought out to an external ground point on module A2 to reduce power supply ripple (P2).

Triac U6 is a voltage surge protector to protect against line voltage surges as well as overvoltage in case of a wrong setting of the selector switch.

Switch S1 is the REF INT/EXT reference selection switch and is not functionally part of the power supply.

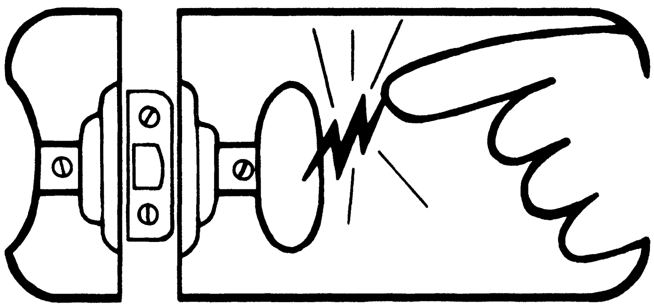
**Table 3-1. Power Supply Rectifier Configurations**

| SUPPLY | RECT. | CONFIG. | CAP | REGULATOR | REMARKS |
|---|---|---|---|---|---|
| +37 | CR6 | Bridge | C11 | A3A1 U4 | Adjustable |
| +15 | CR2 | CT/FW | C2 | " U5 | Fixed |
| +15 | CR2 | CT/FW | C2 | " U1 | Fixed |
| -15 | CR2 | CT/FW | C5 | " U2 | Fixed |
| +5 | CR5 | CT/FW | C8 | A3 U3 | Fixed |
| +18 | CR1 | Bridge | C1 | | Unregulated relay supply |
| FIL | 6V ac with center-tap biased at 6.2V dc. | | | | |

# static awareness

A Message From

**John Fluke Mfg. Co., Inc.**

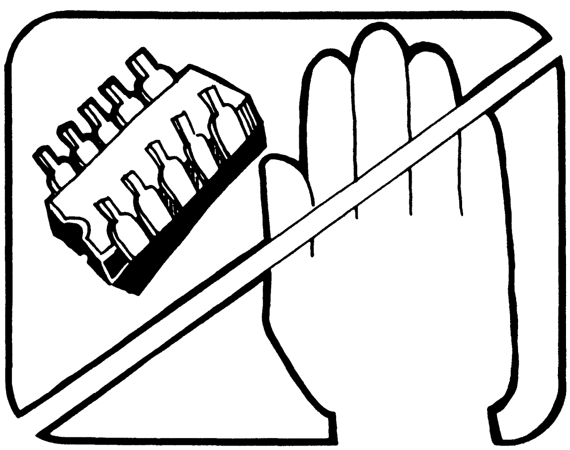


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

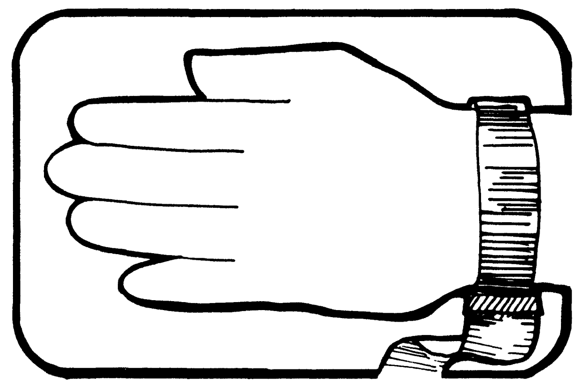
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

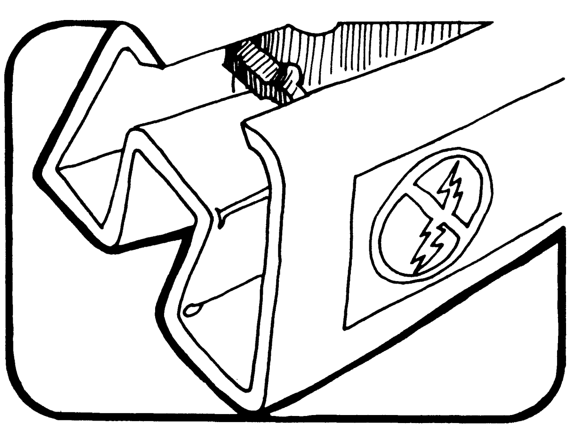
The following practices should be followed to minimize damage to S.S. devices.



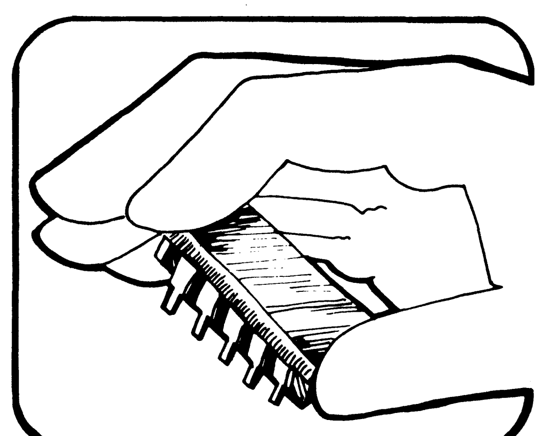
1. MINIMIZE HANDLING



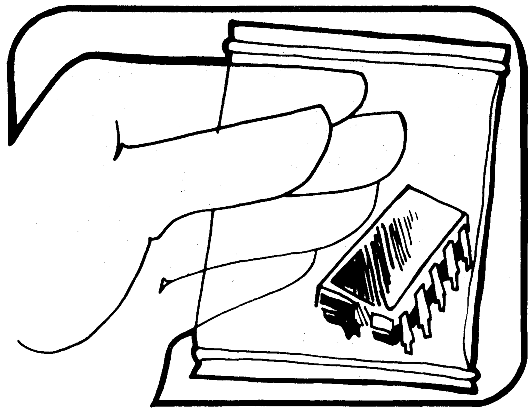
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



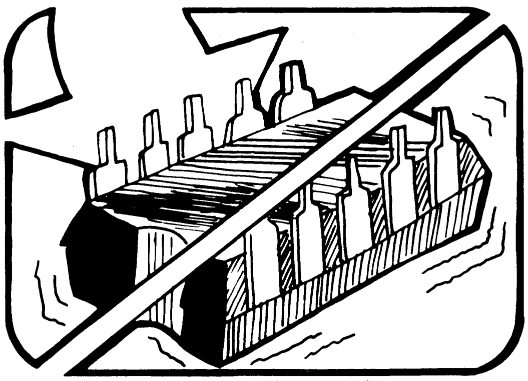
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



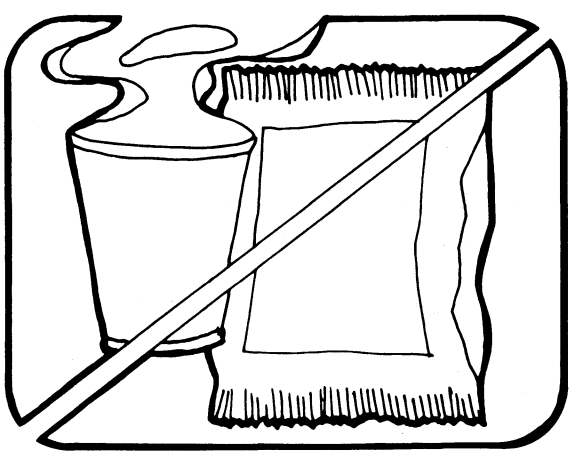
4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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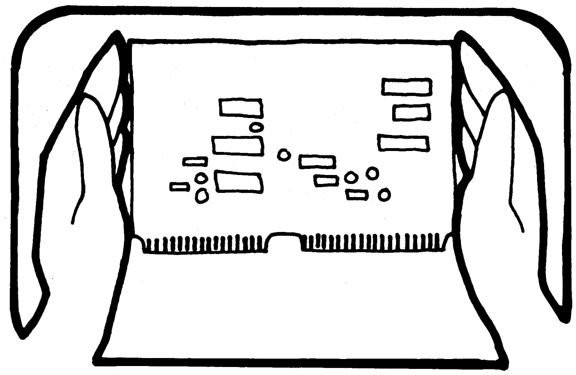
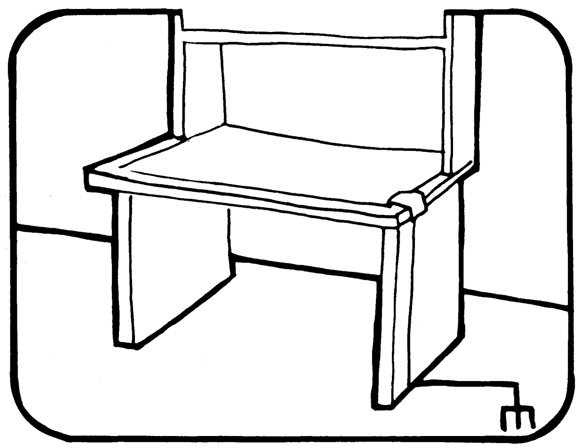
® Dow Chemical



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

---

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

| John Fluke Part No. | Description |
|---|---|
| 453522 | 6" X 8" Bag |
| 453530 | 8" X 12" Bag |
| 453548 | 16" X 24" Bag |
| 454025 | 12" X 15" Bag |
| Pink Poly Sheet<br>30"x60"x60 Mil<br>P/N RC-AS-1200<br>$20.00 | Wrist Strap<br>P/N TL6-60<br>$7.00 |



J0089B-07U7810/SE EN Litho in U.S.A.

# Section 4
# Maintenance

## 4-1. INTRODUCTION

This section of the manual presents warranty information and service methods. Performance test procedures are presented in Section 4A, access procedures in 4B, calibration adjustment procedures in Section 4C, and troubleshooting and repair information in Section 4D.

Each Signal Generator is warranted for a period of one year following delivery to the original purchaser. The warranty is located in front of Section 1 of this manual.

## 4-2. SERVICE METHODS

The Signal Generator is designed to be easily and economically serviced. You may return your instrument to Fluke for service, or you may service it yourself, and repair it, if necessary, by module replacement or component replacement.

### 4-3. Fluke Service

Fluke Service is probably the easiest for you. To ship a Signal Generator to the Fluke Technical Service Center nearest you, see Section 2 for shipping requirements and Section 7 for a list of repair centers. A cost estimate will be provided if you request one and if your instrument purchase date is beyond the warranty period.

### 4-4. Module Replacement

If your Generator develops a problem, see the Troubleshooting Section 4D for information on identifying the faulty module. With a modest amount of technical knowledge and test equipment, you can identify the faulty module and replace it using the Module Exchange Program. This method takes only a day or two to restore the Generator to proper working order. Very little or no calibration is required depending on the module replaced.

Module exchange is used if it is necessary to completely recalibrate any of the three modules in your Generator that have an associated calibration EPROM.

### 4-5. Parts Replacement

Parts replacement requires more equipment and service capability but usually offers the best economy and quickest turnaround. It involves part replacement at the customer's facility.

Most faults are detected by the built-in self tests or the UNCAL status circuits. By noting the self-test error code and interrogating the UNCAL status code, the service technician learns where the problem is. By applying normal signal tracing and troubleshooting procedures (see Troubleshooting in Section 4D of the manual), the fault can be quickly identified.

The faulty component is replaced, and then the instrument is recalibrated using Calibration Adjustments in Section 4C of this manual (if necessary). The Performance Tests explained in Section 4A of this manual are used to verify the Generator performance after repair or recalibration of the Generator.

Some assemblies have some non-field-replaceable parts. These parts, if replaced, would invalidate the calibration EPROM associated with that assembly. They are the Output (A2A4), the VCO (A2A2), and the Attenuator (A2A6) or Attenuator/RPP (A2A5) assemblies. Non-field-replaceable parts are listed in the appropriate parts lists at the bottom of that list.

In the event that a non-field-replaceable part is defective (about 10% of the parts are not field-replaceable), it is necessary for the module to be replaced using the Module Exchange Program in order to realize a complete recalibration of that module and its associated EPROM. Section 7 lists the national and international Sales Representatives and Service Centers.

# Section 4A
# Performance Tests

## 4A-1. INTRODUCTION

The information in the following paragraphs describes the performance tests for the key parameters of the Signal Generator, using the instrument specifications as the performance standard. These covers-on performance tests may be used as an acceptance test upon receipt of the instrument, as an indication that repair and/or calibration is required, or as a performance verification after completing repairs or calibration of the instrument. Individual performance tests can be used as troubleshooting aids.

The Signal Generator being tested (UUT) must be warmed up with all covers in place for at least 20 minutes before starting the performance tests.

## 4A-2. TEST EQUIPMENT

Table 4A-1 gives a list of the recommended test equipment for the performance tests, adjustment procedures, and for troubleshooting the Generator. Figure 4A-1 shows a Two-Turn Loop.

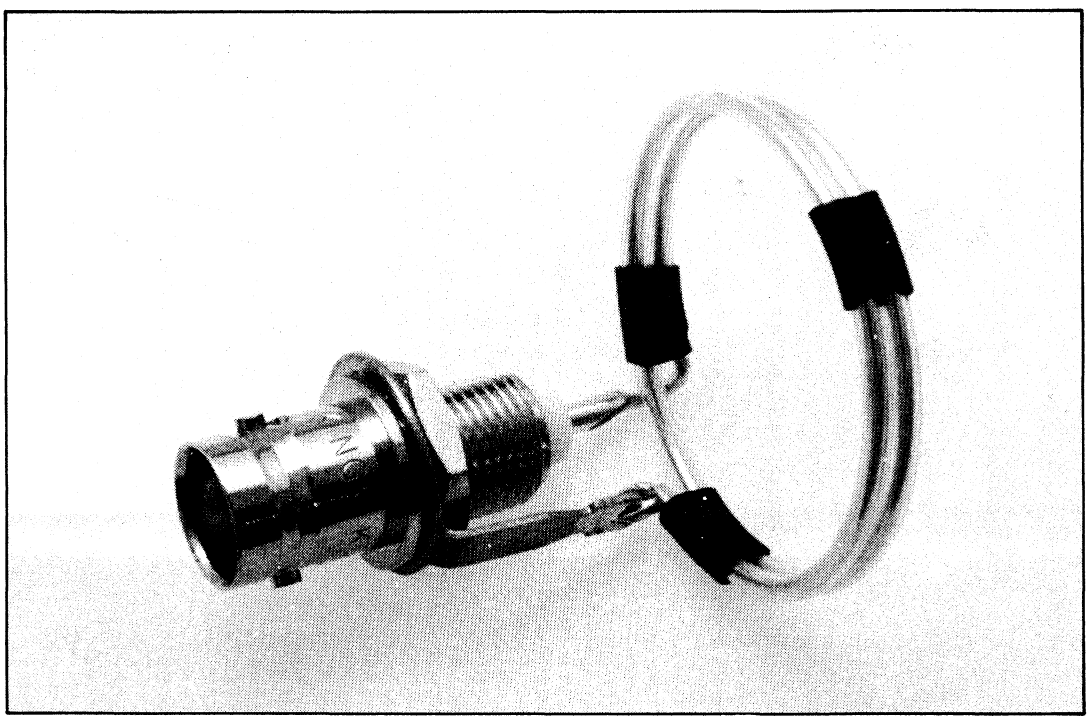


**Figure 4A-1. Two-Turn Loop**

Table 4A-1. Recommended Test Equipment

| INSTRUMENT NAME | MINIMUM REQUIREMENT | MANUFACTURER DESIGNATION | NOTES (1) |
|---|---|---|---|
| DVM | 5 1/2-Digit, 0.3% DC-20 kHz | JF 8840A-09 | A,P |
| DMM | 3 1/2-Digit, 1% DC and 1 KHz | JF 8020B | A,P,T |
| Wideband Amplifier | > 25-dB gain, 0.4 to 1050 MHz NF < 9 dB. | HP 8447D-010 | P |
| RF-Spectrum Analyzer | 0.1 to 1.5 GHz, 1-kHz BW | HP 8558B/182T | P,T |
| Oscilloscope | Four-trace 300 MHz, 5-mV/Div | TEK 2465-11 | T |
| FET Probe | DC-900 MHz | TEK 6201 | T |
| RF Voltmeter | 0.01 to 700 MHz, 0.01 to 3V ±10% | HI RF 801 | T, 2 |
| Frequency Counter | 0.4-1050 MHz; 10 Hz res; 0.1V | JF 7220A | A,P,T |
| Modulation Analyzer | Input: 0.4 to 1050 MHz, 0 to AM: 10 to 90%, ± 1%, FM: 0.1 to 100 kHz dev ± 1% | HP 8901A | A,P,T,4 |
| Distortion Analyzer | 1 to 10% rng, ±1dB, 0.4 and | HP 339B | A,P,T,4 |
| Power Meter<br>Sensor | Instrumentation accuracy < ±1% -30 to 20 dBm; SWR < 1.2 for 0.4 to 1 MHz, < 1.1 for 1 to 1050 MHz | HP 435B<br>HP 8482A | A,P,T,4<br>4 |
| Low-Level Sensor | -67 to -20 dBm; SWR < 1.4 for 10 to 30 MHz < 1.15 for 30 to 1050 MHz | HP 8484A | 4 |
| Attenuator, 60 dB | 0.4 to 1050 MHz SWR < 1.1 | Narda 777C | P,5 |
| LF Synthesized Sig-Gen | 10 Hz to 11 MHz, 10 Hz steps, 1V pk. Spurs and Harm < -50dB | JF 6011A | A,P |
| Frequency Standard | House Standard, 10 MHz | --- | A,P |
| Test Cable | Dual pin to BNC | JF 732891 | A,T |
| Adapter, Coax | 50-ohm, Type-N(m) to BNC(f) | JF Y9308 | A,P,T |
| Adapter, Service | 50-ohm, Module output to SMA | JF 744177 | T |
| Two-Turn Loop | For Leakage test (See Figure 4A-1.) | Homebuilt | P,T,3 |
| Type-N Termination | 50-ohm | JF Y9317 | P |
| Coaxial Cable, 50 ohm | 3 ft, BNC both ends | Y9111 | A,P,T |
| Coaxial Cable, 50 ohm | 6 ft, BNC both ends | Y9112 | A,P,T |
| Screwdriver, electric | Set to 7 inch-pounds torque | Jergens-CL6500/CLT50 | A,T |
| Power Supply, Variable | 0 to 30V dc | | T |

**Table 4A-1. Recommended Test Equipment (cont)**

Notes

1. A = Adjustment; P = Performance Test; T = Troubleshooting.
2. Helper Instruments.
3. Two-Turn, 1-inch diameter loop made of #18 enamel wire soldered to a BNC connector. Figure 4A-1 shows a two-turn loop.
4. The HP8902A/11722A Measuring Receiver may be used in place of the wideband amplifier, 60-dB Attenuator, HP8901A, HP339B, and the HP435B/8482A/8484A for the alternate performance test.
5. SWR verified and actual attenuation calibrated to ± 0.2 dB by the operator at application frequencies.

## 4A-3. POWER-ON TEST

This performance test is the built-in self test that performs a simple functional check of the instrument.

REQUIREMENT

The Generator successfully passes the self test.

REMARKS

The test is begun each time the Signal Generator is turned on. Press any of the FUNCTION keys or the [CLR/LCL] key to abort the test.

PROCEDURE

a. Start the test with the POWER switch off.

b. Turn the POWER switch on.

c. The Signal Generator automatically starts the self tests, which include turning on all indicators, indicators, and every segment of the display. This test takes five seconds.

d. If the instrument fails any of the self tests, the results are shown in the four display fields. See paragraph 4D-17 for the interpretation of the test failure codes.

   If the Generator passes the self test, it programs the Generator to the Instrument Preset state [RCL] [9][8].

   If the Signal Generator has the Option -570 Non-Volatile Memory installed, the Generator is returned to the same front panel condition that existed when the Generator was previously turned off. The IEEE-488 Interface (if installed) is programmed to local control.

## 4A-4. SYNTHESIS TEST

Using a Frequency Counter operating on a common reference with the Generator, the Generator output frequency is measured at several programmed frequencies.

REQUIREMENT

The Generator's measured and programmed frequencies agree within ± one count.

TEST EQUIPMENT

Frequency Counter

REMARKS

Failing this test indicates the need to repair and/or recalibrate the Synthesizer A2A1 assembly.

PROCEDURE

a. Connect the UUT 10 MHz IN/OUT to the Frequency Counter 10-MHz reference input, and connect the UUT RF OUTPUT to the Counter input.

b. Set the UUT REF INT/EXT Switch to INT.

c. Program the UUT to [RCL] [9][8].

d. Program the UUT frequency to 111.1111 MHz.

e. Program the UUT frequency step to 111.1111 MHz.

f. As the frequency is stepped from 111.1111 MHz, 222.2222 MHz, etc., to 999.9999 MHz, verify that the Counter reading agrees with the UUT frequency ± one count.

## 4A-5. HIGH-LEVEL ACCURACY TEST

The output power is measured with a power meter at various frequencies, first with the step attenuator set for zero attenuation, then with each attenuator section individually programmed, the output level accuracy and attenuator section errors are computed.

REQUIREMENT

The output level accuracy, the attenuator section errors, and the sum of the attenuator section errors at each test frequency are less than ± 1.5 dB.

TEST EQUIPMENT

Power Meter with a Sensor

REMARKS

Failing this performance test indicates the need to replace the Output (A2A4) and/ or the Attenuator (A2A6) (or optional Attenuator/RPP A2A5) assemblies. To determine which assembly is at fault, use Section 4D in this manual for Troubleshooting procedures.

The test frequencies of this procedure provide reasonable confidence of the amplitude accuracy of the UUT. However, additional test frequencies may be included in this test.

This test verifies the high-level accuracy of the Generator and also verifies that the amplitude correction factors for the individual Attenuator sections are correct. This test, in conjunction with the mid-level accuracy and low-level accuracy tests, verifies the overall level performance of the UUT.

PROCEDURE

a. Calibrate and zero the Power Meter.

b. Program the UUT to [RCL] [9][8].

c. Connect the Power Sensor to the UUT RF OUTPUT.

d. Program the UUT frequency to 0.4 MHz.

e. Select each attenuator section by programming the UUT amplitude to the levels shown in Figure 4A-2 High-Level Accuracy test conditions, and record the measured power at each level.

f. For each programmed level of Figure 4A-2, compute the output power error (subtract the programmed power in dBm from the measured power in dBm). These errors must not exceed ± 1.5 dB.

g. For attenuator sections 1 through 7, subtract the measured power for section zero from the sum of the measured power for that section and the nominal attenuation for that section, e.g., (-M0+M1+6) for section 1. The eight section errors and their sum must not exceed ± 1.5 dB.

Figure 4A-2 shows the parameters of the high-level accuracy test.

| ATTENUATION | | OUTPUT POWER | | | | |
|---|---|---|---|---|---|---|
| SECTION | NOMINAL | PROGRAM (dBm) | MEASURED (dBm) | ERROR (dB) | SECTION ERROR (dB) | LIMIT (dB) |
| 0 | 0 | +12 | M0 | M0-12 | M0-12 | ±1.5 |
| 1 | 6 | + 6 | M1 | M1-6 | -M0+M1+6 | " |
| 2 | 12 | 0 | M2 | M2-0 | -M0+M2+12 | " |
| 3 | 24 | -12 | M3 | M3-12 | -M0+M3+24 | " |
| 4 | 24 | -12 [SPCL] [8][3] | M4 | M4-12 | -M0+M4+24 | " |
| 5 | 24 | -12 [SPCL] [8][4] | M5 | M5-12 | -M0+M5+24 | " |
| 6 | 24 | -12 [SPCL] [8][5] | M6 | M6-12 | -M0+M6+24 | " |
| 7 | 24 | -12 [SPCL] [8][6] | M7 | M7-12 | -M0+M7+24 | " |
| | | | | | Sum of Errors | ±1.5 |

**Figure 4A-2. High-Level Accuracy Test Conditions**

*NOTE*

*To test Attenuator sections 4 through 7, program the Signal Generator to -12 dBm, and key in [SPCL] [8][3] through [8][6], respectively.*

h. Repeat steps d through g with the UUT programmed to each of the following frequencies:

120 MHz, 244 MHz, 245 MHz, 850, and 1050 MHz.

To illustrate the procedure, Figure 4A-3 is an example in which the measured power and the error calculations are shown. This example is for one frequency, and these measurements and calculations are repeated at other frequencies. In this case, the section errors and the sum of the section errors are within the test limits and, therefore, the unit passed.

## 4A-6. MID-LEVEL ACCURACY TEST

The level accuracy is verified, from –24 to –66 dBm at frequencies of 120, 244, 245, 850, and 1050 MHz, using the Power Meter with a Low-Level Sensor.

REQUIREMENT

Amplitude accuracy is ±1.5 dB from +13 to –137dBm.

TEST EQUIPMENT

Power Meter with a Low-Level Sensor

REMARKS

This test, in conjunction with the High-Level Accuracy Test and the Low-Level Accuracy Test, verifies the overall level performance of the UUT.

It is convenient to use the UUT RF ON/OFF control when zeroing the Power Meter.

PROCEDURE

a. Program the UUT to the Instrument Preset State [RCL] [9][8], and then program 30 MHz and –24 dBm.

b. Calibrate the Power Meter.

c. Connect the Power Meter with a Low-Level Sensor to the UUT RF OUTPUT.

d. Zero the Power Meter.

e. With the Power Meter, measure the UUT output power (in dBm). It should agree with the programmed level within ± 1.5 dB.

f. Repeat steps e and f for levels of -30, -36, -42, -48, -54, -60, and -66 dBm.

g. Repeat steps d to g for frequencies of 244, 245, 850, and 1050 MHz.

| ATTENUATION | | OUTPUT POWER | | ERROR (dB) | SECTION ERROR (dB) | LIMIT (dB) |
|---|---|---|---|---|---|---|
| SECTION | NOMINAL | PROGRAM (dBm) | MEASURED (dBm) | | | |
| 0 | 0 | +12 | +12.2 | +0.2 | +12.2-12.0 | = +0.2 |
| 1 | 6 | + 6 | +05.9 | -0.1 | -12.2+5.9+6 | = +0.3 |
| 2 | 12 | 0 | -00.2 | -0.2 | -12.2-0.2+12 | = -0.4 |
| 3 | 24 | -12 | -12.1 | -0.1 | -12.2-12.1+24 | = -0.3 |
| 4 | 24 | -12 [SPCL][8][3] | -11.8 | +0.2 | -12.2-11.8+24 | = +0.0 |
| 5 | 24 | -12 [SPCL][8][4] | -12.0 | +0.0 | -12.2-12.0+24 | = -0.2 |
| 6 | 24 | -12 [SPCL][8][5] | -12.3 | -0.3 | -12.2-12.3+24 | = -0.5 |
| 7 | 24 | -12 [SPCL][8][6] | -11.9 | +0.1 | -12.2-11.9+24 | = -0.1 |
| | | | | | Sum of Errors | = -1.0 |

**Figure 4A-3. High-Level Accuracy Test Conditions**

## 4A-7. LOW-LEVEL ACCURACY TEST

The Power Meter with a Low-Level Sensor and the calibrated 60-dB Attenuator are used to verify the UUT level accuracy at -127 dBm and at frequencies of 120, 244, 245, 850, and 1050 MHz, by using the Spectrum Analyzer as an indicator.

REQUIREMENT

Amplitude accuracy is ±1.5 dB from +13 to -137 dBm.

TEST EQUIPMENT

Wideband Amplifier
60-dB Attenuator
RF Spectrum Analyzer
Power Meter with a Low-Level Sensor

REMARKS

This test, in conjunction with the Mid-Level Accuracy and High-Level Accuracy Test, verifies the overall level performance of the UUT.

Failing this test, but passing the High-Level Accuracy Test, probably indicates a leak-around problem in the UUT attenuator. Service tip:

> Check for a broken feed-through filter or improper mechanical assembly, i.e., loose screws and/or damaged or misplaced gaskets.
>
> It is convenient to use the UUT RF ON/OFF control when zeroing the Power Meter.

PROCEDURE

a. Program the UUT to the Instrument Preset State [RCL][9][8], then program 30 MHz and -67 dBm.

b. Calibrate and then connect the Power Meter with a Low-Level Sensor to the UUT RF OUTPUT.

c. Program the UUT to -67 dBm.

d. Zero the Power Meter.

e. With the Power Meter, measure the UUT output power (in dBm) and record the measurement as the variable P.

f. Connect UUT RF OUTPUT through the 60-dB Attenuator and the Wideband Amplifier to the input of the RF Spectrum Analyzer. Use well shielded cables to avoid leakage that could affect the measurement.

g. Adjust the Analyzer to display the signal, using a resolution bandwidth of 1 kHz and a vertical display of 1 dB/Div. Adjust the reference level so that the response is at a convenient reference point on the display, e.g., 2 dB below top scale. This signal response corresponds to a level of (P-A) dBm, where A is the value of the 60 dB Attenuator.

h. Program the UUT to a level of -127 dBm, remove the 60-dB Attenuator, and note the difference in the resulting response on the Spectrum Analyzer from the previous response (P-A). The actual UUT output level is (P-A) plus this difference and should agree with the programmed level to within ± 1.5 dB.

i. Repeat steps c through h for frequencies of 244, 245, 850, and 1050 MHz.

## 4A-8. ALTERNATE-LEVEL ACCURACY TEST

The Measuring Receiver is used to verify the UUT level accuracy from +11 dBm to -127 dBm, and at various amplitude and frequency settings that test all level ranges of the UUT on all RF bands.

REQUIREMENTS

Amplitude accuracy is ±1.5 dB from +13 dBm to -137 dBm.

TEST EQUIPMENT

Measuring Receiver

REMARKS

This one test is a more comprehensive test than the High-Level, Mid-Level, and Low-Level Accuracy tests.

Failing this test at levels above approximately -50 dBm indicates the need to replace the A2A4 Output and/or A2A6 Attenuator Assembly (or optional A2A5 Attenuator/RPP).

Failing this test at lower levels probably indicates a leak-around problem with the Attenuator. Check for loose connectors, loose screws, improper gasketing, or a broken feed-through filter.

It is convenient to use the UUT RF ON/OFF control when zeroing the power meter function of the Measuring Receiver.

PROCEDURE

a. Connect the UUT 10 MHz OUT to the 10 MHz timebase input of the Measuring Receiver.

b. Set the UUT REF INT/EXT switch to INT.

c. Program the UUT to [RCL] [9][8], and then program the UUT to 0.4 MHz, +11 dBm and program the Amplitude Step to 6 dB.

d. Calibrate the Measuring Receiver and connect it to the UUT RF OUTPUT.

e. Verify that the level measured with the Measuring Receiver agrees with the UUT programmed level to within ±1.5 dB, as the UUT level is stepped down from +11 dbm to -127 dBm in six dB steps at each of the following frequencies:

   0.4 MHz, 120 MHz, 244 MHz, 245 MHz, 850 MHz, and 1050 MHz.

## 4A-9. OUTPUT LEAKAGE TEST

The output signal leakage is verified with a two-turn loop by measuring the induced signal with a spectrum analyzer and comparing it to a 1 μV reference established at each frequency from the UUT.

REQUIREMENT

The radiated emissions induce less than 1 μV of the Generator's output signal into a 1-inch diameter, two-turn loop, 1 inch away from any surface of the Generator as measured into a 50-ohm receiver.

TEST EQUIPMENT

Wideband Amplifier
RF Spectrum Analyzer
Two-Turn Loop
Type-N Termination
A screen room may be required depending on the RF environment.

REMARKS

Failing this test probably indicates a broken feed-through filter or improper mechanical assembly, i.e.; loose screws and/or damaged or misplaced gaskets.

PROCEDURE

a. Connect the UUT RF OUTPUT to the Wideband Amplifier input, and connect the Amplifier output to the Spectrum Analyzer input. Use well shielded cables to avoid leakage which could affect the measurement.

b. Program the UUT to the Instrument Preset State, [RCL] [9][8].

c. Program the UUT to -107 dBm.

d. Adjust the Spectrum Analyzer to display the UUT signal for a convenient reference, using a vertical scale of 10 dB/division, a resolution bandwidth of 3 kHz, and a span/division of 5 kHz/division.

e. Disconnect the Amplifier from UUT and terminate UUT OUTPUT with type-N Termination.

f. Connect the two-turn loop to the Amplifier input.

g. Program the UUT to +13 dBm.

h. Verify that the leakage is less than -107dBm (1 μV), as indicated by the Spectrum Analyzer by moving the two-turn loop over the UUT surface at a distance of 1 inch.

i. Repeat steps c through h at 550, 850, and 1050 MHz.

## 4A-10. ALTERNATE OUTPUT LEAKAGE TEST

RF leakage is verified by measuring the induced signal in a two-turn loop with the Measuring Receiver.

REQUIREMENTS

The output signal leakage must induce less than 1 μV into a 1-inch diameter two-turn loop, 1 inch away from any surface of the generator as measured into a 50-ohm receiver.

TEST EQUIPMENT

Measuring Receiver
Two-Turn Loop
Type-N Termination
A screen room may be required depending on the RF environment.

REMARKS

This test is an alternative to the Output Leakage test.

Failing this test indicates a problem feed-through filter or improper mechanical assembly, i.e., loose screws, and/or damaged or misplaced gaskets.

The Measuring Receiver is used to measure the UUT leakage relative to a 1 μV reference established at each frequency.

PROCEDURE

a. Connect the UUT 10 MHz OUT to the 10-MHz timebase input of the Measuring Receiver.

b. Set the UUT REF INT/EXT switch to INT.

c. Program the UUT to the Instrument Preset State, [RCL] [98].

d. Program the UUT to -107 dBm.

e. Connect the Measuring Receiver sensor to the UUT RF OUTPUT.

f. Set the Measuring Receiver to make relative level measurements to the –107 dBm signal applied.

g. Disconnect the sensor from the UUT, and terminate the UUT RF OUTPUT with the Type-N Termination.

h. Connect the two-turn loop to the Measuring Receiver sensor.

i. Program the UUT to +13 dBm.

j. Verify the instrument leakage is less than –107 dBm (1 $\mu$V) as indicated by the Measuring Receiver by moving the Two-Turn Loop over the UUT surface at a distance of one inch from the UUT.

k. Repeat steps d through j at 550 MHz, 850 MHz, and 1050 MHz.

## 4A-11. HARMONIC AND SPURIOUS TEST

Using a spectrum Analyzer, the level of the harmonic and spurious signals are compared to the desired signal at various programmed frequencies.

REQUIREMENTS

RF harmonics <–30 dBc; spurious (non-harmonic) <–60 dBc for offsets >10 kHz.

TEST EQUIPMENT

RF Spectrum Analyzer

PROCEDURE

a. Connect the UUT RF OUTPUT to the Spectrum Analyzer input.

b. Program the UUT to [RCL] [9][8]. Then program the Generator to +13 dBm.

c. Program the UUT to 0.4 MHz.

d. Set the Spectrum Analyzer controls to display the UUT output signal and its harmonics (at least three harmonics wherever possible). Be careful not to overload the Analyzer input. Overloading the Analyzer causes it to generate harmonics, thus invalidating the test.

e. Verify that all the harmonics are more than 30 dB below the fundamental signal.

f. Repeat steps c through e for UUT frequencies of 50 MHz, 240 MHz, 300 MHz, 500 MHz, and 750 MHz.

g. Program the UUT to 185 MHz.

h. Verify the spur at 245 MHz is < –60 dBc.

i. Program the UUT to 244 MHz.

j. Verify the spur at 312 MHz is < –60 dBc.

k. Program the UUT to 244.99 MHz, 0 dBm.

l. Set the Spectrum Analyzer controls for the appropriate reference level, center frequency, span, and resolution to display the UUT signals and spurs frequencies with appropriate noise floor and signal resolution for the following steps.

1. Verify the spurs at the offsets of 20 kHz, 30 kHz, 35 kHz, and 40 kHz are < -60 dBc.
2. Verify the spurs at the offsets of 1 MHz and 10 MHz are < -60 dBc.
3. Program the UUT level to 1 dBm with the EXT AM on at 30% modulation (no external modulation input is applied).
4. Verify the spurs at 10 MHz, 20 MHz, and 30 MHz are < -60 dBc.
5. Verify the spurs at 800 MHz, and 1044.99 MHz are < -60 dBc.
6. Program the UUT to 600 MHz, 0 dBm, EXT AM modulation off.
7. Verify the spur at 300 MHz is < -60 dBc.

## 4A-12. MODULATION TESTS

These tests use the Modulation Analyzer to verify modulation accuracy and residual and incidental modulation of the UUT. The modulation distortion is verified by measuring the demodulated output of the Modulation Analyzer with a Distortion Analyzer. The internal modulation oscillator frequency is measured using the Frequency Counter on the demodulated output of the Modulation Analyzer. Table 4A-2 lists the requirements for the modulation tests.

REMARKS

Failing this performance test indicates the need for repair and/or recalibration of the associated circuitry.

Where residual noise affects the Modulation Analyzer measurements accuracy, apply correction methods provided by the Modulation Analyzer manufacturer.

**Table 4A-2. Modulation Tests Requirements**

| REQUIREMENTS PARAMETER | SPECIFICATION |
|---|---|
| MOD FREQ | < ±3% at 0.4 or 1 kHz for 20 to 30°C; add ±0.1%/°C outside this range. |
| AM ACCURACY | < ±(2% + 4% of setting) for internal rates and depths of 90% or less, and peak amplitudes of +13 dbm or less. |
| AM DISTORTION | < 1.5% THD up to 30% AM, < 3% to 70%, < 5% to 90%, at internal rates. |
| RESIDUAL AM | < 0.1% rms (-60 dBc) in a 0.05-kHz to 15-kHz bandwidth. |
| INCIDENTAL FM | < 0.3 fm for internal rates and < 30% AM. |
| FM ACCURACY | < ±7% for rates of 0.3 kHz to 20 kHz, and > 100 Hz deviation. |
| FM DISTORTION | < 1% THD for rates of 0.3 kHz to 20 kHz, and > 100 Hz deviation. |
| RESIDUAL FM | rms in a 0.3-kHz to 3-kHz band:<br>< 13 Hz for 245 MHz to 512 MHz and < 27 Hz elsewhere.<br>rms in a 0.05-kHz to 15-kHz band:<br>< 30 Hz for 245 kHz to 512 MHz and < 60 Hz elsewhere. |
| INCIDENTAL AM | < 1% AM at 1-kHz rate and for deviation < 50 kHz. |

The UUT settings in this procedure are chosen to provide a strong confidence of the modulation performance of the UUT throughout its range. However, performance also may be checked at other instrument settings if desired.

The FM deviation accuracy depends upon software correction data stored in the VCO Calibration EPROM that is derived from the measured data of the particular VCO assembly installed in the Generator.

TEST EQUIPMENT

Modulation Analyzer
Distortion Analyzer
Frequency Counter
Low-Frequency Synthesized Signal Generator (LFSSG)
DVM

PROCEDURE

1. Internal Modulation Oscillator Frequency Test

   a. Connect the UUT RF OUTPUT to the Modulation Analyzer input.

   b. Connect the Modulation Analyzer modulation output to the Frequency Counter input.

   c. Program the Modulation Analyzer to measure AM depth in a 0.05-kHz to 15-kHz bandwidth.

   d. Program the UUT to [RCL] [9][8]. Program the UUT for 90% INT AM at a 1-kHz rate and a level of +1 dBm.

   e. Verify that the Counter reads between 970 and 1030 kHz.

   f. Program that the UUT to a modulation frequency of 400 Hz.

   g. Verify the Counter reads between 388 Hz and 412 Hz.

2. Internal AM Accuracy Test

   a. Measure the mean AM depth, (+PEAK plus -PEAK)/2, with the Modulation Analyzer.

   b. Verify that the mean AM depth is between 84.4% and 95.6%.

   c. Program the UUT to a modulation frequency of 1 kHz.

   d. Verify that the mean AM depth is between 84.4% and 95.6%.

3. AM Accuracy and Distortion Test

   a. Connect the output of the LFSSG to the UUT MOD INPUT and the DVM (use a BNC T connector).

   b. Program the UUT for a frequency of 0.4 MHz, 1 dBm level, and EXT AM at 30% AM depth.

c. Program the LFSSG for 1 kHz at 0.7071V rms as measured by the DVM.

d. Connect the modulation output of the Modulation Analyzer to the input of the Distortion Analyzer.

e. Set the Distortion Analyzer to measure the THD of the 1-kHz modulation signal.

f. Verify that the mean AM depth (+PEAK plus -PEAK)/2, is between 26.8% and 33.2%.

g. Verify that the THD is less than 1.5%.

h. Program the remaining combinations of RF frequency, level, and AM depth listed in Table 4A-3. For each combination, verify that the mean AM depth is between the allowed limits and that the THD is less than the allowed limit, which depends on programmed depth, as shown in Table 4A-4:

i. Disconnect the LFSSG from the UUT.

4. Incidental FM Test

a. Program the UUT for 30% INT AM at 1 kHz, at 1050 MHz, and 10 dBm.

b. Program the Modulation Analyzer to measure peak FM deviation in a 0.3- to 3-kHz bandwidth.

c. Verify the incidental FM is less than 300 Hz.

*NOTE*

*It may be necessary to compensate for residual noise effects using the procedure presented in the Modulation Analyzer manual.*

5. Residual AM Test

a. Program the UUT to 100 MHz, +7 dBm, and no modulation.

b. Program the Modulation Analyzer to measure rms (or average) AM in a 0.05-kHz to 15-kHz bandwidth.

c. Verify the residual AM is less than 0.1% rms (or 0.09% average).

6. FM Accuracy and Distortion Test

a. Connect the output of the LFSSG to the UUT MOD INPUT connector and the DVM (use a BNC T connector).

b. Program the Modulation Analyzer to measure peak FM in a 0.05-kHz to 20-kHz bandwidth.

c. Program the UUT frequency to 245 MHz, 7 dBm, 99.9 kHz (9.99 kHz if the Generator has Option -651) deviation, and EXT FM.

d. Set the LFSSG to 10 kHz and adjust its level so the DVM reads 707.1 mV rms.

Table 4A-3. AM Test Conditions

| FREQUENCY (MHz) | LEVEL (dBm) | AM (%) |
|---|---|---|
| 0.4 | 1 | 30 |
| | | 70 |
| | | 90 |
| | 7 | 30 |
| | | 70 |
| | | 90 |
| 244.9 | 1 | 70 |
| | | 90 |
| | 7 | 70 |
| | | 90 |
| 245 | 1 | 70 |
| | | 90 |
| | 7 | 70 |
| | | 90 |
| 512 | 1 | 70 |
| | | 90 |
| | 7 | 70 |
| | | 90 |
| 1050 | 1 | 70 |
| | | 90 |
| | 7 | 70 |
| | | 90 |

Table 4A-4. AM Depth Range

| PROGRAMMED DEPTH (%) | MEAN AM DEPTH(%) MIN. | MAX. | MAXIMUM THD(%) |
|---|---|---|---|
| 30 | 26.8 | 33.2 | 1.5 |
| 70 | 65.2 | 74.8 | 3 |
| 90 | 84.4 | 95.6 | 5 |

e. Set the Distortion Analyzer to measure distortion at 10 kHz.

f. Verify that the Modulation Analyzer reading is between 93 kHz to 107 kHz, (9.99 kHz if the Generator has Option -651 installed) and the THD is less than 1% as the UUT frequency is stepped up to 1045 MHz in 50-MHz steps. (Tip: use the instrument FREQ STEP feature.)

g. Set the LFSSG to 0.4 kHz and adjust its level so the DVM reads 707.1 mV rms.

h. Program the Modulation Analyzer to measure FM in a 0.05-kHz to 3-kHz bandwidth.

i. Set the Distortion Analyzer to measure distortion at 0.4 kHz.

j. Verify that the Modulation Analyzer reading is between 93 kHz to 107 kHz (9.99 kHz if the Generator has Option -651 installed), and the THD is less than 1% as the UUT frequency is stepped down to 245 MHz in 50-MHz steps.

k. Program the UUT to 9.99 kHz deviation. (Skip to step m if the UUT has Option -651 installed.)

l. Verify that the Modulation Analyzer reading is between 9.3 kHz and 10.7 kHz.

m. Program the UUT to 0.999 kHz deviation.

n. Verify that the Modulation Analyzer reading is between 0.93 kHz and 1.07 kHz.

*NOTE*

*It may be necessary to compensate for residual noise effects using the procedure presented in the Modulation Analyzer manual.*

o. Disconnect the LFSSG from the UUT.

7. Incidental AM Test

a. Program the UUT for 50-kHz deviation, INT FM only, at 1 kHz, a level of 7 dBm and a frequency of 11 MHz.

b. Program the Modulation Analyzer to measure peak AM in a 0.3-kHz to 3-kHz bandwidth.

c. Verify that the incidental AM is less than 1%.

8. Residual FM Test

a. Program the UUT for a frequency of 4 MHz and no modulation.

b. Program the Modulation Analyzer to measure rms (or average) FM in 0.3-kHz to 3-kHz bandwidth.

c. Verify that the Modulation Analyzer reading is less than 27-Hz rms (or 24-Hz average) at the following UUT frequencies:

10, 50, 100, 200, and 244 MHz

d. Verify that the Modulation Analyzer reading is less than 13-Hz rms (or 12-Hz average) at the following UUT frequencies:

250, 385, 450, and 510 MHz

e. Verify that the Modulation Analyzer reading is less than 27-Hz rms (or 24-Hz average) at the following UUT frequencies:

512.03999, 750.03999, 850.03999, 900.03999, 950.03999, 1000.03999, 1025.03999, and 1049.03999 MHz

f. Change the Modulation Analyzer bandwidth from 0.05 kHz to 15 kHz.

g. Verify that the Modulation Analyzer reading is less than 60-Hz rms (or 54-Hz average) at the UUT frequencies listed in step e.

h. Verify that the Modulation Analyzer reading is less than 30-Hz rms (or 27-Hz average) at the UUT frequencies listed in step d.

i. Verify that the Modulation Analyzer reading is less than 60-Hz rms (or 54-Hz average) at the UUT frequencies listed in step c.

# Section 4B
# Access Procedures

## 4B-1. INTRODUCTION

The information in this section describes the general access procedures for the following major module assemblies.

Front Section Assembly, A1
Rear Section Assembly, A3
Synthesizer Board, A2A1
Output Board, A2A4
Attenuator Assembly A2A6, or the Attenuator/RPP Assembly, A2A5
VCO Board, A2A2

Access to other assemblies is straightforward; and therefore, other assemblies are not detailed in this manual.

## 4B-2. LOCATION OF MAJOR ASSEMBLIES

The location of the major assemblies of the Signal Generator is illustrated in Section 8.

Information on exchanging modules is presented in Section 4D.

## 4B-3. ACCESS INSTRUCTIONS

Access instructions for each module of the Signal Generator are provided in the following paragraphs. Before performing any disassembly of the Signal Generator, remove the power cord from the rear panel power receptacle and remove the exterior top and bottom instrument covers.

To install the assemblies, reverse the disassembly steps. Be certain the pin connectors and filter sockets are straight when replacing the boards.

### 4B-4. Removing the Front Section Assembly, A1

1. Disconnect the MOD INPUT wire W1 at the module connector located at the front of the Attenuator module.

2. Disconnect the front panel display ribbon cable at the controller.

3. Remove the decals from both front panel handles. Removing the decals ruins them; new decals should be installed to maintain a proper instrument appearance.

   The part number for the decal is listed in Section 5.

4. Remove the five flathead screws from each front panel handle.

### 4B-5. Removing the Rear Section Assembly, A3

1. Disconnect the Synthesizer, Controller, and Attenuator power cable at the power supply.

2. If the High-Stability Reference option is installed, disconnect the oscillator power cable from the Auxiliary power supply

3. Remove the IEEE-488 Interface assembly (if present) from the back of the instrument rear panel.

4. Remove the inside part of the 10 MHz IN/OUT (and the REF IN, if present) BNC connector.

5. Remove the decals for both rear panel handles. Removing the decals ruins them; replace with new decals to maintain a proper instrument appearance. The part number for the decal is listed in Section 5.

6. Remove the five flathead screws from each handle and swing the rear panel assembly out from the Signal Generator.

7. If you need to completely detach the rear panel assembly from the Generator, unfasten the front panel power switch.

### 4B-6. Removing the Synthesizer Board, A2A1

1. Remove the number 6 screws holding the top module (A2) cover. (The number 10 screws are adjustment access screws and need not be removed.) Remove the module cover.

2. If the Sub-Harmonic Reference option is installed, remove the RG188 pigtail connector, and remove the Sub-Harmonic Refezence option board.

3. Remove the heat sink from both gate arrays U17 and U33.

4. Remove the 4/40 panhead screw, shoulder washer, and insulator from the regulator U25.

5. Remove the number 6 screws holding the board, and then carefully remove the board.

### 4B-7. Removing the Output Board, A2A4

1. Remove the number 6 screws holding the bottom module (A1) cover. (The number 10 screws are adjustment-access screws and need not be removed.) Remove the module cover.

2. Remove the plug-in coupling capacitor between the Output and the VCO boards.

3. Remove the number 6 screws holding the board, and then carefully remove the board.

### 4B-8. Removing the Attenuator A2A6, or Attenuator/RPP A2A5 Assembly

1. Disconnect the SMA connector at the Attenuator that leads to the RF output.

2. Disconnect the control harness from the Relay Driver PCA.

## 4B-9. Removing the VCO Board, A2A1

1. Remove the number 6 screws holding the bottom module (A) cover. (The number 10 screws are adjustment-access screws and need not be removed.) Remove the cover.

2. Remove the plug-in capacitor that couples the Output board to the VCO.

3. Remove the number 6 screws holding the assembly, and remove the board.

# Section 4C
# Calibration Adjustments

## 4C-1. INTRODUCTION
The adjustment procedures for the Generator are described in the following paragraphs. The recommended test equipment for calibration is denoted by an A in Table 4A-1.

Adjustment procedures for the Power Supply, Display, Output, Synthesizer, and Attenuator (or optional Attenuator/RPP) assemblies are covered in this section. Adjustment procedures for the High-Stability Reference, Sub-Harmonic Reference, and Low-Rate FM options are given in Section 6.

## 4C-2. SAFETY
This is a Safety Class I instrument. It is provided with a protective earth terminal. Warnings and cautions are for your protection and to avoid damage to the equipment. Please take them seriously.

**WARNING**

**BECAUSE SOME SERVICE PROCEDURES DESCRIBED HERE ARE DONE WITH POWER APPLIED TO THE SIGNAL GENERATOR AND WITH PROTECTIVE COVERS REMOVED, SERVICE SHOULD BE DONE ONLY BY TRAINED SERVICE PERSONNEL WHO UNDERSTAND THE HAZARDS INVOLVED. WHERE SERVICE CAN BE PERFORMED WITHOUT POWER APPLIED, THE SIGNAL GENERATOR SHOULD BE UNPLUGGED FROM THE LINE POWER.**

**DO NOT INTERRUPT THE PROTECTIVE GROUNDING CONNECTION. TO DO SO WOULD CREATE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. SECURE THE INSTRUMENT AGAINST UNINTENDED OPERATION IF IT IS LIKELY THAT THIS PROTECTION HAS BEEN IMPAIRED. USE ONLY 250V FUSES OF THE PROPER CURRENT RATING.**

**CAUTION**

**To avoid damage to the Generator, unplug the instrument before removing any Printed Circuit Assembly.**

## 4C-3. POWER SUPPLY, A3A1, ADJUSTMENT
This procedure covers the +37V adjustment, R3, on the Power Supply assembly, A3A1. This is the only adjustment on the Power Supply PCB.

TEST EQUIPMENT

DMM

REMARKS

This adjustment is accessible through a hole in the bottom lip of the rear panel.

See Figure 4C-1 for the location of the power supply test points.

PROCEDURE

R3 is adjusted for +37V as measured at TP5.

1. Remove the UUT top and bottom instrument covers. Connect the DMM to TP5 with the ground lead (black wire) connected to the power distribution connection point on the module plate.
2. Program the UUT to [RCL] [9][8].
3. Adjust R3 for a DMM reading of +37.00 ± 0.05V.
4. Verify the other supply voltages at the test points listed in the following:

| TP | Voltage Limits |
|---|---|
| 11 | 14.5 to 15.7 |
| 3 | 14.5 to 15.7 |
| 2 | -14.5 to -15.7 |
| 4 | 4.85 to 5.20 |
| 1 | 17.4 to 22.6 |

*NOTE*

*The voltage at TP1 depends on the line voltage. The limits shown are for a line voltage exactly equal to the line voltage selector setting, i.e., 100, 120, 220, or 240 V ac.*

5. Remove the test leads, and reinstall the top and bottom instrument covers.

## 4C-4. DISPLAY ASSEMBLY, A1A1, ADJUSTMENT PROCEDURE

This procedure covers the adjustment of R16, the external modulation level indicator adjustment.

TEST EQUIPMENT

DVM

REMARKS

This adjustment is independent of other adjustments and assumes proper circuit operation.

Adjustment R16 is located below TP1 on the rear of the Display PCA, just above the POWER switch.

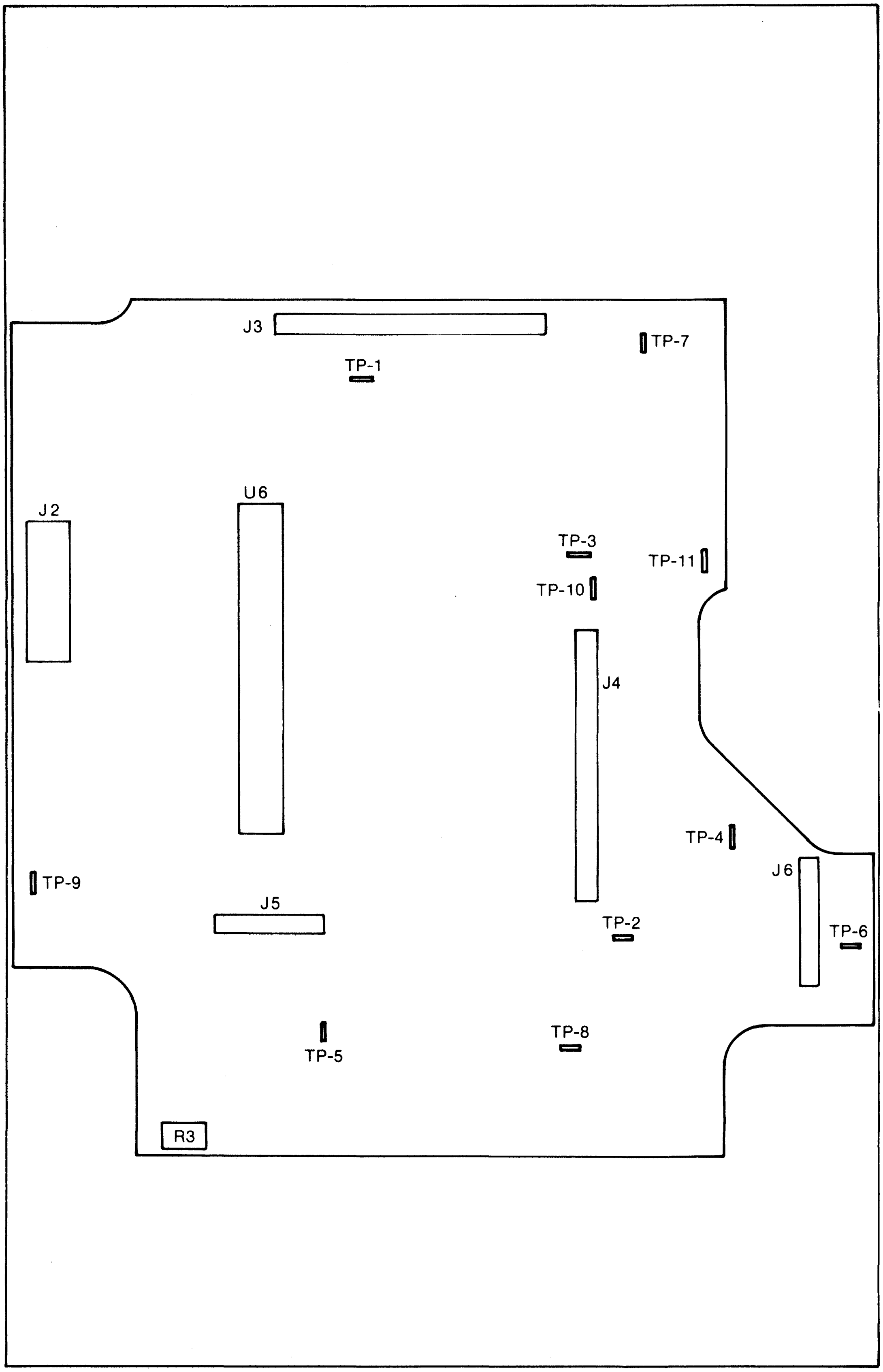



**Figure 4C-1. Power Supply Test Points**

PROCEDURE

Adjust R16 for 0.98V at TP1.

1. Gain access to the rear of the Display PCA by removing the top instrument cover.
2. Connect the DVM to measure the dc voltage at TP1 relative to the chassis.
3. Adjust R16 for +0.9800 ± .0005V dc.

## 4C-5. OUTPUT ASSEMBLY, A2A4, ADJUSTMENT

This procedure covers all of the adjustments on the A2A4 Output PCA, as follows:

1. R309, LEVEL DAC offset
2. R419, modulation oscillator level
3. R144, linearizer detector offset
4. R421, AM depth
5. R311, RF level
6. R227, Het level

These adjustments, as well as TP7, are accessible by removing the seven number 10 access screws in the module cover. Refer to Figure 4C-2 to identify the access screw corresponding to a particular adjustment.

Any adjustment can be made independently unless it is noted that it interacts with another adjustment. Interdependent adjustments must be done in the sequence presented. If more than one adjustment is necessary, do them in the sequence presented.

1. Level DAC Offset Adjustment

TEST EQUIPMENT

DVM

REMARKS

This adjustment is normally required only when U302 or any associated components are replaced or when the adjustment has been changed or has shifted.

**CAUTION**

**This adjustment directly affects the output level and should not be adjusted indiscriminately.**

PROCEDURE

The LEVEL DAC Offset, R309, is adjusted for 0 ± 0.5 mV at TP7 with the RF OUTPUT turned OFF.

a. Gain access by removing the bottom instrument cover and removing the access screws for TP7 and R309.
b. Program the UUT to [RCL] [9][8], and program the RF OUTPUT to OFF.
c. Connect the DVM to measure the voltage between TP7 and the power distribution connection point on the module plate.

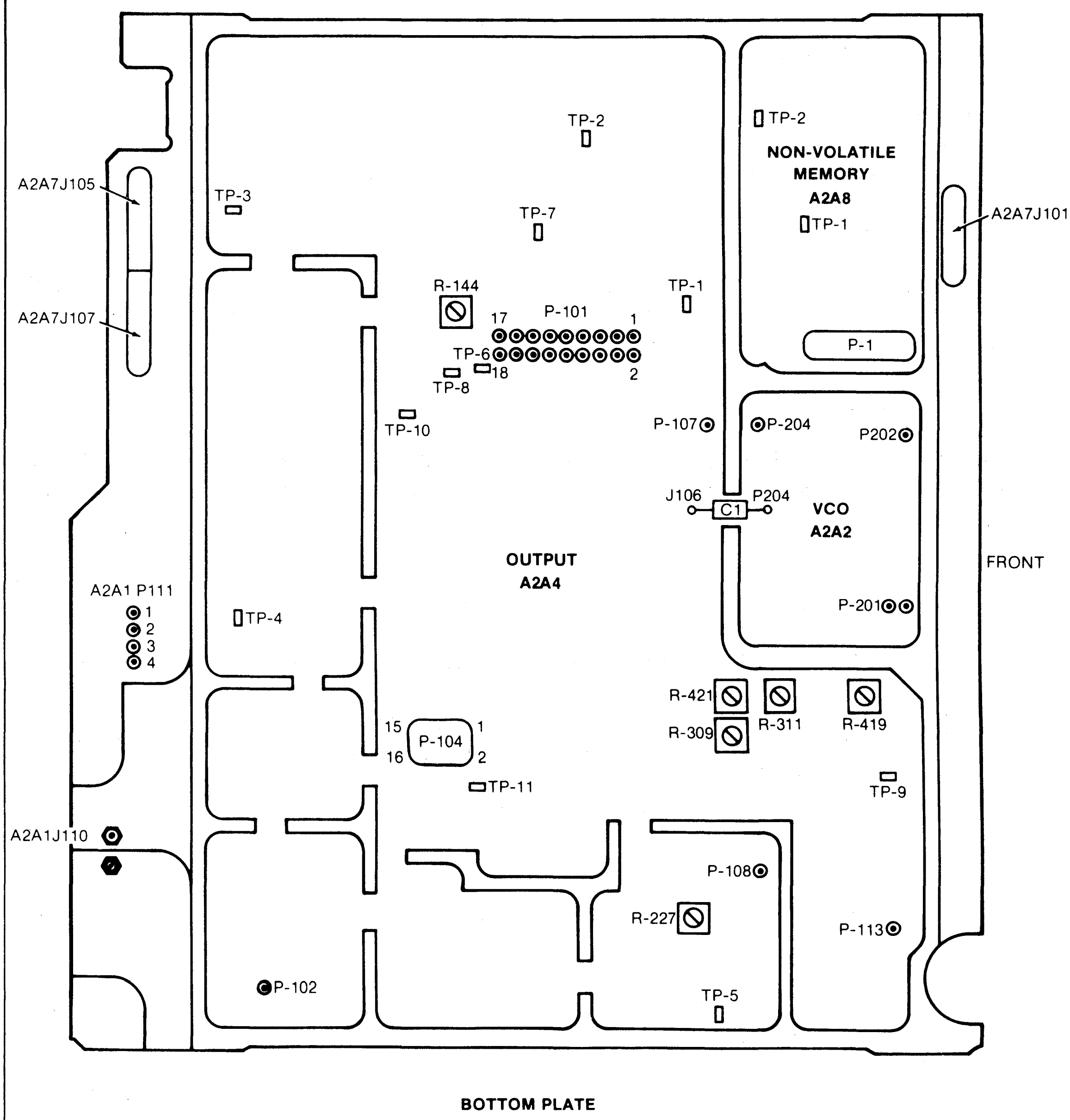



**Figure 4C-2. Module Plate, Bottom View**

d. Adjust R309 for an indication of +0 mV ± 0.5 mV.

e. Program the UUT RF OUTPUT to ON.

f. Replace the access screws.

2. Modulation Oscillator Level Adjustment

This adjustment sets the modulation oscillator level.

TEST EQUIPMENT

Modulation Analyzer
DVM
Low Frequency Synthesized Signal Generator (LFSSG)

REMARKS

The modulation oscillator adjustment is normally required only when components in the modulation oscillator or modulation switching circuits have been replaced or the adjustment has been changed or has shifted.

PROCEDURE

The AM depth, with internal modulation, is adjusted via R419 to equal the AM depth with a 1-volt peak external modulation signal as measured with the Modulation Analyzer.

a. Gain access to the access screws for R419 by removing the bottom instrument cover and the access screws for R419.

b. Connect the output of the LFSSG to the UUT MOD IN connector and the DVM using a BNC tee.

c. Program the UUT to RCL 98, then program the UUT to 350 MHz, 7 dBm, and EXT AM at 90% AM depth.

d. Program the LFSSG for 1 kHz and a voltage of 0.7071V rms, as measured by the DVM.

e. Connect the UUT RF OUTPUT connector to the Modulation Analyzer RF input.

f. Program the Modulation Analyzer to measure + Peak AM in a 0.3-kHz to 15-kHz bandwidth.

g. Note the measured AM depth reading with the Modulation Analyzer.

h. Turn off the UUT EXT AM control and turn on the INT AM control.

i. Program the UUT for 1000-Hz modulation frequency.

j. Adjust R419 for an AM depth equal to that noted in step g.

k. Turn off the UUT INT AM control.

l. Replace the access screw.

3. Detector Offset Adjustment

This adjustment sets the detector offset voltage.

TEST EQUIPMENT

Power Meter and Sensor

REMARKS

The UUT must be operated at room temperature for at least one hour with the module plate cover in place before continuing with this adjustment procedure.

This adjustment is normally required only when components in the detector or detector linearizer circuits have been replaced or when the adjustment has been changed or has shifted. If the Detector Offset is adjusted, perform the AM Depth adjustment.

**CAUTION**

**This adjustment directly affects the output level and should not be adjusted indiscriminately.**

PROCEDURE

The Detector Offset adjustment, R144, is adjusted to provide a 20-dB change in output power for a 20-dB change in the LEVEL DAC with level correction disabled, and while operating in fixed range.

a. Gain access for this adjustment by removing the instrument bottom cover.

b. Program the UUT to [RCL] [9][8], then program the UUT to 350 MHz and 12 dBm.

c. Program the UUT to [SPCL] [8][1] and [SPCL] [9][1]. These special functions disable all level correction and enable amplitude fixed-range.

d. Remove the Detector Offset adjustment access screw from the bottom module plate cover.

e. Zero the Power Meter.

f. Connect the Power Sensor to the UUT RF OUTPUT connector.

g. Program the UUT to +12 dBm.

h. Note the Power Meter reading.

i. Program the UUT for -8 dBm, using the EDIT keys.

j. Adjust the Detector Offset adjustment, R144, for a Power Meter reading 20 dB ±0.1 dB below the reading obtained in step h.

k. Repeat the previous four steps until the difference between the power measurements is 20 ± 0.1 dBm. This adjustment should require three or fewer iterations.

   Program the UUT to +12 dBm, using the EDIT keys. Note the Power Meter reading.

l. Program the UUT for +2 dBm using the EDIT keys. Verify that the Power Meter reading is 10 dB ±.2 dB below the previous reading.

m. Program the UUT for [SPCL] [0][0]. This enables amplitude level correction and disables amplitude fixed range.

n. Disconnect the Power Sensor from the UUT, and replace the Detector Offset adjustment access screw.

4. AM Depth Adjustment

TEST EQUIPMENT

DVM

Modulation Analyzer LFSSG

REMARKS

The UUT must be operated at room temperature for at least one hour with the module plate covers in place before continuing with this adjustment procedure.

**CAUTION**

**This adjustment directly affects the output level and should not be adjusted indiscriminately.**

This adjustment is normally required only when components in the AM signal processing circuits have been replaced, or the adjustment has been changed or shifted. If this adjustment is made, it is necessary to perform the RF level adjustment after the AM depth adjustment has been made.

PROCEDURE

Adjust the AM depth potentiometer R421 for 90% AM depth as measured with the Modulation Analyzer when the UUT is programmed to 90% AM.

a. Remove the AM depth adjustment access screw from the bottom module plate cover.

b. Connect the output of the LFSSG to the UUT MOD IN connector and to the DVM using a BNC Tee.

c. Program the UUT to [RCL] [9][8], then program the UUT for 350 MHz, +1 dBm, and EXT AM at 90% AM depth.

d. Program the LFSSG for 1 kHz and a voltage of 0.7071 rms, as measured by the DVM.

e. Connect the UUT RF OUTPUT connector to the Modulation Analyzer input.

f. Program the Modulation Analyzer to measure AM + Peak, in a 0.05-kHz to 15-kHz bandwidth.

g. Alternately measure + PEAK and – PEAK and adjust the AM Depth Adjustment, R421, until the readings are symmetrical, about 90%.

h. Replace the AM Depth adjustment access screw.

5. RF Level Adjustment

TEST EQUIPMENT

Power Meter and Sensor

REMARKS

The UUT must be operated at room temperature for at least one hour with the module plate covers in place before continuing with this adjustment procedure.

This adjustment is required if any of the following events occur:

The Output Assembly, A2A4, or the Attenuator, A2A5 or A2A6, has been replaced.

The AM Depth adjustment is made.

The LEVEL DAC or any associated components are replaced.

The RF level adjustment has been inadvertently changed or shifted.

**CAUTION**

**This adjustment directly affects the output level and should not be adjusted indiscriminately.**

PROCEDURE

With the UUT programmed to +9 dBm, adjust the RF Level Adjustment, R311, for +9-dBm output as measured with the Power Meter.

a. Program the UUT to [RCL] [9][8], then program the UUT to 350 MHz, +9 dBm, and turn all modulation OFF.

b. Zero the Power Meter.

c. Remove the RF Level Adjustment access screw from the bottom module plate cover.

d. Connect the Power Sensor to the UUT RF connector.

e. Adjust RF Level Adjustment, R311, for a reading of exactly +9 dBm on the Power Meter.

f. Replace the RF Level Adjustment access screw.

6. HET Level Adjustment

TEST EQUIPMENT

Power Meter and Sensor

REMARKS

The UUT must be operated at room temperature for at least one hour with the module plate covers in place before continuing with this adjustment procedure.

This adjustment is normally required only when components in the het band circuits have been replaced or when the adjustment has been changed or has shifted.

**CAUTION**

**This adjustment directly affects the output level and should not be adjusted indiscriminately.**

PROCEDURE

With the UUT programmed to +9 dBm, adjust the Het Level Adjustment, R227, for equal output power at 100 MHz and 350 MHz.

a. Program the UUT to [RCL] [9][8], then program the UUT to 350 MHz and +9 dBm.

b. Zero the Power Meter.

c. Remove the het level adjustment access screw from the bottom module plate cover.

d. Connect the Power Sensor to the UUT RF OUTPUT connector. Note the Power Meter reading.

e. Program the UUT to 100 MHz.

f. Adjust Het Level Adjustment, R227, for a reading equal to that previously noted.

g. Replace the HET level adjustment access screw.

### 4C-6. SYNTHESIZER ASSEMBLY, A2A1 ADJUSTMENT

The following are the routine adjustments for the Synthesizer assembly, A2A1.

1. C153 10-MHz Adjustment

2. R82 FM Cal Adjustment
   R90 Low-Rate Deviation Adjustment
   R87 FM Flatness Adjustment

The following only need adjustment if the associated circuits are repaired.

3. L49 20-kHz Notch Filter Adjustment
   L50 40-kHz Notch Filter Adjustment

4. R104 VCO Upper Clamp Adjustment

5. C206 800-MHz Oscillator Adjustment

Each of the following adjustment procedures is independent; that is, they can be done individually or in any sequence. Figure 4C-3 shows the top view of the module plate.

1. Reference Frequency Adjustment, C153

TEST EQUIPMENT

Frequency Standard
Oscilloscope

REMARKS

The accuracy of this adjustment depends on that of the frequency standard.

The Signal Generator may be equipped with either Option -130 High-Stability Reference, Option -131 Sub-Harmonic Reference, or both. The frequency reference operation and adjustment procedure depend on this configuration. That is, the instrument reference may be the 10-MHz crystal oscillator, the High-Stability Reference, or an external signal. If the Sub-Harmonic Reference option is present, and external reference operation is selected, the 10-MHz crystal oscillator is locked to the external reference signal.

This procedure applies to standard instruments or instruments with only the Sub-Harmonic Reference. If the UUT is equipped with the High-Stability Reference, use the adjustment procedure for the High-Stability Reference in Section 6 of this manual. If the Sub-Harmonic Reference Option is also installed, also perform the Sub-Harmonic Reference Option Adjustment described in Section 6 of this manual.

PROCEDURE

The UUT reference waveform is viewed on the Oscilloscope while triggering on the Frequency Standard. The 10-MHz adjustment, C153, is adjusted for a stationary display.

a. Remove the instrument top cover and the 10-MHz adjustment access screw from the module plate cover.

b. Connect the UUT rear panel 10 MHz IN/OUT to the Oscilloscope vertical input.

c. Connect the Frequency Standard output to the Oscilloscope external trigger input.

d. Set the UUT rear panel REF INT/EXT switch to INT, and set the vertical controls of the Oscilloscope to display the UUT 10-MHz signal.

e. Set the Oscilloscope for external triggering, and adjust the timebase for 0.1 us/div.

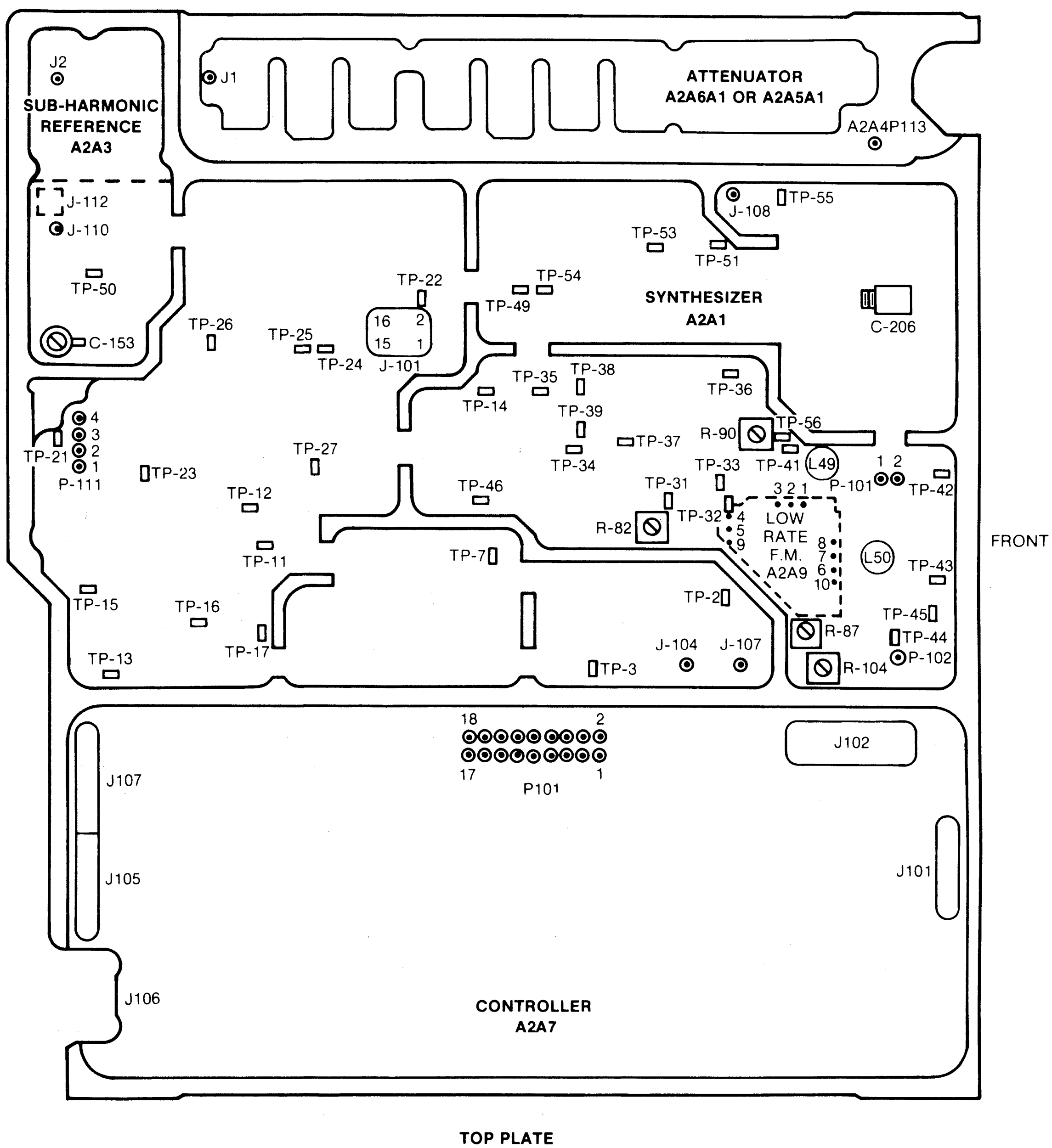



**Figure 4C-3. Module Plate, Top View**

f. Adjust C153 for a drift of less than one cycle per second.

2. FM Adjustments, R82, R90, AND R87

TEST EQUIPMENT

Modulation Analyzer
LFSSG
DVM

REMARKS

The FM Cal adjustment, R82, sets the overall deviation accuracy, whereas the Low-Rate Deviation Adjustment, R90, equalizes the low and high rate deviation. The FM Flatness Adjustment, R87, equalizes the deviation across the band from 0.4 to 10 kHz.

PROCEDURE

The FM deviation of the UUT, as measured with the Modulation Analyzer, is adjusted to agree with the programmed deviation at 10-kHz and 0.4-kHz rates by adjusting R82, R90, and R87, respectively.

a. Remove the instrument cover and the FM CAL, FM flatness, and Low-Rate Deviation adjustment access screws from the cover of the module plate.

b. Connect the output of the LFSSG to the UUT MOD IN connector and to the DVM using a BNC tee.

c. Connect the UUT RF OUTPUT to the Modulation Analyzer input.

d. Program the Modulation Analyzer to measure FM + peak in a 0.05-kHz to > 200-kHz bandwidth.

e. Program the UUT to the [RCL] [9][8]. Then program the UUT to 385.5-MHz, 7 dBm, EXT FM, 99.9-kHz deviation.

f. Program the LFSSG to 10 kHz and 0.7071V rms as measured by the DVM.

g. Adjust R82 for 100.0 kHz, as measured by the Modulation Analyzer.

h. Program the LFSSG to 0.4 kHz and 0.7071V rms, as measured by the DVM.

i. Adjust R90, the low-rate deviation for 100.0 kHz, as measured on the Modulation Analyzer.

j. Program the LFSSG to 1 kHz, and adjust R87 for 100.0 kHz as measured on the Modulation Analyzer.

k. Repeat steps f through j until the deviation flatness is 100.0 kHz ± 0.3 kHz.

l. Turn the UUT EXT FM off, and note the Modulation Analyzer peak deviation (noise) reading.

m. Turn the UUT EXT FM on.

n. Program the LFSSG to 10 kHz and 0.7071V rms as measured by the DVM.

o. With the Modulation Analyzer, alternately measure +peak and -peak FM, and adjust R82 so the readings are symmetrical, about 99.9 kHz plus the noise noted in step l.

3. L49 20-kHz and L50 40-kHz Notch Filter Adjustments

TEST EQUIPMENT

RF Spectrum Analyzer
LFSSG

REMARKS

These adjustments are normally not required unless L49, L50, C123, C99, C124, C126 or C125 are replaced, or unless the Generator has been subjected to severe usage.

PROCEDURE

The 20-kHz and 40-kHz notch adjustments, L49 and L50, are adjusted for sideband level nulls using the RF Spectrum Analyzer.

a. Remove the instrument and the module plate top covers.

b. Connect the LFSSG to TP56 (high) and TP36 (low) using clip leads.

c. Program LFSSG to 20 kHz and 0.2V rms, terminated.

d. Connect the UUT RF OUTPUT to the RF Spectrum Analyzer input.

e. Program the UUT to 300 MHz and +13 dBm.

f. Adjust the RF Spectrum Analyzer to display the signal centered on the display.

g. Set the span to 10 kHz/division and 1-kHz bandwidth. The 20-kHz sidebands should be visible.

h. Adjust L49 to minimize the 20-kHz sidebands.

i. Program the LFSSG to 40 kHz.

j. Adjust L50 to minimize the 40-kHz sidebands.

4. VCO Upper Clamp Adjustment, R104

TEST EQUIPMENT

Frequency Counter

REMARKS

This adjustment is normally required when the VCO is replaced or when the Generator has been subjected to severe usage.

PROCEDURE

The UUT PLL loop is disabled to cause the VCO frequency to be at the upper limit of its range, then R104 is adjusted for 530 MHz.

a. Remove the instrument and module plate top covers.

b. Connect UUT RF OUTPUT to the Frequency Counter input.

c. Program the UUT to [RCL] [9][8]; then, program the UUT for 500 MHz and +13 dBm.

d. Using a clip lead, short TP14 to ground to cause the VCO to go to the upper frequency limit.

e. Adjust R104 for 530 MHz ± 1 MHz.

5. 800-MHz Oscillator Adjustment, C206

TEST EQUIPMENT

Frequency Counter
DMM

REMARKS

This adjustment is normally not required unless components in the 800-MHz oscillator are replaced or the Generator has been subjected to severe usage.

PROCEDURE

The PLL control voltage operating point is adjusted to 16V while the loop is phase-locked.

a. Remove the instrument and the module plate top covers.

b. Program the UUT to [RCL] [9][8]; then, program 200 MHz.

c. Connect the DMM to measure voltage between TP53 and the chassis.

d. Adjust C206 for 16.0V ± 0.5V.

# Section 4D
# Troubleshooting and Repair

## 4D-1. INTRODUCTION

Usually, the Generator is most easily repaired by identifying the defective module and replacing it through the Module Exchange Program. Alternately, you may wish to troubleshoot down to the component level and replace the defective part. This section of the manual provides the necessary information for both repair methods.

After any module repair or replacement, the Performance Tests should be done to verify the performance of the Generator. Signal Generator problems are generally caused by operator error, out-of-spec performance, or by catastrophic failure. The correction strategy is different in each case.

Although most operator errors are detected and indicated, some are not, and therefore, may be mistaken for an out-of-spec condition. Those operator errors that are detected are indicated with either a steady or flashing 'UNCAL' indicator. Consult the Generator Specifications in Table 1-1 and Section 2 in this manual for more information on Generator operation.

Out-of-spec performance is usually corrected by performing the appropriate adjustment procedure(s). Use the Performance Tests to determine which parameters need adjustment. Refer to adjustment paragraphs in this section for more information.

If the problem is not an operator error and is not corrected by adjustment, the Generator has a catastrophic failure. Then the task is to isolate the fault and make appropriate repairs. The UNCAL and self-test failure codes usually provide a good indication of the cause of the problem. Using the Performance Tests in this situation may help to determine which parameters are not affected.

## 4D-2. MODULE REPLACEMENT

This repair method involves identifying and replacing the problem module. The replacement module may be obtained using the Module Exchange Program or from your spare module stock, which may then be restored using the Module Exchange Program.

Use the information in the Troubleshooting section to diagnose the problem. To help you identify the problem module, you may call your local Fluke Technical Center for troubleshooting assistance. Once the Fluke service technician believes the problem module is identified, a replacement module can be shipped prepaid by an overnight air carrier.

After the operator verifies that the replacement module corrects the problem, return the defective module using the shipping container and including the prepaid return shipping papers and label.

*NOTE*

*The Attenuator, Output, and VCO assemblies are individually calibrated, and the correction data are stored in the associated calibration EPROMS.*

**CAUTION**

**If any of these assemblies needs calibration or if any non-field replaceable part needs repair, order a replacement using the Module Exchange Program.**

To order a replacement module, use the part number for the assembly shown in the List of Parts and specify a Module Exchange part. Table 4D-1 shows a list of replaceable assemblies. To order any new assembly, refer to Section 5 for the part number. (New assemblies are ordered by referring to the same part number). Note that two versions of the Synthesizer assembly are available, one with the Low-Rate FM option and one without the option. The following paragraphs describe the available exchange modules, how to install them, and how to adjust the Generator, if necessary, after installation.

**Table 4D-1. Module Exchange Assemblies**

| |
|---|
| A1A1 Display PCA |
| A2A1 Synthesizer PCA |
| A2A2 VCO PCA |
| A2A4 Output PCA |
| A2A6 Attenuator Assembly |
| A2A6A4 Attenuator PCA |
| A2A6A5 Relay Driver PCA |
| A2A7 Controller PCA |
| A3A1 Power Supply PCA |

### 4D-3. Power Supply PCA, A3A1

The Power Supply PCA comes complete with the 5V regulator, A1U3, its socket, and a set of insulated washers for all of the chassis-mounted regulators.

No adjustment is required after installation of the new PCA, but the power supply voltages should be verified, using the last step of the Power Supply Adjustment procedure in this section.

### 4D-4. Sub-Harmonic Reference PCA, A2A3

This module comes ready to install. After installation, perform the Reference Frequency Adjustment procedure for the Sub-Harmonic Reference option.

### 4D-5. Synthesizer PCA, A2A1

Under the Module Exchange Program there are two versions of the A2A1 Synthesizer assembly available. One has the Low-Rate FM option installed on the Synthesizer PCA and the other does not. Therefore, when ordering a replacement Synthesizer module be sure to specify whether or not the Generator being repaired has the Low-Rate FM option.

Also, before replacing the Synthesizer PCA it is important to note what other options are in the Generator and carry out the following instructions pertaining to the option complement of the Generator. If the Low-Rate FM option is present, verify that S1 on the PCB option is set for Low-Rate operation. (See Section 6.)

After the new Synthesizer PCA has been installed, perform the FM CAL, VCO CLAMP, and 10-MHZ adjustments as described in the Synthesizer Adjustment Procedure in Section 4C of this manual. Perform any other adjustments related to the options.

If the Generator has the Sub-Harmonic Reference option installed (which mounts atop the Synthesizer PCA), this option must be removed before removing the Synthesizer PCA. Then L54, C171, and CR20 must be moved from the old Synthesizer PCA to the new PCA. Also C154 on the new PCA must be removed (by clipping it out with a wire cutter). After the Synthesizer and the Sub-Harmonic Reference option PCBs have been installed, the Reference Frequency Adjustment procedure for the Sub-Harmonic Reference option should be done, instead of the 10-MHZ adjustment mentioned above. Refer to Section 6 for this adjustment.

### 4D-6. VCO PCA, A2A2

The VCO assembly comes with its associated VCO Calibration EPROM. This EPROM replaces the old one installed on the Controller PCB, A2A7. After installing the new VCO assembly, the FM CAL and VCO CLAMP adjustments should be done. These adjustments are presented under the Synthesizer Adjustment Procedure.

A plug-in coupling capacitor is used to interconnect the VCO and Output PCBs, thus eliminating the need for a soldering iron when replacing this assembly.

### 4D-7. Output PCA, A2A4

The Output assembly comes with its associated Output Calibration EPROM. This EPROM replaces the old one installed on the Controller PCB. After installing the new Output assembly, perform the level DAC offset, the RF Level, the HET level, and the FM CAL adjustment procedures given in the Calibration Adjustment Section of this manual.

A plug-in coupling capacitor is used to interconnect the VCO and Output PCBs, eliminating the need for a soldering iron when replacing this assembly.

If the Generator is equipped with the Low-Rate FM option, then it is necessary to add a jumper around C401 and C402 on the new Output assembly before installing it.

### 4D-8. Controller PCA, A2A7

The Controller assembly comes without the three calibration EPROMs. Therefore, it is necessary to move these EPROMs from the old to the new Controller. Remember to set the option status switch. No adjustments are required.

### 4D-9. Display PCA, A1A1

After installing a new Display PCA, the Modulation Indicator adjustment should be done. The procedure is presented under the Display Adjustment Procedure.

### 4D-10. Attenuator (Attenuator/RPP) PCA, A2A6 (A2A5)

The Attenuator or the optional Attenuator/RPP PCA comes complete with the housing, Relay Driver PCA and matching Attenuator Calibration EPROM, and comes ready to install. The matching EPROM replaces the Attenuator calibration EPROM on the Controller PCA. After the new Attenuator assembly is installed, perform the RF Level Adjustment procedure on the A2A4 Output PCA in the Calibration Adjustments section of this manual.

### 4D-11. IEEE-488 PCA, A3A3

The IEEE-488 assembly comes complete with panel, frame, and connector and is ready to plug in. No adjustments are required after installation.

### 4D-12. Non-Volatile Memory PCA, A2A8

The Non-Volatile Memory assembly comes ready to plug in, and requires no adjustment after installation.

## 4D-13. PARTS REPLACEMENT

An experienced technician should be able to isolate the defective component and replace it after reading the information presented in Section 3, the Theory of Operation and the troubleshooting information contained in this section. The Schematics are presented in Section 8 (Section 6 for the options) of this manual.

Most parts are replaced using ordinary methods. The parts requiring special attention are the chip components located on the A2A2 VCO PCA. The chip components should be replaced using a 600°F soldering iron, such as an Ungar 50T7 with a number 76 heater and a number 88 tip, and 2% silver solder paste, such as Electro Science Fabrication SP-37D1 or similar wire solder.

## 4D-14. TROUBLESHOOTING

To isolate a fault, it is important to note the conditions under which the symptoms are observed and if the symptoms change with different states of the instrument, such as different RF bands or levels, only when FM is on, only under remote control, etc.

If the symptom is a blank front panel or no response to keystrokes, the fault is most likely a digital problem or a power supply problem. If the power supply and cables are good, go to the digital troubleshooting paragraphs in this section.

If the front panel appears to function properly, but the RF output is abnormal or there is a flashing 'UNCAL' indication, the cause is likely an analog circuit problem (although it could be a control problem).

A properly operating front panel indicates that the majority of the Controller circuitry is functional. It is possible, however, that a digital control problem could exist and cause the RF output to be incorrect. If a digital problem is suspected, go to the Digital and Control troubleshooting paragraphs after checking the power supply.

### 4D-15. Service Special Functions

- Special Function 03, Display check

  All display segments are lit until a key is pressed.

- Special Function 04, Key check

  For each key pressed, the code is displayed in the FREQUENCY display field. Pressing [CLR| LCL] key exits this check. The test also times out after approximately 8 seconds if no keys are pressed.

- Special Function 15, Latch Test

  Special function 15 invokes a built-in latch control test that is useful in verifying that the Controller is sending valid data to the latches of the Output and Synthesizer assemblies. This special function sends an alternating bit pattern (10101010 binary) to each 8-bit latch, and displays "Latch AA". Pressing the [EDIT ↓] key changes the bit pattern to (01010101 binary), and "Latch 55" is displayed. Pressing the [EDIT ↑] key changes the pattern back to 10101010. Pressing any other key causes the instrument to exit the test.

**CAUTION**

**This special function is intended as a troubleshooting tool to check the operation of the digital circuitry and the latches on the analog assemblies. Since the Generator is programmed to an abnormal state, its output is turned off by programming full attenuation.**

- Special Functions 83 Through 86 Alternate Attenuators

  Special functions 83 through 86 program alternate 24-dB Attenuators. The alternate 24-dB attenuators are normally used only when low levels are programmed too low to be verified with a power meter during service. These special functions allow the alternate attenuators, A242L through A245L, to be programmed one at a time, thus keeping the level high. The first 24-dB attenuator, denoted A241L, is automatically programmed for levels between -17.0 dBm and -11.1 dBm with AM off. These special functions allow the other attenuators, A242L through A245L, to be programmed in the same range.

  These special functions also turn off relative amplitude, amplitude fixed range, and all modulation; and turn RF and level correction on. If the level is not in the specified range, -12 dBm will be programmed. Any new entry that normally programs the attenuators causes the default (normal) attenuators to be programmed.

### 4D-16. UNCAL Conditions

There are two hardware fault detectors, the unlock detector on the Synthesizer PCA, and the unleveled detector on the Output PCA. These two fault detectors are constantly monitored by the Controller, and if asserted, cause a flashing UNCAL indication. The detectors are also used during the self test to check the general operation of the Generator.

It is very important to interrogate and note the UNCAL code if there is an UNCAL indication.

If the unit has a UNCAL condition, interrogate the UNCAL code by pressing the [STATUS] key and interpret the code (see Table 2-5 in this manual). Take note if the code indicates that either UNLOK or UNLVL conditions have been asserted. Other codes denote overrange or underrange conditions (operator errors) that should be cleared but are not pertinent to troubleshooting.

Usually the unleveled UNCAL code indicates a problem on the Output PCA, whereas a unlocked UNCAL code indicates a problem on the Synthesizer PCA. Be aware that it is possible to have an Unleveled UNCAL condition due to a problem with the Synthesizer PCA that is not detected by the UNLOK detector.

It is a good idea to check for a different UNCAL code when other RF bands, levels or functions (FM or AM) are selected for a more complete analysis of the symptoms. For example, if the code indicates that UNLOK is asserted only with FM on, and not with FM off, it may be indicating an overmodulation condition. See Table 1-1. Signal Generator Specifications, for the FM limitations.

### 4D-17. Self Test Description

The self test is started whenever the Generator is turned on. It may also be started by [SPCL] [0][2]. If the Generator fails any of the self tests, the self-test failure report is displayed until any key is pressed. The self-test report can also be displayed by [SPCL] [1][1]. The report is presented in four fields as shown in Table 4D-2.

A minus sign in the Frequency Display indicates that the self test was aborted by a front panel entry.

**Table 4D-2. Self Test Display Field**

| MODULATION | FREQUENCY | AMPLITUDE |
|---|---|---|
| A A A | - B B B C C C | D D D |

The four groups (denoted by the A's, B's, C's and D's) in the self-test report correspond to different test categories. These tests are described below, including a tabulation of the Generator instrument state and the test codes that result if any test fails to achieve the expected result. Understanding how these tests are done can provide more meaning to the results and can assist in understanding how they relate to other symptoms. A successful self test is reported with all zeros.

During the self test, the step attenuator is programmed to maximum attenuation and the internal frequency reference is selected. The analog circuit tests make use of the unleveled (UNLVL) and unlocked (UNLOK) status detectors, whereas the digital circuit tests make use of write/read techniques.

## 4D-18. AAA FIELD

AAA is the result of the AM and FM tests. During these tests, level correction is applied. During the four AM tests, a normal AM depth, which should produce a leveled condition, and an abnormally high AM depth, which should provide an unleveled condition, is set for each modulation frequency. During the two FM tests, a normal FM deviation is set, which should produce a locked condition, and then an abnormally high deviation is set, which should produce an unlocked condition. The two FM tests are not performed if the Option -651 Low-Rate FM is installed. Table 4D-3 shows the AAA Field AM and FM tests.

## 4D-19. BBB FIELD

BBB is the result of the synthesizer tests. In the first three test steps, the Synthesizer assembly's main PLL operation is verified by programming a large change in frequency. This should cause a momentary unlocked condition that should clear as the frequency settles to the new frequency.

**Table 4D-3. AAA Field AM and FM Tests**

| AAA (CODE) | FREQ (MHZ) | LEVEL (DBM) | AM (%) | MOD FREQ (HZ) | KV DAC | FM DAC | FM RANGE | EXPECTED RESULT |
|---|---|---|---|---|---|---|---|---|
| 001 | 1050 | 10.7 | 30 | 400 | n/a | n/a | n/a | Leveled |
| 002 | 1050 | 14 | 127 | 400 | n/a | n/a | n/a | Unleveled |
| 004 | 1050 | 10.7 | 30 | 1000 | n/a | n/a | n/a | Leveled |
| 010 | 1050 | 14 | 127 | 1000 | n/a | n/a | n/a | Unleveled |
| 020 | 280 | -10 | n/a | 400 | Normal | 1023 | 4 | Locked |
| 040 | 280 | -10 | n/a | 400 | 1023 | 1023 | 4 | Unlocked |

In the next three steps, the synthesizer is checked by programming 225 MHz, which is outside the normal operating frequency range, and should result in an unlocked condition. Then 385 MHz is programmed, which should result in a locked condition. Next 550 MHz is programmed, which is again outside the normal range, and should result in unlocked condition.

Finally, all frequency reference circuitry is turned off, which should produce an unlocked condition, and then turned on, which should produce a locked condition. Table 4D-4 shows the BBB Field test results.

## 4D-20. CCC FIELD

CCC is the result of the digital tests. The IEEE-488 option (if installed) is verified by writing data to the IEEE-488 chip, A3A3U1, then by reading it back and checking for the expected response. If Non-Volatile Memory is installed, each memory location of the Non-Volatile RAM is checked with a checksum.

**Table 4D-4. BBB Field Test Results**

| BBB (CODE) | SYNTH. FREQ. (MHZ) | MAX. WAIT (MS) | XOENL BIT | EXPECTED RESULT |
|---|---|---|---|---|
| 001 | 245 | 120 | 0 | Locked |
| 002 | 525 | 5 | 0 | Unlocked |
| 004 | 525 | 95 | 0 | Locked |
| 010 | 225 | 120 | 0 | Unlocked |
| 020 | 385 | 120 | 0 | Locked |
| 040 | 550 | 120 | 0 | Unlocked |
| 100 | 385 | 120 | 1 | Unlocked |
| 200 | 385 | 200 | 0 | Locked |

The Generator RAM is verified by writing data to each memory location and checking that the same data can be read back. Both the off-chip RAM (U25) and the on-chip RAM (U1) are tested in this manner. The RAM test is only done during the power-on self test. The data in each of the three calibration EPROMs; VCO (U23), Output (U24), and Attenuator (U26), are summed and compared with a checksum.

The data in each word of the two program EPROMs (U21, 22) are successively summed and rotated by two. The result of this procedure is compared with a checksum for each EPROM. Table 4D-5 shows the CCC field results.

## 4D-21. DDD FIELD

DDD is the result of the Output filter tests. During these tests, the level is programmed to +13.0 dBm with level correction applied. The low-pass filters on the A2A4 Output assembly are tested by setting the frequency near the high end of each of the four half-octave non-het bands and checking for a leveled condition. Then, the frequency is set above the cutoff frequencies of two of the filters, and the output is checked for an unleveled condition. Table 4D-6 shows the DDD field Results.

**Table 4D-5. CCC Field Test Results**

| CCC (CODE) | DIGITAL TEST |
|---|---|
| 001 | IEEE-488 option test |
| 002 | Non-Volatile Memory option test |
| 004 | RAM test |
| 010 | Attenuator calibration EPROM checksum |
| 020 | Output calibration EPROM checksum |
| 040 | Synthesizer calibration EPROM checksum |
| 100 | Lower program EPROM checksum |
| 200 | Upper program EPROM checksum |

**Table 4D-6. DDD Field Test Results**

| DDD (CODE) | FREQ (MHZ) | MIDL | HAOCTH | EXPECTED RESULT |
|---|---|---|---|---|
| 001 | 349.99999 | 0 | 1 | leveled |
| 002 | 511.99999 | 0 | 0 | leveled |
| 004 | 729.99999 | 1 | 0 | leveled |
| 010 | 1050.00000 | 1 | 1 | leveled |
| 020 | 490.00000 | 0 | 1 | unleveled |
| 040 | 1024.00000 | 1 | 0 | unleveled |

**Table 4D-7. Band, Filter, and Frequency Programming Data**

| OUTPUT FREQUENCY ($F_O$) | MIDL | HAOCTH | HETL | SHETH | SYNTH. FREQ ($F_S$) |
|---|---|---|---|---|---|
| 0.2 - 244.99999 MHz | 1 | 1 | 0 | 1 | $(800 + F_O)/2$ |
| 245 - 349.99999 MHz | 0 | 1 | 1 | 0 | $F_O$ |
| 350 - 511.99999 MHz | 0 | 0 | 1 | 0 | $F_O$ |
| 512 - 729.99999 MHz | 1 | 0 | 1 | 0 | $F_O / 2$ |
| 730 - 1050.00000 MHz | 1 | 1 | 1 | 0 | $F_O / 2$ |
| 1 = TTL High<br>0 = TTL Low | | | | | |

## 4D-22. Check Output Signal

At this point, check the Generator output signal with a Spectrum Analyzer or a Counter at various frequencies on each of the three RF bands and at the state where an UNCAL condition exists. If the frequency is incorrect or erratic, check the power supply first. Go to the Synthesizer troubleshooting paragraphs if the power supply functions properly. Table 4D-7 shows the band, filter, and frequency programming data for the output frequency (at the source).

## 4D-23. Auxiliary Power Supply PCA, A3A2

The Auxiliary Power Supply consists of the A3A2A1 PCB and the A3A2T1 transformer mounted together with a bracket. The power supply is electrically preadjusted and needs no adjustment after installation.

The Spectrum Analyzer can also be used to check to see if the modulation functions are generally working. If a modulation problem exists, go to the appropriate AM or FM troubleshooting paragraphs after checking the power supply.

If the frequency is stable and correct, but the output level is abnormal, the problem is most likely in the Output PCB. Check the power supply; then go to the Level Troubleshooting paragraphs in this section of the manual.

Armed with a clear knowledge of the symptoms and the conditions under which the UUT fails, the next task is to isolate the problem. Remove the top and bottom instrument covers and visually inspect the interior for loose cables, connectors, etc. Also be alert for the characteristic odor of burned resistors, etc.

**WARNING**

**DO NOT INTERRUPT THE PROTECTIVE GROUNDING CONNECTION. TO DO SO WOULD CREATE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. SECURE THE INSTRUMENT AGAINST UNINTENDED OPERATION IF IT IS LIKELY THAT THIS PROTECTION HAS BEEN IMPAIRED. USE ONLY 250V FUSES OF THE PROPER CURRENT RATING.**

**WARNING**

**BECAUSE THE PROCEDURES DESCRIBED HERE ARE DONE WITH POWER APPLIED TO THE SIGNAL GENERATOR AND WITH PROTECTIVE COVERS REMOVED, TESTING SHOULD BE DONE ONLY BY TRAINED SERVICE PERSONNEL WHO UNDERSTAND THE HAZARDS INVOLVED.**

**CAUTION**

**To prevent damage to the Generator, turn off the instrument before removing any PCAs.**

## 4D-24. Check Power Supply Voltages

**CAUTION**

**To prevent damage to the Generator, turn off the instrument before disconnecting any power distribution cables.**

Check all power supply voltages. Table 4D-8 gives the expected dc and ripple voltages at key test points. If one supply voltage is unusually low, this could indicate an abnormal load on that supply due to a fault. To isolate the fault, check the abnormal voltage before and after disconnecting (one at a time) the power cable to the Controller, Synthesizer, Attenuator, and the cable from the Controller to the front panel.

Table 4D-8 lists the typically dc and ripple voltages (relative to ground connection on the module plate) at the key test points of the Power Supply, A3A1, PCB. These characteristics apply for [RCL] [9][8].

The unregulated dc and ripple voltages are those expected with a line voltage of 120V ac at 60 Hz. The dc voltages are expected values as measured with a digital voltmeter with respect to the power supply ground connection on the module plate.

The ripple voltages are expected values as measured with an oscilloscope with respect to the power supply ground connection on the module plate, and are the peak-to-peak values of the 120-Hz waveform.

The characteristics of the unregulated +18V relay supply depend directly on the line voltage and the load (the state of the instrument). For example; at 120V ac:

- At 50 MHz and 13 dBm, Vdc is typically 20V with 0.25V (peak-to-peak) ripple.
- At 50 MHz and RF off, Vdc is typically 20.9V with 0V ripple.

Table 4D-8. Power Supply Characteristics

| SUPPLY | UNREGULATED VOLTAGES | | | REGULATED VOLTAGES | | |
|---|---|---|---|---|---|---|
| | @TP | V dc | Ripple(Vpp) | @TP | V dc | Ripple(mVpp) |
| +37 | 9 | 47 | 0.5 | 5 | 36.9 to 37.1 | 2 |
| +15 Syn | 7 | 22 | 0.5 | 11 | 14.5 to 15.7 | 0.5 |
| +15 Out | | | | 3 | " " | " |
| -15 | 8 | -23 | 0.2 | 2 | -14.5 to -15.7 | " |
| +5 | 10 | 9 | 1 | 4 | 4.75 to 5.25 | 1 |
| +18 | 1 | 18 | 2.5 | None | None | None |

## 4D-25. DIGITAL AND CONTROL TROUBLESHOOTING

If the symptoms indicate a digital or control problem, the following suggestions may help you isolate the fault to a particular functional circuit. In this manual, refer to the schematic diagrams in Section 8, and refer to Section 3 for the Theory of Operation.

First, verify that all assemblies are receiving the correct voltages from the power supply.

The most obvious symptom of failure in the Controller assembly is a blank front panel. A properly operating front panel indicates that most of the Controller circuitry is functional. If the front panel is totally blank or unresponsive to any keystrokes, the microprocessor kernel should be checked first. See the paragraphs entitled Microprocessor Kernel in this section.

If the front panel is operating correctly but the RF output is incorrect, determine if the fault is on the Controller side of connector P101. The control to most of the audio and RF analog circuitry passes through P101 via buffers U15 and U16 on the Controller PCB, A2A7.

### 4D-26. Control Activity

This can be checked by verifying data activity on the data and address lines of P101. Program the bright digit for 100-Hz resolution in the FREQUENCY display. While pressing the [EDIT- ↑ ] key, observe with an oscilloscope the activity on P101. Pressing one of the EDIT keys sends bursts of frequency and level control data through the buffers.

Although it is difficult to determine if the data, (BD0-7) and address (BAB0-2) signals on P101 are valid at any given time, the most common failures seen at this point are totally inactive signals. Between bursts, the data and address signals are in the high impedance state (tri-stated). Be careful not to confuse this high impedance state with total inactivity. Observing these signals on a known good unit may be helpful.

If signals are found to be totally inactive, inspect the buffer control signals on U15 (pin 1), and U16 (pins 1 and 19) of the Controller, A2A7. If the buffer control signals are active, check the buffer inputs that correspond to the inactive outputs. If the inputs show activity, replace the buffer and again check the signals. If, however, the inputs to the buffers are also inactive, trace the signals back and determine the fault location.

If all data and address signals show activity and their timing roughly corresponds to the select signals BSEL0L and BSEL1L, assume for now that the Controller is sending the correct data and continue on.

### 4D-27. Latch Control

Use the [SPCL] [1][5] keys to check each available latch on the RF circuit boards to verify that the correct data is reaching them. Passing this test is a good indication that the fault is not in the Controller.

If the IEEE-488 option is present, and an IEEE-488 Bus Controller is available, additional bit-level control of the hardware is available by using the monitor commands (see Section 2). These commands allow you to directly program the DACs, or read and write data to any desired location.

### 4D-28. Microprocessor Kernel

Connect an oscilloscope probe to the external clock input of A2A7 U1 pin 2. There should be a symmetrical 10-MHz square wave with an adequate TTL logic level. If the signal deviates from this description, refer to Section 3, Theory of Operation, in this manual to assist you in troubleshooting the clock oscillator circuit.

### 4D-29. Power Reset

Connect an oscilloscope probe to the RESET input (pin 22) of U1. The signal should generate a low to high transition on power-up and remain high during normal operation. Turning the power on and off generates active low reset pulses to U1. If a problem with the reset circuit is suspected, refer to Section 3, Theory of Operation, and troubleshoot the reset circuitry.

### 4D-30. Microprocessor Inputs

Input pins to U1, CRUIN (pin 13) , INT1 (pin 15), HOLD (pin 18), NMI (pin 21), and READY (pin 23), should all be high. If any of these signals are not high, correct the fault before continuing on.

### 4D-31. IEEE-488 Interrupt

Verify that the IEEE-488 Interface interrupt signal, IEINTL, is in the inactive (high) state. If IEINTL is active, either troubleshoot the interface to the IEEE-488 Interface option, or temporarily bend out pin 14 of U1 and tie it to +5V.

After completing the above steps, there should be activity on the address, data, and control lines as the microprocessor executes instructions.

### 4D-32. Microprocessor Bus

The dynamic nature of microprocessor bus circuitry makes it very difficult to verify the data transmitted at any given time. However, most common bus faults show recognizable symptoms. Look at each of the data (D0 to D7), address (A0 to A15), and bus control (CLKOUT, DBINL, WEL, MEML) signals with an oscilloscope.

Suspect inactive signals or signals that enter invalid logic states. Also compare the driver inputs and outputs of buffered signals. A combination of observation and experience is helpful here. An ohmmeter or a pulse generator may be useful in further investigating suspected signals.

### 4D-33. Address Decoder

Several levels of address decoding are used to select all the memory and I/O devices. The inputs to the address decoders come from the buses and present challenges similar to troubleshooting the buses. A suggested approach is to first choose a decoding path to a particular device or group of devices. Start at the highest level of decoding, and one at a time verify that each part in the path is good.

## 4D-34. Display and Controls

If the display shows signs of activity, but has missing or bright digits or segments, the problem is most likely in U18 on the A2A7 Controller or on one of the data latches or drivers on the A1A1 Display PCB. If the display is blank and the Controller is operational, check the various power supplies and the display blanking circuitry on the Display PCB.

Two special function-service tests are available to test the front panel indicators and keys. [SPCL] [0][3] keys check the front panel displays by lighting all segments. This test is aborted by pressing any key on the Generator.

The [SPCL] [0][4] keys allow all normally open keys to be checked. As each key is pressed, its row and column address is displayed in the center of the FREQUENCY display field. See Table 4D-9 for the address codes for each key. This test is exited by a clear entry.

**Table 4D-9. Address Codes for the Front Panel Keys**

| KEY | CODE |
|---|---|
| [EXTAM] | 1 |
| [EXTFM] | 2 |
| [INTAM] | 4 |
| [INTFM] | 5 |
| [400/1000] | 6 |
| [FREQ] | 9 |
| [AMPL] | 10 |
| [AM] | 11 |
| [FM] | 12 |
| [SPCL] | 13 |
| [STEP] | 14 |
| [7] | 15 |
| [4] | 16 |
| [1] | 17 |
| [0] | 18 |
| [STO] | 19 |
| [8] | 20 |
| [5] | 21 |
| [2] | 22 |
| [.] | 23 |
| [RCL] | 24 |
| [9] | 25 |
| [6] | 26 |
| [3] | 27 |
| [-] | 28 |
| [SEQ] | 29 |
| [MHz\|V] | 30 |
| [kHz\|V] | 31 |
| [Hz\|uV] | 32 |
| STEP[v] | 33 |
| [dB(m)] | 34 |
| [%] | 35 |
| [CLR\|LCL] | (Exit Test) |
| STEP[↑] | 37 |
| EDIT[←] | 38 |
| EDIT[↑] | 40 |
| EDIT[↓] | 41 |
| EDIT[→] | 43 |
| [STATUS] | 45 |
| RF[ON/OFF] | 46 |

## 4D-35. SYNTHESIZER TROUBLESHOOTING

*NOTE*

*All frequencies mentioned are synthesized; hence they are exact (coherent with the 10-MHz reference), unless noted as approximate.*

If the Generator has the Low-Rate FM (Option -651), set A2A9S1 for normal operation (See Table 651-1) while troubleshooting. If the Generator level is inaccurate or an unleveled condition exists, then the A2A4 Output assembly is probably at fault. If an unlock condition exists, the problem is in the synthesizer. If the output frequency is in error or erratic, there is likely a problem with the Synthesizer assembly. However, if the UUT has Option-130 Sub-Harmonic Reference and the unlocked condition only occurs when using an external reference, the problem is probably in the Sub-Harmonic Reference option circuitry.

If the unlocked condition exists with REF INT/EXT set to INT, be sure no signal is applied to the 10 MHz IN/OUT connector. An external signal applied (while operating on internal reference) can cause the main loop to unlock.

Next, check to see if the Generator frequency is stuck high or low. A good way to do this is to check the dc voltage at TP44. If it is around 2V, go to the Reference Circuitry Check in the following paragraphs.

If the voltage is around 25V, the problem is associated with the main PLL, i.e., VCO, UHF binary divider, buffer amplifier, SSB mixer, triple-modulus prescaler, or N-Divider.

Table 4D-10 shows the characteristics of the signals at the various test points on the Synthesizer PCA. The range of the signal and the expected value for a typical instrument state are given. The values in the TYPICAL column are for the UUT programmed to 160.11999 MHz, INT FM on at 1 kHz, and 99.9 kHz deviation.

### 4D-36. Reference Circuitry Check

There should be a 10-MHz square wave at TP50. If there is no signal here, check U55 pin 10. If there is a signal at this point, the problem is in the multiplexer circuitry U55 or latch U32. If there is no signal at U55 pin 10, the problem is in the internal 10-MHz crystal oscillator. The voltage at the junction of R148 and R149 should be a TTL low (approximately 0.2V). If voltage is a TTL high (approximately 3.8V), there is a problem with the latch, U32, or in the interface to the microprocessor. If the 10-MHz circuitry checks out, there should be a 1-MHz signal (20% duty cycle) at TP35.

Table 4D-11 shows the relationship between various reference frequency configurations and the control of the reference circuitry.

### 4D-37. Main Phase Lock Loop

If the voltage at TP44 is around 25V, connect a variable power supply to TP41. This allows the frequency of the VCO to be controlled directly. Use a Spectrum Analyzer or Counter to monitor the Generator output.

Program the UUT to 640 MHz. If the power supply can be adjusted to obtain an output frequency of about 640 MHz, the VCO is probably OK; proceed to the next paragraph. If the power supply cannot be adjusted to obtain about 640 MHz output frequency, troubleshoot the VCO or the circuitry between TP41 and TP44.

**Table 4D-10. Synthesizer PCA Test Points**

| TEST POINT | SIGNAL TYPE | RANGE | TYPICAL | FUNCTION |
|---|---|---|---|---|
| TP1 | RF | 245 to 525 MHz | 480.059995 MHz; -7 dBm | All frequency digits |
| TP2 | GROUND | | | |
| TP3 | RF | 245 to 525 MHz | 480.059995 MHz; +4 dBm | All frequency digits |
| TP7 | GROUND | | | |
| TP11 | TTL | 20 to 39.995 kHz | 39.995 kHz | 10-K, 1-K, 100-, and 10-Hz Digits |
| TP12 | TTL | 1 to 1.99975 MHz | 1.99975 MHz | 10-K, 1-K, 100-, and 10-Hz Digits |
| TP13 | GROUND | | | |
| TP14 | TTL | 1 MHz (AL) | 1 MHz | 1-MHz and lower digits |
| TP15 | TTL | 0.02 to 1 MHz | 20 kHz | |
| TP16 | TTL | 12 to 26 MHz | 24 MHz | All frequency digits |
| TP17 | RF | 245 to 525 MHz | 480.02 MHz; -17 dBm | All frequency digits |
| TP22 | AUDIO | 0 to 0.7V rms | 0.68V rms | FM Deviation |
| TP23 | GROUND | | | |
| TP24 | TTL | 20 MHz, 12.5 ns (AH) | 20 MHz | |
| TP25 | TTL | 20 MHz, 12.5 ns (AH) | 20 MHz | |
| TP26 | GROUND | | | |
| TP27 | TTL | 10 to 19.9975 MHz | 19.9975 MHz | 10-K, 1-K, 100- and 10-Hz Digits |
| TP31 | GROUND | | | |
| TP32 | AUDIO | 0 to 0.8V rms | 0.18V rms | FM Deviation, and Frequency |
| TP33 | AUDIO | 0 to 0.8V rms | 0.18V rms | FM Deviation, and Frequency |
| TP34 | DC | 30 ±0.5V | 30V dc | |
| TP35 | TTL | 1 MHz | 1 MHz | 1-MHz Reference |
| TP36 | GROUND | | | |
| TP37 | DC | -1 to -6V | -2.7V dc | Frequency |
| TP38 | TTL | 1 MHz 200 ns (AH) | 1 MHz 200 ns | |
| TP39 | TTL | 1 MHz 10 ns (AL) | 1 MHz 10 ns | |
| TP40 | DC | 2 to 22V | 17.7V dc | Frequency |
| TP41 | DC | 2 to 22V | 17.3V dc | Frequency |
| TP42 | GROUND | | | |
| TP43 | DC | 2 to 22V | 17.3V dc | Frequency |
| TP44 | DC | 2 to 22V | 16.2V dc | Frequency |
| TP45 | GROUND | | | |
| TP46 | TTL | low = unlocked<br>high = locked | TTL high | |
| TP49 | TTL | 10 MHz 20 ns (AL) | 10 MHz, 20 nS | |
| TP50 | TTL | 10 MHz | 10 MHz | |
| TP51 | GROUND | | | |
| TP52 | TTL | 10 MHz 10 ns (AL) | 10 MHz, 10 nS | |
| TP53 | DC | 7.5 ±1V<br>16 ±2V | <br>16V dc | Above 245 MHz<br>Below 245 MHz |
| TP54 | TTL | 10 MHz | 10 MHz | |
| TP55 | RF | 800 MHz | 800 MHz; -10 dBm | Below 245 MHz |
| TP56 | INPUT | | | To test low-pass filters |

NOTE: AH = active high
AL = active low

**Table 4D-11. Frequency Reference Control**

| OPTION INSTALLED | | | BIT | | | | |
|---|---|---|---|---|---|---|---|
| HIGH-STABILITY | SUB-HARMONIC | INT/EXT | RMUX1H | RMUX0H | RINH | EOENL | SHENL |
| NO | NO | INT | 0 | 0 | 0 | 0 | 1 |
| | | EXT | 1 | 0 | 1 | 1 | 1 |
| YES | NO | INT | 0 | 1 | 0 | 1 | 1 |
| | | EXT | 1 | 0 | 1 | 1 | 1 |
| NO | YES | INT | 0 | 0 | 0 | 0 | 1 |
| | | EXT | 0 | 0 | 0 | 0 | 0 |
| YES | YES | INT | 0 | 1 | 0 | 1 | 1 |
| | | EXT | 0 | 0 | 0 | 0 | 0 |
| 1 = TTL High<br>0 = TTL Low | | | | | | | |

Program the UUT to 320 MHz. If you can adjust the power supply to obtain about 320 MHz output from the VCO, the VCO and binary divider are probably OK; proceed to paragraph 4D-41. If you cannot change the frequency, the problem is either the VCO, or the UHF binary divider, U1.

Check the signal at TP1. It should be the same as the output frequency. The level after the buffer amplifier, Q3, Q4, at TP3 (use RF test cable) should be approximately +3 dBm. The signal at TP17 should be a signal sideband signal with the lower sideband component (the desired signal) at about -20 dBm. If the only signal is the carrier frequency (same frequency as TP3), check the quadrature generator, and the sub-synthesizer circuitry. The signal out of the triple-modulus pre scalar should be approximately 16 MHz (with the output frequency set to approximately 320 MHz). The output of the N-Divider, TP14, should be approximately 1 MHz.

As the UUT frequency is programmed, the frequency at TP14 should change, since the divide ratio is being changed. If the frequency is not 1 MHz and/or it doesn't change, the problem is probably with the N-Divider gate array, U17, or the interface to the microprocessor.

If both the reference (at TP35) and the N-Divider signals at the phase detector are 1 MHz, the loop should lock when the operator removes the variable power supply. If the loop does not lock, check the KNV voltage at TP37. With the Signal Generator programmed to 320 MHz, TP37 should be approximately 1.0 to 2.0V. If this voltage is not correct, check the DAC U27, latches U26 and U30, and op-amp U28. This voltage should also change as the operator changes the Generator frequency.

If the KN DAC appears to function, the problem is with the phase detector. Reconnect the variable power supply as before, and adjust the voltage for a approximately 1-MHz signal at U44 pin 3. With this frequency slightly above 1 MHz, TP38 should be high and TP39 should be low.

With this frequency slightly below 1 MHz, TP38 should be low and TP39 should be high. The only remaining circuitry is the loop amp U48 and the current source, U46, Q18, and Q19.

If the loop is locked, but the 1-MHz, 10-MHz, or 100-MHz digits cannot be programmed, the problem is either the N-divider or the interface to the microprocessor. If the 100-kHz or 10-kHz digit is inoperative or the frequency jumps as the 1-MHz digit is programmed, the problem is likely the triple-modulus prescalar. If the lower order (1-kHz, 100-Hz, 10-Hz) digits cannot be programmed, the problem is the sub-synthesizer or single sideband mixer.

### 4D-38. Sub-Synthesizer and HET (800 MHz), 40-MHz Loop

The frequency at TP24 and TP25 should be 20 MHz. The frequency at U64 pins 14 and 15 should be 40 MHz. If the 40-MHz signal is present, but not the 20 MHz, the problem is most likely with Q4, Q5, U35, or U34. If the 40-MHz signal is in error, the problem is in the 40-MHz loop.

Check the frequency at the 40-MHz VCO, U64 pin 3. It should be 40 MHz. If it is not, lift the op-amp end of R169, and connect it to a variable power supply set to approximately 6V. The signal at U64 pin 3 should be approximately a 40-MHz ECL level (approximately 3.2V to 4.2V) signal. By varying the supply voltage, the frequency should change. A similar signal should be present at U64 pin 2. Check to see if U64 pin 11 is ECL low (approximately 3.2V).

The output of TTL buffer U65 pin 8 should be approximately 40 MHz. The output of the divide-by-4, U66, should be approximately 10 MHz. Once again, if the frequency is greater than 10 MHz, pulses should exist at TP52 and the output of op-amp U60 pin 6 should be low. If the frequency is below 10 MHz, pulses should exist at TP49, and the op-amp should be high (approximately 24V). The loop should lock when the operator reconnects R169.

If the TP checks are all right and the 800-MHz oscillator is not locked when in the HET band, the problem is either with the 800-MHz VCO, the divide-by-4 (U61), the divide-by-5 (U62, U63), or the logic that controls the switched +5V.

Program the UUT to 320 MHz. The frequency at TP27 (the output of the sub-synthesizer gate array U33) should be 10 MHz if the input signals are correct. The frequency at TP12 should be 1 MHz, and TP11 should be 20 kHz. There should be a 20-kHz sine wave at the hot end of R33. The signals at the output of the active quadrature generator, U10 pin 8 and U10 pin 14 should be approximately 300 mv p-p sine waves that are 90o apart in phase. Use a dual-trace Oscilloscope for verification.

The frequency at TP27 should change 500 kHz for a 1-kHz change in the programmed frequency, and 50 kHz for a 100-Hz change, etc.

### 4D-39. FM Circuitry

Program the UUT to 500 MHz, INT FM, 99.9-kHz deviation, and 1-kHz modulation frequency. There should be a 2V p-p 1-kHz sine wave at TP22. Program 50-kHz deviation, and the level should drop to 1V p-p. Reprogram the deviation to 99.9-kHz. The level of the output of the KV DAC, U28 pin 7 will be approximately 1.5V p-p depending on the FM correction value (KV) in the EPROM.

The signals at TP32 and TP33 should be approximately the same, depending on how R87 is set. The output of the audio integrator should be about 1V p-p. To check the FM range, program the UUT to 9.99-kHz deviation. The ac voltage at TP32 should drop to 10% of the 99.9-kHz value. Program 999-Hz, and the voltage should drop to 1% of the 99.9-kHz value.

The INT/EXT FM selection is done on the A2A4 Output PCA. The controls are listed in Table 4D-17.

Tables 4D-12 and 4D-13 provide FM range and FM DAC (10 bits) control information.

Table 4D-12. FM Ranges

| FM DEVIATION (Hz) | FM DEVIATION WITH LOW-RATE FM OPTION (Hz) | FMRN |
|---|---|---|
| 0 - 999 | 0 - 99.9 | 1 |
| 1000 - 9990 | 100 - 999 | 2 |
| 10000 - 99900 | 1000 - 9,990 | 4 |

Table 4D-13. FM DAC Control

| FM DEVIATION (Hz) | FM DEVIATION WITH LOW RATE FM OPTION (Hz) | FM 0 - 9 (Bits) |
|---|---|---|
| | 0 - 99.9 | FM Deviation /.1 |
| 0 - 999 | 100 - 999 | FM Deviation |
| 1000 - 9990 | 1000 - 9,990 | FM Deviation /10 |
| 10000 - 99900 | | FM Deviation /100 |

## 4D-40. LEVEL TROUBLESHOOTING

If the Generator level is inaccurate or an unleveled condition exists, the A2A4 Output assembly or the A2A6 Attenuator assembly is probably at fault. If an unleveled condition exists, the problem is in the circuitry ahead of the detector. Go to the paragraph in this section entitled Unleveled Condition.

If there is no unleveled condition, the problem is likely in the circuitry following the ALC Loop, which includes the Attenuator (or Attenuator/RPP), the heterodyne circuit, and the output amplifier, Q215. If the level problem only exists below 245 MHz, then troubleshoot the heterodyne circuitry. If the problem is not frequency dependent and if the level is accurate above +7 dBm but inaccurate below +7 dBm, then the A2A6 Attenuator (or the A2A5 Attenuator/RPP) is at fault.

### 4D-41. Output Assembly Test Point Signal Information

Table 4D-14 presents the nominal characteristics of the signals at the various test points on the Output PCA. Not only the range of the signal, but also the expected value for the Instrument Preset State [RCL] [9][8], are given.

## 4D-42. ATTENUATOR LEVEL CONTROL

Table 4D-15 lists the Attenuator assembly (A2A5 or A2A6) sections that are inserted in the RF output path for the various level ranges of the generator. This information is useful in isolating a faulty section. The sections are labeled by the control line mnemonics at latch U27 on the Controller PCB. Note that the section is inserted in the RF output path when there is no power applied to the relay.

If the Level problem exists above +7 dBm, the through path (0 dB attenuation) of the Attenuator may be faulty.

### 4D-43. Attenuator Check

Attenuator problems are most likely to be relay contact problems.

To isolate the faulty attenuator section, connect a power meter to the RF OUTPUT connector, and check the nominal levels per Table 4D-16 at both 0.2-MHz and 1050-MHz frequency.

Table 4D-14. Output PCA Test Points

| TEST POINT | SIGNAL TYPE | RANGE | TYPICAL FOR RCL 98 | SIGNAL DESCRIPTION |
|---|---|---|---|---|
| TP1 | RF | 245 to 1050 MHz<br>-18 to -32 dBm | 300 MHz<br>-27 dBm | Output of mid/high bandswitch. |
| TP2 | RF | 245 to 1050 MHz<br>-10 to -25 dBm | 300 MHz<br>-20 dBm | Output of buffer amplifier. |
| TP3 | RF | 245 to 1050 MHz<br>-13 to -28 dBm | 300 MHz<br>-22 dBm | Output of switched low-pass filters. |
| TP4 | RF | 245 to 1050 MHz<br>-13 to -33 dBm | 300 MHz<br>-22 dBm | Power-splitter output. |
| TP5 | RF | 800 MHz<br>-8 dBm | No signal | Het mixer LO signal |
| TP6 | dc+audio | -7 to 14V dc nominal | 3.1V dc | Modulator control voltage. |
| TP7 | dc+audio | 0.04 to 3.0V dc nominal | 1.2V dc | Leveling loop control voltage. |
| TP8 | dc+audio | 0 to 2V dc nominal | 0.63V dc | Detector diode voltage. |
| TP9 | dc+audio | 400 or 1000 Hz,<br>0.71V rms | 400 Hz<br>0.71V rms | Modulation Osc-illator output. |
| TP10 | Ground | | | |
| TP11 | dc+audio | 0 to 0.70V rms | 0V | FM modulation signal to Synth-esizer. |

The through-path operation of the Attenuator (Attenuator/RPP) can be roughly checked by removing the instrument and module bottom covers. Program the frequency to 1 MHz and the level to +13 dBm. Measure (with a high-impedance probe and an RF voltmeter or an oscilloscope) the level at P102 of the A2A4 Output assembly with a power meter connected to the RF OUTPUT connector. If the voltmeter measures a nominal 1V rms, but the power meter does not read +13 dBm, then the signal is not getting through the Attenuator module, and the Attenuator (Attenuator/RPP) is at fault.

If the level problem is subtle rather than catastrophic, a more accurate check is required to determine if the fault is the Attenuator or the Output assembly. Such a check is made by removing the Attenuator assembly, attaching an adapter (6060A-4234; P/N 744177) to the interconnect point, and making power meter measurements of the A2A4 Output assembly output. Use [SPCL] [8][2] to disable the Attenuator correction factors. The level at this point should be flat over 0.4 to 1050 MHz within typically 0.2 dB and should agree with the programmed level within 2 dB.

If the problem has been isolated to the Output assembly and there are no self-test errors or flashing UNCAL condition, the problem is probably in the circuits following the ALC loop. If the problem is only in the Het band (frequency < 245 MHz), check the Het band switch and controls, the Het band circuits (mixer, filter, and amplifier), and the local oscillator signal (800 MHz, nominal -10 dBm at TP5). If the problem is at all frequencies, check the output amp, Q215, and the Het/function switch and controls.

**Table 4D-15. Attenuator Levels Control**

| AMPLITUDE RANGE IN DBM | | | | ATTENUATOR SECTIONS INSERTED INDICATED BY X | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AM Off | | AM On | | A6DBL | A12DBL | A241L | A242L | A243L | A244L | A245L |
| 7.0 | 19.0 | 1.0 | 9.0 | | | | | | | |
| 1.0 | 6.9 | -5.0 | 0.9 | X | | | | | | |
| -5.0 | 0.9 | -11.0 | -5.1 | | X | | | | | |
| -11.0 | -5.1 | -17.0 | -11.1 | X | X | | | | | |
| -17.0 | -11.1 | -23.1 | -17.1 | | | X | | | | |
| -23.1 | -17.1 | -29.1 | -23.2 | X | | X | | | | |
| -29.1 | -23.2 | -35.1 | -29.2 | | X | X | | | | |
| -35.1 | -29.2 | -41.1 | -35.2 | X | X | X | | | | |
| -41.1 | -35.2 | -47.1 | -41.2 | | | X | X | | | |
| -47.1 | -41.2 | -53.2 | -47.2 | X | | X | X | | | |
| -53.2 | -47.2 | -59.2 | -53.3 | | X | X | X | | | |
| -59.2 | -53.3 | -65.2 | -59.3 | X | X | X | X | | | |
| -65.2 | -59.3 | -71.2 | -65.3 | | | X | X | X | | |
| -71.2 | -65.3 | -77.2 | -71.3 | X | | X | X | X | | |
| -77.2 | -71.3 | -83.3 | -77.3 | | X | X | X | X | | |
| -83.3 | -77.3 | -89.3 | -83.4 | X | X | X | X | X | | |
| -89.3 | -83.4 | -95.3 | -89.4 | | | X | X | X | X | |
| -95.3 | -89.4 | -101.3 | -95.4 | X | | X | X | X | X | |
| -101.3 | -95.4 | -107.4 | -101.4 | | X | X | X | X | X | |
| -107.4 | -101.4 | -113.4 | -107.5 | X | X | X | X | X | X | |
| -113.4 | -107.5 | -119.4 | -113.5 | | | X | X | X | X | X |
| -119.4 | -113.5 | -125.4 | -119.5 | X | | X | X | X | X | X |
| -125.4 | -119.5 | -131.4 | -125.5 | | X | X | X | X | X | X |
| -147.0 | -125.5 | -147.0 | -131.5 | X | X | X | X | X | X | X |

**Table 4D-16. Attenuator Levels**

| ATTENUATOR | PROG LEVEL | SPECIAL FUNCTION | OBSERVED LEVEL (NOMINAL) |
|---|---|---|---|
| 6dB | +6dBm | -- | +6dBm |
| 12dB | 0dBm | -- | 0dBm |
| 24dB (number 1) | -12dBm | -- | -12dBm |
| 24dB ( " 2) | -12dBm | 83 | -12dBm |
| 24dB ( " 3) | -12dBm | 84 | -12dBm |
| 24dB ( " 4) | -12dBm | 85 | -12dBm |
| 24dB ( " 5) | -12dBm | 86 | -12dBm |

## 4D-44. Unleveled Condition

If there are self-test failures and/or unleveled indications, the problem is probably in, or prior to, the ALC loop. If the problem is isolated to a specific frequency band (or bands) and other bands work properly, check signal inputs and controls to the various filters that precede the modulator. See Table 4D-7 Band, Filter, and Frequency Data for band definition. If all frequency bands are affected, the leveling ALC loop or associated controls and inputs are probably at fault.

TP6 (modulator control voltage) is a good place to monitor. With the instrument programmed to +13 dBm, the voltage on TP6 should be between +2V and +8V dc (+4V to +5V dc typical). Another place to monitor is TP7 (ALC control voltage). With the instrument programmed to +13 dBm, and the level correction disabled [SPCL] [8][1], the voltage here should be approximately 1.6V dc. With the RF off, the voltage at TP7 should be 0V dc.

When the problem is isolated to a specific area, use the schematic, Theory of Operation, Test Point Chart, and normal troubleshooting techniques to isolate the fault.

### 4D-45. AM TROUBLESHOOTING

The following paragraphs provide information that help the operator to trace an AM problem to a specific circuit on the Output assembly.

### 4D-46. Internal/External AM

If an AM problem exists, determine if the problem occurs with internal AM, external AM or both. This check is done by connecting a 1V peak (2V p-p), 1-kHz signal source to the external MOD INPUT of the UUT and measuring AM depth. Use a Modulation Analyzer. Program the UUT to external AM and then to internal AM at 1-kHz internal modulation rate. The measured AM should agree with the programmed depth within a few percent.

Tables 4D-17 and 4D-18 provide control information for modulation and modulation frequency selection.

If the internal AM does not agree, but external AM is Ok, the Modulation Oscillator is likely at fault. If external AM is bad, but internal AM is Ok, then the problem is somewhere between the external MOD INPUT and the AM DAC.

If both the external and internal AM fail, the problem is likely being caused by either the modulation signal-processing circuit or the leveling loop. To determine which circuit is faulty, perform the following test.

**Table 4D-17. Modulation ON/OFF Control**

| INT AM | EXT AM | INTAML | EXTAML | |
|---|---|---|---|---|
| Off | Off | 1 | 1 | |
| Off | On | 1 | 0 | |
| On | Off | 0 | 1 | |
| On | On | 0 | 0 | |
| **INT FM** | **EXT FM** | **INTFML** | **EXTFML** | **FMENH** |
| Off | Off | 1 | 1 | 0 |
| Off | On | 1 | 0 | 1 |
| On | Off | 0 | 1 | 1 |
| On | On | 0 | 0 | 1 |
| 1 = TTL High<br>0 = TTL Low | | | | |

**Table 4D-18. Modulation Frequency Control**

| FREQUENCY | MF400L |
|---|---|
| 400 Hz | 0 |
| 1 kHz | 1 |
| 1 = TTL High<br>0 = TTL Low | |

## 4D-47. ALC Loop Control Voltage

PROCEDURE

1. Connect a 1V peak (2V p-p), 1-kHz signal source to the external MOD INPUT.
2. Program the UUT for 350 MHz, 7 dBm, 71% AM depth, and EXT AM ON.
3. Measure the ac and the dc voltage at TP7. The rms voltage should be nominally 50% of the dc voltage.
4. Program the UUT for 35% AM depth. The rms voltage should be nominally 25% of the dc voltage.

If the UUT fails this test, the problem lies somewhere between the EXT MOD input and TP7 (ALC loop-control voltage). To further localize the problem, the same test can be done by measuring the ac voltage at U302 pin 8 (input to level DAC). If the measured ac voltage does not change as programmed AM depth is changed, either the AM DAC or its control is at fault. The AM DAC (A2A4U301) is an 8-bit DAC and is set to twice the programmed AM depth, e.g., 180 for 90% AM.

If the UUT passes this test, then the ALC loop control voltage is correct, and the problem is in the ALC loop. A likely cause of excessive AM depth error and harmonic distortion is detector non-linearity. The following test checks detector linearity.

## 4D-48. Detector Linearity

PROCEDURE

1. Install the plate covers and let the UUT warm up at room temperature for one hour.
2. Program the UUT for 350 MHz, 12 dBm, modulation OFF.
3. Program [SPCL] [8][1] and [SPCL] [9][1] to disable level correction and enable amplitude fixed range.
4. Measure power with a power meter at the UUT RF OUTPUT. Note the reading.
5. Program the UUT for 2 dBm using the EDIT keys. The measured power should be 10 dB ± 0.2 dB below the reading noted in step 4.
6. Program the UUT for -8 dBm using the EDIT keys. The measured power should be 20 dB ± 0.4 dB below the noted reading.
7. Program the UUT for [SPCL] [0][0].

If the UUT fails this test, the problem is likely to be in the detector or detector-linearizer circuit. If the UUT passes the test, the problem is constrained to the other ALC loop elements, and is likely to be a bandwidth problem associated with the loop amplifier or the modulator or modulator-linearizer circuit.

# Section 5
# List of Replaceable Parts

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## 5-1. INTRODUCTION

This section contains an illustrated parts breakdown of the instrument. A similar parts list is included in the Options Section for each of the options. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in as accompanying illustration.

### 5-2. Parts List Information

Parts lists include the following information:

1. Reference Designation
2. Description of Each Part
3. FLUKE Stock Number
4. Federal Supply Code for Manufacturers
5. Manufacturer's Part Number
6. Total Quantity of Components Per Assembly
7. Recommended quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument or are deviations from the basic instrument model, the REC QTY column lists the recommended spares quantity for the items in that particular assembly.

## 5-3. HOW TO OBTAIN PARTS

Components may be ordered directly from the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or an authorized representative by using the FLUKE STOCK NUMBER. In the event the part ordered has been replaced by a new or improved part, the replancement will be accompanied by an explanatory note and installation instructions if necessary.

To ensure prompt and efficient handling of your order, include the following information:

1. Quantity
2. FLUKE Stock Number
3. Description
4. Reference Designation
5. Printed Circuit Board Part Number and Revision Letter
6. Instrument Model and Serial number

### 5-4. Recommended Spare Parts Kit

A Recommended Spare Parts Kit for your basic instrument is available from the factory. This kit contains those items listed in the REC QTY column for the parts lists in the quantities recommended.

Parts price information is available from the John Fluke Mfg. Co., Inc., or its representative. Prices are also available in a Fluke Replacement Parts Catalog, which is available upon request.

**CAUTION**

*****

**Indicated devices are subject to damage by static**

TABLE 5-1. 6060A FINAL ASSEMBLY
(SEE FIGURE 5-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| A1 FRONT SECTION | | | | | | | | |
| A2 MODULE SECTION | | | | | | | | |
| A3 REAR SECTION | | | | | | | | |
| H 1 | | SCREW,MACH,FHUP,S.STL,6-32X1/4 | 320093 | 89536 | 320093 | 20 | | |
| H 2 | | SCREW,MACH,PHP SEMS,STL,6-32X1/2 | 177030 | 89536 | 177030 | 4 | | |
| H 3 | | SCREW,MACH,PHP,STL,10-32X1/4 | 218941 | 89536 | 218941 | 11 | 1 | |
| H 4 | | SCREW,MACH,PHP,S.STL,6-32X3/8 | 334458 | 89536 | 334458 | 67 | | |
| H 5 | | SCREW,MACH,PHP,STL,6-32X1/4 | 152140 | 89536 | 152140 | 3 | | |
| MP 1 | | TOP COVER | 704866 | 89536 | 704866 | 1 | | |
| MP 2 | | BOTTOM COVER | 704874 | 89536 | 704874 | 1 | | |
| MP 3 | | FOOT, SINGLE BAIL TYPE (DARK UMBER) | 653923 | 89536 | 653923 | 4 | | |
| MP 4 | | NAMEPLATE, SERIAL -REAR PANEL- | 472795 | 89536 | 472795 | 1 | | |
| MP 5 | | DECAL, FRONT CORNER | 659227 | 89536 | 659227 | 2 | | |
| MP 6 | | SIDE TRIM 18" | 525998 | 89536 | 525998 | 2 | | |
| MP 7 | | DECAL, REAR CORNER | 685214 | 89536 | 685214 | 2 | | |
| MP 8 | | COVER PLATE BLANK, IEEE | 731265 | 89536 | 731265 | 1 | | |
| MP 9 | | COVER, OUTPUT, PLATED 900 | 731430 | 89536 | 731430 | 1 | | |
| MP 10 | | COVER, SYNTHESIZER, PLATED 900 | 731398 | 89536 | 731398 | 1 | | |
| MP 11 | | OPERATION DECAL, 100KHZ | 755363 | 89536 | 755363 | 1 | | |
| TM 1 | | MANUAL, 6060A 100KHZ | 704841 | 89536 | 704841 | 1 | | |
| TM 2 | | MANUAL,GETTING STARTED | 744185 | 89536 | 744185 | 1 | | |
| U 23, 24 | * | IC, 2K X 8 EPROM | 454603 | 01295 | TMS2516JL | 2 | 1 | |
| W 1 | | CABLE ASSEMBLY, SEMI-RIGID W 1 | 731380 | 89536 | 731380 | 1 | | |
| W 2 | | 3 WIRE WITH FEMALE PLUG | 284174 | 89536 | 284174 | 1 | | |

1 UNPROGRAMMED PART

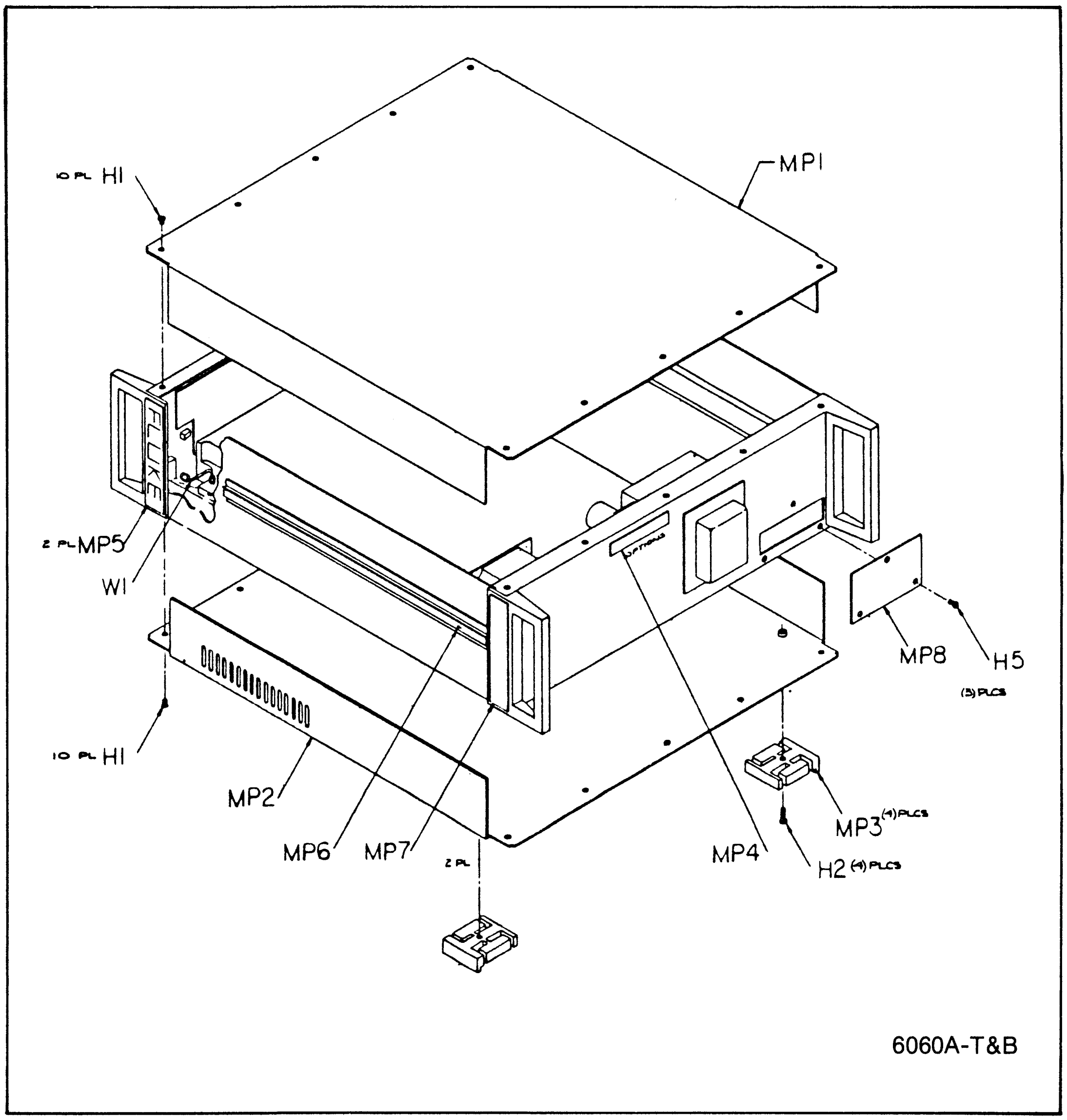



Figure 5-1. 6060A Final Assembly

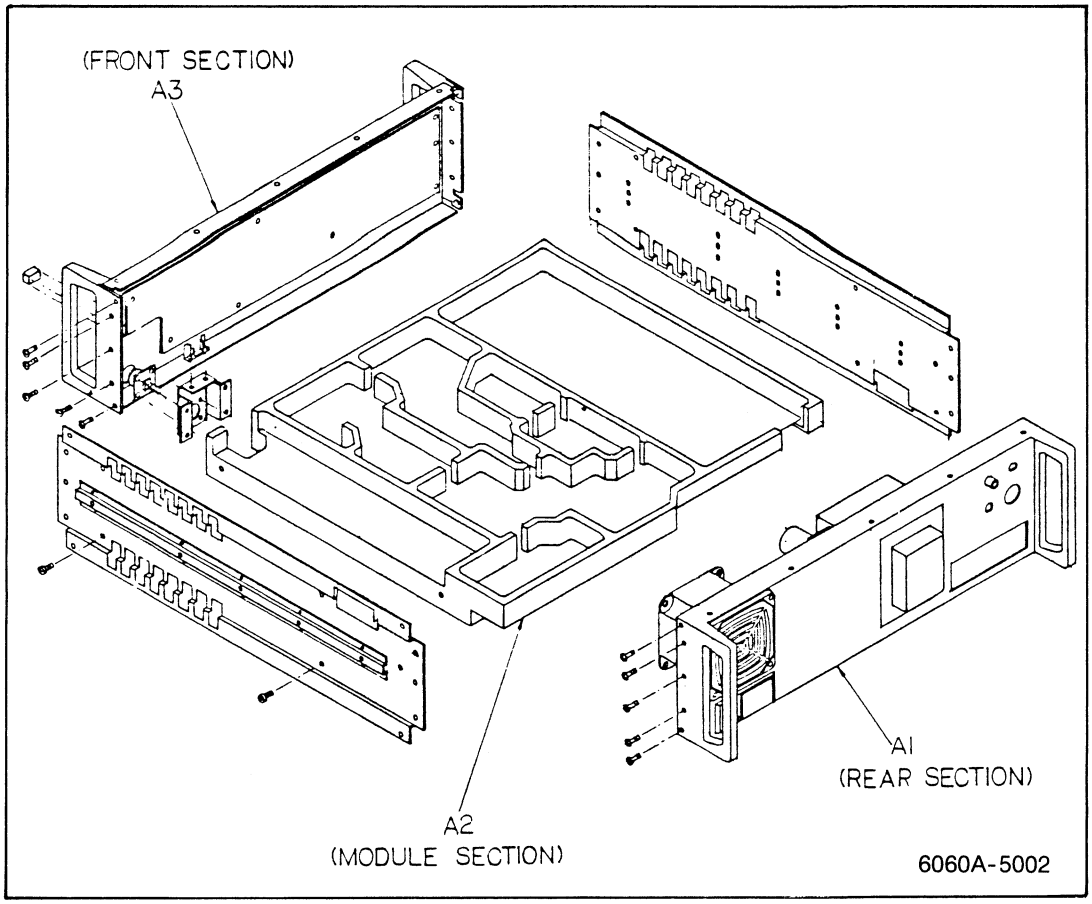



**Figure 5-1. 6060A Final Assembly (cont)**

TABLE 5-2. A1 FRONT SECTION
(SEE FIGURE 5-2.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| A 1 | | DISPLAY PCA | 738609 | 89536 | 738609 | 1 | | |
| A 2 | | SWITCH PWB | 738591 | 89536 | 738591 | 1 | | |
| H 13 | | SCREW,CAP,SCKT,STL,8-32X3/8 | 295105 | 89536 | 295105 | 4 | | |
| H 14 | | SCREW,MACH,PHP SEMS,STL,4-40X1/2 | 353060 | 89536 | 353060 | 10 | | |
| H 15 | | SCREW,MACH,PHP SEMS,STL,4-40X3/16 | 732750 | 89536 | 732750 | 12 | | |
| MP 12 | | CORNER BRACKET | 657601 | 89536 | 657601 | 2 | | |
| MP 13 | | FRONT PANEL SM | 657593 | 89536 | 657593 | 1 | | |
| MP 14 | | DECAL, FRONT PANEL | 707737 | 89536 | 707737 | 1 | | |
| MP 15 | | DECAL, LENS, 100KHZ | 744169 | 89536 | 744169 | 1 | | |
| MP 16 | | LENS DISPLAY | 657718 | 89536 | 657718 | 1 | | |
| MP 17 | | CORNER HANDLE, FRONT 5.25 INCH | 656173 | 89536 | 656173 | 2 | | |
| MP 18 | | BUSHING INSULATION R.F.OUTPUT | 537803 | 89536 | 537803 | 1 | | |
| MP 19 | | RETAINER,RING,STUD-RECEIVER,0.093 | 740217 | 89536 | 740217 | 11 | | |
| MP 37 | | SHIELD, DISPLAY | 731257 | 89536 | 731257 | 1 | | |
| S 1 | | SWITCH, LEFT CONDUCTIVE ELASTOMERIC | 698597 | 89536 | 698597 | 1 | | |
| S 2 | | SWITCH,CENTER CONDUCTIVE ELASTOMERIC | 731349 | 89536 | 731349 | 1 | | |
| S 3 | | SWITCH,RIGHT CONDUCTIVE ELASTOMERIC | 731356 | 89536 | 731356 | 1 | | |
| W 7 | | CABLE ASSY MOD INPUT FRONT | 738500 | 89536 | 738500 | 1 | | |
| X 1 | | SOCKET,SIP,0.100 CTR,7 PIN | 520809 | 30035 | SS-109-1-07 | 2 | | |

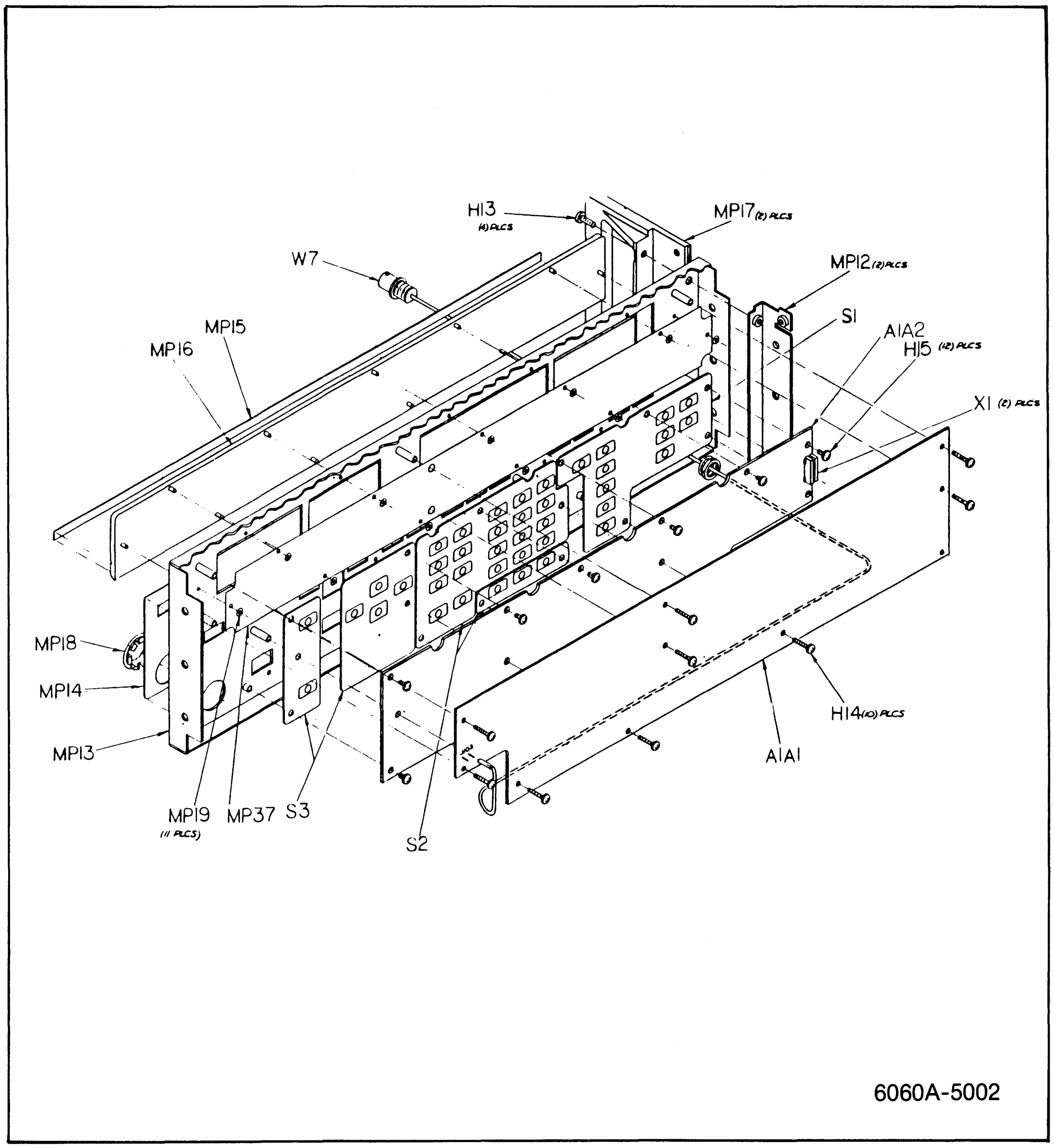



Figure 5-2. A1 Front Section

TABLE 5-3. A2 MODULE SECTION
(SEE FIGURE 5-3.)

| REFERENCE DESIGNATOR A->NUMERICS---> | | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|---|
| A | 1 | * | SYNTHESIZER PCA | 748814 | 89536 | 748814 | 1 | | |
| A | 2 | * | VCO PCA | 748780 | 89536 | 748780 | 1 | | 1 |
| A | 4 | * | OUTPUT PCA | 744045 | 89536 | 744045 | 1 | | 1 |
| A | 6 | | ATTENUATOR ASSEMBLY | 750406 | 89536 | 750406 | 1 | | 1 |
| A | 7 | * | CONTROLLER PCA | 755330 | 89536 | 755330 | 1 | | |
| C | 1 | | CAP,CER,1000PF,+-5%,50V,COG | 528539 | 51406 | RPE113 | 1 | | |
| H | 6 | | SCREW,MACH,PHP SEMS,STL,6-32X1/4 | 178533 | 89536 | 178533 | 1 | | |
| H | 7 | | WASHER,FLAT,STEEL,#6,0.031 THK | 110270 | 89536 | 110270 | 4 | | |
| H | 8 | | SCREW,MACH,PHPO,S.STL,6-32X9/32 | 544122 | 89536 | 544122 | 88 | | |
| H | 9 | | SCREW,MACH,PHP,STL,10-32X1/4 | 218941 | 89536 | 218941 | 3 | | |
| H | 10 | | NUT,CAP,EXT.LOCK,STL,10-32 | 559237 | 89536 | 559237 | 1 | | |
| H | 11 | | WASHER,LOCK,SPLIT,STEEL,#6 | 110692 | 89536 | 110692 | 2 | | |
| H | 12 | | SCREW,MACH,PHP SEMS,STL,6-32X5/16 | 530287 | 89536 | 530287 | 4 | | |
| MP | 7 | | AIDE,PCB PULL | 541730 | 89536 | 541730 | 12 | | |
| MP | 8 | | HEATSINK, OUTPUT TRANSISTOR | 738492 | 89536 | 738492 | 2 | | |
| MP | 9 | | GASKET,SHIELDING,MONEL MESH,CIRCULAR | 720664 | 89536 | 720664 | 11 | | |
| MP | 10 | | SELF-ADHESIVE,ABMM-1,ABS PLASTIC | 407908 | 89536 | 407908 | 1 | | |
| MP | 11 | | CABLE, NYLON STRAP, 4 IN L, SST-1 | 172080 | 89536 | 172080 | 1 | | |
| W | 6 | | CABLE ASSY,MOD INPUT,MODULE | 738542 | 89536 | 738542 | 1 | | |
| W | 10 | | CABLE ASSEMBLY, SYNTHESIZER-POWER | 738526 | 89536 | 738526 | 1 | | |

1 ASSEMBLY INCLUDES ASSOCIATED CALIBRATED EPROM

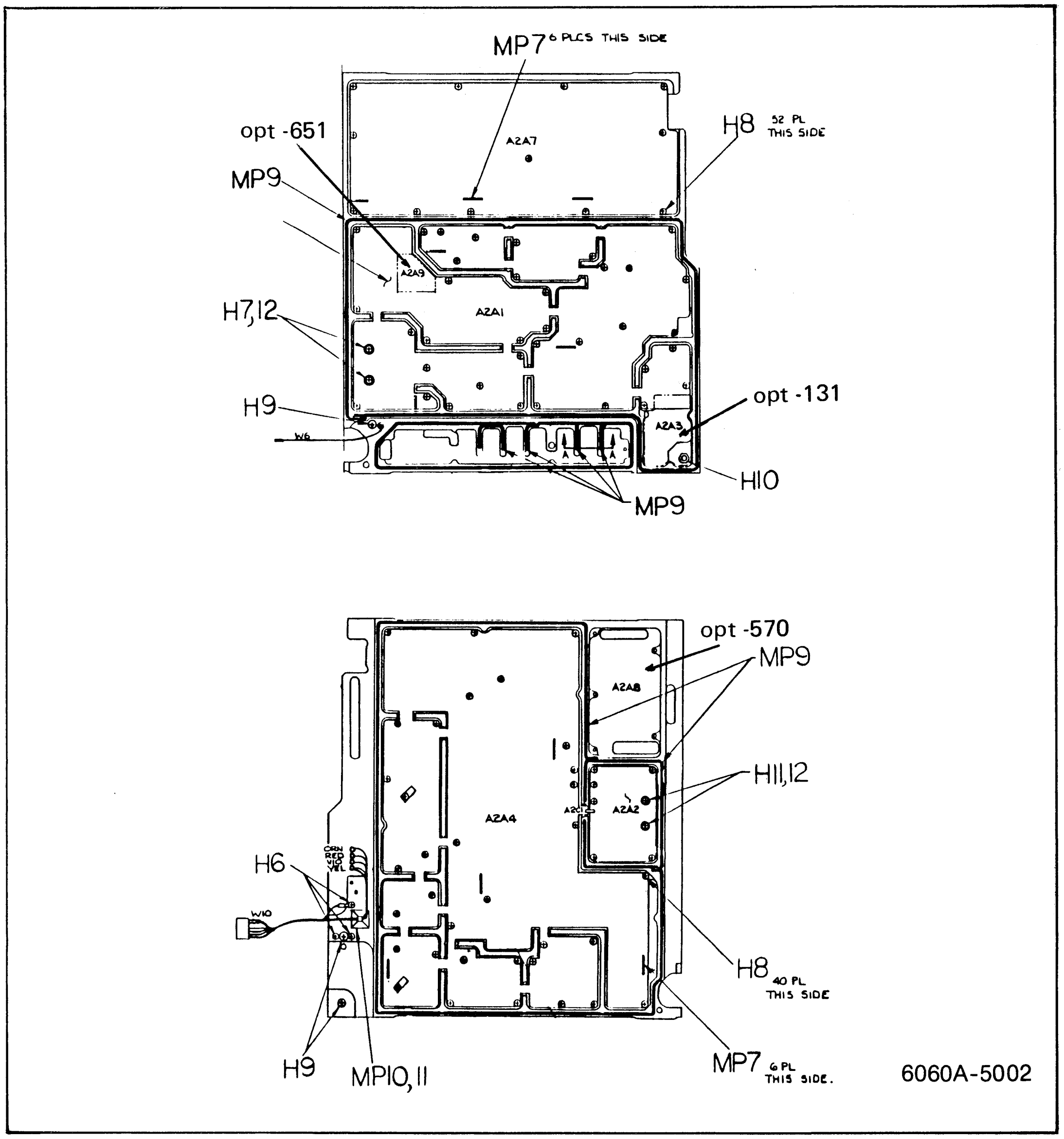



Figure 5-3. A2 Module Section

TABLE 5-4. A3 REAR SECTION
(SEE FIGURE 5-4.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| A 1 | * | POWER SUPPLY PCA | 744052 | 89536 | 744052 | 1 | | |
| B 1 | | SH.POLE,SUBMIN,115VAC11W,ROTRON#5P2A2 | 335083 | 89536 | 335083 | 1 | | |
| E 1 2 | | LUG, SOLDER #6 | 132399 | 78189 | 2104-06-00 | 2 | | |
| E 3 | | LUG,CRIMP,SPLICE,BUTT,18-22AWG | 664458 | 89536 | 664458 | 1 | | |
| F 1 | | FUSE,1/4 X 1-1/4,FAST,1.5A,250V | 109330 | 71400 | AGC1-1/2 | 1 | | |
| FL 1 | | FILTER,LINE,115V/6A,252V/6A,W/CONN | 446328 | 05245 | 6J4 | 1 | | |
| H 16 | | NUT,CAP,EXT.LOCK,STL,8-32 | 195263 | 89536 | 195263 | 4 | | |
| H 17 | | SCREW,MACH,FHUP,S.STL,8-32X1/4 | 320101 | 89536 | 320101 | 3 | | |
| H 18 | | SCREW,CAP,SCKT,STL,8-32X3/8 | 295105 | 89536 | 295105 | 4 | | |
| H 19 | | WASHER,SHLDR,NYLON,#3 | 485417 | 89536 | 485417 | 4 | | |
| H 20 | | NUT,CAP,EXT.LOCK,STL,4-40 | 195255 | 89536 | 195255 | 4 | | |
| H 21 | | SCREW,MACH,PHP SEMS,STL,6-32X5/8 | 272591 | 89536 | 272591 | 6 | | |
| H 22 | | SCREW,MACH,RHS,STL,8-32X2-1/2 | 114454 | 89536 | 114454 | 4 | | |
| H 23 | | WASHER,FLAT,S STEEL,#8,0.032 THK | 176743 | 86928 | 5710-31-32 | 8 | | |
| H 24 | | WASHER,FLAT,FIBER,#8,0.063 THK | 110353 | 73734 | 1472 | 4 | | |
| H 25 | | SCREW,MACH,FHP,STL,6-32X1/2 | 558957 | 89536 | 558957 | 4 | | |
| H 26 | | SCREW,MACH,FHUP,S.STL,6-32X1/4 | 320093 | 89536 | 320093 | 2 | | |
| H 27 | | SCREW,MACH,PHP SEMS,STL,6-32X1/4 | 178533 | 89536 | 178533 | 5 | | |
| H 28 | | FAN ACCESSORY,GRILLE,WITH FOAM FILTER | 740209 | 89536 | 740209 | 1 | | |
| H 29 | | NUT,CAP,EXT.LOCK,STL,6-32 | 152819 | 89536 | 152819 | 5 | | |
| H 30 | | WASHER,LOCK,INTRNL,STEEL,#6 | 110338 | 89536 | 110338 | 1 | | |
| H 31 | | WASHER,SHLDR,FIBER,#6 | 110387 | 86928 | 5604-47 | 2 | | |
| H 32 | | NUT,HEX,MINI,S.STL,6-32 | 110569 | 89536 | 110569 | 3 | | |
| H 33 | | WASHER,LOCK,INTRNL,STEEL,0.267 ID | 110817 | 89536 | 110817 | 3 | | |
| MP 20 | | REAR PANEL SM | 657635 | 89536 | 657635 | 1 | | |
| MP 21 | | CORNER BRACKET | 657601 | 89536 | 657601 | 2 | | |
| MP 22 | | CORNER HANDLE, FRONT 5.25 INCH | 656173 | 89536 | 656173 | 2 | | |
| MP 23 | | SHOCK MOUNT, PS,7116 | 732941 | 89536 | 732941 | 3 | | |
| MP 24 | | PLUG BUTTON | 398206 | 89536 | 398206 | 2 | | |
| MP 25 | | BUSHING COVER RF OUTPUT | 538256 | 89536 | 538256 | 1 | | |
| MP 26 | | INSUL PART,TRANS,SILICONE,POWER | 534453 | 89536 | 534453 | 4 | | |
| MP 27 | | POLYOLEFIN #14 .120ID EXPAND BLK | 149450 | 89536 | 149450 | | | |
| MP 28 | | INSUL PART,TRANS,SILICONE,TO-3 | 473165 | 55285 | 7403-08-FR-05 | 1 | 1 | |
| MP 29 | | POLYOLEFIN #12 .153ID EXPAND,BLACK | 113852 | 89536 | 113852 | | | |
| MP 30 | | TRANSFORMER COVER, PAINTED | 731307 | 89536 | 731307 | 1 | | |
| MP 31 | | CABLE, NYLON STRAP, 4 IN L, SST-1 | 172080 | 89536 | 172080 | 2 | | |
| MP 32 | | CABLE, ETHYL CELLULOSE, TYPE 1/2-6R | 100974 | 89536 | 100974 | 2 | | |
| MP 33 | | SELF-ADHESIVE,ABMM-1,ABS PLASTIC | 407908 | 89536 | 407908 | 2 | | |
| MP 34 | | FAN SKIRT | 716944 | 89536 | 716944 | 1 | | |
| MP 35 | | RETAINER,AUX PWR SUPPLY CONN | 748640 | 89536 | 748640 | 1 | | |
| MP 38 | | HEAT DIS,TRANSISTOR,SNGL T03,ALUM | 740738 | 89536 | 740738 | 1 | | |
| T 1 | | TRANSFORMER, POWER | 717959 | 89536 | 717959 | 1 | | |
| U 1, 5 | * | IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS | 413187 | 04713 | MC7815CT | 2 | 1 | 2 |
| U 1 | * | IC,VOLT REG,FIXED,+5 VOLTS,3 AMP,TO-3 | 453944 | 12040 | LM223K | 1 | | 1 |
| U 2 | * | IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS | 413179 | 04713 | MC7915CP | 1 | 1 | 2 |
| U 4 | * | IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS | 460410 | 12040 | LM317T | 1 | | 2 |
| W 2 | | CABLE ASSY,RF,REF IN/OUT | 748681 | 89536 | 748681 | 1 | | |
| W 15 | | CABLE ASSY,POWER SWITCH | 748673 | 89536 | 748673 | 1 | 1 | |
| W 18 | | CABLE ASSY AUX TRANSFORMER | 748798 | 89536 | 748798 | 1 | | |

1 REFERED TO THROUGHOUT MANUAL AS A3U1

2 PART OF A3A1

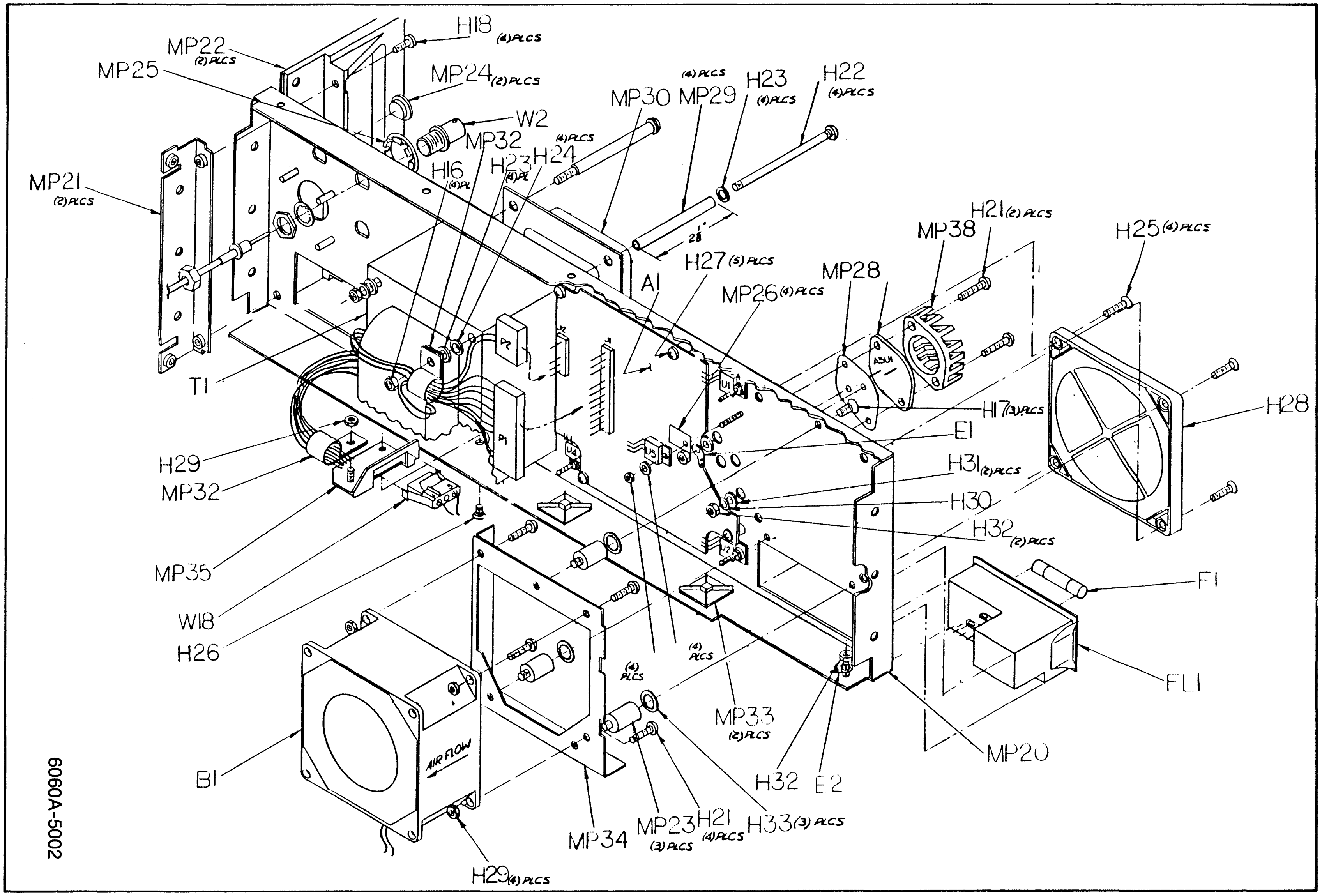



Figure 5-4. A3 Rear Section

TABLE 5-5. A1A1 DISPLAY PCA
(SEE FIGURE 5-5.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1 | | CAP,TA,4.7UF,+-20%,50V | 363721 | 56289 | 196D475X9015HA1 | 1 | | |
| C 2, 27, 28, | | CAP,TA,10UF,+-20%,10V | 176214 | 56289 | 196D106X0010KA1 | 4 | | |
| C 30 | | | 176214 | | | | | |
| C 3- 18 | | CAP,POLYES,0.1UF,+-10%,50V | 696484 | 89536 | 696484 | 16 | | |
| C 23, 24 | | CAP,TA,10UF,+-20%,20V | 330662 | 56289 | 196D106X0020KA1 | 2 | | |
| C 25, 26 | | CAP,TA,39UF,+-20%,6V | 163915 | 56289 | 196D394X0020KA1 | 2 | | |
| C 29 | | CAP,CER,0.001UF,+-20%,100V,X7R | 402966 | 72982 | 8121-A100-W5R-102M | 1 | | |
| DS 1 | | DISPLAY VACUUM FLUORESCENT FREQUENCY | 698456 | 89536 | 698456 | 1 | | |
| DS 2 | | DISPLAY VACUUM FLUORESCENT AMPLITUDE | 698464 | 89536 | 698464 | 1 | 1 | |
| J 101 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 14 | | |
| J 103 | | CONN,PWB,PIN,CRIMP,0.058 DIA | 233411 | 00779 | 60599-3 | 2 | | |
| R 1, 2 | | RES,CF,100K,+-5%,0.25W | 348920 | 80031 | CR251-4-5P100K | 2 | | |
| R 3 | | RES,CF,620,+-5%,0.25W | 442319 | 80031 | CR251-4-5P620E | 1 | | |
| R 4 | | RES,MF,9.09K,+-1%,0.125W,100PPM | 221663 | 91637 | CMF559091F | 1 | | |
| R 5 | | RES,MF,31.6K,+-1%,0.125W,100PPM | 261610 | 91637 | CMF553162F | 1 | | |
| R 6 | | RES,MF,8.06K,+-1%,0.125W,100PPM | 294942 | 91637 | CMF558061F | 1 | | |
| R 7 | | RES,MF,2K,+-1%,0.125W,100PPM | 235226 | 91637 | CMF552001F | 1 | | |
| R 8 | | RES,MF,48.7K,+-1%,0.125W,100PPM | 267385 | 89536 | 267385 | 1 | | |
| R 9, 10 | | RES,CF,30K,+-5%,0.25W | 368753 | 80031 | CR251-4-5P30K | 2 | | |
| R 11- 14 | | RES,CC,10K,+-10%,0.125W | 246975 | 01121 | BB1031 | 4 | | |
| R 15 | | RES,CC,560,+-10%,0.125W | 115303 | 89536 | 115303 | 1 | | |
| R 16 | | RES,VAR,CERM,5K,+-10%,0.5W | 288282 | 75378 | 360T052A2 | 1 | | |
| TP 1 | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 1 | | |
| U 1- 5 | * | IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR | 454892 | 01295 | SN74LS273N | 5 | 1 | |
| U 6- 10 | * | IC,BIPLR,8CHNL FLOURESCNT DISPLY DRVR | 535799 | 56289 | UDN6118A | 5 | | |
| U 11, 17 | * | IC,LSTTL,RETRG MONOSTAB MULTIVB W/CLR | 404186 | 01295 | SN74LS123N | 2 | 1 | |
| U 12 | * | IC,LSTTL,DUAL 4 INPUT AND GATE | 408708 | 01295 | SN74LS21N | 1 | 1 | |
| U 13, 15 | * | IC,TTL,HEX INVERTER W/OPEN COLLECTOR | 288605 | 01295 | SN7416N | 2 | 1 | |
| U 14 | * | IC,LSTTL,HEX BUFFER W/NOR ENABLE | 483800 | 01295 | SN74LS367N | 1 | 1 | |
| U 16 | * | IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP | 478354 | 12040 | LM393N | 1 | 1 | |
| U 18 | * | IC, 1.22V,25 PPM T.C.,BANDGAP REF | 634154 | 32293 | ITS6935-2 | 1 | 1 | |
| W 8 | | CABLE ASSEMBLY, CONTROLLER-DISPLAY | 738476 | 89536 | 738476 | 1 | | |
| XU 1- 5 | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 5 | | |
| XU 6- 10 | | SOCKET,DIP,0.100 CTR,18 PIN | 418228 | 91506 | 318-AG39D | 5 | | |
| XU 11, 14, 17 | | SOCKET,DIP,0.100 CTR,16 PIN | 276535 | 91506 | 316-AG39D | 3 | | |
| XU 12, 13, 15 | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 3 | | |
| XU 16 | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 1 | | |
| Z 1 | | RES,NET,SIP,10 PIN,9 RES,100K,+-2% | 461038 | 80031 | 95081002CL | 1 | | |
| Z 2 | | RES,NET,SIP,10 PIN,9 RES,10K,+-2% | 414003 | 80031 | 95081002CL | 1 | | |

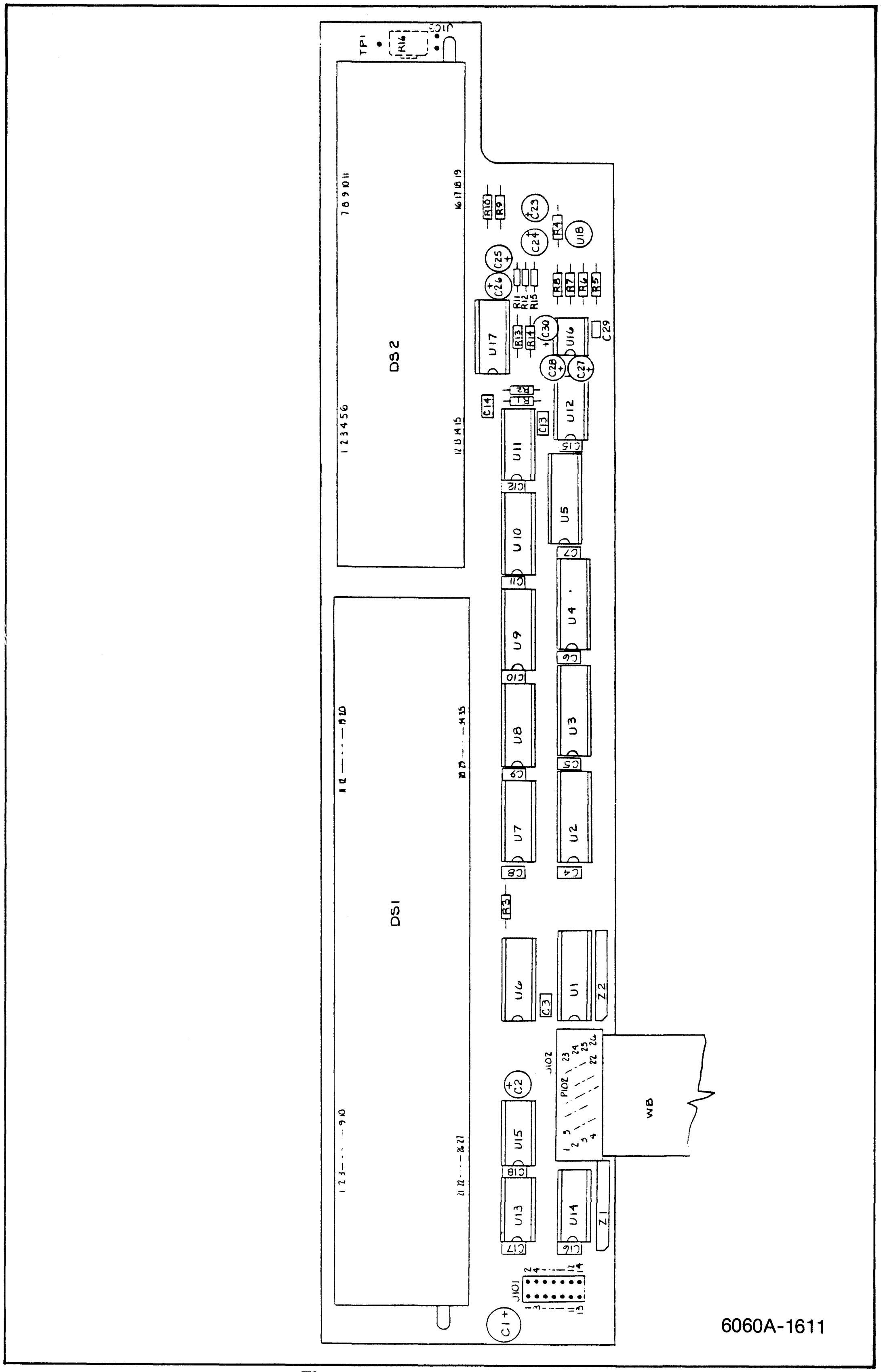



Figure 5-5. A1A1 Display PCA

TABLE 5-6. A2A1 SYNTHESIZER PCA
(SEE FIGURE 5-6.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ------------DESCRIPTION------------ | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1, 2 | | CAP,CER,2.7PF,+-0.25PF,100V,COJ | 363705 | 89536 | 363705 | 2 | | |
| C 3, 4, 62, | | CAP,CER,0.001UF,+-20%,100V,X7R | 402966 | 72982 | 8121-A100-W5R-102M | 16 | | |
| C 98,100,181, | | | 402966 | | | | | |
| C 182,185,186, | | | 402966 | | | | | |
| C 189,190,193, | | | 402966 | | | | | |
| C 196,198,199, | | | 402966 | | | | | |
| C 215 | | | 402966 | | | | | |
| C 5, 7, 10- | | CAP,CER,470PF,+-20%,100V,X7R | 358275 | 72982 | 8111-A100-W5R-471M | 17 | | |
| C 13, 20, 39, | | | 358275 | | | | | |
| C 40, 43, 52, | | | 358275 | | | | | |
| C 53,205,231- | | | 358275 | | | | | |
| C 234 | | | 358275 | | | | | |
| C 8, 21,154 | | CAP,CER,6,8PF,+-0.25PF,100V,COH | 512327 | 89536 | 512327 | 3 | | |
| C 9, 15, 18, | | CAP,CER,100PF,+-2%,100V,COG | 512848 | 51406 | RPE121 | 10 | | |
| C 26, 28, 64, | | | 512848 | | | | | |
| C 89,137,139, | | | 512848 | | | | | |
| C 146 | | | 512848 | | | | | |
| C 14, 27, 30, | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 71 | | |
| C 31, 36, 37, | | | 732883 | | | | | |
| C 49, 55, 59- | | | 732883 | | | | | |
| C 61, 63, 65, | | | 732883 | | | | | |
| C 69, 70, 72- | | | 732883 | | | | | |
| C 74, 76- 81, | | | 732883 | | | | | |
| C 83, 84, 87, | | | 732883 | | | | | |
| C 88,101-106, | | | 732883 | | | | | |
| C 108,110,112, | | | 732883 | | | | | |
| C 120,122,132, | | | 732883 | | | | | |
| C 133,135,138, | | | 732883 | | | | | |
| C 140-145,157- | | | 732883 | | | | | |
| C 165,167-169, | | | 732883 | | | | | |
| C 174,175,180, | | | 732883 | | | | | |
| C 184,188,191, | | | 732883 | | | | | |
| C 192,194,195, | | | 732883 | | | | | |
| C 200 | | | 732883 | | | | | |
| C 16, 17 | | CAP,CER,12PF,+-2%,100V,COG | 376871 | 89536 | 376871 | 2 | | |
| C 19 | | CAP,CER,4.7PF,+-0.25PF,100V,COH | 362772 | 89536 | 362772 | 1 | | |
| C 25 | | CAP,CER,10PF,+-5%,50V,COG | 494781 | 89536 | 494781 | 1 | | |
| C 29, 38,201, | | CAP,CER,47PF,+-2%,100V,COG | 512368 | 89536 | 512368 | 4 | | |
| C 202 | | | 512368 | | | | | |
| C 32 | | CAP,POLYST,470PF,+-1%,63V | 528356 | 12954 | B31063/470/1/63 | 1 | | |
| C 33 | | CAP,POLYST,100PF,+-1%,63V | 528372 | 12954 | B31063/100/1/63 | 1 | | |
| C 34 | | CAP,POLYST,330PF,+-1%,63V | 528364 | 12954 | B31063/330/1/63 | 1 | | |
| C 35 | | CAP,POLYST,1000PF,+-1%,63V | 528380 | 12954 | B31063/1000/1/63 | 1 | | |
| C 41, 42 | | CAP,POLYES,0.047UF,+-10%,50V | 714709 | 89536 | 714709 | 2 | | |
| C 48 | | CAP,POLYES,0.015UF,+-10%,50V | 714691 | 89536 | 714691 | 1 | | |
| C 50,207 | | CAP,POLYES,0.082UF,+-10%,50V | 714717 | 89536 | 714717 | 2 | | |
| C 51 | | CAP,POLYES,0.1UF,+-10%,50V | 696484 | 89536 | 696484 | 1 | | |
| C 54, 71, 91, | | CAP,TA,10UF,+-20%,10V | 176214 | 56289 | 196D106X0010KA1 | 5 | | |
| C 127,166 | | | 176214 | | | | | |
| C 58, 82,107, | | CAP,TA,39UF,+-20%,6V | 163915 | 56289 | 196D394X0020KA1 | 5 | | |
| C 150,173 | | | 163915 | | | | | |
| C 75, 85, 86, | | CAP,CER,22PF,+-2%,100V,COG | 512871 | 89536 | 512871 | 6 | | |
| C 95,155,156 | | | 512871 | | | | | |
| C 92- 94,128 | | CAP,TA,10UF,+-20%,35V | 417683 | 56289 | 196D106X0035KA1 | 4 | | |
| C 99 | | CAP,POLYST,0.0075UF,2%,100V | 484121 | 89536 | 484121 | 1 | | |
| C 109,111 | | CAP,TA,15UF,+-20%,20V | 519686 | 56289 | 196D156X0020KE4 | 2 | | |
| C 113,114 | | CAP,POLYES,0.22UF,+-10%,50V | 696492 | 89536 | 696492 | 2 | | |
| C 115 | | CAP,POLYPR,0.0786UF,+-1%,50V | 422998 | 89536 | 422998 | 1 | | |
| C 116,117 | | CAP,TA,3.3UF,+-20%,20V | 436071 | 01884 | 196D335X0020KA1 | 2 | | |
| C 118,183,187 | | CAP,POLYES,0.47UF,+-10%,50V | 714725 | 89536 | 714725 | 3 | | |
| C 119,121 | | CAP,CER,1000PF,+-5%,50V,COG | 528539 | 51406 | RPE113 | 2 | | |
| C 123 | | CAP,POLYST,0.022UF,+-5%,100V | 484147 | 89536 | 484147 | 1 | | |
| C 124 | | CAP,POLYST,0.056UF,+-5%,100V | 284877 | 89536 | 284877 | 1 | | |
| C 125 | | CAP,POLYST,0.027UF,+-5%,100V | 484154 | 89536 | 484154 | 1 | | |
| C 126 | | CAP,POLYST,0.0015UF,+-2%,100V | 484113 | 89536 | 484113 | 1 | | |
| C 129,130 | | CAP,TA,82UF,+-20%,20V | 357392 | 12954 | D82GS2D20M | 2 | | |
| C 131 | | CAP,POLYCA,5UF,+-10%,50V | 313254 | 84411 | X463UW5.0UF-10P-50 | 1 | | |
| C 134 | | CAP,TA,15UF,+-20%,6V | 161935 | 56289 | 196D156X0006-KA1 | 1 | | |
| C 136 | | CAP,TA,2.2UF,+-10%,15V | 364216 | 56289 | 196D225X0015HA1 | 1 | | |
| C 151 | | CAP,CER,120PF,+-2%,50V,T2J | 362673 | 89536 | 362673 | 1 | | |
| C 152 | | CAP,CER,56PF,+-2%,100V,COG | 512970 | 51406 | RPE121 | 1 | | |
| C 153 | | CAP,VAR,1 TO 10PF,250V,AIR | 733212 | 89536 | 733212 | 1 | | |
| C 176 | | CAP,POLYES,0.27UF,+-10%,50V | 733576 | 89536 | 733576 | 1 | | |
| C 177 | | CAP,POLYES,0.15UF,+-10%,50V | 682955 | 89536 | 682955 | 1 | | |
| C 178 | | CAP,TA,6.8UF,+-20%,35V | 363713 | 56289 | 196D685X0035KA1 | 1 | | |
| C 179 | | CAP,CER,2200PF,+-20%,100V,X7R | 358291 | 89536 | 358291 | 1 | | |
| C 197,219,227 | | CAP,CER,10PF,+-2%,100V,COG | 512343 | 89536 | 512343 | 3 | | |
| C 204 | | CAP,CER,330PF,+-5%,100V,COG | 528620 | 51406 | RPE121 | 1 | | |
| C 206 | | CAP,VAR,0.8-10PF,250V,AIR | 229930 | 91293 | 5201 | 1 | | |
| C 208,209,221 | | CAP,AL,220UF,+50-20%,16V | 435990 | 57640 | SM/VB | 3 | | |
| C 210,211,214, | | CAP,CER,180PF,+-5%,100V,COG | 603506 | 56289 | C023B501E181M | 10 | | |
| C 216,218,224- | | | 603506 | | | | | |
| C 226,228,230 | | | 603506 | | | | | |
| C 212,222 | | CAP,CER,330PF,+-20%,50V,X7R | 650093 | 89536 | 650093 | 2 | | |
| C 213,217,223 | | CAP,CER,4.3PF,+-0.5PF,50V,COG | 514216 | 89536 | 514216 | 3 | | |
| C 220 | | CAP,CER,3.9PF,+-0.25PF,100V,COJ | 512947 | 89536 | 512947 | 1 | | |
| CR 2 | * | ZENER,COMP, 6.4V, 3%, 1 PPM TC, 2.0MA | 357848 | 04713 | SZG20118 | 1 | 2 | |
| CR 5- 8, 17, | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 7 | 1 | |
| CR 18, 21 | * | | 203323 | | | | | |
| CR 9, 10, 12- | * | DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNL | 313247 | 28484 | HP5082-6264 | 6 | 2 | |
| CR 15 | * | | 313247 | | | | | |
| CR 11 | * | ZENER,UNCOMP, 10.0V,10%, 12.5MA, 0.4W | 113324 | 07910 | 1N961A | 1 | 1 | |
| CR 16 | * | ZENER,UNCOMP, 8.2V, 5%, 20.0MA, 0.4W | 386771 | 04713 | 1N756A | 1 | 1 | |
| CR 24, 26, 27 | * | DIODE,SI,VARACTOR,P1V= 30V,HYPER ABRU | 722140 | 89536 | 722140 | 3 | 1 | |

TABLE 5-6. A2A1 SYNTHESIZER PCA (CONT.)
(SEE FIGURE 5-6.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ---DESCRIPTION--- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| J 1, 3, 14, | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 12 | | |
| J 17, 35, 55 | | | 267500 | | | | | |
| J 2, 7, 11, | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 35 | | |
| J 12, 14- 16, | | | 512889 | | | | | |
| J 22- 25, 27, | | | 512889 | | | | | |
| J 31- 46, 49- | | | 512889 | | | | | |
| J 54, 56 | | | 512889 | | | | | |
| J 101 | | SOCKET,SIP,0.100 CTR,9 PIN | 436774 | 30035 | 33-109-1-09 | 2 | | |
| J 104,107,108, | | CONN,SOCKET,SPRING TYPE,.0690D,.143L | 732826 | 89536 | 732826 | 4 | | |
| J 110 | | | 732826 | | | | | |
| J 109 | | SOCKET,SIP,0.100 CTR,7 PIN | 520809 | 30035 | SS-109-1-07 | 1 | | |
| J 112 | | CONN,COAX,SMB,REC,PWB | 512095 | 16733 | 702033 | 1 | | |
| L 1, 18, 21, | | CHOKE,6TURN | 320911 | 89536 | 320911 | 10 | | |
| L 23, 29- 32, | | | 320911 | | | | | |
| L 34, 65 | | | 320911 | | | | | |
| L 2, 3, 71, | | INDUCTOR,0.10 UH,+/-10%,400MHZ,SHLDED | 257154 | 24759 | MR0R10 | 4 | | |
| L 72 | | | 257154 | | | | | |
| L 4, 19, 20, | | INDUCTOR,0.68 UH,+/-10%,221MHZ,SHLDED | 320937 | 24759 | MR0.68 | 10 | | |
| L 40- 42, 44, | | | 320937 | | | | | |
| L 56- 58 | | | 320937 | | | | | |
| L 5, 10, 63, | | CORE,TOROID,FERRITE,.047X.138X.118 | 321182 | 89536 | 321182 | 4 | | |
| L 64 | | | 321182 | | | | | |
| L 11 | | INDUCTOR,150 UH,+/-5%,10.5 MHZ,SHLDED | 174763 | 72259 | WEE150 | 1 | | |
| L 17 | | INDUCTOR,220 UH,+/-5%,9.4 MHZ,SHLDED | 147835 | 72259 | WEE220 | 1 | | |
| L 43 | | INDUCTOR,10 UH,+/-10%,53 MHZ,SHLDED | 249078 | 24759 | MR10 | 1 | | |
| L 49 | | INDUCTOR ADJ 8.4MH | 704999 | 89536 | 704999 | 1 | | |
| L 50 | | INDUCTOR ADJ 11.1MH | 705004 | 89536 | 705004 | 1 | | |
| L 59 | | INDUCTOR, 125UH | 738484 | 89536 | 738484 | 1 | | |
| L 62 | | INDUCTOR,470 UH,+/-5%,6.5 MHZ,SHLDED | 147827 | 72259 | WEE470 | 1 | | |
| L 66 | | INDUCTOR,0.82UH,+/-10%,200MHZ,SHLDED | 320945 | 89536 | 320945 | 1 | | |
| L 67, 68 | | CORE,TOROID,FERRITE,.079X.185X.291 | 219535 | 25088 | B62110A5030X025C | 2 | | |
| L 70 | | INDUCTOR,0.044UH,+/-15%,500MHZ,SHLDED | 249110 | 72259 | WEE0R044 | 1 | | |
| MP 1 | | COMPONENT HOLDER | 422865 | 98159 | 2829-75-2 | 1 | | |
| P 101,102,111 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 7 | | |
| Q 2, 33, 37 | * | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 535013 | 04713 | BFR91 | 3 | 1 | |
| Q 3 | | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 723379 | 89536 | 723379 | 1 | 1 | |
| Q 4, 5 | * | TRANSISTOR,SI,PNP,HI-SPEED SWITCH | 369629 | 07263 | 543576 | 2 | 1 | |
| Q 10- 12 | * | TRANSISTOR,SI,N-JFET,TO-92 | 604678 | 17856 | J2464 | 3 | 1 | |
| Q 13, 14 | * | TRANSISTOR,SI,N-DMOS FET,TO-72 | 477729 | 18324 | SD213EE | 2 | 1 | |
| Q 15, 21, 23 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 218396 | 04713 | 2N3904 | 3 | 1 | |
| Q 16, 17 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 248351 | 04713 | MPS918 | 2 | 1 | |
| Q 18, 19 | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 225599 | 07263 | 2N4250 | 2 | 1 | |
| Q 20 | * | TRANSISTOR,SI,NPN,DARLINGTON | 381798 | 04713 | MPSA-13 | 1 | | |
| Q 22 | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 195974 | 64713 | 2N3906 | 1 | 1 | |
| Q 26, 27 | * | TRANSISTOR,SI,N-JFET,UHF/VHF USE | 403634 | 12040 | J310 | 2 | 1 | |
| Q 28 | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 418707 | 04713 | MPS56562 | 1 | 1 | |
| Q 32, 35 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 483156 | 89536 | 483156 | 2 | 1 | |
| R 1 | | RES,CC,120,+-10%,0.5W | 108696 | 01121 | EB1211 | 1 | | |
| R 2,159,201, | | RES,CF,0.51,+-5%,0.25W | 381954 | 80031 | CR251-4-5P0R5E | 4 | | |
| R 209 | | | 381954 | | | | | |
| R 3, 25, 32 | | RES,CC,51,+-5%,0.125W | 266262 | 01121 | BB5105 | 3 | | |
| R 4 | | RES,CF,430,+-5%,0.25W | 441568 | 80031 | CR251-4-5P430E | 1 | | |
| R 5 | | RES,CC,24,+-5%,0.125W | 681932 | 89536 | 681932 | 1 | | |
| R 6, 56- 58, | | RES,CC,100,+-5%,0.125W | 714469 | 89536 | 714469 | 19 | | |
| R 66- 69,124, | | | 714469 | | | | | |
| R 127,133-139, | | | 714469 | | | | | |
| R 210,212 | | | 714469 | | | | | |
| R 7, 44, 94, | | RES,CF,1K,+-5%,0.25W | 343426 | 80031 | CR251-4-5P1K | 8 | | |
| R 148,152,154, | | | 343426 | | | | | |
| R 169,170 | | | 343426 | | | | | |
| R 8 | | RES,CF,470,+-5%,0.25W | 343434 | 80031 | CR251-4-5P470E | 1 | | |
| R 9 | | RES,CF,200,+-5%,0.25W | 441451 | 80031 | CR251-4-5P200E | 1 | | |
| R 10 | | RES,CC,33,+-5%,0.125W | 720920 | 89536 | 720920 | 1 | | |
| R 11, 74,100, | | RES,CF,1.5K,+-5%,0.25W | 343418 | 80031 | CR251-4-5P1K5 | 4 | | |
| R 153 | | | 343418 | | | | | |
| R 12, 46,165, | | RES CC 510 +-5% 0.125W | 715383 | 89536 | 715383 | 8 | | |
| R 167,171,172, | | | 715383 | | | | | |
| R 177,211 | | | 715383 | | | | | |
| R 13 | | RES,CC,150,+-5%,0.5W | 186056 | 89536 | 186056 | 1 | | |
| R 14, 15,198 | | RES,CC,30,+-5%,0.125W | 512723 | 01121 | BB3005 | 3 | | |
| R 20 | | RES,CC,47,+-5%,0.125W | 512061 | 01121 | BB4705 | 1 | | |
| R 21, 22 | | RES,CC,15,+-10%,0.125W | 261800 | 89536 | 261800 | 2 | | |
| R 23, 24, 40 | | RES,CF,56,+-5%,0.25W | 342618 | 80031 | CR251-4-5P56E | 3 | | |
| R 26, 31, 65, | | RES,MF,100,+-1%,0.125W,100PPM | 168195 | 91637 | CMF551000F | 4 | | |
| R 101 | | | 168195 | | | | | |
| R 27 | | RES,MF,18.2K,+-1%,0.125W,100PPM | 236810 | 91637 | CMF55 | 1 | | |
| R 28 | | RES,MF,10.7K,+-1%,0.125W,100PPM | 293613 | 91637 | CMF55 | 1 | | |
| R 29 | | RES,MF,11.3K,+-1%,0.125W,100PPM | 293639 | 91637 | CMF551132 | 1 | | |
| R 30 | | RES,MF,28.7K,+-1%,0.125W,100PPM | 235176 | 91637 | CMF552872F | 1 | | |
| R 33,161 | | RES,CF,51,+-5%,0.25W | 414540 | 80031 | CR251-4-5P51E | 2 | | |
| R 39,164 | | RES,CF,300,+-5%,0.25W | 441519 | 80031 | CR251-4-5P300E | 2 | | |
| R 41 | | RES,CF,270,+-5%,0.25W | 348789 | 80031 | CR251-4-5P270E | 1 | | |
| R 42 | | RES,CF,180,+-5%,0.25W | 441436 | 80031 | CR251-4-5P180E | 1 | | |
| R 43 | | RES,CF,91,+-5%,0.25W | 441683 | 80031 | CR251-4-5P91E | 1 | | |
| R 45 | | INDUCTOR, 4 TURN | 755314 | 89536 | 755314 | 1 | | |
| R 52 | | RES,MF,3.01K,+-1%,0.125W,100PPM | 312645 | 91637 | CMF553011F | 1 | | |
| R 55 | | RES,CF,2.7K,+-5%,0.25W | 386490 | 80031 | CR251-4-5P2K7 | 1 | | |
| R 72 | | RES,CF,51K,+-5%,0.25W | 376434 | 80031 | CR251-4-5P51K | 1 | | |
| R 73 | | RES,CF,3.3K,+-5%,0.25W | 348813 | 80031 | CR251-4-5P3K3 | 1 | | |
| R 75, 76 | | RES,MF,10K,+-1%,0.125W,100PPM | 168260 | 91637 | CMF551002F | 2 | | |
| R 77 | | RES,MF,90K,+-0.1%,0.25W,50PPM | 225763 | 89536 | 225763 | 1 | | |
| R 78 | | RES,MF,9K,+-0.1%,0.25W,50PPM | 236695 | 89536 | 236695 | 1 | | |
| R 79 | | RES,MF,1K,+-0.1%,0.25W,50PPM | 225813 | 89536 | 225813 | 1 | | |
| R 80, 88, 91 | | RES,MF,4.99K,+-1%,0.125W,100PPM | 168252 | 91637 | MFF1-84991 | 3 | | |
| R 81,182,191 | | RES,MF,1K,+-1%,0.125W,100PPM | 168229 | 91637 | CMF551001F | 3 | | |
| R 82,104 | | RES,VAR,CERM,5K,+-10%,0.5W | 288282 | 75378 | 360T052A2 | 2 | | |

TABLE 5-6. A2A1 SYNTHESIZER PCA (CONT.)
(SEE FIGURE 5-6.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | RSQ | NOTE |
|---|---|---|---|---|---|---|---|---|
| R 83 | | RES,CF,75K,+-5%,0.25W | 394130 | 80031 | CR251-4-5P75K | 1 | | |
| R 84, 89 | | RES,MF,4.02K,+-1%,0.125W,100PPM | 235325 | 91637 | CMF554021F | 2 | | |
| R 86 | | RES,CF,200K,+-5%,0.25W | 441485 | 80031 | CR251-4-5P200K | 1 | | |
| R 87, 90 | | RES,VAR,CERM,1K,+-10%,0.5W | 275750 | 11236 | 360T-102A | 2 | 1 | |
| R 92, 93,113- | | RES,MF,499,+-1%,,0.125W,100PM | 168211 | 91637 | CMF554990F | 5 | | |
| R 115 | | | 168211 | | | | | |
| R 95 | | RES,CF,9.1K,+-5%,0.25W | 441691 | 80031 | CR251-4-5P9K1 | 1 | | |
| R 96 | | RES,CF,820,+-5%,0.25W | 442327 | 80031 | CR251-4-5P820E | 1 | | |
| R 97 | | RES,CF,6.8K,+-5%,0.25W | 368761 | 80031 | CR251-4-5P6K8 | 1 | | |
| R 98,121,147, | | RES,CF,100,+-5%,0.25W | 348771 | 80031 | CR251-4-5P100E | 4 | | |
| R 149 | | | 348771 | | | | | |
| R 99 | | RES,MF,1.5K,+-1%,0.125W,100PPM | 313098 | 91637 | CMF551501F | 1 | | |
| R 102,103,119, | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 4 | | |
| R 129 | | | 348839 | | | | | |
| R 105 | | RES,CF,20K,+-5%,0.25W | 441477 | 80031 | CR251-4-5P20K | 1 | | |
| R 106 | | RES,CF,2.4K,+-5%,0.25W | 441493 | 80031 | CR251-4-5P2K4 | 1 | | |
| R 107 | | RES,MF,3.48K,+-1%,0.125W,100PPM | 260687 | 91637 | CMF553481F | 1 | | |
| R 108,116 | | RES,MF,1.27K,+-1%,0.125W,100PPM | 267369 | 91637 | CMF551271F | 2 | | |
| R 109,111 | | RES,CC,510,+-5%,0.5W | 108951 | 01121 | RC020GF511JS | 2 | | |
| R 110,112 | | RES,CF,36,+-5%,0.25W | 442236 | 80031 | CR251-4-5P36E | 2 | | |
| R 117,118 | | RES,CF,220,+-5%,0.25W | 342626 | 80031 | CR251-4-5P220E | 2 | | |
| R 120,163 | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 2 | | |
| R 122 | | RES,CF,5.6K,+-5%,0.25W | 442350 | 80031 | CR251-4-5P5K6 | 1 | | |
| R 123 | | RES,CF,33K,+-5%,0.25W | 348888 | 80031 | CR251-4-5P33K | 1 | | |
| R 145 | | RES,CF,1M,+-5%,0.25W | 348987 | 80031 | CR251-4-5P1M | 1 | | |
| R 146,150 | | RES,CF,390,+-5%,0.25W | 441543 | 80031 | CR251-4-5P390E | 2 | | |
| R 151 | | RES,CF,2.2K,+-5%,0.25W | 343400 | 80031 | CR251-4-5P2K2 | 1 | | |
| R 160 | | RES,CF,750,+-5%,0.25W | 441659 | 80031 | CR251-4-5P750E | 1 | | |
| R 162 | | RES,CC,10K,+-5%,0.125W | 643940 | 01121 | BB1035 | 1 | | |
| R 178,179 | | RES,CF,5.6,+-5%,0.25W | 441618 | 80031 | CR251-4-5P5R6 | 2 | | |
| R 180,192 | | RES,MF,178,+-1%,0.125W,100PPM | 442996 | 89536 | 442996 | 2 | | |
| R 181,193 | | RES,MF,1.05K,+-1%,0.125W,100PPM | 293530 | 91637 | CMF551051F | 2 | | |
| R 183,194 | | RES,MF,3.24K,+-1%,0.125W,100PPM | 223578 | 91637 | CMF553241F | 2 | | |
| R 184,195,197, | | RES,CC,180,+-5%,0.125W | 512756 | 01121 | BB1815 | 4 | | |
| R 200 | | | 512756 | | | | | |
| R 185,199 | | RES,MF,249,+-1%,0.125W,100PPM | 168203 | 91637 | CMF55249F | 2 | | |
| R 186 | | RES,CC,47,+-5%,0.125W | 512061 | 01121 | BB4705 | 1 | | |
| R 187,189 | | RES,CC,120,+-5%,0.125W | 513978 | 01121 | BB1215 | 2 | | |
| R 188,196 | | RES,CC,12,+-5%,0.125W | 714451 | 89536 | 714451 | 2 | | |
| R 190 | | RES,CF,5.1,+-5%,0.25W | 441287 | 80031 | CR251-4-5P5R1 | 1 | | |
| R 213,214 | | RES,CC,200,+-5%,0.125W | 713917 | 89536 | 713917 | 2 | | |
| U 1 | * | IC,VOLT REG,FIXED,+5 VOLTS,0.1 AMPS | 429910 | 07263 | uA78L05AWC | 1 | 1 | |
| U 1 | * | 1.3 GHZ DIVIDE BY 2 | 707943 | 89536 | 707943 | 1 | 1 | |
| U 6 | | 3DB COUPLER | 704965 | 89536 | 704965 | 1 | | |
| U 7, 8 | | MIXER,DOUBLE BALANCED,1 - 500 MHZ | 733105 | 89536 | 733105 | 2 | 1 | |
| U 9 | * | IC,BPLR,MONOLITHIC VHF-UHF AMPLIFIER | 723387 | 89536 | 723387 | 1 | 1 | |
| U 10 | * | IC,OP AMP,QUAD,JFET INPUT,TO-5 CASE | 483438 | 89536 | 483438 | 1 | | |
| U 15, 58 | * | IC,TTL,100MHZ DIV BY 2,DIV BY 5 CNTR | 473835 | 01295 | SN74S196N | 2 | 1 | |
| U 16 | * | IC,LSTTL,DUAL DIV BY 2,DIV BY 5 CNTR | 483594 | 01295 | SN74LS390N | 1 | 1 | |
| U 17 | * | IC,STTL, 360 CELL GATE ARRAY | 723718 | 89536 | 723718 | 1 | 1 | |
| U 18 | * | IC,ECL,DUAL D M/S F/F,W/SET&RESET | 454959 | 04713 | MC10131P | 1 | 1 | |
| U 19 | * | IC,ECL,QUAD 2 INPUT NOR GATE | 380881 | 04713 | MC10102P | 1 | 1 | |
| U 20 | * | IC,ECL,DIV BY 10,DIV BY 11 COUNTER | 454900 | 89536 | 454900 | 1 | 1 | |
| U 26, 30- 32 | * | IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR | 454892 | 01295 | SN74LS273N | 4 | 1 | |
| U 27, 29 | * | IC,CMOS,10BIT DAC,10BIT ACCUR,CUR OUT | 507566 | 24355 | AD7533LN | 2 | 1 | |
| U 28 | * | IC,OP AMP,DUAL,JFET INPUT,8 PIN DIP | 495192 | 12040 | LF353BN | 1 | 1 | |
| U 33 | * | IC,STTL, 360 CELL GATE ARRAY | 723700 | 89536 | 723700 | 1 | | |
| U 34 | * | IC,FTTL,QUAD 2 INPUT NAND GATE | 654640 | 07263 | 74F00PC | 1 | 1 | |
| U 35, 66 | * | IC,FTTL,DUAL D F/F,+EDG TRG,W/CL&SET | 659508 | 07263 | 74F74PC | 2 | 1 | |
| U 37 | * | IC,LSTTL,3-8 LINE DCDR W/ENABLE | 407585 | 01295 | SN74LS138N | 1 | 1 | |
| U 38 | * | IC,LSTTL,OCTL LINE DRVR W/3-STATE OUT | 429035 | 01295 | SN74LS244N | 1 | 1 | |
| U 41 | * | IC,OP AMP,QUAD JFET INPUT,14 PIN DIP | 659748 | 89536 | 659748 | 1 | 1 | |
| U 42 | * | IC,COMPARATOR,QUAD,14 PIN DIP | 387233 | 12040 | LM339N | 1 | 1 | |
| U 43, 44, 59 | * | IC,STTL,DUAL D F/F,+EDG TRG,W/SET&CLR | 418269 | 01295 | SN74S74N | 3 | 1 | |
| U 45, 65 | * | IC,STTL,QUAD 2 INPUT NAND GATE | 363580 | 01295 | SN7400SN | 2 | 1 | |
| U 46 | * | IC,ARRAY,5 TRANS,5 ISO: 2-PNP,3-NPN | 418954 | 02735 | CA3096E | 1 | 1 | |
| U 47 | * | IC,LSTTL,RETRG MONOSTAB MULTIVB W/CLR | 412734 | 01295 | SN74LS122N | 1 | 1 | |
| U 48, 60 | * | IC,OP AMP,JFET INPUT,8 PIN DIP | 472779 | 12040 | LF386N | 2 | 1 | |
| U 49 | * | IC,OP AMP,SELECTED GBW 600KHZ | 418566 | 12040 | LM358N | 1 | 1 | |
| U 50 | * | ISOLATOR,OPTO,LED TO TRANSISTOR,DUAL | 454330 | 07263 | MCT-6 | 1 | 1 | |
| U 54 | * | IC,FTTL,HEX INVERTER | 634444 | 07235 | 74F04PC | 1 | 1 | |
| U 55 | * | DUAL 4-INPUT MULTIPLEXER | 707935 | 89536 | 707935 | 1 | 1 | |
| U 61 | * | IC,ECL,DIVIDE BY 4 PRESCALER | 722157 | 89536 | 722157 | 1 | 1 | |
| U 62, 63 | * | IC,ECL,DUAL D M/S F/F,+EDG TRG | 525345 | 04713 | MC10231L | 2 | 1 | |
| U 64 | * | IC,ECL,TRIPLE 2/3 INPUT OR/NOR GATE | 723437 | 89536 | 723437 | 1 | 1 | |
| W 1, 2 | | CABLE ASSY, RF JUMPER | 716985 | 89536 | 716985 | 2 | 1 | |
| W 3 | | WIRE,PVC,26AWG,TW-PR,STRND,PUR-BLK | 597849 | 89536 | 597849 | | | |
| XU 10, 15, 34- | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 14 | | |
| XU 36, 41- 45, | | | 276527 | | | | | |
| XU 47, 58, 59, | | | 276527 | | | | | |
| XU 65 | | | 276527 | | | | | |
| XU 18, 19, 27, | | SOCKET,DIP,0.100 CTR,16 PIN | 276535 | 91506 | 316-AG39D | 11 | | 1 |
| XU 29, 46, 62- | | | 276535 | | | | | 1 |
| XU 64 | | | 276535 | | | | | 1 |
| XU 26, 30- 32 | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 4 | | |
| XU 28, 38, 41, | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 7 | | |
| XU 48- 50, 60 | | | 478016 | | | | | |
| Y 1 | * | CRYSTAL,10MHZ,+-0.001%,HC-18/U | 385732 | 89536 | 385732 | 1 | | |
| Z 1 | | RES,NET,CERM,CUSTOM | 501841 | 89536 | 501841 | 1 | | |
| Z 5 | | RES,NET,SIP,10 PIN,9 RES,510,+-2% | 478800 | 89536 | 478800 | 1 | | |
| Z 6 | | RES,NET,SIP,6 PIN,5 RES,100K,+-2% | 412726 | 89536 | 412726 | 1 | | |
| Z 9 | | RES,NET,DIP,16 PIN,8 RES,1K,+-5% | 358119 | 01121 | 314 | 1 | 1 | |
| Z 10 | | RES,NET,SIP,6 PIN,5 RES,510,+-2% | 459974 | 89536 | 459974 | 1 | | |

1 ALSO INCLUDES XZ1 AND XZ29.

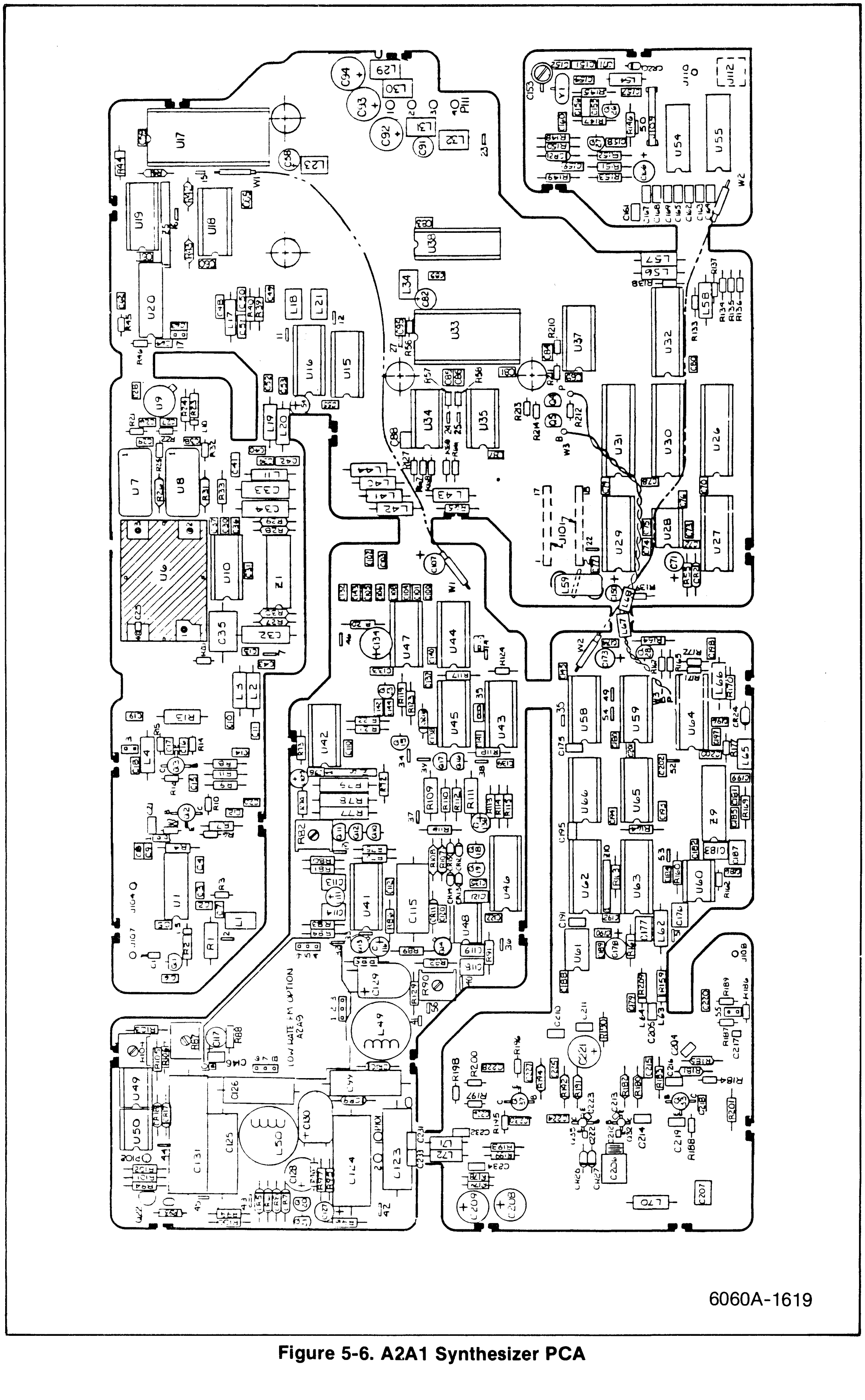


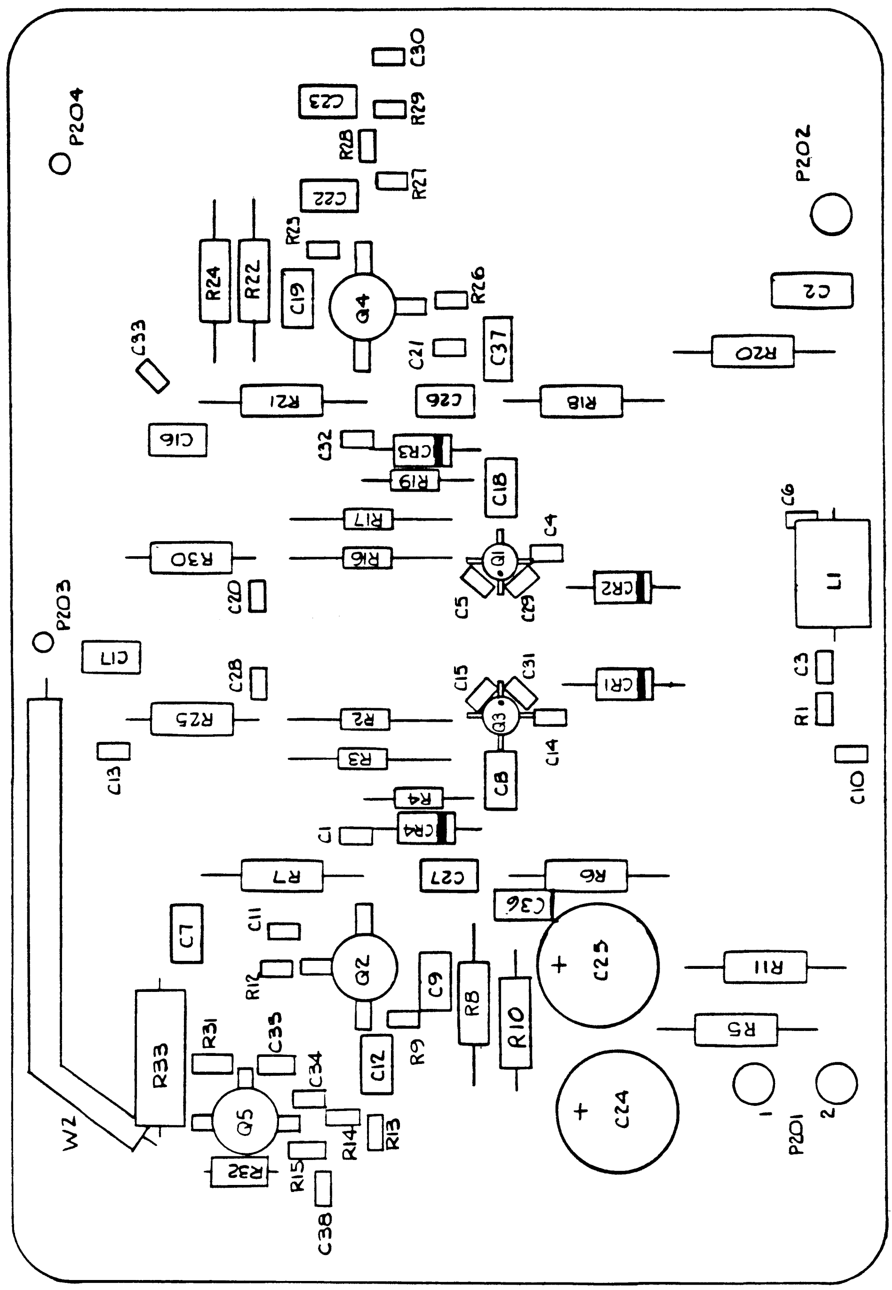

**Figure 5-6. A2A1 Synthesizer PCA**

TABLE 5-7. A2A2 VCO PCA
(SEE FIGURE 5-7.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | NOTE |
|---|---|---|---|---|---|---|---|---|
| C 1, 4, 6, | | CAP,CER,330PF,+-20%,50V,X7R | 650093 | 89536 | 650093 | 11 | | |
| C 10, 13, 14, | | | 650093 | | | | | |
| C 20, 28, 32, | | | 650093 | | | | | |
| C 33, 38 | | | 650093 | | | | | |
| C 2 | | CAP,CER,1800PF,+-5%,50V,COG | 528547 | 89536 | 528547 | 1 | | |
| C 3, 30 | | CAP,CER,1.5PF,+-0.5PF,50V,COG | 514166 | 89536 | 514166 | 2 | | |
| C 5, 15 | | CAP,CER,4.3PF,+-0.5PF,50V,COG | 514216 | 89536 | 514216 | 2 | | |
| C 7- 9, 12, | | CAP,CER,180PF,+-5%,100V,COG | 603506 | 56289 | C023B501E181M | 12 | | |
| C 16- 19, 22, | | | 603506 | | | | | |
| C 23, 26, 27 | | | 603506 | | | | | |
| C 11, 21 | | CAP,CER,10PF,+-5%,50V,COG | 494781 | 89536 | 494781 | 2 | | |
| C 24, 25 | | CAP,AL,220UF,+50-20%,16V | 435990 | 57640 | SM/VB | 2 | | |
| C 29, 31 | | CAP,CER,3.3PF,+-0.5PF,50V,COG | 514208 | 89536 | 514208 | 2 | | |
| C 34 | | CAP,CER,100PF,+-5%,50V,COG | 514133 | 89536 | 514133 | 1 | | |
| C 35 | | CAP,CER,2.7PF,+-0.5PF,50V,COG | 519793 | 89536 | 519793 | 1 | | |
| C 36, 37 | | CAP,CER,22PF,+-2%,100V,COG | 512871 | 89536 | 512871 | 2 | | |
| CR 1, 2 | | DIODE,SI,VARACTOR,PIV= 28V | 741504 | 89536 | 741504 | 2 | 1 | |
| CR 3, 4 | * | DIODE,SI,VARACTOR,PIV= 30V,HYPER ABRU | 722140 | 89536 | 722140 | 2 | 1 | |
| L 1 | | CHOKE,6TURN | 320911 | 89536 | 320911 | 1 | | |
| MP 2 | | SPACER,RND,SOLUBLE | 334797 | 32559 | TO-35-15-E | 4 | | |
| P 201,202 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 3 | | |
| P 203 | | CONN,SOCKET,PWB,0.022 DIAMETER | 376418 | 22526 | 75060-005 | 1 | | |
| P 204 | | PIN TEST BASE | 698472 | 89536 | 698472 | 1 | | |
| Q 1, 3 | * | TRANSISTOR,SI,NPN,SMALL SIG,MICROWAVE | 483164 | 89536 | 483164 | 2 | | |
| Q 2, 4, 5 | * | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 535013 | 04713 | BFR91 | 3 | 1 | |
| R 1, 9, 23 | | RES CHIP CERMET 180 +-5% 0.125W | 720649 | 89536 | 720649 | 3 | | |
| R 2, 16 | | RES,CC,360,+-5%,0.125W | 721761 | 89536 | 721761 | 2 | | |
| R 3, 17 | | RES,CC,680,+-5%,0.125W | 512798 | 01121 | BB6815 | 2 | | |
| R 4, 19 | | RES,CC,1.6M,+-5%,0.125W | 740316 | 89536 | 740316 | 2 | | |
| R 5, 11 | | RES,CF,5.6,+-5%,0.25W | 441618 | 80031 | CR251-4-5P5R6 | 2 | | |
| R 6, 18 | | RES,CF,1.5M,+-5%,0.25W | 349001 | 80031 | CR251-4-5P1M5 | 2 | | |
| R 7, 21 | | RES,MF,3.24K,+-1%,0.125W,100PPM | 223578 | 91637 | CMF553241F | 2 | | |
| R 8, 22 | | RES,MF,1.05K,+-1%,0.125W,100PPM | 293530 | 91637 | CMF551051F | 2 | | |
| R 10, 24 | | RES,MF,249,+-1%,0.125W,100PPM | 168203 | 91637 | CMF55249F | 2 | | |
| R 12, 26 | | RES CHIP CERMET 12 +-5% 0.125W | 715102 | 89536 | 715102 | 2 | | |
| R 13 | | RES,CHIP,CERM,68,+-5%,0.125W | 747675 | 89536 | 747675 | 1 | 1 | |
| R 14 | | RES,CHIP,CERM,120,+-5%,0.125W | 747683 | 89536 | 747683 | 1 | | |
| R 15 | | RES,CC,100,+-5%,0.125W | 714469 | 89536 | 714469 | 1 | | |
| R 20 | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 1 | | |
| R 25, 30 | | RES,MF,649,+-1%,0.125W,100PPM | 309955 | 91637 | CMF556490F | 2 | | |
| R 27, 29 | | RES CHIP CERMET 130 +-5% 0.125W | 720623 | 89536 | 720623 | 2 | | |
| R 28 | | RES CHIP CERMET 47 +-5% 0.125W | 720631 | 89536 | 720631 | 1 | | |
| R 31 | | RES,CC,15,+-5%,0.125W | 512715 | 01121 | BB1505 | 1 | | |
| R 32 | | RES,CC,200,+-5%,0.125W | 713917 | 89536 | 713917 | 1 | | |
| R 33 | | RES,CC,390,+-5%,0.5W | 109082 | 89536 | 109082 | 1 | | |
| W 2 | | UT-85 MINIATUR,TOTAL SHIELDED | 267567 | 89536 | 267567 | | | |

THE FOLLOWING COMPONENTS ARE NON FIELD REPLACEABLE:

C1,3,4,5,6,8,10,11,14,15,18,19,21,26,27,29,31,32,36,37
CR1,2,3,4
Q1,2,3,4
R1,2,3,4,16,17,18,19,25,30




6060A-1618

Figure 5-7. A2A2 VCO PCA

TABLE 5-8. A2A4 OUTPUT PCA
(SEE FIGURE 5-8.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 101,104,106, | | CAP,CER,100PF,+-2%,100V,COG | 512848 | 51406 | RPE121 | 40 | | |
| C 115-117,137, | | | 512848 | | | | | |
| C 138,144,151, | | | 512848 | | | | | |
| C 152,154-156, | | | 512848 | | | | | |
| C 231,238-240, | | | 512848 | | | | | |
| C 243,246,247, | | | 512848 | | | | | |
| C 250,253,301, | | | 512848 | | | | | |
| C 303,305,307- | | | 512848 | | | | | |
| C 314,317-321, | | | 512848 | | | | | |
| C 416 | | | 512848 | | | | | |
| C 103,145,148, | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 34 | | |
| C 201-204,206- | | | 732883 | | | | | |
| C 208,210,211, | | | 732883 | | | | | |
| C 213,214,235, | | | 732883 | | | | | |
| C 245,249,260- | | | 732883 | | | | | |
| C 262,264-266, | | | 732883 | | | | | |
| C 271-274,302, | | | 732883 | | | | | |
| C 304,306,403, | | | 732883 | | | | | |
| C 404,406,412 | | | 732883 | | | | | |
| C 107,124,147, | | CAP,CER,0.001UF,+-20%,100V,X7R | 402966 | 72982 | 8121-A100-W5R-102M | 11 | | |
| C 157,242,254- | | | 402966 | | | | | |
| C 256,259,269, | | | 402966 | | | | | |
| C 270 | | | 402966 | | | | | |
| C 108,119,121- | | CAP,CER,5.6PF,+-0.25PF,100V,COH | 512954 | 89536 | 512954 | 5 | | |
| C 123 | | | 512954 | | | | | |
| C 109,110,118 | | CAP,CER,3.9PF,+-0.25PF,100V,COJ | 512947 | 89536 | 512947 | 3 | | |
| C 111,236,237 | | CAP,CER,3.3PF,+-0.25PF,100V,COJ | 519330 | 89536 | 519330 | 3 | | |
| C 112,113 | | CAP,CER,2.2PF,+-0.25PF,100V,COG | 362731 | 89536 | 362731 | 2 | | |
| C 114,244,248, | | CAP,CER,1.8PF,+-0.25PF,100V,COK | 512897 | 89536 | 512897 | 4 | | |
| C 263 | | | 512897 | | | | | |
| C 120,224,275 | | CAP,CER,2.7PF,+-0.25PF,100V,COJ | 363705 | 89536 | 363705 | 3 | 1 | |
| C 125,127,129, | | CAP,CER,0.01UF,+-20%,50V,Z5U | 614214 | 72982 | 8121-050-651-10NFM | 7 | | |
| C 131,133,135, | | | 614214 | | | | | |
| C 149 | | | 614214 | | | | | |
| C 126 | | CAP,AL,22UF,+-20%,16V | 614750 | 89536 | 614750 | 1 | | |
| C 130,134 | | CAP,AL,15UF,+-20%,35V | 614024 | 89536 | 614024 | 2 | | |
| C 139 | | CAP,CER,1200PF,+-20%,100V,X7R | 358283 | 72982 | 8121-A100-W5R-122M | 1 | | |
| C 140 | | CAP,CER,1800PF,+-5%,50V,COG | 528547 | 89536 | 528547 | 1 | | |
| C 142 | | CAP,CER,4700PF,+-20%,100V,X7R | 362871 | 72982 | 8121-A100-W5R-472M | 1 | | |
| C 146 | | CAP,CER,220PF,+-2%,100V,COG | 512111 | 51406 | RPE121 | 1 | | |
| C 205 | | CAP,CER,39PF,+-2%,100V,COG | 512962 | 89536 | 512962 | 1 | | |
| C 209,212,230 | | CAP,CER,27PF,+-2%,100V,COG | 362749 | 51406 | RPE121 | 3 | | |
| C 216,218,220, | | CAP,CER,8.2PF,+-0.25PF,100V,COH | 715359 | 89536 | 715359 | 4 | | |
| C 223 | | | 715359 | | | | | |
| C 217 | | CAP,CER,18PF,+-2%,100V,COG | 512335 | 51406 | RD870-100V | 1 | | |
| C 219,226-229, | | CAP,CER,4.7PF,+-0.25PF,100V,COH | 362772 | 89536 | 362772 | 6 | | |
| C 277 | | | 362772 | | | | | |
| C 221 | | CAP,CER,10PF,+-2%,100V,COG | 512343 | 89536 | 512343 | 1 | | |
| C 222 | | CAP,CER,12PF,+-2%,100V,COG | 376871 | 89536 | 376871 | 1 | | |
| C 225,252 | | CAP,CER,6,8PF,+-0.25PF,100V,COH | 512327 | 89536 | 512327 | 2 | | |
| C 251,405 | | CAP,CER,47PF,+-2%,100V,COG | 512368 | 89536 | 512368 | 2 | | |
| C 267,411 | | CAP,TA,2.2UF,+-20%,35V | 485185 | 56289 | 196225X0035KA1 | 2 | | |
| C 322,409 | | CAP,TA,0.47UF,+-20%,35V | 161349 | 56349 | 196D474X0035HA1 | 2 | | |
| C 401,402 | | CAP,AL,47UF,+50-20%,16V | 436006 | 62643 | SM/VB | 2 | | |
| C 407,408 | | CAP,POLYPR,0.0786UF,+-1%,50V | 422998 | 89536 | 422998 | 2 | | |
| C 410 | | CAP,TA,4.7UF,+-20%,25V | 161943 | 56289 | 196D475X0025KA1 | 1 | | |
| CR 101,105,111- | * | DIODE,SI,PIN,LO-FREQ,BV=100.0V | 321216 | 28480 | 5082-3080 | 14 | 1 | |
| CR 116,203,205- | * | | 321216 | | | | | |
| CR 208,210 | * | | 321216 | | | | | |
| CR 102-104,106- | * | DIODE,SI,PIN, RF ATTENUATING | 508077 | 26629 | KS8379 | 11 | 1 | |
| CR 110,129,204, | * | | 508077 | | | | | |
| CR 209 | * | | 508077 | | | | | |
| CR 117-120 | * | DIODE,SI,PIN,SMALL SIGNAL,UHF & VHF | 402776 | 28480 | HP3379 | 4 | 1 | |
| CR 121,301 | * | ZENER,UNCOMP, 5.1V, 5%, 20.0MA, 0.4W | 159798 | 04713 | 1N751A | 2 | 1 | |
| CR 123,124 | * | DIODE,SI,BV= 50.0V,IO=150MA,SELCTD VF | 234468 | 07910 | TD9039 | 2 | 1 | |
| CR 125 | * | ZENER,UNCOMP, 4.3V, 5%, 20.0MA, 0.4W | 180455 | 07910 | IN749A | 1 | 1 | |
| CR 126,202 | * | DIODE,SI,SCHOTTKY,MATCHED SET OF 2 | 722470 | 89536 | 722470 | 1 | 1 | |
| CR 127,128 | * | DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNL | 535195 | 28480 | 5082-2800 | 2 | 1 | |
| CR 130,201 | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 2 | 3 | |
| CR 302 | * | ZENER,UNCOMP, 15.0V, 5%, 8.5MA, 0.4W | 266601 | 04713 | 1N965B | 1 | 1 | |
| CR 401,402 | * | DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNL | 313247 | 28484 | HP5082-6264 | 2 | 1 | |
| CR 403 | * | ZENER,COMP, 6.3V, 2%,50 PPM TC, 7.5MA | 172148 | 89536 | 172148 | 1 | 1 | |
| L 102,106,108, | | CHOKE,6TURN | 320911 | 89536 | 320911 | 6 | | |
| L 110,115,230 | | | 320911 | | | | | |
| L 103-105,225 | | INDUCTOR,0.68 UH,+/-10%,221MHZ,SHLDED | 320937 | 24759 | MR0.68 | 4 | | |
| L 113,116,209, | | INDUCTOR,10 TURNS | 463448 | 89536 | 463448 | 11 | | |
| L 210,214-217, | | | 463448 | | | | | |
| L 220,224,227 | | | 463448 | | | | | |
| L 201-203,221, | | INDUCTOR,390 UH,+/-5%,6.9 MHZ,SHLDED | 186288 | 72259 | WEE390 | 5 | | |
| L 228 | | | 186288 | | | | | |
| P 101,113 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 19 | | |
| P 102,107,108 | | PIN TEST BASE | 698472 | 89536 | 698472 | 3 | | |
| P 104 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 14 | | |
| P 106 | | CONN,SOCKET,PWB,0.022 DIAMETER | 376418 | 22526 | 75060-005 | 1 | | |
| Q 101,102,202 | * | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 535013 | 04713 | BFR91 | 3 | 1 | |
| Q 103,302,304, | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 330803 | 07263 | MPS6560 | 4 | 1 | |
| Q 306 | * | | 330803 | | | | | |
| Q 104,201,203, | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 195974 | 64713 | 2N3906 | 8 | 1 | |
| Q 205,208,210, | * | | 195974 | | | | | |
| Q 212,214 | * | | 195974 | | | | | |
| Q 105,106 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 218396 | 04713 | 2N3904 | 2 | 2 | |
| Q 204,206,209, | | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 723379 | 89536 | 723379 | 4 | 1 | |
| Q 211 | | | 723379 | | | | | |

TABLE 5-8. A2A4 OUTPUT PCA (CONT.)
(SEE FIGURE 5-8.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| Q 207 | * | TRANSISTOR,SI,NPN,SMALL SIG,MICROWAVE | 483172 | 89536 | 483172 | 1 | 1 | |
| Q 213,215 | * | TRANSISTOR,SI,NPN,HI-FREQ,SMALL SIGNL | 722256 | 89536 | 722256 | 2 | 1 | |
| Q 301,303,305, | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 418707 | 04713 | MPS56562 | 4 | 1 | |
| Q 307 | * | | 418707 | | | | | |
| Q 401,403 | * | TRANSISTOR,SI,N-JFET,TO-92,SWITCH | 261578 | 15818 | U2366J | 2 | 1 | |
| Q 402 | * | TRANSISTOR,SI,N-JFET,TO-92 | 376475 | 15818 | U2810J | 1 | 1 | |
| R 101,102,104, | | RES,CF,1K,+-5%,0.25W | 343426 | 80031 | CR251-4-5P1K | 19 | | |
| R 114-120,151, | | | 343426 | | | | | |
| R 156,269-271, | | | 343426 | | | | | |
| R 316-318,320 | | | 343426 | | | | | |
| R 103,121,122 | | RES,CC,39,+-5%,0.125W | 713909 | 89536 | 713909 | 3 | | |
| R 105 | | RES,CC,82,+-5%,0.125W | 721043 | 89536 | 721043 | 1 | | |
| R 106 | | RES,CF,470,+-5%,0.25W | 343434 | 80031 | CR251-4-5P470E | 1 | | |
| R 107 | | RES,CF,200,+-5%,0.25W | 441451 | 80031 | CR251-4-5P200E | 1 | | |
| R 108,124,125 | | RES,MF,2.15K,+-1%,0.125W,100PPM | 293712 | 91637 | CMF552151F | 3 | | |
| R 109 | | RES CC 510 +-5% 0.125W | 715383 | 89536 | 715383 | 1 | | |
| R 110 | | RES,CC,270,+-5%,0.5W | 159616 | 01121 | EB2715 | 1 | | |
| R 111,112,159, | | RES,CC,51,+-5%,0.125W | 266262 | 01121 | BB5105 | 6 | | |
| R 243-245 | | | 266262 | | | | | |
| R 113 | | RES,CC,18,+-5%,0.125W | 500397 | 01121 | BB1805 | 1 | | |
| R 123,238 | | RES,MF,2.67K,+-1%,0.125W,100PPM | 289587 | 91637 | CMF552671F | 2 | | |
| R 126 | | RES,MF,1.65K,+-1%,0.125W,100PPM | 293662 | 91637 | CMF551631 | 1 | | |
| R 127 | | RES,MF,665,+-1%,0.125W,100PPM | 320028 | 91637 | CMF556650F | 1 | | |
| R 128,129 | | RES,MF,124K,+-1%,0.125W,100PPM | 288407 | 91637 | CMF551243F | 2 | | |
| R 130 | | RES,MF,1.54K,+-1%,0.125W,100PPM | 289066 | 91637 | CMF551541F | 1 | | |
| R 131 | | RES,MF,3.48K,+-1%,0.125W,100PPM | 260687 | 91637 | CMF553481F | 1 | | |
| R 132 | | RES,MF,24.3K,+-1%,0.125W,100PPM | 236745 | 91637 | CMF55 | 1 | | |
| R 133 | | RES,MF,6.04K,+-1%,0.125W,100PPM | 285189 | 91637 | CMF556041F | 1 | | |
| R 134 | | RES,MF,21.5K,+-1%,0.125W,100PPM | 168278 | 89536 | 168278 | 1 | | |
| R 135,304,413, | | RES,MF,10K,+-1%,0.125W,100PPM | 168260 | 91637 | CMF551002F | 4 | | |
| R 414 | | | 168260 | | | | | |
| R 136,266 | | RES,MF,2.55K,+-1%,0.125W,100PPM | 325498 | 91637 | CMF552551F | 2 | | |
| R 137 | | RES,MF,499,+-1%,,0.125W,100PM | 168211 | 91637 | CMF554990F | 1 | | |
| R 138 | | RES,MF,16.9K,+-1%,0.125W,100PPM | 267146 | 91637 | CMF551692F | 1 | | |
| R 139 | | RES,MF,34.8K,+-1%,0.125W,100PPM | 261487 | 89536 | 261487 | 1 | | |
| R 140,148,149 | | RES,MF,1K,+-1%,0.125W,100PPM | 168229 | 91637 | CMF551001F | 3 | | |
| R 141 | | RES,MF,37.4K,+-1%,0.125W,100PPM | 226241 | 91637 | CMF553742F | 1 | | |
| R 142 | | RES,MF,100K,+-1%,0.125W,100PPM | 248807 | 91637 | CMF551003F | 1 | | |
| R 143,147 | | RES,MF,20K,+-1%,0.125W,100PPM | 291872 | 91637 | CMF552002F | 2 | | |
| R 144 | | RES,VAR,CERM,2K,+-10%,0.5W | 309666 | 89536 | 309666 | 1 | 3 | |
| R 145 | | RES,MF,66.5K,+-1%,0.125W,100PPM | 289082 | 91637 | CMF556652F | 1 | | |
| R 146,422 | | RES,MF,49.9K,+-1%,0.125W,100PPM | 268821 | 91637 | CMF554992F | 2 | | |
| R 150,233,242 | | RES,CC,180,+-5%,0.125W | 512756 | 01121 | BB1815 | 3 | | |
| R 152 | | RES,CF,270,+-5%,0.25W | 348789 | 80031 | CR251-4-5P270E | 1 | | |
| R 153,158,314, | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 4 | | |
| R 319 | | | 348821 | | | | | |
| R 154 | | RES,CC,22,+-5%,0.125W | 474767 | 01121 | BB1-82205 | 1 | | |
| R 155 | | RES,CF,1,+-5%,0.25W | 357665 | 80031 | CR251-4-5P1E | 1 | | |
| R 157,272 | | RES,CC,1K,+-5%,0.125W | 643932 | 01121 | BB1025 | 2 | | |
| R 201,207,213, | | RES,CF,2K,+-5%,0.25W | 441469 | 80031 | CR251-4-5P2K | 7 | | |
| R 232,240,248, | | | 441469 | | | | | |
| R 265 | | | 441469 | | | | | |
| R 202 | | RES,CF,360,+-5%,0.25W | 352286 | 80031 | CR251-4-5P360E | 1 | | |
| R 203,209,214 | | RES,MF,287,+-1%,0.125W,100PPM | 443002 | 89536 | 443002 | 3 | | |
| R 204,205 | | RES,CF,15,+-5%,0.125W | 740027 | 89536 | 740027 | 2 | | |
| R 206,212,217 | | RES,CF,11,+-5%,0.125W | 740019 | 89536 | 740019 | 3 | | |
| R 208,220,234, | | RES,CC,150,+-5%,0.5W | 186056 | 89536 | 186056 | 4 | | |
| R 241 | | | 186056 | | | | | |
| R 210,211,215, | | RES,CF,18,+-5%,0.125W | 740035 | 89536 | 740035 | 4 | | |
| R 216 | | | 740035 | | | | | |
| R 218,239 | | RES,MF,6.65K,+-1%,0.125W,100PPM | 294918 | 91637 | CMF551272F | 2 | | |
| R 219 | | RES,MF,8.45K,+-1%,0.125W,100PPM | 221671 | 89536 | 221671 | 1 | | |
| R 221 | | RES,MF,1.21K,+-1%,0.125W,100PPM | 229146 | 91637 | CMF551211F | 1 | | |
| R 222 | | RES,MF,5.36K,+-1%,0.125W,100PPM | 370981 | 89536 | 370981 | 1 | | |
| R 223 | | RES,CC,300,+-5%,0.5W | 108829 | 01121 | EB3015 | 1 | | |
| R 224,262 | | RES,CF,160,+-5%,0.125W | 740092 | 89536 | 740092 | 2 | | |
| R 225,229 | | RES,CF,75,+-5%,0.125W | 740068 | 89536 | 740068 | 2 | | |
| R 226 | | RES,CF,51,+-5%,0.125W | 740050 | 89536 | 740050 | 1 | | |
| R 227 | | RES,VAR,CERM,100,+-10%,0.5W | 275735 | 11236 | 360T-101A | 1 | | |
| R 228 | | RES,CF,110,+-5%,0.125W | 740076 | 89536 | 740076 | 1 | | |
| R 230,231 | | RES,CC,100,+-5%,0.125W | 714469 | 89536 | 714469 | 2 | | |
| R 235 | | RES,CC,47,+-5%,0.125W | 512061 | 01121 | BB4705 | 1 | | |
| R 236,237 | | RES,CC,30,+-5%,0.125W | 512723 | 01121 | BB3005 | 2 | | |
| R 246 | | RES,MF,5.76K,+-1%,0.125W,100PPM | 260349 | 91637 | CMF555761F | 1 | | |
| R 249 | | RES,MF,63.4,+-1%,0.5W,100PPM | 155101 | 89536 | 155101 | 1 | | |
| R 250 | | RES,CC,160,+-5%,0.125W | 721027 | 89536 | 721027 | 1 | | |
| R 251,252 | | RES,CC,24,+-5%,0.125W | 681932 | 89536 | 681932 | 2 | | |
| R 253 | | RES,CC,110,+-5%,0.125W | 500983 | 01121 | BB1115 | 1 | | |
| R 254 | | RES,CC,220+-5%,0.125W | 721159 | 89536 | 721159 | 1 | | |
| R 255 | | RES,CC,300,+-5%,0.125W | 512772 | 01121 | BB3015 | 1 | | |
| R 256 | | RES,CF,120,+-5%,0.12KW | 740084 | 89536 | 740084 | 1 | | |
| R 258 | | RES,CF,1.2K,+-5%,0.25W | 441378 | 80031 | CR251-4-5P1K2 | 1 | | |
| R 259 | | RES,CC,390,+-5%,0.5W | 109082 | 89536 | 109082 | 1 | | |
| R 261 | | RES,CC,620,+-5%,0.5W | 108704 | 89536 | 108704 | 1 | | |
| R 263,264 | | RES,CF,24,+-5%,0.125W | 740043 | 89536 | 740043 | 2 | | |
| R 267 | | RES,MF,1.4K,+-1%,0.125W,100PPM | 344333 | 91637 | CMF551401F | 1 | | |
| R 268 | | RES,MF,59.0,+-1%,0.5W,100PPM | 150920 | 89536 | 150920 | 1 | | |
| R 301 | | RES,MF,8.45K,+-1%,0.125W,100PPM | 221671 | 89536 | 221671 | 1 | | |
| R 302 | | RES,MF,3.4K,+-1%,0.125W,100PPM | 260323 | 91637 | CMF553401F | 1 | | |
| R 303 | | RES,MF,715,+-1%,0.125W,100PPM | 313080 | 91637 | CMF557150F | 1 | | |
| R 305 | | RES,MF,392,+-1%,0.125W,100PPM | 260299 | 91637 | CMF553920F | 1 | | |
| R 306 | | RES,MF,39.2K,+-1%,0.125W,100PPM | 236414 | 91637 | CMF553922F | 1 | | |
| R 307 | | RES,CF,47,+-5%,0.25W | 441592 | 80031 | CR251-4-5P47E | 1 | | |

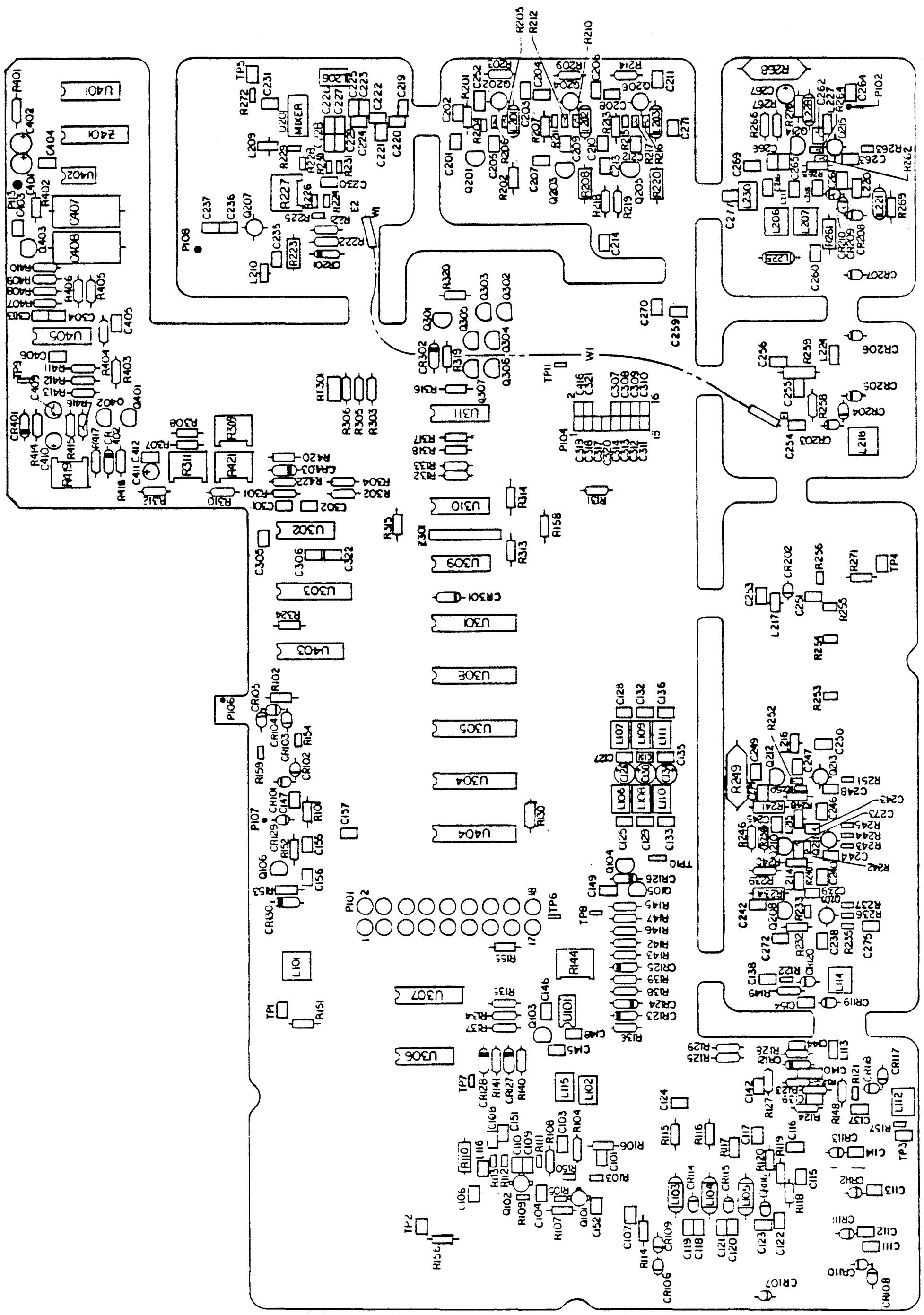
TABLE 5-8. A2A4 OUTPUT PCA (CONT.)
(SEE FIGURE 5-8.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ---------DESCRIPTION--------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| R 308 | | RES,CF,56K,+-5%,0.25W | 441626 | 80031 | CR251-4-5P56K | 1 | | |
| R 309 | | RES,VAR,CERM,10K,+-10%,0.5W | 309674 | 75378 | 360T103A | 1 | | |
| R 310 | | RES,MF,523,+-1%,0.125W,100PPM | 294835 | 91637 | CMF555230D | 1 | | |
| R 311 | | RES,VAR,CERM,200,+-10%,0.5W | 275743 | 89536 | 275743 | 1 | | |
| R 312 | | RES,MF,294,+-1%,0.125W,100PPM | 288472 | 91637 | CMF55294F | 1 | | |
| R 313 | | RES,CF,33K,+-5%,0.25W | 348888 | 80031 | CR251-4-5P33K | 1 | | |
| R 315 | | RES,CF,620,+-5%,0.25W | 442319 | 80031 | CR251-4-5P620E | 1 | | |
| R 324 | | RES,CF,62K,+-5%,0.25W | 348904 | 80031 | CR251-4-5P62K | 1 | | |
| R 401 | | RES,MF,681,+-1%,0.125W,100PPM | 543785 | 91637 | CMF556810F | 1 | | |
| R 402 | | RES,CF,1M,+-5%,0.25W | 348987 | 80031 | CR251-4-5P1M | 1 | | |
| R 403,408 | | RES,MF,3.32K,+-1%,0.125W,100PPM | 312652 | 91637 | CMF553321F | 2 | | |
| R 404,407 | | RES,MF,34.8,+-1%,0.125W,100PPM | 343897 | 89536 | 343897 | 2 | | |
| R 405,409 | | RES,MF,4.99K,+-1%,0.125W,100PPM | 168252 | 91637 | MFF1-84991 | 2 | | |
| R 406,410 | | RES,MF,71.5,+-1%,0.125W,100PPM | 393603 | 91637 | CMF5571R5F | 2 | | |
| R 411 | | RES,MF,4.02K,+-1%,0.125W,100PPM | 235325 | 91637 | CMF554021F | 1 | | |
| R 412 | | RES,MF,1.69K,+-1%,0.125W,100PPM | 321414 | 91637 | CMF551691F | 1 | | |
| R 415 | | RES,MF,6.34K,+-1%,0.125W,100PPM | 267344 | 91637 | CMF556341F | 1 | | |
| R 416 | | RES,MF,147K,+-1%,0.125W,100PPM | 291344 | 91637 | CMF551473F | 1 | | |
| R 417 | | RES,MF,23.2K,+-1%,0.125W,100PPM | 291351 | 91637 | CMF552322F | 1 | | |
| R 418 | | RES,MF,301K,+-1%,0.125W,100PPM | 289488 | 91637 | CMF5530102F | 1 | | |
| R 419 | | RES,VAR,CERM,100K,+-10%,0.5W | 369520 | 11236 | 360T-104A | 1 | | |
| R 420 | | RES,CF,4.3K,+-5%,0.25W | 441576 | 80031 | CR251-4-5P4K3 | 1 | | |
| R 421 | | RES,VAR,CERM,20K,+-10%,0.5W | 335760 | 11236 | 360T-203A | 1 | | |
| RT 301 | | THERMISTOR,DISC,NEG.,10K,+-10%,25C | 104596 | 73168 | JA41J1 | 1 | | |
| TP 1- 5 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 10 | | |
| TP 6- 11 | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 6 | | |
| U 101,402 | * | IC,OP AMP,DUAL,JFET INPUT,8 PIN DIP | 495192 | 12040 | LF353BN | 2 | | |
| U 201 | | MIXER,DOUBLE BALANCED,1 - 1000 MHZ | 525493 | 89536 | 525493 | 1 | 1 | |
| U 301 | * | IC,CMOS,DUAL 8 BIT DAC,CURRENT OUTPUT | 722272 | 89536 | 722272 | 1 | 1 | |
| U 302,311,405 | * | IC,OP AMP,QUAD JFET INPUT,14 PIN DIP | 659748 | 89536 | 659748 | 3 | 1 | |
| U 303 | * | CMOS,12 BIT MULTIPLYING DAC | 722264 | 89536 | 722264 | 1 | 1 | |
| U 304,305,308, | * | IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR | 454892 | 01295 | SN74LS273N | 4 | 1 | |
| U 404 | * | | 454892 | | | | | |
| U 306 | * | IC,LSTTL,QUAD 2 INPUT NAND GATE | 393033 | 01295 | SN74LS00N | 1 | 1 | |
| U 307 | * | IC,LSTTL,3-8 LINE DCDR W/ENABLE | 407585 | 01295 | SN74LS138N | 1 | 1 | |
| U 309,310 | * | IC,COMPARATOR,QUAD,14 PIN DIP | 387233 | 12040 | LM339N | 2 | 1 | |
| U 401 | * | IC,CMOS,QUAD BILATERAL SWITCH | 408062 | 89536 | 408062 | 1 | 1 | |
| U 403 | * | IC,CMOS,10BIT DAC,10BIT ACCUR,CUR OUT | 507566 | 24355 | AD7533LN | 1 | | |
| W 1 | | CABLE ASSY, RF JUMPER | 716993 | 89536 | 716993 | 1 | | |
| XU 301,304,305, | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 5 | | |
| XU 308,404 | | | 454421 | | | | | |
| XU 302,306,309- | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 7 | | |
| XU 311,401,405 | | | 276527 | | | | | |
| XU 303 | | SOCKET,DIP,0.100 CTR,18 PIN | 418228 | 91506 | 318-AG39D | 1 | | |
| XU 307,403 | | SOCKET,DIP,0.100 CTR,16 PIN | 276535 | 91506 | 316-AG39D | 3 | | 1 |
| XU 402 | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 2 | | 2 |
| Z 301 | | RES,NET,SIP,8 PIN,7 RES,10K,+-2% | 412924 | 80031 | 95081002CL | 1 | | |
| Z 401 | | RES,NET,CERM,CUSTOM | 501841 | 89536 | 501841 | 1 | | |

1 ALSO INCLUDES XZ401.
2 ALSO INCLUDES XR144.

THE FOLLOWING COMPONENTS ARE NON FIELD REPLACEABLE:

C202-206,208,209,211,212,216-222,224,225,252,254,263,264,271,277
CR126,202-210
L217,220
Q202,204,206,215
R203-206,209-212,214-217,224-228,253-256,262-264
U201



6060A-1624

Figure 5-8. A2A4 Output PCA

TABLE 5-9. A2A6 ATTENUATOR ASSEMBLY

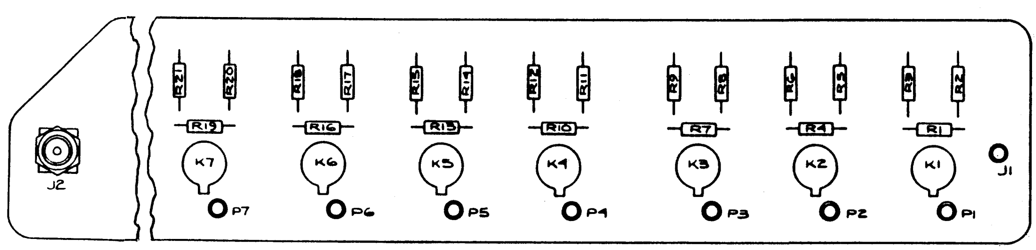
| REFERENCE DESIGNATOR A->NUMERICS---> | S | -----------DESCRIPTION----------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| A 4 | * | ATTENUATOR PCA (RELAY) | 752675 | 89536 | 752675 | 1 | | |
| A 5 | * | RELAY DRIVER PCA | 752808 | 89536 | 752808 | 1 | | |
| FL 1 | | FILTER,RF,EYELET STYLE,2000PF,BL | 529495 | 89536 | 529495 | 11 | | |
| H 1 | | SCREW,MACH,PHP,STL,6-32X1/4 | 152140 | 89536 | 152140 | 1 | | |
| H 2 | | SCREW,MACH,PHP,STL,6-32X1/2 | 152173 | 89536 | 152173 | 7 | | |
| H 3 | | SCREW,MACH,PHP,STL,6-32X7/8 | 114868 | 89536 | 114868 | 11 | | |
| H 4 | | SCREW,MACH,PHP,STL,6-32X1/2 | 152173 | 89536 | 152173 | 2 | | |
| MP 1 | | HOUSING,PLATED,ATTENUATOR,RELAYVERSN | 717017 | 89536 | 717017 | 1 | 1 | |
| U 26 | * | IC, 2K X 8 EPROM | 454603 | 01295 | TMS2516JL | 1 | | 1 |
| W 24 | | CABLE ASSEMBLY, ATTENUATOR | 752725 | 89536 | 752725 | 1 | | |

1 UNPROGRAMMED PART

TABLE 5-10. A2A6A4 ATTENUATOR PCA
(SEE FIGURE 5-9.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| H 1 | | WASHER,SPRNG,COPPER,0.316 ID | 544239 | 89536 | 544239 | 7 | | |
| J 2 | | CONN,COAX,SMA,REC,PWB OR BLKHD | 512087 | 16733 | 705147-001 | 1 | | |
| J 3 | | CONN,SOCKET,SPRING TYPE,.0690D,.143L | 732826 | 89536 | 732826 | 1 | | |
| K 1- 7 | | RELAY,ARMATURE,2 FORM C,26.5VDC | 528638 | 11532 | 712-26 | 7 | | |
| P 1- 8 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 8 | | |
| R 1, 7, 10, | | RES,MF,402,+-0.5%,0.125W,50PPM | 461632 | 89536 | 461632 | 5 | | |
| R 16, 19 | | | 461632 | | | | | |
| R 2, 3, 8, | | RES,MF,56.9,+-0.5%,0.125W,50PPM | 461590 | 89536 | 461590 | 10 | | |
| R 9, 11, 12, | | | 461590 | | | | | |
| R 17, 18, 20, | | | 461590 | | | | | |
| R 21 | | | 461590 | | | | | |
| R 4 | | RES,MF,94.2,+-0.5%,0.125W,50PPM | 461616 | 89536 | 461616 | 1 | | |
| R 5, 6 | | RES,MF,83.5,+-0.5%,0.125W,50PPM | 461608 | 89536 | 461608 | 2 | | |
| R 13 | | RES,MF,37.4,+-0.5%,0.125W,50PPM | 461079 | 89536 | 461079 | 1 | | |
| R 14, 15 | | RES,MF,150,+-0.5%,0.125W,50PPM | 461624 | 89536 | 461624 | 2 | | |

ALL COMPONENTS NON FIELD REPLACEABLE

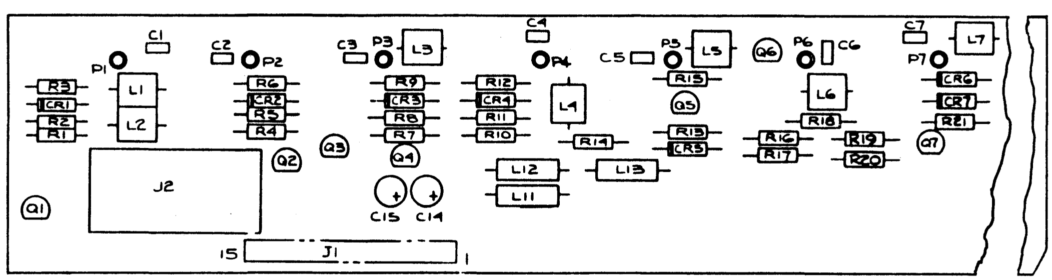



6060A-1646

Figure 5-9. A2A6A4 Attenuator PCA

TABLE 5-11. A2A6A5 RELAY DRIVER PCA
(SEE FIGURE 5-10.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1- 7 | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 7 | | |
| C 14, 15 | | ELECTRO, MIN,LO LEAK, 4.7MF, 35V | 603993 | 89536 | 603993 | 2 | | |
| J 1 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 14 | | |
| J 2 | | SOCKET,DIP,0.100 CTR,24 PIN | 376236 | 91506 | 324-AG39D | 1 | | |
| L 1- 7 | | CHOKE,6TURN | 320911 | 89536 | 320911 | 7 | | |
| L 11 | | INDUCTOR,470 UH,+/-5%,6.5 MHZ,SHLDED | 147827 | 72259 | WEE470 | 1 | | |
| L 12, 13 | | INDUCTOR,47 UH,+/-5%,26.5 MHZ,SHLDED | 147850 | 72259 | WEE47 | 2 | 2 | |
| MP 1 | | PWB, RELAY DRIVER | 752774 | 89536 | 752774 | 1 | | |
| P 1- 7 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 7 | | |
| Q 1- 7 | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 418707 | 04713 | MPS56562 | 7 | 2 | |
| R 1, 4, 7, | | RES,CF,510,+-5%,0.25W | 441600 | 80031 | CR251-4-5P510E | 7 | | |
| R 10, 13, 16, | | | 441600 | | | | | |
| R 19 | | | 441600 | | | | | |
| R 2, 5, 8, | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 7 | | |
| R 11, 14, 17, | | | 348821 | | | | | |
| R 20 | | | 348821 | | | | | |
| R 3, 6, 9, | | RES,CF,100,+-5%,0.25W | 348771 | 80031 | CR251-4-5P100E | 7 | | |
| R 12, 15, 18, | | | 348771 | | | | | |
| R 21 | | | 348771 | | | | | |
| VR 1- 7 | * | ZENER,UNCOMP, 30.0V,10%, 4.2MA, 0.4W | 272633 | 04713 | 1N972A | 7 | | |




6060A-1644

Figure 5-10. A2A6A5 Relay Driver PCA

TABLE 5-12. A2A7 CONTROLLER PCA
(SEE FIGURE 5-11.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1 | | CAP,AL,47UF,+50-20%,16V | 436006 | 62643 | SM/VB | 1 | | |
| C 2, 6, 7, | | CAP,POLYES,0.22UF,+-10%,50V | 696492 | 89536 | 696492 | 26 | | |
| C 10- 13, 16, | | | 696492 | | | | | |
| C 18, 19, 21, | | | 696492 | | | | | |
| C 23- 25, 28- | | | 696492 | | | | | |
| C 31, 34, 35, | | | 696492 | | | | | |
| C 39- 42, 44, | | | 696492 | | | | | |
| C 45 | | | 696492 | | | | | |
| C 3 | | CAP,TA,0.47UF,+-20%,35V | 161349 | 56349 | 196D474X0035HA1 | 1 | | |
| C 4, 5 | | CAP,TA,10UF,+-20%,20V | 330662 | 56289 | 196D106X0020KA1 | 2 | | |
| C 22, 51, 53- | | CAP,CER,220PF,+-10%,1000V,Z5F | 368605 | 89536 | 368605 | 7 | | |
| C 57 | | | 368605 | | | | | |
| C 50, 52, 58, | | CAP,CER,2000PF,+100-0%,1000V,Z5U | 105569 | 71590 | DA140-139CB | 4 | | |
| C 59 | | | 105569 | | | | | |
| C 60 | | CAP,CER,100PF,+-10%,1000V,S3N | 105593 | 71590 | DD-101 | 1 | | |
| C 61 | | CAP,CER,22PF,+-2%,100V,COG | 512871 | 89536 | 512871 | 1 | | |
| CR 1 | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 1 | 1 | |
| J 101,105,107 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 53 | | |
| J 102 | | SOCKET,SIP,0.100 CTR,16 PIN | 485037 | 30035 | SS-109-1-16C | 2 | | |
| J 106 | | CONN,PWB,HEADER,DIP,90,0.100,26 PIN | 512590 | 89536 | 512590 | 1 | | |
| L 1, 2 | | CHOKE,6TURN | 320911 | 89536 | 320911 | 2 | 1 | |
| P 101 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 18 | | |
| R 1, 6- 11 | | RES,CF,180,+-5%,0.25W | 441436 | 80031 | CR251-4-5P180E | 7 | | |
| R 2, 13 | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 2 | | |
| R 3 | | RES,CF,20K,+-5%,0.25W | 441477 | 80031 | CR251-4-5P20K | 1 | | |
| R 4 | | RES,CF,390K,+-5%,0.25W | 442475 | 80031 | CR251-4-5P390K | 1 | | |
| R 5 | | RES,CF,100K,+-5%,0.25W | 348920 | 80031 | CR251-4-5P100K | 1 | | |
| R 12 | | RES,CF,100,+-5%,0.25W | 348771 | 80031 | CR251-4-5P100E | 1 | | |
| R 14, 15 | | RES,CF,1.3K,+-5%,0.25W | 441394 | 80031 | CR251-4-5P1K3 | 2 | | |
| S 1 | | SWITCH, DIL, 6-POS, SPST, ASSY | 454124 | 00779 | 435166-4 | 1 | | |
| U 1 | * | IC,NMOS,16 BIT MICROCOMPUTER | 640417 | 01295 | TMS9995N | 1 | | |
| U 2 | * | IC,LSTTL,HEX BUFFER W/NOR ENABLE | 483800 | 01295 | SN74LS367N | 1 | 1 | |
| U 3, 4, 18 | * | IC,LSTTL,OCTL BUS TRNSCVR W/3-ST OUT | 477406 | 01295 | SN74LS245N | 3 | 1 | |
| U 5, 44 | * | IC,LSTTL,HEX INVERTER | 393058 | 01295 | SN74LS04N | 2 | 1 | |
| U 7 | * | IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP | 478354 | 12040 | LM393N | 1 | 1 | |
| U 8 | * | IC,LSTTL,TRIPLE 3 INPUT NAND GATE | 393074 | 01295 | SN74LS10N | 1 | 1 | |
| U 9 | * | IC,LSTTL,HEX D F/F,+EDG TRG,W/CLEAR | 393207 | 01295 | SN74LS174N | 1 | 1 | |
| U 10 | * | IC,STTL,QUAD 2 INPUT OR GATE | 604629 | 01295 | SN74S32N | 1 | 1 | |
| U 11, 40 | * | IC,LSTTL,OCTAL D TRANSPARENT LATCHES | 504514 | 01295 | SN74LS373N | 2 | 1 | |
| U 14 | * | IC,LSTTL,2-4 LINE DEMUX | 393165 | 01295 | SN74LS139N | 1 | 1 | |
| U 15, 16, 33, | * | IC,LSTTL,OCTL LINE DRVR W/3-STATE OUT | 429035 | 01295 | SN74LS244N | 4 | 1 | |
| U 34 | * | | 429035 | | | | | |
| U 17, 27 | * | IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR | 454892 | 01295 | SN74LS273N | 2 | 1 | |
| U 20, 35, 36, | * | IC,LSTTL,3-8 LINE DCDR W/ENABLE | 407585 | 01295 | SN74LS138N | 4 | 1 | |
| U 38 | * | | 407585 | | | | | |
| U 21 | | EPROM, PROGRAMMED 2764 (FOR 100KHZ) | 748749 | 89536 | 748749 | 1 | | |
| U 22 | | EPROM, PROGRAMMED 27256 (FOR 100KHZ) | 748756 | 89536 | 748756 | 1 | 1 | |
| U 25 | * | IC, 2K X 8 STAT RAM | 584144 | 33297 | uPD4016C-2 | 1 | | |
| U 30, 31 | * | IC,ARRAY,7 TRANS,NPN,DARLINGTON PAIRS | 454116 | 01295 | ULN2003 | 2 | 1 | |
| U 37 | * | IC,LSTTL,QUAD 2 INPUT OR GATE | 393108 | 01295 | SN74LS32N | 1 | 1 | |
| U 42 | * | IC,LSTTL,DUAL JK F/F,-EDG TRIG | 414029 | 01295 | SN74LS112N | 1 | 1 | |
| XU 1 | | SOCKET,DIP,0.100 CTR,40 PIN | 429282 | 09922 | DILB40P-108 | 1 | | |
| XU 2, 9, 14, | | SOCKET,DIP,0.100 CTR,16 PIN | 276535 | 91506 | 316-AG39D | 10 | | |
| XU 20, 30, 31, | | | 276535 | | | | | |
| XU 35, 36, 38, | | | 276535 | | | | | |
| XU 42 | | | 276535 | | | | | |
| XU 3, 4, 11, | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 11 | | |
| XU 15- 18, 27, | | | 454421 | | | | | |
| XU 33, 34, 40 | | | 454421 | | | | | |
| XU 5, 8, 10, | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 5 | | |
| XU 37, 44 | | | 276527 | | | | | |
| XU 7 | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 1 | | |
| XU 21, 22 | | SOCKET,DIP,0.100 CTR,28 PIN | 448217 | 91506 | 328-AG39D | 2 | | |
| XU 23- 26 | | SOCKET,DIP,0.100 CTR,24 PIN | 376236 | 91506 | 324-AG39D | 4 | | |
| Y 41 | * | CRYSTAL,10MHZ,+-0.01%,HC-18/U | 520239 | 89536 | 520239 | 1 | 1 | |
| Z 1 | | RES,NET,SIP,10 PIN,9 RES,4.7K,+-2% | 484063 | 80031 | 95081002CL | 1 | | |
| Z 2- 5 | | RES,NET,SIP,10 PIN,9 RES,10K,+-2% | 414003 | 80031 | 95081002CL | 4 | | |

NOTE

U23 EPROM PART OF A2A2
U24 EPROM PART OF A2A4
U26 EPROM PART OF A2A6

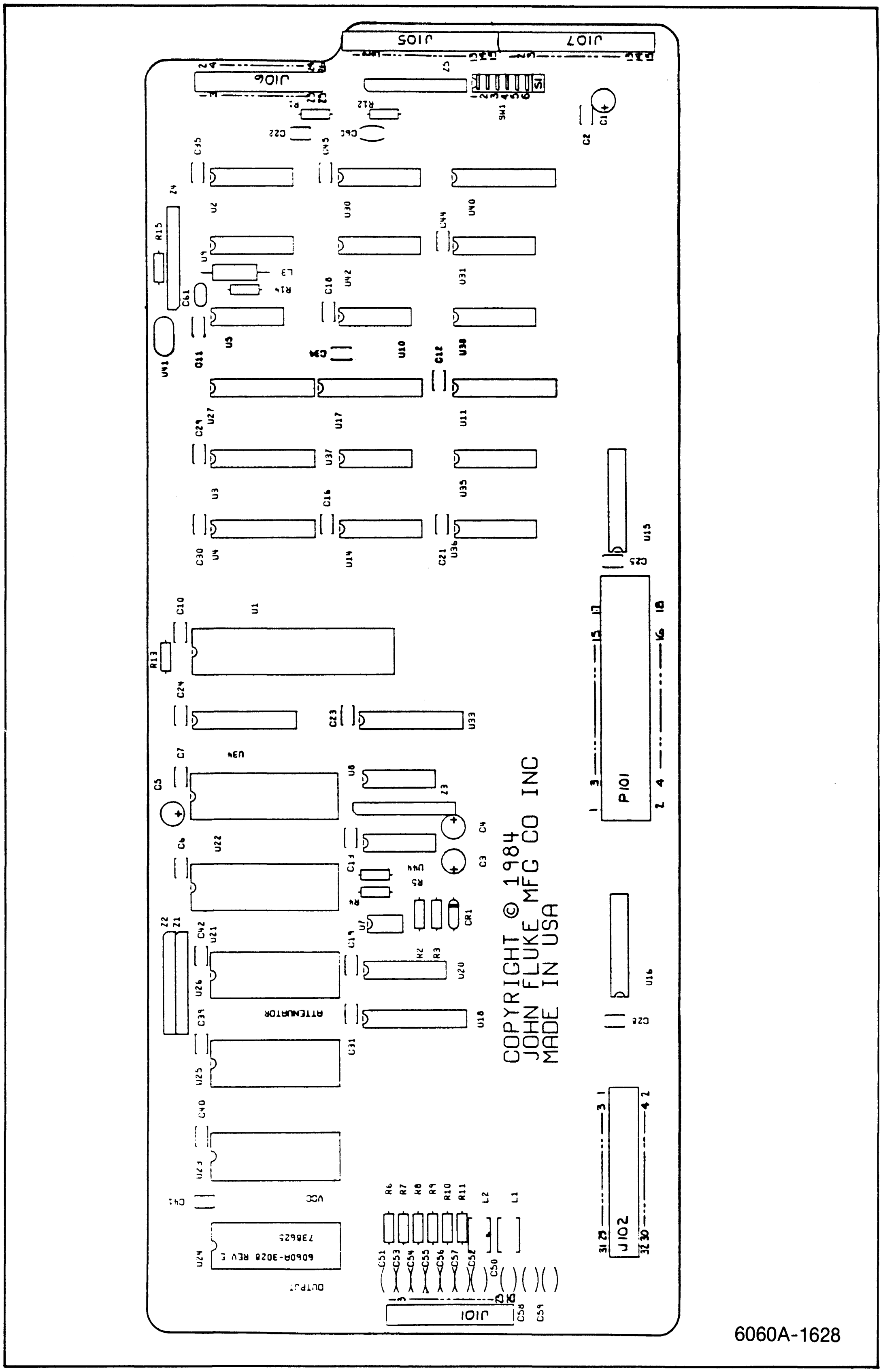
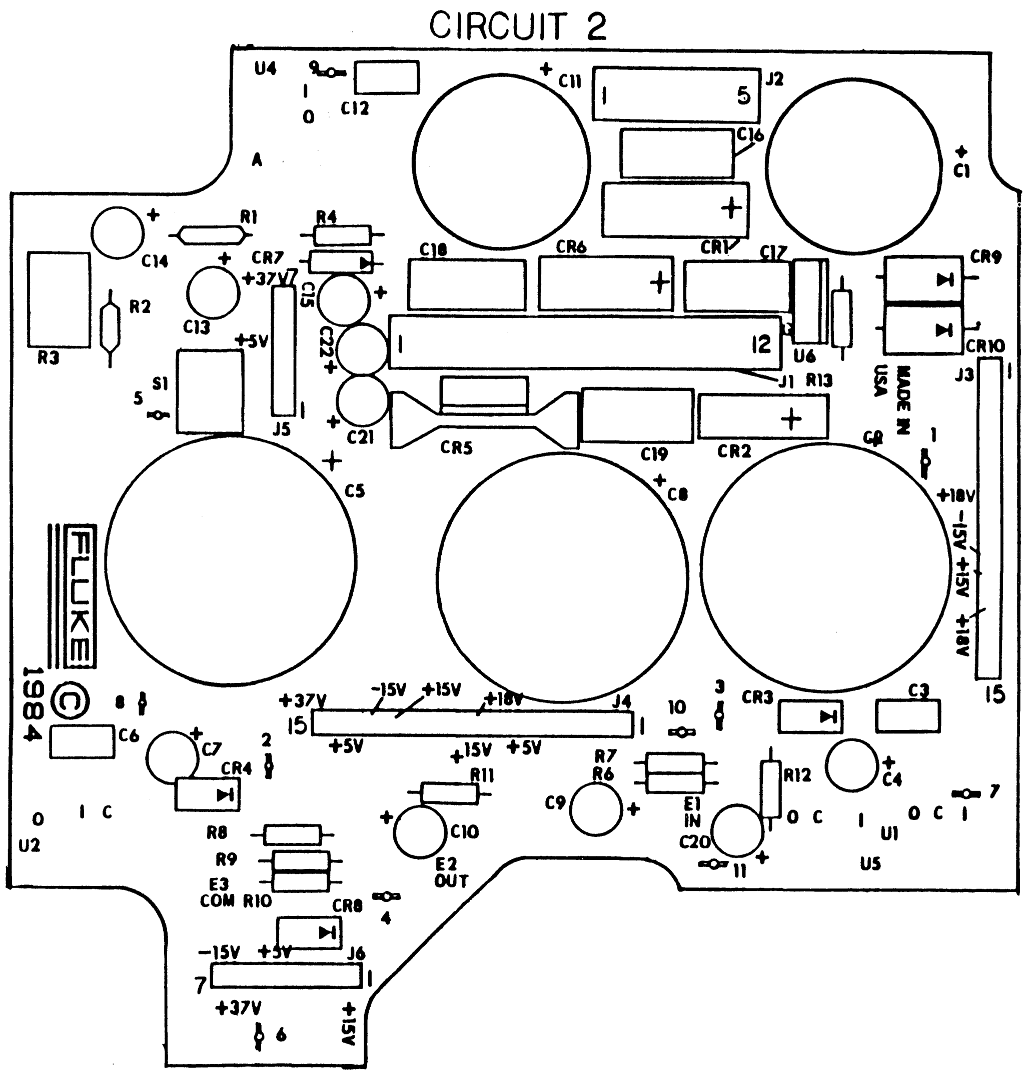



Figure 5-11. A2A7 Controller PCA

TABLE 5-13. A3A1 POWER SUPPLY PCA
(SEE FIGURE 5-12.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1 | | CAP,AL,2200UF,+30-10%,35V | 715334 | 89536 | 715334 | 1 | | |
| C 2, 5 | | CAP,AL,10000UF,+30-20%,35V | 614990 | 89536 | 614990 | 2 | | |
| C 3, 6, 12 | | CAP,CER,0.1UF,+-20%,50V,X7R | 573808 | 72892 | 8131-050-W5R100NFM | 3 | | |
| C 4, 7, 15, | | CAP,TA,6.8UF,+-20%,35V | 363713 | 56289 | 196D685X0035KA1 | 4 | | |
| C 20 | | | 363713 | | | | | |
| C 8 | | CAP,AL,15000UF,+30-10%,25V | 732958 | 89536 | 732958 | 1 | | |
| C 9, 21, 22 | | CAP,TA,2.2UF,+-20%,20V | 161927 | 56289 | 196D225X0020HA1 | 3 | | |
| C 10 | | CAP,TA,22UF,+-20%,15V | 423012 | 56289 | 196D226X0015KA1 | 1 | | |
| C 11 | | CAP,AL,470UF,+30-20%,80V | 574160 | 62643 | NM | 1 | | |
| C 13, 14 | | CAP,TA,4.7UF,+-20%,50V | 363721 | 56289 | 196D475X9015HA1 | 2 | | |
| C 16- 19 | | CAP,POLYES,0.22UF,+-10%,100V | 436113 | 73445 | C280MAH1A220K | 4 | 1 | |
| CR 1, 2, 6 | * | DIODE,SI,RECT,BRIDGE,BV=200V,IO=1.0A | 296509 | 09423 | FB200 | 3 | 1 | |
| CR 3, 4, 8 | * | DIODE,SI, 100 PIV, 1.0 AMP | 343491 | 01295 | 1N4002 | 3 | | |
| CR 5 | | DIODE,SI,45PIV,7.5A,DUAL SCHOTTKY | 741322 | 89536 | 741322 | 1 | 1 | |
| CR 6 | * | THYRISTOR,SI,TRIAC,VBO=200V,8.0A | 413013 | 02735 | T2800B | 1 | | |
| CR 9, 10 | * | ZENER,UNCOMP, 62.0V, 5%, 20MA, 5.0W | 559567 | 89536 | 559567 | 2 | 1 | |
| H 1 | | SCREW,MACH,PHP SEMS,STL,4-40X1/4 | 185918 | 89536 | 185918 | 1 | | |
| H 2 | | NUT,MACH,HEX,STL,4-40 | 110635 | 89536 | 110635 | 1 | | |
| J 1 | | CONN,PWB,HEADER,SIP,0.156,12 PIN | 512160 | 27264 | 09-80-1123 | 1 | | |
| J 2 | | CONN,PWB,HEADER,SIP,0.156,5 PIN | 512186 | 27264 | 09-80-1053 | 1 | 1 | |
| J 3- 6 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 39 | | |
| MP 1 | | HEATSINK, TO-220 | 524934 | 13103 | 6025B-TT | 1 | | |
| R 1 | | RES,MF,249,+-1%,0.125W,100PPM | 168203 | 91637 | CMF55249F | 1 | | |
| R 2 | | RES,MF,6.65K,+-1%,0.125W,100PPM | 294918 | 91637 | CMF551272F | 1 | | |
| R 3 | | RES,VAR,CERM,1K,+-10%,0.5W | 285155 | 71450 | 360S102A | 1 | | |
| R 4 | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 1 | | |
| R 6- 9 | | RES,CF,5.1,+-5%,0.25W | 441287 | 80031 | CR251-4-5P5R1 | 4 | | |
| R 10, 13 | | RES,CF,220,+-5%,0.25W | 342626 | 80031 | CR251-4-5P220E | 2 | | |
| R 11 | | RES,CF,1,+-5%,0.25W | 357665 | 80031 | CR251-4-5P1E | 1 | | |
| R 12 | | RES,CF,0.51,+-5%,0.25W | 381954 | 80031 | CR251-4-5P0R5E | 1 | | |
| S 1 | | SLIDE SWITCH,DPDT SWIDGET JR. | 452862 | 89536 | 452862 | 1 | 1 | |
| TP 1- 11 | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 11 | | |
| VR 7 | * | ZENER,UNCOMP, 6.2V, 5%, 20.0MA. 0.4W | 325811 | 07910 | 1N753A | 1 | 1 | |

U1,2,4,5 LISTED IN TABLE 5-4 (A3).




6060A-1631

**Figure 5-12. A3A1 Power Supply PCA**

# Section 6
# Options


| OPTION NO. | TITLE | PAGE |
|---|---|---|
| -130 | High-Stability Reference | 130-1 |
| -131 | Sub-Harmonic Reference | 131-1 |
| -488 | IEEE-488 Interface | 488-1 |
| -570 | Non-Volatile | 570-1 |
| -651 | Low-Rate Fm | 651-1 |
| -830 | Rear Panel RF Output and Mod Input | 830-1 |
| -870 | Attenuator/RPP (Reverse Power Protector) | 870-1 |

## 6-1. INTRODUCTION

This section includes the theory of operation, a circuit description, and maintenance instructions for each option. The IEEE-488 Interface and the Non-Volatile Memory options theory of operation is covered in Section 2.

# Option -130
# High-Stability Reference

## 130-1. INTRODUCTION

Option -130 the High-Stability Reference, with the rear panel REF INT/EXT switch set to INT, configures the Generator's reference to be supplied by the High-Stability Reference.

## 130-2. OPERATION

The High-Stability Reference consists of the Auxiliary Power Supply (A3A2), and an Ovened Oscillator (Y1). The Auxiliary Power Supply is mounted inside the Generator on the rear panel, and the Ovened Oscillator is mounted inside the instrument on the side rail. Only the Auxiliary Power Supply is field repairable, and it is described here. The Auxiliary Power Supply is also available under the Module Exchange program.

## 130-3. CIRCUIT DESCRIPTION

The Auxiliary Power Supply is connected directly to the line power on the fuse/filter/line-voltage selector assembly to supply power to the Ovened Oscillator even when the Generator POWER switch is off. The Auxiliary Power Supply PCB (A3A2A1) includes a linear-regulated supply and an automatic line-voltage selector circuit.

The linear-regulated supply consists of a diode rectifier bridge CR1, filter capacitor C1, voltage regulator U1, and associated resistors R2, R3, and R4. The circuit associated with CR3, Q1 and U2, provides automatic line voltage selection between two line-voltage ranges. This is implemented by configuring the rectifier circuit as a bridge rectifier for the lower line voltages or as a center-tapped, full-wave rectifier for the higher line voltages.

At low line voltages (less than approximately 150V ac), transistor Q1 is conducting, thus grounding the minus terminal of rectifier CR1 and causing diode CR3 to be reverse biased. This causes the full secondary voltage of T1 to be rectified by the bridge rectifier, CR1.

When the line voltage is greater than 180V ac, (there is approximately 30V hysteresis), the comparator U2 turns off transistor Q1. Diode CR3 becomes forward biased, and the transformer center tap is effectively grounded. The voltage applied to the rectifier CR1 is then half the secondary voltage.

The comparator U2 input voltages are set by resistors R1, R6, R9, and zener diode CR4. U2 controls the base of transistor Q1. The comparator switching point is set between the low and high line voltages, with sufficient hysteresis to accommodate variations in input loading. At very low line voltages, the resistor diode combination R10 and CR5, from the 37V output of the main power supply, augment the Auxiliary Power Supply.

The Ovened Oscillator output is disabled when the control line EXREFL is set low, i.e., when the REF INT/EXT switch is set to EXT during external reference operation. The status line HSOPTL, normally at +5V, is pulled to ground when the High-Stability Reference option is installed.

## 130-4. ADJUSTMENTS

TEST EQUIPMENT

Frequency Standard
Oscilloscope
Two 3-ft. 50-Ohm coaxial cables, Y9111

REMARKS

The generator may be equipped with either the High-Stability Reference option or the Sub-Harmonic Reference option, or both. The instrument reference may be the 10-MHz crystal oscillator, the High-Stability Reference, or an external signal. If the Sub-Harmonic Reference option is present, and the rear panel REF switch is set to EXT, the 10-MHz crystal oscillator is phase-locked to the applied external signal.

The voltage adjustment (A3A2A1-R4) should be made after the first half hour of the three-hour Generator warmup period has begun. For the best results in the frequency accuracy adjustment, the Generator should be operated at room temperature for at least three hours before continuing with the adjustment procedures.

PROCEDURE

The High-Stability Reference Power supply voltage is first adjusted. Then the UUT reference and the Frequency Standard waveforms are viewed on the oscilloscope while triggering on the Frequency Standard. The ovened oscillator FREQ ADJ, COARSE, and then FINE are adjusted for a stationary display.

Voltage Adjustment

1. Remove the Generator top cover.
2. Connect the DMM to the UUT. Connect the positive lead to TP1 and the negative lead to TP3.
3. Adjust R4 for 23.4 ± 0.1V.
4. Remove the DMM connections from the UUT and replace the top cover (temporarily). Wait the remaining Generator warmup time, and perform the frequency accuracy adjustment.

Frequency Adjustment

1. Remove the top Generator cover and the two FREQ ADJ access screws from the top of the ovened oscillator.
2. Connect the Frequency Standard signal to the oscilloscope vertical input channel 1, 50 Ohms termination. Connect the UUT rear panel 10 MHz IN/OUT to the oscilloscope vertical input channel 2, 50 Ohms termination.
3. Set the UUT rear panel UUT REF INT/EXT switch to INT.

4. Set the vertical controls of the oscilloscope to display the UUT 10-MHz signal and the Frequency Standard 10-MHz signal. Set for internal triggering on channel 1, and adjust timebase for 0.1 $\mu$sec/div.

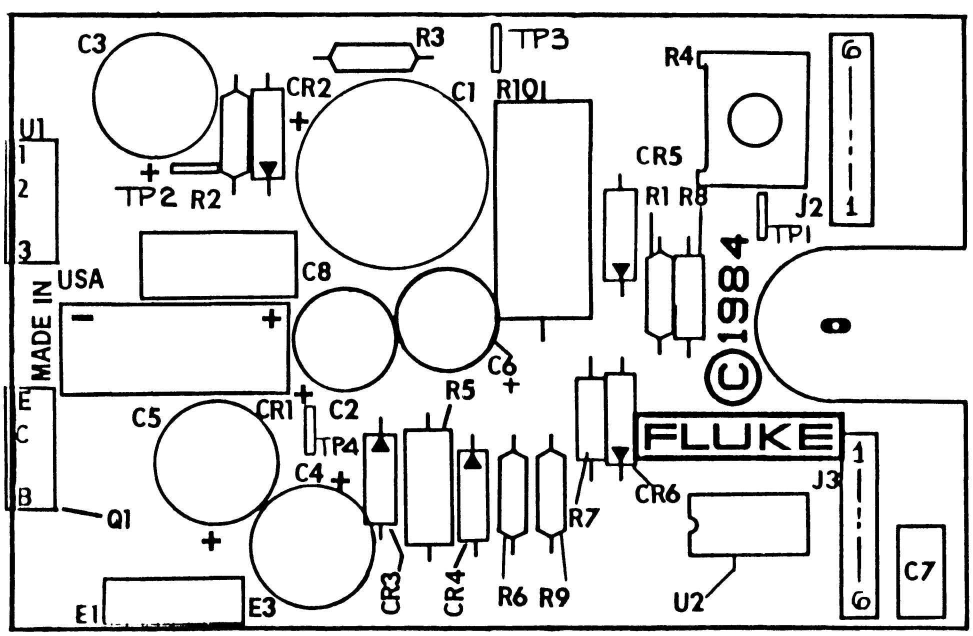
5. Adjust the oscilloscope COARSE, and then adjust the FINE controls for a drift of less than one cycle in 10 seconds (for 0.01 ppm or better if desired.

## 130-5. LIST OF REPLACEABLE PARTS

Table 130-1 lists replaceable parts for the 6060A-130. Figure 130-1 is the component location diagrams for the 6060-130.

TABLE 130-1. A3A2A1 HIGH-STABILITY (OVENED) REFERENCE PCA
(SEE FIGURE 130-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1 | | CAP,AL,470UF,+50-20%,50V | 478792 | 89536 | 478792 | 1 | | |
| C 2, 6 | | CAP,TA,4.7UF,+-20%,50V | 363721 | 56289 | 196D475X9015HA1 | 2 | | |
| C 3, 4 | | CAP,TA,10UF,+-20%,35V | 417683 | 56289 | 196D106X0035KA1 | 2 | | |
| C 5 | | CAP,AL,100UF,+50-20%,50V | 649731 | 89536 | 649731 | 1 | | |
| C 7 | | CAP,POLYES,0.1UF,+-10%,50V | 696484 | 89536 | 696484 | 1 | | |
| C 8 | | CAP,POLYES,0.1UF,+-10%,100V | 393439 | 80031 | 719A1 | 1 | | |
| CR 1 | * | DIODE,SI,RECT,BRIDGE,BV=200V,IO=1.0A | 296509 | 09423 | FB200 | 1 | 1 | |
| CR 2, 3, 5 | * | DIODE,SI, 100 PIV, 1.0 AMP | 343491 | 01295 | 1N4002 | 3 | 1 | |
| CR 6 | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 1 | 1 | |
| J 2, 3 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 10 | | |
| R 1 | | RES,MF,49.9K,+-1%,0.125W,100PPM | 268821 | 91637 | CMF554992F | 1 | | |
| R 2 | | RES,MF,249,+-1%,0.125W,100PPM | 168203 | 91637 | CMF55249F | 1 | | |
| R 3 | | RES,MF,4.02K,+-1%,0.125W,100PPM | 235325 | 91637 | CMF554021F | 1 | | |
| R 4 | | RES,VAR,CERM,500,+-10%,0.5W | 325613 | 89536 | 325613 | 1 | 1 | |
| R 5 | | RES,CC,2.7,+-5%,0.5W | 218743 | 89536 | 218743 | 1 | | |
| R 6, 9 | | RES,MF,6.34K,+-1%,0.125W,100PPM | 267344 | 91637 | CMF556341F | 2 | | |
| R 7 | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 1 | | |
| R 8 | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 1 | | |
| R 10 | | RES,CC,100,+-10%,2W | 109934 | 01121 | HB1011 | 1 | | |
| TP 1- 4 | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 4 | | |
| U 2 | * | IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP | 478354 | 12040 | LM393N | 1 | | |
| VR 4 | * | ZENER,UNCOMP, 6.2, 2%, 20.0MA, 0.4W | 325803 | 89536 | 325803 | 1 | 1 | |




6060A-1632

**Figure 130-1. A3A2A1 High Stability (Ovened) Reference PCA**

# Option -131
# Sub-Harmonic Reference

## 131-1. INTRODUCTION
The Sub-Harmonic Reference (Option -131), allows an external signal of any sub-harmonic of 10 MHz above 1 MHz (generally 1, 2, 2.5, 5 or 10 MHz) to be used as the Signal Generator frequency reference. The signal can be any sine or square wave between 0.3 to 4.0V p-p into 50-ohms termination.

To operate the Generator on an external reference, connect the external reference signal to the rear panel REF IN connector, and set REF INT/EXT switch to EXT. The instrument reference signal (10-MHz TTL) is available at the 10 MHz OUT connector.

**CAUTION**

**When operating the Generator on the internal reference (REF INT/EXT switch set to INT), remove any signal applied to the REF IN connector to prevent reference frequency instability due to interaction (pulling) of the two signals.**

**With the REF IN/EXT switch set to EXT, and with no external reference signal applied to the REF IN connector, the Generator output frequency has a significant error from the programmed frequency because the internal oscillator is unlocked. There is no annunciation of this abnormal operating condition.**

## 131-2. OPERATION
The Sub-Harmonic Reference option operates in conjunction with the 10-MHz crystal oscillator on the Synthesizer PCA (A2A1) to form a sampling phase-locked loop. It basically consists of an ac-to-TTL converter, a sub-harmonic phase detector, an analog control switch, and an out-of-lock detector. When this option is installed, the Synthesizer PCA is modified by adding a frequency control input to the 10-MHz crystal oscillator. Also, a BNC connector labeled REF IN is added to the rear panel of the Generator with a cable assembly connected to the Synthesizer PCA.

The existing 10 MHz IN/OUT connector is relabeled 10 MHz OUT. The option switch on the Controller PCA is set to signal the Controller that the Sub- Harmonic Reference option is installed. The Sub-Harmonic Reference option assembly sits on top of the Synthesizer PCA in the Synthesizer compartment (top side) of the module plate (A2).

## 131-3. CIRCUIT DESCRIPTION
Comparator U1 forms an ac-to-TTL converter. Diodes CR1 and CR2 precondition the REF IN signal to protect the comparator. Resistors R2, R3, R5, and R7 provide hysteresis, preventing oscillation when there is no input.

MOS switch U3 connects the control voltage of the 10-MHz crystal oscillator to a fixed bias network R22 and R23 when the REF IN/OUT switch is set to INT, or to the loop amplifier when the switch is set to EXT, thus closing a phase-locked loop.

The phase detector and loop amplifier are made up of U4, Q1, Q2, Q3, and U5. The signal from the external reference input through the ac-to-TTL converter is applied to the flip-flop clock input, U4-3. The 10-MHz signal at J1-5 from the crystal oscillator goes to the other flip-flop clock input, U4-11. The flip-flops are connected, so the width of the pulse that switches Q2 is the difference in time of these two signals (U4-3, and U4-11). The phase-detector operating point is set by R12 and R13.

The U5 op-amp operates as an integrating loop amplifier providing a loop gain bandwidth of about 300 Hz. A current source Q3, R16, and storage-multiplier network, C5 and R15, maintain constant phase detector gain and constant loop bandwidth for all sub-harmonic input references.

The output of the loop amplifier is applied as the control signal SHTUNE to the frequency control input of the 10-MHz crystal oscillator on the Synthesizer PCA A2A1 through the control switch U3 and connector J1-7. The control switch U3 is controlled by the Generator Controller through the control line SHENL at J1-3. This line is enabled when the rear panel REF IN/EXT switch is set to EXT.

An out-of-lock detector is formed with flip-flop U2 and one-shot U7. The out-of-lock detector provides a status output to the Controller that indicates the 10-MHz oscillator is not locked to the external reference signal. An out-of-lock condition causes the flip-flop output to toggle and triggers the one-shot to act as a pulse stretcher.

The output of the one-shot is an active-low signal and is combined through diode CR3 with other signals on the Synthesizer assembly to form the UNLOK status signal.

### 131-4. ADJUSTMENT

If the Generator has the Sub-Harmonic Reference option but not the High-Stability Reference option, use the Reference Frequency Adjustment procedure in Section 4C under Synthesizer Assembly Adjustments.

If the generator has both the Sub-Harmonic and the High-Stability Reference options, use the following adjustment procedure.

TEST EQUIPMENT

Frequency Standard
Low Frequency Synthesized Signal Generator (LFSSG)
Oscilloscope
BNC Tee

REMARKS

The UUT reference output and the LFSSG signal are viewed simultaneously on the oscilloscope for frequencies near the limit of the lock-in range. The 10-MHz crystal oscillator is adjusted for a stable display on the oscilloscope at both upper and lower limits. The external reference input level to the Generator is reduced to determine sensitivity.

PROCEDURE

1. Remove the top Generator cover and the 10-MHz adjustment access screw from the the module plate. (See Figure 4C-3 C153 for 10-MHz adjustment location.)

2. Connect the frequency standard to the reference input of the LFSSG.

3. Connect the LFSSG output to the oscilloscope vertical input channel 1 using a BNC tee, and then connect the cable to the UUT 10 MHz IN using a cable less than three feet in length.

4. Connect the UUT rear panel 10 MHz OUT to oscilloscope vertical input channel 2.

5. Program the LFSSG to 10 MHz and 0 dBm.

6. Set the UUT rear panel REF INT/EXT switch to EXT.

7. Set the vertical controls of the oscilloscope to display both the LFSSG output and the UUT 10-MHz signal. Set the triggering to channel 1, and adjust the timebase for 0.1 $\mu$s/div.

8. Edit the LFSSG to 80 Hz above 10 MHz (10.00008 MHz).

9. If the signals are unlocked, adjust C153 for a locked condition. Verify the UNCAL indicator is not lit.

10. Adjust C153 clockwise until the two waveforms are not synchronized (break lock). Verify the UNCAL indicator is flashing. Turn C153 counterclockwise to the first stable, locked point. Note the adjustment position of C153.

11. Edit the LFSSG to 80 Hz below 10 MHz (9.99992 MHz).

12. Adjust C153 counterclockwise to an unlock condition. Turn C153 clockwise to the first stable, locked point. Finally, turn C153 midway between this point and the locked point noted in step 10.

13. Program the LFSSG to 10 MHz.

14. Reduce the level of LFSSG until the signals displayed on the oscilloscope indicate an unlock condition.

15. Increase the LFSSG level until the oscilloscope display first indicates the locked-point. Verify that this level is greater than 300 mV peak-to-peak as measured with the oscilloscope.

### 131-5. LIST OF REPLACEABLE PARTS

Table 131-1 lists replaceable parts for the 6060A-131. Figure 131-1 is the component location diagrams for the 6060A-131.

TABLE 131-1. A2A3 SUB-HARMONIC REFERENCE PCA
(SEE FIGURE 131-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1, 11, 12, | | CAP,POLYES,0.1UF,+-10%,50V | 696484 | 89536 | 696484 | 4 | | |
| C 14 | | | 696484 | | | | | |
| C 2- 5, 7, | | CAP,TA,10UF,+-20%,20V | 330662 | 56289 | 196D106X0020KA1 | 7 | | |
| C 9, 10 | | | 330662 | | | | | |
| C 6 | | CAP,CER,4700PF,+-20%,100V,X7R | 362871 | 72982 | 8121-A100-W5R-472M | 1 | | |
| C 8 | | CAP,POLYES,0.022UF,+-10%,50V | 715268 | 89536 | 715268 | 1 | | |
| C 15 | | CAP,CER,56PF,+-2%,100V,C0G | 512970 | 51406 | RPE121 | 1 | | |
| C 16 | | CAP,TA,22UF,+-20%,15V | 423012 | 56289 | 196D226X0015KA1 | 1 | | |
| CR 1, 2 | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 2 | 1 | |
| CR 3 | * | DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNL | 313247 | 28484 | HP5082-6264 | 1 | 1 | |
| J 1 | | CONN,POST,PWB,.025SQ,NON-INSUL,GOLD30 | 277418 | 89536 | 277418 | 7 | | |
| J 2 | | CONN,COAX,SMB,REC,PWB | 512095 | 16733 | 702033 | 1 | | |
| Q 1- 3 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 218081 | 04714 | MPS6520 | 3 | 1 | |
| R 1 | | RES,CF,68,+-5%,0.25W | 414532 | 80031 | CR251-4-5P68E | 1 | | |
| R 2, 15 | | RES,CC,270,+-5%,0.125W | 512764 | 01121 | BB2715 | 2 | | |
| R 3, 7, 18, | | RES,CC,10K,+-5%,0.125W | 643940 | 01121 | BB1035 | 5 | | |
| R 19, 22 | | | 643940 | | | | | |
| R 4 | | RES,CF,1.2K,+-5%,0.25W | 441378 | 80031 | CR251-4-5P1K2 | 1 | 1 | |
| R 5 | | RES,CC,330,+-5%,0.125W | 643965 | 01121 | BB3315 | 1 | | |
| R 6, 11 | | RES,CC,1K,+-5%,0.125W | 643932 | 01121 | BB1025 | 2 | | |
| R 8 | | RES,CF,470,+-5%,0.25W | 343434 | 80031 | CR251-4-5P470E | 1 | | |
| R 12 | | RES,MF,15K,+-1%,0.125W,100PPM | 285296 | 91637 | CMF551502F | 1 | | |
| R 13 | | RES,MF,6.04K,+-1%,0.125W,100PPM | 285189 | 91637 | CMF556041F | 1 | | |
| R 14, 17 | | RES,CC,47,+-5%,0.125W | 512061 | 01121 | BB4705 | 2 | | |
| R 16 | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 1 | | |
| R 20 | | RES,MF,100K,+-1%,0.125W,100PPM | 248807 | 91637 | CMF551003F | 1 | | |
| R 21 | | RES,CF,56,+-5%,0.25W | 342618 | 80031 | CR251-4-5P56E | 1 | | |
| R 23 | | RES,CF,5.6K,+-5%,0.25W | 442350 | 80031 | CR251-4-5P5K6 | 1 | | |
| R 25 | | RES,CF,390,+-5%,0.25W | 441543 | 80031 | CR251-4-5P390E | 1 | | |
| R 26 | | RES,CF,33K,+-5%,0.25W | 348888 | 80031 | CR251-4-5P33K | 1 | | |
| TP 1- 4 | | TURRET,MINI HOLLOW LUG #2010B-1 | 179283 | 88245 | 2010B-5 | 4 | | |
| U 1 | * | IC,COMPARATOR,HI-SPEED,14 PIN DIP | 386920 | 18324 | NE529A | 1 | 1 | |
| U 2, 4 | * | IC,STTL,DUAL D F/F,+EDG TRG,W/SET&CLR | 418269 | 01295 | SN74S74N | 2 | 1 | |
| U 3 | * | IC,CMOS, SPDT ANALOG SWITCH | 723742 | 89536 | 723742 | 1 | 1 | |
| U 5 | * | IC,OP AMP,JFET INPUT,8 PIN DIP | 472779 | 12040 | LF386N | 1 | 1 | |
| U 7 | * | IC,TTL,RTRGRBLE MONOSTABLE MULTIVBRTR | 293134 | 04713 | MC8601P | 1 | | |

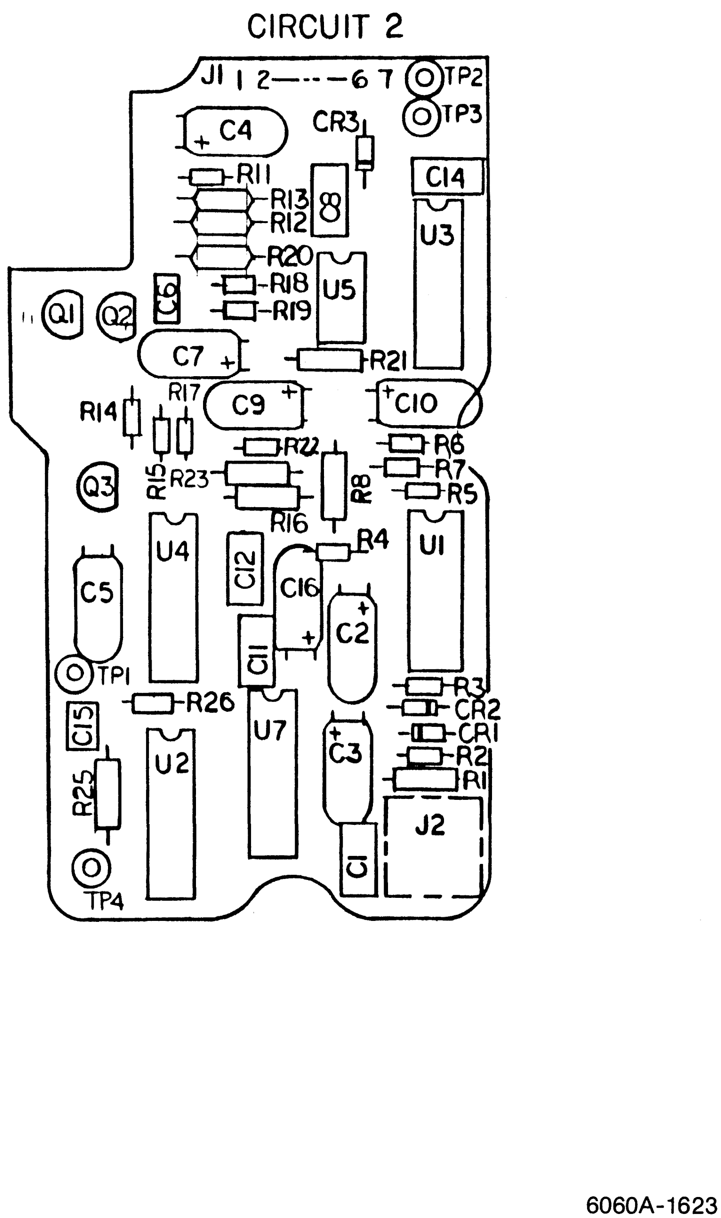



**Figure 131-1. A2A3 Sub-Harmonic Reference PCA**

# Option -488
# IEEE-488 Interface

## 488-1. INTRODUCTION

The IEEE-488 Interface (Option -488), consists of the IEEE-488 printed circuit assembly (A3A3A1) mounted in a metal frame on the Generator rear panel. It is interfaced directly with the Controller assembly A2A7.

## 488-2. OPERATION

The operation of this option is covered in Section 2 of this manual.

## 488-3. CIRCUIT DESCRIPTION

The IEEE-488 Interface uses an 8291A Talker/Listener IC (U1) to handle all IEEE-488 standard communications protocol. All data, address, and control lines to the 8291A are buffered on the Controller. Two MC3447 bus drivers (U3 and U4) interface the 8291A directly to the IEEE-488 bus.

The presence of the optional IEEE-488 Interface is detected by the microprocessor when the option is plugged into the Controller board. The signal IEINL, normally at +5V, is pulled to circuit ground when the option is installed.

### 488-4. Address Switches

Tri-state buffer U6 provides the status of the IEEE-488 rear panel address switches when the Generator is interrogated. These switches determine the IEEE-488 bus address and talk-only (to) or listen-only (lo) modes. When opened, the switch just to the left of the IEEE-488 bus connector disconnects the bus shield ground from the system ground.

## 488-5. MAINTENANCE

This option does not change the performance test or calibration adjustments of the Generator. Troubleshooting information for this option is in Section 4D under Digital and Control troubleshooting.

## 488-6. LIST OF REPLACEABLE PARTS

Table 488-1 lists replaceable parts for the 6060A-488. Figure 488-1 is the component location diagrams for the 6060A-488.

TABLE 488-1. A3A3A1 IEEE-488 INTERFACE PCA
(SEE FIGURE 488-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ---DESCRIPTION--- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1- 4, 6, | | CAP,POLYES,0.22UF,+-10%,50V | 696492 | 89536 | 696492 | 9 | | |
| C 7, 9- 11 | | | 696492 | | | | | |
| J 1 | | CONN,PWB,RIBBON,90,24 POS,STD ORIENT | 658039 | 89536 | 658039 | 1 | | |
| L 1- 3 | | CHOKE,6TURN | 320911 | 89536 | 320911 | 3 | | |
| P 1 | | CONN,PWB,SCKT,HOUSING,DIP,26 | 543512 | 00779 | 86063-9 | 1 | | |
| R 1 | | RES,CF,1K,+-5%,0.25W | 343426 | 80031 | CR251-4-5P1K | 1 | | |
| S 1 | | PIANO MULTI-POLE, ST, SIDE ACTUATED | 658567 | 89536 | 658567 | 1 | | |
| U 1 | * | IC,NMOS,GPIB TALKER/LISTENER | 586909 | 34649 | P8291A | 1 | 1 | |
| U 3, 4 | * | IC,LSTTL,OCTL IEEE-488 BUS TRANSCVR | 524835 | 04713 | MC3447P | 2 | | |
| U 6 | * | IC,LSTTL,OCTAL D TRANSPARENT LATCHES | 504514 | 01295 | SN74LS373N | 1 | 1 | |
| U 7 | * | IC,LSTTL,OCTL BUS TRNSCVR W/3-ST OUT | 477406 | 01295 | SN74LS245N | 1 | 1 | |
| U 8 | * | IC,TTL,QUAD 2 INPUT AND GATE | 393066 | 01295 | SN74LS08N | 1 | | |
| XU 1 | | SOCKET,DIP,0.100 CTR,40 PIN | 429282 | 09922 | DILB40P-108 | 1 | | |
| XU 3, 4 | | SOCKET,DIP,0.100 CTR,16 PIN | 276535 | 91506 | 316-AG39D | 2 | | |
| XU 3, 4 | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 2 | | |
| XU 6, 7 | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 2 | | |
| XU 8 | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 1 | | |
| Z 1- 4 | | RES,NET,SIP,10 PIN,9 RES,10K,+-2% | 414003 | 80031 | 95081002CL | 4 | 1 | |

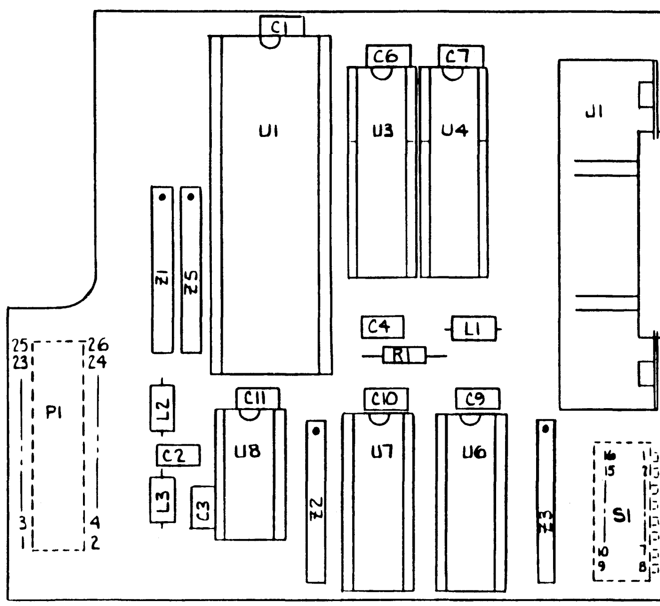



**Figure 488-1. A3A3A1 IEEE-488 Interface PCA**

# Option -570
# Non-Volatile Memory

## 570-1. INTRODUCTION

The A2A8 Non-Volatile Memory (Option -570) stores 50 front panel states. These states are retained when the main power is disconnected from the Generator. A 2K-byte CMOS RAM (U1) stores the front panel states, and a lithium battery (B1) provides the Non-Volatile Memory with backup power when the generator is disconnected from the main power. The battery provides power for memory retention for more than two years with no main power applied.

## 570-2. OPERATION

Operation of the Non-Volatile Memory option is covered in Section 2 of this manual.

## 570-3. CIRCUIT DESCRIPTION

The circuit is functionally divided into a power circuit and a memory control.

### 570-4. Power Circuit

There are two sources of power for the Non-Volatile Memory RAM IC. These are the battery and the regulated +5V Signal Generator supply. Diodes CR1 and CR2 form a basic diode switching circuit that allows the power source with the higher voltage to provide current to the CMOS RAM and isolate the other power source.

Q1 and Q4 are turned on by Q2 and Q3 when the +5V supply is above the threshold voltage set by VR1, R2, and R3. Q1 has a low collector saturation voltage. When it is turned on, the supply voltage to the CMOS RAM is very close to +5V. The output of Q4 is the power valid signal. The CMOS RAM cannot be accessed until the output of Q4 goes high.

### 570-5. Memory Control

All address, data, and control lines to the CMOS RAM are buffered. The enable signals WEL, DBINL, and the CMOS RAM are buffered with open-collector gates. These signals are held at the same potential as the CMOS RAM supply when the +5V supply goes down, ensuring the CMOS RAM draws the minimum standby current.

The presence of the Non-Volatile Memory is detected by the microprocessor when the option is plugged into the Controller board. The signal NVMENL, normally at +5V, is pulled to ground when the option is installed.

## 570-6. MAINTENANCE

This option does not change the performance test or calibration of the Generator. Troubleshooting information for this option is presented in Section 4D under the Digital and Control Troubleshooting.

## 570-7. LIST OF REPLACEABLE PARTS

Table 570-1 lists replaceable parts for the 6060A-570. Figure 570-1 is the component location diagrams for the 6060A-570.

TABLE 570-1. A2A8 NON-VOLATILE (STORE/RECALL) MEMORY PCA
(SEE FIGURE 570-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1 | | CAP,TA,10UF,+-20%,20V | 330662 | 56289 | 196D106X0020KA1 | 1 | | |
| C 2- 6 | | CAP,POLYES,0.22UF,+-10%,50V | 696492 | 89536 | 696492 | 5 | 1 | |
| CR 1, 2 | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 2 | | |
| CR 3 | * | ZENER,UNCOMP, 3.3V,10%, 20.0MA, 0.4W | 309799 | 04713 | 1N746 | 1 | 1 | |
| P 1 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 32 | | |
| Q 1 | * | TRANSISTOR,SI,PNP,SMALL SIG,SELECTED | 380394 | 89536 | 380394 | 1 | 1 | |
| Q 2, 3 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 218396 | 04713 | 2N3904 | 2 | 1 | |
| Q 4 | * | TRANSISTOR,SI,N-DMOS FET,TO-72 | 477729 | 18324 | SD213EE | 1 | 1 | |
| R 1 | | RES,MF,432,+-1%,0.125W,100PPM | 326397 | 91637 | CMF554320F | 1 | | |
| R 2 | | RES,MF,33.2,+-1%,0.125W,100PPM | 296681 | 91637 | CMF553320F | 1 | 1 | |
| R 3 | | RES,MF,100,+-1%,0.125W,100PPM | 168195 | 91637 | CMF551000F | 1 | | |
| R 4 | | RES,MF,562,+-1%,0.125W,100PPM | 340828 | 91637 | CMF555620F | 1 | | |
| R 5 | | RES,CF,100K,+-5%,0.25W | 348920 | 80031 | CR251-4-5P100K | 1 | | |
| R 6 | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 1 | | |
| TP 1, 2 | | CONN,TAB,FASTON,PRESS-IN,0.110 WIDE | 512889 | 02660 | 62395 | 2 | | |
| U 1 | * | IC, 2K X 8 STAT RAM | 647222 | 51157 | HM6116P-3 | 1 | | |
| U 2 | * | IC,LSTTL,OCTL BUS TRNSCVR W/3-ST OUT | 477406 | 01295 | SN74LS245N | 1 | 1 | |
| U 3 | * | IC,LSTTL,OCTL LINE DRVR W/3-STATE OUT | 429035 | 01295 | SN74LS244N | 1 | 1 | |
| U 4 | * | IC,LSTTL,QUAD BUS BFR W/3-STATE OUT | 472746 | 01295 | SN74LS125N | 1 | 1 | |
| U 5 | * | IC,TTL,TRIPLE 3 INPUT NAND GATE | 363465 | 01295 | SN7412N | 1 | 1 | |
| U 6 | * | IC,LSTTL,HEX INVERTER | 393058 | 01295 | SN74LS04N | 1 | 1 | |
| XU 1 | | SOCKET,DIP,0.100 CTR,24 PIN | 376236 | 91506 | 324-AG39D | 1 | | |
| XU 2, 3 | | SOCKET,DIP,0.100 CTR,20 PIN | 454421 | 09922 | DILB20P-108 | 2 | | |
| XU 4- 6 | | SOCKET,DIP,0.100 CTR,14 PIN | 276527 | 09922 | DILB8P-108 | 3 | | |
| Z 1 | | RES,NET,SIP,6 PIN,5 RES,10K,+-2% | 500876 | 80031 | 95081002CL | 1 | | |

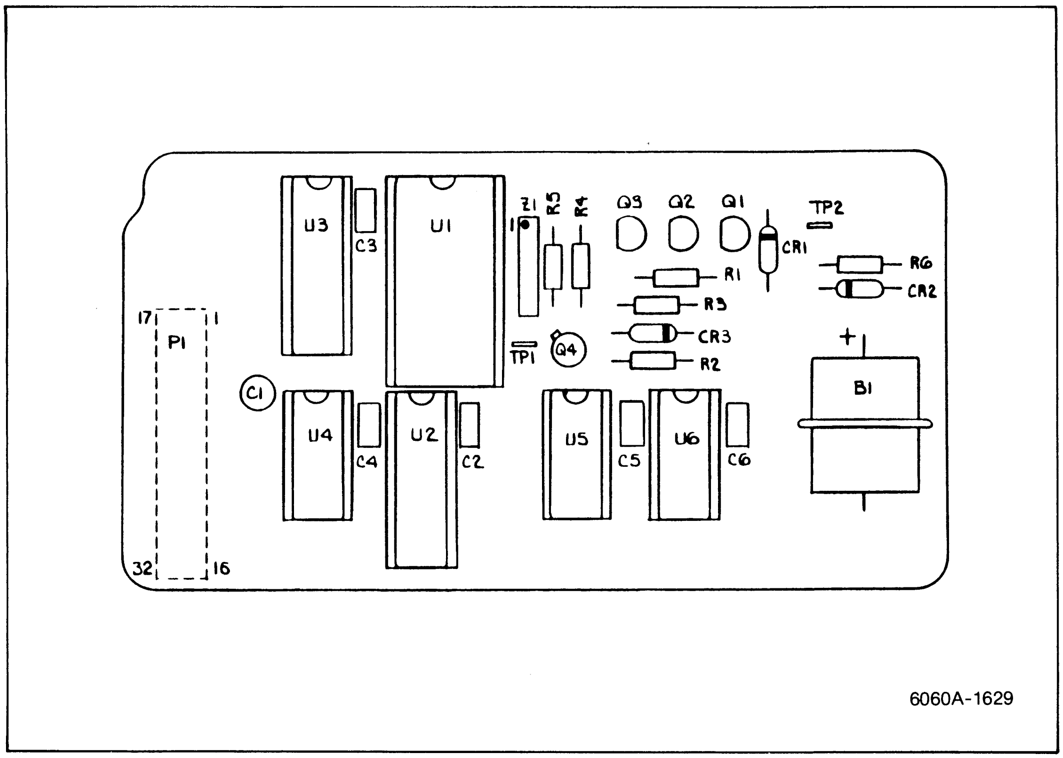



**Figure 570-1. A2A8 Non-Volatile (Store/Recall) Memory PCA**

# Option -651
# Low-Rate Fm

## 651-1. INTRODUCTION

The Low-Rate FM (Option -651), extends the FM 3-dB bandwidth to a lower frequency (approximately 0.5 Hz instead of 20 Hz). This option makes the Generator useful for testing FM radios that use sub-audio tones or low-rate digital techniques.

The option consists of a small printed circuit assembly A2A9 mounted atop the Synthesizer PCB. When installed, certain components are removed from the Synthesizer PCB, the option switch is set on the Controller, and a coupling capacitor is shorted on the Output PCB. A DIP switch on the Low-Rate FM PCB allows the Generator to be configured for Low-Rate FM or standard (normal) operation (except that the coupling capacitor on the Output PCB is shorted in both states). The DIP switch settings are listed in Table 651-1.

## 651-2. OPERATION

Operation of the Generator with the Low-Rate FM option is the same as operation of a standard instrument except that the maximum FM deviation is limited to 9.99 kHz.

## 651-3. CIRCUIT DESCRIPTION

The Low-Rate FM option allows frequency modulation at very low rates for use in digital modulation testing. In the low-rate mode, ac coupling capacitor A2A1 C16 is shorted to prevent any dc current from entering the loop amplifier (A2A1 U27) and changing the phase-detector operating point. The voltage at the output of the audio integrator (A2A1 U41-1) is kept at zero volts.

Keeping the voltage at the output of A2A1 U41 at zero volts is accomplished with a voltage-zeroing loop consisting of A2A9 U1. The positive terminal of this op-amp monitors the output voltage of the audio integrator through A2A9 R8. The negative terminal is connected to ground at A2A9 R9. By feeding current through A2A9 R7 back to the negative input of the audio integrator (A2A1 U41), its output voltage is kept at 0V. This is a lead-lag circuit with a low frequency break of approximately 0.3 Hz.

Potentiometer A2A9 R4 adjusts the compliance of the voltage-zeroing loop. Part of the active high-pass filter (A2A9 U41) is disabled by connecting the previous stage directly to A2A1 C114. Since the maximum deviation is limited to 9.99 kHz, the gain of the audio integrator and the VCO summing network (A2A1 R88, C117, C146) is decreased by a factor of ten. The Generator can be reconfigured back to the normal mode by programming the DIP switches on the option board (See Table 651-1).

## 651-4. PERFORMANCE TEST

The Generator is externally frequency modulated with a low-frequency square wave signal. The droop of the demodulated signal is measured using a spectrum analyzer as an FM demodulator (slope detection is used).

REQUIREMENT

FM Droop is less than 15% with 10 Hz external square wave modulation.

REMARKS

When using the RF Spectrum Analyzer as an FM demodulator using slope detection, it is important to operate the RF Spectrum Analyzer detector in a linear range. This can be checked by stepping the UUT frequency up 5 kHz and then down 5 kHz from the operating point and noting that the display moves equal amounts. If it doesn't, tune the RF Spectrum Analyzer slightly and check for linearity again.

TEST EQUIPMENT

Low-Frequency Synthesized Signal Generator (LFSSG)
RF Spectrum Analyzer

PROCEDURE

1. Remove the Generator top and the Synthesizer module plate covers.

2. Connect the LFSSG TTL output through a 604-ohm resistor and a 320 uF, 6V capacitor to the UUT MOD INPUT. This provides a square wave approximately 2V p-p at the Generator's MOD input.

3. Program the LFSSG to 10 Hz and any level around 1V.

4. Program the UUT to the [RCL] [9][8] and 3-kHz deviation. This provides a 300-MHz signal at -10 dBm.

5. Connect the input of the RF Spectrum Analyzer to the UUT RF OUTPUT. Set the RF Spectrum Analyzer so that the signal response is at the top of the display using linear detection.

6. Program UUT for EXT FM.

7. Using a 10-kHz Resolution Bandwidth and zero Span/Div, adjust either the Generator frequency or the RF Spectrum Analyzer tuning for slope detection to obtain a square-wave display. Adjust Time/Div and Trigger as necessary to obtain a stable square-wave display.

8. Verify that the droop of the demodulated FM is less than 15%. For example, if the displayed square-wave amplitude (vertical edge) is 3.4 divisions, then the droop should be less than 0.51 divisions (0.15 x 3.4).

## 651-5. ADJUSTMENT

TEST EQUIPMENT

DMM

PROCEDURE

The Offset adjustment (A2A9 R4) is set to 0V.

1. Program UUT to [RCL] [9][8] and 9.99 kHz deviation, and set the rear panel EXT/INT FM switch to EXT, with no external modulation signal applied.

2. With the DMM, measure the dc voltage at A2A9 U1-6. Adjust R4 for 0V ± 0.1V.

## 651-6. LIST OF REPLACEABLE PARTS

Table 651-2 lists replaceable parts for the 6060A-651. Figure 651-1 is the component location diagrams for the 6060A-651.

**Table 651-1. Low-Rate FM DIP Switch**

| NORMAL | LOW-RATE FM |
|---|---|
| 1. Closed | Open |
| 2. Open | Closed |
| 3. Closed | Open |
| 4. Closed | Open |
| 5. Not Applicable | Not Applicable |
| 6. Open | Closed |

TABLE 651-2. A2A9 LOW-RATE FM PCA
(SEE FIGURE 651-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1, 2 | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 2 | | |
| C 3 | | CAP,POLYES,0.47UF,+-10%,50V | 714725 | 89536 | 714725 | 1 | | |
| C 4 | | CAP,TA,3.3UF,+-20%,20V | 436071 | 01884 | 196D335X0020KA1 | 1 | | |
| C 6 | | CAP,CER,100PF,+-2%,100V,COG | 512848 | 51406 | RPE121 | 1 | | |
| C 7 | | CAP,CER,10PF,+-2%,100V,COG | 512343 | 89536 | 512343 | 1 | | |
| R 1 | | RES,MF,30.1K,+-1%,0.125W,100PPM | 168286 | 91637 | MFF1-83012F | 1 | | |
| R 2 | | RES,MF,24.3,+-1%,0.125W,100PPM | 281816 | 91637 | CMF5524R2F | 1 | | |
| R 3 | | RES,MF,3.32K,+-1%,0.125W,100PPM | 312652 | 91637 | CMF553321F | 1 | | |
| R 4 | | RES,VAR,CERM,100K,+-10%,0.5W | 369520 | 11236 | 360T-104A | 1 | | |
| R 5, 7 | | RES,CC,6.8M,+-5%,0.25W | 394064 | 01121 | CB | 2 | | |
| R 6 | | RES,CF,200K,+-5%,0.25W | 441485 | 80031 | CR251-4-5P200K | 1 | | |
| R 8, 9 | | RES,CF,1.2M,+-5%,0.25W | 348995 | 80031 | CR251-4-5P1M2 | 2 | | |
| R 11 | | RES,MF,4.99K,+-1%,0.125W,100PPM | 168252 | 91637 | MFF1-84991 | 1 | | |
| R 13 | | RES,MF,49.9K,+-1%,0.125W,100PPM | 268821 | 91637 | CMF554992F | 1 | | |
| S 1 | | SWITCH, DIL, 6-POS, SPST, ASSY | 454124 | 00779 | 435166-4 | 1 | | |
| U 1 | * | IC,OP AMP,JFET INPUT,8 PIN DIP | 472779 | 12040 | LF386N | 1 | | |
| XU 1 | | SOCKET, DIP,0.100 CTR,8 PIN | 478016 | 91506 | 308-AG39D | 1 | 1 | |

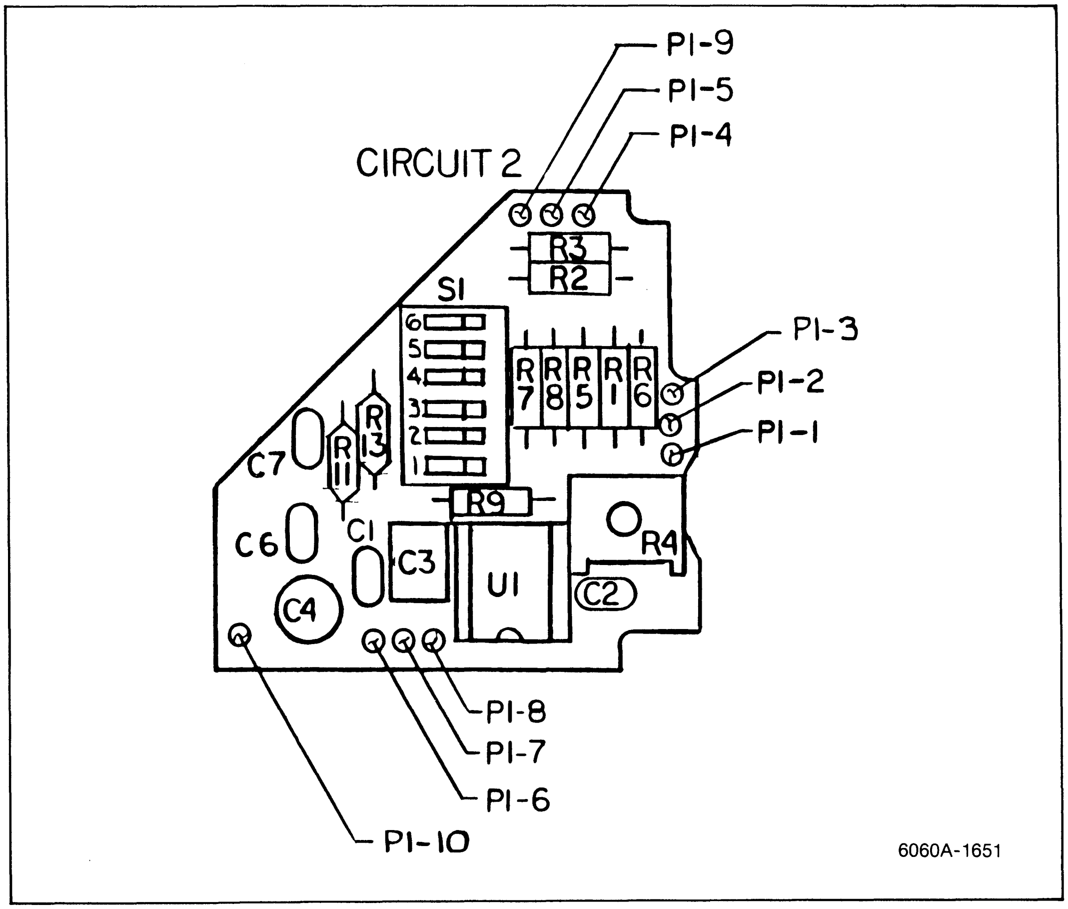



Figure 651-1. A2A9 Low-Rate FM PCA

# Option -830
# Rear Panel RF Output and Mod Input

## 830-1. INTRODUCTION

The Rear Panel RF Output and MOD Input (Option -830), moves the RF OUTPUT and MOD INPUT connectors from the front panel to the rear panel of the Generator. An insulating spacer is used when the RF OUTPUT connector is mounted on the rear panel to reduce ground loops. A longer semi-rigid coaxial SMA cable assembly (W17) replaces the standard cable (W1). The option switch on the Controller is set to indicate that the option is installed.

## 830-2. OPERATION

The additional signal loss of this longer cable is compensated using instrument-independent correction data stored in the Output Calibration EPROM. The Controller applies this correction data only when the rear panel RF Output and MOD Input option jumper is installed on the Controller PCB.

## 830-3. CIRCUIT DESCRIPTION

This option does not change the operation or specifications of the Generator.

## 830-4. MAINTENANCE

This option does not change the performance tests, calibration, adjustment, or service of the Generator.

# Option -870
# Attenuator/RPP (Reverse Power Protector)

## 870-1. INTRODUCTION
The Attenuator/RPP (Option -870) protects the Generator from damaging dc and/or RF signal levels applied to the Generator RF OUTPUT connector. Protection for the RF Output is provided only when the Generator is on.

## 870-2. OPERATION
Option -870 Attenuator/RPP (A2A5) replaces the standard Attenuator (A2A6) assembly, and includes two printed circuit assemblies, the Attenuator/RPP (A2A5A4) and the Relay Driver RPP Control (A2A5A5). The frequency response correction data is unique to the complete Attenuator/RPP assembly (A2A5) and is stored in the Attenuator calibration EPROM. Although the assembly is field-repairable, if certain parts are replaced, the EPROM must be reprogrammed.

If any of these parts need replacement, it is recommended the Attenuator/RPP assembly (complete with the housing and calibration EPROM) be replaced by means of the Module Exchange Program.

## 870-3. CIRCUIT DESCRIPTION
Coupling capacitors C6 and C7 protect against dc or low-frequency power. The diode limiter, consisting of CR2 through CR9, provides protection against medium RF power levels and short-term protection (fast acting) against high RF power levels. Long-term (latched) protection is provided by relay K8 whenever the reverse RF power exceeds a preset level.

RF power detected by CR1 is compared with the preset voltage in one section of comparator U1. When the detected voltage exceeds the set value, the output of U1 pin 1 goes positive, turning on Q1 and Q2. This actuates K8 to the protect position. In the protect position, the output connector is shorted to ground and the Generator output is disconnected from the output connector.

CR15 and R6 form a latching network such that K8 remains in the protect position until the Generator RF Output is reset by an RF ON entry. The output of the comparator is buffered and sent as RPTRPL to interrupt the Controller signal that annunciates the RPP trip condition by flashing the UNCAL and RF OFF lights.

## 870-4. MAINTENANCE
This option does not change the performance test of the Generator and there are no adjustments.

When servicing the A2A5A2 Attenuator/RPP Control PCB, use the three dual-pin test points to aid in the troubleshooting of the assembly. The RPP can be tripped (to the protect position) by momentarily shorting the two points of TP1. It can be reset by momentarily shorting TP2. Shorting TP3 reduces the level required to trip the Attenuator/RPP, so it trips on the Generator's own output. This provides a convenient way to verify the operation of the entire trip circuitry, although at a reduced trip level.

To check the trip function with TP3 shorted, it is best to program the Generator to an output level of +10 dBm; then, program it for fixed amplitude range ([SPCL] [9][1]). This allows the level to be varied from a low value up to the maximum value without any transients that might otherwise trip the RPP. Then, starting at a low level, such as -10 dBm (with the RPP reset), increase (EDIT) the UUT level in 1 dB steps until the RPP trips. RPP trip normally occurs between +10 and +15 dBm.

## 870-5. LIST OF REPLACEABLE PARTS

Table 870-1 lists replaceable parts for the 6060A-870. Figure 870-1 is the component location diagram for the 6060A-870.

TABLE 870-1. A2A5 ATTENUATOR/RPP ASSEMBLY

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| A 4 | | ATTENUATOR/RPP PCA | 752667 | 89536 | 752667 | 1 | | |
| A 5 | | RELAY DRIVER/RPP PCA | 752816 | 89536 | 752816 | 1 | | |
| FL 1 | | FILTER,RF,EYELET STYLE,2000PF,BL | 529495 | 89536 | 529495 | 11 | | |
| H 1 | | SCREW,MACH,PHP,STL,6-32X1/4 | 152140 | 89536 | 152140 | 1 | | |
| H 2 | | SCREW,MACH,PHP,STL,6-32X1/2 | 152173 | 89536 | 152173 | 7 | | |
| H 3 | | SCREW,MACH,PHP,STL,6-32X7/8 | 114868 | 89536 | 114868 | 11 | | |
| H 4 | | SCREW,MACH,PHP,STL,6-32X1/2 | 152173 | 89536 | 152173 | 2 | | |
| MP 1 | | HOUSING,PLATED,ATTENUATOR,RELAYVERSN | 717017 | 89536 | 717017 | 1 | 1 | |
| U 26 | * | IC, 2K X 8 EPROM | 454603 | 01295 | TMS2516JL | 1 | | |
| W 24 | | CABLE ASSEMBLY, ATTENUATOR | 752725 | 89536 | 752725 | 1 | | |

FOR MODULE EXCHANGE, ORDER P/N 750414 (INCLUDES CALIBRATED EPROM)

TABLE 870-2. A2A5A4 ATTENUATOR/RPP PCA
(SEE FIGURE 870-1.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | N O T -E |
|---|---|---|---|---|---|---|---|---|
| C 1, 2, 4 | | CAP,CER,1000PF,+-20%,50V,X7R | 514059 | 89536 | 514059 | 3 | | |
| C 3, 5 | | CAP,AL,4.7UF,+-10%,15V | 519363 | 56289 | 193D475X9015C2 | 2 | | |
| C 6, 7 | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 2 | | |
| CR 1 | * | DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNL | 535195 | 28480 | 5082-2800 | 1 | 2 | |
| CR 2- 9 | * | DIODE,SI,BV= 70.0V,500 MW | 454181 | 03508 | 1N4606 | 8 | | |
| H 1 | | WASHER,SPRNG,COPPER,0.316 ID | 544239 | 89536 | 544239 | 8 | | |
| J 2 | | CONN,COAX,SMA,REC,PWB OR BLKHD | 512087 | 16733 | 705147-001 | 1 | | |
| J 3 | | CONN,SOCKET,SPRING TYPE,.0690D,.143L | 732826 | 89536 | 732826 | 1 | | |
| K 1- 8 | | RELAY,ARMATURE,2 FORM C,26.5VDC | 528638 | 11532 | 712-26 | 8 | | |
| P 1- 8 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 8 | | |
| P 9- 11 | | CONN,SOCKET,PWB,0.038 DIAMETER | 386144 | 89536 | 386144 | 3 | | |
| R 1, 7, 10, | | RES,MF,402,+-0.5%,0.125W,50PPM | 461632 | 89536 | 461632 | 5 | | |
| R 16, 19 | | | 461632 | | | | | |
| R 2, 3, 8, | | RES,MF,56.9,+-0.5%,0.125W,50PPM | 461590 | 89536 | 461590 | 10 | | |
| R 9, 11, 12, | | | 461590 | | | | | |
| R 17, 18, 20, | | | 461590 | | | | | |
| R 21 | | | 461590 | | | | | |
| R 4 | | RES,MF,94.2,+-0.5%,0.125W,50PPM | 461616 | 89536 | 461616 | 1 | | |
| R 5, 6 | | RES,MF,83.5,+-0.5%,0.125W,50PPM | 461608 | 89536 | 461608 | 2 | | |
| R 13 | | RES,MF,37.4,+-0.5%,0.125W,50PPM | 461079 | 89536 | 461079 | 1 | 1 | |
| R 14, 15 | | RES,MF,150,+-0.5%,0.125W,50PPM | 461624 | 89536 | 461624 | 2 | | |
| R 22 | | RES,CC,10K,+-5%,0.125W | 643940 | 01121 | BB1035 | 1 | | |

ALL COMPONENTS NON FIELD REPLACEABLE

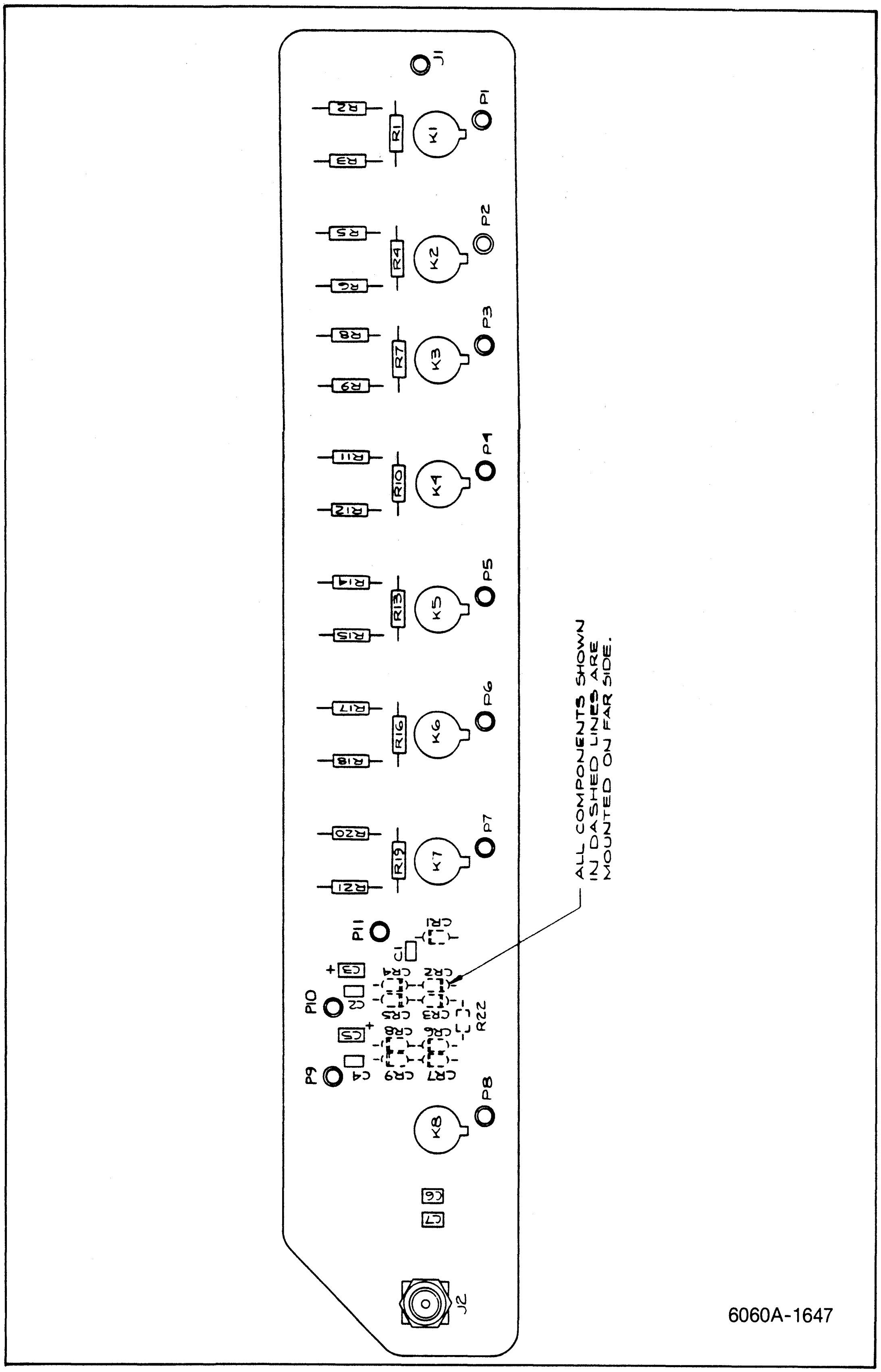



**Figure 870-1. A2A5A4 Attenuator/RPP PCA**

TABLE 870-3. A2A5A5 RELAY DRIVER/RPP PCA
(SEE FIGURE 870-2.)

| REFERENCE DESIGNATOR A->NUMERICS---> | S | ----------DESCRIPTION---------------- | FLUKE STOCK --NO-- | MFRS SPLY CODE- | MANUFACTURERS PART NUMBER --OR GENERIC TYPE-- | TOT QTY | R S -Q | NOTE |
|---|---|---|---|---|---|---|---|---|
| C 1- 7, 11 | | CAP,POLYES,0.1UF,+-20%,50V | 732883 | 89536 | 732883 | 8 | | |
| C 8, 9, 12, | | CAP,CER,0.01UF,+-20%,100V,X7R | 407361 | 72982 | 8121-A100-W5R-103M | 4 | | |
| C 13 | | | 407361 | | | | | |
| C 10, 16 | | CAP,CER,0.22UF,+-20%,50V,Z5U | 519157 | 51406 | RPE111Z5U224M50V | 2 | | |
| C 14, 15 | | ELECTRO, MIN,LO LEAK, 4.7MF, 35V | 603993 | 89536 | 603993 | 2 | | |
| CR 11- 14, 16, | * | DIODE,SI,BV= 75.0V,IO=150MA,500 MW | 203323 | 07910 | 1N4448 | 6 | 1 | |
| CR 17 | * | | 203323 | | | | | |
| J 2 | | SOCKET,DIP,0.100 CTR,24 PIN | 376236 | 91506 | 324-AG39D | 1 | | |
| L 1- 10 | | CHOKE,6TURN | 320911 | 89536 | 320911 | 10 | | |
| L 11 | | INDUCTOR,470 UH,+/-5%,6.5 MHZ,SHLDED | 147827 | 72259 | WEE470 | 1 | | |
| L 12, 13 | | INDUCTOR,47 UH,+/-5%,26.5 MHZ,SHLDED | 147850 | 72259 | WEE47 | 2 | 2 | |
| P 1- 11 | | CONN,SOCKET,PWB,0.049 DIAMETER | 544056 | 89536 | 544056 | 11 | | |
| Q 1- 7, 9 | * | TRANSISTOR,SI,PNP,SMALL SIGNAL | 418707 | 04713 | MPS56562 | 8 | 1 | |
| Q 8 | * | TRANSISTOR,SI,NPN,SMALL SIGNAL | 330803 | 07263 | MPS6560 | 1 | 1 | |
| R 1, 4, 7, | | RES,CF,510,+-5%,0.25W | 441600 | 80031 | CR251-4-5P510E | 8 | 1 | |
| R 10, 13, 16, | | | 441600 | | | | | |
| R 19, 38 | | | 441600 | | | | | |
| R 2, 5, 8, | | RES,CF,4.7K,+-5%,0.25W | 348821 | 01121 | CB4725 | 9 | | |
| R 11, 14, 17, | | | 348821 | | | | | |
| R 20, 39, 41 | | | 348821 | | | | | |
| R 3, 6, 9, | | RES,CF,100,+-5%,0.25W | 348771 | 80031 | CR251-4-5P100E | 8 | | |
| R 12, 15, 18, | | | 348771 | | | | | |
| R 21, 40 | | | 348771 | | | | | |
| R 22, 23, 29, | | RES,CF,1K,+-5%,0.25W | 343426 | 80031 | CR251-4-5P1K | 7 | | |
| R 35, 36, 42, | | | 343426 | | | | | |
| R 45 | | | 343426 | | | | | |
| R 24 | | RES,CF,30K,+-5%,0.25W | 368753 | 80031 | CR251-4-5P30K | 1 | | |
| R 25, 30, 31, | | RES,CF,10K,+-5%,0.25W | 348839 | 80031 | CR251-4-5P10K | 4 | | |
| R 37 | | | 348839 | | | | | |
| R 27 | | RES,MF,1.07K,+-1%,0.125W,100PPM | 344325 | 89536 | 344325 | 1 | | |
| R 28 | | RES,MF,422,+-1%,0.125W,100PPM | 288506 | 91637 | CMF554220F | 1 | | |
| R 32 | | RES,MF,1.5K,+-1%,0.125W,100PPM | 313098 | 91637 | CMF551501F | 1 | | |
| R 33 | | RES,CF,56,+-5%,0.25W | 342618 | 80031 | CR251-4-5P56E | 1 | | |
| R 34 | | RES,CF,100K,+-5%,0.25W | 348920 | 80031 | CR251-4-5P100K | 1 | | |
| R 43 | | RES,CF,13K,+-5%,0.25W | 441402 | 80031 | CR251-4-5P13K | 1 | | |
| R 44 | | RES,CF,2K,+-5%,0.25W | 441469 | 80031 | CR251-4-5P2K | 1 | | |
| R 46 | | RES,CF,470,+-5%,0.25W | 343434 | 80031 | CR251-4-5P470E | 1 | | |
| R 47 | | RES,CF,12K,+-5%,0.25W | 348847 | 80031 | CR251-4-5P12K | 1 | | |
| R 48 | | RES,CF,4.3K,+-5%,0.25W | 441576 | 80031 | CR251-4-5P4K3 | 1 | | |
| TP 1- 11 | | CONN,POST,PWB,.025SQ,NON-INSUL,SELECT | 267500 | 00779 | 87022-1 | 20 | | 1 |
| U 1 | * | IC,OP AMP,QUAD,JFET INPUT,TO-5 CASE | 483438 | 89536 | 483438 | 1 | | |
| VR 1- 7, 15 | * | ZENER,UNCOMP, 30.0V,10%, 4.2MA, 0.4W | 272633 | 04713 | 1N972A | 8 | | |
| VR 8, 9, 18 | * | ZENER,UNCOMP, 4.7V, 5%, 20.0MA, 0.4W | 524058 | 14552 | 1N751 | 3 | 2 | |
| VR 10 | * | ZENER,COMP, 6.4V, 5%, 1 PPM TC, 2.0MA | 381988 | 89536 | 381988 | 1 | 2 | |

1 ALSO INCLUDES J1.

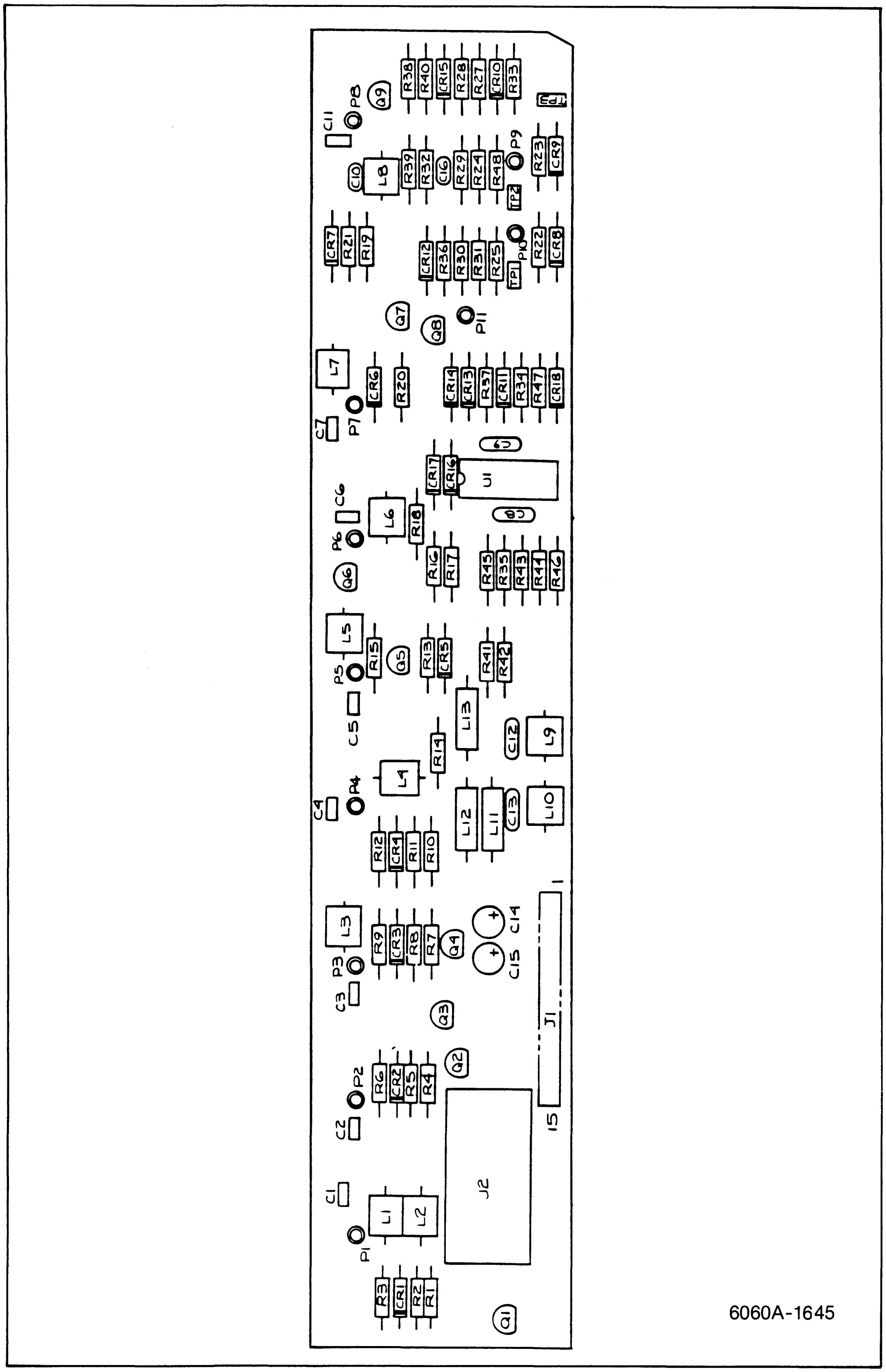



**Figure 870-2. A2A5A5 Relay Driver/RPP PCA**

# Section 7
# General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

## List of Abbreviations and Symbols

| | |
|---|---|
| **A or amp** | ampere |
| **ac** | alternating current |
| **af** | audio frequency |
| **a/d** | analog-to-digital |
| **assy** | assembly |
| **AWG** | american wire gauge |
| **B** | bel |
| **bcd** | binary coded decimal |
| **°C** | Celsius |
| **cap** | capacitor |
| **ccw** | counterclockwise |
| **cer** | ceramic |
| **cermet** | ceramic to metal(seal) |
| **ckt** | circuit |
| **cm** | centimeter |
| **cmrr** | common mode rejection ratio |
| **comp** | composition |
| **cont** | continue |
| **crt** | cathode-ray tube |
| **cw** | clockwise |
| **d/a** | digital-to-analog |
| **dac** | digital-to-analog converter |
| **dB** | decibel |
| **dc** | direct current |
| **dmm** | digital multimeter |
| **dvm** | digital voltmeter |
| **elect** | electrolytic |
| **ext** | external |
| **F** | farad |
| **°F** | Fahrenheit |
| **FET** | Field-effect transistor |
| **ff** | flip-flop |
| **freq** | frequency |
| **FSN** | federal stock number |
| **g** | gram |
| **G** | giga ($10^9$) |
| **gd** | guard |
| **Ge** | germanium |
| **GHz** | gigahertz |
| **gmv** | guaranteed minimum value |
| **gnd** | ground |
| **H** | henry |
| **hd** | heavy duty |
| **hf** | high frequency |
| **Hz** | hertz |
| **IC** | integrated circuit |
| **if** | intermediate frequency |
| **in** | inch(es) |
| **intl** | internal |
| **I/O** | input/output |
| **k** | kilo ($10^3$) |
| **kHz** | kilohertz |
| **kΩ** | kilohm(s) |
| **kV** | kilovolt(s) |
| **lf** | low frequency |
| **LED** | light-emitting diode |
| **LSB** | least significant bit |
| **LSD** | least significant digit |
| **M** | mega ($10^6$) |
| **m** | milli ($10^{-3}$) |
| **mA** | milliampere(s) |
| **max** | maximum |
| **mf** | metal film |
| **MHz** | megahertz |
| **min** | minimum |
| **mm** | millimeter |
| **ms** | millisecond |
| **MSB** | most significant bit |
| **MSD** | most significant digit |
| **MTBF** | mean time between failures |
| **MTTR** | mean time to repair |
| **mV** | millivolt(s) |
| **mv** | multivibrator |
| **MΩ** | megohm(s) |
| **n** | nano ($10^{-9}$) |
| **na** | not applicable |
| **NC** | normally closed |
| **(-) or neg** | negative |
| **NO** | normally open |
| **ns** | nanosecond |
| **opnl ampl** | operational amplifier |
| **p** | pico ($10^{-12}$) |
| **para** | paragraph |
| **pcb** | printed circuit board |
| **pF** | picofarad |
| **pn** | part number |
| **(+) or pos** | positive |
| **pot** | potentiometer |
| **p-p** | peak-to-peak |
| **ppm** | parts per million |
| **PROM** | programmablle read-only memory |
| **psi** | pound-force per square inch |
| **RAM** | random-access memory |
| **rf** | radio frequency |
| **rms** | root mean square |
| **ROM** | read-only memory |
| **s or sec** | second (time) |
| **scope** | oscilloscope |
| **SH** | shield |
| **Si** | silicon |
| **serno** | serial number |
| **sr** | shift register |
| **Ta** | tantalum |
| **tb** | terminal board |
| **tc** | temperature coefficient or temperature compensating |
| **tcxo** | temperature compensated crystal oscillator |
| **tp** | test point |
| **u or μ** | micro ($10^{-6}$) |
| **uhf** | ultra high frequency |
| **us or μs** | microsecond(s) ($10^{-6}$) |
| **uut** | unit under test |
| **V** | volt |
| **v** | voltage |
| **var** | variable |
| **vco** | voltage controlled oscillator |
| **vhf** | very high frequency |
| **vlf** | very low frequency |
| **W** | watt(s) |
| **ww** | wire wound |
| **xfmr** | transformer |
| **xstr** | transistor |
| **xtal** | crystal |
| **xtlo** | crystal oscillator |
| **Ω** | ohm(s) |
| **μ** | micro ($10^{-6}$) |

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

# Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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**LA, New Orleans**
(504) 455-0814

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25 "B" Street
Burlington MA 01803
(617) 273-4674

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John Fluke Mfg. Co., Inc.
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Rockville, MD 20852
(301) 770-1570

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John Fluke Mfg. Co., Inc.
33031 Schoolcraft
Livonia, MI 48150
(313) 522-9140

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1801 E. 79th St., Suite 9
Bloomington, MN 55420
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John Fluke Mfg. Co., Inc.
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Suite 105
St. Louis, MO 63141
(314) 993-3805

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John Fluke Mfg. Co., Inc.
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Greensboro, NC 27408
(919) 273-1918

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King of Prussia, PA 19406
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**Pittsburgh**
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Dallas, TX 75234
(214) 233-9990

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Stafford, TX 77477
(713) 491-5995

**San Antonio**
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San Antonio, TX 78216
(512) 340-2621

**UT, Salt Lake City**
6914 So. 3000 East
Suite 206
Salt Lake City, UT 82021
(801) 268-9331

**WA, Seattle**
John Fluke Mfg. Co., Inc.
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Suite 110
Redmond, WA 98052
(206) 881-6966

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**WA, Everett** (206) 356-5560

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Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands. Phone (013) 673973
Litho in U.S.A. 10/84

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Concord, N.S.W. 2137
Australia
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Australia
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Elmeasco Instruments Pty, Ltd.
P.O. Box 95
Gosnells, West Australia 6110
Australia
Tel: (9) 398-3362

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Walter Rekirsch Elektronische
Gerate GmbH & Co.
Vertrieb KG
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1220 Vienna, Austria
Tel: (222) 235555, TLX: (847) 134759

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Motherland Corporation
24 Hatkhola Road, Tikatuli
Dacca-3, Bangladesh
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# Appendix 7A
# Manual Change Information

### 7A-1. INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with the earlier PCB configurations. To identify the configuration of the PCBs used in your instrument, refer to the revision letter (marked in ink) on the component side of each PCB assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected PCA. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual. To identify the configuration the PCAs used in your Generator, refer to the revision letter on the component side of each PCA.

### 7A-2. BACKDATING INSTRUCTIONS

To backdate this manual to conform with an earlier assembly revision level, perform the changes indicated in Table 7A-1. If this manual documents all PCAs at their original level, no changes are necessary, and no changes will be indicated in Table 7A-1.

### Table 7A-1. Manual Status and Backdating Information

| REF OR OPTION NO. | ASSEMBLY NAME | FLUKE PART NO. | *To adapt manual to earlier rev configurations perform changes in decending order (by no.), ending with change under desired rev letter | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | — | A | B | C | D | E | F | G | H | J | K | L | M | N | P | | | | | | | |
| A1A1 | Display PCA | 738609 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A1 | Synthesizer PCA | 748814 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A2 | VCO PCA | 748780 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A4 | Output PCA | 744045 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A6 A4 | Attenuator PCA | 752675 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A6 A5 | Relay Driver PCA | 752808 | X | | | | | | | | | | | | | | | | | | | | | |
| A2A7 | Controller PCA | 755330 | X | | | | | | | | | | | | | | | | | | | | | |
| A3A1 | Power Supply PCA | 744052 | X | | | | | | | | | | | | | | | | | | | | | |
| -130 | High Stability Reference PCA | 744102 | X | | | | | | | | | | | | | | | | | | | | | |
| -131 | Sub-Harmonic Reference PCA | 738583 | X | | | | | | | | | | | | | | | | | | | | | |
| -488 | IEEE-488 PCA | 738617 | X | | | | | | | | | | | | | | | | | | | | | |
| -570 | Non-Volatile Memory PCA | 744094 | X | | | | | | | | | | | | | | | | | | | | | |
| -651 | Low-Rate FM PCA | 716969 | X | | | | | | | | | | | | | | | | | | | | | |
| -870 | A4 Attenuator/ RPP PCA | 752667 | X | | | | | | | | | | | | | | | | | | | | | |
| -870 | Relay Driver/A5 RPP Control PCA | 752816 | X | | | | | | | | | | | | | | | | | | | | | |
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* X The PCB revision levels documented in this manual.
* ● These revision letters were never used in the instrument.
* — No revision letter on the PCB.
* · Change did not affect manual.

# Section 8
# Schematic Diagrams

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| MNEMONIC | DESCRIPTION | SIGNAL TYPE * |
|---|---|---|
| A 0-15 | Address | B |
| A12DB | Attenuator 12-dB Section Control | L |
| A24(1-5) | Attenuator 24-dB Section Controls | L |
| A6DB | Attenuator 6-dB Section Control | L |
| BAB 0-3 | Module Section Address | H |
| BD 0-7 | Module Section Data | B |
| BSEL 0,1 | Module Section Select | L |
| CKN | N-Divider Clock | L |
| CLR | Display Clear | L |
| D 0-7 | Data | B |
| DBIN | Read Enable | L |
| DD 0-7 | Display Data | B |
| DIG | Display Digit Select | L |
| EXREF | External Reference Control | L |
| EXTAM | External AM Control | L |
| EXTFM | External FM Control | L |
| FIL 1,2 | Display Filament Supply | AC+DC |
| FM 0-9 | FM Deviation DAC Control | H |
| FMEN | FM Enable | H |
| FMRNG 0-2 | FM Range Control | H |
| FMV | FM Audio | AF |
| HAOCT | Half-Octave Control | H |
| HET | Het (Low) Band Control | L |
| HSOPT | High-Stability Option Installed | L |
| IEA 13-15 | IEEE Address Bus | B |
| IEADR | IEEE Address Latch Enable | L |
| IECS | IEEE Chip Enable | L |
| IED 0-7 | IEEE Data Bus | B |
| IEDB | IEEE Read Enable | L |
| IEIN | IEEE Option Installed | L |
| IEINT | IEEE Interrupt | L |
| IEW | IEEE Write Enable | L |
| INTAM | Internal AM Control | L |
| INTFM | Internal FM Control | L |
| KBIN | Keyboard Input Select | H |
| KN 0-9 | PLL Gain Compensation DAC | H |
| KNV | Main PLL Gain Compensation Voltage | DC |
| KV 0-9 | VCO Compensation DAC Control | H |
| LEV 0-11 | RF Level DAC Control | H |

| MNEMONIC | DESCRIPTION | SIGNAL TYPE * |
|---|---|---|
| LRFM | Low-Rate FM Option Installed | L |
| MF400 | Modulation Frequency Control | L |
| MID | Mid Band Control | L |
| MLEVHI | External Modulation High-Level Status | H |
| MLEVLO | External Modulation Low-Level Status | H |
| MODE | Triple-Modulus Prescaler | L |
| NVCS | NVM RAM Chip Select | L |
| NVEN | NVM Enable | L |
| NVIN | NVM Option Installed | L |
| RIN | 10-MHz Output Buffer Enable | H |
| RMUX0,1 | Reference Multiplexer Select | H |
| ROPT | Rear Output Option Installed | L |
| RPP | RPP Option Installed | L |
| RPRST | RPP Reset Control | H |
| RPTRP | RPP Tripped Status | L |
| SEG 1-3,9 | Display Segment Select | L |
| SHEN | Sub-Harmonic Reference Control | L |
| SHET | Synthesizer Heterodyne Control | L |
| SHREF | Sub-Harmonic Ref Option Installed | L |
| SHTUNE | Sub-Harmonic Ref Tuning Voltage | DC |
| TBOUT | Output Test Bit | H |
| TBSYN | Synthesizer Test Bit | H |
| TRMOD | Triple-Modulus Prescalar Select | L |
| TRSEQ | Remote Sequence Trigger | L |
| TUNE | Main PLL Tuning Voltage | DC |
| UNLOK | PLL Unlocked or Overmodulated Status | L |
| UNLVL | ALC Loop Unleveled Status | L |
| WE | Write Enable | L |
| XOEN | 10-MHz Crystal Oscillator Control | L |

* Six SIGNAL types are listed in the following:

DC= DC Control
AC= Line Frequency
AF= Audio (modulation) Signal
L = Logic (binary) signal, active low at the source
H = Logic (binary) signal, active high at the source
B = Dynamic bus

**Figure 8-1. Mnemonics**

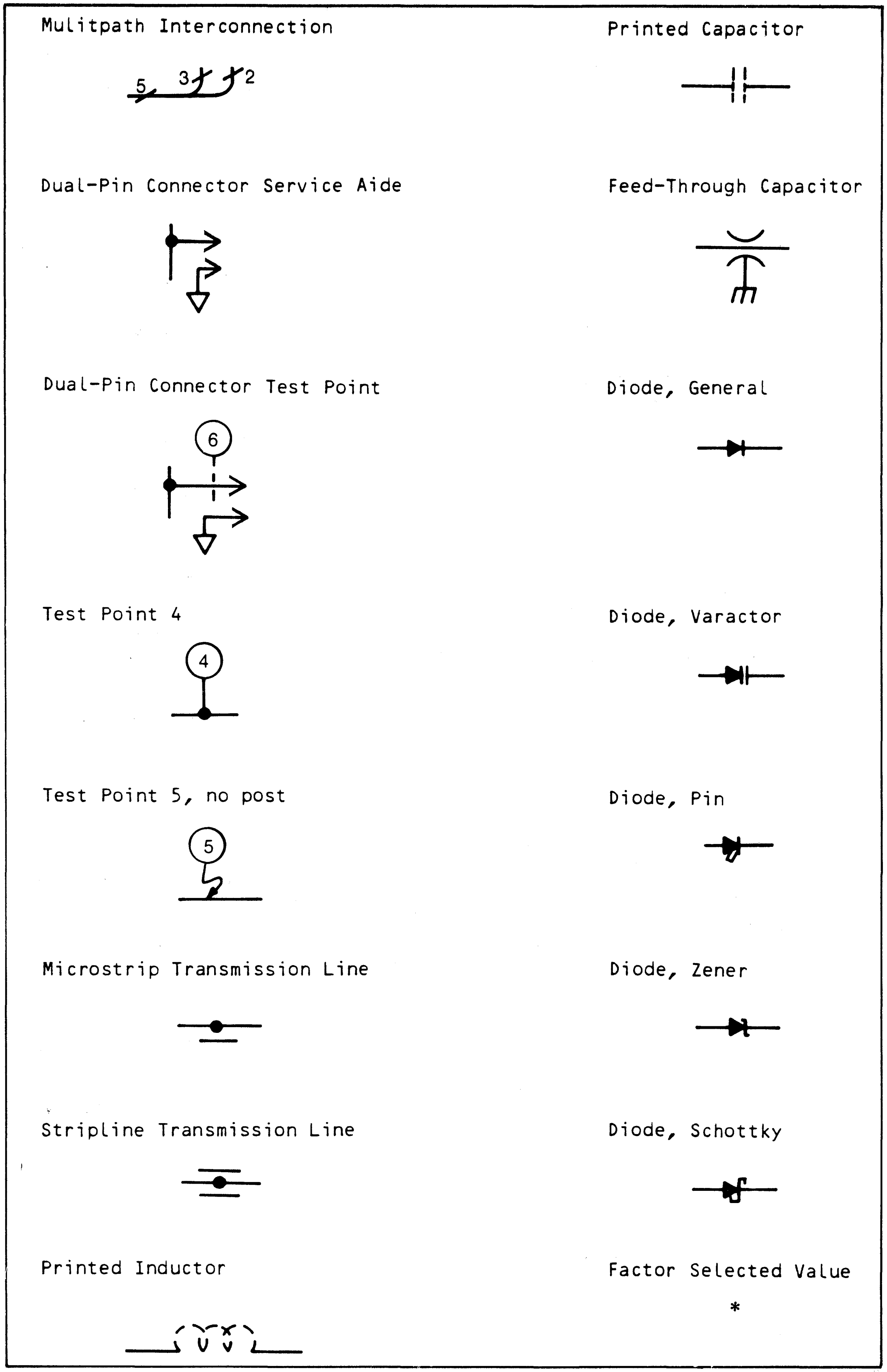



**Figure 8-2. Schematic Symbols (cont)**

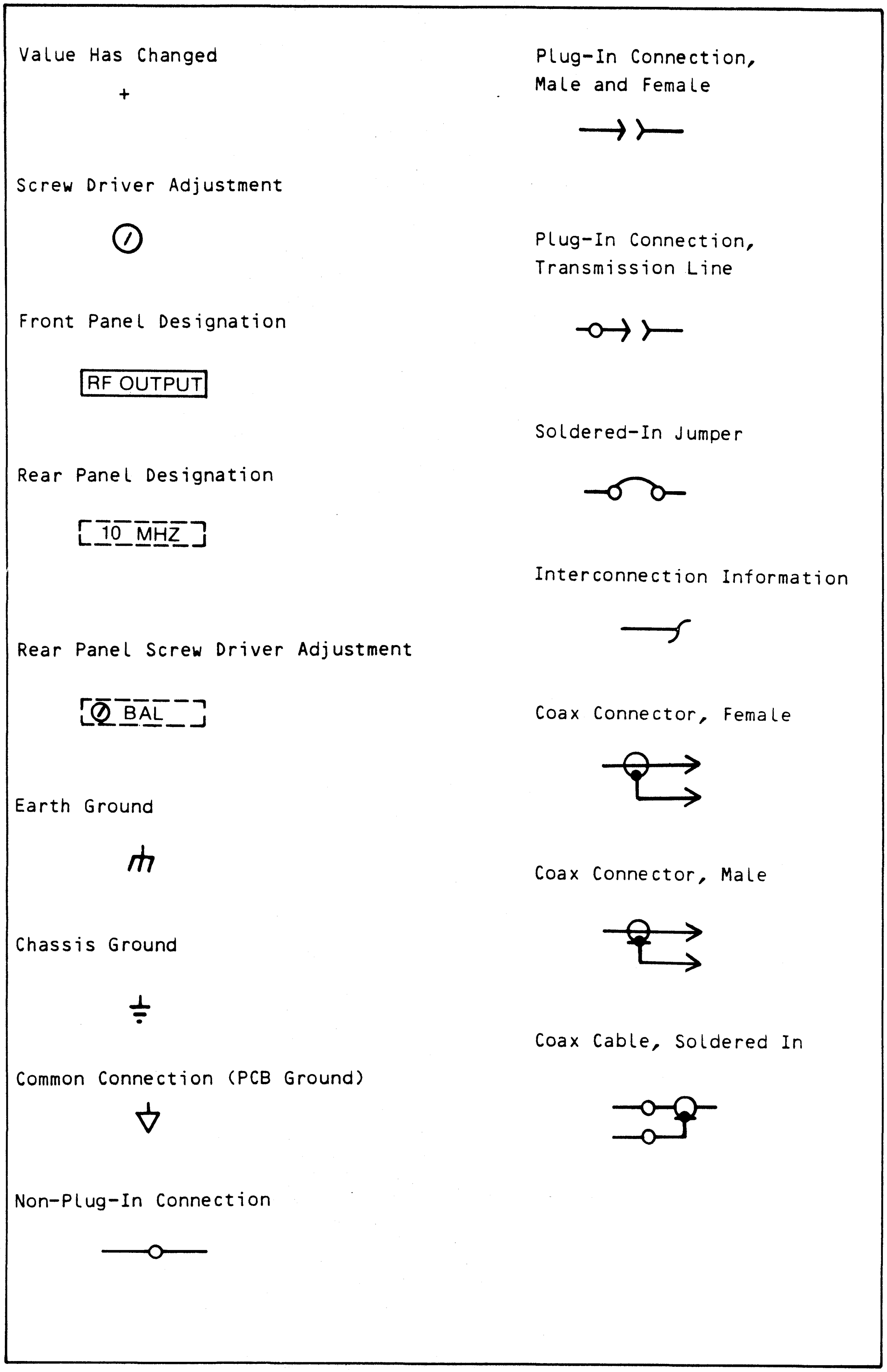



**Figure 8-2. Schematic Symbols (cont)**

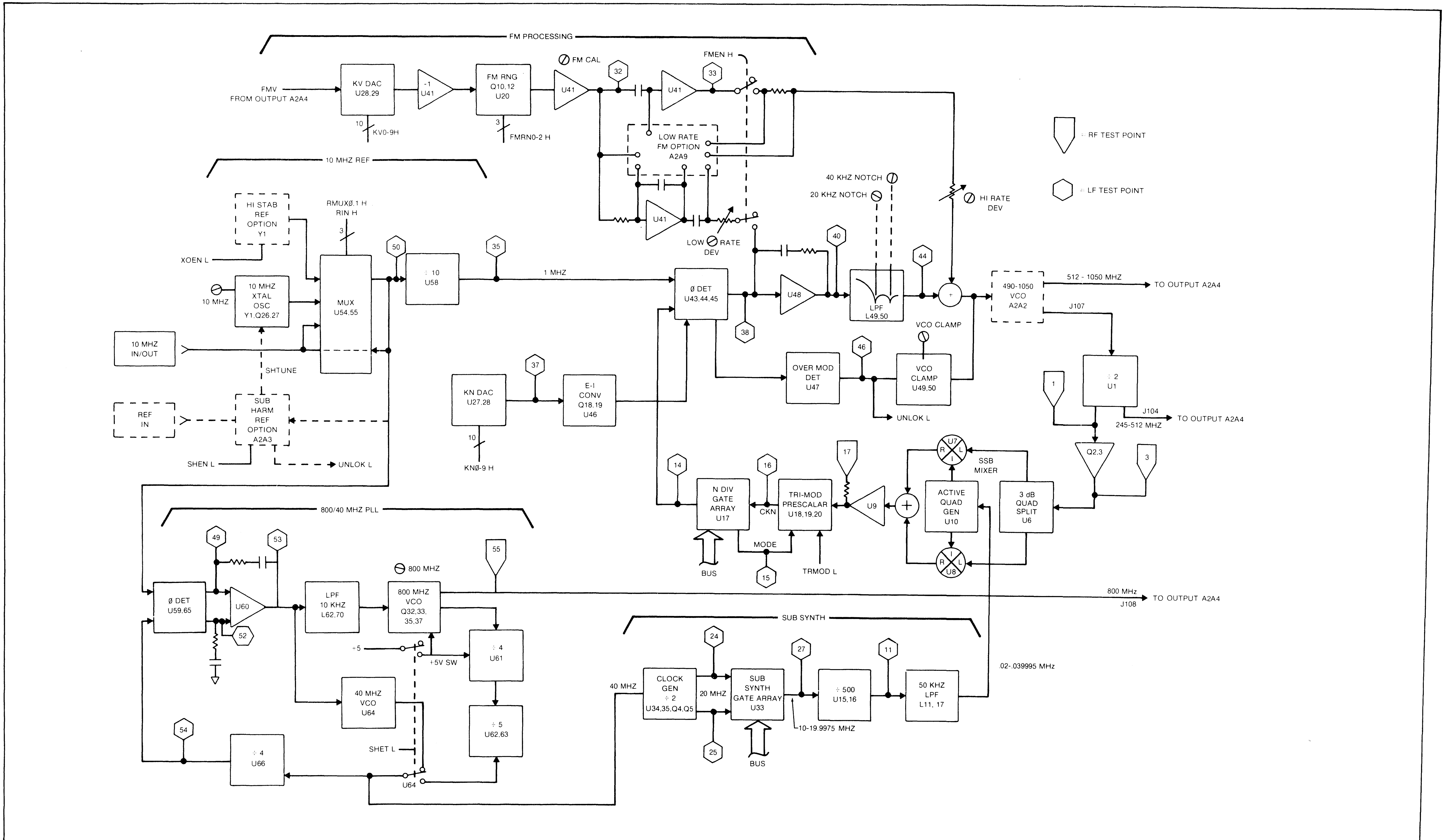



Figure 8-3. Synthesizer Block Diagram

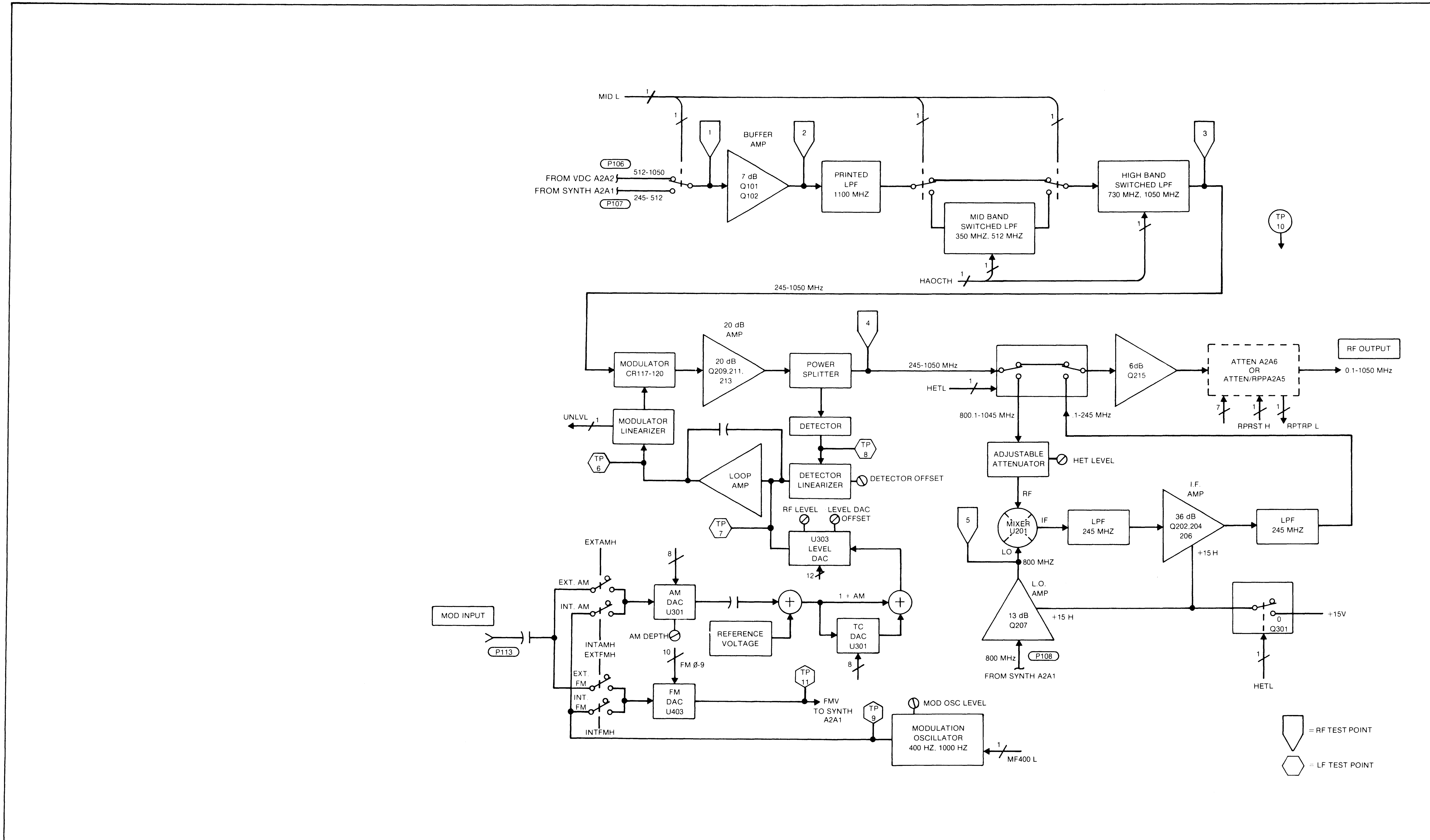



**Figure 8-4. Output Block Diagram**

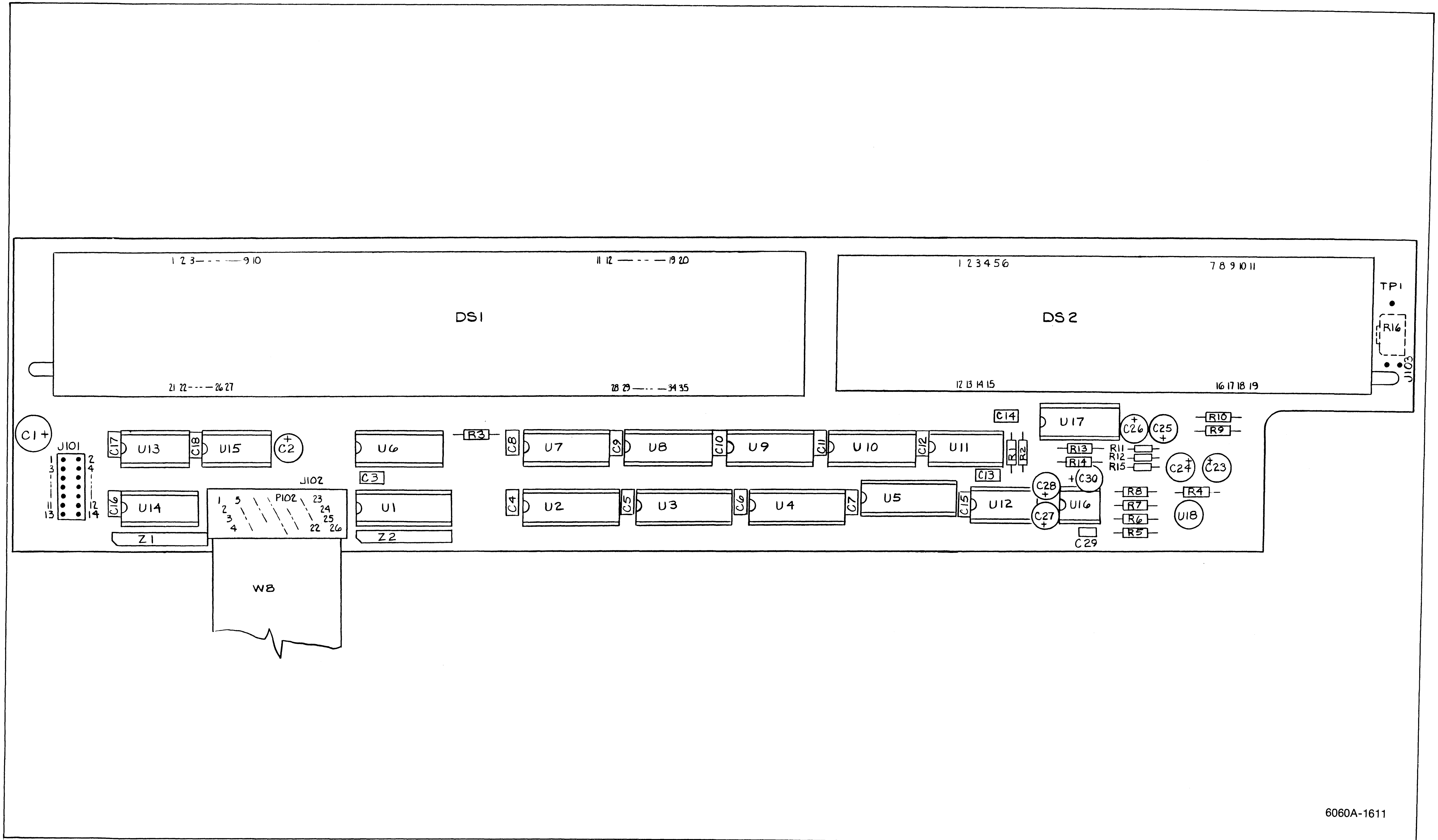
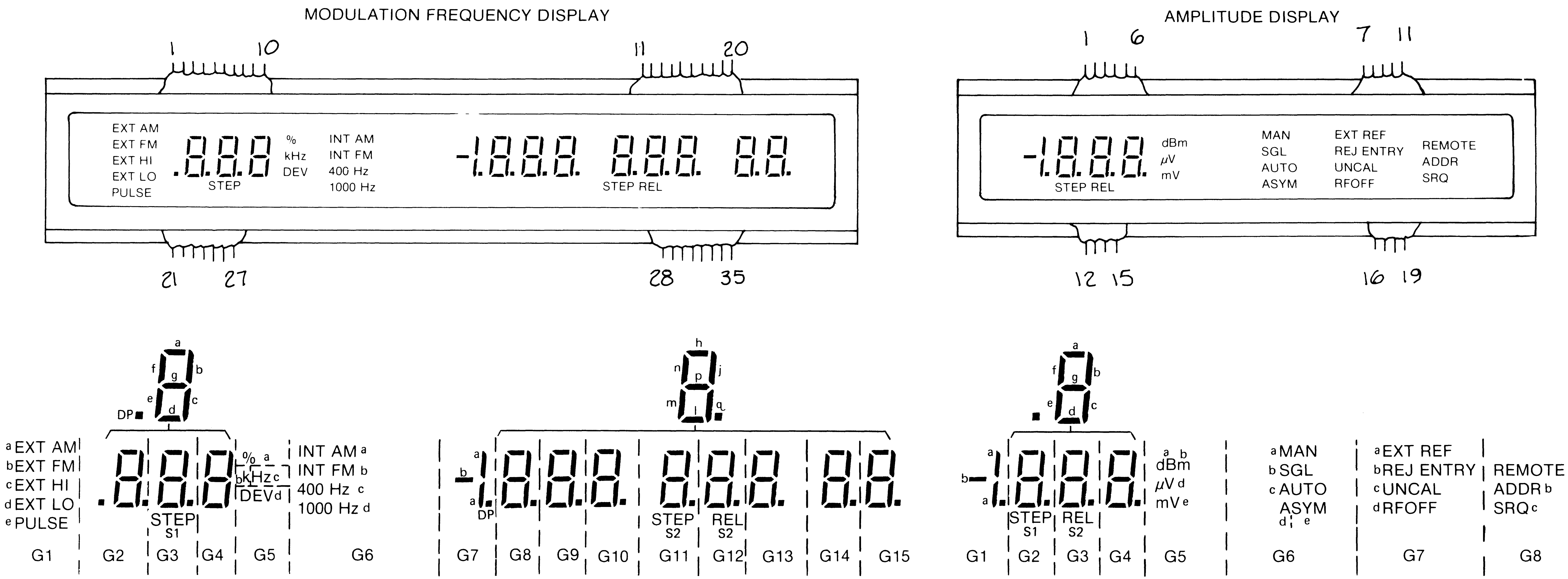



Figure 8-5. A1A1 Display PCA




| PIN NO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONNECTION | F | $P_{S1}$ | $P_{DP}$ | $P_d$ | $P_c$ | $P_e$ | $P_g$ | $P_f$ | $P_b$ | $P_a$ | $P_h$ | $P_j$ | $P_n$ | $P_p$ | $P_m$ | $P_n$ | $P_l$ | $P_q$ | $P_{S2}$ | F |
| | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | | | | | |
| | G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 | G9 | G10 | G11 | G12 | G13 | G14 | G15 | | | | | |

| PIN NO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONNECTION | F | $P_{S1}$ | $P_{np}$ | $P_c$ | $P_g$ | $P_a$ | $P_b$ | $P_f$ | $P_e$ | $P_d$ | F | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 |

DISPLAY CONNECTION INFORMATION

NOTES:

F Denotes Filament

G Denotes Grid (numeric suffix identifies display field)

P Denotes Plate (subscript identifies display segment)

**Figure 8-5. A1A1 Display PCA (cont)**

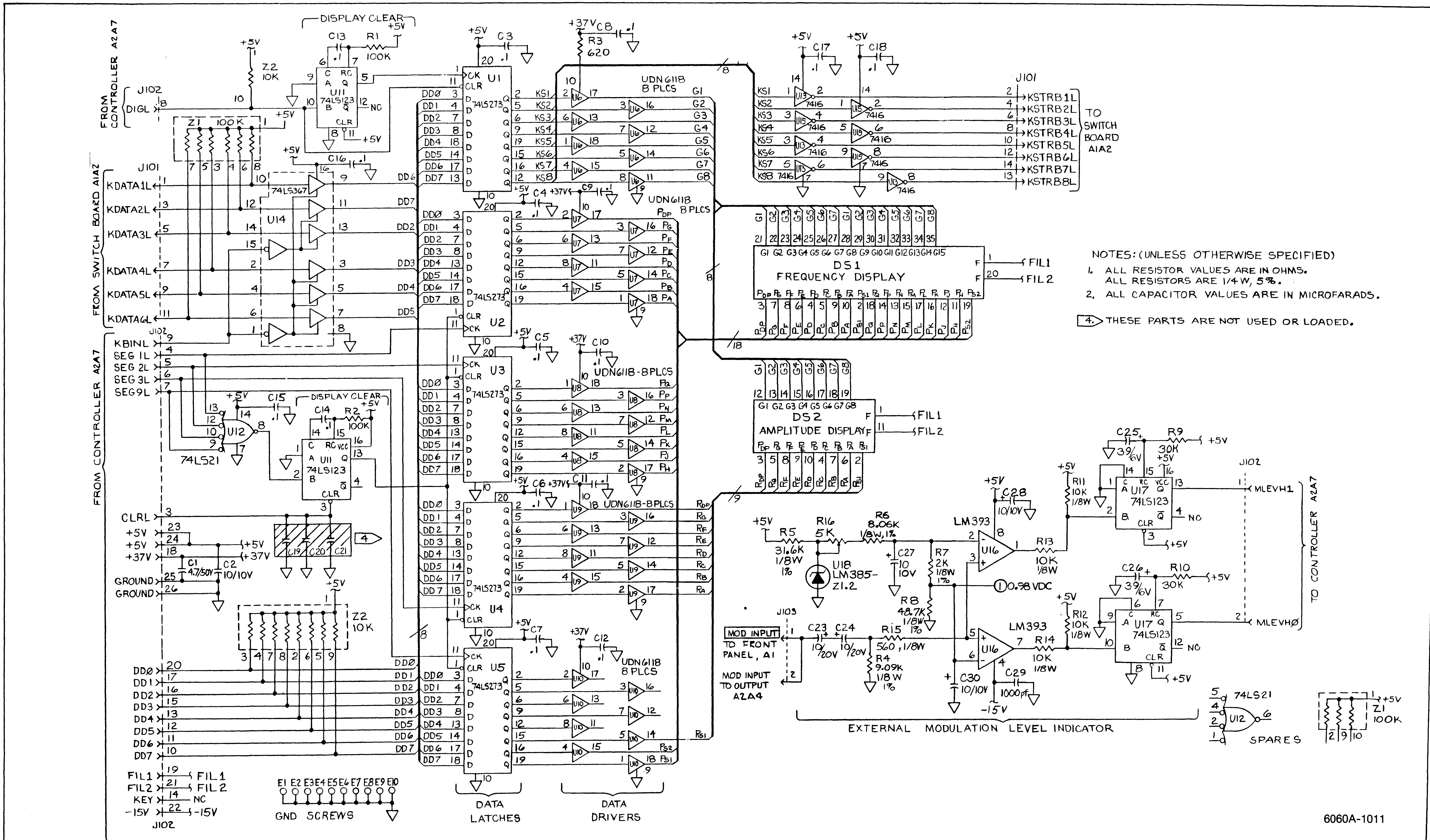



Figure 8-5. A1A1 Display PCA (cont)

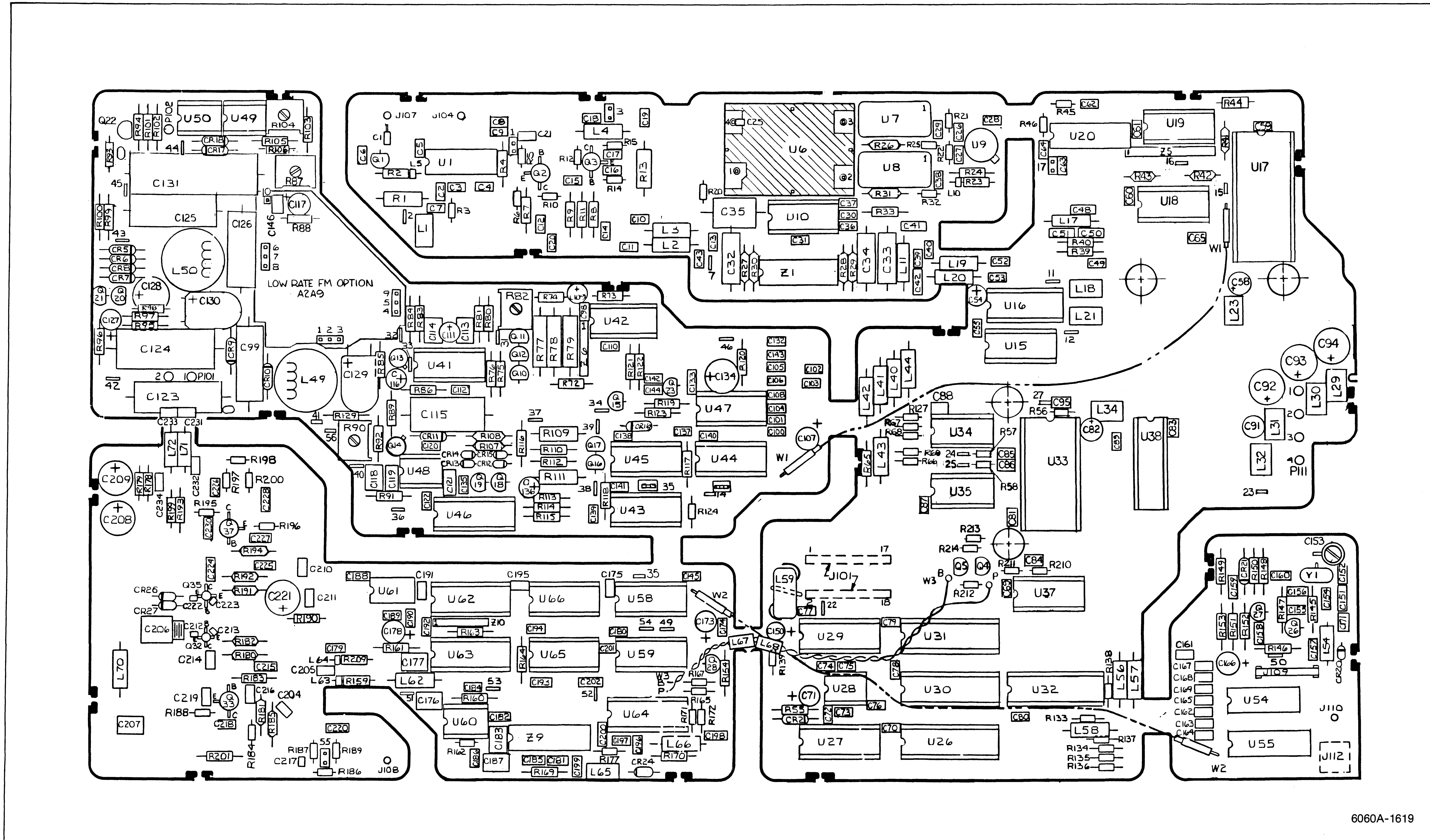
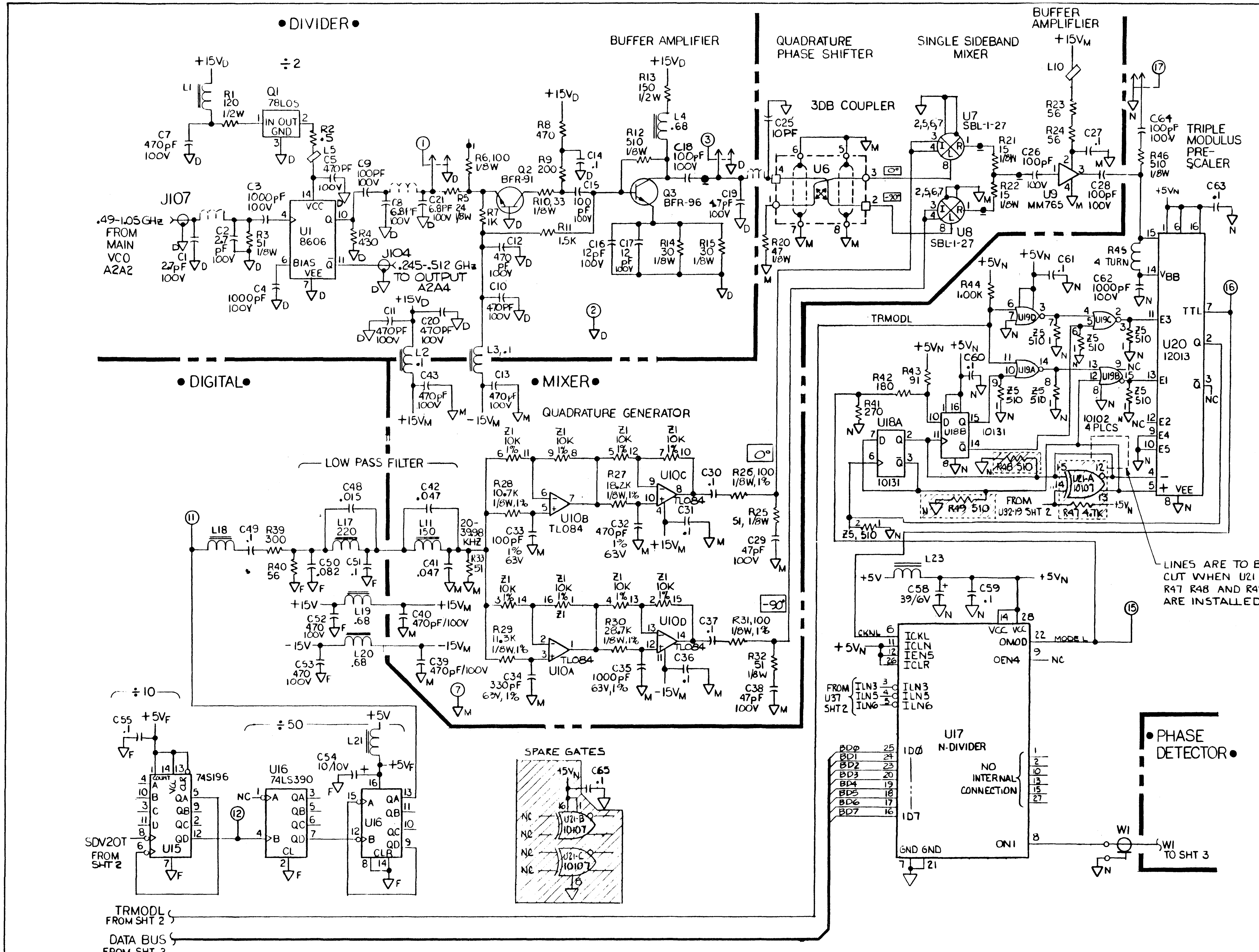



Figure 8-6. A2A1 Synthesizer PCA




NOTES: (UNLESS OTHERWISE SPECIFIED).

1. ALL RESISTANCES ARE IN OHMS. ALL RESISTORS ARE 1/4W. ALL RESISTORS ARE 5%.
2. ALL CAPACITANCES ARE IN MICROFARADS. ALL CAPACITORS ARE 50V.
3. ALL CHOKES ARE 6-TURN BEADS.
4. ALL DIODES ARE 1N4448.
5. ALL INDUCTOR VALUES ARE IN MICROHENRIES.
6. SYMBOLS DRAWN WITH DASHED LINES INDICATE COMPONENTS PRINTED ON CIRCUIT BOARD.
7. THE SYMBOL '—●—' INDICATES TRANSMISSION LINES OF OTHER THAN 50 OHM IMPEDANCE WHICH CONSTITUTE CIRCUIT ELEMENTS. 50 OHM TRANSMISSION PATHS ARE NOT INDICATED.
8. PARTS IN SHADED AREAS ARE OPTIONAL AND ARE NOT TO BE INSTALLED.

| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| C234 | C6, 22, 23, 24, 44, 45, 46, 47, 66, 67, 68, 90, 96, 97, 147, 148, 149, 170, 172, 203, 229, 56, 57, |
| CR27 | CR4, 19, 22, 23, 25, 1, 3 |
| L72 | L6, 7, 8, 9, 12, 13, 14, 15, 16, 24, 25, 26, 27, 28, 35, 36, 37, 38, 39, 45, 46, 47, 48, 51, 52, 53, 55, 60, 61, 69, 22, 33 |
| Q37 | Q6, 8, 9, 24, 25, 29, 30, 31, 34, 36, 7 |
| R214 | R16, 17, 18, 19, 34, 35, 36, 37, 38, 50, 51, 52, 53, 54, 60, 61, 62, 63, 64, 70, 71, 125, 128, 126, 130, 131, 132, 140, 141, 142, 143, 144, 155, 156, 157, 158, 173, 174, 175, 176, 166, 168, 202, 203, 204, 205, 206, 207, 208 |
| TP56 | TP4, 5, 6, 8, 9, 10, 18, 19, 20, 28, 29, 30, 47, 48, 21 |
| U66 | U2, 3, 4, 5, 11, 12, 13, 14, 22, 23, 24, 25, 36, 39, 40, 51, 52, 53, 56, 57 |
| W3 | —— |
| Y1 | —— |
| Z10 | Z2, 3, 4, 7, 8 |

6060A-1019
(1 of 4)

**Figure 8-6. A2A1 Synthesizer PCA (cont)**

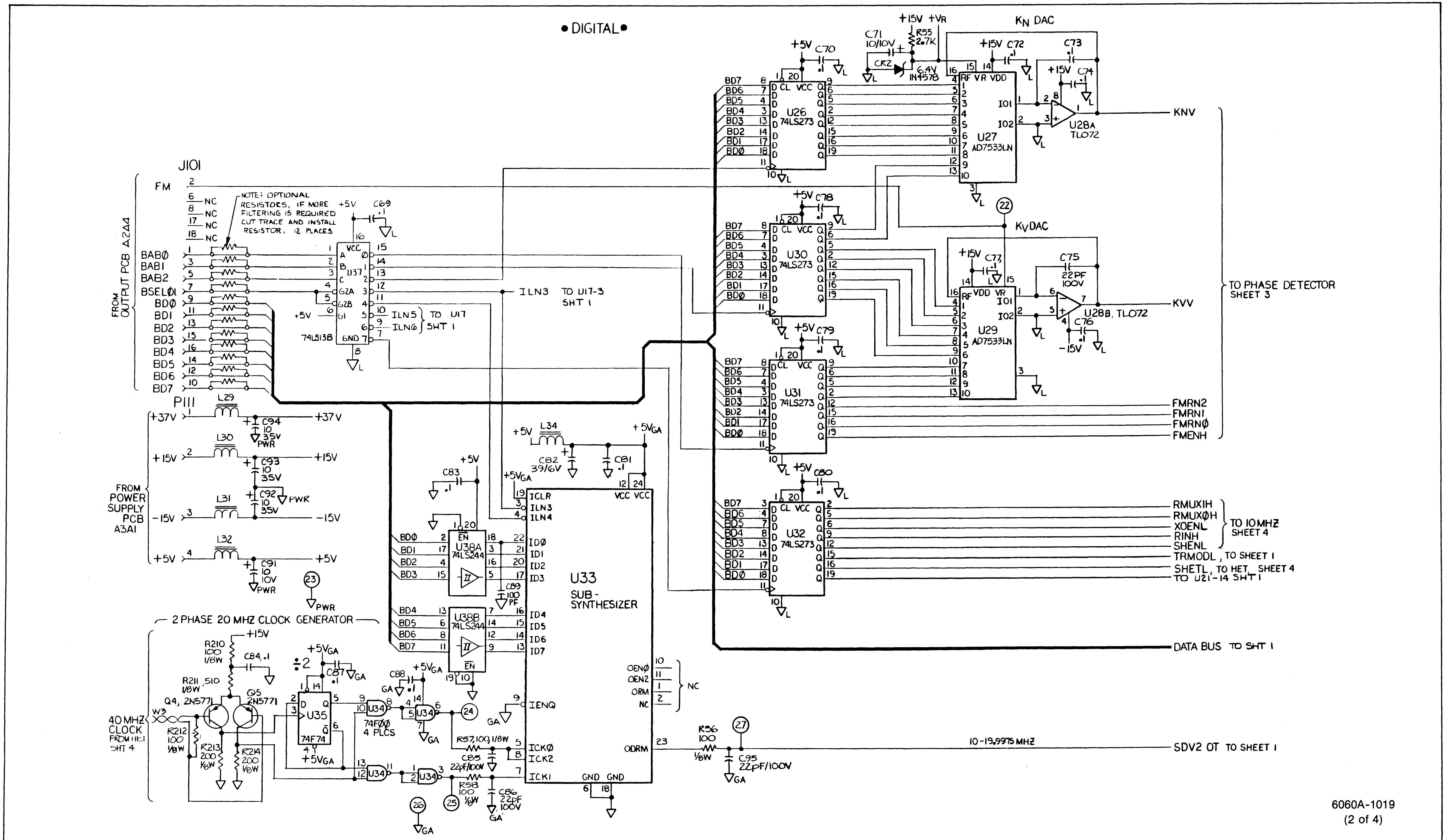



Figure 8-6. A2A1 Synthesizer PCA (cont)

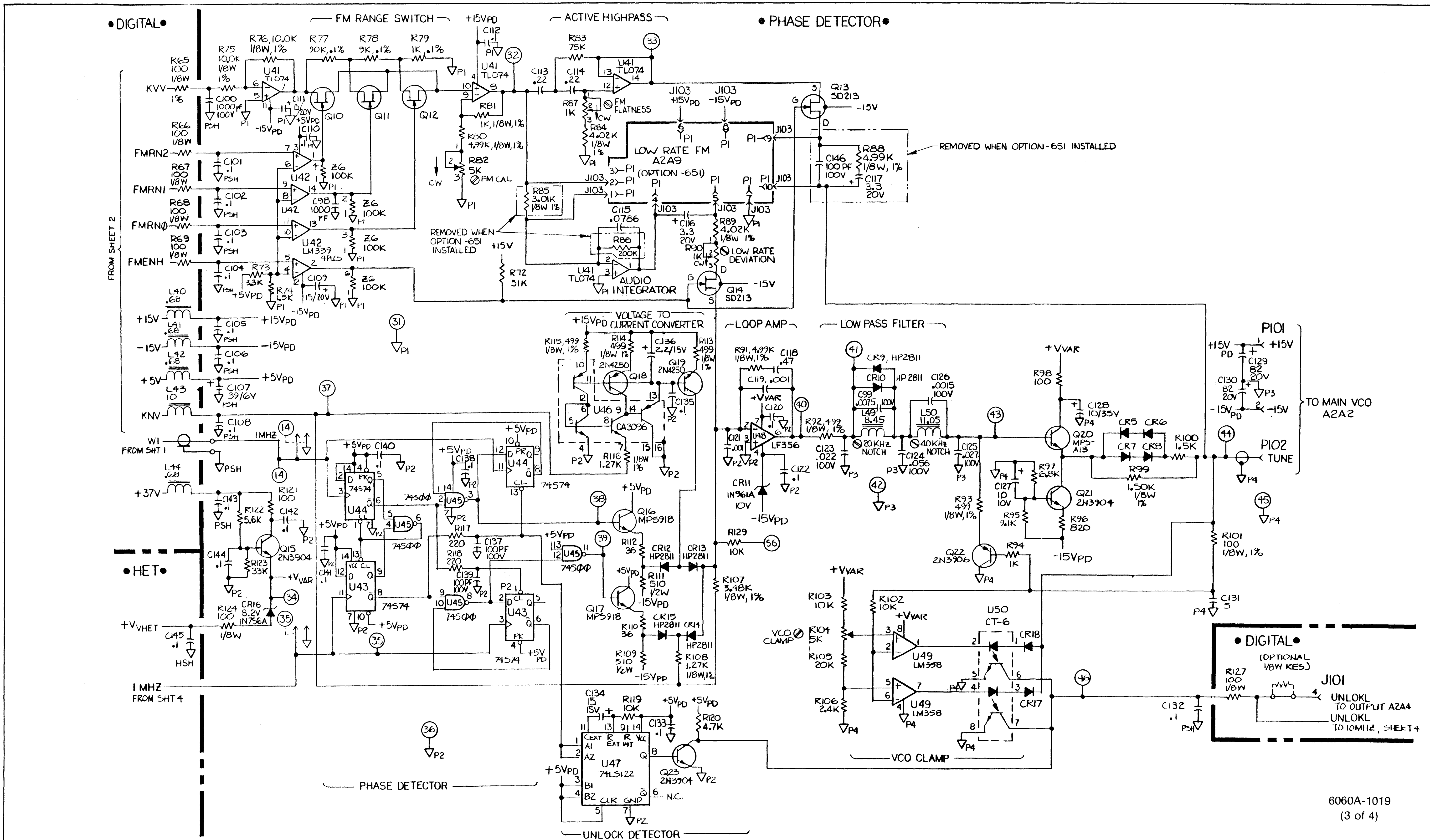



Figure 8-6. A2A1 Synthesizer PCA (cont)

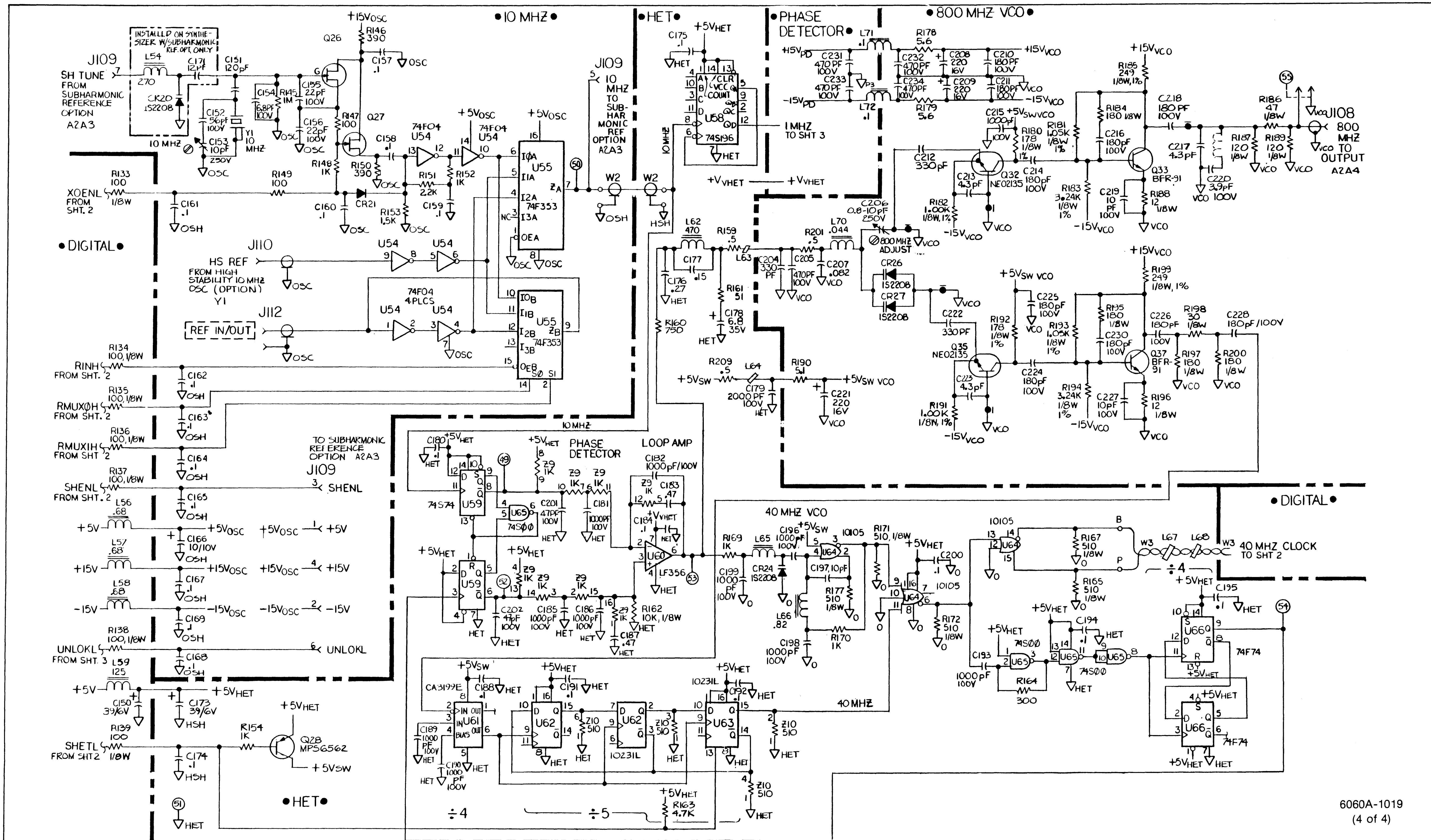
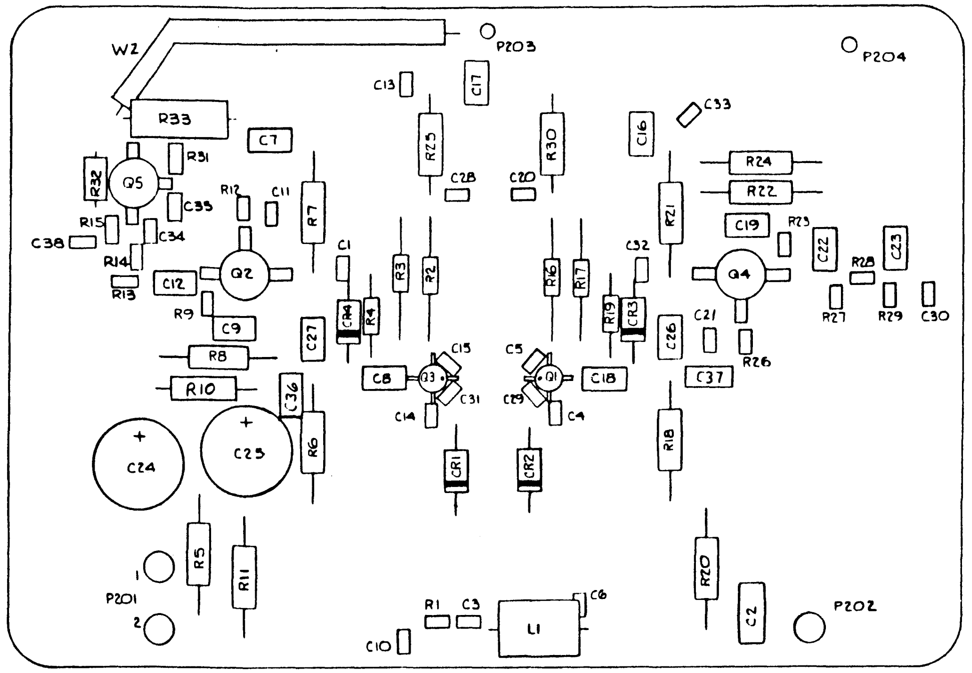



Figure 8-6. A2A1 Synthesizer PCA (cont)

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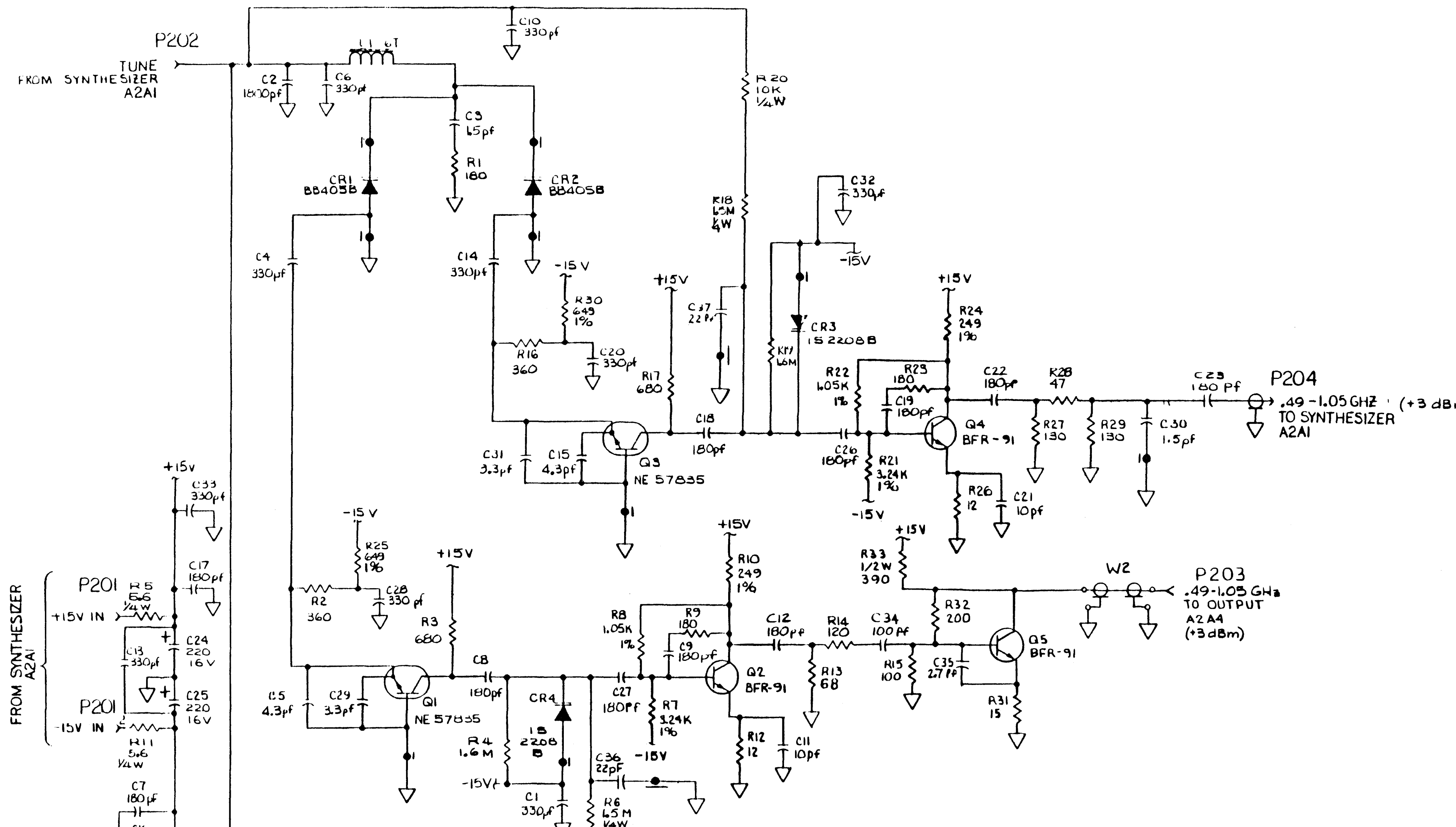



NOTES: (UNLESS OTHERWISE SPECIFIED.)

1. ALL RESISTOR VALUES ARE IN OHMS, 5%
ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. ALL RESISTORS ARE 1/8W.

| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| R33 | P1-200 |
| C38 | |
| Q5 | |
| CR4 | |
| L1 | |
| P204 | |
| W2 | W1 |

6060A-1018

Figure 8-7. A2A2 VCO PCA

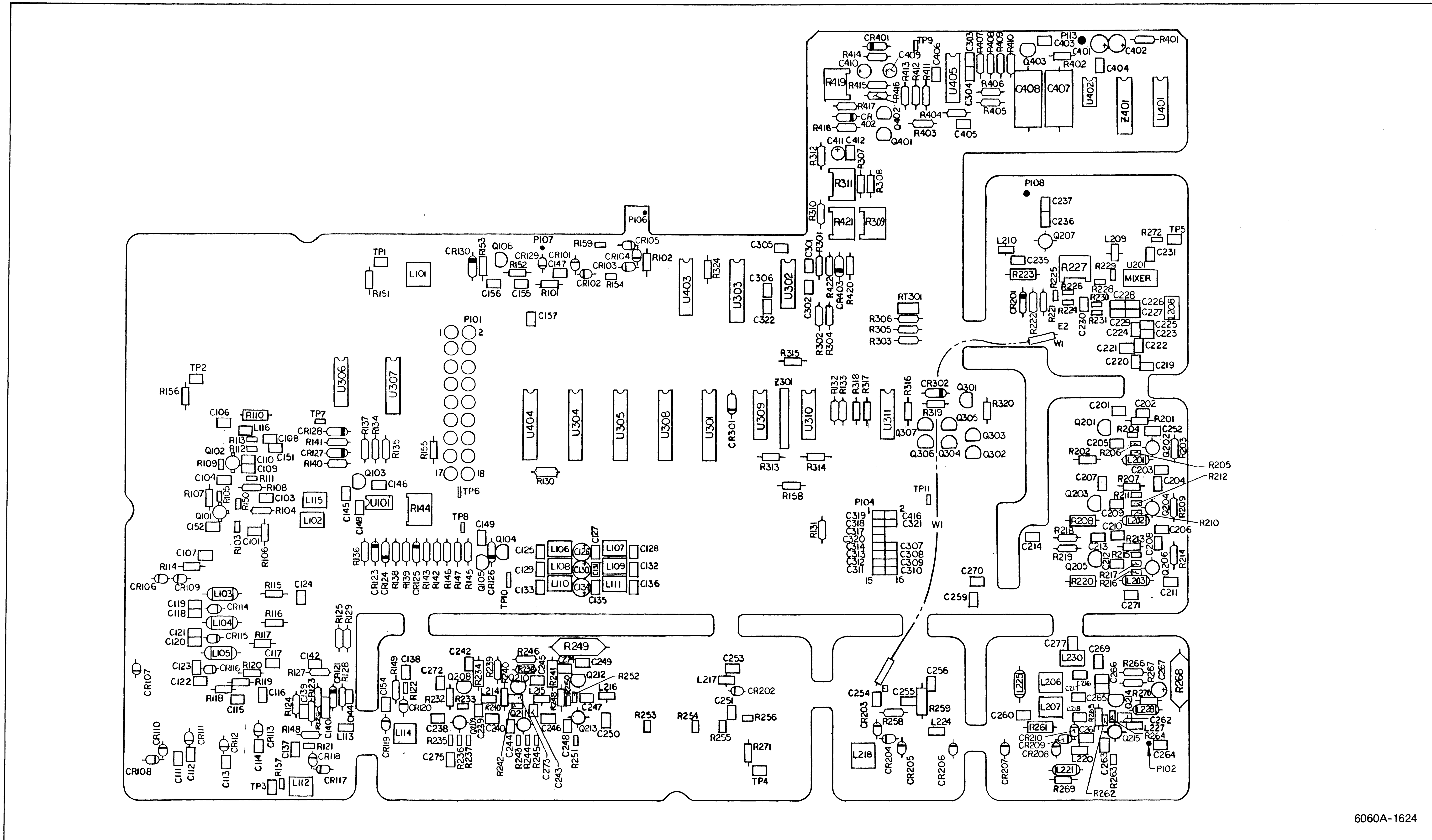



Figure 8-8. A2A4 Output PCA

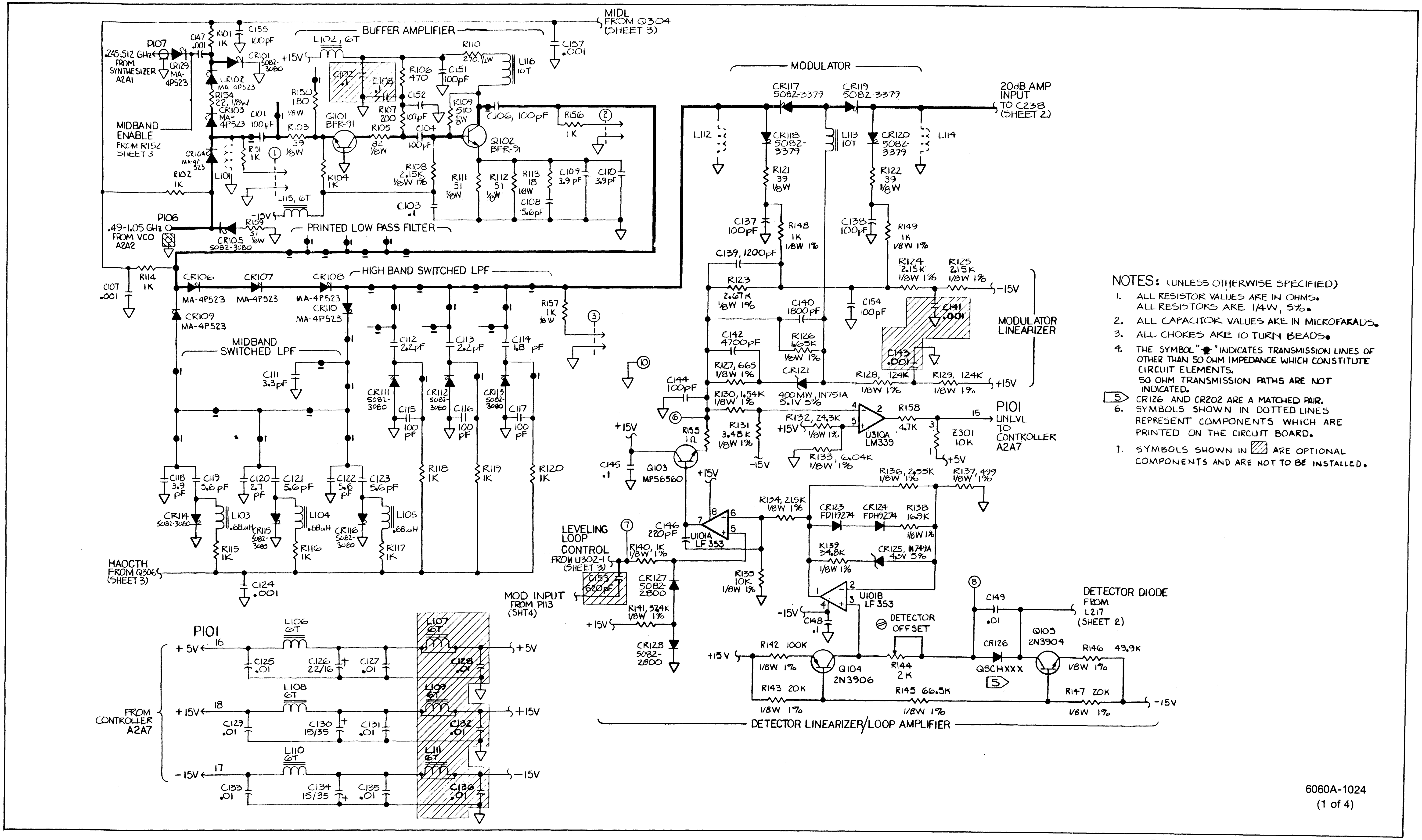



Figure 8-8. A2A4 Output PCA (cont)

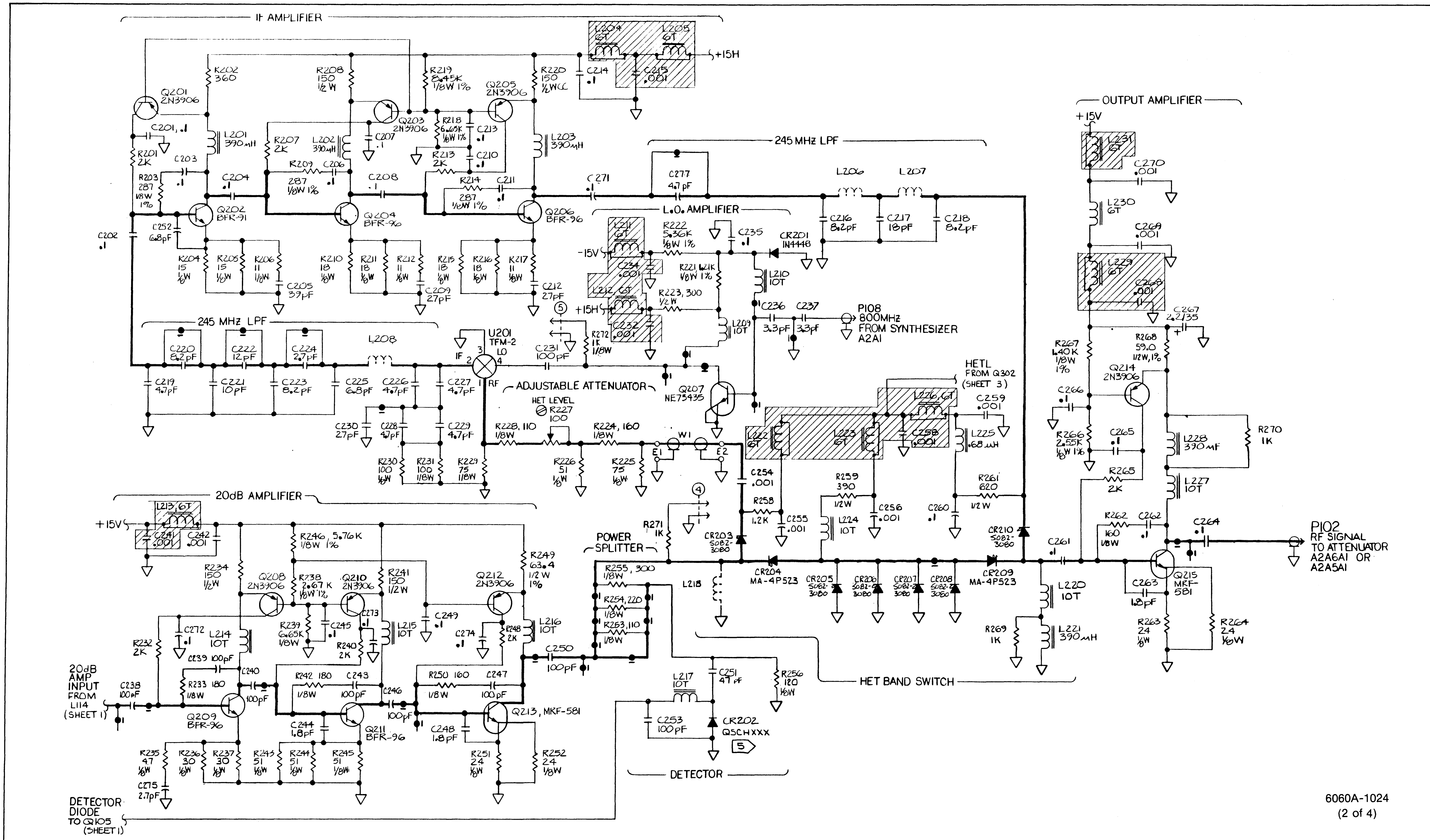



Figure 8-8. A2A4 Output PCA (cont)

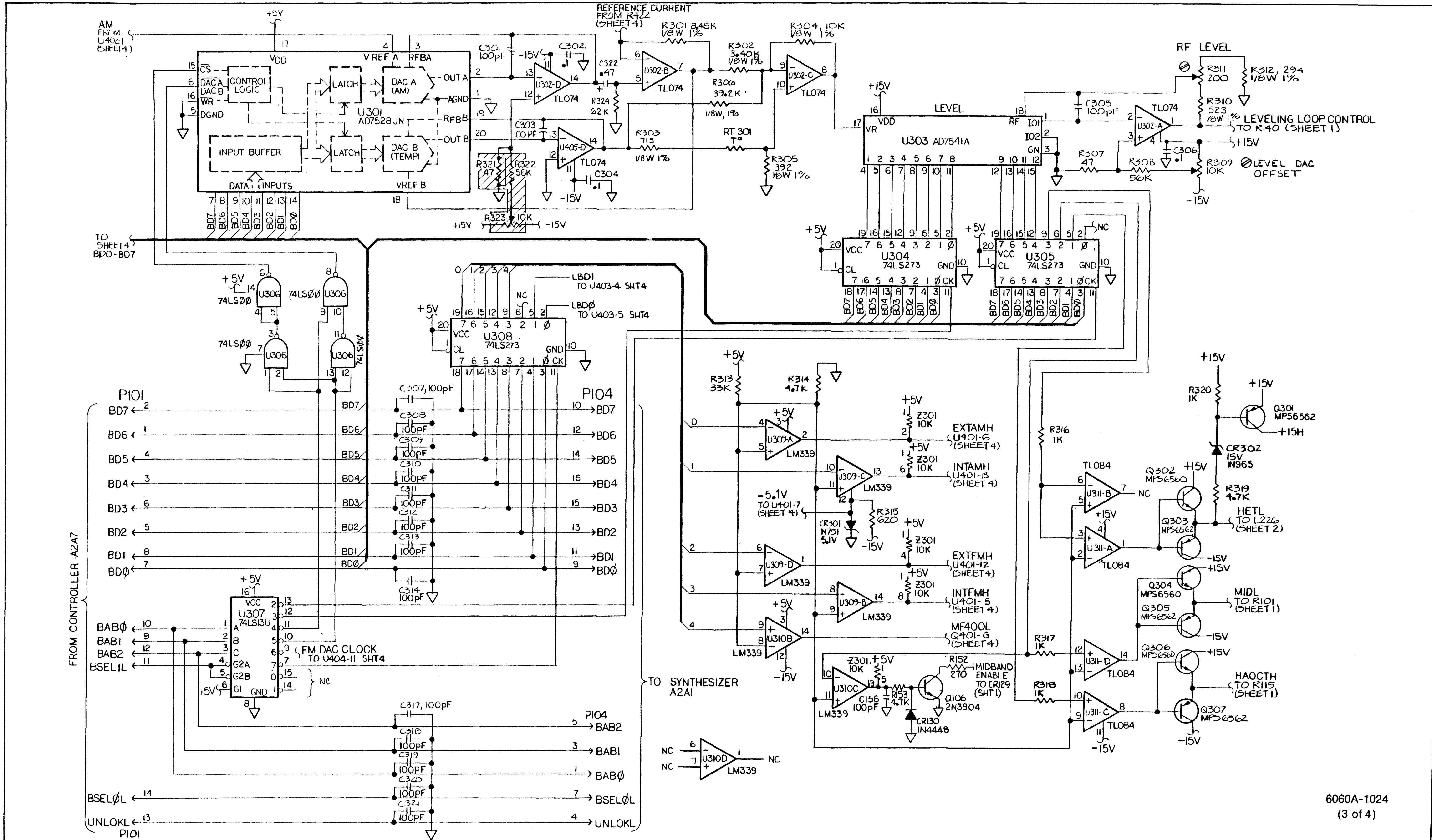



Figure 8-8. A2A4 Output PCA (cont)

| REFERENCE DESIGNATIONS. | |
|---|---|
| LAST USED | NOT USED |
| C416 | C1-100, C150, C158-C200, C233, C257, C276, C278-300, C315, C316, C323-400. |
| CR403 | CR1-100, CR122, CR131-200, CR211-300, CR303-400. |
| L231 | L1-100, L117-200, L219. |
| Q403 | Q1-100, Q107-200, Q216-300, Q308-400. |
| R422 | R1-100, R160-200, R247, R257, R260, R273-300, R325-400. |
| RT301 | RT1-300 |
| U405 | U1-100, U102-200, U202-300, U312-400. |
| Z401 | Z1-300, Z302-400. |
| P113 | P1-100, P103, P105, P109-112. |
| TP11 | —— |
| W1 | —— |

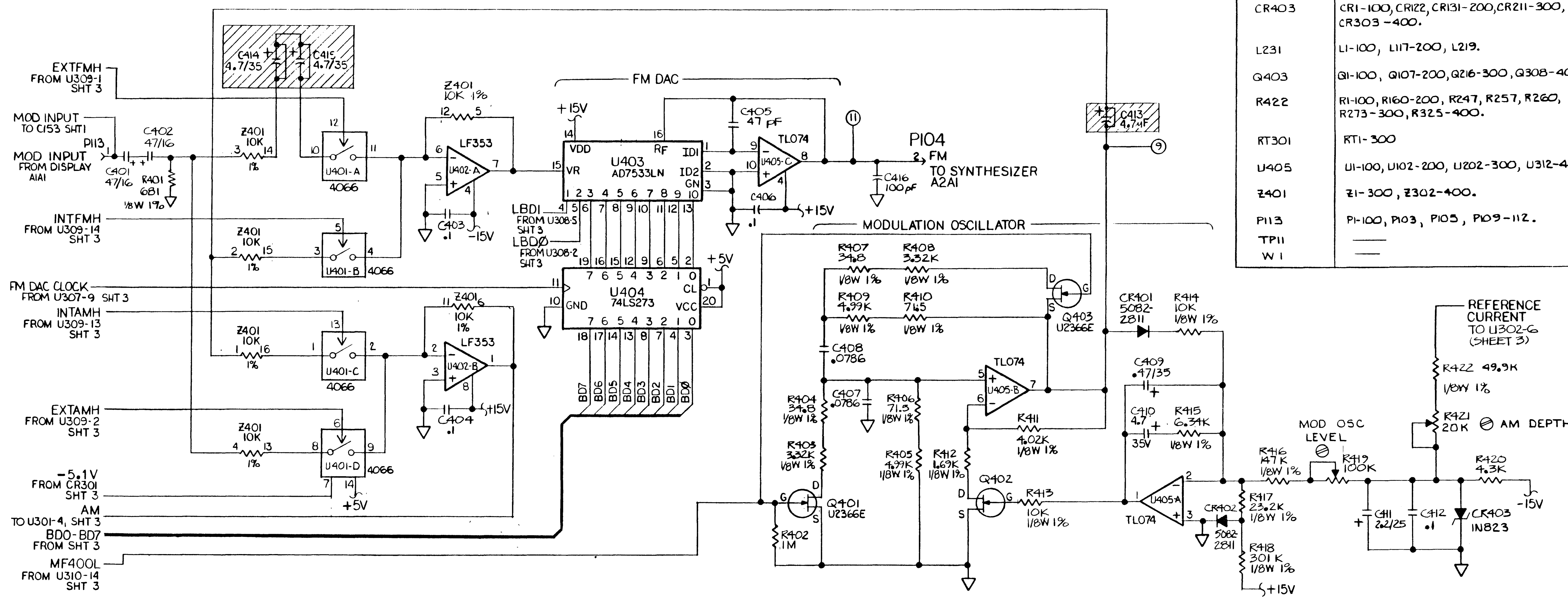
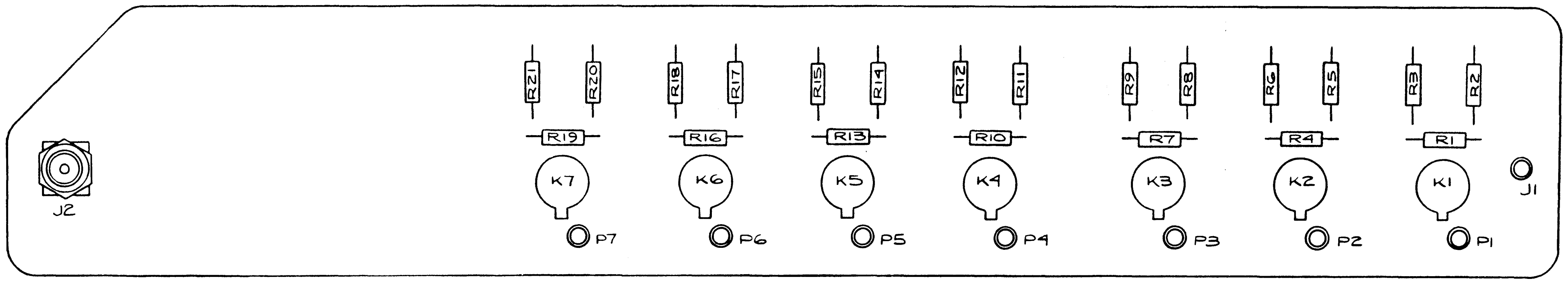
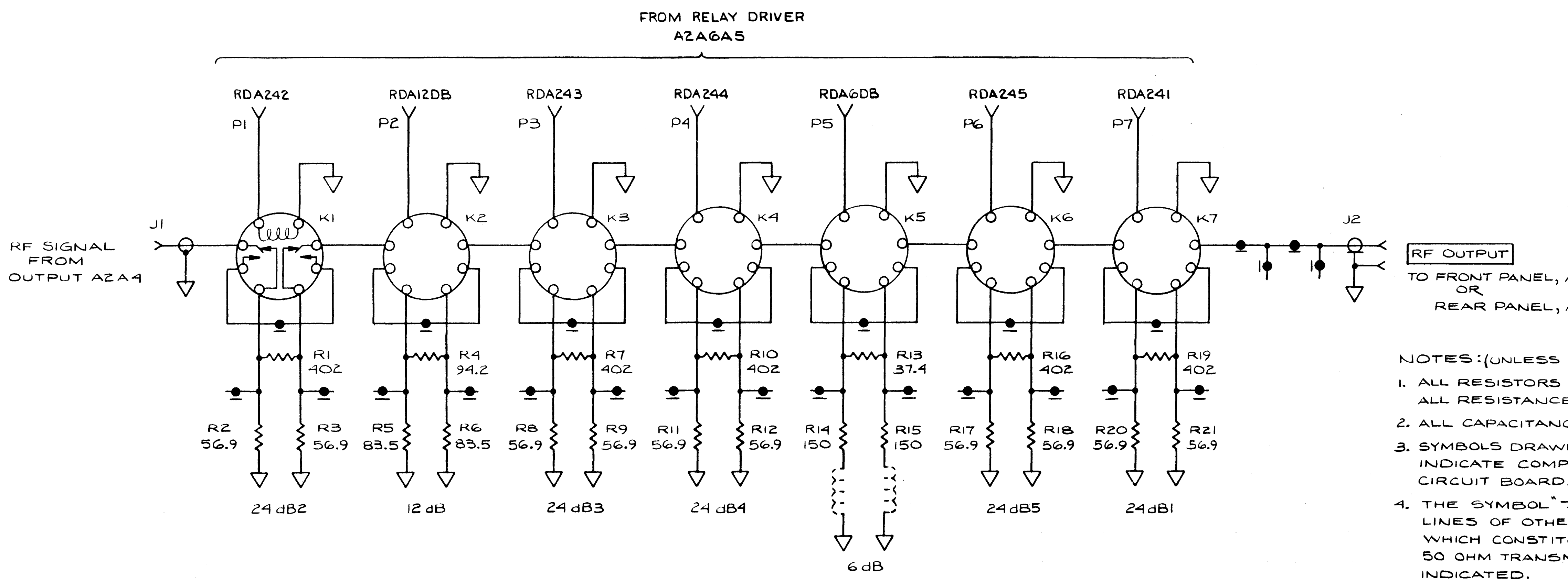



Figure 8-8. A2A4 Output PCA (cont)




6060A-1046



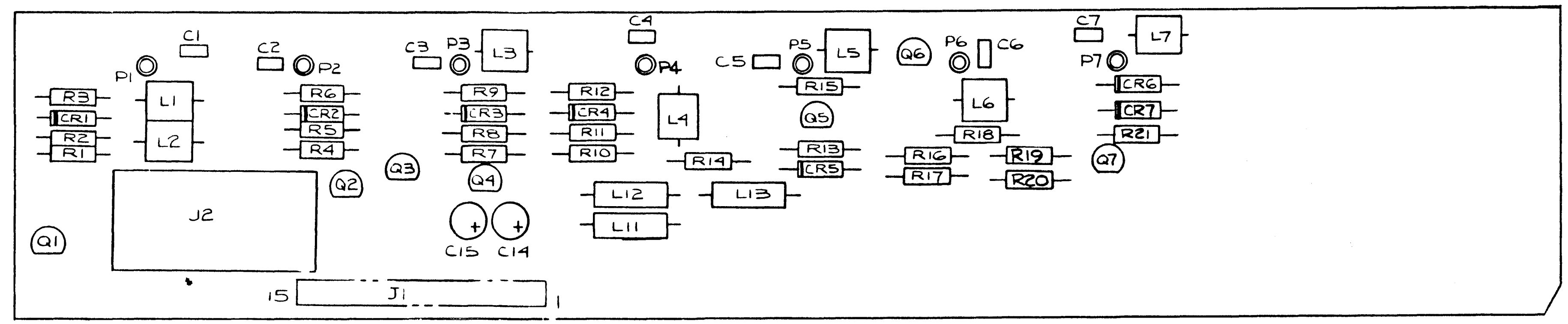

NOTES: (UNLESS OTHERWISE SPECIFIED).

1. ALL RESISTORS ARE 1/8 W, 0.5%. ALL RESISTANCES ARE IN OHMS.
2. ALL CAPACITANCES ARE IN MICROFARADS.
3. SYMBOLS DRAWN WITH DASHED LINES INDICATE COMPONENTS PRINTED ON CIRCUIT BOARD.
4. THE SYMBOL "-•-" INDICATES TRANSMISSION LINES OF OTHER THAN 50 OHM IMPEDANCE WHICH CONSTITUTE CIRCUIT ELEMENTS. 50 OHM TRANSMISSION PATHS ARE NOT INDICATED.

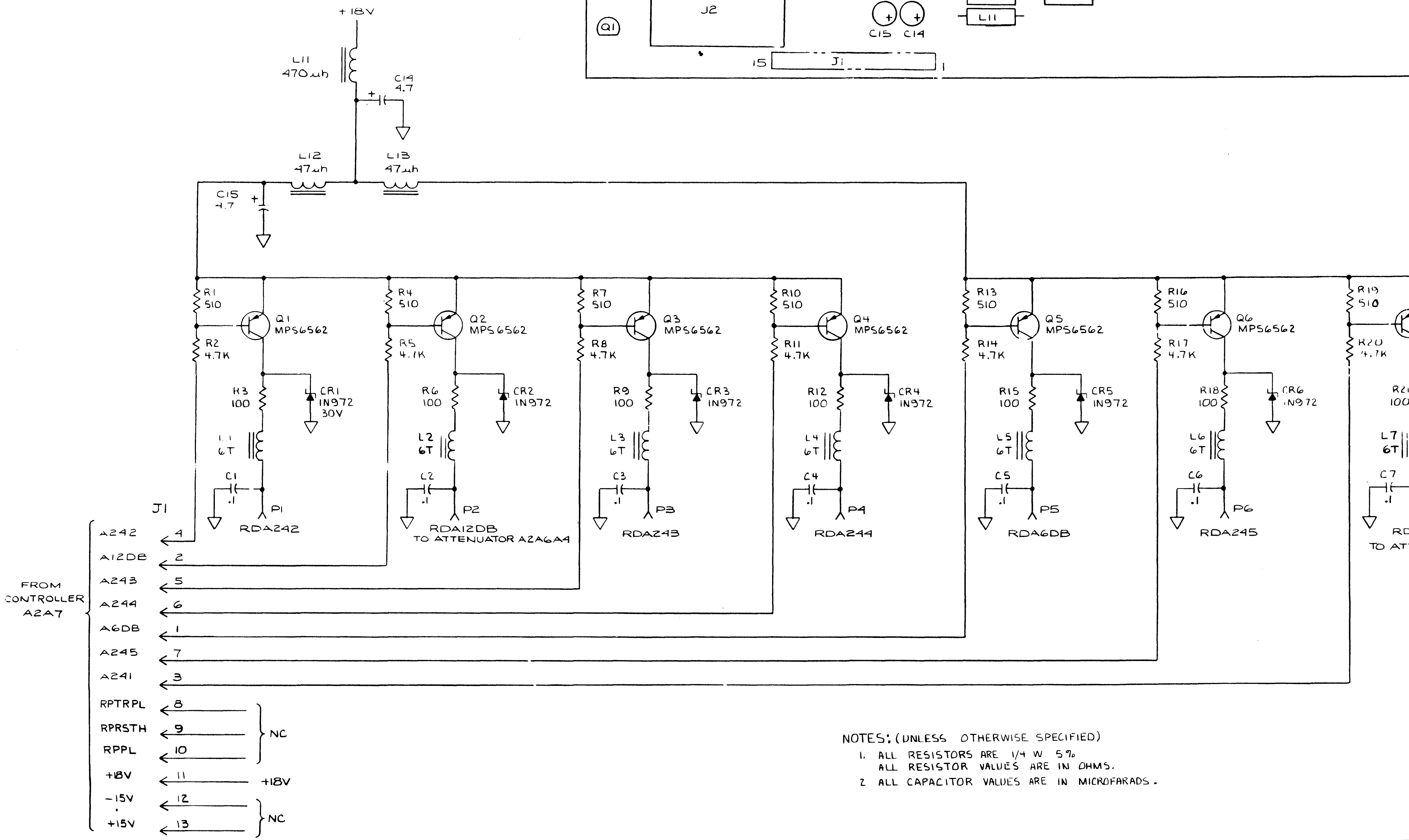
| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| J2<br>R21<br>K7<br>P7 | |

6060A-1646

**Figure 8-9. A2A6A4 Attenuator PCA**




6060A-1644

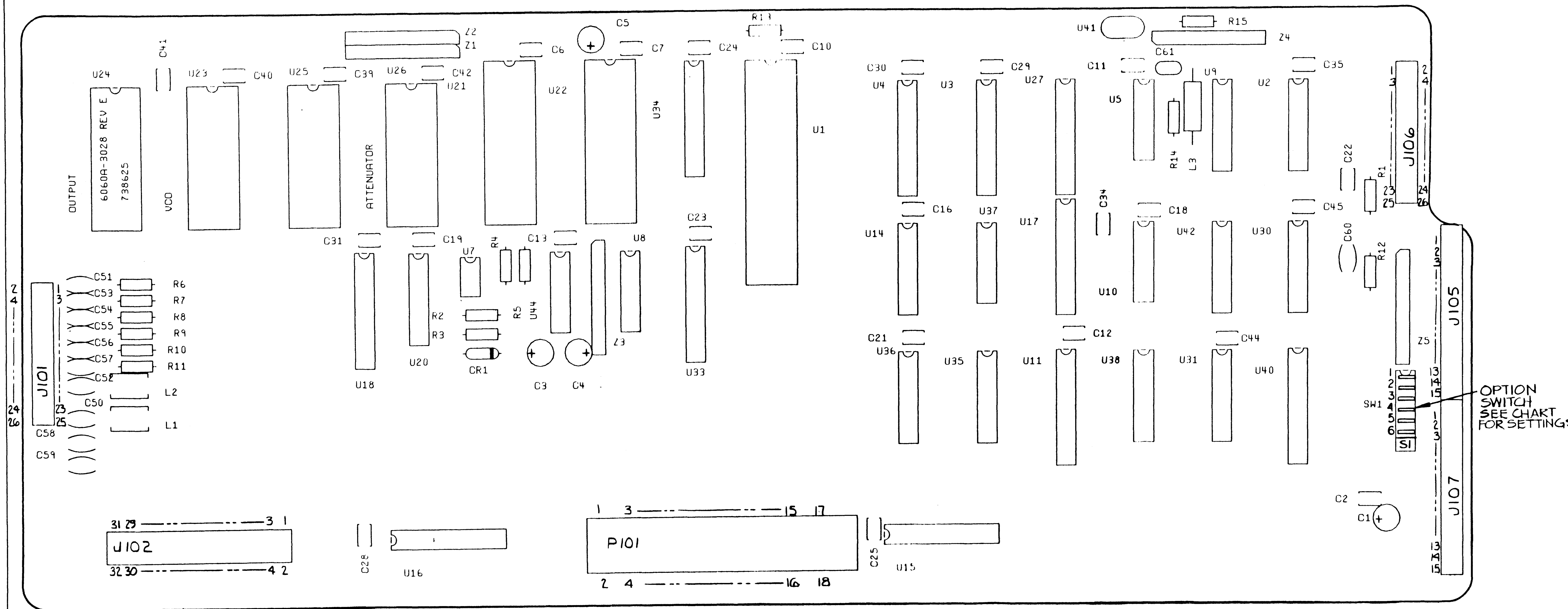



NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTORS ARE 1/4 W 5%
ALL RESISTOR VALUES ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

| REFERENCE DESIGNATIONS | |
|---|---|
| HIGHEST | NOT USED |
| R21 | |
| Q7 | |
| C15 | C8-C13 |
| CR7 | |
| L13 | L8-L10 |
| P7 | |
| J1 | |

6060A-1044

Figure 8-10. A2A6A5 Relay Driver PCA



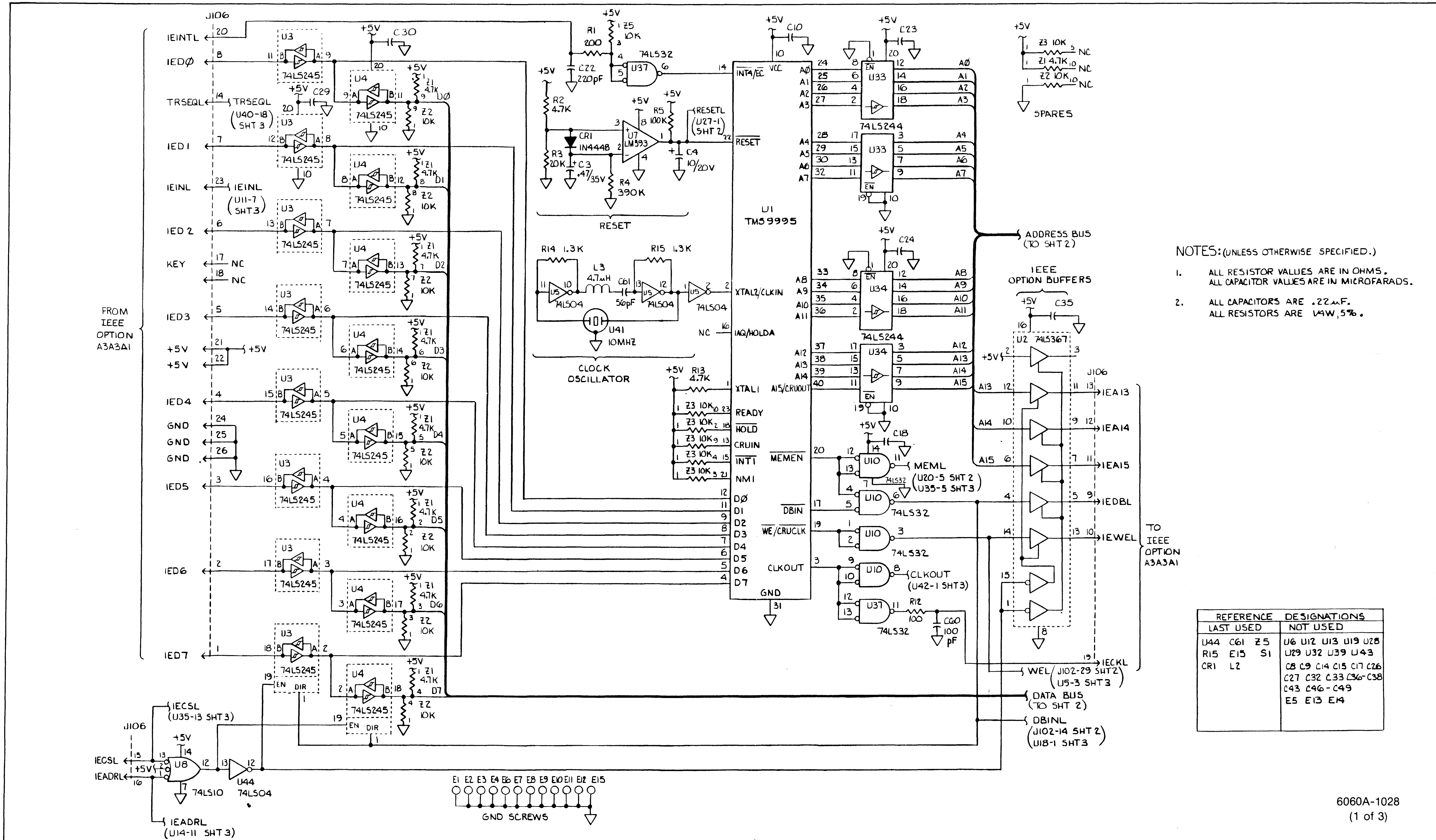

OPTION SWITCH SETTINGS (S1)

| SWITCH SECTION IN "ON" POSITION | OPTION INSTALLED |
|---|---|
| 1 | SUBHARMONIC REFERENCE OPTION -131 |
| 3 | LOW RATE FM OPTION -651 |
| 4 | REAR OUTPUT OPTION -830 |

ALL OTHER SWITCH SECTIONS SHALL BE IN "OFF" POSITION

6060A-1628

**Figure 8-11. A2A7 Controller PCA**




NOTES: (UNLESS OTHERWISE SPECIFIED.)

1. ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL CAPACITORS ARE .22 µF. ALL RESISTORS ARE 1/4W, 5%.

| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| U44 C61 Z5<br>R15 E15 S1<br>CR1 L2 | U6 U12 U13 U19 U28<br>U29 U32 U39 U43<br>C8 C9 C14 C15 C17 C26<br>C27 C32 C33 C36-C38<br>C43 C46-C49<br>E5 E13 E14 |

Figure 8-11. A2A7 Controller PCA (cont)

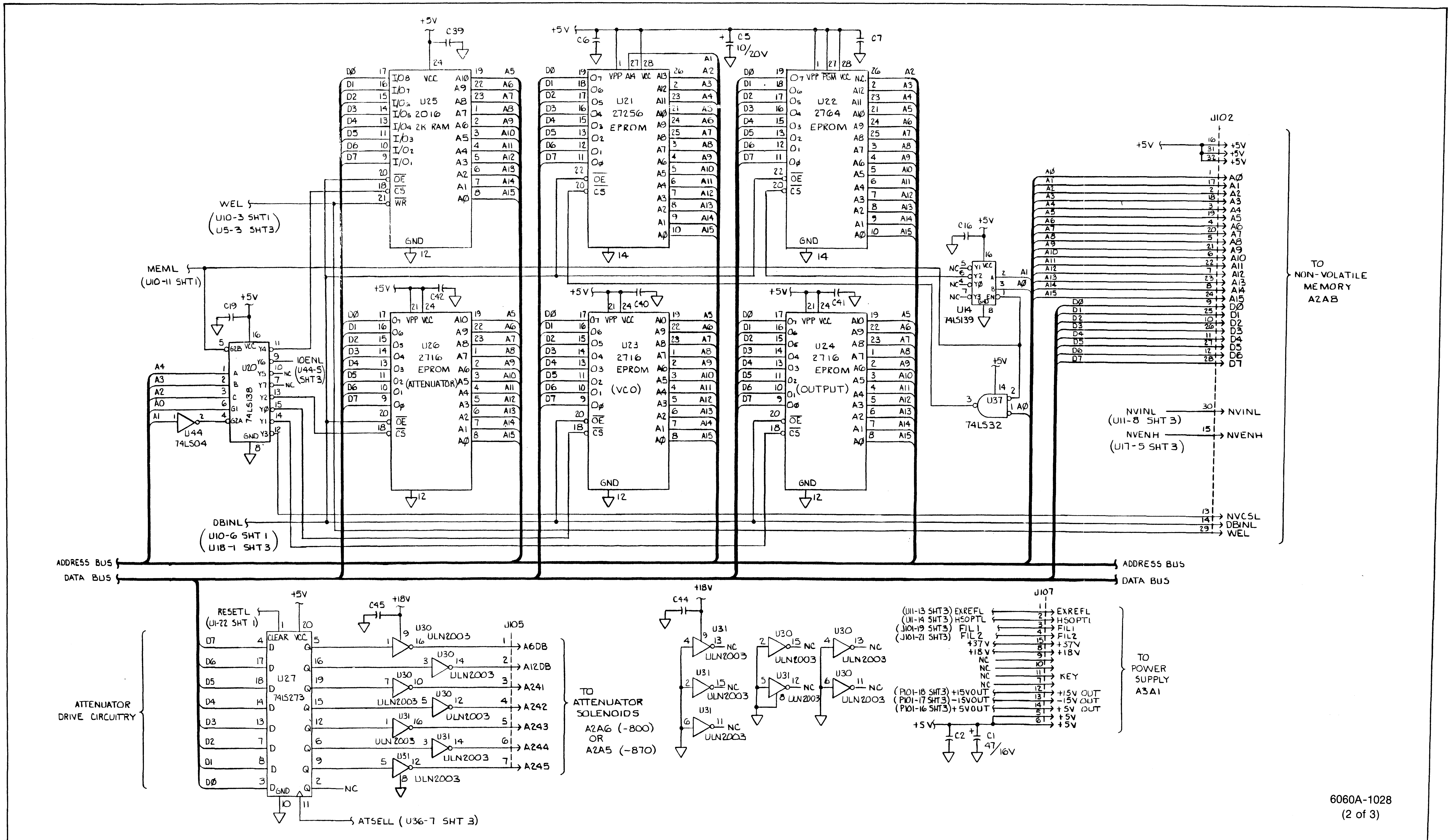


Figure 8-11. A2A7 Controller PCA (cont)

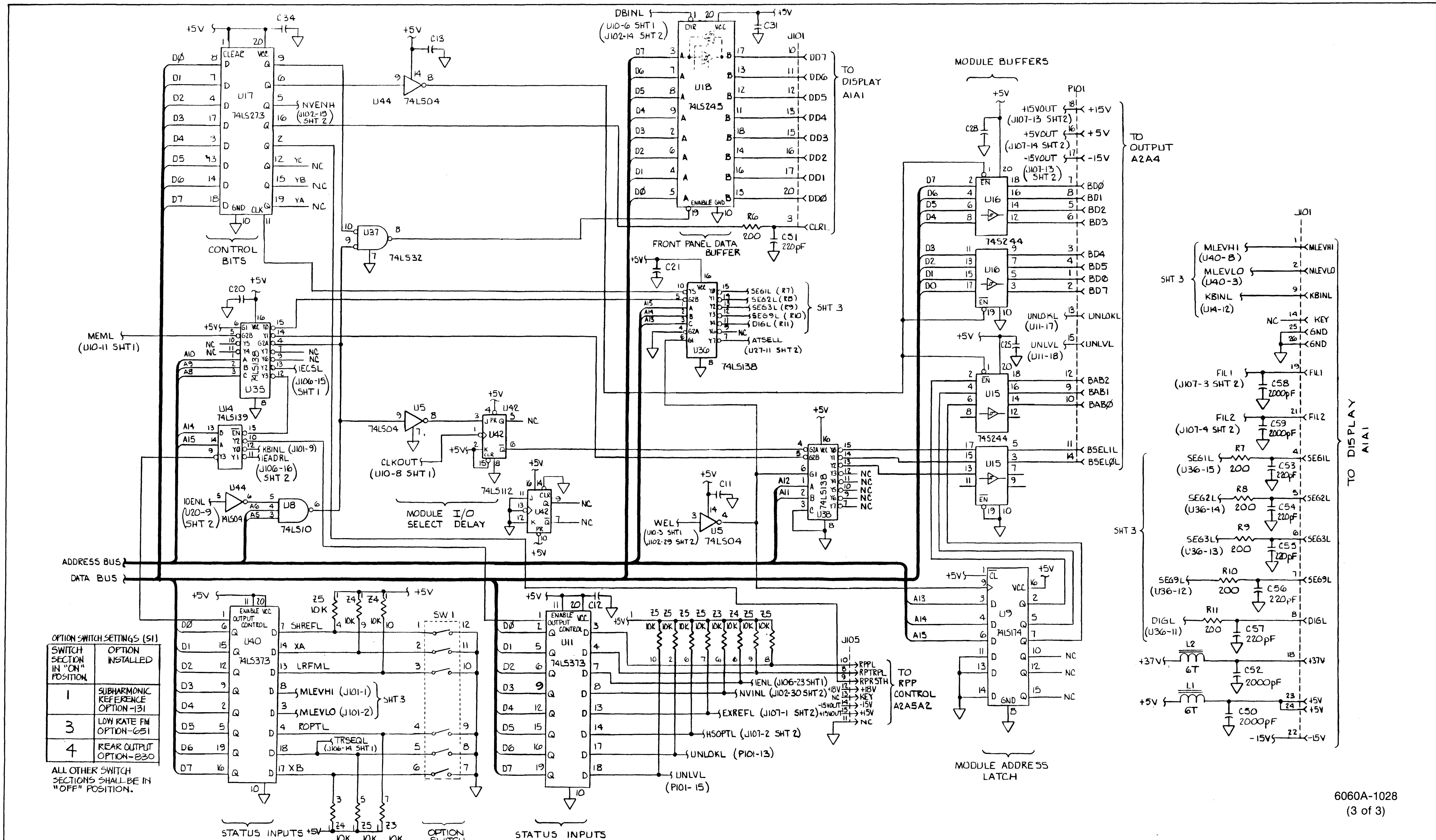
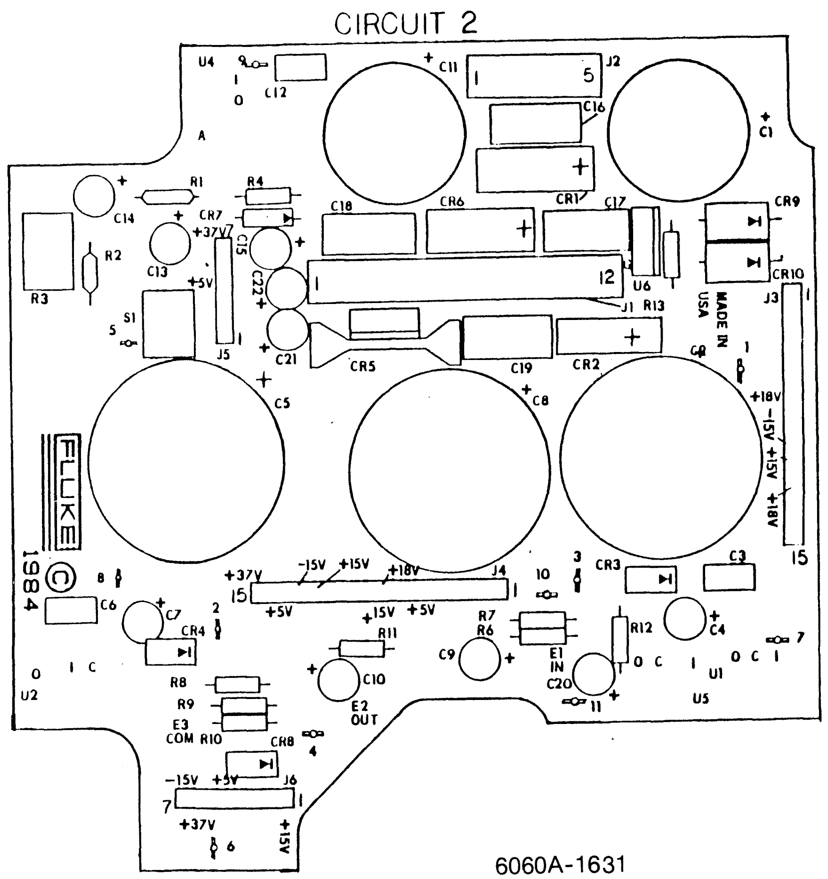
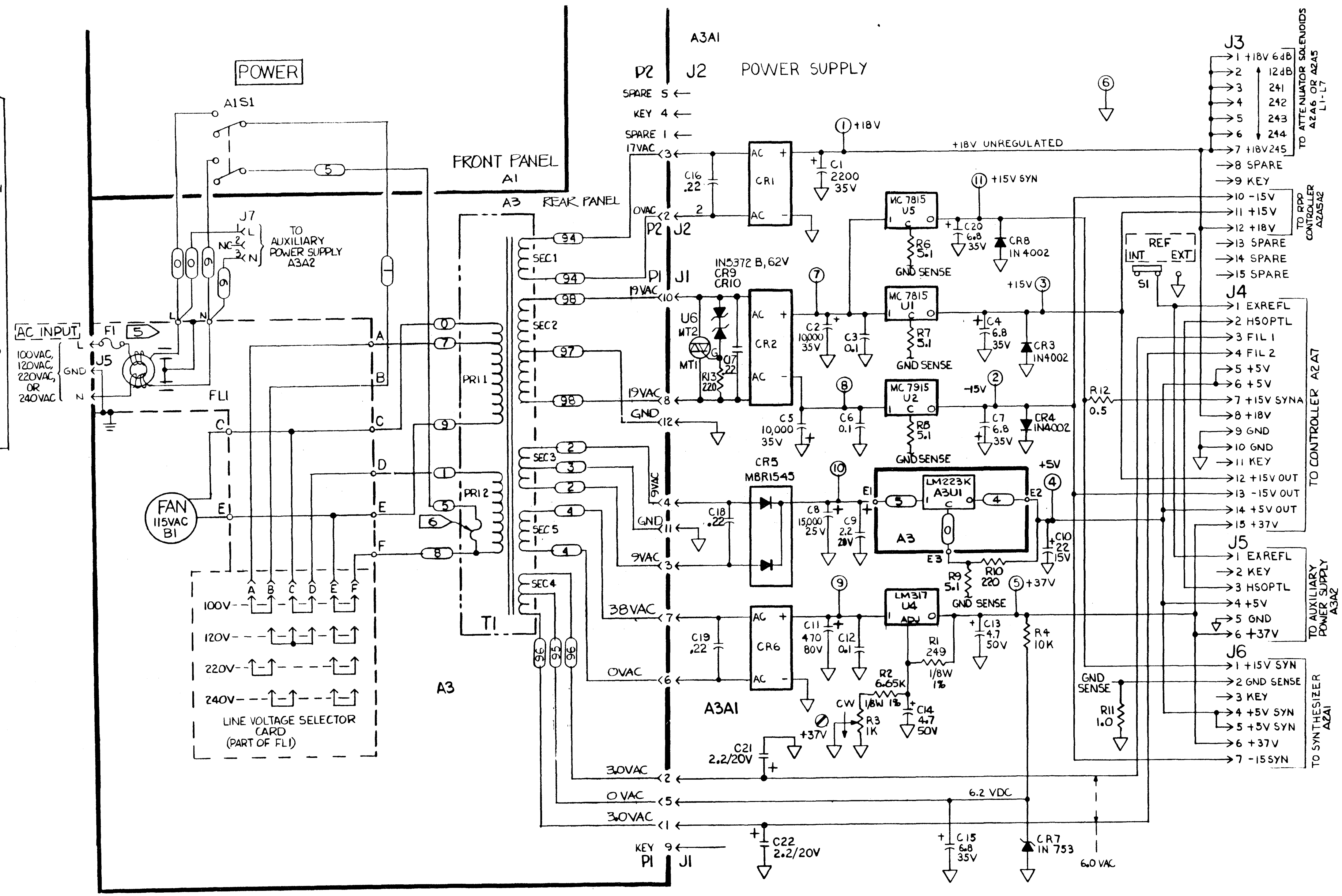



Figure 8-11. A2A7 Controller PCA (cont)




**A3A1 REFERENCE DESIGNATIONS**

| LAST USED | UNUSED |
|---|---|
| R13 | R5 |
| C22 | U3 |
| CR10 | |
| U6 | |
| S1 | |
| TP11 | |

NOTES: UNLESS OTHERWISE SPECIFIED.

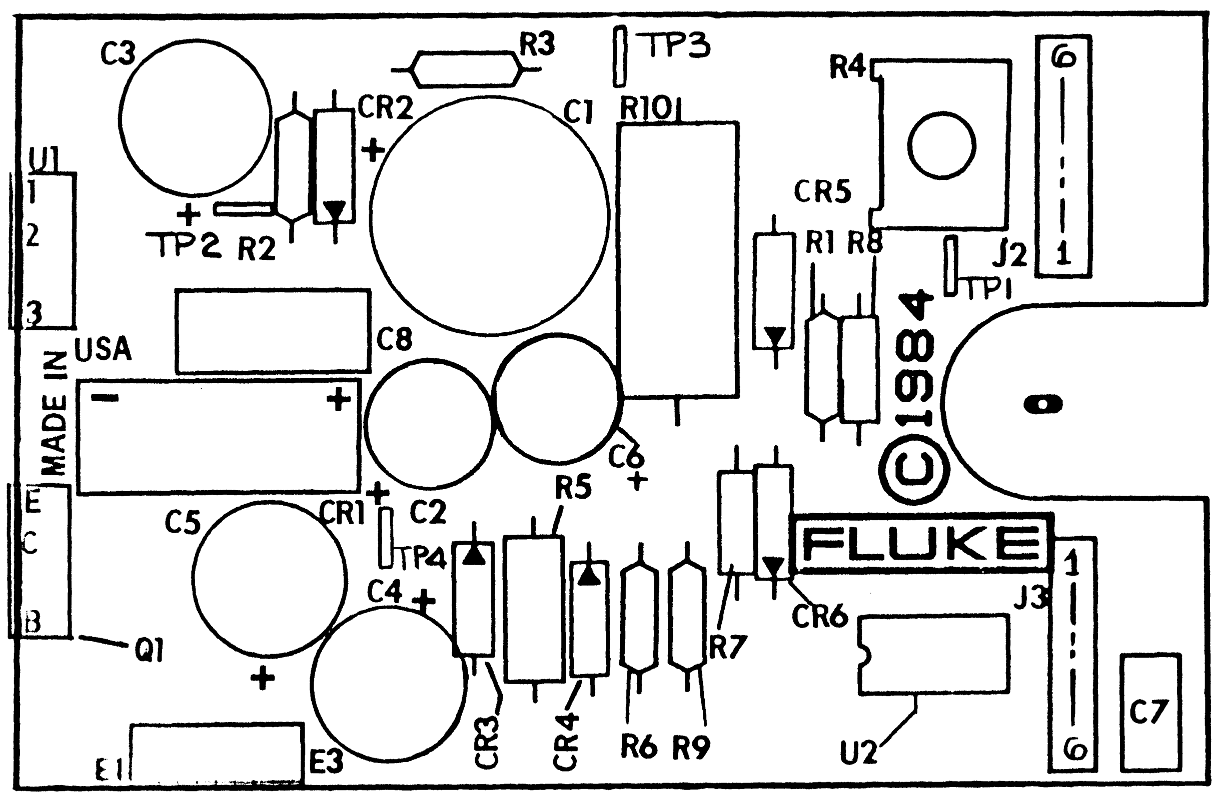
1. ALL RESISTANCES IN OHMS. ALL RESISTORS 1/4 W, 5%.
2. ALL CAPACITANCES IN MICROFARADS.

5 RATING OF F1: 1.5A WHEN AC INPUT IS 100/120 VAC; .75A WHEN AC INPUT IS 200/240 VAC

6 THERMAL PROTECTOR INTERNAL TO T1.

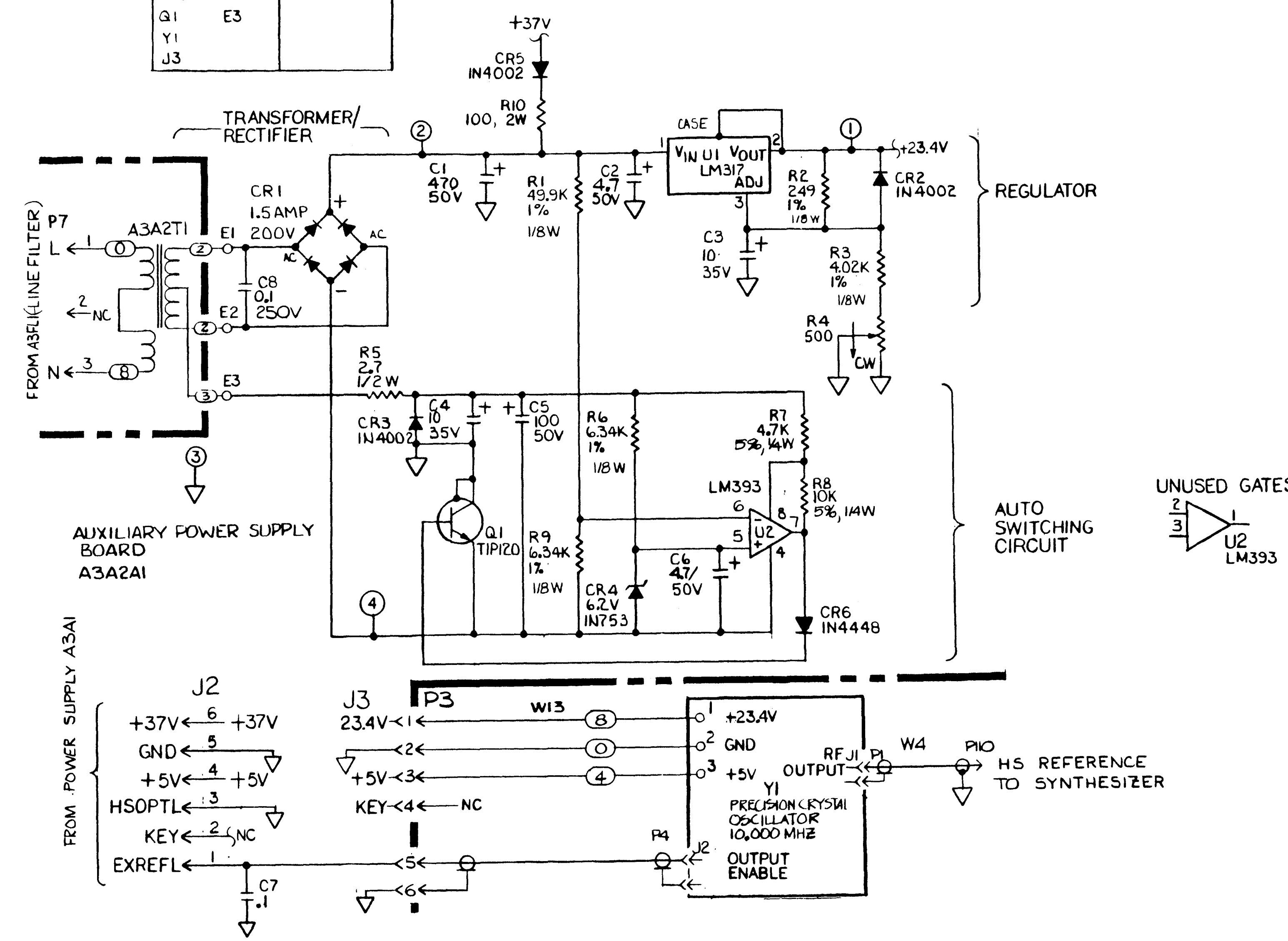
6060A-1031

**Figure 8-12. A3A1 Power Supply PCA**




6060A-1632

| REFERENCE DESIGNATIONS | | |
|---|---|---|
| HIGHEST USED | | NOT USED |
| R10 | C8 | J1 |
| CR6 | U2 | |
| Q1 | E3 | |
| Y1 | | |
| J3 | | |

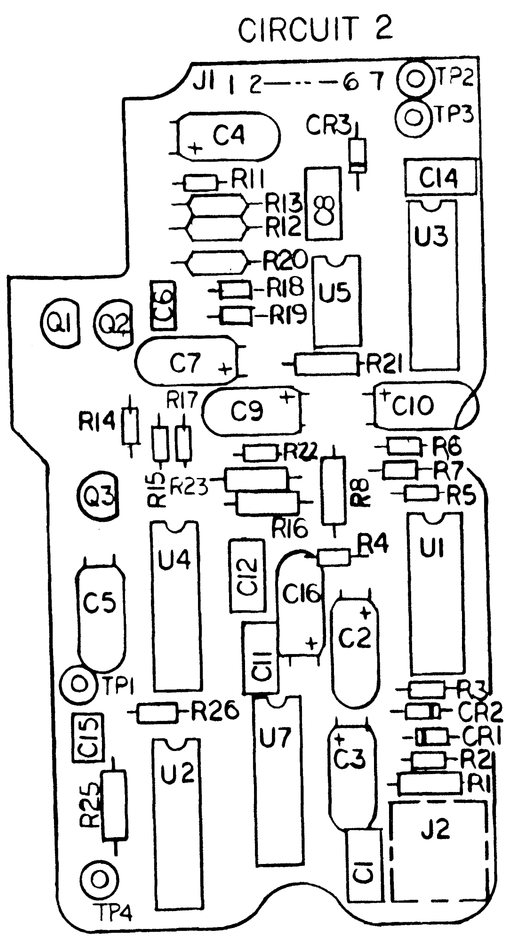



NOTES : (UNLESS OTHERWISE SPECIFIED.)

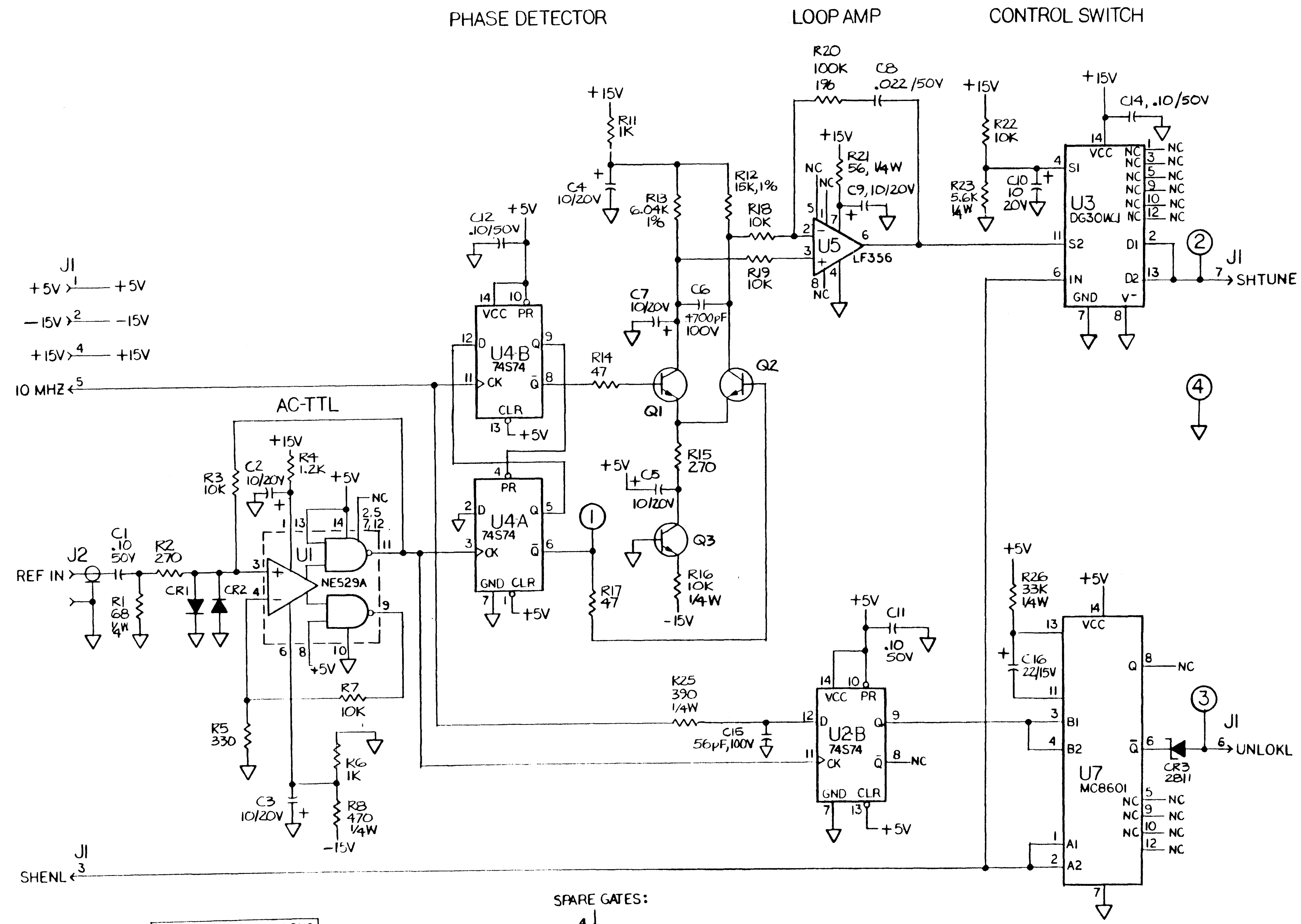
1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL CAPACITOR VALUES ARE IN MICROFARADS

6060A-1032

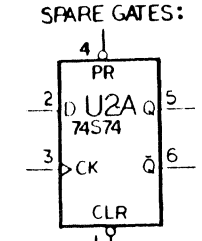
Figure 8-13. A3A2A1 High-Stability (Ovened) Reference PCA




6060A-1623




SPARE GATES:




NOTES: (UNLESS OTHERWISE SPECIFIED.)

1. ALL RESISTORS ARE 1/8W.
   ALL RESISTORS ARE 5%.
   ALL RESISTOR VALUES ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. ALL DIODES ARE IN4448.
4. ALL TRANSISTORS ARE MPS6520.

| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| C16 | C13 |
| CR3 | |
| Q3 | |
| R26 | R9, 10, 24 |
| TP4 | |
| U7 | U6 |
| J2 | |

**Figure 8-14. A2A3 Sub-Harmonic Reference PCA**

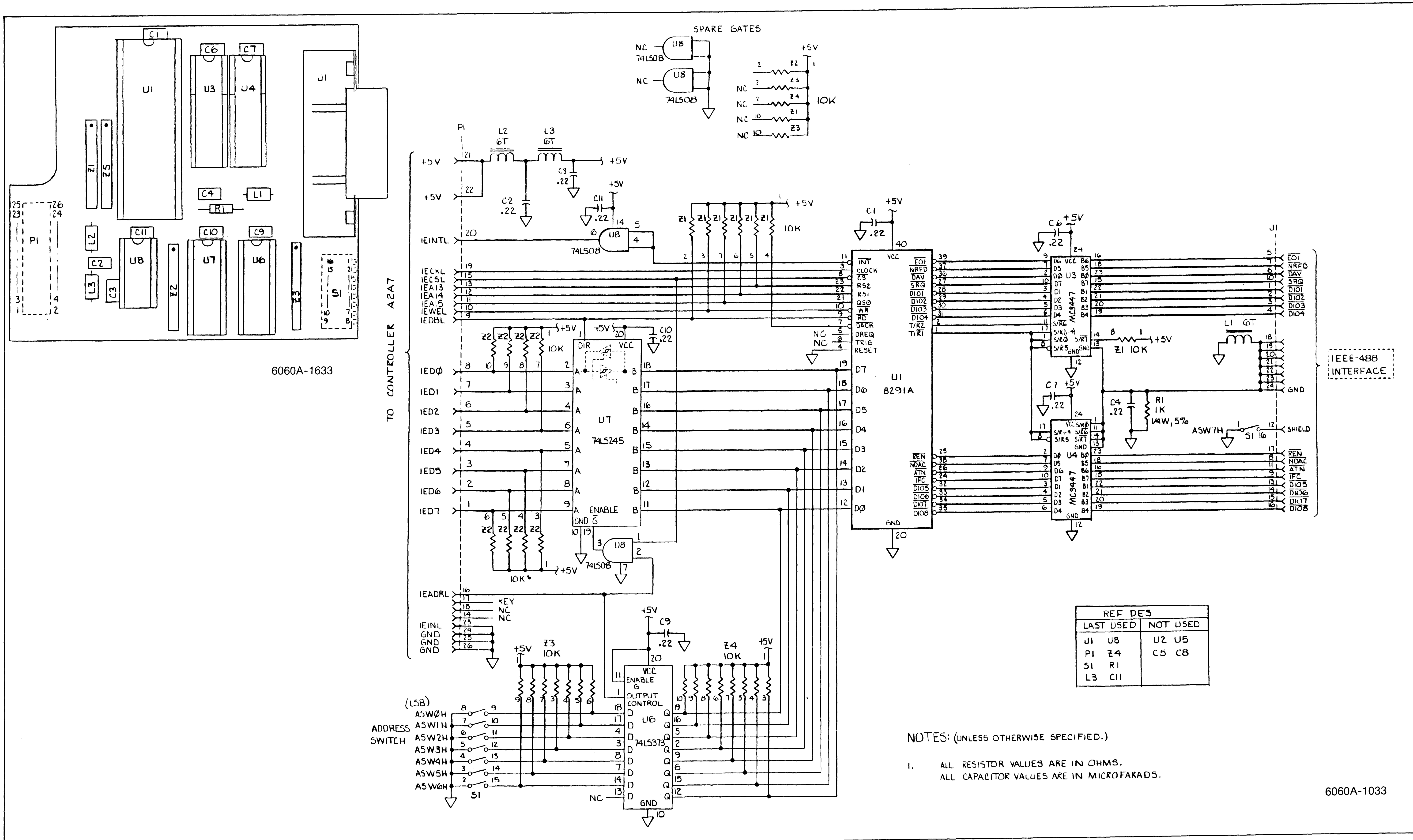
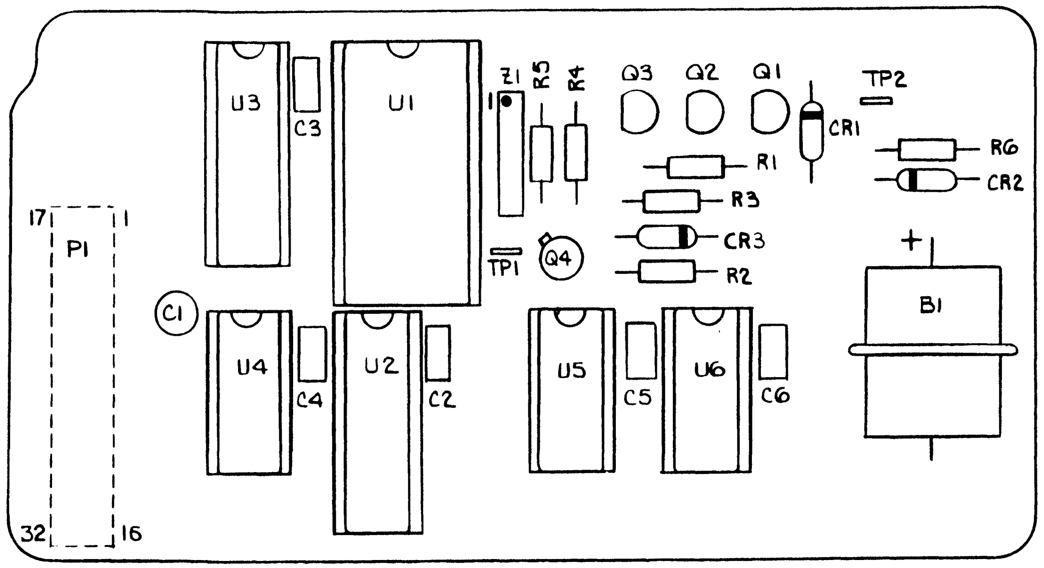
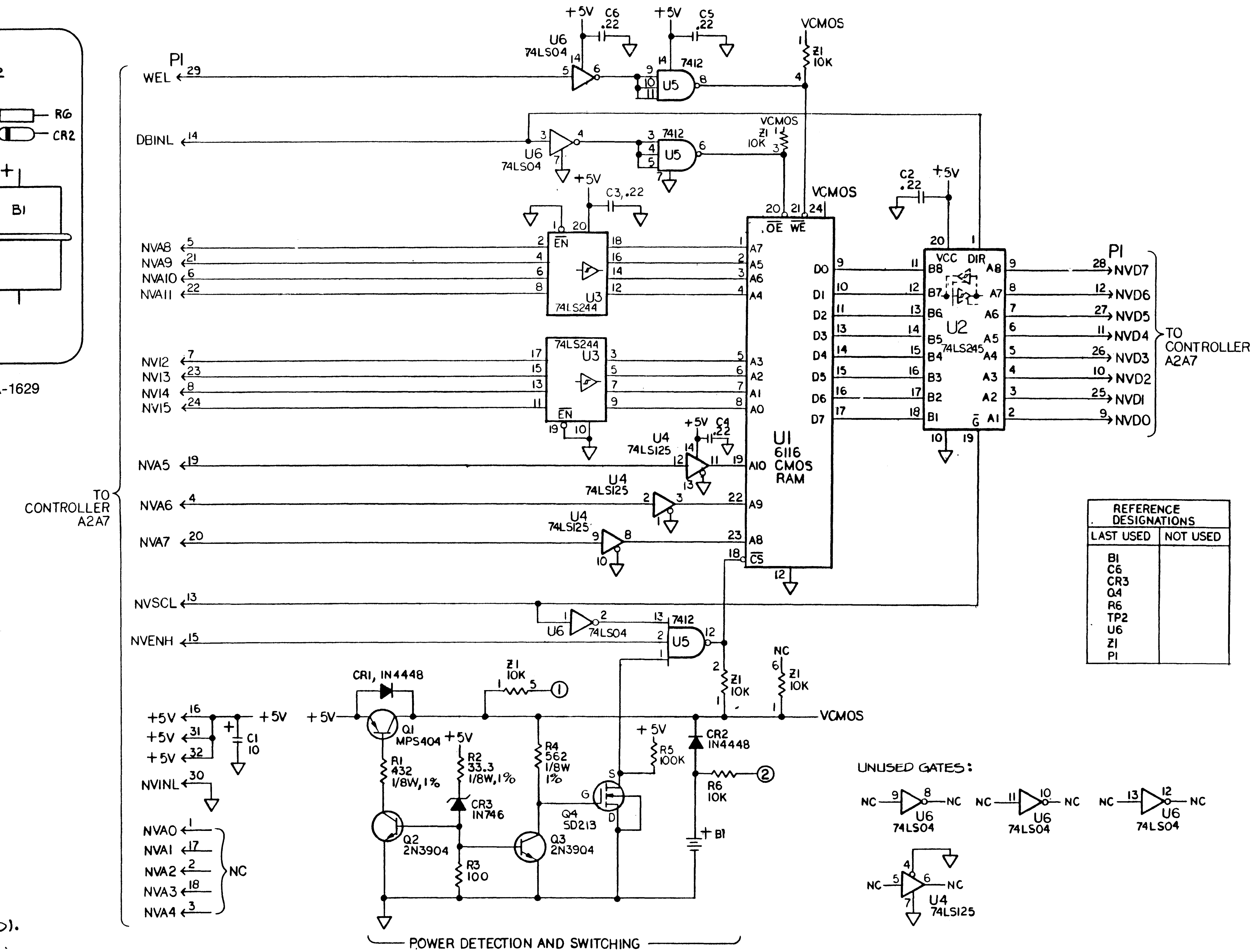



**Figure 8-15. A3A3A1 IEEE-488 Interface PCA**



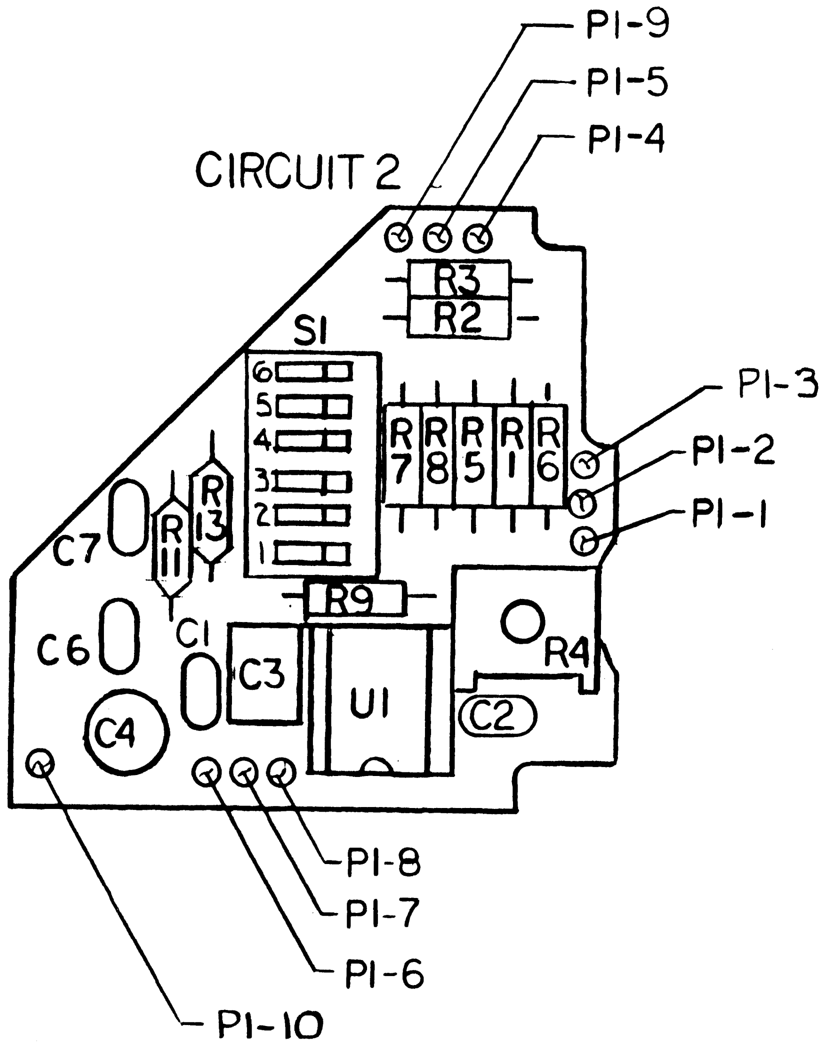




| REFERENCE DESIGNATIONS | |
|---|---|
| LAST USED | NOT USED |
| B1<br>C6<br>CR3<br>Q4<br>R6<br>TP2<br>U6<br>Z1<br>P1 | |

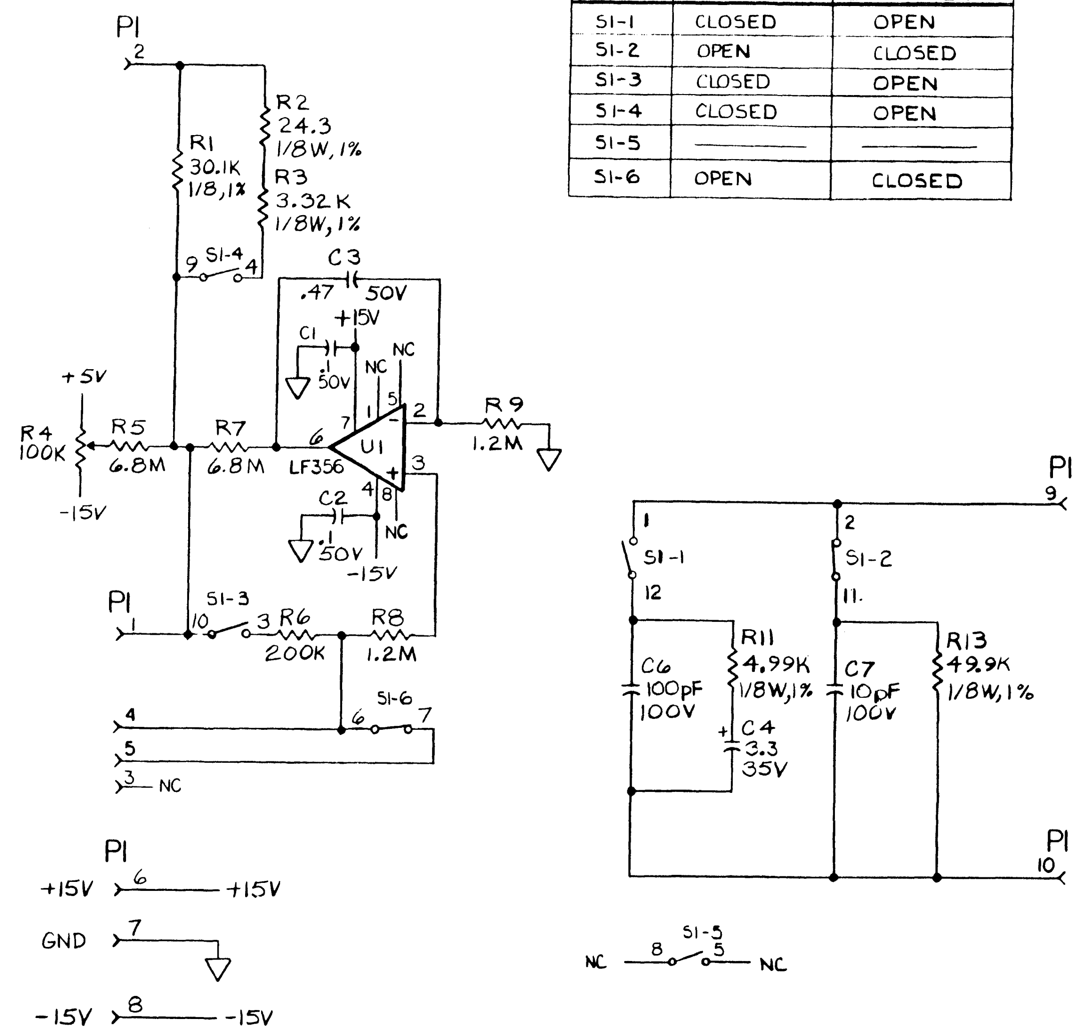
NOTES: (UNLESS OTHERWISE SPECIFIED).

1. ALL RESISTORS ARE 1/4W, 5%. ALL RESISTOR VALUES ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

**Figure 8-16. A2A8 Non-Volatile (Store/Recall) Memory PCA**




6060A-1651




| OPTION SWITCH SETTINGS | | |
|---|---|---|
| SWITCH | NORMAL FM | LOW RATE FM |
| S1-1 | CLOSED | OPEN |
| S1-2 | OPEN | CLOSED |
| S1-3 | CLOSED | OPEN |
| S1-4 | CLOSED | OPEN |
| S1-5 | ——— | ——— |
| S1-6 | OPEN | CLOSED |

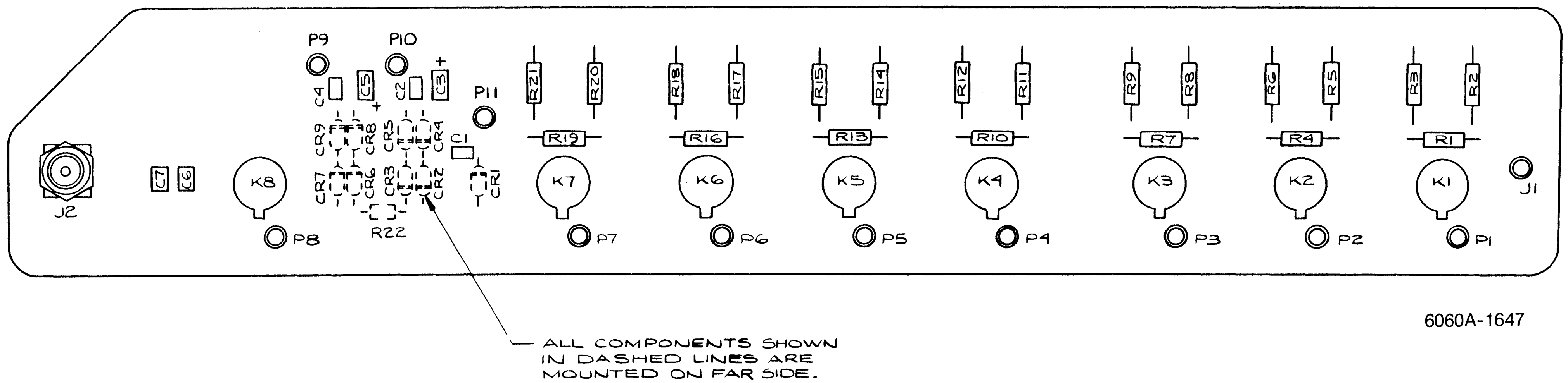
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL RESISTORS ARE 1/4W, 5%, CF.
3. ALL CAPACITOR VALUES ARE IN MICROFARADS.
4. S1 IS SHOWN SET IN LOW RATE FM POSITIONS.

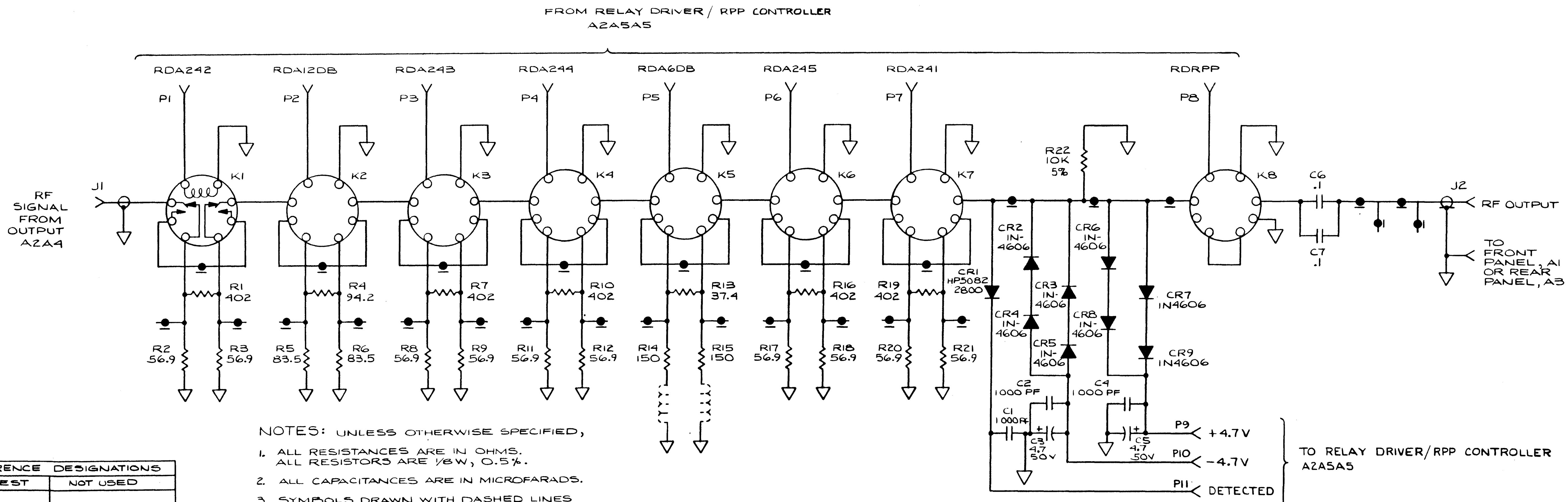
| REFERENCE DESIGNATORS | |
|---|---|
| LAST USED | NOT USED |
| C7 | C5 |
| R13 | R10, 12 |
| P1 | |
| S1 | |
| U1 | |

6060A-1051

**Figure 8-17. A2A9 Low-Rate FM PCA**




6060A-1647




NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL RESISTANCES ARE IN OHMS.
   ALL RESISTORS ARE 1/8W, 0.5%.
2. ALL CAPACITANCES ARE IN MICROFARADS.
3. SYMBOLS DRAWN WITH DASHED LINES INDICATE COMPONENTS PRINTED ON CIRCUIT BOARD.
4. THE SYMBOL ⏚ INDICATES TRANSMISSION LINES OF OTHER THAN 50 OHM IMPEDANCE WHICH CONSTITUTE CIRCUIT ELEMENTS. 50 OHM TRANSMISSION PATHS ARE NOT INDICATED.

| REFERENCE DESIGNATIONS | |
|---|---|
| HIGHEST | NOT USED |
| P11<br>K8<br>R22<br>C7<br>CR9<br>J2 | |

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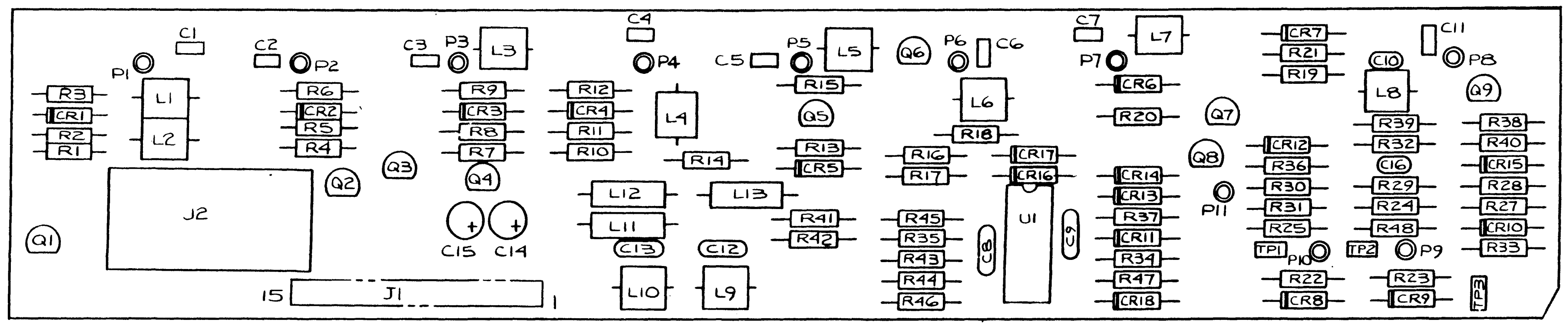
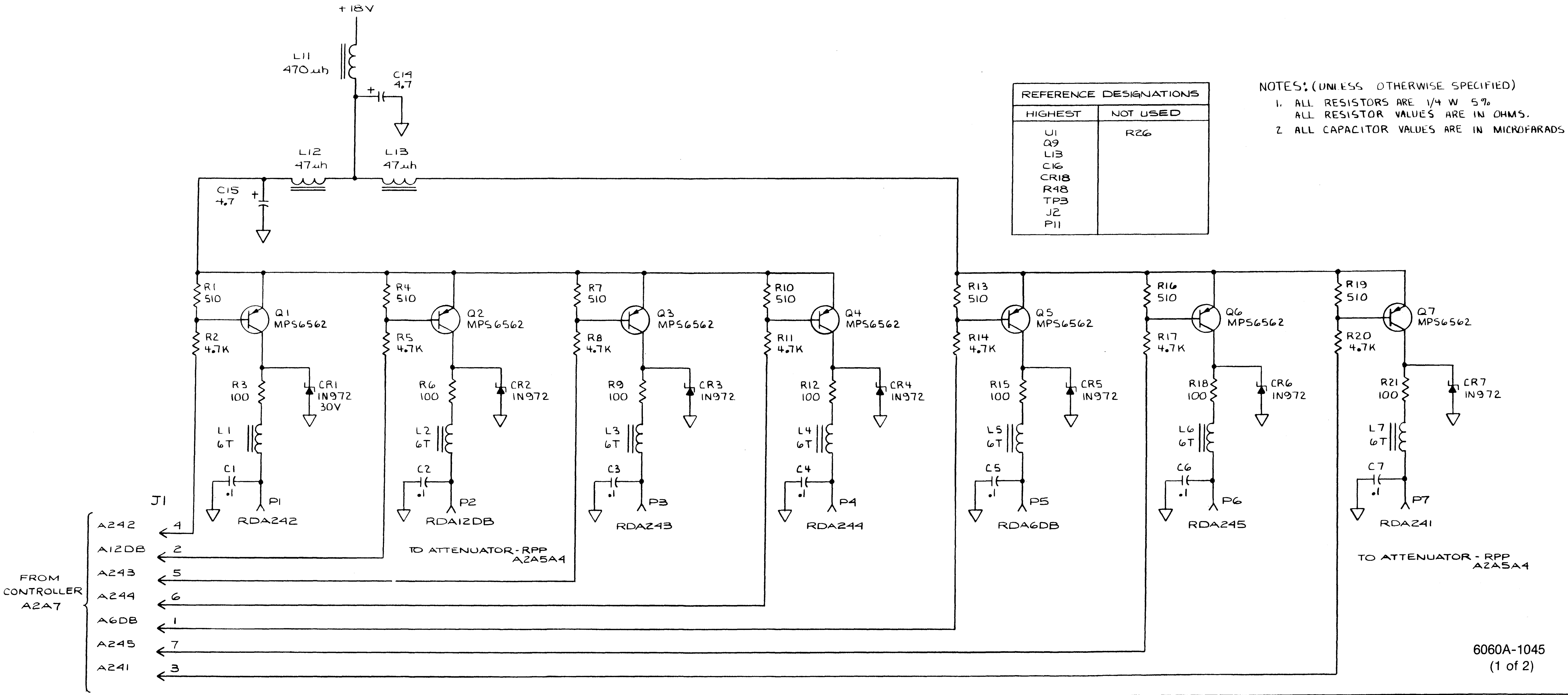
Figure 8-18. A2A5A4 Attenuator/RPP PCA




6060A-1645




| REFERENCE DESIGNATIONS | |
|---|---|
| HIGHEST | NOT USED |
| U1<br>Q9<br>L13<br>C16<br>CR18<br>R48<br>TP3<br>J2<br>P11 | R26 |

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS ARE 1/4 W 5%.
   ALL RESISTOR VALUES ARE IN OHMS.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.

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(1 of 2)

Figure 8-19. A2A5A5 Relay Driver/RPP PCA (cont)

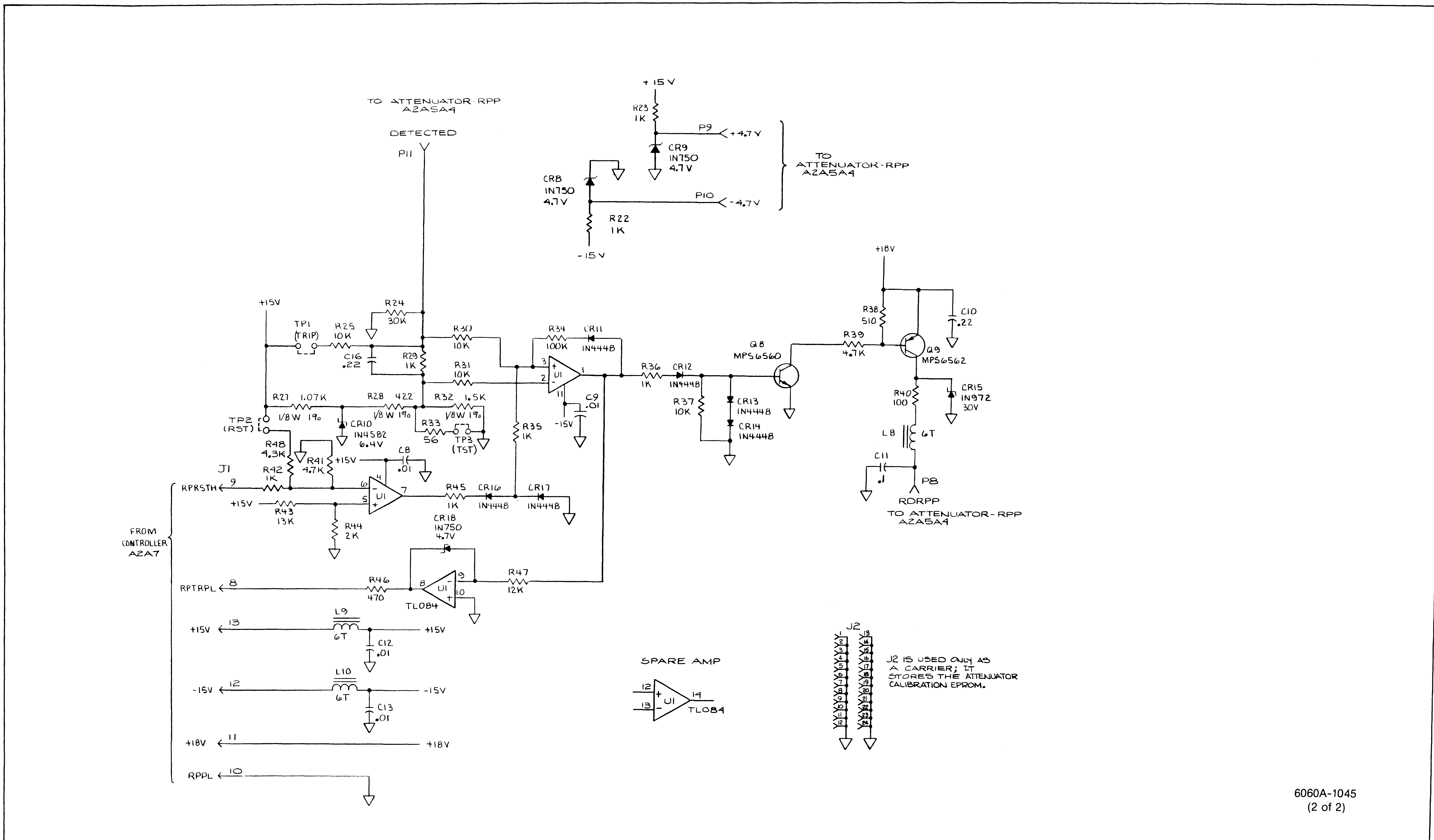



**Figure 8-19. A2A5A5 Relay Driver/RPP PCA (cont)**

# FLUKE 6060A OPERATOR INFORMATION CARD

**REJECTED ENTRY CODES** (Press the [STATUS] key to display codes)

000 000 000 indicates no rejected entries.

001 000 000 = FM Deviation not between 0 and 99.9 kHz (9.99 kHz with option-651)
002 000 000 = FM Deviation Step not between 0 and 99.9 kHz (9.99 kHz with option-651)
004 000 000 = AM Depth not between 0 and 99%
010 000 000 = AM Depth Step not between 0 and 99%
020 000 000 = IEEE-488 command syntax error
040 000 000 = IEEE-488 input value out of range
100 000 000 = Special function requires IEEE option
200 000 000 = IEEE edit or step beyond allowed range
000 001 000 = Frequency not between 0.1 and 1050 MHz
000 004 000 = Frequency Step not between 0 and 1050 MHz
000 040 000 = Invalid memory location
000 100 000 = Invalid data in memory
000 200 000 = Special function not allowed
000 000 001 = Output amplitude not between 10 nV and 2V
000 000 002 = Insufficient resolution for units conversion
000 000 004 = Units conversion to volts not allowed with reference in volts
000 000 010 = Units conversion to dB not allowed with reference in volts
000 000 020 = Amplitude Step not between 0 and 166 dB or 0 and 1999V
000 000 040 = Units conversion of Amplitude Step not allowed
000 000 100 = Amplitude step and current amplitude display not in same units

**UNCAL CODES** (Press the [STATUS] key to display codes)

Flashing codes (denoted by *) indicate abnormal operation or aberrated output. Non-flashing codes indicate operation outside specified range.

000 000 000 indicates no UNCAL conditions.

001 000 000 = FM Dev < 100 Hz ( < 10 Hz with option -651)
002 000 000 = Excess FM Deviation for output freq < .4 MHz
* 004 000 000 = Excess FM Deviation, main or reference PLL unlocked
020 000 000 = AM depth > 90%
* 000 010 000 = Main or reference PLL unlocked
000 000 001 = Level vernier below calibrated range
000 000 002 = Peak (AM) amplitude > +13 dBm
* 000 000 004 = Amplitude unleveled
* 000 000 010 = Fixed-range level vernier at 0
* 000 000 020 = Fixed-range level vernier at full scale
* 000 000 040 = RPP tripped
000 000 100 = Level < -137 dBm
000 000 200 = Level correction disabled
* 000 000 400 = RF off

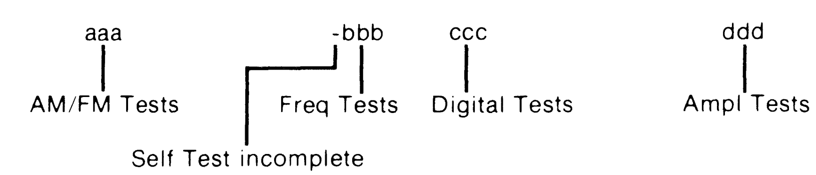
**SPECIAL FUNCTION OPERATION** (Press the [SPCL] key, then press the 2-digit code)

The two-digit code consists of a class numeric followed by a mode numeric. The activated modes of classes 2 through 9 are shown in the FREQUENCY display field while the [SPCL] key is pressed. For example, reading from left to right, 01000201 indicates that relative amplitude, slow key-repeat-rate, and amplitude fixed-range are selected.

| Code | Function | Code | Function |
|---|---|---|---|
| 00 | Clears all special functions | 20/21 | Disable/enable relative freq. |
| 02 | Initiates self test | 30/31 | Disable/enable relative ampl |
| 03 | Display check | 40 | Not used |
| 04 | Key check | 50 | Not used |
| 07/08 | Set/reset SRQ | 60 | Not used |
| 09 | Display S/W rev & instr ID | 70/71/72 | Medium/fast/slow key-rep-rate |
| 10 | Display IEEE-488 address | 80 | Enable amplitude correction |
| 11 | Display self test results | 81 | Disable all level correction |
| 12/13 | Turn on/off Display | 82 | Disable attenuator correction |
| 14 | Initialize Memory | 83-86 | Program alternate 24 dB atten |
| 15 | Latch test | 90/91 | Disable/enable ampl fixed-rng |

**SELF TEST RESULTS** (Press the [SPCL] [1] [1] keys to display the results)

The self test results are reported in the four display fields as follows:




000 000 000 000 indicates all tests passed.

**MEMORY**

Instrument settings may be stored in locations 01 through 07 (01 through 50 with option -570) and later recalled. Location 98 contains the Instrument Preset State.

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