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Operation/Maintenance Manual

for

Model 8500 Angle Position Indicator

1. In section 1, Table 1-3 (Specifications), add the following caution just below the table heading:

Item	Specification
CAUTION ALL INPUT/OUTPUT BINDING POSTS ARE PROTECTED FROM ELECTRO-STATIC DISCHARGE BY TRANSIENT SUPPRESSION DEVICES CONNECTED TO CHASSIS GROUND. APPLICATION OF ANY VOLTAGE GREATER THAN 130 Vrms (183 V peak) TO CHASSIS GROUND WILL RESULT IN DAMAGE TO THE INSTRUMENT. **NOTE:** CORRESPONDING REAR PANEL CONNECTORS HAVE THE SAME INPUT RESTRICTIONS.	

2. In section 2, paragraph 2-4, add the following caution just below the paragraph heading:

CAUTION

ALL INPUT/OUTPUT BINDING POSTS ARE PROTECTED FROM ELECTRO-STATIC DISCHARGE BY TRANSIENT SUPPRESSION DEVICES CONNECTED TO CHASSIS GROUND. APPLICATION OF ANY VOLTAGE GREATER THAN 130 Vrms (183 V peak) TO CHASSIS GROUND WILL RESULT IN DAMAGE TO THE INSTRUMENT. **NOTE:** CORRESPONDING REAR PANEL CONNECTORS HAVE THE SAME INPUT RESTRICTIONS.

3. In section 6, Table 6-1 (Test Equipment Required), revise the following table entry:

Item	Minimum Use/Critical Specifications	Manufacturer and Model
Synchro/Resolver Simulator	No change to existing data	North Atlantic Instruments, Model 5300

1. In front matter, page ix, under the heading SPECIFICATIONS change the following:

Fuses	115V operation - 1.0 amp. SLO-BLO 230V operation - 0.5 amp. SLO-BLO

2. In section 8, Table 8-1 (Model 8500-FXXX- Common Parts), add parts list information as follows:

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
F1	Fuse, 1.0 Amp., Slo-Blo, 2AG	811082	75915	229001S	
F1	Fuse, 0.5 Amp., Slo-Blo, 2AG	811081	75915	229.500S	

3. In section 8, Table 8-9 (8500 Main Circuit Card Assembly) change parts list information as follows:

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
CB1	Deleted				

4. In section 9, Figure 9-1, sheet 7 of 8 (Main Circuit Card Assembly A1 Schematic Diagram), in zone C6, change information as follows:

   a. Replace circuit breaker symbol CB1 with a fuse symbol and label it F1.
   b. Add notation below F1 - "Fuseholder located on chassis."

In section 8, Table 8-9 (Main Circuit Card Assembly), revise parts list information as follows:

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
U9	IC, A/D Converter	887652	24335	AD670JN	

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INFORMATION FOR UNITS SOLD WITHIN THE EUROPEAN UNION

GENERAL

Information contained within the following paragraphs supplements and in some cases supersedes information contained throughout this Manual. Where there is a conflict between information contained in these paragraphs and information contained elsewhere in the manual, these paragraphs take precedence for units sold within the European Union.

SPECIFICATIONS

Add to the list of specifications the following information:

Environmental	
Temperature, operating	0° to 50° C, standard
Temperature, non-operating	-55° to 75° C
Relative Humidity	95%, non condensing
Altitude	3050 Meters operating, 12,000 Meters non-operating
Overvoltage/Installation Category	Category II
Pollution Degree	Degree 1
Fuses	115V and 220V operation: Reset-able circuit breaker, 1.0A

LINE CORD

The model 8500 is normally shipped with a UL approved detachable line cord. This line cord does not meet safety requirements of the European Community and should be discarded and replaced with a properly approved type for applications within the European Community.

INSTALLATION AND MAINS INPUT

The model 8500 is designed for bench top or permanent rack-mount installation. An IEC-320 appliance coupler is provided for mains power input. It is not recommended that mains power be applied through the 50-pin D-subminiature connector. The internal CONN/LINE switch (serviceable by Maintenance personnel only) should be kept in the LINE position. When the model 8500 is used in a bench top or rack-mount installation with power applied through the IEC-320 power input, safety (earth) ground is provided through this power input and the detachable line cord provides the required means of disconnection. When the model 8500 is used in a permanent rack-mount installation with only the front panel accessible to the operator and mains supply applied to the 50-pin D-subminiature connector, there is no high quality safety (earth) ground provided for the chassis. If such a ground is desired in your application, connect safety (earth) ground to one of the jackscrews for the 50-pin connector using an AWG 16 wire and lug.

For continued safe operation of the model 8500 API, observe the following:

a. Mains input wiring to 50-pin D-subminiature connector (not recommended) must include a disconnect device such as a switch (2 pole), or circuit breaker easily accessible to the operator.

b. Insulation rating for all wires connected to 50-pin D-subminiature connector must be consistent with the applied mains supply .

c. Mains supply may not be applied to the 50-pin D-subminiature connector for bench-top use.

LINE VOLTAGE SELECTION

Selection of power line voltage is to be accomplished by Maintenance personnel only and is not to be done by the OPERATOR. When the line voltage selection is changed, the proper label must be affixed to the top cover. Refer to Manual section 2-4.3.

SAFETY GROUNDING

For safety from electrical shock and fire in bench-top applications, the unit must be connected to Safety (Earth) ground through the power cord.

IMPROPER USAGE

If the equipment is installed or used in a manner not specified safety may be impaired.

MAINTENANCE

The OPERATOR only has access to the exterior of the unit. All maintenance, including any procedures that require removal of covers, must be referred to qualified Maintenance personnel

TECHNICAL ASSISTANCE

Contact your local Sales Representative for any technical assistance. Alternately, contact the Factory at:

North Atlantic Instruments, Incorporated
170 Wilbur Place
Bohemia, NY 11716 USA

Telephone: **(516) 567-1100**
Fax: **(516) 567-1823**

WARNING

SAFETY SUMMARY

GENERAL SAFETY NOTICES

The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein.

DO NOT REPAIR OR ADJUST ALONE

Under no circumstances should repair or adjustment of energized equipment be attempted alone. The immediate presence of someone capable of rendering aid is required.

HIGH VOLTAGE IS USED IN THE OPERATION OF THIS EQUIPMENT

DEATH ON CONTACT may result if personnel fail to observe safety precautions. Learn the areas containing high voltage on this equipment. Be careful not to contact high-voltage connections when installing, operating, or maintaining this equipment.

SECTION 1

GENERAL INFORMATION

MODEL 8500

1-1 INTRODUCTION

This manual contains general description, installation and operating instructions, maintenance and troubleshooting procedures, replacement parts list, and schematic diagrams for the Angle Position Indicator (API) Model 8500, hereinafter referred to as the API. The manual is divided into ten sections as follows:

1-1.1 Section 1 - General Information. This section provides general physical and functional descriptions of the API. It includes a table of specifications and feature/option information.

1-1.2 Section 2 - Installation. This section gives instructions for unpacking, general inspection, installation and mounting procedures, power and grounding requirements and selection, interconnection cabling, signal input data, and includes an API outline and dimension drawing.

1-1.3 Section 3 - Operation. This section lists synchro and resolver conventions, operation of system controls and indicators, mode selection and data transfer details, error condition indicators, and built-in-test equipment information.

1-1.4 Section 4 - Theory of Operation. This section describes functional theory of operation for the API. It includes a Control Loop block diagram and Display Option Circuit illustration.

1-1.5 Section 5 - 8500 IEEE-488 Remote Operation. This section contains procedures and programming examples for remote operation of the API using IEEE-488 and MATE interface.

1-1.6 Section 6 - Maintenance. This section contains cleaning, performance tests, and alignment procedures for the API.

1-1.7 Section 7 - Troubleshooting. This section provides troubleshooting instructions for isolating faults within the API.

1-1.8 Section 8 - Parts List. This section contains replaceable parts lists, federal supply codes of manufacturers (FSCM), parts location diagrams, and a list of manufacturers of parts used in the API.

1-1.9 Section 9 - Schematic Diagrams. This section contains schematic diagrams for the API.

1-1.10 Section 10 - Update Information. As NAI continues to improve the performance of the API, corrections and modifications to the manual may be received. This section contains Product Revision Sheets (PRS) data which updates the unit to the most current configuration available.

1-2 FEATURES AND OPTIONS

To identify the Model 8500 options, a three digit number is assigned in accordance with table 1-1.

For example, the Standard Model 8500 with half rack mounting (1), 47 Hz to 440 Hz frequency selectable display (2), and parallel interface (1) would have an option number of F121.

8500-F | 1 | 2 | 1 |

F1 F2 F3

Table 1-1. Features and Options

No.	Feature	Options
F1	Configuration Options	1. Panel mount, half rack 2. Bench use (includes front terminals and stand) 3. Panel mount, full rack
F2	Frequency and Display*	1. Not Available 2. 47-440 Hz, selectable display 3. Not Available 4. 360 Hz to 1200 Hz, selectable display
F3	Interface**	1. Parallel only 2. Parallel and IEEE 3. Not Available

1-3 ACCESSORIES

The API can be ordered with mounting adapters for mounting either one or two units in a standard 19-inch equipment rack. Table 1-2 describes full rack and tandem full rack mounting accessories.

Table 1-2. Rack Mounting Adapter Accessories

Type of Mount	Description	NAI P/N
Full Rack Mounting	Mounts one unit in 19-inch rack	300697
Tandem Full Rack Mounting	Mounts two units side by side in 19-inch rack	300698

*Frequency/Display Option 1 (47 Hz - 440 Hz, 0-359.99°) and Option 3 (360 Hz - 1200 Hz, 0.359.99°) are not available.

**Feature 3 Interface Option 3 (MATE/CIIL, IEEE-488 and Parallel) is not available.

1-4 PHYSICAL DESCRIPTION

The physical features of the API are illustrated in figure 1-1. It is housed in a 9 1/2-inch wide rack panel and is packaged primarily for computer controlled or fixed installation applications.

1-4.1 Front Panel Description. The front panel contains a group of controls and indicators including a power ON/OFF switch, a set of function switches and coordinated LED indicators, a set of input terminals, and a display for angular data, degree/minutes, and IEEE-488 interface status information. Refer to Section 3 Operation for details.

1-4.2 Rear Panel Description. The rear panel provides an ac input receptacle (J2), a parallel I/O connector (J1), and an 8-position mode DIP switch with appropriate instruction label. An IEEE-488 ADDRESS switch and connector (J3) are optionally available. Refer to Section 3 Operation for details.

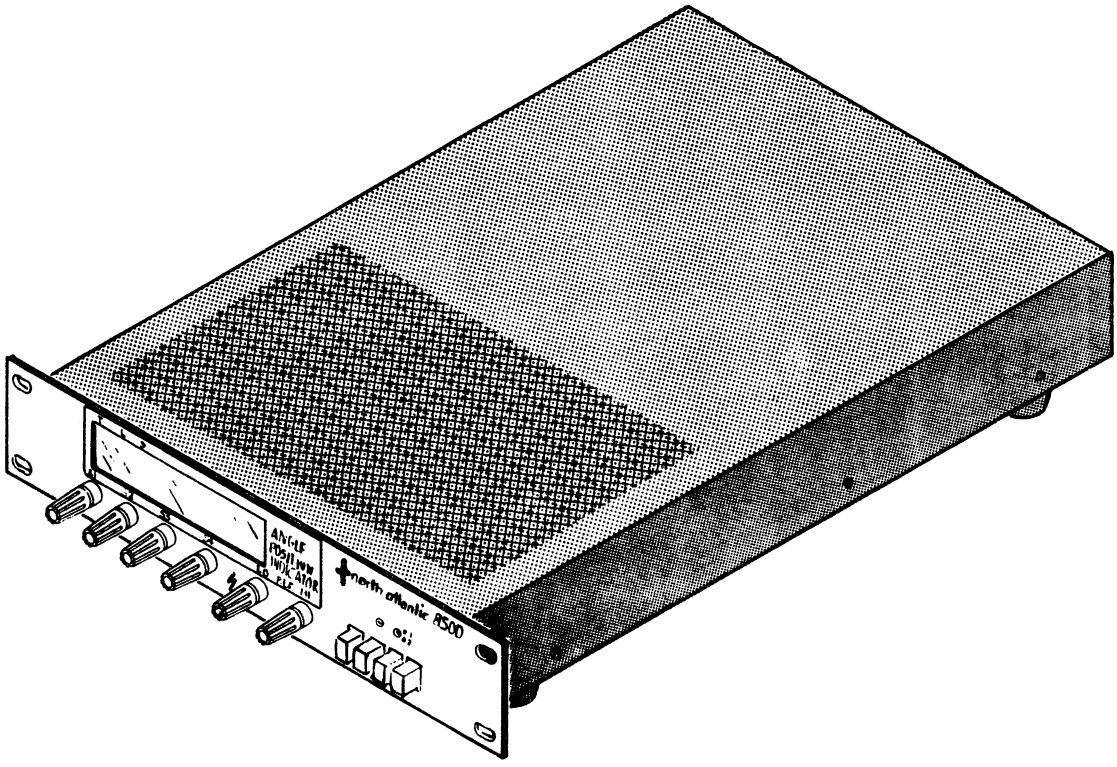


Figure 1-1. Angle Position Indicator Model 8500

1-5 PURPOSE

The API is a synchro/resolver-to-digital converter that performs high quality analog-to-digital conversions of synchro or resolver data.

The API transmits the converted digital representation of the analog data simultaneously to the following locations:

a. The front panel display which uses six seven-segment LED planar information displays.

b. The BCD outputs of the rear panel parallel I/O connector.

c. The optional IEEE-488 interface bus which has full MATE compatibility.

1-6 MAJOR ASSEMBLIES

The API contains one major circuit card assembly which includes the display circuits, power circuits, and basic operating circuitry. An IEEE-488 interface circuit card and related connectors are optional (refer to paragraph 1-2).

1-7 SPECIFICATIONS

Table 1-3 provides electrical and mechanical specifications for the Model 8500.

Table 1-3. Specifications

Item	Specification
Input Specifications	
Input channels	2 (selectable)
Signal inputs	Automatic line-to-line tracking, synchro or resolver. 10 to 100 V L-L, 47-440 Hz (F2, option 2) or 360 to 1200 Hz (F2, option 4).
Signal input impedance	250 k ohms (minimum)
Reference levels	1 to 115 V rms, all frequency ranges. (All synchro or resolver data must be derived from this reference.)
Reference input impedance	100 k ohms (minimum)
Power requirements	115/230 V rms ±10% 47 to 440 Hz, 20 VA

Table 1-3. Specifications (Continued)

Item	Specification
Data Freeze	Freeze / Track
DF	+5 V / 0 V or open
$\overline{DF}$	0 V / +5 V or open
	(Display and output frozen; internal circuitry continues to track signal.)
Channel Remote Program	0 V or GND=CH1, +5 V or OPEN=CH2
Output Specifications	
Display	5 decimal digits, 0.56-inch high LED indicators for channel and remote
Readout resolution	0.01 degree or 1 minute (F2, option 2 or 4)
Digital output data	5 decades of BCD digits (1,2,4,8 code)
Digital output level	
Logic 1	+3.9 V minimum, 4 standard LS TTL loads
Logic 0	0.1 V maximum
Converter Busy	TTL compatible (pulses are present when converter is busy)
Performance Specifications	
Angular Accuracy	0.03 degrees
Angular Resolution	0.01 degrees
Angular Range	0 to 359.99 degrees or 0 to 359 degrees 59 minutes; or, -179.99 to +180 degrees or -179 degrees 59 minutes to +180 degrees 00 minutes (F2=2 or 4)
Auto phase correction	Automatically corrects for signal phase shift up to ±80 degrees.
Tracking speed	Selectable:
	Lo speed = 180 degrees/sec with no tracking error, 47-440 Hz (F2, option 2)
	Hi speed = 1800 degrees/sec with no tracking error, 360-1200 Hz (F2, option 4)

Table 1-3. Specifications (Continued)

Item	Specification
Settling time	Dependent on tracking speed selected and frequency range: Less than 1.5 seconds for 180 degrees step change, Lo tracking speed and 47-440 Hz (F2, option 2). Less than 1.0 seconds for 180 degrees step change, Hi tracking speed and 360-1200 Hz (F2, option 4).
Velocity output:	
HI Tracking rate	2.85 mV dc/degree/second (nominal)
LO Tracking rate	28.5 mV dc/degree/second (nominal)
Operating mode	Track only
Fault indications	No reference present: all 8s displayed No synchro or resolver connected or input line-to-line voltage is too low: display is blanked. Over velocity: "o" displayed to left of angle display Optional IEEE-488 MATE relay closure
Lamp test	Disconnect reference to display all 8s or apply logic "0" to J1-38.
Mechanical Specifications	(See figure 2-1 Outline and Dimension Drawing, API Model 8500)
Front Panel Color	Semi-gloss gray, 26440 per Fed-Std-595 window area black #27038 per Fed-Std-595
Markings	Semi-gloss black enamel 27038 per Fed-Std-595; Pantone Warm Red U (warnings and logo only); White #27875 per Fed-Std-595
Size	9.5" W x 1.75" H x 12" D
Weight	4 lbs. (maximum)
Operating Temperature	0-50° C

1-8 EQUIPMENT REVISION LEVEL STATUS

Table 1-4 lists the major assemblies of the Model 8500 and the current revision level status of each assembly. For subsequent updates to Model 8500 assemblies refer to Section 10 - UPDATE INFORMATION.

Table 1-4. Revision Level Status of Major Assemblies

Ref Des	Name	Part No.	Current Revision
A1	Main/Display Circuit Card Assembly (CCA)	787833-1,-2,-3,-4	B
A1A1	8500 Main CCA	787760-1,-2,-3,-4	G
A1A2	Display CCA	787759	E
A2	IEEE-488 Interface CCA	787788-1	E
A3	Front Panel Assembly	548665-1,-2,-3	E

SECTION 2

INSTALLATION

2-1 INTRODUCTION

This section provides instructions for unpacking, inspecting, installing, and initial checkout of the API. This instrument has been thoroughly tested, inspected, and its performance evaluated at the factory before shipment.

2-2 UNPACKING

The API is shipped in a cardboard container with the unit cushioned by foam to avoid damage during shipment. Unpack the unit as follows:

a. Place cardboard container on a level surface with shipping label facing up.

b. Open top flaps by cutting tape at the center and sides of container. Remove the top foam cover to expose unit.

c. Remove unit from the container. Save container for future use when storing or shipping.

2-3 INSPECTION

a. Check contents of the shipping container against shipping list. Including the manual, the carton should contain:

   (1) 1 NAI Model 8500 API
   (2) 1 Ac Line Cord
   (3) 1 50-Pin AMP Connector (Female)

b. Check for obvious damage to unit and immediately notify carrier if unit is damaged.

c. Check unit for loose or disconnected parts.

d. Check for damage to front panel switches and display.

e. Check switches for smooth operation. Switch buttons should be secure.

f. Check condition of rear panel connectors.

g. Check unit cover for damage and loose screws.

If unit passes this inspection, install it and begin operation. If damage is found, refer to Warranty in back of manual.

2-4 INSTALLATION

The API is designed for bench or rack mounting in any position. It requires no special cooling equipment, but it should be placed in such a way to allow free flow of air around it. An outline and dimension drawing of the API is shown in figure 2-1.

2-4.1 Mounting Instructions. The API is manufactured for half-rack mounting (9 1/2-inch front panel) and should be installed accordingly. Other mounting options are available including bench mounts and accessories for standard 19-inch equipment racks which accommodate full rack (one unit) or tandem full rack (two unit) adapters.

NOTE

Mounting screws are not supplied.

2-4.1.1 Panel Mounting (Half Rack). Install API into desired rack mount position and secure with four screws. Refer to figure 2-1.

2-4.1.2 Bench Mounting. Place API on a level surface and raise tilt stand (optional) for increased viewing angle.

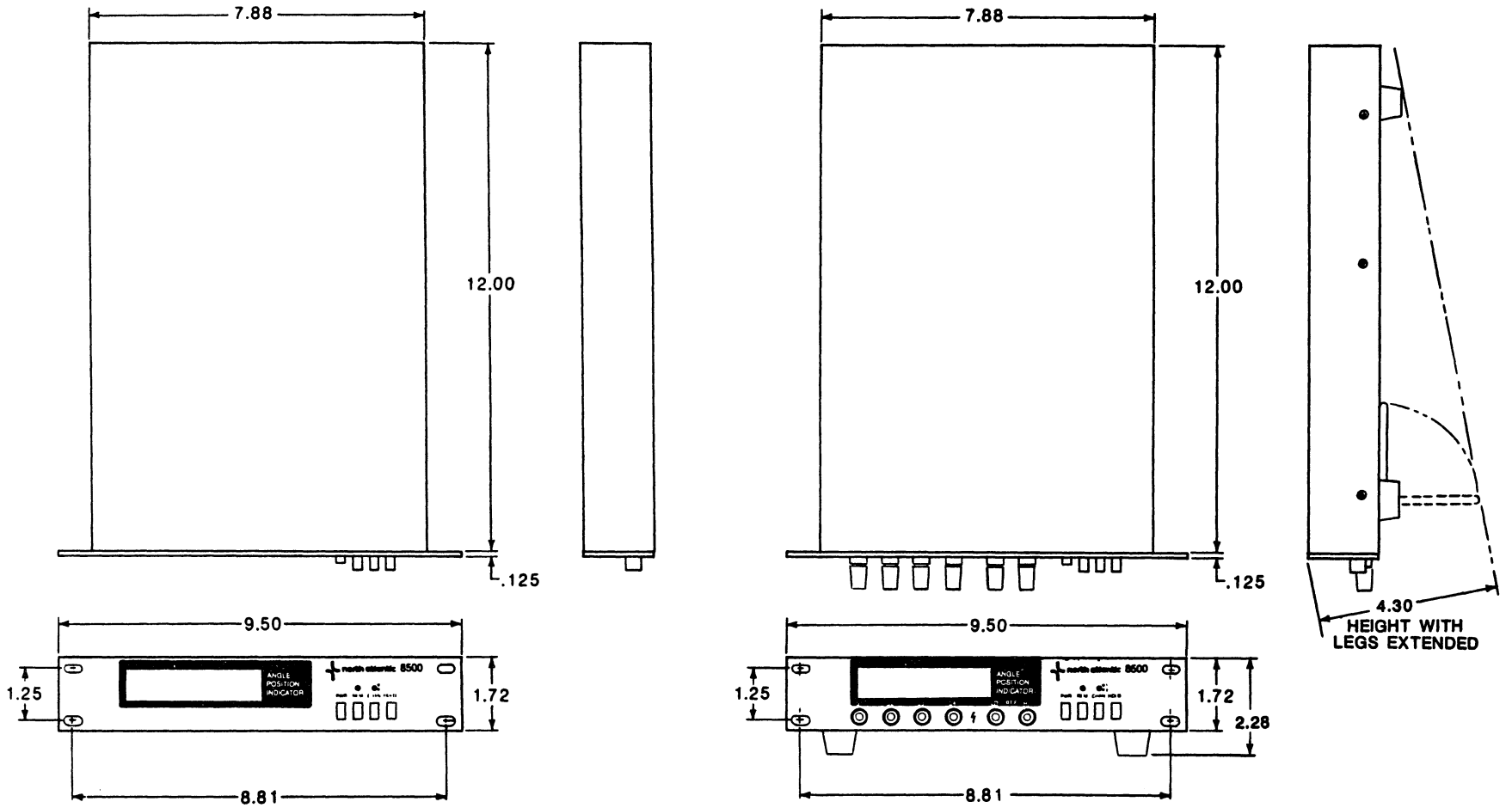
2-4.1.3 Full Rack Mounting Adapter. Secure full rack adapter to standard 19-inch equipment rack with four screws. Secure API to full rack mounting adapter with four screws. Refer to 2-2A.

2-4.1.4 Tandem Full Rack Mounting Adapter. Secure tandem full rack adapter to standard 19-inch equipment rack with two screws. Secure each API to tandem full rack mounting adapter with four screws each. Refer to figure 2-2B.

2-4.2 Cabling Instructions. External system interconnection to the API is through rear panel connector J1. Pin designations for all J1 inputs and outputs are listed in table 2-1.

API parallel I/O 50-pin mating connector J1 is supplied by North Atlantic Industries (NAI P/N 783718) but cable assembly must be made by operator. It consists of the following parts:

Description	AMP P/N	Qty
Shell	205211-1	1
Clamp	205732-1	1
Retainer	205980-1	2
Pins	66569-3	50



A. Half Rack Mount

B. Bench Mount

Figure 2-1. NAI Model 8500 Outline and Dimension Drawing

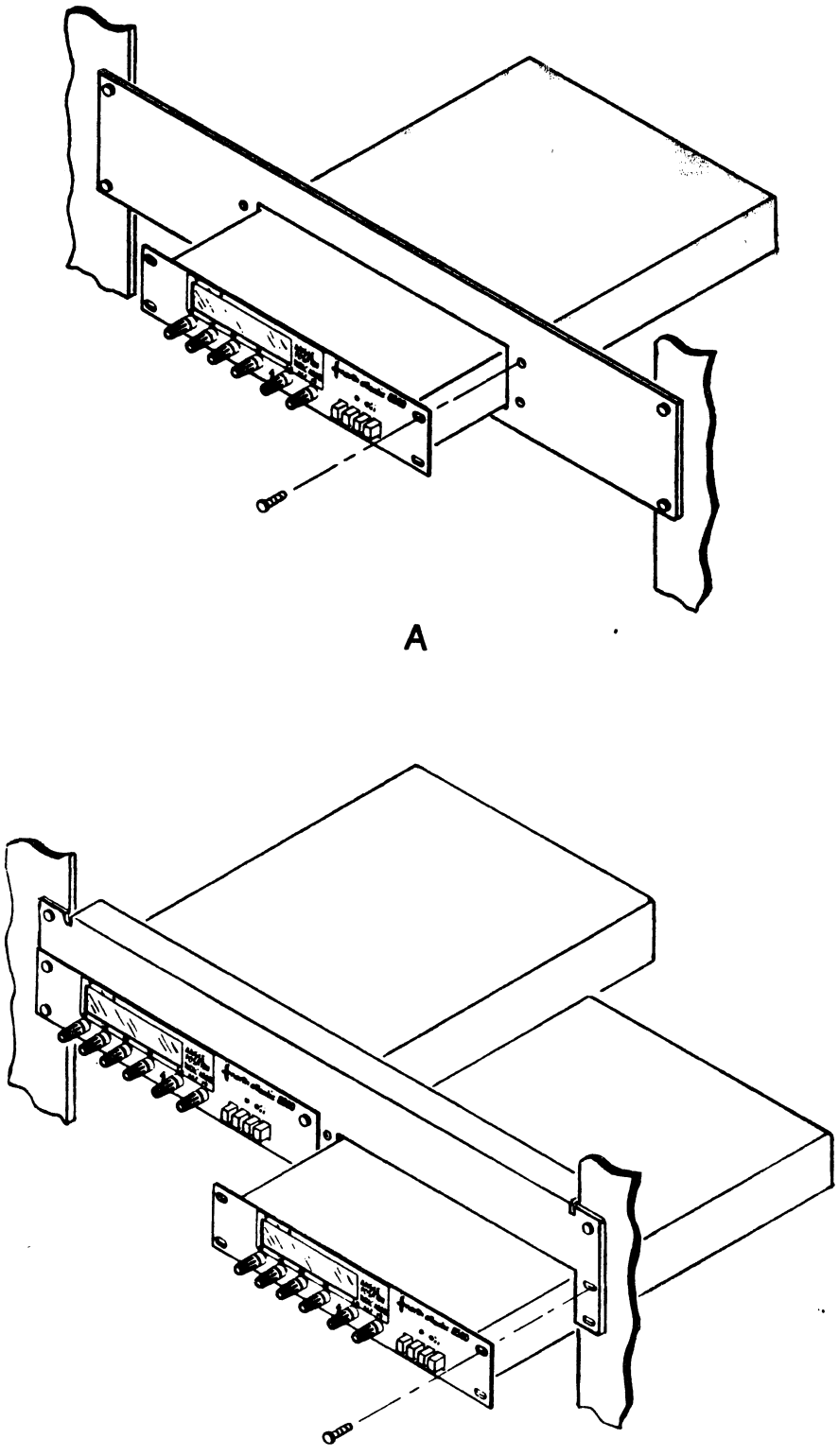


Figure 2-2. Full Rack and Tandem Rack Mounting Adapters

2-4.3 Power Requirements. The API operates with either 115 V ac or 230 V ac, 47 to 440 Hz power source. Power may be applied from the line cord or parallel I/O rear connector J1. Refer to table 2-1 for J1 power connections and figure 2-3 for switch selection of voltage and power source.

2-4.3.1 Internal Power Connections. All API models are factory set for 115 V ac line cord operation (line cord is supplied), but can operate using 115 V ac or 230 V ac as selected by internal switch SW3. In addition, a rear power connector which also accepts 115 V/230 V ac can be used in place of the line cord by selecting the position of internal switch SW5 (see figure 2-3). To select position of switches SW3 and SW5 proceed as follows:

WARNING

Do not connect ac power to the API at this time. Connection to the wrong voltage source will damage unit and could bring operator in contact with high voltages.

a. Remove six screws securing top cover and remove cover.

b. If an IEEE-488 optional circuit card is installed, remove four securing screws and two jackscrews from rear panel IEEE-488 (J3) connector and lift out circuit card.

c. Locate switch SW3 and select desired voltage setting.

d. Locate switch SW5 and select desired voltage source.

e. If voltage is to be supplied via the rear parallel I/O connector, locate and switch SW5 to proper position.

f. Replace IEEE-488 circuit card (optional) and top cover assembly.

g. With front panel power switch in the OFF position, insert rear power cord into unit.

h. Insert power cord into selected ac outlet and switch front panel ON/OFF switch to ON.

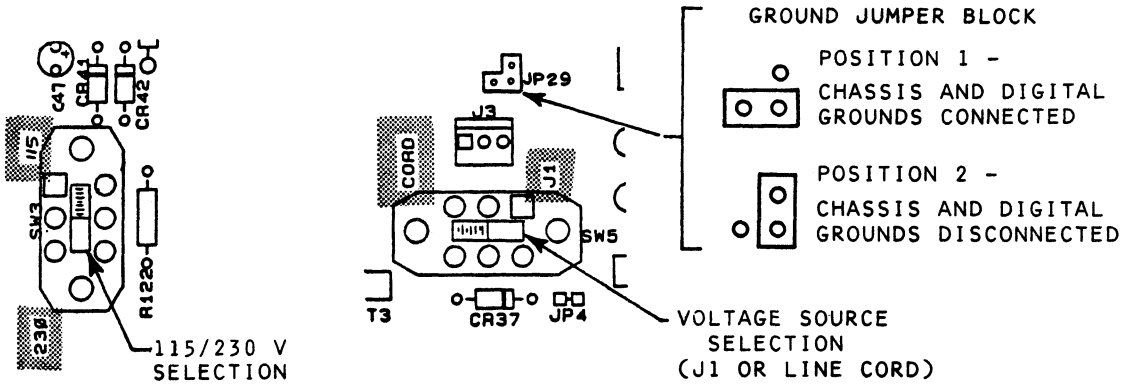


Figure 2-3. Internal Voltage and Grounding Selection

Table 2-1. J1 Pin Designations

Pin	Function
1	Power input Hi (internal switch enables pins 1 & 2; disables IEC pwr conn.)
2	Power input Lo
3	Chassis ground
4	Digital ground
5	S1 — Channel 1 (CH1)
6	S2
7	S3
8	S4
9	R1
10	R2
11	Converter Busy
12	.04 degrees or 4' — BCD outputs
13	.01 degrees or 1'
14	.8 degrees or not used
15	.2 degrees or 20'
16	4 degrees
17	1 degree
18	CH2 synchro jumper (connect to pin 35 for CH2 synchro operation)
19	NC
20	Tracking $\overline{HI}$/LO input
21	S1 — Channel 2 (CH2)
22	S2
23	S3
24	S4
25	R1
26	R2
27	Data freeze ($\overline{DF}$)
28	.02 degrees or 2' — BCD outputs
29	.08 degrees or 8'
30	.1 degree or 10'
31	.4 degrees or 40'
32	2 degrees
33	8 degrees
34	CH1 synchro jumper (Connect to pin 35 for CH1 synchro operation)
35	Synchro jumper common
36	Fault 1 — Not used
37	Fault 2
38	$\overline{\text{Lamp Test}}$
39	Unipolar/$\overline{\text{bipolar}}$ for F2=2 or 4.
40	BITE output (Built-in Test Equipment)
41	Velocity output (analog)
42	Data Freeze (DF)
43	Remote Program (0=CH1, 1=CH2)
44	NC spare
45	20 degrees — BCD Outputs
46	40 degrees
47	80 degrees
48	10 degrees
49	100 degrees
50	200 degrees or sign bit in bipolar

2-4.4 Grounding. In a high accuracy synchro/resolver-to-digital converter it is necessary for both chassis and signal ground to be connected together.

2-4.4.1 System Applications. Ground loops should be avoided in system applications. For this reason, chassis ground J1-3 and signal ground J1-4 are brought out separately. In system applications the separate pins J1-3, and J1-4 make connections to other parts of the system possible. When not used, connect them together at the connector.

2-4.4.2 Bench Applications. In bench applications, J1-3, -4 should be connected together and then connected to the low side of the signal source of the synchro or resolver.

2-4.4.3 Internal Ground Jumper JP29. Internal jumper block JP29 is provided to allow chassis ground and digital ground to be connected without requiring connections to J1. To select jumper block position refer to figure 2-2 and the following instructions:

CAUTION

To avoid damage to unit, do not connect ac power to API when selecting jumper block position.

a. Remove six screws securing top cover and remove cover.

b. If an IEEE-488 optional circuit card is installed, remove four securing screws and two jackscrews from rear panel IEEE-488 connector and lift out circuit card.

c. Locate jumper block JP29 and select desired position (refer to figure 2-3).

2-4.5 Signal Inputs.

WARNING

Signals applied to rear connector J1 also appear on the front panel terminals. To avoid shock hazard do not connect signals to both terminal locations at the same time nor touch any metal portion of the front terminals. Input voltages may exist at both terminal locations whether the API power is on or off.

The standard panel mounted Model 8500 API accepts synchro or resolver inputs through rear parallel I/O connector J1. Refer to table 2-1 for pin connection designations.

The bench Model 8500 API unit will accept signal inputs either through the rear parallel I/O connector J1 or the appropriate front panel terminals (figure 3-1).

2-4.6 Line-to-Line Programming. The API automatically detects the line-to-line voltage within the ranges of 10 to 100 V. No line-to-line programming is required.

SECTION 3

OPERATION

3-1 INTRODUCTION

This section contains synchro/resolver conventions, general operating procedures, descriptions of controls and indicators, and practical applications for the API.

3-2 SYNCHRO AND RESOLVER CONVENTIONS

Conventions for polarities, terminal designation, and direction of shaft rotation for synchros and resolvers are most frequently defined in accordance with military specifications MIL-S-20708 (synchros) and MIL-R-21530 (resolvers). The API is provided with terminal designations and electrical characteristics to meet these specifications. In applying the conventions, exercise caution that:

a. The manufacturers of the synchro or resolver have followed the MIL specification.

b. The system in use has not dictated a change in convention for a different characteristic (i.e., direction reversal or angular offset).

3-2.1 Synchro Transmitter Conventions.

$$E(S1\text{-}S3) = -NE(R1\text{-}R2)\sin\theta$$
$$E(S3\text{-}S2) = -NE(R1\text{-}R2)\sin(\theta + 120^{o})$$
$$E(S2\text{-}S1) = -NE(R1\text{-}R2)\sin(\theta + 240^{o})$$

Where:

E(S1-S3) is the stator voltage S1 with respect to S3. Other stator and rotor voltages are similarly defined.

N is the ratio of the maximum voltage across a pair of stator terminals to the voltage across the rotor terminals.

θ is the shaft angle displacement from electrical zero which satisfies these equations.

A schematic of the synchro transmitter is shown in figure 3-1.

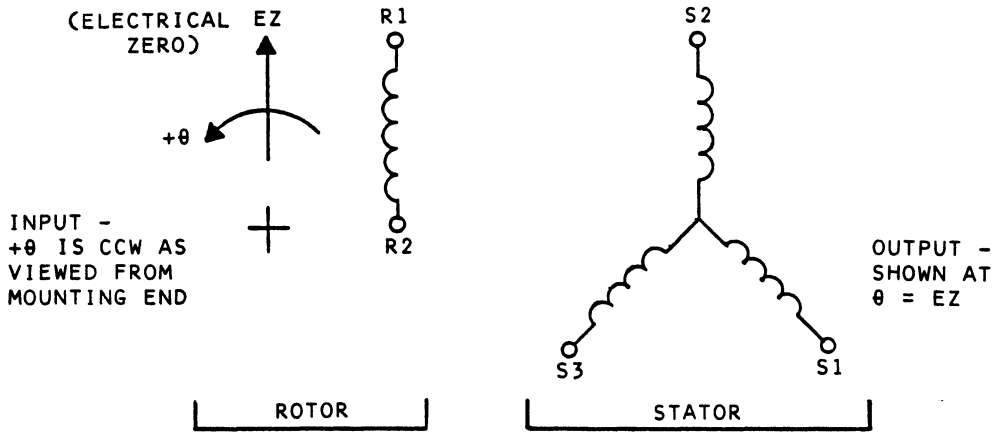


Figure 3-1. Synchro Transmitter, Schematic Diagram

3-2.2 Resolver Transmitter Conventions. For rotor energized resolvers:

$$E(S1\text{-}S3) = NE(R1\text{-}R3)\cos\theta - NE(R2\text{-}R4)\sin\theta$$
$$E(S2\text{-}S4) = NE(R2\text{-}R4)\cos\theta + NE(R1\text{-}R3)\sin\theta$$

A rotor energized resolver transmitter schematic is shown in figure 3-2. Input and output may be reversed for stator energized devices.

Since the NAI standard assumes an R2-R4 energized resolver, the resolver outputs become:

$$E(S1\text{-}S3) = -NE(R2\text{-}R4)\sin\theta$$
$$E(S2\text{-}S4) = +NE(R2\text{-}R4)\cos\theta$$

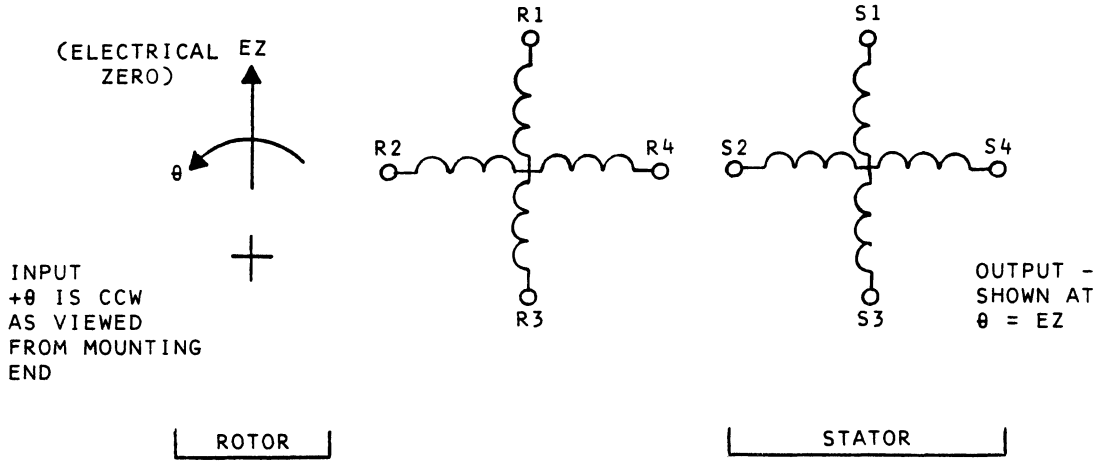


Figure 3-2. Resolver Transmitter, Schematic Diagram

3-3 CONTROLS AND INDICATORS

3-3.1 Front Panel. The front panel controls and indicators for the API are described in table 3-1 and illustrated in figure 3-3.

Table 3-1. Front Panel Controls and Indicators

Control/Indicator	Function
PWR push button	Alternate Acting Switch. Turns power on and off (push button in: power on; push button out: power off).
REM push button	Alternate Acting Switch. Selects remote operation of the API (push button in: Remote; push button out: local).
CHAN push button	Alternate Acting Switch. Selects input channel (push button in: CH 1; push button out: CH 2).
HOLD push button	Momentary Switch. Push in to freeze display and output data.
REM LED	When ON, indicates the API is in remote operation.
CHAN LED	When on, indicates Channel 1 is selected. When off, indicates Channel 2 is selected.

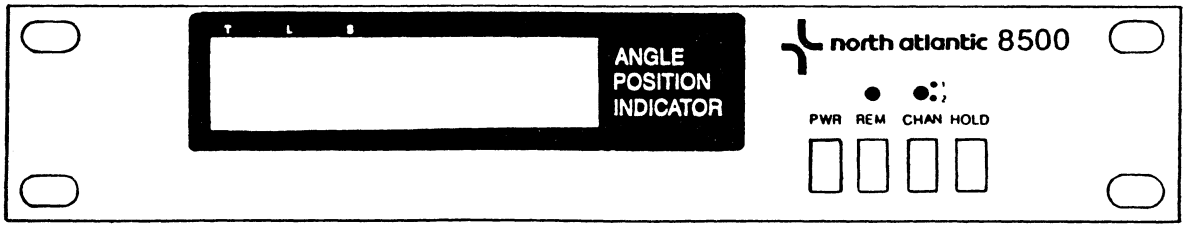
CAUTION

Terminals S1, S2, S3, S4, and REF HI and LO are directly connected to the transformer inputs and must not be used if J1 inputs are used. Refer to table 2-1, J1 pin connections.

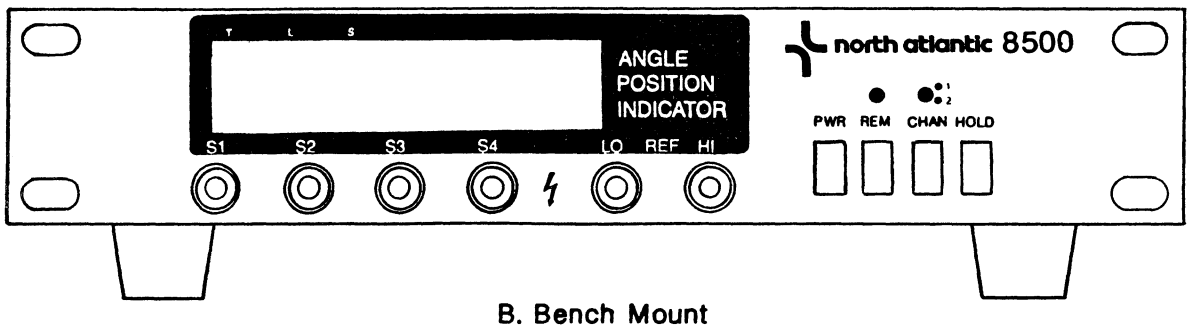
S1,S2,S3,S4 Terminals	Accepts synchro or resolver input signals (bench units only).
REF HI and LO Terminals	Accepts reference input signal (bench units only).

Table 3-1. Front Panel Controls and Indicators (Continued)

Control/Indicator	Function
Main Display	Model 8500 displays angular information in degrees and decimal degrees. Model 8500 main display can be selected using rear panel switches or by external host via IEEE-488 interface as follows: Degrees and decimal degrees 0.00° to 359.99° Degrees and decimal degrees -179.99° to 0.00° to +180.00° Degrees and minutes 0°00' to 359°59' Degrees and minutes -179.59' to 0°00' to +180°00' Refer to paragraph 3-5 for error condition indications.
"T", "L", and "S" Indicators	Letters indicate present status of IEEE-488 interface: T = TALK L = LISTEN S = SRQ (Service Request) NOTE TALK, LISTEN, and SRQ indicators appear dimmer than other displays and indicators.



A. Half Rack Mount



B. Bench Mount

Figure 3-3. Front Panel Controls and Indicators

3-3.2 Rear Panel. The rear panel connectors, receptacles, and switches are described in table 3-2 and illustrated in figure 3-4.

Table 3-2. Rear Panel Description

Control/Indicator	Function
Input Power Receptacle	Power cable connector (J2) for 115 V ac or 230 V ac input.
ADDRESS Switches*	ADDRESS DIP switches set unit address for IEEE bus.
Parallel I/O Connector	Provides API interconnection with external systems, power sources, etc. Refer to table 2-1.
MODES Switch	8-position DIP switch which controls selectable modes. Refer to paragraph 3-3.3.
IEEE-488 Connector*	Connects IEEE-488 standard I/O bus to unit.

*Used only with Feature 3, option 2.

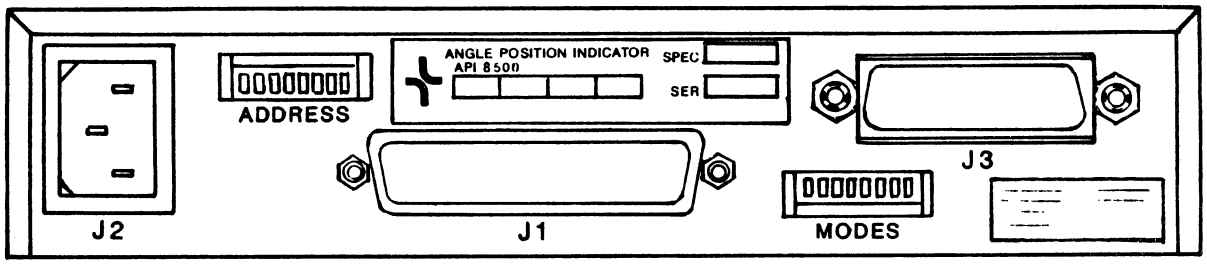


Figure 3-4. Rear Panel

3-3.3 Mode Selection. The MODES 8-position DIP switch is located on the rear panel and controls selection of available mode features. It is described in table 3-3 and illustrated in figure 3-5.

Table 3-3. Mode Switch SW2

Switch Number	Switch Signal Name	Switch Position 1	Switch Position 0
1	CH1 SYN	Channel 1 in resolver mode or for remote control of Channel 1.	Channel 1 in synchro mode.
2	CH2 SYN	Channel 2 in resolver mode or for remote control of Channel 2.	Channel 2 in synchro mode.
3	INT/EXT REF	Selects auto phase corrected internal reference.	Selects external reference.
4	Bandwidth (H/L)	Selects low bandwidth (tracking speed) or remote control of tracking speed.	Selects high bandwidth (tracking speed).
5	Deg/Min	Selects 2 LSDs of display in minutes of arc.	Selects 2 LSDs of display in hundredths of degrees.
6	Display (U/B)	Unipolar display. (0° to 359.99°) or remote control of display.	Bipolar display ±180°.
7	Sign	Sign bit equals plus sign (+) in F2=2 or 4 units.	Sign bit equals minus sign (-) in F2=2 or 4 units.
8	P/I*	Selects IEEE-488 interface for remote control	Selects parallel interface for remote control.

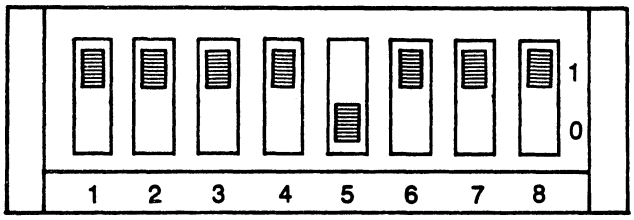


Figure 3-5. MODES Switch SW2

*P/I has no effect in units without IEEE-488 interface.

3-4 DATA TRANSFER CHARACTERISTICS

3-4.1 Timing. The S/D converter outputs changes in discrete 1 LSB steps. To prevent data from changing during the time it is transferred into the system or computer, provisions have been made to insure data stability during this transfer.

3-4.2 Converter Busy Signal. The first method of transferring converter output data into the system is to monitor the Busy signal supplied by the S/D converter. This signal indicates output data changes. The following conditions allow data transfer:

a. Data may be safely transferred on the trailing edge of the converter Busy signal.

b. Data may also be safely transferred whenever the converter Busy signal is a logic 0.

A timing diagram representing the converter Busy signal during the time the API is tracking at its maximum rate of 1800 deg/sec is shown in figure 3-6.

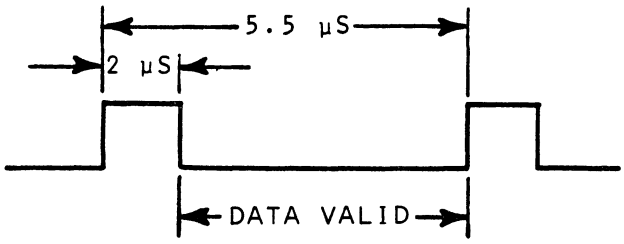


Figure 3-6. Converter Busy Signal

3-4.3 Data Freeze. The second method of data transfer is to freeze the data output with an externally supplied Freeze signal. The Freeze signal must be applied for a minimum of 2 uS before transferring data into the system or computer.

Two Data Freeze inputs are provided (refer to table 2-1):

a. Active High (DF, J1 pin 42)

b. Active Low ($\overline{DF}$, J1 pin 27)

Since the Data Freeze signal does not stop the API from tracking, it may be applied for as long as necessary to transfer data. 50 nS after removing the Data Freeze signal the output data will represent the Synchro/Resolver input angle provided no over velocity or other error conditions have occurred (refer to paragraph 3-5.2, BITE Output). A timing diagram of a typical data transfer is shown in figure 3-7.

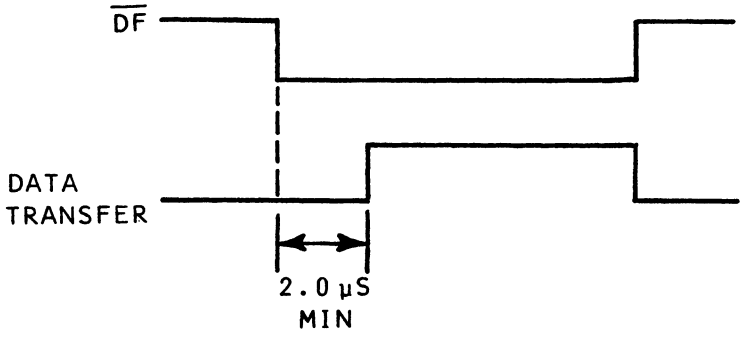


Figure 3-7. Typical Data Transfer

3-5 ERROR CONDITIONS

3-5.1 Error Condition Indicators. In addition to angular information, the main display indicates three error conditions. Refer to table 3-4.

Table 3-4. Main Display Error Indications

Error Condition	Main Display Indication
OVER VELOCITY	A small "o" is displayed to the left of the angular display.
	NOTE When operating in the Bipolar Mode (F2=2 or 4 only) the "o" display indication will conceal the minus sign indicator.
LOSS OF or LOW LINE TO LINE VOLTAGE	The display goes blank with the exception of the decimal point or degree sign.
LOSS OF or LOW REFERENCE VOLTAGE	All 8s are displayed. (This function overrides all other display indications.)

3-5.2 Built-in Test Equipment (BITE) Output. A digital output is available at J1 pin 40 (refer to table 2-1) that indicates one or more of the three error conditions described in paragraph 3-5.1. When an error condition exists, the BITE output will change to and remain at a logic 1 until the error condition is corrected.

SECTION 4

THEORY OF OPERATION

4-1 INTRODUCTION

This section provides functional theory of operation for the API. It includes block diagrams that illustrate the major system components and basic signal paths.

4-2 FUNCTIONAL DESCRIPTION

The API is designed with an NAI closed servo loop (refer to figure 4-1). This system continuously tracks the analog input data with a precision Scott-T transformer, resistive bridge, automatic gain control, phase detector, integrator, and clock generator that drives a counter which updates the bridge to the synchro data angle input.

4-2.1 Control Loop. The heart of the system is a custom LSI TRIG LOGIC™ processor. This LSI contains analog switches, an Up/Down counter, and trigonometric digital circuitry for processing the input signals (figure 4-1).

4-2.1.1 Input Signal Path. The input signal, whether synchro (three wire) or resolver (four wire), feeds directly into the precision transformer assembly which outputs a Sin θ signal and a Cos θ signal to the coarse bridge. Both signals drive analog switches which switch at 20° intervals. These points are referred to as αc. The signals produced within the coarse bridge circuit are Sin θ Cos αc, Sin θ Sin αc, Cos θ Cos αc, and Cos θ Sin αc. These four functions are combined to derive Sin $(\theta - \alpha c)$ error signal and Cos $(\theta - \alpha c)$ interpolation signal, implementing the following trigonometric relationships:

$$\text{Sin}(\theta - \alpha c) = \text{Sin}\ \theta\ \text{Cos}\ \alpha c - \text{Cos}\ \theta\ \text{Sin}\ \alpha c$$
$$\text{Cos}(\theta - \alpha c) = \text{Sin}\ \theta\ \text{Sin}\ \alpha c + \text{Cos}\ \theta\ \text{Cos}\ \alpha c$$

Since αc takes on values at only 20° intervals, $\theta - \alpha c$ will be somewhere between 0° and +20°, depending upon the value of the input angle θ. The error signal Sin $(\theta - \alpha c)$ is then balanced out in the interpolation circuit using Cos $(\theta - \alpha c)$ as an interpolation reference signal.

The interpolation circuit contains a precision resistor network to bridge the error signal against the interpolation reference signal. The precision resistor network as well as the analog switches of the coarse bridge are driven digitally by the counter. The result of the bridging process is an ac error signal proportional to:

$$\text{Sin}\ (\theta - \alpha c)\ \text{Cos}\ \ f\ \text{Cos}\ (\theta - \alpha c)$$

This equals Sin $(\theta - \alpha c - \alpha f)$, where αf is the digitally generated angle in the interpolation circuit.

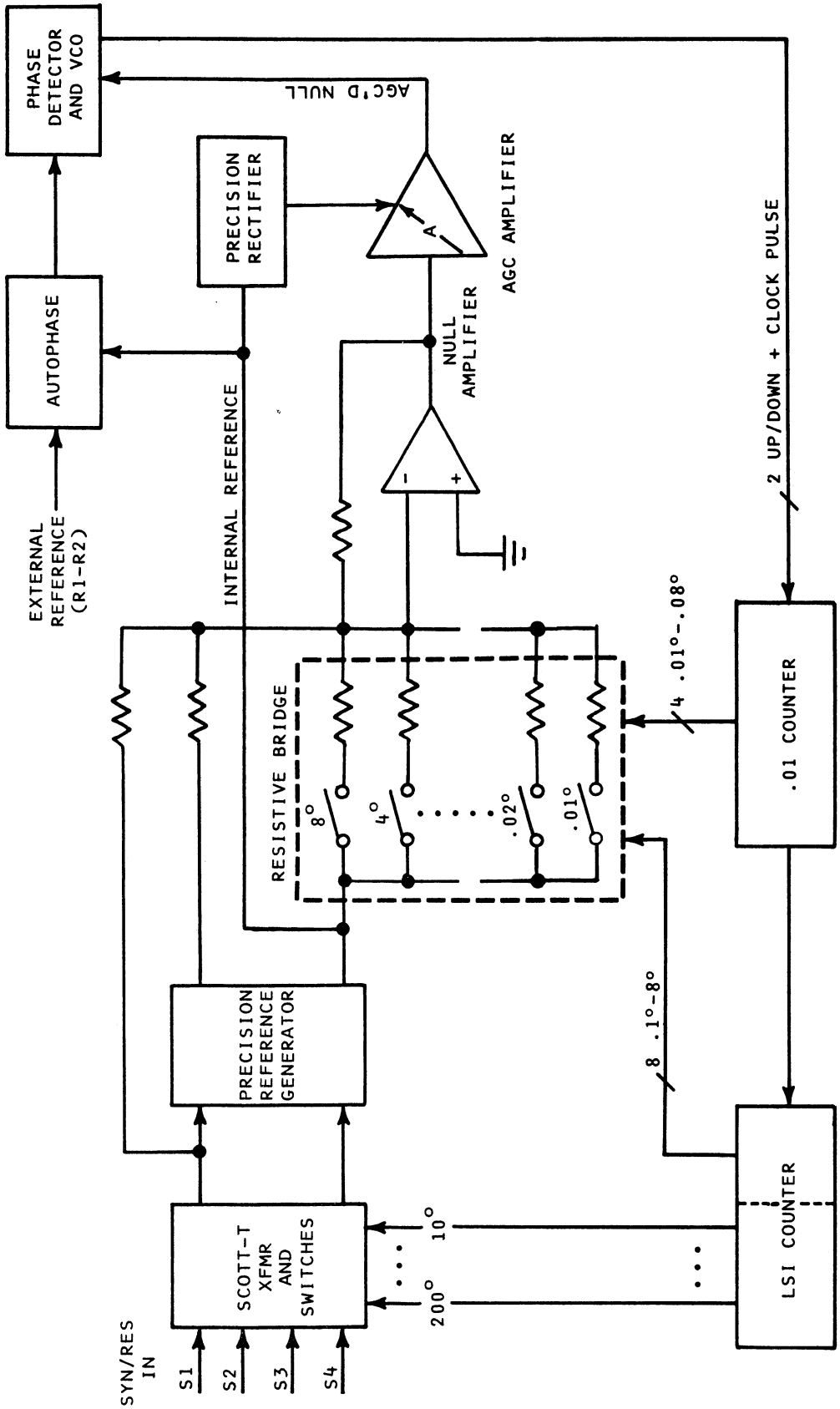


Figure 4-1. Control Loop Block Diagram

4-2.1.2 Internal Reference Signal Derivation. An internal reference signal is derived from the input data by the Precision Reference Generator section of the LSI processor (figure 4-1). This signal is proportional to the line-to-line voltage of the input and is essentially constant as a function of the input. The Precision Rectifier converts this signal into a dc voltage and sends it to the Automatic Gain Control (AGC) amplifier.

4-2.1.3 Automatic Gain Control. The AGC amplifier is configured from an analog-to-digital converter and a multiplying digital-to-analog converter combination. The converted dc (L-L) voltage from the Precision Rectifier is sent to the A/D converter and its output digitally controls the gain of the multiplying D/A converter. The null voltage output of the interpolation circuit is applied to the input of the AGC amplifier (D/A converter). The output (AGC Null) is now automatically adjusted for changes in line-to-line voltage and produces a constant error gradient (volts of null signal per degree error) at the input of the Phase Detector.

4-2.1.4 Autophase Circuit. The Autophase circuit compares the phase of the internal and external reference signals and automatically corrects for phase shifts of up to $\pm 80^{o}$ between them. The circuit will also select the external reference when required.

4-2.1.5 Phase Detector Circuit. The phase corrected reference and the AGC null signal are input to the Phase Detector and produce a bipolar dc signal proportional to the in-phase portion of the ac error voltage. The dc error is integrated and applied to the input of the Voltage Controlled Oscillator (VCO) which produces a train of clock pulses with a frequency proportional to the magnitude of the dc error voltage. An auxiliary comparator detects the sign of the dc error and generates a directional up/down signal.

4-2.1.6 UP/DOWN Counter Circuit. The clock pulses and up/down signals go into a two section BCD Up/Down Counter consisting of an LSI Counter and a .01 Counter. The lower section counts in increments of $.01^{o}$ and the upper sections, part of the LSI chip, count from 0.1^{o} and up. The output of the BCD counter closes the loop with coarse bridge rectifier and interpolation circuits.

In operation, whenever the input synchro or resolver is turned, an ac error builds up causing a corresponding dc error. The dc error causes clock pulses to appear in the proper direction to reduce the magnitude of the error signals. When the error signals are reduced to zero, plus or minus the threshold voltages, the digital output then equals the new input synchro or resolver angle.

4-2.2 Display and Digital Signals. In standard API units the outputs of the BCD counters are applied directly to the display circuits and output buffers. They can also be applied via an optional scaling circuit of three specially programmed EPROMs (figure 4-2). In standard API units the BCD digits are combined with the Lamp Test and other signals to form the input to the seven-segment LED displays.

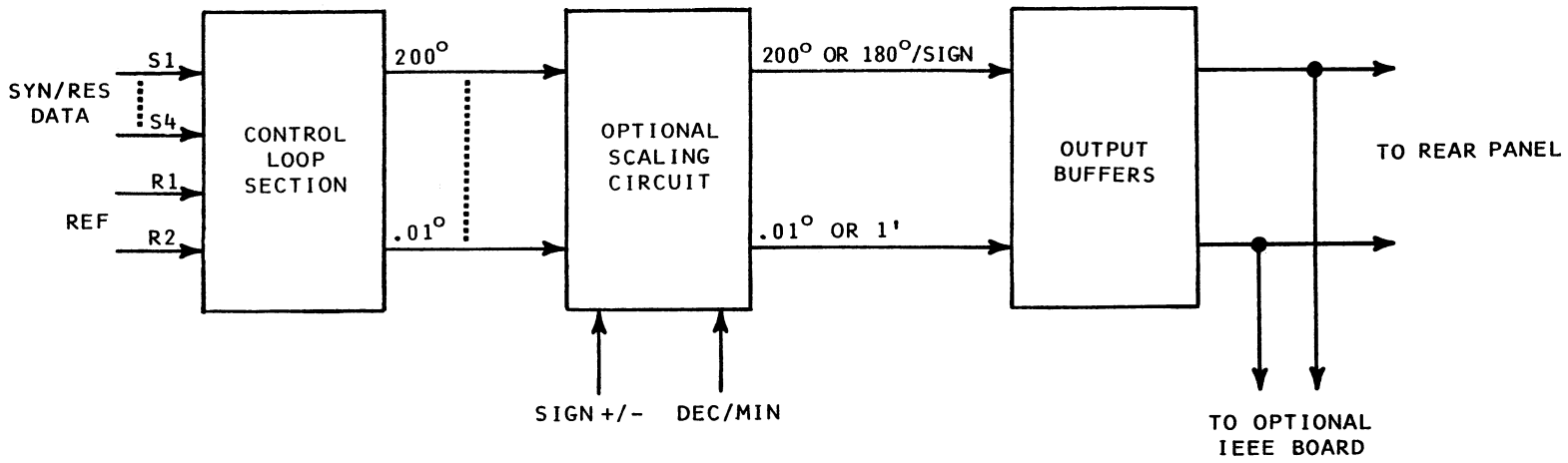


Figure 4-2. Display Option Circuit

In the units with F2=2 or 4 the BCD signals are converted from the normal 0-359.99 degree format to the ±180 degree format. Also, the lower two digits may be converted from the normal 0.00 to 0.99 to 0 to 59 minutes of arc. The output signals are buffered before being applied to the parallel output connector.

A final section of digital control logic chooses among selector switch controls, rear panel connector signals, and optional IEEE-488 interface signals for control of the API modes. These signals select the channel in use, the type of channel (synchro or resolver), determine if the API responds to remote or local control, etc.

SECTION 5

8500 IEEE-488 REMOTE OPERATION

5-1 INTRODUCTION

This section describes the operation and programming of the Model 8500 Angle Position Indicator (API) using the IEEE-STD 488-1978, Standard Digital Interface for Programmable Instrumentation.

5-2 SETTING THE DEVICE ADDRESS

The addresses that the API will respond to are set by the binary weighted rear panel ADDRESS DIP switches labeled A1-A5. The ADDRESS switch is only checked upon power up. Figure 5-1 illustrates the API address set to binary 5. Table 5-1 Device Address Codes lists the allowable addresses in ASCII, Binary, and Hexadecimal.

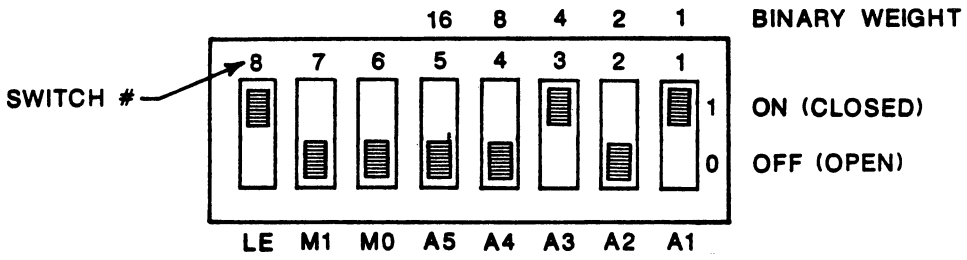


Figure 5-1. Rear Panel IEEE DIP Switch

5-3 SETTING OPERATING MODE

To operate API using the IEEE-488 interface, mode switch SW2 must be set to mode options which allow remote operation. Set modes as follows (refer to table 3-3):

SW2-1	RES	(1)
-2	RES	(1)
-3	N/A	
-4	HI	(0)
-5	N/A	
-6	180	(0)
-7	N/A	
-8	IEEE	(1)

5-4 FRONT PANEL IEEE STATUS LEDS

Front panel status LEDs are provided to allow the operator to monitor the operation of the API on the IEEE-488 bus. The three LEDs are integrated into the data display and indicate TALK, LISTEN and SRQ. These indicators must be enabled via the IEEE DIP switch LE (number 8) on the rear panel. Position 1 enables the LEDs and position 0 disables them. When the TALK LED is lit the API is addressed to talk. The LISTEN LED indicates the API is addressed to listen, and when the SRQ LED is on the API is asserting the service request line on the IEEE-488 bus. Figure 5-2 shows the status LEDs enabled and illustrates the position of the IEEE status LEDs in the display.

NOTE

TALK, LISTEN, and SRQ indicators appear dimmer than other displays and indicators.

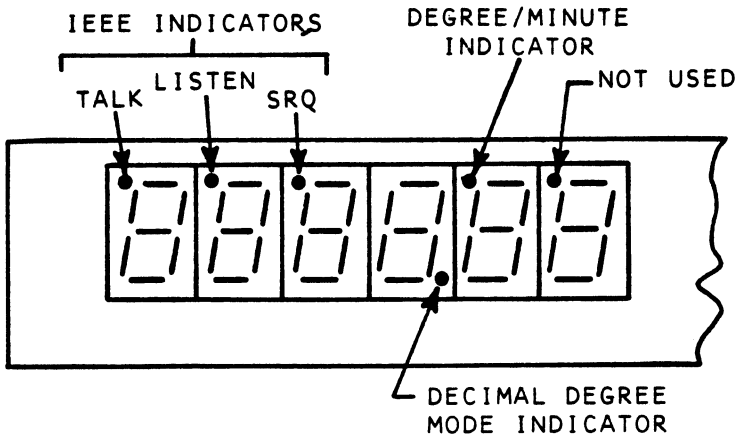


Figure 5-2. IEEE Status LEDs

Table 5-1. Device Address Codes

Device	ASCII		A D D R E S S Binary					Hexadecimal	
	Listen	Talk	A5	A4	A3	A2	A1	Listen	Talk
0	SP	@	0	0	0	0	0	20	40
1	!	A	0	0	0	0	1	21	41
2	"	B	0	0	0	1	0	22	42
3	#	C	0	0	0	1	1	23	43
4	$	D	0	0	1	0	0	24	44
5	%	E	0	0	1	0	1	25	45
6	&	F	0	0	1	1	0	26	46
7	'	G	0	0	1	1	1	27	47
8	(	H	0	1	0	0	0	28	48
9	)	I	0	1	0	0	1	29	49
10	*	J	0	1	0	1	0	2A	4A
11	+	K	0	1	0	1	1	2B	4B
12	,	L	0	1	1	0	0	2C	4C
13	-	M	0	1	1	0	1	2D	4D
14	.	N	0	1	1	1	0	2E	4E
15	/	O	0	1	1	1	1	2F	4F
16	0	P	1	0	0	0	0	30	50
17	1	Q	1	0	0	0	1	31	51
18	2	R	1	0	0	1	0	32	52
19	3	S	1	0	0	1	1	33	53
20	4	T	1	0	1	0	0	34	54
21	5	U	1	0	1	0	1	35	55
22	6	V	1	0	1	1	0	36	56
23	7	W	1	0	1	1	1	37	57
24	8	X	1	1	0	0	0	38	58
25	9	Y	1	1	0	0	1	39	59
26	:	Z	1	1	0	1	0	3A	5A
27	;	]	1	1	0	1	1	3B	5B
28	<	\	1	1	1	0	0	3C	5C
29	=	[	1	1	1	0	1	3D	5D
30	>	^	1	1	1	1	0	3E	5E

5-5 FIRMWARE SELECTION

The rear panel IEEE DIP switches allow the operator to select the NATIVE mode (Standard 8500) firmware. The selection is made via the ADDRESS DIP switches labeled M1 and M0. Table 5-2 shows the switch positions for the NATIVE mode of operation and figure 5-1 shows the NATIVE mode enabled.

Table 5-2. Mode Selection Switch Positions

M1	M0	Mode
0	0	NATIVE mode
0	1	reserved
1	0	reserved
1	1	reserved

5-6 IEEE-488 BUS COMMANDS

Table 5-3 lists the applicable IEEE-488 bus commands for the API.

Table 5-3. IEEE-488 Bus Commands

Mnemonic	ASCII	Hex	Function
GTL	SOH	01	Go To Local - This command instructs the API to go to local mode. All front panel controls are active.
SDC	EOT	04	Selected Device Clear - When the SDC command is received, and if the API is addressed to listen, the API will initialize to the conditions listed under DCL.
DCL	DC4	14	Device Clear - When the API receives the DCL command it is initialized to the following state: SYNCHRO CHANNEL 1 DATA FREEZE - OFF UNIPOLAR MODE TRACKING RATE - SLOW SRQ MODE - OFF LAMP TEST - OFF GET MODE - OFF
GET	BS	08	Group Execute Trigger - When the GET command is received, and if the API is addressed to listen and has the GET mode switch on, data sent to the API will be applied to the instrument.

Table 5-3. IEEE-488 Bus Commands (Continued)

Mnemonic	ASCII	Hex	Function
LLO	DC1	11	Local Lockout - This command disables the front panel REM switch. It gives the controller complete control over whether the API is in remote or local operation.
SPE	CAN	18	Serial Poll Enable - After receipt of this command the API, when addressed to talk, will transmit the Status Byte.
SPD	EM	19	Serial Poll Disable - This command cancels the SPE command and allows the API, when it is addressed to talk, to send data.
UNL	?	3F	Unlisten - Unaddresses the API listen address.
UNT	-	5F	Untalk - Unaddresses the API talk address.

5-7 NATIVE MODE OPERATION

5-7.1 IEEE-488 Interface Function Subsets. Table 5-4 lists the interface function capability codes for the API in Native mode (standard 8500).

Table 5-4. Interface Function Capability Codes.

Code	Function
AH1	Acceptor handshake - complete capability
SH1	Source handshake - complete capability
T6	Talk capability - all except TON
TE0	Extended Talk capability - none
L4	Listen capability - all except LON
LE0	Extended Listen capability - none
SR1	Sevice request - complete capability
RL1	Remote/Local - complete capability
PP0	Parallel Poll - no capability
DC1	Device Clear - complete capability
DT1	Device Trigger - complete capability

5-7.2 Commands. All commands are a single letter or number. The commands may be sent in any order and the entire command string must be terminated with a carriage return-line feed sequence <cr><lf>. The letters of the commands can be entered in either upper or lower case. Table 5-5 lists all of the commands and their actions. Any characters not appearing in table 5-5 are ignored.

Table 5-5. IEEE-488 Interface Commands

Command	Effect
S	Programs SYNCHRO mode
R	Programs RESOLVER mode
T	Allows the API to track the input signal
F	Freezes the API display
V	Programs the API to assert SRQ when data is stable
G	Programs GET mode
L	Selects low tracking rate
H	Selects high tracking rate
U	Selects Unipolar mode
B	Selects Bipolar mode (if option is installed)
I	Turns on Lamp Test
D	Turns off Lamp Test and returns display to normal
1	Selects channel 1
2	Selects channel 2

5-7.3 Data. The API will send angle data to the controller in the following format:

SDDD.DDD<cr><lf>
E.g., -175.001<cr><lf>

S is the sign character. It will be a space if the angle is positive or a minus sign if the angle is negative. When the FAULT bit is set in the STATUS byte the ASCII character "E" will be sent in place of the sign.

D represents data digits. They will be characters 0-9.

The data message will always be 8 characters long plus a <cr><lf>.

5-7.4 Serial Poll. The status byte returned by the API indicates the status of the instrument. The bits of the status byte are defined as:

D7	D6	D5	D4	D3	D2	D1	D0
ERROR	RQS	CH2	BIPOLAR	FAST	FAULT	FREEZE	RESOLVER

ERROR - When bit is set the API data is not stable. Stability is defined as having no converter clocks spaced closer than 100 mS. This bit will be set when running at rates greater than .1°/Sec. The error bit will also be set whenever the FAULT bit is set.

RQS - When bit is set the API is asserting the SRQ line.

CH2 - When bit is set the API is programmed to channel 2. When cleared the API is set to channel 1.

BIPOLAR - When bit is set the unit is in bipolar mode. When cleared the API is in unipolar mode.

FAST - When bit is set the instrument is programmed for the fast tracking rate. When cleared the unit is programmed for the slow tracking rate.

FAULT - When FAULT bit is set, one or more of the following conditions have been detected:

a. REF voltage low
b. SIGNAL (S1-S4 voltage low)
c. OVERVELOCITY condition
d. LAMP TEST is on

FREEZE - When bit is set the display is frozen. When cleared the API tracks the input signal.

RESOLVER - When bit is set the API is programmed for RESOLVER mode. When cleared the API is set to SYNCHRO mode.

If the RQS bit is set, the remaining bits indicate the state of the API when the SRQ line was last asserted. If the RQS line is not set then the remaining bits indicate the state of the API at the time the status byte is read.

5-7.5 Service Request. The API can be programmed to assert the SRQ line when the display data is stable. Stability is defined as having no clock pulses spaced closer than 100 mS. The V command (table 5-5) instructs the API to assert the SRQ line when stable data is detected. If stability is not detected within 4 seconds, SRQ will be asserted nevertheless and the ERROR bit in the STATUS byte will be set. This command cancels itself once SRQ is asserted and must be reprogrammed for subsequent SRQs. When SRQ is asserted the display data is saved and will be transmitted to the controller (when addressed to talk) regardless of the display value. Once read, the API output data will then agree with the display.

5-7.6 GET Mode. When the G command (table 5-5) is included in the programming string, the API will hold off applying the programming data until the GET bus command is received. GET mode is cancelled once the bus command GET is received and must be reprogrammed if desired again.

5-8 API IEEE-488 APPLICATION EXAMPLES

The scope of applications for the API IEEE-488 Interface is large and cannot be fully addressed here. Program examples for the NATIVE mode are listed in tables 5-6 and 5-7. The program example in table 5-6 utilizes an HP85 computer as a controller whereas the program example in table 5-7 uses an IBM PC.

Table 5-6. NATIVE IEEE-488 Application Example #1

NOTE

The following program is an application example written for the HP85 computer.

```
 10 CLEAR
 20 DIM U(35)
 22 DIM D(35)
130 A=705 @ S=706
135 W=SPOLL(A)
140 OUTPUT A ;"RTH1"
150 PRINT "ANGLE      UP    DOW
    N      AVG"
160 PRINT  "
    ----------
170 FOR I=0 TO 350 STEP 10
180 A$=VAL$(I*100+100000)
190 OUTPUT S ;A$[2,6]&"013"
200 GOSUB 900
210 ENTER A ; D$
215 R=VAL(D$[2,7])
216 IF R>355 THEN R=R-360
220 ! PRINT USING "DDD.DD,4X,SZ.
    DD" ; I,R-I
225 U(I/10)=R-I
230 NEXT I
240 OUTPUT S ;"00000"
250 WAIT 1000
370 FOR I=350 TO 0 STEP -10
380 A$=VAL$(I*100+100000)
390 OUTPUT S ;A$[2,6]&"013"
400 GOSUB 900
410 ENTER A ; D$
415 R-VAL(D$[2,7])
416 IF R>355 THEN R=R-360
425 D(I/10)=R-I
430 NEXT I
500 FOR I=0 TO 35
520 PRINT USING "DDD.DD,3X,S4Z.DD
    ,3X,SZ.DD,3X.SZ.DDD" ; I*10,
    U(I),D(I),(U(I)+D(I))/2
540 NEXT I
899 END
900 !
905 ! WAIT FOR SRQ
910 !
915 W-SPOLL(A)
917 WAIT 100
920 OUTPUT A ;"RTV"
930 STATUS 7,2; Q
935 IF BIT(Q,5)=0 THEN 930
945 W=SPOLL(A)
946 STATUS 7,2 ; Q
947 IF BIT(Q,5)=1 THEN 945
950 RETURN
```

Table 5-7. NATIVE IEEE-488 Application Example #2

NOTE

This program is written for the IBM PC with the Hewlett-Packard IEEE Interface card using the HPIB command library. This program should be appended to the SETUP.BAS program supplied with the HPIB software.

```
1000  API=705: SIM=706 :ISC=7 :L=5
1002  DIM U(35),D(35)
1005  C$="RTHV" : LC=LEN(C$) "SRQ=1
1006  BEEP
1008  PRINT "COUNTING UP"
1010  FOR I=0 TO 350 STEP 10          :'DO ACCURACY STEPPING UP
1020  A=I*100+100000!
1030  A$=MID$(STR$(A),3,5)
1040  CALL IOOUTUPTS(SIM,A$,L)        :'OUTPUT ANGLE
1050  CAL IOOUTPUTS(API,C$,LC)
1060  CALL IOSTATUS(ISC,SRQ,STATUS)   :'WAIT FOR SRQ
1070  IF STATUS=0 THEN 1060
1080  CALL IOSPOLL(API,SP)            :'DO A SERIAL POLL
1090  CALL IOENTER(API,READING)       :'READ API DATA
1095  IF READING>355 THEN READING=READING-360
1100  U(I/10)=READING-I
1110  NEXT I
1800  PRINT "COUNTING DOWN"
1900  SIM$="00000013" : SL=LEN(SIM$)
2000  CALL IOOUTPUTS(SIM,SIM$,SL)
2010  FOR I=350 TO 0 STEP -10         :'DO ACCURACY STEPPING DOWN
2020  A=I*100+100000!
2030  A$=MID$(STR$(A),3,5)
2040  CALL IOOUTPUTS(SIM,A$,L)        :'OUTPUT ANGLE
2051  CALL IOOUTPUTS(API,C$,LC)
2060  CALL IOSTATUS(ISC,SRQ,STATUS)   :'WAIT FOR SRQ
2070  IF STATUS=0 THEN 2060
2080  CALL IOSPOLL(API,SP)            :'DO A SERIAL POLL
2090  CALL IOENTER(API,READING)       :'READ API DATA
2095  IF READING>355 THEN READING=READING-360
2100  D(I/10)=READING-I
2110  NEXT I
3010  LPRINT "ANGLE     UP     DOWN      AVG"
3020  LPRINT "-----------------------------"
3030  FOR I=0 TO 35                   :'PRINT OUT DATA
3040  LPRINT USING "###.##    +#.##    +#.##    +#.####":I*10,U(I),D(I),(U(I)+D (I))/2
3050  NEXT I
```

SECTION 6

MAINTENANCE

6-1 INTRODUCTION

This section contains cleaning, performance tests, and alignment procedures for the API.

WARNING

> High voltages exist at several points in this instrument. Normal precautions should be taken to avoid shock hazard.

6-2 CLEANING

No special cleaning procedures or fluids are required other than keeping the instrument free of dust and dirt.

6-3 PERFORMANCE TEST

The API is designed to operate as a solid state, two-channel, synchro or resolver-to-digital converter with a built-in display. This display is a LED type located on the front panel.

The following paragraphs provide performance test procedures. Perform these tests periodically to ensure proper equipment operation.

6-3.1 Equipment Required. Table 6-1 lists the test equipment required to test and align the API. The Minimum Use/Critical Specifications column lists the parameters required for alignment and are not for the purpose of alternate equipment selection. Satisfactory performance of alternate equipment should be verified before use.

6-3.2 API Test Characteristics. Table 6-2 lists the various API characteristics and the methods which are used to test them.

Table 6-1. Test Equipment Required

Item	Minimum Use/Critical Specifications	Manufacturer and Model
Synchro/resolver simulator	Frequency: 60 to 400 Hz Range: 00.000° to 359.999° Accuracy: 10 arc second Modes: Synchro or resolver Synchro conventions meet MIL-S-20708A Resolver conventions meet MIL-R-21530 (paragraph 3-2)	North Atlantic Industries, Model 530/20 Synchro/Resolver Simulator
Mating connector	Connector wired for the function to be tested (figure 6-1)	North Atlantic Industries, Mating Connector Kit P/N 783718 Qty — Amp P/N 1 shell — 205211-1 1 clamp — 205732-1 2 retainers — 205980-1 50 pins — 66569-3
Ac power source	Frequency: 60 to 400 Hz Range: 0 to 120 V rms Distortion: 0.6% Output rating: 20 VA Load regulation: ±1% Phase: Single	Elgar, Model 121 with Model 401 V plug-in
Phase angle voltmeter	Frequency: 60 and 400 Hz Sensitivity: 10 V to 0.003 V Voltage accuracy: ±2% full scale Phase accuracy: ±1°	North Atlantic Industries, Model 321 or 2250 Phase Angle Voltmeter
Oscilloscope	Horizontal sweep time: 1 uS Vertical sensitivity: 1 V/cm Rise time: 24 ns Input R and C: 1 M ohms paralleled by approximately 33 pf	Tektronix, Model 422
DVM	Range: 199.9 mV Z in: 100 M ohms Resolution: 3-1/2 digits	Weston, Model 4449

Table 6-2. API Test Characteristics

Characteristic	Performance Specification	Test Method
Line voltage	The line voltage may range from 47 to 440 Hz, 102 to 125 V.	Not tested.
Signal inputs	10 V to 100 V, L-L synchro or resolver at 47 to 440 Hz. Signal input impedance 250 k, minimum.	Not tested.
Reference input	1 V to 115 V rms, 47 to 400 Hz. Input impedance 100 k, minimum.	Not tested.
Angular accuracy	±0.03 (standard)	Accuracy is tested by injecting known synchro or resolver angles and observing them on the display.
Angular resolution	0.01° (standard)	None
Tracking characteristics	Low: Up to 0.5 rps (180°/sec) High: 5 rps (1800°/sec)	Not tested.

6-3.3 Preliminary Operations. Perform the following preliminary steps.

a. Refer to paragraph 3-3 for setup information.

b. Verify that power switch is off and connect equipment to appropriate power source.

c. Verify that the mating connector has been wired for function to be tested. Refer to figure 6-1.

6-3.4 Grounding. In bench applications, pins 3 and 5 should be tied together and connected to the low side of the signal source of the synchro or resolver.

In system applications, the separate pins make it possible to connect to other parts of the system. If they are not connected, however, they should be tied together at the connector.

6-3.5 Performance Test Setup. Set up equipment as shown in figure 6-1 and perform the following:

a. Set all auxiliary equipment controls as necessary to avoid damage to the equipment and to prevent dangerous voltages at the output terminals when power switches are turned on.

b. Set DIP switch SW2 located on main chassis circuit card assembly as follows:

SW2-1	RES	(1)
-2	SYN	(0)
-3	INT	(1)
-4	LO	(1)
-5	PEG	(0)
-6	360	(1)
-7	+	(1)
-8	PAR	(0)

c. Turn all power switches on, with the exception of the API, and allow time for the auxiliary equipment to stabilize. (The API does not require warm up time.)

d. Set the synchro/resolver simulator for 11.8 V L-L, 400 Hz resolver output (00.000°).

e. Adjust the variable power and reference source for 400 Hz ±10 Hz, 115 V ±2 V output.

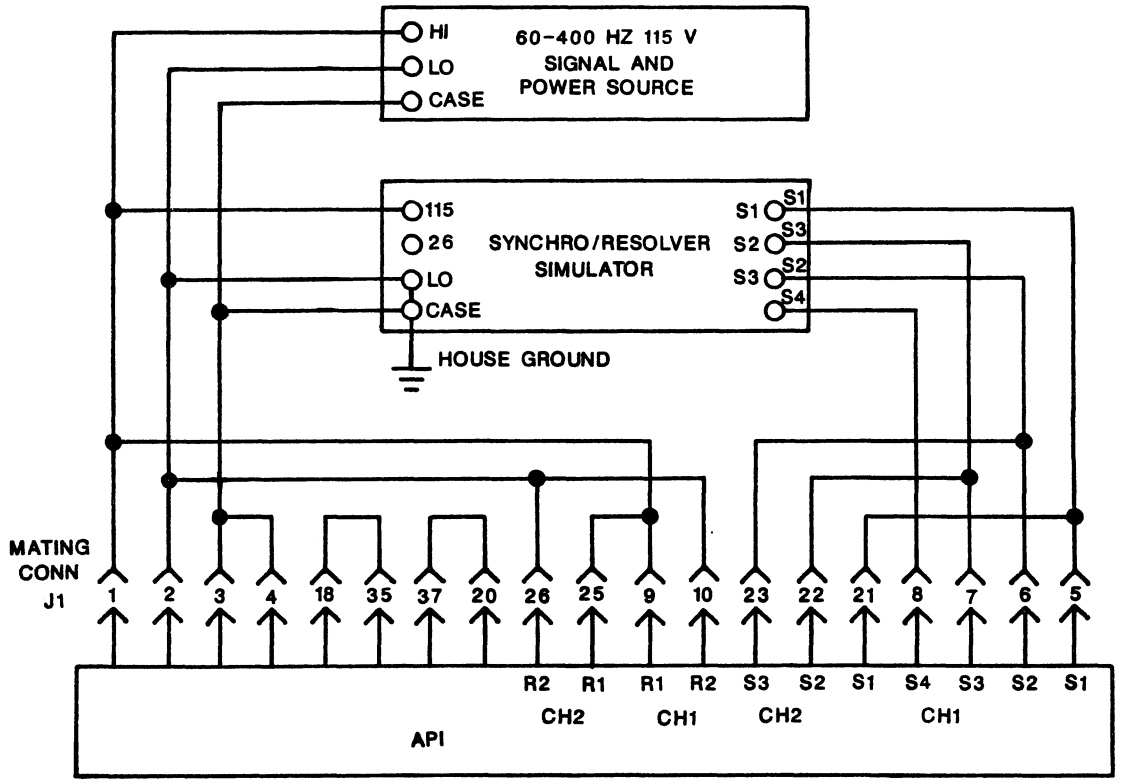


Figure 6-1. Performance Test Setup

6-3.6 Channel 1 Accuracy Test.

a. On the API front panel depress CH1 push button.

b. Advance the synchro/resolver simulator in 10° steps (00.000° through 350.000°). API should read within ±0.03° of the input angle.

c. Advance the resolver/synchro simulator in 1° through 9°, 0.1° through 0.9°, and 0.01° through 0.09° steps, respectively. API should read within ±0.03° of the input angle.

6-3.7 Channel 2 Accuracy Test.

a. Depress CH2 push button on the API.

b. Set the synchro/resolver simulator for 90 V L-L, 60 Hz synchro output.

c. Adjust the variable power source for 60 Hz ±5 Hz, 115 V ±2 V output.

d. Advance the synchro/resolver simulator in 1° through 9°, 0.1° through 0.9°, and 0.01° through 0.09° steps, respectively. API should read within ±0.03° of the input angle.

6-4 ALIGNMENT PROCEDURE

This procedure describes the alignment sequence and test equipment required to align the API. The unit is aligned by adjusting two potentiometers. Periodic alignment is unnecessary and should not be attempted unless the performance test reveals a misaligned condition.

6-4.1 Test Equipment. Minimum Use/Critical Specifications are the principal parameters required for performance of the alignment procedure. They are included to assist in the selection of alternate equipment which may be used at the discretion of the aligning activity. Satisfactory performance of alternate items shall be verified before use. All applicable equipment must bear evidence of current calibration. See table 6-1 for equipment requirements.

6-4.2 Alignment Set Up.

a. Set all auxiliary equipment controls as necessary to avoid damage to the equipment and to prevent dangerous voltages from existing at the output terminals when power switches are turned on.

b. Setup equipment as shown in figure 6-1. Tie the auxiliary equipment to house ground at only one point to avoid ground loops.

c. Set DIP switch SW2 on Main circuit card assembly as follows:

SW2-1	SYN	(0)
-2	SYN	(0)
-3	EXT	(0)
-4	LO	(1)
-5	DEG	(0)
-6	360	(1)
-7	+	(1)
-8	PAR	(0)

d. Remove six screws securing top cover and remove cover.

e. If optional IEEE-488 circuit card assembly is installed, remove four securing screws and two jackscrews from rear panel IEEE-488 connector and lift out circuit card.

f. Turn all power switches on, with the exception of the API, and allow time for the auxiliary equipment to stabilize. (The API does not require warm up time.)

g. Set the synchro/resolver simulator for 11.8 V L-L, 400 Hz synchro output at 0.000°.

6-4.3 Precision Rectifier Offset Alignment.

a. On the Main circuit card assembly locate and short U4-14 to ground (TP4) with a short jumper and monitor TP9 with DVM.

b. Locate and adjust R3 for 0.000 $\pm$.001 V dc at TP9.

c. Remove short jumper from U4-14.

6-4.4 VCO DC Gain Alignment.

a. Set DIP switch SW2 on Main circuit card assembly as follows:

SW2-1	SYN	(0)
-2	SYN	(0)
-3	EXT	(0)
-4	LO	(1)
-5	DEG	(0)
-6	360	(1)
-7	+	(1)
-8	PAR	(0)

b. Set simulator to 0.00°.

c. Remove shorting link between test points TP4 and TP5.

d. Connect the high side of the signal input of PAV to TP7 (ac null) and low side to TP4 (analog ground). Connect PAV reference input to the signal source.

e. Adjust simulator for an inphase null on PAV.

f. Connect DVM between TP6 (dc null) and TP4.

g. Adjust threshold centering pot R12 until DVM reads 0 V dc.

h. Install shorting link between TP4 and TP5.

i. Reinstall IEEE-488 interface circuit card assembly and top cover.

j. Turn API on and check operation by advancing simulator in 10^{o} steps (00.000^{o} through 350.000^{o}). If maximum angle errors tend to be of the same sign (positive or negative), repeat adjustment of R12 as required to cause an even distribution between maximum positive and negative errors.

SECTION 7

TROUBLESHOOTING

7-1 INTRODUCTION

This section contains troubleshooting procedures for the API. Additional information listing typical test conditions including voltage levels and signal waveforms, preliminary troubleshooting checks, and visual inspection procedures is also supplied.

WARNING

High voltages are present at several points in the API. Normal precautions should be taken to avoid shock hazard.

CAUTION

The API contains CMOS integrated circuits. Handle these ICs with extreme care. Never remove any integrated circuit with the power on and use only properly grounded test equipment.

7-2 TROUBLESHOOTING PROCEDURE

When a failure occurs during preliminary checkout tests, alignment procedures, or during normal operation of the API, refer to the following subparagraphs to isolate the faulty circuit assembly or component. For additional information during the troubleshooting process, refer to the detailed schematic, interconnection diagrams, and to the parts location diagrams.

a. Preliminary Unit Checks

Turn off the power switch and disconnect the API from the ac line when a failure first occurs. Remove the top cover (paragraph 2-4.3.1) and inspect the unit for the following obvious causes of trouble:

(1) Cable connectors not properly seated.

(2) ICs not properly seated in their sockets.

(3) Broken wires or loose components.

(4) Burnt components indicating thermal overload. (The cause should be located and corrected immediately.)

(5) Metallic particles shorting adjacent lands on PC board. Both sides of boards should be inspected (where convenient) and all exposed boards completely brush cleaned to remove dust particles.

(6) Input signals and power levels are not at their proper levels and frequencies and/or voltage levels.

(7) Mode programming is incorrect.

(8) The unit is not properly grounded.

(9) Switch SW3 or SW5 is not in the proper position for power input.

b. Test Point Data Checks

Table 7-1 provides a list of test points and signals to be checked during the preliminary troubleshooting process. Refer to table 6-1 for required test equipment.

Table 7-1. Troubleshooting Test Points

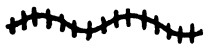
Test Point	Signal
TP8	Ac null from U7-8
TP12	Dc null from U34-7
LSI CLK	Clock to LSI from U35-2
.01 CLK	Clock to .01° decade from U45-12 anode
UP/DN	Count direction signal from U34-1
TP1	Analog signal from U1-1
TP2	Analog signal from U1-7
TP6	Integrator output from U34-2
+12 V	Dc power supply level from U50-2
-12 V	Dc power supply level from U51-2
+5 V	Dc power supply level from U52-2
+3.1 V	Dc power supply level from WT1

c. Typical Test Conditions

The following test condition information can aid in troubleshooting the API. It provides testing conditions which illustrate the proper voltage levels and signal waveforms which occur at various test points on the API.

TEST CONDITION 1

Set API at Null (approx. 0.00°): Input Angle 0.00°; 90 V L-L Synchro; Data Freeze Off.

U1 pin 8	-200 mV inphase		clean sine wave
U1 pin 14	-200 mV inphase		clean sine wave
TP8	±5 mV inphase		noise spikes
TP12	±10 mV dc		
TP6	0 ±2.6 V dc		

TEST CONDITION 2

Set API at 0.00°: Remove JP9 shorting jumper. Set input angle 0.10°; 90 V L-L Synchro; Data Freeze On.

U1 pin 8	-200 mV		clean sine wave
U1 pin 14	-200 mV		clean sine wave
TP8	+90 mV inphase		
TP12	+10.8 V dc ±1 V		
TP6	-10.8 V dc ±1 V		
UP/DN (CR14 anode)	+5.3 V dc ±.5 V		

TEST CONDITION 3

Set API at 45.00°': Input Angle 44.90°'; 90 V L-L Synchro; Data Freeze On.

U1 pin 8	-265 mV inphase		clean sine wave
U1 pin 14	-270 mV inphase		clean sine wave
TP8	-725 mV inphase		clean sine wave
TP12	-10.8 V dc ±1 V		
TP6	+10.8 V dc ±1 V		
UP/DN	-0.35 V dc ±.3 V		

NOTE

When the API is tracking, LSI CLK (U35 pin 2) should have -12 V to +5 V clock pulses 1 us in width.

d. Determination of Failure Symptom

Examine the types of failure symptoms listed in tables 7-2, 7-3, and 7-4 and determine which best describes the API failure encountered. Refer to the left-hand column of the appropriate troubleshooting table.

e. Isolation of Defective Circuit Card

After the failure symptom is determined, proceed to the troubleshooting table and follow the procedure indicated to find the defective circuit card assembly or component.

f. Repair of Defective Circuit Card Assembly or Component

Remove and replace the defective circuit card assembly or component. At the discretion of the maintenance technician, the defective circuit card assembly may be repaired using standard troubleshooting techniques and shop practices. Refer to Section 4 - Theory of Operation for detailed theory of API assemblies.

7-3. POWER SUPPLY TROUBLESHOOTING

Check the power supply for correct voltage levels before troubleshooting any circuit cards or components. Power supply voltage levels should be measured between the ground test point and the designated power supply level test point (table 7-1). They are as follows:

+12 V dc	±0.5 V
-12 V dc	±0.5 V
+5 V dc	±0.25 V
+3.1 V dc	±.75 V

For detailed troubleshooting procedures and identification of failure symptoms of the power supply, refer to table 7-2.

Table 7-2. Power Supply Troubleshooting

Symptom	Possible Cause	Remedy
No voltage or low +12 V	1. Defective T4, pins 10 through 12	1. Replace T4.
	2. U50 defective	2. Replace U50.
	3. Integrated circuit loading	3. Remove Z1,Z3,Z4,Z7, Z27,Z29, and Z34-Z36 one at a time replacing shorted IC(s) as needed.
	4. U53 defective	4. Replace U53.
+12 V low with high ripple	C44 open	Replace C44.
No voltage or low -12 V	1. Defective T4, pins 10 through 12	1. Replace T4.
	2. U51 defective	2. Replace U51.
	3. Integrated circuit loading	3. Remove Z1,Z3,Z4,Z7, Z27,Z29,Z34-Z36, and U2 one at a time replacing shorted IC(s) as needed.
	4. U53 defective	4. Replace U53.
-12 V low with high ripple	C45 open	Replace C45

Table 7-2. Power Supply Troubleshooting (Continued)

Symptom	Possible Cause	Remedy
No voltage or low +5 V	1. Defective T4, pins 7 through 9	1. Replace T4.
	2. U52 defective	2. Replace U52.
	3. Integrated circuit loading	3. Remove U2,U5,U6,U8-U19,U24,U28,U31-U33, U37-U41,U44-U46,U48, U49, and U55 one at a time replacing shorted IC(s) as needed.
	4. U54 defective	4. Replace U54.
	5. Display board defective	5. See table 7-3.
+5 V low with high ripple	C46 open	Replace C46.
No voltage or low +3.1 V	1. Defective T4, pins 7 through 9	1. Replace T4.
	2. U54 defective	2. Replace U54.
	3. Display board defective	3. See table 7-3.

7-4. TROUBLESHOOTING DISPLAY CIRCUIT CARD ASSEMBLY

Table 7-3 provides troubleshooting procedures including failure symptom identification and corrective actions for repair of the Display Circuit Card Assembly.

Table 7-3. Troubleshooting Display Circuit Card Assembly (CCA)

Symptom	Possible Cause	Remedy
No display	1. Circuit breaker CB1 tripped	1. Determine what caused CB1 to trip and reset.
	2. No +3.1 V dc	2. Power supply (table 7-2).
One or more segments of the display always on.	1. Defective decoder driver on Display CCA	1. Replace decoder driver.
	2. Defective buffer	2. Replace buffer.
One display not lit.	Defective display	Replace display.
Letters A, B, C, D, E, or F displayed	1. Defective decoder driver	1. Replace decoder driver
	2. Defective buffer	2. Replace buffer.

7-5. TROUBLESHOOTING MAIN CIRCUIT CARD ASSEMBLY

Table 7-4 provides the troubleshooting procedures including failure symptom identification and corrective actions for repair of Main Circuit Card Assembly.

Table 7-4. Troubleshooting Main Circuit Card Assembly

Symptom	Possible Cause	Remedy
API does not track input data. Display frozen at one angle.	1. Data Freeze asserted	1. Check Data Freeze lines (J1-27 and J1-42).
	2. No ac error signal (TP18): U3,U4, U9,U10,U11 or U49 are defective.	2. Replace defective IC.
	3. No dc error signal (TP12): U34 or U36 defective.	3. Replace defective IC.
	4. No error signal from integrator (TP6): U34, U35, or U36 defective.	4. Replace defective IC.
	5. No clock pulses (.01 CLK): U45 defective; no UP/DN: U34 defective.	5. Replace defective IC.
	6. .01° counter: U12 or U13 defective	6. Replace U12 and U13.
.01° decade only	No clock to LSI: U35 (LSI CLK) or U2 LSI defective.	Replace defective IC.
API free runs and will not settle at any angle	Loss of precision reference generator (TP1 or TP2): U1 defective; ac amplifier (TP8): U7 defective; phase detector (TP12): U34 defective; integrator (TP6): U34 or U35 (.01 CLK or UP/DN) defective.	Replace defective IC(s).
API displays large angular errors.	1. K1,K2, or K3 defective; or U26, U48 or U28 defective.	1. Replace defective relay or IC(s).
	2. Open input data line-loss of reference signal: LSI CLK, U35 defective. Defective component in any of the following will result in large errors: Precision reference generator U1; ac amplifier U7; phase detector U34 integrator U34 .01° counter; U13 9's complementer defective; U3 or U4 BCD ladder booster amplifiers U2 LSI.	2. Replace defective component.

SECTION 8

PARTS LIST

8-1 INTRODUCTION

This section contains the replaceable parts list, federal supply codes for manufacturers (FSCM), usable on codes (UOC), parts location diagrams, and a list of manufacturers of parts used for the Model 8500 API.

8-1.1 Parts List. The parts list contains only replaceable parts for the API. It is prepared in tabular form and divided into six columns as follows:

8-1.1.1 Column 1 - Ref Des (Reference Designations). Lists alphanumerical reference designations for circuit card assembly replaceable parts shown on schematic and parts location diagrams.

8-1.1.2 Column 2 - Description. Contains descriptions which identify replaceable parts.

8-1.1.3 Column 3 - NAI P/N. Lists North Atlantic Industries part numbers assigned to replaceable parts.

8-1.1.4 Column 4 - FSCM. Lists Federal Supply Code for Manufacturers. The FSCM identifies manufacturer or government agency whose number is listed in the manufacturer's part number column. If a FSCM is not assigned to a manufacturer, a five letter code is given and alphabetically referenced (AAAAA, BBBBB, etc.) to the List of Manufacturer's table within this manual.

8-1.1.5 Column 5 - Mfr P/N. Lists manufacturers' part numbers of replaceable parts.

8-1.1.6 Column 6 - UOC (Usable On Code). This column contains codes to identify specific equipment configurations (model, assembly, etc). When a part applies to all configurations, no coding system is used. The coding system is as follows: A, B, C,... and continues with double, AA through AZ, BA, BB, etc., when necessary. For example:

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A1A1	Main Circuit Card Assy.	787760-1	07342	787760-1	A
A1A1	Main Circuit Card Assy.	787760-2	07342	787760-2	B
T1	Transformer	808261-1	07342	550494	A
T2	Transformer	888511-1	07342	888511-1	B

8-1.2 List of Manufacturers. This list contains the names, addresses, FSCM's, and other identifying codes of manufacturers referenced in the parts list. It is arranged numerically using the manufacturers' FSCMs provided in the Federal Supply Code for Manufacturers, Cataloging Handbooks H4-1, H4-2, and H4-3.

The list is prepared in tabular form as follows:

a. Column 1 contains FSCMs of all manufacturers referenced in the parts list.

b. Column 2 contains the names and addresses of manufacturers applicable to FSCMs listed in column 1.

8-1.3 Parts Location Illustrations. Parts location illustrations are provided to give the user a quick and positive method for locating parts on specific assemblies being repaired. Each parts location diagram provides reference designations for circuit card components.

Table 8-1. Model 8500-FXXX- Common Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
J2	Connector, 3-pin, Snap-in, Panel Mount	885865	60046	42R02-3212-150	
MP1	Rear Cover	300241	07342	300241	
MP3	Button, Black	808438	31910	FSC Black	
MP4-MP6	Same as MP3				
W1	Line Cord, P.S. 3 Con-ductor, Detachable, Un-shielded	870165	70903	17251	
W2	Cable Assembly, Power	787776	07342	787776	
	Mating Connector Kit, API Model 8300	783718	07342	783718	
	Shell (1)		00779	205211-1	
	Clamp (1)		00779	20732-1	
	Retainer (2)		00779	205980-1	
	Pins (50)		00779	66569-3	

Table 8-2. Model 8500-F1XX Feature 1, Option 1 - Panel Rack Mounting - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A3 [1]	Front Panel Assembly	548665-1	07342	548665-1	

[1]Front Panel Assemblies A3 revision C and lower part numbers are as follows: F1XX - NAI P/N 548665-2, F2XX - NAI P/N 548665-1

Table 8-3. Model 8500-F2XX Feature 1, Option 2 - Bench Mounting - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A3 [2]	Front Panel Assembly	548665-2	07342	548665-2	
A3J1	Connector, 6-pin	887964	06383	CE100F12-6	
E1	Binding Posts, Red	887982	60064	2410104	
E2-E4	Same as E1				
E5	Binding Posts, Black	887981	60064	2410103	
E6	Same as E1				
MP2	Tilt Stand	808180	02954	TTS-95	

Table 8-4. Model 8500-F3XX Feature 1, Option 3 - Full Rack Mounting - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A3	Front Panel Assembly	548665-3	07342	548665-3	

Table 8-5. Model 8500-FX2X Feature 2, Option 2 - 47 Hz-440 Hz, Selectable Display - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A1	Main/Display Circuit Card Assembly (CCA)	787833-2	07342	787833-2	
A1A1	8500 Main CCA	787760-2	07342	787760-2	
A1A2	Display CCA	787759	07342	787759	

[2]Front Panel Assemblies A3 revision C and lower part numbers are as follows: F1XX - NAI P/N 548665-2, F2XX - NAI P/N 548665-1

Table 8-6. Model 8500-FX4X Feature 2, Option 4 - 360 Hz-1200 Hz, Selectable Display - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A1	Main/Display Circuit Card Assembly (CCA)	787833-4	07342	787833-4	
A1A1	8500 Main CCA	787760-4	07342	787760-4	
A1A2	Display CCA	787759	07342	787759	

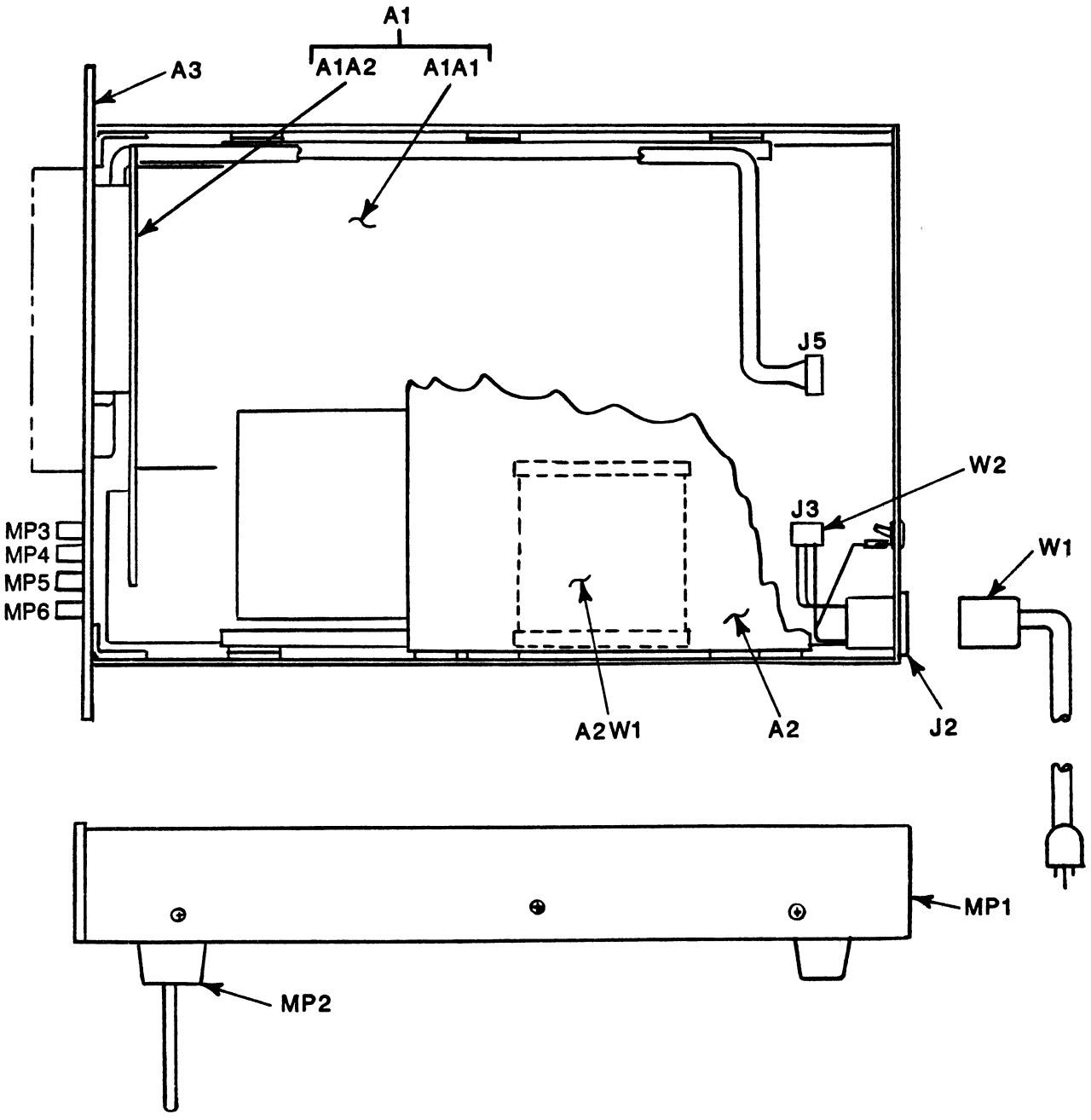
Table 8-7. Model 8500-FXX1 Feature 3, Option 1 - Parallel Interface Option - Unique Parts

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
MP7	Plate, Rear Cover	300275	07342	300275	

Table 8-8. Model 8500-FXX2 Feature 3, Option 2 - NATIVE IEEE-488 and Parallel Interface - Unique Parts

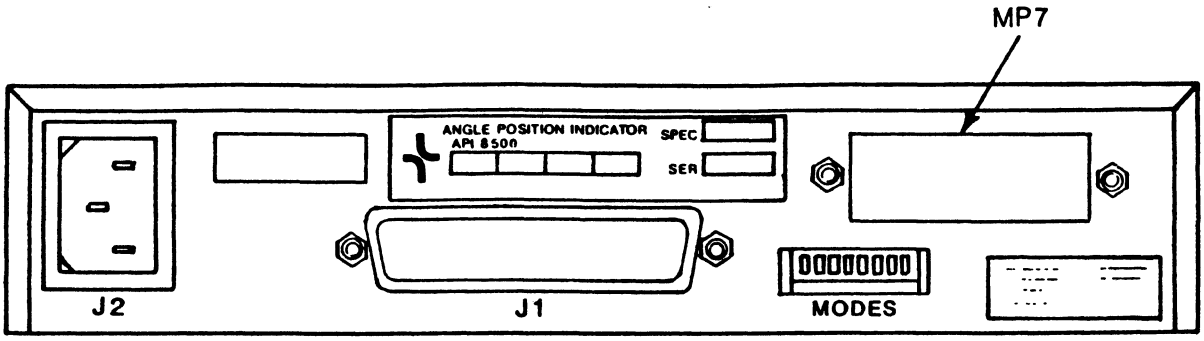
Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A2	IEEE-488 Interface Circuit Card Assembly	787788-1	07342	787788-1	
A2W1	IEEE-488 Interface Cable Assembly	787835	07342	787835	

Front View

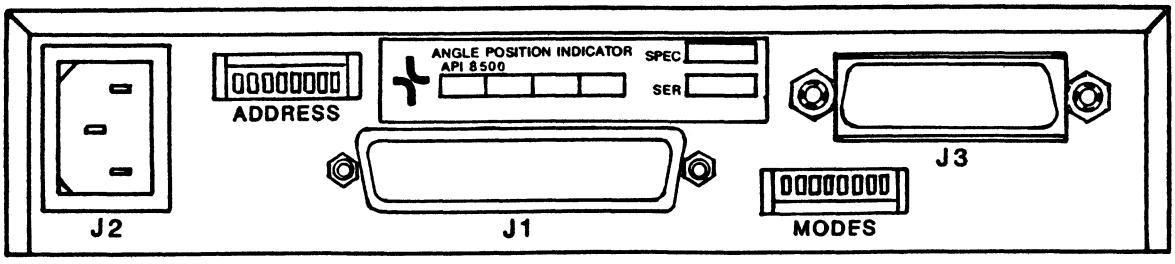


Right Side View

Figure 8-1. Model 8500 API, Parts Location Diagram (Sheet 1 of 2)



Model 8500 FXX1 (Feature 3, Option 1 – Parallel Interface)



Model 8500 FXX2 (Feature 3, Option 2 – Parallel and IEEE Interface)

Figure 8-1. Model 8500 API, Parts Location Diagram (Sheet 2 of 2)

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
A1A1	Main Circuit Card Assy.	787760-1	07342	787760-1	A
A1A1	Main Circuit Card Assy.	787760-2	07342	787760-2	B
A1A1	Main Circuit Card Assy.	787760-3	07342	787760-3	C
A1A1	Main Circuit Card Assy.	787760-4	07342	787760-4	D
C1,C2	Not used				
C3	Capacitor, EL, Tant, 68 µf, 15 V, ±10%	883746	56289	196D686X90 15PE4	
C4	Capacitor, EL, Tant, 2.2 µf, 35 V, ±20%	808201	11100	PDT-2.2/35	
C5	Capacitor, Ceramic, 1 µf, 50 V, ±5%	886073	81349	CK06BX105J	
C6	Capacitor, Ceramic, 0.0022 µf, 200 V, ±10%	882037	81349	CK06BX222K	
C7	Same as C5				
C8	Capacitor, Ceramic, 1 µf, 50 V, ±10%	807730	81349	CK05BX104K	
C9	Same as C8				
C10	Capacitor, Ceramic, 220 pf, 200 V, ±10%	805156	81349	CK0513X221K	
C11	Same as C10				
C12	Capacitor, Ceramic, 0.068, 50 V, ±10%	884941	81349	CK05BX683K	
C13	Same as C4				
C14-C16	Not used				
C17	Capacitor, Ceramic, 24 pf, 200 V, ±5%	886394	51406	CK05BX240K	
C18	Capacitor, Ceramic, 0.01 µf, 100 V, ±10%	883357	81349	CK05BX103K	
C19-C27	Same as C18				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4
(Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
C28-C30	Same as C8				
C31	Same as C18				
C32	Not used				
C33-C38	Same as C18				
C39,C40	Not used				
C41	Capacitor, Ceramic, 820 pf, 50 V, ±5%	885052	71590	CN20C821J (100V)	
C42	Capacitor, Stacked, MF, 27 µf, 63 V, ±15%	888014	61058	ECQ-V1H274-JZ	
C43	Capacitor, Stacked, MF, 0.056 µf, ±5%	888013	61058	ECQ-V1H563JZ	
C44	Capacitor, Aluminum, EL, 1500 µf, 25 V	886361	AAAAA	NRE-E-1500M-25V	
C45	Same as C44				
C46	Capacitor, EL, AL, 16 V, .630 D x, .984 L	887951	61058	ECE-B1CU332	
C47	Capacitor, Tantalum, 4.7 µf, 35 V, ±20%	881427	56289	196D475X0035JE3	
C48,C49	Same as C4				
C50	Capacitor, Ceramic, 0.01 µf, 50 V, ±10%	883798	71590	CW15C103K	
C51	Capacitor, Ceramic, 1 µf, 50 V, ±20%	807067	91674	8131-050-651-105M	
C52	Same as C18				
C53	Capacitor, Ceramic, 1000 pf, 200 V, ±10%	805788	81349	CK05BX102K	
C54-C59	Not used				
C60	Capacitor, Ceramic, 39 pf, 200 V, ±10%	808624	81349	CK05BX390K	
C61	Same as C60				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
C62	Capacitor, Ceramic, 27 pf, 200 WVDC, ±10%	808401	72982	CK05BX270K	
C63	Capacitor, Ceramic, 33 pf, 200 V, ±10%	886080	81349	CK050X330K	
C64	Same as C51				
C65-C67	Not used				
C68	Capacitor, Ceramic, 10 pf, 100 V, ±10%	880706	96095	SA101A100KAA	
CB1	Circuit Breaker, 1 amp	887684	BBBBB	251-1.0A-H	
CR1	Diode, Signal, IN	808974	07263	1N4148	
CR2-CR8	Same as CR1				
CR9	Diode, Schottky Dc Power Dissipation 400 mW, Maximum Capacitance 2.2 pf	883449	81349	1N6263	
CR10	Same as CR9				
CR11, CR12	Same as CR1				
CR13	Not used				
CR14	Same as CR9				
CR15, CR16	Not used				
CR17-CR21	Same as CR1				
CR22, CR23	Not used				
CR24, CR25	Same as CR1				
CR26	Not used				
CR27	Diode, Power/Rectifier	808787	81349	JAN1N4001	
CR28,CR29	Same as CR27				
CR30, CR31	Same as CR1				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
CR32-CR36	Not used				
CR37	Same as CR1				
CR38, CR39	Not used				
CR40-CR42	Same as CR9				
J1	Connector, Rack and Panel, 50-pin	808198	00779	745099-2	
J2	Not used				
J3	Connector, Wafer Lock, 0.100 Centers x 3 pin	887939	06383	MLSS100-3	
J4	Not used				
J5	Connector, Wafer Lock, 0.100 Centers x 6 pin	887940	06383	MLSS100-6	
JP1-JP8	Not used				
JP9	Jumper, Mini, Shorting Strip	884691	22526	65474-001	
JP10-JP28	Not used				
JP29[3]	Same as JP9				
JP30	Not used				
K1	Relay, DPDT, DIP, 5V, Coil	886321	70255	H62C-5S	
K2-K4	Same as K1				
MP1	Heatsink, TO-220 Case, Clip on (U50, U51)	884837	13103	6045B	

[3]Main CCA-A1 NAI P/N 787760-1, -2, -3, -4 revision B does not include jumper JP30 terminals.

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
R1	Resistor, Metal Film, 536 k, 1/10 W, ±1%	807642	91637	MF1/10536K 1%	
R2	Resistor, Metal Film, 100 k, 1/8 W, ±1%	806492	16299	Type NC4	
R3	Resistor, Variable, 100 k, 13 Turn	808690	80294	3279W-1-104	
R4	Resistor, Composition, 10 k, 1/4 W, ±5%	882035	81349	RCR07G103JS	
R5	Resistor, Composition, 100 ohm, 1/4 W, ±5%	880077	01121	CB1015	
R6	Same as R4				
R7	Resistor, Composition, 2 k, 1/4 W, ±5%	882153	81349	RCR07G202JP	
R8	Resistor, Composition, 10 Meg, 1/4 W, ±5%	803389	01121	CB1065	
R9	Resistor, Composition, 390 k, 1/4 W, ±5%	801987	01121	CB3945	
R10	Resistor, Metal Film, 294 k, 1/20 W, ±1%	887947	91637	RN50D2943F	
R11	Resistor, Metal Film, 137 k, 1/10 W, ±1%	808289	01121	CC1373F	
R12	Same as R3				
R13	Resistor, Metal Film, 232 ohm, 1/2 W, ±1%	887946	91637	RN50D2320F	
R14	Not used				
R15	Resistor, Composition, 1 k, 1/4 W, ±5%	880084	01121	CB1025	
R16-R19	Not used				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
R20	Same as R4				
R21	Resistor, Composition, 2.0 Meg, 1/4 W, ±5%	807094	01121	CB2055	
R22-R26	Not used				
R27	Resistor, Composition, 5.1 k, 1/8 W, ±5%	880576	01121	BB5125	
R29	Resistor, Composition, 910 k, 1/4 W, ±5%	883799	81349	RCR07G914JS	
R30	Resistor, Composition, 1.3 Meg, 1/4 W, ±5%	803657	01121	CB1355	
R31	Resistor, Metal Film, 442 k, 1/10 W, ±1%	808683	71785	MNCT0442K	
R32	Resistor, Metal Film, 49.9 k, 1/10 W, ±1%	807635	91637	MF1/1049.9K 1%	
R33	Same as R4				
R34	Not used				
R35	Same as R4				
R36	Same as R2				
R37	Not used				
R38	Same as R4				
R39-R40	Not used				
R41	Resistor, Metal Film, 105 k, 1/10 W, ±1%	807413	81349	RN55D1053F	
R42	Same as R41				
R43-R45	Not used				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
R46	Resistor, Composition, 1 Meg, 1/4 W, ±5%	880100	01121	CB1055	
R47	Not used				
R48	Same as R7				
R49-R99	Not used				
R100	Resistor, Composition, 330 ohm, 1/4 W, ±5%	880080	01121	CB3315	
R101	Not used				
R102	Same as R4				
R103	Same as R2				
R104-R106	Not used				
R107	Same as R4				
R108-R114	Not used				
R115	Resistor, Composition, 100 k, 1/4 W, ±5%	882763	81349	RCR7G104JP	
R116	Same as R115				
R117, R118	Not used				
R119	Same as R21				
R120	Resistor, Composition, 8.2 k, 1/4 W, ±5%	880091	01121	CB8225	
R121	Resistor, Composition, 2.4 k, 1/4 W, ±5%	880087	01121	CB2425	
R122	Resistor, Composition, 470 k, 1/4 W, ±5%	881573	81349	RCR07G474JP	

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
R123	Same as R7				
R124, R125	Resistor, Metal Film, 6.19 k, 1/10 W, ±1%	888015	16299	Type C4	
R126	Resistor, Metal Film, 121 k, 1/10 W, ±1%	888012	91637	Type CMF55, T1	
R127	Same as R4				
SW1A	Switch, 1 Position Push Button, Push-Push	887950	71950	K10422DE3 w/PBB1-F	
SW1B, SW1C	Same as SW1A				
SW2	Switch, Misc, DIP, 16-pin, 8 Piano Switches	808582	81072	76PSB08S	
SW3	Switch, Slide, DPDT	808112	79727	GF126 Terminal G-20-39	
SW4	Not used				
SW5	Same as SW3				
SW6-SW9	Not used				
SW10	Switch, 1 Position Push Button, Momentary	887949	71950	K10122DE3 w/PBB1-F	
T1,T2	Transformer Set, 11.8 V to 90 V, Line-to-Line	808261-1	07342	550494	A,B
T1,T2	Transformer Set, 11.8 V to 90 V, Line-to-Line, 360 Hz to 1200 Hz	888511-1	07342	888511-1	C,D
T3	Transformer, SPCL, 5 V - 115 V, 47-440 Hz, Reference	808148	07342	559493	

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
T4	Transformer, Power	300193	07342	300193	
U1	IC/L, Quad Low Offset, OP Amp QUAD	808545	06665	OF11FY	
U2[4]	IC, LSI Data Converter	888068	07342	888068	
U3	Same as U1				
U4	IC/L, Quad OP Amp, 14-pin	808496	01295	TL084CN	
U5	IC, Data Converter	808304	02735	CD4053BE	
U6	Same as U5				
U7	Same as U4				
U8	IC, CMOS, Retriggerable, Resettable Monostable Multivibrator	808819	04713	MC14538BCP	
U9	IC, A/D Converter	887652	24355	AD7524LN	
U10	IC, CMOS, Quad 2-Input OR Gate	808702	04713	MC14071	
U11	IC, Data Conversion, DAC/8-Bit	886205	24355	AD7524LN	
U12	IC, CMOS, BCD Up/Down Converter	808987	04713	MC14510BCP	
U13	IC, CMOS, Low Power Complementer	807702	04713	MC14561BCP	
U14	IC, Octal Transparent Latch w/3-State Outputs	886829	01295	74HC373	
U15,U16	Same as U14				
U17	IC, PROM, Programmed	887941	07342	27C64	B,D
U18	IC, PROM, Programmed	887942	07342	27C64	B,D
U19	IC, PROM, Programmed	887943	07342	27C64	B,D

[4]U2 NAI P/N 888068 is NAI P/N 807155 on assembly 787760-1, -2, -3, -4 revisions B-C.

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
U20-U23	Not used				
U24	IC, CMOS, Hex Inverter	886367	02735	CD4049BE	
U25	IC, CMOS, Quad 2-Line to 1-Line Data Selector/ Multiplexer w/3-State Outputs	887683	18324	74HC257	
U26	IC, Dual Darlington Driver Amplifier	886050	80183	ULN2061M	
U27	IC, Quad Comparator	807626	01295	LM339N	
U28	IC, TTL, Hex Buffer/Driver	808140	01295	SN7407N	
U29	IC/L, OP Amp ST, NML	808211	12040	LF356N	
U30	Not used				
U31	IC, CMOS, Quad 2-Input	808092	04713	MC14011BCP	
U32	Same as U31				
U33	Same as U24				
U34	Same as U4				
U35	Same as U27				
U36	IC, Data Converter, Analog Switch, 4 NC Switches	886001	27014	DG211CJ	
U37	IC/D, Dual-In-Line Quad 2-Input Positive AND Gate	883236	01295	SN74LS08N.1	
U38	Same as U28				
U39	IC, TTL, Decoder Driver	808501	01295	SN74LS347N	
U40,U41	Same as U39				
U42,U43	Not used				
U44	Same as U10				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

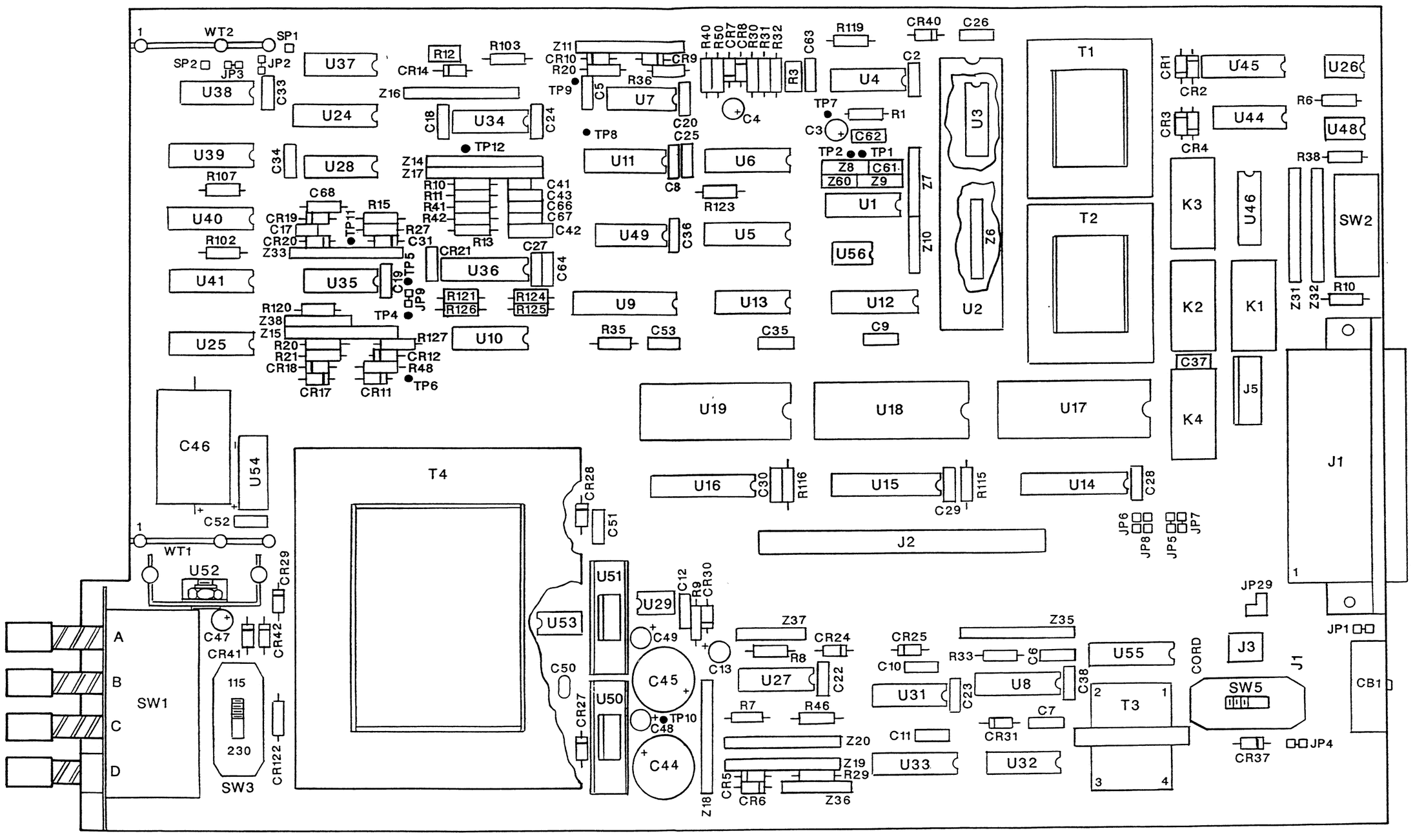
Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
U45	Same as U24				
U46	IC, CMOS, Triple 3-Input Positive AND Gate	887945	01295	SN74HC11N	
U47	Not used				
U48	Same as U26				
U49	IC, CMOS, Dual 4-Input, NOR Gate	887944	07235	CD4002BE	
U50	IC, Voltage Regulator	883622	04713	MC7812CT	
U51	IC/L, Voltage Regulator, -12 V	808500	12040	LM320T-12	
U52	IC/L, Voltage Regulator, +5 V	808498	12040	LM340T-5.0	
U53	Diode, Bridge Rectifier, 50 V	807704	30857	VM08	
U54	Diode, Bridge Rectifier	887938	14936	2KBP02	
U55	Same as U25				
U56	IC, Operational Amplifier, Ultra Low Noise, 8-Pin DIP	886029	06665	OP37-GZ	
XU1	Not used				
XU2	IC, Socket Strip, 25-Pin	808694	06776	SB-25-100-T	
XU3	Not used				
XU4	Socket, 14-pin, Low Profile	887876	CCCCC	BU-140ZSF	
XU5,XU6	Not used				
XU7	Same as XU4				
XU8	Not used				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
XU9	IC, Socket, 20-pin, DIP	808408	DDDDD	LSO-320TBB	
XU10	Not used				
XU11	IC, Socket, 16-Pin	808197	00779	2-640358-3	
XU12-XU16	Not used				
XU17-XU19	Socket, 28-pin, Low Profile	887821	64411	42628-83-445	
XU20-XU33	Not used				
XU34	Same as XU4				
XU35	Not used				
XU36	Same AS XU11				
Z1-Z5	Not used				
Z6	Resistor, Network, SIP, PRCN BCD INTRPL	297745	07342	297745	
Z7	Resistor, Network, SIP, Tenths BCD INTRPL	297838	07342	297838	
Z8	Resistor, Network, SIP, PRCN INTRPL A	297743	07342	297743	
Z9	Resistor, Network, SIP, PRCN INTRPL B	297744	07342	297744	
Z10	Resistor, Network, SIP, Hundreds BCD	297821	07342	297821	
Z11	Resistor, Network, 100 k, SIP, 5 Isolated Resistors	884840	32997	4310R-102-104F	
Z12,Z13	Not used				

Table 8-9. 8500 Main Circuit Card Assembly - A1A1 - 787760-1, -2, -3, -4 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
Z14	Same as Z11				
Z15	Resistor, Network, 47 k, SIP, 10-pin, 5 Resistors	884742	32997	4310R-102-473	
Z16	Resistor, Network, 10 k, 10-pin, 5 Resistors	887097	32997	4310R102103	
Z17,Z18	Same as Z11				
Z19,Z20	Same as Z16				
Z21-Z30	Not used				
Z31	Resistor, Network, NML, 100 k, 18-pin, 9 Resistors	808581	23223	750-101-R 100K	
Z32	Same as Z31				
Z33	Resistor, Network, NML, SIP, 10-pin, 5 Resistors	808630	32997	4310R-102-332	
Z34	Not used				
Z35	Same as Z11				
Z36	Resistor, Network, SIP, 10 k, 6-pin, 3 Res, Low Profile	884756	32997	4306R-102-103	
Z37	Resistor, Network, 33 k, 6-pin, 3 Resistors	887948	32997	4306R-102-333	
Z38	Resistor, Network, 100 k, 6-pin, 3 Res	887978	32997	4306R-102-104	



787760-H-1

Figure 8-2. Model 8500 API. Parts Location Diagram

Table 8-10. Display Circuit Card Assembly A1A2 - 787759

Ref Des	Description	NAI P/N	FSCM	Mfr P/N	UOC
C1	Capacitor, Ceramic, 0.01 µf, 100 V, ±10%	883357	81349	CK05BX103K	
D1	LED Display, 7 Segment, .56 HT Red, Single, Common Anode, High Efficiency	885642	EEEEE	LTS6960HR	
D2-D6	Same As D1				
D7	Diode, LED	807493	09182	HLMP-1000	
D8	Same as D7				
P1	Terminal Strip	888465	51306	TA5-136-21-T5-RA	
R1	Resistor, Composition, 10 k, 1/4 W, ±5%	880092	01121	CB1035	
R2	Resistor, Composition, 200 ohm, 1/4 W, ±5%	802226	01121	CB2015	
R3	Same as R2				
U1	IC, TTL, Decoder/Driver	808501	01295	SN74LS347N	
U2	Same as U1				
XD1	Socket, Strip, 30 Pos, .165 HT	887828	51167	30-0520-10	
XD2-XD6	Same as XD1				
Z1	Resistor, Network, 100 ohm, 10-pin, ±2%	808480	32997	4310R-102-101	
Z2-Z9	Same as Z1				

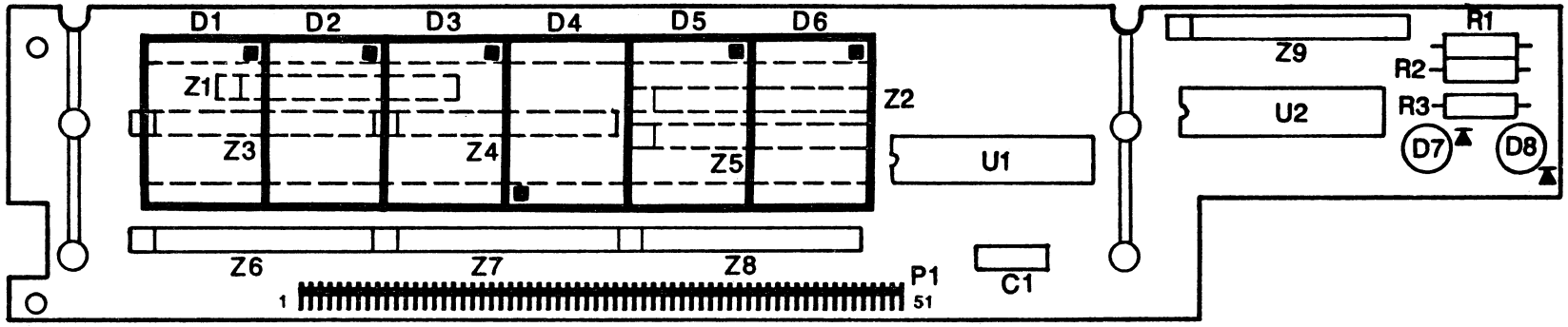


Figure 8-3. Display Circuit Card Assembly A1A2, Parts Location Diagram

Table 8-11. Model 8500 IEEE-488 Interface Circuit Card Assembly A2 - 787788-1

Ref Des	Description	NAI P/N	FSCM	Mfr P/N
A2	IEEE-488 Interface Circuit Card Assembly (CCA)	787788-1	07342	787788-1
C1	Capacitor, 3300 µf, 16 V, 0.630 D x 0.984 L inches	887951	61058	ECE-B1CU332
C2	Capacitor, Ceramic, 0.22 µf, 100 V, ±10%	887899	16299	CAC05Z5u224-100A
C3	Same as C2			
C4	Capacitor, Ceramic, 56 pf, 200 V, ±10%	883333	81349	CKR05BX560K
C5	Same as C4			
C6	Capacitor, Ceramic, 1 µf, 50 V, ±10%	882876	81349	CKR06BX105-KP
C7	Capacitor, Ceramic, 0.1 µf, 50 V, ±20%	885498	96095	SA105E104 MAA
C8-C23	Same as C7			
CR1	Diode, Power/Rectifier	808787	81349	JAN1N4001
CR2	Diode Signal, In	808974	07263	1N4148
CR3	Diode, Bridge Rectifier	887938	14936	2KBP02
CR4	Diode, SIG, Schottky, Dc Power Dissipation 400 mW, Maximum Capacitance 2.2 pf	883449	81349	1N6263
J1	Connector, 24-pin, GPIB Bus, Right Angle (IEEE)	888455	00779	552740-3
P1	Non-replaceable Item			
R1	Resistor, Composition, 75 k, 1/4 W, ±5%	880821	01121	CB7535

Table 8-11. Model 8500 IEEE-488 Interface Circuit Card Assembly A2 - 787788-1 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N
R2	Resistor, Composition, 620 ohm, 1/4 W, ±5%	880820	01121	CB6215
R3,R4	Same as R2			
SW1	Switch, DIP, 16-pin, 8 Piano Switches	808582	81073	76PSB08S
U1	IC, Octal General Purpose Interface Bus Transceiver	885998	01295	SN75161A
U2	IC, Interface, IEEE-488 Controller	885996	01295	TMS9914A
U3	IC, RAM, 2 k x 8, 120 mSec	886097	52464	MSM5128RS-12
U4	IC, Octal General Purpose Interface Bus Tranceiver	885997	01295	SN74160A
U5	IC, PROM, 27C64 Programmed, 8500 IEEE	887960	07342	887960
U6	IC/L, Voltage Regulator, +5 V	808498	12040	LM340T-5.0
U7	IC, High Speed CMOS, Dual D-Flip-Flop	887859	04713	MC74HC74N
U8	IC, Octal Transparent Latch with 3-State Outputs	886829	01295	74HC373
U9	IC, Microprocessor	886828	81349	80C85
U10	IC, CMOS, Quad 2-Input AND Gate	886831	01295	74HC08

Table 8-11. Model 8500 IEEE-488 Interface Circuit Card Assembly A2 - 787788-1 (Continued)

Ref Des	Description	NAI P/N	FSCM	Mfr P/N
U11	IC, CMOS, 3 Line to 8 Line, DEC/MUX	886830	01295	74HC138
U12	IC, Octal D-Flip-Flop with 3-State Outputs	886833	01295	74HC374
U13	Same as U12			
U14	IC, CMOS, Octal Buffer/ Driver	886834	01295	74HC244
U15	IC, 256 x 8 RAM (1 k), I/O Ports and Timer	887862	52464	MSM81C55
U16	IC, Power Driver	885099	56289	ULN2003A
U17	IC, High Speed CMOS, Hex 3-State Inverter	887861	04713	MC74HC368-N
U18	Same as U14			
XU2	Socket, 28-pin, Low Profile	887821	64411	42628-83-445
Y1	Crystal Oscillator, 4 MHz Series, Resonant at cut .005%	808336	51406	E400
Z1	Resistor, Network, NML, 9 Res @ 10 k	808410	32997	4310R-101-103

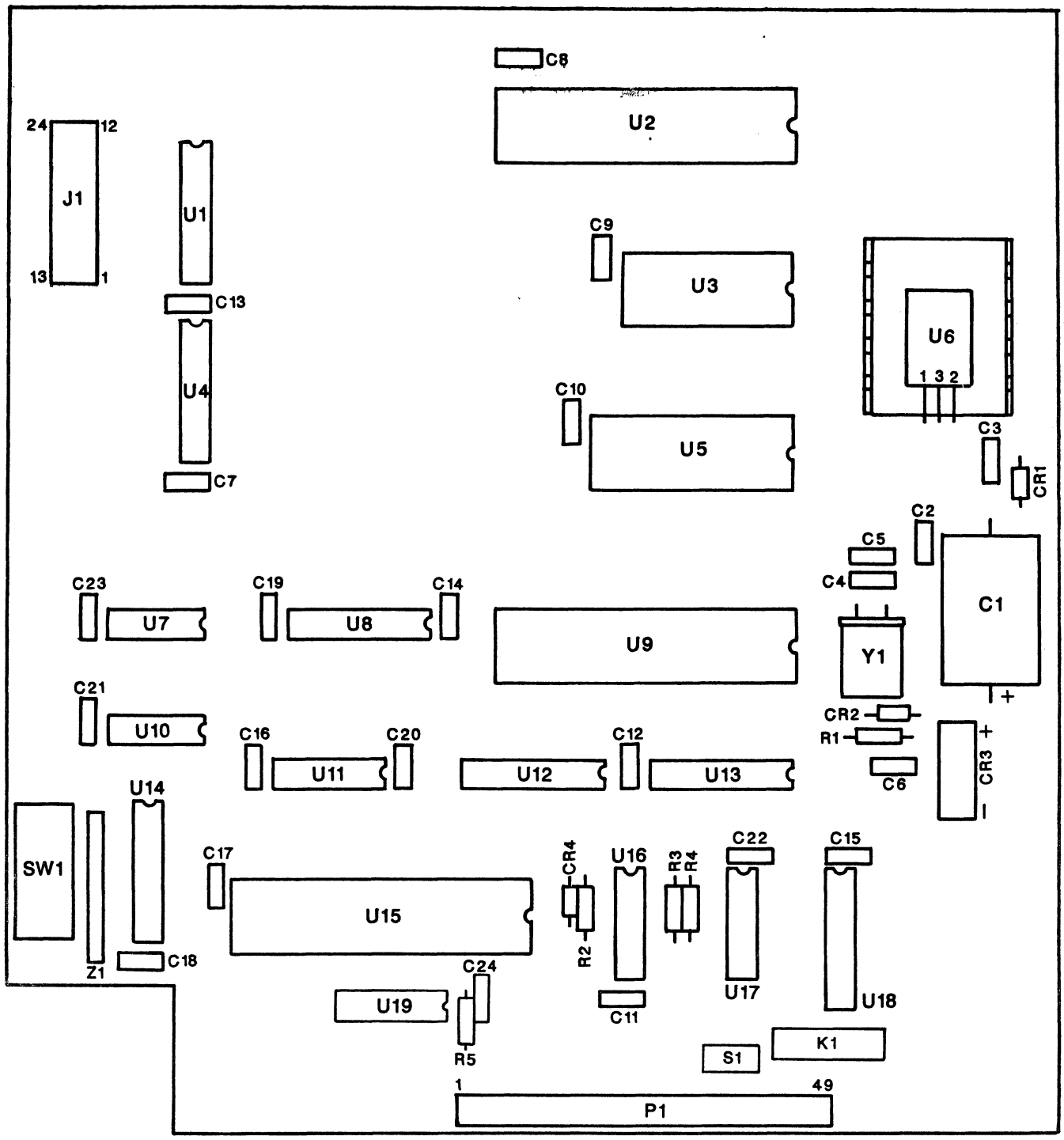


Figure 8-4. Model 8500 IEEE-488 and MATE/CIIL Interface Circuit Card Assembly A2, Parts Location Diagram

Table 8-12. List of Manufacturers

FSCM	Name and Address
00779	AMP Inc. 2800 Fulling Mill P.O. Box 3608 Harrisburg, PA 17105
00815	Midland-Ross Corp. Northern Engineering Labs Div. 357 Beloit Street Burlington, WI 53105
01121	Allen-Bradley Co. 1201 S. 2nd Street Milwaukee, WI 53204
01295	Texas Instruments Semiconductor Group 13500 North Central Expressway P.O. Box 225012 M/S 49 Dallas, TX 75265
02735	RCA - Solid State Route 202 Somerville, NJ 08876
02954	Premier Metal Products Co. Div. of Sunshine Mining Co. 381 Canal Pl. Bronx, NY 10451-5913
04713	Motorola, Inc. Semiconductor Products Inc. 5005 E. McDowell Road Phoenix, AZ 85008
06383	Panduit Corporation 17301 Ridgeland Tinley Park, IL 60477
06665	Precision Monolithics Inc. Sub. of Bourns Inc. 1500 Space Park Drive Santa Clara, CA 95050
06776	Robinson Nugent Inc. 800 E. 8th Street P.O. Box 1208 New Albany, IN 47150
07235	Albion Electrical Industries Albion, IN
07263	Fairchild Camera andInstr. Corp. Semiconductor Division 401 Ellis Street P.O. Drawer 7284 Mountain View, CA 94042
07342	North Atlantic Industries, Inc. 60 Plant Avenue Hauppauge, NY 11788
09182	Hewlett-Packard Co. New Jersey Division Berkeley Heights, NJ
11100	Nemco Corporation 3329 Prospect Indianapolis, IN 46203
12040	National Semiconductor Corp Commerce Drive P.O. Box 443 Danbury, CT 06810
13103	Thermalloy Co., Inc. 2021 W. Valley View Lane P.O. Box 810839 Dallas, TX 75381
14936	General Instrument Corp. Discrete Semiconductor Div. 600 W. John Street Hicksville, NY 11802
16299	Corning Glass Works 3900 Electronics Drive Raleigh, NC 27604
18324	Signetics Corporation Military Products Div. 4130 S. Market Court Sacramento, CA 95834
22526	DuPont E I de Nemours & Co., Inc. Photo Systems and Electronic Products Dept. Berg Electronics Div. Route 83 New Cumberland, PA 17070

Table 8-12. List of Manufacturers (Continued)

FSCM	Name and Address
23223	CTS Microelectronics Inc. P.O. Box 1278 Lafayette, IN 47902
24355	Analog Devices Route 1 Industrial Park P.O. Box 280 Norwood, MA 02062
27014	National Semiconductor 2900 Semiconductor Drive Santa Clara, CA 95051
30857	Varo Inc., Micro Circuit Prods. 900 North Shiloh Road Garland, TX 75040
32997	Bourns, Inc. Trimpot Division 1200 Columbia Avenue Riverside, CA 92507
51406	Murata Erie North America Inc. Georgia Operations 1148 Franklin Road S.E. Marietta, GA 30067
52464	OKI Electronics of America Inc. 4031 NE 12th Terrace Fort Lauderdale, FL 33334
55261	LSI Computer Systems Inc. 1235 Walt Whitman Road Melville, NY 11747
56289	Sprague Electric 87 Marshall Street North Adams, MA 01247
60046	Power Dynamics Inc. 59 Lakeside Avenue P.O. Box 539 West Orange, NJ 07052-5539
60064	Fiberguide Instruments Inc. 1101-B State Road Princeton, NJ 08540-1501
61058	Matsushita Elect. Corp. of America Panasonic Indstl Co. Div. One Panasonic Way P.O. Box 1502 Secaucus, NJ 07094-2917
70255	Emerson Electric Co. Alco Controls DIv. 11911 Adie Road Maryland Heights, MO 63043
71590	Centralab Inc. North American Philips Co. Highway 20 W P.O. Box 858 Fort Dodge, IA 50501
71785	TRW Inc. TRW Cinch Connectors Div. 1501 Morse Avenue Elk Grove, IL 60007

Table 8-12. List of Manufacturers (Continued)

FSCM	Name and Address
72982	Murata Erie North America Inc. Erie Operations 645 W. 11th Street Erie, PA 16512
79727	C-W Industries 130 James Way Southampton, PA 18966
80183	Sprague Products Co. 87 Marshall St. North Adams, MA 02147
80294	Bourns Instruments Inc. 135 Magnolia Avenue Riverside, CA 92506
81072	American Sawmill Machinery Co. Tate Street - P.O. Box 711 Corinth, MS 38834
81073	Grayhill, Inc. P.O. Box 373 561 Hillgrove Avenue LaGrange, IL 60525
81349	Military Specifications Promulgated by Military Departments/Agencies Under Authority of Defense Standardization Manual
91637	Dale Electronics Inc. P.O. Box 609 Columbus, NE 68601
95348	Gordos Corporation 250 Glenwood Avenue Bloomfield, NJ 07003
AAAAA	NIC Components Corp. 6000 New Horizons Boulevard North Amityville, NY 11701
BBBBB	Not Used
CCCCC	EURO Electronics Limited Shirley House 27 Camden Road London, England
DDDDD	K Wall 80 Pompton Avenue Verona, NJ 07044
EEEEE	LITON - Lite-On Corp. (USA) Parkway Business Center 1 Suite 570 4951 Airport Parkway Dallas, TX 75248

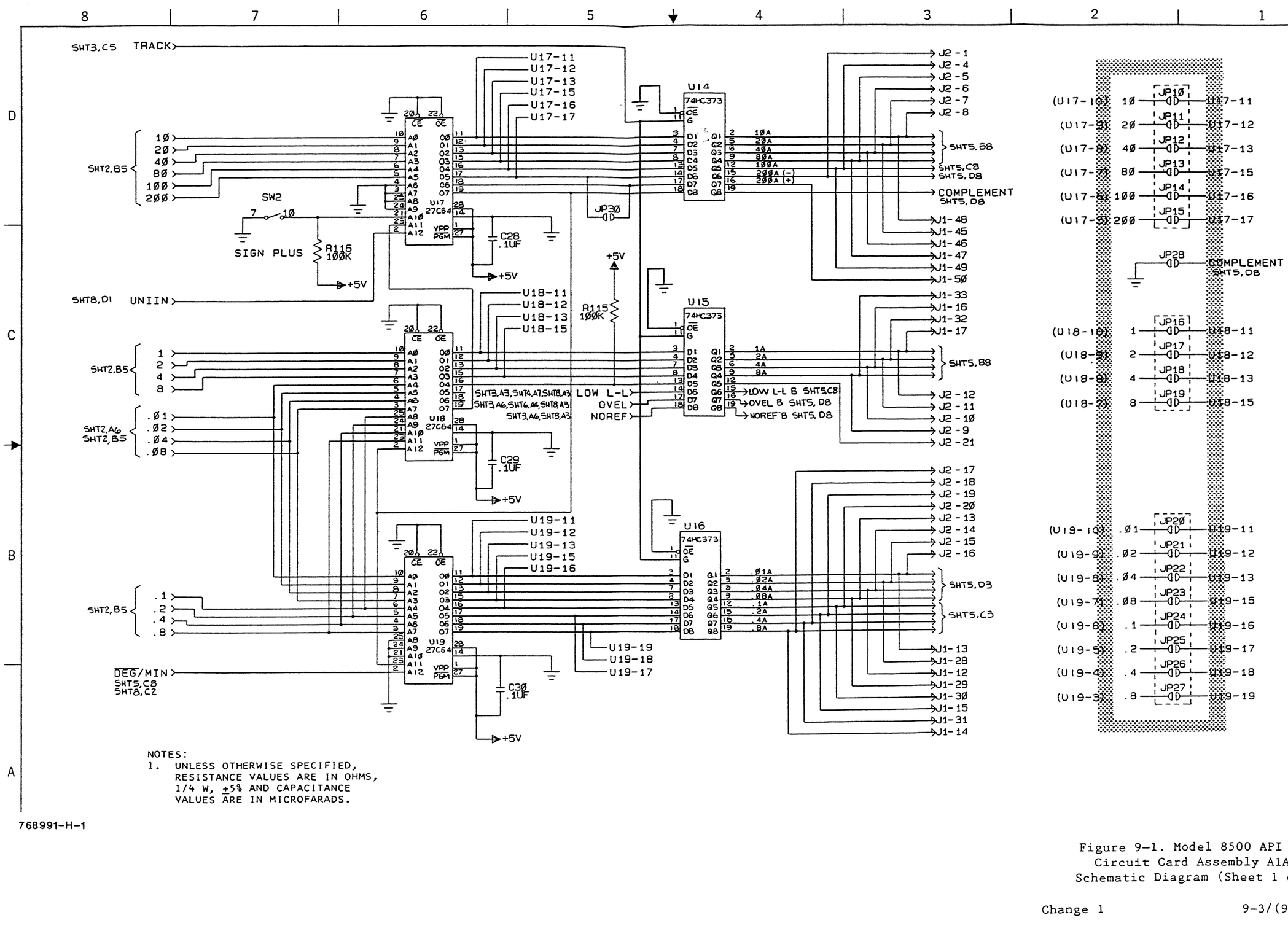
SECTION 9

SCHEMATIC DIAGRAMS

9-1 INTRODUCTION

This section contains schematic diagrams for the Model 8500 API.

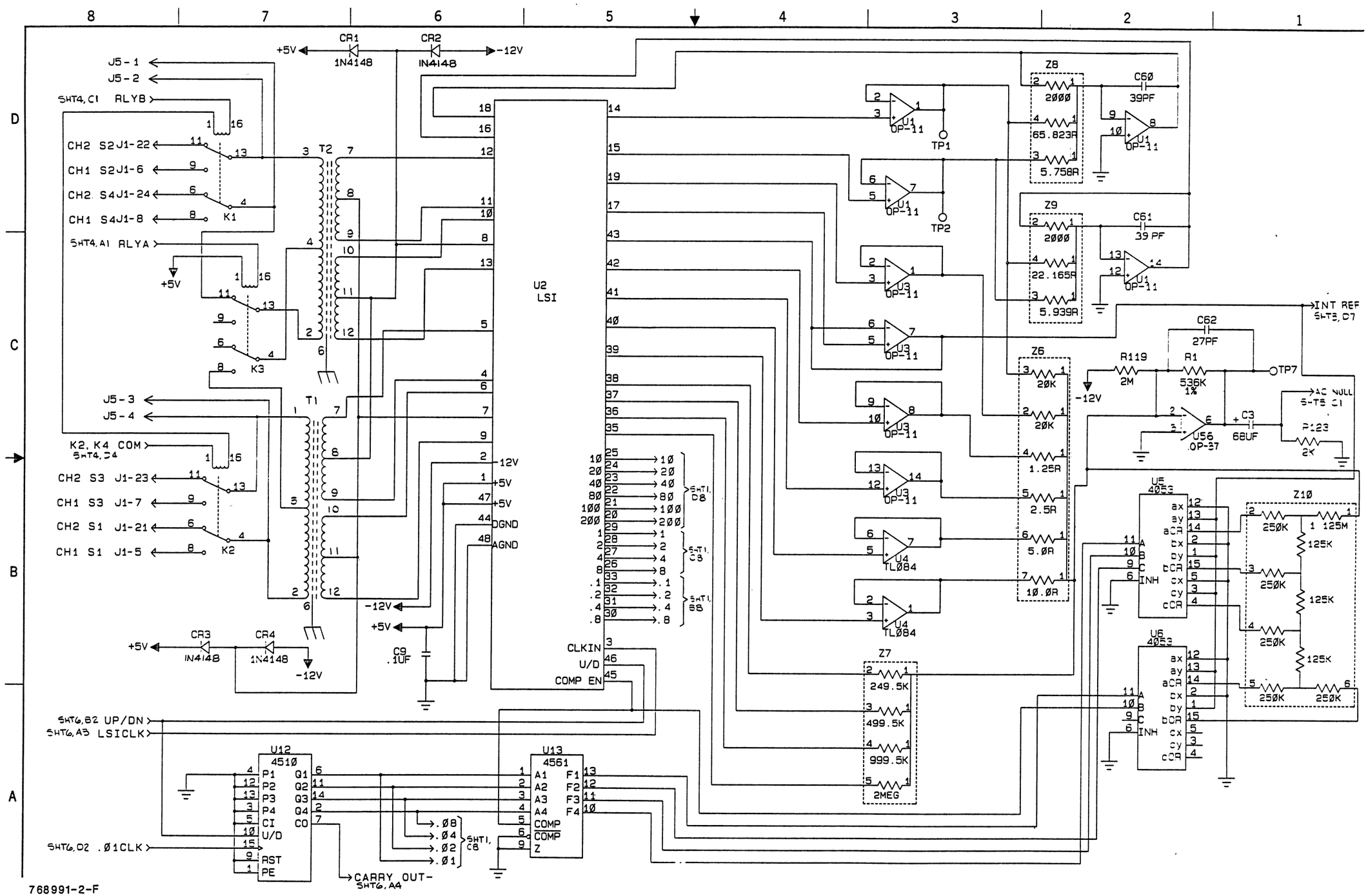
Figure	Title	Page
9-1	Model 8500 API Main Circuit Card Assembly A1A1, Schematic Diagram	9-3
9-2	Display Circuit Card Assembly A1A2, Schematic Diagram	9-19
9-3	IEEE-488 Interface Circuit Card Assembly A2, Schematic Diagram	9-21



NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, 1/4 W, ±5% AND CAPACITANCE VALUES ARE IN MICROFARADS.

768991-H-1

Figure 9-1. Model 8500 API Main Circuit Card Assembly A1A1. Schematic Diagram (Sheet 1 of 8)



768991-2-F

Figure 9-1. Model 8500 API Main Circuit Card Assembly A1, Schematic Diagram (Sheet 2 of 8)

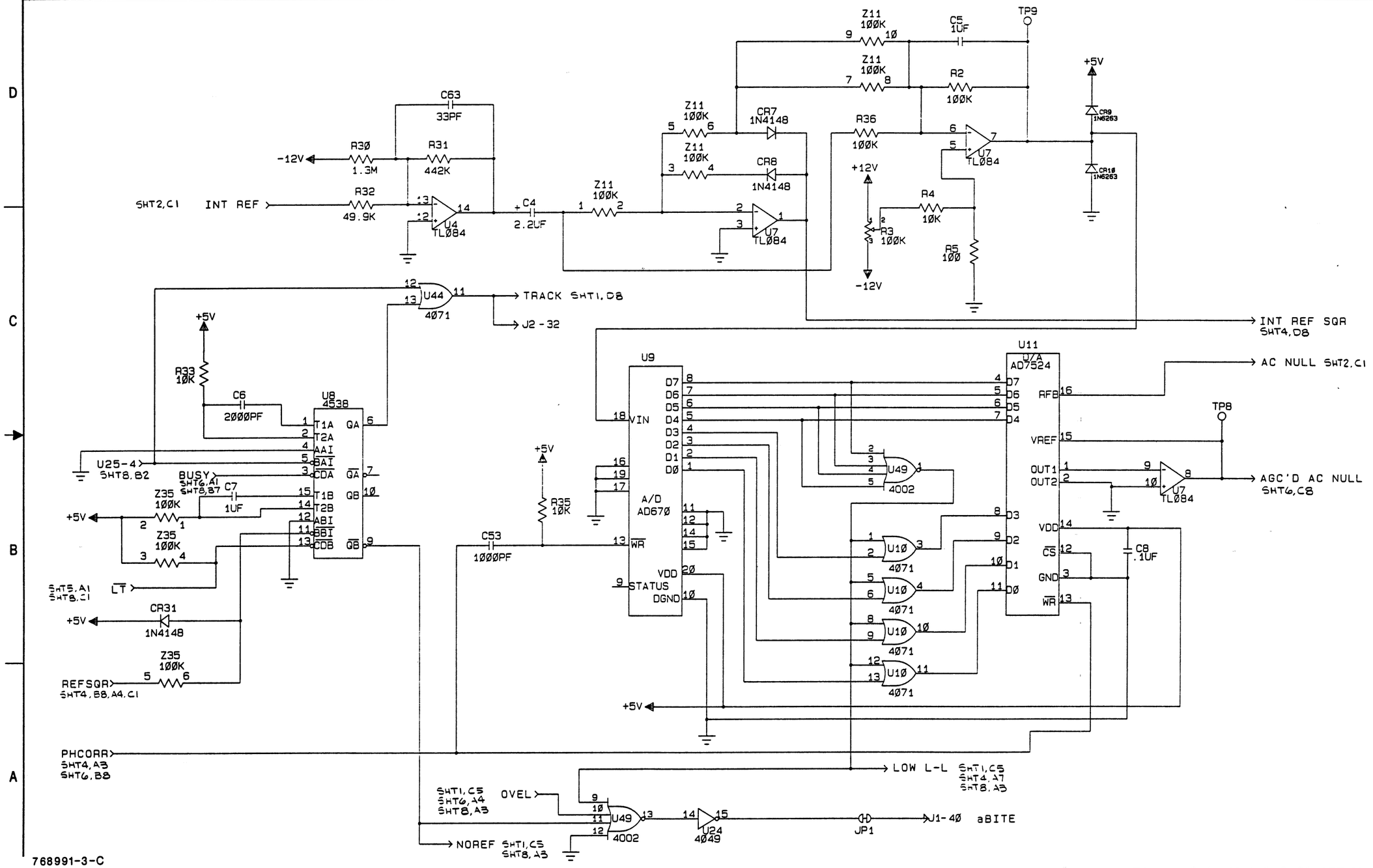


Figure 9-1. Model 8500 API Main Circuit Card Assembly A1A1, Schematic Diagram (Sheet 3 of 8)

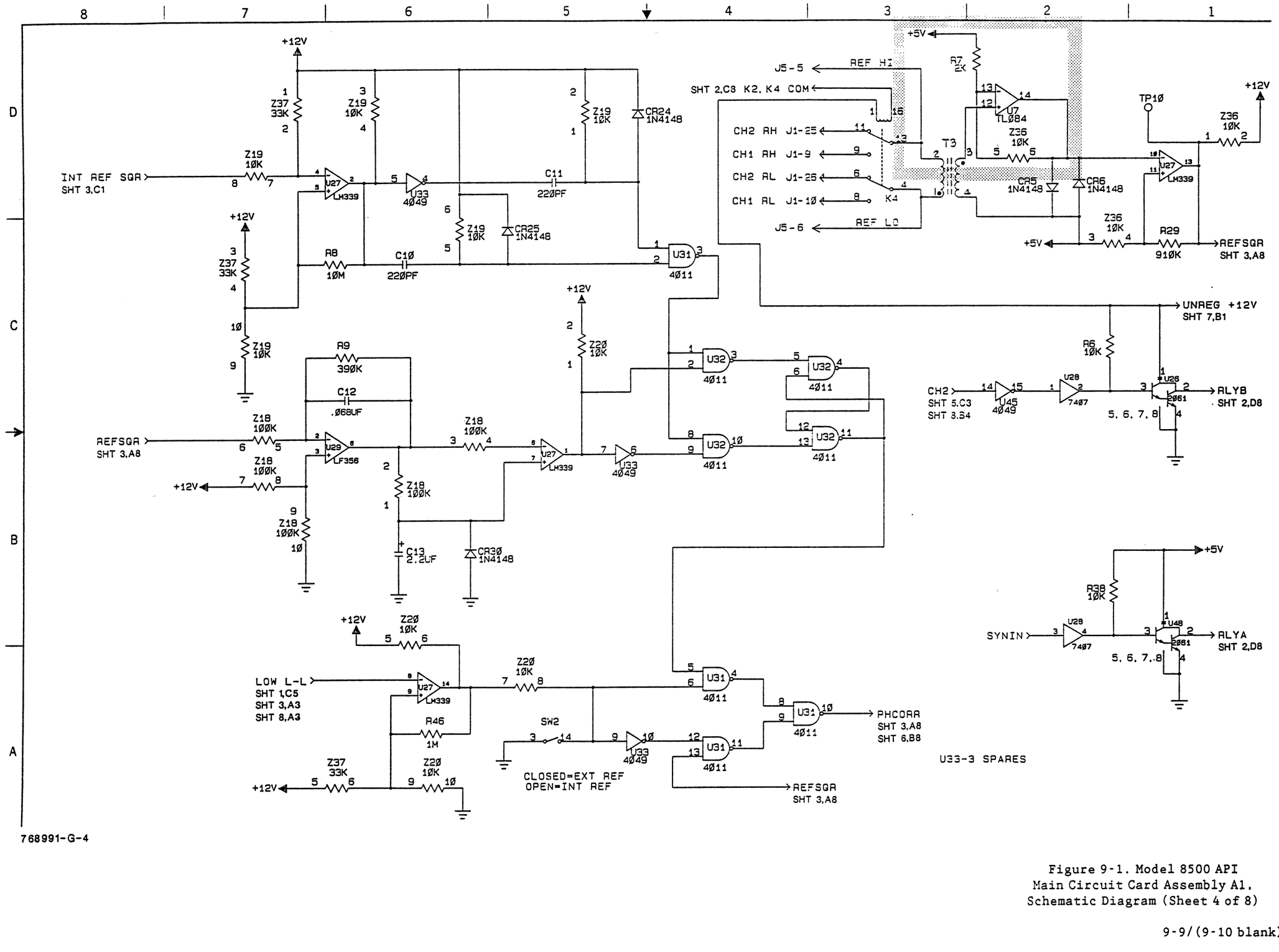


Figure 9-1. Model 8500 API
Main Circuit Card Assembly A1,
Schematic Diagram (Sheet 4 of 8)

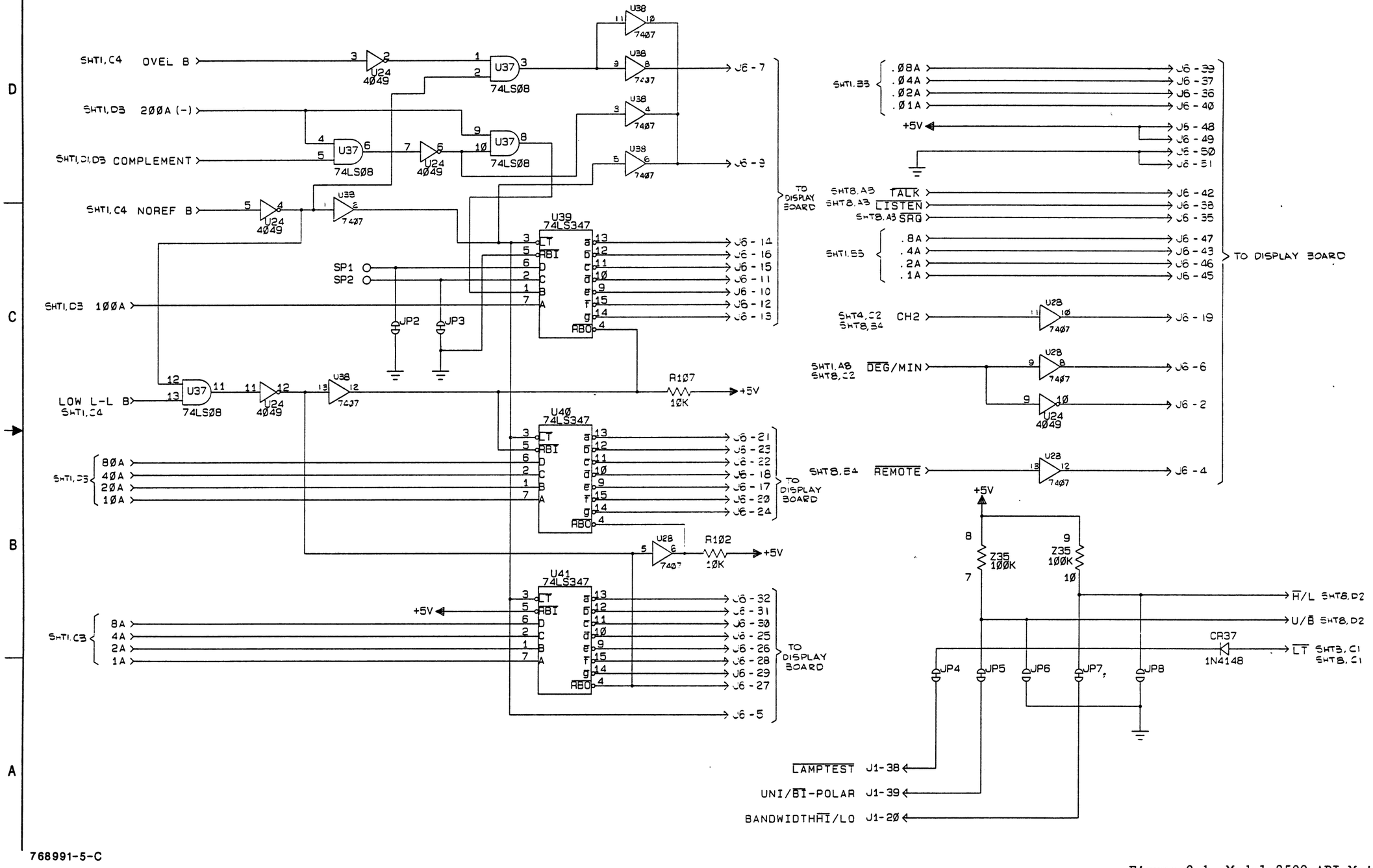
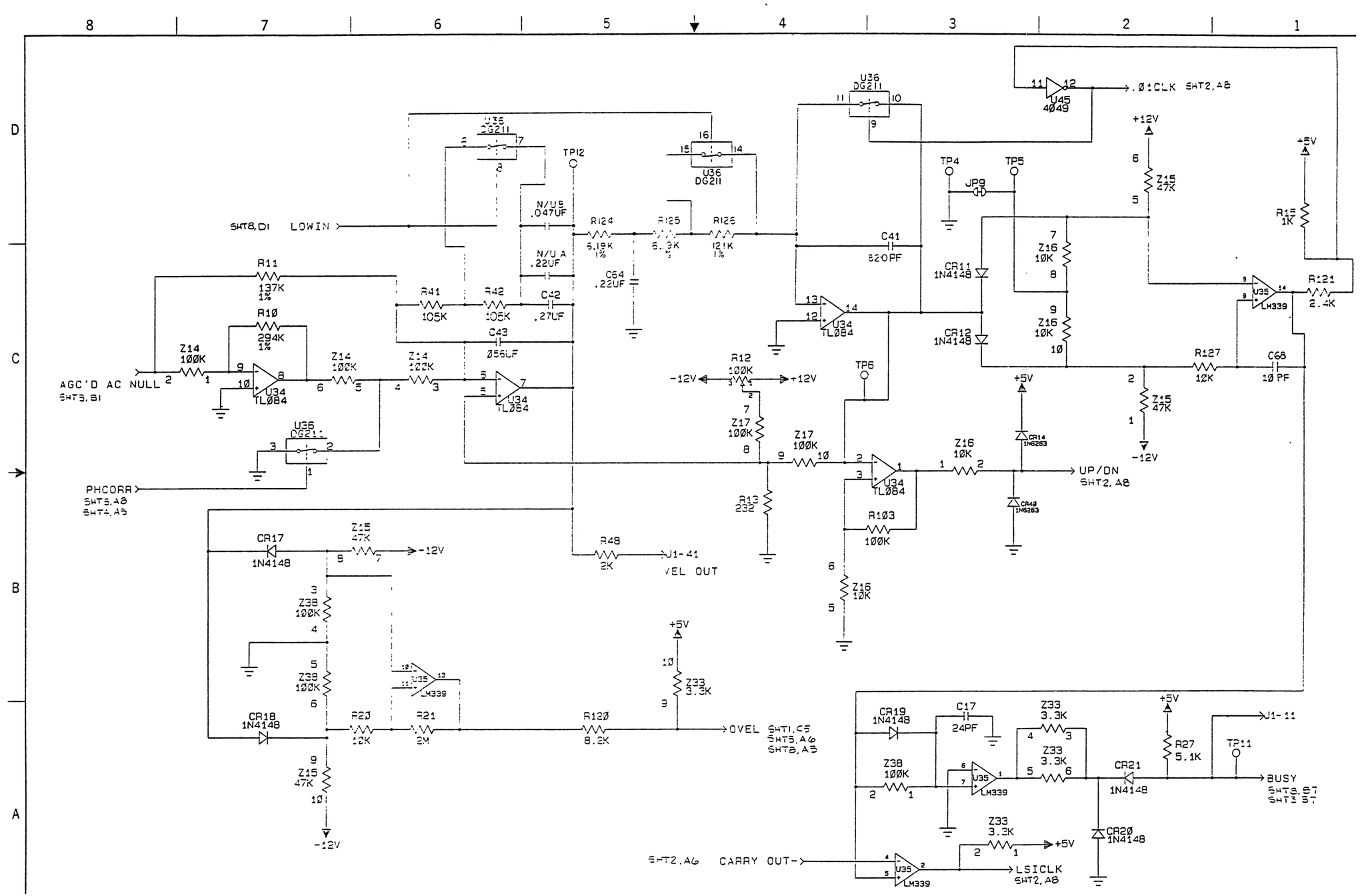
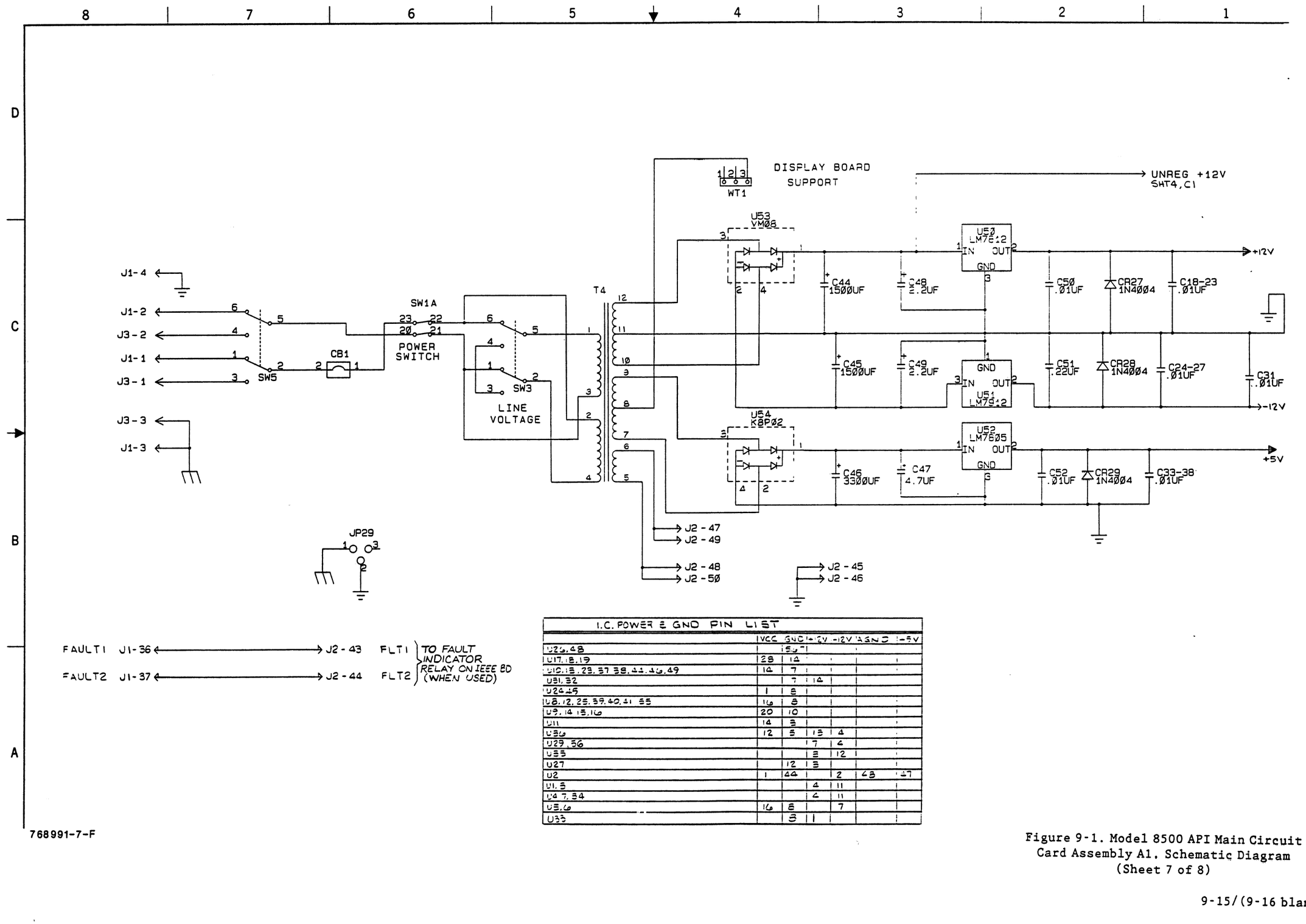


Figure 9-1. Model 8500 API Main Circuit Card Assembly A1A1, Schematic Diagram (Sheet 5 of 8)



768991-G-6

Figure 9-1. Model 8500 API Main Circuit Card Assembly A1A1, Schematic Diagram (Sheet 6 of 8)



I.C. POWER & GND PIN LIST						
	VCC	GND	+12V	-12V	AGND	-5V
U26,48		5				
U17,18,19	28	14				
U10,13,23,37,38,44,46,49	14	7				
U31,32		7	14			
U24,45	1	8				
U8,12,25,39,40,41,55	16	8				
U9,14,15,16	20	10				
U11	14	3				
U36	12	5	13	4		
U29,56			7	4		
U35			3	12		
U27		12	3			
U2	1	44		2	43	17
U1,5			4	11		
U4,7,34			4	11		
U3,6	16	8		7		
U33		3	1			

Figure 9-1. Model 8500 API Main Circuit Card Assembly A1, Schematic Diagram (Sheet 7 of 8)

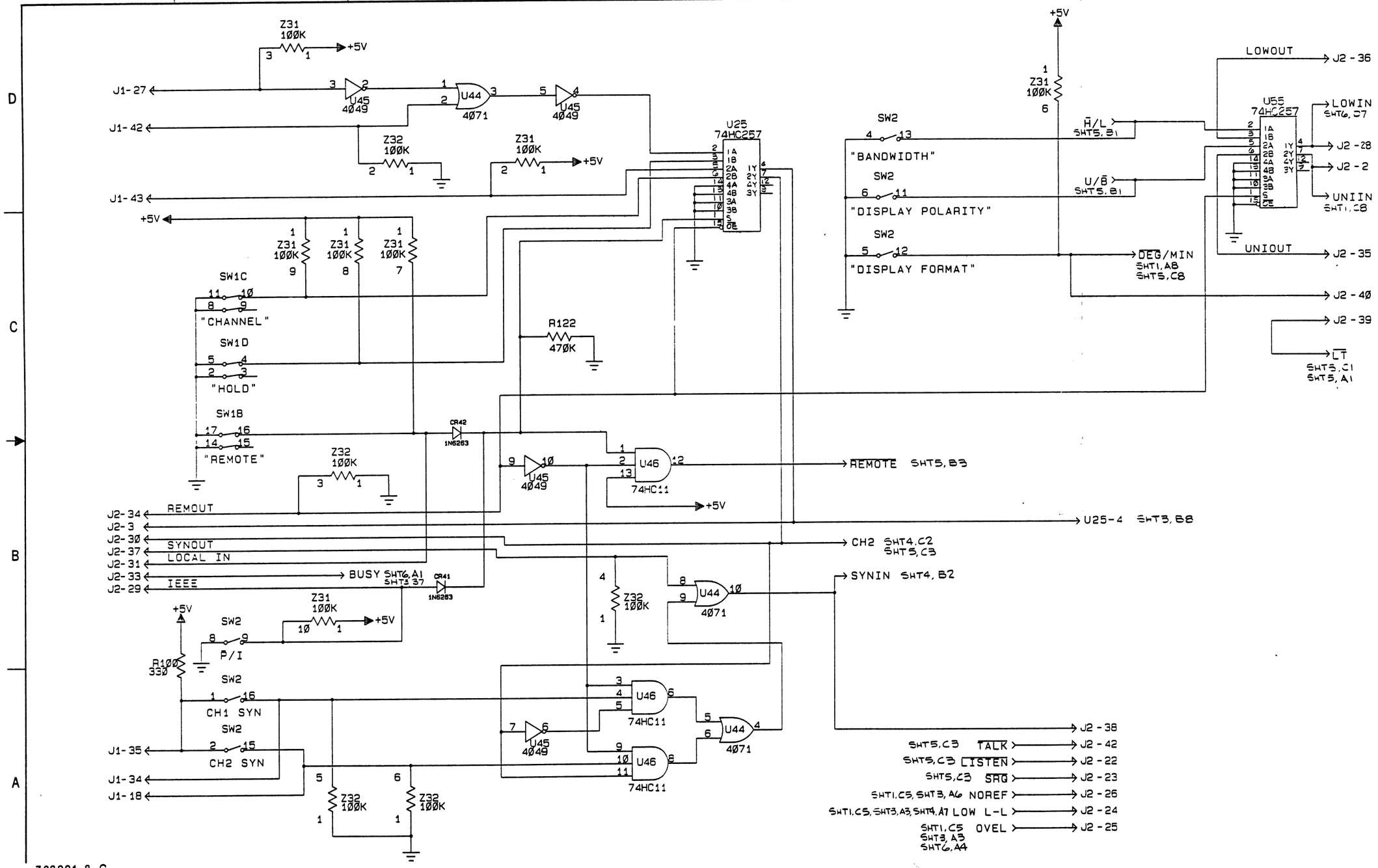


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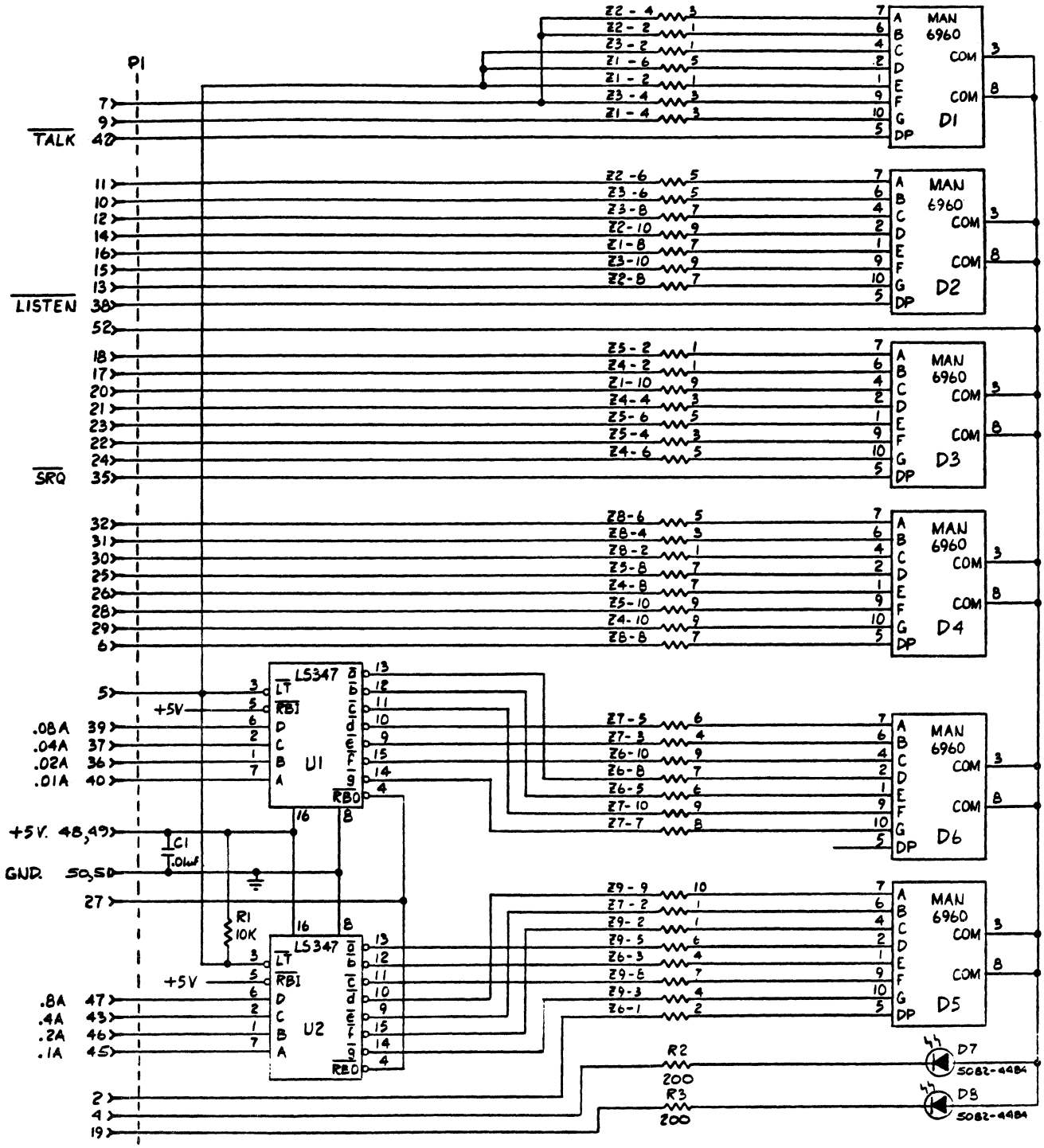
Figure 9-1. Model 8500 API Main Circuit Card Assembly A1A1, Schematic Diagram (Sheet 8 of 8)



NOTES: UNLESS OTHERWISE SPECIFIED:
1. Z1 THROUGH Z9 ARE 100 OHM SIPS, 10 PIN, 5 RESISTORS.
2. DISCRETE RESISTORS ARE 1/4 W, 5%.

Figure 9-2. Display Circuit Card Assembly A1A2, Schematic Diagram

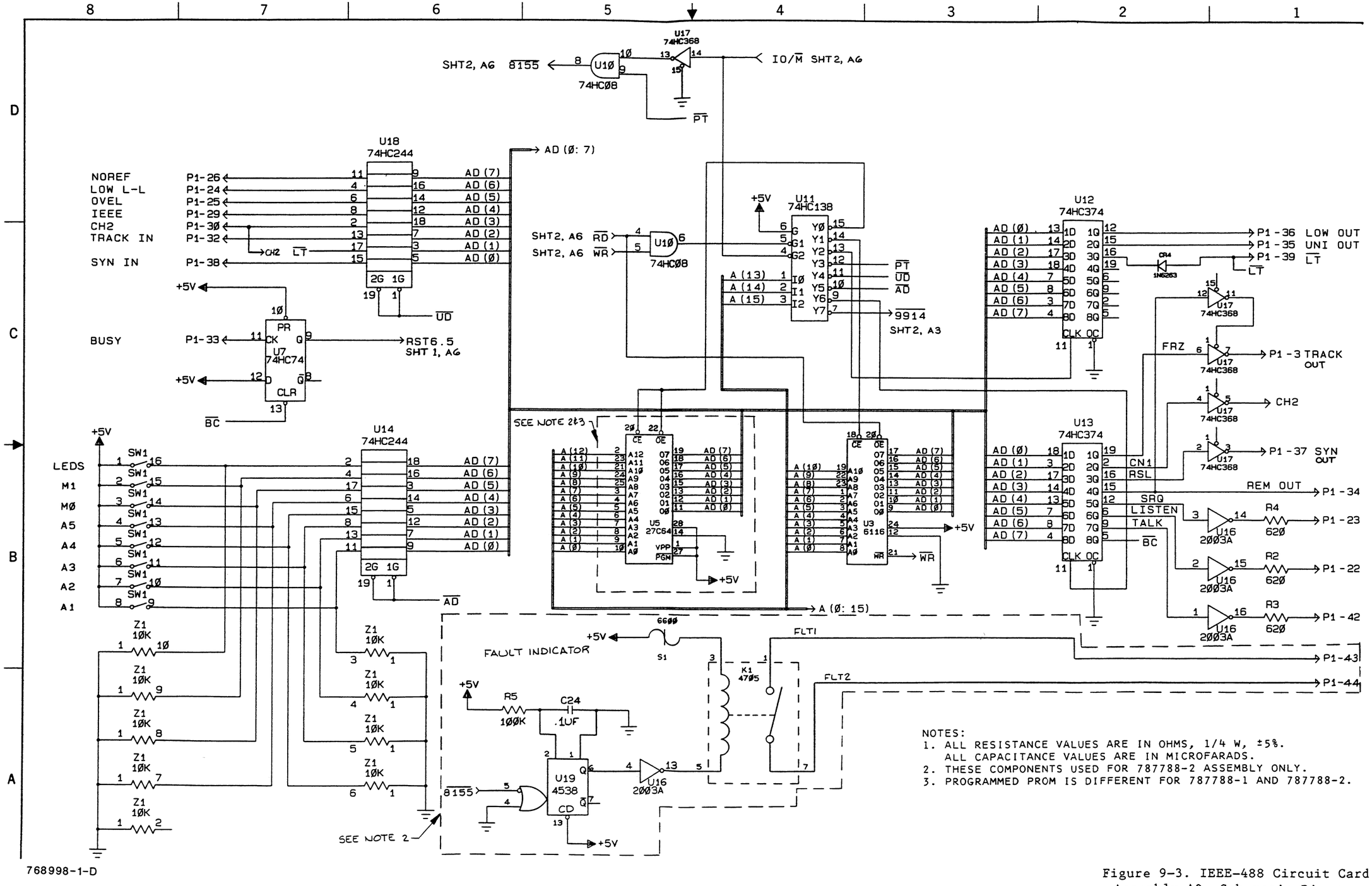


Figure 9-3. IEEE-488 Circuit Card Assembly A2, Schematic Diagram (Sheet 1 of 2)

VOLTAGE & GROUND CHART		
INTEGRATED CIRCUIT	+5	GND
U1,4,8,12,14,13,18	20	10
U2,9,15	40	20
U3	24	12
U5	28	14
U6	2	3
U7,10	14	7
U16	9	8
U11,17,19	16	8

768998-2-E

Figure 9-3. IEEE-488 Circuit Card Assembly A2. Schematic Diagram (Sheet 2 of 2)

SECTION 10

UPDATE INFORMATION

10-1 INTRODUCTION

As NAI continues to improve the performance of the API, corrections and modifications to the manual may be received. This section contains Product Revision Sheet (PRS) data which updates the unit to the most current configuration available.

DECLARATION OF CONFORMITY

We **NORTH ATLANTIC INSTRUMENTS, INC.**
170 WILBUR PL.
BOHEMIA, NY 11716-2416

declare under our sole responsibility that the product(s)

8500 SERIES ANGLE POSITION INDICATOR

to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

EN 50081-1: 1992 EN 55022; CONDUCTED EMISSIONS
EN 55022; RADIATED EMISSIONS

EN 50082-1: 1992 IEC 801-2; 1984 ESD
IEC 801-3; 1984 RADIATED IMMUNITY
IEC 801-4; 1988 EFT BURST

EN 61010-1: 1993/A2: 1995 SAFETY

following the provisions of COUNCIL DIRECTIVE 89/336/EEC
73/23/EEC

Place Bohemia, NY, U.S.A.

(Signature)

Date 1-31-97

Daniel A. Palladino
(Full Name)

Quality Manager
(Position)

FORM006.B

LIMITED WARRANTY

A. The seller warrants products against defects in material and workmanship for twelve months from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

B. The seller specifically excludes from the warranty 1) calibration, 2) fuses, 3) source inspection, 4) test data, 5) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, printheads, recording heads, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

C. The seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of products.

D. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require subsequently manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

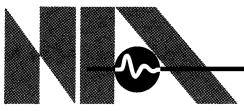
F. No other warranty expressed or implied is offered by the seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.



north atlantic instruments, inc.

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