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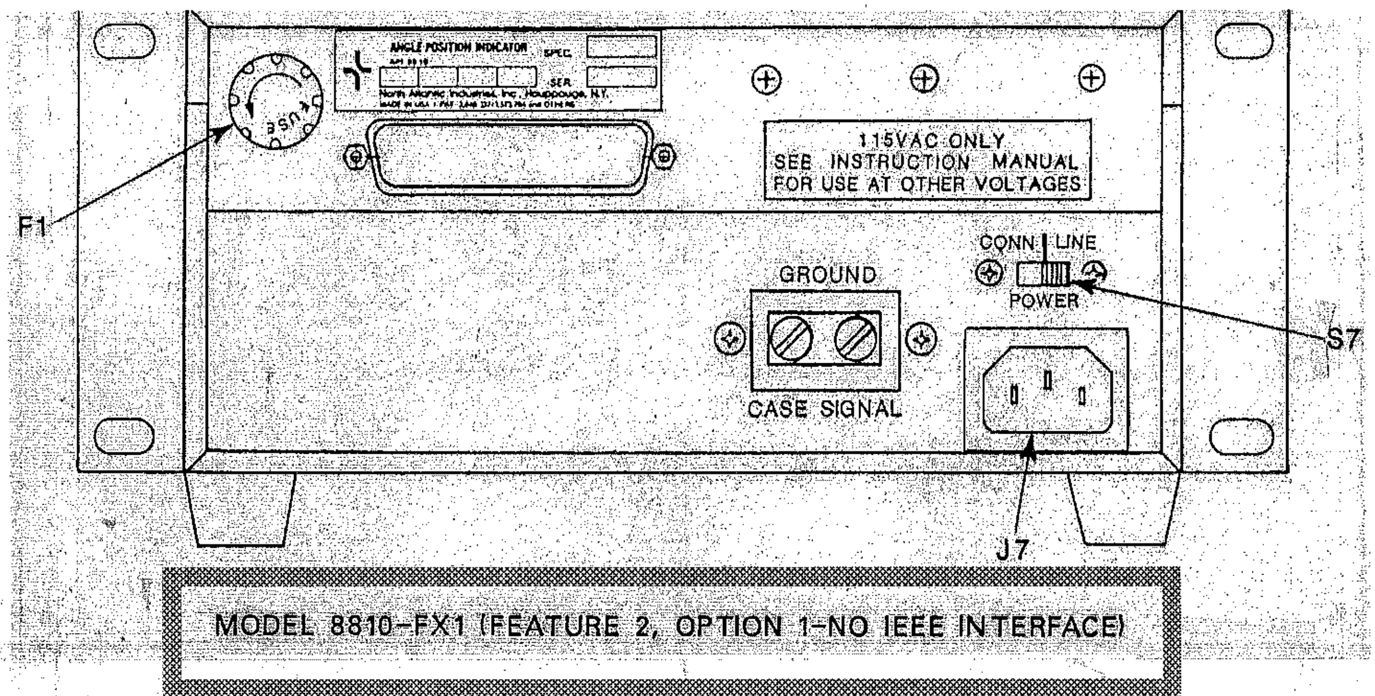
Operation/Maintenance Manual for Model 8810 Angle Position Indicator

In section 2, revise Table 2-2 as shown below. Changes are shown shaded.

Table 2-2. J5 Pin Designations (IEEE)

Pin	Function
1	Power input Hi
2	Power input Lo
3	Case ground
4	Digital ground
5	S1
6	S2
7	S3
8	Spare
9	R1
10	R2
11 – 18	Do not use
19	Spare
20	Spare
21	S1
22	S2
23	S3
24	S4
25	R1
26	R2
27 – 35	Do not use
36	FAULT relay (-FX3 only)
37	FAULT relay (-FX3 only)
38 - 50	Do not use

In section 7, revise Figure 7-1 as shown below. Changes are shown in shaded box.



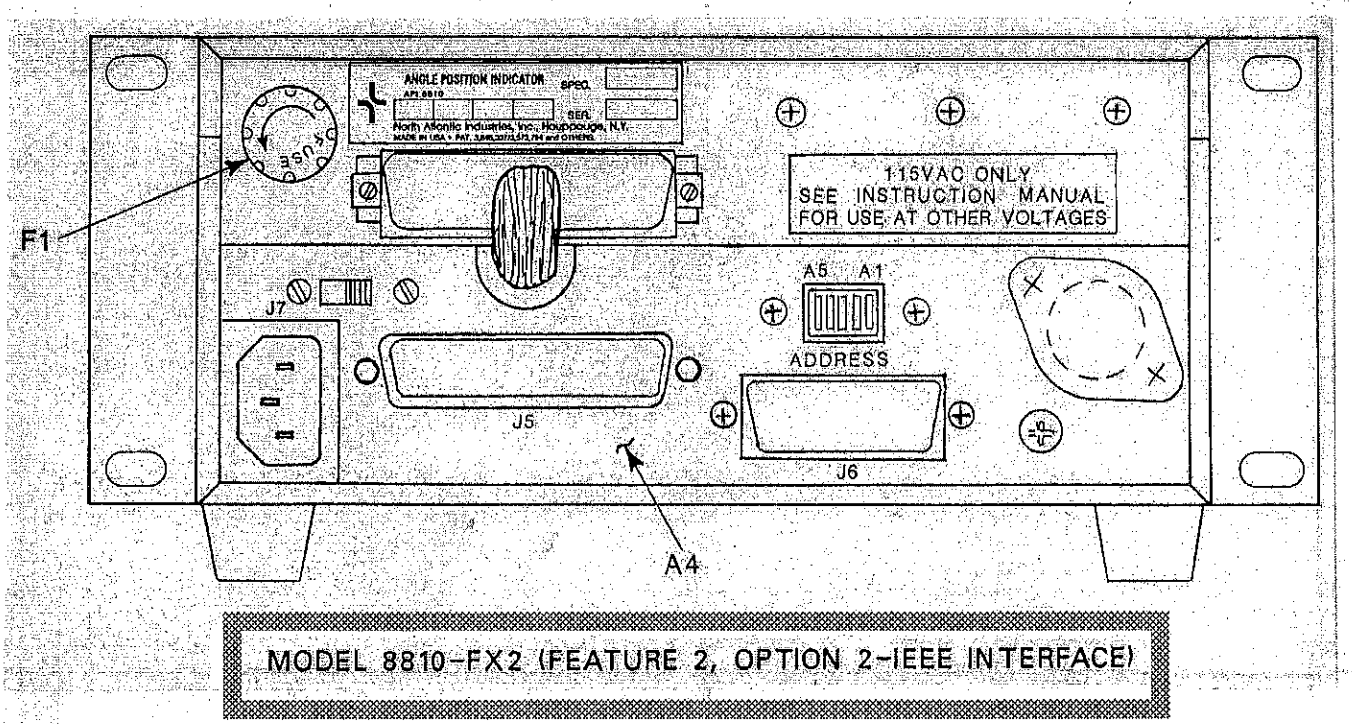


Figure 7-1. Model 8810 API, Parts Location Diagram (Sheet 2 of 4)

In section 6, replace paragraph 6.4.2 (alignment procedure) with the following information.

6-4.2 Procedure

a. Depress SYN push button on the API. Adjust the synchro/resolver simulator for 0.000° angle position indicator display and set the toggle switch to $\overline{DF}$ (data freeze). Adjust the synchro/resolver simulator for 0.0000°.

b. Connect the low side of the DVM to TP1 (ground) on the mother board and connect the high side to TP4. The voltage at TP4 should be between +0.5 mV dc and +3 mV dc.

c. Connect the high side of the DVM to TP2. Adjust R19 until the voltage at TP2 is the same as that measured at TP4 ± 100 µV.

d. Connect the high side of the DVM to TP3. Adjust R26 until the voltage at TP3 is the same as that measured at TP4 ± 100 µV.

e. Connect the high side of the DVM to TP5 and adjust R29 for 0 mV ± 100 µV. This is a preliminary adjustment. This is a preliminary adjustment.

f. Connect the high side of the DVM to TP7 and adjust R55 for 0 V ± 200 mV.

g. Remove data freeze. With the DVM at TP7, set the simulator to 10.000°. Manipulate the simulator so that the API display indi-cates 10.000°. Freeze the API. Set the simulator again to 10.000°. Note dc offset at TP7.

h. Remove data freeze. Manipulate the simulator so that the API display indicates 9.999° (9.995° for units with 0.005° resolution). Freeze the API and set the simulator to 9.999° (9.995° for units with 0.005° resolution). Read the dc offset at TP7. Readjust R29 until the offset is the same as that obtained in step g above. Repeat steps g and h to assure no change in dc offset.

i. Connect the low side of the scope to TP1 (GND) and the high side to TP10 (use an X10 probe).

j. Set the vertical sensitivity to 2V/division (pulse to be measured in 5 V pp) and the time base to 0.1 ms/ division. Adjust the scope time base and triggering so that the scope triggers on each successive pulse, displaying <u>one</u> pulse per sweep.

k. Adjust R65 so that pulses are of equal width (double edges on scope overlap and appear as a single edge). Disconnect scope.

l. Manipulate simulator so that the API display indicates 0.000°. Freeze the API. Connect the PAV to TP7. Adjust the simulator for an in-phase null at TP7 (angle on synchro/resolver simulator should be 0.000° ± .002°).

m. Connect the DVM to TP12 and adjust R103 for 0 mV ± 500 µV. This is a preliminary adjustment. Final adjustment will be made later.

n. Connect the DVM to TP14 and adjust R116 for 0V ± 200 mV.

o. Switch the Auto-phase switch on the main board from INT to EXT and note offset change at TP14. If there is, readjust R103 until there is no dc change at TP14 when the unit is switched from INT to EXT. Leave switch in the INT position.

p. Readjust R116 for 0 V ± 200 mV at TP14.

q. Connect the PAV to TP7. Remove data freeze. Set the simulator to 20.000°. Freeze the API. Adjust the simulator for an in-phase null at TP7. Record the simulator setting (20.000° ± 0.002°).

r. Remove data freeze. Manipulate the simulator so that the API display indicates 19.999° (19.9995° for units with 0.005° resolution). Freeze the API. Adjust the simulator for an in-phase null. Record the simulator setting.

s. Subtract the simulator setting of step r, above, from that of step q. The difference should be 0.001° (0.005° for units with 0.005° resolution). Adjust R63, if necessary, to obtain this difference. Remove data freeze.

t. Repeat steps q through s until desired result is obtained.

u. Advance the simulator through 360° in 10° steps, observing the API display. Ascertain that the largest angle errors are distributed as positive and negative errors. If maximum angle errors tend to be of the same sign (all positive or all negative), readjust R116 to minimize these errors.

1. In section 1, Table 1-1 (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 2-3, 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

STATUS OF PUBLICATION

Publication No. TM–I–5017A

This manual applies to units with serial numbers GV–590 and higher.

Original – May 1988
Change 1 – September 1988
Change 2 – January 1989
Change 3 – March 1989
Change 4 – July 1989
Change 5 – November 1989
Change 6 – March 1990
Change 7 – September 1990
Change 8 – March 1, 1991
Change 9 – September 27, 1991
Change 10 - January 28, 1997

WARNING

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

North Atlantic Industries, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration, or setting up of the instrument.

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LIST OF TABLES

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 70° 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 operation - 0.50 amp. FAST-BLO 230V operation - 0.25 amp. FAST-BLO

LINE CORD

The model 8810 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 8810 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 rear panel CONN/LINE switch should be kept in the LINE position. When the model 8810 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 8810 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 8810 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 rear panel and the proper fuse must be installed. Refer to Manual section 2-3.6.

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 Industries
170 Wilbur Place
Bohemia, NY 11716 USA

Telephone: (631) 567-1100
Fax: (631) 567-1823
Email: sales@naii.com
Web site: www.naii.com

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 DESCRIPTION

1-1 GENERAL

This manual contains general description, installation, operating instructions, maintenance and troubleshooting procedures, replacement parts lists, and schematic diagrams for the Angle Position Indicator, Model 8810 (hereinafter referred to as API).

1-2 PHYSICAL DESCRIPTION

The API (figure 1-1) is a bench-top version of the rack-mounted Model 8800 featuring front panel controls and input terminals. The unit is furnished with feet and foldaway tilt stand. By using mounting brackets, the unit may be rack mounted. Brackets for half-rack mounting are included as standard equipment. Full rack flanges are available.

1-3 FUNCTIONAL DESCRIPTION

The API is an extension of the instrument product line using the exclusive LSI TRIG-LOGIC™ processor.

It is a full-tracking type II servo, which follows synchros or resolvers to speeds of 1000°/second without velocity errors. It accepts any standard line-to-line level without preselecting or preprogramming the input signals. The converted synchro or resolver data is presented in three forms:

- o Front-panel display using planar gas discharge information displays
- o BCD outputs on the rear panel connector
- o Optional IEEE Interface

1-4 SPECIFICATIONS

Table 1-1 provides characteristics and specifications for the API.

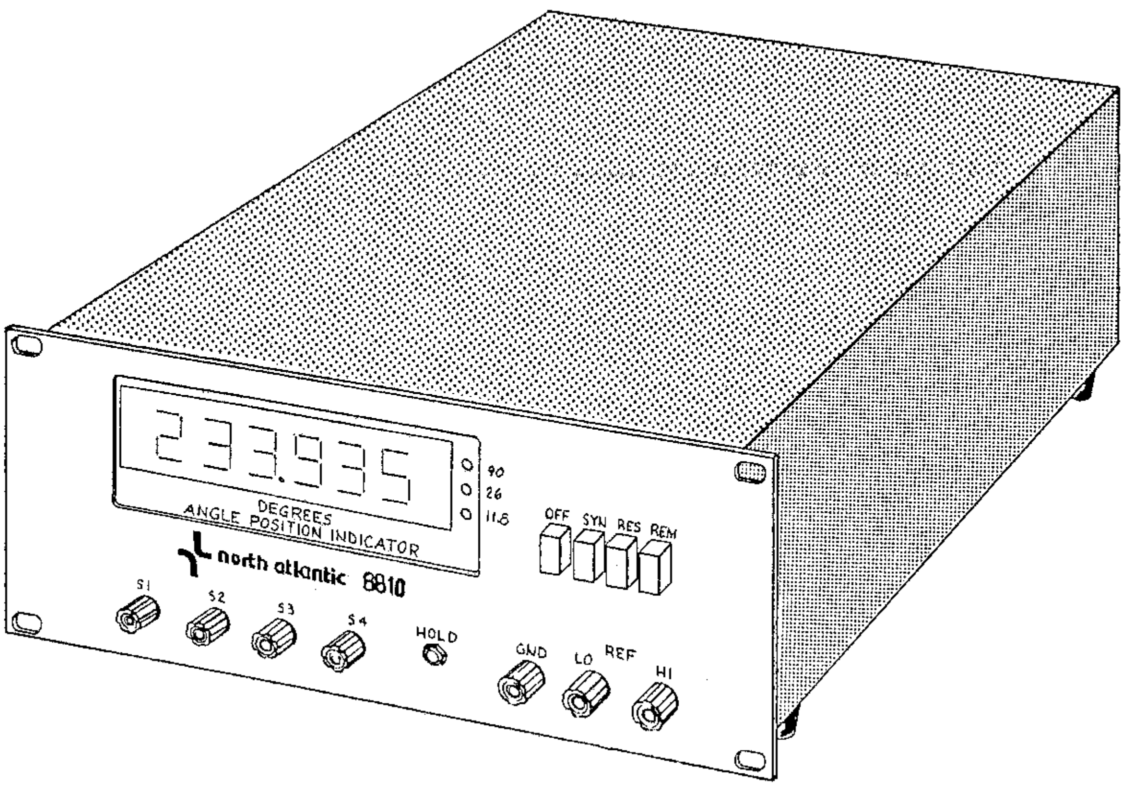


Figure 1-1. Angle Position Indicator

Table 1-1. Specifications

Item	Specification
Resolution	0.001° (0.005° with ±179.995° option)
Input channels	2
Signal inputs Channel 1 Channel 2	 Synchro: 11.8, 26, or 90 V L-L auto ranging Resolver: 11.8, 26, or 90 V L-L auto ranging (Non-standard input levels available; consult factory)
Accuracy (includes errors from all sources)	±0.004° (standard); ±0.010° (with ±179.995° option)
Frequency range	360-1200 Hz (standard); 47-440 Hz (optional)
Angular range	0.000°-359.999° (standard); ±179.995° (optional)
Reference voltage	3 V to 115 V (AGC)
Input impedance Signal Reference	 1 M ohm (min.) 100 k ohm (min.)
Tracking speed	200°/s (standard); 1000°/s (with ±179.995° option); 75°/s (with 47-440 Hz option); 180°/s (with ±179.995° and 47-440 Hz options)
Settling time	1.5 s max. for 180° step change (standard); 400 ms max. (with ±179.995° option); 3.0 s max. (with 47-440 Hz option); 1.5 s max. (with ±179.995° and 47-440 Hz options)
Digital output	6 decade BCD (1-2-4-8) 10 TTL loads Logic 1: +2.5 V min. Logic 0° +0.6 V max.
Data availability	Continuous or data freeze: DF (J1 pin 42) track = 0 V or open; freeze = +5 V; $\overline{DF}$ (J1 pin 27) track = +5 V or open; freeze = 0 V
Auto phase correction	Unit automatically corrects for up to ±30° phase shift between stator and rotor signals.
Converter busy	TTL compatible pulses, 1 us wide (nom.); pulses present when tracking (see paragraph 3.4.2)
Temperature range	0-70°C (operating) standard
Input power	115/230 V rms ±10% or 125/350 V rms ±10% 47-440 Hz; 25 VA max.
Mating connector	P/N 783718

1-5 CONFIGURATION

The Model 8810 is available in various configurations. Order a Model 8810 by specifying the model followed by a four-digit number as follows:

8810-F ☐ ☐

- IEEE-488
  - 1 = without IEEE-488
  - 2 = with NATIVE IEEE-488 (Option #12)
  - 3 = with IEEE MATE/CIIL
- Display and frequency
  - 1 = .001 Resolution 0.000°-359.999°; 360-1200 Hz (ref. old option #06)
  - 2 = .001 Resolution 0.000°-359.999°; 47-440 Hz (ref. old option #07)
  - 3 = .005 Resolution ±179.995°; 360-1200 Hz (ref. old option #01)
  - 4 = .005 Resolution ±179.995°; 47-440 Hz (ref. old option #01,07)

For example, 8810-F12 is a 0.000°-359.999° unit with a 360-1200 Hz frequency range, and the IEEE interface bus.

1-5.1 Explanation of Options. Throughout this manual the various options are differentiated by a shortened description. For an equivalent full description, refer to table 1-2.

Table 1-2. Option Description

Short description	Full description
Standard	360-1200 Hz, 0.001° resolution, 0-359.999° display
±180°	360-1200 Hz, 0.005° resolution, ±179.995° display
Low frequency	47-440 Hz, 0.001° resolution, 0-359.999° display
Low frequency, 0.005° resolution	47-440 Hz, 0.005° resolution
IEEE-488	Uses IEEE - NATIVE language
IEEE MATE/CIIL	Uses CIIL language

1-5.2 Accessories. The API can be ordered with mounting adapters for mounting either one or two units in a standard 19-inch equipment rack. Table 1-3 describes full rack and tandem full rack mounting accessories.

Table 1-3. Rack Mounting Adapter Accessories

Type of Mount	Description	NAI P/N
Full Rack Mounting	Mounts one unit in 19-inch rack	783893
Tandem Full Rack Mounting	Mounts two units side by side in 19-inch rack (3-1/2" rack height)	548557
Tandem Full Rack Mounting	Mounts two units side by side in 19-inch rack (increases rack height to 7")	787026

1-5.3 IEEE Interface. When the IEEE NATIVE interface or IEEE MATE/CIIL option is ordered, rear panel ground connections, tile stand, and mounting feet are deleted (refer to figure 2-1). Power, reference, and signal inputs are applied through standard 50-pin input connector J5 (table 2-2). It does not contain the following logic signals: BCD outputs, data freeze, and converter busy.

The logic signals are connected to the IEEE board which interfaces with the external computer lines by way of IEEE standard 24-pin connector J6 (table 2-3).

If desired the unit may be operated as a standard API with BCD outputs and data freeze by removing P1 from J1 and connecting the input conenctor to J1. This mode of operation is convenient for servicing and alignment of the main API board.

1-6 EQUIPMENT REVISION LEVEL STATUS

Table 1-4 lists the major assemblies of the Model 8810 and the current revision level status of each assembly. For subsequent updates to Model 8810 assemblies refer to SECTION 9 – UPDATE INFORMATION.

Table 1-4. Revision Level Status of Major Assemblies

Ref Des	Description	NAI P/N	Current Revision
A1	Relay Adapter Assembly	787337	C
A2	Display Circuit Card Assembly (CCA)	787739	D
A2	360° Display CCA	787779	D
A2	180° Display CCA	783747	B
A3	Digital ±180° CCA	783719	E
A4	NATIVE IEEE Interface, Lower Chassis Assembly	500916-1,-2	V
A4A1	IEEE Interface CCA	787836-1,-2	F
A4A2	Front Panel Assembly	787617	A

SECTION 2

INSTALLATION

2.1 INTRODUCTION

This section provides instructions for unpacking, inspecting, and installing the API.

2.2 UNPACKING AND INSPECTION

This instrument has been thoroughly tested, inspected, and evaluated at the factory before shipment. Care has been taken in the design of the wrapping and packaging material to insure that no damage results from mishandling.

Inspect the instrument externally. Check the front panel for signs of damage to the switches and display. Check the switches for smooth operation. Switch buttons should be secure. Check the condition of the connector and fuse on the back panel. Check covers for damage and loose screws. If the instrument passes this inspection, install it and place it in operation. If damage is found, refer to the Warranty in the back of the manual.

2.3 INSTALLATION

2.3.1 Mounting Instructions. The Model 8810 may be mounted in a standard 19-inch equipment rack when a full rack mountin adapter is used. It requires no special cooling equipment. Mount the unit so that air flows freely around it, particularly the rear panel used to transmit the power supply heat to the ambient air. Figure 2-1 provides outline dimensions for the Model 8810 and figure 2-2 illustrates full and tandem rack mounting.

2-3.1.1 Full Rack Mounting.

a. Mount full rack extender panels to each side of unit using #10-32 x 5/8-inch pan head screws (figure 2-1).

b. Mount unit to standard 19-inch equipment rack using four securing screws (not supplied).

2-3.1.2 Tandem Full Rack Mounting (NAI P/N 548557).

a. Referring to figure 2-2, establish left and right mounting locations for each instrument.

b. Remove top cover mounting screws from right side of Instrument A and left side of Instrument B.

c. Mount bracket (NAI P/N 299399 w/o PEM) to the right side of Instrument A using #4-40 x 3/8-inch securing screws and lock washers.

NOTE

Make certain larger clearance holes in end of bracket are toward the front.

d. Mount bracket (NAI P/N 299405 w/PEM) to the left side of Instrument B using #4-40 x 3/8-inch securing screws and lock washers.

NOTE

PEMs in bracket shoud be positioned towards the rear.

e. Join the two instruments together side by side so that the bracket of Instrument B slides inside of the bracket of Instrument A.

f. Secure the front panels of both instruments to the mounting brackets using four #6-32 x 7/16-inch screws and #10-32 lock nuts.

g. Secure the rear ends of the brackets together by screwing four #6-32 x 7/16-inch screws into threaded PEM holes.

h. Install the tandem mounted instruments into a standard 19-inch equipment rack using four securing screws (not supplied).

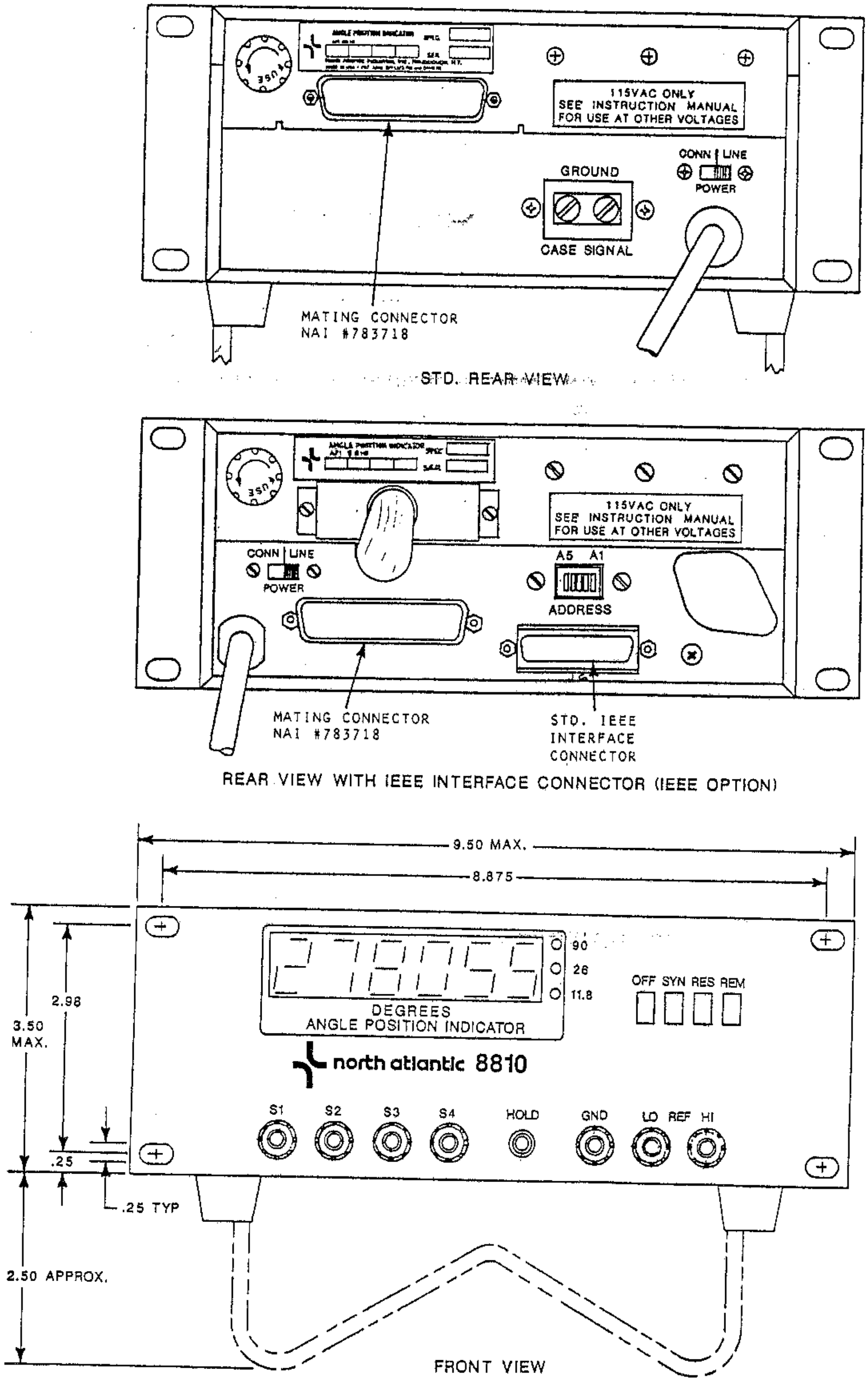
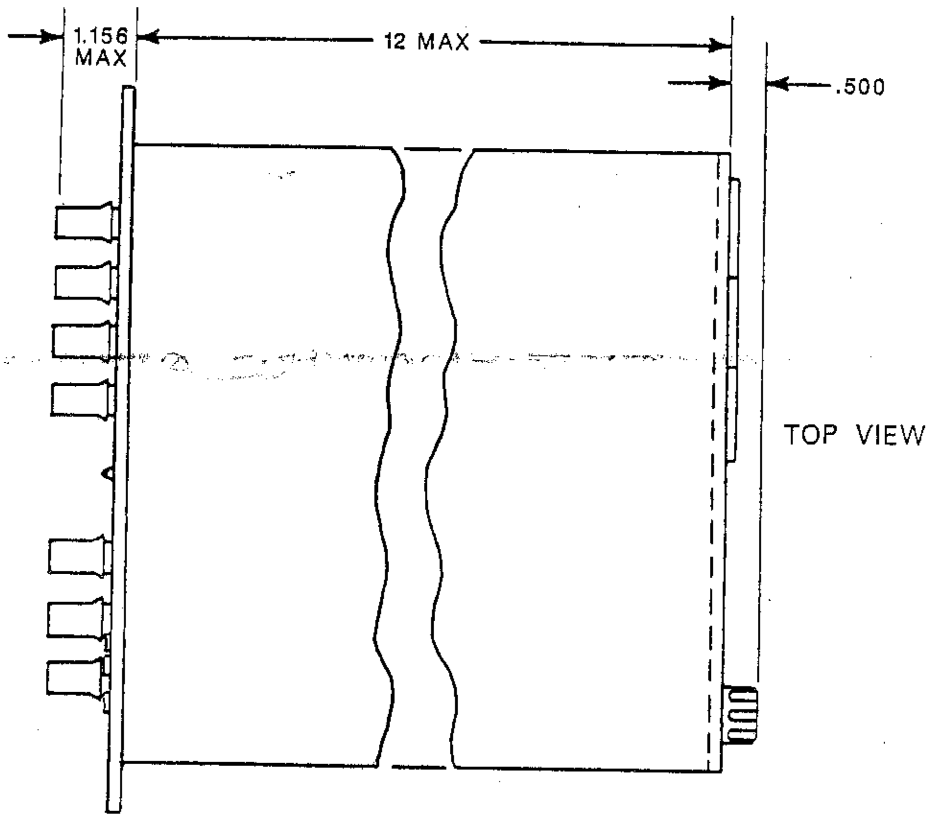
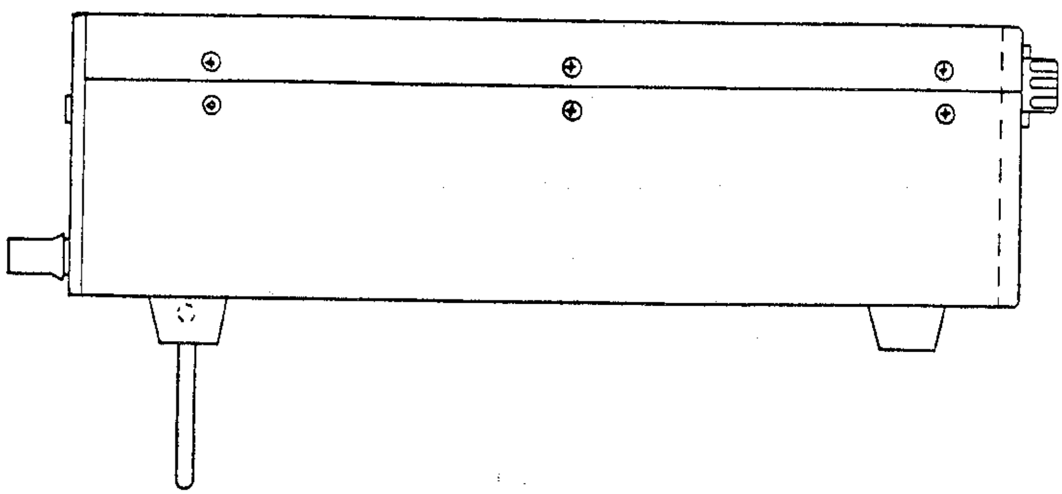


Figure 2-1. API Outline Drawing (Sheet 1 of 2)





SIDE VIEW SHOWN WITH TILT STAND EXTENDED
(NOTE: API IEEE VERSIONS DO NOT INCLUDE RUBBER FEET OR TILT STAND)

Figure 2-1. API Outline Drawing (Sheet 2 of 2)

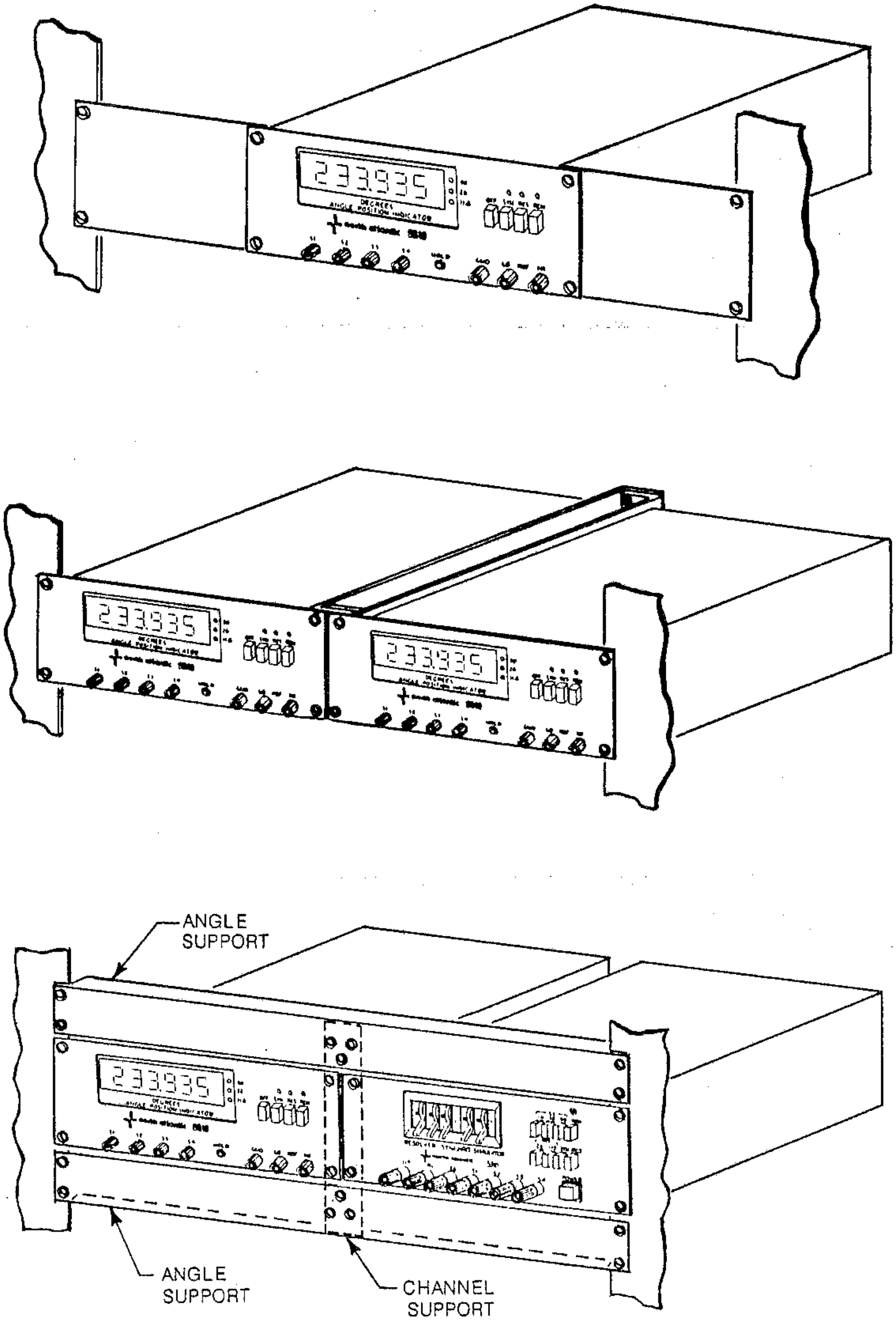


Figure 2-2. Full Rack and Tandem Rack Mounting Adapters

2-3.1.3 Tandem Full Rack Mounting (NAI P/N 787026)

a. Referring to figure 2-2, establish left and right mounting locations for each instrument.

b. Secure channel support bracket to the two angle support rack mounts by screwing six flat head #8-32 x 1/2-inch screws into threaded PEM holes.

c. Secure both instruments to channel support bracket by screwing four #10-32 x 1/2-inch screws into threaded PEM holes.

d. Install the tandem mounted instruments into a standard 19-inch equipment rack using twelve securing screws (not supplied).

2-3.2 Cabling Instructions. System interconnection to the S/D is through rear panel connector J1. Pin designations are given 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

2-3.3 Cabling Instructions for IEEE Interface. Connection to 115 V or 230 V rms power source is made through rear connector J5 or through furnished line cord. Table 2-2 gives pin designations for J5.

Table 2-1. J1 Pin Designations[1]

Pin	Function	
1	Power input Hi	
2	Power input Lo	
3	Case ground	
4	Digital ground	
5	S1	
6	S2	Synchro
7	S3	
8	Not used	
9	R1	
10	R2	Synchro ref
11	Converter busy	
12	0.04°	
13	0.01°	
14	0.8°	
15	0.2°	BCD outputs
16	4°	
17	1°	
18	Not used	
19	Spare	
20	$\overline{REM}$	
21	S1	
22	S2	
23	S3	Resolver
24	S4	
25	R1	
26	R2	Resolver ref
27	Data freeze ($\overline{DF}$)	
28	0.02°	
29	0.08°	
30	0.1°	
31	0.4°	BCD outputs
32	2°	
33	8°	
34	Not used	
35	Not used	
36	Spare	
37	Spare	
38	0.008°[2]	
39	0.002°[2]	BCD outputs
40	0.001°[2]	
41	Spare	
42	Data freeze (DF)	
43	Remote program	
44	0.004°[2]	

[1]Use without IEEE option.

[2]On 0.005 resolution units, pins 40 and 44 are connected internally and act as the 0.005 bit. Pins 38 and 39 are grounded at logic 0.

Table 2-1. J1 Pin Designations[1]
(Continued)

Pin	Function	
45	20°	BCD outputs
46	40°	
47	80°	
48	10°	
49	100	
50	200[3]	

Signal and reference inputs may be connected to the front panel binding posts or the rear connector J1.

Connection to reference and to synchro or resolver inputs may optionally be through connector J5. Refer to tables 2-2 and 2-3 for J5 and J6 pin designations, respectively.

Observe the synchro and resolver conventions and the grounding instructions.

Table 2-2. J5 Pin Designations (IEEE)

Pin	Function	
1	Power input Hi	
2	Power input Lo	
3	Case ground	
4	Digital ground	
5	S1	Synchro
6	S2	
7	S3	
8	Spare	
9	R1	Synchro ref
10	R2	
11 - 18	Do not use	
19	Spare	
20	Spare	
21	S1	Resolver
22	S2	
23	S3	
24	S4	
25	R1	Resolver ref
26	R2	
27 - 35	Do not use	
36	Spare	
37	Spare	
38 - 50	Do not use	

[1]Use without IEEE option.
[3]±bit (±180° option).

Table 2-3. J6 Pin Designations (IEEE)

Pin	Function
1	DIO1
2	DIO2
3	DIO3
4	DIO4
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	Shield
13	DIO5
14	DIO6
15	DIO7
16	DIO8
17	REN
18	Gnd., DAV
19	Gnd., NRFD
20	Gnd., NDAC
21	Gnd., IFC
22	Gnd., SRQ
23	Gnd., ATN
24	Gnd., Logic

2-3.4 Grounding. In a high-accuracy synchro/resolver-to-digital converter it is necessary for both chassis and signal ground to be tied together. Ground loops should be avoided in system applications. For this reason, chassis ground pin 3 and signal ground pin 4 are brought out separately and are also available at terminals on the rear panel.

In bench applications, pins 3 and 4 should be tied together and connected to the low side of the signal source to the synchro or resolver.

In system applications, the separate pins make connections in other parts of the system possible. When not used, tie them together at the connector.

2.3.5 Signal Inputs. The API is designed to accept both synchro and resolver inputs through the rear connector (J1). See table 2-4 for signal input connections and pin programming.

2.3.6 Internal Power Connections. The API is designed to operate from 115 V or 230 V, 47 to 440 Hz input power. It is normally set in the factory for 115 V operation. For 230 V operation move Power switch (figure 2-3), located on the standard board near the power transformer, to 230 V position. For 125 V or 250 V operation, see schematic.

Table 2-4. Signal Inputs and Programming

Signal	Signal input	J1 pin
Synchro	S1 S2 S3	5 6 7
Synchro reference	R1 R2	9 10
Resolver	S1 S3 S2 S4	21 23 22 24
Resolver reference	R1 R2	25 26

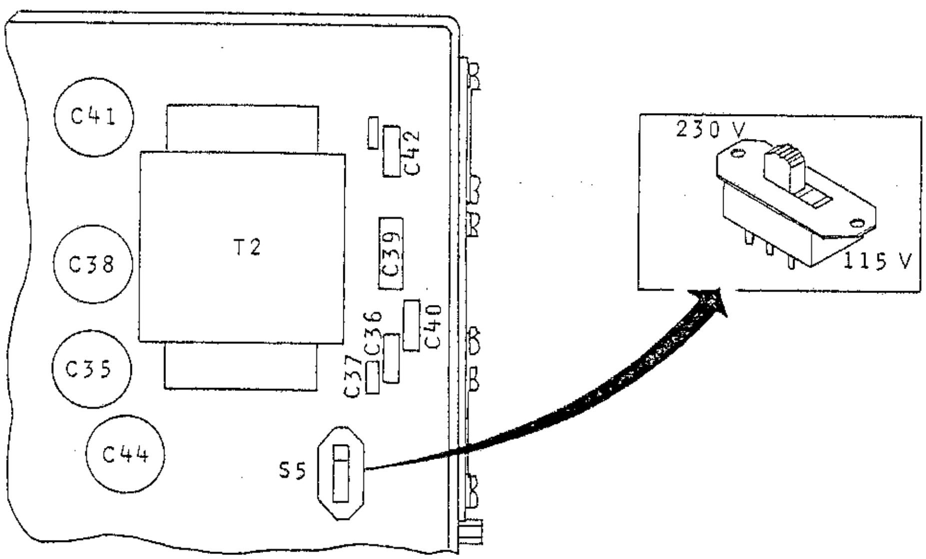


Figure 2-3. Power Programming

SECTION 3

OPERATION

3-1 GENERAL

This section provides operating procedures 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-2153 (resolvers). The unit is provided with terminal designations and electrical characteristics to these specifications. In applying the conventions, exercise caution that:

- The manufacturer of the synchro or resolver has followed the MIL specification.
- The system 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

$$E(S1-S3) = -NE(R1-R2)\sin\theta$$
$$E(S3-S2) = -NE(R1-R2)\sin(\theta+120^\circ)$$
$$E(S2-S1) = -NE(R1-R2)\sin(\theta+240^\circ)$$

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.

3-2.2 Resolver Transmitter Conventions

For rotor energized resolvers:

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

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-Hi and R4-Lo energized resolver, the resolver outputs become:

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

3-3 CONTROLS AND INDICATORS

The controls and indicators for the API are described in table 3-1 and illustrated in figure 3-3.

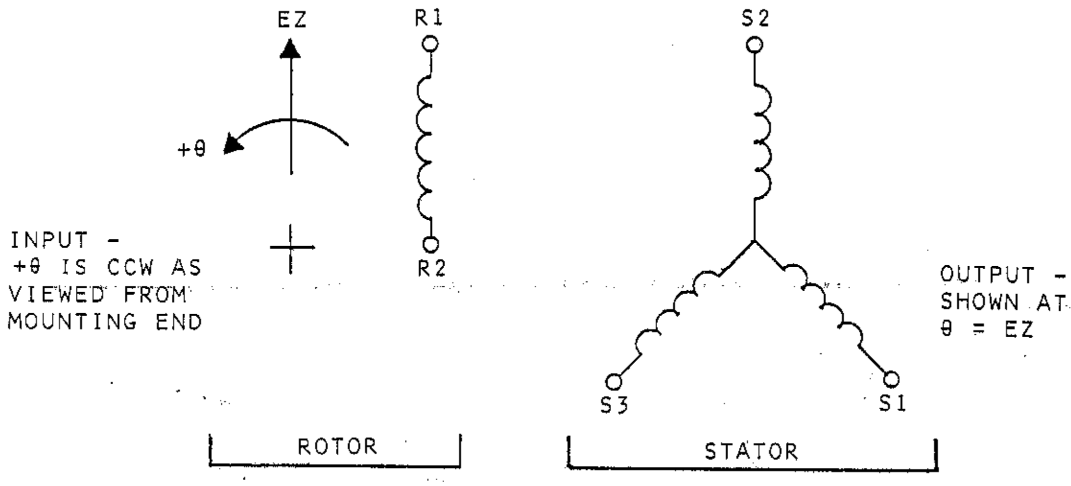


Figure 3-1. Synchro Transmitter, Schematic

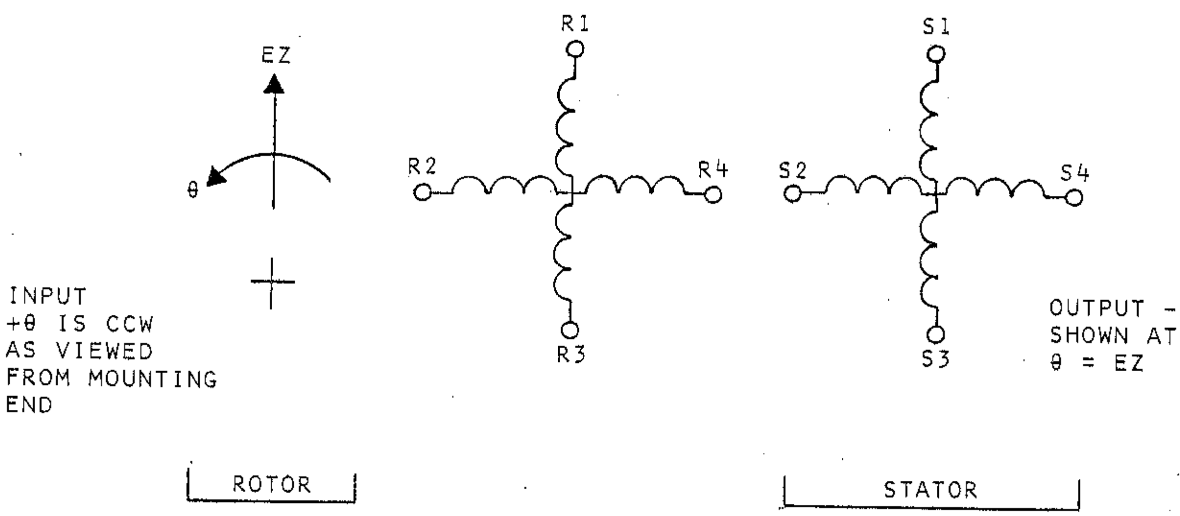


Figure 3-2. Resolver Transmitter, Schematic

Table 3-1. Controls and Indicators

Control or indicator	Function
OFF push button	Turns power off.
SYN push button	When pressed in, selects synchro operation and turns power on. If optional IEEE-488 or MATE/CIIL interface is installed, and API is in Remote mode (see Remote push button below), the interface may select either synchro or resolver operation.
SYN LED	Optional LED used on units with IEEE-488 or MATE/CIIL intefaces. When lit, indicates synchro operation has been selected.
RES push button	When pressed in, selects resolver operation and turns power on. If optional IEEE-488 or MATE/CIIL interface is installed, and API is in Remote mode (see Remote push button below), the interface may select either synchro or resolver operation.
RES LED	Optional LED used on units with IEEE-488 or MATE/CIIL interfaces. When lit, indicates resolver operation has been selected.
REM push button	When pressed in, allows remote programming of synchro or resolver operation via rear panel remote connector and turns power on. When pressed in, and if optional IEEE-488 or MATE/CIIL interface is installed, allows remote control of synchro or resolver operation via interface. If the IEEE-488 local lockout bus command is received by the API, remote control of synchro or resolver operation via the interface is allowed if either the SYN, RES, or REM push button is pressed in.
REM LED	Optional LED used on units with IEEE-488 or MATE/CIIL interfaces. When lit, indicates that the API is in Remote mode.
Numeric display	Displays angular information in degrees and decimal degrees.
HOLD momentary push button	Freezes display when pushed in.

Table 3-1. Controls and Indicators

Control or indicator	Function
115 V - 230 V Power switch (located on main chassis)	Allows unit to operate from either 115 V or 230 V power source.
EXT-INT Reference switch (located on main chassis)	Provides a means of switching reference as required in calibration procedure. Normally is set to INT.
90 V LED	When lit, indicates that input signal is 90 V L-L.
26 V LED	When lit, indicates that input signal is 26 V L-L.
11.8 V LED	When lit, indicates that input signal is 11.8 V L-L.
S1, S2, S3, S4 terminals	Accepts synchro or resolver input data.
HI, LO REF terminals	Accepts input reference voltage.
GND terminal	Chassis ground.
POWER switch (rear panel)	Transfers power input to rear-panel connector J1 for use in rack-mounted units.

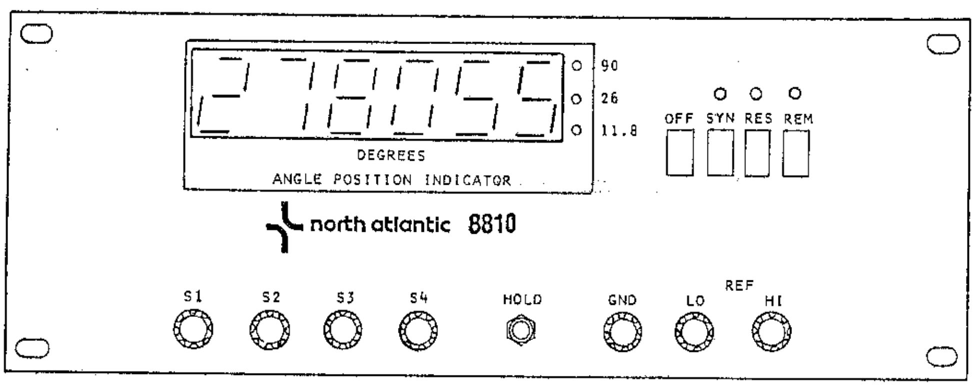


Figure 3-3. Controls and Indicators

3-4 DATA TRANSFER CONSIDERATIONS

3-4.1 Timing. The S/D converter output 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. 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 is a 1 us-wide logic 1 pulse and indicates output data changes.

It is necessary to transfer data 2 us after the trailing edge of the converter Busy. The data will be stable for a minimum of 5.5 us when the converter is tracking at its maximum rate of 200°/S.

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

Since the inhibit signal stops the S/D converter output from tracking, it should be applied for as short a time as necessary, otherwise large errors will accumu-late under high angular rate conditions. When this occurs, time will have to be allowed for the converter to settle. In general, application of the inhibit for less than 30 us will produce a maximum peak transient error of less than 1 LSB at an angular input rate of 0.25 rps (90°/S).

Application of the inhibit for less than 3 us will produce a maximum peak transient error of less than 1 LSB at an angular input rate of 2.5 rps (900°/S).

NOTE

At slower angular input rates the converter can be frozen for much longer periods with no appreciable error buildup. In addition, the change allows for a reasonable capacitive load on the digital output lines (500 pf or less). Special precautions must be taken for capacitive charge and discharge for applications with excessive capacitive loads.

A remote data freeze signal (+5 V) may be applied to the DF (pin 42) terminal of J1.

SECTION 4

THEORY OF OPERATION

4-1 GENERAL

This section contains theory of operation for the API.

4-2 DETAILED DESCRIPTION

The API is designed with NAI's closed servo loop (refer to block diagram, figure 4-1). This system continuously tracks the analog input data with a precision Scott-T transformer, resistive bridge, phase detector, integrator, and clock generator, driving a counter which updates the bridge to the synchro data angle input.

The heart of the system is a custom LSI TRIG LOGIC™ processor. This LSI contains analog switches, an UP/DN counter and trigonometric digital circuitry for processing the input signals.

The input signal, whether synchro (three wire) or resolver (four wire) goes 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 are turned at 40° intervals. These points are referred to as αc. The signals produced within the coarse bridge circuit are Sin θ Cos αc, Sin θ Sin α, Cos θ Cos αc, and Cos θ Sin αc. These four functions are combined to derive Sin (θ-αc) error signal and Cos (θ-αc) interpolation signal, implementing the following trigonometric relationships:

$$\sin(\theta-\alpha c) = \sin\theta \cos\alpha c - \cos\theta \sin\alpha c$$
$$\cos(\theta-\alpha c) = \sin\theta \sin\alpha c + \cos\theta \cos\alpha c$$

Since αc takes on values at only 40° intervals, θ-αc will be somewhere between 0° and ±20°, depending upon the value of the input angle θ. The error signal Sin (θ-αc) is then balanced out in the interpolation circuit, using Cos (θ-αc) 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 range of the interpolation section is 20°. When interpolating angles larger than αc, the output of the interpolation bits are complemented, the CEF switch is closed and the interpolation ladder subtracts from αc. This allows the interpolation section to cover a total span of 40°.

Since the Sin function is not a linear one, interpolating a full 20° would result in rather large errors. Several methods are used to reduce the interpolation error. The first is to break up the 20° interpolation span into two 10° segments. From 0° to 9.999°, the Sin 10° is applied to a resistor at the summing amplifier, and the Sin 20° to Sin 10° is applied to the interpolation ladder. This reduces the interpolation error to about ±0.005°. This error is further reduced by three analog switches which perform slight amplitude changes in the ladder reference. The final mathematical error is less than ±0.001°. The result of the bridging process is an ac error signal at the output of U13 proportional to Sin (θ-αc) Cos αf Cos (θ-αc).

This equals Sin (θ-αc-αf), where αf is the digitally generated angle in the interpolation circuit.

The output of summing amplifier U13 is fed to amplifier U17 for further amplification.

Since the ac scale factor changes with coarse bridge angles, it is necessary to normalize this scale factor to maintain constant sensitivity throughout the entire

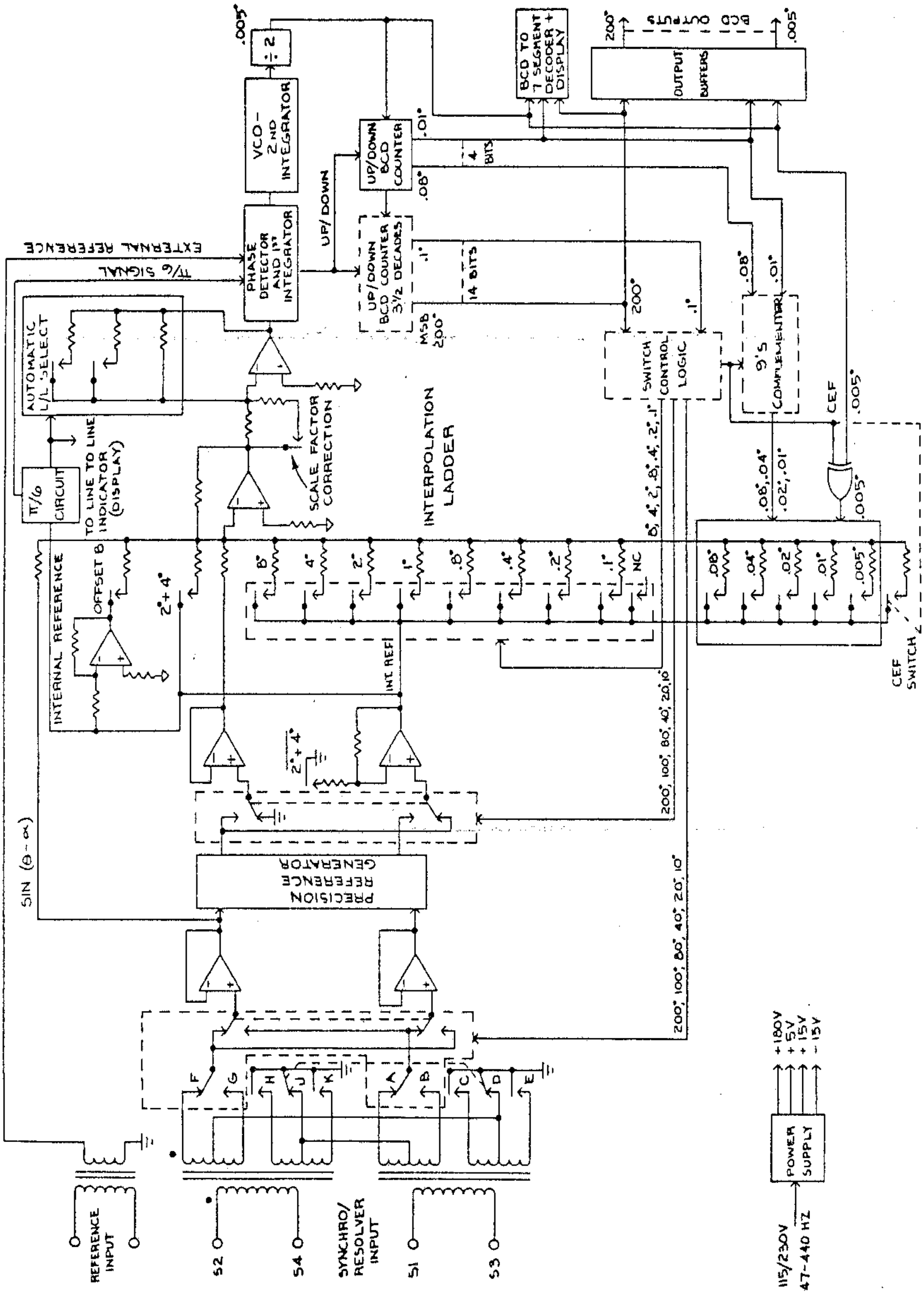


Figure 4-1. Model 8810 API, Block Diagram

360° span. Resistor R94 is switched in and out to eliminate this change. (The change would be 40% without this normalization.) In addition, gain changes to U17 are performed for line-to-line voltage changes. At 11.8 V L-L, resistor R92 is the feedback. R91 is in parallel with R92 for 26 V L-L operation. For 90 V L-L operation, R90 and R91 are in parallel with R92. The ac scale factor at the output of U17 (TP7) is 2.5 V rms/degree at all three line-to-line levels.

In most S/D Converters, reference to the null circuit is supplied externally from the same source exciting the synchro. Since all synchros generate phase shift, their output signal is phase shifted in respect to the reference, usually 5° to 10°. For optimum performance, the reference applied to an S/D converter should be phase shifted by the same angle as the synchro signal. The API contains an autophase circuit which eliminates the need for external reference phase correction. This circuit is able to correct for maximum phase of ±30°. Reference phase correction is accomplished by sampling the interpolation ladder reference. Since this signal is derived directly from the synchro input signal, it is inphase with the synchro signal.

The interpolation reference is coupled through C10 and applied to full wave rectifier circuit U14. FET switch Q8 switches the gain of the rectifier when the interpolation reference changes amplitude so that the rectified signal at TP 9 is a constant amplitude (figure 4-2). The output of the rectifier drives the inverting input (pin 6) of comparator U15. The output of the rectifier is divided and filtered by components R73, R74, and C12. This network applies exactly 50% of the peak value of the full-wave rectified signal which corresponds to the Sin of 30°. This develops a π/6 (±30°) signal at the output of the comparator (TP10). The π/6 signal is applied to the phase detector which is discussed later.

After scale factor correction is made with Q8, the output voltage of the rectifier is directly proportional to the input line-to-line voltage. The filtered voltage at C12 is buffered by voltage follower U14, and the output (TP11) is connected to two comparators. The dc voltage (TP11) is approximately 1/20th of input line-to-line voltage (rms). The two comparators sense the voltage amplitude at TP11. When the voltage is less than 0.9 V, the outputs of both comparators are low. This sets the gain of U16 for 11.8 V L-L. When the voltage is between 0.9 V and 1.8 V, the output of U15, pin 13, goes high, and switches the API to 26 V L-L. when the voltage at TP11 exceeds 1.8 V, both comparator outputs go high, switching the API to 90 V L-L. The outputs of the comparators are decoded by U16 to drive the line-to-line indicator LEDs on the front panel.

The null circuit receives the π/6 signal, the external reference, and the ac error signal from U17. This circuit performs three discrete functions: (1) phase-sensitive detection, (2) clock pulse generation, and (3) countup/count down signal. In addition, an Auto-phase defeat switch is provided so that, if necessary, the synchro information may be referenced to the external reference. With the Auto-phase switch in the external position, the phase detector operates as a normal full wave detector. This mode of operation is explained first.

The external reference applied to J1 is isolated and stepped down by transformer T3. This signal is squared by comparator U15. At this point the signal splits. One side is connected to U21, pin 6, the other inverted by U20. This inverted signal connects to U21, pin 8. Since the π/6 signal is grounded by S6, the NAND gates function as inverters. This two-phase reference signal is buffered and drives the phase detector switches. The third grounding switch remains open.

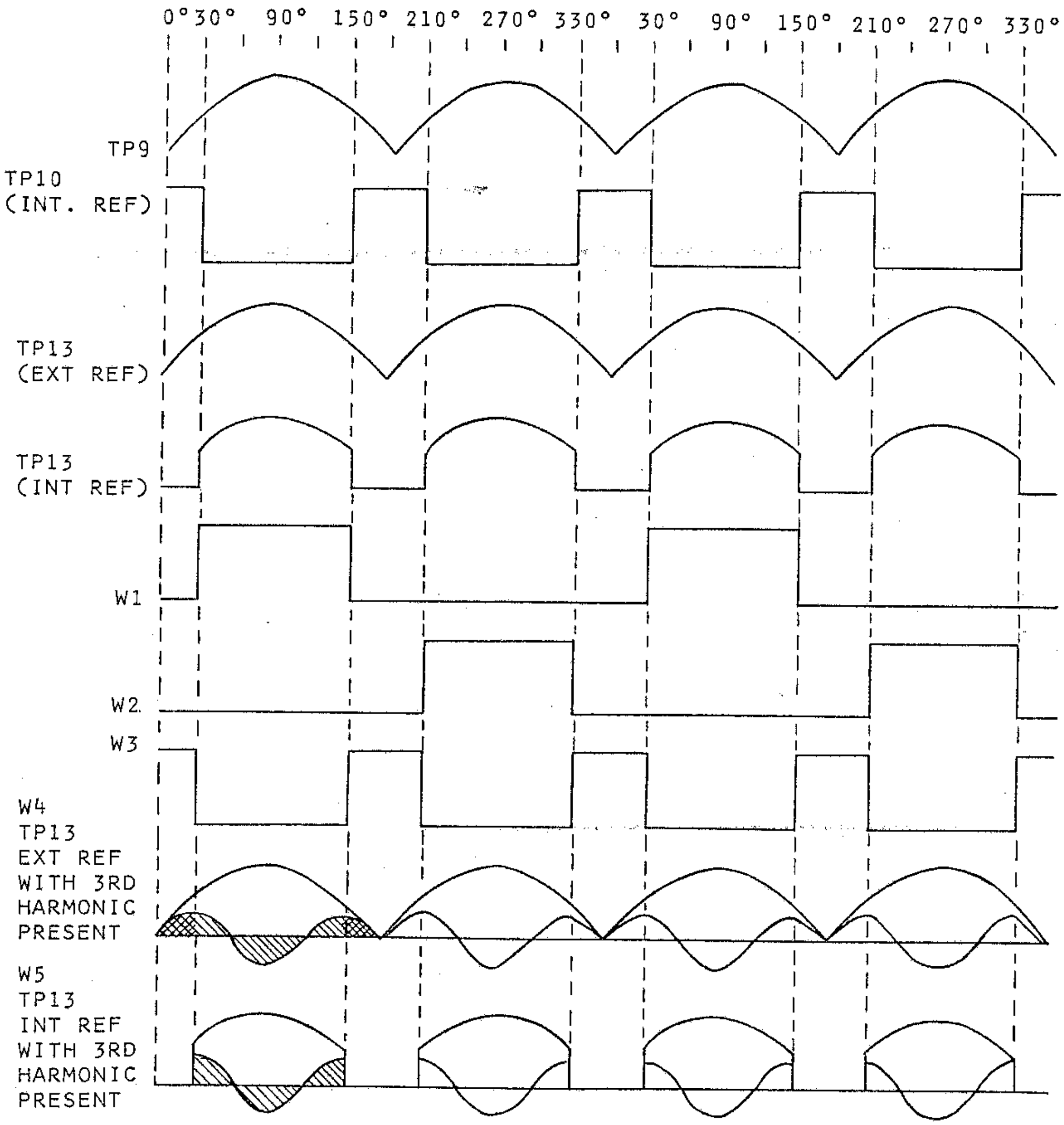


Figure 4-2. Null Circuit Waveforms

The ac error signal from U17 is coupled through C15 to U18. With the Auto-phase switch in the external position, U18 operates as a noninverting unity gain buffer. The signal at TP8 is identical to that at TP7, except that any dc offset present at TP7 is blocked by C15. This signal is applied to one of the phase detector switches. The ac error signal at TP8 is also inverted by U19 and fed to another phase detector switch. These two switches alternately open and close inphase with the external reference and form a phase-sensitive full wave detector. The output of the phase detector is a dc signal whose amplitude is proportional to the inphase portion of the ac error signal. Polarity depends on whether the ac error signal is inphase or 180^o out-of-phase with the reference. U23 integrates the phase detector output.

When the Auto-phase switch is in the INT position, the $\pi/6$ signal is digitally combined with the external reference square wave. The $\pi/6$ signal removes 30^o of the leading and trailing edges which reduces the switch closure angle from 180^o to 120^o (waveforms W1 and W2, figure 4-2). Grounding switch U22, pin 2 is closed when the other switches are both open to insure no signals leak through to the integrator during the $\pi/6$ interval (waveform W3, figure 4-2). Since this reduces the gain of the phase detector, resistor R97 is grounded by the Auto-phase switch, increasing the gain of U18 proportionately.

In addition to automatic phase correction, the $\pi/6$ null circuit provides complete rejection of the third harmonic and all multiples of the third harmonic. A normal full wave detector provides a 3:1 attenuation of 3rd harmonics and an attenuation of all other odd harmonics proportional to the ratio of the harmonic to the fundamental (i.e., 7th harmonic 7:1, etc.). For all odd harmonics, not a multiple of the third harmonic, the $\pi/6$ phase detector provides the same attenuation as the full wave phase detector. Both types provide complete rejection of even harmonics. Within the null circuit there is a half-wave rectifier and filter, comprising of CR20, R104, R207, and C16. Comparator U14 monitors the voltage across C16 and trips when the ac error is greater than 10 V rms. This occurs when the angular error between the API and synchro exceeds 4^o. This will cause the internal signal supplied to the $\pi/6$ circuitry randomly to change amplitude until the converter slews closer to the input angle. This results in a momentary disruption of the $\pi/6$ signal applied to the phase detector. To insure proper operation of the phase detector, the $\pi/6$ signal is disabled by comparator U14, pin 10 until the error is reduced.

The API uses a Type II servo, which does not require a continuous error signal to generate clock pulses. Depending upon the phase relationship with the reference and the direction of the synchro rotation, an ac error signal will either accelerate or decelerate the clock until clock rate matches the rate of the incoming synchro data. At this point, the ac error signal drops to zero and the clock continues to run at its present rate until an error signal again appears to accelerate or decelerate it.

The VCO consists of integrator U24 and two sections of comparator U25. In operation, a dc voltage from U23 charges C23 through R117, and R118 until the output of U24 reaches the trip point of one of the comparators. When this occurs, CR25 or CR26 is forward biased and C23 discharged until the comparator flips back to its original state. The cycle is then repeated. The microprocessor clock pulses are derived from U25, pin 1 and the down clock pulses are derived form U25, pin 2. The output of U24 is also fed to comparator U25, pin 10 to develop an up/down signal for the LSI counter.

The clock lines drive the BCD up/down counter. The counter outputs (decoded and complemented) close the loop with the coarse bridge and interpolation circuits. The digital word, in BCD form, from the LSI goes to the output buffers. These buffers isolate the LSI and drive the rear connector for external use. They also go to the display board for decoding to drive the seven segments of the Beckman Planar Gas Discharge Information Display.

4.3 IEEE INTERFACE BLOCK DIAGRAM DESCRIPTION

Refer to figure 4-3 for the following discussion. The diagram represents the interface system required to connect the API to the IEEE Standard Digital Interface for Programmable Instrumentation (IEEE Std-488-1975).

The interface accepts control signals and control data from the IEEE bus, and outputs control signals, angle position data and status data to the IEEE bus. All data transfers on the bus use ASCII code. The IEEE bus is connected to J6 on the back of the API and interconnected to J1 on the interface.

The interface responds to the bus by providing control signals to the API, and accepting BCD and status data words from the API. These functions are connected from J2 of the IEEE board to J6 on the back of the API.

The interface accepts control signals and data while in the listen mode. It transmits data in the talk mode. Control of the interface is performed by a 8085 microprocessor and the program stored in the ROM. Under control of the program the microprocessor (U3) checks control lines, sets registers, converts BCD to ASCII, and transmits the data and status words.

The interface consists of a power-up reset, a microprocessor, address and data line buffers, ROM decoders, PIA, transceivers, tristate buffers, and multiplexers. The function of each group is explained in the following paragraphs.

4.3.1 Microprocessor. The IEEE-488 interface contains an 8-bit 8085 microprocessor (U3) which operates at 4 MHz and controls the overall operation of the interface. Its operation is initialized when it receives a power-up reset signal ($\overline{\text{RSTIN}}$) at output RSTIN from reset circuitry CR2, R1, and C6.

The microprocessor also generates a reset signal (RSTOUT) for other circuits in the unit. Timing is controlled by internal clock circuitry which uses crystal Y1 to generate internal clock signals and external signal CLK.

The microprocessor utilizes an 8-bit data bus and a 16-bit address bus for data control. Address bits A8-A15 are output directly by the microprocessor, whereas address bits A0-A7 and data bits D0-D7 are multiplexed. The bus demultiplexer (U6) separates and latches address lines A0-A7 using the ALE signal.

4-3.2 ROM and RAM. The interface consists of an 8 k by 8-bit Read Only Memory (ROM) which contains a total of 64 k data bits of memory capacity. It also contains a 2 k by 8-bit Random Access Memory (RAM) with a total working storage capacity of 16 k data bits. All program data reside in ROM while RAM provides temporary storage for system variables. Data is both written to and read from RAM, while data is only read from ROM. ROM and RAM are accessed via address decoder circuitry (U8 and U9) and signals RD (read) and WR (write) as determined by API program logic.

4-3.3 Address Decoding. The memory address circuitry (U8 and U9) uses the address generated by the microprocessor, in conjunction with the RD and WR signals, to generate enable signals which select memory space blocks as needed. The microprocessor address space is divided into eight 8 k deep memory blocks.

4-3.4 IEEE-488 Interface. The IEEE Controller (U5) regulates all low level timing, handshaking operations, and data transfers for the IEEE-488 data bus. The microprocessor inputs and outputs data via respective input and output data registers within the IEEE controller. Microprocessor control signals are also transferred to control registers within the IEEE controller. SPecifically, signals CLK, WR SI, and RST5.5 are used during these data transfers. Special purpose Bus Transceivers (U10 and U11) communicate IEEE-488 bus data and control signals to the IEEE controller.

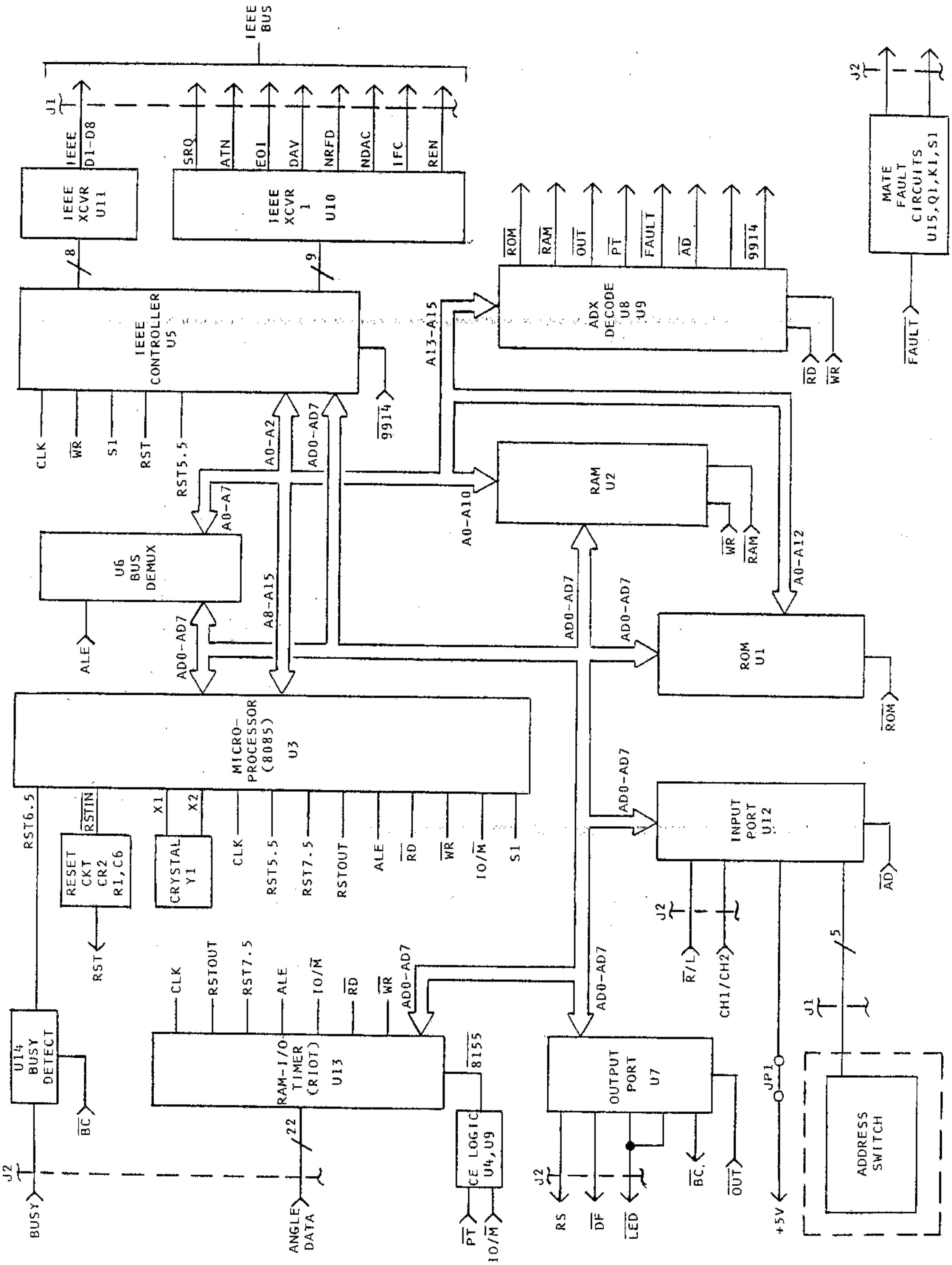


Figure 4-3. IEEE Interface Board, Block Diagram

4-3.5 Input/Output Ports. Communication of angle data from the API to the microprocessor is accomplished through RAM-I/O-Timer (RIOT) U13. The RIOT contains I/O ports, a timer, and RAM capacity. In the API it functions as a data input port. The RIOT RAM is accessed by the chip enable (CE) logic circuit (U4 and U9).

Additional data inputs to the microprocessor are provided by input port U12. This tri-state buffer data port supplies data to the rear panel address switch and API status signals to the microprocessor. The API status signals are as follows: R/L (remote/local status), CH1/CH2 (channel 1/channel 2 status), and JP1 (±180 display status).

Control signal outputs to the API are communicated through output port U7. This port is a latch which transfers data from the data bus to API control inputs. This port controls the resolver/synchro mode (RS), data freeze (DF), and front panel remote mode indicator (LED) API functions.

4-3.6 Busy Detect Circuitry. To determine the stability of the IEEE-488 service request data (e.g., angle display data) the microprocessor monitors the $\overline{BUSY}$ signal. The microprocessor writes the $\overline{BC}$ (busy clear) signal to the Busy Detect circuitry clearing flip-flop U14. It then checks whether its output (RST6.5) has been reset by another API BUSY pulse.

4-3.7 MATE Fault Circuits. Units equipped with the MATE/CIIL interface option must provide a relay closure indication when a system failure occurs. The relay closure indication is accomplished by the microprocessor repeatedly writing to the FAULT address block. This causes a continual retriggering of one-shot U15 and a constant energizing of relay K1 which is in series with thermostat S1. When a failure of the control logic occurs the microprocessor stops writing to the FAULT address block and one-shot U15 times out and de-energizes relay K1. If power fails, the relay will also be de-energized. If an over-temperature condition occurs, thermostat S1 will open and make relay K1 appear to be de-energized.

SECTION 5

8810 IEEE-488 REMOTE OPERATION

5-1 INTRODUCTION

This section describes the operation and programming of the Model 8810 Angle Position Indicator (API) using the IEEE-STD 488-1978, Standard Digital Interface for Programmable Instrumentation.

5-2 SETTING THE DEVICE ADDRESS

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

5-3 FRONT PANEL IEEE STATUS LED

The front panel REM LED illuminates when the API is in the Remote state. If the LED is lit, the IEEE interface is controlling the unit. When not lit, the front panel has control.

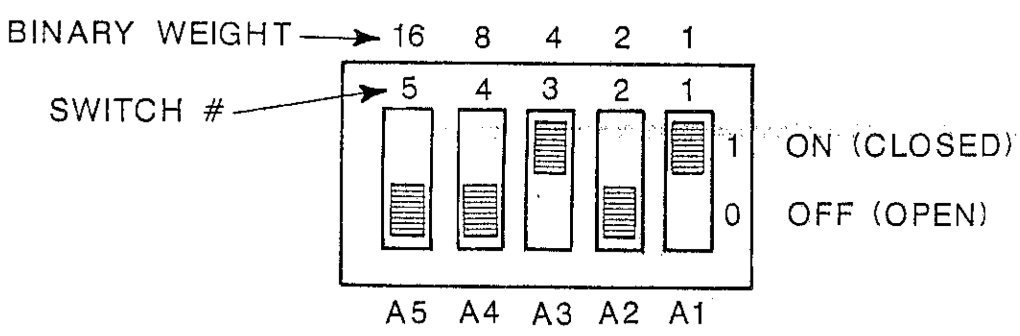


Figure 5-1. Rear Panel IEEE Dip Switch

Table 5-1. Device Address Codes

Device	ASCII		ADDRESS 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

5-4 IEEE-488 BUS COMMANDS

Table 5-2 lists the applicable IEEE-488 bus commands for the API.

Table 5-2. 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 DATA FREEZE - OFF SRQ MODE - 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.
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.

5-5 NATIVE MODE OPERATION

5-5.1 IEEE-488 Interface Function Subsets. Table 5-3 lists the interface function capability codes for the API in Native mode.

Table 5-3. 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

5-5.2 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 5-4 lists all of the commands and their actions. Any characters not appearing in table 5-4 are ignored.

Table 5-4. 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

5-5.3 Data. The standard API will send angle data to the controller in the following format:

<DDDDDD<CR><LF>
E.g., <179999<CR><LF>

The standard API data message will always be 7 characters long plus a <cr><lf>.

The API with the ±180 degree option (feature 1, option 3 and 4) will send angle data to the IEEE controller in the following format:

<SDDDDDD<CR><LF>
e.g., <-149999<CR><LF>

The ±180 degree option data message will always be eight characters long plus a <CR><LF>.

5-5.4 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	0	0	0	0	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, or when FREEZE mode is programmed. This bit will be set when running at rates greater than .1°/Sec. If FREEZE is programmed, this bit will always be 0.

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

FREEZE - When bit is set the display is frozen. When cleared the API tracks the input signal. The FREEZE bit is active only when in remote operation (front panel REM LED is on). When in LOCAL mode, the FREEZE bit will always be 0, whether or not the front panel hold button is depressed.

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.

5-5.5 <u>Service Request.</u> 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 or the FREEZE mode is programmed. The V command (table 5-4) 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.

5-5.6 <u>GET Mode.</u> When the G command (table 5-4) is included in the programming string, the API will hold off applying the programming data until the GET (Group Executive Trigger) bus command is received. GET mode is cancelled once the bus command GET is received and must be reprogrammed if desired again.

5-6 APPLICATION EXAMPLES

The scope of applications for the API IEEE-488 Interface is so large that it cannot be fully addressed here. The following program example, written for the HP85 computer, records the accuracy of the 8810 API using the North Atlantic 5310 Resolver/Synchro Simulator.

```
10    CLEAR
20    DIM U(35)
22    DIM D(35)
130   A=705 @ S=706
135   W=SPOLL(A)
140   OUTPUT A ;"RT"
150   PRINT "ANGLE   UP    DOWN
              AVG"
160   PRINT "________________
      ____________"
170   FOR I=0 TO 350 STEP 10
180   A$=VAL$(I*100+100000)
190   OUTPUT S ;A$[2,6]&"013"
200   GOSUB 900
210   ENTER A ;0$
215   R=VAL(D$[2,7]*.001
216   IF R>355 THEN R=R-360
225   U(I/10)=R-I
230   NEXT I
240   OUTPUT S ;"00000"
250   WAIT 1000
370   FOR I=350 TO 0 STEP -10
380   A$=VAL$(I*100+100000)
390   OUTPUT S ;A$[2,6]&"013"
400   GOSUB 900
410   ENTER A ;D$
415   R=VAL(D$[2,7]#.001
416   IF R>355 THEN R=R-360
425   D(I/10)=4-I
430   NEXT I
500   FOR I=0 TO 35
520   PRINT USING "DDD.DD,2X,SZ,DD
      D,2X,SZ.DDD,3X,SZ,DDD" ; I*1
      0,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
```

5-7 MATE/CIIL PROGRAMMING

5-7.1 Introduction. This section describes the operation and programming of the API using the MATE/CIIL language option. Recommended reference documents are:

a. MATE Control Interface Intermediate Language - Standard 2806763 Rev C

b. MOD 1 - MATE User's Group Action Traveler - CIIL Definitions

The following notation shall be used to describe various input and output strings:

¦	:- exclusive OR
<>	:- the boundaries of a field or structure of inseparable items.
<b>	:- one ASCII blank
[ ]	:- an optional field, item, or structure.
...	:- the field or structure may be repeated as often as required.
<setcode>	:- SET ¦ SRX ¦ SRN
<noun>	:- SYN or RSL
<mchar>	:- four ASCII encoded characters. See table 5-6 for a complete list.
<modifier>	:- four ASCII encoded characters. See table 5-6 for a complete list.
<chan num>	:- 1 or 2 digit number indicating the channel number.
<value>	:- any ASCII encoded number in floating point, engineering, or integer notation.
<cr,lf>	:- ASCII encoded carriage return followed by line feed.

5-7.2 IEEE-488 Bus Commands. The following IEEE-488 bus commands are implemented:

a. IFC (Interface Clear) - The IFC command will clear the Model 8810 IEEE-488 interface.

b. DCL (Device Clear) - The DCL command resets the Model 8810 to a power-up condition.

5-7.3 Inputs. There are nine transmission types of inputs applicable to the API in the CIIL language. At the start of each type the instrument will be "listen addressed" by the control computer. The end of the transmission will be indicated by <cr,lf>. Each transmission type begins with its own characteristic <verb>. They are as follows:

FNC	Setup the instrument
INX	Initiate the measurement
FTH	Transmit the measurement result to the control computer
CLS	Close the input path
OPN	Open the input path
RST	Reset the instrument
STA	Report status
IST	Initiate built-in-test
CNF	Initiate confidence test

As a general rule, anywhere one <b> (blank) is indicated, the API will accept multiple blanks as if they were one blank.

5-7.3.1 Format of FNC. The FNC string is used to set up the instrument prior to making a measurement. The general format of the FNC string is:

FNC<b><noun><b><mchar><b>:CH<chan num>
<b><setcode><b><ANGL><b><value>
[<b><setcode><b><modifier><b><value>]
...<cr,lf>

where:

<noun> defines the type of signal to be measured:

SYN - selects synchro
RSL - selects resolver

If any other <noun> appears an error message will be generated.

<mchar> defines the characteristic of the signal to be measured. The only <mchar> applicable to the API is:

ANGL - measures angle

If any other <mchar> appears an error message will be generated.

<chan num> specifies the input channel. In the MATE/CIIL mode the API acts as a single channel device. Therefore only channel 0 or 00 may be specified.

<set code> is defined as the ASCII sequences of SRX, SET, or SRN. If the same <modifier> appears more than once with a different <set code>, the API will use the one with the highest priority. The order of priority is:

1. SRX 2. SET 3. SRN

<modifier> Modifiers do not program any features of the API. If present, however, modifiers are checked to verify that they are within the capabilities of the API. The modifiers recognized by the API are:

Modifier	Description
ANGL	angle
ANRT	angle rate
VOLT	voltage
FREQ	frequency

Any other modifiers appearing in the input string will be ignored.

<value> is an ASCII encoded number in floating point, engineering, or integer notation. The value following all <modifier> fields is checked to insure that it is within the limits given as follows:

47	$\leq$	FREQUENCY	< 1201
0	$\leq$	VOLTAGE	< 91
0	$\leq$	ANGLE-RATE	< 1001
0	$\leq$	ANGLE	< 360

5-7.3.2 Format of INX. The INX string instructs the API to make a measurement. The general format of the INX string is:

INX<b><mchar><cr,lf>

Since the API only recognizes the ANGL <mchar> the INX string will always be as follows:

INX<b>ANGL<cr,lf>

If any other <mchar> appears in the INX string an error message will be generated.

5-7.3.3 Format of FTH. The FTH string instructs the API to return the measurement result to the control computer. The general format of the FTH string is:

FTH<b><mchar><cr,lf>

Since the API only recognizes the ANGL <mchar> the FTH string will always be as follows:

FTH<b>ANGL<cr,lf>

If any other <mchar> appears in the FTH string an error message will be generated.

5-7.3.4 Format of CLS. The format of the CLS message can be either of the following:

CLS<b>:CH0<cr,lf> or CLS<b>:CH00<cr,lf>

The CLS command opens the isolation relays.

5-7.3.5 Format of OPN. The format of the OPN string can be either of the following:

OPN<b>:CH0<cr,lf> or OPN<b>:CH00<cr,lf>

The OPN command opens the isolation relays.

NOTE

When the isolation relays are open, the display may continue to show the last message and the interface will transmit this value when requested. This displayed value should not be interpreted as a valid measurement.

5-7.3.6 Format of RST. The RST command causes the API to reset the current measurement. The format of RST is:

RST<b><noun><b><mchar><b>:CH<channum>
<cr,lf>

The <noun> must match the <noun> in the previous FNC message and the <mchar> must be ANGL, otherwise this command will be ignored.

The RST command also causes the unit to reset to its initial conditions and open the isolation relays.

5-7.3.7 Format of STA. The STA command instructs the API to return the status of the instrument. The format of this command is:

STA<cr,lf>

5-7.3.8 Format of IST. The IST command instructs the API to perform an internal self-test. This consists of a brief test of all circuits. A maximum of 48 seconds is required. After the test is completed the result can be obtained using the STA command. No messages are allowed to be sent to the API while the test is in progress or an error message will be generated. The format of the IST is:

IST<cr,lf>

5-7.3.9 Format of CNF. The CNF command instructs the API to perform a confidence test. In the API this test is an abbreviated version of the IST test. A maximum of 15 seconds is required. The format of the CNF is:

CNF<cr,lf>

5-7.4 <u>Outputs.</u>

5-7.4.1 Errors. Error messages are generated for the following basic reasons:

a. Syntax errors
b. Values out of range
c. Failure of CNF or IST
d. Measurement time-outs

Once an error is loaded into the output buffer it will remain there until it is read by the control computer, or an RST or IEEE-488 DCL command is issued. If an error exists when a request for data is made (FTH), the error message will be transmitted in place of the data. Error messages have one of the following forms:

F05APIOO (DEV): <ASCII message><cr,lf>

F07APIOO (MOD): <ASCII message><cr,lf>

F07APIOO (DEV): <ASCII message><cr,lf>

The first form is used if a measurement cannot be completed in the allotted amount of time. The other forms are used to report syntax errors, CNF and IST problems, and <value> range errors. See table 5-6 for a complete list of error messages.

5-7.4.2 Response to INX. After receiving the INX command, the API will load the output buffer with the maximum amount of time in seconds that it will take to make the measurement. For the API this time will always be 5 seconds. The format of this transmission is:

<b>5<cr,lf>

5-7.4.3 Response to FTH. After receiving the FTH command and after completion of the measurement, the API will load the measurement result into the output buffer. The format of this transmission is:

<b><value><cr,lf>

The field <value> will contain the synchro or resolver angle in degrees. A typical transmission would be:

<b>315.000<cr,lf>

5-7.4.4 Response to STA. The response to STA will be either:

<b><cr,lf> or an error message

STA is typically used after a CNF or IST to determine whether or not the test was successful. The <b><cr,lf> message indicates no errors were found.

Table 5-5. CIIL Codes

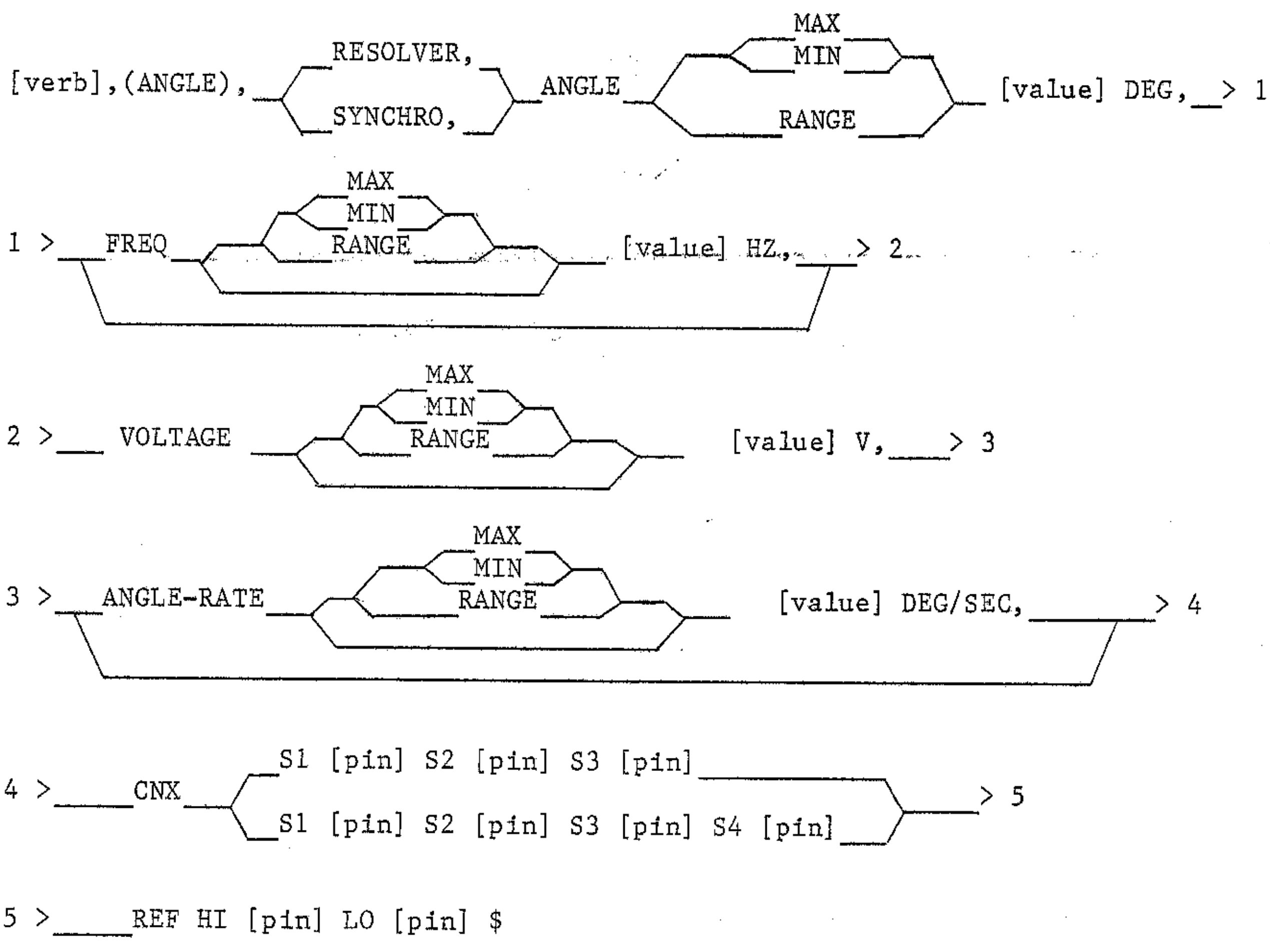
CIIL	Description
<verbs>:	
FNC	function
OPN	open
CLS	close
STA	status
RST	reset
CNF	confidence test
IST	BIT test
INX	initiate
FTH	fetch
<setcodes>:	
SET	set
SRX	set maximum
SRN	set minimum
<nouns>:	
SYN	synchro
RSL	resolver
<mchars>:	
ANGL	angle
<modifiers>:	
ANGL	angle
ANRT	angle rate
VOLT	voltage
FREQ	frequency

Table 5-6. Error Messages

F07API00 (MOD): ILLEGAL NOUN
F07API00 (MOD): ILLEGAL <MCHAR>
F07API00 (MOD): ILLEGAL CHANNEL NUMBER
F07API00 (MOD): SYNTAX ERROR
F07API00 (MOD): SET PROG ERROR
F07API00 (MOD): BAD MODIFIER
F07API00 (MOD): RATE SETUP ERROR
F07API00 (MOD): ANGLE SETUP ERROR
F07API00 (MOD): BAD INX STRING
F07API00 (MOD): BAD FTH STRING
F07API00 (MOD): ILLEGAL VERB
F07API00 (MOD): STATUS STRING ERROR
F07API00 (MOD): VOLTAGE SETUP ERROR
F07API00 (MOD): FREQUENCY SETUP ERROR
F07API00 (MOD): VOLTAGE RANGE ERROR
F07API00 (MOD): FREQUENCY RANGE ERROR
F07API00 (MOD): ANGLE RANGE ERROR
F07API00 (MOD): ANGLE-RATE RANGE ERROR
F05API00 (MOD): TIMEOUT ERROR
F07API00 (MOD): MEASUREMENT NOT INITIATED
F07API00 (MOD): API NOT SETUP
F07API00 (MOD): <CNF> STRING SYNTAX ERROR
F07API00 (MOD): COMMUNICATIONS DURING INTERNAL TESTING
F07API00 (MOD): INTERNAL CONFIDENCE TEST FAILURE
F07API00 (MOD): <IST> STRING SYNTAX ERROR
F07API00 (MOD): API NOT IN REMOTE MODE

5-8 ATLAS CONSTRUCTIONS

The following are typical ATLAS program syntax constructions for programming the Model 8810 API with the IEEE-488 interface.



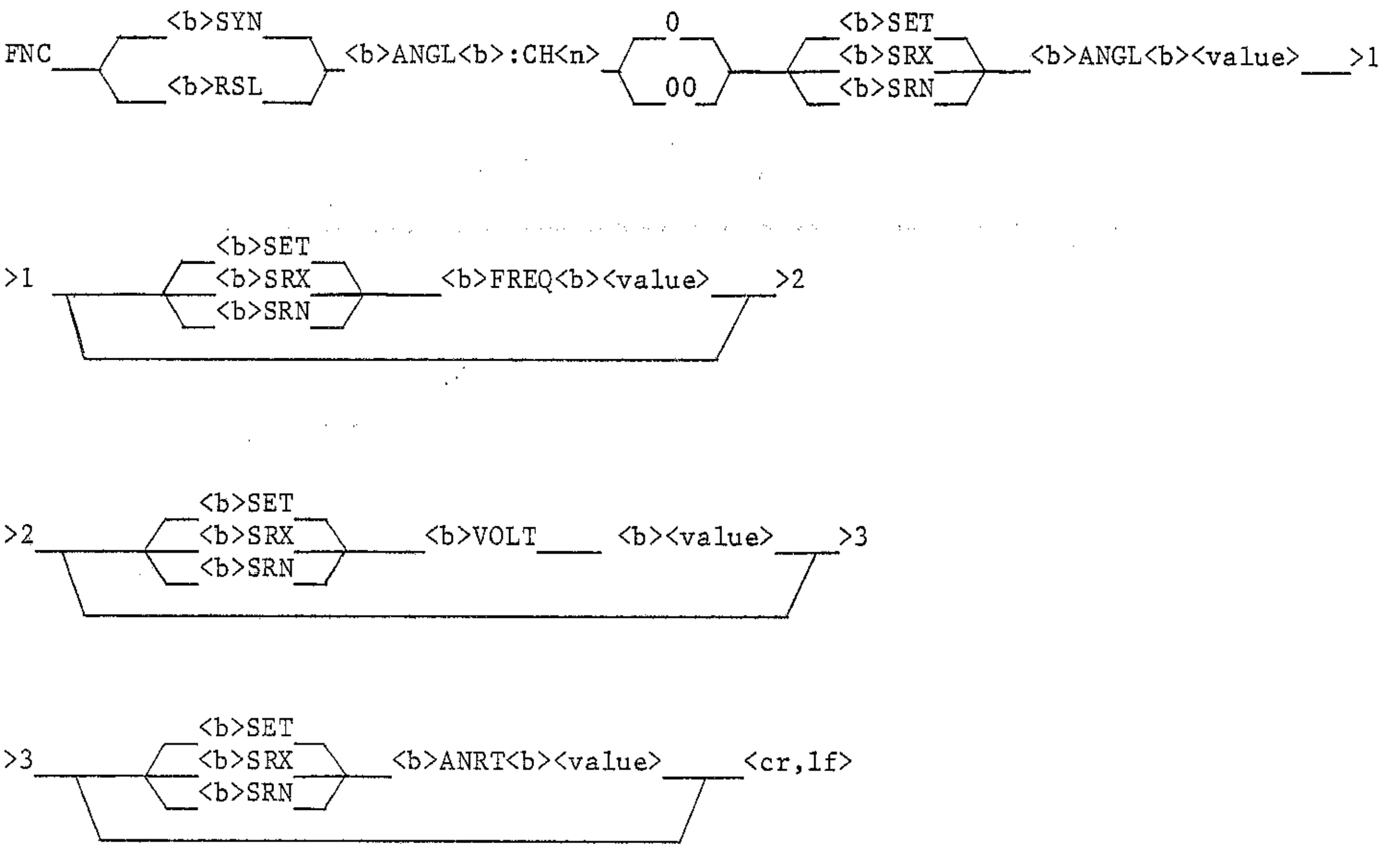
NOTES:

1. The following is the allowable range of [value]:

47	$\leq$	FREQ	<	1201
0	$\leq$	VOLTAGE	<	91
0	$\leq$	ANGLE-RATE	<	1001
0	$\leq$	ANGLE	<	360

5-9 RAILROAD DIAGRAMS

The following are typical Railroad diagrams for programming the Model 8810 API.



SECTION 6

MAINTENANCE

6-1 GENERAL

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.

CAUTION

The API contains the following MOS integrated circuits. Handle these ICs with extreme care. Never remove an IC with the power on. Use only properly grounded test equipment.

U3 - LSI	*U201 - 74C192
U16,21,26,30 - 4011	*U202 - 74C902
U27 - 4027	*U203 - 14561
U28 - 4030/14070	**Z1 - 74C00
U29 - 4069	**Z2,5,8,11,14 - MC14519
U31 - 74C192/34192	**Z3,6,9,12,15 - MC14560
U32 - 14561	**Z4,7,10,13,16 - MC14561
U33,34,35 - 74C902 (8810 only)	

6-2 CLEANING

No special cleaning procedures or fluids are required. Apply good housekeeping rules to maintain 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 gas discharge type located on the front panel. The synchro or resolver input data frequency range is determined by the options selected (paragraph 1-5).

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 specification column lists the parameters required for alignment and are not for the purpose of alternate equipment selection. Satisfactory performance of alternates should be verified before use.

*0.001° resolution units only

**±180° digital board

Table 6-1. Test Equipment Required

Item	Minimum use/critical specifications	Manufacturer and model
Synchro/resolver simulator	Frequency: 400 Hz Range: 00.0000° to 359.9999° Accuracy: 2 arc seconds Modes: Synchro or resolver. Synchro conventions meet MIL-S-20708A. Resolver conventions meet MIL-R-21530 (paragraph 3-2).	North Atlantic Industries, Model 530-S741 Synchro Resolver Simulator
Mating connector	Connector wired for the functions to be tested.	North Atlantic Industries mating connector kit 783718 Qty / AMP P/N 1 shell 205211-1 1 clamp 205732-1 2 retainer 205980-1 50 pins 66569-3
Ac power source	Frequency: 400 Hz Range: 0 V 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: 400 Hz Sensitivity: 300 V to 0.003 V Mode: In-phase Voltage accuracy: ±2% full scale Phase accuracy: ±1%	North Atlantic Industries, Model 213C or 2250 DAV
Oscilloscope	Horizontal sweep time: 1 us Vertical sensitivity: 1 V/cm Rise time: 24 ns Input R and C: 1 megohm paralleled by ±2% approximately 33 pf	Tektronix, Model 422
DVM	Range: 199.9 mV Z in: 100 megohm Accuracy: ±0.05% Resolution: 3-1/2 digits	Weston, Model 4449

6-3.2 Performance Test Setup.

a. Wire up the test connector and connect the equipment as shown in figure 6-1.

b. Set the synchro/resolver simulator MODE switch to OFF to avoid damage to the equipment and to prevent dangerous voltages from existing at the output terminals when Power switches are turned on.

c. Turn all Power switches (with the exception of the API) on and allow the test equipment to stabilize.

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.

6-3.3 Resolver Accuracy Test.

a. On API, depress RES push button. The 11.8 V LED lights.

b. Advance the synchro/resolver simulator in 10° steps (00.000° through 350.000°). API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

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 ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

6-3.4 Synchro Accuracy Test.

a. Depress SYN push button on the API.

b. Set the synchro/resolver simulator for 26 V L-L output. The 26 V LED on the API lights.

c. Set the synchro/resolver simulator for 90 V L-L synchro output. The 90 V LED in the API lights.

d. Advance the synchro/resolver simulator in 10° steps (00.000° through 350.000°). API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

e. 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 ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

6-4 ALIGNMENT PROCEDURE

This procedure describes the alignment sequence and test equipment required to align the API. The unit is aligned by adjusting eight potentiometers for proper dc offsets at various test points. Periodic alignment is unnecessary and should not be attempted unless the performance test reveals a misaligned condition.

6-4.1 Alignment Procedure Setup.

a. Set Mode switch on synchro/resolver simulator to OFF to avoid damage to the equipment and to prevent dangerous voltages from existing at the output terminals when power switches are turned on.

b. Turn all Power switches (with the exception of the API) on and allow time for the auxiliary equipment to stabilize.

c. Wire up the test connector and connect the equipment as shown in figure 6-1.

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

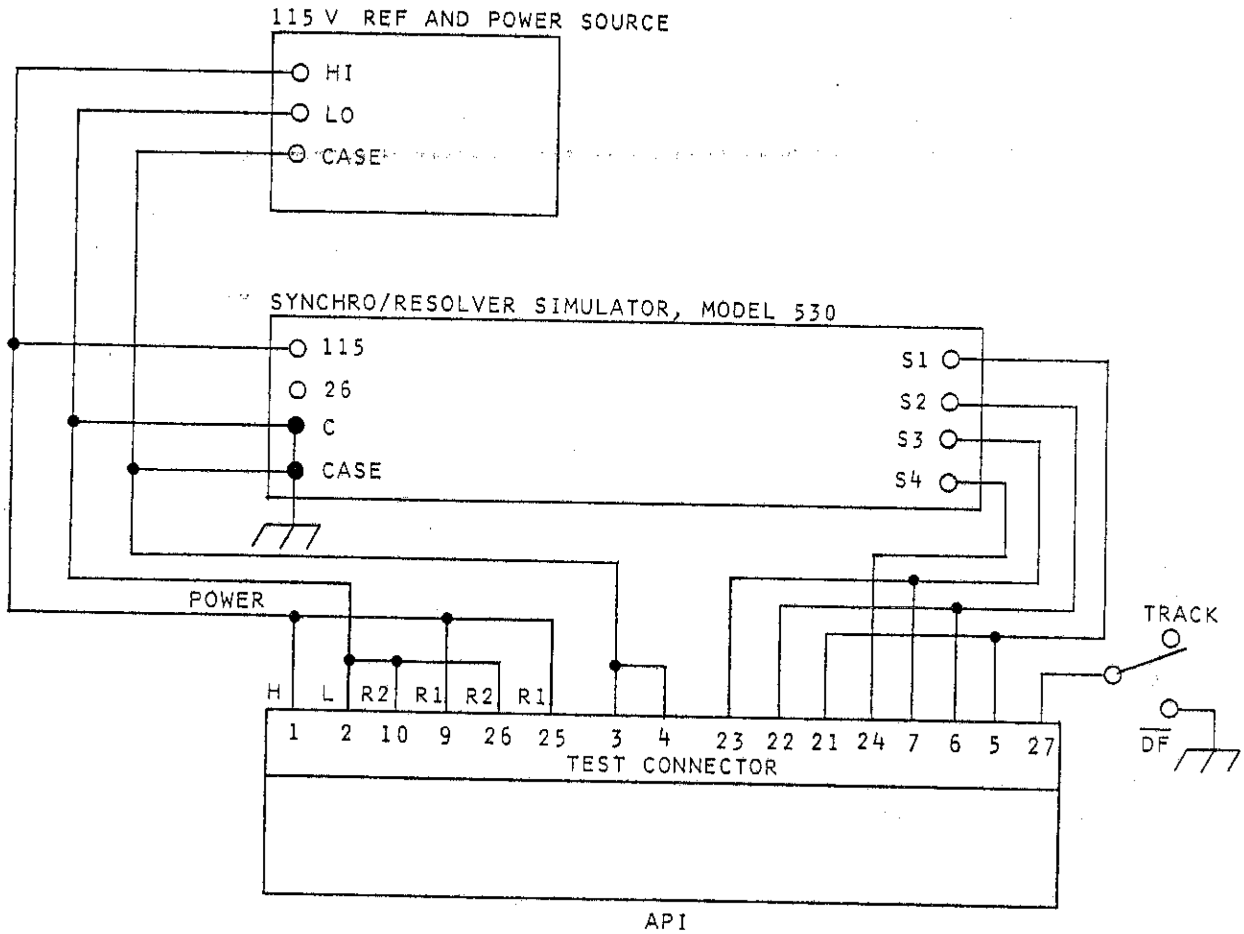


Figure 6-1. Test Setup

6-4.2 Procedure.

a. Depress SYN push button on the API. Adjust the synchro/resolver simulator for 0.000° angle position indicator display and set the toggle switch to DF. Adjust the synchro/resolver simulator for 0.0000°.

b. Connect the low side of the DVM to TP1 (ground) on the mother board and connect the high side to TP4. The voltage at TP4 should be between +0.5 mV dc and +3 mV dc.

c. Connect the high side of the DVM to TP2. Adjust R19 until the voltage at TP2 is the same as that measured at TP4 ±100 uV.

d. Connect the high side of the DVM to TP3. Adjust R26 until the voltage at TP3 is the same as that measured at TP4 ±100 uV.

e. Connect the high side of the DVM to TP5 and adjust R29 for 0 mV ±100 uV. This is a preliminary adjustment.

f. Connect the high side of the DVM to TP7 and adjust R55 for 0 V ±200 mV.

g. With the DVM at TP7, set the simulator to 10.000°. Manipulate the simulator so that the API display indicates 10.000°. Freeze the API. Set the simulator again to 10.000°. Note dc offset at TP7.

h. Remove data freeze. Manipulate the simulator so that the API display indicates 9.999° (9.995° for units with 0.005° resolution). Freeze the API and set the simulator to 9.999° (9.995° for units with 0.005° resolution). Read the dc offset at TP7. Readjust R29 until the offset is the same as that obtained in step g above. Repeat steps g and h to assure no change in dc offset.

i. Connect the low side of the scope to TP1 (GND) and the high side to TP10 (use an X10 probe).

j. Set the vertical sensitivity to 2V/division (pulse to be measured in 5 V pp) and the time base to 0.1 ms/division. Adjust the scope time base and triggering so that the scope triggers on each successive pulse.

k. Adjust R65 so that pulses are of equal width (double edges on scope overlap and appear as a single edge).

l. Connect the DVM to TP12 and adjust R103 for 0 mV ±500 uV. This is a preliminary adjustment. Final adjustment will be made later.

m. Connect the PAV to TP7. Adjust the simulator for an in-phase null at TP7 (angle on synchro/resolver simulator should be 0.000° ±.002°).

n. Connect the DVM to TP14 and adjust R116 for 0V ±200 mV.

o. Switch the Auto-phase switch on the main board from INT to EXT and note offset change at TP14. If there is, readjust R103 until there is no dc change at TP14 when the unit is switched from INT to EXT.

p. Readjust R116 for 0 V ±200 mV at TP14.

q. Connect the PAV to TP7. With data freeze removed, set the simulator to 20.000°. Freeze the API. Adjust the simulator for an in-phase null at TP7. Record the simulator setting (20.000° ±0.002°).

r. Remove data freeze. Manipulate the simulator so that the API display indicates 19.999° (19.9995° for units with 0.005° resolution). Freeze the API. Adjust the simulator for an in-phase null. Record the simulator setting.

s. Subtract the simulator setting of step r, above, from that of step q. The difference should be 0.001° (0.005° for units with 0.005° resolution). Adjust R63, if necessary, to obtain this difference.

t. Repeat steps q through s until desired result is obtained.

u. Advance the simulator through 360° in 10° steps, observing the API display. Ascertain that the largest angle errors are distributed as positive and negative errors. If maximum angle errors tend to be of the same sign (all positive or all negative), readjust R116 to minimize these errors.

SECTION 7

PARTS LIST

7-1 INTRODUCTION

This section contains replaceable parts lists, federal supply codes of manufacturers (FSCM), parts location diagrams, and a list of manufacturers of parts used for the Model 8810 Angle Position Indicator (API).

7-2 PARTS LIST

The parts list contains only replaceable parts for the Model 8810. It is prepared in tabular form and is divided into six columns as follows:

7-2.1 Column 1 - Ref Des. Lists alpha numerical reference designations for replaceable parts shown on schematic and parts location diagrams.

7-2.2 Column 2 - Description. Contains descriptions which identify replaceable parts.

7-2.3 Column 3 - NAI P/N. Lists North Atlantic Industries part numbers assigned to replaceable parts.

7-2.4 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 Manufacturers table within this manual.

7-2.5 Column 5 - MFR P/N. Lists manufacturer's part numbers of replaceable parts or data to aid in determining parts substitution.

7-2.6 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.

7-3 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 manufacturer's 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.

7-4 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 illustration provides corresponding location index numbers and each parts location diagram provides reference designations for circuit card components.

Table 7-1. Model 8810-FXX - Common Parts

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
A1	Relay Adapter Assembly	787337	07342	787337
C1–C4	Not used			
C5	Capacitor, Ceramic, 15 pf, 200 V, ±10%	807629	81349	CK05BX150K
C6	Not used			
C7	Capacitor, Ceramic, 0.1 µf, 100 V, ±10%	882188	81349	CKR06BX104KP
C8,C9	Same as C7			
C10	Capacitor, El, Tantalum, 10 µf, 20 V, ±20%	880073	06751	TS2K-20-106
C11	Same as C5			
C12	Same as C10			
C13,C14	Same as C7			
C15	Capacitor, Ceramic, 1 µf, 50 V, ±10%	882876	81349	CKR06BX105KP
C16	Same as C15			
C17	Same as C7			
C18–C20	Not used			
C21	Same as C7			
C22,C23	Not used			
C24	Same as C7			
C25	Capacitor, Ceramic, 27 pf, 200 W VDC, ±10%	808401	72982	CK05BX270K
C26	Same as C25			
C27	Same as C7			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
C28	Capacitor, Ceramic, 100 pf, 200 V, ±10%	805210	81349	CK05BX101K
C29	Same as C28			
C30	Same as C7			
C31	Same as C5			
C32-C34	Same as C7			
C35	Capacitor, El, Al, 1500 µf, 35 V, Radial Leads	887265	74840	158CKR035MPX
C36	Capacitor, El, Tantalum, 0.22 µf, 35 V, ±20%	801297	56289	150D224X0035A2
C37	Same as C7			
C38	Same as C35			
C39	Capacitor, El, Tantalum, 2.2 µf, 35 V, ±10%	802914	56289	150D225X9035B2
C40	Capacitor, El, Tantalum, 1 µf, 35 V, ±20%	801343	56289	150D105X0035A2
C41	Capacitor, El, Al, 1000 µf, 16 V, ±10%	807686	56289	502D108G016EK5C
C42	Same as C36			
C43	Same as C7			
C44	Capacitor, El, Al, 10 µf, 250 V, +75-10%	885188	74840	106RAR-250APX
C45	Same as C5			
C46-C51	Same as C7			
C52	Not used			
C53	Capacitor, Ceramic, 0.0047 µf, 200 V, ±10%	805153	81349	CK06BX472K
C54	Same as C53			
C55	Same as C7			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
CR1-CR4	Not used			
CR5	Diode, Signal	808974	07263	1N414B
CR7-CR10	Same as CR5			
CR12-CR16	Same as CR5			
CR17	Diode, Signal, 1N6263	883449	09182	5002-HSCH-1001
CR18	Same as CR17			
CR19-CR21	Same as CR5			
CR22	Same as CR17			
CR23,CR24	Not used			
CR25-CR31	Same as CR5			
CR32-CR34	Diode, Power/Rectifier	803735	07395	1N4004
CR35	Diode, Zener	808157	04713	1N5280B
CR36	Same as CR5			
E1	Post Binding, Red	800119	81073	29-1R
E2	Post Binding, Black	800120	81073	29-1B
F1	Fuse, 0.5A, 250 V, Type 3AG	880795	75915	312.500
F1	Fuse, 0.25A, 250 V, Type 3AG	802530	75915	312.250
J1	Connector, Rack and Panel	808198	00779	206971-1
J2	Connector, Misc., PL/RCPT, 16 Pin	885521	00779	643116-1
J3	Connector, Misc., PL/RCPT, 14 Pin	885522	00779	643114-1
J4	Socket, 16 Pin	808197	00779	2-640358-3

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
Q1	Transistor, FET, N-Channel	804583	01295	TIS73
Q2–Q6	Same as Q1			
Q7	Transistor, Signal, NPN	807607	04713	2N4123
Q8	Same as Q1			
Q9,Q10	Same as Q7			
Q11	Transistor, Signal, NPN, Low Power	807690	04713	MPSA-43
Q12–Q22	Not used			
Q23,Q24	Same as Q7			
R1	Resistor, Composition, 100 k, 1/4 W, ±5%	880846	01121	CB1045
R2	Same as R1			
R3	Resistor, Composition, 24 k, 1/4 W, ±5%	801393		
R4	Same as R3			
R5,R6	Same as R1			
R7	Resistor, Composition, 47 k, 1/4 W, ±5%	801638	01121	CB4735
R8	Same as R1			
R9	Resistor, Composition, 510 k, 1/4 W, ±5%	880099	01121	CB5145
R10–R14	Same as R9			
R15-R17	Resistor, Wirewound, Matched Set includes:	808160	07342	808160
	R16 = 2000 ±0.1% ohms (Set Reference Resistor	808160–1		
	R15 = 65.823047 x Reference Resistor (R16) ±0.05%	808160–3		
	R17 = 5.758771 x Reference Resistor (R16) ±0.005%	808160–2		

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R18	Resistor, Composition, 180 k, 1/4 W, ±5%	882398	81349	RCR07G184JP
R19	Resistor, Variable, 100 k, ±20%	807625	02111	62-1-1-104
R20	Resistor, Composition, 160 ohm, 1/4 W, ±5%	804212	01121	CB1615
R21-R23	Resistor, Wirewound, Matched Set includes:	808161	07342	808161
	R22 = 2000 ±0.1% ohms (Set Reference Resistor)	808161-1		
	R21 = 22.165512 x Reference Resistor (R22) ±0.02%	808161-3		
	R23 = 5.939231 x Reference Resistor (R22) ±0.005%	808161-2		
R24	Same as R18			
R25	Same as R20			
R26	Same as R19			
R27	Resistor, Metal Film, 158 k, 1/10 W, ±0.5%	808359	01121	CC1583D
R28	Resistor, Metal Film, 750 ohm, 1/10 W, ±0.5%	808360	01121	CC750RD
R29	Resistor, Variable, 20 k, 1/2 W, ±10%	808229	94271	548-00H8
R30	Resistor, Metal Film, 20 k, 1/10 W, ±0.5%	808226	16299	MC55
R31	Resistor, Composition, 10 k, 1/4 W, ±5%	880092	01121	CB1035
R32	Same as R30			
R33	Resistor, Metal Film, 2.1 Meg, 1/10 W, ±1%	808107	91637	MF1/10,2.1M,1%

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R34	Resistor, Metal Film, 698 k, 1/10 W, ±0.5%	808108	16299	NC4
R35-R42, R50-R58	Resistor, Wirewound, Matched Set includes:	808162	07342	808162
	R50 = 2000 ±0.1% ohms (Set Reference Resistor)	808162-1		
	R35 = 1.25 x Reference Resistor (R50) ±0.010%	808162-3		
	R36 = 2.5 x Reference Resistor (R50) ±0.025%	808162-4		
	R37 = 5.0 x Reference Resistor (R50) ±0.05%	808162-5		
	R38 = 10.0 x Reference Resistor (R50) ±0.025%	808162-6		
	R39 = 12.5 x Reference Resistor (R50) ±0.063%	808162-7		
	R40 = 25.0 x Reference Resistor (R50) ±0.125%	808162-8		
	R41 = 50.0 x Reference Resistor (R50) ±0.3%	808162-9		
	R42 = 100 x Reference Resistor (R50) ±0.63%	808162-10		
	R58 = 2000 x Reference Resistor (R50) ±0.005%	808162-2		
R43	Resistor, Metal Film, 250 k, 1/8 W, ±0.5%	806106	81349	RN60C2503D
R44	Resistor, Metal Film, 449 k, 1/4 W, ±1%	806929	16299	NC5499K±1%
R45	Resistor, Metal Film, 1 Meg, 1/8 W, ±1%	807692	91637	DC-1/8-1M 1%
R46	Resistor, Metal Film, 2 Meg, 1/8 W, ±1%	807691	91637	DC-1/8-2M 1%
R47,R48	Not used			
R49	Resistor, Metal Film, 976 k, 1/10 W, ±5%	808097	91637	MF-1/10-976K 1%
R50	See listing R35-R42,R50,R58 above			
R51	Resistor, Metal Film, 1.05 Meg, 1/10 W, ±1%	808144	91637	CMF-1/10,T-0

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R52	Resistor, Metal Film, 26.7 k, 1/10 W, ±1%	807634	91637	MF-1/10-26.7K1%
R53	Same as R9			
R54	Resistor, Composition, 430 ohm, 1/4 W, ±5%	801399	01121	CB4315
R55	Resistor, Variable, 100 k, 13 turn	808690	80294	3279 W-1-104
R56	Resistor, Composition, 270 ohm, 1/4 W, ±5%	880079	01121	CB2715
R57	Resistor, Composition, 470 ohm, 1/4 W, ±5%	880567	01121	CB4715
R58	See listing R35–R42,R50,R58 above			
R59	Resistor, Metal Film, 4.02 k, 1/10 W, ±1%	808316	16299	NC55
R60	Resistor, Metal Film, 59.0 k, 1/10 W, ±1%	808184	01121	CC5902F
R61	Same as R60			
R62	Same as R59			
R63	Resistor, Potentiometer, 250 k, ±10%	887867	80294	3262 W-1-204
R64	Not used			
R65	Resistor, Variable, Miniature, 100 k, ±10%	807062	32997	3299 W104
R66	Resistor, Composition, 3.9 Meg, 1/4 W, ±5%	807480	01121	CB3955
R67	Resistor, Metal Film, 30.1 k, 1/8 W, ±1%	880646	16299	NC4
R68	Same as R67			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R70	Resistor, Metal Film, 24.9 k, 1/10 W, ±1%	808096	91637	MF-1/10-24.9K1%
R71	Same as R70			
R72	Resistor, Metal Film, 40.2 k, 1/10 W, ±1%	884538	81349	RN55C4022F
R73	Resistor, Metal Film, 27.4 k, 1/10 W, ±1%	808098	91637	MF-1/10-27.4K1%
R74	Resistor, Metal Film, 100 k, 1/10 W, ±1%	806992	81349	RN55D1003F
R75	Resistor, Composition, 6.8 k, 1/4 W, ±5%	880090	01121	CB6825
R76	Same as R3			
R77	Resistor, Metal Film, 49.4 k, 1/10 W, ±1%	807635	91637	MF-1/10-49.9K1%
R78	Same as R31			
R79	Resistor, Metal Film, 3.32 k, 1/10 W, ±1%	807631	91637	MF-1/10-3.3K 1%
R80	Same as R31			
R81	Same as R79			
R82	Same as R31			
R83	Resistor, Composition, 10 Meg, 1/4 W, ±5%	803389	01121	CB1065
R84	Same as R83			
R85	Same as R31			
R86	Resistor, Composition, 5.1 k, 1/4 W, ±5%	880089	01121	CB5125
R87	Not used			
R88	Same as R31			
R89	Same as R7			
R90	Same as R77			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R91	Resistor, Metal Film, 221 k, 1/10 W, ±1%	808099	91637	MF-1/10-221K 1%
R92	Resistor, Metal Film, 267 k, 1/10 W, ±1%	807641	91637	MF-1/10-267K 1%
R93	Resistor, Metal Film, 4.99 k, 1/10 W, ±1%	808182	01121	CC4991F
R94	Resistor, Metal Film 16.2 k, 1/8 W, ±1%	806559	16299	MC4
R95	Same as R7			
R96	Same as R75			
R97	Resistor, Metal Film, 634 k, 1/10 W, ±1%	808146	91637	MF-1/10-634 1%
R98	Same as R74			
R99	Same as R1			
R100	Resistor, Metal Film, 20 k, 1/10 W, ±1%	807409	81349	RN55D2002F
R101	Same as R100			
R102	Same as R31			
R103	Resistor, Variable, 20 k, 1/4" dia.	808110	02111	62-1-1-203
R104	Resistor, Metal Film, 10 k, 1/8 W, ±1%	806103	16299	MC55-100K 1%
R105	Same as R31			
R106	Resistor, Metal Film, 78.7 k, 1/10 W, ±1%	807288	81349	RN-55-D7872F
R107	Same as R77			
R108	Same as R45			
R109	Same as R77			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R110	Same as R75			
R111	Same as R31			
R112	Resistor, Metal Film, 90.9 k, 1/10 W, ±1%	808185	91637	CMF-55T-1
R113	Not used			
R114	Same as R99			
R115	Resistor, Metal Film, 100 ohm, 1/10 W, ±1%	808143	91637	MF-1/10-100 1%
R116	Same as R29			
R117	Same as R31			
R118	Same as R74			
R119	Not used			
R120	Same as R1			
R121	Same as R3			
R122	Same as R75			
R123	Same as R3			
R124	Resistor, Composition, 130 k, 1/4 W, ±5%	801394	01121	CB1345
R125	Same as R3			
R126	Same as R52			
R127	Same as R100			
R128	Resistor, Metal Film, 13.3 k, 1/10 W, ±1%	807633	91637	MF-1/10-13.3K 1%
R129,R130	Same as R79			
R131	Same as R77			
R132	Same as R128			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
R133,R134	Same as R79			
R135	Same as R77			
R136	Same as R75			
R137	Resistor, Composition, 13 k, 1/4 W, ±5%	880094	01121	CB1335
R138	Same as R75			
R139,R140	Same as R137			
R141,R142	Same as R1			
R143	Resistor, Composition, 18 k, 1/4 W, ±5%	802183	01121	CB1325
R144	Same as R143			
R145	Resistor, Composition, 91 k, 1/4 W, ±5%	803240	01121	CB9135
R146	Same as R3			
R147	Same as R143			
R148-R150	Same as R31			
R151	Same as R1			
R152	Same as R31			
R153	Resistor, Composition, 330 ohm, 1/4 W, ±5%	880080	01121	CB3315
R154	Same as R75			
R155,R156	Same as R1			
R157–R161	Not used			
R162,R163	Same as R104			
R164–R201	Not used			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
S1	Switch, Push button, 4 Station, DPDT	808934	07342	808934
S2-S4	Same as S1			
S5	Switch, Slide, DPDT	808112	79727	GF126,Terminal G-20-39
S6	Same as S5			
S7-S301	Not used			
S302	Switch, Pushbutton, SPST	808178	09353	8531MNZB
T1	Not used			
T2	Transformer, Power	807659	71938	807659
T3	Transformer, 5V-115V, 47-440Hz	808148	07342	550493
U1	IC, Quad Comparator	807626	01295	LM339N
U2	Same as U1			
U3	IC, LSI, Data Converter	888068	07342	888068
U4	IC/L, Op Amp, NML	807797	12040	LF356H
U5	Same as U4			
U6	IC, Quad Op Amp, High Performance	808404	06665	OP09FY
U7	Same as U4			
U8	IC, Quad Analog Switch	808089	12040	LF13202N
U9	IC/L, Quad Op Amp	807530	07933	RC4136DB
U10	Same as U9			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
U11,U12	Same as U8			
U13	IC/L, Op Amp, NML	808145	12040	LF357H
U14	Same as U9			
U15	Same as U1			
U16	IC, CMOS, Quad, 2-Input NAND Gate	808092	04713	MC14011BCP
U17	Same as U13			
U18,U19	Same as U4			
U20	IC, TTL, Hex Inverter	808188	01295	SN74L04N
U21	Same as U16			
U22	Same as U8			
U23,U24	Same as U4			
U25	Same as U1			
U26	Same as U16			
U28	IC, CMOS, Quad Exclusive OR Gate	808091	04713	MC14070BP
U29	IC, CMOS, Hex Inverter	808090	04713	MC140690BCP
U30	Same as U16			
U31	IC, TTL, 4 Bit BCD Counter	807700	12040	74C192
U32	IC, CMOS, Low Power Complementer	807702	04713	MC14561BCP
U33-U36	IC/D, TTL (SSI), Octal Non-Inverter Buffer	808357	12040	DMBIL595N
U37-U38	Diode, Bridge Rectifier	807704	31757	VM08
U39	Diode, Bridge Rectifier	807705	31757	VM48

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
U40	Voltage Regulator, +15 V, 1 Amp	808388	12040	LM340T-157815UC
U41	Voltage Regulator, -15 V, 1 Amp	808390	12040	LM7915TC
U42	Voltage Regulator, +5 V, 1 Amp	808389	12040	LM7805TC
U43	IC, Dual Op-Amp	885063	12040	LF-353H
VP1	Varistor, 130 V	807699	03508	V130LA10A
VP2	Same as VP1			
XF1	Fuse, Holder/Caps, 3AG	800137	75915	342004L
XF2	Same as XF1			
XU1	Socket, IC, 14 Pin	880166	00779	2-640357-3
XU2	Same as XU1			
XU3	Socket Strip, 25 Pin, 1-inch center	808363	06776	SB-25-T
XU4–XU7	Not used			
XU8	Socket, 16 Pin	808197	00779	2-640358-3
XU9,XU10	Same as XU1			
XU11,XU12	Same as XU8			
XU13	Not used			
XU14–XU16	Same as XU1			
XU17–XU19	Not used			
XU20,XU21	Same as XU1			
XU22	Same as XU8			
XU23,XU24	Not used			

Table 7-1. Model 8810-FXX - Common Parts (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
XU25–XU30	Same as XU1			
XU31	Same as XU8			
XU32	Same as XU1			
XU33–XU36	Socket, IC, 20 Pin	808408	00779	2–640464–3
XU37–XU200	Not used			
XU201	Same as XU8			
XU202	Not used			
XU203	Same as XU1			
XU204	Same as XU8			
W1	Line Cord, P.S. 3 Contact, detachable, unshielded	870165	70903	17251

Table 7-2. Model 8810 - F1X Feature 1, Option 1 - .001 Resolution, 360°, 360-1200 Hz - Unique Parts

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A2	Display Circuit Card Assy	783739	07342	783739
A3	Not used			
C18	Capacitor, Ceramic, 0.1 µf, 100 V, ±10%	880640	96095	SR301C104KAA
C19	Capacitor, Ceramic, 0.33 µf, 50 V, ±10%	882457	81349	CKR06BX334KP
C20	Capacitor, Ceramic, 0.068 µf, 100 V, ±10%	805468	81349	CK06BX683K
C22	Capacitor, Ceramic, 0.056 µf, 100 V, ±10%	805454	81349	CK06BX563K
C23	Capacitor, Ceramic, 100pf, 200 V, ±10%	805210	81349	CK05BX101K
C201	Same as C18			
R48	Resistor, Composition, 20 Meg, 1/4 W, ±5%	804362	01121	CB 2065
R113	Resistor, Metal Film, 133 k, 1/10 W, ±1%	807639	91637	MF 1/10 133K1%
R119	Resistor, Metal Film, 100 k, 1/10 W, ±1%	806992	81349	RN55D1003F
R201	Same as R48			
R202	Resistor, Composition, 10 Meg, 1/4 W, ±5%	803389	01121	CB1065
R203	Resistor, Metal Film, 4.99 Meg, 1/10 W, ±1%	808254	91637	CMF-1/10T1
R204	Resistor, Metal Film, 2.49 Meg, 1/10 W, ±1%	808255	91637	CMF552,49M,1%,T1
T1	Transformer Assembly, Scott-T	783741	07342	783741
U201	IC, TTL, 4 BIT BCD Counter	807700	12040	74C192
U203	IC, CMOS, Low Power Complementer	807702	04713	MC145618CP
U204	IC, Quad Analog Switch	808089	12040	LF13202N

Table 7-3. Model 8810 - F2X Feature 1, Option 2 - .001 Resolution, 360°, 47-440 Hz - Unique Parts

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A2	Display Circuit Card Assy	783739	07342	783739
A3	Not Used			
C18	Capacitor, Ceramic, 0.39 µf, 50 V, ±10%	808193	56289	5CX7R394 X9100C5
C19	Same as C18			
C20	Capacitor, Ceramic, 0.082 µf, 100 V, ±10%	808405	81349	CK06BX823K
C22	Capacitor, Ceramic, 0.82 µf, 50 V, ±10%	805076	81349	CK06BX824KL
C23	Capacitor, Ceramic, 390pf, 200 V, ±10%	805284	81349	CK05BX391K
C201	Capacitor, Ceramic, 0.1 µf, 100 V, ±10%	880640	96095	SR301C104KAA
R48	Resistor, Composition, 10 Meg, 1/4 W, ±5%	804362	01121	CB2065
R113	Resistor, Metal Film, 232 k, 1/8 W, ±2%	806937	16299	C4,232K,±2%
R119	Resistor, Metal Film, 100 k, 1/10 W, ±1%	806992	81349	RN55D1003F
R201	Same as R48			
R202	Resistor, Composition, 10 Meg, 1/4 W, ±5%	803389	01121	CB1065
R203	Resistor, Metal Film, 4.99 Meg, 1/10 W, ±1%	808254	91637C MF-1/1 0T1	
R204	Resistor, Metal Film, 2.49 Meg, 1/10 W, ±1%	808255	91637	CMF552,49M,1%,T1
T1	Transformer Assembly, Scott-T	783740-1	07342	783740-1
U201	IC, TTL, 4 BIT BCD Counter	807700	12040	74C192
U202	Not used			
U203	IC, CMOS, Low Power Complementer	807702	04713	MC14561BCP
U204	IC, Quad Analog Switch	808089	12040	LF13202N

Table 7-4. Model 8810 - F3X Feature 1, Option 3 - .005 Resolution, 180°, 360-1200 Hz - Unique Parts

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A2	180 Degree Display, Circuit Card Assembly	783747	07342	783747
A3	Digital Circuit Card Assy, ±180 Degrees	783719	07342	783719
C18	Capacitor, Ceramic, 0.1 µf, 100 V, ±10%	880640	96095	SR301C104KAA
C19	Capacitor, Ceramic, 0.33 µf, 50 V, ±10%	882457	81349	CKR06BX334KP
C20	Capacitor, Ceramic, 0.068 µf, 100 V, ±10%	805468	81349	CK06BX683K
C22	Capacitor, Ceramic, 0.056 µf, 100 V, ±10%	805454	81349	CK06BX563K
C23	Capacitor, Ceramic, 100pf, 200 V, ±10%	805210	81349	CK05BX101K
J1-J4	Not used			
J5	Connector, 22 Pin	808168	00779	87334-9
J6	Same as J5			
R47	Resistor, Metal Film, 4.02 Meg, 1/10 W, ±1%	808095	91637	CMF554.02M-1%-T1
R48	Same as R47			
R113	Resistor, Metal Film, 59.0 k, 1/10 W, ±1%	808184	01121	CC5902F
R119	Resistor, Metal Film, 41.2 k, 1/10 W, ±1%	807695	81349	RN-55C-4122F
T1	Transformer Assembly, Scott-T	783741	07342	783741
U27	IC, CMOS, Dual JK flip-flop	808093	04713	MC14027BP

Table 7-5. Model 8810 - F4X Feature 1, Option 4 - .005 Resolution, 180°, 47-440 Hz - Unique Parts

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A2	180 Degree Display, Circuit Card Assembly	783747	07342	783747
A3	Digital Circuit Card Assy, ±180 Degrees	783719	07342	783719
C18	Capacitor, Ceramic, 0.39 µf, 50 V, ±10%	808193	56289	5CX7R394 X9100C5
C19	Same as C18			
C20	Capacitor, Ceramic, 0.082 µf, 100 V, ±10%	808405	81349	CK06BX823K
C21	Not used			
C22	Same as C18			
C23	Capacitor, Ceramic, 1000 pf, 200 V, ±10%	805788	81349	CK05BX102K
J5	Connector, 22 Pin	808168	00779	87334-9
J6	Same as J5			
R47	Resistor, Metal Film, 4.02 Meg, 1/10 W, ±1%	808095	91637	CMF554.02M-1%-T1
R48	Same as R47			
R113	Resistor, Metal Film, 165 k, 1/10 W, ±1%	808365	01121	CC1653F
R119	Resistor, Metal Film, 41.2 k, 1/10 W, ±1%	807695	81349	RN-55C-4122F
T1	Transformer Assembly, Scott-T	783740-1	07342	783740-1
U27	IC, CMOS, Dual JK flip-flop	808093	04713	MC14027BP

Table 7-6. Model 8810 - FX1 Feature 2, Option 1 - No IEEE Interface Option - Unique Parts

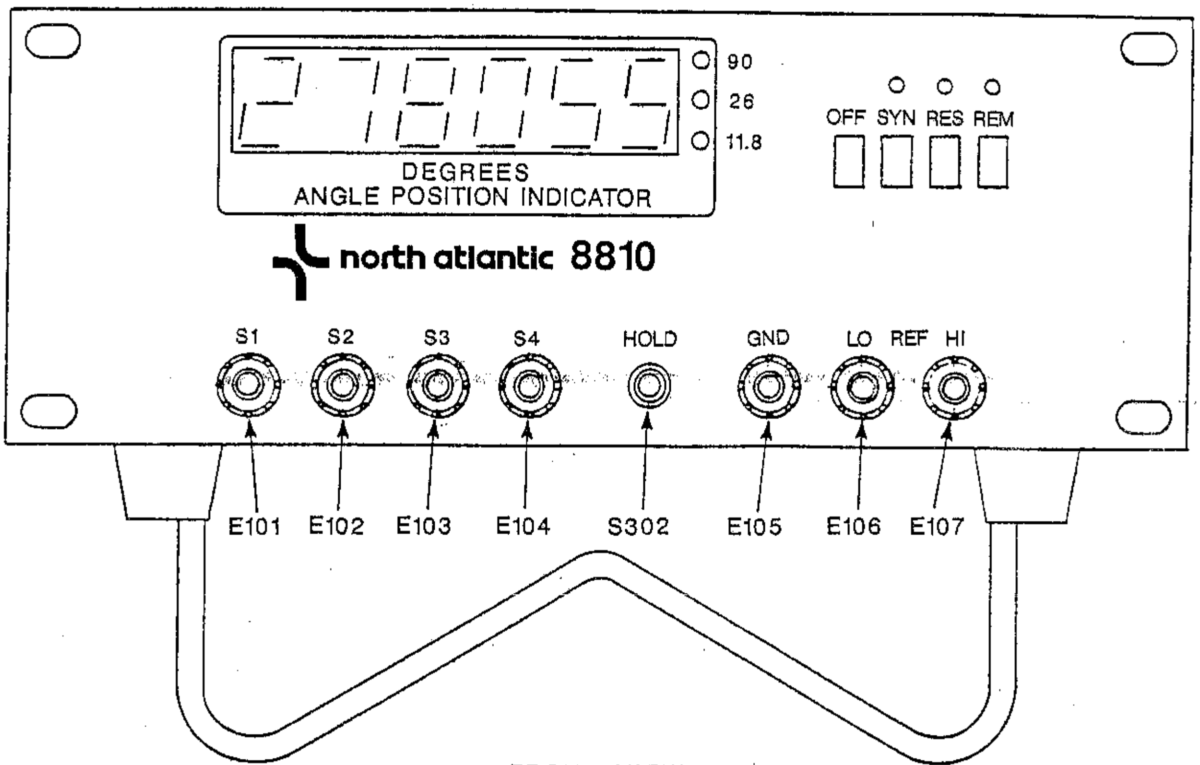
Ref Des	Description	NAI P/N	FSCM	MFR P/N
A4A2	Front Panel Assembly	783755	07342	783755
J7	Connector, Primary Circuit, 3-pin Snap-in Panel Mount	885865	60046	42R02-3212-150
MP1	Tilt Stand	808180	02954	TTS-95
S7	Switch, Slide, DPDT	808112	79727	GF126, Terminal G-20-39
W1	Cable Assembly, Front Panel/API	787482	07342	787482

Table 7-7. Model 8810 - FX2 Feature 2, Option 2 - NATIVE IEEE Interface Option - Unique Parts

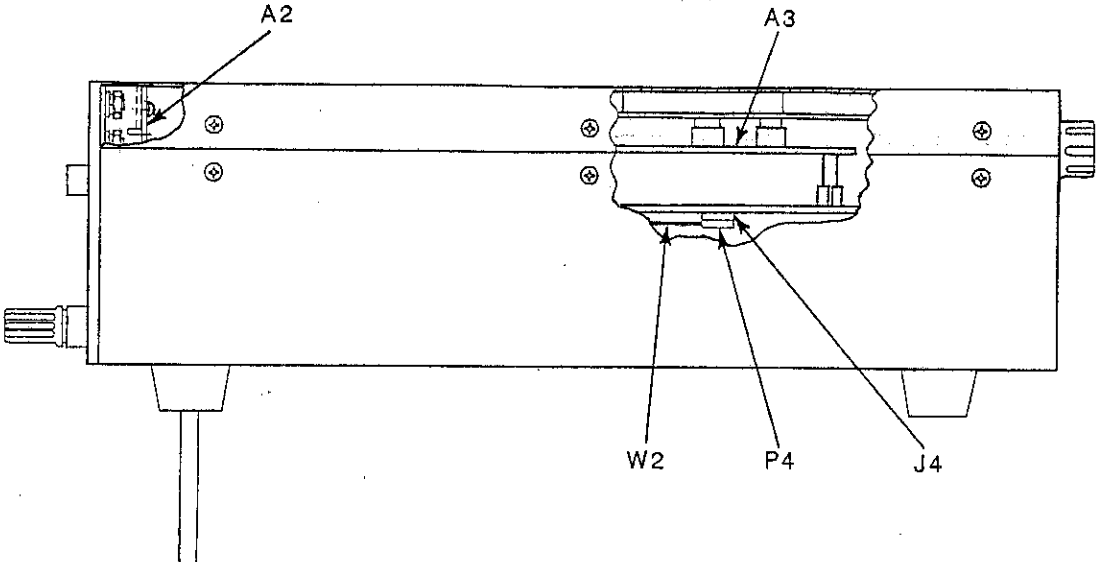
Ref Des	Description	NAI P/N	FSCM	MFR P/N
A4	NATIVE IEEE Interface, Lower Chassis Assembly	500916-1	07342	500916-1
A4A2	Front Panel Assembly	787617	07342	787617
A4A2W1	SYN/RES Indicators, Cable Assembly	548621	07342	548621
MP1	LED Mounting Clip	808895	50579	004-9016
R164	Resistor, Composition, 330 ohm, 1/4 W, ±5%	880080	01121	CB3315
W1	Cable Assembly, Front Panel/API	548531	07342	548531
	Connector Kit, 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 7-8. Model 8810 - FX3 Feature 2, Option 3 -
IEEE MATE/CIIL Interface Option - Unique Parts

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A4	IEEE MATE/CIIL Interface, Lower Chassis Assembly	500916-2	07342	500916-2
A4A2	Front Panel Assembly	787617	07342	787617
A4A2W1	SYN/RES Indicators, Cable Assembly	548621	07342	548621
A4A2W2	Cable Assembly Front Panel, API	787482	07342	787482
MP1	LED Mounting Clip	808895	50579	004-9016
R164	Resistor, Composition, 330 ohm, 1/4 W, ±5%	880080	01121	CB3315
W1	IEEE Cable Assembly	548531	07342	548631
	Connector Kit, 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

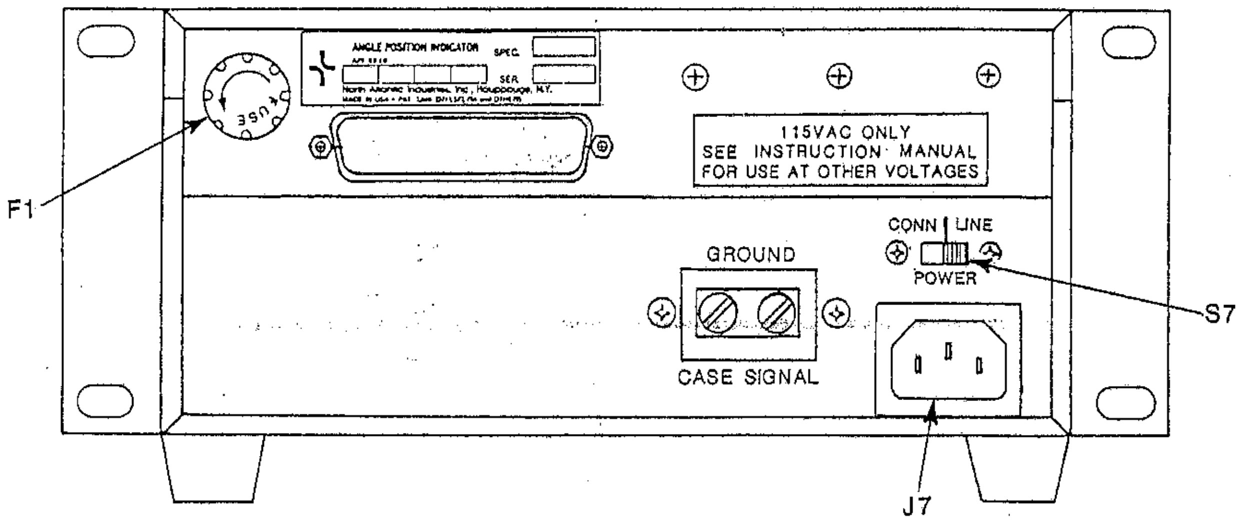


FRONT VIEW

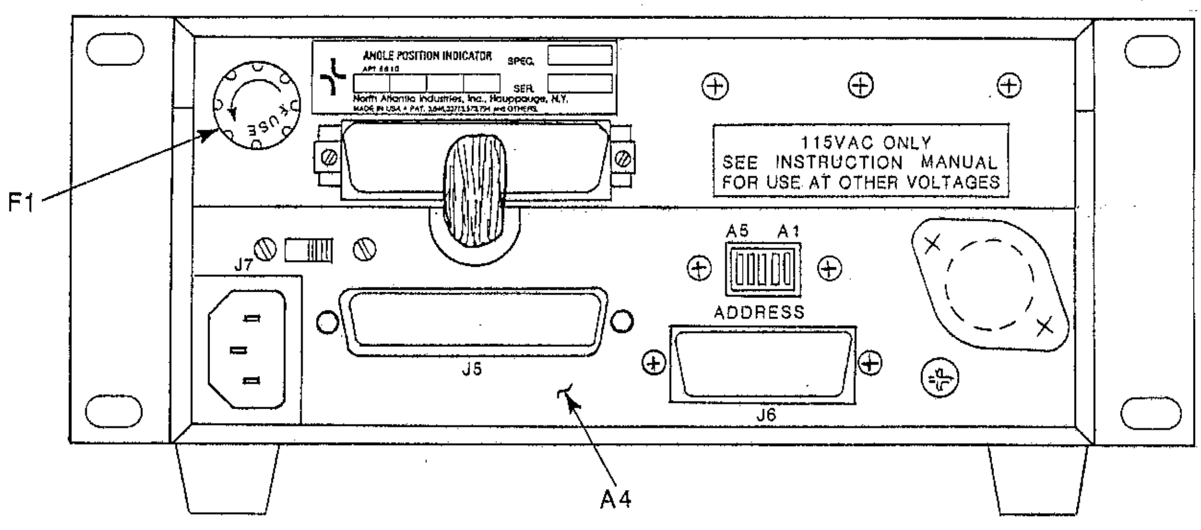


RIGHT SIDE VIEW

Figure 7-1. Model 8810 API, Parts Location Diagram (Sheet 1 of 4)



MODEL 8810-FX2 (FEATURE 2, OPTION 2-IEEE INTERFACE)



MODEL 8810-FX1 (FEATURE 2, OPTION 1-NO IEEE INTERFACE)

Figure 7-1. Model 8810 API, Parts Location Diagram (Sheet 2 of 4)

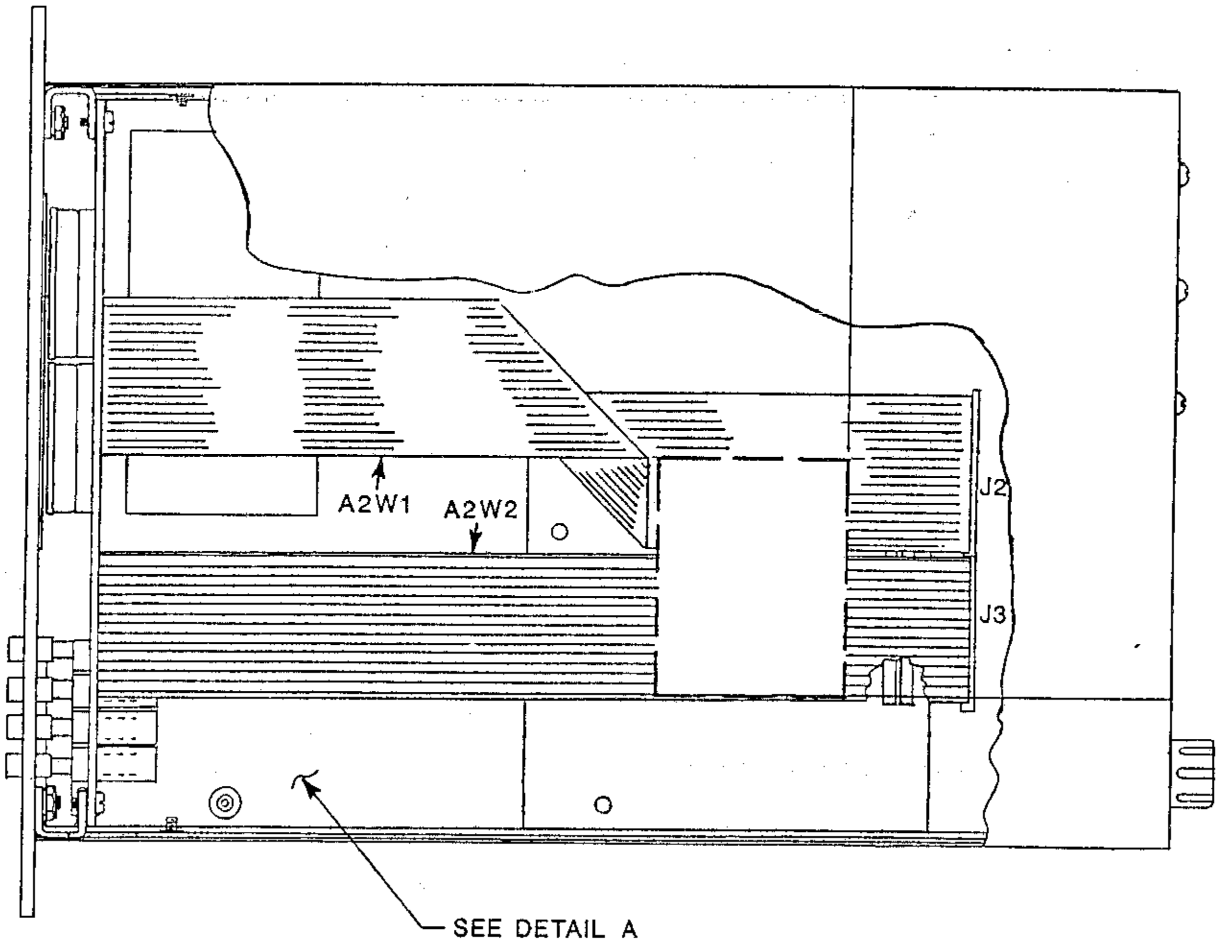


Figure 7-1. Model 8810 API, Parts Location Diagram (Sheet 3 of 4)

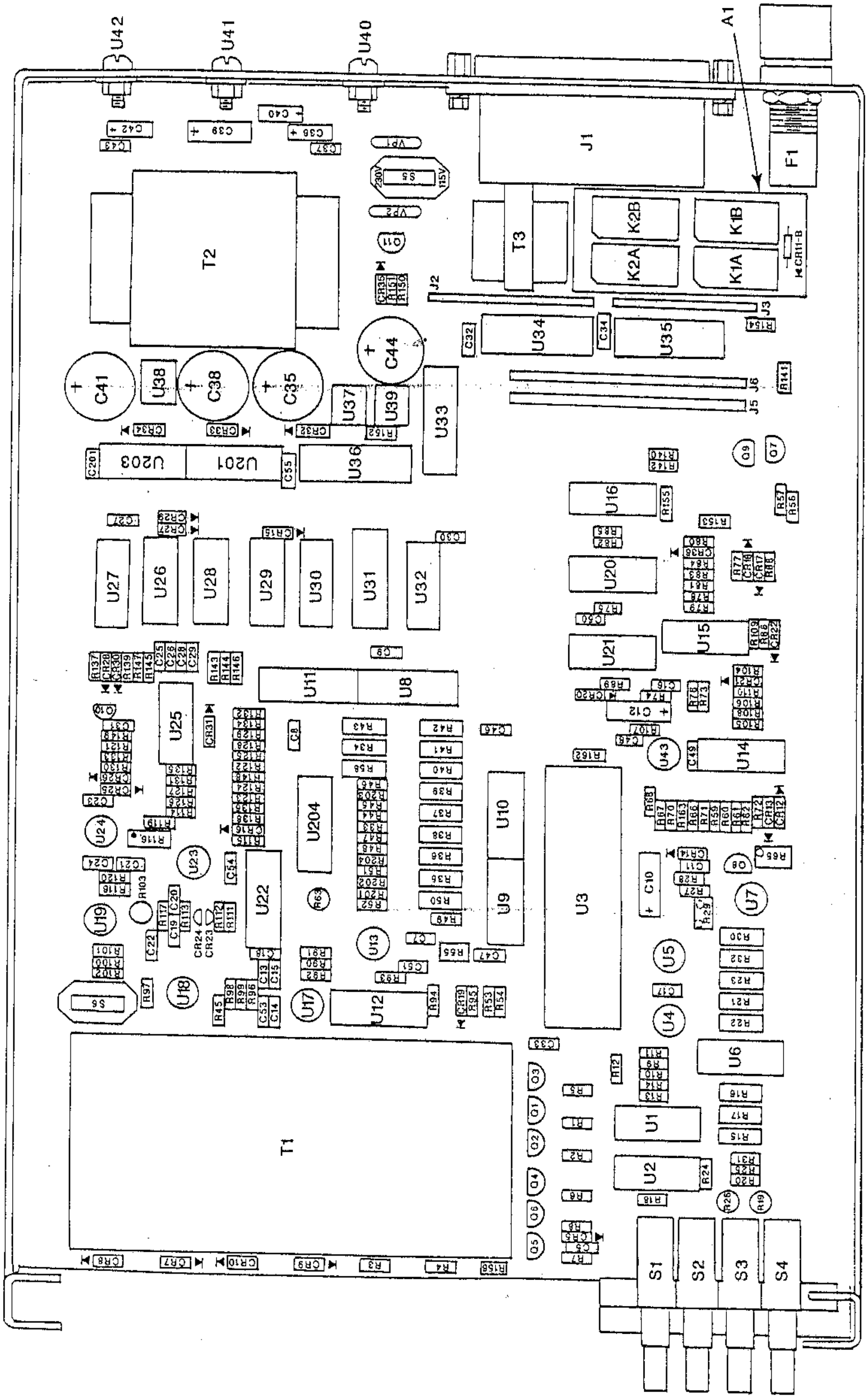


Figure 7-1. Model 8810 API, Parts Location Diagram (Sheet 4 of 4)

Table 7–9. Relay Adapter Assembly A1 - 787337

Ref Des	Description	NAI P/N	FSCM	MFR P/N
CR11-B	Diode, Signal, In	808974	07263	1N4148
K1A,K1B, K2A,K2B	Relay, DPDT, 5V, Coil	889073	0CY05	MR602–5SR
XUK1A, XUK1B, XUK2A, XUK2B	Socket, IC, 16 Pin	808197	00779	2-640358-3

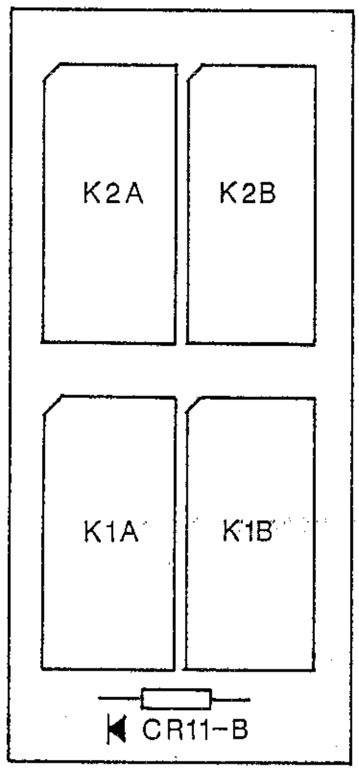


Figure 7-2. Relay Adapter Assembly A1, Parts Location Diagram

Table 7-10. 360° Display Circuit Card Assembly A2 - 787379

Ref Des	Description	NAI P/N	FSCM	MFR P/N
DS1,DS2	Display/Readout, 3 Digit	807670	73138	SP353
DS3-DS5	LED	807493	28480	5082-4484
R1	Resistor, Composition, 430 ohm, 1/4 W, ±5%	802519	01121	CB4345
R2-R7	Resistor, Composition, 2.2 k, 1/2 W, ±5%	800079	01121	EB2225
R8-R13	Resistor, Composition, 13 k, 1/4 W, ±5%	880094	01121	CB1335
R14	Resistor, Composition, 150 ohm, 1/4 W, ±5%	880200	01121	CB1515
U1-U6	IC, Decoder Driver	806945	73138	DD700
W1	Cable, Jumper, 16 Cond, 12 Lg	808117	00779	5107-651-74
W2	Cable, Jumper, 14 Cond, 10.25 Lg	808116	00779	5107-651-157
XDS1,XDS2	Socket, Readout	807672	73138	CS353

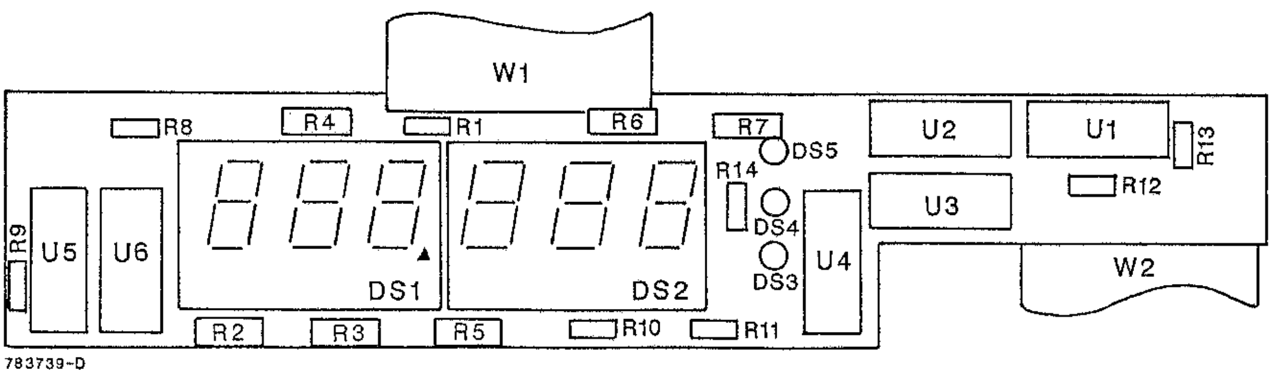


Figure 7-3. 360° Display Circuit Card Assembly A2, Parts Location Diagram

Table 7-11. ±180° Display Circuit Card Assembly A2 - 783747

Ref Des	Description	NAI P/N	FSCM	MFR P/N
DS1	Display/Readout, 3 Digit and ±	808279	73138	SP354
DS2	Display/Readout, 3 Digit	807670	73138	SP353
DS3-DS5	LED	807493	09182	5082-4484
Q1	Transistor, Signal, NPN	804088	04713	2N4123
R1	Resistor, Composition, 430 k, 1/4 W, ±5%	802519	01121	CB4345
R2-R7	Resistor, Composition, 2.2 k, 1/2 W, ±5%	800079	01121	EB2225
R8-R13	Resistor, Composition, 13 k, 1/4 W, ±5%	880094	01121	CB1335
R14	Resistor, Composition, 150 ohm, 1/4 W, ±5%	880200	01121	CB155
R15	Resistor, Composition, 27 k, 1/8 W, ±5%	808278	01121	BB2735
R16	Resistor, Composition, 10 k, 1/8 W, ±5%	880830	01121	BB1035
R17	Resistor, Composition, 4.7 k, 1/8 W, ±5%	880829	01121	BB4721
U1-U5	IC, Decoder Driver	806945	73138	DD700
U6	IC, Display Driver	807761	73138	DD702
W1	Cable, Jumper, 16 Cond, 12 Lg	808117	00779	5107-651-74
W2	Cable, Jumper, 14 Cond, 10.25 Lg	808116	00779	5107-651-157

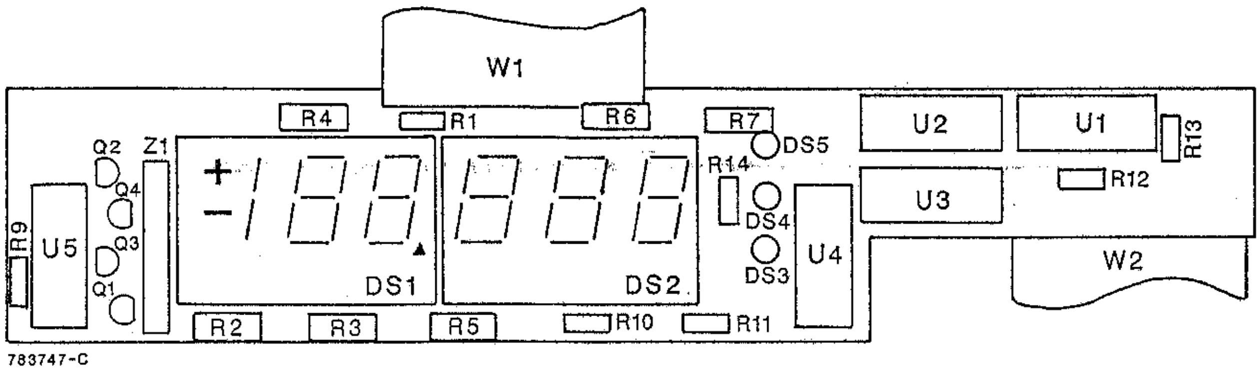


Figure 7-4. ±180° Display Circuit Card Assembly A2, Parts Location Diagram

Table 7-12. Digital ±180° Circuit Card Assembly A3 - 783719

Ref Des	Description	NAI P/N	FSCM	MFR P/N
C1,C2	Capacitor, Ceramic, 0.01 µf, 25 V, +80-20%	880034	72982	5835-000Y5U0103Z
XZ1	Socket, 14-pin	880166	00779	2-640357-3
XZ2	Socket, 16-pin	808197	00779	2-640358-3
XZ3	Same as XZ2			
XZ4	Same as XZ1			
XZ5,XZ6	Same as XZ2			
XZ7	Same as XZ1			
XZ8,XZ9	Same as XZ2			
XZ10	Same as XZ1			
XZ11,XZ12	Same as XZ2			
XZ13	Same as XZ1			
XZ14,XZ15	Same as XZ2			
XZ16	Same as XZ1			
XZ23	Same as XZ2			
Z1	IC, CMOS	807701	12040	74C00
Z2	IC, CMOS	807780	04713	MC14519BCP
Z3	IC, CMOS	807779	04713	MC14560CP
Z4	IC, CMOS	807702	04713	MC14561BCP
Z5	Same as Z2			
Z6	Same as Z3			
Z7	Same as Z4			

Table 7-12. Digital ±180° Circuit Card Assembly A3 - 783719 (Continued)

Ref Des	Description	NAI P/N	FSCM	MFR P/N
Z8	Same as Z2			
Z9	Same as Z3			
Z10	Same as Z4			
Z11	Same as Z2			
Z12	Same as Z3			
Z13	Same as Z4			
Z14	Same as Z2			
Z15	Same as Z3			
Z16	Same as Z4			

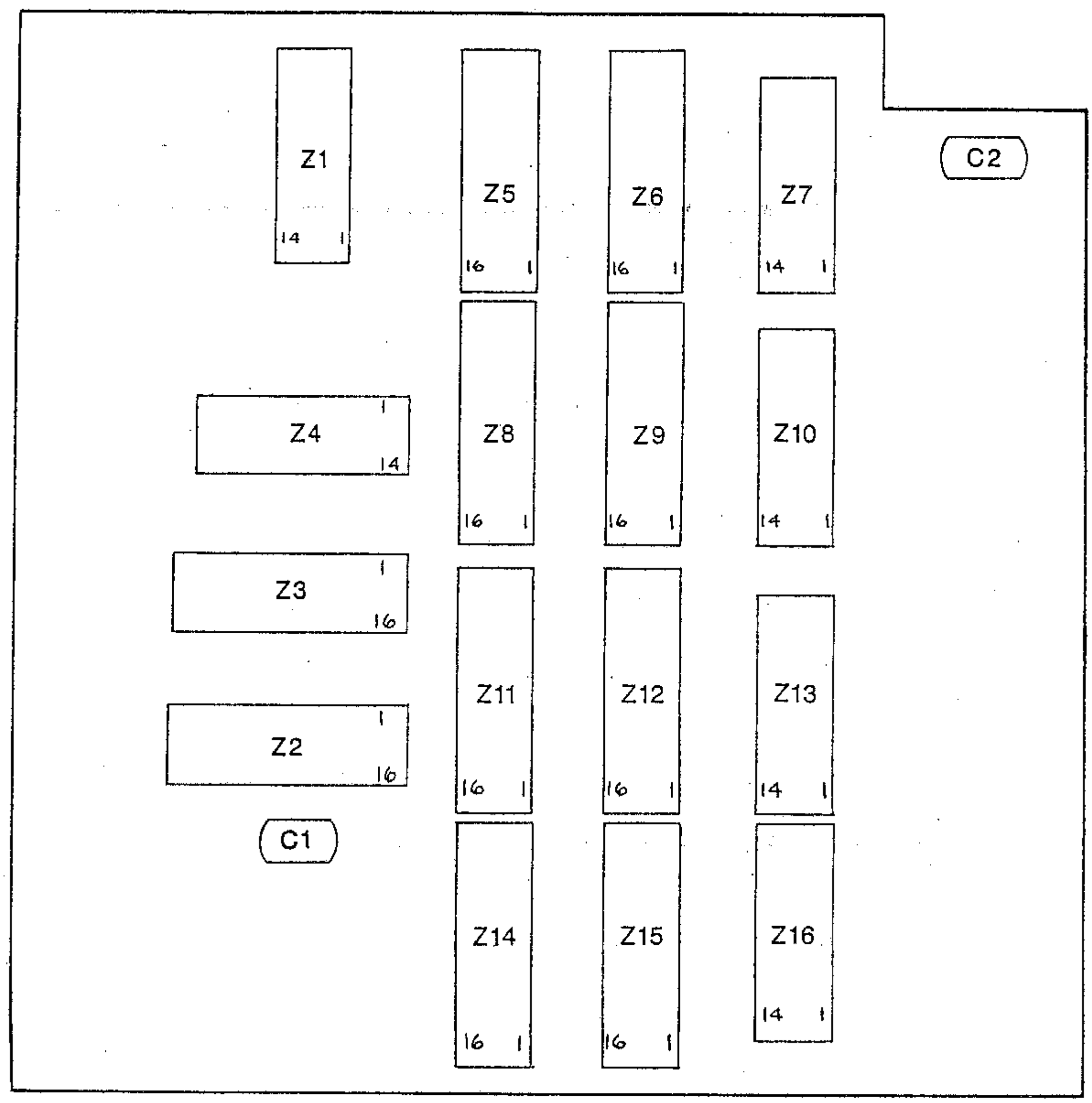


Figure 7-5. Digital ±180° Circuit Card Assembly A3, Parts Location Diagram

Table 7-13. IEEE Interface Lower Chassis Assembly A4 - 500916-1, -2

Ref Des	Description	NAI P/N	FSCM	MFR P/N
A4	Lower Chassis Assembly, NATIVE IEEE Interface	500916-1	07342	500916-1
A4	Lower Chassis Assembly, IEEE MATE/CIIL Interface	500916-2	07342	500916-2
A4A1	NATIVE IEEE Interface, Circuit Card Assembly	787836-1	07342	787836-1
A4A1	IEEE MATE/CIIL Interface, Circuit Card Assembly	787836-2	07342	787836-2
C201	Capacitor, Electrolytic, Al, 13,000 µf, 15 V, +75-10%	804185	56289	36D1330015AC2A
J7	Connector, Primary Circuit, 3-pin Snap-in Panel Mount	885865	60046	42R02-3212-150
SW1	Switch Assembly, 5	297726	07342	297726
SW2	Switch, Slide, DPDT	808112	79727	GF126, Terminal G-20-39
T201	Power Transformer	808309	08779	DFC16-1500
U201	Diode, Bridge Rectifier	804332	30870	VS247
U202	Voltage Regulator, 3 Amp. Input, +5 V Output	808205	12040	LN323K
W2	Cable Assembly, IEEE Interface	787219	07342	787219
W3	Cable Assembly, IEEE MATE/CIIL Interface	787926	07342	787926

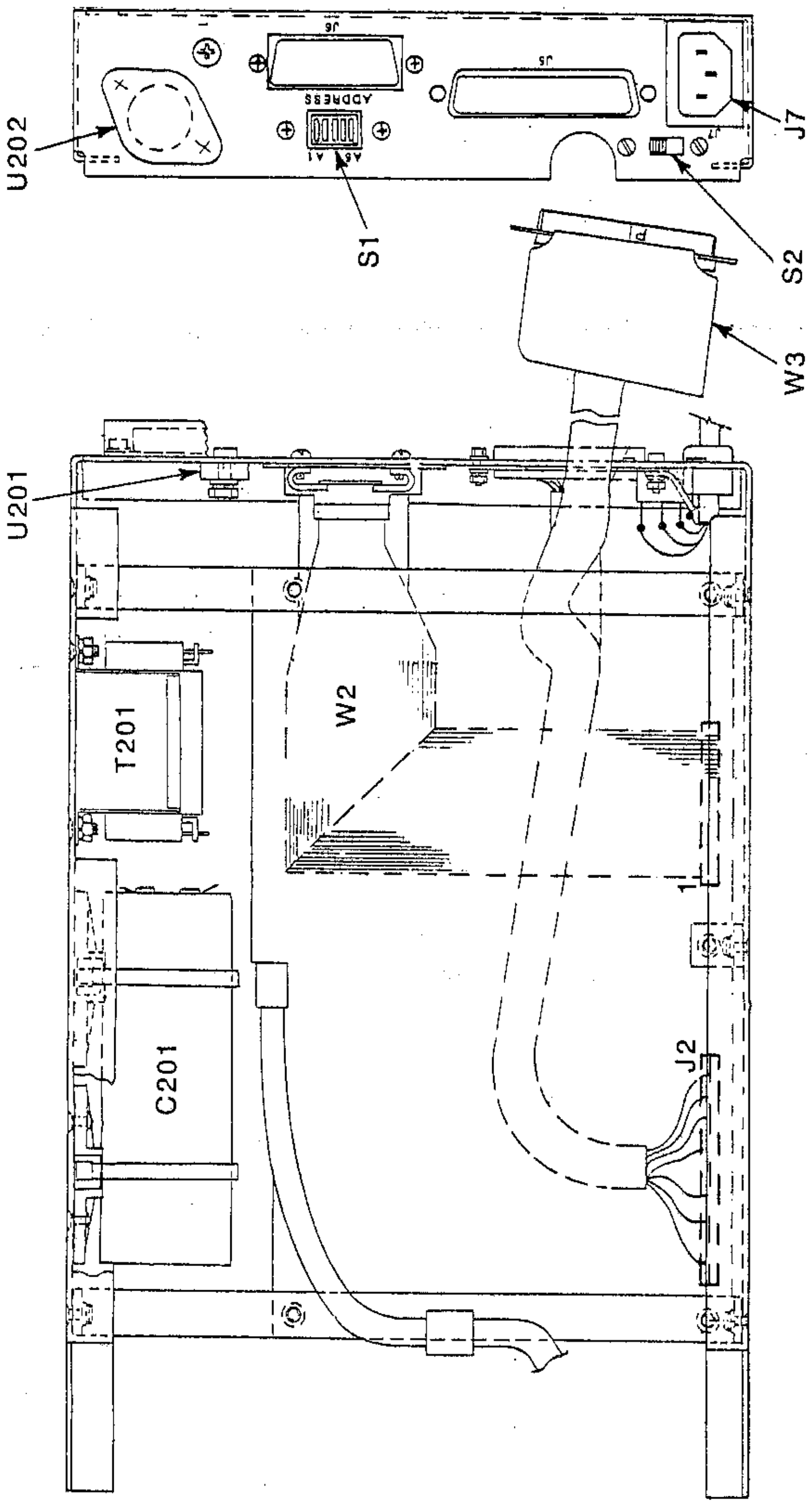


Figure 7-6. IEEE Interface Lower Chassis Assembly A4, Parts Location Diagram

Table 7-14. IEEE Interface Circuit Card Assembly A4A1 - 787836-1, -2

Ref Des	Description	NAI P/N	FSCM	MFR P/N	UOC
A4A1	NATIVE IEEE Interface, Circuit Card Assembly	787836-1	07342	787836-1	A
A4A1	IEEE MATE/CIIL Interface, Circuit Card Assembly	787836-2	07342	787836-2	B
C1	Capacitor, EL, Tantalum, 10 µf, 25 V, ±10%	808259	90201	TLX106K025T1N	
C2,C3	Not used				
C4,C5	Capacitor, Ceramic, 56 pf, 200 V, ±10%	883333	81349	CK05DX560K	
C6	Capacitor, Ceramic, 1 µf, 50 V, ±10%	882876	81349	CKR06BX105KP	
C7-C20	Capacitor, Ceramic, 0.1 µf, 50 V, ±10%	807730	81349	CK05BX104K	
C21	Same as C7				B
CR1	Diode, Power Rectifier	808787	81349	JAN 1N4001	
CR2-CR5	Diode, Signal In	808974	07263	1N4148	
CR6	Same as CR1				B
E1,E2	Terminal	883071	52458	1011-04	
K1	Relay, SPST, SIP, 5 V Coil	888067	AAAAA	4705	B
Q1	Transistor, Signal, NPN, TO-18	805062	04713	2N2222	B
R1	Resistor, Composition, 75 k, 1/4 W, ±5%	880821	01121	CB7535	
R2	Resistor, Composition, 300 ohm, 1/4 W, ±5%	803236	01121	CB3015	
R3	Resistor, Composition, 100 k, 1/4 W, ±5%	808846	81349	RNR50K26R7FM	B
R4	Resistor, Composition, 3.9 k, 1/4 W, ±5%	801409	01121	CB3925	B
S1	Thermostat, 90°C ±5°C	888066	33533	66L090	B
U1	PROM, Programmed, 8810 IEEE (Native Mode)	888130	07342	888130	

Table 7-14. IEEE Interface Circuit Card Assembly A4A1 - 787836-1, -2 (Continued)

Ref Des	Description	NAI P/N	FSCM	MFR P/N	UOC
U1	PROM, Programmed, 8810 IEEE (MATE/CIIL)	888131	07342	888131	B
U2	IC, RAM, 2 k x 8, 120 ms	886097	52464	MSM5128RS-12	
U3	IC, CMOS, Microprocessor	886828	81349	80C85	
U4	IC, CMOS, Quad NAND Gate	888129	01295	SN74NC00N	
U5	IC, IEEE-488 Controller	885996	01295	TMS9914A	
U6	IC, Octal Transparent Latch with Tristate Outputs	886829	01295	74HC373	
U7	IC, CMOS, Octal D Latch with Tristate Outputs	886833	01295	74HC374	
U8	IC, CMOS, 3 Line to 8 Line, Decoder/Demultiplexer	886830	01295	74HC138	
U9	IC, CMOS, Quad 2-Input AND Gate	886831	01295	74HC08	
U10	IC, Interface, Octal General Purpose Bus Transceiver	885998	01295	SN75161A	
U11	IC, Interface, Octal General Purpose Bus Transceiver	885997	01295	SN75160A	
U12	IC, CMOS, Octal Bus Trans-ceiver with Tristate Outputs	886834	01295	74HC244	
U13	IC, Microcomputer, 1 k RAM with I/O Ports and Timer	887862	52464	MSM81C55	
U14	IC, High Speed CMOS, Dual D-Type Edge-Triggered Flip-Flop	887859	04713	74HC74N	
U15	IC, CMOS, Monostable Multivibrator	886840	04713	MC14538	B
XU1	Socket, 28-pin, Low Profile	887821	BBBBB	LS628-49TG	
Y1	Crystal, 4 MHz Series, Resonant at cut ±.005%	808336	51406	E400	
Z1	Resistor, Network, SIP, NML, 9 Resistors, 10 k	808410	32997	4310R-101-103	

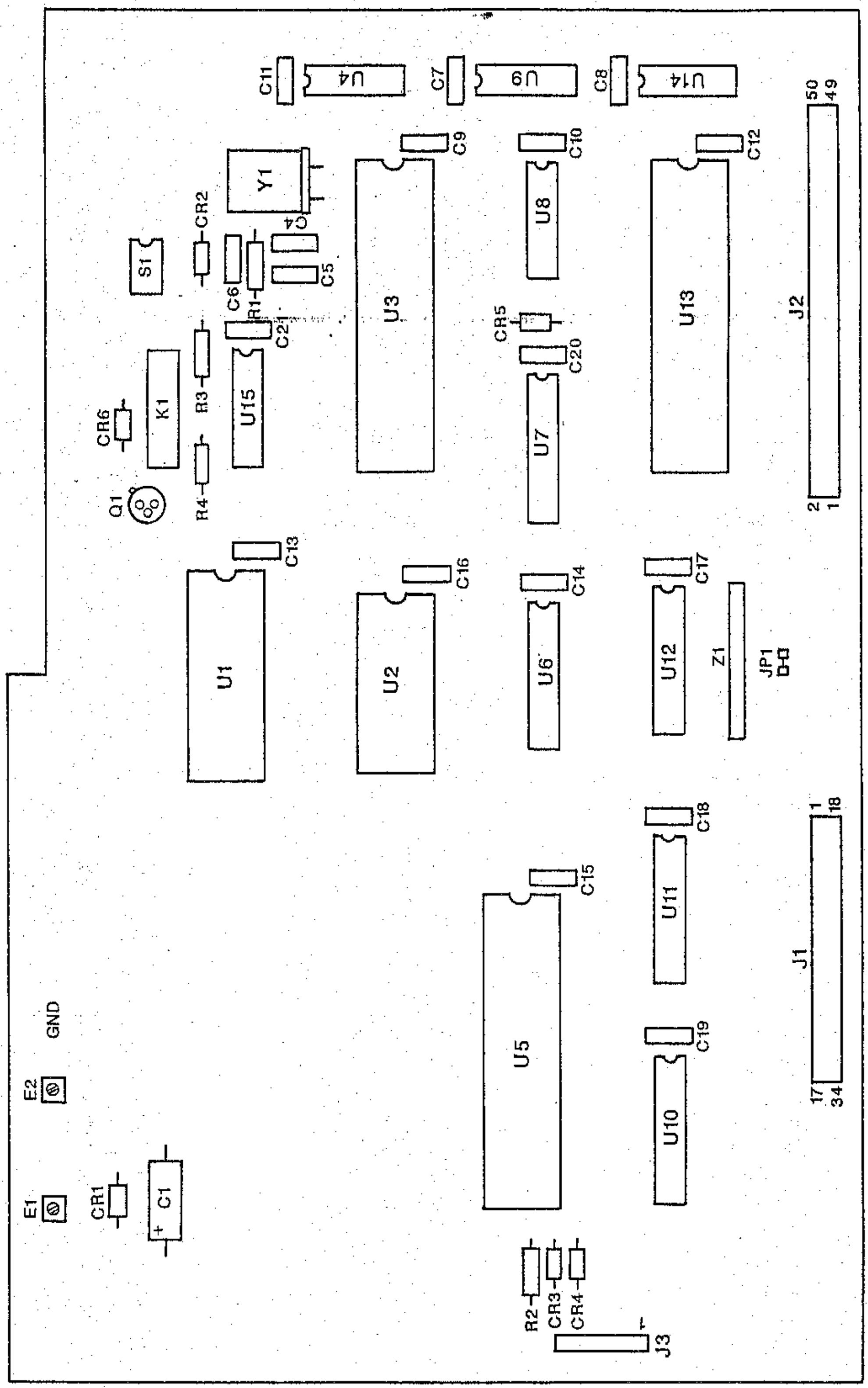


Figure 7-7. IEEE Interface Circuit Card Assembly A4A1, Parts Location Diagram

Table 7-15. List of Manufacturers

Code	Manufacturer's Name and Address
0CY05	NEC Information Technologies, 4-10 Shiba Yonchome, Minato-ku, Tokyo 108 Japan
00779	AMP Inc., Harrisburg, Pennsylvania 17105
00815	Midland-Ross Corporation, Burlington, Wisconsin 53105
01121	Allen-Bradley Company, Milwaukee, Wisconsin 53204
01295	Texas Instruments, Dallas, Texas 75265
02111	Spectrol Electronics, City of Industry, California 91745
03508	General Electric Company, Auburn, New York 13021
04713	Motorola Semiconductor, Pheonix, Arizona 85008
06665	Precision Monolithics, Inc., Santa Clara, California 95050
06751	Components, Inc., Semcor Division, Phoenix, Arizona
06776	Robinson Nugent, New Albany, Indiana 47150
07187	Sperry Corporation, Albuquerque, New Mexico 87119
07263	Fairchild Camera, Mountain View, California 94042
07342	North Atlantic Industries, Inc., Hauppauge, New York 11788
07395	GTE Products Corporation, Williamsport, Pennsylvania 17701
07933	Raytheon Company, Mountain View, California 94042
07980	Hewlett-Packard Co., Rockaway, New Jersey 07866
08779	Signal Transformer, Inwood, New York 11696
09182	Hewlett-Packard Company, Berkeley Heights, New Jersey
09353	C & K Components, Newton, Massachusetts 02158
09922	Burndy Corporation, Norwalk, Connecticut 06856
12040	National Semiconductor, Danbury, Connecticut 06810
12749	James Electronics, Inc., Chicago, Illinois 60618
16299	Corning Glass Works, Raleigh, North Carolina 27604
18677	Scanbe Manufacturing Company, El Monte, California 91731
19587	Kelvin Industries, Inc., Fajardo, Puerto Rico 00648
22526	EI DuPont, Berg Electronics Div., New Cumberland, Pennsylvania 17070
28218	3M Company, 3M Center, St. Paul, Minnesota 55144
28480	Hewlett-Packard Co., Palo Alto, California 94304
30870	Republic Machinery Co., Carson, California 90749
31433	Union Carbide Corporation, Greenville, South Carolina 29606
31757	Micropac Industries, Garland, Texas 75040
32997	Bourns Inc., Riverside, California 92507
33533	The Brenco Corporation, St. Louis, Missouri 63110-2336
51406	Murata Erie North America Inc., Marietta, Georgia 30067
52458	Magnum Electric Corporation, Erie, Minnesota 48133
52464	OKI Electronics of America, Inc., Fort Lauderdale, Florida 33334
55261	LSI Computer Systems Inc., Melville, New York 11747
56289	Sprague Electric Company, North Adams, Massachusetts 01247
71590	Centralab, Inc., Fort Dodge, Iowa 50501
71938	Dietz Manufacturing Company, Los Angeles, California
72136	Electro-Motive Corporation, Florence, South Carolina 29501
72982	Murata Erie North America, Erie, Pennsylvania 16512
73138	Beckman Industries, Fullerton, California 92634
74840	Illinois Capacitor, Inc., Lincolnwood, Illinois 60645
75037	3M Electro Products Division, St. Paul, Minnesota 55101

Table 7-15. List of Manufacturers (Continued)

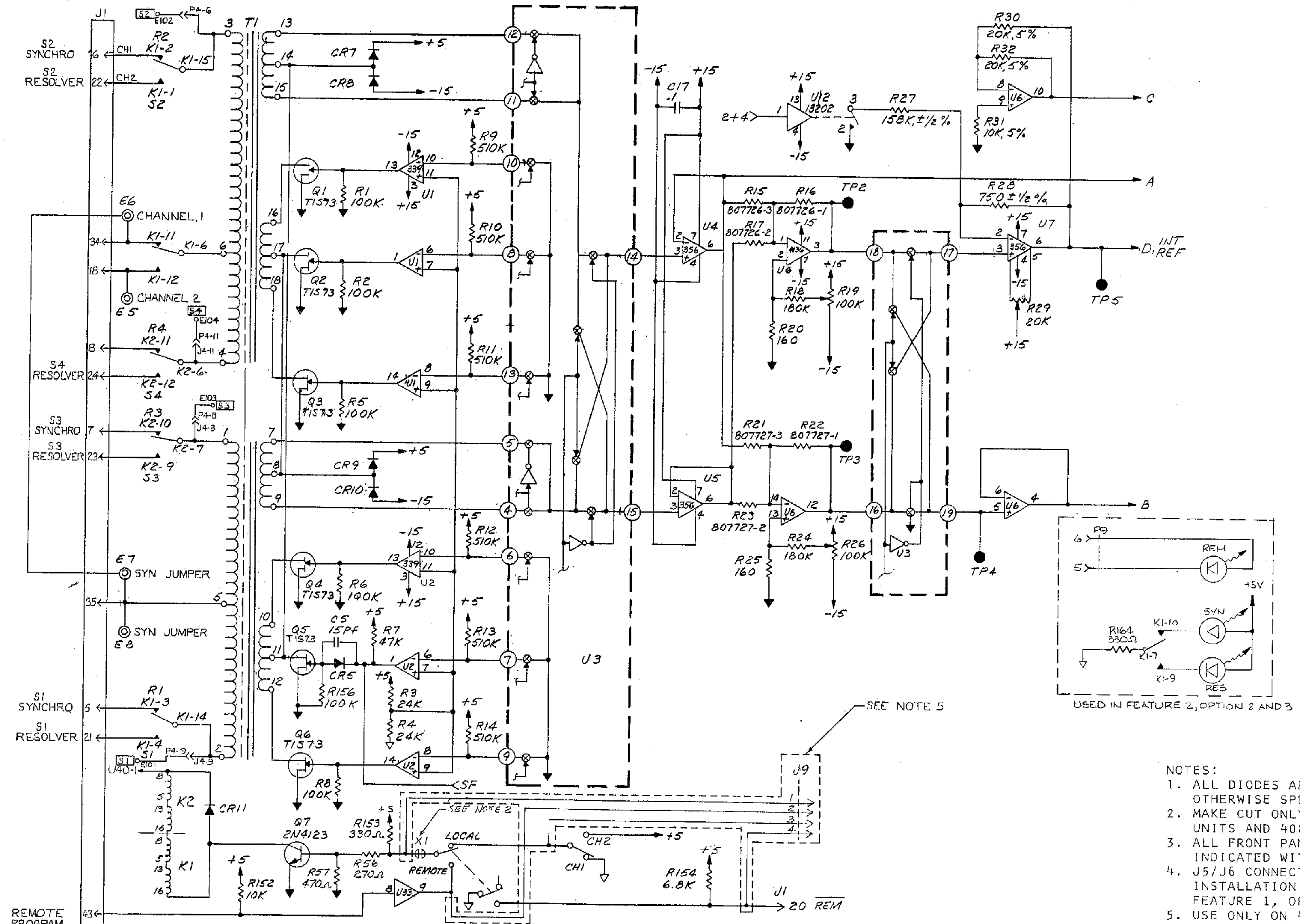
Code	Manufacturer's Name and Address
75915	Tracor Littelfuse, Inc., Des Plaines, Illinois 60016
76381	3M Company, St. Paul, Minnesota 55101
79727	C-W Industries, Southampton, Pennsylvania 18966
80126	Pacific Electricord Company, Gardena, California 90247
80294	Bourns Instruments, Inc., Riverside, California 92506
81073	Grayhill, Inc., LaGrange, Illinois 60525
81349	Military Specifications promulgated by Military Departments/Agencies under Authority of Defense Standardization Manual
90201	Mallory Capacitor Co., Indianapolis, Indiana 46206
91506	Augat, Inc., Attleboro, Massachusetts 02703
91637	Dale Electronics Corporation, Columbus, Nebraska 68601
94271	Fairchild Weston Systems, Inc., Archbald, Pennsylvania 18403
96095	AVX Ceramics, Olean, New York 14760
97525	EECO, Santa Ana, California 92701
AAAAA	Gordes Corporation, Bloomfield, New Jersey 07003
BBBBB	Vantage, Commack, New York 11725

SECTION 8

SCHEMATIC DIAGRAMS

8-1 INTRODUCTION.

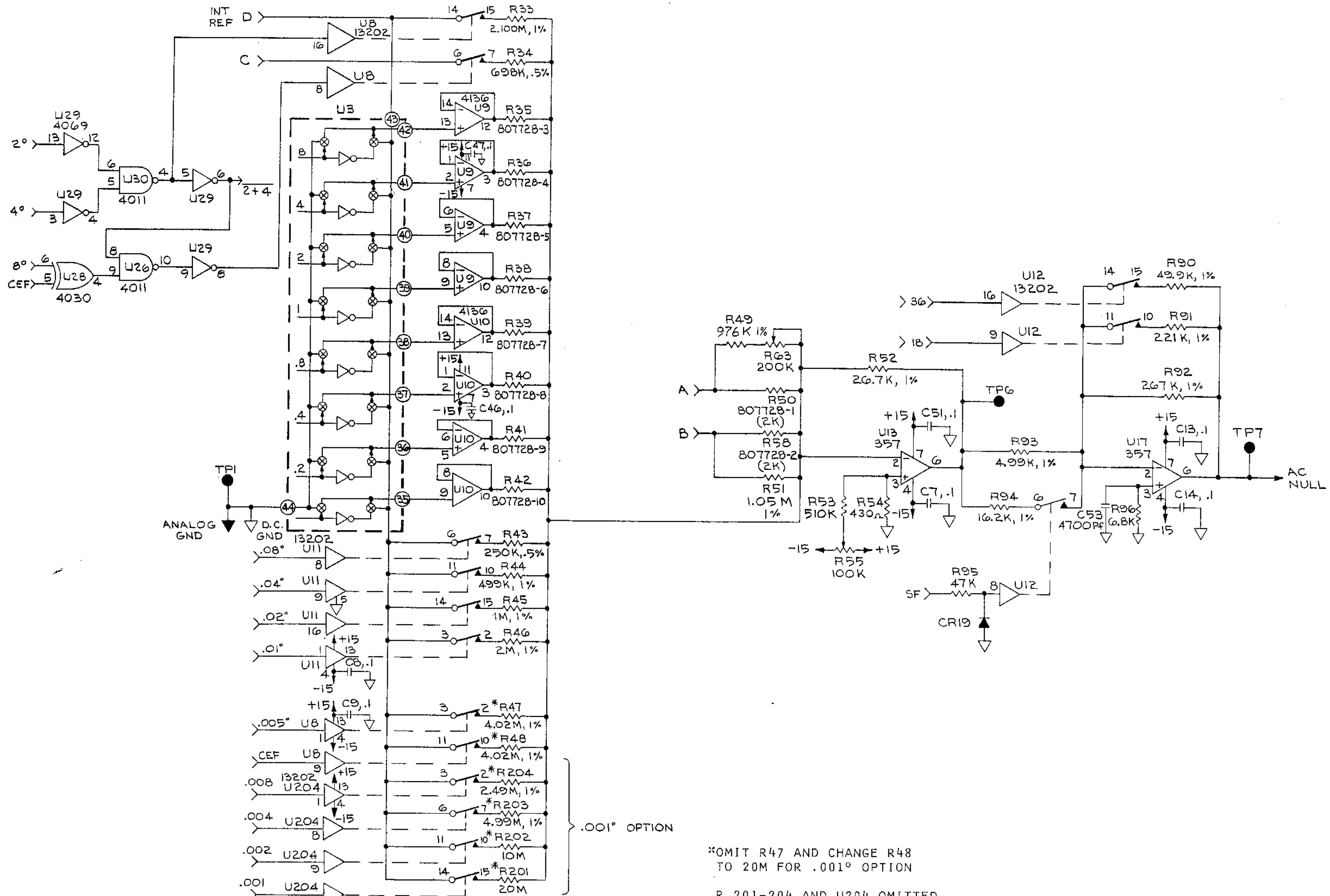
This section contains schematic diagrams for the Model 8810 API.



768812-1-T

NOTES:
1. ALL DIODES ARE 1N4148 UNLESS OTHERWISE SPECIFIED.
2. MAKE CUT ONLY ON 408810-S3271 UNITS AND 408810-S3283 UNITS.
3. ALL FRONT PANEL LABELS ARE INDICATED WITH BOXES (E.G., [S2])
4. J5/J6 CONNECTIONS CUT FOR INSTALLATION OF DIGITAL BOARD IN FEATURE 1, OPTIONS 3 AND 4.
5. USE ONLY ON 408810-S3271 AND 408810-S3283 UNITS.

Figure 8-1. Model 8810 API, Schematic Diagram (Sheet 1 of 5)

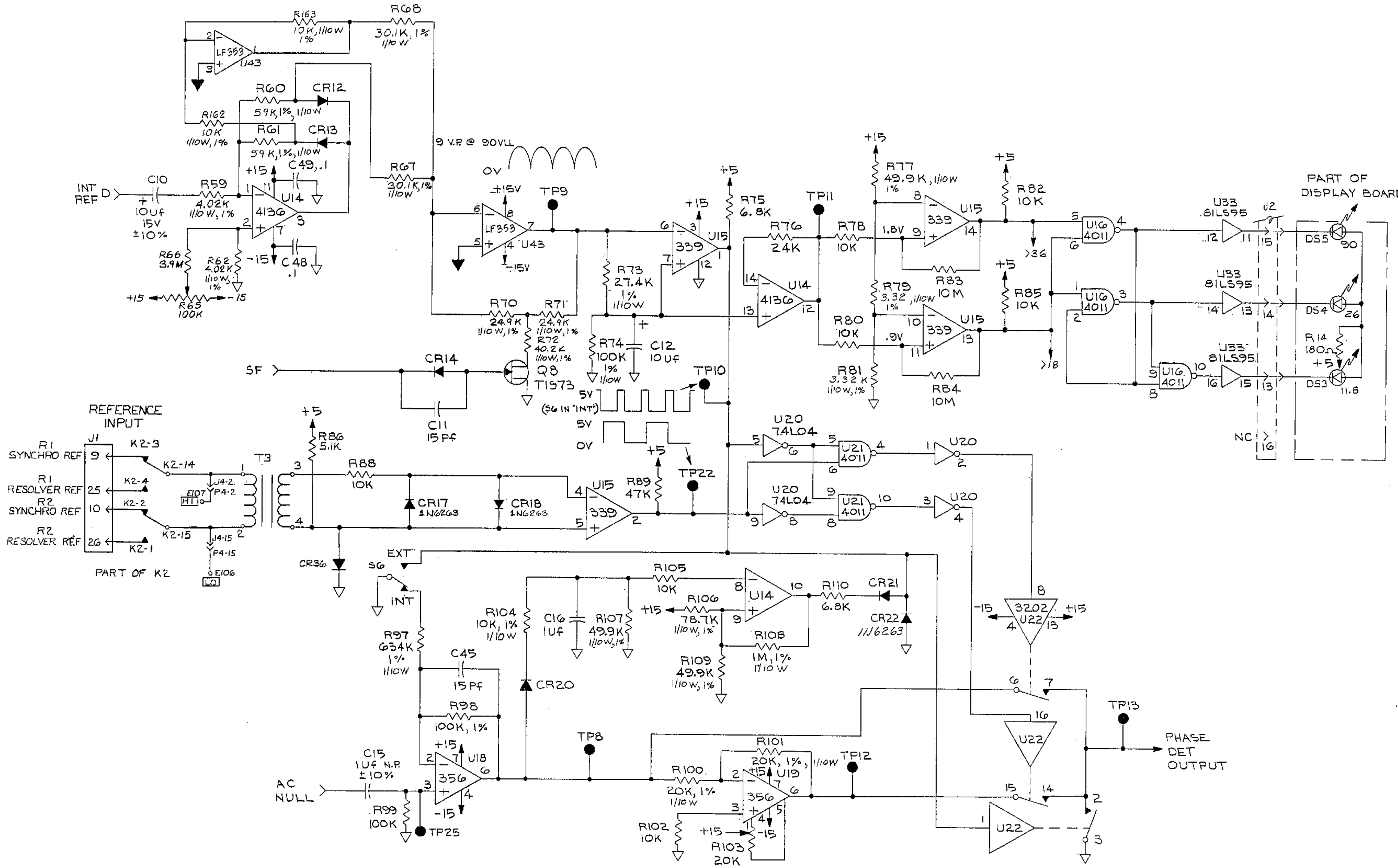


*OMIT R47 AND CHANGE R48 TO 20M FOR .001° OPTION

R 201-204 AND U204 OMITTED FOR .005° RESOLUTION

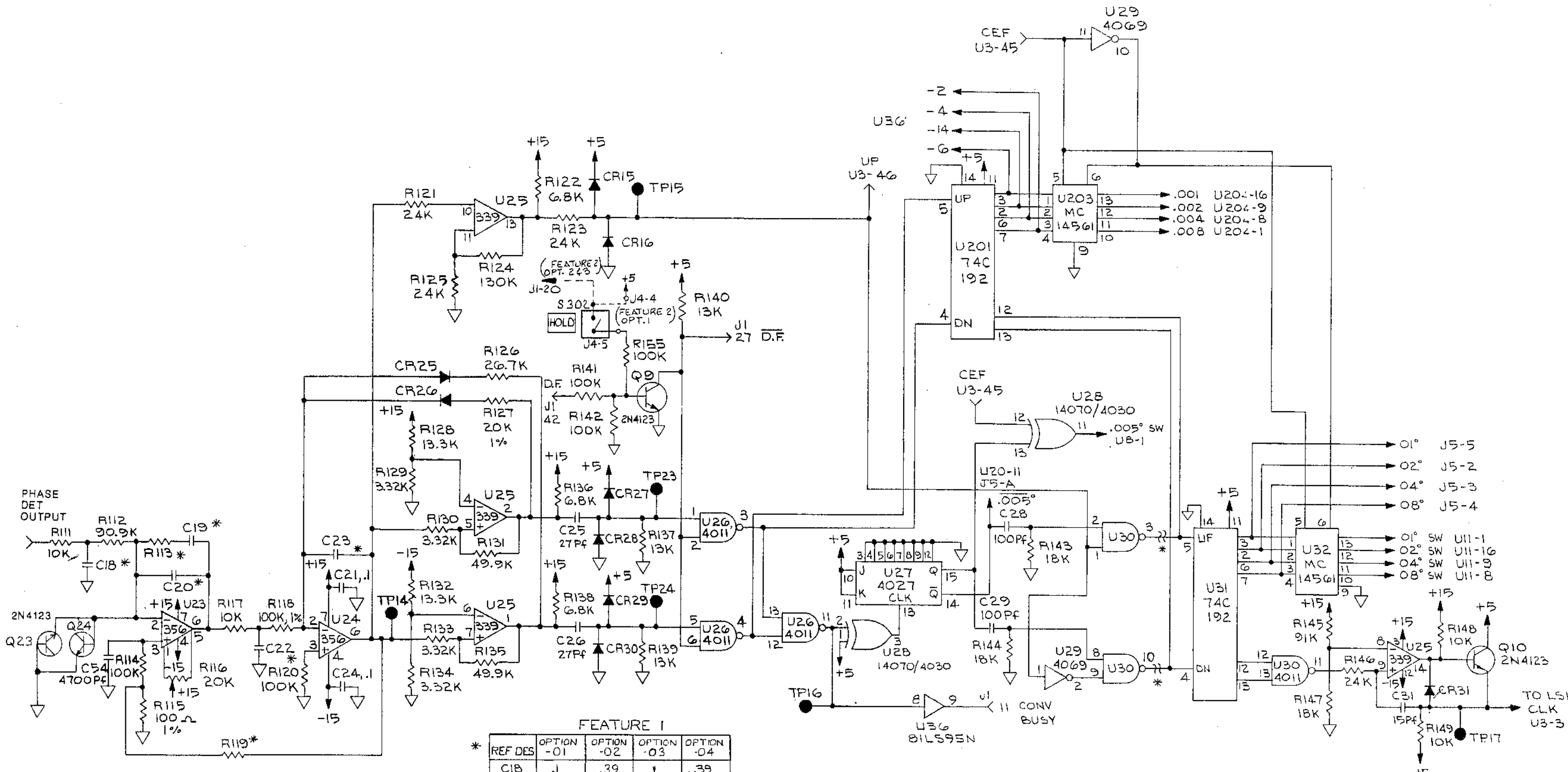
768812-2-A

Figure 8-1. Model 8810 API, Schematic Diagram (Sheet 2 of 5)



768812-3-J

Figure 8-1. Model 8810 API, Schematic Diagram (Sheet 3 of 5)



FEATURE 1

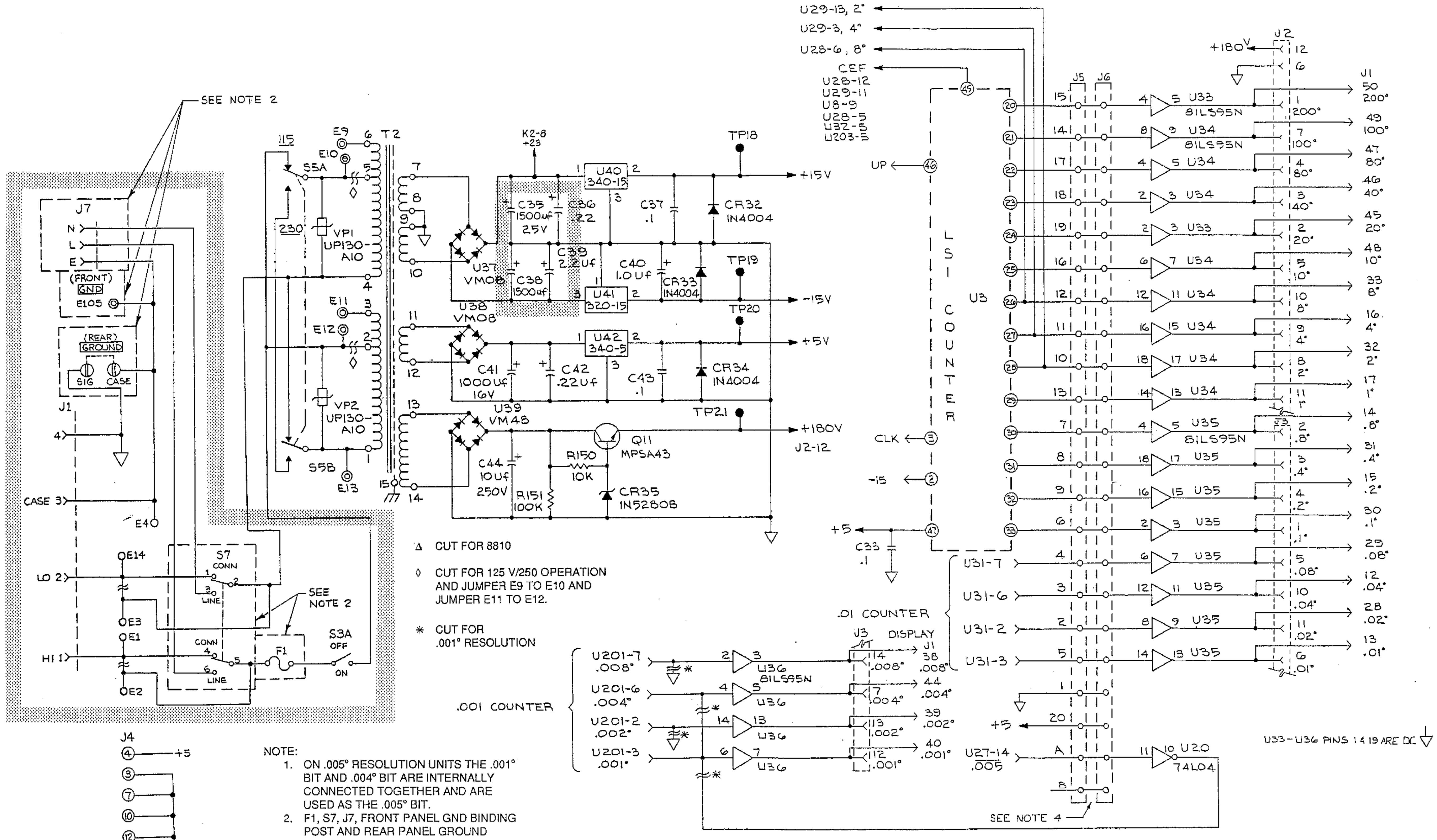
* REF DES	OPTION -01	OPTION -02	OPTION -03	OPTION -04
C18	.1	.39	.1	.39
C19	.33	.39	.33	.39
C20	.068	.082	.068	.082
C22	.056	.82	.056	.39
C23	100PF	390PF	100PF	1000PF
R113	133K	232K	590K	165K
R119	100K	100K	41.2K	41.2K

*CUT FOR .001 RESOLUTION

NOTES:
1. U201 AND U203 USED ON .001° RESOLUTION UNITS ONLY (OPTIONS 01 AND 02).
2. U27 USED ON .005° RESOLUTION UNITS ONLY (OPTIONS 03 AND 04).

768812-4-K

Figure 8-1. Model 8810 API, Schematic Diagram (Sheet 4 of 5)



Δ CUT FOR 8810

◊ CUT FOR 125 V/250 OPERATION AND JUMPER E9 TO E10 AND JUMPER E11 TO E12.

✱ CUT FOR .001° RESOLUTION

NOTE:

1. ON .005° RESOLUTION UNITS THE .001° BIT AND .004° BIT ARE INTERNALLY CONNECTED TOGETHER AND ARE USED AS THE .005° BIT.
2. F1, S7, J7, FRONT PANEL GND BINDING POST AND REAR PANEL GROUND TERMINAL STRIPS ARE EXTERNAL TO 787205 ASSY.

768812-5-N

Figure 8-1. Model 8810 API, Schematic Diagram (Sheet 5 of 5)

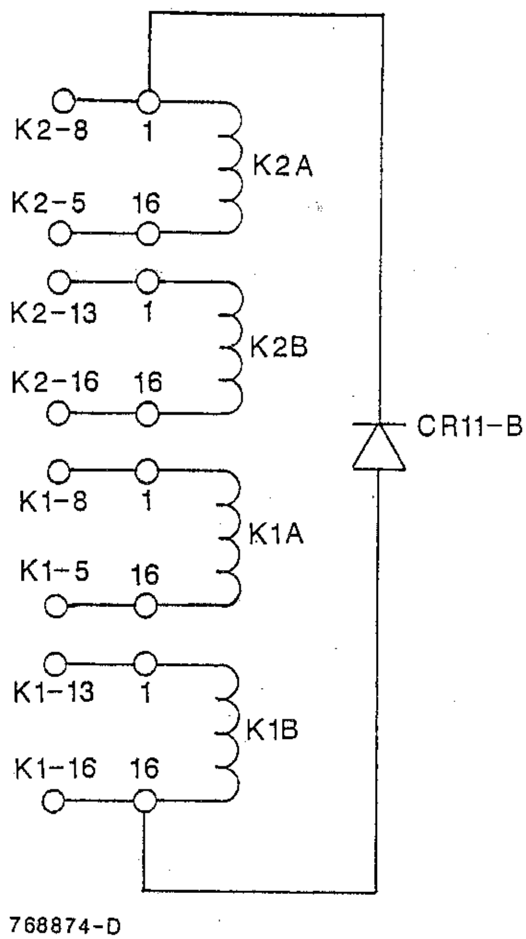


Figure 8-2. Relay Adapter Assembly A1, Schematic Diagram

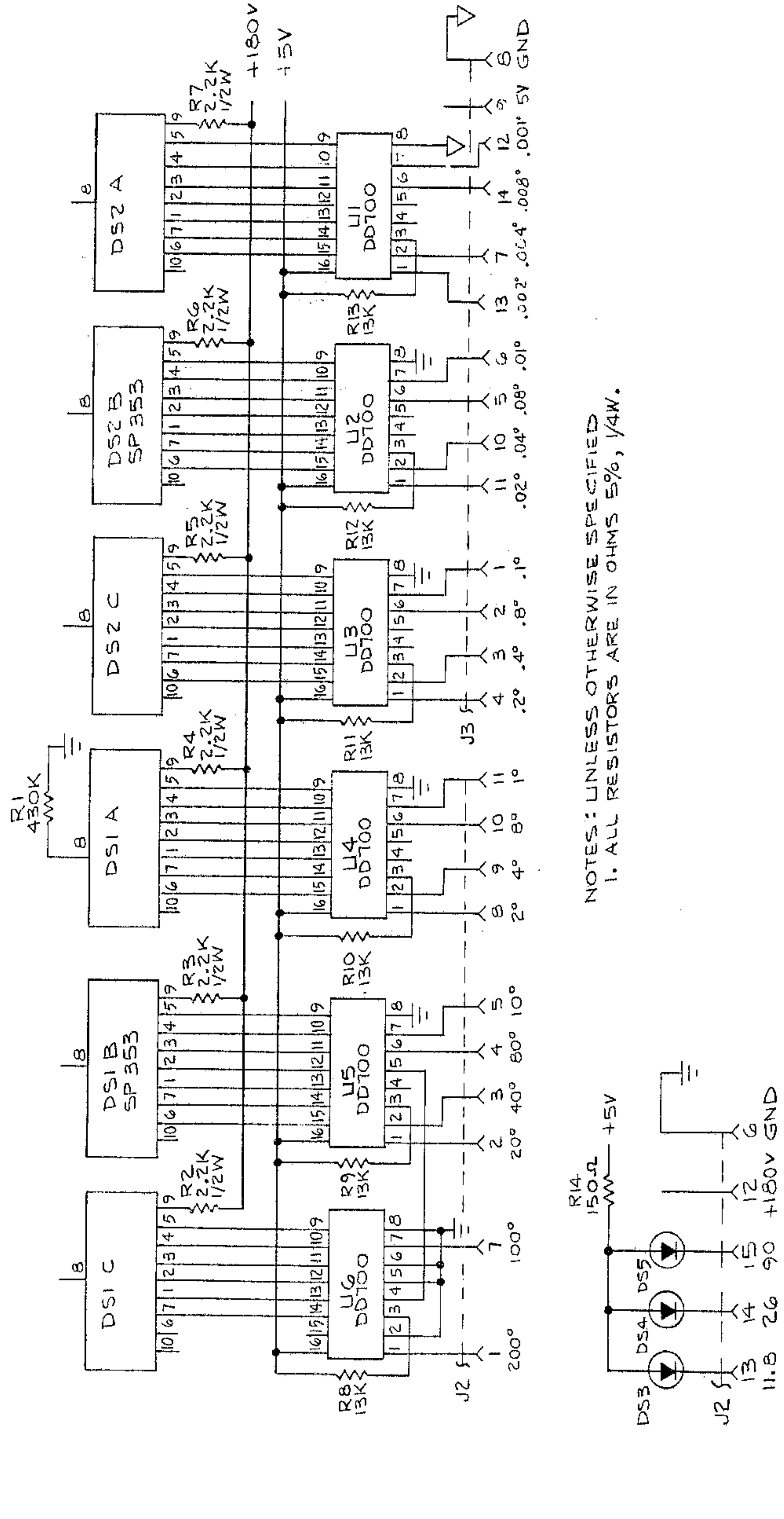
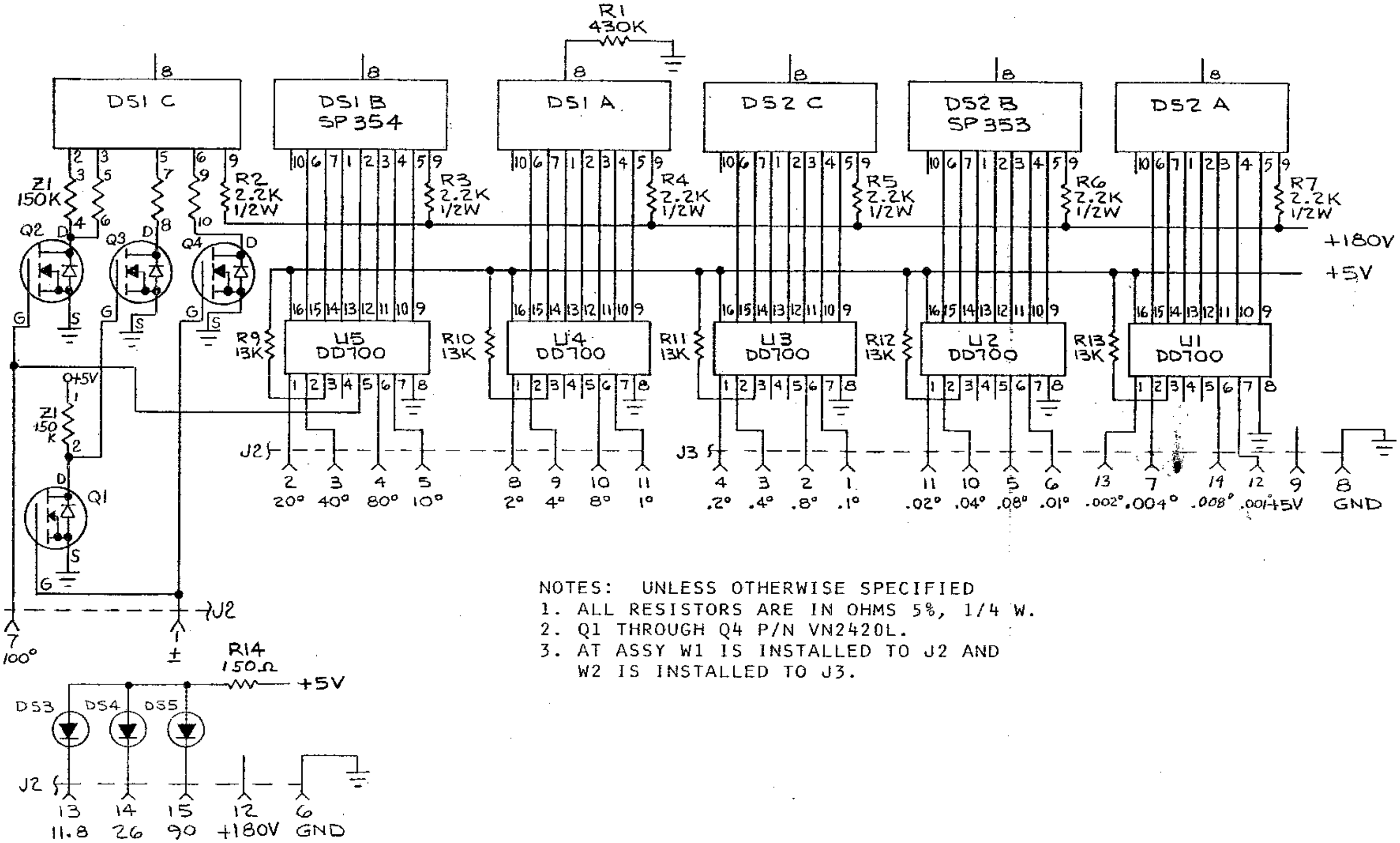


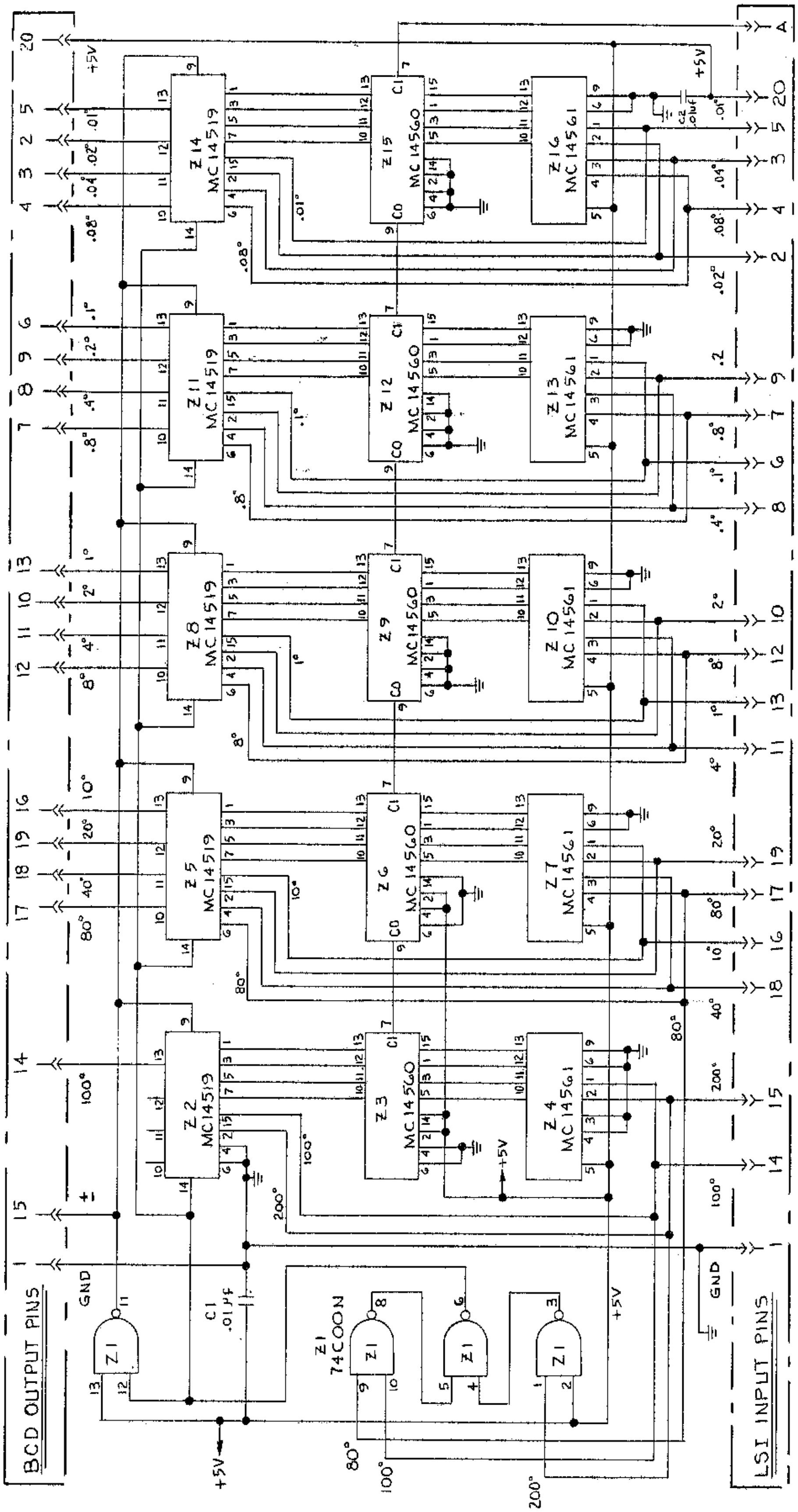
Figure 8-3. 360° Display Circuit Card Assembly A2, Schematic Diagram



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS 5%, 1/4 W.
2. Q1 THROUGH Q4 P/N VN2420L.
3. AT ASSY W1 IS INSTALLED TO J2 AND
   W2 IS INSTALLED TO J3.

761738-D

Figure 8-4. ±180° Display Circuit Card Assembly A2, Schematic Diagram

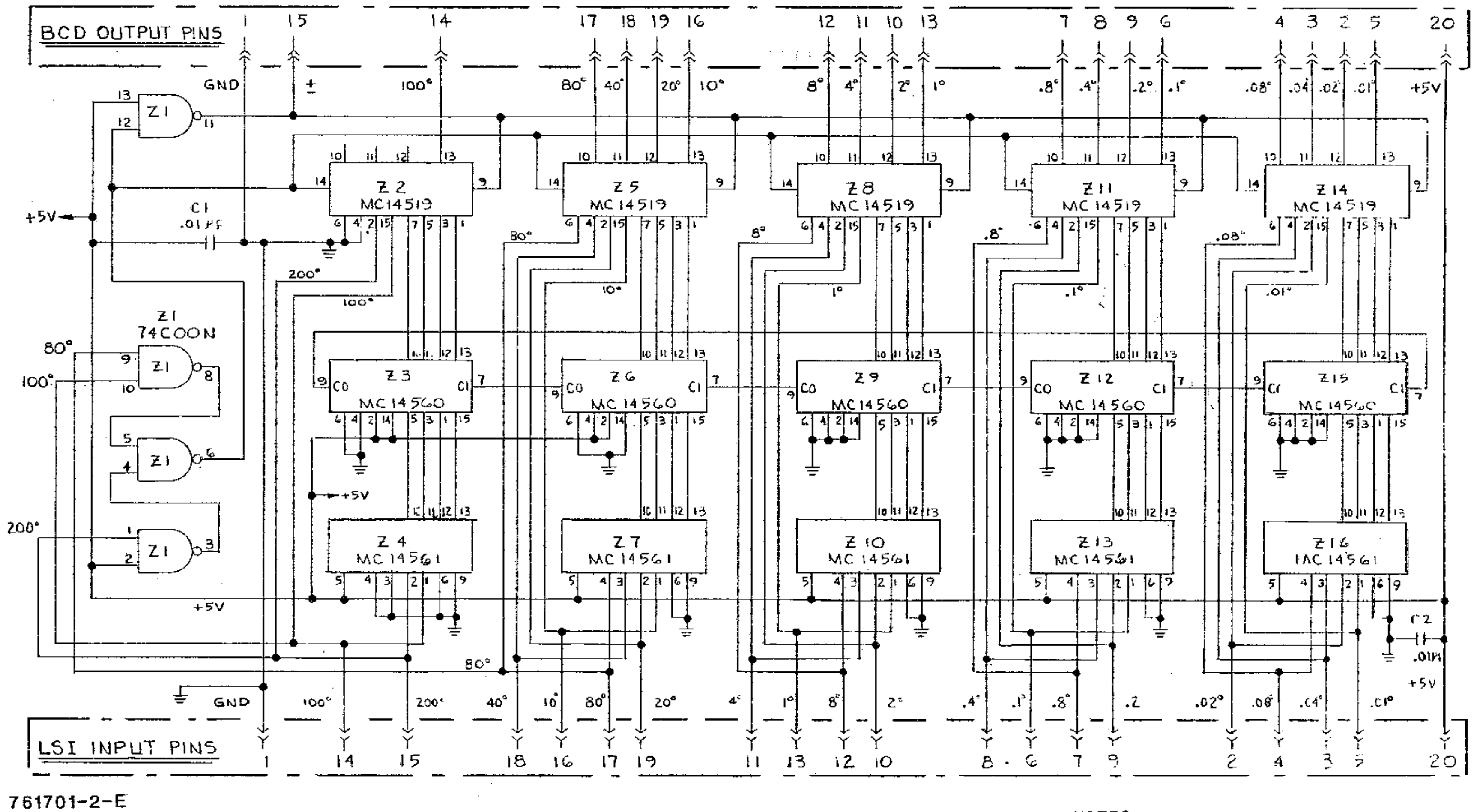


NOTES:

1. Z1 (74C00N), AND Z4, 7, 10, 13, AND 16 (MC14561) ARE 14 PIN IC'S WITH PIN 7 TO GND AND PIN 14 TO +5 V.
2. Z2, 3, 5, 6, 8, 9, 11, 12, 14, AND 15 ARE 16 PIN IC'S WITH PIN 8 TO GND AND PIN 16 TO +5 V.
3. THIS SHEET IS FOR PCB 205745 REV "A" AND UP. SEE SHEET 2 FOR NO REV.

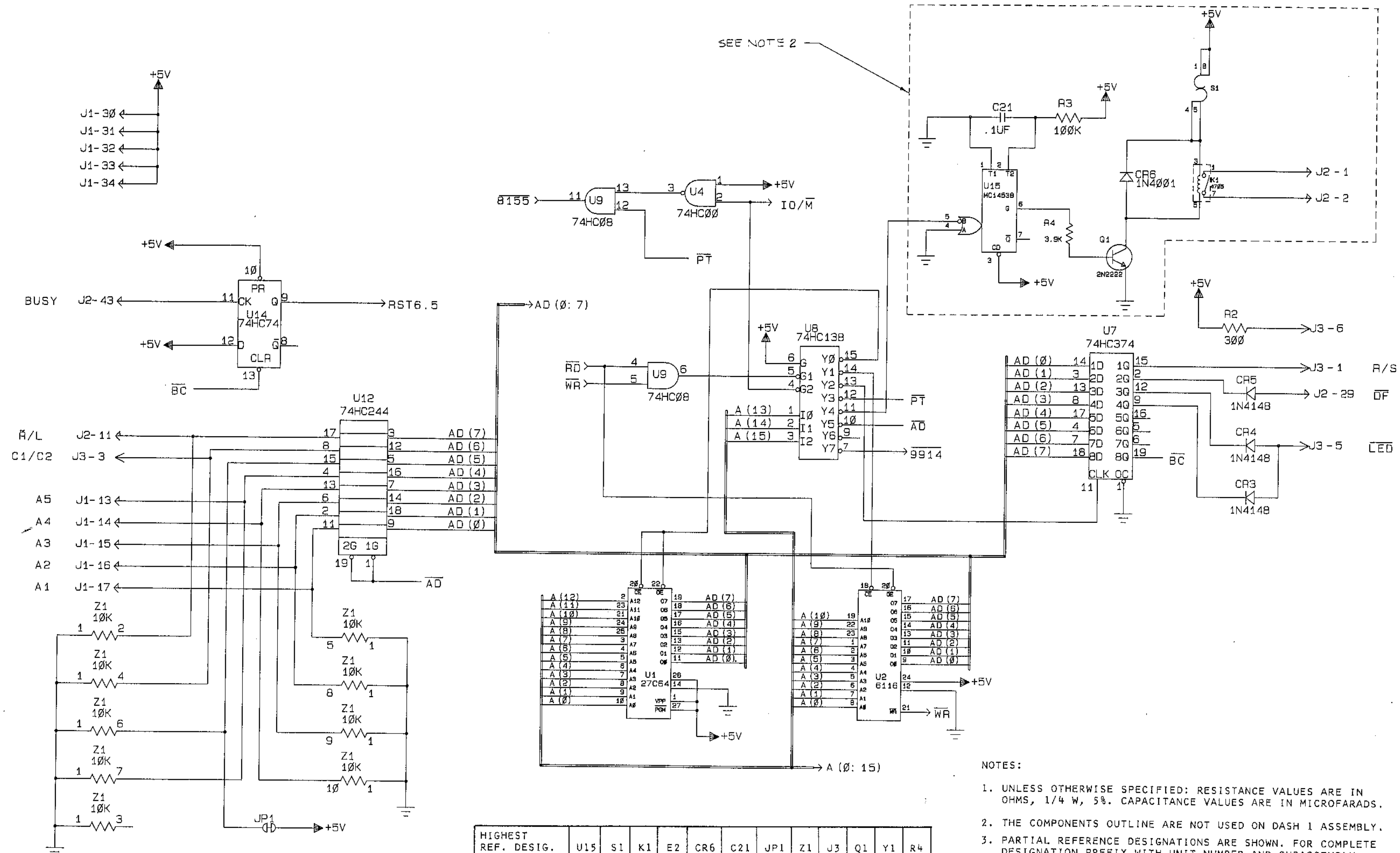
761701-1-E

Figure 8-5. Digital ±180° Circuit Card Assembly A3, Schematic Diagram (Sheet 1 of 2)



NOTES:
1. Z1 (74C00N), AND Z4, 7, 10, 13, AND 16 (MC14561) ARE 14 PIN TO +5 V.
2. Z2, 3, 5, 6, 8, 9, 11, 12, 14, AND 15 ARE 16 PIN IC'S WITH PIN 8 TO GND AND PIN 16 TO +5 V.
3. THIS SHEET IS FOR PCB 205745 "NO" REV.

Figure 8-5. Digital ±180° Circuit Card Assembly A3, Schematic Diagram (Sheet 2 of 2)

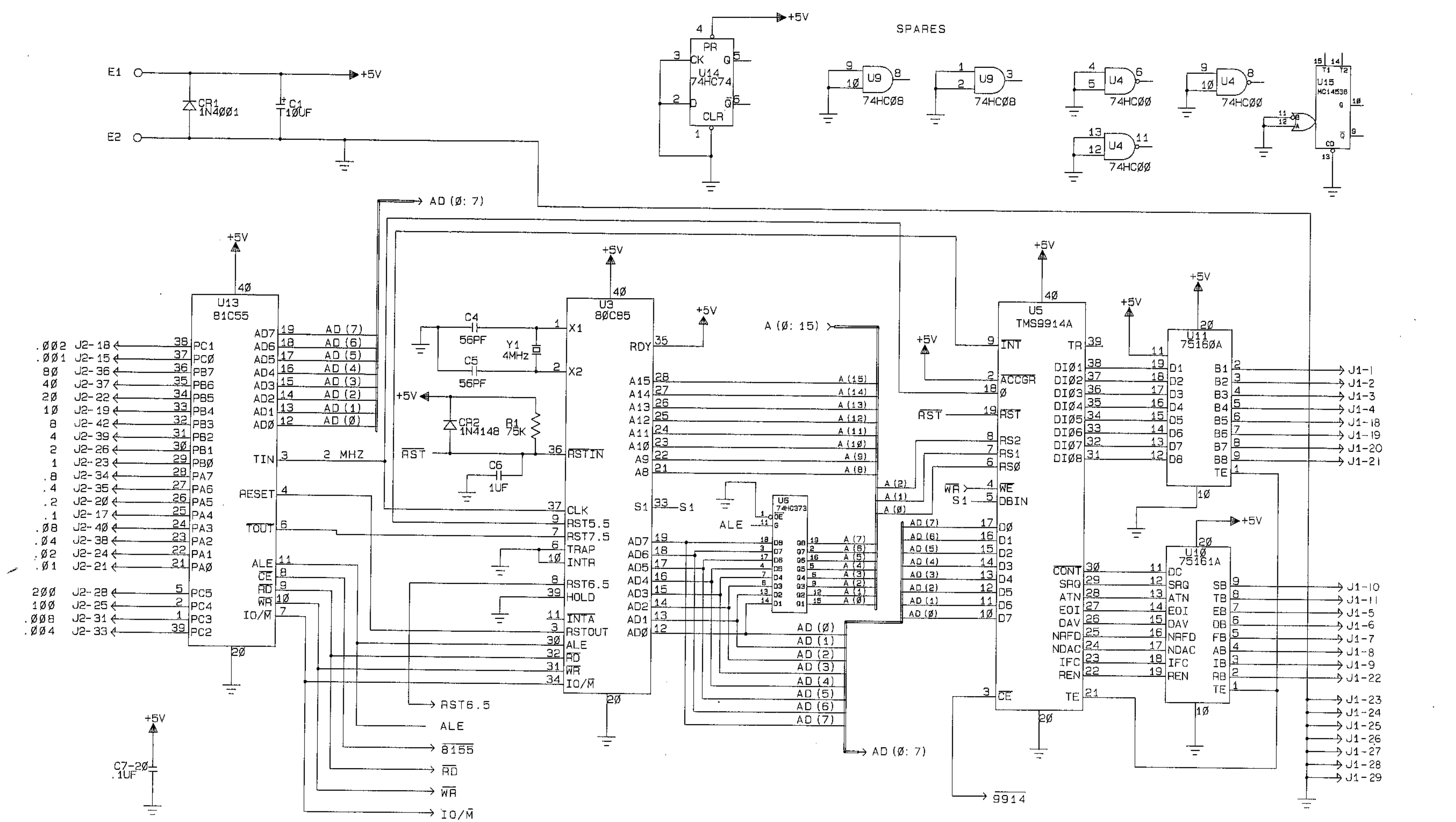


HIGHEST REF. DESIG.	U15	S1	K1	E2	CR6	C21	JP1	Z1	J3	Q1	Y1	R4
REF. DESIG. NOT USED	C2	C5										

NOTES:

1. UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS, 1/4 W, 5%. CAPACITANCE VALUES ARE IN MICROFARADS.
2. THE COMPONENTS OUTLINE ARE NOT USED ON DASH 1 ASSEMBLY.
3. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND SUBASSEMBLY DESIGNATIONS.
4. JUMPER JP1 TO BE CUT FOR UNITS WHICH HAVE +/- 180° OPTION.

Figure 8-6. IEEE Interface Circuit Card Assembly A4A1, Schematic Diagram (Sheet 1 of 2)



769031-E-2

Figure 8-6. IEEE Interface Circuit Card Assembly A4A1, Schematic Diagram (Sheet 2 of 2)

SECTION 9

UPDATE INFORMATION

9-1 INTRODUCTION

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

MODEL 8810 (TM-I-5017A) PRODUCT REVISION SHEET #28527 JULY 26, 1991
SEPTEMBER 22, 1989
FEBRUARY 2, 1995

1.0 ASSEMBLIES AND REVISION LEVELS AFFECTED:

1.1 Top Assembly NAI P/N 408810 Revision P and higher.
1.2 IEEE Interface Lower Chassis Assembly A4 NAI P/N 500916-1 Revision V and higher.
1.3 IEEE-488 Interface CCA A4A1 NAI P/N 787836-1 Revision D and higher.
1.4 IEEE MATE/CIIL Interface CCA A4A1 NAI P/N 787836-2 Revision D and higher.
1.5 IEEE MATE/CIIL Self-Test CCA A4A3 NAI P/N 789135 Revision A and higher.

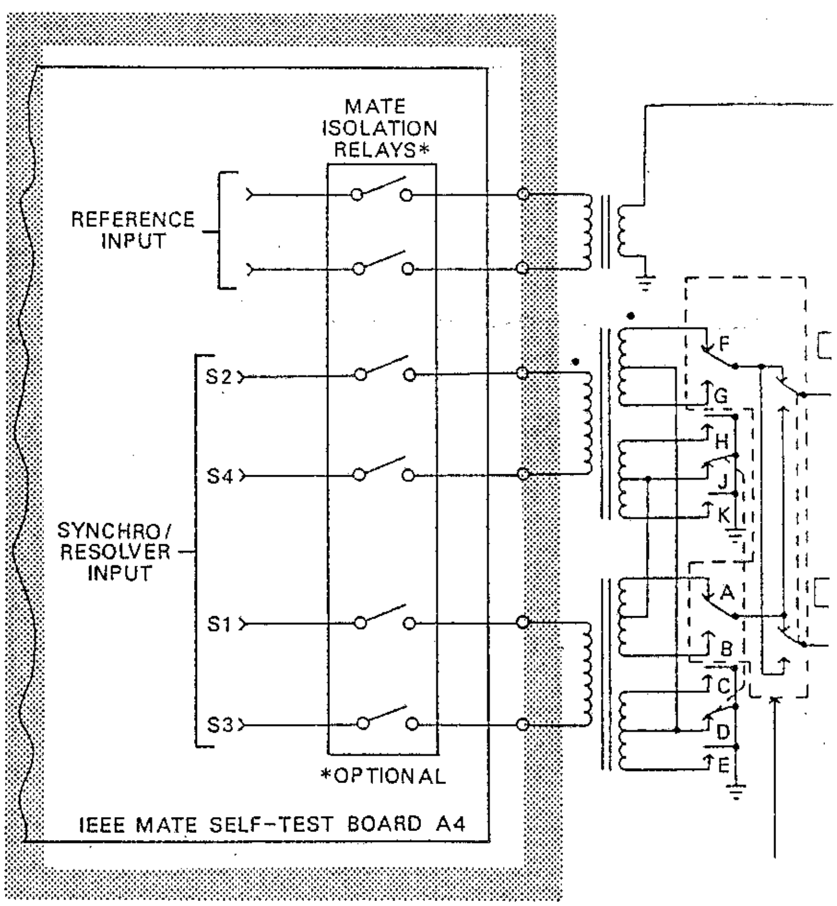
2.0 CHANGES:

2.1 In SECTION 1 - GENERAL INFORMATION add to paragraph 1-6 the following:

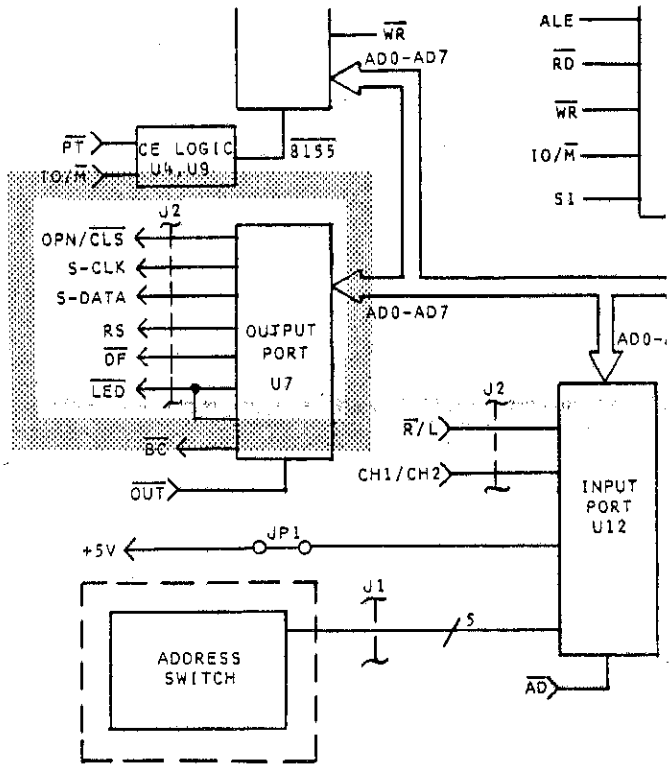
Ref Des	Description	NAI P/N	Current Revision
A4A3	8810 IEEE MATE/CIIL Self-Test CCA	789135	C

2.2 In SECTION 4 - THEORY OF OPERATION change the following:

2.2.1 Change figure 4-1 as shown:



2.2.2 Change figure 4-3 as shown:



2.2.3 In paragraph 4-3.5 add the following to the last subparagraph:

It also controls MATE/CIIL Self-Test (S-CLK, S-DATA) and isolation (OPN/$\overline{\text{CLS}}$) functions.

2.2.4 Add paragraph 4-4 and figure 4-4 as follows:

4-4 IEEE MATE/CIIL SELF-TEST BLOCK DIAGRAM DESCRIPTION

Refer to figure 4-4 for the following block diagram discussion. The block diagram represents the circuitry necessary to perform internal self-test for API synchro-to-digital circuits as required by MATE/CIIL IST and CNF commands (see section 5 for MATE/CIIL command descriptions).

The MATE/CIIL self-test circuits accept control signals from the IEEE-488 Interface and output analog resolver angle data which are applied to the API input circuits. Isolation relays are provided to allow internal circuitry self-testing without disconnecting front and rear panel inputs.

The MATE/CIIL self-test circuits consist of a serial input data receiver, resolver simulator circuits, and isolation relays.

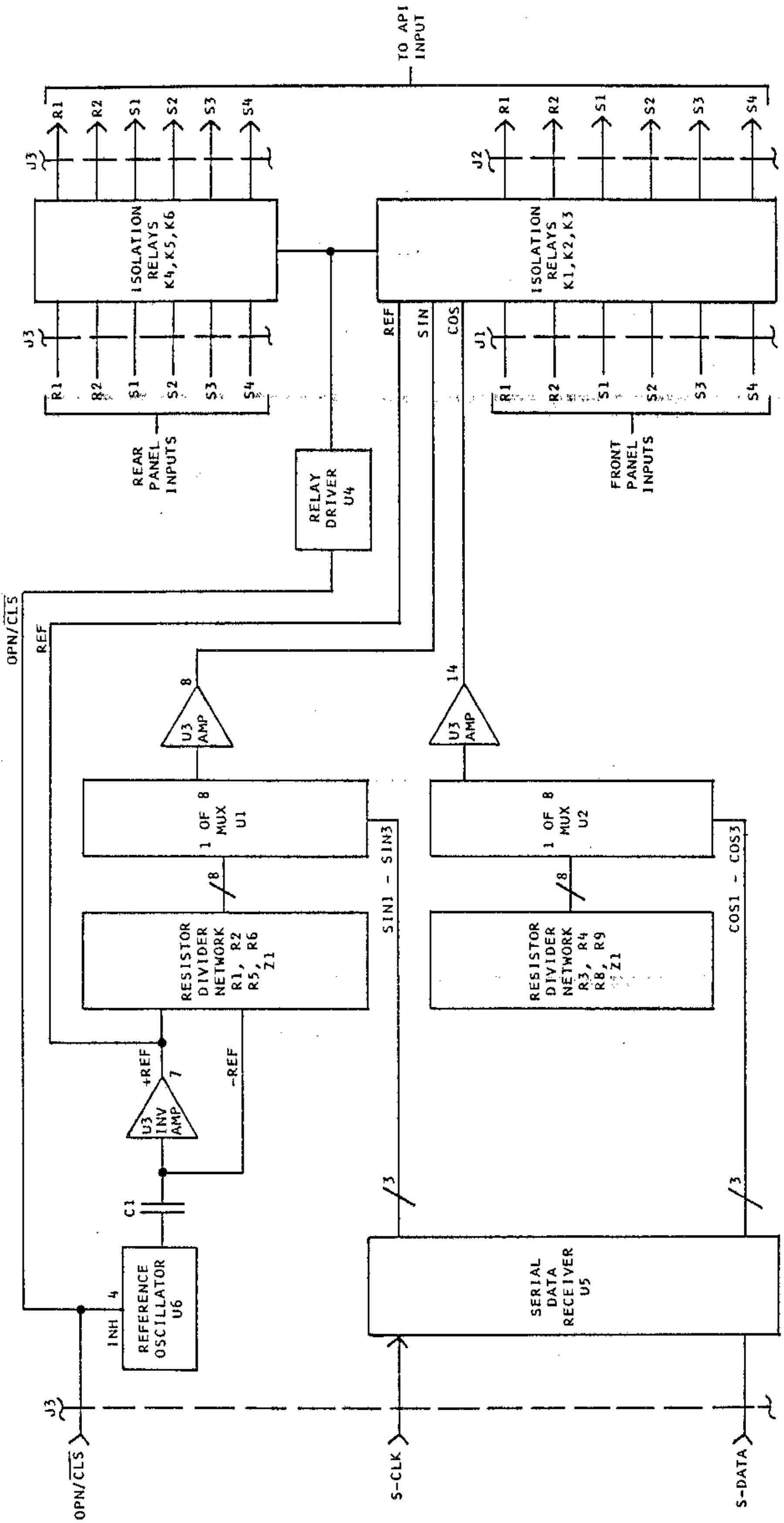


Figure 4-4. IEEE MATE/CIIL Self-Test CCA, Block Diagram

4-4.2 Resolver Simulator Circuits. The resolver simulator consists of a reference oscillator, resistor divider networks, 1 of 8 multiplexers, and amplification circuitry.

In operation, reference oscillator U6 is enabled when the OPN/$\overline{CLS}$ signal line is high. The oscillator produces a square-wave output signal of approximately 500 Hz. This square-wave output is inverted by amplifier U3-7 which produces signal -REF. Signals +REF and -REF are input to a resistor divider network. The resistor dividers generate three prositive and three negative voltage values, as well as 0 volts, for each resolver channel (SIN or COS). 1 of 8 multiplexers U1 and U2 select the proper SIN and COS output levels, respectively. Selection is based on the state of serial data receiver U5 control lines SIN1-SIN3 and COS1-COS3. Output voltage levels are buffered by amplifiers U3-8 and U3-14 and sent to the isolation relays.

4-4.3 Isolation Relays. In order to allow the connection of internal self-test signals to the API inputs, any external signals which may be present at these inputs must be isolated. Relays K1, K2, and K3 isolate the front panel inputs and relays K4, K5, K6 isolate the rear panel iputs. These relays are activated and isolate the inputs when the signal OPN/$\overline{CLS}$ of relay driver U4 is high. Internal self-test signals REF, SIN, and COS are applied to the API inputs once the relays are activated.

2.3 In SECTION 5 - 8810 IEEE-488 REMOVE OPERATION change the following:

2.3.1 Replace paragraph 5-7.3.8 with the following:

5-7.3.8 Format of IST. The IST command instructs the API to perform an internal self-test procedure. This consists of a 15-second test of the IEEE Interface CCA and the S/D Converter circuitry. After the test is completed the result can be obtained by issuing the STA command (unit status). No messages are allowed to be sent to the API while the test is in progress or an error message will be generated. When the test is complete the API will be in the open state (OPN). The format of the IST command is:

IST<cr,lf>

2.3.2 Replace paragraph 5-7.3.9 with the following:

5-7.3.9 Format of CNF. The CNF command instructs the API to perform a confidence test. In the API this test is an abbreviated version of the IST test and requires eight seconds to complete. When the test is complete the API will be in the open state (OPN). The format of the CNF command is:

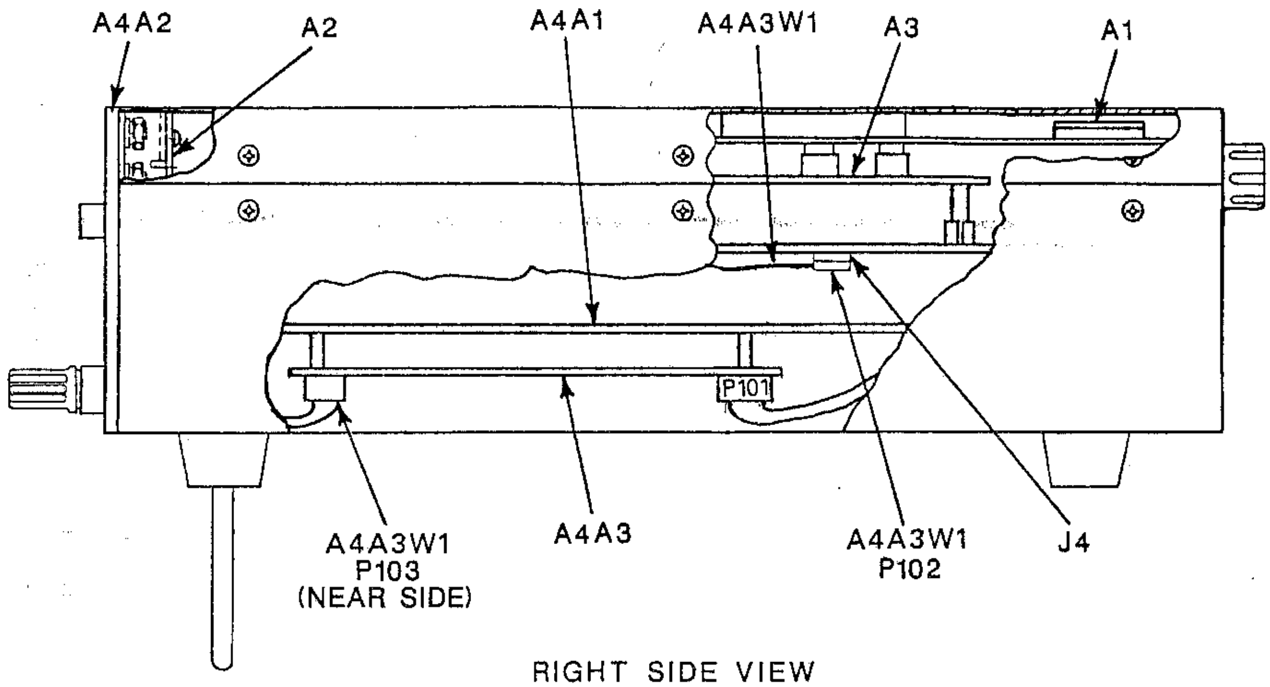
CNF<cr,lf>

2.4 In SECTION 7 - PARTS LIST change the following:

2.4.1 Add the following to table 7-8:

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
A4A3	IEEE MATE/CIIL Self-Test CCA	789135	07342	789135
A4A3W1	8810 Self-Test Cable Assembly #2	789261	07342	789261

2.4.2 Change figure 7-1 (Sheet 1 of 4) as shown:

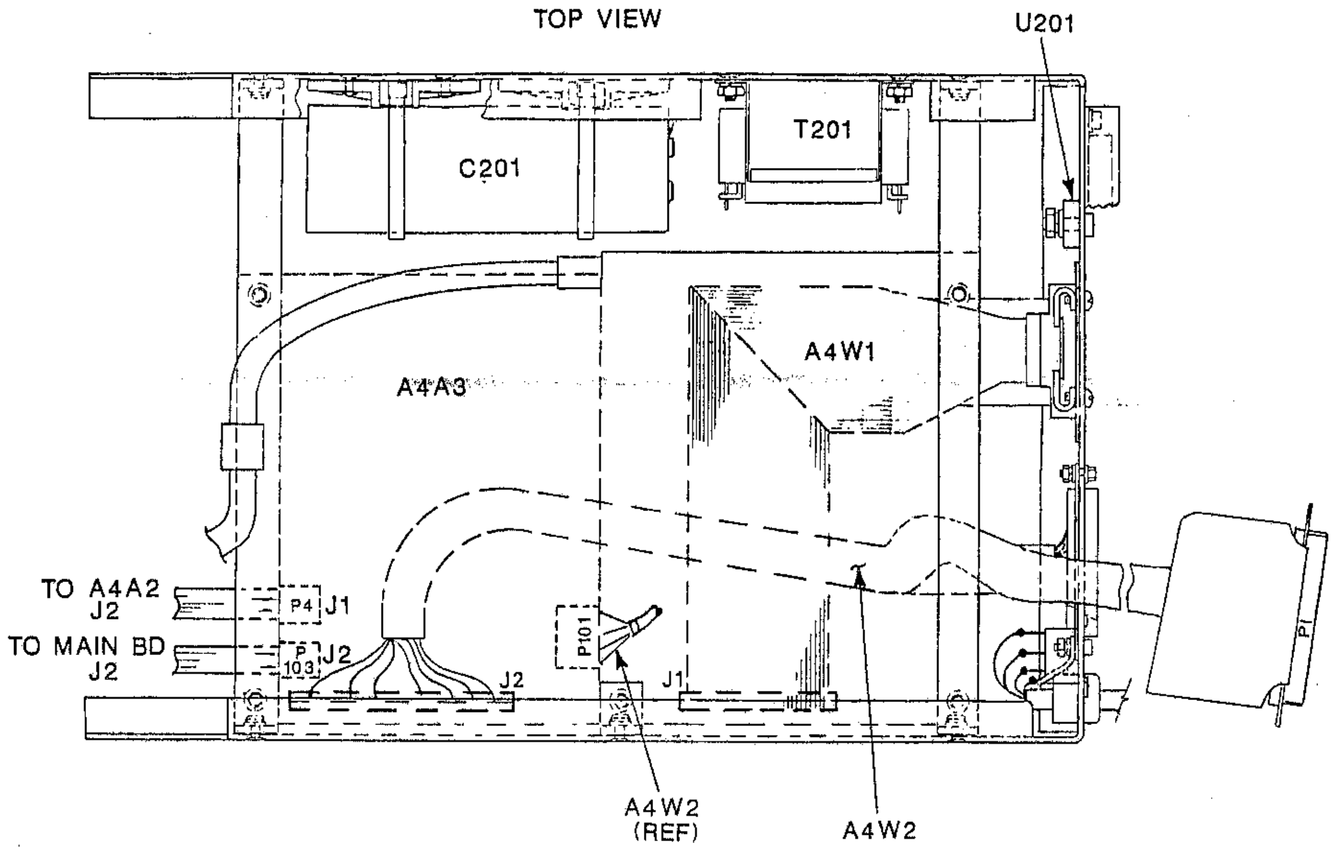


RIGHT SIDE VIEW

2.4.3 Add the following to table 7-16:

Ref Des.	Description	NAI P/N	FSCM	MFR P/N	UOC
A4A3	IEEE MATE/CIIL Self-Test CCA	789135	07342	789135	B
A4A3W1	8810 Self-Test Cable Assembly #2	789261	07342	789261	B
A4W1	Cable Assembly, IEEE Interface	787219	07342	787219	
A4W2	Modified Cable Assembly, IEEE MATE/ CIIL Interface (Harness)	789260	07342	789260	B

2.4.4 Change figure 7-6 as shown:



2.4.5 Add table 7-18 replacement parts list and figure 7-8 as follows:

Table 7-18. IEEE MATE/CIIL Self-Test CCA A4A3 - 789135

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
C1	Capacitor, Tantalum, 47 uf, 25 VDC, ±10%	884614	56289	199D476X9025FA2
C2	Capacitor, Ceramic, 0.01 uf, 100 V, ±10%, Axial Leads	887766	90201	CKR11BX103KP
C3	Capacitor, Ceramic, 0.0015 uf, 100 V, ±10% Axial Leads	886733	96095	SA101C152KAA
C4	Same as C1			
C5	Same as C2			
C6	Same as C1			
C7	Same as C2			
C8	Same as C1			

Table 7-18. IEEE MATE/CIIL Self-Test CCA A4A3 - 789135 (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
C9	Same as C2			
J1	Socket, 16-pin DIP	808197	00779	2-640358-3
J2	Same as J1			
J3	Header, Right Angle, 50-pin	887286	51167	50-903-42
K1	Relay, 5 V, Coil, PDPT	889073	05065	MR602-5SK
K2-K6	Same as K1			
K7	Relay, 5 V, Coil, SPST	888067	95348	4705
R1	Resistor, Metal Film, 2.67 k, 1/10 W, ±1%	887987	16299	Type C4
R2	Resistor, Metal Film, 7.32 k, 1/8 W, ±1%	887370	81349	RN55D7321D
R3	Same as R2			
R4	Same as R1			
R5	Same as R2			
R6	Same as R1			
R7	Resistor, Metal Film, 9.09 k, 1/8 w, ±1%	884642	81349	RN55D9091F
R8	Same as R2			
R9	Same as R1			
R10	Same as R7			
R11	Resistor, Metal Film, 1 k, 1/8 w, ±1%	882479	81349	RNR55E1001FS
R12	Resistor, Metal Film, 1 Meg, 1/10 W, ±1%	808262	16299	NA55
TP1	Post	880007	00779	87022-9
TP2-TP9	Same as TP1			
U1	IC, 1 of 8 Analog Multiplexer, 16-pin DIP	888952	17856	DG508ACJ
U2	Same as U1			
U3	IC, Quad Op-Amp, 14-pin DIP	808496	17856	TL084
U4	IC, Dual Darlington Driver, 8-pin DIP	886050	80183	ULN2061M
U5	IC, CMOS, High Speed Shift Register, 8-bit, 14-pin DIP	888955	04713	MC74HC164N

Table 7-18. IEEE MATE/CIIL Self-Test CCA A4A3 - 789135 (Continued)

Ref Des.	Description	NAI P/N	FSCM	MFR P/N
U6	IC, CMOS, Timer, 8-pin	888953	82647	TLC555C
U7	DC/DC Converter, 5 V Input, ±15V Output, 750 mW, Isolated, Unregulated	889438	13919	HPR105
Z1	Resistor Network, 10 k, ±2%	808481	32997	4310R-102-103
Z2	Same as Z1			
Z3	Resistor Network, 3.3 k, 1/2 W, 3 Resistor, 6-pin	889551	32997	4306M-102-332
Z4	Same as Z3			

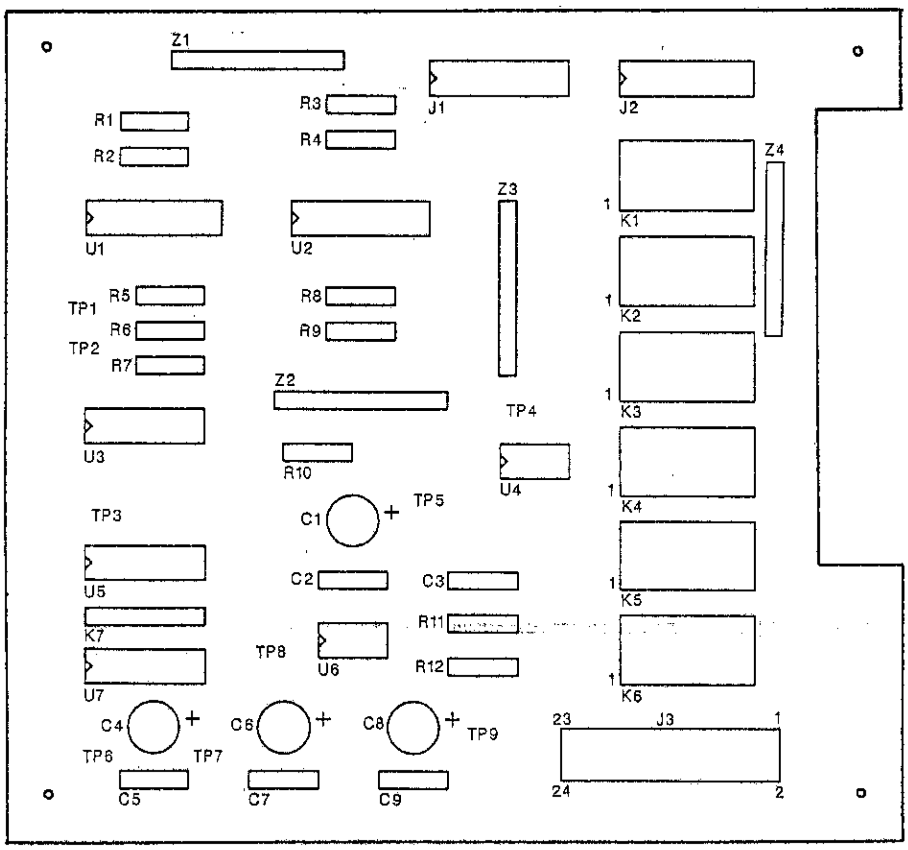


Figure 7-8. IEEE MATE/CIIL Self-Test CCA A4A3, Parts Location Diagram

2.5 In SECTION 8 - SCHEMATIC DIAGRAMS change the following:

2.5.1 In paragraph 8-1 add the following figure title:

FIGURE	TITLE	PAGE
8-7	IEEE MATE/CIIL Self-Test CCA	8-21

2.5.2 Change figure 8-1 (Sheets 1 and 3) as shown in this addendum.

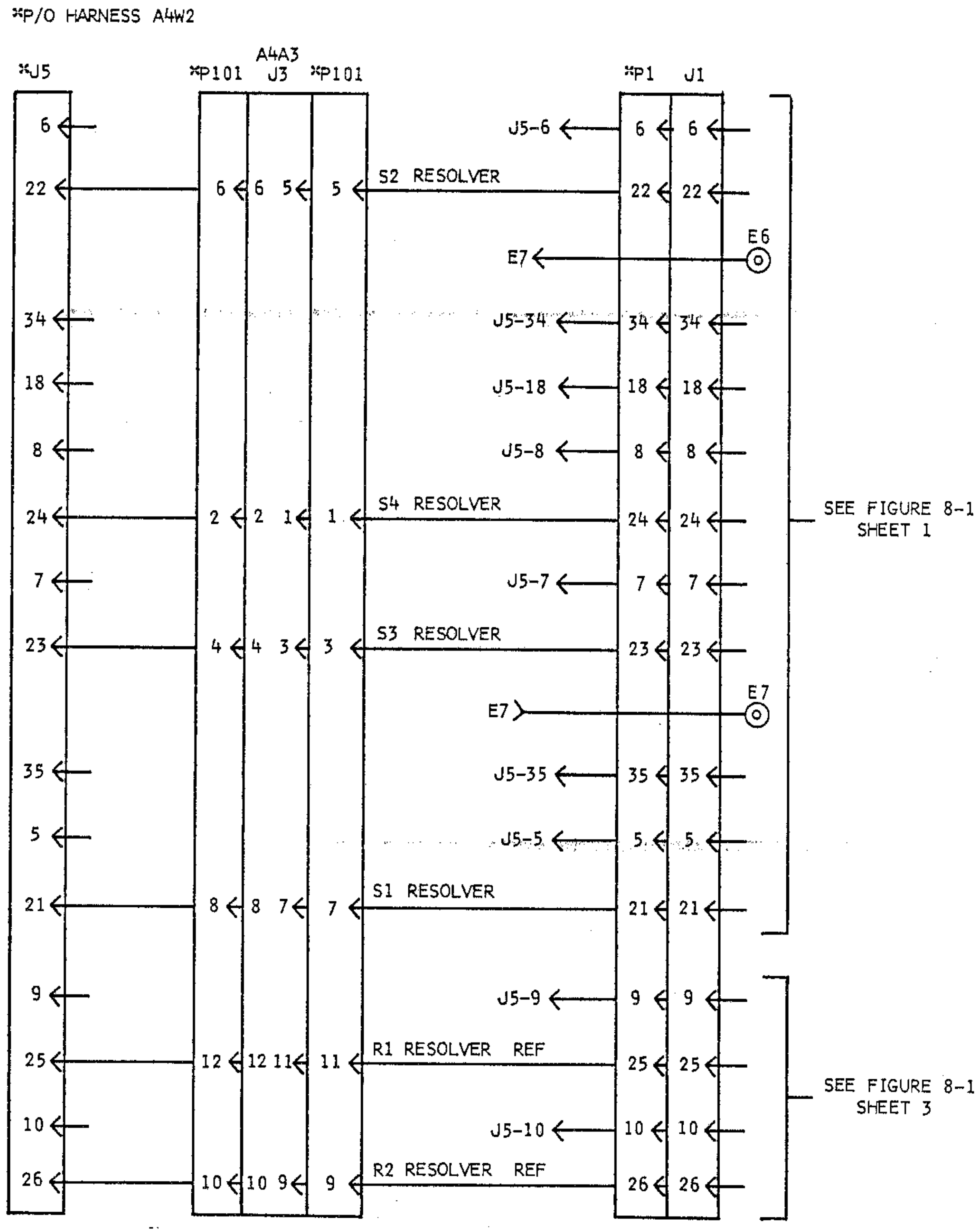


Figure 8-1. (Sheet 1 of 5)

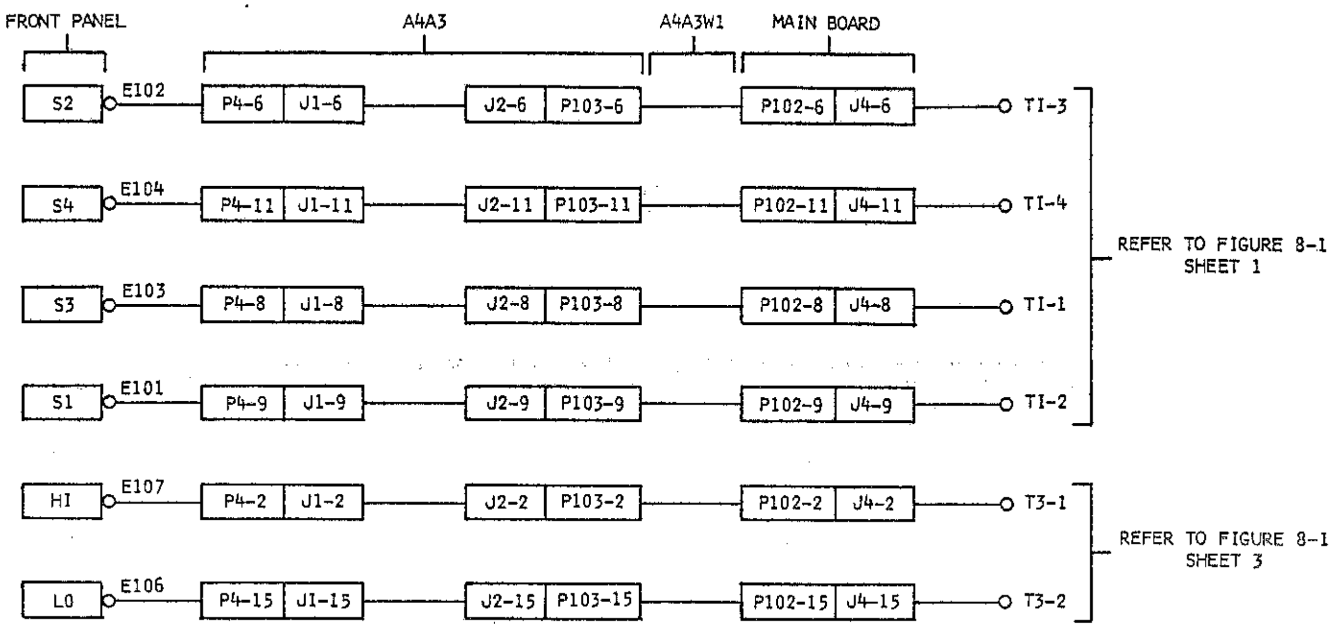
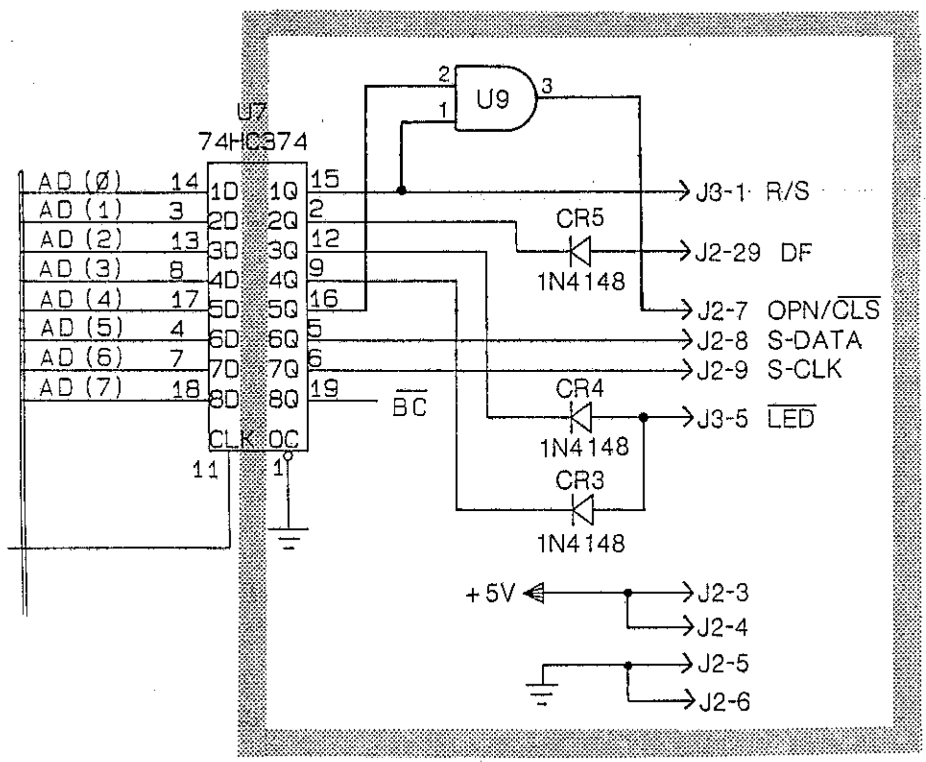
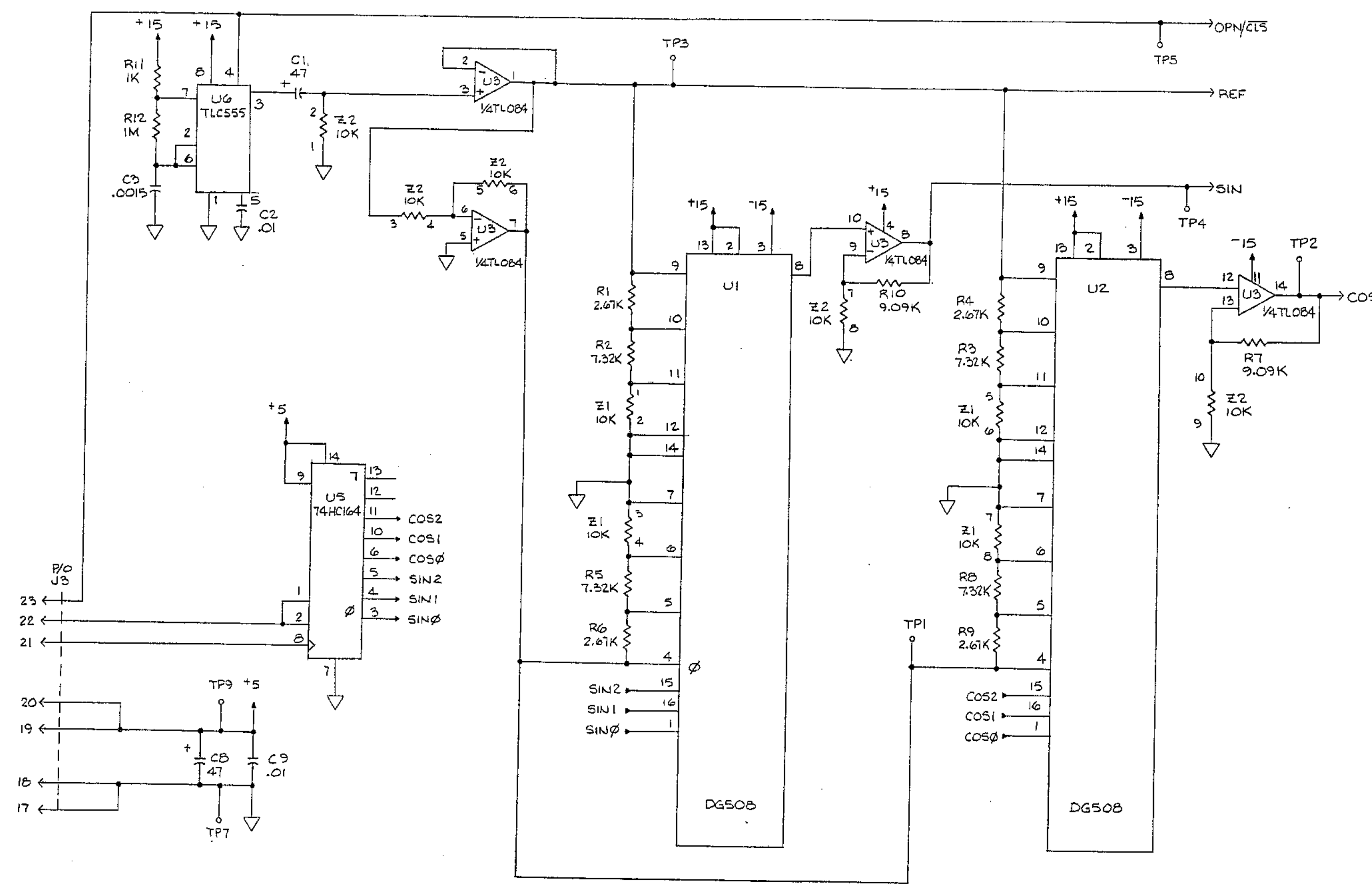


Figure 8-1. (Sheet 3 of 5)

2.5.3 Change figure 8-6 (Sheet 1 of 2) as shown:

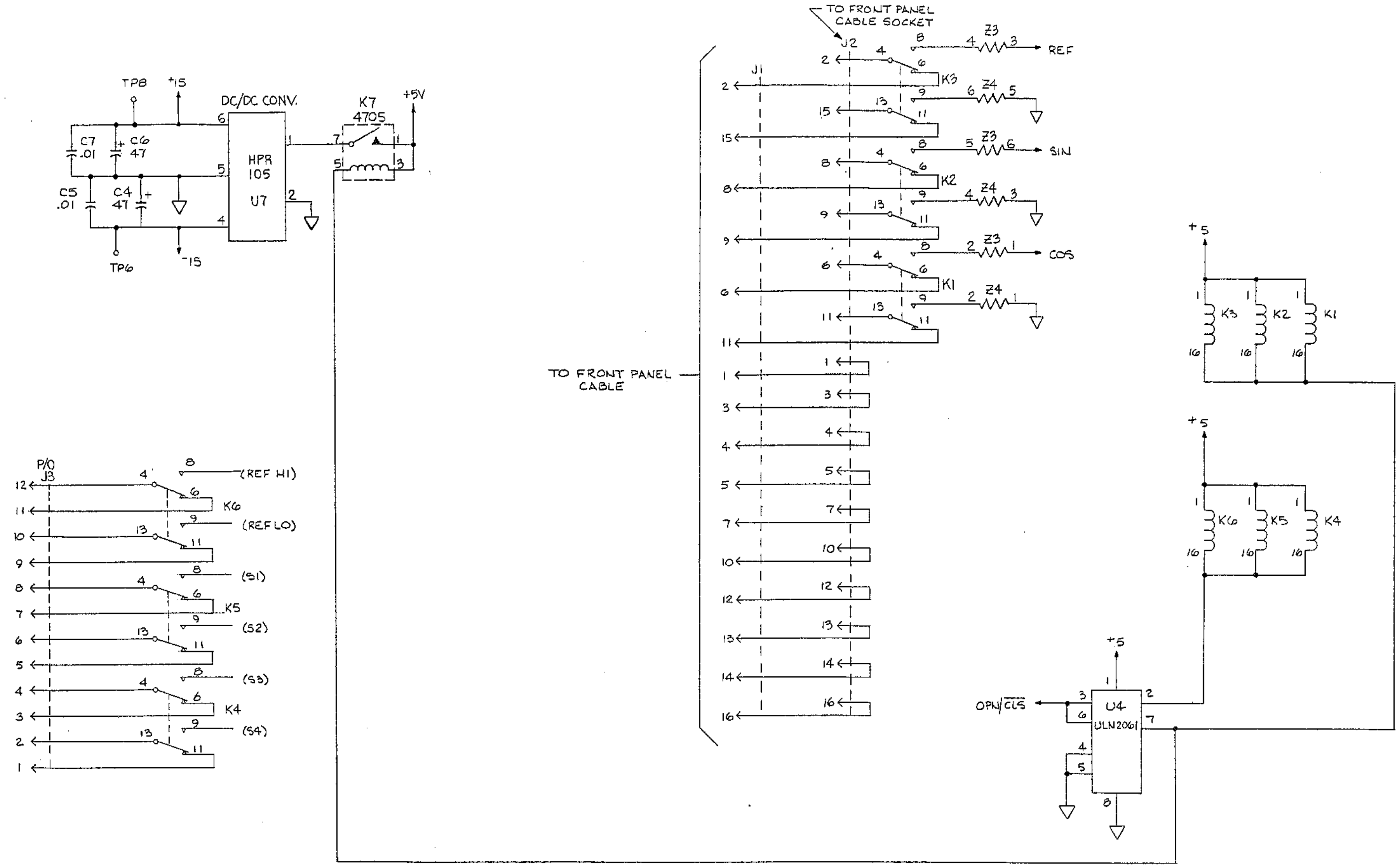


2.5.4 Add figure 8-7 as shown in this addendum.



769111-E-1

Figure 8-7. IEEE MATE Self-Test CCA - A4A3, Schematic Diagram (Sheet 1 of 2)



769111-C-2

Figure 8-7. IEEE MATE Self-Test CCA - A4A3, Schematic Diagram (Sheet 2 of 2)

SERVICE BULLETIN

north atlantic

Instrument Division
February 16,1990

Service Bulletin No. 145

REFERENCE: MODEL 8810 and MODEL 5310 IEEE-488 INTERFACE

North Atlantic Industries has been alerted to customer difficulties when using current model 8810 and 5310 replacements in systems originally setup using older models. There have been subtle changes made to our IEEE-488 interface design to enhance and speed operation. The following list highlights the effected areas of change.

MODEL 8810

The Model 8810 design has changed from the older one which used a 6802 microprocessor to the new design using an 8085 microprocessor. The major difference occurs in response state of the Serial Poll status byte. In the older Model 8810 the serial Poll status byte, bit 5 (DI06) is set to 1 when the front panel REM switch is not engaged (indicating Local control) and is 0 when the REM switch is engaged. The current version has front panel LED indicators and takes advantage of the local lockout capability so that it has the Serial Poll byte, bit 5 (DI06) always 0.

MODEL 5310

The model 5310 has been upgraded from an older hard logic design to the new design using an 8085 microprocessor. The affected areas of change are in its defined "Listen Only" state and how it responds to unadddressed bus commands.

The original design could cause a bus hangup if the model 5310 was inadvertently adressed for Talk responses such as Serial Poll and request for data. The current design allows for the same "Listen Only" state, however it will respond with zero for Serial Polls and with a Null for data requests.

North Atlantic Indusries Inc., 60 Plant Avenue, Hauppauge, New York, 11778-3890
Tel:516-582-6500 o Fax:516-582-8079 o TWX:510-227-9660 NO ATL INDUS o TLX:685-2370 NOATL

WARRANTY

A. The seller warrants products against defects in material and workmanship for one year 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, and 3) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, relays, gear trains, 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 forgoing.

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 container with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitable 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.

DECLARATION OF CONFORMITY

We **NORTH ATLANTIC INDUSTRIES**
110 WILBUR PL.
BOHEMIA, NY 11716-2416

declare under our sole responsibility that the product(s)

8810 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 DIRECTIVES: 89/336/ EEC
73/23/EEC

Place Bohemia, NY, U.S.A.

(Signature)

Date 8/19/08

Roger V. Maurizio
(Full Name)

Quality Manager
(Position)

FORM008