

# ORTEC

INCORPORATED

AN  EG&G COMPANY

ELECTRONICA

SERVICE ✓

Models 401A and 401B

Modular System Bins

and Model 402H

Power Supply

Operating and Service Manual

# **ORTEC**

Models 401A and 401B  
Modular System Bins  
and  
Model 402H  
Power Supply

## **Operating and Service Manual**

This manual applies to instruments

401A "Rev 27" (on rear panel)  
401B "Rev 03" (on rear panel)  
402H "Rev 14" (on rear panel)

## STANDARD WARRANTY FOR ORTEC INSTRUMENTS

ORTEC warrants its instruments other than preamplifier FET input transistors, vacuum tubes, fuses, and batteries to be free from defects in workmanship and materials for a period of twelve months from date of shipment provided that the equipment has been used in a proper manner and not subjected to abuse. Repairs or replacement, at ORTEC option, will be made on in-warranty instruments, without charge, at the ORTEC factory. Shipping expense will be to the account of the customer except in cases of defects discovered upon initial operation. Warranties of vacuum tubes and semiconductors made by their manufacturers will be extended to ORTEC customers only to the extent of the manufacturers' liability to ORTEC. Specially selected vacuum tubes or semiconductors cannot be warranted. ORTEC reserves the right to modify the design of its products without incurring responsibility for modification of previously manufactured units. Since installation conditions are beyond the company's control, ORTEC does not assume any risks or liabilities associated with methods of installation or with installation results.

### QUALITY CONTROL

Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

### REPAIR SERVICE

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization

Number can be assigned to the unit. Also, ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

### DAMAGE IN TRANSIT

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

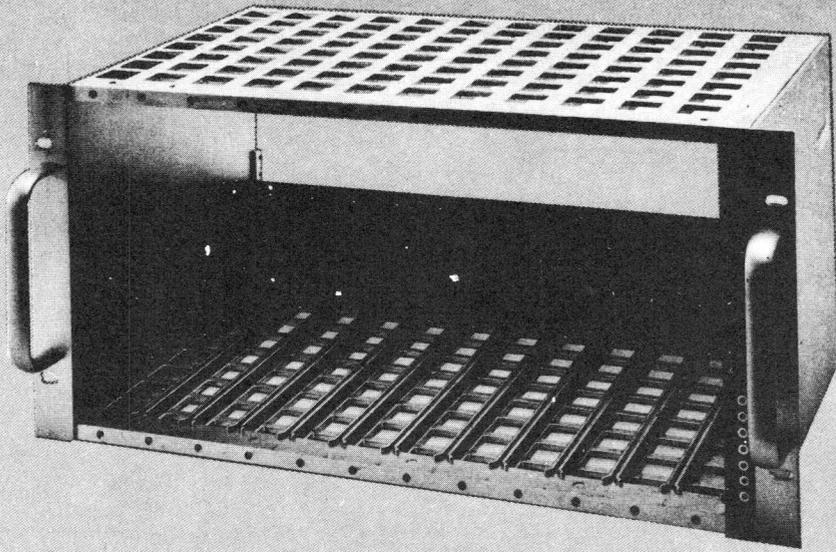
## CONTENTS

## 401A and 401B MODULAR SYSTEM BIN

	Page
WARRANTY . . . . .	2
PHOTOGRAPHS . . . . .	4
1. DESCRIPTION . . . . .	5
2. SPECIFICATIONS . . . . .	6
3. INSTALLATION . . . . .	6
4. OPERATING INSTRUCTIONS . . . . .	7
5. CIRCUIT DESCRIPTION . . . . .	8
6. MAINTENANCE INSTRUCTIONS . . . . .	8
APPENDIX	
Replaceable Parts . . . . .	9
Schematics & Drawing	
401A-0100-S1 . . . . .	11
401-0002 Hardware and Connector Drawing . . . . .	13

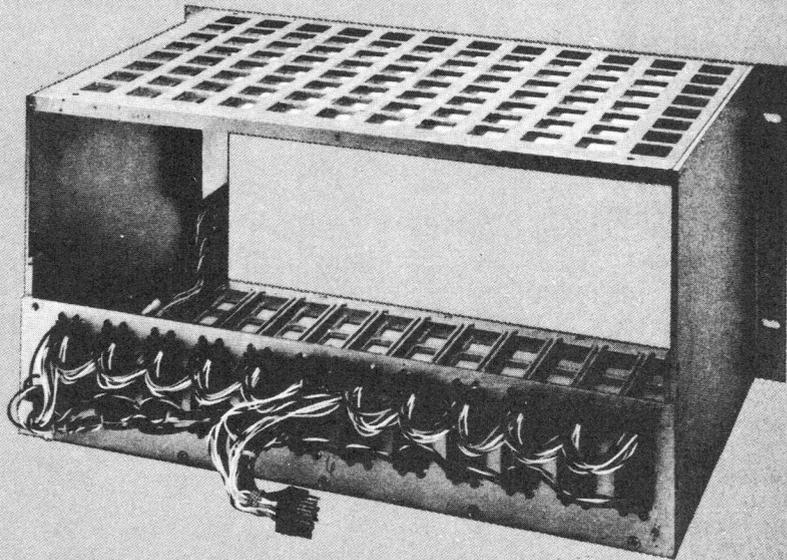
## 402H POWER SUPPLY

PHOTOGRAPH . . . . .	14
1. DESCRIPTION . . . . .	15
2. SPECIFICATIONS . . . . .	15
3. INSTALLATION . . . . .	16
4. OPERATING INSTRUCTIONS . . . . .	16
5. CIRCUIT DESCRIPTION . . . . .	17
6. MAINTENANCE INSTRUCTIONS . . . . .	18
APPENDIX	
Replaceable Parts . . . . .	20
Schematics	
402H-0201-S1 . . . . .	29
402H-0301-S1 . . . . .	31
402H-0401-S1 . . . . .	33

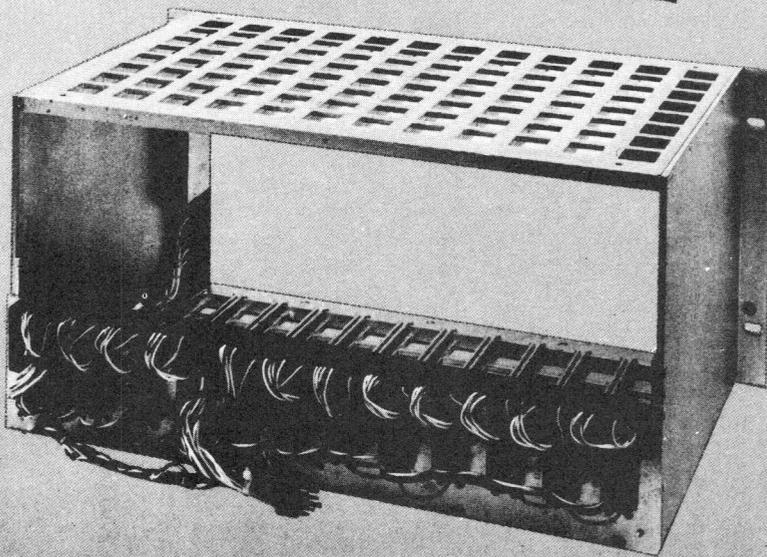


401A or 401B

401A



401B



## ORTEC 401A AND 401B MODULAR SYSTEM BIN

### 1. DESCRIPTION

#### 1.1. AEC STANDARD MODULE PROGRAM

The ORTEC 401A(B) Modular System Bin conforms to the recommended standards of AEC Report TID-20893 (Rev.), "Standard Nuclear Instrument Modules." This report, the work of a committee of equipment users from AEC-related institutions, provides standards for a modular instrument system that allow electrical and mechanical interchangeability of units made in conformance with the standards. The standards prescribe the necessary mechanical dimensions and connector types to ensure mechanical interchangeability. They also specify standard power supply voltages and pin assignments in the connectors so that electrical interchangeability is assured, at least with respect to the main connector joining module to bin.

The standards currently specify power supply voltages of plus and minus 6, 12, and 24 V dc and of 115 V ac delivered to assigned module connector pins. The available current specified to each pin has undergone some change with successive issues of the standards. Refer to the most recent issue of TID-20893 (Rev.) and addenda for current requirements. Also, since power supplies of earlier manufacture conformed to earlier versions of the standards, the user should familiarize himself with the specifications of the particular supply in use to determine the available current at each voltage.

Twelve basic module widths of 1.35 in. each are provided in a standard bin. Modules may be of single width or any multiple thereof as required by the individual module design. However, all 12 module connectors are provided in the standard bin, allowing any desired combination of module location. Two module and bin heights are provided by the standards, 8 $\frac{3}{4}$  in. and 5 $\frac{1}{4}$  in. These standard heights, as well as the basic external mounting dimensions of the bin, conform to the established ASA standards for relay rack mounting of electrical equipment. Therefore the TID-20893 (Rev.) standard bins will mount in standard relay racks along with other rack-mounted equipment.

The TID-20893 (Rev.) standards deal only with requirements for electrical and mechanical interchangeability. They do not deal with circuit designs or methods except to the extent of the power supply voltage standards.

In addition to the firm requirements designated as "Standards" in TID-20893 (Rev.), there are "Preferred Practices" which deal with subsidiary matters in the interest

of suggested further compatibility. Included in the Preferred Practices are standard linear and logic signal parameters which, if observed, allow compatible interconnections between instruments.

#### 1.2. ORTEC MODULAR INSTRUMENTS

ORTEC Modular Nuclear Instruments conforming to the standards of TID-20893 (Rev.) are designed for insertion and operation in a 401A(B) Bin with an attached mating power supply. In addition to meeting the basic requirements of TID-20893 (Rev.), each ORTEC module also provides two additional compatibility features:

1. Where applicable, the standard linear and logic signal parameters of the Preferred Practices of TID-20893 (Rev.) are used, providing compatible interconnections between instruments.
2. The power supply demand of any given ORTEC module is limited to no more than its proportional share of the occupancy of Bin space. In this way, the user does not have to compute the power supply total demand and compare this to the capability of the supply. Any system of ORTEC modules will automatically be compatible with the available Bin power.

These ORTEC instrument modules are made only in the 8 $\frac{3}{4}$ -in.-high standard module package. The panel space requirements of this type of research instrumentation have precluded the use of the smaller 5 $\frac{1}{4}$ -in. standard height.

#### 1.3. ORTEC 401A(B) MODULAR SYSTEM BIN

The ORTEC 401A Modular System Bin provides mounting space for 12 standard module widths of the 8 $\frac{3}{4}$ -in.-high type. The 12 corresponding module connectors are provided, with necessary wiring for distribution of all of the standard power supply voltages. The ORTEC 401B Bin is identical except that the standard power supply voltages are distributed to the module connectors through bus bars instead of wires. These power distribution circuits terminate in the standard connector prescribed by TID-20893 (Rev.) for connection to the power supply. A small control panel, not occupying any of the available module space, is located at the right side of the Bin, providing the dc level test points, a control switch, and indicator lamps for the power supply. Further description of the 401A(B) Bin is given in the remaining sections of this manual.

## 1.4. POWER SUPPLY CONSIDERATIONS

The power supply provisions of TID-20893 (Rev.) allow either a supply mounted on the rear of the standard bin or an external supply, possibly furnishing power to several standard bins. Specified mounting-screw dimensions and a standard power connector make the bin-mounting power

supplies interchangeable when they are made to the TID-20893 (Rev.) standards.

The ORTEC 402A or 402H Power Supply, which conforms to the requirements of TID-20893 (Rev.) in force at time of manufacture, is usually furnished with the 401A(B) Bin. Please refer to the instruction manual provided with each Power Supply.

## 2. SPECIFICATIONS

**MECHANICAL TOLERANCES** In accordance with TID-20893 (Rev.) provide for interchangeability of all standard modules.

**PANEL DIMENSIONS** Standard Relay Rack, 8 $\frac{3}{4}$  in. high, 19 in. wide.

**DEPTH BEHIND PANEL** Without Power Supply, 10.5 in. (26.6 cm); with 402A Power Supply, 16.0 in. (40.6 cm); with 402H Power Supply, 18.0 in. (45.7 cm).

**MODULE CONNECTORS** 12 each connectors as specified by TID-20893 (Rev.).

**INSTALLED WIRING** All connectors of the 401A are wired in parallel for +6 V, -6 V, +12 V, -12 V, +24 V, -24 V, high-quality power return and 115 V ac, in

accordance with TID-20893 (Rev.) pin assignments, with interface connector furnished for connection to power supply as required by TID-20893 (Rev.). The 401B is equipped with laminated bus bars on the +6 V, -6 V, +12 V, -12 V, +24 V, -24 V (AWG #14 equivalent) and for the power ground return (AWG #10 equivalent).

**CONSTRUCTION** Extruded aluminum side members. Die-cast aluminum top and bottom members containing module guides and cadmium-plated steel rear connector plate. Iridite or cadmium finished, with convenience handles on front panel mounting members.

**WEIGHT** 28 lb net with 402A Power Supply; shipping weight 35 lb; 36 lb net with 402H Power Supply; shipping weight 43 lb.

## 3. INSTALLATION INSTRUCTIONS

### 3.1. POWER SUPPLY INPUT VOLTAGE

The ORTEC 402A or 402H Power Supply that usually accompanies the 401A(B) Bin may be used on either 115 V or 230 V, 50 or 60 Hz, input power. The conversion from one voltage to the other is accomplished by a slide switch located on the rear of the Power Supply, labeled as to voltage choice. The Power Supply will be shipped with the voltage set according to the customer's order instructions. However, it is prudent to check this switch for proper setting before operating the supply on 230 V. The power transformer is tapped for a simple conversion to 100-V or 200-V input levels.

Note that when the Power Supply is operated from 115-V input power, a direct connection provides the 115-V ac

power to the assigned pins in the module connectors and the amount of 115-V power available is limited only by the fuse. However, when input power is 230 V, the 115-V ac power provided for the module connectors is limited by transformer ratings in the Power Supply, as stated in the Power Supply specifications.

The fuse supplied installed in the Power Supply is the proper one for input voltage selection as shipped. If a field change of input voltage is made, the proper fuse change should be made as outlined in the Power Supply instruction manual.

### 3.2. INSTALLATION IN RACK

The mounting provisions of the 401A(B) Bin conform to the well-established ASA standards for rack mounting equipment. The mounting holes at the edge of the panel will

match the standard spacing of tapped 10-32 holes provided in the standard relay rack. The use of the usual oval-head screws and cup washers is recommended. Mechanical support of the Bin may be entirely from the panel members. However, the use of horizontal guide brackets to support the bottom of the Bin will facilitate removal of the Bin from the rack and will remove strain from the Bin and rack.

The basic design of the TID-20893 (Rev.) standard bin and modules provides for cooling by natural convection flow. Several bins can be mounted above each other without heat problems in the usual installation. However, one should not mount heat-producing vacuum tube equipment or other large sources of heat in the same cabinet with the standard bin without accounting for the temperature rise.

The use of cooling fans in equipment cabinets will reduce the operating temperature of the enclosed equipment. How-

ever, it will also invariably couple the circuits involved more tightly to the temperature variations of the environment. In systems installations requiring the ultimate in stability of operating parameters, the best practice is to provide only for natural convection cooling of the equipment. This provides long time constants between the equipment and external temperature variations, with resultant smaller variations, even though the average absolute temperature may be higher.

ORTEC modules are designed with all major signal connections on the front panel to the greatest extent possible. In some cases secondary connections are located on the rear of the module when necessary, due to panel space limitations. If systems are contemplated that require use of rear panel connections to any great extent, the user may find it convenient to leave open gaps between installed bins for convenience in making front-to-rear connections.

## 4. OPERATING INSTRUCTIONS

### 4.1. CONTROL PANEL FUNCTIONS

**ON-OFF** Switch interrupts both sides of the input power line.

**POWER** Pilot lamp indicates that ac input power is being supplied to the power transformer primary. Either a blown fuse or a temperature cutout will extinguish this lamp.

**TEMP** Warning pilot lamp is illuminated if the Power Supply temperature rises to within  $\sim 20^{\circ}\text{C}$  of the maximum safe operating temperature. When the maximum safe temperature is reached, an internal cutout in the Power Supply removes power and neither lamp will be illuminated.

**TEST JACKS** Located on the panel allow convenient checking of the Power Supply voltages from the front panel without disassembly of the supply.

### 4.2. POWER SUPPLY LIMITATIONS

The available current at each voltage is dependent on the Power Supply. Since the requirements of TID-20893 (Rev.)

have been changed from time to time, the actual capability of any given power supply will depend on its date of manufacture. The instruction manual for the particular power supply in use should be consulted.

The power requirements of individual modules are stated on their front panels. The user should verify that the Power Supply capability is not exceeded in any given system in one bin. Note that a system composed entirely of ORTEC modules will not require this verification, since each ORTEC module uses no more power than its proportional share based on panel space occupancy in the Bin.

### 4.3. INSERTION AND REMOVAL OF MODULES

No damage will result to the Power Supply from insertion or removal of modules while power is on. However, since the sequence of power application to a module is indeterminate when inserted with Bin power on, it is prudent to turn off the Bin power when modules are being changed or inserted.

## 5. CIRCUIT DESCRIPTION

The Bin circuit consists only of passive power distribution wiring. The accompanying wiring diagram provides full information on the wiring.

Power Supply circuit information is contained in the 402A or 402H Power Supply instruction manual immediately following the Bin wiring diagram.

Note the provisions of two "ground" connections in the module connector. Pin 42 is a "high quality ground," and Pin 34 is the "power return ground." The intent is that the high quality ground normally carry negligible current and serve as the reference ground in sensing circuits.

The pins in the module are assigned according to a schedule. Refer to TID-20893 (Rev.) for details on pin assignments.

## 6. MAINTENANCE INSTRUCTIONS

Because of the passive nature of the Bin wiring, maintenance will probably be limited to the addition or removal of wiring. To retain the interchangeability features of the TID-20893 (Rev.) standards, all wiring changes or additions should be done with careful reference to the standard pin assignment schedule, a synopsis of which is given in the figure and table on page 13.

The connector pins specified for use with the standard bins attach to wires by means of a crimped joint. A hand crimping tool is required for this purpose, and is used after the contacts have been pushed into place in the connector block. Removal of a contact also requires the use of a special tool, called a pin-socket extractor.

Assembly details for the connectors and blocks are shown in ORTEC drawing 401-0002, included in this manual. Note that there are two alternate manufacturing sources for the component parts: AMP, Inc., of Harrisburg, Pennsylvania, and Winchester Electronics of Oakville, Connecticut. Each source also provides a hand-crimping tool and a pin-socket extractor. The proper tool for each application must be selected from the same manufacturing source as the connector block and connectors in order to ensure compatibility.

As listed in the details in drawing 401-0002, the AMP connector block for bin mounting is their #202516-3 and is

blue. The equivalent Winchester block is WIN 111-20854 and is orange. The connector block that is mounted on a module that is designed for insertion into the bin can have either an AMP 204186-5 (green) or a WIN 111-20853 (gray) identification.

The hand-crimping tool for use with AMP products is an AMP 90067, which is ORTEC part number 9097-65313. The hand-crimping tool for use with Winchester products is their part 107-0903-2A.

The AMP pin-socket extractor is their part number 305183, ORTEC part number 42947. The Winchester pin-socket extractor is their 107-1015, ORTEC part number 44694.

Either of these tools can be obtained from an authorized distributor of AMP or Winchester parts, respectively, or directly from the manufacturer. They may also be ordered from ORTEC.

The connector pins that are used in the bin and modules are available in several types. Consult TID-20893 and its referenced drawings for suitable types. Additional related information is included in Tables 1, 2, and 3 on ORTEC drawing 401-0002.

## APPENDIX

## REPLACEABLE PARTS

## ORDERING INFORMATION

The Replaceable Parts List shown below contains information needed for ordering spare and/or replacement parts. Each listing indicates the reference designator number, the part number, a description of the component, and the part manufacturer and manufacturer's part number.

All inquiries concerning spare and/or replacement parts and all orders for same should include the model serial, and revision ("Rev" on rear panel) numbers of the instruments involved and should be addressed to the Customer Service Department at 100 Midland Road, Oak Ridge, Tennessee 37830. The Manager of Customer Services can be reached

by telephone at (615) 482-4411. The minimum order for spare and/or replacement parts is \$25.00.

ORDERING INFORMATION  
FOR PARTS NOT LISTED

In order to facilitate the ordering of a part not listed below, the following information should be submitted to the Customer Service Department:

1. the instrument model number,
2. the instrument serial number,
3. revision ("Rev" on rear panel) number,
4. a description of the part,
5. information as to the function and location of the part.

The solid-state-device (diodes, transistors, and integrated circuits) types installed in your instrument may differ from those shown in the schematic diagram and parts list. In such cases, necessary replacements can be made with either the type shown or the type actually installed in the instrument.

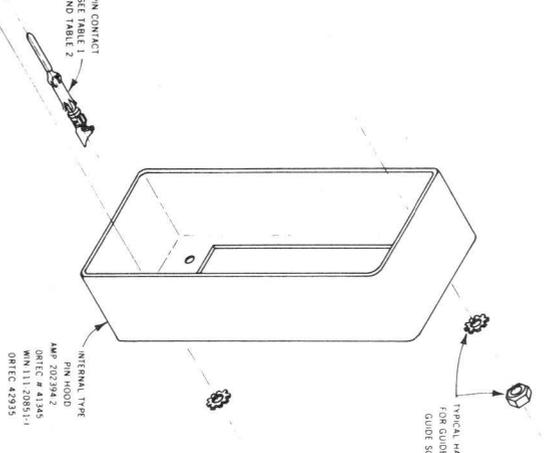
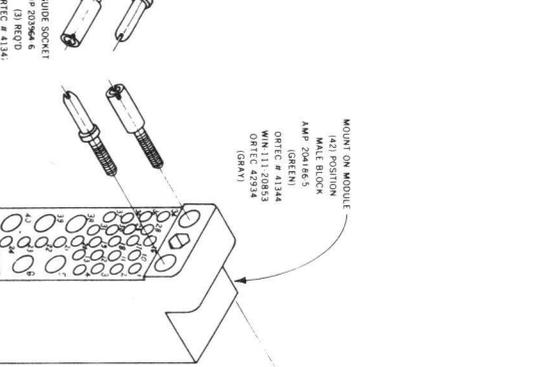
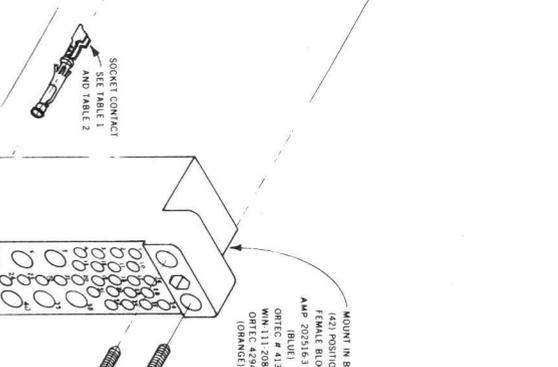
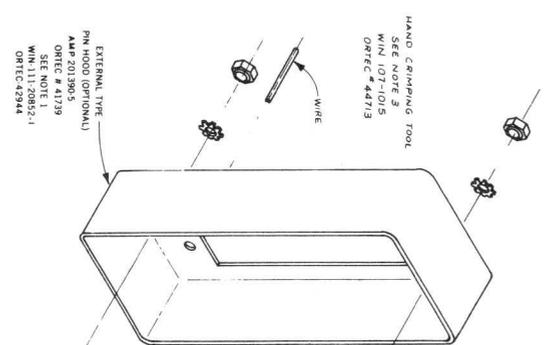
Replaceable Parts List

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
401A-0500	3001 04011			
14	9097 42941	Female Bin Block	81312	#111-20854
15	9097 42942	Harness Block (PG-13)	81312	#111-20859
16	9097 42936	Guide Pin (Bin)	81312	#111-20855
17	9097 42932	Guide Socket (Bin)	81312	#111-20858
18	9097 44696	Contact Socket (Bin)	81312	#100-0820S
19	9097 42943	Contact Socket (Bin)	81312	#100-0817S
20	9097 44695	Contact Pin (PG-13)	81312	#100-0815P
21	9103 41374	Pilot Lamp Assembly	91802	#2150A1
22	9094 41278	Switch, Toggle, DPDT	95146	#MST205-N
30	9097 42937	Guide Socket (Bin)	81312	#111-20856
39	9097 42939	Contact Pin (PG-13)	81312	WIN #100-0812P
40	7180 64835	Terminal Board	ORTEC	401A-0122
C1	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2
C2	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2
C3	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2
C4	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2
C5	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2
C6	9065 40948	6.8 uf 20% 35V Tan.	80183	SPR #150D685X0035B2





HAND CRIMPING TOOL  
SEE NOTE 3  
WIN 107-1015  
ORTEC #44715



ORTEC #44544 IS A STANDARD PUT-UP OF TEN EACH 8 INCH #20 AWG WITH #41357 (AMP PIN CONTACT 66104-1) WIRE COLORS: BLACK, BROWN, RED, ORANGE, GREEN, BLUE, GRAY, VIOLET, WHITE/WHITE. WHITE SPECIAL ORDERS PER TABLE FOR TABLE 2

TABLE 1 - AMP SOCKET AND PIN CONTACTS (TYPE III - 4)

SOCKET CONTACT AMP NO.	ORTEC NO.	PIN CONTACT AMP NO.	ORTEC NO.	FOR WIRE SIZE (AWG) *
66358-1	42433	66359-1	42434	1 #14 OR 2 #18
66100-1	41360	66098-1	41349	1 #16, 1 #18 OR 2#20
66104-1	41357	66102-1	41355	1 #20 OR 2 #22
66108-1	SPECIAL	66106-1	SPECIAL	1 #24 OR 2 #28

\*ALL WIRE TENSION INSULATED TYPE EXCEPT #18 OR TYPE E

XXXX-XXX-XXX-XX/XX  
ORTEC NO. NO. WIRE GAUGE (INCHES) LENGTH (INCHES) COLOR(S) (PIN OR SOCKET)  
1-BROWN  
2-RED  
3-YELLOW  
4-GREEN  
5-BLUE  
6-BLUE  
7-VIOLET  
8-GRAY  
9-WHITE  
10-BLACK

EXAMPLE: SOCKET CONTACT FOR 2 #22 WIRES, 4-YELLOW, 10 INCHES LONG, COLORS: ONE RED, ONE BLACK, 41357/282210/2/10

NOTES: 1. PIN HOODS ARE OPTIONAL PARTS. PIN HOOD IS NOT USED IN THIS APPLICATION. THICK SPACERS MUST BE SUBSTITUTED (4 PLACES).  
2. PIN SOCKET EXTRACTOR NECESSARY TO REMOVE CONTACTS FROM ALL BLOCKS.  
3. HAND CRIMPING TOOL NECESSARY WHEN INSTALLING WIRE IN CONTACTS.

TABLE 2 - WINCHESTER SOCKET AND PIN CONTACTS

SOCKET CONTACT AMP NO.	ORTEC NO.	PIN CONTACT AMP NO.	ORTEC NO.	FOR WIRE SIZE (AWG)
100-08165	42940	100-08119	42938	1 #14, #18 OR 1 #20 OR #22
100-08175	42946	100-08129	42939	1 #20 OR #22
100-08205	44696	100-08159	44695	2 #18

TABLE 3 - AMP SOCKET AND PIN CONTACTS (TYPE III)

SOCKET CONTACT AMP NO.	ORTEC NO.	PIN CONTACT AMP NO.	ORTEC NO.	FOR WIRE SIZE (AWG)
202508-2	48214	202507-2	48215	1 #16, 1 #18
202726-2	48216	202725-2	48217	2 #16, 1 #14

\*SPECIAL - MACHINED PARTS

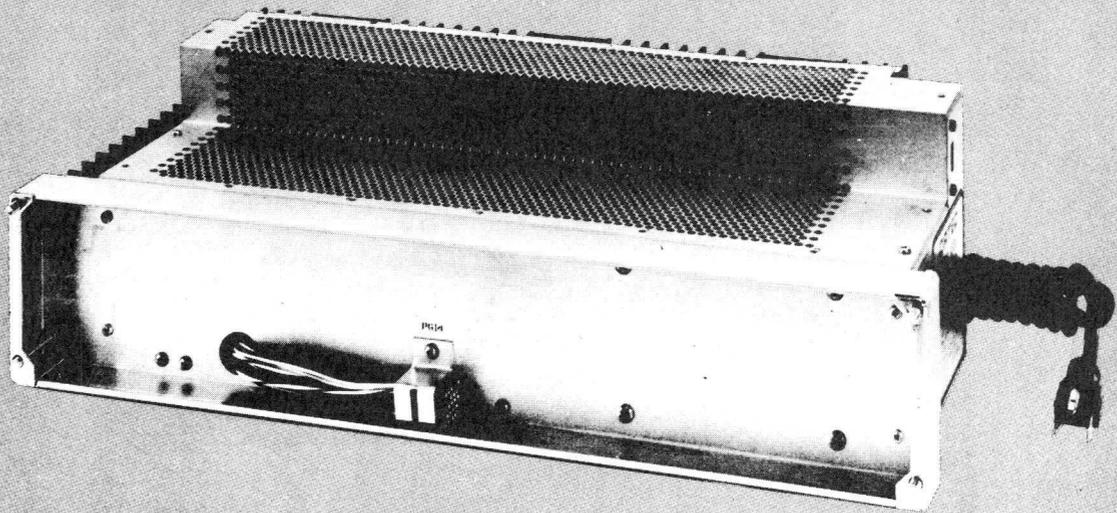
ORTEC CORPORATION  
42 POSITION CONNECTOR & HARDWARE  
401-0002

**BIN/MODULE CONNECTOR PIN ASSIGNMENTS  
FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES  
PER TID-20893**

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	-3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	-24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	-6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*16	+12 volts	38	Coaxial
*17	-12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	115 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (\*) are installed and wired in ORTEC 401A and 401B Modular System Bins.

Pins marked (\*) and (\*\*) are installed and wired in EG&G/ORTEC-HEP M250/N and M350/N NIMBINS.



## ORTEC 402H POWER SUPPLY

### 1. DESCRIPTION

The ORTEC 402H Power Supply is designed to be mounted in the space provided on the rear of the 401A(B) Modular System Bin. The Supply was designed to exceed the recommended power supply specifications, Appendix A of TID-20893 (Rev. 3), Type V-H, adopted by the AEC Committee on Nuclear Instrument Modules.

The 402H was designed for worldwide usage. Input voltage mains of 115 V ac or 230 V ac, 47-63 Hz, may be used. A convenience indicating switch clearly identifies the intended main to use.

The Supply furnishes six standard dc voltages, +24 V at 1 A, -24 V at 1 A, +12 V at 2 A, -12 V at 2 A, +6 V at 8 A and -6 V at 8 A, with a maximum power capability of 132 W at 50°C. The dc outputs are regulated, short-circuit protected, current limited, and thermal protected.

The 115 V ac is supplied to the Bin connector independent of input mains. The 115-V ac power available is limited only by the Power Supply fuse when operating from 115-V ac mains. When operating from 230-V ac mains, the 115 V ac is derived by autotransformer action and is limited to 60 VA output with a dc load on the Power Supply of 132 W.

A control panel is provided on the ORTEC 401A(B) Bin for operating and monitoring the 402H Power Supply. An On-Off switch, a power indicating lamp, a thermal warning lamp, and convenience dc monitor jacks are provided. The thermal warning lamp is lighted when the internal temperature rises to within 20°C of the maximum safe operating temperature. The Power Supply is automatically cut off by an internal switch should the temperature exceed the maximum safe operating temperature.

The power transistors are virtually indestructible due to their power handling capability, current limiting, and short-circuit protection. Silicon semiconductors, 85°C capacitors with conservative working voltage ratings, high-quality-carbon resistors, and metal film resistors are combined to produce the 402H Power Supply, which exceeds the TID-20893 (Rev.) requirements.

The dc output voltages are adjustable through holes in the top of the Power Supply cover plate, over a  $\pm 2\%$  range from their nominal ratings. The adjustment potentiometers are 20-turn cermet potentiometers for superior adjustment resolution and resettability of the output voltages.

### 2. SPECIFICATIONS

**INPUT** 100 to 129 V ac, 57-63 Hz, or 200 to 258 V ac, 47-53 Hz. Input current at 117 V is 3.5 A for a 132-W dc output.

**DC OUTPUTS** The Supply provides six simultaneous dc outputs with the following current ratings:

VOLTAGE (V)	CURRENT (A)
+24.00	0 to 1
-24.00	0 to 1
+12.00	0 to 2
-12.00	0 to 2
+ 6.00	0 to 8
- 6.00	0 to 8

Maximum output power from 0 to 50°C ambient is 132 W. Operation to 60°C ambient, with current derated not more than 3%/°C for temperatures above 50°C.

**115-V AC OUTPUT** 115-V ac output is limited only by the Supply fuses when operating from 115-V ac mains. Output is limited to 60 VA at 132-W dc load while operating from 230-V ac mains.

**REGULATION**  $\pm 0.1\%$  (typically  $\pm 0.05\%$ ) for  $\pm 12$  V and  $\pm 24$  V, and  $\pm 0.2\%$  (typically  $\pm 0.1\%$ ) for  $\pm 6$  V over the combined range of zero to full load and input voltage of 100 to 129 V ac or 200 to 258 V ac, when measurements are made within a period of 1 min.

$\pm 0.3\%$  ( $\pm 12$  V and  $\pm 24$  V) and  $\pm 0.6\%$  ( $\pm 6$  V) over any 24-hr period at constant ambient temperature over the combined range of no load to full load and input voltage of 100 to 129 V ac or 200 to 258 V ac, after a 60-min warmup.

**STABILITY** Long-term stability over a 6-month period is better than  $\pm 0.5\%$  after a 1-hr warmup at constant load, line, and ambient temperature.

**OUTPUT IMPEDANCE**  $< 0.15\Omega$  for the  $\pm 6$ -V outputs and  $< 0.3\Omega$  for all other outputs at any frequency to 100 kHz.

**TEMPERATURE COEFFICIENT**  $< 0.02\%/^{\circ}\text{C}$  over a range of 0 to  $60^{\circ}\text{C}$ .

**THERMAL PROTECTION** A thermal warning switch will close when the supply temperature approaches within  $20^{\circ}\text{C}$  of the safe operating value. A thermal cutout switch disables the Power Supply when the temperature exceeds the safe operating value.

**NOISE AND RIPPLE**  $< 3$  mV peak to peak for all six outputs, as observed on a 50-MHz bandwidth oscilloscope.

**VOLTAGE ADJUSTMENTS**  $\pm 2\%$  minimum range, reset-tability  $\pm 0.05\%$  of Supply voltage.

**RECOVERY TIME**  $< 100$   $\mu\text{sec}$  to return to within  $\pm 0.1\%$  of rated voltage for all six outputs for any change in input voltage and load current from 10% to 100% full load.

**CIRCUIT PROTECTION** Both sides of the input line to the power supply are fused. In addition, output current foldback limiting to prevent damage to the Supply and automatic recovery when the demand is removed are provided by electronic circuitry.

All six supplies are protected so that any one can be shorted to any other one without resulting in permanent damage.

Overvoltage protection is provided on  $\pm 6$  V so that these outputs will not exceed 7.5 V maximum.

**OUTPUT CONNECTOR** All power and control circuits terminate in a connector, specified by TID-20893 (Rev. 3), which mates the Bin interface connector, completing the necessary control and Power Supply wiring.

**DIMENSIONS** Conform to AEC drawing ND-515 and paragraph L, page A-10, of TID-20893 (Rev. 3).

**WEIGHT** 20 lb (8.9 kg) net; with 401A(B) Bin 36 lb (16 kg) net. Shipping weight for 401A(B)/402H 43 lb (19.3 kg) gross.

### 3. INSTALLATION

The 402H Power Supply is normally supplied factory-connected to an ORTEC 401A(B) Modular System Bin. However, the Supply is designed to TID-20893 (Rev.) specifications and may be attached, in the space provided, to any bin manufactured to TID-20893 (Rev.) specifications.

For attachment to other than an ORTEC 401A(B) Bin, refer to the appropriate instruction manual. The On-Off switch and other controls necessary to operate the supply are part of the Bin and are not furnished with the Power Supply.

For attachment to the ORTEC 401A(B) Bin the following steps are advised:

1. Place the Bin on a table with the back part facing you. Place the Power Supply in the proper mounting position, leaving enough space between it and the Bin to attach the interface connector.
2. Mate the interface connector, being careful to align the polarizing pins. Fold and form all wiring close to the connector edges to prevent any wires from being pinched and producing a short circuit in succeeding steps.
3. Mount the Supply to the Bin by securely tightening the four 10-32 screws, being careful not to pinch any wires or to use undue force on any parts.

### 4. OPERATING INSTRUCTIONS

#### 4.1. POWER SUPPLY LIMITATIONS

The available current from the Power Supply is given in Section 2. Care must be used to ensure natural convection of heat dissipated by the heat sinks and power transformer.

For best results, when using at maximum power loadings the Bin and Power Supply should be in an open space, placed upon blocks at least 1 in. off the table mounting surface to allow maximum ventilation. When used in a rack, maximum attention should be paid to placement of other

heat-generating equipment. Adequate unobstructed space on all sides is necessary for convection ventilation and cooling. If the Bin contains other heat-generating equipment, a blower may be advisable to remove the dissipated heat.

When it is necessary to rack-mount several bins and power supplies, especially when other heat-generating equipment is located within the rack, the term "ambient temperature" becomes less clearly defined. A better guide to maximum power loading capability is to monitor the heat sink temperature. In no case allow the heat sink temperature to continuously run above 100°C. Although this is not the maximum operation temperature, any additional temperature rise due to other conditions of the system may force the Supply out of tolerance and may cause it to automatically shut down operation. Should your operation produce a temperature of 100°C, a blower to remove the dissipated heat is indicated.

#### 4.2. 6-V POWER SUPPLIES CROWBAR OPERATION

Both the +6-V and the -6-V outputs are protected against overvoltage. If for any reason one of these output voltages exceeds 7.5 V maximum in absolute value an internal "crowbar circuit" is triggered, which places a short-circuit across the output of the corresponding voltage. Since this circuit contains an SCR, normal operation, after suppression of the cause of the overvoltage, can be resumed only by turning the power switch of the 401 Bin to Off for a couple of seconds, and then turning it to On again.

If in normal operation it is suddenly discovered that the +6-V or -6-V output is missing, first check whether it can be restored by following this procedure, after having removed all the modules from the Bin. The crowbar protection circuit of the corresponding voltage may have been triggered by a temporary fault in one module or even by a strong spurious voltage transient.

## 5. CIRCUIT DESCRIPTION

### 5.1. GENERAL DESCRIPTION

The 402H Power Supply produces six dc output voltages. A power transformer transforms the input ac line voltage into six separate low voltage sources. The sources or windings are full-wave rectified, capacitor filtered, and regulated by electronic series regulator circuits. Each regulator consists of an integrated circuit voltage regulator and one or two boost transistors. In order to improve the combined line-load regulation, the input voltage to the integrated circuit regulators of the positive supplies is provided by an additional supply, which will be referred to hereafter as "reference supply." The input voltage to the regulators of the negative supplies is taken directly from the output of one of the positive supplies.

The six series regulators have a similar operation; they differ only in component values and some circuit details. The regulator essentially operates in two modes. First and normal is the voltage regulation mode. Second is the current foldback or current limiting protection mode.

The regulator will operate in the voltage regulation mode at any current output up to and including the full rated output of a particular supply. When current output beyond the rated output is required, which includes a direct short across the output terminals, the regulator automatically shifts into a current foldback mode. When excessive current demands are removed, the regulator resumes the voltage regulation mode.

### 5.2. REFERENCE SUPPLY (ASSEMBLY A1)

The reference supply contains a very simple regulator, located on the +24-V and +12-V assembly (drawing 402H-0201-S1). It consists of a Darlington series element (Q1 and Q2), a single stage comparison amplifier (Q3), and a zener diode (D1). One side of the regulated output is clamped to ground through two diodes so as to provide two output voltages. The -1.5-V output furnishes the negative voltage needed to keep the current limiting circuits of the positive supplies biased in case of a short-circuit. The second output, +30 V with respect to ground, is used as a prefiltered and preregulated voltage at the input of the +24-V, +12-V, and +6-V voltage regulators, and biases the current sources of their current limiting circuits.

### 5.3. +24-V AND +12-V REGULATORS (ASSEMBLY A1)

The operation of these two regulators, shown on drawing 402H-0201-S1, is very similar, and so for convenience only the +24-V regulator will be discussed here.

In the normal voltage regulation mode the integrated circuit voltage regulator IC1 provides from its output (pin 1) the base drive needed by the series element, transistor Q200, to equalize both the output voltage and the level shifted voltage. The output voltage is sensed directly at the load by pin 5 of IC1 through a separate remote sense lead, and the level shifted voltage is built up across resistors R13, R14, and the +24-V Adjust variable resistor R12 (pins 6, 9, and 8 of IC1).

Capacitor C5, connected to the compensation lead (pin 4) of IC1, provides the roll-off necessary to stabilize the regulator at all frequencies. Capacitor C4 is connected to a high impedance node of the regulator (pin 7) and filters the noise generated by its internal zener diode.

In the current foldback mode, resistor R18, in series with the output, senses the output current level and produces a proportional voltage rise. The sense voltage is compared to the voltage drop across R16 at the input of a differential long-tail pair (Q7, Q8) fed by a 2-mA current source (Q9) and followed by a second differential stage (Q6, Q15). For output currents less than or equal to the rated output, Q8 and Q6 remain back-biased and will have no effect on the regulator performance. However, when the output current exceeds the rated output, Q8 becomes forward-biased and conducts, causing Q6 to turn on and to derive current from pin 4 of IC1, which is the driving point of the series element contained inside the integrated circuit regulator, thereby reducing the base drive current to the series pass transistor. As a result the output voltage is reduced, which in turn decreases the voltage drop across R16. This produces the current foldback characteristic and less current than was initially needed is now required to maintain Q8 and Q6 conducting.

#### 5.4. +6-V AND -6-V REGULATORS (ASSEMBLY A2)

These circuits, shown on drawing 402H-0301-S1, are very similar to the ones just described. The main differences are the use of a Darlington configuration at the output of both integrated circuit voltage regulators to provide the rated output current of 8 A and the addition of an overvoltage protection circuit on both outputs. For the +6-V Supply, for instance, this "crowbar" circuit consists of a transistor Q56 and the silicon controlled rectifier D51. If the output voltage, measured at the sense input (pin 5) of the corresponding voltage regulator (IC50), exceeds by more than one junction drop the voltage of zener diode D56 (6.5 V max), Q56 turns on and triggers the gate of the SCR (D51), which acts almost as a short circuit across the output to the supply.

#### 5.5. -24-V AND -12-V REGULATORS (ASSEMBLY A3)

These circuits are very similar to the +24-V and +12-V Regulators and will not be described here in more detail (see drawing 402H-0401-S1).

## 6. MAINTENANCE INSTRUCTIONS

### 6.1. SUGGESTIONS FOR TROUBLESHOOTING

Several possible sources of trouble are described below, and suggestions are given for remedying the trouble.

**6.1.1. All Output Voltages Missing** Check to see whether +30 V is present on TP1 of A1, all outputs being unloaded. If the +30 V disappears when one of the positive outputs is loaded, the corresponding integrated circuit voltage regulator is very likely damaged and must be replaced.

**6.1.2. One of the Output Voltages Missing** If operation of this supply resumes when its load is removed, check to see that the connection between the filter capacitor and the collector of the series pass transistor corresponding to that voltage supply is not interrupted or if the boost transistor is not damaged. Otherwise, check the correct setting of the 100 $\Omega$  trim potentiometer used to balance the short-circuit current sensing amplifier associated with this output. The procedure to readjust this potentiometer is as follows:

1. Turn the 1-turn potentiometer fully counterclockwise, looking at it from the top edge of the board.

2. Load the output of the corresponding supply to 1.3 A (for  $\pm 24$  V), 2.4 A (for  $\pm 12$  V), or 8.6 A (for  $\pm 6$  V).

3. Turn the potentiometer slowly clockwise while observing the output voltage with a digital voltmeter. Stop turning when the voltage just starts to drop.

**6.1.3. +6-V or -6-V Output Missing** Turn off power switch of the Bin and wait a couple of seconds before turning on again. This ensures that the crowbar protection circuit is disabled, in case it had been triggered accidentally. If voltage does not resume, apply the procedure of Section 6.1.2.

**6.1.4. All Three Negative Outputs Missing** The trouble most probably lies in the +12-V supply. Apply procedure described in Section 6.1.2.

### 6.2. TYPICAL VOLTAGES

Table 6.1 lists typical voltages that were measured with respect to ground potential and they are given here for ease of maintenance.

The voltages given in Table 6.1 are typical values for 115 or 230 main voltage and all outputs unloaded.

Table 6.1.

## Assembly A1 (+24 V and +12 V)

Checkpoint	DC Voltage	Checkpoint	DC Voltage	Checkpoint	DC Voltage	Checkpoint	DC Voltage
Q1e	+30.5 V	Q5e	+24.4 V	Q15e	-13 mV	Q12e	+12.5 V
Q1b	+31.0 V	Q5b	+24.4 V	Q15b	+0.62 V	Q12b	+11.9 V
Q1c	+43.8 V*	Q5c	+25.8 V	Q15c	0	Q12c	+0.63 V
Q3e	+13.6 V	Q6e	-13 mV	IC2 pin 1	+12.6 V	Q13e	+12.5 V
Q3b	+14.1 V	Q6b	-1.27 V	2	0	Q13b	+12.0 V
Q3c	+31.6 V	Q6c	+25.8 V	3	+17.6 V	Q13c	-1.19 V
TP1	+30.0 V	Q7e	+24.4 V	4	+14.0 V	Q14e	+16.5 V
TP2	-1.36 V	Q7b	+23.8 V	5	+12.0 V	Q14b	+15.9 V
IC1 pin 1	+24.4 V	Q7c	+0.62 V	6&9	+12.0 V	Q14c	+12.6 V
2	0	Q8e	+24.5 V	8	+3.5 V	Q16e	-13 mV
3	+29.6 V	Q8b	+24.0 V	Q10e	+12.6 V	Q16b	+0.63 V
4	+25.8 V	Q8c	-1.27 V	Q10b	+12.6 V	Q16c	0
5	+24.0 V	Q9e	+26.9 V	Q10c	+14.0 V	PC Board Connector:	
6&9	+24.0 V	Q9b	+26.3 V	Q11e	-13 mV	pin 1	+21.6 V*
8	+3.5 V	Q9c	+24.5 V	Q11b	-1.19 V	9	340.7 V*
				Q11c	+14.0 V	21	-1.36 V

## Assembly A2 (+6 V and -6 V)

Checkpoint	DC Voltage						
IC50 pin 1	+7.05 V	Q52c	+8.41 V	Q63c	0	Q59b	-1.12 V
2	0	Q53e	+6.46 V	IC51 pin 1	+1.03 V	Q59c	+2.38 V
3	+13.5 V	Q53b	+5.85 V	2	-6.00 V	Q60e	+0.51 V
4	+8.41 V	Q53c	+0.64 V	3	+12.0 V	Q60b	-0.13 V
5	+5.99 V	Q54e	+6.55 V	4	+2.38 V	Q60c	+0.47 V
6&9	+6.00 V	Q54b	+6.00 V	5	-7 mV	Q61e	+0.55 V
8	+3.5 V	Q54c	-1.16 V	6&9	+7 mV	Q61b	0
Q50e	+7.04 V	Q55e	+16.4 V	8	-2.52 V	Q61c	-1.12 V
Q50b	+7.05 V	Q55b	+15.7 V	Q57e	+1.02 V	Q62e	0
Q50c	+8.41 V	Q55c	+6.6 V	Q57b	+1.03 V	Q62b	+22 mV
Q51e	+6.53 V	Q56e	+6.00 V	Q57c	+2.38 V	Q62c	-6.00 V
Q51b	+7.04 V	Q56b	+6.08 V	Q58e	+0.53 V	Q64e	-0.15 V
Q51c	+14.4 V*	Q56c	0	Q58b	+1.02 V	Q64b	+0.47 V
Q52e	-11 mV	Q63e	-11 mV	Q58c	+8.46 V*	Q64c	0
Q52b	-1.16 V	Q63b	+0.64 V	Q59e	-0.15 V		

## Assembly A3 (-24 V and -12 V)

Checkpoint	DC Voltage	Checkpoint	DC Voltage	Checkpoint	DC Voltage	Checkpoint	DC Voltage
IC100 pin 1	+0.58 V	Q101c	+1.93 V	3	+8.45 V	Q106b	-0.14 V
2	-24.0 V	Q102e	+0.50 V	4	+1.94 V	Q106c	+0.48 V
3	+8.4 V	Q102b	-0.14 V	5	-6 mV	Q107e	+0.58 V
4	+1.93 V	Q102c	+0.47 V	6&9	+6 mV	Q107b	0
5	-6 mV	Q103e	+0.55 V	8	-8.62 V	Q107c	-1.10 V
6&9	+11 mV	Q103b	0	Q104e	+0.56 V	Q109e	-0.16 V
8	-20.5 V	Q103c	-1.19 V	Q104b	+0.59 V	Q109b	+0.48 V
Q100e	+0.55 V	Q108e	-0.15 V	Q104c	+1.94 V	Q109c	0
Q100b	+0.58 V	Q108b	+0.47 V	Q105e	-0.16 V	PC Board Connector:	
Q100c	+1.93 V	Q108c	0	Q105b	-1.10 V	pin 2	+10.1 V*
Q101e	-0.15 V	IC101 pin 1	+0.59 V	Q105c	+1.94 V	10	-1.35 V
Q101b	-1.19 V	2	-12.0 V	Q106e	+0.51 V	11	+17.5 V*

\*dc average

## APPENDIX

## REPLACEABLE PARTS

## ORDERING INFORMATION

The Replaceable Parts List shown below contains information needed for ordering spare and/or replacement parts. Each listing indicates the reference designator number, the part number, a description of the component, and the part manufacturer and manufacturer's part number.

All inquiries concerning spare and/or replacement parts and all orders for same should include the model serial, and revision ("Rev" on rear panel) numbers of the instruments involved and should be addressed to the Customer Service Department at 100 Midland Road, Oak Ridge, Tennessee 37830. The Manager of Customer Services can be reached

by telephone at (615) 482-4411. The minimum order for spare and/or replacement parts is \$25.00.

ORDERING INFORMATION  
FOR PARTS NOT LISTED

In order to facilitate the ordering of a part not listed below, the following information should be submitted to the Customer Service Department:

1. the instrument model number,
2. the instrument serial number,
3. revision ("Rev" on rear panel) number,
4. a description of the part,
5. information as to the function and location of the part.

The solid-state-device (diodes, transistors, and integrated circuits) types installed in your instrument may differ from those shown in the schematic diagram and parts list. In such cases, necessary replacements can be made with either the type shown or the type actually installed in the instrument.

Replaceable Parts List

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0100	5004 46596			
Cont'd				
6	9180 47010	Bar, PC Connector	ORTEC	402H-0107
15	9097 42428	Connector Clamp	ORTEC	402A-1204
42	9101 41746	Fuse, 3-Amp, Std.	75915	LIT #312003
43	9101 41752	Fuse, 5-Amp, Std.	75915	LIT #3AG
44	9097 41304	Connector, 22-Pin	CHJ	CHJ #250-22-30-170
47	9090 43468	Transformer, Power	95333	CET #Y24-148
48	9090 43469	Transformer, Power	95333	CET #Y24-149
C200	9055 40843	0.01 uf 20% 1KV Disc	80183	SPR #C023H103L103P
C201	9055 40843	0.01 uf 20% 1KV Disc	80183	SPR #C023H103L103P
C202	9055 40846	0.1 uf 20% 50V Disc	80183	SPR #C023K101L104M
C203	9055 40846	0.1 uf 20% 50V Disc	80183	SPR #C023K101L104M
C204	9055 40843	0.01 uf 20% 1KV Disc	80183	SPR #C023H103L103P
C205	9055 40843	0.01 uf 20% 1KV Disc	80183	SPR #C023H103L103P
C250	9067 47360	22,000 uf 16V El.	ORTEC	FRAKO #HSF22000/16V1735B1
C251	9067 47360	22,000 uf 16V El.	ORTEC	FRAKO #HSF22000/16V1735B1
C252	9055 40845	0.05 uf 20% 500V Disc	80183	SPR #41C105

## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
<b>402H-0100</b>	<b>5004 46596</b>			
<b>Cont'd</b>				
D200	9080 44206	F.W. Bridge	27777	VRO #VH247
D201	9080 44206	F.W. Bridge	27777	VRO #VH247
D202	9080 44221	F.W. Bridge, MDA980-1	80211	MOT
D203	9080 44221	F.W. Bridge, MDA980-1	80211	MOT
D204	9080 44206	F.W. Bridge	27777	VRO #VH247
D205	9080 44206	F.W. Bridge	27777	VRO #VH247
Q200	9078 43682	Transistor - MJE3055	80211	MOT
Q201	9078 43682	Transistor - MJE3055	80211	MOT
Q202	9078 43682	Transistor - MJE3055	80211	MOT
Q203	9078 43682	Transistor - MJE3055	80211	MOT
Q204	9078 43682	Transistor - MJE3055	80211	MOT
Q205	9078 43682	Transistor - MJE3055	80211	MOT
Q206	9078 43682	Transistor - MJE3055	80211	MOT
Q207	9078 43682	Transistor - MJE3055	80211	MOT
R200	9043 44318	0.050 $\Omega$ Res. Wire VDM	ORTEC	(5 cm)
R201	9043 44318	0.050 $\Omega$ Res. Wire VDM	ORTEC	(5 cm)
R202	9043 44318	0.050 $\Omega$ Res. Wire VDM	ORTEC	(5 cm)
R203	9043 44318	0.050 $\Omega$ Res. Wire VDM	ORTEC	(5 cm)
<b>402H-0200</b>	<b>5007 46597</b>			
C1	9059 40895	1000 pf 2% 100V D.M.	84171	ARC #DM15-102G
C2	9065 40951	22 uf 20% 35V Tan.	80183	SPR #150D226X0035R2
C4	9055 40849	0.02 uf 20% 500V Disc.	80183	SPR #C023H501J203M
C5	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C6	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C7	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0035A2
C9	9055 40849	0.02 uf 20% 500V Disc	80183	SPR #C023H501J203M
C10	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C11	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C12	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0035A2
C13	9055 40855	0.01 uf 20% 50V Disc	80183	SPR #C023K101F103M
D1	9080 44219	Diode - 1N5245	80211	MOT (15V - Zener)
D2	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D3	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)

## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-Q200	5007 46597			
Cont'd				
D4	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D5	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D6	9080 41098	Diode - 1N270	24446	GEC
D7	9080 44228	Diode - 1N4735A	80211	MOT (6.2V - Zener)
D8	9080 44228	Diode - 1N4735A	80211	MOT (6.2V - Zener)
D9	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D10	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
IC-1	9079 44076	IC - MC1469R	80211	MOT
IC-2	9079 44076	IC - MC1469R	80211	MOT
Q1	9078 43682	Transistor - MJE3055	80211	MOT
Q2	9078 41083	Transistor - 2N3643	13715	FSC
Q3	9078 41052	Transistor - 2N3565	13715	FSC
Q4	9078 41083	Transistor - 2N3643	13715	FSC
Q5	9078 43655	Transistor - MPS6531	80211	MOT
Q6	9078 41083	Transistor - 2N3643	13715	FSC
Q7	9078 43650	Transistor - MPS6534	80211	MOT
Q8	9078 43650	Transistor - MPS6534	80211	MOT
Q9	9078 43650	Transistor - MPS6534	80211	MOT
Q10	9078 43655	Transistor - MPS6531	80211	MOT
Q11	9078 41083	Transistor - 2N3643	13715	FSC
Q12	9078 43650	Transistor - MPS6534	80211	MOT
Q13	9078 43650	Transistor - MPS6534	80211	MOT
Q14	9078 41075	Transistor - 2N3638	13715	FSC
Q15	9078 41083	Transistor - 2N3643	13715	FSC
Q16	9078 41083	Transistor - 2N3643	13715	FSC
R1	9015 40237	3.9 K 1/4W 5% C	01121	ABC CB
R2	9015 40231	2 K 1/4W 5% C	01121	ABC CB
R3	9015 40212	200 $\Omega$ 1/4W 5% C	01121	ABC CB
R4	9015 40277	3.6 K 1/4W 5% C	01121	ABC CB
R5	9035 40689	9.1 $\Omega$ 2W 5% WW	IRC	IRC BWH
R6	9015 40232	2.2 K 1/4W 5% C	01121	ABC CB
R7	9051 40792	500 $\Omega$ 1-T Cer. Pot	73138	BEK #62P-R500
R8	9015 40232	2.2 K 1/4W 5% C	01121	ABC CB
R9	9015 40248	15 K 1/4W 5% C	01121	ABC CB
R10	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R11	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R12	9051 43741	10 K 20-T Cer. Pot.	73138	BEK #78P-R10K
R13	9026 46828	34.8 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R14	9026 46768	6.81 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R15	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R16	9027 40601	38.3 $\Omega$ 1/8W 1% MF	IRC	IRC CEA

## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0200	5007 46597			
Cont'd				
R17	9027 40535	5.62 K 1/8W 1% MF	IRC	IRC CEA
R18	9035 40687	0.2 $\Omega$ 2W 5% WW	IRC	IRC BWH
R19	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60152-001
R20	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R21	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R22	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R23	9015 40276	1.6 K 1/4W 5% C	01121	ABC CB
R24	9015 40237	3.9 K 1/4W 5% C	01121	ABC CB
R25	9015 40252	27 K 1/4W 5% C	01121	ABC CB
R26	9015 40242	7.5 K 1/4W 5% C	01121	ABC CB
R27	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R28	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R29	9051 40791	5 K 20-T Cer. Pot.	73138	BEK #78P-R5K
R30	9026 46829	14.3 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R31	9026 46768	6.81 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R32	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R33	9027 40586	26.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R34	9027 40522	2 K 1/8W 1% MF	IRC	IRC CEA
R35	9035 40688	0.1 $\Omega$ 2W 5% WW	IRC	IRC BWH
R36	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60152-001
R37	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R38	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R39	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R40	9015 40241	6.8 K 1/4W 5% C	01121	ABC CB
R41	9015 43957	16 K 1/4W 5% C	01121	ABC CB
R42	9015 40249	18 K 1/4W 5% C	01121	ABC CB
R43	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R44	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R45	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R46	9015 40226	1 K 1/4W 5% C	01121	ABC CB
TP-1	9107 41411	Vertical Jack, Blue	74970	JEF #105-860
TP-2	9107 41411	Vertical Jack, Blue	74970	JEF #105-860
TP-3	9107 41411	Vertical Jack, Blue	74970	JEF #105-860
402H-0300	5007 46598			
C51	9055 40849	0.02 uf 20% 500V Disc.	80183	SPR #C023H501J203M
C52	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C53	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C54	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0035A2
C55	9067 47347	47 uf 35V El.	ORTEC	ROE #EK47/35
C56	9055 40846	0.1 uf 20% 50V Disc.	80183	SPR #C023K101L104M
C57	9055 40849	0.02 uf 20% 500V Disc.	80183	SPR #C023H501J203M

## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0300	5007 46598			
Cont'd				
C58	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C59	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C60	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0035A2
C61	9067 47347	47 uf 35V El.	ORTEC	ROE #EK47/35
D50	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D51	9080 44226	Diode - 2N4441 (SCR)	80211	MOT
D53	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D54	9080 44226	Diode - 2N4441 (SCR)	80211	MOT
D55	9080 44229	Diode - 1N4745A	80211	MOT
D56	9080 44218	Diode - 1N753A	80211	MOT (6.2V - Zener)
D57	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D58	9080 44218	Diode - 1N753A	80211	MOT (6.2V - Zener)
D59	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
IC-50	9079 44076	IC - MC1469R	80211	MOT
IC-51	9079 44076	IC - MC1469R	80211	MOT
Q50	9078 43655	Transistor - MPS6531	80211	MOT
Q51	9078 43682	Transistor - MJE3055	80211	MOT
Q52	9078 41083	Transistor - 2N3643	13715	FSC
Q53	9078 43650	Transistor - MPS6534	80211	MOT
Q54	9078 43650	Transistor - MPS6534	80211	MOT
Q55	9078 41075	Transistor - 2N3638	13715	FSC
Q56	9078 41080	Transistor - 2N3638A	13715	FSC
Q57	9078 43655	Transistor - MPS6531	80211	MOT
Q58	9078 43682	Transistor - MJE3055	80211	MOT
Q59	9078 41083	Transistor - 2N3643	13715	FSC
Q60	9078 43650	Transistor - MPS6534	80211	MOT
Q61	9078 43650	Transistor - MPS6534	80211	MOT
Q62	9078 41080	Transistor - 2N3638A	13715	FSC
Q63	9078 41083	Transistor - 2N3643	13715	FSC
Q64	9078 41083	Transistor - 2N3643	13715	FSC
R50	9015 40239	5.1 K 1/4W 5% C	01121	ABC CB
R51	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R52	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R53	9051 43757	2 K 20-T Cer Pot.	73183	BEK #78P-R2K
R54	9026 46826	2.74 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R55	9026 46798	5.11 K 1/8W 1% MF	IRC	IRC CEA (T-2)

## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0300	5007 46598			
Cont'd				
R56	9015 40213	220 $\Omega$ 1/4W 5% C	01121	ABC CB
R57	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R58	9027 40589	93.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R59	9027 43712	1.82 K 1/8W 1% MF	IRC	IRC CEA
R61	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60152-001
R62	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R63	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R64	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R65	9015 40221	620 $\Omega$ 1/4W 5% C	01121	ABC CB
R66	9015 40241	6.8 K 1/4W 5% C	01121	ABC CB
R67	9015 43957	16 K 1/4W 5% C	01121	ABC CB
R68	9015 40249	18 K 1/4W 5% C	01121	ABC CB
R69	9015 40211	150 $\Omega$ 1/4W 5% C	01121	ABC CB
R70	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R71	9015 40239	5.1 K 1/4W 5% C	01121	ABC CB
R72	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R73	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R74	9051 43757	2 K 20-T Cer Pot.	73183	BEK #78P-R2K
R75	9026 46826	2.74 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R76	9026 46798	5.11 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R77	9015 40213	220 $\Omega$ 1/4W 5% C	01121	ABC CB
R78	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R79	9027 40589	93.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R80	9027 43712	1.82 K 1/8W 1% MF	IRC	IRC CEA
R81	9015 40240	5.6 K 1/4W 5% C	01121	ABC CB
R82	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60152-001
R83	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R84	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R85	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R86	9015 40221	620 $\Omega$ 1/4W 5% C	01121	ABC CB
R87	9015 40211	150 $\Omega$ 1/4W 5% C	01121	ABC CB
R88	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R89	9015 40238	4.7 K 1/4W 5% C	01121	ABC CB
R90	9015 40233	2.4 K 1/4W 5% C	01121	ABC CB
R91	9015 40215	300 $\Omega$ 1/4W 5% C	01121	ABC CB
R92	9015 40215	300 $\Omega$ 1/4W 5% C	01121	ABC CB
R93	9015 40271	51 $\Omega$ 1/4W 5% C	01121	ABC CB
R94	9015 40271	51 $\Omega$ 1/4W 5% C	01121	ABC CB
R95	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R96	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R97	9027 40589	93.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R98	9027 40589	93.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA

## Replaceable Parts List (continued)

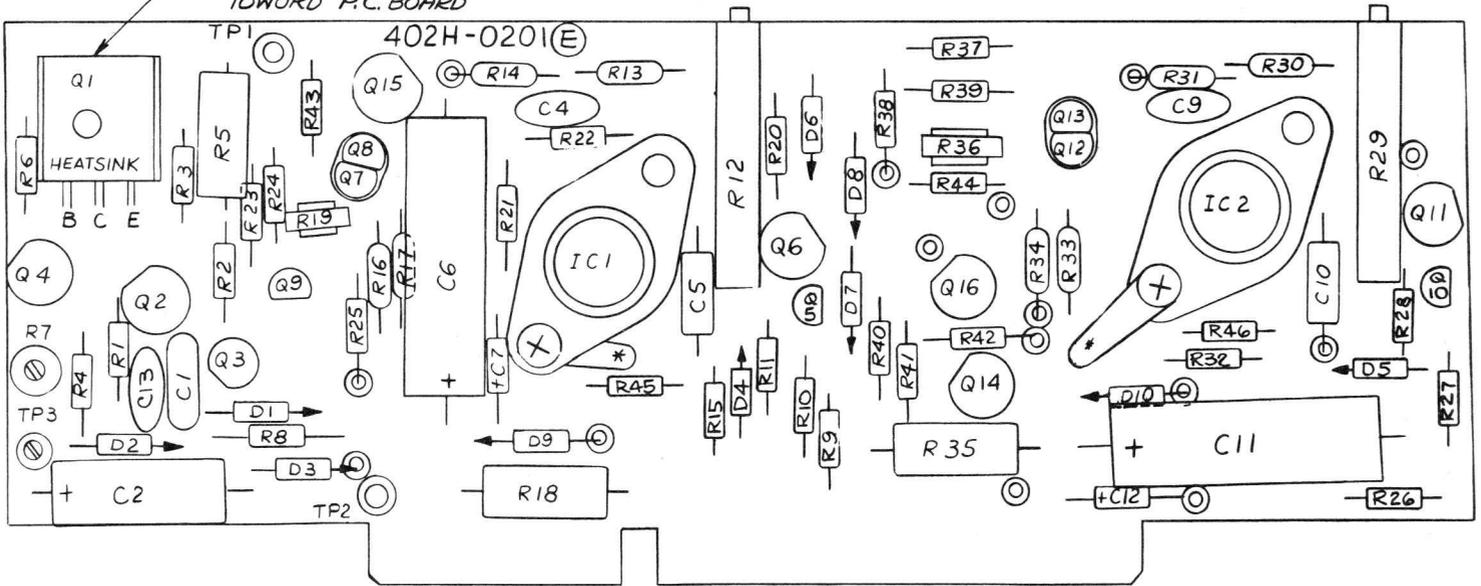
REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0400	5007 46599			
C100	9055 40846	0.1 uf 20% 50V Disc.	80183	SPR #C023K101L104M
C101	9055 40849	0.02 uf 20% 500V Disc.	80183	SPR #C023H501J203M
C102	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C103	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C104	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0035A2
C105	9055 40846	0.1 uf 20% 50V Disc.	80183	SPR #C023K101L104M
C106	9055 40849	0.02 uf 20% 500V Disc.	80183	SPR #C023H501J203M
C107	9061 40915	0.01 uf 10% 200V Myl.	80183	SPR #192P10392
C109	9067 42688	150 uf 25V El.	80183	SPR #TE-1212
C110	9065 40942	1 uf 20% 35V Tan.	80183	SPR #150D105X0034A2
D102	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D103	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D104	9080 44205	Diode - 1N4728 (Zener)	80211	MOT
D105	9080 44205	Diode - 1N4728 (Zener)	80211	MOT
D106	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
D107	9080 60228	Diode - 1N4005	80211	MOT (GP Leads)
IC-100	9079 44076	IC - MC1469R	80211	MOT
IC-101	9079 44076	IC - MC1469R	80211	MOT
Q100	9078 43655	Transistor - MPS6531	80211	MOT
Q101	9078 41083	Transistor - 2N3643	13715	FSC
Q102	9078 43650	Transistor - MPS6534	80211	MOT
Q103	9078 43650	Transistor - MPS6534	80211	MOT
Q104	9078 43655	Transistor - MPS6531	80211	MOT
Q105	9078 41083	Transistor - 2N3643	13715	FSC
Q106	9078 43650	Transistor - MPS6534	80211	MOT
Q107	9078 43650	Transistor - MPS6534	80211	MOT
Q108	9078 41083	Transistor - 2N3643	13715	FSC
Q109	9078 41083	Transistor - 2N3643	13715	FSC
R100	9015 40248	15 K 1/4W 5% C	01121	ABC CB
R101	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R102	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R103	9051 43741	10 K 20-T Cer Pot.	73138	BEK #78P-R10K
R104	9026 46828	34.8 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R105	9026 46768	6.81 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R106	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R107	9027 40601	38.3 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R108	9027 40535	5.62 K 1/8W 1% MF	IRC	IRC CEA

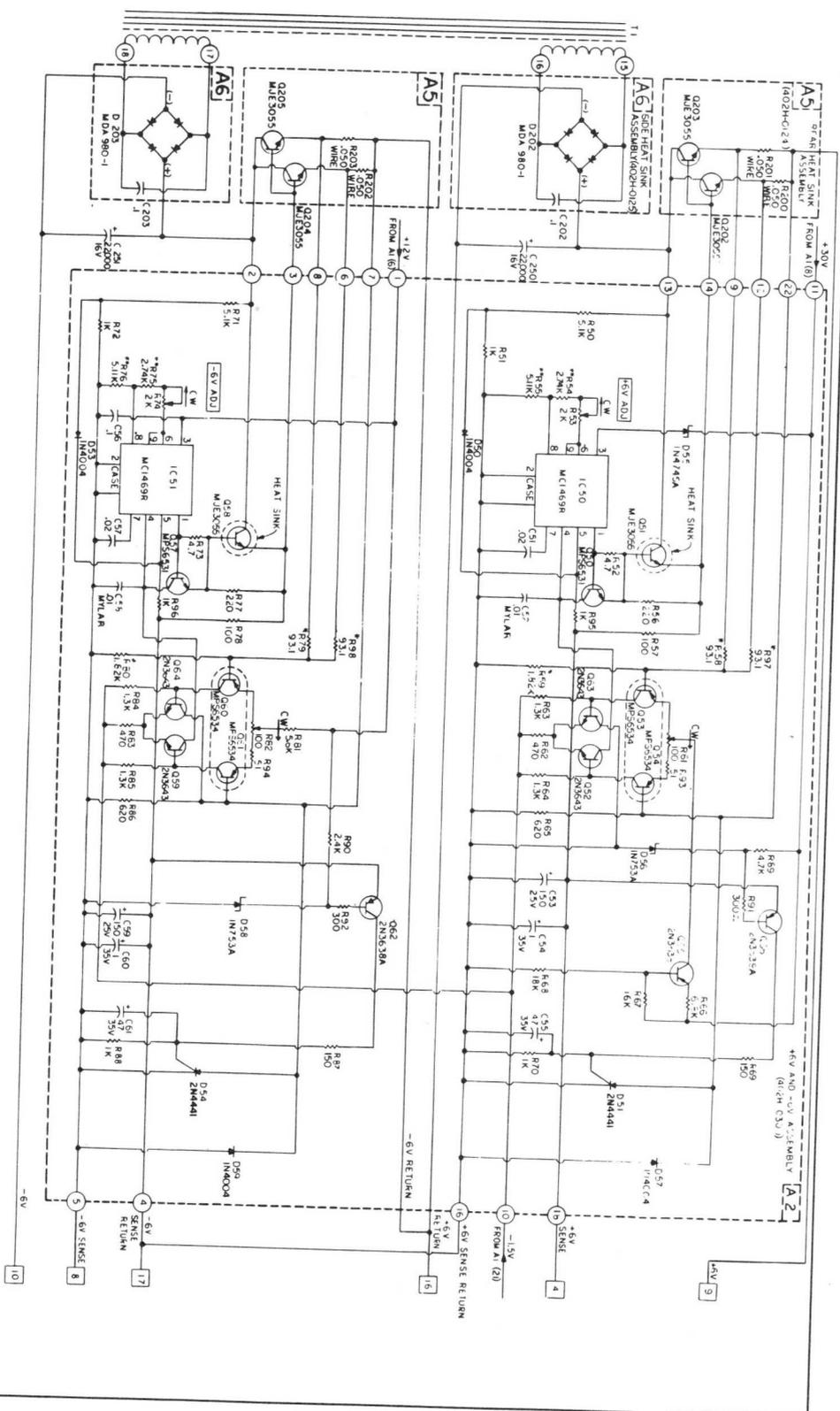
## Replaceable Parts List (continued)

REFERENCE DESIGNATOR	ORTEC PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
402H-0400	5007 46599			
Cont'd				
R109	9015 40240	5.6 K 1/4W 5% C	01121	ABC CB
R110	9035 40687	0.2 $\Omega$ 2W 5% WW	IRC	IRC BWH
R111	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60152-001
R112	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R113	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R114	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R115	9015 40242	7.5 K 1/4W 5% C	01121	ABC CB
R116	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R117	9015 40295	4.7 $\Omega$ 1/4W 5% C	01121	ABC CB
R118	9051 40791	5 K 20-T Cer. Pot.	73138	BEK #78P-R5K
R119	9026 46829	14.3 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R120	9026 46768	6.81 K 1/8W 1% MF	IRC	IRC CEA (T-2)
R121	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R122	9027 40586	26.1 $\Omega$ 1/8W 1% MF	IRC	IRC CEA
R123	9027 40522	2 K 1/8W 1% MF	IRC	IRC CEA
R124	9035 40688	0.1 $\Omega$ 2W 5% WW	IRC	IRC BWH
R125	9015 40240	5.6 K 1/4W 5% C	01121	ABC CB
R126	9051 49192	100 $\Omega$ 0.1W Pot.	ORTEC	PREH #60-152-001
R127	9015 40219	470 $\Omega$ 1/4W 5% C	01121	ABC CB
R128	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R129	9015 40287	1.3 K 1/4W 5% C	01121	ABC CB
R130	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R131	9015 40209	100 $\Omega$ 1/4W 5% C	01121	ABC CB
R132	9015 40226	1 K 1/4W 5% C	01121	ABC CB
R133	9015 40226	1 K 1/4W 5% C	01121	ABC CB
402H-0500	5007 46600			
C150	9067 47358	1000 uf 62V El.	ORTEC	FRAKO #EF1000/63HPF
C151	9067 47358	1000 uf 62V El.	ORTEC	FRAKO #EF1000/63HPF
C152	9067 47359	2200 uf 35V El.	ORTEC	FRAKO #EF2200/35HPF
C153	9067 47359	2200 uf 35V El.	ORTEC	FRAKO #EF2200/35HPF
C154	9067 47358	1000 uf 63V El.	ORTEC	FRAKO #EF1000/63HPF
C155	9067 47359	2200 uf 35V El.	ORTEC	FRAKO #EF2200/35HPF
C156	9067 47359	2200 uf 35V El.	ORTEC	FRAKO #EF2200/35HPF
D150	9080 44216	F.W. Bridge, 1-Amp, 400V	14936	GLI #W04



LETTERING ON  
TRANSISTOR  
TOWARD P.C. BOARD





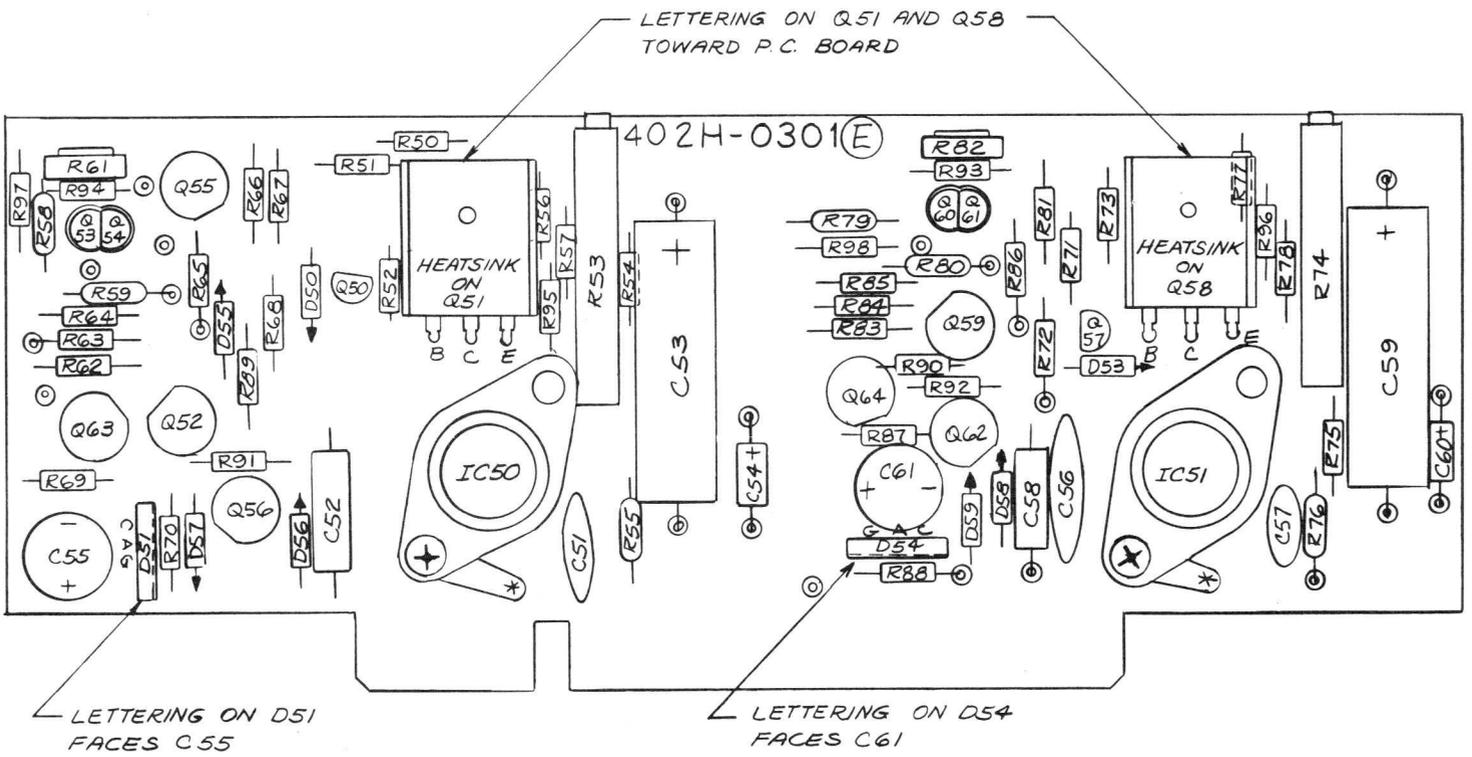
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C	50-61		202-203	200-201
D	50-59		202-203	200-201
R	50-58	200-203		
Q	50-64	202-203		
T	50-54			

NOT USED  
D52  
C50

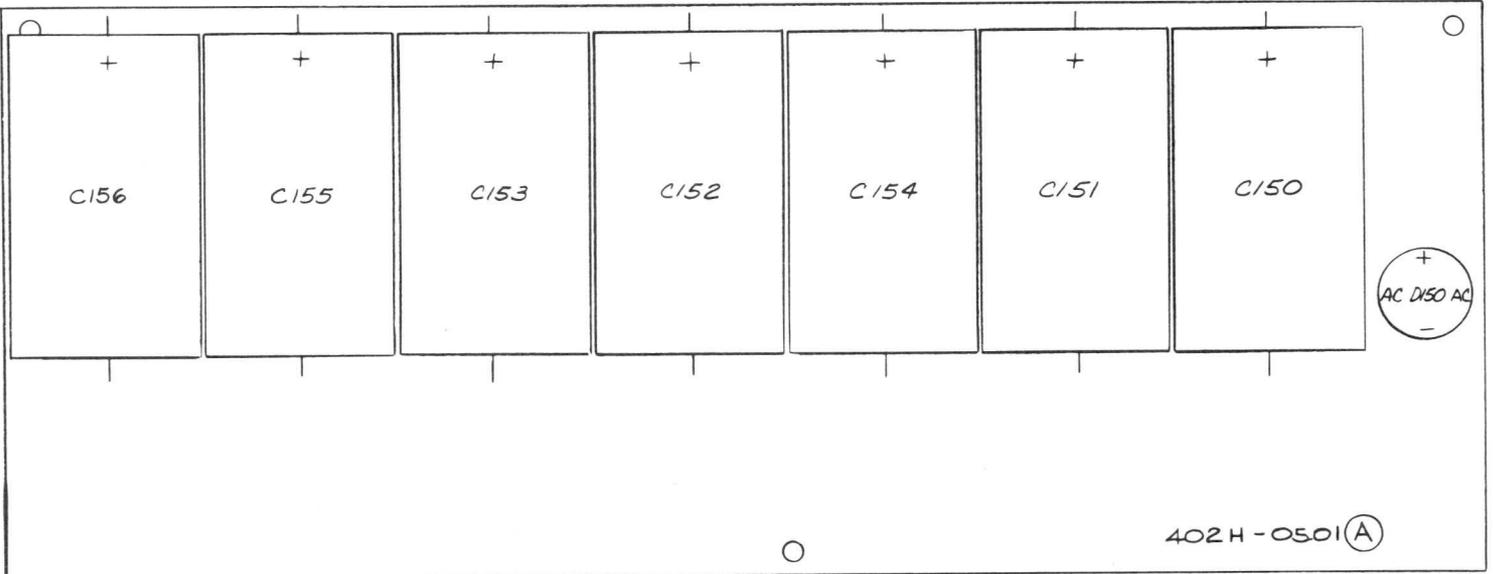
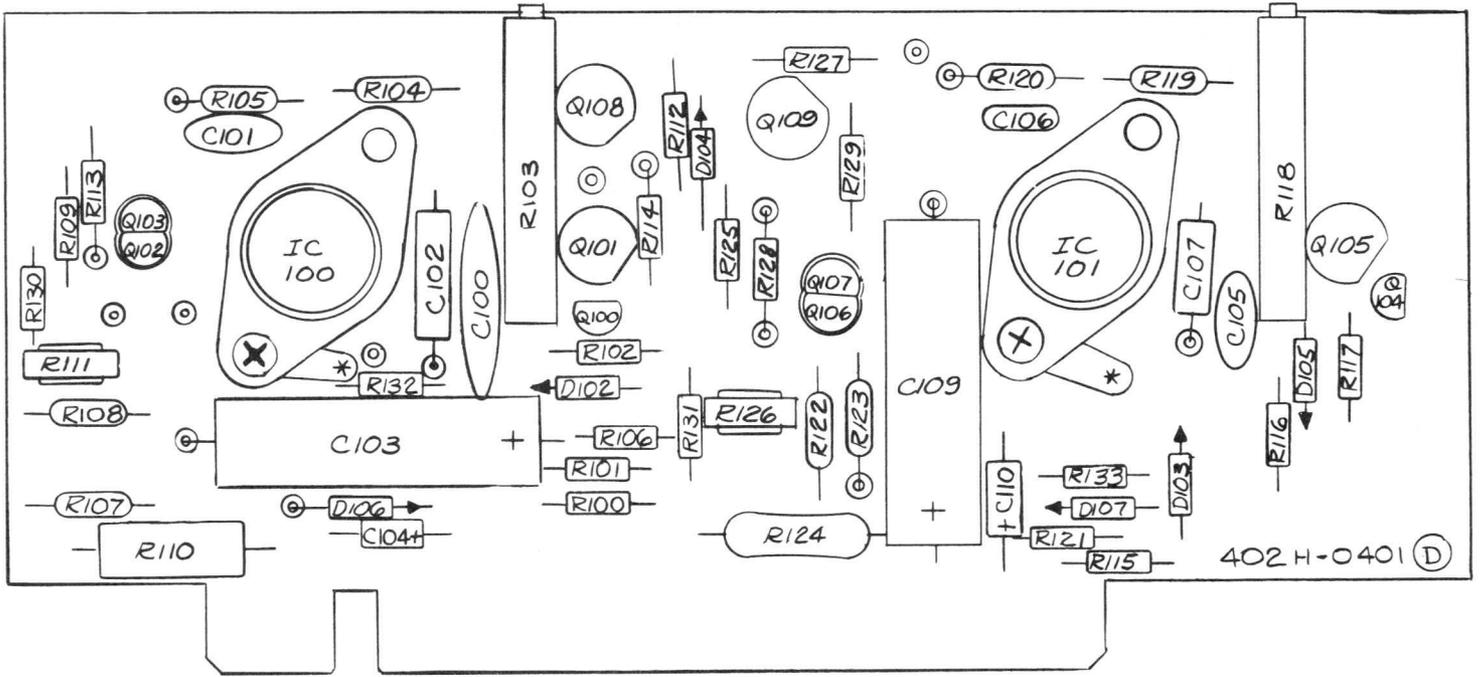
- NOTES:  
 1 UNLESS OTHERWISE SPECIFIED:  
 ALL RESISTORS ARE 1/4W  
 2 RESISTORS MARKED \* ARE 1/2, 1/8W TO  
 4 RESISTORS MARKED # ARE 1/2, 1/8W 1.

REV	1	DATE	10/1/78	BY	JW
REV	2	DATE	10/1/78	BY	JW
REV	3	DATE	10/1/78	BY	JW
REV	4	DATE	10/1/78	BY	JW
REV	5	DATE	10/1/78	BY	JW
REV	6	DATE	10/1/78	BY	JW
REV	7	DATE	10/1/78	BY	JW
REV	8	DATE	10/1/78	BY	JW
REV	9	DATE	10/1/78	BY	JW
REV	10	DATE	10/1/78	BY	JW

**ORTEC** CORPORATION  
 100 MIDLAND ROAD, DAYTON, TENNESSEE 37820  
 MODEL 402H  
 ANALOG SYSTEMS  
 (REV)









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