

Model 456 High Voltage Power Supply Operating and Service Manual

This manual applies to instruments marked
"Rev 65" on rear panel

WARNING

This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Standard Warranty for EG&G ORTEC Nuclear Electronic Instruments

EG&G ORTEC warrants that the items will be delivered free from defects in material or workmanship. EG&G ORTEC makes no other warranties, express or implied, and specifically **NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within **two years** from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

Quality Control

Before being approved for shipment, each EG&G ORTEC nuclear electronic 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, EG&G ORTEC must be informed, either in writing, by telephone [(615) 482-4411] or by telex (55-7450) 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 EG&G 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 EG&G ORTEC repair center. (In the case where the instrument did not function upon purchase, EG&G ORTEC will pay shipment costs both ways.) 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

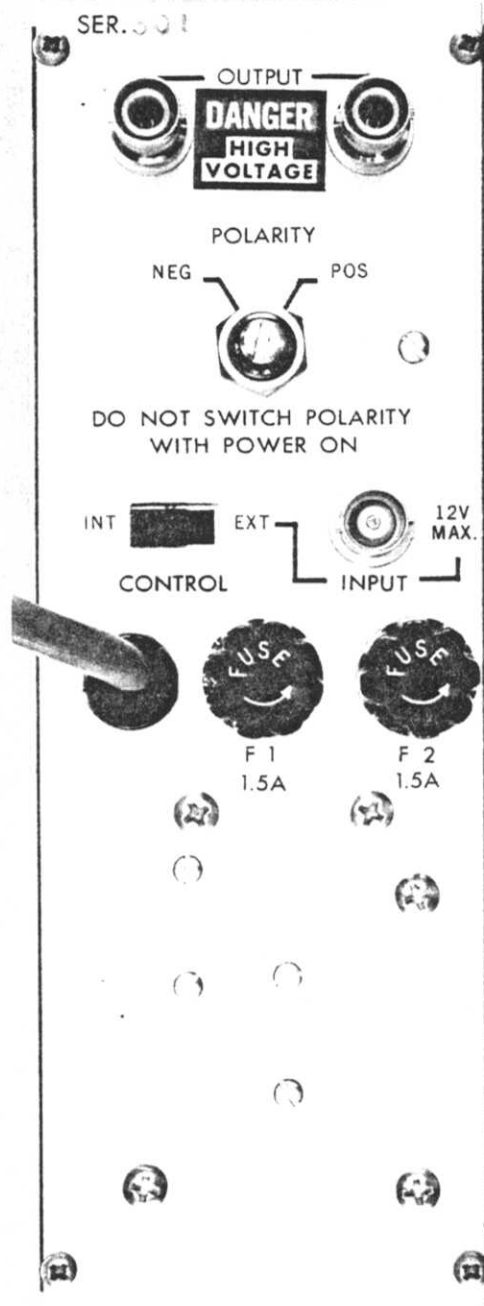
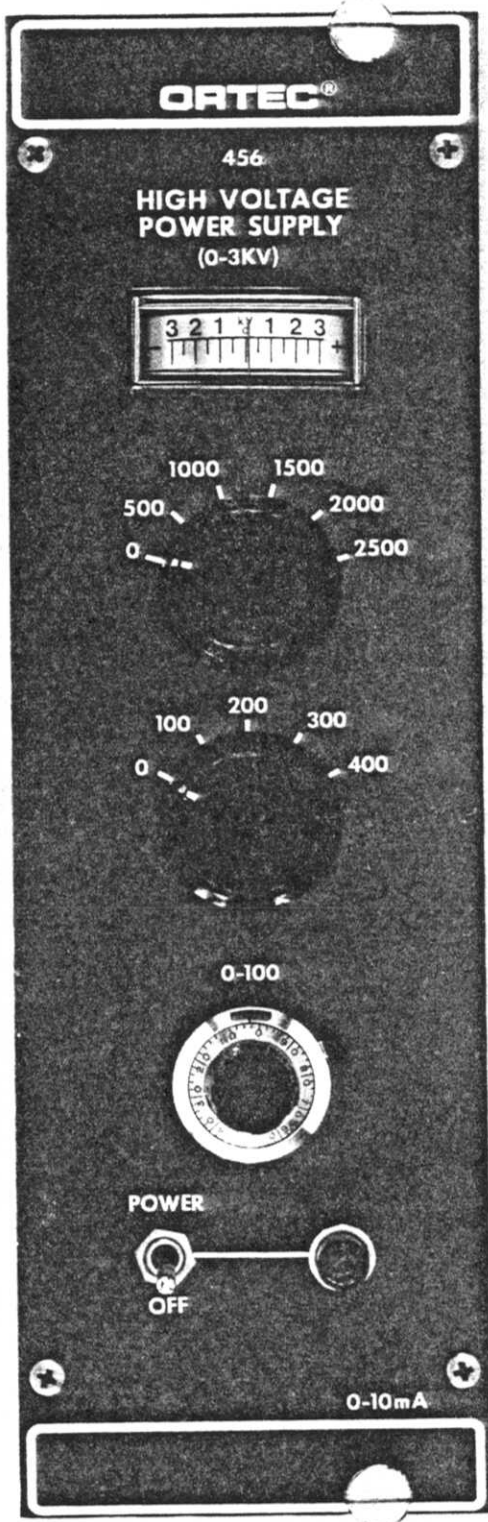
Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should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

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ORTEC 456 HIGH VOLTAGE POWER SUPPLY

1. DESCRIPTION

The ORTEC 456 High Voltage Power Supply is a standard double-width NIM module that provides either polarity of output voltage from 50 to 3000 V, 0 to 10 mA. The adjusted output voltage of the selected polarity is available simultaneously through two SHV rear-panel connectors. An internal slide switch permits operation on either 115- or 230-V ac input power, furnished through a power line cord and connector; both sides of the input power line are fused in the 456.

The 456 features a front-panel indicating meter, nominal 16-kHz internal oscillator frequency, optional external regulation for stabilizer applications, and low-noise output.

It provides the well-regulated and highly stable voltage that is required for proper operation of photomultiplier tubes, ionization chambers, and lithium-drifted semiconductor detectors.

WARNING

THIS INSTRUMENT PRODUCES VOLTAGES THAT CAN BE HAZARDOUS. ALWAYS SWITCH POWER OFF AND WAIT FOR THE METER TO RETURN TO CENTER-SCALE ZERO BEFORE CONNECTING OR REMOVING CABLES AND BEFORE CHANGING THE OUTPUT POLARITY.

2. SPECIFICATIONS

PERFORMANCE

OUTPUT POLARITY Positive or negative, selected by switch on rear panel.

OUTPUT RANGE 50 to 3000 V; min usable voltage 10 V.

OUTPUT LOAD CAPACITY 0 to 10 mA.

REGULATION $\leq 0.0025\%$ variation in output voltage for combined line and load variations within operating range at constant ambient temperature.

TEMPERATURE STABILITY $\leq \pm 50$ ppm/ $^{\circ}\text{C}$ after 30 min warmup, operating range 0 to 50°C .

LONG-TERM DRIFT $< 0.01\%/hr$ and $< 0.03\%/24-hr$ variation in output voltage at constant input line voltage, load, and ambient temperature after 30 min warmup.

OUTPUT RIPPLE < 15 mV peak to peak, 5 Hz to 5 MHz.

OVERLOAD PROTECTION Built-in overload and short-circuit protection with max output current limit of ≈ 12 mA. Overload is indicated by low-frequency oscillations on front-panel meter.

CONTROLS

POWER OFF Toggle switch on front panel is used to energize unit when power cord is plugged into an appropriate source, and an adjacent indicator lamp shows when power is applied to the 456.

OUTPUT LEVEL One 6-position switch, one 5-position switch, and a 10-turn precision potentiometer; output level is sum of the 3 selections $\pm 0.25\%$.

POLARITY A rear-panel switch selects either Positive or Negative output polarity.

CONTROL A slide switch on the rear panel selects the reference source for the output voltage.

Int Selects the internal reference source; the front-panel controls select the output amplitude, and the rear-panel switch is used to select either polarity.

Ext Selects the external reference source; output voltage is proportional to reference input.

INPUTS

AC POWER LINE 103-129 V or 206-258 V, 47-65 Hz, 50 W nom; power supplied through 3-wire captive line cord with standard NEMA connector; both sides of line are fused in the 456.

EXTERNAL CONTROL Full range of output voltage can be based on an external reference level furnished through a rear-panel BNC connector; control voltage range is 0 through $\sim \pm 9$ V dc; this input protected by a nominal 9-V zener.

OUTPUTS

REGULATED DC OUTPUT The adjusted and regulated voltage, with selected polarity, is furnished simultaneously to the SHV connectors on rear panel.

INDICATOR

METER A front-panel zero-center indicating meter shows the polarity and approximate amplitude of the adjusted output voltage.

ELECTRICAL AND MECHANICAL

DIMENSIONS Standard double-width module, 2.70 x 8.714 in. per TID-20893 (Rev.).

POWER REQUIREMENTS 115 or 230 V 47-65 Hz, 50 W nom; no dc power requirements.

WEIGHT (Shipping) 10 lb (4.5 kg).

WEIGHT (Net) 8 lb (3.6 kg).

ACCESSORIES AVAILABLE

Standard ORTEC 12-ft-long adapter cables are available for the SHV output connectors to accommodate the high voltage input connector on the preamplifier or detector, or other accessory that is to have the output power level applied.

ORTEC C-36-12 SHV to SHV 75 Ω Cable Assembly
ORTEC C-35-12 SHV to Kings KV-59-22 75 Ω Cable Assembly
ORTEC C-34-12 SHV to MHV 75 Ω Cable Assembly

RELATED EQUIPMENT

Each of the two outputs of the 456 can be used as a power source for any application that is within the operating limits of the power supply. Both output levels are identical and of the same polarity. The load on the 456 output circuit is the sum of the individual loads connected to both output connectors.

This power supply is ideal for use with either one detector or a pair of detectors where the voltage level requirements are the same for both detectors. The appropriate types of detectors for which the 456 is designed include scintillation, ionization chambers, and lithium-drifted semiconductor detectors.

3. INSTALLATION

3.1 GENERAL

The 456 is normally used in conjunction with other modular electronics and may be installed in an ORTEC 401A Bin. As such, it can be rack mounted. Therefore any other equipment that may be installed in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the circuits in the 456. The temperature of equipment operating in racks can easily exceed the recommended maximum unless precautions are taken. The 456 should not be subjected to temperatures in excess of 50°C (120°F).

3.2 CONNECTION TO POWER

The 456 contains all required power supplies to operate and receives input power by way of a 3-wire captive line cord with a standard NEMA male connector when connected to a suitable source. An internal slide switch permits the selection of the proper input circuit for either 115- or 230-V ac nominal power input. This power supply may be operated entirely removed from a 401A Bin if desired, since it is totally self-contained and requires no dc operating power levels from the Bin. However, precautions should be taken to ensure that personnel know of the shock hazard at the rear connectors, and air space should be provided at the top and bottom of the instrument.

3.3 CONNECTING INTO A SYSTEM

1. Check to see that the power switch is in the Off position.
2. Plug the ac power cord into the appropriate receptacle.
3. Check the polarity switch on the rear panel and set it

for either positive or negative output polarity as required for the application.

4. Connect a high-voltage cable from either output connector on the 456 to the instrument to be powered. Use the other output connector if a second instrument is to be operated at the same output voltage.

5. Set the front-panel selector switches and potentiometer for the desired voltage level. This is normally specified with the instruments to which the voltage is to be applied. The adjusted output voltage will be the sum of the settings of all three controls.

6. Turn on the power with the toggle switch on the front panel. The indicator lamp next to the switch will light to show that input power is being applied. The indicating meter at the top of the front panel will also deflect to show both the polarity and the amplitude of the adjusted output voltage.

3.4 CONNECTING AN EXTERNAL REFERENCE INPUT

An output voltage level can be controlled by an external reference level that is furnished through the rear-panel BNC connector when the Control slide switch is set at Ext. The range of input voltage is 0 to ~ 9 V to provide an output level to 3000 V. The front-panel voltage level controls are ineffective for external reference operation.

For positive output the polarity selector switch on the rear panel is set at Positive, and the external reference should be positive. For negative output the polarity switch is set at Negative and the external reference should be negative. The external reference voltage should be stable and filtered since the output is linearly proportional to this reference. The external reference should be capable of driving the 47 k Ω input impedance.

4. CIRCUIT DESCRIPTION

4.1. GENERAL

Figure 4.1 is a simplified block diagram of the 456 circuits. Schematics 456-0101-S1 and 456-0301-S1 are included at the back of the manual.

The 456 requires an ac power input, regardless of the use of an internal or an external reference level. The selected reference level is applied to a precision regulator and controls the low voltage input level to an internal nominal 16 kHz oscillator. The oscillator output voltage is stepped up for the high voltage output through a converter transformer, and this is rectified and filtered to produce the output to each output connector.

The front-panel indicating meter is connected to the output connectors and monitors the voltage present at these connectors. This is an excellent safety feature since it indicates whenever there is a voltage present at the connectors, as well as the output polarity and the approximate level.

4.2. REGULATION

IC302 is a differential input amplifier that receives inputs from the voltage control board and the output divider string. This is an error signal that is amplified by IC301 and furnished to the regulating transistor, Q317. Q315 is used as a constant-current transistor. Q318 is a driver for the pass transistor, Q104. The overload transistor is Q316 and it samples the voltage across R102.

A preregulator controls Q103. The current to turn Q103 on is supplied through D304, R309, and Q302. Q302 is actually turned on by current through R311, R310, and D305 into the base of Q302. Q311 and Q312 keep the voltage across pass transistor Q104 at a low value by shunting base current from Q302. When there is an overload, the base current for Q302 is shunted away by the action of Q313, which is turned on by current from overload transistor Q316. To prevent SCR spikes, Q103 is prevented from being triggered by Q301 if there is any voltage across Q103. This allows the SCR to be triggered only at those times when the voltage across it is at or very near zero.

When Q103 is triggered one time, Q303 through Q310 ensure that it will be triggered a second time. This prevents saturation of the input transformer by ensuring that current passes through the transformer in both directions. Q303, Q304, and Q305 are speedup transistors that trigger a flip-flop, Q306 and Q307. When Q307 is turned on, Q310 supplies current to Q302 to trigger Q103 the second time.

The preregulator can be bypassed for troubleshooting purposes. To bypass the preregulator, short the anode and cathode of Q103 together; this can be done by shorting pins 13 and 14 of Regulator Board 456-0301 to each other. This allows the voltage to go high on the collector of Q104 and requires care when loading the output to prevent exceeding the power dissipation rating of Q104.

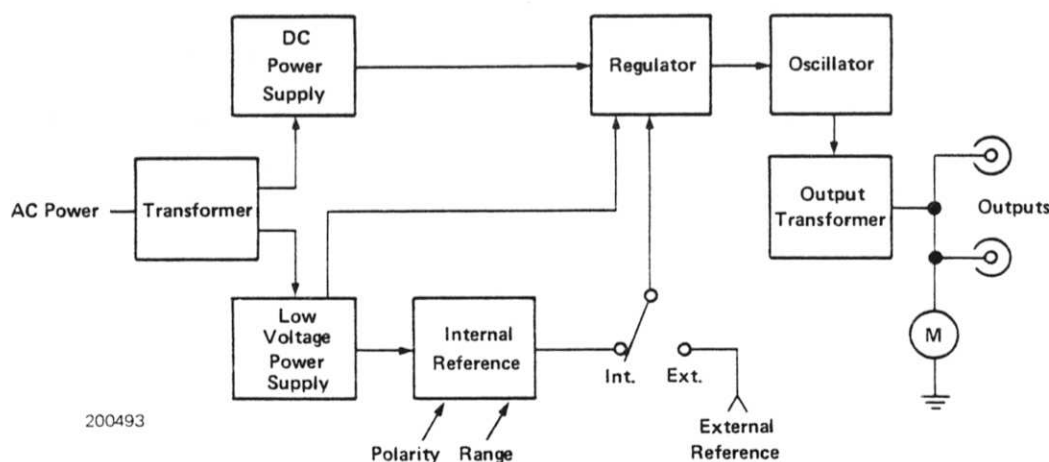


Fig. 4.1. Simplified Block Diagram of ORTEC 456.

5. CORRECTIVE MAINTENANCE

5.1 GENERAL

These units should rarely require more than cleaning to prevent leakage paths from being created by dust collection. If an apparent malfunction is noted, it is important to determine if it is within the High Voltage power supply by disconnecting it from its position in a circuit and performing routine diagnostic tests with a voltmeter and oscilloscope. The power supply is short-circuit protected, and under a short circuit the output voltage will drop to zero. If an external short circuit has been applied to the output, the short circuit must be removed before the power supply will again produce its adjusted full voltage. If this supply is operating at or near rated output current when short circuit occurs, it may be necessary to lower voltage setting to allow supply to recover properly.

5.2 TROUBLESHOOTING SUGGESTIONS

Troubleshooting procedures for this power supply should consist of simply removing the output loads and measuring the output voltage, and then applying a load and monitoring the output voltage again to see whether the output voltage is regulated. Internal dc measurements may be performed in the field since typical dc voltages are indicated in the schematic diagram. Be cautious when measuring voltage within this power supply because of the personnel hazard associated with the high voltages. The 456, or any other standard ORTEC product, may be returned to the factory for repair service at any time for a nominal cost. Our standard procedures for repair include the same extensive quality control tests that a new instrument receives.

The following table lists some possible problems that may occur in an ORTEC 456 High Voltage Power Supply, together with one or more possible causes for each of these problems.

Table 5.1.

Problem	Possible Causes
Blows input fuses	Check internal 115/230 switch. Oscillator stopped. Q101 or Q102 shorted. D101 defective. One or more of the following capacitors shorted: C101, C102, C201, C203.
No output with Control switch set at Ext.	Q103 open. Q104 open. No reference voltage input. Q101 or Q102 open. Leaky Q104.
Output ok at high setting, but does not drop properly when controls are set to zero.	
Output ok at low setting, but will not increase to high levels.	Q101 or Q102 defective. Low reference voltage.
Output oscillates at a low frequency.	Supply is overloaded.

**BIN/MODULE CONNECTOR PIN ASSIGNMENTS
FOR AEC STANDARD NUCLEAR INSTRUMENT
MODULES PER TID-20893 (Rev 4)
(adopted by DOE)**

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	117 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	117 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in EG&G ORTEC's 4001A, 4001B, 4001C, 401A, and 401B Modular System Bins.

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

ORTEC
456-0201(L)

METER
CAL

R210
BAL

14

10

C204

R203

R202

10

10

10

10

D201

GRN

C201
C202
C203
C204

INSTALLED DURING
FINAL ASSEMBLY

R206
R207
HV ADJ

C104

R205

C105

C210 +
C211 +

D202
D203
D204
D205

C203
BLK

A

C

G

GND

E

B

C

R206

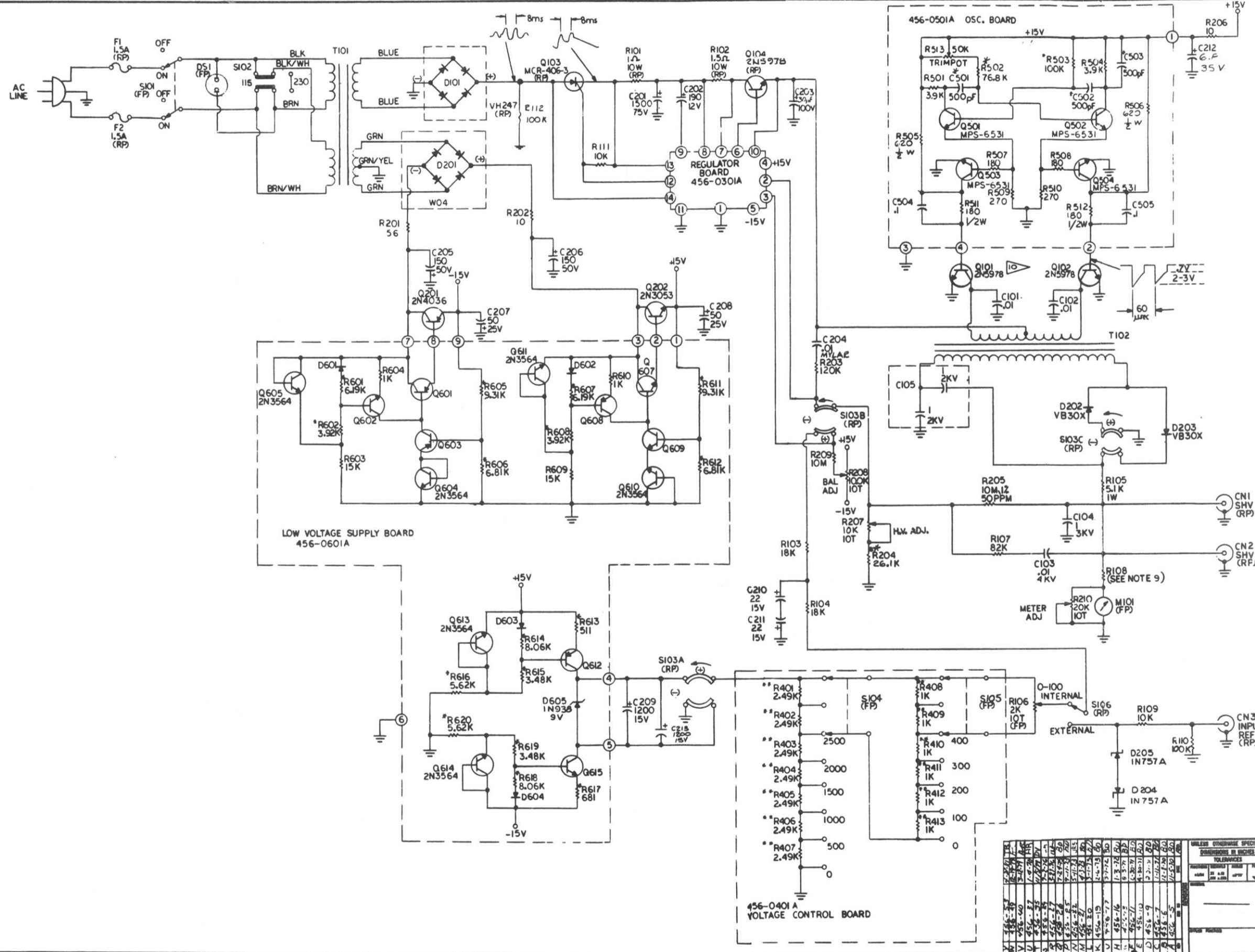
+C212

C206

C205

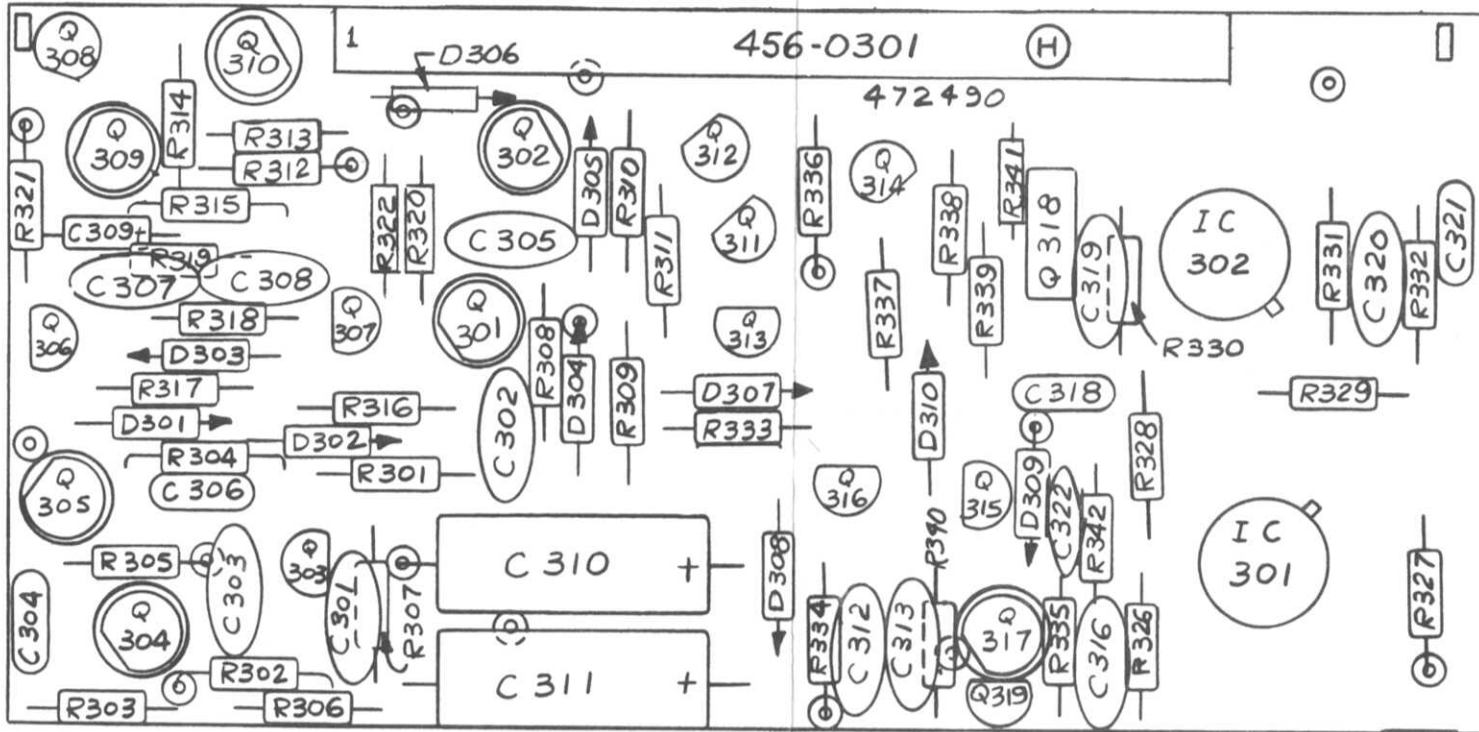
C208

C207

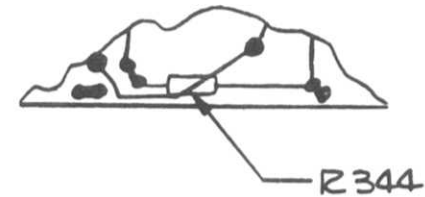


NOTES: UNLESS OTHERWISE SPECIFIED
 1. ALL DIODES ARE IN4009.
 2. ALL RESISTORS ARE 1/4W, 5% CARBON.
 3. CAPACITANCE IS IN μF FARADS.
 4. NPN TRANSISTORS ARE 2N3568.
 5. PNP TRANSISTORS ARE 2N3638A.
 6. *RESISTORS ARE 1/8W, 1% MF-T2.
 7. *RESISTORS ARE 1/8W, 1% MF-T2.
 8. *CAPACITORS ARE DIPPED MICA.
 9. R108=(1)5.1M (4)6.2M 1/2W, 5%.
 10. Q101 & Q102 ARE SELECTED TO HAVE $V_{ce(SAT)}$ OF LESS THAN 300mV AT 15mA BASE CURRENT AND V_{ce} OF GREATER THAN 90V

UNLESS OTHERWISE SPECIFIED		ORTEC INCORPORATED	
100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830			
MODEL 456		HIGH VOLTAGE POWER SUPPLY	
R.W.V. 8-12-70	T. SATERFIELD		
456-0101-S1			



PARTIAL REAR VIEW



REV	REV NO	DATE	APR
K	456-58	9-10-82	WH
J	456-56	7-14-82	WH
H	456-53	5-1-81	TB
G	456-40	3-12-79	AR
F	456-37	1-4-78	HR
E	456-20	6-18-72	BD
D	456-14	9-25-71	BD
C	ECN 456-13	8-3-71	BD
B	GC-64	2-11-71	BD
A	GC-48	9-2-70	BD

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES

FRACTIONS	DECIMALS	ANGLES	FINISH
$\pm 1/64$	XX $\pm .01$ XXX $\pm .005$	$\pm 0^{\circ}30'$	<input checked="" type="checkbox"/> RUS

MATERIAL	APPLIED PRACTICES

ORTEC INCORPORATED

100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830

TITLE MODEL 456 P.C. BOARD LAYOUT			
DRAFTSMAN D. NOE	DATE 7-31-70	RESPONSIBLE ENGINEER T. SATTERFIED	REFERENCE
CHECKED	DATE	ENG. APPROVAL	DATE
SCALE 2:1	MFG. APPROVAL B. D. Shiley	DATE 8-3-70	DRAWING NO. 456-0300
ENG. ISSUED	DATE 9-30-71	RELEASED FOR MFG.	DATE

PRINTS
TO
FILE NO.
53


1. ALL DIODES ARE 1N4009
2. ALL RESISTORS ARE 1/4 W 5% CARBON
3. CAPACITANCE IS IN μ FARADS
4. NPN TRANSISTORS ARE 2N3568
5. PNP TRANSISTORS ARE 2N3638A
6. * CAPACITORS ARE DIPPED MICA



L	456-60	1-7-83	WH
K	456-56	7-14-81	WH
J	456-53	4-28-81	WH
H	456-40	3-12-79	AC
G	456-37	1-4-78	HR
F	456-20	9-21-82	80
D	456-14	9-25-71	80
C	456-13	8-23-71	80
B	456-17	1-10-71	80
A	456-1	9-15-70	80
REV	REV	DATE	BY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES

TOLERANCES		
FRACTIONS	DECIMALS	ANGLES
±.004	±.01	±.01°
±.001	±.005	±.005°

APPROVAL: 


DATE: 9-30-71

ORTEC

INCORPORATED

100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830

MODEL 456 REGULATOR BOARD

DRAWN	DATE	RESPONSIBLE ENGINEER	REFERENCE
DC	8-4-70	T. SATTERFIELD	456-0101-S1
CHECKED	DATE	ENG. APPROVAL	DATE
			8-19-70
ISSUED	DATE	ENG. APPROVAL	DATE
		B. Denny	8-19-70
RELEASED FOR MFG		DATE	STOCK NO.
37		9-30-71	456-0301-S1

Part #

9

53

54

Part #

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