BERTAN ASSOCIATES, Inc.
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INSTRUCTION MANUAL

FOR

SERIES 602B HIGH VOLTAGE POWER SUPPLIES

WARRANTY

BERTAN ASSOCIATES, INC. warrants this instrument to be free from defects in material and workmanship for a period of one year from the date of shipment. This warranty does not apply to equipment that has been subjected to misuse or which has been repaired or altered in any way by the user. BERTAN ASSOCIATES, INC. is responsible only for the cost of materials and labor to repair or replace FOB our factory products proved to be defective during the warranty period. We are not liable for consequential damages incurred due to failure of this equipment. No other warranty is expressed or implied. All products returned under warranty must be shipped prepaid to the factory with documentation describing the malfunction noted. It is recommended that the factory be notified prior to shipment. The equipment will be evaluated, repaired or replaced and promptly returned if the warranty claims are substantiated. A nominal service charge will be made for unsubstantiated claims. Include the BERTAN ASSOCIATES, INC. model and serial number in all correspondence with the factory.

CAUTION: THIS UNIT PRODUCES HAZARDOUS VOLTAGE. DO NOT APPLY LINE VOLTAGE INPUT UNLESS ADEQUATE GROUND IS CONNECTED TO THE POWER SUPPLY AND THE HIGH VOLTAGE OUTPUT HAS BEEN PROPERLY CONNECTED.

SECTION I SCOPE

1.0 SCOPE OF MANUAL

This manual contains instructions for the installation, operation and maintenance of the -BA- SERIES 602B High Voltage Power Supplies.

SECTION II DESCRIPTION

2.0 GENERAL DESCRIPTION

These units are basically dc-dc converters that convert low voltage dc power to a high voltage dc output. This output is highly regulated and filtered and can be varied by either local or remote controls. The input to the dc-dc converter is obtained from a conventional low voltage power supply with ac line input.

2.1 CIRCUIT DESCRIPTION

An oscillator determines the high frequency (approximately 20kHz) at which all amplification, high voltage transformation, rectification, and filtering occurs. The amplification is a function of a control voltage which performs the function of control and regulation. A sample of the output voltage is compared against a reference voltage in the sensing circuit. The sensing circuit generates the control voltage to set and maintain a fixed high voltage output.

2.2 THEORY OF OPERATION

The input ac is converted to B+ (40 Vdc) and regulated ±12V low voltage. The B+ supply is a transformer and full wave bridge rectifier circuit located on the chassis. The + and -12V dc regulated low voltage power supply circuits are located on the plug-in board and are IC regulator circuits.

The output of the oscillator circuit is amplified in the gain controlled integrated circuit, IC 106. The gain of IC 106 is a function of the control voltage developed at the output of the amplifier IC 103. The outputs of IC 106 are amplified, buffered and then drive the power transistors. The amplifier and buffer for both half cycles of operation is IC 105.

A sample of the high voltage dc output is buffered and then fed to the sensing circuit where it is compared to a reference voltage. The buffer and sensing circuits consists of the differential operational amplifiers IC 101 and 103. Output voltage control is obtained by varying the command voltage fed to the differential amplifier, IC 103. This command voltage is controlled by the HIGH VOLTAGE ADJUST potentiometer which provides a variable sample of the reference voltage. The reference voltage is developed by the reference zener, CR2 and IC 102 circuit.

The encapsulated high voltage assembly includes a high voltage power transformer, rectifier circuit, ripple filter and sensing circuit. These are all critical custom designed and encapsulated components. It is recommended that trouble shooting of this assembly be performed at the factory.

A METER output allows continuous monitoring of the high voltage output. The metering output is a buffered sample of the output voltage and is always positive polarity, independent of output polarity. The meter output is developed by IC 101.

2.3 SPECIFICATIONS

INPUT:	115/230 V ±10%, 50 to 400 Hz
OUTPUT VOLTAGE:	Refer to Table I
OUTPUT CURRENT:	Refer to Table I
RIPPLE:	Refer to Table I
METER OUTPUT:	0 to +5V/100uA at 0 to maximum output voltage
REGULATION:	0.001% Line, 0.001% Load
STABILITY:	0.01%/hr., 0.02%/8 hrs.
CONTROL - LOCAL:	20 Turn Potentiometer
CONTROL - REMOTE:	Voltage or Resistance
TEMP. COEFF:	50 PPM/°C
TERMINATIONS:	Input, Programming, Metering- Barrier Strip Terminals H.V. Output - (602B-15,30,50) UG-931/U Mating connector is UG-932/U H.V. Output - (602B-150) Alden 8101FP Mating connector is supplied
SIZE:	Refer to Fig. 3

TABLE I

MODEL	OUTPUT	MAX. RIPPLE PK-PK
602B-15P,N	0 to 1500 V @ 10mA	15mV
602B-30P,N	0 to 3000 V @ 5mA	30mV
602B-50P,N	0 to 5000 V @ 50mA	50mV
602B-150P,N	0 to 15,000 V @ 0.6mA	150mV

SECTION III INSTALLATION AND OPERATION

3.0 INSTALLATION

SERIES 602B Power Supplies can be mounted in any position by means of three tapped holes (8-32 NC) in their base plate. Input ac power and programming and monitoring terminals are accessible on a terminal strip mounted on the front face of the instrument. The local HIGH VOLTAGE ADJUST potentiometer is accessible for screwdriver adjustment thru an opening in the tope cover. The HIGH VOLTAGE OUTPUT is available at the connector on the rear of the unit.

3.1 INPUT POWER

Input ac LINE voltage required is 115 or 230V, single phase, 50-400 Hz to TERMINALS 1 and 2 of the TERMINAL STRIP. Connect TERMINAL 3 to GROUND. A recessed line voltage selector located on the front panel is used to select either 115 or 230V operation.

The line side of the ac input is fused. A fuse holder located on the front panel accommodates a type 3 AG slow blow cartridge fuse. A 1/2A fuse is required for 115V and 1/4A for 230V operation.

3.2 PROGRAMMING

A MODEL 602B offers extremely versatile local adjustment and external resistance and voltage programming capability. The local HIGH VOLTAGE ADJUST is accomplished thru a multi-turn potentiometer, accessible thru a hole in the top cover, that varies the HIGH VOLTAGE OUTPUT between zero and maximum output voltage. Connecting an external resistance between TERMINALS 4 and 5 of the terminal strip will shift the maximum output voltage downward.

NOTE: THE HIGH VOLTAGE ADJUSTMENT WILL HAVE NO CONTROL AND THE OUTPUT VOLTAGE WILL BE ZERO UNLESS A JUMPER OR AN EXTERNAL RESISTOR IS APPLIED BETWEEN TERMINALS 4 AND 5 ON THE TERMINAL STRIP.

3.2.1 RESISTANCE/POTENTIOMETER PROGRAMMING

External programming of the SERIES 602B can be accomplished by applying a resistance between TERMINALS 4 and 5 or by applying a potentiometer to TERMINALS 3,4, and 5. In both cases the HIGH VOLTAGE ADJUST potentiometer will set the maximum voltage (V_{max}) that the unit can be programmed to.

Applying a resistance (R_{ext}) between TERMINALS 4 and 5 will produce an output voltage, as described by the equation $V_o = V_{max} \times \left(\frac{1}{1 + \frac{R_{ext}}{8k}} \right)$

If a 100k rheostat is employed, the voltage will be programmable over the range of V_{max} (when $R_{ext}=0$) down to approximately 7 1/2% of V_{max} (when $R_{ext}=100k$). It is clear from the equation above that the output voltage does not vary linearly with R_{ext}.

Applying a potentiometer with the CCW TERMINAL connected to TERMINAL 3, the CW TERMINAL connected to TERMINAL 5, and the wiper TERMINAL connected to TERMINAL 4 allows for programming over the entire range of 0 to V_{max}. For best results a potentiometer of resistance 1 or 2k should be used to obtain good linearity. A 1k pot will produce a worst case error (or non linearity) of less than 2% of V_{max}. A 10k pot will produce a worst case error of less than 15% of V_{max}. Do not use a potentiometer of resistance value less than 1k.

3.2.2 VOLTAGE PROGRAMMING

External voltage programming can be accomplished by connecting a stable external voltage source to TERMINAL 4. For this application, TERMINAL 5, which supplies the internal REFERENCE voltage, is not connected. With the HIGH VOLTAGE ADJUST set maximum clockwise, a 0 to -5V external source will linearly program the HIGH VOLTAGE OUTPUT between zero and full output voltage. With the HIGH VOLTAGE ADJUST set halfway to maximum, a 0 to -10V external source will be required to linearly program the HIGH VOLTAGE OUTPUT between zero and full output voltage.

NOTE: Depending on their location, pickup on any external leads to the programming terminals may introduce ripple into the HIGH VOLTAGE OUTPUT of a MODEL 602B. If this occurs, it is suggested that an electrolytic capacitor be connected across TERMINALS 3 and 4, with the negative lead of the capacitor connected to TERMINAL 4. A 100 uF at 10V dc capacitor should be adequate. The voltage programming time constant is approximately 100 msec. rise time and fall time at maximum rated load current.

3.3 REMOTE METERING

A meter connected between TERMINAL 6 and GROUND will provide monitoring of the HIGH VOLTAGE OUTPUT, with the meter reading directly proportional to the output voltage. A low impedance dc ammeter will indicate a current 0 to +100uA proportional to output voltage. A high impedance voltmeter will read 0 to +5V proportional to output voltage. The metering circuit has an accuracy of better than ±2% and a temperature coefficient of less than 50 ppm/°C.

SECTION IV MAINTENANCE

4.0 GENERAL

SECTION IV contains information required for the maintenance of the 602B SERIES. It is organized around the approved performance test procedures used to determine that the equipment is operating to specifications.

4.1 TEST EQUIPMENT REQUIRED

The test equipment required to test and maintain the 602B SERIES is listed as follows (equivalents may be used):

a. Oscilloscope
b. Digital or differential voltmeter
c. Variable autotransformer, General Radio Model W2
d. High impedance, high voltage 1000:1 precision dc voltage divider
e. Capacitive coupled ac viewing circuit (High Voltage dc blocking capacitor)
f. High voltage load resistor rated for maximum voltage and current of the unit under test
g. High voltage shorting stick.

4.2 PREPARATION FOR MEASUREMENTS

Connect the HIGH VOLTAGE OUTPUT to the high voltage terminal of the dc voltage divider and to the capacitor input of the ac viewing circuit. The viewing capacitor should be returned to ground with a 1 megohm resistor on the scope input side. The low voltage terminal of the dc divider should be connected to the digital voltmeter input and the ac viewing circuit output connected to the oscilloscope input. Make sure that a good ground is connected to all instruments, viewing circuits and the Model 602B. After the ground has been checked, adequate safety precautions have been taken, and the HIGH VOLTAGE ADJUST set at zero, input power can be applied. The ac input should be applied thru the variable autotransformer, which should be initially set for 115 or 230V output, as appropriate.

4.3 PERFORMANCE TESTS

Check to assure that the procedures of SECTION 4.2 have been followed.

Set the HIGH VOLTAGE ADJUST for maximum output. Connect one end of the high voltage load resistor to ground and the other end to the shorting stick. Then, with the shorting stick, connect the load resistor across the HIGH VOLTAGE output and observe the change in output voltage. During this no load to full load test, the digital voltmeter reading should not change by more than 0.001%. With the load connected as above, observe the ac ripple voltage on the oscilloscope. The ripple should be less than the specified peak-to-peak ripple under this condition of full load and maximum output voltage.

Vary the autotransformer to produce an ac line input change of ±10% and again observe the change in digital voltmeter reading. This change should be less than 0.001%.

Additional line and load regulation and ripple measurements may be performed at other voltage levels using the same procedure outlined above. This should not usually be necessary. Satisfactory test data at maximum output voltage, and the full range of voltage control generally indicate that satisfactory test data will be obtained at all voltage levels. However, full range testing is performed at the factory on each unit prior to shipment.

NOTE: SERIES 602B POWER SUPPLIES ARE CALIBRATED AND ADJUSTED PRIOR TO SHIPMENT. READJUSTMENT IS NOT NECESSARY PRIOR TO USE.

4.4 ADJUSTMENTS

With the HIGH VOLTAGE ADJUST control set for maximum output, adjust R 10 on PCB 100 for an output voltage of exactly the rated maximum output voltage of the unit under test.

4.5 TROUBLE-SHOOTING

The 602B SERIES High Voltage Power Supplies consist of a plug-in printed circuit board and a main chassis assembly which includes the encapsulated high voltage assembly. Removal of the cover provides access to all circuitry.

No further disassembly is required for trouble-shooting purposes. ONCE THE COVER HAS BEEN REMOVED, EXTREME CAUTION MUST BE EXERCISED AS POTENTIALLY DANGEROUS VOLTAGES ARE ACCESSIBLE. Make sure all test instruments are grounded, either to the high voltage connector shield or directly to the chassis prior to application of ac input power to the unit. The following procedure should then be followed.

Remove the plug-in board from the unit. This leaves only the low voltage B+ power supply operable. Turn on ac line power and measure the dc voltage obtained at the positive terminal of capacitor C 21 located to the side of the circuit board bracket. This voltage should be approximately +40 V dc. If this voltage differs by more than ±15%, the power transformer, bridge rectifier, capactor C21, Q1 or Q2 is probably defective.

If the B+ supply is operating properly, switch off line power, insert the plug-in board, and switch the line power back on. The regulated ±12 V dc is now accessible on the board at pin 2 of IC 107 and 108 respectively. The + and - voltages should be within the range of 11.5 to 12.5 V dc. If the magnitude is not within the range specified above, this circuitry is probably defective.

If all the low voltage power supplies are operating properly, and no output voltage is obtainable, test for ac drive to the base of transistor Q1 and Q2 at the rear of the unit. If drive is present, the encapsulated high voltage assembly or transistors Q1 and/or Q2 is probably defective. If there is no drive even when the voltage control is raised, then the fault is probably in the drive or control circuitry on PCB 100.

The plug-in printed circuit board can be repaired in the field or returned to the factory for repair or replacement. Spare boards can be obtained from the factory. These boards are completely assembled and tested and can be directly utilized as replacements for a board that is believed to have malfunctionted. A replacement encapsulated high voltage assembly can also be inserted in the field. It is recommended that the entire unit be returned to the factory for repair of the encapsulted high voltage assembly. Specify model number and serial number in all correspondence with the factory.

After installation of a new printed circuit board or high voltage assembly, it is necessary to readjust the oscillator control, R4, located on the printed circuit board. Set the unit for maximum voltage and no load and,observing the waveform at the emitter of Q1 or Q2, adjust R4 for minimum emitter waveform.

R10 should also be adjusted using the calibration procedure called out in Section IV Paragraph 4.4.

SECTION V SPARES

5.0 Operational spares to support the 602B Series power supplies are available from the factory. It is recommended that the common electronics components; ie resistors, capacitors, transistors, etc. be purchased from local electronics distributors. The value and description of these components are indicated in Fig. 1 & 2. Specialized -BA- parts may be ordered directly from the factory and are indicated in the spares parts list below. Indicate the Model No. (602B-XX) and serial number when ordering spare parts.

5.1 PARTS LIST

Description	-BA- P/N
Power Transformer	40113
Bridge Rectifier	CR-21
Printed Circuit Board Assy	PCB 100
High Voltage Module	HVM - 100
Connector 5kV	UG-931/U
Connector 15kV	01202

LTR	REVISIONS	DATE	APPROVED
A	ADDED C24 ECR 2288	11/3/77	DK

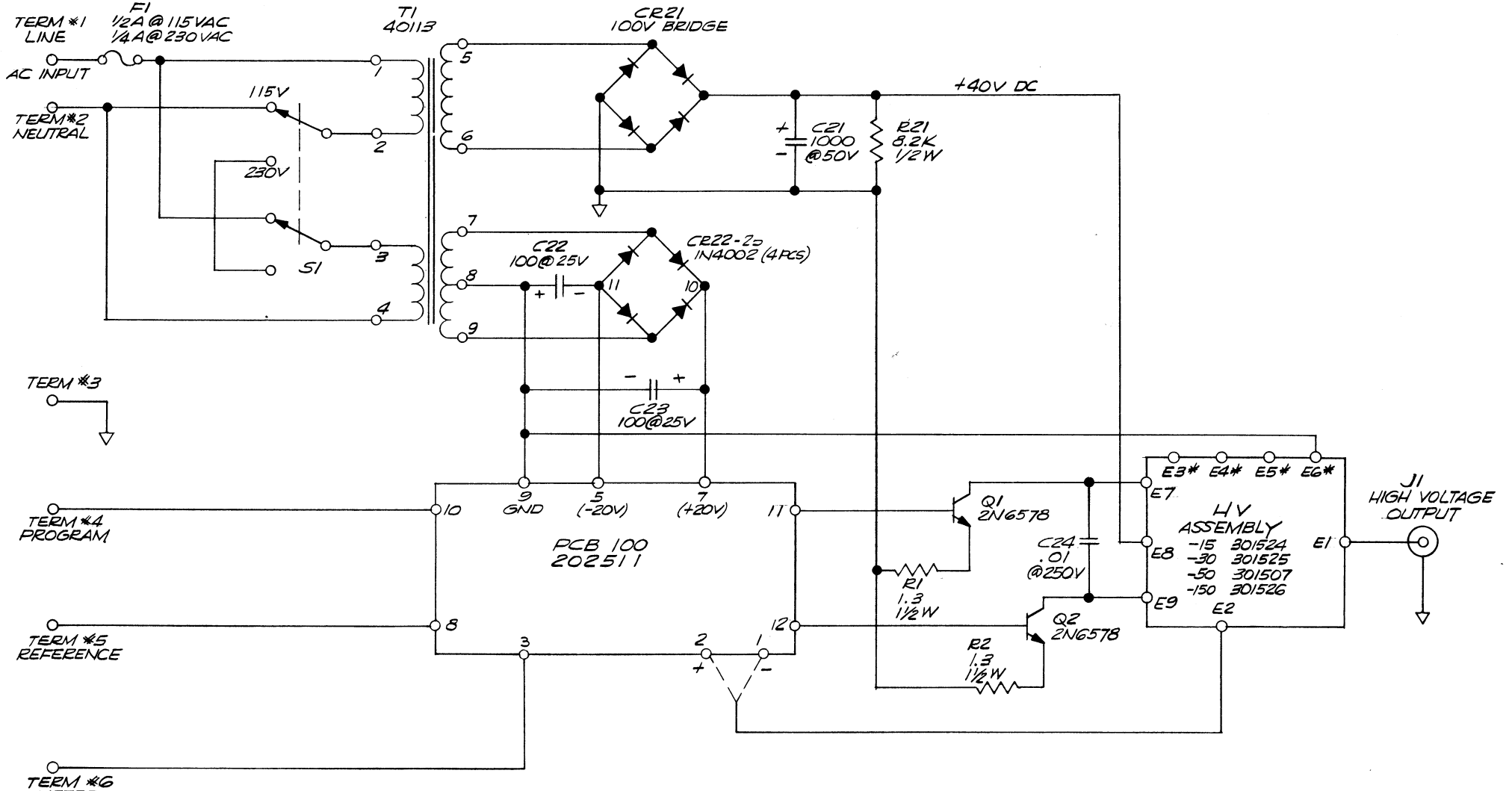

CHART I	
MODEL	HV OUTPUT
602B-15N/P	1500V @ 10mA
602B-30N/P	3000V @ 5mA
602B-50N/P	5000V @ 2mA
602B-150N/P	15000V @ 600μA

* FOR POSITIVE OUTPUT UNITS CONNECT E3 TO E6 AND E4 TO E5. FOR NEGATIVE OUTPUT UNITS CONNECT E3 TO E5 AND E4 TO E6.

FIGURE 1

102517	602B	MATERIAL:	BERTAN ASSOCIATES, INC SYOSSET, NEW YORK
NEXT ASSY	USED ON	FINISH:	SCHEMATIC BLOCK DIAGRAM MODEL 602B
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS·DECIMALS·ANGLES		DR CB 3/25/77 CK DK 4/14/77 APVD	SIZE C · CODE IDENT NO 50429 · DRAWING NO 202512 · SCALE — · SHEET 1 OF 1

LTR	REVISIONS	DATE	APPROVED
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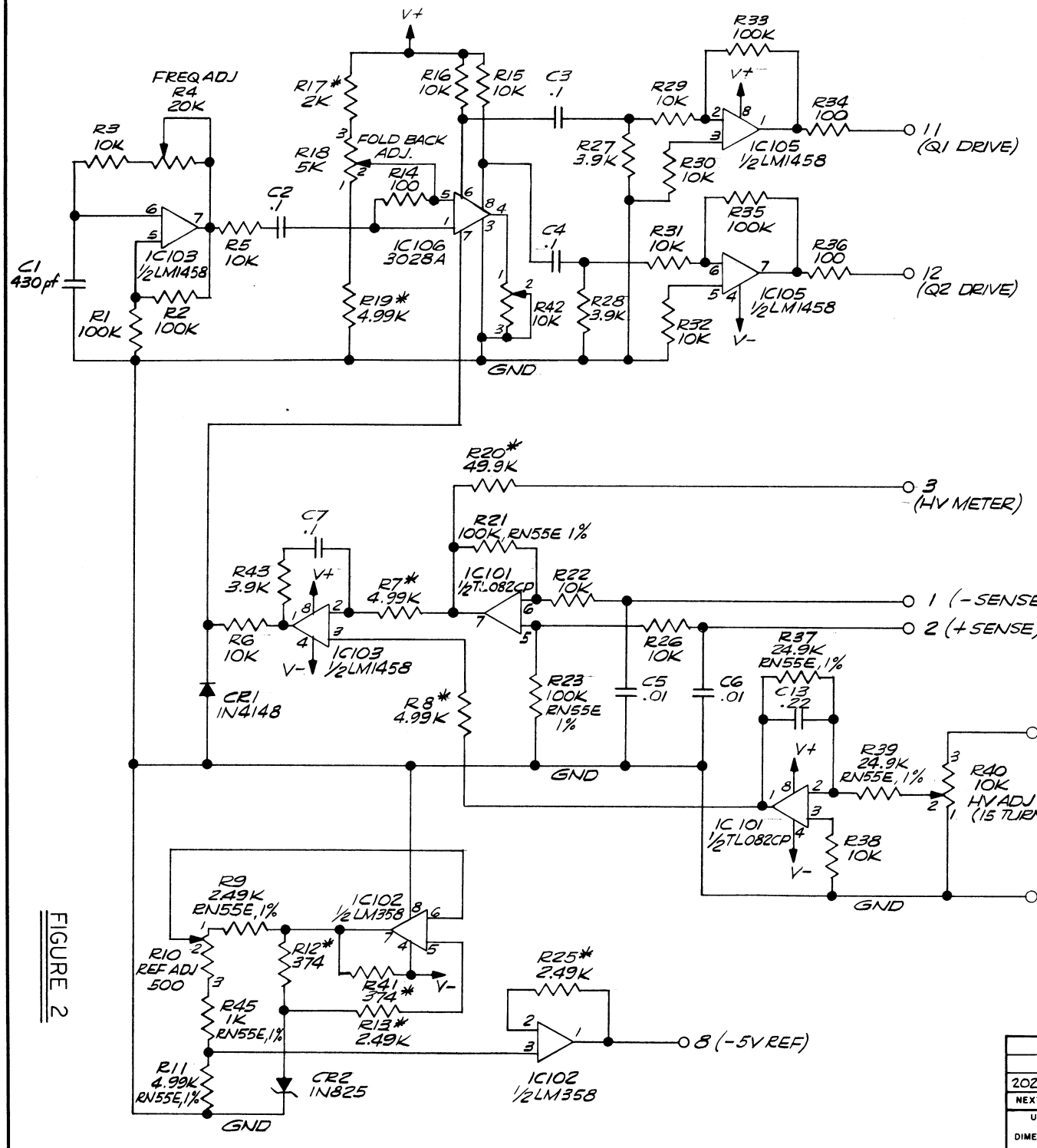
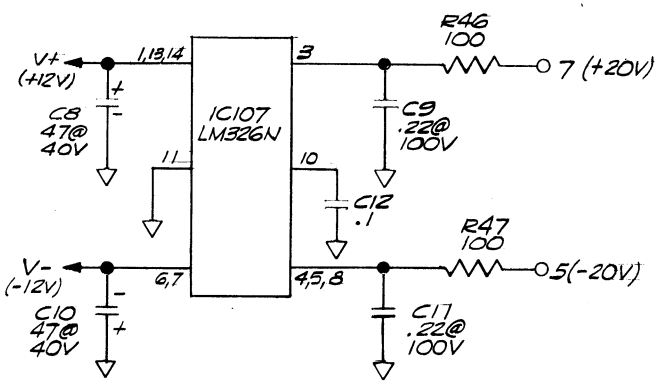
B	SEE ECN 498	11/1/77	DK





NOTES:

1. THE ASTERISK (*) DENOTES RN55C, 1% RESISTOR.
2. EXCEPT AS OTHERWISE SPECIFIED:
   a. RESISTOR VALUES IN OHMS ±5%.
   b. CAPACITOR VALUES IN MICROFARADS ±10%.

FIGURE 2

	603A	MATERIAL:	BERTAN ASSOCIATES, INC SYOSSET, NEW YORK
202533	602B	FINISH:	SCHEMATIC PCB 100
NEXT ASSY	USED ON		
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES		DR CB 3/25/77 CK DK 4/14/77 APVD	SIZE C · CODE IDENT NO 50429 · DRAWING NO 202511 · SCALE — · SHEET 1 OF 1

LTR	REVISIONS	DATE	APPROVED
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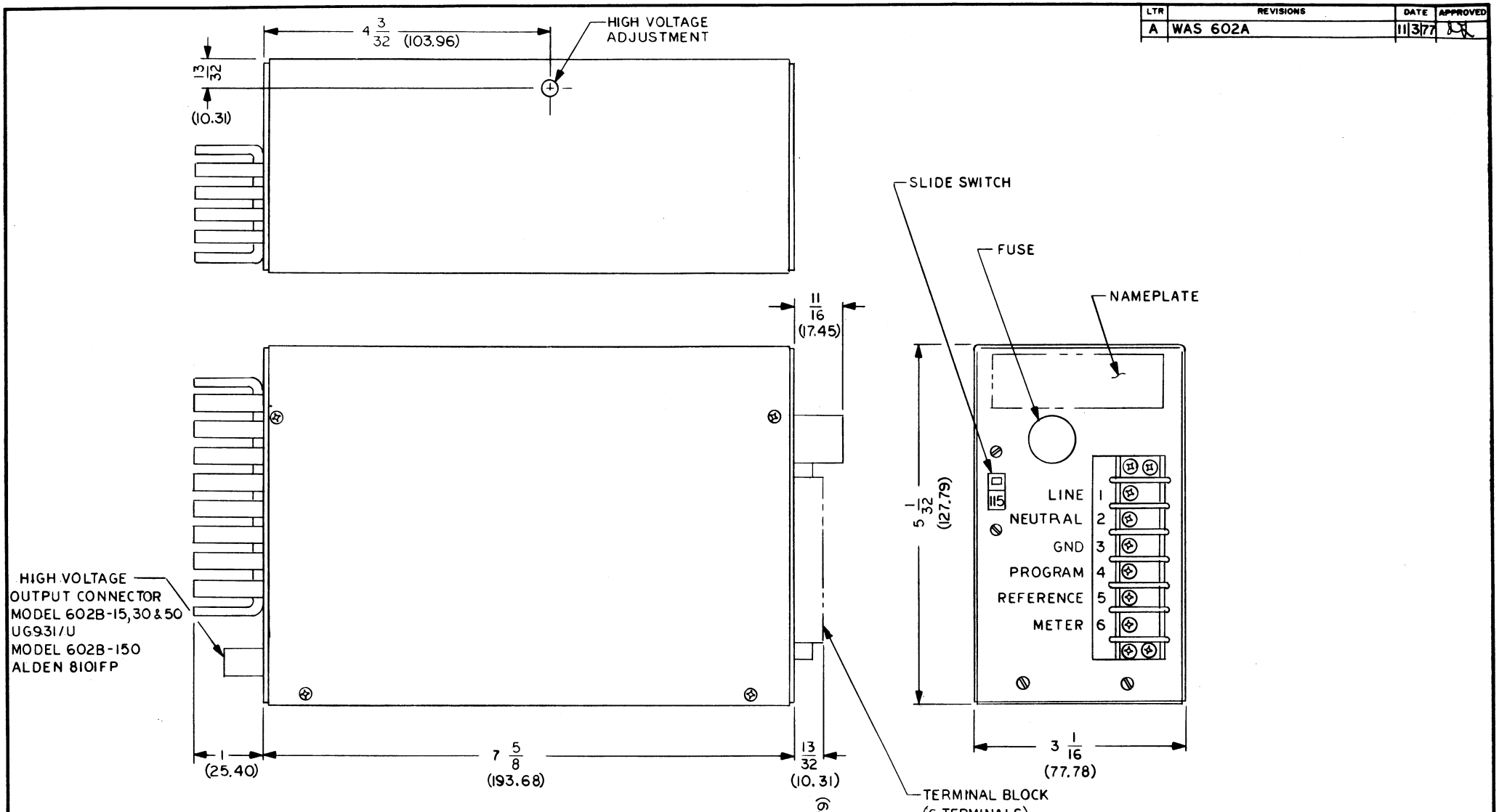

MOUNTING DETAIL

FIGURE 3

NOTE:
DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS ± .75mm

		MATERIAL:	BERTAN ASSOCIATES, INC HICKSVILLE, NEW YORK
		FINISH:	OUTLINE DRAWING MODEL 602B
602B		DR W.M. 12-29-75	SIZE C / CODE IDENT NO 50429 / DRAWING NO 200578
NEXT ASSY	USED ON	CK J.G. 12-29-75	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS DECIMALS ANGLES		APVD [illegible] 1/21/76	SCALE 1/1 SHEET 1 OF 1