BERTAN ASSOCIATES, Inc.
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INSTRUCTION MANUAL

FOR

SERIES 603 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.

790105

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 603 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. A sample of the output voltage is compared against a reference voltage in the sensing circuit. The sensing circuit generates the control voltage which determines and regulates the high voltage output by adjusting the gain of the amplifier circuitry.

2.2 THEORY OF OPERATION

The input AC is converted to B+ (+40V nominal) and V+ and V- (+ and - 20V nominal). The +40V provides the power required to generate the high voltage output and is fed directly to the high voltage assembly. The + and - 20V DC supplies provide the power for the control circuitry located on PCB 100.

Transformer T1 transforms the input line voltage to the appropriate levels required by the low voltage power supplies. The bridge rectifier CR21 and filter capacitor C21 develop the +40V B+. Rectifiers CR22 through CR25, and capacitors C22 and C23 develop the + and - 20V. All of these components are located on the main chassis assembly.

All of the control circuitry is located on PCB 100 (Fig. 2). The power transistors (Q1 thru Q4) are located on the heat sink assembly secured to the main chassis (Fig. 1). All high voltage components are contained inside the encapsulated assembly.

The oscillator output (from IC 103B) is amplified by the gain control amplifier, IC 106. The gain of IC 106 is controlled by the differential control amplifier IC 103A, which compares a sample of the output voltage against a command signal. The output voltage sample is generated by IC 101B and the command signal is derived by IC 101A. IC 101B also provides the meter output.

IC 106 provides two outputs, shifted 180^{o} in phase from each other. These two outputs are further amplified and buffered by IC 105A and IC 105B. The outputs from IC 105 drive the power transistors.

PCB 100 also contains the reference circuitry consisting of Zener CR2 and the control and buffer IC, IC 102. The -5V reference voltage can be connected (via an external jumper) to the internal control R40, or remote programming can be applied to R40.

The drive signal out of IC 105B is measured by a peak detector and employed to limit the power output. R42 is adjusted such that excessive drive causes Q101 to reduce the gain control signal fed to amplifier IC 106.

The encapsulated high voltage assembly contains all of the high voltage components. These include the high voltage transformer, rectifier circuit, ripple filter, and output sensing circuitry. These are custom designed components and encapsulated to assure reliability and stable operation.

2.3 SPECIFICATIONS

INPUT:	115/230V AC ±10% 50 to 400Hz. Model 603 is prewired for 115V AC operation and requires internal modification of the terminal strip wiring for conversion to 230V AC operation.
OUTPUT POWER:	Refer to Table I.
RIPPLE:	0.001% pk-pk.
METER OUTPUT:	0 to +5V/100uA for 0 to maximum output voltage (see 3.3)
REGULATION:	0.001% for ±10% line change; 0.002% for NL-FL or FL-NL.
STABILITY:	0.01%/hr., 0.02%/8hr.
CONTROL:	Internal - 20 turn potentiometer for 0 to maximum output voltage. Remote - external potentiometer or voltage programming (see 3.2).
TEMP. COEFF.:	50 ppm/^{o}C, maximum.
TERMINATIONS:	Input line, programming, and metering connections via Barrier Strip Terminals appropriately marked.
H V OUTPUT CONNECTOR:	See Table I.

SIZE & MOUNTING: See Figure 3

WEIGHT: 3.6kg (8.0 lbs.)

SERIES 603

TABLE I

Model[1]	HV Output	HV Connector	Mating Connector
603-10P/N	0 to 1,000V @ 30mA DC	SHV	1705-1[2]
603-15P/N	0 to 1,500V @ 20mA DC	SHV	1705-1[2]
603-30P/N	0 to 3,000V @ 10mA DC	SHV	1705-1[2]
603-50P/N	0 to 5,000V @ 5mA DC	SHV	1705-1[2]
603-100P/N	0 to 10,000V @ 2.5mA DC	Alden 8101FP	BA-01202[3]
603-150P/N	0 to 15,000V @ 1.5mA DC	Alden 8101FP	BA-01202[3]

1. Units are either positive or negative (NOT floating or reversible outputs) and must be ordered as either "P" or "N". i.e. 603B-15P has an output of 0 to +1500V, the 603-50N has an output of 0 to -5,000V.

2. Mating connector not supplied with unit.

3. Mating connector assembled to 1m (39") of unshielded high voltage cable supplied with unit.

SECTION III INSTALLATION AND OPERATION

3.0 INSTALLATION

The SERIES 603 Power Supplies can be mounted in any position by means of the tapped holes in their base plate. Input ac power, programming and monitoring terminals are accessible on a terminal strip mounted on the face of the unit. The local HIGH VOLTAGE ADJUST potentiometer is accessible for screwdriver adjustment thru an opening in the top cover. The HIGH VOLTAGE OUTPUT is available at the connector located on the face of the unit. For detailed information, see Figure 3.

3.1 INPUT POWER

Input ac LINE voltage required is 115 or 230V, single phase, 50-400Hz to TERMINALS 1 and 2 of the TERMINAL STRIP. Connect TERMINAL 3 to GROUND. The SERIES 603 is initially prewired for 115V AC line operation but can be changed by rewiring the transformer (T1) primary connections to TERMINAL 1 and 2 (see Figure 1).

The SERIES 603 line input is not fused. The input current required is less than 1A for 115V or 1/2A for 230V operation.

3.2 CONTROL AND PROGRAMMING

The 603 SERIES High Voltage Power Supplies offer extremely versatile capability for internal control and remote programming. The units can be internally or externally controlled over their full range of zero to maximum output. In addition, the internal control can be employed to limit the range of external control or, conversely, the external control can be employed to limit the range of internal adjustment.

3.2.1 INTERNAL CONTROL

The internal control can vary the output voltage from zero to maximum output when a jumper (not supplied with unit) is applied, shorting terminals 4 and 5. Applying a resistance between terminals 4 and 5 will reduce the maximum output voltage settable using the internal control. The internal control will always adjust down to zero output voltage.

The relationship for the external resistance required to limit the voltage control is approximately defined by the equation:

$$\text{Rext (in Kilohms)} = 8\left(\frac{Vo(\text{rating})}{Vo(\text{limit})} - 1\right)$$

For example, if we desire to limit the range of control to 1/2 the rating, we would require an external resistance of 8K connected between terminals 4 and 5.

The internal voltage adjustment will have no control and the output voltage will be zero unless a jumper or an external resistance is applied across terminals 4 and 5.

3.2.2 VOLTAGE PROGRAMMING

External voltage programming can be accomplished by connecting a stable external voltage source to Terminal 4. For this application, NO connection is made to Terminal 5.

During external voltage programming operation, the internal high voltage control functions as a proportionality adjustment. At maximum setting of this control, a 0 to -5V programming input will allow a 0 to maximum output voltage control. With the control set at 1/2 maximum, a 0 to -5V programming input will provide a 0 to 1/2 maximum output voltage control, or a 0 to -10V programming input would be required for full output control.

3.2.3 POTENTIOMETER PROGRAMMING

A potentiometer can be employed to simulate voltage programming using the -5V reference available at Terminal 5. The external potentiometer is connected across the -5V reference and ground. The wiper arm is then connected to the programming input, Terminal 4, and applies the 0 to -5 control voltage.

The input impedance at Terminal 4 is between 7K and 10K and therefore introduces non-linearity during potentiometer control. For best results, a 1K potentiometer should be employed. The resulting non-linearity would be less than 5%.

3.3 METERING

An output, proportional to the high voltage, is provided at Terminal 6 to allow for remote monitoring of the high voltage. This output is identical for all units.

The output is 0 to +5V for an output of 0 to maximum output high voltage. The impedance of the metering circuit is 50K so that a 100uA current meter can be employed for output monitoring as conveniently as a 5V voltmeter.

SECTION IV MAINTENANCE

4.0 GENERAL

SECTION IV contains information required for the maintenance of the 603 SERIES. It is organized around the approved performance test procedures employed at the factory to determine that the equipment is operating to specifications.

4.1 TEST EQUIPMENT REQUIRED

The test equipment required to test and maintain the 603 SERIES is listed as follows:

a. Oscilloscope
b. Digital or differential voltmeter
c. Variable autotransformer
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 thru a 1 megohm resistor. The low voltage terminal of the dc divider should be connected to the digital voltmeter input. The ac viewing circuit output, at the 1 megohm resistor, should be connected to the oscilloscope input.

Make sure that a good ground is connected to all instruments, viewing circuits and the Model 603. 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 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 0.002%. 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: THE 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 R10 on PCB 100 for an output voltage of exactly the rated maximum output voltage of the unit under test.

R42 is employed to set the output current limiting. With the output voltage set at zero, apply a load which would draw 50% more than the rated current at full output voltage. Raise the output voltage and adjust R42 such that the maximum obtainable output is 80% of full output voltage. This results in the current limit being set at 20% above the rated maximum current.

4.5 TROUBLE-SHOOTING

The 603 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 +40V DC and ±20V DC power supplies operable. Turn on AC line power and measure the DC voltage obtained at the positive terminal of capacitor C21. This voltage should be approximately +40V DC. If this voltage differs by more than ±15%, the power transformer, bridge rectifier CR21, capacitor C21, or power transistors are probably defective.

Next, test for ±20V DC at terminals 10 and 11 of T1, respectively. If they differ by more than ±15%, the power transformer, rectifiers CR22 thru CR25, or capacitors C22 and C23 are probably defective.

If the unregulated supplies are operating properly, switch off line power, insert the plug-in board, and switch the line power back on. The regulated ±12V DC is now accessible on the board at Pin 1 and 11 of IC107. The + and - voltages should be within the range of 11.5 to 12.5V DC. If the magnitude is not within this range, IC107 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 the power transistors on the chassis. If drive is present, the encapsulated high voltage assembly or the power transistors are 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 malfunctioned.

The high voltage assembly consists of critical components carefully assembled and encapsulated to insure reliability and stable operation. These assemblies can be repaired by trained personnel at the factory. Replacement assemblies can be provided for field installation.

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 and R42 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 603 SERIES power supplies are available from the factory. It is recommended that the common electronics components; i.e. resistors, capacitors, transistors, etc. be purchased from local electronics distributors. The value and description of these components are indicated in Fig. 1 and 2. Specialized -BA- parts may be ordered directly from the factory and are indicated in the spares parts list on the following page. Indicate the Model No. (603B-XX) and serial number when ordering spare parts.

5.1 PARTS LIST

Description	P/N
Power Transformer	202193
Bridge Rectifier	CR-21
Printed Circuit Board Assembly	202511
High Voltage Module	See Figure 1

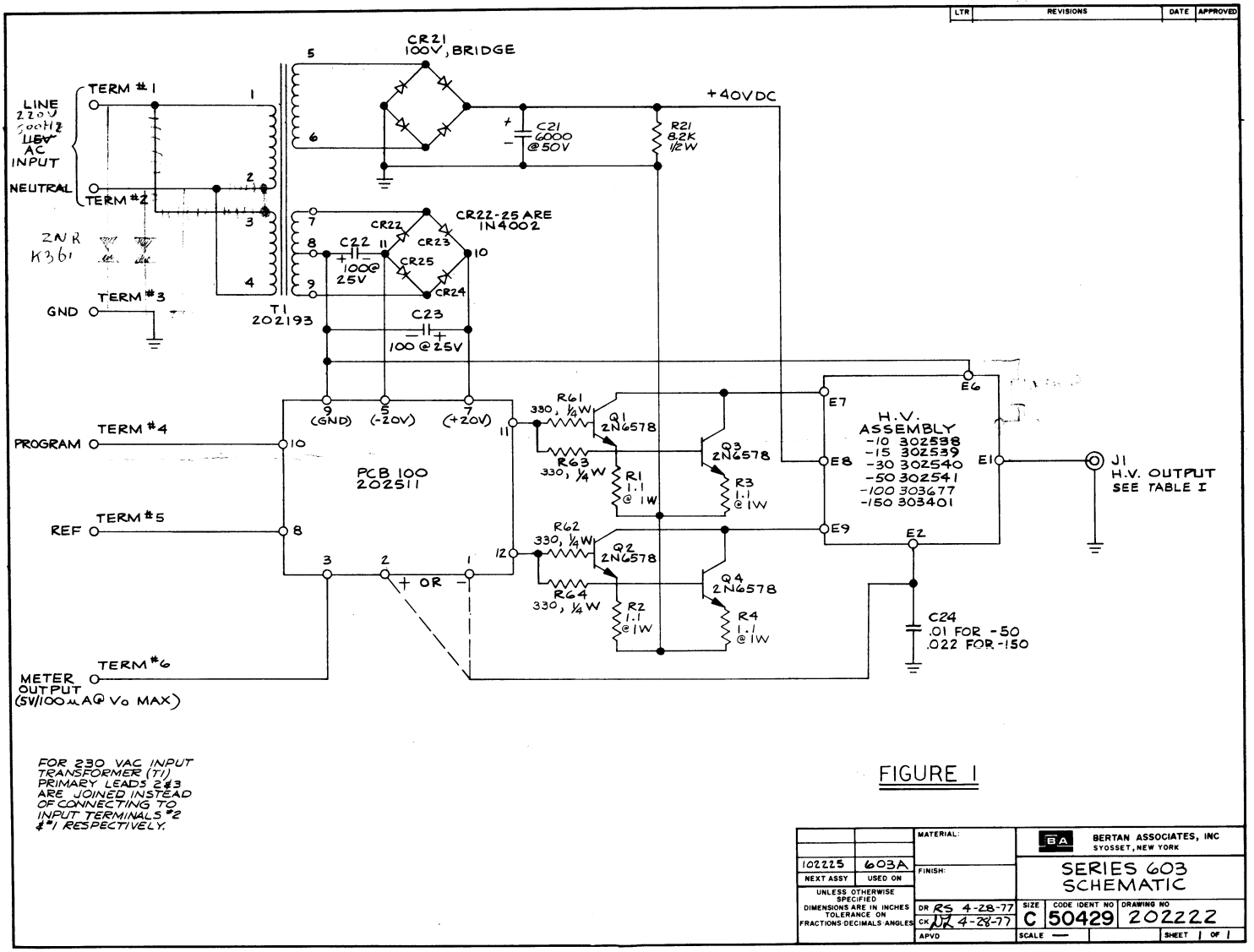
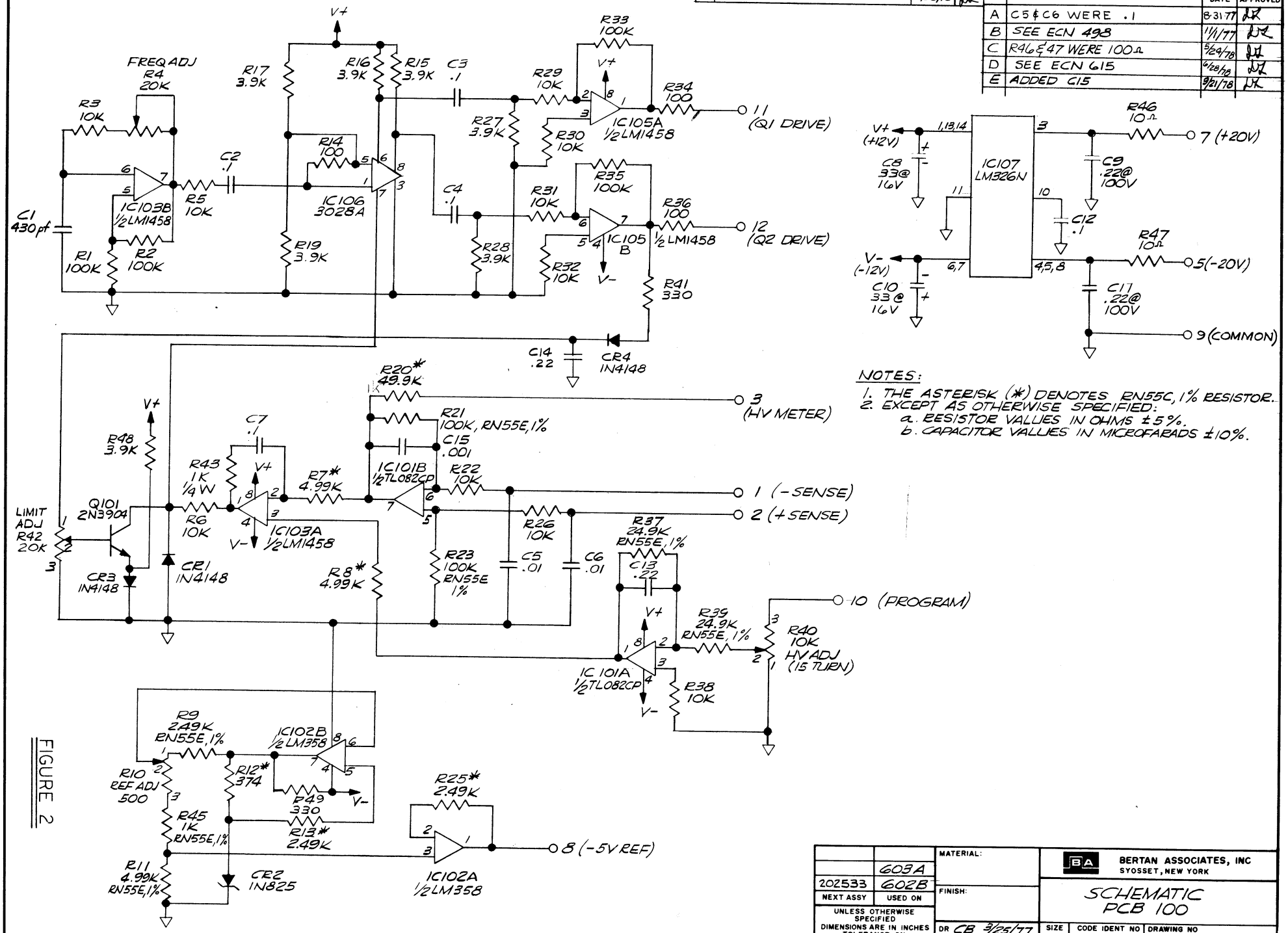


FIGURE 1

LTR	REVISIONS	DATE	APPROVED
F	SEE ECN 697	10/23/78	
A	C5 & C6 WERE .1	8-31-77	
B	SEE ECN 498	11/1/77	
C	R46 & 47 WERE 100Ω	5/24/78	
D	SEE ECN 615	6/28/78	
E	ADDED C15	9/21/78	



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
202533	602B
NEXT ASSY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS·DECIMALS·ANGLES

MATERIAL:

FINISH:

DR CB 3/25/77

CK 4/14/77

APVD

BERTAN ASSOCIATES, INC
SYOSSET, NEW YORK

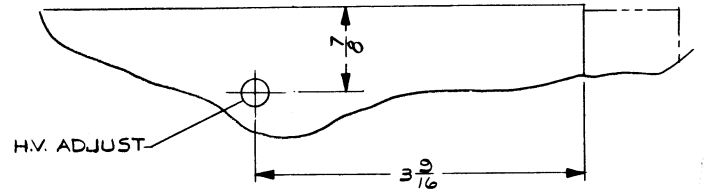
SCHEMATIC
PCB 100

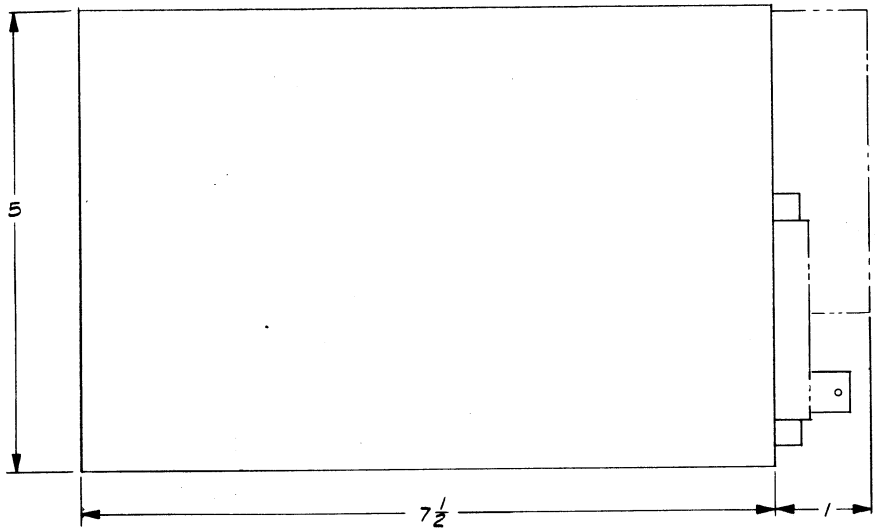
SIZE C | CODE IDENT NO 50429 | DRAWING NO 202511

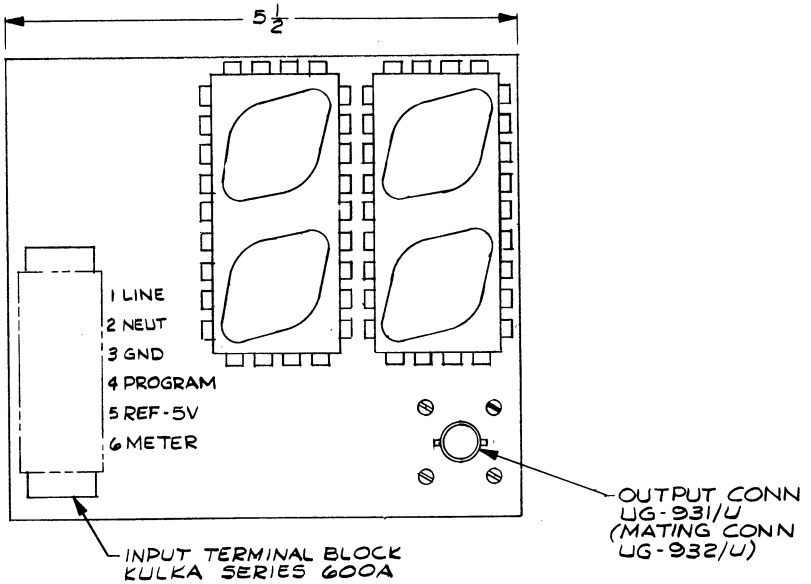
SCALE —

SHEET 1 OF 1

LTR	REVISIONS	DATE	APPROVED







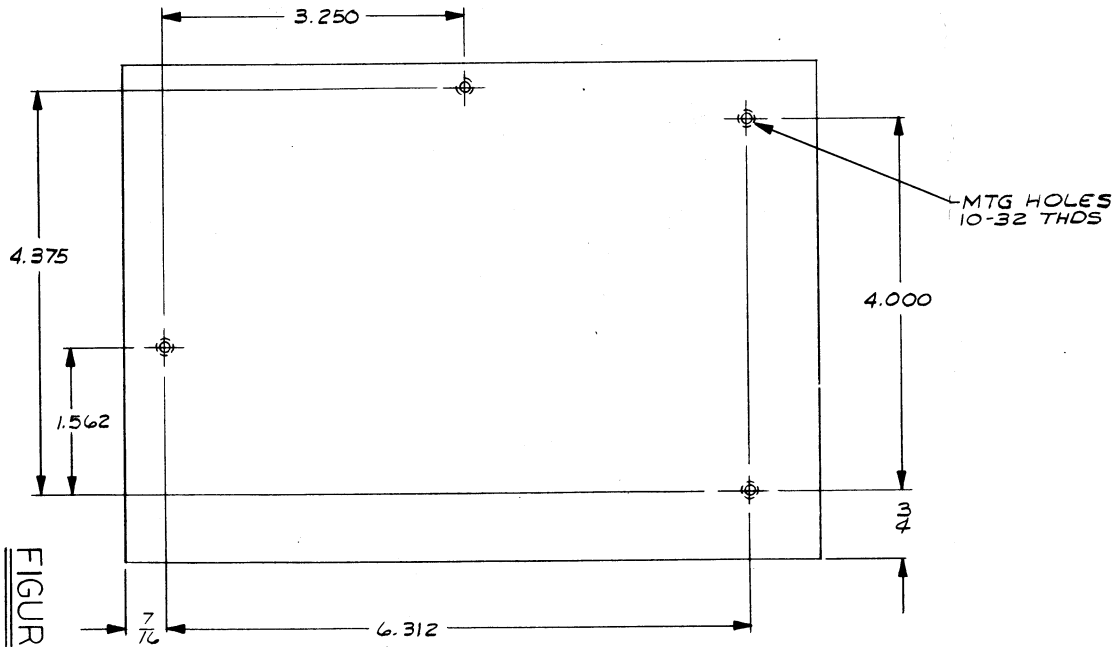


FIGURE 3

		MATERIAL:	BERTAN ASSOCIATES, INC SYOSSET, NEW YORK
		FINISH:	OUTLINE DRAWING MODEL 603
NEXT ASSY	USED ON		
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON FRACTIONS·DECIMALS·ANGLES		DR RA 1/8/79 CK 1/10/79 APVD	SIZE C · CODE IDENT NO 50429 · DRAWING NO 202505 SCALE · SHEET OF