

OPERATORS' MANUAL

DC Voltage Calibrator / Standard

Model MV 106 + MV 116

Serial No.



ELECTRONIC
DEVELOPMENT
CORPORATION MADE IN U.S.A.

TABLE OF CONTENTS

i	Warranty
ii	Factory Service Request and Aughorization
iii	List of Drawings
I	GENERAL DESCRIPTION AND APPLICATIONS
II	INSTALLATION
III	OPERATION OF INSTRUMENT
IV	THEORY OF OPERATION
V	MAINTENANCE
VI	CALIBRATION PROCEDURE
VII	SPARE PARTS LIST
ADDENDAE:	GALVENOMETER CHART RECORDER
	DIFFERENTIAL VOLTMETER - OPTIONS G-1 OR G-2
	SUPPLEMENT FOR GALVO OPTION:
	OPERATION OF GALVANOMETER

WARRANTY

The ELECTRONIC DEVELOPMENT CORPORATION (EDC) warrants to the original purchaser each instrument manufactured by them to be free from defects in material and workmanship. This warranty is limited to servicing, repairing and/or replacing any instrument or part thereof returned to the EDC factory for that purpose in accordance with the instructions set forth below; and furthermore to repair or replace all materials, except tubes, fuses, transistors and other semi-conductor devices which shall within one year of shipment to the original purchaser be returned to the EDC factory and upon examination be deemed defective.

EDC instruments may not be returned to the factory under the terms of this warranty without the prior authorization of the EDC Service Department. All instruments returned to EDC for service hereunder should be carefully packed and shipped. All transportation charges shall be paid by the purchaser.

EDC reserves the right to discontinue instruments without notice and to make changes to any instrument at any time without incurring any obligation to so modify instruments previously sold.

This warranty is expressly in lieu of all other obligations or liabilities on the part of EDC. No other person or persons is authorized to assume in the behalf of EDC any liability in the connection with the sale of its instruments.

CAUTION: The instrument you have purchased is a precision instrument manufactured under exacting standards. Any attempts to repair, modify or otherwise tamper with the instrument by anyone other than an EDC employee or authorized representative may result in this warranty becoming void.

FACTORY SERVICE REQUEST
and
AUTHORIZATION

WARRANTY SERVICE

Instruments may be returned only on prior authorization. Please obtain a RETURN AUTHORIZATION NUMBER either directly from the factory or from an authorized E.D.C. Representative. (See General Instructions below.)

CHARGEABLE REPAIRS

If requested, an estimate of charges will be submitted prior to repairs. We suggest that you request a RETURN AUTHORIZATION NUMBER to facilitate handling.

GENERAL INFORMATION

- A) Please provide the following information in order to expedite the repair:
- 1) Indicate MODEL
 - 2) Serial Number
 - 3) Complete description of the trouble:
Symptoms, measurements taken, equipment used, lash-up procedures, attempted repairs, suspected location of failure and any other pertinent information.
- B) Freight Charges must be prepaid.
- C) The RETURN AUTHORIZATION NUMBER should be noted on your documentation.

SECTION I

1.0.0 GENERAL DESCRIPTION AND APPLICATIONS

1.0.1 The precision DC Voltage Standard Source is a highly versatile reference source, designed to meet the needs of computer systems, production line testing, automated calibration, and standards laboratories.

1.0.2 The instruments have a specified accuracy, and are traceable through a bank of saturated standard cells to the National Bureau of Standards.

1.0.3 Depending on the model of the instrument, resolutions of .1 part per million are attainable.

1.0.4 The instruments are highly accurate references which can be used for calibration of digital voltmeters, analog meters, semiconductor analyzing systems, analog references for computers, analog-to-digital converters, telemetry and data acquisition systems, and wherever a stable source is required.

1.0.5 There are no adjustments made during normal operation; the trims are made during calibration and are described under the calibration procedure.

1.0.6 The circuitry is completely solid state made of discrete, hybrid and/or integrated circuits packaged on etched glass circuit boards. These are proven circuits, using derated components to insure long life and maximum reliability.

1.0.7 The instrument is overload and short-circuit proof, and is fully operational in adverse environmental conditions.

1.0.8 The Standard Source will drive a short circuit indefinitely without damage to the instrument, and will recover to rated specifications in less than 2 minutes.

1.0.9 When used with a voltmeter, the source becomes a potentiometer for measuring DC Voltages.

ELECTRICAL CHARACTERISTICS:

MV 106 & MV 116

1. Absolute Accuracy
RANGE 10 V $\pm 0.003\%$ of setting $+0.0005\%$ of range $+2 \mu\text{V}$
RANGE 100 mV Temp 23°C Ambient, TC $\pm 0.0005\%/^{\circ}\text{C}$
2. Stability
8 hour period $\pm 0.001\%$ of range $+2 \mu\text{V}$
1 year period $\pm 0.0025\%$ of range $+2 \mu\text{V}$
3. Resolution
1 part in 1,000,000
4. "0" Output Voltage Selector
Output terminals are shorted and disconnected from Reference Amplifier.
5. Output Voltage
RANGE 10 V ± 11.111 10 Vdc, selectable from 6 decades
RANGE 100 mV ± 111.1110 mVdc, selectable from 6 decades
6. Output Current
RANGE 10 V 50 mA, short-circuit/automatic recovery
RANGE 100 mV Not applicable in this Range
7. Output Impedance
RANGE 10 V Less than 0.030Ω
RANGE 100 mV Approximately 3Ω
8. Ripple & Noise
Less than 40 microvolts rms
3 dB band-width of 0.8 to 100 kHz

ELECTRICAL CHARACTERISTICS: additional for MV 106

1. RANGE 10 mV $\pm 0.003\%$ of setting $+ 0.0005\%$ of range $+2 \mu\text{V}$
2. Output Voltage ± 11.111 10 mV selectable from 6 decades

ELECTRICAL CHARACTERISTICS: additional for MV 116

1. RANGE 1 V $\pm 0.003\%$ of setting $+ 0.0005\%$ of range $+2 \mu\text{V}$
2. Output Voltage ± 1.111 110 Vdc selectable from 6 decades

WARM UP TIME: 30 Seconds (min); 15 min (max)

TEMPERATURE:	Calibration Temperature	23°C ± 1°C
	Ambient Temperatures	20°C to 30°C
	Operating Limit Temperatures	-10°C to 50°C
	Storage Temperatures	-40°C to 85°C
TEMPERATURE	Ambient Temperatures	± .0005%/°C
COEFFICIENT:	Operating Limit Temperatures	± .001%/°C
POWER REQUIREMENTS:	2 watts, 50-400 Hz	105 to 125 Vac
		220 to 240 Vac

DIMENSIONS:	BENCH:	RACK:
Series J	5 1/4 x 17 x 12	5 1/4 x 19 x 12
Series C,E,R	3 1/2 x 17 x 10	3 1/2 x 19 x 10

WEIGHT: 12 Pounds

SHIPPING WEIGHT: 16 Pounds

CIRCUIT CONDITION INDICATOR: Front panel indicator for short circuit, overload, over-voltage condition low line voltage or malfunction.

PROTECTION: Short circuit and overload protection. Automatic recovery.

DOCUMENTATION: 1.) CERTIFICATION OF COMPLIANCE Traceability to U.S. National Bureau of Standards.

2.) CALIBRATION LABORATORY CERTIFICATION includes static and dynamic tests.

3.) MAINTENANCE MANUAL including block diagrams, mechanical layout, schematics.

WARRANTY: ONE YEAR - includes accuracy and stability.

SECTION II

2.1.0 INSTALLATION

2.1.1 Electronic Development Corporation instruments may be obtained in several case configurations.

2.1.2 Portable units are rugged, light weight, completely enclosed in a dust tight case supplied with a carrying handle.

2.1.3 Rack mountable instruments are designed primarily for mounting in the standard 19" relay rack. When installing in the rack, it is recommended that nylon inserts be placed between the cup washer and the front panel to prevent scratching of the paint.

2.1.4 All instruments are supplied with a standard three (3) prong polarized plug and power cable.

2.1.5 A multitap transformer is provided, however it is set to 115VAC or 230VAC via the slide switch on the internal chassis. Other voltages can be accommodated by making the proper selections of the transformer taps.

SECTION III

OPERATION OF INSTRUMENT

3.1.0 FRONT PANEL CONTROLS

3.1.1 Power Switch: Toggle off-on, line power.

3.1.2 Polarity Switch: This switch has 3 settings. With the polarity switch on "+" the red output terminal is positive with respect to the black terminal. On "-" the red output terminal is negative with respect to the black terminal. On "0" a short circuit exists between the red and black output terminals.

3.1.3 Output and Sense Terminals: 4 Terminals are provided for output and sense. The red terminals represent the polarity with respect to the black as the common terminals. The red terminals are indicated by the polarity switch.

If a high impedance or a low current load is connected, the output and sense terminals may be shorted with the sense links (provided) e.g., plus output to plus sense.

If drawing current is desired, the remote sensing capability should be used. The advantage of remote sense is that the output and the 2 sense lines are brought directly to the load, thus eliminating the IR drop of the output lines. The metal terminal is case ground.

3.1.4 Decade Switches: the decade switches are used to select the desired output, relative to its position from the decimal point light.

SECTION IV

4.0.0

THEORY OF OPERATION

4.1.0 The Basic Circuitry for Electronic Development Corporation's standards/sources are similar. The Basic circuitry is:

1. Power supply
2. Internal Precision reference
3. Chopper stabilized amplifier
4. Feedback circuitry
5. Output selector

4.2.0 Electronic chopper stabilization is utilized to automatically compensate for the DC drift of aging components and to provide stability of the output. The effects of warm-up drift are virtually none existant, and are confined to those components outside the feedback loop. Drift due to thermal gradients and self heating is minimized.

4.2.1 The Chopper stabilized amplifier utilized in EDC equipment is the synchronous amplitude modulated carrier type. The input signal to the main amplifier from the error point is fed into a modulator or switch. This modulates the voltage, converting it to a square wave which is AC coupled to the AC amplifier where it is amplified. The modulated output is AC coupled to the demodulator where it is filtered to a correcting DC voltage and fed to the plus or non-inverting input of the main amplifier.

4.2.2 The basic amplifier has a very high open-loop gain in order to maintain the high accuracy.

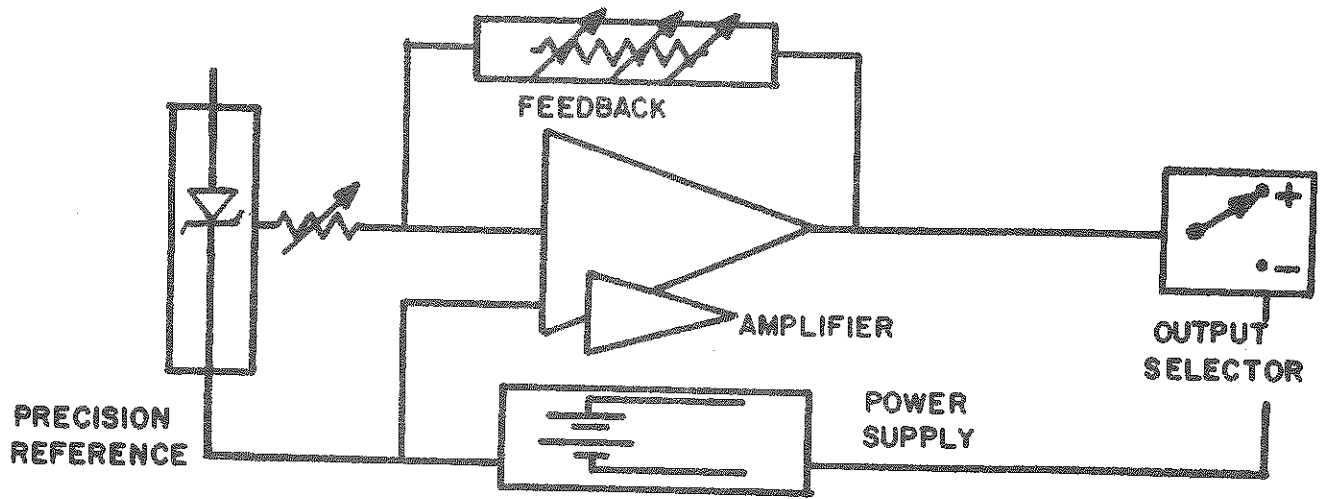


FIG. 4-1 BASIC CIRCUITRY

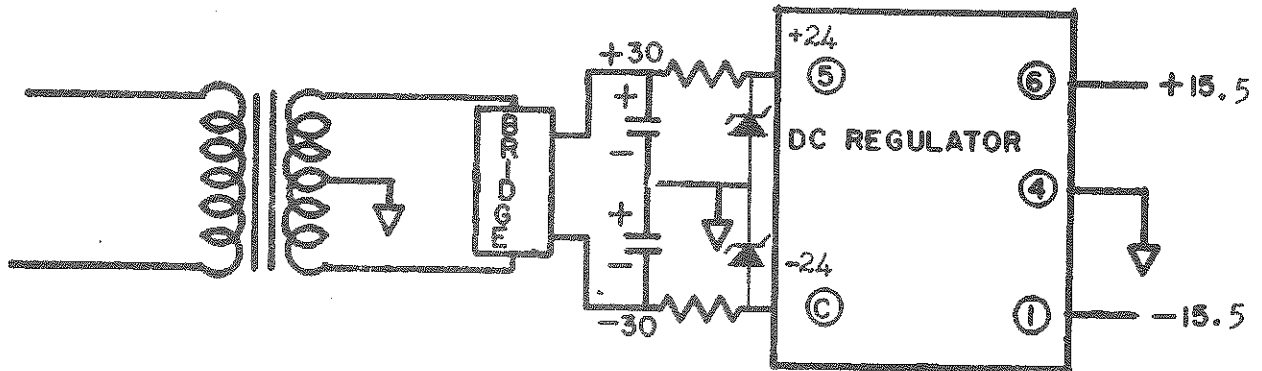


FIG. 4-2 POWER SUPPLY SIMPLIFIED

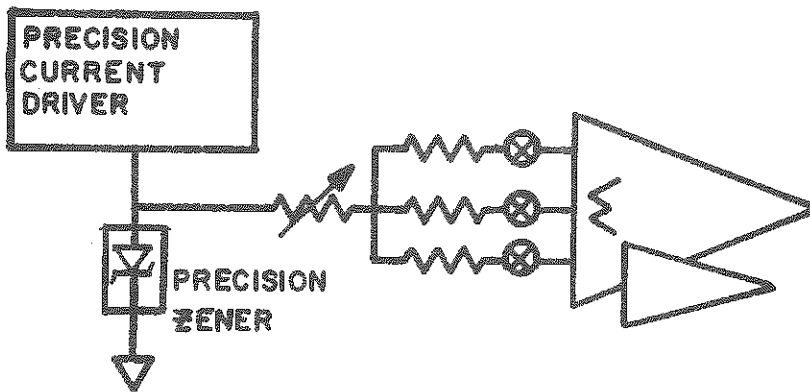


FIG. 4-3 PRECISION REFERENCE

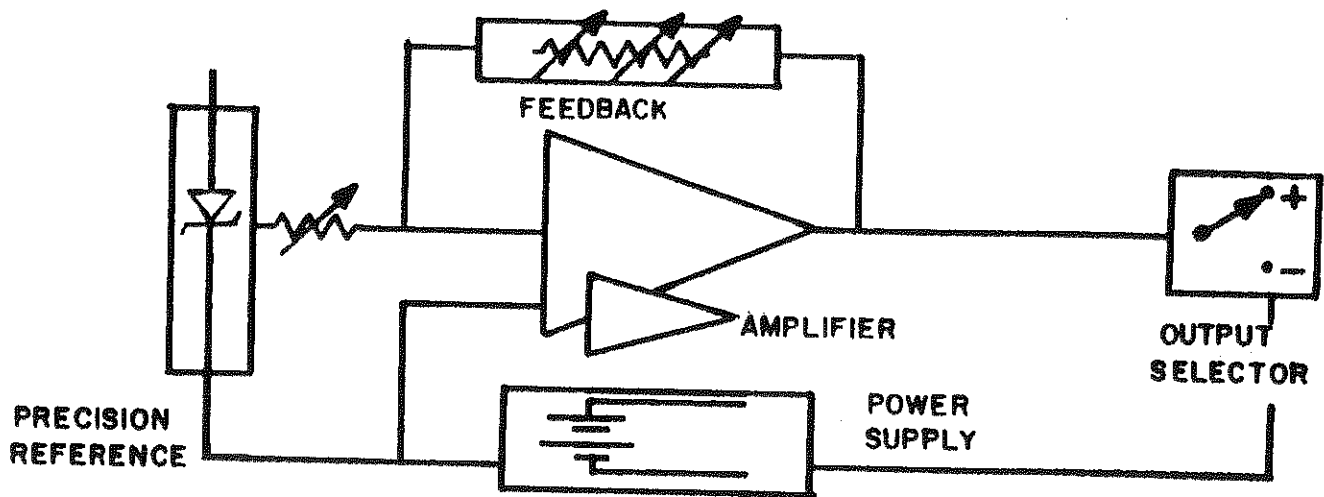


FIG. 4-1 BASIC CIRCUITRY

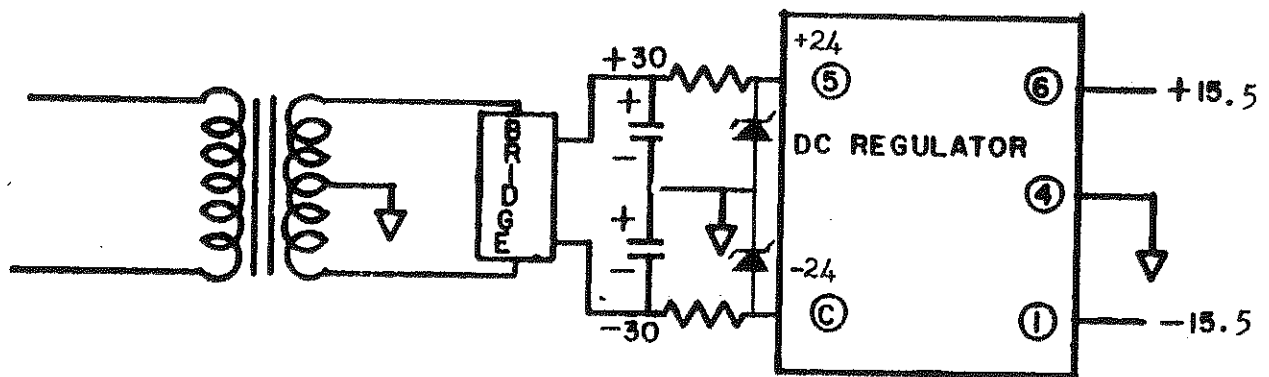


FIG. 4-2 POWER SUPPLY SIMPLIFIED

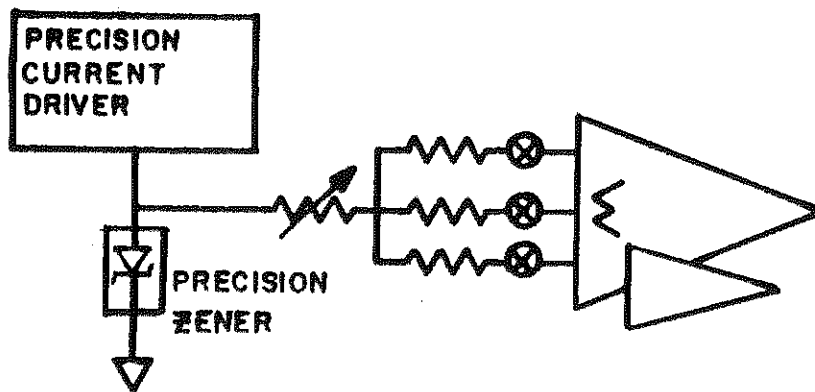
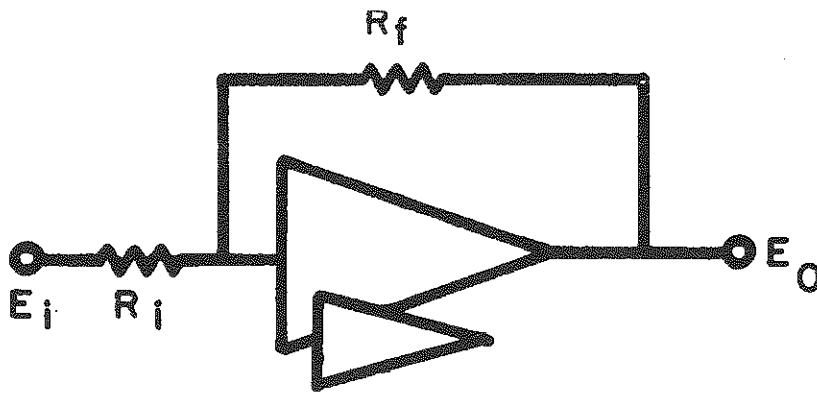


FIG. 4-3 PRECISION REFERENCE



4.3.0 Brief Mathematical Model of the Operation of a Voltage Reference Source:

4.3.1

An operational amplifier using negative feedback tries to drive the summing or error point to ground potential. This is useful in that the current flow into the error point through the (R_f) feedback string is equal to the current (I_{R_i}) flowing through the input resistance (R_i), e.g. if $R_f = 63K\Omega$ then:

$$E_o = -E_i \frac{R_f}{R_i} = -6.3V \times \frac{63K}{63K} = -6.3V(1) = -6.3V$$

4.3.2

It is interesting to note that R_f times the input current (I_{R_i}) is the same output voltage therefore:

$$E_o = -I_{Rin} \times R_{Fb} = -100\mu A \times 100 K = -10 V$$

CHOPPER STABILIZED AMPLIFIER

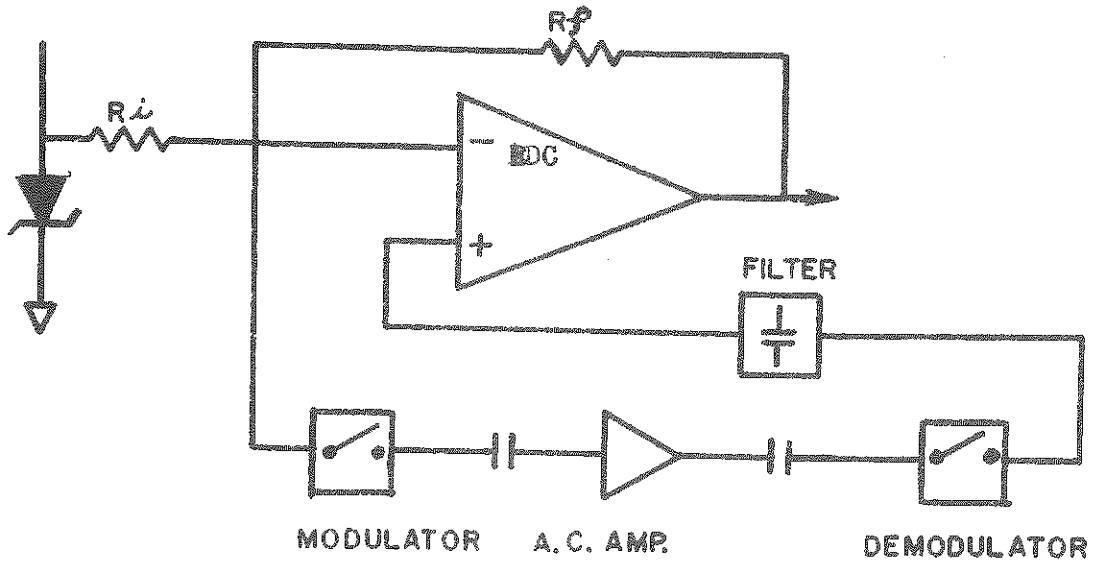


FIG. 4-4 CHOPPER STABILIZED AMPLIFIER

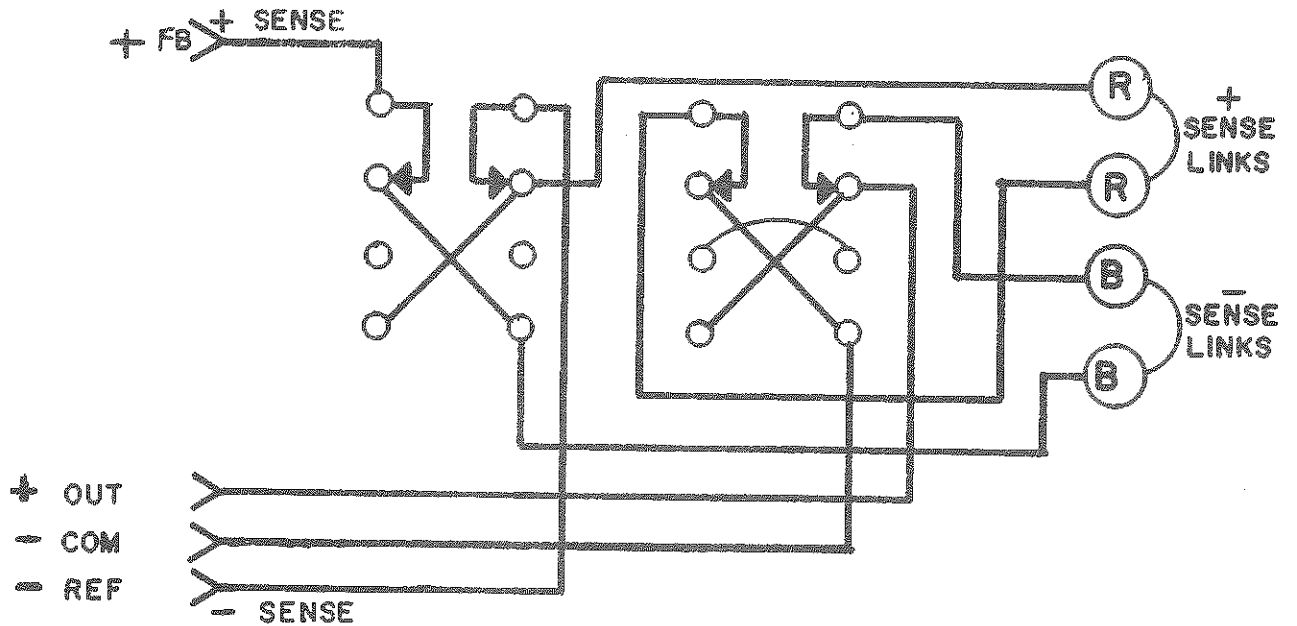


FIG. 4-5 OUTPUT SELECTOR

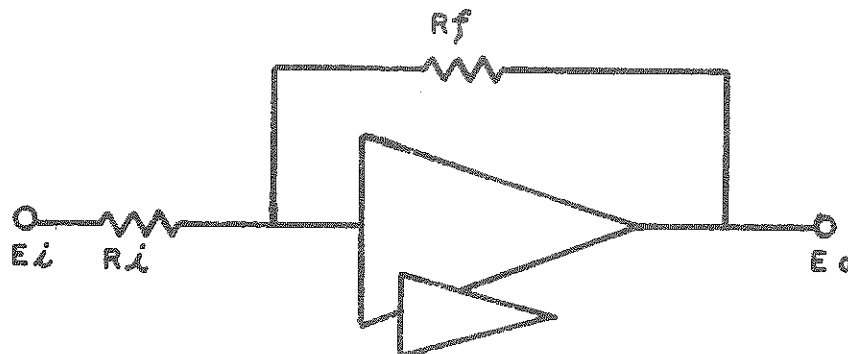


FIG. 4-6 OPERATIONAL AMPLIFIER

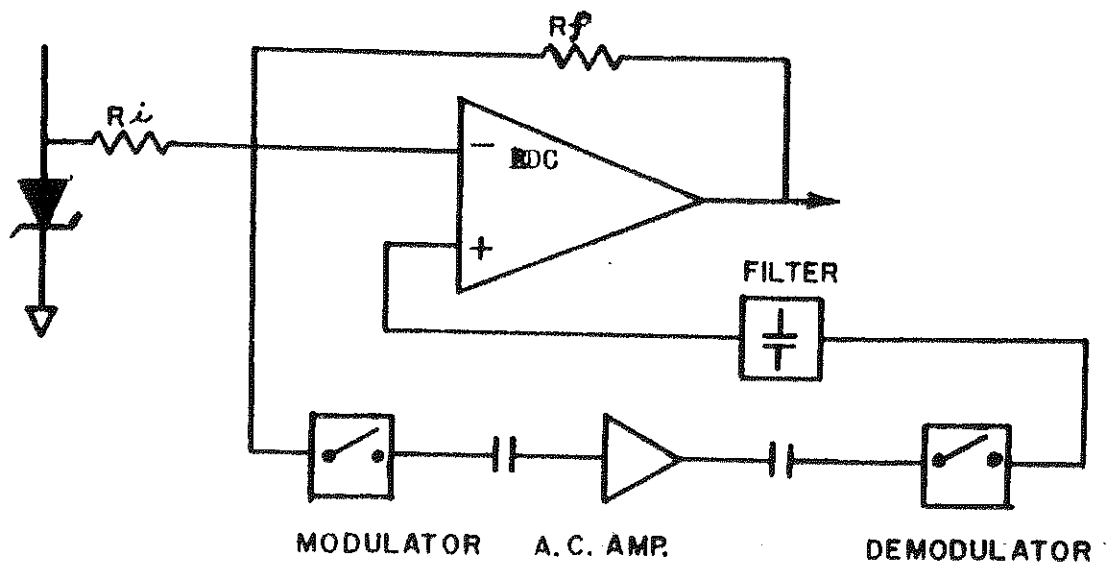


FIG. 4-4 CHOPPER STABILIZED AMPLIFIER

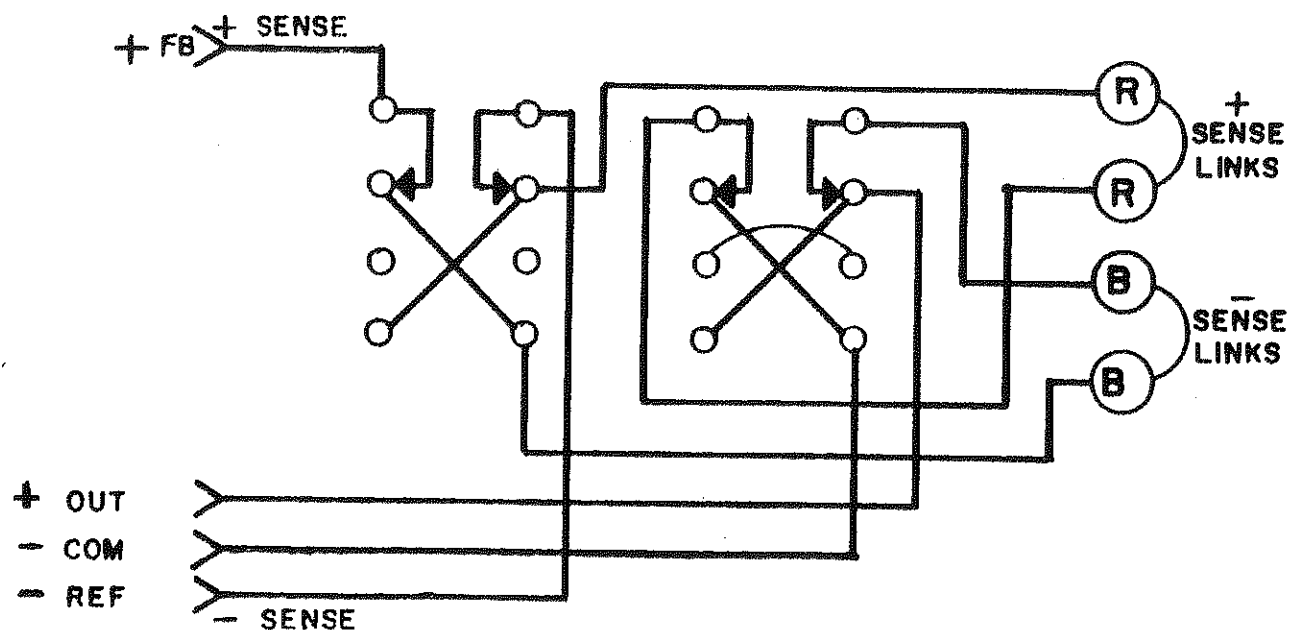


FIG. 4-5 OUTPUT SELECTOR

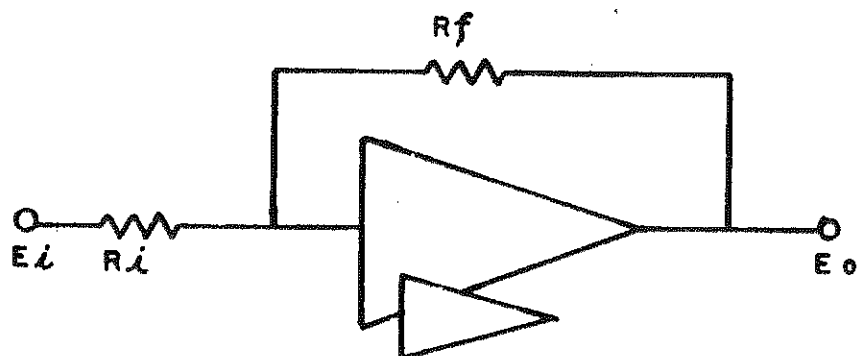


FIG. 4-6 OPERATIONAL AMPLIFIER

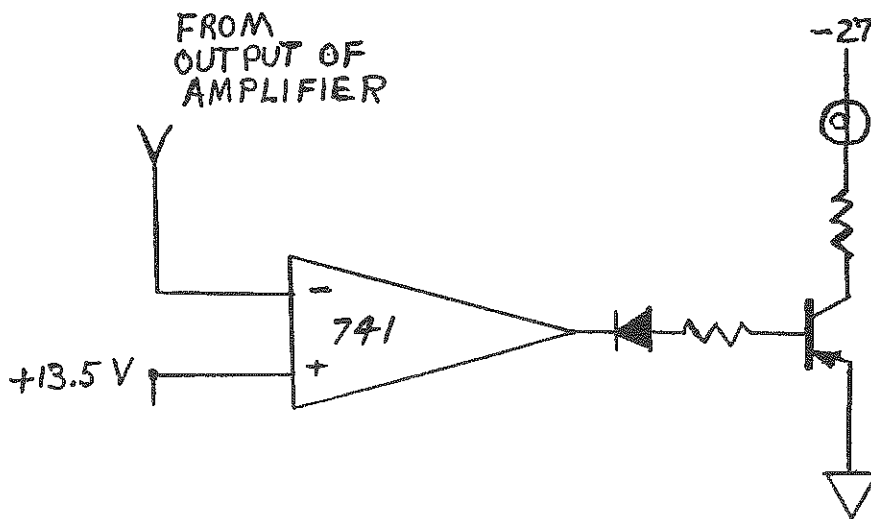


FIG. 4-7 SIMPLIFIED OVERLOAD INDICATOR CIRCUIT

4.4.0 Overload protection is provided by a current limiting resistor in the output stage. In the event of an overload or short circuit, the chopper amplifier will be saturated and its output will be approximately +14 Volts. This condition is detected by a comparator. The comparator output goes negative and turns on the indicator light driver transistor.

4.5.0 Overload Indicator Light, basically, shows the condition of the output of the chopper circuit. Any or all of the following conditions can cause the indicator to light:

- 1) Chopper amplifier is correcting output voltage,
- 2) Low Line Voltage,
- 3) Load is drawing more than rated current,
- 4) Short circuit,
- 5) Sense loops not complete.

SECTION V

MAINTENANCE

5.1.0 PREVENTIVE MAINTENANCE

5.1.1 The decade and polarity (rotary) switches are lubricated at the factory. We recommend that these switches are NOT serviced during the first year.

NOTE: Over-zealous, arbitrary, or unnecessary cleaning may damage the switches.

CLEANING: DO NOT ARBITRARILY CLEAN THE SWITCHES

5.1.2 In many instances, lubrication may be all that is required.

RELUBRICATE AFTER CLEANING!

THE USE OF A CLEANER WITHOUT LUBRICATING WILL SHORTEN THE LIFE OF THE SWITCHES TO ABOUT TWO MONTHS.

LUBRICATING - DO NOT USE OIL

Switch Contacts: Use:

EDC 2008 - Electronic Development
Corporation (Lubricant)

5.1.3 Apply a small amount of one of the above products carefully to the switch contacts. Rotate switch several times to disperse the lubricant.

NOISE MEASUREMENTS

5.2.1 EDC uses the following procedure to measure the noise levels on the voltage calibrators. Techniques are employed to minimize external ground loops and radiation paths which may introduce improper data into the desired measurements.

5.2.2 "RULE OF THUMB": If the measurement indicates more than 1 millivolt p.p. of noise on any EDC instrument, the operator should recheck his equipment and lash-up.

5.2.3 Because noise may appear in many forms, EDC recommends the use of an oscilloscope to make the noise measurements.

5.2.4 A high gain 50 μ V/CM or better, differential pre-amp is well suited for this application.

5.2.5 In an environment with excessive EMI levels, these tests should be performed in a screen room. This will prove the specs of the EDC unit, and will, with a comparison test in the normal environment, permit calibration for radiated noise pick-up on the test measurements.

5.2.6 The noise test should not be made simultaneously with regulation and voltage accuracy test. The "pump back" currents from some measuring devices will seriously disturb noise measurements.

5.2.7 Differential inputs measurements are the most reliable. They will cancel out common mode, due to slight errors in lash-up.

5.2.8 The scope and the EDC Calibrator under test should be connected to adjacent power outlets on the same phase. A three wire ground is required. In the event the line does not have a ground, the scope and unit under test should have a separate, heavy wire chassis-to-chassis connection separate from the shield of the differential input leads.

5.2.9 The lead used between the scope input and the source output should be a shield, twisted pair with the shield connected to the frame of the scope, and, to the ground lug adjacent to the output terminals of the EDC source.

5.2.10 Do not use the shield of the input cable as the chassis-to-chassis connection in place of line system ground. Use additional separate heavy wire.

5.2.11 If the EDC instrument has remote sensing, be sure that the "output" and "sense" terminals are bussed.

SECTION VI

Calibration Procedure for Initial Setup

6.1.0 After a unit has been turned on for several minutes and it has been in a relatively stable temperature 23 to 25°C for about 30 minutes, the unit can be calibrated. The overload light should be in a stable condition, mainly "out". Very dim may be proper at this time, indicating a large offset voltage at "0". A continuous light is an indication of a malfunction, a wrong hookup or a short on the output. This must be corrected before proceeding with the calibration.

1. Adjustment #1 controls the Zener voltage and should be set to the specified voltage as marked on the chassis label inside near the zener. Place Digital Voltmeter across cap at the zener location A to B and adjust to within $\pm 100 \mu\text{V}$.

2. Adjustment pot #2 is the zero offset adjustment and should be adjusted with all decades at zero, but have the range selector in a voltage range to obtain best zero. DVM on output terminals.

- 2A. Adjustment pot #2A is the sense "0" offset adjustment. Set all decades to zero and polarity to plus, range at 10 volt. Remove sense link from black terminals and measure across black terminals and adjust 2A to less than 1 millivolt.

3. Adjustment pot #3 sets the feedback current accurately as required in order to produce an accurate output voltage.

Dial 1 volt on the second decade, using dialed position 10 only. With a DVM connected to the output terminals, observe that the output voltage is read to 1.0000 $\pm 50 \mu\text{V}$. For Model E 100, MV 105, and MV 106 proceed to page 6.1.1 to complete the 1st decade adjustments.

7.0.0 SUPPLEMENT FOR GALVANOMETER OPTION
OPERATION OF THE EDC INSTALLED HIGH IMPEDANCE GALVANOMETER

A. Differential Mode

1. It is to be noted that the galvanometer adds a number of controls to the panel.
 - a. "USE ZERO" switch: This control is used to balance the galvanometer measurement circuitry.
 - b. "ZERO ADJ": This control is used in conjunction with the "USE ZERO" switch to adjust the galvanometer for zero.
 - c. "SENSITIVITY": This is used to set sensitivities and to disengage the galvanometer circuitry in the "OFF" position.
 2. Balance of Galvanometer. The zero balance of the high impedance galvanometer may be performed at any time, even with voltage connected to the unknown terminals.
 3. Initial Zero adjustment:
 - a. "USE ZERO" switch in zero position
 - b. "SENSITIVITY" switch to off
 - c. Apply power to instrument
 - d. Check mechanical zero of meter
 - e. Move "SENSITIVITY" to 100 μ V.
 - f. Adjust "ZERO ADJ" control for "0" on meter.
- NOTE: This sets up initial zero. Zero can be checked at any time by performing steps a, e and f of the above.
4. Voltage Measurement with the galvanometer.
 - a. Perform steps in Paragraph 3.
 - b. With polarity switch on "0" and switch in "USE" set switch to maximum e.g. 10 V.
 - c. Note meter deflection. If the deflection is to the left, set polarity switch to "+" and vice versa.
 - d. Increase first decade 1 step at a time until meter approaches "0". If meter overshoots "0" decrease by one step.
 5. Replacing the galvanometer amplifier may require adjusting the full scale sensitivity. Short the galvanometer input terminals, dial 10 volts on the voltage source, set galvanometer sensitivity to 10 volts. Adjust pot on galvanometer board for full scale reading on meter.

DIFFERENTIAL VOLTMETER
AND
ELECTRONIC GALVANOMETER
OPTIONS G-1 OR G-2

OPTION G-1

Accuracy: $\pm(0.005\%$ of input $+0.001\%$ of Range)

Special Note:

Basis for Accuracy Statement. Calibration Accuracy 15 ppm R.S.S. of tolerance of primary calibration system.

*Accuracy (Limit of Error or "Worst Case" method) Based on a 4:1 calibration ratio to the primary calibration system. All peripheral, additive specifications, i.e., error for line change, temperature change, drift and noise, are included in the "Limit of Error". Normal operating environment: 65° to 85°F. 70% R.H.

Input Ranges (Vdc): 10V, 1V, 100 mV and 10 mV

The ranges are dependent on the model selected. (See chart A).

Resolution: As a Differential Voltmeter: 1 ppm, 6 decades. As a Galvanometer: 20 divisions from center to full scale. Mirrored meter to eliminate parallax. (See chart B).

Sensitivity: The maximum sensitivity is 0.1 μ V. (See chart B).

Input Impedance: At Null: Infinite
Off Null: 10 M Ω

Measurement Ranges (Chart A)

MODEL	MV106	MV116
MEASUREMENT INPUT RANGES	10 V --- 100 mV 10 mV	10 V 1 V 100 mV ---

OPTION G-1 continued

Sensitivity (Chart B)

	Meter Res. full-scale	Meter Resolution V/Minor Div.	Galvanometer Sensitivity (max)
Meter	10 V	500 mV	-
Resolu- tion	1 V	50 mV	-
and	100 mV	5 mV	1 mV
Sensi- tivity	10 mV	500 μ V	100 μ V
	1 mV	50 μ V	10 μ V
	100 μ V	5 μ V	1 μ V
	10 μ V	0.5 μ V	0.1 μ V

OPTION G-2 With Recorder Output

All of the input specifications listed for option G-1 apply to the G-2 option.

Output (to recorder): ± 1 Vdc full scale, for all sensitivity settings.

Driving Current: 5 mA

Load: Recorder $Z_{in} > 200 \Omega$

Recorder output accuracy: $\pm (3\% \text{ of rdg} + 30 \text{ mV})$

Isolation: The recorder output is totally isolated from the "unknown" input and the ("source") main frame instrument.

RECORDER OUTPUT
PIN CONNECTIONS

- A - Earth Ground
- B - Output
- C - Output common

The recorder output is developed between pins B and C.

GALVANOMETER CHART RECORDER

ISO-AMPLIFIER CALIBRATION

- 1) Set oscilloscope to 0.1 ms/cm Hor, and 5 V/cm vertical. Feed in the vertical input signal from the 0.1 MFD capacitor shown in Fig. 1.
- 2) Force meter to maximum negative position by dialing up -10 volts on source with galvo sensitivity on 10 V. Adjust symmetry control, R_1 , so that T_1 is approximately equal to T_2 .
- 3) Dial up +10 volts on source. T_1 should now be 3 to 4 times T_2 with no noticeable rounding of the ramp. If there is noticeable rounding, adjust R_1 to minimize it.
- 4) Dial up zero polarity on source, adjust zero control, R_2 , for a chart recorder output between ± 5 mV.
- 5) Dial up +10 V and adjust full scale control, R_3 , for a chart recorder output of +1 V.
- 6) Dial up -10 V and check to see if the output is within 1% of the output in step 5.

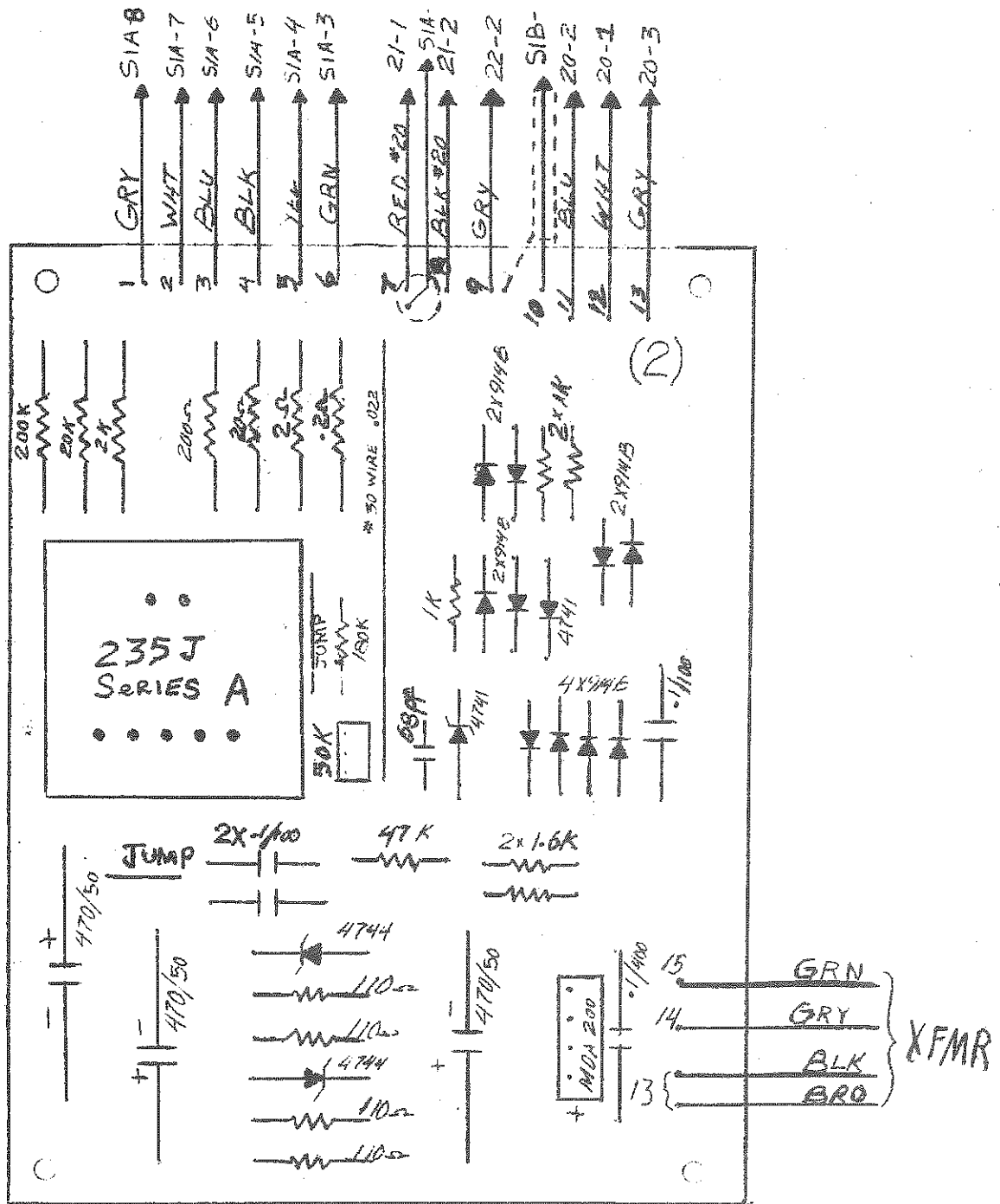
For periodic re-calibrations omit steps 1, 2, 3.

SECTION VII

8.0.0 PARTS LIST

<u>DESCRIPTION</u>	<u>PART NUMBER</u>	<u>QTY</u>
Amplifier Series 7652	EDC Chopper Module	1
IC Amplifier TI	μ A 741CP	1
Regulator 15 V	MC7815 & MC7915	1 each
Regulator 1N5359B	24 V	2
Diode 1N829A/Resistor Match	6 V	1
Diode 1N4005	Rect	2
Diode 1N914B	Clamp	7
Diode 200 PIV	Rect (Bridge)	1
Transistor 2N2905A	Ovld	1
Transistor TIP48	Output	1
Transistor 2N5088	Reference	1
Transistor 2N5086	Reference	1
Capacitor 470/50	EG-40	3
Capacitor 1/200	Feed Back	1
Capacitor .01/400	4PS-S10	5
Capacitor 1000 Pf	DM 15	2
Resistor 770 Ω .1%	Reference PR128	1
Resistor 660 Ω .1%	Reference PR124	1
Resistor 50 Ω 5W	Collector	1
Resistor 180 k Ω 1/2 W	Ohmite	1
Resistor 4.7 k Ω 1/2 W	Ohmite	2
Resistor 2.0 k Ω 1/2 W	Ohmite	2
Resistor 1.0 k Ω 1/2 W	Ohmite	3
Resistor 270 Ω 1 W	Ohmite	2
Resistor 100 Ω 1/2 W	Ohmite	1
Resistor 10 Ω 1/2 W	Ohmite	1
Resistor 7.5 k Ω 1/2 W	Ohmite	1
Resistor 47 Ω 1/2 W	Ohmite	1
Resistor 10 k Ω 1/2 W	Ohmite	1
Resistor 39 k Ω 1/2 W	Ohmite	1
Resistor 33 k Ω 1/2 W	Ohmite	1
Potentiometer 68 wr 50 K Ω	68 WR 50 k Ω	1
Potentiometer 68 wr 200 Ω	68 WR 200 Ω	3
Potentiometer 68 xr 20 Ω	68 XR 20 Ω	6
Capacitor 10/25 CP224	TLB1E100M	2
Capacitor .22/400	MKC 1860	1
Capacitor 100/63 CP231	TLB1J101M	1

<u>DESCRIPTION</u>	<u>PART NUMBER</u>	<u>QTY</u>
Knob	RB-67-2A-CSK BLK	6
Pointer	RB-67-1-B-M	2
Slide Switch 115/230	46206-LFR	1
Binding Posts	DF 30 RC & BC	2
Decade Switch	A 2983 517-132-623	6
Power Switch	SC2CK-P1-92-95	1
Output Switch	A 3150 Non Shorting	1
Transformer	A 2631 B	1
Range Switch	PA 2031 or 399711JC	1
PC Res Board	P 3580	1
Resistor 19990 Ω 0.05%	PR143	6
Resistor 0.2 Ω 5%	PR110	6
Resistor 2 Ω 0.25%	PR112	6
Resistor 20 Ω 0.02	PR116	6
Resistor 200 Ω 0.005%	PR120	6
Resistor 2 k Ω 0.005%	PR132	6
Resistor 62 k - 63 k Ω 0.05%	PR214	1
Fuse Post	342004	1
Fuse	1/2 MDL	1
Bulb, Overload	327	1
Light, Decimal	LT119 (72609-01)	2

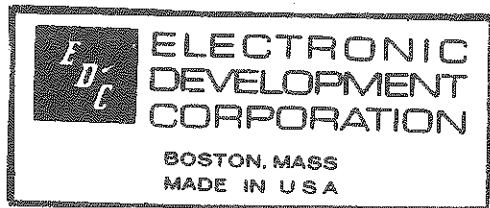


GALVANOMETER

Schematic B3165A

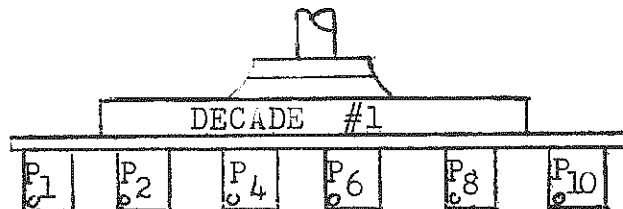
LAYOUT A3578

G I



Linearity Adjustment of 1st Decade

1. Having set 1 volt on the second decade (dial up to ten) and adjusted FS scale pot (#3) on main PC board, proceed to the following linearity adjustments of the MSD's on the rear of the first decade. (Return 2nd decade to zero.)
2. Dial 2 V on 1st decade adjust P2 exactly. Go to 1 V on 1st decade and adjust P1 to 1 V.
3. Dial 4 V on 1st decade adjust P4 exactly, look at 3 V for possible minor tweak of P4.
4. Dial 6 V on 1st decade adjust P6 exactly, look at 5 V for possible minor tweak of P6.
5. Dial 8 V on 1st decade adjust P8 exactly, look at 7 V for possible minor tweak of P8.
6. Dial 10 V on 1st decade adjust P10 exactly, look at 9 V for possible minor tweak of P10.
7. Pot #4 is full scale adjustment of the Millivolt Range and should be adjusted only after DECADE #1 has been completed in the first 6 steps.

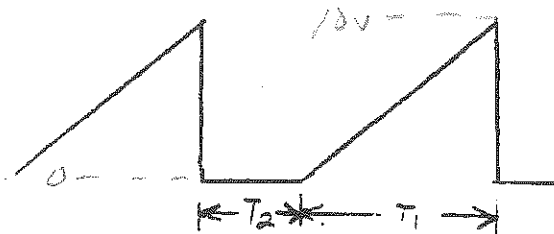


GALVANOMETER CHART RECORDER

ISO-AMPLIFIER CALIBRATION

- 1) Set oscilloscope to .1 msec/cm Hor. and 5V/cm vertical. Feed in the vertical input signal from the .1 MFD capacitor shown in Fig. 1.
- 2) Force meter to maximum negative position by dialing up -10 volts on source with galvo sensitivity on 10 V. Adjust symmetry control, R_1 , so that $T_1 \approx T_2$.
- 3) Dial up +10 volts on source. T_1 should now be 3 to 4 times T_2 with no noticeable rounding of the ramp. If there is noticeable rounding, adjust R_1 to minimize it. *X1 PROBE ONLY*
- 4) Dial up zero polarity on source, adjust zero control, R_2 , for a chart recorder output between $\pm 5mV$.
- 5) Dial up +10V and adjust full scale control, R_3 , for a chart recorder output of +1V.
- 6) Dial up -10V and check to see if the output is within *(10mV)* 1% of the output in step 5.

For periodic recalibrations omit steps 1, 2, 3.



For Models with
G2 Recorder option.

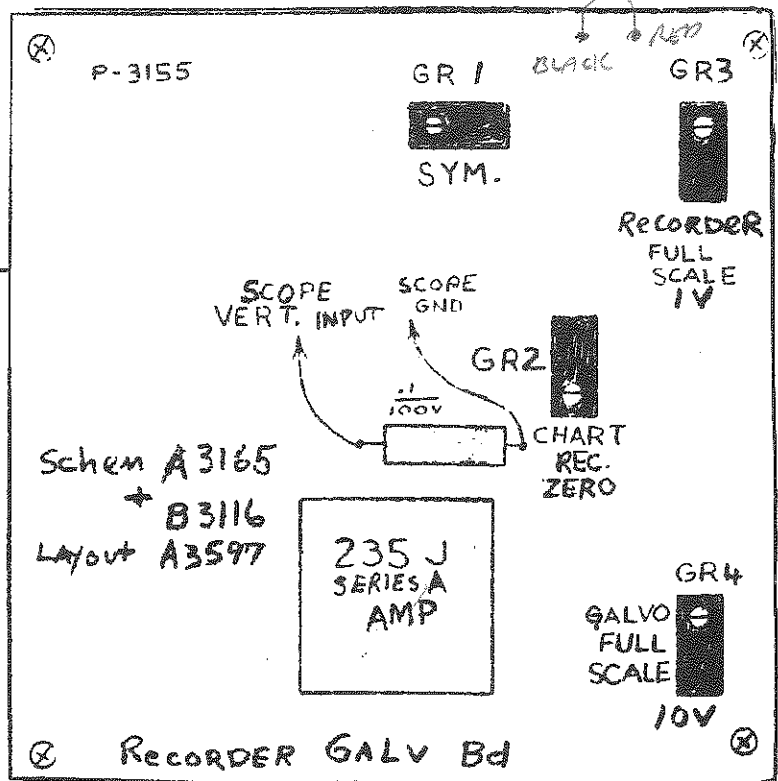


FIG 4

**DIFFERENTIAL VOLTMETER
and
ELECTRONIC GALVANOMETER
OPTIONS G-1 or G-2**

OPTIONS G-1

Accuracy: $\pm(0.005\%$ of Input + 0.001% of Range)

Special Note:

Basis for Accuracy Statement. Calibration Accuracy 15 ppm R.S.S. of tolerance of primary calibration system.

*Accuracy (Limit of Error or "Worst Case" method) Based on a 4:1 calibration ratio to the primary calibration system. All peripheral, additive specifications, i.e., error for line change, temperature change, drift and noise, are included in the "Limit of Error." Normal operating environment: 65° to 85° F. 70% R.H.

Input Ranges (Vdc): $\pm 11.111, 10 \text{ V}$, $\pm 1.111, 110 \text{ V}$
 $\pm 111.111, 0 \text{ mV}$, $\pm 11.111, 10 \text{ mVdc}$

The ranges are dependent on the model selected.
(See chart A).

Resolution: As a Differential Voltmeter: 1 ppm, 6 decades.

As a Galvanometer: 20 divisions from center to full scale.
Mirrored meter to eliminate parallax. (See chart B).

Sensitivity: The maximum sensitivity is 0.1 μV .
(See chart B).

Input Impedance: At Null: Infinite
Off Null: 10 megohms

Measurement Ranges (Chart A)

Model	MV105	MV106	MV116
Measurement Input Ranges	10 V -- 100mV --	10 V -- 100mV 10mV	10 V 1 V 100mV --

Sensitivity (Chart B)

	Meter Resolution Full-Scale	Meter Resolution V/Minor Div.	Galvanometer Sensitivity (max)
Meter Resolution and Sensitivity	10 V 1 V 100mV 10mV 1mV 100 μV 10 μV	500mV 50mV 5mV 500 μV 50 μV 5 μV 0.5 μV	-- -- 1mV 100 μV 10 μV 1 μV 0.1 μV

OPTION G-2 With Recorder Output

All of the input specifications listed for option G-1 apply to the G-2 option.

Output (to recorder): $\pm 1 \text{ Vdc}$ full scale, for all sensitivity settings.

Driving Current: 5mA

Load: Recorder $Z_{in} > 200\Omega$

Recorder output accuracy: $\pm(3\%$ of rdg + 30mV)

Isolation: The recorder output is totally isolated from the "unknown" input and the ("source") main frame instrument.

**RECORDER OUTPUT
PIN CONNECTIONS**

A - Earth Ground

B - Output

C - Output common

The recorder output is developed between pins B and C

SUPPLEMENT - FOR GALVANOMETER OPTION

OPERATION OF THE EDC INSTALLED HIGH IMPEDANCE GALVANOMETER

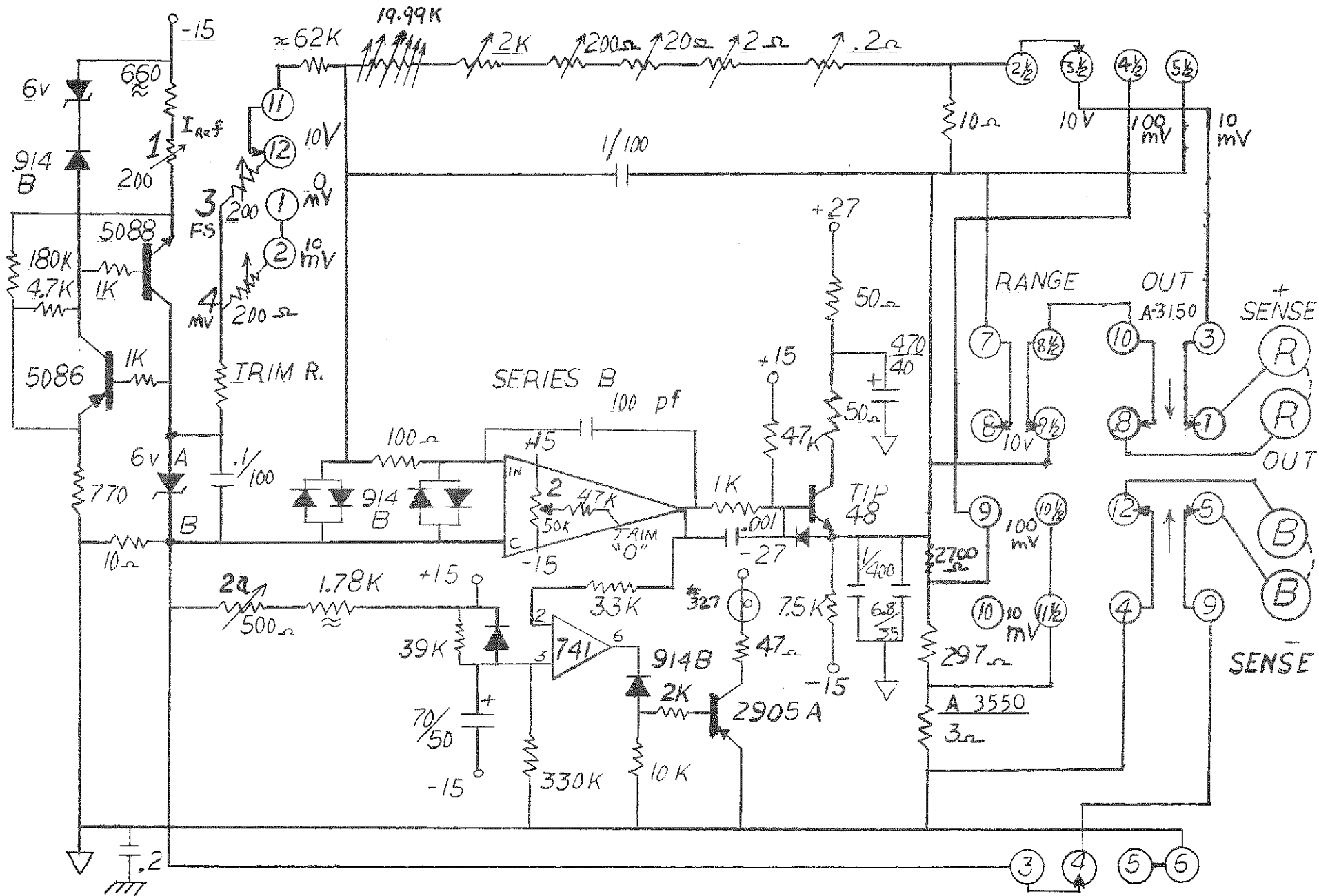
A. Differential Mode

1. It is to be noted that the galvanometer adds a number of controls to the panel.
 - a. "USE ZERO" switch: this control is used to balance the galvanometer measurement circuitry.
 - b. "ZERO ADJ": this control is used in conjunction with the "USE ZERO" switch to adjust the galvanometer for zero.
 - c. "SENSITIVITY": this is used to set sensitivities and to disengage the galvanometer circuitry in the "OFF" position.
2. Balance of Galvanometer. The zero balance of the high impedance galvanometer may be performed at any time, even with voltage connected to the unknown terminals.
3. Initial Zero Adjustment:
 - a. "USE ZERO" switch in zero position
 - b. "SENSITIVITY" switch to off
 - c. Apply power to instrument
 - d. Check mechanical zero of meter
 - e. Move "SENSITIVITY" to 100 μ V.
 - f. Adjust "ZERO ADJ" control for "0" on meter.

NOTE: This sets up initial zero. Zero can be checked at any time by performing steps a, e, and f of the above.

4. Voltage Measurement with the Galvanometer.
 - a. Perform steps in Paragraph 3.
 - b. With polarity switch on "0" and switch in "USE" set switch to maximum e.g. 10V.
 - c. Note meter deflection. If the deflection is to the left, set polarity switch to "+", and vice versa.
 - d. Increase first decade 1 step at a time until meter approaches "0". If meter overshoots "0" decrease by one step.
5. Replacing the Galvanometer Amplifier may require adjusting the full scale sensitivity. Short the Galvanometer input terminals, dial 10 volts on the voltage source, set Galvanometer sensitivity to 10 volts. Adjust pot on Galvanometer board for full scale reading on meter.

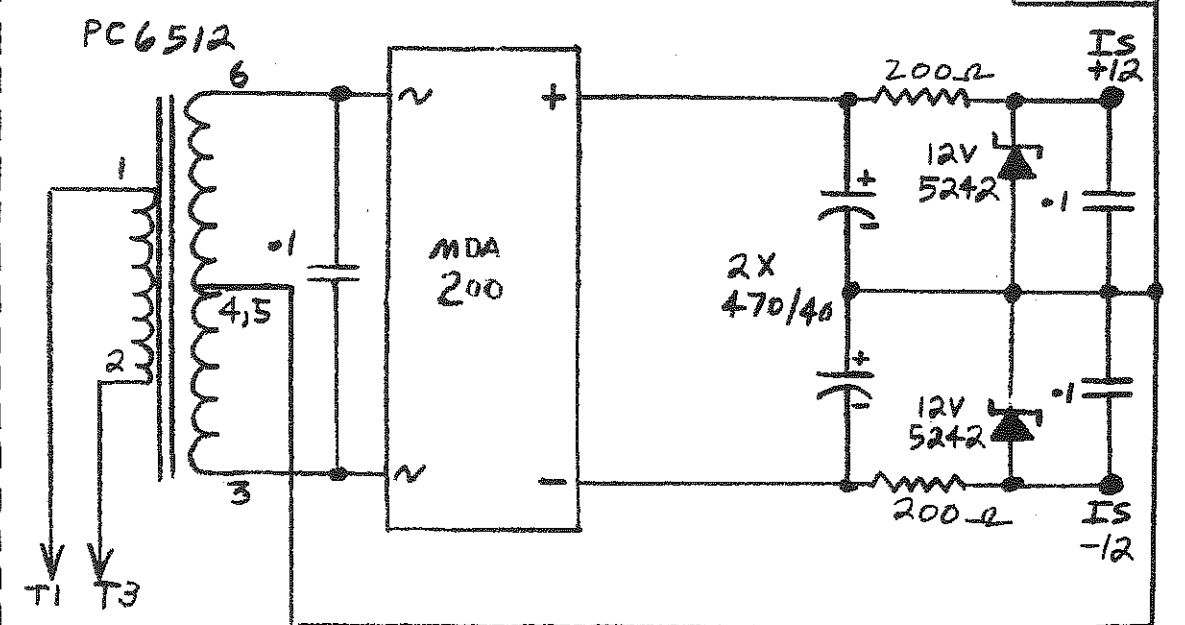
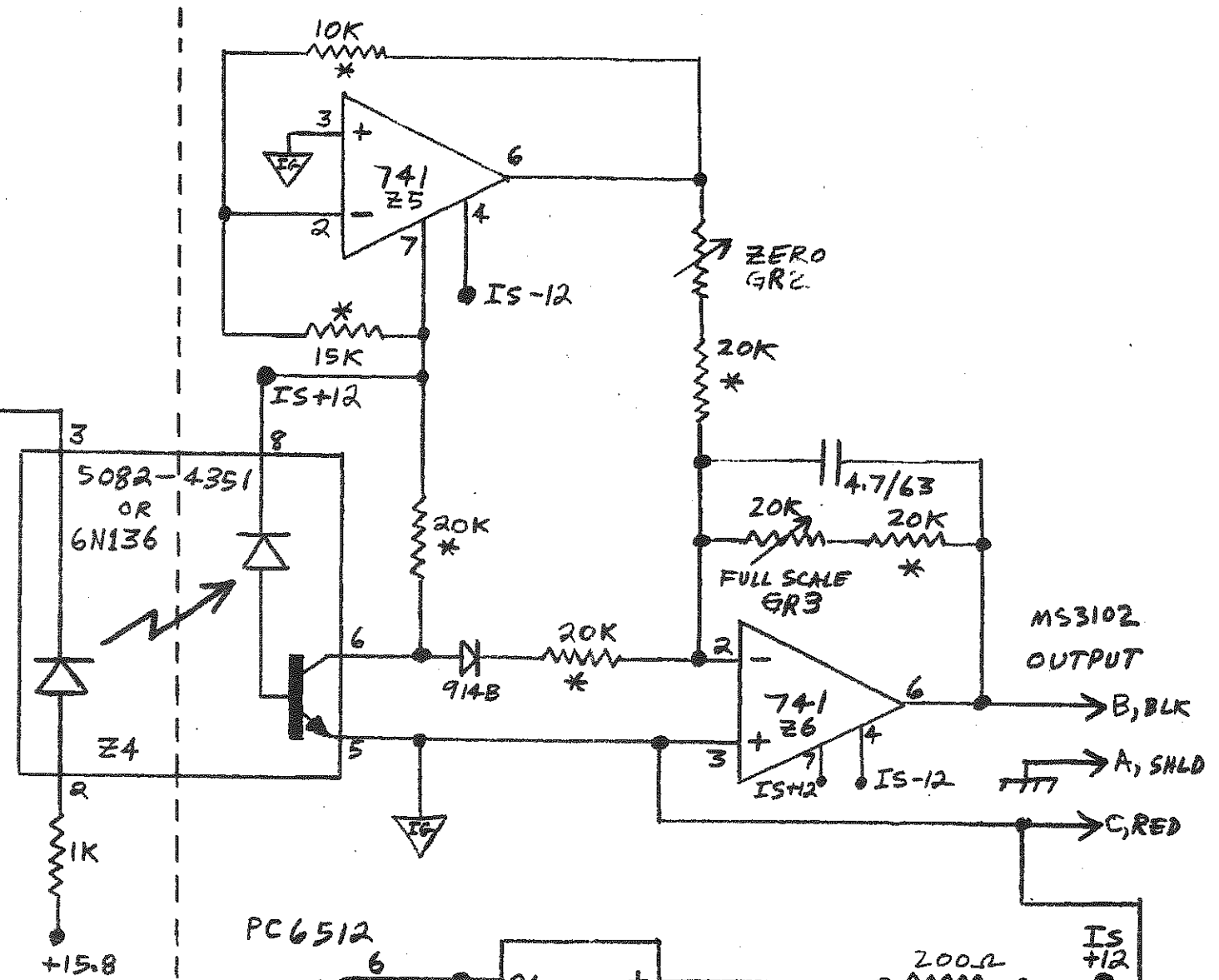
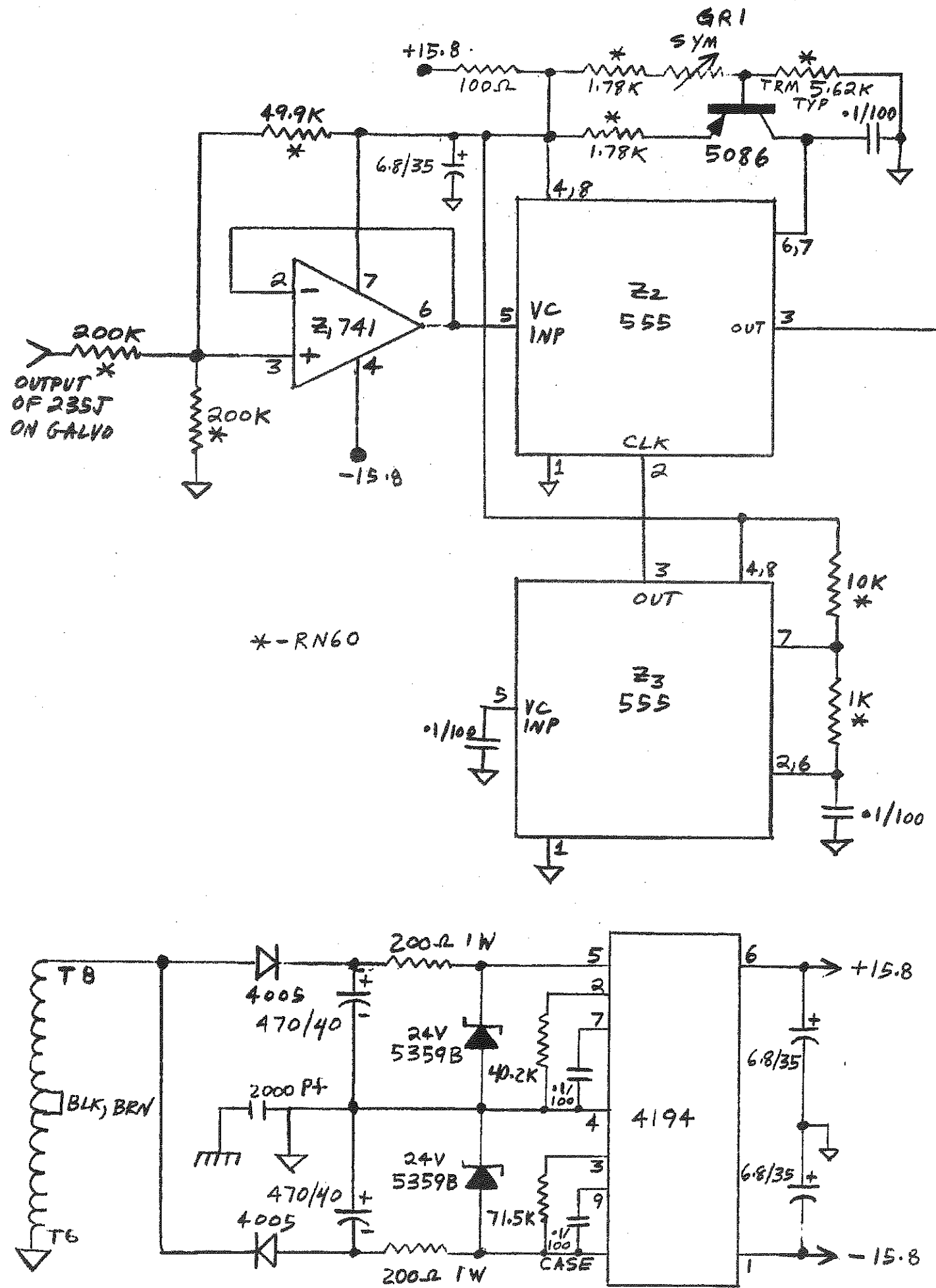
MV 106



ELECTRONIC DEVELOPMENT CORPORATION A-3050-4
 11 HAMLIN STREET, BOSTON, MASS. 02127

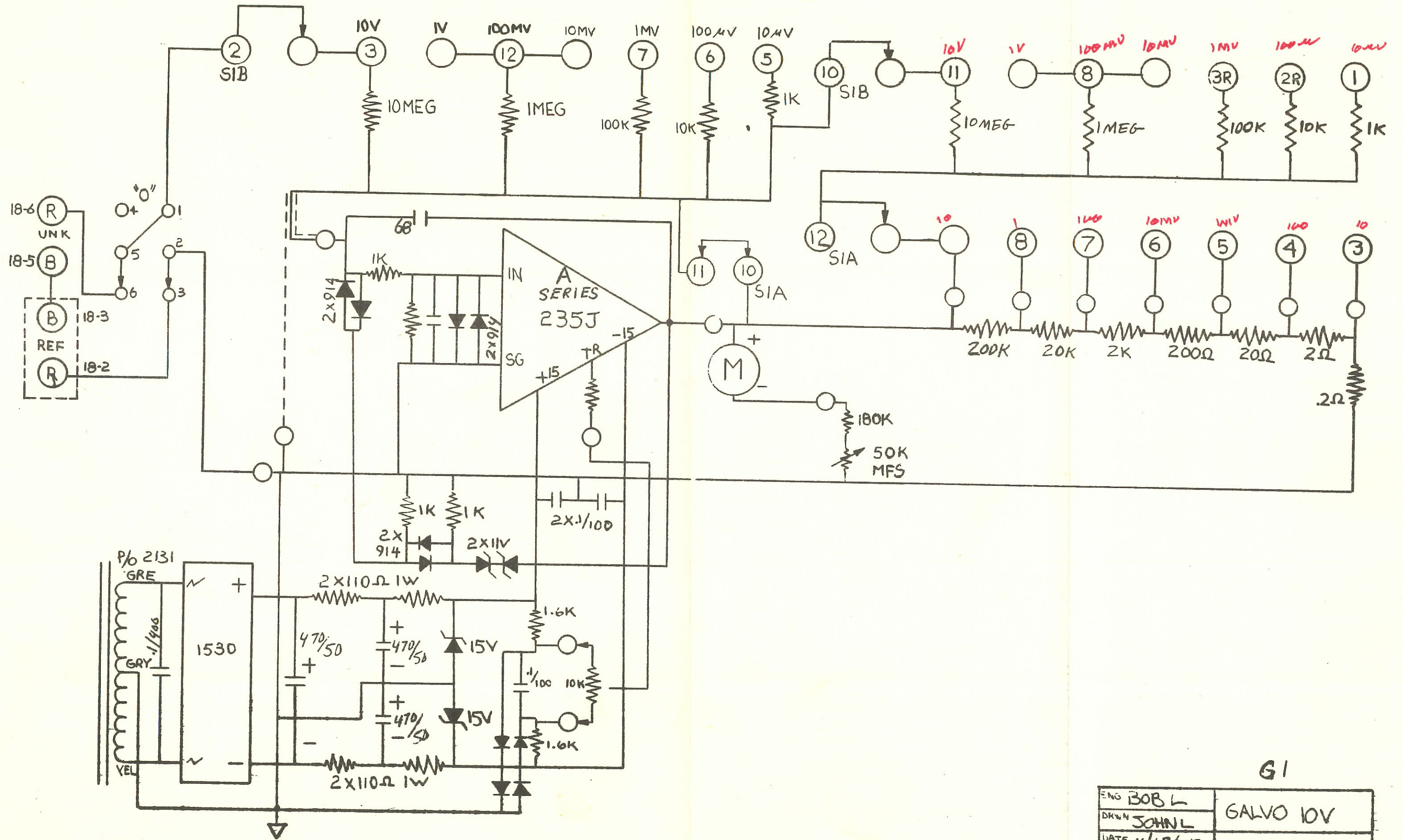
<u>DESCRIPTION</u>	<u>PART NUMBER</u>	<u>QTY</u>
Amplifier Series B	EDC	1
IC Amplifier TI	uA741CP	1
Regulator 15 V	.	1
Regulator 1N5359B	24 V	2
Diode 1N829A /Resistor Match	6 V	1
Diode 1N4005	Rect	2
Diode 1N914B	Clamp	7
Diode MDA 200	Rect	1
Transistor 2N2905A	Ovld	1
Transistor TIP48	Output	1
Transistor 2N5088	Reference	1
Transistor 2N5086	Reference	1
Capacitor 470/50	EG-40	3
Capacitor 1/200	Feed Back	1
Capacitor .01/400	4PS-s10	5
Capacitor 1000 Pf	DM 15	2
Resistor 770 Ω .1%	Reference	1
Resistor 660 Ω .1%	Reference	1
Resistor 50 Ω 5W	Collector	1
Resistor 180 k Ω 1/2W	Ohmite	1
Resistor 4.7 k Ω 1/2W	Ohmite	2
Resistor 2.0 k Ω 1/2W	Ohmite	2
Resistor 1.0 k Ω 1/2W	Ohmite	3
Resistor 270 Ω 1W	Ohmite	2
Resistor 100 Ω 1/2W	Ohmite	1
Resistor 10 Ω 1/2W	Ohmite	1
Resistor 7.5 k Ω 1/2W	Ohmite	1
Resistor		
Resistor 47 Ω 1/2W	Ohmite	1
Resistor 10 k Ω 1/2W	Ohmite	1
Resistor 39 k Ω 1/2W	Ohmite	1
Resistor 33 k Ω 1/2W	Ohmite	1
Resistor 71.5 k Ω 1%	RN60C	1
Resistor 40.2 k Ω 1%	RN60C	1
Potentiometer 68 wr 50 k Ω	68 WR 50 k Ω	1
Potentiometer 68 wr 200 Ω	68 WR 200 Ω	3
Potentiometer 68 xr 20 Ω	68 XR 20 Ω	6
Capacitor 10/25	500 D	2
Capacitor .22/400	MKC 1860	1
Capacitor 75/50 or 50/50	TE	1

<u>DESCRIPTION</u>	<u>PART NUMBER</u>	<u>QTY</u>
Knob	RB-67-2A-CSK-29M	6
Pointer	RB-67-1-B-M	2
Slide Switch 115/230	46206-LFR	1
Binding Posts	DF 30 RC & BC	2
Decade Switch	A 2983 517-132-623	6
Power Switch	SC2CK-P1-92-95	1
Output Switch	A 3150 Non Shorting	1
Transformer	A 2631 B	1
Range Switch	PA 2031 or 399711JC	1
PC Res Board	P 3580	1
Resistor 19990 Ω 0.05%	SA 2	6
Resistor 0.2 Ω 5%	SA 1	6
Resistor 2 Ω 0.25%	SA 1	6
Resistor 20 Ω 0.02%	SA 1	6
Resistor 200 Ω 0.005%	SA 1	6
Resistor 2 k Ω 0.005%	SA 2	6
Resistor 62 k - 63 k Ω 0.05%	SA 2	1
Fuse Post	342004	1
Fuse	1/2 MDL	1
Bulb, Overload	327	1
Light, Decimal	650-10-HM-553 (72609-01)	2




 ELECTRONIC
 DEVELOPMENT
 CORPORATION

B-3116 REV B G-2
 GALVANOMETER CHART
 RECORDER ISO-AMPLIFIER



G1

ENG BOBL	GALVO 10V
DRWN JOHN L	
DATE 4/18/78	B-3165 A
MODEL MV	