ELECTRONIC DEVELOPMENT CORPORATION

INSTRUCTION AND MAINTENANCE
MANUAL

PRECISION STANDARD

Model 330 Serial #

ELECTRONIC DEVELOPMENT CORPORATION

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Insert Certificate of Calibration

ELECTRONIC DEVELOPMENT CORPORATION

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, transitors and other semi-condutor devices which shall within six months 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.

<u>CAUTION</u>: 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.

SECTION I

1.1.0 GENERAL DESCRIPTION

1.1.1 The Model VS 330 is a multi-range, high accuracy DC voltage source and calibrator.

1.1.2 The unit is laboratory calibrated against a primary measuring system, having an absolute error of less than 10ppm. The saturated standard cells used are certified, and are traceable to the National Bureau of Standards, having a long history of documented Stability.

1.1.3 Calibrator controls are obtained through front panel switches and decade switches.

No trims of adjustments required between Calibration Cycles. Two adjustment settings are made at final calibration and are fully described under calibration procedure.

1.1.4 The circuitry is completely solid state packaged in discrete, hybrid and integrated circuit modules. These are proven circuits, using derated components to insure maximum reliability. Major discrete circuits are packaged on etched glass epoxy boards, so that the instrument can withstand abnormal environmental conditions. The instrument is also overload and short circuit protected.

1.2.0 APPLICATIONS

1.2.1 One of the major applications of the instrument as a DC calibrator is a system reference for electronic analog computers, digital converters, strain gages, and other peripheral equipment. Telemetry, data acquisition, control, and test facilities or electronic data handling systems using analog voltage inputs, either throughout or in part, will find the calibrator useful as a standard for systems calibration and checkout.

Other applications include the use of the instrument as a sophisticated ultrastable power supply providing an excellent source of bias current for operational amplifier and networks, semiconductor parameter tests, as well as for other experimental and breadboard circuitry.

Industrial checkout of power supplies, sensors, recorders, scopes, as well as analog, differential and digital voltmeters using the instrument as a DC voltage reference are other primary applications.

Colleges, universities and commercial research laboratories use the instrument in their physics and chemistry laboratories as a constant voltage source in calorimetric electrolytic and other applications.

1.3.0. GENERAL SPECIFICATIONS

LINE REGULATIONS:	.0005% for 10% line change
POWER REQUIREMENT:	115 VAC 50-400 Hz Approx. 20 watts.
STABILITY:	1 hr. 10 ppm 8 hrs. 20 1 month 40 6 months 50ppm

TEMPERATURE:

Calibration Temperature	$23^{o}C \pm 1^{o}C$	
Ambiant Operating Temp.	$20^{o}C \pm 30^{o}C$	($68^{o}F$ to $86^{o}F$)
Operating Limit	$-10^{o}C + 40^{o}C$	($14^{o}F$ to $104^{o}F$)
Storage Temperature	$-40^{o}C + 70^{o}C$	($-40^{o}F$ to $158^{o}F$)

ISOLATION: The output terminals may be floated 500 Vdc and the primary isolation is 1500 Vac RMS

OUTPUT TERMINALS: Floating output with case ground terminal.

REMOTE SENSING: 2 additional terminals are provided for sensing the IR drop across the connecting leads. Local Sensing is attained by a front panel links that connects the buss between the "output" and "remote" terminals.

POLARITY SWITCHING: (3 positions) plus (+), zero (0), minus (-). The input and output terminals (floating) can be reversed with respect to each other.

The zero (0) setting of the polarity switch short circuits the output and open-circuits the input terminals. In effect this is a "stanby" control as well as a positive "zero".

ELECTRICAL SPECIFICATIONS

Accuracy:	Line at nominal and with Sense at load or Links closed at terminals.
a) CALIBRATION ACCURACY:	23°C ± 1°C at 70% RH
300 V range:	±(0.002% of setting + 0.0005% of range)
30 V range:	±(0.002% of setting + 0.0005% of range)
3 V range:	±(0.002% of setting + 0.0005% of range)
300mV range:	±(0.005% of setting + 3μV)
b) LIMIT OF ERROR ACCURACY:	± (0.003% of setting +0.001% of range)

OUTPUT RANGES:

f.s.	Resolution
300 V	100μV
30 V	10μV
3 V	1μV
300mV	.1μV

OUTPUT CURRENT: up to 100mA with remote sensing.

OUTPUT IMPEDANCES:

Ranges	Output Impedances
300 V @ 50mA	30 milliohms
30 V @100mA	30 milliohms
3 V @100mA	30 milliohms
300mV	20 ohms

LOAD REGULATION:	± 0.0005% + 25 μV Not applicable on 300mV range.
NOISE & RIPPLE:	less than 100 μV rms on all ranges in a band pass of 0.8 Hz to 60 kHz.
WARM UP TIME:	30 seconds for calibrator.
CIRCUIT CONDITION INDICATOR:	Front panel indication of short-circuit overload, overange, low-line voltage or malfunction.

TEMPERATURE COEFFICENT:	Ambient	.0002%/°C
	Operating	.001%/°C

PROTECTION: Short-circuit and overload protection. Automatic recovery. Front panel indicator.

DIMENSIONS: 5 1/4 X 19" X 9 1/4 " 13.3 X 48.3 X 23.5 cı

WEIGHT: 14 lbs. 6.35 kg.
Shipping weight USA 16 lbs.

MOUNTING: BENCH USE: Supplies with carrying handle, resilient feet, and folding tilt bale.
RACK MOUNTING: The bench use accessories are easily removable. 19" mounting can be added to instrument chassis.

HUMIDITY: 0 to 95% relative humidity.

ALTITUDE: Operating: 10,000 ft; Non-operating 50,000 ft.

FUNGUS NUTRIENTS: None.

DOCUMENTATION:

1) Certificate of Compliance traceability to U. S. National Bureau of Standards.

2) Calibration Laboratory Certification includes static and dynamic tests and point by point nominal deviation reports.

3) Maintenance Manual including block diagrams, mechanical layout, schematics, parts list.

4) WARRANTY: Six months including accuracy and stability.

SECTION II

2.0.0 INSTALLATION

2.1 1 The instrument is available in rack version, designed for mounting in standard 19" racks. It is completely enclosed in dust covers and therefore suitable for bench top use. Resilient feet and a folding tilt bale are supplied. Order for rack mounting if desired.

2.1.2 The overall size is 5 1/4 " high X 19" wide X 9 1/4" back of the panel. It weighs 14 pounds. A standard 3 prong polarized plug and power cable is attached, and the unit is ready for use.

POWER REQUIREMENT = 20 WATTS
LINE VOLTAGE RANGE 115-230V50/60Hz

The instrument has been designed to be easily transported from one location to another and will be in a stable and accurate operation condition in less than one minute from turn on time.

SECTION III

3.0.0 OPERATION OF INSTRUMENT

3.1.0 FRONT PANEL CONTROLS

3.1.1 Power Switch: Line power, self-illuminating.

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 "O" a short circuit exists between the red and black output terminal.

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 sense capability should be used. The advantage of remote sense is that you have a 4 wire output and the sense lines ate 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, and each switch is labeled with the multiple of the decimal it controls. The decimal lights facilitate the reading of resolution.

3.2.0 OPERATION AS A VOLTAGE SOURCE

3.2.1 With power switch off, connect power cord to recommended power source, e.g. 115 VAC 60Hz or 220 VAC 50Hz

3.2.2 Connect the output terminals of the instrument to their respective loads as required, observing the sensing rules (see diagram below).

CAUTION: Do not place more than a 500 volt potential between the output terminals and chassis ground when using a floating output. In some applications it may be necessary to isolate chassis form line common. This practice is not recommended.

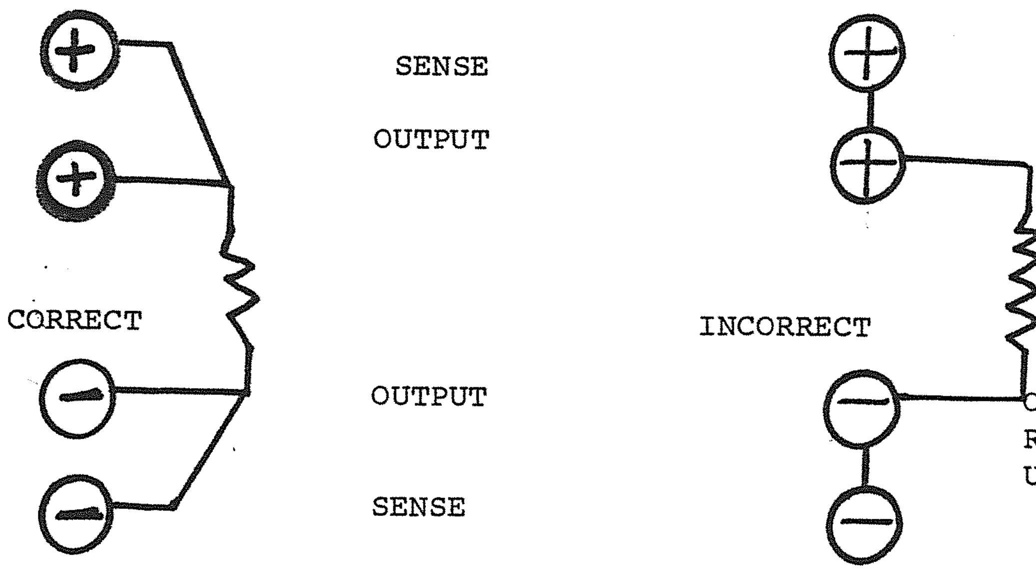


FIG. 3-2
OUTPUT SENSING RULES WHEN UNLOAD

3.2.5 With polarity switch on "0" posistion, place power on switch to the "On" posistion. This procedure will prevent any possible turn on transient from appearing accross the output terminals.

3.2.6 Select the desired output voltage on the decade switches, set range switch to appropriate range, and switch the polarity switch to required polarity.

SECTION IV

THEORY OF OPERATION

4.1.0 GENERAL

The model 330 serves as a precision standard (calibrator).

4.2.0 CALIBRATOR:

4.2.1 The basic circuitry for Electronic Development Corporation's standards/sources are simialr. The basic circuitry is: 1, power supply, 2, Internal precision reference, 3, Chopper stabilized amplifier, 4, feedback circuitry, and 5, output selector.

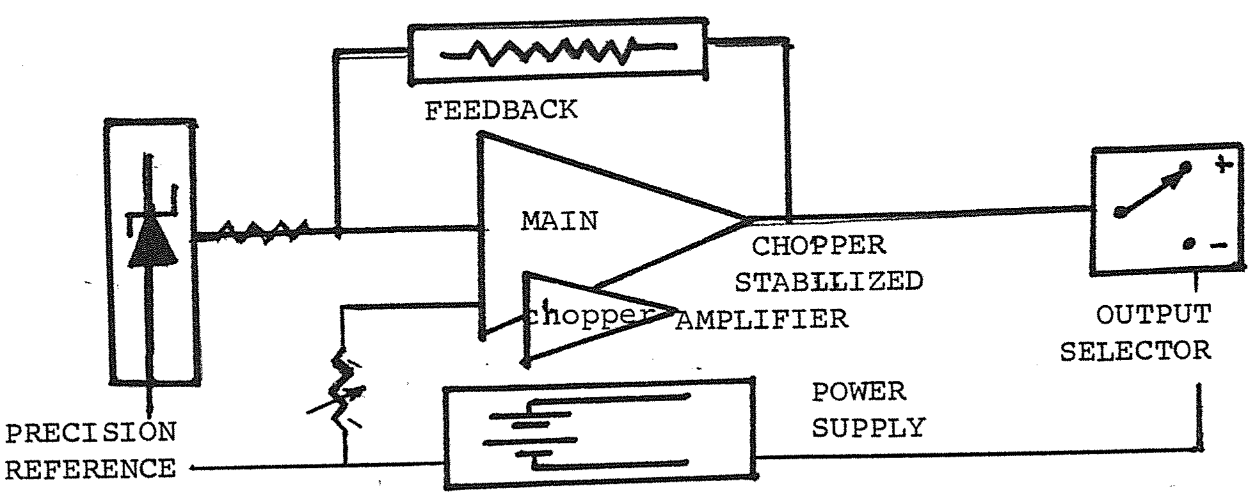


FIG. 4-1 BASIC CIRCUITRY

4.2.3 Power Supply: The basic power supply supplies the unit with the required voltages for operation. The standard power supply voltages are ±18V, ±23V, ±30V.

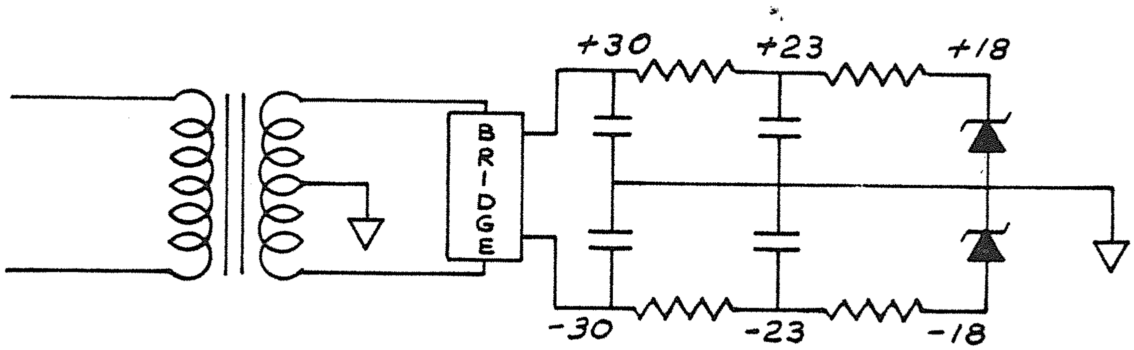


FIG. 4-2 POWER SUPPLY SIMPLIFIED

4.2.4 Internal Precision reference: An ultra stable zener reference is carefully selected for zero temperature coefficient. The zener current is established by a 2 transistor current driver. At the cathode of the zener, there is a very stable and precise voltage. e.g. 6.2235V. This voltage is used to establish a precise feedback current of 1 or .1 milliampere to the error or summing point of the chopper amplifier.

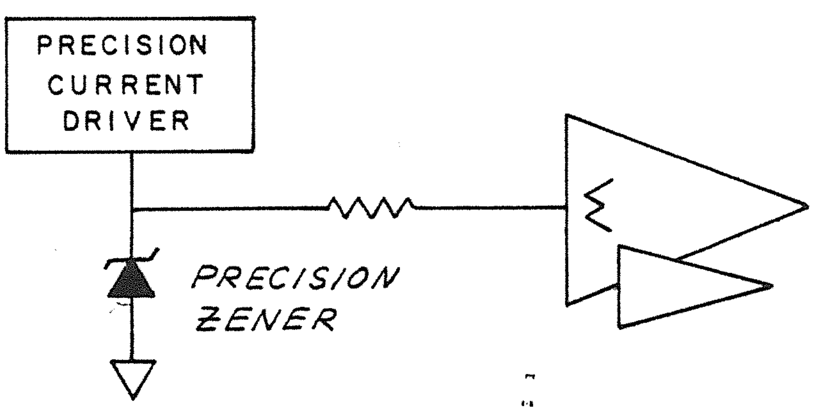


FIG. 4-3 PRECISION REFERENCE

4.2.5 Chopper stabilization was designed to compensate for the DC offset, thermal instability and other factors that are inherent in high gain voltage amplifiers.

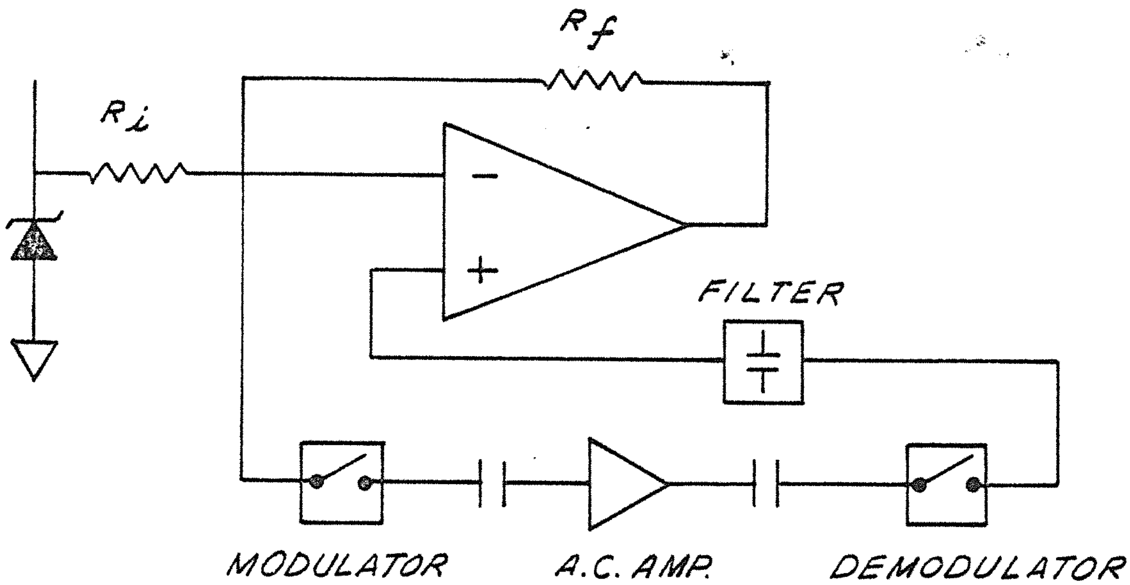


FIG. 4-4 CHOPPER STABILIZED AMPLIFIER

The Chopper stabilized amplifier utilized in EDC equipment is the synchronous amplitude modulated carrier type. The input signal to the chopper 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 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 amplifier.

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

4.2.6 Feedback Circuitry. The feedback around the chopper stabilized amplifier determines the output voltage. The output voltage is a function of the precise current set up in the feedback circuit by the internal precision reference.

4.2.7 Output Selector: Provides means to switch polarity of output and sense lines.

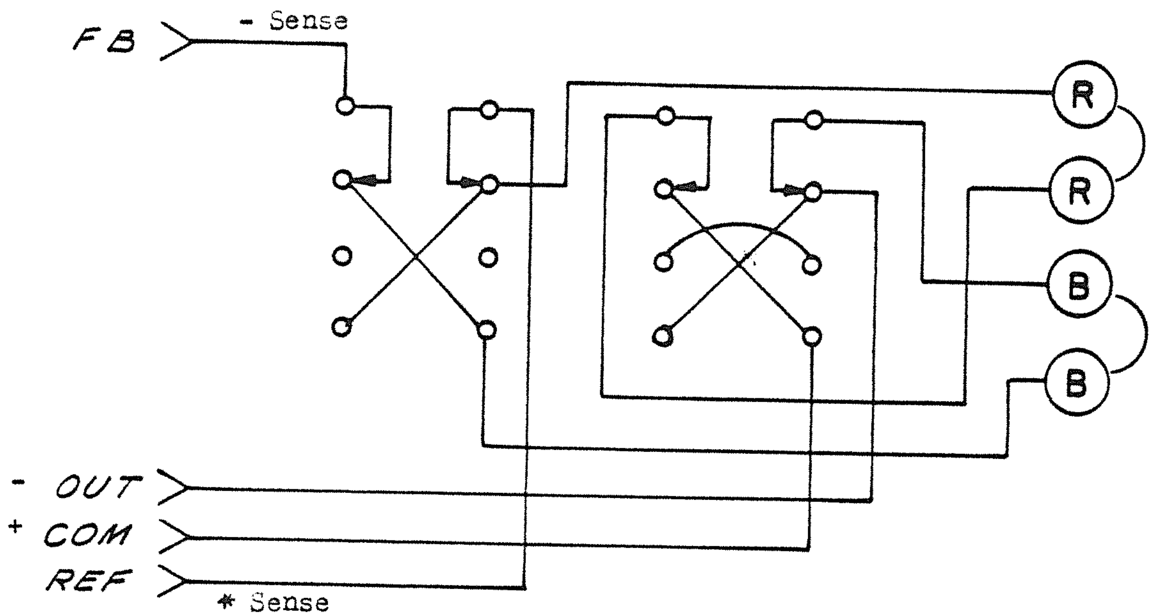


FIG. 4-5 OUTPUT SELECTOR

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

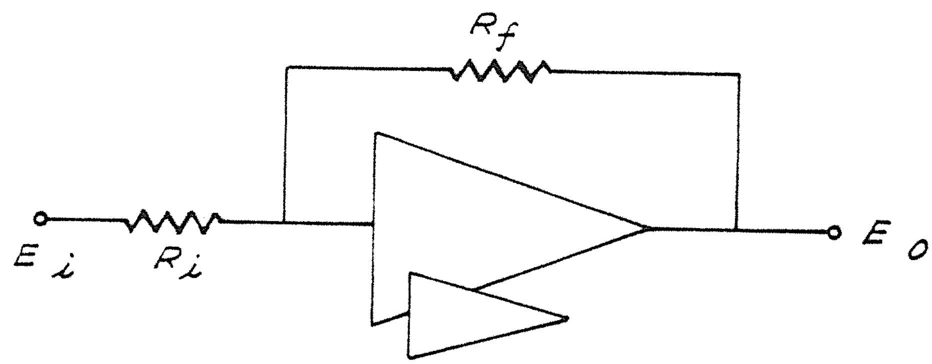


FIG. 4-6 OPERATIONAL AMPLIFIER

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 (IR_i) flowing through the input resistance (R_i), e.g. if R_f = 6.3KΩ then:

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

$R_f = 10K\Omega$

$$E_o = -E \frac{R_f}{R_i} = -6.3V \times \frac{10K}{6.3K} = -6.3 \times 1.585 = -10V$$

It is interesting to note that R_f times the input current (IR_i) is the same output voltage therefore:

$$E_o = -IR_iR_f = -1 \text{ max } 10K\Omega = -10V$$

4.2.9 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 is saturated and the excess voltage is stored in the demodulator filter capacitor until the condition is corrected. The recovery from this condition after removing the overload or short is a function of the discharge of this circuit.

4.2.10 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.

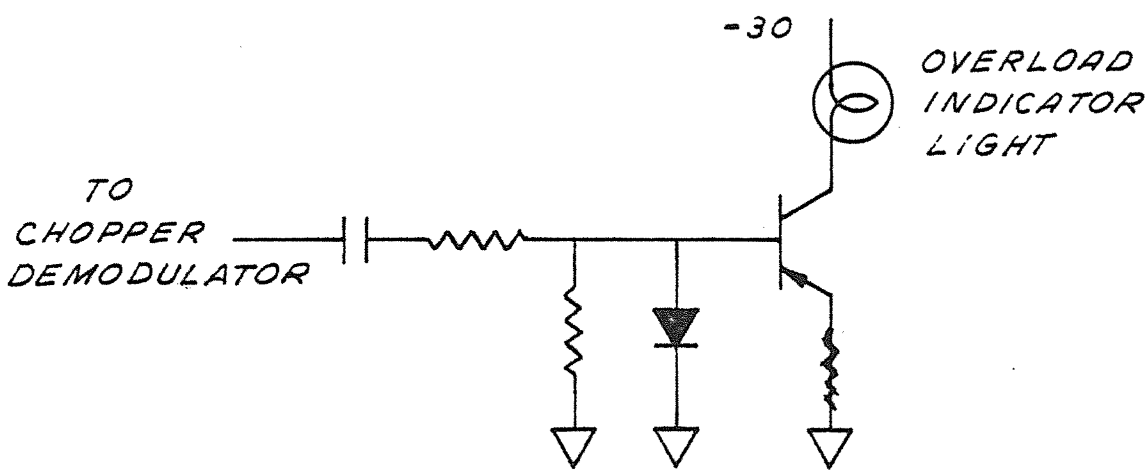


FIG.4-7 OVERLOAD INDICATOR

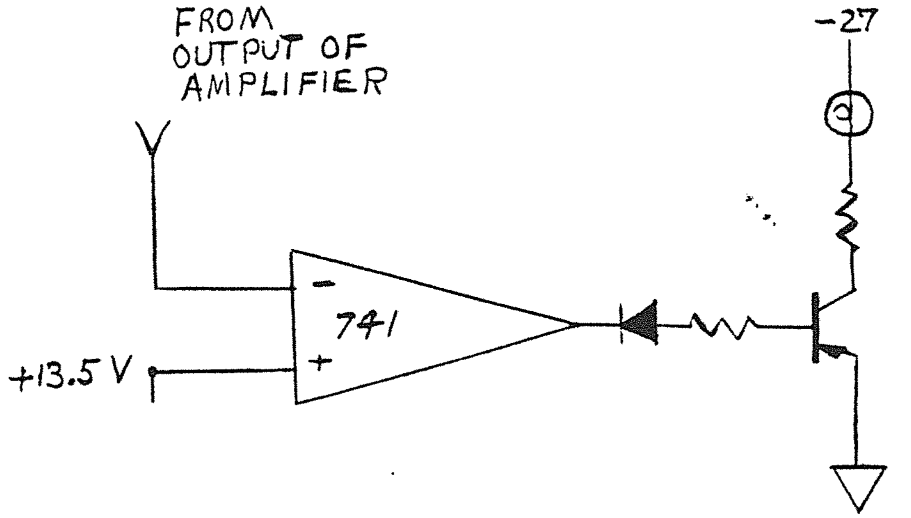


FIG. 4-7 SIMPLIFIED OVERLOAD INDICATOR CIRCUIT

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 ouput 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.

Installed in
some units.

SECTION V

MAINTENANCE

5.1.0 INTROBUCTION

5.1.1 In servicing the Model 330 Series, it is recommended that malfunctions be treated in two categories-one producing gross errors, which can be isolated with general test equipment, will be covered in Section entitled "Trouble-shooting". Correction of fine errors, requiring more specialized test equipment will be discussed in the Section intitled "Calibration". However, before any maintenance is attempted, the chapter on the "theory of Operation" should be read and thoroughly understood.

CAUTION
Care should be taken to prevent an internal short, while working on the unit, as this may cause the components to be damaged.

5.1.2 As the major circuits are all contained on printed circuit board modules, this section will discuss the isolation of any malfunctions to the Functional block diagrams.

NOTE: Dangerous high voltage is always present in the high voltage section (360Vdc - 150 ma).

5.2.0 DISASSEMBLY PROCEDURES

5.2.1. The cover can be removed to examine the Precision Voltage reference Standard (calibrator). Remove the screws holding the top rear dust cover and lift the cover. This should suffice for physical inspection and electrical troubleshooting. If parts should have to be replaced, however, further disassembly may become necessary.

5.3.0 PREVENTIVE MAINTENANCE

5.3.1 Calibration: refer to calibration section for annual or semi-annual accuracy adjustment.

5.3.2 Switches: The only other type of preventive maintanence is the lubrication of the switches.

5.3.3 The decade and polarity (rotary) switches are lubricated at the factory. We recommended that these switches are not serviced during the first year.

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

The switch manufacturer claims a life of 50,000 revolutions which equals about 3 years (or 6000 Hrs.) average use.

The foregoing statement is intended as a guide and does not represent a direct or implied warranty of the switches beyond the stated instrument warranty.

5.3.4 CLEANING: DO NOT ARBITRARILY CLEAN THE SWITCHES .

In many instances, lubrication only may be all that is required. If a switch looks like it needs cleaning it is probably worn out and should be replaced if accuracy is to be maintained. BE CERTAIN TO RE-LUBRICATE AFTER CLEANING.

LUBRICATING: DO NOT USE OIL

Switch Contacts: Use: Rycon 2EP - Standard Oil of N.J. (Lubricant) DISC.
or: Beacon 325- Standard Oil of N.J. (Lubricant) DISC
or: ~~Oak 2008~~ - Oak Manufacturing (Lubricant) 35
or: May be ordered from Electronic Development under EDC Part #~~2008~~.

Apply a small amount of one of the above products carefully to the switch contacts. Rotate switch several times to disperse the lubricant. DO NOT OVER LUBRICATE. DO NOT USE OIL. DO NOT ARBITRARILY CLEAN THE SWITCHES. In some instances, lubrication only may be all that is required.

SHAFT AND DETENTS: Use: Be~~acon~~ ~~325~~ 35 Standard Oil of N.J. (Lubricant). Apply sparingly at the recognised points of friction. Do not use ordinary grease. Oil and some greases have a tendency to migrate.

5.3.5 If soldering to the switch leads becomes necessary reasonable care must be used in the amount of heat applied. Excessive heat can significantly change the tension of the contacts and/or wiper and thus may change the contact resistance.

5.4.0 NOISE MEASUREMENTS

5.4.1 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.

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

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

5.4.4 A high gain 50 μV/CM or better, <u>differential</u> pre-amp such as the 1A7A, or the 7A22 Textronic models, or equivalent, are well suited for this application.

5.4.5 In an enviroment 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 enviroment, permit calibration for radiated noise pick-up on the test measurements.

5.4.6 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.

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

5.4.8 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 seperate, heavy wire chassis-to-chassis connection seperate from the shield of the differential input leads.

5.4.9 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.

5.4.10 <u>Do not</u> use the shield of the input cable as the chassis-to-chassis connection in place of line system ground. Use additional seperate heavy wire.

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

5.2.0 TROUBLE SHOOTING

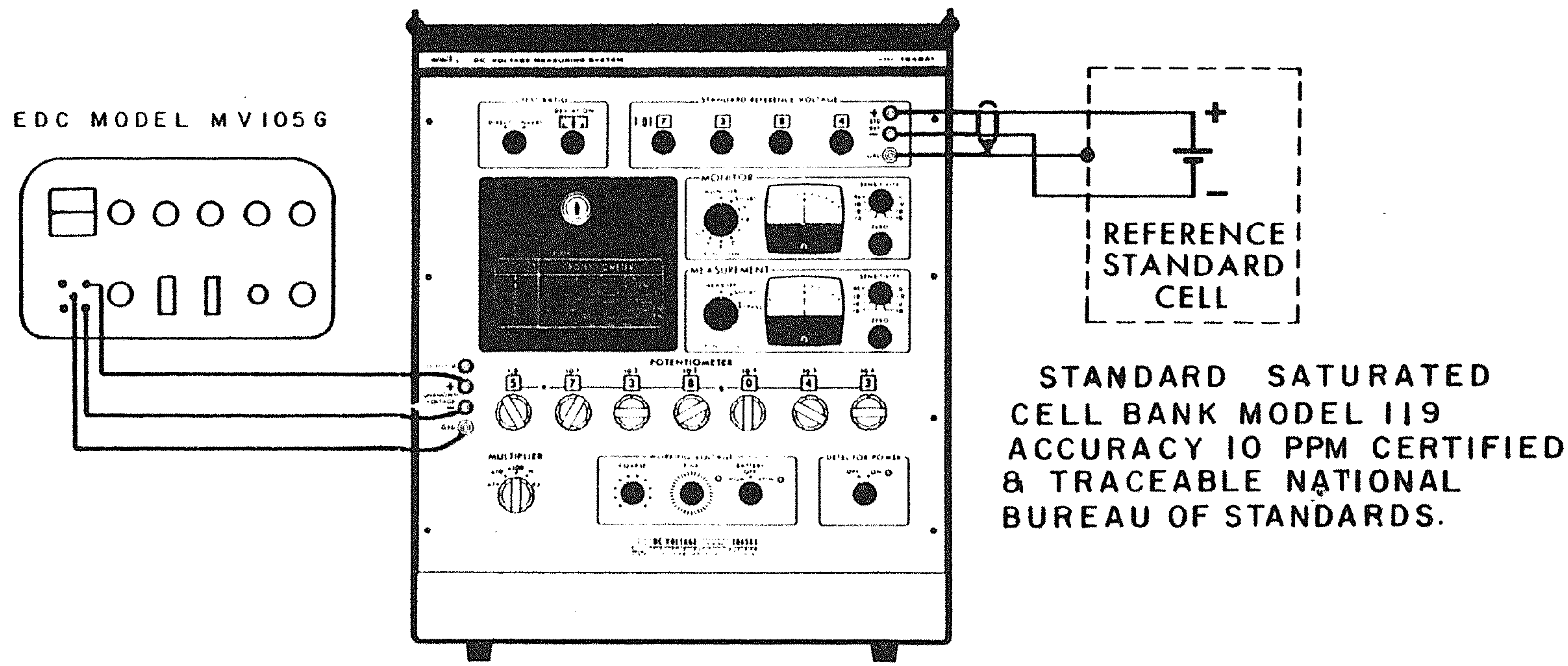
SYMPTOM	PROBABLE CAUSE	REMEDY
Output voltage not selectable, reads above full scale	Feedback string is open	check feedback string
No output at any setting, voltage very low, or lmv	Reference circuit malfunction	Examine reference circuit and repair as necessary
Low and unstable output voltage	+18 Volt supply overloaded	Check transistors in reference circuit and replace as necessary
Gross output error on low selected voltages	Output stage may be oscillating	Examine output stage and replace output transistor
Unit blows line fuse	Component breakdown in power supply	Examine power supply and repair as necessary
	Incorrect fuse installed	Install fuse of proper rating
Large AC signal observed from either output terminal to case	Interconnection of instruments are forming ground loops.	Examine connection and observe that the polarity of the ground buss connections is maintained to each of the instruments and cases are equal.

<u>NOTE:</u> When the malfunction is subtle, the overload light may not indicate an active chopper wave. A very low light or a low intensity flicker may indicate an oscillating unit, accompanied by an unstable output voltage.

SYMPTOM	PROBABLE CAUSE	REMEDY
Output exhibits gross, but selectable error	Chopper correction signal is large and amplifier error point is approx. 5 volts	Examine input differential stage and replace faulty transistor.
Output voltage not selectable and reads -.5VDC at all settings	Chopper amplifier not functioning	Examine chopper amplifier and replace faulty component.
Output voltages read 7.2VDC regardless of setting	Output stage or driver stage malfunctioning	Examine output and driver stage and replace faulty component
Output voltage out of specification	Out of calibration	Recalibrate in accordance with the section on calibration.
Percentage error of part of range.	Defective resistor in feedback string	Locate defective resistor and replace.
Poor Load regulation	Defect in output stage	Examine output and switching circuitry and replace faulty component
	Incorrect use of sense terminals	Sense at lead
On turn on: Output voltage rises to selected voltage the decays to zero voltage	Zener voltage = "0" or no input voltage at R_{in} or open R_{in} open Trim Pot	Check complete reference circuit, and repair measure R_{in} for approx correct value Measure Trim Pot for correct value. Check for R as pot is adjusted.
Voltage at "0" selected is larger than specs.	Zero trim pot has drifted, components have aged.	adjust to "0" $\pm 30\mu V$ as described in calibration section.

SYMTOMS	PROBABLE CAUSE	REMEDY
High Zero offset Not adjustable with Offset Pot Unit otherWISE Operational	Pot defective	Replace
Jumpy output	Mechanical	Locate the Decade And replace worn Switch.
No Output on any One of the ranges	Defective or WORN Switch, or open Rin Precision Resistor	Replace switch or Resistor.
No output with Overload indicator "ON".	Loss of HV also Check Q7 to Q12	Replace defective component.
IRRATIC or Random Output with NO Overload indicator Light	Chopper AMP MALFUNCTION or MULTIVIBRATOR Malfunction	Replace IC 741V Check Q19 + Q20 Also 2N5088 MultiVibrator.

VOLTAGE REFERENCE STANDARD CHECKOUT ARRANGEMENT



ESI 1045AI
DC VOLTAGE MEASURING SYSTEM
FIGURE 5-3

BASIS FOR EDC ACCURACY STATEMENT

VOLTAGE POINTS	1000V	100V	10V	1V
MODEL 1045A1 POTENTIOMETER	0.2	0.2	0.2	2
MODEL 1045A1 MULTIPLIER VOLTBOX	4	2	0	0
MODEL 1045A1 WORKING VOLTAGE	2	2	2	2
MODEL 1045A1 MEASUREMENT DETECTOR	0.2	0.2	0.2	0.2
MODEL 1045A1 MONITOR DETECTOR	2	2	2	2
MODEL 1045A1 STANDARD REFERENCE VOLTAGE DIVIDER	2	2	2	2
MODEL 1045A1 THERMO ELECTRIC VOLTAGE	0.01	0.01	0.01	0.1
MODEL 1045A1 END ERROR	0.01	0.01	0.01	0.1
MODEL 1045A1 POWER COEFFICENT	10.5	0.7	0.5	0.5
MODEL 1045A1 SHORT TERM STABILITY	0.5	0.5	0.5	0.5
SATURATED CELL EPPLY MODEL 119	10.0	10.0	10.0	10.0
R.S.S. OF TOLERANCE CAL. ACCURACY IN PPM	15.4	10.8	10.6	11.5

FIGURE 5-4

5.5.0 CALIBRATION PROCEDURE

5.5.1 In order to maintain optimum accuracy, the Model 330 should be calibrated once a year, more frequently if desired. The instrument may be returned to factory for calibration or it can be field calibrated by the customer. The power should be turned on for at least an hour, the line should be regulated, ambient temperature should be $23^0C \pm 1^0C$ and the relative humidity less than 70%.

5.5.2 The recommended calibration equipment includes:

1) Standard Cell: Eppley Labs. Model 119 .001%
   Certified traceable to NBS
2) DC Voltage Measurement System: ESI Model 1045 A1.

3) Oscilloscope: Tektonix 541.

4) Pre-amp High Gain Differential: Tekronix 1A7

5.5.3 The calibration of the calibrator section of the model 330 is done in the following manner:

1) Arrange and connect Laboratory instruments to measure as required.

2) Set all decade switches of the calibrator to zero and measure on the ESI model 1045. The measurement detector should indicate less than 20µV.

This is theinherent offset of the instrument.

3) Reverse the polarity selector switch and check as in step #2.

4) Adjust the zero offset pots (5,6,7) DWGA-~~2463~~ A2688 for all 3 ranges to best "0" ± 20µV.

5) Go to the 100V range, set the Gold 17Ω trimpot (#3) to the middle of its range. Set 10 Full clockwise on Decade #3. Adjust factory trim in series with pot for 10V output.

6) Adjust the 17Ω pot for 10V output. (10 on third decade) This is the Key Adjustment, necessary before proceeding to the following Linearity adjustment of the 1st full (0-10) Decade, on switch #2.

7) Linearity Adjustment of 2nd Decade Switch: Set all decades to "O" and proceed as described below. The lowest offset voltage should have been obtianed before proceeding.

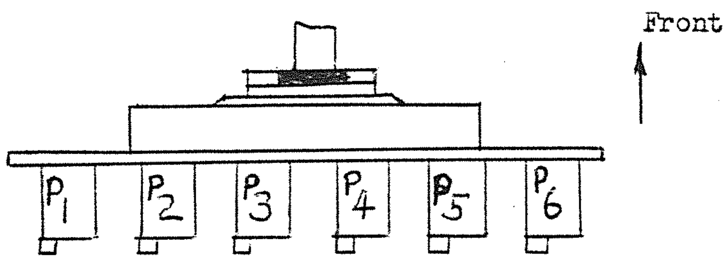
8) Set to 20V on 2nd decade adjust P2 exactly. Go to 10V on 2nd decade and adjust P1 to 10V. Compare with 10V Full clockwise on Decade #3.

9) Set to 40V on 2nd decade adjust P3 exactly. Look at 30V for possible minor tweak of P3.

10) Set to 60V on 2nd decade adjust P4 exactly. Look at 50 V for possible minor tweak of P4.

11) Set to 80V on 2nd decade adjust P5 exactly. Look at 70V for possible minor adjustment of P5.

12) Set to 100V on 2nd decade adjust P6 exactly. Look at 90V for possible minor adjustment of P6.



13) Proceed to adjust full scales trims 2 and 1 on 3V & 30V ranges. DWG A-2463

14) Set in 10V fullscale on 30V range. Adjust trim #2.

15) Set in 1V fullscale on 3V range. Adjust trim #1.

16) Set the First Switch to zero for the above adjustments.

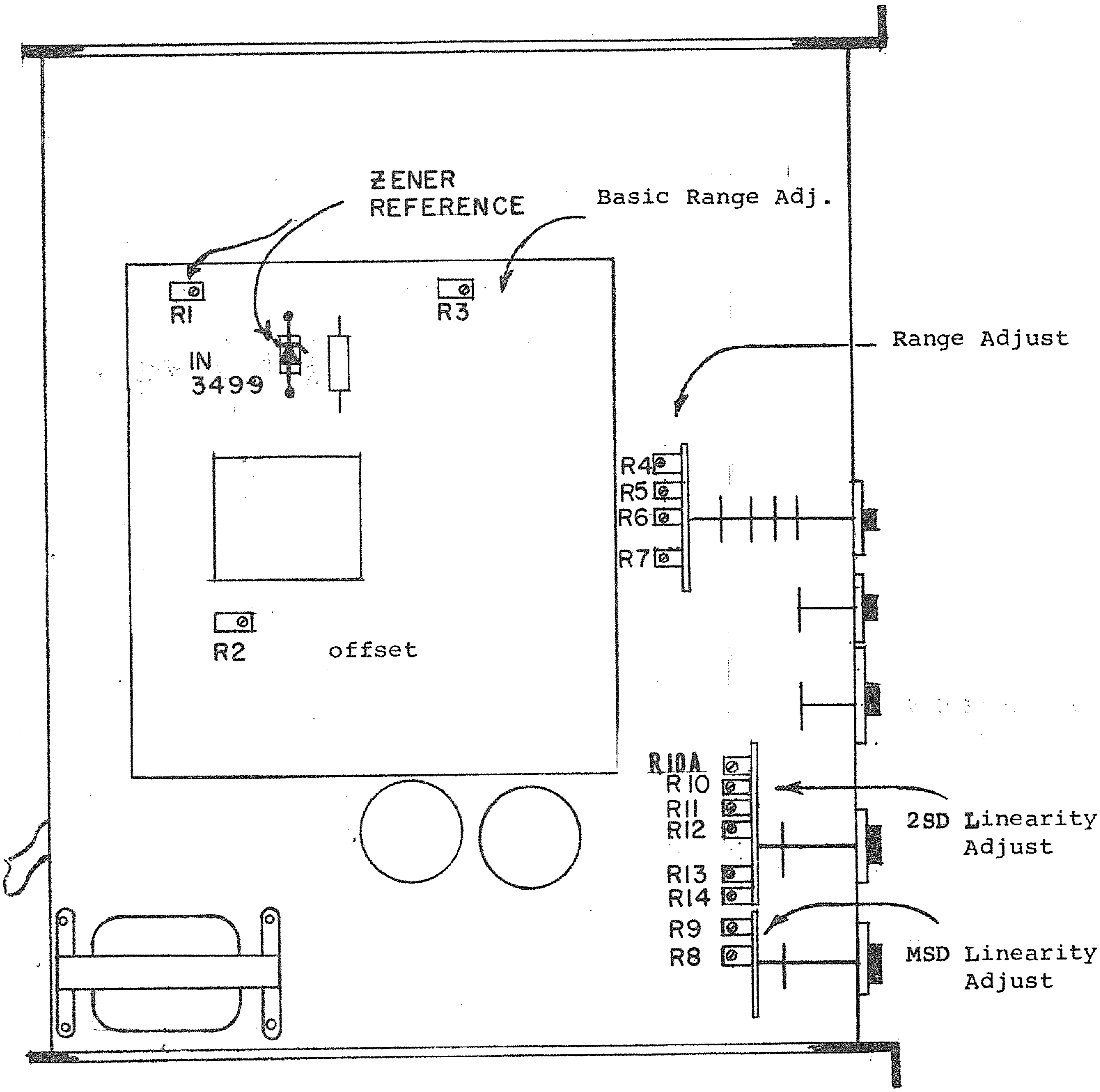
17) Checkout entire range outputs by progressively stepping through the decade switches. Record the deviations from normal.

TYPICAL PARTS LIST

DESCRIPTION	MFR	PART NO	QTY
Line Cord	General Cable	3532	1
Transformer	EDC	A2414-1	1
Fuse Clip	L Fuse	357001	1
Fuse 1A MDL	Buss	1A MDL	1
Binding Post	Superior	291R	2
Binding Post	Superior	291B	2
Indicator Light		#600WD HM533	3
Switch, Decade	Oak	259542FD1X	6
Switch, Polarity	CRL	PA 2031	1
Knobs 0-10	Buckeye	PS-95-752-BLK	7
Knobs Bar	Rogan	RB-67-1-BM	2
Trim Pot 50KΩ	Beckman	66WR50KΩ	1
Trim Pot 20Ω	Beckman	66WR20Ω	6
Trim Pot 200	Amphenol	3800-201-P	2
Precision Res.			
.2Ω5%	RCL/Daven	7010/1250	6
2Ω.25%			6
20Ω.05%			6
200Ω.01%			6
2000Ω,005%			6
19990Ω.01%	RCL/Daven	7020/1195	6
590Ω .1%	RCL/Daven	7010/1250	1
600Ω .01%	RCL/Daven	7010/1250	1
1000Ω .25%		7020/1195	1
6000Ω.005%		7020/1195	1
60000Ω.005%		7020/1195	1
100K Ω.005%		7020/1195	1
600K Ω.005%	Daven	7020/1251	1

PARTS LIST

DESCRIPTION		MFR	PART NO	QTY
RESISTORS	100Ω 1W	A-B		2
RESISTORS	150Ω 1W			2
RESISTORS	68Ω 3W	SPRAGUE	BJ	2
RESISTORS	22K 2W	A-B	741V	1
IC	741 V			1
TRANSISTORS	2N 5986	MOTROLA		8
TRANSISTORS	DTS 425	DELCO		1
TRANSISTORS	2N 1306	RCA		1
TRANSISTORS	TIS75	TI		1
TRANSISTORS	2N 2905A	MOTROLA		2
TRANSISTORS	2N 5088	MOTROLA		7
DIODES	IN705	TRANS		1
DIODES	IN914	TRANS		2
DIODES	IN456	TRANS		14
DIODES	IN4744	MOTROLA		2
DIODES	IN3499	TRANS	REFERENCE	1
DIODES	IN4005	TRANS		4
DIODES	FW-500	MALLORY OR PDE	PD1350	1
DIODES	FW-300	MALLORY OR PDE	PD1530	2
CAPACITORS	0.001/200	AREOVOX		1
CAPACITORS	.01/100	ELMENCO	DM15	8
CAPACITORS	.1/100	STT	MKC 1860	10
CAPACITORS	.33/100	STT	"	3
CAPACITORS	1.0/100	STT	"	2
CAPACITORS	1/200	SPRAGUE	631P	2
CAPACITORS	5/50	SPRAGUE	TE-1303	1
CAPACITORS	16/150	SPRAGUE	TVA-1409	1
CAPACITORS	50/25	SPRAGUE	TE-1209	1
CAPACITORS	100/35	SPRAGUE	TE-1211	2
CAPACITORS	160/250	AREOVOX	AFH-1-31-75	1
CAPACITORS	300/6	SPRAGUE	TE-1066	1
CAPACITORS	500/50	SPRAGUE/STT	31D / EG	2
CAPACITORS	2000/6	SPRAGUE	39D	1
CAPACITORS	68pF	ARCO	DM15	1
CAPACITORS	200pF	ARCO	DM15	2



VS 330 CALIBRATION ADJUSTMENTS
+ ZENER REFERENCE TEST POINT

Linearity Adjustments are
inter-dependent and must be
adjusted in sequence.

A2688

TABLE MODEL 330 CALIBRATION

Allow one hour warmup before attempting calibration. Refer to Fig. A2688 for trimpot and zener reference location. MSD refers to most significant digit, 2SD refers to the second most significant digit, etc.

Step	Range Set-ting	Voltage Setting	Test Point	ADJ Test Value	Remarks
1	3V	0	Output	R2 Minimal	Off set ADJUST pot
2	3V	0	Reference Zener	R1 Voltage on tag	Zener Voltage set pot
3	300V	10 on 3sD	Output Terminals	R3 10V	Set R -R7 to midrange before adjusting R3-R4 can be used as fine Adj.
4 5 6	30V 3V 300MV	10 on 3sD 10 on 3sD 10 on 3sD	" " "	R5 1V R6 100MV R7 10MV	These are preliminary adjustments, to test for any gross malfunction.
7 8 9 10 11 12	300V 300V 300V 300V 300V 300V	1 on 2sD 2 on 2sD 4 on 2sD 6 on 2sD 8 on 2sD 10 on 2sD	" " " " " "	R10A 10V R10 20V R11 40V R12 60V R13 80V R14 100V	R10 also adjusts 10V, R10 also adjusts 30V, etc. on steps 7-11 drop 10V lower and readjust trim-pot for optimum compromi value if necessary.
13	300V	10 on 2sD &1 on MSD	"	R8 200V	
14	300V	10 on 2sD &2 on MSD	"	R9 300V	
15	30V	10 on 2sD &2 on MSD	"	R5 30V	
16	3V	10 on 2sD &2 on MSD	"	R6 3V	
17	300MV	10 on 2sD &2 on MSD	"	R7 300MV	

MODEL 330

EXPLANATION OF TEST POINTS

A - Zener reference voltage, nominally +6.3V with respect to ground.

B - High quality or signal ground

C - By measuring the voltage between A & C, and computing $i = \frac{V}{100}$ the current flowing out of the zener reference supply may be determined

D - Chopper output of operational amplifier

E - Output of operational amplifier

F - Output of intermediate amplifier

G - Output of final output amplifier

EP - Error point of operational amplifier

TABLE 6.3.0 MODEL 330 CALIBRATION

Allow one hour warmup before attempting calibration. Refer to Fig. A2688 for trimpot and test point location. MSD refers to most significant digit, 2SD refers to second most significant digit, etc.

Step	Range Setting	Voltage Setting	Test Point	ADJ Test Value	Remarks
1	3V	0	Reference Zener	R1 Voltage on tag	Zener Voltage set pot
2	3V	0	Output Terminals	R2 Minimal	Off set ADJUST pot
2A	3V	0	Between the black terminals Polarity set to minus out	R2A Minimal	Disconnect sense links before adjusting R2A, Reconnect after adjustment.
3	300V	10 on 3sD	output terminals	R3,R4 10V *	Set R4-R7 to mid-range before adjusting R3,R4 can be used as fine adj
4 5 6	30V 3V 300MV	10 on 3sD 10 on 3sD 10 on 3sD	" " "	R5 1V R6 100MV R7 10MV	These are preliminary adjustments, to test for any gross malfunction.
7 8 9 10 11 12	300V 300V 300V 300V 300V 300V	2 on 2sD 1 on 2sD 4 on 2sD 6 on 2sD 8 on 2sD 10 on 2sD	" " " " " "	R10 20V R10A 10V R11 40V R12 60V R13 80V R14 100V	R10 also adjusts 10 R11 also adjusts 30 etc. on steps 7-11 drop 10V lower and readjust trimpot for optimum compromise value if necessary.
13	300V	10 on 2sD &1 on MSD	"	R8 200V	
14	300V	10 on 2sD &2 on MSD	"	R9 300V	
15	30V	10 on 2sD &2 on MSD	"	R5 30V	
16	3V	10 on 2sD &2 on MSD	"	R6 3V	
17	300MV	10 on 2sD	"	R7 300MV	

*R3 Eliminated & replaced with fixed value in some units

MODEL 330
EXPLANATION OF TEST POINTS

A - Zener reference voltage, nominally +6.3V with respect to ground.

B - High quality or signal ground

C - By measuring the voltage between A & C, and computing $i = \frac{V}{100}$ the current flowing out of the zener reference supply may be determined

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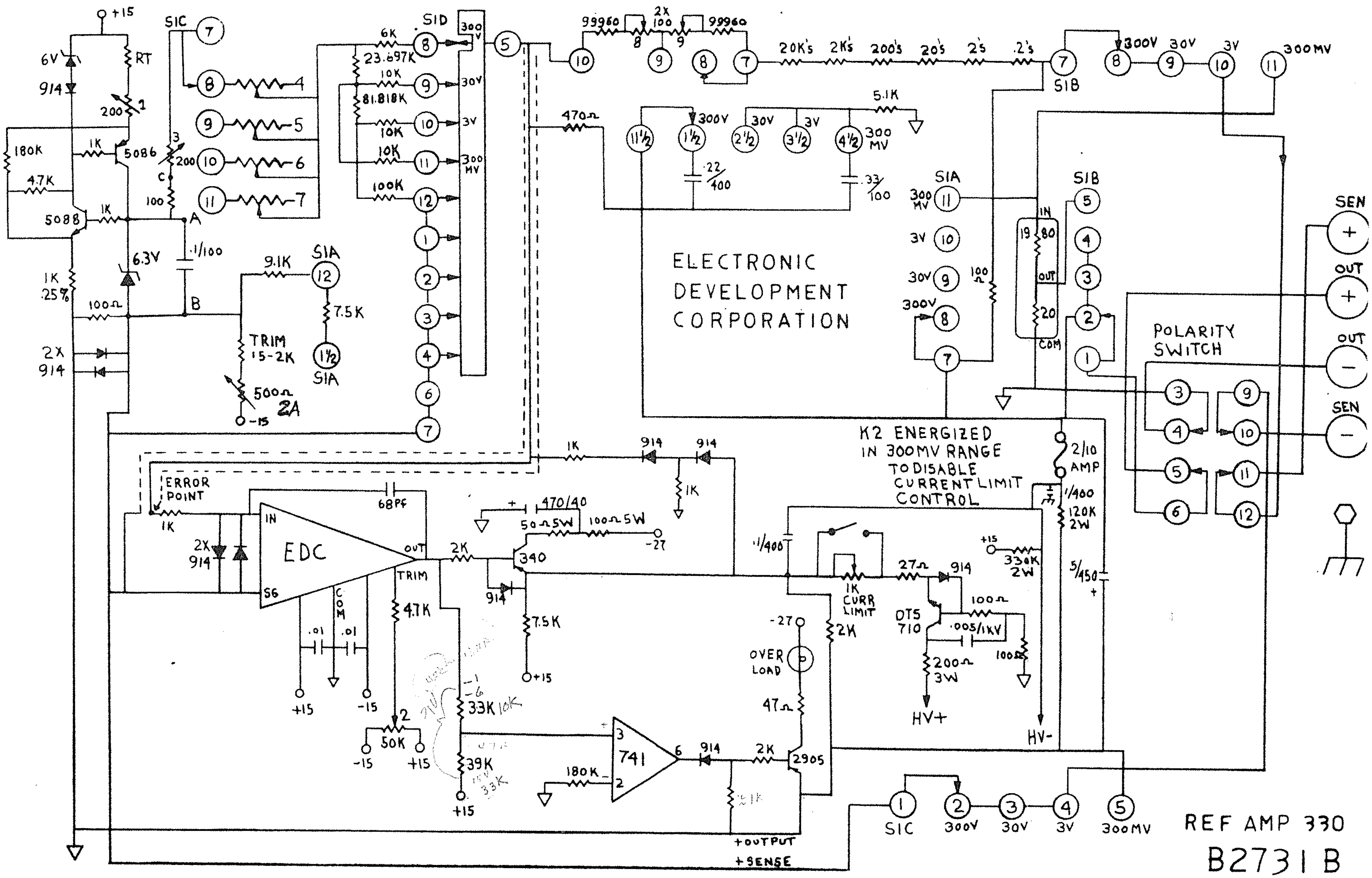

REF AMP 330

B2731B

1980 AND BEFORE

Early Master
~ 1979