AC VTVM and AMPLIFIER

MODEL

250

INSTRUCTION

MANUAL

ELECTRONIC INSTRUMENT CO. INC.
3300 NOSTRAND BLVD., L. I. CITY 1, N. Y.

AC VTVM and AMPLIFIER

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FIGURES

ELECTRONIC INSTRUMENT CO., INC.
33-00 NORTHERN BLVD., L.I.C. 1, N.Y.

EICO 250

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INSTRUCTION BOOK

SECTION I. GENERAL DESCRIPTION AND SPECIFICATIONS

1-1. GENERAL DESCRIPTION

The Model 250 is a high sensitivity, wide-band AC VTVM & AMPLIFIER of laboratory accuracy and quality. It measures AC voltage from 100 microvolts to 300 volts in 12 ranges. A function selector switch on the panel converts the instrument to a wide-band amplifier with a gain of 60db on the 1mv range, and a maximum output of 5 volts RMS.

The instrument responds to the average value of the applied wave and reads in RMS value of a sine wave. The 0-1, 0-3 voltage scales are linear. The decibel scale is based on 0db = 1mw in 600 ohms, with 10 db interval between ranges.

1-2. FEATURES

1. Frame-grid triode cathode follower input circuit; frequency-compensated input attenuator, and cathode circuit attenuator.

2. Use of high-gain frame-grid pentodes permits fewer amplifier stages for less phase shift and greater stability.

3. Two-stage R-C coupled amplifier, and full-bridge meter circuit in one overall feedback loop.

4. Single sensitivity adjust.

5. No response adjustment required in amplifier circuit.

6. Regulated power supply.

7. DC-biased filaments and hum-adjust pot.

1-3. SPECIFICATIONS

Voltmeter
Voltage Ranges: 1, 3, 10, 30, 100, 300 RMS millivolts.
1, 3, 10, 30, 100, 300 RMS volts.
Decibel Range: -80 to +52db, in 12 ranges
Frequency Response: ±0db 10c to 600kc
Input Impedance: 10 megohms shunted by 15mmf
Accuracy: ±3% of full scale
Amplifier
Max. Output Voltage: 5 RMS volts
Max. Gain (1mv Range): 60db
Frequency Response: +0, -3db 8c to 800kc
Maximum Hum & Noise: -40db with input signals above 2mv
Input Impedance: 10 megohms shunted by 15mmf
Output Impedance: 5K ohms
Tube Complement: 2-6EJ7/EF184 frame-grid pentodes, 1-6FY5/EC97 frame grid triode, 1-6X4 full-wave rectifier, 1-OA2 voltage regulator
Power Requirements: 105-125 VAC, 60/50c; 15 watts drain
Size (HWD): 8 1/2" x 5 3/4" x 7"
Weight: 7 lbs.

SECTION II. OPERATING INSTRUCTIONS

2-1. CONTROLS AND TERMINALS

RANGE switch

Provides selection from 12 ranges, 1mv to 300v full scale. The db value given at each range position on the dial is the correction factor for dbm readings.

AMP-VTVM switch

Selects either amplifier or vtvm operation of the instrument.

INput terminals

The left pair of binding posts on the panel are the input terminals both for voltage measurement and for use of the instrument as an amplifier. The binding post designated G, is connected to chassis ground. These binding posts will accomodate a wire, a pin tip, or a banana plug.

OUTput terminals

The right-hand pair of binding posts on the panel are the output terminals of the instrument when it is used as an amplifier (AMP-VTVM switch set at AMP). The binding post designated G, is connected to chassis ground. These binding posts will accomodate a wire, a pin tip, or a banana plug.

OUTPUT CONTROL & AC POWER switch

When the control is turned past maximum counter-clockwise rotation of the pot to OFF, the instrument is disconnected from the a-c power line. Clockwise rotation from OFF, turns the instrument on, as indicated by the pilot lamp. The OUTPUT control is a continuous attenuator at the output of the instrument when it is used as an amplifier (AMP-VTVM switch set at AMP). Maximum output is obtained at 10 on the dial and zero output at 0 on the dial. The setting of the OUTPUT control is not significant in the VTVM function of the instrument, except that it must be turned clockwise from OFF.

CAUTION

The blocking capacitor in the input circuit of the instrument is rated at 600 volts. This means that the sum of the dc voltage and the peak value of the AC voltage applied to the input of the instrument must not exceed 600 volts. Higher voltage will result in breakdown of the input circuit capacitor.

FUSE

An extractor post fuseholder on the rear apron contains a cartridge fuse in the primary circuit of the power transformer. This fuse is a standard type, rated 1/2 ampere.

Figure 2-1. Front Panel Controls and Terminals

2-2. OPERATION

VENTILATION

Adequate ventilation is necessary for proper operation of the instrument and to avoid the possibility of heat damage. Perforations on the case permit convective movement of air through the unit to remove the heat generated by tubes and other components. The air movement consists of cool air drawn through the bottom of the case being heated and escaping through the rear. Take sensible measures to avoid impeding the required air flow.

NOTES

When the instrument is turned off, the meter pointer should be at zero. If not, see Section 4, paragraph 4-3 "Meter Mechanical Zero Adjust".

On the four lowest ranges of the instrument, the meter pointer will deflect fully to the right-hand stop if the input terminals are not connected to a source. This is an entirely normal effect of stray pick-up voltage on an instrument of such high gain and high input impedance, and in no way affects the accuracy of measurement when the input terminals are connected across a voltage source. The same effect will be observed during measurement on the low ranges, as the test lead is transferred from one test point to another. There is no delcterious affect on the instrument as a result of this phenomenon.

Where voltage is being measured across a high-impedance source, it is possible that hum pick-up can affect the reading. In this case, shielded leads will minimize pick-up, but attention must be given to the added shunt capacity, which in some cases may excessively load or detune the source circuit.

The instrument responds to the average value of the wave, but reads in RMS value of a sine wave. Non-sinusoidal waveforms will not be read accurately. Distortion in a sine wave will affect reading accuracy, but distortion must be quite severe before accuracy is significantly affected, i.e., 20% 2nd harmonic distortion will cause readings up to 2% low, 50% up to 10% low; 10% 3rd harmonic distortion will cause readings up to 4% high or low, 20% up to 6% high or low. There is no fixed correction because the reading varies with the phase relationship between the fundamental and harmonic frequencies.

The accuracy is stated as a percentage of the full-scale value. This means that better accuracy is obtained when the reading is closer to full-scale. The range intervals are such that voltages more than 1/3mv can always be read on the upper two-thirds of the scale.

CAUTION

Connect the instrument to a 105-125 VAC, 60/50 cycles line only. It will not operate from, nor should it be connected to, a dc line.

a. VOLTAGE MEASUREMENTS

1. Turn the OUTPUT control clockwise from OFF.

2. Set the RANGE switch to the appropriate range for the anticipated voltage value to be measured. Always use a higher range, if there is any doubt, to avoid overloading the meter.

3. Set the AMP-VTVM switch to VTVM. Allow a 5-minute warmup to attain stable operation.

4. Connect leads from the INput binding posts across the voltage being measured. The G binding post lead should be connected to the low or ground side of the voltage source.

CAUTION

When measuring line voltage, there is a 50% chance that the instrument chassis will be connected to the "hot" side of the line. This can be dangerous and due caution should be exercised.

5. There are two voltage (V) scales, 0-1 and 0-3. The scale to be read depends on the range used: if the setting on the RANGE dial contains the integer "1", read the 0-1 scale; if the setting contains the integer "3", read the 0-3 scale. Before the scale can be read, the value of a full-scale reading must be known. This is also given by the setting on the RANGE dial.

b. VOLTAGE RATIO/POWER RATIO DB READINGS

The difference between two voltmeter readings can be read as a difference between two decibel scale readings. This difference in db is a measure of the ratio of the two voltages. The two measurements can be taken across different impedances without affecting the validity of the difference reading for measuring pure voltage ratio (not power).

If the load impedance is the same for both readings, than the difference on the decibel scale is a measure of power ratio, as well as voltage ratio.

Since db readings are difference readings, one need only know that there is a 10db intsrval between ranges. For example, if the second reading is made on the next higher voltage range, you must add 10db to the second scale reading before subtracting the first from the second reading to determine the db difference.

EXAMPLE

First Reading: +1db on the 3V range
Second Reading: -5db on the 10V range

To find the difference, the second reading must be corrected for being read on the next higher range than the first reading. This correction is +10db. Therefore the difference between the second and first readings is

$$(-5db + 10db) - 1db = 4db$$

c. DBM READINGS WITH VOLTMETER

NOTE: A dbm value is the logarithm of the ratio of an absolute power level to a fixed reference

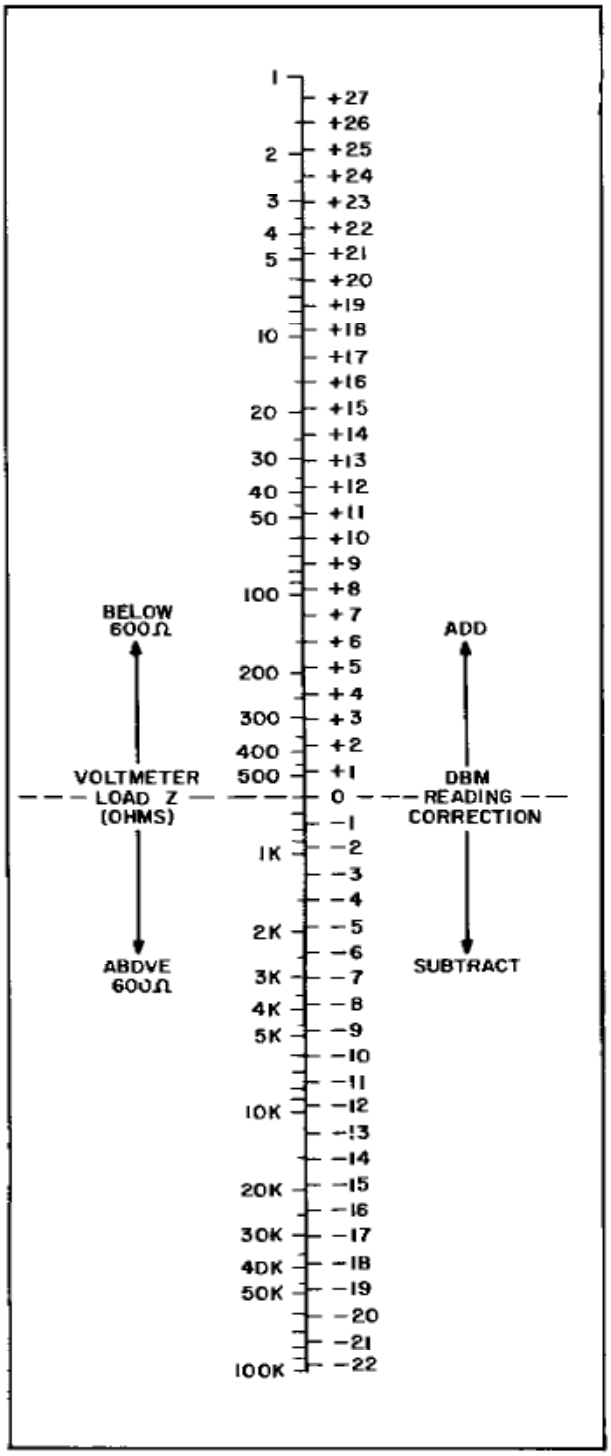


Figure 2-2. Nomograph of DB Connections vs. Load Impedance for DBM Readings in Voltmeter Operation.

power level. As such, it is directly convertible into power. See Fig. 2-3.

The decibel scale is drawn on the basis of a 600 ohm load impedance, and a zero voltage reference level of 0.775 volt*. This scale reads directly in dbm on the 1V range when the load impedance is 600 ohms. On other ranges, 10db per range must be added or subtracted for each range above or below the 1V range. the cumulative correction is given by the inner circle of numerals on the RANGE dial for each range position. With other impedances, a correction must be added or subtracted according to the graph of Fig. 2-2. This facility is valuable when it is required to make absolute power measurements in loads of any impedance in either dbm or watts. To convert dbm values into milliwatts, refer to the table of Milliwatts vs. DBM, Fig. 2-3.

*Constituting a power reference level of $(0.775)^2/600 = 1mw$

EXAMPLE

With a load impedance of 200 ohms, a scale reading of -6dbm is obtained on the 10V range. As the 10V range is two ranges above the 1V range, ±20db must be added to the readings as follows:

-6dbm +20db = 14dbm

Milliwatts	Level dbm	Milliwatts
1.000	−0+	1.000
.794 3	1	1.259
.631 0	2	1.585
.501 2	3	1.995
.398 1	4	2.512
.316 2	5	3.162
.251 2	6	3.981
.199 5	7	5.012
.158 5	8	6.310
.125 9	9	7.943
.100 0	10	10.000
.079 43	11	12.59
.063 10	12	15.85
.050 12	13	19.95
.039 81	14	25.12
.031 62	15	31.62
.025 12	16	39.81
.019 95	17	50.12
.015 85	18	63.10
.012 59	19	79.43
.010 00	20	100.00
.003 16	25	316.2
.001 00	30	1.000W
.000 316	35	3.162W
.000 100	40	10.00W
3.16×10^{-5}	45	31.62W
1.00×10^{-5}	50	100W
3.16×10^{-6}	55	316.2W
1.00×10^{-6}	60	1 000W
3.16×10^{-7}	65	3 162W
1.00×10^{-7}	70	10 000W
3.16×10^{-8}	75	31 620W
1.00×10^{-8}	80	100 000W

Figure 2-3. Table of Milliwatts vs. DBM for Power Readings in Voltmeter Operation

Consulting the graph of Fig. 2-2, we read the correction for 200 ohms load impedance as +5db. Adding in the impedance correction, we obtain the true dbm value:

14dbm +5db = 19dbm

Consulting the table of Fig. 2-3, we find that 19dbm corresponds to a power level of 79.43 mw.

d. AMPLIFIER OPERATION

1. Set up the instrument for voltage measurement and measure the input signal voltage on the lowest possible range.

2. Now set the AMP-VTVM switch to AMP.

3. If the signal voltage read on the upper half of the scale in step 1, maximum amplification without distortion can be obtained by setting the RANGE switch to the next lower range. If the signal voltage read between one-third and one-half scale, maximum amplification without distortion can be achieved by setting the RANGE switch two ranges lower.

4. Connect the OUTput pair of binding posts to the input of the device which is to receive the amplified signal voltage. The input impedance of the device being fed should be not less than 5K ohm.

5. Adjust the OUTPUT control as desired. Maximum output is obtained at 10 on the dial.

SECTION III. CIRCUIT DESCRIPTION

The block diagram, Fig. 3-1, incorporates a simplified version of the range switching, and details of the signal path in the instrument.

On the lower six ranges, the voltage applied to the INput binding posts is coupled directly to the grid of a cathode follower. On the six higher ranges, the voltage is attenuated 60db (1000:1) by a frequency-compensated attenuator before it is coupled to the cathode follower grid.

In the output circuit of the cathode follower, there is a six-tap voltage divider. Out of this divider, the voltage is fed to a two stage amplifier. The amplifier output is fed to the arm of the AMP-VTVM switch.

At the VTVM position, the amplifier output is fed to a full-wave bridge rectifier with the meter connected as the load.

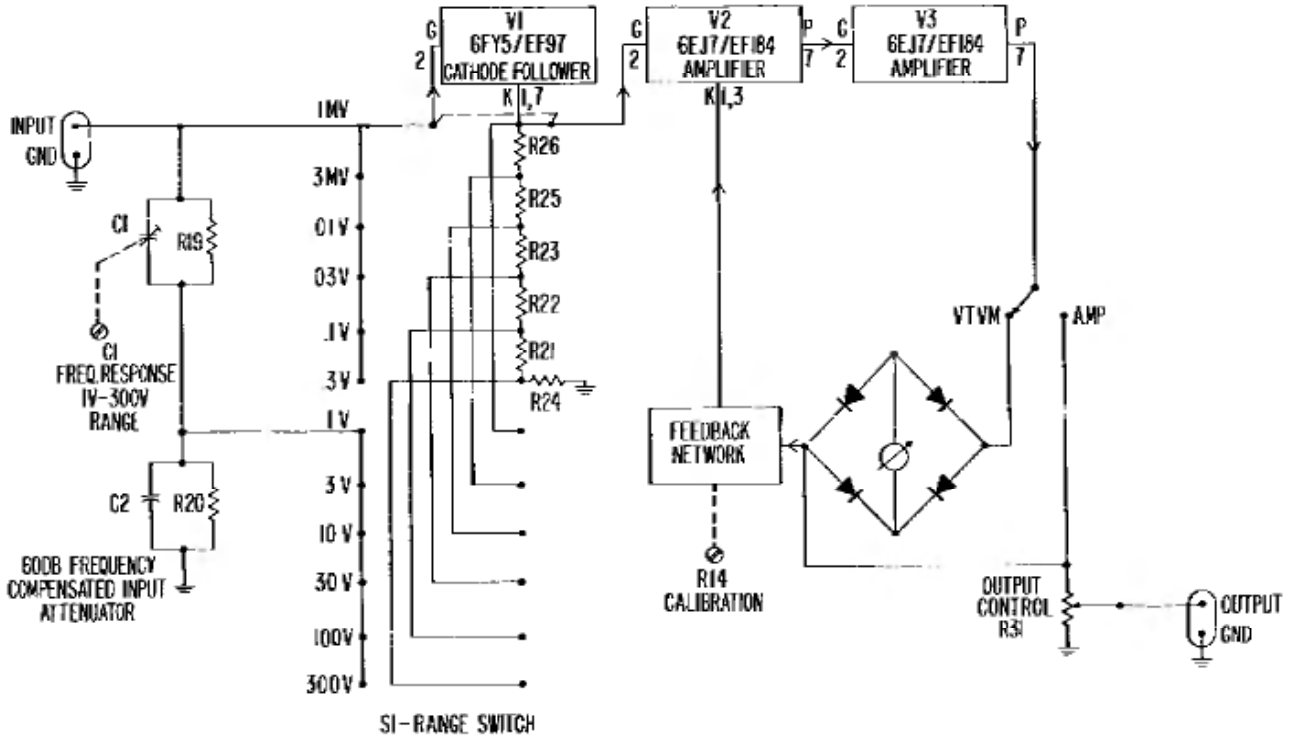


Figure 3-1. Block Diagram

From the opposite side of the bridge, there is a degenerative feedback network back to the cathode of the first amplifier. The calibration control is incorporated in the feedback network.

At the AMP position, the amplifier output is fed through the OUTPUT control to the OUTput binding posts, and the meter-rectifier circuit is by-passed.

The power supply incorporates a full-wave tube rectifier, a pi-type RC filter, and a voltage regulator tube that provides regulated B+ voltage for all stages. A hum balance potentiometer is connected across the filament winding. The B+ voltage is applied, through a voltage divider, to the arm of the hum-balance potentiometer, in order to provide dc bias for the tube filaments valuable for suppressing hum arising from cathode-heater leakage. An electrolytic capacitor provides the necessary a-c ground return.

SECTION IV. MAINTENANCE

4-1. GENERAL

Your instrument will normally require little service outside of tube replacement. The performance of the instrument is not dependent on tube selection and all of the types employed are available nationally.

All of the required adjustment procedures are described in this section. Trouble-shooting information is provided also. Operating voltages and transformer winding resistances are shown on the schematic diagram. In reading the schematic diagram, it may be found helpful to refer to the Block Diagram Fig. 3-1, which includes a simplified presentation of the switching.

4-2. CASE REMOVAL

Loosen and remove the two sheet metal screws at the rear. Slide the case out of the panel frame and off the instrument.

4-3. METER MECHANICAL ZERO ADJUST & HUM BALANCE ADJUST

With the case removed, set the RANGE switch at 1MV, and turn the instrument on. With the INPUT terminals shorted, adjust hum balance control R5 for minimum deflection of the meter pointer.

4-4. ATTENUATOR FREQUENCY COMPENSATION ADJUST

Trimmer capacitor C1, fixed capacitor C2, and resistors R19 and R20 comprise a 60db (1000:1) attenuator. Trimmer C1 must be adjusted by the following method so that the voltage division will be constant throughout the frequency range of the instrument.

To make the adjustment, the case must be removed. The trimmer C2 adjustment is accessible through a hole in the shield over the range switch on the left side of the instrument. (See Fig. 4-1).

Set the AMP-VTVM switch at VTVM and the RANGE switch at .3V. Connect an audio generator to the INput binding posts, and set the generator frequency to 600kc. Adjust the generator output for a reading of .3 volt (full-scale) on the 250 meter. Then set the RANGE switch at 1V, and adjust trimmer C1, with an alignment tool, for a reading of exactly .3 volt on the 1V range. This completes the frequency compensation adjustment.

4-5. CALIBRATION ADJUST

Potentiometer R14 in the amplifier feedback loop is provided for calibration adjustment of the instrument. The AC power line voltage is used as a known voltage for the adjustment. If possible, use a known accurate instrument to measure the line voltage accurately at the time of calibration.

To make the adjustment, remove the plug button on the left side of the case. The shaft of the calibration control, R14, is accessible through this hole. The control has a slotted shaft to permit screwdriver adjustment. (The control located in Fig. 4-1.)

Set the AMP-VTVM switch at VTVM, and the RANGE switch at 300V. Connect leads from the INput binding posts across the AC power line. Keep in mind that there is a 50% chance of the instrument chassis being connected to the "hot" side of the line, and exercise due caution. As stated previously, check the line voltage with a known accurate instrument, if possible. Now set the calibration control R14 so that the meter reads either the measured value of the line voltage or the nominal value of the line voltage if no accurate measurement is possible. This completes the calibration adjustment.

4-6. SERVICE POLICY

SERVICE CONSULTATION

If you are experiencing trouble that you cannot diagnose yourself, you are invited to avail yourself of the EICO Service Consultation Department. The consultant handling your inquiry will make every effort to diagnose the cause of your particular difficulty based on the information that you provide. Please be as thorough as possible. Include the following information about your unit:

a) Have you made a thorough check of the wiring, checking also for cold solder joints, or accidental shorting between parts, or to chassis?

b) Have you checked that the proper tube or transistor is in each socket, and also making proper contact in the socket? Are all shields firmly in place?

c) Does the trouble occur at one time or one operating situation, but not at another time or operating situation? Be as specific as possible in this respect.

d) If the unit is of the type that involves alignment or calibration, be as specific as possible as to what you have done or not done with regard

to these requirements. If the unit incorporates tuned circuits stated to be factory pre-aligned, did you change any settings? If so, what alignment procedure did you use?

e) Have you observed any pecularity about a part? If a part appears charred or otherwise damaged by excessive heat, please say so. If you think you have damaged a particular part in the assembly or wiring, please say so. In conjunction with the symptoms, the consultant may be able to determine whether such a part is likely to be defective.

f) Have you gone through any trouble-shooting procedure that may be provided? If your manual includes a table of contacts made at each switch position, have you checked out the switches accordingly (if the trouble is such that doing this would be appropriate)? Have you been able to make checks of the operating voltages and/or resistances, if this is appropriate, and your manual provides a table of voltages and resistances? What are the results of these checks? Also, have you taken any other trouble-shooting approaches? What have been the results?

In addition, list any code numbers in red under the words INSTRUCTION MANUAL on the cover of the book provided with your unit. If there are no red code numbers, state this specifically. If the unit bears a serial number, it is essential that you include this also.

PARTS REPLACEMENT

If it appears that a component is defective, and you desire a replacement from EICO, address your correspondence to our Customer Service Department.

If you are claiming the right to a no-charge replacement under the terms and conditions of the warranty, it is required that you shall have sent in the registration card within 10 days of the date of purchase, and that you send back the defective part transportation prepaid. EICO will make the necessary replacement at no charge for parts eligible under the terms and conditions of the warranty. In returning tubes, pack them very carefully to avoid breakage in shipment. Broken tubes will not be replaced. Please read the warranty on the subject of parts eligible for replacement.

Further information required on a part returned to the factory for a no-charge replacement under the terms and conditions of the warranty is as follows:

a) Model number and serial number, if any, of unit. Also any code numbers in red under the words INSTRUCTION MANUAL on the cover of the book supplied with the unit.

b) Stock number and description of part as given on the parts list.

c) Describe as completely as possible the nature

of the defect, or your reason for requiring replacement.

FACTORY REPAIR SERVICE

EICO maintains a Factory Repair Service Department for in-warranty or out-of-warranty repair of EICO equipment. It is intended to serve those customers who are not adequately familiar with electronics to make use of the EICO Service Consultation facilities, or whose difficulties cannot be solved by correspondence.

For all out-of-warranty units, there is a minimum labor and handling fee. For the Model No. 250, this fee is $7.00. Charges for components replaced are additional to the minimum fee.

For in-warranty completed kit units, there is a minimum labor and handling fee. For the Model No. 250, this fee is $7.00. There is no charge for a replaced defective part provided that the terms and conditions of the warranty for no charge replacement are not violated in the judgement of EICO.

For in-warranty factory-wired units, there is no labor and handling fee if the unit complies with the terms and conditions of the warranty in the judgement of EICO. However, if the terms and conditions of the warranty are violated, then there will be charged to customer a minimum labor and handling fee plus the cost of parts replaced.

In all cases, the unit must be sent to the factory transportation prepaid, and the unit will be returned to the customer transportation collect.

The services rendered for the minimum labor and handling fee are the correction of any minor wiring errors (not extensive corrections or re-wiring), the labor involved in replacing defective parts, and any adjustments, alignment, or calibration procedures that would normally be performed on a factory-wired unit. Units not wired according to instructions, or modified in any way, or showing evidence of the use of acid core solder, will not be serviced and will be returned to the customer forthwith.

Units requiring extensive corrections or re-wiring will incur an additional labor charge which will be set by EICO. The customer will be informed of this situation and written authorization from the customer will be required before the work is done.

Please note: minimum labor and handling fees are subject to revision at any time.

LOCAL REPAIR FACILITIES

Out-of-warranty repair work may also be performed by authorized service stations as well as the EICO factory. A list of authorized service stations is provided with this manual. The roster of stations may change from time to time, and if considerable time has elapsed since you purchased your unit, you are advised to contact the station you choose before sending the unit to them for repair. Use of a local service station will often result in faster service, and, usually, lower transportation costs.

It is necessary that you comply with the Shipping Instructions that follow when sending in a unit for service.

SHIPPING INSTRUCTIONS

You are strongly advised to retain the original shipping carton and inserts in the case that re-shipment is required for service or any other purpose. The carton may be collapsed, for storage in as small a space as possible. In very many cases, the same carton is used for kit and factory-wired units so that the kit carton will werve for re-shipment of the completed kit.

To submit a unit for service, either to the factory or an authorized service station,* fill out completely the Service Work Order form provided with the manual. Pack the unit very carefully, preferably in the original shipping carton with the original inserts.

If this is not possible, use a strong oversize carton, preferably wood, allowing at least 3 inches of resilient packing material such as shredded paper or excelsior, to be inserted between all sides of the unit and the carton. Seal the carton with strong gummed paper tape or strong twine, or both. Include the Service Work Order in the carton and in addition, attach a tag to the instrument on which is printed your name and address and brief reference to the trouble experienced. Affix "FRAGILE" or "HANDLE WITH CARE" labels to at least four sides of the carton, or print these words large and clear with a bright color crayon. Ship by prepaid Railway Express or parcel post to:

Electronic Instrument Co., Inc.
33-00 Northern Blvd.
Long Island City 1, New York
Attention: Service Department

Include your name and address on the outside of the carton. Return shipment will be made transportation charges collect. Note that a carrier cannot be held liable for damages in transit, if packing, IN HIS OPINION, is insufficient.

*Authorized service stations are for out-of-warranty units only, unless the station is specifically noted on the List of Authorized Service Stations to be authorized for other work.

THE EICO WARRANTY

The Electronic Instrument Company, Inc., hereafter referred to as EICO, warrants that, for a period of 90 days from the date of purchase, any EICO kit will be free of defects in parts, and that any EICO factory-wired unit will be free of defects in parts and workmanship. For an EICO kit, EICO's obligation is limited to those parts which are returned transportation prepaid to the factory without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use. For an EICO factory-wired unit, EICO's obligation is limited to those parts, sections, or the entire unit which is returned transportation prepaid to the factory without further damage, and in the judgement of EICO are either originally defective or have become defective in normal use.

The warranty does not apply to any parts damaged in the course of handling, assembling, or wiring by the customer, or damaged due to abnormal usage or in violation of instructions or reasonable practice, or further damaged to a consequential degree in return shipment. Furthermore, the foregoing warranty is made only to the original customer, and is and shall be in lieu of all other warranties, whether expressed or implied, and of all other obligations or liabilities on the part of EICO, and in no event shall EICO be liable for any anticipated profits, consequential damages, loss of time, or other losses incurred by the customer in connection with the purchase or operation of EICO products or components thereof.

The registration card, which accompanies each EICO kit or factory-wired unit, must be filled in and returned to the company within 10 days after the date of purchase. This warranty applies only to registered units.

4-7. TROUBLE SHOOTING CHART

SYMPTOM	POSSIBLE CAUSE & REPAIR PROCEDURE
Instrument inoperative; pilot lamp does not glow	Blown fuse (replace): defective line cord/defective on-off switch S3 (check for T1 pri resistance through line cord plug with OUTPUT control turned clockwise from OFF); defective B+ supply (check T1 h.v. sec. resistance, rectifier V4, capacitor C5, or B+ short or break).
Instrument inoperative; pilot lamp does glow	Break or short in signal path or feedback path around amplifier. See Block Diagram Fig. 3-1. Check operation as voltmeter first, then as amplifier. If former o.k. and latter not, then trouble lies in circuitry associated with R30,R31,S2.
Non-linear reading of meter scale	One or more diodes CR1, CR2, CR3, CR4 defective (replace).
Meter pointer vibrates at low frequencies	Capacitor C12 defective.
Meter reads incorrectly at low frequencies	Check capacitors C4, C7, C9, C10, and C13

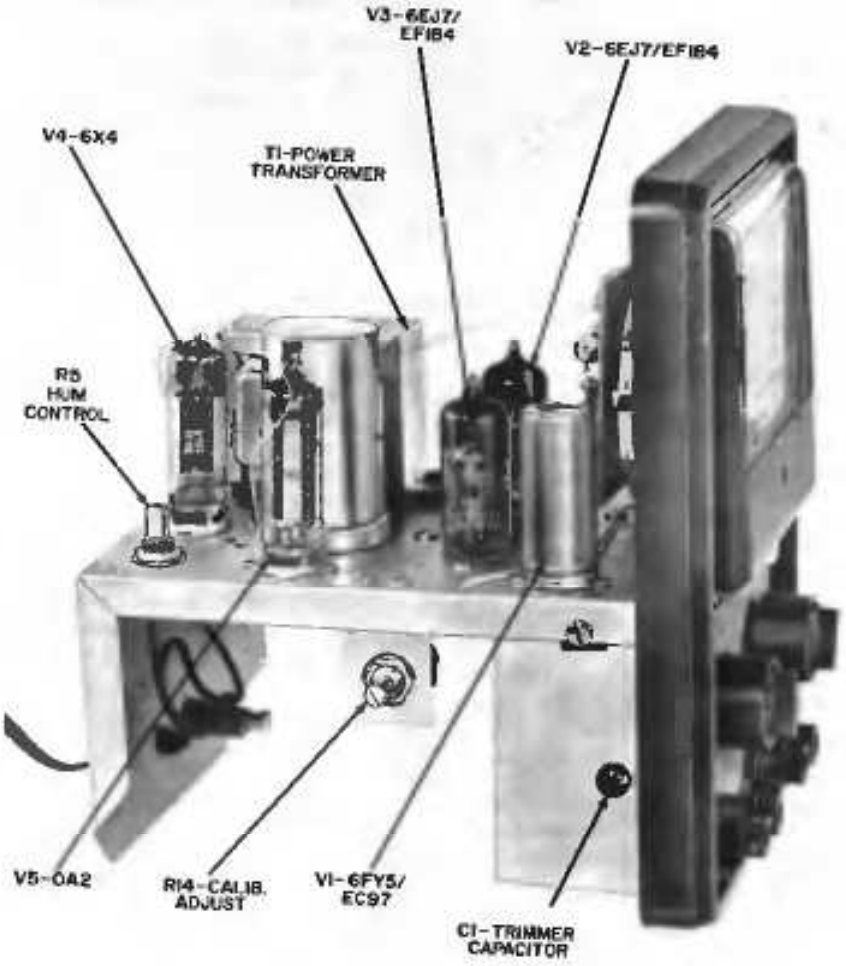


Figure 4-1. Top Chassis View

SECTION V. REPLACEMENT PARTS LIST

SYM.#	STOCK#	AM'T.	DESCRIPTION
C1	29512	1	capacitor, trimmer, 4-22mmf
C2	22505	1	capacitor, disc, .01mfd (10K or 10,000mmf) GMV
C3	20008	1	capacitor, paper, .02mfd, 400V
C4	23025	1	capacitor, elec., 40mfd, 10V
C5	24018	1	capacitor, elec., 40mfd +3 x 20mfd, 300V
C6	23025	1	capacitor, elec., 40mfd, 10V
C7	23044	1	capacitor, elec., 300mfd, 3V
C8	23009	1	capacitor, elec., 2 x 20mfd, 150V
C9	20050	1	capacitor, paper, .25mfd, 200V
C10	23046	1	capacitor, elec., 150mfd, 3V
C11	22530	1	capacitor, disc, .006mfd (6K or 6000mmf), 10%
C12	23023	1	capacitor, elec., 100mfd, 12V
C13	20056	1	capacitor, paper, 1mfd, 200V
CR1,2,3,4	95005	4	diode, crystal
F1	91007	1	fuse, .5 Amp
I1	97715	1	indicator, neon
J1, 2, 3, 4	52006	4	binding post
M1	72011	1	meter, 200uA
R1	10435	1	resistor, 150K ohm, 1/2W, 10% (brown,green,yellow,silver)
R2	10430	1	resistor, 4700 ohm, 1/2W, 10% (yellow,violet,red,silver)
R3	10961	1	resistor, 1500 ohm, 2W, 10% (brown,green,red,silver)
R4	10950	1	resistor, 2200 ohm, 2W, 10% (red,red,red,silver)
R5	19013	1	potentiometer, 35 ohm
R6	10426	1	resistor, 33K ohm, 1/2W, 10% (orange,orange,orange,silver)
R7	10003	1	resistor, 100 ohm, 1/2W, 20% (brown,black,brown)
R8	10450	1	resistor, 3900 ohm, 1/2W, 10% (orange,white,red,silver)
R9	10428	1	resistor, 47K ohm, 1/2W, 10% (yellow,violet,orange,silver)
R10	10852	1	resistor, 15K ohm, 1W, 10% (brown,green,orange,silver)
R11	10441	1	resistor, 150 ohm, 1/2W, 10% (brown,green,brown,silver)
R12	10416	1	resistor, 15K ohm, 1/2W, 10% (brown,green,orange,silver)
R13	10856	1	resistor, 3300 ohm, 1W, 10% (orange,orange,red,silver)
R14	16013	1	potentiometer, 200 ohm
R15	10030	1	resistor, 1M ohm,-1/2W, 20% (brown,black,green)
R16	10851	1	resistor, 22K ohm, 1W, 10% (red,red,orange,silver)
R17	10527	1	resistor, 130 ohm, 1/2W, 5% (brown,orange,brown,gold)
R18	10424	1	resistor, 22K ohm, 1/2W, 10% (red,red,orange,silver)
R19	11708	1	resistor, 10M ohm, 1W, 1%
R20	11051	1	resistor, 10K ohm, 1W, 1%
R21	11073	1	resistor, 68.38 ohm, 1/2W, 1%
R22	11072	1	resistor, 216.2 ohm, 1/2W, 1%
R23	11071	1	resistor, 683.8 ohm, 1/2W, 1%
R24	11074	1	resistor, 31.62 ohm, 1/2W, 1%
R25	11070	1	resistor, 2162 ohm, 1/2W, 1%
R26	11069	1	resistor, 6838 ohm, 1/2W, 1%
R27	10454	1	resistor, 10 ohm, 1/2W, 10% (brown,black,black,silver)
R28	10462	1	resistor, 15 ohm, 1/2W, 10% (brown,green,black,silver)
R29	10432	1	resistor, 1000 ohm, 1/2W, 10% (brown,black,red,silver)
R30	10449	1	resistor, 5.6K, 1/2W, 10% (green,blue,orange,silver)
R31	18005	1	pot., 10K, SPST
S1	60094	1	switch, rotary
S2		1	switch, part of R31
S3	62017	1	switch, toggle, SPST
T1	30053	1	transformer, power
TB1,2	54007	2	terminal strip, 3 Post, 2 right with ground
TB3	54006	1	terminal strip, 3 Post, 2 right
TB4	54008	1	terminal strip, 4 Post
TB5	54003	1	terminal strip, 2 Post
TB6	54013	1	terminal strip, 1 Post, left, with ground
TB7	54007	1	terminal strip, 3 Post, 2 right with ground
TB8	82500	1	terminal board

REPLACEMENT PARTS LIST (CONT'D,)

SYM.#	STOCK#	AM'T.	DESCRIPTION
V1	90072	1	tube, EF97/6FY5 (6GK5 direct replacement)
V2,3	90075	2	tube, EF184/6EJ7
V4	90036	1	tube, 6X4
V5	90074	1	tube, OA2
XF1	97805	1	fuseholder, black
XV1	97047	1	socket, 7 pin miniature, with shield support
XV2,3	97025	2	socket, 9 pin miniature, bottom mount
XV4,5	97062	2	socket, 7 pin miniature, top mount
	40000	12	nut, hex, #6-32
	40001	5	nut, hex, 3/8
	40007	12	nut, hex, #4-40
	40012	2	nut, hex, #10-32
	40016	1	nut, hex, 1/2-24
	40019	2	nut, Tinnerman, #6-32
	41047	2	screw, #8 self tapping (P.K.)
	41063	4	screw, #6-32 x 1/4, flat head
	41065	2	screw, #10-32 x 1/2, nylon
	41066	10	screw, #6-32 x 5/16
	41069	10	screw, #6-32 x 3/16, round head
	41090	10	screw, #4-40 x 5/16
	41091	2	screw, #4-40 x 1/4, flat head
	42000	3	washer, lock, 3/8
	42001	4	washer, flat, 3/8
	42002	12	washer, lock, #6
	42004	2	washer, lock, #10
	42005	4	washer, flat, #6
	42007	12	washer, lock, #4
	42029	1	washer, flat, 1/2, rubber
	42511	1	retainer, indicator
	43001	1	lug, 3/8
	43004	4	lug, #8
	43006	3	lug, #4
	46016	4	foot, rubber, grey
	48000	1	button
	53036	2	knob
	56520	2	spring holders for tubes
	57004	1	line cord
	80153	1	panel
	81292	1	chassis
	81295	1	shield
	81914	1	bracket, pot.
	82101	1	strain relief
	82507	1	insulator (transformer), plastic
	86005	1	frame
	87006	1	handle with rings
	46016	1	cabinet
	89246	1	nomenclature label
	89649	2	bracket, handle
	97301	1	shield, tube
	66103	1	instruction manual
	66356	1	construction manual

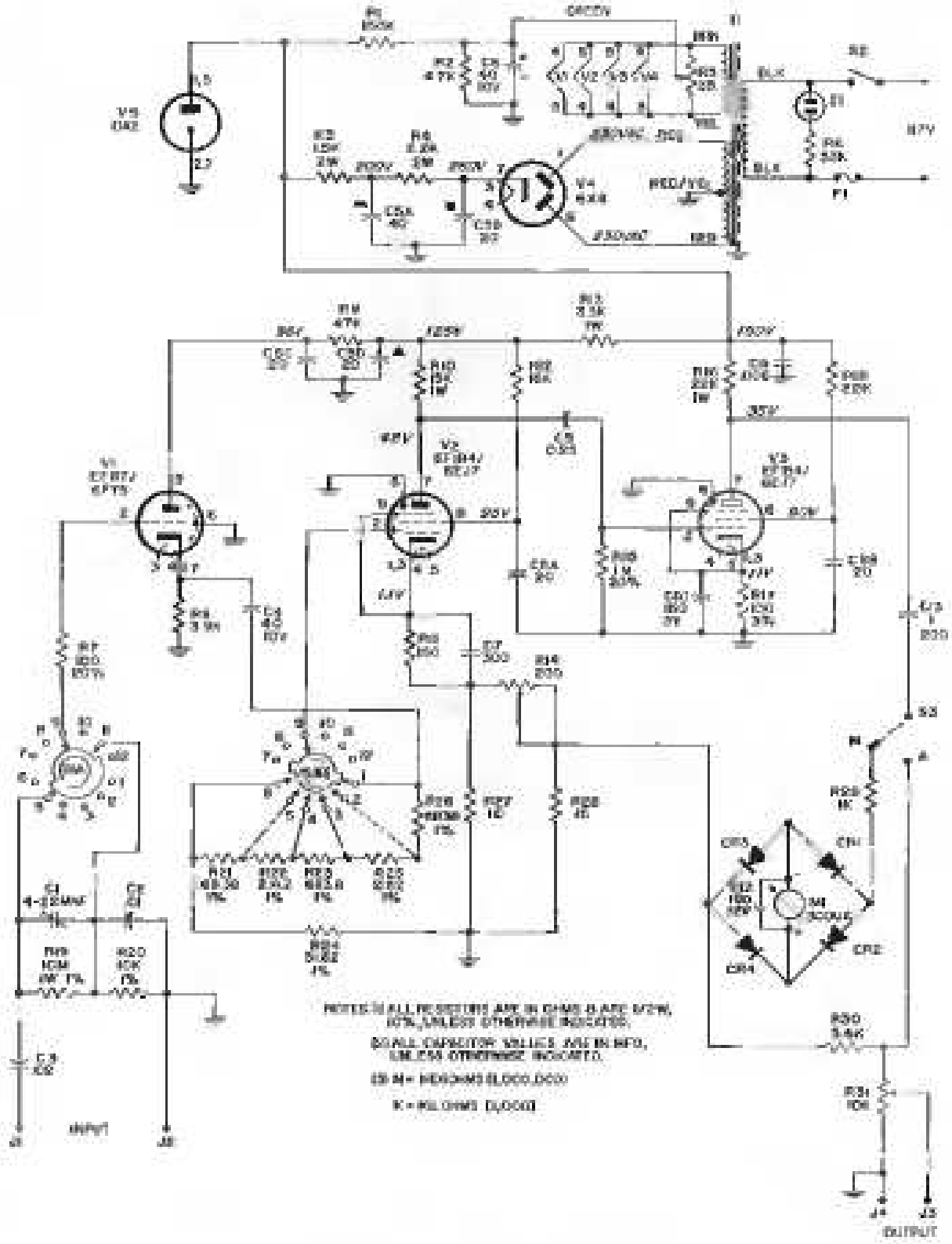
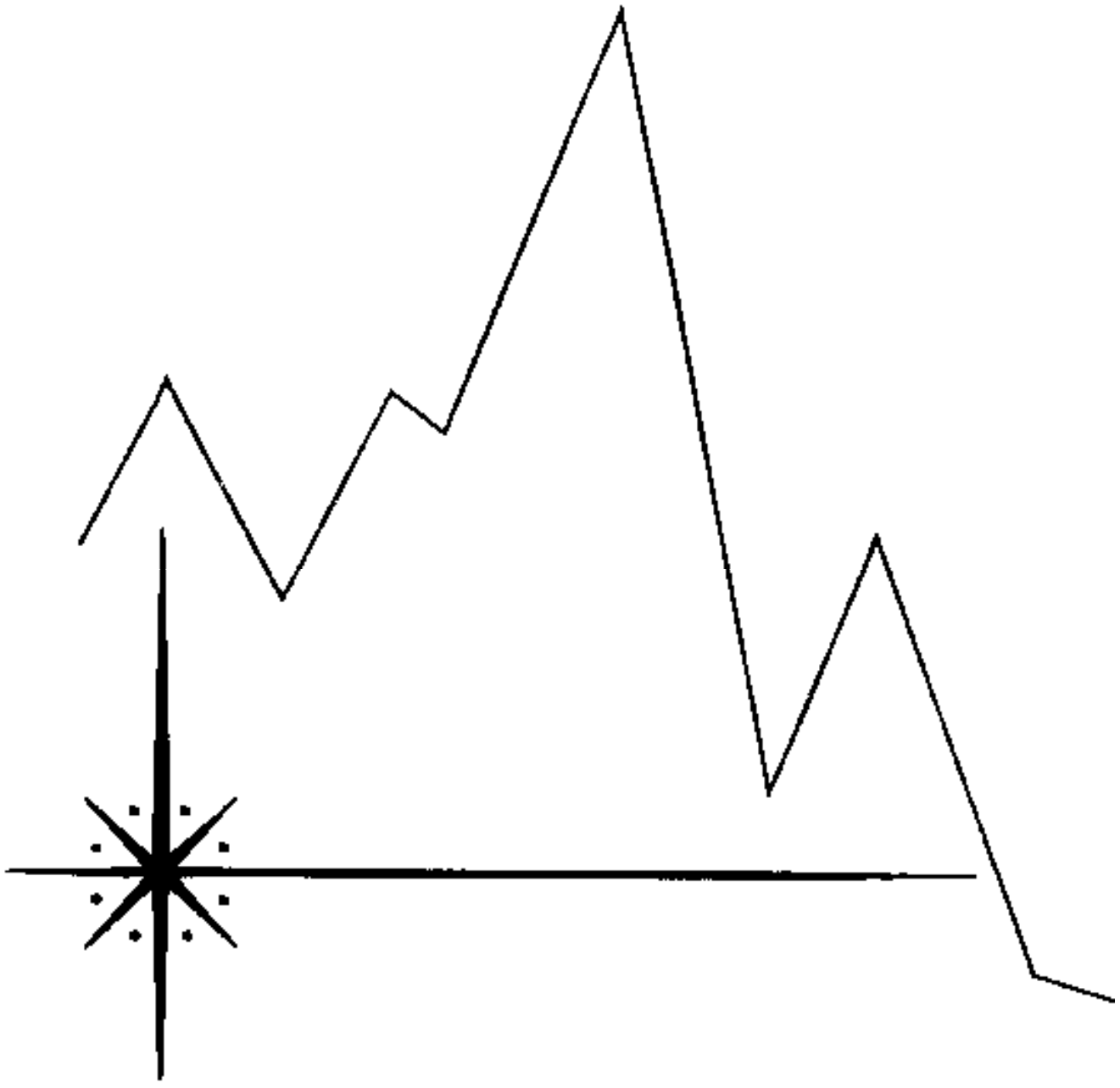


Figure 4-2. 250 Schematic Diagram



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