

INSTRUCTION MANUAL FOR
MODEL 230B STAT-ARC
STATIC ELECTRICITY DETECTOR/MONITOR

Monroe Electronics, Inc.
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Lynconville, New York 14098

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SECTION 1
APPLICATIONS/FEATURES

A. APPLICATIONS:

- - Trouble Shooting Static Problems On Production Lines
- - Safety Monitoring
- - Checking High Voltage D.C. Terminals

B. FEATURES - METER:

- - Ruggedly Built for Industrial Use
- - Uses Readily Available Batteries
- - All Solid State Integrated Circuit Construction
- - Non-Radioactive
- - Stable Operation For Continuous Monitoring
- - Recorder Output
- - Wide Range - to 100 KV

C. FEATURES - PROBE:

- - Small Extendable Probe Can Be Located Up To 28" Away From Meter
- - Permits Measurements Of Otherwise Inaccessible Surfaces
- - May Be Mounted On Operating Machinery And Monitored Remotely for Safety.

SECTION 2
SPECIFICATIONS

A. RANGE:

Full scale range is dependent on probe-to-surface distance. Three meter ranges are provided with full scale ranges as follows:

Probe-to-Surface Distance

| | ON "X 1" RANGE | ON "X 3" RANGE | ON "X 10" RANGE |
|------|----------------|----------------|-----------------|
| @1" | 0 to +/-500V | 0 to +/-1500V | 0 to +/-5000V |
| @12" | 0 to +/- 1500V | 0 to +/-4500V | 0 to +/-15000V |

An additional "X10" range expansion is available with use of a special "snap-on" clip which attaches to the probe. This provides a full scale range of up to 150,000 V at 12" probe-to-surface spacing.

B. Sensitivity:

50 Volts at 1" probe-to-surface spacing.

C. Static Accuracy

Better than 5%.

D. Drift Accuracy:

Less than 50 Volts per hour at 1" probe-to-surface spacing, (non-cumulative under clean operating conditions).

E. Speed-of-Response:

Less than 1/2 second after 10 second warm-up.

F. Recorder Output:

Dependent on probe-to-surface spacing:

| Probe-To-Surface Spacing | Volts out per KV |
|--------------------------|------------------|
| 1" | -1.00 |
| 12" | -0.33 |

When the special "snap-on" clip is used the recorder output is 1/10 of the values given above.

Recorder output load - 10K Ohm minimum

Recorder output connector - G.C. Electronics F2-820 or F2-821.

G. Probe Dimensions:

1 5/8" maximum diameter x 1 5/8" long. Coiled probe cable extends to 28" from meter housing.

H. Size and Weight:

9 1/4" maximum length x 7 3/8" maximum height x 3 1/4" maximum breadth. 2 lbs 13 oz. Aluminum casting.

SECTION 3

OPERATION

A. Probe Mounting:

As supplied, the probe of the Model 230B is mounted in the barrel of the meter housing, and the instrument may be used by pointing the probe at the surface to be measured as though it were a pistol. It is desirable for accurate measurements to keep the surface of the probe parallel with the surface to be measured.

For many applications, it will be desirable to use the small probe remote from the meter. It can be removed from the meter housing barrel by twisting it approximately 1/8 turn counter-clockwise (as far as it will go) and pulling it out. The coiled cable to which it is attached will extend to over 28" from the meter housing. When replacing the probe in the barrel, wind the cable slightly so that its tension will hold the probe in its socket.

IMPORTANT NOTICE

1. THE PROBE SHOULD ALWAYS BE HANDLED AND MOUNTED BY THE UNPLATED PLASTIC PART. THE PLATED METAL PARTS ARE NOT AT GROUND POTENTIAL AND SHOULD NOT BE PERMITTED TO COME INTO CONTACT WITH ANYTHING CONDUCTIVE (INCLUDING FINGERS) DURING THE OPERATION OF THE INSTRUMENT.
2. FOR BEST RESULTS, THE INSTRUMENT SHOULD BE ZEROED WITH THE PROBE IN THE POSITION IN WHICH IT WILL BE USED.

B. Grounding:

For best operation, the Model 230B should be grounded during use. This is accomplished by connecting a clip lead between the grounding screw provided on the instrument and any convenient metal objects terminated in Earth, e.g., water pipes, most metal parts of buildings, etc.

C. On/Off Range Switch:

A four position "power range" switch is used to turn the instrument ON. When the instrument is ON an audible tone can be heard from the probe.

NOTE

Since the instrument uses little power, and since it does have a 10 second warm-up, it is generally all right to leave it ON between measurements if many measurements are to be made within a short period of time

D. Zero Control:

The zero control is provided to null the effect of varying ambient conditions, probe cleanliness, battery condition, etc. The control has a wide range and is stable with time after instrument warm-up.

Position probe at desired operating distance from a large grounded metal surface (or the surface under test if it is convenient to ground that surface). Ground the instrument and energize. After a ten second stabilization period adjust zero control for best zero indication.

E. Meter Calibration:

The instrument is calibrated in volts of surface potential for a given spacing between the probe and the surface being measured. The meter is provided with two separate scales which read directly in surface voltage for 1" and 12" probe-to-surface spacings. Accurate measurements of surface voltages are most easily made with the probe at one of these distances. Additionally, for best accuracy, the surface to be measured should be at least six times as large in its minimum dimension as the probe-to-surface distance used. Appendix I provides calibration curves which permit use of the Model 230B at other probe-to-surface distances and other aspect ratios, e.g., the ratio of the size of the surface being measured to the probe-to-surface distance.

NOTE:

1. Factory calibration is with the probe suspended in front of a large metal plate at 1" probe-to-surface spacing. The presence of the meter and fixtures or a hand holding the probe will alter the calibration since it distorts the electric field.
2. The Model 230B will read less voltage than actually present if:
 - a. Any large grounded conductive object (roller, etc.) is less than several times as far away as the probe-to-surface spacing used. This includes the meter itself and the person holding the meter as well as metal rollers, etc.

- b. Linear dimensions of the surface under test are at minimum less than six times the probe-to-surface distance.

The object being measured must be large compared to the spacing.

F. Recorder Output:

The recorder output is provided to allow continuous monitoring of the static charge accumulation using the Model 230B STAT-ARC. Recorder output voltage per kilovolt of surface potential is dependent on probe-to-surface distance, and is specified at 1" and 12" distances assuming aspect ratios of at least 6 to 1. Calibration at other distances or aspect ratios may be accomplished by referencing the curves in Appendix I.

Output is inverted form of input.

NOTE: It is necessary to use a recorder with an input resistance of at least 10,000 ohms to prevent loading of the output circuitry. Maximum instrument output voltage is 5 volts.

G. Batteries:

1. Test:

Battery testing is accomplished by depressing the + and - pushbuttons located on the instrument panel. The instrument should be OFF. When a button is pressed, the meter should deflect past the red dot, or past 350V on the 1" scale. If either battery does not check "OK", replace both.

2. Battery Replacement:

The screw in the bottom of the handle of the instrument must first be removed. The plug in the handle may now be removed by pushing it out using a pointed object inserted through the screw hole. The batteries may now be pulled out of the handle, unclipped from their holder, and replaced.

NOTE:

Battery types Eveready No. 216, Burgess No. 2V6 or equivalent 9V battery may be used.

3. Life:

Battery life should exceed 8 hours of continuous use; or many more hours of intermittent operation.

H. Snap-On "X-10" Clip:

The clip, furnished with each Model 230B, is an accessory designed to decrease the sensitivity of the instrument and thus increase its range by a factor of 10.

CAUTION:

At 1" spacing, this clip extends the range of the instrument to 50 KV/in. at which spacing breakdown of air is likely to occur causing a potential hazard to the instrument and operator.

Conditions for its use, therefore, should be carefully controlled.

The clip should be carefully fitted over the two socket head capscrews in the probe cap.

The center of the clip at the point where the aperture is found should bear flat against the face of the cap over as much area as possible.

SECTION 4

THEORY

The Model 230B STAT-ARC detects static charge accumulation by measurement of electrostatic field with respect to the essentially grounded probe assembly.

When the probe is brought into proximity with a charged object either conductive or insulating, an electric field is established between them. This field is proportional to the amount of charge present and the geometry with regard to probe-to-surface distance, and object size and shape. The Model 230B STAT-ARC measures the field using a unique "nulling" technique which can be summarized as follows: (Refer to Figure 4-1, Simplified Block Diagram.)

The vibrating sensitive electrode, "senses" the field through the aperture in the probe housing. The A.C. signal induced on this electrode is proportional to its excursion path length and the strength of the field. The polarity of the field determines phase. This signal and a reference signal from the oscillator are fed into a phase sensitive demodulator whose output feeds a D.C. integrating amplifier. The output of this amplifier is used to drive the probe end cap to a potential just sufficient to neutralize the net field at the sensitive electrode. This feedback principle and null-seeking operation make the instrument remarkably stable and highly accurate. Solid state components and integrated circuits are used throughout for reliability.

NOTE:

Although this instrument actually measures electric field (Volts per unit distance) at the probe, the meter is calibrated in terms of volts of surface potential at the measured surface. This calibration technique has been chosen because it is most convenient to the average user; but this type of calibration is very sensitive to geometrical considerations. The Model 230B is factory calibrated using a large, flat metal sheet and the probe suspended outside the meter housing. The calibration would be altered if large grounded objects are near the surface being measured, or if the surface were not essentially flat, or if the surface were not essentially uniformly charged.

In general, these considerations do not present a problem in use, since for any given geometry, the meter indication will be

directly proportional to surface voltage (and charge) and therefore provide excellent accuracy for relative measurements.

For further information concerning electrical field measurements in various geometries refer to:

"The Use Of Electric Field Meters For Precision Measurements" by A. Van Roggen (E. I. DuPont DeNemours and Company, Inc.) presented at the Conference on Electrical Insulation and Dielectric Phenomena, October, 1972.

SECTION 5
MAINTENANCE

Normal maintenance for this instrument should be limited to periodic cleaning and battery replacement. Frequency of cleaning will depend on the cleanliness of the environment in which the instrument is used.

A. Repairs:

In the event of catastrophic failure, the instrument should be returned to the factory for repair.

B. Cleaning:

It is impossible for the aperture in the probe housing to be covered by a window of any sort and continue to operate normally.

So long as this aperture is open, foreign materials may enter the volume associated with the vibrating electrode and generate undesired signals, offset or drift thereby impairing the accuracy and utility of the instrument. For best performance, therefore, it is necessary to periodically clean the probe.

For routine cleaning, it is easiest to use a spray can of some suitable non-residue producing solvent, for example, Freon(R) T-P35* (Catalog #MS-160) or isopropyl alcohol to remove dirt, dust, fingerprints and other contamination. If this technique proves inadequate, it is possible to disassemble the probe for cleaning (although not recommended due to the delicate nature of the internal parts) by removing the two socket head screws holding the end cap in place and carefully removing the cap.

Dry parts in free air or use "canned" air such as MS-220 Aero-Duster(R) * and allow sufficient time (several hours) for the surfaces of the materials to stabilize. Check zero and calibration before attempting to make critical measurements.

DO NOT USE ABRASIVE CLEANERS AND WIPE PARTS ONLY WHEN ABSOLUTELY ESSENTIAL.

* Miller-Stephenson Chem. Co., Inc., Danbury, CT 06810

C. Calibration:

1. Hold Model 230B steadily in its normal operating position (usually horizontal).

2. With instrument OFF turn meter adjusting screw (below center of meter) as required to bring meter needle to exact mid-scale position.
3. Open case and remove electronics:
 - a.) Lay instrument on its left side and remove four large screws which are visible noting the location of each for re-assembly.
 - c.) Hold case halves together and turn case over so that it is lying on its right side.
 - d.) Carefully pull left half of case directly away from right half leaving electronics (attached to panel) in right half of case.
 - e.) Withdraw panel and circuitry far enough from the right case section to gain access to R-101 which is a small round potentiometer mounted on the inside of the output jack.
4. Remove probe from barrel (see "Probe Mounting" and "Important Notes", Section III).
5. Fixture right case section and electronics so that meter is in its normal operating attitude.
6. Remove snap-on "X10" from probe if so equipped.
7. Fixture probe so that it is spaced 1" from a large plane metal surface insulated to at least 5Kv.

The surface of the probe cap should be as nearly parallel to the test surface as practicable.
8. Ground Model 230B and test surface.
9. Switch Model 230B to x10 range and zero instrument after at least a ten second stabilization period.
10. Apply 5000 volts to test surface and adjust R-101 for full-scale reading.
11. Return test surface to ground potential and re-check instrument zero, adjusting if necessary.
12. Repeat steps 10 and 11 until no further changes are noted.
13. Verify calibration of other ranges if desired.
14. Reassemble case.

15. Verify that calibration is within 5%.

NOTE: Calibration accuracy is a direct function of calibrating voltage and care taken in fixturing.

D. Alternate Calibration (for specific geometry):

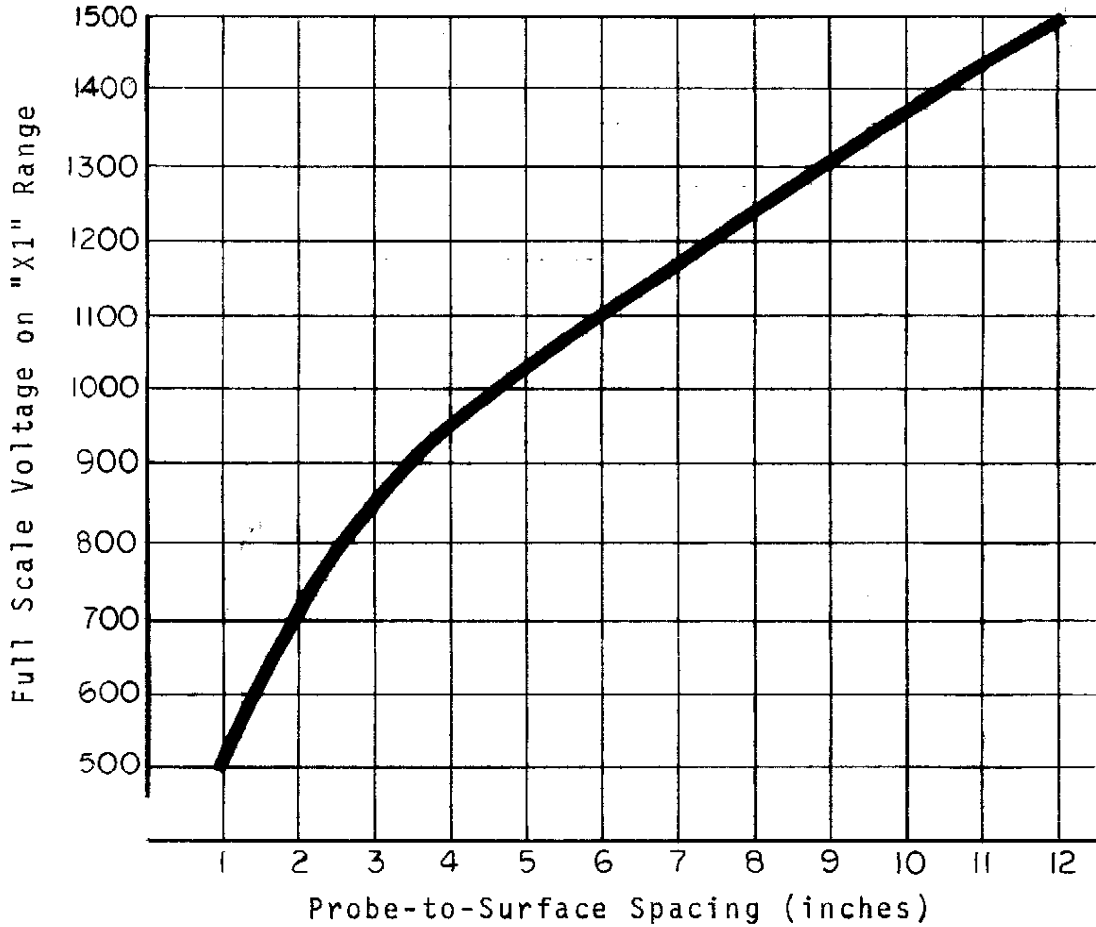
If the Model 230B and/or probe is to be used in a fixed location with fixed probe-to-surface spacing, e.g., inside a machine as a monitor, it is best calibrated in that location.

The procedure is similar to above except that the surface to be measured must be raised to a known potential in order to perform the calibration.

This procedure will better account for field distortion.

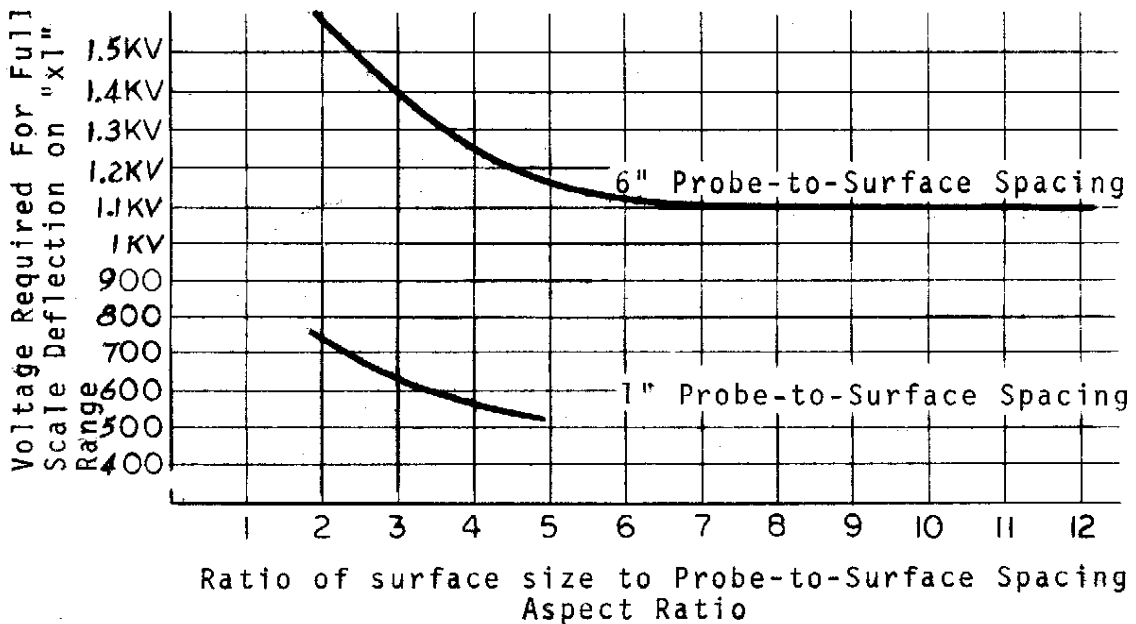
APPENDIX I

A. Calibration at other than 1" or 12" probe-to-surface spacing:



NOTE: Measured data taken using a 72" square metal surface.

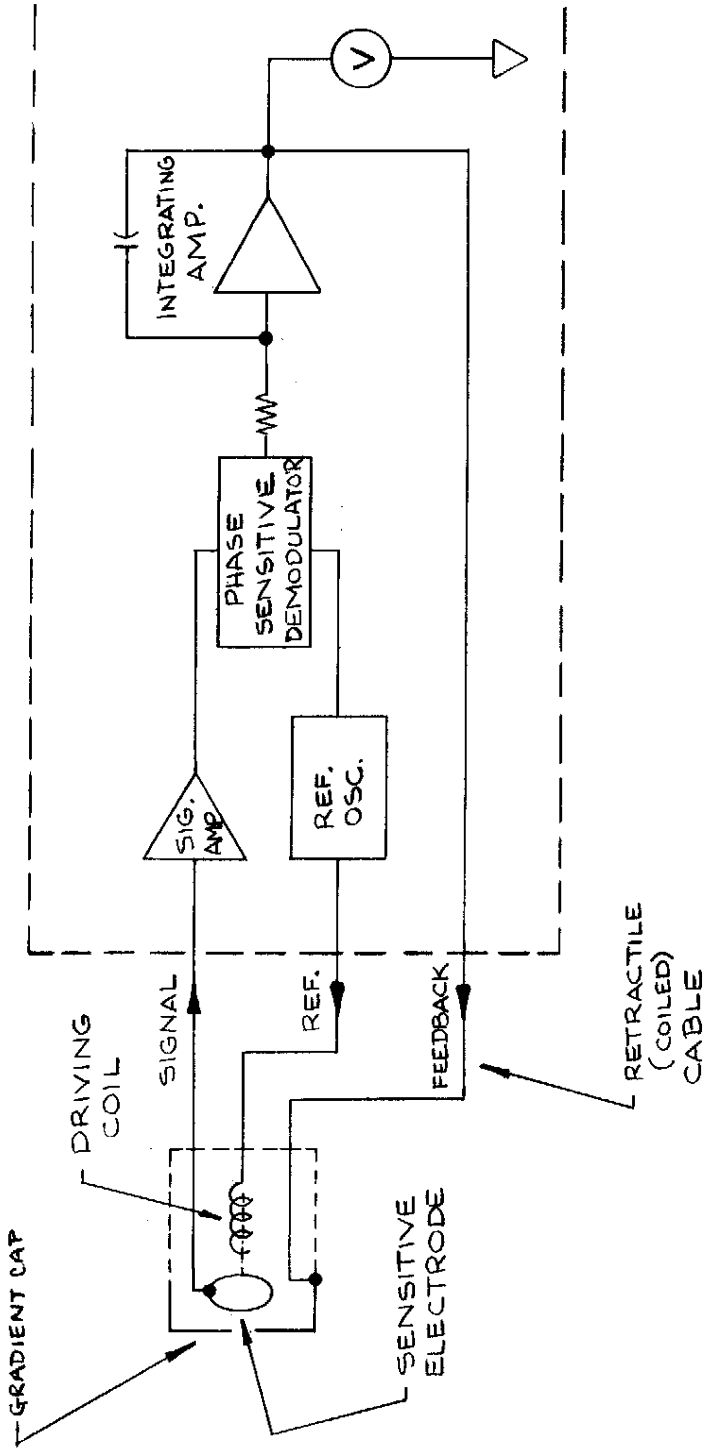
B. Calibration vs. Aspect Ratio:



NOTE: Surface "Size" refers to the edge dimension of a square surface.

PROBE

METER HOUSING



SIMPLIFIED
BLOCK DIAGRAM

BNC
12/22/72

MODEL 230B
STAT - ARC

230B/12

MATERIAL LIST

MODEL 230B HAND HELD FIELDMETER

| REF. NO. | DESCRIPTION | VENDOR NO. |
|------------------|---------------------------|------------------------|
| R101 | Pot, 100K | Spectrol 62-1-1-104 |
| R102 | Pot, 100K, 10T, .25% Lin. | Beckman 7276 |
| R103 & R104 | Resistor 1K, 1/4W, 5% | AB CB |
| R105 & R106 | Resistor 200K, 1/4W, 5% | AB CB |
| R107 | Resistor 100K, 1/4W, 1% | Electra MF |
| CR101 & CR102 | Diode | GE IN4148 |
| M101 | Meter | M.E. 98015B |
| S102 & S103 | Push Button | Grayhill 39-1 |
| S101 | Rotary Switch | Grayhill 71B30-01-3-4N |
| | X10 End Cap | M.E. 230B/24 |

MATERIAL LIST

MODEL 230B PROBE SUB-ASSEMBLY

| REF. NO. | DESCRIPTION | VENDOR NO. |
|----------|--------------------------|--------------|
| | Cable, Coiled Microphone | Belden 8491 |
| | Gradient Cap | M.E. 230B/42 |

MATERIAL LIST

MODEL 3089-1 P.C. BOARD ASSEMBLY

| REF. NO. | DESCRIPTION | VENDOR NO. |
|--------------|--------------------------|-------------------------|
| R-1 & R-9 | RESISTOR, 100K, 1/4W, 5% | AB CB |
| R-2 & R-4 | " 10M, 1/4W, 5% | AB CB |
| R-3 | " 1M, 1/4W, 5% | AB CB |
| R-5 & R-6 | " 3.32K, 1/8W, 1% | ELECTRA MF 1/8 |
| R-7, R-8, | | |
| R-10 | " 100K, 1/8W, 1% | ELECTRA MF 1/8 |
| R-11 | " 1K, 1/8W, 1% | ELECTRA MF 1/8 |
| R-12 | " 150 OHM, 1/4W, 5% | AB CB |
| R-13 | " 100 OHM, 1/4W, 5% | AB CB |
| R-14 | " 820K, 1/4W, 5% | AB CB |
| R-15 & R-16 | " 499K, 1/8W, 1% | ELECTRA MF 1/8 |
| R-17 | " 240K, 1/4W, 5% | AB CB |
| R-18 | " 1K, 1/4W, 5% | AB CB |
| R-19 | " 9.31K, 1/8W, 1% | ELECTRA MF 1/8 |
| R-20 | " 29.4K, 1/8W, 1% | ELECTRA, MF 1/8 |
| C1 | CAPACITOR, 27P | ELMenco DM15-270 |
| C2 | " 330P | ELMenco DM15-331 |
| C3 | " 1MF, 25V | SPRAGUE TE-1200 |
| C4 | " .068mF, 80V | SPRAGUE 192P-6839R8 |
| C5 | " .033mF, 80V | SPRAGUE 192P-3339R8 |
| C6 & C7 | " .022mF, 80V | SPRAGUE 192P-2239R8 |
| C8 | " .22 MF, 80V | SPRAGUE 192P-2249R8 |
| C9 | " .1 MF, 80V | SPRAGUE 192P-1049R8 |
| C10 & C11 | " 100 mF, 10V | SPRAGUE 150D-107X9010R2 |
| CR1 & CR2 | DIODE | SYN/TI IN457 |
| CR3, CR4, | | |
| CR10, CR11 | " | GE IN4148 |
| CR5 & CR6 | " | N.S. LM329DZ |
| CR7 | " BRIDGE RECTIFIER | VARO VE08 |
| CR9 | " ZENER | MOT. IN4729 |
| LED/PC-1 | LED/PHOTO-CONDUCTOR | M.E. 90901 |
| A1 | INT. CIRCUIT | N.S. LM-308H |
| A2, A3, & A4 | INT. CIRCUIT | FAIRCHILD U5B7741393 |
| T1 | TRANSFORMER | MICRO-TRAN MMT-31-FB |