

THERMOCOUPLE SIMULATOR
MODELS ETS-15, TSC-46, TSC-47UR
INSTRUCTION MANUAL
(Patent No. 3504522)

NOTE: Throughout this manual, wherever the Model TSC-46 is referred to, please bear in mind that the Model TSC-47UR has the same operating characteristics and features, but has one additional decade of resolution, and other improved specifications (see specification sheet herein).

PRIME TECHNOLOGY, INC.
General Resistance Division
P.O. Box 185 / Twin Lakes Road
North Branford, CT 06471

Ph: (203) 481-5721
FAX: (203) 481-8937

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LIMITED WARRANTY

General Resistance Div. warrants each instrument to be free from defects in material and workmanship for a period of one year from date of purchase.

The obligation of General Resistance Div. under this Warranty is limited solely to servicing or adjusting any failed instrument returned, shipped prepaid, to the factory for that purpose.

Units returned under this Warranty shall be examined by General Resistance Div. to establish that the failure resulted from defective material and/or workmanship and not as a result of misuse, neglect or improper operation, which latter failure is not within the meaning of this Warranty.

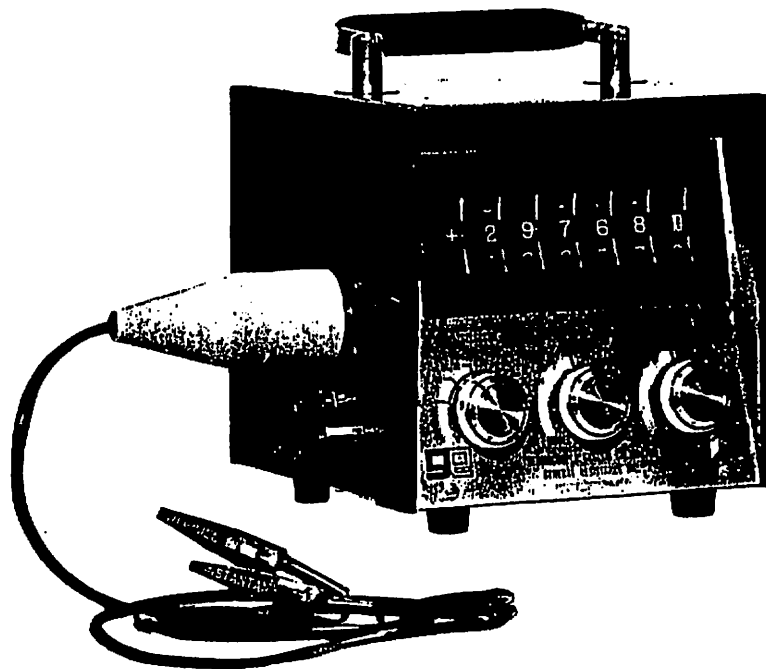
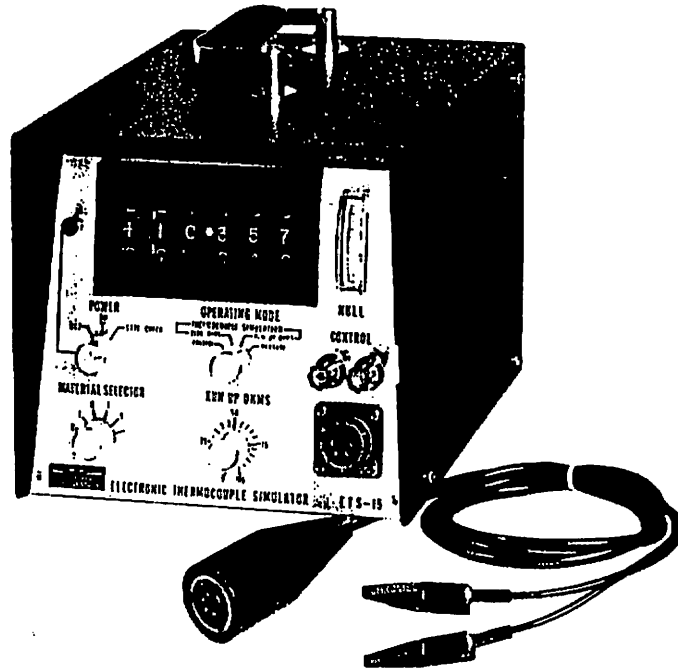
This Warranty does not cover collateral or consequential damages of any nature, type or description, whether resulting from express warranties, implied warranties or negligence.

General Resistance Div. reserves the right to make changes to design at any time without incurring any obligation to install same in units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of General Resistance Div., express or implied, and General Resistance Div. neither assumes nor authorizes any person to assume for them any other liability in connection with the sale of General Resistance Div. products.

PHOTOGRAPHS (ETS & TSC)

FIGURE A



1.0 INTRODUCTION AND DESCRIPTION

1.1 GENERAL

General Resistance Thermocouple Simulators (ETS/TSC) are versatile laboratory instruments that provide high precision and stability in compact portable units.

They are designed and constructed as to be essentially independent of the ambient temperature and loading within their ratings.

Each has the following basic functional modules:

- 1. A chopper-stability operational amplifier.**
- 2. A highly stable reference source.**
- 3. A Kelvin-Varley potential divider.**
- 4. A cold junction compensator (CJC) for each of 5 separate thermocouple systems.**
- 5. Connection facilities for any thermocouple type.**

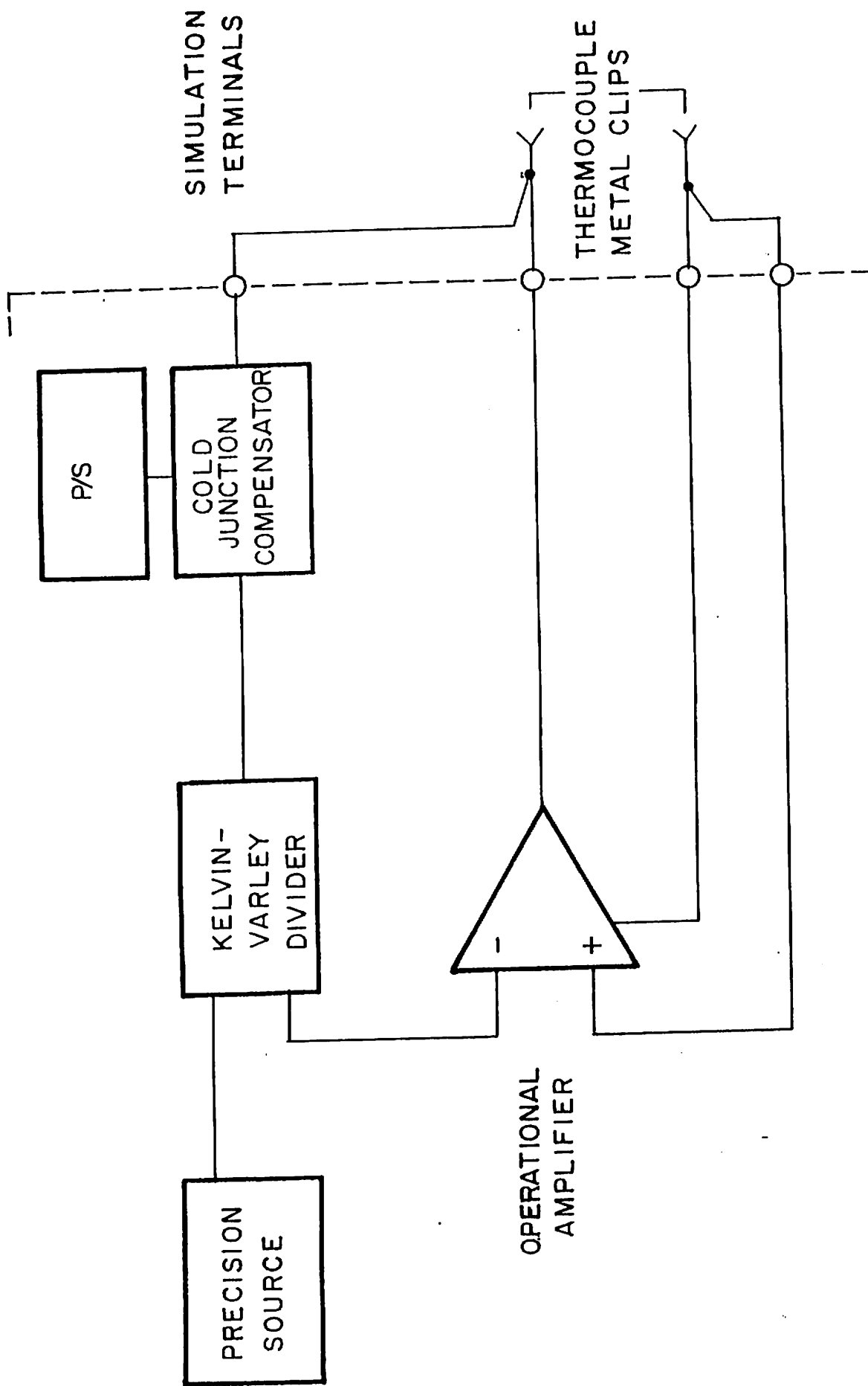
TSC Series instruments are 6-7/16" high by 6" wide by 7" deep and weigh 9 pounds.

The ETS-15 is 7" high by 8" wide by 10-5/16" deep; it weighs 11 pounds.

The instruments are shown in Figure A and a functional block diagram is shown as Figure B.

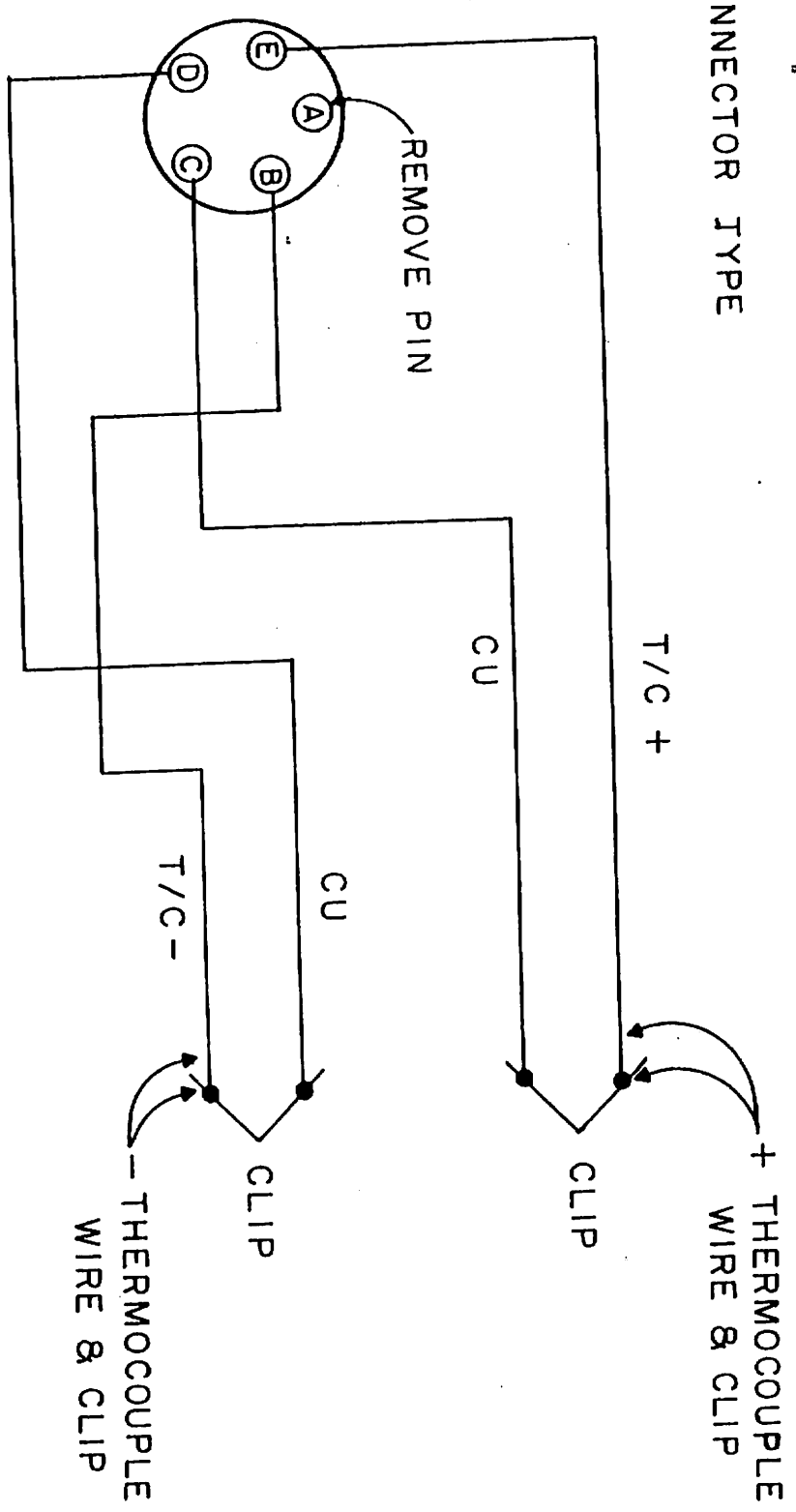
A stable reference voltage source is precisely controlled by a Kelvin-Varley divider (KVD) in the feedback loop of a high gain chopper-stabilized amplifier. The feedback loop also contains the cold junction compensator whose values reflect the choice of the thermocouple system. The unique output coupling arrangement permits proper connection to any thermocouple system.

At the output terminals, the arrangement is equivalent to a thermocouple located in a temperature environment that would give the same voltage. The use of remote sensing leads extends the thermocouple terminals to the connection clips.



THERMOCOUPLE SIMULATOR
SYSTEM BLOCK DIAGRAM
FIGURE B

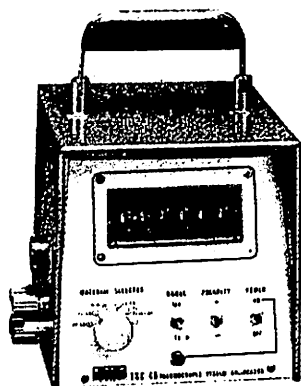
CONNECTOR TYPE



OUTPUT CABLE & CONNECTOR



Thermocouple Simulators



- Specifically engineered for the test, analysis, calibration and troubleshooting of thermocouple readouts, datalogging systems, etc.
- For use with all thermocouple types (standard models for E, J, K, T, R/S, all others on option).
- Exclusively designed with "zero output Z."

These precision instruments are not to be confused with low-cost hand-held "do-everything" devices. The TSC/ETS line of T/C Simulators provides "standards lab performance." TSC/ETS units provide $\pm 1/4\%$ accuracy and can be used to calibrate virtually any T/C system at any temperature with internal cold junction compensation referenced to 0°C . Potentiometers and ice baths are not required.

These GR instruments, moreover, provide "zero output impedance," an exclusive feature available with no other simulator. "Zero output Z" insures that the system element (readout device, scanner or whatever) under test or calibration will respond *only* to the simulated temperature signal supplied by the General Resistance TSC or ETS. This eliminates the need to disconnect the system thermocouple.

In addition to its TSC/ETS line of ultra-precision instruments, General Resistance offers its Model E-35B

Instant Lab for use as a T/C simulator. Model E-35B is unmatched for multi-usage versatility. It performs as a thermocouple and RTD simulator, current/voltage source and resistance decade box ... all with $\pm 0.1\%$ accuracy. (See Table I and back cover for further details on E-35B.)

MODELS AVAILABLE

Model TSC-47UR — The finest and most versatile instrument of its type available anywhere outside of a primary standards laboratory. Designed for use as a portable standard and as a constant voltage/current source as well as thermocouple simulator.

Model TSC-46 — Similar to the TSC-47UR with 6 rather than 7 decade KVD. See Table I Specifications for specific differences between these two models.

Model ETS-15 — Same accuracy and "Zero output Z" performance as TSC Series relative to T/C simulation. Differs from TSC units in that it is truly portable with internal batteries. It also provides built-in run-up pot, control circuit and temperature measurement capability. Does not offer 10V F.S. voltage source performance.

Model E-35B —see back page.

THERMOCOUPLE SIMULATION:

These instruments simulate all thermocouple types —E, J, K, R, S, T, B, N, etc. —internally referenced-junction-compensated to 0°C . Connection to the thermocouple system to be tested is through the use of specially designed THERMOCLIPS™ (see Table II). Output is *dialled in voltage* on thumbwheel-decade switches. Any reference tables can be used — DIN, NBS, etc.

BATTERY OPERATION (ETS-15, E-35B):

Instrument will operate for approximately 8 hours on a full charge under normal conditions and recharge within 10 hours. Units are fully operative during the charge cycle. Trickle charging takes place as long as unit is plugged in, whether it is turned ON or OFF.

OPERATION:

Five basic operating modes are as follows:

1. Thermocouple simulation with zero output impedance.

ADVANTAGES

- Zero output impedance. Readout being calibrated sees *only* the output of the GR instrument ... even when T/C remains connected.
- Battery operation.
- High accuracy voltage/current source (1V and 10V FR) in addition to T/C simulation.
- Basic accuracy of $\pm 1/4^{\circ}\text{C}$.
- Designed for calibration of analog meters, as well as digital meters. (Unit provides built-in "run-up" capability.)
- Temperature measurement capability.*
- Built-in cold junction compensation provided. No ice bath required.

TSC ETS E-35B

X	X	
	X	X
X		X†
X	X	
	X	
X	X	X
X	X	X

*TSC and E-35B require additional external equipment.

†See E-35B data in Table I and on back page for exact performance specifications.

Appropriate Thermoclips (See Table II) are clipped into the system. Since output impedance is "zero" there is no need to disrupt system wiring. After temperature-equivalent voltage is dialed, this known signal is used to calibrate or troubleshoot scanners, linearizers or readouts.

2. Thermocouple simulation with output impedance established by front panel "run-up" pot. (AVAILABLE WITH MODEL ETS-15 ONLY.) Built-in run-up pot is set to the system impedance. Thermoclips are used to substitute the simulated output for the active thermocouple. The "run-up" pot is used to simulate the system's wiring in order to calibrate loop-impedance-dependent analog readout devices.

3. Temperature measurements. The Simulator is connected to the active measuring thermocouple with the appropriate Thermoclips. The thumbwheel switches are adjusted until a null is indicated on a built-in meter which is designed for logarithmic response. (External null detector required for Models TSC-46, TSC-47UR, E-35.)

4. Control mode. (AVAILABLE WITH MODEL ETS-15 ONLY.) Appropriate Thermoclips are connected. Any voltage differences between that set on the Simulator dials and that produced by the system thermocouple is detected and amplified by a fixed gain of 25. This "error signal" appears at the CONTROL terminals and provides external control circuitry with the analog information required to correct temperature, activate alarms, etc.

5. High accuracy voltage/current source. (AVAILABLE WITH MODELS TSC-46 and TSC-47UR ONLY.) These sophisticated instruments provide all of the precision performance characteristics of GR's time-tested DAS voltage/current sources in addition to serving as thermocouple simulators.

A. Constant voltage source. Full scale outputs are ± 1 Vdc and ± 10 Vdc at 30mA maximum load current. TSC-46 resolution: $1\mu\text{V}$ on 1V range, $10\mu\text{V}$ on 10V range. Accuracy: $\pm 0.0025\%$ of setting. Stability: ± 7 ppm/24 hours, ± 20 ppm/year. TSC-47UR resolution: $0.1\mu\text{V}$ on 1V range, $1\mu\text{V}$ on 10V range. Accuracy: $\pm 0.0015\%$ of setting. Stability: ± 5 ppm/24 hours, ± 15 ppm/year. Other outstanding features

THERMOCLIPS™

Table II

A single pair of Thermoclips is supplied as standard equipment for each of the thermocouple types listed below. Please specify choice when ordering. Additional pairs of Thermoclips, as well as Thermoclips manufactured of *other* materials, are available on special order.

Type	Thermocouple material
E	Chromel/Constantan
J	Iron/Constantan
K	Chromel/Alumel
R	Platinum/Platinum 13% Rhodium (simulated)
S	Platinum/Platinum 10% Rhodium (simulated)
T	Copper/Constantan

include "zero" output impedance, and remote sensing. An optional LNA-100 Low Noise Attenuator reduces dialed output voltage, and any drift or offset, by a factor of 100, thus decreasing "noise" to the nanovolt level, permitting use of the TSC at extremely low output voltage levels where output current is not a consideration. The accuracy of the LNA-100 is $\pm 0.005\%$.

B. Constant current source (with the addition of optional DAA-40 adaptor). Full scale current output of either the TSC-46 or the TSC-47UR is $\pm 10\text{mA}$ on the 1V range, $\pm 30\text{mA}$ on the 10V range. Resolution of the TSC-46: 10nA on the 1V range, 100nA on the 10V range. Accuracy: $\pm 0.0055\%$ of setting. Resolution of the TSC-47UR: 1nA on the 1V range, 10nA on the 10V range. Accuracy: $\pm 0.0045\%$ of setting.

6. Voltage/current source. The E-35 and E-35B can provide ± 20 Vdc with up to 200mA load current. They will also function as a constant current source providing up to 200mA dc.

SPECIFICATIONS

Table I

	Model TSC-47UR	Model TSC-46	Model ETS-15	Model E-35B
Number of decades	7	6	5	5
Resolution	$0.1\mu\text{V}$ or $1.0\mu\text{V}^{(1)}$	$1.0\mu\text{V}$ or $10.0\mu\text{V}^{(1)}$	$1.0\mu\text{V}$	$10.0\mu\text{V}$
Range(s), full scale DC	$\pm 1.0\text{V}$ and 10.0V	$\pm 1.0\text{V}$ and 10.0V	$\pm 100.0\text{mV}$	$\pm 200.0\text{mV}$ $\pm 20.0\text{V}$
Accuracy of voltage setting @ $+25^\circ\text{C}$	$\pm 0.0015\%^{(2)}$	$\pm 0.0025\%^{(2)}$	$\pm 10.0\mu\text{V}$	$\pm 0.1\% \pm 15\mu\text{V}$ $\pm 0.1\% \pm 100\mu\text{V}$
Noise and ripple (peak) exclusive of random transients. DC to 10kHz.	2 ppm or $15.0\mu\text{V}^{(3)}$	3 ppm or $20.0\mu\text{V}^{(3)}$	$20.0\mu\text{V}^{(3)}$	$2.0\mu\text{V}$ $\pm 100\mu\text{V}$
Output voltage T.C. (ppm/ $^\circ\text{C}$)	± 0.7 typ./ ± 1.5 max.	± 1 typ./ ± 2 max.	± 1 typ./ ± 2 max.	Included in accuracy
Output voltage stability @ $+25^\circ\text{C}$	± 5 ppm/24hrs. ± 15 ppm/year	± 7 ppm/24 hrs. ± 20 ppm/year	± 7 ppm/24hrs. ± 20 ppm/year	Included in accuracy
Accuracy of thermocouple simulation	$\pm 1/4^\circ\text{C}^{(4)}$			$\pm 0.1\%$ of setting $\pm 15\mu\text{V} + 1/2^\circ\text{C}$
Maximum load current	30mA			200mA
Line regulation (105-125VAC)	± 0.5 ppm			Included in accuracy
Load regulation (no load to full load)	1 ppm $\pm 1.0\mu\text{V}$ peak			Included in accuracy
Isolation (floating output)	Either terminal can be grounded/guarded up to 500V with respect to ground. Leakage approx. $10^9\Omega$, less than 20pF.			
Typical output impedance	$50\mu\Omega$			$< 10\text{ m}\Omega$
Input power	115V, 60Hz (Specify if 220V, 50 Hz operation is desired)			

(1) Dependent upon range. (2) $\pm 5\mu\text{V}$. (3) Whichever is greater.

(4) Providing that output of thermocouple simulated is $\geq 40\mu\text{V}/^\circ\text{C}$, accuracy of simulation of noble metals with outputs $\geq 10\mu\text{V}/^\circ\text{C}$ is 1.5°C (except for Type S).

2.0 INITIAL SET-UP

2.1 UNPACKING AND INSPECTION

= > On receipt of unit

- 1) Check all switches for proper operation, ie: thumbwheels have a good detent action and no broken tabs. Rotary switch positions should match the panel markings.**
- 2) Check that the correct thermocouple cable(s) are with the instrument.**
- 3) Check operation (see Section 3.0 for TSC; 4.0 for ETS).**

2.2 OUTPUT CABLES

The output and connector are essential parts of the instrument. One connector cable assembly is supplied with each instrument. Factory assembled cables are available for all thermocouple types.

The output permits the instrument to be connected properly to the corresponding thermocouple system without extraneous thermal emfs.

The cable consists of four wires (two of thermocouple materials, each with an associated sense line), two clips and 5-pin connector. Each clip is made with one jaw of copper and the other of thermocouple metal, which are connected to the like material of the cable. The outputs of thermocouple simulators are injected into the system under test/calibration.

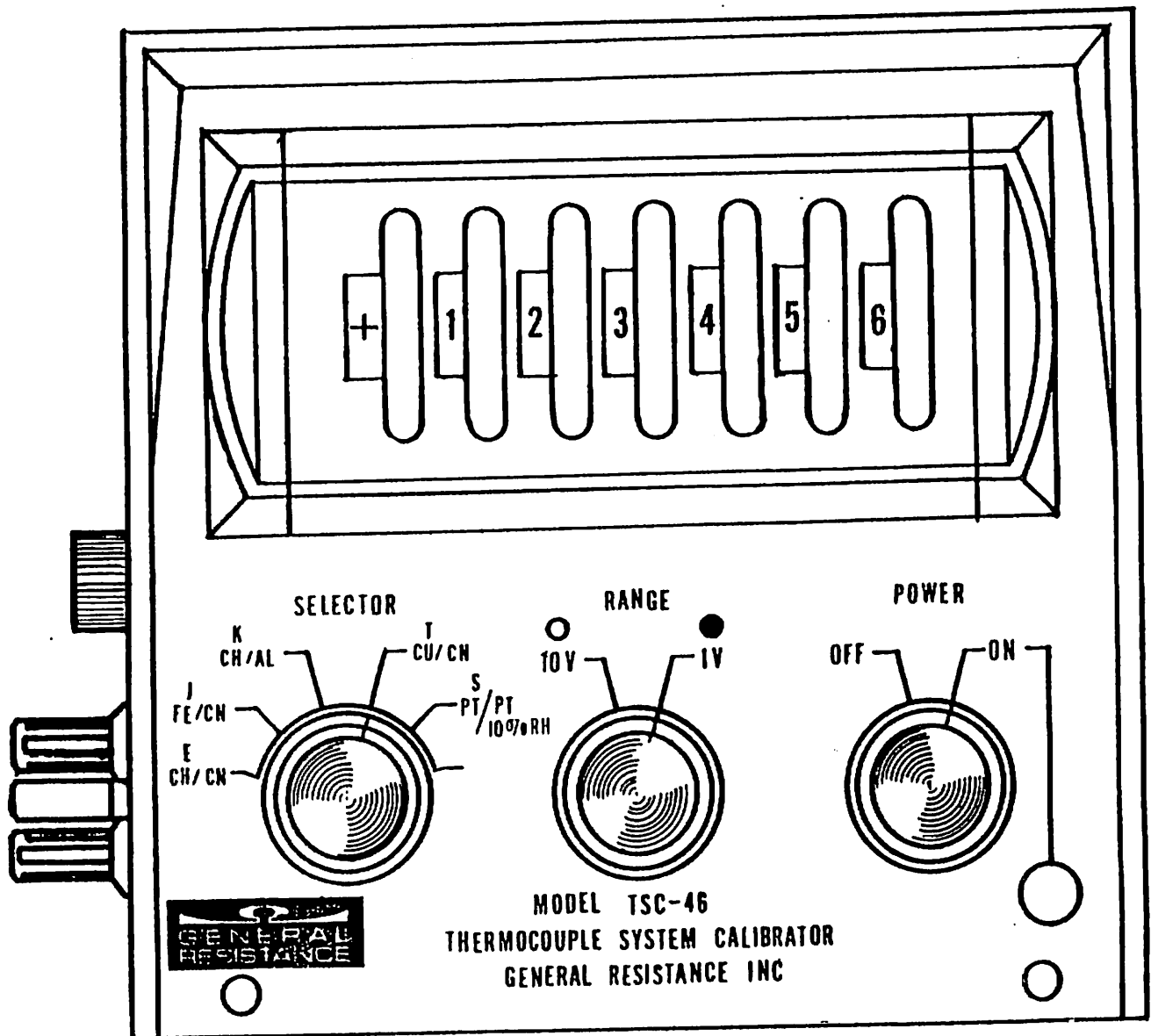
2.3 OUTPUT CONNECTOR

The thermocouple simulator must be connected without spurious or temperature dependent emfs, therefore, cold junction compensation (0 deg C reference) is used to cancel temperature effects.

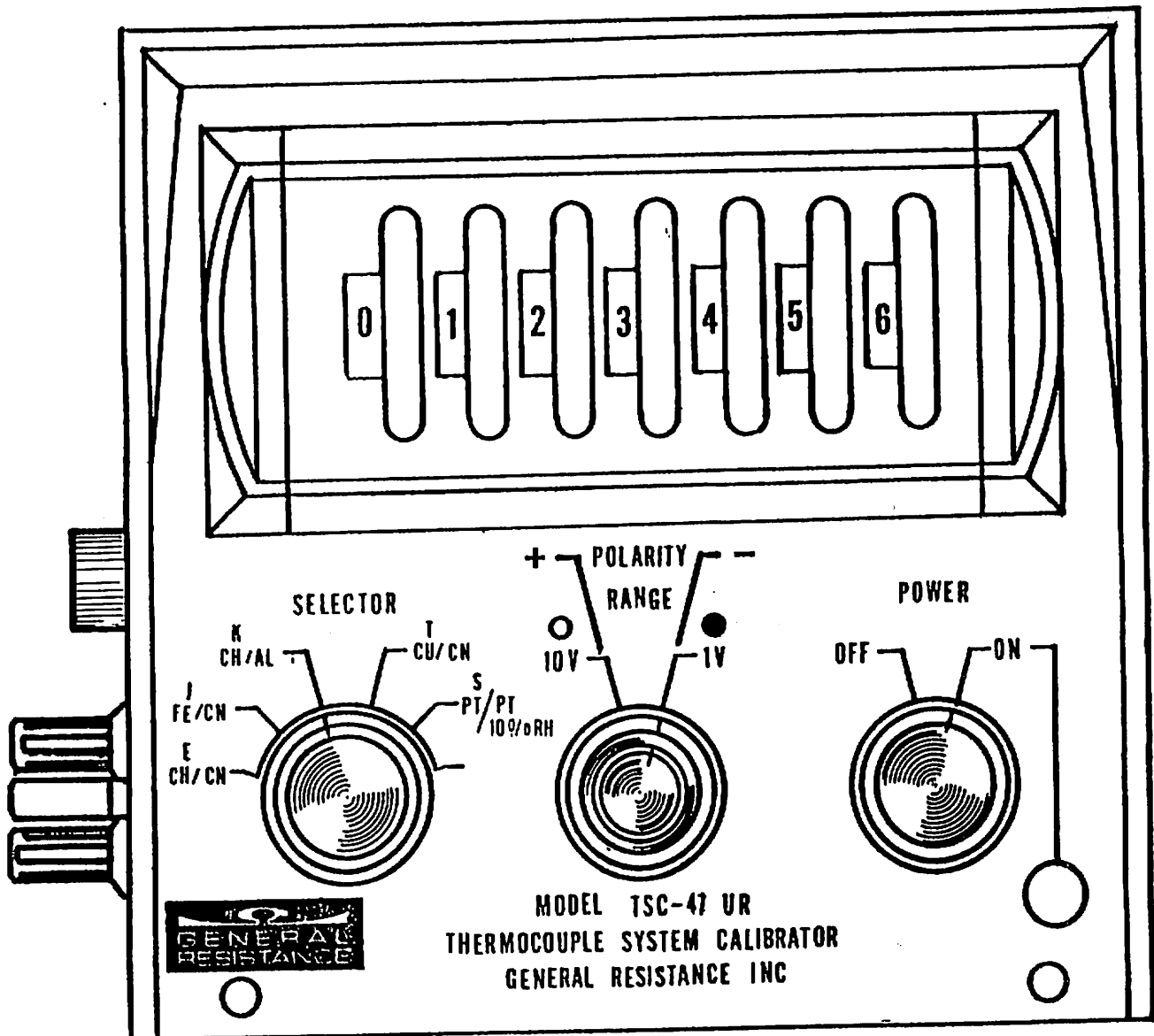
Since copper to thermocouple metal junctions are made at the connector, the temperature sensitive resistor of the reference junction compensator is implanted in the output receptacle. The resistor and the junctions are at the same temperature and isolated from local temperature variations by the connector and its covering.

The schematic diagram of the output cable and connector is shown in Figure C. The receptacle pins are gold plated to minimize the thermal emf to copper. By changing the output connector and cable assembly, all thermocouple types can be accommodated.

FRONT PANEL CONTROLS
MODEL TSC-46
FIGURE D



FRONT PANEL CONTROLS
MODEL TSC-47UR
FIGURE E



3.0 OPERATING INSTRUCTIONS (TSC SERIES)

3.1 OPERATING CONTROLS

Front panel controls are shown in Figures D & E.

These consist of a power on/off switch, a pilot lamp, a range switch (1V/10V), a thermocouple material selector switch, a polarity selector and thumbwheel output voltage selector switches.

The most significant decade has stops below zero and above nine; intermediate decades have no stops and may be set to any value zero through nine; the least significant decade has no stops and may be set to any value zero through ten.

3.2 OPERATION AS A THERMOCOUPLE SIMULATOR

The sequence of operation is as follows:

- 1. With power switch OFF, set range switch to 1V position. Make sure terminal shorting plugs/links are connected.**
- 2. Set selector switch to the thermocouple material in use.**
- 3. Set all thumbwheel switches to 0.**
- 4. Turn power switch to ON position; make sure that the pilot lamp is on and allow the unit to warm up for at least 90 seconds.**
- 5. Insert the appropriate thermocouple cable into the connector.**
- 6. Connect thermocouple clips to system to be calibrated/ tested.**
- 7. Remove terminal shorting plugs/links.**

NOTE: WHEN CONNECTING OR REMOVING THERMOCLIPS FROM THE UNIT UNDER TEST/CALIBRATION, THE PLUS (+) SENSE AND THE MINUS (-) OUTPUT TO MINUS (-) SENSE. IF THEY ARE NOT, THE INSTRUMENT WILL SATURATE AT APPROXIMATELY 13V TRYING TO MAINTAIN THE REQUIRED VOLTAGE AT THE THERMOCLIPS. WHILE THIS IS NOT INJURIOUS TO THE TSC, IT MAY BE TO YOUR SYSTEM.

- 8. Dial the emf equivalent of the thermocouple at the desired temperature, observing the correct polarity. EXAMPLE: A typical application would be to check the calibration of the indicator portion of a Chromel-Alumel thermocouple system. In preparation, select the temperature calibration points and obtain the equivalent voltage for each of them from the appropriate thermocouple reference table(s).**

3.2 (Continued)

EXAMPLE (Chromel/Alumel):

<u>TEMPERATURE (°C)</u>	<u>OUTPUT (mV)</u>
300	+ 12.207
500	+ 20.640
800	+ 33.277
1100	+ 45.108

Attach the Chromel/Alumel cable to the output connector and the clips to the corresponding leads of the indicator. By successively setting the thumbwheels to:

+012207

+020640

+033277

+045108

your System indicator should successively display temperatures of 300, 500, 800 and 1100°C respectively.

3.3 OPERATION AS A VOLTAGE/CURRENT REFERENCE SOURCE

See Section 6 of manual.

Also see Section 5.3: Optional accessories.

4.0 OPERATING INSTRUCTIONS (ETS-15)

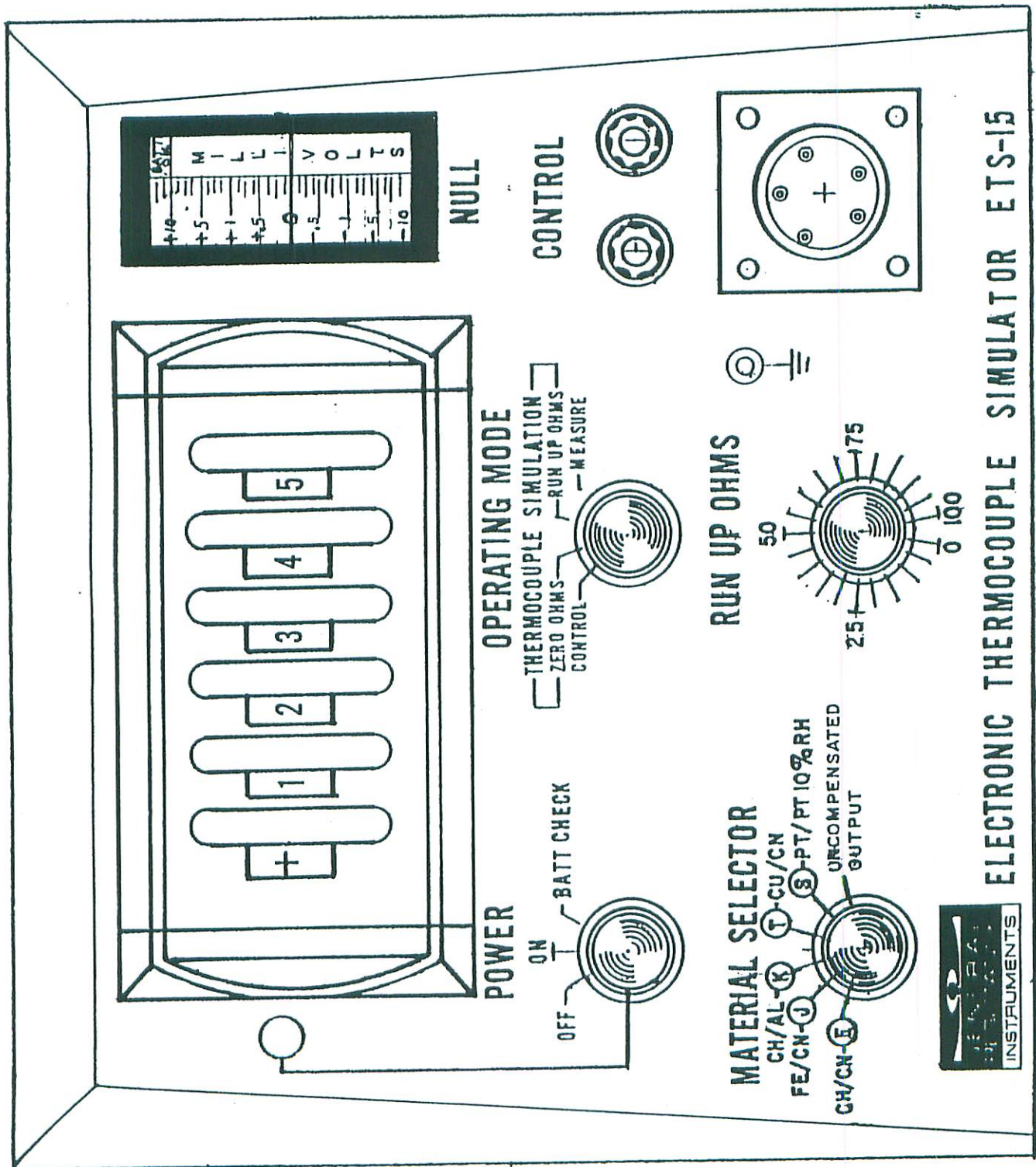
4.1 OPERATING CONTROLS

Front panel controls are shown in Figure F. These consist of a power ON/OFF switch with a battery check position, a pilot lamp, a thermocouple material selector, an operating mode selector, a "run-up" pot, a null indicator and thumbwheel polarity & output voltage selector switches. The most significant decade has stops below zero and above nine; intermediate decades have no stops and may be set to any value zero through nine; the least significant decade has no stops and may be set to any value zero through ten.

FRONT PANEL CONTROLS

MODEL ETS-15

FIGURE F



4.2 OPERATION: ZERO OHMS THERMOCOUPLE SIMULATION MODE

A. The sequence of operation is as follows:

- 1. With power switch OFF, set Operating Mode to Zero ohms. (No shorting plugs/links are necessary since an automatic voltage limiting circuit prevents the ETS from going into saturation).**
- 2. Set Material Selector to the thermocouple type in use.**
- 3. Set all thumbwheel switches to 0.**
- 4. Turn power to ON; make sure that the pilot lamp is on and allow the unit to warm up for at least 90 seconds.**
- 5. Insert the appropriate thermocouple cable into the connector.**
- 6. Connect thermocouple clips to system to be calibrated/tested.**
- 7. Set the thumbwheel switches to the emf equivalent of the thermocouple at the desired temperature. Also, see Example in Step 8 of Section 3.2, bearing in mind that the ETS is a 5-decade single range instrument reading out in millivolts to 3 decimal places (LSD equals 1uV).**

B. By switching Material Selector to Uncompensated Output and using the optional Uncompensated Output Adaptor (Type C-15), the ETS can be used as a remote sensing precision voltage source with a maximum output of +/-100 mV, 1uV resolution and a maximum load current of 30 mA.

Also, see Section 5.3 for other optional accessories.

4.3 OPERATION: RUN-UP OHMS THERMOCOUPLE SIMULATION MODE

Used to calibrate loop-impedance-dependent analog readout devices. The active thermocouple and its associated wiring must be disconnected from the readout. Set operating mode to Run-Up ohms, set run-up pot to the required system impedance (0 to 100 ohms). This impedance should equal that of the active thermocouple with its associated wiring and is specified on the readout device. Connect appropriate thermoclips to the readout. Balance of procedure is substantially as outlined in Section 4.2A.

4.4 OPERATION: MEASURE MODE

With the operating mode set to Measure, the temperature of the active thermocouple can be determined by connecting the appropriate thermoclips to it and adjusting the thumbwheel switches until a null is indicated on the built-in meter, which has a logarithmic response.

Follow the general procedure outlined in Section 4.2A.

4.5 OPERATION: CONTROL MODE

In the Control mode, with the proper thermoclips connected, any voltage difference between that set on the thumbwheel switches and that produced by the system thermocouple is amplified by a fixed gain of 25. This error signal appears at the Control terminals and can provide external control circuitry with analog information for temperature correction, activation of alarms, etc.

Follow the general procedure outlined in Section 4.2A.

4.6 BATTERY OPERATION

The ETS will operate for 8 hours on a full charge and will re-charge within 16 hours. This instrument trickle-charges as long as it is plugged in and can be operated during the charge cycle.

Battery condition is indicated in two ways: (1) By turning to "Battery check", battery condition is shown in a special area on the null meter scale; and (2) Whenever its condition weakens to the point where accurate operation may be affected, the pilot lamp flashes continually.

5.0 REPAIR AND MAINTENANCE

5.1 REPAIR

Repair of thermocouple simulators is limited to the replacement of pilot lamps or the line fuse.

The precise output values are dependent upon resistors matched and accurate to better than 0.001%. Should any of these resistors be damaged or over-dissipated, the instrument must be returned to the factory.

5.2 MAINTENANCE

The usual routine maintenance will be the periodic zero setting of the operational amplifier (all models) and recalibration of the reference source (TSC Series only). General Resistance Division offers complete calibration at a nominal charge.

5.2.1 AMPLIFIER ZERO SET (TSC SERIES)

The amplifier zero set should be checked periodically. Annual calibration is adequate for most applications.

PROCEDURE

1. Set the dials to zero and the range switch to 1V. Allow a 30 minute warm-up.
2. Use a microvoltmeter such as the Keithley Model 155 or equivalent, set to the 10-0-10 microvolt range and connect it across the + and - sense terminals on the left side of the unit. The terminal shorting plugs/links **MUST BE IN PLACE.**
3. If the meter exceeds ± 5 microvolts, adjust the zero set, which is located under an access hole on the right side of the case at the top rear. Remove the snap-in cap, and adjust with a screwdriver until the output is within ± 5 microvolts of zero. Switch polarity from "+" to "-" and keep adjusting until the readings for each polarity are equal. Replace the cap.

5.2.2 AMPLIFIER ZERO SET (ETS-15)

The amplifier zero set zero set should be checked periodically. Annual calibration is adequate for most applications.

PROCEDURE

1. Set the dials to zero, the Material Selector to Uncompensated Output and the Operating Mode to Thermocouple Simulation Zero Ohms. Allow at least 1 hour warm-up since thermal stability is extremely important.
2. Use a microvoltmeter such as the Keithley Model 155 or equivalent, set to the 10-0-10 microvolt range and connect it across the C-15* terminals.
3. If the meter reading exceeds ± 5 microvolts, adjust the zero set, which is located under an access hole on the left side of the case at the top rear. Remove the snap-in cap and adjust with a screwdriver until the output is within ± 5 microvolts of zero. Switch polarity from "+" to "-" and keep adjusting until the readings for each polarity are equal. Replace the cap.

5.2.3 REFERENCE SOURCE CALIBRATION

The reference source calibration should be checked annually.

PROCEDURE (ETS SERIES)

1. Zero set the amplifier as described in Section 5.2.1.
2. Set the dials to zero, the polarity to "+" and the range switch to 10V.
3. Set the dials to the standard cell value. Connect the TSC, microvolt meter and standard cell in a differential voltmeter configuration, using the 100-0-100 microvolt range.
4. The meter should read within ± 25 microvolts of zero. If it does not, adjust the potentiometer through the hole covered by a snap-in cap on the right side at the lower front. Replace cap.

* C-15 Uncompensated Output Adaptor - (see Optional Accessories)

PROCEDURE (ETS-15)

{Applies to instrument S/N 146 and higher}

- 1. Zero set the amplifier as described in 5.2.2.**
- 2. Set the dials to 999910 polarity to "+" and leave all other switches as set for 5.2.2.**
- 3. Using a calibrated 100 mV source (ie: General Resistance Model DAS46-AL) accurate to better than $\pm 0.0015\%$ of output, connect the ETS, the microvolt meter and the 100 mV source in a differential voltmeter configuration. Set the microvolt meter to the 10-0-10 microvolt range.**
- 4. The meter should read within ± 5 microvolts of zero. If it does not, adjust the potentiometer through the hole covered by the snap-in-cap on the right side of the ETS at the upper rear. Replace cap.**

5.3

OPTIONAL ACCESSORIES

A. UNCOMPENSATED OUTPUT ADAPTOR (C-15)

When used with the ETS-15, the C-15 provides remote sensing constant voltage operation (copper outputs). Maximum output ± 100 mV; resolution 1 μ V: maximum load current 30 mA. See Section 4.2B.

Not for use with TSC's, which have built-in constant voltage capability to ± 10 V (copper outputs). See specification sheet: TSC, Constant Voltage Source.

B. CONSTANT CURRENT ADAPTOR (DAA-40)

The scale factor of the DAA-40 is 10 mA/V; its sensing resistor is 100 ohms. When used with the TSC Series, it provides constant current operation as described in the specification sheet under: TSC, Constant Current Source. The DAA-40 is not recommended for use with the ETS-15 due to low compliance voltage.

C. LOW NOISE ATTENUATOR (LNA-100)

In constant voltage operation at very low output levels, the inaccuracy contributed by a possible ± 5 μ V offset may become the determining element of output voltage accuracy. Where output current is not a consideration, the use of the LNA-100 will reduce the offset (and the dialed output voltage) by a factor of 100. The output impedance of the LNA-100 is 10 ohms; its accuracy is $\pm 0.005\%$.

6.0 OPERATING INSTRUCTIONS TSC AS A VOLTAGE/CURRENT SOURCE

6.1 POWER

Connect the power plug to a source of 115 VAC at 50/60 cps and turn the POWER switch on. Power is indicated by the red light on the front panel.

6.2 WARMUP

The instrument is ready for use almost immediately after the power is turned on. Allow a period of 30 to 40 seconds for the amplifier to come out of saturation. The instrument will be within its accuracy specifications within 2 to 5 minutes after turn-on in a 25°C environment, although 30 minutes may be required for maximum stability.

6.3 RANGE

With the instrument Range switch in the 10V position, output voltages from 0 to 10 volts may be dialed in 10 microvolt steps. For voltages from 0 to 1.0 volt, greater accuracy and resolution (1uV per step) will be obtained with the RANGE SWITCH in the 1V position. These resolution figures are 0.1 uV per step & 1uV per step in the 1 and 10 volt ranges using a seven decade model.

6.4 POLARITY

Position the OUTPUT SWITCH to PLUS if the desired polarity is that indicated by the OUTPUT terminals. For the opposite polarity, throw the OUTPUT switch to MINUS.

6.5 OUTPUT VOLTAGE

Set the dial switches to read the desired output voltage. On the 10V range, the decimal point is read between the first and second digits. On the 1V range, it is read before the first digit. These decimal point positions are conveniently color coded. All dials except the first may be continuously rotated in either direction. This permits quicker switching between high and low digits. The first dial has stops at the 0 to 9 positions.

6.6 REMOTE SENSING

If the load is to be connected through an appreciable resistance such as a long cable, remove the shorting bars between the SENSE terminals and the OUTPUT terminals and connect the SENSE terminals to the load by separate wires. The dialed voltage will then appear across the load. The loop resistance of the OUTPUT leads should be limited to 20 ohms when remote sensing is employed, so that the 10 volt maximum output can be attained. The remote sensing leads may require shielding to prevent hum pick up on the output leads.

6.7 LOAD IMPEDANCE

To maintain proper operating conditions for the amplifier, the OUTPUT terminals should not be directly loaded with more than 1 MFD of capacitance. Shorting the output will not injure the DIAL-A-SOURCE, but 60 seconds may be required for it to return to normal operation after the short is removed.

6.8 CONSTANT CURRENT OPERATION

To operate the instrument as an adjustable constant current source, a model DAA-40 is required. The following instructions apply:

Remove the shorting bars between the +SENSE and +OUTPUT terminals, & plug the Adaptor into all four terminals. Connect the load to the output of the Adaptor. The load current, in milliamperes, is read directly from the dials. On the 1V range, the decimal point falls between the first & second dials. On the 10V range, the decimal point falls between the second & third dials.

NOTE: On the 10V range, do not dial more than 30 ma. Higher settings will not damage the instrument, but the dialed current will not be delivered.

The product of load resistance and dialed current should not exceed the maximum voltage available at the output of the Dial-An-Amp Adaptor. The maximum available voltage is 10.0 volts minus the voltage indicated by the dials as normally read for voltage.

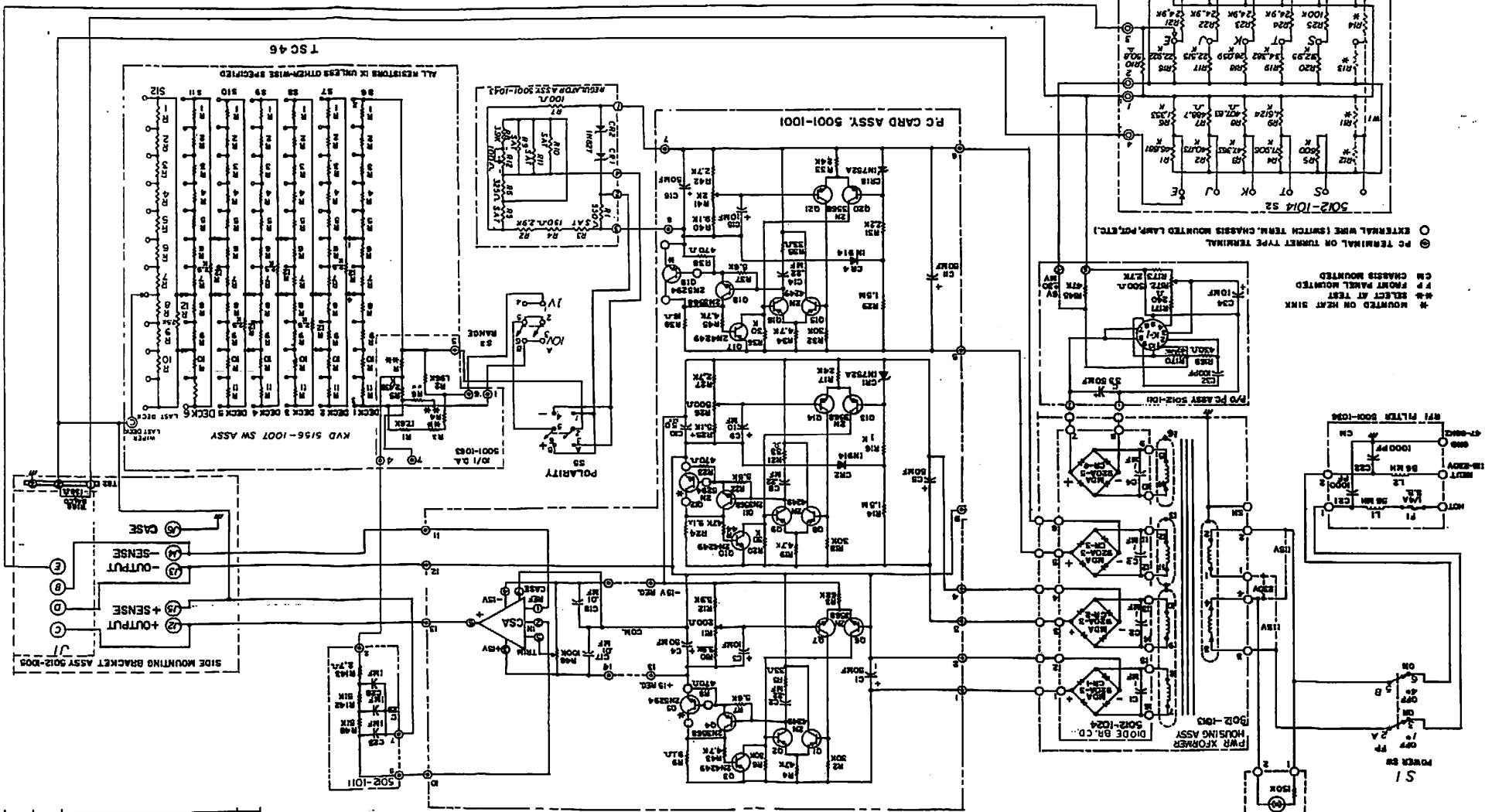
For example, on either range, when the dials are set for a constant current of 5 ma, they also indicate a voltage of 0.5V. Therefore, the maximum available voltage for this current is $10.0V - 0.5V = 9.5V$. The corresponding maximum permissible load resistance is $9.5 - 5ma$ equal 1.9K.

PLEASE NOTE:

TSC-46 performs as DAS-46AX

TSC-47 performs as DAS-47AL

GENERAL RESISTANCE, INC.		SCHEMATIC TSC47	
DRAWING DATE: 1/1/71		SHEET: 1 OF 1	
SCALE: 1/8"		5031-1000	
TOLERANCE: 1%		D	
FINISH: 1/8"		N	
MATERIAL: 1/8"		N	
USED ON: 1/8"		N	



REV	DATE	APPROV	DESCRIPTION
1	1/1/71		REDRAWN ORG. WORK
2	1/1/71		CI-C4 WERE 0.5% 1/2"

- * MOUNTED ON HEAT SINK
- ** SELECT AT TEST
- CM CHASSIS MOUNTED
- EXTERNAL WIRE (SWITCH TERM. CHASSIS MOUNTED LAMP, PWR, ETC.)
- PC TERMINAL ON TURNUP TYPE TERMINAL

* VALUE TO BE DETERMINED UPON SELECTION OF AN ADDITIONAL THERMO-COUPLE MATERIAL

