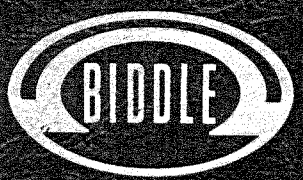
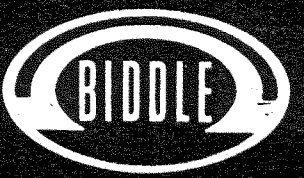


James G. Biddle Co.

PLYMOUTH MEETING, PA. 19462

Instruction Manual
72-320J

Digital Thermocouple Test Set Catalog No. 72-320



James G. Biddle Co.

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INSTRUCTION MANUAL 72-320J
FOR
DIGITAL THERMOCOUPLE TEST SET
CATALOG NO. 72-320-

JAMES G. BIDDLE CO.
TOWNSHIP LINE & JOLLY ROAD
PLYMOUTH MEETING, PA. 19462

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FIGURE 1: CATALOG NO. 72-320
DIGITAL THERMOCOUPLE TEST SET

SECTION A
INTRODUCTION

The Catalog 72-320 Digital Thermocouple Test Set is a portable, lightweight rugged, and completely self-contained dual-range instrument which automatically provides a digital display of temperature from thermocouples.

Standard models are furnished with two thermocouple ranges or with one thermocouple and one millivolt range for maximum flexibility and use.

The Test Set also can generate a calibrated millivolt output, exactly as if it had originated at a thermocouole, for calibrating other thermocouple type measuring instruments. The Test Set may be used for the following applications:

1. Measuring temperature with thermocouples.
2. Comparison of working and reference thermocouples.
3. Measuring millivolts from thermocouples or other sources (Test Sets with one range in mV).
4. Calibrating thermocouple type recorders, controllers, indicators, and other instruments of the deflection, null-balance, or digital type.
5. Calibrator for millivolt type recorders, controllers and indicators (Test sets with one range in mV).
6. Troubleshooting in thermocouple or millivolt dc control loops.

The Test Set features automatic reference-junction compensation to permit direct temperature measurement and "linearization" to compensate for the non-linearity of thermocouple millivolt output vs. temperature.

The Test Set is simple to operate, easy to read and has a high accuracy over a wide ambient temperature range. All models are battery-powered with self contained rechargers. The instrument is equipped with two sets of binding posts for maximum convenience when reading dual thermocouple inputs, or when using the Test Set for calibrating purposes.

SECTION B
SAFETY PRECAUTIONS

- SAFETY IS THE RESPONSIBILITY OF THE USER -

- LA SEGURIDAD ES EL CARGO DEL OPERADOR -

The 72-320 Test Set has been designed and constructed to meet the requirements of ANSI C39.5-1974 "Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation". This Test Set does not present any shock hazard during operation; however, all persons making or assisting in tests must use all practical safety precautions to prevent contact with energized parts of other test equipment and associated circuits.

Corrective maintenance must be performed only by a person who is familiar with the construction and operation of the Test Set and the shock hazard involved. The high voltage output of the DC/DC Converter which powers the gas discharge display is nominally 175V dc and can deliver up to 5 mA which, while not considered dangerous to life, could cause injury due to involuntary reaction. Use caution when handling the Test Set when it is removed from its case.

SECTION C
RECEIVING INSTRUCTIONS

Your Digital Thermocouple Test Set has been thoroughly tested and inspected to rigid inspection specifications before being shipped and is ready for use. Check the equipment received against the packing list. Notify James G. Biddle Co., Plymouth Meeting, Pa. of any shortage of materials. The Digital Thermocouple Test Set should be examined for damage received in transit. If any damage is found, file a claim with the carrier at once and notify James G. Biddle Co. or its nearest representative giving a detailed description of the damages observed.

BEFORE INITIAL USE OF TEST SET CHARGE BATTERIES FOR AT LEAST 12 HOURS.
Refer to Section H4 on page 20 for charging procedure.

SECTION D
SPECIFICATIONS

RANGES, LIMIT OF ERROR, RESOLUTION & REPEATABILITY: Refer to Table 1.

INPUT RESISTANCE: 20 megohms, nominal.

MAXIMUM SOURCE RESISTANCE: 2 KΩ causes less than 1 digit error on all ranges.

REFERENCE JUNCTION COMPENSATION: Automatic

INITIAL WARM-UP: <30 seconds for guaranteed limit of error.

OVERVOLTAGE: 50V dc continuous, 100V dc for short periods without damage.

OPERATING MODES: Selected by rotary switch.

- .Measure: For measurement within range listed in table.
- .Output: For generating output within range listed in table.
- .Check: For checking instrument reading against separate internal preset "reference" value.

OUTPUT: Continuously adjustable. Refer to Table 1 for Range and Resolution. Output resistance is less than 30 ohms. Display shows value of output.

INPUT/OUTPUT TERMINALS: 5-way binding posts. Two pairs with selector switch.

DISPLAY: 7-bar planar gas discharge with 0.33" character height. Readout is biploar with 4 digits and "-" sign.

- .Reading Rate: 2 per second. No blinking unless input changes.
- .Overrange Indication: Display blinks OFF/ON.
- .Open Thermocouple Indication: Display blinks OFF/ON.
- .Low Battery Indication: Display blinks DIM/BRIGHT.

SAFETY: Meets new ANSI C39.5-1974 specification - "Electrical Safety Requirements for Electrical Measuring and Controlling Instrumentation". Insulated case and panel.

BATTERY AND RECHARGER: Five Nickel Cadmium Cells ("Sub C" size). 1.2 AH capacity.

- .Minimum of 8 hours of continuous operation.
- .Batteries can be fully recharged overnight - (12 hours recharge time)
- .Instrument can be operated continuously while on recharge.
- .Power Required (Charge): 120V, 50/60 Hz, 0.1A - Unless otherwise marked on panel.

ACCESSORIES: ac line cord for battery charger included with instrument.

ENCLSOURE: Plastic panel with off-white finish. Impact-resistant charcoal gray textured finish, ABS plastic case with handle and hinged removable lid. Storage compartment for manual, test leads, and line cord for battery charger.

OPERATING TEMPERATURE RANGE: -10° to +55°C (14° to 131°F)

DIMENSIONS: 9" x 7-½" x 7-3/8" high (22.9 x 19 x 18.7 cm)

WEIGHT: 4-½ lbs. (2.0 kg)

TABLE 1

STANDARD RANGES, RESOLUTION AND LIMIT OF ERROR

RANGE NO.	RANGE COMBINATION (MEASURE & OUTPUT)	TC TYPE	RESOLUTION & REPEATABILITY (MEASURE & OUTPUT)	LIMIT OF ERROR* 1 YEAR, AT 25°C ±10°C
001	-310° to +1600°F	J	1°F	0.15% of Span
	0° to +2480°F	K	1°F	0.15% of Span
002	-305° to +625°F	T	0.1°F	0.25% of Span
	-50 to +99.99 mV Δ	-	10μV	0.05% of Span
003	-310° to +1600°F	J	1°F	0.15% of Span
	-50 to +99.99 mV Δ	-	10μV	0.05% of Span
004	0° to +2480°F	K	1°F	0.15% of Span
	-50 to +99.99 mV Δ	-	10μF	0.05% of Span
005	-190° to +745°C	J	0.1°C	0.15% of Span
	0° to +1380°C	K	1°C	0.15% of Span

*Includes Linearization Conformity, Reference Junction Compensation, Zero Drift and Noise.

ΔRange for measure mode. For output mode range is -12 to +55 mV.

SECTION E
BASIC CIRCUIT DESCRIPTION

1. GENERAL:

The 72-320 Portable Digital Thermocouple Test Set is a dual-range digital temperature indicator with internal cold junction reference.

The 72-320 accepts the millivolt output of a thermocouple and provides a digital display of the equivalent temperature. To accomplish this, it contains measuring circuitry to convert the input voltage to digital form and to display the result. As the voltage generated by the thermocouple is a nonlinear function of temperature, this circuitry includes a "linearizer".

2. FUNCTIONAL ELEMENTS:

The measuring circuitry of the 72-320 is shown in block diagram form in Figure 2. The circuitry includes the following functional elements.

(a) Dual Slope Voltage-to-Time Interval Converter (a)

The converter is a unique, low-level, double-loop auto-zeroing circuit with a capacitively coupled reference. The converter has three operating phases as follows:

(1) Input Integration - (Sample time approximately 200 milliseconds). The input is taken via a low level preamplifier whose gain is set by the range dependent span feedback network.

(2) Reference Integration - Generates a time interval proportional to the ratio of the integrated input to an internal precision temperature-compensated zener diode reference. A pulse train is counted during this time interval to obtain a digital result.

(3) Autozeroing Phase - Any offsets in the converter (including its low level, front end) are stored for use in correcting the next measurement.

(b) Reference-Junction Measuring Circuit (b)

A diode connected transistor is used as the reference-junction sensing element. The diode drop at 0°C is nulled out, and the remaining temperature varying voltage is divided by the reference-junction scaling attenuator (which is range dependent) to match the thermocouple characteristics. The net reference-junction compensation voltage is fed into the converter to add to the input voltage (in TC measure and output modes).

(c) Counter/Latch (c)

This is an LSI integrated circuit that includes a four-decade counter. The counter functions to:

(1) Time out the V to T.I. converter input integration period.

(2) Accumulate the result during the reference integration period.

(3) Time out the autozeroring interval.

The LSI circuit also includes a polarity store flip/flop and latch, output data scanning means.

(d) Clock (d)

This is a nominal 100 kHz clock oscillator used as the basis of all V to T.I. converter timing.

(e) Digital Control (e)

This circuitry includes a four-state "V to T.I. converter control counter". The states of this counter are as follows:

State 10 - Input Integration - During this state the clock is divided by two (to 50 kHz) and counted by the LSI

counter. The carrying pulse from the LSI counter advances the control counter. Also during the carry pulse the polarity information is stored.

State 11 - Reference Integration - During this state the LSI counter counts pulses processed by the linearizer. The counter is advanced when the comparator within the V to T.I. converter changes state. At the end of this state the data in the LSI counter is transferred to the latches within the LSI counter.

States 00 and 01 - During these two states the V to T.I. converter autozeroes. The LSI counter counts as in State 10. The Control Counter Advance occurs on the LSI Counter Carry Pulse.

(f) Digital Linearizer (f)

The linearizer operates on the 100 kHz clock during the reference integration time to produce a result pulse train. The linearizer includes a "Read Only Memory" which controls a digital rate multiplier.

The linearizer approximates the thermocouple characteristic with 16 straight-line segments per range. If the range is bipolar, there are eight segments for each polarity. The Read Only Memory contains 10 bits of slope information, 4 bits of segment length information, and 2 bits that control overload detection, for each of the 16 segments.

The linearizer includes a 16-state segment counter which addresses the ROM. To save battery power, the linearizer circuitry is only powered during the Reference Integration.

(g) Scan Oscillator (g)

This is an approximate 1 kHz oscillator which controls the display scanning. The oscillator has a 1/3 on-, 2/3 off-duty cycle.

(h) Display (h)

A four-digit and minus sign gas discharge type display. The display is scanned at the rate determined by the scan oscillator.

(i) Power Supply System

Includes the following components:

(1) Battery Pack (i): 6.2V nominal output

(2) DC/DC Converter (j): converts the 6.25V into a -10V supply and a 175V supply.

(3) Voltage Regulators (k): for the +5V, -7.5V and 175V supplies.

(4) Reference Supply (l): A precision zener diode acts as a reference voltage for the system. This diode has a temperature coefficient of 10 ppm/°C or better.

(5) Battery Low Detector (m): This circuit compares the battery voltage with a system logic level related to the regulated -7.5V supply. If the battery is low, the circuit causes the display to blink from normal brightness to dim.

(6) Charger (n): 120V, 50/60 Hz nominal input; 8.5V dc nominal output.

(j) Output Adjust Dual Potentiometer

When the unit is in the output mode, the Output Adjust Dual Potentiometers are energized with the system regulated voltages. The potentiometer outputs are mixed and attenuated with a resistor network and switched to the selected pair of input terminals.

1. GENERAL

Since proper operation of the Digital Thermocouple Test Set depends on correct use of switches and controls, the function of these devices is described before the operating procedures are presented. The location of the controls on the panel is shown in Figure 3.

2. CONTROLS & TERMINALS

(a) MODE Selector

This is a seven position switch having the following mode selections:

(1) OFF (center): Turns instrument OFF.
Take care to turn off instrument when not in use to conserve battery power. The instrument may be re-charged when OFF (recommended).

(2) MEASURE RANGE 1:
MEASURE RANGE 2:

These are the normal operating positions. In these positions the unit will measure and display the temperature of the thermocouple (or the voltage for mV range) attached to the selected TC binding post pair (A or B).

NOTE: In the measure selector switch position an open thermocouple or an input exceeding the limits of the selected range will result in the display blinking alternately OFF and ON.

(3) OUTPUT RANGE 1:
OUTPUT RANGE 2:

In these positions the selected TC binding post pair (A or B) is driven with a voltage that may be varied using the "OUTPUT ADJUST" control. The instrument measures the "OUTPUT ADJUST" voltage exactly as if it had originated at a thermocouple.

NOTE: In the "OUTPUT" selector switch positions an output voltage setting simulating a temperature outside of the limits of the selected range will result in the display blinking alternately OFF and ON.

Connection of a thermocouple to the selected TC binding posts in the "OUTPUT" mode will short out the output voltage - defeating the operation of this mode.

(4) CHECK RANGE 1:
CHECK RANGE 2:

In these positions the TC binding posts are disconnected from the measuring circuitry and a stable (appoximately 1.5 mV) internal reference is measured. The normal reading of your instrument, on the selected range is recorded on a label in the lid of the instrument. Obtaining the normal reading, ±2 counts, offers assurance to the operator that the measuring circuitry is functioning properly.

(b) Output Adjust:

This is a dual control rheostat for adjusting the instrument output. The display shows the simulated temperature or mV value of the output. The outer portion of the control is "coarse" and the inner control is "fine"; the ratio of the outer control to inner control is approximately 30/1. Turning the controls in a clockwise direction increases the output value.

(c) Binding Posts (TC A OR TC B):

Two pairs of posts are provided for connection to input or output. The posts are five-way type with standard 3/4" spacing.

(d) Binding Post Selector:

This is a paddle handle switch for selecting the desired pair of binding posts (A or B).

(e) Charge Receptacle:

This receptacle is provided for recharging the batteries from a 120V 50/60 Hz ac line. A special ac line cord is furnished with the instrument and is stored in the lid compartment.

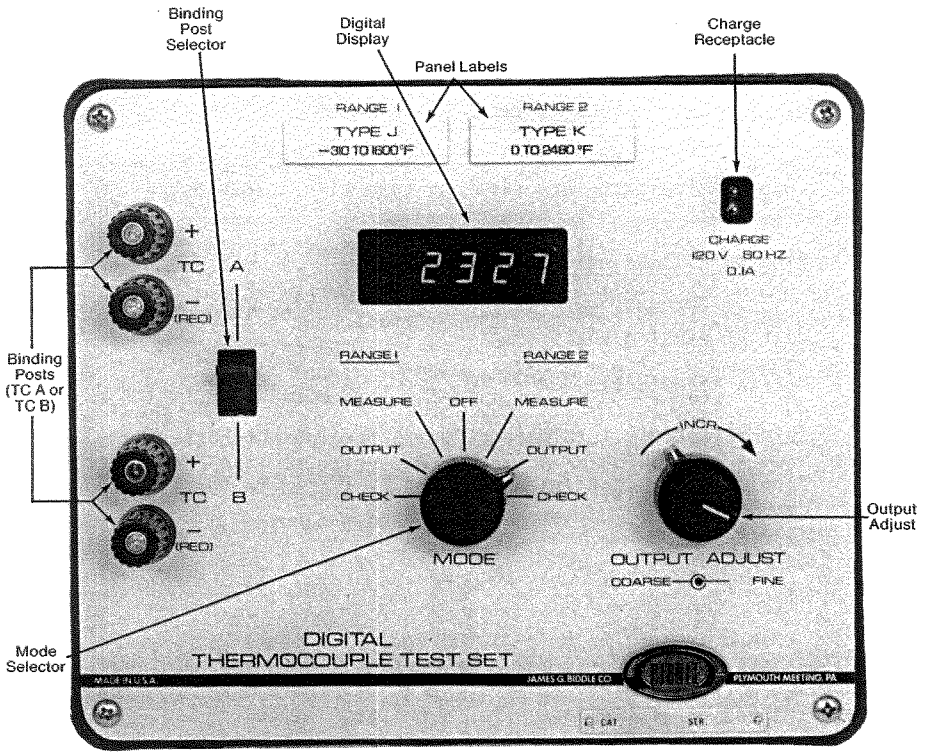


FIGURE 3
72-320 CONTROL IDENTIFICATION

SECTION G
CONNECTIONS

1. TEMPERATURE MEASUREMENT WITH A THERMOCOUPLE

Connect the thermocouple to be measured to either pair of input binding posts (A or B) as shown in Figure 4, taking care to connect the negative thermocouple wire (red) to the (-) binding post and the positive wire to the (+) binding post. Thermocouple extension leadwires, of the same type as the thermocouple must be used if it is desired to make the measurement at a remote location from the thermocouple termination.

If a shielded thermocouple is used, it is recommended that the shield be returned to the (+) input binding post along with the positive thermocouple lead.

2. CHECKING RECORDERS, INDICATORS OR CONTROLLERS

Connect the instrument to be chcked to either pair of the 72-320 binding posts (A or B) as shown in Figure 5. When using the TC range of the Test Set, thermocouple extension leadwires of the same type as the instrument calibration must be used to connect the two instruments. Take care to connect the negative thermocouple wire (red) to the (-) terminals of both instruments and the positive wire to the (+) terminals of both instruments.

Use copper wire to connect the two instruments when using the mV range of the Test Set.

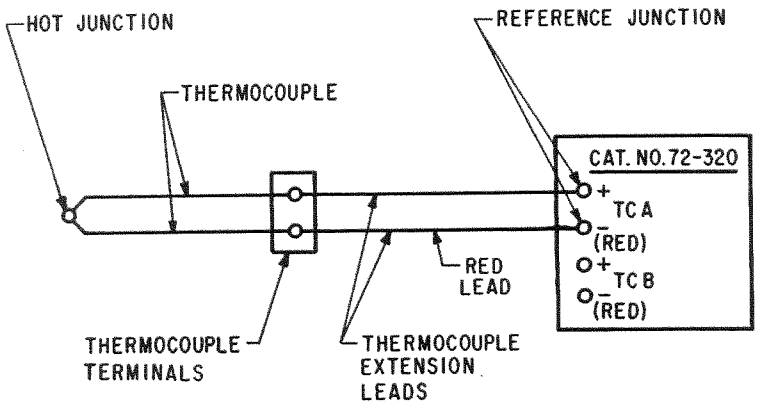


FIGURE 4: CONNECTION TO A THERMOCOUPLE

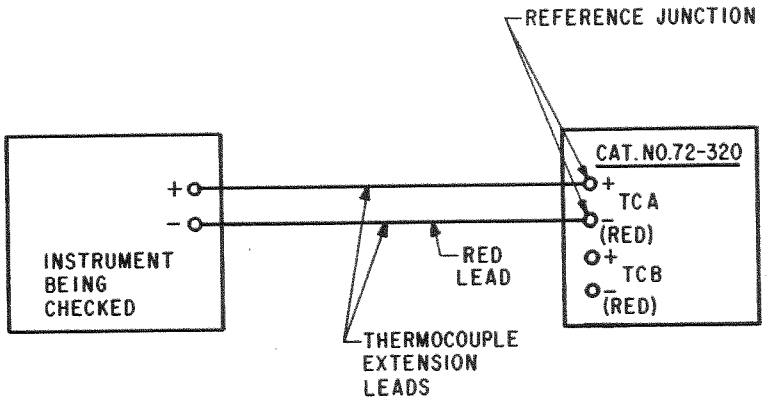


FIGURE 5: CONNECTION FOR CALIBRATING ANOTHER INSTRUMENT
(USE COPPER LEADS IF TEST SET IS ON mV RANGE)

SECTION H
OPERATING PROCEDURE

TO SAVE BATTERIES TURN SET OFF WHEN NOT IN USE.

DO NOT CONTINUE TO USE TEST SET AFTER LOW BATTERY WARNING.

1. GENERAL

The instrument can be operated in any position and is unaffected by normal vibration. The warmup time is less than 30 seconds for guaranteed limit of error. The Test Set should be battery operated for maximum accuracy.

2. TEMPERATURE MEASUREMENTS USING TC RANGE

Proceed as follows:

(a) Connect the instrument as described in Section G1 and as shown in Figure 4.

(b) Set the binding post selector switch to the position corresponding to the pair of binding posts used.

(c) Rotate the MODE selector switch to the MEASURE position which corresponds to the thermocouple type being measured. The range information is listed on the range labels.

(d) Read the value of the measured temperature on the display.

NOTE: The cold junction reference compensation circuitry is functioning in this mode so that the 72-320 reads the correct hot junction temperature.

3. CHECKING RECORDERS, INDICATORS, OR CONTROLLERS, TC TYPE, USING TC RANGE

Proceed as follows:

(a) Connect the instrument as described in Section G2 and as shown in Figure 5. Use thermocouple extension leadwires.

(b) Set the binding post selector switch to the position corresponding to the pair of binding posts used.

(c) Standardize the instrument to be checked, if required.

(d) Rotate the MODE selector switch to the OUTPUT position which corresponds to the thermocouple type of the instrument to be checked. The range information is listed on the range labels.

(e) On millivoltmeter Pyrometers it will be necessary to add an external resistance in either one of the connection leads to compensate for the lead resistance of the millivoltmeter. The value of this resistance should be equal to the resistance value which is marked on the scale of the millivoltmeter Pyrometer being checked.

(f) Adjust the OUTPUT ADJUST of the 72-320 so that the instrument to be checked comes to the selected check point.

(g) Read the value of the simulated temperature on the display. By repeating the procedure at various check points, a series of correction factors may be obtained.

NOTE: In some cases it may be more convenient to set the 72-320 to the desired simulated temperature and then observe the reading on the instrument to be checked.

The cold junction reference compensation circuitry is functioning in this mode so that the 72-320 and the instrument to be checked need not be at the same temperature.

When checking manual balanced instruments which have a low resistance circuit (<100 ohms) set the check instrument to the desired check value then adjust the output of the 72-320. This will avoid annoying interaction between the instruments due to off-null loading of the 72-320 output circuit.

4. BATTERY CHARGING

To charge the battery, plug the battery charger line cord into the CHARGE receptacle and into a 120V 50/60 Hz line. A full charge will be accummulated in approximately 12 hours (overnight). Charging occurs most efficiently with the instrument "OFF" (MODE switch in center "OFF" position). The 72-320 cannot be overcharged; it can be simultaneously operated while on charge indefinitely. However, when maximum accuracy is desired it is recommended the instrument be battery operated.

NOTE: To obtain maximum battery life, it is recommended that the unit be allowed to discharge to the point where the low battery indication (display blinks DIM/BRIGHT) is observed before recharging. However, operation to the point of complete display extinction may permanently damage the batteries.

5. CHECKING OPERATION

Proceed as follows:

(a) Rotate the MODE selector switch to Range 1 CHECK position.

(b) The Test Set should display the temperature value marked on the Range 1 label in the lid of the Test Set. The values should agree within ±2 counts.

(c) Rotate the MODE selector switch to Range 2 CHECK position.

(d) The Test Set should display the temperature or mV value marked on the Range 2 label in the lid of the Test Set. The values should agree within ±2 counts.

NOTE: If the deviation exceeds ±2 counts it is recommended that the test set be returned to the factory for recalibration.

1. TEMPERATURE MEASUREMENTS USING mV RANGE

Proceed as follows:

(a) Connect the 72-320 as described in Section GI and as shown in Figure 4.

NOTE: The automatic reference-junction compensator is not in the circuit on mV calibrated ranges; therefore, copper leads may be used in place of thermocouple extension leadwire between the test set and the thermocouple termination.

(b) Measure the thermocouple reference-junction temperature with an accurate mercury-in-glass thermometer and record the temperature.

NOTE: The reference-junction is at the point where the thermocouple leads or thermocouple extension leads are connected to the 72-320; however, if copper leads are used in place of thermocouple extension leads the reference-junction will be located at the point where the copper leads are connected to the thermocouple.

(c) Convert the reference-junction temperature reading to millivolts by referring to the appropriate table in JGB Thermocouple Temperature-Millivolt Conversion Table 60-35T (or NBS Monograph 125 or ASTM Standard E 230-72).

(d) Set the binding post selector switch to the position corresponding to the pair of binding posts used.

(e) Rotate the MODE selector switch to the MEASURE position which has the mV calibration.

(f) Read and record the value of the measured emf.

(g) Add, algebraically, the measured emf reading and the millivolt equivalent of the reference-junction temperature (step c).

h. Convert the corrected millivolts to temperature directly from the same conversion table. This value is the hot junction temperature reading.

Example: When ambient temperature is above 32°F

Test Set emf reading	35.98 mV
Reference-junction at 75°F type J	1.22 mV
Sum	37.20 mV

From conversion table 37.20 mV = 1235°F

Example: When ambient temperature is below 32°F

Test Set emf reading	15.07 mV
Reference-junction at 20°F type J	-0.34 mV
Sum	14.73 mV

From conversion table 14.73 mV = 520°F

2. CHECKING THERMOCOUPLES

In order to check a thermocouple, some means, such as an electric checking furnance, must be provided to maintain the hot (measuring) junction of the thermocouples at a known temperature. The checking procedure is basically that of comparing the emf output of a thermocouple to be checked against that of a Reference Thermocouple when the hot junction of the two thermocouples are at the same temperature. The procedure is as follows:

(a) Insert the hot (measuring) junction of the Reference and Check thermocouples, to a sufficient depth, into a temperature equalizing block within the checking furnace. This will maintain thermal uniformity between the two thermocouples and also will prevent the hot junction of the couples from being affected by heat flow along the wires. Connect the thermocouples to the Test Set as shown in Figure 6, observing proper polarity as described in Section G1.

NOTE: When optimum accuracy is not required, the temperature equalizing block can be eliminated, however, if practical, the thermocouples should be inserted into the check furnace in intimate contact with each other, and necessary precautions should be taken to minimize errors at the hot junction due to non-uniformity of temperature.

(b) Adjust the checking furnace to the temperature at which the thermocouples are to be checked.

(c) Set the Binding Post Selector Switch to position A.

(d) Rotate the MODE selector switch to the MEASURE position which corresponds to the proper thermocouple type used.

(e) Re-adjust the controls on the checking furnace, if necessary, until the desired temperature is obtained.

(f) Read the value of the measured temperature (Reference Thermocouple).

(g) Set the Binding Post Selector Switch to position B.

(h) Read the value of the measured temperature (Check Thermocouple). The thermocouple error is the difference between the temperature measured with the Check Thermocouple from that measured with the Reference Thermocouple.

NOTE:

(1) By repeating the above procedure at various known temperatures, a thermocouple can be checked for accuracy over its intended measurement range.

(2) It is not critical that the checking furnace be adjusted to the exact check temperature since the thermocouples are compared by a temperature difference method.

(3) To check a thermocouple using a millivolt calibrated range follow the procedure as outlined in Section II. Maximum accuracy, in this case, can be achieved by maintaining the reference-junction precisely at 32°F (0°C) by using a melting ice bath or an equivalent ice-point thermocouple reference system. This will minimize the errors due to any non-uniformity of temperature which may occur at an unprotected reference-junction terminal.

3. CHECKING RECORDERS, INDICATORS, OR CONTROLLERS, TC TYPE, USING mV RANGE

Proceed as follows:

(a) Connect the instrument to be checked to the desired binding posts (A or B) of the 72-320 using copper wire and observing proper polarity. See Figure 5.

NOTE:

(1) The automatic reference-junction compensator is not in the circuit on mV calibrated ranges.

(2) On millivoltmeter Pyrometers it will be necessary to add an external resistance in either one of the connection leads to compensate for the lead resistance of the millivoltmeter. The value of the resistance must be equal to the resistance value which is marked on the scale of the Pyrometer.

(b) Measure the reference-junction temperature with an accurate mercury-in-glass thermometer and record the temperature.

NOTE: The reference junction is located at the thermocouple terminals of the instrument to be checked.

(c) Convert the reference-junction temperature reading to millivolts by referring to the appropriate table in JGB Thermocouple Temperature-Millivolt Conversion Table 60-35T, ASTM Standard E 230-72 or NBS Monograph 125).

(d) Standardize the instrument to be checked, if required.

(e) Disconnect the leadwire at the instrument to be checked.

(f) Connect a short circuit jumper across the input terminals if the instrument is a null balance type; leave open circuited for deflection type instruments.

(g) The instrument to be checked should indicate the same reference-junction temperature as measured above. If necessary, adjust the reference-junction compensation for the correct temperature indication.

(h) Remove the short circuit jumper and reconnect the leadwire.

(i) Set the Binding Post Selector Switch to the position corresponding to the pair of binding posts used.

(j) Rotate the MODE selector switch to the MEASURE position which has the mV calibration.

(k) Convert the temperature point to be checked to the equivalent millivolt value using the proper temperature-millivolt conversion table. Subtract, algebraically, the millivolt equivalent of the reference-junction temperature (Step C). This value is the corrected hot junction equivalent millivolts for the simulated temperature.

(l) Adjust the OUTPUT ADJUST of the 72-320 to the corrected hot junction equivalent millivolt value.

(m) The temperature indicated on the check instrument should agree with the selected check point temperature value.

4. CHECKING POTENTIOMETER INDICATORS, RECORDERS, OR CONTROLLERS (MILLIVOLT TYPE)

Proceed as follows:

(a) Connect the instrument to be checked to the desired binding posts (A or B) of the 72-320 using copper wire and observing proper polarity. See Figure 5.

(b) Standardize the instrument to be checked, if required.

(c) Set the Binding Post Selector Switch to the position corresponding to the pair of binding posts used.

(d) Rotate the MODE selector switch to the OUTPUT position which has the mV calibration.

(e) Adjust the OUTPUT ADJUST of the 72-320 so that the instrument to be checked balances at the selected check point.

(f) The mV value indicated on the check instrument should agree with the mV reading on the 72-320.

NOTE: The automatic reference-junction compensation is not in the circuit on mV calibrated ranges.

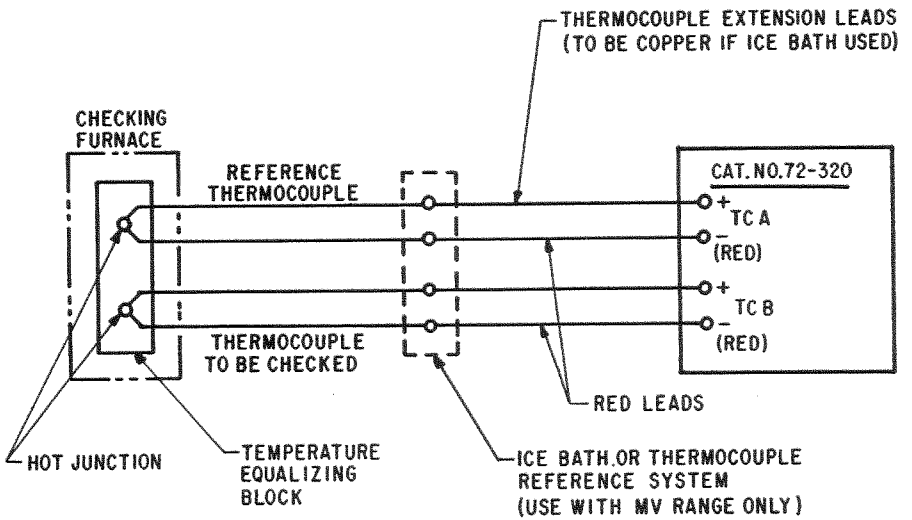


FIGURE 6: CHECKING THERMOCOUPLES

SECTION J
MAINTENANCE

1. GENERAL

For maintenance not described below, or the replacement of parts not listed in Section L, it is recommended that the Test Set be returned to the factory.

2. REMOVAL OF TEST SET FROM CASE

Unscrew the screws from the 4 corners of the unit front panel and lift the unit out of its case. With the unit out of its case it may be inspected for broken wires or unplugged or loose connectors or subassemblies.

WARNING

Body contact with any electrically conductive part in the high voltage (175V dc) circuit is a potential shock hazard. Refer to Section B Safety Precautions.

3. CALIBRATION ADJUSTMENTS

All calibration adjustments are found on the underside of the unit. The zero and span adjustment trimmers are sandwiched between the lower analog board and a smaller customizing board which is plugged and soldered into the lower analog board. Adjustment screws are accessible from the sides of the unit. The detailed calibration for the Test Set is described in Section K while Figure 9 shows the location of the calibration trimmers.

4. BATTERY REPLACEMENT

The symptoms of a battery pack failure is the inability of the batteries to hold a charge.

To remove the battery pack first pull out the long red and black wires from the connector assembly on the side of the battery pack cover, then unscrew its two hold down screws.

Carefully remove the battery pack then unsolder the short red and black connector wires at the battery solder tabs.

Replace all five batteries in the battery pack with Sub C size Nickel Cadmium Cells (Gould Nicad 1.2SCL, Eveready CH1.2T or equal). Connect the 5 cells in series by soldering short lengths of solid copper wire between the battery solder tabs. Resolder the short red lead to the plus (+) six volt end terminal and the black lead to the minus (-) six volt end terminal. Replace the battery pack taking care to match the red battery lead with the red connector lead of the unit and similarly to match the two black leads.

After replacement of the battery pack recalibrate the Low Battery Blink Point as described in Section K6.

5. DISPLAY ASSEMBLY REPLACEMENT

The display assembly may be removed and replaced to facilitate quick repair of display related failures such as an incorrectly illuminated display segment or a bad digit.

To replace the display it is necessary to remove the Display PC Board as well as the attached linearizer PC board. Remove the 2 flat head screws from the hold down bracket above the linearizer PC board then remove the bracket. This is the bracket at the bottom of the unit adjacent to the flat multi-color cable. Cut the white pastic tie-down strap which secures the linearizer PC board to the large mating PC board. The display linearizer combination may then be unpluged and lifted out of the unit. Take care not to bend or damage the connector pins and mates.

Separate the display board from the linearizer board by unsoldering and disconnecting the interlocking slots holding them together.

Replace the entire display board assembly with a new assembly then reassemble the unit. In reassembling the unit, first plug in the new display board, taking care to line up pins and their mates, then plug in the linearizer board taking care to line up pins and their mates. Check Test Set and display for proper operation, then resolder the interlocking slots of the two PC board assemblies. Resecure the linearizer board hold down bracket then install a new plastic tie-down strap.

SECTION K
CALIBRATION

1. GENERAL

The purpose of this calibration is to check or correct changes caused by component aging or by component changes in the 72-320. Before attempting to recalibrate the Test Set check for proper operation. A complete overall accuracy check should be performed before attempting to readjust any of the calibration trimmers.

The calibration check should be performed in a laboratory free from drafts and where the temperature is stable and maintained at 25°C ±2°C. The Test Set should be battery operated for the entire calibration and should be off charge for at least 2 hours before starting calibration.

Two calibration methods are described, one using a Melting Ice-Bath (or equivalent Ice-Point Thermocouple Reference System) in conjunction with portable millivolt Potentiometer; the other using a portable millivolt Potentiometer having a built-in reference-junction compensator. The Melting-Ice Bath method is recommended, however, the other is generally more convenient.

2. EQUIPMENT RECOMMENDED

(a) Precision Millivolt Potentiometer with manual reference-junction compensator or Precision Variable Voltage Source: Output range 100 mV, Accuracy ±0.03% of reading, Resolution & Stability 1μV. — JGB Cat. No. 72-3110 (or equal) JGB Cat. No. 72-311 (field calibration with ±0.05% accuracy)

NOTE: For Test Set with a mV calibrated range the Potentiometer or voltage source should have a full scale accuracy of ±0.01%.

(b) Melting Ice Bath or Equivalent Ice-Point Thermocouple Reference System: Capable of maintaining a temperature of 32°F (0°C) ±0.2°F

(c) Thermocouple Extension Leads: Same Type as Test Set Calibration

(d) Mercury Thermometer: Capable of reading 32°F (0°C) or ambient temperature: Accuracy ±0.2°F

(e) Variable Power Supply 0 to 10 volts dc output, 1A (To set low battery blink point)

3. CALIBRATION OF THERMOCOUPLE RANGES (USING MELTING ICE BATH)

Proceed as follows:

(a) Connect the 72-320 Test Set to the check instrument (72-3110) as shown in Figure 7.

NOTE: Thermocouple extension leadwires of the same type as the instrument calibration must be used to connect the melting ice bath to the 72-320. Take care to observe proper polarity.

(b) Check thermometer to make sure temperature of melting ice bath is 32°F (0°C) ±0.2°F.

(c) Set the binding post selector of both instruments to position (A).

(d) Rotate the function selector switch of the check instrument (72-3110) to the EMF OUTPUT position.

(e) Rotate the MODE selector switch of the 72-320 Test Set to the MEASURE position which corresponds to the thermocouple range to be checked.

(f) Using Table 2, for proper range, adjust the mV output of the check instrument (72-3110) to obtain the specified zero mV and span mV calibration values, then depress the DET key on the

72-3110.

NOTE: The points chosen are the segment end points for the actual linearization.

(g) Read the temperature values on the 72-320. These values should agree with the table 2 temperature values within the stated tolerances (values in parenthesis). Record all readings in the space provided in the table.

(h) If the deviation exceeds the given tolerance, remove the test set from the case (4 panel screws) to gain access to the zero and span trimmer potentiometers. See Figure 9 for location of trimmers.

(i) Following the steps (f) and (g) procedure, readjust the trimmers to obtain the correct zero and span temperature values.

NOTE: Each of the two ranges have a separate zero and span trimmer and must be separately calibrated.

WARNING

Body contact with any electrically conductive part in the high voltage (175V dc) circuit is a potential shock hazard. Refer to Section B Safety Precautions.

(j) Place the Test Set in its case and proceed with the calibration check using the remaining seven check point entries in Table 2. Adjust the mV output of the check instrument (72-3110) to the desired mV value then read the corresponding temperature value on the 72-320. Record the results.

(k) The deviation of the temperature values from the seven check point values should be within the stated tolerance.

(l) Following the entire foregoing procedure proceed with the calibration check for the second range. Remember to change

the thermocouple extension leadwires to the same type as the range calibration.

(m) If the errors for both ranges are offset from nominal predominantly in one direction and the shift is in excess of the given tolerance, make necessary correction with the (Balance Control" trimmer (See Figure 9). Adjust trimmer to give a balanced + and - deviation from nominal over the entire range.

NOTE: The balance control shifts both ranges simultaneously.

(n) If the balance control has been reset, recheck the calibration of the Test Set, on both ranges, at each of the calibration and check points listed in Table 2.

(o) If the Test Set error exceeds the tolerance values listed in Table 2, after readjusting all calibration trimmers, it is recommended that the Test Set be returned to the factory.

4. CALIBRATION OF THERMOCOUPLE RANGES (REFERENCE-JUNCTION COMPENSATION METHOD)

Proceed as follows:

(a) Connect the 72-320 Test Set to the check instrument (72-3110) as shown in Figure 8.

NOTE: Thermocouple extension leadwires of the same type as the instrument calibration must be used to connect the two instruments. Take care to observe proper polarity.

(b) Measure the reference-junction temperature at the terminals of the check instrument (72-3110) with the mercury-in-glass thermometer.

(c) Set the reference-junction emf (equivalent to the reference-junction temperature for the appropriate type of thermocouple) in the 72-3110 check instrument. The procedure is explained in the 72-3110 instruction manual.

(d) Set the binding post selector switch of both instruments to position (A).

(e) Rotate the function selector switch of the 72-3110 check instrument to the TC OUTPUT position.

NOTE: The reference-junction compensator of the 72-3110 is functioning in this output position.

(f) Rotate the MODE selector switch of the 72-320 Test Set to the MEASURE position which corresponds to the thermocouple range to be checked.

(g) Following the same exact procedure as stated in Paragraph 3, step (f) through (o) proceed with the calibration check for both thermocouple ranges.

5. CALIBRATION OF MILLIVOLT RANGE

Proceed as follows:

(a) Connect the 72-320 Test Set to the check instrument as shown in Figure 8 except use copper wire. Observe proper polarity.

NOTE: The check instrument should have a full scale accuracy of ±0.01% for this calibration.

(b) Set the binding post selector switch of both instruments to position (A).

(c) Rotate the function selector switch of the check instrument to the EMF OUTPUT position.

(d) Rotate the MODE selector switch of the 72-320 Test Set to the Range 2 MEASURE position (mV range).

(e) Following the same procedure as stated in paragraph 3, starting with step (f), proceed with the calibration check for the millivolt range, using the Table 2 millivolt values.

6. CALIBRATION OF LOW BATTERY BLINK POINT

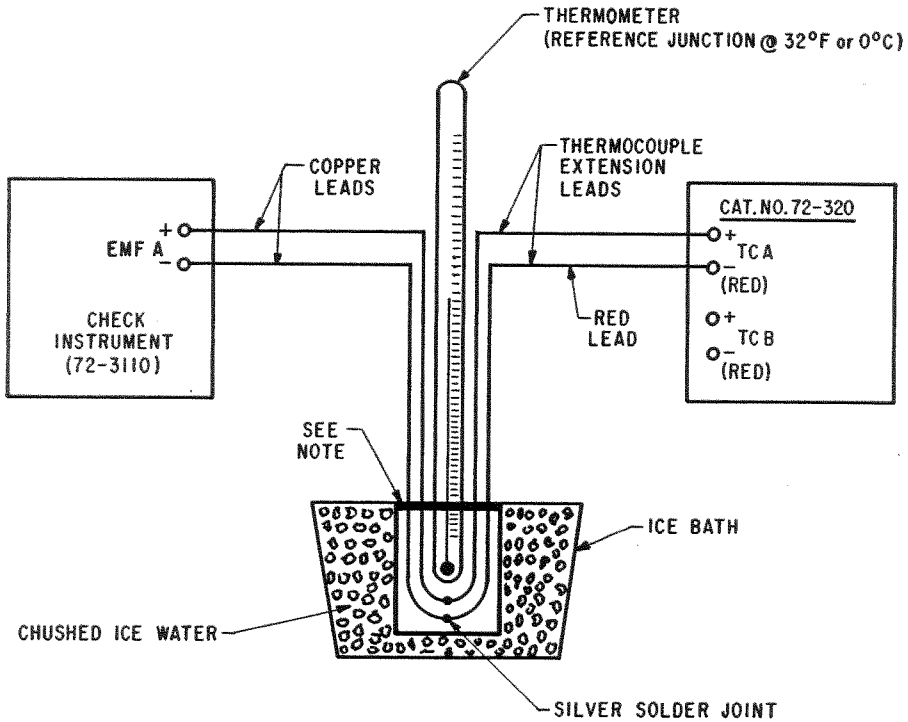
Proceed as follows:

(a) Disconnect the red and black wires at the battery pack connector (internal connection) and connect the variable dc Power Supply to the ac power line and to the Test Set. Connect the red wire to the (+) terminal of the Supply and the black wire to the (-) terminal.

(b) Rotate the MODE selector switch of the 72-320 to one of the CHECK positions.

(c) Set trimmer R50 (low battery threshold adjust) so the threshold of blinking is at 6.00 to 6.05 volts input voltage. See Figure 9 for location of trimmer.

(d) Reconnect the red and black wires in the battery pack connector, observing the polarity connection as on the opposite side of the connector, and replace the Test Set in its case.



NOTE: THERMOCOUPLE & THERMOMETER IN METAL TUBE, SEALED AT TOP TO PREVENT AIR FROM CIRCULATING IN & OUT OF TUBE. BOTTOM OF TUBE TO BE PACKED WITH HEAT SINK COMPOUND TO COVER THERMOCOUPLE JUNCTION & THERMOMETER BULB.

FIGURE 7: CALIBRATION OF THERMOCOUPLE RANGES BY ICE-BATH METHOD.

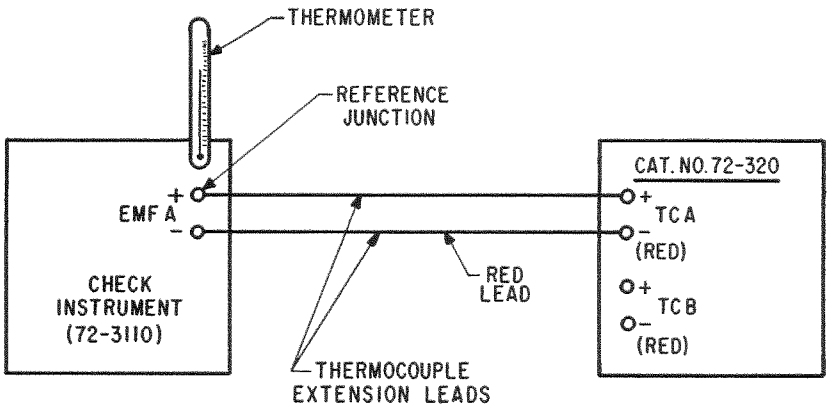


FIGURE 8: CALIBRATION OF THERMOCOUPLE RANGES BY REFERENCE-JUNCTION COMPENSATION METHOD.

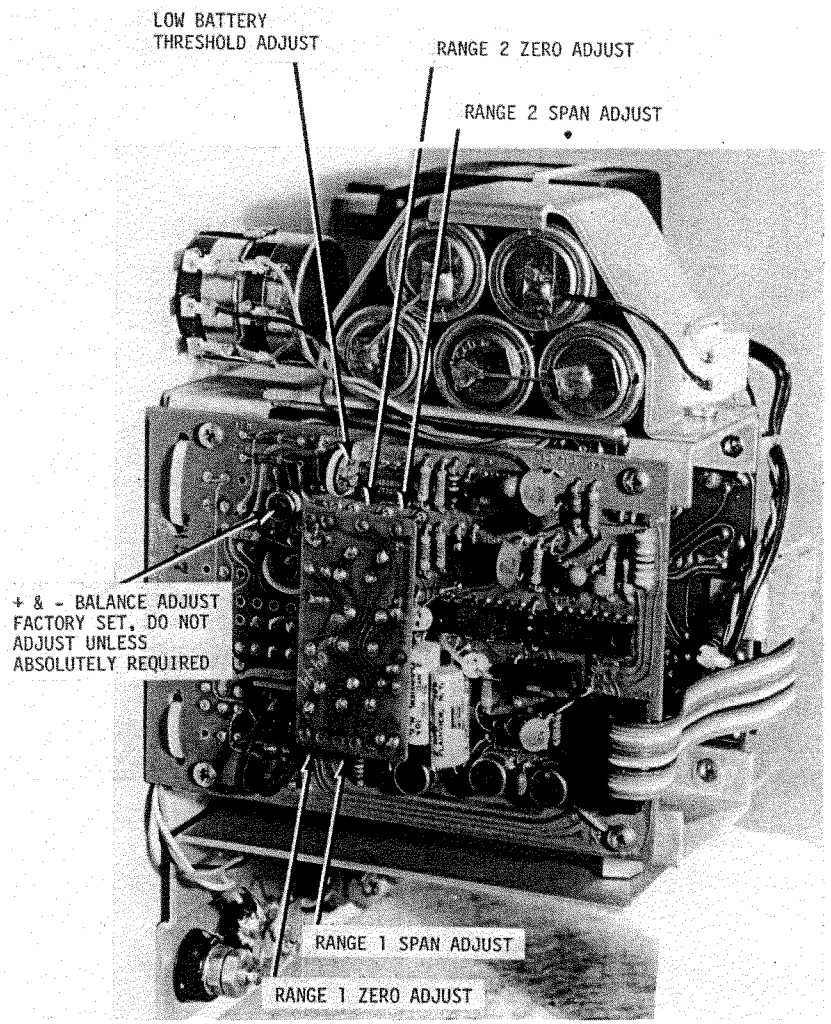


FIGURE 9: LOCATION OF CALIBRATION TRIMMERS.

TABLE 2 CALIBRATION TABLE

RANGE	DESCRIPTION	CALIBRATION POINTS		CHECK POINTS						
		SET ZERO TRIMMER	SET SPAN TRIMMER	1	2	3	4	5	6	7
J -311° to 1601°F	72-320 °F Check Inst. mV Tolerance °F Reading °F	0° -0.885 (±0°)	1576° 49.213 (±0°)	-295° -7.447 (±1°)	-204° -5.841 (±1°)	-133° -4.285 (±1°)	-64° -2.586 (±1°)	177° 4.216 (±1°)	940° 27.637 (±1°)	1293° 39.165 (±1°)
J -190.0° to 743.0°C	72-320 °C Check Inst. mV Tolerance °C Reading °C	0.0° 0.000 (±0.2°)	730.0° 41.013 (±0.2°)	-185.0° -7.533 (±0.4°)	-147.8° -6.426 (±0.4°)	-110.0° -5.036 (±0.4°)	-64.8° -3.111 (±0.4°)	210.3° 11.348 (±0.4°)	382.0° 20.853 (±0.4°)	591.8° 32.617 (±0.4°)
K 0° to 2480°F	72-320 °F Check Inst. mV Tolerance °F Reading °F	0° -0.692 (±0°)	2423° 53.381 (±0°)	227° 4.439 (±1°)	464° 9.745 (±1°)	807° 17.688 (±1°)	1202° 27.022 (±1°)	1420° 32.088 (±1°)	1721° 38.849 (±1°)	2131° 47.583 (±1°)
K 0° to 1380°C	72-320 °C Check Inst. mV Tolerance °C Reading °C	0° 0.000 (±0°)	1380° 55.149 (±0°)	219° 8.898 (±1°)	391° 16.016 (±1°)	642° 26.684 (±1°)	813° 33.809 (±1°)	991° 40.918 (±1°)	1277° 51.592 (±1°)	-
T -306.5° to 624.7°F	72-320 °F Check Inst. mV Tolerance °F Reading F	20.0° -0.256 (±0.3°)	520.3° 13.210 (±0.3°)	-295.5° -5.296 (±0.6°)	-127.8° -3.052 (±0.6°)	-54.1° -1.745 (±0.6°)	54.7° 0.494 (±0.6°)	275.3° 5.965 (±0.6°)	439.8° 10.717 (±0.6°)	-
mV -50.00 to 99.99mV	72-320 mV Check Inst.mV Tolerance mV Reading mV	N/A	99.95 99.950 (±0.010)	-50.00 -50.000 (±0.020)	-25.00 -25.000 (±0.020)	0.00 0.000 (±0.010)	25.00 25.000 (±0.020)	50.00 50.000 (±0.020)	75.00 75.000 (±0.020)	-

SECTION L
FIELD REPLACEABLE PARTS LIST

JGB PART NO.	QUANTITY/ INSTRUMENT	DESCRIPTION
11166-2	4	Binding Posts (Superior #DF31BC)
14877	1	Knob, Mode Selector (Rogan #RB-67-2-SB-M color black)
14877-1	1	Knob, Dual, Output Adjust (Rogan #RB-67-2-SB+1-M-L color black)
14870-1	1	Switch (TC A - TC B), (C & K #7201J2ZQ)
14913	1	Potentiometer, Dual, Output Adjust.
14914	1	Filter, Display
14915	5	Battery, Rechargeable, Sub C size, (Gould Nicad 1.2 SCL, Eveready CH1.2T or equal)
~~14916~~ 15004	1	Charger, Battery, 120V a.c. Type A11-1300
14911	1	Line Cord, 120V a.c. 6 ft. long (Craig #1306-144)
14910	1	Receptacle, 120V a.c., (Craig #2607083)
10998	1	Case, Test Set, Bottom
10997-1	1	Case, Test Set, Lid
72-320J	1	Instruction Manual, Cat.No.72-320
60-35T	1	Temperature-Millivolt Conversion Table (used on mV ranges only).
14917	1	Display Assembly

SECTION M
WARRANTY

All products supplied by the James G. Biddle Co. are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

REPAIRS

The James G. Biddle Co. maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.

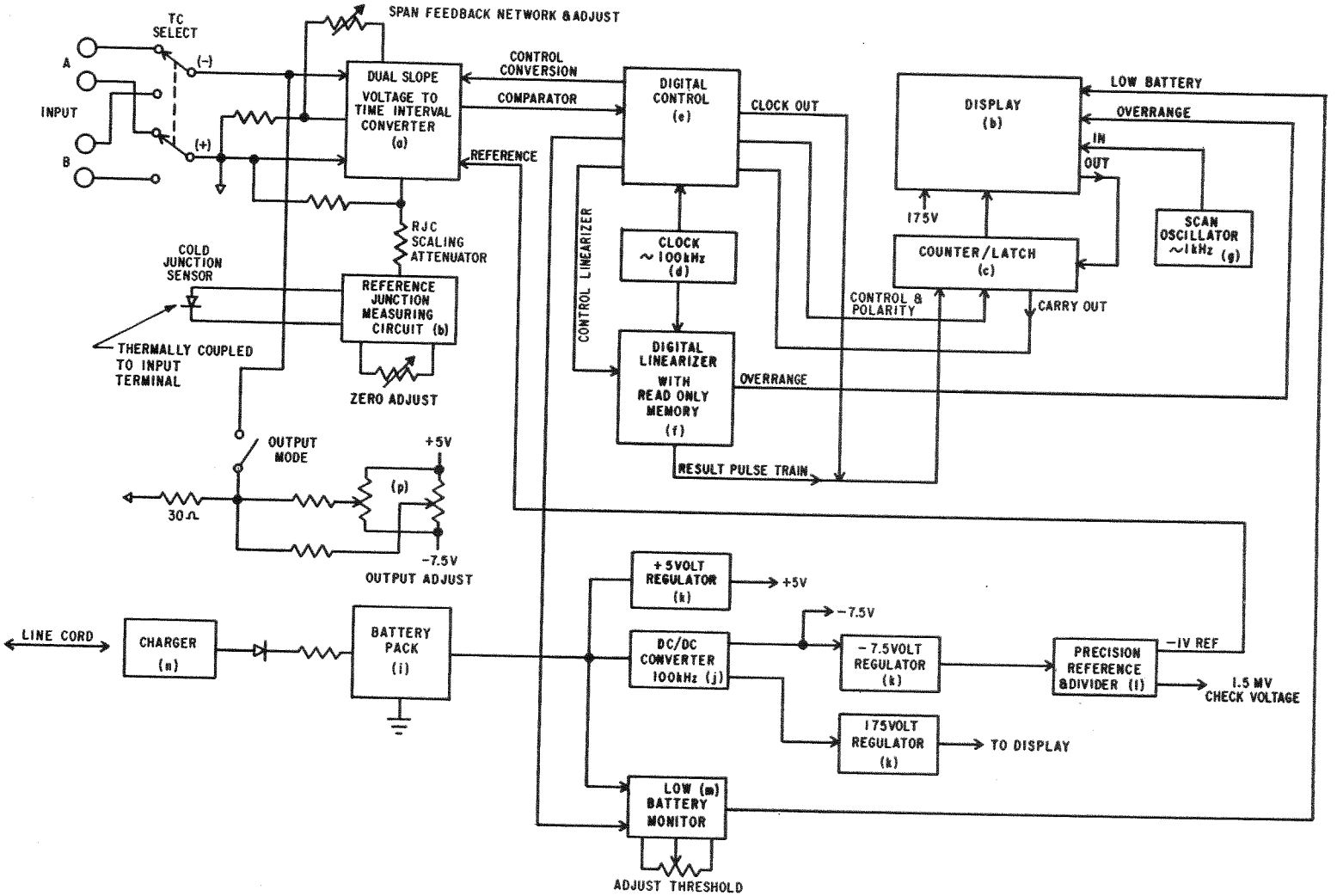


FIGURE 2 BLOCK DIAGRAM OF 72-320