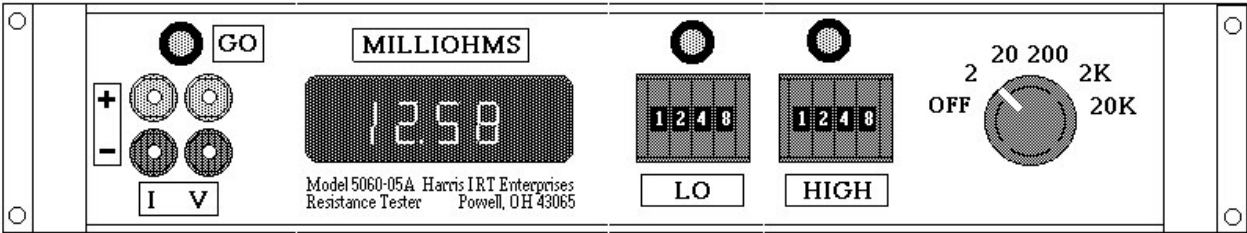


Model 5060-05A Milliohm Resistance Tester



Operators Manual

Harris IRT Enterprises, Inc.
Digital Milliohm Resistance Tester - Model 5060-05A

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EQUIPMENT CONFIGURATION:

Resistance Tester Model 5060-05A, serial number _____, is equipped with the following options as indicated.

_____ Temperature Compensation at _____ for _____

RS-232 Computer Interface _____

Binary Coded Decimal Computer Interface _____

Remote Range Select _____

Sample and Hold _____

Safety Relay _____

230 VAC Service _____

Diode Polarity Test _____

Foot Switch _____

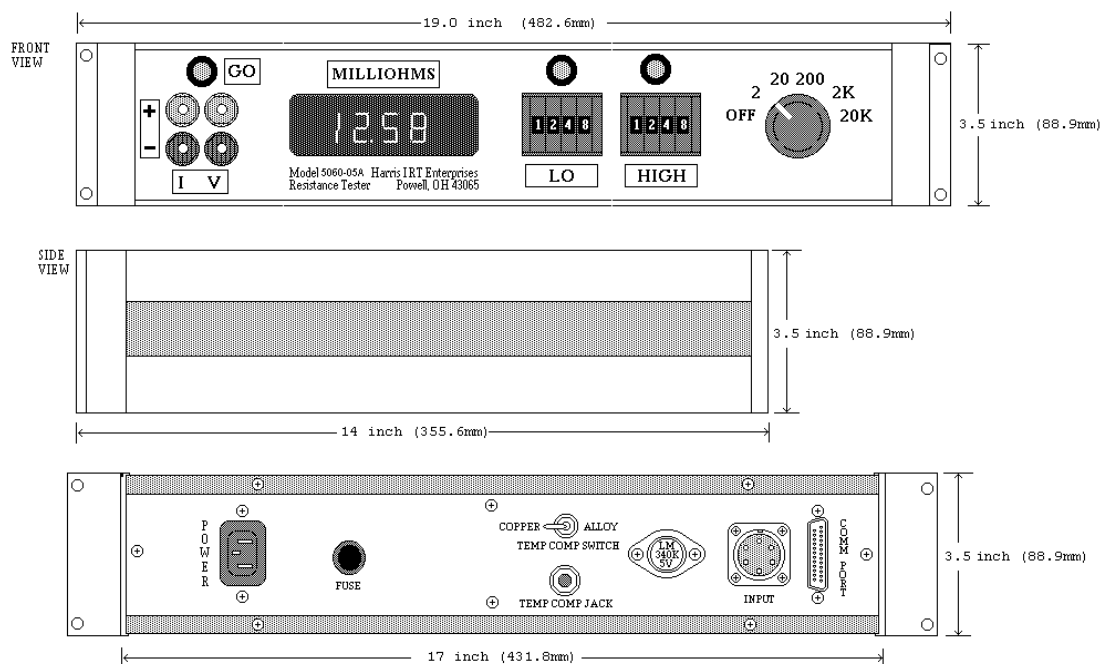
Buzzer _____

Other _____

SPECIFICATIONS

ACCURACY (% FULL SCALE)	+/-0.05% (Includes +/- 1 digit) at 25 o C +/-0.001% per o C from 0 to 70 o C
RANGES	0 to 1.999, 19.99, 199.9, 1.999K, 19.99K Milliohms
DISPLAY	3 1/2 digit LED
READING RATE	4 readings per second (minimum)
TERMINALS	Max. Full-scale voltage is 2.0 Volts and less than 1Amp. Current
POWER REQUIREMENTS	117 VAC +/- 10 %, 50-60 Hz, 5 Watts. 2 amp Slo-Blo fuse (230 VAC optional)
TEST CONNECTIONS	4 wire Kelvin required
CONNECTORS	Rear panel MS-style circular connector and front panel banana jacks
LIMIT ALARM TERMINALS	Dry contacts rated at 5A. At 117 VAC

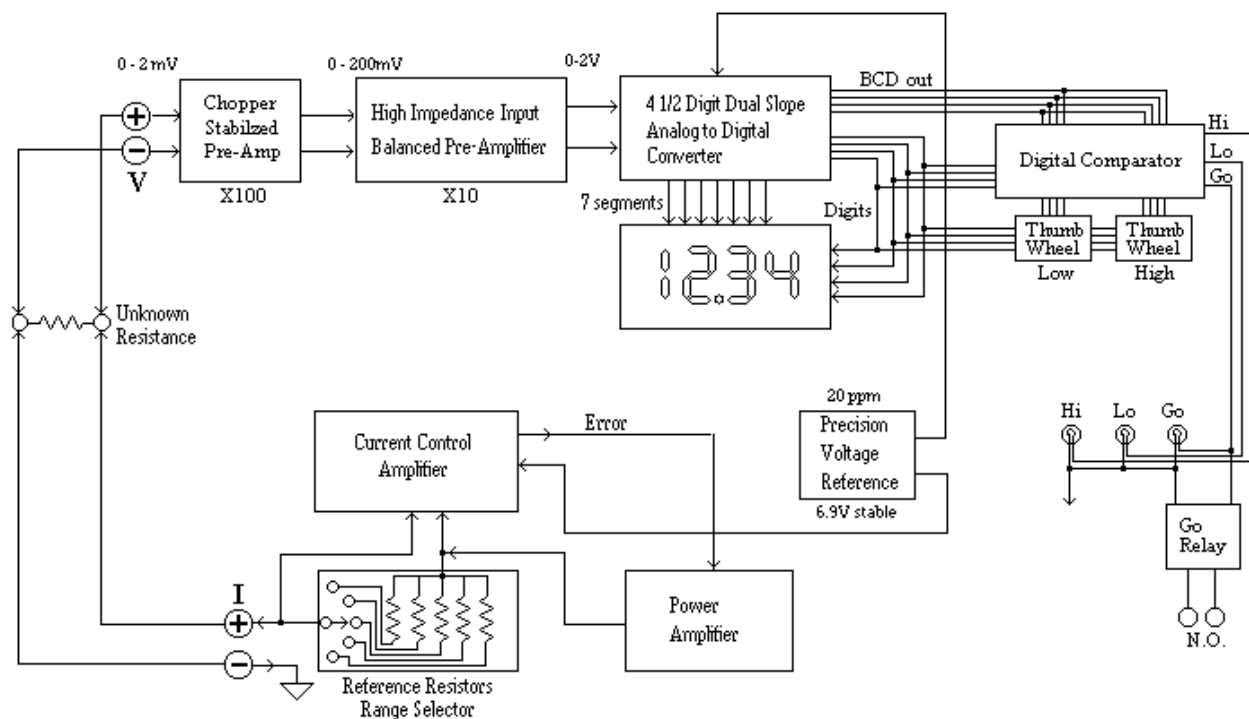
DIMENSIONS



THEORY of OPERATION:

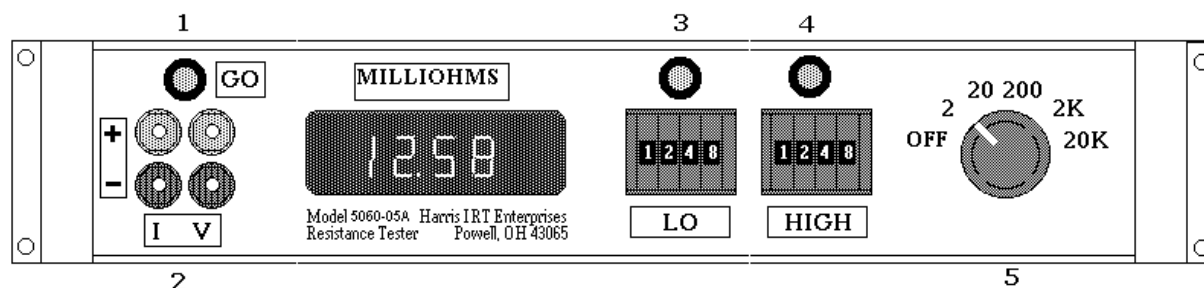
The Harris IRT Enterprises Model 5060-05A Milliohm Resistance Tester is a digital milliohmmeter that includes a precision constant current source which drives a known current through an unknown resistance. It features four readings per second and a temperature compensated voltage reference serving both the DVM and the constant current source. This results in a stable calibration reference. A digital voltmeter measures the potential across the resistance and presents a digital display of the resistance in Ohms. CMOS circuit construction includes a dual limit comparator which compares the measured resistance with upper and lower tolerance values entered on front panel thumbwheels. Red and green front panel lights indicate whether or not the resistance is within tolerance. An output relay permits the resistance tester to be converted to a rejection device. For "fail-safe" operation the contacts are normally open. The contacts close if the part is within tolerance.

BLOCK DIAGRAM:



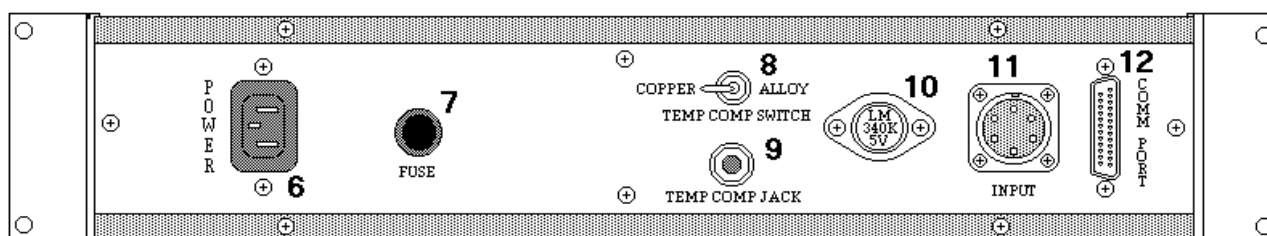
OPERATION of UNIT

FRONT PANEL VIEW:



- 1) Green light indicates that the part under test is within tolerance.
- 2) Front panel banana jacks allows a 4-wire Kelvin connection to be made.
- 3) Select LOW limit. Red light located above LOW limit thumbwheel switches indicates that the part under test is below tolerance.
- 4) Select HIGH limit. Red light located above HIGH limit thumbwheel switches indicates that the part under test is above tolerance.
- 5) Range select knob. Rotate to correct range. Resistance of the part under test appears on the LED display. A flashing "0000" display indicates that the RANGE SELECTOR (5) is set lower than the resistance being measured.

REAR PANEL VIEW:



- 6) Power cord. Connect to 117 VAC 50-60 Hz. Optional 230 VAC operation available.
- 7) Fuse holder. Use a 2 Amp Slo-Blo Fuse.
- 8) Temperature compensation switch.¹ Center position is OFF.
- 9) Temperature compensation jack for Harris IRT Enterprises, Inc. temperature probe (TC Probe)².
- 10) LM340 KC-5 regulator transistor.
- 11) 6-pin female MS-style circular connector.³ 12) 25-pin female DB-style connector, for use with RS-232 or BCD.⁴

¹ Optional equipment.

² Optional equipment. Order MA1061 for replacement TC probe.

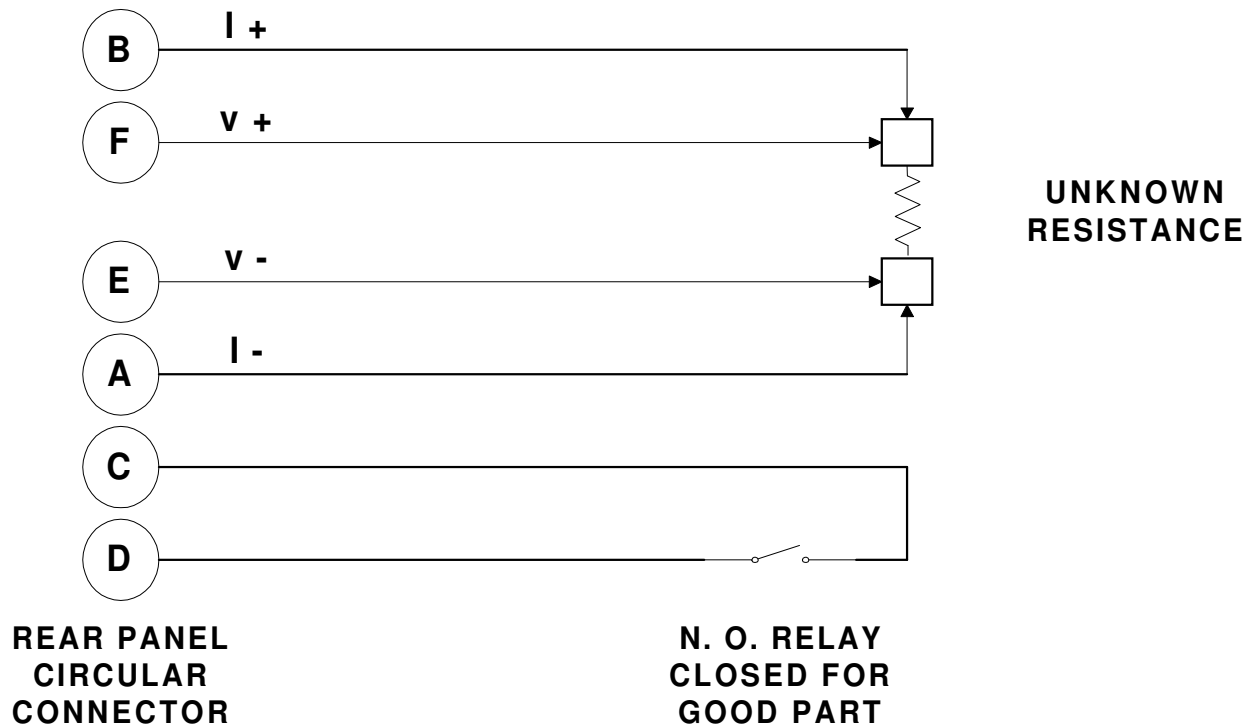
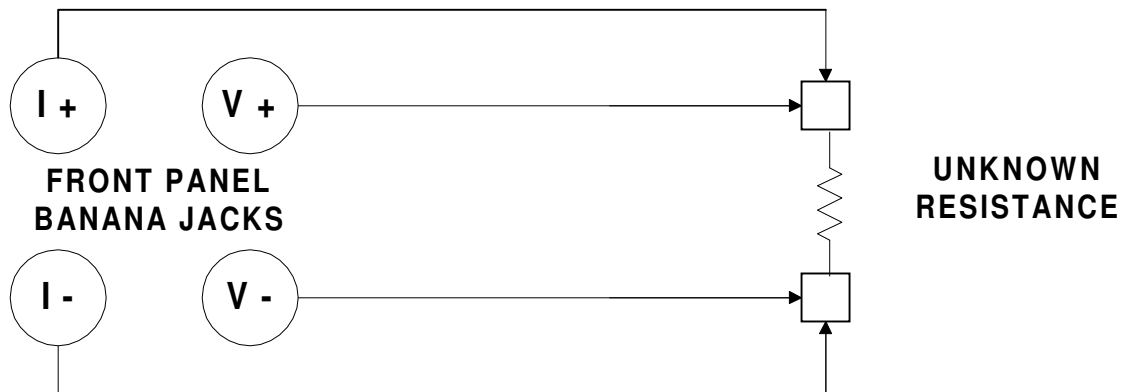
³ Mating connector for rear panel connection is available from Harris IRT Enterprises, part # 97.

⁴ Optional equipment

TEST CONNECTIONS:

NOTE:

For greatest accuracy each voltage and current lead must connect separately to the component under test.



5060-05A CALIBRATION PROCEDURE REQUIRED EQUIPMENT:

A. A digital voltmeter / milliammeter with a 4 ½ digit resolution is required. A Fluke® Model 8050A is suitable.

B. A set of five standard resistances, one for each range to be calibrated. A precision of at least 0.02% is necessary to calibrate this instrument to specifications. Harris IRT Enterprises, Inc. can supply a 0.02% resistance set, Model 2005, with standard resistances and switchable Kelvin connections.

Recommended standard resistance:

1.9990 Milliohms
19.990 Milliohms
199.90 Milliohms
1999.0 Milliohms
19990 Milliohms
4 Wire Short or "Zero"

NOTE: The resistances must be just below the full-scale value of each range.

C. A set of test leads for a four wire Kelvin connection between the resistance standards and the resistance tester.

- 1) Place meter on the 2K Ω range. Connect a "Zero" standard (4-wire short) to the meter.
- 2) Adjust the potentiometer labeled "ZERO" on the 5012-05A Main PCB Assembly until the display on the meter reads all zeros (0000). (See drawing on page 16 for location of potentiometer.) Disconnect the "Zero" standard.
- 3) Connect a 20 Ω standard to the meter. Select the 20K range on the meter. Adjust the FS potentiometer on the 3692041 assembly until the display reads the certified value of the 20 Ω standard. Disconnect the 20 Ω standard.
- 4) Connect a 2 Ω standard to the meter. Select the 2K range on the meter. Adjust the 200 potentiometer on the 3692041 assembly until the display reads the certified value of the 2 Ω standard. Disconnect the 2 Ω standard.
- 5) Connect a 199.9m Ω standard to the meter. Select the 200 range on the meter. Adjust the 20 potentiometer on the 3692041 assembly until the display reads the certified value of the 199.9m Ω standard. Disconnect the 199.9m Ω standard.
- 6) Connect a 19.99m Ω standard to the meter. Select the 20 range on the meter. Adjust the 2 potentiometer on the 3692041 assembly until the display reads the certified value of the 19.99m Ω standard. Disconnect the 19.99m Ω standard.
- 7) Connect a 1.99m Ω standard to the meter. Select the 2 range on the meter. Adjust the potentiometer located on the 3697116 assembly (1 Amp Option) until the display reads the certified value of the 1.99m Ω standard. Disconnect the 1.99m Ω standard.

Model 5060-05A calibration procedure is completed.

OPTIONS :

TEMPERATURE COMPENSATION (TC): Temperature changes of a few degrees in a product can have significant effects on the product's resistance. Therefore, the need for temperature compensation may arise when the temperature of the part being tested changes over a period of time. The benefits of temperature compensation include the saving of time, energy, and money by eliminating the need to refer to coefficient tables as the ambient plant temperature varies during the day. Before now, such compensation was available only in expensive and delicate laboratory-grade instruments. Harris IRT has now made it available in rugged resistance testers designed for use in production.

With temperature compensation, a probe sends ambient temperature data to the instrument. This temperature information is used to modify the constant current that is being passed through the part under test. The resistance then registered is the resistance the item under test would have at the specified temperature. The compensation option can be calibrated for the measurement of either of two measurement coefficients or it can be operated without any compensation. The accuracy of the compensation is within 0.2% of the actual resistance between 0 and 50°C.

RS-232 COMPUTER INTERFACE (RS232): A three wire link between the resistance tester and a computer can be made through the RS-232 port. This is a standard null-modem connection with an adjustable baud rate (50 - 19,200) and word length of 8 bit.

This permits the reading shown on the front panel display to be sent to the computer at the set baud rate every time the instrument is sent a character by the computer. This interface is useful for the statistical analysis of production, predictive control, and data logging. It is compatible with any computer having an RS-232 port and any terminal program.

Factory settings: 9600 Baud, No stop bit, 8 bit word, No parity, (9600,N,8,1)

BINARY CODED DECIMAL (BCD): The BCD output allows the resistance tester to transmit readings to a Programmable Logic Controller (PLC). The BCD option generates a 1, 2, 4, and 8 bit for each of the 5 characters in the resistance reading. An output strobe is also provided to allow synchronization of the resistance tester with the PLC. The BCD output is a TTL logic level of 0 to 5 VDC and a maximum output current of 24 mA.

REMOTE RANGE SELECT (RR): The remote range select option is typically used in on-line testing when various resistances must be tested. This option allows a PLC or other controller on the production line to set the range of the resistance tester. This option is usually used in conjunction with the BCD or RS-232 options.

SAMPLE and HOLD (SH): This option permits the measurement of a component's resistance 'on-the-fly' even though the contact time with the component is very brief (a few milliseconds). It is possible to hold a resistance reading for digital processing and display. 100 % testing is possible under such conditions.

SAFETY RELAY (RY): When a resistance tester is used in conjunction with high pot or surge tests, an internal safety relay can be provided to lock-out the resistance tester circuitry during other testing. This will protect the resistance tester from possible high-voltage or high-current damage.

RS-232 SERIAL INTERFACE OPTION

The Harris IRT Serial Interface Option provides a simple method for gathering resistance measurement data from any Harris IRT Resistance Tester. This option is frequently used to implement continuous data logging for SPC and ISO9000 programs or to permit complete computer control of an automated production testing station.

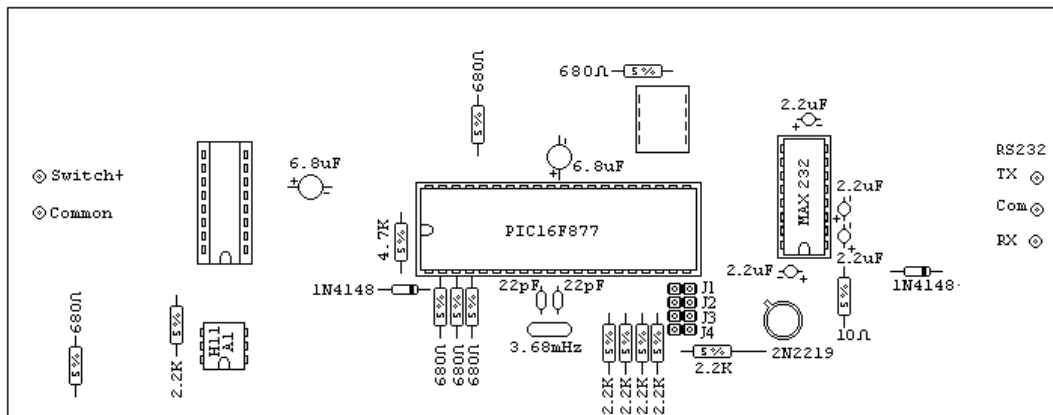
FUNCTIONAL DESCRIPTION:

The RS-232 serial option connects to the Binary Coded Decimal (BCD) output from the Analog to Digital Converter, and to each of the five available digit strobe lines. Each time an LED display digit is updated, the BCD data is captured and stored in the serial option memory location for that digit. A transmission of the last five characters, most significant digit first, is sent whenever a data request is received. No decimal point or other delimiter character is sent with the five numerical digits. In the factory default configuration, any character received at the setup baud rate and protocol, will serve to request a five digit data report. If a carriage return, or semicolon is used for the request character, most spreadsheets can directly import the reported data, using the request character as a delimiter. Optionally an external normally open switch can be used to request a data report. See the assembly drawing below for the switch terminal locations.

Any good computer terminal program can be used to collect and store the collected data. Make certain that the serial port being used is configured for 'no control', as there is no x-on/x-off or hardware control of the data provided with this option. This mode can be selected in Window by changing the Comm Port Properties in System Setup.

BAUD RATE SETTINGS:

Four pre-programmed standard baud rates are available from the Serial Interface Option. The factory default protocol setting is 9600,N,8,1. There are no longer any options available for a 7-bit word protocol. The other Baud rates can be selected by using the jumpers available on the serial option board. See the assembly drawing below for jumper locations.



Baud Rate Jumpers: (select one jumper only)

No Jumper	9600 baud (default)
J1	300 baud
J2	1200 baud
J3	19.2K baud
J4	57.6K baud

The RS-232 Serial Interface Option now contains a microprocessor based communications port. Because of this feature, it is possible to request non-standard data reports, RS-485 network configuration and many other custom features. If the standard product does not fill your needs, please inquire with Engineering about custom software that may already be available.

BCD OUTPUT and REMOTE RANGE SELECT CONFIGURATION:

The BCD and Remote Range Select options are supplied with a FEMALE DB-25 style connector located on the rear panel with the following connections.

Pin Number	Data	Explanation
1	1	MSD
2	2	
3	1	2nd Digit
4	2	
5	4	
6	8	3rd Digit
7	1	
8	2	
9	4	4th Digit
10	8	
11	1	LSD
12	2	
13	4	
14	8	
15	1	Highest Range (Default)
16	2	
17	4	
18	8	
19	Range #5	
20	Range #4	Lowest Range
21	Range #3	
22	Range #2	
23	Range #1	
24	Data Ready	
25	Common	

Pins 1 through 18 are TTL-buffered BCD data output from a 74LS244 buffer. Data common is available at Pin 25. Pins 19 through 23 are range selector pins. Ranges are selected by connecting these pins one at a time to common (Pin 25). If no range is selected, the unit will default to the highest range (20K). Data is valid only while the Data Ready pulse on Pin 24 is high. This pulse has a 10% duty cycle. Data taken at any other time may be invalid because digits are strobed sequentially.

TEMPERATURE COMPENSATION PROCEDURE

PRE-CALIBRATION PROCEDURE:

Plug the Temperature Compensation Probe into the stereo jack located on the rear panel. Using a Voltmeter, measure the voltage between the green and gray wires on the stereo jack located on the rear panel. The measured reading should be approximately 2.73 Volts +10 mV per C°. For example, the room temperature is 25°C. The voltage reading should be about 2.98 Volts. If the voltage reading is more than +-20 mV from the calculated reading or the reading is 12 V, then the TC probe is defective. Replacement TC probes can be ordered from Harris IRT Enterprises, Inc. as part # MA1061.

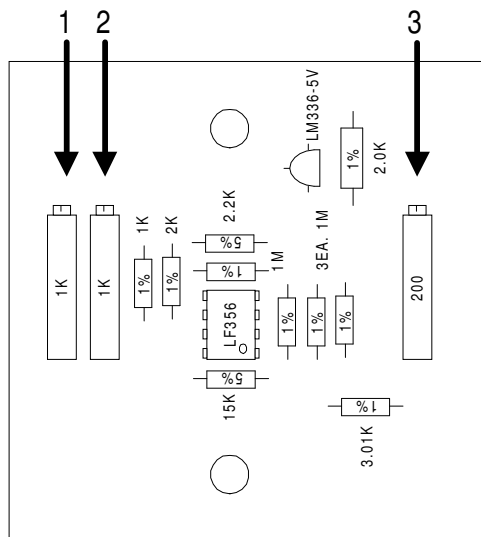
Note:

TC probes are not interchangeable without re-calibration.

PREPARING THE WATER BATHS:

Three water baths will be needed for proper calibration: One bath at the SPECIFIED temperature, a HOT bath at +20°C from the specified temperature and a COLD bath at -20°C from the specified temperature. For example purposes, the specified temperature is 25°C. Using a Celsius thermometer prepare one bath for 25°C, a HOT bath at 45 °C and a COLD bath (using ice cubes if necessary) at 5°C. It is important that enough water is used in each bath so that room temperature will not effect the temperatures of the baths before the calibration is complete. Also make sure that the specified bath is EXACTLY what the temperature should be.

Temperature Compensation PC Board



CALIBRATION PROCEDURE:

- 1) Plug the temperature compensation probe and the resistance standard into the rear of the resistance tester.
- 2) Set the resistance tester to the $2K\Omega$ range. Make sure the temperature compensation switch located on the rear panel is in the OFF (center) position.
- 3) Place the TC probe and the resistance standard into the specified temperature bath. "Stir" the TC probe and the resistance standard a few times until the readings stabilize. After the display stabilizes (usually a few minutes) record the reading.

Step #3 Reading _____

- 4) Switch the temperature compensation switch to the Cu/A1 (right) position.
- 5) Adjust POT #3 until the display reads the same as the recorded reading in Step #3. Switch the temperature compensation switch to the Alloy (left) position. Adjust POT #3 until the display reads the same as the recorded reading in Step #3. Make sure no change occurs when switching through all three positions of the temperature compensation switch. Return the temperature compensation switch to the Cu/A1 position before proceeding.
- 6) Place the TC probe and the resistance standard into the HOT bath. "Stir" the TC probe and the resistance standard a few times until the display stabilizes (usually a few minutes), adjust POT #1 until the display reads the same as the recorded reading in Step #3.
- 7) Place the TC probe and the resistance standard into the specified temperature bath. After a few minutes, place the TC probe and the resistance standard into the COLD bath. "Stir" the TC probe and the resistance standard a few times until the display stabilizes. Record the reading.

Step #7 Reading _____

- 8) Subtract the reading from Step #7 from the recorded reading in Step #3. Divide the ANSWER by 2. Add this result to the original reading in Step #7, and record the result.

Step #3 reading _____ Answer/2 = _____

Step #7 reading _____ + Step #7 + _____

Answer = _____ Step #8 result _____

- 9) Adjust POT #1 until the display reads the same as the recorded result in Step #8.
- 10) Switch the temperature compensation switch to the OFF position. Record the displayed reading.

Step #10 Reading _____

- 11) Subtract the reading from Step #10 from the recorded reading in Step #3. Divide the ANSWER by 2. Add this result to the original reading in Step # 10, and record the result.

Step #3 reading _____ **Answer / 2 =** _____

Step # 10 reading _____ **= Step # 10 +** _____

Answer = _____ **Step #11 result** _____

- 12) Switch the temperature compensation switch to the Alloy position and adjust POT #2 until the display reads the same as the recorded result in Step #11.

- 13) Turn the temperature compensation switch to the OFF position.

The temperature compensation procedure is completed.

TROUBLE-SHOOTING HINTS

SYMPTOM:

The Resistance Testers' display flashes '0000' no matter what resistance is being measured.

POSSIBLE SOLUTIONS:

- ◆ The Resistance Tester is in over-range mode, select a higher range.
- ◆ The ICL7135 CPI A/D converter could be burned-out. This IC is socketed and can easily be replaced by the user¹.

SYMPTOM:

The Resistance Tester displays changing numbers or "garbage" readings.

POSSIBLE SOLUTIONS:

- ◆ Check to make sure a "load" is connected to the Resistance Tester via the back panel circular connector or front panel banana plugs.
- ◆ Check to make sure you have a true 4-wire Kelvin connection.

SYMPTOM:

Readings appear to be incorrect.

POSSIBLE SOLUTIONS:

- ◆ Check to see that the Temperature Compensation probe is plugged in all the way and that the Temperature Compensation switch is in the correct position.
- ◆ Check to see if the Resistance Tester is due for calibration. A calibration should be performed once a year.
- ◆ One or more of the MAX400 (or alternate OP177) op-amps could be burned-out. These IC's are socketed and can easily be replaced by the user¹.
- ◆ Check to make sure you have a true 4 wire Kelvin connection.

NOTE:

Resistance changes as temperature changes. If the ambient temperature varies during the day so will the resistance of the part under test. This could make it appear that the Resistance Tester is not working properly. You may require the use of Temperature Compensation.

For Technical assistance call Harris IRT Enterprises, Inc.

Phone (740) 881-5508

Fax (740) 881-4630

¹ Opening the meter to replace any IC's could void the manufacturers warranty.

RETURN POLICY

NOTE:

*Before returning a Resistance Tester for repair or calibration you must **first** call and receive an RMA#. Any package received without an RMA# may be delayed in the service department. Please write the RMA# on the package and packing slip.*

To return a Resistance Tester for repair after you receive an RMA# ship to:

**Harris IRT Enterprises, Inc.
Resistance Tester Service Department
3276 Home Road
Powell, Ohio 43065
Phone: (740) 881-5508
Fax: (740) 881-4630**

MANUFACTURER'S WARRANTY

Equipment shall meet all engineering performance data and design requirements described in the specifications. Within a period of one year from the date of shipment, if the equipment should fail to function due to a defect in parts or workmanship, Harris IRT Enterprises, Inc, at its option, will replace or repair the equipment at its facility in Powell, Ohio.

NOTE:

Removing the calibration seal and performing unauthorized repairs will void the calibration and could void the manufacturers warranty. Please call Harris IRT Enterprises before performing any repairs.

The diagram illustrates a 100W audio amplifier circuit. Key components and their connections include:

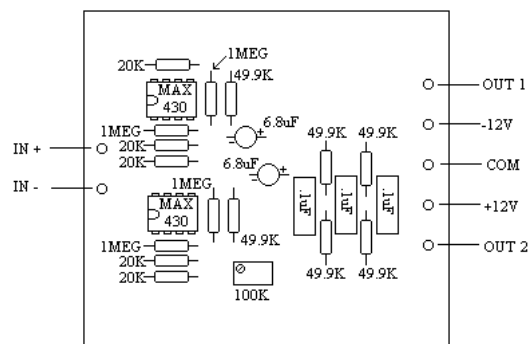
- Power Supply:** A 100W transformer with a 220V primary and 0V, 250V, 270V, 290V, 310V, 330V, 350V, 370V, 390V, 410V, 430V, 450V, 470V, 490V, 510V, 530V, 550V, 570V, 590V, 610V, 630V, 650V, 670V, 690V, 710V, 730V, 750V, 770V, 790V, 810V, 830V, 850V, 870V, 890V, 910V, 930V, 950V, 970V, 990V secondary. The secondary is connected to a 2200uF 35V electrolytic capacitor. The positive terminal is connected to a 7812 regulator, and the negative terminal is connected to a 7912 regulator. The 7812 and 7912 regulators are connected to a 100uF 35V electrolytic capacitor.
- Pre-amplifier Stage:** An ICL7135 op-amp is configured with a feedback network of 100K, 10K, and 1M resistors. The input is connected to a 100K potentiometer. The output is connected to a 4013 monostable multivibrator.
- Driver Stage:** A 4013 monostable multivibrator is connected to a 4049 MOSFET driver. The 4049 is connected to a 75491 MOSFET.
- Power Output Stage:** The 75491 MOSFET is connected to a 100W speaker. The gate is connected to a 100K potentiometer.
- Other Components:** A 10X GAIN potentiometer is connected to the input. A 502 potentiometer is connected to the output. A 20V CAT100UF capacitor is connected to the power supply.

MAIN BOARD 11-19-95
A A 9 2 0 4 1

[illegible][illegible]

TEMP. COMP BOARD
A81004N 9-11-95

MODEL 5060-05A CHOPPER STABILIZED PRE-AMP ASSEMBLY DRAWING



All Resistors 1% RN-55D

Do NOT Use sockets on MAX430's

ECN #21 07-05-95 added 3 Pole Low Pass Filter

HARRIS INSTRUMENT CORPORATION 155 Johnson Drive Delaware, OH 43015		
0	02-13-95	D. E. Harris
Rev.	Date:	Drawn By:
Description: Chopper Stabilized Pre-Amp for 5060 Ω Meter		
A	Dwg. Number: 3695031A	
Size:		