Heathkit® Manual

for the

RLC BRIDGE

Model IB-5281

595-1958-03

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INITIAL TEST AND ADJUSTMENTS

The purpose of this section of the Manual is to make sure your RLC Bridge operates properly and will not be damaged as a result of a wiring error. A transistor, for example, could be destroyed instantly by a short circuit that causes excessive current.

( ) Inspect the Bridge for improperly soldered connections, or connections that may be missed or unsoldered. Also check for solder bridges across two or more circuit board foils, which would cause a short circuit.

( ) Examine the chassis mounted parts and make sure they are properly mounted and connected.

( ) Make sure no bare wires are touching any components or the chassis.

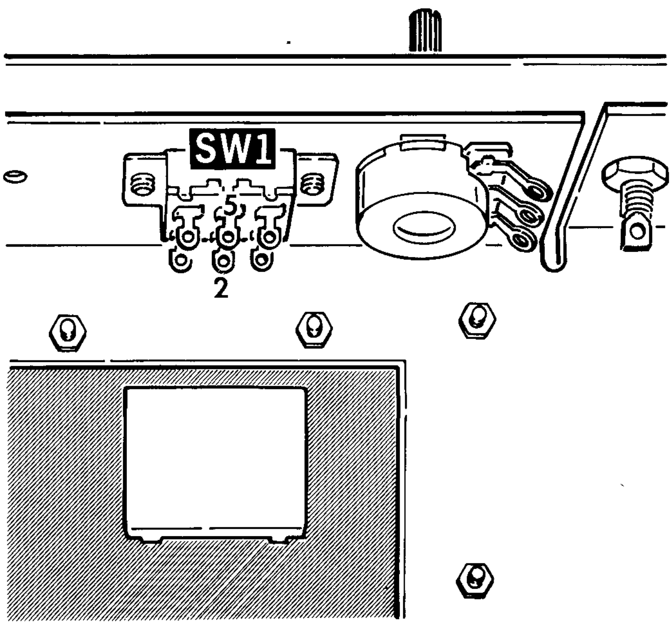
RESISTANCE MEASUREMENTS

NOTE: You will need an ohmmeter to make the following resistance measurements. The readings may take a few seconds to reach the indicated settings due to the charging of capacitors in the circuit. If you do not have an ohmmeter, proceed to "Power Supply Connection."

( ) Set your ohmmeter to read R × 100.

( ) Connect the common lead of your ohmmeter to the chassis.

NOTE: The readings in the following steps, are the minimum desired. If the readings you get are significantly less, you must determine the reason (such as a short circuit between the foils caused by a solder bridge) and correct it before you proceed.



PICTORIAL 4-1

Refer to Pictorial 4-1 for the following steps.

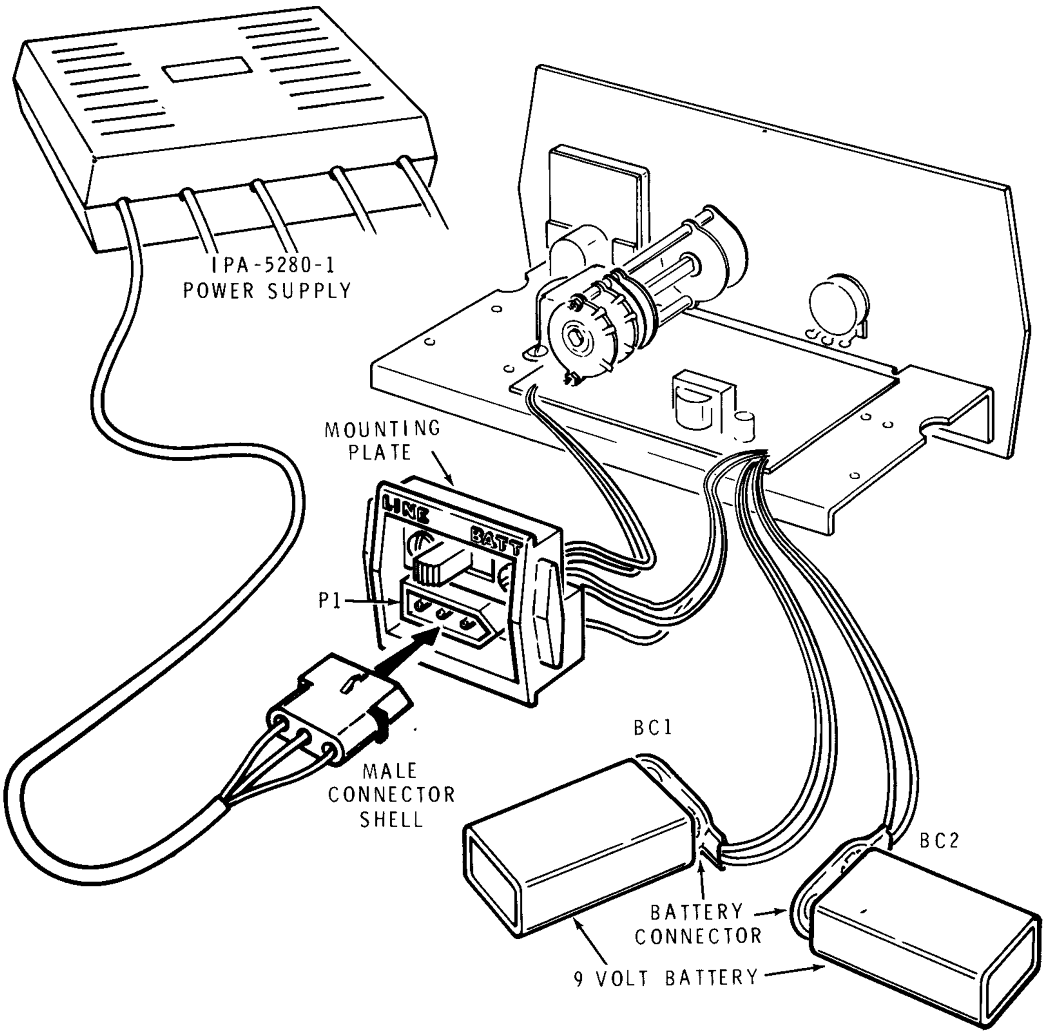
( ) Place the POWER switch to ON.

( ) Touch the ohmmeter probe to switch SW1 lug 2. The reading should be 5 kΩ or higher.

( ) Touch the ohmmeter probe to switch SW1 lug 5. The reading should be 1 kΩ or higher.

( ) Place the POWER switch to OFF.

Proceed to "Power Supply Connection."



PICTORIAL 4-2

POWER SUPPLY CONNECTION

Refer to Pictorial 4-2 for the following steps.

( ) Position the RLC Bridge as shown.

( ) Connect one of the five connector shells coming from the Power Supply to P1 on the mounting plate. Make sure the wire colors at both connectors are the same and are not reversed.

( ) Place the LINE/BATT switch to the LINE position.

( ) Plug the Power Supply line cord into the appropriate AC receptacle.

NOTE: If you intend to use batteries in addition to the Power Supply, proceed with the following steps. Otherwise, proceed to "Bias Adjustment."

BATTERY CONNECTION

( ) Connect the two 9-volt batteries, which you purchased earlier, to battery connectors BC1 and BC2.

( ) If you intend to use batteries at this time, place the LINE/BATT switch to the BATT position.

Proceed to "Bias Adjustment" on Page 31.

BIAS ADJUSTMENT

Refer to Pictorial 4-3 (Illustration Booklet, Page 5) for the following steps.

(✓) Position the RLC Bridge as shown.

NOTE: Use a small-bladed screwdriver to make the following adjustments. If you do not obtain the proper results during the bias adjustment, refer to "In Case of Difficulty" to help you correct the problem. Do not proceed with any other steps until the problem is corrected.

(✓) Preset controls R9, R14, and R33 to the center of their rotation.

(✓) Place the POWER switch to ON.

NOTE: You will need a voltmeter capable of measuring both AC and DC for the following steps.

(✓) Set the meter to the lowest range capable of measuring 5 volts DC.

(✓) Connect the common lead of your voltmeter to the chassis.

(✓) Touch the voltmeter probe to circuit board point A and adjust control R9 (Bias Adj A) for 0 ±.1 volts. Note: Adjust R9 very slowly and wait for the reading to stabilize each time you stop. Then adjust the control further if necessary to obtain the correct reading.

(✓) Set your meter to the lowest range capable of measuring 5 volts AC (rms).

(✓) Touch the voltmeter probe at circuit board point A and adjust control R14 (Feedback Adj) for a reading of 3 volts AC.

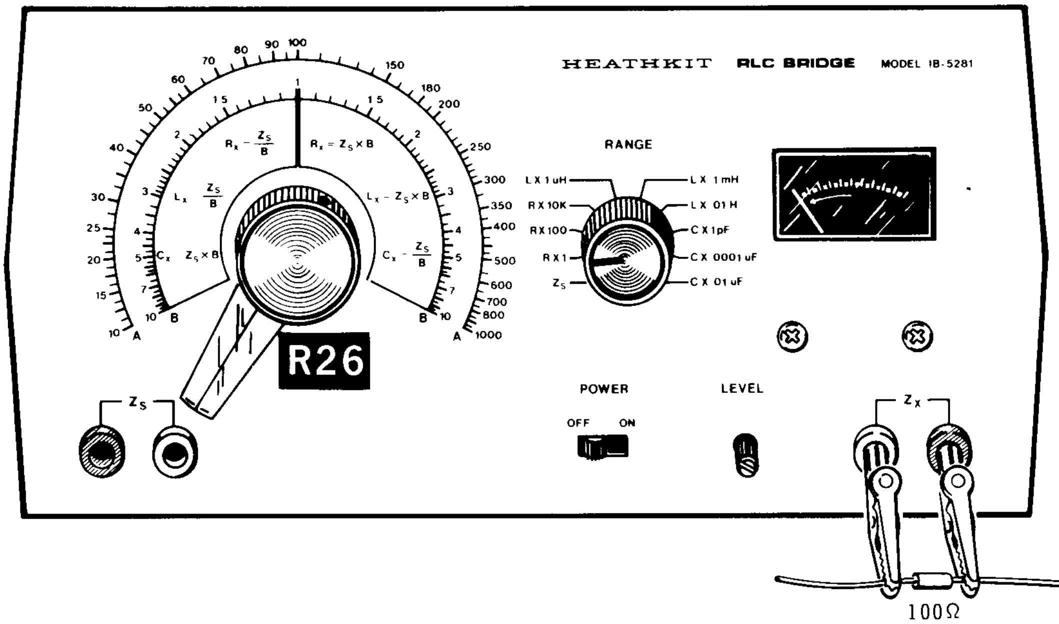
(✓) Set your meter to the lowest range capable of measuring 5 volts DC.

(✓) Touch the voltmeter probe to the collector (C) of transistor Q8 and adjust control R33 (Bias Adj B) for a reading of 4.5 volts.

(✓) Repeat the steps after the second NOTE:

( ) Place the POWER switch to OFF. Disconnect the voltmeter leads.

This completes the "Bias Adjustment." Proceed to "Dial Calibration."



PICTORIAL 4-4

DIAL CALIBRATION

Refer to Pictorial 4-4 for the following steps.

Preset the front panel controls as follows:

( ) BALANCE control R26 fully counterclockwise.

( ) RANGE switch to R×1.

( ) LEVEL control fully counterclockwise.

( ) Plug both alligator clips into the Z_x terminals.

( ) Locate the 100 Ω (brown-black-brown) resistor which was left over, and install it between the two alligator clips as shown.

( ) Place the POWER switch to ON. The meter should swing full scale, then drop back towards 0.

( ) Gradually increase the LEVEL control until the meter reads 10.

( ) Carefully turn the BALANCE control R26 clockwise. The meter reading should decrease. When the meter reaches a null (lowest reading), stop turning the control.

( ) Increase the LEVEL control fully clockwise, rock the BALANCE control back and forth a few times to obtain the best null possible.

( ) Very carefully, loosen the setscrew on the balance control knob without moving the control. Position the dial pointer so it is over the 100 mark on the A scale. Tighten the setscrew.

( ) Check the null on the meter and make sure the pointer is directly over the "100" mark. If it is not, repeat the previous step.

( ) Turn the LEVEL control fully counterclockwise.

( ) Return the POWER switch to OFF.

( ) Disconnect the 100 Ω resistor and remove the alligator clips from the front panel terminals. Note: Save the resistor in case you would like to recalibrate your unit later.

( ) Remove the plug from the AC receptacle. If you are using the Power Supply, disconnect it from the Bridge.

This completes the "Dial Calibration." Proceed to "Final Assembly."

OPERATION

This RLC Bridge is a conventional bridge circuit powered by a 1 kHz, 10 kHz, or 100 kHz oscillator. It has a resistance range of 10 ohms to 10 megohms, an inductance range of 10 μH to 10 H, and a capacitance range of 10 pF to 10 μF. An external standard range increases the versatility of this Bridge for the experimenter.

Refer to Pictorial 6-1 (Illustration Booklet, Page 7) for a brief description of the controls, meter, and terminals.

NOTE: It is always best to connect the component under test directly to the Z_x terminals. Long leads may pick up stray AC fields and give inaccurate readings. If you use test leads, keep them as short as possible.

USING THE BRIDGE

NOTE: The following procedure uses a resistance measurement as an example. Inductance or capacitance measurements are made with the same procedure. Make sure you change the RANGE switch to the appropriate setting when you measure different types of components. Refer to Pictorial 6-1 (Illustration Booklet, Page 7) for a description of the controls.

To test an unknown resistance, perform the following steps.

1. Turn the LEVEL control fully counterclockwise.
2. Turn the RANGE switch knob to the proper "R" multiplier. If you do not know the resistance value, switch to the RX 1 position as a start.
3. Place the POWER switch to ON.
4. Connect the unknown resistance to the Z_x terminals.
5. Advance the LEVEL control for an approximate full-scale meter reading (10).
6. Adjust the BALANCE control for a null (minimum deflection) on the meter. If you do not obtain a null, switch to the next highest "R" multiplier.
7. Turn the LEVEL control clockwise for an approximate full-scale reading and carefully readjust the BALANCE control for any further null on the meter.
8. Read the resistance, indicated by the dial pointer, on the "A" scale. Multiply the reading by the RANGE switch setting.

USING AN EXTERNAL STANDARD

The following description gives only one typical example for the external standard function. You may want to use the external standard for other applications. When you use the external standard function, make sure you keep the two component values within a 10:1 ratio; otherwise, you will not obtain a null. A null is the lowest reading obtained on the meter. You will not always obtain a "0" reading when you null your meter.

EXAMPLE:

To match several 100 Ω resistors of an unknown value with a 100 Ω resistor of a known value to obtain a matched pair, perform the following:

1. Turn the LEVEL control fully counterclockwise.
2. Set the RANGE switch to the Z_s position.
3. Connect the 100 Ω resistor of a known value to the Z_s (external standard) terminals.
4. Place the POWER switch to ON.
5. Connect a 100 Ω resistor of an unknown value to the Z_x terminals.
6. Advance the LEVEL control clockwise for an approximate full-scale meter reading.
7. Adjust the BALANCE control and obtain a null on the meter.
8. Turn the LEVEL control clockwise for a full-scale meter reading and carefully readjust the BALANCE control for a null on the meter.

9. Read the resistance, indicated by the dial pointer, on the "B" scale. If the dial pointer indicates "1" (center scale), the resistors are of equal value. If the pointer is to the right or left of center scale, the resistors are not of equal value. To determine the value of the unequal resistor (or any component being tested), use the formulas shown inside the "B" scale. If the pointer is to the left of center scale, use the formulas inside the left scale.

   If the pointer is to the right of center scale, use the formulas inside the right scale. It is normal when you measure extreme values, to have the null occur at a much higher point on the null meter.

NOTE: If you use batteries with your RLC Bridge, measure them with a voltmeter occasionally to make sure they are 7 volts or higher. This will insure the best operation for your bridge.

IN CASE OF DIFFICULTY

This part of the Manual provides you with information that will help you locate and correct difficulties which may occur in your RLC Bridge. This information is divided into two sections. The first section, "General," contains suggestions of a general nature in the following areas:

- Visual check and inspection.
- Precautions to observe when bench testing.

The second section contains a "Troubleshooting Chart" that has a series of "Conditions" and "Possible Causes." Start your troubleshooting procedure by first reading the following "General" section. Then proceed to the appropriate "Condition" and "Possible Cause."

GENERAL

Visual Checks

1. About 90% of the kits that are returned for repair do not function properly due to poor soldering. Therefore, you can eliminate many troubles by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Assembly Notes." Re-heat any doubtful connections and be sure all the wires are soldered at places where several wires are connected. Check carefully for solder bridges between circuit board foils.

2. Check to be sure that all transistors are in their proper locations, and are installed correctly.

3. Check the value of each part. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagrams and is called out in the wiring instructions. It would be easy, for example, to install a 200 Ω (red-black-brown) resistor in a step that calls for a 1000 Ω (brown-black-red) resistor.

4. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

5. Check all component leads connected to the circuit board. Make sure the leads do not extend too far through the circuit board and make contact with other connections or parts.

6. Check all of the wires that are connected to the circuit board or switches to be sure the wires do not touch each other or other lugs. Make sure all wires are properly soldered.

7. If the difficulty still is not cured, read the "Precautions for Bench Testing," then refer to the "Troubleshooting Chart."

SPECIFICATIONS

Resistance Ranges	10 Ω to 10 MΩ in three ranges.
Inductance Ranges	10 μH to 10 H in three ranges.
Capacitance Ranges	10 pF to 10 μF in three ranges.
Oscillator Frequencies	1 kHz, 10 kHz, 100 kHz.
External Standard Range	1:1 to 10:1
Power Supply	(2) 9-volt batteries, and/or Heathkit Model IPA-5280-1 Power Supply.
Cabinet Dimensions	11" wide × 5-3/4" high × 7-3/4" deep (27.9 × 14.6 × 19.7 cm).
Net Weight	3-1/2 lbs. (1.6 kg).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Illustration Booklet, Page 8) and Schematic Diagram (fold-in) as you read the "Circuit Description."

Part 1 of Pictorial 7-1 shows the configuration for a Wheatstone Bridge. When all the values of R are equal, the voltage at point A will equal the voltage at point B and the meter will indicate "0" (no current flow) or a "balanced bridge."

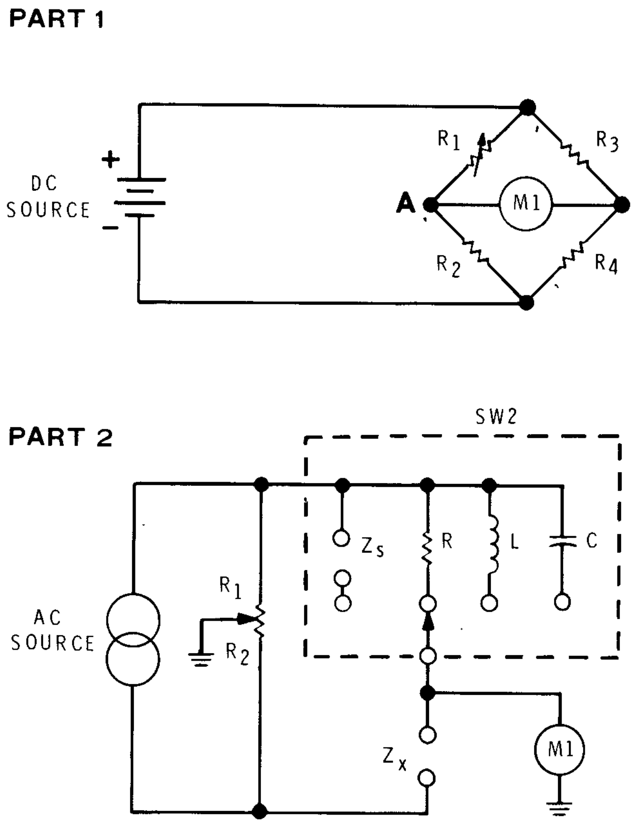
Assume that R3 is an unknown value. If the bridge becomes unbalanced, the voltages at points A and B become unequal, and the meter deflects and indicates the difference voltage. By adjusting R1 to give a balanced bridge condition, you will now know the value of R3, since it is equal to R1. R1 is usually a calibrated control or a step-type variable resistor for convenience of adjustment and readout.

Part 2 of Pictorial 7-1 shows the configuration for the RLC Bridge. It is basically the same as that of the Wheatstone Bridge. A fixed, internal component standard (Z_s) rather than a calibrated potentiometer (as used in the Wheatstone Bridge), is used in conjunction with the Range switch, SW2. The Range switch selects the multiplication factor and a certain frequency for the type of component being tested. The variable function is provided by a single control, which is divided to act as two arms of the bridge, at R1 and R2. Changing both of these values on the bridge provides a much greater range than a single control would provide.

When you test an unknown component value (Z_X), the known component (Z_S) must be the same type as the unknown component (Z_X). The balance control at R1 and R2 is actually matching the ratio of the unknown component to the known standard. The range switch is marked in R, L, and C values to simplify the readout.

The RLC Bridge circuit uses an AC source rather than a DC type since capacitors and inductors cannot be tested with DC. The AC required to operate the bridge is generated by a Wien bridge oscillator. This oscillator consists of transistors Q1 through Q5. It provides a low impedance output to drive bridge transformer T1. Level control R24 adjusts the oscillator output level to keep meter M1 on scale. The oscillator output voltage is rectified by diode D3 and is used as a control voltage at the gate of transistor Q2. Q2 acts as a variable source resistance for transistor Q1 and controls its gain. The oscillator provides three output frequencies, which are selected by the Range switch for the particular type of component being tested. The frequency used for each range is as follows:

RANGE	FREQUENCY
Z_S (external standard)	1000Hz
R×1	1000 Hz
R×100	1000 Hz
R×10k	1000 Hz
L×1 μH	100 kHz
L×.1 mH	10 kHz
L×.01 H	1000 Hz
C×1 pF	100 kHz
C×F .0001 μF	10 kHz
C×.01 μF	1000 Hz



PICTORIAL 7-1

Meter M1, which indicates a null (or balanced bridge condition), is powered by amplifier stages Q6 through Q10. DC feedback is provided via R31 while AC feedback is provided through the meter circuit via capacitors C14 and C15. Both types of feedback enhance circuit stabilization.

Power is supplied by two 9-volt batteries (see "Introduction" for the type) and/or the Heath Model IPA-5280-1 Power Supply.

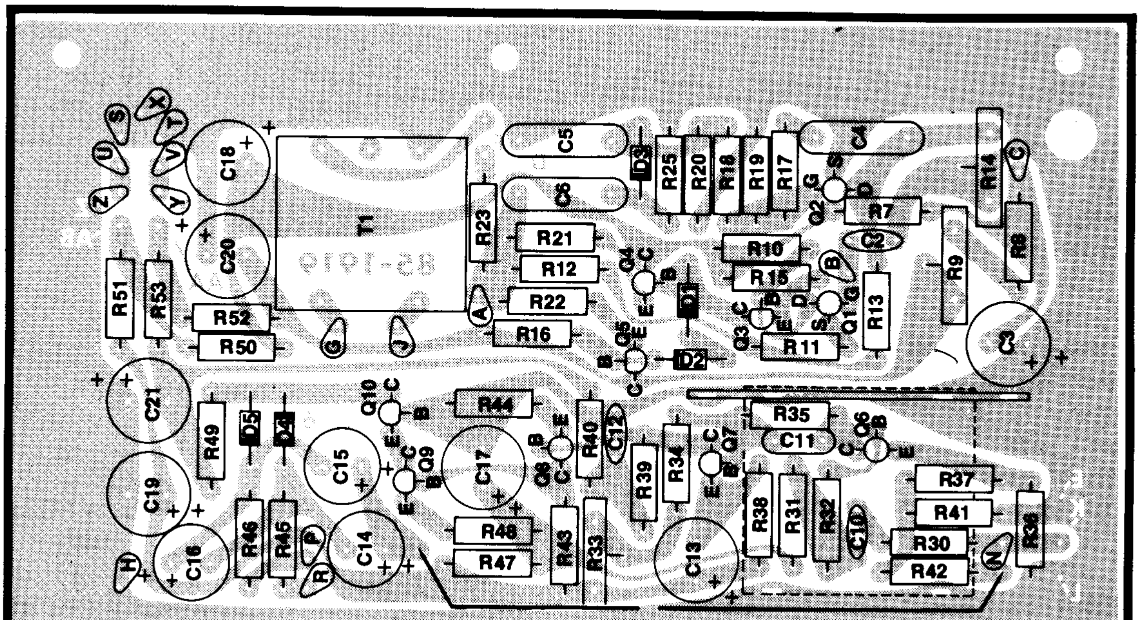
CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the X-Ray View.

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.

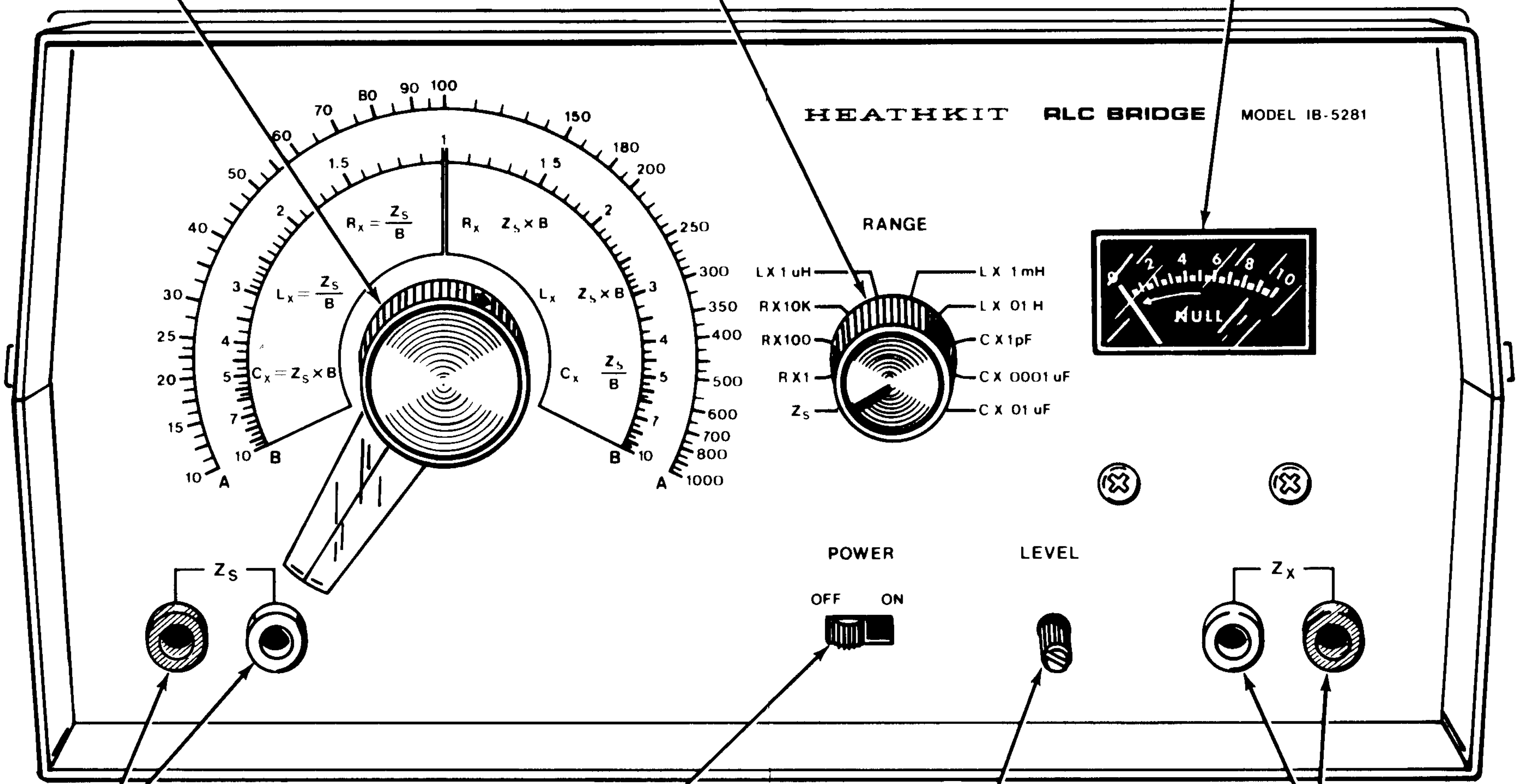


VIEWED FROM COMPONENT SIDE

BALANCE CONTROL: Varys the two arms of the bridge for balancing purposes.

RANGE SWITCH: Used to select the proper standard for the bridge circuit.

METER: Indicates when the bridge is balanced.



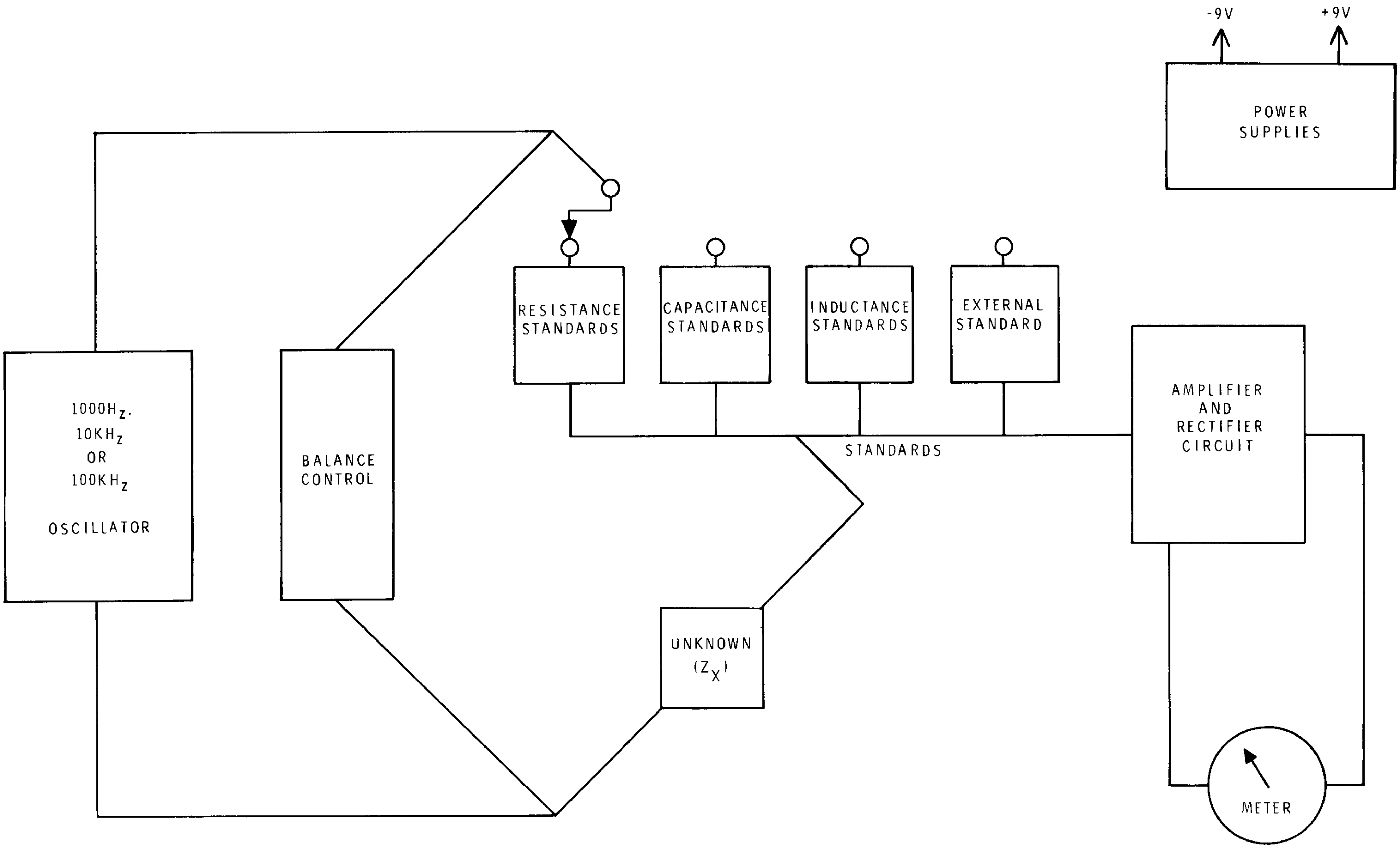
Zs TERMINALS: Enables you to connect external standard component into the bridge circuit.

Zx TERMINALS: Used for connecting the component under test to the bridge circuit.

POWER ON-OFF SWITCH: Used to turn the instrument on or off.

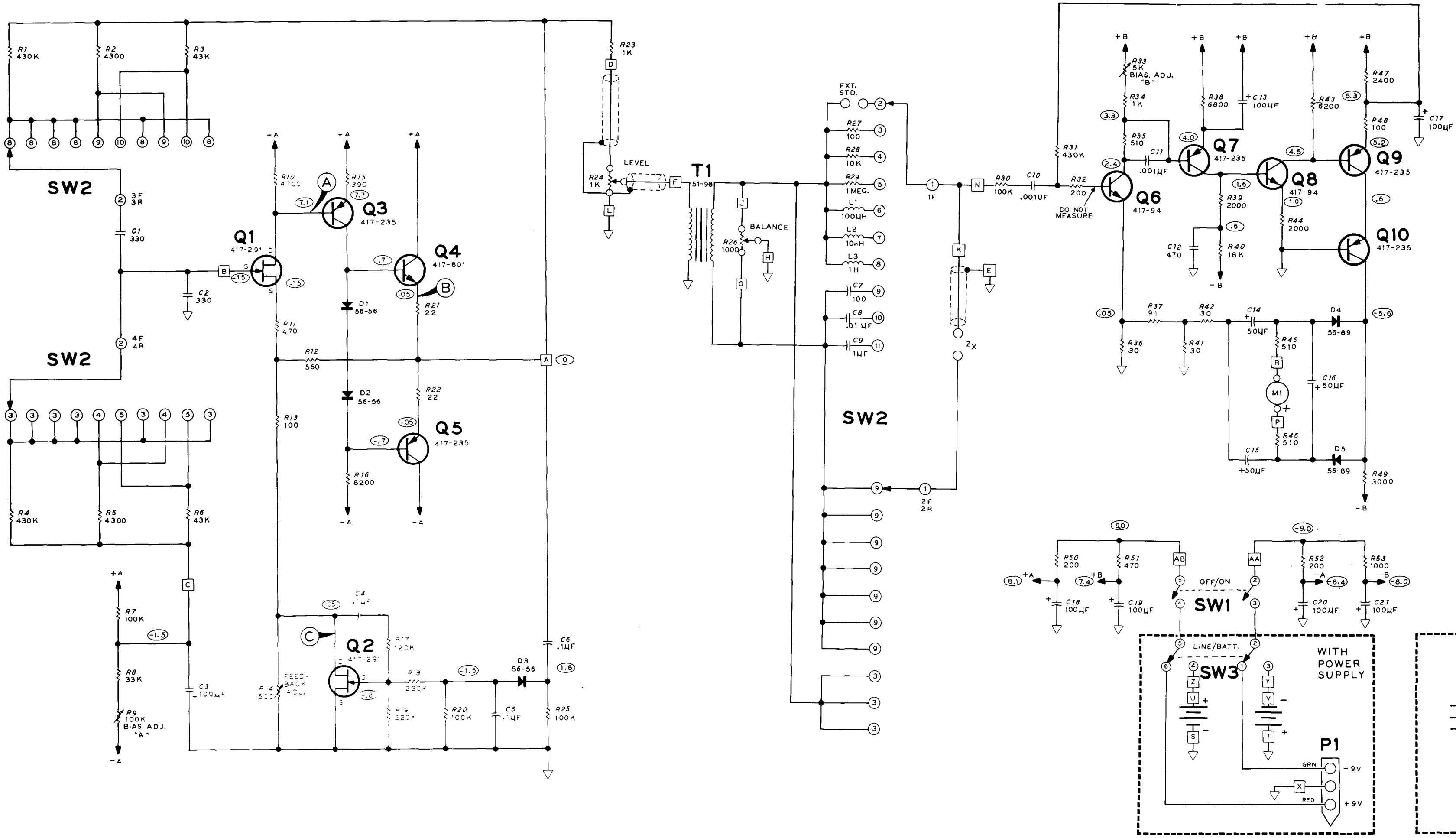
LEVEL: Used to select the proper working voltage when you check components.

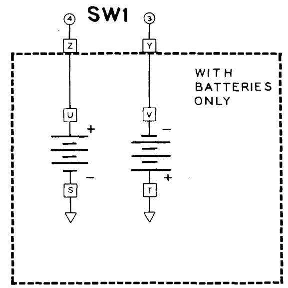
PICTORIAL 6-1



BLOCK DIAGRAM

SCHEMATIC OF THE HEATHKIT® MODEL IB-5281 RLC BRIDGE





NOTES:

1. ALL RESISTORS ARE 1/2 WATT, 5% UNLESS OTHERWISE SPECIFIED. RESISTOR VALUES ARE IN OHMS (K=1,000, M=1,000,000).
2. CAPACITORS ARE IN PF UNLESS SPECIFIED OTHERWISE.
3. SW1 AND SW3 ARE SLIDE SWITCHES AND SW2 IS A ROTARY SWITCH.
4. ⬭ THIS SYMBOL INDICATES A DC VOLTAGE TAKEN UNDER THE FOLLOWING CONDITIONS FROM THE POINT INDICATED TO CHASSIS GROUND WITH A HIGH IMPEDANCE VOLTMETER:
   - A. $Z_X = 0$
   - B. LEVEL CONTROL-MAXIMUM CCW
   - C. BALANCE CONTROL-CENTERED
   - D. RANGE SWITCH-EXT. STD. (Z_S).
5. ▽ THIS SYMBOL INDICATES CIRCUIT GROUND.
6. ○ THIS SYMBOL INDICATES A SWITCH LUG.
7. [A] THIS SYMBOL INDICATES A LETTERED CIRCUIT BOARD CONNECTION THAT IS SOLDERED.
8. VOLTAGES MAY VARY 10%.
9. +A AND -A INDICATE AC GENERATOR SUPPLY VOLTAGE.
10. +B AND -B INDICATE METER AMPLIFIER SUPPLY VOLTAGE.
11. WAVEFORMS ARE TAKEN WITH THE RANGE SWITCH AT THE Zs POSITION.

Part of 595-1958-03