DC Resistance Bridge Model QJ 57

ORERATING INSTRUCTIONS

1. Uses and Features

1.1 Uses: Model QJ 57 is a portable accuracy DC double bridge with Kelvin network (hereinafter referred to as "Bridge"). The instrument is provided with seven measuring ranges from 0 - 1.1111 k Q and the minimum resolution is 0.01 μ Q . It is suitable for accuracy measurement of \ow-value resistance or DC resistance in the conductivity of metal conductor, DC current divider, the contact resistance of switch, wire and cable, motors and transformers, etc .

1.2 Features: The main resistance element of the bridge is made by high-grade alloy material, and subjected to long-term high and low temperature aging test, as well as rigid technological treatment and adjustment so as to lower the temperature coefficient, increase the accuracy and improve the annual stability. By adopting the specific switch in Fang Ke accuracy instrument, the contact resistance of the bridge is small and so does its variation; by using model JZ28 zero indicator, the bridge features high sensitivity, low noise and less power dissipation. Therefore, the portable bridge is characterized by wide measurement range, high accuracy, well stability and reliability, compact and lightweight.

2. Specifications

2.1 All technical indicators of Model QJ57 conform to the standard IEC564 - 77 "DC Bridge for Measuring Resistance".

2.2 Environment condition

a. Temperature:

Reference value: 20 ± 0.5 ℃ , nominal va\ue:15 ℃ - 25 ℃ .

b. Relative humidity:

Reference value: 40% -60 %, nominal value: 25% - 75%.

2.3 Main parameters are shown in Table 1.

Table 1

Multipe	Effective range	Resolution.	Class index	Rn	Iman
X 10_,	0 ~ 1.1111 Ωm Q	10n Q	2	1m Q	3A
X 10-2	O~ 11. 111 Ωm Q	100n Q	0.2	10m o	1A
X 10-1	0 ~ 111.11 Ωm Q	1 μ Q	0.05	100m Q	500mA
X 1	O ~ 1.11110 Q	m μ o	0.05	1 Q	100mA
X 10	0 ~ 11.1110 Q	100 μ ll	0.05	10 Q	15mA
X 10^2	O ~ 111.110Q	1m Q	0.05	100 Q	1.5mA
X 10°	0 ~ 1.11110k Q	10m n	0.05	1k Q	200 μ A

2.4 Allowable limit of elementary error

$E_{lim} = \pm C\% (- 8 - + 1)$

Where:

E_{lim} Allowable limit of elementary error:

C — Grading index of accuracy;

Rn — Reference value (10 to the maximum integer power in the measuring range);

X — Indicating value of measuring plate.

2.5 Built-in zero indicator

a. Zero setting: provided with mechanical and electrical balancing control;

b. Sensitivity: sensitivity is adjustable. The bridge will start from the equilibrium point at the highest sensitivity. When the measuring plate deflects a grading index, the pointer of zero setting will at least deflect 2 graduations;

c. Dumping time: not over 4 seconds.

2.6 Power supply: supply for bridge circuit is 1.5V, formed by shunt connection of 8 R20 (#1) batteries; supply for built-in zero indicator is 9V, formed by a 6F22 laminated cell.

2.7 Overall dimensions: 300mm X 250mm X 160m.

2.8 Weight: ca. 6kg.

3. Operating principle

As shown in Figure 1, the circuit diagram of model QJ57 is a typical Kelvin double bridge circuit, which consists of multiplying plate (or measuring range dish), measuring plate (or reading dish), zero indicator and power circuit. Switch over 7 convertible measuring ranges of 7 constant-value standard resistors R_s of the multiplying plate. 5 measuring plates are comprised of 5 pairs of decimal step-by-step resistors R_A & R_a, which make up a bridge circuit with a pair of constant-value resistors R_B & R_b. In the bridge there are four terminals, of which C_1 & C_2 are terminals of current. Power supply for the bridge delivers test current to R_X, and flows to the standard resistor R_S in series connection with R_X; P_1 & P_2 are terminals of potential, which delivers the voltage drop formed at R_X to the bridge, then reaches an equilibrium with the voltage drop formed at R_S through the bridge circuit comprised of four bridge arms R_A , R_a, R_B & R_b as well as zero indicator G. As shown from calculation, the value of resistance measured at the bridge is that of the resistive element at which the voltage drop produces. If the conductor resistance measured at the conductor and the contact resistance at each contact fall within the prescribed limit, their influence on the measurement can be neglected, thus assuring the accuracy of measurement.

4. Operation

4.1 Preparation

a. Install properly 8 R20 (#1) batteries and a 6F22 laminated cell in the battery compartment at the back of the bridge. Rotate the multiplying plate from "Off" to "B_V" and "G_V" positions respectively - checking of supply voltage. When the pointer entering or passing the green line, it shows that the voltages both at batteries of bridge circuit and zero indicator are proper.

b. Rotate the multiplying plate and measuring plate from the starting point to the end point to and fro several times to make the switch well contact. Place the multiplying plate at a certain multiplying power, and turn on the power supply of the zero indicator. After preheating for 5 minutes, adjust the "Zero-setting" potentiometer to make zero adjustment to the zero indicator. Connect properly the resistors to be tested to the terminals of C_1, P_1, P2 & C2 according to the method of four-terminal measurement, as shown in Figure 2.

4.2 Measurement

Estimate the value of resistance of the resistor to be measured and choose an appropriate multiplying power. then press the push buttons of "G" & "B". Adjust the measuring plate to make the zero indicator return to zero balance of bridge, thus the value of resistance of the resistor to be measured is expressed by the following formula:

Rx= Multiplying power X Lndicating value of measuring plate.

4.3 Operation of relative components of bridge

a. Measuring plate: in order to make the value of measurement have effective digit number, the multiplying plate should be adjusted in such a way that the indicating value of No. 1 measuring plate on the left side is not at zero, so the accuracy of measurement and resolution are assured. The round dot on the left lower part of No. 1 measuring plate is a decimal point. The symbol "X" on all measuring piates is used for expressing 10.

b. Zero indicator

1} Direction of deflection: as specified in the bridge design, the direction of deflection of the zero indicator is identical with the direction of rotation of the measuring plate in the process of bridge balance. If the measuring plate rotates in clockwise direction, the pointer of zero indicator will follow it to make clockwise deflection. On the contrary, if the former rotates in anti-clockwise direction, the latter will be anti-clockwise deflection.

2) Sensitivity: the sensitivity should be in a lower position at the beginning of measurement, then increases after initial balance of bridge, thus able to prevent effectively from overload of the zero indicator and to shorten the measurement time.

c. Push buttons "B" & "G": button "B" is the control switch for bridge supply and button "G" is the control switch for the input end of zero indicator. Press the button-and then let go, the button will reset of its own accord. Rotate the button 90 ° after pressing, it can be locked; rotate another 90 ° , it will reset of its own accord.

4.4 Key measuring and testing techniques

4.4.1 Method of four-terminal measurement

The method of four-terminal measurement (or method of four lead-wire measurement) is adopted for measuring resistance in Kelvin bridges, at which the measurement of low-value resistance is extremely important. The connection of four lead-wire type resistors (e.g.

standard resistor, current diverter, etc.) is shown in Figure 2a; the connection of two lead-wire type resistors is shown in Figure 2b. The result of bridge measurement is expressed by $R_{AB} = R_X + r_A + r_B$, where R_{AB} is the resistance between two points A & B that contact to the potential end; R_X is the resistance of the resistor body; r_A , r_B are the resistance of the lead-wire between R_X and two points A & B respectively. For measuring the resistance wire stock as wire and cable, their connection is shown in Figure 2c, and the result of bridge measurement is expressed by R_{AB}.

If the conductor resistance of each conductor and the contact resistance of each connecting point are less than 0.1 W, their influence on the result of measurement can be neglected.

4.4.2 Measurement by inching push button

a. Operation: press the push button "G" (either inching or locking) while inching push button "B". As soon as knowing the direction of deflection of the zero indicator, reset the push button "B"; properly adjust the measuring plate once more according to the prescription of 4.3.b.1); repeat the operating procedure mentioned above to make the zero indicator return to zero point, finally reaching bridge balance.

b. Scope of application

1) Measurement of low-value resistance: when measuring low-value resistance, the output measuring current from the bridge is rather great. If keeping pressing of push button "B", even though the temperature coefficient of the resistor to be measured is not too great, the bridge will also heat up because of the temperature-rise exceeding the allowable value caused by a greater dissipated power, resulting in decreasing the accuracy of measurement. However, by using the method of inching, the accuracy of measurement can be ensured.

2) Measurement of resistance in the trades of wire and cable: in the trades of wire and cable, copper products are the major objects measured. If constantly pressing the button "B" during measuring, the objects measured will heat up to subject the resistance to variation because of the objects measured having greater temperature coefficient, thus resulting in extremely unstable bridge balance point and the reading constantly increasing. To avoid the above phenomenon, the method of inching push button "B" should be used to ensure the stability and accuracy of data measured. The resistance measured is Rt at environmental temperature t, to get the resistance at temperature 20 ℃ or 25 ℃ , the following reduction formula can be used:

$$R_{20} = \frac{1 + 20\alpha}{1 + \alpha t} R_t \qquad R_{25} = \frac{1 + 25\alpha}{1 + \alpha t} R_t$$

Where

R_{20} —— resistance reduced to one at temperature of 20 ℃ ;

R_{25} —— resistance reduced to one at temperature of 25 ℃ ;

t —— room temperature at the measuring site;

Rt —— resistance measured at room temperature t;

α —— temperature coefficient of industrial copper （≈0.43 %） .

3) In case of measuring the resistance of wire & cable per meter, QD series conductor bridge fixture should be used.

4.4.3 Influence of thermo-electromotive force on measuring low-value resistance

a. The contact between two different metals will generate thermo-electromotive force, of which the value relates to the temperature at the contact. The measurement of bridge needs a measuring conduct with connector (brass or ferroalloy) that is different from the material of measuring conductor (industrial copper). In addition, the connector has been plated with other metal coatings (gold, silver, tin - cerium alloy, etc. that have small thermo-electromotive force to copper, as well as nickel, zinc, titanium, etc. that have great thermo-electromotive force to copper). The thermo-electromotive force generated at the connected point will give heavy influence on the measuring result of low-value resistance.

b. Eliminating or reducing the influence of thermo-electromotive force on low-value resistance

1) The conductor that being associated with the measuring conductor should be made of copper (or copper alloy), of which the surface should be plated with gold, silver or tin only, or simply no coating.

2) The temperatures at terminals P_1 & P_2, as well as those at contacts A & B should be kept identical. In case of connecting wire with hands, the temperatures at every connected points will differ to some extent, therefore, sufficient time should be needed to reach an isothermal state.

3) External power supply (because the internal batteries fail to change polarity) is used in the bridge. With the change of power supply, make a measurement for each change, then take the average to eliminate the influence of thermo-electromotive force.

4.4.4 Measuring DC resistance with inductance

a. Measuring conductor: generally, the measuring conductor of transformer is long, so the cross section of conductor should not too small, i. e. the resistance of each conductor should not be greater than 0.1 Ω. It is advisable to use the special measuring conductor CD18C or CD19C four-wire system manufactured by our works.

b. Measuring procedure: first press push button "B" and lock it during measuring, then press intermittently push button "G"; upon the completion of measurement, first let go button "G", then button "B". When pressing button "B" (in the process of measurement), do not disconnect four measuring conductors a, A, B & b as shown in Figure 3, otherwise it will arc over to endanger personal safety.

c. Stability of equilibrium point: when measuring DC resistance of transformer winding, the unstable equilibrium point of bridge will occur (pointer of zero indicator flickered), slightly flickering shows a questionable measuring result, and heavily flickering makes the measurement unavailable. To improve the stability of equilibrium point of bridge, some methods may be adopted as follows:

1) Avoiding the interference of electromagnetic field and geomagnetic field: the four measuring conductors should be stranded; the earth terminal " ⊥ " should be in earth connection.

2) Power supplied by external electric supply: the adjustment of measuring plate should be made in the process of bridge balancing. A slight mechanical vibration will change the contact resistance between No.1 battery and the contact piece, thus causes the fluctuation of measuring current and results in a counter electromotive force caused by great inductance, which affects the stability of the bridge equilibrium point. By adopting an external electric supply with sufficient capacity and well contact, the stability of equilibrium point can be improved.

3) When measuring DC resistance of transformer winding, it is advisable to use battery or dry cell as power supply instead of voltage stabilizing source supplied directly by municipal power supply. The series mode interference and common mode interference of electric supply will affect the stability of bridge equilibrium point.

4) To increase the measuring speed of DC resistance of transformer winding is required, model ZY9624 double bridge rapid test auxiliary manufactured by our works should be used.

4.5 External electric supply and external zero indicator

a. External electric supply: when measuring low-value resistance in a longer duration is required, it is necessary to adopt an external electric supply. Place the select switch of power supply in the position "B_{ext}", the external electric supply will be led in from the terminal "B_{ext}".

b. External zero indicator: when improving the sensitivity of zero indicator is required, place the select switch of zero indicator in the position "G_{ext}", the external zero indicator can be connected from the terminal "G_{ext}".

5. Point for attention

5.1 Battery

5.1.1 power supply for bridge circuit

a. 1.5V battery is used as power supply for bridge circuit, i. e. measuring circuit. Because of the greater output current of low-value resistance during measuring, so the high quality battery having great capacity should be used. It is advisable to use the leakless alkaline battery. The battery should be connected properly and contacted reliably with the contact pieces. In case of loose contact, correct the contact pieces.

b. Judgement of battery performance: electromotive force and internal resistance are the main parameters of battery. The open-circuit voltage measured with multimeter is approximate to the electromotive force. The values of electromotive forces used for batteries should be close to each other and not less than 80% of the nominal value. Internal resistance can be measured by the method of instantaneous short-circuit current, i. e. measured by instantaneous short-circuit by using high-current measuring range of multimeter. The smaller the short-circuit current and the internal resistance, the better the battery performance.

5.1.2 Power supply for zero indicator: high quality 6F22 9V laminated cell should be used for zero indicator.

5.2 External power supply: any kinds of 1.5V batteries or 2V storage batteries are available. Commercial conventional voltage-stabilized source will cause the bridge damaged owing to its limited trimming for the output of low voltage as well as easy to be out of control. It is advisable to use our works' model ZY9844 - 1double bridge DC voltage-stabilized source, which is characterized by compact, lightweight, well reliability and high performance - price - ratio. It is applied to where there is AC power supply, but not suitable for measuring transformer winding.

5.3 The bridge can only be used for measuring passive (uncharged) resistance. Municipal power supply or other power sources led in via measuring terminal are strictly prohibited.

5.4 Upon the completion of operation, reset the push buttons "B" & "G", and place the switch of multiplying power in the position "Off". In case the bridge is not in use for the near term, take out all batteries to prevent batteries from leakage; if leakage has occurred, cleaning thoroughly should be made without delay to prevent circuits from being damaged.

5.5 Storage conditions for bridge: temperature of 5 ~ 35 ℃, relative humidity of 25% ~ 80%. No corrosive gas in the air. Avoid sunlight.

6. Attachment

a. Certificate of inspection	1 copy,
b. Operating instructions	1 copy,
c. Measuring conductor	1 piece.