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68.5.-2

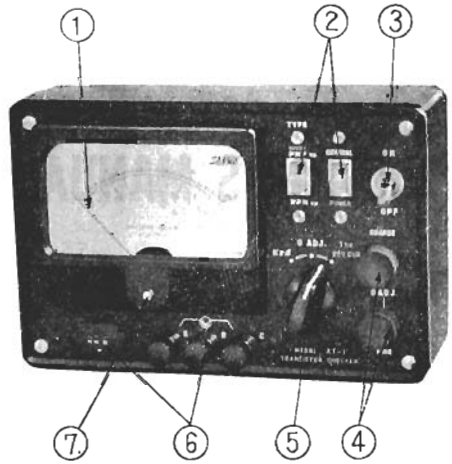
SANWA

OPERATOR'S MANUAL

FOR

AT-1

MULTITESTER



1. Pointer
2. Type switches
3. Power switch
4. Zero adjusting knobs.
5. Range selector switch knob
6. Transistor holders
7. Zero position adjusting screw

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MODEL AT-1
TRANSISTOR CHECKER

I GENERAL DESCRIPTION

1. Introduction

The Model AT-1 is a simplified checker to judge of the quality of transistors and diodes on its moving coil type meter movement of 50 microamperes (1,600 ohms) in sensitivity. It measures in a very simple operation the leak current commonly called Ico (collector current with emitter cut off), the reverse current of semiconductors, and DC powered β ($\frac{\triangle Ic}{\triangle Ib}$, or DC current amplification factor with emitter earthed).

Almost all kinds of transistors can be tested on the two ranges provided for checking power transistors as well as ordinary ones.

Even if the internal battery(6 volts) drops down to, say, 2 volts, indication error will be kept within 5%. This is a notable feature of the Model AT-1 Transistor Checker.

2. Measurement Ranges

1. Ico (Icbo) and reverse current of diodes :
   0~50μa (1μa per scale) on GENERAL position
   0~1ma (20μa per scale) on POWER position
2. β : 5~200 (2 per scale)
   Bias current – {1ma on GENERAL position / 5ma on POWER position}
3. α : 0.9~0.995 (from $\beta=\frac{\alpha}{1-\alpha}$)

3. Allowance

Ico – ±3% of full deflection
β & α – ±3% of the value indicated

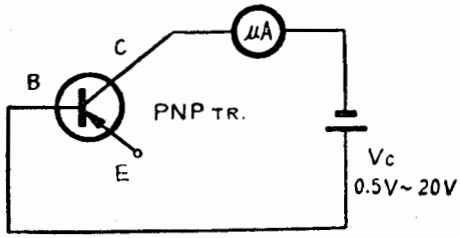
4. Internal Batteries

As power – 6v (UM-3)×4
As base current – 1.3v mercury battery (Matsushita MT type or Malory RM-502R)

II OPERATING INSTRUCTIONS

1. Measurement of Ico

The Ico of transistors is measured on the circuit as shown below.



It can be measured if one is provided with a microampere meter and a battery. Ico value has little to do with the size of Vc, while it is affected more by temperature. If, however, Vc is in excess of a certain voltage, Ico will suddenly increase. The voltage on the bend of the increase curve is known by gradually raising Vc by way of a voltmeter connected in series.

Now the Ico of a transistor is checked in the following procedure :

a. The TYPE switch (2) is set depending on either the type of the transistor to be checked, PNP or NPN, or the kind of the transistor, a universal small-size or a power transistor.

   The type of a transistor is known by setting the selector switch (5) to Ico position and quickly changing the TYPE switch (2) alternately to PNP and NPN positions. The side where the pointer deflects less tells the type.

b. The unit to be checked is connected to either of the transistor holders (6) taking note of the poles of the leads.

c. The range selector switch (5) is set to Ico position, and the power switch (3) is snapped to ON position.

d. As the pointer (1) deflects, read the Ico value on the meter. On GENERAL position of the change-over switch, read 0~50μa line and on POWER (red) position, 0~1000μa (1ma) line.

e. Ico values of transistors are various depending on their size and description, and the values published by the makers are to be taken as normal.

If Ico indicated on the meter is smaller than the value announced, the unit checked is definitely of good quality, but if is twice or by far the bigger compared with the others of the same description, the unit shall be judged to be of bad quality.

f. Ico fluctuates affected by temperature at which the unit is checked. It may be doubled at each 10°C. When it is measured in a high temperature, it must fully be taken into consideration, Do not hold the transistor by the hand while checking it to avoid it being warmed.

g. The pointer of the meter will bump across the scale end when :

(1) the base and the collector are shorted due to defect;

(2) the transistor is misconnected to the holder (B and C reversed) ;

(3) PNP and NPN are switched the other way.

(2) and (3) are not unlikely. Check and correct them.

2. Measurements of β anb α

a. After Ico is checked, the range selector switch is set to 0ADJ position to be immediately followed by zero position adjustment of the pointer.

If the pointer lies on the right hand half of the scale, the knob COARSE is slowly turned anti-clockwise and the pointer is adjusted to be exactly on 0 position of the scale (left extermity). If it does on the left hand half, clockwise to adjust. The knob FINE is for fine adjustment used jointly with the knob COARSE.

b. As the pointer is adjusted to 0 position, the range selector switch is reset to α & β position to read β or α value on the meter.

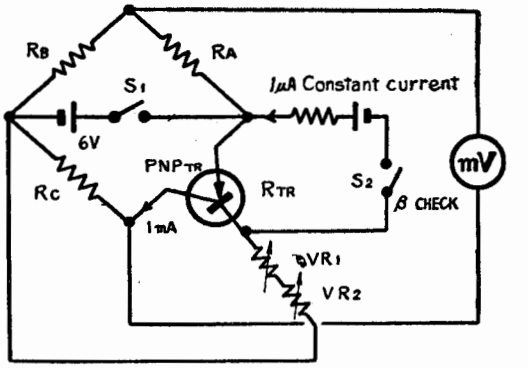
c. If the pointer fails to reach 0 position, when the knob is turned full clockwise, the transistor checked may be judged defective with little or no amplification factor. If same is the case when the knobs are turned full anti-clockwise, it indicates the collector current to be excessive. This is often the case with transistors of big Ico and β values, or when the emitter and the collector are shorted.

d. With ordinary transistors, GENERAL position is once changed over to POWER position. Repeat the zero adjustment. Too big Ico or β often occurs in a high temperature room, when a transistor may be checked in this way.

e. β is the DC current amplification factor of a transistor. It is the variation ratio of the collector current (Ic) against the slightest change of the base current (Ib) with the emitter earthed.

Roughly, therefore, providing there is a variation of 100 microamperes of Ic against that of 1 microampere of Ib, the β shall be 100. In actual circuits, this value varies according to the nature of the load, the relation between the power voltage and the load resistance, how the bias is fed, or the frequency. But this is an important factor to be taken as a basis in comparing transistors. The method of measurement of a transistor checker is defined by how this slight change of Ic is detected.

f. Given below is the bridge circuit that the Model AT-1 is composed of. A transistor is inserted in one side of the bridge. The bridge is balanced by means of VR1 and



VR2 (0 adjustment) and to the base is given 1 microampere constant current. The impedance of the transistor (R_{TR}) decreases and Ico increases in proportion to the β value, resulting in so much voltage drop by Rc. This unbalanced voltage of the bridge is measured on a highly sensitive millivolt meter to obtain the value on the scale converted to β value.

Rc is taken as small as possible against the impedance of the transistor so that its varying factor may be least affected by Rc. Being a bridge circuit, power voltage effect can be minimized.

3. Measurement of Iceo (collector current with base cut off).

a. The connections of a transistor are not regular. To B is connected the emitter instead of the base to be checked just in the same way as the measurement of Ico.

b. Usually Iceo is 10 to 100 times bigger than Ico. The bigger the ratio, so is the amplification factor of the transistor. $\left(\frac{Iceo}{Ico} \fallingdotseq \beta\right)$

Depending on the size of Ico, even a small-size transistor may cause the pointer to swing up on GENERAL position (0~50μa), when Iceo is checked on POWER position. This is also a simpler way often employed for checking transistors.

4. Measurement of Reverse Current.

a. The reverse current value between emitter and base may sometimes be needed for pulse amplifier. In this case, as the emitter base of a transistor corresponds to a diode, the emitter lead is connected to C of the holder in place of the collector. For a NPN transistor, the TYPE switch is set to NPN position.

b. The range selector switch is set to REV. CUR. position and the power switch is thrown. Read for reverse current at full deflection on 0-50 μa and 0-1 ma lines respectively for GENERAL and POWER positions.

c. The reverse current of a diode can also be checked by setting the TYPE switch to the DIODE side. With silicon diodes, the reverse current is sometimes too small to be readable even on 0-50μa line.

5. Creeping Phenomenon.

a. At the time of zero adjustment as explained in 2, observe the movement of the pointer, and you will sometimes see it not always stable on the zero position. It does not stagger, but it slowly shifts its position to

one direction, to the right on the right half or to the left on the left half.

b. This is creeping incidental to a transistor test. For an accurate reading, change the selector switch quickly over to β position after zero adjustment and read the indication promptly.

c. Theoretically, there shall be no such phenomenon as long as the room temperature is normal and does not change. Creeping should desirably be small, but it is practically unavoidable to a certain degree. It is a source of trouble to the designers of transistors for use of DC amplifying circuits.

d. If creeping is observed extending over half the scale length within 2~3 seconds after zero adjustment, the transistor checked may be judged defective. Thus the Model AT-1 Transistor Checker serves to judge of the degree of creeping on its 0 ADJ range.

III. MAINTENANCE

1. Replacement of Batteries

Connect across B and C a resistor of 1 megohm. Setting the range selector switch to Ico position, the power switch is thrown.

The pointer of the meter will swing up to 3~5μa. If it falls within 3μa, the internal batteries (1.5v) must immediately be replaced.

The Model AT-1 adopts a bridge circuit and the voltage drop of the internal batteries will little affect the indication, but they had better be replaced with fresh ones at the first opportunity.

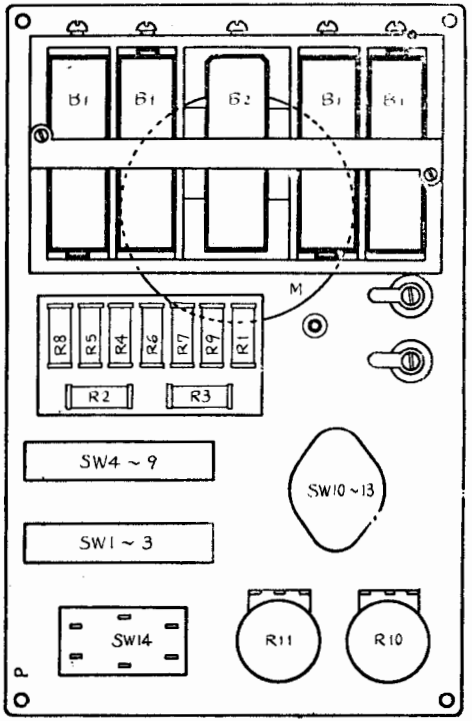
2. A highly sensitive meter movement equipped, be very careful not to give the instrument a severe vibration or shock.

3. Do not leave the instrument in high temperature or moisture for a long time.

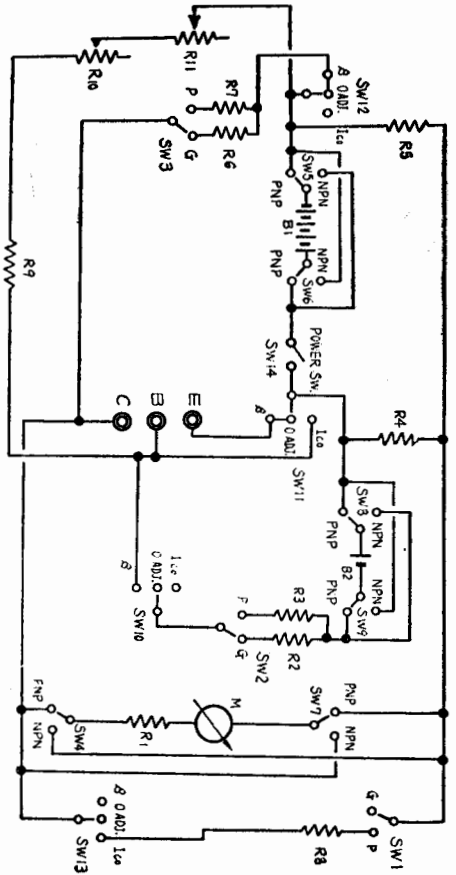
4. When the meter is kept long unused, the batteries had better be taken out to avoid possible damage to the internal components on account of leakage of electrolyte.

IV. SUPPLEMENTARY CHARTS

1. Arrangement of Parts



2. Schematic Diagram



3. Parts List

DESCRIPTION	R. S.
50~250 ohm meter movement mv calibration resistor	R 1
1.3 megohm carbofilm resistor	R 2
260k ohm carbofilm resistor	R 3
6k ohm carbofilm resistor	R 4
400 ohm carbofilm resistor	R 5
500 ohm carbofilm resistor	R 6
100 ohm carbofilm resistor	R 7
84.2 ohm carbofilm resistor	R 8
1k ohm carbofilm resistor	R 9
200k ohm FINE adjustment carbofilm resistor	R 10
3 megohm COARSE adjustment carbofilm resistor	R 11
POWER/GENERAL change switch	SW1~3
TYPE change switch	SW4~6
Range selector switch	SW10~13
Power switch	SW14
Dry cell 1.5 volts (4 required)	B 1
Mercury battery 1.3 volts	B 2
Meter movement, sensitivity 50μa (1.6k ohm)	M
Panel	P
Bakelite case	
Battery case with holder	
Resistor holder	
E-B-C holder	
Transistor holder base	
Knob for POWER/GENERAL change switch	
Knob for TYPE change switch	
Knob for range selector switch	
Knob for FINE adjustment	
Knob for COARSE adjustment	
Panel bolts & nuts (4 sets required)	
R. S. Reference symbol	

MEMO