Immersion probe set for determination of the temperature coefficient (CT)

07163.00

Operating instructions

Fig. 1. Immersion probe set, Order-No. 07163.00

1. PURPOSE AND DESCRIPTION

Using the immersion probe set in Fig. 1, the electrical properties of different electronic components and materials can be investigated at defined temperatures (up to approximately 100° C). The immersion probe set contains the following components:

— Carbon-film resistor
— Metallic film resistor, TC 50
— PTC resistor
— NTC resistor
— Copper wire
— Constantan wire
— Silicon diode
— Germanium diode
— Z diode, 2.7 v
— Z diode, 6.8 V

2. USE

The immersion probe set first enclosed in a heat-resistance plastic bag (contained in the delivery set) and then placed in a temperature-controlled water bath. In this manner, the following parameters can be measured as a function of the (exactly adjustable) temperature:

— Resistance of conductors (metals)
— Resistance of semi-conductors
— Diode threshold voltage (Si, Ge)
— Diode blocking voltage (Si, Ge)
— Z voltage for the Zener effect
— Z voltage by the avalanche effect

From the measured values, additional parameters, such as the temperature coefficient, can be calculated.

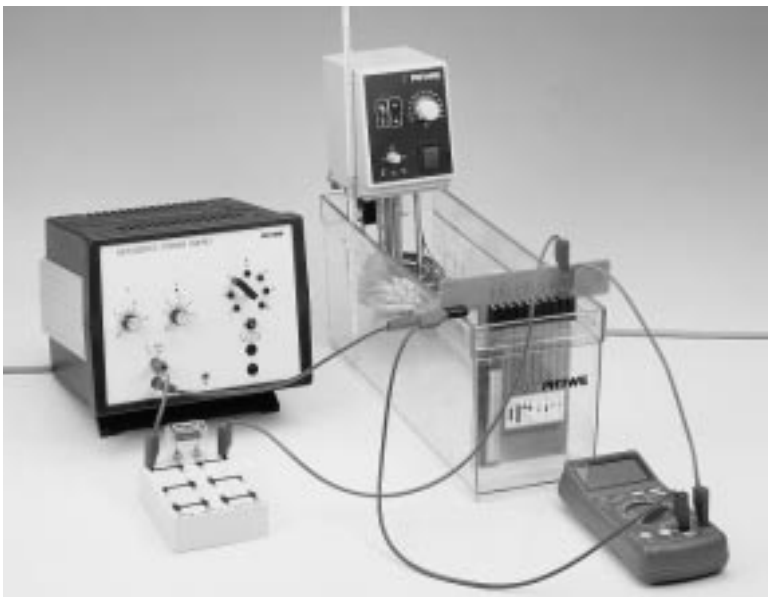

Fig. 2 shows an appropriate experimental set up. Assuming a lower water temperature by full output of the circulating thermoregulator, it is advisable to perform nearly all of the 10 K measurements either during the warming or (after reaching the maximum temperature and switching off the heating) during the cool-down phase. The resistance values are directly measured with the digital multimeter. The diode voltages are measured after the diodes have been connected to a voltage of 10 V- across a 4.7 kΩ resistor.

The plastic bag should fit as tightly as possible around the immersion probe set. For this reason press out the air before immersing the probe set. Do not immerse the set in water without its protective plastic bag.!

Fig. 2. Experimental set-up for measuring the temperature dependence of electrical characteristics of electronic components.

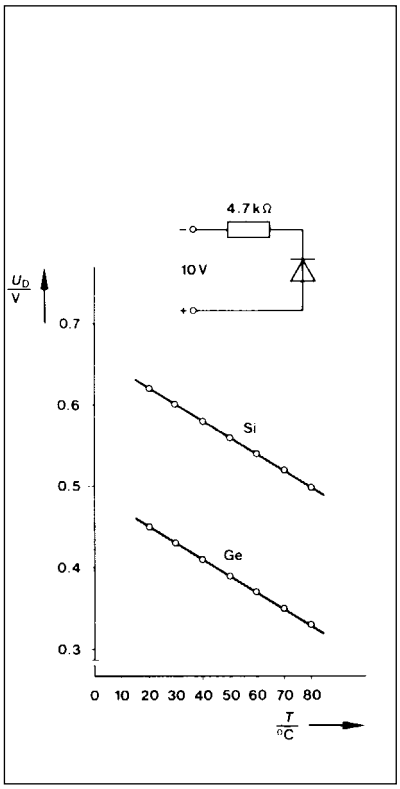

Fig. 3. The threshold voltage of semiconducting diodes as a function of the temperature.

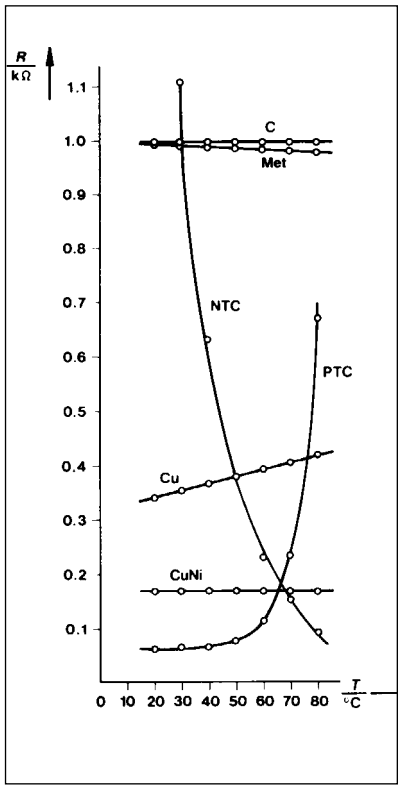

Fig. 4. The resistance of some materials and components as a function of temperature.

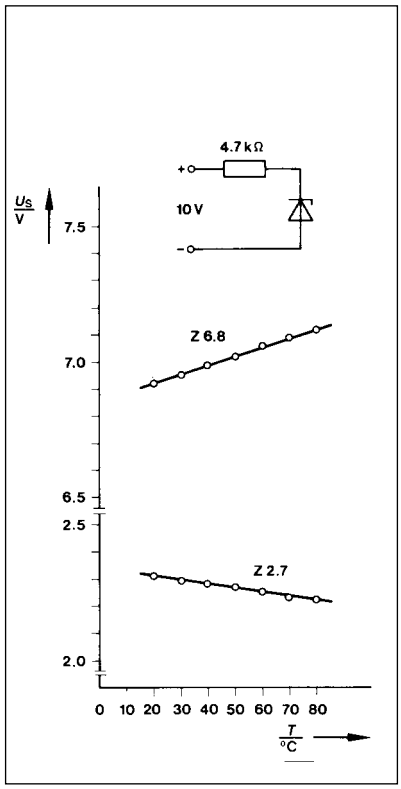

Fig. 5. Blocking voltage of Z diodes as a function of temperature.

3. SAMPLE MEASUREMENTS

The diagrams show a selection of the measuring results. The different signs of temperature coefficient of the blocking voltage of two Z diodes (Fig. 3), which results from the avalanche and Zener effects, is very clearly shown. In practice, Z diodes with a Z voltage of approximately 5 V are used to generate particularly stable reference voltages, as in this case the temperature coefficient is nearly zero.

From the measured values for the copper wire (Fig. 4), the temperature coefficient α_R is calculated according to

$$\alpha_R = \frac{R - R_a}{R_a(\vartheta - \vartheta_a)}$$

R(ϑ_a = initial temperature, ϑ = final temperature, R = resistance at ϑ, R_a = resistance at ϑ_a)
to be equal to the following:

$\alpha_R = 3.91 \cdot 10^{-3}\ ^oC^{-1}$ (copper).

This value corresponds very well with the corresponding literature values.

The nearly linear correlation between threshold voltage and temperature for semiconducting diodes (Fig. 5) is also interesting. Due to this, the threshold voltage can also be used for making temperature measurements.

4. TECHNICAL DATA

Z diodes (at T_{amb} = 25° C	**ZPD 2.7**	**ZPD 6.8**
Rated voltage U_z at I_z = 5 mA	2.7 ±7.41%	5.8 ±5.9%
Output	max 0.5 W	max 0.5 W
Operating current	max 160 mA	max 58 mA
Temperature coefficient CT	-9 ... -4 · 10^{-4}/K	+2 ... +7 · 10^{-4}/K

Si diode (1 N 4005)	
Threshold voltage U_F at 0.1 A	approx. 0.55 V
Nominal current	1 A
Blocking current at U_R = 800 V, T_j = 25° C	max. 5A

Ge diode (AA 118)	
Threshold voltage	
U_F at I_F = 10 mA	typ. 1.05 V
at I_F = 0.1 mA	typ. 0.18 V
Continuous average forward current	
at U_R = 75 V, T_{amb} = 75° C	max. 5 mA
Blocking current at U_R= 75 V,	typ. 35 µA

PTC resistor (Posistor, Type Q 63100-P330-C12, SIEMENS)	
Cold resistance at T_{amb} = 25° C	approx. 60 Ω
Initial temperature (Start of pos. TC)	30° C
Initial resistance at 30° C	30 Ω
Nominal resistance at 60° C	100 Ω
Tc in steepest region of the characteristic line	20%/K
Limit temperature	max 140° C

NTC resistor

(Thermistor, Type 2322 610 11132, VALVO)	
Resistance at T_{amb} = 25° C	1300 Ω ±20%
Therm. cooling constant	60 s
Component constant $_{25/85}$	5450 K
Temperature coefficient	-6.15%/K
Output at T_{amb} = 55° C	max 1 W

Metal film resistor

Nominal resistance	1 kΩ ±2%
Temperature coefficient	±0 ... 50 · 10^{-6}/K
Output at T_u = 70° C	max 0.5 W

Carbon-film resistor

Nominal resistance	1 kΩ ±5%
Temperature coefficient	-240 · 10^{-6}/K
Output at T_{amb} = 70° C	max 0.5 W

Copper wire resistor

Resistance at T_{amb} = 20° C	351 Ω ±1%
Wire-Cu diameter	0.05 mm
Wire length	approx. 40 m
Temperature coefficient	0.004/K
Loading current	max 5 mA

CuNi wire resistor (constantan)

Resistance at T_{amb} = 20° C	172 Ω ±1%
Wire-Cu diameter	0.2 mm
Wire length	approx. 11 m
Temperature coefficient	-3 · 10^{-5}/K
Loading current	max 50 mA

Other Values

Immersion width and depth of the device	100 mm x 105 mm
Width of the upper cross bridge	180 mm
Freezer bag dimensions (w x l)	180 mm x 250 mm
Connection jacks, diameter	4 mm
Operating temperature	max 100° C

5. EQUIPMENT ORDER-NO. PCS

Immersion probe set for ct determination	07163.00
Circulating thermostat up to 85° C	08482.93
Bath for thermostat, 4 l, plastic	08482.93
Digital hand multimeter 10 A, LCD	07133.00
Thermostat bridge with cooling hose	08482.02
Power supply, universal	11704.93
Resistor 4.7 Ωk in plug-in box	39104.27
Connection box	06030.23
Connection cords	