

INTERNATIONAL STANDARD

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Semiconductor devices – STANDARD PREVIEW
Part 14-5: Semiconductor sensors – PN-junction semiconductor temperature
sensor (standards.iteh.ai)

Dispositifs à semiconducteurs – [IEC 60747-14-5:2010](https://standards.iteh.ai)
Partie 14-5: Capteurs à semiconducteurs – Capteur de température à
semiconducteurs à jonction PN





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IEC 60747-14-5

Edition 1.0 2010-02

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Dispositifs à semiconducteurs –
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semiconducteurs à jonction PN

[IEC 60747-14-5:2010](#)

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

R

ICS 31.080.01

ISBN 978-2-88910-278-5

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The text of this standard is based on the following documents:

FDIS	Report on voting
47E/390/FDIS	47E/392/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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SEMICONDUCTOR DEVICES –

Part 14-5: Semiconductor sensors – PN-junction semiconductor temperature sensor

1 Scope

This standard is applicable to semiconductor PN-junction temperature sensors and defines terms, definitions, symbols, essential ratings, characteristics and test methods that can be used to determine the characteristics of semiconductor types of PN-junction temperature sensors.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60747-14-1, *Semiconductor devices – Part 14-1: Semiconductor sensors – General and classification* **iTeh STANDARD PREVIEW**

IEC 60749-5, *Semiconductor devices – Mechanical and climatic test methods – Part 5: Steady-state temperature humidity bias life test*

[IEC 60747-14-5:2010](#)

IEC 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature* [c8fa1b73ea5b/iec-60747-14-5-2010](#)

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purpose of this document, the following terms and definitions apply. For the general terms and definitions, refer to IEC 60747-14-1.

3.1.1

voltage output style

output style of the temperature sensor where output change is expressed by voltage change

3.1.2

current output style

output style of the temperature sensor where output change is expressed by current change

3.1.3

supply voltage range

voltage range where the sensor operates normally

3.1.4

operating temperature range

temperature range where the sensor operates normally

3.1.5**line regulation**

ratio of output voltage change to supply voltage change

NOTE The unit mV/V is usually used in the line regulation.

3.1.6**load regulation**

ratio of output voltage change to output current change

NOTE The unit mV/mA is usually used in the load regulation.

3.2 Symbols S sensitivity ΔV_{out} full scale of output voltage change ΔF full scale of temperature change H hysteresis H_{max} maximum difference between two outputs by the increasing input and decreasing input R_x resistors Q_x transistors R_{max} maximum difference between or among outputs I_1 current at emitter of transistor Q_1 I_2 current at emitter of transistor Q_2 $V_{\text{BE}1}$ voltage between base and emitter of transistor Q_1 $V_{\text{BE}2}$ voltage between base and emitter of transistor Q_2 V_T equals $\frac{kT}{q}$ <https://standards.iteh.ai/catalog/standards/sist/568eaa97-e355-492c-8a85-c8fa1b73ea5b/iec-60747-14-5-2010> k Boltzmann constant T absolute temperature q electron charge S_j junction area V_F junction voltage I_F forward current N_a acceptor density N_d donor density D_p hole diffusion constant D_n electron diffusion constant L_p hole diffusion distance L_n electron diffusion distance n_i intrinsic carrier density**4 Essential ratings and characteristics****4.1 General**

This clause gives ratings and characteristics required for specifying PN-junction temperature sensors.

4.2 Limiting values (absolute maximum rating system)

4.2.1 Electrical limiting values

Limiting values shall be specified as in Table 1.

Table 1 – Electrical limiting values

Subclause	Parameters	Min.	Max.
4.2.1.1	Bias supply voltage		+
4.2.1.2	Output terminal voltage		+

4.2.2 Temperatures

Operating temperature

Storage temperature

4.3 Electrical characteristics

The characteristics shall apply over the full operating temperature range, unless otherwise specified.

The parameters shall be specified as in Table 2.

Table 2 – Parameters electrical characteristics

Subclause	Parameters	IEC 60747-14-5:2010	Min.	Typical	Max.
4.3.1	Temperature sensitivity	http://temperature.sensitivity.log/standards/sist/568caa97-355-492c-8a85-c8fa1b73ea5b/iec-60747-14-5-2010		+	+
4.3.2	Bias supply operating current			+	+
4.3.3	Output voltage		+	+	+
4.3.4	Nonlinearity			+	
4.3.5	Line regulation				+
4.3.6	Load regulation				+

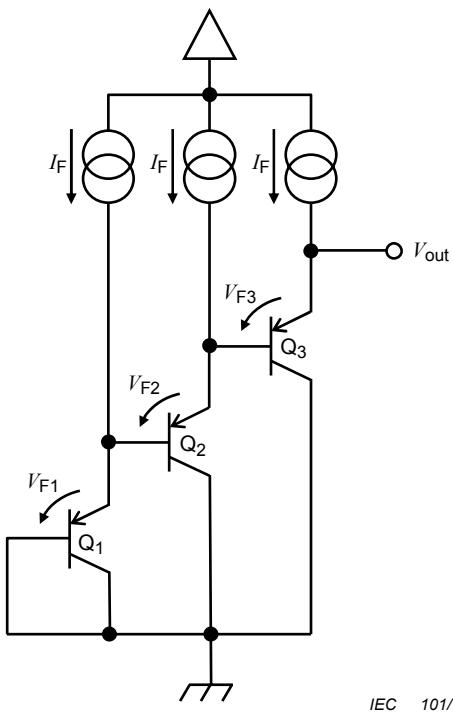
5 Measuring methods

5.1 General

This clause prescribes measuring methods for electrical characteristics of PN-junction temperature sensors.

5.2 Circuit diagrams of PN-junction temperature sensors

Circuit diagrams of PN-junction temperature sensors are shown as follows. Figure 1 is a typical circuit diagram of a PN-junction temperature sensor with a negative temperature coefficient.



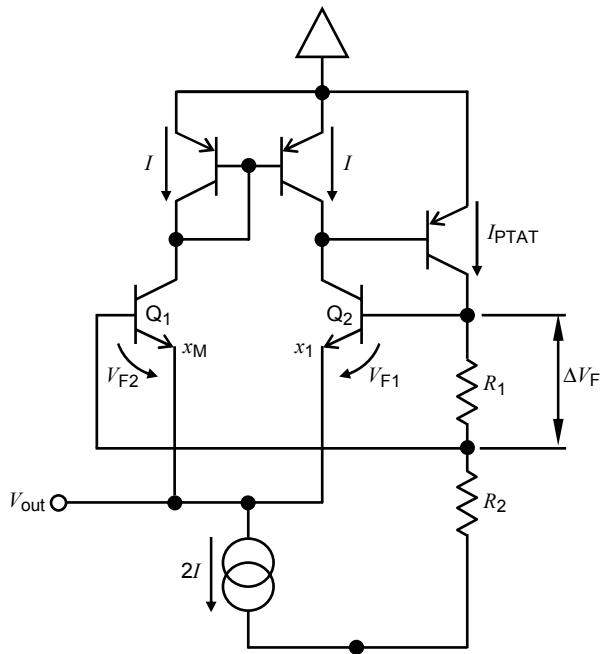
IEC 101/10

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**Figure 1 – The circuit diagram of a PN-junction temperature sensor
with a negative temperature coefficient**
(standards.iteh.ai)

$$I_F = S_{jq} \cdot \left(\frac{I_P}{I_p N_d} + \frac{D_{n4-5}}{N_a N_d} \cdot n_j^{20} \right) \exp \left(\frac{qV_F}{kT} \right) \quad (1)$$

<https://standards.iteh.ai/ci/Iec/60747-14-5/standards/ist/568eaa97-e754-492c-8a85-c8fa1b73ea5b/iec-60747-14-5-2010>

Figure 2 shows typical circuit diagrams of a PN-junction temperature sensor with a positive temperature coefficient.



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M emitter size ratio of Q_1 and Q_2 (standards.iteh.ai)

Figure 2 – The circuit diagram of a PN-junction temperature sensor with a positive temperature coefficient

<https://standards.iteh.ai/catalog/standards/sist/568eaa97-e355-492c-8a85-c8fa1b73ea5b/iec-60747-14-5-2010>

$$\Delta V_F = V_{F1} - V_{F2}$$

$$= \frac{kT}{q} \ln(M) \quad (2)$$

$$I_{\text{PTAT}} = \frac{\Delta V_F}{R_1} \quad (3)$$

$$\begin{aligned} V_{\text{out}} &= \left(1 + \frac{R_2}{R_1}\right) \Delta V_F - V_{F1} \\ &= \left(1 + \frac{R_2}{R_1}\right) \frac{kT}{q} \ln(M) - V_{F1} \end{aligned} \quad (4)$$

5.3 Temperature sensitivity

5.3.1 Purpose

To measure the temperature sensitivity under specified conditions.

5.3.2 Circuit diagram

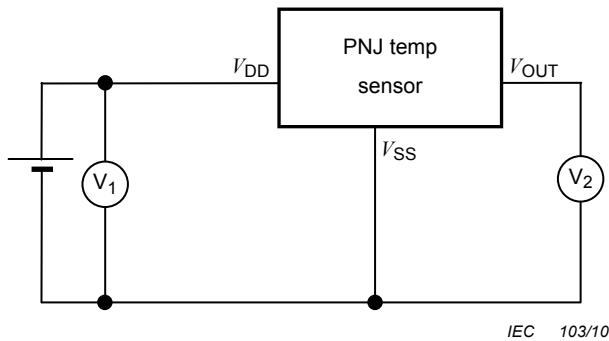


Figure 3 – Circuit diagram for the measurement of the temperature sensitivity

5.3.3 Principle of measurement

Temperature sensitivity α_{SE} is derived from the output voltages at low measuring temperature T_L and high measuring temperature T_H as follows:

$$\alpha_{SE} = \frac{V_{outH} - V_{outL}}{T_H - T_L} \quad (5)$$

where

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V_{outH} is the output voltage at high measuring temperature T_H ;

V_{outL} is the output voltage at low measuring temperature T_L ;

α_{SE} is expressed with the unit mV/°C. See Figure 4.

<https://standards.iteh.ai/catalog/standards/sist/568eaa97-e355-492c-8a85-c8fa1b73ea5b/iec-60747-14-5-2010>

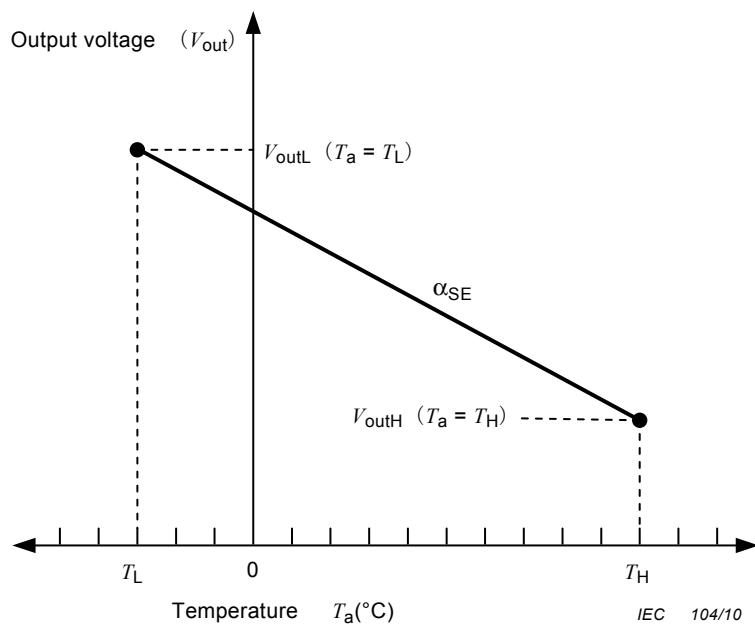


Figure 4 – Circuit diagram for the measurement of the temperature sensitivity

5.3.4 Measurement procedure

The supply voltage shall be applied as specified.