

TSYS03

Digital Temperature Sensor

Product Description

The TSYS3 is a miniature digital temperature sensor that provides factory calibrated highly accurate temperature data.

The device contains a durable temperature sensor element, A/D converter, and microcontroller to manage data communications via an I²C interface.

TSYS3 is available in a TDFN8 or a XDFN6 package to easily adapt to the space available on a PC board. These packages are very small and have low thermal mass which provides a quick response to temperature changes.

The operating and measurement temperature range is -40 to +125°C with a resolution of $\pm 0.01^\circ\text{C}$.

Operating and sleep currents are extremely low making this sensor ideal for mobile and battery power applications

Features

- High Accuracy $\pm 0.5^\circ\text{C}$ @ Temp.: 0°C to $+60^\circ\text{C}$
- Adjustment of high accuracy temperature range on request
- Low Supply Current $< 5 \mu\text{A}$ (standby $< 0.4 \mu\text{A}$)
- I²C Interface up to 1MHz
- Small IC-Package TDFN8 2.5mm x 2.5mm and XDFN6 1.5mm X 1.5mm
- Operating Temperature Range: -40°C to $+125^\circ\text{C}$
- Programmable I2C Address

Applications

- Industrial Control
- Replacement of Precision RTDs, Thermistors and NTCs
- Heating / Cooling Systems
- HVAC
- Medical probes and patient monitoring
- Weather Stations
- Fitness watches and wearables
- Consumer appliances

Absolute Maximum Ratings

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----------------------|------------|---|------|-----|------|------|
| Supply Voltage | V_{DD} | --- | -0.3 | --- | +5.5 | V |
| Operating Temperature | T_{op} | --- | -40 | --- | +125 | °C |
| Storage temperature | T_{stor} | --- | -55 | --- | +150 | °C |
| ESD rating | ESD | Human Body Model (HBM) pin to pin incl. V_{DD} & GND | -4 | --- | +4 | kV |
| Humidity | Hum | Non-condensing | 0 | --- | 95 | RH |

Operating Conditions

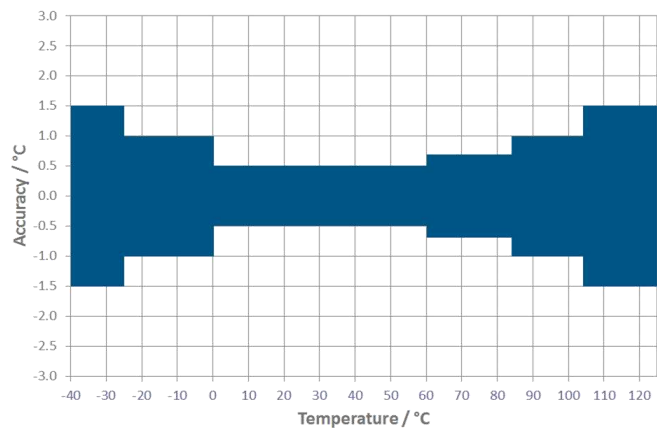
| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|--------------------------|------------|---|------------|----------------------|----------------------|------|
| Operating Supply Voltage | V_{DD} | stabilized | 2.4 | 3.3 | 5.5 | V |
| Supply Current | I_{DD} | 1 sample per second | --- | 5 | --- | μA |
| Standby current | I_S | No conversion, $V_{DD} = 5.0V$ $T = +25^{\circ}C$ $T = +85^{\circ}C$ $T = +125^{\circ}C$ | --- | 0.16 0.32 1.02 | 0.34 1.32 6.27 | μA |
| Peak Supply Current | I_{DD} | $V_{DD} = 5.0 V$ $T = 25^{\circ}C$ $T = -40^{\circ}C \dots +125^{\circ}C$ | 345 327 | 402 | 486 515 | μA |
| Conversion time | T_{CONV} | --- | --- | 12 | --- | ms |
| Serial Data Clock I2C | F_{SCL} | --- | --- | --- | 1 | MHz |
| VDD Capacitor | --- | Place close to the chip | 100 | | | nF |

Operational Characteristics

If not otherwise noted, 3.3V supply voltage is applied.

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-------------------------|------------|--|------|-----|------|------|
| Temp. Measurement Range | T_{RANG} | --- | -40 | --- | 125 | °C |
| Accuracy 1 | T_{ACC1} | $0^{\circ}C < T < +60^{\circ}C$ $V_{DD} = 3.2V - 3.4V$ | -0.5 | --- | +0.5 | °C |
| Accuracy 2 | T_{ACC2} | $60^{\circ}C < T < +85^{\circ}C$ $V_{DD} = 3.2V - 3.4V$ | -0.7 | --- | +0.7 | °C |
| Accuracy 3 | T_{ACC3} | $-25^{\circ}C < T < +105^{\circ}C$ $V_{DD} = 3.2V - 3.4V$ | -1.0 | --- | +1.0 | °C |
| Accuracy 4 | T_{ACC4} | $-40^{\circ}C < T < +125^{\circ}C$ $V_{DD} = 3.2V - 3.4V$ | -1.5 | --- | +1.5 | °C |
| PSRR | --- | $V_{DD} = 2.4 - 5.5$ $T = 25^{\circ}C$, $C = 100nF$ | --- | --- | 0.1 | °C |
| Self-Heating | SH | 10 samples/s, 60s, still air | --- | --- | +0.1 | °C |

Accuracy



Analogue to Digital Converter

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----------------|--------|-----------|-----|-----|-----|------|
| Resolution | --- | --- | --- | 16 | --- | bit |
| Conversion Time | t_c | --- | --- | 12 | --- | ms |

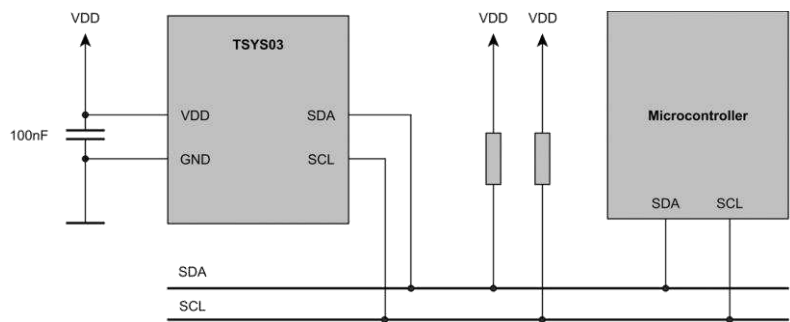
Digital Inputs (SCLK, SDA)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----------------------|----------------------------------|--|--------------|--------------|--------------|---------|
| Input High Voltage | V_{IH} | $V_{DD} = 3.0 \dots 5.5V$ | $0.7 V_{DD}$ | --- | V_{DD} | V |
| Input Low Voltage | V_{IL} | $V_{DD} = 3.0 \dots 5.5V$ | $0.0 V_{DD}$ | --- | $0.3 V_{DD}$ | V |
| Input leakage Current | I_{leak_25} I_{leak_85} | $T = 25^{\circ}C$ $T = 85^{\circ}C$ | --- | 0.01 0.25 | 0.14 1.40 | μA |
| Input Capacitance | C_{IN} | --- | --- | --- | 6 | pF |

Digital Outputs (SDA)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---------------------|----------|--------------------|--------------|-----|--------------|------|
| Output High Voltage | V_{OH} | $I_{Source} = 1mA$ | $0.8 V_{DD}$ | --- | V_{DD} | V |
| Output Low Voltage | V_{OL} | $I_{Sink} = 1mA$ | $0.0 V_{DD}$ | --- | $0.2 V_{DD}$ | V |

Connection Diagram



Pin Function Table

TDFN Package

| Pin | Name | Type | Function |
|---------|-----------------|------------------------|--------------------------------------|
| 1 | V _{DD} | Power | Supply Voltage |
| 2 | SCL | Digital Input | I ² C: Serial Data Clock |
| 3 | SDA | Digital Input / Output | I ² C Data Input / Output |
| 4 | VSS | Power | Ground |
| 5 ... 8 | NC | --- | Not connected / Do not connect |

XDFN Package

| Pin | Name | Type | Function |
|-----|-----------------|------------------------|--------------------------------------|
| 1 | NC | --- | Not connected / Do not connect |
| 2 | VSS | Power | Ground |
| 3 | SDA | Digital Input / Output | I ² C Data Input / Output |
| 4 | SCL | Digital Input | I ² C: Serial Data Clock |
| 5 | V _{DD} | Power | Supply Voltage |
| 6 | NC | --- | Not connected / Do not connect |

I²C Interface

An I²C communication message starts with a start condition and it is ended by a stop condition. Each command consists of two bytes: the address byte and command byte.

I²C Address

The standard I²C address is 0x40 (0b1000000x). Every sensor will respond to this address. But the sensor can also react to a second, alternative I²C address.

It is possible to do a one-time subsequent writing of an alternative static I²C address. This leads to a wrong memory CRC but the sensor is still functional.

The alternative address could be written to the sensor already during production. There won't be a wrong CRC at the end in this case.

It is also possible to write an alternative I²C address to the sensor during operation. This address is temporally and is overwritten during a software reset or a hardware restart.

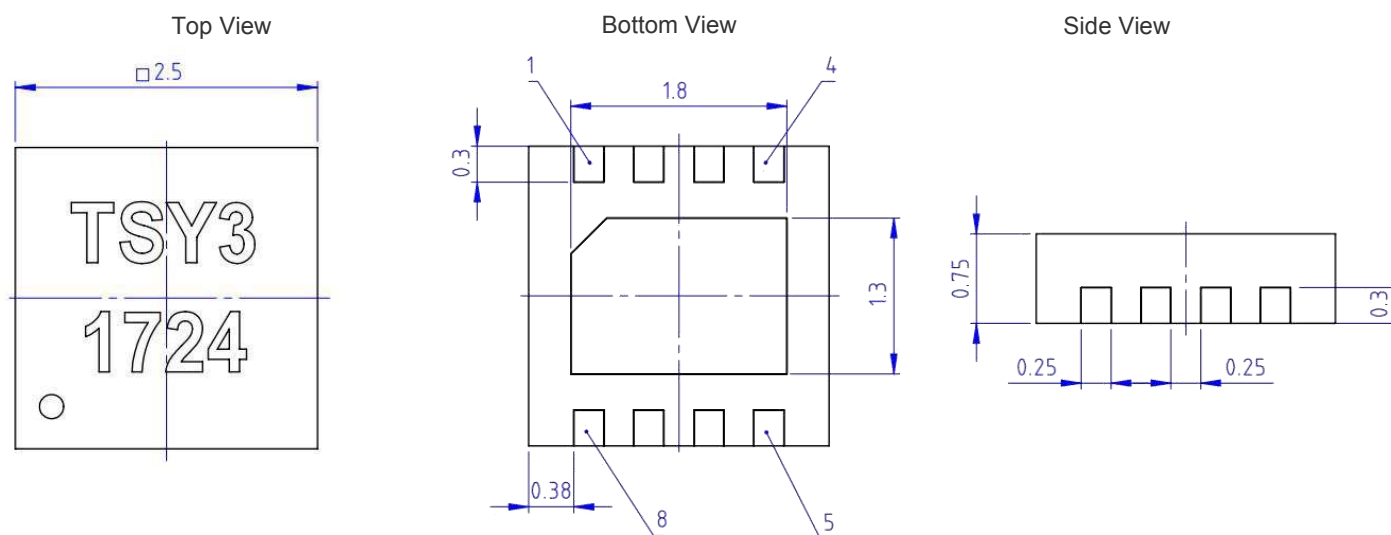
Further information on writing the alternative I²C address are given in the Application Note.

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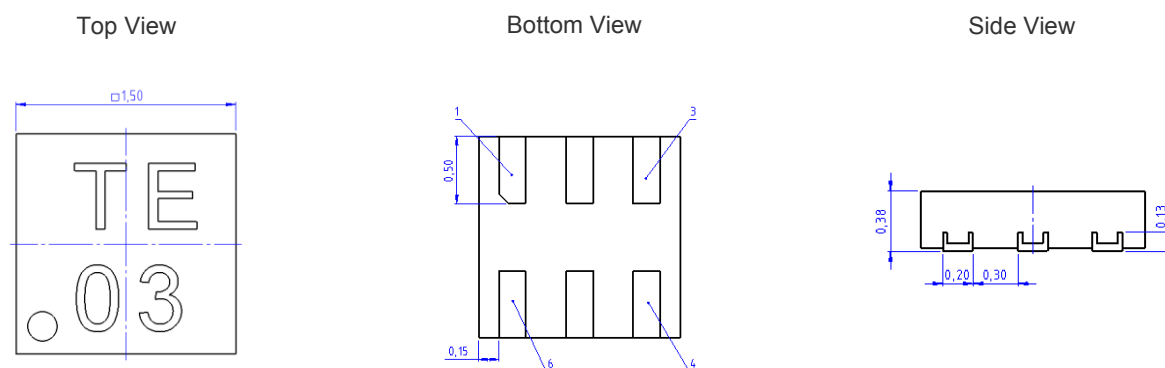
Digital Temperature Sensor

Dimensions

TDFN 2.5mm X 2.5mm



XDFN 1.5mm X 1.5mm



Marking

| Line | 8L TDFN 2.5x2.5 | | 6L XDFN 1.5x1.5 | |
|------|---------------------------|------|-------------------------|------|
| | Description | Text | Description | Text |
| 1 | Product Name | TSY3 | Product Name | TE |
| 2 | Pin 1 Dot, Date Code YYWW | 1724 | Pin 1 Dot, Product Name | 03 |

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Packaging Information

The TSYS03 will be delivered in tape and reel package.

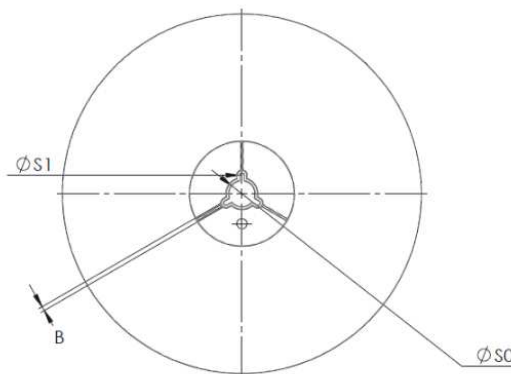
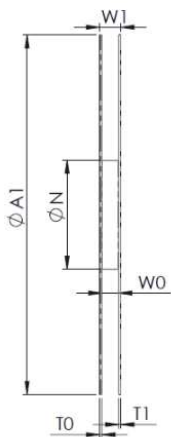
TDFN: Reel diameter: 7in (179mm): 3000 pieces per reel

XDFN: Reel diameter: 7in (179mm): 5000 pieces per reel

Each reel is equipped with a protective band and separately vacuum sealed into ESD protective moisture barrier bag. Furthermore, each bag contents a dry pack and humidity indicator.

Each bag is separately warped with bubble sheet and packed in a karton box, called pizza box.

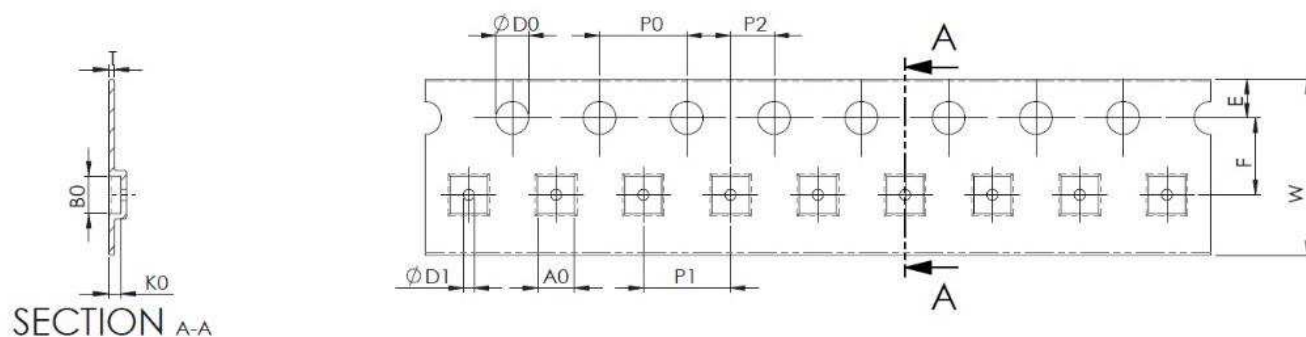
Dimension of Reel



**8L TDFN 2.5x2.5,
6L XDFN 1.5x1.5**

| | |
|----|------------------|
| A1 | 179.00 +/- 0.5mm |
| B | 1.5 min. |
| N | 55.00 +/- 0.5mm |
| S0 | 20.20 min. |
| S1 | 13.00 mm |
| T0 | 1.80 mm |
| T1 | 1.80 mm |
| W1 | 8.40 mm |

Dimension of Tape


8L TDFN 2.5x2.5

| | |
|----|------------------|
| A0 | 2.75 +/- 0.10 mm |
| B0 | 2.75 +/- 0.10 mm |
| D0 | 1.55 +/- 0.05 mm |
| D1 | 1.00 min. |
| E | 1.75 +/- 0.10 mm |
| F | 3.50 +/- 0.05 mm |
| K0 | 1.00 +/- 0.10 mm |
| P0 | 4.00 +/- 0.10 mm |
| P1 | 4.00 +/- 0.10 mm |
| P2 | 2.00 +/- 0.50 mm |
| T | 0.25 +/- 0.05 mm |
| W | 8.00 +/- 0.30 mm |

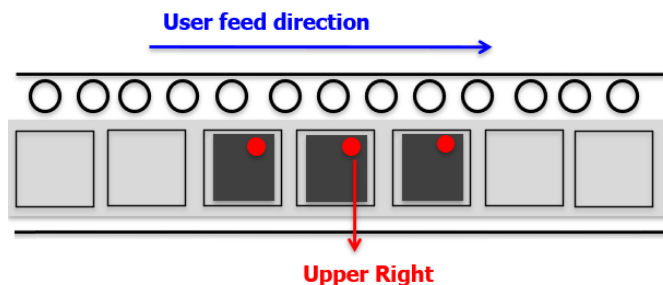
6L XDFN 1.5x1.5

| | |
|----|------------------|
| A0 | 1.70 +/- 0.10 mm |
| B0 | 1.70 +/- 0.10 mm |
| D0 | 1.55 +/- 0.05 mm |
| D1 | 0.50 min. |
| E | 1.75 +/- 0.10 mm |
| F | 3.50 +/- 0.05 mm |
| K0 | 0.56 +/- 0.10 mm |
| P0 | 4.00 +/- 0.10 mm |
| P1 | 4.00 +/- 0.10 mm |
| P2 | 2.00 +/- 0.50 mm |
| T | 0.25 +/- 0.05 mm |
| W | 8.00 +/- 0.30 mm |

Orientation of Sensors inside Tape

8L TDFN 2.5x2.5,

6L XDFN 1.5x1.5



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Order Information

Further customer specific adaptations are available on request. Please refer to the table below for part name, description and order information.

| Part Number | Part Description | Comment |
|-------------|--|---|
| 20011957-00 | TSYS03 TEMP SENSOR TDFN8 2.5X2.5MM I2C | Digital Temperature Sensor, TDFN8, I2C Interface, one or multiple reels |
| 20011957-01 | TSYS03 TEMP SENSOR XDFN6 1.5X1.5MM I2C | Digital Temperature Sensor, XDFN6, I2C Interface, one or multiple reels |

EMC

Due to the use of these modules for OEM application no CE declaration is done. Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low-price feature. There is no protection circuit against reverse polarity or over voltage implemented. The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good

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