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Final Datasheet V1.0

Tire Pressure Monitoring Sensor SP30T

Revisions dates:

| | |
|----|------------|
| 00 | 2007-06-11 |
| 1 | 2007-12-20 |
| 2 | 2008-05-29 |

Document history: See end of document

| | Date | Sign | Rev | Reference | Date | Dok | Stamp |
|-----------------|--------|------|-----|---------------|--------|-----|-------|
| Prepared | 070611 | ML | 0 | Archive 11843 | 070813 | HKW | |
| Checked | 070613 | NPH | 1 | EM 11866 | 080616 | HKW | |
| Approved | 070716 | RH | 2 | EM 12044 | 080616 | | |



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Edition 2008-05-29
Published by Infineon Technologies AG,
Am Campeon 1-12
85579 Neubiberg, Germany
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1 Product Description

1.1 Overview

The SP30T Tire Pressure Monitoring (TPM) Sensor represents Infineon's high pressure range TPM sensor for SUV and Truck application. The SP30T combines a high pressure range with a high level of integration by including a microcontroller and LF-input stage to meet market demands for flexible, customer specific solutions and overall system cost reduction.

The sensor design is based upon Infineon's proprietary and patented solutions for high reliability measurements in harsh automotive environments, with a predictable and stable quality in high volume applications.

The SP30T measures pressures up to 1600kPa, temperature, supply voltage and acceleration (optional), and by integrating these functions with an ASIC in one package, Infineon has developed the ideal product for high pressure TPM applications.

1.2 Features

- Integrated Sensors
 - High pressure range
 - Acceleration
 - Temperature
 - Voltage
- Integrated Peripherals
 - Microcontroller
 - On board EEPROM
 - GPIOs
 - ADC for signal conditioning
 - 2x LF Receiver for triggering
- Measurement Ranges
 - Pressure Sensor 100 to 1600 kPa
 - Temperature Sensor -40 to +125°C
 - Supply Voltage Sensor 2.1 to 3.6 V
 - Acceleration Sensor -12 to 115 g

1.3 Ordering Information

| Product Name | Product Type | Ordering Code | Package |
|-----------------|---------------------------------|---------------|--------------|
| SP30T-00E00-06B | Tire Pressure Monitoring Sensor | SP000411794 | P-DSOSP-14-6 |

2 Product Characteristics

The max and min numbers are to be understood as + and – 5σ values (Cpk = 1.67) unless otherwise specified.

2.1 Measurement Performance

2.1.1 Pressure Measurement

The presented performance reflects the use of 11-bit measurement of pressure signal and 10-bit measurement of temperature.

Table 1 Pressure measurement specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | | COMMENTS |
|-----------------------|---------------|-----|------|------|--------------------|------------|----------------|---|
| | Min | Typ | Max | Unit | Temp [°C] | VDD [V] | Pressure [kPa] | |
| Input pressure range* | 100 | | 1600 | kPa | -40 to 125 | 2.1 to 3.6 | | |
| Measurement error | -25 | | 25 | kPa | 0 to 50 | 2.1 to 3.6 | 100 to 1000 | Linear behavior between 1000 kPa and 1600 kPa according to Figure 1 |
| | -30 | | 30 | kPa | -40 to 125 | 2.1 to 3.6 | | |
| | -45 | | 45 | kPa | 0 to 50 | 2.1 to 3.6 | 1000 to 1600 | |
| | -50 | | 50 | kPa | -40 to 125 | 2.1 to 3.6 | | |

Table 2 Pressures 100, 375, 657, 1000, 1300, 1600 kPa verified in qualification

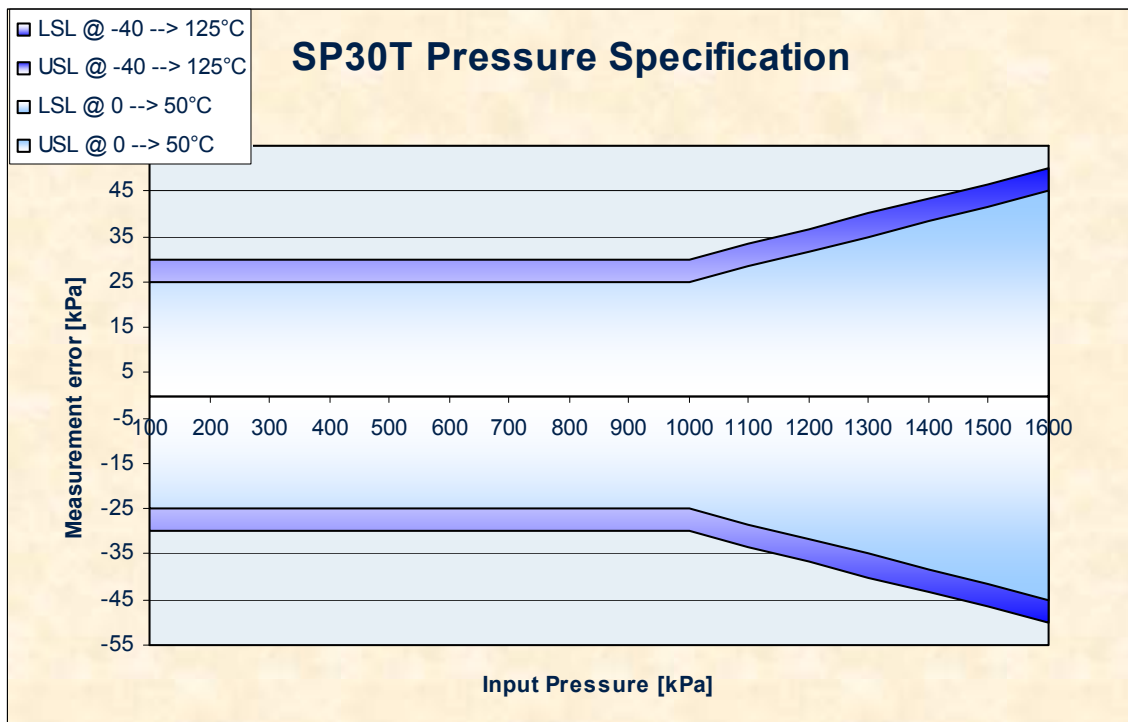



Figure 1: Pressure measurement error

| | | | | | | | |
|---|-----------------------------|--|--|--|--|------|------|
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2.1.2 Acceleration Measurement

The presented performance reflects the use of 12-bit measurement of acceleration signal and 10-bit measurement for temperature.

Table 2 Acceleration measurement specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|--------------------------|---------------|-----|-------|------|--------------------|------------|----------|
| | Min | Typ | Max | Unit | Temp [°C] | VDD [V] | |
| Input acceleration range | -12 | | 115 | g | -40 to 125 | 2.1 to 3.6 | |
| Sensitivity error | -18.75 | | 18.75 | % | -40 to 90 | 2.1 to 3.6 | |
| | -24 | | 24 | | 90 to 125 | | |
| Offset error@9g | -6 | | 6 | g | -20 to 70 | 2.1 to 3.6 | |
| | -8.5 | | 8.5 | | -40 to 90 | | |
| | -12 | | 12 | | 90 to 125 | | |

2.1.3 Temperature Measurement

The presented performance reflects the use of 10-bit measurement of temperature.

Table 3 Temperature measurement specifications


| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|-------------------|---------------|-----|-----|------|--------------------|------------|----------|
| | Min | Typ | Max | Unit | Temp [°C] | VDD [V] | |
| Measurement error | -3 | | 3 | °C | -20 to 70 | 2.1 to 3.6 | |
| | -5 | | 5 | °C | -40 to 90 | 2.1 to 3.6 | |
| | -3 | | 7 | °C | 90 to 125 | 2.1 to 3.6 | |

2.1.4 Supply Voltage Measurement

The presented performance reflects the use of 9-bit measurement of supply voltage.

Table 4 Supply voltage measurement specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|-------------------|---------------|-----|------|------|--------------------|-------------------------|----------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| Measurement error | -100 | | +100 | mV | -40 to 125 | V _{THR} to 3.6 | |

| | | | | | | | |
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2.2 Current Consumption

Table 5 Current consumption

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|----------------------------|---------------|------|-----|------|--------------------|------------|--|
| | Min | Typ | Max | Unit | Temp [°C] | VDD [V] | |
| Power down current | | 0.4 | 0.6 | µA | 25 | 3.0 | |
| Power down current | | 13 | 20 | µA | 125 | 3.0 | |
| IDLE current | | 30 | 50 | µA | 25 | 3.0 | |
| IDLE current | | 50 | 75 | µA | 125 | 3.0 | |
| RUN current | | 0.53 | 0.8 | mA | 25 | 3.0 | |
| RUN current | | 0.65 | 1.0 | mA | 125 | 3.0 | |
| Pressure measurement | | 4 | 12 | µAs | -40 to 125 | 2.1 to 3.6 | 11 bit A/D conversion, excl. temperature meas |
| Acceleration measurement | | 6 | 16 | µAs | -40 to 125 | 2.1 to 3.6 | 12 bit A/D conversion, excl. temperature meas |
| Temperature measurement | | 0.9 | 2.5 | µAs | -40 to 125 | 2.1 to 3.6 | 10 bit A/D conversion |
| Supply voltage measurement | | 0.3 | 2.5 | µAs | -40 to 125 | 2.1 to 3.6 | 9 bit A/D conversion |
| Peak current | | 1.6 | 2.5 | mA | 25 | 3.0 | Pressure measurement and 1 LF channel on, duration is 1280µs for 11 bit measurement for the peak current only. |
| 1 channel LF current | | 2.6 | 4.6 | µA | 25 | 3.0 | |
| 1 channel LF current | | 3.0 | 6.7 | µA | 125 | 3.0 | |
| 2 channel LF current | | 4.5 | 5.5 | µA | 25 | 3.0 | 2 nd LF channel is optional |
| 2 channel LF current | | 6.5 | 11 | µA | 125 | 3.0 | 2 nd LF channel is optional |
| Thermal shutdown current | | 18 | 25 | µA | 125 | 3.0 | |
| Thermal shutdown current | | 30 | 50 | µA | 150 | 3.0 | |

2.3 Tmax

ϑ_{SHTD} represents the temperature at which the Thermal Shut-down function can be enabled and ϑ_{REL} represents the temperature at which the Master Reset state is released. The ϑ_{SHTD} is always higher than ϑ_{REL} .

Table 6 Trigger temperatures for thermal shutdown


| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|---------------------------|---------------|-----|-----|------|--------------------|------------|-------------------------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| ϑ_{SHTD} | 102 | | 123 | °C | -40 to 175 | 2.1 to 3.6 | Thermal shutdown enable |
| ϑ_{REL} | 100 | | 121 | °C | -40 to 175 | 2.1 to 3.6 | Master Reset release |

2.4 Vmin

The voltage at which the Vmin-circuit will return a low battery voltage status is specified in Table :

Table 7 Vmin specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|-----------|---------------|-----|-----|------|--------------------|-------------------------|----------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| Vmin | 2.0 | 2.1 | 2.2 | V | -40 to 125 | V _{THR} to 3.6 | |

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2.5 Clock Sources

2.5.1 System Clock (MCLK)

Table 8 System clock (MCLK) specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|----------------|---------------|-----|-----|------|--------------------|---------|----------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| MCLK frequency | 1.8 | 2.0 | 2.2 | MHz | -40 to 125 | 2.1 3.6 | |

2.5.2 Low Power (LP) Oscillator

Table 9 LP oscillator specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|------------------------|----------------------|-----|-----|------|--------------------|------------|--------------------------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| T _{it} | 0.5, 1.0, 2.0 or 4.0 | | | s | -40 to 125 | 2.1 to 3.6 | Interval timer main tick |
| del _{2t} | 25, 50, 75 or 100 | | | ms | -40 to 125 | 2.1 to 3.6 | Delay to extra tick |
| LP oscillator accuracy | -20 | | 20 | % | -40 to 125 | 2.1 to 3.6 | |

2.5.3 External Clock

Table 10 External clock specifications

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|----------------|---------------|-----|-----|------|--------------------|------------|----------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| External clock | | | 3.5 | MHz | -40 to 125 | 2.1 to 3.6 | |

2.6 LF Input

Table 11 LF telegram

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|---------------------|---|-----|--------|-------|--------------------|------------|---|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| Modulation | | ASK | | | -40 to 125 | 2.1 to 3.6 | |
| Carrier frequency | 121.25 | 125 | 128.75 | kHz | -40 to 125 | 2.1 to 3.6 | |
| Preamble period | 4 | | | ms | -40 to 125 | 2.1 to 3.6 | |
| Data rate | 3.84 | 3.9 | 3.96 | kHz | -40 to 125 | 2.1 to 3.6 | |
| Settling time | | | 2 | ms | -40 to 125 | 2.1 to 3.6 | Time from LF interface is turned on by RISC to the LF interface is active |
| Detection threshold | | | 5 | mVp-p | -40 to 125 | 2.1 to 3.6 | |
| Input capacitance | | 10 | 12 | pF | -40 to 125 | 2.1 to 3.6 | |
| Input resistance | 500 | | | kΩ | -40 to 125 | 2.1 to 3.6 | |
| Other | The input signals from the enabled LF channels are rectified and real time summed | | | | | | |


| | | | | | | | |
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Table 12 LF Carrier Detection

| PARAMETER | SPECIFICATION | | | | AMBIENT CONDITIONS | | COMMENTS |
|---|---------------|-----|--------|-------|--------------------|------------|----------|
| | Min | Typ | Max | Unit | TEMP [°C] | VDD [V] | |
| Carrier frequency | 121.25 | 125 | 128.75 | kHz | -40 to 125 | 2.1 to 3.6 | |
| Maximum sensitivity not to detect, 2 amplifiers enabled | 4 | | | mVp-p | 0 to 90 | 2.1 to 3.6 | |
| | 3.5 | | | mVp-p | 90 to 125 | 2.1 to 3.6 | |
| | 3.5 | | | mVp-p | -40 to 0 | 2.1 to 3.0 | |
| | 2.9 | | | mVp-p | -40 to 0 | 3.0 to 3.6 | |
| Minimum sensitivity to detect, 2 amplifiers enabled | 10 | | | mVp-p | 0 to 90 | 2.1 to 3.6 | |
| | 12.2 | | | mVp-p | 90 to 125 | 2.1 to 3.6 | |
| | 12.2 | | | mVp-p | -40 to 0 | 2.1 to 3.6 | |
| Maximum sensitivity not to detect, 3 amplifiers enabled | | 0.8 | | mVp-p | -40 | 3.6 | |
| | 0.25 | | | mVp-p | -40 | 2.1 to 3.0 | |
| | 0.25 | | | mVp-p | 0 to 125 | 2.1 to 3.6 | |
| Minimum sensitivity to detect, 3 amplifiers enabled | | | 2.5 | mVp-p | -40 to 125 | 2.1 to 3.6 | |

2.7 Power-on Reset

Table 13 Power-on reset level

| PARAMETER | SPECIFICATION | | | | COMMENTS |
|---------------------------------|---------------|------|-----|------|----------|
| | Min | Typ | Max | Unit | |
| Power-on reset level, V_{THR} | 1.8 | 1.85 | 1.9 | V | |

2.8 Digital I/O


Table 14 Digital I/O specifications

| PARAMETER | SPECIFICATION | | | | COMMENTS |
|---------------------|--------------------|-----|--------------------|---------|----------------------|
| | Min | Typ | Max | Unit | |
| Digital output high | $V_{DD}-0.3$ | | | V | At 1 mA load current |
| Digital output low | | | 0.3 | V | At 1 mA load current |
| Digital input high | $0.8 \cdot V_{DD}$ | | | V | |
| Digital input low | | | $0.2 \cdot V_{DD}$ | V | |
| Input current | | | ± 1 | μA | |

3 Operating Range

Table 15 Operating range

| PARAMETER | SPECIFICATION | | | | COMMENTS |
|---------------------|---------------|-----|-----|------|----------------------------|
| | Min | Typ | Max | Unit | |
| Supply voltage | V_{THR} | | 3.6 | V | Unless otherwise specified |
| Ambient temperature | -40 | | 125 | °C | |

| | | | | | | |
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4 Absolute Maximum Ratings

Table 16 Absolute maximum ratings

| PARAMETER | SPECIFICATION | | | | COMMENTS |
|------------------------------------|---------------|-----|----------------------|------|---|
| | Min | Typ | Max | Unit | |
| Ambient temperature, operating | -40 | | 150 | °C | Max 24 h accumulated over life time |
| Ambient temperature, storage | -40 | | 150 | °C | Max 1000 h |
| Transient temperature ¹ | | | 175 | °C | Max 3 min |
| Supply Voltage | -0.3 | | 4.0 | V | |
| Input voltage | -0.3 | | V _{dd} +0.3 | V | |
| Input current, any pin (DC) | -10 | | 10 | mA | |
| Input current, any pin (transient) | -100 | | 100 | mA | |
| Input current, LF pins | -1 | | 1 | mA | |
| Maximum input pressure | 50 | | 2000 | kPa | |
| | | | 2500 | kPa | Max 2 s, 5 times over lifetime |
| Static acceleration | | | 3000 | g | |
| Mechanical shock | | | 4000 | g | Half sine, 0.3ms |
| ESD HBM | 2 | | | kV | Human body model JESD22-A114 |
| ESD CDM | 750 | | | V | Charge Device Model ESD-STM5.3.1, Corner pins |
| | 500 | | | | Charge Device Model ESD-STM5.3.1, All other pins |
| Latch Up | 100 | | | mA | AEC-Q100 |

¹ Will withstand standard SnPb Eutectic reflow soldering process (JEDEC J-STD-020, J-STD-A113)

Attention: *Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the device.*

5 Physical dimensions

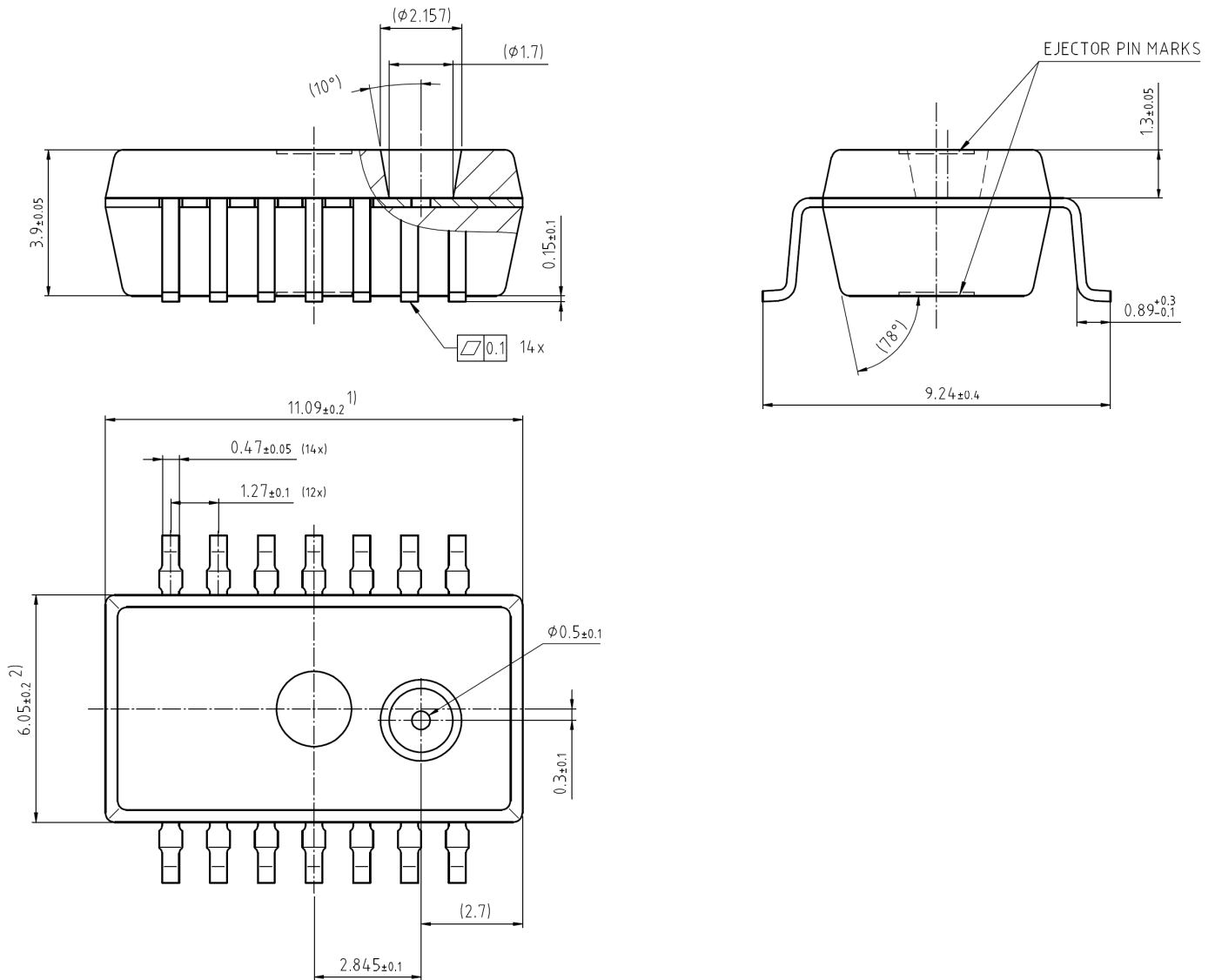


Figure 2: Physical Dimensions – Drawing P-DSOSP-14-6 1) Dimension does not include mold flash, protrusions or gate burrs. Mold flash, protrusions and gate burrs do not exceed 0.15mm (0.006 inch) per side. 2) Dimension does not include inter-lead flash or protrusions. Inter-lead flash and protrusions do not exceed 0.25mm (0.010 inch) per side.

6 Pin Configuration

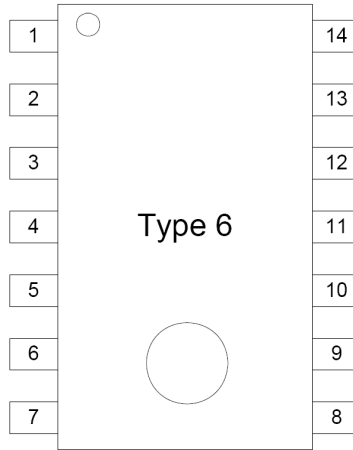



Figure 3: Pin Configuration. Top view, not to scale

Table 17 Pin Description

| PIN | NAME | FUNCTION |
|-----|------|--|
| 1 | IN4 | LF receiver channel 2, negative input |
| 2 | P10 | General purpose I/O with external wakeup, internal pull-up/pull-down |
| 3 | P11 | General purpose I/O with external wakeup, internal pull-up/pull-down |
| 4 | MSDA | Monitor Serial Data I/O, internal pull-up |
| 5 | MSCL | Monitor Serial Clock input |
| 6 | VDD | Supply pad VDD (battery, positive terminal) |
| 7 | VSS | Common ground (battery, negative terminal) |
| 8 | VSS | Common ground (battery, negative terminal) |
| 9 | P17 | General purpose I/O (or digital modulator output) |
| 10 | P15 | General purpose I/O or external clock |
| 11 | P14 | General purpose I/O (or digital modulator output) |
| 12 | IN1 | LF receiver channel 1, positive input |
| 13 | IN2 | LF receiver channel 1, negative input |
| 14 | IN3 | LF receiver channel 2, positive input |

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7 Document history

| Rev | Paragraphs | Description |
|-----|------------|--|
| 00 | | First issue of TS1378 |
| 1 | 1 | Disclaimer included |
| 1 | 2.1.1 | Pressure range extended from max 1500kPa to max 1600kPa. Measurement error adjusted accordingly. |
| 1 | 2.1.1 | Footnote included displaying the Pressure values verified in qualification |
| 1 | 5 | Physical Drawing updated |
| 2 | 1 | Added section "Product Description " |
| 2 | 5 | Physical Drawing updated |
| 2 | 5 | Added wording to Figure title of figure 2 |
| 2 | 6 | Added section "Pin Configuration" |
| 2 | | Removed "Confidential" marking |
| 2 | 2 | Updated fig. 1 |