GXCAS Technology

High-Accuracy Digital Temperature Sensor IC

DESCRIPTION

The GXTS04 is GXCAS's new high accuracy digital temperature sensor. Its functionality includes enhanced signal processing, two distinctive and user selectable I2C addresses and communication speeds of up to 1 MHz. The DFN package has a footprint of 2 x 2mm² while keeping a height of 0.75 mm. This allows for integration of the GXTS04 into a great variety of applications. Additionally, the wide supply voltage range of 1.6 V to 5.5 V guarantees compatibility with a wide range of applications.

FEATURES

- Fully calibrated and linearized digital output
- Wide supply voltage range, from 1.6 V to 5.5 V
- I2C Interface with communication speeds up to 1MHz and two user selectable addresses
- Typical accuracy of ± 0.3 °C
- Very fast start-up and measurement time
- Measures Temperatures from -45~130℃
- ±0.1°C Accuracy from 35°C to +45°C Thermometer Resolution is 16 Bits
- Converts Temperature to 16-Bit Digital Word in 1.5ms
- 6-Pin DFN package

PIN CONFIGURATIONS

Content

1 Sensor Performance

1.1 Temperature Sensor Performance

Parameter	Condition	Value	Units
Accuracy tolerance	typ., 35°C to 45°C	±0.1	°C
Accuracy tolerance	typ., 0°C to 90°C	±0.3	°C
Repeatability	Low	0.24	°C
	Medium	0.12	°C
	High	0.06	°C
Resolution	Typ.	0.015	°C
Specified Range	-	-40 to 125	°C
Response time	$\tau_{63\%}$	>1	s
Long Term Drift	max	<0.02	℃/y

Table 1 Temperature sensor specification.

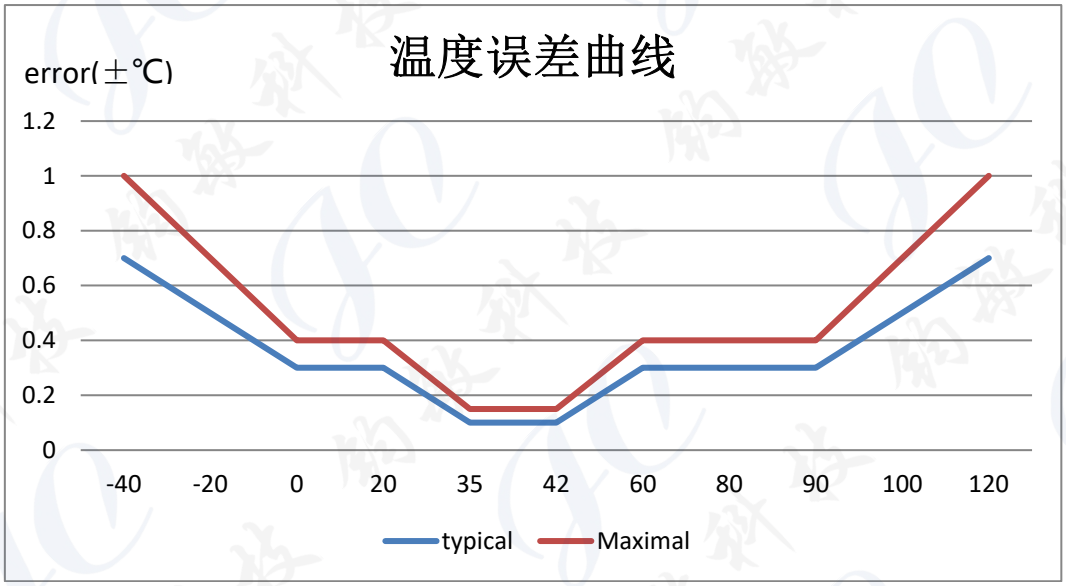


Figure 2 Temperature accuracy of the GXTS04 sensor.

2 Specifications

2.1 Electrical Specifications

Parameter	Symbol	Condition	Min.	Typ.	Max.	Units	Comments
Supply voltage	V_{DD}		1.6	3.3	5.5	V	
Power-up/down level	V_{POR}		1.6	2.3	5.5	V	
Slew rate change of the supply voltage	$V_{DD,slew}$		-	-	20	V/ms	Voltage changes on the VDD line between $V_{DD,min}$ and $V_{DD,max}$ should be slower than the maximum slew rate
Supply current	I_{DD}	idle state (single shot mode)	-	0.15	2.0	µA	Current when sensor is not performing a measurement during single shot mode
		idle state (periodic data acquisition mode)	-	45	70	µA	Current when sensor is not performing a measurement during periodic data acquisition mode
		Measuring	-	600	1200	µA	Current consumption while sensor is measuring
		Average	-	2	5	µA	Current consumption (operation with one measurement per second at lowest repeatability, single shot mode)
Alert Output driving strength	IOH		0.8x V_{DD}	1.5x V_{DD}	2.1x V_{DD}	mA	See also section 3.5

Table 2 Electrical specifications, valid at 25°C and typical VDD.

2.2 Timing Specification for the Sensor System

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Units	Comments
Power-up time	t_{PU}	After hard reset, $V_{DD} \geq V_{POR}$		-	180	240	µs	Time between V_{DD} reaching V_{PU} and sensor entering the idle state
Soft reset time	t_{SR}	After soft reset.		-	180	240	µs	Time between ACK of soft reset command and sensor entering the idle state
Measurement duration	t_{MEAS}	Average	Normal Mode	-	10.8	12.1	ms	Duration for a humidity and temperature measurement
			Low Power M.	-	1	1.5		

Table 3 System timing specification, valid from -40 °C to 125 °C and 1.6 V to 5.5 V.

2.3 Absolute Minimum and Maximum Ratings

Stress levels beyond those listed in Table 4 may cause permanent damage to the device or affect the reliability of the sensor. These are stress ratings only and functional operation of the device at these conditions is not guaranteed.

Parameter	Rating	Units
Supply voltage V_{DD}	-0.3 to 6	V
Max Voltage on pins	-0.3 to VDD+0.3	V
Input current on any pin	±100	mA
Operating temperature range	-40 to 125	°C
Storage temperature range	-40 to 150	°C
ESD HBM (human body model)[4]	4	kV
ESD CDM (charge device model)[5]	750	V

Table 4 Minimum and maximum ratings; values may only be applied for short time periods.

[4] Sensor in application configuration. ESD HBM 2 kV according to JEDEC JS-001.

[5] According to JEDEC JS-002.

3 Pin Assignment

The GXT04 comes in a tiny 6-pin DFN package see Table 5.

Pin	Name	Comments
1	VDD	Supply Power
2	R	No electrical function recommends to connect VSS
3	SCL	Serial Clock bidirectional
4	SDA	Serial Data bidirectional
5	R	No electrical function recommend to Connect VSS
6	GND	ground

Power-supply pins supply voltage (VDD) and ground (VSS) must be decoupled with a 100 nF capacitor that shall be placed as close to the sensor as possible.

SCL is used to synchronize the communication between the microcontroller and the sensor. The master must keep the clock frequency within 0 to 1 MHz. The GXTS04 may pull down the SCL line when clock stretching is enabled.

The SDA pin is used to transfer data in and out of the sensor. For safe communication, the timing specifications defined in the I²C manual must be met.

To avoid signal contention, the microcontroller must only drive SDA and SCL low. External pull-up resistors (e.g.4.7 kΩ) are required to pull the signal high. For dimensioning resistor sizes please take the bus capacity requirements into account. Note that pull-up resistors may be included in I/O circuits of microcontrollers.

4 Operation and Communication

All commands and memory locations of the GXTS04 are mapped to a 16-bit address space which can be accessed via the I²C protocol.

4.1 I2C Address

The I2C device address is given Table 6:

GXTS04	Hex. Code	Bin. Code
I²C address	0x70	111'0000

Table 6 GXTS04 I²C device addr.

Each transmission sequence begins with START condition (S) and ends with an (optional) STOP condition (P) as described in the I2C-bus specification.

4.2 Power-Up, Sleep, Wakeup

Upon VDD reaching the power-up voltage level V_{POR}, the GXTS04 enters the idle state after a duration of t_{PU}. After that, the sensor should be set to sleep mode with the command given in Table 7.

Command	Hex. Code	Bin. Code
Sleep	0xB098	1011'0000'1001'1000

Table 7 Sleep command of the sensor

When the sensor is in sleep mode, it requires the following wake-up command before any further communication, see Table 8.

Command	Hex. Code	Bin. Code
Wakeup	0x3517	0011'1001'0001'0111

Table 8 Wakeup command of the sensor

4.3 Measurement Commands

When the sensor is in wakeup mode, it required the measurement command to trigger a temperature measurement, see Table9.

Command	Hex. Code	Bin. Code
Measuremeny Normal mode	0x7866	0111'1000'0110'0110
Measuremeny Low power mode	0x609C	0110'0000'1001'1100

Table 9 Measurement Commands

4.4 Measuring and Reading the Signals

Each measurement cycle contains a set of four commands, each initiated by the I2C START condition and ended by the I2C STOP condition:

1. Wakeup Command
2. Measurement Command
3. Readout Command
4. Sleep Command

An exemplary measurement set is shown in Figure3

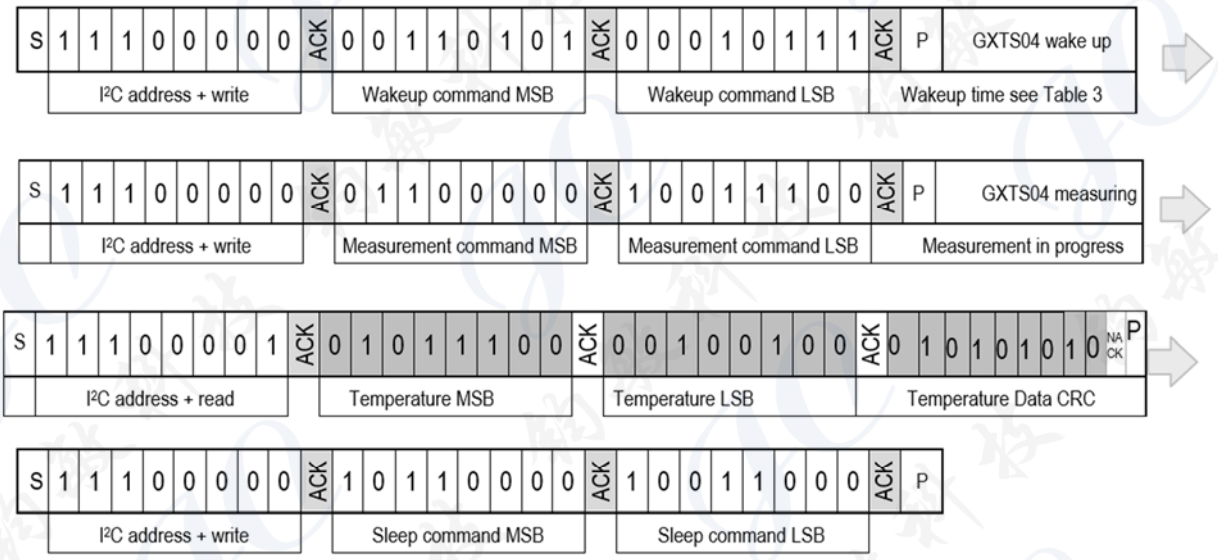


Figure 3 Communication sequence for waking up the sensor, starting a measurement and reading measurement results.

4.5 Readout Measurement Results

After a measurement command has been issued and the sensor has completed the measurement, the master can read the measurement results by sending a START condition followed by an I²C read header. The sensor will acknowledge the reception of the read header and send two bytes of data followed by one byte CRC checksum. Each byte must be acknowledged by the microcontroller with an ACK condition for the sensor to continue sending data. If the GXTS04 does not receive an ACK from the master after any byte of data, it will not continue sending data.

The I²C master can abort the read transfer with a NACK condition after any data byte if it is not interested in subsequent data, e.g. the CRC byte in order to save time.

4.6 Soft Reset

The GXTS04 provides a soft reset mechanism that forces the system into a well-defined state without removing the power supply. If the system is in its idle state (i.e. if no measurement is in progress) the soft reset command can be sent to GXTS04 according to Table 10. This triggers the sensor to reset all internal state machines and reload calibration data from the memory.

Command	Hex. Code	Bin. Code
Soft reset	0x805D	1000'0000'0101'1101

Table 10 Soft reset command

4.7 Read-out of ID Register

The GXTS04 has an ID register which contains an GXTS04 specific product code. The read-out of the ID register can be used to verify the presence of the sensor and proper communication. The command to read the ID register is shown in Table 11.

Command	Hex. Code	Bin. Code
Read ID	0xEFC8	1110'1111'1100'1000

Table 11 Read-out command of ID register

It needs to be sent to the GXTS04 after an I²C write header. Once the GXTS04 has acknowledged the proper reception of the command, the master can send an I²C read header and the GXTS04 submits the 16-bit ID followed by 8 bits of CRC.

4.8 Checksum Calculation

The 8-bit CRC checksum transmitted after each data word is generated by a CRC algorithm with the properties displayed in Table 12. The CRC covers the contents of the two previously transmitted data bytes.

Property	Value
Name	CRC-8
Width	8 bits
Polynomial	0x31 ($x^8 + x^5 + x^4 + 1$)
Initialization	0xFF
Reflect input	False
Reflect output	False
Final XOR	0x00
Examples	CRC (0x00) = 0xAC CRC (0xBEEF) = 0x92

Table 12 GXTS04 CRC properties.

4.8 Conversion of Sensor Output

Measurement data is always transferred as 16-bit values. These values are already linearized and temperature compensated by the GXTS04. Temperature values can be calculated with the formulas in given below.

$$T = -45 + 175 \cdot \frac{S_T}{2^{16}}$$

S_T denote the raw sensor output (as decimal values) for temperature.

5. Quality

5.1 Environmental Stability

Qualification of the GXTS04 is performed based on the JEDEC JESD47 qualification test method.

5.2 Material Contents

The device is fully RoHS, REACH and Halogen-Free. GXTS04 sensors are provided in a DFN package with an outline of 2 × 2 × 0.75 mm^3 and a terminal pitch of 1 mm. DFN stands for dual flat no leads.

The sensor chip is made of silicon and is mounted to a lead frame. The latter is made of Cu plated with Ni/Pd/Au. Chip and lead frame are over molded by an epoxy-based mold compound. Please note that the sidewalls of sensor are diced and therefore these diced lead frame surfaces are not covered with the respective plating.
The Moisture Sensitivity Level classification of the GXTS04 is MSL1, according to IPC/JEDEC J-STD-020.

All GXTS04 sensors are laser marked for easy identification and traceability. The marking on the sensor consists of two lines and a pin-1 indicator. The top line contains the sensor type (GXTS04), the bottom line contains a 5-digit, alphanumeric tracking code. The pin-1 indicator is located in the top left corner. See Figure 4 for illustration.

Figure 4 Laser marking on GXTS04, the top line with the pin-1 indicator and the sensor type, the bottom line with the 5-digit alphanumeric tracking code.

Reels are also labeled and provide additional traceability information

6. Ordering Information

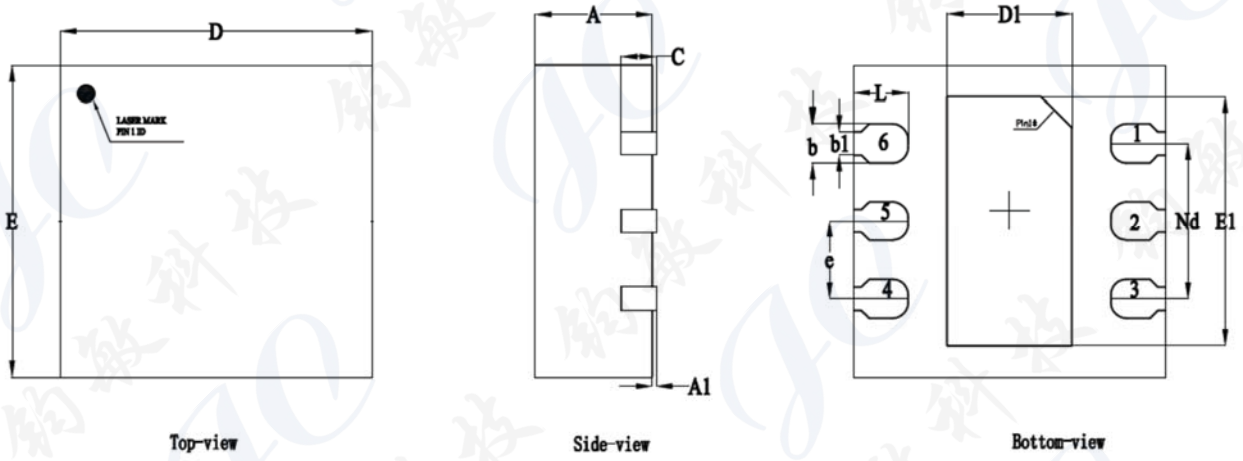
The GXTS04 can be ordered in tape and reel packaging with different sizes, see Table 13. The reels are sealed into antistatic ESD bags.

Quantity	Packaging	Reel Diameter	Order Number
2500	Tape & Reel	180 mm (7 inch)	3.000.047
10'000	Tape & Reel	330 mm (13 inch)	1-101681-01

Table 13 GXTS04 ordering option

7 Technical Drawings

7.1 Package Outline



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.20	0.25	0.30
b1	—	0.15	—
L	0.30	0.35	0.40
c	0.203 REF		
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D1	0.60	0.70	0.80
E1	1.50	1.60	1.70
Nd	1.0 BSC		
e	0.50 BSC		

Figure 5 Package outline drawing of the GXTS04. Dimensions are given in millimeters.

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7.2 Tape and Reel Package

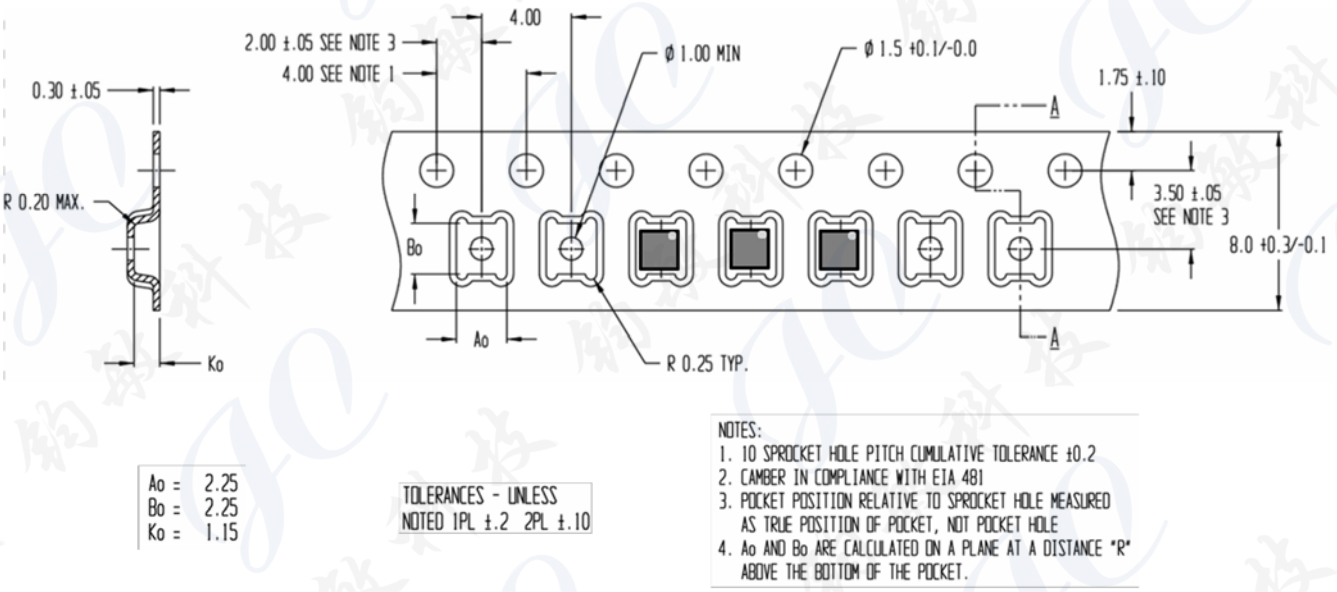

Figure 6 Technical drawing of the packaging tape with sensor orientation in tape. Header tape is to the right and trailer tape to the left on this drawing. Dimensions are given in millimeters.