High Accuracy Digital Temperature Sensor IC

1 Features

- Fully calibrated and linearized digital output
- Wide supply voltage range, from 1.6V to 5.5V
- 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 −40°C to 125°C
- ±0.1°C Accuracy from 35°C to +45°C
- Converts Temperature to 16-Bit Digital Word in 1.5ms

2 Applications

- General System Thermal Management
- Computer Peripheral Thermal Protection
- Thermal Protection
- Power-system Monitors

3 Description

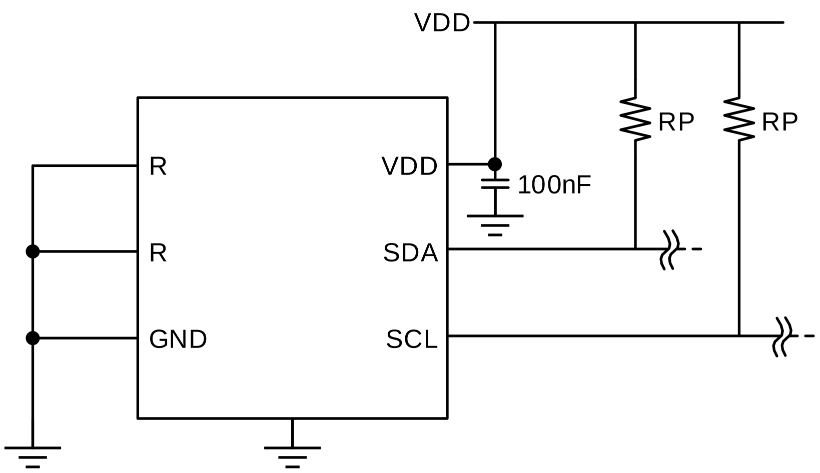
The GD30TS004T is GigaDevice's new high accuracy digital temperature sensor. Its functionality includes enhanced signal processing, two distinctive and user selectable I2C addresses and communication speeds of up to 1MHz. The DFN package has a footprint of 2mm x 2mm while keeping a height of 0.75 mm. This allows for integration of the GD30TS004T into a great variety of applications. Additionally, the wide supply voltage range of 1.6V to 5.5V guarantees compatibility with a wide range of applications.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30TS004T	DFN-6	2.00mm × 2.00mm

1. For packaging details, see *Package Information* section.

Simple Schematic Diagram



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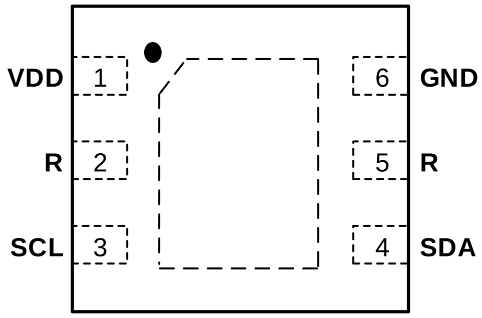
4.1 Pinout and Pin Assignment

DFN Package
6-Pin Top View



4.2 Pin Description

PINS		PIN TYPE[1]	FUNCTION
NAME	NUM		
VDD	1	P	Supply voltage.
SCL	3	I	Serial clock.
SDA	4	IO	Serial data.
GND	5	G	Ground.
P	2,5		No use.

1. P = power, G = Ground, I = input, O = Output, IO=input and output.

5 Parameter Information

5.1 Absolute Minimum and Maximum Ratings

Exceeding the operating temperature range (unless otherwise noted)[1]

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{DD}	Power supply	−0.3	6	V
V_{IO}	Voltage at SCL, SDA, and ADDR	−0.3	VDD+0.3	V
V_{ALERT}	Voltage at ALERT	−0.3	VDD+0.3	V
I_{IN}	Input current on any range	−100	100	mA
T_A	Operating temperature	−40	125	°C
T_J	Junction temperature		150	°C
T_{stg}	Storage temperature	−40	150	°C

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

5.2 Recommended Operation Conditions

SYMBOL[1]	PARAMETER	MIN	TYP	MAX	UNIT
V_{DD}	Supply voltage	1.6	3.3	5.5	V
T_A	Operating Temperature	−40		125	°C

1. Unless otherwise stated, over operating free-air temperature range.

5.3 Electrical Sensitivity

SYMBOL[1]	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human-body model (HBM), ANSI/ESDA/JEDEC JS-001-2017[1]	±4000	V
$V_{ESD(CDM)}$	Charge-device model (CDM), ANSI/ESDA/JEDEC JS-002-2022[2]	±750	V

1. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
2. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.4 Electrical Characteristics

Electrical characteristics of devices at T_A = +25°C and typical VDD, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{DD}	Power Supply Voltage		1.6	3.3	5.5	V
V_{POR}	Power-up/down level		1.3	1.4	1.5	V
$V_{DD,slew}$	Slew rate change of the supply voltage	Voltage changes on the VDD line between VDD,min and VDD,max should be slower than the maximum slew rate			20	V/ms
I_{DD}	Supply current	Current when sensor is not performing a measurement during single shot mode		0.15	2	μA
		Current when sensor is not performing a measurement during periodic data acquisition mode		45	70	
		Current consumption while sensor is measuring		600	1200	
		Current consumption (operation with one measurement per second at lowest repeatability, single shot mode)		2	5	
I_{OH}	Alert Output driving		0.8 x V_D	1.5 x V_D	2.1 x V_{DD}	mA

5.5 Timing Specification for the Sensor System

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

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
T_{PU}	Power-up time	After hard reset, $V_{DD} \geq V_{POR}$		180	240	μs
T_{SR}	Soft reset time	After soft reset		180	240	μs
$T_{MEAS,l}$	Measurement duration	Low repeatability		10.8	12.1	ms
$T_{MEAS,m}$		Medium repeatability		1	1.5	ms

5.6 Temperature Sensor Performance

PARAMETER	CONDITIONS	VALUE	UNIT
Accuracy tolerance	35°C to 45°C	±0.1	°C
Accuracy tolerance	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	°C/y

6 Functional Description

6.1 Pin Functional

6.1.1 Power Pins(VDD)

The power supply pins must be decoupled with a 100nF capacitor that shall be placed as closed to the sensor as possible.

6.1.2 Serial Clock and Serial Data(SCL, SDA)

SCL is used to synchronize the communication between microcontroller and the sensor. The clock frequency can be freely chosen between 0 to 1MHz. Commands with clock stretching according to I2C Standard are supported.

The SDA pin is used to transfer data to and from the sensor. Communication with frequencies up to 400KHz must meet the I2C Fast Mode standard. Communication frequencies up to 1MHz are supported.

Both SCL and SDA lines are open-drain I/Os with diodes to the VDD and VSS. They should be connected to external pull-up resisters. A device on the I2C bus must only drive a line to ground. The external pull-up resistors (e.g. Rp = 4.7kΩ) are required to pull the signal high. For dimensioning resistor sizes please take bus capacity and communication frequency into account. It should be noted that pull-up resistors may be included in I/O circuits of microcontrollers.

6.2 Communication Functional

All commands and memory locations of the GD30TS004T are mapped to a 16-bit address space which can be accessed via the I2C protocol.

6.2.1 I2C Address

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

Table 1. I2C Device Address

GD30TS004T	HEX CODE	BIN CODE
I2C Address	0x70	0111 0000

6.2.2 Power-Up, Sleep and Wakeup

Upon VDD reaching the power-up voltage level VPOR, the GD30TS004T enters the idle state after a duration of tPU. After that, the sensor should be set to sleep mode with the command given in Table 2.

Table 2. Sleep Command of the Sensor

GD30TS004T	HEX CODE	BIN CODE
Sleep	0xB098	1011 0000 1001 1000

When the sensor is in sleep mode, it requires the following wake-up command before any further communication, see Table 3.

Table 3. Wakeup Command of the Sensor

GD30TS004T	HEX CODE	BIN CODE
Wakeup	0x3517	0011 0101 0001 0111

6.3 Measurement Commands

When the sensor is in wakeup mode, it required the measurement command to trigger a temperature measurement, see Table 4.

Table 4. Measurement Command

GD30TS004T	HEX CODE	BIN CODE
Measurement Normal Mode	0x7866	0011 0101 0001 0111
Measurement Low Power Mode	0x609C	0110 0000 1001 1100

6.4 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 Figure 1.

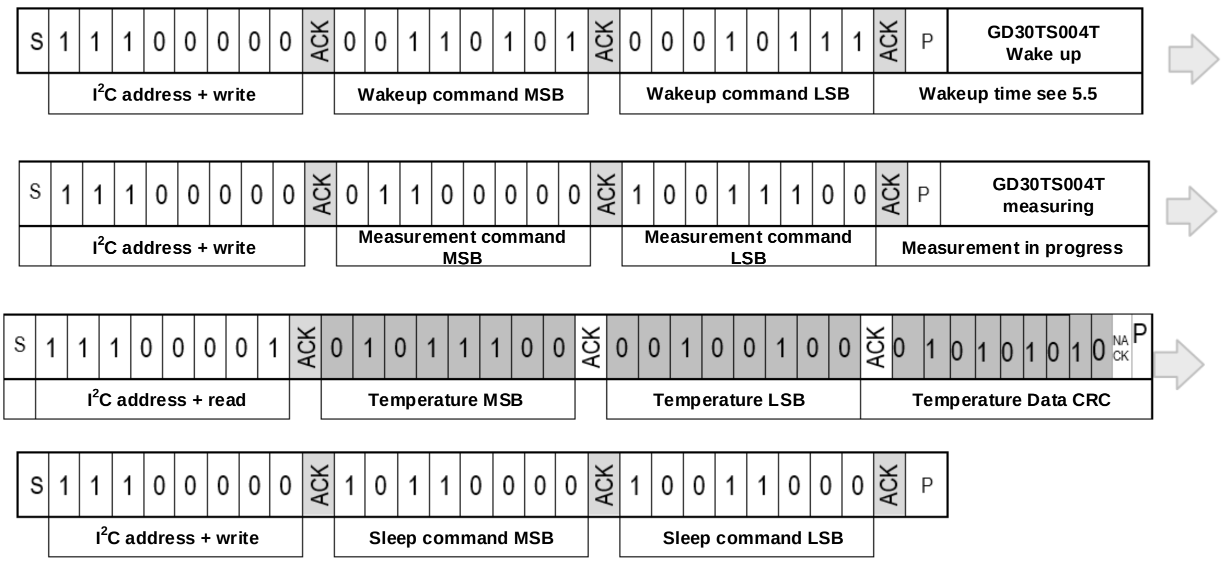


Figure 1. Communication Sequence for Wakeup the Sensor, Starting a Measurement and Reading Measurement Results

6.5 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 GD30TS004T 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.

6.6 Soft Reset

The GD30TS004T 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 GD30TS004T according to Table 5. This triggers the sensor to reset all internal state machines and reload calibration data from the memory.

Table 5. Soft Reset Command

GD30TS004T	HEX CODE	BIN CODE
Soft Reset	0x805D	1000 0000 0101 1101

6.7 Read-out of ID Register

The GD30TS004T has an ID register which contains an GD30TS004T 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 6.

Table 6. Read-out Command of ID Register

GD30TS004T	HEX CODE	BIN CODE
Read ID	0xEFC8	1110 1111 1100 1000

It needs to be sent to the GD30TS004T after an I2C write header. Once the GD30TS004T has acknowledged the proper reception of the command, the master can send an I2C read header and the GD30TS004T submits the 16-bit ID followed by 8 bits of CRC.

6.8 Checksum Calculation

The 8-bit CRC checksum transmitted after each data word is generated by a CRC algorithm with the properties displayed in Table 7. The CRC covers the contents of the two previously transmitted data bytes.

Table 7. GD30TS004T CRC Properties

PROPERTY	VALUE
Name	CRC-8
Width	8 bits
Polynomial	0x31 ($x^8 + x^5 + x^4 + 1$)

PROPERTY	VALUE
Initialization	0xFF
Reflect input	False
Reflect output	False
Final XOR	0x00
Examples	CRC (0x00) = 0xAC CRC (0xBEEF) = 0x92

6.9 Conversion of Sensor Output

Measurement data is always transferred as 16-bit values. These values are already linearized and temperature compensated by the GD30TS004T. Temperature values can be calculated with the formulas in given below.

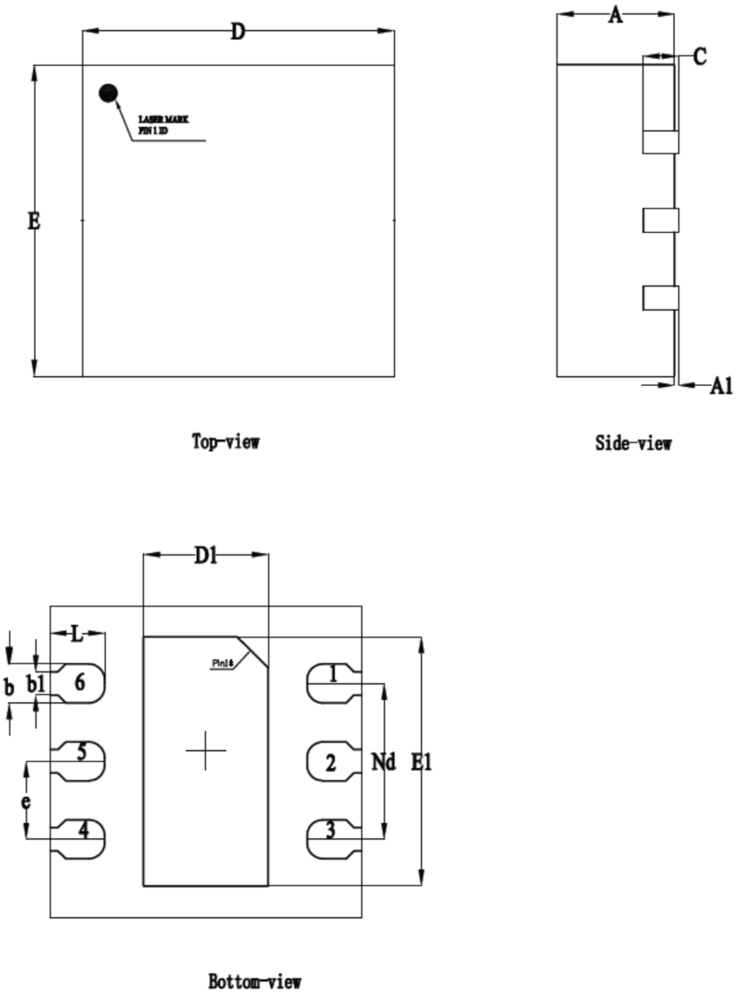
$$T = -45 + 175 \cdot \frac{S_T}{2^{16}}$$

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

7 Package Information

7.1 Outline Dimension

DFN-6 Package Outline



NOTES:

1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to the *Table 8. DFN-6 dimensions(mm)*.

Table 8. DFN-6 dimensions(mm)

SYMBOL	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	
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
e		0.50 BSC	
L	0.30	0.35	0.40
Nd		1.0 BSC	

8 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30TS004TSET7-I	DFN-6	Green	Tape & Reel	2500	-40°C to +125°C
GD30TS004TSETD-I	DFN-6	Green	Tape & Reel	10000	-45°C to +125°C

9 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024

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