Temperature and Humidity Sensor

1 Features

- Ultra-low power consumption
- Wide supply voltage range (1.60V to 5.5V)
- Typical accuracy: ±3 %RH and ±0.3°C
- Digital output：I2C bus speed of 1 MHz
- Factory calibrated and reflow solderable
- Available in DFN-6 Package

2 Applications

- Washer & dryer
- Smart home
- Air quality/dehumidifier
- Cold chain transportation
- Wireless sensor
- Consumer electronics

3 Description

GD30TSHTC3 is a temperature and humidity sensor specifically designed for consumer electronics applications. It meets the requirements of the consumer electronics field in terms of package size, power consumption, supply voltage range, and cost performance. The GD30TSHTC3 achieves a complete temperature and humidity sensor system on a single chip, including a capacitive humidity sensing unit, PN junction temperature measurement unit, 16-bit ADC, digital signal processing circuit, calibration data storage unit, and I2C digital communication interface circuit.

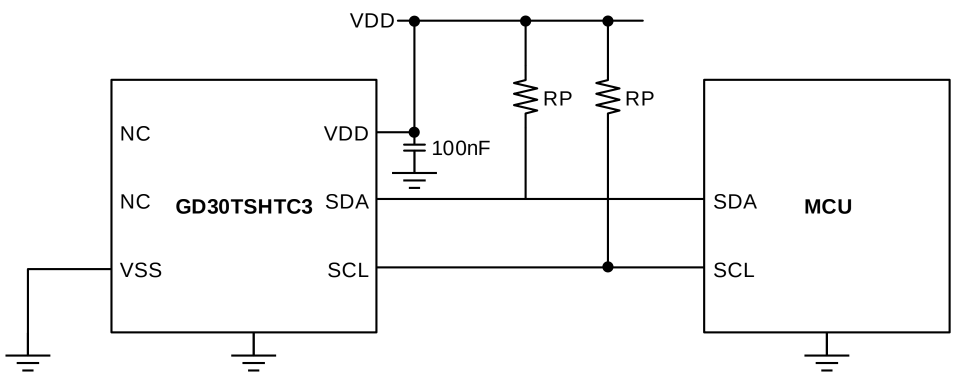
The GD30TSHTC3 adopts a compact DFN6 package with dimensions of 2.00mm x 2.00mm, making it suitable for the most space-limited applications. Its humidity measurement range is 0%RH to 100%RH, and its temperature measurement range is −45°C to 135°C. With a supply voltage range of 1.60V to 5.5V and energy consumption of only 2μJ, the GD30TSHTC3 is especially suited for mobile or wireless communication devices powered by batteries. Each GD30TSHTC3 is fully calibrated before leaving the factory to ensure consistency and accuracy. Its tape-and-reel packaging and compatibility with standard SMD production processes further enhance its ease of application.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30TSHTC3	DFN-6	2.00mm x 2.00mm

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

Simplified Application Schematic



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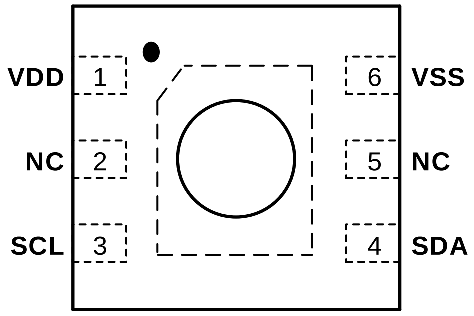
4 Device Overview

4.1 Pin Assignment

DFN Package
6-Pin Top View



4.2 Pin Description

PINS		PIN TYPE[1]	FUNCTION
NAME	NUM		
VDD	1	P	Supply voltage.
NC	2		No connection.
SCL	3	IO	Serial clock; input/output.
SDA	4	O	Data pin; input/output.
NC	5		No connection.
VSS	6	G	Ground.

1. P = power, G = Ground, I = input, O = 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
T_A	Operating temperature range	−45	130	°C
T_{stg}	Storage temperature	−45	130	°C

1. The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Note that the device is not guaranteed to operate properly at the maximum ratings. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

5.2 Recommended Operation Conditions

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V_{DD}	Supply voltage	1.6	3.3	5.5	V
T_A	Operating Temperature range	−45		130	°C

5.3 Electrical Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human-body model (HBM), ANSI/ESDA/JEDEC JS-001-2017	±4000	V
$V_{ESD(CDM)}$	Machine Mode (MM)	±500	V

5.4 Electrical Characteristics

Operating conditions in the table default to 25°C and 3.3V supply voltage.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
Power supply							
V_{DD}	Power Supply Voltage			1.6	3.3	5.5	V
V_{POR}	Power-up/down level	Static power supply		1.3	1.4	1.5	V
I_{DD}	Supply current	Idle state			45	80	μA
		Sleep mode			0.2	0.3	
		Measurement	Normal		500	860	
			Low power		320	620	
		Average	Normal		3		
			Low power		1		
V_{IL}	Low level input voltage					0.4 x VDD	V
V_{IH}	High level input voltage				0.7 x VDD		V
V_{OL}	Low level output voltage	3mA sink current				0.2 x VDD	V
Timing Specification for the Sensor System							
t_{PU}	Power-up time	After hard reset, $V_{DD} \geq V_{POR}$			180	500	μs

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
t_{SR}	Soft reset time	After soft reset			180	500	µs
t_{MEAS}	Measurement time	Average	Normal		10	11	ms
			Low power		1.5	2	

5.5 Humidity Sensor Characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Accuracy	Typ		±3.0	Figure 1	%RH
Resolution			0.01		%RH
Hysteresis			±1.0		%RH
Specified Range		0		100	%RH
Response Time	τ63%		8		Second
Long Term Drift	Typ		<0.5		%RH

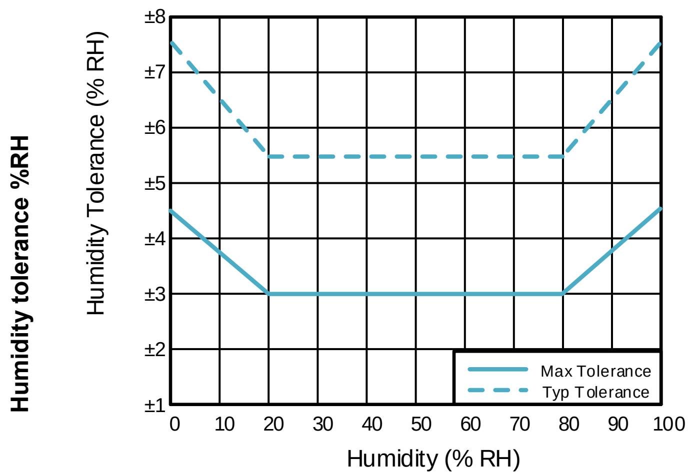


Figure 1. Tolerance of RH @25°C for GD30TSHTC3

5.6 Temperature Sensor Characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Accuracy			±3.0	Figure 2	°C
Resolution			0.01		°C
Hysteresis			±1.0		°C
Specified Range		−45		130	°C
Response Time	τ63%		<5	30	second
Long Term Drift	Typ		<0.02		°C/year

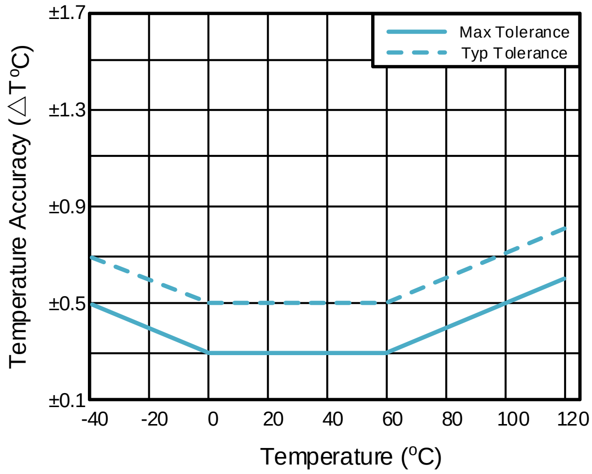


Figure 2. Temperature Accuracy of GD30TSHTC3

5.7 RH Accuracy at Different Temperatures

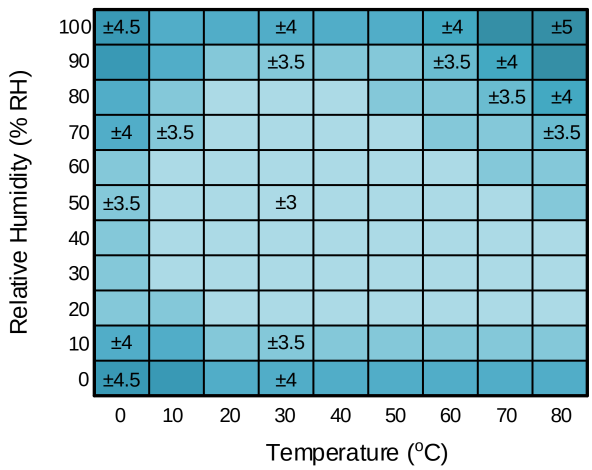


Figure 3. Typical Accuracy of Relative Humidity Measurements for Different Temperature

The sensor shows optimum performance when operating within the recommended normal temperature and humidity ranges (5°C ~ 60°C and 20%RH ~ 80%RH, respectively). Long-term exposure to conditions outside the normal range, especially in high humidity conditions, may cause temporary offset in RH signal (eg, 4%RH error after 60 hours at >80% RH). After returning to normal temperature and humidity ranges, the sensor will slowly revert to its factory calibration state. Long-term exposure to extreme conditions may accelerate aging. To ensure stable operation of the humidity sensor, the conditions described in the document "GD30TSHT-xx Assembly of SMD Packages", section "Storage and Handling Instructions" regarding exposure to volatile organic compounds must be met. Note that this applies not only to transportation and manufacturing, but also to the operation of the GD30TSHTC3.

6 Functional Description

6.1 Block Diagram

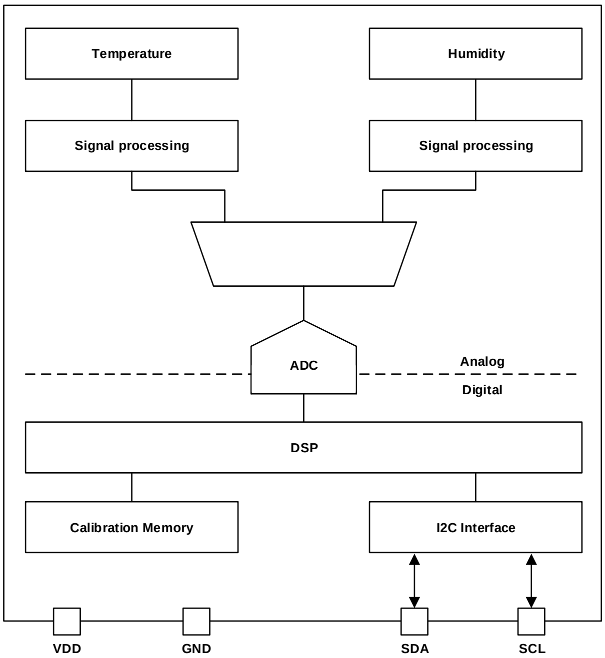


Figure 4. GD30TSHTC3 Block Diagram

6.2 Operation

6.2.1 Overview

All commands and memory locations of the GD30TSHTC3 are mapped to a 16-bit address space which can be accessed via the I²C protocol.

Table 1. I2C device Address

GD30TS002T	I²C ADDRESS in HEX	BINARY
I²C Address	0x70	111’0000

1. The I2C device address of the GD30TSHTC3.
2. According to the I²C protocol, each communication starts with a START signal and ends with a STOP signal.

6.2.2 Power-Up, Sleep and Wakeup

When the power supply voltage VDD reaches the power-up voltage level VPOR, the GD30TSHTC3 enters the idle state. Then the sensor should be set to sleep mode to reduce the power consumption.

Table 2. Sleep Command of the Sensor

COMMAND	HEX	BINARY
Sleep	0xB098	1011’0000’1001’1000

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

Table 3. Wake-up Command of the Sensor

COMMAND	HEX	BINARY
Wakeup	0x3517	0011’0101’0001’0111

6.2.3 Measurement Commands

The GD30TSHTC3 provides clock stretching option and the order of temperature and humidity data. These parameters can be implemented with the different commands in Table 4. Each command triggers a temperature and humidity conversion.

Table 4. Temperature and Humidity Measurement Command

	CLOCK STRETCHING OPEN		CLOCK STRETCHING CLOSE	
	TEMP FIRST	RH FIRST	TEMP FIRST	RH FIRST
Normal	0x7CA2	0x5C24	0x7866	0x58E0
Low Power	0x6458	0x44DE	0x609C	0x401A

6.2.4 Measuring and Reading the Signals

Each measurement consists four commands, starting with a STRAT signal and ending with a STOP signal. The specific execution sequence is as follows:

- Wake-up command
- Measurement command
- Read command
- Sleep command

The specific typical command sequence is shown in Figure 5.

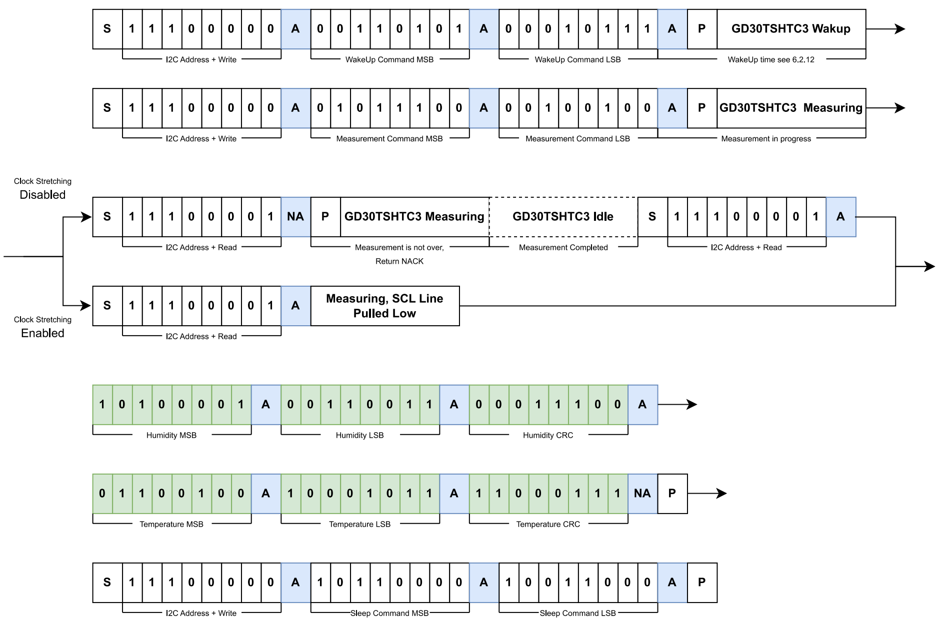


Figure 5. Wake-up, Start Temperature and Humidity Measurement, Temperature and Humidity Conversion and Sleep Command Execution Sequence Diagram

This example shows that the humidity data is sent first. The actual humidity data is 63% and the temperature is 23.7°C. The white box is controlled by the microcontroller and the gray box is controlled by the sensor.

6.2.5 Measurement Process

In general, the sensor will not respond to any I2C communication request during the temperature and humidity measurement process. For example, the microcontroller will receive a NACK signal when sending read and write commands. However, when the clock stretching mode is enabled, the sensor responds to the read command of the microcontroller with an ACK signal and pulls down the SCL line until the measurement is complete. At this time, the sensor starts sending the measurement results.

The power consumption during measurement is shown in 5.4. In order to ensure the repeatability of the temperature and humidity measurement, it is recommended to avoid any I2C communication during the measurement.

6.2.6 Readout of Measurement Results

After the microcontroller sends the temperature and humidity measurement command, the sensor starts to perform temperature and humidity conversion. After the conversion is completed, the microcontroller can read the measurement results by sending the START signal and the I2C read header. The sensor will acknowledge the reception of the I2C read header, and send 2 bytes of temperature/humidity data and 1 byte of CRC checksum. Then continue to send two bytes of humidity/temperature data and 1 byte of CRC check data. The microcontroller must generate an ACK response signal for each received byte. If the sensor does not receive the ACK signal sent by the microcontroller, it will not continue to transmit subsequent data.

If the I2C master is not concerned about the subsequent data, it can abort the data transmission with a NACK signal.

If the user needs temperature and humidity data and is unwilling to process CRC data, it is recommended to read the first two bytes of data with the CRC byte after reading the second two data bytes with a NACK to abort data transmission.

6.2.7 Soft Reset

The GD30TSHTC3 provides a soft reset mechanism to force the system into an idle state without power loss. It acts the same as power-on reset.

The send command for soft reset is shown in Table 5:

Table 5. Soft Reset Command of the Sensor

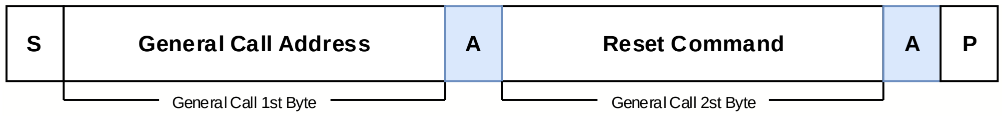
COMMAND	HEX	BINARY
Soft Reset	0x805D	1000’0000’0101’1101

6.2.8 General Call Reset

Sensors can also be reset using General Call in the I2C specification, which acts as an on-power reset. It is important to note that this reset is not for GD30TSHTC3, it resets slave devices on all I2C buses, but it requires that the slave devices be able to respond to this command. The specific reset commands are shown in Table 6:

Table 6. General Call Reset

COMMAND	HEX CODE
Address byte	0x00
Second byte	0x06
Reset command using the general call address	0x0006



6.2.9 Readout of ID Register

The GD30TSHTC3 has an ID register for storing the product code of GD30TSHTC3. The readout of the ID register can be used to verify the communication between the sensor and the microcontroller. The commands for reading the ID register are shown in Table 7:

Table 7. Readout Command of ID Register

COMMAND	HEX	BINARY
Read ID	0xEFC8	1110’1111’1100’1000

1. This command needs to be followed by I2C write header, then the microcontroller can send the I2C read header to read the 16-bit ID and one byte CRC check data.

6.2.10 CRC Checksum

The CRC check algorithm for data transmission is shown in Table 8. The CRC check object is the 2 bytes of data transmitted before it.

Table 8. I²C CRC8 properties

PROPERTY	VALUE
Name	CRC-8
Width	8 bit
Protected data	Read and/or write data
Polynomial	0X31(x8 + x5 + x4 + 1)
Initialization	0xFF
Reflect input	False
Reflect output	False
Examples	CRC(0xBEEF) = 0x92

6.2.11 Conversion of Signal Output

The output temperature and humidity data are 16-bit unsigned data. These data have been linearized and compensated for temperature. Converting these raw values into real temperature and humidity data can be achieved using the following formulas:

Relative humidity conversion formula (result in %RH):

$$RH = 100 \times \frac{S_{RH}}{2^{16} - 1}$$

Temperature conversion formula (result in °C):

$$T\left[{}^{\circ}C\right] = -45 + 175 \times \frac{S_T}{2^{16} - 1}$$

S_{RH} and S_T represent the raw sensor output for humidity and temperature, respectively. It is important to note that the raw output is converted to decimal in formula calculation.

6.2.12 Communication Timing

SYMBOL	PARAMETER	TEST CONDITION	NORMAL		LOW POWER		UNIT
			MIN	MAX	MIN	MAX	
f_{SCL}	SCL clock frequency		0	100	0	1000	KHz
$t_{HD;STA}$	Hold time (repeated) START condition	After this period, the first clock pulse is generated	4.0		0.6		μs
t_{LOW}	LOW period of the SCL clock		4.5		0.5		μs
t_{HIGH}	HIGH period of the SCL clock		4.0		0.26		μs
$t_{SU;STA}$	Set-up time for a repeated START condition		4.7		0.5		μs
$t_{HD;DAT}$	SDA hold time		0		0		μs
$t_{SU;DAT}$	SDA set-up time		250		50		ns
t_R	SCL/SDA rise time			1000		120	ns
t_F	SCL/SDA fall time			300		120	ns
$t_{VD;DAT}$	SDA valid time			3.5		0.5	μs
$t_{SU:STO}$	Set-up time for STOP condition		4		0.26		μs
C_B	Capacitive load on bus line			500		400	pF

1. Communication timing parameters, the working conditions in the table default to 25°C and a 3.3V operating voltage.

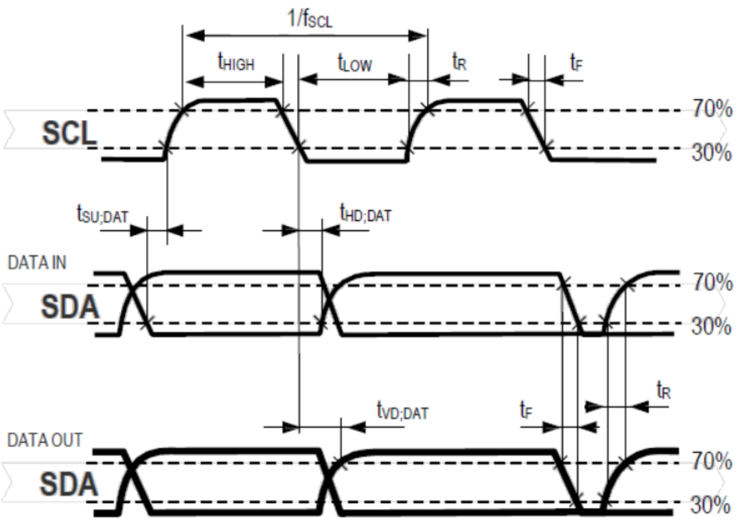


Figure 6. Timing Diagram for Digital Input/Output Pads

7 Application Information

7.1 Typical Application Circuit

The GD30TSHTC3 supports the normal mode and Fast Mode Plus of the I2C protocol (with a maximum SCL clock frequency of up to 1MHz), and also supports the clock stretching mode. Users can choose the mode according to their actual needs. For detailed information about the I2C protocol, please refer to the NXP I2C bus specification and user manual UM10204, Rev.6, April 4th, 2014.

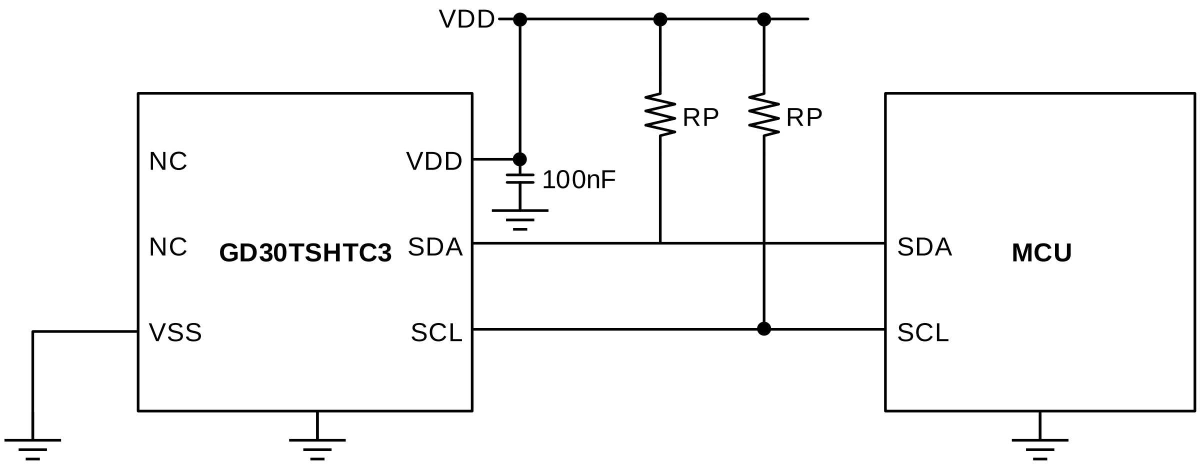


Figure 7. GD30TSHTC3 Reference Circuit

Between VDD and GND, a 100nF decoupling capacitor is required, and the closer this capacitor is to the sensor, the better.

SCL is used to synchronize communication between the microprocessor and the sensor, and the microprocessor must ensure that the SCL clock frequency does not exceed 1MHz. The GD30TSHTC3 may pull down the SCL clock line in clock stretching mode.

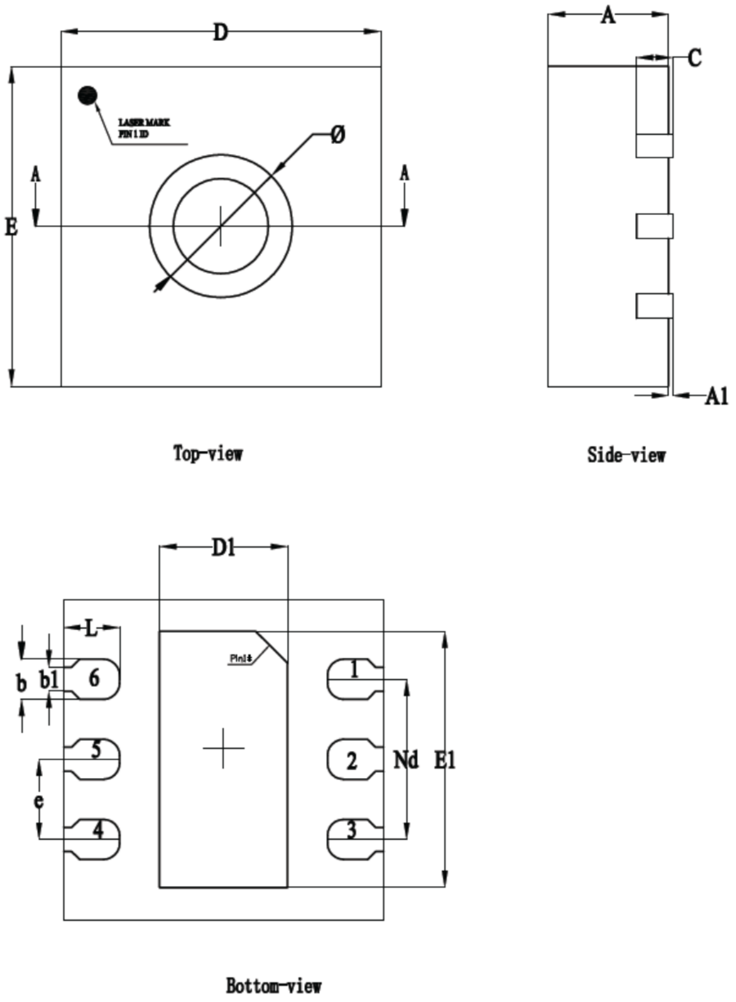
SDA is used for data input and output of the sensor, and to ensure reliable communication, its timing must meet the requirements specified in the I2C protocol.

To avoid data conflicts, the microprocessor can only pull down the SDA and SCL bus lines, with the high level of the bus being achieved through pull-up resistors. The selection of pull-up resistors needs to be determined based on the load of the bus. It should be noted that some microprocessor IOs may include pull-up resistors. For mechanical stress considerations, the central pad must be soldered to the ground.

8 Package Information

8.1 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 9. DFN-6 dimensions(mm)*.

Table 9. 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	
L	0.30	0.35	0.40
c		0.203REF	
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		1.0BSC	
e		0.50BSC	
θ	0.70	0.80	0.90
h		0.29	

9 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30TSHTC3SETR-I	DFN-6	Green	Tape & Reel	2000	−40°C to +130°C
GD30TSHTC3SETC-I	DFN-6	Green	Tape & Reel	2000	−40°C to +130°C

1. GD30TSHTC3SETC-I chip comes with a dust-proof breathable membrane.

10 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024
1.1	Version upgrade	2025

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