Digital Temperature Sensor with I²C Interface and ALT

1 Features

- Temperature range: −55°C to +125°C
- Accuracy: −25°C to +55°C: ±0.4°C (Typical)
- Resolution: 0.0625°C (12Bits)
- Supply voltage: 1.4V to 5.5V
- Conversion Time: 26ms
- Low quiescent current:
  - Normal operation: 15μA@12Hz
  - Shutdown mode: 0.3μA
- Digital output: I2C, SMBus

2 Applications

- Portable, battery-powered applications
- Server and Computer Thermal Management
- Telecommunication Equipment
- Office Machines
- Video Game Consoles
- Set-Top Boxes
- Power Supply and Battery Thermal Protection
- Thermostat Control
- Environmental Monitoring and HVAC
- Electrical Motor Driver Thermal Protection
- Industrial Control

3 Description

The GD30TS075B is a fully integrated digital temperature sensor with a 12bit ADC that can operate at a 1.8V supply, and is pin and register compatible with the x75.

The GD30TS075B requires no external components to sense the temperature. The on-chip 12bit ADC offers resolution down to 0.0625°C. Each chip is specially calibrated for ±1°C (Max) accuracy over −55°C to +125°C range in factory before shipment to customers, eliminating the need for users to make any additional adjustments for temperature output.

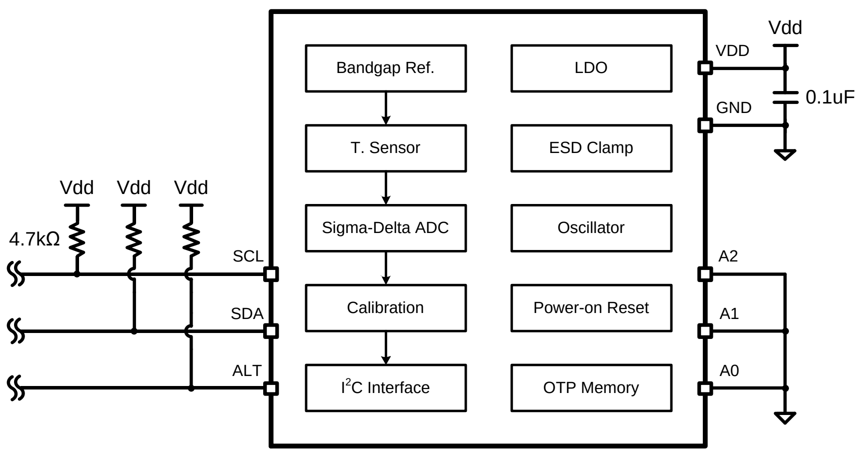
The GD30TS075B features SMBus and I2C interface with speed up to 1MHz (2.3MHz at high-speed mode), and allows up to eight devices on the same bus. The programmable temperature limits and the ALT pin allow the sensor to operate as a stand-alone thermostat.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30TS075B	SOP-8	4.90mm × 3.90mm
	MSOP-8	3.00mm × 3.00mm
	DFN-8	3.00mm × 3.00mm

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

Internal Schematic Diagram



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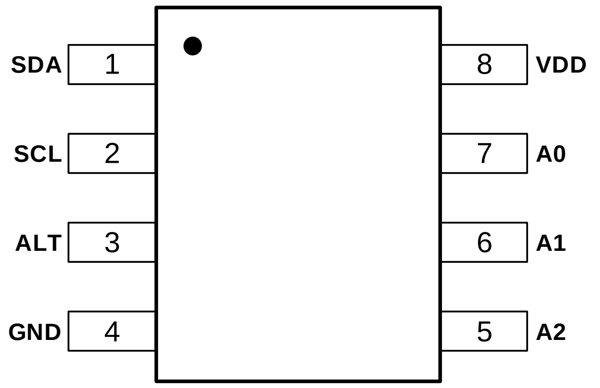
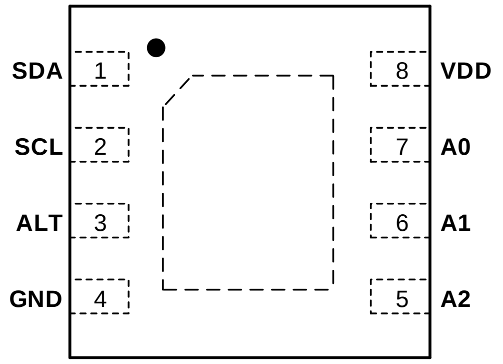
4 Device Overview

4.1 Pinout and Pin Assignment

SOP & MSOP Package
8-Pin Top View



DFN Package
8-Pin Top View



4.2 Pin Description

PINS		PIN TYPE[1]	FUNCTION
NAME	MSOP8/SOP8/DFN8		
SDA	1	IO	Serial data. Open-drain output; requires a pull-up resistor.
SCL	2	O	Serial clock. Open-drain output; requires a pull-up resistor.
ALT	3	O	Over-temperature alert. Open-drain output; requires a pull-up resistor.
GND	4	G	Ground.
A2	5	I	Address select. Connect to GND or VDD.
A1	6	I	Address select. Connect to GND or VDD.
A0	7	I	Address select. Connect to GND or VDD.
VDD	8	P	Supply voltage, 1.4V to 5.5V.

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

5 Parameter Information

5.1 Absolute Maximum Ratings

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

SYMBOL	PARAMETER	MIN	MAX	UNIT
VDD	Power supply	−0.3	6	V
V_{IO}	Voltage at SCL, SDA, ALT, A2, A1 and A0	−0.3	6	V
T_J	Junction temperature	−55	150	°C
T_{stg}	Storage temperature	−60	150	°C

1. Over operating free-air temperature range (unless otherwise noted). Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device.

5.2 Recommended Operation Conditions

SYMBOL[1]	PARAMETER	MIN	TYP	MAX	UNIT
VDD	Supply voltage	1.4	3.3	5.5	V
T_A	Local channel operating range	−55		125	°C

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

5.3 Electrical Sensitivity

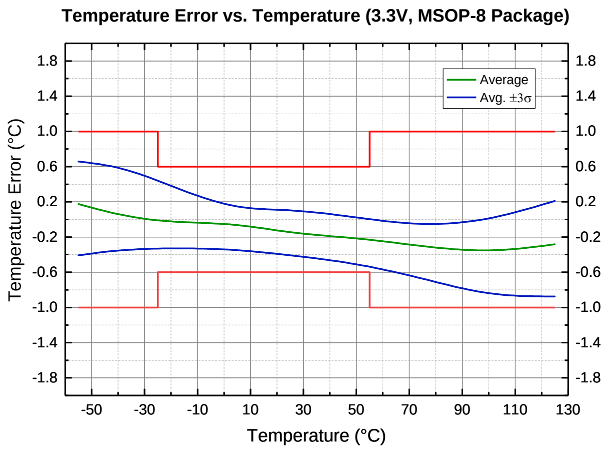
SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human Body Mode (HBM), per ANSI/ESDA/JEDEC JS-001	±8000	V
$V_{ESD(CDM)}$	Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002-2022	±1400	V
$V_{ESD(MM)}$	Machine Mode (MM), per JEDEC-STD Classification	±200	V
LU	Latch-up, per JESD 78F(2022)	±200	mA

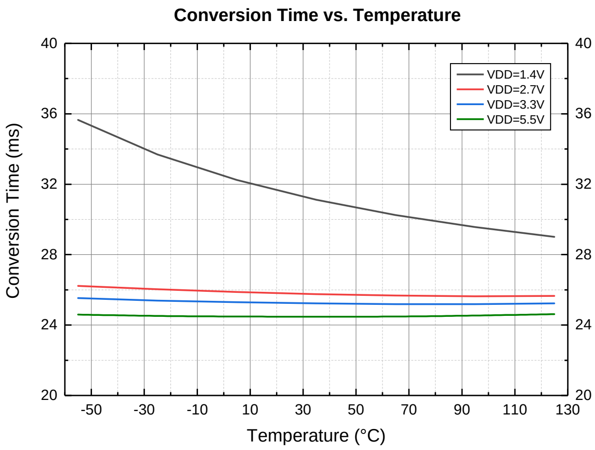
5.4 Electrical Characteristics

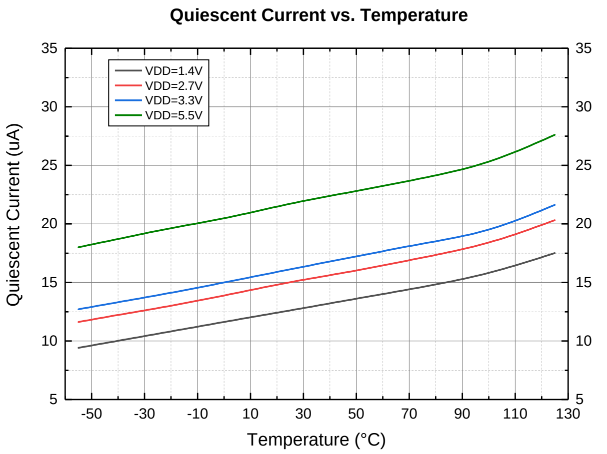
At T_A = −40°C to +125°C and VDD = 1.4 V to 5.5 V, unless otherwise noted. Typical values at T_A = 25°C and VDD = 1.8V.

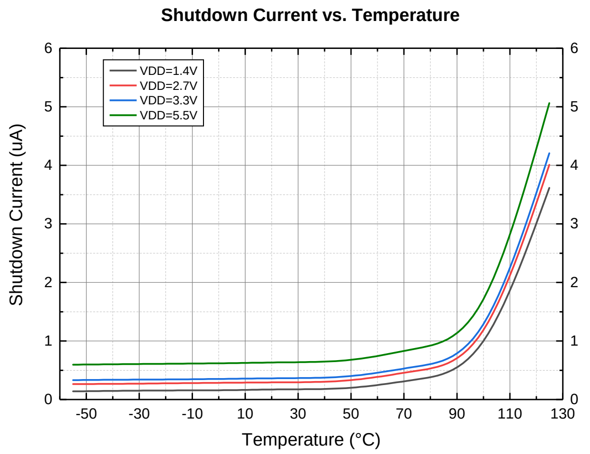
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
VDD	Power Supply Voltage		1.4	3.3	5.5	V
T_A	Operating Temperature Range		−55		125	°C
I_Q	Quiescent Current	Serial bus inactive		15	30	µA
I_{SD}	Shutdown Current	Serial bus inactive		0.3	6	µA
t_{CON}	Conversion Time			26	35	ms
T_{ACC}	Temperature Accuracy	−25°C to +55°C		±0.4	±0.6	°C
		−55°C to +125°C		±0.6	±1.0	°C
	Supply Voltage Sensitivity	−40°C to +125°C		±0.0625	±0.1	°C/V
	ADC Resolution			0.0625		°C
				12		Bits
f_{BUS}	Bus Frequency	Fast mode	0.001		1.0	MHz
		High-Speed mode	0.001		2.3	
t_{TIME_OUT}	Bus Timeout Time		18	20	26	ms
V_{IH}	Input Logic High Level		0.7 x V_{DD}		V_{DD}	V
V_{IL}	Input Logic Low Level		−0.3		0.3 x V_{DD}	V
V_{OL}	Output Logic Low Level	$V_{DD} \geq 2V$, I_{OL} = 3mA			0.4	V
		$V_{DD} < 2V$, I_{OL} = 3mA			0.2 x V_{DD}	

5.5 Typical Characteristics









6 Functional Description

6.1 Temperature Output

The 12bit digital output of each temperature measurement is saved in a read-only temperature register, where 1 LSB = 0.0625°C and negative numbers are represented in binary complement form. When powered on or reset, the GD30TS075's temperature register is initialized to 0x0000 until the next temperature conversion is complete. Unused bits in the temperature register are always read as 0. A specific example is shown in Table 1.

Getting the temperature output requires reading two bytes, where byte 1 is a high significant byte (MSB), followed by byte 2 is a low significant byte (LSB). The left-justified high 12 bits are used to indicate temperature. If a temperature resolution of less than 1 °C is not required, the user can choose not to read bytes 2.

Table 1. Temperature Data Format

TEMPERATURE (°C)	BINARY	HEX
128	0111 1111 1111 0000	0x7FF0
127.9375	0111 1111 1111 0000	0x7FF0
100	0110 0100 0000 0000	0x6400
80	0101 0000 0000 0000	0x5000
75	0100 1011 0000 0000	0x4B00
50	0011 0010 0000 0000	0x3200
25	0001 1001 0000 0000	0x1900
0.25	0000 0000 0100 0000	0x0040
0	0000 0000 0000 0000	0x0000
–0.25	1111 1111 1100 0000	0xFFC0
–25	1110 0111 0000 0000	0xE700
–55	1100 1001 0000 0000	0xC900

1. Table 1 does not provide data formats for all temperatures.

6.2 Register Map

The GD30TS075 internal register stack consists of four 16-bit registers, and the mapping is shown in Table 2.

Table 2. Pointer Address

POINTER	REGISTER	TYPE	RESET VALUE
0x00	Temperature	R	0x0000
0x01	Configuration	R/W	0x00C0
0x02	Low Limit	R/W	0x4B00
0x03	High Limit	R/W	0x5000

1. R/W=Read/Write; R=Read only; W=Write only.

Table 3. Temperature Register (pointer=0h) (reset=0000h)

BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1	T0	-	-	-	-
Default	sign	64	32	16	8	4	2	1	2^{-1}	2^{-2}	2^{-3}	2^{-4}	0	0	0	0
Type	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

1. R/W=Read/Write; R=Read only; W=Write only; -=Reserved.

Table 4. Temperature Low Limit Register(T_{LOW})

BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	L0	-	-	-	-
Default	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R	R	R	R

1. LEGEND: R/W=Read/Write; R=Read only; W=Write only; -=Reserved.

Table 5. Temperature High Limit Register(T_{HIGH})

BIT	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	H11	H10	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0	-	-	-	-
Default	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Type	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R	R	R	R

1. LEGEND: R/W=Read/Write; R=Read only; W=Write only; -=Reserved.

Table 6. Configuration Register

BIT	7	6	5	4	3	2	1	0
Binary	-	-	-	FQ1	FQ0	POL	TM	SD
Default	0	0	0	0	0	0	0	0
Type	R	R	R	R/W	R/W	R/W	R/W	R/W

1. LEGEND: R/W=Read/Write; R=Read only; W=Write only; -=Reserved

Table 7. Configuration Register Description

Field	Description
-	Reserved bits Write 0 to these bits on configuration register update.
FQ	Fault queue to trigger the ALT pin FQ=0h : 1 fault (default) FQ=1h : 2 fault FQ=2h : 4 fault FQ=3h : 6 fault
POL	ALT polarity control POL=0 : ALT is active low (default) POL=1 : ALT is active high
TM	ALT thermostat mode control TM=0 : ALT is in comparator mode (default) TM=1 : ALT is in interrupt mode
SD	Shutdown control SD=0 : Device is in continuous mode (default) SD=1 : Device is in shutdown mode

6.3 Functional Modes

6.3.1 Continuous Mode

The default mode of the GD30TS075B is continuous conversion, where the ADC performs continuous temperature conversions and stores each result to the Temperature register, overwriting the result from the previous conversion. The typical conversion rate of GD30TS075B is 12Hz, with 80ms between the start of each consecutive conversion. The GD30TS075B has a typical conversion time of 26ms. To achieve its conversion rates, the GD30TS075B makes a conversion, and then powers down and waits for a delay 54ms.

After power-up, the GD30TS075B immediately starts a conversion, as shown in Figure 1. The first result is available after 26ms (typical). The active quiescent current during conversion is 40μA (typical at +25°C). The quiescent current during delay is 3μA (typical at +25°C).

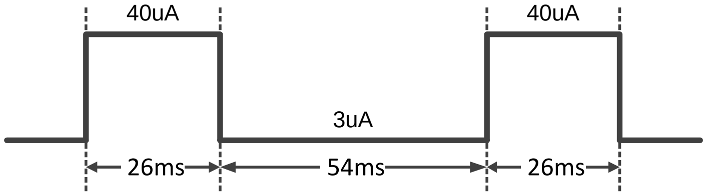


Figure 1. Conversion Diagram

6.3.2 Shutdown Mode

The shutdown mode saves maximum power by shutting down all device circuitry other than the serial interface, and reduces current consumption to typically less than 0.3μA. Shutdown mode is enabled when the SD bit in the configuration register is set to 1; the device shuts down and terminates a conversion if it is ongoing.

6.4 Over-Temperature Alarm

6.4.1 Comparator Mode

The GD30TS075 defaults to comparator mode. In this mode, the ALT pin becomes active when the temperature is equal to or exceeds the value in T_{HIGH} for a consecutive number of conversions as set by the FQ bits of the configuration register. ALT clears when the temperature falls below T_{LOW} for the same consecutive number of conversions. The difference between the two limits acts as a hysteresis on the comparator output, and a fault counter prevents false ALTs as a result of environmental noise.

6.4.2 Interrupt Mode

In this mode, the ALT pin becomes active when the temperature equals or exceeds the value in T_{HIGH} for a consecutive number of fault conditions. The ALT pin remains active until a read operation of any register occurs. After the ALT pin is cleared, this pin becomes active again only when temperature falls below T_{LOW} for a consecutive number of fault conditions, and remains active until cleared by a read operation of any register. The cycle repeats with the ALT pin becoming active when the temperature equals or exceeds T_{HIGH}, and so on. The ALT pin is cleared also when the device is placed in shutdown mode. This action also clears the fault counter memory.

The operation of the ALT pin in the various modes is illustrated in Figure 2.

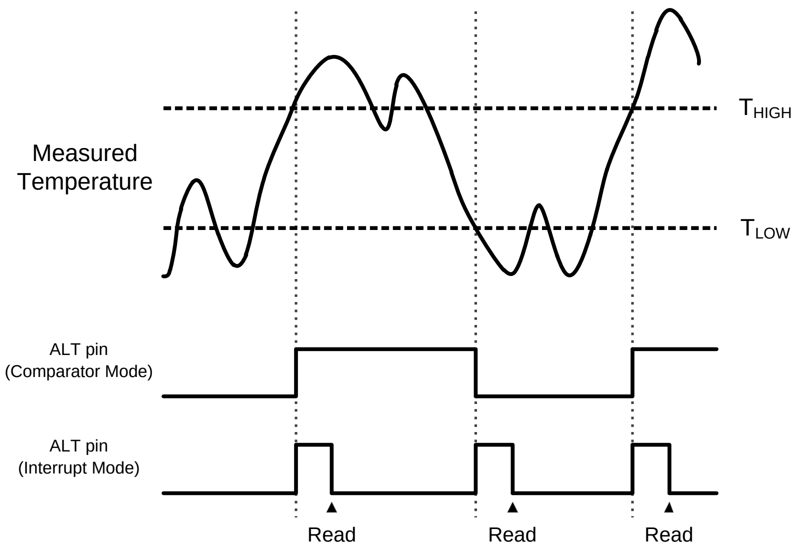


Figure 2. ALT Pin Modes of Operation

6.5 Serial Interface

6.5.1 Bus Overview

I2C/SMBus is a two-wire serial communication interface supporting multi-master and multi-slave. The device that initiates the communication is called the master, and the device controlled by the master is called the slave. The master is responsible for generating the serial clock (SCL) and controlling the bus access.

Data transfer is sent over eight clock pulses followed by an acknowledge bit. During data transfer, SDA must remain stable when SCL is high because any change in SDA while SCL is high is interpreted as a START or STOP conditions. Parameters for Figure 3 are defined in Table 8.

Table 8. Timing Diagram Requirements

SYMBOL	PARAMETER	FAST MODE		HIGH-SPEED MODE		UNIT
		MIN	MAX	MIN	MAX	
f_{SCL}	SCL operating frequency	1	400	1	2300	kHz
$t_{SU:STA}$	Repeated START condition setup time	0.6		0.26		us
$t_{HD:STA}$	Repeated START condition hold time	0.6		0.26		us
$t_{SU:STO}$	STOP condition setup time	0.6		0.26		us
t_{BUF}	Bus free time between STOP and START	1.3		0.5		us
$t_{SU:DAT}$	Data setup time	0.1		0.05		us
$t_{HD:DAT}$	Data hold time	0		0		us
t_{HIG}	SCL clock high period	0.6		0.26		us
t_{LOW}	SCL clock low period	1.3		0.5		us
t_R	Clock and data rise time		300		120	ns
t_F	Clock and data fall time		300		120	ns

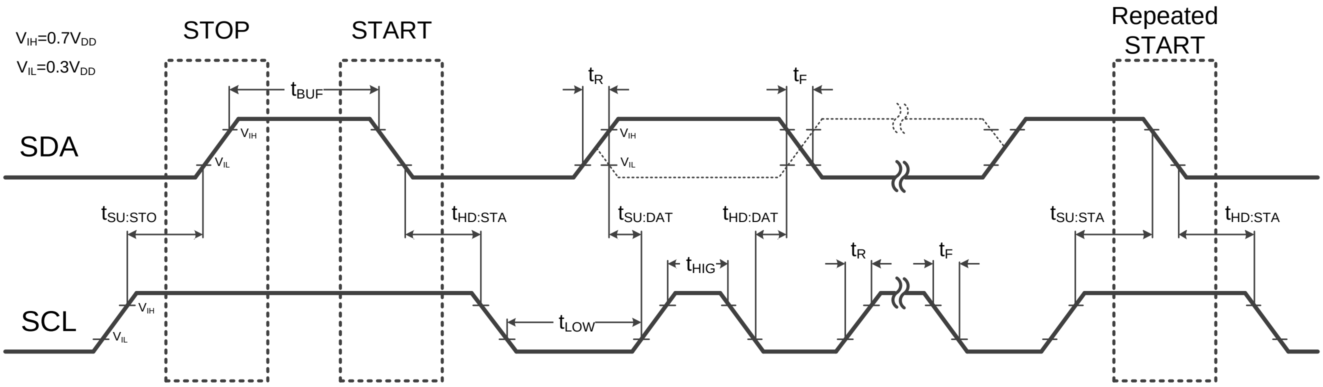


Figure 3. Two-Wire Timing Diagram

6.5.2 Serial Bus Address

The GD30TS075B features three address pins that allow up to eight devices to be addressed on a single bus. Table 2 describes the pin logic levels and the corresponding address values. It is crucial for the logic level of the address pin to remain consistent throughout communication in order to avoid potential failures. The address pin must be connected either to VDD or GND and should not be left in a suspended state.

The slave address byte consists of seven address bits, and a direction bit indicating the intent of executing either a read or write operation. All data bytes are transmitted MSB first.

Table 9. Address Pin Connections and Slave Addresses

A2	A1	A0	DEVICE TWO-WIRE ADDRESS
GND	GND	GND	0x90 (write), 0x91 (read)
GND	GND	VDD	0x92 (write), 0x93 (read)
GND	VDD	GND	0x94 (write), 0x95 (read)
GND	VDD	VDD	0x96 (write), 0x97 (read)
VDD	GND	GND	0x98 (write), 0x99 (read)
VDD	GND	VDD	0x9A (write), 0x9B (read)
VDD	VDD	GND	0x9C (write), 0x9D (read)
VDD	VDD	VDD	0x9E (write), 0x9F (read)

6.5.3 Writing and Reading Operation

Accessing a particular register on the GD30TS075B is accomplished by writing the appropriate value to the pointer register. The value for the pointer register is the first byte transferred after the slave address byte with the R/W bit low. Every write operation to the GD30TS075B requires a value for the pointer register (see Figure 4).

When reading from the GD30TS075B, the last value stored in the pointer register by a write operation is used to determine which register is read by a read operation. To change the register pointer for a read operation, a new value must be written to the pointer register. This action is accomplished by issuing a slave address byte with the R/W bit low, followed by the pointer register byte. No additional data are required. The master can then generate a start condition and send the slave address byte with the R/W bit high to initiate the read command. See Figure 5 for details of this sequence. If repeated reads from the same register are desired, there is no need to continually send the pointer register bytes because the GD30TS075B stores the pointer register value until it is changed by the next write operation.

Note that register bytes are sent with the most significant byte first, followed by the least significant byte.

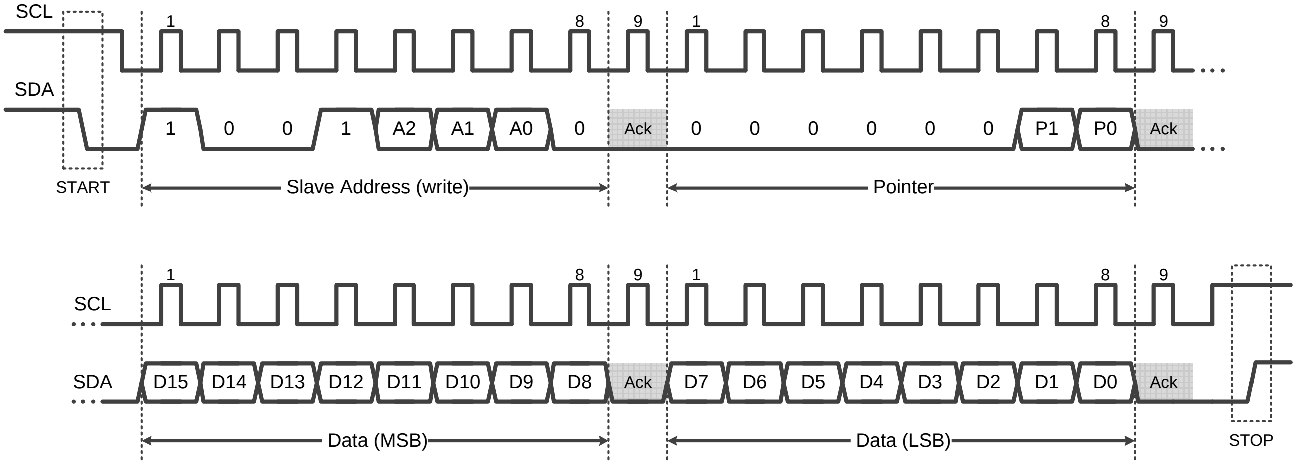


Figure 4. Two-wire Write Command Timing Diagram

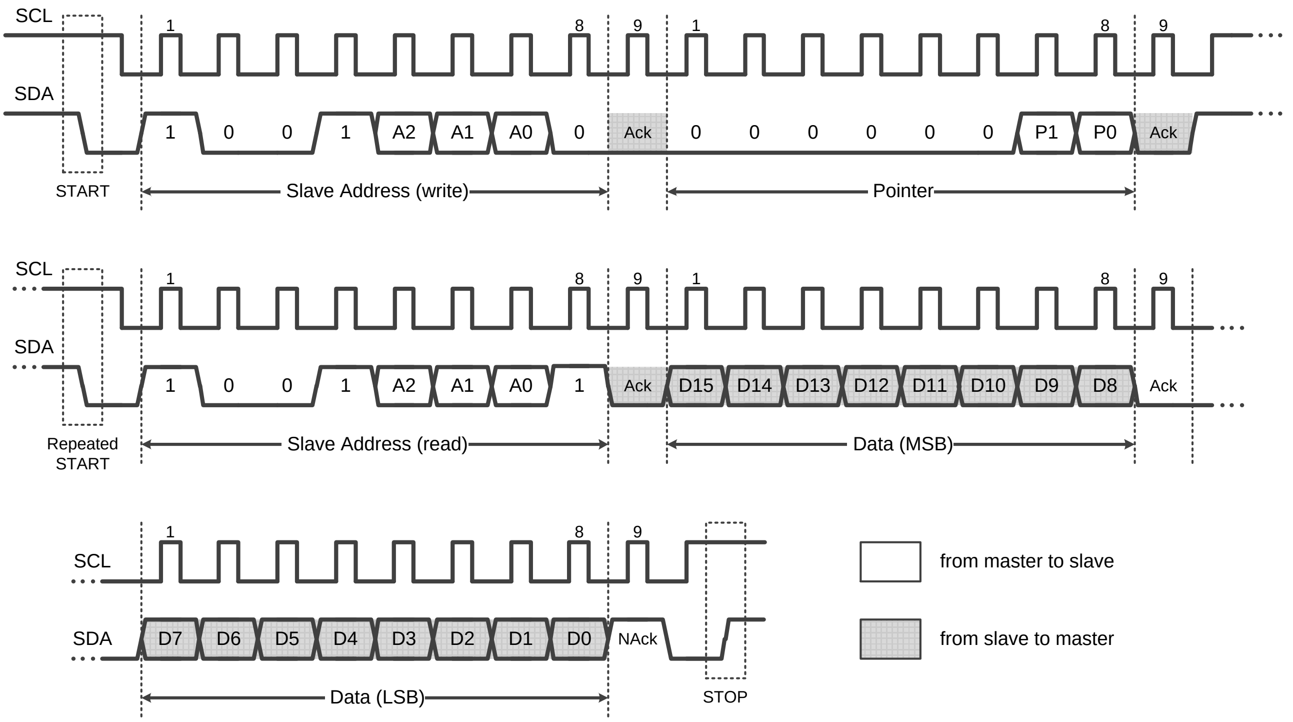


Figure 5. Two-wire Read Command Timing Diagram

6.5.4 Time-Out Function

The GD30TS075B resets the serial interface if SCL or SDA are held low for 20ms (typ) between a start and stop condition. If the GD30TS075B is pulled low, it releases the bus and then waits for a start condition. To avoid activating the timeout function, it is necessary to maintain a communication speed of at least 1kHz for the SCL operating frequency.

6.5.5 High-Speed Mode

In order for the I2C bus to operate at frequencies above 400kHz, the master device must issue an Hs-mode code (00001xxx) as the first byte after a start condition to switch the bus to high-speed operation. The GD30TS075B does not acknowledge this byte, but does switch its input filters on SDA and SCL and its output filters on SDA to operate in Hs-mode, allowing transfers at up to 2.3MHz. After the Hs-mode code has been issued, the master transmits a slave address to initiate a data-transfer operation. The bus continues to operate in Hs-mode until a stop condition occurs on the bus. Upon receiving the stop condition, the GD30TS075B switches the input and output filters back to fast-mode operation(See Figure 6).

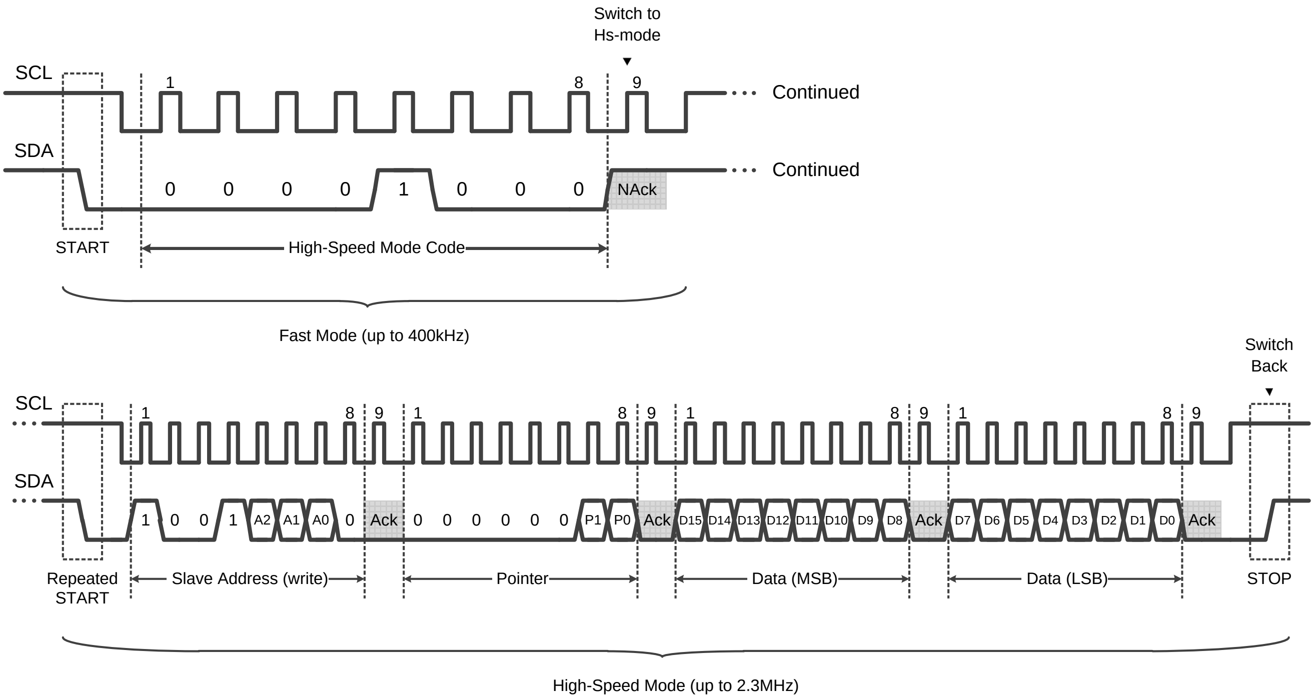


Figure 6. Two-wire Timing Diagram for Write Word Format in High-Speed Mode

7 Application Information

The following contents are the precautions for GD30TS075B recommended by GigaDevice in practical applications. Customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

7.1 Remote Temperature Probe Selection

The GD30TS075B has an extremely low average power consumption, so an RC filter circuit can be added to the power supply pin to further reduce the impact of power supply noise. As shown in Figure 7, the resistance must be less than 1kΩ, the capacitance must be greater than 0.1μF, and the power supply voltage cannot be lower than 1.4V.

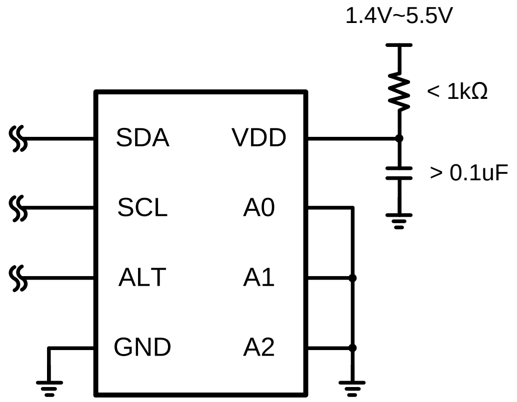


Figure 7. Typical Connections of the GD30TS075B

8 Layout Guidelines and Example

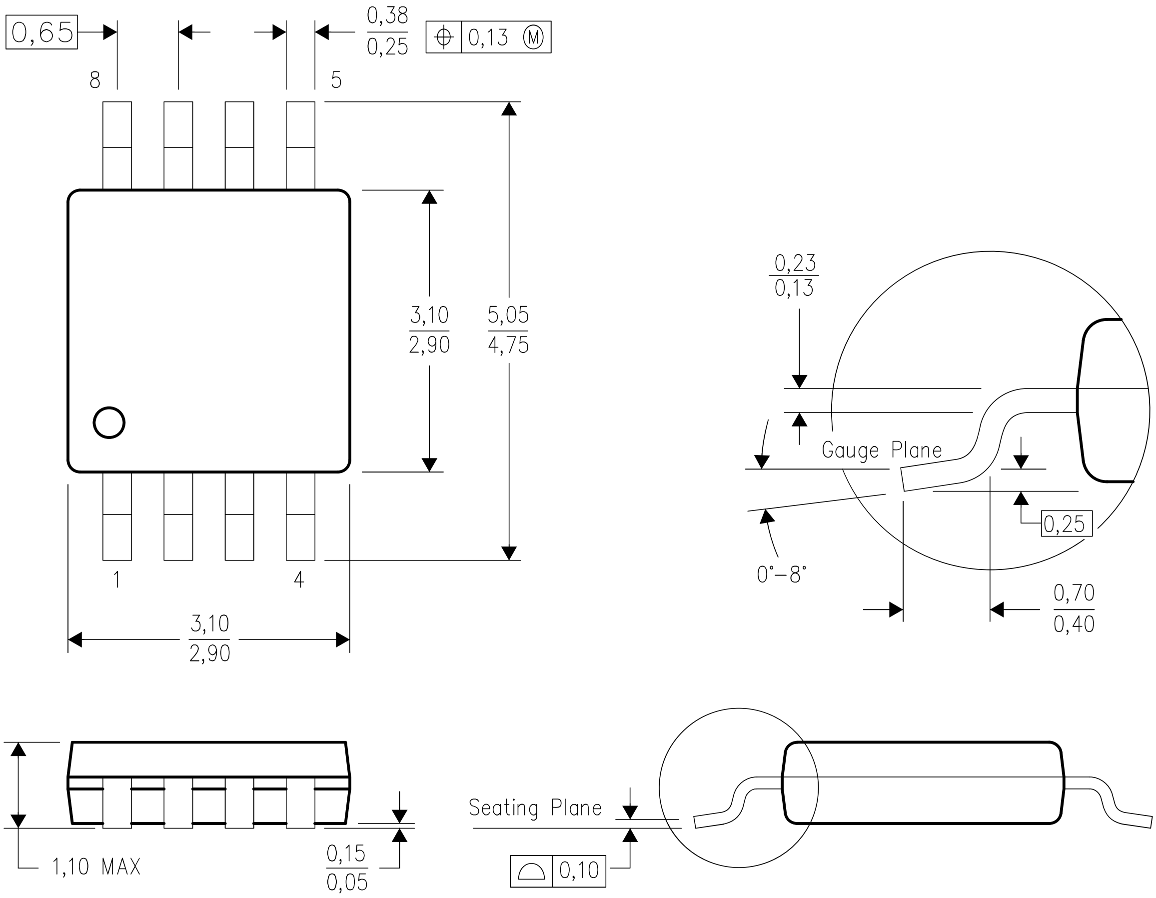
Place the device as far away as possible from noise sources such as high-speed digital buses, coil elements and wireless antennas. Place the power-supply bypass capacitor as close as possible to the supply and ground pins. The recommended value of this bypass capacitor is 0.1μF. For severe noise environments, GD recommends the use of multiple different capacitance values in parallel, such as 1μF+0.1μF+0.01μF, etc., so as to filter out digital noise in multiple frequency ranges.

Place the device in close proximity to the heat source that must be monitored, with a proper layout for good thermal coupling. This placement verifies that temperature changes are captured within the shortest possible time interval. The average power consumption is extremely low, and the self-heating effect is negligible.

9 Package Information

9.1 Outline Dimensions

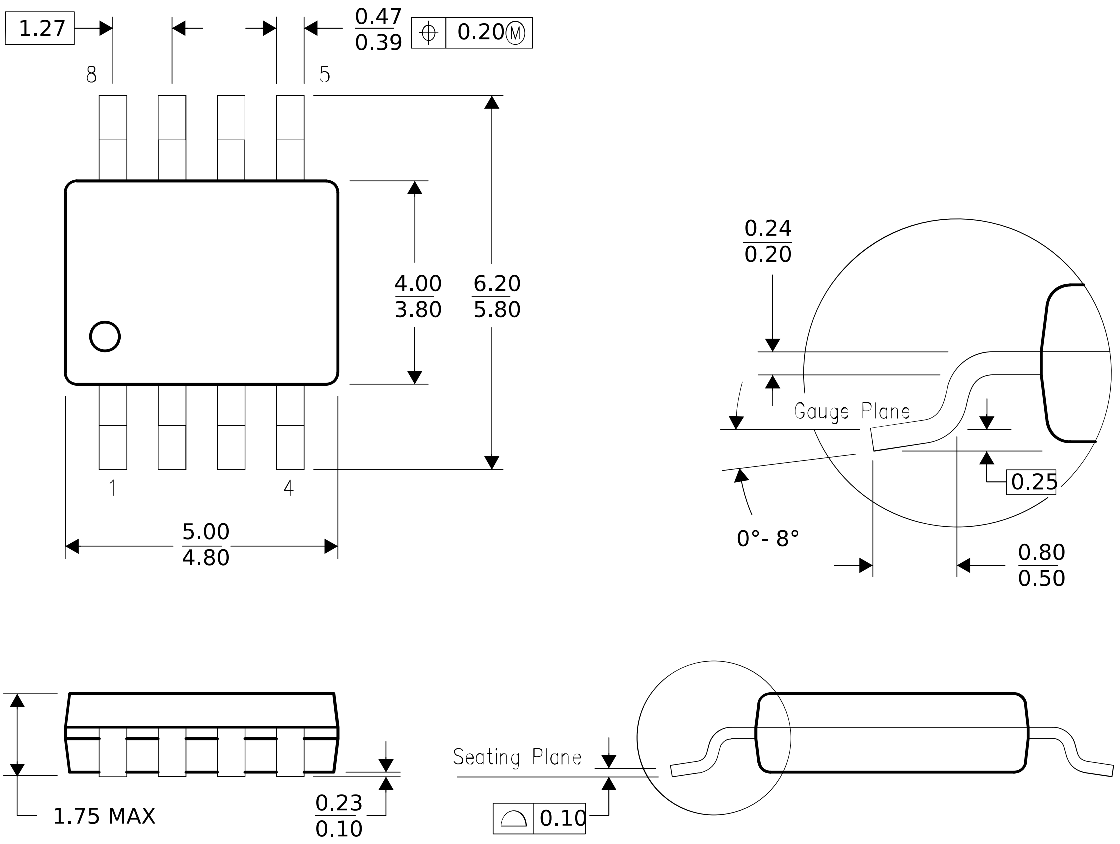
MSOP-8 Package Outline



NOTES:

1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs

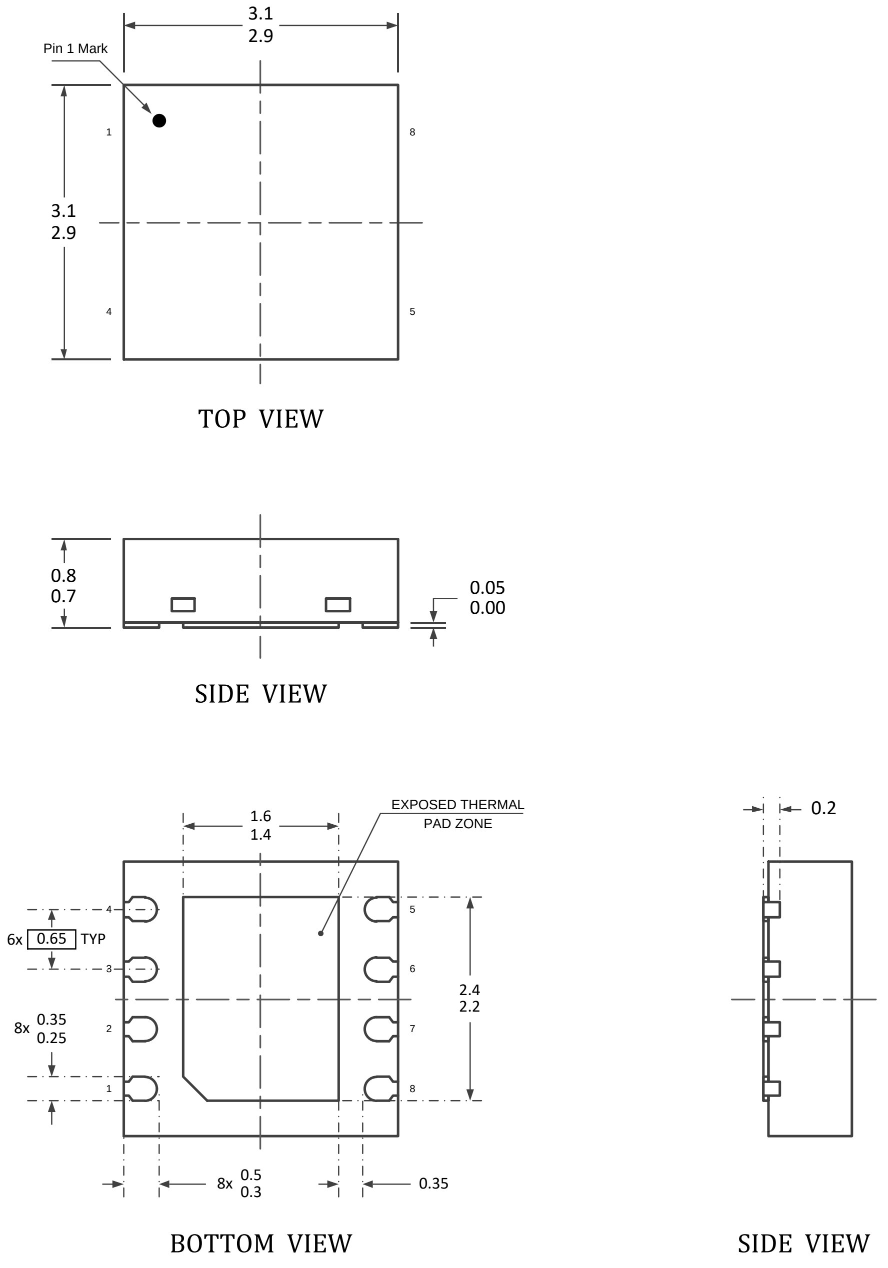
SOP-8 Package Outline



NOTES: (Continued)

1. All dimensions are in millimeters.

DFN-8 Package Outline



NOTES: (Continued)

1. All dimensions are in millimeters.

10 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30TS075BWGTR-I	SOP-8	Green	Tape & Reel	4000	−55°C to +125°C
GD30TS075BWMTR-I	MSOP-8	Green	Tape & Reel	4000	−55°C to +125°C
GD30TS075BWETR-I	DFN-8	Green	Tape & Reel	4000	−55°C to +125°C

11 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial and device details	2024

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