Multi-Address Local & Remote Digital Temperature Sensor

1 Features

- Multi-Channel Temperature Measurement:
  - GD30TS431N: 1 Local, 1Remote Channel
  - GD30TS432N: 1 Local, 2Remote Channel
- Temperature Range: −55°C to 150°C (Local & Remote Channels)
- Local Measurement Accuracy: ±0.5°C (−40°C to 125°C)
- Remote Measurement Accuracy: ±1.0°C (−40°C to 125°C)
- Resolution: 0.00390625°C (16 Bits)
- Supply voltage: 2.7V to 5.5V
- Low Quiescent Current: (3.3V,27°C)
  - Local Channel: 230μA
  - Remote Channel: 630μA
  - Shutdown mode: 2μA
- Digital output: SMBus™, I2C Compatibility
- Remote Diode Feature:
  - Series-Resistance Cancellation
  - η-Factor Correction
  - β Value Detection and Automatic Compensation
  - Open and Short Circuit Detection and other Functions
- Package:
  - GD30TS431N: 8-PIN MSOP
  - GD30TS432N: 10-PIN MSOP

2 Applications

- Servers, processors, FPGAs
- Desktop and laptop computers
- Storage Area Network (SAN)
- General temperature measurement:
  - industrial control
  - test equipment
  - medical equipment

3 Description

The GD30TS43XN series are high-precision and low-power digital temperature sensors compatible with SMBus and I2C interfaces. The devices can simultaneously monitor the remote temperature of the area where up to 1 (GD30TS431N) / 2 (GD30TS432N) remote temperature probes are located besides the local temperature of the chip. The series have functions such as series resistance elimination, programmable η factor correction, β value detection and automatic compensation, and programmable temperature thresholds, providing a high-precision, low-power reliable temperature monitoring solution.

The GD30TS43XN series are particularly suitable for temperature measurement using remote transistors (NPN / PNP Type) integrated in servers and processors under advanced processes. The series support compensation for PNP connected in transistor form with $0.09 < \beta < 21.36$ to achieve high-precision temperature measurement.

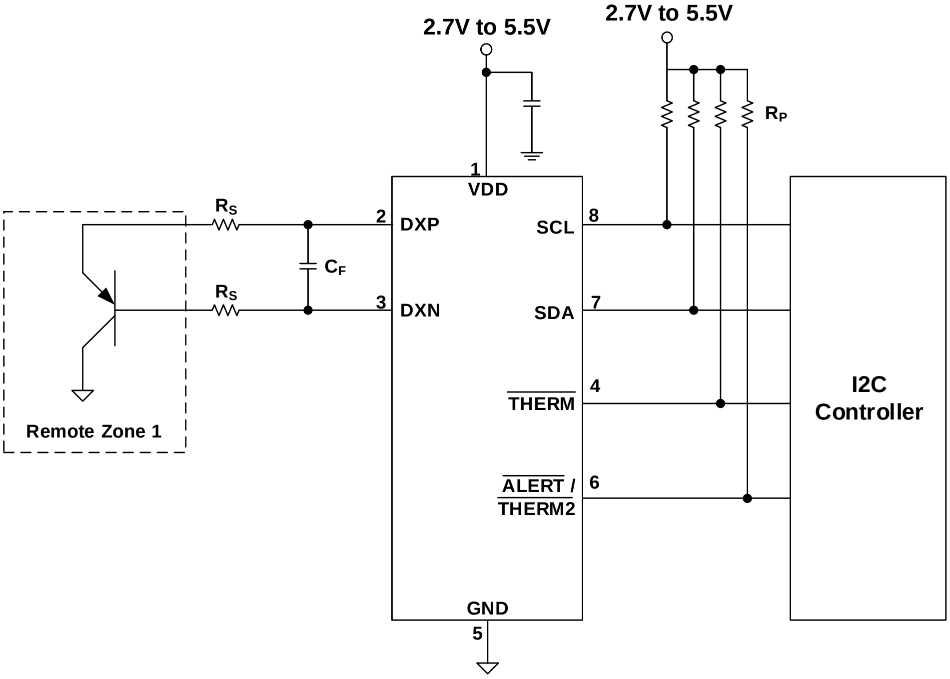
The GD30TS43XN series have a typical temperature measurement accuracy of ±0.5°C for local channels and ±1°C for remote channels respectively. The series feature a temperature measurement resolution of 0.00390625°C and a temperature measurement range of −55°C to +150°C. The power supply voltage range of the GD30TS43x series is 2.7V to 5.5V.

Device Information[1]

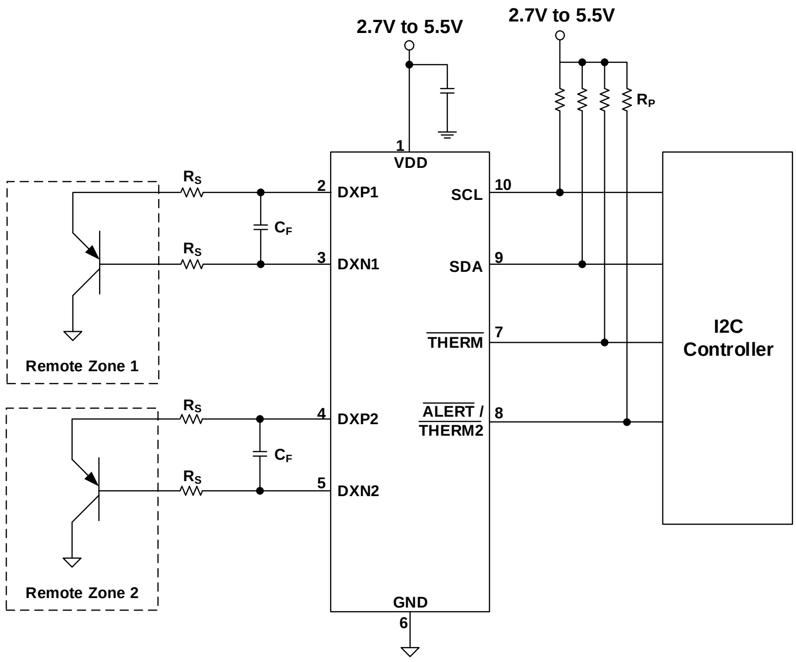
PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30TS431N	MSOP-8	3.00 mm × 3.00 mm
GD30TS432N	MSOP-10	3.00 mm × 3.00 mm

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

GD30TS431N Simplified Application Schematic



GD30TS432N Simplified Application Schematic



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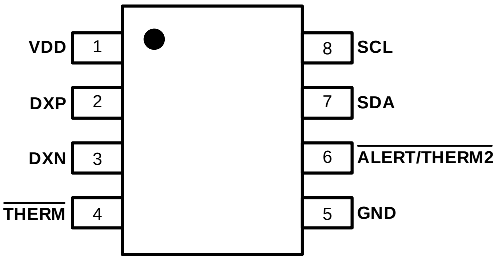
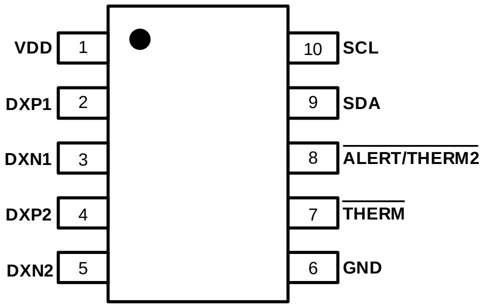
4 Device Overview

4.1 Pinout and Pin Assignment

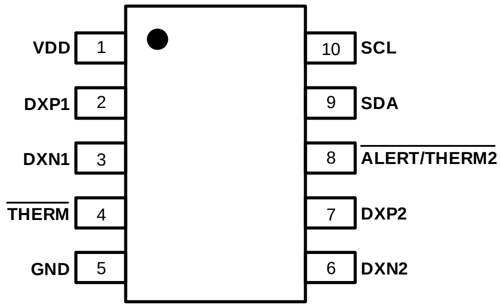
GD30TS431/MSOP-8
(Top View)



GD30TS432-I/MSOP-10
(Top View)



GD30TS432-S/MSOP-10
(Top View)



4.2 Pin Description

PINS				PIN TYPE[1]	FUNCTION
NAME	GD30TS431	GD30TS432-I	GD30TS432-S		
VDD	1	1	1	P	Power supply voltage, 2.7V to 5.5V.
DXP	2			I	Remote analog positive input pin.
DXN	3			I	Remote analog negative input pin.
DXP1		2	2	I	Remote 1-channel analog positive input pin.
DXN1		3	3	I	Remote 1-channel analog negative input pin.
DXP2		4	7	I	Remote 2-channel analog positive input pin.
DXN2		5	6	I	Remote 2-channel analog negative input pin.
$\overline{\text{THERM}}$	4	7	4	O	Digital, thermal flag, active low. Open-drain output, requires pull-up resistor to VDD.
GND	5	6	5	G	Ground connection.

Pin Description (Continued)

PINS				PIN TYPE[1]	FUNCTION
NAME	GD30TS431	GD30TS432-I	GD30TS432-S		
$\overline{\text{ALERT}}/\overline{\text{THERM2}}$	6	8	8	O	Digital alert output. Can be configured as a second THERM output. Open-drain; requires pull-up resistor.
SDA	7	9	9	IO	Serial data line. Open-drain output, requires pull-up resistor.
SCL	8	10	10	I	Serial clock line. Open-drain output, requires pull-up resistor.

1. P = Power, G = Ground, I = Input, 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
V_{DD}	Power supply voltage		6	V
V_{DXP}	DXP voltage	−0.5	VDD+5	V
V_{DXN}	DXN voltage	−0.5	VDD+5	V
V_{IO}	$\overline{THERM}$、$\overline{ALERT}$/$\overline{THERM2}$、SCL、SDA Input voltage	−0.5	6	V
I_{IN}	Input current		10	mA
T_A	Operating range	−55	150	°C
T_J	Junction temperature		150	°C
T_{stg}	Storage temperature	−60	160	°C

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

5.2 Recommended Operation Conditions

SYMBOL[1,2]	PARAMETER	MIN	TYP	MAX	UNIT
V_{DD}	Supply voltage	2.7	3.3	5.5	V
T_A	Local channel operating range	−50		150	°C

5.3 Electrical Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human Body Mode (HBM), per ANSI/ESDA/JEDEC JS-001	±4000	V
$V_{ESD(MM)}$	Machine Mode (MM), per JEDEC-STD Classification	±300	V
LU	Latcj-Up, per JESD 78, Class IA	±200	mA

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

5.4 Electrical Characteristics

V_{DD} = 2.7V to 5.5V, at T_A = +25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
TE_{LOCAL}	Local temperature sensor	T_L = −40°C to 125°C		±0.5	±1	°C
TE_{REMOTE}	Remote temperature sensor Remote temperature sensor versus supply	T_L= 0°C to 100°C, T_R = –40°C to 125°C, V_{DD} = 3.3V		±0.25	±1	°C
		$T_{L/R}$ = −40°C to 125°C		±1	±2	°C
	Local channel supply voltage sensitivity			±0.2	±0.5	°C/V
	Remote channel supply voltage sensitivity			±0.2	±0.5	°C/V
	Resolution	All channel		0.00390625		°C
T_{CON}	Conversion time	Local channel	12	15	17	ms
		Remote channel, β compensation on, RC = 1		126	140	
		Remote channel, β compensation on, RC = 1		47	55	
		Remote channel, β compensation on, RC = 1		93	105	
		Remote channel, β compensation on, RC = 1		44	50	
I_{BIAS}	Bias current of remote temperature measurement probe	High		120		μA
		Medium-High		60		
		Medium-Low		12		
		Low		6		
	η value of remote temperature measurement probe	Beta compensation on		1.000		
		Beta compensation off		1.008		
	β Compensation Range of Remote Temperature Measurement Probe		0.09		21.36	
f_{BUS}	Bus Communication Frequency		0		2.5	MHz
t_{DEC}	IIC Interface Timeout Detection		25	32	35	ms
t_{WAIT}	IIC Communication Waiting Time	Since power-on or general call reset		300	0.4	μs
V_{IL}	SDA Pin Outputs Low Level	I_{OUT}= 6mA		0.06		V
V_{IO}	$\overline{\text{THERM}}$、$\overline{\text{ALERT}}$/$\overline{\text{THERM2}}$ Pin Output Low Level	I_{OUT}= 6mA		0.13	0.4	V
V_{DD}	Power Supply Operating Voltage		2.7	3.3	5.5	V

Electrical Characteristics (Continued)

V_{DD} = 2.7V to 5.5V, at T_A = +25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
I_Q	Quiescent Current	Local channel continuous switching I_{LTS}		230	345	µA
		Remote channel continuous switching I_{RTS}		630	945	
		Idle Mode I_{IDLE}		9	15	
		Shutdown mode I_{SD}		2	6	
V_{DD_UVLO}	Supply under voltage lockout			2.45	2.6	V
V_{POR}	Power-on reset threshold			1.6	2.3	V

6 Function Description

6.1 Device Functional Modes

6.1.1 Remote Temperature Measurement Connection Method

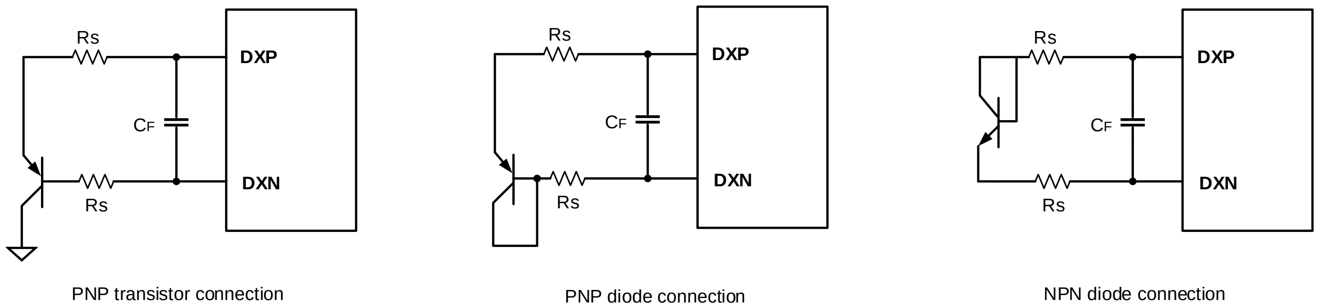


Figure 1. Remote Temperature Measurement Connection Method

The GD30TS43XN series support three different remote temperature measurement connection methods: PNP transistor connection, PNP diode connection, and NPN diode connection, as shown in Figure 1. Among them, only the PNP transistor connection method is applicable to the β value detection and automatic compensation of the GD30TS43XN series in remote temperature measurement, see section 6.1.5 for details. For the PNP / NPN diode connection method, it is recommended to use a transistor with β > 50 to avoid the influence of the β value on the remote temperature measurement accuracy.

6.1.2 Continuous Conversion Mode

The default operating mode of the GD30TS43XN series is continuous conversion mode. In this mode, the GD30TS43XN series will perform continuous conversions in the order of local channel, remote 1 channel, and remote 2 channel (GD30TS432N). The LEN, REN, and REN2 (GD30TS432N) bits in the configuration register 2 (1Ah for GD30TS431N, 3Fh for GD30TS432N) control the channel enable during the continuous conversion process. If some channels are not activated, the above inactivated channels will be skipped. The R3:R0 bits in the conversion rate register (0Ah) can configure the GD30TS43XN series to different conversion rates, see section 6.3.5.

All channels of the GD30TS43XN series can output 16 bits of temperature measurement results, with a temperature measurement resolution of 0.00390625°C. The temperature measurement results are stored in the temperature register of the corresponding channel using two bytes. In normal temperature measurement mode, the temperature measurement range of all channels of the chip is 0°C ~ 128°C. The measurement results of negative temperatures are always represented as 0000h, and the measurement results more than or equal to 128°C are always represented as 7FFFh.

The GD30TS43XN series provide an extended temperature measurement mode to achieve a wider range of temperature measurements. Writing the RANGE bit in the configuration register 1 (09h) to 1 allows the chip to enter the extended temperature measurement mode and output the temperature measurement result in the extended mode after the next temperature conversion. In this mode, the final temperature measurement result of the chip is the sum of the actual temperature measurement result and 64°C (40h). At this time, the theoretical temperature measurement range of the chip will be extended to −64°C ~ 192°C. Table 1 and Table 2 give the high and low byte data formats of the chip temperature register in the normal temperature measurement mode and the extended temperature measurement mode.

The recommended temperature range for all channels of the GD30TS43XN series is −50° ~ 150°C.

Table 1. High-byte Data Format of Local/Remote Temperature Measurement Results

TEMPERATURE (°C)	HIGH-BYTE OF LOCAL/REMOTE TEMPERATURE MEASUREMENT RESULTS			
	NORMAL MODE		EXTENDED MODE	
	BINARY	HEXADECIMAL	BINARY	HEXADECIMAL
-64	0000 0000	00	0000 0000	00
-50	0000 0000	00	0000 1110	0E
-25	0000 0000	00	0010 0111	27
0	0000 0000	00	0100 0000	40
1	0000 0001	01	0100 0001	41
5	0000 0101	05	0100 0101	45
10	0000 1010	0A	0100 1010	4A
25	0001 1001	19	0101 1001	59
50	0011 0010	32	0111 0010	72
75	0100 1011	4B	1000 1011	8B
100	0110 0100	64	1010 0100	A4
125	0111 1101	7D	1011 1101	BD
127	0111 1111	7F	1011 1111	BF
150	0111 1111	7F	1101 0110	D6
191	0111 1111	7F	1111 1111	FF

Table 2. Low-byte Data Format of Local/Remote Temperature Measurement Results

TEMPERATURE (°C)	LOW-BYTE DATA FORMAT OF LOCAL/REMOTE TEMPERATURE	
	BINARY	HEXADECIMAL
0.00000000	0000 0000	00
0.00390625	0000 0001	01
0.01562500	0000 0100	04
0.06250000	0001 0000	10
0.12500000	0010 0000	20
0.25000000	0100 0000	40
0.50000000	1000 0000	80
0.75000000	1100 0000	C0
0.93750000	1111 0000	F0

6.1.3 Shutdown Mode

Shutdown mode of the GD30TS43XN series allow the user to conserve power by shutting down all device circuitry except the serial interface, thereby reducing the current of the GD30TS43XN series to less than 2μA (typ.). The shutdown mode is initiated when the SD bit in the configuration register 1 (09h) is set to 1; after configuring the registers in this way, the GD30TS43XN series will immediately enter shutdown mode. To exit shutdown mode, write SD bit to 0, the GD30TS43XN series will re-enter continuous conversion mode.

In particular writing the LEN, REN, REN2 (GD30TS432N) bits in the configuration register 2 to 0 also puts the GD30TS43XN series into shutdown mode. Under this situation, to exit shutdown mode, write any one or more of the LEN, REN, REN2 (GD30TS432N) bits as 1.

6.1.4 One-Shot Conversion Mode

The GD30TS43XN series can be configured in One-Shot mode. When the GD30TS43XN series are in shutdown mode (SD = 1), writing any value to the One-Shot register (0Fh) can start a single temperature conversion, and the value will not be stored in the One-Shot register. The temperature measurement channels included in this temperature conversion are determined by the values of the LEN, REN, and REN2 (GD30TS432N) bits. To ensure the smooth progress of the above single temperature conversion, at least one of the LEN, REN, and REN2 (GD30TS432N) bits should be written to 1. After the single temperature conversion is completed, the GD30TS43XN series will return to shutdown mode. When continuous temperature measurement is not required, this function can significantly reduce chip power consumption.

6.1.5 β Value Detection and Compensation

In common remote temperature measurement chips, the remote PNP generally generates different V_{BE} voltages by controlling the current flowing into the remote PNP emitter. The chip performs remote temperature measurement by quantifying the above V_{BE} voltage. However, the V_{BE} voltage of the PNP actually depends directly on its collector current rather than the emitter current. When the β value of the remote PNP is large (>50), the collector current of the remote PNP is basically equal to the emitter current, which has small effect on the remote temperature measurement result. When the remote PNP process is ≤90nm, its β value will drop sharply, making the collector current of the remote PNP much lower than the emitter current, resulting in a large remote temperature measurement error.

The GD30TS43XN series can detect the β value of the PNP connected in the form of a transistor (as shown in Figure 2) for remote temperature measurement, and compensate for different β values to avoid the influence of the β value on the remote temperature measurement accuracy. The GD30TS43XN series provide two β compensation modes: automatic and manual. Writing the BC3:BC0 bits of the β compensation register (25h, 26h for GD30TS432N) to 1XXXb can configure the chip to enter the automatic β compensation mode. In this mode, the GD30TS43XN series will automatically detect the β value of the remote PNP connected to the channel before each remote temperature measurement starts, and automatically adjust the internal compensation circuit of the chip according to the β value. At this time, the value of the β compensation register of the channel will return to the detection interval value, as shown in Table 8.

Writing the BC3:BC0 bits of the β compensation register to 0000b~0110b configures the chip to enter manual β compensation mode. In this mode, the GD30TS43XN series no longer automatically detects the β value of the connected remote PNP, but determines the working mode of the chip's internal compensation circuit based on the value written into the β compensation register. Therefore, when using manual β compensation mode, the β value of the remote PNP should be specified in advance, and the β compensation register should be correctly configured accordingly.

Writing BC3:BC0 bits of the beta compensation register to 0111b can manually shut down the β compensation circuit inside the chip. To avoid excessive temperature measurement errors, the β value of the selected remote

PNP should be greater than 50.

The above discussion is based on the use of PNP connected in the form of a transistor for remote temperature measurement. If PNP/NPN connected in the form of a diode is used for remote temperature measurement, no matter whether the chip is configured in automatic or manual β compensation mode, the chip will first detect the diode connection status and automatically shut down the β compensation circuit inside the chip. Therefore, when using PNP/NPN connected in the form of a diode for remote temperature measurement, it should be ensured that the β value of the selected remote PNP is greater than 50. If the chip is in automatic β compensation mode at this time, the β compensation register will always return 1111b.

The above configuration of the β compensation register is detailed in section 6.3.3.

6.1.6 Series Resistance Elimination and Filtering

When using the GD30TS43XN series for remote temperature measurement, it is necessary to consider the impact of the remote series resistance R_S on the remote temperature measurement results. The parasitic resistance of the traces on the PCB is one of the main sources of R_S. Writing the RC bit in the configuration register 2 to 1 can turn on the series resistance elimination function of the GD30TS43XN series to automatically eliminate the temperature measurement error caused by R_S.

In addition, environmental noise will also reduce the temperature measurement accuracy of the GD30TS43XN series. The GD30TS43XN series integrates a 65kHz low-pass filter between the DXP and DXN pins to suppress the temperature measurement error caused by the above environmental noise. Despite this, it is still recommended to connect a filter resistor R_S in series to the DXP and DXN pins of the GD30TS43XN series, and connect a filter capacitor CF across the two pins to form an external low-pass filter outside the chip, so that the chip can better filter out irrelevant coupling signals between the pins, as shown in Figure 1.

The sum of the above filter resistor and the PCB trace resistance R_S should be ≤1kohm (β compensation is turned off) or ≤300ohm (β compensation is turned on); the above filter capacitor C_F should be ≤2.2nF. In some specific applications, in order to obtain better remote temperature measurement accuracy, the size of the above filter resistor and capacitor can be appropriately adjusted.

To ensure the accuracy of remote temperature measurement, in most applications, the RC bit in configuration register 2 must be enabled. However, in some cases, the temperature measurement time of the remote channel can be reduced by about 50% by turning off the series resistance elimination function, thereby further reducing the average power consumption during remote temperature measurement.

6.1.7 Sensor Misconnection Detection

The GD30TS43XN series can continuously detect the misconnection of the remote temperature probe mounted on the corresponding remote channel during the remote temperature conversion process. When the voltage of the DXP pin of the corresponding channel is higher than (VDD - 0.6V), the GD30TS43XN series will determine that the pin is open, the OPEN bit in the status register (02h) will be set to 1, and the temperature measurement result of the remote channel will return 0000 h; if the chip is in ALERT alarm mode at this time, the $\overline{\text{ALERT}}$ pin will be activated ($\overline{\text{ALERT}}$ = 0).

The GD30TS43XN series can also continuously detect the short circuit misconnection between the DXP pin and the DXN/GND pin of the corresponding remote channel during the remote temperature conversion process. When a short circuit occurs, the temperature measurement result of the remote channel will also return 0000h, but the

OPEN bit in the status register will not be activated.

The behavior of the OPEN bit is detailed in section 6.3.1.

When the remote temperature measurement function of the GD30TS43XN series is not used, the DXP pin and DXN pin of the corresponding channel must be short-circuited to prevent meaningless misconnection detection.

6.1.8 Alarm Function

The GD30TS43XN series use two alarm pins $\overline{\text{THERM}}$ and $\overline{\text{ALERT}}$ / $\overline{\text{THERM2}}$ to realize the alarm function.

THERM Mode

For the $\overline{\text{THERM}}$ pin, after obtaining the temperature measurement results of each channel, the GD30TS43XN series will compare its high byte with the value in the 8-bit local/remote THERM threshold register (20h/19h for GD30TS431N, 20h/19h/1Ah for GD30TS432N). If the temperature measurement result of a channel is higher than the value of the THERM threshold registers of the channel for a number of times that reaches the value defined by CTH2:CTH0 in the continuous alarm register (22h), the LTHRM bit or RTHRM bit in the GD30TS431N status register (02h) will be set to 1; the LTHRM bit or R1THRM bit or R2THRM bit in the GD30TS432N THERM threshold status register (37h) will be set to 1. If any of the above three bits is set to 1, the THERM bit in the GD30TS432N status register (02h) will be set to 1. When any of the above alarm status bits is activated, the $\overline{\text{THERM}}$ pin will be activated at the same time ($\overline{\text{THERM}}$ = 0).

The above alarm status bits will remain activated until the temperature measurement result of the corresponding channel is lower than the value of the THERM threshold register minus the THERM hysteresis register (21h) of the channel for a number of times that reaches the value defined by CTH2:CTH0 in the continuous alarm register, after which the corresponding status bits will be reset to 0. The $\overline{\text{THERM}}$ pin will remain activated until the above status bits are reset to 0, after which the $\overline{\text{THERM}}$ pin will be reset to 1.

THERM2 Mode

The $\overline{\text{ALERT}}$ / $\overline{\text{THERM2}}$ pins can be configured as a $\overline{\text{THERM2}}$ pin by writing the $\overline{\text{AL/TH}}$ bit in the configuration register 1 to 1. If the temperature measurement result of a channel is higher than the 16-bit high threshold register of the channel (0Bh&16h / 0Dh&13h for GD30TS431N, 0Bh&3Dh / 0Dh&13h / 15h&17h for GD30TS432N), and reaches the value defined by CALT2:CALT0 in the continuous alarm register, the LHIGH bit or RHIGH bit in the GD30TS431N status register will be set to 1; the LHIGH bit or R1HIGH bit or R2HIGH bit in the GD30TS432N high threshold status register (35h) will be set to 1. If any of the above three bits are set to 1, the HIGH bit in the GD30TS432N status register will be set to 1. When any of the above alarm status bits are activated, the $\overline{\text{THERM2}}$ pin will be activated at the same time ($\overline{\text{THERM2}}$ = 0).

The above alarm status bits will remain activated until the temperature measurement result of the corresponding channel is lower than the value of the high threshold register of the channel minus the value of the THERM hysteresis register (21h) for a number of times that reaches the value defined by CALT2:CALT0 in the continuous alarm register, after which the corresponding status bit will be reset to 0. The $\overline{\text{THERM2}}$ pin will remain activated until the above alarm status bits are reset to 0, after which the $\overline{\text{THERM2}}$ pin will be reset to 1.

ALERT Mode

The $\overline{\text{ALERT}}$ / $\overline{\text{THERM2}}$ pins can be configured as a $\overline{\text{THERM2}}$ pin by writing the $\overline{\text{AL/TH}}$ bit in the configuration register 1 to 1. If the temperature measurement result of a channel is higher than the high threshold register of the channel or lower than the low threshold register of the channel (0Ch&17h / 0Eh&14h for GD30TS431N, 0Ch&3Eh / 0Eh&14h / 16h&18h for GD30TS432N) for a number of times that reaches the value defined by CALT2:CALT0 in the continuous alarm register, the LHIGH bit or LLOW bit or RHIGH bit or RLOW bit in the GD30TS431N status register (02h) will be set to 1, as shown in section 6.3.1 the corresponding bit in the high threshold status register (35h) or low threshold status register (36h) of the GD30TS432N will be set to 1, and the HIGH bit or LOW bit in the status register will be set to 1, as shown in section 6.3.1.

The above status bits will remain activated until the temperature measurement result of the corresponding channel is no longer in the over-temperature state and the corresponding status register (02h for GD30TS431N, 35h & 36h for GD30TS432N) is read, and then the corresponding alarm status bit will be reset to 0. The GD30TS43XN series will also immediately reset the corresponding alarm status bit when it successfully responds to the SMBus alarm command.

The MASK bit in the GD30TS43XN series configuration register 1 controls the behavior of the $\overline{\text{ALERT}}$ pin only in ALERT mode. When MASK = 0, the $\overline{\text{ALERT}}$ pin will be activated ($\overline{\text{ALERT}}$ = 0) when any of the above alarm status bits are activated. The above alarm status bits are reset to 0, and then the $\overline{\text{ALERT}}$ pin will be reset to 1. When MASK = 1, the $\overline{\text{ALERT}}$ pin will be masked and will never be activated, but the corresponding alarm status bit is not affected by the MASK bit.

The GD30TS43XN series channel mask each MASK bit register (1Fh) and mask the $\overline{\text{ALERT}}$ pins activated by the temperature measurement results or the wrong connection of the corresponding channel. The working mode is consistent with the MASK bit in the configuration register 1.

The above alarm function is shown in Figure 2.

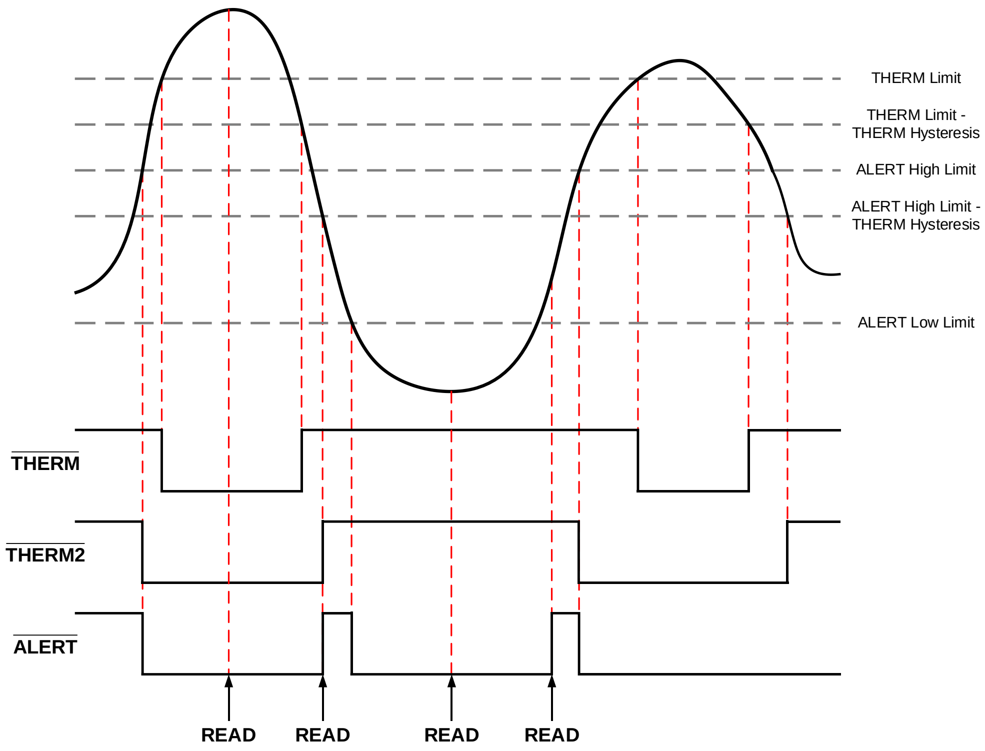


Figure 2. Three Alarm Functions

6.1.9 Low-Voltage Detection

The GD30TS43XN series can automatically detect the power supply voltage VDD to determine in real time whether VDD can meet the minimum voltage VDD_{MIN} required by the chip's internal ADC. During the chip's internal ADC conversion process, if VDD < VDD_{MIN1} = 2.45V (TYP), the current temperature conversion will stop immediately, the temperature registers of all channels will stop refreshing, and the most recent temperature measurement result will always be maintained until VDD ⩾ VDD_{MIN2} = 2.17V (TYP), the chip will restart the conversion and refresh the corresponding temperature registers again according to the conversion result.

The typical power supply voltage range of the GD30TS43XN series is 2.7V to 5.5V. To obtain accurate temperature measurement results, please keep the chip operating within this power supply voltage range.

6.2 Serial Interface

6.2.1 Bus Overview

The GD30TS43XN series are compatible with SMBus and I2C interfaces. In the SUMBus protocol, the device that initiates the transfer is called a master, and the devices controlled by the master are slaves. The bus must be controlled by a master device that generates the serial clock (SCL), controls the bus access, and generates the START and STOP conditions. To address a specific device, a START condition is initiated, indicated by pulling the data line (SDA) from a high- to low-logic level when the SCL pin is high. All slaves on the bus receive the 8-bits slave address on the rising edge of the clock, and the last bit indicates whether a read or write operation is intended. During the ninth clock pulse, the addressed slave generates an acknowledge and pulls the SDA pin low to respond to the master. A data transfer is then initiated and sent over eight clock pulses followed by an acknowledge bit. When all data are transferred, the master generate a STOP signal to end the communication by pulling SDA from low to high when SCL is high.

During the data transfer, the SDA pin must remain stable when the SCL pin is high because any change in the SDA pin when the SCL pin is high is interpreted as a START or STOP signal.

6.2.2 Serial Bus Address

To communicate with the GD30TS43XN series, the host must address the corresponding slave by sending slave address bytes. The slave address byte consists of seven address bits and a read-write (R/W) bit that indicates the intent of executing a read or write operation. The GD30TS43XN series provide four slave addresses, and the specific configuration is shown in Table 1.

Each time the GD30TS43XN series is powered on or a general call reset command is sent, it is necessary to wait at least 300μs before sending the slave address byte to wait for the chip to generate the corresponding slave address to avoid communication errors.

Table 3. Description of Slave Addresses in the GD30TS43XN Series

NO.	Slave Addresses
GD30TS431NWMTR-IAA / GD30TS431NWMTR-IAB	1001100b
GD30TS431NWMTR-IBA / GD30TS431NWMTR-IBB	1001101b
GD30TS431NWMTR-ICA / GD30TS431NWMTR-ICB	1001110b
GD30TS431NWMTR-IDA / GD30TS431NWMTR-IDB	1001111b
GD30TS432NAMTR-IA0/SA0	1001100b
GD30TS432NAMTR-IB0/SB0	1001101b
GD30TS432NAMTR-IC0/SC0	1001110b
GD30TS432NAMTR-ID0/SD0	1001111b

6.2.3 Read and Write Operations

The GD30TS43XN series allow the host to access specific registers inside the chip by writing the target value into the pointer register.

When writing data to the GD30TS43XN series, after sending the slave address byte with the low $R/\overline{W}$ bit, the corresponding pointer register byte needs to be sent to write the data into a specific register in the GD30TS43XN series. Each write operation to the GD30TS43XN series requires sending the pointer register byte.

When reading data from the GD30TS43XN series, send the corresponding pointer register byte after sending the slave address byte with the low $R/\overline{W}$ bit; then the host generates the Start signal again and sends the slave address byte with the high $R/\overline{W}$ bit to start the read command. If you need to read data from the same register repeatedly, you do not need to send the pointer byte of the register repeatedly. The GD30TS43XN series allow the host to automatically read data from the register specified by the previous pointer byte. When the data reading is completed, the host needs to send a NACK bit at the end of the last byte read to terminate the read operation. If only a single byte (MSB) needs to be read, the NACK bit can be sent in advance at the end of the MSB transmission. The above read and write operations are shown in Figure 3 and Figure 4.

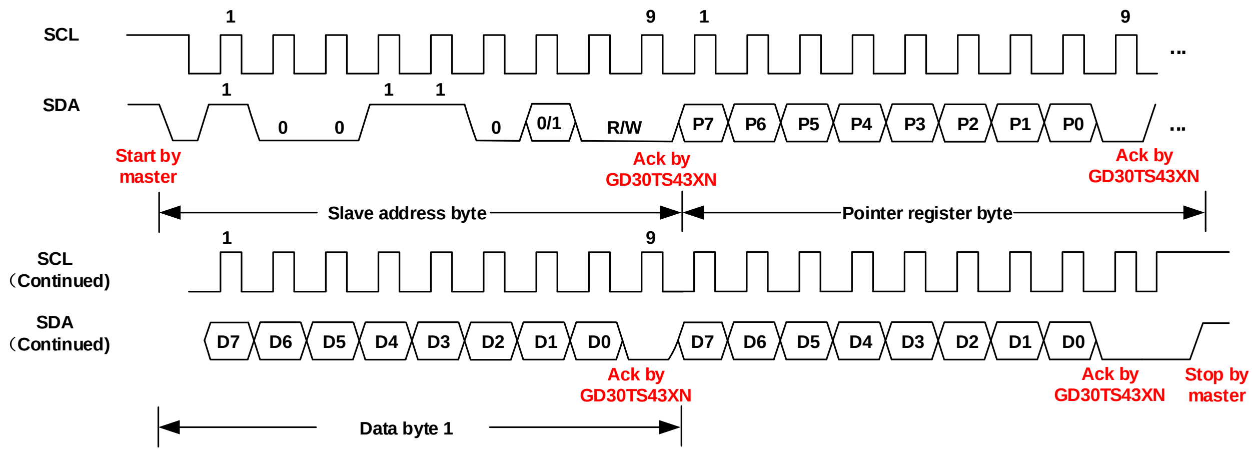


Figure 3. Two-Wire Write Command Timing Diagram

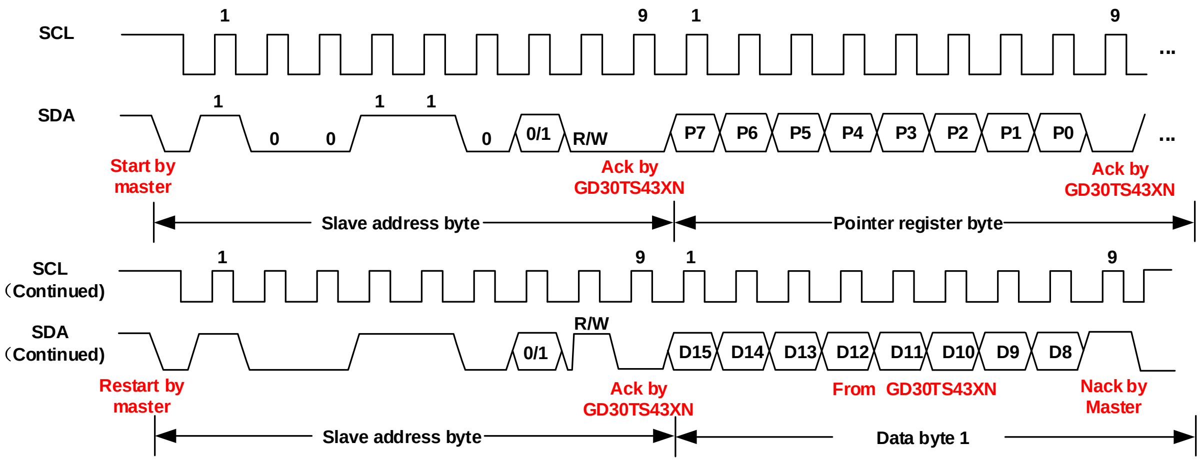


Figure 4 Two-Wire Read Command (1 Byte) Timing Diagram

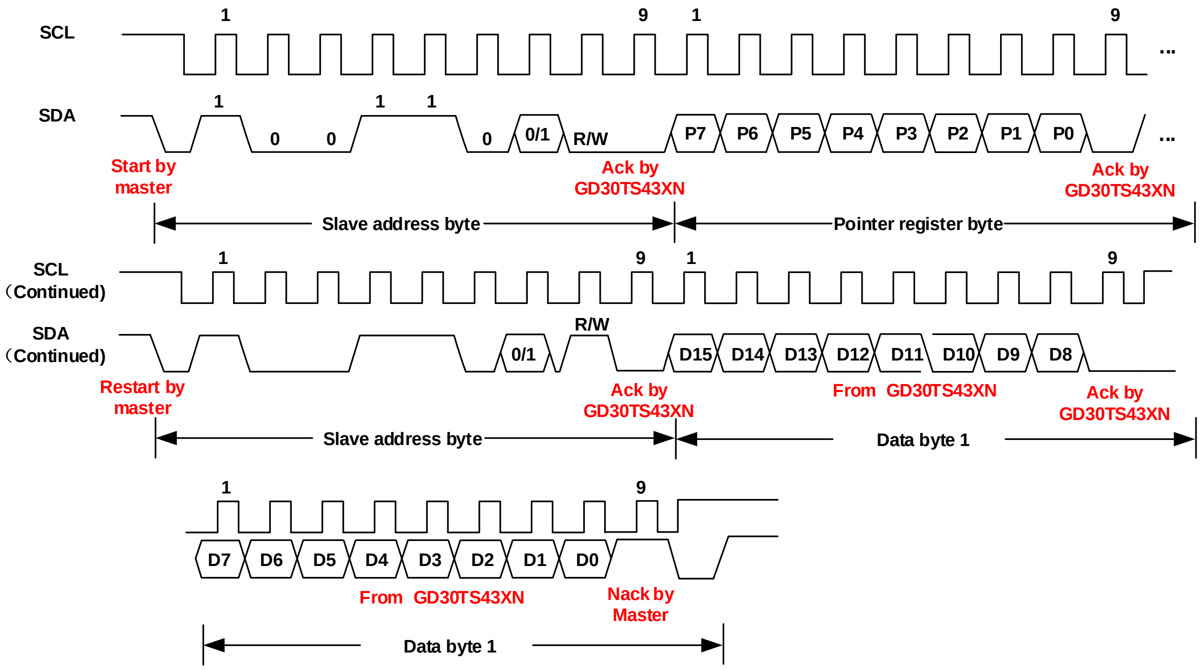


Figure 5. Two-Wire Read Command (2 Byte) Timing Diagram

All registers in the GD30TS43XN series are in single-byte, 8-bit format, and the temperature registers and high/low threshold registers of each channel are divided into high-byte registers and low-byte registers. The GD30TS43XN series support double-byte reads of the above registers. In the read command, when sending the pointer address of the high-byte register, the chip will automatically return all 16-bit data in the order of high byte and low byte, as shown in Figure 5.

The high and low bytes of the temperature register read out by the above method all come from the same temperature conversion.

6.2.4 SMBus Alarm Function

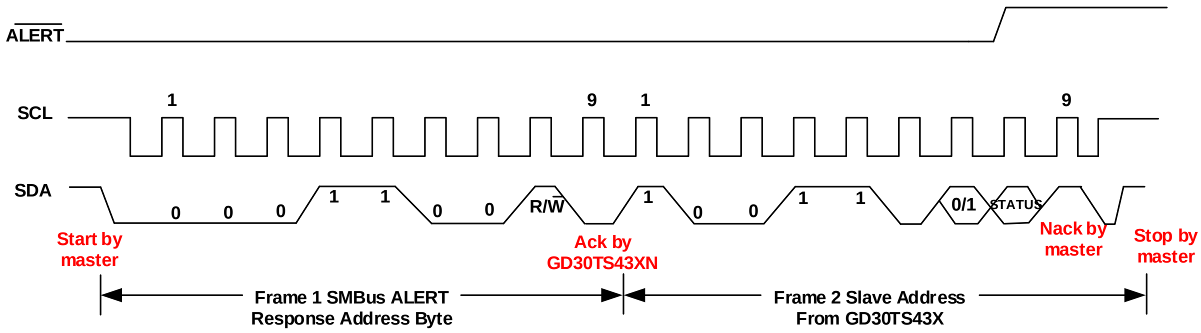


Figure 6. SMBus Alert Timing Diagram

The GD30TS43XN series support the SMBus alarm function. When the GD30TS43XN series is in the ALERT alarm mode, the host can send the SMBus alarm command (19h) to the bus. At this time, if the $\overline{\text{ALERT}}$ pin in one of the GD30TS43XN series on the bus is in an activated state, the chip will respond to the SMBus alarm command and return its slave address. If the alarm state is activated by the temperature measurement result being higher than the high threshold register, the eighth bit (LSB) of the slave address byte will be set to 1; if the alarm state is activated by the temperature measurement result being lower than the low threshold register, the eighth bit (LSB) of the slave address byte will be set to 0.

If multiple devices on the bus respond to the SMBus ALERT command, the bus will return the lowest two-wire address. the GD30TS43XN series $\overline{\text{ALERT}}$ pin becomes inactive at the completion of the SMBus $\overline{\text{ALERT}}$ command; the $\overline{\text{ALERT}}$ pin of the GD30TS43XN series that does not return an address will remain active. Sending the SMBus alarm command again can continue to clear the $\overline{\text{ALERT}}$ pin of the GD30TS43XN series with the current lowest address.

The above process is detailed in Figure 6.

6.2.5 General Call Reset

The GD30TS43XN series respond to the two-wire general call address 00h. The device acknowledges the general call address and responds to commands in the second byte. If the second byte is 06h, the GD30TS43XN series resets the internal registers to the power-up reset values, and aborts the current temperature conversion and reset $\overline{\text{ALERT}}$ and $\overline{\text{THERM}}$ pins. If the second byte is other value, the GD30TS43XN series will not respond.

Writing any value to the soft reset register (FCh) of the GD30TS43XN series can also achieve a general call reset of the chip.

6.2.6 High-Speed Mode

The GD30TS43XN series support the two-wire bus to operate at frequencies above 400kHz, the host device must issue a high-speed mode host code (0000 1xxxb) as the first byte after a START condition to switch the bus to high-speed operation. the GD30TS43XN series device does not acknowledge this byte, but it does switch the input filters on the SDA and SCL and the output filters on the SDA to operate in High-Speed mode, allowing the bus to transmit data at frequencies up to 2.75MHz. After the High-Speed mode host code is issued, the host transmits a two-wire device address to initiate a data transfer operation. The bus continues to operate in high-speed mode until a STOP condition occurs on the bus. Upon receiving the STOP condition, the GD30TS43XN series switches the input and output filters back to fast-mode operation.

6.2.7 Time-Out Function

The GD30TS43XN series have a function to detect serial bus timeout. If SDA and SCL remain low for 32ms (typ.) between START and STOP signals, the GD30TS43XN series will reset its serial interface, release the bus and wait for a START signal. To avoid activating the timeout function, the SCL operating frequency should be more than 1kHz.

6.3 Register Description

Table 4. GD30TS431N Register List

POINTER ADDRESS		POR	BIT DESCRIPTIONS								REGISTER DESCRIPTIONS
READ	WRITE		D7	D6	D5	D4	D3	D2	D1	D0	
00	NA[1]	00	LT15	LT14	LT13	LT12	LT11	LT10	LT9	LT8	Local Temperature Register (High Byte)
01	NA	00	RT15	RT14	RT13	RT12	RT11	RT10	RT9	RT8	Remote Temperature Register (High Byte)
02	NA	80	BUSY	LHIGH	LLOW	RHIGH	RLOW	OPEN	RTHRM	LTHRM	Status Register
03	09	00	MASK	SD	$\overline{\text{AL}}$/TH	0	0	RANGE	0	0	Configuration Register 1
04	0A	07	0	0	0	0	R3	R2	R1	R0	Conversion rate Register
05	0B	55	LTH15	LTH14	LTH13	LTH12	LTH11	LTH10	LTH9	LTH8	Local Temperature High Limit Register (High Byte)
06	0C	00	LTL15	LTL14	LTL13	LTL12	LTL11	LTL10	LTL9	LTL8	Local Temperature Low Limit Register (High Byte)
07	0D	55	RTH15	RTH14	RTH13	RTH12	RTH11	RTH10	RTH9	RTH8	Remote Temperature High Limit Register (High Byte)
08	0E	00	RTL15	RTL14	RTL13	RTL12	RTL11	RTL10	RTL9	RTL8	Remote Temperature Low Limit Register (High Byte)
NA	0F	X[2]	X	X	X	X	X	X	X	X	One-shot Register
10	NA	00	RT7	RT6	RT5	RT4	RT3	RT2	RT1	RT0	Remote Temperature Register (Low Byte)
13	13	00	RTH7	RTH6	RTH5	RTH4	RTH3	RTH2	RTH1	RTH0	Remote Temperature High Limit Register (Low Byte)
14	14	00	RTL7	RTL6	RTL5	RTL4	RTL3	RTL2	RTL1	RTL0	Remote Temperature Low Limit Register (Low Byte)
15	NA	00	LT7	LT6	LT5	LT4	LT3	LT2	LT1	LT0	Local Temperature Register (Low Byte)
16	16	00	LTH7	LTH6	LTH5	LTH4	LTH3	LTH2	LTH1	LTH0	Local Temperature High Limit Register (Low Byte)
17	17	00	LTL7	LTL6	LTL5	LTL4	LTL3	LTL2	LTL1	LTL0	Local Temperature Low Limit Register (Low Byte)
18	18	00	NC7	NC6	NC5	NC4	NC3	NC2	NC1	NC0	η-factor Correction Register
19	19	55[3]	RTHL7	RTHL6	RTHL5	RTHL4	RTHL3	RTHL2	RTHL1	RTHL0	Remote THERM Limit Register
1A	1A	1C	0	0	0	REN	LEN	RC	0	0	Configuration Register 2
1F	1F	00	0	0	0	0	0	0	RMASK	LIMAS	Channel Mask Register
20	20	55[(3)]	LTHL7	LTHL6	LTHL5	LTHL4	LTHL3	LTHL2	LTHL1	LTHL0	Local THERM Limit Register

POINTER ADDRESS		POR	BIT DESCRIPTIONS								REGISTER DESCRIPTIONS
READ	WRAD		D7	D6	D5	D4	D3	D2	D1	D0	
21	21	0A	TH7	TH6	TH5	TH4	TH3	TH2	TH1	TH0	THERM Hysteresis Register
22	22	70	0	CTH2	CTH1	CTH0	CALT2	CALT1	CALT0	0	Consecutive Alert Register
25	25	08	0	0	0	0	BC3	BC2	BC1	BC0	Beta Range Register
NA	FC	00	X	X	X	X	X	X	X	X	Software Reset Register
FD	NA	31	0	0	1	1	0	0	0	1	GD30TS431N Device ID
FE	NA	55	0	1	0	1	0	1	0	1	Manufacturer ID Register

1. NA means that the register cannot be read or written.
2. X represents an arbitrary value.
3. The power-on initial value of the local/remote THERM threshold register (20h/19h) is different in various different chip models, see for details.

Table 5. GD30TS432N Register List

POINTER ADDRESS		POR	BIT DESCRIPTIONS								REGISTER DESCRIPTIONS
READ	WRITE		D7	D6	D5	D4	D3	D2	D1	D0	
00	NA[1]	00	LT15	LT14	LT13	LT12	LT11	LT10	LT9	LT8	Local Temperature Register (High Byte)
01	NA	00	RT15	RT14	RT13	RT12	RT11	RT10	RT9	RT8	Remote Temperature 1 Register (High Byte)
02	NA	80	BUSY	0	0	HIGH	LOW	OPEN	THERM	0	Status Register
03	09	00	MASK	SD	$\overline{\text{AL}}$/TH	0	0	RANGE	0	0	Configuration Register 1
04	0A	07	0	0	0	0	R3	R2	R1	R0	Conversion rate Register
05	0B	55	LTH15	LTH14	LTH13	LTH12	LTH11	LTH10	LTH9	LTH8	Local Temperature High Limit Register (High Byte)
06	0C	00	LTL15	LTL14	LTL13	LTL12	LTL11	LTL10	LTL9	LTL8	Local Temperature Low Limit Register (High Byte)
07	0D	55	RTH15	RTH14	RTH13	RTH12	RTH11	RTH10	RTH9	RTH8	Remote Temperature 1 High Limit Register (High
08	0E	00	RTL15	RTL14	RTL13	RTL12	RTL11	RTL10	RTL9	RTL8	Remote Temperature 1 Low Limit Register (High
NA	0F	X(2)	X	X	X	X	X	X	X	X	One-shot Register
10	NA	00	RT7	RT6	RT5	RT4	RT3	RT2	RT1	RT0	Remote Temperature 1 Register (Low Byte)
13	13	00	RTH7	RTH6	RTH5	RTH4	RTH3	RTH2	RTH1	RTH0	Remote Temperature 1 High Limit Register (Low
14	14	00	RTL7	RTL6	RTL5	RTL4	RTL3	RTL2	RTL1	RTL0	Remote Temperature 1 Low Limit Register (Low

POINTER ADDRESS		POR	BIT DESCRIPTIONS								REGISTER DESCRIPTIONS
READ	WRITE		D7	D6	D5	D4	D3	D2	D1	D0	
15	15	55	RTH15	RTH14	RTH13	RTH12	RTH11	RTH10	RTH9	RTH8	Remote Temperature 2 High Limit Register (High
16	16	00	RTL15	RTL14	RTL13	RTL12	RTL11	RTL10	RTL9	RTL8	Remote Temperature 2 Low Limit Register (High
17	17	00	RTH7	RTH6	RTH5	RTH4	RTH3	RTH2	RTH1	RTH0	Remote Temperature 2 High Limit Register (Low
18	18	00	RTL7	RTL6	RTL5	RTL4	RTL3	RTL2	RTL1	RTL0	Remote Temperature 2 Low Limit Register (Low
19	19	55	RTHL7	RTHL6	RTHL5	RTHL4	RTHL3	RTHL2	RTHL1	RTHL0	Remote 1 THERM Limit Register
1A	1A	55	RTHL7	RTHL6	RTHL5	RTHL4	RTHL3	RTHL2	RTHL1	RTHL0	Remote 2 THERM Limit Register
1B	NA	00	0	0	0	0	0	R2OPE	R1OPE	0	Open Status Register
1F	1F	00	0	0	0	0	0	R2MAS	R1MAS	LMASK	Channel Mask Register
20	20	55	LTHL7	LTHL6	LTHL5	LTHL4	LTHL3	LTHL2	LTHL1	LTHL0	Local THERM Limit
21	21	0A	TH7	TH6	TH5	TH4	TH3	TH2	TH1	TH0	THERM Hysteresis
22	22	70	0	CTH2	CTH1	CTH0	CALT2	CALT1	CALT0	0	Consecutive Alert Register
23	NA	00	RT15	RT14	RT13	RT12	RT11	RT10	RT9	RT8	Remote Temperature 2 Register (High Byte)
24	NA	00	RT7	RT6	RT5	RT4	RT3	RT2	RT1	RT0	Remote Temperature 2 Register (Low Byte)
25	25	08	0	0	0	0	BC3	BC2	BC1	BC0	Remote Channel 1 Beta Range Register
26	26	08	0	0	0	0	BC3	BC2	BC1	BC0	Remote Channel 2 Beta Range Register
27	27	00	NC7	NC6	NC5	NC4	NC3	NC2	NC1	NC0	Remote Channel 1 η-factor Correction
28	28	00	NC7	NC6	NC5	NC4	NC3	NC2	NC1	NC0	Remote Channel 2 η-factor Correction
29	NA	00	LT7	LT6	LT5	LT4	LT3	LT2	LT1	LT0	Local Temperature Register (Low Byte)
35	NA	00	0	0	0	0	0	R2HIG	R1HIG	LHIGH	High Limit Status Register
36	NA	00	0	0	0	0	0	R2LO	R1LO	LLOW	Low Limit Status Register
37	NA	00	0	0	0	0	0	R2THE	R1THE	LTHERM	THERM Status Register
3D	3D	00	LTH7	LTH6	LTH5	LTH4	LTH3	LTH2	LTH1	LTH0	Local Temperature High Limit Register (Low Byte)
3E	3E	00	LTL7	LTL6	LTL5	LTL4	LTL3	LTL2	LTL1	LTL0	Local Temperature Low

POINTER ADDRESS		POR	BIT DESCRIPTIONS								REGISTER DESCRIPTION
READ	WRITE		D7	D6	D5	D4	D3	D2	D1	D0	
3F	3F	3C	0	0	REN2	REN	LEN	RC	0	0	Configuration Register 2
NA	FC	00	X	X	X	X	X	X	X	X	Software Reset Register
FD	NA	32	0	0	1	1	0	0	1	0	GD30TS432N Device ID
FE	NA	55	0	1	0	1	0	1	0	1	Manufacturer ID Register

1. NA means that the register cannot be read or written.
2. X represents an arbitrary value.

6.3.1 Status Register

BUSY BIT (POR=0)

BUSY=1: The ADC inside the GD30TS43XN series is performing temperature conversion; please note that within 100µs after the power supply voltage is powered on, this bit automatically changes to 1, and the ADC inside the chip starts the first conversion.

BUSY=0: The ADC inside the GD30TS43XN series stops temperature conversion.

LHIGH /LLOW/RHIGH/RLOW BIT (POR=0)

The above 4 bits are only applicable to the GD30TS431N. The LHIGH/RHIGH bit is controlled by the bit in configuration register 1 $\overline{\text{AL/TH}}$, and the RHIGH/RLOW bit is only $\overline{\text{AL/TH}}$ valid when = 0.

When configuration register 1 $\overline{\text{AL/TH}}$ = 1, the chip is in the THERM2 alarm mode, and the status of the LHIGH/RHIGH bit is as follows:

LHIGH/RHIGH=1: The temperature measurement result of the local/remote channel is higher than the value of the local/remote high threshold register of the corresponding channel, and remains higher than the value of the local/remote high threshold register of the corresponding channel minus the THERM hysteresis register;

LHIGH/RHIGH=0: The temperature measurement result of the local/remote channel is lower than the value of the local/remote high threshold register of the corresponding channel minus the value of the THERM hysteresis register;

When configuration register 1 $\overline{\text{AL/TH}}$ = 0, the chip is in ALERT alarm mode, and the status of the LHIGH/LLOW/RHIGH/RLOW bits are as follows:

LHIGH/RHIGH=1: Since the last reset, the local/remote channel temperature measurement result is higher than the value of the local/remote high threshold register of the corresponding channel;

LHIGH/RHIGH=0: When the temperature measurement result of the local/remote channel is lower than the value of the local/remote high threshold register of the corresponding channel, the status register is read; the chip successfully responds to the SMBus alarm command; the chip is generally reset;

LLOW/RLOW=1: Since the last reset, the local/remote channel temperature measurement result is lower than the value of the local/remote low threshold register of the corresponding channel;

LLOW/RLOW=0: When the temperature measurement result of the local/remote channel is higher than the value of the local/remote low threshold register of the corresponding channel, the status register is read; the chip successfully responds to the SMBus alarm command; the chip is generally reset;

HIGH/LOW bit (POR=0)

The above 2 bits are only applicable to GD30TS432N and are controlled by the corresponding bits in the high threshold status register (35h) or the low threshold status register (36h), and meet the following conditions: HIGH = LHIGH OR R1HIGH OR R2HIGH; LOW = LLOW OR R1LOW OR R2LOW.

The LHIGH/R1HIGH/R2HIGH bits are controlled by the $\overline{\text{AL/TH}}$ bits in configuration register 1, and the LLOW/R1LOW/R2LOW bits are only valid when $\overline{\text{AL/TH}}$ = 0.

When configuration register 1 $\overline{\text{AL/TH}}$ = 1, the chip is in the THERM2 alarm mode, and the status of the LHIGH/R1HIGH/R2HIGH bits are as follows:

LHIGH/R1HIGH/R2HIGH=1: The temperature measurement result of the local/remote channel is higher than the value of the local/remote high threshold register of the corresponding channel, and remains higher than the value of the local/remote high threshold register of the corresponding channel minus the THERM hysteresis register;

LHIGH/R1HIGH/R2HIGH=0: The temperature measurement result of the local/remote channel is lower than the value of the local/remote high threshold register of the corresponding channel minus the value of the THERM hysteresis register;

When $\overline{\text{AL/TH}}$ =0, the chip is in ALERT alarm mode, and the status of the LHIGH/R1HIGH/R2HIGH/LLOW/R1LOW/R2LOW bits are as follows:

LHIGH/R1HIGH/R2HIGH=1: Since the last reset, the local/remote channel temperature measurement result is higher than the value of the local/remote high threshold register of the corresponding channel;

LHIGH/R1HIGH/R2HIGH=0: When the temperature measurement result of the local/remote channel is lower than the value of the local/remote high threshold register of the corresponding channel, the high threshold status register is read; the chip successfully responds to the SMBus alarm command; the chip is generally reset;

LLOW/R1LOW/R2LOW=1: Since the last reset, the local/remote channel temperature measurement result is lower than the value of the local/remote low threshold register of the corresponding channel;

LLOW/R1LOW/R2LOW=0: When the temperature measurement result of the local/remote channel is higher than the value of the local/remote low threshold register of the corresponding channel, the low threshold status register is read; the chip successfully responds to the SMBus alarm command; the chip is generally reset;

OPEN bit (POR=0)

The GD30TS43XN series detect the OPEN state of the corresponding remote channel only when the remote channel is turned on.

OPEN for GD30TS431N=1: The remote channel temperature probe is open since the last reset;

OPEN for GD30TS431N=0: Read the status register when the remote channel temperature probe is not open;

OPEN for GD30TS432N=1: Since the last reset, any remote channel temperature probe is open, and the corresponding position in the open status register (1Bh) is set to 1; OPEN = R1OPEN OR R2OPEN;

OPEN for GD30TS432N=0: When all remote channel temperature probes are not open, read the open status register and set R1OPEN/R2OPEN to 0; OPEN=R1OPEN OR R2OPEN;

RTHRM/LTHRM bit (POR=0)

The above 2 bits are only applicable to GD30TS431N.

RTHRM/LTHRM=1: The temperature measurement result of the local/remote channel is higher than the value of the local/remote THERM threshold register of the corresponding channel, and remains higher than the value of the local/remote THERM threshold register of the corresponding channel minus the THERM hysteresis register;

RTHRM/LTHRM=0: The temperature measurement result of the local/remote channel is lower than the value of the local/remote THERM threshold register of the corresponding channel minus the THERM hysteresis register;

THERM bit (POR=0)

This bit is only applicable to GD30TS432N and is controlled by the LTHERM/R1THERM/R2THERM bits in the THERM status register (37h) and satisfies THERM = LTHERM OR R1THERM OR R2THERM.

LTHERM/R1THERM/R2THERM =1: The temperature measurement result of the local/remote channel is higher than the value of the local/remote THERM threshold register of the corresponding channel, and remains higher than the value of the local/remote THERM threshold register of the corresponding channel minus the THERM hysteresis register;

LTHERM/R1THERM/R2THERM =0: The temperature measurement result of the local/remote channel is lower than the value of the local/remote THERM threshold register minus the THERM hysteresis register of the corresponding channel.

6.3.2 Configuration Register

The configuration register 1 of the GD30TS43XN series controls the conversion mode of the chip. Any write operation to this register will immediately terminate the current temperature conversion, and then the chip will restart a new conversion or enter shutdown mode (SD=1) according to the value written to this register.

Table 6. Description of the Configuration Register 1 Bit

Bit	Field	Default	Description
D7	MASK	0	1 = shield $\overline{\text{ALERT}}$ pin 0 = open $\overline{\text{ALERT}}$ pin (Only valid when $\overline{\text{AL/TH}}$=0)
D6	SD	0	1 = The chip enters shutdown mode 0 = The chip enters continuous conversion mode
D5	$\overline{\text{AL/TH}}$	0	1 = The chip enters THERM2 alarm mode 0 = The chip enters ALERT alarm mode
D 2	RANGE	0	1 = The chip enters extended temperature measurement mode 0 = The chip enters normal temperature measurement mode
D4/D3/D1/D0	Reserved	0	Reserved

The configuration register 2 of the GD30TS43XN series controls the enabling of the chip temperature measurement channel. Any write operation to this register will immediately terminate the current temperature conversion, and then the chip will restart a new conversion or enter shutdown mode (LEN=REN=REN2=0) according to the value written to this register.

Table 7. Description of the Configuration Register 2 Bit

Bit	Field	Default	Description
D5	REN2	0 (GD30TS431N) 1 (GD30TS432N)	1 = Remote temperature measurement channel 2 is enabled 0 = Remote temperature measurement channel 2 is off
D4	REN	1	1 = Remote temperature measurement channel 2 is enabled 0 = Remote temperature measurement channel 2 is off
D3	LEN	1	1 = Local temperature measurement channel 2 is enabled 0 = Local temperature measurement channel 2 is turned off
D2	RC	1	1 = Series resistance cancellation function enabled 0 = Series resistance cancellation function off
D7/D6/D1/D0	Reserved	0	Reserved

6.3.3 β Compensation Register

GD30TS43XN series can automatically detect the β value of the PNP connected in the form of a transistor for remote temperature measurement, and compensate for different β values to avoid the influence of the β value on the remote temperature measurement accuracy. For details, see section 6.1.5. The GD30TS43XN series can compensate for the β value in the range of 0.09＜β＜21.36. The specific register configuration of Table 8.

In particular, when the chip is configured in manual β compensation mode, the left boundary of the interval given in Table 8 defines the maximum compensation range that the corresponding configuration word can support. Taking the selected PNP transistor β = 1 as an example, manually configuring the β compensation register to 0000~0100 can achieve β compensation for the PNP transistor, but configuring it to 0100 can obtain the best temperature measurement result.

If the selected remote temperature measurement transistor is connected in the form of a diode, in order to avoid causing a large temperature measurement error, it is recommended to use a transistor model with β>50 and configure the β compensation register to 0111.

Table 8. Description of the β Compensation Register Bit

BCx3 ~ BCx0	BETA RANGE DESCRIPTION	η -FACTOR	CONV TIME
1000	Automatically select β interval: 0.09＜β＜0.20	1.000	126ms
1001	Automatically select β interval: 0.18＜β＜0.26	1.000	126ms
1010	Automatically select β interval: 0.24＜β＜0.38	1.000	126ms
1011	Automatically select β interval: 0.35＜β＜0.72	1.000	126ms

BCx3 ~ BCx0	BETA RANGE DESCRIPTION	η -FACTOR	CONV TIME
1100	Automatically select β interval: 0.64<β<1.68	1.000	126ms
1101	Automatically select β interval: 1.47<β<10.03	1.000	126ms
1110	Automatically select β interval: 6.83<β<61.90	1.000	126ms
1111	Automatically select β interval: β>21.36	1.000	126ms
1111	Automatically detect the diode connection	1.008	93ms
0000	Manual selection of β interval: 0.09<β<0.20	1.000	93ms
0001	Manual selection of β interval: 0.18<β<0.26	1.000	93ms
0010	Manual selection of β interval: 0.24<β<0.38	1.000	93ms
0011	Manual selection of β interval: 0.35<β<0.72	1.000	93ms
0100	Manual selection of β interval: 0.64<β<1.68	1.000	93ms
0101	Manual selection of β interval: 1.47<β<10.03	1.000	93ms
0110	Manual selection of β interval: 6.83<β<61.90	1.000	93ms
0111	Manually turn off the beta compensation function	1.008	93ms

6.3.4 η Factor Correction Register

The GD30TS43XN series support remote temperature measurement using remote temperature probes with different η factors. When the β compensation register is configured to 0111 or the chip automatically detects that the remote temperature probe is in diode connection, the default η factor inside the chip is 1.008; when the chip automatically or manually turns on the β compensation function, the default η factor inside the chip is 1.000. In actual use, the η factor correction register should be correctly configured to avoid unnecessary temperature measurement errors.

η factor correction register is shown in Table 9; where η_{eff} is the η factor value of the remote temperature probe actually used, N is the value of the η factor correction register, and negative values are represented in binary complement form, with a trimming range of -128 to +127. When the default value of the η factor or $\eta_{default}$ = 1.008, the corresponding relationship between the two is shown in the following Equation(1):

$$\eta_{eff}=\frac{1.008\times 270}{270-N} \quad N=270-\frac{1.008\times 270}{\eta_{eff}} \tag{1}$$

When the default value of the η factor or $\eta_{default}$ = 1.000, the corresponding relationship between the two is shown in the following Equation(2):

$$\eta_{eff}=\frac{1.000\times 270}{270-N} \quad N=270-\frac{1.000\times 270}{\eta_{eff}} \tag{2}$$

Table 9. Description of the η Factor Correction Register Bit

N			η eff	
BINARY	HEX	DECIMAL	$\eta_{default}$ =1.008	$\eta_{default}$ =1.000
0111 1111	7F	127	1.903217	1.888112
0000 1010	0A	10	1.046769	1.038462
0000 1000	08	8	1.038779	1.030534
0000 0110	06	6	1.030909	1.022727
0000 0100	04	4	1.023158	1.015038
0000 0010	02	2	1.015522	1.007463
0000 0001	01	1	1.011747	1.003717
0000 0000	00	0	1.008 (default)	1.000 (default)
1111 1111	FF	−1	1.004280	0.996310
1111 1110	FE	−2	1.000588	0.992647
1111 1100	FC	−4	0.993285	0.985401
1111 1010	FA	−6	0.986087	0.978261
1111 1000	F8	−8	0.978993	0.971223
1111 0110	F6	−10	0.972000	0.964286
1000 0000	80	−128	0.683819	0.678392

6.3.5 Conversion Rate Register

The GD30TS43XN series can change the frequency of temperature measurement result refresh by configuring the conversion rate register. This register controls the idle time between two adjacent conversions, rather than the conversion time itself. The specific configuration of the conversion rate register is shown in Table 10. In particular, if the time of a conversion is too long and exceeds the time corresponding to the conversion rate shown in the table, then under this register configuration, there will be no idle time between two adjacent conversions.

Taking the GD30TS432N as an example, the default conversion after power-on consists of one local temperature conversion and two remote temperature conversions, and its typical conversion time is 1*15ms+2*126ms=267ms. At this time, the initial value of the chip's conversion rate register is 07h, and the default conversion is 8 times per second. In theory, each conversion takes 125ms, which is significantly less than the actual conversion time of the chip. At this time, the GD30TS432N will automatically skip the idle state between two adjacent conversions.

Table 10. Description of the Conversion Rate Register Bit

R7	R6	R5	R4	R3	R2	R1	R0	CONVERSION PER SEC
0	0	0	0	0	0	0	0	0.0625
0	0	0	0	0	0	0	1	0.125
0	0	0	0	0	0	1	0	0.25
0	0	0	0	0	0	1	1	0.5
0	0	0	0	0	1	0	0	1

R7	R6	R5	R4	R3	R2	R1	R0	CONVERSION PER SEC
0	0	0	0	0	1	0	1	2
0	0	0	0	0	1	1	0	4
07h to 0Fh								8

6.3.6 Continuous Alarm Register

This register can control the number of over-temperature times required for the GD30TS43XN series to activate $\overline{\text{THERM}}$ and $\overline{\text{ALERT}}$ / $\overline{\text{THERM2}}$ pins, so as to avoid the chip temperature measurement results shaking near the corresponding alarm threshold, thus causing the chip to repeatedly activate the alarm mode. The specific configuration of this register is shown in Table 11.

Table 11. Description of the Continuous Alarm Register Bit

CALT2/CTH2	CALT1/CTH1	CALT0/CTH0	Number of Over-Temperature Times Required to Activate the Alarm Pin
0	0	0	1
0	0	1	2
0	1	1	3
1	1	1	4

6.3.7 Threshold Register

The GD30TS43XN series can compare the temperature measurement results of each channel with different threshold registers according to the user configuration, thus achieving different alarm functions, as shown in section 6.1.8.

The high and low threshold registers of each channel of the GD30TS43XN series are in 2Byte, 16bit data format, which are used in THERM2 and ALERT alarm modes. Their resolution is the same as that of the temperature registers of each channel, which is 0.00390625°C, and bit to bit data comparison can be achieved. The THERM threshold registers of each channel of the GD30TS43XN series are in 1Byte, 8bit data format, which are used in THERM alarm mode. Their resolution is 1°C, and only the high byte of the corresponding temperature register is compared during data comparison.

The power-on initial values of the THERM threshold registers of different models of chips in the GD30TS43XN series are shown in

Table 12.

Table 12. Power-on Initial Value of the THERM Limit Registers

NO.	POR VALUE of THERM LIMIT REGISTER
GD30TS431NWMTR-IAA	55h
GD30TS431NWMTR-IBA	
GD30TS431NWMTR-ICA	
GD30TS431NWMTR-IDA	
GD30TS431NWMTR-IAB	69h
GD30TS431NWMTR-IBB	
GD30TS431NWMTR-ICB	
GD30TS431NWMTR-IDB	
GD30TS432NAMTR-IA0/SA0	55h
GD30TS432NAMTR-IB0/SB0	
GD30TS432NAMTR-IC0/SC0	
GD30TS432NAMTR-ID0/SD0	

In particular, configuring the chip to the extended temperature measurement mode only changes the data format of each temperature register, but does not affect each threshold register. To achieve the expected alarm function, please configure each threshold register correctly.

7 Application Information

The following contents are the precautions for the GD30TS43XN recommended by GD. in practical applications. Customers are responsible for determining suitability of components for their purposes based on their own usage needs and application scenarios. Customers should test and verify their design implementation to confirm system functionality and avoid losses.

When users use PNP connected in the form of transistors for remote temperature measurement, the GD30TS43XN series provide β value detection and automatic compensation functions to obtain accurate remote temperature measurement results. The range of compensation for PNP connected in the form of transistors by the GD30TS43XN series is $0.09 < \beta < 21.36$. When users use PNP or NPN connected in the form of diodes for remote temperature measurement, regardless of the configuration of the β compensation register, the chip will automatically detect the diode connection form and shut down the internal β compensation circuit. Therefore, if you need to use PNP or NPN connected in the form of diodes for remote temperature measurement, or manually configure the β compensation register to 0111, you should select the correct transistor used. The selection criteria are as follows:

- At the highest measured temperature and bias current of 6μA , $V_{BE} > 0.25$ V;
- At the lowest measured temperature and bias current of 120μA , $V_{BE} < 0.95$ V;
- Base resistance < 100 Ω;
- The range of β value should be as small as possible (50 ~ 150);

Based on the above standards, the recommended remote temperature probe model is 2N3904 (NPN) or 2N3906 (PNP).

The RC bit in the GD30TS43XN series configuration register 2 can realize the remote series resistance elimination function. By configuring this function, the remote temperature measurement accuracy can be significantly improved. In some applications, in order to improve the temperature measurement efficiency of the remote channel, the RC bit can be written to 0 and the remote series resistance elimination function can be turned off, thereby shortening the single remote temperature measurement time to about 50% of the original. However, this will greatly reduce the remote temperature measurement accuracy. Users need to compromise between conversion time and temperature measurement accuracy according to their own needs.

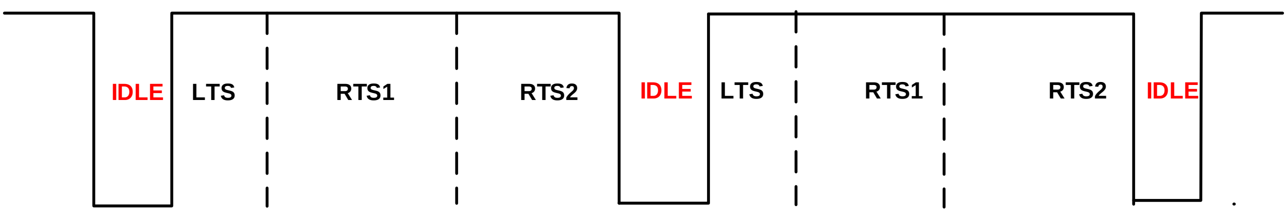


Figure 7. Conversion Cycle and Idle Time

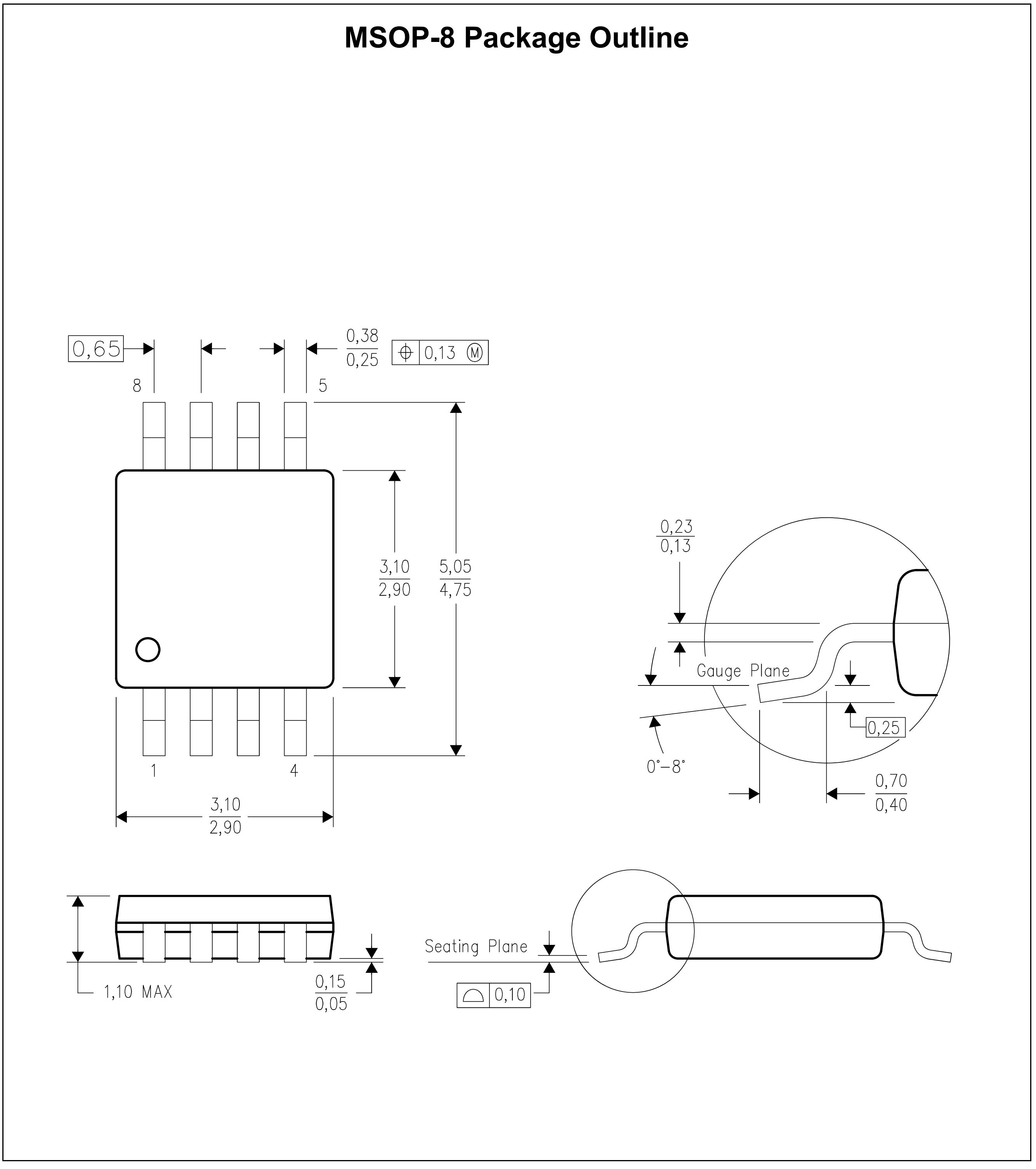
The conversion rate register of the GD30TS43XN series controls the conversion rate of the chip by adjusting the idle time between two adjacent conversions, as shown in Figure 7.When the GD30TS43XN series are configured to different conversion rates, the average current of the chip in the continuous conversion mode also changes accordingly. The calculation formula of the average current is shown in the following Equation(3).

$$I_{AVER} = \frac{I_{LTS} * T_{LTS} * LEN + I_{RTS} * T_{RTS1} * REN1 + I_{RTS} * T_{RTS2} * REN2 + I_{IDLE} * T_{IDLE}}{T_{LTS} * LEN + T_{RTS1} * REN1 + T_{RTS2} * REN2 + T_{IDLE}} \quad (3)$$

Among them, ILTS, IRTS, IIDLE are the static currents of the chip in local conversion, remote conversion, and idle state. Among them, T_{LTS}, T_{RTS1}, T_{RTS2}, T_{IDLE} are the time of the chip in local channel conversion, remote channel 1 conversion, remote channel 2 conversion, and idle state; the typical value of T_{LTS} is 15ms, and the values of T_{RTS1} and T_{RTS2} are controlled by the β compensation register and the RC bit in the configuration register 2; the value of T_{IDLE} is controlled by the conversion rate register. Among them, LEN, REN1, and REN2 are the enable bits of each channel in the configuration register 2. If a channel is not enabled, the above bit value is 0, and the channel does not participate in the calculation of the average current formula. For details of all the above parameters, please refer to section 5.4.

8 Package Information

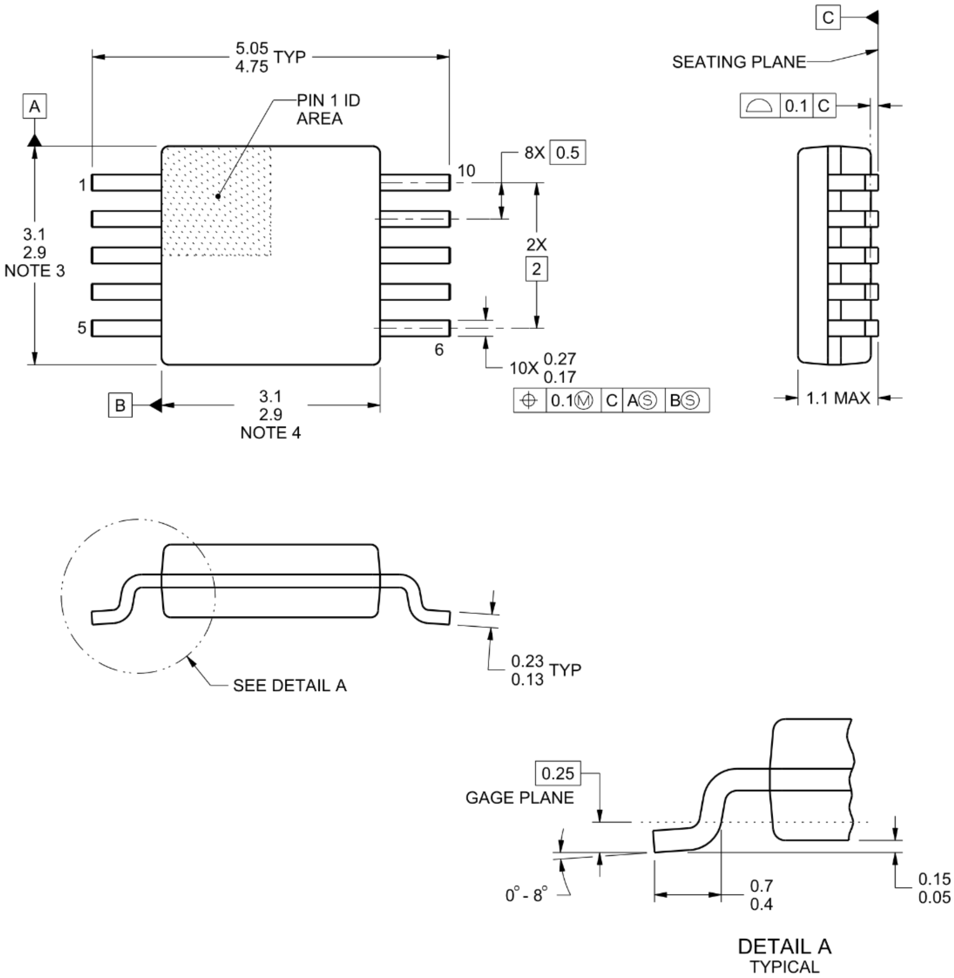
8.1 Outline Dimensions



NOTES:

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

MSOP-10 Package Outline



NOTES: (Continued)

1. All dimensions are in millimeters.

9 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30TS431NWMTR-IAA	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-IBA	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-ICA	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-IDA	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-IAB	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-IBB	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-ICB	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS431NWMTR-IDB	MSOP-8	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-IA0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-IB0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-IC0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-ID0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-SA0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-SB0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-SC0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C
GD30TS432NAMTR-SD0	MSOP-10	Green	Tape & Reel	4000	−55°C to +150°C

10 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024
1.1	Add GD30TS432NAMTR-SA0/SB0/SC0/SD0	2025

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