GXHT3W Temperature and Humidity Sensor IC

1 Features

- 1 Wire protocol compatibility
- Wide supply voltage range (2.4 V ~ 5.5 V)
- DFN8 package (2.5×2.5×0.9mm^3)
- Typical accuracy: humidity±3%RH, temperature ±0.3℃
- Factory calibrated, support reflow soldering
- With multi-point distributed temperature and humidity measurement function
- With user-defined non-volatile temperature alarm settings

2 Applications

- Communication equipment
- Photovoltaic energy storage
- Consumer electronics
- Cold chain transportation
- Smart home
- Smart agriculture



Figure 1. Chip Rendering

3 Description

The GXHT3W is a new generation of single-chip integrated temperature and humidity sensor, which integrates high-sensitivity MEMS humidity-sensitive components on silicon-based CMOS wafers, thereby reducing signal transmission interference, reducing device area and improving product reliability. The GXHT3W uses 1-Wire protocol to communicate with the host computer, only one signal wire and one ground wire are needed. It has a temperature measurement range of -45°C ~ +130°C. The test accuracy in the range of -40°C ~ +90°C is ±0.3°C. In addition, it can also work in parasitic mode and supply power to the device directly through the signal line, no additional power supply is required. Each GXHT3W has a globally unique 64-bit serial number. Multiple GXHT3Ws can be connected in series on the same 1-Wire for networking. One processor can control multiple GXHT3Ws distributed in a large area. This networking method is especially suitable for HVAC environmental control, construction, equipment, grain condition and industry, and process temperature and humidity monitoring and control.

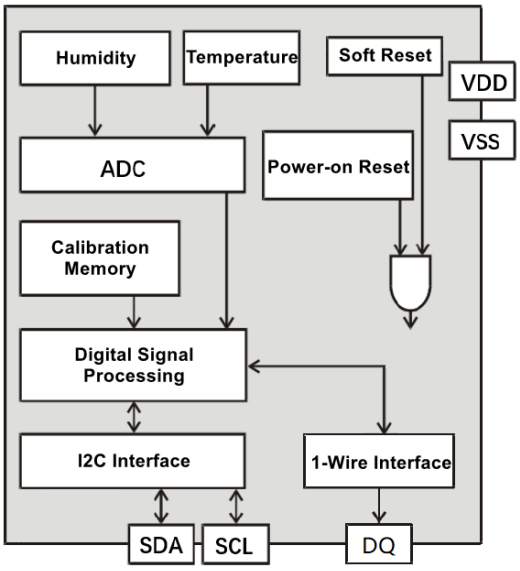


Figure 2. The GXHT3W block diagram

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4 Sensor Performance

Each sensor is individually calibrated, and the reference instrument has passed the metrological calibration of ISO/IEC17025 certified laboratory.

Table 1. Humidity sensor performance index

Parameter	Condition	Value	Units
Accuracy	Typ.	±3.0	%RH
	Max.	See Figure 3	-
Resolution	-	0.01	%RH
Hysteresis	-	±1.0	%RH
Range	-	0-100	%RH
Response Time	τ63%	8	s
Long Term Drift	Typ.	<0.5	%RH/y

Table 2. Temperature sensor performance index

Parameter	Condition	Value	Units
Accuracy	Typ.	±0.3	℃
	Max.	See Figure 5	-
Resolution	-	0.015	℃
Hysteresis			
Range	-	-45 to +130	℃
Response Time	τ63%	< 5-30	s
Long Term Drift	Typ.	<0.02	℃/y

Temperature and humidity sensor performance diagram

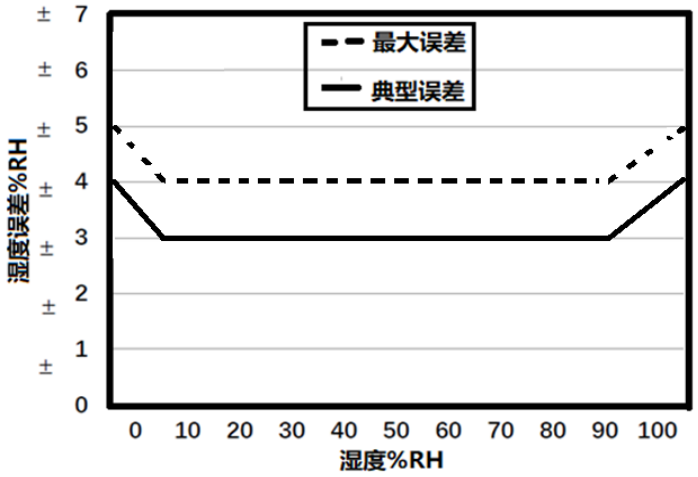


Figure 3. Tolerance of RH at 25°C for GXHT3W

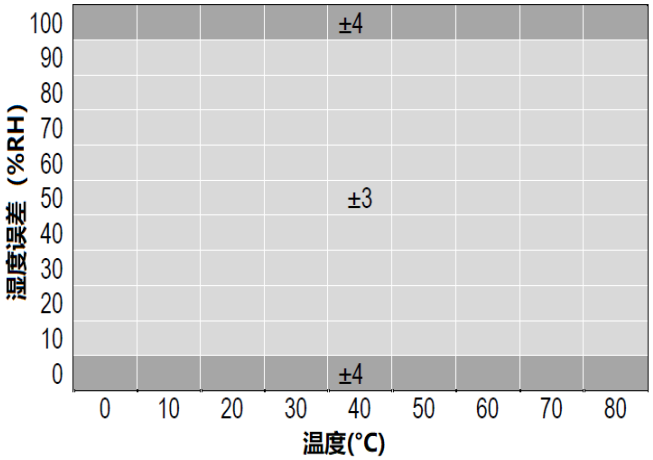


Figure 4. Typical errors in relative humidity at different temperature

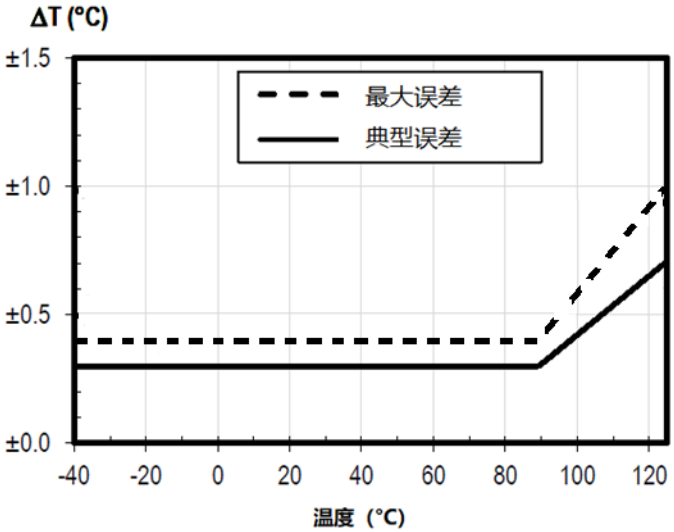


Figure 5. Temperature accuracy of GXHT3W

Recommended Operating Condition

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 at high humidity, may temporarily shift the relative humidity signal. After returning to normal temperature and humidity ranges, the sensor will slowly return to calibration state by itself.

5 Specifications

5.1 Electrical Characteristic Parameters

Table 3. Electrical characteristic parameters（@25℃, 3.3V）

Parameter	Symbol	Condition	Min	Typ	Max	Uni	Comments
Supply Voltage	V_{DD}		2.4	3.3	5.5	V	-
Power-on Reset Voltage	V_{POR}	DC Power Supply	1.3	1.4	1.5	V	-
Current	I_{DD}	Idle State	-	0.2	2.0	μA	Device is in idle state after power up, unless a measurement command is sent
		Measurement State	-	600	1000	μA	Average power consumption when the device is measured
		Average Value	-	2	-	μA	
Input Low Level	V_{IL}	-	-	-	$0.42V_{DD}$	V	
Input High Level	V_{IH}	-	-	$0.7V_{DD}$	-	V	
Output Low Level	V_{OL}	3mA Current Sink	-	-	$0.2V_{DD}$	V	

5.2 Absolute Maximum Ratings

Table 4. Absolute maximum ratings

Parameter	Rated Values	UNIT
Supply Voltage V_{DD}	-0.3 to +6	V
Operating Temperature Range	-45 to 130	℃
Storage Temperature Range	-45 to 130	℃
ESD HBM (human body model)	-4 to +4	kV
ESD CDM (charge device model)	-500 to +500	V
Latch up，JESD78 Class Ⅱ，125° C	-100 to +100	mA

Note：Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device, sensor performance can't be guaranteed under these extreme conditions.

5.3 Sensor System Timing

Table 5. Sensor system timing parameters（@ 25℃ ， 3.3V）

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Comments
Power Up Time	t_{PU}	After hard reset, $V_{DD} > V_{POR}$	-	500	1000	μs	The time from power-on to when the voltage value reaches VPOR.
Soft Reset Time	t_{SR}	After soft reset	-	500	1000	μs	The time from the receipt of the ACK signal of the soft reset to the time when the device enters the idle state.

Measure Time	$t_{MEAS,l}$	Low repetition rate	-	2.5	4	ms	Temperature and humidity conversion duration.
	$t_{MEAS,m}$	Medium repetition rate	-	4.5	6	ms	
	$t_{MEAS,h}$	High repetition rate	-	12.5	15.5	ms	

5.4 Communication Timing

Table 6. 1-Wire communication timing description（@ 25℃ ， 3.3V）

Parameter	Symbol	Condition	MIN	TYP	MAX	Unit	Remark
Time Slot	t_{SLOT}		60		120	μs	1
Recovery Time	t_{REC}		1			μs	1
LOW Time to Write 0	t_{LOW0}		60		120	μs	1
LOW Time to Write 1	t_{LOW1}		1		15	μs	1
Read Data Valid Time	t_{RDV}				15	μs	1
Reset HIGH Duration	t_{RSTH}		480			μs	1
Reset LOW Duration	t_{RSTL}		1			ms	1
Detect HIGH Propagation Time	t_{PDHIGH}		15		60	μs	1
Detect LOW Propagation Time	t_{PDLOW}		60		240	μs	1
Load Capacitance	C_{INOUT}				25	pF	1

Remark 1: See timing figure

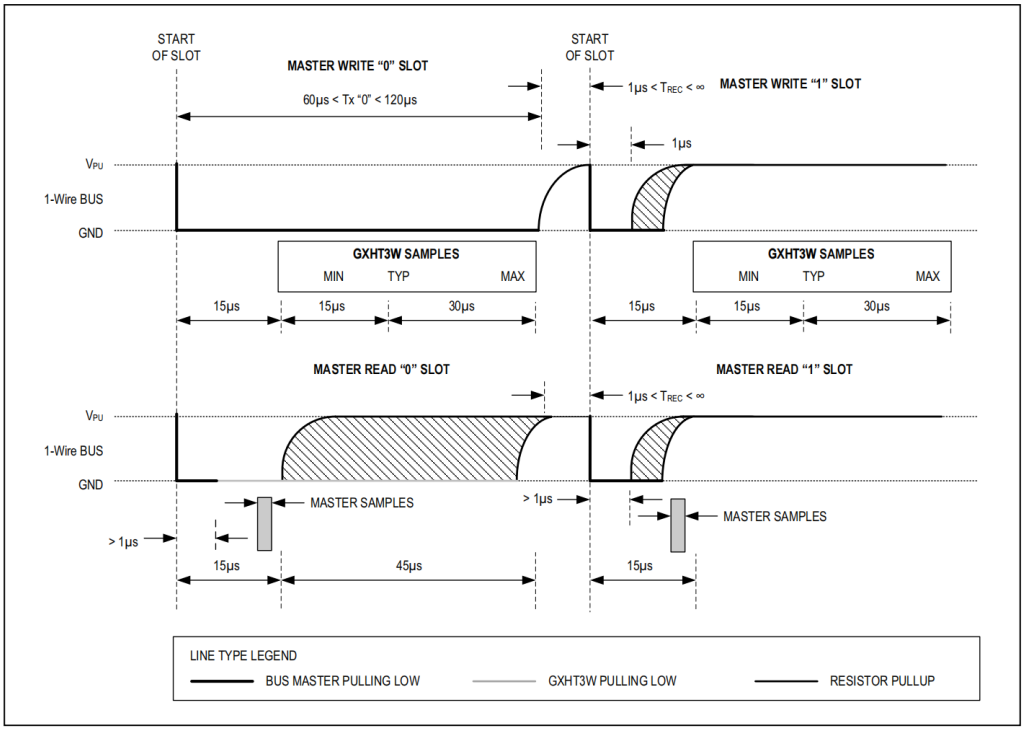
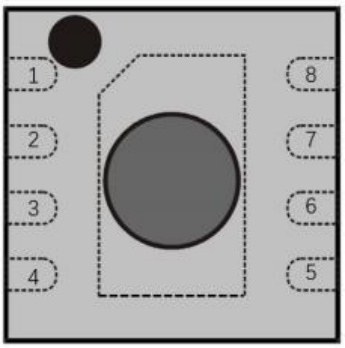


Figure 6. 1-Wire communication timing description

6 Pin Assignment

DFN-8 TOP VIEW



Note：Dashed lines are only visible viewed from below.
The middle pad is internally connected to V_{SS}

Table 7. Pin Assignment

Pin	Name	Description
1	No use	Data transmission line in I2C communication mode
2	No use	Grounded
3	No use	Grounded
4	No use	Clock line in I2C communication mode
5	V_{DD}	Power supply
6	DQ	Data transmission line in 1-Wire communication mode
7	No use	Grounded
8	GND	Ground

The GXHT3W can work without external power supply in 1-Wire mode. When the bus is in the high-level state, DQ is connected to the pull-up resistor to power the device through 1-Wire. At the same time, the bus signal in the high-level state charges the internal capacitor (Cpp). When the bus is in the low-level state, the capacitor provides energy to the device, and the way of providing energy becomes a "parasitic power supply". Of course, the GXHT3W can be powered by an external power supply through the V_{DD} pin.

7 Operation and Communication

7.1 1-Wire Mode Instructions

When the GXHT3W is in 1-Wire communication mode, it communicates through a 1-Wire DQ port. When all devices are connected to the bus via a tri-state port or open-drain port, the control line needs to be connected to a weak pull-up resistor. In this bus system, the microprocessor (master) relies on each device's unique 64-bit chip serial

number to identify devices on the bus and record the device address on the bus. Since each device has a unique chip serial number, the number of devices that can be connected to the bus is virtually unlimited.

7.1.1 Temperature and Humidity Measurement

The core function of the GXHT3W is direct digital temperature and humidity output. The temperature and humidity resolution are 12-bit and 16-bit respectively. After the GXHT3W is started, it keeps low power consumption waiting state; when it needs to perform temperature and humidity measurement and AD conversion, the bus controller must issue [44h] command. After that, the generated temperature data is stored in the temperature register in the form of two bytes, the generated humidity data is stored in the humidity register, and the GXHT3W continues to keep the waiting state. When the GXHT3W is powered by an external power supply, the bus controller initiates a "read sequence" after the temperature and humidity conversion command (see the 1-Wire system section), the GXHT3W returns 0 during the temperature and humidity conversion, and returns 1 when the conversion is over. There will be no return value unless the bus is pulled high by a strong pull-up when entering the temperature and humidity conversion. The bus requirements for parasitic power are explained in detail in the GXHT3W Power Supply section.

7.1.2 Alarm Operation

After the GXHT3W completes a temperature and humidity conversion, it uses the temperature value stored in the TH and TL registers (as shown in Figure 9) to compare with a user-defined alarm threshold of one byte. The flag bit (S) indicates the positive and negative of the temperature value: positive number S=0, negative number S=1. The TH and TL registers are non-volatile (EEPROM), so the data remains after power off. The memory section explains how TH and TL are stored in the 2nd and 3rd bytes of the register.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
S	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Figure 7. T_H and T_L register format

When T_H and T_L are 8-bit registers, only Bit 4 to 11 of the temperature registers are used in comparisons with T_H and T_L. If the measured temperature is higher than T_H or lower than T_L, the alarm condition is established, and an alarm flag will be set inside the GXHT3W. Make an update to this sign without taking a temperature measurement. Therefore, if the alarm condition disappears, the flag will be turned off after the next temperature transition.

The bus controller detects all GXHT3W alarm flags on the bus by issuing the alarm search command [ECh]. Any GXHT3W with alarm flag will respond to this command, so the bus controller can pinpoint each GXHT3W that meets

the alarm condition. If the alarm condition is true and the setting of T_H or T_L has been changed, another temperature conversion will reconfirm the alarm condition.

7.2 1-Wire Powered Mode

The GXHT3W can be powered by an external power supply through the V_{DD} pin, or it can work in parasitic power mode. The parasitic power mode allows the GXHT3W to operate without external power. Parasitic power modes are useful in long-distance testing or space-constrained applications. This parasitic power control loop "steals" energy from the bus when it is high. Part of the energy is stored in the parasitic power storage capacitor (C_{PP}), which is released for device when the bus is low. When the GXHT3W is in parasitic power mode, the V_{DD} pin must be grounded.

In parasitic power mode, the 1-Wire bus and C_{PP} can supply enough current to the GXHT3W to meet the specified timing and voltage in most operations. However, when the GXHT3W is performing temperature conversions or transferring data from registers to EEPROM, the operating current is 1.5mA. This current can cause an unacceptable voltage drop across weak pull-up resistors connected to the 1-Wire bus, requiring more current than the C_{PP} can provide. To ensure that the GXHT3W has enough power supply, when performing temperature conversion or copying data to the EEPROM operation, a strong pull-up must be provided for the 1-Wire bus by directly pulling the bus to the power supply by MOSFET, as shown in Figure 8. After issuing the temperature conversion command [44h] or the copy register command [48h], the 1-Wire bus must be converted to a strong pull-up within 10us, and the temperature conversion timing (tvov) or copy data timing (ter=10ms) must be always maintain a strong pull-up state. When the strong pull-up state is maintained, no other actions are allowed.

Another way to power the GXHT3W is to connect an external power supply from the V_{DD} pin conventionally, as shown in Figure 9. The advantage of this method is that the 1-Wire bus does not need a strong pull-up, and the bus does not always remain high during temperature conversion. For temperatures higher than 100°C, the use of parasitic power supplies is not recommended, because the GXHT3W exhibits relatively large leakage currents at such temperatures, and communication may not be possible. In the case of temperature like this, it is highly recommended to use the V_{DD} pin of GXHT3W for power supply. If the bus controller does not know whether the GXHT3W on the bus is using a parasitic power supply or an external power supply, the GXHT3W has prepared a schematic diagram of the use of a signal indicating the power supply. The bus controller sends a Skip ROM command [CCh], and then sends a power command [B4h]. After this command is sent, the controller sends a read sequence command, the parasitic power will pull the bus low, and the external power will keep the bus as high. If the bus is pulled low, the bus controller knows to provide a strong pull-up on the 1-Wire bus during temperature transitions.

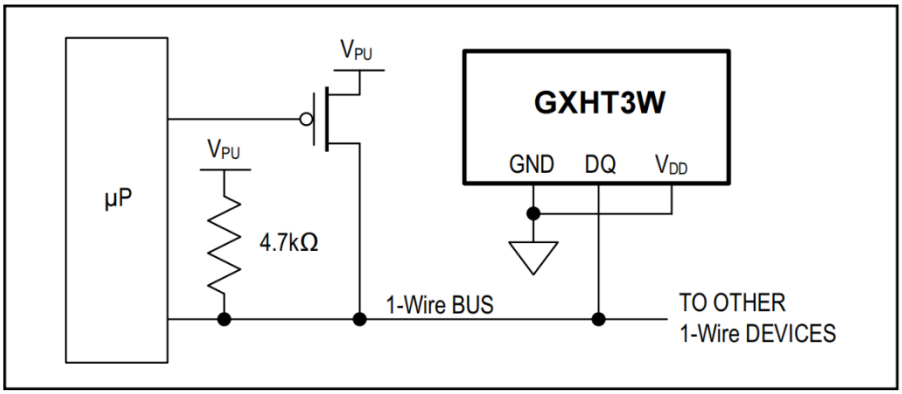


Figure 8. Parasitic power supply scheme during temperature conversion

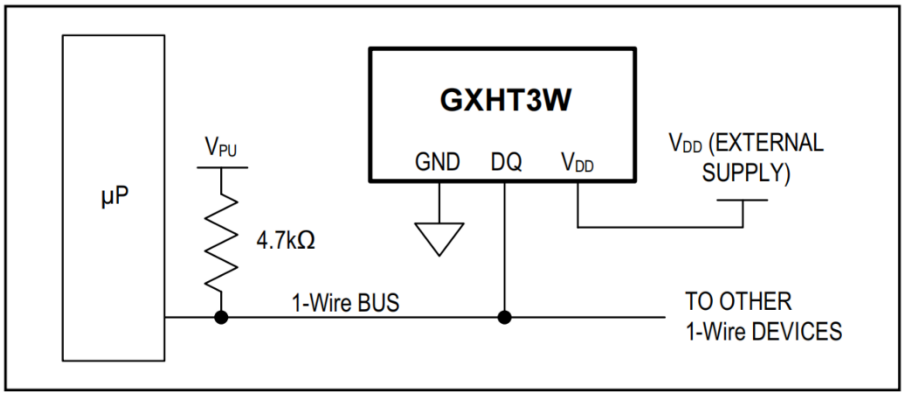


Figure 9. Single bus external power supply scheme

7.3 1-Wire ROM

Each GXHT3W has a globally unique 64-bit code stored in ROM. The first 8 bits are the 1-Wire serial code: 28h. The next 48 bits are a unique serial number. The last 8 bits are the CRC encoding of the above 56 bits. See the CRC Generator section for a detailed explanation of CRC. The 64-bit ROM and ROM operation control area allow the GXHT3W to operate as a 1-Wire device and according to the 1-Wire protocol detailed in the 1-Wire System section.

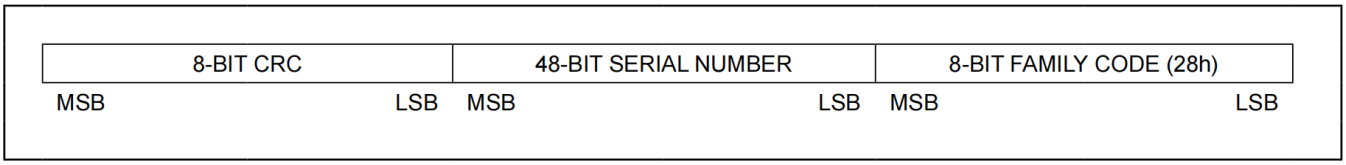


Figure 10. 64-bit ROM code

7.4 Memory

The memory structure of the GXHT3W is shown in Figure 11. The memory consists of a scratchpad SRAM and a non-volatile electrically erasable EEOROM that stores T_H and T_L. Note that when the alarm function can't be used, the T_H and T_L registers can be used as normal registers. All memory instructions are detailed in the GXHT3W Function Command section.

The Byte 0 and Byte 1 of the memory are the LSB and MSB of the temperature register respectively, and the memory of these two bytes is a read-only memory. The 2nd and 3rd bytes are T_H and T_L. The 4th byte is the configuration register data, which is detailed in the Configuration Registers section. The 5th byte is reserved by the device and can't be written; the 6th and 7th bytes are the LSB and MSB of the humidity register respectively.

The 8th byte of memory is read-only and contains the CRC code for the above 8 bytes, performed as described in the CRC Generator section.

Data is written to Bit 2, 3, 4, 6 and 7 of the memory by the write register instruction [4Eh]; data must be transferred starting with the 2nd byte as the LSB. For complete verification of the data, the memory can be read after the data has been written (using the read register instruction [BEh]). When a register is read, data is shifted out on 1-Wire with Byte 0 as the LSB. The bus controller must issue the copy register instruction [48h] when transferring T_H, T_L and configuration data from registers to EEPROM.

The data in the EEPROM memory persists after the device is powered off; upon power up, the data is loaded into the registers. Data can also be loaded from the registers into the EEPROM with the Recall EEPROM command. The bus controller issues a read sequence after issuing this command, the GXHT3W returns 0 to indicate that it is recalling, and returns 1 to indicate that the operation is over.

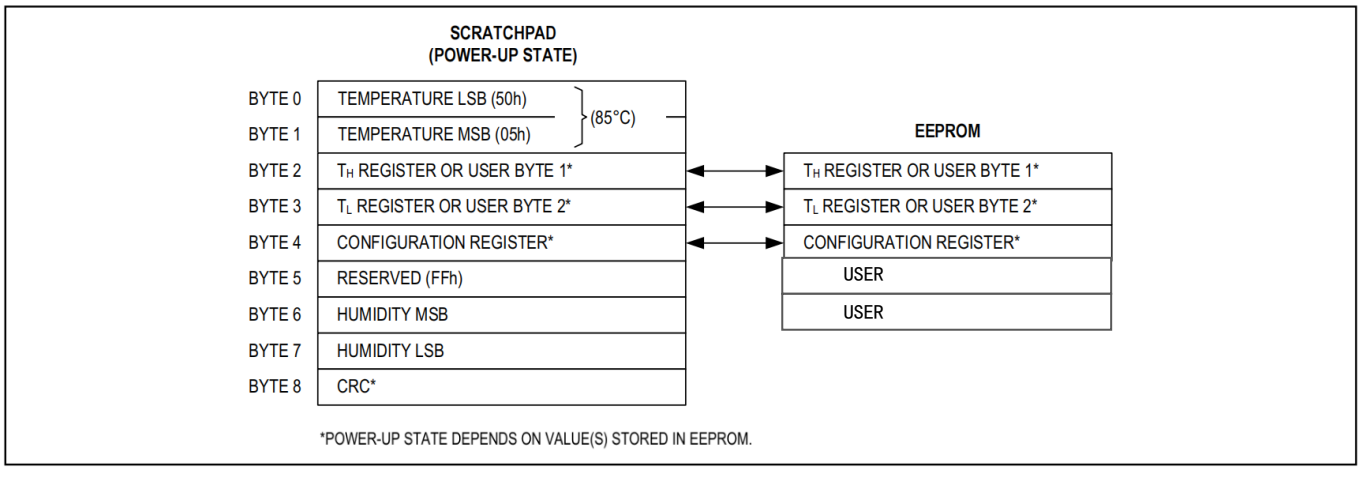


Figure 11. Memory accessible by the GXHT3W in 1-Wire mode

Byte 0 and Byte 1 store temperature data, its lower 12 bits are valid. Byte 6 and Byte 7 store humidity data. The conversion relationship between them and the real temperature and humidity is as follows:

Temperature conversion formula:

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

Humidity conversion formula:

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

S_{RH} and S_T represent the original codewords of humidity and temperature (lower 12 bits) output by the temperature and humidity sensor chip, respectively. Note that S_{RH} and S_T must be converted to decimal numbers in formula calculations.

7.5 CRC Generator

The CRC is stored in memory as part of the GXHT3W 64-bit ROM. The CRC code is calculated from the first 56 bits of the ROM and is included in the significant bytes of the ROM. The CRC is calculated from the data stored in the memory, so when the data in the memory changes, the CRC value also changes.

CRC enables data verification when the bus controller reads the GXHT3W. To verify whether the data is read correctly, the bus controller must calculate a CRC value from the received data and the value stored in the 64-bit ROM of the GXHT3W (when reading the ROM) or the 8-bit CRC value calculated inside the GXHT3W (when reading a register) to compare. If the calculated CRC value matches the read CRC value, the data is transmitted error-free. The comparison of the CRC values and whether to proceed further is entirely at the discretion of the bus controller. When the CRC value stored in or calculated by the GXHT3W does not match the value calculated by the bus controller, there is no circuit inside the GXHT3W that prevents the command sequence from proceeding. The calculation formula of CRC is as follows:

$$CRC = X^8 + X^5 + X^4 + 1$$

1 Wire-bus CRC can be generated by a polynomial generator consisting of a shift register and XOR gates, as shown in Figure 12. This loop consists of a shift register and several XOR gates, each bit of the shift register is initialized to 0. Starting with the LSB in ROM or Byte 0 of the register, the registers are shifted one bit at a time. The CRC value is stored in the shift register after the data in the 56-bit ROM has been transferred or the MSB of Byte 7 of the register has been shifted. Next, the CRC value must be cyclically shifted in. At this point, if the calculated CRC is correct, the shift register will be reset to 0.

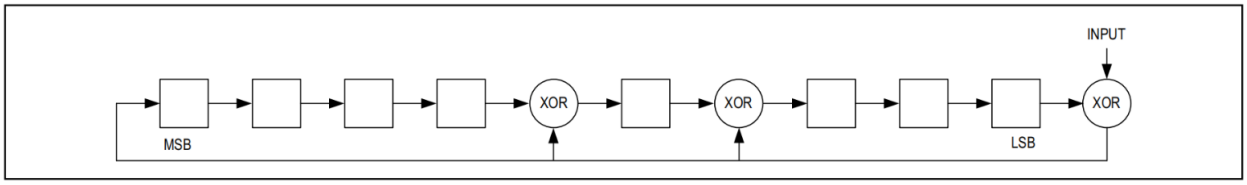


Figure 12. CRC generator

7.6 1-Wire Generator

The 1-Wire system use a 1-Wire controller to control one or more slave devices. The GXHT3W always acts as a slave. When only one slave is attached to the bus, the system is called a "single-point" system; if multiple slaves are attached to the bus, the system is called a "multi-point" system.

All data and instruction transfers are over a single bus starting with the LSB. The 1-Wire system is discussed in three aspects: hardware structure, execution sequence and 1-Wire signal (signal type and timing).

Hardware Structure

The 1-Wire system has only one defined signal line, and the devices on each bus must be open-drain or tri-state outputs. The device (master or slave) on each bus must be open-drain or tri-state output. Such a mechanism would cause each device on the bus to transfer data to release the bus for use by other devices. The 1-Wire port (DQ pin) of the GXHT3W is open-drain type, and the internal equivalent circuit is shown in Figure 15.

1-Wire requires an external pull-up resistor of about 5KΩ; the 1-Wire idle state is high. If a transfer is suspended for some reason, the bus must remain idle if the transfer is to be resumed. During recovery, if 1-Wire is inactive (high), the bit-to-bit recovery time can be infinite. If the bus stays low for over 480us, all devices on the bus will be reset.

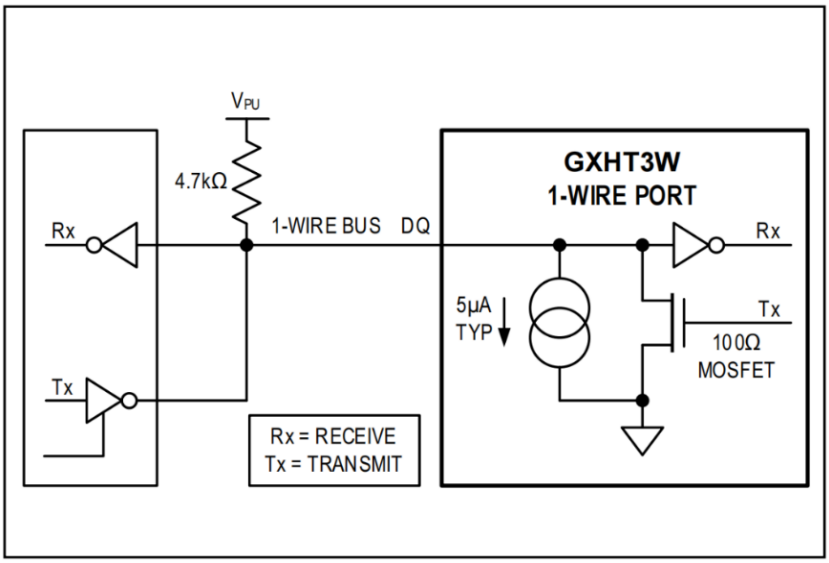


Figure 13. 1-Wire hardware structure

Execution Sequence

The execution sequence for accessing the GXHT3W via 1-Wire is as follows:

Step 1: Initialization

Step 2: ROM operation instructions

Step 3: The GXHT3W function command

Each operation of the GXHT3W must meet the above steps. If the steps are missing or the sequence is out of order, the device will not have a return value. The exceptions are the Search ROM command and the Alarm Search command. When these two commands are executed, the master controller must return to step 1.

1) Initialization

All executions over 1-Wire begin with an initialization sequence. The initialization sequence consists of a reset pulse from the bus controller followed by a presence pulse from the slave. The presence pulse lets the bus controller know that the GXHT3W is on the bus and is ready to operate, see the 1-Wire Signal section for details.

2) ROM Instruction

Once the bus controller detects a presence pulse, it issues a ROM instruction. If more than one GXHT3W is attached to the bus, these instructions will give the device a unique 64-bit ROM serial code to enable the bus controller to select a specific device to operate. These commands can also make the bus controller identify how many and what type of devices are on the bus, and they can also identify which devices have met the alarm condition. There are five ROM instructions, all of which are 8 bits long. The bus controller issues a ROM instruction before issuing the GXHT3W function instruction. The ROM instruction operation diagram is shown in Figure 14.

SEARCH ROM [F0h]

When the system is powered on and initialized, the bus controller must obtain the number and model of the slaves by identifying all the ROM serial codes on the bus. The bus controller cycles through the ROM code multiple times by searching for the ROM instruction to identify all slave devices. If there is only one slave on the bus, the simpler Read ROM instruction (see below) can be used instead of the Search ROM instruction. After each ROM instruction search, the bus controller must return to step 1 (initialization).

READ ROM [33h]

This command can only be used when there is a single GXHT3W on the main system. This command allows the bus controller to read the 64-bit serial code of the slave without using the Search ROM instruction. If this command

is used with over one slave on the bus, a data collision occurs when all slaves attempt to transmit at the same time.

MATCH ROM [55h]

The MATCH ROM instruction is followed by the 64-bit ROM serial number, and the bus controller locates a specific slave device on the multidrop bus. Only the GXHT3W that exactly matches the 64-bit ROM serial number can respond to subsequent memory manipulation commands; all slaves that do not match the 64-bit ROM serial number will wait for a reset pulse.

SKIP ROM [cch]

This command allows the bus controller to use functional commands without providing 64-bit ROM code. For example, the bus controller can issue a ignore ROM command followed by a temperature conversion command [44h] to complete the temperature conversion operation. NOTE: When only one slave is on the bus, in any case, the ROM instruction can be ignored followed by a read register instruction [BEh]. Using this command in a single-point bus situation saves time by eliminating the need for the device to send back a 64-bit ROM code. If there is more than one slave on the bus, if the instruction to ignore the ROM is issued, since multiple slaves transmit data at the same time, a data conflict will occur on the bus.

ALARM SEARCH [ECh]

The operation process of this instruction is the same as that of the Search ROM instruction, and only the slaves that meet the alarm condition will respond to this command. This command allows the master to determine if any GXHT3W experienced an alarm condition during the last temperature transition. After each cycle of the alarm search command, the bus controller must return to Step1. For the alarm operation process, see the Alarm Signal Operation section.

3) The GXHT3W Function Command

After the bus controller uses ROM commands to determine which GXHT3W it wishes to communicate with, the host can issue a GXHT3W function command. These commands allow the bus controller to read and write GXHT3W registers, initiate temperature conversions and identify power modes. The functional instructions of the GXHT3W are detailed below, and are summarized in Table 8 and shown in Figure 14 with a flowchart.

CONVERT T [44h]

This command is used to start a temperature and humidity conversion. After the temperature and humidity

conversion instruction is executed, the generated temperature and humidity conversion result data is stored in the temperature register and the humidity register in the form of 2 bytes, and then the GXHT3W maintains a low-power wait state. If this command is issued in parasitic power mode, during the temperature and humidity conversion (t_{CONV}), a strong pull-up must be given to the 1-Wire within 10us (at most), see the GXHT3W power supply section. If the GXHT3W is powered by an external power supply, the bus controller issues this command followed by a read sequence. If the GXHT3W is in conversion, the bus returns 0, and if the temperature conversion is complete, it returns 1. In parasitic power mode, this communication method will not be used until the bus is pulled up by a strong pull-up.

WRITE SCRATCH PAD [4Eh]

This command writes data to the register of the GXHT3W, starting from the T_H register (Byte 2 of the register), then to the T_L register (Byte 3 of the register), and finally to the configuration register (Byte 4 of the register), data is transmitted with the LSB. The writing of the above three bytes must occur before the reset command is issued by the bus controller, otherwise a data conflict will occur.

READ SCRATCH PAD [BEh]

This command is the host read register command. The read will start from the LSB of Byte 0 and continue until the 9th byte (Byte 8, CRC) is read. If the user doesn't want to read all bytes, the controller can issue a reset command at any time to abort read.

COPY SCRATCH PAD [48h]

This command copies the contents of T_H, T_L and configuration registers (Byte 2, 3, and 4) to EEPROM. If parasitic power is used, the bus controller must initiate a strong pull-up within 10us of issuing this command and hold it for a minimum of 10ms, as described in the GXHT3W Power Supply section.

RECALL E^2 [B8h]

This command copies the T_H, T_L and configuration data from the EEPROM back into the registers. The bus controller sends the read sequence after issuing this command, and the GXHT3W will output the copyback flag: 0 indicates that the copyback is in progress, and 1 indicates that the copyback is over. This operation is performed automatically when the GXHT3W is powered on, so that there is valid data in the registers as soon as the device is powered on.

READ POWER SUPPLY [B4h]

The bus controller issues a read sequence after this command is sent to the GXHT3W. If it is in parasitic power mode, the GXHT3W will pull the bus low; if it is in external power mode, the GXHT3W will pull the bus high. Information on the usage of this command is detailed in the **GXHT3W Power Supply** section.

Table 8. The GXHT3W function command list

COMMAND	DESCRIPTION	PROTOCOL	1-Wire BUS ACTIVITY AFTER COMMAND IS ISSUED	NOTES
TEMPERATURE CONVERSION COMMANDS				
Convert T	Initiates temperature conversion.	44h	GXHT3W transmits conversion status to master (not applicable for parasite-powered GXHT3Ws).	1
MEMORY COMMANDS				
Read Scratchpad	Reads the entire scratchpad including the CRC byte.	BEh	GXHT3W transmits up to 9 data bytes to master.	2
Write Scratchpad	Writes data into scratchpad bytes 2, 3, and 4 (T_H, T_L, and configuration registers).	4Eh	Master transmits 3 data bytes to GXHT3W	3
Copy Scratchpad	Copies T_H, T_L, and configuration register data from the scratchpad to EEPROM.	48h	None	1
Recall E^2	Recalls T_H, T_L, and configuration register data from EEPROM to the scratchpad.	B8h	GXHT3W transmits recall status to master.	
Read Power Supply	Signals GXHT3W power supply mode to the master.	B4h	GXHT3W transmits supply status to master.	

Note 1: For parasite-powered GXHT3Ws, the master must enable a strong pullup on the 1-Wire bus during temperature conversions and copies from the scratchpad to EEPROM. No other bus activity may take place during this time.
Note 2: The master can interrupt the transmission of data at any time by issuing a reset.
Note 3: All three bytes must be written before a reset is issued.

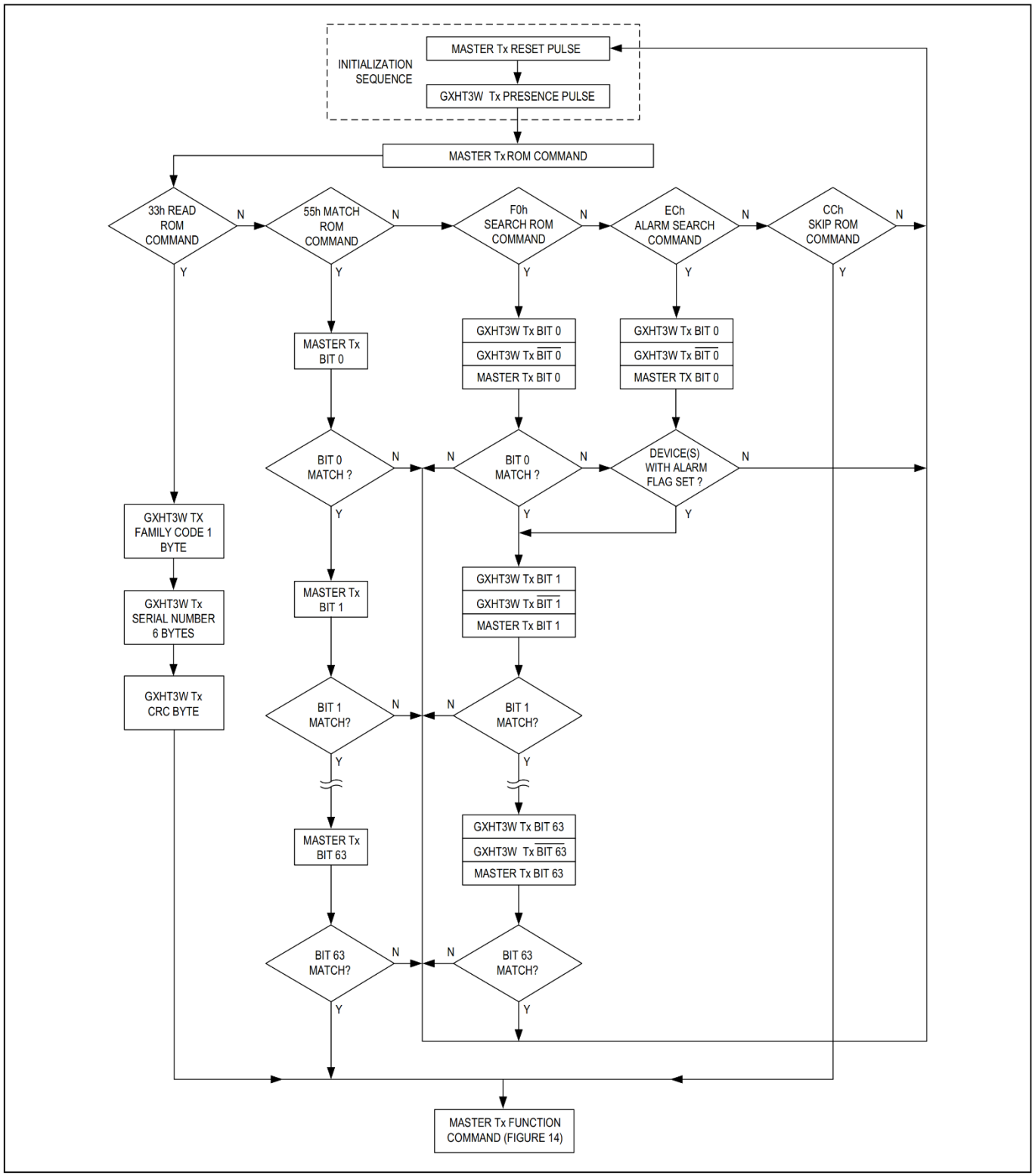


Figure 14 ROM instruction flow chart

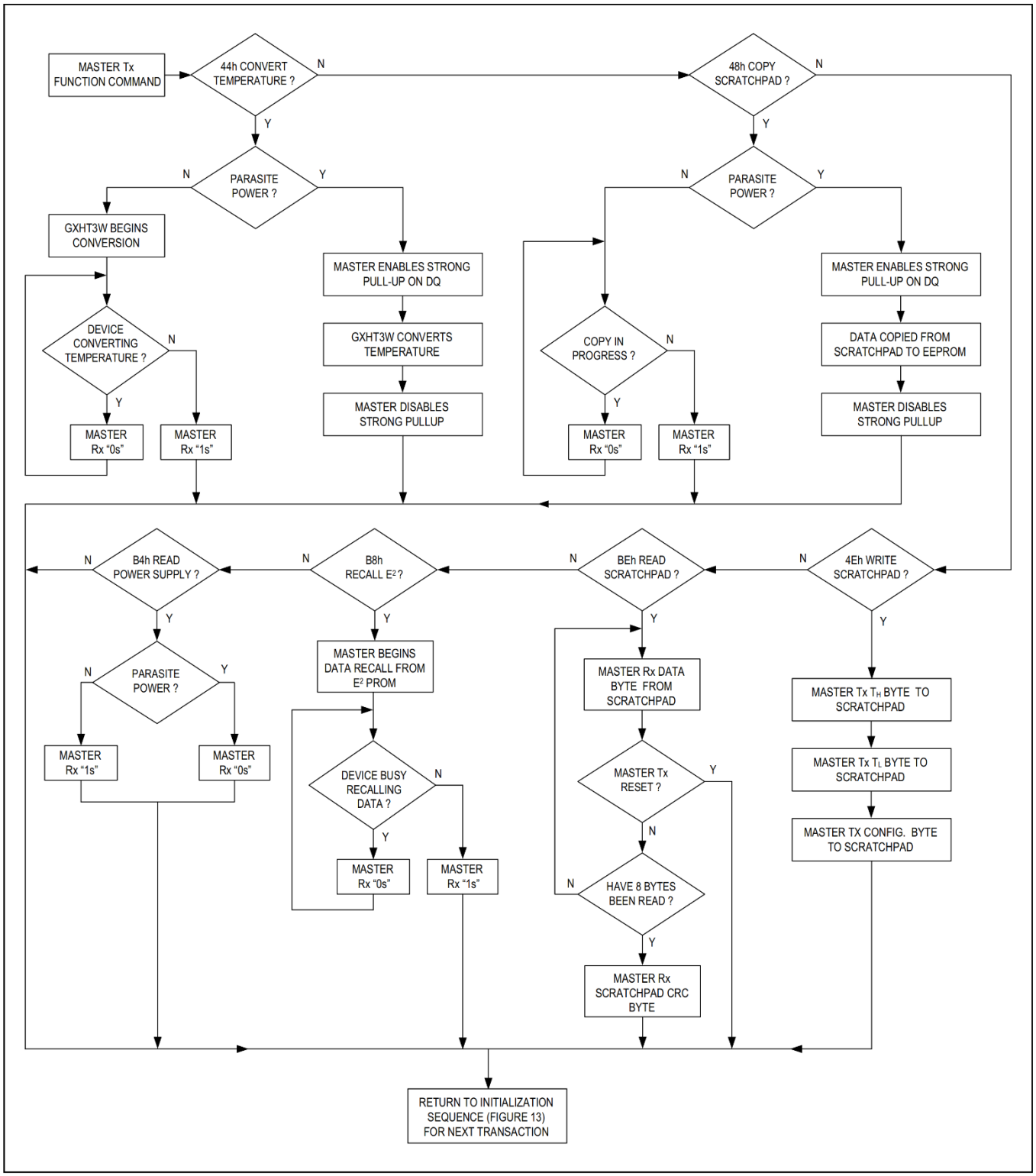


Figure 15 The GXHT3W function command flow chart

7.7 1-Wire Signal

The GXHT3W requires a strict 1-Wire protocol to ensure data integrity. The protocol defines several types of 1-Wire signals: reset pulse, presence pulse, write 0, write 1, read 0, and read 1. All of these signals, except the presence pulse, are issued by the bus controller.

Reset Sequence: Reset and Presence Pulse

All communication with the GXHT3W begins with an initialization sequence as shown in Figure 16. A reset pulse followed by a presence pulse indicates that the GXHT3W is ready to transmit and receive data. During the initialization sequence, the bus controller pulls the bus low for 480us to issue (TX) a reset pulse, then releases the bus and enters the receive state (RX). When the bus is released, a 5kΩ pull-up resistor pulls the bus high. When the GXHT3W detects a rising edge on the IO pin, it waits for 15-60us, and then issues a presence pulse consisting of a 60-240us low-level signal.

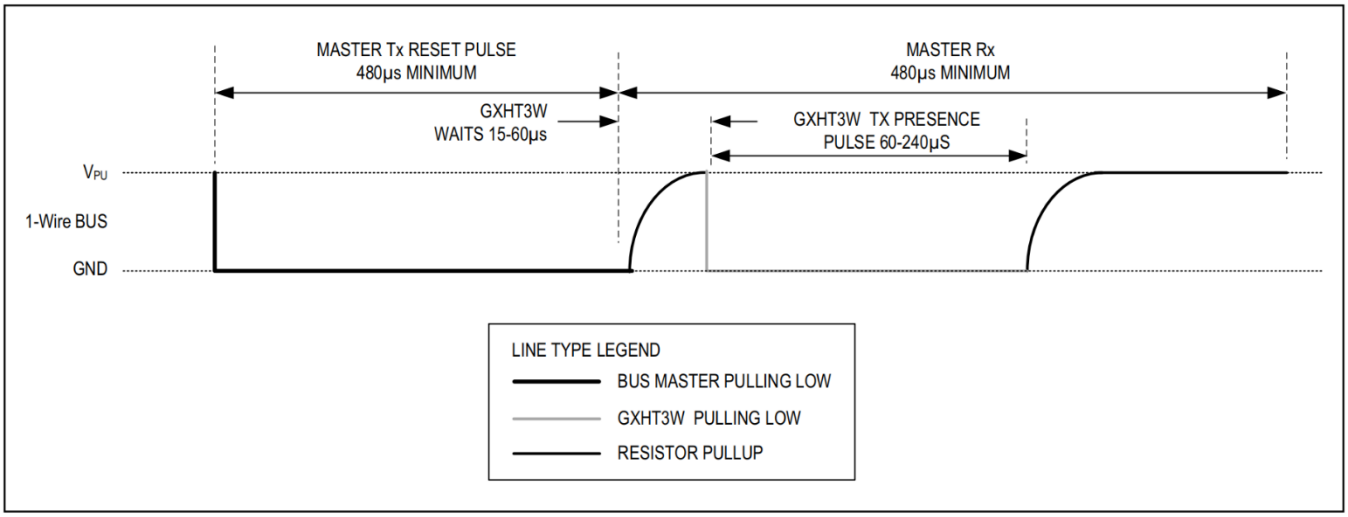


Figure 16. Initialization timing

Read and Write Timing

The data read and write operations of the GXHT3W is to exchange information through sequential processing, and each time sequence transmits 1 bit of data.

Write Timing

The GXHT3W has two types of write timings: write 1 and write 0 timing. The bus controller writes a logic 1 through a write 1 sequence; it writes a logic 0 through a write 0 sequence. The write sequence must last at least 60us, including a recovery time of at least 1us between two write cycles. The write sequence begins when the bus

controller pulls the data line from logic high to low (see Figure 18).

For the bus controller to generate a write sequence, the data line must be pulled to a low level and then released, and the bus must be released within 15us. When the bus is released, the pull-up resistor pulls the bus high. To generate a write 0 sequence, the bus controller must pull the data line low for at least 60us.

After the bus controller initializes the write sequence, the GXHT3W applies the signal lines within a 15us to 60us window. If the line is high, write a 1. Conversely, if the line is low, write 0.

Read Timing

When the bus controller initiates a read sequence, the GXHT3W is only used to transfer data to the controller. Therefore, the bus controller must start the read sequence immediately after issuing the read register command [BEh] or the read power mode command [B4h] for the GXHT3W to provide the requested data. In addition, the bus controller reads the timing after sending the temperature conversion command level [44h] or recalling the EEPROM command [B8h], see the GXHT3W Function Command section for details.

All read sequences must be at least 60us, including a recovery time of at least 1us between two read cycles. When the bus control pulls the data line from high to low, the read sequence begins, the data line must be held for at least 1us, and then the bus is released (see Figure 17). After the bus controller issues a read sequence, the GXHT3W transfers 1 or 0 by pulling high or low on the bus. When the transfer of 0 is completed, the bus will be released and return to the high idle state through the pull-up resistor. The data output from the GXHT3W is valid within 15us after the falling edge of the read timing. Therefore, the bus controller releases the bus within 15us from the beginning of the read sequence and then samples the bus state to read the state of the data line.

Figure 18 indicates that the sum of T_{INIT}, T_{RC}, and T_{SAMPLE} must be less than 15us. Figure 20 indicates that the system time can be maximized by keeping the T_{INIT} and T_{RC} hold times as short as possible, and placing the controller sampling time at the end of the 15us period.

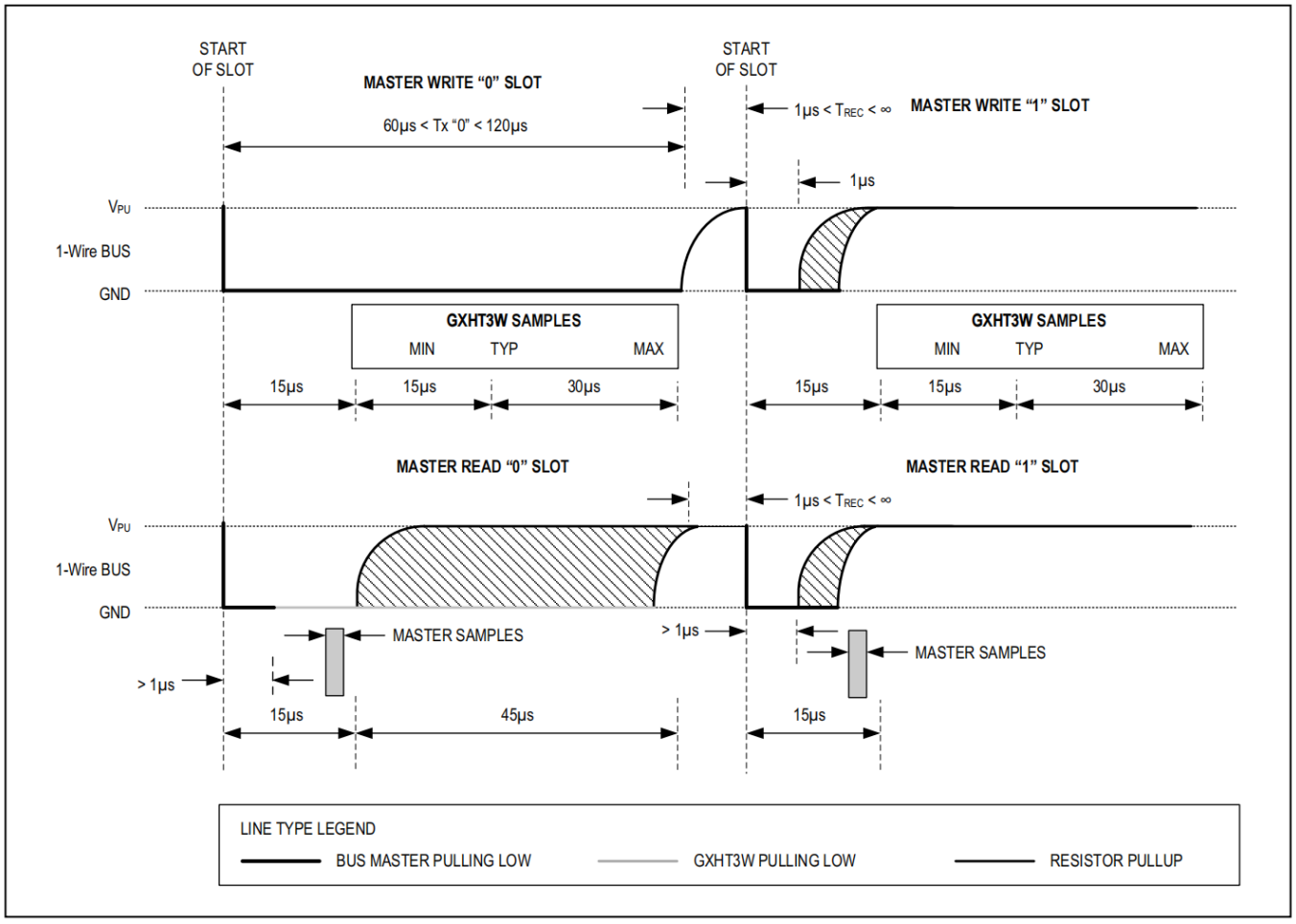


Figure 17. 1-Wire read and write timing diagram

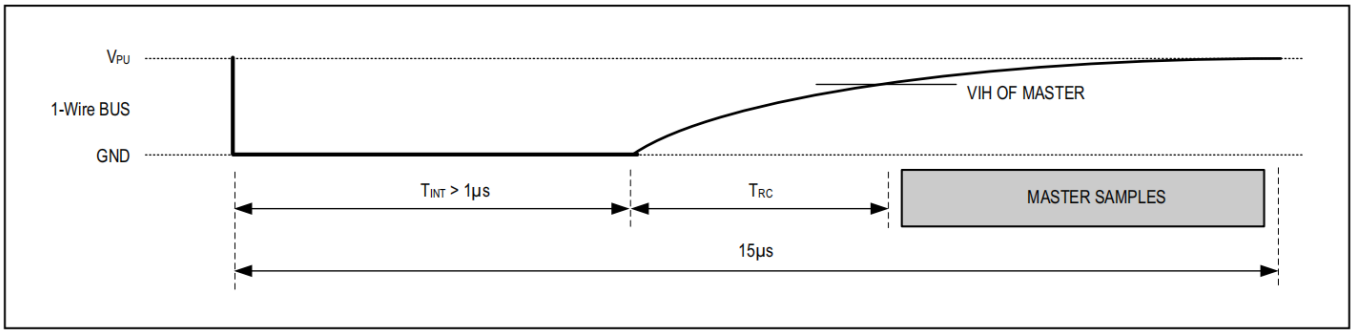


Figure 18. Detailed timing of the host read 1

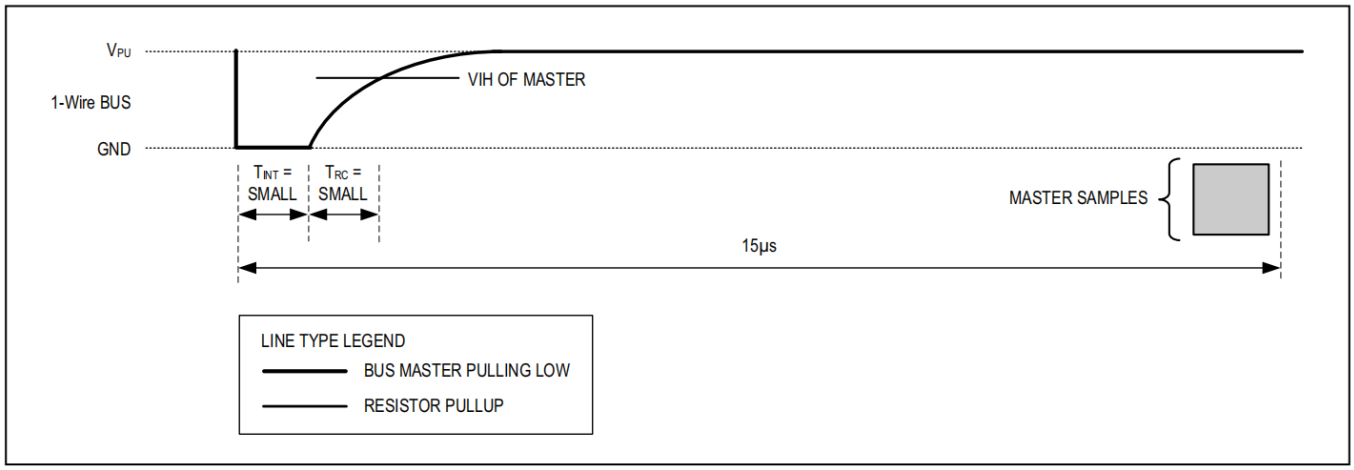


Figure 19 Recommended timing of the host read 1

7.8 The GXHT3W Operation Example

7.8.1 Example 1

In this example, there are multiple GXHT3W powered by parasitic power on the bus. The bus controller initiates a conversion on a specific GXHT3W, then reads its registers and recalculates the CRC to confirm the data.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	Master issues reset pulse.
Rx	Presence	GXHT3Ws respond with presence pulse.
Tx	55h	Master issues Match ROM command.
Tx	64-bitROMcode	Master sends GXHT3W ROM code.
Tx	44h	Master issues Convert T command.
Tx	DQ line held high by strong pull up	Master applies strong pullup to DQ for the duration of the conversion (tCONV).
Tx	Reset	Master issues reset pulse.
Rx	Presence	GXHT3Ws respond with presence pulse.
Tx	55h	Master issues Match ROM command.
Tx	64-bitROMcode	Master sends GXHT3W ROM code.
Tx	BEh	Master issues Read Scratchpad command.
Rx	9 data bytes	Master reads entire scratchpad including CRC. The master then recalculates the CRC of the first eight data bytes from the scratchpad and compares the calculated CRC with the read CRC (byte 9). If they match, the master continues; if not, the read operation is repeated.

7.8.2 Example 2

In this example, there is only one parasitic powered GXHT3W on the bus. The controller writes the T_H, T_L and configuration registers, then reads the registers and calculates the CRC to verify the data. The host controller then copies the data in the registers to the EEPROM.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	Master issues reset pulse.
Rx	Presence	GXHT3Ws respond with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	4Eh	Master issues Write Scratchpad command.
Tx	3 data bytes	Master sends three data bytes to scratchpad (T_H, T_L, and config).
Tx	Reset	Master issues reset pulse.
Rx	Presence	GXHT3W responds with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	BEh	Master issues Read Scratchpad command.
Rx	9 data bytes	Master reads entire scratchpad including CRC. The master then recalculates the CRC of the first eight data bytes from the scratchpad and compares the calculated CRC with the read CRC (byte 9). If they match, the master continues; if not, the read operation is repeated.
Tx	Reset	Master issues reset pulse.
Rx	Presence	GXHT3W responds with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	48h	Master issues Copy Scratchpad command.
Tx	DQ line held high by strong pull up	Master applies strong pullup to DQ for at least 10ms while copy operation is in progress.

8 Quality Control

8.1 Environmental Stability

The quality inspection of the GXHT3W is based on the JEDEC JESD47 quality test specification.

8.2 Material Composition

The GXHT3W is fully RoHS, REACH and Halogen compliant and does not contain Pb, Cd and Hg.

9 Packaging Information

The GXHT3W is packaged in a miniaturized DFN8 package with an outline size of 3 × 3 × 0.9mm^3 and a pin pitch of 0.5mm. DFN stands for 2-sided no-lead form. The device is made of silicon wafers and fastened to the lead frame. The lead frame consists of copper and Ni/Pd/Au. The device and lead frame are molded by epoxy resin compound.

The device complies with the Small Outline Plastic Leadless Specification as described in 4.22 of JEDEC95 and in Small Outline (QFN/SON) Specification D.01.2009. The GXHT3W complies with IPC/JEDEC J-STD-020 moisture sensitive Class 1 standards.

9.1 Product Traceability

All GXHT3Ws are laser-printed on the front for easy product identification and traceability. As shown in Figure 20, the upper left corner of the front of the sensor is marked with Pin1 and the sensor model number. The bottom mark contains 7 characters, the first four ABCD characters represent the production date, the following X represents the signal output type, X=D represents the digital output, X=A represents the analog output, and the last two YZ characters represent the product batch mark. Lot tag decoding is handled by GXCAS, enabling traceability of product production, calibration and testing information. If there is a reasonable request, the user can apply for the decoding of the batch mark with GXCAS for product traceability.

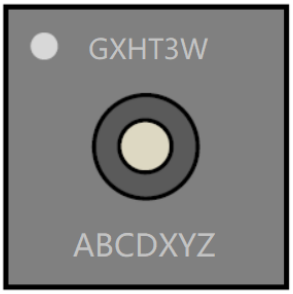
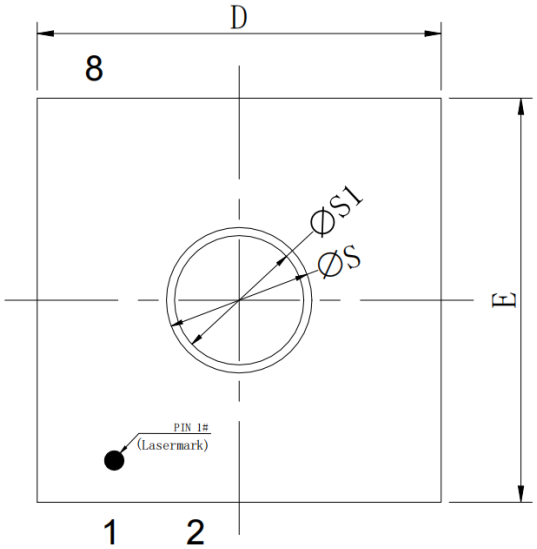
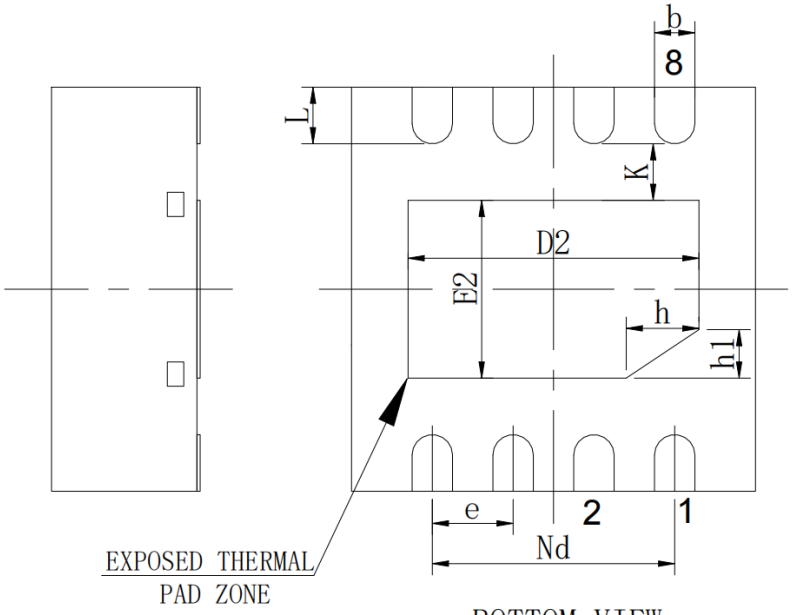


Figure 20. GXHT3W

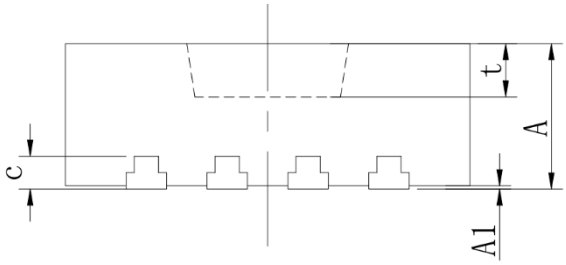
9.2 Technical Drawings



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.85	0.90	0.95
A1	0	0.02	0.05
b	0.20	0.25	0.30
c	0.203REF		
D	2.40	2.50	2.60
D2	1.70	1.80	1.90
Nd	1.50BSC		
E	2.40	2.50	2.60
E2	1.00	1.10	1.20
e	0.50BSC		
K	0.35REF		
L	0.30	0.35	0.40
h	0.40	0.45	0.50
h1	0.25	0.30	0.35
t	-	0.33	-
ØS	0.90BSC		
ØS1	0.80BSC		

10 Chip description and Ordering information

Order number description:

GXHT3W-T&R：GXHT3W represents the product.number, T&R represents packaged form is tape and reel.

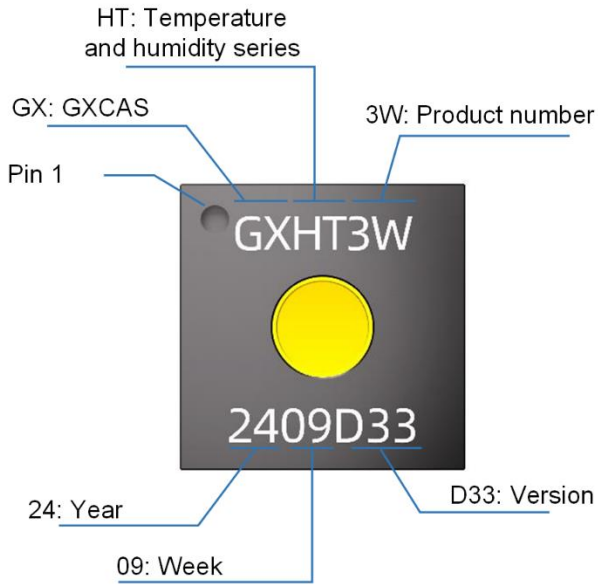
Model Coding：

（1）GXHT3W：GX represents the trademark of the company GXCAS, which can also be represented by G; HT represents temperature and humidity series products; 3W: represents the chip number

（2）GXHT3WC：GX represents the trademark of the company GXCAS, which can also be represented by G; HT represents temperature and humidity series products; 3W: represents the chip number; C: Indicates that the chip is covered with a dustproof and breathable film, which cannot be removed and provides protection for the chip.

（3）GXHT3WCF：GX represents the trademark of the company GXCAS, which can also be represented by G; HT represents temperature and humidity series products; 3W: represents the chip number; CF: Indicates that the chip is coated with a conformal coating film, which needs to be removed after Painting

GXHT3W LOGO description：



Ordering Information：

Purchase Number	Device	Package	SPQ	Note
GXHT3W-T&R	GXHT3W	DFN8 (2.5mm*2.5mm)	2000	Tape and reel
GXHT3WC-T&R	GXHT3WC	DFN8 (2.5mm*2.5mm)	2000	Tape and reel; covered with a dustproof breathable film
GXHT3WCF-T&R	GXHT3WCF	DFN8 (2.5mm*2.5mm)	2000	Tape and reel; covered with a conformal coating film

11 Important Notices

（1）ESD Precautions

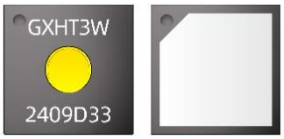
The inherent design of this part makes it very sensitive to electrostatic discharge (ESD). To prevent damage or degradation caused by electrostatic discharge, operate the sensor in an Electrostatic Protected Area (EPA) and take proper measures (operator should be grounded by wrist strap, and all non-insulated or conductive objects should be grounded).

（2）Exposure to Chemicals

The temperature and humidity sensors of Galaxy-CAS Technology are high-sensitivity environmental sensor, not ordinary electronic components. The sensors should not be in close contact with volatile chemicals, such as chemical solvents or organic compounds, especially high concentrations and prolonged exposure are more dangerous. (Ethyl)ketene, acetone, isopropanol, ethanol, toluene, etc., have been shown to cause a shift in humidity readings that is irreversible in most cases.

（3）Dustproof Breathable Film

The temperature and humidity sensors are different from the general sensor chips. The sensors are very sensitive, so their opening part are easily polluted by dust and impurities. For customers in outdoor applications, it is recommended to order our products with a dust-proof and breathable film, which can prevent dust. It can protect the sensor, resist pollution, improve the life and reliability of the sensor, and must not be torn off.



（4）Applications in Extreme Environments

Some applications require the temperature and humidity sensor to be exposed to harsh environments. In many cases, the suitability of the sensor is not considered. There are some situations that require special attention.

a) The sensor needs to return to the normal environment to recover for a period of time after working under abnormal temperature and humidity conditions (> 90).

b) In some application environments, the sensor may be exposed to a high concentration of volatile organic solvents for a long time, which may occur in both the assembly process and the application process. Such applications require attention.

c) In some application environments, the sensor may be exposed to an acidic or alkaline environment, but only a certain concentration will cause harm to the sensor. For bases, pH > 9 will cause damage to the sensor. Etching

materials, such as H2O2, NH3, etc., can also harm the sensor in high concentrations.

d) There may be corrosive gases in some application environments. If the concentration is relatively low, it will not affect the sensor, but it will affect the connection of the solder joints. Higher concentrations can also cause damage to the sensor.

（5）Spraying of Conformal Coating

The paint itself is contaminating to the temperature and humidity sensor. For customers who must spray the paint on the board, they need to order our products with a conformal coating film, after spraying the conformal coating, tear off the conformal coating film before normal testing of temperature and humidity. When spraying the conformal coating, keep at least thirty centimeters away from the sensor and move the can slowly to ensure an even coating, the surface will dry in about thirty minutes and the second spraying can be carried out. Allow the paint to dry fully, approximately 24 hours, then gently remove the film.



（6）Packaging and Storage

Before use, it is strongly recommended to store the sensor in its original packaging in the following environment: temperature 10 °C ~ 50 °C (0 °C - 125 °C for a limited time), 20% ~ 65% RH.

（7）Assemblage

The sensor can be stored for 1 year in normal storage environment, and the sensor has a moisture resistance level of 1.