GX1822 Programmable Resolution 1-wire bus Temperature Sensor

1.FEATURES

- Only one port pin is required for communication using a 1-wire bus interface
- Each chip has an independent 64-bit serial number
- With multi-point distributed temperature measurement function without external components
- Can be powered by the data line.
  the supply voltage range is：2.5V~5.5V
- Measuring Range：-55°C to +125°C (-67°F to +257°F)
- 3v, the transient current of a single working temperature measurement is only 45uA
- 3v, the average current of one temperature measurement per second is only 12uA
- The accuracy is ±0.4°C within the range of -10°C~85°C
- Temperature resolution 9-12 bits optional
- Under the highest 12-bit precision, the temperature conversion speed is less than 320ms
- Has user-defined non-volatile temperature alarm settings
- Alarm search command identifies and flags devices exceeding programmed temperature
- Super electrostatic protection ability: HBM 8000V MM 800V
- Available in SMD MSOP8 package and 3-pin TO-92, TO-92S package

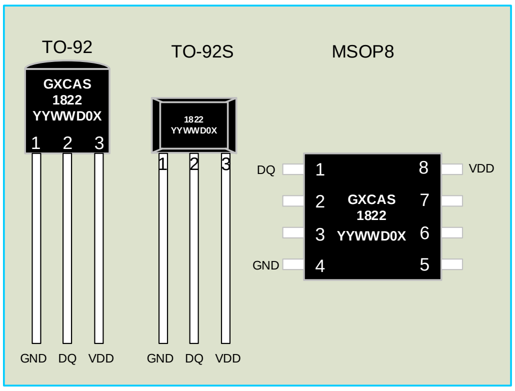
2.Application Scenario

- temperature control
- industrial system
- consumer goods
- grain temperature measurement
- thermometer
- any thermal system

3.DESCRIPTION

GX1822 digital thermometer provides temperature measurement with 9 to 12bit resolution, and can realize the lower limit and upper limit alarm of temperature through the programmable non-volatile memory unit. GX1822 uses a 1-wire bus protocol to communicate with the host computer, and only needs one signal line and one ground line. It has a temperature measurement range of -55°C to +125°C (-67°F to +257°F). The test accuracy in the range of -10°C~85°C can reach ±0.4°C. In addition, it can also work in parasitic mode, directly supplying power to the chip through the signal line, so that no additional power supply is required. Each GX1822 has an independent 64-bit serial number. Multiple GX1822s can be connected in series on the same 1-wire bus for networking. Only one processor can control multiple GX1822s distributed in a large area. This networking method is especially suitable for HVAC environment control, building, equipment, grain temperature measurement and industrial temperature measurement, process monitoring and control and other application fields.computer, consumeren, vironmental,industrial, and instrumentation applications.

4.PIN CONFIGURATIONS



Selection table

TYPE	Package	smallest packaging
GX1822	TO-92（3Pin）	2000
GX1822H	TO-92（3Pin）	2000
GX1822W	TO-92-2（2Pin）	2000
GX1822S	TO-92S	2000
GX1822U	MSOP8	4000
GX1822Z	SOP8	4000

PIN CONFIGURATIONS

Pin location				Name	Function
MOSP8	TO-92	TO-92S			
2,3,5,6,7	—	—		N.C.	Empty pin or no Connection
8	3	3		VDD	Optional VDD. VDD must be grounded for operation in parasite power mode.
1	2	2		DQ	Data Input/Output. Open-drain 1-Wire interface pin. Also provides power to the device when used in parasite power mode (see the Powering the GX1822 section.)
4	1	1		GND	Ground

Version update information

V1.0（ 27th January 2018）：Original edition；

V2.0（ 26th April 2018）：second edition；

V3.0（ 25th February 2019）：third edition；

V4.0（ 13th May 2020）：fourth edition；

V5.0（ 29th July 2020）：fifth edition；

V5.9（ 27th September 2022）；

Contents

5. Details

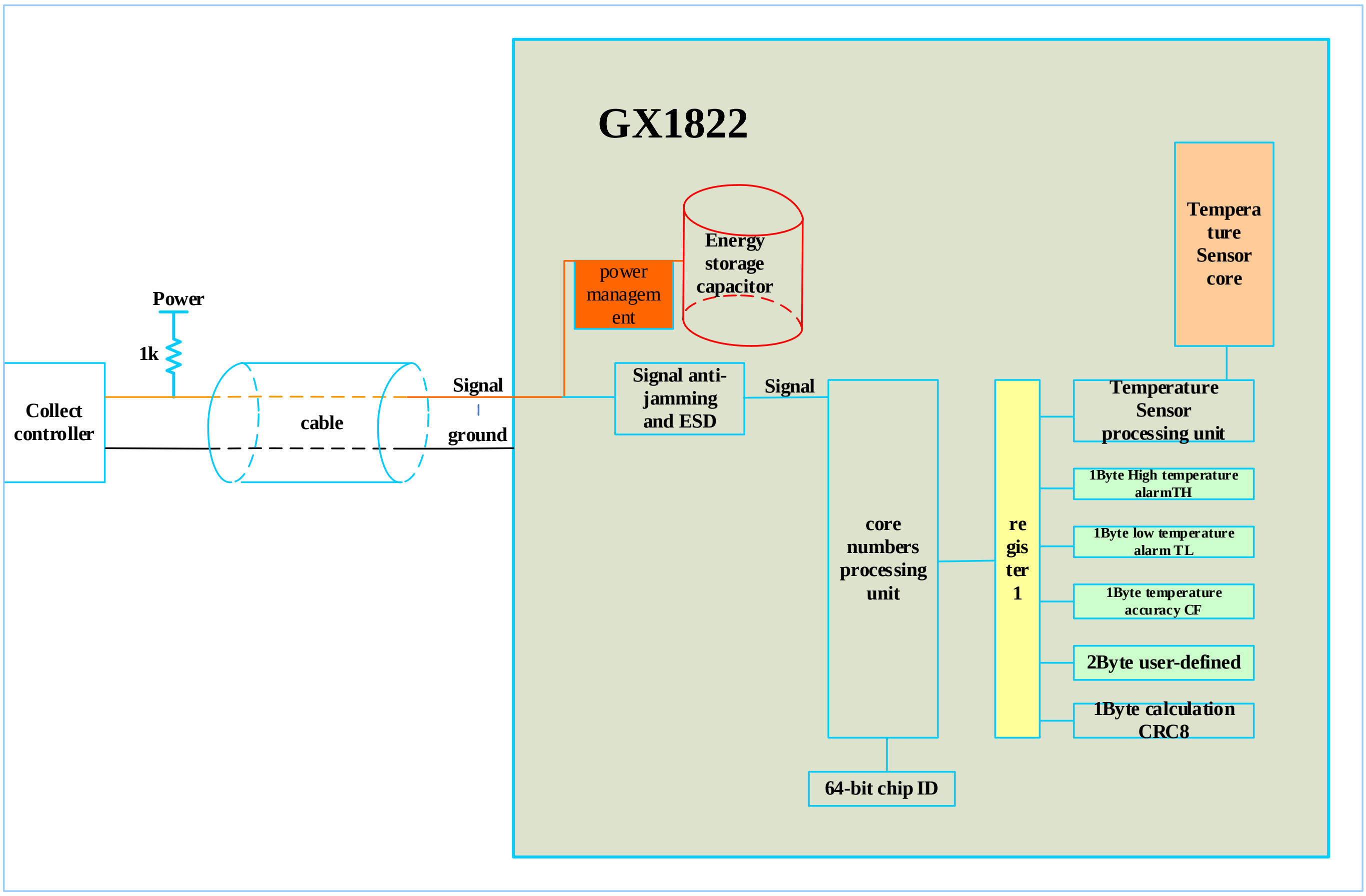
5.1 Overview

As shown in Figure 1, it is the structural block diagram of GX1822. The chip uses a 64-bit read-only memory to store the unique chip serial number of the device. The chip's internal scratchpad contains two-byte temperature registers, which are used to store the data output by the temperature sensor. In addition, the chip also provides two-byte temperature alarm threshold registers (T_H and T_L) and one-byte configuration register. Configuration registers allow the user to set the temperature measurement resolution to 9, 10, 11 or 12 bits. T_H, T_L and configuration registers are non-volatile erasable registers (EEPROM), and the stored data will not disappear after the device is powered off.

The GX1822 uses a 1-wire bus protocol and communicates through a 1-wire port. When all devices are connected to the bus through a tri-state port or an open-drain port, the control line needs to be connected to a weak pull-up resistor. In this bus system, the microprocessor (master device) relies on each device's unique 64-bit slice serial number to identify devices on the bus and record device addresses 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. For a detailed explanation of the 1-wire bus protocol, including instructions and "timing," see the 1-wire bus Systems section.

Another feature of GX1822 is that it can work without external power supply. When the bus is in a high state, DQ is connected to a pull-up resistor to supply power to the device through a 1-wire bus. 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 "parasit ic power supply". Of course, GX1822 can be connected to an external power supply through the VDD pin.

Figure 1. GX1822 Block Diagram



5.2 Temperature measurement operation

The core function of the GX1822 is its direct digital temperature sensor. The accuracy of the temperature sensor is user programmable with 9, 10, 11 or 12 bits. The temperature resolutions are 0.5°C, 0.25°C, 0.125°C and 0.0625°C, respectively. The default precision of the chip is 12 bits when it is powered on. After GX1822 is started, it maintains a low power consumption waiting state; when it needs to perform temperature measurement and AD conversion, the bus controller must issue a [44h] command. After that, the generated temperature data is stored in the temperature register in the form of two bytes, and GX1822 continues to maintain the waiting state. When GX1822 is powered by an external power supply, the bus controller initiates a "read sequence" after the temperature conversion command (see the 1-wire bus system section), GX1822 returns 0 during temperature conversion, and returns 1 when the conversion is completed. If the GX1822 is powered by a parasitic supply, there will be no return value unless the bus is pulled high by a strong pullup when entering a temperature transition. The bus requirements for parasitic power are explained in detail in the GX1822 Power Supply section.

Figure 2. Temperature Register Format

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
LSB	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}
	BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT 9	BIT 8
MSB	sign	sign	sign	sign	sign	2^6	2^5	2^4

Table 1. Temperature/Data Relationship

Temperature (°C)	Digital output (Binary)	Digital output (Hexadecimal)
+125	0000 0111 1101 0000	07D0h
+85*	0000 0101 0101 0000	0550h
+25.0625	0000 0001 1001 0001	0191h
+10.125	0000 0000 1010 0010	00A2h
+0.5	0000 0000 0000 1000	0008h
0	0000 0000 0000 0000	0000h
-0.5	1111 1111 1111 1000	FFF8h
-10.125	1111 1111 0101 1110	FF5Eh
-25.0625	1111 1110 0110 1111	FE6Fh
-55	1111 1100 1001 0000	FC90h

**The default value of the temperature register is +85℃ at power-on reset*

5.3 Alarm operation

After GX1822 completes a temperature conversion, it compares the temperature value with a byte user-defined alarm threshold stored in TH and TL registers (as shown in Figure 3). The flag bit (S) indicates whether the temperature value is positive or negative: positive number S=0, negative number S=1. The TH and TL registers are non-volatile (EEPROM), so the data is retained after power down. How TH and TL are stored in the 2nd and 3rd bytes of the register will be explained in the memory section.

Figure 3. TH and TL Register Format

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
TH/TL	sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0

When TH and TL are 8-bit registers, only bits 4 to 11 of the temperature register are used in the comparison with TH and TL. If the measured temperature is higher than TH or lower than TL, the alarm condition is established, and an alarm flag will be set inside GX1822. This logo is updated every time a temperature measurement is performed. Therefore, if the alarm condition disappears, the flag will be turned off after the next temperature transition.

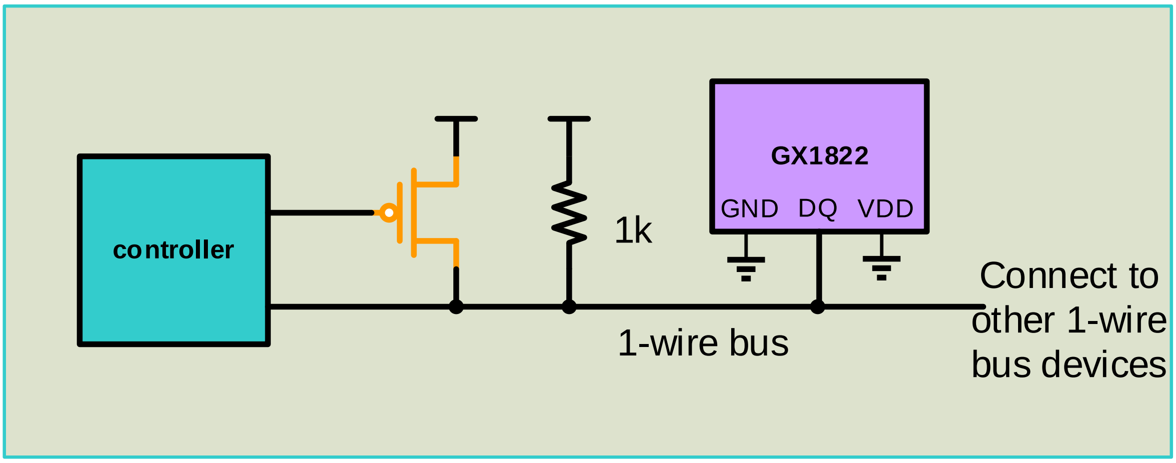
The bus controller detects all GX1822 alarm signs on the bus by issuing an alarm search command [ECh]. Any GX1822 that sets the alarm flag will respond to this command, so the bus controller can accurately locate each GX1822 that meets the alarm condition. If the alarm condition holds while the setting of TH or TL has been changed, another temperature conversion will re-affirm the alarm condition.

5.4 Power supply of GX1822

GX1822 can be powered by an external power supply through the pin VDD, and can also work in parasitic power supply mode. The parasitic power mode allows GX1822 to work in the state of external power demand. The parasitic power mode is useful for remote testing or space-constrained applications. The control loop of the parasitic power supply is shown in Figure 1. When the bus is high, the control loop "steals" energy from the bus. Part of the "stolen" energy is stored in the parasitic power storage capacitor (CPP), which is released for use by the device when the bus is low. When GX1822 is in parasitic power mode, the VDD pin must be grounded.

In parasitic power mode, the 1-wire bus and CPP can provide sufficient current to meet the specified timing and voltage (see DC characteristics and AC characteristics section) to GX1822 in most operations. However, when GX1822 is performing temperature conversion or transferring data from register to EEPROM, the operating current can be as high as 1.5mA. This current may cause an unacceptable voltage drop on a weak pull-up resistor connected to a 1-wire bus, which requires more current than the CPP can supply at this time. In order to ensure that GX1822 has sufficient power supply, when performing temperature conversion or copying data to EEPORM, a strong pull-up must be provided for the 1-wire bus, which is realized by directly pulling the bus to the power supply with a MOSFET, as shown in Figure 4. 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 at most 10us, and the temperature conversion timing (tvonv) or copy data timing (twr=10ms) must be Always maintain a strong pull-up state. No other actions are allowed while the strong pull-up state is maintained.

Figure 4. Supplying the Parasite-Powered GX1822 During Temperature Conversions

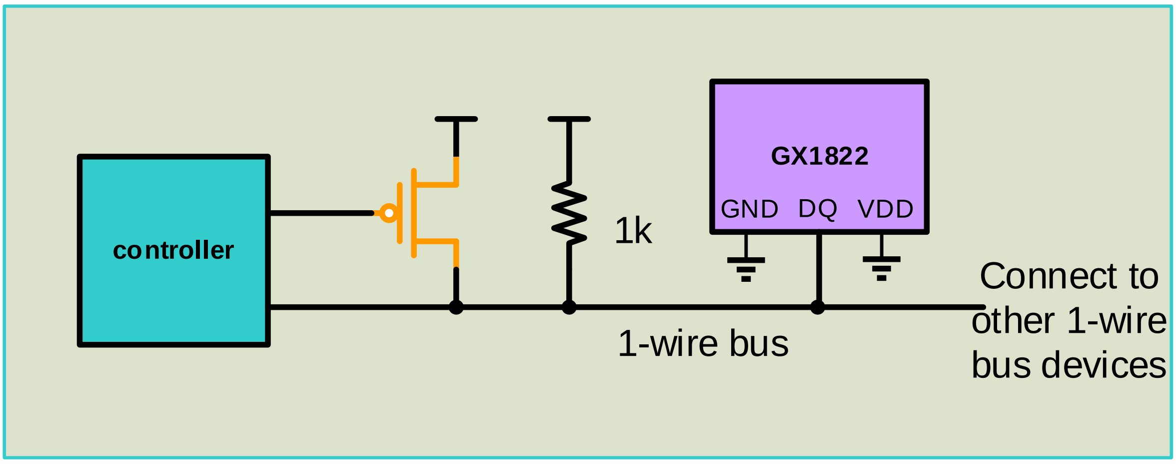


Another way to supply power to the GX1822 is to connect an external power supply from the VDD pin, as shown in Figure 5. The advantage of this is that no strong pull-up is required on the 1-wire bus, and the bus does not need to be kept high during temperature conversion.

When the temperature is higher than 100°C, it is not recommended to use the parasitic power supply, because the GX1822 exhibits a relatively large leakage current at this temperature, and communication may not be possible. In the case of such temperature, it is strongly recommended to use the VDD pin of GX1822 for power supply.

For the case where the bus controller does not know whether the GX1822 on the bus uses a parasitic power supply or an external power supply, GX1822 has prepared a schematic diagram of a signal indicating the use of the power supply. The bus controller sends out a Skip ROM command [CCh], and then sends out a read power command [B4h]. 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 5. Powering the GX1822 with an External Supply



6. Memory

6.1 64-bit ROM

Each GX1822 has a unique 64-bit code stored in ROM. The first 8 bits are the 1-line series 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 GX1822 to operate as a 1-wire bus device and operate according to the 1-wire bus protocol detailed in the 1-wire bus System section.

Figure 6. 64-Bit Lasered ROM Code

ROM	8 bit CRC	48 bit serial number	8 bit family code (28h)
	MSB LSB	MSB LSB	MSB LSB

6.2 Memory unit

The memory structure of GX1822 is shown in Figure 7. The memory consists of a scratchpad SRAM and a nonvolatile electrically erasable EEOROM that stores the alarm thresholds TH and TL. Note that TH and TL registers can be used as normal registers when the alarm function cannot be used. All memory instructions are detailed in the GX1822 Functional Instructions section.

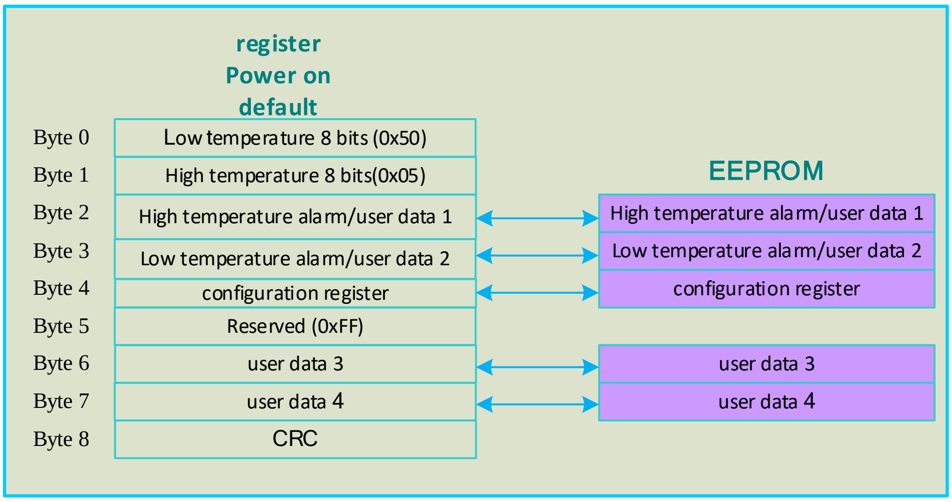
The byte 0 and byte 1 bytes of the memory are the LSB and MSB of the temperature register respectively, and the memory of these two bytes is a read-only memory. The 2nd and 3rd bytes are TH and TL. The 4th byte is the configuration register data, which is detailed in the configuration register section. The 5th byte is reserved by the device and cannot be written; the 6th and 7th bytes can be used by users.

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

Data is written to bits 2, 3, 4, 6, and 7 of the memory via the Write Register instruction [4Eh]; data must be transmitted starting with the 2nd byte as the least significant bit. In order to completely verify the data, the memory can be read after the data has been written (using the Read Register instruction [BEh]). When reading a register, data is shifted out of the 1-wire bus with byte 0 as the least significant bit. The copy register command [48h] must be issued when the bus controller transfers TH, TL and configuration data from the register to the EEPROM.

Data in the EEPROM memory is retained after the device is powered down; at power-up, the data is loaded into the registers. Data can also be loaded from the registers to the EEPROM by the Recall EEPROM command. After the bus controller issues this command, it issues a read sequence. GX1822 returns 0 to indicate that it is recalling, and returns 1 to indicate that the operation is over.

Figure 7. GX1822 Memory Map



6.3 CONFIGURATION REGISTER

The fourth byte of the memory is the configuration register, whose structure is shown in Figure 8. Users can set the precision of GX1822 by setting the R0 and R1 bits as shown in Table 2. Power-on default setting: R0=1, R1=1 (12-bit precision). NOTE: There is a direct relationship between accuracy and conversion time. Bit 7 and Bits 0 through 4 of the configuration register are reserved by the device and inhibited from writing; they all appear as logic 1s when reading data.

Figure 8. Configuration Register

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
CF	0	R1	R0	1	1	1	1	1

Table 2. Thermometer Resolution Configuration

R1	R0	Resolution （BITS）	Maximum conversion time	
0	0	9	40ms	(t_{CONV}/8)
0	1	10	80ms	(t_{CONV}/4)
1	0	11	160ms	(t_{CONV}/2)
1	1	12	320ms	(t_{CONV})

7. CRC generator

The CRC is stored in memory as part of the GX1822 64-bit ROM. The CRC code is calculated from the first 56 bits of the

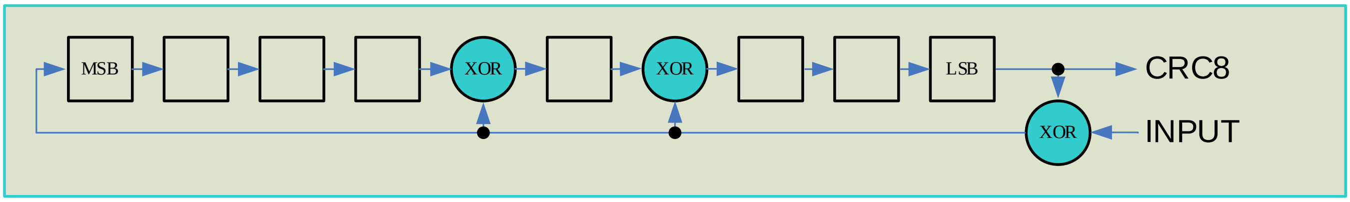
ROM and is included in the important bytes of the ROM. The CRC is calculated from the data stored in the memory, so when the data in the memory changes, the value of the CRC changes accordingly.

CRC can perform data verification when the bus controller reads GX1822. In order to verify whether the data is read correctly, the bus controller must use the received data to calculate a CRC value and the value stored in the 64-bit ROM of the GX1822 (when reading the ROM) or the 8-bit CRC value calculated internally by the GX1822 (when reading a register) to compare. If the calculated CRC value matches the read CRC value, the data is transmitted without error. The comparison of the CRC value and whether to proceed to the next step are completely determined by the bus controller. When the CRC value stored in or calculated by the GX1822 does not match the value calculated by the bus controller, there is no circuit inside the GX1822 that can prevent the command sequence from proceeding. The calculation formula of CRC is as follows:

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

A 1-wire CRC can be generated by a polynomial generator consisting of a shift register and an XOR gate, as shown in Figure 9. This loop consists of a shift register and several XOR gates, the individual bits of the shift register are initialized to 0. The register is shifted one bit at a time, starting with the least significant bit in ROM or byte 0 of the register. After the data in the 56-bit ROM is transferred or the highest bit of the 7th byte of the register is shifted, the CRC value is stored in the shift register. Next, the CRC value must be cycled in. At this point, if the calculated CRC is correct, the shift register will be reset to 0.

Figure 9. CRC Generator



8. 1-wire bus system

1-wire bus systems use a 1-wire bus controller to control one or more slave devices. GX1822 always acts as a slave. When only one slave is connected to the bus, the system is called a "1-point" system; if multiple slaves are connected to the bus, the system is called a "multipoint" system.

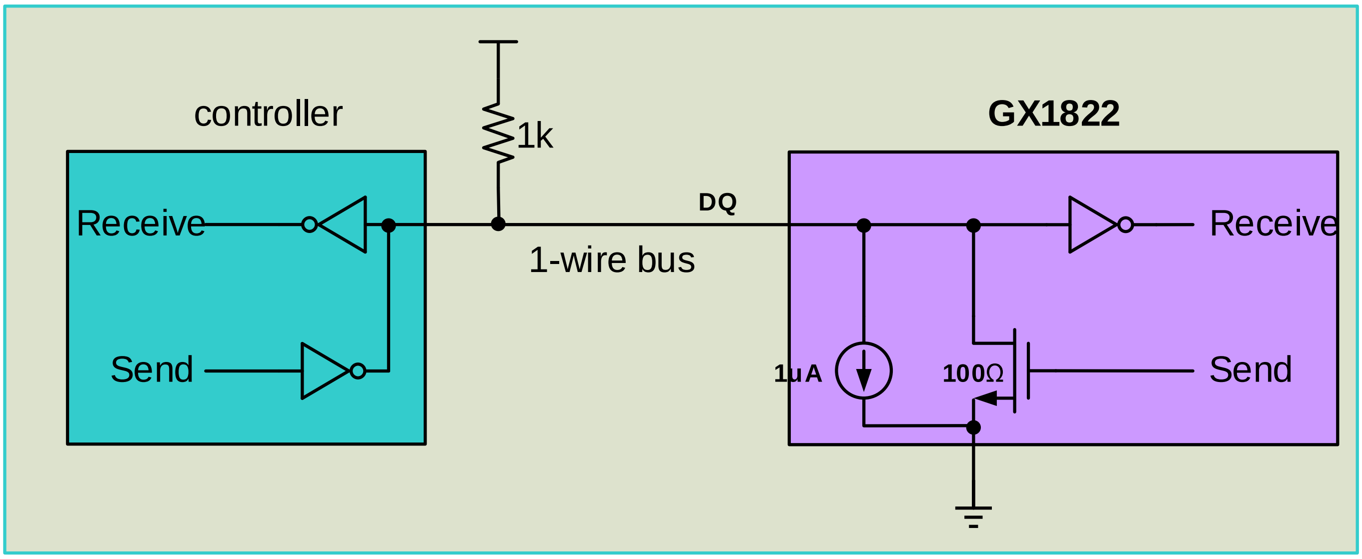
All data and instructions are transferred through the 1-wire bus starting from the least significant bit. There are three aspects to discuss about 1-wire bus system: hardware structure, execution sequence and 1-wire bus signal (signal type and timing).

9. hardware structure

1-wire bus systems have only one defined signal line, and each device on the bus must have an open-drain or three-state output. Each device on the bus (master or slave) must have an open-drain or tri-state output. Such a mechanism will cause every device on the bus that does not transmit data to release the bus for other devices to use. The 1-wire bus port (DQ pin) of GX1822 is open-drain, and the internal equivalent circuit is shown in Figure 10.

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

Figure 10. Hardware Configuration



10. execution sequence

The transaction sequence for accessing the GX1822 is as follows:

Step 1. Initialization

Step 2. ROM Command

Step 3. GX1822 Function Command

Every operation of GX1822 must meet the above steps. If steps are missing or the order is disordered, the device will not return a value. Except for the search ROM command and the alarm search command. When these two commands are executed, the main controller must return to step 1.

10.1 initialization

All execution over the 1-wire bus begins with an initialization sequence. The initialization sequence consists of a reset pulse from the bus master followed by a presence pulse from the slave. The presence pulse lets the bus controller know that the GX1822 is on the bus and ready to operate, see Bus Signals section for details.

10.2 ROM instruction

Once the bus controller detects a presence pulse, it issues a ROM command. If there are multiple GX1822s on the bus, these commands will give the device a unique 64-bit ROM sequence code, allowing the bus controller to select a specific device to operate. These instructions can also enable the bus controller to identify how many and what types of devices are hung on the bus. Similarly, they can also identify which devices have met the alarm conditions. There are 5 ROM instructions, all of which are 8-bit in length. The bus controller issues a ROM command before issuing a GX1822 function command. The ROM command operation diagram is shown in Figure 11.

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 ROM serial codes on the bus. The bus controller cycles through the ROM code multiple times with the Search ROM command to identify all slave devices. If there is only one slave on the bus, the Search ROM command can be replaced by the simpler Read ROM command (see below). After each search ROM instruction, the bus controller must return to step 1 (initialization).

READ ROM [33h]

This command can only be used when there is a single GX1822 in the main system. This command allows the bus controller to read the slave's 64-bit serial code without using the Search ROM command. If there is more than one slave on the bus and this command is used, a data collision will occur when all slaves try to transmit at the same time.

MATCH ROM [55h]

The MATCH ROM command is followed by a 64-bit ROM serial number, and the bus controller locates a specific slave device on the multidrop bus. Only the GX1822 that completely matches the 64-bit ROM serial number can respond to subsequent memory operation instructions; all slaves that do not match the 64-bit ROM serial number will wait for the reset pulse.

SKIP ROM [CCh]

This command allows the bus controller to use functional instructions without providing a 64-bit ROM code. For example, the bus controller can issue an ignore ROM command first, and then issue the temperature conversion command [44h], thus completing the temperature conversion operation. NOTE: When there is only one slave on the bus, however, ignore the ROM command followed by a Read Register command [BEh]. Using this command in a 1-drop 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 ignore ROM command is issued, data conflicts will occur on the bus because multiple slaves transmit data at the same time.

ALARM SEARCH [ECh]

The operation process of this command is the same as the search ROM command, only the slaves that meet the alarm conditions will respond to this command. This command allows the master to determine if any of the GX1822s experienced an alarm condition during the most recent temperature conversion. After each alarm search command cycle, the bus controller must return to step 1. For the alarm operation process, see the alarm signal operation section.

10.3 GX1822 function instruction

After the bus controller uses ROM commands to determine the GX1822 it wishes to communicate with, the host can issue a GX1822 function command. These instructions allow the bus controller to read and write the GX1822's registers, initiate temperature conversions and identify power modes. The functional instructions of GX1822 are detailed below, and are summarized in Table 4, and shown in Figure 12 with a flow chart.

CONVERT T [44h]

This command is used to start a temperature conversion. After the temperature conversion instruction is executed, the generated temperature conversion result data is stored in the temperature register in the form of 2 bytes, and then GX1822 maintains a low power consumption waiting state. If this command is issued in parasitic power supply mode, a strong pull-up must be given to the 1-wire bus within 10us (maximum) during the temperature conversion period (tCONV), see GX1822 power supply section. If the GX1822 is powered by an external power supply, the bus controller sends out the read sequence after issuing the command. If the GX1822 is in conversion, the bus returns 0, and if the temperature conversion is completed, it returns 1. In parasitic power mode, such communication will not be used until the bus is pulled high by a strong pull-up.

WRITE SCRATCHPAD [4Eh]

This command writes data to the register of GX1822, starting at the TH register (the second byte of the register), then writing to the TL register (the third byte of the register), and finally writing to the configuration register (the second byte of the register) 4th byte), the data is transmitted starting with the least significant bit. The writing of the above three bytes must occur before the bus controller issues a reset command, otherwise data conflicts will occur.

READ SCRATCHPAD [BEh]

This command is the host read register command. The reading will start from the least significant bit of byte 0 and continue until the ninth byte (byte 8, CRC) is read. If you do not want to read all bytes, the controller can issue a reset command at any time to Abort reading.

COPY SCRATCHPAD [48h]

This command copies the contents of TH, TL and configuration registers (bytes 2, 3, and 4) to EEPROM. If a parasitic power supply is used, the bus controller must start a strong pull-up within 10us of issuing this command and keep it for at least 10ms, see GX1822 power supply section.

RECALL E2 [B8h]

This command copies TH, TL and configuration data from EEPROM back to the register. After the bus controller issues this command, the read sequence will be issued, and GX1822 will output the copyback flag: 0 means copying is in progress, 1 means copyback is over. This operation is automatically performed when the GX1822 is powered on, so that there will be valid data in the register as soon as the device is powered on.

READ POWER SUPPLY [B4h]

After the bus controller sends this command to GX1822, it will issue a read sequence. If it is in parasitic power mode, GX1822 will pull down the bus; if it is in external power mode, GX1822 will pull the bus up. Information on the usage of this command is detailed in the GX1822 Power Supply section.

Table 3. GX1822 Function Command Set

COMMAND	DESCRIPTION	PROTOCOL	1-Wire BUS ACTIVITYAFTER COMMAND IS ISSUED	NOTES
TEMPERATURE CONVERSION COMMANDS				
Convert T	Initiates temperature conversion	44h	GX1822 transmits conversion status to master (not applicable for parasite- powered GX1822).	1
MEMORY COMMANDS0				
Read Scratchpad	Reads the entire scratchpad including the CRC byte.	BEh	GX1822 transmits up to 9 data bytes to master.	2
Write Scratchpad	Writes data into scratchpad bytes 2, 3, 4, and 6, 7(T_H, T_L, configuration registers and User Bytes).	4Eh	Master transmits 3 or 4 or 5 data bytes to GX1822.	3
Copy Scratchpad	Copies T_H, T_L, config register and User Bytes data from the scratchpad	48h	None	1
Recall E^2	Recalls T_H, T_L, config register and User Bytes data from EEPROM to the	B8h	GX1822 transmits recall status to master.	
Read Power Supply	Signals GX1822 power supply mode to the	B4h	GX1822 transmits supply status to master.	

Note1:For parasite-powered GX1822s, 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.

Note2:The master can interrupt the transmission of data at any time by issuing a reset.

Note3: The three bytes TH, TL and configuration register must be written before the reset signal is initiated.

Figure 11. ROM Instruction Flowchart

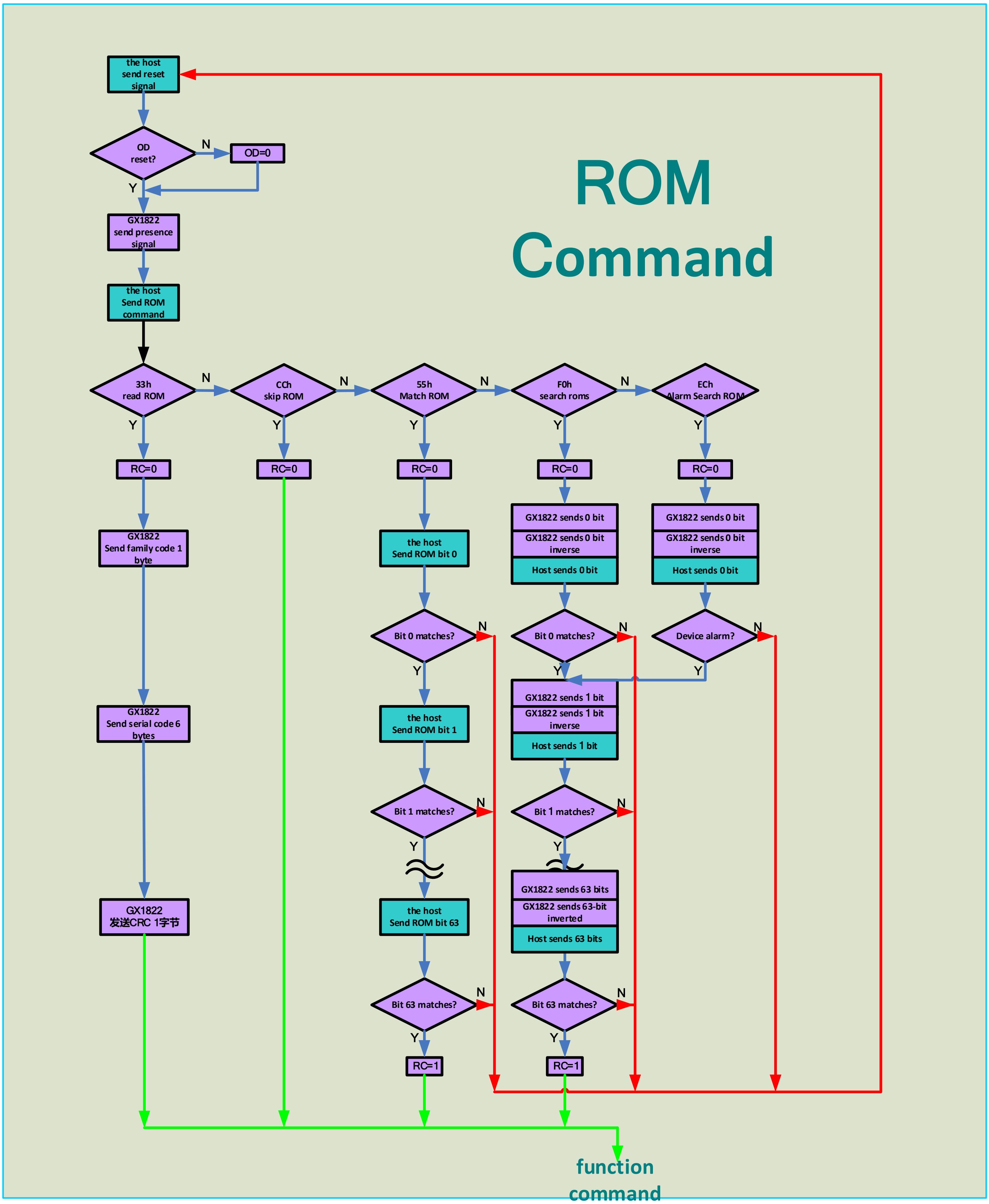
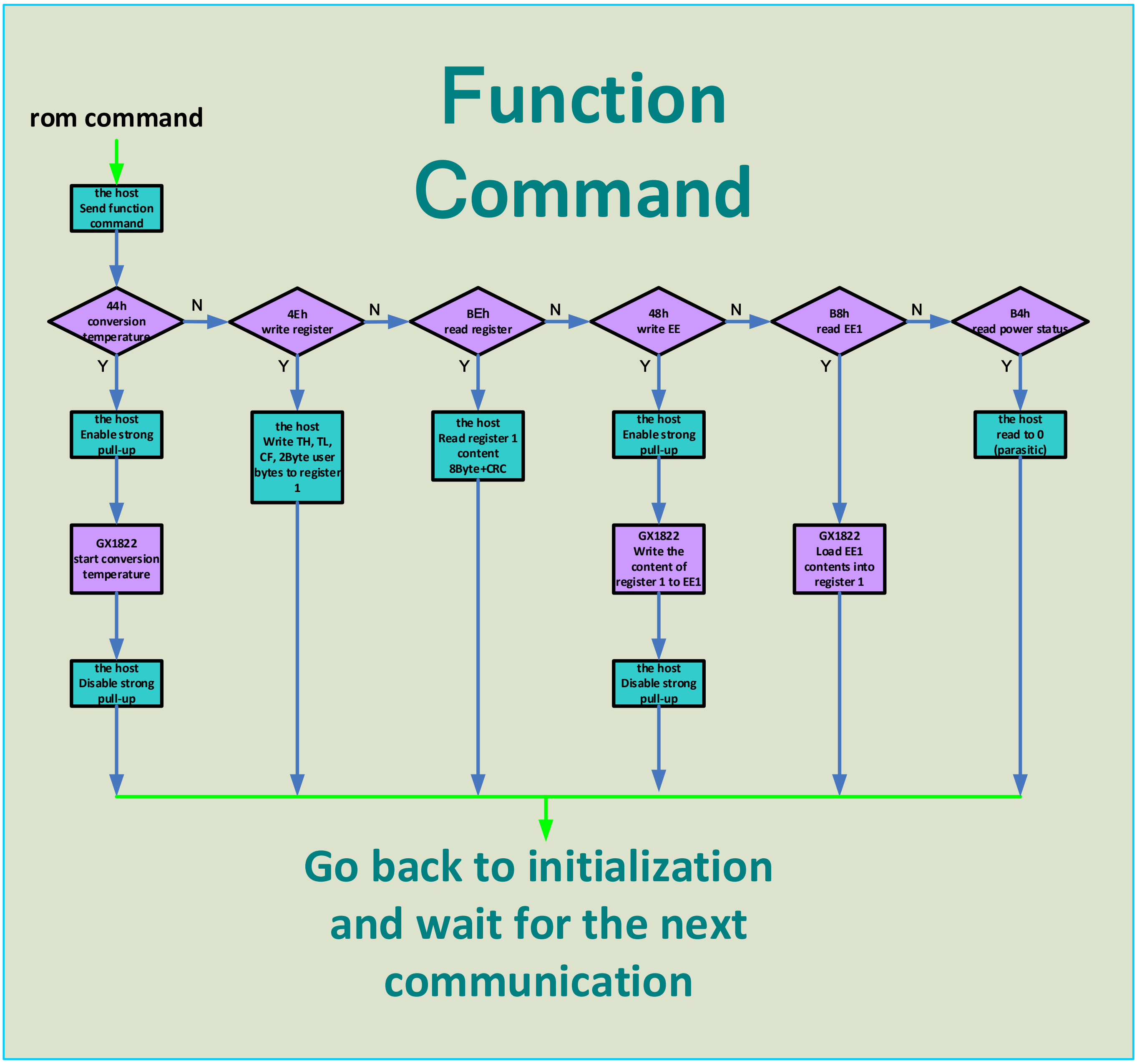


Figure 12. GX1822 function instruction flowchart



11. 1-wire bus signal

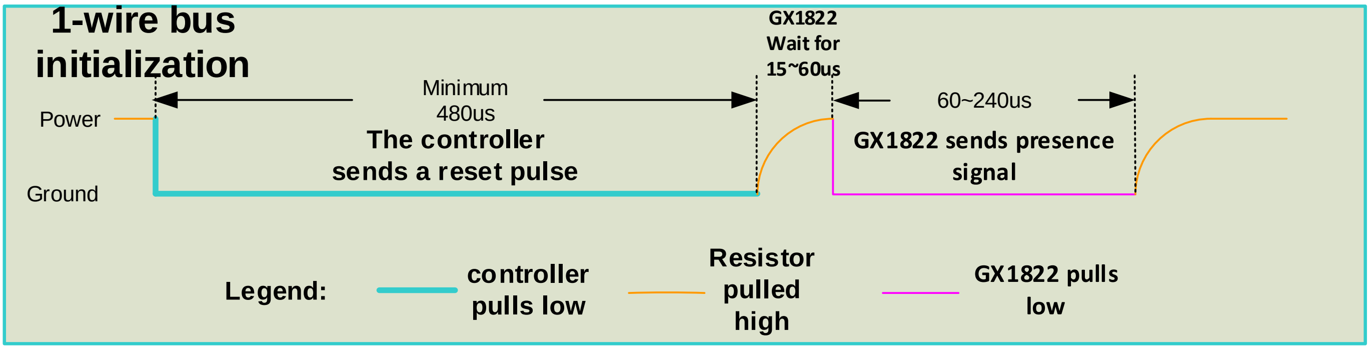
The GX1822 uses a strict 1-Wire communication protocol to ensure data integrity. Several signal types are defined by this protocol: reset pulse, presence pulse, write 0, write 1, read 0, and read 1. The bus master initiates all these signals, with the exception of the presence pulse.

11.1 RESET SEQUENCE: RESET AND PRESENCE PULSE

All communications with the GX1822 begin with an initialization sequence, which is shown in Figure 13. A reset pulse followed by a presence pulse indicates that the GX1822 is ready to send and receive data.

During the initialization sequence, the bus controller pulls the bus low for 480us to issue (TX) a reset pulse signal, then releases the bus and enters the receive state (RX). When the bus is released, a 1kΩ pull-up resistor pulls the bus to a high level. When GX1822 detects the rising edge on the IO pin, wait for 15-60us, and then send a presence pulse consisting of a 60-240us low-level signal.

Figure 13. Initialization Timing



11.2 Read/Write Timing

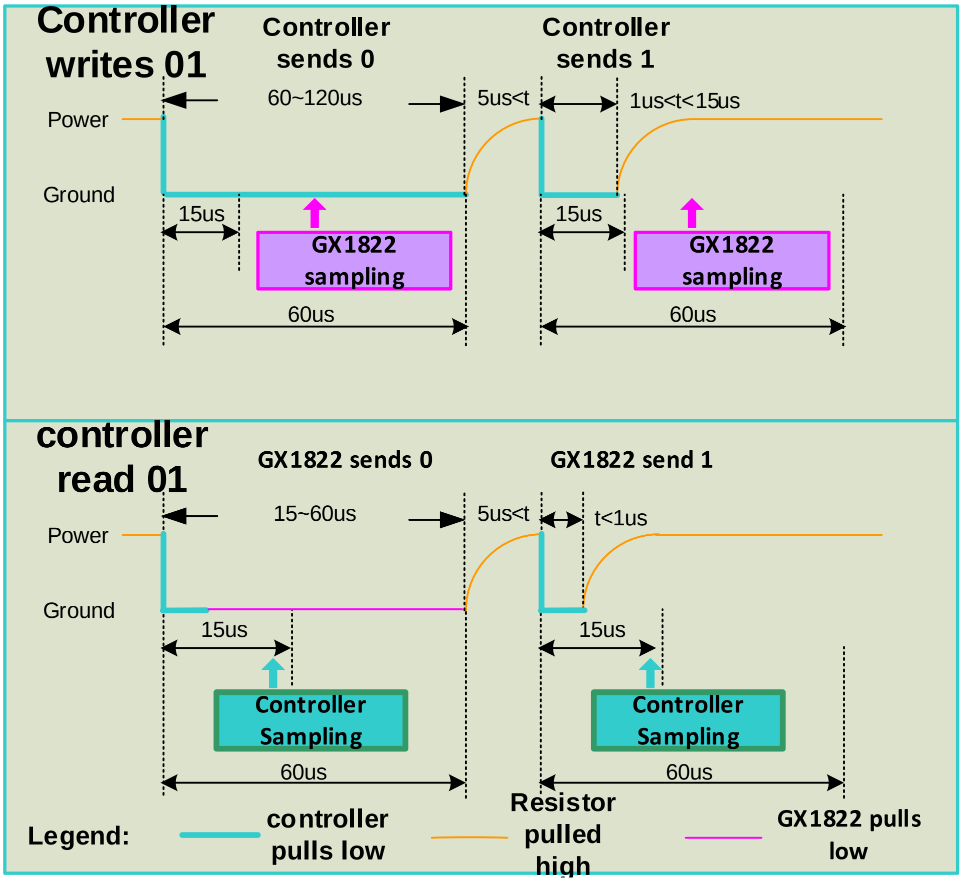
The data read and write of GX1822 is exchanged through timing processing, and each timing transmits 1 bit of data.

WRITE TIME SLOTS

GX1822 has two write timings: write 1 timing and write 0 timing. The bus controller writes a logic 1 by writing a 1 sequence; writes a logic 0 by writing a 0 sequence. The write sequence must last a minimum of 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 14).

To generate a write sequence, the bus controller must pull the data line to a low level and then release it, 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 to a low level and keep it for at least 60us.
After the bus controller initializes the write sequence, GX1822 adopts the signal line in a window of 15us to 60us. If the line is high, write 1. Conversely, if the line is low, write 0.

Figure 14. Read/Write Time Slot Timing Diagram



READ TIME SLOTS

When the bus controller initiates a read sequence, the GX1822 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 read power mode command [B4h], so that GX1822 can provide the requested data. In addition, the bus controller reads the sequence after issuing the send temperature conversion command [44h] or the recall EEPROM command [B8h], see the GX1822 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 level to low level, the read sequence starts, the data line must be kept at least 1us, and then the bus is released (see Figure 14). After the bus controller issues a read sequence, the GX1822 transmits 1 or 0 by pulling high or low on the bus. When the transmission of 0 ends, the bus will be released and return to the high level idle state through the pull-up resistor. The data output from GX1822 is valid within 15us after the falling edge of the read sequence occurs. 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 15 indicates that the sum of TINIT, TRC, and TSAMPLE must be less than 15us. Figure 16 indicates that system time can be maximized by keeping TINIT and TRC as short as possible and placing the controller sampling time at the end of the

15us period.

Figure 15. Detailed Master Read 1 Timing

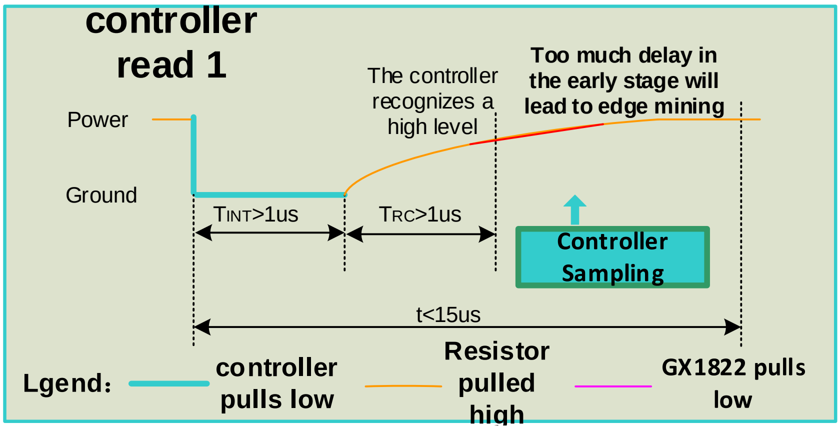
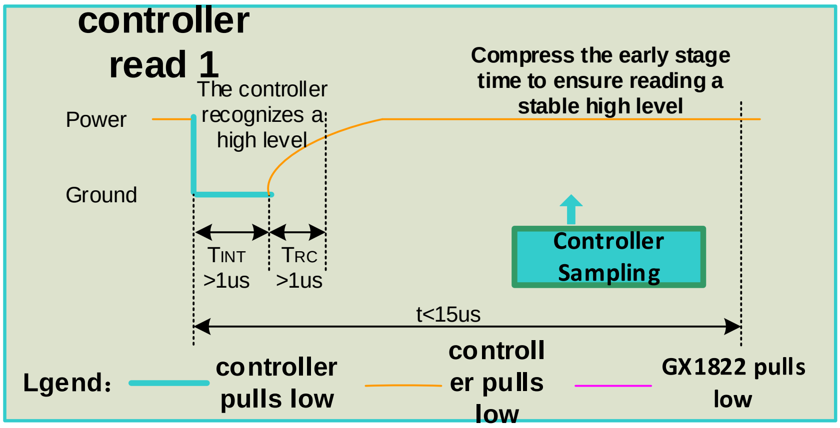


Figure 16. Recommended Master Read 1 Timing



12. GX1822 operation example

12.1 Example 1

In this example, there are multiple GX1822 powered by parasitic power on the bus. The bus controller initiates a temperature conversion for a specific GX1822, then reads its registers and recalculates the CRC to validate the data.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	The controller issues a reset pulse
Rx	Presence	GX1822 returns presence pulse
Tx	55h	The main controller sends a matching ROM instruction
Tx	64-bit ROM code	Master sends GX1822 ROM code.
Tx	44h	Master issues Convert T command
Tx	DQ line held high by strong pullup	The DQ signal remains at a high level for at least 500ms, and the temperature conversion has been completed
Tx	Reset	Master issues reset pulse.
Rx	Presence	GX1822 respond with presence pulse.
Tx	55h	Master issues Match ROM command.
Tx	64-bit ROM code	Master sends GX1822 ROM code.
Tx	BEh	The main control issues a read register command
Rx	9 data bytes	Read the entire register plus CRC: the controller recalculates the CRC of the 8 data bytes read from the register, and compares the calculated CRC with the read CRC. If they are the same, the controller proceeds downward; if they are different, it re-calculates operate

12.1 Example 2

In this example there is only one parasitic powered GX1822 on the bus. The controller writes TH, TL and configuration registers, then reads the registers and calculates CRC to verify the data. The master controller copies the data in the registers to the EEPROM.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	reset pulse
Rx	Presence	GX1822 returns presence pulse
Tx	CCh	Skip ROM instruction
Tx	4Eh	write register instruction
Tx	3 data bytes	Write 3 data to T_H, T_L, and configuration registers.
Tx	Reset	reset pulse
Rx	Presence	GX1822 returns presence pulse
Tx	CCh	Skip ROM instruction
Tx	BEh	Read register instruction.

Rx	9 data bytes	The main controller reads all registers including CRC: the controller recalculates the 8-byte CRC read from the register, compares the calculated CRC with the read CRC, and if they are the same, the controller proceeds downward; if If not, repeat the read operation.
Tx	Reset	reset pulse.
Rx	Presence	GX1822 returns presence pulse
Tx	CCh	Skip ROM instruction.
Tx	48h	copy register instruction
Tx	DQ line held high by strong pullup	The controller gives a strong pull-up to DQ and keeps it at least 10ms when performing a copy operation

13. extreme conditions of use

Voltage range of each pin to ground ....-0.5V to +6.0V

Range of working temperature ………………... -55°C to +125°C

Storage range ……………….. -55°C to +125°C

Soldering temperature range .... Refer to the J-STD-020A Specification.

The above points out the environmental conditions required by the device for normal operation, and long-term work under extreme conditions may affect the reliability of the device.

14. DC characteristics

(-55°C to +125°C; V_{DD}=2.5V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT	NOTES
supply voltage	V_{DD}	local power	+2.5		+5.5	V	1
Pull up supply voltage	V_{PU}	parasitic power	+2.5		+5.5	V	1,2
		local power	+2.5		V_{DD}		
temperature error	t_{ERR}	-10℃~+85℃			±0.4	℃	3
		-55℃~+125℃			±1.2		
input logic low	V_{IL}		-0.3		+0.8	V	1,4,5
input logic high	V_{IH}	local power	+2.2		The lower of 5.5 or V_{DD}+0.3	V	1,6
		parasitic power	+2.5				
Sink current	I_L	$V_{I/O}$ = 0.4V	4.0			mA	1
stand-by current	I_{DDS}			750	1000	nA	7,8
Working current	I_{DD}	V_{DD} = 5V		45		uA	9

DQ input current	I_{DQ}			5		μA	10
Drift				±0.2		℃	11

NOTES:

1) All voltages are referenced to ground.

2) The Pullup Supply Voltage specification assumes that the pullup device is ideal, and therefore the high level of the pullup isequal to VPU. In order to meet the VIH spec of the GX1822, the actual supply rail for the strong pullup transistor must include margin for the voltage drop across the transistor when it is turned on; thus: VPU_ACTUAL = VPU_IDEAL + VTRANSISTOR.

3) See typical performance curve in Figure 17.

4) Logic-low voltages are specified at a sink current of 4mA.

5) To guarantee a presence pulse under low voltage parasite power conditions, VILMAX may have to be reduced to as low as 0.5V.

6) Logic-high voltages are specified at a source current of 1mA.

7) Standby current specified up to +70°C. Standby current typically is 3μA at +125°C.

8) To minimize IDDS, DQ should be within the following ranges: GND ≤ DQ ≤ GND + 0.3V or VDD – 0.3V ≤ DQ ≤ VDD.

9) Active current refers to supply current during active temperature conversions or EEPROM writes.

10) DQ line is high (“high-Z” state).

11) Drift data is based on a 1000-hour stress test at +125°C with VDD = 5.5V.

15. AC characteristics

(-55°C to +125°C; V_{DD} = 2.5V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NV Write Cycle Time	t_{WR}			8	12	ms
EEPROM Writes	N_{EEWR}	-55°C to +125°C	1000			writes
EEPROM Data Retention	t_{EEDR}	-55°C to +125°C	10			years

(-55°C to +125°C; V_{DD} = 2.5V to 5.5V)

PARAMETER	SYMBO	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Temperature Conversion Time	t_{CONV}	9-bit resolution			40	ms	1
		10-bit resolution			80		
		11-bit resolution			160		
		12-bit resolution			320		
Time to Strong Pullup On	t_{SPON}	Start Convert T Command Issued			10	μs	
Time Slot	t_{SLOT}		60		120	μs	1
Recovery Time	t_{REC}		1			μs	1

Write 0 Low Time	t_{LOW0}		60		120	µs	1
Write 1 Low Time	t_{LOW1}		1		15	µs	1
Read Data Valid	t_{RDV}				15	µs	1
Reset Time High	t_{RSTH}		480			µs	1
Reset Time Low	t_{RSTL}		1			ms	1
Presence-Detect High	t_{PDHIGH}		15		60	µs	1
Presence-Detect Low	t_{PDLOW}		60		240	µs	1
Capacitance	$C_{IN/OUT}$				25	pF	

NOTES:

1)

Figure 17. Typical Performance Curve

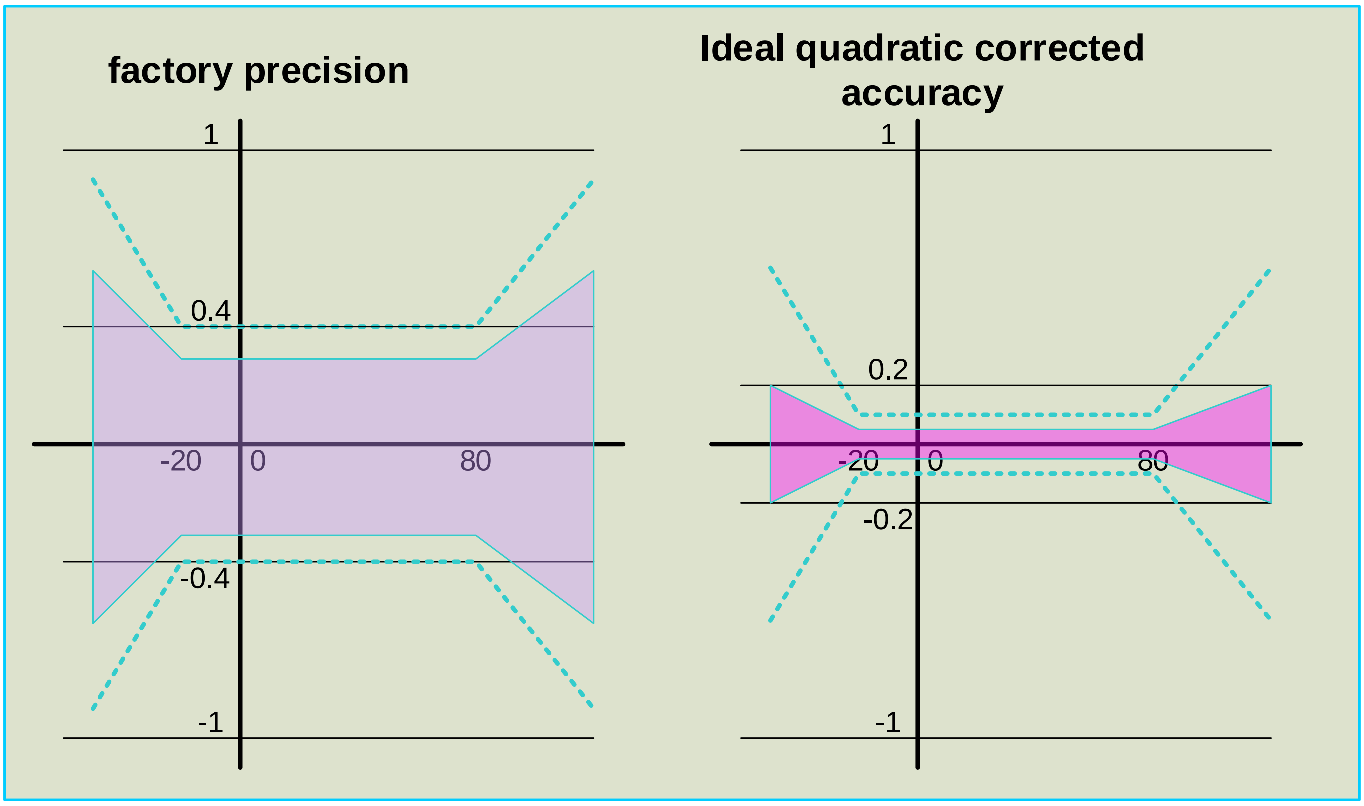
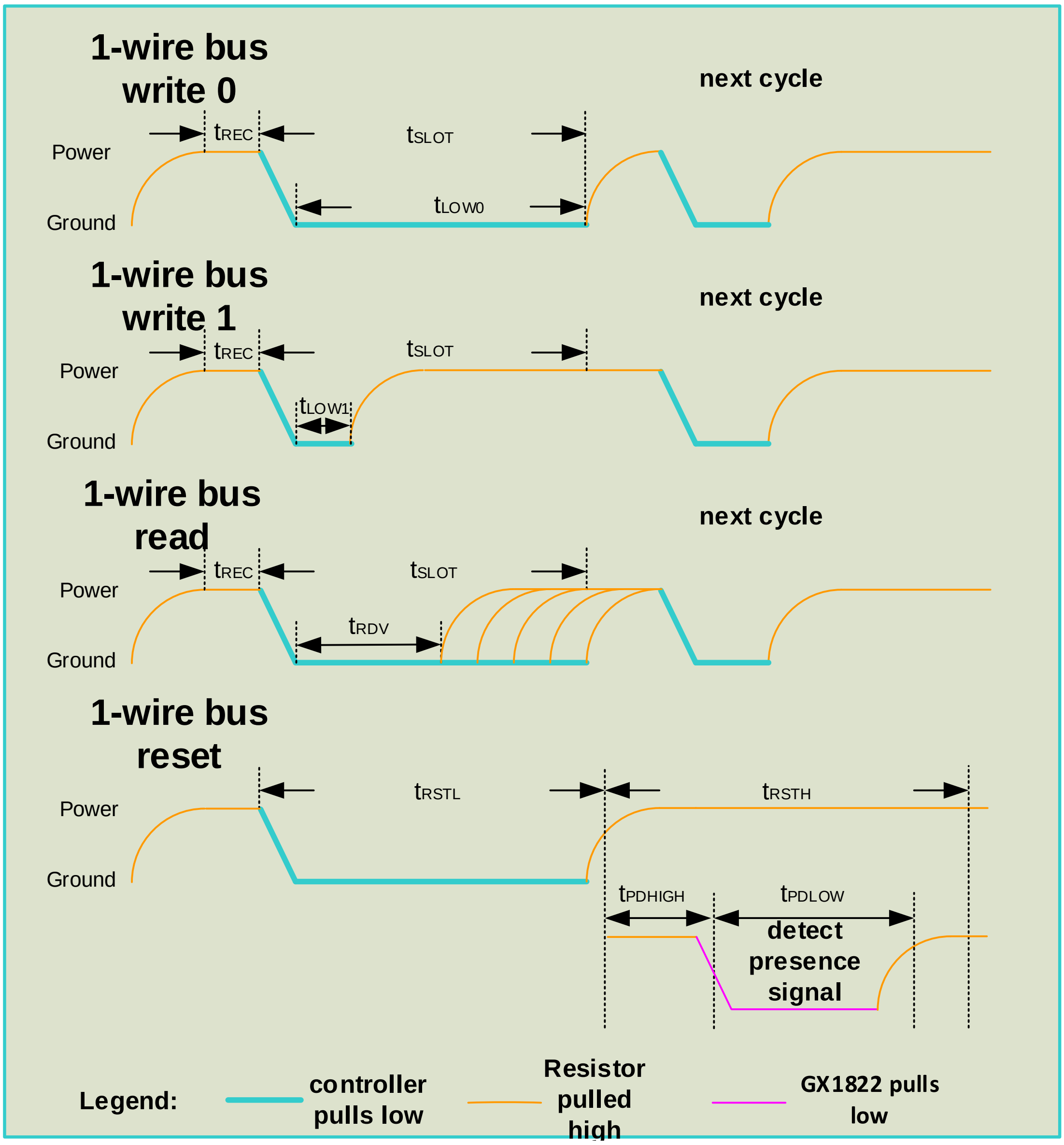


Figure 18. Timing Diagrams

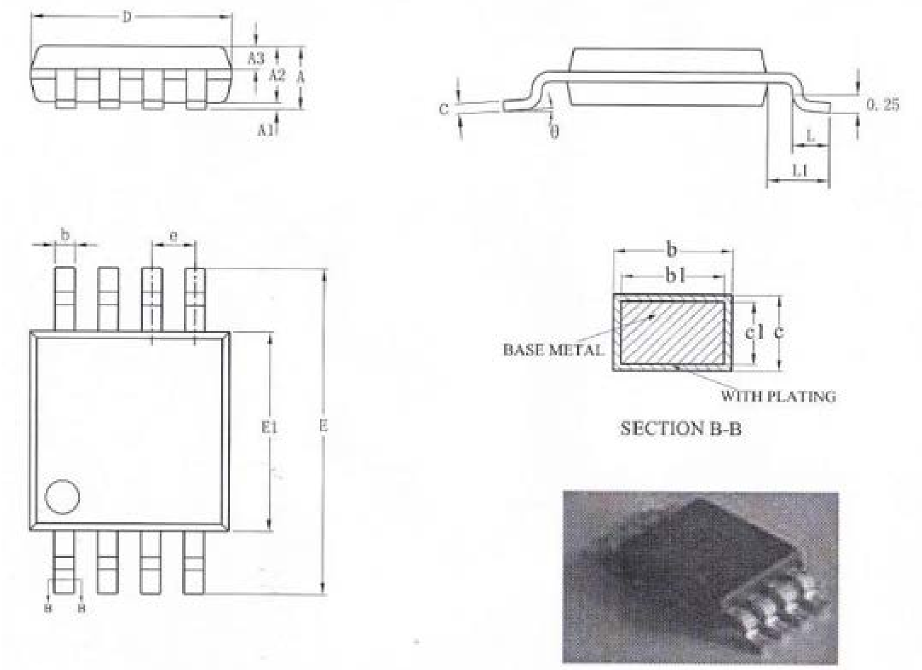


16. Product Package Model List

Product	package	accuracy
GX1822	TO-92（3 pin）	±0.4°C(customizable±0.3°C/0.2°C)
GX1822U	MSOP8	±0.5°C
GX1822S	TO-92S	±0.4°C(customizable±0.3°C/0.2°C)

16. 1 Package size

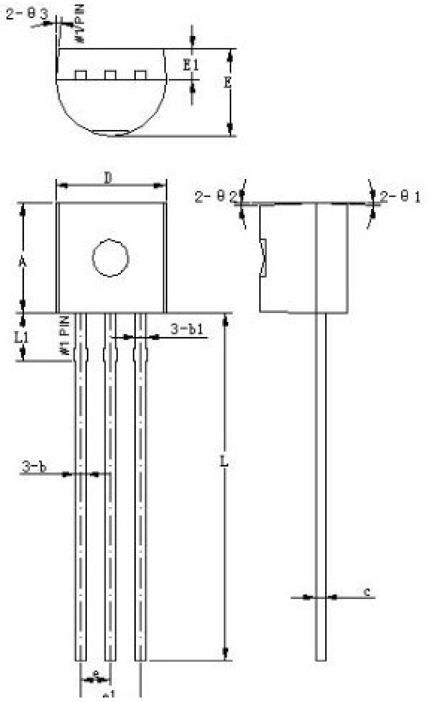
1) GX1822U　MSOP8



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.05	—	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	—	0.36
b1	0.27	0.30	0.33
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40	—	0.70
L1	0.95REF		
θ	0	—	8°

2）GX1822　TO92

TO-92-A1

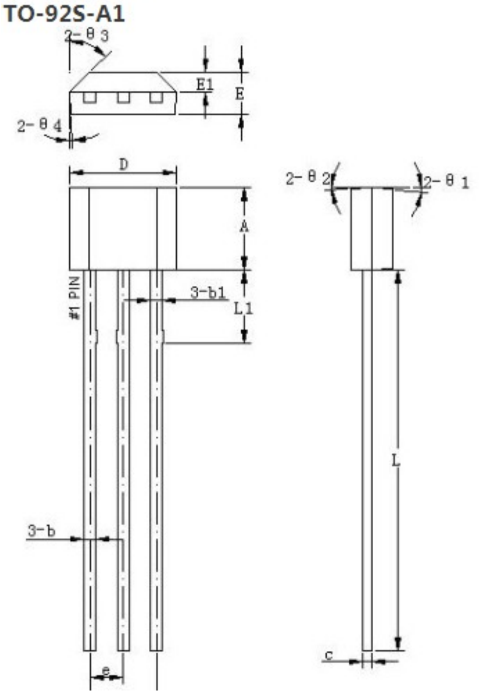


符号	机械尺寸/mm		
	最小值	典型值	最大值
A	4.5	4.6	4.7
b	0.38	0.46	0.56
b1		0.46	
c	0.36	0.38	0.51
D	4.5	4.6	4.7
E	3.45	3.6	3.75
E1	1.2	1.3	1.4
e		1.27	
e1		2.54	
L	13.5	14.5	15.3
L1		1.96	
θ1		2°	
θ2		2°	
θ3		5°	

3）GX1822S　TO92S

TO-92S-A1/A2

TO-92S-A1



符号	机械尺寸/mm		
	最小值	典型值	最大值
A	3.08	3.18	3.28
b	0.38	0.44	0.56
b1		0.44	
c	0.36	0.38	0.51
D	4.0	4.1	4.2
E	1.47	1.57	1.67
E1		0.76	
e		1.27	
e1		2.54	
L	13.5	14.5	15.5
L1		2.8	
θ1		6°	
θ2		3°	
θ3		45°	
θ4		3°	