SENSYLINK

CT1780

Cold-Junction Compensated, Single-Wire Thermocouple-to-Digital Converter

PDescription

CT1780 performs cold-junction compensation and digitizes the signal from a K-, J-, N-, T-, S-, R-, or E-type thermocouple. The converter resolves temperatures to 0.25°C, allowing readings as high as +1768°C and as low as -270°C.
Communication with the master microcontroller is over a Single-Wire bus that by definition requires only one data line (and ground) for communication.
Each device has a unique 64-bit serial code, which allows multiple units to function on the same Single-Wire bus. Therefore, it is simple to use one microcontroller (the master device) to monitor temperature from many thermocouples distributed over a large area.

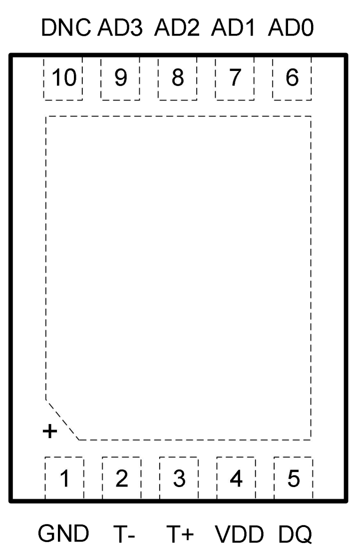
Features

- Operation Voltage: 3.0V to 5.5V
- 14-bit for 0.25°C resolution
- Integrated Cold-Junction Compensation
- Available for Multiple Thermocouples Types: Supports K-, J-, N-, T-, and E- Type
- Detects Thermocouple Shorts to GND or VDD
- Detects Open Thermocouple
- Compatible with Single-Wire interface
- Operation Temperature Range: -40°C to 125°C

Application

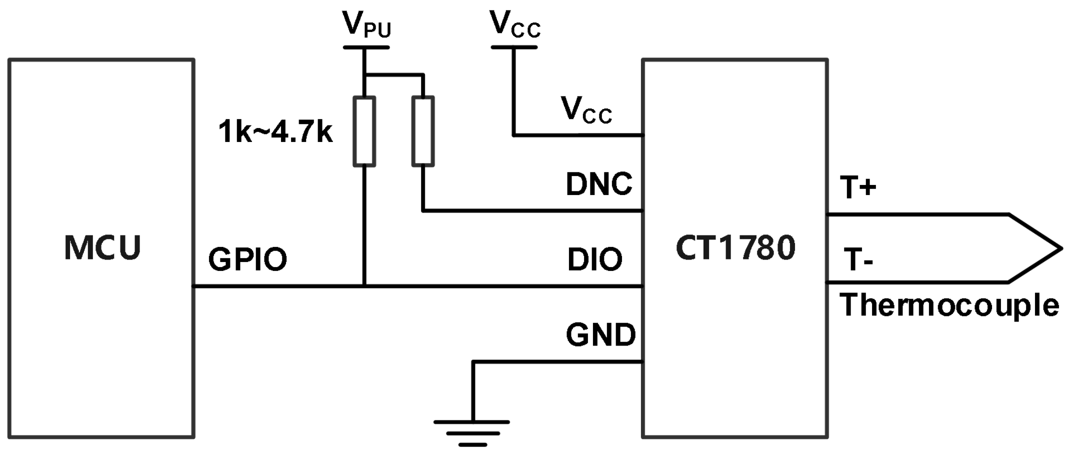
- HVAC
- Industrial
- Medical
- Appliances

PIN Configurations (Top View)



DFN3x4-10 (Package Code DN)

Typical Application

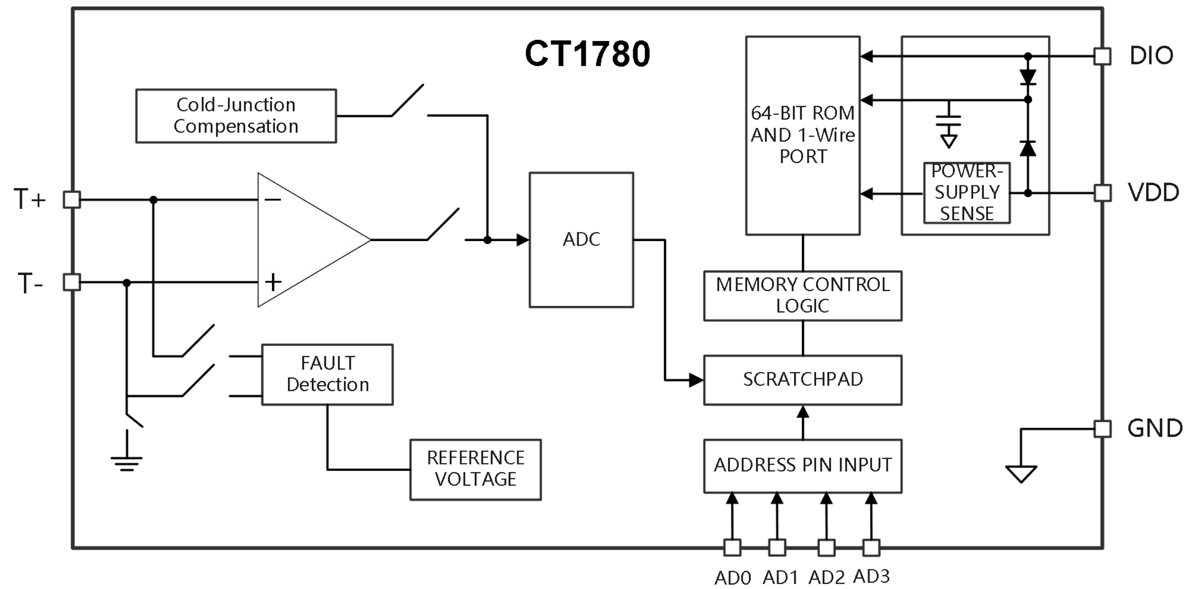


CT1780 Typical Application

Pin Description

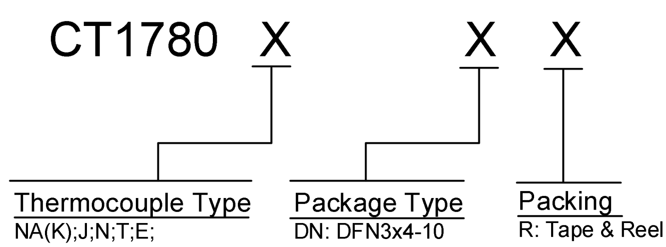
Pin NO.	Pin Name	Type	Description
1	GND	Ground	Ground
2	T-	Analog Input	Thermocouple Input. Do not connect to GND.
3	T+	Analog Input	Thermocouple Input
4	VDD	Power	Power-Supply Voltage
5	DQ	Digital I/O	Data Input/Output. Open-drain Single-Wire interface pin.
6	AD0	Digital Input	Location Address Input (Least Significant Bit)
7	AD1	Digital Input	Location Address Input
8	AD2	Digital Input	Location Address Input
9	AD3	Digital Input	Location Address Input (Most Significant Bit)
10	DNC	/	Connect to V_{PU} through a Pull-up resistor.

Function Block



Function Block

Ordering Information



Order PN	Thermocouple Type	Green	Package	Marking ID	Packing	MPQ	Operation Temperature
CT1780DNR	K	Halogen free	DFN3X4-10	1780 YWWAXX	Tape & Reel	5,000	-40ºC~+125ºC
CT1780JDNR	J	Halogen free	DFN3X4-10	1780J YWWAXX	Tape & Reel	5,000	-40ºC~+125ºC
CT1780NDNR	N	Halogen free	DFN3X4-10	1780N YWWAXX	Tape & Reel	5,000	-40ºC~+125ºC
CT1780TDNR	T	Halogen free	DFN3X4-10	1780T YWWAXX	Tape & Reel	5,000	-40ºC~+125ºC
CT1780EDNR	E	Halogen free	DFN3X4-10	1780E YWWAXX	Tape & Reel	5,000	-40ºC~+125ºC

Notes

1. Based on ROHS Y2012 spec, Halogen free covers lead free. So most package types Sensylink offers only states halogen free, instead of lead free.

2. Marking ID includes 2 rows of characters. In general, the 1st row of characters are part number, and the 2nd row of characters are date code plus production information.

Table of Contents

1. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to 6.5	V
All Other Pins Voltage	V_{IO}	-0.3 to Vcc+0.3	mA
Junction Temperature	T_J	-50 to 150	ºC
Storage temperature Range	T_{STG}	-65 to 150	ºC
Lead Temperature (Soldering, 10 Seconds)	T_{LEAD}	260	ºC
ESD MM	ESD_{MM}	±200	V
ESD HBM	ESD_{HBM}	±4000	V
ESD CDM	ESD_{CDM}	±1000	V

Note：

1. *Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at the "Absolute Maximum Ratings" conditions or any other conditions beyond those indicated under "Recommended Operating Conditions" is not recommended. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.*

2. Recommended Operating Conditions

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	3.0 ~ 5.5	V
Ambient Operation Temperature Range	T_A	-40 ~ +125	°C

3. Electrical Characteristics

Test Conditions: VCC = 3.0V to 5.5V, TA = -40°C to +125°C, unless otherwise noted.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{CC}		3.0		5.5	V
Pullup Supply Voltage	V_{PU}		3.0		V_{CC}	V
Input Logic-Low	V_{IL}		-0.3		+0.8	V
Input Logic-High	V_{IH}		2.2		V_{CC} + 0.3	V
Output Sink Current	I_L	$V_{I/O}$ = 0.4V	4.0			mA
Standby Supply Current	I_{stb}	T_A = 70℃		280	1000	nA
Active Supply Current	I_{cc}	VDD = 3.7V		1300	1750	μA
DIO Input Current	I_{DIO}	DIO is high-impedance state with external pullup		3.5		μA
Power-Supply Rejection		V_{CC}=3.0V to 5.0V		-0.3		°C/V
Input Leakage Current (AD0–AD3 Pins)			-1		+1	μA
Thermocouple Input Bias Current	I_{BTC}	T_A = -40℃ to +125℃, 100mV across the thermocouple inputs	-100		+100	nA

4. Thermal Characteristics

Not including cold-junction temperature error or thermocouple nonlinearity.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
CT1780K Thermocouple Temperature Gain and Offset Error (41.276FV/°C nominal sensitivity)	$T_{THERMOCOUPLE}$ = -100°C to +100°C, T_A = 0°C to +70°C	-1		1	°C
	$T_{THERMOCOUPLE}$ = -200°C to +700°C, T_A = -20°C to +85°C	-2		+2	
	$T_{THERMOCOUPLE}$ = +700°C to +1372°C, T_A = -20°C to +85°C	-4		+4	
	$T_{THERMOCOUPLE}$ = -270°C to +1372°C, T_A = -40°C to +125°C	-6		+6	
CT1780J Thermocouple Temperature Gain and Offset Error (57.953FV/°C nominal sensitivity)	$T_{THERMOCOUPLE}$ = -100°C to +100°C, T_A = 0°C to +70°C	-1		+1	°C
	$T_{THERMOCOUPLE}$ = -210°C to +750°C, T_A = -20°C to +85°C	-2		+2	
	$T_{THERMOCOUPLE}$ = -210°C to +1200°C, T_A = -40°C to +125°C	-4		+4	
CT1780N Thermocouple Temperature Gain and Offset Error (36.256FV/°C nominal sensitivity)	$T_{THERMOCOUPLE}$ = -100°C to +100°C, T_A = 0°C to +70°C	-1		+1	°C
	$T_{THERMOCOUPLE}$ = -200°C to +700°C, T_A = -20°C to +85°C	-2		+2	
	$T_{THERMOCOUPLE}$ = +700°C to +1300°C, T_A = -20°C to +85°C	-4		+4	
	$T_{THERMOCOUPLE}$ = -270°C to +1300°C, T_A = -40°C to +125°C	-6		+6	
CT1780T Thermocouple Temperature Gain and Offset Error (52.18FV/°C nominal sensitivity)	$T_{THERMOCOUPLE}$ = -100°C to +100°C, T_A = 0°C to +70°C	-1		+1	°C
	$T_{THERMOCOUPLE}$ = -270°C to +400°C, T_A = -20°C to +85°C	-2		+2	
	$T_{THERMOCOUPLE}$ = -270°C to +400°C, T_A = -40°C to +125°C	-4		+4	
CT1780E Thermocouple Temperature Gain and Offset Error (76.373FV/°C nominal sensitivity)	$T_{THERMOCOUPLE}$ = -120°C to +100°C, T_A = -20°C to +85°C	-1		+1	°C
	$T_{THERMOCOUPLE}$ = -200°C to +700°C, T_A = -20°C to +85°C	-2		+2	

	$T_{THERMOCOUPLE}$ = +700°C to +1000°C, T_A = -20°C to +85°C	-4		+4	
	$T_{THERMOCOUPLE}$ = -270°C to +1000°C, T_A = -40°C to +125°C	-5		+5	
	$T_{THERMOCOUPLE}$ = -50°C to +700°C, T_A = -20°C to +85°C	-3		+3	
	$T_{THERMOCOUPLE}$ = +700°C to +1768°C, T_A = -20°C to +85°C	-5		+5	
	$T_{THERMOCOUPLE}$ = -50°C to +1768°C, T_A = -40°C to +125°C	-7		+7	
Thermocouple Temperature Data Resolution			0.25		°C
Internal Cold-Junction Temperature Error	T_A = -40°C to +100°C	-2		+2	°C
Cold-Junction Temperature Data Resolution	T_A = -40°C to +125°C		0.0625		°C
Temperature Conversion Time (Thermocouple, Cold Junction, Fault Detection)			72	100	ms

5. Single-Wire Timing Characteristics

Test Conditions: VCC = 3.0V to 5.5V, TA = -40°C to +125°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Time to Strong Pullup On	t_{SPON}	Start Convert T command issued			8	µs
Time Slot	t_{SLOT}		50		120	µs
Recovery Time	t_{REC}		1			µs
Write-0 Low Time	t_{W0L}		50		120	µs
Write-1 Low Time	t_{W1L}		1		15	µs
Read Data Valid	t_{HSR}				15	µs
Reset Time Low	t_{RESET}	Local power	480			µs
Presence Detect High	t_{PDH}		15		60	µs
Presence Detect Low	t_{PDL}		60		240	µs
Capacitance: DIO	$C_{IN/OUT}$				25	pF
Capacitance: AD0–AD3	C_{IN_ADD}				50	pF

6. Function Description

Detailed Description

The CT1780 is a sophisticated thermocouple-to-digital converter with a built-in 14-bit ADC, cold-junction compensation sensing and correction, a digital controller, a Single-Wire data interface, and associated control logic.

6.1.1. Temperature Conversion

The device includes signal-conditioning hardware to convert the thermocouple's signal into a voltage compatible with the input channels of the ADC. The T+ and T- inputs connect to internal circuitry that reduces the introduction of noise errors from the thermocouple wires.

Before converting the thermoelectric voltages into equivalent temperature values, it is necessary to compensate for the difference between the thermocouple cold-junction side (device ambient temperature) and a 0°C virtual reference. For a K-type thermocouple, the voltage changes by approximately 41µV/°C, which approximates the thermocouple characteristic with the following linear equation:

$$V_{OUT} = (41.276\mu V/°C) \times (T_R - T_{AMB})$$

where V_{OUT} is the thermocouple output voltage (µV), T_R is the temperature of the remote thermocouple junction (°C), and T_{AMB} is the temperature of the device (°C).

Other thermocouple types use a similar straight-line approximation but with different gain terms. Note that the CT1780 assumes a linear relationship between temperature and voltage. Because all thermocouples exhibit some level of nonlinearity, apply appropriate correction to the device's output data.

6.1.2. Cold-Junction Compensation

The function of the thermocouple is to sense a difference in temperature between two ends of the thermocouple wires. The thermocouple's "hot" junction can be read across the operating temperature range. The reference junction, or "cold" end (which should be at the same temperature as the board on which the device is mounted) can range from -40°C to +125°C. While the temperature at the cold end fluctuates, the device continues to accurately sense the temperature difference at the opposite end.

The device senses and corrects for the changes in the reference junction temperature with cold-junction compensation. It does this by first measuring its internal die temperature, which should be held at the same temperature as the reference junction. It then measures the voltage from the thermocouple's output at the reference junction and converts this to the non-compensated thermocouple temperature value. This value is then added to the device's die temperature to calculate the thermo-couple's "hot junction" temperature. Note that the "hot junction" temperature can be lower than the cold junction (or reference junction) temperature.

Optimal performance from the device is achieved when the thermocouple cold junction and the device are at the same temperature. Avoid placing heat-generating devices or components near the CT1780 because this could produce cold-junction-related errors.

Table 1 Thermocouple Wire Connections and Nominal Sensitivities

TYPE	T- WIRE	T+ WIRE	TEMP RANGE (°C)	SENSITIVITY (μV/°C)	COLD-JUNCTION SENSITIVITY (μV/°C) (0°C TO +70°C)
K	Alumel	Chromel	-270 to +1372	41.276 (0°C to +1000°C)	40.73
J	Constantan	Iron	-210 to +1200	57.953 (0°C to +750°C)	52.136
N	Nisil	Nicrosil	-270 to +1300	36.256 (0°C to +1000°C)	27.171
T	Constantan	Copper	-270 to +400	52.18 (0°C to +400°C)	41.56
E	Constantan	Chromel	-270 to +1000	76.373 (0°C to +1000°C)	44.123

6.1.3. Conversion Functions

During the conversion time, t_{CONV}, three functions are performed: the temperature conversion of the internal cold-junction temperature, the temperature conversion of the external thermocouple, and the detection of thermo-couple faults.

Powering the CT1780

The CT1780 can be powered by an external supply on the VDD pin.

64-bits ROM ID

Each device contains a unique 64-bit code stored in ROM. The least significant 8 bits of the ROM code contain the device's Single-Wire family code 3Bh. The next 48 bits contain a unique serial number. The most significant 8 bits contain a cyclic redundancy check (CRC) byte that is calculated from the first 56 bits of the ROM code.

8-BIT CRC CODE	48-BIT SERIAL NUMBER	8-BIT FAMILY CODE(3Bh)

Figure 1 64-Bit ROM Code

CRC generator

CRC (Cyclic Redundancy Check) bytes are provided as part of the chip’s 64-bit ROM ID code and in the 9th byte of the register. The equivalent polynomial function of the CRC (ROM or Register) is:

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

7. Scratchpad

Byte 0 and byte 1 of Scratchpad contain the least significant byte and the most significant byte of the thermocouple temperature register, respectively. Bytes 2 and 3 contain the LSB and MSB of the internal (cold-junction) temperature value, as well as fault status. Byte 4 contains the configuration information. Bytes 5, 6, and 7 are reserved for internal use by the device and cannot be overwritten; these bytes return all ones when read.

Byte 8 of Scratchpad is read-only and contains the CRC code for bytes 0–7 of the scratchpad.

	SCRATCHPAD (Power-Up State)
BYTE 0	Cold-Junction-Compensated Thermocouple Temperature LSB and Fault Status (00h)
BYTE 1	Cold-Junction-Compensated Thermocouple Temperature MSB (00h)
BYTE 2	Internal (Cold Junction) Temperature and Fault Status LSB (00h)
BYTE 3	Internal (Cold Junction) Temperature MSB (00h)
BYTE 4	Configuration Register
BYTE 5	RESERVED (FFh)
BYTE 6	RESERVED (FFh)
BYTE 7	RESERVED (FFh)
BYTE 8	CRC

Figure 2 CT1780 Memory Map

Table 2 Temperature Data Format

Cold-Junction-Compensated Thermocouple Temperature Data (Byte 0 and 1)								
BIT	7	6	5	4	3	2	1	0
LSB (BYTE 0)	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	RESERVED	1=Fault
BIT	15	14	13	12	11	10	9	8
MSB (BYTE 1)	Sign	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4

Internal (Cold-Junction) Temperature Data (Byte 2 and 3)								
BIT	7	6	5	4	3	2	1	0
LSB (BYTE 2)	2^{-1}	2^{-2}	2^{-3}	2^{-4}	RESERVED	1 = Short to VDD	1 = Short to GND	1 = Open Circuit
BIT	15	14	13	12	11	10	9	8
MSB (BYTE 3)	Sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Table 3 Thermocouple Temperature Data Format

TEMPERATURE (°C)	DIGITAL OUTPUT
+1600.00	0110 0100 0000 00
+1000.00	0011 1110 1000 00
+100.75	0000 0110 0100 11
+25.00	0000 0001 1001 00
0.00	0000 0000 0000 00
-0.25	1111 1111 1111 11
-1.00	1111 1111 1111 00
-250.00	1111 0000 0110 00

Table 4 Internal (Cold-Junction) Temperature Data Format

TEMPERATURE (°C)	DIGITAL OUTPUT
+127.0000	0111 1111 0000
+100.5625	0110 0100 1001
+25.0000	0001 1001 0000
0.0000	0000 0000 0000
-0.0625	1111 1111 1111
-1.0000	1111 1111 0000
-20.0000	1110 1100 0000
-55.0000	1100 1001 0000

Byte 4 of Scratchpad contains the configuration register, which is organized as shown in Configuration Register Format. The configuration register allows the user to read the programmed value of the address pins. The AD[3:0] bits report the pin-programmed location information. Pins connected to DIO are reported with logic 1, and pins connected to GND are reported as logic 0. Pins connected to DIO or GND through a resistor are valid logic 1s or logic 0s if the resistor is less than 10kΩ. Unconnected or high-impedance (>10kΩ) connections are indeterminate. Bits [7:4] are reserved for internal use and cannot be overwritten; they return a 1 when read.

Table 5 Configuration Register Format

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
—	—	—	—	AD3	AD2	AD1	AD0

8. Single-Wire Bus System

Single-Wire bus system consists of a host and one or more salve devices. In any case, CT1780 are slave devices. The bus host could be a micro-controller or SOC.

Hardware Configuration

According to the definition of Single-Wire bus system, it has only one data line physically. In order to facilitate this, each device on the bus needs to have open-drain or tri-state output, and CT1780's Single-Wire port (DIO pin) uses an open-drain output. Multi-node system consists of a Single-Wire host and multiple slave devices. CT1780 supports around 16kbps (default rate) of fixed and variable communication rate. Pull-up resistor depends primarily on the number of nodes, the communication distance and the line load. If for some reason the device needs suspend temporally and then return to work, it must be placed on the bus idle state.

Operation Sequence

To access this sensor chip through Single-Wire port, the complete procedure includes:

Part 1, Device Reset, refer to below section for description in detail.

Part 2, Bus function command, including ROM Function command and Device Function command. In most cases, Device Function command is followed by ROM Function command. Sometimes, ROM Function command can be used independently without Device Function command, like Search ROM.

Part3, Data Receiving/Transmitting, includes receive data from Single-Wire device or send data to Singe-Wire device.

Device Reset

When the chip is applied power first time, it will perform internal Device Reset action automatically, reset all registers and configurations as initial state, and recall memory data into register as default. All operations of Single-Wire bus always begin with a Device Reset. Device Reset consists of a reset pulse sent by the host and a device responses pulse shown in below Figure. The presence pulse is used to notify the host that the chip is already connected on the bus. When a Single-Wire device sends a response pulse to the host, it tells the host that it is on the bus and ready to work. During the initialization process, host pulls the bus low for t_{RESET} period time, thus produces (Tx) Device Reset pulse. Then, the host releases the bus and goes into receive mode (Rx). When the bus is released, the bus is pulled up by an external pull-up resistor. When a Single-Wire device detects a rising edge, it will remain high for t_{PDH} (2T in typical), then the Single-Wire device generates a presence pulse by pulling the bus low for t_{PDL} (8T in typical). After that the bus is released and pulled back high by the external pull-up resistor, at least keeping the 6T time. Thus, the entire Single-Wire device response cycle is at least t_{PD} (16T in typical). After that, the host can begin to transfer the ROM command. If user needs more precise communication time match, the host can measure the Single-Wire device response t_{PDL} (8T in typical) low pulse, and adjust the time of the original Device Reset pulse, t_{RESET}, and the read sampling timing. Once the device successfully captures the communicate reset pulse, it will use it to set the communication speed.

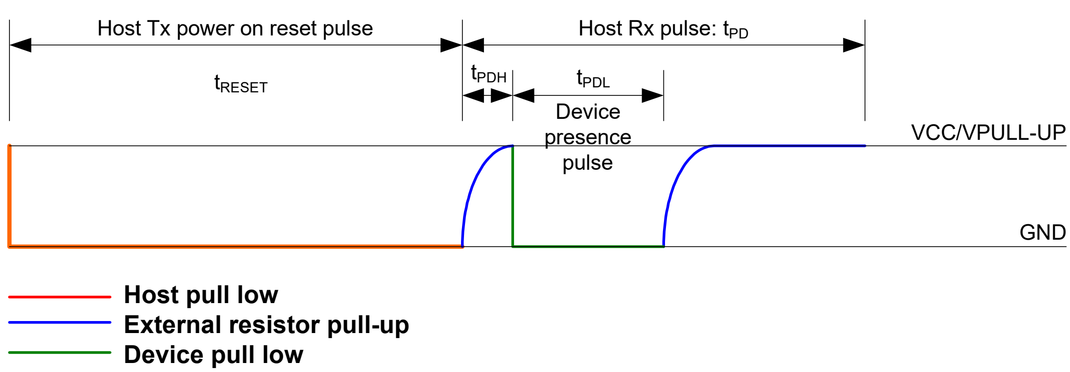


Figure 3 Device Reset Timing Diagram

Single-Wire Timing

After complete reset successfully on Single-Wire bus, the next step is to perform ROM Function command and/or

Device Function command. The following section is to descript the bit transmission. All Single-Wire devices require to strictly comply with Single-Wire communication protocol to ensure data integrity. The protocol defines several signal types: power-on reset pulse, communications reset pulse, presence pulse, write “0”, write “1”, read “0”, and read “1”. All these signals except presence pulse are synchronous signals issued by the host. And all the commands and data are the low byte first which is different from other serial communication format (high byte first).

During Write Time Slot the host writes data to a Single-Wire device; and during the Read Time Slot, the host reads the data from the Single-Wire device. In each time slot, the bus can only transmit one bit data.

8.4.1. Write Time Slot

There are two write time slot modes: write "1" and write "0" slot. The host writes into Single-Wire device "1" by using a write "1" slot, and host write into Single-Wire device "0" by using write "0". All write time slots are at least t_{SLOT} (4*T + t_{REC} in typical), and need the recovery time at least 3μs between two separate time slots. Two kinds of write slots start with pull-down bus by the host shown in below Figure. To produce a write "1" slot, the host must release the bus within t_{W1L} (<= 1*T) after pulling down for 1us, and then the bus is pulled-up by an external pull-up resistors on the bus. To produce a write "0" slot, after the host is pulling the bus low, it maintains a low level during the entire time slot, that is t_{W0L} (> = 4T). During the write time slots, Single-Wire device samples bus level status at t_{SSR} (2*T in typical) time. If sampling results at this time is high, then the logic "1" is written to the device; If "0", the write logic is "0".

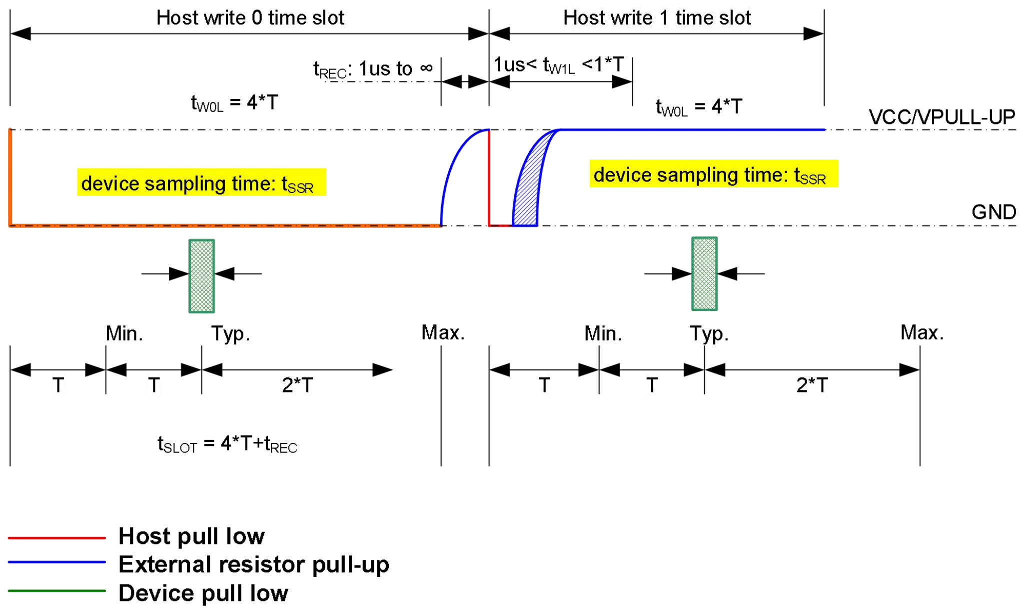


Figure 4 Write Timing Slot Diagram

8.4.2. Read Time Slot

Single-Wire device can only transmit data to the host after the host issues read time slots. After the host issues a read data command, a read time slot must be generated in order to read data from the Single-Wire device. A complete read time slot is at least t_{SLOT} (4*T + t_{REC}), and requires at least 3us recovery time between two separate time slots. Each time slot is generated by the host to initiate the read bit, a low level period is required to be at least 1μs shown in below Figure. Once the device detects a Single-Wire bus low, the device immediately sent bit "0" or "1" on the bus. If Single-Wire device sends "1", the bus is pulled-up high by a pull-up resistor after the short low period; if sent "0", then the bus is keeping low for t_{DRV} (2*T in typical). After that the device releases the bus from pull-up resistors and back to idle high. Therefore, the data issued by Single-Wire device after read time slot at the beginning stay effective during time t_{DRV} (2*T in typical). During the read time slots the host must release the bus, and samples the bus states at 2T after the start of a slot (optimum sampling time point 1T).

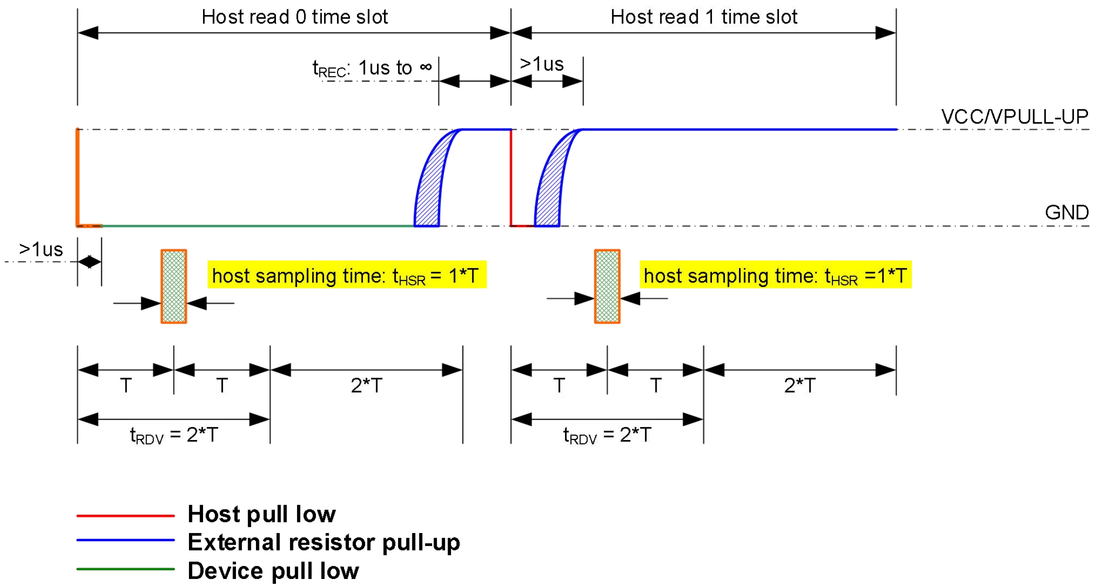


Figure 5 Read Timing Slot Diagram

8.4.3. Multi Devices in Single-Wire Line

This chip is also can be used multi devices connection in Single-Wire line in hardware configuration. The connection is shown as below Figure.

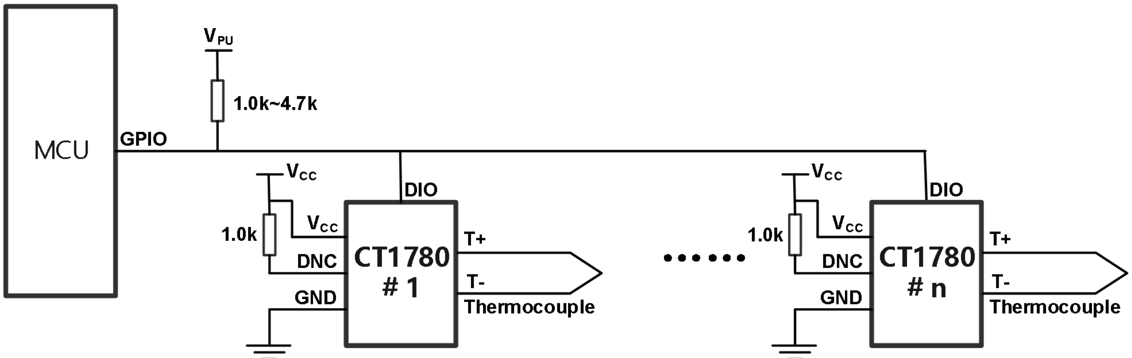


Figure 6 Multi Devices in Single-Wire Line

9. ROM Function Command

After the host detects a presence pulse, it can issue a ROM function command. These commands are related to each device's unique 64-Bit ROM ID code, allowing multiple Single-Wire devices connected on a single bus line and operated accordingly. These commands also allow the host to detect the number of Single-Wire devices and the types, and whether a device is in the alarm state. Each device supports basic 5 kinds ROM command (the actual situation relates to the specific part no.), each command code length is 8-bit. Before Device Function commands are issued, the host must submit the appropriate ROM Function command.

Read ROM [0x33]

This ROM command only applies to one device on Single-Wire bus. It allows the host to read directly the device's 64-Bit ROM ID code without performing a search ROM. If the command is used for multi-node connections, data conflict is inevitable because each device will respond to this command at same time.

Match ROM [0x55]

This command is followed by 64-ROM ID allowing the host to access a specified Single-Wire device in multi-node connections. Only when the slave device completely matches 64-Bit ROM ID, it will respond to the function command that host issued; all other devices will wait for a reset pulse.

Search ROM [0xF0]

When the system powers up, the host must identify all Single-Wire devices' ROM ID codes on the bus. And therefore the host can determine the number and the type of devices. By repeatedly performing a Search ROM command (Search ROM command followed by bits of data exchange), the host identifies all Single-Wire devices on the bus. If the bus has only one device, you can use the read ROM command to replace Search ROM command. After completion of each ROM search, the host must return to the first step in the command sequence (initialization).

Skip ROM [0xCC]

In a single-node application, the host can use this command to quickly access the device on the bus without issuing identical ROM ID code information, which saves corresponding time instead of sending the 64-Bit ROM ID. However in a multi-node application, if the host wants all devices on the bus to perform the same subsequent function command, the host can also use the Skip ROM command. For example, the host issues a Skip ROM command before a Temperature Conversion [0x44] command; then all the CT1780 devices on the same bus will begin the temperature conversion simultaneously. In this way it saves time for performing the entire temperature measurements and gets the temperature conversion results simultaneously. This example is particularly useful for the analysis of temperature fields. Please note, if user issue a Skip ROM command followed by a Read Register [0xBE] command (including other read command), this command can only be applied to a single node system; otherwise multiple nodes will respond to the command and therefore cause conflicting communication data.

10. Function Command

CT1780 Function Commands After the bus master has used a ROM command to address the CT1780 with which it wishes to communicate, the master can issue one of the CT1780 function commands. These commands allow the master to read from the device's scratchpad memories, initiate temperature conversions, and determine the power-supply mode. Figure 17 shows a flowchart for operation of the Function commands. And there are brief description for each Device Function command and the usage.

Temperature Conversion [0x44]

This command initiates a single thermocouple temperature conversion, which consists of measuring the internal (cold junction) temperature, measuring the thermocouple temperature, and detecting any faults. Following the conversion, the resulting cold-junction-compensated thermocouple data, internal temperature data, and fault status are stored in the two 2-byte temperature registers in the scratchpad memory, and the CT1780 returns to its low-power idle state. If the device is powered by an external supply, the master can issue read time slots after the Convert T command and the device responds by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done.

Read Register [0xBE]

This command allows the master to read the contents of Scratchpad. The data transfer starts with the least significant bit of byte 0 and continues through the scratchpad until the 9th byte (byte 8, CRC) is read. The master can issue a reset to terminate reading at any time if only part of the scratchpad data is needed. The CRC is computed while data is read from bytes 0–7, and is shifted out as byte 8.

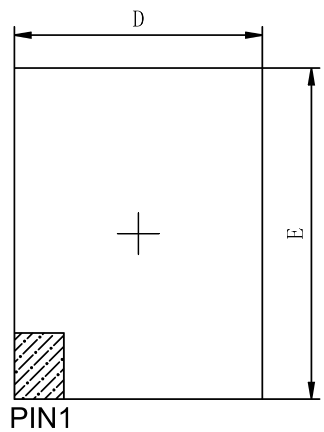
Read Power Mode [0xB4]

When this command is executed, the host will receive 0xFF if the chip is power in normal supply mode (force power at VDD pin).

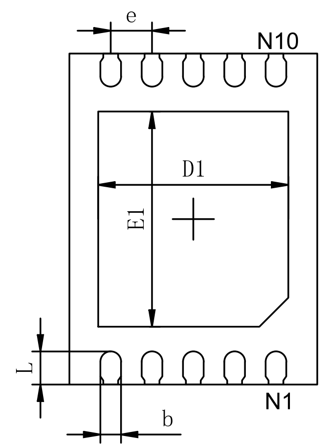
11. Package Outline Dimension and Recommended Land Pattern Layout

Package Outline Dimension (DFN3X4-10)

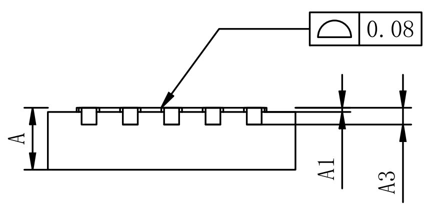
DFN3X4-10 **Unit (mm)**



Top View



Bottom View



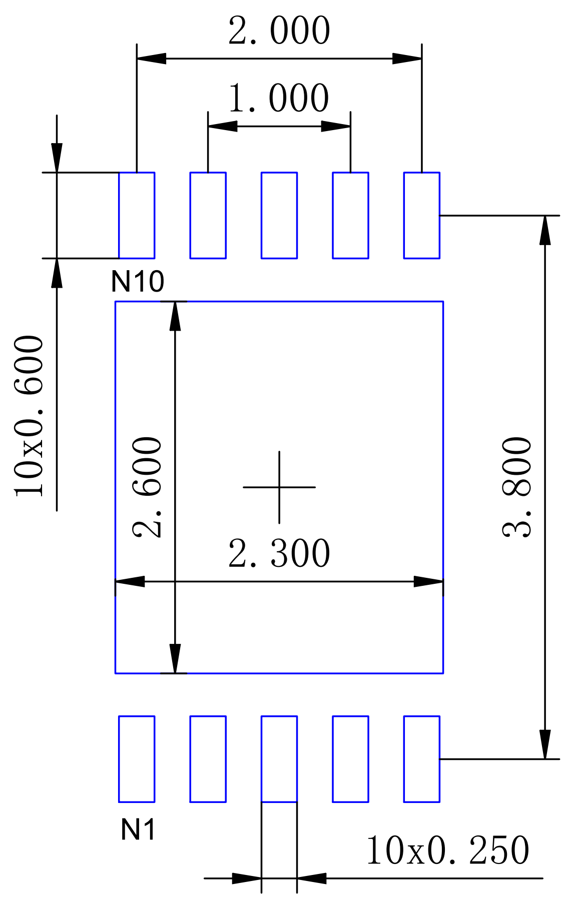
Side View

Symbol	Dimensions in millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203 REF		0.008 REF	
D	2.900	3.100	0.114	0.122
E	3.900	4.100	0.154	0.161
D1	2.200	2.400	0.087	0.094
E1	2.500	2.700	0.098	0.106
b	0.200	0.300	0.008	0.012
e	0.500 BSC		0.020 BSC	
L	0.350	0.450	0.014	0.018

Note：Pin1 shape on backside is not limited to bevel, it can be a notch or arch

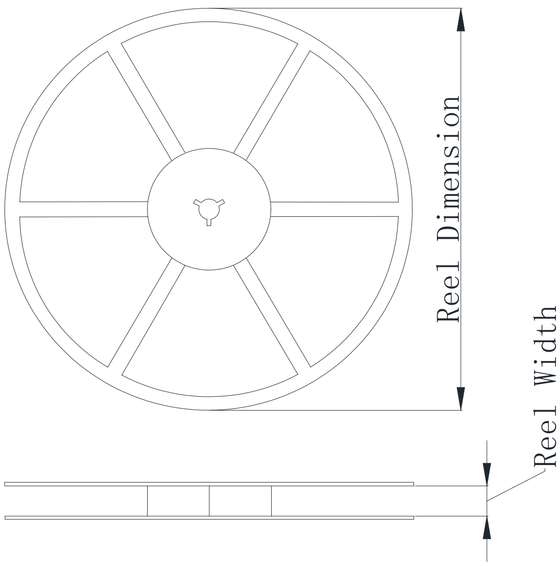
Recommended Land Pattern Layout

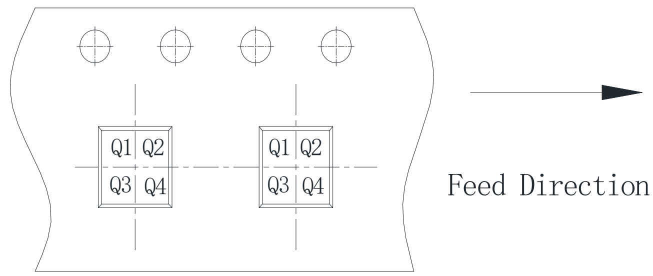
DFN3X4-10 **Unit (mm)**

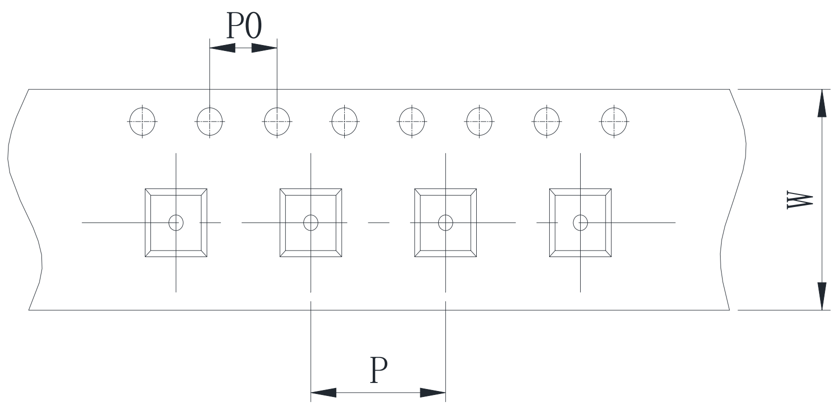


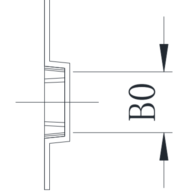
Note：
1. *All dimensions are in millimeter*
2. *Recommend tolerance is within ±0.1mm*
3. *If the thermal pad is not necessary, designer can leave the land pattern area blank*
4. *Change without notice*

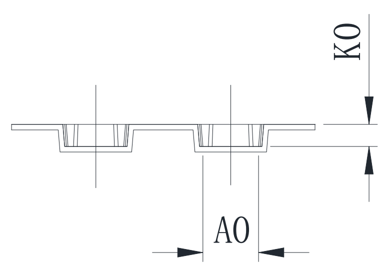
12. Packing Information











Package type	Reel size	Reel dimension (±3.0mm)	Reel width (±1.0mm)	A0 (±0.1mm)	B0 (±0.1mm)	K0 (±0.1mm)	P (±0.1mm)	P0 (±0.1mm)	W (±0.3mm)	Pin1
DFN3x4-10	13'	330	12.4	3.3	4.3	1	8.0	4.0	12.0	Q2

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