TMP110 Ultra-Small, ±1.0°C Accurate, I^{2}C Digital Temperature Sensor for Cost-Sensitive Systems

1 Features

- Ultra-small, leadless X2SON-5 package
  - Package size: 0.8 × 0.8 × 0.4mm
- Wide operating ranges
  - V+ operating range: 1.14V to 5.5V
  - Temperature range: -40°C to 125°C
- Accuracy holds across temperature
  - ±1.0°C (maximum) from -40°C to 125°C
- 12-bit resolution: 0.0625°C (LSB)
- Flexible digital interface
  - I^{2}C and SMBus compatible
  - I3C Mixed Bus co-existence capable
- Pinout and software compatible upgrades
  - ±0.5°C → TMP112 (X2SON package)
- Low supply current
  - 55µA Active current (typical)
  - 0.15µA Shutdown current (typical)
  - 3.2µA Average current (typical) at 1Hz
- Software compatible with Industry-Standard
  - TMP102, TMP112
- Two (2) pinout options available
  - ALERT Pin: TMP110D0, TMP110D1, TMP110D2, TMP110D3
  - Address Pin: TMP110D
- GUI-Based C-Code Generator

2 Applications

- Building automation
  - Occupancy detection
  - Video doorbell
  - HVAC: Wireless environmental sensor
- Factory automation & control
  - Machine vision camera
  - Industrial PC: Single board computer
  - CPU (PLC controller)
- Cold chain
- Data center & enterprise computing
  - Solid state drive (SSD)
  - Rack Server Motherboard
- Personal electronics
  - PC & notebooks, tablets
  - Digital still & video camera
  - Augmented reality glasses
  - Smart speakers

3 Description

The TMP110 is a I^{2}C-compatible digital temperature sensor in an ultra-small (0.64mm^2) 5-pin package. The small size and height package optimizes volume constrained systems where DSBGA packages can be considered unsuitable. Unlike DSBGA packages of comparable size, TMP110 provides a 5th pin that can either be used as an address pin or alert pin, providing flexibility for both scalability of number of sensors or monitoring critical thermal events.

The TMP110 offers an accuracy of ±1.0°C across the temperature range with an on-chip 12-bit analog-to-digital converter (ADC) that provides a temperature resolution of 0.0625°C.

The TMP110 is designed to operate from a supply range as low as 1.14V, with a low average and shutdown current of 3.2µA (at 1Hz) and 0.15µA, respectively, allowing for an on-demand temperature conversion and maximizing of battery life. The supply can also be raised to as high as 5.5V for a range of industrial applications.

Package Information

PART NUMBER	PACKAGE[1]	PACKAGE SIZE[2]
TMP110	X2SON (5)	0.8mm × 0.8mm

(1) For more information, see Section 12.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

Figure 3-1. Simplified Schematic

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4 Related Products

Pin-to-pin and software compatible options are available.

Table 4-1. Related Temperature Sensors

DEVICE	BEST ACCURACY (MAXIMUM)	SOFTWARE COMPATIBLE	ADDRESS/ALERT PIN FUNCTIONALITY	PACKAGE OPTIONS
TMP102	2.0 °C	Yes	Address + Alert	DRL (6-pin SOT563) (1.6 mm × 1.2 mm)
TMP110	1.0 °C	Yes	Separate (Address & Alert)	DPW (5-pin X2SON) (0.8 mm × 0.8 mm)
TMP112	0.5 °C	Yes	Address + Alert (DRL)	DRL (6-pin SOT563) (1.6 mm × 1.2 mm)
			Separate (Address & Alert) (DPW)[1]	DPW (5-pin X2SON) (0.8 mm × 0.8 mm)[1]

(1)   In development.

5 Pin Configuration and Functions
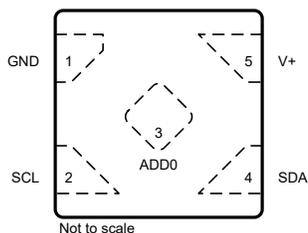
**Figure 5-1. DPW Package
5-Pin X2SON
Address variant
(Top View)**
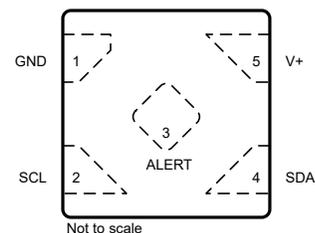
**Figure 5-2. DPW Package
5-Pin X2SON
Alert variant
(Top View)**

Table 5-1. Pin Functions

PIN NAME	PIN NO.	PIN NO.	TYPE[1]	DESCRIPTION
GND	1	1	—	Ground **Pin-1 has curved edges.**
SCL	2	2	I	Serial clock
ADD0 (**TMP110D**)	3	—	I	Address select. Connect to GND, SCL, SDA or V+. **Only for Address variant.**
ALERT (**TMP110D0, TMP110D1, TMP110D2, TMP110D3**)	—	3	O	Overtemperature and undertemperature alert. Open-drain output; requires a pullup resistor. **Only for Alert variant.** **Note:** Connecting to GND if Alert pin is not used is preferred.
SDA	4	4	I/O	Serial data input. Open-drain output; requires a pullup resistor.
V+	5	5	I	Supply voltage

(1)   I = Input, O = Output, I/O = Input or Output.

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6 Specifications

6.1 Absolute Maximum Ratings

Over free-air temperature range unless otherwise noted[1]

		MIN	MAX	UNIT
Supply voltage	V+	−0.3	6	V
Input/Output voltage	SCL, SDA, ADD0, ALERT	−0.3	6	V
Output current			±10	mA
Operating temperature, T_A		−40	125	°C
Junction temperature, T_J			150	°C
Storage temperature, T_{stg}		−55	150	°C

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[1]	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101[2]	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V+	Supply voltage	1.14	3.3	5.5	V
$V_{I/O}$	SCL, SDA, ADD0, ALERT	0		5.5	V
I_{OL}	SDA, ALERT	0		3	mA
T_A	Operating ambient temperature	-40		125	°C

6.4 Thermal Information

	THERMAL METRIC[1]	TMP110	UNIT
		DPW	
		5-pins	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	230	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	194	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	158.4	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	20	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	158.3	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	108.4	°C/W
M_T	Thermal Mass	TBD	mJ/°C

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application note.

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6.5 Electrical Characteristics

Over free-air temperature range and V+ = 1.14 V to 5.5 V (unless otherwise noted); Typical specifications are at T_A = 25 °C and V+ = 3.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
TEMPERATURE SENSOR							
T_{ERR}	Accuracy (temperature error)	-40°C to 125°C	1.14 ≤ V+ ≤ 1.4			± 2.0	°C
			1.4 < V+ ≤ 5.5			± 1.0	°C
PSR	DC power supply rejection	V+ ≥ 1.4			0.02		°C/V
T_{RES}	Temperature resolution				12		Bits
					62.5		m°C
T_{REPEAT}	Repeatability[1]	V+ = 3.3 V 1-Hz conversion cycle			0.0625		°C
T_{LTD}	Long-term stability and drift	1000 hours at 125°C[2]			TBD		°C
t_{RESP_L}	Response time (Stirred Liquid)	2-layer FR4 PCB 1.5748 mm thickness	τ = 63% for step response from 25°C to 75°C		1.45		s
T_{HYST}	Temperature cycling and hysteresis[3]				0.0625		°C
t_{ACT}	Active conversion time	V+ ≥ 1.4 V			10.25	11.25	ms
		V+ < 1.4 V			10.5	12	
t_{CONV}	Conversion Period			0.125	0.25	4	s
t_{VAR}	Timing variation of all device settings	V+ ≥ 1.4 V		-10		10	%
		V+ < 1.4 V		-15		15	
DIGITAL INPUT/OUTPUT							
C_{IN}	Input capacitance	f = 1 MHz			3		pF
V_{IH}	Input logic high	V+ < 1.4		0.8 × V+		V+	V
		1.4 ≤ V+		0.7 × V+		V+	V
V_{IL}	Input logic low	V+ < 1.4		-0.3		0.2 × V+	V
		1.4 ≤ V+		-0.3		0.3 × V+	V
V_{HYST}	Hysteresis				0.1		V
I_{IN}	Input current					± 0.1	µA
V_{OL}	Output logic	V+ ≥ 1.4 V	I_{OL} = –3 mA		0.13	0.4	V
		V+ < 1.4 V	I_{OL} = –0.75 mA			0.2	V
POWER SUPPLY							
I_{DD_ACTIVE}	Supply current during active conversion	Active Conversion, serial bus idle			55	TBD	µA
I_{DD_AVG}	Average current consumption	Continous conversion mode 1 Hz conversion period	Serial bus idle		3.2		µA
			SCL = 1 MHz		13.5		
I_{DD_SB}	Standby current[4]	Continous conversion mode Serial bus idle			2.6	TBD	µA
I_{DD_SD}	Shutdown current	T_A = +25°C, Serial bus inactive			0.15	0.22	µA
		T_A = -40°C to 125°C				1.5	
		Serial bus active, SCL frequency = 400 kHz			5.5		
		Serial bus active, SCL frequency = 1 MHz			13		
V_{POR}	Power-on reset threshold voltage	Supply rising			1.02	1.06	V
	Brownout detect	Supply falling		0.94	0.97		V
t_{INIT}	Power-on reset time				1	TBD	ms

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6.5 Electrical Characteristics (continued)

Over free-air temperature range and V+ = 1.14 V to 5.5 V (unless otherwise noted); Typical specifications are at T_A = 25 °C and V+ = 3.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{RESET}	Reset Time	General Call Reset		0.1	TBD	ms

(1)   Repeatability is the ability to reproduce a reading when the measured temperature is applied consecutively, under the same conditions.
(2)   Long term stability is determined using accelerated operational life testing at a junction temperature of 150°C.
(3)   Hysteresis is defined as the ability to reproduce a temperature reading as the temperature varies from room → hot →room→cold→room. The temperatures used for this test are -40°C, 25°C, and 125°C.
(4)   Quiescent current between periods

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6.6 I²C Interface Timing

minimum and maximum specifications are over –40 °C to 125 °C and V+ = 1.14 V to 5.5 V (unless otherwise noted)[1]

		FAST MODE		FAST MODE PLUS		UNIT
		MIN	**MAX**	**MIN**	**MAX**	
$f_{(SCL)}$	SCL operating frequency	1	400	1	1000	kHz
$t_{(BUF)}$	Bus-free time between STOP and START conditions	0.6		0.5		µs
$t_{(SUSTA)}$	Repeated START condition setup time	0.6		0.26		µs
$t_{(HDSTA)}$	Hold time after repeated START condition. After this period, the first clock is generated.	0.6		0.26		µs
$t_{(SUSTO)}$	STOP condition setup time	0.6		0.26		µs
$t_{(HDDAT)}$	Data hold time[2]	100	900	12	150	ns
$t_{(SUDAT)}$	Data setup time	100		50		ns
$t_{(LOW)}$	SCL clock low period	1.3		0.5		µs
$t_{(HIGH)}$	SCL clock high period	0.6		0.26		µs
$t_{(VDAT)}$	Data valid time (data response time)[3]		0.9		0.45	µs
t_R	SDA, SCL rise time		300		120	ns
t_F	SDA, SCL fall time		300	20 x (V+ / 5.5 V)	120	ns
$t_{timeout}$	Timeout (SCL = GND or SDA = GND)	30		30		ms
t_{LPF}	Glitch suppression filter	50		50		ns

(1) The controller and device have the same V+ value. Values are based on statistical analysis of samples tested during initial release.
(2) The maximum $t_{(HDDAT)}$ can be 0.9 µs for fast mode, and is less than the maximum $t_{(VDAT)}$ by a transition time.
(3) $t_{(VDAT)}$ = time for data signal from SCL LOW to SDA output (HIGH to LOW, depending on which is worse).
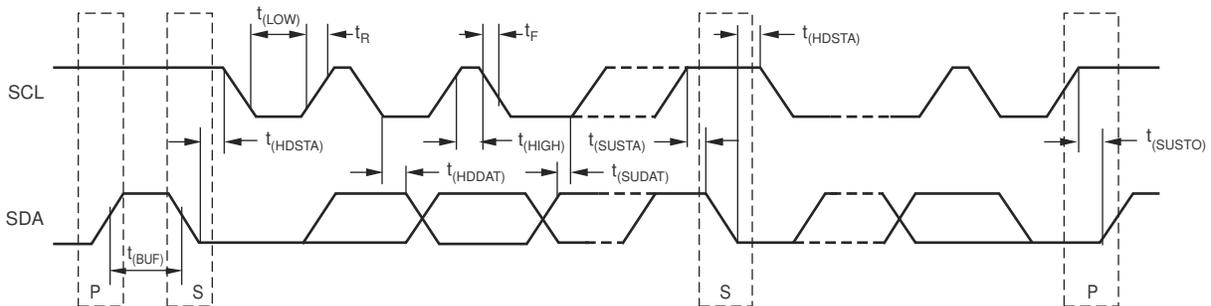
Figure 6-1. Two-Wire Timing Diagram

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6.8 Typical Characteristics

at T_A = 25°C and V_+ = 3.3 V (unless otherwise noted)

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V+ = 3.3 V for Mean, Mean + 3σ, Mean - 3σ

Graphics Placeholder
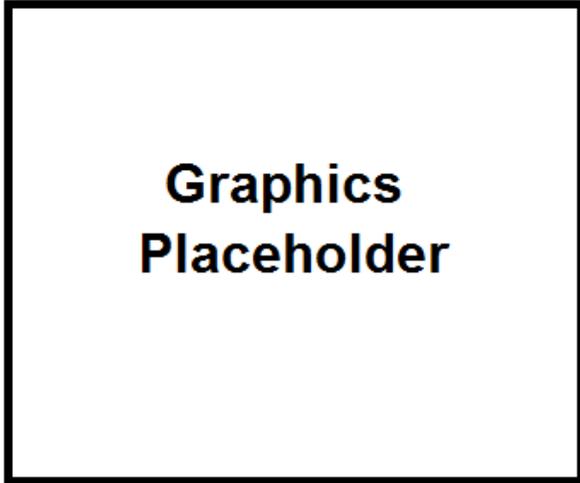
Figure 6-2. Temperature Error vs Temperature

V+ = 1.14 V to 5.5 V; T**A** = -40 °C, 25 °C, 125 °C

Graphics Placeholder
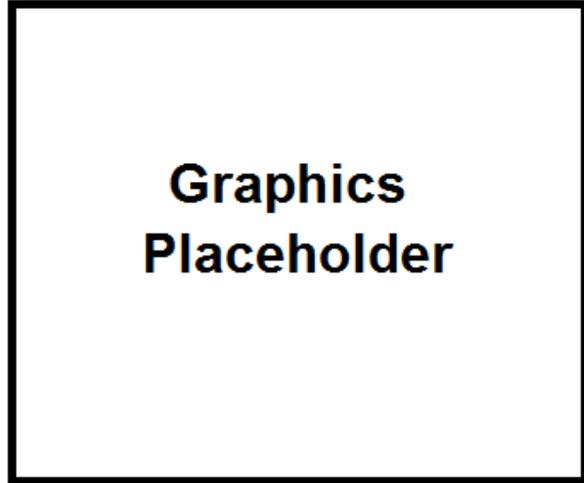
Figure 6-3. Temperature Error vs Supply Voltage

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V and Four conversions per second

Graphics Placeholder
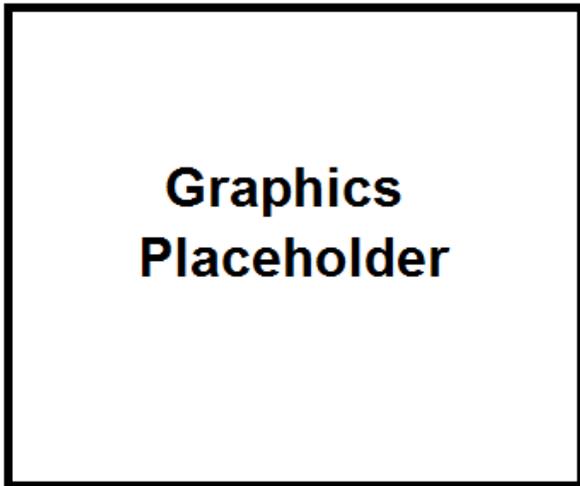
Figure 6-4. Average Quiescent Current vs Temperature

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V

Graphics Placeholder
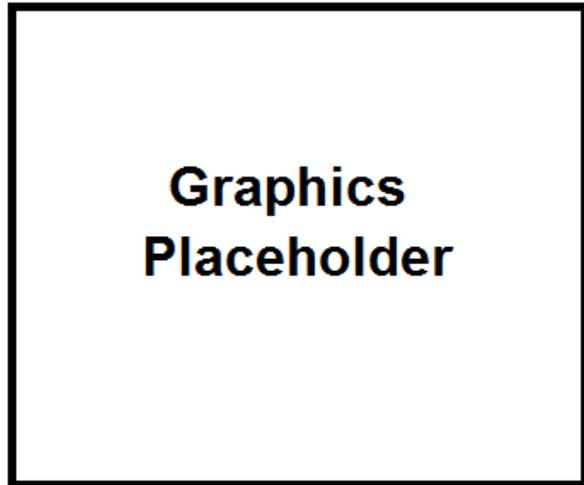
Figure 6-5. Conversion Current vs Temperature

6.8 Typical Characteristics (continued)

at T_A = 25°C and V_+ = 3.3 V (unless otherwise noted)

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V
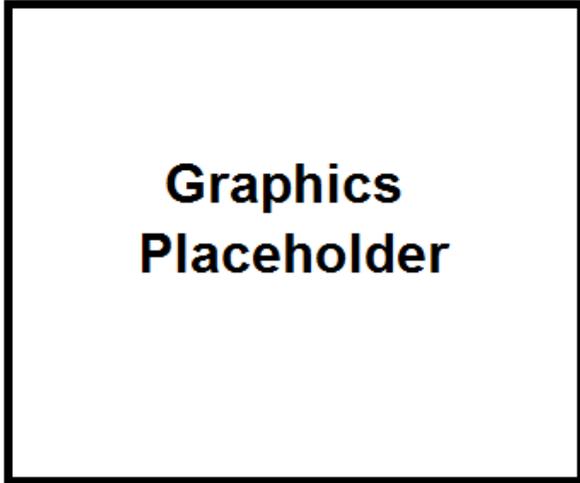
Figure 6-6. Shutdown Current vs Temperature
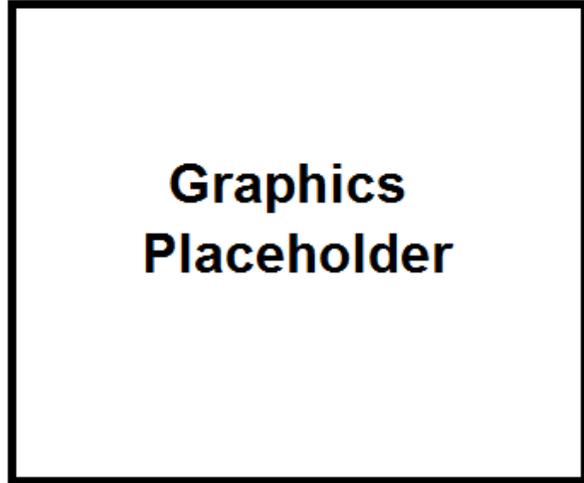
V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V

Figure 6-7. Standby Current vs Temperature

T**A** = -40 °C, 25 °C, 125 °C
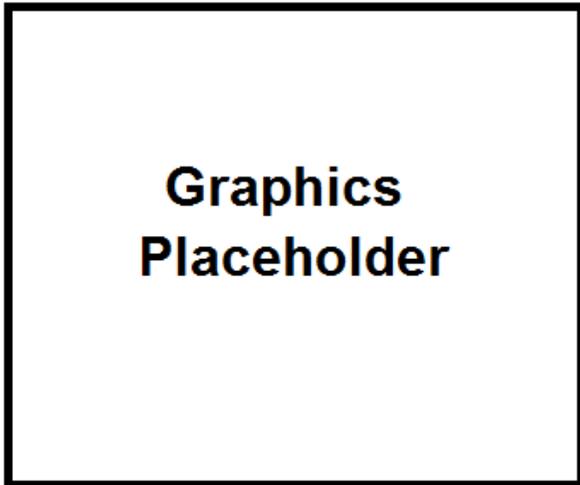
Figure 6-8. Quiescent Current vs Bus Frequency (Temperature at 3.3-V Supply)

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V
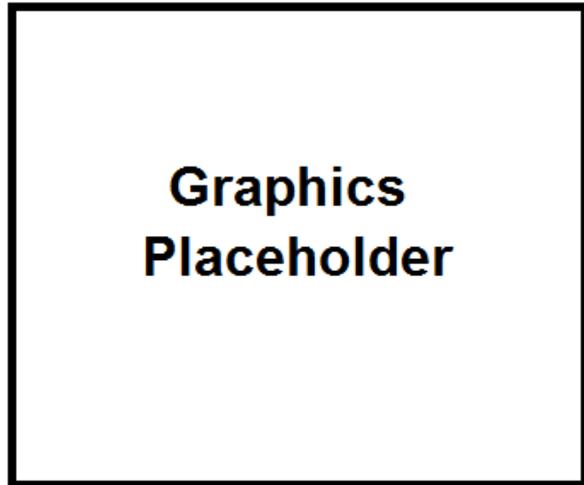
Figure 6-9. Conversion Time vs Temperature

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6.8 Typical Characteristics (continued)

at T_A = 25°C and V_+ = 3.3 V (unless otherwise noted)

V+ = 3.3 V

Graphics Placeholder

Figure 6-10. Average Supply Current vs Conversion Rate

V+ = 3.3 V

Graphics Placeholder

Figure 6-11. Temperature Error at 25 °C

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V

Graphics Placeholder

Figure 6-12. Sampling Time vs Temperature

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V

Graphics Placeholder

Figure 6-13. ALERT Pin Output Voltage vs Pin Sink Current

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6.8 Typical Characteristics (continued)

at T_A = 25°C and V_+ = 3.3 V (unless otherwise noted)

V+ = 3.3 V; T**A** = -40 °C, 25 °C, 125 °C
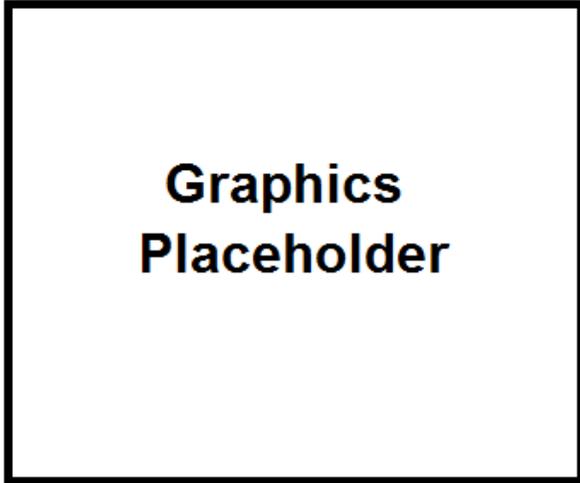
Figure 6-14. Noise Histogram

V+ = 1.2 V, 1.8 V, 2.5 V, 3.3 V, 5.0 V
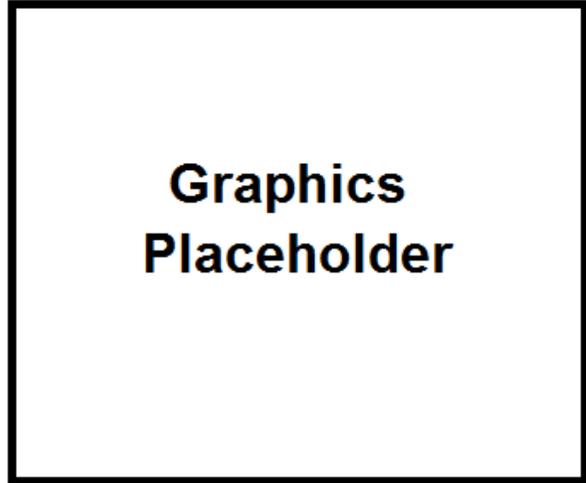
Figure 6-15. Supply Current vs Input Cell Input Voltage

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7 Detailed Description

7.1 Overview

The TMP110 is a digital output temperature sensor that comes factory calibrated for accuracy. The device features a two-wire, SMBus and I²C compatible interface with two modes of operation: continuous conversion mode and one-shot conversion mode, designed for thermal management and thermal protection applications. The TMP110 also includes an alert status register with individual high and low thresholds. Depending on the application requirement the 5th pin is either a device address input pin for multiple devices on the same bus or an open-drain alert output pin for thermal switch application.

7.2 Functional Block Diagram
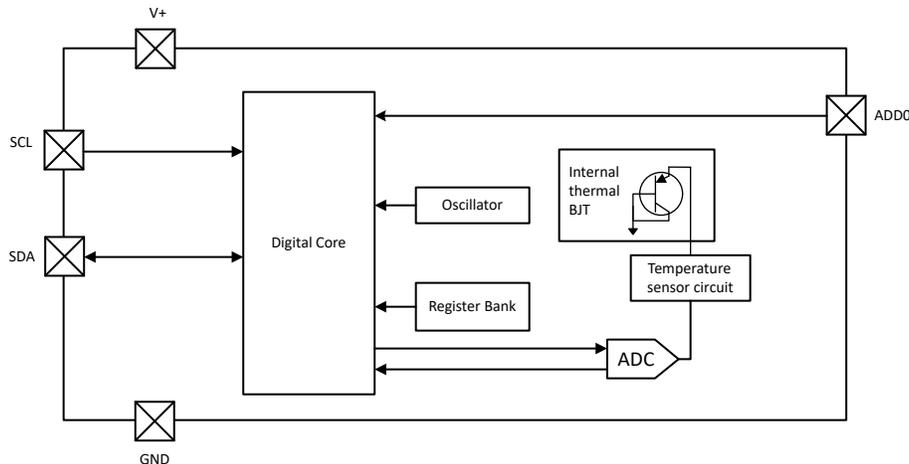
Figure 7-1. Address Variant
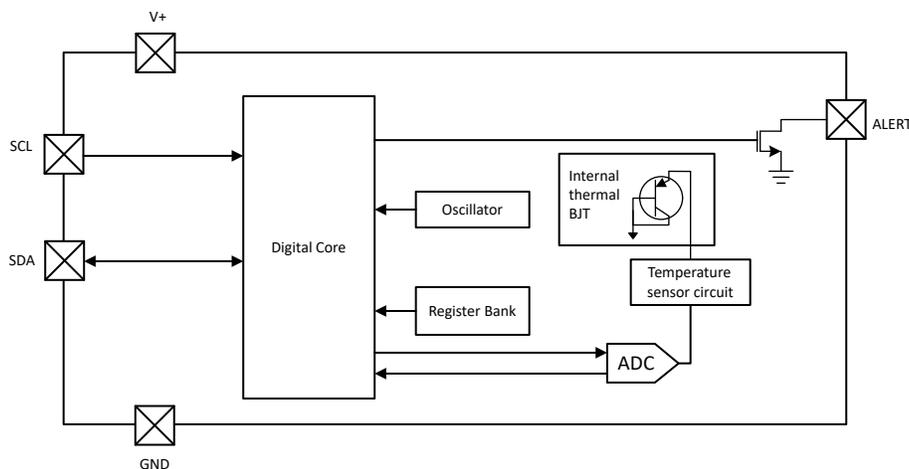
Figure 7-2. Alert Variant

7.3 Feature Description

7.3.1 Digital Temperature Output

The digital output from each temperature measurement is stored in the read-only temperature register. The temperature register of the TMP110 device is configured as a 12-bit, read-only register (configuration register EM bit = 0), or as a 13-bit, read-only register (configuration register EM bit = 1) that stores the output of the most recent conversion. Note that the EM bit defaults to 0 (12-bit format). As this value limits the highest temperature digital code, the device output is as shown in Table 7-1.

Table 7-1. 12/13-Bit Temperature Data Guidelines

EM Bit	Temperature Bit Length	Q Notation	LSB (°C)	Range (+)
0	12	4	0.0625	127.93475
1	13	4	0.0625	256

Two bytes must be read to obtain data. Byte 1 is the most significant byte (MSB), followed by byte 2, the least significant byte (LSB). The first 12 bits (13 bits in extended mode) are used to indicate temperature. The least significant byte does not have to be read if that information is not needed. The data format for temperature is summarized in Table 7-2 and Table 7-3. One LSB equals 0.0625°C. Negative numbers are represented in binary twos-complement format. Following power-up or reset, the temperature register reads 0°C until the first conversion is complete. Bit D0 of byte 2 indicates normal mode (EM bit = 0) or extended mode (EM bit = 1), and can be used to distinguish between the two temperature register data formats. The unused bits in the temperature register always read 0.

Table 7-2. 12-Bit Temperature Data Format

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	HEX
>127.9375	0111 1111 1111	7FF
127.9375	0111 1111 1111	7FF
100	0110 0100 0000	640
80	0101 0000 0000	500
75	0100 1011 0000	4B0
50	0011 0010 0000	320
25	0001 1001 0000	190
0.25	0000 0000 0100	004
0.0625	0000 0000 0001	001
0	0000 0000 0000	000
-0.0625	1111 1111 1111	FFF
−0.25	1111 1111 1100	FFC
−25	1110 0111 0000	E70
−55	1100 1001 0000	C90

Table 7-2 does not list all temperatures. Use the following rules to obtain the digital data format for a given temperature or the temperature for a given digital data format.

To convert positive temperatures to a digital data format:
1. Divide the temperature by the resolution
2. Convert the result to binary code with a 12-bit, left-justified format, and MSB = 0 to denote a positive sign.

    Example: (50°C) / (0.0625°C / LSB) = 800 = 320h = 0011 0010 0000

To convert a positive digital data format to temperature:
1. Convert the 12-bit, left-justified binary temperature result, with the MSB = 0 to denote a positive sign, to a decimal number.
2. Multiply the decimal number by the resolution to obtain the positive temperature.

    Example: 0011 0010 0000 = 320h = 800 × (0.0625°C / LSB) = 50°C

To convert negative temperatures to a digital data format:
1. Divide the absolute value of the temperature by the resolution, and convert the result to binary code with a 12-bit, left-justified format.
2. Generate the twos complement of the result by complementing the binary number and adding one. Denote a negative number with MSB = 1.

    Example: (|−25°C|) / (0.0625°C / LSB) = 400 = 190h = 0001 1001 0000

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Two's complement format: 1110 0110 1111 + 1 = 1110 0111 0000

To convert a negative digital data format to temperature:

1. Generate the twos compliment of the 12-bit, left-justified binary number of the temperature result (with MSB = 1, denoting negative temperature result) by complementing the binary number and adding one. This represents the binary number of the absolute value of the temperature.
2. Convert to decimal number and multiply by the resolution to get the absolute temperature, then multiply by –1 for the negative sign.

    Example: 1110 0111 0000 has twos compliment of 0001 1001 0000 = 0001 1000 1111 + 1

    Convert to temperature: 0001 1001 0000 = 190h = 400; 400 × (0.0625°C / LSB) = 25°C = (|–25°C|); (|–25°C|) × (–1) = –25°C

Table 7-3. 13-Bit Temperature Data Format

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	HEX
150	0 1001 0110 0000	0960
128	0 1000 0000 0000	0800
127.9375	0 0111 1111 1111	07FF
100	0 0110 0100 0000	0640
80	0 0101 0000 0000	0500
75	0 0100 1011 0000	04B0
50	0 0011 0010 0000	0320
25	0 0001 1001 0000	0190
0.25	0 0000 0000 0100	0004
0.0625	0 0000 0000 0001	0001
0	0 0000 0000 0000	0000
−0.0625	1 1111 1111 1111	1FFF
−0.25	1 1111 1111 1100	1FFC
−25	1 1110 0111 0000	1E70
−55	1 1100 1001 0000	1C90

7.3.2 Decoding Temperature Data

The TMP110 temperature registers use a 12-bit format. The 12 bits are aligned to the left side, or most significant side, of the 16-bit word. The four unused bits are on the right side, or least significant side. For this reason, a shift is needed to discard the extra bits. 2's Complement is employed to describe negative temperatures. C code can easily convert the 2's Complement data when the data is typecast into the correct signed data type. Q notation describes the number of bits which represent a fractional result. 4 bits of fractional data, known as Q4, offers 0.0625°C resolution.

Table 7-4. 12-Bit Q4 Encoding Parameters

PARAMETER	VALUE
Bits	12
Q	4
Resolution	0.0625
Range (+)	127.9375
Range (−)	-128
25°C	0x0190

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Table 7-5. 12-Bit Q4 Bit Values in °C

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Sign	64	32	16	8	4	2	1	0.5	0.25	0.125	0.0625	-	-	-	-
-128	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	-	-	-	-
-2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	-	-	-	-

```
/* 12-bit format will have 4 bits discarded by right shift
 q4 is 0.062500 resolution
 the following bytes represent 24.5C */
uint8_t byte1 = 0x18;
uint8_t byte2 = 0x80;
float f = (((int8_t) byte1 << 8 | byte2) >> 4) * 0.0625f;
int mC = (((int8_t) byte1 << 8 | byte2) >> 4) * 1000 >> 4;
int C = (int8_t) byte1;
```

Similarly, in extended mode, the temperature register is extended to a 13-bit format with the same resolution (Q4). This changes the range and effective bits but the resolution remains the same. For this reason, the bit shift also changes. Encoding and C code examples for extended mode are shown below.

Table 7-6. 13-Bit Q4 Encoding Parameters

PARAMETER	VALUE
Bits	13
Q	4
Resolution	0.0625
Range (+)	255.9375
Range (–)	-256
25°C	0xC80

Table 7-7. 13-Bit Q4 Bit Values in °C

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Sign	128	64	32	16	8	4	2	1	0.5	0.25	0.125	0.0625	-	-	-
-256	128	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	-	-	-
-2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	-	-	-

```
/* 13-bit format will have 3 bits discarded by right shift
 q4 is 0.062500 resolution
 the following bytes represent 24.5C */
uint8_t byte1 = 0xC;
uint8_t byte2 = 0x40;
float f = (((int8_t) byte1 << 8 | byte2) >> 3) * 0.0625f;
int mC = (((int8_t) byte1 << 8 | byte2) >> 3) * 1000 >> 4;
int C = (((int8_t) byte1 << 8 | byte2) >> 3) >> 4;
```

7.3.3 Temperature Limits and Alert

The TMP110 has alert feature and uses the TLow_limit register for low threshold comparison and THigh_Limit register for high threshold comparison. The alert limit is programmed in the TMP110 in a 12-bit or 13-bit two's complement format based on the Extended_Mode setting in the configuration register, with a resolution of 62.5 m°C. At the end of each temperature conversion, the temperature result is compared with the high limit and low limit registers, and the alert status flag and/or ALERT pin is updated.

The alert status flag in configuration register and/or the ALERT pin are updated based on the Alert_Mode and Polarity bit setting in the configuration register after every temperature conversion.

As shown in Figure 7-3, in comparator mode (Alert_Mode = 0b), the ALERT pin and status flag become active when the temperature equals or exceeds the value in THigh_Limit for Fault number of consecutive conversions.

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The ALERT pin and status flag remain active until the temperature falls below the TLow_Limit for the same number of consecutive conversions.
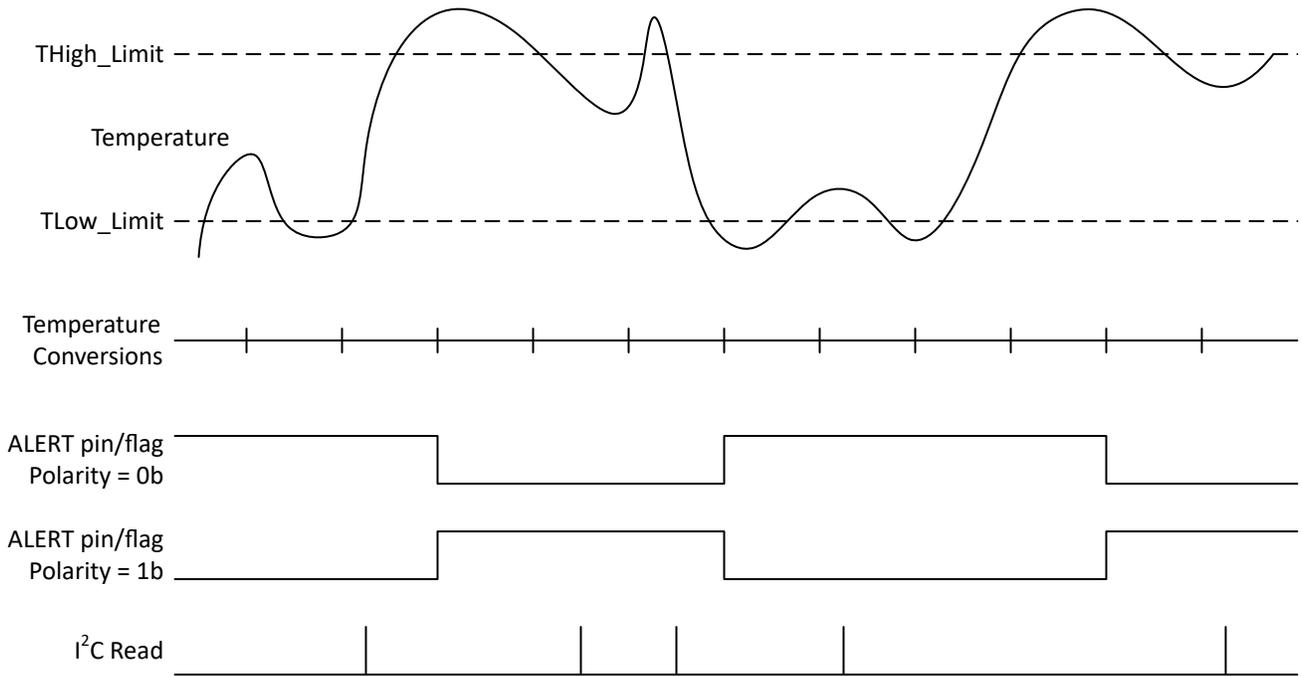
Figure 7-3. Comparator Mode

As shown in Figure 7-4, in alert mode (Alert_Mode = 1b), the ALERT pin becomes active only when the temperature equals or exceeds the THigh_Limit for Fault number of consecutive conversion. The ALERT pin remains active, until a read operation of any register occurs, or the device responds to the SMBus Alert Response. When the ALERT pin is cleared, the pin becomes active only when the temperature is less than the TLow_Limit for Fault number of consecutive conversion and remains active, until a read operation of any register occurs, or the device responds to the SMBus Alert Response. When the ALERT pin is cleared after a TLow_Limit crossing, the above cycle repeats. The ALERT pin and status can also be cleared by issuing the General Call Reset command.

Product Folder Links: *TMP110*

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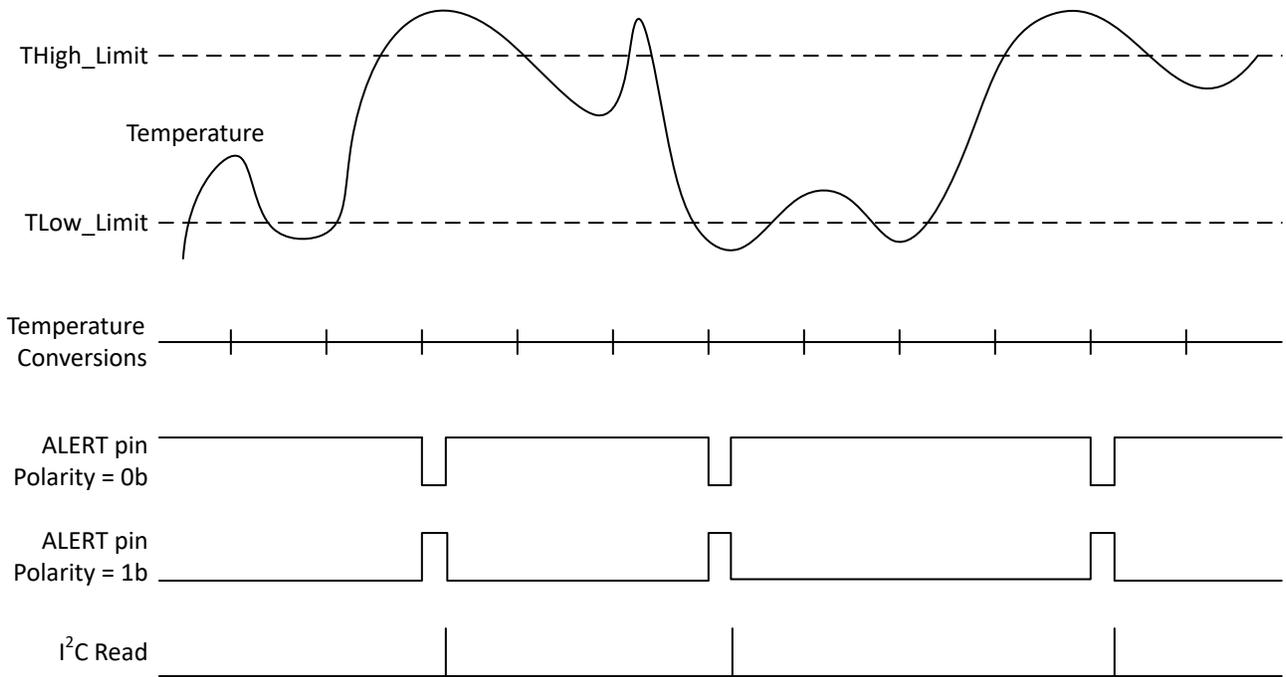
Figure 7-4. Alert Mode

7.4 Device Functional Modes

The TMP110 can be configured to operate in continuous or one-shot mode. This flexibility enables users to balance the requirements of power efficiency and performance.

7.4.1 Continuous-Conversion Mode

When the Shutdown bit is set to 0b in the configuration register, the device operates in continuous conversion mode. Figure 7-5 shows the device in a continuous conversion cycle. In this mode, the device performs conversion at fixed intervals and updates the temperature result register, ALERT pin and flag at the end of every conversion. The typical active conversion time is around 10 ms.
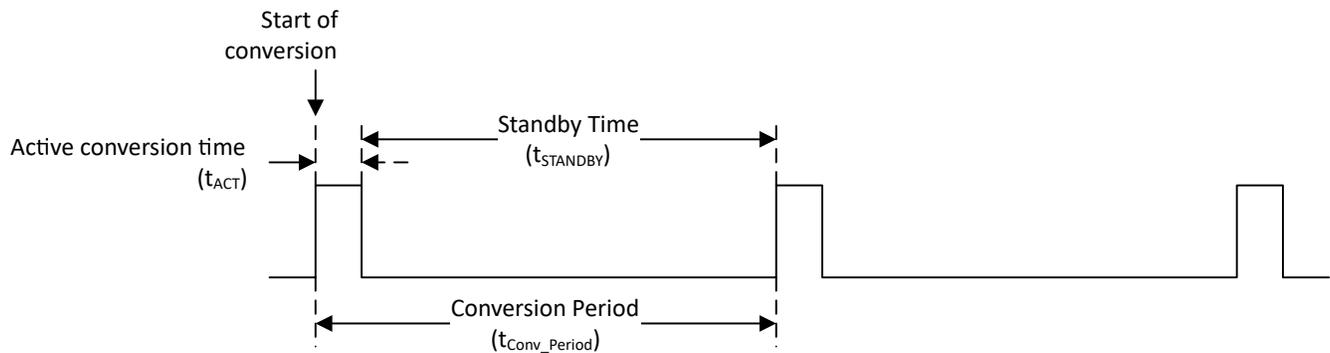
Figure 7-5. Continuous Conversion Cycle Timing Diagram

The Conversion_Rate[1:0] bits in the configuration register controls the rate at which the conversions are performed. The device typically consumes 55 µA during conversion and 2.6 µA during the low power standby period. By decreasing the rate at which the conversion are performed, the application can benefit from reduced average current consumption in continuous mode.

Use Equation 1 to calculate the average current in continuous mode.

$$\text{Average Current} = ((I_{DD\_ACTIVE} \times t_{ACT}) + (I_{DD\_SB} \times t_{STANDBY})) / t_{Conv\_Period} \tag{1}$$

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Where

- t_{ACT} = Active conversion time
- t_{Conv_Period} = Conversion Period
- $t_{STANDBY}$ = Standby time between conversions calculated as t_{Conv_Period} - t_{ACT}

7.4.2 One-Shot Mode

When a 1 is written to the One_Shot bit in the configuration register, the TMP110 immediately starts a one-shot temperature conversion as shown in Figure 7-6. Requesting another conversion when the TMP110 is performing a temperature conversion, the device does not stop the active conversion. After completing the one-shot conversion the TMP110 enters shutdown mode, and the One_Shot bit is set to 1b.
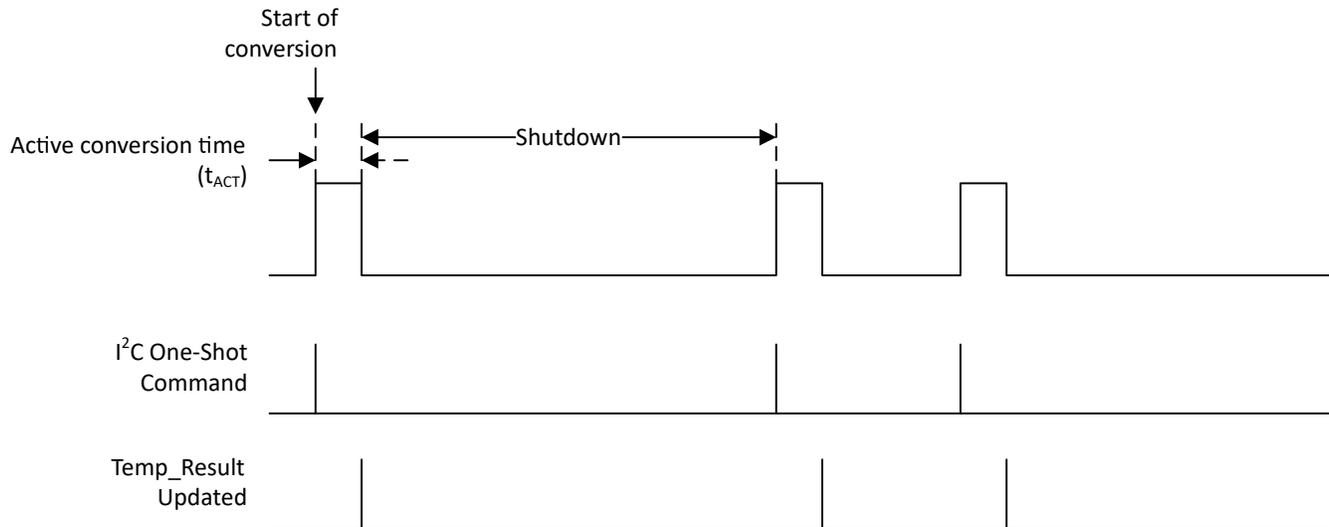
Figure 7-6. One-Shot Timing Diagram

The one-shot conversion is only supported when the Shutdown bit is set to 1b. Due to the short conversion time, the TMP110 device achieves a higher conversion rate. A single conversion typically takes 10 ms and a read can take place in less than 20 µs. When using the one-shot mode, 50 or more conversions per second are possible.

7.5 Programming

7.5.1 Serial Interface

The TMP110 has a standard bidirectional I²C interface that is controlled by a controller device in order to be configured or read the status of this device. Each target device on the I²C bus has a specific device address to differentiate between other target devices that are on the same I²C bus. Many target devices require configuration upon start-up to set the behavior of the device. This is typically done when the controller accesses internal register maps of the target, which have unique register addresses. A device can have one or multiple registers where data is stored, written, or read. The TMP110 includes 50-ns glitch suppression filters, allowing the device to coexist on an I3C mixed bus. The TMP110 supports transmission data rates up to 1 MHz.

7.5.2 Bus Overview

The physical I²C interface consists of the serial clock (SCL) and serial data (SDA) lines. The SDA line must be connected to a supply through a pullup resistor. The size of the pullup resistor is determined by the amount of capacitance on the I²C lines, the communication frequency and I²C bus voltage. For further details, see the I²C Pullup Resistor Calculation application note. Data transfer can be initiated only when the bus is idle. A bus is considered idle if both SDA and SCL lines are high after a STOP condition or time out events (see Definition of Start and Stop Conditions and Figure 7-8).

The following is the general procedure for a controller to access a target device:

1. If a controller wants to send data to a target:

- Controller-transmitter sends a START condition and addresses the target-receiver.
- Controller-transmitter sends the requested register to write target-receiver.
- Controller-transmitter sends data to target-receiver.
- Controller-transmitter terminates the transfer with a STOP condition.
2. If a controller wants to receive or read data from a target:
   - Controller-receiver sends a START condition and addresses the target-transmitter
   - Controller-receiver sends the requested register to read to target-transmitter.
   - Controller-receiver receives data from the target-transmitter
   - Controller-receiver terminates the transfer with a STOP condition.
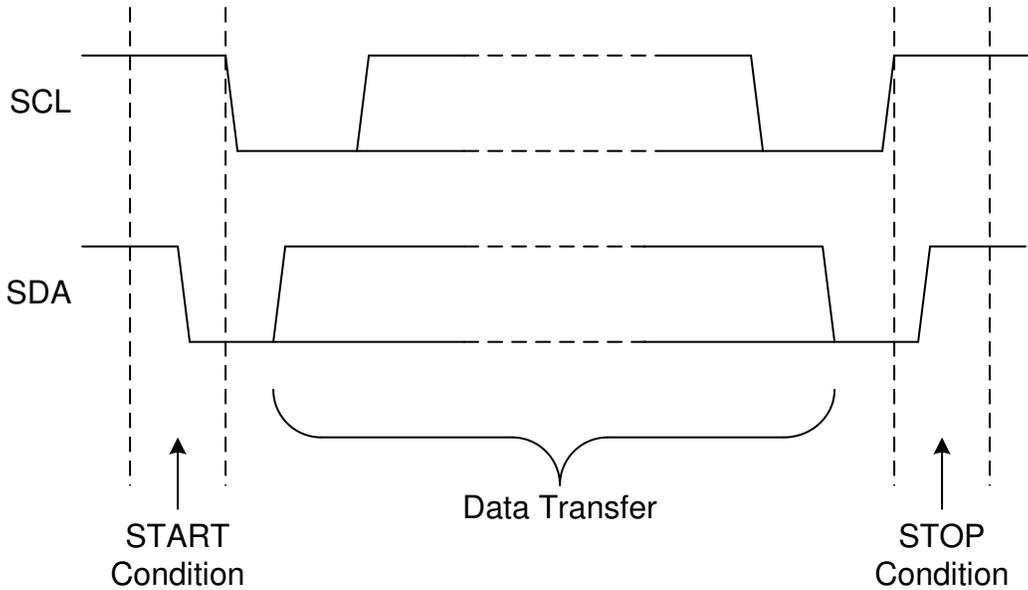
**Figure 7-7. Definition of Start and Stop Conditions**
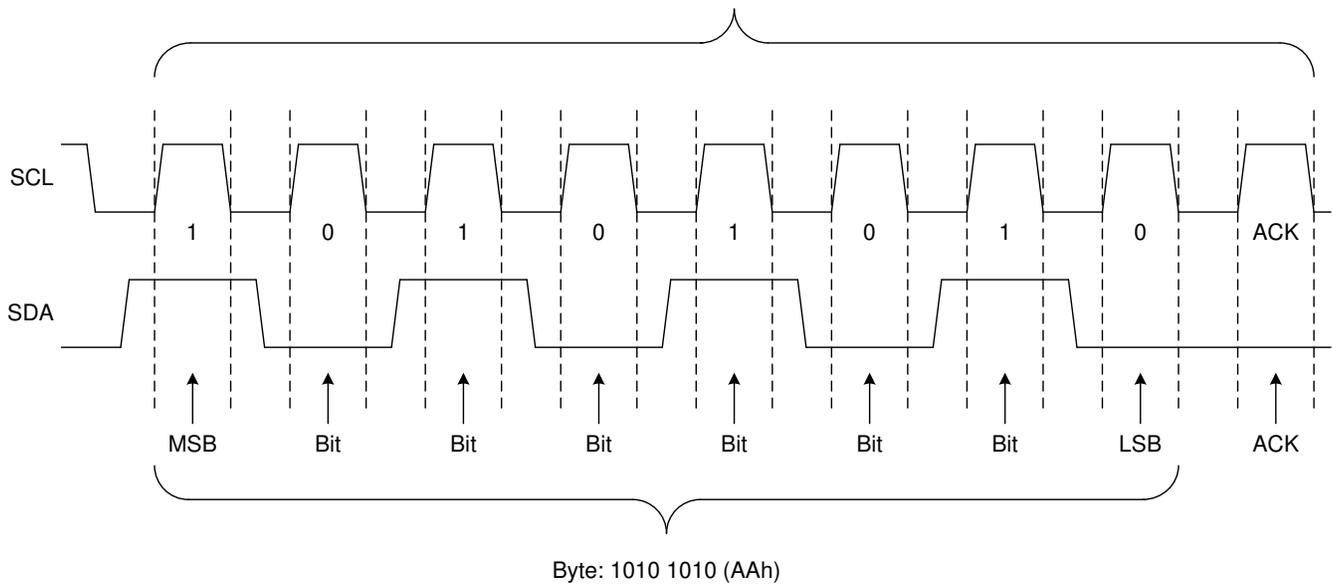
Figure 7-8. Bit Transfer

7.5.3 Device Address

To communicate with the TMP110, the controller must first address target devices through an address byte. The address byte has seven address bits and a read-write (R/$\overline{W}$) bit that indicates the intent of executing a read or write operation. The TMP110D features an address pin to allow up to four devices to be addressed on a single bus. Table 7-8 describes the pin logic levels used to properly connect up to four devices. This table aslo describes four different address options available when ALERT pin is used.

Table 7-8. Address and Alert Variant Device Target Address

DEVICE ORDERABLE		ADD0 PIN CONNECTION	DEVICE I^{2}C BUS ADDRESS	DEVICE I^{2}C BUS ADDRESS (Hex)
Address Variant	TMP110D	GND	1000000	40h
		V+	1000001	41h
		SDA	1000010	42h
		SCL	1000011	43h
Alert Variant	TMP110D0	N/A	1001000	48h
	TMP110D1		1001001	49h
	TMP110D2		1001010	4Ah
	TMP110D3		1001011	4Bh

7.5.4 Bus Transactions

7.5.4.1 Writes

To write on the I^{2}C bus, the controller sends a START condition on the bus with the address of the target, as well as the last bit (the R/$\overline{W}$ bit) set to 0b, which signifies a write. The target acknowledges, letting the controller know the target is ready. After this operation, the controller starts sending the register pointer and data to the target, and the controller terminates the transmission with a STOP condition.

Writes to read-only registers or register locations outside of the register map is ignored. The TMP110 still performs and acknowledge when writing outside of the register map. Figure 7-9 shows an example of writing a single word write communication.
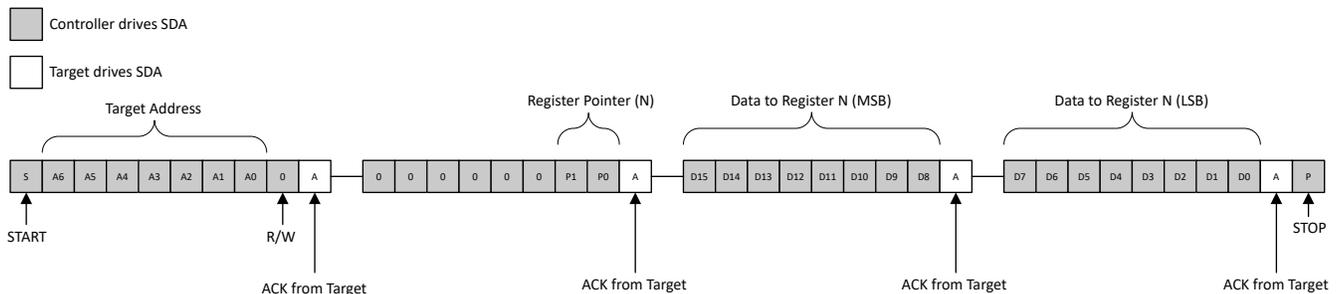

Figure 7-9. Write to Single Register

7.5.4.2 Reads

For a read operation the controller sends a START condition, followed by the target address with the R/$\overline{W}$ bit set to 0b (signifying a write). The target acknowledges the write request, and the controller sends the Register Pointer. The controller initiates a restart followed by the target address with the R/$\overline{W}$ bit set to 1b (signifying a read). The controller continues to send out clock pulses but releases the SDA line so that the target can transmit data. At the end of every byte of data, the controller sends an ACK to the target, letting the target know that the controller is ready for more data. Once the controller has received the expected number of bytes, the controller sends a NACK, signaling to the target to halt communications and release the SDA line. The controller follows this up with a STOP condition. Figure 7-10 shows an example of reading a single word from a target register.

Product Folder Links: *TMP110*
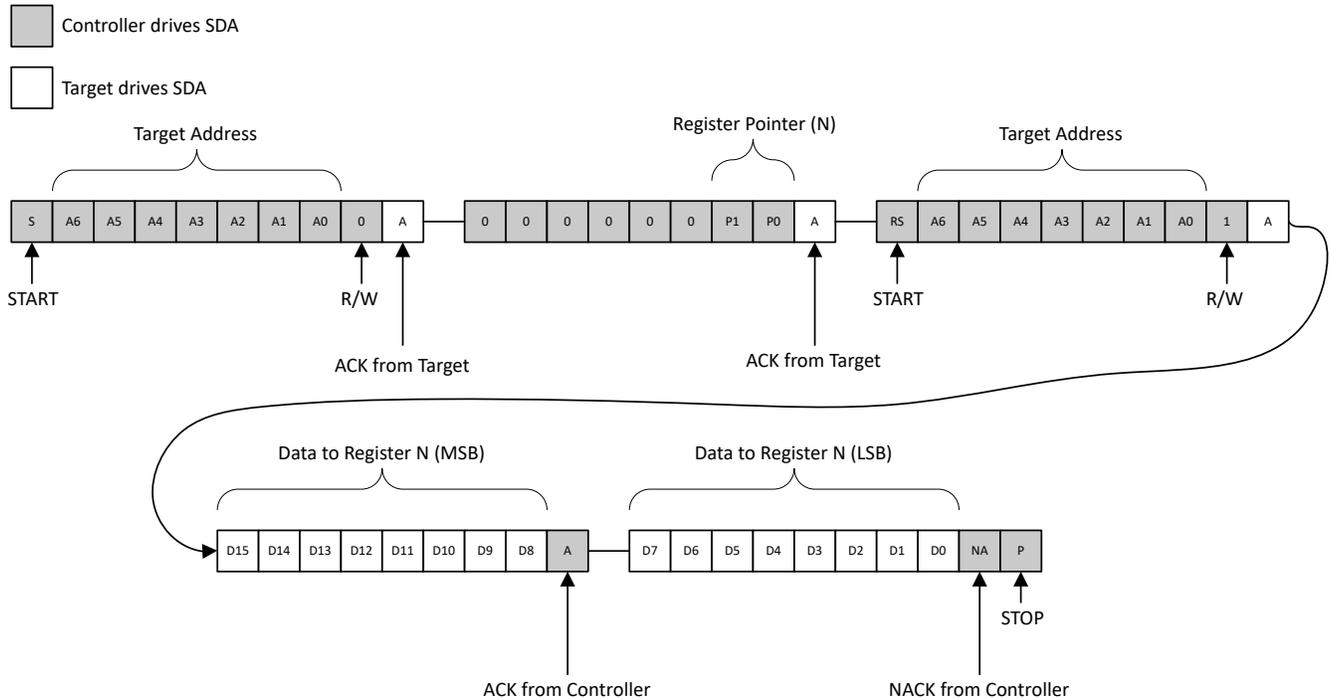
Figure 7-10. Read from Single Register

7.5.4.3 General Call Reset Function

The TMP110 responds to a general-call address (0000 000) if the eighth bit is 0b. The device acknowledges the general-call address and responds to commands in the second byte. If the second byte is 0000b 0110b, the TMP110 internal registers are reset to power-up values as shown in SMBus General Call Reset Timing Diagram. The serial address is unaffected by the general call reset.
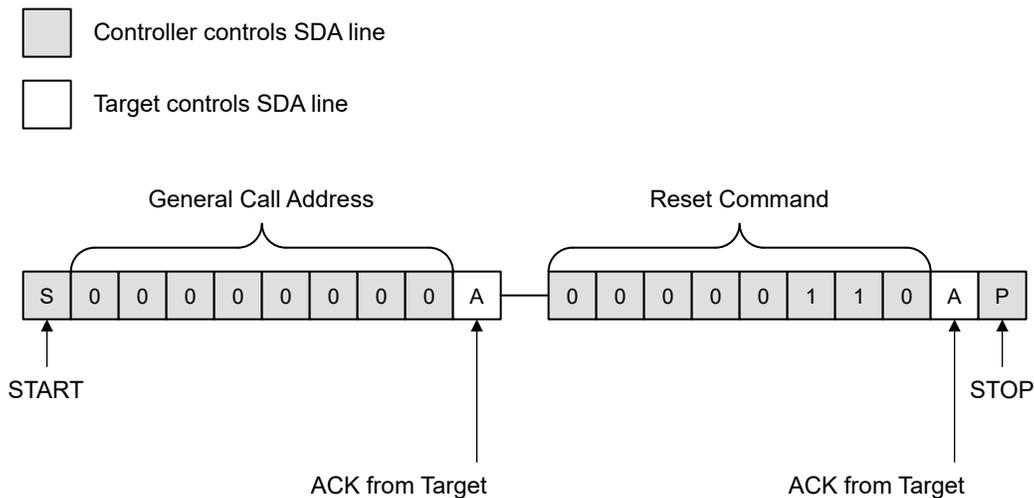
Figure 7-11. SMBus General Call Reset Timing Diagram

7.5.4.4 SMBus Alert Response

The TMP110 device supports the SMBus alert response. When the TMP110 operates in Alert Mode, and the ALERT pin is available, the controller can sense that an alert condition is present. Irrespective of the availability of the ALERT pin, the alert status is set. As shown in Figure 7-12, if the controller sends an SMBus alert command (19h or 00011001b) on the bus, and the alert is set, the device acknowledges the SMBus alert

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command and responds by returning the device addess on the SDA line. The eigth bit (LSB) of the device address byte indicates if the alert condition was caused by the temperature exceeding THigh_Limit or falling below the TLow_Limit. The value of the eight bit follows the Polarity bit setting.
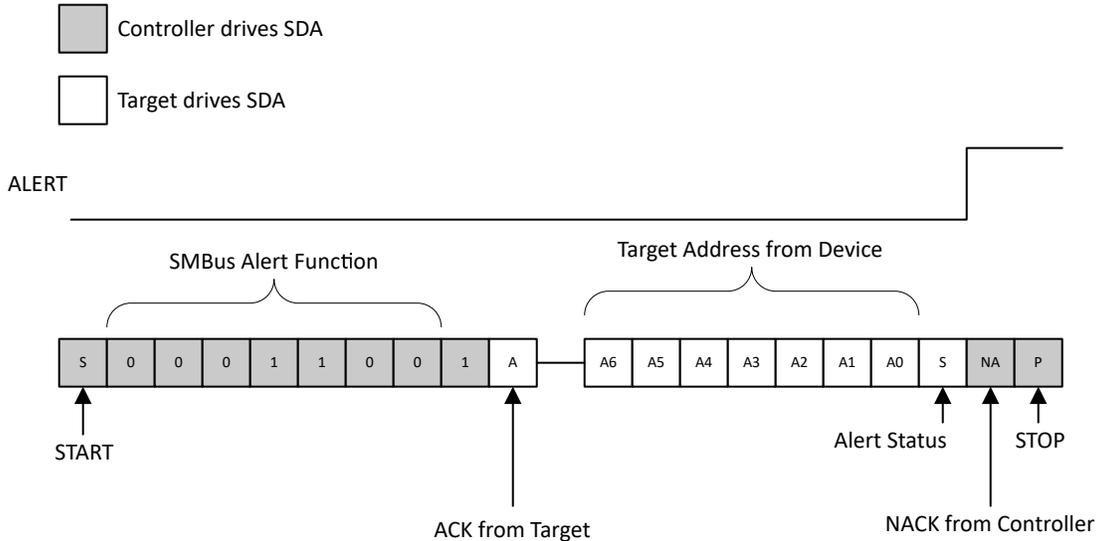

Figure 7-12. SMBus Alert Response

If multiple devices on the bus respond to the SMBus alert command, arbitration during the device address portion of the SMBus alert command determines which devices the ALERT pin is activated. The device with the lowest address wins the arbitration. On winning the arbitration, the TMP110 inactivates the ALERT pin and/or clears the status bit. To prevent the device with lowest I^2C address in continuous conversion mode sees the alert line and halt others with higher I^2C address to report the alert, the controller has to temporarily disable the Alert mode in device with smallest I^2C address until all alerts in the system are cleared.

7.5.4.5 Time-Out Function

The TMP110 resets the serial interface if the SCL line is held low by the controller or the SDA line is held low by the TMP110 for 30 ms (typical) between a START and STOP condition. The TMP110 releases the SDA line if the SCL pin is pulled low and waits for a START condition from the controller. To avoid activating the timeout function, maintain a communication speed of at least 1 kHz for the SCL operating frequency. If another device on the bus is holding the SDA pin low, the TMP110 does not reset.

7.5.4.6 Coexist on I3C Mixed Bus

A bus with both I3C and I^2C interfaces is referred to as a mixed with clock speeds up to 12.5 MHz. The TMP110 is an I^2C device that can be on the same bus that has an I3C device attached as the TMP110 incorporates a spike suppression filter of 50 ns on the SDA and SCL pins to avoid any interference to the bus when communicating with I3C devices.

8 Register Map

Table 8-1. TMP110 Register Map

ADDRESS	TYPE	RESET	ACRONYM	REGISTER NAME	SECTION
00h	R	xxxxh	Temp_Result	Temperature result register	Go
01h	R/W	60A0h	Configuration	Configuration register	Go
02h	R/W	4B00h	TLow_Limit	Temperature low limit register	Go
03h	R/W	5000h	THigh_Limit	Temperature high limit register	Go
04h - FFh	R	xxxxh	Reserved	Reserved	

Table 8-2. TMP110 Register Section/Block Access Type Codes

Access Type	Code	Description
Read Type		
R	R	Read
RC	R	Read
	C	to Clear
R-0	R	Read
	-0	Returns 0s
Write Type		
W	W	Write
W0CP	W	W
	0C	0 to clear
	P	Requires privileged access
Reset or Default Value		
-*n*		Value after reset or the default value

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8.1 Temp_Result Register (address = 00h) [reset = xxxxh]

This register stores the latest temperature conversion result in a 12-bit or 13-bit two's complement format with a LSB equal to 0.0625°C depending on the Extended_Mode bit setting in the configuration register. The default format for the register at power up is normal mode.

Return to Register Map.

Table 8-3. Temp_Result Register (Normal Mode)

15	14	13	12	11	10	9	8
Temp_Result[11:4]							
R-xxh							
7	6	5	4	3	2	1	0
Temp_Result[3:0]				Reserved			
R-xh				R-0000b			

Table 8-4. Temp_Result Register (Extended Mode)

15	14	13	12	11	10	9	8
Temp_Result[12:5]							
R-xxh							
7	6	5	4	3	2	1	0
Temp_Result[4:0]					Reserved		
R-xxh					R-001b		

Table 8-5. Temp_Result Register Field Description (Normal Mode)

Bit	Field	Type	Reset	Description
15:4	Temp_Result[11:0]	R	xxxh	12-bit temperature conversion result Temperature data is represented by a 12-bit, two's complement word with an LSB equal to 0.0625°C when Extended_Mode bit is 0b
3:0	Reserved	R	0000b	Reserved

Table 8-6. Temp_Result Register Field Description (Extended Mode)

Bit	Field	Type	Reset	Description
15:3	Temp_Result[12:0]	R	xxxxh	13-bit temperature conversion result Temperature data is represented by a 13-bit, two's complement word with an LSB equal to 0.0625°C when Extended_Mode bit is 1b
2:0	Reserved	R	001b	Reserved

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8.2 Configuration Register (address = 01h) [reset = 60A0h]

This register is used to configure the operation of the TMP110 and also provides the alert status when ALERT pin is not available on the pin-out.

Return to Register Map.

Table 8-7. Configuration Register

15	14	13	12	11	10	9	8
One_Shot	Reserved		Fault[1:0]		Polarity	Alert_Mode	Shutdown
R/W-0b	R-11b		R/W-00b		R/W-0b	R/W-0b	R/W-0b
7	6	5	4	3	2	1	0
Conversion_Rate[1:0]		Alert	Extended_Mode	Reserved			
R/W-10b		R-1b	R/W-0b	R-0000b			

Table 8-8. Configuration Register Field Description

Bit	Field	Type	Reset	Description
15	One_Shot	R/W	0b	One-shot conversion trigger applicable in shutdown mode only. In continuous conversion mode the bit reads 0b. In shutdown mode the bit reads 1b. Triggering a one-shot conversion happens only when the TMP110 is in shutdown mode. 0b = Active conversion ongoing 1b = Trigger a one-shot conversion or active conversion complete
14:13	Reserved	R	11b	Reserved
12:11	Fault[1:0]	R/W	00b	The fault bit is used to count the number of consecutive conversions for which the alert condition exists before the ALERT pin is asserted or status bit is set. 00b = 1 fault 01b = 2 faults 10b = 4 faults 11b = 6 faults
10	Polarity	R/W	0b	The polarity bit allows the host to adjust the polarity of the ALERT pin/flag output. 0b = ALERT pin/flag output is active low 1b = ALERT pin/flag output is active high
9	Alert_Mode	R/W	0b	The alert mode bit indicates the how the temperature limits operate. 0b = Comparator mode 1b = Alert mode
8	Shutdown	R/W	0b	The shutdown bit is used to change the device conversion mode. 0b = Continuous conversion mode 1b = Shutdown mode
7:6	Conversion_Rate[1:0]	R/W	10b	The conversion rate bits configure the TMP110 conversion period. The default is conversion every 250 ms. 00b = 4 s / 0.25 Hz 01b = 1 s / 1 Hz 10b = 0.25 s / 4 Hz 11b = 0.125 s / 8 Hz
5	Alert flag	R	1b	The alert is a read-only bit which provides the information about the alert status in comparator mode and is not affected by Alert_Mode setting. The polarity bit affects the alert.
4	Extended_Mode	R/W	0b	The extended mode bit configures the temperature format. 0b = Normal format with 12-bit 1b = Extended format with 13-bit
3:0	Reserved	R	0000b	Reserved

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Product Folder Links: *TMP110*

8.3 TLow_Limit Register (address = 02h) [reset = 4B00h]

This register is used to configure the low temperature alert limit of the TMP110. The limit is formatted in a 12-bit or 13-bit two's complement format with a LSB equal to 62.5 m°C depending on the Extended_Mode bit setting in the configuration register. The default value on start-up is 4B00h or 75 °C in normal mode format.

Note: If the temperature register format is changed, the low limit register value must be updated accordingly.

Return to Register Map.

Table 8-9. TLow_Limit Register (Normal Mode)

15	14	13	12	11	10	9	8
TLow_Limit[11:4]							
R/W-4Bh							
7	6	5	4	3	2	1	0
TLow_Limit[3:0]				Reserved			
R/W-0h				R-0000b			

Table 8-10. TLow_Limit Register (Extended Mode)

15	14	13	12	11	10	9	8
TLow_Limit[12:5]							
R/W-4Bh							
7	6	5	4	3	2	1	0
TLow_Limit[4:0]					Reserved		
R/W-00h					R-000b		

Table 8-11. TLow_Limit Register Field Description (Normal Mode)

Bit	Field	Type	Reset	Description
15:4	TLow_Limit[11:0]	R/W	4B0h	12-bit temperature low limit setting. Temperature low limit is represented by a 12-bit, two's complement word with an LSB equal to 62.5 m°C when Extended_Mode bit is 0b. The default setting for this is 75°C.
3:0	Reserved	R	0000b	Reserved

Table 8-12. TLow_Limit Register Field Description (Extended Mode)

Bit	Field	Type	Reset	Description
15:3	TLow_Limit[12:0]	R/W	4B00h	13-bit temperature low limit setting. Temperature low limit is represented by a 13-bit, two's complement word with an LSB equal to 62.5 m°C when Extended_Mode bit is 1b.
2:0	Reserved	R	000b	Reserved

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8.4 THigh_Limit Register (address = 03h) [reset = 5000h]

This register is used to configure the high temperature alert limit of the TMP110. The limit is formatted in a 12-bit or 13-bit two's complement format with a LSB equal to 62.5 m°C depending on the Extended_Mode bit setting in the configuration register. The default value on start-up is 5000h or 80 °C in normal mode format.

Note: If the temperature register format is changed, the high limit register value must be updated accordingly.

Return to Register Map.

Table 8-13. THigh_Limit Register (Normal Mode)

15	14	13	12	11	10	9	8
THigh_Limit[11:4]							
R/W-50h							
7	6	5	4	3	2	1	0
THigh_Limit[3:0]				Reserved			
R/W-0h				R-0000b			

Table 8-14. THigh_Limit Register (Extended Mode)

23	22	21	20	19	18	17	16
THigh_Limit[12:5]							
R/W-50h							
7	6	5	4	3	2	1	0
THigh_Limit[4:0]					Reserved		
R/W-0h					R-000b		

Table 8-15. THigh_Limit Register Field Description (Normal Mode)

Bit	Field	Type	Reset	Description
15:4	THigh_Limit[11:0]	R/W	500h	12-bit temperature high limit setting. Temperature high limit is represented by a 12-bit, two's complement word with an LSB equal to 62.5 m°C when Extended_Mode bit is 0b. The default setting for this is 80 °C.
3:0	Reserved	R	0000b	Reserved

Table 8-16. THigh_Limit Register Field Description (Extended Mode)

Bit	Field	Type	Reset	Description
15:3	THigh_Limit[12:0]	R/W	5000h	13-bit temperature low limit setting. Temperature low limit is represented by a 13-bit, two's complement word with an LSB equal to 62.5 m°C.
2:0	Reserved	R	000b	Reserved

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9 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

9.1 Application Information

The TMP110 can be operated with a two-wire I²C or SMBus compatible interface and features the ability to operate with a 1.2-V bus voltage. The TMP110 features a uniquely small size of 0.8 mm × 0.8 mm with a 0.4 mm z-height for space-constrained applications.

9.2 Separate I²C Pullup and Supply Application
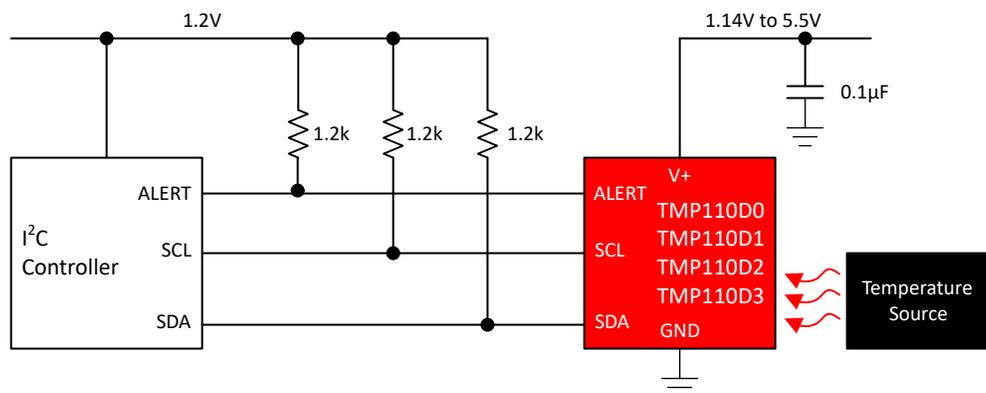
Figure 9-1. Separate I2C Pullup and Supply Voltage Application

9.2.1 Design Requirements

For this design example, use the parameters listed below.

Table 9-1. Design Parameters

PARAMETER	VALUE
Supply (V+)	1.14 V to 5.5 V
SDA, SCL V$_{PULLUP}$	1.2 V
SDA, SCL R$_{PULLUP}$	1.2 kΩ

9.2.2 Detailed Design Procedure

The TMP110 converts temperature at fixed intervals in continuous conversion mode. The SDA and SCL pin voltage of the TMP110 can be at a lower voltage than the V+ pin voltage, removing the need for power sequencing when using the TMP110.

The TMP110 is a very small package with low thermal mass and can be placed as close to the measured object as possible for better thermal coupling.

9.3 Equal I²C Pullup and Supply Application
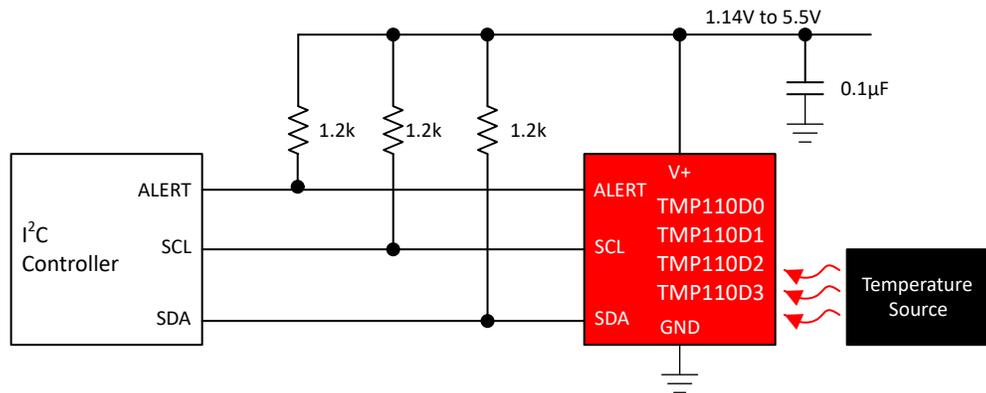
Figure 9-2. Equal I²C Pullup and Supply Voltage Application

9.3.1 Design Requirements

For this design example, use the parameters listed below.

Table 9-2. Design Parameters

PARAMETER	VALUE
Supply (V+)	1.14 V to 5.5 V
SDA, SCL V$_{PULLUP}$	V+
SDA SCL R$_{PULLUP}$	1.2 kΩ

9.3.2 Detailed Design Procedure

The SDA and SCL pin voltage of the TMP110 can be the same as the supply voltage V+. The accuracy of the TMP110 is not affected by the pullup voltage. However, using a minimal SDA and ALERT pins pull-up current is recommended to prevent self-heating and temperature accuracy reduction.

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9.4 Power Supply Recommendations

The TMP110 operates with power supply in the range of 1.14 V to 5.5 V. The device can measure temperature accurately in the full supply range. A power-supply bypass capacitor is required for proper operation. Place this capacitor as close as possible to the supply and ground pins of the device. A typical value for this supply bypass capacitor is 0.1 µF. Applications with noisy or high-impedance power supplies can require additional decoupling capacitors to reject power-supply noise.

9.5 Layout

9.5.1 Layout Guidelines

The TMP110 is a simple device to layout. Place the power supply bypass capacitor as close to the device as possible. Pull up the open-drain output pin SDA through R_{PULLUP} pullup resistor.

For devices where the 5th pin is ADD0, the pin can easily be connected to one of the 4 edge pins for setting the device address as shown in Figure 9-3. For devices where the 5th pin is ALERT, a 4 mil trace can be routed between pins 1 and 5 or pins 2 and 4 as shown in Figure 9-4.

9.5.2 Layout Example

There are special considerations that need to be taken for the TMP110 X2SON package. These considerations are due to the center pad being electrically connected to either address or alert (depending on the orderables shown in Table 7-8) and because of the dimensions of the package and the pads. With the address option, the center pad can be directly connected with a trace on the same layer to the desired pin of the device as shown in Figure 9-3.
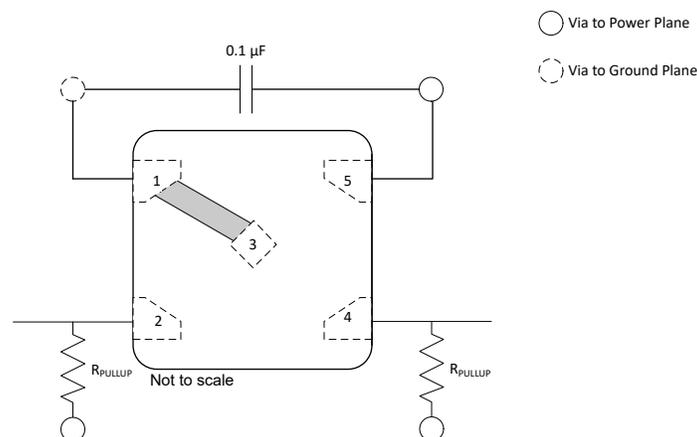

Figure 9-3. ADD0 Pin Layout Example

Product Folder Links: *TMP110*
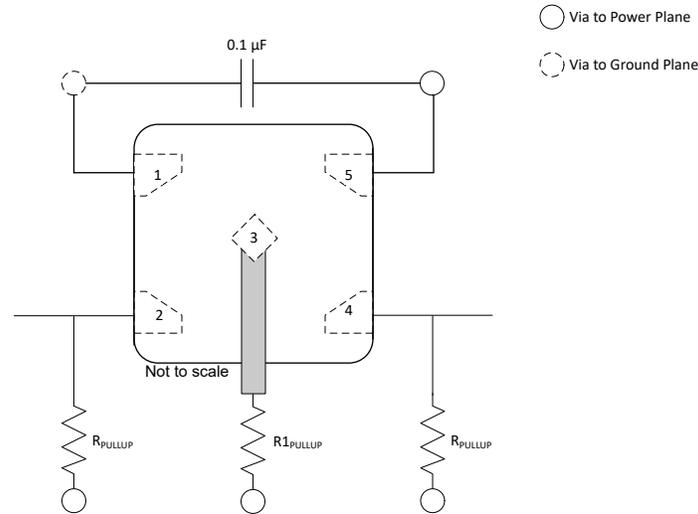
Figure 9-4. ALERT Pin Layout Example

When using the ALERT pin of the device, this signal can be either routed out in between the pads or on a different layer using a via within the center pad as shown in . Both of these methods have constraints that must be considered as explained below. Ultimately, choosing one of these methods depends on the specifications of the board manufacturing process:

- **Routing in between pads** introduces trace clearance and trace width limitations. As the maximum space between pads is 0.26 mm (10.2 mil), assuming a trace width of 0.1 mm (4 mil) limits the minimum clearance to 0.08 mm (3.15 mil).
- **Routing on a different layer using a via** has specific benefits to the user application. For instance, minimum trace clearance and trace width are higher but require a via on the center pad with specific dimensions. The via diameter must be less than 0.305 mm (13.78 mil) to keep the via smaller than the center pad and a minimum drill diameter of 0.1 mm (4 mil) can be assumed to avoid manufacturing issues. With this scenario, a minimum annular ring width specification of 0.125mm (5 mil) is required: Anullar Ring Width (mm) = (0.305-0.1)/2.
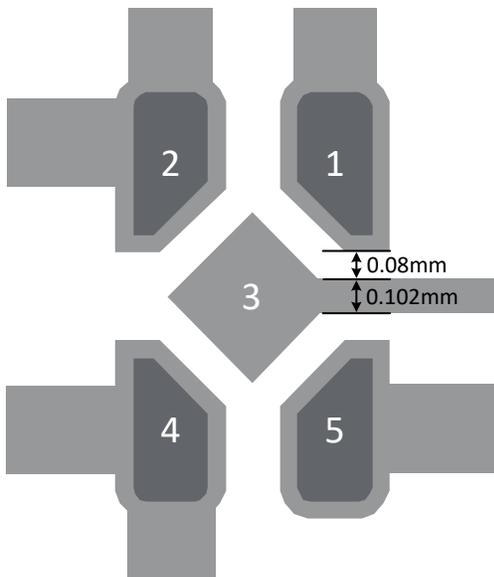
Figure 9-5. X2SON-5 (DPW) Package Center Pin Layout Option 1
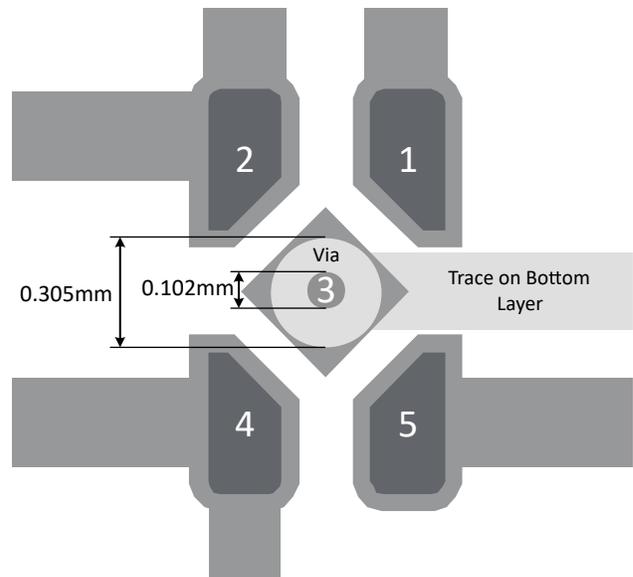
Figure 9-6. X2SON-5 (DPW) Package Center Pin Layout Option 2

ADVANCE INFORMATION

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10 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

10.1 Documentation Support

10.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, *TMP102 Low-Power Digital Temperature Sensor With SMBus and Two-Wire Serial Interface in SOT563*, data sheet
- Texas Instruments, *TMP112x High-Accuracy, Low-Power, Digital Temperature Sensors With SMBus and TwoWire Serial Interface in SOT563*, data sheet
- Texas Instruments, *TMP1075 Temperature Sensor With I2C and SMBus Interface in Industry Standard LM75 Form Factor and Pinout*, data sheet
- Texas Instruments, *TMP LM 75 Comparison Common FAQs*, application note
- Texas Instruments, *TMP110 Evaluation Module*, EVM user's guide
- Texas Instruments, *Small-Size TMP110 Versus TI's Temperature Sensors*, product overview

10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

10.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

10.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

10.5 Electrostatic Discharge Caution

![ESD warning symbol]

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

10.6 Glossary

TI Glossary   This glossary lists and explains terms, acronyms, and definitions.

11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
February 2024	*	Initial Release

Product Folder Links: *TMP110*

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

ADVANCE INFORMATION

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PACKAGE OUTLINE

DPW0005A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

ADVANCE INFORMATION

0.85 / 0.75

PIN 1 INDEX AREA

0.85 / 0.75

0.4 MAX

SEATING PLANE

NOTE 3

4X (0.05)

(0.324)

□ 0.25 ± 0.1

2X 0.48

2X (0.26)

0.239 / 0.139

4X 0.27 / 0.17

3X 0.288 / 0.188

(0.1)

0.05 / 0.00

NOTE 3

| ⌖ | 0.1 Ⓜ | C | A | B |
| | 0.05 Ⓜ | C | | |

4223102/D   03/2022
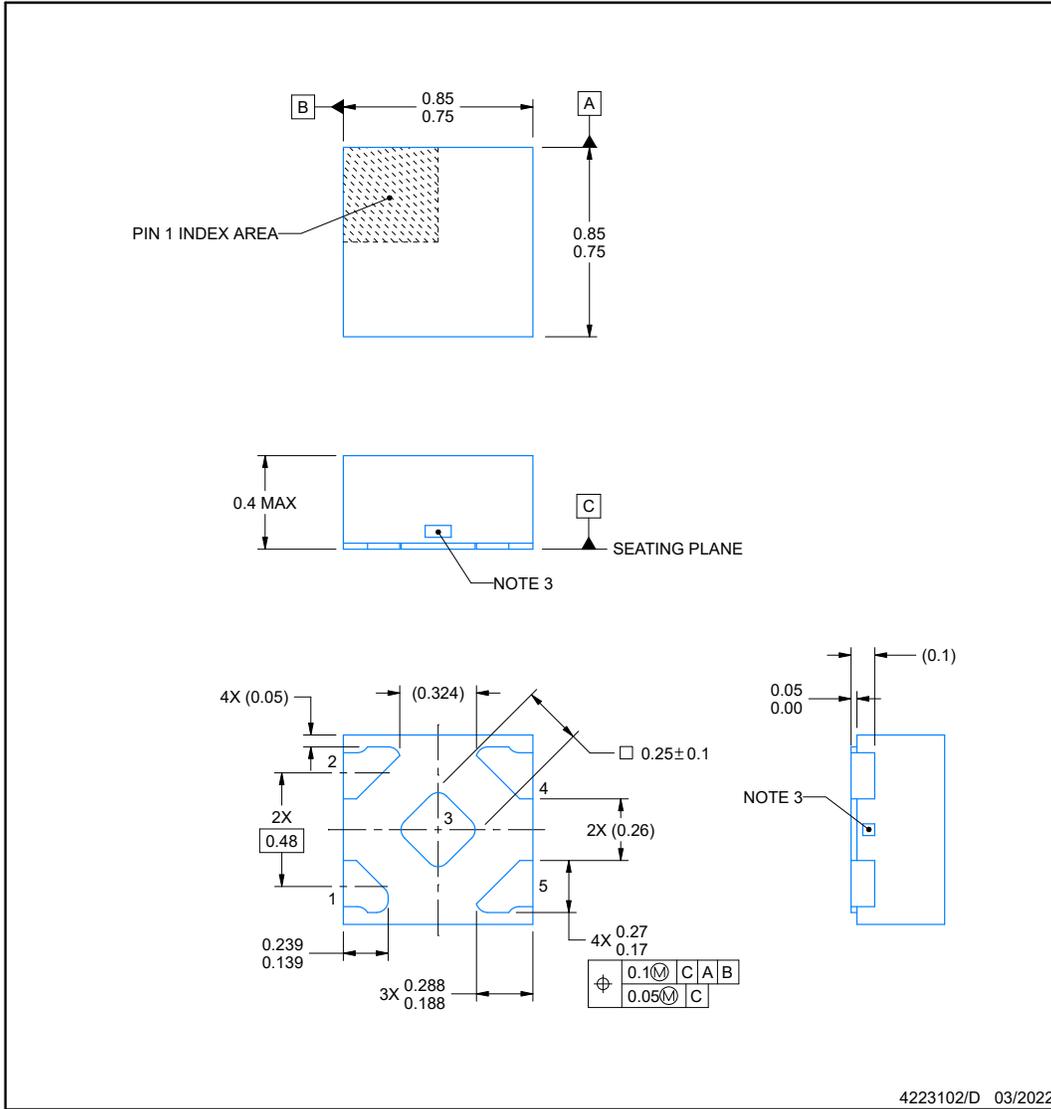
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The size and shape of this feature may vary.

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Product Folder Links: *TMP110*

EXAMPLE BOARD LAYOUT

DPW0005A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

(0.78)

4X (0.42)

SYMM

(⌀0.1) VIA

0.05 MIN ALL AROUND TYP

1

4X (0.22)

5

SYMM

4X (0.26)

(0.48)

2

3

4

(R0.05) TYP

(□0.25)

4X (0.06)

SOLDER MASK OPENING, TYP

METAL UNDER SOLDER MASK TYP

(0.21) TYP EXPOSED METAL CLEARANCE

LAND PATTERN EXAMPLE
SOLDER MASK DEFINED
SCALE:60X

4223102/D   03/2022
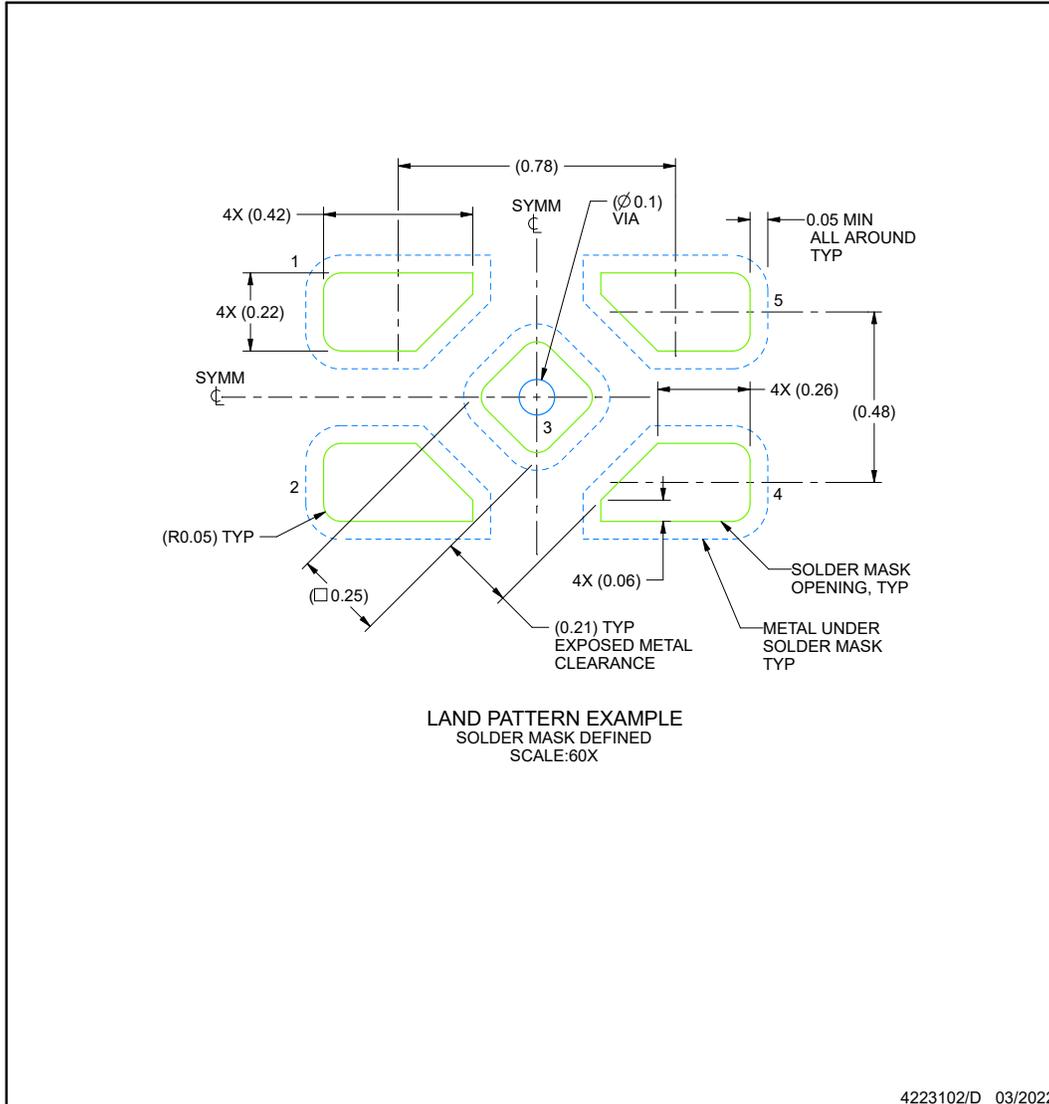
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, refer to QFN/SON PCB application note in literature No. SLUA271 (www.ti.com/lit/slua271).

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EXAMPLE STENCIL DESIGN

DPW0005A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

ADVANCE INFORMATION

4X (0.42)
4X (0.06)

4X (0.22)   1

4X (0.26)

SYMM

(□ 0.24)

SOLDER MASK
EDGE

3

(0.21)
TYP

5

(0.48)

2

4

(R0.05) TYP

SYMM

(0.78)

SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 3
92% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:100X

4223102/D   03/2022
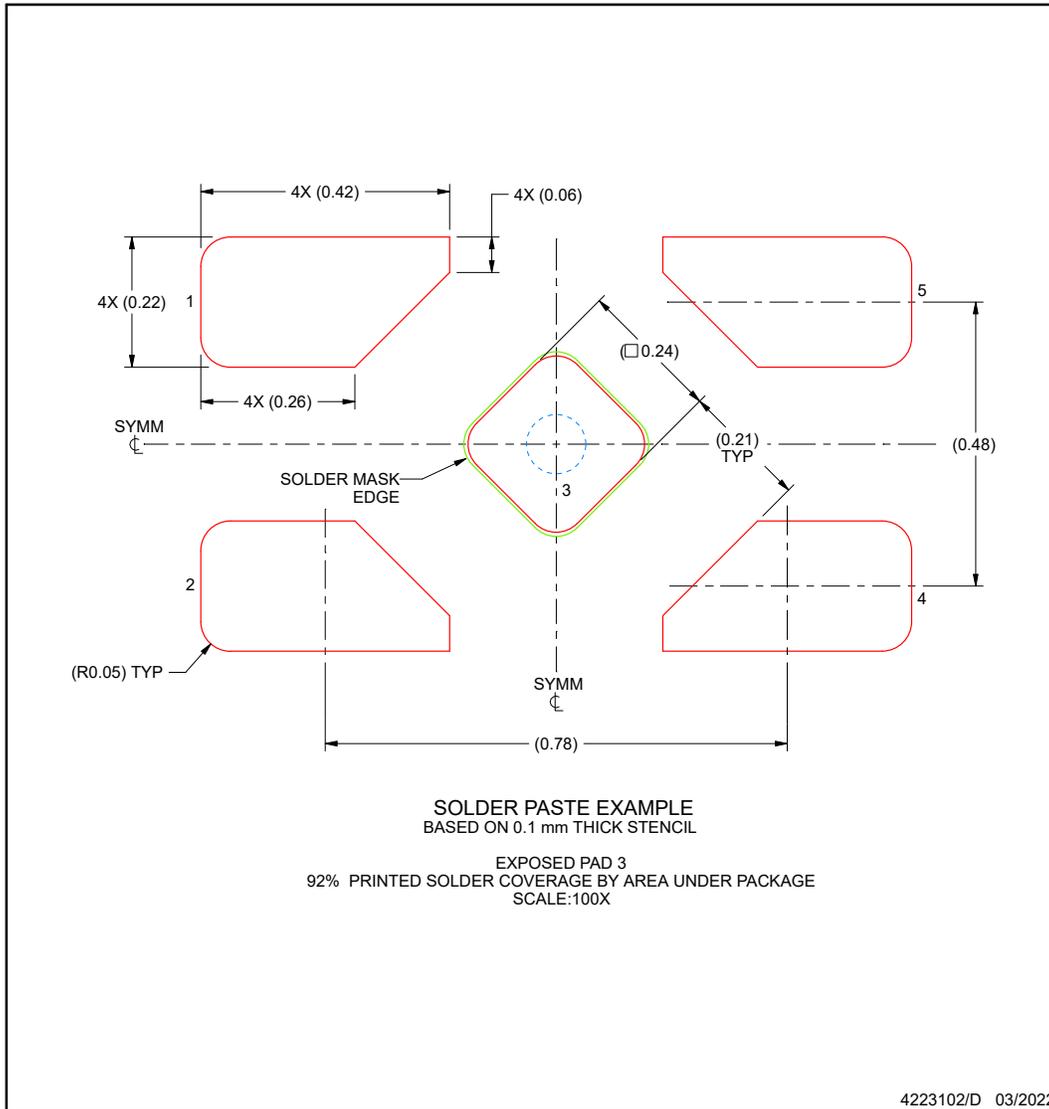
NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate
design recommendations.

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Product Folder Links: *TMP110*

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PTMP110D0IDPWR	ACTIVE	X2SON	DPW	5	3000	TBD	Call TI	Call TI	-40 to 125		Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

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