EPT-200TMP-TS-U2

TMP102 Temperature Sensor Docking Board

Data Sheet

This docking board is based on the TMP102 Temperature Sensor chip from Texas Instruments. It can measure the ambient temperature between -25℃ to +85℃. The temperature is measured with an accuracy of ± 0.5℃ across the temperature range. The TMP102 is capable of reading temperatures to a resolution of 0.0625°C

The EPT-200TMP-TS-U2 is a combination of the TMP102 sensor, daughter board and docking board. The docking board provides a convenient method to connect the TMP102 to an array of Arduino boards. It is compatible with both +3.3V and +5V Arduinos. There is a power indicator Green LED, and a user Green LED. It has stackable Headers that allow the board to plug into an Arduino and allow other boards to stack on top of it.

Hardware Features:

- Uses the I2C interface
- 12-bit, 0.0625°C resolution
- Typical temperature accuracy of ±0.5°C
- +3.3V sensor
- Compatible with +3.3V or +5V interface

1 Description

The EPT-200TMP-TS-U2 contains a TMP102 sensor, daughter board and docking board in one package. The docking board with plug directly into Arduino boards. There is no need to use wires to jumper from the TMP102 daughter card to an Arduino. Just plug the EPT-200TMP-TS-U2 into an Arduino, then start writing code. This board is perfect for applications that require a robust connection between Arduino and Temperature Sensor.

The EPT-200TMP-TS-U2 is compatible with the following Arduino Boards:

- Uno
- Genuino 101
- Ardudino 101
- Zero
- Yun

- Leonardo
- Pro

1.1 Hardware Description

The EPT-200TMP-TS-U2 consists of the following hardware

- TMP102 Temperature Sensor
- Arduino compatible stackable headers
- One Green LED for power indication
- One Green LED for user
- Two bread board areas

1.1.1 Temperature Sensor

The TMP102 device is a digital temperature sensor that offers an accuracy of ±2°C without requiring calibration or external component signal conditioning. Device temperature sensors are highly linear and do not require complex calculations or lookup tables to derive the temperature. The on-chip 12-bit ADC offers resolutions down to 0.0625°C

The TMP102 device features two-wire and I2C interface compatibility. The device is specified to operate over supply voltages from 1.4 to 3.6 V with the maximum quiescent current of 10 µA over the full operating range. The device is specified for operation over a temperature range of –40°C to 125°C.

The TMP102 device operates as a slave device only on the two-wire bus. Connections to the bus are made through the open-drain I/O lines, SDA and SCL. Because these signals are both open drain, the TMP102 can operate on both +3.3V and +5V Arduinos. The EPT-200TMP-TS-U2 board routes the +3.3V to power the TMP102 and to the pullups for the open drain lines. The TMP102 device supports the transmission protocol for both fast (1 kHz to 400 kHz) and high-speed (1 kHz to 2.85 MHz) modes. All data bytes are transmitted MSB first.

I2C Bus

The daughter board has built-in 4.7 kΩ pull up resistors for I2C communications. If connecting multiple I2C devices on the same bus, ensure that the pull-up resistors for one or more boards is disabled. If multiple pull-up resistors are connected in parallel on the I2C bus, the combined resistance will be lower than the 4.7 kΩ. This could cause failure in the I2C transactions as the master will be required to the bus with more current than it is designed for.

Serial Bus Address

To communicate with the TMP102, the master must first address slave devices via a slave address byte.

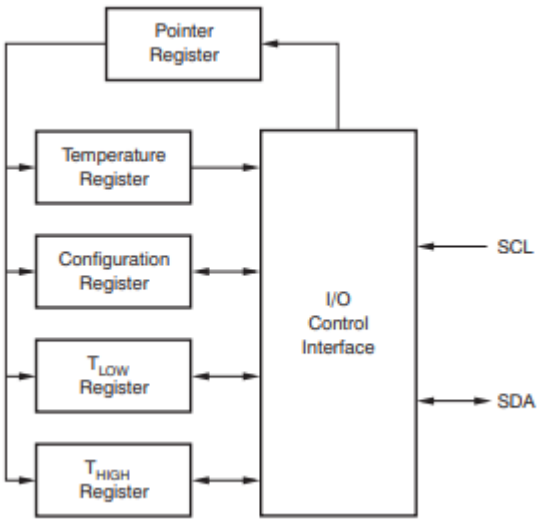
The slave address byte consists of seven address bits, and a direction bit indicating the intent of executing a read or write operation. The TMP102 features an address pin to allow up to four devices to be addressed on a single bus. Table 4 describes the pin logic levels used to properly connect up to four devices.

DEVICE TWO-WIRE ADDRESS	A0 PIN CONNECTION
1001000	Ground
1001001	V+
1001010	SDA
1001011	SDA

Register Set

There are five registers accessible using the TMP102 I2C interface.

- Pointer Register
- Temperature Register
- Configuration Register
- T_{LOW} Register
- T_{HIGH} Register



Pointer Register

The 8-bit Pointer Register of the device is used to address a given data register. The Pointer Register uses the two least-significant bytes (LSBs) (see Table 15 and Table 16) to identify which of the data

registers must respond to a read or write command. Table 6 identifies the bits of the Pointer Register byte. During a write command, P2 through P7 must always be '0'. Table 7 describes the pointer address of the registers available in the TMP102 device. The power-up reset value of P1 and P0 is 00. By default, the TMP102 device reads the temperature on power up.

P7	P6	P5	P4	P3	P2	P1	P0
0	0	0	0	0	0	Register Bits	

P1	P2	Register Bits
0	0	Temperature Register (Read Only)
0	1	Configuration Register (Read/Write)
1	0	TLOW Register (Read/Write)
1	1	THIGH Register (Read/Write)

Temperature Register

The Temperature Register of the TMP102 is configured as a 12-bit, read-only register (Configuration Register EM bit = 0, see the Extended Mode section), or as a 13-bit, read-only register (Configuration Register EM bit = 1) that stores the output of the most recent conversion. Two bytes must be read to obtain data, and are described in Table 8 and Table 9. Note that byte 1 is the most significant byte, followed by byte 2, the least significant byte. 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.

Byte 1 of Temperature Register

D7	D6	D5	D4	D3	D2	D1	D0
T11 (T12)	T10 (T11)	T9 (T10)	T8 (T9)	T7 (T8)	T6 (T7)	T5 (T6)	T4 (T5)

Byte 2 of Temperature Register

D7	D6	D5	D4	D3	D2	D1	D0
T3 (T4)	T2 (T3)	T1 (T2)	T0 (T1)	0 (T0)	0 (0)	0 (0)	0 (0)

Configuration Register

The Configuration Register is a 16-bit read/write register used to store bits that control the operational modes of the temperature sensor. Read/write operations are performed MSB first. Table 10 and Table 11 list the format and the power-up or reset value of the configuration register. For compatibility, Table 10 and Table 11 correspond to the configuration register in the TMP75 device and TMP275 device (for more information see the device data sheets, SBOS288 and SBOS363, respectively). All registers are updated byte by byte.

D7	D6	D5	D4	D3	D2	D1	D0
OS 0	R1 1	R0 1	F1 0	F0 0	POL 0	TM 0	SD 0

D7	D6	D5	D4	D3	D2	D1	D0
CR1 1	CR0 0	AL 1	EM 0	0 0	0 0	0 0	0 0

High- and Low-Limit Registers

The temperature limits are stored in the T(LOW) and T(HIGH) registers in the same format as the temperature result, and their values are compared to the temperature result on every conversion. The outcome of the comparison drives the behavior of the ALERT pin, which operates as a comparator output or an interrupt, and is set by the TM bit in the configuration register.

Byte 1 Temperature Register HIGH

D7	D6	D5	D4	D3	D2	D1	D0
H11 (H12)	H10 (H11)	H9 (H10)	H8 (H9)	H7 (H8)	H6 (H7)	H5 (H6)	H4 (H5)

Byte 2 Temperature Register HIGH

D7	D6	D5	D4	D3	D2	D1	D0
H3 (H4)	H2 (H3)	H1 (H2)	H0 (H1)	0 (H0)	0 0	0 0	0 0

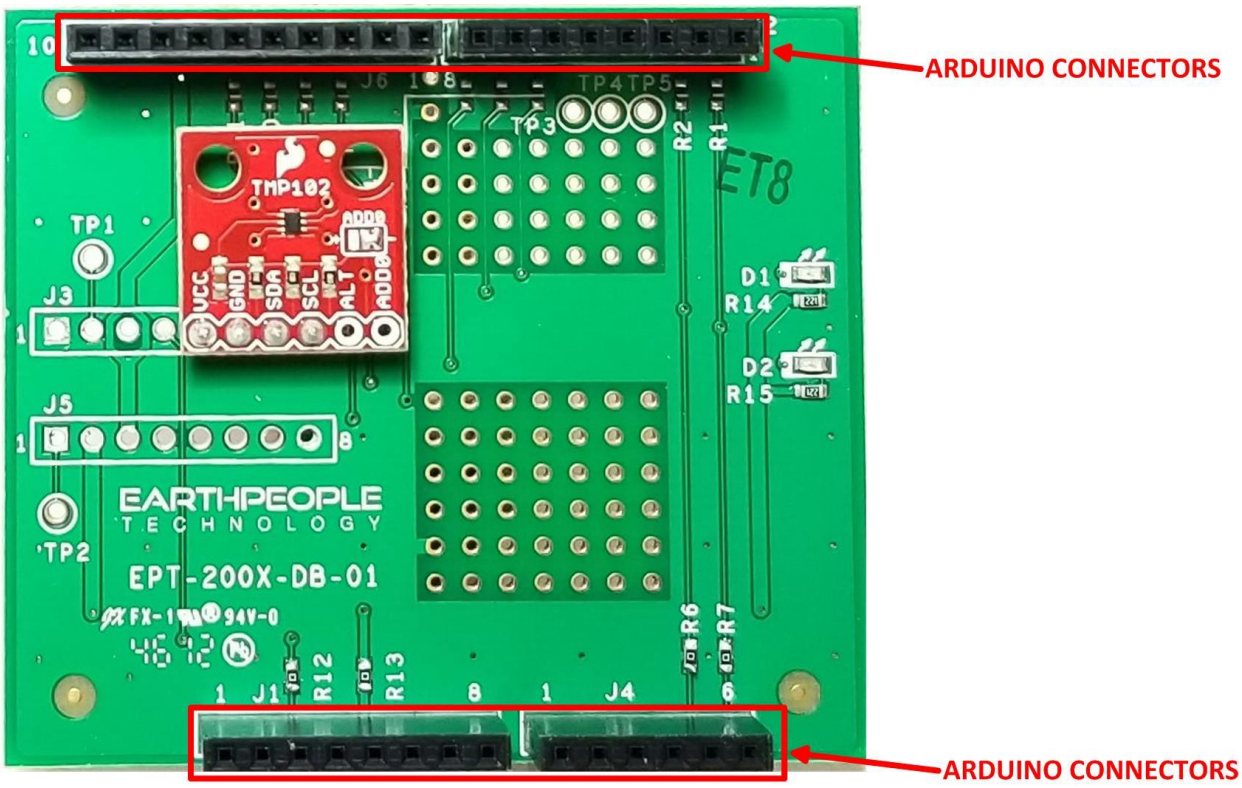
Byte 1 Temperature Register LOW

D7	D6	D5	D4	D3	D2	D1	D0
L11 (L12)	L10 (L11)	L9 (L10)	L8 (L9)	L7 (L8)	L6 (L7)	L5 (L6)	L4 (L5)

Byte 2 Temperature Register LOW

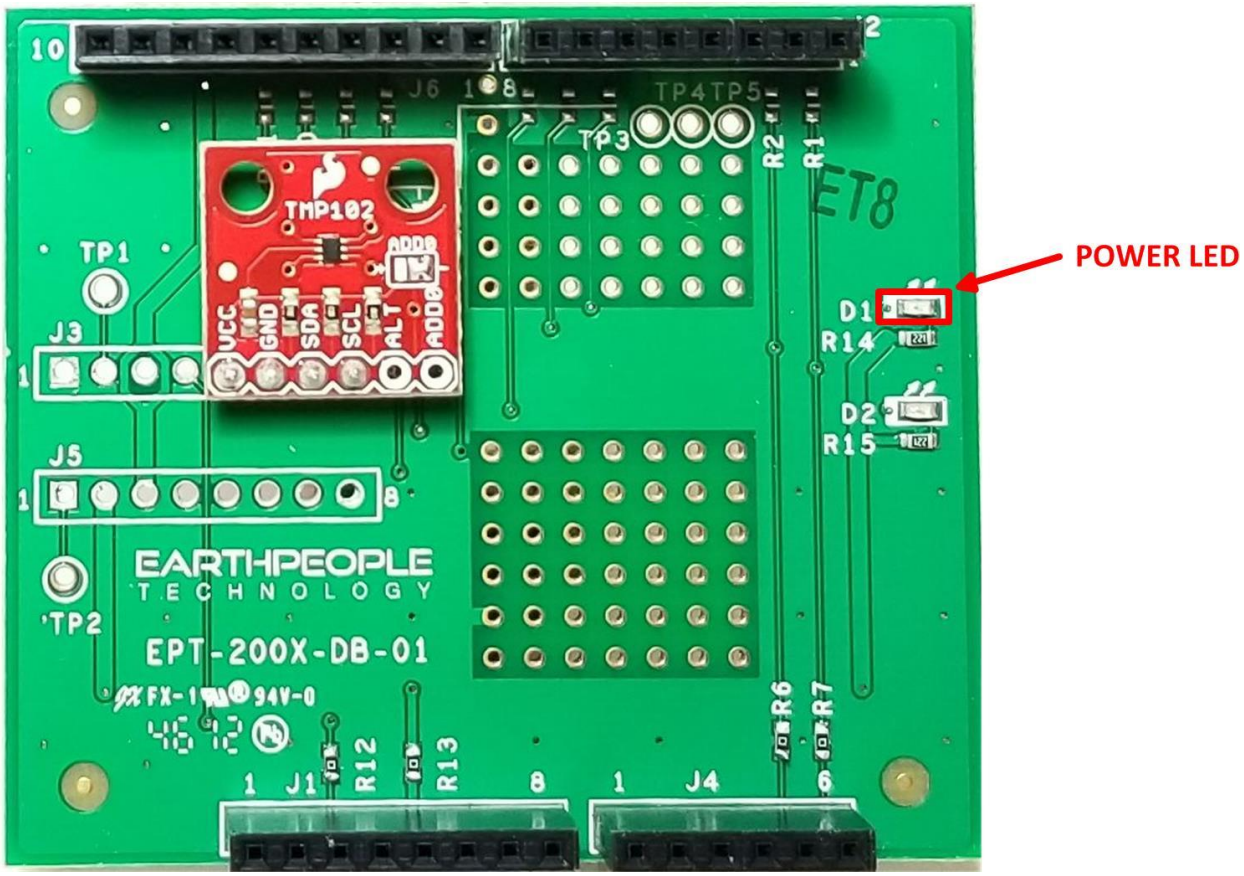
D7	D6	D5	D4	D3	D2	D1	D0
L3 (L4)	L2 (L3)	L1 (L2)	L0 (L1)	0 (L0)	0 0	0 0	0 0

1.1.2 Arduino compatible stackable headers



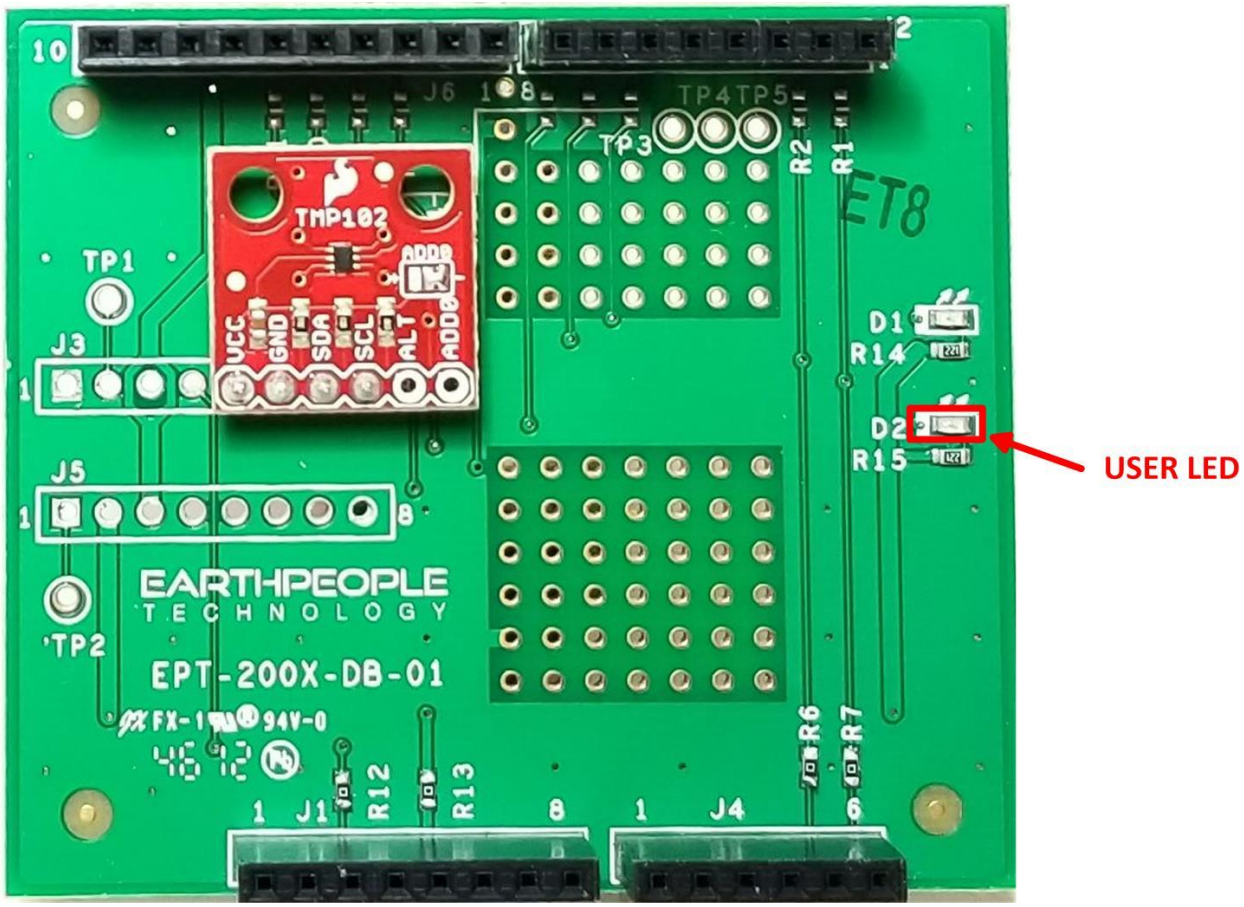
The stackable headers of the EPT-200TMP-TS-U2 are compatible with the Arduino Uno (R3) and similar boards. The board mates perfectly with no alterations required. All pins of each connector pass through from Arduino to stackable header. One exception has been made for the RESET pin 3 of the POWER (J1) connector. This pin has been disconnected from the Arduino. The RESET pin of the POWER (J1) connector on the EPT-200TMP-TS is connected to +3.3V. It is not recommended to use this pin.

1.1.3 Power Indication LED



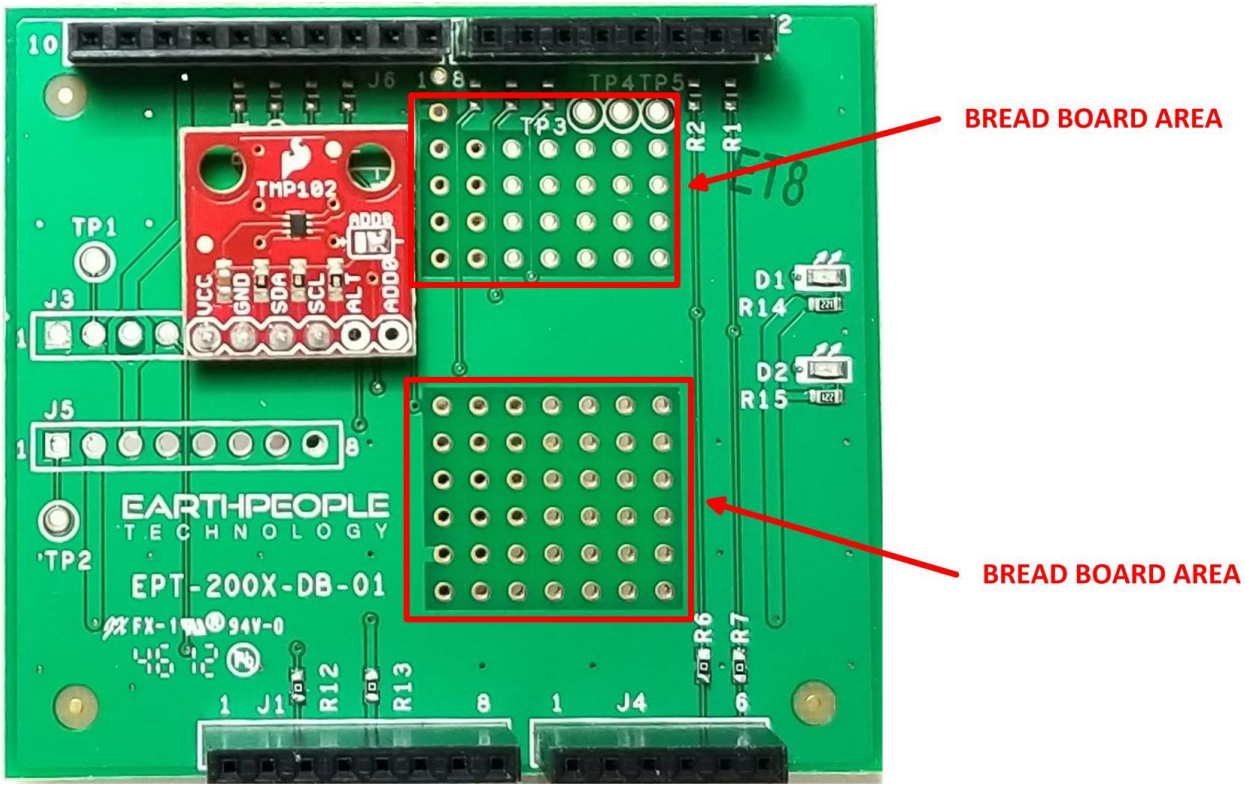
The power LED sources current from the +5V power rail. When the Arduino base board is powered up, the LED will light up.

1.1.4 User LED



A user LED is available on the EPT-200TMP-TS-U2. This LED sources current from the +5V power. The user will apply a ground to sink the current for the LED and turn it on. The user LED maps to the pin 8 of IOL (J2) connector.

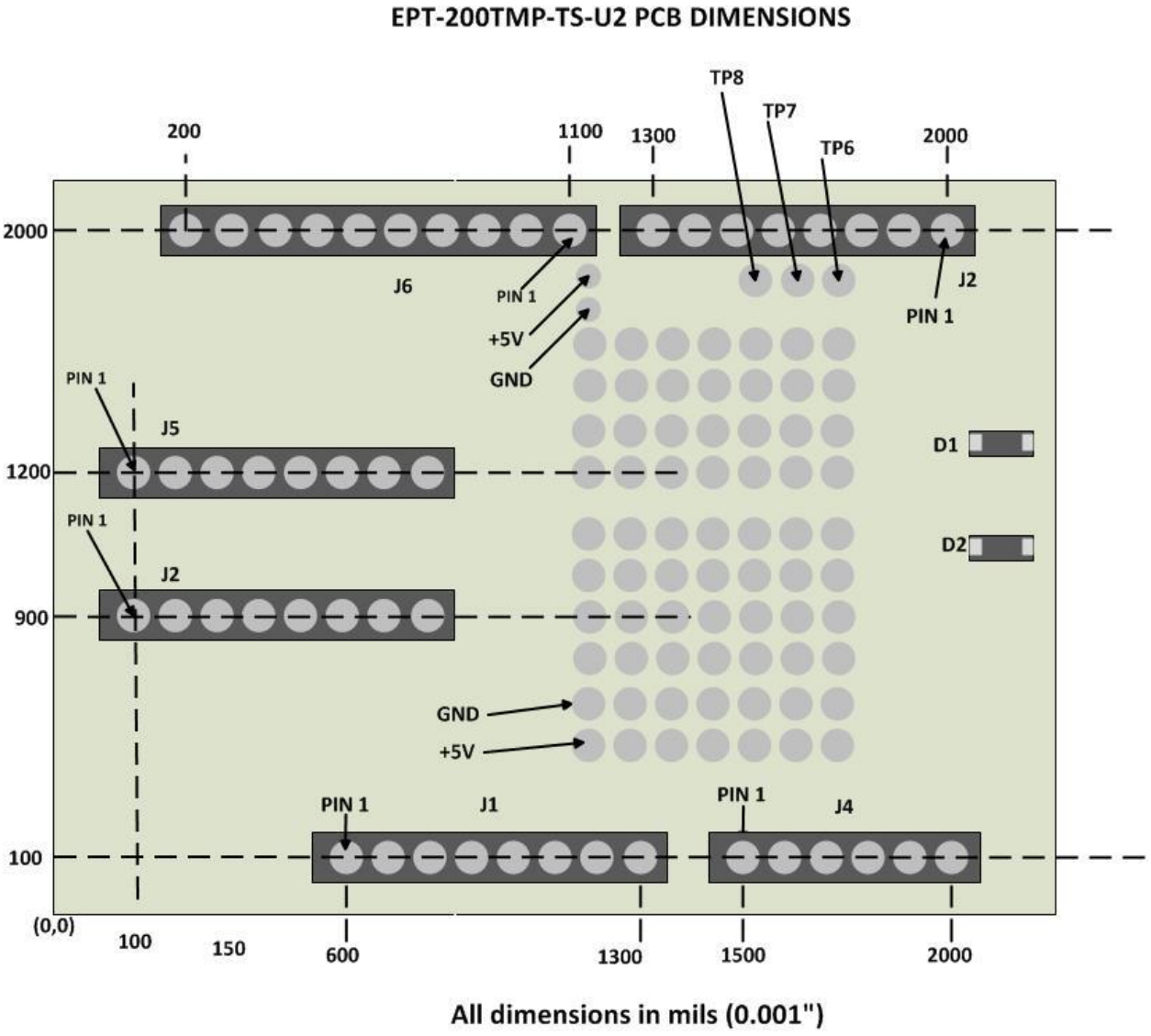
1.1.5 Bread Board Areas



The EPT-200TMP-TS-U2 PCB has two bread board areas. The bread board areas are a matix of through hole pads that have 28 mil drill size. The pads are spaced at 0.1 inch adjacent to each through hole pad. Most of the pads are blank and do not connect to any part of the PCB. The exception is that each matrix area has a ground pad and a +5V pad. These power pads are located in the upper left section and lower left section of each respective matrix. See the Mechanical Dimension section for exact location of the power pads. There are also three test points which connect directly to the IOL (J2) connector. These test points are:

- TP6 connects to pin 5 of IOL (J2)
- TP7 connects to pin 4 of IOL (J2)
- TP8 connects to pin 3 of IOL (J2)

2 Mechanical Dimensions



3 Pin Mapping

EPT-200TMP-TS-U2 to Arduino Pin Mapping

Arduino Connector	Arduino Connector Pin Number	Arduino Pin Description	EPT-200TMP-TS-U2 Description	EPT-200TMP-TS-U2 Connector Pin Number	EPT-200TMP-TS-U2 Connector
IOH	1	IO8	NC	1	J6
	2	IO9	NC	2	
	3	SS	MC_SS	3	
	4	MOSI	MC_MOSI	4	
	5	MISO	MC_MISO	5	
	6	SCK	MC_SCK	6	
	7	GND	NC	7	
	8	AREF	NC	8	
	9	SDA	NC	9	
	10	SCL	NC	10	
AD	1	ADO	NC	1	J4
	2	AD1	NC	2	
	3	AD2	NC	3	
	4	AD3	NC	4	
	5	AD4	MC_SDA	5	
	6	AD5	MC_SCL	6	
IOL	1	IO0	MC_RXD	1	J2
	2	IO1	MC_TXD	2	
	3	IO2	TP8	3	

	4	IO3	TP7	4	
	5	IO4	TP6	5	
	6	IO5	MC_IO3	6	
	7	IO6	MC_IO2	7	
	8	IO7	MC_USER1	8	
POWER	1	NC	NC	1	J1
	2	+5V	NC	2	
	3	RESET	+3.3V	3	
	4	+3.3V	+3.3V	4	
	5	+5V	+5V	5	
	6	GND	GND	6	
	7	GND	GND	7	
	8	VIN	NC	8	

4 Inputs/Outputs

The TMP102 I/O pins are compatible with either +3.3V or +5V. The TMP102 is powered from the +3.3V provided by the Arduino on pin 4 of J1. Because the SDA and SCL signals are open drain, due to I2C specification, they can be pulled up to either +3.3V or +5V. The TMP102 has no problem recognizing either voltage on its I2C bus. The user LED on the EPT-200TMP-TS-U2 is a current sink, so either float the signal to turn it off or assert to ground to turn the LED on.

4.1.1 Power Budget

Device	**Part Number**	**+5V**	**+3.3V**		
Temperature Sensor	TMP102		1mA		
Power LED		6mA			
User LED		6mA			
Total		**12mA**	**1mA**		