TMP390EVM

User's Guide

Literature Number: SNIU033
May 2019

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TMP390EVM User's Guide

The TMP390 is an ultra-low power, dual-trip, dual-output, resistor-programmable temperature switch. This device enables thermal protection and thermal event monitoring over a wide temperature range. The TMP390 offers independent overtemperature (hot) and undertemperature (cold) detection in the temperature range from –55°C to +130°C with ±2.5°C trip accuracy. The Texas Instruments TMP390EVM (Evaluation Module) is easy to use and can evaluate the performance of the TMP390 right out of the box. The EVM has pre-populated resistors corresponding to a hot and cold trip point with 5°C hysteresis, and LED indicators at the outputs of the device. The trip test function is available through the use of onboard push buttons to test the output of both channels. The sensor is also located on a perforated portion of the PCB that can be separated from the main board for prototyping. The TMP390EVM does not require any calibration or software programming, as the trip points are programmed through two resistors. This document provides detailed information about the device operation and evaluation board features.

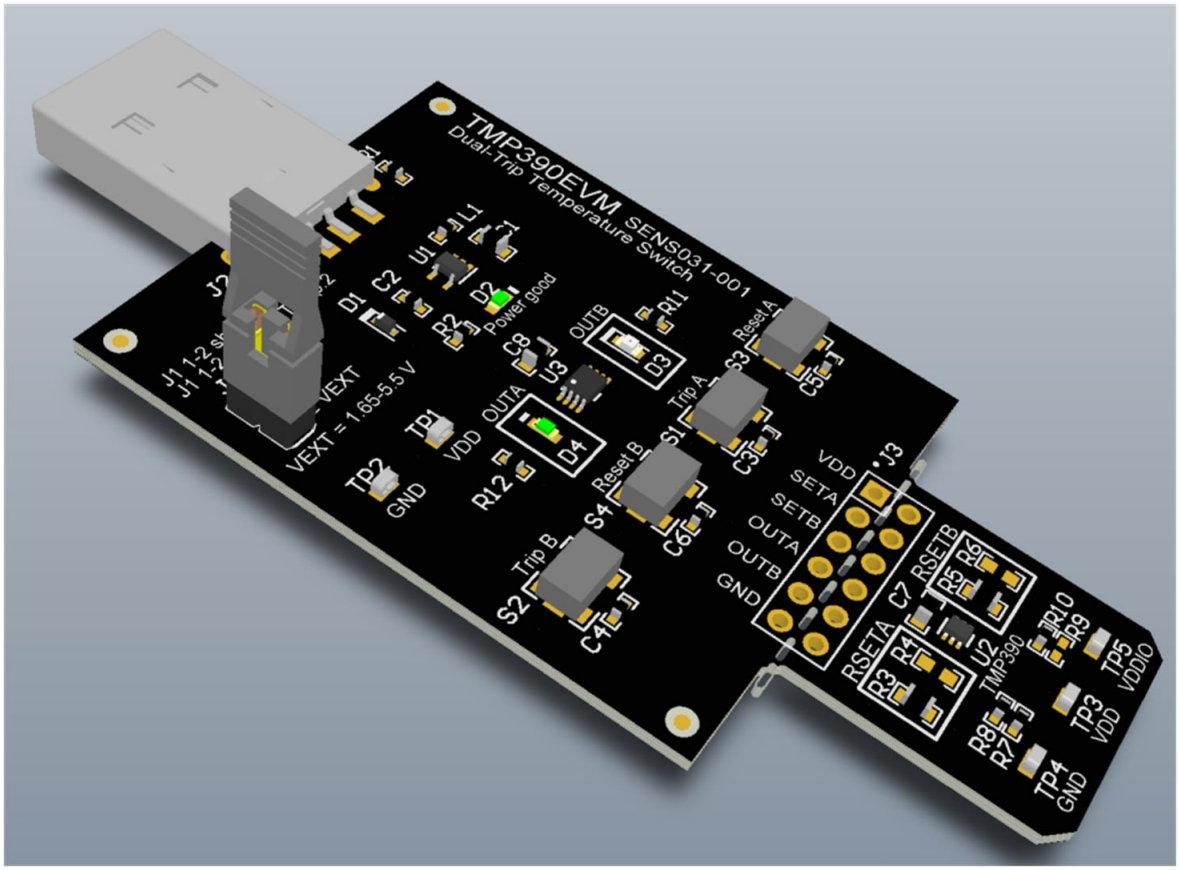


Figure 1. TMP390 Evaluation Board

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1 Trademarks

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2 Overview

The TMP390EVM allows users to evaluate the performance of the TMP390 dual-trip programmable temperature switch. The EVM comes in a USB stick form factor that can plug into a USB port to supply power and begin the evaluation of the temperature switch. The hardware is as shown in Figure 1. The module is designed so all of the features, including the manual trip test and reset of both channels, are readily available for testing. Two LED indicators are illuminated when either output of the TMP390 is triggered based on the temperature trip point. The EVM also features a perforated breakout portion of the board which can be wired to test the TMP390 in either an existing system or an oven.

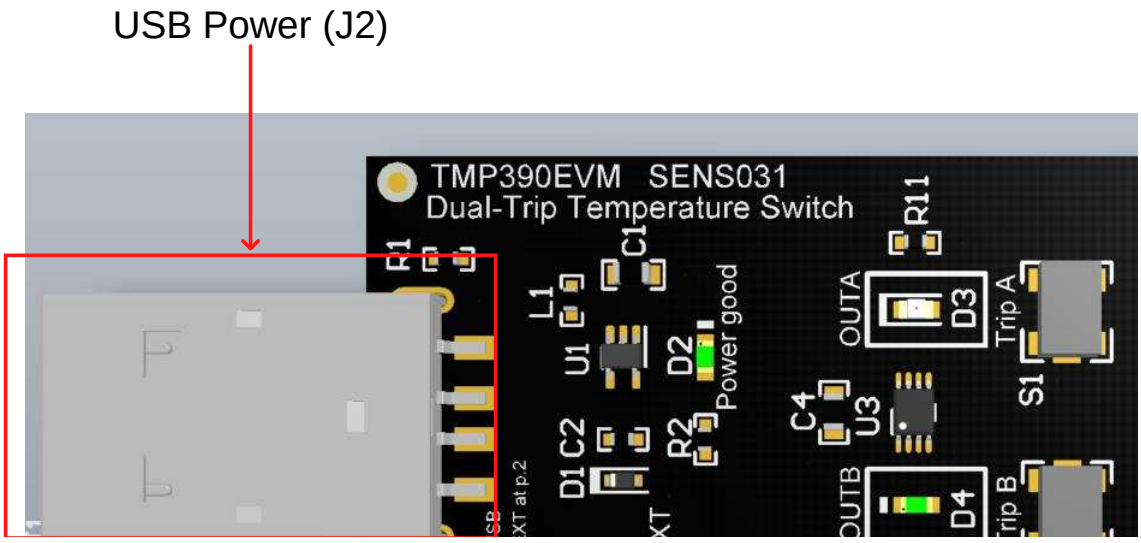


Figure 2. TMP390 Evaluation Board Top Side

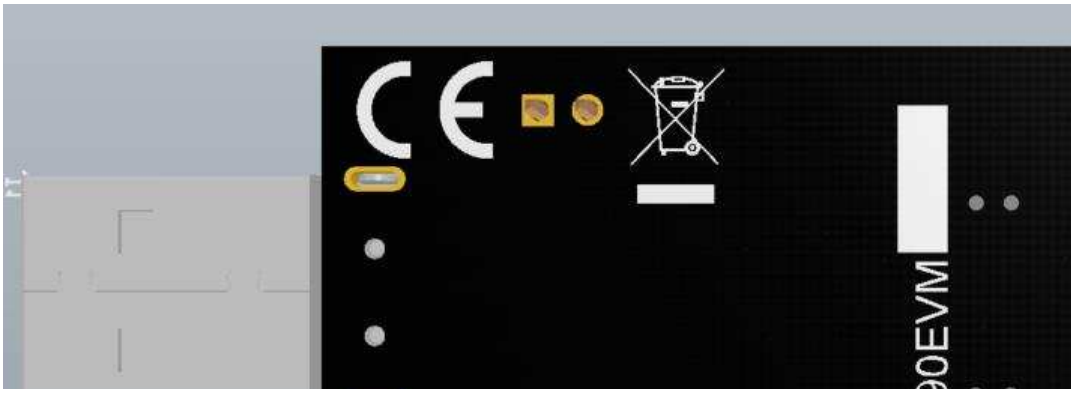


Figure 3. TMP390 Evaluation Board Bottom Side

2.1 TMP390EVM Kit Contents

Table 1 summarizes the contents of the TMP390EVM kit. Figure 1 shows all of the included hardware.

Table 1. TMP390EVM Kit Contents

Item	Quantity
PCB Test Board: TMP390EVM	1
USB Cable Extender	1

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3 EVM Hardware Overview and Operation

The TMP390EVM block diagram is shown in Figure 4, and each block is described in detail in the following sections.

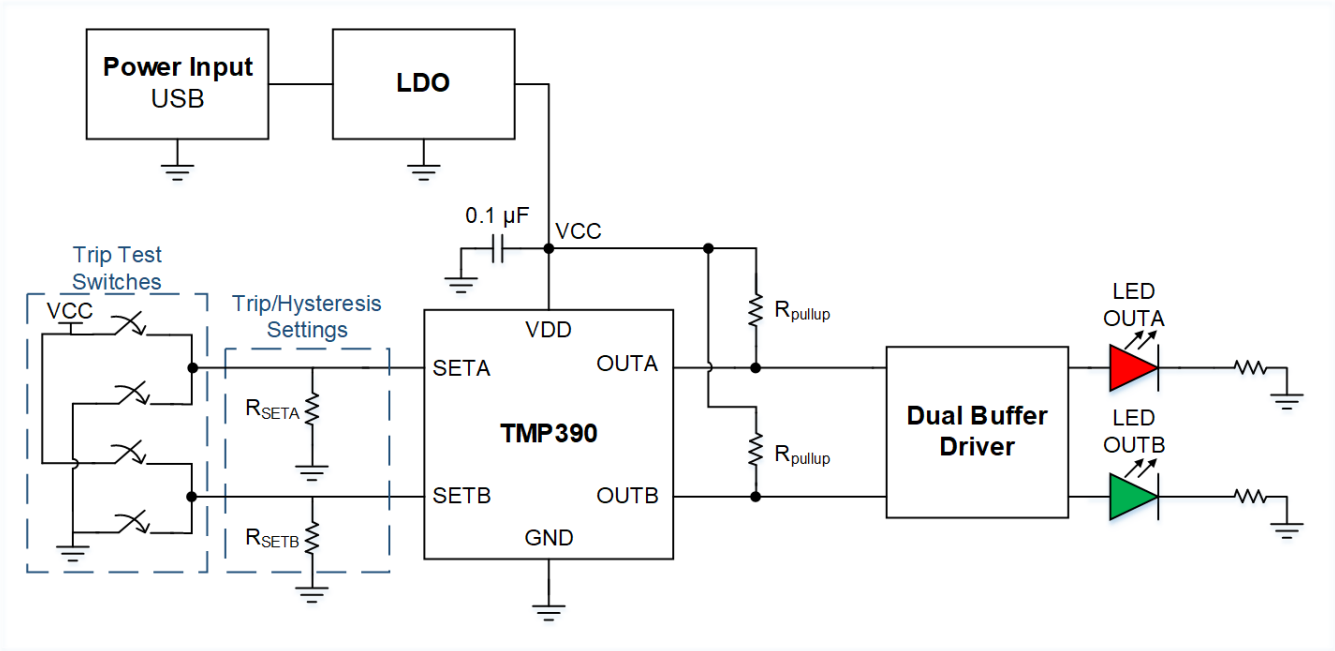


Figure 4. TMP390 Evaluation Board Block Diagram

3.1 Power Input and Regulation

Power is supplied from the USB connector, J2, with +5 V. This input can connect to the USB port of a laptop or desktop. The evaluation board does not require an external power supply, but one may be used if desired (such as when the breakout board is disconnected), so long as the voltage is within the maximum rated voltage of the TMP390.

USB power is used when J1 is shorted at pins 1-2 using a jumper. This connects +5 V to the LDO (low dropout regulator), providing a regulated output voltage of +3.3 V. If an external supply is required, then jumper J1 can be removed and power may be connected to pin 2 of J1. If an external supply is used, the input voltage can be from +2.2 V to +5.5 V. The input voltage can be measured at test pin TP1 (VDD). The LED, D2, will illuminate when power is good.

3.2 Perforated Breakout Board

The EVM board is perforated along the unpopulated J3 designator to break away the sensor portion of the board from the power and LED output for additional prototyping and testing. J3 provides connections for the breakout board for power, inputs, and outputs. The pins located on both sides of the J3 designator are labeled with silkscreen on the EVM, including SETA, SETB, OUTA, OUTB, VDD, and GND. All components on the breakout board are rated up to +150°C. The EVM was not designed with high-temperature PCB material, and thus was not designed for prolonged testing at high temperature.

3.3 Dual-Channel Resistor Programmable Trip Points

The engineer can use two 1.05-kΩ to 909-kΩ E96-series resistors to set the high and low temperature trip points. There are 48 available trip points in the hot trip point range and 48 available trip points corresponding to a cold trip point and hysteresis setting. The hot trip point may be in the +30°C to +124°C range, while the cold trip point is in the –50°C to +25°C range. These settings can be found in the TMP390 device data sheet. On the TMP390EVM, resistors R3 and R5 are populated to set the trip points for SETA and SETB, respectively. These are located on the same breakout board where the TMP390 is

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located, and are designated as RSETA and RSETB. The resistor in the SETA programs the hot trip point, while the resistor in the SETB programs the cold trip point and the hysteresis settings for both channels. R3 is populated on the EVM with a 5.90-kΩ resistor, corresponding to the hot trip point at 54°C. R5 is 10.5 kΩ, corresponding to the cold trip point at 25°C and hysteresis of 5°C. With the trip point at 25°C, the user can immediately visualize the tripped output after opening the EVM. Two additional footprints for 0603 resistors, R4 and R6, are available to solder different resistors and program alternate hot and cold trip points. Remember that R3 and R4 should not be populated at the same time, and that R5 and R6 should also not be populated at the same time. Standard resistor values in the E96-series that have 1% tolerance should be used for best performance.

Figure 5 shows the behavior of the output using hysteresis. When the high trip point of +54°C is reached, OUTA is tripped and the output will remain low until the temperature drops below the hysteresis level subtracted from the hot threshold temperature. In this case, the hysteresis is set at 5°C, so OUTA returns high when the temperature drops to +49°C. The same goes for the lower threshold, which is set at +25°C. When the sensor goes to +25°C, OUTB goes low and will return high when the temperature rises above 30°C.

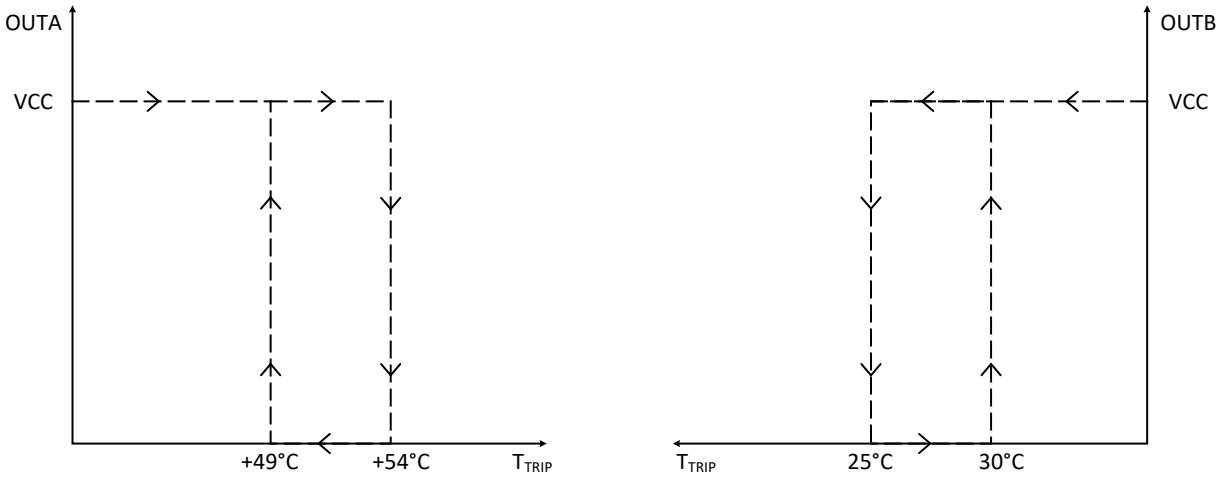


Figure 5. Hysteresis Behavior Example

3.4 Manual Trip Test and Reset

Both outputs can be tripped manually by applying a logic high to the SETA and SETB inputs to evaluate the functionality of the outputs. On the evaluation board, there are two designated push buttons—S1 and S2—to trip OUTA and OUTB, respectively. The output LEDs for OUTA and OUTB, D3 (red) and D4 (green), will illuminate when the trip point is reached or if the output is forced by the trip test.

3.5 Open-Drain Output

Pullup resistors are located at the open-drain OUTA and OUTB outputs. TI recommends to tie the pullup voltage to the VDD of the TMP390. If this is not possible, however, an external voltage may be used for VDDIO that must be less than or equal to VDD of the TMP390. To connect an external VDDIO, the 0-Ω resistor at R7 may be desoldered to remove connection to VDD, then resoldered at R9 to connect an external supply at TP5 as shown in Figure 6.

4 Board Layout

The PCB is a four-layer board which includes a power regulator, the TMP390 sensor, all of the necessary auxiliary circuitry, and various test points. The portion of the board where the sensor and resistors is located may be broken off for evaluation separately from the rest of the EVM. This breakout board was minimized in size to reduce the thermal mass for improving the thermal response of the TMP390. Further layout considerations in the final design using the TMP390 can be taken into account depending on the

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application. Refer to *Temperature Sensors: PCB Guidelines for Surface Mount Devices* (SNOA967) for design and layout recommendations for temperature sensors. The breakout board includes resistors rated up to 150°C for high-temperature testing as well as the decoupling capacitor, C7, which is placed closely to the TMP390. Note that this PCB will not withstand temperatures of 150°C for extended periods of time because it was not manufactured with high-temperature material.

5 Schematic and Bill of Materials

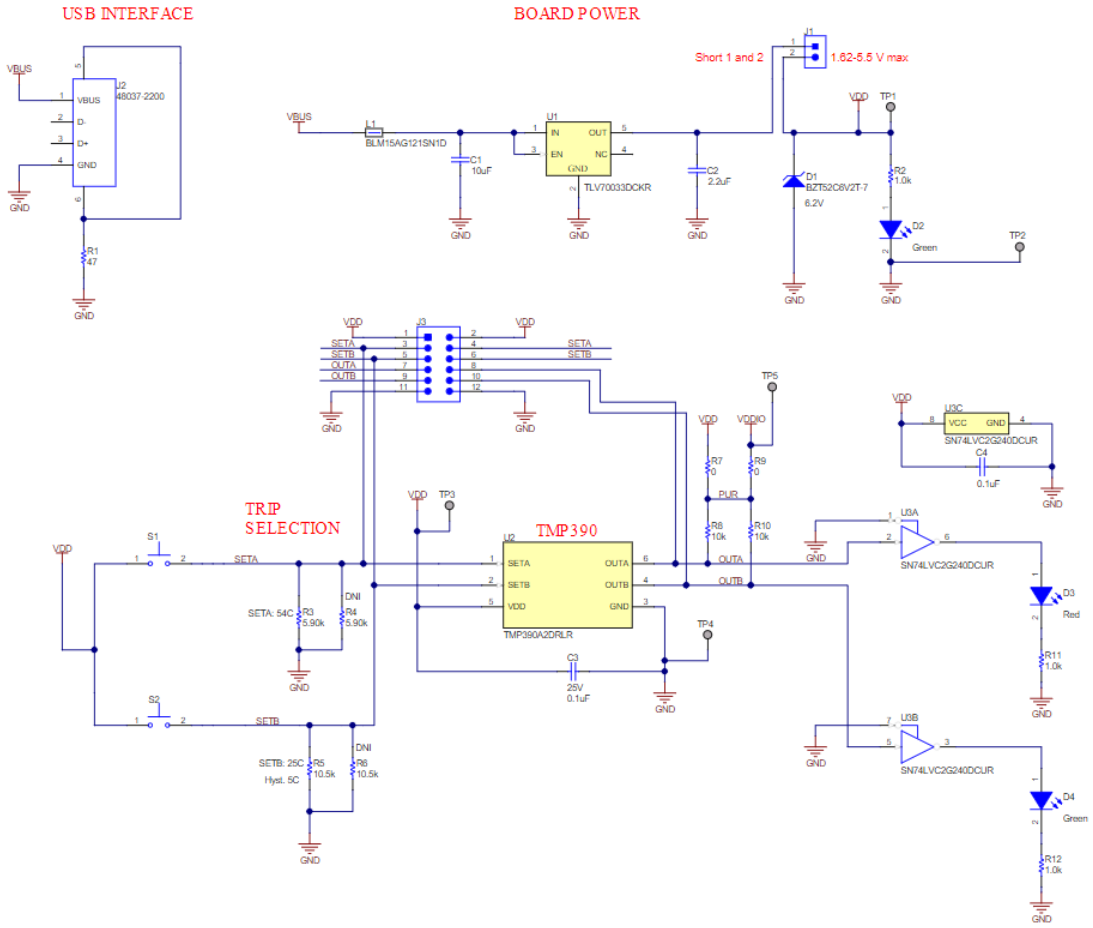


Figure 6. TMP390 Evaluation Board Schematic

Table 2. TMP390 Test Board Bill of Materials

Item No.	Qty	Value	Ref Des	Description	Vendor/Mfr	Part Number
1	1	10 µF	C1	CAP, CERM, 10 µF, 10 V, ±20%, X5R, 0603	TDK	C1608X5R1A106M080AC
2	1	2.2 µF	C2	CAP, CERM, 2.2 µF, 16 V, ±10%, X5R, 0402	MuRata	GRM155R61C225KE11D

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Table 2. TMP390 Test Board Bill of Materials (continued)

Item No.	Qty	Value	Ref Des	Description	Vendor/Mfr	Part Number
4	2	0.1 µF	C7, C8	CAP, CERM, 0.1 µF, 25 V, ±10%, X8R, AEC-Q200 Grade 0, 0603	TDK	CGA3E2X8R1E104K080AA
5	1	6.2 V	D1	Diode, Zener, 6.2 V, 300 mW, SOD-523	Diodes Inc.	BZT52C6V2T-7
6	2	Green	D2, D4	LED, Green, SMD	Lumex	SML-LX0603GW-TR
7	1	Red	D3	LED, Red, SMD	Lite-On	LTST-C191KRKT
8	1		J1	Header, 2.54 mm, 2x1, Gold, TH	Wurth Elektronik	61300211121
9	1		J2	Connector, Plug, USB Type A, R/A, Top Mount SMT	Molex	48037-2200
10	1	120	L1	Ferrite Bead, 120 Ω at 100 MHz, 0.55 A, 0402	MuRata	BLM15AG121SN1D
11	1	47	R1	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	Panasonic	ERJ-2GEJ470X
12	3	1k	R2, R11, R12	RES, 1.0 kΩ, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	Panasonic	ERJ-2GEJ102X
13	1	5.90k	R3	RES, 1 KΩ, 1%, 0.1 W, AEC-Q200, 0603	Panasonic	ERJ-3EKF1001V
14	1	10.5k	R5	RES, 10.5 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060310K5FKEA
15	1	0	R7	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW04020000Z0ED
16	2	10k	R8, R10	RES, 10 kΩ, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	Panasonic	ERJ-2GEJ103X
17	2		S1, S2	Switch, SPST-NO, Off-Mom, 0.05A, 12VDC, SMD	C&K Components	PTS820 J20M SMTR LFS
18	1		SH-J1	Shunt, 100mil, Tin plated, Black	Samtec	SNT-100-BK-T-H
19	5		TP1, TP2, TP3, TP4, TP5	Natural PC Test Point Brass, SMT	Harwin	S2761-46R
20	1		U1	Single Output LDO, 200 mA, Fixed 3.3 V Output, 2 to 5.5 V Input, with Low IQ	Texas Instruments	TLV70033DCKR
21	1		U2	Dual-Trip, Resistor-Programmable Temperature Switch	Texas Instruments	TMP390A2DRLR
22	1		U3	Dual Buffer/Driver With 3-State Outputs	Texas Instruments	SN74LVC2G240DCUR
23	0		J3	Header, 100 mil, 6x2, Gold, TH	Samtec	TSW-106-07-G-D
24	0	5.90k	R4	RES, 1 KΩ, 1%, 0.1 W, AEC-Q200, 0603	Panasonic	ERJ-3EKF1001V
25	0	10.5k	R6	RES, 10.5 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060310K5FKEA
26	0	0	R9	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW04020000Z0ED

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