

# TMP708/709EVM Evaluation Board and Software Tutorial

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This user's guide describes the characteristics, operation, and use of the TMP708/709EVM evaluation board. It reviews the hardware and operation for the TMP708EVM and the TMP709EVM. Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the TMP708/709EVM. This user's guide also includes information regarding operating procedures and input/output connections, an electrical schematic, printed circuit board (PCB) layout drawings, and a parts list for the two EVMs.

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## 1 Overview

The TMP708 and TMP709 are fully-integrated, resistor-programmable temperature switches with temperature thresholds that are set by just one external resistor. The TMP708/709 provide an open-drain, active-low output and are operational over the +2.7-V to +5.5-V supply voltage range. The temperature threshold accuracy is typically  $\pm 0.5^{\circ}\text{C}$  with a maximum of  $\pm 2^{\circ}\text{C}$  (from  $+60^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ ) or  $\pm 3^{\circ}\text{C}$  (from  $0^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ), and the quiescent current consumption is typically 25  $\mu\text{A}$ . Hysteresis is pin-selectable.

The TMP708/709 are available in a 5-pin SOT-23 package. The devices are specified for operation over a temperature range of  $0^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

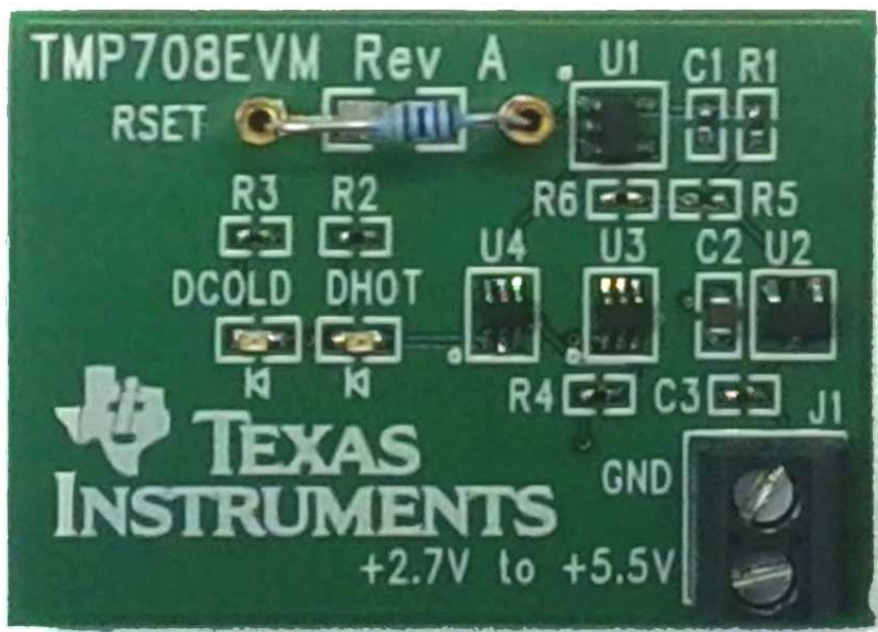
The TMP708/709EVM is a platform for evaluating the performance of the TMP108/709. This document gives a general overview of the TMP708/709EVM and provides a general description of the features and functions to be considered while using this evaluation module.

### 1.1 TMP708/709EVM Kit Contents

Table 1 summarizes the contents of the TMP708/709EVM kit. Figure 1 shows all of the included hardware. Contact the [Texas Instruments Product Information Center](#) nearest you if any component is missing. It is highly recommended that you also check the TMP708 and TMP709 product folders on the TI web site at [www.ti.com](http://www.ti.com) to verify that you have the latest versions of the related software.

**Table 1. TMP708/709EVM Kit Contents**

Item	Quantity
TMP708/709EVM test board	1



**Figure 1. Hardware Included with TMP708/709EVM Kit**

## 1.2 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits used in the assembly of the TMP708/709EVM. This user's guide is available from the TI web site under literature number **SBOU120**. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the [TI web site](#), or call the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

**Table 2. Related Documentation**

Document	Literature Number
TMP708 product data sheet	SBOSxxx
TMP709 product data sheet	<a href="#">SBOS583</a>

## 2 TMP708/709EVM Hardware Overview and Setup

This section describes the hardware and setup for the TMP708/709EVM.

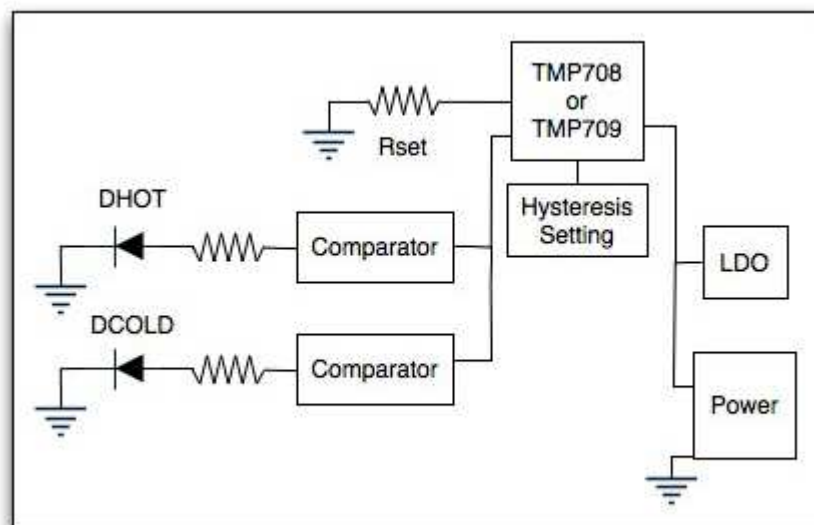
### 2.1 TMP708/709EVM Hardware Theory of Operation

The TMP708/709 test boards feature a power connector labeled J1. This off-board power is connected directly to the TMP708/709 (depending on which EVM you are using). A low-dropout (LDO) regulator provides power to two comparators which sense the output from the TMP708/709.

Depending on the output, either a green LED or a red LED illuminates to visually represent the status of the temperature switch. The temperature limit is determined by the resistor Rset; see **Section 2.4.3**.

The hysteresis setting is controlled by populating either R5 or R6 with a 0- $\Omega$  resistor. This behavior is described in **Section 2.4.2**.

[Figure 2](#) shows the basic interactions that occur on the TMP708/709 test board.



**Figure 2. TMP708/709EVM Hardware Setup**

## 2.2 Electrostatic Discharge Warning

### CAUTION

Many of the components on the TMP708/709EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

## 2.3 Connecting the Hardware

Provide power to the test board from a bench-top power supply using the terminal block labeled J1 in the bottom right corner of the test board, as shown in [Figure 3](#). As labeled, the power supply must be between +2.7 V and +5.5 V.



Figure 3. Connecting the Power Supply to the Test Board

## 2.4 TMP708/709EVM Features

This section describes some of the hardware features present on the TMP708/709EVM test boards.

### 2.4.1 External Power Header

The TMP708/709 test boards feature a terminal block to provide external power. This power is applied directly to the TMP708/709 device. The power is also regulated by an LDO to power the comparators and LEDs that indicate temperature switch status.

### 2.4.2 Hysteresis Options

The test boards ship with R6 populated by a 0-Ω resistor that pulls pin 4 (HYST pin) of the TMP708/709 to GND. The hysteresis function keeps the outputs from oscillating when the temperature is close to the threshold. Thus, the HYST pin should always be connected to either VCC or GND by populating either R5 or R6 with a 0-Ω resistor, respectively. The hysteresis setting is set by the HYST pin, as described in [Table 3](#).

Table 3. Hysteresis Setting

Device	HYST Pin Connection	
	VCC (°C)	GND (°C)
TMP708	10	30
TMP709	10	2

### 2.4.3 SMD Pads and Pin Sockets for Rset

The test boards features SMD pads and pin sockets for Rset so that either a surface-mount resistor or a through-hole resistor may be used to set the temperature threshold. The resistor value is determined by Equation 1:

$$R_{set} \text{ (k}\Omega\text{)} = 0.0012 \times T^2 - 0.9308 \times T + 96.147$$

where:

T is the temperature threshold in degrees Celsius. (1)

### 2.5 LED Status Indicators

The status of the temperature switch may be monitored at a glance by the on-board LEDs. The temperature threshold is set by Rset and the hysteresis setting. An illuminated green LED (as shown in Figure 4) indicates that the current temperature is below the threshold. An illuminated red LED (as shown in Figure 5) indicates that the current temperature is above the threshold.



Figure 4. On-Board LEDs Indicating that Current Temperature is Below the Limit Set by Rset

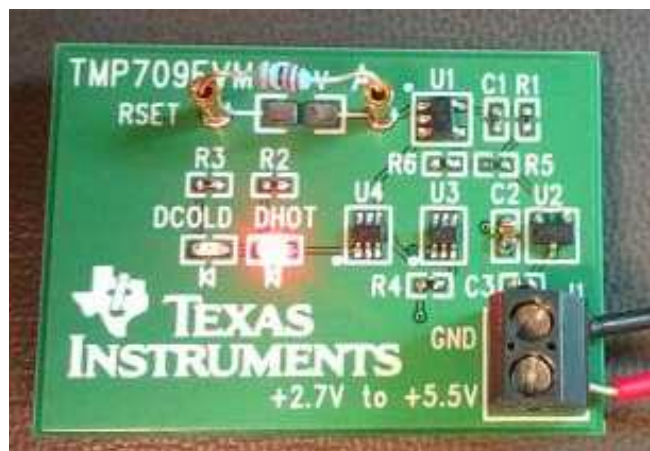
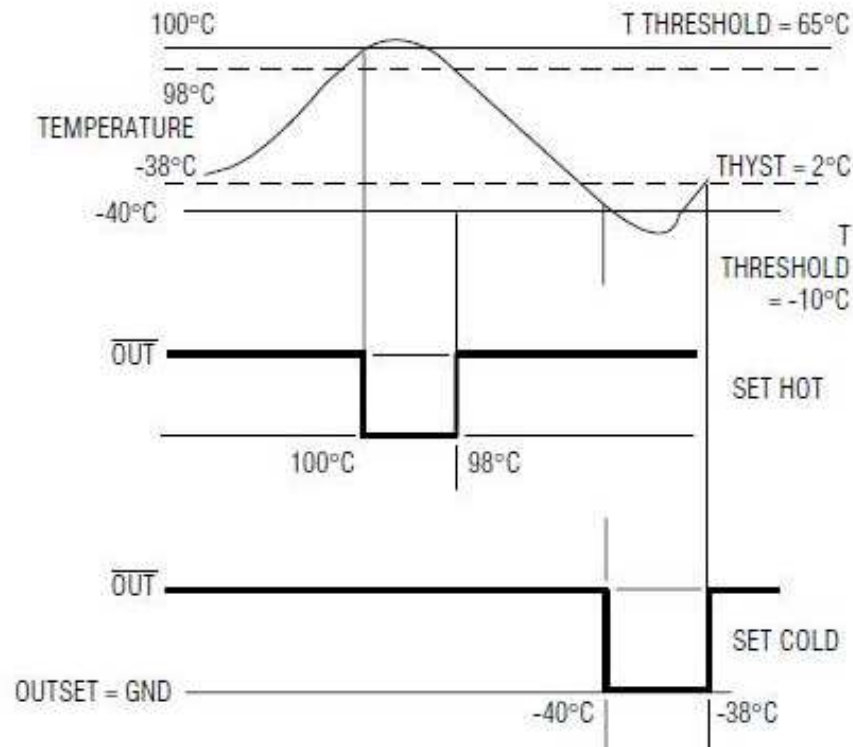


Figure 5. On-Board LEDs Indicating that Current Temperature is Above the Limit Set by Rset

For example, a TMP709 with its trip point set to  $100^{\circ}\text{C}$  asserts when its temperature rises above  $+100^{\circ}\text{C}$ , and does not de-assert until its temperature drops below  $+100^{\circ}\text{C}$  minus the selected hysteresis value (that is,  $+98^{\circ}\text{C}$  if  $2^{\circ}\text{C}$  hysteresis is chosen). Conversely, if the trip temperature of the TMP709b is  $-40^{\circ}\text{C}$ , the output asserts at  $-40^{\circ}\text{C}$  as temperature falls, and de-asserts when temperature rises above  $-40^{\circ}\text{C}$  plus the hysteresis value (that is,  $-38^{\circ}\text{C}$  if  $2^{\circ}\text{C}$  hysteresis is chosen). This behavior is shown in [Figure 6](#).



**Figure 6. Hysteresis Behavior Example**

### 3 TMP708/709EVM Test Board Documentation

This section contains the component layout, schematic diagram, and bill of materials for the TMP708/709EVM test boards.

#### 3.1 TMP708/709EVM Test Board Schematic

Figure 7 shows the schematic for the TMP708/709EVM test boards.

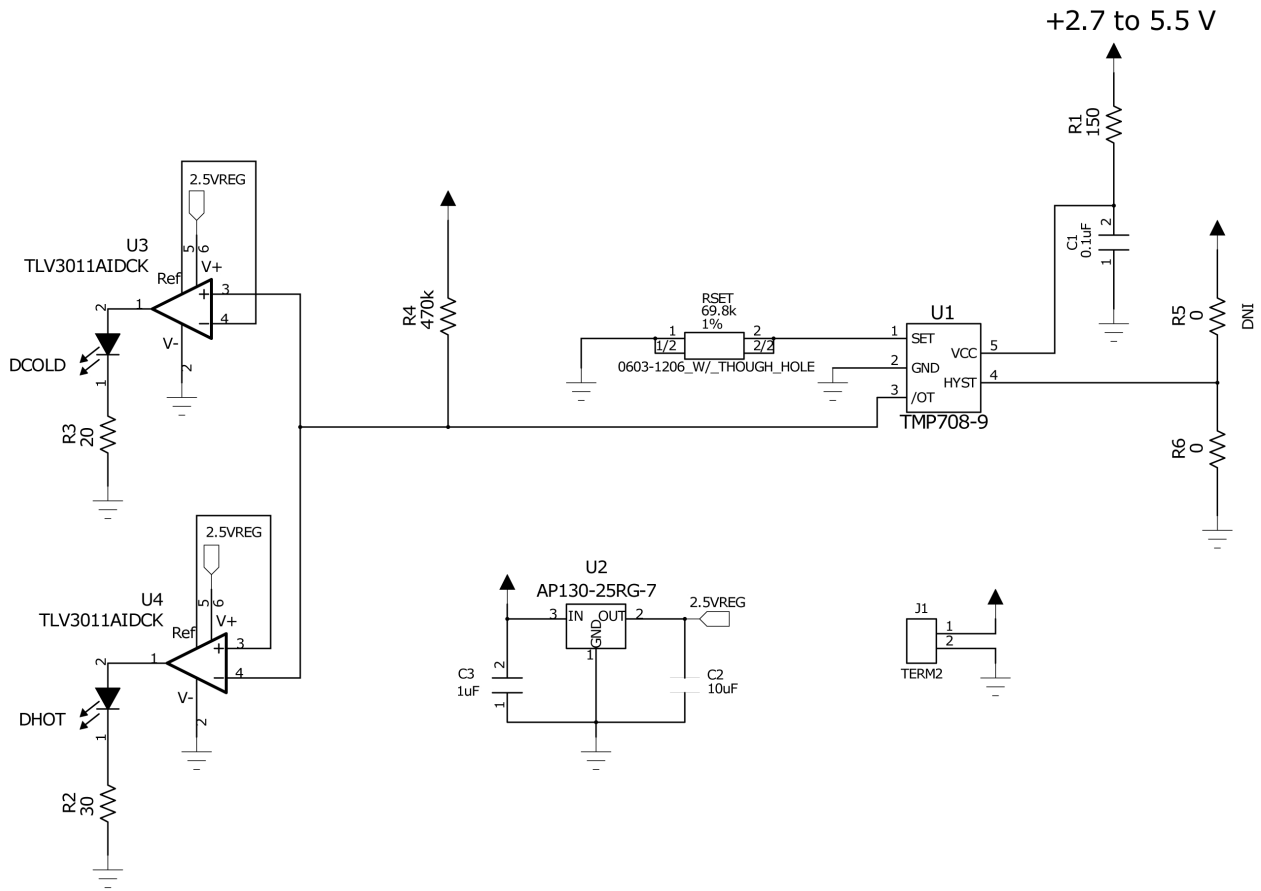


Figure 7. TMP708/709EVM Test Board Schematic

### 3.2 TMP708/709 Test Board Components Layout

Figure 8 and Figure 9 show the top-side layout of the components for the TMP708/709EVM test boards. Note that they are identical except for the EVM label on the top silkscreen layer.

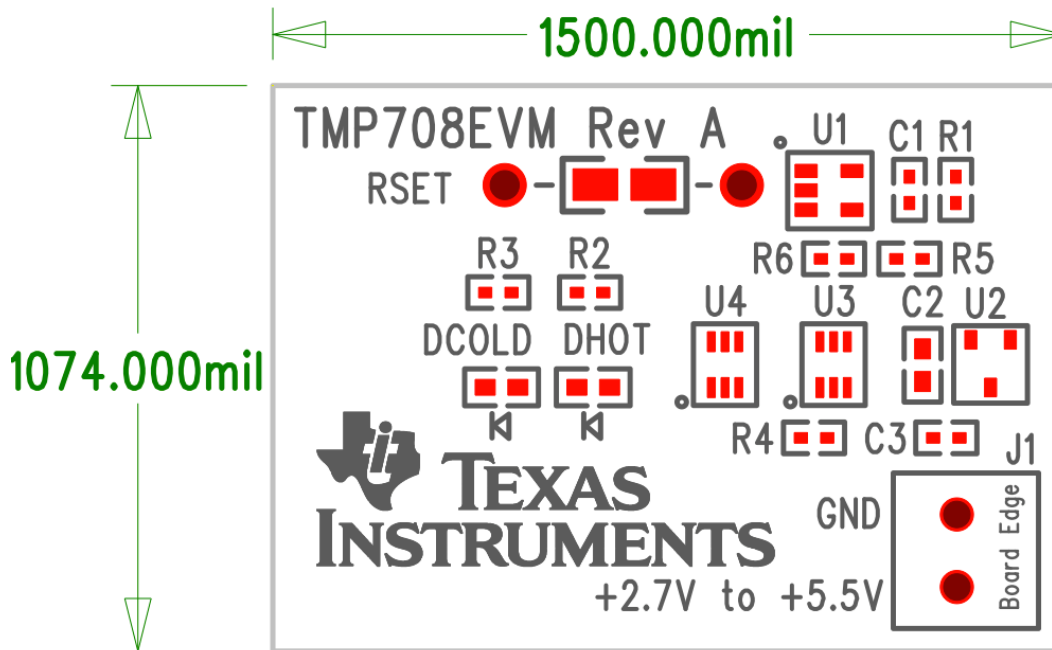


Figure 8. TMP708EVM Test Board Components Layout

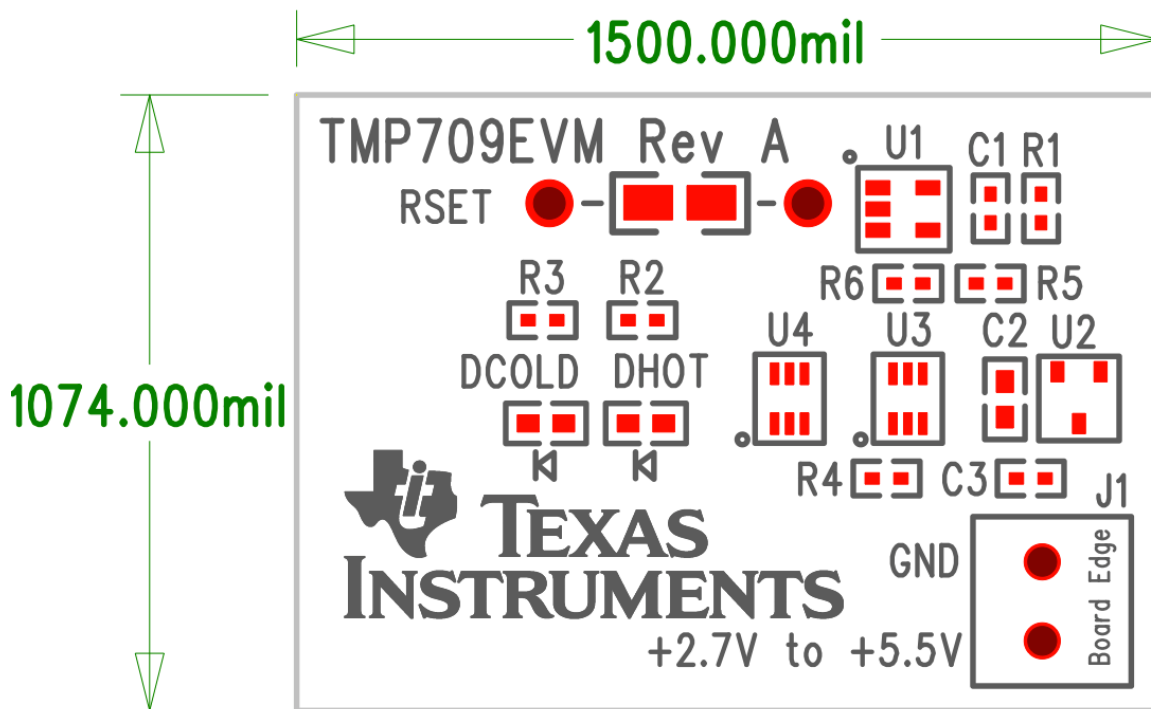


Figure 9. TMP709EVM Test Board Components Layout



### 3.3 Bill of Materials

Table 4 lists the bill of materials for the TMP708/709EVM.

**Table 4. TMP104 Test Board Bill of Materials**

Item No.	Qty	Value	Ref Des	Description	Vendor/Mfr	Part Number
1	1	TMP708 or TMP709	U1	Resistor-programmable SOT temperature switch	Texas Instruments	TMP708AIDBV or TMP709AIDBV
2	1	LDO	U2	Device, regulator, LDO, 300 mA, 2.5 V, SC59-3	Diodes Inc	AP130-25RG-7
3	2	Comparator	U3, U4	Device, comparator, 1.8 V with reference, SC70-6	Texas Instruments	TLV3012AIDCKR
4	4	Bump-ons	n/a	Bumper, clear, 0.312-inch × 0.085-inch dome	Richco Plastic Co	RBS-7
5	1	DHOT	DHOT	LED, red, orange, clear, 0603, SMD	Lite-On Inc	LTST-C190EKT
6	1	DCOLD	DCOLD	LED, green, clear, 0603, SMD	Lite-On Inc	LTST-C190GKT
7	1	150 Ω	R1	Resistor, TF, 150 Ω, 5%, 1/16 W, 0402	Stackpole Electronics Inc	RMCF0402JT150R
8	1	30 Ω	R2	Resistor, 30 Ω, 1/10 W, 5%, 0402, SMD	Panasonic - ECG	ERJ-2GEJ300X
9	1	20 Ω	R3	Resistor, TF, 20 Ω, 5%, 1/16 W, 0402	Stackpole Electronics Inc	RMCF0402JT20R0
10	1	470 kΩ	R4	Resistor, TF, 470 kΩ, 1%, 1/16 W, 0402	Stackpole Electronics Inc	RMCF0402FT470K
11	DNI	0 Ω	R5	Resistor, 0 Ω, 1/16 W, 0402, SMD	Stackpole Electronics Inc	RMCF0402ZT0R00
12	1	0 Ω	R6	Resistor, 0 Ω, 1/16 W, 0402, SMD	Stackpole Electronics Inc	RMCF0402ZT0R00
13	1	43 kΩ	Rset	Resistor, 43 kΩ, metal film, 2 W, 5%	Vishay/BC Components	PR02000204302JR500
14	1	0.1 μF	C1	Capacitor, ceramic, 0.10 μF, 10 V, X5R, 0402	Taiyo Yuden	LMK105BJ104KV-F
15	1	10 μF	C2	Capacitor, ceramic, 10 μF, 6.3 V, Y5V, 0603	TDK Corporation	C1608Y5V0J106Z
16	1	1uF	C3	Capacitor, ceramic, 1.0 μF, 6.3 V, X5R, 0402	Taiyo Yuden	JMK105BJ105KV-F
17	1	Terminal block	J1	Terminal block, 3.5 mm, 2 pos, PCB	On Shore Technology Inc	ED555/2DS
18	2	Pin socket	Rset	Conn recept pin, 0.110 inch, 0.025 inch	Mill-Max Manufacturing Corp.	0300-1-15-15-47-27-10-0

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## EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 2.7 V to 5.5 V and the output voltage range of 2.7 V to 5.5 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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