

## **TRF372017EVM**

The [TRF372017](#) is a high-performance, direct up-conversion device, integrating a high-linear, low-noise IQ modulator and an integer-fractional PLL/VCO. The device is capable of converting complex modulated signals from baseband or IF directly up to RF frequencies ranging from 300 MHz to 4.8 GHz. The PLL/VCO, along with the internal 2/4/8 divider configuration as shown in the following table, is used to obtain the desired frequency.

Part Number	VCO Frequency		Div by 2		Div by 4		Div by 8	
	Fmin	Fmax	Fmin	Fmax	Fmin	Fmax	Fmin	Fmax
TRF372017	2400	4800	1200	2400	600	1200	300	600

This document outlines the basic procedures for connecting the evaluation module (EVM) to test equipment for basic testing.

### **1 Power Requirements**

The TRF372017 requires a 3.3-Vdc Vcc power supply through test-point TP2 and 5-Vdc Vcc power supply through test-point TP5.

Removing jumper JP6 enables the onboard regulator. With the onboard regulator enabled, the 5-V supply is regulated to provide 3.3 V, and no direct 3.3-V connection through TP2 is required. High-performance analog measurements must not be performed using the onboard regulator.

### **2 TRF372017 Operating Procedures for Modulator and Internal VCO Mode**

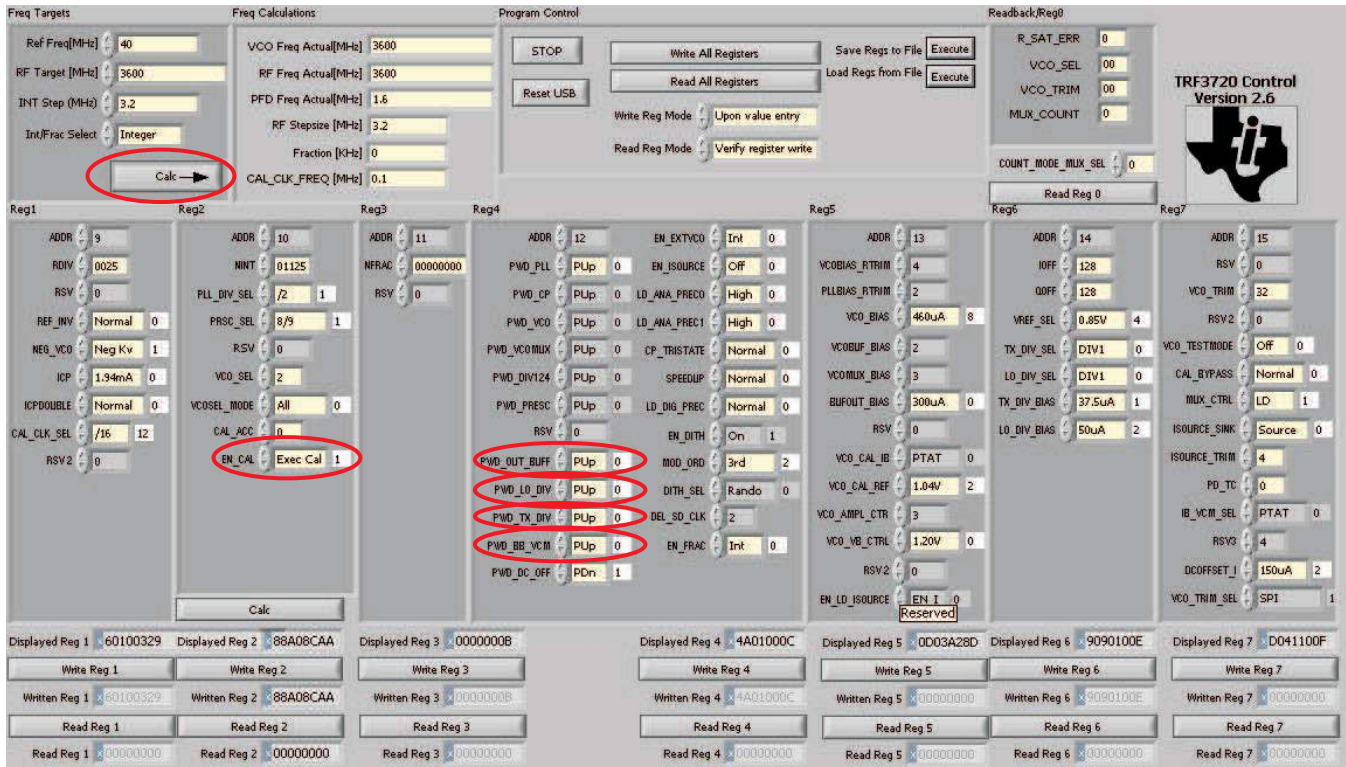
1. Connect the USB to the computer and the mini-USB to the EVM board.
2. Power-supply connections:
  - (a) Set the 3.3-V supply current limit to 450 mA.
  - (b) Set the 5-V supply current limit to 200 mA.
  - (c) Connect the 3.3-V supply to TP2, 5-V supply to TP5, and common ground to TP4.
  - (d) Switch on the Vcc 3.3-V supply.
  - (e) Switch on the Vcc 5-V supply.
3. Input connections: Use a DAC or an arbitrary waveform generator to provide I/Q input signals at 1.7 Vdc to J3/J4 and J9/J10. By default, the EVM ac couples the I/Q signals to the device.
4. Output connections:
  - (a) To measure the PLL output: Connect a spectrum analyzer to the SMA connector marked LON (J1) or LOP (J5) to monitor the VCO output single-ended. These output nodes can be used for two purposes:
    - (i) Check the PLL functionality and measure the frequency range.
    - (ii) Use the TRF372017 in the PLL/VCO mode alone.
  - (b) To measure the modulator output: Connect a spectrum analyzer to the SMA connector marked RF\_OUT (J6) to monitor the up-converted signal in the regular operational mode (default mode of operation).
5. Run the TRF372017 GUI software.
6. Click **Reset USB** to reset the USB connection.
7. Click on **Write All Regs** to load the GUI default settings to the device.
8. On start, the LOP and LON outputs and the RF\_OUT output are disabled. Enable them as follows:

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- (a) To enable the PLL output: toggle PWD\_OUT\_BUFF and PWD\_LO\_DIV from PDn to PUp.
- (b) To enable the RF\_OUT output: toggle PWD\_TX\_DIV, PWD\_BB\_VCM, from PDn to PUp. If offset adjustment is performed, also toggle PWD\_DC\_OFFSET from PDn to PUp.

9. Click **Calc** → to initialize the PLL divider settings.

10. Toggle the EN\_CAL control from Idle to Exec Cal to perform a calibration and lock the PLL/VCO at the default setting.



The screenshot displays the TRF3720 Control software interface, Version 2.6. The interface is divided into several sections:

- Freq Targets:** Includes fields for Ref Freq [MHz] (40), RF Target [MHz] (3600), INT Step [MHz] (3.2), and Int/Frac Select (Integer).
- Freq Calculations:** Shows VCO Freq Actual [MHz] (3600), RF Freq Actual [MHz] (3600), PFD Freq Actual [MHz] (1.6), RF Stepsize [MHz] (3.2), Fraction [KHz] (0), and CAL\_CLK\_FREQ [MHz] (0.1).
- Program Control:** Contains buttons for STOP, Write All Registers, Read All Registers, Save Regs to File, Load Regs from File, Write Reg Mode (Upon value entry), and Read Reg Mode (Verify register write).
- Readback/Reg0:** Displays R\_SAT\_ERR (0), VCO\_SEL (00), VCO\_TRIM (00), MUX\_COUNT (0), and COUNT\_MODE\_MUX\_SEL (0).
- Registers (Reg1-Reg7):** A grid of controls for various registers. Key settings include:
  - Reg2: EN\_CAL set to Exec Cal (1).
  - Reg4: PWD\_OUT\_BUFF, PWD\_LO\_DIV, PWD\_TX\_DIV, and PWD\_BB\_VCM all set to PUp (0).
  - Reg4: PWD\_DC\_OFFSET set to PDn (1).
- Bottom Panel:** Shows displayed and written values for registers 1 through 7, along with buttons for Write, Read, and Read Reg.

11. The GUI settings now look as follows:



12. To change frequencies, enter the desired operating frequency in the RF Target (MHz) control. The GUI automatically calculates resulting frequencies to display in the Freq Calculations display. It also automatically calculates values for the necessary register settings and writes those values to the device. The calculated register entries are highlighted in blue.

### 3 TRF372017 GUI Setup and Board Options

Place the mouse over any control that corresponds directly to a register bit to see a brief description of the control functionality and the corresponding SPI bit. More detailed descriptions may be found in the TRF372017 data sheet ([SLWS224](#)).

#### 1. RF Frequencies

RF frequency control is split into sets of controls and outputs.

- Frequency controls. The Ref Freq (MHz) control must be set to match the frequency injected onto the DUT REFIN terminal. By default, the EVM is configured to use a 40-MHz VCO included on the board. Jumpers are included to allow the user to connect an external signal to connector EXT\_REF (J8). Remove JP3 and JP4 to use an external reference signal.
- Frequency controls. VCO Target (MHz) must be set to the desired VCO frequency. This is the frequency at which the VCO oscillates, before any divider, and may not match the final RF output frequency. This control is a factor in determining the PLL N-divider factor.
- Frequency controls. RF Step (MHz) is used by the GUI to set the PLL R-divider, prior to the PFD.
- RF outputs. LO Freq Actual (MHz) is calculated by the GUI software based on the R Divider, N Divider, and LO Divider settings.
- RF outputs. Mix Freq Actual (MHz) is calculated by the GUI software based on the R Divider, N Divider, and Tx Divider settings.
- Frequency calculations. By default, changing any control in the Freq Targets area initiates a recalculation of register values.

## 2. Program Control

Program controls provide an interface to the GUI function without directly impacting the register settings.

- (a) STOP. The STOP button must be used to terminate program operation. Terminating the program through other means may require a USB reset to re-establish USB communications.
- (b) Reset USB. The USB-to-SPI converter device is powered through the USB connection, not the DUT supplies. This button can be used to reset the USB session.
- (c) Write All Registers. The Write All Registers button initiates a write to each register using the displayed values. The write sequence starts with the lowest numbered register and proceeds sequentially to the highest numbered register. If the Read Reg Mod control is set to verify the writes by reading the registers, then the read registers occur after all writes have been completed.
- (d) Read All Registers. The Read All Registers button initiates a read of each register, starting with register 1, proceeding sequentially to register 7, and finishing with register 0.
- (e) Write Reg Mode. When the Write Reg Mode control is set to Upon value entry, changing any displayed register setting or frequency target initiates a write of the impacted registers. When it is toggled to Write button only, register writes only occur when the Write All Registers or Write Reg n buttons are used.
- (f) Read Reg Mode. When the Read Reg Mode button is set to Verify register write, each write sequence is followed by a read sequence for the affected registers. When it is set to Read button only, register reads only occur when the Read All Registers or Read Reg n buttons are used.
- (g) Save Regs to File. The Save Regs to File button saves all of the displayed register values to a file.
- (h) Load Regs from File. The Load Regs from File button loads a previously saved set of register values into the displayed controls. The loaded values are not automatically written to the DUT.

## 3. Register 0

- (a) Register 0 is used to initiate register Readback for each register. Writes to register 0 for the purpose of reading back registers are performed with every read operation.
- (b) Readback bits from register 0 can either indicate VCO calibration results or frequency counter results depending on the value of the VCO\_TESTMODE control. The register 0 readback display changes appropriately with the VCO\_TESTMODE control. When VCO\_TESTMODE is set to On, the register 0 display shows both the count bits and a calculated value indicating the corresponding approximate frequency.

## Revision History

<b>Changes from Original (October, 2010) to A Revision</b>	<b>Page</b>
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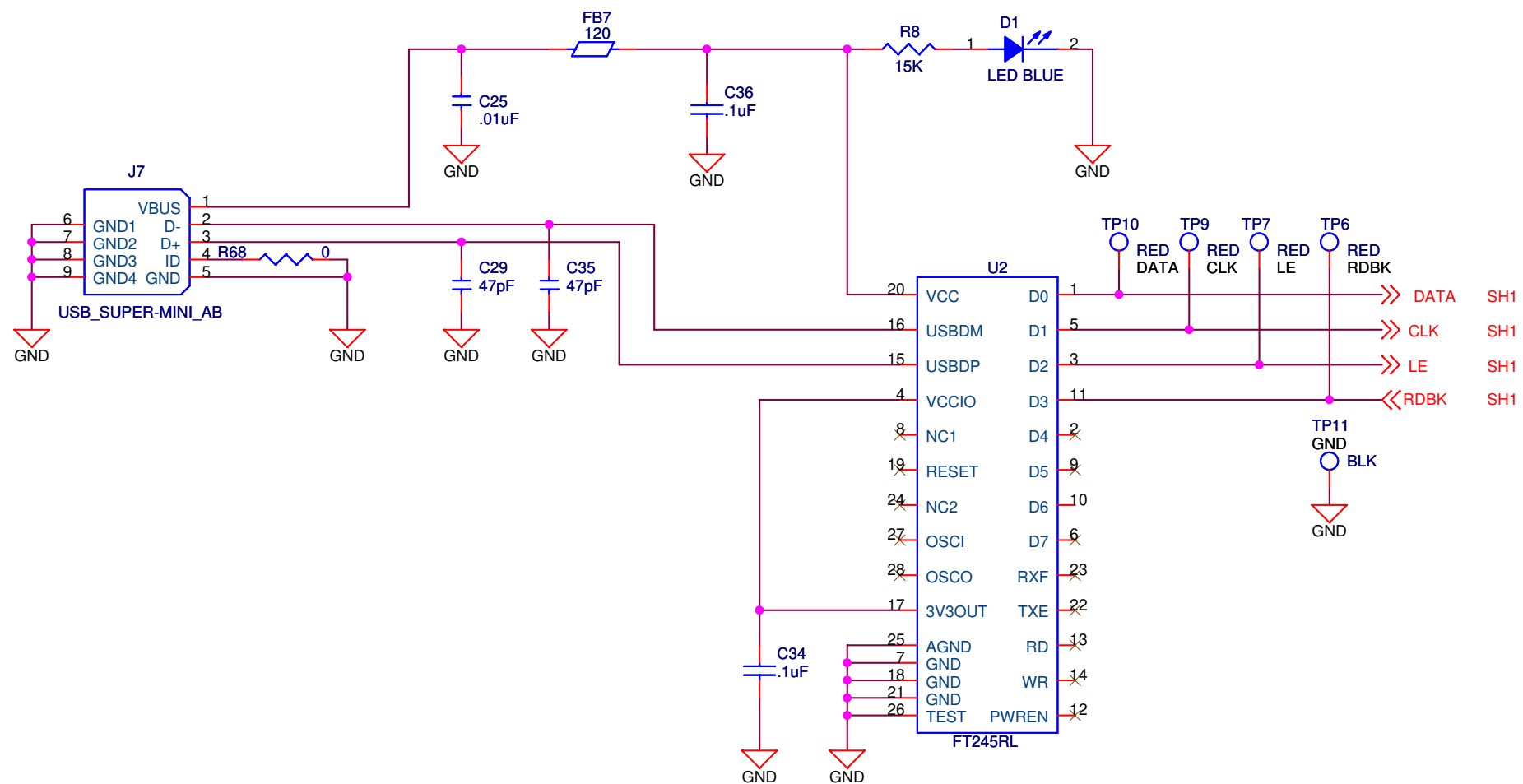
- Changed document title ..... [1](#)
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NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

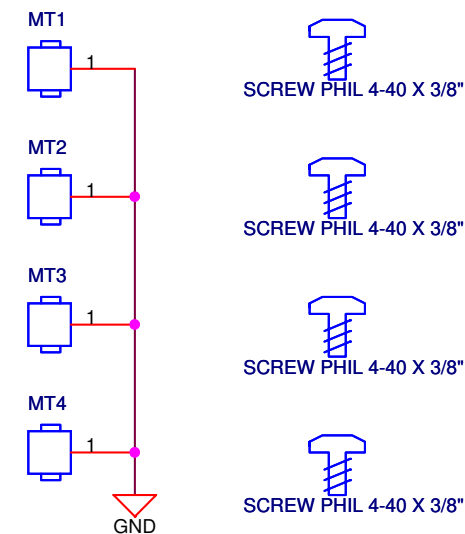




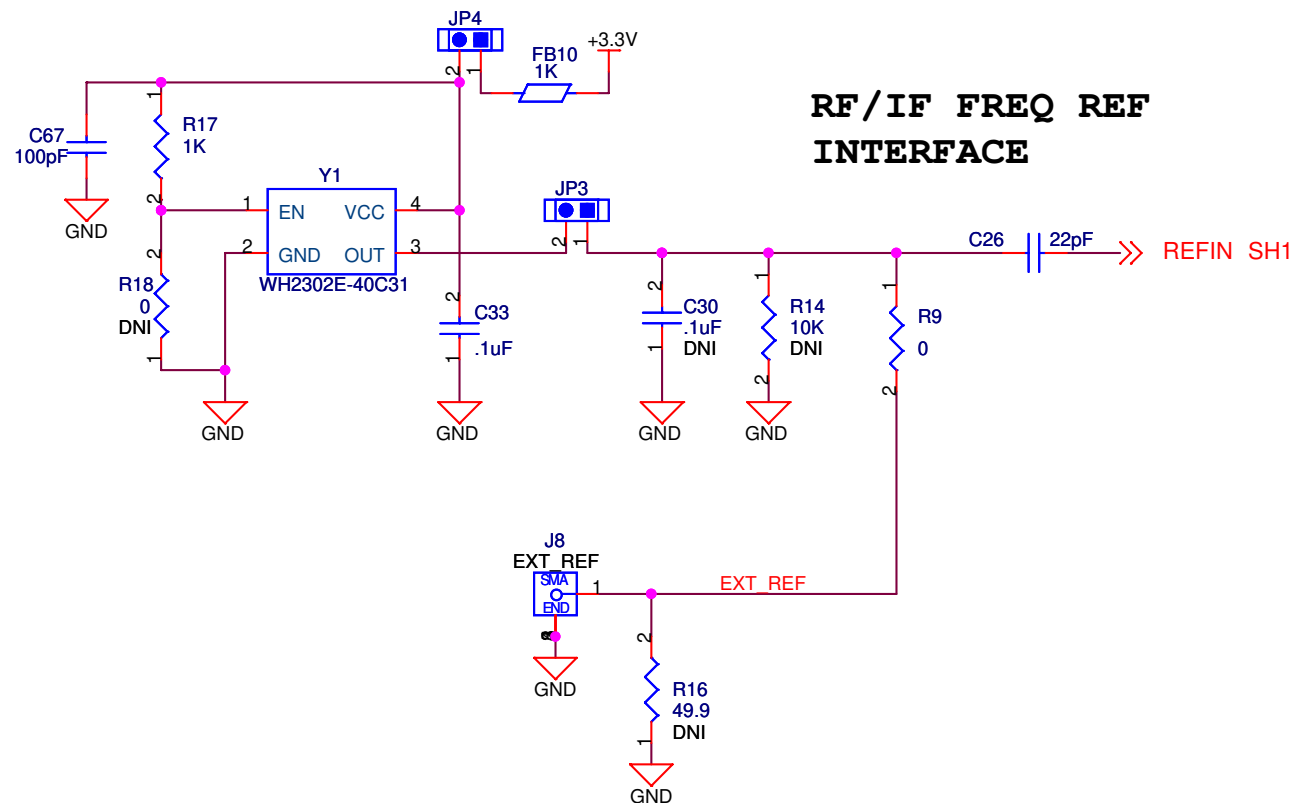
### SERIAL INTERFACE



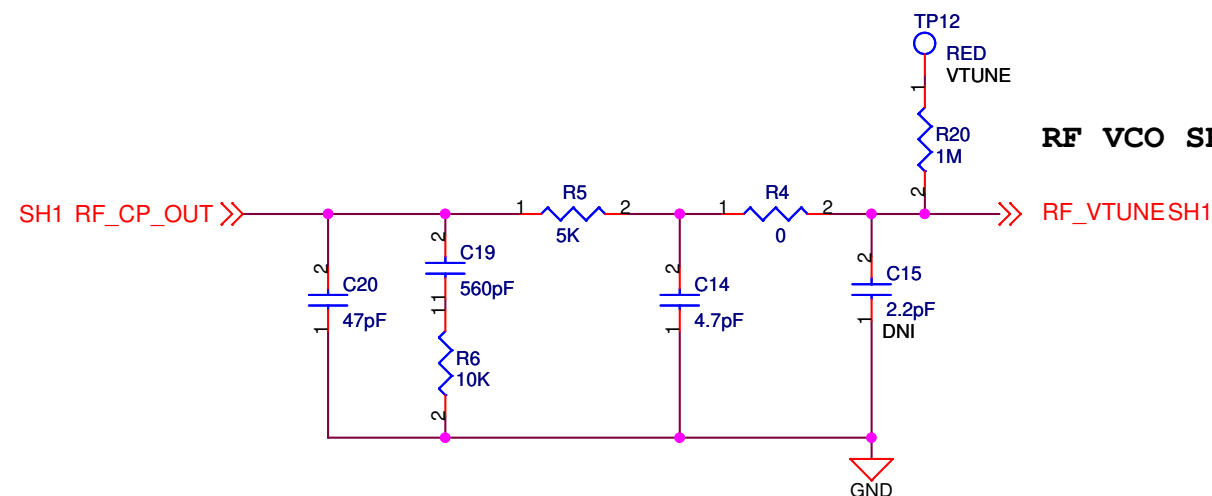
### BOARD STANDOFFS



### RF/IF FREQ REF INTERFACE



### RF VCO SELECT



<b>TEXAS INSTRUMENTS</b>		
Title <b>TRF3720 EVM</b>		
Size <b>B</b>	Document Number <b>TRF3720 - SCH</b>	Rev <b>C</b>
Date: Wednesday, October 28, 2009 Sheet 2 of 2		

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## EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 3 V to 5.5 V and the output voltage range of 0 V to 4 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 +55° C. The EVM is designed to operate properly with certain components above +55° 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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