*EVM User's Guide: LM7320-30EVM*

# *LM7311, LM7320, and LM7330 Evaluation Module*

## Description

The LM7320-30EVM evaluates the performance of the LM7311, LM7320, and LM7330 eFuse devices. The LM7320-30EVM comes with LM7311 and LM7330 eFuse for evaluation of 12V (typical) and 5A (steady state) designs.

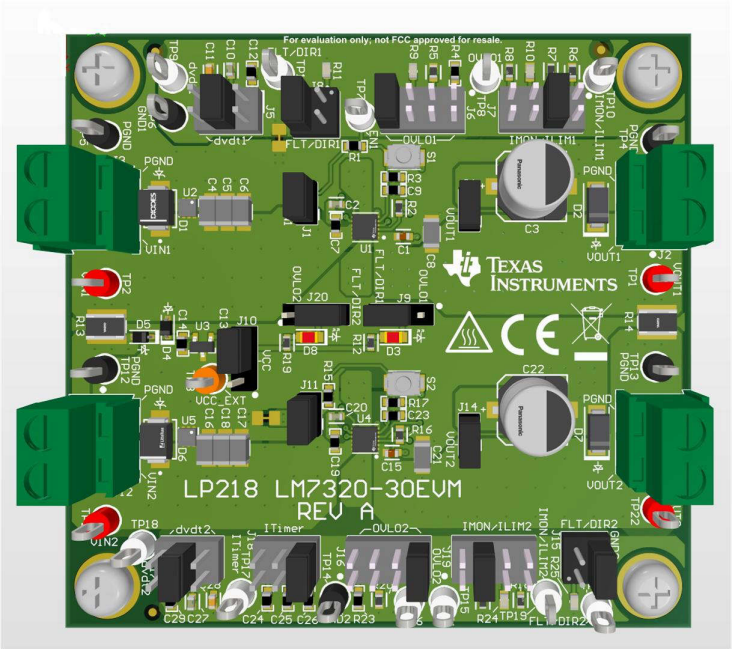
Evaluate the LM7320 by replacing LM7311 on the U1 slot.

## Features

- Overvoltage protection
- Active High Enable with adjustable UVLO threshold
- Adjustable analog current monitor and output voltage slew rate control using onboard jumpers
- Schottky diode for output transient protections
- LED status for fault indications
- Short circuit protection during startup and steady state
- LM7320 and LM7330 offers integrated internal smart TVS diode
- Linear ORing based Reverse Current Blocking

## Applications

- PC/Notebooks
- Monitors/Docks
- ePOS
- Industrial PC
- Power Banks
- Power tools
- Multi-function printers




**LM7320-30EVM REV A**



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# 1 Evaluation Module Overview

## 1.1 Introduction

The LM7320-30EVM eFuse evaluation board allows for reference circuit evaluation of the Texas Instruments LM7311, LM7320-30 eFuses. Table 1-1 provides the features of the efuses.

**Table 1-1. eFuse Features**

| FEATURES | LM7311 | LM7320 | LM7330 |
|---|---|---|---|
| Overvoltage protection | Fixed OVP of 24V | Fixed OVP of 24V | Pin selectable OVP of 24V/34V |
| ON resistance | 33mΩ | 20mΩ | 20mΩ |
| Maximum continuous current | 5A | 7A | 7A |
| IEC62368-3 support | YES, IEC61000-4-5 support up to 35V | YES, Integrated smart surge clamp | YES,Integrated smart surge clamp |
| Short circuit protection | YES | YES | YES |
| Precise load current monitoring | YES | YES | YES |
| Adjustable output slew rate control | YES | YES | YES |
| Fault indication pins | YES | YES | YES |
| Linear ORing based Reverse Current Blocking | YES | YES | YES |

This EVM user's guide describes the evaluation module (EVM) for LM7311, LM7320, and LM7330 eFuses.

**CAUTION**
Hot surface. Contact can cause burns. Do not touch.

## 1.2 Kit Contents

**Table 1-2. LM7320-30EVM: Kit Contents**

| ITEM | DESCRIPTION | QUANTITY |
|---|---|---|
| LM7320-30EVM | Evaluation module for LM7311, LM7320, and LM7330 eFuses | 1 |

## 1.3 Specification

Table 1-3 provides the LM7320-30EVM specifications.

**Table 1-3. LM7320-30EVM Design Specifications**

| PARAMETER | LM7311 | LM7320 | LM7330 |
|---|---|---|---|
| Input voltage range ($V_{IN}$) | 3.5V to 23V | 3.5V to 23V | 3.5 to 32V |
| Maximum RMS load current ($I_{OUT(max)}$) | < 5A | <7A | <7A |
| Over-voltage protection threshold ($V_{TRIP}$) | 24V | 24V | 24V,34V |



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## 1.4 Device Information

The LM7320-30EVM enables the evaluation of LM7311, LM7320, and LM7330 eFuses from EPR family. LM7320 and LM7330 are populated on the EVM by default. Apply the input power across the connectors J3-2 (+), J3-1(-) and J12-2(+), and J12-1(-). Connectors J2-1 (+), J2-2(-) and J13-1(+), and J13-2(-) provide the output connection for the EVM as shown in Figure 4-1. Figure 3-1 includes the EVM test setup. Schottky diodes in D2 and D7 protect the output by clamping the negative voltage excursion at the OUT pin of the LM7320-30 eFuses, within the maximum absolute rating.

Fault indicators (FLTB1 and FLTB2) indicators are provided by LED D3 and D8, respectively.

**Table 1-4. LM7320-30EVM eFuse Evaluation Board Options and Setting**

| EVM FUNCTION | CHANNEL | Vin UVLO THRESHOLD | Vin OVLO THRESHOLD | OUTPUT SLEW RATE (dv/dt) |
|---|---|---|---|---|
| Performance evaluation of LM7311, LM7320 eFuses | CH1 | 10.87V | 24V | Selectable - 5.4V/ms, 0.5V/ms, and 0.25V/ms |
| Performance evaluation of LM7330 eFuse | CH2 | 10.87V | 24V/34V | Selectable - 5.4V/ms, 0.5V/ms, and 0.25V/ms |

Additional LM7320-30EVM device information includes:

- Survives a *hot-short* on output condition
- Survives a *power up into short* condition
- A board can be hot-plugged in
- A board can be power cycled
- Current load monitoring


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# 2 Hardware

## 2.1 General Configurations

### *2.1.1 Physical Access*

Table 2-1 lists the LM7320-30EVM eFuse Evaluation Board input and output connectors functions. Table 2-2 describes the availability of test points and Table 2-3 describes the functions of the jumpers. Table 2-4 details the functions of the signal LED indicators.

**Table 2-1. Input and Output Connector Functionality**

| CONNECTOR | LABEL | DESCRIPTION |
|---|---|---|
| J3-2 | VIN1 (+) | Positive terminal for the input power to LM7311/LM7320 |
| J3-1 | VIN1(-) | Negative terminal for the input power to LM7311/LM7320 |
| J12-2 | VIN2(+) | Positive terminal for the input power to LM7330 |
| J12-1 | VIN2(-) | Negative terminal for the input power to LM7330 |
| J2-1 | VOUT1(+) | Positive terminal for the output power from LM7311/LM7320 |
| J2-2 | PGND(-) | Negative terminal for the output power from LM7311/LM7320 |
| J13-1 | VOUT2(+) | Positive terminal for the output power from LM7330 |
| J13-2 | PGND(-) | Negative terminal for the output power from LM7330 |

**Table 2-2. Test Points Description**

| TEST POINTS | LABEL | DESCRIPTION |
|---|---|---|
| TP1 | VOUT1 | LM7320 output voltage |
| TP2 | VIN1 | LM7320 input voltage |
| TP3 | VCC_EXT | External pullup |
| TP7 | EN1 | Active high enable for LM7320 |
| TP9 | DVDT1 | Start-up slew rate control for LM7320 |
| TP10 | IMON1 | LM7320 Current monitor |
| TP11 | FLT/DIR1 | Fault indication for LM7320 |
| TP15 | EN2 | Active high Enable for LM7330 |
| TP17 | ITIMER2 | Overcurrent blanking timer for LM7330 |
| TP18 | DVDT2 | Start-up slew rate control for LM7330 |
| TP19 | ILIM2 | LM7330 current monitor |
| TP20 | FLT/DIR2 | Fault indication for LM7330 |
| TP21 | VIN2 | LM7330 input voltage |
| TP22 | VOUT2 | LM7330 output voltage |
| TP4,TP5 | PGND | Common power ground for LM7320 |
| TP6 | GND1 | CH1 IC ground signal |
| TP12,TP13 | PGND | Common power ground for LM7330 |
| TP14 | GND2 | CH2 IC ground signal |

**Table 2-3. Jumper Descriptions and Default Positions**

| JUMPER | LABEL | DESCRIPTION | DEFAULT JUMPER POSITION |
|---|---|---|---|
| J1 | EN/UVLO1 | 1-2 position sets the UVLO threshold at 10.88V | 1-2 |
| J4 | VOUT1 | 1-2 position adds a capacitive load of 220uF to LM7320/LM7311 | OPEN |


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**Table 2-3. Jumper Descriptions and Default Positions (continued)**

| JUMPER | LABEL | DESCRIPTION | DEFAULT JUMPER POSITION |
|---|---|---|---|
| J5,J17 | DVDT1, DVDT2 | 1-2 position sets the output slew rate to 5.4V/ms | 3-4 |
| | | 3-4 position sets the output slew rate to 0.5V/ms | |
| | | 5-6 position sets the output slew rate to 0.25V/ms | |
| J7 | IMON/ILIM1 | 1-2 position sets voltage on IMON pin as 2.35V for a load of 5A | 1-2 |
| | | 3-4 position sets voltage on IMON pin as 0.71V for a load of 5A | |
| | | 5-6 position sets voltage on IMON pin as 0.44V for a load of 5A | |
| | | 7-8 position sets voltage on IMON pin as 0.31V for a load of 5A | |
| J17 | IMON/ILIM2 | 1-2 position sets voltage on IMON pin as 2.35V for a load of 7A | 1-2 |
| | | 3-4 position sets voltage on IMON pin as 0.71V for a load of 7A | |
| | | 5-6 position sets voltage on IMON pin as 0.44V for a load of 7A | |
| | | 7-8 position sets voltage on IMON pin as 0.31V for a load of 7A | |
| J8 | FLT/DIR1 | 1-2 position sets voltage on FLT/DIR1 during Fault | OPEN |
| | | 3-4 position grounds the FLT1 pin | |
| J15 | FLT/DIR2 | 1-2 position sets voltage on FLT/DIR2 during Fault | OPEN |
| | | 3-4 position grounds the FLT2 pin | |
| J11 | EN/UVLO2 | 1-2 position sets the UVLO threshold at 10.88V | 1-2 |
| J14 | VOUT2 | 1-2 position adds a capacitive load of 220uF<br>To LM7330 | OPEN |

**Table 2-4. LED Descriptions**

| LED | DESCRIPTION |
|---|---|
| D3 | When ON, indicates that FLTb1 is asserted |
| D8 | When ON, indicates that FLTb2 is asserted |

### *2.1.2 Test Equipment and Setup*

**Power supplies:** Two adjustable power supply with a 0V to 40V output and a 0A to 10A output current limit.

**Meters:** Two digital multimeters (DMM).

**Oscilloscope:** A DPO2024 or equivalent, three 10× voltage probes, and a DC current probe rated to 30A.

**Loads:** One resistive load or equivalent which can tolerate up to 10A DC load at 40V.



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# 3 Implementation Results

## 3.1 Test Setup and Procedures

This EVM user's guide describes test procedure for the LM7311, LM7320, and LM7330 eFuse. Verify that the evaluation board has the default jumper settings as Table 3-1 shows.

**Table 3-1. Default Jumper Setting for LM7320-30EVM eFuse Evaluation Board**

| J-1, J-11 | J5, J17 | J7, J19 | J8, J15 | J6, J16 | J4, J14 | J9, J10 |
|---|---|---|---|---|---|---|
| 1-2 | 3-4 | 1-2 | OPEN | OPEN | OPEN | OPEN |

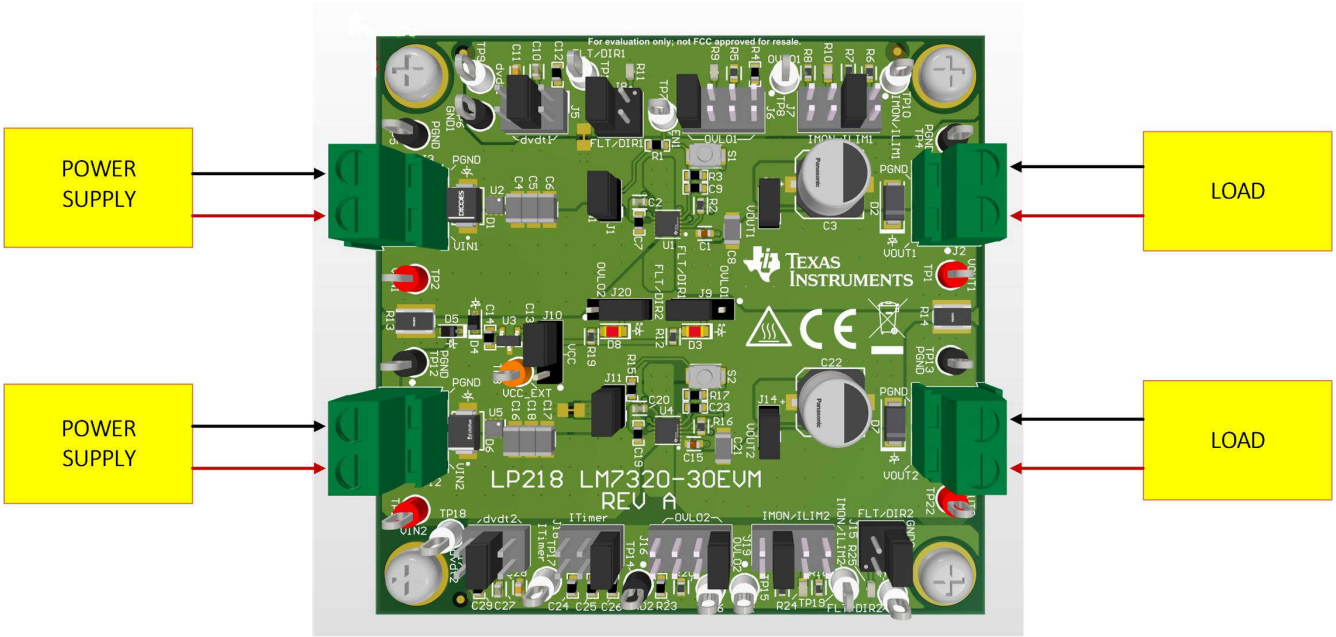


**Figure 3-1. LM7320-30EVM Setup with Test Equipment**

Adhere to the following instructions before starting any test and repeat again before moving to the next test:

1. Set the power supply output (VIN) to zero volts.
2. Turn off the power supply.
3. Adjust the jumper positions on the EVM to the default configuration as shown in Table 3-1.



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### 3.1.1 Input Hotplug Test

Use the following instructions to perform the input hot-plug test on the LM7320 eFuse:

1. Confirm that the experiment is setup initially as per the instructions in Section 3.1.
2. Configure the jumper J5 position to the desired start-up slew rate as detailed in Table 2-3.
3. Change the J4 jumper setting to the 1-2 position
4. Connect the negative terminal of the power supply to connector J3-1.
5. Set the input supply voltage VIN to 12V and current limit to 10A.
6. Enable the power supply. Then connect the positive terminal of the power supply to connector J3-2.
7. Use an oscilloscope to observe the waveforms at VOUT1(TP1), VIN1(TP2), FLT1(TP11), and the input current.

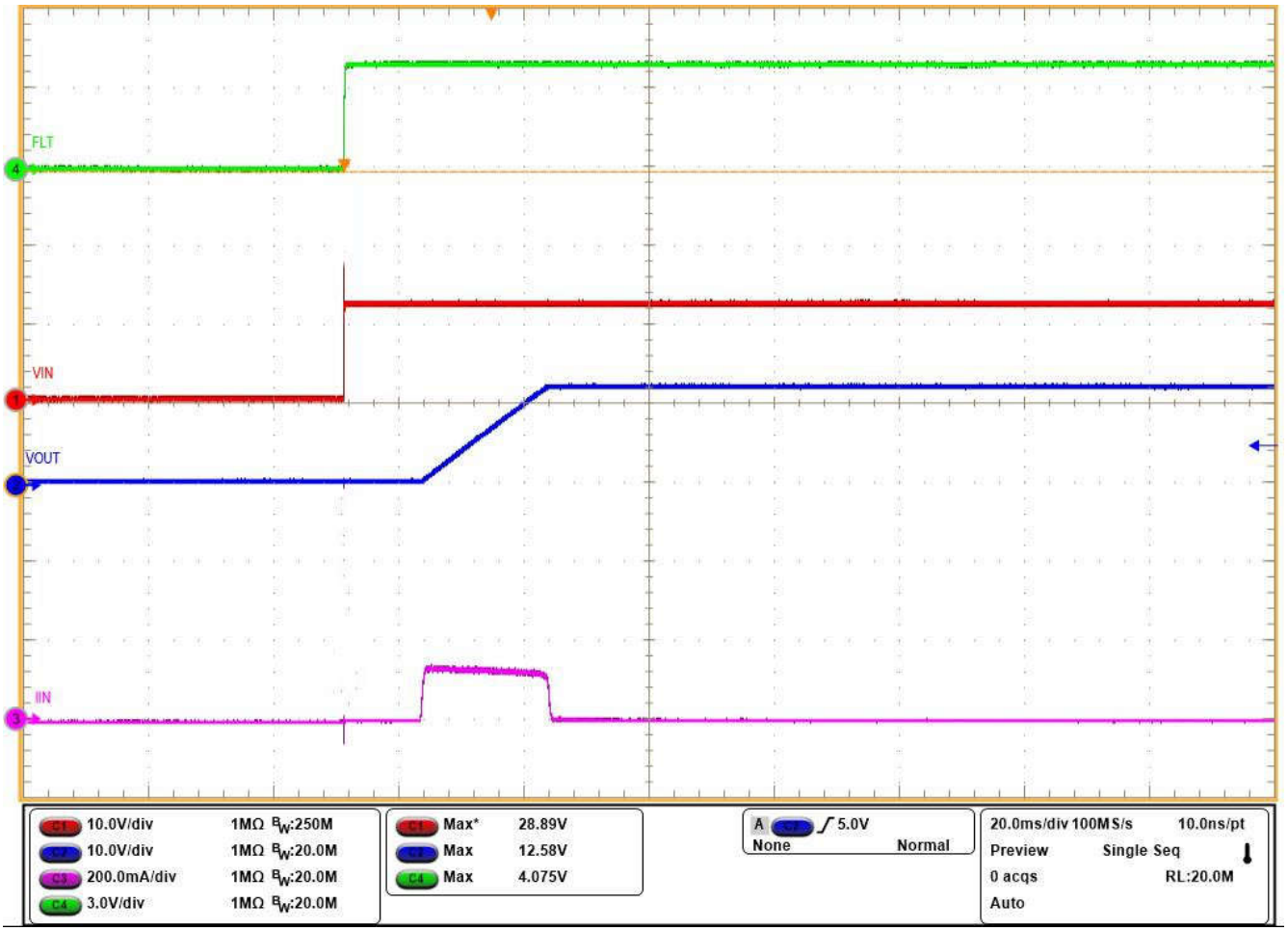


**Figure 3-2. LM7311 eFuse Input Hotplug Profile**


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### 3.1.2 Power Up Into Short

Follow the instructions to perform the power-up into short test:

1. Confirm that the experiment is setup initially as per the instructions in Section 3.1.
2. Set the input supply voltage VIN to 12V and current limit to 30A. Keep the power supply OFF.
3. Connect the negative terminal of power supply to J3-1 and positive terminal of power supply to J3-2.
4. Short the output of the EVM to ground. For example, short VOUT1 (connector J2-1) to PGND (connector J2-2) through a cable.
5. Turn ON the power supply.

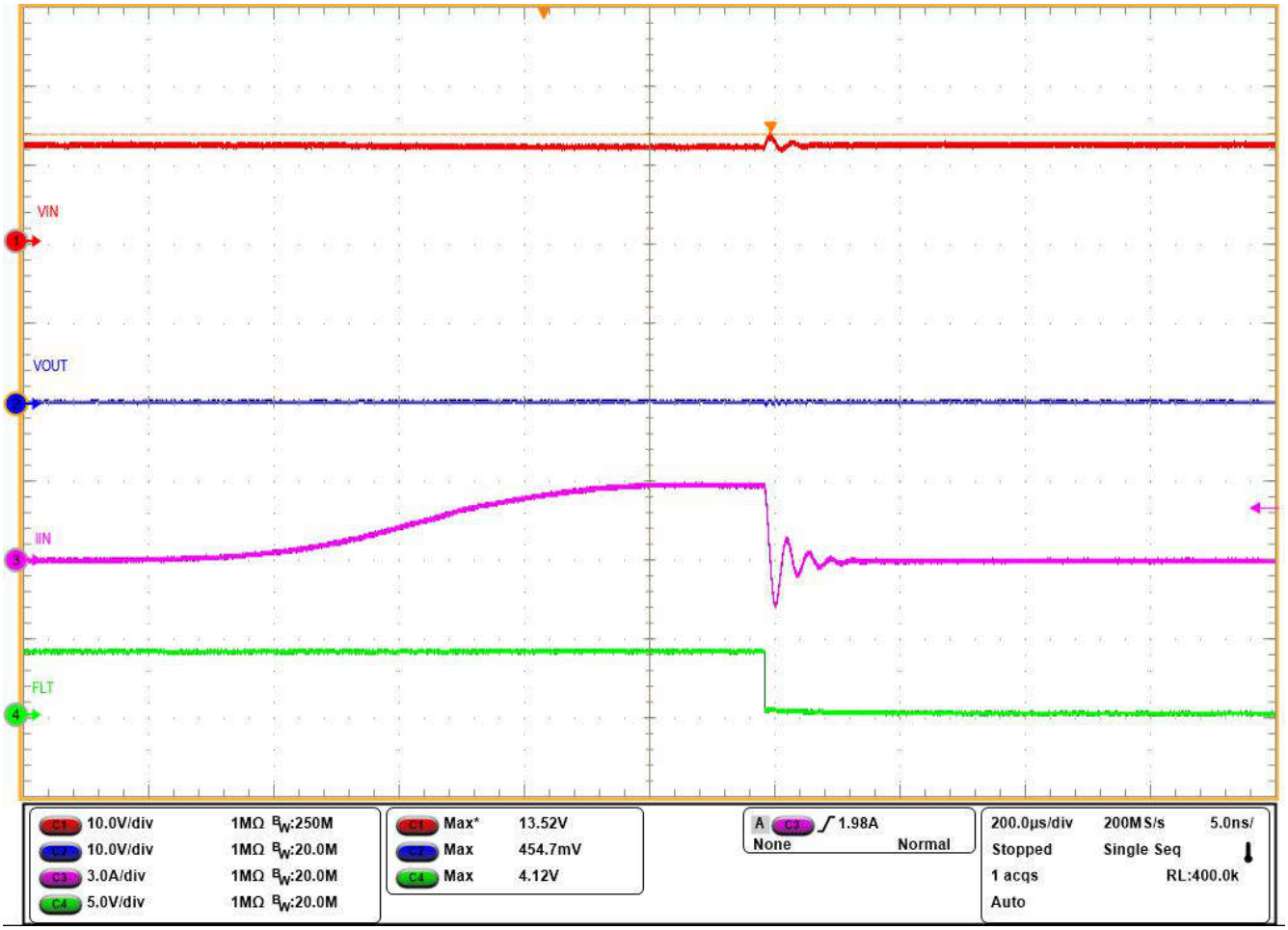


**Figure 3-3. Power Up Into Output Short Response of LM7311**



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### 3.1.3 Reverse-Current Blocking Test

Follow the instructions to perform the reverse-current blocking test:

1. Confirm that the experiment is setup initially as per the instructions in Section 3.1.
2. Set the first input supply voltage VIN1 to 12V and current limit to 10A.
3. Set the second power supply voltage to 14.5V and current limit to 10A.
4. Apply a resistive load of 25ohm across the terminals J2-2 and J2-1.
5. Connect the first supply positive terminal to J3-2 and negative terminal to J3-1 and turn on the first power supply and confirm that VOUT has a voltage of 12V with respect to ground.
6. Apply a voltage of 14.5V at VOUT through a diode using second power supply.

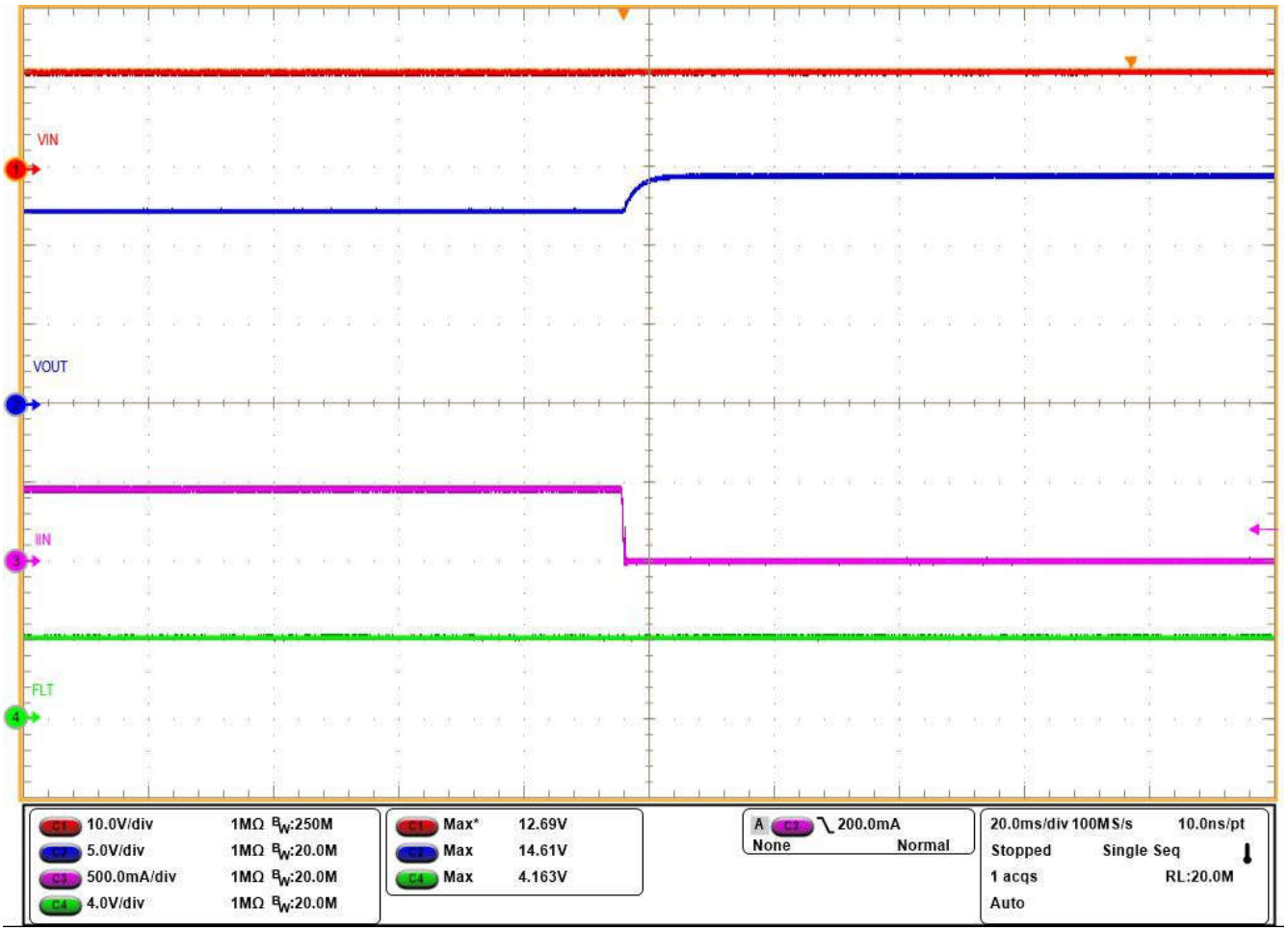


**Figure 3-4. Reverse Current Blocking Test Response of LM7311**


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### 3.1.4 Overvoltage Lockout

Use the following instructions to perform the overvoltage protection test:

1. Confirm that the experiment is setup initially as per the instructions in Section 3.1.
2. Set the input supply voltage VIN1 to 12V and current limit to 10A. Apply the supply between VIN1 (connector J3-2) and PGND (connector J3-1) and enable the power supply.
3. Increase the input supply VIN1 from 12V to 25V. Observe the waveforms using an oscilloscope.

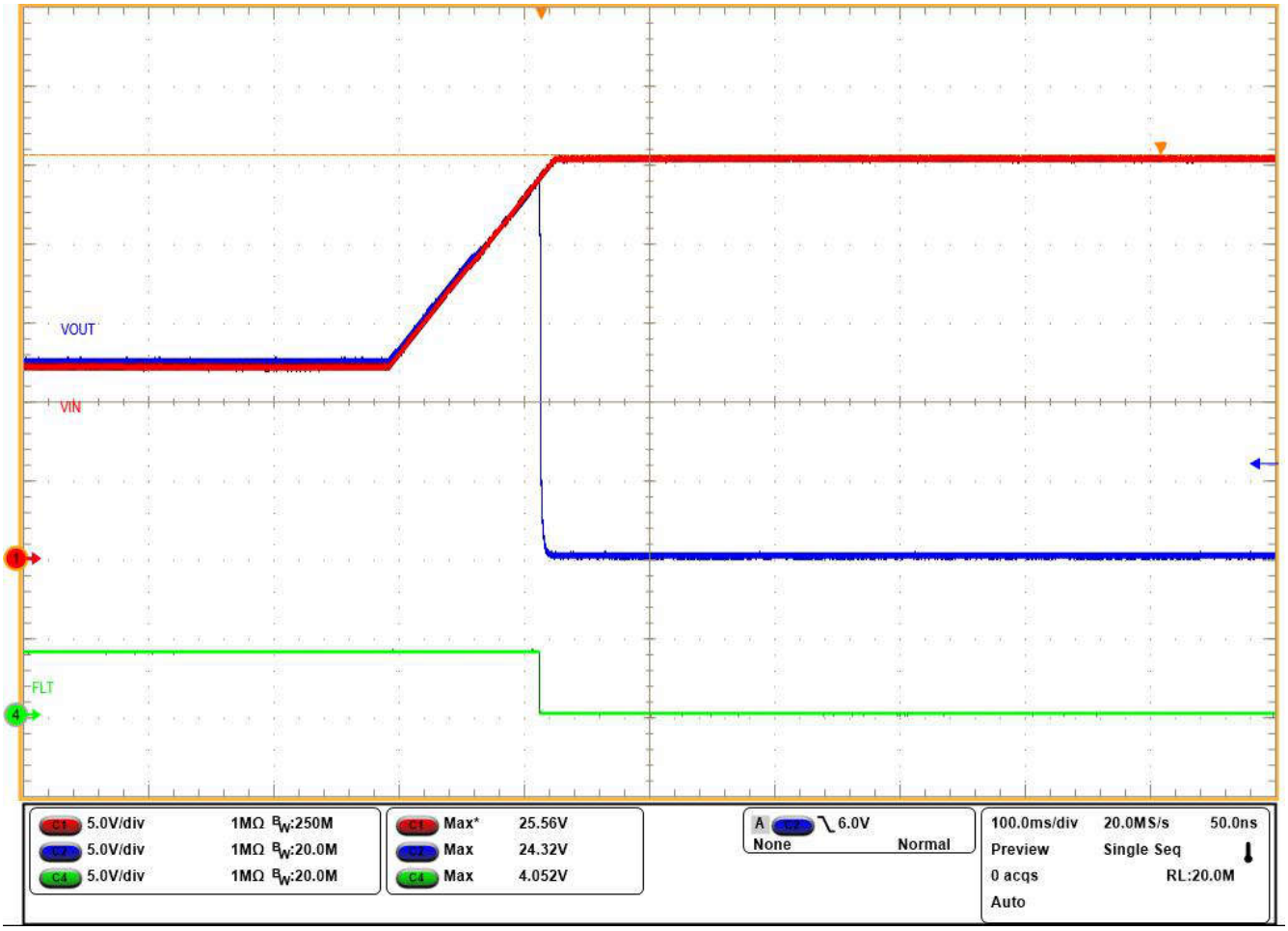


**Figure 3-5. Overvoltage Lockout Response of LM7311 eFuse**



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### 3.1.5 IMON Pin Test

Use the following instructions to perform the input hot-plug test on the LM7320 eFuse:

1. Confirm that the experiment is set up initially as per the instructions in Section 3.1.
2. Configure the jumper J5 position to the desired start-up slew rate as detailed in Table 2-3.
3. Connect the negative terminal of the power supply to connector J3-1.
4. Set the input supply voltage VIN to 12V and current limit to 10A.
5. Connect the positive terminal of the power supply to connector J3-2. Enable the power supply.
6. Connect a resistive load of 10Ω at the output.
7. Throughout the test, use an oscilloscope to observe the waveforms at IMON(TP10), VIN(TP2), VOUT(TP1) and input current.

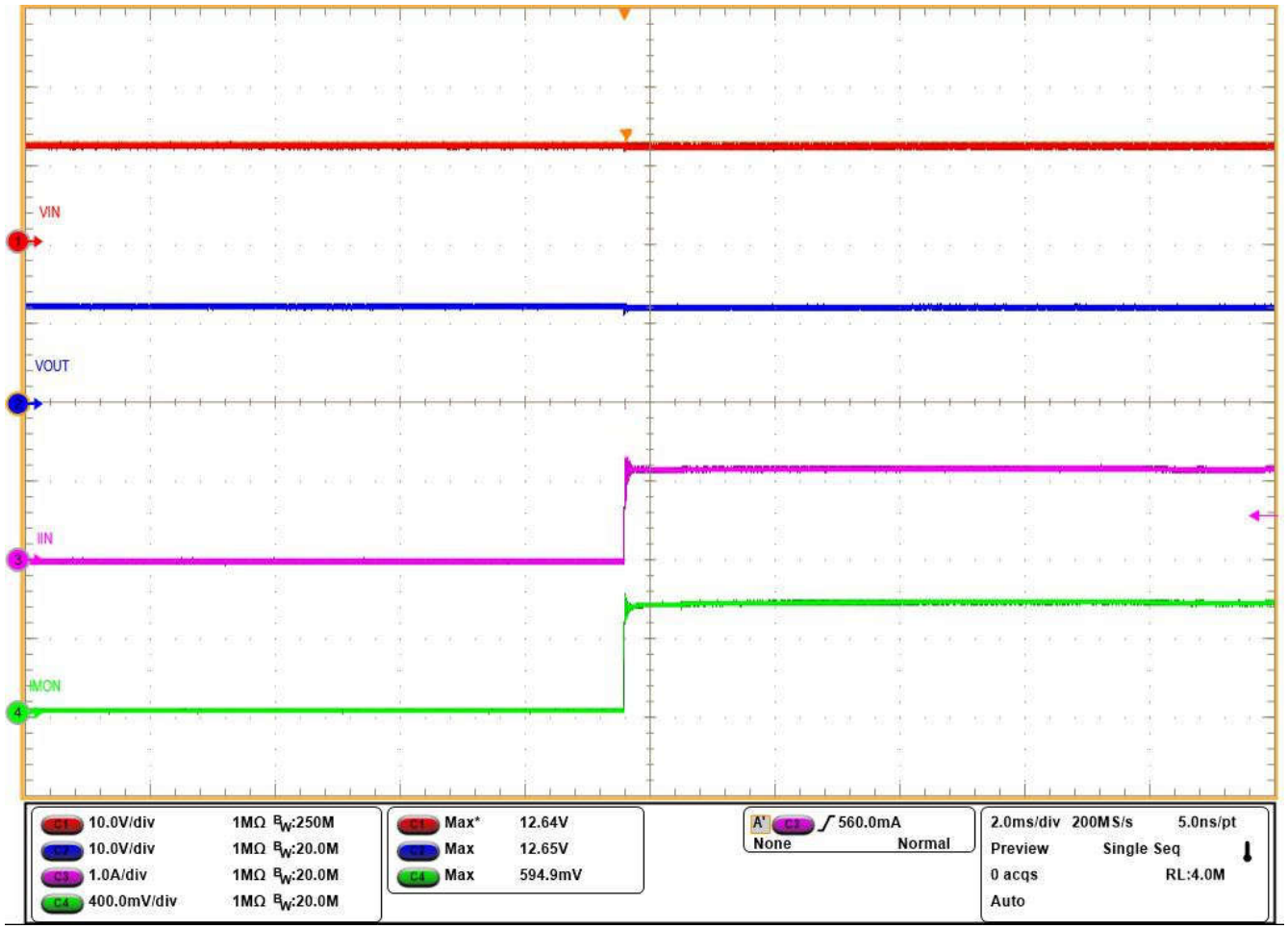


**Figure 3-6. IMON Pin Test of LM7311**


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### 3.1.6 Output Hot Short

Use the following instructions to perform the output hot short test:

1. Confirm that the experiment is set up initially as per the instructions in Section 3.1.
2. Set the input supply voltage VIN1 to 12V and connect the power supply between VIN1 (connector J3-2) and PGND (Connector J3-1).
3. Turn ON the power supply to power up the EVM.
4. Short the output of the device for example, VOUT1 (connector J2-1) to PGND (connector J2-2) through a short cable.
5. Observe the waveforms using an oscilloscope.

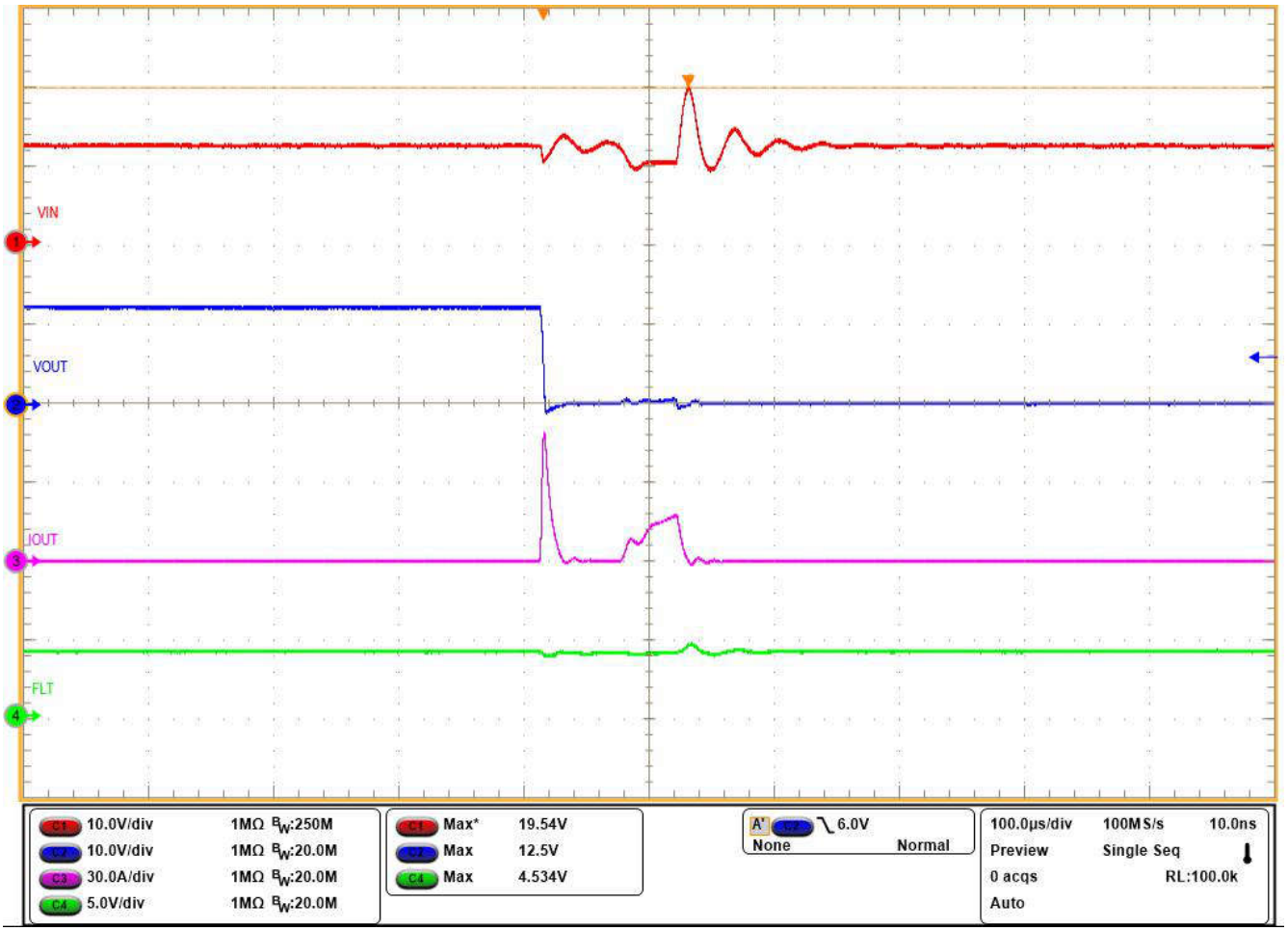


**Figure 3-7. Output Hot Short Response for LM7311**

**Note**

Verify that there is sufficient input capacitor to eliminate voltage dips at the input. A combination of electrolytic and ceramic capacitors are preferred. With these capacitors, a large current can be provided for a short period of time during short-circuit.

Obtaining repeatable and similar short-circuit testing results can be difficult. The following factors contributes to the variation in results:

- Source bypassing
- Input leads
- Board layout
- Component selection
- Output shorting method



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- Relative location of the short
- Instrumentation

The actual short exhibits a certain degree of randomness because the short microscopically bounces and arcs. Verify that the configuration and methods are used to obtain realistic results. Hence, do not expect to see waveforms exactly like the waveforms in this user's guide because every setup is different.


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# 4 Hardware Design Files

## 4.1 Schematics

Figure 4-1 shows the EVM schematic.

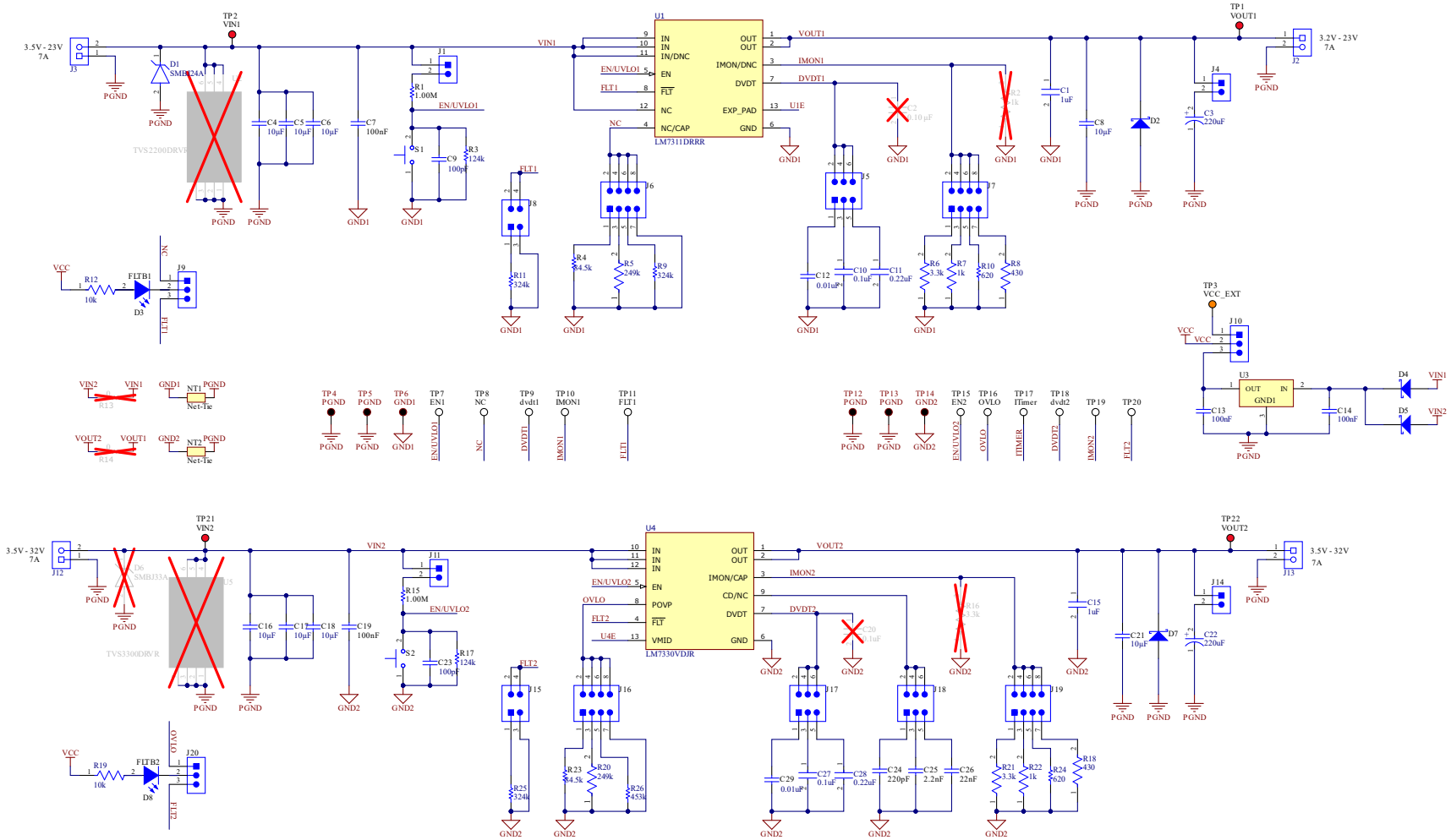


**Figure 4-1. LM7320-30EVM Evaluation Board Schematic**



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## 4.2 PCB Drawings

Figure 4-2 and Figure 4-3 show the component placement of the EVM.

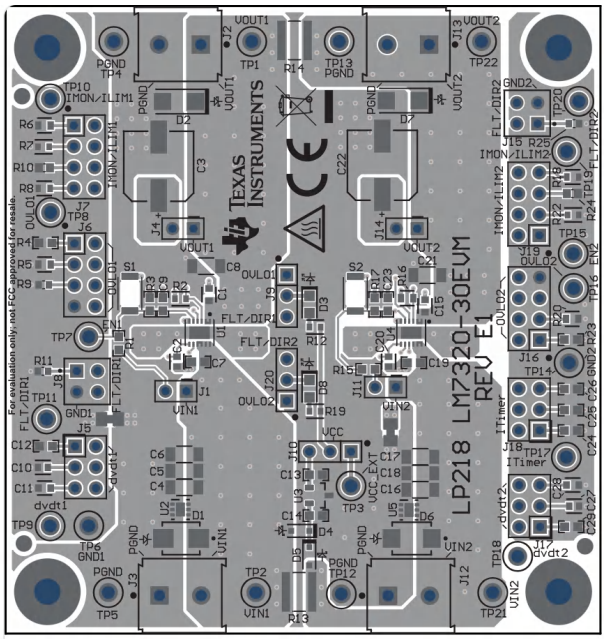


Figure 4-2. LM7320-30EVM Board: Top Assembly

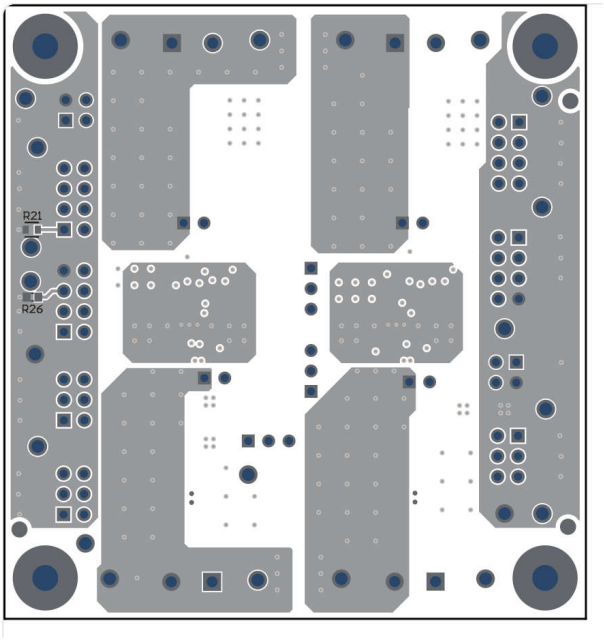

Figure 4-3. LM7320-30EVM Board: Bottom Assembly

**Note**

Analog signal nets, such as IMON, DVDT must be routed away as much as possible from power nets, such as VIN, VOUT, and PGND.


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## 4.3 Bill of Materials (BOM)

Table 4-1 lists the EVM BOM.

**Table 4-1. Bill of Materials**

| Designator | Quantity | Value | Description | Footprint | PartNumber | Manufacturer | Comments |
|---|---|---|---|---|---|---|---|
| !PCB1 | 1 | | Printed Circuit Board | | LP218 | Any | |
| C1, C15 | 2 | | CAP CER 1UF 50V X7R 0603 | FP-CC0603-DB-MFG | CL10B105KB9VPJC | | |
| C3, C22 | 2 | | CAP ALUM 220UF 20% 50V SMD | FP-FTF-MFG | | | |
| C4, C5, C6, C8, C16, C17, C18, C21 | 8 | 10uF | CAP, CERM, 10 µF, 50V, ± 10%, X7R, AEC-Q200 Grade 1, 1206 | 1206_190 | CGA5L1X7R1H106K160AC | TDK | |
| C7, C19 | 2 | 0.1uF | CAP, CERM, 0.1uF, 50V, ± 10%, X7R, 0603 | 0603 | C1608X7R1H104K080AA | TDK | |
| C9, C23 | 2 | 100pF | CAP, CERM, 100pF, 50V, ± 5%, C0G/NP0, 0603 | 0603 | 885012006057 | Wurth Elektronik | |
| C10, C27 | 2 | 0.10µF | CAP CER 0.1UF 50V X7R 0603 | FP-C0603C-CF-MFG | C0603C104K5RACTU | KEMET | |
| C11, C28 | 2 | 220nF | 0.22µF 50V Ceramic Capacitor X7R 0603 (1608 Metric) 0.063" L × 0.031" W (1.60mm × 0.80mm) | FP-CC0603-DA-MFG | CC0603KRX7R9BB224 | YAGEO | |
| C12, C29 | 2 | 0.01uF | CAP, CERM, 0.01uF, 50V, ± 5%, C0G/NP0, 0603 | 0603 | GRM1885C1H103JA01D | MuRata | |
| C13, C14 | 2 | 0.1uF | CAP, CERM, 0.1uF, 50V, ± 10%, X7R, 0603 | 0603 | 06035C104KAT2A | AVX | |
| C24 | 1 | 220pF | CAP, CERM, 220pF, 50V, ± 10%, X7R, 0603 | 0603 | C0603C221K5RACTU | Kemet | |
| C25 | 1 | 2200pF | CAP, CERM, 2200pF, 50V, ± 10%, X7R, 0603 | 0603 | C0603C222K5RAC | Kemet | |
| C26 | 1 | 0.022uF | CAP, CERM, 0.022uF, 50V, ± 10%, X7R, 0603 | 0603 | C0603X223K5RACTU | Kemet | |
| D1 | 1 | | TVS DIODE 24V 38.9V SMB | FP-SMB-MFG | SMBJ24A | Diodes Inc | |



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**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Footprint | PartNumber | Manufacturer | Comments |
|---|---|---|---|---|---|---|---|
| D2, D7 | 2 | 30V | Diode, Schottky, 30V, 3A, SMA | SMA | B330A-13F | Diodes Inc. | |
| D3 | 1 | FLTB1 | LED, Red, SMD | LED_LTST-C170_Red | LTST-C170KRKT | Lite-On | |
| D4, D5 | 2 | 30V | Diode, Schottky, 30V, 0.2A, SOD-323 | SOD-323 | BAT54WS-7F | Diodes Inc. | |
| D6 | 1 | | TVS DIODE 33V 53.3V DO214AA | FP-SMBJ-MFG | SMBJ33A | Littelfuse Inc | DNL |
| D8 | 1 | FLTB2 | LED, Red, SMD | LED_LTST-C170_Red | LTST-C170KRKT | Lite-On | |
| H1, H2, H3, H4 | 4 | | Machine Screw, Round, #4-40x 1/4, Nylon, Philips panhead | NY PMS 440 0025 PH | NY PMS 440 0025 PH | B&F Fastener Supply | |
| H5, H6, H7, H8 | 4 | | Standoff, Hex, 0.5"L #4-40 Nylon | Keystone_1902C | 1902C | Keystone | |
| J1, J4, J11, J14 | 4 | | Header, 100mil, 2x1, Tin, TH | CONN_PEC02SAAN | PEC02SAAN | Sullins Connector Solutions | |
| J2, J3, J12, J13 | 4 | | Terminal Block, 2x1, 5.08mm, TH | TEC_282841-2 | 282841-2 | TE Connectivity | |
| J5, J17, J18 | 3 | | Header, 100mil, 3x2, Tin, TH | SULLINS_PEC03DAAN | PEC03DAAN | Sullins Connector Solutions | |
| J6, J7, J16, J19 | 4 | | Header, 100mil, 4x2, Tin, TH | CONN_PEC04DAAN | PEC04DAAN | Sullins Connector Solutions | |
| J8, J15 | 2 | | Header, 100mil, 2x2, Tin, TH | Sullins_PEC02DAAN | PEC02DAAN | Sullins Connector Solutions | |
| J9, J10, J20 | 3 | | Header, 100mil, 3x1, Tin, TH | CONN_PEC03SAAN | PEC03SAAN | Sullins Connector Solutions | |
| R1, R15 | 2 | 1.00Meg | RES, 1.00M, 1%, 0.1W, 0603 | 0603 | RC0603FR-071ML | Yageo America | |
| R3, R17 | 2 | 124k | RES, 124k, 1%, 0.1W, AEC-Q200 Grade 0, 0603 | 0603 | CRCW0603124KFKEA | Vishay-Dale | |
| R4, R23 | 2 | 84.5k | RES, 84.5k, 1%, 0.1W, 0603 | 0603 | RC0603FR-0784K5L | Yageo | |
| R5, R20 | 2 | | 249k | Vishay_CRCW0603e3_MFG | CRCW0603249KFKEA | Vishay Dale | |
| R6, R21 | 2 | | RES Thick Film, 3.3kΩ, 1%, 0.33W, 100ppm/°C, 0603 | FP-CRCW0603-HPe3-MFG | CRCW06033K30FKEA | Vishay Dale | |
| R7, R22 | 2 | | RES 1K Ω 1% 1/10W 0603 | FP-RC0603-0_55-IPC_C | RMCF0603FT1K00 | Stackpole Electronics Inc | |


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**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Footprint | PartNumber | Manufacturer | Comments |
|---|---|---|---|---|---|---|---|
| R8, R18 | 2 | | 430Ω ±5% 0.1W 0603 Thick Film Chip Resistor AEC-Q200 compliant | FP-RMCF0603-MFG | RMCF0603FT430R | Stackpole Electronics Inc | |
| R9, R11, R25 | 3 | | | RESC1608X55X30LL 15T15 | ERJ-3EKF3243V | Panasonic | |
| R10, R24 | 2 | | | RESC1609X50X30ML 10T20 | CRCW0603620RFKEA | Vishay Dale | |
| R12, R19 | 2 | | RES 10K Ω 1% 1/10W 0603 | FP-RC0603-0_55-IPC_C | RC0603FR-0710KL | YAGEO | |
| R26 | 1 | | | RESC1608X55X30ML 15T15 | ERJ-3EKF4533V | Panasonic | |
| S1, S2 | 2 | | Switch, SPST-NO, 0.05A, 12VDC, SMT | SW_SKRKAE | SKRKAEE020 | Alps | |
| SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16 | 16 | 1x2 | Shunt, 100mil, Flash Gold, Black | SPC02SYAN | SPC02SYAN | Sullins Connector Solutions | SH-J1-(J1-Pin1,2), SH-J2-(J20-Pin2,3), SH-J3-(J18-Pin5,6), SH-J4-(J4-Pin1,2), SH-J5-(J5-Pin3,4), SH-J6-(J6-Pin7,8), SH-J7-(J7-Pin3,4), SH-J8-(J8-Pin3,4), SH-J9-(J9-Pin2,3), SH-J10-(J10-Pin2,3), SH-J11-(J11-Pin1,2), SH-J12-(J17-Pin3,4), SH-J13-(J19-Pin3,4), SH-J14-(J14-Pin1,2), SH-J15-(J15-Pin3,4), SH-J16-(J16-Pin7,8) |
| TP1, TP2, TP21, TP22 | 4 | | Test Point, Multipurpose, Red, TH | Keystone5010 | 5010 | Keystone | |
| TP3 | 1 | | Test Point, Multipurpose, Orange, TH | Keystone5013 | 5013 | Keystone | |
| TP4, TP5, TP6, TP12, TP13, TP14 | 6 | | PC TEST POINT MULTIPURPOSE BLACK | Keystone5011 | 5011 | Keystone | |
| TP7, TP8, TP9, TP10, TP11, TP15, TP16, TP17, TP18, TP19, TP20 | 11 | | Test Point, Multipurpose, White, TH | Keystone5012 | 5012 | Keystone | |
| U1 | 1 | | LM7311DRRR | DRR0012H-MFG | LM7311DRRR | Texas Instruments | |



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**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Footprint | PartNumber | Manufacturer | Comments |
|---|---|---|---|---|---|---|---|
| U3 | 1 | | 100mA, Quasi Low-Dropout Linear Voltage Regulator, 3-pin SOT-23, Pb-Free | DBZ0003A_N | LM3480IM3-3.3/NOPB | Texas Instruments | |
| C2, C20 | 2 | 0.10µF | CAP CER 0.1UF 50V X7R 0603 | FP-C0603C-CF-MFG | C0603C104K5RACTU | KEMET | DNL |
| R2 | 1 | | RES 1K Ω 1% 1/10W 0603 | FP-RC0603-0_55-IPC_C | RMCF0603FT1K00 | Stackpole Electronics Inc | DNL |
| R13, R14 | 2 | 0 | 0Ω Jumper Chip Resistor Wide 1812 (4532 Metric), 1218 Moisture Resistant Thick Film | FP-RC1218JK-070RL_1218-MFG | RC1218JK-070RL | Yageo | DNL |
| R16 | 1 | | RES Thick Film, 3.3kΩ, 1%, 0.33W, 100ppm/°C, 0603 | FP-CRCW0603-HPe3-MFG | CRCW06033K30FKEA | Vishay Dale | DNL |
| U2 | 1 | | 22V Precision Surge Protection Clamp, DRV0006A (WSON-6) | DRV0006A | TVS2200DRVR | Texas Instruments | DNL |
| U4 | 1 | | LM7330VDJR | VDJ0012A-MFG | LM7330VDJR | Texas Instruments | |
| U5 | 1 | | 33V Precision Surge Protection Clamp, DRV0006A (WSON-6) | DRV0006A | TVS3300DRVR | Texas Instruments | DNL |


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# 5 Additional Information

## 5.1 Trademarks

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# 6 Revision History

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

| Changes from Revision * (August 2026) to Revision A (October 2026) | Page |
|---|---|
| • Changed from LM7320 to LM7311 for evaluation of 12V (typical) and 5A (steady state) designs | 1 |
| • Added LM7320 evaluation information | 1 |
| • Deleted LM7311DRRR information | 1 |
| • Updated board image | 1 |
| • Added maximum continuous current feature information | 2 |
| • Deleted integrated smart surge clamp feature information | 2 |
| • Added IEC62368-3 feature information | 2 |
| • Changed to combine short-circuit protection information | 2 |
| • Deleted maximum output capacitance and output voltage slew rate parameters from Table 1-3 | 2 |
| • Deleted steps four and five from instructions | 6 |
| • Added step three | 7 |
| • Deleted electronic load and output information from step five | 7 |
| • Changed from EN1(TP7) to FLT1(TP11) in step seven | 7 |
| • Deleted step two | 8 |
| • Changed from 15V to 14V throughout test | 9 |
| • Added step four | 9 |
| • Deleted previous version step six | 9 |
| • Changed input supply VIN1 maximum from 24V to 25V | 10 |
| • Updated step six | 11 |
| • Deleted previous version step two | 12 |
| • Updated images in Section 4.1 | 14 |
| • Updated Section 4.2 | 15 |
| • Updated Section 4.3 | 16 |



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   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

## WARNING

**Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.**

**User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

# 3 *Regulatory Notices:*

## 3.1 *United States*

### 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

### 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

**CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

**FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

## 3.2 *Canada*

### 3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

**Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

**Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

**Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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