

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 LM7320 and LM7330 eFuse to evaluate a 12V (typical) and 7A (steady state) designs.

Evaluate LM7311DRRR on this EVM by placing the LM7311DRRR at the U1 slot.

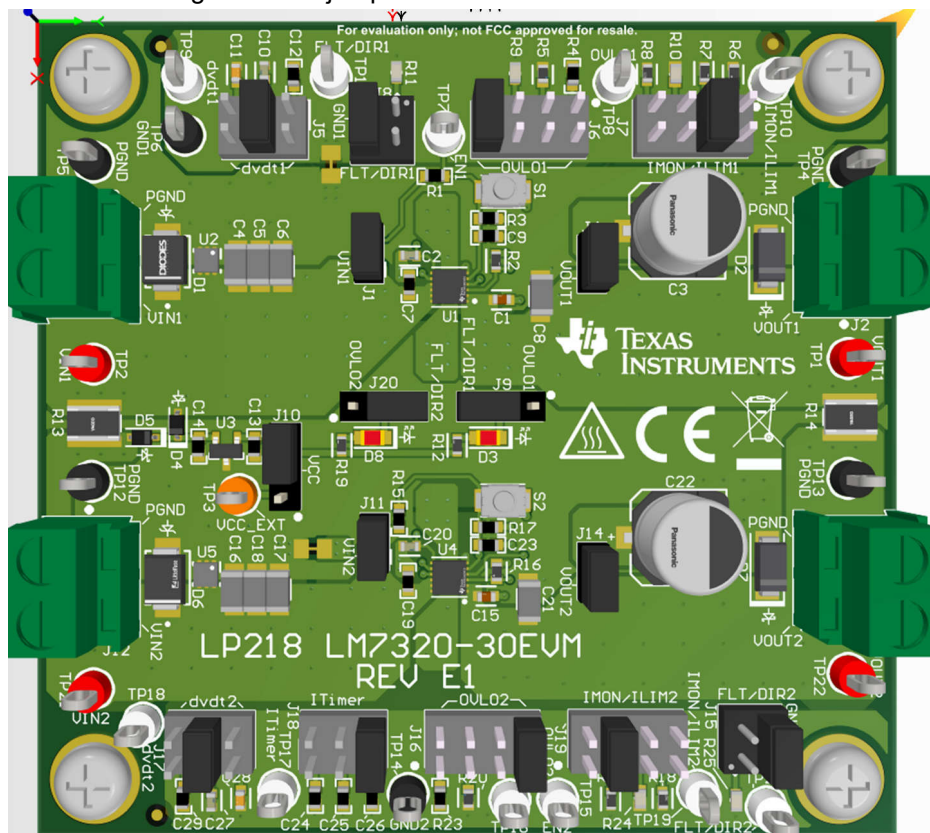
Features

- Overvoltage protection
- Active High Enable with adjustable UVLO threshold
- Adjustable analog current monitor and output voltage slew rate control using on-board 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

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
Integrated smart surge clamp	NO	YES, ± 8kV System level ESD	YES, ± 8kV System level ESD
Short circuit protection during startup, steady state	YES	YES	YES
Short circuit protection during Steady state	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
Maximum output capacitance (C_{LOAD})	1mF	1mF	1mF
Output voltage slew rate	0.5V/ms	0.5V/ms	0.5V/ms

1.4 Device Information

The LM7320-30EVM enables the evaluation of LM7311, LM7320, and LM7330 eFuses from the 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	V _{in} UVLO THRESHOLD	V _{in} 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

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	VOOUT1(+)	Positive terminal for the output power from LM7311/LM7320
J2-2	PGND(-)	Negative terminal for the output power from LM7311/LM7320
J13-1	VOOUT2(+)	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	VOOUT1	LM7320 output voltage
TP2	VIN1	LM7320 input voltage
TP3	VCC_EXT	External pull up
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	VOOUT2	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	VOOUT1	1-2 position adds a capacitive load of 220uF to LM7320/LM7311	OPEN

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 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.

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

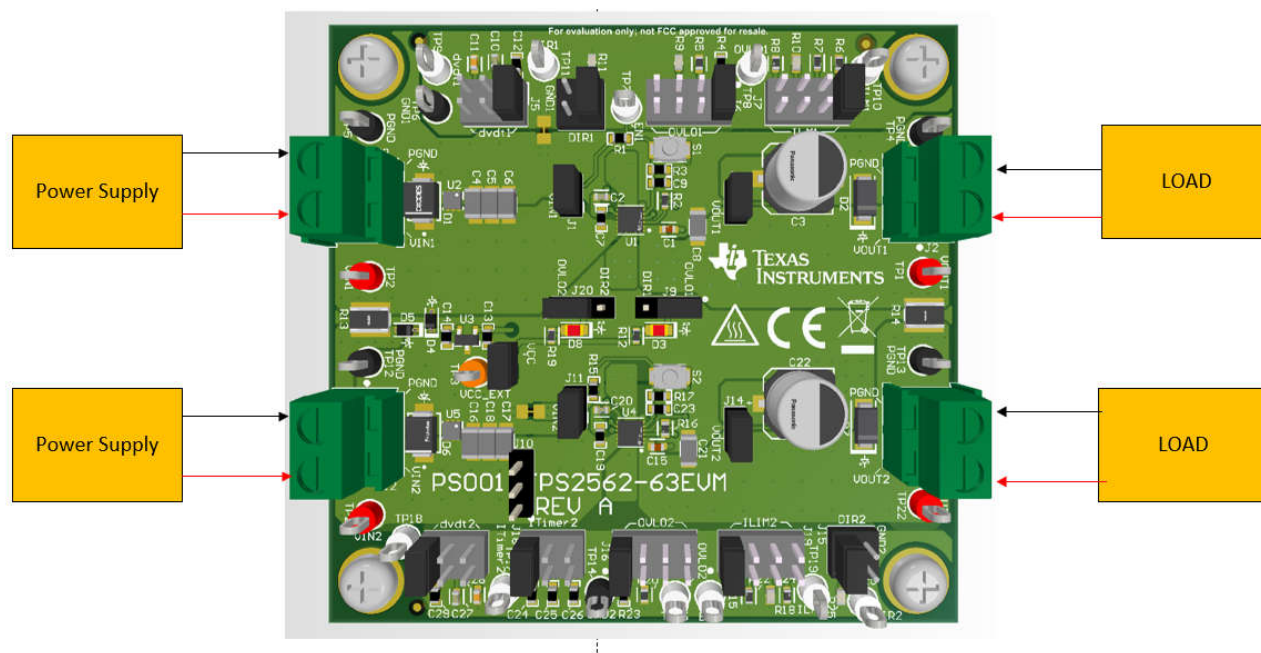


Figure 3-1. LM7320-30EVM Setup with Test Equipment

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](#).
4. Connect an electronic load in CR mode with resistance configured to 24Ω at the output of eFuse. The positive terminal of electronic load connects to J2-1 and the negative terminal to J2-2
5. Turn the power supply on and set the power supply output (VIN) to 12V and 20A. Verify that the power supply output is disabled and turn on the electronic load

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. 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. Enable the electronic load at the output.
5. Enable the power supply. Then connect the positive terminal of the power supply to connector J3-2.
6. Use an oscilloscope to observe the waveforms at VOUT1(TP1), VIN1(TP2), EN1(TP7), and the input current.

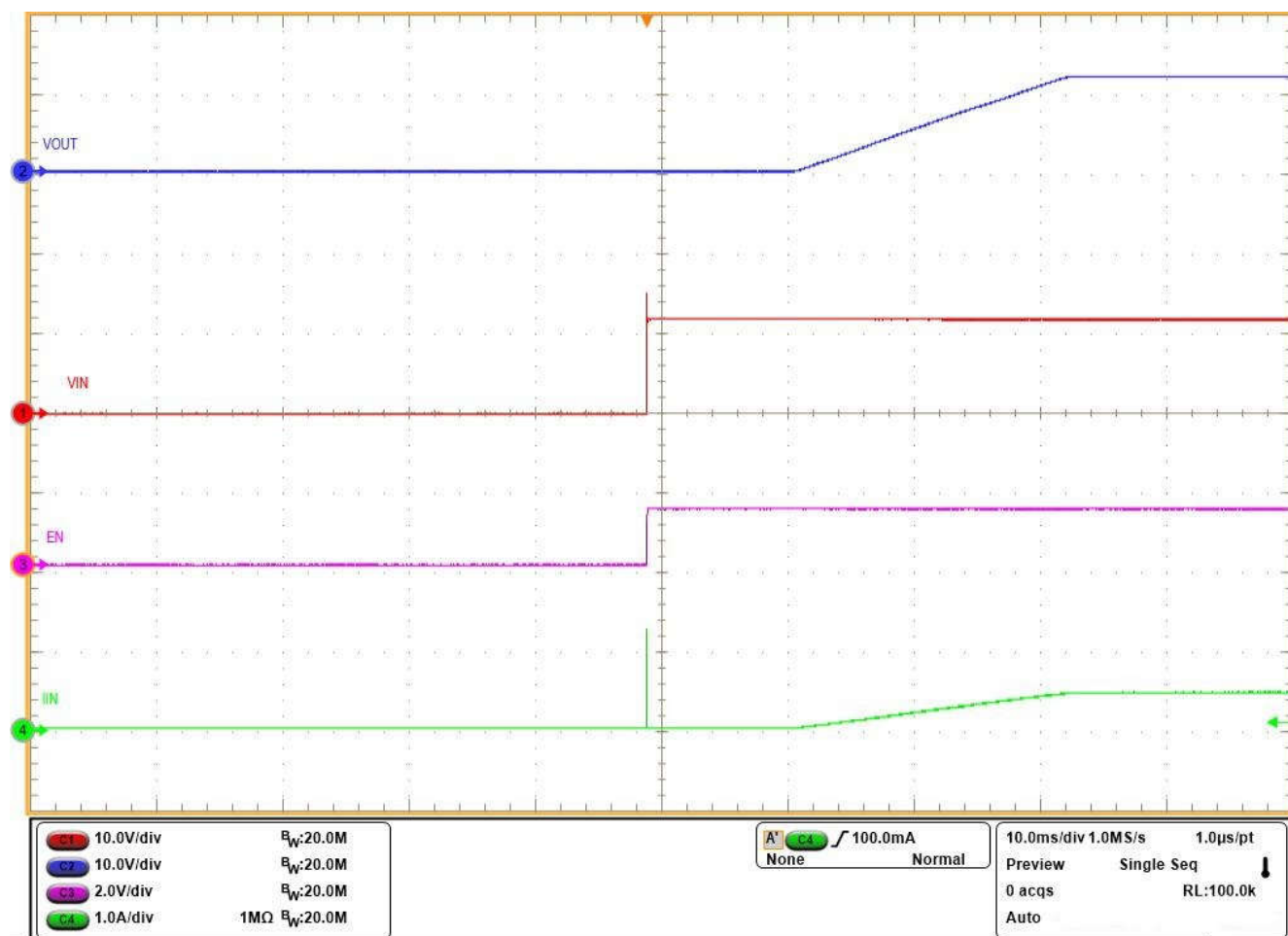


Figure 3-2. LM7311 eFuse Input Hotplug Profile

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. Disconnect the electronic load at the output of eFuse.
3. Set the input supply voltage VIN to 12V and current limit to 30A. Keep the power supply OFF.
4. Connect the negative terminal of power supply to J3-1 and positive terminal of power supply to J3-2
5. Short the output of the EVM to ground. For example, short VOUT1 (connector J2-1) to PGND (connector J2-2) through a cable.
6. Turn ON the power supply.

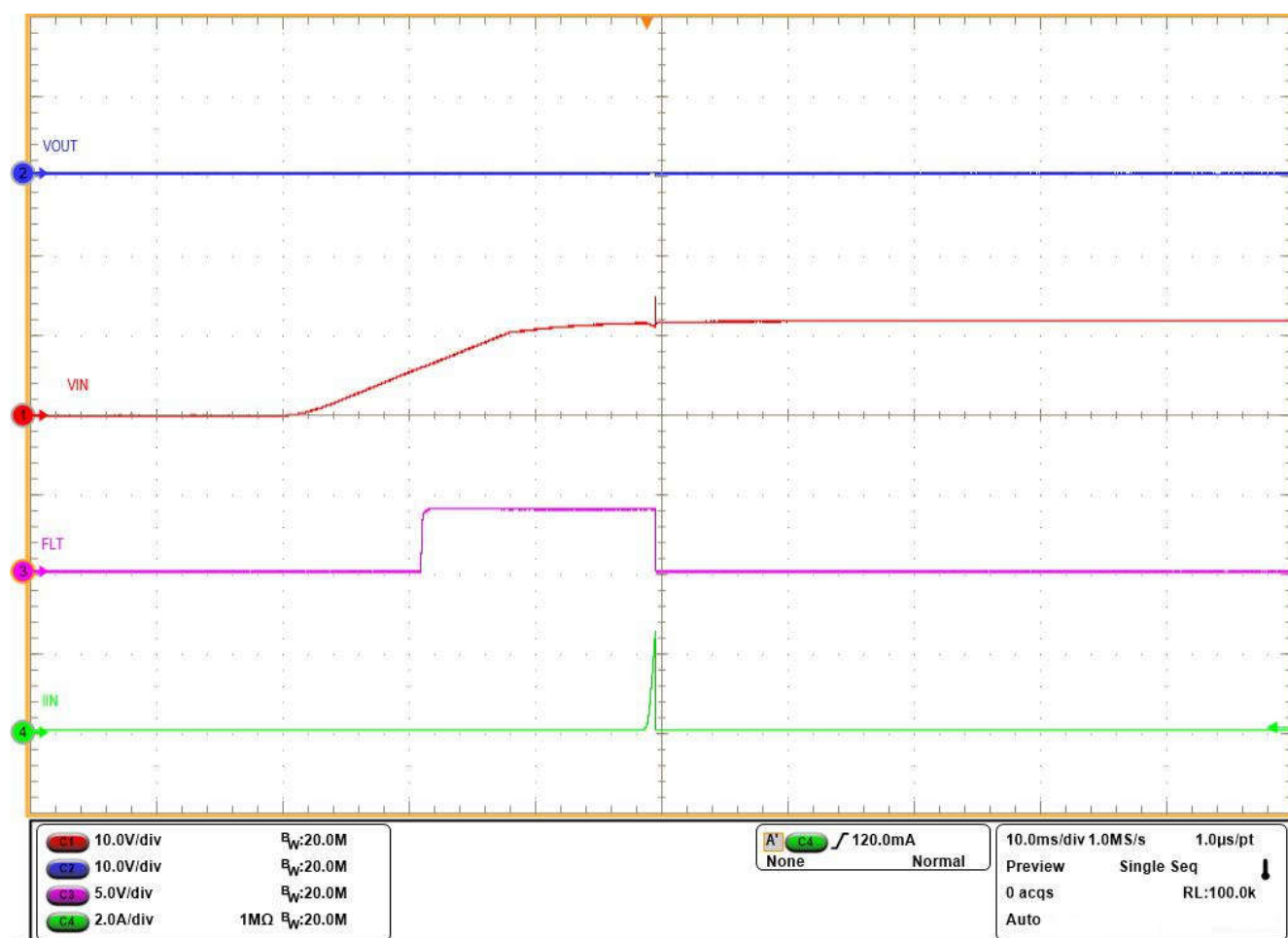


Figure 3-3. Power Up Into Output Short Response of LM7311

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 15V and current limit to 10A.
4. 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.
5. Apply a voltage of 15V to VOUT through a diode using second power supply.
6. Observe the input current through the first power supply. The input current goes from 500mA to zero.

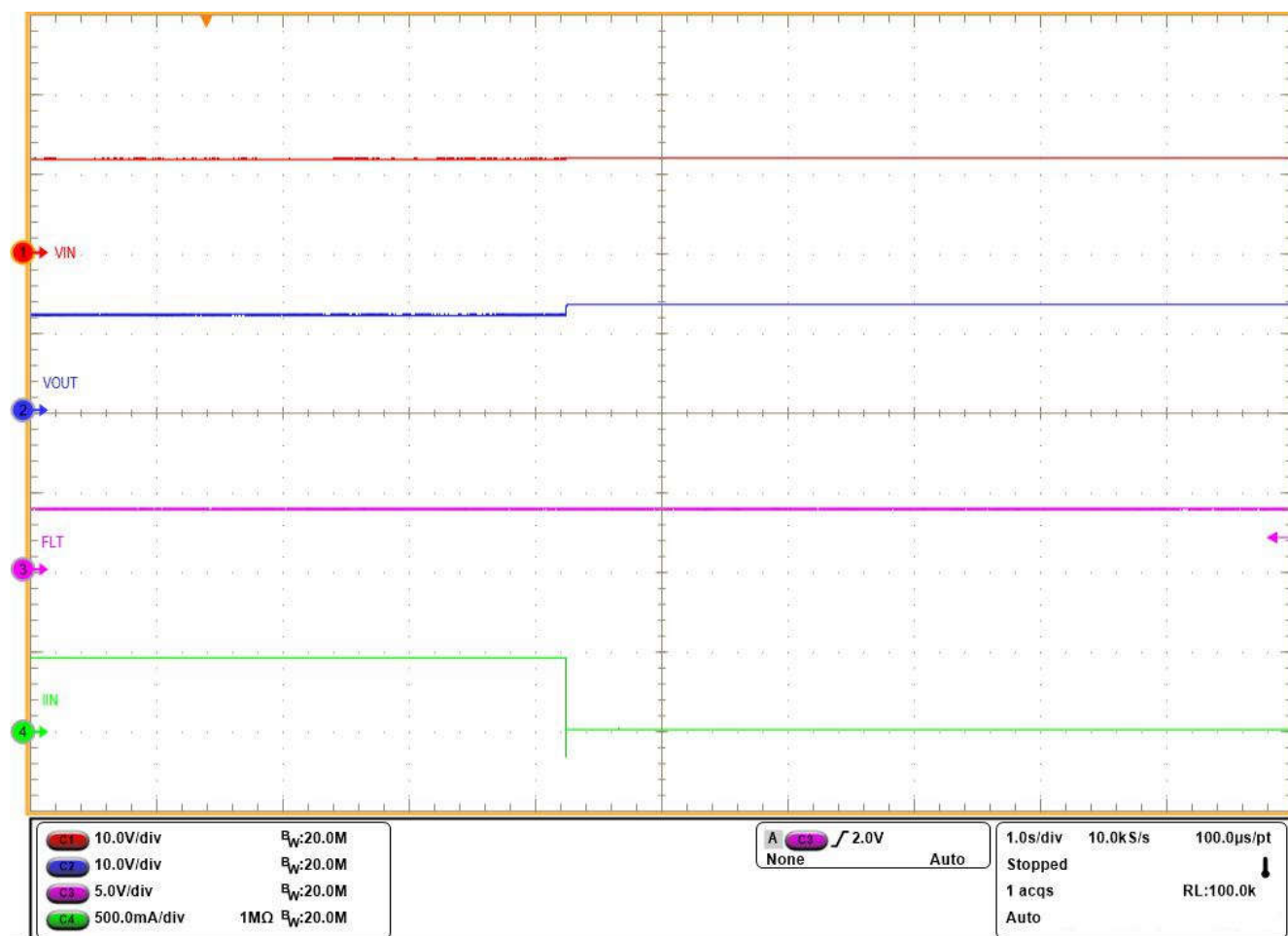


Figure 3-4. Reverse Current Blocking Test Response of LM7311

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 24V. Observe the waveforms using an oscilloscope.

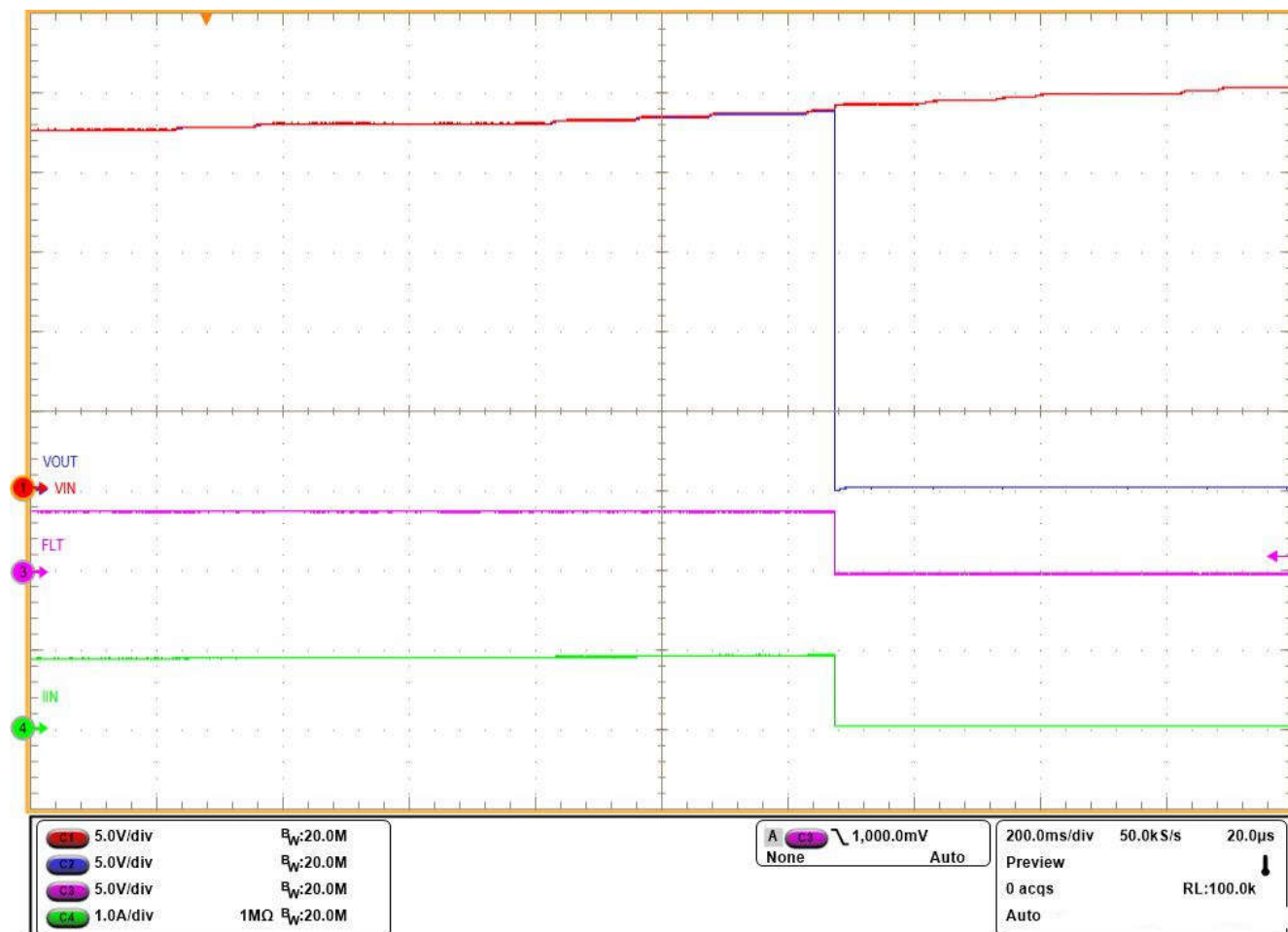


Figure 3-5. Overvoltage Lockout Response of LM7311 eFuse

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 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. 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. Disconnect the electronic load at the output.
7. Throughout the test, use an oscilloscope to observe the waveforms at IMON(TP10), VIN(TP2), VOUT(TP1) and input current.

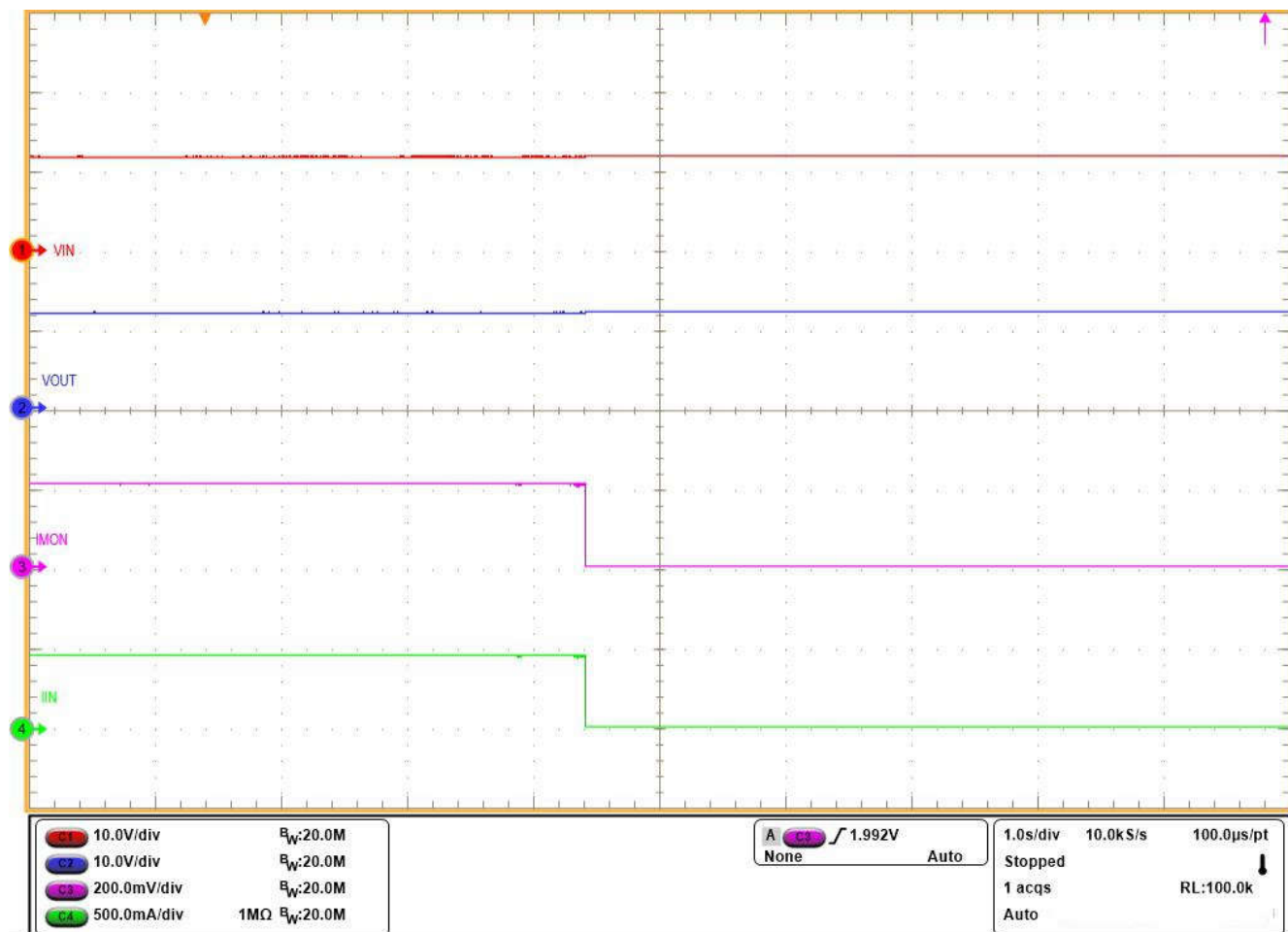


Figure 3-6. IMON Pin Test of LM731

3.1.6 Output Hot Short

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

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

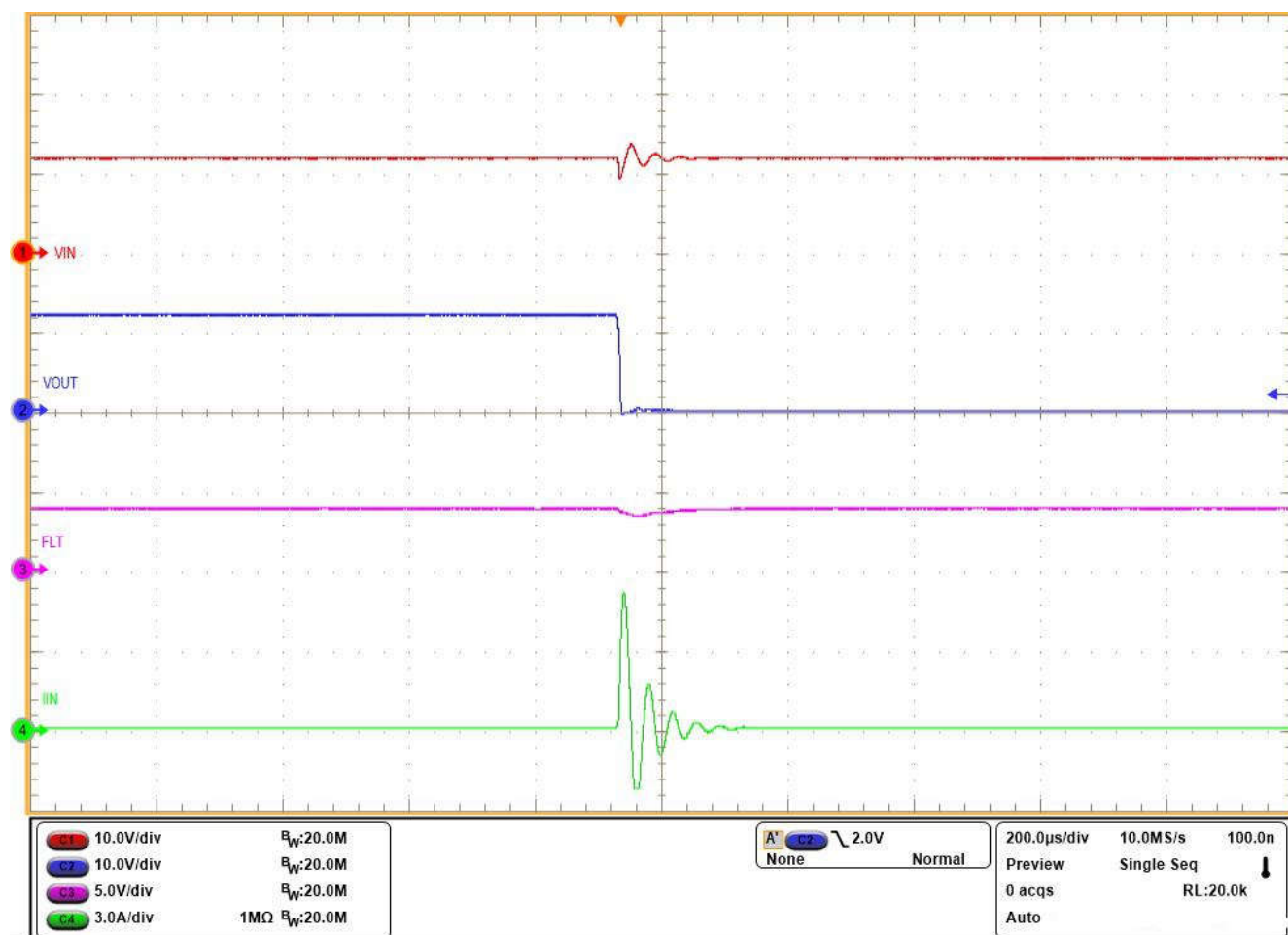


Figure 3-7. Output Hot Short Response for LM7311

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 contribute to the variation in results:

- Source bypassing
- Input leads
- Board layout
- Component selection

- Output shorting method
- 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.

4 Hardware Design Files

4.1 Schematics

Figure 4-1 shows the EVM schematic.

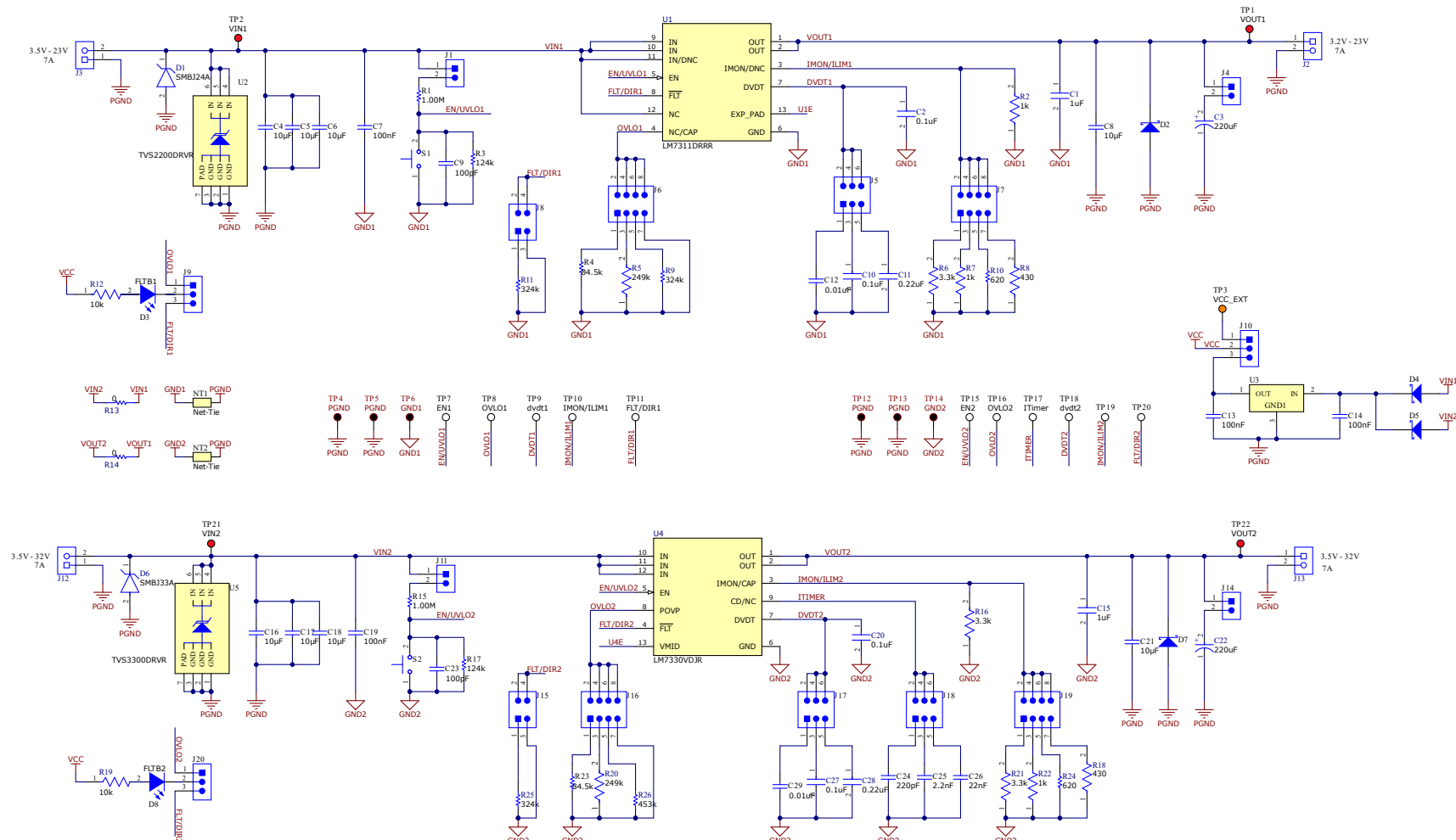


Figure 4-1. LM7320-30EVM Evaluation Board Schematic

4.2 PCB Drawings

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

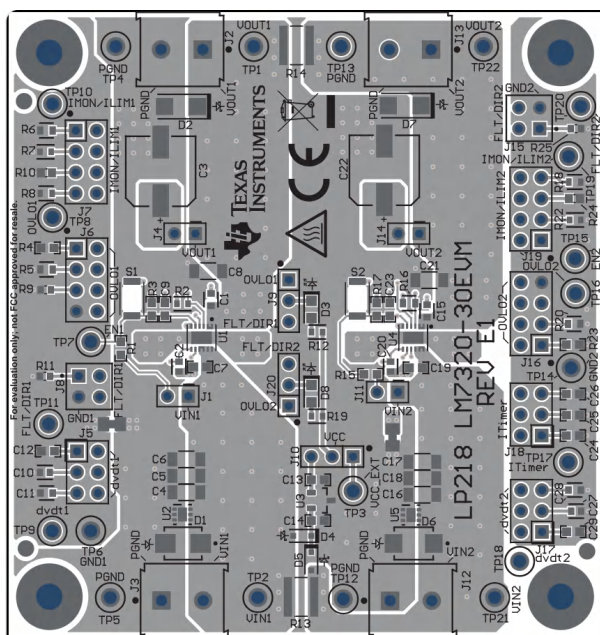


Figure 4-2. LM7320-30EVM Board: Top Assembly

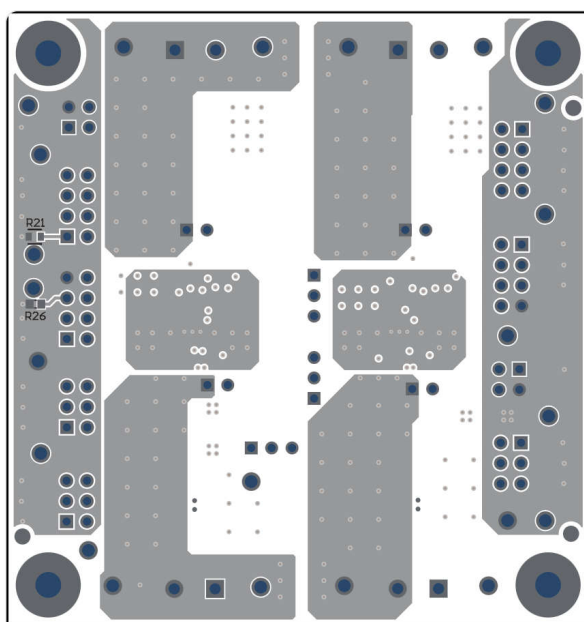


Figure 4-3. LM7320-30EVM Board: Bottom Assembly

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.

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 μ F, 50V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 1206	1206_190	CGA5L1X7R1H106K1 60AC	TDK	
C7, C19	2	0.1uF	CAP, CERM, 0.1uF, 50V, $\pm$ 10%, X7R, 0603	0603	C1608X7R1H104K08 0AA	TDK	
C9, C23	2	100pF	CAP, CERM, 100pF, 50V, $\pm$ 5%, C0G/NP0, 0603	0603	885012006057	Wurth Elektronik	
C10, C27	2	0.10 μ F	CAP CER 0.1UF 50V X7R 0603	FP-C0603C-CF-MFG	C0603C104K5RACTU	KEMET	
C11, C28	2	220nF	0.22 μ F 50V Ceramic Capacitor X7R 0603 (1608 Metric) 0.063" L $\times$ 0.031" W (1.60mm $\times$ 0.80mm)	FP-CC0603-DA-MFG	CC0603KRX7R9BB22 4	YAGEO	
C12, C29	2	0.01uF	CAP, CERM, 0.01uF, 50V, $\pm$ 5%, C0G/NP0, 0603	0603	GRM1885C1H103JA0 1D	MuRata	
C13, C14	2	0.1uF	CAP, CERM, 0.1uF, 50V, $\pm$ 10%, X7R, 0603	0603	06035C104KAT2A	AVX	
C24	1	220pF	CAP, CERM, 220pF, 50V, $\pm$ 10%, X7R, 0603	0603	C0603C221K5RACTU	Kemet	
C25	1	2200pF	CAP, CERM, 2200pF, 50V, $\pm$ 10%, X7R, 0603	0603	C0603C222K5RAC	Kemet	
C26	1	0.022uF	CAP, CERM, 0.022uF, 50V, $\pm$ 10%, X7R, 0603	0603	C0603X223K5RACTU	Kemet	
D1	1		TVS DIODE 24V 38.9V SMB	FP-SMB-MFG	SMBJ24A	Diodes Inc	

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	
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	CRCW0603124KFKE A	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	CRCW0603249KFKE A	Vishay Dale	
R6, R21	2		RES Thick Film, 3.3kΩ, 1%, 0.33W, 100ppm/°C, 0603	FP-CRCW0603-HPe3-MFG	CRCW06033K30FKE A	Vishay Dale	
R7, R22	2		RES 1K Ω 1% 1/10W 0603	FP-RC0603-0_55-IPC_C	RMCF0603FT1K00	Stackpole Electronics Inc	

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	CRCW0603620RFKE A	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	SKRKAE020	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	

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	DNL
U5	1		33V Precision Surge Protection Clamp, DRV0006A (WSON-6)	DRV0006A	TVS3300DRVR	Texas Instruments	DNL

5 Additional Information

5.1 Trademarks

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 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 DEGRADATION 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 instructions, 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/sds/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.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.
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