EVM User's Guide: TPS7H1301EVM-CVAL

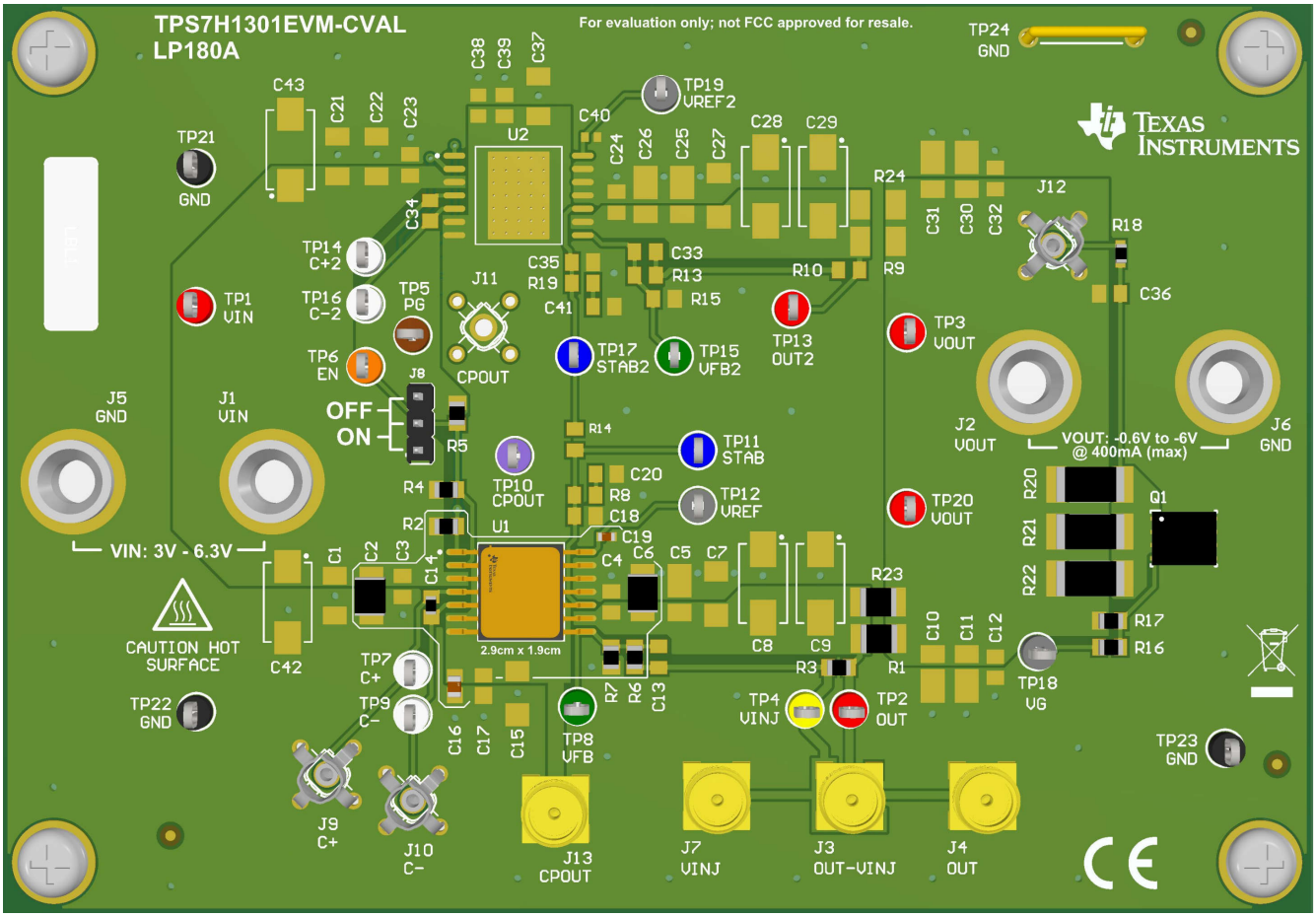
TPS7H1301-SP Evaluation Module (EVM)

Description

The TPS7H1301EVM-CVAL demonstrates the operation of a single TPS7H1301-SP Switched Capacitor Voltage Inverter with Integrated Low Dropout Regulator (ceramic package). The board provides footprints that can be populated with additional components to allow for testing of customized configurations.

Features

- Flexible configuration options, including capability to configure parallel devices
- On-board load transient circuitry



1 Evaluation Module Overview

1.1 Introduction

The TPS7H1301EVM-CVAL is the Evaluation Module (EVM) for the ceramic package option of the TPS7H1301 and provides a platform to electrically evaluate its features. This user's guide provides details about the EVM, including the configuration, schematics, and BOM. The EVM is designed to provide flexibility to configure the device as desired, through footprints for external components and an additional IC footprint for parallel configurations. By default, the device on the EVM is configured as shown in TPS7H1301EVM-CVAL Default Configuration and Default EVM Schematic. To set up the device in a different configuration, please refer to the TPS7H1301 data sheet to calculate the values of the passives around the device that needs to be changed.

1.2 Kit Contents

- EVM board (1)
- EVM Kit User Guide (1)

1.3 Device Information

The TPS7H1301 is a low-noise regulated switched-capacitor voltage inverter with an integrated low dropout adjustable regulator with an input voltage range of 3V to 6.3V, the TPS7H1301 is capable of providing an output current of 400mA with an adjustable voltage range of -0.6V to -6V. The TPS7H1301's integrated LDO offers external compensation by incorporating direct error amp access via the STAB pin and uses an internal switching frequency of 500kHz.

1.4 Specification

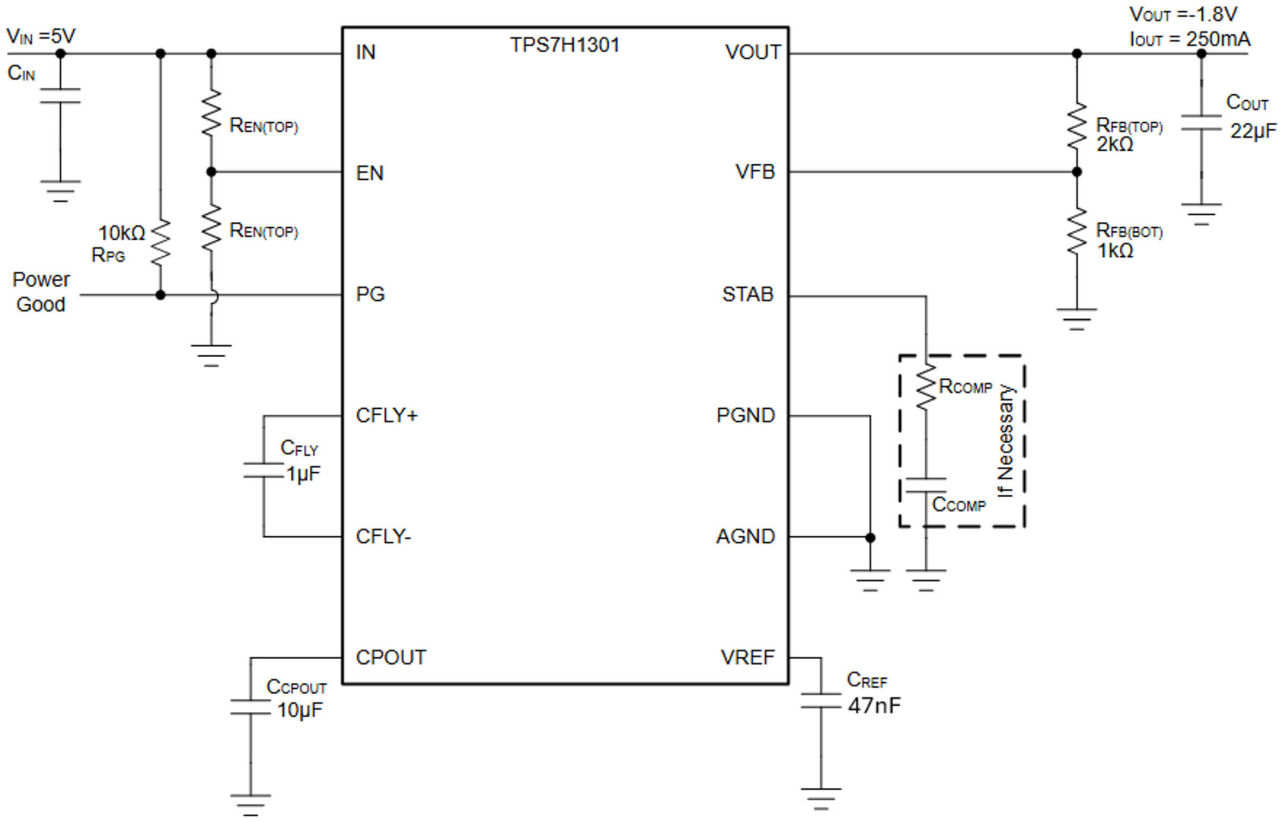


Table 1-1. Default EVM Configuration

Specification	Value	Description
Input Voltage VIN	5V	Falls within the recommended device input voltage range of 3V to 6.3V.
Output Voltage VOUT	-1.8V	Within the recommended VOUT range of -0.6V to -6V. Set by: R6 = 2kΩ R7 = 1kΩ
Load current IOUT	250mA	Within the max output current rating of 400mA per device.
Enable Voltage	3.89V	VIN value that brings EN above the turn-on threshold. Set by: R4 = 54.9kΩ R5 = 10kΩ
Disable Voltage	2.25V	VIN value that brings EN below the turn-off threshold. Set by: R4 = 54.9kΩ R5 = 10kΩ
Switching Frequency fsw	500kHz	Fixed switching frequency of the internal switch cap array.

2 Hardware

2.1 Power Requirements

The TPS7H1301EVM-CVAL requires a single positive power rail (VIN).

- 3V ≤ VIN ≤ 6.3V

2.2 Jumper Information

Designator	Function	
J1	VIN	Positive voltage power input for VIN
J5	GND	
J2	VOUT	Negative voltage power output for VOUT
J6	GND	
J8	EN	Jumper to tie EN to VIN or GND for simple enable/disable.

2.3 Test Points

Designator	Function	
TP1	VIN	Test point for VIN
TP2	OUT	Test Point for OUT of the main device.
TP13	OUT2	Test Point for OUT of the secondary device.
TP3	VOUT	Test point for shared VOUT of both main and secondary devices.
TP5	PG	Test point for the shared PG signals of both the main and secondary device.
TP6	EN	Test point for the shared EN signal of both the main and secondary devices.
TP7	C+	Test point for positive terminal of the flying capacitor of the main device.
J9		Probe test point for positive terminal of the flying capacitor of the main device.
TP14	C+2	Test point for positive terminal of the flying capacitor of the secondary device.
TP9	C-	Test point for negative terminal of the flying capacitor for the main device.
J10		Probe test point for negative terminal of the flying capacitor for the main device.
TP16	C-2	Test point for negative terminal of the flying capacitor of the secondary device.
TP10	CPOUT	Test point for the shared CPOUT of both the main and secondary devices.
J11		Probe test point for CPOUT.
J13		SMA test point for CPOUT
TP12	VREF	Test point for VREF of the main device.
TP19	VREF2	Test point for VREF of the secondary device.
TP8	VFB	Test point for VFB of the main device.

Designator	Function	
TP15	VFB2	Test point for VFB of the secondary device.
TP11	STAB	Test point for STAB of the primary device.
TP17	STAB2	Test point for STAB of the secondary device.
TP21, TP22, TP23, TP24	GND	Test points for GND.
TP4	VINJ	Test point for stability testing.
J3	OUT-VINJ	SMA connector for stability injection.
J4	VINJ	SMA connector for stability measurement.
J7	OUT	SMA connector for OUT and stability measurement.
TP18	VG	Test point used for control of the gate signal used in the load transient circuitry.
TP20	VOUT	
J12	TRANS	Probe test point for sensing the load demanded by the load transient circuitry.

2.4 Best Practices

- Calculate the expected VDroop and VDropout requirements for the expected load when selecting VIN and VOUT.
- Ensure proper orientation of components on the negative rails (such as tantalum capacitors).
- Determine VIN ripple requirements when selecting input capacitance.
- Be aware of areas of the board that may heat up during operation.

CAUTION

Hot surface. Contact can cause burns. Do Not Touch!

3 Implementation Results

Waveforms are shown below for the following behaviors:

1. Startup
2. Shutdown
3. Charge pump operation
4. Stability plots

3.1 Startup

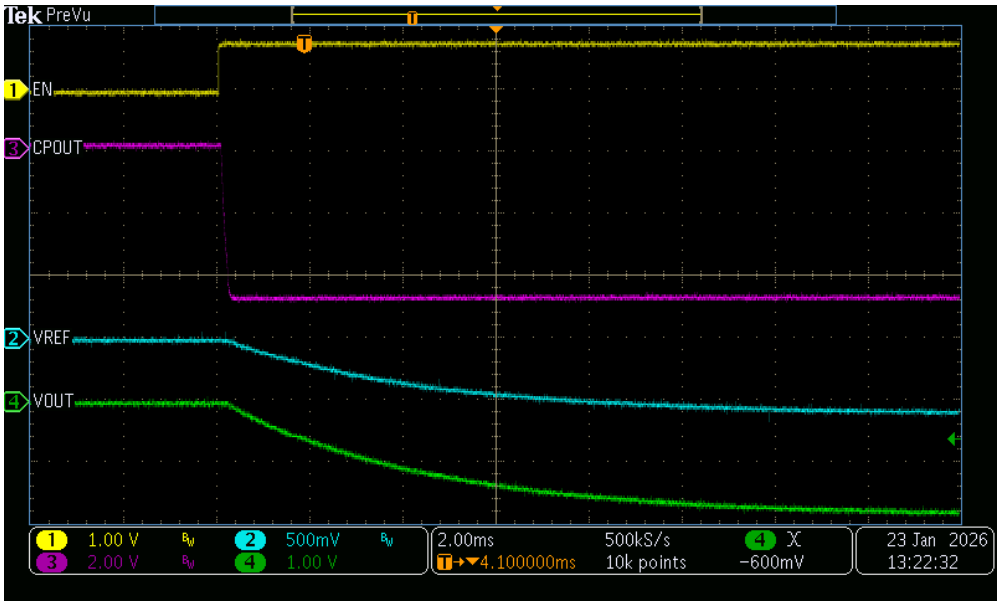


Figure 3-1. EN Independently Driven HIGH

EN follows rising VIN. CPOUT turns on when EN passes the turn-on threshold, then continues to follow VIN as it rises further. VOUT turns on once the magnitude of CPOUT has reached ≅60-80% of the magnitude of VIN and the charge pump has exited frequency foldback mode.

Figure 3-2. EN Tied to Rising VIN via Resistor Divider

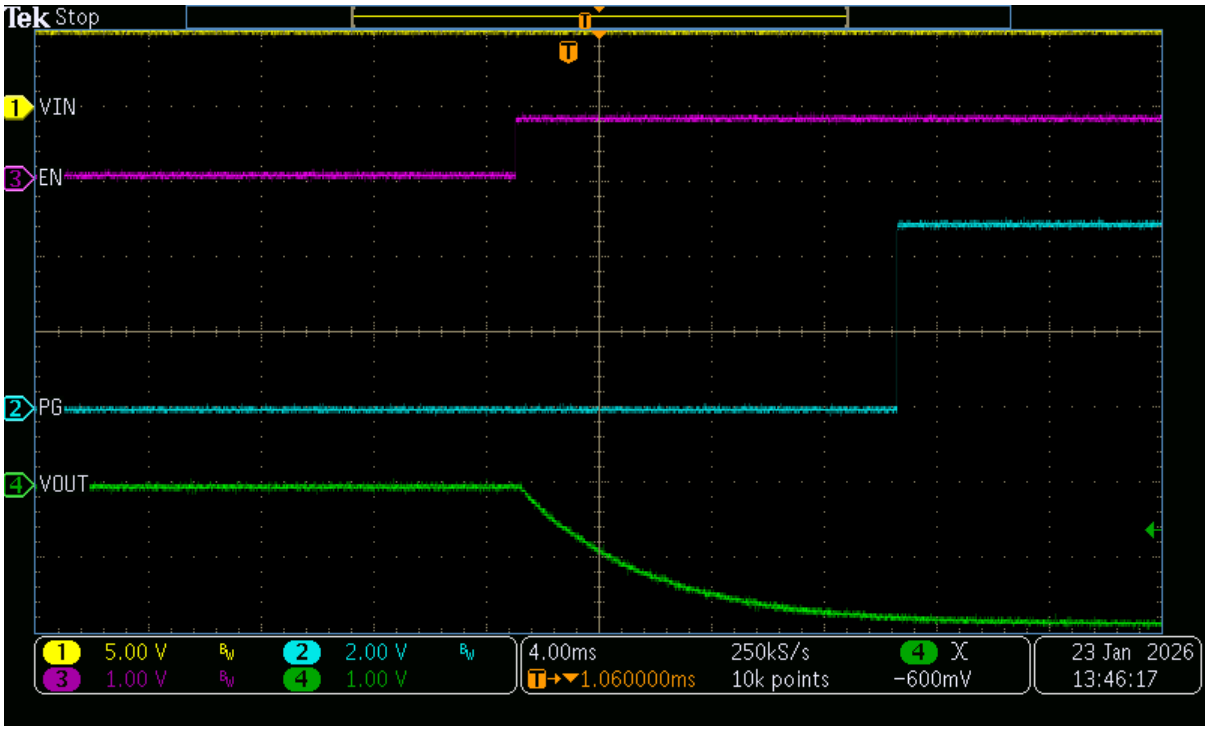


Figure 3-3. Power Good Assert - EN Independently Driven HIGH

Because VIN is rising in this waveform, the PG output can be observed briefly in an undefined state while VIN is below VIN_MIN_PG (0.8V nominal).

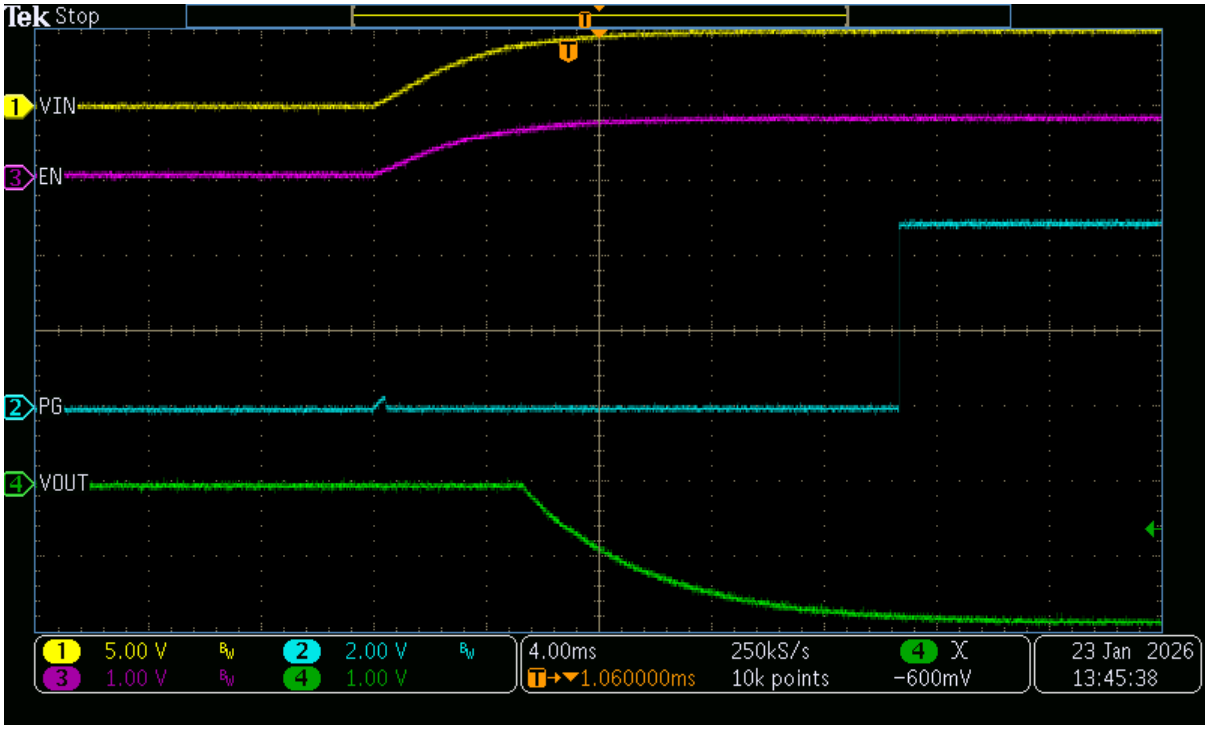


Figure 3-4. Power Good Assert - EN Tied to Rising VIN via Resistor Divider

3.2 Shutdown

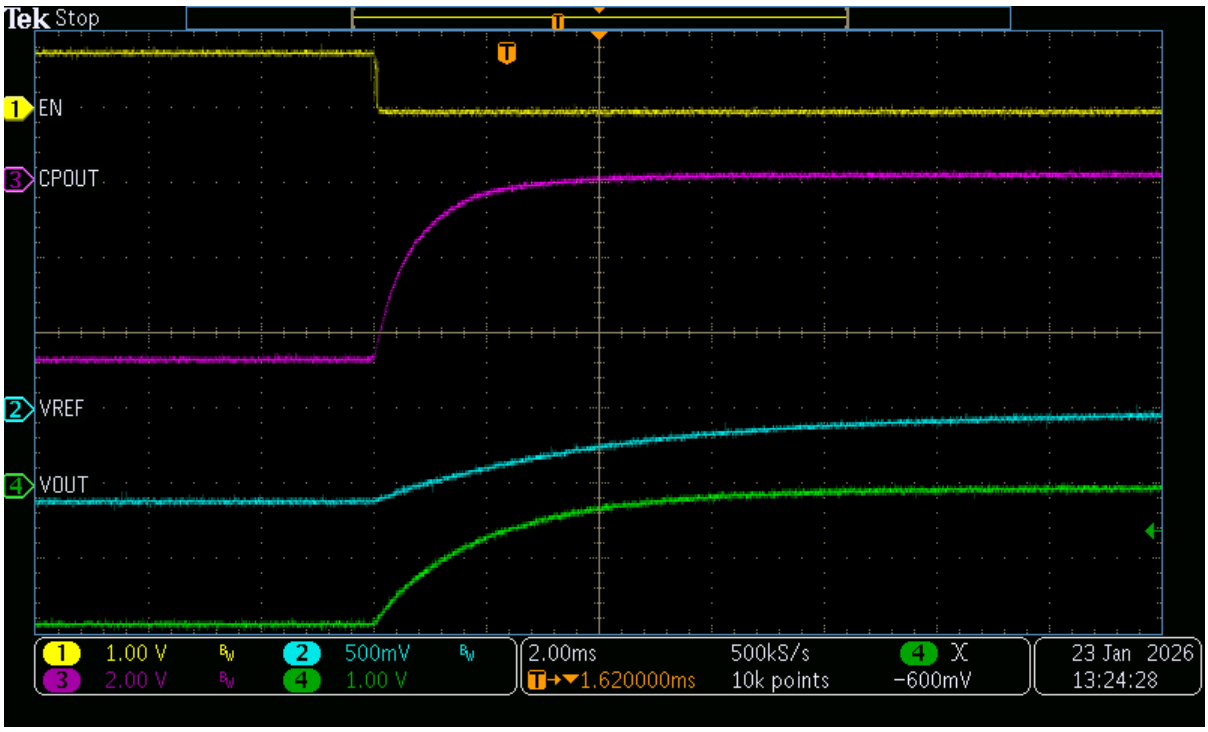


Figure 3-5. EN Independently Driven LOW

CPOUT and EN follow the falling VIN voltage until EN reaches the turn-off threshold and disables CPOUT and VOUT.

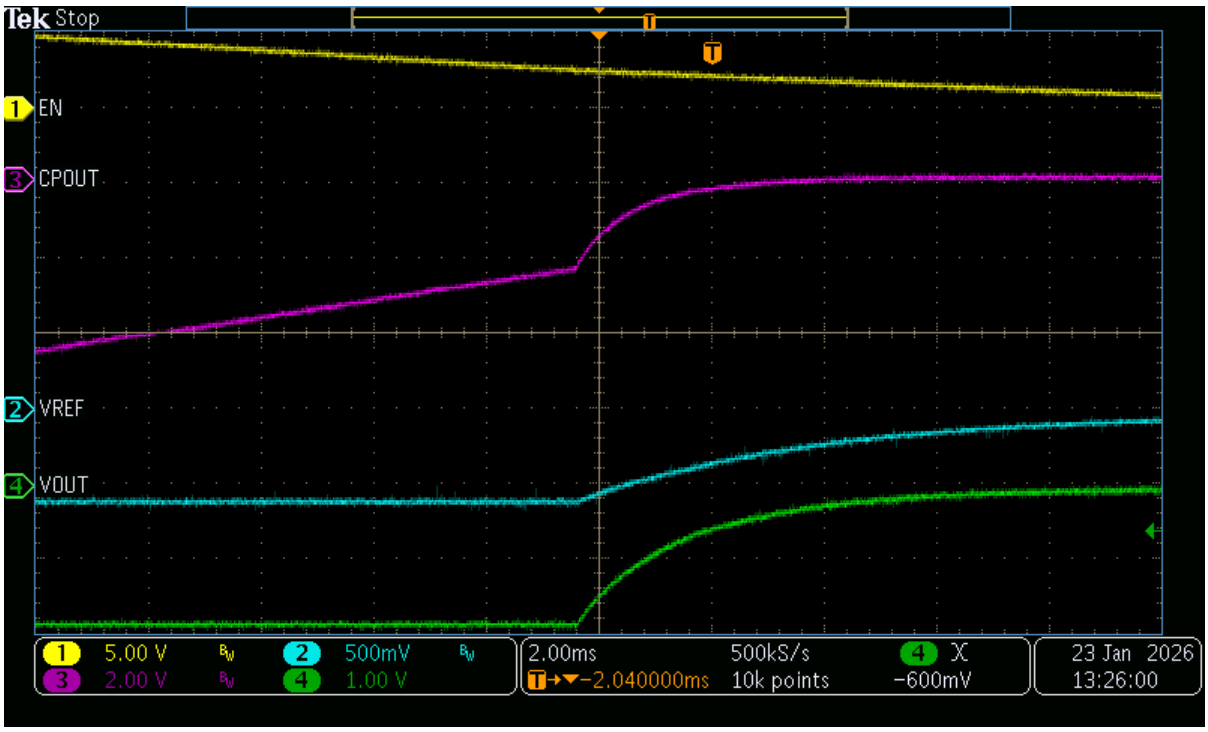


Figure 3-6. EN Tied to Falling VIN via Resistor Divider

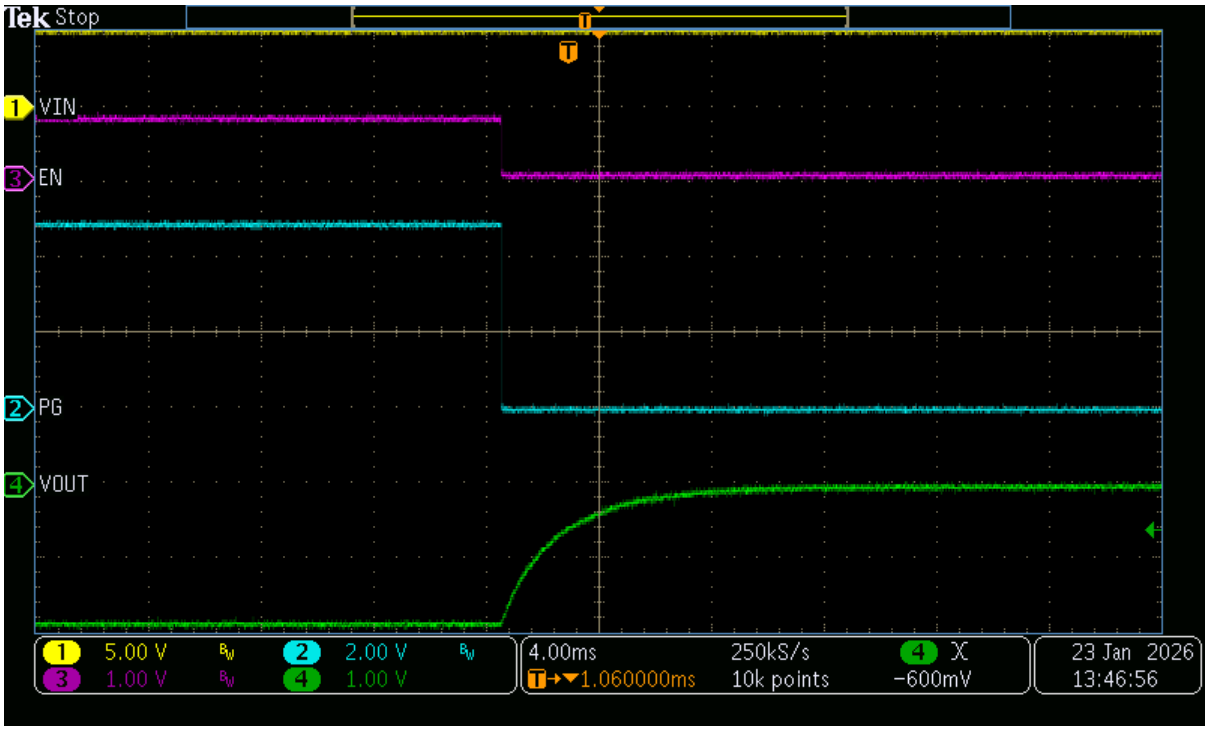


Figure 3-7. Power Good De-assert - EN Independently Driven LOW

Because VIN is falling in this waveform, the PG output can be observed briefly in an undefined state while VIN is below VIN_MIN_PG (0.8V nominal).

Figure 3-8. Power Good De-assert - EN Tied to Falling VIN via Resistor Divider

3.3 Charge Pump Operation

C+ and C- show the charge pump at the foldback switching frequency during the startup charging of CPOUT, before entering the nominal 500kHz switching frequency.

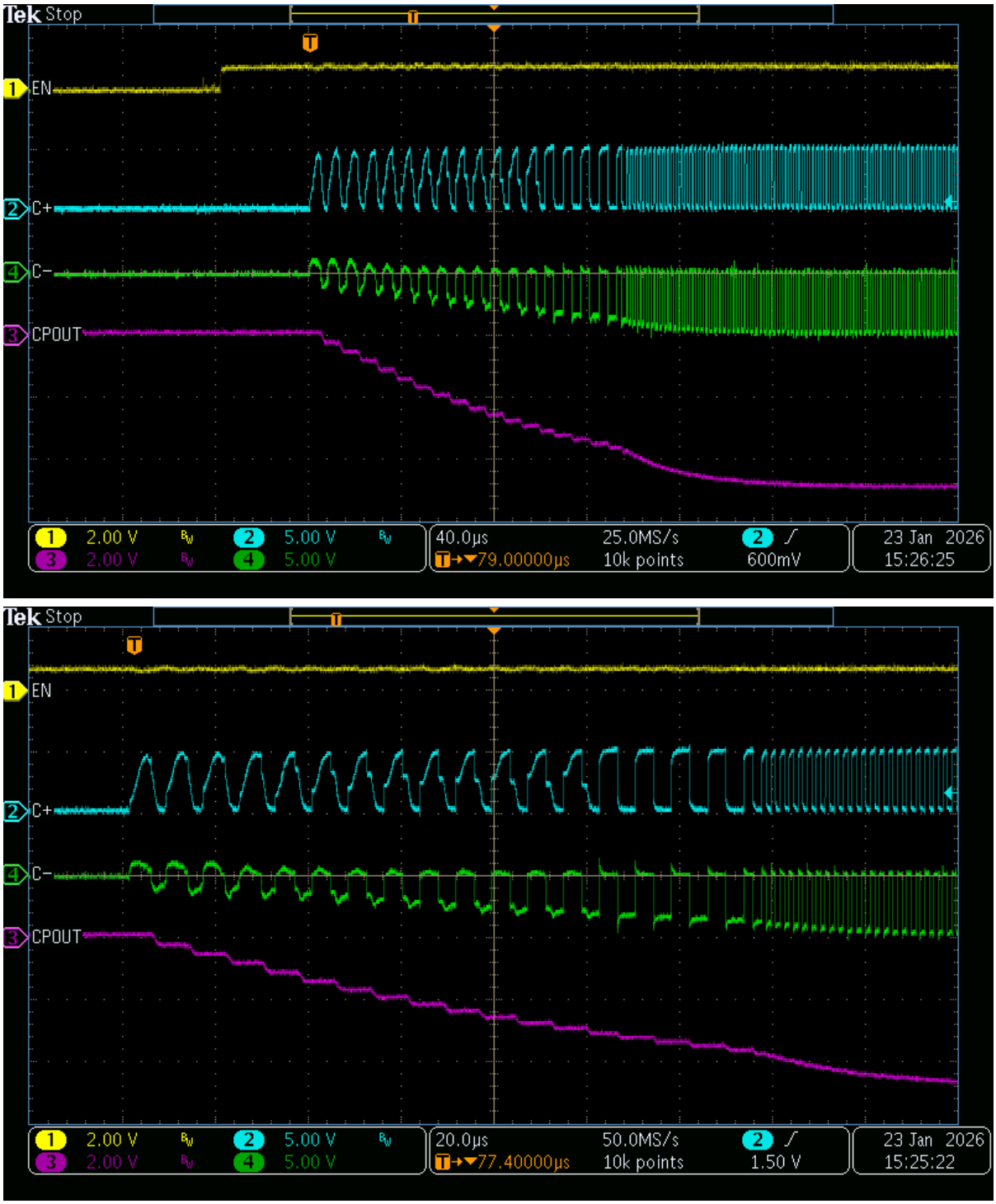


Figure 3-9. Startup

The current demanded by the charge pump produces a ripple on VIN. Bulk capacitor and bypass capacitor selection can aid mitigation of this ripple if needed, such as in cases where VIN is a shared rail.

Figure 3-10. VIN Ripple

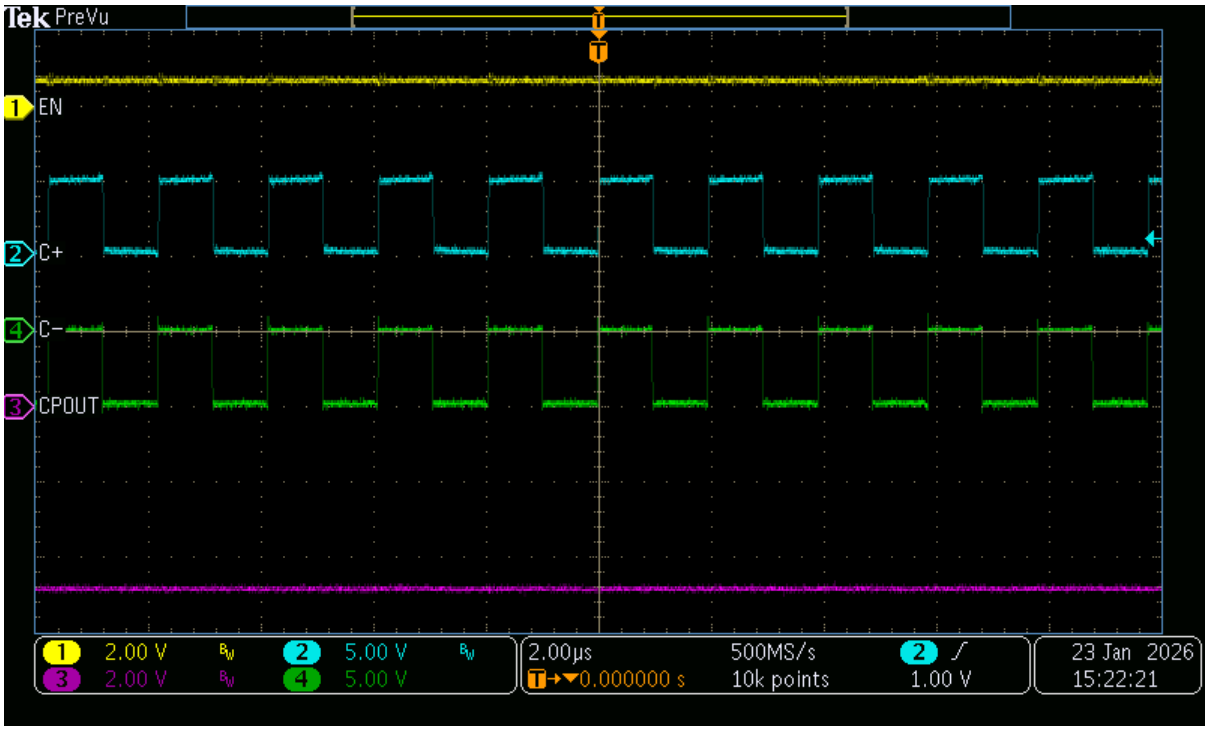


Figure 3-11. Steady-state

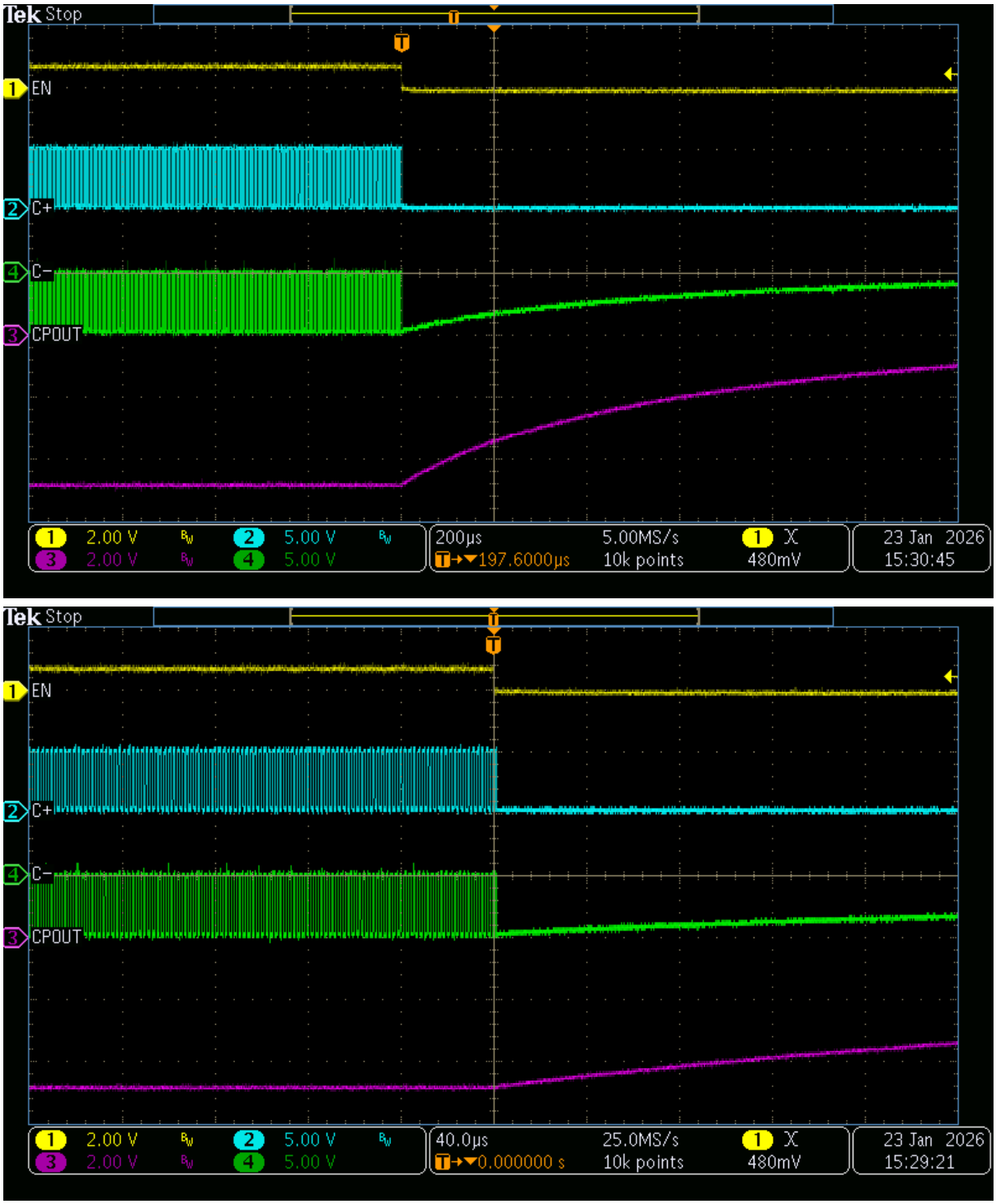


Figure 3-12. Shutdown

3.4 LDO Stability Plots

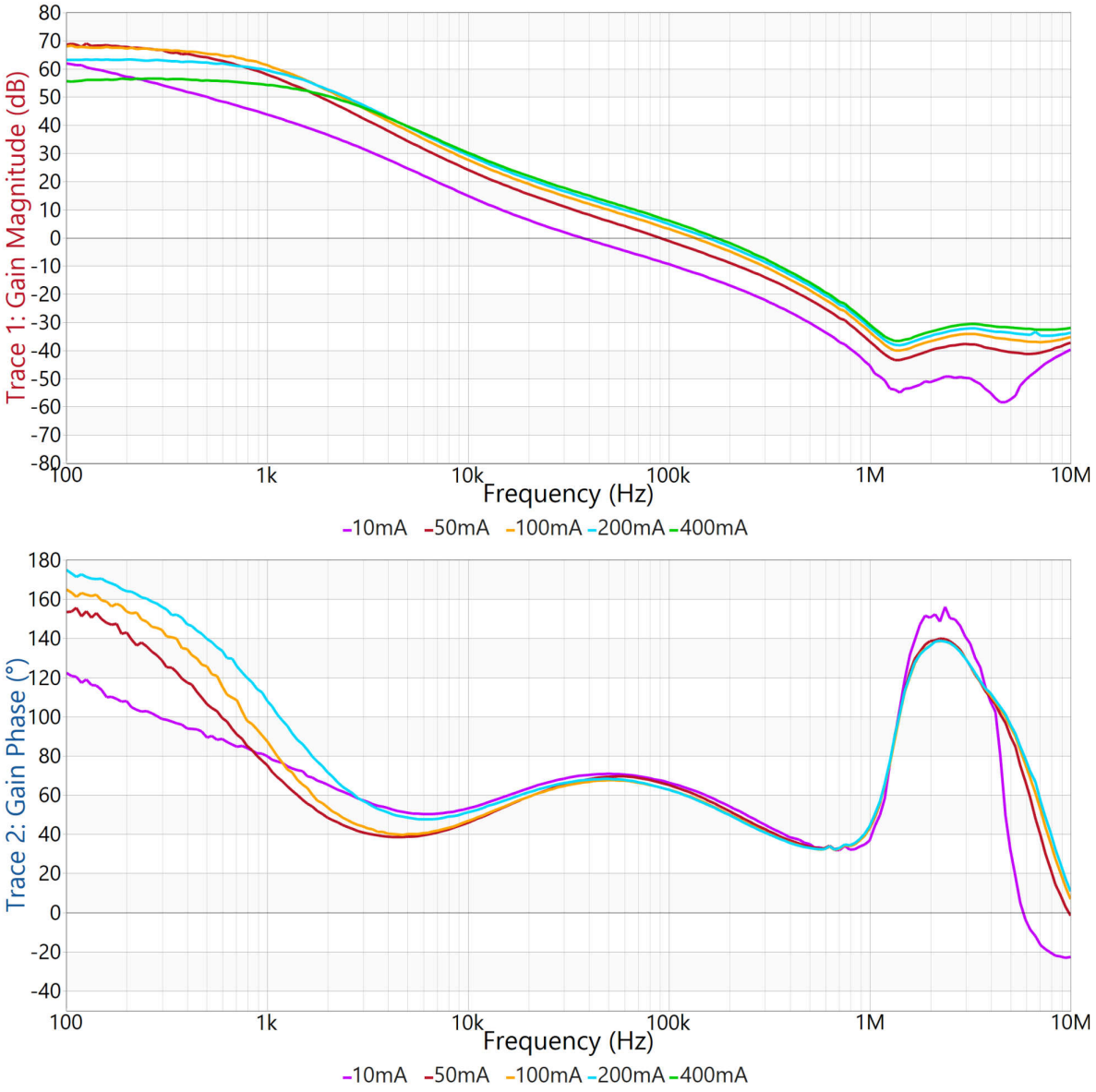


Figure 3-13. Stability Plots Across Load

Load (mA)	Fco (kHz)	PM (deg)	GM (dB)
10mA	36.9	70	51
50mA	90.2	66	38
100mA	133.5	58	>20
200mA	156.2	55	>20
400mA	172.0	53	>20

4 Hardware Design Files

4.1 Schematics

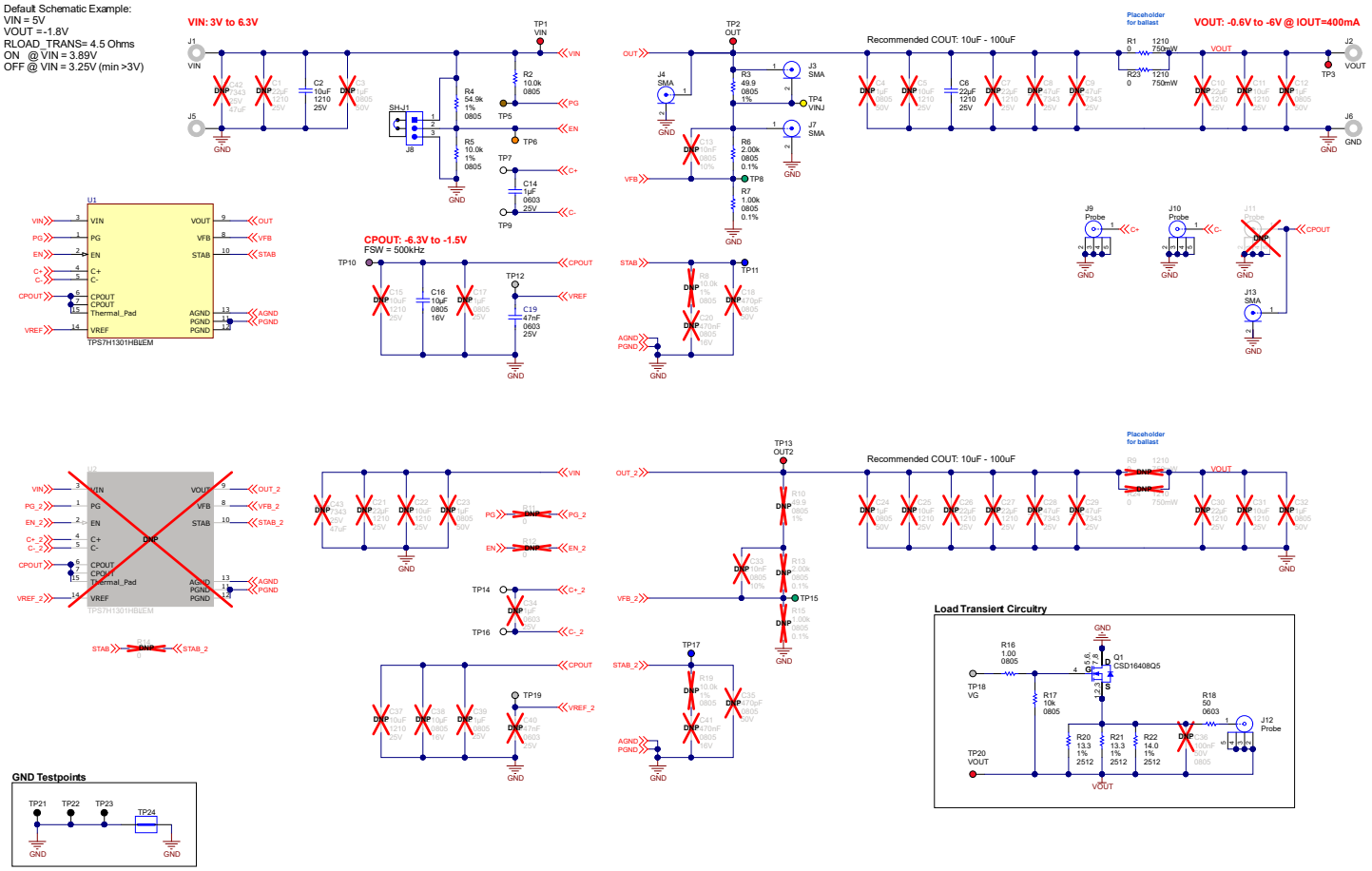


Figure 4-1. Default EVM Schematic

The schematic below shows an example of how the TPS7H1301 can be configured for a parallel-device design.

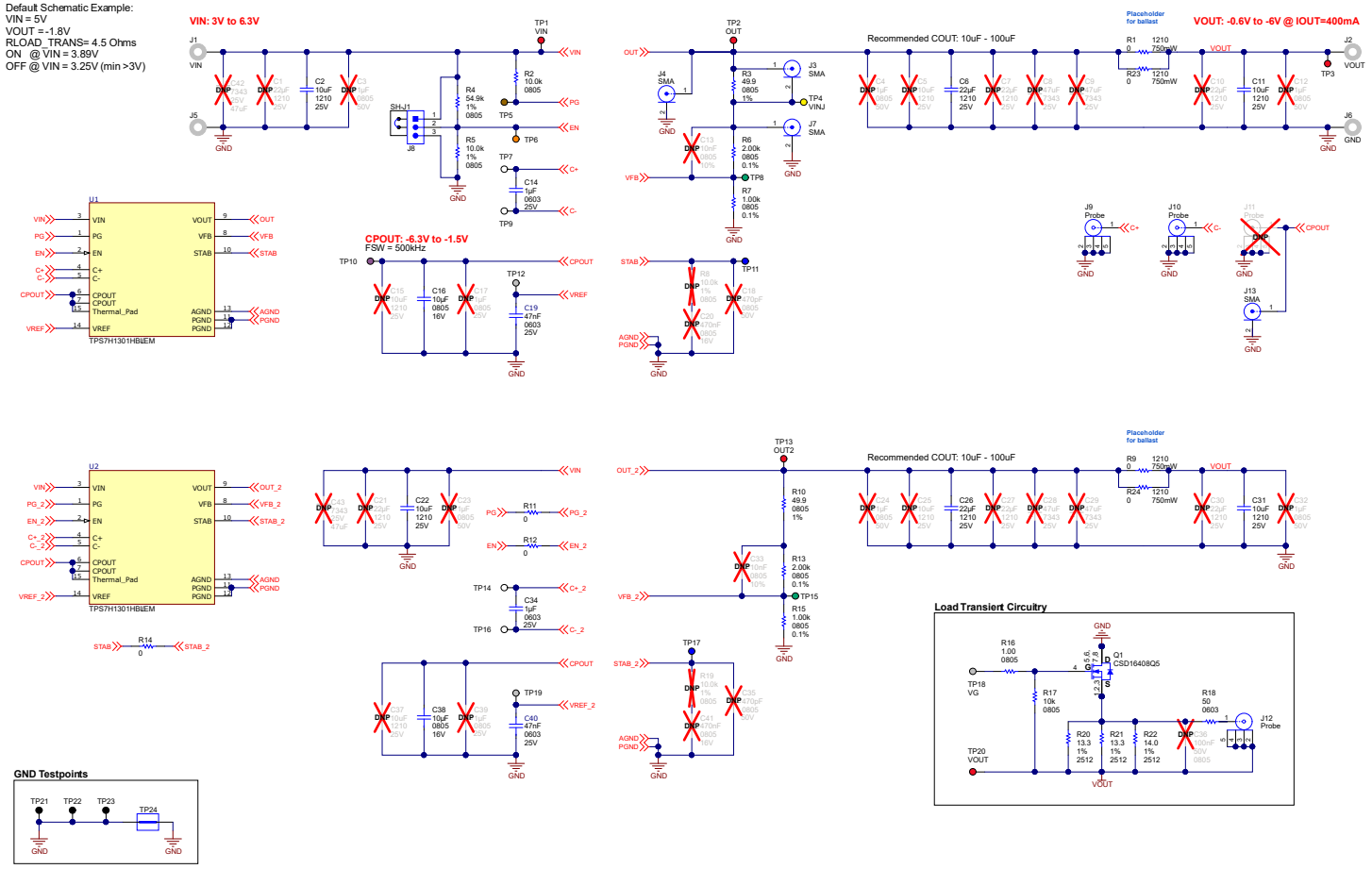


Figure 4-2. Example Schematic: Parallel TPS7H1301-SP

4.2 PCB Layouts

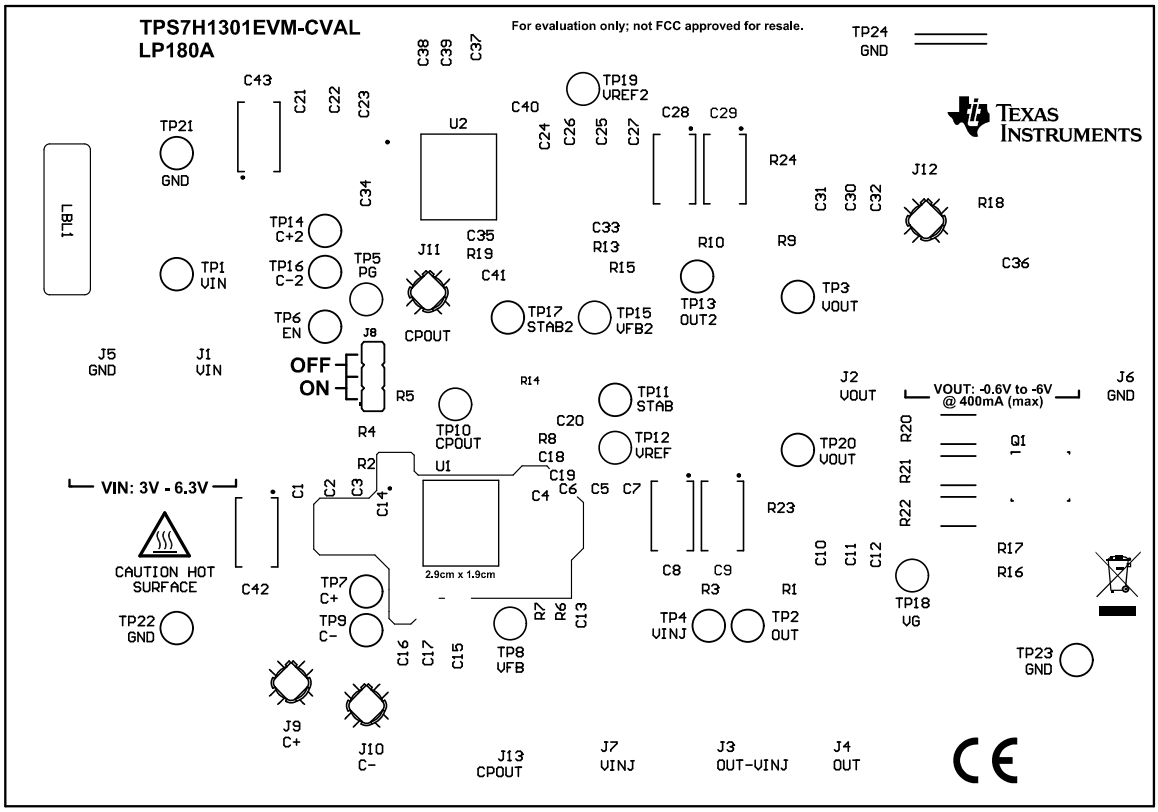


Figure 4-3. Top Silkscreen

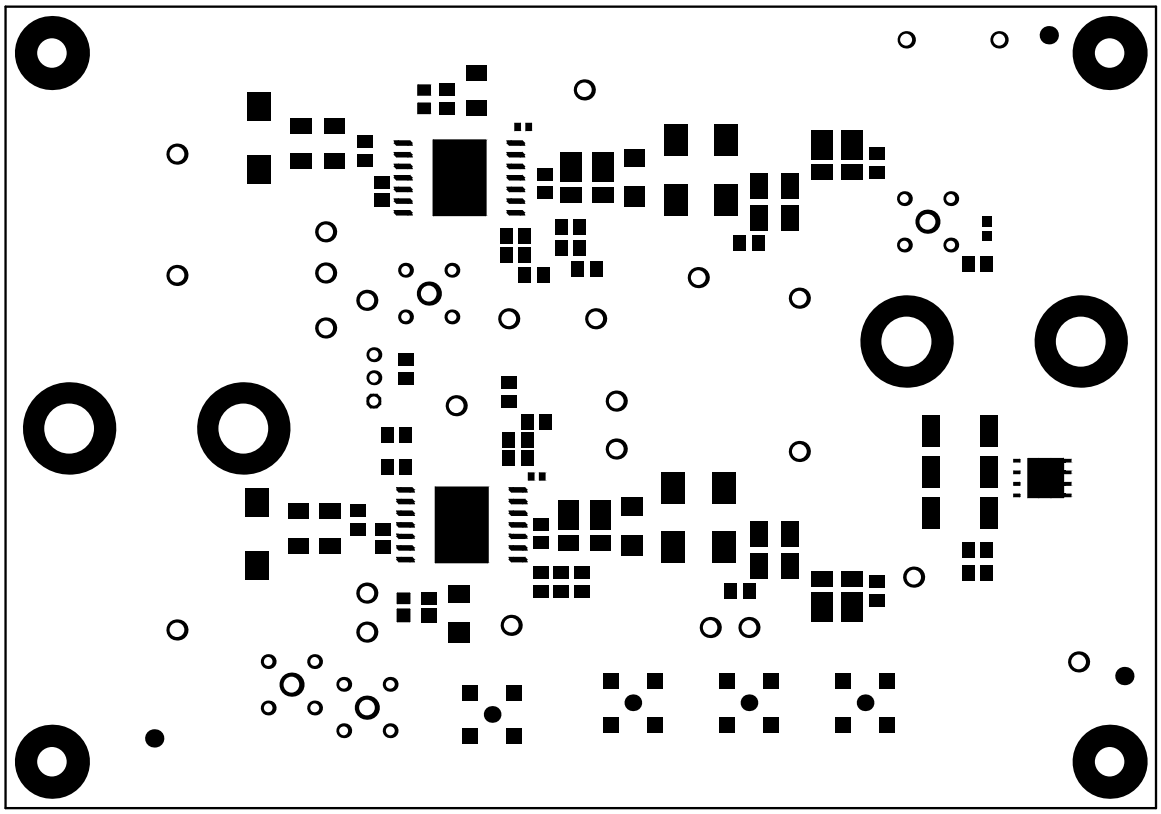


Figure 4-4. Top Solder Mask

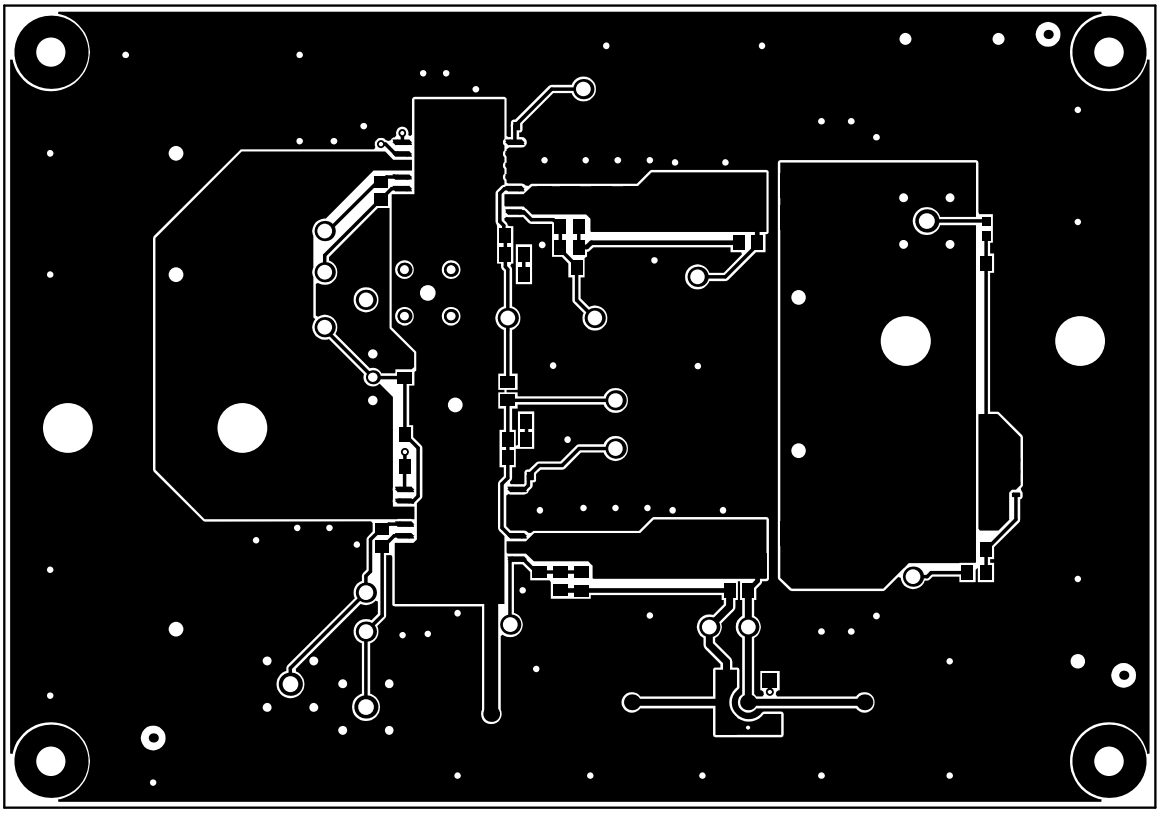


Figure 4-5. Top Layer

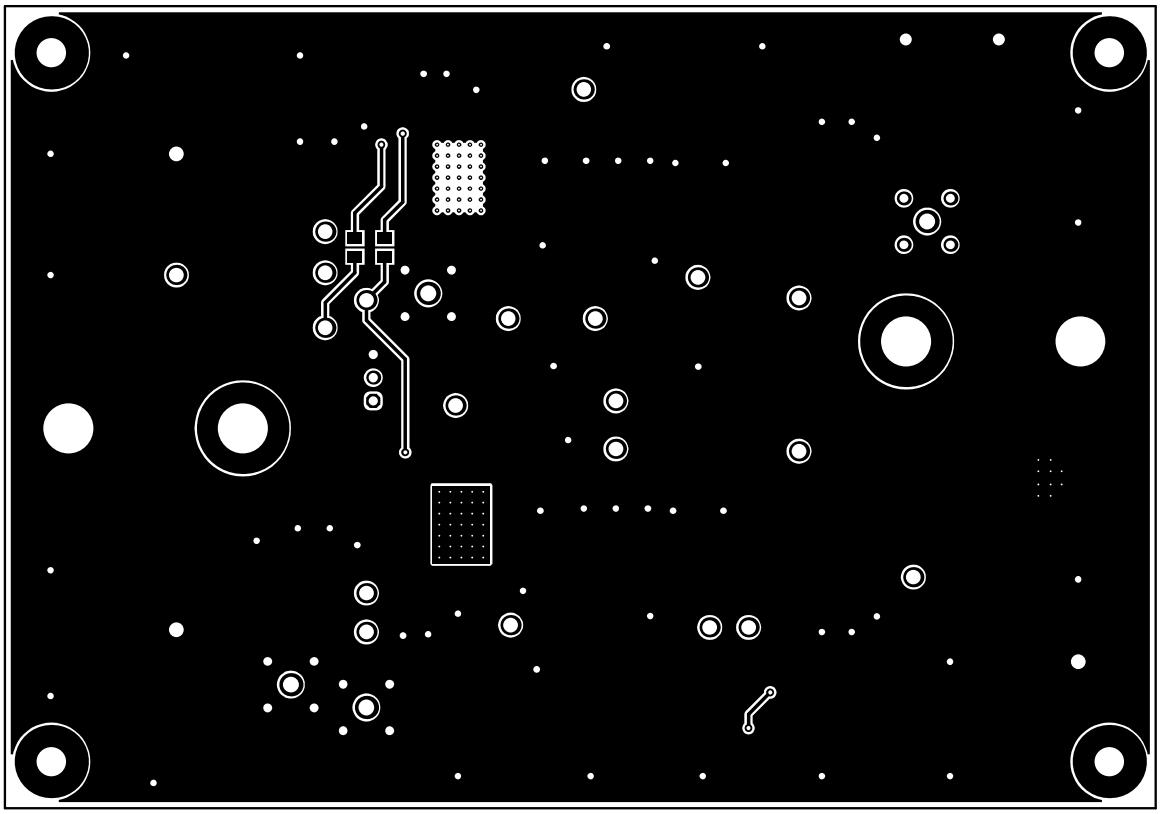


Figure 4-6. Bottom Layer

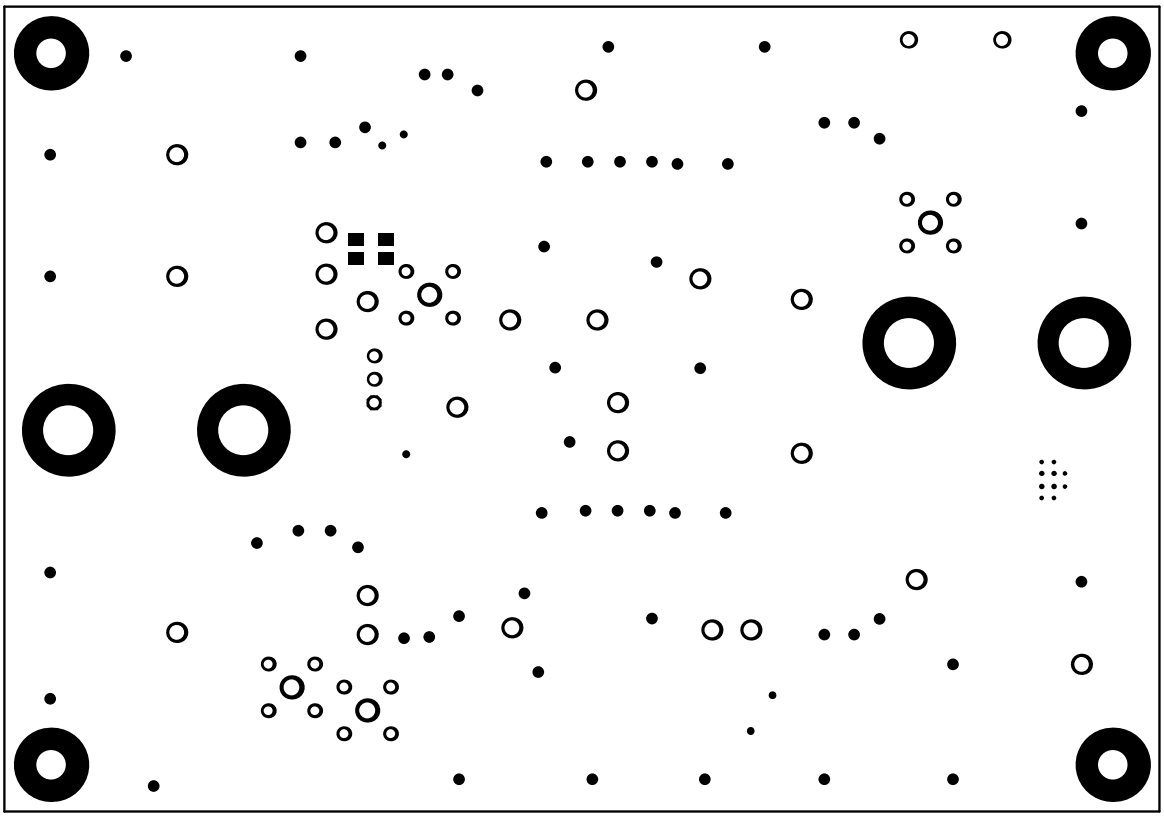


Figure 4-7. Bottom Solder Mask

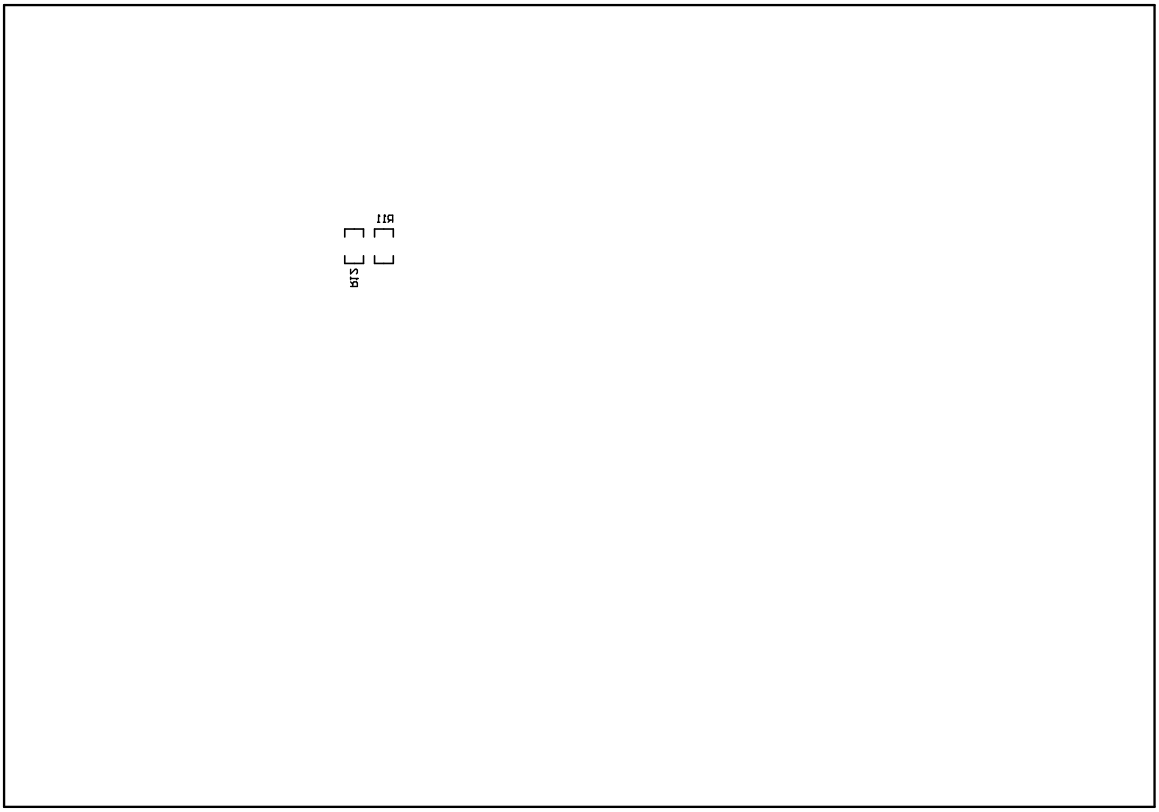
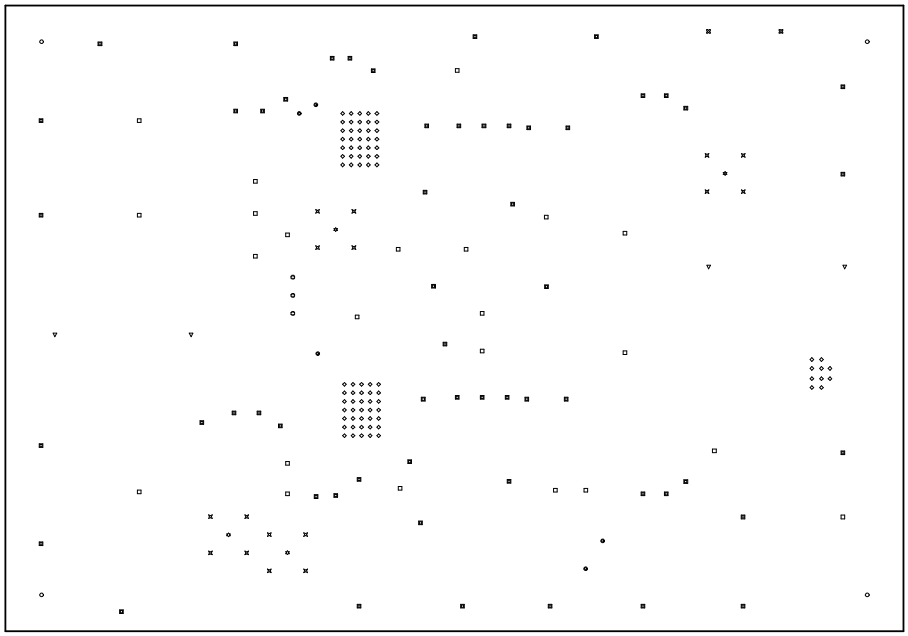


Figure 4-8. Bottom Silkscreen



Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
◇	80	7.87mil (0.200mm)	PTH	Round	Top Layer - Bottom Layer	
◎	5	18.00mil (0.457mm)	PTH	Round	Top Layer - Bottom Layer	
▣	57	28.00mil (0.711mm)	PTH	Round	Top Layer - Bottom Layer	
⊠	16	38.00mil (0.965mm)	PTH	Round	Top Layer - Bottom Layer	
⯐	3	40.16mil (1.020mm)	PTH	Round	Top Layer - Bottom Layer	+/-1.97mil
⊠	2	51.18mil (1.300mm)	PTH	Round	Top Layer - Bottom Layer	
□	23	63.00mil (1.600mm)	PTH	Round	Top Layer - Bottom Layer	
✡	4	68.00mil (1.727mm)	PTH	Round	Top Layer - Bottom Layer	
○	4	125.98mil (3.200mm)	PTH	Round	Top Layer - Bottom Layer	
▽	4	214.57mil (5.450mm)	PTH	Round	Top Layer - Bottom Layer	
	198 Total					

Figure 4-9. Drill Drawing

4.3 Bill of Materials (BOM)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C2	1	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X7R, 1210	1210	12103C106KAT2A	AVX
C6	1	22uF	CAP, CERM, 22 µF, 25 V,+/- 10%, X7R, 1210	1210	C1210C226K3RAC7800	Kemet
C14	1	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C105K3RACTU	Kemet
C16	1	10µF	10 µF ±10% 16V Ceramic Capacitor X7R 0805 (2012 Metric)	0805	0805YC106KAT2A	Kyocera AVX
C19	1	0.047uF	CAP, CERM, 0.047 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C473K3RAC7867	Kemet
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J5, J6	4		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J3, J4, J7, J13	3		Connector, SMA Jack, Vertical, Gold, SMD	SMA	142-0711-201	Cinch Connectivity
J8	1		Header, 2.54mm, 3x1, Tin, TH	Header, 2.54mm, 3x1, Tin, TH	22284030	Molex
J9, J10, J12	4		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
Q1	1	25V	MOSFET, N-CH, 25 V, 113 A, DQH0008A (VSON-CLIP-8)	DQH0008A	CSD16408Q5	Texas Instruments
R1, R23	1	0	RES, 0, 1%, 0.75 W, AEC-Q200 Grade 0, 1210	1210	CRCW12100000Z0EAHP	Vishay-Dale
R2, R5	2	10k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R3	1	49.9	RES, 49.9, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080549R9FKEA	Vishay-Dale
R4	1	54.9k	RES, 54.9 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080554K9FKEA	Vishay-Dale
R6	1	2k	RES, 2.00 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD072KL	Yageo America
R7	1	1k	RES, 1.00 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD071KL	Yageo America
R16	1	1	RES, 1.00, 1%, 0.125 W, 0805	0805	RC0805FR-071RL	Yageo America
R17	1	10k	RES, 10 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0JNEA	Vishay-Dale
R18	1	50	RES, 50, 0.1%, 0.125 W, 0603	0603	FC0603E50R0BTBST1	Vishay-Dale
R20, R21	2	13.3	RES, 13.3, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW251213R3FKEG	Vishay-Dale
R22	1	14	RES, 14.0, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW251214R0FKEG	Vishay-Dale
SH-J1	1		CONN JUMPER S2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) Gold SHORTING .100" GOLD	JUMPER	QPC02SXGN-RC	Sullins

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2, TP3, TP13, TP20	5		Test Point, Multipurpose, Red, TH		5010	Keystone Electronics
TP4	1		Test Point, Multipurpose, Yellow, TH		5014	Keystone Electronics
TP5	1		Test Point, Multipurpose, Brown, TH		5125	Keystone Electronics
TP6	1		Test Point, Multipurpose, Orange, TH		5013	Keystone Electronics
TP7, TP9, TP14, TP16	4		Test Point, Multipurpose, White, TH		5012	Keystone Electronics
TP8, TP15	2		Test Point, Multipurpose, Green, TH		5126	Keystone Electronics
TP10	1		Test Point, Multipurpose, Purple, TH		5129	Keystone Electronics
TP11, TP17	2		Test Point, Multipurpose, Blue, TH		5127	Keystone Electronics
TP12, TP18, TP19	3		Test Point, Multipurpose, Grey, TH		5128	Keystone Electronics
TP21, TP22, TP23	3		Test Point, Multipurpose, Black, TH		5011	Keystone Electronics
TP24	1		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
U1	1		TPS7H1301HBL/EM	CFP14	TPS7H1301HBL/EM	Texas Instruments

5 Compliance Information

5.1 Compliance and Certifications

- Texas Instruments, TPS7H1301EVM-CVAL EU RoHS Declaration of Conformity (DoC)

6 Additional Information

6.1 Trademarks

All trademarks are the property of their respective owners.

7 Related Documentation

- Texas Instruments, Standard Terms for Evaluation Modules

STANDARD TERMS FOR EVALUATION MODULES

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 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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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.

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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