

TPS65580 Buck Converter Evaluation Module User's Guide



ABSTRACT

This user's guide contains information for the TPS65580 as well as support documentation for the TPS65580EVM-575 evaluation module. Included are the performance specifications, board layouts, schematic, and the bill of materials of the TPS65580EVM-575.

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Trademarks

D-CAP2™ is a trademark of Texas Instruments.
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1 Introduction

The TPS65580 is a triple output, advanced D-CAP2™-mode, synchronous buck converter requiring a very low external component count. The advanced D-CAP2 control circuit is optimized for low-ESR output capacitors such as POSCAP, SP-CAP, or ceramic types and features fast transient response with no external compensation. The switching frequency is internally set at a nominal 700 kHz. The high-side and low-side switching MOSFETs are incorporated inside the TPS65580 package along with the gate-drive circuitry. The low drain-to-source on resistance of the MOSFETs allows the TPS65580 to achieve high efficiencies and helps keep the junction temperature low at high output currents. The TPS65580 dc/dc synchronous converter is designed to provide up to 1.5-A, 2.5-A and 1.5-A output for each of 3 channels from an input voltage source of 4.5 V to 18 V. The output voltage range is from 0.76 V to 6.5 V. Rated input voltage, output voltage and output current ranges for the evaluation module are given in [Table 1-1](#). This user's guide describes the TPS65580EVM-575 performance.

Table 1-1. Input Voltage, Output Voltage and Output Current Summary

EVM	Input Voltage Range	Channel	Output Voltage	Output Current Range
TPS65580EVM-575	$V_{IN} = 4.5 \text{ V to } 18 \text{ V}$	CH1	3.3 V	0-A to 1.5-A
		CH2	1.2 V	0-A to 2.5-A
		CH3	1.5 V	0-A to 1.5-A

2 Performance Specification Summary

A summary of the TPS65580EVM-575 performance specifications is provided in [Table 2-1](#). Specifications are given for an input voltage of $V_{IN} = 12\text{ V}$ and $T_a = 25^\circ\text{C}$ unless otherwise noted.

Table 2-1. TPS65580EVM-575 Performance Specifications Summary

Specifications		Test Conditions	Min	Typ	Max	Unit
Input voltage range (V_{IN})			4.5	12	18	V
Operating frequency				700		kHz
CH1	Output voltage			3.3		V
	Output current range		0		1.5	A
	Over current limit	$V_{IN} = 12\text{ V}, L_O = 3.3\ \mu\text{H}$		2.0		A
	Output ripple voltage	$V_{IN} = 12\text{ V}, I_O = 1.5\text{ A}$		10		mV _{PP}
CH1	Output voltage			1.2		V
	Output current range		0		2.5	A
	Over current limit	$V_{IN} = 12\text{ V}, L_O = 2.2\ \mu\text{H}$		3.5		A
	Output ripple voltage	$V_{IN} = 12\text{ V}, I_O = 2.5\text{ A}$		10		mV _{PP}
CH1	Output voltage			1.5		V
	Output current range		0		1.5	A
	Over current limit	$V_{IN} = 12\text{ V}, L_O = 2.2\ \mu\text{H}$		2.0		A
	Output ripple voltage	$V_{IN} = 12\text{ V}, I_O = 1.5\text{ A}$		10		mV _{PP}

3 Modifications

These evaluation modules are designed to provide access to the features of the TPS65580. Some modifications can be made to this module.

3.1 Output Voltage Setpoint

To change the output voltage of the EVMs, it is necessary to change the value of the top resistor in the voltage set point divider network (R9, R13, and R17). Changing the value of R_{TOP} can change the output voltage above 0.765 V. The value of R_{TOP} for a specific output voltage can be calculated using [Equation 1](#).

$$R_{TOP} = R_{BOT} \times \left(\frac{V_{OUT}}{0.764\text{V}} - 1 \right) \quad (1)$$

[Table 3-1](#) lists the R_{TOP} values for some common output voltages. A feed-forward capacitor (C_{FF}) may be optionally used to improve phase margin. Pads for this component (C12, C18, and C24) are provided on the printed-circuit board. Note that the values given in [Table 3-1](#) are standard values and not the exact value calculated using [Equation 1](#).

Table 3-1. Output Voltages

Output Voltage (V)	R_{TOP} (k Ω)	R_{BOT} (k Ω)	C_{FF} (pF)	L_{OUT} (μH)			C_{OUT} (μF)
				Min	Typ	Max	
1.0	.681	2.21	220 - 680	1.5	2.2	3.3	22 - 68
1.05	.825	2.21	100 - 680	1.5	2.2	3.3	22 - 68
1.2	1.27	2.21	68 - 680	1.5	2.2	3.3	22 - 68
1.5	2.10	2.21	68 - 330	1.5	2.2	3.3	22 - 68
1.8	3.01	2.21	5 - 68	1.5	2.2	3.3	22 - 68
2.5	4.99	2.21	5 - 22	2.2	3.3	4.7	22 - 68
3.3	7.32	2.21	5 - 22	2.2	3.3	4.7	22 - 68
5.0	12.4	2.21	5 - 22	2.2	3.3	4.7	22 - 68
6.5	16.5	2.21	5 - 22	2.2	3.3	4.7	22 - 68

4 Test Setup and Results

This section describes how to properly connect, set up, and use the TPS65580EVM-575. The section also includes test results typical for the evaluation modules and efficiency, output load regulation, output line regulation, load transient response, output voltage ripple, input voltage ripple, start-up, and switching frequency.

4.1 Input/Output Connections

The TPS65580EVM-575 is provided with input/output connectors and test points as shown in [Table 4-1](#). A power supply capable of supplying 5 A must be connected to J1 through a pair of 20-AWG wires. The loads must be connected to J2, J3 and J4 through pairs of 20-AWG wires. The maximum load current capability is for each channel is shown in [Table 1-1](#). Wire lengths must be minimized to reduce losses in the wires. Test point TP1 provides a place to monitor the V_{IN} input voltages with TP2 providing a convenient ground reference. Test points TP11, TP15 and TP19 are used to monitor the output voltage for each of the three channels. Test points TP12, TP18 and TP20 are used as the ground reference for each of the three channels.

Table 4-1. Connections and Test Points

Reference Designator	Function
J1	V_{IN} (see Table 1-1 for V_{IN} range)
J2	CH1 V_{OUT} , 3.3 V at 1.5-A maximum
J3	CH2 V_{OUT} , 1.2 V at 2.5-A maximum
J4	CH3 V_{OUT} , 1.5 V at 1.5-A maximum
JP1	CH1 EN control. Jumper JP1-2 to JP1-3 to disable, jumper JP1-2 to JP1-1 to enable.
JP2	CH2 EN control. Jumper JP2-2 to JP2-3 to disable, jumper JP2-2 to JP2-1 to enable.
JP3	CH3 EN control. Jumper JP3-2 to JP3-3 to disable, jumper JP3-2 to JP3-1 to enable.
TP1	V_{IN} test point at V_{IN} connector
TP2	GND test point at V_{IN}
TP3	CH1 EN test point
TP4	CH2 EN test point
TP5	CH3 EN test point
TP6	Power good test point
TP7	Power ground test point
TP8	Analog ground test point
TP9	CH1 switch node test point
TP10	CH1 loop response test point
TP11	CH1 output voltage test point
TP12	CH1 ground test point at output connector
TP13	CH2 switch node test point
TP14	CH2 loop response test point
TP15	CH2 output voltage test point
TP16	CH2 ground test point at output connector
TP17	CH3 switch node test point
TP18	CH3 loop response test point
TP19	CH3 output voltage test point
TP20	CH3 ground test point at output connector

4.2 Start-Up Procedure

1. Ensure that the jumpers at JP1 (CH1 Enable control), JP2 (CH2 Enable control) and JP3 (CH3 Enable control) is set from ON to OFF
2. Apply appropriate V_{IN} voltage to V_{IN} and GND terminals at J1
3. Set the jumpers at JP1 (CH1 Enable control), JP2 (CH2 Enable control) and JP3 (CH3 Enable control) to ON. The EVM enables the output voltages for each of the three channels.

4.3 Efficiency

Figure 4-1 shows the efficiency for the TPS65580EVM-575 CH1.

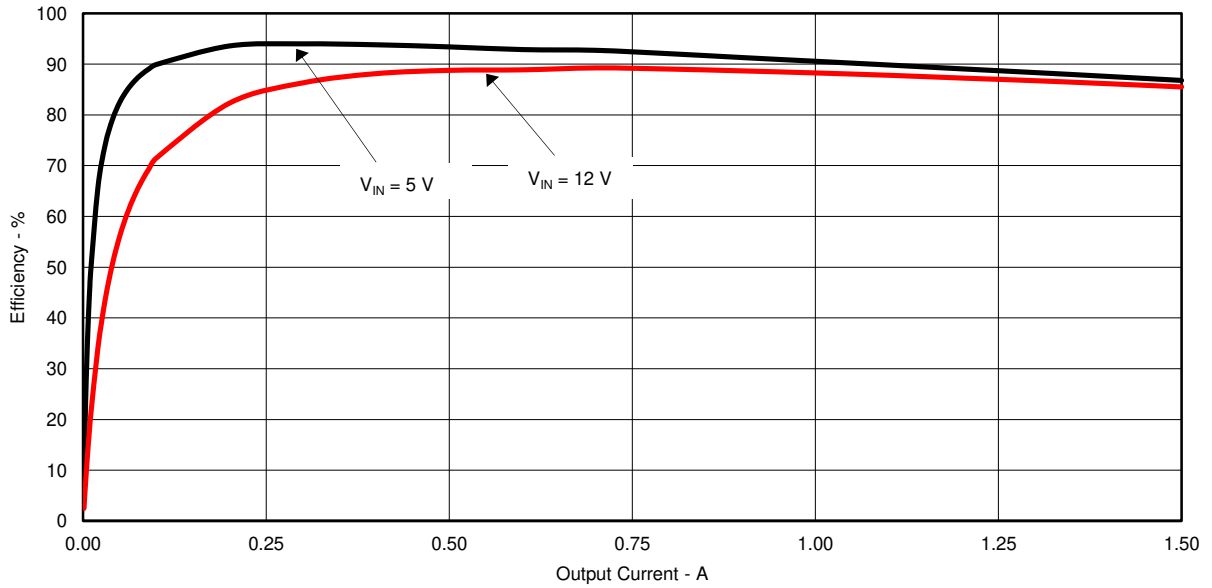


Figure 4-1. TPS65580EVM-575 CH1 Efficiency

Figure 4-2 shows the efficiency at light loads for the TPS65580EVM-575 CH1.

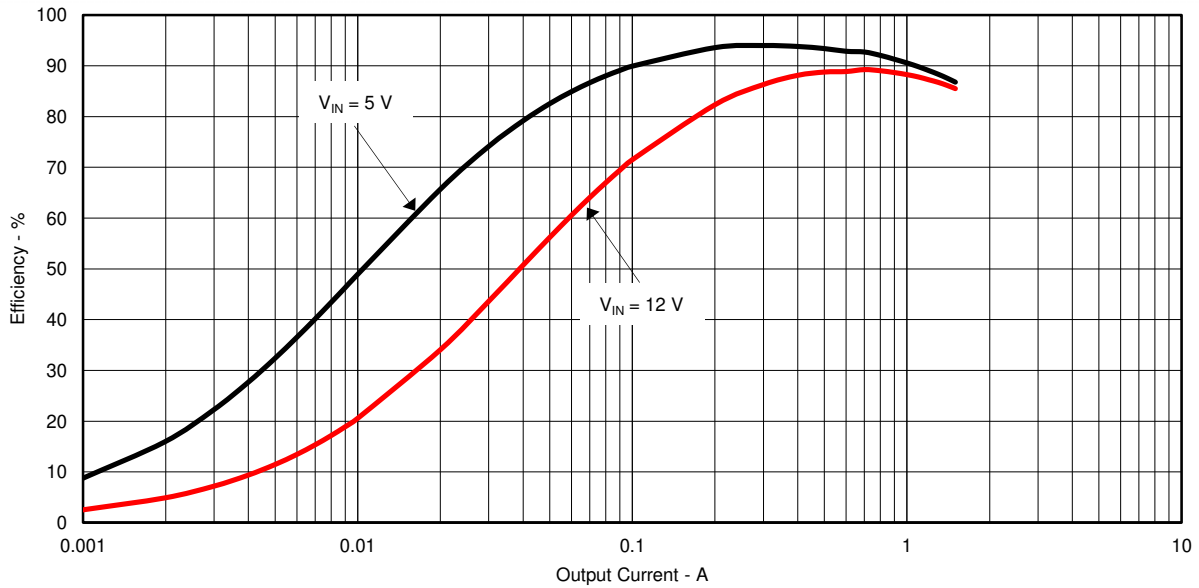


Figure 4-2. TPS65580EVM-575 Light CH1 Load Efficiency

Figure 4-3 shows the efficiency for the TPS65580EVM-575 CH2.

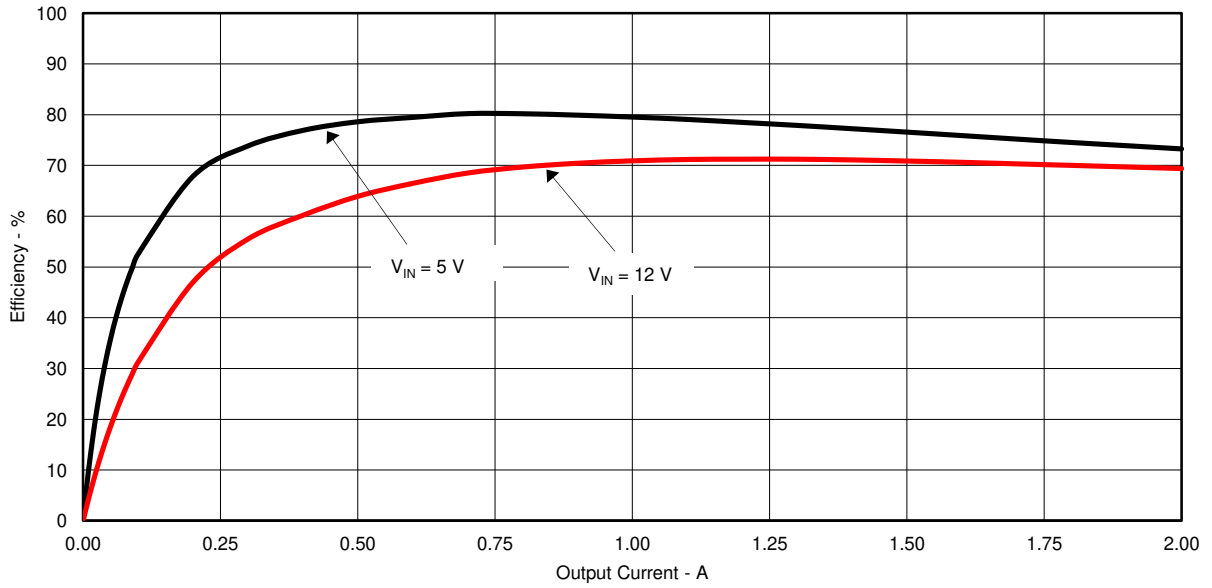


Figure 4-3. TPS65580EVM-575 CH2 Efficiency

Figure 4-4 shows the efficiency at light loads for the TPS65580EVM-575 CH2.

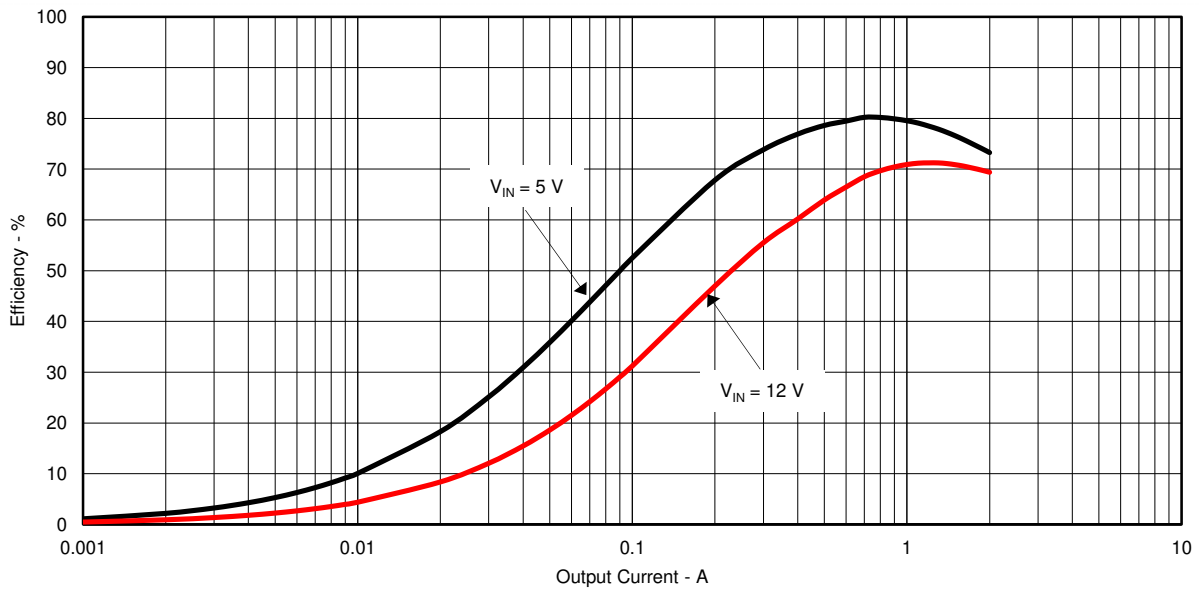


Figure 4-4. TPS65580EVM-575 Light CH2 Load Efficiency

Figure 4-5 shows the efficiency for the TPS65580EVM-575 CH3.

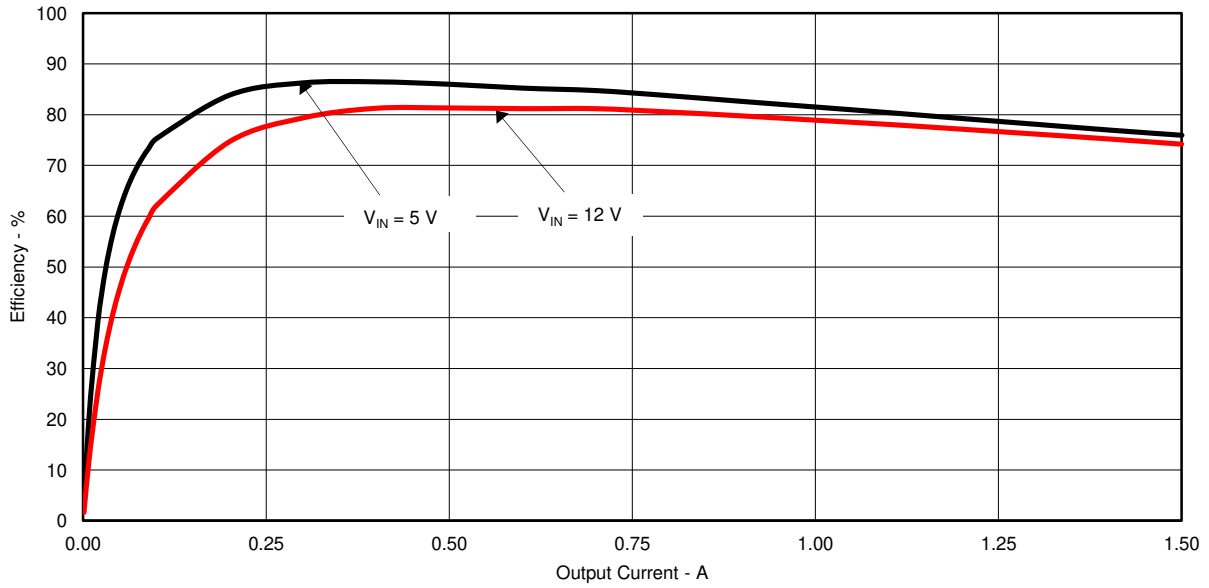


Figure 4-5. TPS65580EVM-575 CH3 Efficiency

Figure 4-6 shows the efficiency at light loads for the TPS65580EVM-575 CH3.

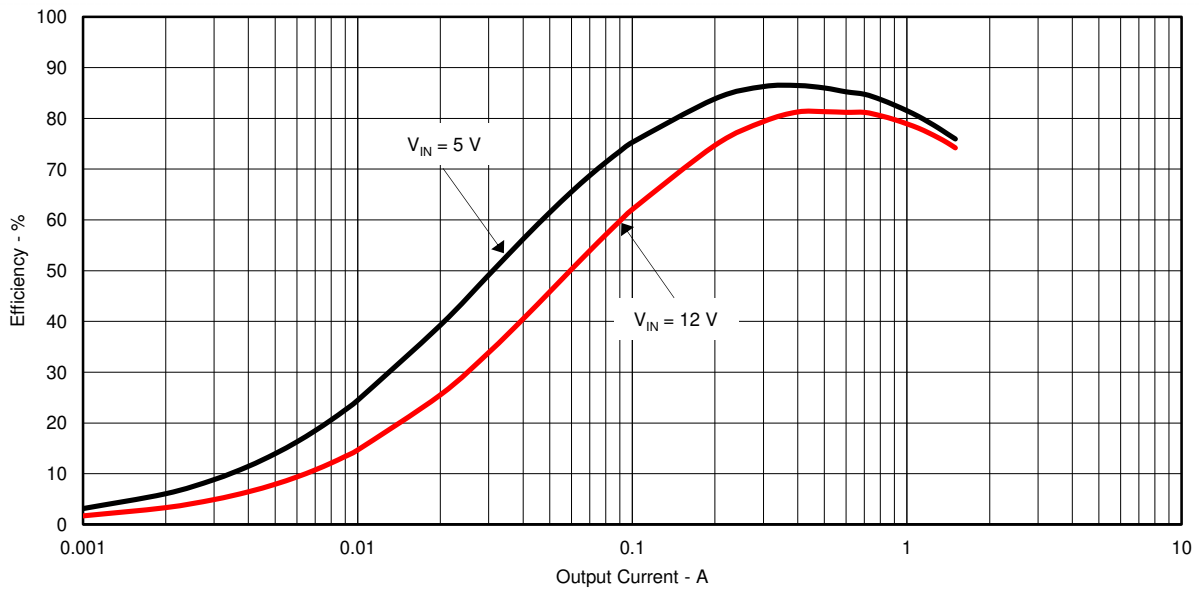


Figure 4-6. TPS65580EVM-575 Light CH3 Load Efficiency

4.4 Load Regulation

The load regulation for the TPS65580EVM-575 CH1 is shown in Figure 4-7. The load regulation for CH2 and CH3 is similar and is not shown.

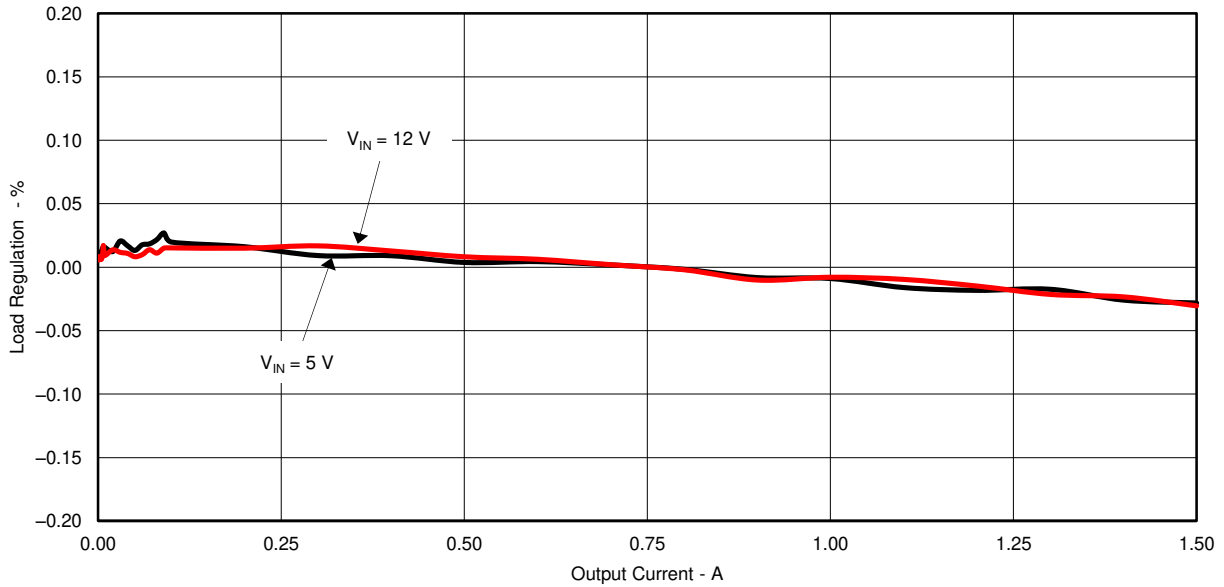


Figure 4-7. TPS65580EVM-575 CH1 Load Regulation

4.5 Line Regulation

The line regulation for the TPS65580EVM-575 CH1, CH2, and CH3 is shown in Figure 4-8. Note that the CH1 output voltage is 3.3 V and the line regulation is lessened as V_{IN} approaches V_{OUT} .

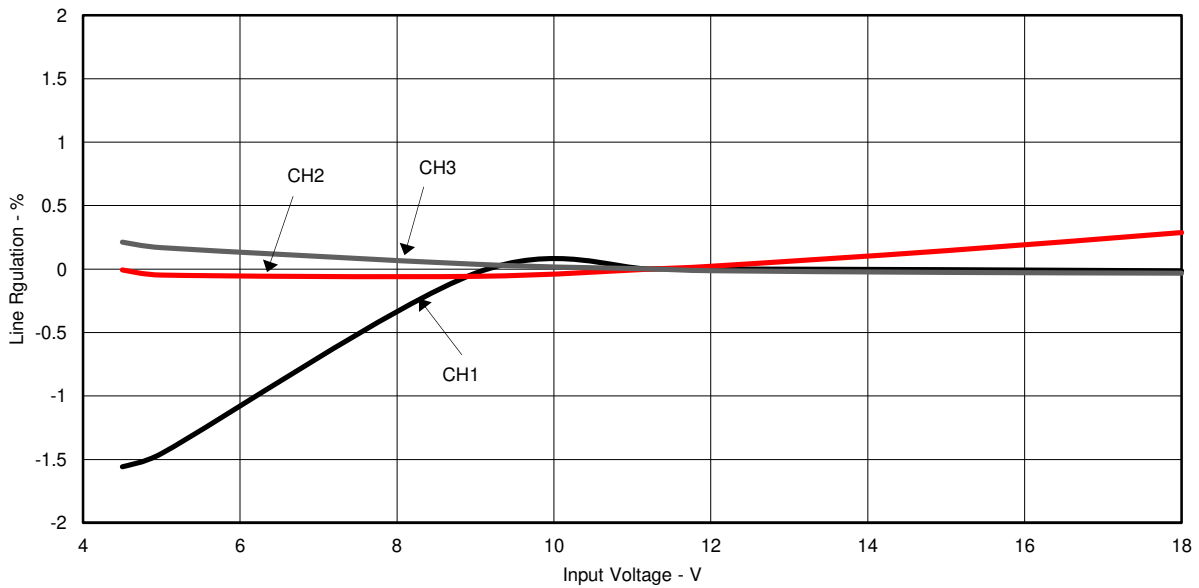


Figure 4-8. TPS65580EVM-575 Line Regulation

4.6 Load Transient Response

The TPS65580EVM-575 CH1 response to load transients is shown in Figure 4-9. The current steps and slew rates are indicated in the figures. Total peak-to-peak voltage variation is as shown. The transient response for CH2 and CH3 is similar and is not shown.

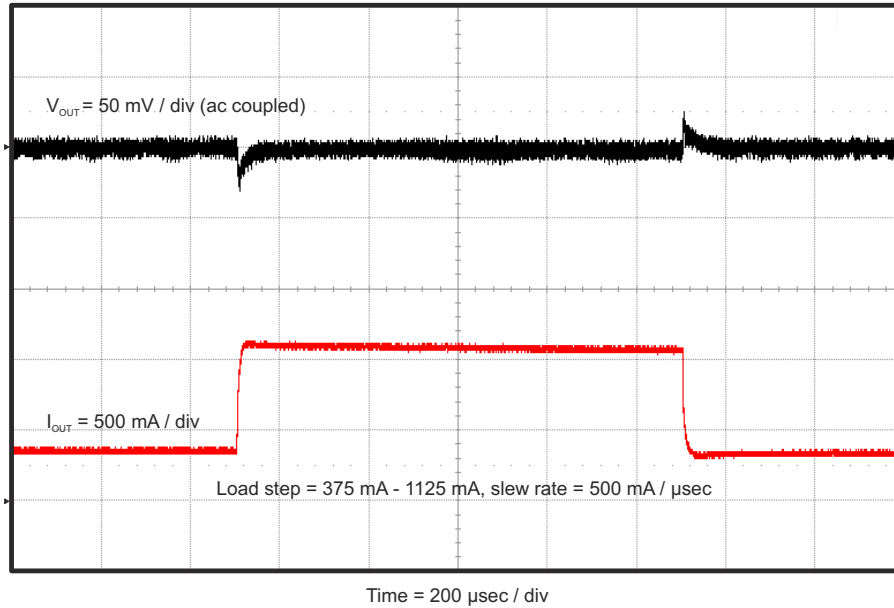


Figure 4-9. TPS65580EVM-575 CH1 Load Transient Response, 25% to 75% Load Step

4.7 Input Voltage Ripple

The TPS65580EVM-575 input voltage ripple is shown in Figure 4-10. The output current for each channel is the full rated load of 1.5-A, 2.5-A and 1.5-A. Note that the switching waveforms for each channel are out of phase to reduce input ripple.

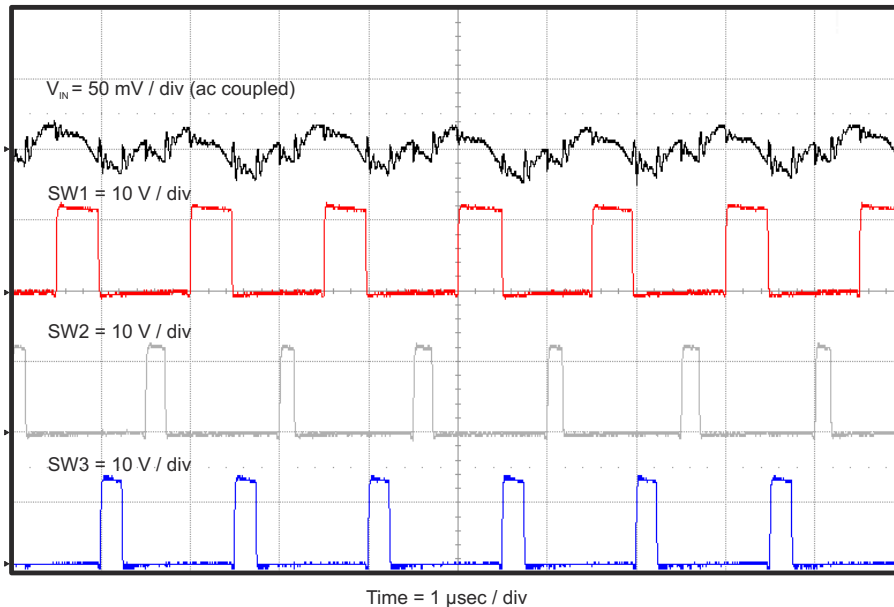


Figure 4-10. TPS65580EVM-575 Input Voltage Ripple

4.8 Start-Up

The TPS65580EVM-575 start-up waveform for CH1 relative to V_{IN} is shown in Figure 4-11. Load = 4 Ω resistive. The start up waveforms for CH2 and CH3 are similar and not shown.

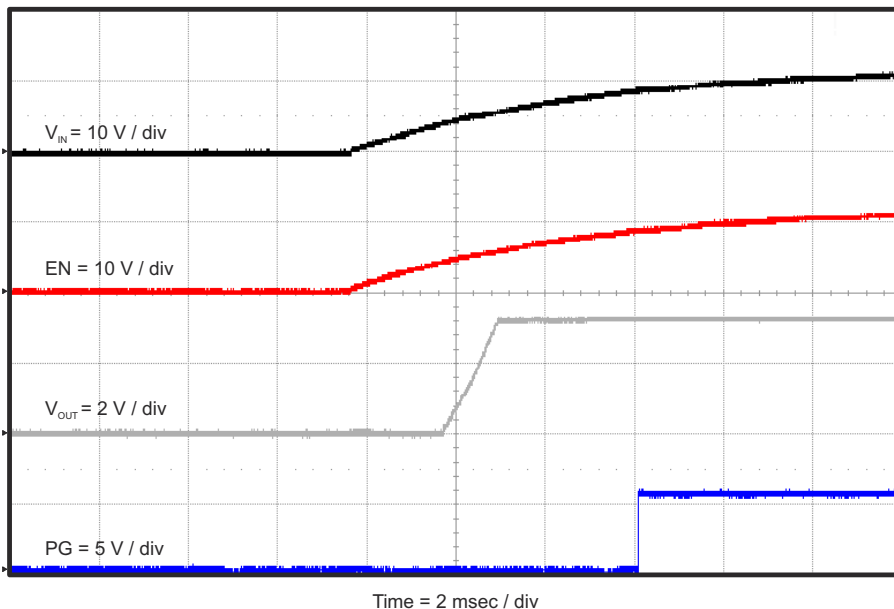


Figure 4-11. TPS65580EVM-575 CH1 Start-Up Relative to V_{IN}

The TPS65580EVM-575 start-up waveform for CH1 relative to enable (EN) is shown in Figure 4-12. Load = 4 Ω resistive. The start up waveforms for CH2 and CH3 are similar and not shown.

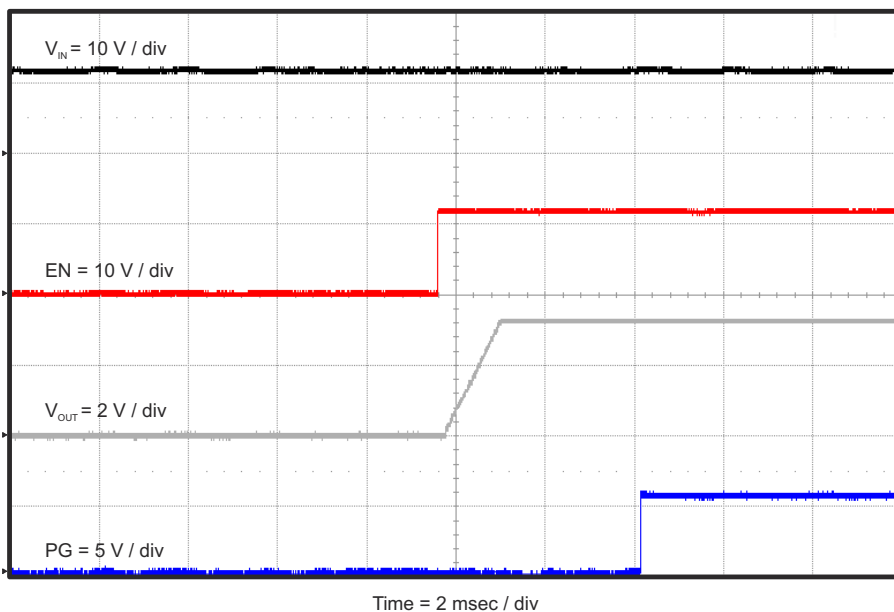


Figure 4-12. TPS65580EVM-575 CH1 Start-Up Relative to EN

5 Board Layout

This section provides a description of the TPS65580EVM-575, board layout, and layer illustrations.

5.1 Layout

The board layout for the TPS65580EVM-575 is shown in [Figure 5-1](#) through [Figure 5-5](#).

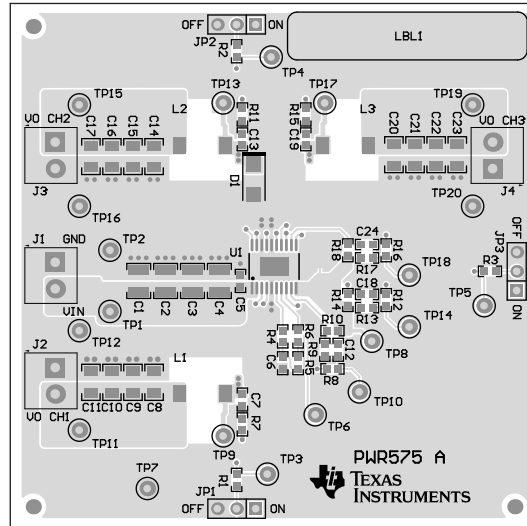


Figure 5-1. Top Assembly

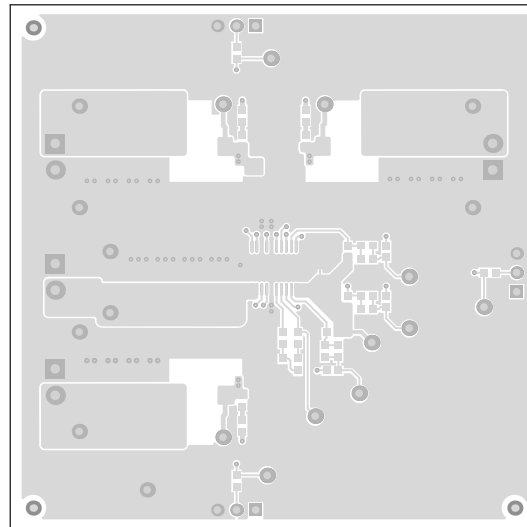


Figure 5-2. Top Layer

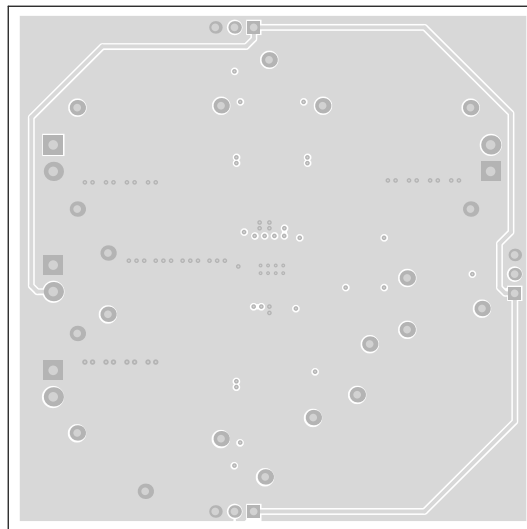


Figure 5-3. Internal Layer 1

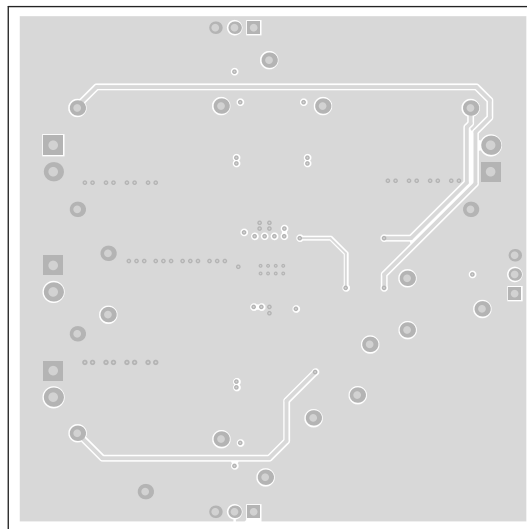


Figure 5-4. Internal Layer 2

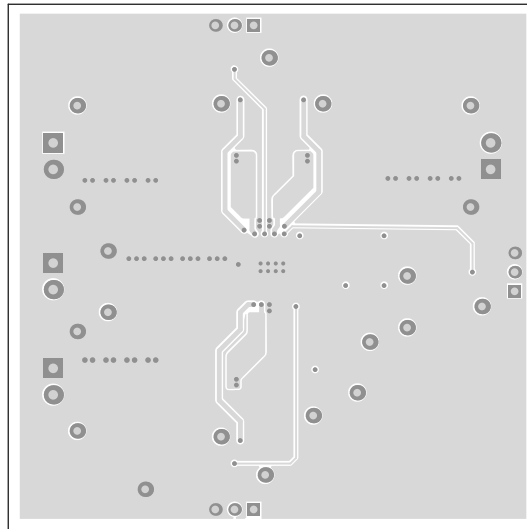


Figure 5-5. Bottom Layer

6 Schematic, Bill of Materials, and Reference

6.1 Schematic

Figure 6-1 is the schematic for the TPS65580EVM-575.

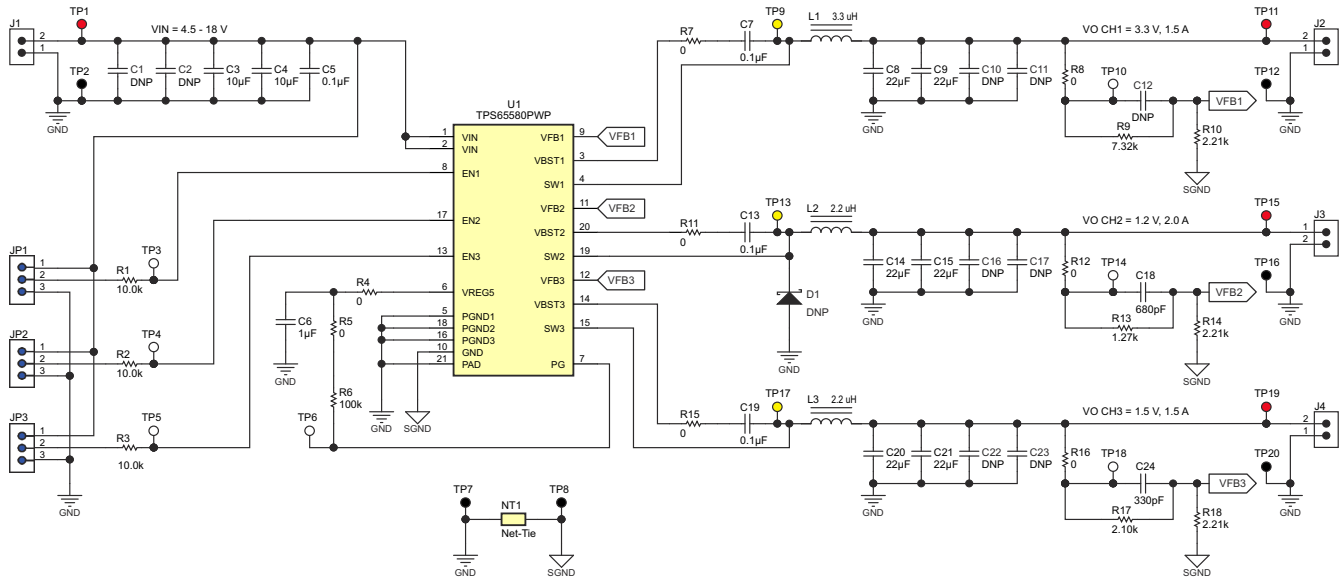


Figure 6-1. TPS65580EVM-575 Schematic Diagram

6.2 Bill of Materials

Table 6-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
PCB1	1		Printed Circuit Board		PWR575	Any
C3, C4	2	10 μ F	CAP, CERM, 10uF, 25V, +/-10%, X5R, 1210	1210	GRM32DR61E106KA12L	MuRata
C5, C7, C13, C19	4	0.1 μ F	CAP, CERM, 0.1uF, 25V, +/-10%, X5R, 0603	0603	GRM188R61E104KA01D	MuRata
C6	1	1 μ F	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0603	0603	GRM185R61A105KE36D	MuRata
C8, C9, C14, C15, C20, C21	6	22 μ F	CAP, CERM, 22uF, 10V, +/-10%, X5R, 1206	1206	GRM31CR61A226KE19L	MuRata
C18	1	680 pF	CAP, CERM, 680pF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H681KA01D	MuRata
C24	1	330 pF	CAP, CERM, 330pF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H331KA01D	MuRata
J1, J2, J3, J4	4		Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology, Inc.
JP1, JP2, JP3	3	1x3	Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
L1	1	3.3 μ H	Inductor, Power Line, Magnetic Shielded, \pm 30%	6.9x7.2 mm	CLF7045T-3R3N	TDK
L2, L3	2	2.2 μ H	Inductor, Power Line, Magnetic Shielded, \pm 30%	6.9x7.2 mm	CLF7045T-2R2N	TDK
R1, R2, R3	3	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R4, R5, R7, R8, R11, R12, R15, R16	8	0	RES, 0 ohm, 5%, 0.1W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R6	1	100k	RES, 100k ohm, 1%, 0.1W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R9	1	7.32k	RES, 7.32k ohm, 1%, 0.1W, 0603	0603	CRCW06037K32FKEA	Vishay-Dale
R10, R14, R18	3	2.21k	RES, 2.21k ohm, 1%, 0.1W, 0603	0603	CRCW06032K21FKEA	Vishay-Dale
R13	1	1.27k	RES, 1.27k ohm, 1%, 0.1W, 0603	0603	CRCW06031K27FKEA	Vishay-Dale
R17	1	2.10k	RES, 2.10k ohm, 1%, 0.1W, 0603	0603	CRCW06032K10FKEA	Vishay-Dale
SH-JP1, SH-JP2, SH-JP3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP11, TP15, TP19	4	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP2, TP7, TP8, TP12, TP16, TP20	6	Black	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone
TP3, TP4, TP5, TP6, TP10, TP14, TP18	7	White	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP9, TP13, TP17	3	Yellow	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	5004	Keystone
U1	1		4.5V to 18V Input 1.5A/2A/1.5A Triple Synchronous Step-Down SWIFT Converter, PWP0020B	PWP0020B	TPS65580PWP	Texas Instruments
C1, C2	0	10uF	CAP, CERM, 10uF, 25V, +/-10%, X5R, 1210	1210	GRM32DR61E106KA12L	MuRata
C10, C11, C16, C17, C22, C23	0	22uF	CAP, CERM, 22uF, 10V, +/-10%, X5R, 1206	1206	GRM31CR61A226KE19L	MuRata
C12	0		CAP, CERM,		Used in BOM report	Used in BOM report
D1	0	30V	Diode, Schottky, 30V, 3A, SMA	SMA	B330A-13-F	Diodes Inc.

6.3 Reference

TPS65580: 4.5V to 18V Input 1.5A, 2.5A, 1.5A Triple Synchronous Step-Down Converter data sheet ([SLVSC29](#))

7 Revision History

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

Changes from Revision A (October 2013) to Revision B (May 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	2
• Updated user's guide title.....	2

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 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 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/lstds/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。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

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/lstds/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。http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

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.

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- 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, INDEMNITY 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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