SN6501 Multi-Transformer EVM User's Guide

This user's guide explains how to quickly obtain the push-pull converter performance results with the SN6501 evaluation module (EVM). This EVM provides five push-pull converters for various input-to-output voltage conversions utilizing regulated and non-regulated outputs. All push-pull converters use low-power, center-tapped transformers from Wurth-Electronics/Midcom whose designs have been optimized in form-factor, turns ratio, and saturation product to operate in combination with the SN6501 transformer driver. Table 1 lists the push-pull converter configurations with their associated transformers and Figure 3 shows the EVM schematic.

Table 1. Push-pull Converters Provided on the SN6501 EVM

Converter Configuration	Application VIN : VOUT	LDO	Xfmr No.	Turns Ratio	V-T (Vμs)	Performance Characteristics
1	3.3 V : 3.3 V	No	T1	1.0:1.1	7	Figure 6 and Figure 7
2	5 V : 5 V		T2	1.0:1.1	11	Figure 8 and Figure 9
3	3.3 V : 5 V		T3	1.0:1.7		Figure 10 and Figure 11
4	3.3 V : 5 V	Yes	T4	1.0:2.0		Figure 12 and Figure 13
5a	3.3 V : 3.3 V		T5	1.0:1.3		Figure 14 and Figure 15
5b	5 V : 5 V					Figure 16 andFigure 17

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13 Efficiency Versus Load Current Vin = 3.3 V, Vout = 5 V 8
14 Output Voltage Versus Load Current Vin = 3.3 V, Vout = 3.3 V 8
15 Efficiency Versus Load Current Vin = 3.3 V, Vout = 3.3 V 8
16 Output Voltage Versus Load Current Vin = 5 V, Vout = 5 V 8
17 Efficiency Versus Load Current Vin = 5 V, Vout = 5 V 8

1 Performance Measurements

Figure 1 shows the principle measurement set-up when using discrete volt and amp meters. Note: Sense lines have been used to prevent efficiency losses due to I^2R heating.

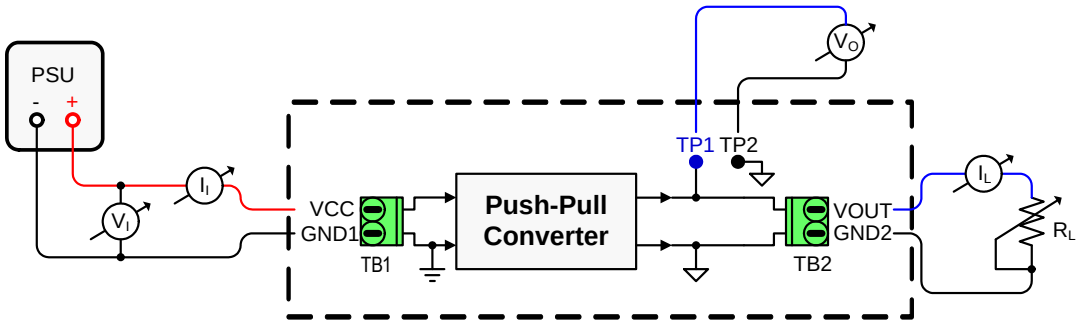

Figure 1. Measurement Set-Up for Measuring Output Voltage and Efficiency as a Function of Load Current

The nominal input voltage V_I of 3.3 V or 5 V, depending on the push-pull converter configuration, is applied to the input terminal block, while measuring the input current I_I. The output voltage V_O, taken from the output and ground test pins TPx, is recorded as a function of the load current I_L, which is adjusted with the load resistor R_L, that connects to the output terminal block. While the above measurement principle applies to all push-pull converters, the 5th converter providing two regulated outputs allows for only one linear regulator (LDO) to be active while the other one must be disabled. Thus, for a 3.3 Vin-to-3.3 Vout or a 5 Vin-to-5 Vout configuration, apply the jumper settings as shown in Figure 2.

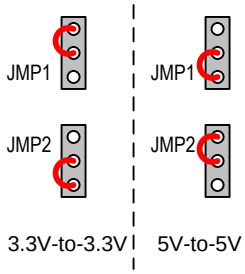

Figure 2. Jumper Settings

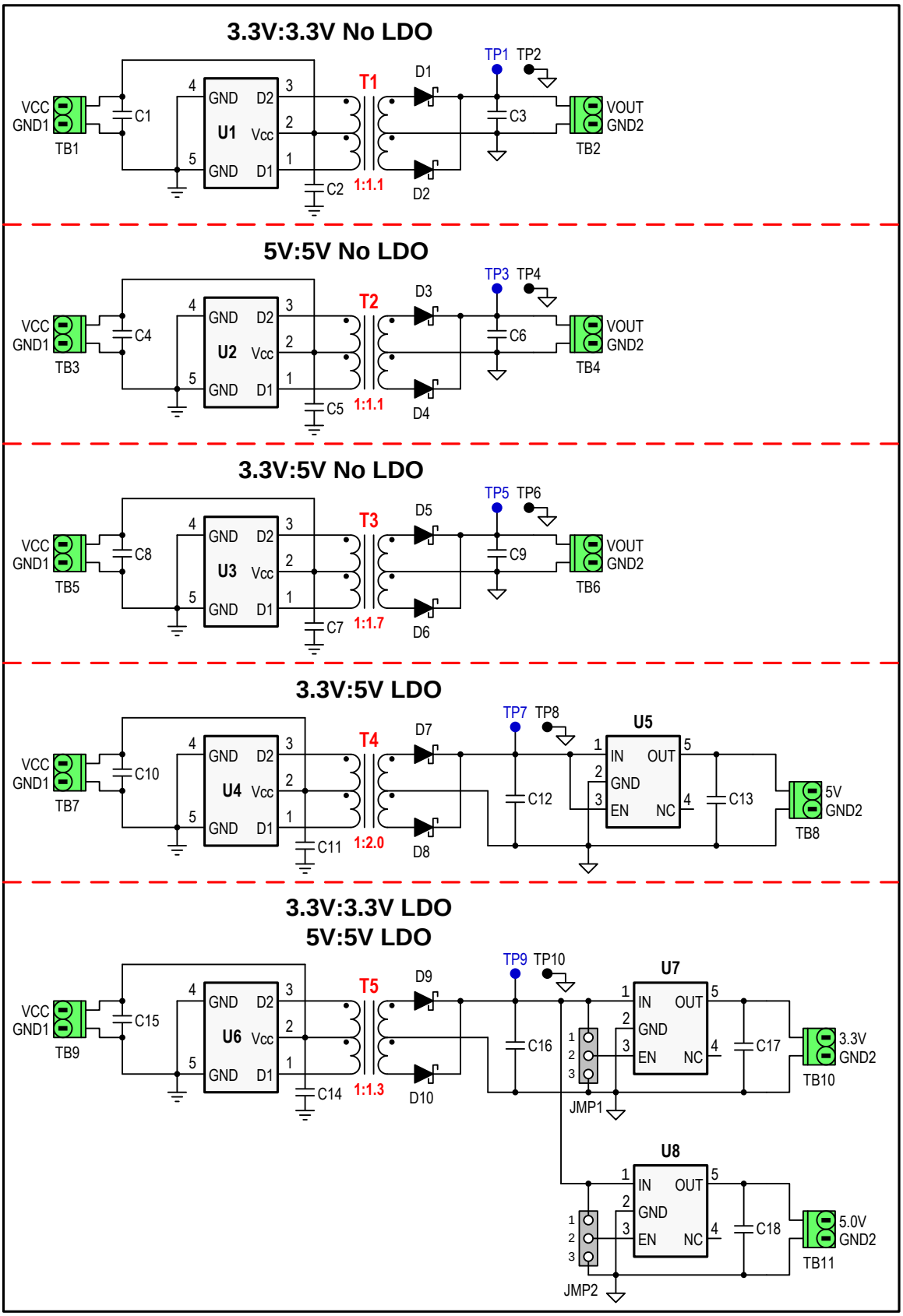

Figure 3. SN6501 EVM Schematic

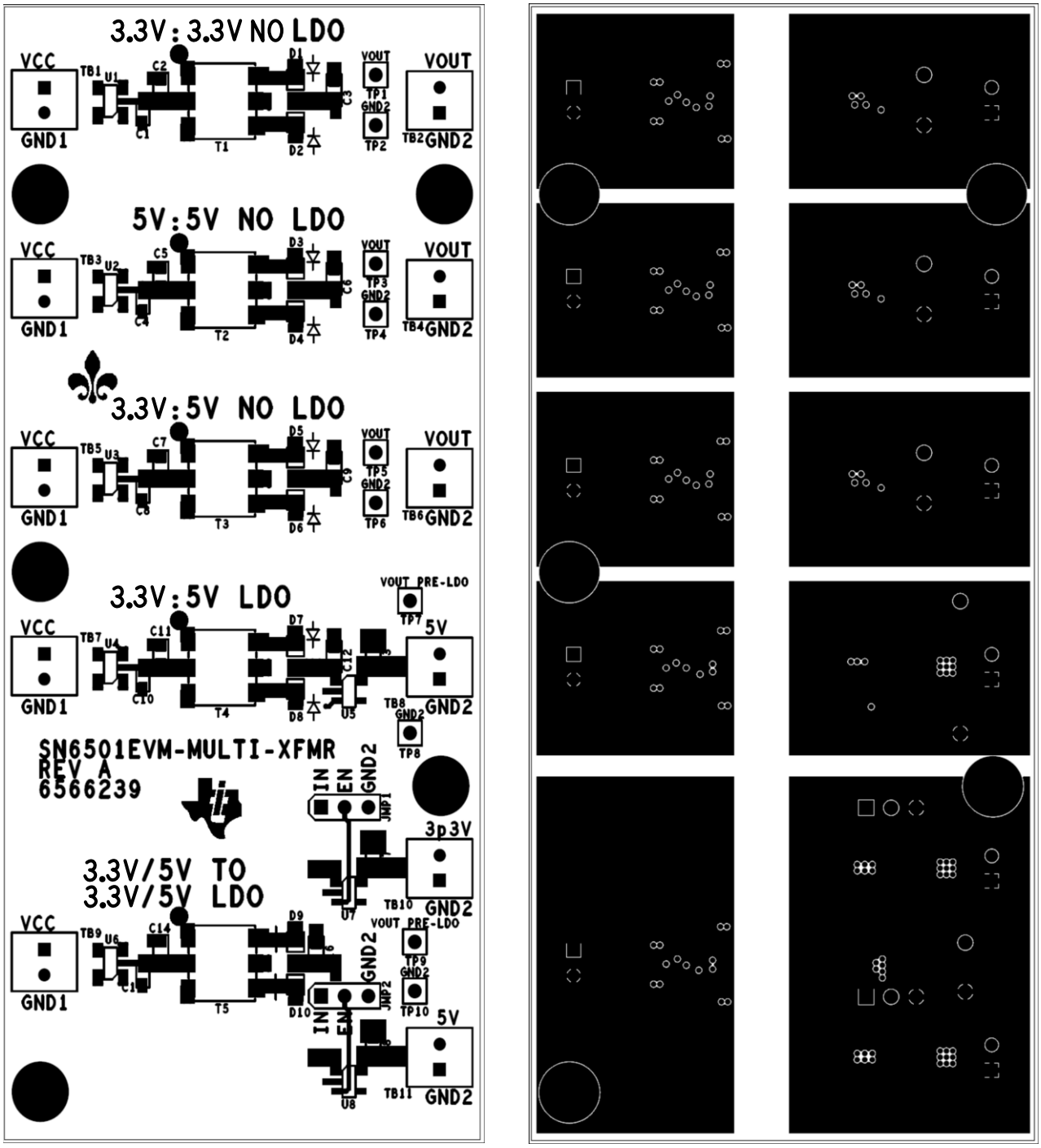

Figure 4. Top Layer (Left) and Layer 2 (Right)

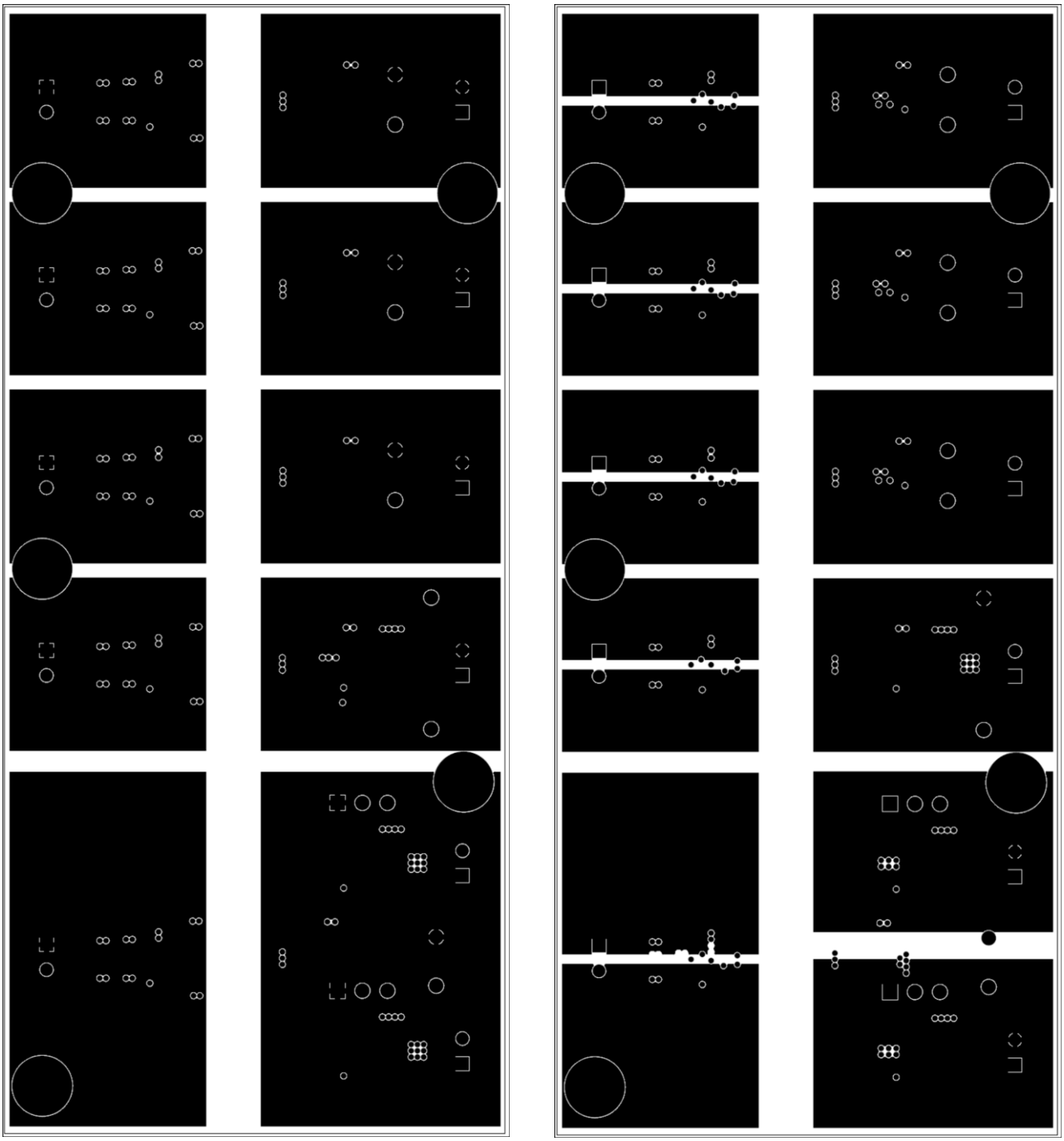

Figure 5. Layer 3 (Left) and Bottom Layer (Right)

1.1 Bill Of Materials

DESIGNATOR	VALUE	DESCRIPTION	PACKAGE	MFR	PART NUMBER
C1, C4, C8, C10, C15	1µF, 10%, 10V, X5R	Capacitor	0402	Taiyo Yuden	LMK105BJ105KV-F
C2, C3, C5, C6, C7, C9, C11, C12, C14, C16	1µF, 10%, 16V, X7R	Capacitor	0603	TDK	C1608X7R1C105K
C13, C17, C18	4.7µF, 10%, 6.3V, X5R	Capacitor	0603	TDK	C1608X5R0J475K/0.80
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10	MBR0520L	Rectifier Diode	SOD-123	ON-Semi	MBR0520LT1G
U1, U2, U3, U4, U6	SN6501	Transformer Driver	DBV	TI	SN6501DBV
U7	TPS76333	3.3 V, 3% LDO	DBV	TI	TPS76333DBVR
U5, U8	TPS76350	5 V, 3% LDO	DBV	TI	TPS76350DBVR
T1	1:1.1, 7Vµs	Transformer	6.73 x 7.14 x 4.06 mm	Wurth Electronics/Midcom	760390011
T2	1:1.1, 11Vµs				760390012
T3	1:1.7, 11Vµs				760390013
T4	1:2.0, 11Vµs				760390015
T5	1:1.3, 11Vµs				760390014
TP1, TP3, TP5, TP7, TP9	Test Loop - Black	Test Point	0.04	Keystone Electronics	5001
TP2, TP4, TP6, TP8, TP10	Test Loop - Blue	Test Point	0.04	Components Corporation	TP-105-40-06
JMP1, JMP2	1 x 3 Jumper	Jumper	0.1"	Samtec	HTSW-150-07-G-S
TB1 to TB11	2-pin female	Terminal Block	2.54 cm	Phoenix Contact	1725656

1.2 Performance Characteristics (Push-Pull Converters with Non-Regulated Outputs)

Figure 6 through Figure 11 show performance characteristics for push-pull converters with non-regulated outputs.

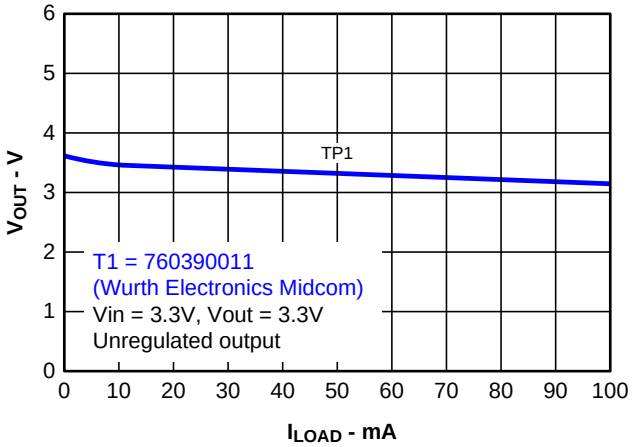

Figure 6. Output Voltage Versus Load Current Vin = 3.3 V, Vout = 3.3 V

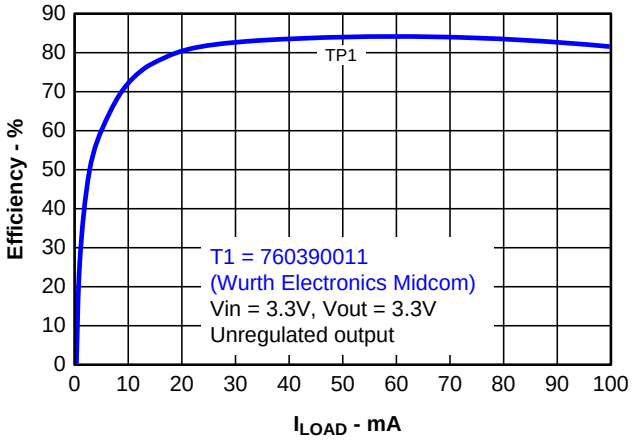

Figure 7. Efficiency Versus Load Current Vin = 3.3 V, Vout = 3.3 V

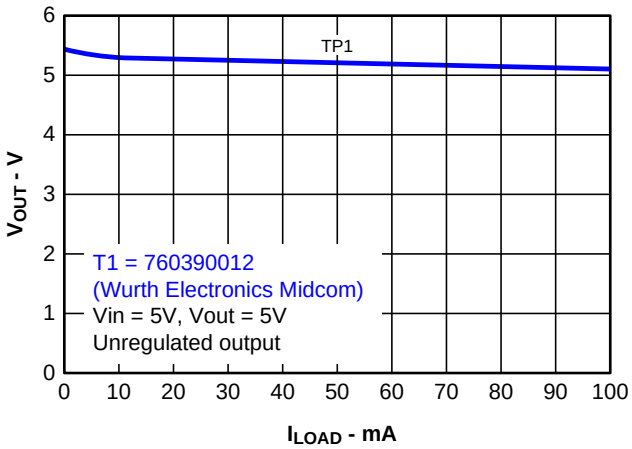

Figure 8. Output Voltage Versus Load Current Vin = 5 V, Vout = 5 V

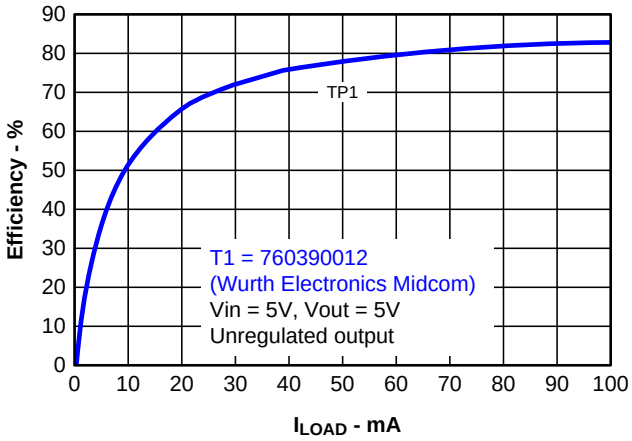

Figure 9. Efficiency Versus Load Current Vin = 5 V, Vout = 5 V

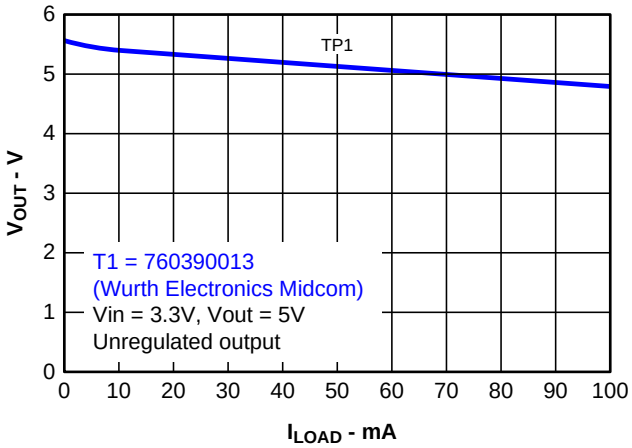

Figure 10. Output Voltage Versus Load Current Vin = 3.3 V, Vout = 5 V

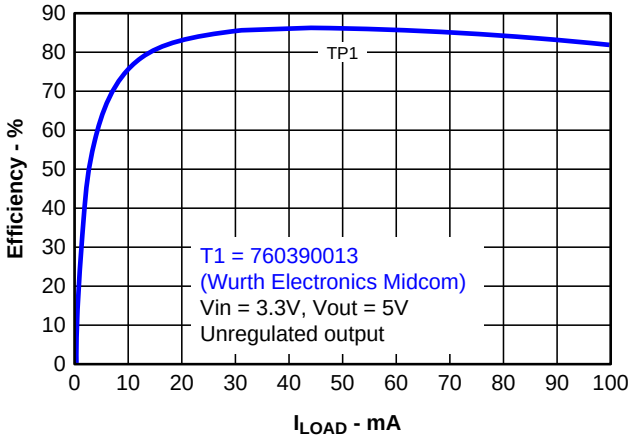

Figure 11. Efficiency Versus Load Current Vin = 3.3 V, Vout = 5 V

1.2.1 Performance Characteristics (Push-Pull Converters with Regulated Outputs)

Figure 12 through Figure 17 show performance characteristics for push-pull converters with regulated outputs.

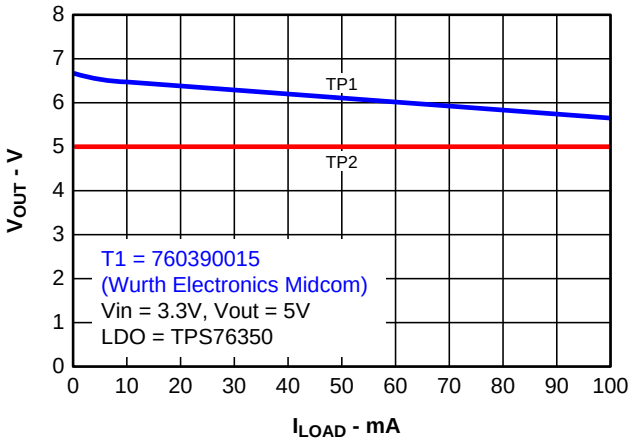

Figure 12. Output Voltage Versus Load Current Vin = 3.3 V, Vout = 5 V

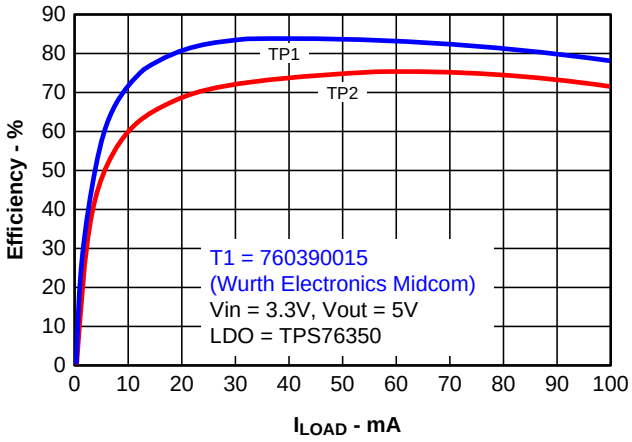

Figure 13. Efficiency Versus Load Current Vin = 3.3 V, Vout = 5 V

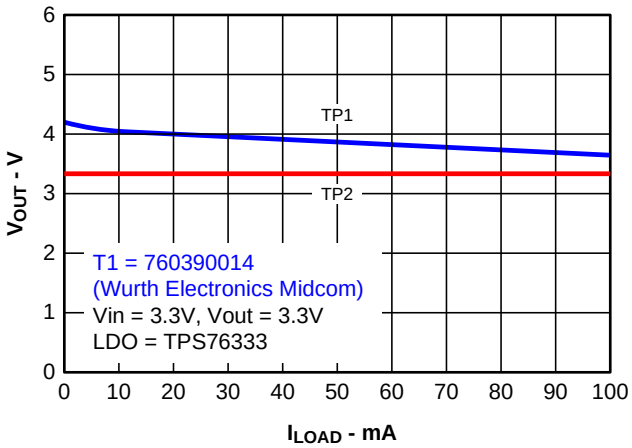

Figure 14. Output Voltage Versus Load Current Vin = 3.3 V, Vout = 3.3 V

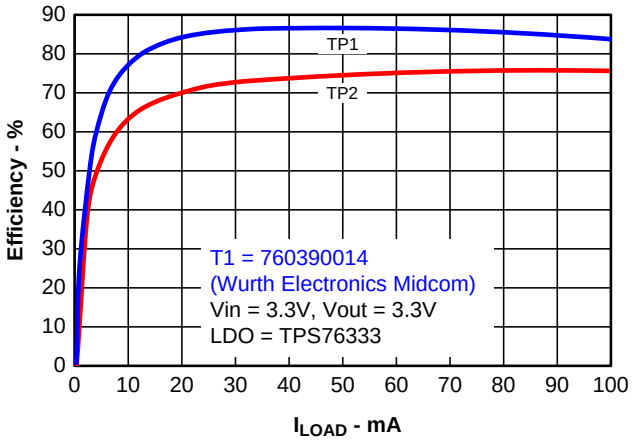

Figure 15. Efficiency Versus Load Current Vin = 3.3 V, Vout = 3.3 V

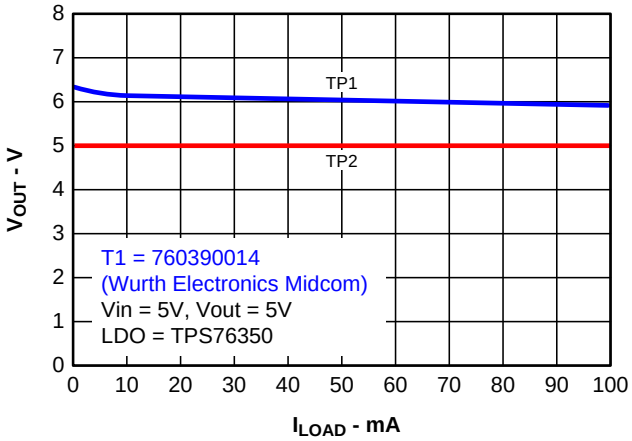

Figure 16. Output Voltage Versus Load Current Vin = 5 V, Vout = 5 V

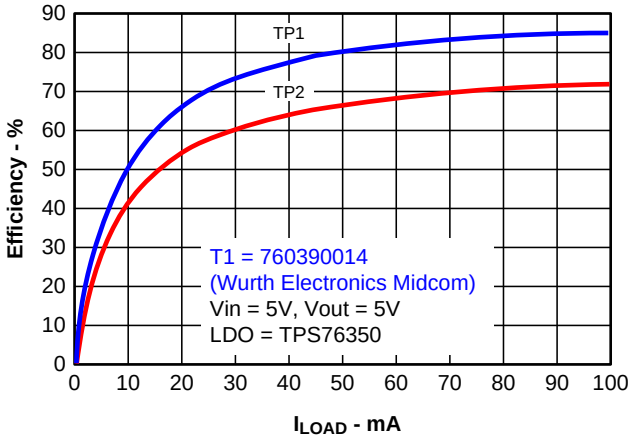

Figure 17. Efficiency Versus Load Current Vin = 5 V, Vout = 5 V

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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