1 Introduction

An isolated bias supply is implemented in this evaluation board with LM5017 Constant-On-Time regulator. LM5017 regulator integrates both the high- and low-side power switches essential for creating isolated buck converter.

Board specifications are as follows:
- Input Range: 20 V to 100 V
- Primary Output Voltage: 10 V
- Secondary (Isolated) Output Voltage: 9.5 V
- Maximum Load Current (Primary + Secondary): 300 mA
- Maximum Power Output: 3 W
- Nominal Switching Frequency: 750 kHz
- Efficiency (FIN = 48 V, IOUT2 = 300 mA): 76 percent
- Board size: 2 inch x 2 inch
UVLO Threshold and Hysteresis

The UVLO resistors are selected using the following two equations:

\[ V_{\text{IN(HYS)}} = I_{\text{HYS}} R_6 \]  

(1)

and

\[ V_{\text{IN(UVLO, rising)}} = 1.225V \times \left( \frac{R_6}{R_7} + 1 \right) \]  

(2)

On this evaluation board \( R_1 = 127 \, \text{k}\Omega \) and \( R_2 = 8.25 \, \text{k}\Omega \), resulting in UVLO rising threshold at \( V_{\text{IN}} = 20.5 \, \text{V} \) and a hysteresis of 2.54 V.

2.1 Board Connection and Start-Up

The input connections are made using TP1 (VIN) and TP2 (GND) terminals. The primary output appears at TP3 (VOUT1) and TP4 (GND). The secondary (isolated) output is available across TP5 (VOUT2) and TP6 (IGND). The input voltage should be gradually increased above UVLO set point of 20.5 V. Both the outputs (VOUT1 and VOUT2) should be close to 10 V at this point. This board is designed to function with input voltage range of 20 V to 100 V. The minimum VIN threshold can be changed by changing the UVLO resistors R1, R2. VIN should not exceed 100 V.
The magnetics in this design is optimized for solution size, and therefore limits the output power. The total load at the output should not exceed 300 mA otherwise the coupled inductor will saturate/overheat which can destroy both the coupled inductor and the regulator IC U1. If a sustained over-current situation is to be tolerated, a coupled inductor with higher saturation and rms ratings should be used.

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Table 1. Bill of Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Mfg., Part Number</th>
<th>Package</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Sync Switching Regulator</td>
<td>Texas Instruments, LM5017</td>
<td>SO PowerPAD-8</td>
<td>100V, 0.6A</td>
</tr>
<tr>
<td>T1</td>
<td>Coupled Inductor, 1500 VDC</td>
<td>Coilcraft, LPD5030V-333ME</td>
<td>5mm x 5mm</td>
<td>33uH, 0.47A</td>
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<tr>
<td></td>
<td>Alternate Part</td>
<td>Wurth, 750312750</td>
<td>8.26mm x 6.60mm</td>
<td>22uH, 0.76A</td>
</tr>
<tr>
<td>D1</td>
<td>Schottky Diode</td>
<td>Diodes Inc., DFLS1100-7</td>
<td>Pwr–DI123</td>
<td>100V, 1A</td>
</tr>
<tr>
<td>D2</td>
<td>Schottky Diode</td>
<td>Diodes Inc., SDM10U45-7</td>
<td>SOD–523</td>
<td>40V, 100mA</td>
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<tr>
<td>C1</td>
<td>Ceramic Capacitor</td>
<td>TDK, C3225X7R2A225K</td>
<td>1210</td>
<td>2.2 µF, 100V, X7R</td>
</tr>
<tr>
<td>C2</td>
<td>Ceramic Capacitor</td>
<td>TDK, C1608X7R1C103K</td>
<td>0603</td>
<td>0.01 µF, 16V, X7R</td>
</tr>
<tr>
<td>C3, C4</td>
<td>Ceramic Capacitor</td>
<td>TDK, C2012X7R1E105K</td>
<td>0805</td>
<td>1 µF, 25V, X7R</td>
</tr>
<tr>
<td>C5</td>
<td>Ceramic Capacitor</td>
<td>Murata, GRM21BR72A474KA73L</td>
<td>0805</td>
<td>0.47 µF, 100V, X7R</td>
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<tr>
<td>C6</td>
<td>Ceramic Capacitor</td>
<td>TDK, C1608X7R1C105K</td>
<td>0603</td>
<td>1 µF, 16V, X7R</td>
</tr>
<tr>
<td>C7</td>
<td>Ceramic Capacitor</td>
<td>Murata, GRM188R72A332KA01D</td>
<td>0603</td>
<td>3300pF, 100V, ±5%</td>
</tr>
<tr>
<td>C8</td>
<td>Ceramic Capacitor</td>
<td>AVX, 0603YC104KAT2A</td>
<td>0603</td>
<td>0.1 µF, 16V, X7R</td>
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<tr>
<td>R1</td>
<td>Resistor</td>
<td>Vishay/Dale, CRCW0805127KFKEA</td>
<td>0805</td>
<td>127k Ω, 1%</td>
</tr>
<tr>
<td>R2</td>
<td>Resistor</td>
<td>Vishay/Dale, CRCW08058K25FKEA</td>
<td>0805</td>
<td>8.25k Ω, 1%</td>
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Table 1. Bill of Materials (continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Mfg., Part Number</th>
<th>Package</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>Resistor</td>
<td>Vishay/Dale, CRCW0805130KFEA</td>
<td>0805</td>
<td>130k Ω, 1%</td>
</tr>
<tr>
<td>R4</td>
<td>Resistor</td>
<td>Panasonic, ERJ-3EKF7321V</td>
<td>0603</td>
<td>7.32k Ω, 1%</td>
</tr>
<tr>
<td>R5</td>
<td>Resistor</td>
<td>Panasonic, ERJ-3EKF1001V</td>
<td>0603</td>
<td>1.0k Ω, 1%</td>
</tr>
<tr>
<td>R6</td>
<td>Resistor</td>
<td>Yageo, RC0603JR-070RL</td>
<td>0603</td>
<td>0 Ω</td>
</tr>
<tr>
<td>R7, R9</td>
<td>Resistor</td>
<td>Yageo, RC0603JR-070RL</td>
<td>0603</td>
<td>0 Ω</td>
</tr>
<tr>
<td>R8</td>
<td>Resistor</td>
<td>Panasonic, ERJ-3EKF4642V</td>
<td>0603</td>
<td>46.4k Ω, 1%</td>
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<td>R10</td>
<td>Resistor</td>
<td>Panasonic, ERJ-6GEYJ202V</td>
<td>0805</td>
<td>2k Ω, 5%</td>
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</tbody>
</table>

3 Performance Curves

Figure 3. Efficiency at 750 kHz, VOUT1=10V

Figure 4. Steady State Waveform (VIN=48V, IOUT1=100mA, IOUT2=200mA)
Figure 5. Step Load Response (VIN=48V, IOUT1=0, Step Load on IOUT2=100mA to 200mA)

4 PC Board Layout

Figure 6. Board Silkscreen
Figure 7. Board Top Layer
Figure 8. Board Bottom Layer
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Caution

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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

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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.

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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 détaçables

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.
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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.

Texas Instruments Japan Limited
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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. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. 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 about 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.

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