User's Guide
SLVU450–March 2011

TPS3860xxEVM-736 Evaluation Modules

This user's guide describes the evaluation modules (EVM) for the TPS386000 (TPS386000EVM-736) and TPS386040 (TPS386040EVM-736). The TPS386000 and TPS386040 are quad supervisors with built-in watchdog timer (WDT), manual reset, programmable delay, and a windowed or positive and negative monitor.

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1 Description

The TPS3860xxEVM-736 can be used to evaluate the various features of the TPS3860xx family of supervisors. Through resistor dividers, each supervisor can be individually configured to monitor voltages as low as 0.4 V with the EVM initially being set up for 3.3 V - 12%, 2.5 V - 6%, and 1.8 V - 7 % for supervisors 1 through 3, respectively. The fourth supervisor (SENSE4L and SENSE4H) can be configured for either windowed or positive and negative monitoring, with the EVM default being set as a 1.2 V ± 7% windowed supervisor. The delays for each supervisor can also be individually set through timing capacitors. An input and output are provided for the WDT as well as an input for the manual reset.

1.1 General Features

- Inputs provided for all four supervisors, including a negative supply input for the fourth supervisor
- Placeholders to configure supervisor 4 for positive and negative monitoring
- Watchdog timer input and output
- Manual reset input
- Replaceable timing capacitors to independently program the delay of each supervisor

1.2 Orderable Options

- TPS386000EVM-736 - 4-channel supervisor/sequencer with open-drain RESET outputs
- TPS386040EVM-736 - 4-channel supervisor/sequencer with push-pull RESET outputs

2 Schematic

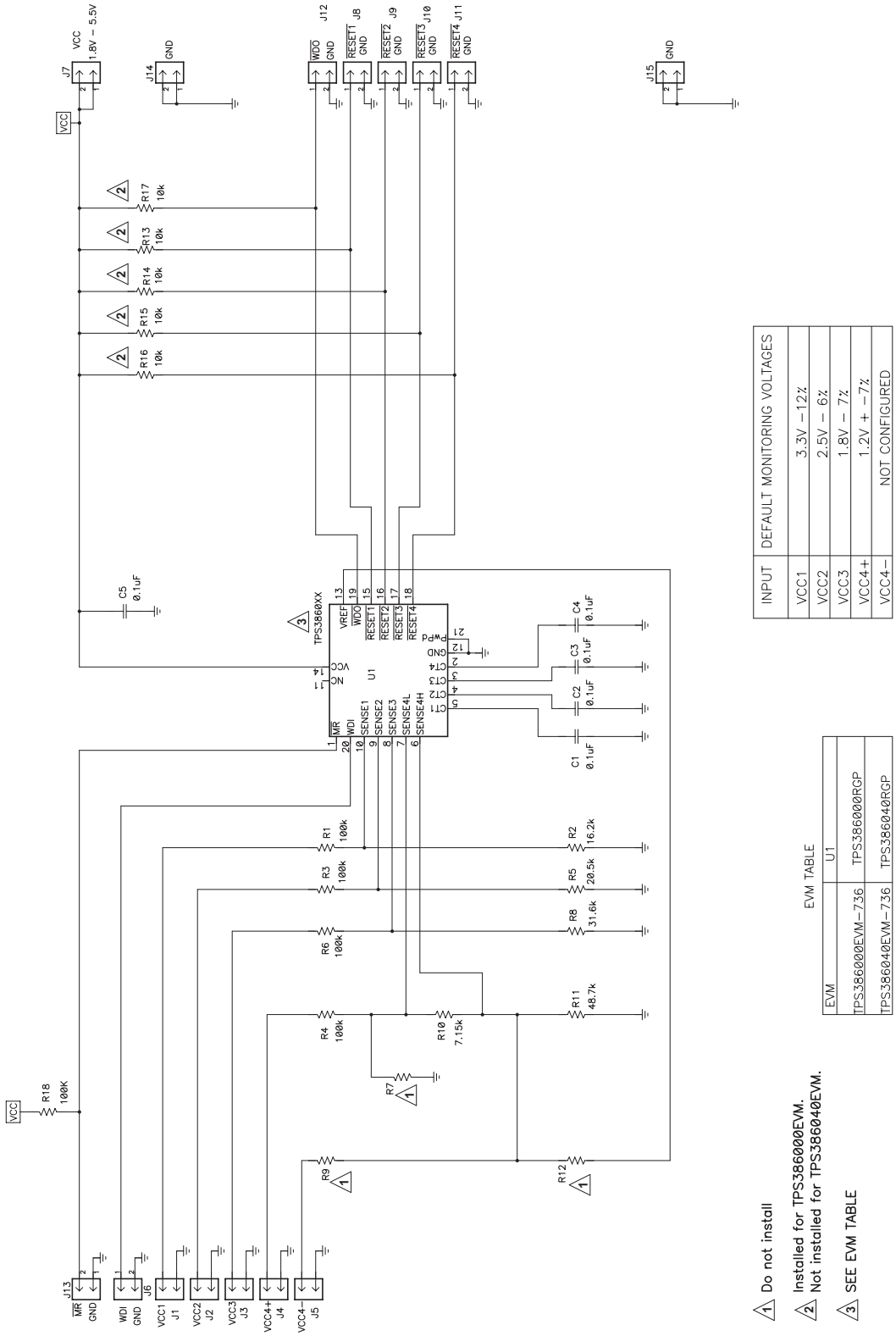

Figure 1. TPS3860xxEVM-736 Schematic

3 EVM Input/Output Connectors

Table 1. EVM Input/Output Connectors

Connector	Description
J1	Supervisor-1 input and GND (default: 3.3 V - 12%)
J2	Supervisor-2 input and GND (Default: 2.5 V - 6%)
J3	Supervisor-3 input and GND (Default: 1.8 V - 7%)
J4	Supervisor-4 window and positive supply input and GND (default: 1.2 V ± 7%)
J5	Supervisor-4 negative supply input and GND (default: not configured)
J6	Watchdog timer input and GND
J7	VCC connector (1.8 V – 5.5 V)
J8	RESET1 output and GND
J9	RESET2 output and GND
J10	RESET3 output and GND
J11	RESET4 output and GND
J12	Watchdog timer output and GND
J13	Manual reset input and GND
J14	GND
J15	GND

4 General Operation and Functionality

The following paragraphs describe the functionality and operation of the TPS3860xxEVM-736.

4.1 Input Power

The TPS3860xx family of supervisors requires a VCC voltage between 1.8 V and 5.5 V. This voltage can be supplied through J7 and its return through J14. The chip itself only requires 12 µA to operate.

4.2 Supervisor Inputs

The TPS3860xx supervisor inputs (SENSE1, SENSE2, SENSE3, SENSE4L, and SENSE4H) can be used to monitor voltages down to 0.4 V. The default EVM configuration monitors 3.3 V - 12%, 2.5 V - 6%, 1.8 V - 7%, and 1.2 V ± 7% through supervisors 1 through 4, respectively. If voltages other than the defaults are desired, the SENSE input trip points can be adjusted by changing the resistor dividers using the following equations as given in the data sheet (R_U is the upper resistor, R_L is the lower):

$$V_{ITN} = 400\ mV$$

$$R_U = R_L \times \left(\frac{V_{CC\_TARGET}}{V_{ITN}} \right) - 1$$

$$V_{CC\_ACTUAL} = V_{ITN} \times \left(\frac{R_U}{R_L} + 1 \right)$$

Example for $3.3\ V - 12\%$:

$$V_{CC\_TARGET} = 2.904\ V, \text{Choose } R_L = 34.0\ k\Omega$$

$$R_U = 34.0\ k\Omega \times \left(\frac{2.904\ V}{0.4\ V} - 1 \right) = 212.84\ k\Omega \text{ (Choose } 215\ k\Omega)$$

$$V_{CC\_ACTUAL} = 0.4\ V \times \left(\frac{215\ k\Omega}{34.0\ k\Omega} + 1 \right) = 2.929\ V$$

(1)

Additionally, the SENSE4H input can be used along with V_{REF} to monitor negative voltages applied at J5. The EVM is not configured by default for negative voltage monitoring. In order to use this feature, R10 and R11 need to be removed and R7, R9, and R12 need to be installed. The values for the resistor dividers can be calculated using the equations from the data sheet, including the equations for using a windowed supervisor. The following is an example of setting up a positive and negative supervisor for a -5-V supply (R_U is the resistor from V_{REF} to SENSE4H, and R_L is the resistor from SENSE4H to VCC4-):

$$V_{REF} = 1.2\ V,\ V_{ITP} = 400\ mV$$

$$R_L = R_U \times \frac{V_{ITP} - V_{CC\_TARGET}}{V_{REF} - V_{ITP}}$$

$$V_{CC\_ACTUAL} = V_{ITP} - \frac{R_L}{R_U} \times (V_{REF} - V_{ITP})$$

Example for $-5\ V - 12\%$:

$$V_{CC\_target} = -4.4\ V, \text{Choose } R_U = 49.9\ k\Omega$$

$$R_L = 49.9\ k\Omega \times \frac{0.4\ V - (-4.4\ V)}{1.2\ V - 0.4\ V} = 299.4\ k\Omega \text{ (Choose } 301\ k\Omega)$$

$$V_{CC\_ACTUAL} = 0.4\ V - \frac{301\ k\Omega}{49.9\ k\Omega} \times (1.2\ V - 0.4\ V) = -4.426\ V$$

(2)

4.3 RESET Outputs

The TPS3860xxEVM-736 RESET outputs can be used to reset power supplies or processors when the power supply voltage drops below the setpoint. They can also be used to sequence power supplies to avoid violating the maximum voltage ratings of devices. The TPS386000 has open-drain outputs and are pulled up by 10-kΩ resistors installed as R13–R16 by default on the TPS386000EVM-736. The TPS386040 has push-pull outputs, and R13–R16 are not installed on the TPS386040EVM-736.

4.4 RESET Timing Delay

The time delay for each supervisor can be adjusted by the capacitor at the CT1–CT4 pins. The EVM has been configured with 0.1-µF capacitors on each of these pins for a nominal delay of 413.7 ms. Figure 2 shows the operation of the RESET output with respect to the supervised voltage. The top trace shows VCC1 as it ramps up from 0 V to 3.3 V and the bottom trace shows the delay before RESET1 goes high. To change this delay, the following equations from the data sheet can be used to calculate a new timing capacitor:

$$C_{CT}\ (nF) = \left[t_{DELAY}\ (ms) - 0.5\ (ms)\right] \times 0.242$$

$$t_{DELAY\_ACTUAL}\ (ms) = \frac{C_{CT}(nF)}{0.242} + 0.5\ (ms)$$

Example for 200 ms :

$$t_{DELAY\_TARGET} = 200\ ms$$

$$C_{CT}\ (nF) = \left[200 - 0.5\right] \times 0.242 = 48.279\ nF\ (\text{Choose } 0.047\ \mu F)$$

$$t_{DELAY\_ACTUAL}\ (ms) = \frac{47}{0.242} + 0.5 = 194.7\ ms \quad (3)$$

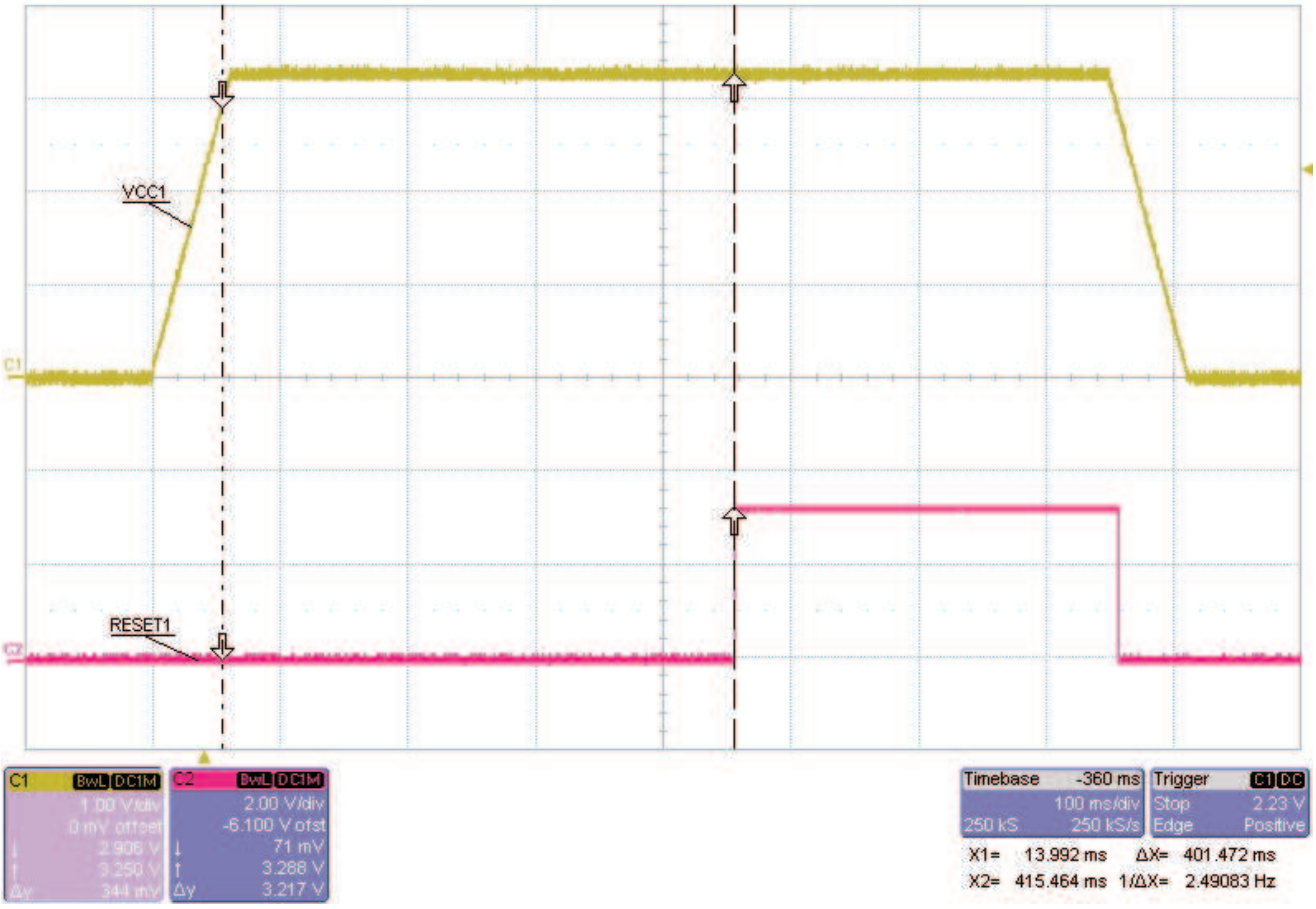

Figure 2. RESET1 Timing for VCC1 From 0 V to 3.3 V

4.5 Watchdog Timer Function

The TPS3860xx contains a watchdog timer (WDT) which can be evaluated using the TPS3860xxEVM-736. The watchdog timer times out approximately 600 ms after the last rising or falling edge seen at WDI (J6), and WDO (J12) is asserted. Once WDO has been asserted, RESET1 must be asserted in order to reset WDO. This is accomplished when manual reset (J13) is asserted, the SENSE1 voltage drops below the setpoint, or VCC is reset. Figure 3 shows the operation of the watchdog timer. WDO starts low, indicating a timeout condition, but goes high when RESET1 is asserted by using the MR input. The WDO pin goes low again 600 ms after the last edge seen at WDI.

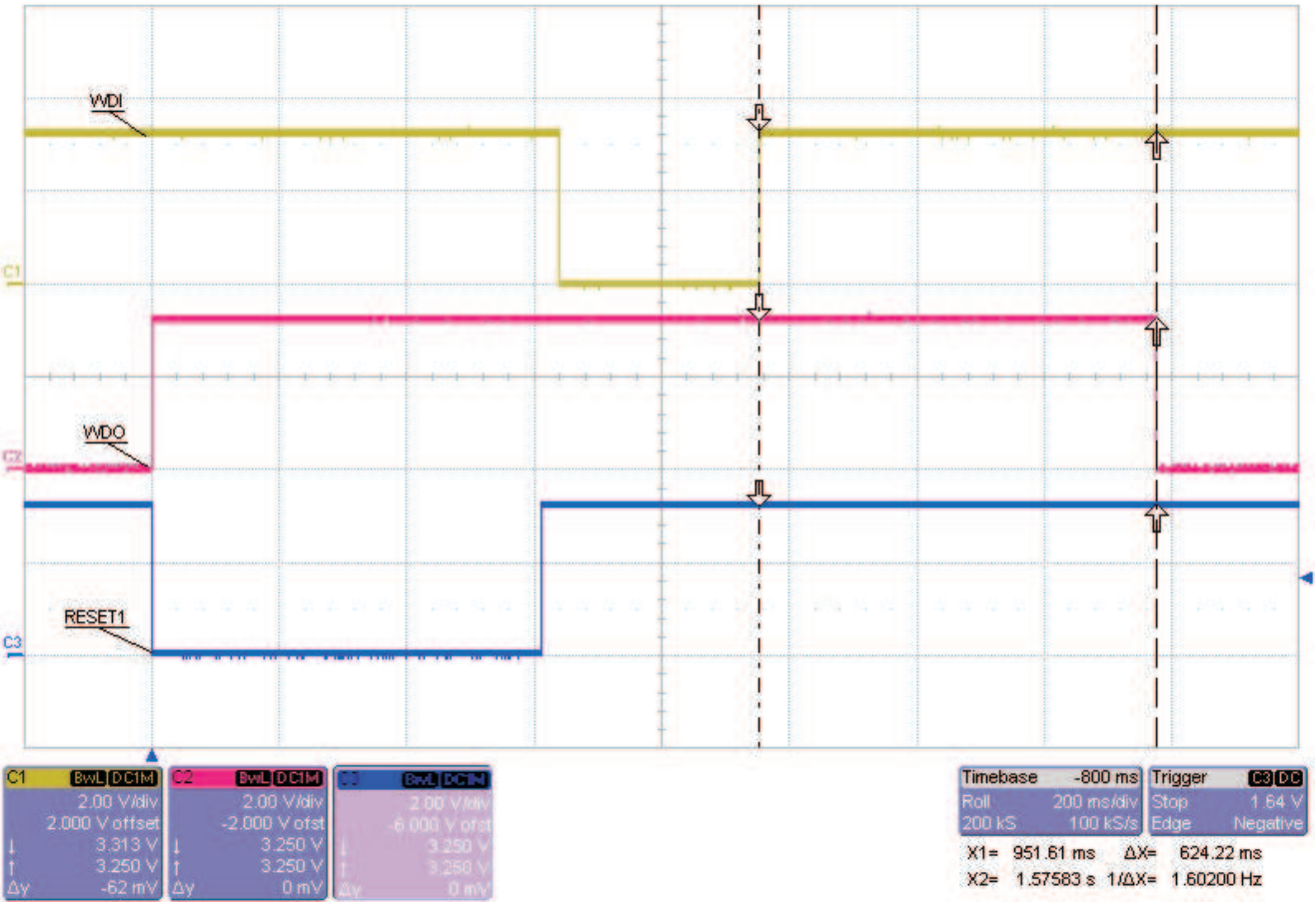

Figure 3. WDT Timing and Operation

5 EVM Assembly Drawings and Layout Guidelines

5.1 PCB Drawings

The following figures show component placement and layout.

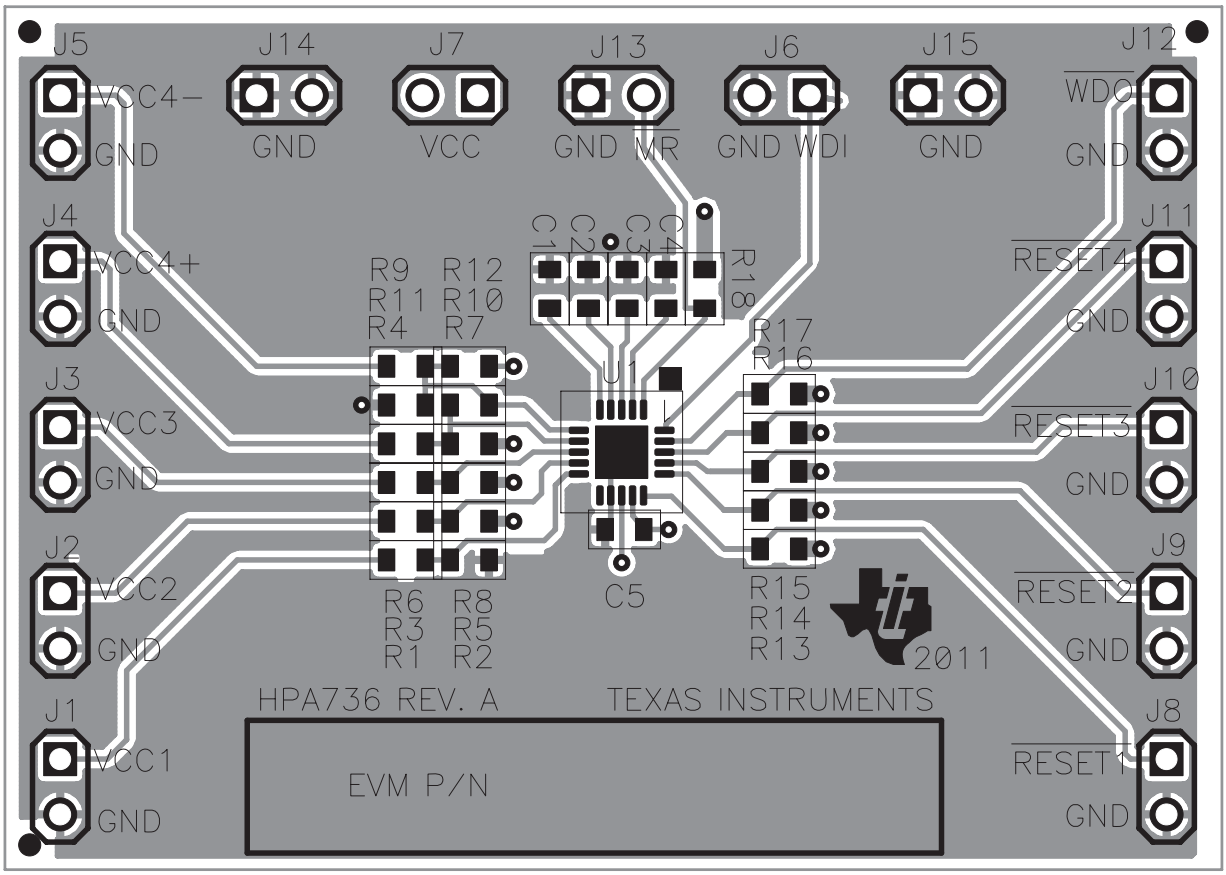

Figure 4. Top-Side Placement/Routing

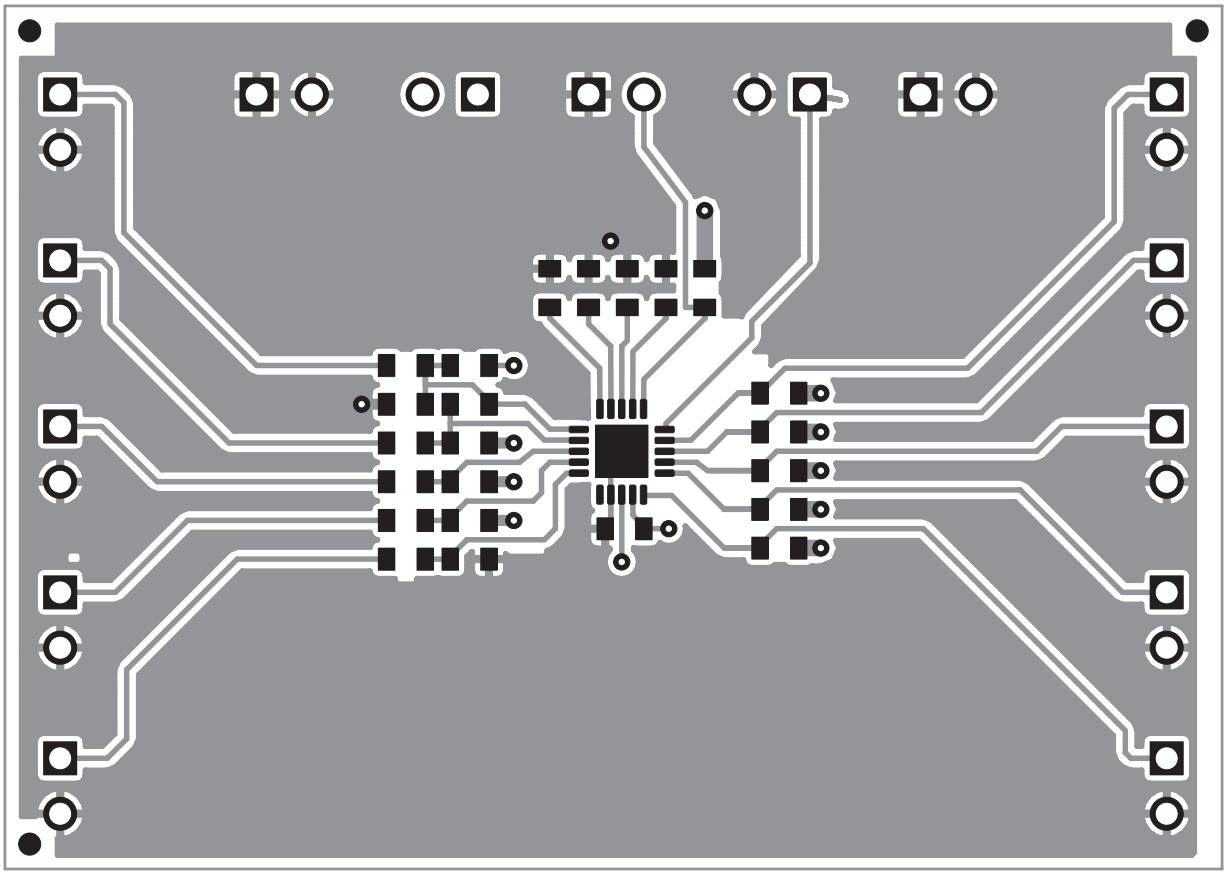

Figure 5. Top-Side Layout/Routing

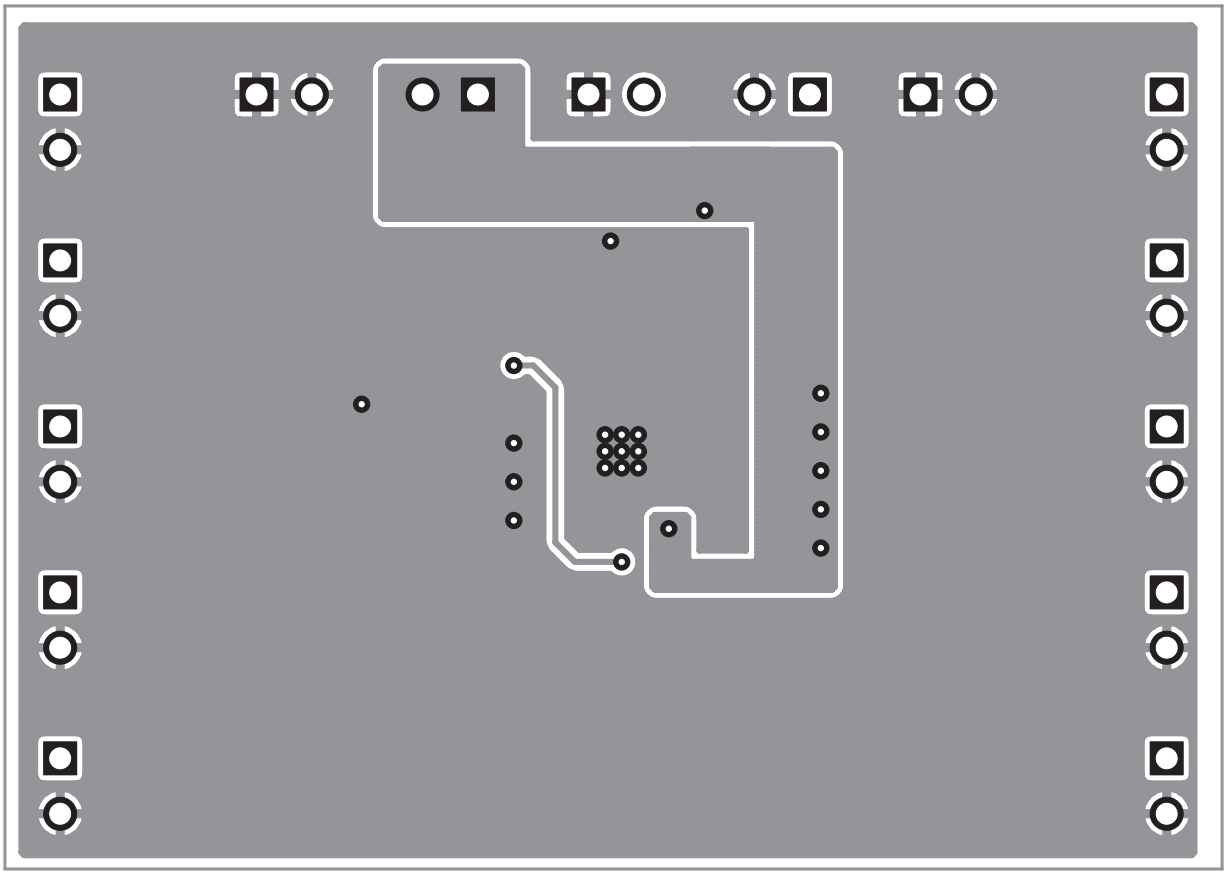

Figure 6. Bottom-Side Layout/Routing

5.2 Layouts Guidelines

Thermal Pad

The thermal pad provides a thermal and mechanical interface between the device and the printed-circuit board (PCB). Connect the exposed thermal pad of the PCB to the device VSS pins and provide at least a 3 x 3 pattern of PCB vias to connect the thermal pad and GND pin to the circuit ground on other PCB layers.

Supply Voltage Decoupling

Provide power supply pin bypass to the device as follows:

- 0.1-µF, X5R ceramic at pin 15 (VCC)
- 1-nF, X7R ceramic at pins 6–10 (SENSE1, SENSE2, SENSE3, SENSE4L, and SENSE4H) although not required can provide noise filtering in noisy power supply systems.

6 Bill of Materials

Table 2. TPS3860xxEVM-736 Bill of Materials

EVM Count		RefDes	Value	Description	Size	Part Number	MFR
TPS386000	TPS386040						
5	5	C1, C2, C3, C4, C5	0.1 µF	Capacitor, Ceramic, Low Inductance, 6.3V, X5R, 20%	0603	Std	Std
15	15	J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 in x 2	PEC02SAAN	Sullins
5	5	R1, R3, R4, R6, R18	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R10	7.15k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R11	48.7k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
5	0	R13, R14, R15, R16, R17	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R2	16.2k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R5	20.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R7, R9, R12	DNI	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R8	31.6k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	U1	TPS386000RGP	IC, Quad Supply Voltage Supervisors	--	TPS386000RGP	TI
0	1	U1	TPS386040RGP	IC, Quad Supply Voltage Supervisors	--	TPS386040RGP	TI
1	1	--	--	Label	1.25 x 0.25 inch	THT-13-457-10	Brady
1	1	--	HPA736	2.200 x 1.560 x 0.062 inch 2 layer 2oz. PCB	2.200 x 1.560 inch	HPA736	Any

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 7 V and the output voltage range of 0 V to 7 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. 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 85° C. The EVM is designed to operate properly with certain components above 85° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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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

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1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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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.

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