

TPS65090EVM User's Guide

This guide details the use of the TPS65090 evaluation module, *TPS65090EVM* (referred to as EVM for the remainder of this document).

The TPS65090, front-end power management unit (PMU), is an integrated high-input voltage (6 V–17 V) charger and power path management device including 3 step-down converters, 2 low-dropout regulators (LDO), 7 load-switches, 16-channel 10-bit A/D converter and I²C™ interface.

The EVM facilitates evaluation of the integrated circuit (IC) and serves as a reference design. For more information on the TPS65090, refer to the datasheet: *TPS65090 High Input Voltage Frontend PMU for Mobile Computer*, ([SLVSAU3](#)).

Contents

1	Requirements	2
2	Setup and Operation	2
	2.1 Power Connections	2
3	Headers and Jumpers	3
4	Graphical User Interface (GUI)	4
5	Schematic Diagram	4
6	Board Layout	9
7	Bill of Materials	16
8	References	18

List of Figures

1	TPS65090EVM GUI	4
2	TPS65090EVM Schematic Charger or Power Path and Configuration.....	5
3	TPS65090EVM Schematic Converters and Load Switches.....	6
4	TPS65090EVM Schematic USB to I ² C Interface	7
5	TPS65090EVM Schematic Test Pads	8
6	TPS65090EVM Board Layout, Top Assembly	9
7	TPS65090EVM Board Layout, Bottom Assembly (mirrored)	10
8	TPS65090EVM Board Layout, Top	11
9	TPS65090EVM Board Layout, Internal 2.....	12
10	TPS65090EVM Board Layout, Internal 3.....	13
11	TPS65090EVM Board Layout, Bottom (mirrored).....	14
12	TPS65090EVM Board Layout, Top Silkscreen	15

List of Tables

1	EVM Header and Jumper Descriptions	3
2	TPS65090 Solution, Required Components	16
3	TPS65090EVM Evaluation Components	17

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1 Requirements

In order to use the EVM, a lab power supply capable of supplying at least the TPS65090 output power at a voltage between 6 V and 17 V and/or a rechargeable multi-cell lithium battery is required. Additionally, a computer running Windows® 7 or Windows XP loaded with the *TPS65090EVM-SW* graphical user interface (GUI) and a mini-USB cable are recommended.

2 Setup and Operation

2.1 Power Connections

Connect the lab power supply to the input labeled AC (AC adapter), J1; pin 1 positive lead and pin 6 negative lead.

Connect the rechargeable Li-Ion battery to J3; pin 1 positive lead and pin 6 negative lead.

By default, the charger and converters are enabled and disabled by external pins. The LDOs are always on, since they additionally provide power to internal blocks.

3 Headers and Jumpers

Many of the 6-pin headers provide Kelvin sense lines, S+ and S– (pins 3 and 4), for sensing the voltage directly at the input or output capacitors.

Table 1. EVM Header and Jumper Descriptions

Reference Designator	Name	Description
J1	V_AC	Input connection for AC adapter
J2	VSYS	Header for power path output system voltage
J3	V_BAT	Header for Li-Ion battery connection
J4	DCDC1	Header for output voltage of switching converter, DCDC1
J5	DCDC2	Header for output voltage of switching converter, DCDC2
J6	DCDC3	Header for output voltage of switching converter, DCDC3
J7	Digital	Header for open drain outputs, each pulled up to J14
J8	VIO	Jumper to select pull-up for I ² C bus, default: USB_3P3
J9	USB_3P3	Header for output of U4, 5-V to 3.3-V LDO
J10	I ² C	Header for I ² C bus
J11	J11	Mini-USB connection to PC for GUI
J12	SCL pull-Up	Jumper to pull-up SCL to J8, default: installed
J13	SDA pull-Up	Jumper to pull-up SDA to J8, default: installed
J14	Output pull-up	Jumper to select pull-up for open-drain outputs
J15	ENC	Jumper to externally enable or disable charger
J16	TS1	Header connection to pin TS1 network
J17	TS2	Header connection to pin TS2 network
J18	EN_DCDC1	Jumper to externally enable or disable DCDC1
J19	EN_DCDC2	Jumper to externally enable or disable DCDC2
J20	EN_DCDC3	Jumper to externally enable or disable DCDC3
J21	LDO1	Header to output voltage of LDO1
J22	LDO2	Header to output voltage of LDO2
J23	FET Out	Header to FET outputs
J24	FET In	Header to FET inputs
J25	Factory Use	Jumper used for firmware install only
JP1	I_VSYS	Solder bridge to optionally measure VSYS current
JP2	I_VBAT	Solder bridge to optionally measure V_BAT inductor current
JP3	I1	Solder bridge to optionally measure DCDC1 inductor current
JP4	I2	Solder bridge to optionally measure DCDC2 inductor current
JP5	I3	Solder bridge to optionally measure DCDC3 inductor current

4 Graphical User Interface (GUI)

The GUI design allows the TPS65090 to easily interface with a PC. The GUI gives the capability to read and write the contents of the I²C registers and simplifies use with radio check boxes, drop-down menus and pushbuttons.

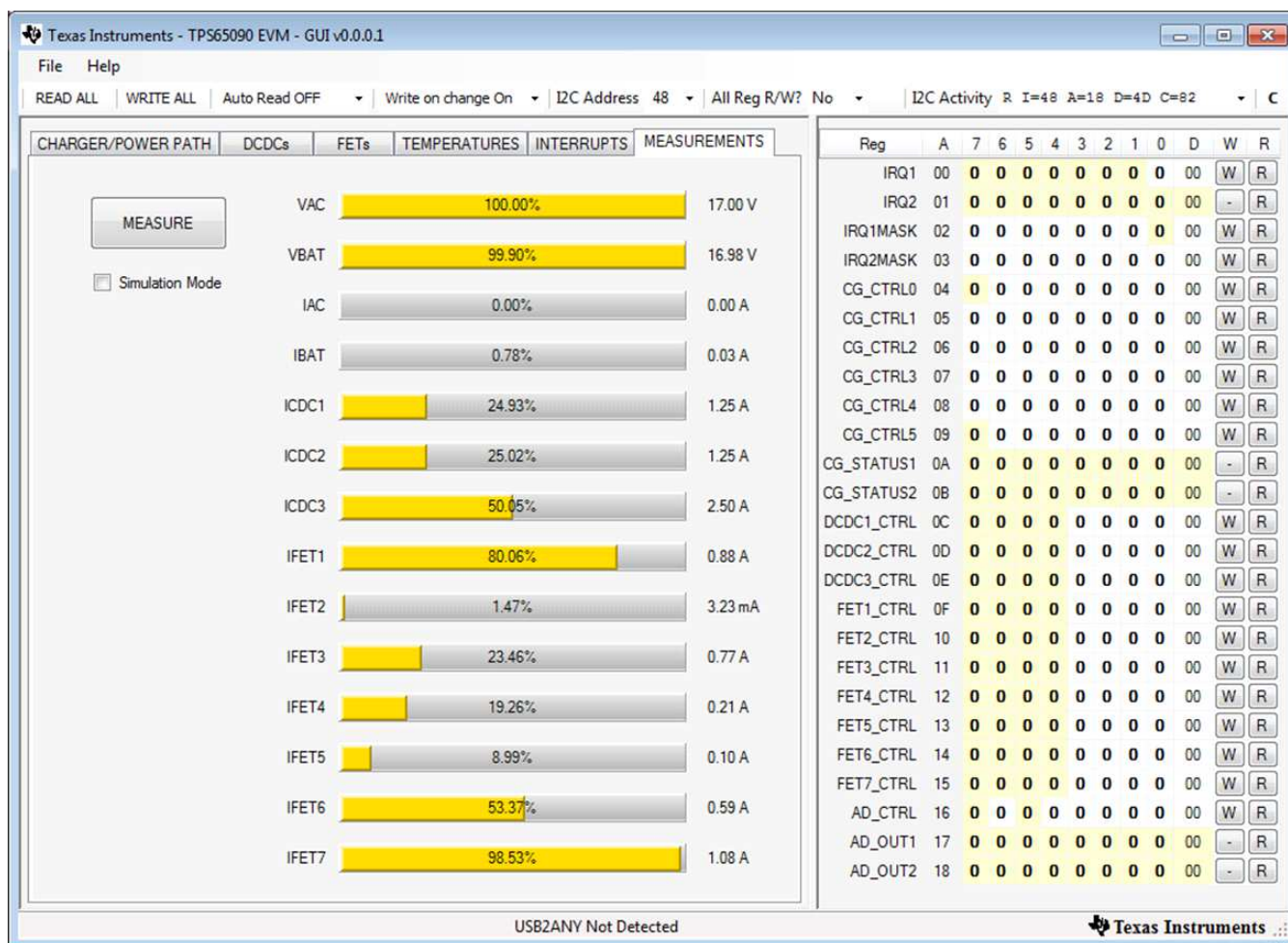


Figure 1. TPS65090EVM GUI

5 Schematic Diagram

The schematic diagram illustrates the circuit connections of the EVM.

This EVM contains many components that are not necessary for an end-product. These additional components are added to simplify evaluation of the IC. In Section 7, the Bill of Materials (BOM), there are two tables; the first table includes the required materials for functionality of the TPS65090 and the second table contains the additional materials added for evaluation.

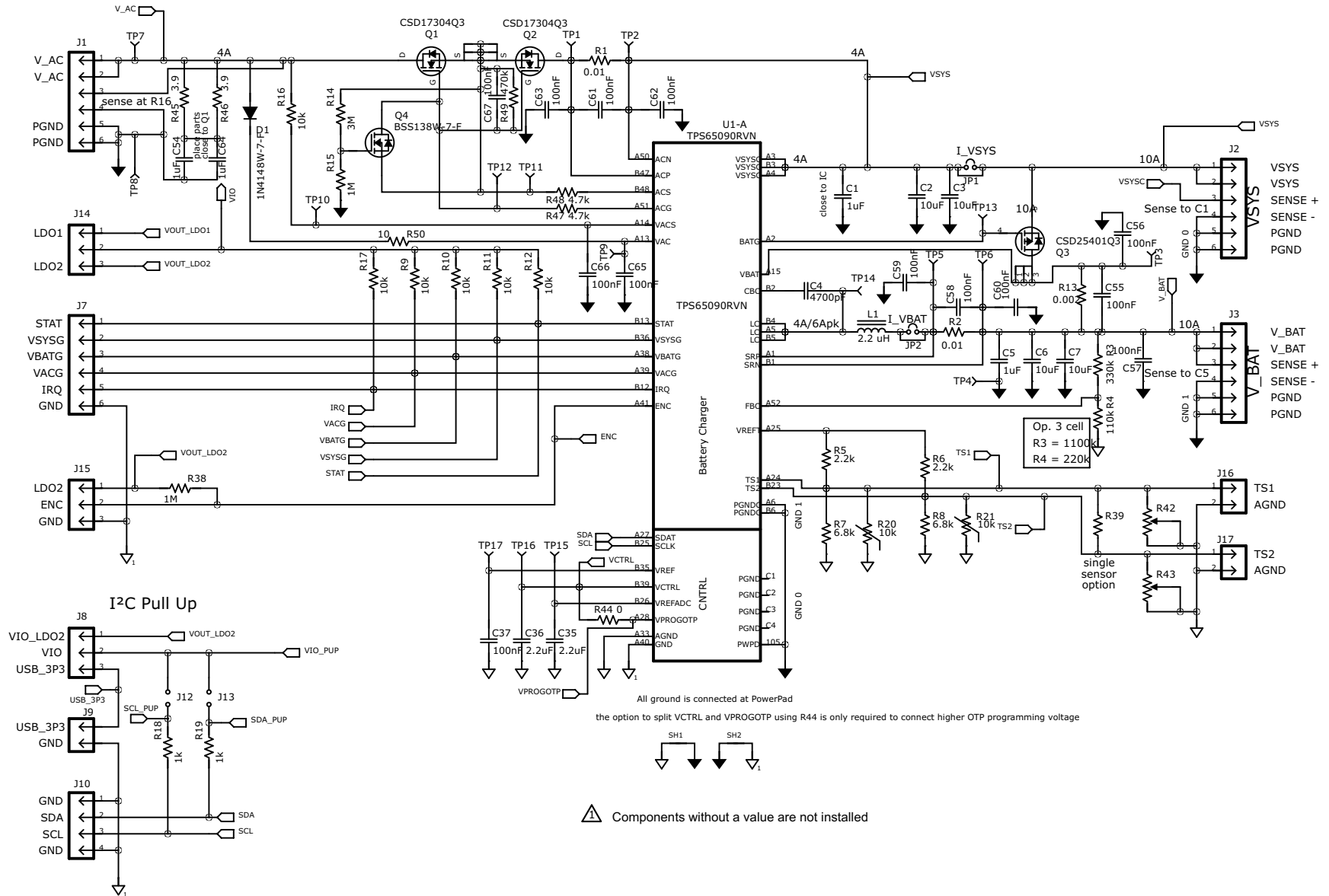


Figure 2. TPS65090EVM Schematic Charger or Power Path and Configuration

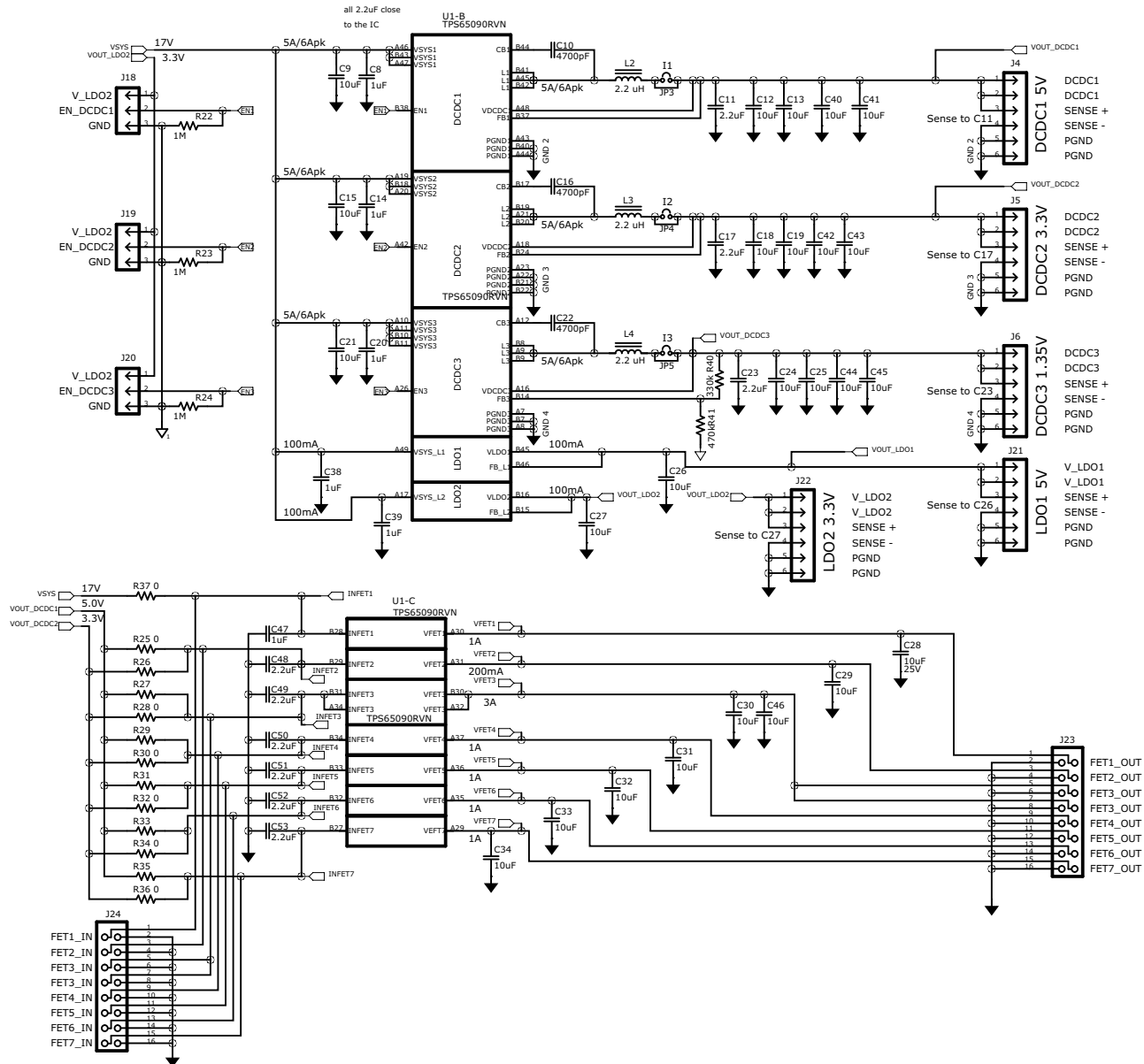


Figure 3. TPS65090EVM Schematic Converters and Load Switches

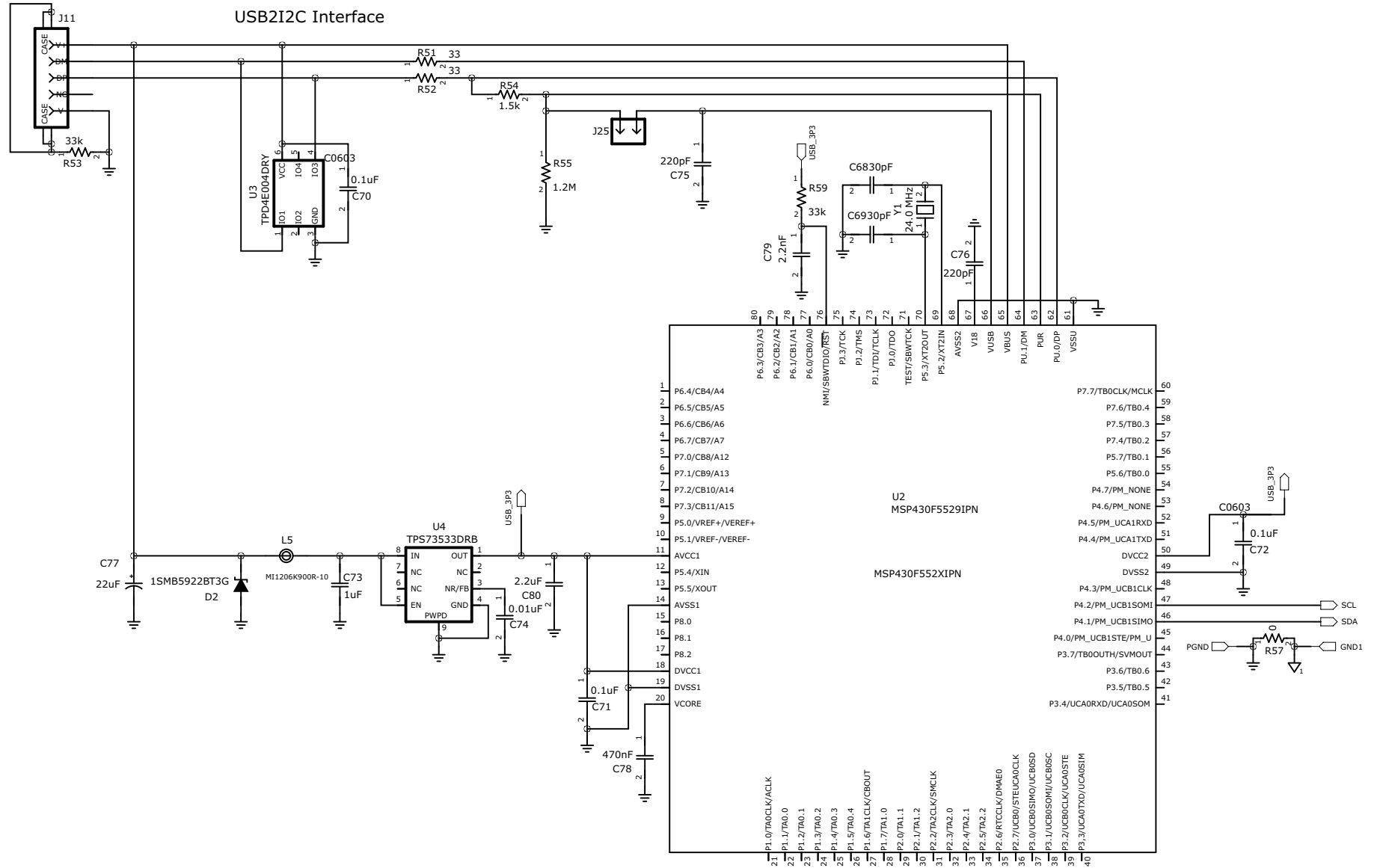
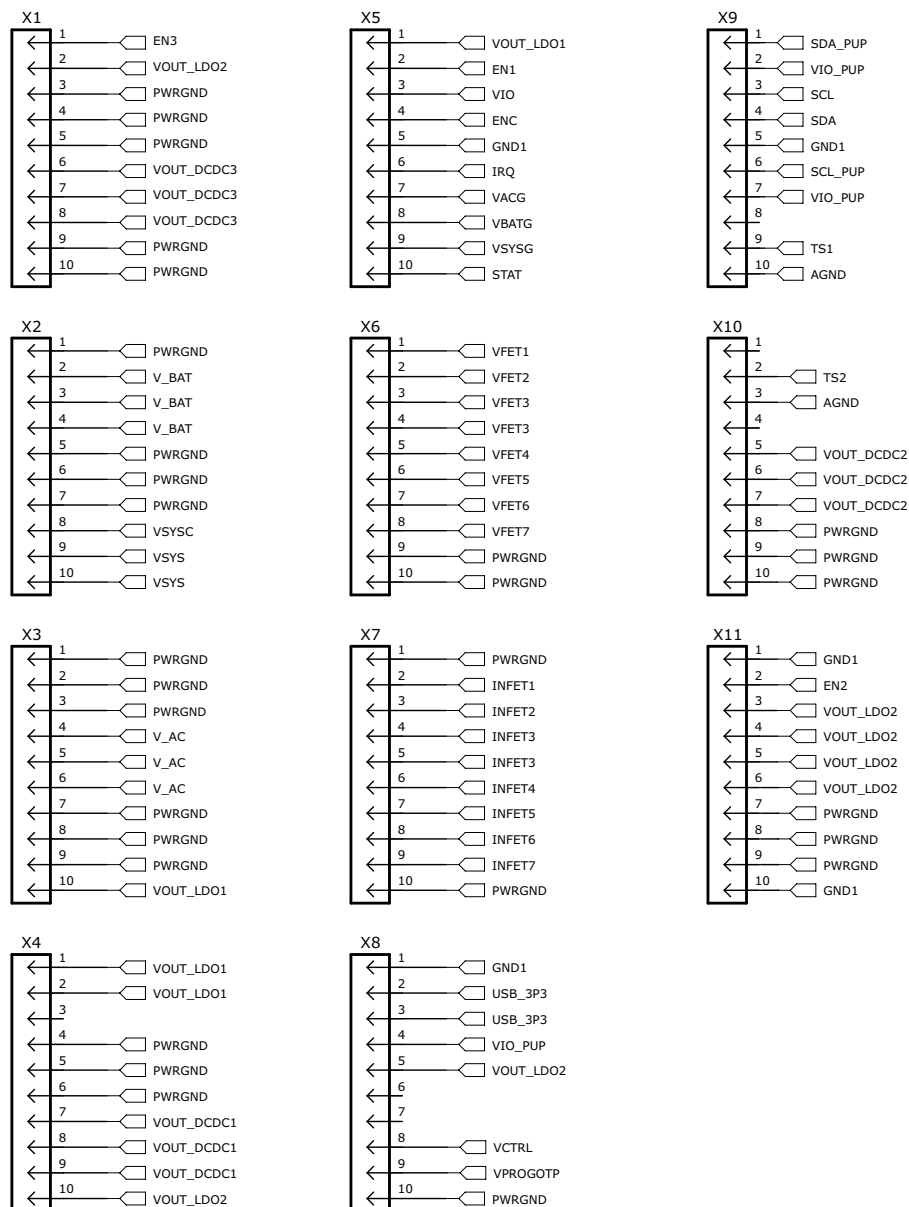


Figure 4. TPS65090EVM Schematic USB to I²C Interface


Figure 5. TPS65090EVM Schematic Test Pads

6 Board Layout

This section provides the EVM board layout and illustrations.

Board layout is critical for all high-frequency, switch-mode power supplies. The following figures show the board layout for the EVM printed-circuit board. The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance.

Careful attention has been given to the routing of high-frequency current loops and a single-point grounding scheme is used. See the data sheet for specific layout guidelines.

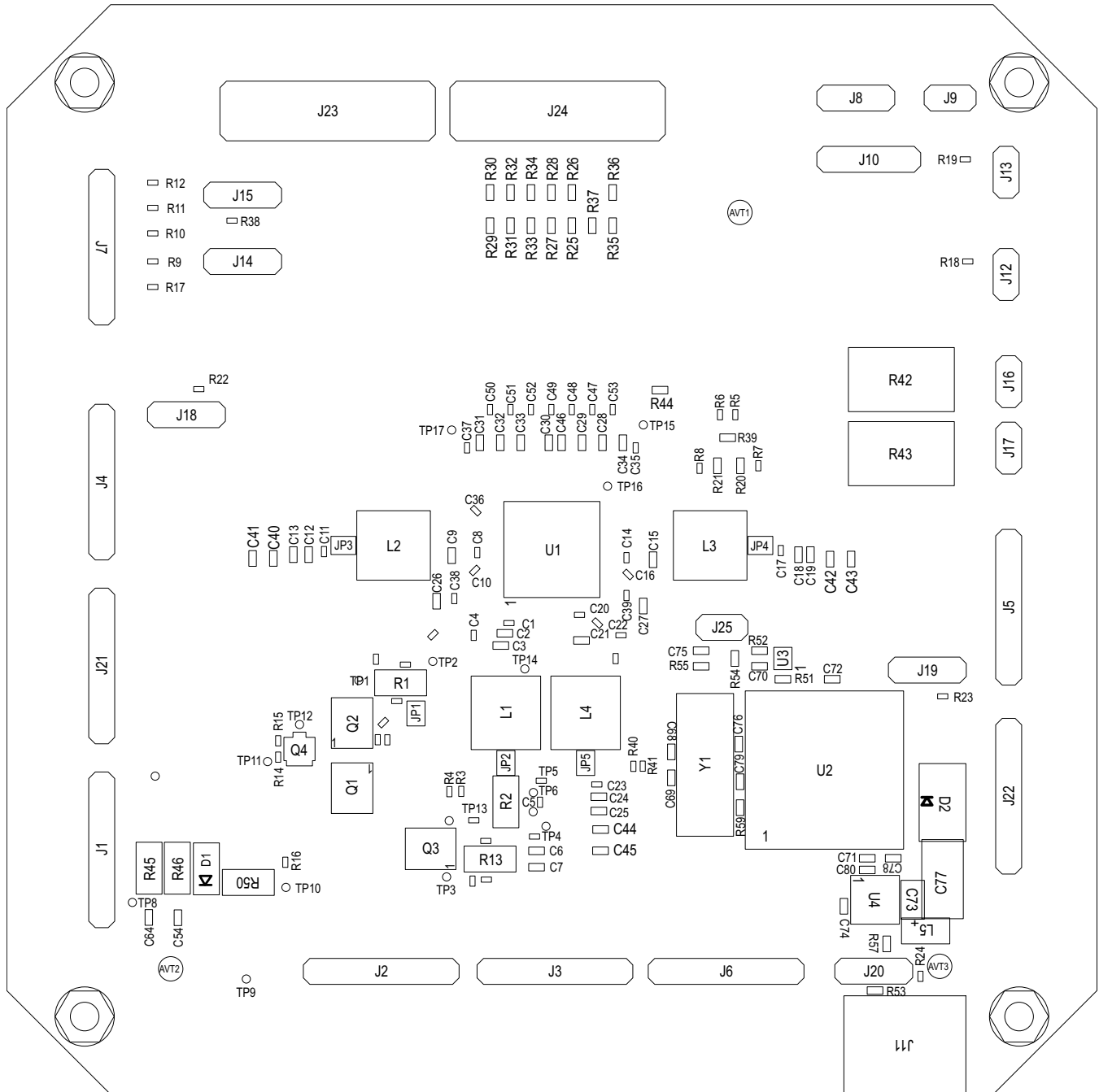


Figure 6. TPS65090EVM Board Layout, Top Assembly

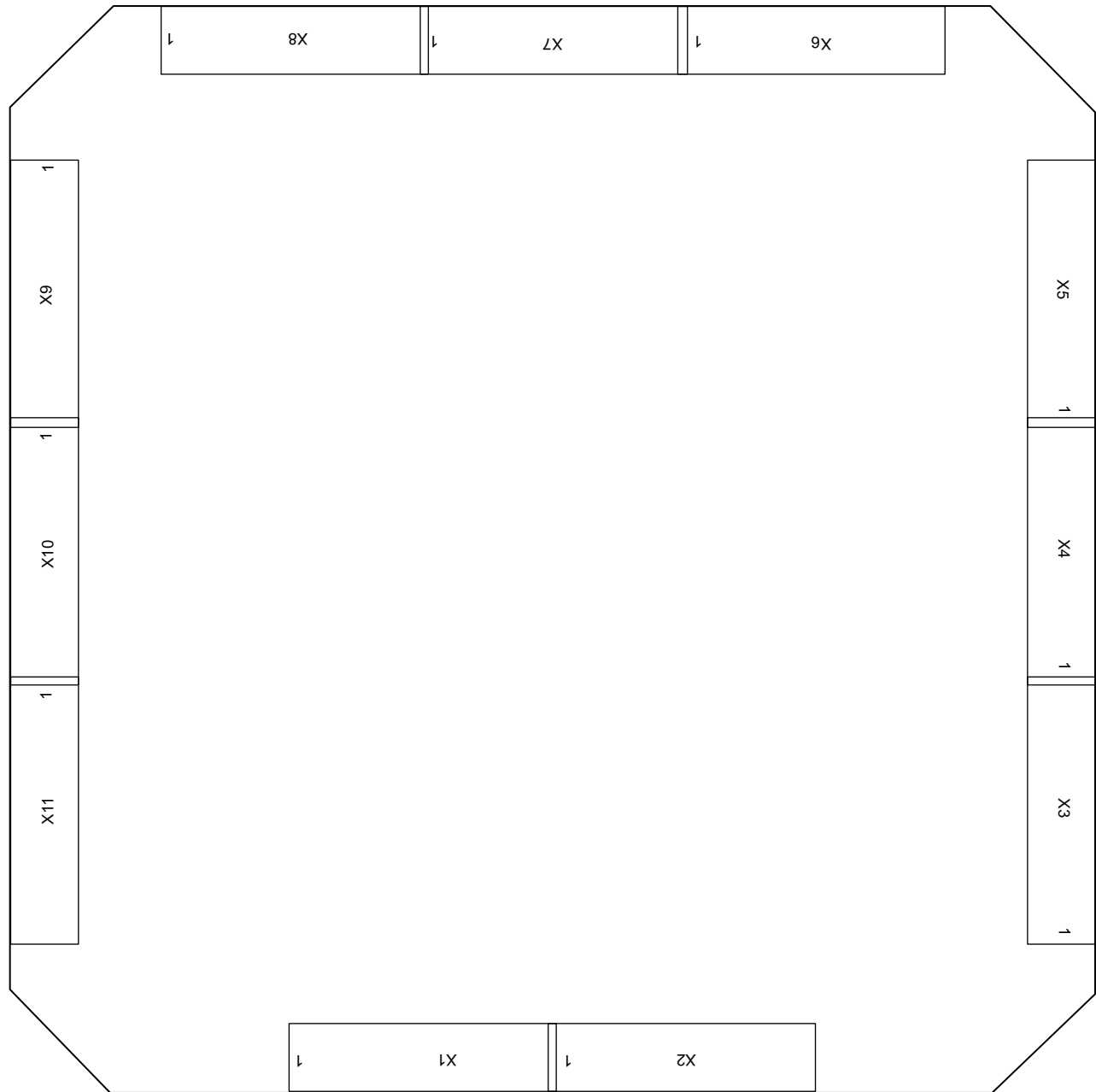


Figure 7. TPS65090EVM Board Layout, Bottom Assembly (mirrored)

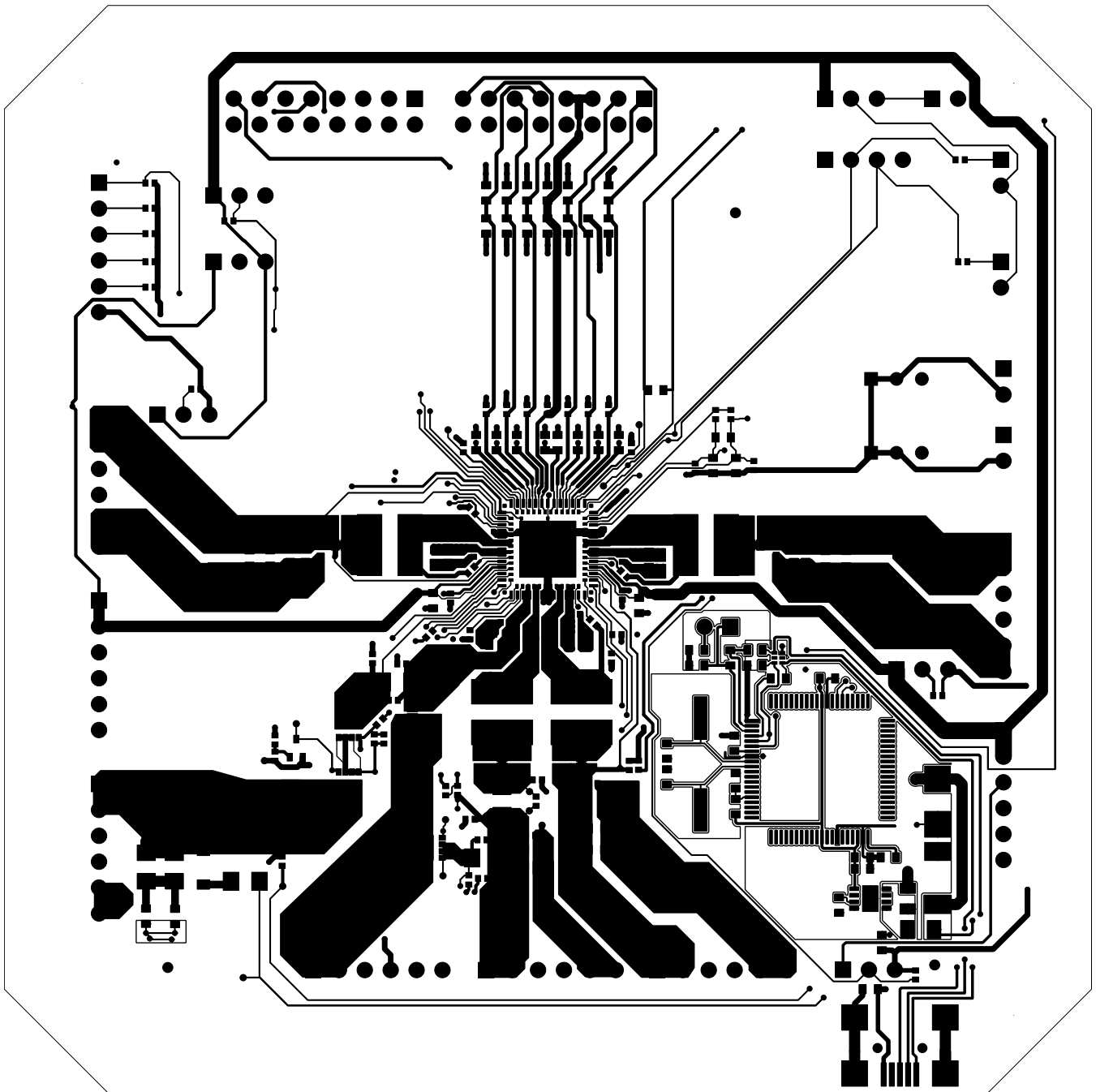


Figure 8. TPS65090EVM Board Layout, Top

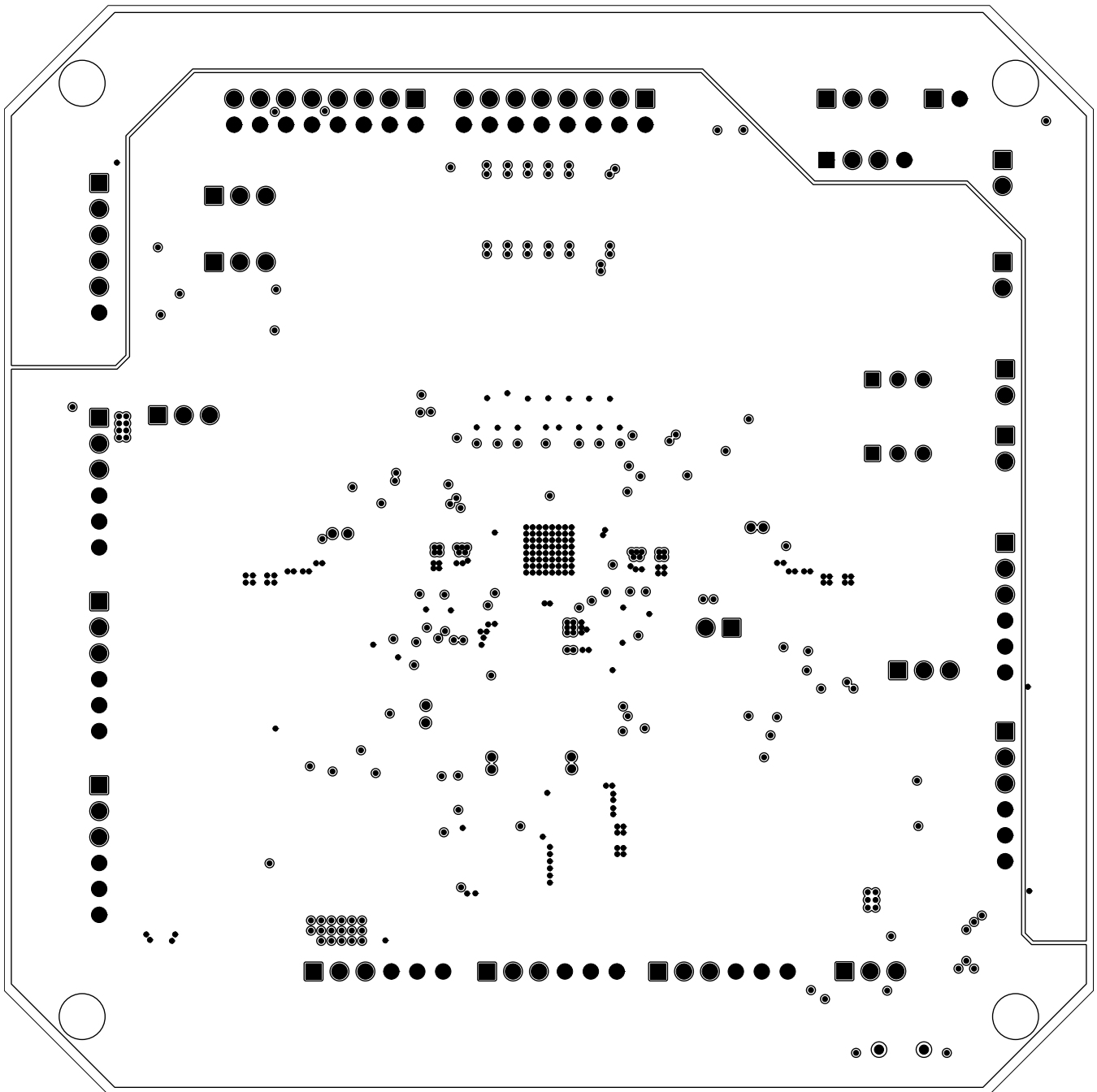


Figure 9. TPS65090EVM Board Layout, Internal 2

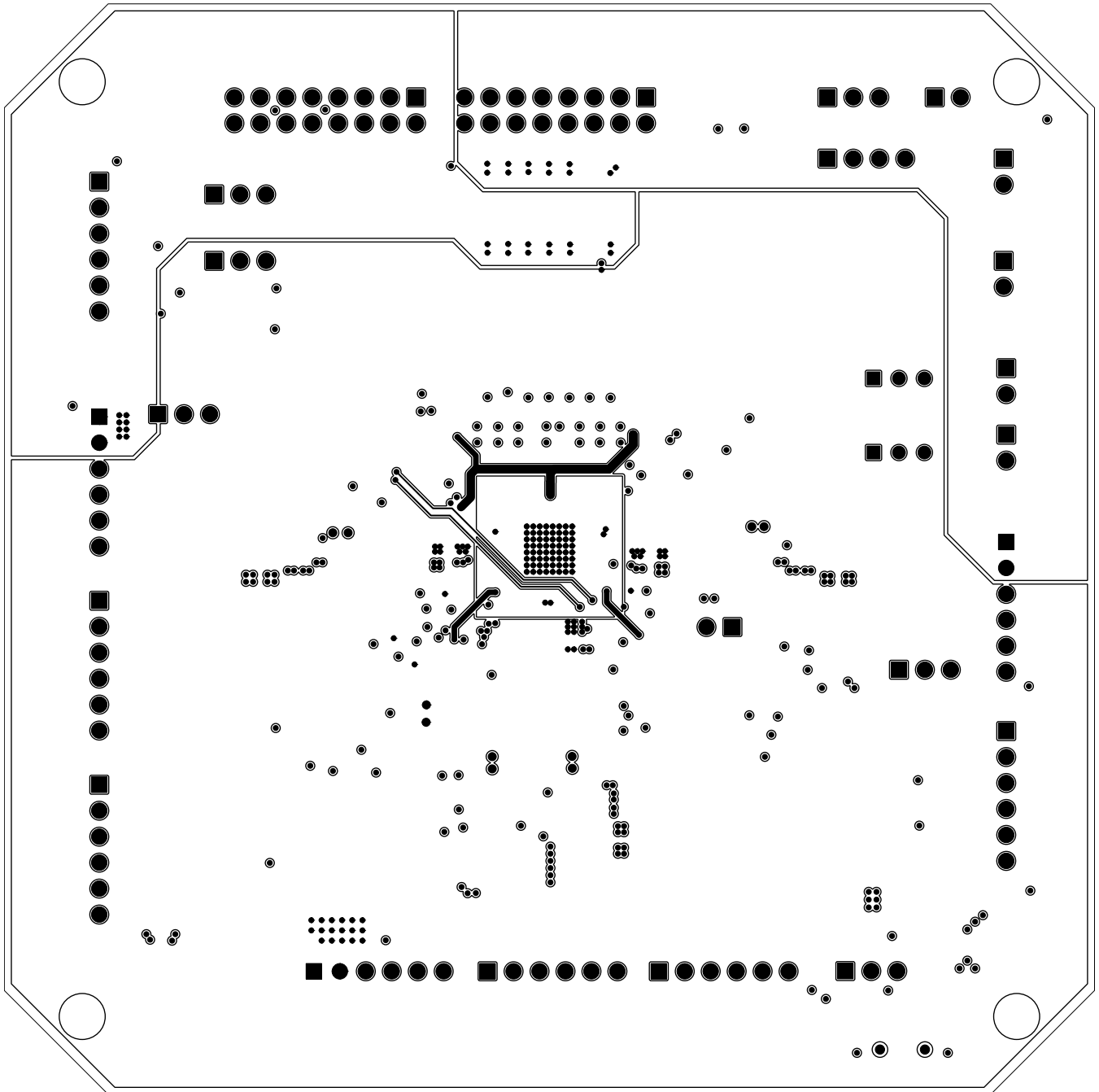


Figure 10. TPS65090EVM Board Layout, Internal 3

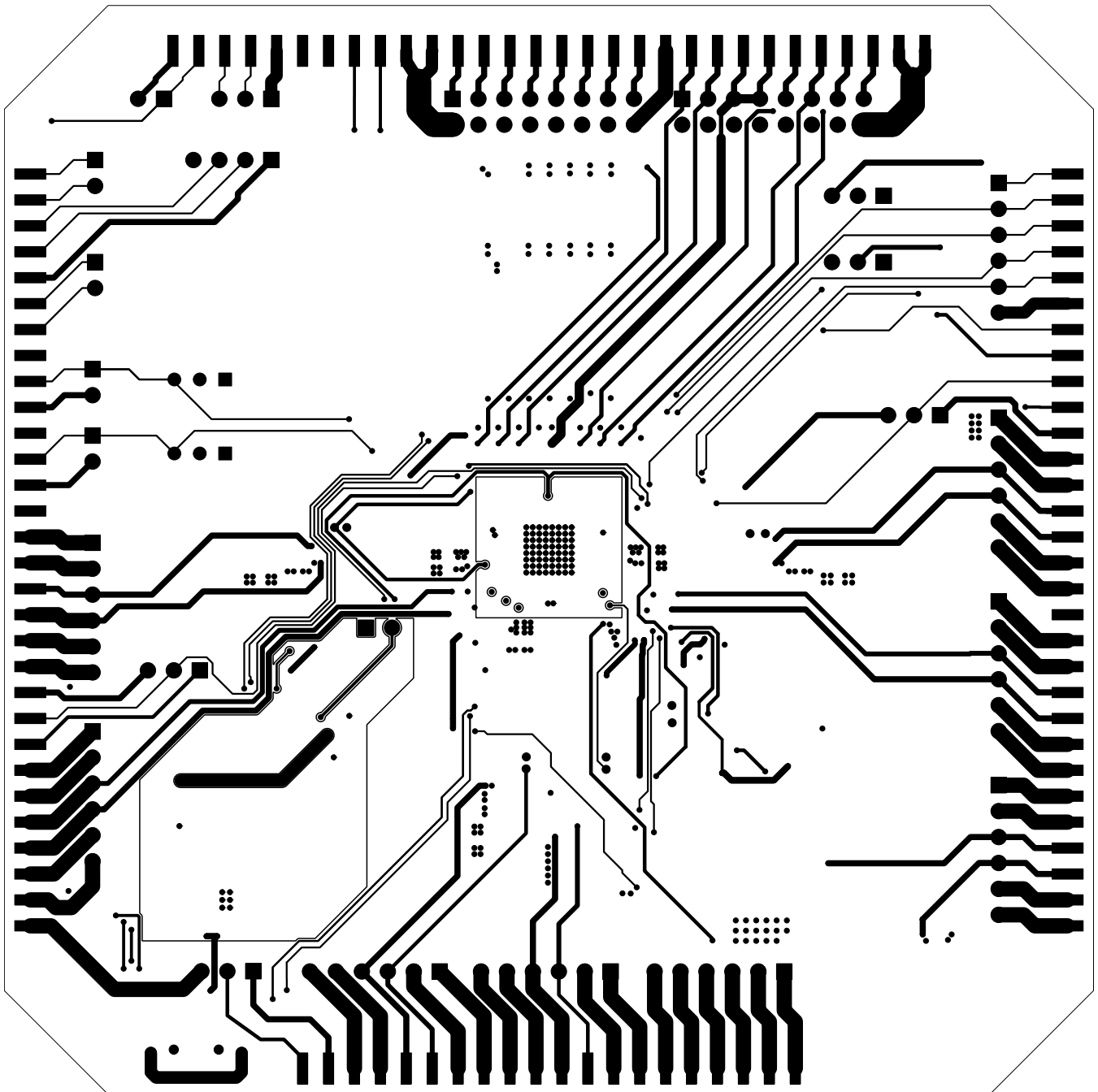


Figure 11. TPS65090EVM Board Layout, Bottom (mirrored)

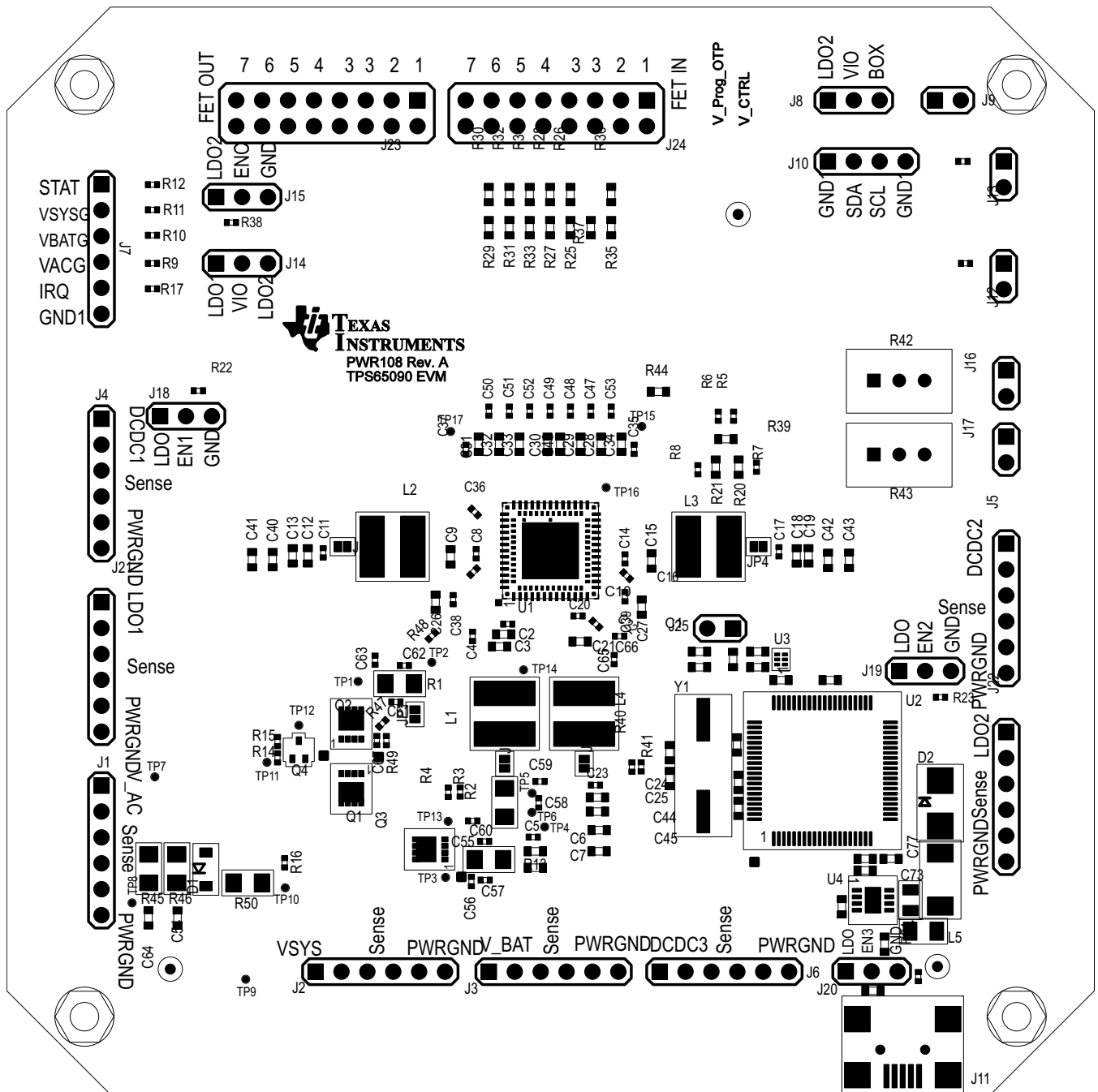


Figure 12. TPS65090EVM Board Layout, Top Silkscreen

7 Bill of Materials

This EVM contains many components that are not necessary for an end-product. These additional components are added to simplify evaluation of the IC. The first table includes required materials for functionality of the TPS65090 and the second table contains the additional materials added for evaluation.

Table 2. TPS65090 Solution, Required Components

Count	RefDes	Value	Description	Size	Part Number	MFR
8	C1, C5, C8, C14, C20, C38, C39, C47	1 μ F	Capacitor, ceramic, X5R, 25 V, 20%	0402	GRM155R61E105MA12	Murata
11	C11, C17, C23, C35, C36, C48, C49, C50, C51, C52, C53	2.2 μ F	Capacitor, ceramic, X5R, 6.3 V, 10%	0402	GRM155R61A225KE95	Murata
29	C2, C3, C6, C7, C9, C12, C13, C15, C18, C19, C21, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C40, C41, C42, C43, C44, C45, C46	10 μ F	Capacitor, ceramic, X5R, 25 V, 10%	0603	GRM188R61E106MA73	Murata
13	C37, C55, C56, C57, C58, C59, C60, C61, C62, C63, C65, C66, C67	100 nF	Capacitor, ceramic, 25 V, X5R, 20%	0402	STD	STD
4	C4, C10, C16, C22	4700 pF	Capacitor, ceramic, 50 V, X5R, 10%	0402	STD	STD
2	C54, C64	1 μ F	Capacitor, ceramic, 25 V, X5R, 10%	0603	GRM188R61E105KA12D	Murata
1	D1	1N4148W-7-F	Diode, signal, 300 mA, 75 V, 350 mW	SOD-123	1N4148W-7-F	Diodes
4	L1, L2, L3, L4	2.2 μ H	Inductor, power, 9.2 A, \pm 20%	5 x 5 mm	XAL5030-222ME	Coilcraft
2	Q1, Q2	CSD17304Q3	MOSFET, NChannel, 30 V, 56 A, 9.8 m Ω	QFN3.3x3.3 mm	CSD17304Q3	TI
1	Q3	CSD25401Q3	MOSFET, PChannel, -20 V, 60 A, 8.7 m Ω	QFN3.3X3.3mm	CSD25401Q3	TI
1	Q4	BSS138W-7-F	MOSFET, NChannel, 50 V, 200 mA	SOT323	BSS138W-7-F	Diodes
2	R1, R2	0.01 Ω	Resistor, chip, 1/4 watt, 1%	1206	WSL1206R0100FEA	Vishay
1	R13	0.002 Ω	Resistor, chip, 3/4 watt, 1%	1206	PMR18EZPFV2L00	Rohm
1	R14	3 m Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
1	R15	1M	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R18, R19	1 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R20, R21	10 k Ω	Thermistor, NTC, 10 k Ω , 1%	0603	NTCS0603E3103FLT	Vishay
2	R3, R40	330 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
1	R4	110 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R41, R49	470 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R45, R46	3.9 Ω	Resistor, chip, 1/4 watt, \pm 1%	1206	STD	STD
2	R47, R48	4.7 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R5, R6	2.2 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
1	R50	10 Ω	Resistor, chip, 1/4 watt, \pm 1%	1206	STD	STD
2	R7, R8	6.8 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
6	R9, R10, R11, R12, R16, R17	10 k Ω	Resistor, chip, 1/16W, 1%	0402	STD	STD
1	U1	TPS65090RVN	IC, Multi output power management with ADC and battery charger	QFN	TPS65090RVN	TI

Table 3. TPS65090EVM Evaluation Components

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C68, C69	30 pF	Capacitor, ceramic, 50 V, C0G, 10%	0603	STD	STD
3	C70, C71, C72	0.1 µF	Capacitor, ceramic, 16 V, X7R, 10%	0603	STD	STD
1	C73	1 µF	Capacitor, ceramic chip, 10 V, ±10%	0805	STD	STD
1	C74	0.01 µF	Capacitor, ceramic, 16 V, X7R, 10%	0603	STD	STD
2	C75, C76	220 pF	Capacitor, ceramic, 50 V, C0G, 5%	0603	STD	STD
1	C77	22 µF	Capacitor, alum. 10 VDC, ±20%	6032	EEE-1AA220WR	Panasonic
1	C78	470 nF	Capacitor, ceramic, 16 V, X7R, 10%	0603	STD	STD
1	C79	2.2 nF	Capacitor, ceramic, 25 V, X7R, 20%	0603	STD	STD
1	C80	2.2 µF	Capacitor, ceramic, 10 V, X7R, 10%	0603	STD	STD
1	D2	1SMB5922BT3G	Diode, Zener, 7.5 V, 50 mA, 3 W	SMB	1SMB5922BT3G	On Semi
9	J1–J6, J21, J22, J7	PEC06SAAN	Header, male 6 pin, 100-mil spacing,	0.100 in x 6	PEC06SAAN	Sullins
1	J10	PEC04SAAN	Header, male 4 pin, 100-mil spacing,	0.100 in x 4	PEC04SAAN	Sullins
1	J11	1734035-2	Connector, recpt, USB-B, mini, 5 pins, SMT	0.354 x 0.400 in	1734035-2	
2	J23, J24	PEC08DAAN	Header, male 2x8 pin, 100-mil spacing	0.100 in x 2 x 8	PEC08DAAN	Sullins
6	J8, J14, J15, J18–J20	PEC03SAAN	Header, male 3-pin, 100-mil spacing,	0.100 in x 3	PEC03SAAN	Sullins
6	J9, J12, J13, J16, J17, J25	PEC02SAAN	Header, male 2 pin, 100-mil spacing	0.100 in x 2	PEC02SAAN	Sullins
1	L5	MI1206K900R-10	Bead, ferrite, SMT, 90 Ω, 1.5A	1206	MI1206K900R-10	Laird
4	R22, R23, R24, R38	1M	Resistor, chip, 1/16W, 1%	0402	STD	STD
2	R20, R21	10 kΩ	Thermistor, NTC, 10 kΩ, 1%	0603	NTCS0603E3103FLT	Vishay
9	R25, R28, R30, R32, R34, R36, R37, R44, R57	0 Ω	Resistor, chip, 1/16W, 1%	0603	STD	STD
0	R26, R27, R29, R31, R33, R35	0 Ω	Resistor, chip, 1/16W, 1%	0603	STD	STD
0	R39	0 Ω	Resistor, chip, 1/16W, 0.1%	0603	STD	STD
0	R42, R43	50 kΩ	Potentiometer, single slide, 50 kΩ, 0.1 W, 20%		0.378 x 0.217 in	Copal
2	R51, R52	33 Ω	Resistor, chip, 1/16W, 1%	0603	Std	Std
2	R53, R59	33 kΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	R54	1.5 kΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	R55	1.2 MΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	U2	MSP430F5529IPN	IC, mixed signal microcontroller	TQFP-80	MSP430F5529IPN	TI
1	U3	TPD4E004DRY	IC, 4-chan ESD-protection array	SON-6	TPD4E004DRY	TI
1	U4	TPS73533DRB	IC, 500 mA, low quiescent current, ultra-low noise, high PSRR LDO, 3.3 V	SON-8	TPS73533DRB	TI
1	Y1	24.0 MHz	Crystal, SMT quartz crystal	0.484 x 0.190 in	ECS-240-20-5PX-TR	CTS
1	--		PCB, 4.2 in x 4.2 in x 0.062 in		PWR108	Any

8 References

1. *TPS65090 High Input Voltage Frontend PMU for Mobile Computer*, ([SLVSAU3](#))

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

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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2. 実験局の免許を取得後ご使用いただく。
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EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

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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STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.
 - 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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
 - 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.
3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

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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 WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (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 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.
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- 8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS 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.
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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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