SMP-TPS7A4001-MVK User's Guide

User's Guide

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SMP-TPS7A4001-MVK User's Guide

1 Introduction

This document discusses the Modular and Versatile Reference Kit (MAVRK) TPS7A4001 low-dropout linear regulator (LDO) submodule. After reading this guide, a developer should understand the features of the SMP-TPS7A4001-MVK. For more information on the MAVRK system, see the MAVRK Introduction page.

2 EVM Overview

The SMP-TPS7A4001-MVK highlights the TPS7A4001 100-V input, 50-mA LDO. This submodule is intended to convert 7 to 100 V DC to voltages down to 1.175 V on MAVRK PMU modules, such as the PMU-CARRIER-MVK. The default output voltage for this module is 12 V DC.

2.1 EVM Description

Figure 1 shows the SMP-TPS7A4001-MVK submodule.

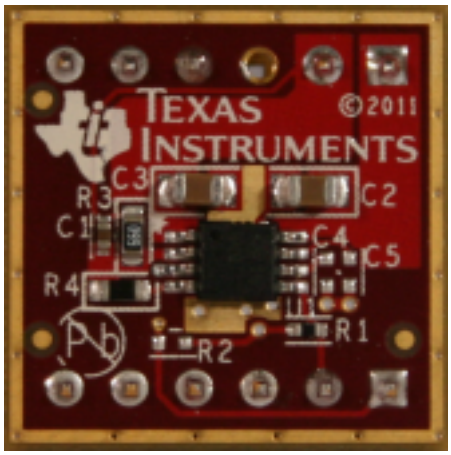

Figure 1. SMP-TPS7A4001-MVK Submodule

The SMP-TPS7A4001-MVK contains the TPS7A4001 integrated circuit and all other onboard components necessary to generate 12 V from a source of up to 100 V. The SMP-TPS7A4001-MVK can be used with a PMU-CARRIER-MVK carrier board to evaluate the TPS7A4001 performance as part of a power-management system. An onboard I²C™ temperature sensor can report the board temperature to the carrier board.

PowerPAD is a trademark of Texas Instruments.
I²C is a trademark of Phillips Semiconductor.

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2.2 Features

2.2.1 TPS7A4001

- Very high maximum input voltage: 100 V
- Wide input voltage range: 7 V to 100 V
- Accuracy:
  - Nominal: 1%
  - Over line, load, and temperature: 2.5%
- Low quiescent current: 25 µA
- Quiescent current at shutdown: 4.1 µA
- Maximum output current: 50 mA
- CMOS logic-level-compatible enable pin
- Adjustable output voltage from aprroximately 1.175 V to 90 V
- Stable with ceramic capacitors:
  - Input capacitance: ≥ 1 µF
  - Output capacitance: ≥ 4.7 µF
- Dropout voltage: 290 mV
- Built-in current-limit and thermal shutdown protection
- Package: high thermal performance MSOP-8 PowerPAD™
- Operating temperature range: –40°C to 125°C

2.2.2 SMP-TPS7A4001-MVK

- Default 12-V output
- Onboard TMP103 I^2C temperature sensor
- Compatible with MAVRK PMU carrier boards
- Breadboard compatible with 0.1-inch headers

2.3 Featured Applications

The SMP-TPS7A4001-MVK submodule can be used on the following applications:

- Microprocessors and microcontrollers powered by industrial buses with high-voltage transients
- Industrial automation
- Telecommunications infrastructure
- Automotive
- Power over Ethernet (PoE)
- LED lighting
- Bias power supplies

2.4 Highlighted Products

The SMP-TPS7A4001-MVK submodule highlights the following devices:

- TPS7A4001 100-V input, 50-mA, single-output LDO
- TMP103 digital temperature sensor with I2C/SMBUS expanded interface

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2.5 Block Diagram

Figure 2 shows the SMP-TPS7A4001-MVK block diagram.

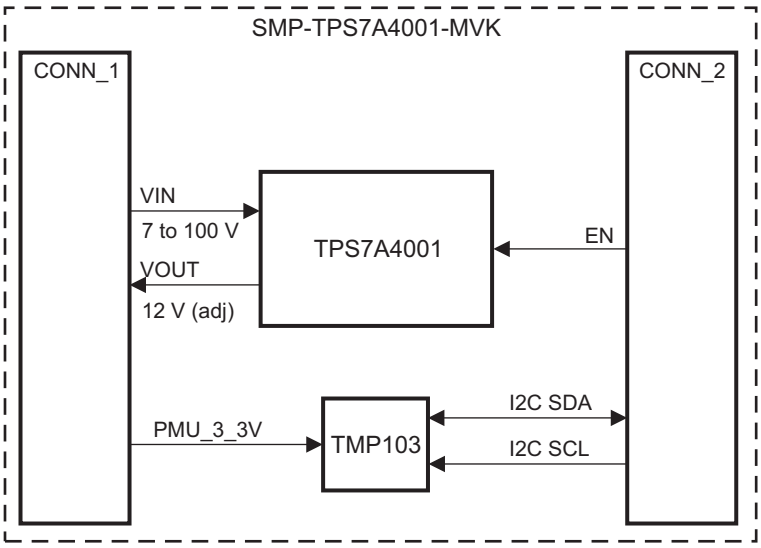

Figure 2. SMP-TPS7A4001-MVK Block Diagram

2.6 EVM Wiki

The most up-to-date information on this module is located on the SMP-TPS7A4001-MVK MAVRK submodule wiki page.

2.7 EVM Landing Page

Ordering information and availability of this module is located on the SMP-TPS7A4001-MVK MAVRK submodule tool folder.

3 Hardware Description

3.1 Power Requirements

The SMP-TPS7A4001-MVK can accept an input of 7 to 100 V. By default, the SMP-TPS7A4001-MVK generates 12 V on the output. The output voltage can be modified by adjusting feedback resistors R_3 and R_4, as shown in Equation 1.

$$R_3 = R_4 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$

Where V_{REF} = 1.173 V. (1)

To ensure stability under no-load conditions, this resistive network must provide a current equal to or greater than 10 mA.

$$\left(\frac{V_{OUT}}{R_3 + R_4} \right) \geq 10\ \mu A$$

(2)

The minimum input voltage required for regulation is the output voltage plus the dropout voltage of the LDO, shown in Figure 3.

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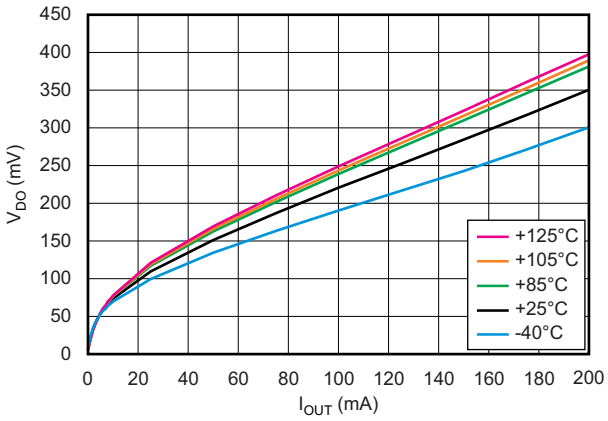

Figure 3. TPS7A4001 Dropout Voltage Versus Output Current

The output current of the SMP-TPS7A4001-MVK must not exceed 50 mA. Due to the small PCB area of the submodule, it is recommended not to exceed 0.75 W of power consumption on the board. The power consumption can be estimated as $(V_{IN} – V_{OUT}) \times I_{OUT}$. The onboard temperature sensor can measure the temperature rise at different power levels.

The SMP-TPS7A4001-MVK can be used in a breadboard if pin 4 of CONN_1 (PMU_3_3V) is tied to a pullup voltage within the enable (EN) voltage range of the device. To avoid damage to the onboard temperature sensor, this voltage must not exceed 3.6 V. For connector pinout information, see the Hardware Design Guide for MAVRK PMU DC-DC Modules.

3.2 Connector Signal Descriptions

For information about the SMP-TPS7A4001-MVK connector pinouts, see the Hardware Design Guide for MAVRK PMU DC-DC Submodules.

3.3 Getting Started: Configuring the EVM

The SMP-TPS7A4001-MVK should be connected to a DC-DC converter slot on a MAVRK PMU carrier board, such as the PMU-CARRIER-MVK. The carrier board voltage and current limits must not be exceeded when using this module. For detailed setup information, see the Configuring Power Submodules on a PMU Carrier Board page.

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4 Board Files

4.1 Bill of Materials (BOM)

Download PDF of the bill of materials.

Table 1. SMP-TPS7A4001-MVK Bill of Materials

Item	Quantity	Reference Designator	Value	Part Description	Temperature °C	Manufacturer	Manufacturer Part Number
1	1	C1	10 nF	Capacitor, Ceramic, 10 nF, 25 V, ±10%, X7R, 0402	–55 to 125	Taiyo Yuden	TMK105B7103KV-F
2	2	C2 C3	10 µF	Capacitor, Ceramic, 10 µF, 25 V, ±10%, X5R, 0805	–55 to 85	Murata Electronics	GRM21BR61E106KA73L
3	1	C4	10 nF	Capacitor, Ceramic, 10 nF ,25 V, ±10%, X7R, 0402	–55 to 125	Taiyo Yuden	TMK105B7103KV-F
4	0	C5	0.001 µF	Capacitor, Ceramic, 1000 pF, 50 V, C0G, 0402	–55 to 125	Murata Electronics	GRM1555C1H102JA01D
5	1	C6	10 nF	Capacitor, Ceramic, 10 nF, 2 5 V, ±10%, X7R, 0402	–55 to 125	Taiyo Yuden	TMK105B7103KV-F
6	1	CONN_1	1 × 6	High temp, 0.100-inch-pitch, 1x6, Overall 430L Post Gold, Single, 230 Post height Pin three is polarized	–55 to 125	Samtec	HMTSW-106-07-G-S-230-003
7	1	CONN_2	1 × 6	High temp, 0.100-inch pitch, 1x6, Overall 430L Post Gold, Single, 230 Post height	–55 to 125	Samtec	HMTSW-106-07-G-S-230
8	1	R1	10 kΩ	Resistor, thick film, 10 kΩ 0.1 W, ±200ppm/°C, ±5%, 0402	±200 ppm/°C	Panasonic - ECG	ERJ-2GEJ103X
9	0	R2	10 kΩ	Resistor, thick film, 10 kΩ, 0.1W, ±200ppm/°,C ±5%, 0402	±200 ppm/°C	Panasonic - ECG	ERJ-2GEJ103X
10	0	R3	200 kΩ	Resistor, thick film, 200 kΩ, 0.1 W, ±100ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF2003V
11	0	R4	113 kΩ	Resistor, thick film, 113 kΩ, 0.1W, ±100ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF1133V
12	1	U2	ADDR = 1110000	IC TEMP SENSOR DGTL SMBUS 4DSBGA - ADDR=1110000	–10 to 100	Texas Instruments	TMP103AYFF
13	1	R3	147 kΩ	Resistor, thick film, 147 kΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF1473V
14	1	R4	133 kΩ	Resistor, thick film 133 kΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF1333V
15	0	R3	475 kΩ	Resistor, thick film, 475 kΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF4753V
16	0	R4	51.1 kΩ	Resistor, thick film, 51.1 kΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Panasonic - ECG	ERJ-3EKF5112V
17	0	LB1	Line 1 Line 2	SMP-TPS7A4001-MVK BOM REV C		Brady	THT-14-423-10
18	0	U1	TPS7A4001DGN	IC REG LDO ADJ 50 mA 8MSOP	–40 to 125	Texas Instruments	TPS7A4001DGN
19	0	R3	1.5 MΩ	Resistor, thick film, 1.5 MΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Vishay/Dale	CRCW06031M50FKEA
20	0	R4	1.37 MΩ	Resistor, thick film, 1.37 MΩ, 0.1 W, ±100 ppm/°C, ±1%, 0603	±100 ppm/°C	Vishay/Dale	CRCW06031M37FKEA

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4.2 Layout (PDF)

Download PDF of additional board layers.

Figure 4 through Figure 13 show the separate SMP-TPS7A4001-MVK board layers.

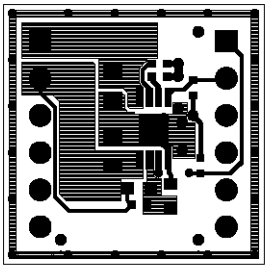

Figure 4. SMP-TPS7A4001-MVK Board Layer 1 – Top Side

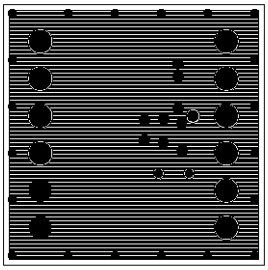

Figure 5. SMP-TPS7A4001-MVK Board Layer 2 – Ground Plane

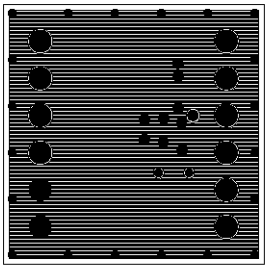

Figure 6. SMP-TPS7A4001-MVK Board Layer 3 – Top Side

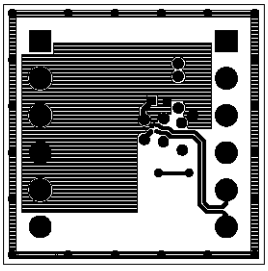

Figure 7. SMP-TPS7A4001-MVK Board Layer 4 – Bottom Side

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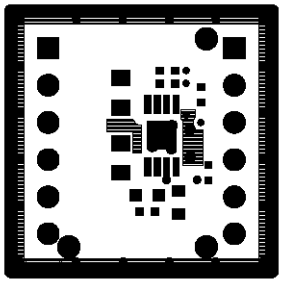

Figure 8. SMP-TPS7A4001-MVK Board Solder Mask – Top Side

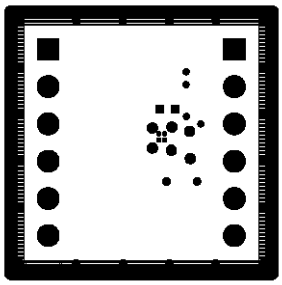

Figure 9. SMP-TPS7A4001-MVK Board Solder Mask – Bottom Side

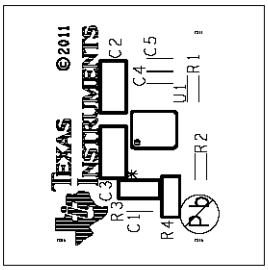

Figure 10. SMP-TPS7A4001-MVK Board Silkscreen – Bottom Side

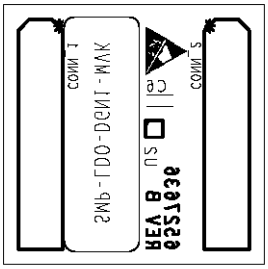

Figure 11. SMP-TPS7A4001-MVK Board Silkscreen – Bottom Side

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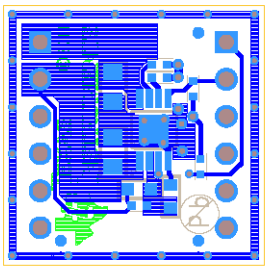

Figure 12. SMP-TPS7A4001-MVK Board Layer 1 – Top Side

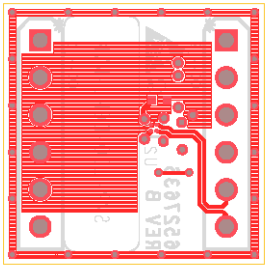

Figure 13. SMP-TPS7A4001-MVK Board Layer 4 – Bottom Side

4.3 Schematics (PDF)

Download PDF of the schematic.

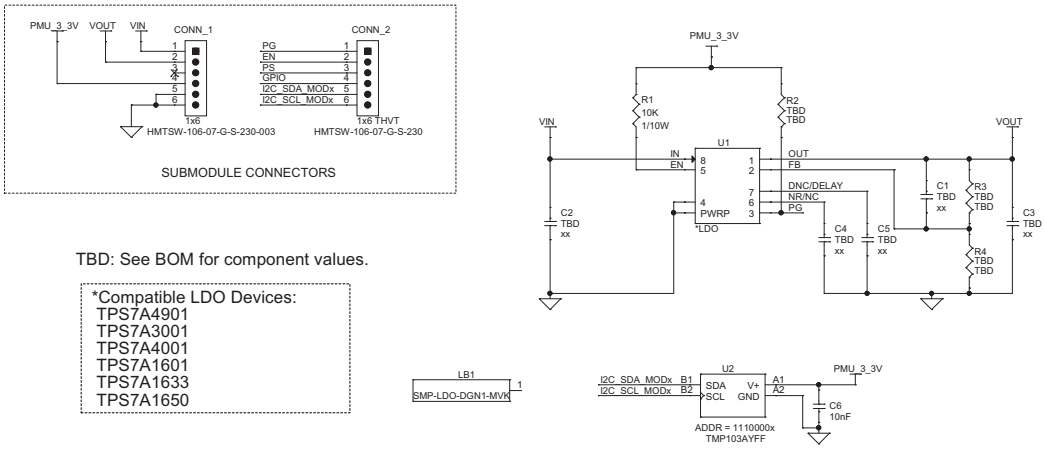

Figure 14. SMP-TPS7A4001-MVK Schematic

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4.4 Fabrication Drawings (PDF)

Download PDF of the fabrication drawing.

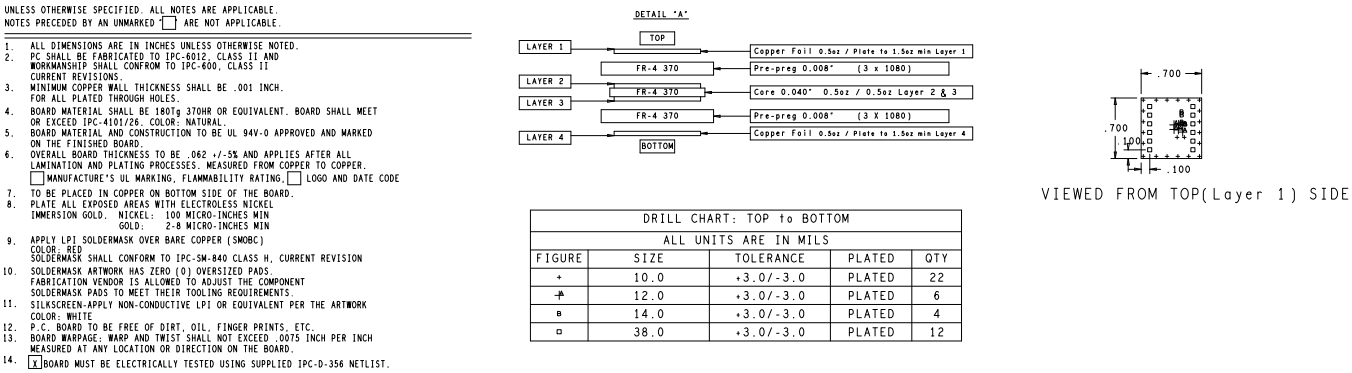

Figure 15. SMP-TPS7A4001-MVK Fabrication Drawing

4.5 Gerber Files

Download a ZIP of the Gerber files.

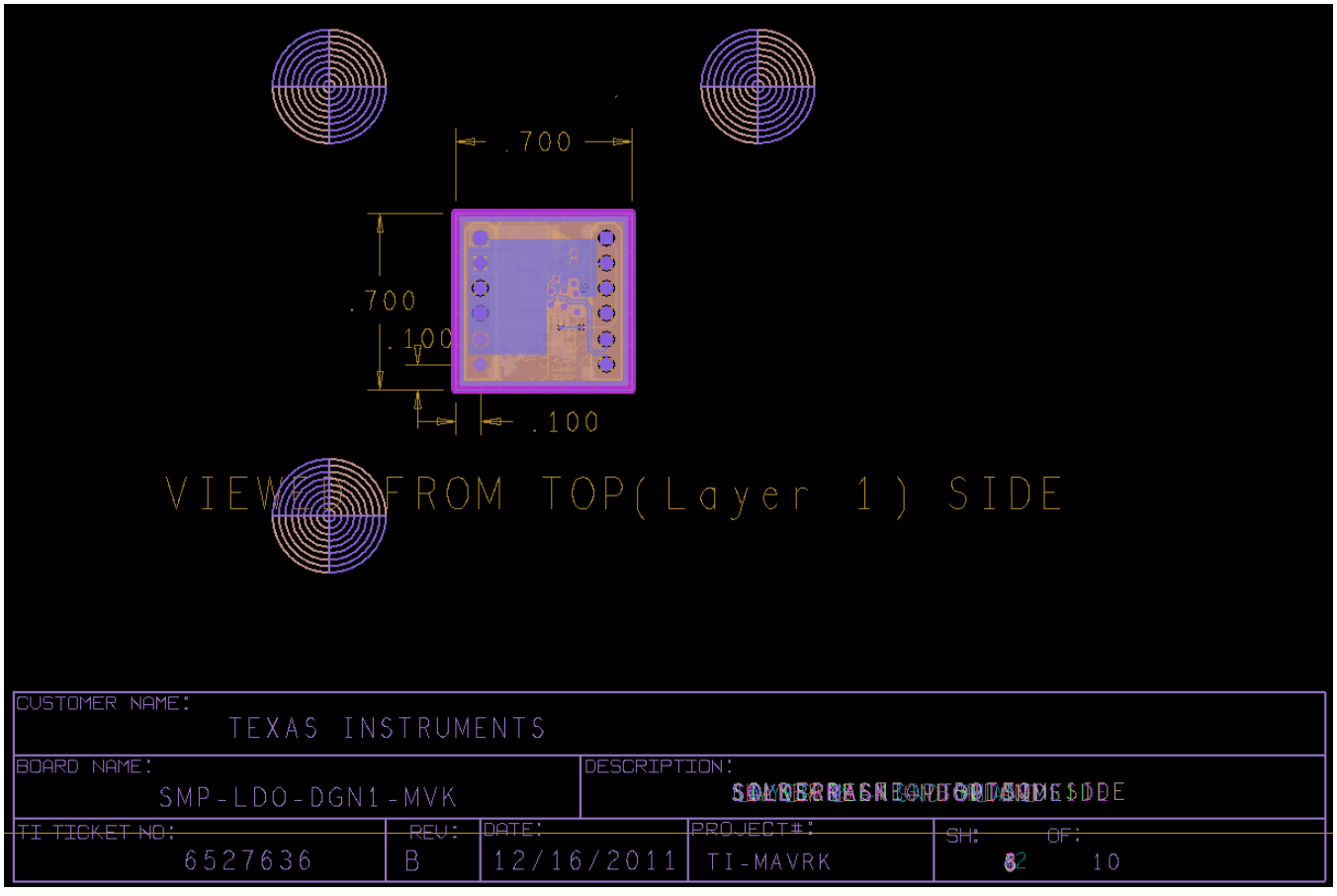

Figure 16. SMP-TPS7A4001-MVK Gerber Files

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4.6 Cadence Schematic and Board Files

Download a ZIP of the Cadence schematic and board files.

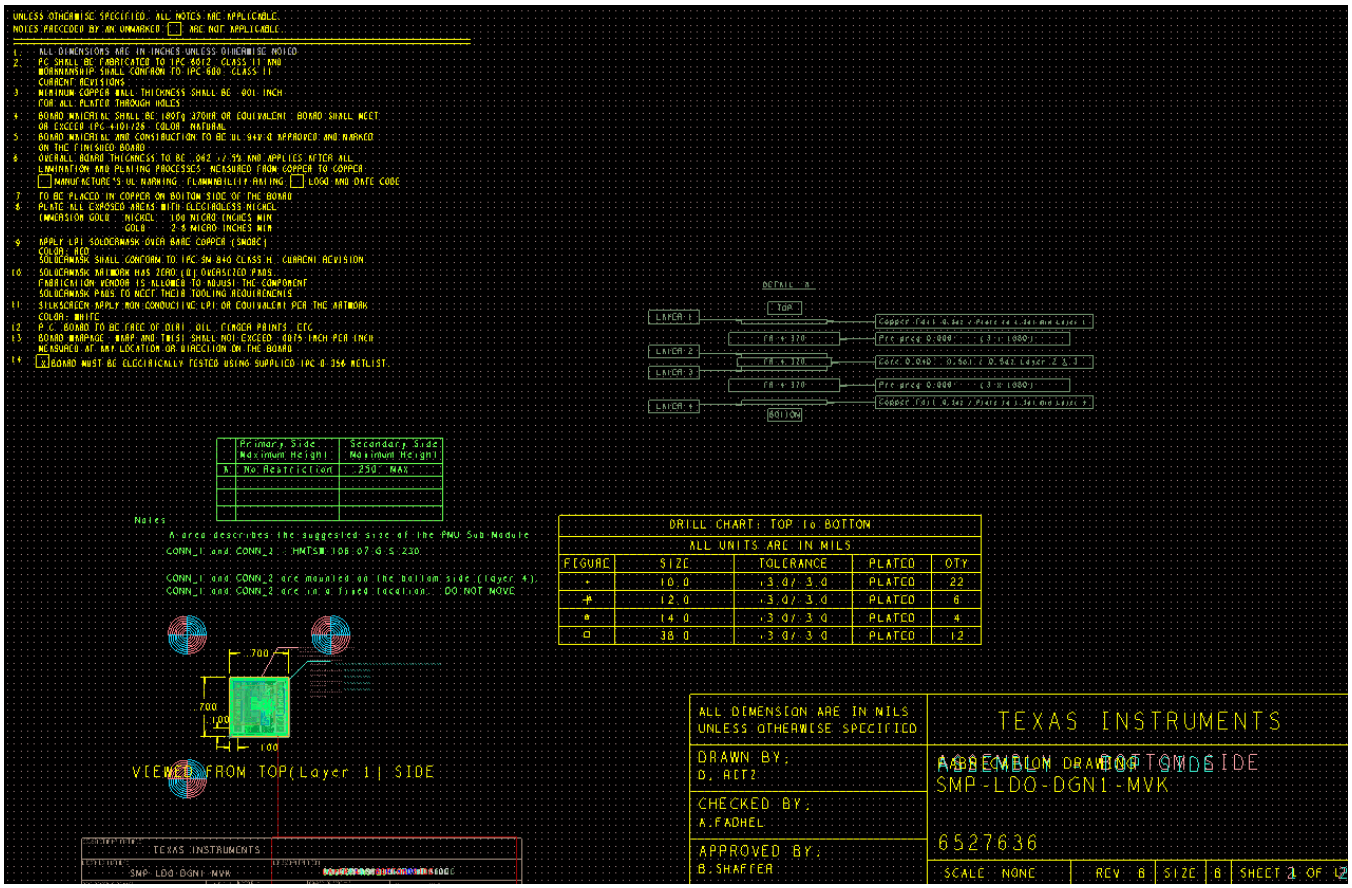

Figure 17. SMP-TPS7A4001-MVK Cadence Schematic and Board Files

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5 Precautions and Certifications

5.1 ESD Precautions

The following guidelines should be followed to avoid ESD damage to the board components:

- Any person handling boards must be grounded either with a wrist strap or ESD protective footwear, used in conjunction with a conductive or static-dissipative floor or floor mat.
- The work surface where boards are placed for handing, processing, testing, and so forth, must be made of static-dissipative material and be grounded to ESD ground.
- All insulator materials either must be removed from the work area or neutralized with an ionizer. Static-generating clothes should be covered with an ESD-protective smock.
- When boards are being stored, transferred between operations or workstations, or shipped, they must be maintained in a Faraday-shield container whose inside surface (touching the boards) is static dissipative.

5.2 Certifications

FCC and ICES standard EMC test report for the SMP-TPS7A4001-MVK submodule, aboard the MB-PRO-MVK motherboard

Eco-Info & Lead-Free Home

RoHS-Compliant Solutions

Statement on Registration, Evaluation, Authorization of Chemicals (REACh)

6 MAVRK Links

6.1 Additonal Information on MAVRK

Visit the MAVRK wiki pages to get comprehensive information on MAVRK.

6.2 MAVRK Questions

Post any questions on the MAVRK Forum.

6.3 Additional Technical Information on MAVRK Hardware

Review the wiki pages related to designing MAVRK hardware.

6.4 Additional Technical Information on MAVRK Software

Review the wiki pages related to working with MAVRK software.

6.5 Obtaining a MAVRK Board

See the MAVRK Starter Kit tool folder page to order a MAVRK starter kit. To order other modules, search for them by name on the TI Web site to find their tool folder pages.

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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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

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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.

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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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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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