

TPS65721EVM

This user's guide provides an overview of the TPS65721EVM evaluation module, a description of the connector and test points, and setup instructions. Also included are the EVM schematic, board art, and bill of materials.

Contents

1	Introduction	2
	1.1 Requirements	2
	1.2 Applications	2
	1.3 Features	2
2	TPS65721EVM Electrical Performance Specifications	3
3	TPS65721EVM Schematic	4
4	Connector and Test Point Descriptions	5
	4.1 Enable Jumpers/Switches	5
5	Setup	7
	5.1 Software Setup	7
	5.2 Hardware Setup	7
	5.3 Running the Software	7
6	TPS65721EVM Assembly Drawings and Layout	13
7	Bill of Materials	16

List of Figures

1	TPS65721EVM Schematic	4
2	Hardware Board Connection	7
3	Starting the Software	8
4	Software Charger View.....	9
5	DCDC1/LDO1 View	10
6	GPIO View.....	11
7	Interrupts View	12
8	TPS65721EVM Component Placement (Viewed From Top)	13
9	TPS65721EVM Top Copper (Viewed From Top)	14
10	TPS65721EVM Bottom Copper (X-Ray View)	15

List of Tables

1	TPS65721EVM Electrical and Performance Specifications	3
2	HPA516B Bill of Materials	16

1 Introduction

The TPS65721EVM-516 evaluation module (EVM) is a fully assembled and tested circuit for evaluating the TPS65721 2-Channel Power Management integrated circuit (IC).

1.1 Requirements

In order to operate this EVM, the following components must be connected and properly configured. All components and connectors are supplied in the EVM except for the host computer and the DC power supply. Software must be downloaded from the TI Web site at www.ti.com.

1.1.1 Software

To download the software that is necessary to operate the TPS65721EVM, check the TPS65721 product folder on the TI Web site (www.ti.com) .

1.1.2 Host Computer

A computer with a USB port is required to operate this EVM. The TPS65721 software runs on a personal computer (PC) and communicates with the EVM via the PC's USB port and the USB-to-GPIO interface.

PC Requirements :

- Windows™ 2000 or XP operating system
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

1.1.3 Power Supply Requirements

A DC power supply capable of delivering 5 V at 1 A is required to operate this EVM.

1.2 Applications

- Bluetooth headsets
- Handheld applications

1.3 Features

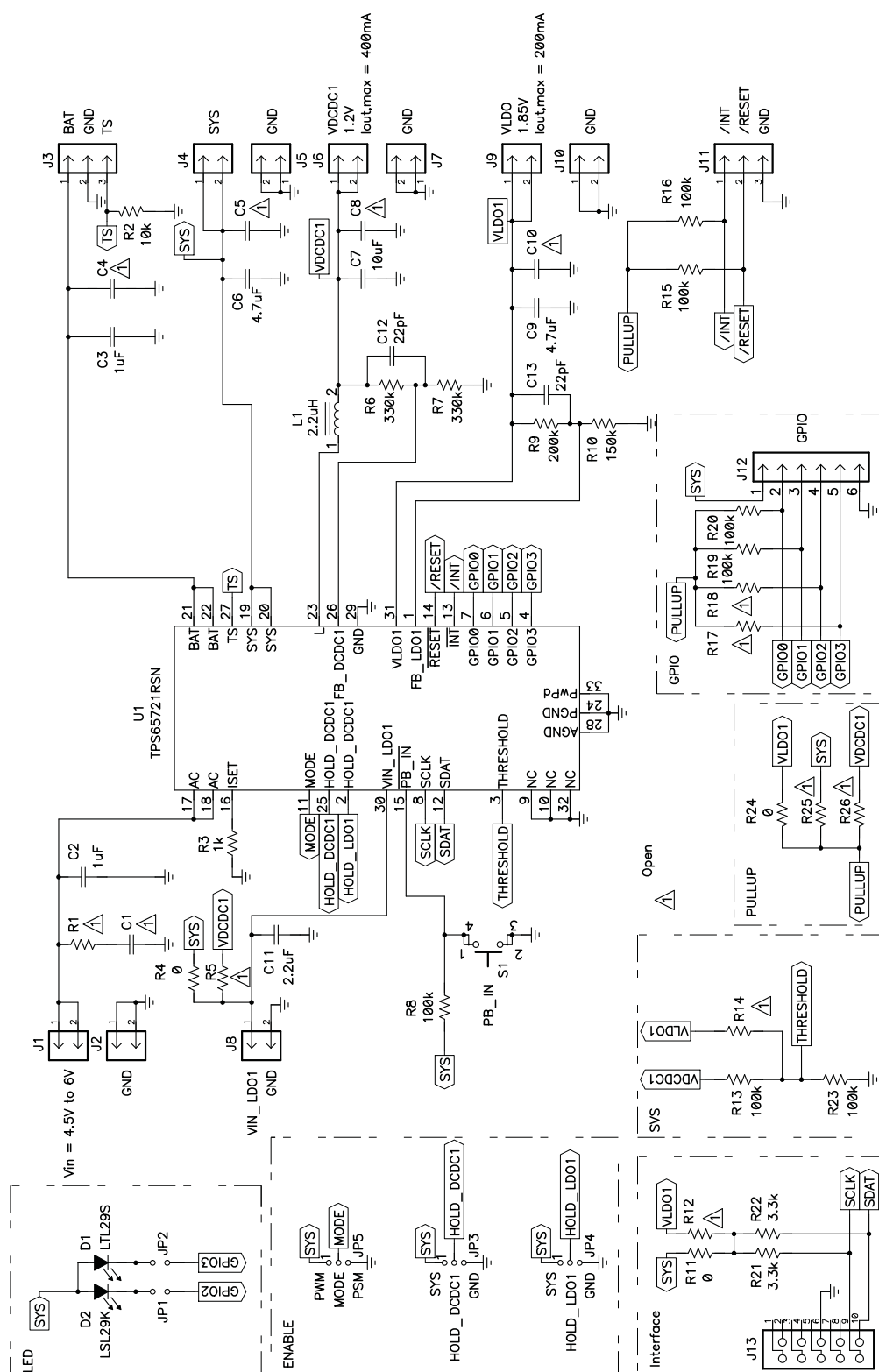
- Input voltage rating
- Output voltage adjustable via I²C™ Interface
- Battery charger with power path management
- 300-mA charge current
- 400-mA step-down converter for TPS65721
- 2.25-MHz switching frequency
- 1 General-purpose 200-mA LDO

2 TPS65721EVM Electrical Performance Specifications

Table 1. TPS65721EVM Electrical and Performance Specifications

Symbol	Parameter	Notes and Conditions	Min	Typ	Max	Unit
Input Characteristics						
V _{AC}	Input Voltage AC		4.35		28	V
V _{IN_DCDC1}	Input Voltage DCDC1		2.1		5.6	V
V _{IN_LDO1}	Input Voltage LDO1		1.8		6.6	V
I _{AC,max}	Input Current	Bit <AC input current1, AC input current0> = 00	90	95	100	mA
		Bit <AC input current1, AC input current0> = 01 or 10	450	475	500	
V _{UVLO}	UVLO	V _{AC} rising	3.2	3.3	3.45	V
V _{HYS -UVLO}	UVLO Hysteresis	V _{AC} falling	200		300	mV
Output Characteristics						
V _{SYS}	Voltage range at SYS		2.2		5.6	V
V _{DCDC1}	Output Voltage DCDC1	V _{IN} = Nom, I _{OUT} = Nom		1.2		V
	Output Voltage Accuracy DCDC1	V _{IN} = 2.3V to 5.6V, PFM operation, 0mA to I _{OUT,max}		1%	2%	
			-2%	2%		
	Load Regulation	PWM operation		0.5%		
I _{OUT,DCDC1}	Output Current DCDC1	V _{IN} = MIN to MAX			400	mA
I _{LIMF}	Forward Current Limit high- and low-side MOSFET	V _{IN} = 2.3 V to 5.6 V	625	850	1150	mA
	Dropout Voltage LDO1	V _{IN,LDO} = 2.05 V, I _{OUT} = 200 mA		120		mV
V _{LDO1}	Output Voltage LDO1	V _{IN} = Nom, I _{OUT} = Nom, (including 1% resistor tolerance), as configured on the EVM	1.73	1.8	1.88	V
	Output Voltage Accuracy LDO1		-1.5%		2.5%	
	Output Current of LDO1				200	mA
	Line Regulation LDO1		-1%		1%	
	Load Regulation LDO1		-1%		2%	
Systems Characteristics						
F _{SW}	Switching Frequency		2030	2250	2480	kHz
η _{pk}	Peak Efficiency	V _{IN} = Nom			95%	
η	Full Load Efficiency	V _{IN} = 3.6, V _{OUT} = 1.8, I _{OUT} = 400mA, MIPS25202R2		85%		

3 TPS65721EVM Schematic



For Reference Only, See Table 2 for Specific Values

Figure 1. TPS65721EVM Schematic

4 Connector and Test Point Descriptions

4.1 Enable Jumpers/Switches

4.1.1 J1 – VIN

This header is the positive connection to the input power supply. The power supply must be connected between J1 and J2 (GND). The leads to the input supply must be twisted and kept as short as possible. The input voltage has to be between 4.35 V and 6 V.

4.1.2 J2 – GND

This header is the return connection to the input power supply. Connect the power supply between J2 and J1 (VIN). The leads to the input supply must be twisted and kept as short as possible. The input voltage has to be between 4.35 V and 6 V.

4.1.3 J3 – BAT/GND/TS

Connect your battery's positive connection to pin 1 of J3 and negative connection to pin 2 of J3. The battery thermistor can be connected to pin 3 of J3. If an external thermistor is used, R2 must be removed.

4.1.4 J4 – SYS

This header is the positive output of the power path.

4.1.5 J5 – GND

This header is the negative output of the power path.

4.1.6 J6 – VDCDC1

This header is the positive output of the VDCDC1 step-down converter. The output voltage of DCDC1 can be adjusted to any voltage between 0.6 V and VINDCDC1 with the external voltage divider R7 and R8.

The default setting is 1.2 V. VDCDC1 is capable of sourcing up to 200 mA. A load can be connected between J7 and J8 (GND).

4.1.7 J7 – GND

J8 is the return connection of VDCDC1 output rail. A load can be connected between J8 and J7 (VDCDC1).

4.1.8 J8 – VINLDO/GND

This header is the input supply for the LDO1 on the EVM. VINLDO1 is directly connected to SYS with R4. It also can be connected to VDCDC1 with R5.

An external power supply can be connected between J8 pin 1 (VINLDO) and pin 2 (GND). Note that the resistors R4 and R5 must be removed when supplying the LDO1 from an external power supply.

4.1.9 J9 – VLDO

This header is the positive output of the LDO1 linear regulator. The default output voltage of LDO1 is 1.85 V. VLDO1 can be adjusted via I2C interface in the range between.

LDO1 is capable of sourcing up to 300 mA. A load can be connected between J9 and J10 (GND).

4.1.10 J10 – GND

J10 is the return connection of LDO1 output rail. A load can be connected between J10 and J9 (VDCDC1).

4.1.11 J11 – $\overline{\text{INT}}$ / $\overline{\text{RESET}}$ /GND

J11 pin 1 is connected to the open-drain output $\overline{\text{INT}}$. J11 pin 2 is connected to the open-drain output $\overline{\text{RESET}}$. All open-drain outputs are pulled up with a resistor to the pullup voltage PULLUP. Pullup is connected to VLDO1 with R10 on the EVM. PULLUP also can be connected to VIN and VDCDC1 with the resistors R20 and R21. J13 pin 3 is connected to GND.

4.1.12 J12 – SYS/GPIO0/GPIO1/GPIO2/GPIO3/SYS

Four GPIOs are available on this header.

- J12 pin 1 is connected to the SYS voltage.
- J12 pin 2 is connected to GPIO0.
- J12 pin 3 is connected to GPIO1.
- J12 pin 4 is connected to GPIO2.
- J12 pin 5 is connected to GPIO3.

4.1.13 J13

J13 is the interface connector for the I2C interface. Connect a 10-pin ribbon cable between J13 and the USB-to-GPIO interface.

4.1.14 JP1

JP1 connects the cathode of the LED D2 to GPIO2. If GPIO2 is configured as a current sink, JP1 can be removed to measure the current through the LED with an ammeter.

If GPIO2 is configured as an input or output, JP1 must be removed to disconnect the LED D2.

4.1.15 JP2

JP2 connects the cathode of the LED D1 to GPIO3. If GPIO3 is configured as a current sink, JP2 can be removed to measure the current through the LED with an ammeter.

If GPIO3 is configured as an input or output, JP2 must be removed to disconnect the LED D1.

4.1.16 JP3 – HOLD_DCDC1

Connect a shorting jumper between HOLD_DCDC1 and SYS to enable DCDC1. Note that if a power supply is connected to AC, DCDC1 is enabled independent of the status of HOLD_DCDC1.

If the IC is supplied from BAT, DCDC1 is enabled when $\overline{\text{PB_IN}}$ is pulled low. To keep DCDC1 enabled, HOLD_DCDC1 must be pulled high before $\overline{\text{PB_IN}}$ is released high.

4.1.17 JP4 – HOLD_LDO1

Connect a shorting jumper between HOLD_LDO1 and SYS to enable LDO1. Note that if a power supply is connected to AC LDO is enabled independent of the status of HOLD_LDO1.

If the IC is supplied from BAT, LDO is enabled when $\overline{\text{PB_IN}}$ is pulled low. To keep LDO1 enabled, HOLD_LDO1 must be pulled high before $\overline{\text{PB_IN}}$ is released high.

4.1.18 S1 – PB_IN

This is the Push-Button Input. Pressing S1 pulls $\overline{\text{PB_IN}}$ to GND and therefore enables DCDC1 and LDO1. To keep DCDC1/LDO1 enabled, the individual HOLD pins must be pulled high before $\overline{\text{PB_IN}}$ is released high.

If a power supply is present at AC, both DCDC1 and LDO1 are enabled independent of the HOLD pins.

5 Setup

5.1 Software Setup

To download the software, go the TPS65721 product folder on the TI Web site (www.ti.com). Download the software, and execute it to install the software.

5.2 Hardware Setup

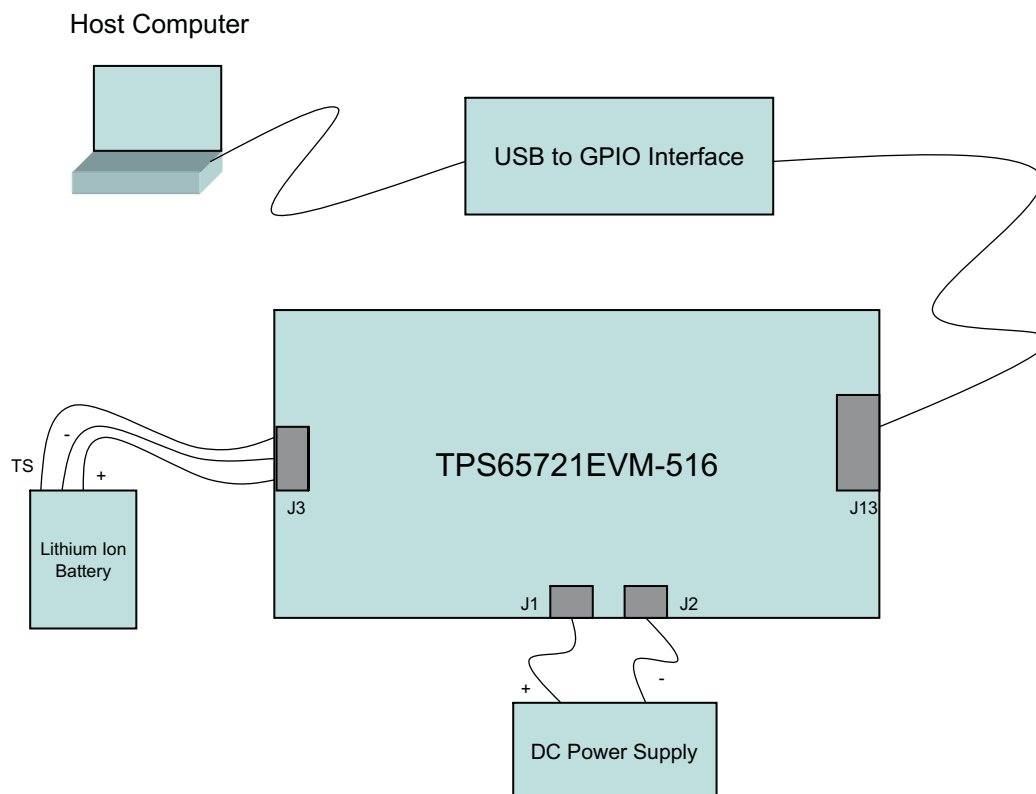


Figure 2. Hardware Board Connection

5.3 Running the Software

Click on the TPS65720_1EVM icon to start the software. If no icon appears on the host computer, then use the start button in the lower left corner of the screen to browse the program folders to find the software. The default directory for software installation is Program Files\Texas Instruments\TPS65720_1EVM.

Once started, the software dialog box appears (see [Figure 3](#)), and asks to select whether a TPS65720 or TPS65721 is connected.

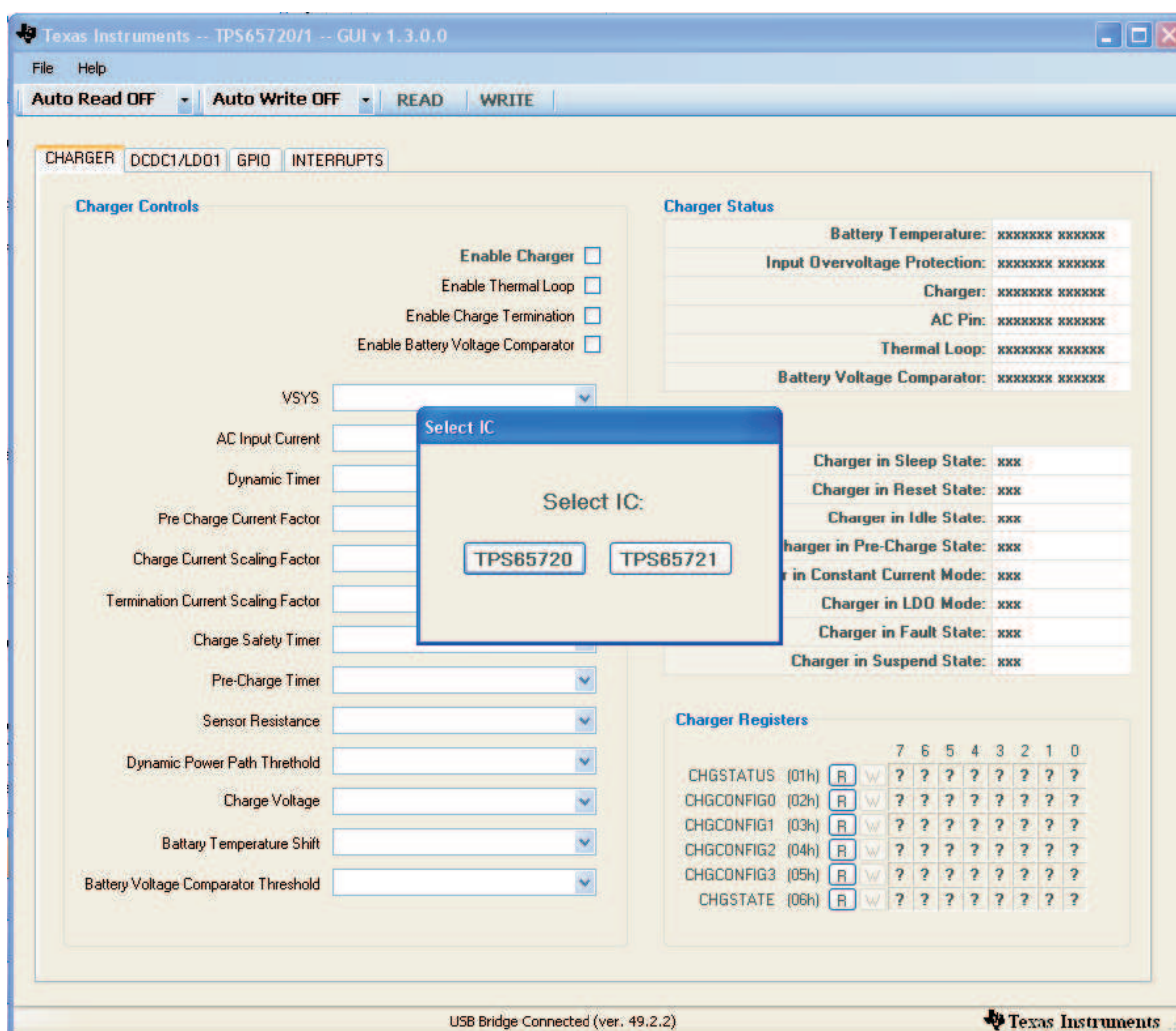


Figure 3. Starting the Software

Once the used device is selected, the software starts up (see Figure 4).

By clicking on the Tabs CHARGER, DCDC1/LDO1, GPIO, and INTERRUPTS, the user can navigate through the different Views.

The window that first appears allows control of all charger settings and shows all the charger status flags. In the CHARGER tab, the user can enable/disable the charger, change charger parameters as regulated output voltage on the Power Path (VSYS), charge voltage, safety timers, etc.

In the lower right corner of the window, all charger-related Charger Registers are displayed.

See the TPS65721 data sheet for detailed description on these registers.

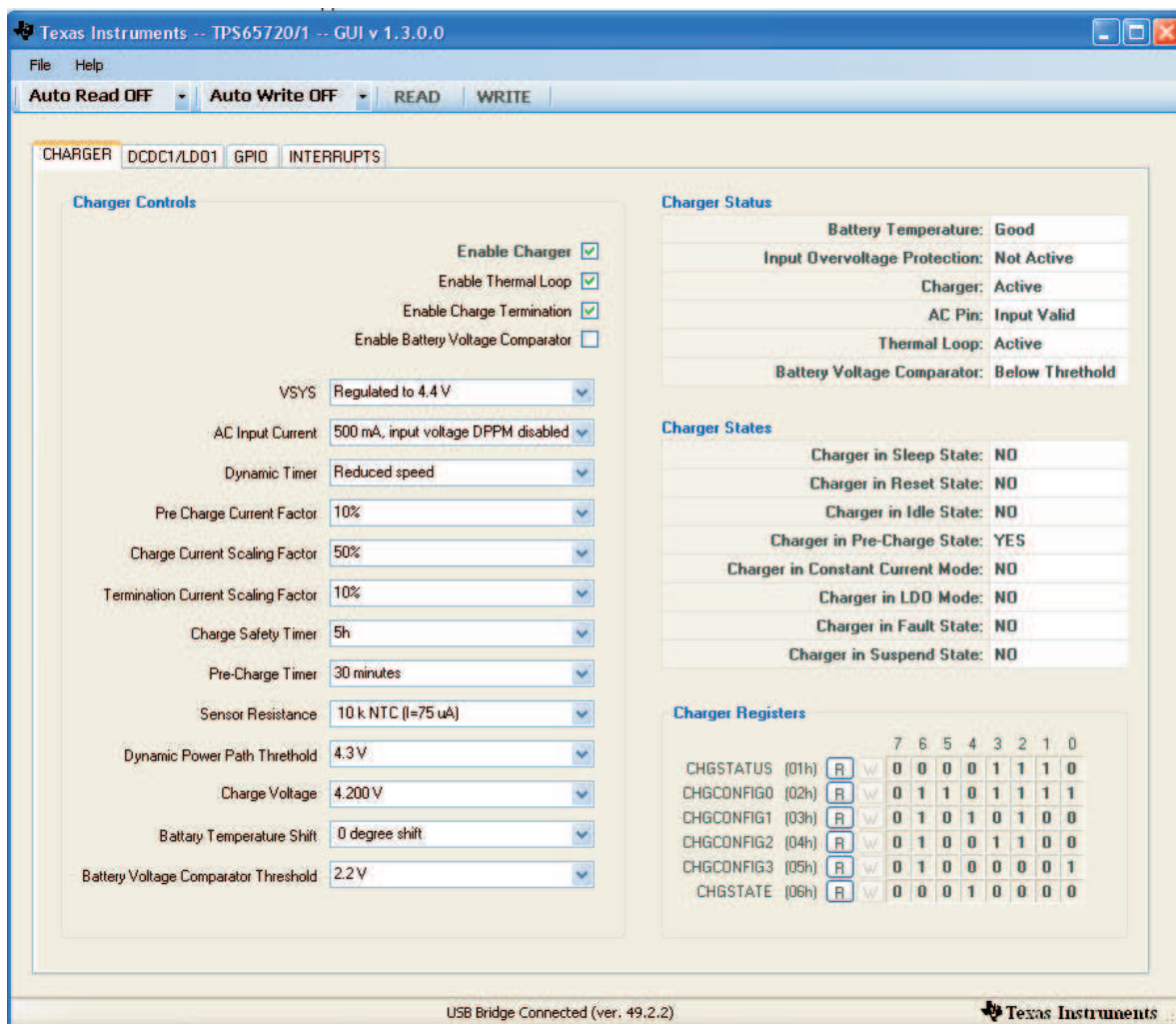


Figure 4. Software Charger View

The DCDC1/LDO1 control window (see Figure 5) allows control of the operating mode (PWM/PFM) for the DC/DC converter, output voltage of LDO1 (TPS65720 only), and shows the status flags related to DCDC1 and LDO1.

In the lower right corner of the window, all DCDC1/LDO1-related User Registers are displayed.

See the TPS65721 data sheet for a detailed description on these registers.

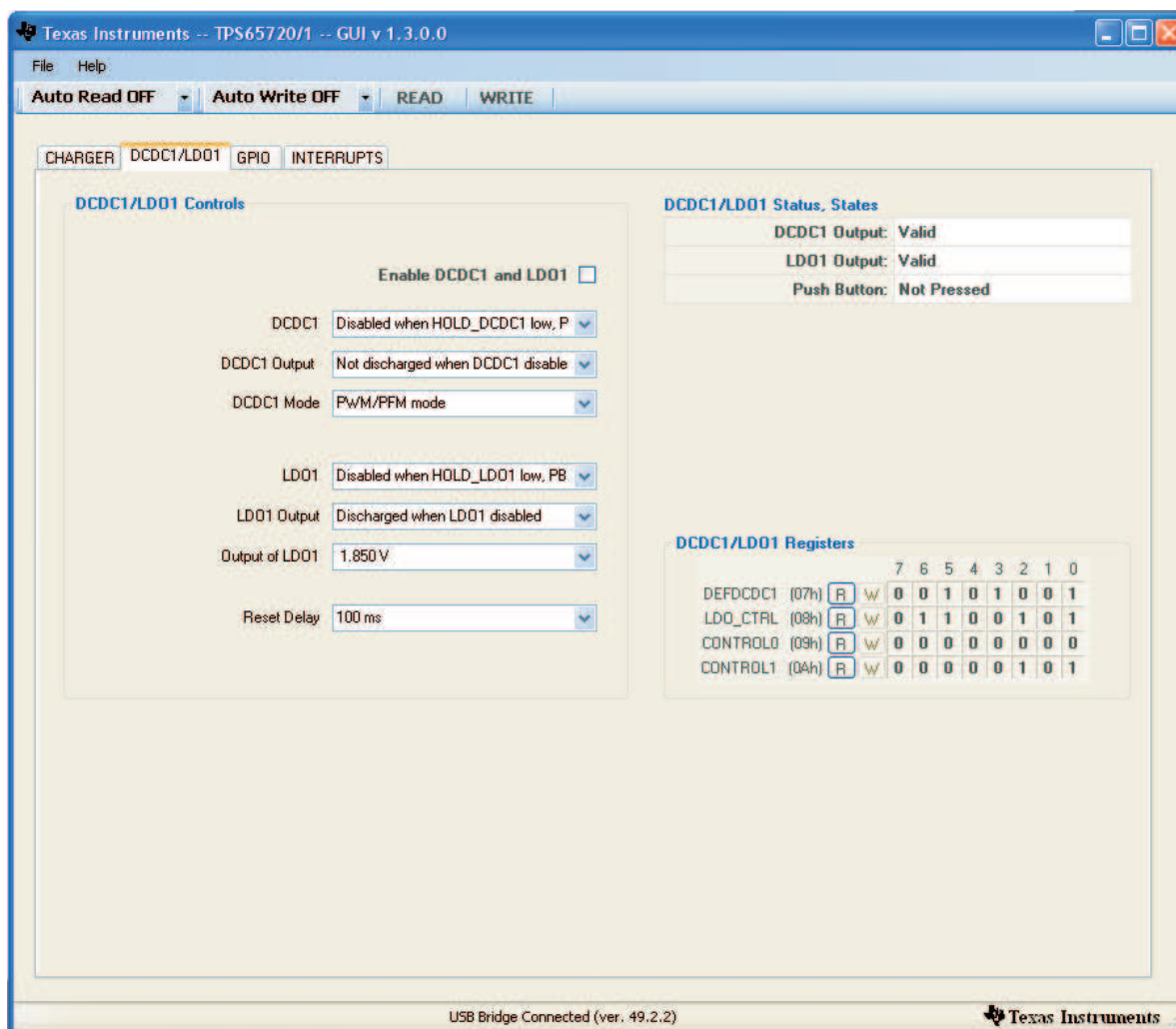


Figure 5. DCDC1/LDO1 View

The GPIO control window (see Figure 6) allows control of the four GPIOs of the TPS65720/1. The GPIOs can be configured as input or output. In addition GPIO2 and GPIO3 can configured as current sink to drive an external LED.

In the lower right corner of the window, all GPIO-related User Registers are displayed.

See the TPS65721 data sheet for the detailed description on these registers.

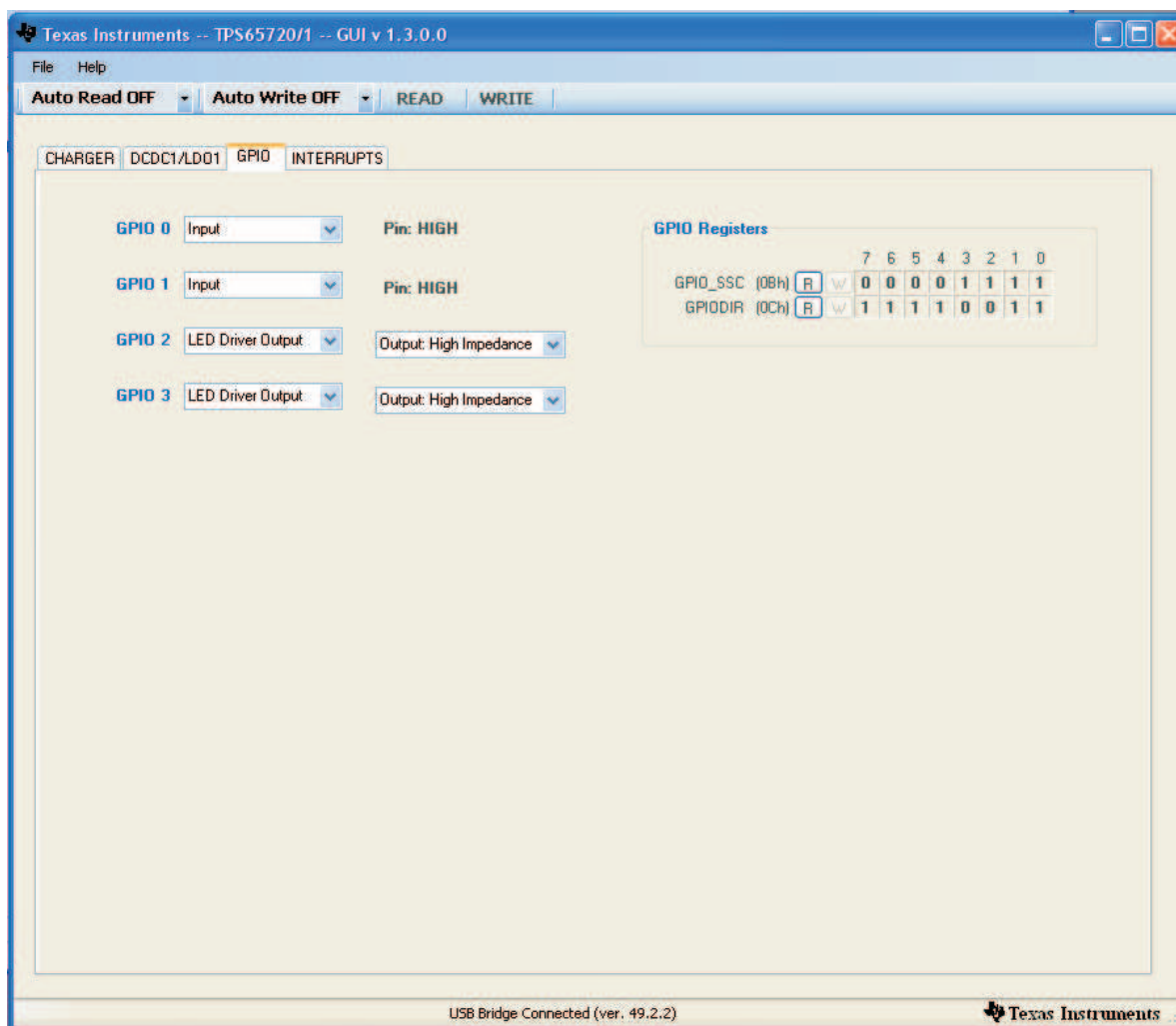


Figure 6. GPIO View

The INTERRUPT control window allows the user to configure and mask interrupts. The default setup is that all interrupts are masked. If an event is masked, it is ignored and no interrupt is generated. If an event is not masked, an interrupt is generated based on that event. If any interrupt is pending, the $\overline{\text{INT}}$ pin is driven low.

In the lower right corner of the window, all INTERRUPT-related User Registers are displayed.

See the TPS65721 data sheet for a detailed description on these registers.

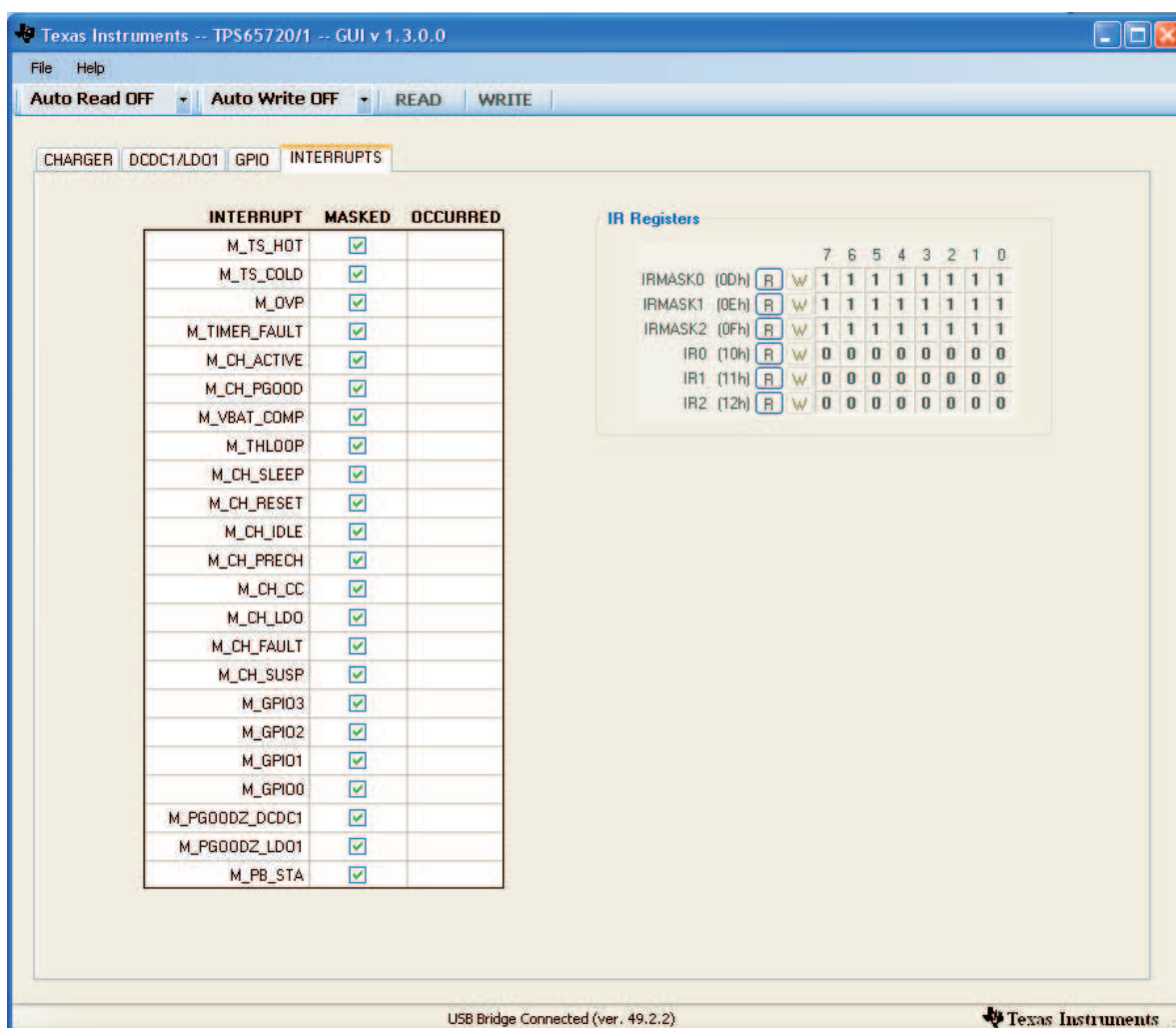


Figure 7. Interrupts View

6 TPS65721EVM Assembly Drawings and Layout

The following figures (Figure 8 through Figure 10) show the design of the TPS65721EVM printed-circuit board.

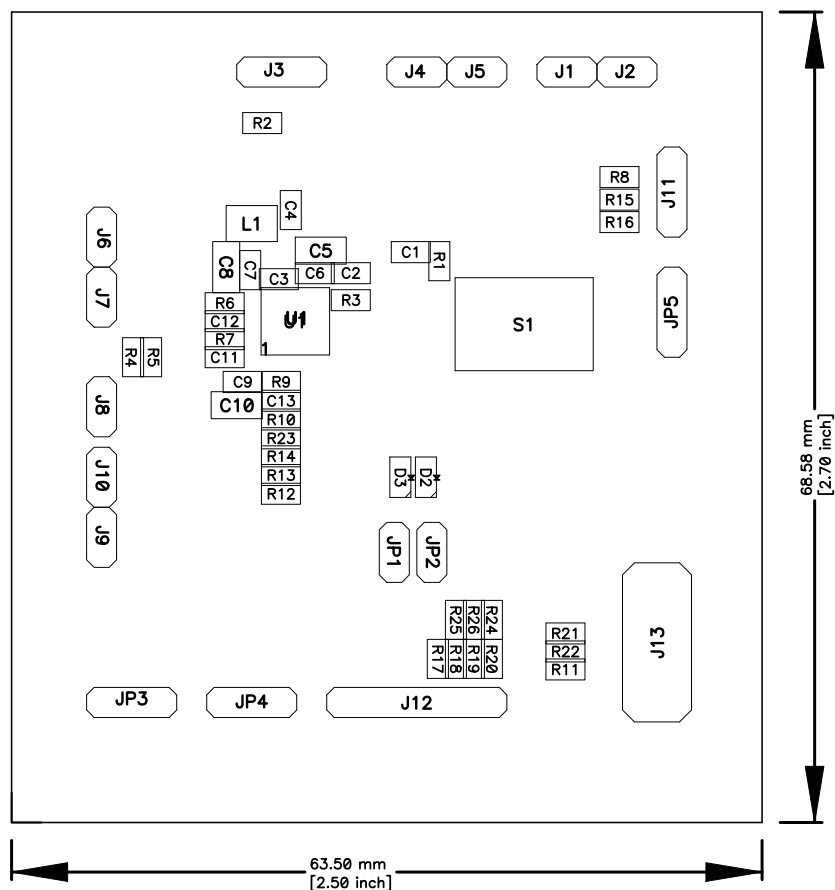


Figure 8. TPS65721EVM Component Placement (Viewed From Top)

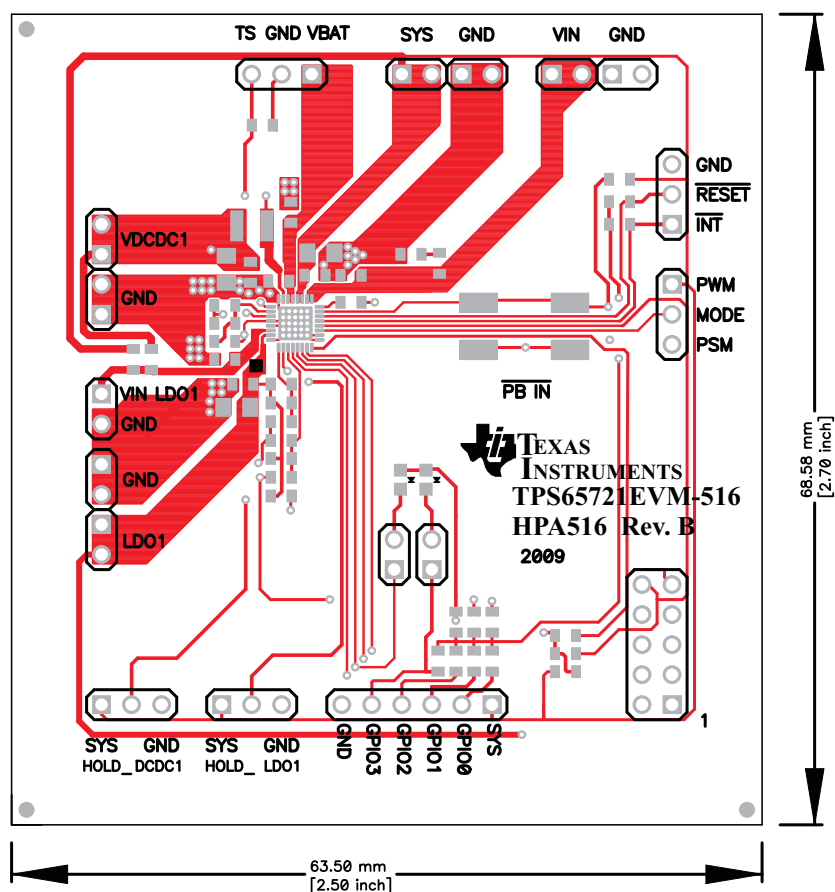


Figure 9. TPS65721EVM Top Copper (Viewed From Top)

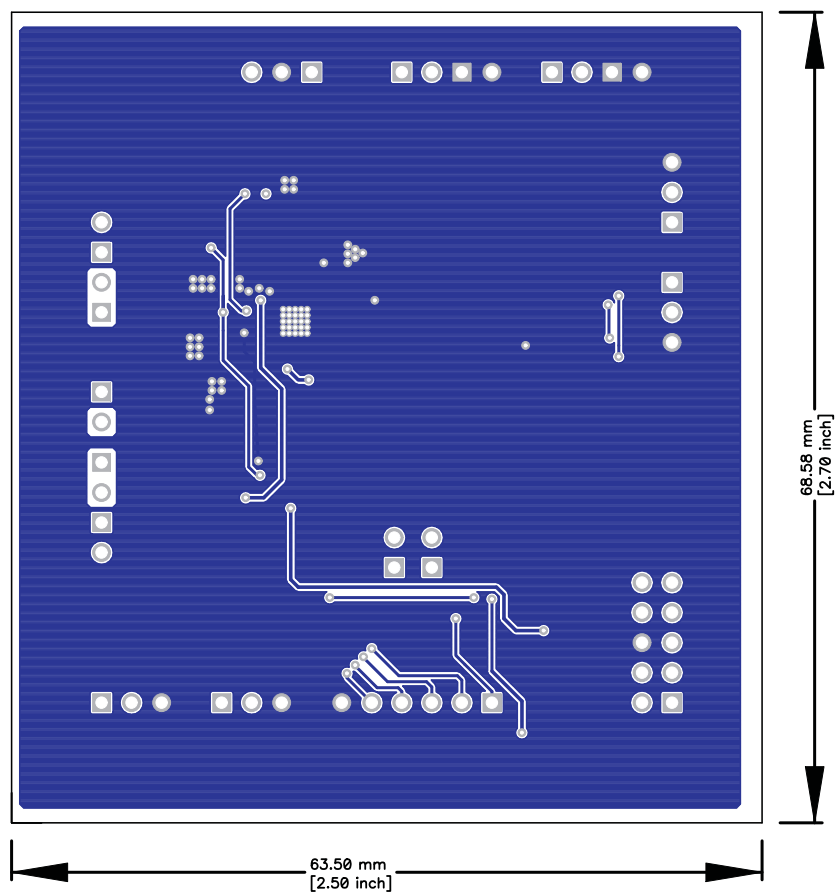


Figure 10. TPS65721EVM Bottom Copper (X-Ray View)

7 Bill of Materials

Table 2. HPA516B Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
0	C1	open	Capacitor, Ceramic, 35V, X5R, 10%	0603		
0	C10	open	Capacitor, Ceramic, 6.3V, X5R, 10%	0805		
1	C11	2.2uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	GRM155R60J22ME15D	Murata
2	C12, C13	22pF	Capacitor, Ceramic, 50V, COG, 5%	0603	GRM1885C1H220JA01D	Murata
1	C2	1uF	Capacitor, Ceramic, 35V, X5R, 10%	0603	GMK107BJ105K	Taiyo Yuden
1	C3	1uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	JMK107BJ105KK-T	Taiyo Yuden
0	C4	open	Capacitor, Ceramic, 10V, X7R, 10%	0603		
0	C5	open		0805		
2	C6, C9	4.7uF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	GRM188R60J475K	Murata
1	C7	10uF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	GRM188R60J106ME47D	Murata
1	C8	open	Capacitor, Ceramic, 6.3V, X5R, 20%	0805	LMK212BJ475_G	Murata
1	D1	LTL29S	Diode LED, green, 60 mW, 15mA	0603	LT L29S-N2Q1-25	Osram
1	D2	LSL29K	Diode LED, red. 40 mW, 20mA	0603	LS L29K-G1H2-1	Osram
1	L1	2.2uH	Inductor, Power, 1.1 A, 110 milliohms	2.5 × 2.0 mm	MIPSA2520D1R0	FDK
0	R1, R5, R14, R17, R18, R25, R26	open	Resistor, Chip, 1/16W, 1%	0603	std	std
1	R10	150k	Resistor, Chip, 1/16W, 1%	0603	std	std
1	R11	0	Resistor, Chip, 1/16W, 5%	0603	std	std
1	R12	open	Resistor, Chip, 1/16W, 5%	0603	std	std
1	R2	10k	Resistor, Chip, 1/16W, 1%	0603	std	std
2	R21, R22	3.3k	Resistor, Chip, 1/16W, 5%	0603	std	std
1	R3	1k	Resistor, Chip, 1/16W, 1%	0603	std	std
2	R4, R24	0	Resistor, Chip, 1/16W, 1%	0603	std	std
2	R6, R7	330k	Resistor, Chip, 1/16W, 1%	0603	std	std
7	R8, R13, R15, R16, R19, R20, R23	100k	Resistor, Chip, 1/16W, 1%	0603	std	std
1	R9	200k	Resistor, Chip, 1/16W, 1%	0603	std	std
1	U1	TPS65721RSN	IC, PMU for Bluetooth Headsets	QFN-32	TPS65721RSM	Ti
1	--		PCB, 2.2 In x 2.7 In x 0.062 In		HPA516	Any

Notes 1. These assemblies are ESD sensitive, ESD precautions shall be observed.

2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.

4. Ref designators marked with an asterisk (***) cannot be substituted. All other components can be substituted with equivalent MFG's components.

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit 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. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

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 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.**

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. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

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.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

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 contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit 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 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments 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.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 4.35 V to 28 V and the output voltage range of 0.6 V to 5.6 V for dc/dc converter and 0.8 V to 3.3 V for LDO.

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 60° C. The EVM is designed to operate properly with certain components above 60° 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2010, Texas Instruments Incorporated

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for 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, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps