

UCD90SEQ48EVM-560: 48-Pin Sequencer Development Board

This user's guide describes the 48-pin Sequencer Development Board – UCD90SEQ48EVM-560. This development board contains a 48-pin socket and interface circuitry to support the UCD9090.

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1 Description

The UCD90SEQ48EVM-560 allows the Texas Instruments UCD9090 48-pin sequencer to be installed into the onboard socket for evaluation. Access to all of the user input/output (I/O) is provided via strip connectors for integration into complex systems using clip-type jumper wires.

This development board also allows direct PMBus (power management bus) communication with the sequencer via an onboard USB interface. This interface allows direct control of and feedback from the sequencer when using the TI Fusion Digital Power Designer graphical user interface (GUI).

1.1 General Features

- USB port powered or power with single 5-V supply
- JTAG programming port for in-socket device configuration
- Serial port for advanced debugging
- Status LEDs on all GPIO
- Strip connector I/O access
- USB-PMBus interface for communication
- UCD9090 (in socket) and mini-USB cable provided

1.2 Sequencer Applications

- Industrial/ATE
- Telecommunications and networking equipment
- Servers and storage systems
- Any system requiring sequencing and monitoring of multiple power rails

2 Quick Start

2.1 Test Setup

[Figure 1](#) shows a typical test setup for the UCD90SEQ48EVM-560. All that is required is a personal computer (PC) with a USB port and the TI Fusion Digital Power Designer GUI. The USB-EVM cable is provided with the evaluation module (EVM) and is used for EVM power.

When installing the UCD9090 sequence devices into XU1, ensure that the device pin 1 is oriented as shown in [Figure 1](#).

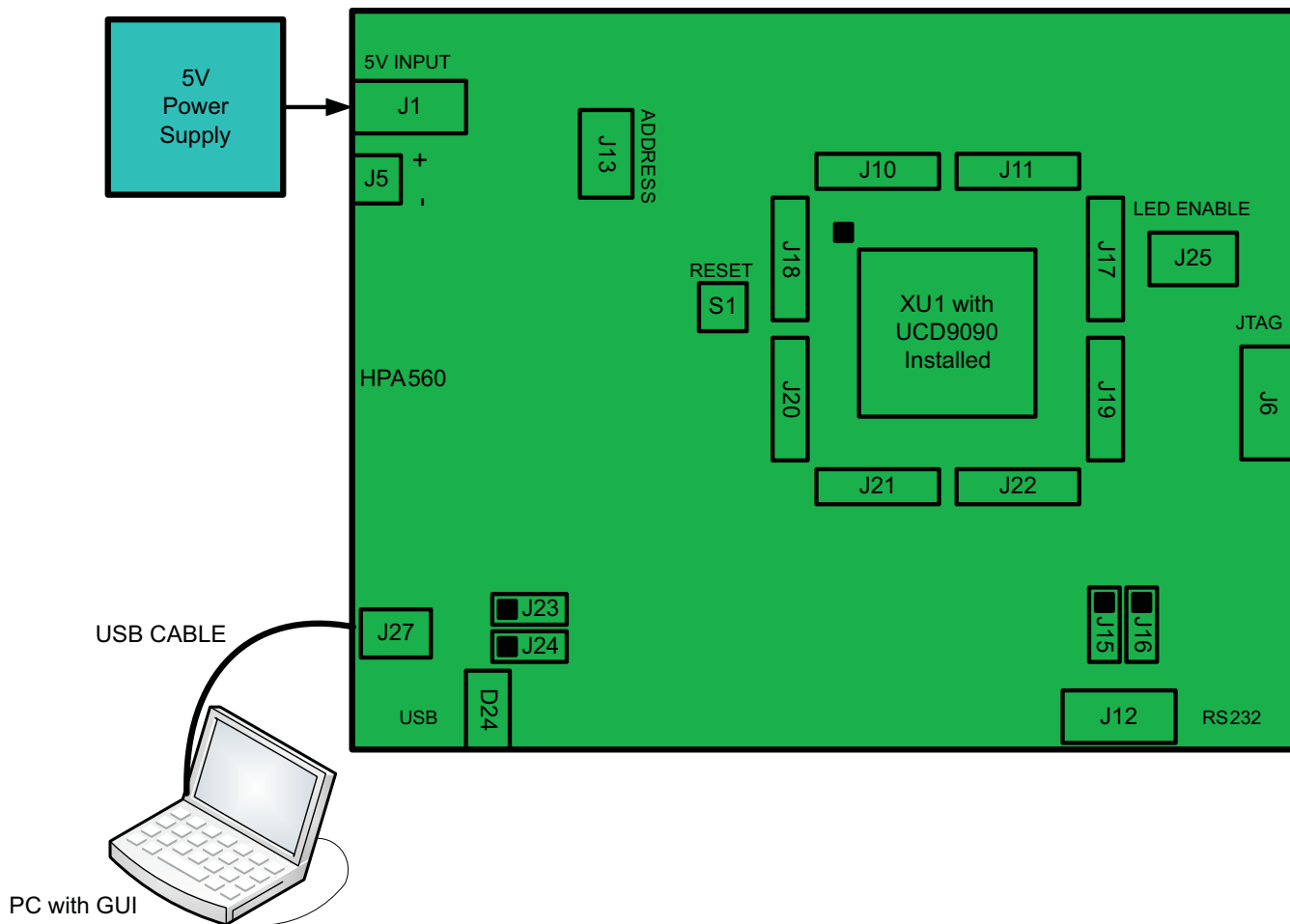


Figure 1. Typical Test Setup

3 UCD90SEQ48EVM-560 GUI Setup

3.1 UCD90SEQ48EVM-560 GUI Installation

The UCD90SEQ48EVM-560 uses the TI Fusion Digital Power Designer GUI which may be downloaded from the following Web site:

http://focus.ti.com/docs/toolsw/folders/print/fusion_digital_power_designer.html

Click the link for the official release for sequencers to start the download. Place the TI Fusion Digital Power Designer zip file in a known location on the PC. Unzip the TI Fusion Digital Power Designer zip file.

Double-click the unzipped TI Fusion Digital Power Designer .exe file. Proceed through the installation by accepting the installer prompts and the license agreement. Accept the GUI-suggested default PC installation locations to complete the install.

Once the GUI completes the installation, the program starts. The first time the GUI is launched on a particular PC, the user may be prompted to select a device. Choose UCD9xxx. Afterwards, the GUI may be closed.

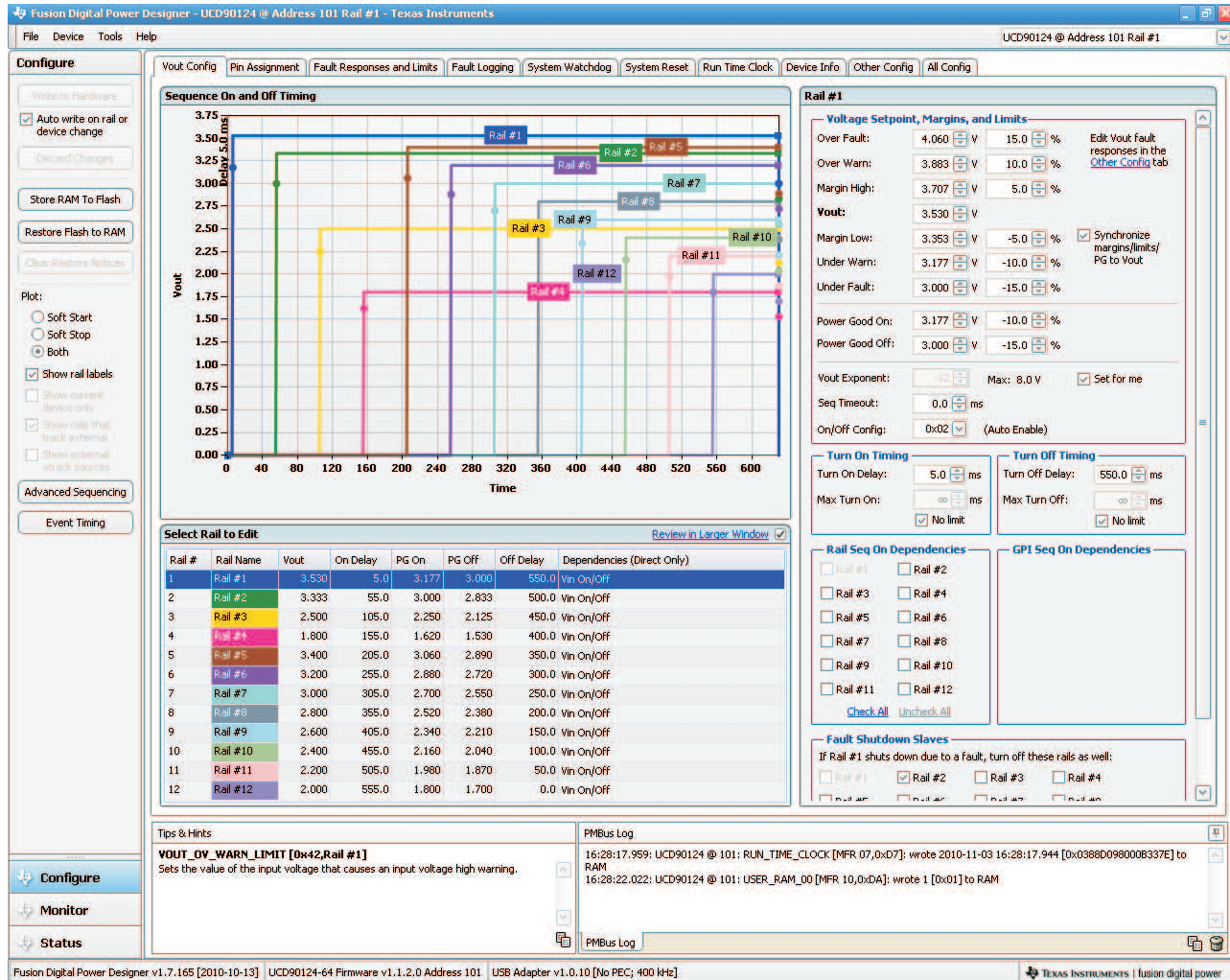
Note that the TI Fusion Digital Power Designer version 1.7.165 was used for the GUI figures in this document.

3.2 UCD90SEQ48EVM-560 GUI Operation

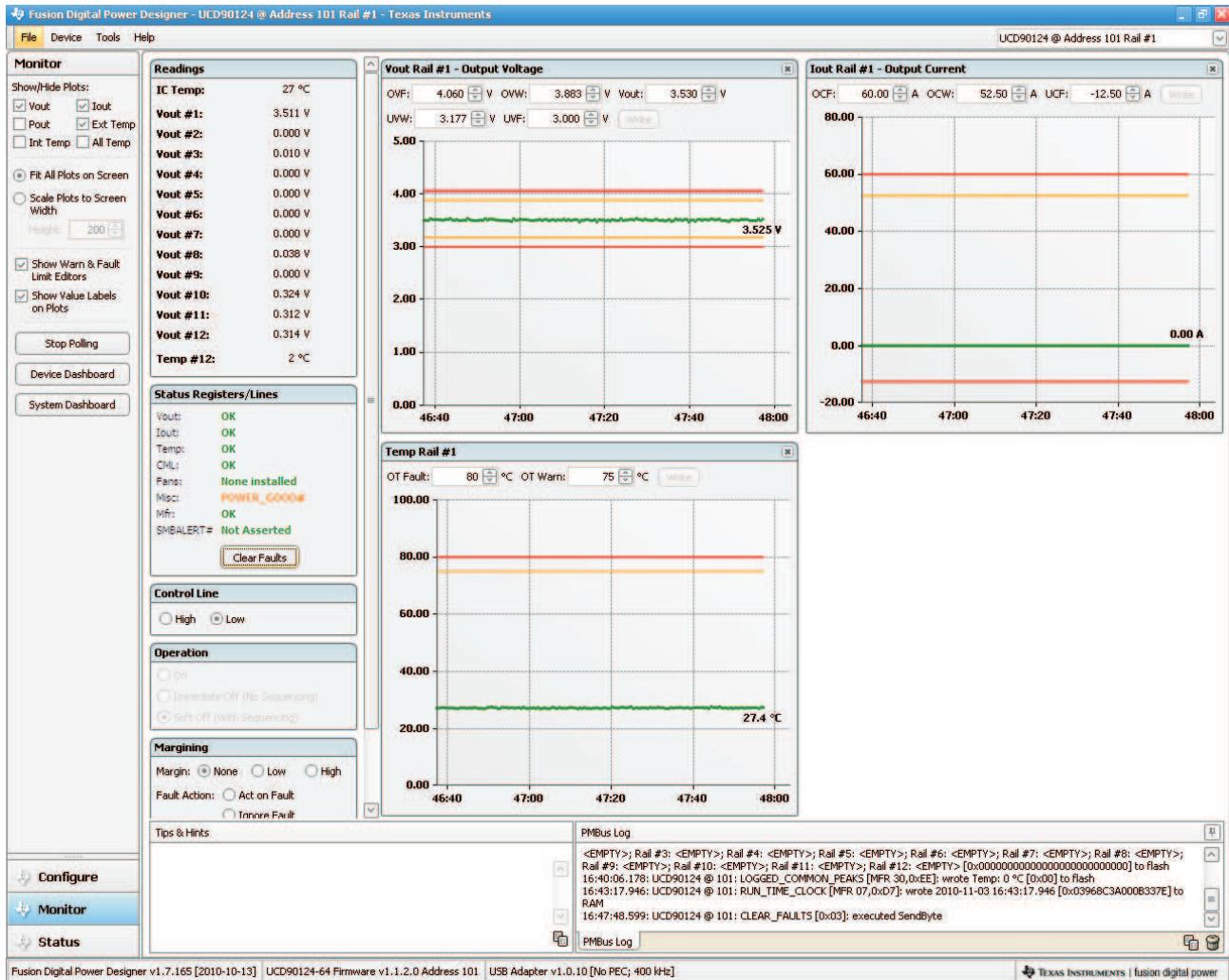
The EVM comes preloaded with a 10-rail default project that illuminates the onboard GPIO LEDs at power up. Export the default project to a file on the PC prior to making changes. To do this, go to the File menu and select *Save Project As ...*, then select a project file name and location.

3.2.1 Launch TI Fusion Digital Power Designer

Navigate to the location where the Fusion GUI is installed (Start → All Programs → Texas Instruments Fusion Digital Power Designer → Fusion Digital Power Designer), and start it. A window similar to the following illustration appears.



Most of the GUI control features are available from the Configure window. Monitor and Status information is available from the respective buttons on the GUI lower left. A typical Monitor window follows.



4 General-Use Features

4.1 EVM Input/Output Connectors and Switches

| Connector/ Switch | Label | Description |
|----------------------|-----------|--|
| J1 | +5V POWER | 5-Vdc jack |
| J5 | +5V | 5-V screw jack |
| J27 | USB IN | USB input connector for communication and EVM power |
| J12 | RS232 | Serial debug connector |
| J6 | JTAG | JTAG connector |
| XU1 | XU1 | Onboard socket for the 64-pin sequencer |
| S1 | PBRESET | Pushbutton reset |
| J18 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J20 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J21 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J22 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J19 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J17 | | Sequencer I/O strip connector. Pin name silkscreened on EVM |
| J11 | | Sequencer I/O strip connector. Pin name silkscreened on EVM. |
| J10 | | Sequencer I/O strip connector. Pin name silkscreened on EVM. |

4.2 EVM Test Jumpers

The EVM is equipped with shunts on the jumper positions identified in the Default Pin Position shown in the following table. Shunts can be moved and removed as required during use.

| Jumper | Default Pin Position | Label | Description |
|--------|---|-----------|--|
| J2 | 1-2 | LDO 3.3V | LDO 3.3V. Install for complete EVM operation. Remove to allow power access to only the sequencer device. |
| J23 | 1-2 | SCL | EEPROM SCL. For EVM manufacturing only. |
| J24 | 1-2 | SDA | EEPROM SDA. For EVM manufacturing only. |
| J9 | 1-2 | GPI1 | General-purpose input #1. Install shunt to allow status LED operation. |
| J14 | 1-2 | GPI2 | General-purpose input #2. Install shunt to allow status LED operation. |
| J13 | 1-2,7-8 | PM ADDR | PMBus address (default to 101). Remove shunts for JTAG operation at address 126. |
| J7 | | TCK | JTAG TCK. Install shunt when JTAG operation is desired. |
| J3 | | TDI | JTAG TDI. Install shunt when JTAG operation is desired. |
| J8 | | TDO | JTAG TDO. Install shunt when JTAG operation is desired. |
| J4 | | TMS | JTAG TMS. Install shunt when JTAG operation is desired. |
| J25 | 1-2 | LEDEN | Status LED enable. Install to enable non-PWM GPIO status LEDs. Remove to disable status LED loading on the GPIOs. |
| J26 | 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16 | LEDEN | Status LED enable for FPWMs (GPIO5-GPIO12). Install to enable FPWM GPIO status LEDs. Remove to disable status LED loading on the FPWM GPIOs. |
| J15 | | GPIO14/TX | Debug port TX (used for debug) |
| J16 | | GPIO15/RX | Debug port RX (not used during debug) |

4.3 EVM Test Points

| TP | Color | Label | Description |
|------|--------|----------|-------------------------------------|
| TP2 | WHT | LDO 3.3V | LDO 3.3V. EVM 3.3V |
| TP1 | WHT | V33D | V33D. Sequencer 3.3V. |
| TP5 | WHT | ADDR0 | ADDRSENS0. EVM PMBus address. |
| TP6 | ORG | ADDR1 | ADDRSENS1. EVM PMBus address. |
| TP3 | WHT | RIN | Receive input from terminal device. |
| TP4 | WHT | TOUT | Transmit output to terminal device. |
| TP7 | SM-SLV | GND | Surface mount GND |
| TP8 | SM-SLV | GND | Surface mount GND |
| TP9 | SM-SLV | GND | Surface mount GND (bottom) |
| TP10 | SM-SLV | GND | Surface mount GND |
| TP11 | SM-SLV | GND | Surface mount GND |
| TP12 | SM-SLV | GND | Surface mount GND (bottom) |

4.4 EVM Status LEDs

| LED | Color | Label | Description |
|-----|-------|-----------|--------------------|
| D4 | RED | 5V ON | 5VBUS ON indicator |
| D3 | RED | V33D | Sequencer power ON |
| D10 | RED | ALERT | PMBus Alert |
| D13 | GREEN | CTRL | PMBus Control |
| D24 | GREEN | USB ON | USB attached |
| D5 | AMBER | GPI1 | GPI1 input HIGH |
| D6 | AMBER | GPI2 | GPI2 input HIGH |
| D7 | GREEN | GPIO1 | GPIO1 HIGH |
| D8 | GREEN | GPIO2 | GPIO2 HIGH |
| D9 | GREEN | GPIO3 | GPIO3 HIGH |
| D11 | GREEN | GPIO4 | GPIO4 HIGH |
| D12 | GREEN | GPIO13 | GPIO13 HIGH |
| D14 | GREEN | GPIO14/TX | GPIO14 HIGH |
| D15 | GREEN | GPIO15/RX | GPIO15 HIGH |
| D16 | GREEN | GPIO16 | GPIO16 HIGH |
| D17 | GREEN | GPIO17 | GPIO17 HIGH |
| D18 | GREEN | GPIO18 | GPIO18 HIGH |
| D19 | GREEN | GPIO19 | GPIO19 HIGH |
| D20 | GREEN | GPIO20 | GPIO20 HIGH |
| D21 | GREEN | GPIO21 | GPIO21 HIGH |
| D22 | AMBER | GPIO5 | GPIO5 HIGH |
| D23 | AMBER | GPIO6 | GPIO6 HIGH |
| D25 | AMBER | GPIO7 | GPIO7 HIGH |
| D26 | AMBER | GPIO8 | GPIO8 HIGH |
| D27 | AMBER | GPIO9 | GPIO9 HIGH |
| D28 | AMBER | GPIO10 | GPIO10 HIGH |
| D30 | AMBER | GPIO11 | GPIO11 HIGH |
| D32 | AMBER | GPIO12 | GPIO12 HIGH |

5 Description

The following paragraphs describe the UCD90SEQ48EVM-560 functionality and operation.

5.1 Communication Interface

Several communication interfaces to the sequencer are provided on the EVM.

5.1.1 USB Interface

An onboard USB-to-PMBus interface is provided through the USB Input (J27) connector. D24 provides USB attach status. The EVM can be fully operated from USB input power only.

5.1.2 PMBus

Standard PMBus interface is provided to the sequencer from the onboard USB-PMBus circuitry. PMBus addressing is set using the J13 jumper block for ADDRSENS1 and ADDRSENS0, respectively. ADDR_x = 8 and ADDR_x = 5 positions for each are provided. The EVM comes with PMBus address set to 101 decimal.

PMBus Address (decimal) = 12 x ADDR1 + ADDR0 jumper block setting.

5.1.3 JTAG

Standard JTAG programming interface is provided to the sequencer through the J6 connector. The sequencer address must be set to 126 decimal to invoke sequencer JTAG operation. Install shunts at J3, J4, J7, and J8, and remove the shunts on J13 to use the JTAG interface.

5.1.4 RS232 Debug

A serial debug port is provided to the sequencer through the J12 connector. Install J15 when using the RS232 interface. For debug, the terminal listens only to the sequencer.

5.2 Input Power

The 5-Vdc EVM input power is provided through the USB interface. For stand-alone operation without a USB source, EVM input power can be provided at J1 (standard dc jack) or J5 (screw jack). A wall or laptop adapter with 200-mA capability and 2.5-mm I.D. × 5.5-mm O.D. × 9.5-mm dc jack can power the EVM.

5.3 Status LEDs

Visual status information for the GPI, GPIO, and PMBus signals (control and alert) is provided. Logic high at GPI1-4 or GPIO1-21 illuminates the associated LED. The GPIO status LEDs can be enabled (J25 shunt installed) or disabled (J25 shunt not installed) to prevent the LED bias from affecting the logic state of the GPIO signal during device reset. In addition, the sequencer PWM signals PWM1, PWM2, and FPWM1-FPWM8 can be disconnected from the status LEDs through the use of shunts when used for voltage margining.

5.4 Analog Monitor Inputs

The sequencer monitor inputs can be used to monitor offboard voltages. Each monitor input has a 4-k Ω resistor to ground. Ensure that the external source does not exceed 2.5 V.

6 EVM Schematic, Assembly Drawings, Layout Guidelines, and Bill of Materials

6.1 Schematic

48-pin Sequencer Development Board

1. UCD9090 48 pin socket
2. Main power bus
3. Communication (UAR/T, JTAG)

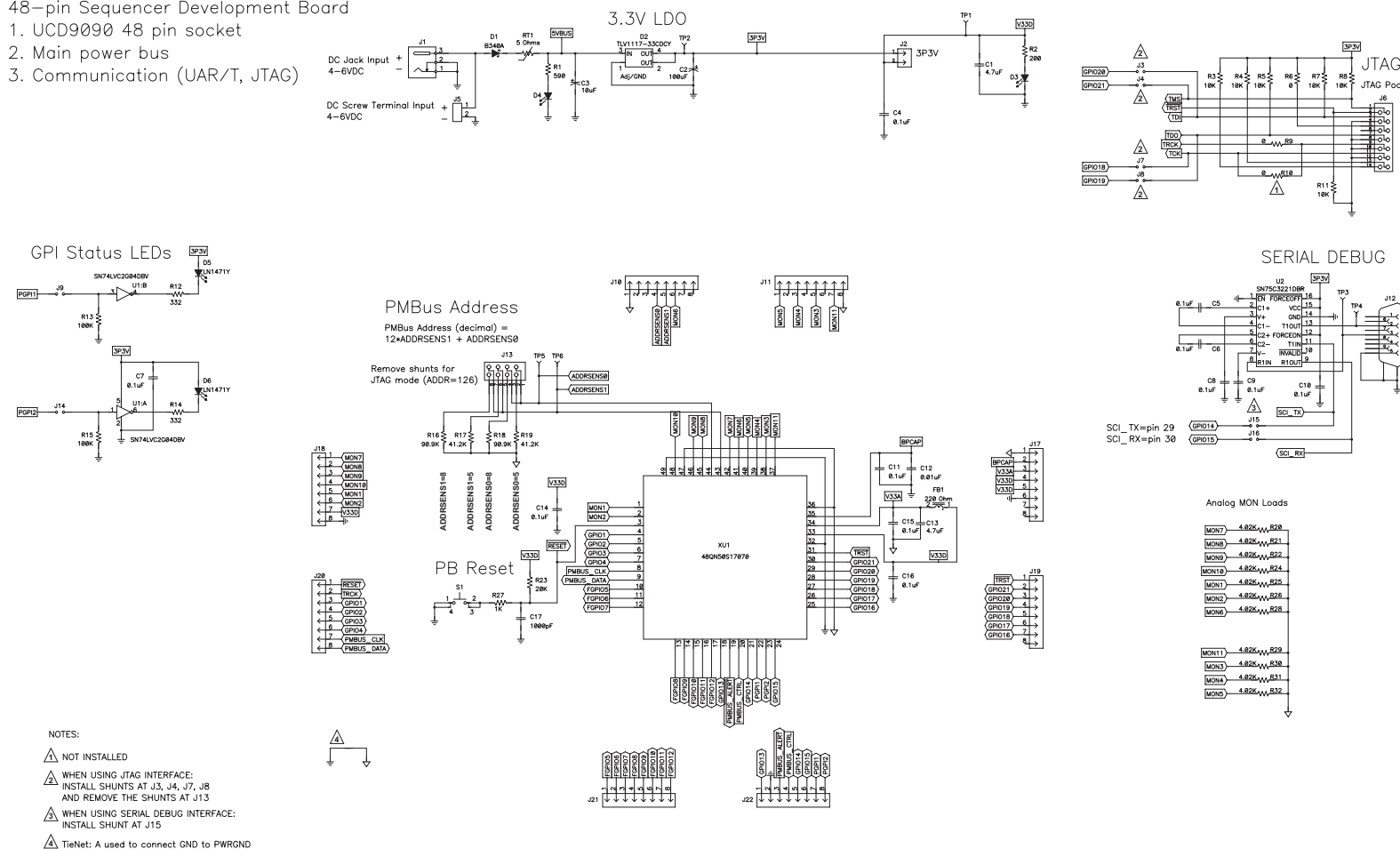


Figure 2. UCD90SEQ48EVM-560 Schematic, Sheet 1 of 2

48-pin Sequencer Development Board

1. Status LED's
2. Local/external PMBUS/USB-I2C

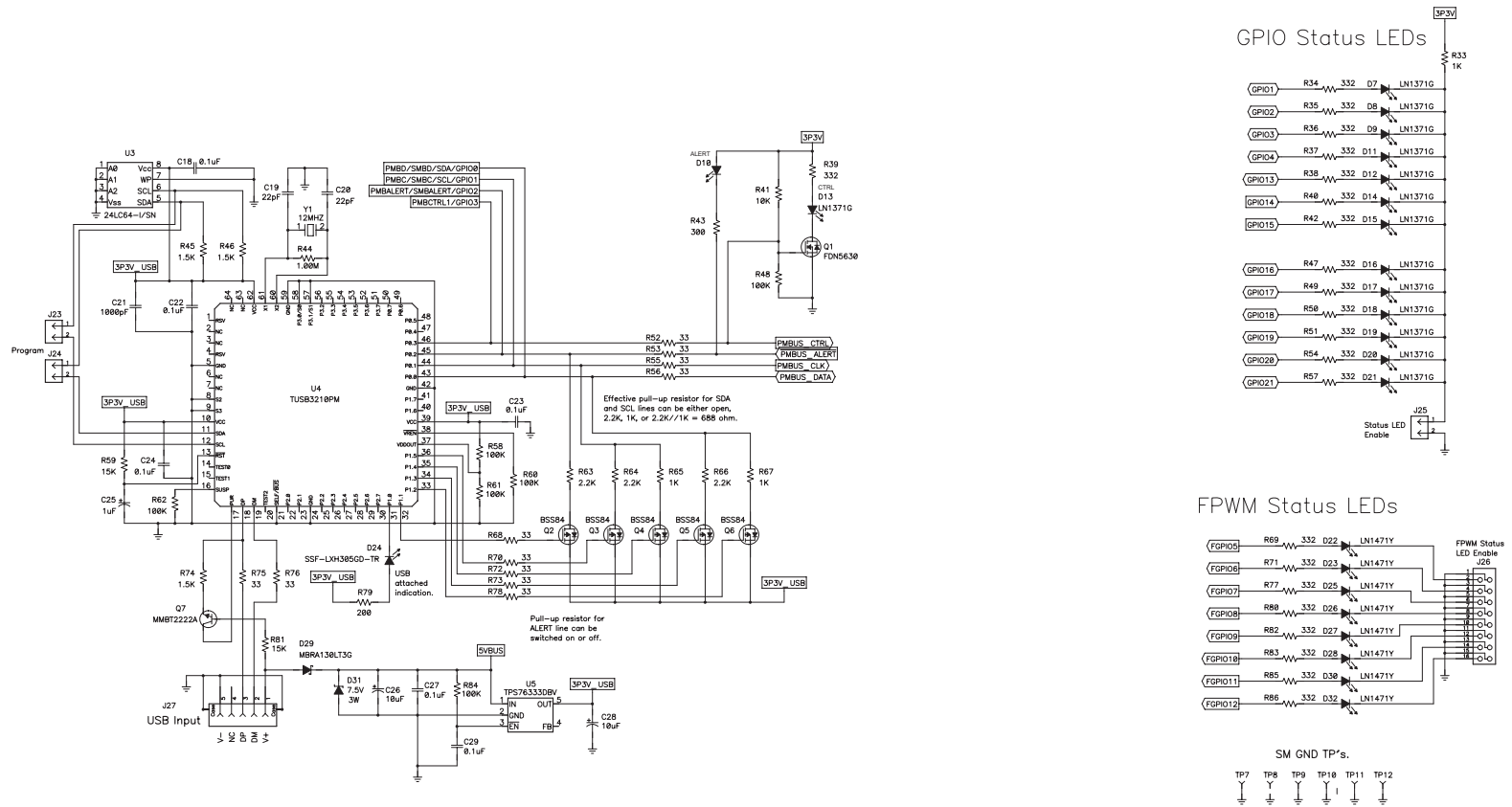


Figure 3. UCD90SEQ48EVM-560 Schematic, Sheet 2 of 2

6.2 Printed-Circuit Board Drawings

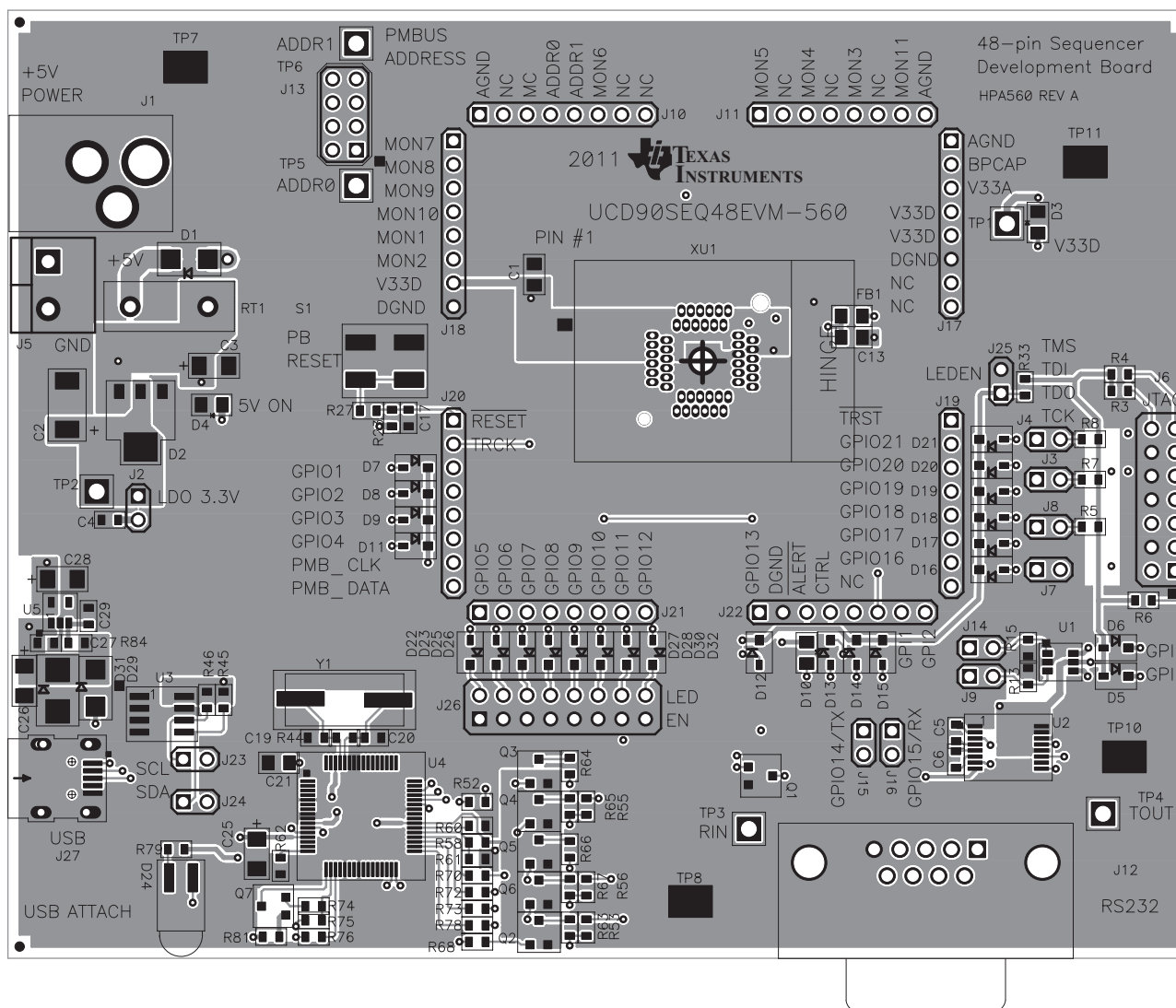


Figure 4. Top-Side Layout/Routing

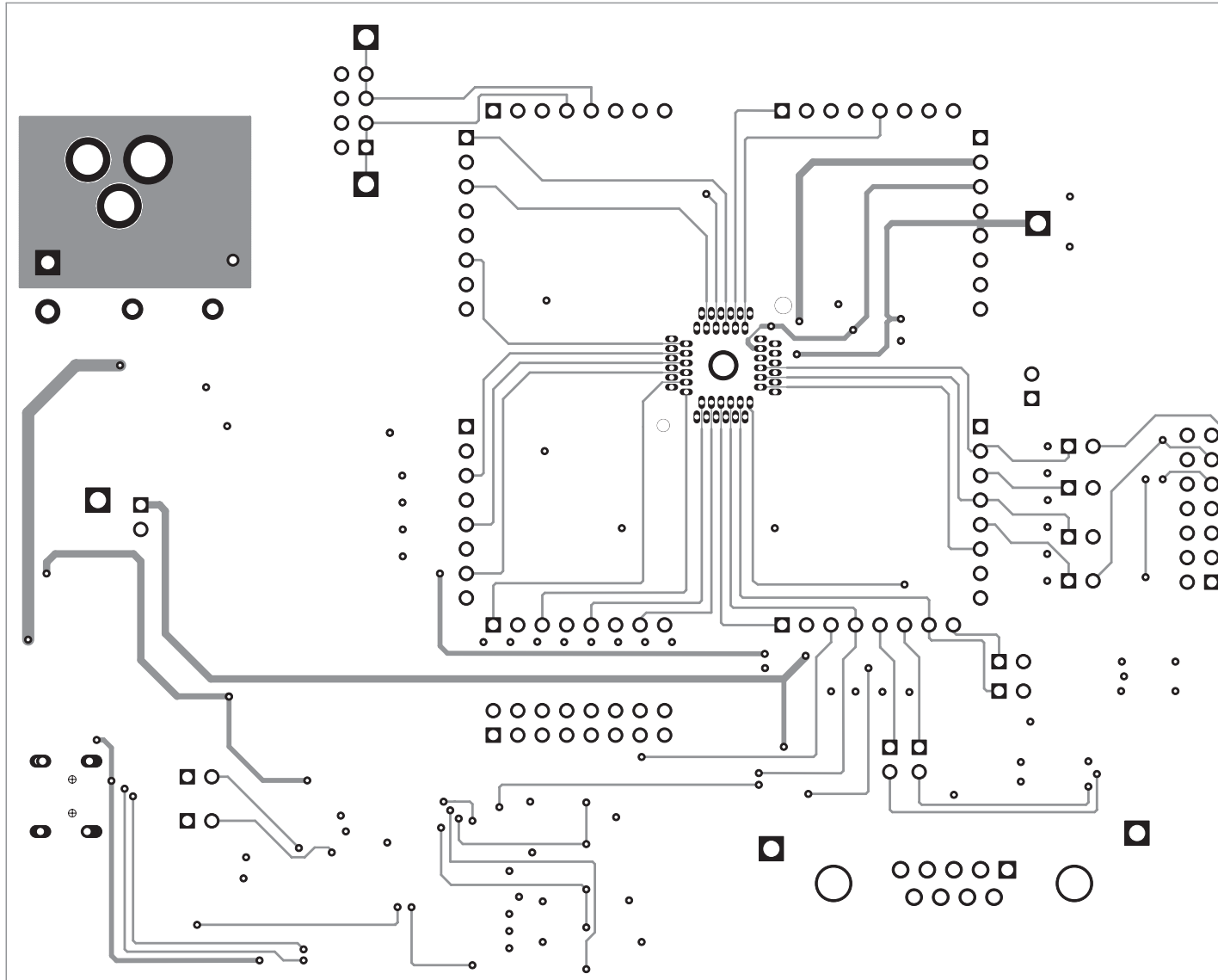


Figure 5. Layer-2 Routing

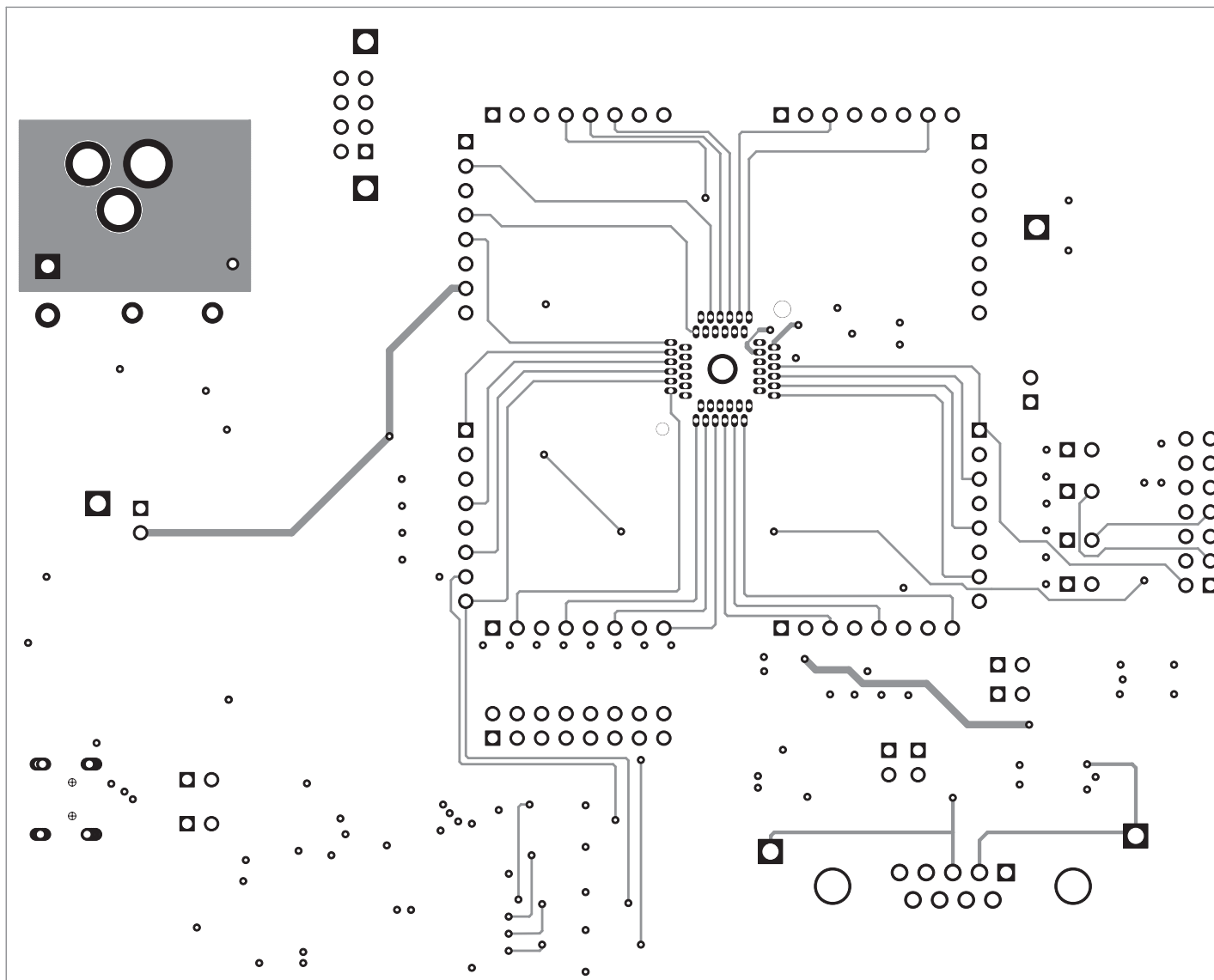


Figure 6. Layer-3 Routing

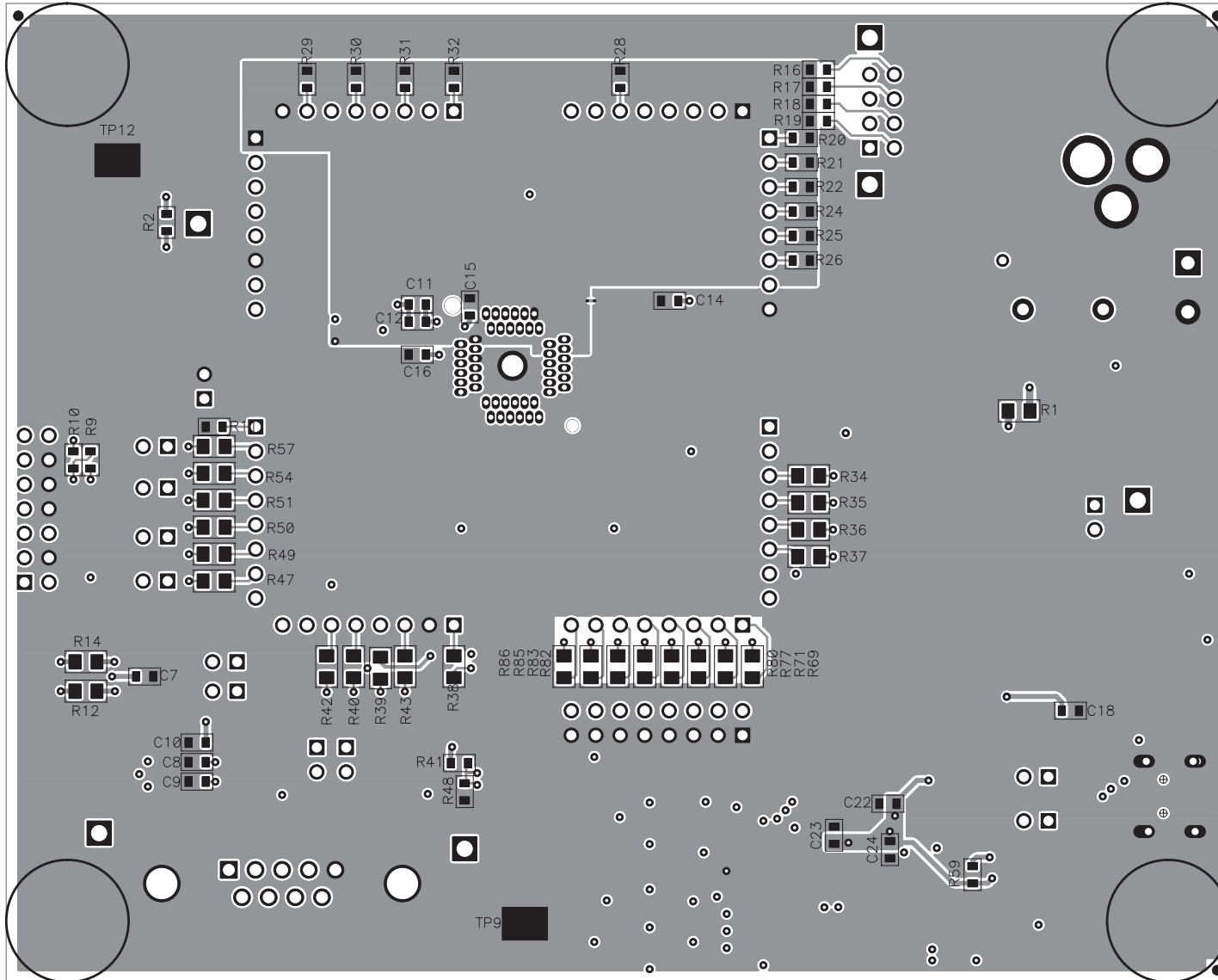


Figure 7. Bottom-Side Placement/Routing

6.3 Bill of Materials

Table 1. HPA560A Bill of Materials

| Count | RefDes | Value | Description | Size | Part Number |
|-------|--|-------------------|--|---------------------|-------------------|
| 2 | C1, C13 | 4.7 μ F | Capacitor, Ceramic, 10V, X5R, 20% | 0805 | Std |
| 1 | C12 | 0.01 μ F | Capacitor, Ceramic, 50V, X7R, 10% | 0603 | Std |
| 1 | C17 | 1000 pF | Capacitor, Ceramic, X7R, 16V, 10% | 0603 | Std |
| 2 | C19, C20 | 22 pF | Capacitor, Ceramic, 50V, C0G, 10% | 0603 | Std. |
| 1 | C2 | 100 μ F | Capacitor, Tantalum, 10V, 10% | 6032 | TAJC107K010R |
| 1 | C21 | 1000 pF | Capacitor, Ceramic, 100V, C0G, 5% | 0805 | Std. |
| 1 | C25 | 1 μ F | Capacitor, Tantalum, 16V, 20% | 3216 | 293D105X0016A2T |
| 3 | C3, C26, C28 | 10 μ F | Capacitor, Tantalum, 10V, 20% | 3216 | 293D106X0010A2T |
| 17 | C4, C5, C6, C7, C8, C9, C10, C11, C14, C15, C16, C18, C22, C23, C24, C27, C29 | 0.1 μ F | Capacitor, Ceramic, X7R, 16V, 10% | 0603 | Std |
| 1 | D1 | B340A | Diode, Schottky, 3A, 40V | SMA | B340A-13-F |
| 1 | D2 | TLV1117-33CDCY | IC, 3.3 V, 800mA LDO Voltage Regulator | SOT-223 | TLV1117-33CDCY |
| 1 | D24 | SSF-LXH305GD-TR | Diode, LED, Green, 20 mA, 30 mcd | SMD | SSF-LXH305GD-TR |
| 1 | D29 | MBRA130LT3G | Diode, Schottky, 1A, 30V | SMA | MBRA130LT3G |
| 3 | D3, D4, D10 | SML-LXT0805SRW-TR | Diode, LED, Red, 100 mA | 0805 | SML-LXT0805SRW-TR |
| 1 | D31 | 7.5V | Diode, Zener, 7.5V, 3W | SMB | 1SMB5922BT3G |
| 10 | D5, D6, D22, D23, D25, D26, D27, D28, D30, D32 | LN1471Y | Diode, LED, Amber, 20-mA, 0.4-mcd | 0.114 X 0.049 inch | LN1471YTR |
| 14 | D7, D8, D9, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21 | LN1371G | Diode, LED, Green, 20-mA, 0.9-mcd | SMD | LN1371G |
| 1 | FB1 | 220 Ohm | Ferrite Bead, 2A, 0.050 m-ohm | 0805 | BLM21PG221SN |
| 1 | J1 | RAPC712X | Connector, DC Jack, Pin dia.2.5mm, Shell dia 5.5mm | 0.57 x 0.35 inch | RAPC712X |
| 8 | J10, J11, J17, J18, J19, J20, J21, J22 | PEC08SAAN | Header, Male 8-pin, 100mil spacing, | 0.100 inch x 8 | PEC08SAAN |
| 1 | J12 | 182-009-213R171 | Connector, 9-pin D, Right Angle, Female | 1.213 x 0.510 | 182-009-213R171 |
| 1 | J13 | PEC04DAAN | Header, Male 2x4-pin, 100mil spacing | 0.20 x 0.40 inch | PEC04DAAN |
| 12 | J2, J3, J4, J7, J8, J9, J14, J15, J16, J23, J24, J25 | PEC02SAAN | Header, Male 2-pin, 100mil spacing, | 0.100 inch x 2 | PEC02SAAN |
| 1 | J26 | PEC08DAAN | Header, Male 2x8 pin, 100mil spacing | 0.100 inch X2X8 | PEC08DAAN |
| 1 | J27 | UX60-MB-5ST | Connector, Recpt, USB-B, Mini, 5-pins, SMT | 0.354in. x 0.303in. | UX60-MB-5S8 |
| 1 | J5 | ED120/2DS | Terminal Block, 2-pin, 15-A, 5.1mm | 0.40 x 0.35 inch | ED120/2DS |
| 1 | J6 | PEC07DAAN | Header, Male 2x7 pin, 100mil spacing | 0.100 inch x 2X7 | PEC07DAAN |
| 1 | Q1 | FDN5630 | MOSFET, N-ch, 60-V,1.7-A, 100-milliohm | SSOT3 | FDN5630 |
| 5 | Q2, Q3, Q4, Q5, Q6 | BSS84 | Transistor, PFET, -50 V, 130 mA, Rds(ON) < 10 ohm at V(gs) = 5 V | SOT-23 | BSS84 |

Table 1. HPA560A Bill of Materials (continued)

| Count | RefDes | Value | Description | Size | Part Number |
|-------|--|----------------|--|--------------------|----------------|
| 1 | Q7 | MMBT2222A | Transistor, NPN, 40 V, 500 mA | SOT-23 | MMBT2222A |
| 1 | R1 | 590 | Resistor, Chip, 1/10W, 1% | 0805 | Std |
| 24 | R12, R14, R34, R35, R36, R37, R38, R39, R40, R42, R47, R49, R50, R51, R54, R57, R69, R71, R77, R80, R82, R83, R85, R86 | 332 | Resistor, Chip, 1/10W, 1% | 0805 | Std |
| 8 | R13, R15, R48, R58, R60, R61, R62, R84 | 100K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 2 | R16, R18 | 90.9K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 2 | R17, R19 | 41.2K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 2 | R2, R79 | 200 | Resistor, Chip, 1/16W, 5% | 0603 | Std |
| 11 | R20, R21, R22, R24, R25, R26, R28, R29, R30, R31, R32 | 4.02K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 1 | R23 | 20K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 4 | R27, R33, R65, R67 | 1K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 7 | R3, R4, R5, R7, R8, R11, R41 | 10K | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 1 | R43 | 300 | Resistor, Chip, 1/10W, 1% | 0805 | Std |
| 1 | R44 | 1.00M | Resistor, Chip, 1/16 W, 1% | 0603 | Std. |
| 3 | R45, R46, R74 | 1.5K | Resistor, Chip, 1/16 W, 5% | 0603 | Std |
| 11 | R52, R53, R55, R56, R68, R70, R72, R73, R75, R76, R78 | 33 | Resistor, Chip, 1/16W, 5% | 0603 | Std |
| 2 | R59, R81 | 15K | Resistor, Chip, 1/16 W, 5% | 0603 | Std. |
| 2 | R6, R9 | 0 | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 0 | R10 | 0 | Resistor, Chip, 1/16W, 1% | 0603 | Std |
| 3 | R63, R64, R66 | 2.2K | Resistor, Chip, 1/16 W, 5% | 0603 | Std. |
| 1 | RT1 | 5 Ohms | Inrush current limiter, 4.7A, 0.11 ohms | 0.180 X 0.550 | CL-150 |
| 1 | S1 | KT11P2JM34LFS | Switch, SPST, PB Momentary, Sealed Washable | 0.245 X 0.251 | KT11P2JM34LFS |
| 5 | TP1, TP2, TP3, TP4, TP5 | 5012 | Test Point, White, Thru Hole | 0.125 x 0.125 inch | 5012 |
| 1 | TP6 | 5013 | Test Point, Orange, Thru Hole | 0.125 x 0.125 inch | 5013 |
| 6 | TP7, TP8, TP9, TP10, TP11, TP12 | 5016 | Test Point, SM, 0.150 x 0.090" | 0.185 x 0.135 | 5016 |
| 1 | U1 | SN74LVC2G04DBV | IC, Dual Schmitt-Trigger Inverter | SOT23-6 | SN74LVC2G04DBV |
| 1 | U2 | SN75C3221DBR | IC, RS-232 Transceivers with AutoShutdown | SSOP-16 | SN75C3221DBR |
| 1 | U3 | 24LC64-I/SN | IC, Serial EEPROM, 64K, 2.5-5.5V, 400 kHz Max. | SO-8 | 24LC64-I/SN |
| 1 | U4 | TUSB3210PM | IC, USB, General Purpose Device Controller | PQFP-64 | TUSB3210PM** |
| 1 | U5 | TPS76333DBV | IC, Micro-Power 100 mA LDO Regulator | SOT23-5 | TPS76333DBV |

Table 1. HPA560A Bill of Materials (continued)

| Count | RefDes | Value | Description | Size | Part Number |
|-------|--------|--------------|--|-------------------|--------------|
| 1 | XU1 | 48QN50S17070 | Socket, 48 pin TH, QFN Pack, Clam-shell | 1.08 x 0.800 inch | 48QN50S17070 |
| 1 | Y1 | 12MHZ | Crystal, 12-MHz, 20 pF, +/- 50 PPM@25C | 0.185 x 0.532 | CY12BPSMD |
| 1 | NA | UCD9090RGZ | IC, Digital PWM System Controller | PFC-48 | UCD9090RGZ |
| 4 | | SJ-5003 | BUMPON HEMISPHERE .44X.20 BLACK | | SJ-5003 |
| 16 | | | Shunt, Black | 100-mil | 929950-00 |
| 1 | -- | | PCB, 5 In x 4 In x 0.062 In | | HPA560 |
| 1 | N/A | | USB Cable, 5-pin, B-Mini Male to Type A Male, 2m | | AK672M/2-2-R |

Evaluation Board/Kit Important Notice

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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 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.

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 0 V to 5.5 V and the output voltage range of 0 V to 3.8 V .

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

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 40°C. The EVM is designed to operate properly with certain components above 70°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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