

DP83867ERGZ EVM User's Guide

User's Guide



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October 2015

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|----------|--|----------|
| 1 | Introduction | 4 |
| 1.1 | Purpose..... | 4 |
| 1.2 | Key Features..... | 4 |
| 1.3 | Description | 4 |
| 1.4 | Applications | 4 |
| 1.5 | Operation – Quick Setup | 5 |
| 2 | Board Setup Details | 6 |
| 2.1 | Block Diagram | 6 |
| 2.2 | Power Supply Options..... | 7 |
| 2.3 | Serial Management and MAC Interfaces | 7 |
| 2.4 | LED Options | 7 |
| 2.5 | Bootstrap Options/Jumpers | 8 |
| 2.6 | JTAG Interface | 8 |
| 2.7 | Clock Options..... | 8 |
| 2.8 | Capacitive Coupling..... | 9 |
| 2.9 | Schematics | 10 |
| 2.10 | Layout | 15 |
| 2.11 | Board Assembly | 23 |
| 2.12 | Board Marking (Silk)..... | 25 |
| 2.13 | Bill of Materials (BOM) | 27 |

DP83867ERGZ User's Guide

The DP83867ERGZ RGMII EVM (DP83867ERGZ-R-EVM) supports 1000/100/10 Mb/s and is compliant with the IEEE 802.3 standard. This reference design supports RGMII interfaces.

The DP83867ERGZ-R-EVM includes three onboard status LEDs, 5V connectors with onboard LDOs, and is JTAG accessible. The EVM is capable of providing a 125MHz reference clock from an onboard 25MHz crystal. Serial management interface, MDIO/MDC, is supported and can be used to access PHY registers for additional features. There are 4-level straps, which allow for system configurations without the need to directly access PHY registers. External power supplies can be connected to each specified voltage rail for additional system evaluation. The EVM supports Wake-on-LAN, Start of Frame Detect IEEE 1588 Time Stamp and configurable I/O voltages.

1 Introduction

1.1 Purpose

This user guide details the characteristics, operation, and use of the Industrial Ethernet DP83867ERGZ EVM. The EVM enables Texas Instruments customers to quickly design and market systems using the DP83867ERGZ. This document also includes schematic diagrams, a printed-circuit board layout, board assembly, board marking drawings, and a bill of materials.

1.2 Key Features

- 1000BASE-T, 100BASE-TX and 10BASE-T IEEE 802.3 compliant
- RGMII MAC interfaces
- SFD IEEE 1588 Time Stamp
- JTAG interface
- Three status LEDs
- Low Power Modes
 - Active Sleep
 - Passive Sleep
 - IEEE Power Down
 - Deep Power Down
- Wake-on-LAN
- Variable I/O voltage range: 1.8V, 2.5V and 3.3V
- 1000BASE-T error free data transfer over 125 meters on CAT5 cable

1.3 Description

The Industrial Ethernet DP83867ERGZ EVM has an RJ45 connector with integrated magnetics, jumper configurable straps for easy evaluation and can be operated from a single supply (5V DC jack, J10). Customers are encouraged to use a design similar to the EVM circuit to expedite their product development. Serial management interface pins allow customers to also access additional features by directly controlling PHY registers.

1.4 Applications

- Industrial – Factory Automation
- Wireless Communications Infrastructure
 - Base Stations
 - Small Cell
 - Microwave Backhaul
- Wireline Communications
- Test and Measurements
- Network Printers and Servers
- Consumer Electronics

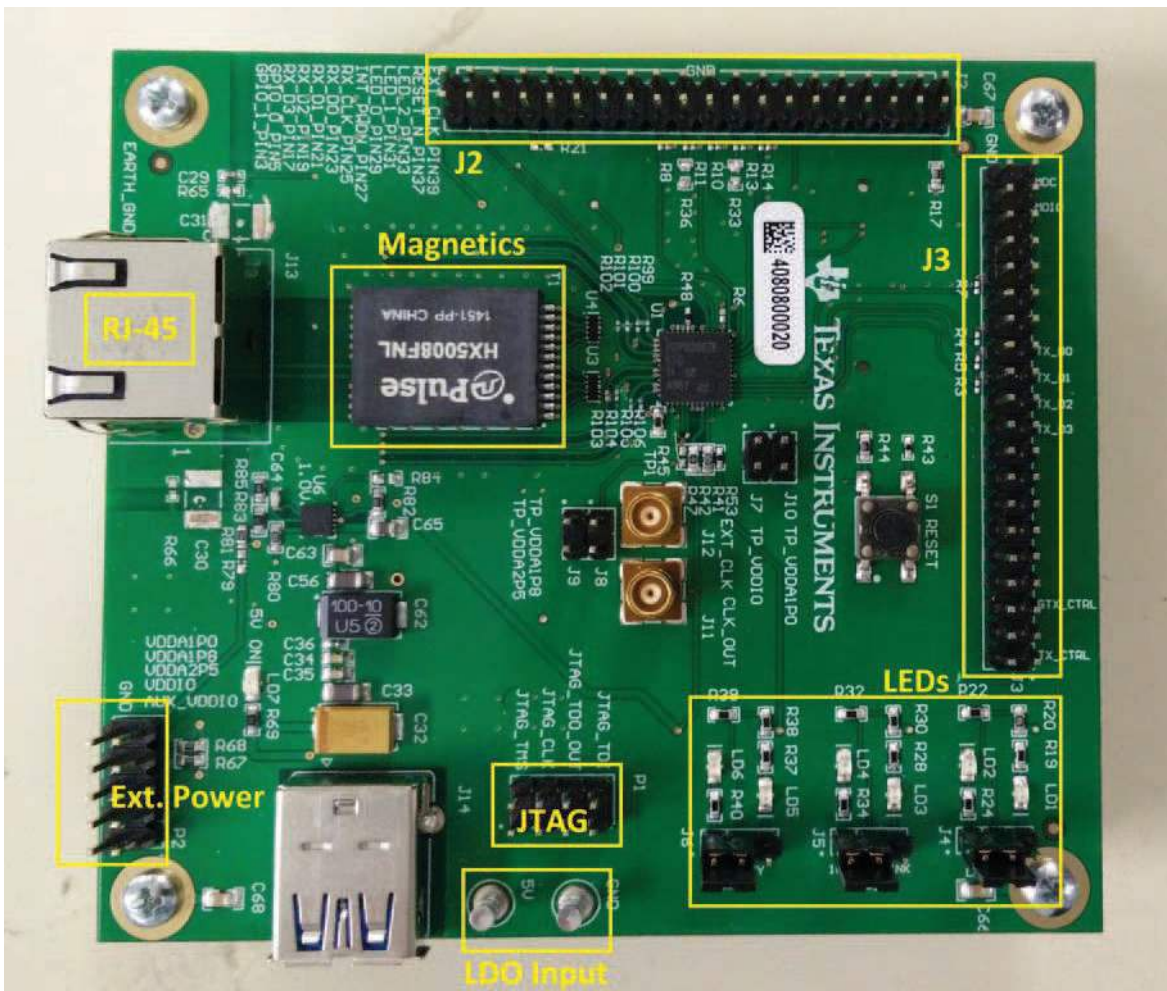


Figure 1. DP83867ERGZ RGMII EVM

1.5 Operation – Quick Setup

- Turn ON the PHY by plugging in a 5V DC source 5V and GND on the EVM. Alternatively, the EVM can be powered up through USB connector.
- Plug a CAT5, CAT5E or CAT6 cable into the integrated RJ45 connector (J13)
- Connect the far end of the Ethernet cable to a link partner
- Connect a MAC interface to J2 and J3
- LED Indication
 - The 5V LED (LD7) will be illuminated if the 5V supply is connected
 - Look for the LINK LED to light up on the DP83867ERGZ EVM after the PHY links with a connected partner.
 - If the link partner supports 1000M mode and a 1000M link is established, then the 1000M LINK LED will light up

2 Board Setup Details

2.1 Block Diagram

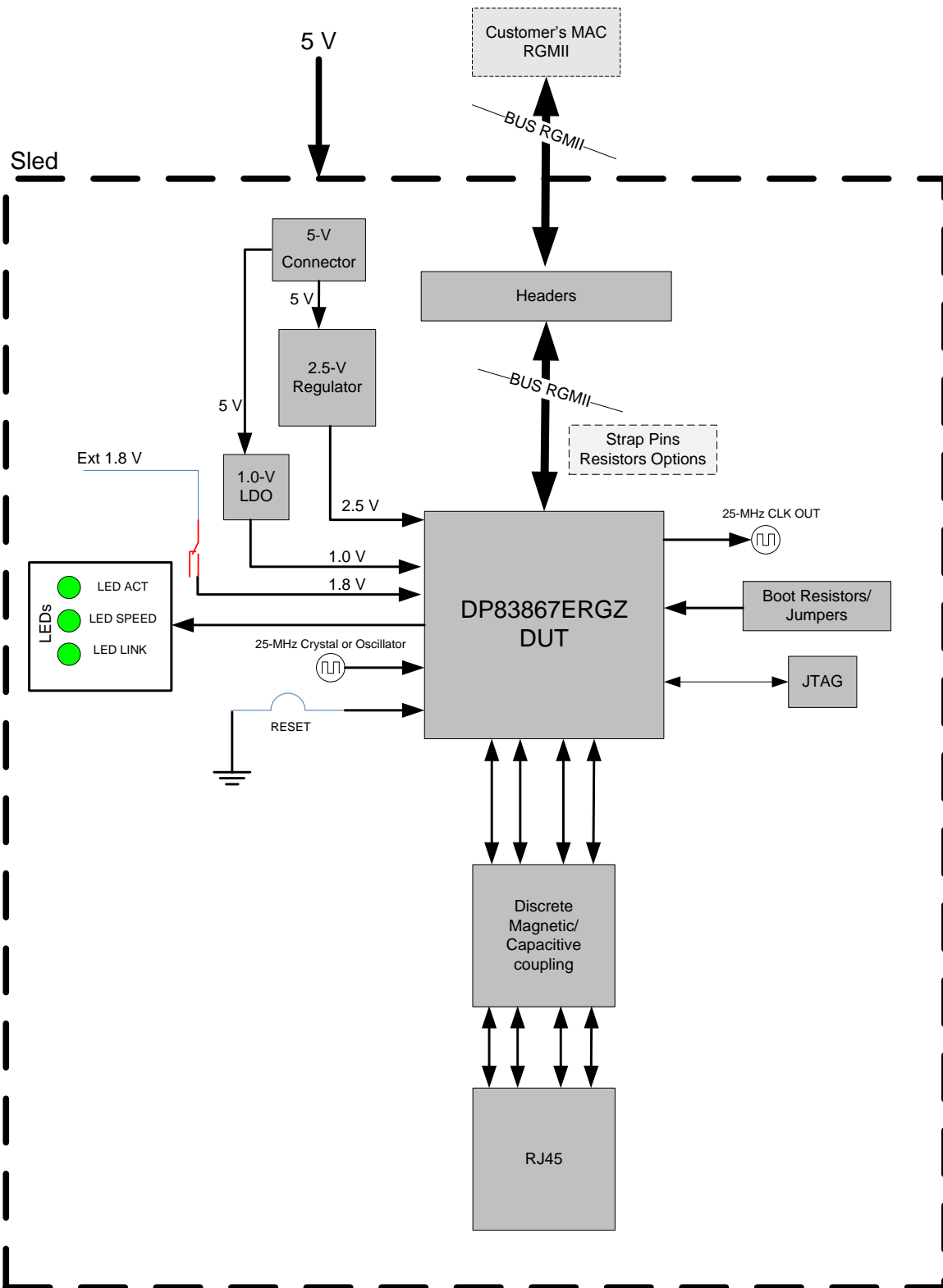


Figure 2. DP83867ERGZ EVM Block Diagram

2.2 Power Supply Options

The DP83867ERGZ EVM power is supplied by a single 5V DC jack. This option uses onboard LDOs to provide 2.5V and 1.0V voltage rails.

The DP83867ERGZ EVM can be operated from external supplies. Connect external supplies to P2:

- Pin 1 – AUX_IOVDD_EXT
- Pin 3 – VDDIO_EXT
- Pin 5 – VDDA2P5_EXT
- Pin 7 – VDDA1P8_AB and VDDA1P8_CD
- Pin 9 – VDDA_1V0_EXT

Do the following to enable external power operation:

- Remove R71, R74, R81
- Populate R67, R68, R70, R77, R79

2.3 Serial Management and MAC Interfaces

The DP83867ERGZ EVM supports serial management (MDIO/MDC) and RGMII MAC interfaces. Serial management interface is accessible through J3. MDIO is located at pin 37 and MDC is located at pin 39. Ground connection between the DP83867ERGZ EVM and serial interface controller is required for proper operation. DP83867ERGZ supports both clause 22 and clause 45 in the IEEE 802.3 specification.

NOTE: The default PHY_ID is '0'. PHY_ID can be changed via strap options found in the datasheet.

MAC interface pins are located on J9 and J8. RGMII/GMII/MII configurations are located in the datasheet and can be configured by bootstrapping or direct register access through the serial management interface. Refer to the DP83867ERGZ datasheet ([SNLS504](#)) for specific pin requirements for each MAC interface.

2.4 LED Options

DP83867ERGZ supports up to four LEDs, Link/Speed/ACT/MLED indications. The DP83867ERGZ EVM has three onboard status LEDs that can be controlled by direct register access using the serial management interface. LED pins can operate as either current sources (when connected to pull-down) or current sinks (when connected to pull-up).

2.5 Bootstrap Options/Jumpers

Some DP83867ERGZ configurations are done through bootstrap options. Options can be selected with resistor population.

The DP83867ERGZ EVM supports the following resistor configurations:

- PHY_ID[4:0]
- SPEED_SEL
- Mirror Enable
- Auto-Negotiation Disable
- RGMII Clock Skew RX[2:0]
- RGMII Clock Skew TX[2:0]

2.6 JTAG Interface

The DP83867ERGZ EVM has JTAG accessible though P1:

- Pin 2 – TRSTN
- Pin 4 – TMS
- Pin 6 – CLK
- Pin 8 – TDO
- Pin 10 – TDI

2.7 Clock Options

The DP83867ERGZ EVM supports three different clock options:

- 25MHz crystal (Default)
- 25MHz oscillator configured by onboard modifications
- External 25MHz reference clock connected to pin 39 on J2 or J12 MCX connector

2.7.1 Default Configuration

The DP83867ERGZ EVM default configuration has a 25MHz crystal. In this mode and external crystal resonator is connected across pins XO and XI.

The crystal must be 25MHz \pm 50ppm-tolerance crystal reference.

2.7.2 25MHz Oscillator Configuration

The DP83867ERGZ can also operate with a 25MHz external CMOS-level oscillator source connected to pin XI only.

Refer to the data sheet ([SNLS504](#)) for OSC requirement specifications.

In order to operate with a 25MHz OSC, the following modifications are required:

- U2 OSC should be mounted – Epson SG-210STF 25MHz \pm 50ppm
- Populate R57 and R59 with 0 Ohm resistors
- Remove R51, R54

2.7.3 External Configuration

External clock can be supplied to the DP83867ERGZ by using pin 39 on J9 or J12 MCX connector.

The external clock must meet the DP83867ERGZ datasheet requirements and to be within 25MHz \pm 50ppm-tolerance. For external clock configuration, X_O should be left floating.

Refer to the data sheet ([SNLS504](#)) for capacitor divider recommendations.

The following changes are required to route an external clock to the DP83867ERGZ for a 1.8V clock source:

- Populate R57, R58 with 0 Ohm resistors.
- Remove R51, R54.

2.8 Capacitive Coupling

The EVM can be operated in capacitive coupling mode instead of the magnetic coupling mode. The following changes are required for capacitive coupling.

- Populate C17, C19, C20, C22, C 23, C25, C26, C28, R99-R106.
- Remove R91-R98 & T1.

2.9 Schematics

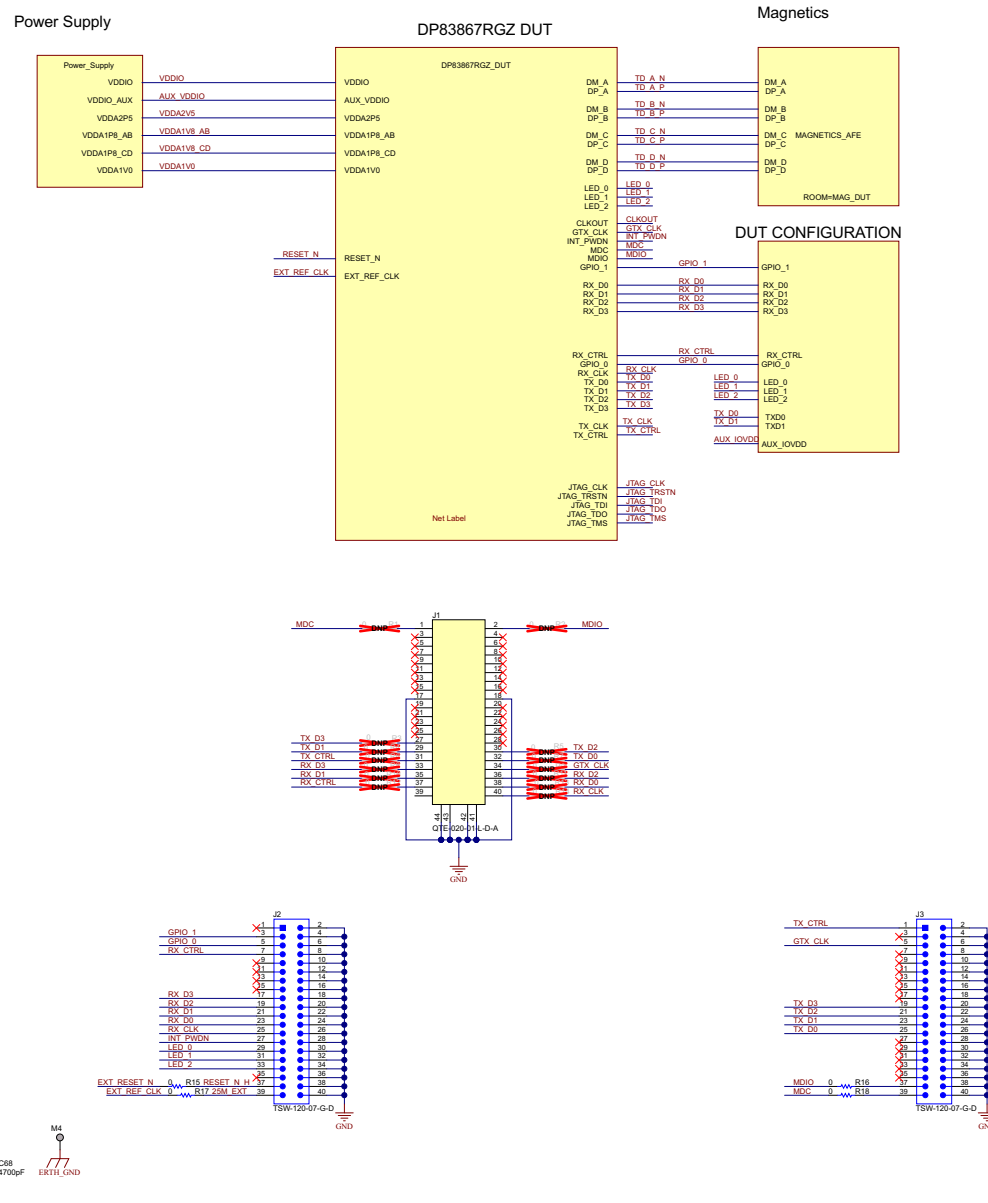


Figure 3. Schematic (1 of 5)

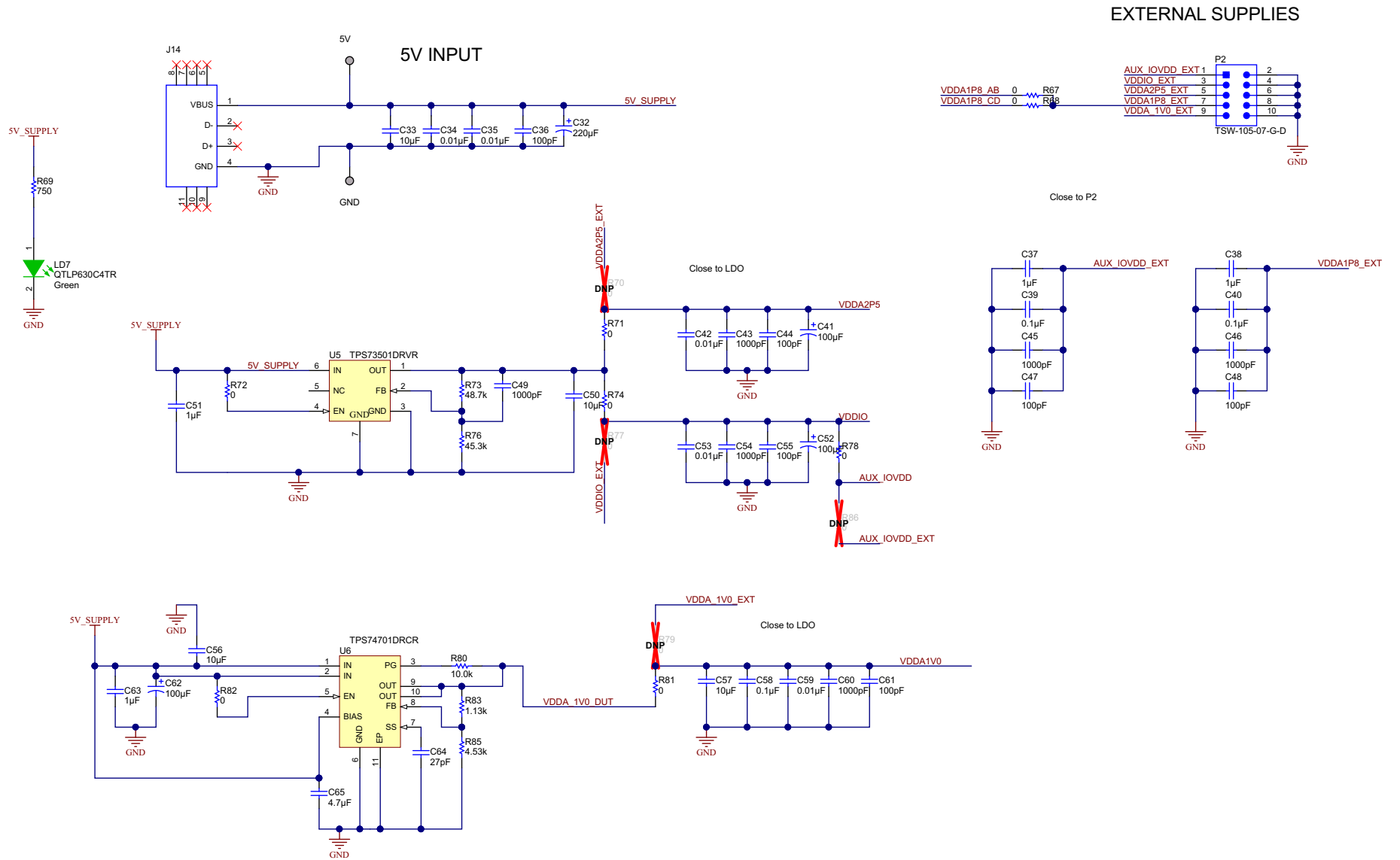


Figure 4. Schematic (2 of 5)

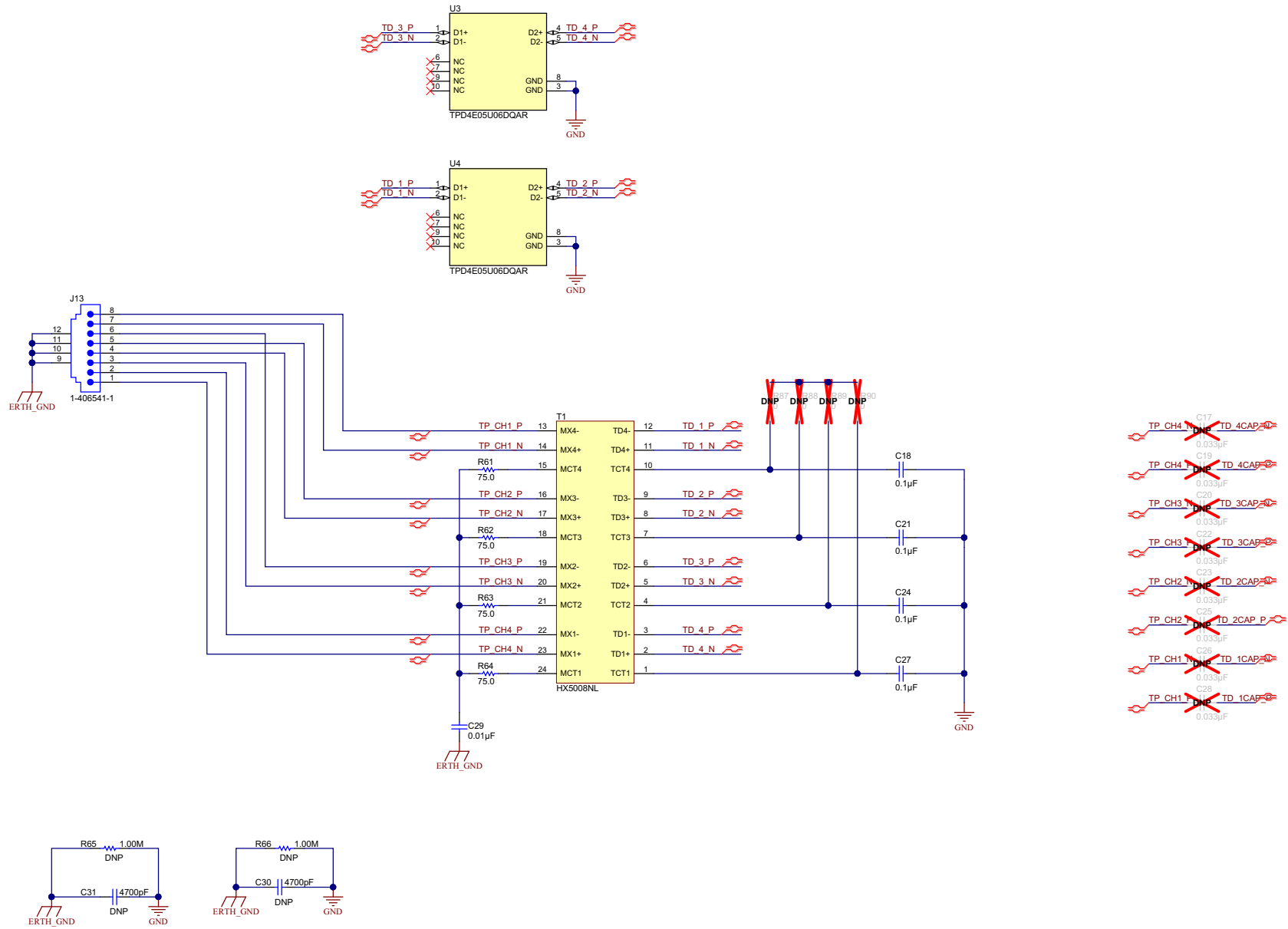


Figure 5. Schematic (3 of 5)

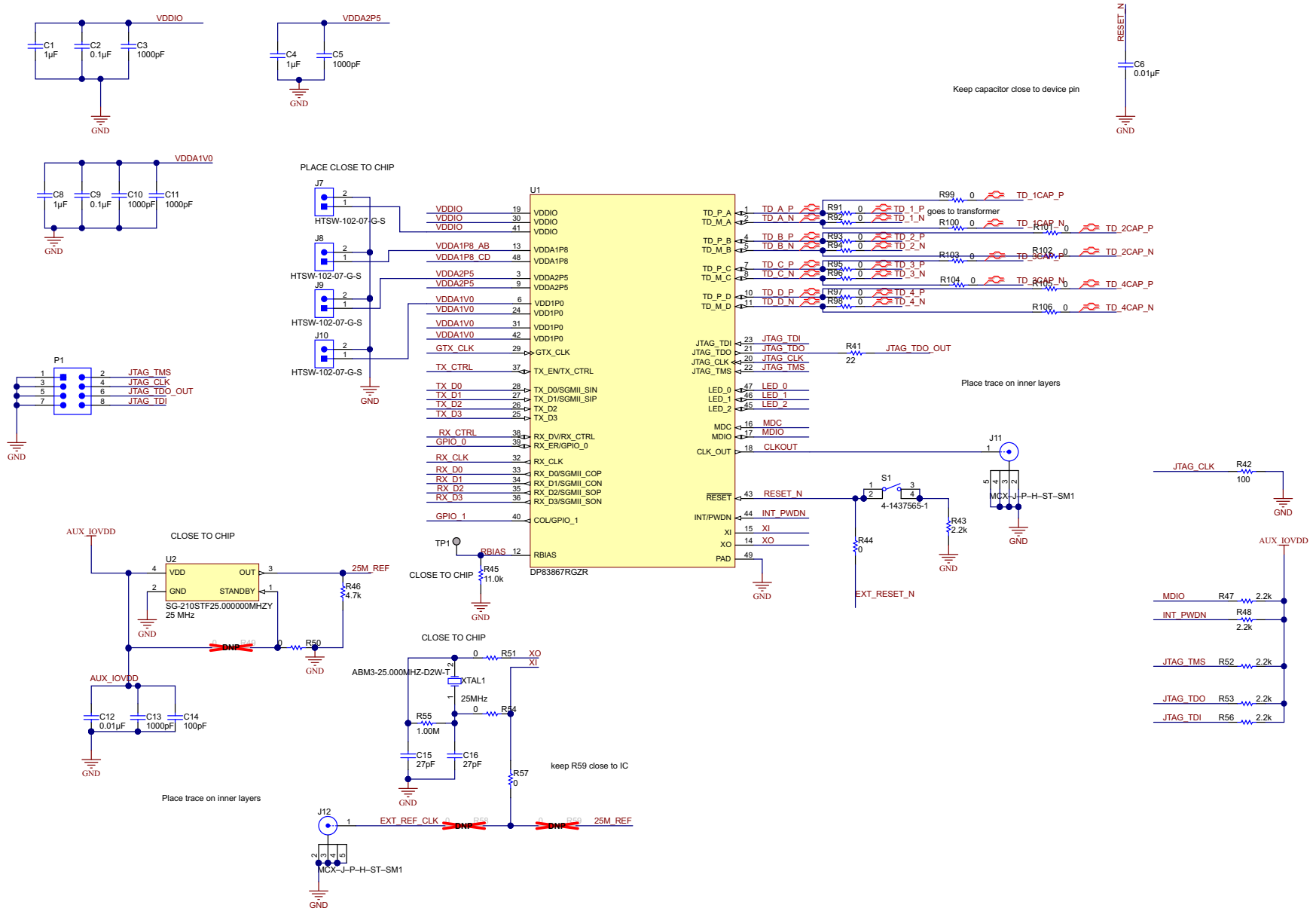


Figure 6. Schematic (4 of 5)

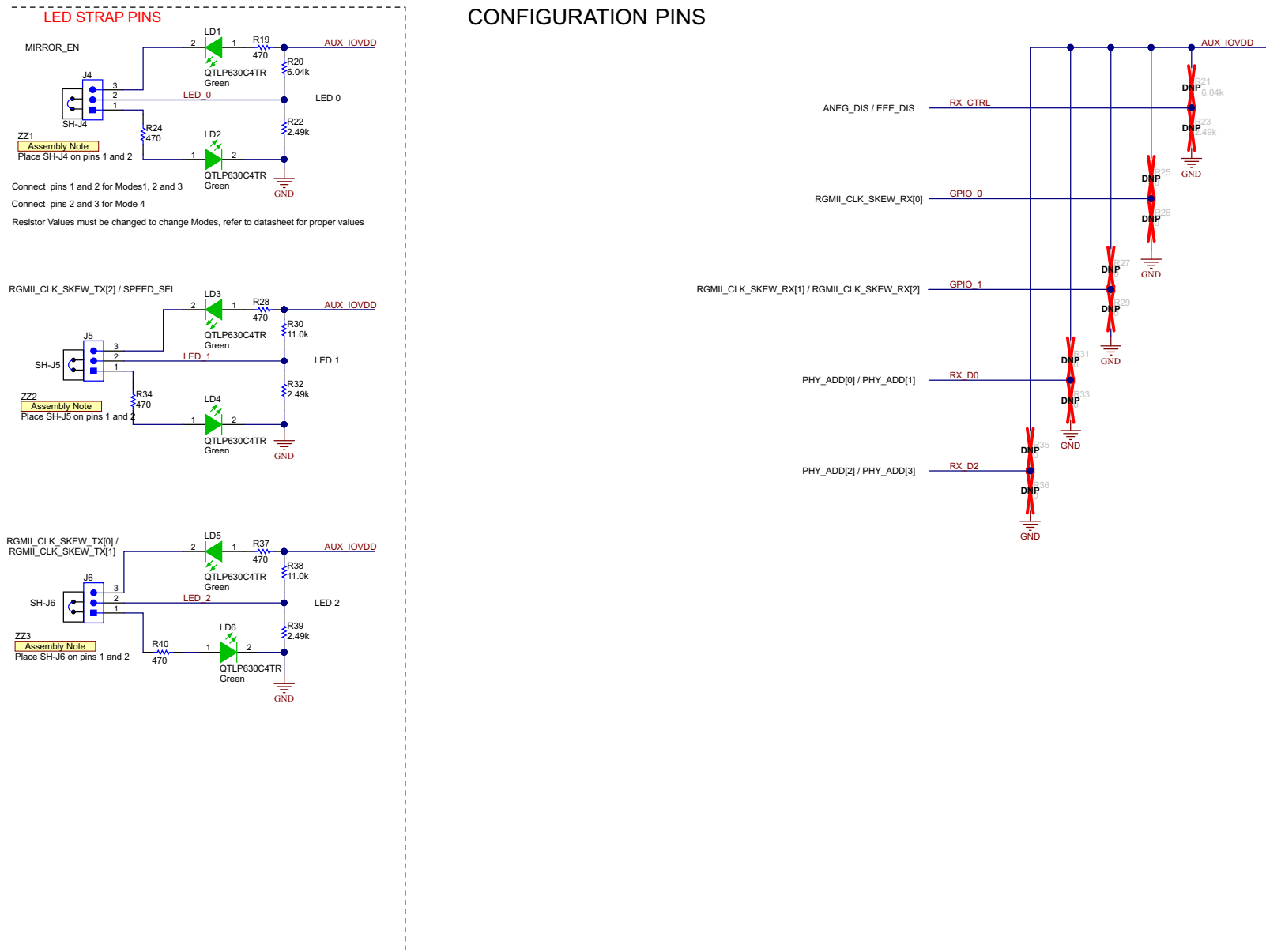


Figure 7. Schematic (5 of 5)

2.10 Layout

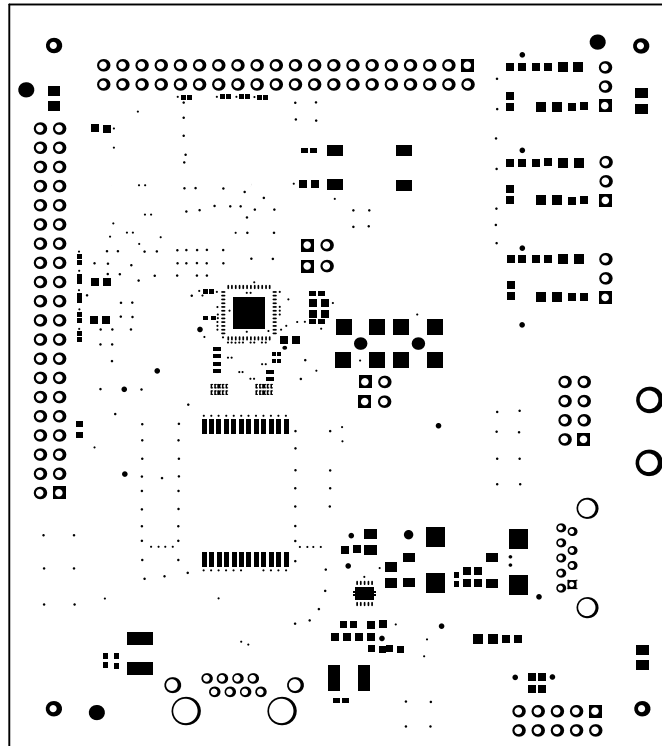


Figure 8. Top Solder

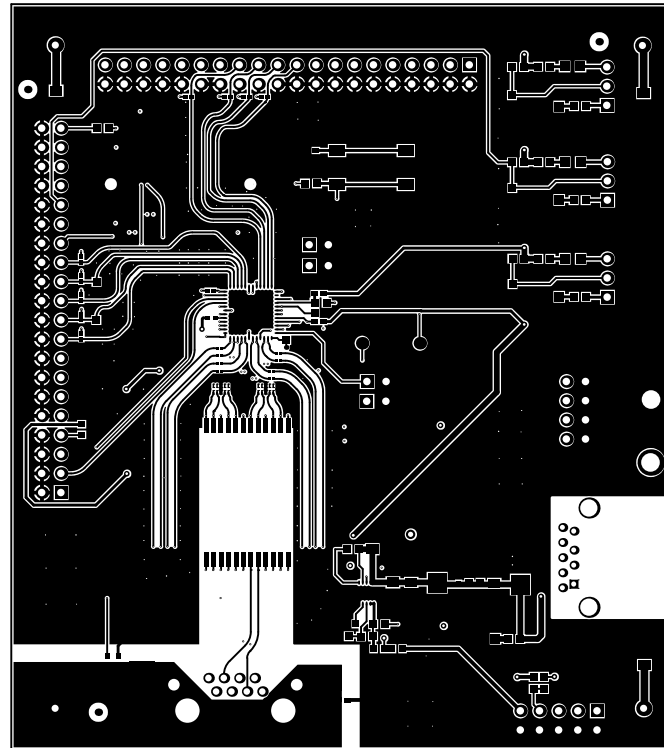


Figure 9. Top Layer

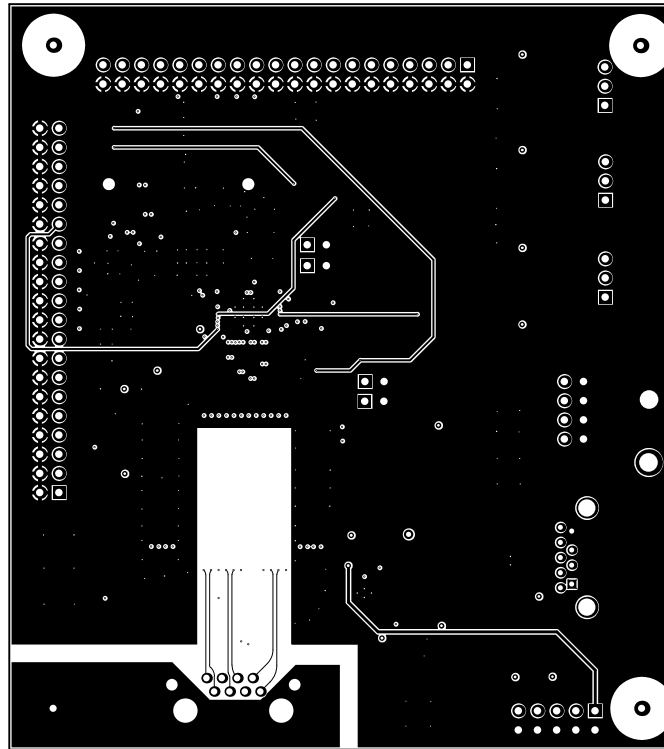


Figure 10. Signal Layer 1

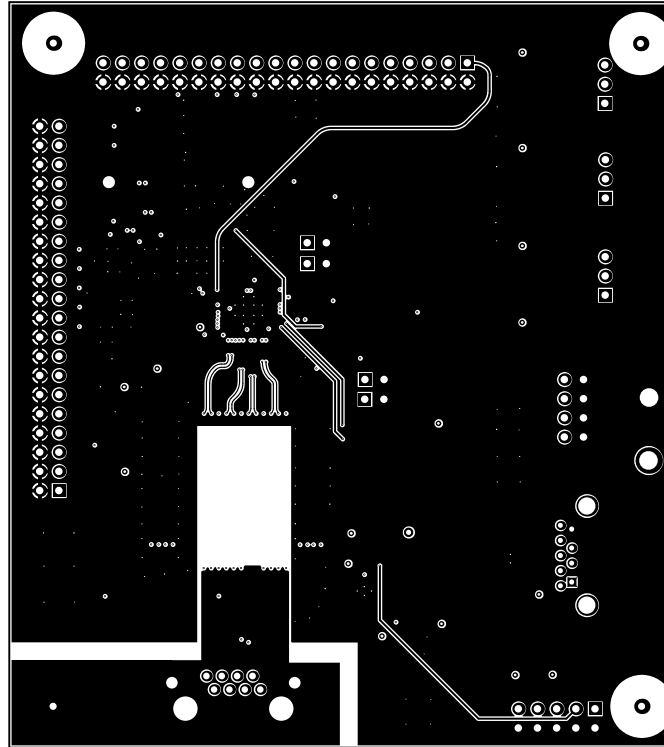


Figure 11. Signal Layer 2

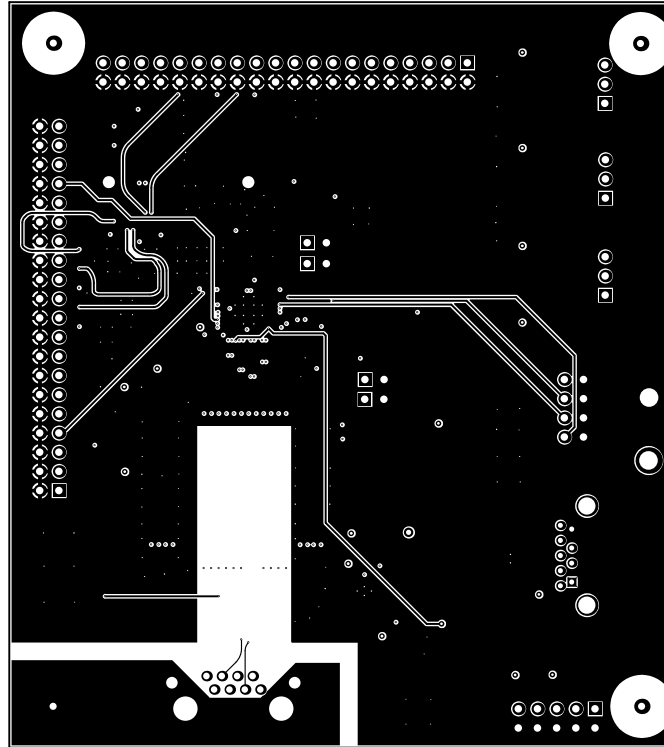


Figure 12. Signal Layer 3

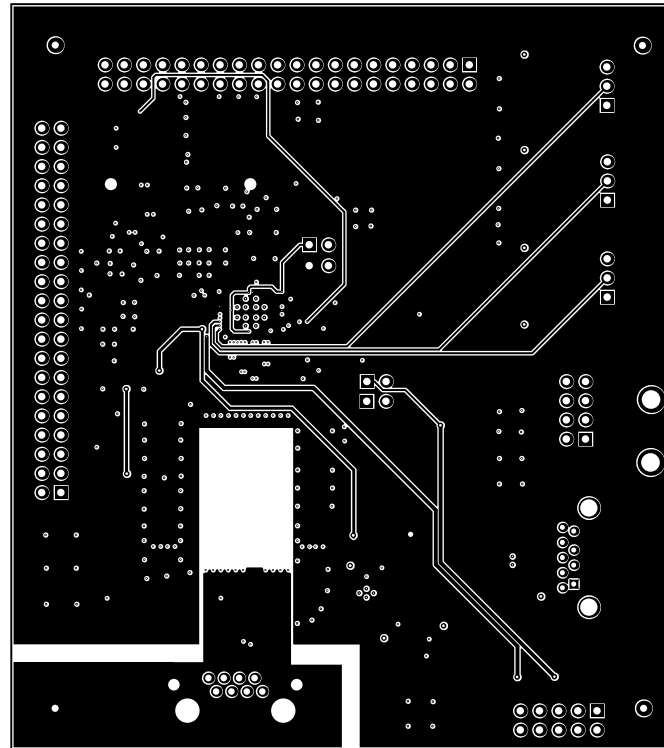


Figure 13. Signal Layer 4

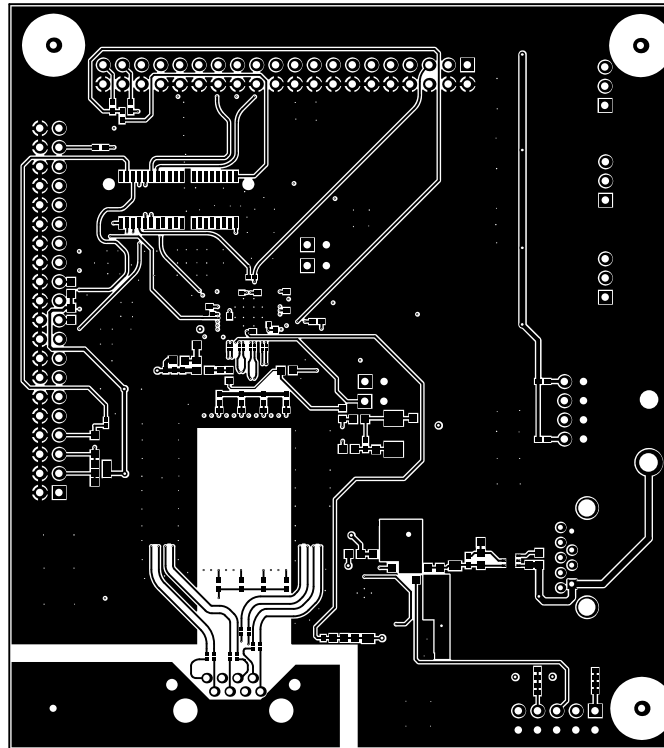


Figure 14. Bottom Layer

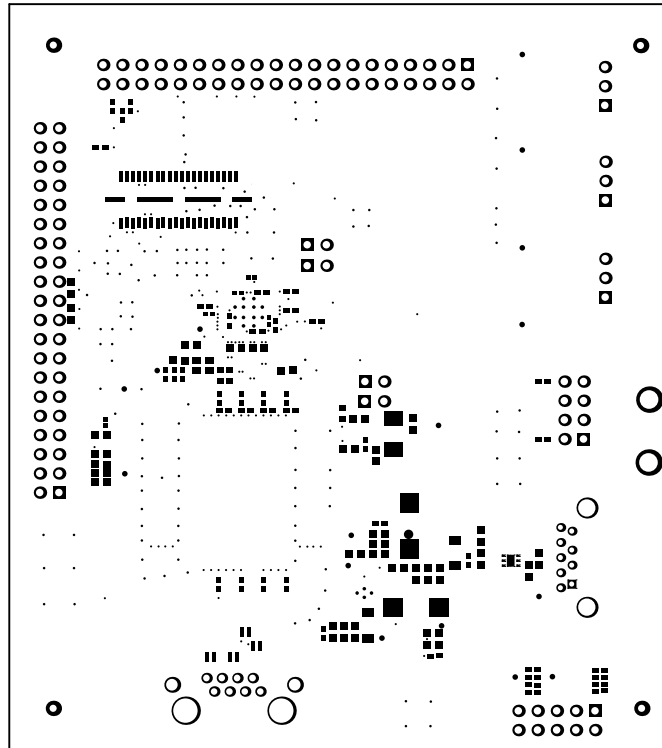
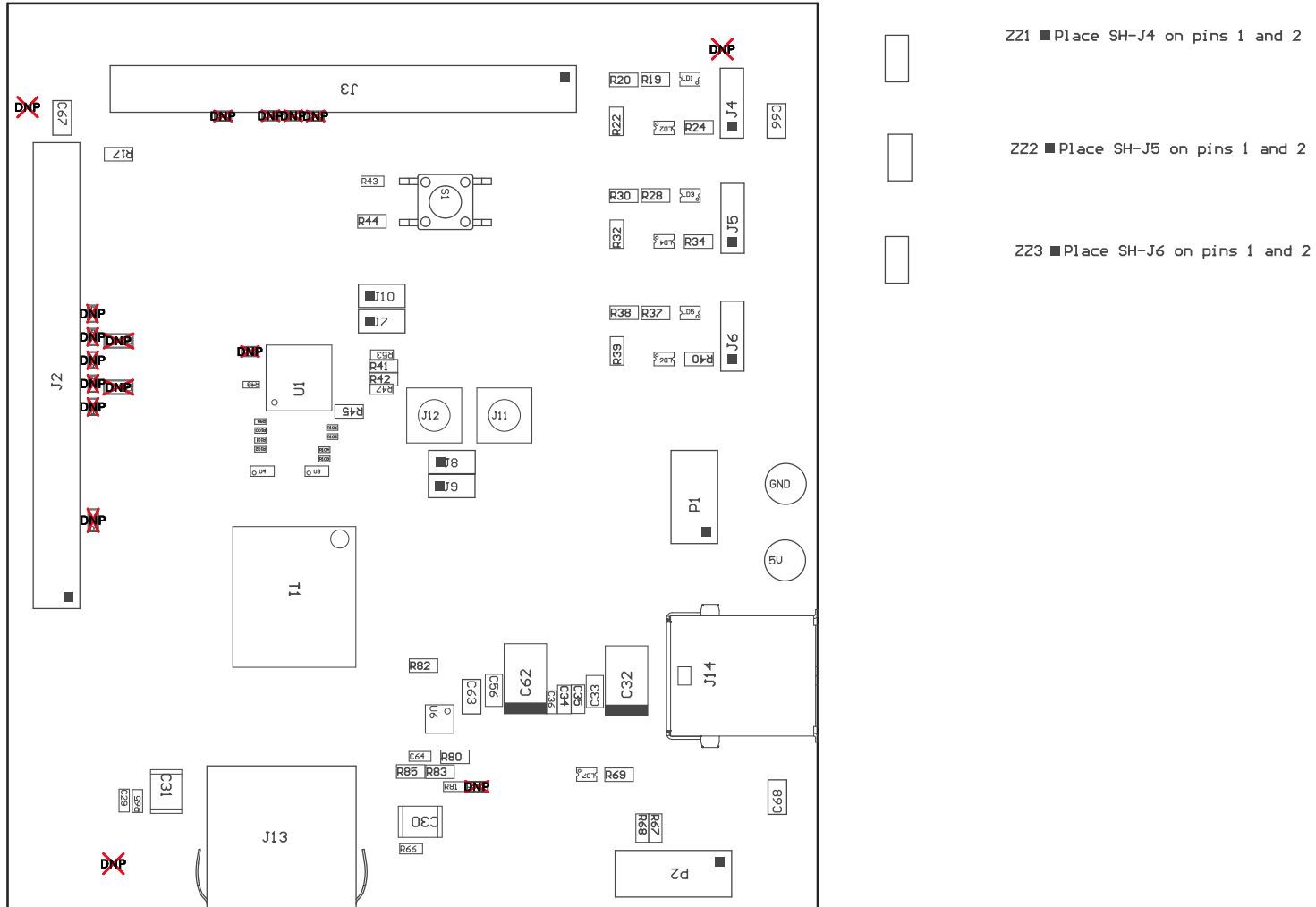


Figure 15. Bottom Solder Mask

2.11 Board Assembly



COMPONENTS MARKED 'DNP' SHOULD NOT BE POPULATED.
ASSEMBLY VARIANT: 001

Figure 16. Board Assembly Top

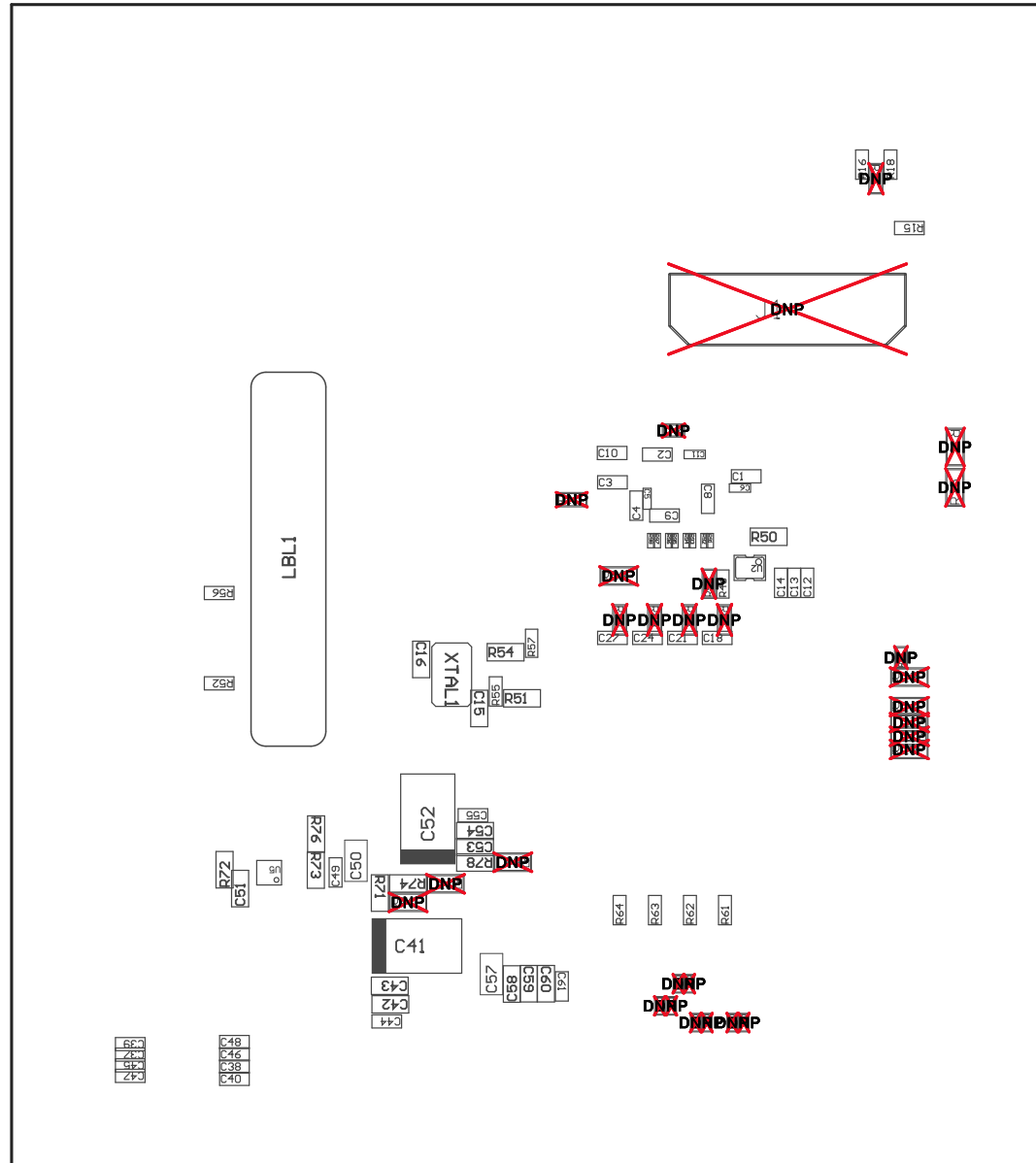


Figure 17. Board Assembly Bottom

2.12 Board Marking (Silk)

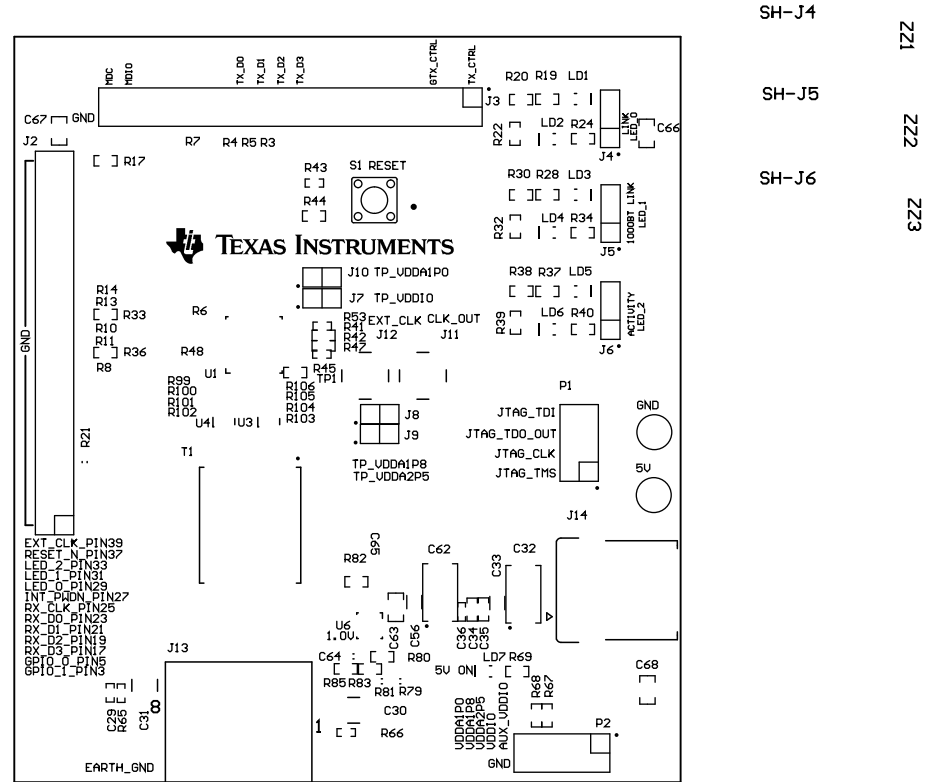


Figure 18. Top Overlay

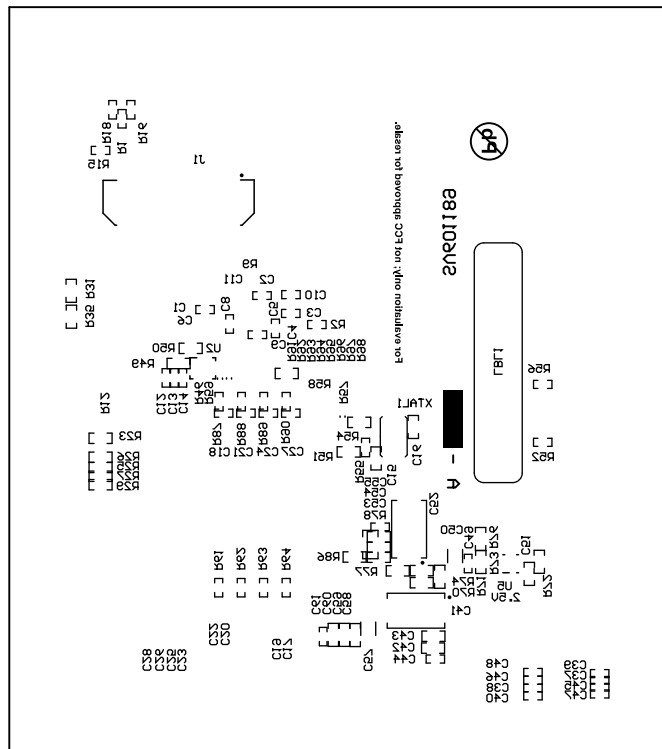


Figure 19. Bottom Overlay

2.13 Bill of Materials (BOM)

Table 1. Engineering Bill of Material

| Designator | Description | Manufacturer | Part Number |
|------------|---|---------------------------|---------------------|
| 5V | Terminal, Turret, TH, Double | Keystone | 1502-2 |
| C1 | CAP, CERM, 1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A105K050BB |
| C2 | CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A104K050BA |
| C3 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C4 | CAP, CERM, 1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A105K050BB |
| C5 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C6 | CAP, CERM, 0.01 μ F, 50 V, +/- 10%, X7R, 0402 | MuRata | GRM155R71H103KA88D |
| C8 | CAP, CERM, 1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A105K050BB |
| C9 | CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A104K050BA |
| C10 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C11 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C12 | CAP, CERM, 0.01 μ F, 50 V, +/- 5%, X7R, 0402 | Kemet | C0402C103J5RACTU |
| C13 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C14 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C15 | CAP, CERM, 27 pF, 50 V, +/- 1%, C0G/NP0, 0603 | Samsung Electro-Mechanics | CL10C270FB8NNNC |
| C16 | CAP, CERM, 27 pF, 50 V, +/- 1%, C0G/NP0, 0603 | Samsung Electro-Mechanics | CL10C270FB8NNNC |
| C17 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C18 | CAP, CERM, 0.1 μ F, 6.3 V, +/- 10%, X5R, 0402 | TDK | C1005X5R0J104K |
| C19 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C20 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C21 | CAP, CERM, 0.1 μ F, 6.3 V, +/- 10%, X5R, 0402 | TDK | C1005X5R0J104K |
| C22 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C23 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C24 | CAP, CERM, 0.1 μ F, 6.3 V, +/- 10%, X5R, 0402 | TDK | C1005X5R0J104K |
| C25 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C26 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C27 | CAP, CERM, 0.1 μ F, 6.3 V, +/- 10%, X5R, 0402 | TDK | C1005X5R0J104K |
| C28 | CAP, CERM, 0.033 μ F, 6.3 V, +/- 10%, X5R, 0201 | MuRata | GRM033R60J333KE01D |
| C29 | CAP, CERM, 0.01 μ F, 50 V, +/- 5%, X7R, 0402 | Kemet | C0402C103J5RACTU |
| C30 | CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812 | AVX | 1812GC472KAT1A |
| C31 | CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812 | AVX | 1812GC472KAT1A |
| C32 | CAP, TA, 220 μ F, 6.3 V, +/- 10%, 0.7 ohm, SMD | Kemet | T491D227K006AT |
| C33 | CAP, CERM, 10 μ F, 35 V, +/- 20%, X7R, 1206_190 | TDK | C3216X7R1V106M160AC |
| C34 | CAP, CERM, 0.01 μ F, 50 V, +/- 5%, X7R, 0603 | Kemet | C0603C103J5RACTU |
| C35 | CAP, CERM, 0.01 μ F, 50 V, +/- 5%, X7R, 0603 | Kemet | C0603C103J5RACTU |
| C36 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C37 | CAP, CERM, 1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A105K050BB |
| C38 | CAP, CERM, 1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A105K050BB |
| C39 | CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A104K050BA |
| C40 | CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X5R, 0402 | TDK | C1005X5R1A104K050BA |
| C41 | CAP, TA, 100 μ F, 10 V, +/- 20%, 0.1 ohm, SMD | Vishay-Sprague | 593D107X0010D2TE3 |
| C42 | CAP, CERM, 0.01 μ F, 50 V, +/- 5%, X7R, 0603 | Kemet | C0603C103J5RACTU |
| C43 | CAP, CERM, 1000 pF, 50 V, +/- 10%, C0G/NP0, 0603 | AVX | 06035A102KAT2A |
| C44 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |

Table 1. Engineering Bill of Material (continued)

| Designator | Description | Manufacturer | Part Number |
|------------|--|----------------|---------------------|
| C45 | CAP, CERM, 1000 pF, 25 V, +/- 10%, X5R, 0402 | MuRata | GRM155R61E102KA01D |
| C46 | CAP, CERM, 1000 pF, 25 V, +/- 10%, X5R, 0402 | MuRata | GRM155R61E102KA01D |
| C47 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C48 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C49 | CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402 | Kemet | C0402C102J3RACTU |
| C50 | CAP, CERM, 10 µF, 35 V, +/- 20%, X7R, 1206_190 | TDK | C3216X7R1V106M160AC |
| C51 | CAP, CERM, 1 µF, 6.3 V, +/- 10%, X7R, 0603 | Samsung | CL10B105KQ8NNNC |
| C52 | CAP, TA, 100 µF, 10 V, +/- 20%, 0.1 ohm, SMD | Vishay-Sprague | 593D107X0010D2TE3 |
| C53 | CAP, CERM, 0.01 µF, 50 V, +/- 5%, X7R, 0603 | Kemet | C0603C103J5RACTU |
| C54 | CAP, CERM, 1000 pF, 50 V, +/- 10%, C0G/NP0, 0603 | AVX | 06035A102KAT2A |
| C55 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C56 | CAP, CERM, 10 µF, 35 V, +/- 20%, X7R, 1206_190 | TDK | C3216X7R1V106M160AC |
| C57 | CAP, CERM, 10 µF, 35 V, +/- 20%, X7R, 1206_190 | TDK | C3216X7R1V106M160AC |
| C58 | CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R, 0603 | Samsung | CL10B104KO8NNNC |
| C59 | CAP, CERM, 0.01 µF, 50 V, +/- 5%, X7R, 0603 | Kemet | C0603C103J5RACTU |
| C60 | CAP, CERM, 1000 pF, 50 V, +/- 10%, C0G/NP0, 0603 | AVX | 06035A102KAT2A |
| C61 | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402 | Yageo America | CC0402JRNPO9BN101 |
| C62 | CAP, TA, 100 µF, 10 V, +/- 20%, 0.1 ohm, SMD | Vishay-Sprague | 593D107X0010D2TE3 |
| C63 | CAP, CERM, 1 µF, 16 V, +/- 10%, X5R, 0805 | AVX | 0805YD105KAT2A |
| C64 | CAP, CERM, 27 pF, 50 V, +/- 1%, C0G/NP0, 0603 | Samsung | CL10C270FB8NNNC |
| C65 | CAP, CERM, 4.7 µF, 10 V, +80/-20%, Y5V, 0805 | Yageo America | CC0805ZRY5V6BB475 |
| C66 | CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805 | AVX | 08051C472KAT2A |
| C67 | CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805 | AVX | 08051C472KAT2A |
| C68 | CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805 | AVX | 08051C472KAT2A |
| FID1 | Fiducial mark. There is nothing to buy or mount. | N/A | N/A |
| FID2 | Fiducial mark. There is nothing to buy or mount. | N/A | N/A |
| FID3 | Fiducial mark. There is nothing to buy or mount. | N/A | N/A |
| GND | Terminal, Turret, TH, Double | Keystone | 1502-2 |
| J1 | Connector, Header, High Speed, 20 pairs, SMT | Samtec | QTE-020-01-L-D-A |
| J2 | Header, 100mil, 20x2, Gold, TH | Samtec | TSW-120-07-G-D |
| J3 | Header, 100mil, 20x2, Gold, TH | Samtec | TSW-120-07-G-D |
| J4 | Header, 100mil, 3x1, Gold, TH | Samtec | TSW-103-07-G-S |
| J5 | Header, 100mil, 3x1, Gold, TH | Samtec | TSW-103-07-G-S |
| J6 | Header, 100mil, 3x1, Gold, TH | Samtec | TSW-103-07-G-S |
| J7 | Header, 100mil, 2x1, Gold, TH | Samtec | HTSW-102-07-G-S |
| J8 | Header, 100mil, 2x1, Gold, TH | Samtec | HTSW-102-07-G-S |
| J9 | Header, 100mil, 2x1, Gold, TH | Samtec | HTSW-102-07-G-S |
| J10 | Header, 100mil, 2x1, Gold, TH | Samtec | HTSW-102-07-G-S |
| J11 | Mini-RFCable Connector 50 Ohm | Samtec | MCX-J-P-H-ST-SM1 |
| J12 | Mini-RFCable Connector 50 Ohm | Samtec | MCX-J-P-H-ST-SM1 |
| J13 | RJ-45, Right Angle, No LED, tab up | AMP | 1-406541-1 |
| J14 | Connector, Receptacle, USB Type A, 9 Pins, R/A, TH | FCI | 10117835-002LF |
| LBL1 | Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll | Brady | THT-13-457-10 |
| LD1 | LED, Green, SMD | Everlight | QTLP630C4TR |
| LD2 | LED, Green, SMD | Everlight | QTLP630C4TR |

Table 1. Engineering Bill of Material (continued)

| Designator | Description | Manufacturer | Part Number |
|------------|-------------------------------|---------------|------------------|
| LD3 | LED, Green, SMD | Everlight | QTLP630C4TR |
| LD4 | LED, Green, SMD | Everlight | QTLP630C4TR |
| LD5 | LED, Green, SMD | Everlight | QTLP630C4TR |
| LD6 | LED, Green, SMD | Everlight | QTLP630C4TR |
| LD7 | LED, Green, SMD | Everlight | QTLP630C4TR |
| P1 | Header, 100mil, 4x2, Gold, TH | Samtec | TSW-104-07-G-D |
| P2 | Header, 100mil, 5x2, Gold, TH | Samtec | TSW-105-07-G-D |
| R1 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R2 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R3 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R4 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R5 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R6 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R7 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R8 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R9 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R10 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R11 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R12 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R13 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R14 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R15 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R16 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R17 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R18 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R19 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |
| R20 | RES, 6.04 k, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW06036K04FKEA |
| R21 | RES, 6.04 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-076K04L |
| R22 | RES, 2.49 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-072K49L |
| R23 | RES, 2.49 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-072K49L |
| R24 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |
| R25 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R26 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R27 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R28 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |
| R29 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R30 | RES, 11.0 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-0711KL |
| R31 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R32 | RES, 2.49 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-072K49L |
| R33 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R34 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |
| R35 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R36 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R37 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |
| R38 | RES, 11.0 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-0711KL |
| R39 | RES, 2.49 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-072K49L |
| R40 | RES, 470, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-07470RL |

Table 1. Engineering Bill of Material (continued)

| Designator | Description | Manufacturer | Part Number |
|------------|--------------------------------|---------------|------------------|
| R41 | RES, 22, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW060322R0JNEA |
| R42 | RES, 100, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW0603100RFKEA |
| R43 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R44 | RES, 0, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06030000Z0EA |
| R45 | RES, 11.0 k, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW060311K0FKEA |
| R46 | RES, 4.7 k, 5%, 0.1 W, 0603 | Vishay-Dale | CRCW06034K70JNEA |
| R47 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R48 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R50 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R51 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R52 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R53 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R54 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R55 | RES, 1.00 M, 1%, 0.063 W, 0402 | Yageo America | RC0402FR-071ML |
| R56 | RES, 2.2 k, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04022K20JNED |
| R57 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R58 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R59 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R61 | RES, 75.0, 1%, 0.063 W, 0402 | Vishay-Dale | CRCW040275R0FKED |
| R62 | RES, 75.0, 1%, 0.063 W, 0402 | Vishay-Dale | CRCW040275R0FKED |
| R63 | RES, 75.0, 1%, 0.063 W, 0402 | Vishay-Dale | CRCW040275R0FKED |
| R64 | RES, 75.0, 1%, 0.063 W, 0402 | Vishay-Dale | CRCW040275R0FKED |
| R65 | RES, 1.00 M, 1%, 0.063 W, 0402 | Yageo America | RC0402FR-071ML |
| R66 | RES, 1.00 M, 1%, 0.063 W, 0402 | Yageo America | RC0402FR-071ML |
| R67 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R68 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R69 | RES, 750, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-07750RL |
| R70 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R71 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R72 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R73 | RES, 48.7 k, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW060348K7FKEA |
| R74 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R76 | RES, 45.3 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-0745K3L |
| R77 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R78 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R79 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R80 | RES, 10.0 k, 1%, 0.1 W, 0603 | Yageo America | RC0603FR-0710KL |
| R81 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R82 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R83 | RES, 1.13 k, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW06031K13FKEA |
| R85 | RES, 4.53 k, 1%, 0.1 W, 0603 | Vishay-Dale | CRCW06034K53FKEA |
| R86 | RES, 0, 5%, 0.1 W, 0603 | Yageo America | RC0603JR-070RL |
| R87 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R88 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R89 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R90 | RES, 0, 5%, 0.063 W, 0402 | Vishay-Dale | CRCW04020000Z0ED |
| R91 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |

Table 1. Engineering Bill of Material (continued)

| Designator | Description | Manufacturer | Part Number |
|------------|---|---------------------|------------------------|
| R92 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R93 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R94 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R95 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R96 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R97 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R98 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R99 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R100 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R101 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R102 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R103 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R104 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R105 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| R106 | RES, 0, 5%, 0.05 W, 0201 | Panasonic | ERJ-1GE0R00C |
| S1 | Switch, Tactile, SPST-NO, 0.05A, 12V, SMT | TE Connectivity | 4-1437565-1 |
| SH-J4 | Shunt, 100mil, Gold plated, Black | 3M | 969102-0000-DA |
| SH-J5 | Shunt, 100mil, Gold plated, Black | 3M | 969102-0000-DA |
| SH-J6 | Shunt, 100mil, Gold plated, Black | 3M | 969102-0000-DA |
| T1 | Transformer, 325 uH, SMT | Pulse Engineering | HX5008NL |
| U1 | Robust, Low Power 10/100/1000 Ethernet Physical Layer Transceiver, RGZ0048B | Texas Instruments | DP83867RGZR |
| U2 | OSC, 25 MHz, 1.6 to 3.6 V, SMD | Epson | SG-210STF25.000000MHZY |
| U3 | 1, 4, 6 CHANNEL PROTECTION SOLUTION FOR SUPER-SPEED (UP TO 6 GBPS) INTERFACE, DQA0010A | Texas Instruments | TPD4E05U06DQAR |
| U4 | 1, 4, 6 CHANNEL PROTECTION SOLUTION FOR SUPER-SPEED (UP TO 6 GBPS) INTERFACE, DQA0010A | Texas Instruments | TPD4E05U06DQAR |
| U5 | Single Output High PSRR LDO, 500 mA, Adjustable 1.25 to 6 V Output, 2.7 to 6.5 V Input, with Low IQ, 6-pin SON (DRV), -40 to 125 degC, Green (RoHS & no Sb/Br) | Texas Instruments | TPS73501DRVR |
| U6 | Single Output LDO, 500 mA, Adjustable 0.8 to 3.6 V Output, 0.8 to 5.5 V Input, with Programmable Soft Start, 10-pin SON (DRC), -40 to 125 degC, Green (RoHS & no Sb/Br) | Texas Instruments | TPS74701DRCR |
| XTAL1 | Crystal, 25 MHz, 18 pF, SMD | Abracon Corporation | ABM3-25.000MHZ-D2W-T |

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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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.

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