



A New Direction in Mixed-Signal

May 2014

## XRP7724/7725EVB-DEMO-2

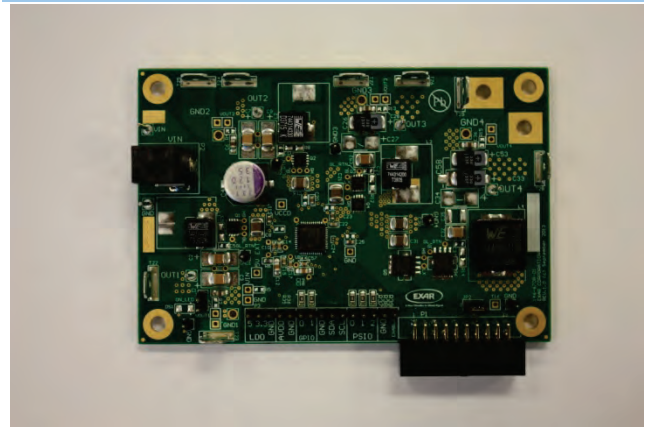
### Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

Rev. 1.0.0

#### GENERAL DESCRIPTION

The XRP7724/7725EVB-DEMO-2 board is a complete four channel power system. It is configured to provide 3.3V, 2.5V 1.5V and 1V at a maximum of 3A, 3A, 5A and 10A loads respectively. The 1.5V and 1V supplies can be adjusted in 2.5mV increments, the 2.5V supply in 5mV increments, and the 3.3V supply is adjustable in 10mV increments. The order and ramp rates for each supply can be programmed to accommodate any sequencing requirement. All power supply operations can be controlled over an I<sup>2</sup>C interface. Faults, output voltages and currents can also be monitored. Two GPIO and three PSIO signals are available and can be programmed to provide a variety of functions. Unused GPIO/PSIO pins can be programmed as I/O expansion for a microcontroller. The board is supported by PowerArchitect™ 5.1 or later and plugs directly onto the interposer board acting as an interface to an Arduino controller or Exar's XCM.

#### EVALUATION BOARD MANUAL



XRP7724/7725EVB-DEMO-2

#### FEATURES

- **XRP24/7725 Programmable Controller**
- **4 Channel Power System**
- **Wide Input Voltage Range: 5.5V-25V**
- **I<sup>2</sup>C Interface**
  - Programming
  - Remote re-configurability
  - Monitoring
  - Control
- **Arduino GPIO, PSIO and ENABLE control**



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# XRP7724/7725EVB-DEMO-2

## Quad Channel Digital PWM/PFM Demo Board

### Programmable Power Management System

Rev. 1.0.0

## EVALUATION BOARD SCHEMATICS

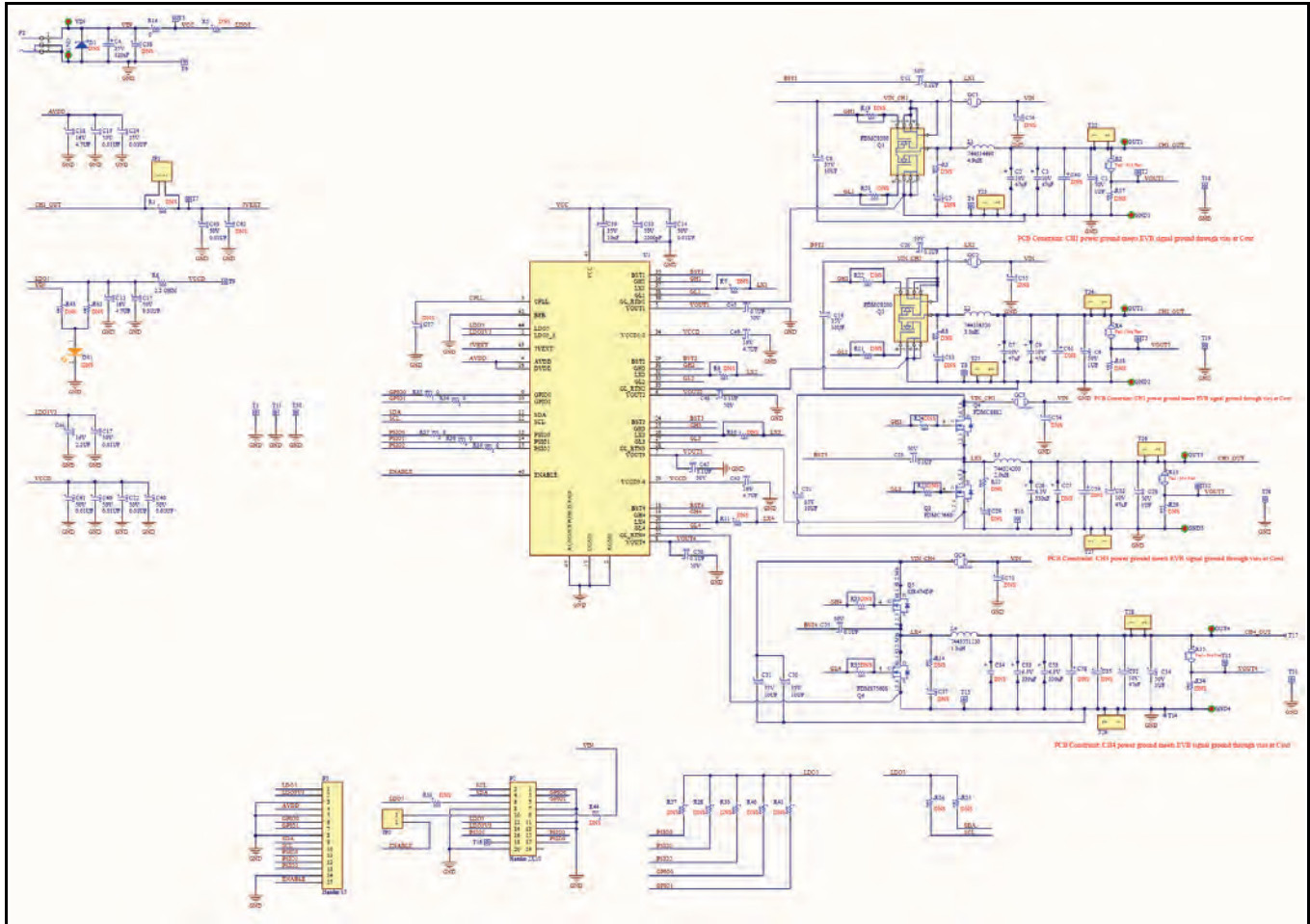


Figure 1 XRP7724/7725 Evaluation Board Schematics

### PIN ASSIGNMENT

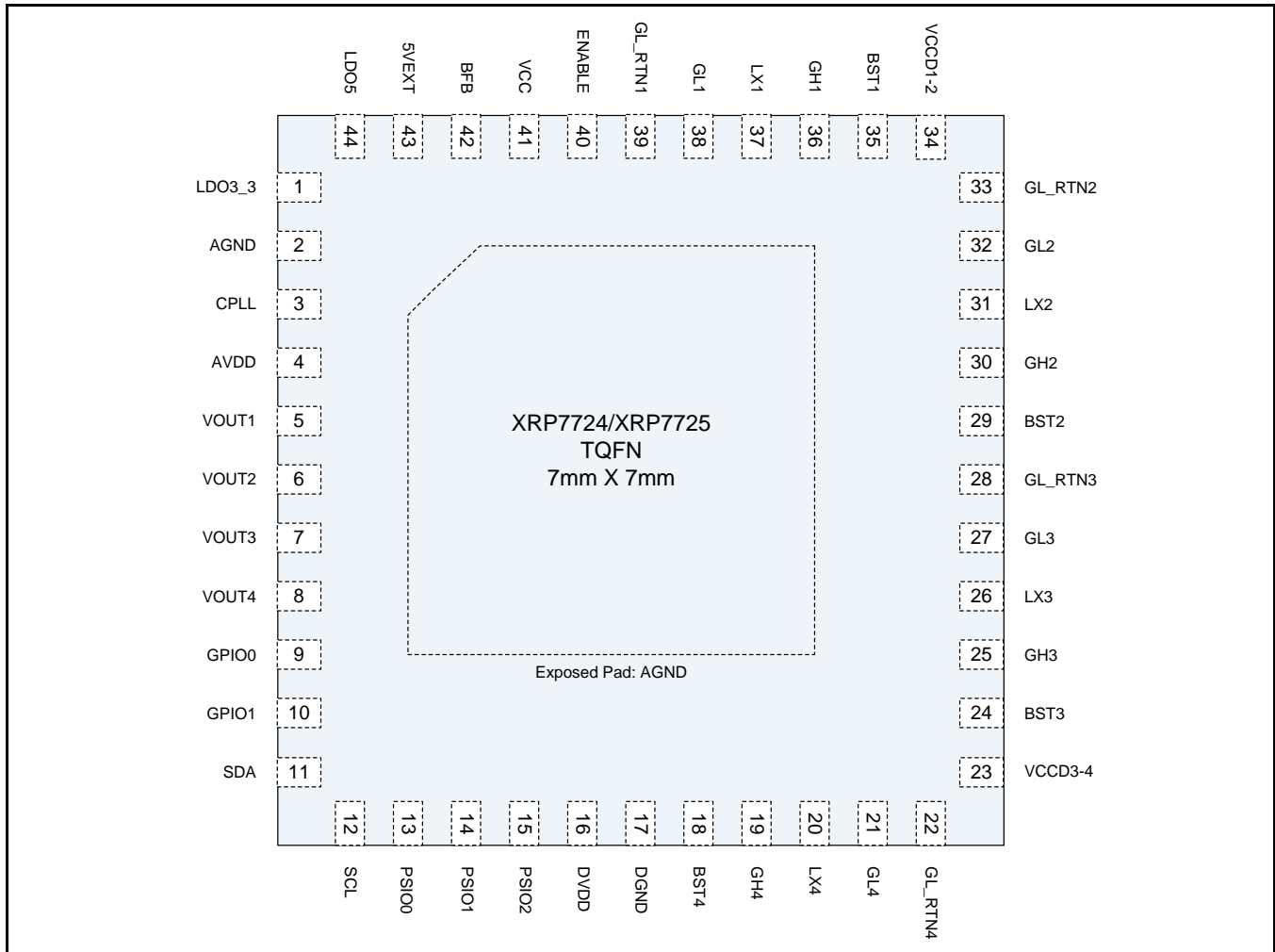


Figure 2 XRP7724/7725 Pin Assignment

### PIN DESCRIPTION

| Name               | Pin Number   | Description   |
|--------------------|--------------|---|
| VCC                | 41           | Input voltage. Place a decoupling capacitor close to the pin. This input is used in UVLO fault generation.  |
| DVDD               | 16           | 1.8V supply for digital circuitry. Connect pin to AVDD. Place a decoupling capacitor close to the pin.  |
| VCCD1-2<br>VCCD3-4 | 23,34        | Gate Drive supply. Two independent gate drive supply pins where pin 34 supplies drivers 1 and 2 and pin 23 supplies drivers 3 & 5. One of the two pins must be connected to the LDO5 pin to enable two power rails initially. It is recommended that the other VCCD pin be connected to the output of a 5V switching rail (for improved efficiency or for driving larger external FETs), if available, otherwise this pin may also be connected to the LDO5 pin. A bypass capacitor (>1uF) to PAD is recommended for each VCCD pin with the pin(s) connected to LDO5 with shortest possible etch. |
| AGND               | 2            | Analog ground pin. This is the small signal ground connection.  |
| GL_RTNA1-4         | 39,33, 28,22 | Ground connection for the low side gate driver. This should be routed as a signal trace with GL. Connect to the source of the low side MOSFET.  |
| GL1-GL4            | 38,32, 27,21 | Output pin of the low side gate driver. Connect directly to the gate of an external N-channel MOSFET.   |



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## XRP7724/7725EVB-DEMO-2 Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

| Name        | Pin Number   | Description  |
|-------------|--------------|--|
| GH1-GH4     | 36,30, 25,19 | Output pin of the high side gate driver. Connect directly to the gate of an external N-channel MOSFET.   |
| LX1-LX4     | 37,31, 26,20 | Lower supply rail for the GH high-side gate driver. Connect this pin to the switching node at the junction between the two external power MOSFETs and the inductor. These pins are also used to measure voltage drop across bottom MOSFETs in order to provide output current information to the control engine.                             |
| BST1-BST4   | 35,29, 24,18 | High side driver supply pin(s). Connect BST to the external capacitor as shown in the Typical Application Circuit on page 5. The high side driver is connected between the BST pin and LX pin and delivers the BST pin voltage to the high side FET gate each cycle.   |
| GPIO-GPIO1  | 9,10         | These pins can be configured as inputs or outputs to implement custom flags, power good signals, enable/disable controls and synchronization to an external clock.   |
| PSIO0-PSIO2 | 13,14,15     | Open drain, these pins can be used to control external power MOSFETs to switch loads on and off, shedding the load for fine grained power management. They can also be configured as standard logic outputs or inputs just as any of the GPIOs can be configured, but as open drains require an external pull-up when configured as outputs. |
| SDA, SCL    | 11,12        | SMBus/I <sup>2</sup> C serial interface communication pins. These pins can be configured open drain or pseudo-TTL requiring a pull-up resistor.  |
| VOUT1-VOUT4 | 5,6,7,8      | Connect to the output of the corresponding power stage. The output is sampled at least once every switching cycle  |
| LDO5        | 44           | Output of a 5V LDO. This is a micro power LDO that can remain active while the rest of the IC is in the stand-by mode. This LDO is also used to power the internal Analog Blocks.  |
| LDO3_3      | 1            | Output of the 3.3V standby LDO. This is a micro power LDO that can remain active while the rest of the IC is in shutdown.  |
| ENABLE      | 40           | If ENABLE is pulled high or allowed to float high, the chip is powered up (logic is reset, registers configuration loaded, etc.). The pin must be held low for the XRP7724 to be placed into shutdown. Active channels will automatically be ramped down, if desired, prior to the disabling of the chip.                                    |
| BFB         | 42           | Input from the 15V output created by the external boost supply. When this pin goes below a pre-defined threshold, a pulse is created on the low side drive to charge this output back to the original level. If not used, this pin should be connected to GND.   |
| DGND        | 17           | Digital ground pin. This is the logic ground connection, and should be connected to the ground plane close to the PAD.   |
| CPLL        | 3            | PLL compensation capacitor   |

### ORDERING INFORMATION

| Part Number            | Description   |
|------------------------|---|
| XRP7724EVB-DEMO-2      | XRP7724EVB-DEMO-2 Evaluation Board  |
| XRP7724EVB-DEMO-2-KIT  | Evaluation kit includes XRP7724EVB-DEMO-2 Evaluation Board with Power Architect software and interface board  |
| XRP7724EVB-DEMO-2-KITA | Evaluation kit includes XRP7724EVB-DEMO-2 Evaluation Board with Power Architect software, interface and Arduino controller boards                           |
| XRP7725EVB-DEMO-2      | XRP7725EVB-DEMO-2 Evaluation Board  |
| XRP7725EVB-DEMO-2-KIT  | Evaluation kit includes XRP7725EVB-DEMO-2 Evaluation Board with Power Architect software and interface board  |
| XRP7725EVB-DEMO-2-KITA | Evaluation kit includes XRP7725EVB-DEMO-2 Evaluation Board with Power Architect software, interface and Arduino controller boards                           |
| XR77EVB-INT-1          | Interface board designed for use with an Arduino controller and compatible evaluation boards. Also has connectivity for the Exar Configuration Module (XCM) |
| XRP77XXEVB-XCM         | Exar Configuration Module (XCM). USB to I2C interface board.  |

### USING THE EVALUATION BOARD

#### INPUT VOLTAGE RANGE

The input voltage range of these boards is from 5.5V to 25V. The power components have been optimized for a 12V input rail. When running the board at an input voltage other than 12V, use PowerArchitect™ 5.1 to evaluate the system performance.

#### I<sup>2</sup>C INTERFACE

The XRP7724 and XRP7725 programmable power controllers employ a standard I<sup>2</sup>C interface. Although the I<sup>2</sup>C signals can be pulled up to LDO5 on board by means of installing resistors at the locations R25 and R26, the I<sup>2</sup>C bus signals are pulled up on the controller interface board (XR77EVB-INT-1) by default (refer to Appendix – jumpers installed shorting pins 2 and 3 together at the locations JP6 and JP7).

#### OPERATING THE EVALUATION BOARD

The XRP7724/7725EVB-DEMO-2 is designed to be powered from either an AC/DC wall wart (the output voltage must be in the range of the controllers - 5.5V to 25V) connected to the barrel connector or a test bench DC power supply (the voltage must be in the range of the controllers - 5.5V to 25V) connected to the V<sub>IN</sub> connectors.

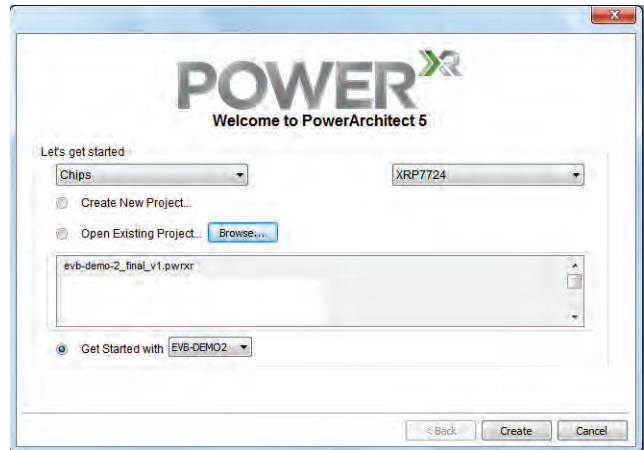
#### BRING UP PROCEDURE

Plug the XRP7724/7725EVB-DEMO-2 evaluation board and the Arduino board into the controller interface board as shown below.



Load the [latest](#) PowerArchitect™ 5 software and run it.

After selecting the proper family (Chips) and the device (XRP7724 or XRP7725), select the “Get Started with the EVB-DEMO2” option when prompted as shown below.



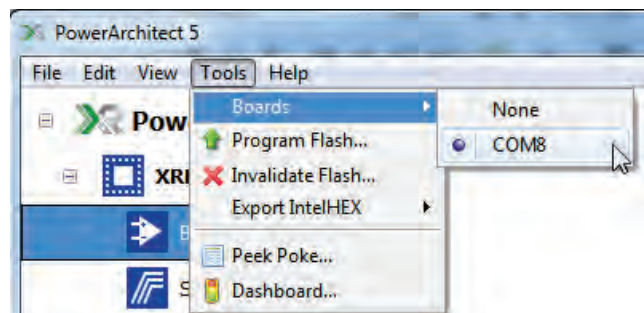
When done, click “Create”. PowerArchitect™ 5 will load the default configuration automatically.

Apply Power to the board. Please refer to the sections above on how to properly supply power to the board and what voltage range to use.

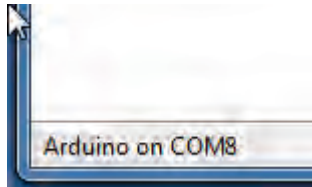
Turn on the Power supply.

Use USB cable to connect the computer (type A) and the Arduino controller board (type B).

Go to the Tools tab in PA 5 and select Boards. The software will identify communication ports where it found the Arduino controller board. Select the port.

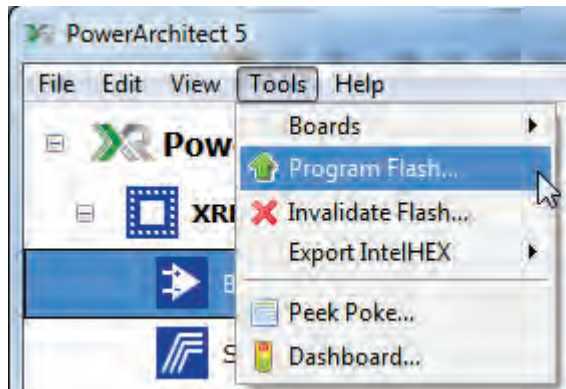


PA 5 is now communicating with the Arduino controller board which is indicated in the lower left corner.

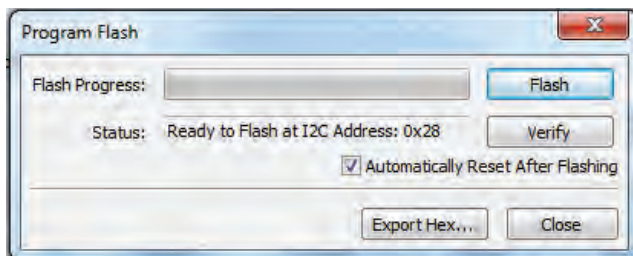


### Programming the Configuration onto XRP7724/7725

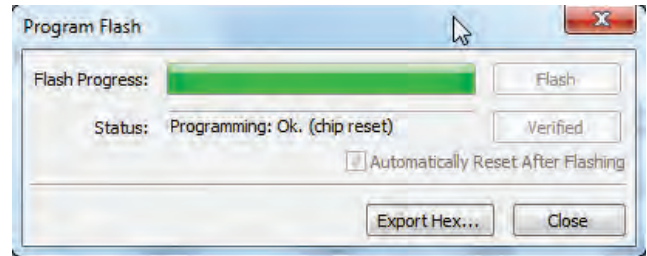
To program a configuration go to the Tools tab in PA 5 and select Program Flash.



The program Flash window will appear.



Click the Flash button.



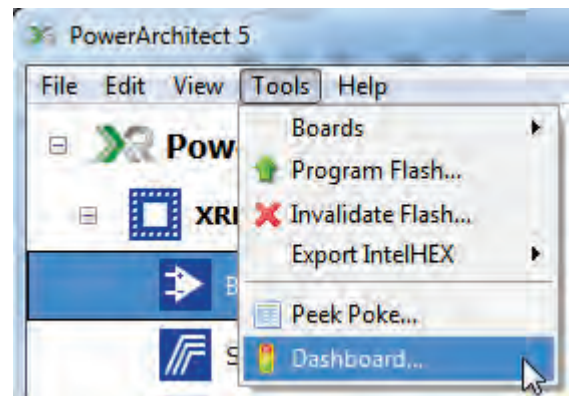
PA 5 will go through the process of loading configuration in the flash. Once it has successfully completed the task, it will report the outcome as seen above and reset the device if "Automatically Reset After Flashing" box checked (default option).

Close the window.

Note that XRP7724/7725EVb-DEMO-2 boards will be pre-loaded with the default configuration.

### Regulation

To enable channel regulation go to the Tools tab in PA 5 and select Dashboard.



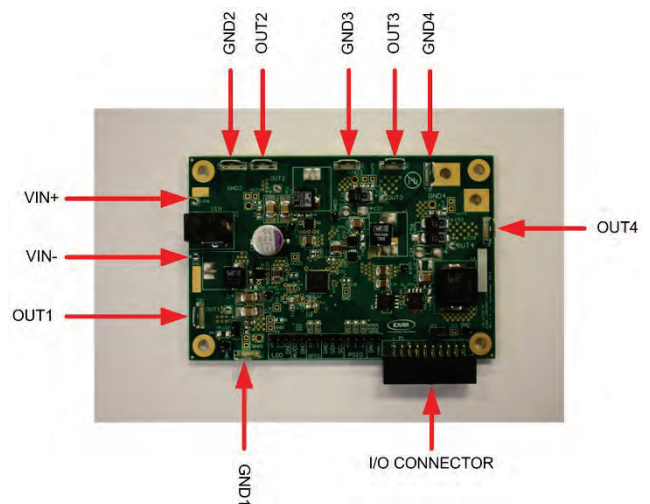
In Dashboard turn Group 1 and Group 2 on. The configuration groups the channels 1 and 2 into the group 1, and the channels 3 and 4 into the group 2. The channels are now in regulation as indicated by  $V_{OUT}$  readings as well as the in-regulation indicators.



desired. To do this, one will need to populate the locations R27, R28, R30.

### EVALUATION BOARD CONNECTIONS

The following picture illustrates how  $V_{IN}$  supplied from a test bench DC power supply and instruments attached to the outputs would be connected to the XRP7724/7725EVB-DEMO-2 board.



Channels can be turned on individually if desired.

### GPIO and PISO interface

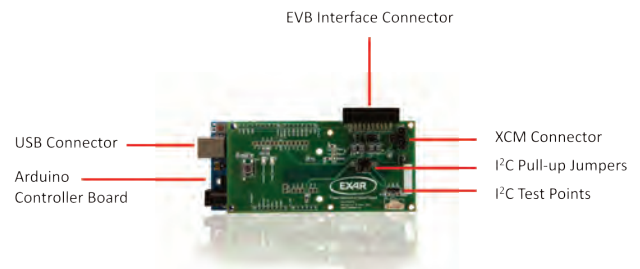
The GPIOs, PSIOs and ENABLE can be controlled from the Arduino controller dynamically in the dashboard.

ENABLE signal is connected to the Arduino controller board by default (JP2 header is shorted). Arduino drives the ENABLE pin low to place XRP7724/7725 into the shutdown mode. It releases the ENABLE pin to enable the device. If leaving the ENABLE pin floating is desired, the jumper at JP2 shall be removed.

The PSIOs are not pulled up on XRP7724/7725EVB-DEMO-2 by default. There is a loading option to pull PSIOs up to LDO5 if

### INTERFACE BOARD CONNECTIONS

The following picture illustrates connections on the interface board - XR77EVB-INT-1. Its primary task is to provide interface between the Arduino controller board and EVB. In addition, as explained in the subsequent sections, it can be used to make connection between XCM and EVB using 10-wire ribbon cable.



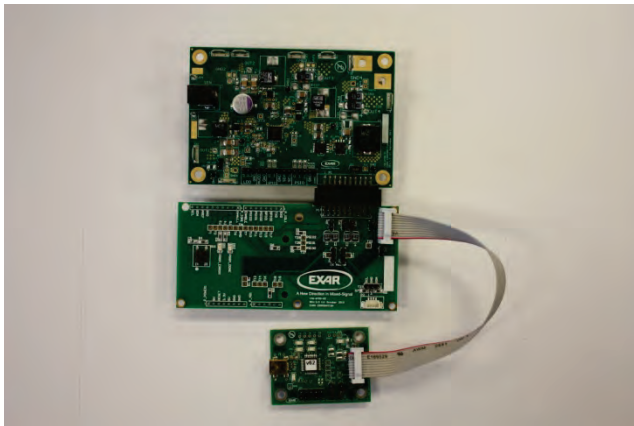
### USING EXAR CONFIGURATION MODULE (XCM) TO COMMUNICATE WITH THE EVALUATION BOARD

It is possible to use the XCM (firmware version v62) to communicate with the XRP7724/7725EVB-DEMO-2 board. PA 5 supports XCM. The main task will be connecting XCM to the evaluation board.

#### Using Interface Board

If the interface board is available use following steps:

- Make sure no Arduino controller board is connected to the interface board
- Remove I2C pull-up jumpers at location JP6 and JP7 (need to be open in all positions)
- If the 10-wire ribbon cable is available connect the XCM to the interface board as shown below



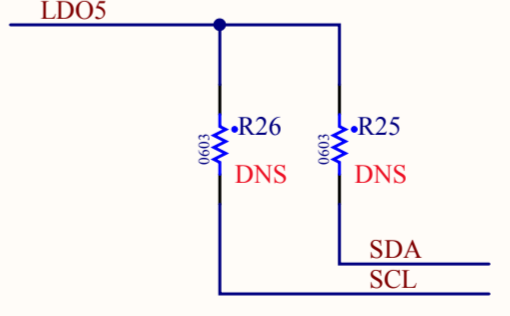
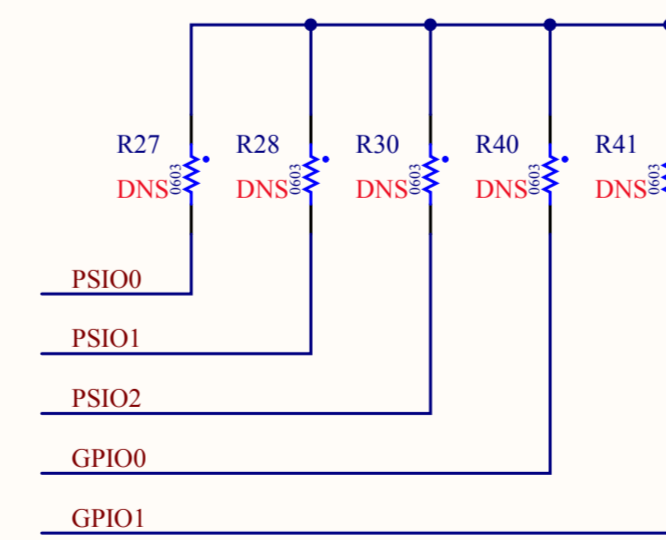
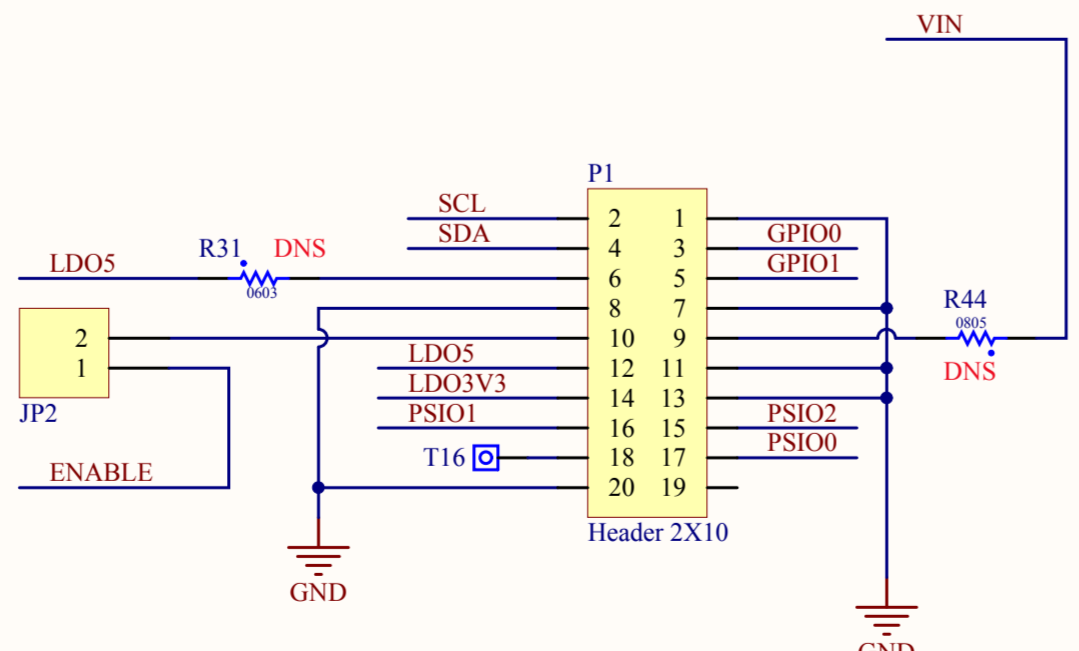
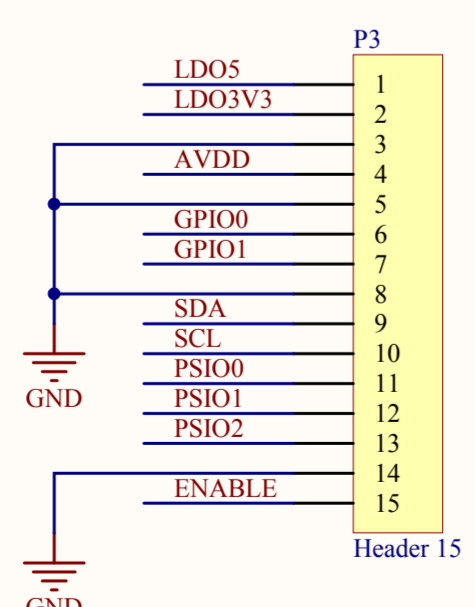
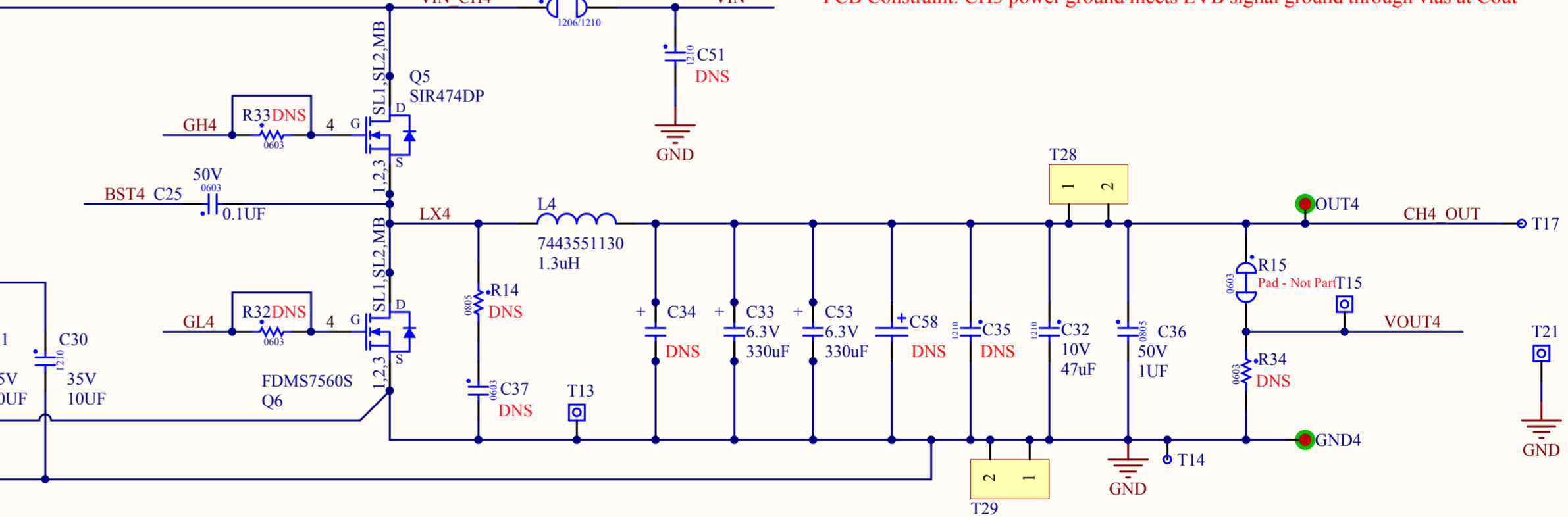
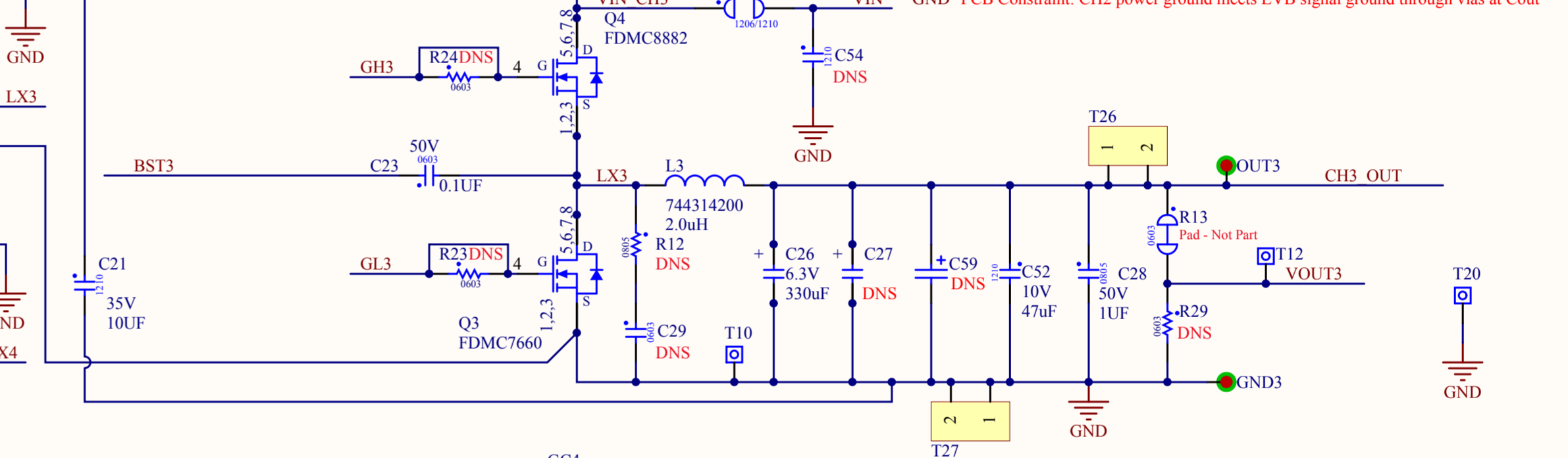
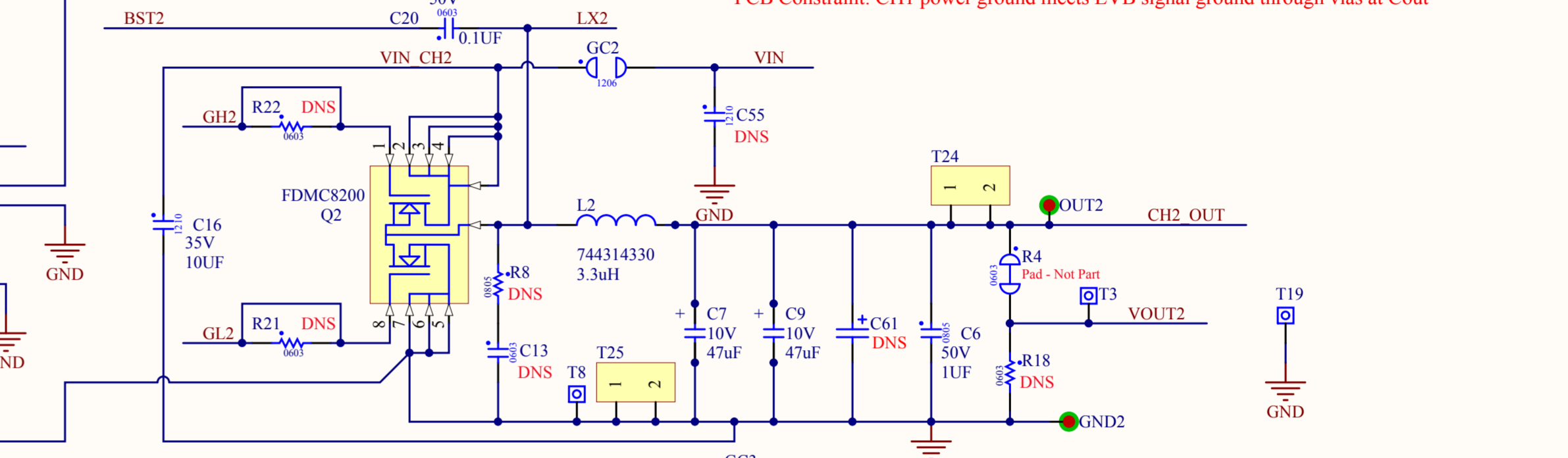
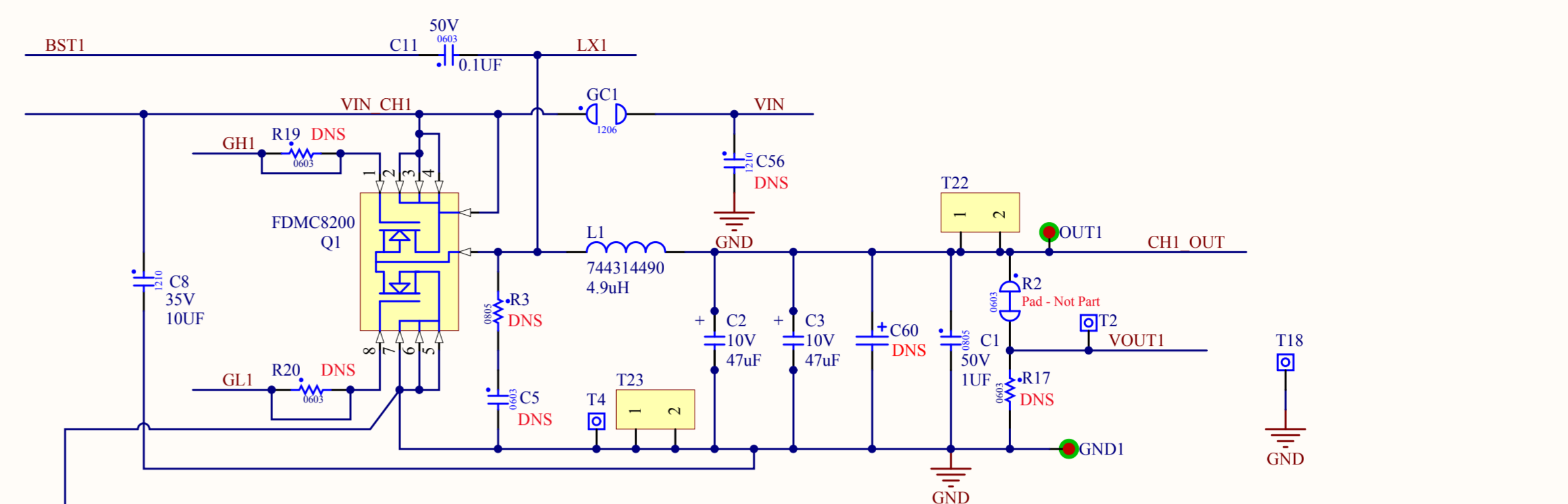
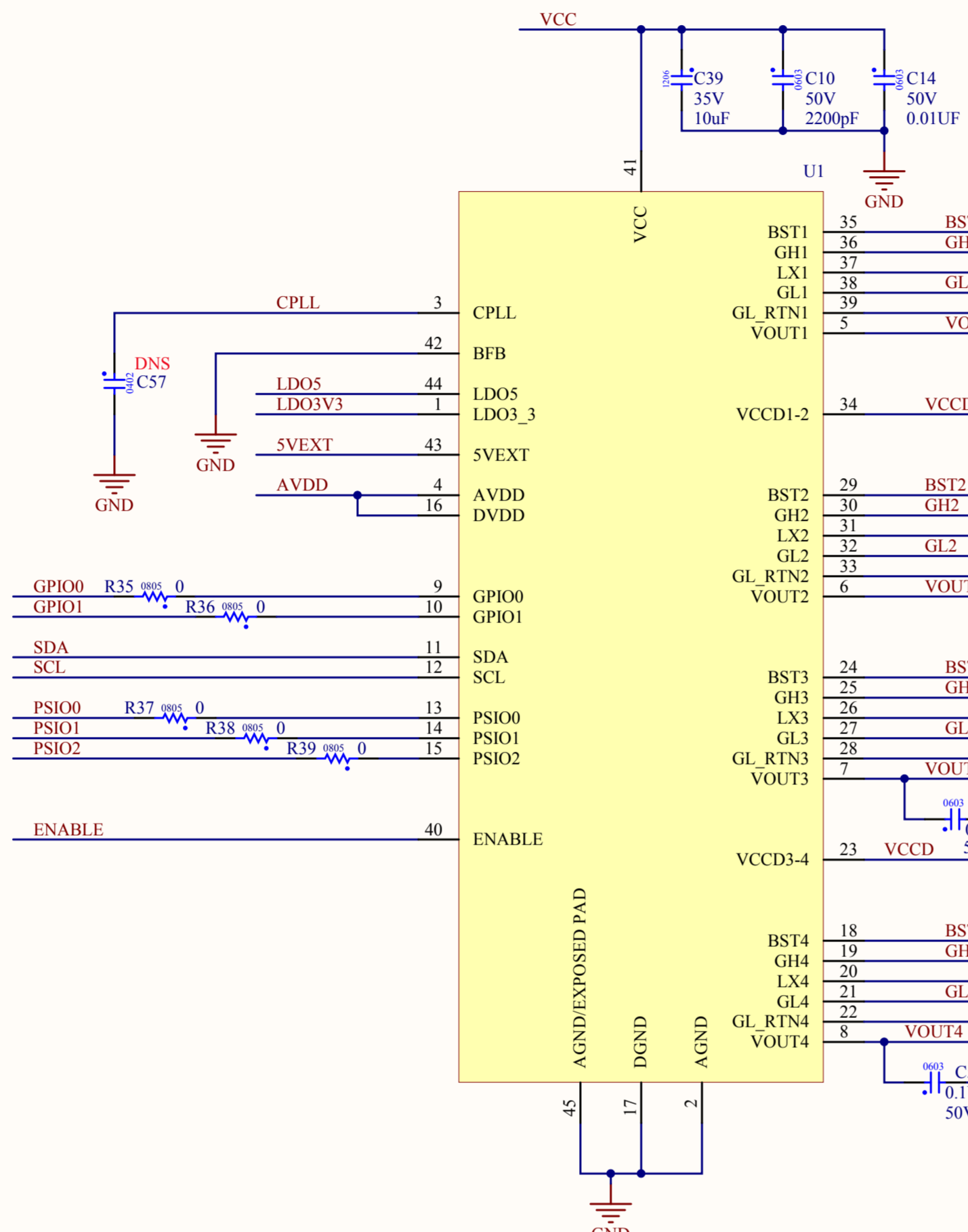
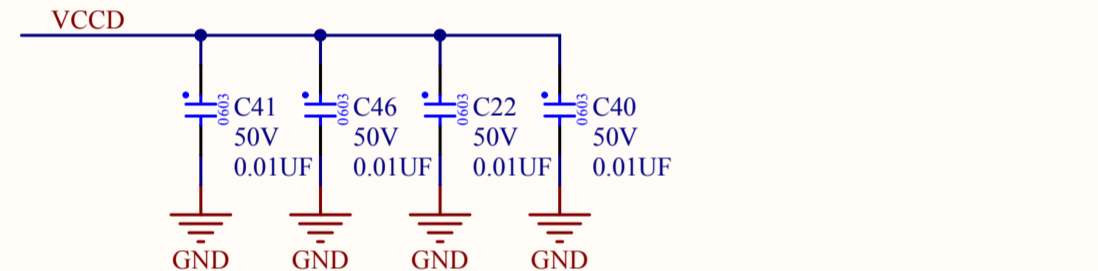
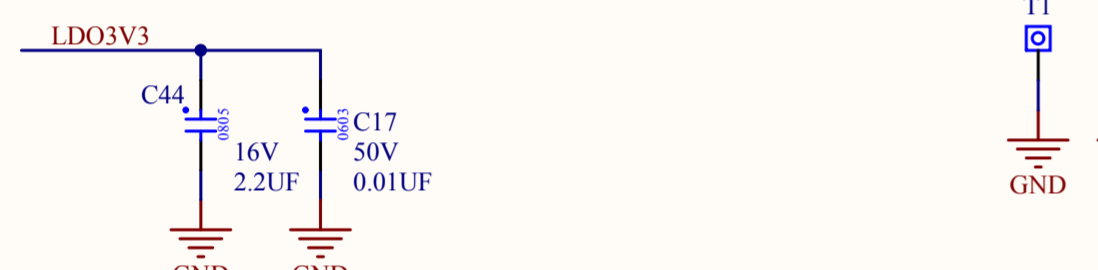
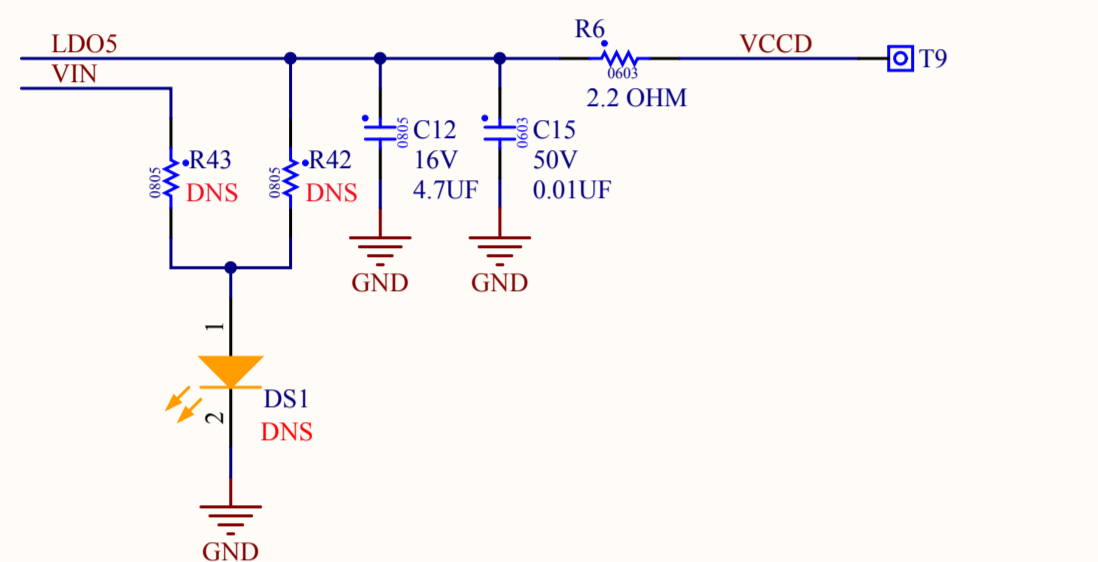
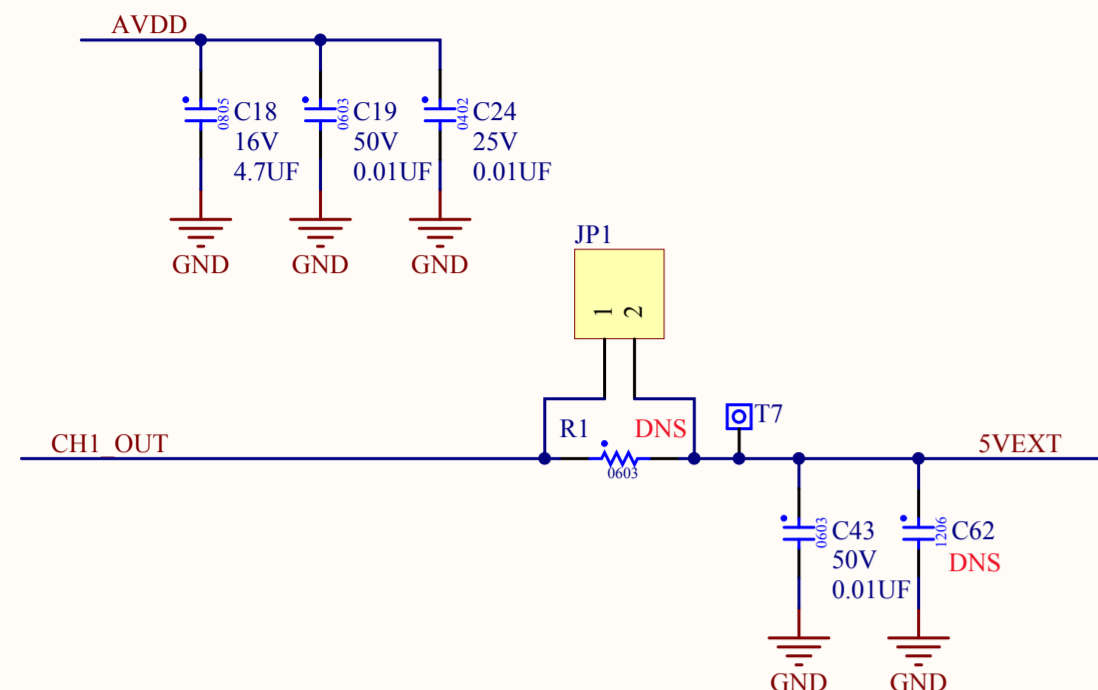
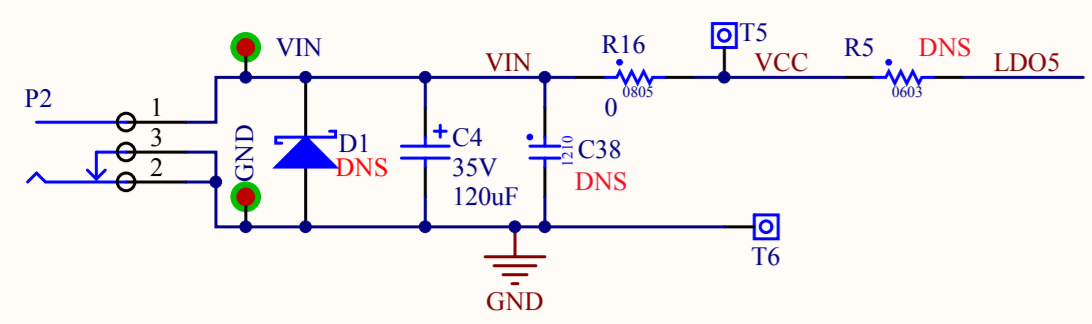
- Use I2C pull-up resistors on XCM (install headers at the locations JP2 and JP3 shorting pins 2 and 3)
- If 10-wire ribbon cable is not available use 3-wire connection between JP4 pins 1-3 on XCM (pin 1 – SCL; pin 2 – GND; pin 3 – SDA) to test points T23 (SCL), T24 (GND) and T25 (SDA) on the interface board. Make a use of the silkscreen labels on both boards.
- Connect the interface board and the evaluation board as shown above.

### Wiring XCM directly to the Evaluation Board

Use 3-wire connection between JP4 pins 1-3 on the XCM (pin 1 – SCL; pin 2 – GND; pin 3 – SDA) to the P3 connector on the evaluation board, the pin 8 (GND), the pin 9 (SDA) and the pin 10 (SCL) on the interface board. Make a use of the silkscreen labels on both boards.



# EVALUATION BOARD SCHEMATICS



PCB Constraint: CH1 power ground meets EVB signal ground through vias at Cout

PCB Constraint: CH2 power ground meets EVB signal ground through vias at Cout

PCB Constraint: CH3 power ground meets EVB signal ground through vias at Cout

PCB Constraint: CH4 power ground meets EVB signal ground through vias at Cout

### BILL OF MATERIAL

| Ref.  | Qty | Manufacturer       | Part Number        | Size          | Component                          |
|---|-----|--------------------|--------------------|---------------|------------------------------------|
|   | 1   | Exar Corporation   | 146-6708-01        | 4.05x2.70in   | PCB                                |
| U1  | 1   | Exar Corporation   | XRP7724/XRP7725    | TQFN44        | 2nd Generation 4Ch. Sw. Controller |
| Q1,Q2                                       | 2   | Fairchild          | FDMC8200           | Power 33      | Dual N-Channel Power Trench MOSFET |
| Q3  | 1   | Fairchild          | FDMC7660           | Power 33      | N-Channel Power Trench MOSFET      |
| Q4  | 1   | Fairchild          | FDMC8882           | MLP 3.3X3.3   | N-Channel Power Trench MOSFET      |
| Q5  | 1   | Vishay Siliconix   | SIR474DP           | PowerPAK SO-8 | N-Ch. 30-V (D-S) MOSFET            |
| Q6  | 1   | Fairchild          | FDMS7560S          | Power 56      | N-Channel Power Trench SyncFET     |
| L1  | 1   | Würth Elektronik   | 744314490          | 7.0x6.9mm     | Inductor 4.9uH, 14.5mΩ, 6.5A       |
| L2  | 1   | Würth Elektronik   | 744314330          | 7.0x6.9mm     | Inductor 3.3uH, 9.0mΩ, 9.0A        |
| L3  | 1   | Würth Elektronik   | 744314200          | 7.0x6.9mm     | Inductor 2.0uH, 5.85mΩ, 11.5A      |
| L4  | 1   | Würth Elektronik   | 7443551130         | 13.2X12.8mm   | Inductor 1.3uH, 1.8mΩ, 25A         |
| C1, C6, C28, C36                            | 4   | Murata Corporation | GRM21BR71H105KA12L | 0805          | Ceramic Capacitor 1μF, 50V, X7R    |
| C2, C3, C7, C9, C32, C52                    | 6   | Murata Corporation | GRM32ER71A476KE15L | 1210          | Ceramic Capacitor 47μF, 10V, X7R   |
| C4  | 1   | Panasonic/Sanyo    | 35SVPF120M         | F12           | OSCON Capacitor 120μF, 35V         |
| C8, C16, C21, C30, C31                      | 5   | Murata Corporation | GRM32ER71H106KA12L | 1210          | Ceramic Capacitor 10μF, 50V, X7R   |
| C10   | 1   | Murata Corporation | GRM188R71H222KA01D | 0603          | Ceramic Capacitor 2200pF, 50V, X7R |
| C11, C20, C23, C25, C45, C47, C48, C50      | 8   | Murata Corporation | GRM188R71H104KA93D | 0603          | Ceramic Capacitor 0.1μF, 50V, X7R  |
| C12, C18, C42, C49                          | 4   | Murata Corporation | GRM21BR71C475KA73  | 0805          | Ceramic Capacitor 4.7μF, 16V, X7R  |
| C14, C15, C17, C19, C22, C40, C41, C43, C46 | 9   | Murata Corporation | GRM188R71H103KA01D | 0603          | Ceramic Capacitor 0.01μF, 50V, X7R |

## XRP7724/7725EVB-DEMO-2

### Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

| Ref.                                      | Qty | Manufacturer                | Part Number          | Size        | Component   |
|---|-----|-----------------------------|----------------------|-------------|---|
| C24                                       | 1   | Murata Corporation          | GRM155R71H103KA88D   | 0402        | Ceramic Capacitor<br>0.01 $\mu$ F, 50V, X7R                                 |
| C26, C33, C53                             | 3   | Panasonic/Sanyo             | 6TPF330M9L           | 7343 D3L    | POSCAP Capacitor<br>330 $\mu$ F, 6.3V, 9m $\Omega$                          |
| C39                                       | 1   | TDK Corporation             | C3216X7R1V106K160AC  | 1206        | Ceramic Capacitor<br>10 $\mu$ F, 35V, X7R                                   |
| C44                                       | 1   | Murata Corporation          | GRM21BR71C225KA12L   | 0805        | Ceramic Capacitor<br>2.2 $\mu$ F, 16V, X7R                                  |
| GC1, GC2                                  | 2   | Vishay Dale                 | CRCW12060000Z0EAHP   | 1206        | RES 0 $\Omega$ , 1/2W, SMD  |
| GC3, GC4                                  | 2   | Vishay Dale                 | CRCW12100000Z0EA     | 1210        | RES 0 $\Omega$ , 1/2W, SMD  |
| R6  | 1   | Panasonic                   | ERJ-3RQF2R2V         | 0603        | RES 2.2 $\Omega$ , 1/10W, 1%,<br>SMD  |
| R16, R35, R36, R37, R38, R39              | 6   | Panasonic                   | ERJ-6GEY0R00V        | 0805        | RES 0 $\Omega$ , 1/8W, SMD  |
| JP1, JP2                                  | 2   | Würth Elektronik            | 61300211121          | 0.20x0.10in | Connector, Male<br>Header, 2 Positions,<br>100mil Spacing,<br>Vertical, TH  |
| P1  | 1   | Sullins Connector Solutions | SFH11-PBPC-D10-RA-BK | 1.20x0.55in | Connector, Female<br>Header, 20 Positions,<br>100mil Spacing, RA, TH        |
| P2  | 1   | Switchcraft                 | RAPC722X             | 0.60x0.40in | Connector, Power Jack<br>Mini R/A, T/H                                      |
| P3  | 1   | Würth Elektronik            | 61301511121          | 1.50x0.10in | Connector, Male<br>Header, 15 Positions,<br>100mil Spacing,<br>Vertical, TH |
| T1, T4, T8, T10, T13, T30                 | 6   | Würth Elektronik            | 61300111121          | 0.10x0.10in | Square Test Posts, TH   |
| T22, T23, T24, T25, T26, T27,<br>T28, T29 | 8   | Würth Elektronik            | 7471287              | 0.32x0.10in | Mounting Tabs   |
| GND, OUT1, OUT2, OUT3, OUT4,<br>VIN       | 6   | Vector Electronics          | K30C/M               |             | Round Test Posts, TH  |

### EVALUATION BOARD LAYOUT

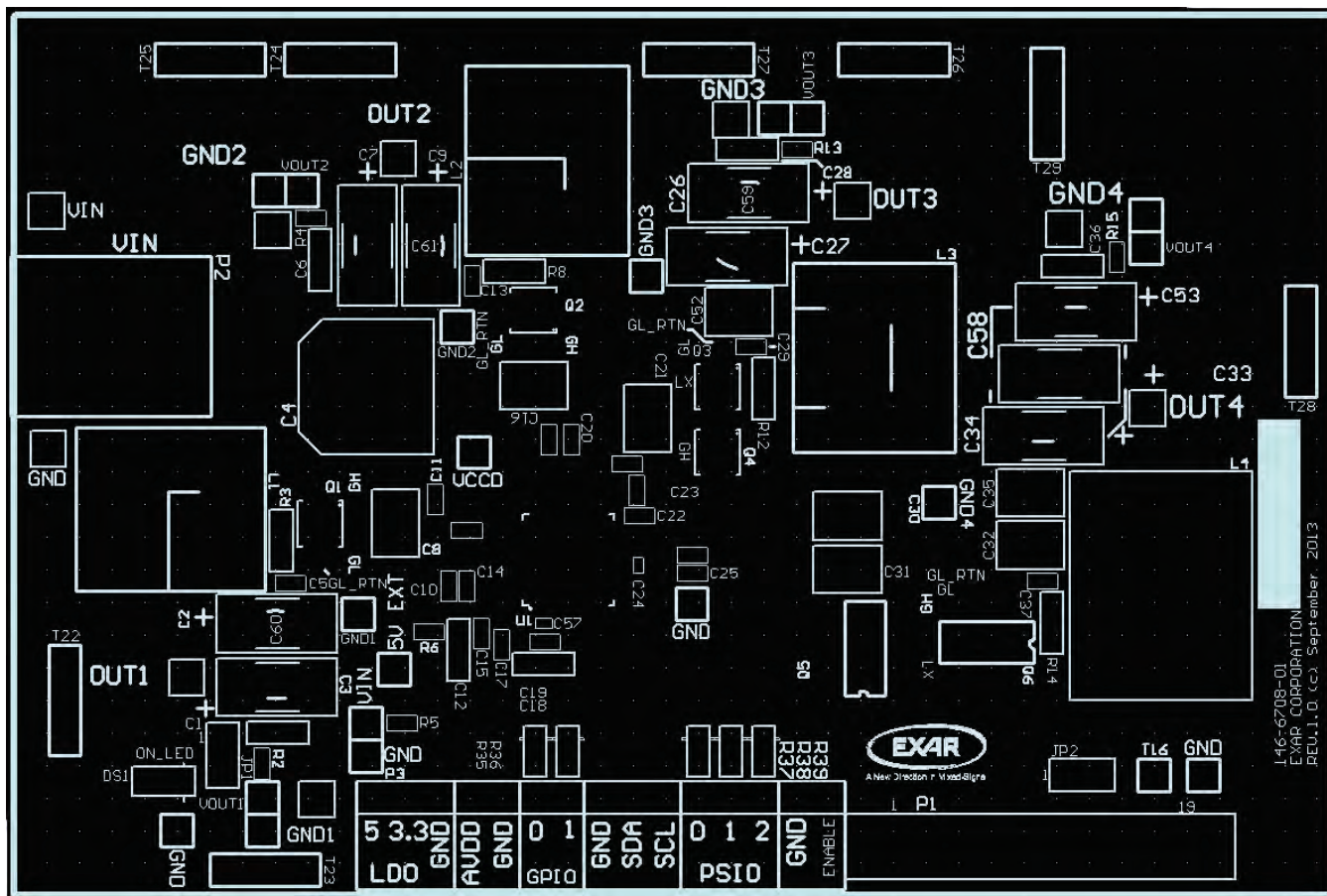


Figure 3 Component Placement – Top Side



A New Direction in Mixed-Signal

# XRP7724/7725EVB-DEMO-2

## Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

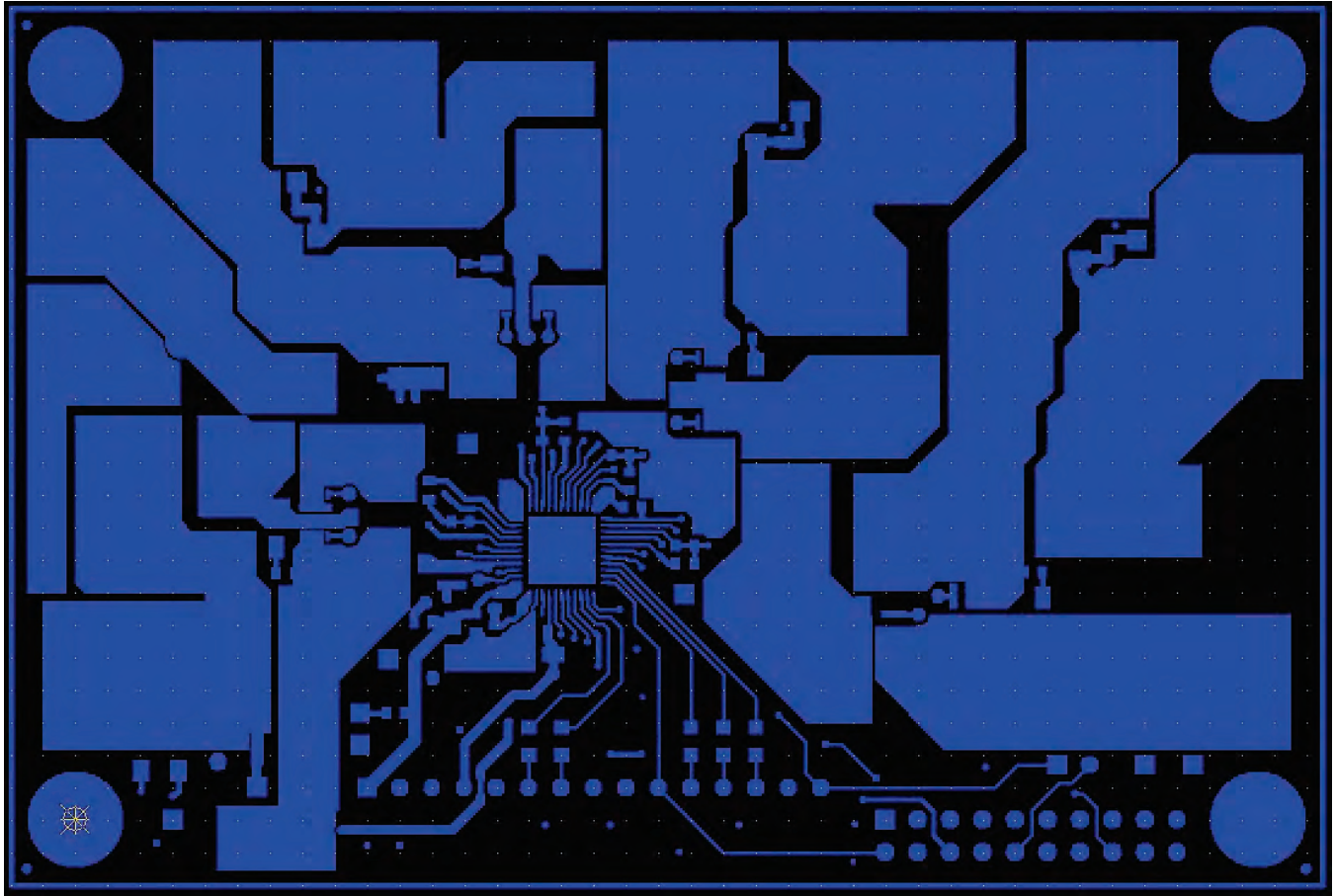


Figure 4 Layout – Top Layer

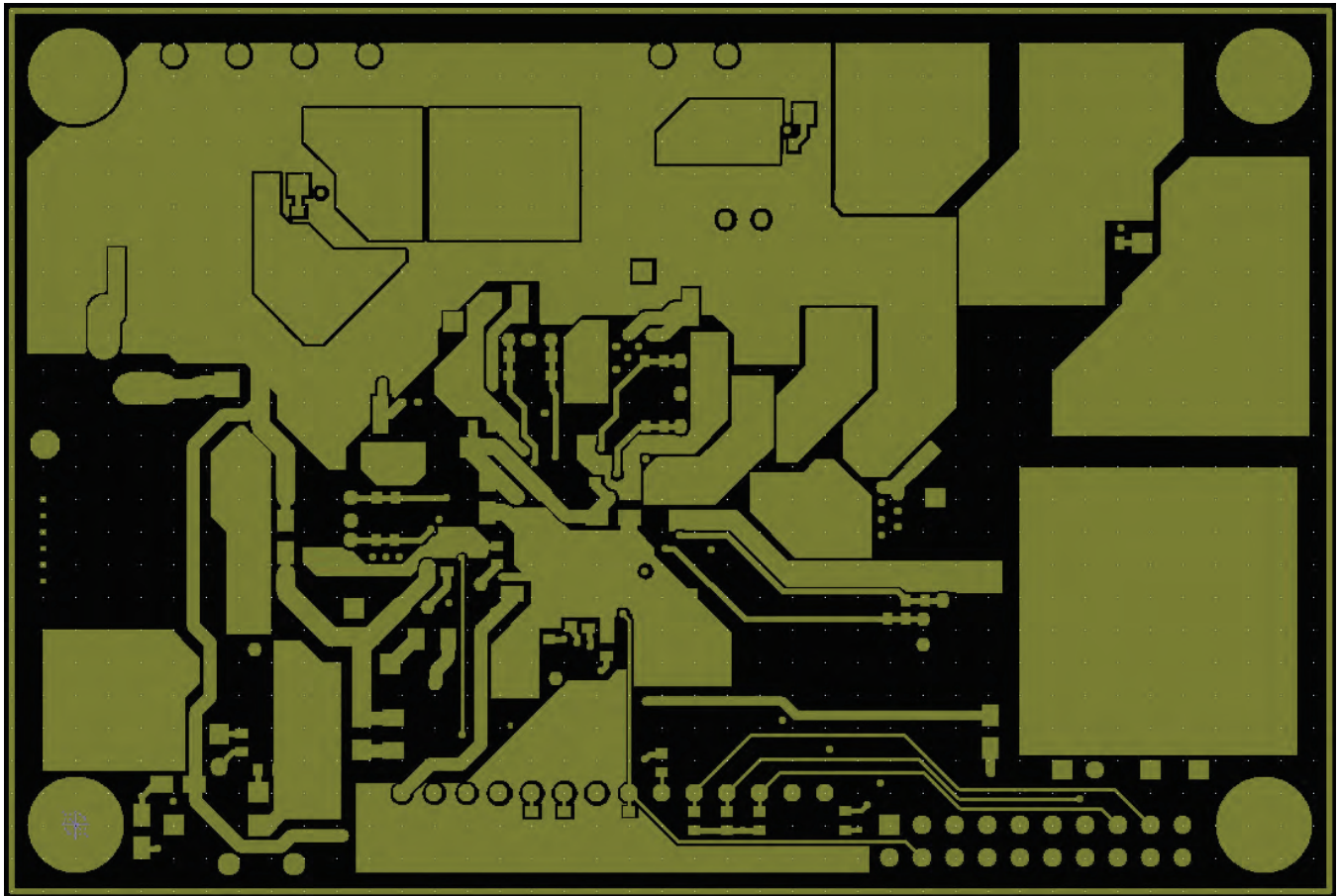


Figure 5 Layout – Bottom Layer

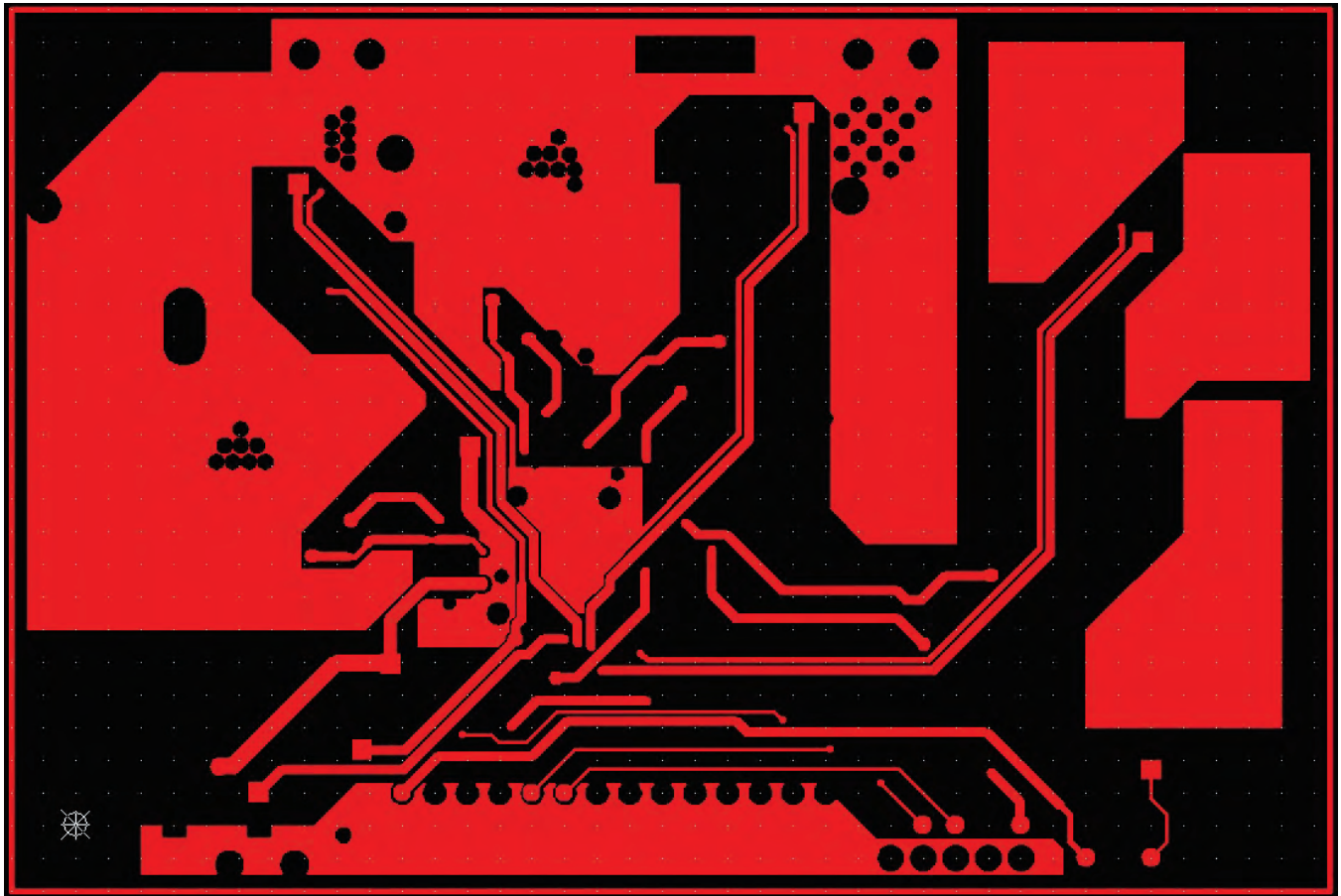


Figure 6 Layout – Middle Layer 1



A New Direction in Mixed-Signal

# XRP7724/7725EVB-DEMO-2

## Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

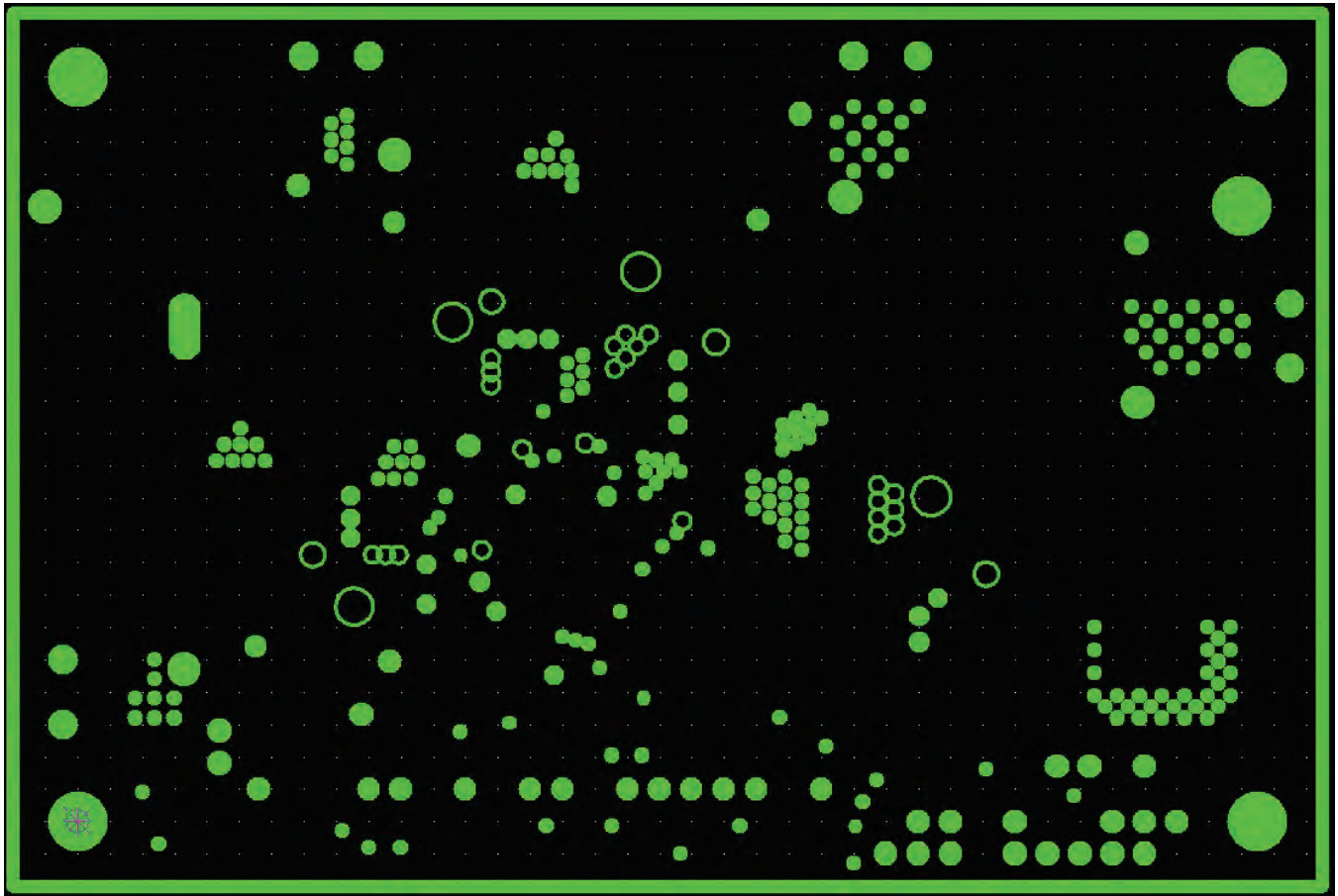
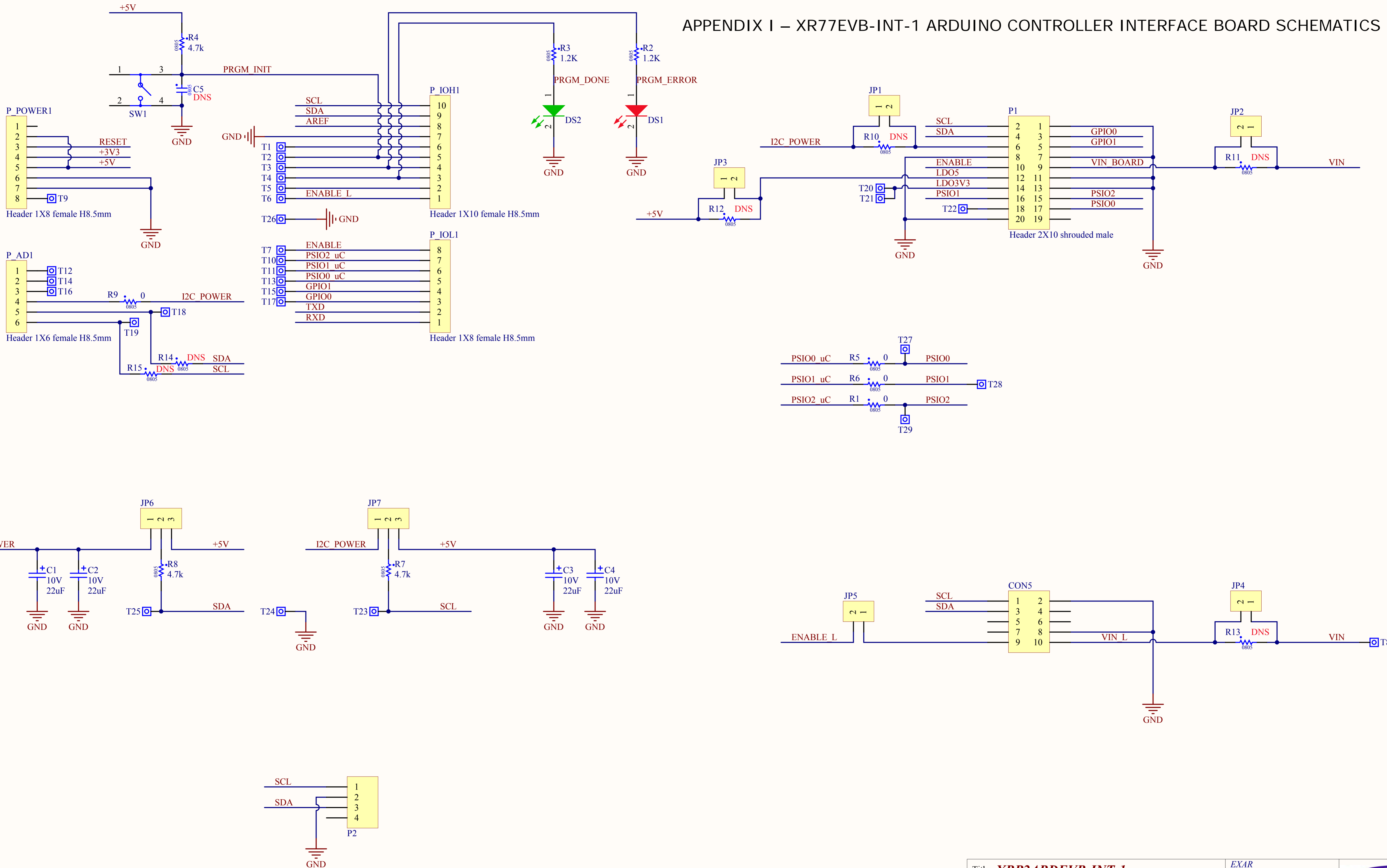


Figure 7 Layout – Signal Ground Plane



APPENDIX I – XR77EVb-INT-1 ARDUINO CONTROLLER INTERFACE BOARD SCHEMATICS



### BILL OF MATERIAL - XR77EVB-INT-1 ARDUINO CONTROLLER INTERFACE BOARD

| Ref.                    | Qty | Manufacturer     | Part Number       | Size        | Component  |
|-------------------------|-----|------------------|-------------------|-------------|--|
|                         | 1   | Exar Corporation | 146-6703-01       | 4.40x2.10   | PCB  |
| DS1                     | 1   | Würth Elektronik | 150120RS75000     | 1206        | SMD Red Chip LED   |
| DS2                     | 1   | Würth Elektronik | 150120VS75000     | 1206        | SMD Green Chip LED   |
| C1, C2, C3, C4          | 4   | Vishay Sprague   | 293D226X9010B2TE3 | B           | Tantalum Capacitor 22 $\mu$ F, 10V, 10%  |
| R1, R5, R6, R9          | 4   | Panasonic        | ERJ-6GEY0R00V     | 0805        | RES 0 $\Omega$ , 1/8W, 5% SMD  |
| R2, R3                  | 2   | Panasonic        | ERJ-6GEYJ122V     | 0805        | RES 1.2k $\Omega$ , 1/8W, 5%, SMD  |
| R4, R7, R8              | 3   | Panasonic        | ERJ-6GEYJ472V     | 0805        | RES 4.7k $\Omega$ , 1/8W, 5%, SMD  |
| SW1                     | 1   | Würth Elektronik | 430182050816      | 6x6mm       | Tact Switch, SMD   |
| CON5                    | 1   | Würth Elektronik | 61301021121       | 0.50x0.20in | Connector, Male Header, 10 Positions, Dual Row, 100mil Spacing, Vertical, TH     |
| JP1, JP2, JP3, JP4, JP5 | 5   | Würth Elektronik | 61300211121       | 0.20x0.10in | Connector, Male Header, 2 Positions, 100mil Spacing, Vertical, TH                |
| JP6, JP7                | 2   | Würth Elektronik | 61300311121       | 0.30x0.10in | Connector, Male Header, 3 Positions, 100mil Spacing, Vertical, TH                |
| P1                      | 1   | Würth Elektronik | 612020235221      | 1.20x0.55in | Connector, Male Header, 20 Positions, Dual Row, 100mil Spacing, Shrouded, RA, TH |
| P2                      | 1   | Würth Elektronik | 653104124022      | 11x6mm      | Wire-to-Board Connector, Male, 4 Positions, 1.25mm Spacing, Shrouded, SMT        |
| P_IOH1                  | 1   | Würth Elektronik | 61301011121       | 1.00x0.10in | Connector, Male Header, 10 Positions, 100mil Spacing, Vertical, TH               |
| P_POWER1, P_IOL1        | 2   | Würth Elektronik | 61300811121       | 0.80x0.10in | Connector, Male Header, 8 Positions, 100mil Spacing, Vertical, TH                |
| P_AD1                   | 1   | Würth Elektronik | 61300611121       | 0.60x0.10in | Connector, Male Header, 6 Positions, 100mil Spacing, Vertical, TH                |
| T23, T24, T25           | 3   | Würth Elektronik | 61300111121       | 0.10x0.10in | Square Test Posts, TH  |



# XRP7724/7725EVB-DEMO-2

## Quad Channel Digital PWM/PFM Demo Board Programmable Power Management System

### DOCUMENT REVISION HISTORY

| Revision | Date       | Description                 |
|----------|------------|-----------------------------|
| 1.0.0    | 05/12/2014 | Initial release of document |
|          |            |                             |
|          |            |                             |

### BOARD REVISION HISTORY

| Board Revision            | Date     | Description                             |
|---------------------------|----------|---|
| XRP7724/7725EVB-DEMO-2-01 | 05/12/14 | Initial release of the evaluation board |
|                           |          |   |
|                           |          |   |

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