

# ISLNGULTRADEMO1Z

Renesas RT Power Solution for NanoXplore NG-ULTRA FPGA

## Description

The ISLNGULTRADEMO1Z reference design provides a complete power management solution for the NanoXplore NG-ULTRA family, built entirely from Renesas' radiation-tolerant power management devices. The design generates all required NG-ULTRA supply rails, including core, digital, analog, I/O, and DDR4 memory rails, enabling evaluation of both DC and AC electrical performance. Rail sequencing is managed through a cascaded, AND-gated architecture to ensure each rail powers up only after its required conditions are met. The design also supports integration with the ISL71148VMREFEV2Z ADC voltage monitor board for real-time rail monitoring through a companion GUI. In addition, the power architecture can be readily adapted to support the ULTRA300 system with minimal changes to rail configuration and sequencing.

## Features

- Regulators for all NG-ULTRA rails, DDR4 memory, and general-purpose 5V and 3.3V buses
- Direct 12V-to-1V, 20A conversion for the VDDCORE rail
- Cascaded power-up sequencing across all rails for increased system reliability
- Input bus current sensing
- Voltage monitoring using the ISL71148VMREFEV2Z reference board
- Plastic-packaged, radiation-tolerant design, RLAT-qualified to TID levels of 30krad and 50krad
- Reconfigurable to power the ULTRA300 with minimal rail and sequencing changes

## Power Supply Specifications

- 12V<sub>DC</sub> ±10% (Supports bench top supply with banana jack or AC adapter using barrel jack)

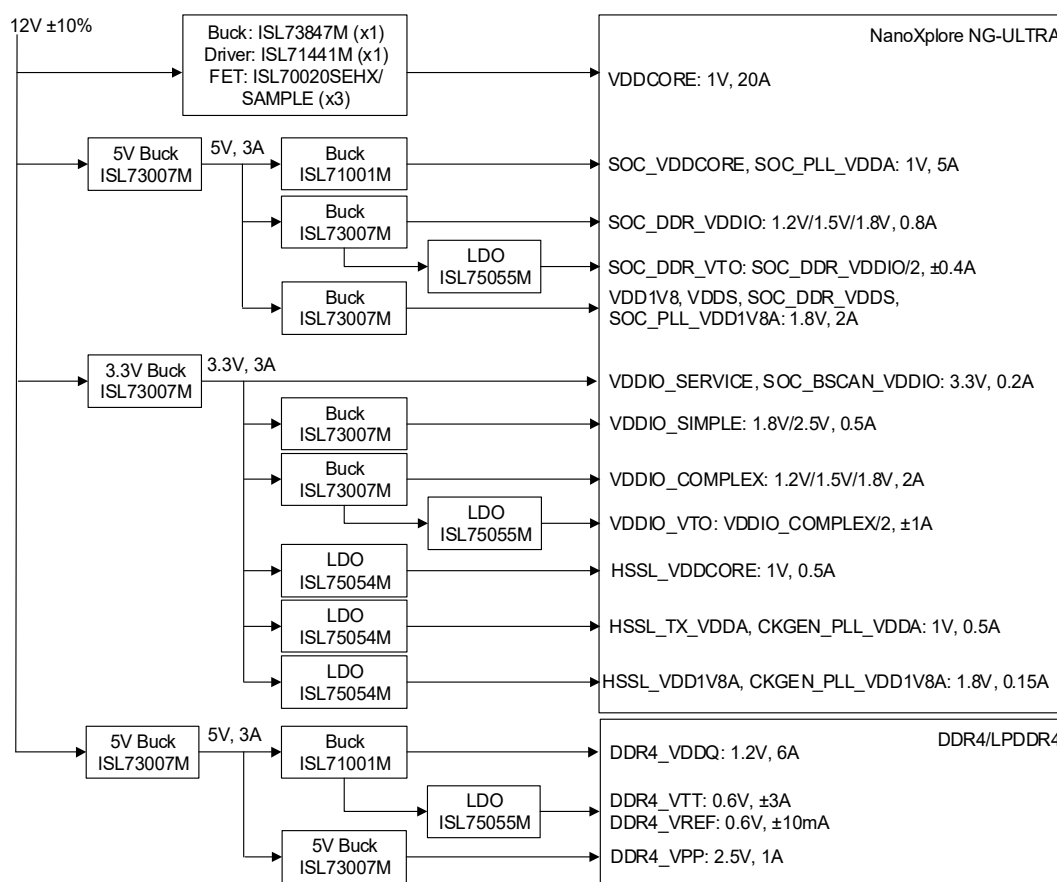


Figure 1. Power Management Block Diagram

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# 1. Functional Description

## 1.1 Power Tree

Figure 2 shows the NanoXplore NG-ULTRA supply rail requirements and Figure 3 shows the power tree diagram. The power management solution is designed for maximum resource utilization and uses NanoXplore's NXPowerEstimator tool to model worst-case power consumption. Under the NG-ULTRA's maximum-utilization scenario, total board power reaches 28.3W, while the VDDCORE rail draws approximately 20.8A. This scenario represents a conservative upper bound, stacking maximum load across every functional category (RF, Logic, RAM, DSP, and I/O) simultaneously.

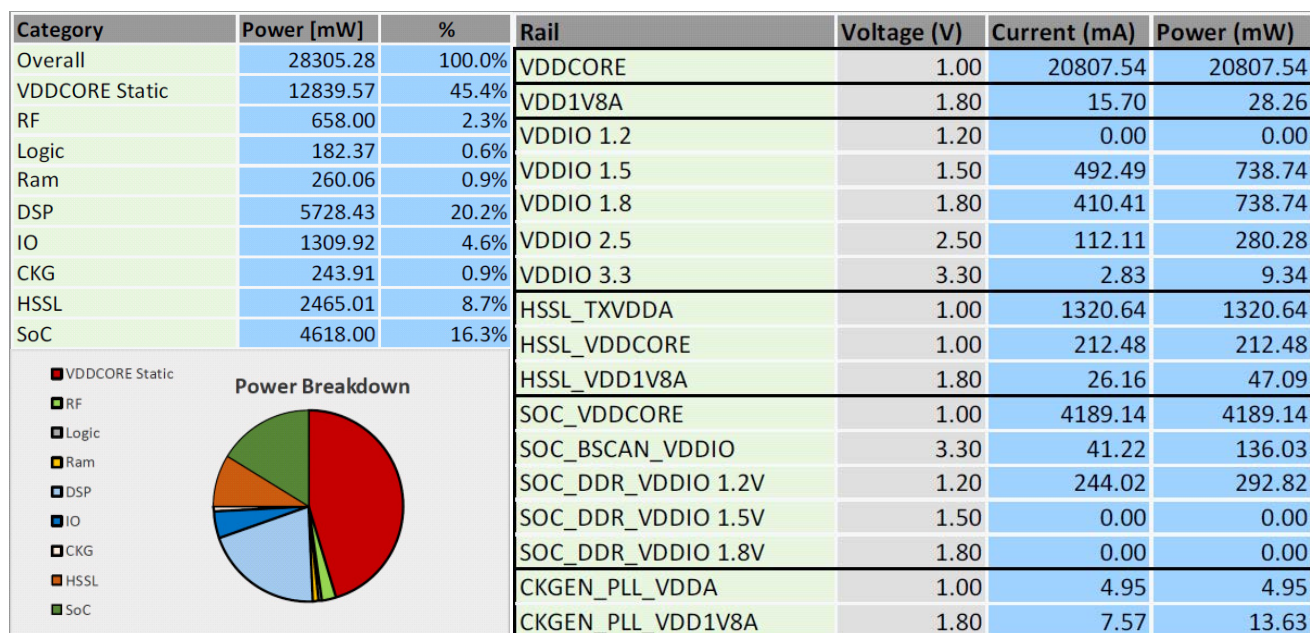


Figure 2. Power Management Specification from NanoXplore NG-ULTRA's Power Estimator Tool

**Note:** Actual power requirements vary based on the user's design and FPGA resource utilization.

The ISLNGULTRADEMO1Z reference design board operates from a +12V DC input supplied through either the onboard barrel jack or the banana jacks for bench-power operation. The design also incorporates Renesas solutions for input current sensing, voltage monitoring, and rail sequencing.

An ISL70100M current-sense amplifier monitors the input current and feeds an ISL71218M comparator, which asserts a KILL signal when the input current exceeds a predefined threshold. Two cascaded ISL70321SEH sequencers control the rail enable sequence by monitoring individual rail voltages and the KILL signal. The sequencers coordinate the power-up cascade through DONE and INIT handshaking between devices. A manual start/stop control allows users to initiate or halt the sequencing cascade directly from the board.

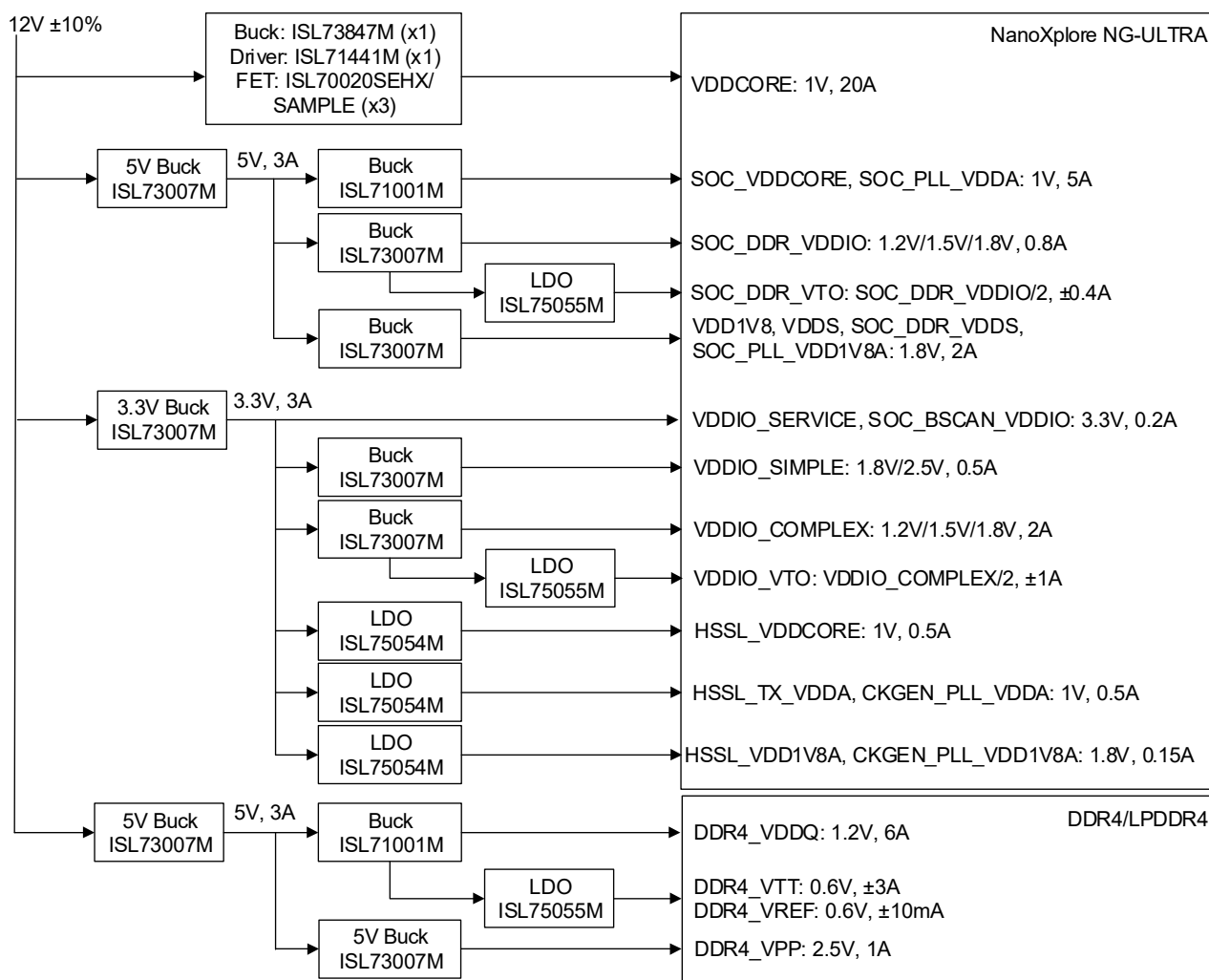


Figure 3. Renesas Radiation Tolerant Power Tree for NanoXplore NG-ULTRA

## 1.2 Renesas Power Management Solution

Figure 4 shows the standalone ISLNGULTRADEMO1Z reference design board, while Figure 5 shows the board connected to the ISL71148VMREFEV2Z voltage-monitor companion board. Together, the boards provide real-time voltage monitoring of all supported supply rails through the companion GUI.

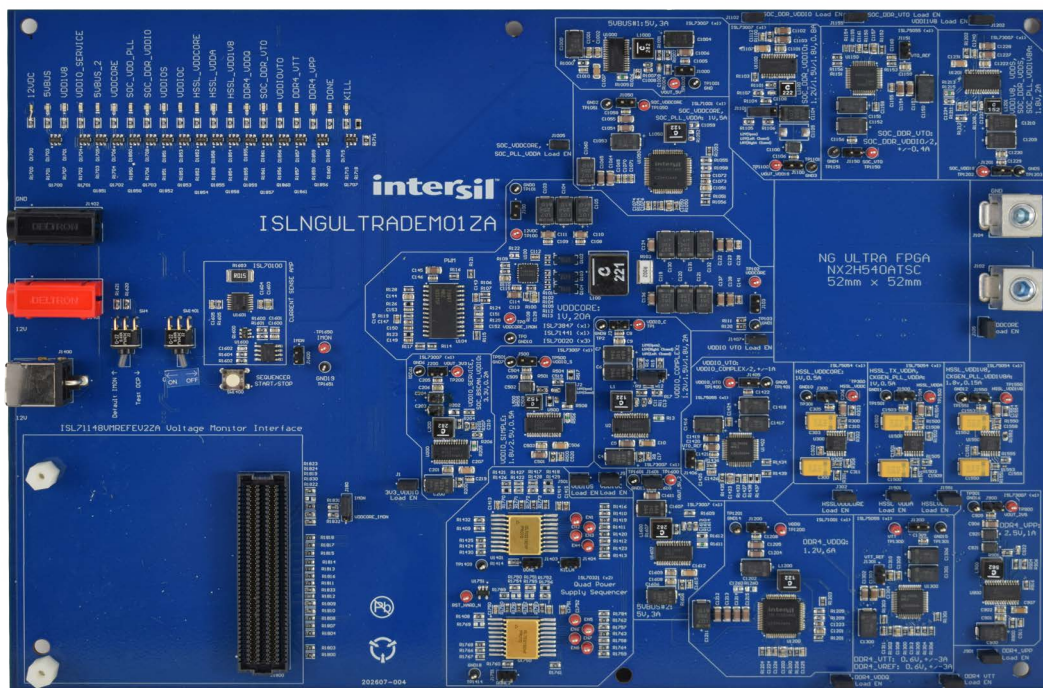


Figure 4. ISLNGULTRADEMO1Z Board Photo

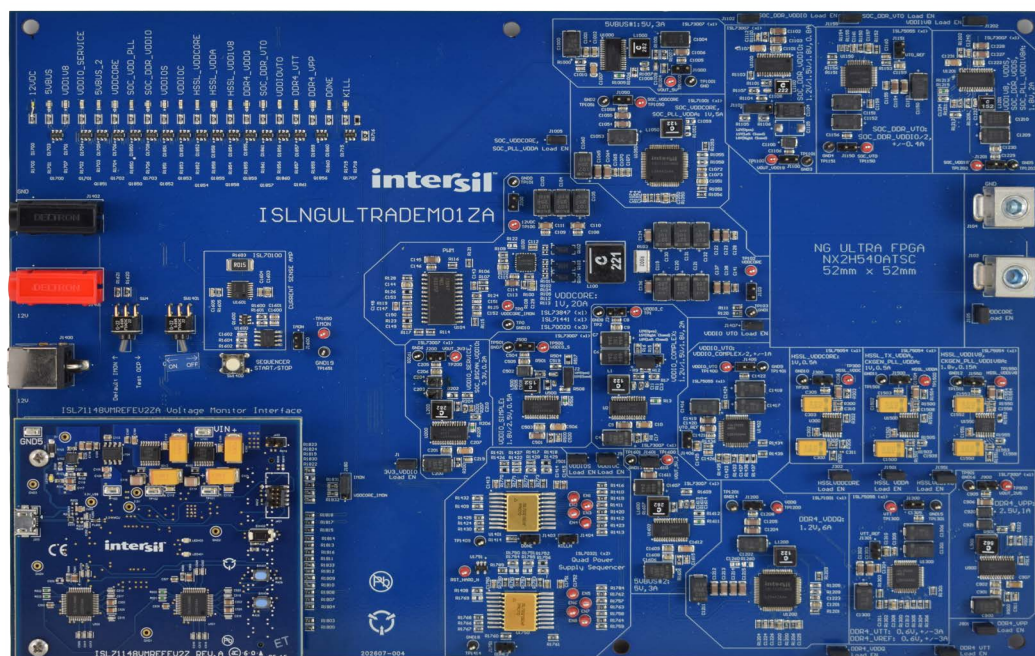


Figure 5. ISLNGULTRADEMO1Z Board Photo with the ISL71148VMREFEV2Z Board Attached

The most demanding power supply rail in the NanoXplore power management solution is VDDCORE, which delivers 1V at up to 20A. The design steps VDDCORE directly down from the 12V input while operating at a switching frequency of 500kHz. This rail is generated by a radiation-tolerant point-of-load regulator comprising an ISL73847M radiation-tolerant single/dual-phase current-mode PWM controller, an ISL71441M radiation-tolerant 12V half-bridge GaN FET driver, and three ISL70020SEH 40V, 65A, 3.5mΩ GaN FETs in a die-bump package.

The ISL75054M radiation-tolerant, low-noise, low-dropout linear regulator is used for the noise-sensitive supply rails, namely the high-speed serial link (HSSL) rails.

The ISL73007M radiation-tolerant 3A point-of-load regulator powers the I/O, GPIO, and auxiliary rails and generates the 3.3V and 5V bus rails. For rails with higher current requirements, the design uses the ISL71001 radiation-tolerant synchronous buck regulator.

The design also includes a complete DDR4 memory power solution. An ISL71001 6A radiation-tolerant synchronous buck regulator with integrated MOSFETs generates the 1.2V VDDQ rail, an ISL75055 3A sink/source LDO generates the 0.6V VTT rail, and an ISL73007M regulator generates the 2.5V VPP rail.

Two ISL70321 quad power supply sequencers are cascaded together to manage the power-up sequence for all voltage rails. See [Power Sequencing and Monitoring](#) for additional details on the sequencing architecture.

An ISL70100 current-sense amplifier monitors input current, while an ISL71218 operational amplifier configured as a comparator detects input overcurrent conditions.

[Table 1](#) shows the power management specifications for the NanoXplore NG-ULTRA.

**Table 1. Power Management Specifications for NanoXplore NG-ULTRA**

| Rail Name         | Rail Voltage (V)           | Current Demand (A) | DC Tol + Ripple (%) | Power Sequencing | Renesas Solution                                                                                                                                        |
|-------------------|----------------------------|--------------------|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| VDDCORE           | 1                          | 20                 | ±5                  | 4                | ISL73847 - RT Current Mode PWM Controller<br>ISL71441 - RT 12V Half-Bridge GaN FET Driver<br>ISL70020 - 40V, 65A Enhancement Mode GaN Power Transistors |
| 5VBUS             | 5                          | 3                  | N/A                 | 1                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| SOC_VDDCORE       | 1                          | 5                  | ±5                  | 4                | ISL71001 - RT 5.5V, 6A Point-of-Load Regulator                                                                                                          |
| SOC_PLL_VDDA      |                            |                    |                     |                  |                                                                                                                                                         |
| SOC_DDR_VDDIO     | 1.2/1.5/1.8                | 0.8                | ±5                  | 6                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| SOC_DDR_VTO       | SOC_DDR_VDDIO/2            | ±0.4               | ±10                 | 7                | ISL75055 - RT 3A Source and Sink DDR Terminator/LDO with Buffered Reference                                                                             |
| VDD1V8A           | 1.8                        | 2                  | ±5                  | 2                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDS_x            |                            |                    |                     |                  |                                                                                                                                                         |
| SOC_DDR_VDDS      |                            |                    |                     |                  |                                                                                                                                                         |
| SOC_PLL_VDD1V8A   |                            |                    |                     |                  |                                                                                                                                                         |
| 3V3BUS            | 3.3                        | 3                  | N/A                 | 3                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_SERVICE     |                            | 0.2                | ±10                 |                  |                                                                                                                                                         |
| SOC_BSCAN_VDDIO   |                            |                    |                     |                  |                                                                                                                                                         |
| VDDIO_x (Simple)  | 1.8/2.5/3.3 <sup>[1]</sup> | 0.5                | ±10                 | 6                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_x (Complex) | 1.2/1.5/1.8                | 2                  | ±5                  | 6                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_VTO         | VDDIO_x (Complex)/2        | ±1                 | ±10                 | 7                | ISL75055 - RT 3A Source and Sink DDR Terminator/LDO with Buffered Reference                                                                             |
| HSSL_VDDCORE      | 1                          | 0.5                | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| HSSL_TX_VDDA      | 1                          | 0.5                | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| CKGEN_PLL_VDDA    |                            |                    |                     |                  |                                                                                                                                                         |
| HSSL_VDD1V8       | 1.8                        | 0.15               | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| CKGEN_PLL_VDD1V8  |                            |                    |                     |                  |                                                                                                                                                         |

Table 1. Power Management Specifications for NanoXplore NG-ULTRA (Cont.)

| Rail Name | Rail Voltage (V) | Current Demand (A) | DC Tol + Ripple (%) | Power Sequencing | Renesas Solution                                                            |
|-----------|------------------|--------------------|---------------------|------------------|-----------------------------------------------------------------------------|
| 5VBUS_2   | 5                | 3                  | N/A                 | 3                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                               |
| DDR4_VDDQ | 1.2              | 6                  | ±10                 | 6                | ISL71001 - RT 5.5V, 6A Point-of-Load Regulator                              |
| DDR4_VTT  | 0.6              | ±3                 | ±10                 | 7                | ISL75055 - RT 3A Source and Sink DDR Terminator/LDO with Buffered Reference |
| DDR4_VREF | 0.6              | ±0.01              | ±10                 | 7                |                                                                             |
| DDR4_VPP  | 2.5              | 1                  | ±5                  | 8                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                               |

1. 3.3V output is not a jumper-selectable option. The VDDIO\_x (SIMPLE) ISL73007's input must be connected to 12V rather than 3.3V at layout time, and the associated feedback, compensation, and passive component values must be redesigned around the new input voltage.

### 1.3 Adjustable Output Voltages

The NanoXplore NG-ULTRA specifies different operating voltage options on certain rails, depending on system requirements. The ISLNGULTRADEMO1Z includes jumpers to adjust the feedback resistor network and set the output voltage on these key rails.

The SOC\_DDR\_VDDIO rail can be adjusted for 1.2V, 1.5V, or 1.8V.

Table 2. SOC\_DDR\_VDDIO Output Voltage Setting

| V <sub>OUT</sub> (V) | Jumper J1101     |
|----------------------|------------------|
| 1.2                  | Open             |
| 1.5                  | Pin 1 Connection |
| 1.8                  | Pin 3 Connection |

The VDDIO\_x (Simple) rail can be adjusted for 1.8V or 2.5V.

Table 3. VDDIO\_x (Simple) Output Voltage Setting

| V <sub>OUT</sub> (V) | Jumper J2 |
|----------------------|-----------|
| 1.8                  | Open      |
| 2.5                  | Closed    |

The VDDIO\_x (Complex) rail can be adjusted for 1.2V, 1.5V or 1.8V

Table 4. VDDIO\_x (Complex) Output Voltage Setting

| V <sub>OUT</sub> (V) | Jumper J4        |
|----------------------|------------------|
| 1.2                  | Open             |
| 1.5                  | Pin 1 Connection |
| 1.8                  | Pin 3 Connection |

## 1.4 Output Voltage Test Points and Load Transient Control

The ISLNGULTRADEMO1Z provides test points for monitoring output voltage and applying an external load. All output rails include an onboard transient load step generator, which can be enabled by populating the corresponding enable jumper. [Table 5](#) summarizes the output rail test points and load transient generator control for the voltage rails.

**Table 5. VOUT Test Points and Load Transient Jumpers**

| Voltage Rail                                      | Oscilloscope V <sub>OUT</sub> Test Point | V <sub>OUT</sub> DC Test Point/External Load Access (VOUT/GND) | On-board Load Transient Enable (Closed = ON) |
|---------------------------------------------------|------------------------------------------|----------------------------------------------------------------|----------------------------------------------|
| 12VDC                                             | J100                                     | TP100/TP101                                                    | -                                            |
| VDDCORE                                           | J103                                     | TP102/TP103                                                    | J105                                         |
| 5VBUS                                             | J1000                                    | TP1000/TP1001                                                  | -                                            |
| SOC_VDDCORE,<br>SOC_PLL_VDDA                      | J1050                                    | TP1050/TP1051                                                  | J1005                                        |
| SOC_DDR_VDDIO                                     | J1100                                    | TP1100/TP1101                                                  | J1102                                        |
| SOC_DDR_VTO                                       | J1150                                    | TP1150/TP1151                                                  | J1155                                        |
| VDD1V8, VDDS,<br>SOC_DDR_VDDS,<br>SOC_PLL_VDD1V8A | J1201                                    | TP1202/TP1203                                                  | J1202                                        |
| 3V3BUS,VDDIO_SERVICE,<br>SOC_BSCAN_VDDIO          | J200                                     | TP200/TP201                                                    | J1                                           |
| VDDIO_x (Simple)                                  | J500                                     | TP500/501                                                      | J501                                         |
| VDDIO_x (Complex)                                 | J3                                       | TP1/TP2                                                        | J5                                           |
| VDDIO_VTO                                         | J1405                                    | TP1400/TP1401                                                  | J1407                                        |
| HSSL_VDDCORE                                      | J300                                     | TP300/TP301                                                    | J302                                         |
| HSSL_TX_VDDA,<br>CKGEN_PLL_VDDA                   | J1500                                    | TP1500/TP1501                                                  | J1501                                        |
| HSSL_VDD1V8,<br>CKGEN_PLL_VDD1V8                  | J1550                                    | TP1550/TP1551                                                  | J1551                                        |
| 5VBUS_2                                           | J1601                                    | TP1600/TP1601                                                  | -                                            |
| DDR4_VDDQ                                         | J1200                                    | TP1200/TP1201                                                  | J1260                                        |
| DDR4_VTT, DDR4_VREF                               | J1300                                    | TP1300/TP1301                                                  | J1314                                        |
| DDR4_VPP                                          | J900                                     | TP900/TP901                                                    | J901                                         |

The transient load generator consists of a FET driver that controls a common-source NFET. When activated, the NFET switches a load resistor to GND, applying a transient load to the supply rail. The VDDCORE rail uses an ISL71040M GaN FET driver. [Figure 6](#) shows a typical implementation of this circuit. Most other load generators use the HIP2211 half-bridge driver, with a typical implementation shown in [Figure 7](#).

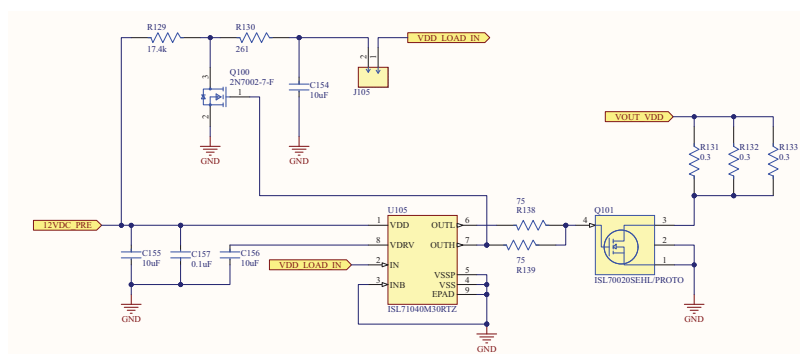


**Figure 6. 10A VDDCORE Load Transient Circuit using the ISL71040M RT GaN FET Driver and the ISL70020 GaN Power Transistor**

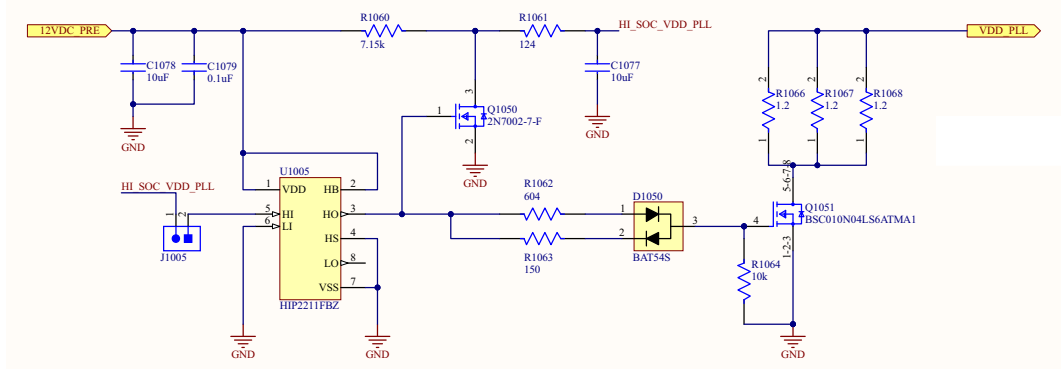


Figure 7. Typical Load Transient Circuit using the HIP2211 Half-Bridge Driver

For sink/source rails, where the transient load current must swing in both positive and negative directions, the transient load generator uses an ISL71441 half-bridge GaN FET driver to control a complementary pair of FETs. As shown in Figure 8, the circuit alternately sources current into and sinks current from the load resistor by switching the phase node between the supply rail and ground. This push-pull topology enables load transients in either direction, rather than only drawing current from the rail.

Unlike the VDDCORE and HIP2211 load transient circuits, which generate gate-drive timing directly from an RC charge/discharge network connected to the FET driver input, the sink/source transient load circuit generates its PWM timing from a dedicated CD4027BM96 flip-flop. The flip-flop generates the PWM control signal, which drives the ISL71441M enable (EN) input through an RC filter network.

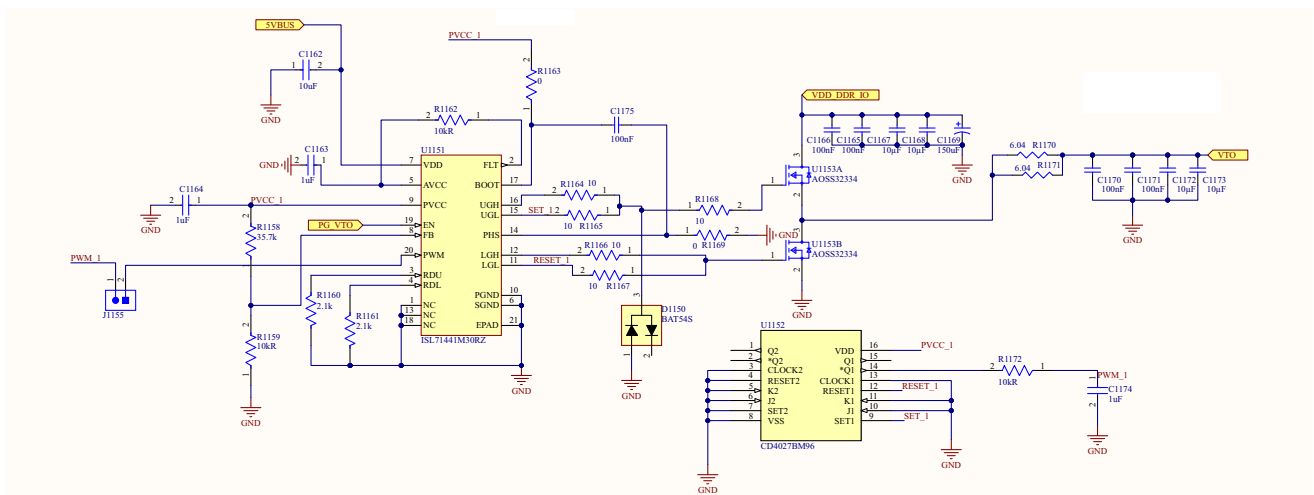


Figure 8. Typical Sink/Source Load Transient Circuit using the ISL71441 Half-Bridge GaN FET Driver

When the transient load generator is enabled, supporting circuitry automatically generates load step pulses.

The automatically generated load step pulses and period can also be altered by changing the resistors and capacitor around the gate drive circuit. For HIP2211, the  $V_{IH}$  is 2.1V typical and the  $V_{IL}$  is 1.4V typical. For the ISL71040M, the  $V_{IH}$  is 1.7V typical and the  $V_{IL}$  is 1.4V typical. By default, for all the HIP2211 load transient circuits  $R_{ON}$  is 124Ω,  $R_{OFF}$  is 7.15kΩ, and C is 10μF. By default, for the ISL71040M load transient circuit  $R_{ON}$  is 261Ω,  $R_{OFF}$  is 17.4kΩ, and C is 10μF.

Use Equation 1 to set the on-time.

$$(EQ. 1) \quad R_{ON} = \frac{t_{ON}}{-C \times \ln\left(\frac{V_{IL}}{V_{IH}}\right)}$$

where:

- $R_{ON}$  is the active on-time resistor.
- $t_{ON}$  is the required active on-time.
- $C$  is the active on-charge and active off-discharge capacitor.
- $V_{IH}$  is FET driver input high-level voltage.
- $V_{IL}$  is the FET driver input low-level voltage.

Use Equation 2 to set the off-time.

$$(EQ. 2) \quad R_{OFF} = \frac{t_{OFF}}{-C \times \ln\left(\frac{V_{IH} - 12V}{V_{IL} - 12V}\right)} - R_{ON}$$

where:

- $R_{OFF}$  is the active off-time resistor.
- $t_{OFF}$  is the required active off-time.

## 1.5 Power Sequencing and Monitoring

The ISL70321SEH quad power-supply sequencer controls the power-up and power-down sequencing of all supply rails. When a power-up sequence is initiated, the supply rails are enabled in the order shown in Table 6.

Two sequencers are cascaded together giving a total of eight EN signals to enable or disable all converters across eight groups as shown in Figure 9. The first sequencer in the chain has its INIT pin tied to its own UP pin through a resistor, while the second sequencer's INIT pin is instead driven by the first sequencer's DONE output. Completion of the overall power-up sequence is indicated when the second sequencer's DONE signal goes high. The DONE signal can be measured on test point J1751.

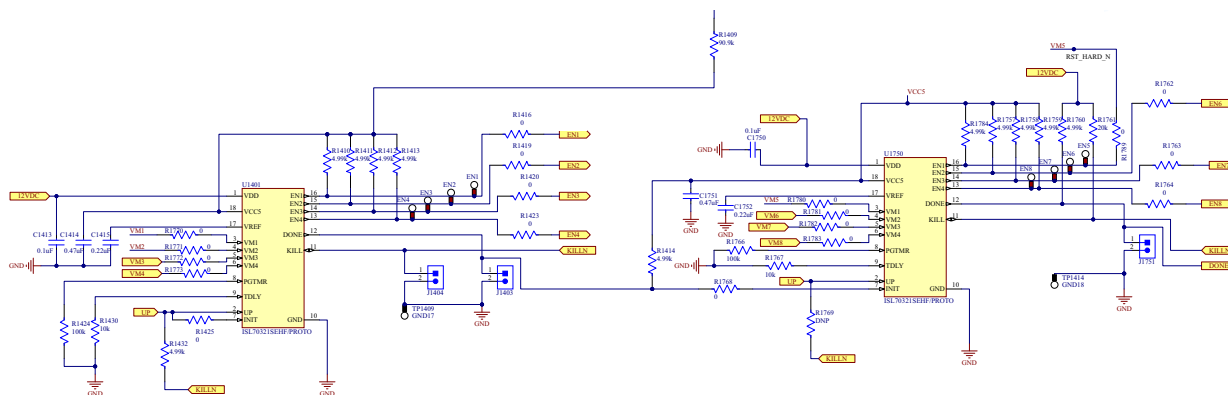


Figure 9. Power Supply Sequencer Schematic

To monitor all rails within a given group, their individual voltage-monitor outputs are ANDed together onto a single VMx signal in an open-drain configuration as shown in Figure 10. Each monitored rail pulls the shared node low unless it is satisfied, so VMx reads high only when every input is high. This VMx signal feeds into a voltage divider, shown in Figure 11, which pulls the VMx voltage above the 0.6V threshold required at the VMx inputs of the ISL70321s when the group is fully satisfied. VM6 and VM7 deviate from the voltage divider arrangement since these groups have three or more inputs feeding the AND node. With additional FETs sharing the same pull-down, the cumulative leakage current across all the off-state devices becomes significant enough to introduce error into a resistor-divider output. To avoid this, VM6 and VM7 instead pull their open-drain output directly to VCC5, eliminating the leakage-dependent error.

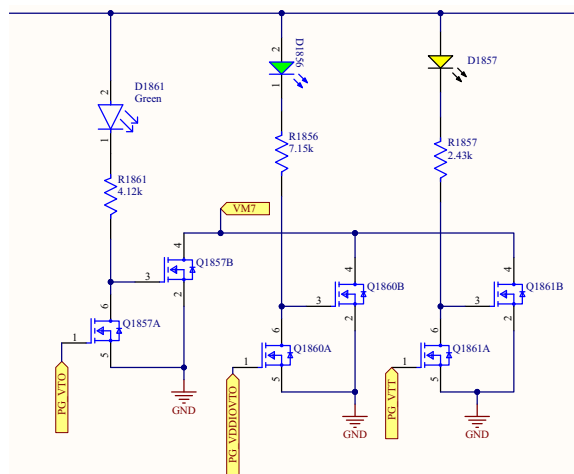


Figure 10. AND Circuit using VM7 Example

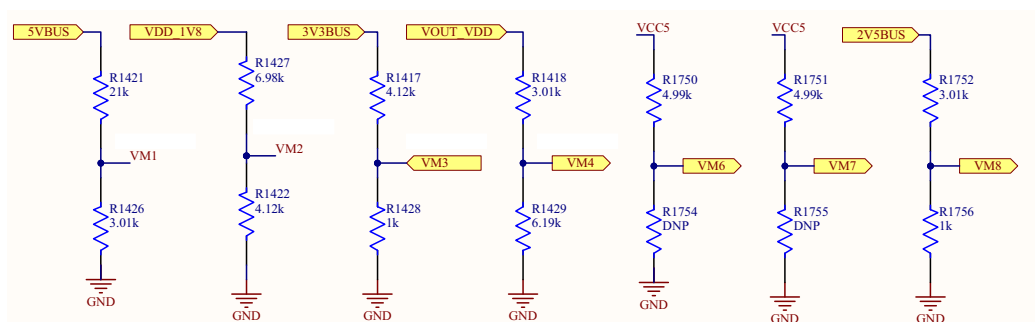


Figure 11. Power Supply Sequence Voltage Monitor Dividers

Table 6 details the grouping of the EN signals.

Table 6. Sequencing Enable Signal for Corresponding Power Rails

| ENx Output | Voltage Rail                                                                                                                                   |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| EN1        | 5VBUS                                                                                                                                          |
| EN2        | VDD1V8A, VDDS_x, SOC_DDR_VDDS, SOC_PLL_VDD1V8A                                                                                                 |
| EN3        | VDDIO_SERVICE, SOC_BSCAN_VDDIO, 5VBUS_2                                                                                                        |
| EN4        | VDDCORE, SOC_VDDCORE, SOC_PLL_VDDA                                                                                                             |
| EN5        | RST_HARD_N                                                                                                                                     |
| EN6        | SOC_DDR_VDDIO, VDDIO_x(Simple), VDDIO_x (Complex), HSSL_VDDCORE, HSSLx_TXx_VDDA, CKGENx_PLL_VDDA, HSSLx_VDD1V8A, CKGENx_PLL_VDD1V8A, DDR4_VDDQ |
| EN7        | SOC_DDR_VTO, VTO_x, DDR4_VTT, DDR4_VREF                                                                                                        |
| EN8        | DDR4_VPP                                                                                                                                       |

... ..

1. *Journal of the American Medical Association*, 1997; 277: 1039-1043.

TL = 10V, input frequency = 100NQUOTRADEMO13: parallel circuit with the load (14400) on the

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

## 1.7 Switching Converters/Controllers

All DC/DC converters on the ISLNGULTRADEMO1Z use external components to configure loop compensation, slope compensation, and, with the exception of the ISL71001, switching frequency. The ISL71001 operates at its default internal switching frequency of 1MHz, while its loop and slope compensation are configured externally.

Table 8 lists the regulator IC used for each power rail and its associated switching frequency. Figure 13 through Figure 15 show example configurations for each regulator IC.

Table 8. Switching Converters/Controllers

| Voltage Rail                                | Regulator IC | Switching Frequency (kHz) |
|---------------------------------------------|--------------|---------------------------|
| VDDCORE                                     | ISL73847     | 500                       |
| 5VBUS                                       | ISL73007     | 1000                      |
| SOC_VDDCORE, SOC_PLL_VDD                    | ISL71001     | 1000                      |
| SOC_DDR_VDDIO                               | ISL73007     | 500                       |
| VDD1V8, VDDS, SOC_DDR_VDDS, SOC_PLL_VDD1V8A | ISL73007     | 1000                      |
| 3V3_BUS,VDDIO_SERVICE, SOC_BSCAN_VDDIO      | ISL73007     | 1000                      |
| VDDIO_x (Simple)                            | ISL73007     | 1000                      |
| VDDIO_x (Complex)                           | ISL73007     | 1000                      |
| 5VBUS_2                                     | ISL73007     | 1000                      |
| DDR4_VDDQ                                   | ISL71001     | 1000                      |

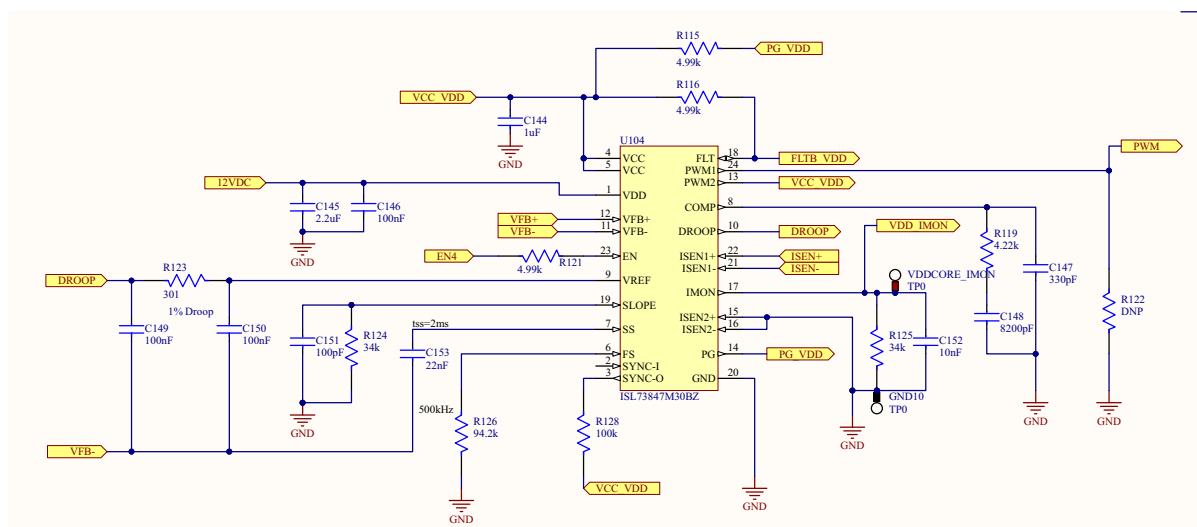
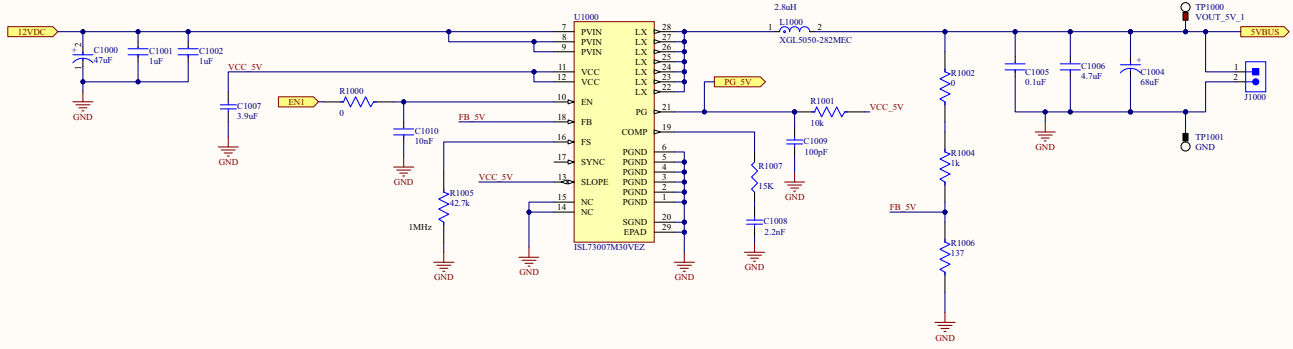
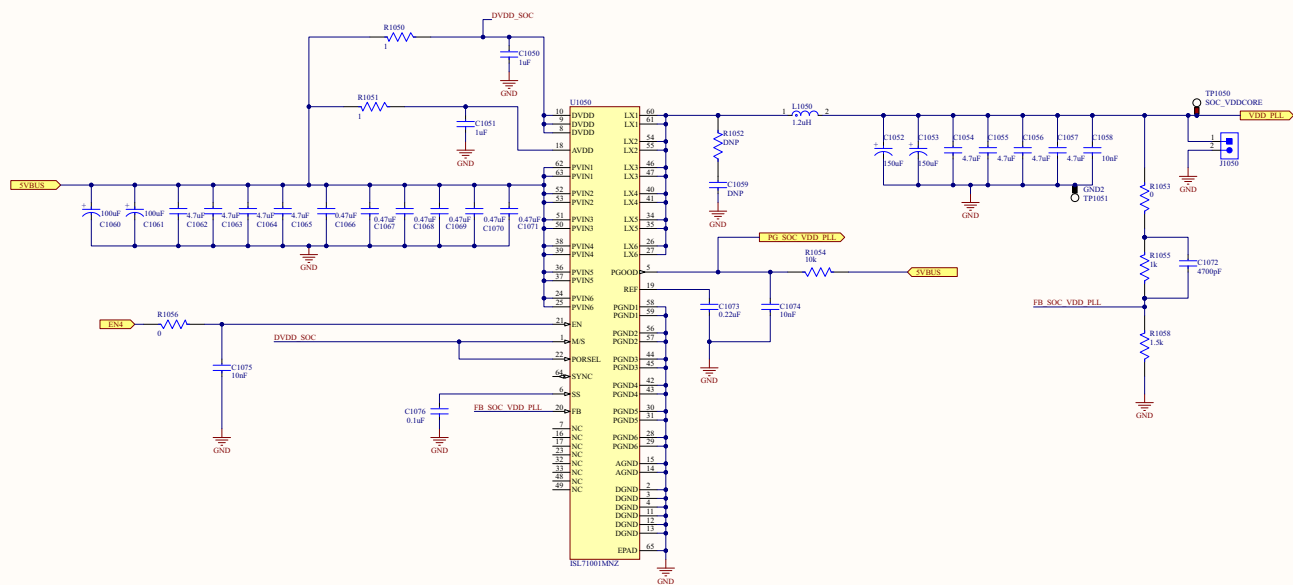


Figure 13. ISL73847 Circuit Configuration Example -  $f_{SW}$  500kHz

Figure 14. ISL73007 Circuit Configuration Example -  $f_{sw}$  1MHzFigure 15. ISL71001 Circuit Configuration Example -  $f_{sw}$  1MHz

## 1.8 VDDCORE Current Sensing

The VDDCORE rail current can be monitored as a voltage at VDD\_IMON using the ISL73847M internal current-sense amplifier and IMON output pin. The device converts the VDDCORE load current into a proportional output current through its internal transconductance amplifiers. This current develops a voltage across the external output resistor, R125, producing the VDD\_IMON signal. When jumper J180 is configured to select VDD\_IMON, R1831 and R1832 must be considered in parallel with R125, since this configuration routes VDD\_IMON through the shared voltage divider that scales the signal for the ADC.

Use Equation 3 to convert the VDD\_IMON voltage to VDDCORE load current.

$$(EQ. 3) \quad I_{LOAD} = \frac{VDDIMON}{R_{SENSE} \times R_{OUT} \times gm}$$

The default  $R_{SENSE}$  on the board is 2mΩ (R103).  $R_{OUT}$  is calculated by R125 in parallel with R1831 and R1832, an equivalent value of 29.1kΩ.

where:

- VDDIMON is the IMON output voltage of the ISL73847M current-sense amplifier.
- $I_{LOAD}$  is the VDDCORE rail load current in amps.

- $R_{SENSE}$  is the VDDCORE current-sense resistance in ohms.
- $R_{OUT}$  is the output load scaling resistance.
- $g_m(CSA, IMON)$  is the transconductance from the input of the current sense amp to the IMON pin, which is  $0.39\mu A/mV$  (typical).

*Note:* Actual VDD\_IMON readings may vary from calculated values due to normal device-to-device variation in  $g_m$  and resistor tolerances.

## 1.9 12V Bus Current Sensing and KILL Comparator

The total +12V bus supply current to the system can be monitored as a voltage (IMON) using the ISL70100M current-sense amplifier. The circuit converts 0A to 10A to an output voltage of 0V to 2.17V. The output voltage range can be scaled by adjusting the output load resistor, R1605.

Use Equation 4 to convert the IMON voltage to the 12V input supply current. The default  $R_{SENSE}$  on the board is  $15m\Omega$ .  $R_{OUT}$  is calculated as R1605 in parallel with R1831 and R1832 when J180 is configured to select IMON, resulting in an equivalent resistance of  $7.23k\Omega$ .

$$(EQ. 4) \quad I_{SENSE} = \frac{IMON}{R_{SENSE} \times R_{OUT} \times 0.002A/V}$$

where:

- IMON is the OUT voltage of the current sense amp.
- $I_{SENSE}$  is the 12V bus supply current in amps.
- $R_{SENSE}$  is the 12V bus current sense resistance in ohms.
- $R_{OUT}$  is the output load scaling resistance

The IMON signal is tied to the inverting input of the ISL71218M op amp. The circuit in Figure 16 shows how to configure the op amp as a comparator, which disables all the power outputs simultaneously by pulling the KILL pin low on the ISL70321 power sequencer. KILL is pulled low by the comparator when IMON is greater than or equal to  $1.0V$  ( $V_{IH}$ ). When IMON is less than or equal to  $0.8V$  ( $V_{IL}$ ), the KILL pins are released and the power supplies automatically start up sequentially again. R1601, R1602, and R1604 can be adjusted to change  $V_{IH}$  and  $V_{IL}$ .

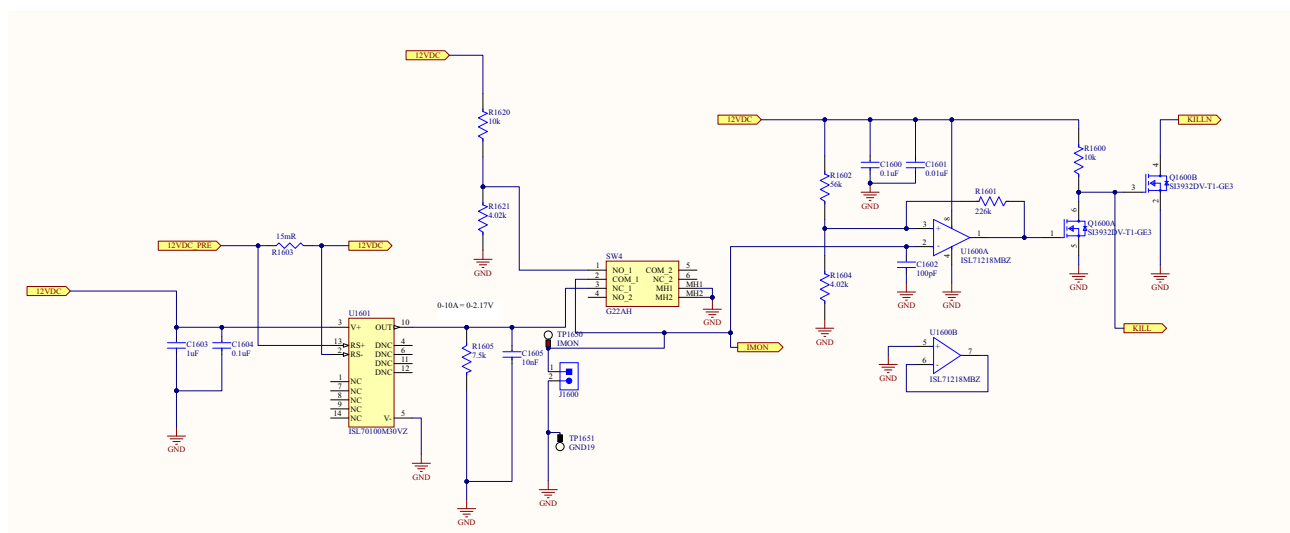


Figure 16. ISL70100 Input Current-Sense Schematic

Use Equation 5 to calculate the resistors for the required  $V_{IH}$  threshold.

$$\text{(EQ. 5)} \quad R_{1602} = \frac{R_{1601} \times R_{1604} \times (12V - V_{IH})}{R_{1601} \times V_{IH} - R_{1604} \times (12V - V_{IH})}$$

where:

- R1602 is the top resistor in the comparator non-inverting input voltage-divider reference in ohms.
- R1604 is the bottom resistor in the comparator non-inverting input voltage-divider reference in ohms.
- R1601 is the hysteresis resistor in ohms.
- $V_{IH}$  is the required comparator high-level threshold in volts.

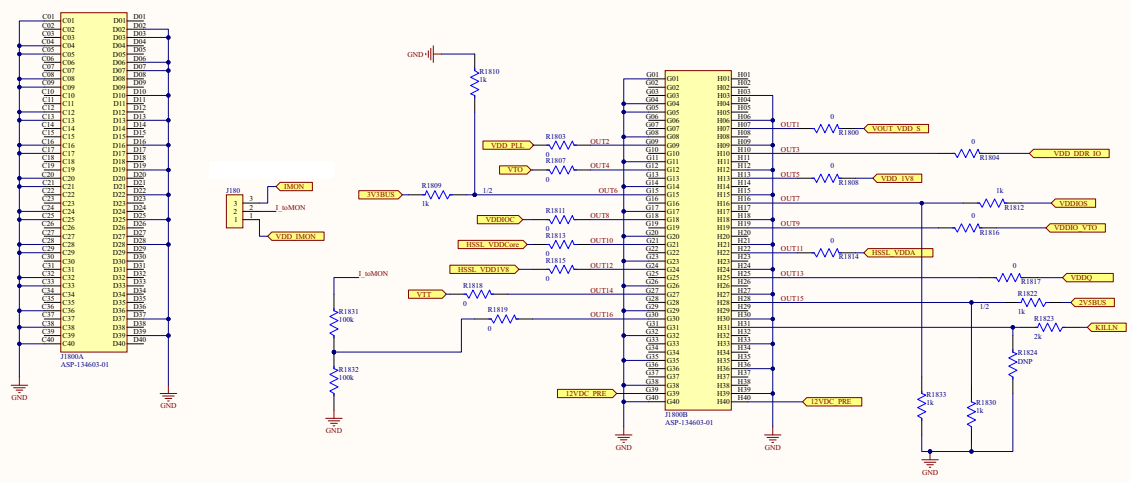
When the  $V_{IH}$  resistors are determined, the  $V_{IL}$  threshold can be calculated using Equation 6. Verify the hysteresis ( $V_{IH} - V_{IL}$ ) is acceptable. If it is not, increase R1601 and recalculate R1602 and  $V_{IL}$ .

$$(EQ. 6) \quad V_{IL} = \frac{R1601 \times R1602 \times 12V}{R1602 \times (R1601 + R1604) - R1601 \times R1604}$$

Use SW1600 to toggle between default current monitoring and simulated OCP conditions.

## 1.10 Voltage Rail Monitoring

Refer to the *ISL71148VMREFEV2Z Evaluation Board Manual* for more information about voltage monitoring and instructions on how to interface with the iRADNavigator software GUI. The voltage monitor reference design connects to the board using connector J1800 as shown in [Figure 17](#). Using voltage dividers ensures that no signal greater than 2.5V is applied to the ADC inputs.



### Figure 17. Voltage Monitoring Board Connection

The signals listed in [Table 9](#) are equal to or close to the ADC's 2.5V maximum analog input range, so a voltage divider is applied to each. The iRADNavigator software GUI then applies the inverse of this divider factor to each ADC reading to display the actual rail voltage.

### Table 9. Voltage Monitor Input Scaling

| Input Signal                              | Expected Maximum Voltage (V) | Voltage Divider Factor |
|-------------------------------------------|------------------------------|------------------------|
| 3V3_BUS,VDDIO_SERVICE,<br>SOC_BSCAN_VDDIO | 3.3                          | 1/2                    |
| VDDIO_x (Simple)                          | 2.5                          | 1/2                    |
| DDR4_VPP                                  | 2.5                          | 1/2                    |
| VDDCORE_IMON/IMON                         | 2.17                         | 1/2                    |

The IMON signal, which represents 12V bus current, and VDD\_IMON, which represents VDDCORE rail current, share a common ADC input channel on the ISL71148VMREFEV2Z. Jumper J180 selects which signal is connected to the I<sub>to</sub>MON net, allowing only one current measurement to be monitored by the ADC at any given time.

Resistors R1831 and R1832 form a voltage divider that attenuates the selected signal before it reaches the ADC input. The divider also limits the input current to below the ADC's 3mA specification.

## 1.11 ULTRA300 Reconfiguration

The power management board's modular rail architecture allows it to support the ULTRA300 with a limited set of rail-specific changes, rather than a full redesign. Because the ULTRA300 does not include the embedded SoC subsystem, several SoC-dedicated rails are no longer required, while a small number of remaining rails require adjusted current ratings or component substitutions to meet the ULTRA300's supply requirements. Two new rails, DAC\_VDD1V8A and ADC\_VDD1V8A, are also added to support ULTRA300's ADC/DAC blocks. Additionally, the ULTRA300 specifies a different recommended power-up order than NG-ULTRA, requiring a corresponding change to the sequencer configuration. Table 10 summarizes these changes.

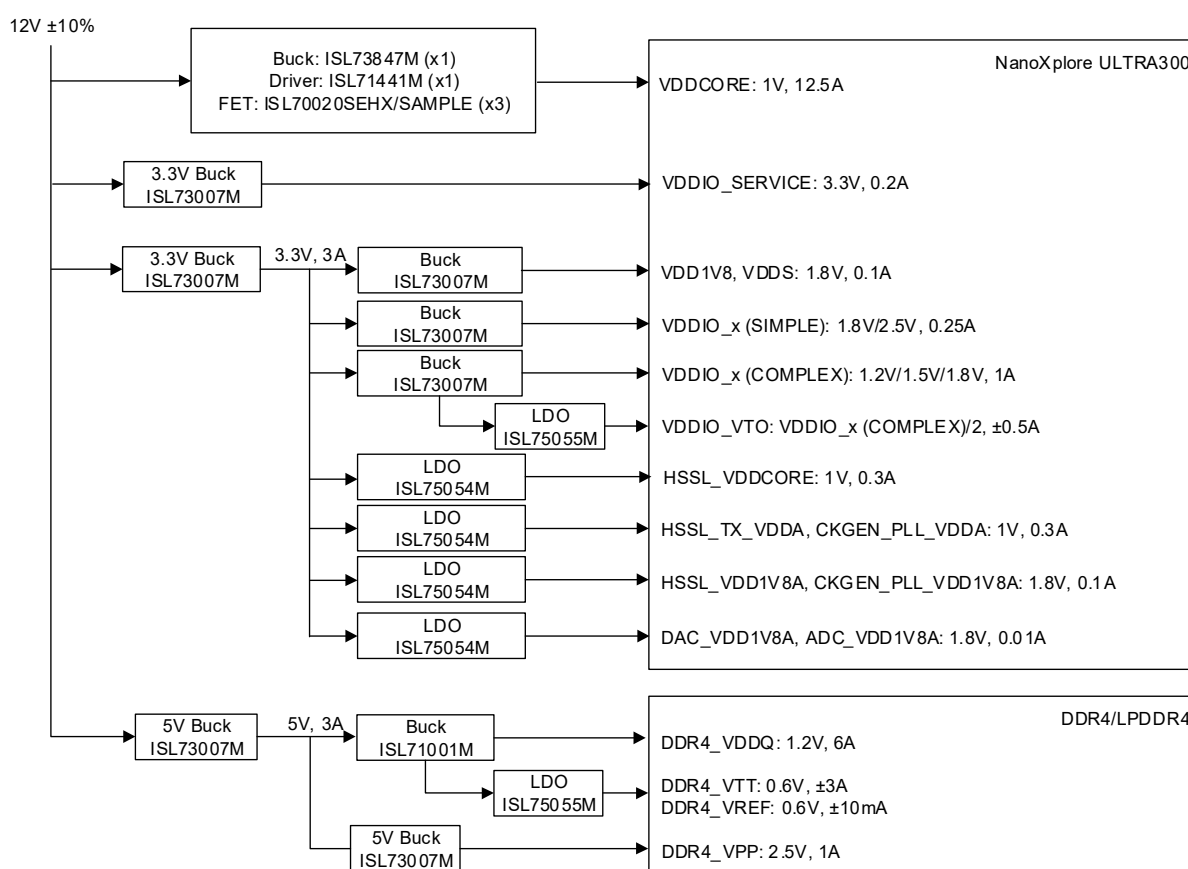


Figure 18. Renesas Radiation-Tolerant Power Tree for NanoXplore ULTRA300

Table 10. Power Management Specifications for NanoXplore ULTRA300 FPGA

| Rail Name         | Rail Voltage (V)           | Current Demand (A) | DC Tol + Ripple (%) | Power Sequencing | Renesas Solution                                                                                                                                        |
|-------------------|----------------------------|--------------------|---------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| VDDCORE           | 1                          | 12.5               | ±5                  | 3                | ISL73847 - RT Current Mode PWM Controller<br>ISL71441 - RT 12V Half-Bridge GaN FET Driver<br>ISL70020 - 40V, 65A Enhancement Mode GaN Power Transistors |
| VDD1V8A           | 1.8                        | 0.1                | ±5                  | 2                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDS_x            |                            |                    |                     |                  |                                                                                                                                                         |
| 3.3V BUS          | 3.3                        | 3                  | N/A                 | 1                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_SERVICE     | 3.3                        | 0.2                | ±10                 | 4                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_x (Simple)  | 1.8/2.5/3.3 <sup>[1]</sup> | 0.25               | ±5                  | 6                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_x (Complex) | 1.2/1.5/1.8                | 1                  | ±5                  | 6                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| VDDIO_VTO         | VDDIO_x (Complex)/2        | ±0.5               | ±5                  | 7                | ISL75055 - RT 3A Source and Sink DDR Terminator/LDO with Buffered Reference                                                                             |
| HSSL_VDDCORE      | 1                          | 0.3                | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| HSSL_TX_VDDA      | 1                          | 0.3                | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| CKGEN_PLL_VDDA    |                            |                    |                     |                  |                                                                                                                                                         |
| HSSL_VDD1V8       | 1.8                        | 0.1                | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| CKGEN_PLL_VDD1V8  |                            |                    |                     |                  |                                                                                                                                                         |
| DAC_VDD1V8A       | 1.8                        | 0.01               | ±5                  | 6                | ISL75054 - RT Ultra-Low Noise, 1A LDO                                                                                                                   |
| ADC_VDD1V8A       | 1.8                        | 0.002              | ±5                  | 6                |                                                                                                                                                         |
| 5V BUS            | 5                          | 3                  | N/A                 | 3                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |
| DDR4_VDDQ         | 1.2                        | 6                  | ±10                 | 6                | ISL71001 - RT 5.5V, 6A Point-of-Load Regulator                                                                                                          |
| DDR4_VTT          | 0.6V                       | ±3                 | ±10                 | 7                | ISL75055 - RT 3A Source and Sink DDR Terminator/LDO with Buffered Reference                                                                             |
| DDR4_REF          | 0.6V                       | ±0.01              | ±10                 | 7                |                                                                                                                                                         |
| DDR4_VPP          | 2.5                        | 1                  | ±5                  | 8                | ISL73007 - RT 18V, 3A Point-of-Load Regulator                                                                                                           |

1. 3.3V output is not a jumper-selectable option. The VDDIO\_x (SIMPLE) ISL73007's input must be connected to 12V rather than 3.3V at layout time, and the associated feedback, compensation, and passive component values must be redesigned around the new input voltage.

## 2. Typical Performance Curves

### 2.1 Steady State Output Voltage Ripple

The recommended power supply tolerances, as described by the *NanoXplore NG-ULTRA Datasheet*, include power supply ripple over the customer design frequencies of interest, as measured at the device package pins. An example for a valid power supply that meets the recommendations for the VDDCORE supply is  $1.0\text{V} \pm 50\text{mV}$  for power supply ripple.

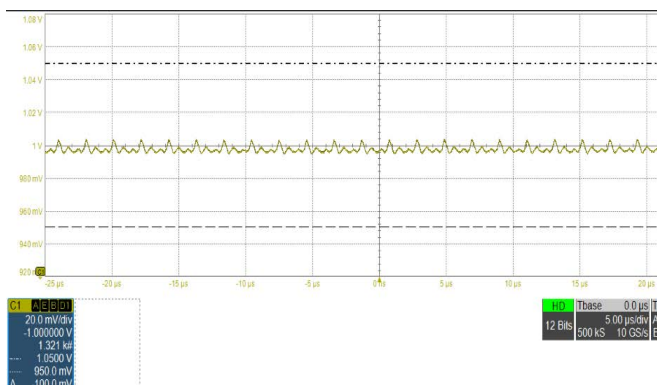


Figure 19. VDDCORE Output Voltage, ISL73847, 1V/20A,  $\pm 50\text{mV}$  Limits

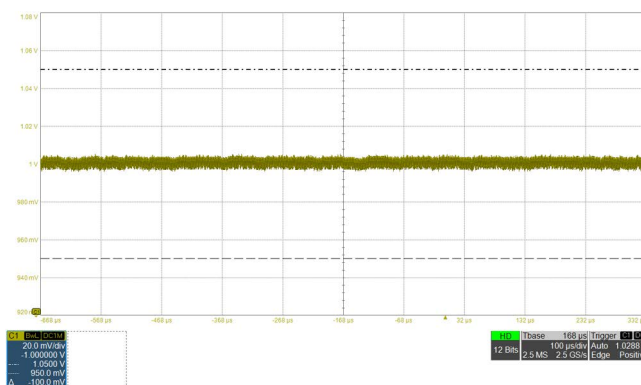


Figure 20. SOC\_VDDCORE, SOC\_PLL\_VDDA Output Voltage, ISL71001, 1V/5A,  $\pm 50\text{mV}$  Limits

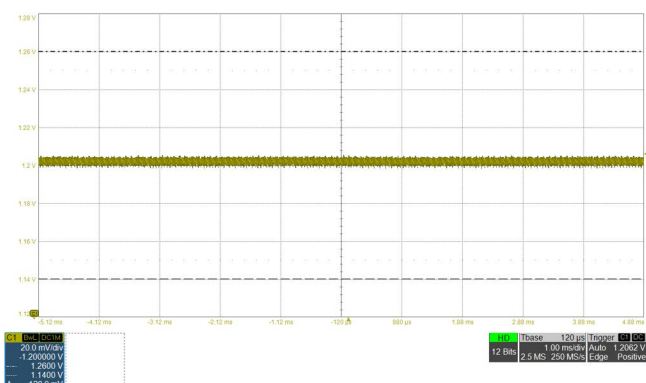


Figure 21. SOC\_DDR\_VDDIO Output Voltage, ISL73007, 1.2V/0.8A,  $\pm 60\text{mV}$  Limits

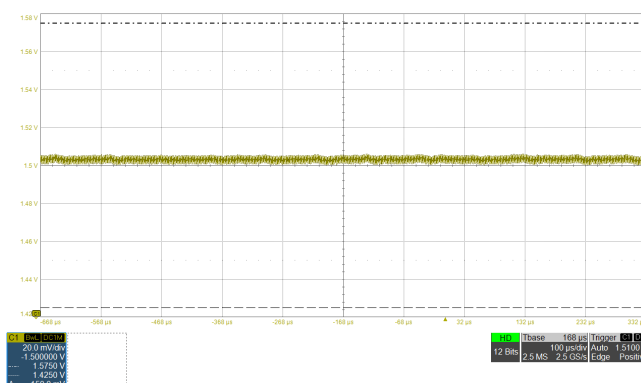


Figure 22. SOC\_DDR\_VDDIO Output Voltage, ISL73007, 1.5V/0.8A,  $\pm 75\text{mV}$  Limits

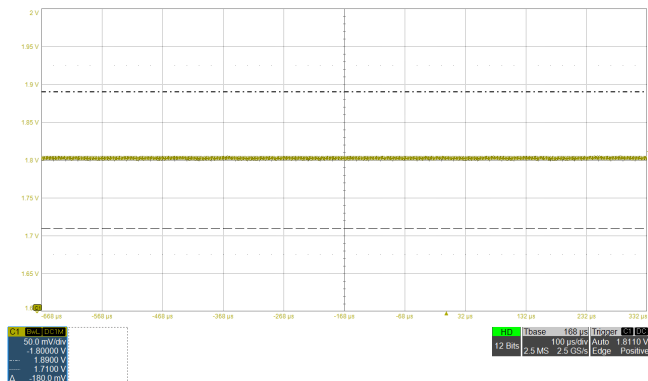


**Figure 23. SOC\_DDR\_VDDIO Output Voltage, ISL73007, 1.8V/0.8A,  $\pm 90$ mV Limits**

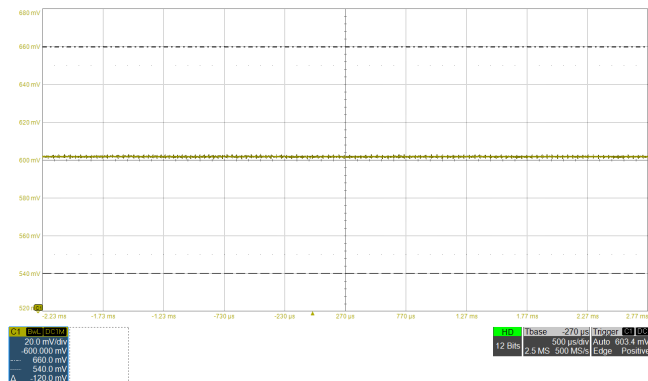


**Figure 24. SOC\_DDR\_VTO Output Voltage, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 60$ mV Limits, SOC\_DDR\_VDDIO = 1.2V**

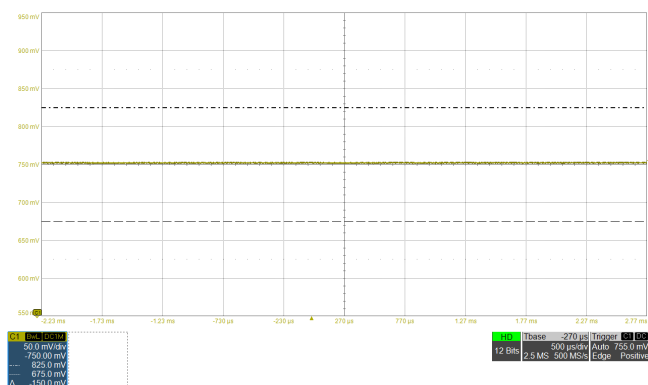


**Figure 25. SOC\_DDR\_VTO Output Voltage, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 75$ mV Limits, SOC\_DDR\_VDDIO = 1.5V**

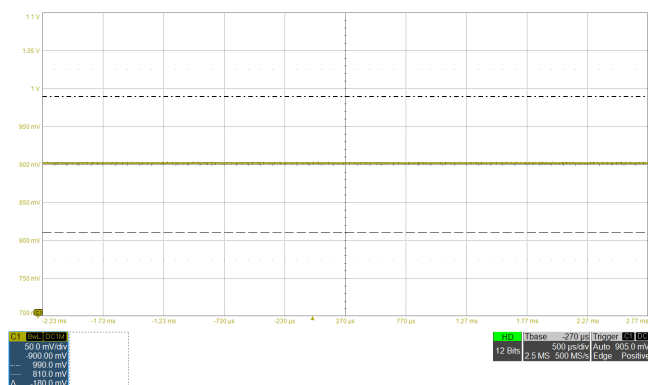


**Figure 26. SOC\_DDR\_VTO Output Voltage, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 90$ mV Limits, SOC\_DDR\_VDDIO = 1.8V**

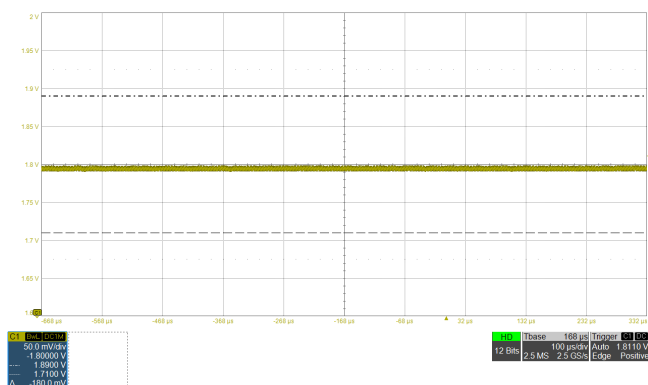


**Figure 27. VDD1V8, VDDS, SOC\_DDR\_VDDS, SOC\_PLL\_VDD1V8A Output Voltage, ISL73007, 1.8V/2A,  $\pm 90$ mV Limits**

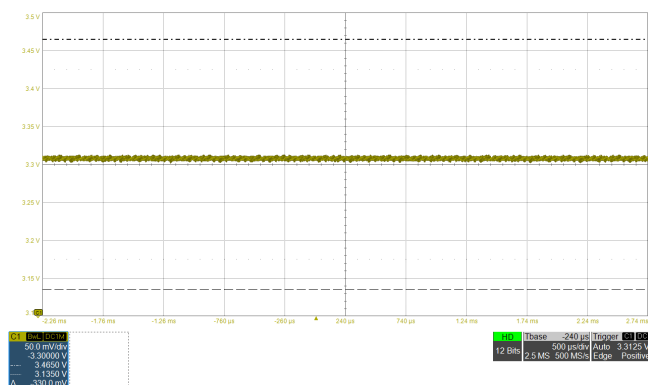


**Figure 28. VDDIO\_SERVICE, SOC\_BSCAN\_VDDIO Output Voltage, ISL73007, 3.3V/0.2A,  $\pm 165$ mV Limits**

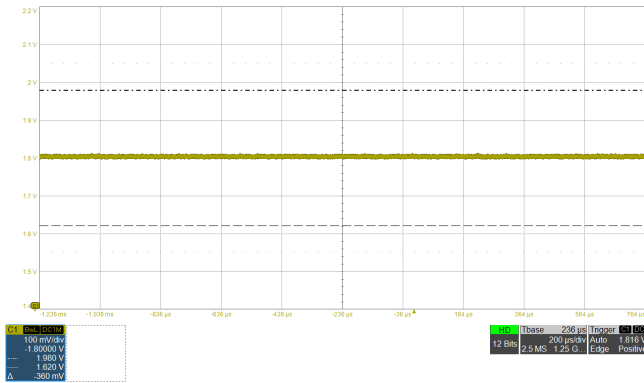


Figure 29. VDDIO\_x (Simple) Output Voltage, ISL73007, 1.8V/0.5A,  $\pm 180\text{mV}$  Limits

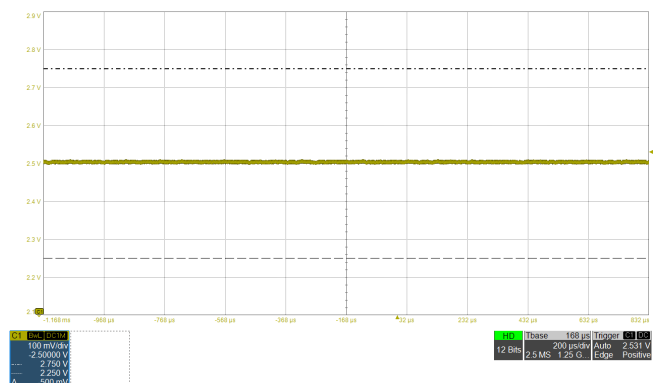


Figure 30. VDDIO\_x (Simple) Output Voltage, ISL73007, 2.5V/0.5A,  $\pm 250\text{mV}$  Limits

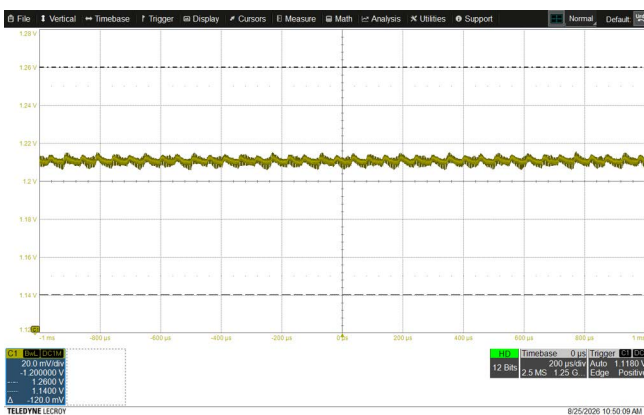


Figure 31. VDDIO\_x (Complex) Output Voltage, ISL73007, 1.2V/2A,  $\pm 60\text{mV}$  Limits

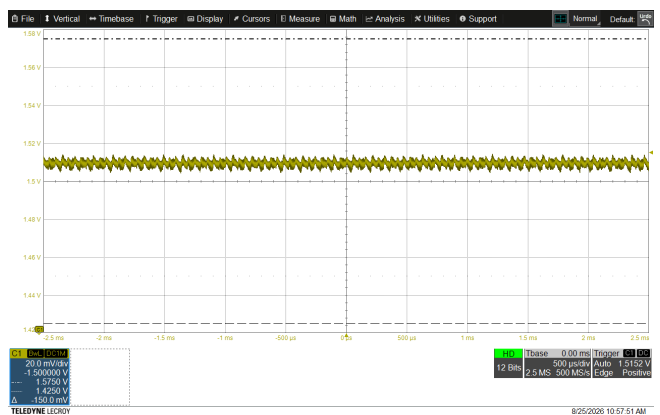


Figure 32. VDDIO\_x (Complex) Output Voltage, ISL73007, 1.5V/2A,  $\pm 75\text{mV}$  Limits

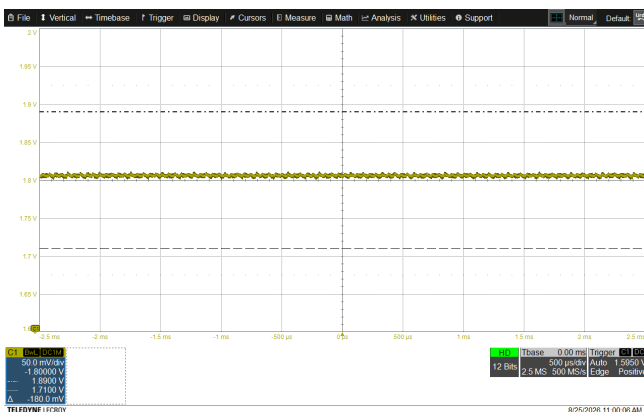


Figure 33. VDDIO\_x (Complex) Output Voltage, ISL73007, 1.8V/2A,  $\pm 90\text{mV}$  Limits

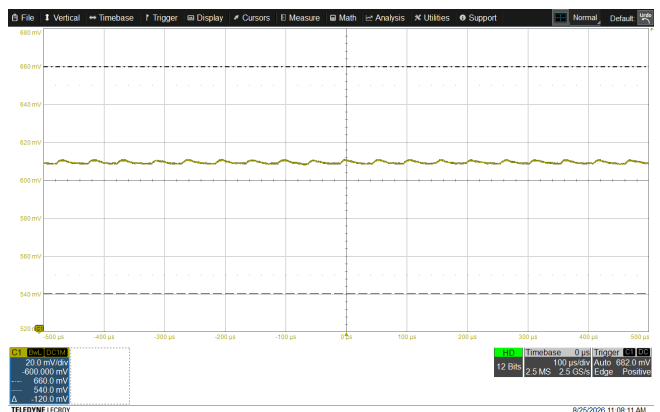


Figure 34. VDDIO\_VTO Output Voltage, ISL75055,  $(\text{VDDIO}_x (\text{Complex})/2) \pm 1\text{A}$ ,  $\pm 60\text{mV}$  Limits,  $\text{VDDIO}_x (\text{Complex}) = 1.2\text{V}$

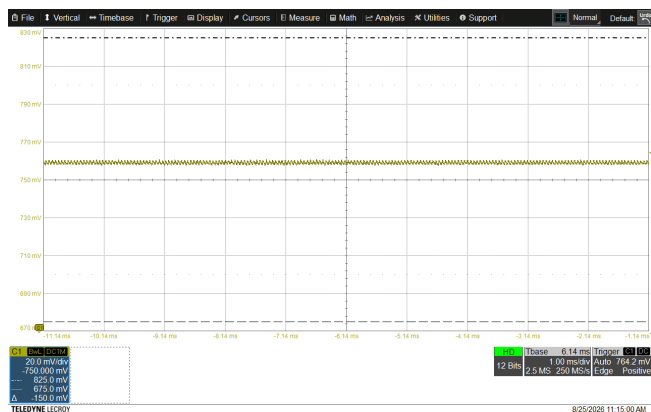


**Figure 35. VDDIO\_VTO Output Voltage, ISL75055, (VDDIO\_x (Complex)/2)/±1A, ±75mV Limits, VDDIO\_x (Complex) = 1.5V**



**Figure 36. VDDIO\_VTO Output Voltage, ISL75055, (VDDIO\_x (Complex)/2)/±1A, ±90mV Limits, VDDIO\_x (Complex) = 1.8V**

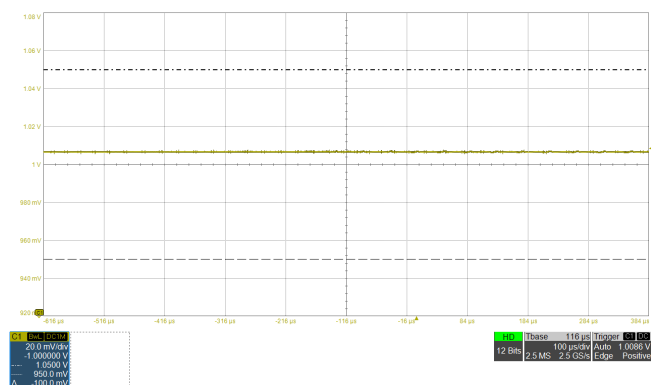


**Figure 37. HSSL\_VDDCORE Output Voltage, ISL75054, 1V/0.5A, ±50mV Limits**

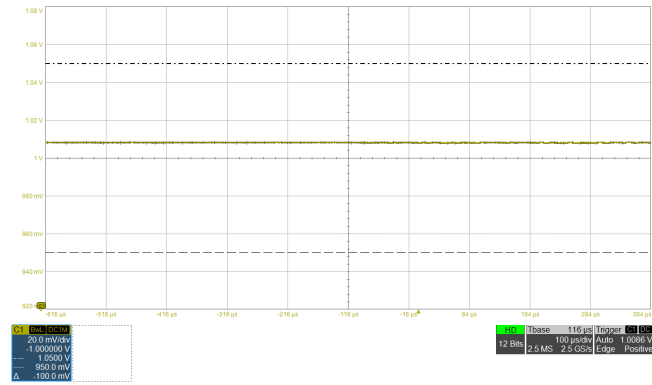


**Figure 38. HSSL\_TX\_VDDA, CKGEN\_PLL\_VDDA Output Voltage, ISL75054, 1V/0.5A, ±50mV Limits**

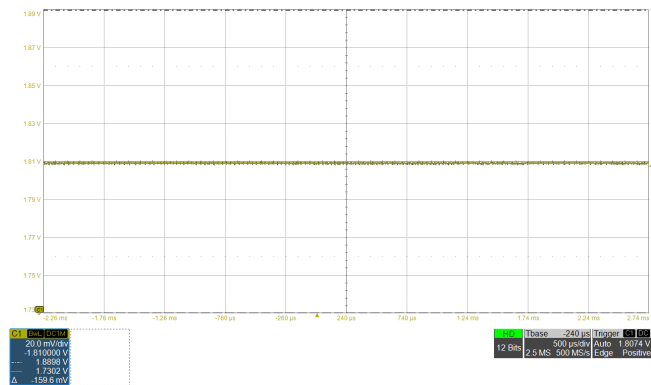


**Figure 39. HSSL\_VDD1V8, CKGEN\_PLL\_VDD1V8A Output Voltage, ISL75054, 1.8V/0.15A, ±90mV Limits**

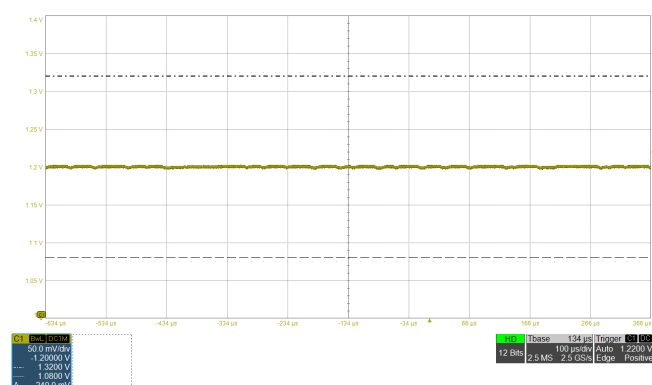


**Figure 40. DDR4\_VDDQ Output Voltage, ISL71001, 1.2V/6A, ±120mV Limits**

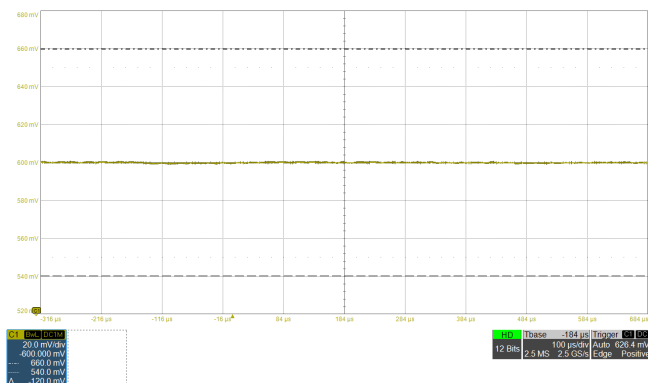


Figure 41. DDR4\_VTT/DDR4\_VREF Output Voltage, ISL75055, 0.6V/±3A, ±60mV Limits

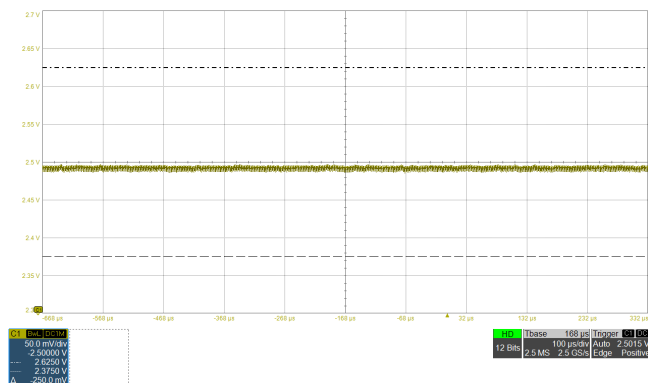


Figure 42. DDR4\_VPP Output Voltage, ISL73007, 2.5V/1A, ±125mV Limits

## 2.2 Load Transient/AC Performance

All overshoots and undershoots must be within the absolute maximum ratings provided in the *NanoXplore NG-ULTRA Datasheet*. The transient current is half of the maximum current. Maximum current is taken from NanoXplore's NXPowerEstimator.

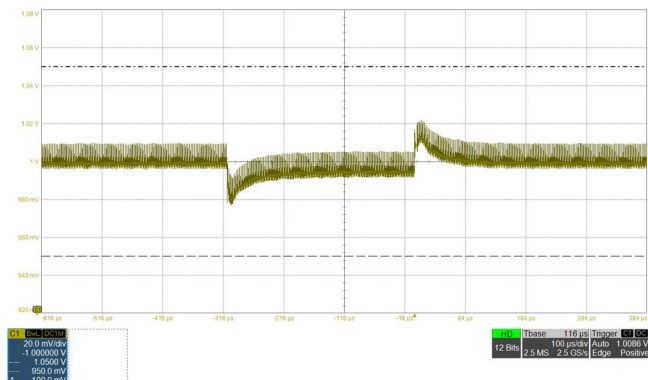


Figure 43. VDDCORE Output Voltage Transient Response, ISL73847, 1V/20A, ±50mV Limits

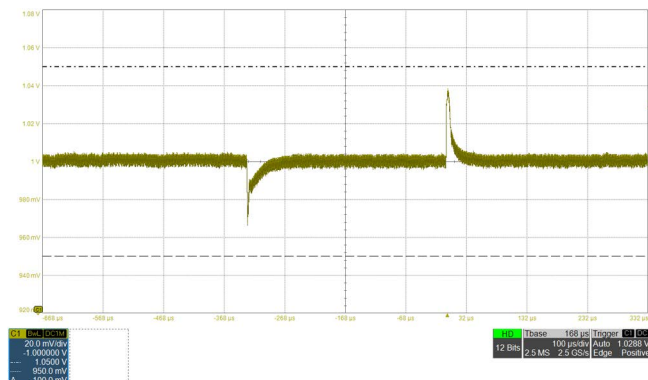


Figure 44. SOC\_VDDCORE, SOC\_PLL\_VDDA Output Voltage Transient Response, ISL71001, 1V/5A, ±50mV Limits

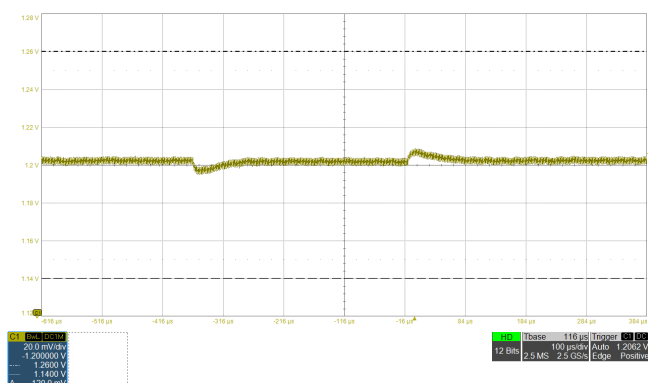


Figure 45. SOC\_DDR\_VDDIO Output Voltage Transient Response, ISL73007, 1.2V/0.8A, ±60mV Limits

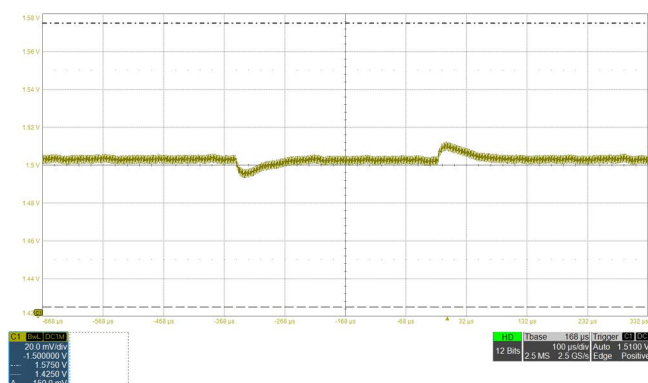


Figure 46. SOC\_DDR\_VDDIO Output Voltage Transient Response, ISL73007, 1.5V/0.8A, ±75mV Limits

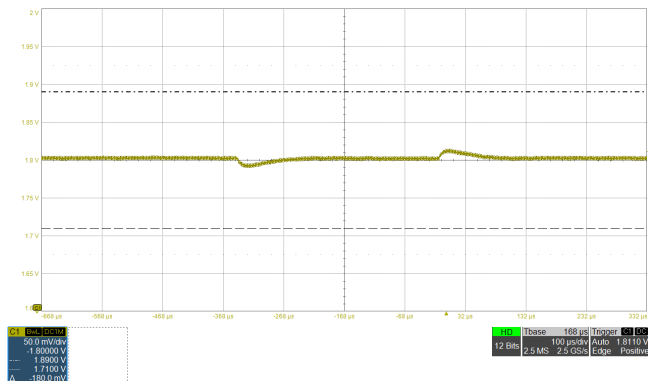


**Figure 47. SOC\_DDR\_VDDIO Output Voltage Transient Response, ISL73007, 1.8V/0.8A,  $\pm 90\text{mV}$  Limits**

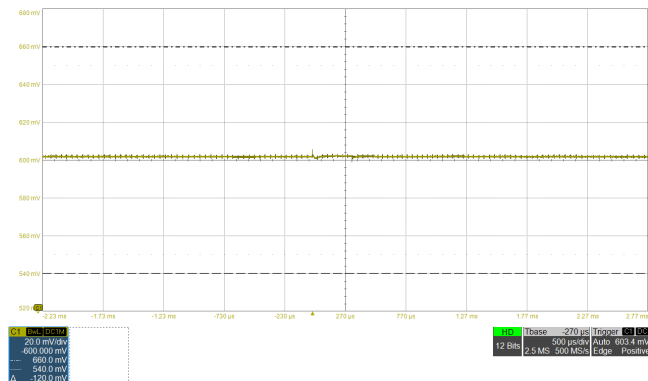


**Figure 48. SOC\_DDR\_VTO Output Voltage Transient Response, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 60\text{mV}$  Limits, SOC\_DDR\_VDDIO = 1.2V**

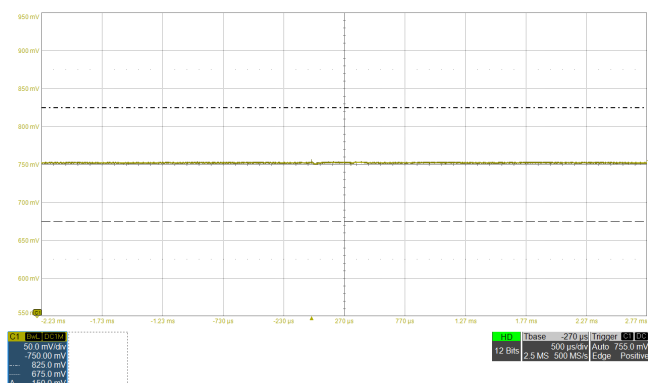


**Figure 49. SOC\_DDR\_VTO Output Voltage Transient Response, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 75\text{mV}$  Limits, SOC\_DDR\_VDDIO = 1.5V**

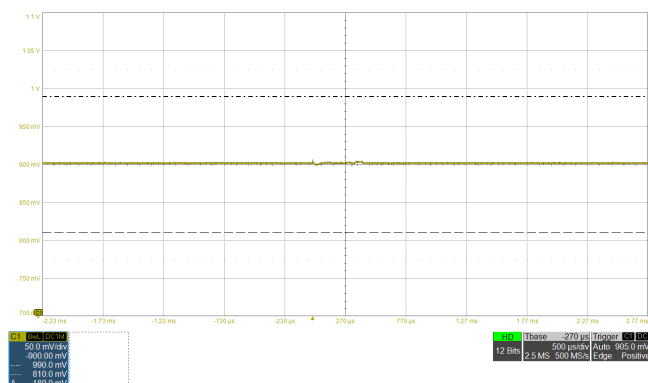


**Figure 50. SOC\_DDR\_VTO Output Voltage Transient Response, ISL75055, (SOC\_DDR\_VDDIO/2)/0.4A,  $\pm 90\text{mV}$  Limits, SOC\_DDR\_VDDIO = 1.8V**

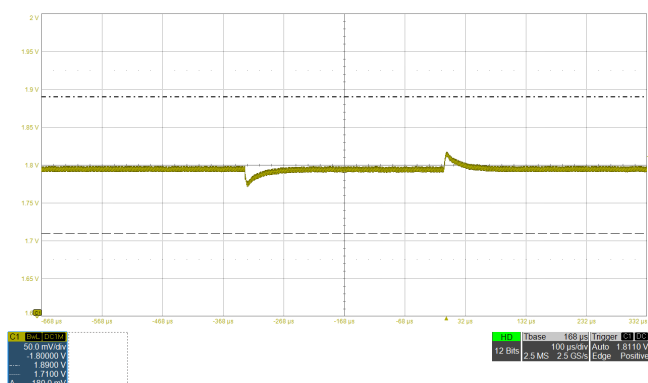


**Figure 51. VDD1V8, VDDS, SOC\_DDR\_VDDS, SOC\_PLL\_VDD1V8A Output Voltage Transient Response, ISL73007, 1.8V/2A,  $\pm 90\text{mV}$  Limits**

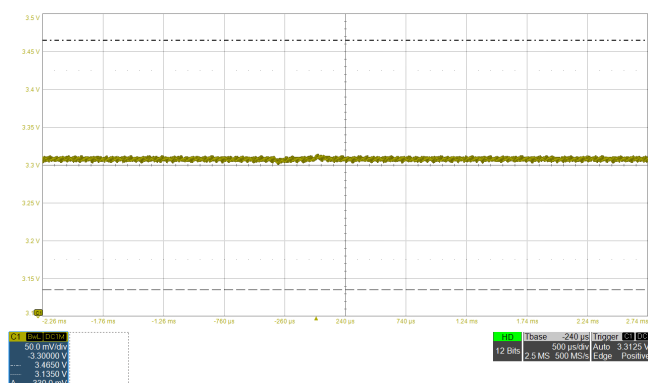


**Figure 52. VDDIO\_SERVICE, SOC\_BSCAN\_VDDIO Output Voltage Transient Response, ISL73007, 3.3V/0.2A,  $\pm 165\text{mV}$  Limits**

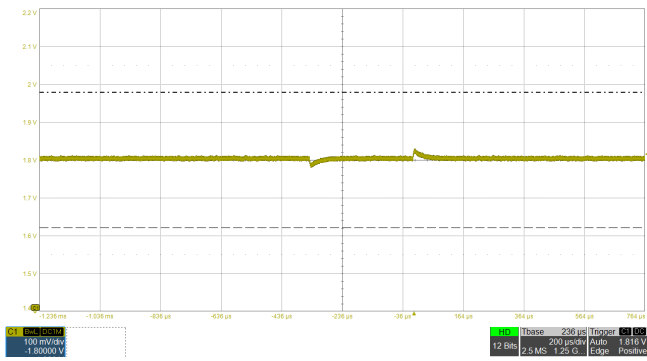


**Figure 53. VDDIO\_x (Simple) Output Voltage Transient Response, ISL73007, 1.8V/0.5A,  $\pm 180\text{mV}$  Limits**

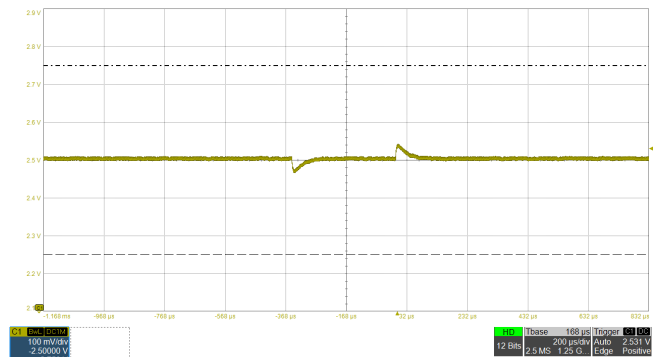


**Figure 54. VDDIO\_x (Simple) Output Voltage Transient Response, ISL73007, 2.5V/0.5A,  $\pm 250\text{mV}$  Limits**

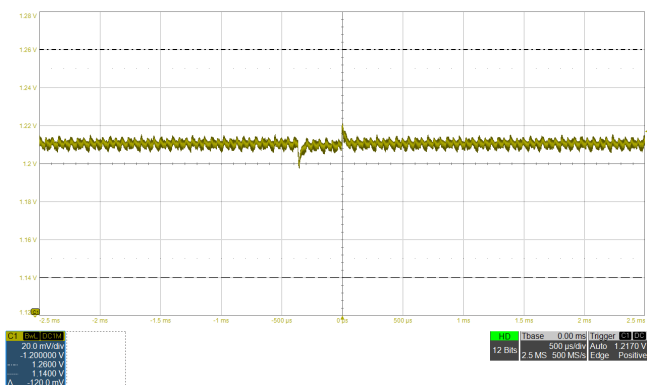


**Figure 55. VDDIO\_x (Complex) Output Voltage Transient Response, ISL73007, 1.2V/2A,  $\pm 60\text{mV}$  Limits**

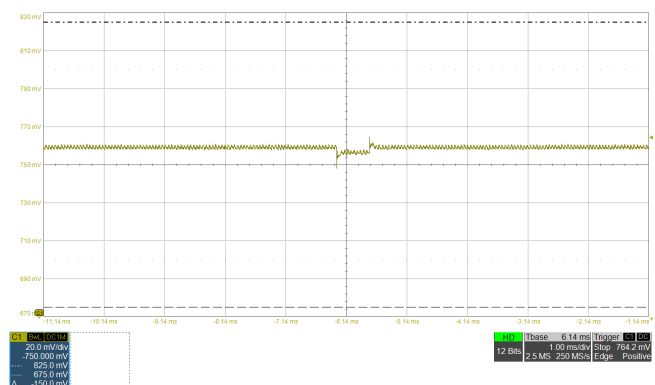


**Figure 56. VDDIO\_x (Complex) Output Voltage Transient Response, ISL73007, 1.5V/2A,  $\pm 75\text{mV}$  Limits**

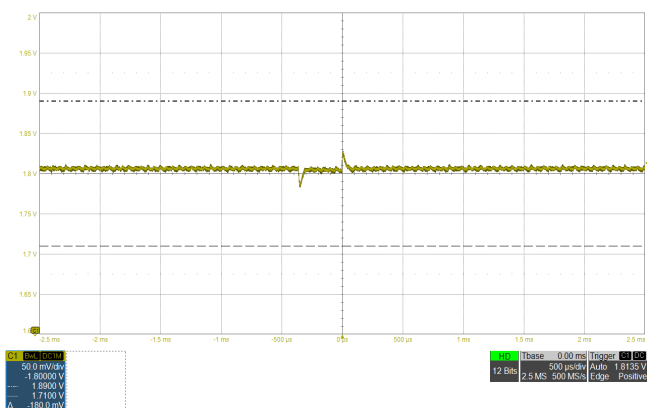


**Figure 57. VDDIO\_x (Complex) Output Voltage Transient Response, ISL73007, 1.8V/2A,  $\pm 90\text{mV}$  Limits**

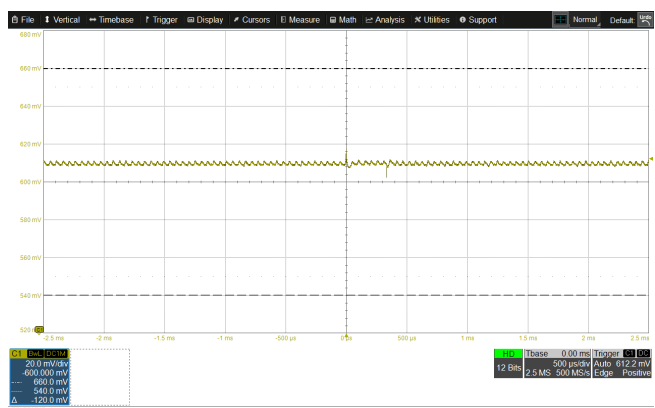


**Figure 58. VDDIO\_VTO Output Voltage Transient Response, ISL75055,  $(\text{VDDIO}_x (\text{Complex})/2) \pm 1\text{A}$ ,  $\pm 60\text{mV}$  Limits,  $\text{VDDIO}_x (\text{Complex}) = 1.2\text{V}$**

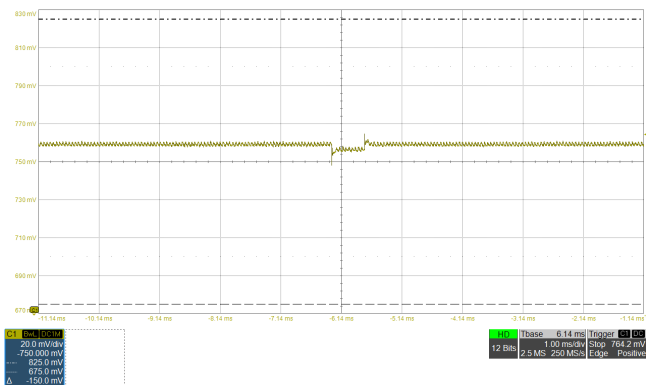


**Figure 59. VDDIO\_VTO Output Voltage Transient Response, ISL75055, (VDDIO\_x (Complex)/2)±1A, ±75mV Limits, VDDIO\_x (Complex) = 1.5V**



**Figure 60. VDDIO\_VTO Output Voltage Transient Response, ISL75055, (VDDIO\_x (Complex)/2)±1A, ±90mV Limits, VDDIO\_x (Complex) = 1.8V**

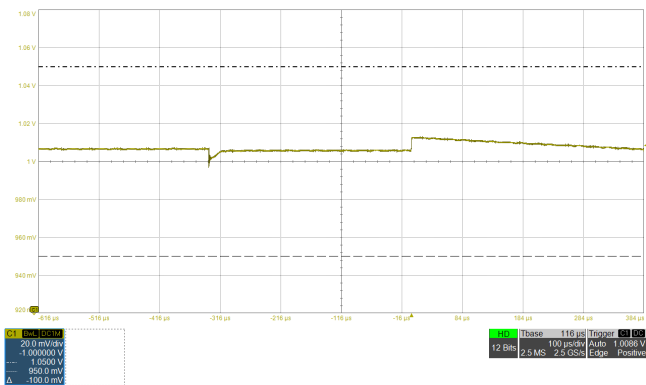


**Figure 61. HSSL\_VDDCORE Output Voltage Transient Response, ISL75054, 1V/0.5A, ±50mV Limits**

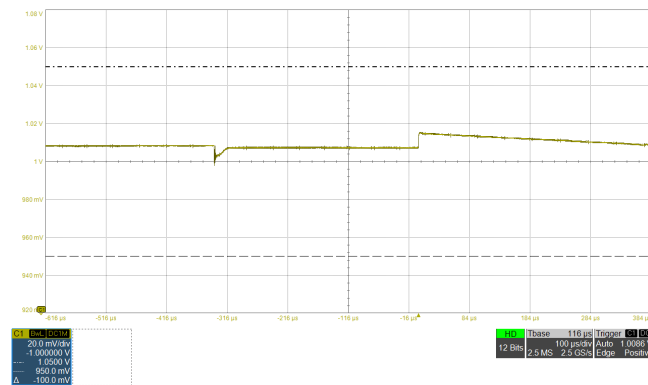


**Figure 62. HSSL\_TX\_VDDA, CKGEN\_PLL\_VDDA Output Voltage Transient Response, ISL75054, 1V/0.5A, ±50mV Limits**

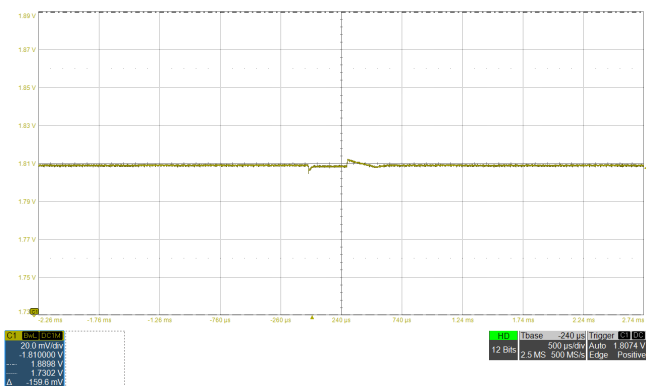


**Figure 63. HSSL\_VDD1V8, CKGEN\_PLL\_VDD1V8A Output Voltage Transient Response, ISL75054, 1.8V/0.15A, ±90mV Limits**

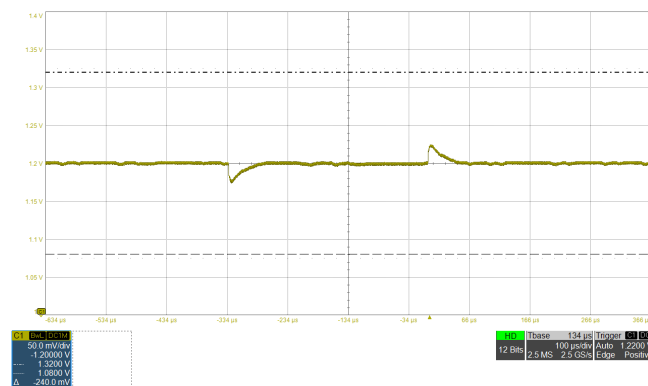


**Figure 64. DDR4\_VDDQ Output Voltage Transient Response, ISL71001, 1.2V/6A, ±120mV Limits**

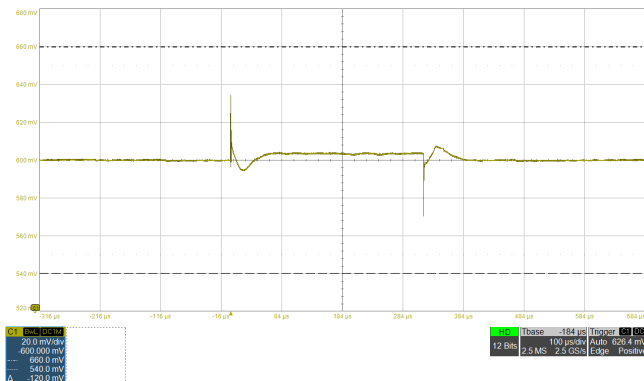


Figure 65. DDR4\_VTT/DDR4\_VREF Output Voltage Transient Response, ISL75055, 0.6V/±3A, ±60mV Limits

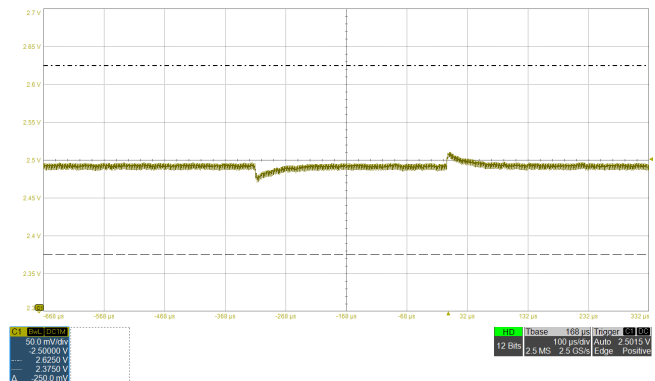


Figure 66. DDR4\_VPP Output Voltage Transient Response, ISL73007, 2.5V/1A, ±125mV Limits

## 2.3 Power Sequencing

As described in the *NanoXplore NG-ULTRA Datasheet*, the general recommendation for power supply ramp-up is to enable each power supply rail only after the previous rail reaches 90% of its nominal voltage, while avoiding long delays between rails.

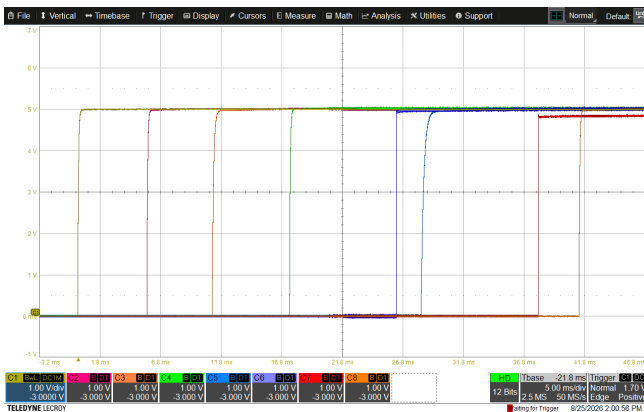


Figure 67. Startup, EN 1-8, No Load

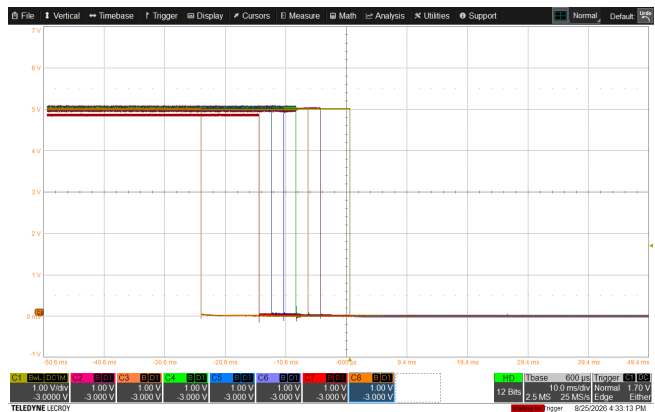


Figure 68. Shutdown, EN 1-8, No Load

## 2.4 Thermal Performance

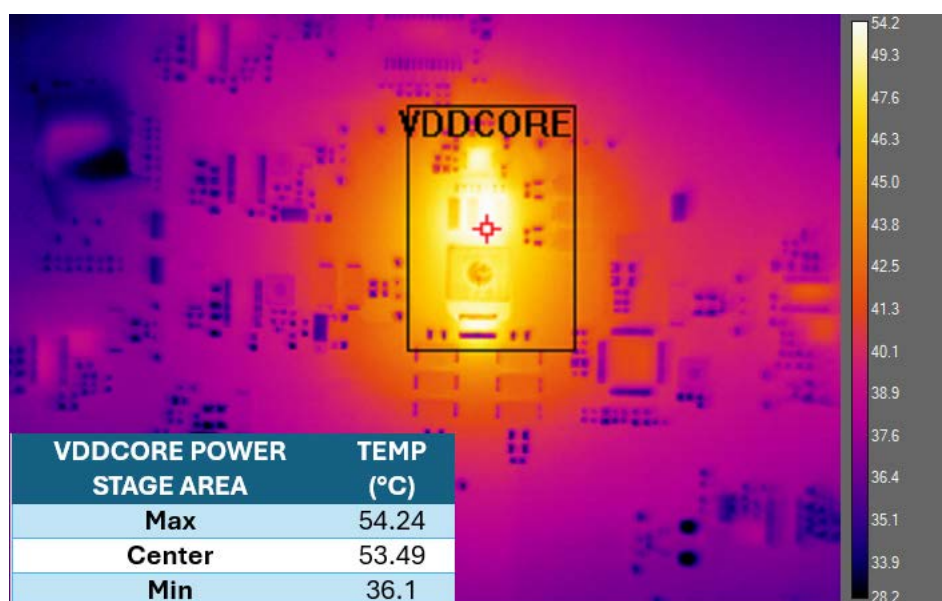


Figure 69. VDDCORE Rail Thermal Image, 1V/20A, Open Air (25C Ambient)

### 3. Board Design

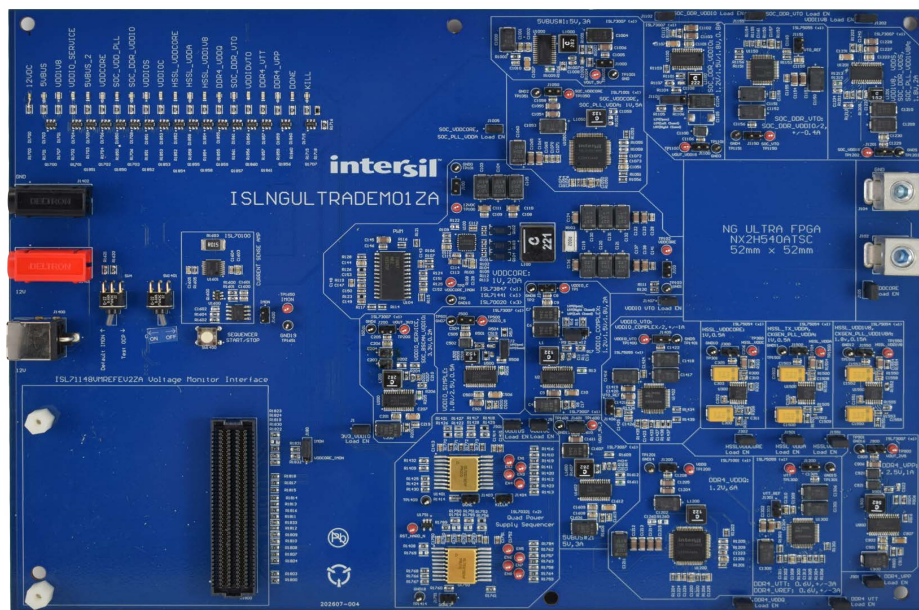


Figure 70. ISLNGULTRADEMO1Z Board (Top)



Figure 71. ISLNGULTRADEMO1Z Board (Bottom)



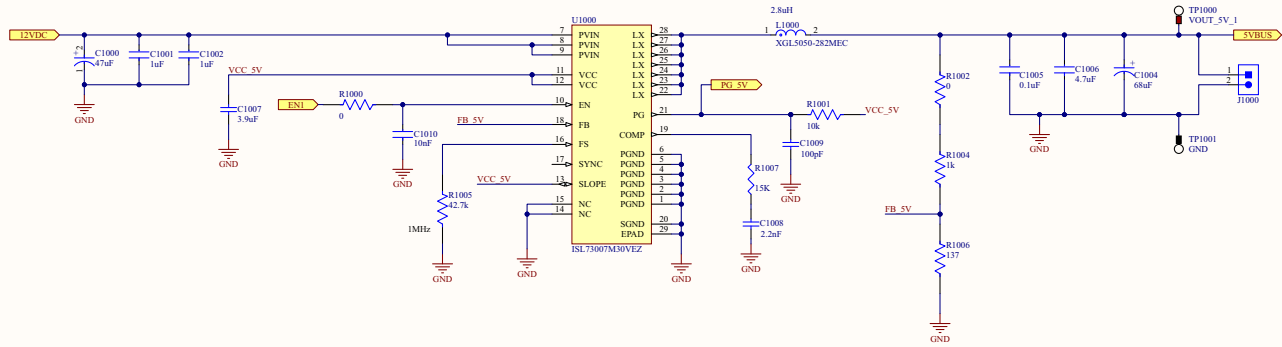


Figure 74. 5V Bus #1

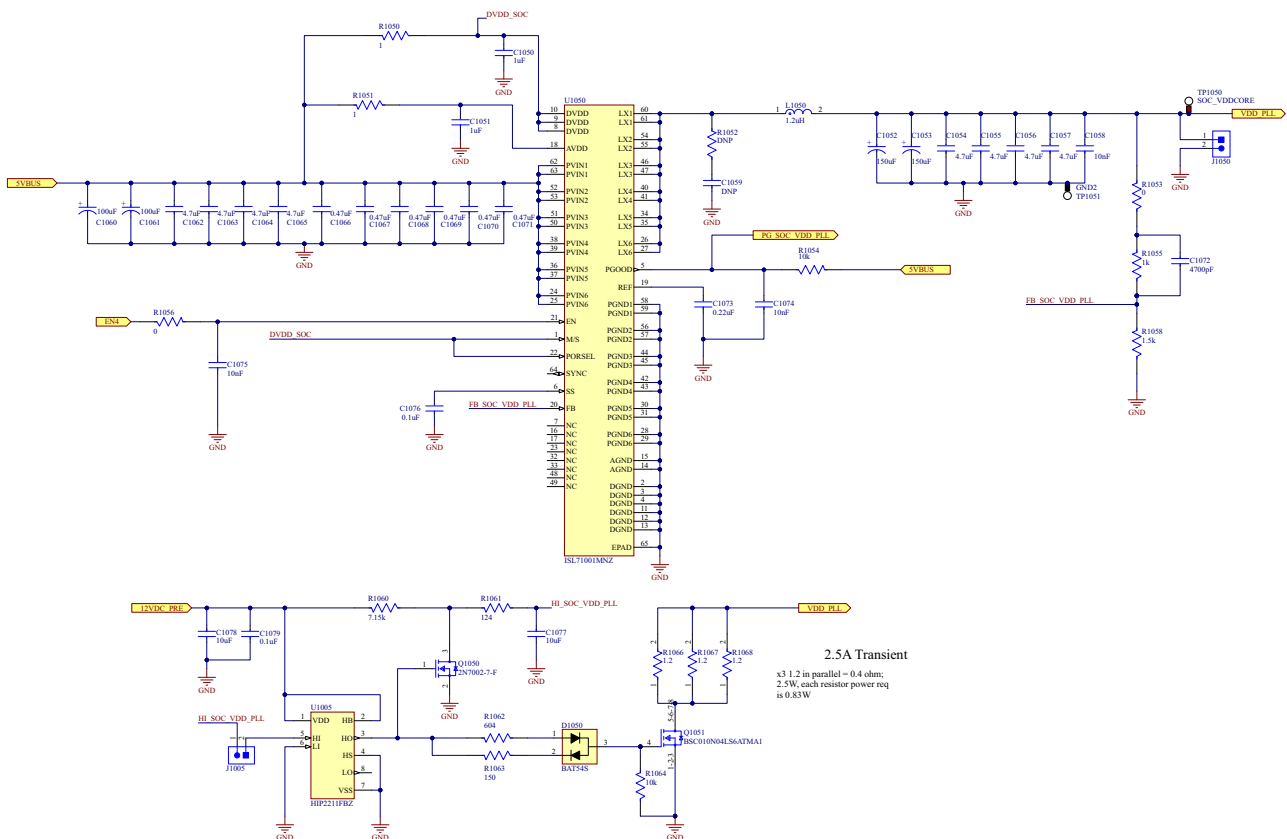


Figure 75. SOC\_VDDCore, SOC\_PLL\_VDD Rail with Transient Load

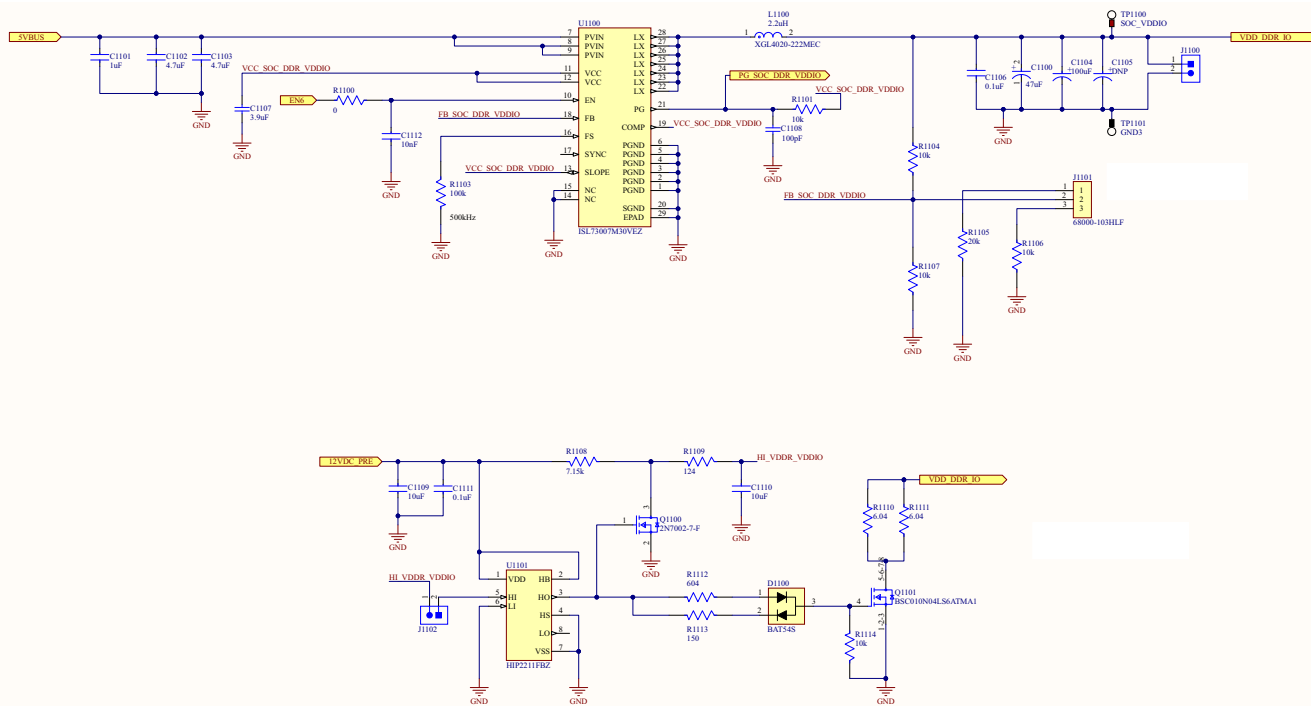


**Figure 76. SOC\_DDR\_VDDIO Rail with Transient Load**

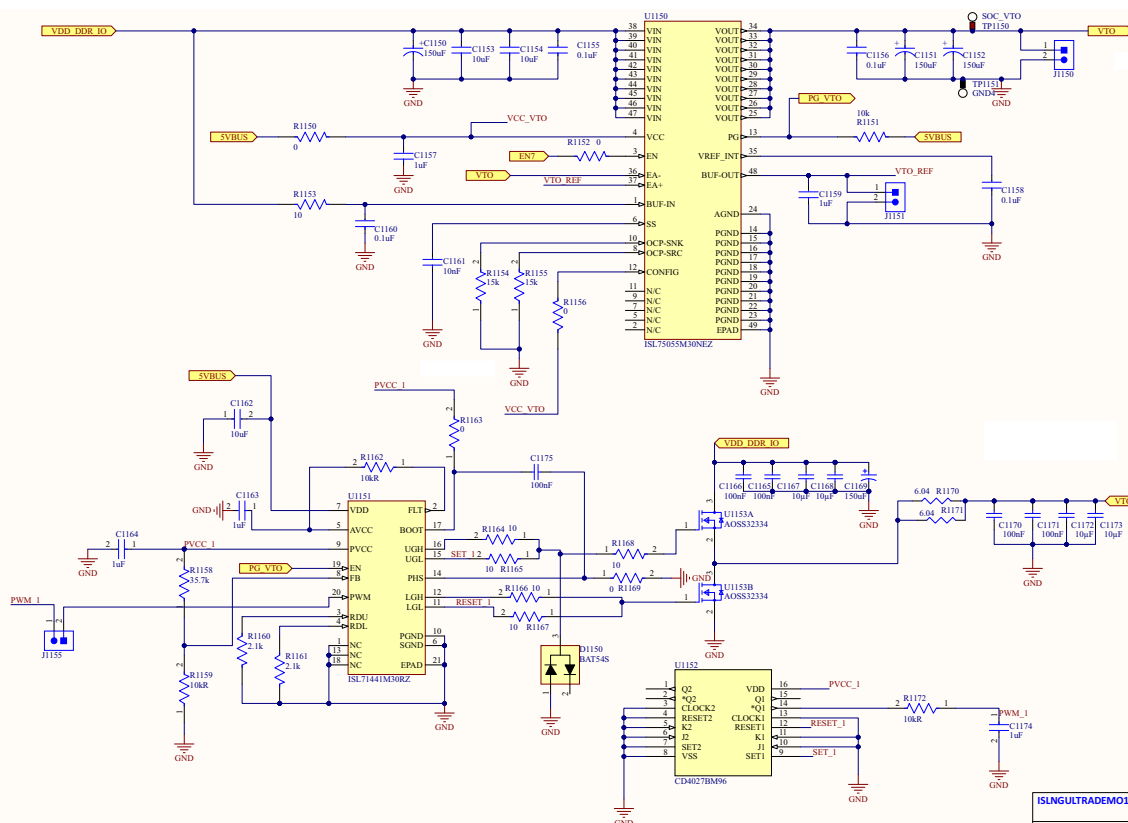
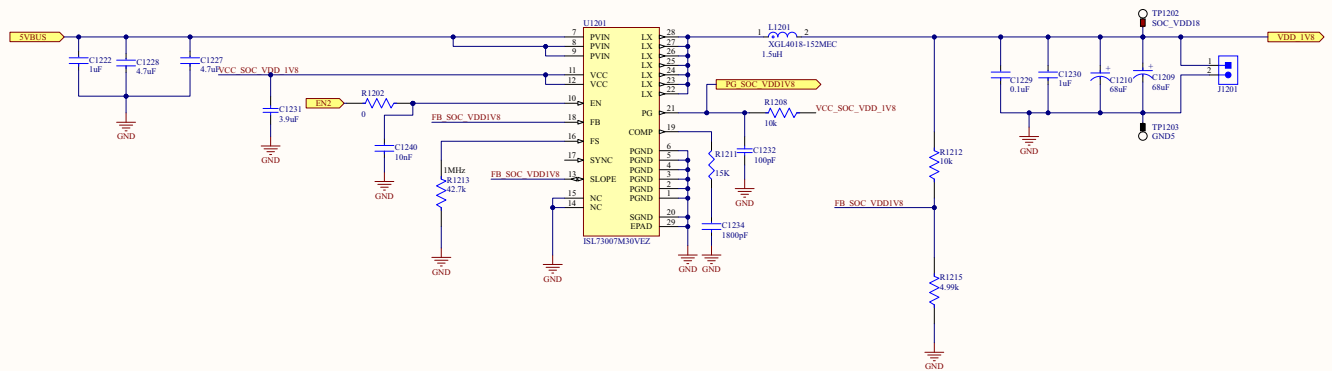
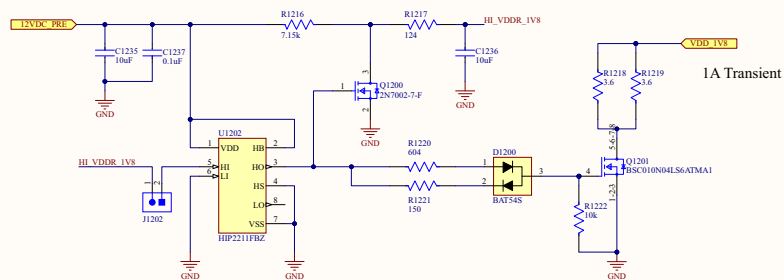


**Figure 77. SOC\_DDR\_VTO Rail with Sink/Source Transient Load**

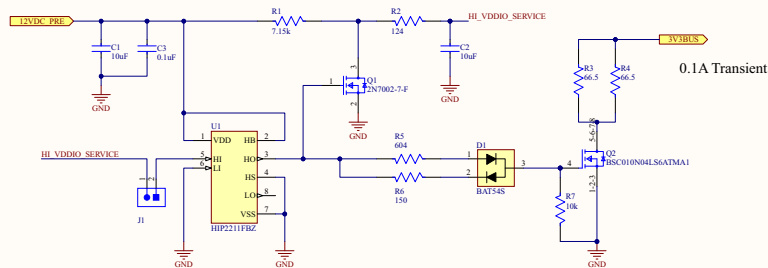
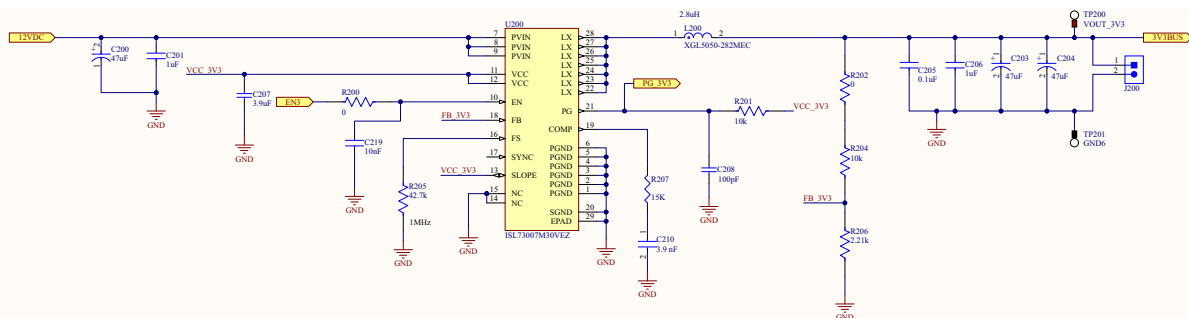


Load Transient



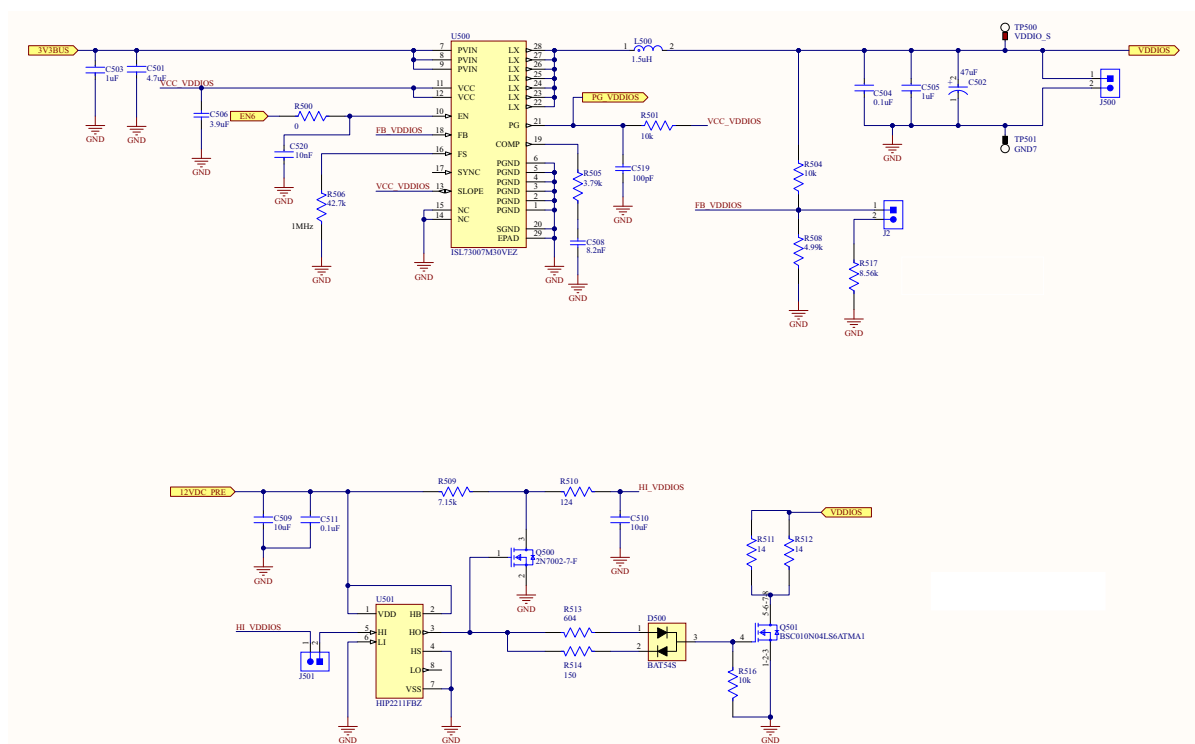
1A Transient

Figure 78. VDD1V8, VDDS, SOC\_DDR\_VDDS, SOC\_PLL\_VDD1V8A Rail with Transient Load

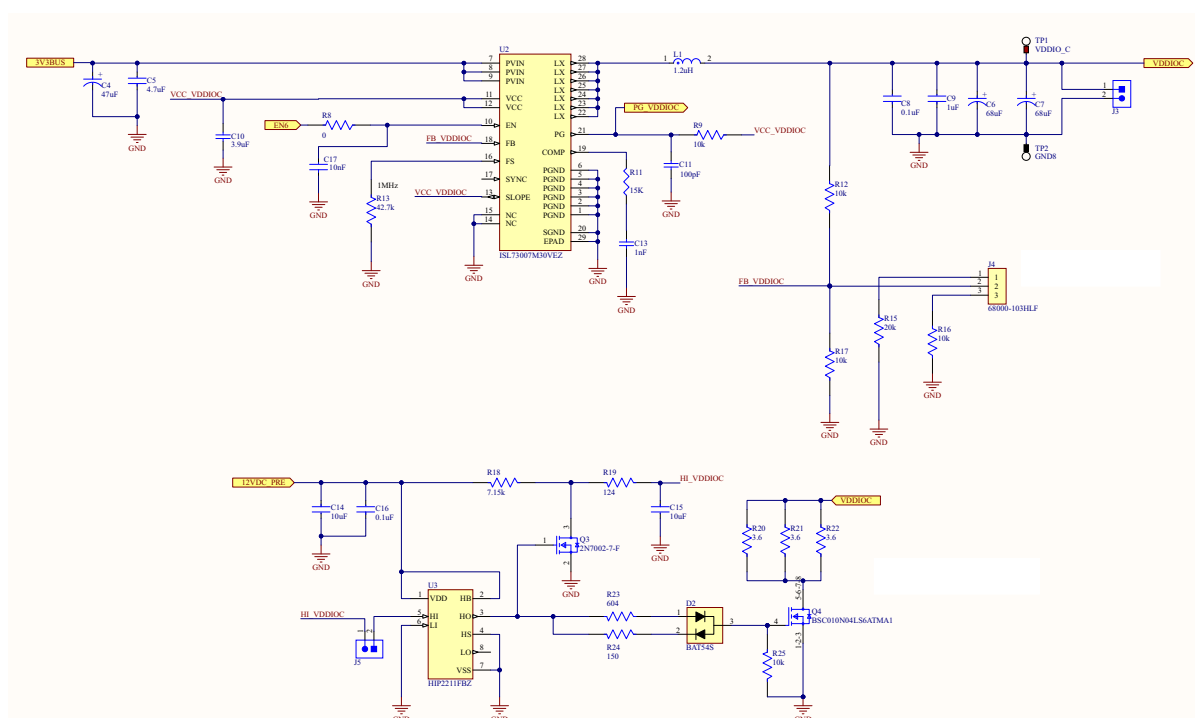


0.1A Transient

Figure 79. 3V3BUS, VDDIO\_SERVICE, SOC\_BSCAN\_VDDIO Rail with Transient Load



### Figure 80. VDDIO\_x (Simple) Rail with Transient Load



### Figure 81. VDDIO\_x (Complex) Rail with Transient Load

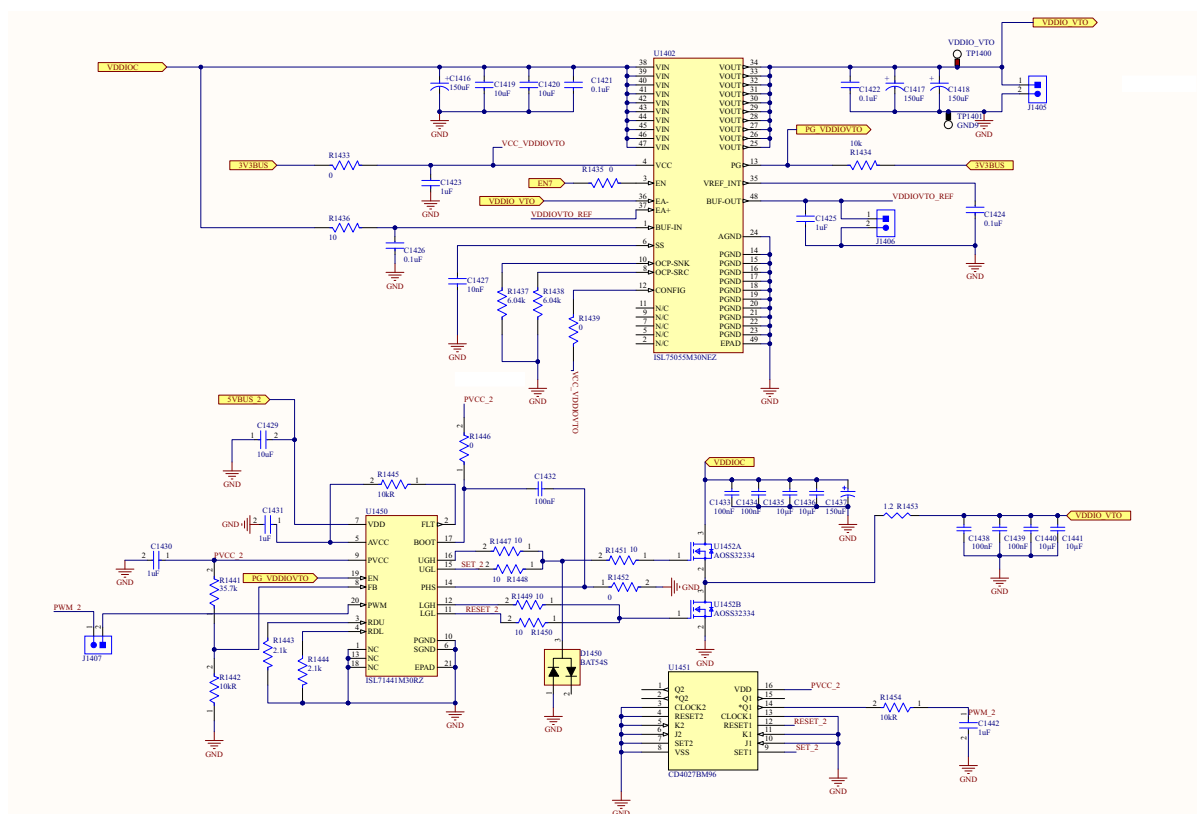
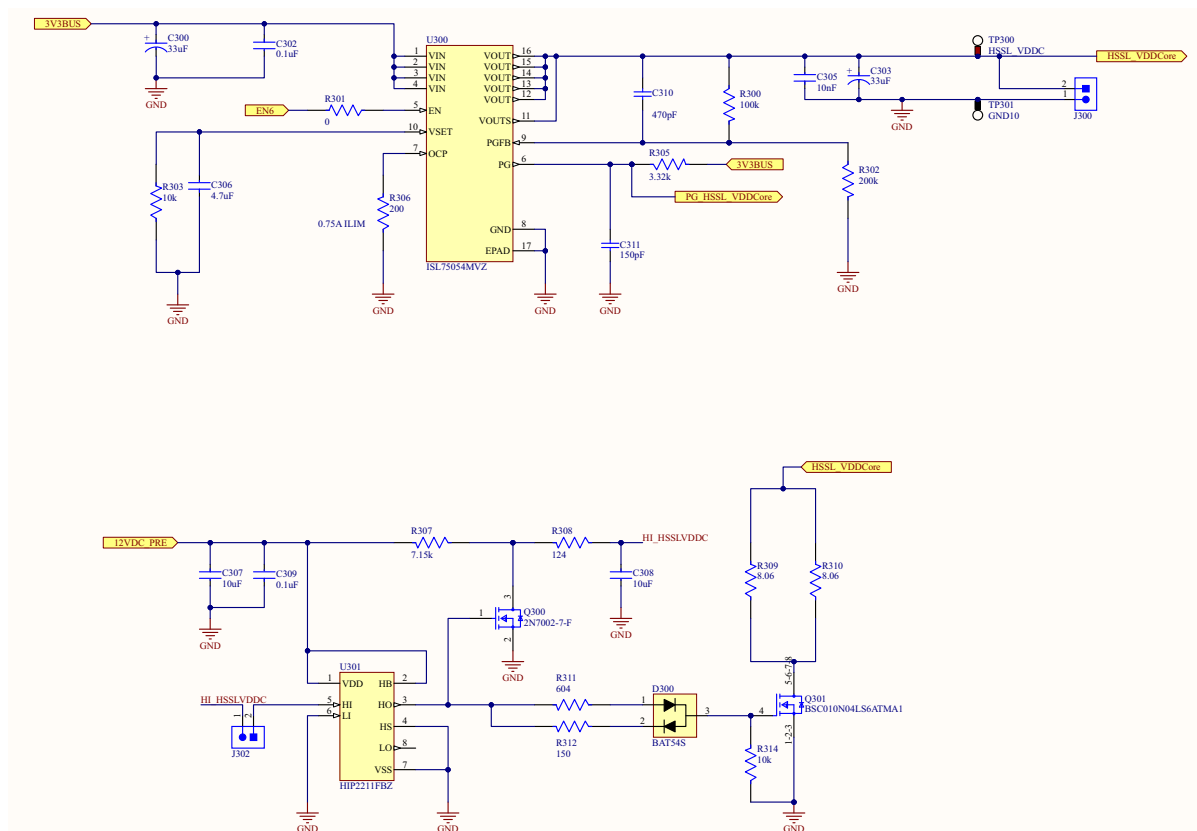


**Figure 82. VDDIO\_VTO Rail with Transient Load**



### Figure 83. HSSL\_VDDCore Rail with Transient Load

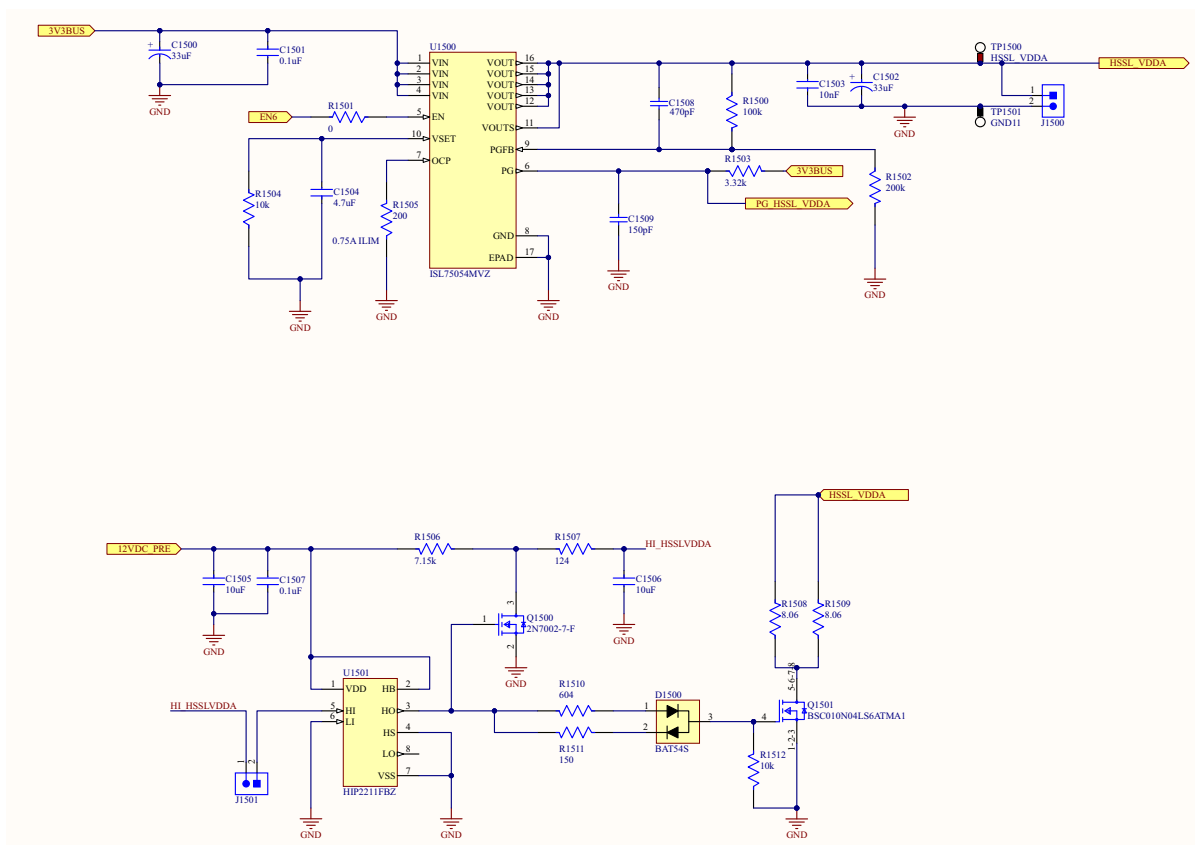


Figure 84. HSSL\_TX\_VDDA, CKGEN\_PLL\_VDDA Rail with Transient Load

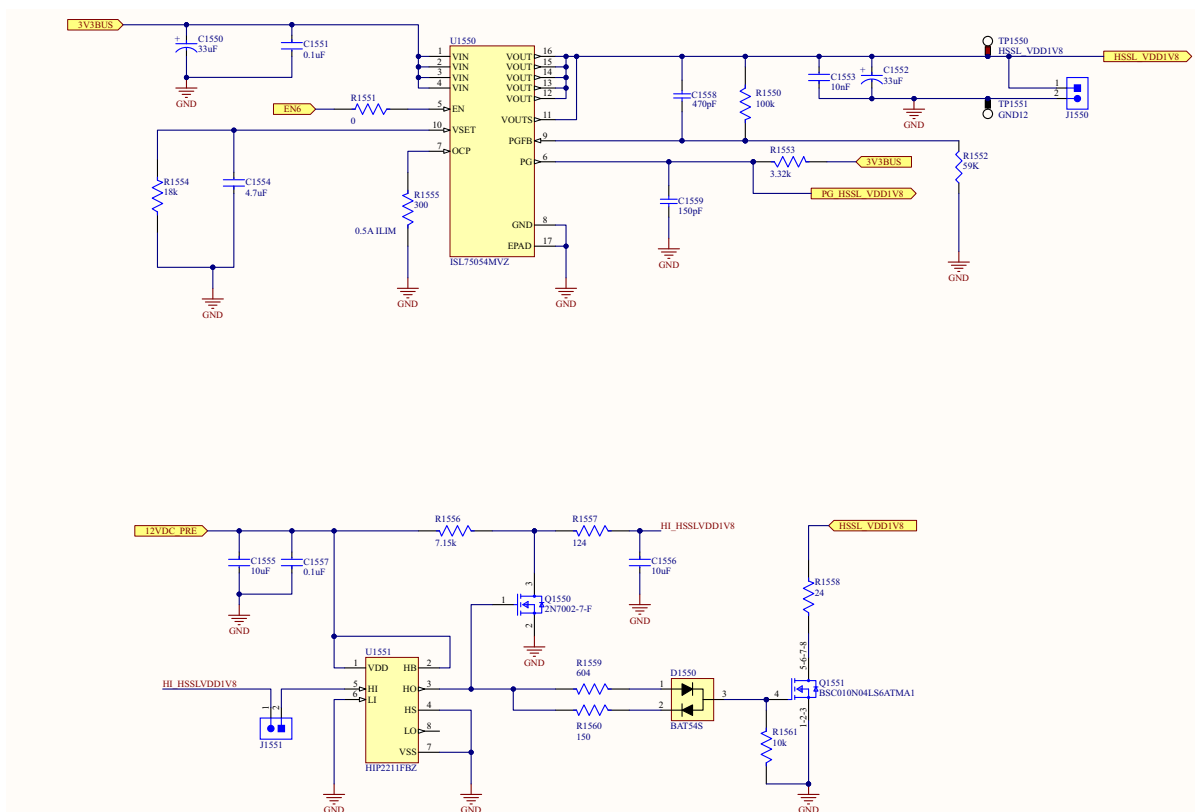


Figure 85. HSSL\_VDD1V8, CKGEN\_PLL\_VDD1V8 Rail with Transient Load

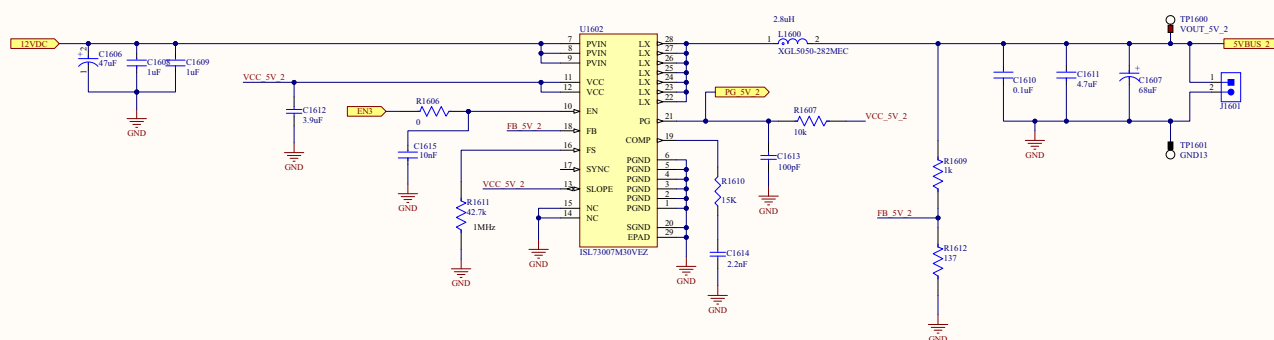


**Figure 86. 5VBUS #2**

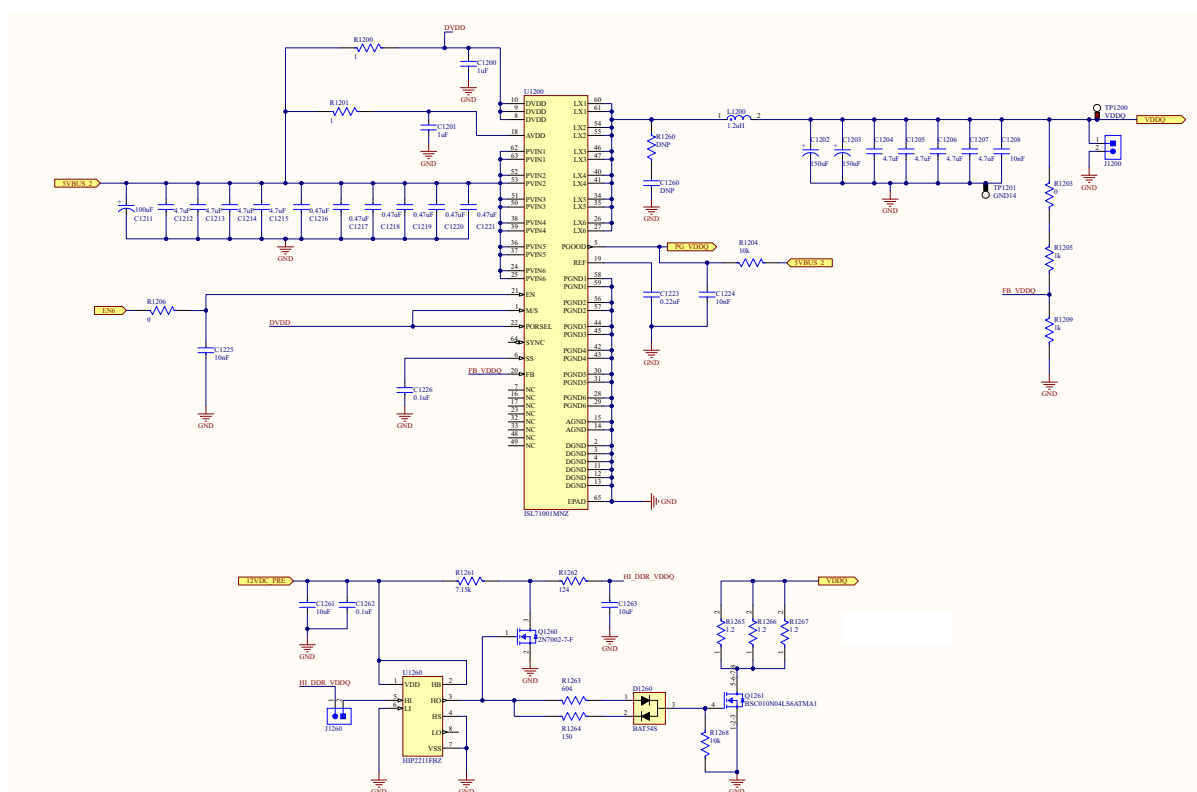


**Figure 87. DDR4\_VDDQ Rail with Transient Load**

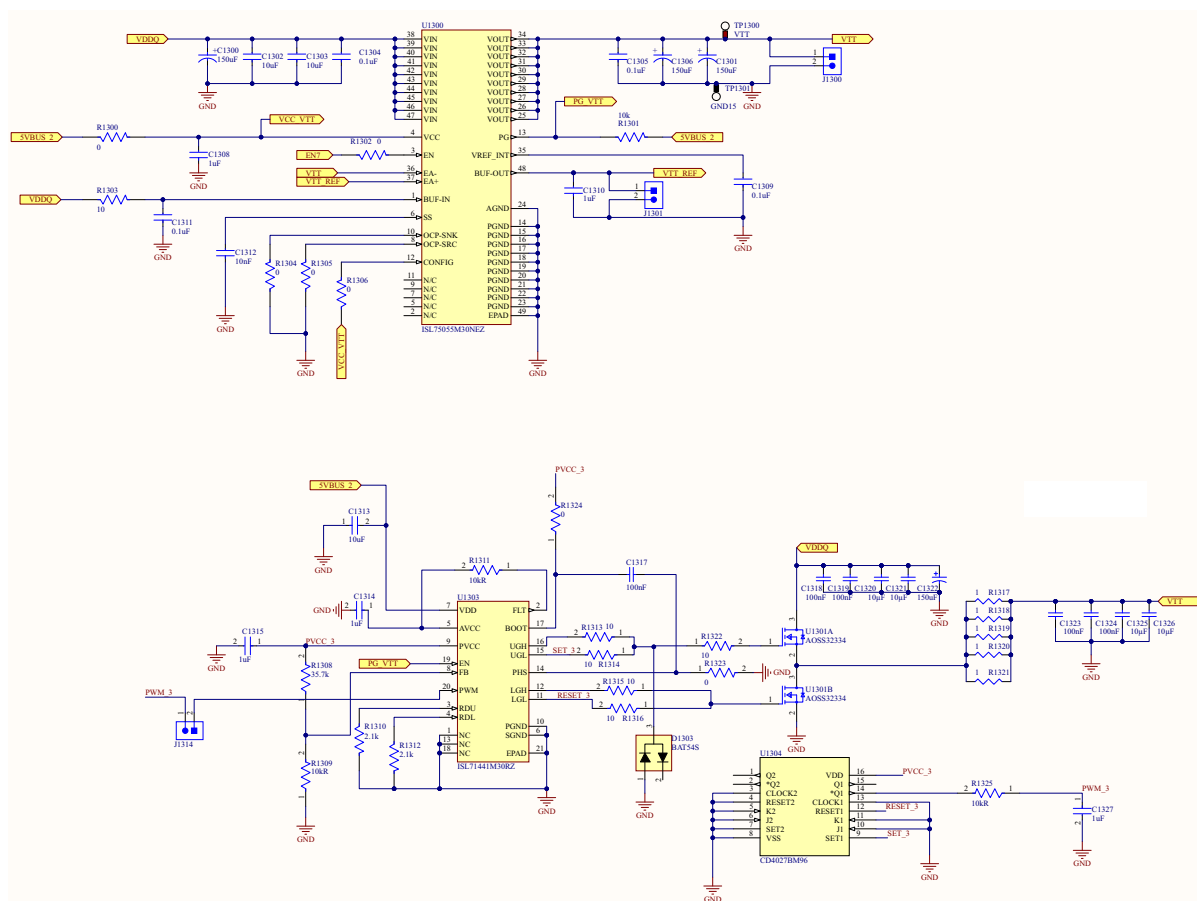


**Figure 88. DDR4\_VTT, DDR4\_VTT\_REF Rail with Sink/Source Transient Load**

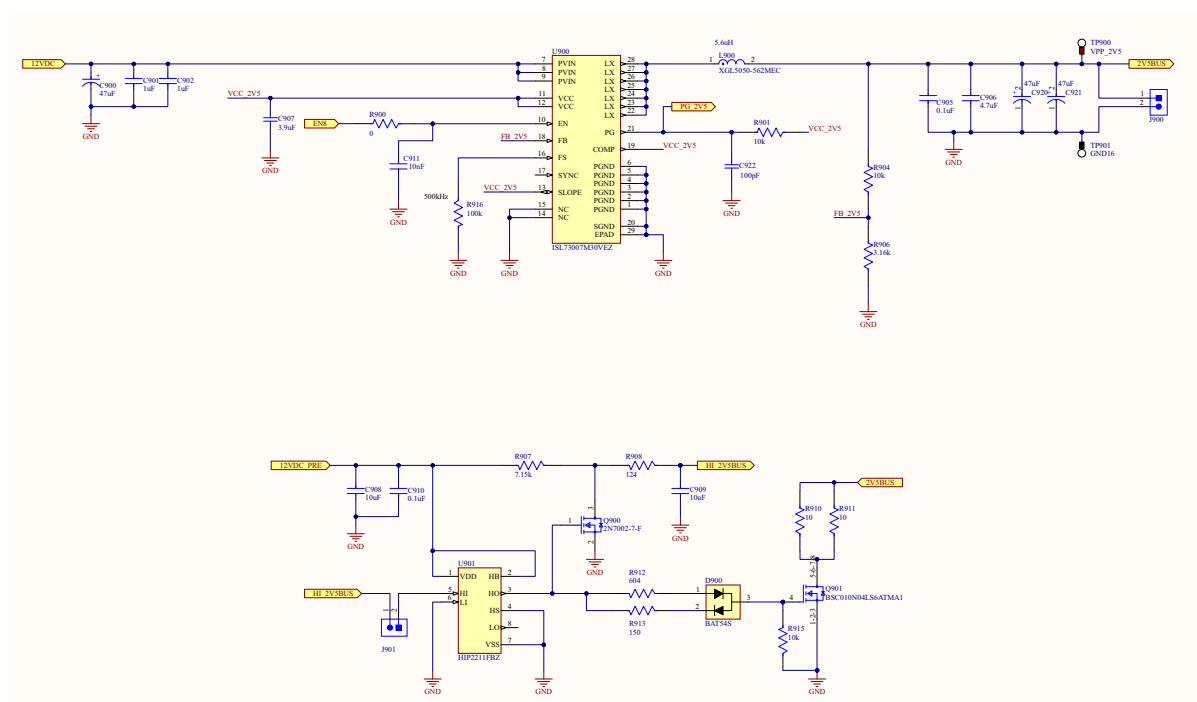


**Figure 89. DDR4\_VPP Rail with Transient Load**

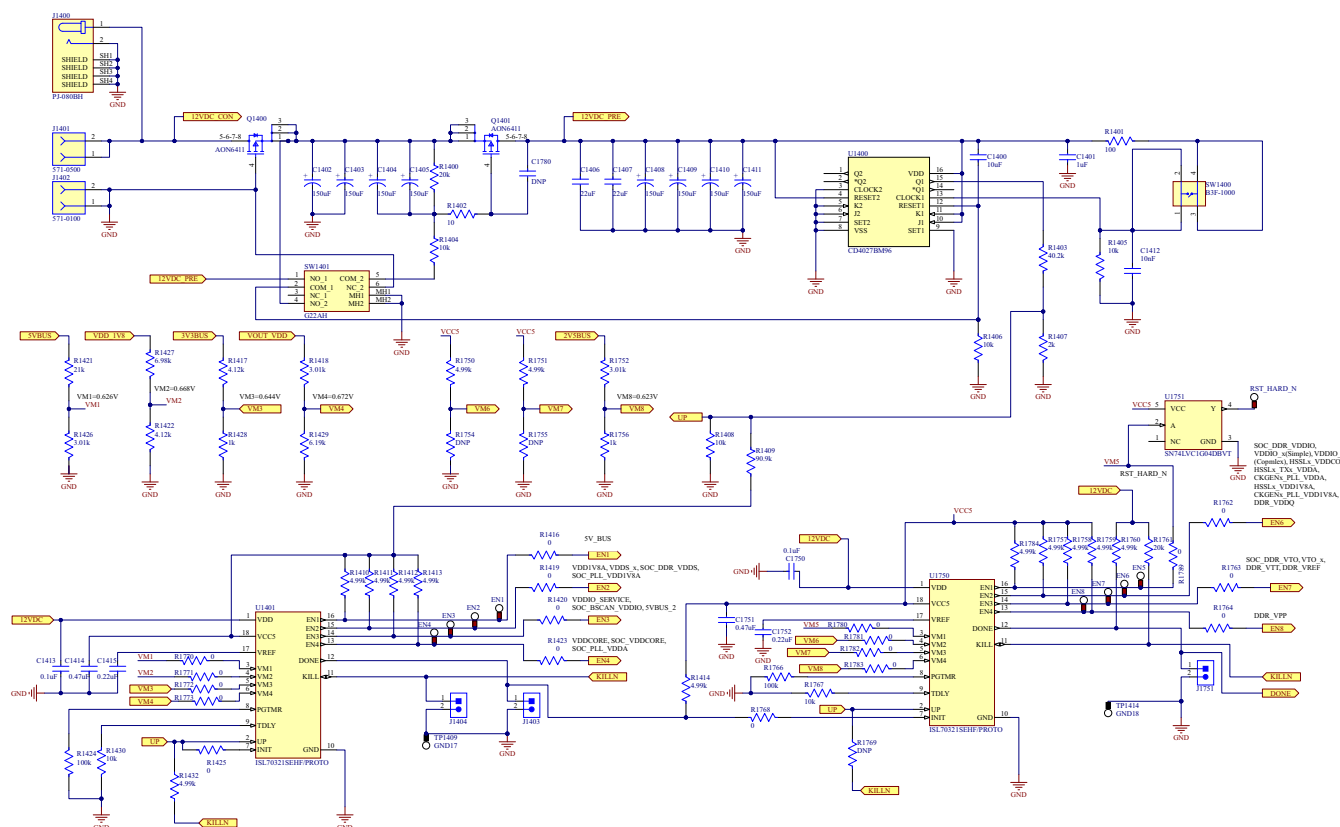


Figure 90. Input Power and Sequencer Circuit

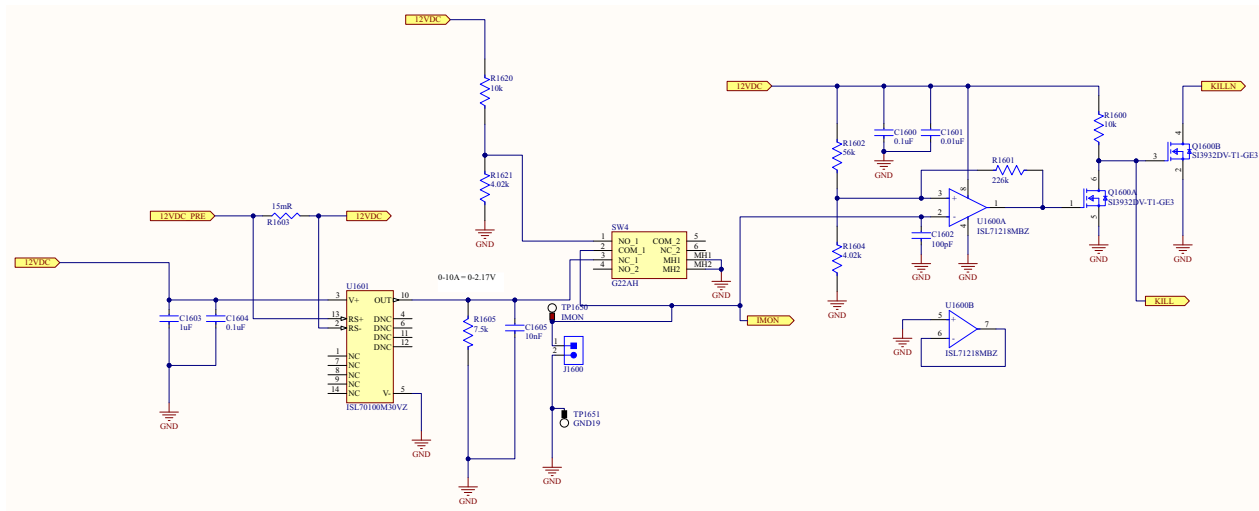
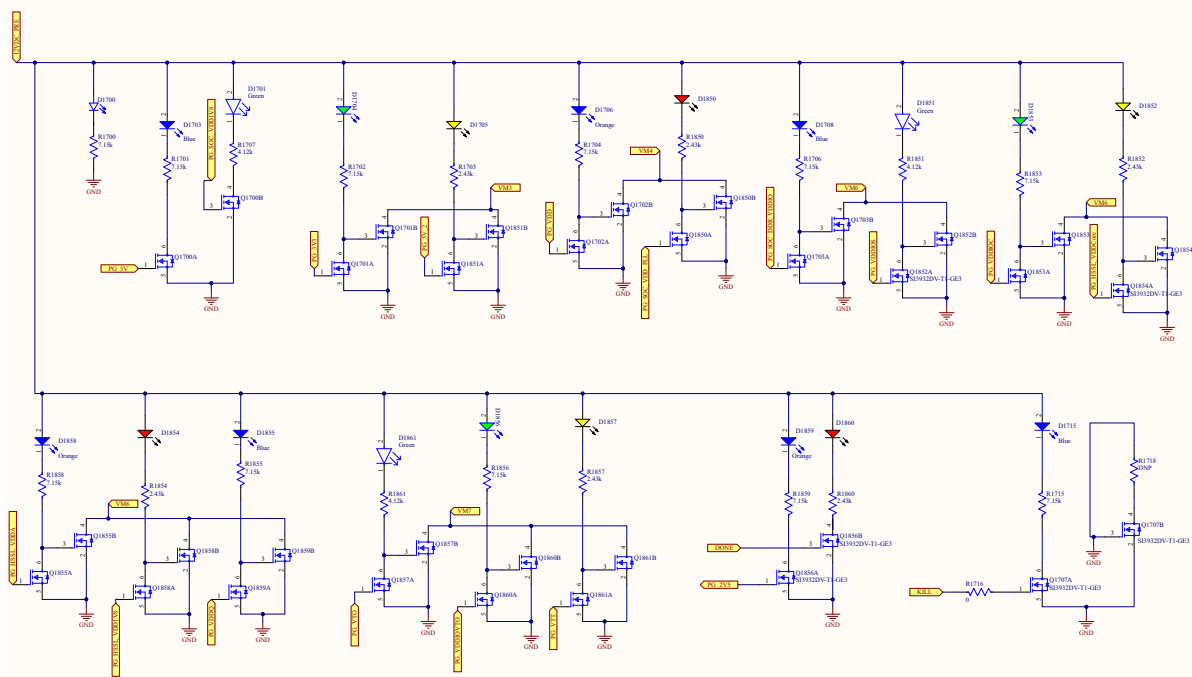


Figure 91. Current-Sense Amplifier Circuit



### Figure 92. LEDs and AND Logic Circuit

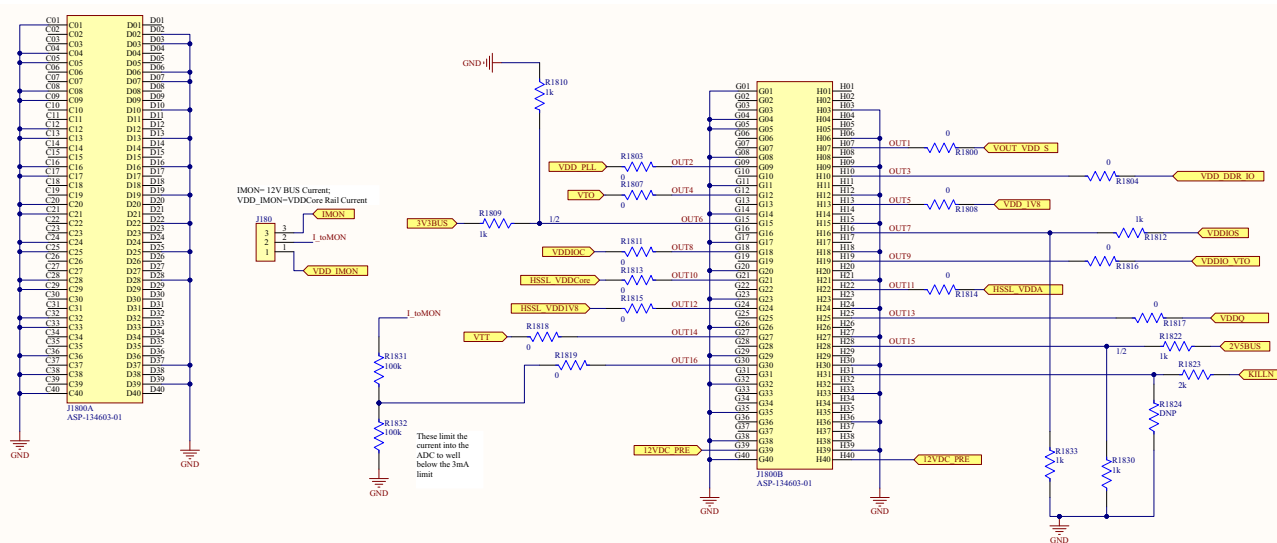


**Figure 93. ISL71148VMREFEV2Z Connector**

### 3.2 Bill of Materials

| Qty | Reference Designator                                                                                                                                                                                                                                                  | Description                                                                              | Manufacturer | Manufacturer Part  |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------|--------------------|
| 25  | C1, C2, C14, C15, C154, C155, C156, C307, C308, C509, C510, C908, C909, C1077, C1078, C1109, C1110, C1235, C1236, C1261, C1263, C1505, C1506, C1555, C1556                                                                                                            | CAP CER 10 $\mu$ F 25V X5R 0805                                                          | Kemet        | C0805C106K3PACTU   |
| 40  | C3, C8, C16, C114, C157, C205, C302, C309, C504, C511, C905, C910, C1005, C1079, C1106, C1111, C1155, C1156, C1158, C1160, C1229, C1237, C1262, C1304, C1305, C1309, C1413, C1421, C1422, C1424, C1426, C1501, C1507, C1551, C1557, C1600, C1604, C1610, C1750, C1311 | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 0.1 $\mu$ F, X7R, 10%, 50V | Kemet        | C0603C104K5RACTU   |
| 2   | C4, C900                                                                                                                                                                                                                                                              | 47 $\mu$ F Tantalum Polymer Capacitor 35 V 2917 (7343 Metric)                            | Kemet        | T521X476M035ATE070 |
| 23  | C5, C501, C906, C1006, C1054, C1055, C1056, C1057, C1062, C1063, C1064, C1065, C1102, C1103, C1204, C1205, C1206, C1207, C1212, C1213, C1214, C1215, C1611                                                                                                            | General Purpose Ceramic Capacitor, 1206, 4.7 $\mu$ F, X7R, 10%, 16V                      | Kemet        | C1206C475K4RACTU   |
| 6   | C6, C7, C1004, C1209, C1210, C1607                                                                                                                                                                                                                                    | CAP TANT POLY 68 $\mu$ F 10V 2917                                                        | Kemet        | T520W686M010ATE025 |
| 26  | C9, C115, C129, C144, C201, C505, C901, C902, C1001, C1002, C1050, C1051, C1101, C1157, C1159, C1200, C1201, C1222, C1308, C1310, C1401, C1423, C1425, C1603, C1608, C1609                                                                                            | CAP CER 1 $\mu$ F 25V X7R 0805 10%                                                       | Kemet        | C0805C105K3RACTU   |
| 8   | C10, C207, C506, C907, C1007, C1107, C1231, C1612                                                                                                                                                                                                                     | CAP CER 3.9 $\mu$ F 25V X5R 1206                                                         | Kemet        | C1206C395K3PACTU   |
| 8   | C11, C208, C519, C922, C1009, C1108, C1232, C1613                                                                                                                                                                                                                     | CAP CER 100pF 25V C0G/NP0 0603                                                           | Kemet        | C0603C101J3GACAUTO |
| 1   | C13                                                                                                                                                                                                                                                                   | CAP CER 1nF 50V C0G/NP0 0402                                                             | Kyocera AVX  | KGM05ACG1H102FH    |

| Qty | Reference Designator                                                                                                                              | Description                                                                         | Manufacturer | Manufacturer Part  |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------|--------------------|
| 22  | C17, C152, C219, C305, C520, C911, C1010, C1058, C1074, C1075, C1112, C1161, C1208, C1224, C1225, C1240, C1312, C1427, C1503, C1553, C1605, C1615 | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 10nF, X7R, 10%, 25V   | Kemet        | C0603C103K3RACTU   |
| 9   | C100, C101, C102, C103, C104, C105, C1060, C1061, C1211                                                                                           | CAP TANT POLY 100µF 25V 2917                                                        | Kemet        | T521X107M025ATE030 |
| 8   | C106, C107, C108, C109, C127, C128, C141, C142                                                                                                    | Chip Multilayer Ceramic Capacitors, 0603, 0.1µF, X7R, 10%, 10V                      | Kemet        | C0603C104K8RACTU   |
| 5   | C110, C111, C306, C1504, C1554                                                                                                                    | General Purpose Ceramic Capacitor, 1206, 4.7µF, X7R, 10%, 25V                       | Kemet        | C1206C475K3RACTU   |
| 2   | C112, C146                                                                                                                                        | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 100nF, X7R, 10%, 50V  | Kemet        | C0603C104K5RACTU   |
| 2   | C113, C145                                                                                                                                        | General Purpose Ceramic Capacitor, 1206, 2.2µF, X7R, 10%, 25V                       | Kemet        | C1206C225K3RACTU   |
| 12  | C116, C117, C118, C119, C120, C121, C130, C131, C132, C133, C134, C135                                                                            | CAP TANT POLY 220µF 10V 2917                                                        | Kemet        | T530D227M010ATE006 |
| 6   | C122, C123, C124, C136, C137, C138                                                                                                                | General Purpose Ceramic Capacitor, 1206, 4.7µF, X7R, 10%, 10V                       | Kemet        | C1206C475K8RACTU   |
| 4   | C125, C126, C139, C140                                                                                                                            | CAP CER 1µF 10V X7R 0805 10%                                                        | Kemet        | C0805C105K8RACTU   |
| 1   | C143                                                                                                                                              | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 680pF, X7R, 10%, 50V  | Kemet        | C0603C681K5RACTU   |
| 1   | C147                                                                                                                                              | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 330pF, X7R, 10%, 50V  | Kemet        | C0603C331K5RACTU   |
| 1   | C148                                                                                                                                              | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 8200pF, X7R, 10%, 50V | Kemet        | C0603C822K5RACTU   |
| 2   | C149, C150                                                                                                                                        | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 100nF, X7R, 10%, 25V  | Kemet        | C0603C104K3RACTU   |
| 1   | C151                                                                                                                                              | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 100pF, X7R, 10%, 25V  | Kemet        | C0603C101K3RACTU   |
| 1   | C153                                                                                                                                              | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 22nF, X7R, 10%, 16V   | Kemet        | C0603C223K4RACTU   |

| Qty | Reference Designator                                                                                                                              | Description                                                                                                                                                                              | Manufacturer | Manufacturer Part      |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------|
| 2   | C203, C204                                                                                                                                        | T520, Tantalum, Polymer Tantalum, Commercial Grade, 47 $\mu$ F, 20%, 10 VDC, SMD, Polymer, Molded, Low ESR, Non-Combustible, 35m $\Omega$ , 3528, Height Max = 2mm<br>T520B476M010ATE035 | Kemet        | T520B476M010ATE035     |
| 2   | C206, C1230                                                                                                                                       | CAP CER 1 $\mu$ F 25V X7R 0805 10%<br>C0805C105K3RACTU                                                                                                                                   | Kemet        | C0805C105K3RACTU       |
| 1   | C210                                                                                                                                              | CAP CER 3900PF 50V 10% X7R 0603                                                                                                                                                          | Kemet        | C0603C392K5RACTU       |
| 6   | C300, C303, C1500, C1502, C1550, C1552                                                                                                            | CAP TANT POLY 33 $\mu$ F 50V 2917                                                                                                                                                        | Kemet        | T541X336M050AH6510     |
| 3   | C310, C1508, C1558                                                                                                                                | CAP CER 470pF 50V X7R 0603                                                                                                                                                               | Kemet        | C0603C471K5RACTU       |
| 3   | C311, C1509, C1559                                                                                                                                | 150 pF $\pm$ 10% 50V Ceramic Capacitor X7R 0402<br>C0402C151K5RACTU                                                                                                                      | Kemet        | C0402C151K5RACTU       |
| 4   | C502, C920, C921, C1100                                                                                                                           | CAP TANT POLY 47 $\mu$ F 6.3V 1411 35ohms                                                                                                                                                | Kemet        | T520B476M006ATE035     |
| 1   | C503                                                                                                                                              | CAP CER 1 $\mu$ F 25V X7R 0805 10%<br>C0805C105K3RACTU-T                                                                                                                                 | Kemet        | C0805C105K3RACTU-T     |
| 1   | C508                                                                                                                                              | CAP CER 8200pF 25V X7R 0402                                                                                                                                                              | Kemet        | GRM155R71E822KA01D     |
| 3   | C1000, C200, C1606                                                                                                                                | CAP TANT POLY 47 $\mu$ F 35V 2917                                                                                                                                                        | Kemet        | T521X476M035ATE0307280 |
| 2   | C1008, C1614                                                                                                                                      | CAP CER 2200pF 50V X7R 0603                                                                                                                                                              | Kemet        | C0603C222K5RACTU       |
| 21  | C1052, C1053, C1150, C1151, C1152, C1202, C1203, C1300, C1301, C1306, C1402, C1403, C1404, C1405, C1408, C1409, C1410, C1411, C1416, C1417, C1418 | CAP TANT POLY 150 $\mu$ F 20V 2917                                                                                                                                                       | Kemet        | T521D157M020ATE050     |
| 2   | C1059, C1260                                                                                                                                      | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 1000pF, X7R, 10%, 25V                                                                                                      | Kemet        | C0603C102K3RACTU       |
| 14  | C1066, C1067, C1068, C1069, C1070, C1071, C1216, C1217, C1218, C1219, C1220, C1221, C1414, C1751                                                  | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 0.47 $\mu$ F, X7R, 10%, 16V                                                                                                | Kemet        | C0603C474K4RACTU       |
| 1   | C1072                                                                                                                                             | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 4700pF, X7R, 10%, 25V                                                                                                      | Kemet        | C0603C472K3RACTU       |
| 4   | C1073, C1223, C1415, C1752                                                                                                                        | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 0.22 $\mu$ F, X7R, 10%, 16V                                                                                                | Kemet        | C0603C224K4RACTU       |
| 2   | C1076, C1226                                                                                                                                      | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 0.1 $\mu$ F, X7R, 10%, 16V                                                                                                 | Kemet        | C0603C104K4RACTU       |
| 1   | C1104                                                                                                                                             | 100 $\mu$ F Tantalum Polymer Capacitor 25 V 2917 (7343 Metric) 30mOhm                                                                                                                    | Kemet        | T521X107M025ATE030     |

| Qty | Reference Designator                                                                                    | Description                                                                               | Manufacturer                 | Manufacturer Part    |
|-----|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------|----------------------|
| 7   | C1153, C1154, C1302, C1303, C1400, C1419, C1420                                                         | General Purpose Ceramic Capacitor, 1206, 10 $\mu$ F, X7R, 10%, 16V                        | Kemet                        | C1206C106K4RACTU     |
| 3   | C1162, C1313, C1429                                                                                     | Cap Ceramic 10 $\mu$ F 25V X7R $\pm$ 10% SMD 1206 +125°C Embossed T/R                     | Kemet                        | C1206C106K3RACTU     |
| 9   | C1163, C1164, C1174, C1314, C1315, C1327, C1430, C1431, C1442                                           | Multilayer Ceramic Capacitors 1 $\mu$ F $\pm$ 10% 25V X7R SMD 0805                        | TDK                          | C2012X7R1E105K125AB  |
| 15  | C1165, C1166, C1170, C1171, C1175, C1317, C1318, C1319, C1323, C1324, C1432, C1433, C1434, C1438, C1439 | CAP CER 0.1 $\mu$ F 16V X7R 0603                                                          | Yageo                        | CC0603KRX7R7BB104    |
| 12  | C1167, C1168, C1172, C1173, C1320, C1321, C1325, C1326, C1435, C1436, C1440, C1441                      | CAP CER 10 $\mu$ F 10V X7R 0805                                                           | Murata Electronics           | GCJ21BR71A106KE01L   |
| 3   | C1169, C1322, C1437                                                                                     | CAP TANT POLY 150 $\mu$ F 16V 2917                                                        | Kemet                        | T530X157M016ATE015   |
| 2   | C1227, C1228                                                                                            | CAP CER 4.7 $\mu$ F 25V X7R 1206 C1206C475K3RACTU                                         | Kemet                        | C1206C475K3RACTU     |
| 1   | C1234                                                                                                   | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 1800pF, X7R, 10%, 50V       | Kemet                        | C0603C182K5RACTU     |
| 2   | C1406, C1407                                                                                            | CAP CER 22 $\mu$ F 25V X7R 1210                                                           | Taiyo Yuden                  | TMK325B7226MM-TR     |
| 2   | C1412, C1601                                                                                            | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 10nF, X7R, 10%, 50V         | Kemet                        | C0603C103K5RACTU     |
| 1   | C1602                                                                                                   | Chip Multilayer Ceramic Capacitors for General Purpose, 0603, 100pF, X7R, 10%, 50V        | Kemet                        | C0603C101K5RACTU     |
| 14  | D1, D2, D300, D500, D900, D1050, D1100, D1150, D1200, D1260, D1303, D1450, D1500, D1550                 | DIODE ARR SCHOTT 30V 200MA SOT23                                                          | ONSEMI                       | BAT54S               |
| 1   | D1700                                                                                                   | LED WHITE DIFFUSED 2SMD                                                                   | Everlight Electronics Co Ltd | 16-219AUTD/S3151/TR8 |
| 3   | D1701, D1851, D1861                                                                                     | LED GREEN CLEAR CHIP SMD                                                                  | LITE_ON                      | LTST-C190KGKT        |
| 4   | D1703, D1708, D1715, D1855                                                                              | LED BLUE DIFFUSED CHIP SMD                                                                | Broadcom Limited             | HSMR-C190            |
| 3   | D1704, D1853, D1856                                                                                     | Chip LED, Yellow-Green, 5 V, 25 mA, -40 to 85 degC, 2-Pin SMD (0603), RoHS, Tape and Reel | Würth Elektronik             | 150060VS75000        |
| 3   | D1705, D1852, D1857                                                                                     | LED Uni-Color Yellow, 65 mW, 20 mA, -40 to 85 degC, 2-Pin SMD, RoHS, Tape and Reel        | Broadcom Limited             | HSMY-C190            |
| 3   | D1706, D1858, D1859                                                                                     | LED ORANGE CLEAR CHIP SMD                                                                 | LITE_ON                      | LTST-C190KFKT        |
| 3   | D1850, D1854, D1860                                                                                     | LED Uni-Color Red, 65 mW, 20 mA, -40 to 85 degC, 2-Pin SMD, RoHS, Tape and Reel           | Broadcom Limited             | HSMH-H190            |

| Qty | Reference Designator                                                                                                                                                                                                                                                    | Description                                                                       | Manufacturer       | Manufacturer Part |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------|-------------------|
| 29  | EN1, EN2, EN3, EN4, EN5, EN6, EN7, EN8, RST_HARD_N, SOC_VDDCORE, SOC_VTO, TP1, TP100, TP200, TP300, TP500, TP900, TP1000, TP1100, TP1200, TP1202, TP1300, TP1400, TP1500, TP1550, TP1600, TP1650, VDDCORE, VDDCORE_IMON                                                 | Test Point, wire loop, RED nylon sleeve, miniature                                | Keystone           | 5000              |
| 22  | GND0, GND1, GND2, GND10, TP2, TP201, TP301, TP501, TP901, TP1001, TP1101, TP1151, TP1201, TP1203, TP1301, TP1401, TP1409, TP1414, TP1501, TP1551, TP1601, TP1651                                                                                                        | Test Point, wire loop, BLACK nylon sleeve, miniature                              | Keystone           | 5001              |
| 41  | J1, J2, J3, J5, J100, J103, J105, J200, J300, J302, J500, J501, J900, J901, J1000, J1005, J1050, J1100, J1102, J1150, J1151, J1155, J1200, J1201, J1202, J1260, J1300, J1301, J1314, J1403, J1404, J1405, J1406, J1407, J1500, J1501, J1550, J1551, J1600, J1601, J1751 | CONN HEADER VERT 2POS 2.54MM                                                      | Würth, Samtec Inc. | 61300211121       |
| 3   | J4, J180, J1101                                                                                                                                                                                                                                                         | CONN HEADER VERT 3POS 2.54MM                                                      | Amphenol ICC       | 68000-103HLF      |
| 2   | J102, J104                                                                                                                                                                                                                                                              | Connector, BUS for PCB Mount                                                      | IHI Connectors     | B2C-PCB           |
| 1   | J1400                                                                                                                                                                                                                                                                   | 2.5 x 6.4 mm, 10.0 A, Horizontal, Through Hole, Shielded, Dc Power Jack Connector | CUI Devices        | PJ-080BH          |
| 1   | J1401                                                                                                                                                                                                                                                                   | Test Jack, 4mm Dia Test Plugs, 10 A, 1.94 mm, 50 V, Red, 571 Series               | Deltron Components | 571-0500          |
| 1   | J1402                                                                                                                                                                                                                                                                   | Test Jack, 4mm Dia Test Plugs, 10 A, 1.94 mm, 50 V, Black, 571 Series             | Deltron Components | 571-0100          |
| 1   | J1800                                                                                                                                                                                                                                                                   | CONN HDR 160POS SMD VITA 57.1 FEMALE                                              | Samtec             | ASP-134603-01     |
| 3   | L1, L1200, L1050                                                                                                                                                                                                                                                        | FIXED IND 1.2µH 20.1A 4.6 MOHM                                                    | Coilcraft          | XGL5050-122MEC    |
| 1   | L100                                                                                                                                                                                                                                                                    | Shielded Power Inductors - XAL1010 0.22µH 20%                                     | Coilcraft          | XAL1010-221MEB    |
| 1   | L900                                                                                                                                                                                                                                                                    | FIXED IND 5.6µH 8A 19.7 MOHM SMD                                                  | Coilcraft          | XGL5050-562MEC    |

| Qty | Reference Designator                                                                                                                             | Description                                                                        | Manufacturer                | Manufacturer Part |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------|-------------------|
| 3   | L200, L1000, L1600                                                                                                                               | FIXED IND 2.8μH 12.4A 8.5mΩ                                                        | Coilcraft                   | XGL5050-282MEC    |
| 2   | L500, L1201                                                                                                                                      | XGL4018-152MEC Power Inductor, molded, composite, 20% tol, SMT, RoHS, halogen-free | Coilcraft                   | XGL4018-152MEC    |
| 1   | L1100                                                                                                                                            | Shielded Power Inductors                                                           | Coilcraft                   | XGL4020-222MEC    |
| 6   | MP1800, MP1801, MP1802, MP1803, MP1804, MP1805                                                                                                   | 1957 Standoff, 1/4 Hex M-F, Threaded (8-32), Length 0.500, Brass/Nickel            | Keystone Electronics        | 1957              |
| 12  | Q1, Q3, Q100, Q300, Q500, Q900, Q1050, Q1100, Q1200, Q1260, Q1500, Q1550                                                                         | MOSFET N-CH 60V 115MA SOT23-3                                                      | Diodes Incorporated         | 2N7002-7-F        |
| 11  | Q2, Q4, Q301, Q501, Q901, Q1051, Q1101, Q1201, Q1261, Q1501, Q1551                                                                               | MOSFET N-CH 40V 40A/100A TDFON                                                     | Infineon                    | BSC010N04LS6ATMA1 |
| 2   | Q1400, Q1401                                                                                                                                     | MOSFET P-CH 20V 47A 8DFN                                                           | Alpha & Omega Semiconductor | AON6411           |
| 18  | Q1600, Q1700, Q1701, Q1702, Q1703, Q1707, Q1850, Q1851, Q1852, Q1853, Q1854, Q1855, Q1856, Q1857, Q1858, Q1859, Q1860, Q1861                     | MOSFET 2N-CH 30V 3.7A 6-TSOP                                                       | Vishay                      | SI3932DV-T1-GE3   |
| 22  | R1, R18, R307, R509, R907, R1060, R1108, R1216, R1261, R1506, R1556, R1700, R1701, R1702, R1704, R1706, R1715, R1853, R1855, R1856, R1858, R1859 | RES 7.15kΩ 1% 1/10W 0603                                                           | Yageo                       | RC0603FR-077K15L  |
| 11  | R2, R19, R308, R510, R908, R1061, R1109, R1217, R1262, R1507, R1557                                                                              | RES 124Ω 1% 1/10W 0603                                                             | Yageo                       | RC0603FR-07124RL  |
| 2   | R3, R4                                                                                                                                           | RES SMD 66.5Ω 1% 1W 2512 ERJ-1TNF66R5U                                             | Panasonic                   | ERJ-1TNF66R5U     |
| 11  | R5, R23, R311, R513, R912, R1062, R1112, R1220, R1263, R1510, R1559                                                                              | RES 604Ω 1% 1/10W 0603                                                             | Yageo                       | RC0603FR-07604RL  |
| 11  | R6, R24, R312, R514, R913, R1063, R1113, R1221, R1264, R1511, R1560                                                                              | RES 150Ω 1% 1/10W 0603                                                             | Yageo                       | RC0603FR-07150RL  |

| Qty | Reference Designator                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Description                                                                                   | Manufacturer | Manufacturer Part    |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------|----------------------|
| 43  | R7, R9, R12, R16, R17, R25, R100, R201, R204, R303, R314, R501, R504, R516, R901, R904, R915, R1001, R1054, R1064, R1101, R1104, R1106, R1107, R1114, R1151, R1204, R1208, R1212, R1222, R1268, R1301, R1406, R1408, R1430, R1434, R1504, R1512, R1561, R1600, R1607, R1620, R1767                                                                                                                                                                                                     | RES 10kΩ 1% 1/10W 0603                                                                        | Yageo        | RC0603FR-0710KL      |
| 69  | R8, R107, R111, R120, R200, R202, R301, R500, R900, R1000, R1002, R1053, R1056, R1100, R1150, R1152, R1156, R1163, R1169, R1202, R1203, R1206, R1300, R1302, R1304, R1305, R1306, R1323, R1324, R1416, R1419, R1420, R1423, R1425, R1433, R1435, R1439, R1446, R1452, R1501, R1551, R1606, R1716, R1762, R1763, R1764, R1768, R1770, R1771, R1772, R1773, R1780, R1781, R1782, R1783, R1789, R1800, R1803, R1804, R1807, R1808, R1811, R1813, R1814, R1815, R1816, R1817, R1818, R1819 | RES 0Ω 1% 1/10W 0603                                                                          | Yageo        | RC0603JR-070RL       |
| 5   | R11, R207, R1007, R1211, R1610                                                                                                                                                                                                                                                                                                                                                                                                                                                         | RES SMD 15kΩ 1% 100mW 0603                                                                    | YAGEO        | RC0603FR-0715KL      |
| 5   | R13, R506, R1005, R1213, R1611                                                                                                                                                                                                                                                                                                                                                                                                                                                         | RES 42.7kΩ 0.1% 0.21W 0603<br>TNPW060342K7BEEA                                                | Vishay Dale  | TNPW060342K7BEEA     |
| 3   | R15, R1105, R1761                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RES 20kΩ 1% 1/10W 0603                                                                        | Yageo        | RC0603FR-0720KL      |
| 5   | R20, R21, R22, R1218, R1219                                                                                                                                                                                                                                                                                                                                                                                                                                                            | RES 3.6Ω 1% 2W 2512<br>RC2512FK-7W3R6L                                                        | Yageo        | RC2512FK-7W3R6L      |
| 6   | R101, R102, R104, R105, R112, R113                                                                                                                                                                                                                                                                                                                                                                                                                                                     | RES Thick Film, 0Ω, 0.063W, 0402                                                              | YAGEO        | RC0402JR-070RL-T     |
| 1   | R103                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | KRL6432E-M-R002-G-T1 Metal Foil Low Resistance Chip Resistor (long-side terminal), 2512, RoHS | Susumu       | KRL6432E-M-R002-G-T1 |
| 1   | R106                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | RES 30.1Ω 1% 1/10W 0603                                                                       | Yageo        | RC0603FR-0730R1L     |
| 1   | R108                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | RES 3.65kΩ 1% 1/10W 0603                                                                      | Yageo        | RC0603FR-073K65L     |
| 8   | R109, R110, R1160, R1161, R1310, R1312, R1443, R1444                                                                                                                                                                                                                                                                                                                                                                                                                                   | RES 2.1kΩ 1% 1/10W 0603                                                                       | Yageo        | RC0603FR-072K1L      |
| 1   | R114                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | RES 3.24kΩ 1% 1/10W 0603                                                                      | Yageo        | RC0603FR-073K24L     |

| Qty | Reference Designator                                                                                               | Description                                       | Manufacturer              | Manufacturer Part |
|-----|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------|-------------------|
| 17  | R115, R116, R121, R1215, R1410, R1411, R1412, R1413, R1414, R1432, R1750, R1751, R1757, R1758, R1759, R1760, R1784 | RES 4.99kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-074K99L  |
| 1   | R117                                                                                                               | RES 4.87kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-074K87L  |
| 1   | R119                                                                                                               | RES 4.22kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-074K22L  |
| 8   | R128, R300, R916, R1103, R1424, R1500, R1550, R1766                                                                | RES 100kΩ 1% 1/10W 0603                           | Yageo                     | RC0603FR-07100KL  |
| 1   | R123                                                                                                               | RES 301Ω 1% 1/10W 0603                            | Yageo                     | RC0603FR-07301RL  |
| 2   | R124, R125                                                                                                         | RES 34kΩ 1% 1/10W 0603                            | Yageo                     | RC0603FR-0734KL   |
| 1   | R126                                                                                                               | RES SMD 94.2kΩ 0.1% 1/10W 0603 RT0603BRD0794K2L   | Yageo                     | RT0603BRD0794K2L  |
| 1   | R129                                                                                                               | RES 17.4kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-0717K4L  |
| 1   | R130                                                                                                               | RES 261Ω 1% 1/10W 0603                            | Yageo                     | RC0603FR-07261RL  |
| 3   | R131, R132, R133                                                                                                   | RES 0.3Ω 1% 3.5W 2512                             | Stackpole Electronics Inc | CSRT2512FTR300-UP |
| 2   | R138, R139                                                                                                         | RES 75Ω 1% 1/10W 0603                             | Yageo                     | RC0603FR-0775RL   |
| 1   | R205                                                                                                               | RES 42.7kΩ 0.1% 0.21W 0603 TNPW060342K7BEEA       | Vishay Dale               | TNPW060342K7BEEA  |
| 1   | R206                                                                                                               | RES 2.21kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-072K21L  |
| 2   | R302, R1502                                                                                                        | RES 200kΩ 1% 1/10W 0603                           | Yageo                     | RC0603FR-07200KL  |
| 3   | R305, R1503, R1553                                                                                                 | RES 3.32kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-073K32L  |
| 2   | R306, R1505                                                                                                        | RES SMD 200Ω 1% 100mW 0603 RC0603FR-07200RL       | Yageo                     | RC0603FR-07200RL  |
| 4   | R309, R310, R1508, R1509                                                                                           | AC2512 8.06Ω 1W 1.00% AC2512FK-078R06L            | Yageo                     | AC2512FK-078R06L  |
| 1   | R505                                                                                                               | RES SMD 3.79KOHM 0.1% 1/10W 0603 RT0603BRD073K79L | Yageo                     | RT0603BRD073K79L  |
| 1   | R508                                                                                                               | RES SMD 4.99kΩ 1% 1/10W 0603                      | TE Connectivity           | CRG0603F4K99      |
| 2   | R511, R512                                                                                                         | RES Thick Film, 14Ω, 1%, 1W, 100ppm/°C, 2512      | Yageo                     | RC2512FK-0714RL   |
| 1   | R517                                                                                                               | RES 8.56kΩ 0.1% 1/10W 0603                        | Yageo                     | RT0603BRD078K56L  |
| 1   | R906                                                                                                               | RES 3.16kΩ 1% 1/10W 0603                          | Yageo                     | RC0603FR-073K16L  |

| Qty | Reference Designator                                                | Description                                                            | Manufacturer               | Manufacturer Part  |
|-----|---------------------------------------------------------------------|------------------------------------------------------------------------|----------------------------|--------------------|
| 2   | R910, R911                                                          | RES SMD 10 $\Omega$ 1% 1W 2512<br>CRCW251210R0FKEG                     | Vishay Dale                | CRCW251210R0FKEG   |
| 6   | R1004, R1055, R1205,<br>R1209, R1405, R1609                         | RES 1k $\Omega$ 1% 1/10W 0603                                          | Yageo                      | RC0603FR-071KL     |
| 2   | R1006, R1612                                                        | RES 137 $\Omega$ 1% 1/10W 0603                                         | Panasonic                  | ERJ-3EKF1370V      |
| 4   | R1050, R1051, R1200,<br>R1201                                       | RES 1 $\Omega$ 0.1% 1/10W 0603                                         | Yageo                      | RC0603FR-071RL     |
| 2   | R1052, R1260                                                        | RES Thick Film, 10, 1%, 0.125W,<br>0805                                | Vishay Dale                | CRCW080510R0FKEA-T |
| 1   | R1402                                                               | RES Thick Film, 10, 1%, 0.125W,<br>0805                                | Vishay Dale                | CRCW080510R0FKEA-T |
| 1   | R1058                                                               | 1.5k $\Omega$ $\pm$ 1% 0.1W, 1/10W Chip<br>Resistor 0603               | Yageo                      | RC0603FR-071K5L    |
| 7   | R1066, R1067, R1068,<br>R1265, R1266, R1267,<br>R1453               | RES 1.2 $\Omega$ 1% 2W 2512<br>RC2512FK-7W1R2L                         | Yageo                      | RC2512FK-7W1R2L    |
| 4   | R1110, R1111, R1170,<br>R1171                                       | 6.04 $\Omega$ $\pm$ 1% 1W Chip Resistor 2512                           | KOA Speer Electronics Inc. | SR733ATTE6R04F     |
| 3   | R1153, R1303, R1436                                                 | RES 10 $\Omega$ 1% 1/10W 0603                                          | Yageo                      | RC0603FR-0710RL    |
| 2   | R1154, R1155                                                        | RES SMD 15k $\Omega$ 0.1% 1/10W 0603<br>ERA-3AEB153V                   | Panasonic                  | ERA-3AEB153V       |
| 3   | R1158, R1308, R1441                                                 | RC0603FR-0735K7L RES 35.7k $\Omega$<br>1% 1/10W 0603                   | Yageo                      | RC0603FR-0735K7L   |
| 9   | R1159, R1162, R1172,<br>R1309, R1311, R1325,<br>R1442, R1445, R1454 | RES Thick Film, 10k $\Omega$ , 1%, 0.1W,<br>100ppm/ $^{\circ}$ C, 0603 | Vishay Dale                | CRCW060310K0FKEB   |
| 9   | R1164, R1165, R1166,<br>R1313, R1314, R1315,<br>R1447, R1448, R1449 | RES 10 $\Omega$ 1% 1/10W 0603<br>RC0603FR-0710RL                       | Yageo                      | RC0603FR-0710RL    |
| 6   | R1167, R1316, R1450,<br>R1168, R1451, R1322                         | RES 10 $\Omega$ 1% 1/10W 0603<br>RC0603FR-0710RL                       | Yageo                      | RC0603FR-0710RL    |
| 5   | R1317, R1318, R1319,<br>R1320, R1321                                | RES SMD 1 $\Omega$ 1% 2W 2512                                          | Bourns Inc.                | CRM2512-FX-1R00ELF |
| 1   | R1400                                                               | CRCW080520K0FKEA RES SMD<br>20k $\Omega$ 1% 1/4W 0805                  | Vishay Dale                | CRCW080520K0FKEA   |
| 1   | R1401                                                               | RES 100 $\Omega$ 1% 1/10W 0603                                         | Yageo                      | RC0603FR-07100RL   |
| 1   | R1403                                                               | RES 40k $\Omega$ 1% 1/10W 0603                                         | Yageo                      | RC0603FR-0740KL    |
| 2   | R1404, R1718                                                        | CRCW080510K0FKEA RES SMD<br>10k $\Omega$ 1% 1/4W 0805                  | Vishay Dale                | CRCW080510K0FKEA   |
| 1   | R1407                                                               | RES 2k $\Omega$ 1% 1/10W 0603                                          | Yageo                      | RC0603FR-072KL     |
| 1   | R1409                                                               | RES 90.9k $\Omega$ 1% 1/10W 0603                                       | Yageo                      | RC0603FR-0790K9L   |
| 5   | R1417, R1422, R1707,<br>R1851, R1861                                | RES 4.12k $\Omega$ 1% 1/10W 0603                                       | Yageo                      | RC0603FR-074K12L   |
| 3   | R1418, R1426, R1752                                                 | RES 3.01k $\Omega$ 1% 1/10W 0603                                       | Yageo                      | RC0603FR-073K01L   |

| Qty | Reference Designator                                               | Description                                                                                                                     | Manufacturer | Manufacturer Part  |
|-----|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------|
| 1   | R1421                                                              | RES 21kΩ 1% 1/10W 0603                                                                                                          | Yageo        | RC0603FR-0721KL    |
| 1   | R1427                                                              | RES 6.98kΩ 1% 1/10W 0603                                                                                                        | Yageo        | RC0603FR-076K98L   |
| 8   | R1428, R1756, R1809, R1810, R1812, R1822, R1830, R1833             | RES 1kΩ 0.1% 1/10W 0603                                                                                                         | YAGUEO       | RC0603FR-071KP     |
| 1   | R1429                                                              | RES 6.19kΩ 1% 1/10W 0603                                                                                                        | Yageo        | RC0603FR-076K19L   |
| 2   | R1437, R1438                                                       | Automotive Metal Thin Film Chip Resistor, 0603, 6.04kΩ, 0.1%, 25ppm/°C, 0.1W, 100V RG1608P-6041-B-T5                            | Susumu       | RG1608P-6041-B-T5  |
| 1   | R1552                                                              | RES SMD 59kΩ 1% 100mW 0603                                                                                                      | Vishay Dale  | CRCW060359K0FKEA   |
| 1   | R1554                                                              | RES SMD 18kΩ 0.1% 1/10W 0603 RT0603BRE0718KL                                                                                    | Yageo        | RT0603BRE0718KL    |
| 1   | R1555                                                              | RES SMD 300Ω 1% 100mW 0603                                                                                                      | Yageo        | RC0603FR-07300RL   |
| 1   | R1558                                                              | RES 24Ω 1% 1W 2512 RC2512FK-0724RL                                                                                              | Yageo        | RC2512FK-0724RL    |
| 1   | R1601                                                              | RES 226kΩ 1% 1/10W 0603                                                                                                         | Yageo        | RC0603FR-07226KL   |
| 1   | R1602                                                              | RES 56kΩ 1% 1/10W 0603                                                                                                          | Yageo        | RC0603FR-0756KL    |
| 1   | R1603                                                              | RES 0.015Ω 1% 3W 2512                                                                                                           | Bourns Inc.  | CRA2512-FZ-R015ELF |
| 2   | R1604, R1621                                                       | RES 4.02kΩ 1% 1/10W 0603                                                                                                        | Yageo        | RC0603FR-074K02L   |
| 1   | R1605                                                              | RES 7.5kΩ 1% 1/10W 0603                                                                                                         | Yageo        | RC0603FR-077K5L    |
| 6   | R1703, R1850, R1852, R1854, R1857, R1860                           | RES 2.43kΩ 1% 1/10W 0603                                                                                                        | Yageo        | RC0603FR-072K43L   |
| 1   | R1823                                                              | RES 2kΩ 0.1% 1/10W 0603                                                                                                         | Yageo        | RC0603FR-072KP     |
| 2   | R1831, R1832                                                       | RES SMD 100kΩ 1% 100mW 0603 RC0603FR-07100KL                                                                                    | Yageo        | RC0603FR-07100KL   |
| 2   | SW4, SW1401                                                        | Toggle Switches ON-NONE-ON DPDT                                                                                                 | NKK Switches | G22AH              |
| 1   | SW1400                                                             | SWITCH TACTILE SPST-NO 0.05A 24V                                                                                                | OMRON        | B3F-1000           |
| 11  | U1, U3, U301, U501, U901, U1005, U1101, U1202, U1260, U1501, U1551 | Renesas 100V, 3A Source, 4A Sink, High Frequency Half-Bridge Drivers with HI/LI or Tri-Level PWM Input and Adjustable Dead Time | Renesas      | HIP2211            |
| 8   | U2, U200, U500, U900, U1000, U1100, U1201, U1602                   | Renesas Radiation-Tolerant 18V, 3A Point-of-Load Regulator                                                                      | Renesas      | ISL73007M30VEZ     |
| 4   | U100, U1151, U1303, U1450                                          | Renesas Radiation-Tolerant 12V Half-Bridge GaN FET Driver                                                                       | Renesas      | ISL71441M30RZ      |
| 1   | U104                                                               | Renesas Radiation-Tolerant Single/Dual-Phase Current Mode PWM Controller                                                        | Renesas      | ISL73847M30BZ      |
| 1   | U105                                                               | Renesas Radiation-Tolerant Low-Side GaN FET Driver                                                                              | Renesas      | ISL71040M30RTZ     |

| Qty | Reference Designator                           | Description                                                                                     | Manufacturer                | Manufacturer Part   |
|-----|------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------|---------------------|
| 3   | U300, U1500, U1550                             | Renesas Radiation-Tolerant Ultra Low Noise LDO                                                  | Renesas                     | ISL75054M30VZ       |
| 2   | U1050, U1200                                   | Renesas Radiation-Tolerant 6A Synchronous Buck Regulator with Integrated MOSFETs                | Renesas                     | ISL71001MNZ         |
| 3   | U1150, U1300, U1402                            | Renesas Radiation-Tolerant 3A Source and Sink DDR Terminator/LDO with Buffered Reference        | Renesas                     | ISL75055M30NEZ      |
| 2   | U1401, U1750                                   | Renesas Radiation-Hardened Quad Power Supply Sequencers                                         | Renesas                     | ISL70321SEHF/PROTO  |
| 1   | U1600                                          | Dual Low-Power Precision Operational Amplifier Single-Supply Rail-to-Rail Output 36V 5-Pin SOIC | Renesas                     | ISL71218MBZ         |
| 1   | U1601                                          | Renesas Radiation-Tolerant 40V Current Sense Amplifier                                          | Renesas                     | ISL70100M30VZ       |
| 3   | Q102, Q103, Q104                               | IC-SAMPLE DIE, Radiation-Hardened, 40V GAN FET, ROHS                                            | Renesas                     | ISL70020SEHX/SAMPLE |
| 1   | Q101                                           | IC-PROTO, Radiation-Hardened, 40V GAN FET, 4P, CLCC, ROHS                                       | Renesas                     | ISL70020SEHL/PROTO  |
| 4   | U1152, U1304, U1400, U1451                     | IC FF JK TYPE DBL 1-BIT 16-SOIC                                                                 | Texas Instruments           | CD4027BM96          |
| 6   | U1153A, U1301A, U1452A, U1153B, U1301B, U1452B | MOSFET N-CH 30V 6.2A SOT23                                                                      | Alpha & Omega Semiconductor | AOSS32334           |
| 1   | U1751                                          | IC INVERTER 1CH 1-INP 5 pin SOT-23                                                              | Texas Instruments           | SN74LVC1G04DBVT     |

### 3.3 Board Layout

For detailed layout recommendations of the individual components, refer to the respective datasheets and evaluation board manuals. The ISLNGULTRADEMO1Z board design files can be downloaded from the board product page on the Renesas website.

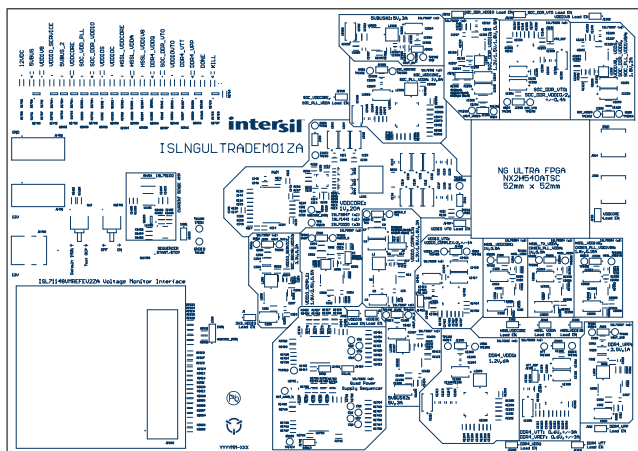


Figure 94. Top Silkscreen

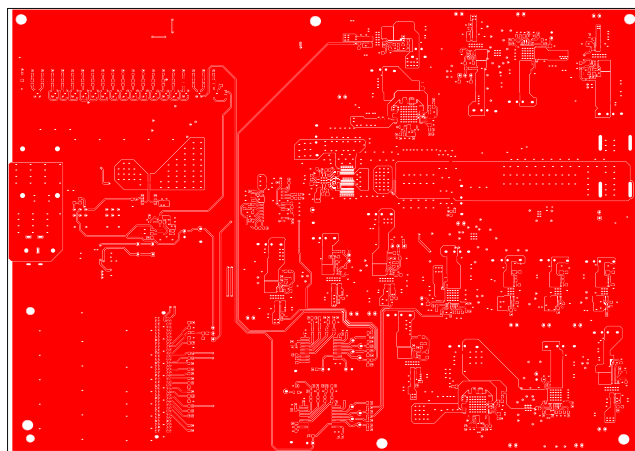


Figure 95. Top Layer

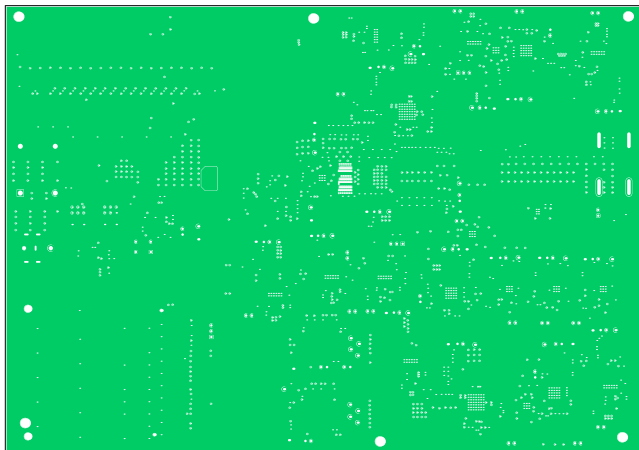


Figure 96. Layer 2

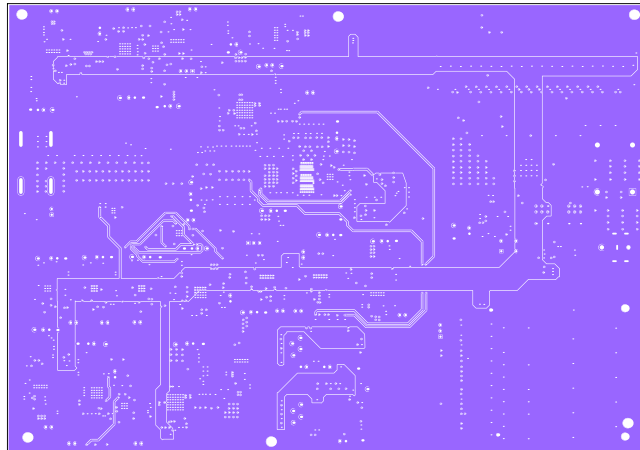


Figure 97. Layer 3

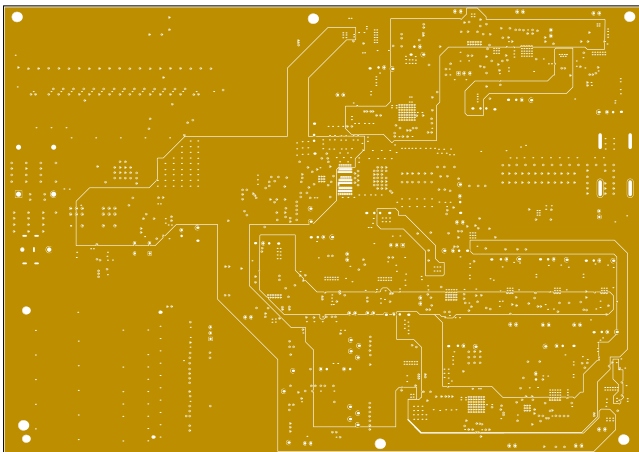


Figure 98. Layer 4

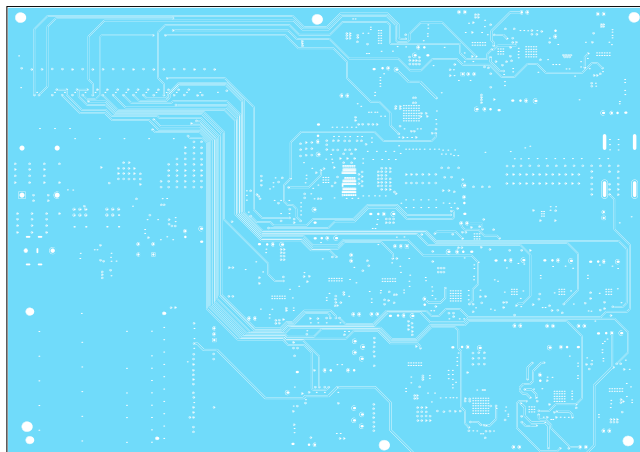


Figure 99. Layer 5

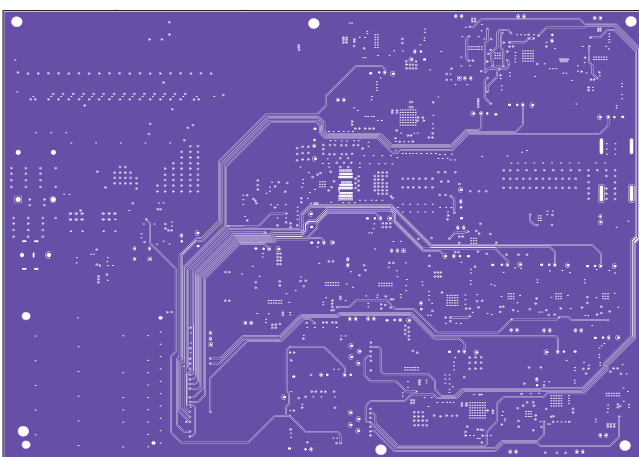


Figure 100. Layer 6

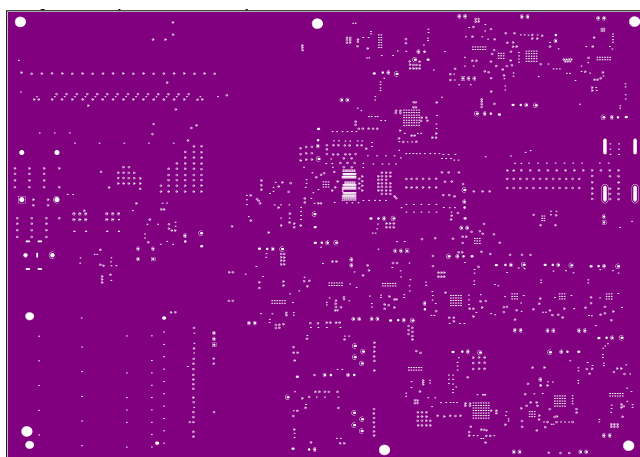


Figure 101. Layer 7

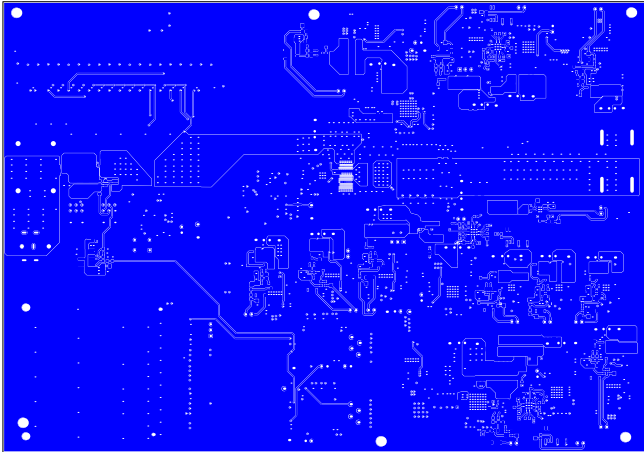


Figure 102. Bottom Layer

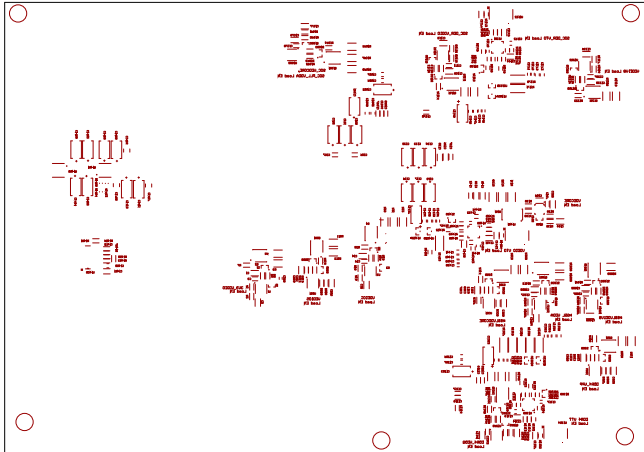


Figure 103. Bottom Silkscreen

4. Ordering Information

| Part Number      | Description                                            |
|------------------|--------------------------------------------------------|
| ISLNGULTRADEMO1Z | Renesas RT Power Solution for NanoXplore NG-ULTRA FPGA |

5. Revision History

| Revision | Date         | Description      |
|----------|--------------|------------------|
| 1.00     | Sep 25, 2026 | Initial release. |

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