

ISL78226EVKIT1Z, ISL78224EVKIT2Z

Evaluation Kits and Software User Manual

Automotive Group

1. Overview

This user guide enables you to quickly install the software, set up and configure the hardware, use the hardware with the ISLUSBADAPT-EVZ dongle, and use the software to read and write to the ISL78226 and ISL78224 data registers. This guide includes step-by-step setup instructions for the software and hardware, an overview of software operation, and a detailed description of the software functions. Operation is similar for both the ISL78226 and ISL78224. This guide describes the operation of the ISL78226. Details specific to the ISL78224 are highlighted and discussed.

The ISL78226 and ISL78224 software enables control and observation of register settings and functional status of the controllers. It works primarily through a USB to I²C interface dongle that enables logic (GPIO) control of discrete pins of the controllers.

This software allows you to interact and evaluate all aspects of the [ISL78226](#) and [ISL78224](#) PWM controllers. It is designed to enable you to quickly configure register settings and mode selections. The approximately 60 control selections are programmable at the register hex level or from user-selectable combo controls in the software. The software can also poll more than 70 alert and operation indicators.

1.1 Software Key Features

- I²C/PMBus compatible digital interface
- Read/write registers using direct hex or human translated interface elements
- Quick access control of EN and PWM_EN pins
- Functional combo box selection of more than 60 control register setting selections
- Direct hex read of fault and status registers
- Functional display of faults and operating status
- File-based save and recall of control register values
- User-selectable automatic startup options

1.2 Specifications

The ISL78226EVKIT1Z and ISL78224EVKIT2Z are configured and optimized for the following operating conditions:

- V_{IN} = 5V to 64V
- BAT12 = 12V
- BAT48 = 48V
- VIN_FLY = 5V to 64V
- Efficiency = >95%, 12V at 100A, Buck mode input at 48V

1.3 Related Literature

For a full list of related documents visit our website:

- [ISL78226](#) and [ISL78224](#) product pages

1.4 Ordering Information

Part Number	Description
ISL78226EVKIT1Z	Evaluation kit for the ISL78226 6-phase PWM controller
ISL78224EVKIT2Z	Evaluation kit for the ISL78224 4-phase PWM controller

1.5 Kit Contents

The evaluation kit contains:

- ISL78226EVAL1Z or ISL78224EVAL2Z evaluation board
- ISLUSBADAPT-EVZ REV A USB to I²C interface kit
- USB cable, I²C cable (four wires), and GPIO cable (11 wires)

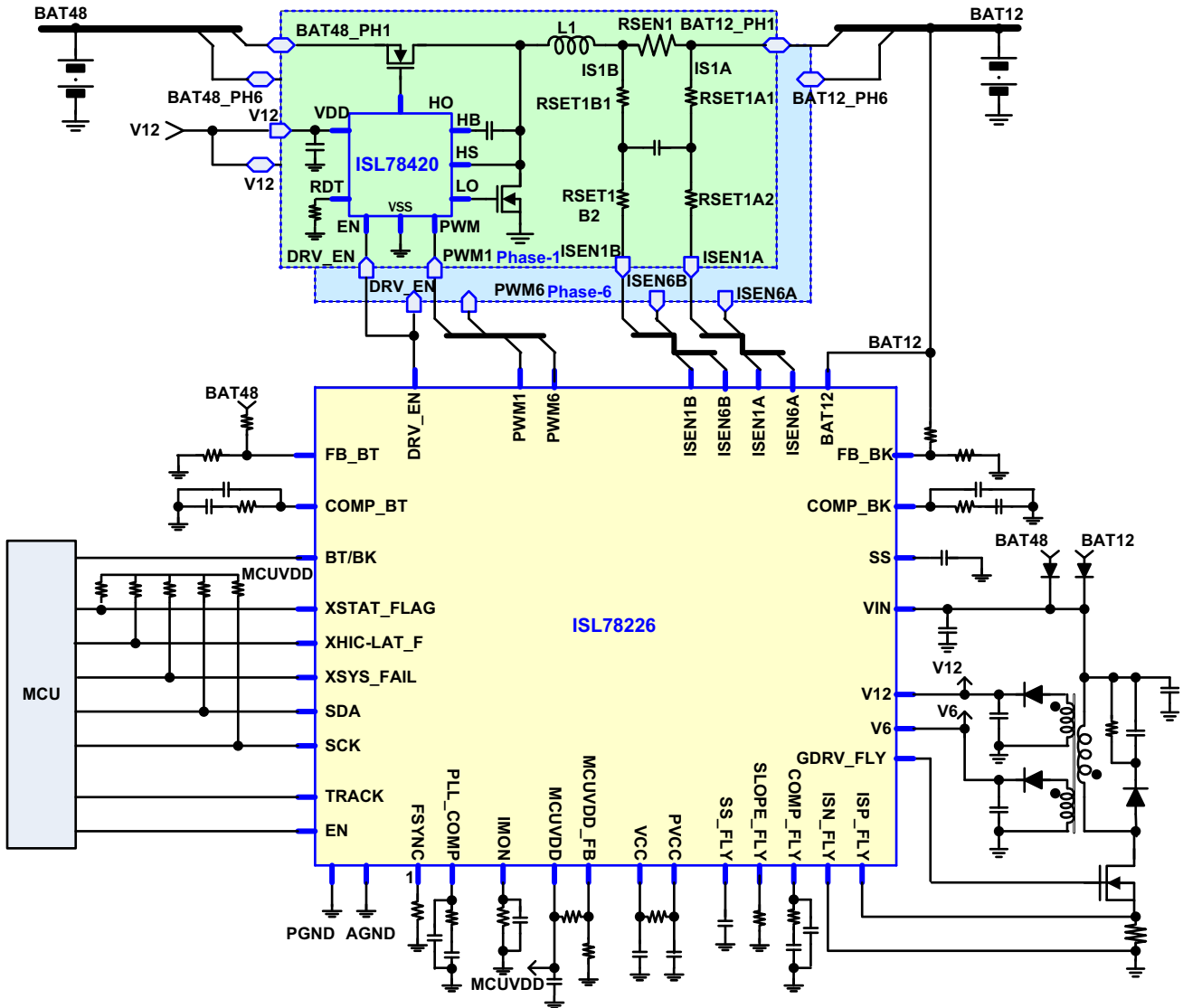


Figure 1. ISL78226 Simplified Typical Application Schematic

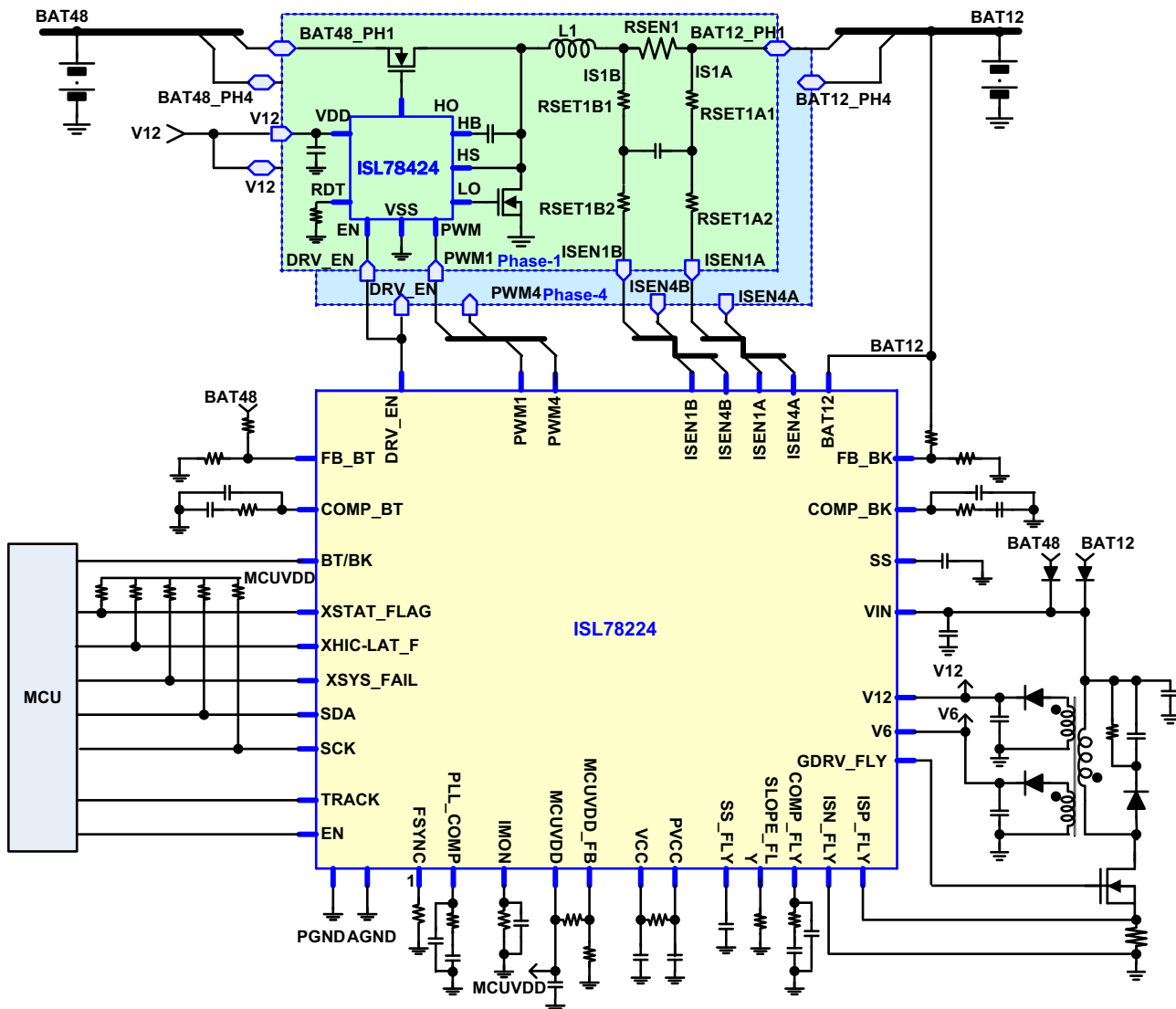


Figure 2. ISL78224 Simplified Typical Application Schematic

Contents

1. Overview	2
1.1 Software Key Features	2
1.2 Specifications	2
1.3 Related Literature	2
1.4 Ordering Information	2
1.5 Kit Contents	3
2. Quick Start Videos	6
3. Functional Description	7
3.1 Operating Range	7
3.2 Getting Started	7
3.3 Quick Hardware Setup Guide	7
3.4 Installing the Software	9
3.5 Connecting Hardware	13
4. Overview - Using the Software	24
4.1 Quick Access Control Panel	24
4.2 Understanding Device Operation	26
4.3 Tab Overviews	27
5. Using the Software - Detailed	29
5.1 Startup	29
5.2 Control Regs (Hex) Tab	32
5.3 Control Registers Tab	33
5.4 Status Regs (Hex) Tab	36
5.5 Alert Display Tab	37
5.6 Config & Status Tab	39
6. Alternate Configurations	41
6.1 Buck Operation of the ISL78224EVAL2Z without Flyback and with the GUI	41
6.2 Buck operation of the ISL78224EVAL2Z without flyback and without GPIO from the GUI	42
6.3 Boost Operation of the ISL78224EVAL2Z without Flyback and with the GUI	43
6.4 Boost Operation of the ISL78224EVAL2Z without Flyback and without GPIO from the GUI	44
6.5 Buck Operation of the ISL78226EVAL1Z without Flyback and with the GUI	45
6.6 Buck Operation of the ISL78226EVAL1Z without Flyback and without GPIO from the GUI	46
6.7 Boost Operation of the ISL78226EVAL1Z without Flyback and with the GUI	47
6.8 Boost Operation of the ISL78226EVAL1Z without Flyback and without GPIO from the GUI	48
7. PCB Layout Guidelines	50
7.1 Maximum Operating Power for Evaluation Boards	50
7.2 Evaluation Boards	51
7.3 ISL78226EVAL1Z Circuit Schematics	52
7.4 ISL78224EVAL2Z Circuit Schematics	62
7.5 ISLUSBADAPT-EVZ Schematic	70
7.6 ISL78226EVAL1Z Bill of Materials	71
7.7 ISL78224EVAL2Z Bill of Materials	75
7.8 ISL78226EVAL1Z Board Layout (Six Layers)	78
7.9 ISL78224EVAL2Z Board Layout (Eight Layers)	88
8. Typical Performance Curves	100
8.1 Gain Phase Plots, Buck and Boost	100
8.2 Efficiency Curves, Buck and Boost	102
9. Revision History	103

2. Quick Start Videos

The following quick start videos explain how to load the software and describe the basic functionality of the software. The titles of the videos are:

- [ISL78226 PWM Controller Webinar](#)
- [Automotive 6-Phase Bidirectional PWM Controller Video](#)
- [ISL78226EVAL1Z: Software and Hardware](#)
- [ISL78226EVKIT1Z: Phase Dropping and Tracking](#)

[Figure 4](#) shows the connection of the cables on the ISL78226EVAL1Z REV A evaluation board. Pin 1 of the I²C cable is connected to J₇₄ and is marked with a white line on the connector. The GPIO cable is connected to J₇₇.

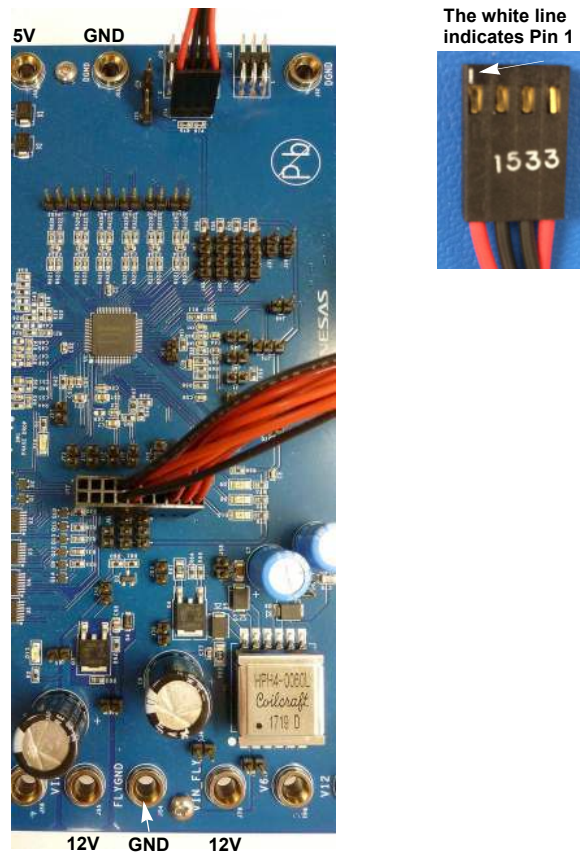


Figure 4. Connecting Cables to the ISL78226EVAL1Z

[Figure 5](#) shows the connection of the cables on the ISL78224EVAL2Z Rev A evaluation board. Pin 1 of the I²C cable is connected to J₇₄ and is marked with a white line on the connector. The GPIO cable is connected to J₇₇.

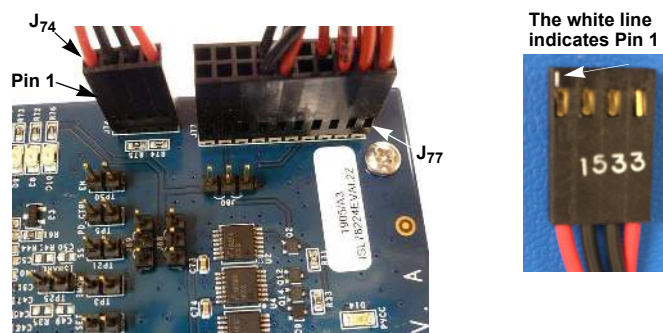


Figure 5. Connecting Cables to the ISL78224EVAL2Z

3.4 Installing the Software

- (1) Download the software from the Renesas [website](#). The screen in [Figure 6](#) appears.

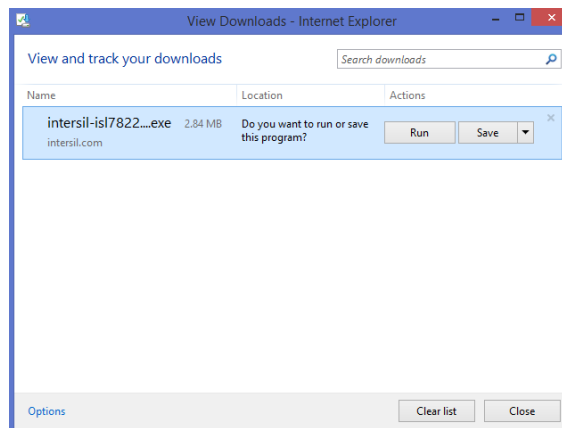


Figure 6. Download Screen

- (2) Click **Run** and approve the request to download the software. The Setup Wizard screen in [Figure 7](#) appears.

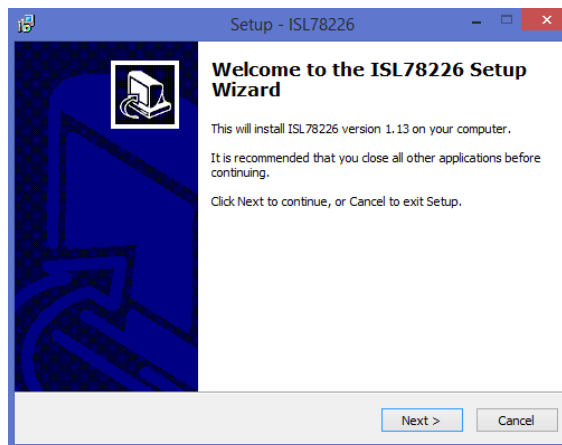


Figure 7. Setup Wizard

- (3) Click **Next** and select the location to save the file. The default location is **C:\Users\Public\ISL78226**. Click **Browse** to save the file in a different location. When finished, click **Next**.

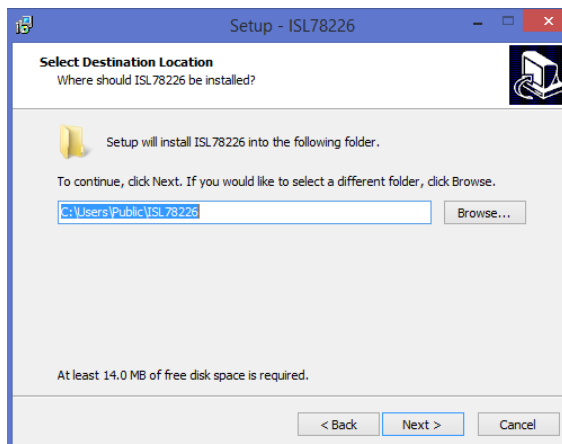


Figure 8. Setup Wizard

- (4) The Startup menu folder appears. Click **Browse** to save the shortcut in a different location. When finished, click **Next**.

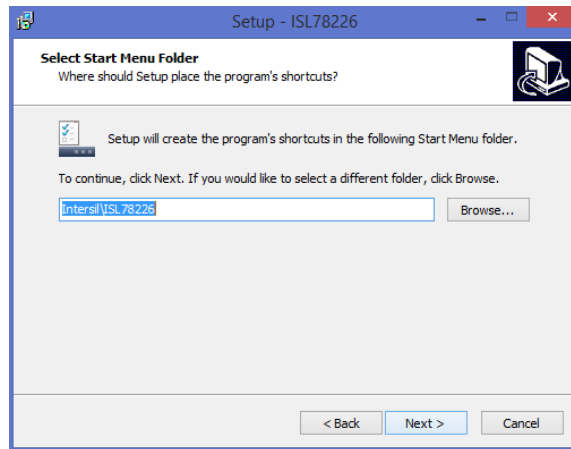


Figure 9. Select Destination Location

- (5) To create a desktop icon, check the box next to **Create a desktop icon** and click **Next**.

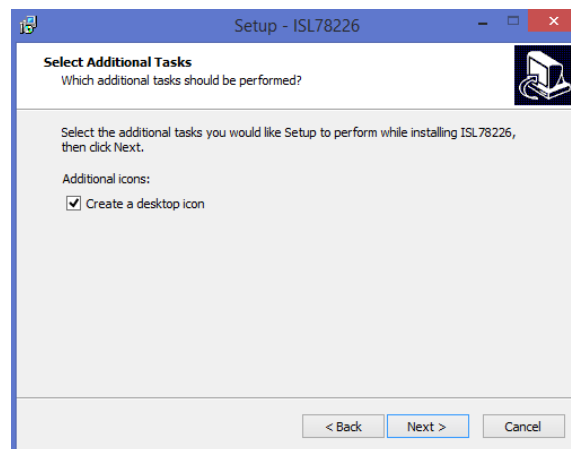


Figure 10. Select Destination Location

- (6) Click **Install** to install the software.

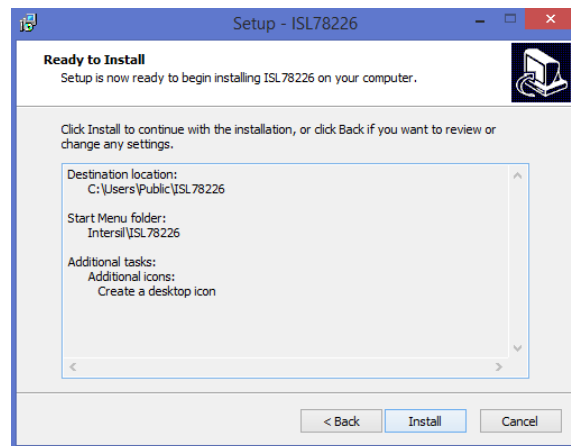


Figure 11. Select Destination Location

- (7) To launch the software, check the box next to **Launch ISL78226** and click **Finish**. The installation is now complete. Restart your computer if instructed to do so.

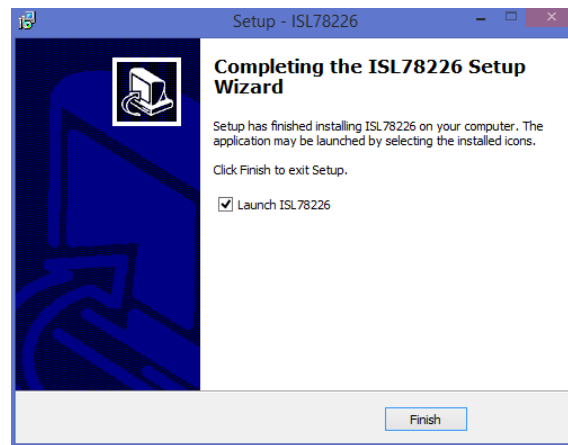


Figure 12. Select Destination Location

- (8) Select either **ISL78226 Ready: Proceed to Standard Demo** or **ISL78224 Ready: Proceed to Standard Demo** from the drop-down menu.
- (a) [Figure 13](#) shows the ISL78226 startup screen.

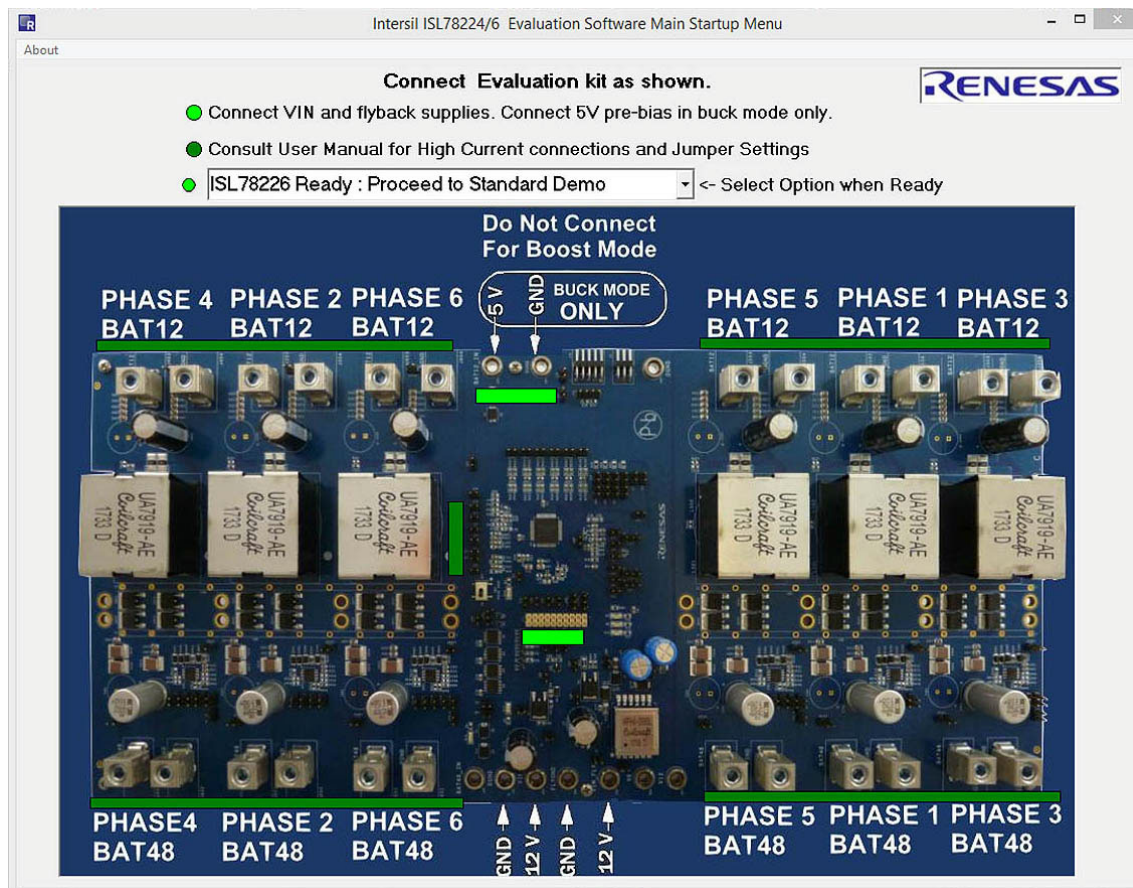


Figure 13. Software Startup Screen (ISL78226 Selected)

(b) [Figure 14](#) shows the ISL78224 startup screen.

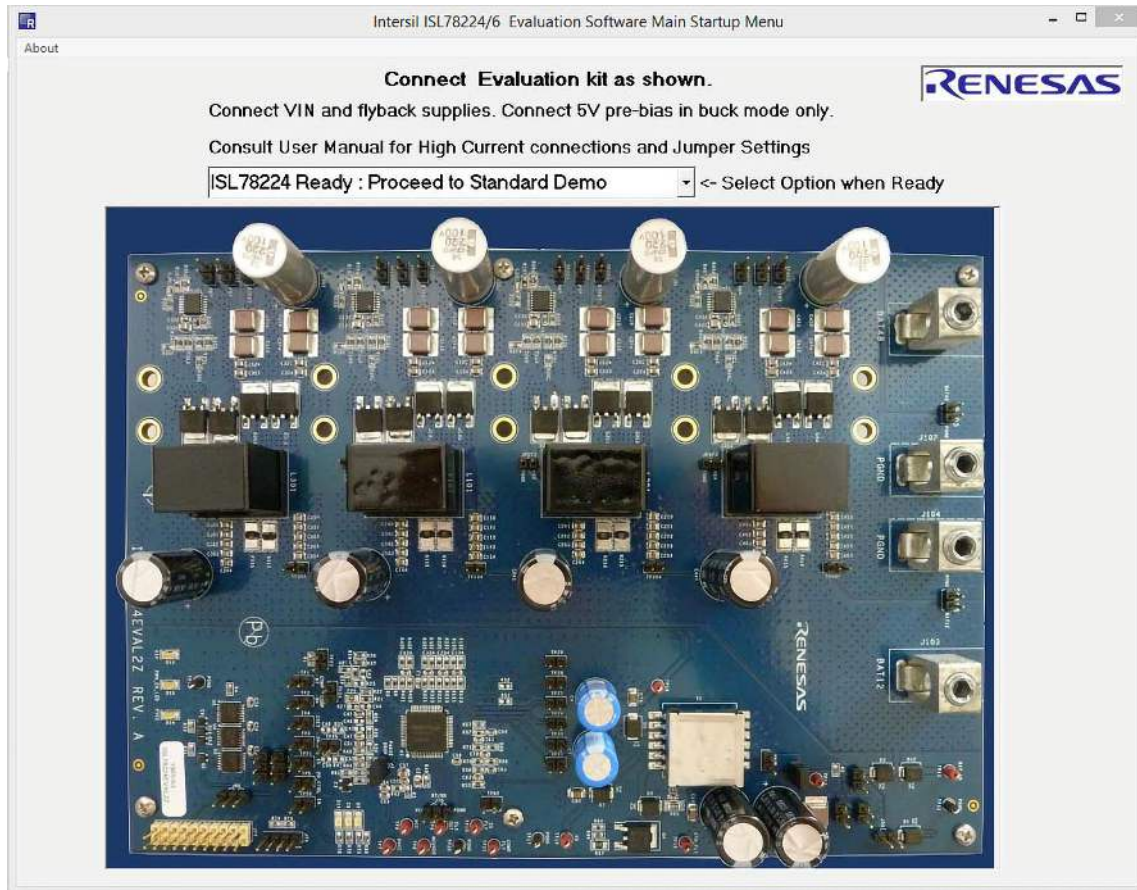


Figure 14. Software Startup Screen (ISL78224 Selected)

(c) The flashing green bars indicate connections to the board. When the device under test is selected, the screen in [Figure 15 on page 13](#) appears. The Quick Access Control Panel to the right in [Figure 15](#) provides quick access to enable and disable the part, select either Buck or Boost operation, turn on the PWM, select either DE or CCM operation mode of operation, set the fault response to Hiccup or Latch, check fault registers, clear all faults, and automatically update the status of changes made in the Control and Observation panels.

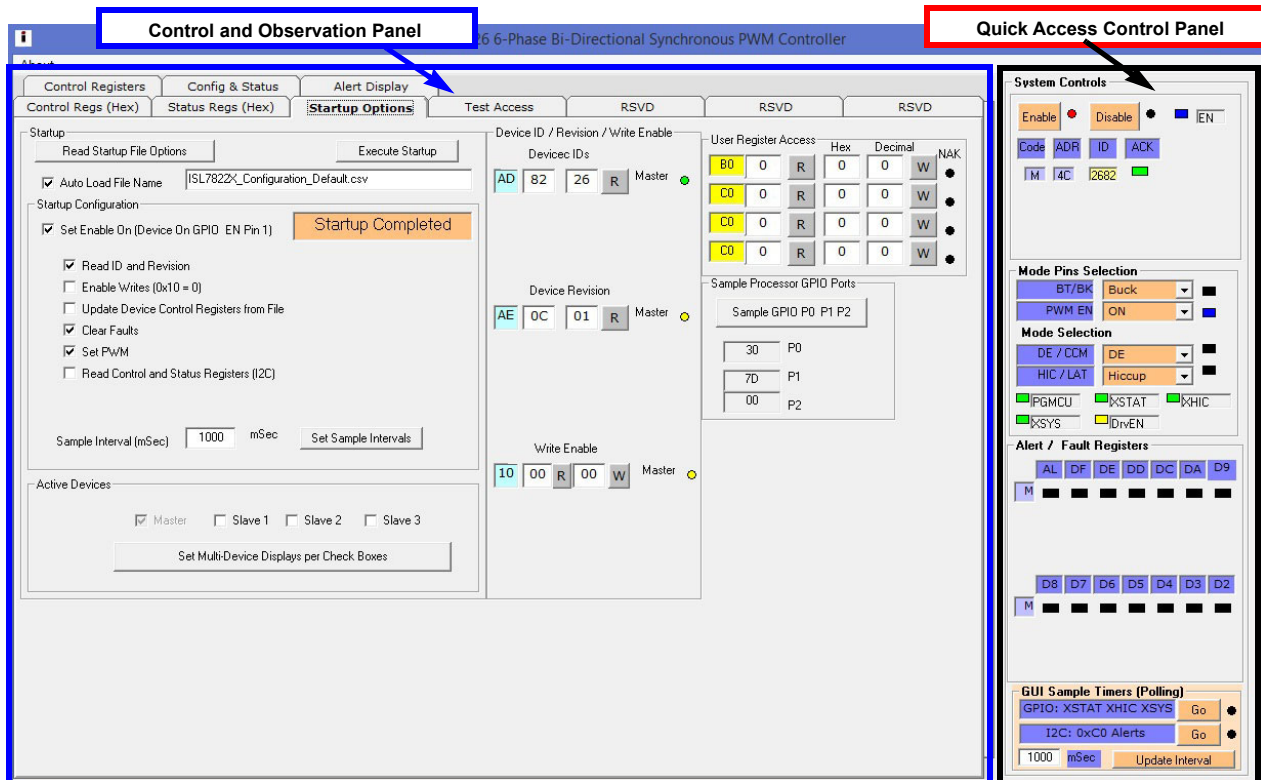


Figure 15. Software Status Screen with Control and Observation Panel and Quick Access Control Panel

3.5 Connecting Hardware

3.5.1 Buck Mode

Caution: This is a high power application board. Renesas recommends disabling the part through the software and turning off all supplies before making connections to the board. Failure to do this could damage the board.

- (1) Verify that the computer is connected to the USB to I²C board and the evaluation board.
 - (a) See [Figures 3](#) and [4](#) for the ISL78226EVAL1Z setup.
 - (b) See [Figures 3](#) and [5](#) for the ISL78224EVAL2Z setup.
- (2) Verify the jumper connections in [Table 1](#). **Note:** Jumpers not listed in the table are not populated. Some of these “jumpers” are measurement terminals and cannot tolerate being shorted.

Table 1. Jumper Configuration

Jumper ID	Device	Action	Function
J ₁₄	ISL78226	Installed	BAT48 Bode Injection, Jumper for normal operation
TP ₂₃	ISL78224	Installed	
J ₁₅	ISL78226	Installed	BAT12 Bode Injection, Jumper for normal operation
TP ₂₄	ISL78224	Installed	
J ₂₀ Pin 2 connected to J ₂₁ Pin 2	ISL78226	Installed	Short ISET to ISHARE, Jumper for master only operation
	ISL78224	NA	
J ₂₆	ISL78226	Installed	MCUVDD Bode Injection, Jumper for normal operation
	ISL78224	Not Used	

Table 1. Jumper Configuration (Continued)

Jumper ID	Device	Action	Function
J ₃₅	ISL78226	Switch	PD_CTRL Switch toward BAT48 (Phase drop ON) Switch toward BAT12 (Phase drop OFF)
J ₁	ISL78224	No Jumper	Phase drop ON
		Installed	Phase drop OFF
J ₆₃	ISL78226	Installed	Disable V _{IN} voltage clamp
	ISL78224	N/A	
J ₇₀	ISL78226	No Jumper	BT/BK Control Remove for software operation
	ISL78224	No Jumper	
J ₇₁	ISL78226	Installed 1-2	PWM_TRI Enable tri-state driver operation
	ISL78224	N/A	
J ₈₀	ISL78226	Installed 2-3	TRACK
	ISL78224	Installed 2-3	
J ₈₁	ISL78226	Installed 2-3	ADDR1 Configures as master
	ISL78224	N/A	
J ₈₂	ISL78226	Installed 2-3	ADDR2 Configures as master
	ISL78224	N/A	
J ₈₈	ISL78226	No Jumper	DE/CCM Remove for software operation
	ISL78224	No Jumper	
J ₈₉	ISL78226	No Jumper	HIC/LAT Remove for software operation
	ISL78224	No Jumper	
JP ₃₁₀	ISL78226	Installed	Jumper to enable Phase 3
	ISL78224	N/A	
JP ₄₁₀	ISL78226	Installed	Jumper to enable Phase 4
	ISL78224	N/A	
JP ₅₁₀	ISL78226	Installed	Jumper to enable Phase 5
	ISL78224	N/A	
JP ₆₁₀	ISL78226	Installed	Jumper to enable Phase 6
	ISL78224	N/A	

- (3) Connect the 48V supply or battery to one or more of the BAT48 connectors. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections. **Note:** the PCB connects all BAT48 phases together and all BAT48 PGNDs together. For high power evaluations, Renesas recommends connecting the 48V supply or battery to all six phases for distribution of power across the board.
- (4) Connect a DC electronic load or a 12V battery to one or more of the BAT12 connectors. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections. **Note:** the PCB connects all BAT12 phases together and all BAT12 PGNDs together. For high power evaluations, Renesas recommends connecting the DC electronic load or a 12V battery to all six phases for distribution of power across the board.
- (5) Connect a 12V supply to the VIN and VIN_FLY with its ground connected to FLYGND.
- (6) Connect a 5V supply to BAT12_IN with its ground connected to DGND. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections.

- (7) Connect the probes to the evaluation board. Use the connections shown in [Table 2](#) and [Figure 16](#) (ISL78226) or [Figure 17](#) (ISL78224). **Note:** Renesas recommends disabling the part through the software and turning off all supplies before making connections to the board.
 - (a) (ISL78226) Use the connections shown in [Figure 16](#) and [Table 2](#).

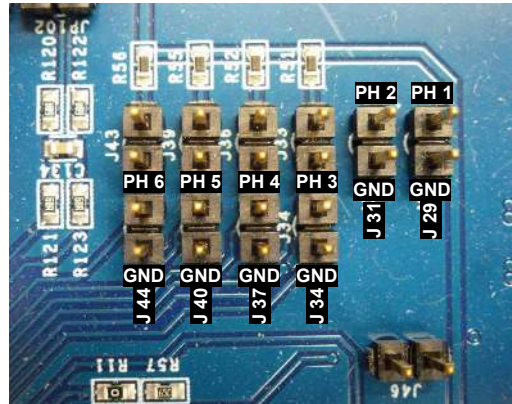


Figure 16. ISL78226 Scope Probe Connections

Table 2. ISL78226 Probe Connections to Monitor Phase Voltages

Jumper	Phase
29	1
31	2
34	3
37	4
40	5
44	6

- (b) (ISL78224) Use the connections shown in [Figure 17](#) and [Table 3 on page 16](#).

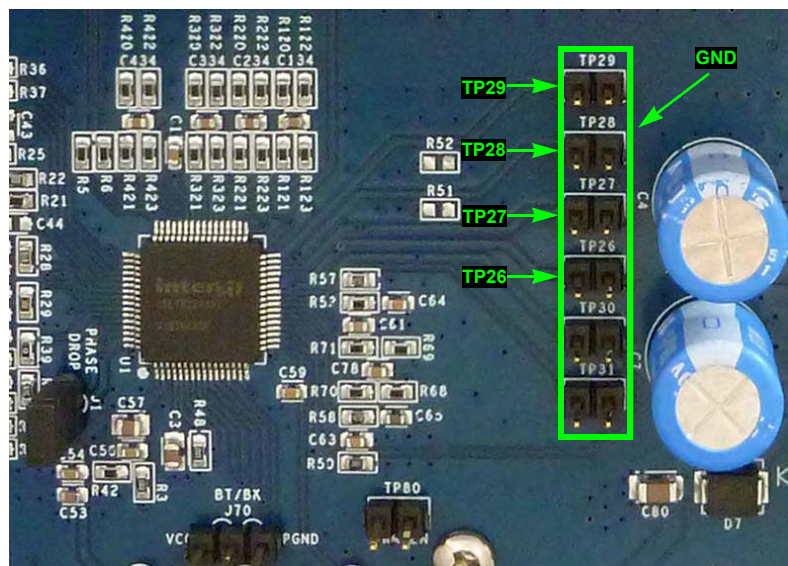
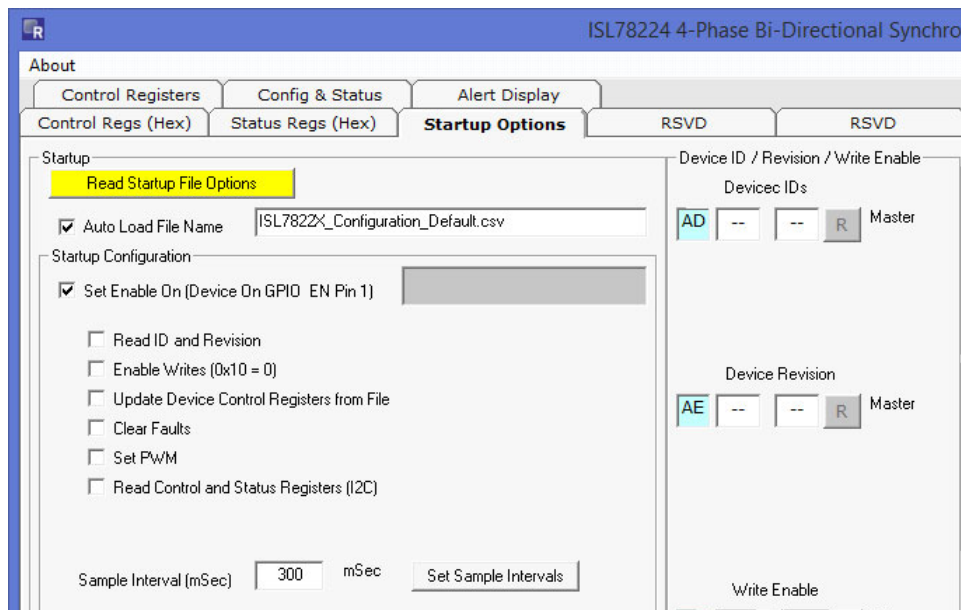


Figure 17. ISL78224 Scope Probe Connections

Table 3. ISL78224 Probe Connections to Monitor Phase Voltages

Jumper	Phase
TP ₂₆	1
TP ₂₇	2
TP ₂₈	3
TP ₂₉	4
N/A	5
N/A	6

- (8) Turn on the 12V supplies, 5V supplies, and the 48V supply (with no particular power supply sequence).
- (9) The first time you power up the board after configuring the board for the Buck mode operation, verify the operation is set to Buck mode.
 - (a) In the software, navigate to the Quick Access Control Panel under **Mode Pin Selection**.
 - (b) Select **Buck mode** from the **BT/BK** drop-down menu.
 - (c) Click the **Enable** button at the top of the Quick Access Control Panel. The indicator next to the **Enable** button turns red.
 - (d) Verify the flyback circuit is working by measuring the voltages at V6 and V12 (see [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections). V6 should measure about 6V and V12 around 12V. If the V6 and V12 measurements are correct, the controller is running and providing the proper clock signal to the flyback circuit. If the measurements are correct, proceed to [Step 10](#).
If the V6 and V12 measurements are not correct, disable the part through the software, turn off all the supplies, and recheck all the connections.
- (10) To automatically start the converter, click the **Read Startup Files Options** button shown in [Figure 18](#). This loads the startup.csv file in the project directory that specifies startup options that set initial device settings. **Note:** You can manually edit the file.

**Figure 18. Read Startup File Options**

- (11) Click **Execute Startup**. The program sets the initial device registers as well as the GUI controls and value windows.

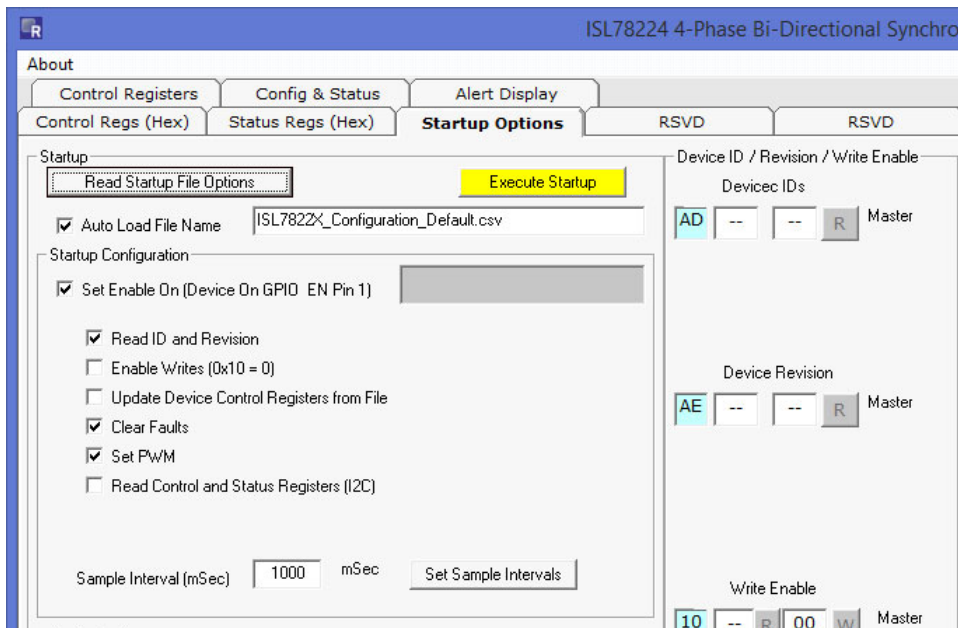


Figure 19. Execute Startup

(12) Observe the Startup Running window for several seconds.

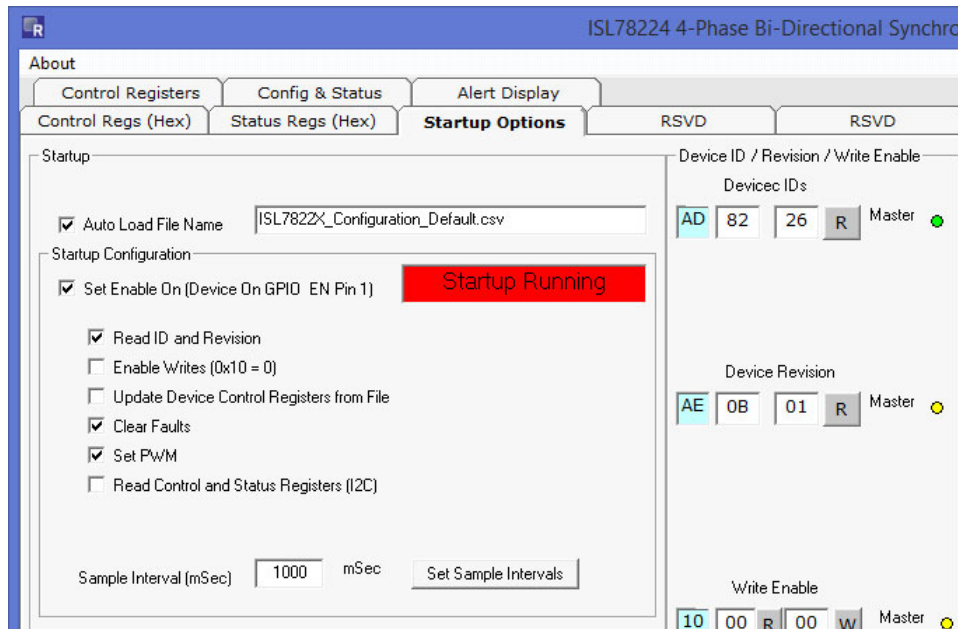


Figure 20. Startup Running

- (13) Wait for the “Startup Completed” message to display. The setup process takes a few seconds to complete.

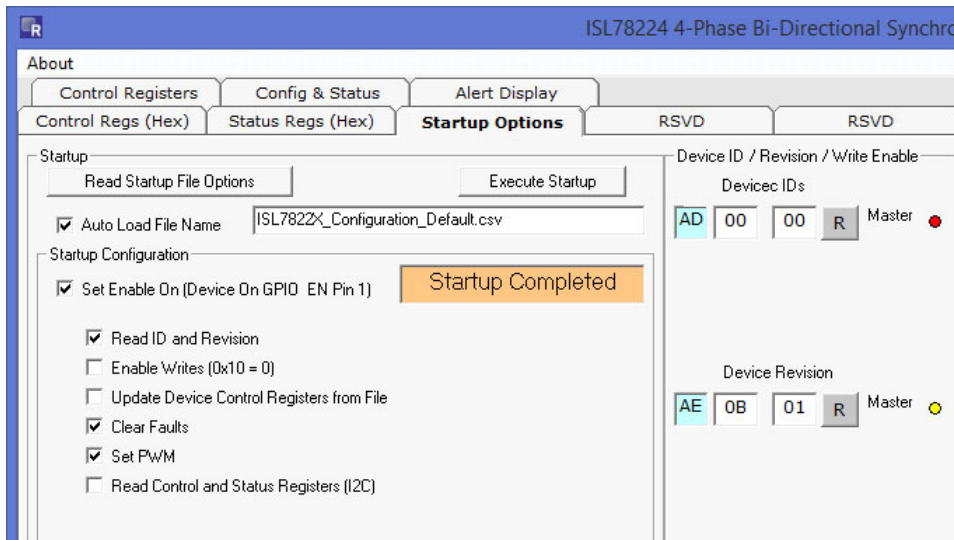


Figure 21. Startup Completed

3.5.2 Boost Mode

Caution: This is a high power application board. Renesas recommends disabling through the software and turning off all supplies before making connections to the board. Failure to do this could damage the board.

- (1) Verify that the computer is connected to the USB to I²C board and the evaluation board
 - (a) See [Figures 3](#) and [4](#) for the ISL78226EVAL1Z setup.
 - (b) See [Figures 3](#) and [5](#) for the ISL78224EVAL2Z setup.
- (2) Verify the jumper connections in [Table 4](#). **Note:** Jumpers not listed in the table are not populated. Some “jumpers” are measurement terminals and do not tolerate being shorted.

Table 4. Jumper Configuration

Jumper ID	Device	Action	Function
J ₁₄	ISL78226	Installed	BAT48 Bode Injection, Jumper for normal operation
TP ₂₃	ISL78224	Installed	
J ₁₅	ISL78226	Installed	BAT12 Bode Injection, Jumper for normal operation
TP ₂₄	ISL78224	Installed	
J ₂₀ Pin 2 connected to J ₂₁ Pin 2	ISL78226	Installed	Short ISET to ISHARE, Jumper for master only operation
	ISL78224	N/A	
J ₂₆	ISL78226	Installed	MCUVDD Bode Injection, Jumper for normal operation
	ISL78224	N/A	
J ₃₅	ISL78226	Switch	PD_CTRL, Switch toward BAT48 (Phase drop ON) Switch toward BAT12 (Phase drop OFF)
J ₁	ISL78224	Jumper	PD_CTRL, Jumper for no Phase drop No jumper for Phase drop
J ₁	ISL78224	Jumper	Phase drop OFF
		No Jumper	Phase drop ON

Table 4. Jumper Configuration (Continued)

Jumper ID	Device	Action	Function
J ₆₃	ISL78226	Installed	Disable V _{IN} voltage clamp
	ISL78224	N/A	
J ₇₀	ISL78226	No Jumper	BT/BK Control Remove for software operation
	ISL78224	No Jumper	
J ₇₁	ISL78226	Installed 1-2	PWM_TRI Enable tri-state driver operation
	ISL78224	N/A	
J ₈₀	ISL78226	Installed 2-3	TRACK
	ISL78224	Installed 2-3	
J ₈₁	ISL78226	Installed 2-3	ADDR1 Configures as master
	ISL78224	N/A	
J ₈₂	ISL78226	Installed 2-3	ADDR2 Configures as master
	ISL78224	N/A	
J ₈₈	ISL78226	No Jumper	DE/CCM Remove for software operation
	ISL78224	No Jumper	
J ₈₉	ISL78226	No Jumper	HIC/LAT Remove for software operation
	ISL78224	No Jumper	
JP ₃₁₀	ISL78226	Installed	Jumper to enable Phase 3
	ISL78224	N/A	
JP ₄₁₀	ISL78226	Installed	Jumper to enable Phase 4
	ISL78224	N/A	
JP ₅₁₀	ISL78226	Installed	Jumper to enable Phase 5
	ISL78224	N/A	
JP ₆₁₀	ISL78226	Installed	Jumper to enable Phase 6
	ISL78224	N/A	

- (3) Connect the DC electronic load or 48V battery to one or more of the BAT48 connectors. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections. **Note:** the PCB connects all BAT48 phases together and all BAT48 PGNDs together. For high power evaluations, Renesas recommends connecting the 48V load or battery to all six phases for distribution of power across the board.
- (4) Connect a 12V supply or battery to one or more of the BAT12 connectors. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections. **Note:** the PCB connects all BAT12 phases together and all BAT12 PGNDs together. For high power evaluations, Renesas recommends connecting the 12V supply or battery to all six phases for distribution of power across the board.
- (5) Connect a 12V supply to the VIN and VIN_FLY with its ground connected to FLYGND. Disconnect the 5V supply from BAT12_IN if it was previously connected. See [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections. The evaluation board has a diode to prevent the reverse current flowing from the BAT12 supply to the 5V supply so the 5V supply can be safely disconnected. A normal application circuit has a 12V battery for precharge and the BAT12_IN voltage is not required.
- (6) Connect probes as shown in [Table 2](#) and [Figure 16](#) or [17](#). **Note:** Renesas recommends disabling the part through the software and turning off all supplies before making connections to the board.
- (7) Turn on the 12V supplies, 5V supplies, and the 48V supply (no particular power supply sequence).

- (8) The first time you power up the board after configuring the board for Boost mode operation, verify the operation is set to Boost mode.
 - (a) In the software, navigate to the Quick Access Control Panel under **Mode Pin Selection**.
 - (b) Select **Boost mode** from the **BT/BK** drop-down menu.
 - (c) Click the **Enable** button at the top of the Quick Access Control Panel. The indicator next to the **Enable** button turns red.
 - (d) Verify the flyback circuit is working by measuring the voltages at V6 and V12 (see [Figure 55](#) for ISL78226 connections and [Figure 56](#) for ISL78224 connections). V6 should measure about 6V and V12 should measure around 12V. If the V6 and V12 measurements are correct, the controller is running and providing the proper clock signal to the flyback circuit. If the measurements are correct, proceed to [Step 9](#).
- (9) To automatically start the converter, click the **Read Startup Files Options** button shown in [Figure 22](#). This loads the startup.csv file in the project directory that specifies startup options that set initial device settings. **Note:** You can manually edit the file.

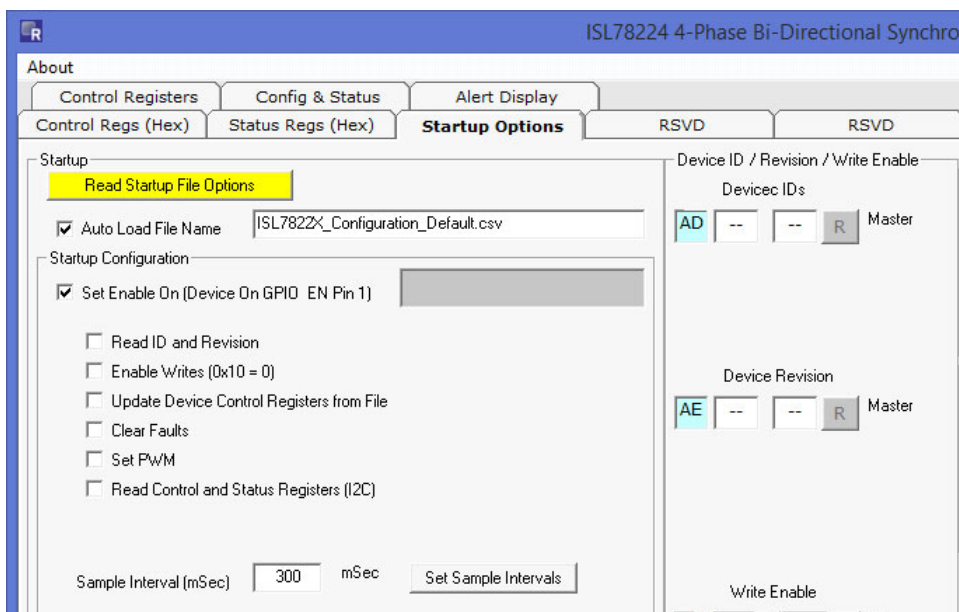


Figure 22. Read Startup File Options

- (10) Click **Execute Startup**. The program sets the initial device registers as well as the GUI controls and value windows.

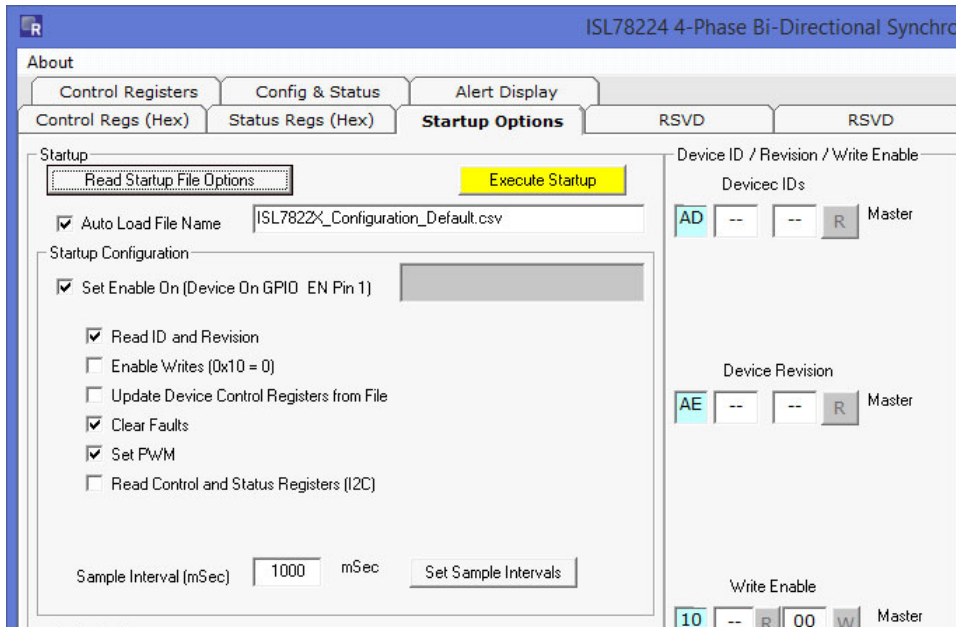


Figure 23. Execute Startup

- (11) Observe the Startup Running window for several seconds.

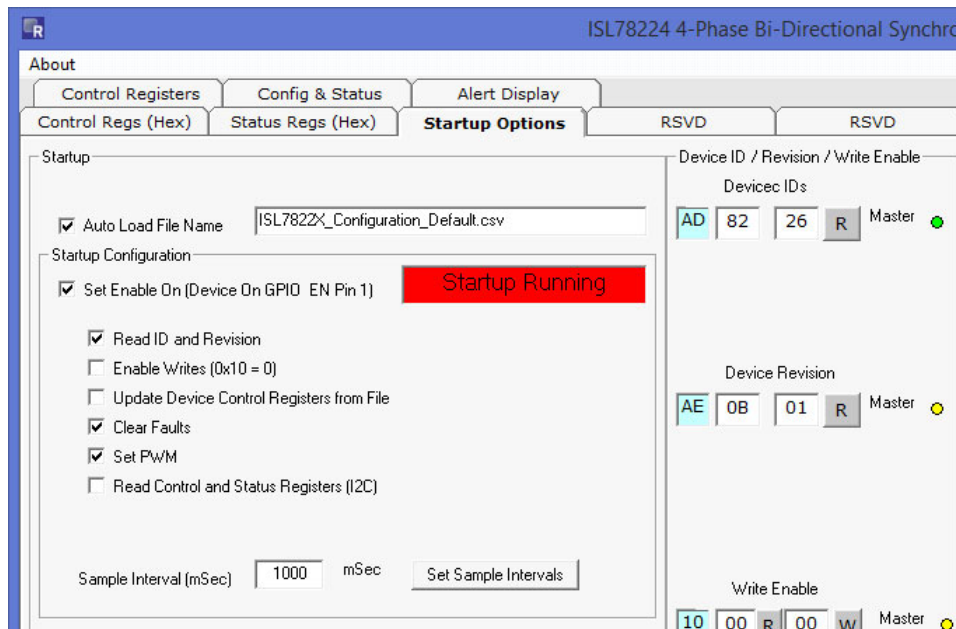


Figure 24. Startup Running

(12) Wait for the “Startup Completed” message to display. The setup process takes a few seconds to complete.

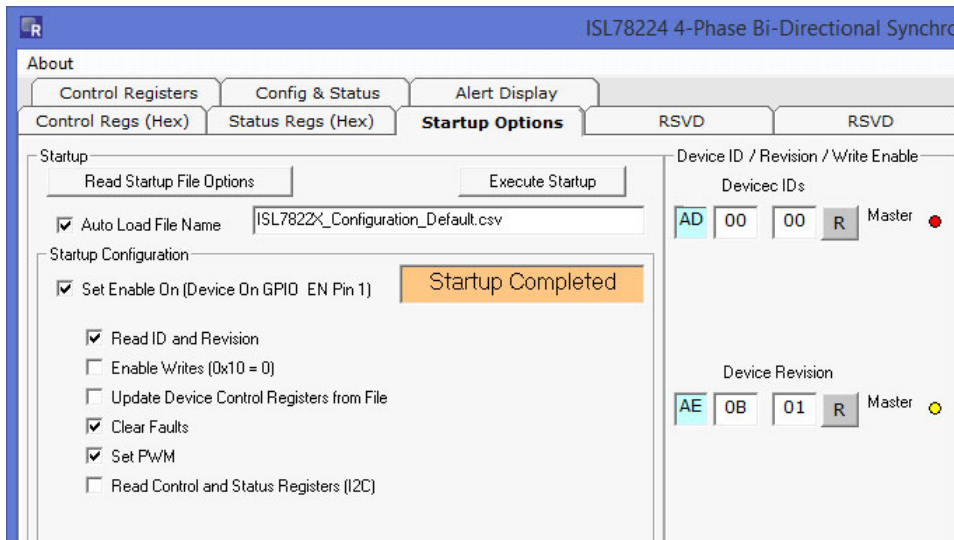


Figure 25. Startup Completed

The Quick Access Control Panel in [Figure 26](#) shows the status for multi-chip operation with one master and three slaves.

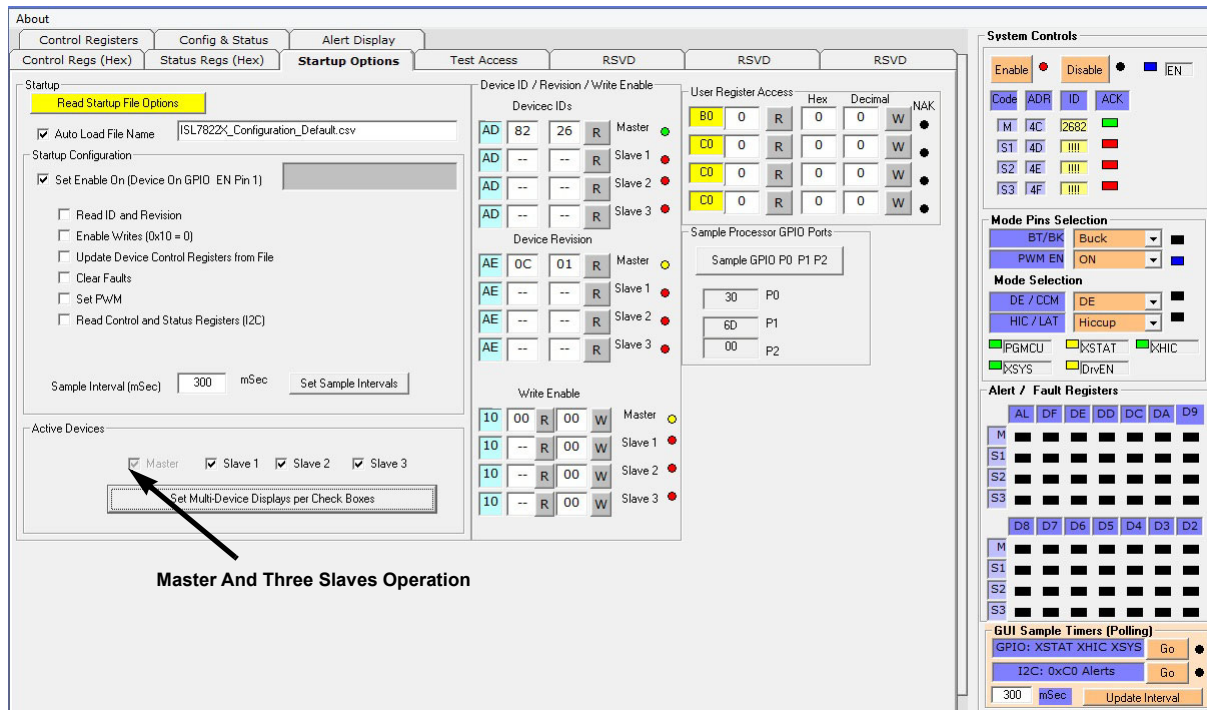


Figure 26. Master and Three Slave Selection

To simplify the screen for single master operation, click the **Master** box in the **Active Devices** section of the Startup Options screen and click the **Set Multi-Device Displays per Checked Boxes** bar. [Figure 27 on page 23](#) shows the **Startup Options** and the Quick Access Control Panel for this configuration.

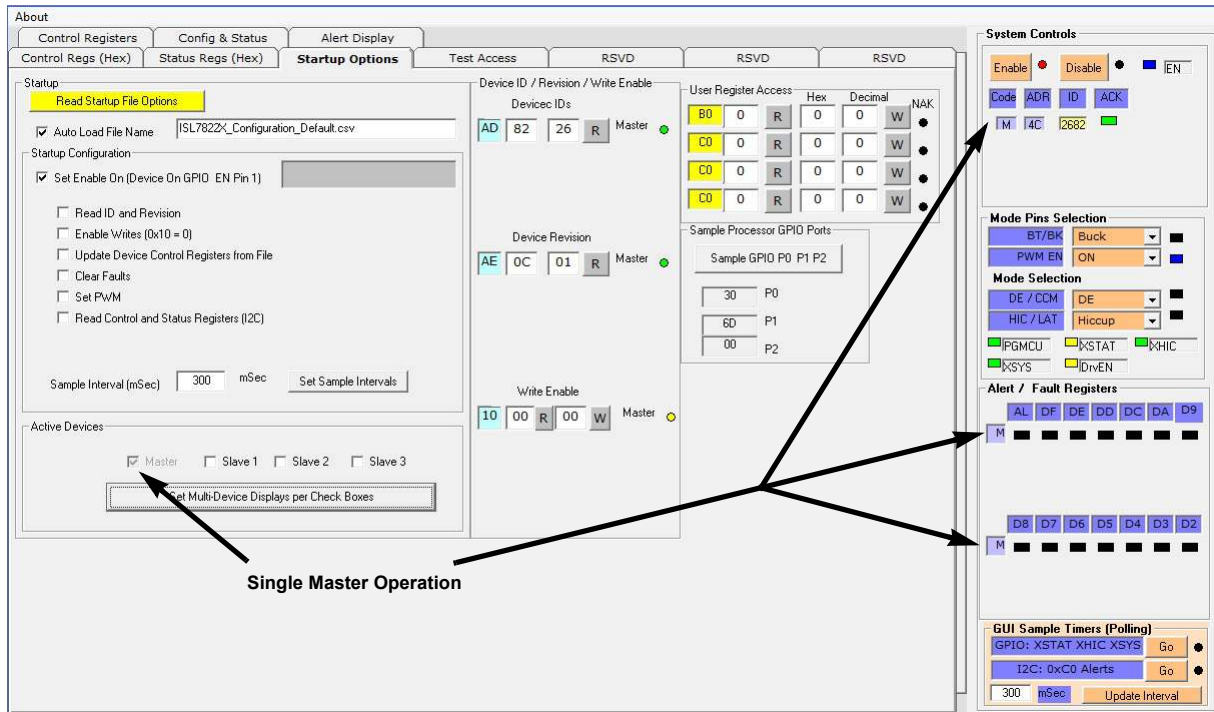


Figure 27. Master Only Selection

4. Overview - Using the Software

4.1 Quick Access Control Panel

[Figure 28](#) shows the Quick Access Control Panel configured as a single master with zero slaves.

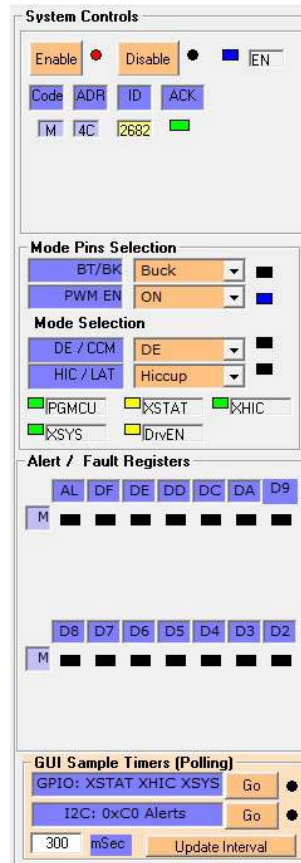


Figure 28. One Master and Zero Slaves

[Figure 29](#) shows the Quick Access Control Panel configured as a master with three slaves.

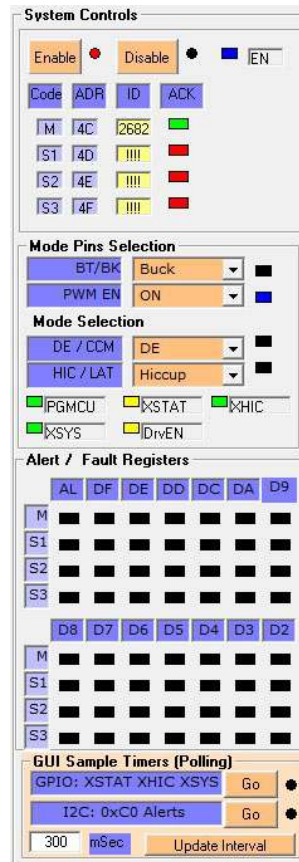


Figure 29. One Master and Three Slaves

The controllers can be configured with up to four devices. **Note:** The customer evaluation boards are equipped for single controller operation only. See the [ISL78226](#) and [ISL78224](#) datasheets for information about multi-chip operation. Notice the red ACK (acknowledgment) for the slave devices indicates a failed transfer, because no slaves are connected.

The Quick Access Control Panel shows the top level status of all devices.

4.1.1 System Controls

The top portion of the **System Controls** section controls the main EN (enable) pin for turning the master device on and off. Click **Enable** to bring up the internal LDO and enable I²C communications.

The **ID** window (device ID) and **ADR** window (I²C addresses) are located below **Enable** in the **System Controls** panel. The ID Register I²C read back value is displayed along with a Green or Red indicator for I²C Acknowledge.

4.1.2 Mode Pins Selection

The **Mode Pins Selection** section controls the GPIO interface pins.

[Figure 29](#) shows five GPIO pins being controlled: four in the **Mode Pins Selection** section and the main Enable pin above. Below the GPIO pins, five status pins are also monitored (PGMCU, XSTAT, XHIC, XSYS, and DrvEN).

4.1.3 Alert/Fault Registers

A main function of the ISL78226 and ISL78224 is to monitor the many different digital and analog fault indicators. As many as 70 different conditions are monitored. However, the controllers have a digital architecture to simplify the verification of these indicators. A common Fault Index Register provides a top level way to check the status conditions. Each bit in the Fault Index Register (0xC0) indicates that one or more of eight different fault registers is active. By reading Register 0xC0 with a single I²C byte read transaction, the controller can check all 56+ fault indicators.

The ideal design target has minimal overhead, a single I²C byte read, and all faults can be monitored. The discrete outputs monitored in **Mode Pins Selection** (XSTAT, XHIC, XSYS) can also be used as a total monitor of all fault conditions.

4.1.4 GUI Sample Timers (Polling)

This section enables timer controlled polling. The software has two different timers that both sample all I²C fault registers (0xC0, 0xD2 to 0xDA) and system status registers (0xDC, 0xDD, and 0xDF).

Click **Go** to enable timer controlled polling, which continues until you click **Stop**.

The software reads all fault registers and system status registers during every poll.

Note: When polling is active, all other software inputs are disabled. To enable them, click **Go** again to stop polling.

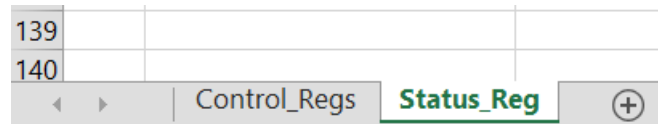
4.1.5 Quick Access Control Panel Summary

The Quick Access Control Panel design enables a quick power down using the EN or PWM_EN GPIO controls. If polling is enabled, the panel provides a visual monitor if the GPIO pins or the 0xC0 fault index register detect faults. Therefore, the screen design provides the ability to detect faults and power down the device quickly no matter which tab is active.

4.2 Understanding Device Operation

Although the analog aspects of the buck/boost process and the related multiple phase circuitry are key to successful performance, it is easier to understand device operation from a digital standpoint. The [RegisterDefinitions](#) provide detailed register definitions for both control registers and status registers.

The spreadsheet workbook has two tabs, Control_Regs and Status_Reg.



Review the control and status registers for an overview of the controller's major functions.

4.2.1 Control Registers 0xB0 - 0xBF

The first tab in the spreadsheet lists the control registers. These registers are both readable and writable and control the operational aspects of the device.

4.2.2 Fault and Status Registers 0xC0, 0xD2-0xDF

The second tab in the spreadsheet lists the status registers. While the ISL78226 and ISL78224 control Buck/Boost and Phase operation, the system status is also monitored in real time. This information includes many Faults/Alert functions. In addition, the system status registers feedback from programmed conditions and self adjusting operating parameters.

4.2.3 Register Summary Overview

50% of the digital capability is focused on control and 50% is focused on monitoring. This also drives the tabs of the software.

4.3 Tab Overviews

[Figure 30](#) shows the tabs.

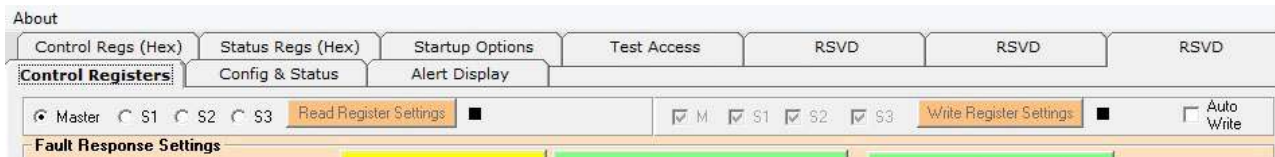


Figure 30. Display Tabs

4.3.1 Startup Options Tab

The **Startup Options** tab configures the first options after the software connects to the USB dongle as shown in [Figure 27 on page 23](#).

Although a certain amount of startup automated convenience is desirable when working with the ISL78226 and ISL78224, sometimes only operator requested specific actions take place. A portion of this tab deals with operator options for initializing the device and the project software/hardware.

Other portions of this tab deal with basic functions such as reading the ID register, reading the revision level, and enabling register writes. This tab also controls some requested general purpose register access tools that enable you to access any register.

The **Active Devices** portion allows you to force the active devices setting (Master, Slave 1, Slave 2, and Slave 3). This tab is mostly used during program development, but also helps convey master to slave signal/interconnect.

4.3.2 Alert Display Tab

The **Alert Display** tab displays all Faults/Alerts and is shown in [Figure 47 on page 38](#). The information is presented in datasheet terminology. Faults that go active change the indicator color to dark red. Use the macro buttons to clear faults.

4.3.3 Control Registers Tab

The **Control Registers** tab (shown in [Figure 39 on page 33](#)) provides a user-level way to interactively select specific options related to each register. English language settings enable you to better understand functional operation.

4.3.4 Config & Status Tab

The **Config & Status** tab displays device conditions (Registers 0xDC, 0xDD, and 0xDF) and interprets bits in the same descriptive terms used in the datasheet as shown in [Figure 49 on page 39](#).

4.3.5 Hex Tabs

The **Control Regs (Hex)** and **Status Regs (Hex)** tabs control the basic register (Hex) contents that verify device content at the byte level and are useful for verifying firmware performance during development.

4.3.5.1 Control Regs (Hex) Tab

The **Control Regs (Hex)** tab allows you to directly read and write hex data to each register location as shown in [Figure 38 on page 32](#). These bidirectional registers set up the device operation.

This tab enables the basic read/write for all active devices and contains buttons that enable you to write to and read from configuration files. You can also use the buttons to create and load new files.

Note: use the **Save Configuration File** button to save user-developed specific settings. If you do not save these settings, you must reprogram all the operational options from scratch after each power up. See [“Editing Startup Files for Fault Response” on page 35](#) and [“Quick Start Videos” on page 6](#) for more information about using the software.

4.3.5.2 Status Regs (Hex) Tab

The **Status Regs (Hex)** tab is similar to the **Control Regs (Hex)** tab except these registers are read only. The tab is shown in [Figure 46 on page 37](#). There is no provision for initialization of these registers. This tab also accommodates configurations of one to four devices.

5. Using the Software - Detailed

The following section details the main features of the software.

5.1 Startup

5.1.1 Startup Options Tab

The **Startup Options** tab ([Figure 26 on page 22](#)) enables automated startup or lets you manually perform specific steps. The Automatic feature goes through the four steps shown in [Figure 31](#).

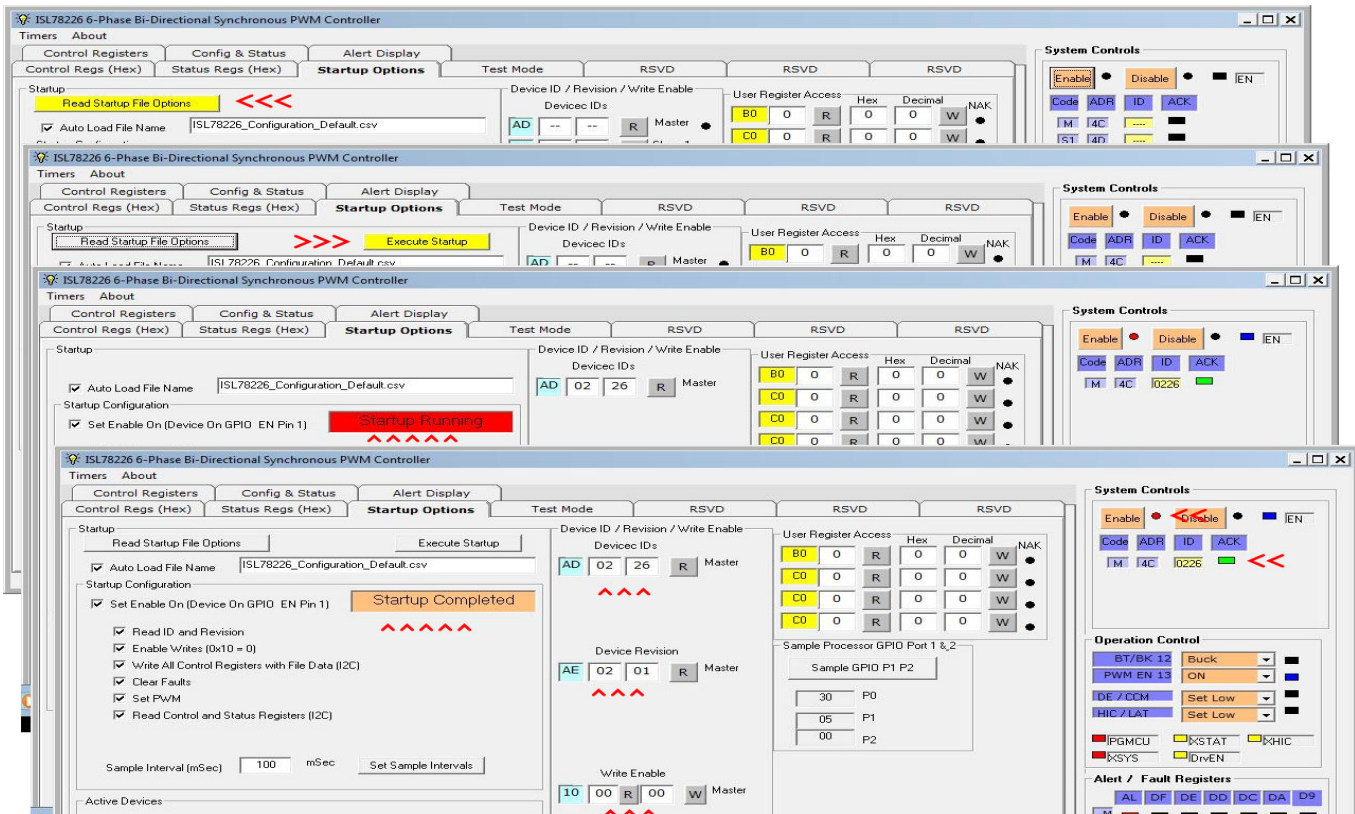


Figure 31. Automatic Startup Using the Startup Tab

5.1.1.1 Startup Panel (Startup Options Tab)

Start the Automatic process in the **Startup** panel of the **Startup Options** tab. Complete the following steps to use the Automatic process.

- (1) Click **Read Startup File Options** (see [Figure 32](#)).

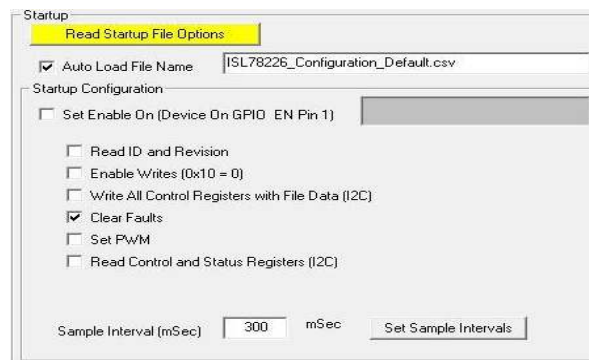


Figure 32. Startup Screen

(2) The program opens the **startup.csv** file in the project directory.

[Figure 33](#) shows the contents of the **startup.csv** file.

	A	B	C	D	E	F	G	H	I
1	ISL78226 Startup File	Date	030316						
2	Auto Load	True	File Name	ISL78226_Configuration_Default					
3	Auto Detect	False	Master	True	Slave1	False	Slave2	False	Slave
4	Set Enable	True							
5	ReadID and Revision	True							
6	Enable Write 0x10	True							
7	Write Control Registers and Set Status	True							
8	Read Control Registers Status	True							
9	Set Buck	True							
10	Set Boost	True							
11	Set PWM On	True							
12	GPIO_Sample Interval	300							
13	IC2_Sample Interval	300							
14									

Figure 33. Startup.csv Options Definition File

(3) The file contents set the option buttons in the **Startup Configuration** panel shown in [Figure 34](#).

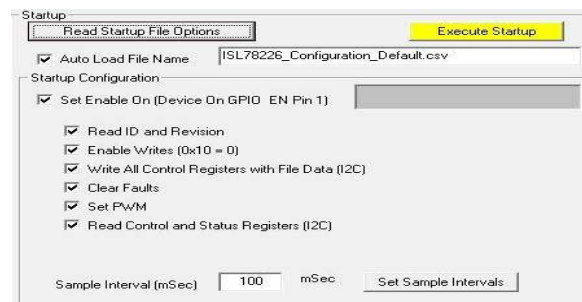


Figure 34. Execute Startup

- (4) After loading the file and before executing the automatic startup, you can change the startup conditions by checking or unchecking the boxes. When you are ready for startup, click **Execute Startup**.
- (5) The software executes the enabled functions specified in the **startup.csv** file. The status window turns red during processing and indicates when the process is complete. As shown in [Figure 31 on page 29](#), various fields are updated when completed.

5.1.1.2 Device ID/Revision/Write Enable Frame

Review the datasheet and register definitions related to Address 0xAD, 0xAE, and especially Address 0x10. The Write Enable Register must be set to 0x00 to modify the contents of the ISL78226 and ISL78224 I²C registers.

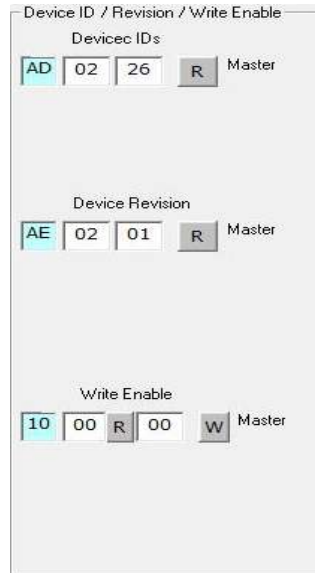


Figure 35. Device ID, Revision, and Write Enable

5.1.1.3 User Register Access



Figure 36. User Register Access

The User Register Access panel provides a general purpose tool for accessing I²C registers. You can edit the yellow address field. After you edit the field, you can read or write the contents with a typed in hex or decimal value. A green ACK indicates a successful transfer. A red ACK indicates a failed transfer. Make sure the address is valid; if writing, register 0x10 (Write Enable) must be written with a 0x00.

5.1.1.4 GPIO Monitor Panel

[Figure 37](#) shows the GPIO monitor panel. The panel is used for advanced troubleshooting and displays the GPIO port read values of the Renesas dongle. Contact Renesas [support](#) for more information.

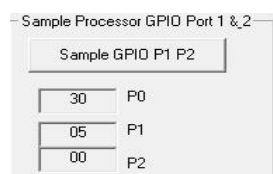


Figure 37. GPIO Monitor

5.2 Control Regs (Hex) Tab

The **Control Regs (Hex)** tab (Figure 38 on page 32) enables you to both read and write locations 0xB0 to 0xBF and 0xEC to 0xED. The tab's registers control the 60+ mode/operation settings of the ISL78226 and ISL78224. The form is designed to configure up to four controllers at a time. Figure 38 shows operation of the master controller only.

Register	Name	R	W	M		
B0	Control Register : Tracking PINV Clear Enable	--	R	--	W	●
B1	Individual Fault Response 1 : BAT12 Volt	--	R	--	W	●
B2	Individual Fault Response 2 : BAT48 Volt	--	R	--	W	●
B3	Individual Fault Response 3 : V12 / V6 Volt	--	R	--	W	●
B4	Individual Fault Response 4 : Fly OC ACP Fly S	--	R	--	W	●
B5	Reserved					
B6	Individual Fault Response 5 : Phase Removal C	--	R	--	W	●
B7	Individual Fault Response 6 : BAT12 Voltage	--	R	--	W	●
B8	Individual Fault Response 7 : BAT48 Volt	--	R	--	W	●
B9	BAT 12 Over Voltage Setting Control	--	R	--	W	●
BA	BAT 12/ BAT 48 Under Voltage Control	--	R	--	W	●
BB	BAT 48 Over Voltage Setting Control	--	R	--	W	●
BC	Individual Phase Removal Control	--	R	--	W	●
BD	Serious Fault Response Control	--	R	--	W	●
BE	Minimum On Time / ISHARE	--	R	--	W	●
BF	Maximum On Duty	--	R	--	W	●
EC	Boot Refresh Control Register	--	R	--	W	●
ED	Average Current Protection Limit	--	R	--	W	●

File Name: Un-Named

Figure 38. Control Regs (Hex) Tab (After Clicking Read All Control Registers Button)

The low level hex interface form enables you to verify and write fundamental contents of each register, which is useful when troubleshooting. The displayed results can be compared to the datasheet or Excel register tables.

You can read or write to individual byte locations. Each register also has an activity indicator that changes color whenever a register is accessed.

Enter hex data in the **W** text box. The **R** text box returns the hex value of the contents of the selected register.

Use the **Read All Control Registers** button to read all values. Use the **Write All Control Registers** button to write all values. You can also write register information to a configuration file in the project directory.

The configuration file(s) enable you to store and recall device settings for all control registers, which allows you to return to multiple test setups and experiments.

The **ACK** indicator provides immediate feedback if I²C communication problems occur. A green **ACK** indicates that no communication problems occurred. A red **ACK** indicates a communication problem.

5.3 Control Registers Tab

The **Control Registers** tab is hierarchically a level up from the **Control Regs (Hex)** tab and is shown in [Figure 39](#).

Figure 39. Control Registers Tab

This tab provides information on an address-by-address basis. Therefore, the information is presented at the byte level, so you must parse the fields, review the options, and calculate the end byte value.

[Figure 40](#) shows the 0xB8 portion of the **Control Regs (Hex)** tab.

Figure 40. Control Regs Hex Tab: 0xB8

The 0xB8 location content values can be read and written in hex.

The **Control Registers** tab has a much more user friendly way to set or interpret the 0xB8 contents. On the **Control Registers** Tab, the 0xB8 register is set or read using four different combo boxes highlighted in red in [Figure 39 on page 33](#).

The [RegisterDefinitions](#) link provided here contains detailed register definitions for both Control Registers and Status Registers.

The combo boxes shown in [Figure 41](#) allow only combinations recognized by the device.

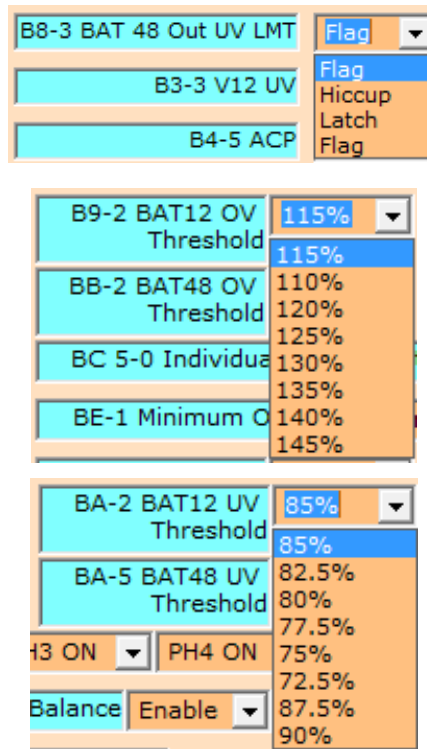


Figure 41. Combo Boxes with Drop-down Selection Shown

The example byte of the control register in [Figure 42](#) shows that one byte manages four different mode settings and that more than 60 different individual operator settings can exist.

Name	Address	Bit	R/W	Name/ Purpose	Default Value	Description
Individual Fault Response Control Register 7	0xB8	0	R/W	BAT48 Output Over Voltage Limit Fault Response Control bit	0x0	0,0 =Flagging only (Default) 0,1 = Hiccup 1,0 = Latch-off 1,1 = Ignore
		1				
		2	R/W	BAT48 Output Under Voltage Limit Fault Response Control bit	0x0	0,0 = Flagging only (Default) 0,1 = Hiccup 1,0 = Latch-off 1,1 = Ignore
		3				
		4	R/W	BAT48 Input Over Voltage Limit Fault Response Control bit	0x0	0,0 = Flagging only (Default) 0,1 = Hiccup 1,0 = Latch-off 1,1 = Ignore
		5				
		6	R/W	BAT48 Input Under Voltage Limit Fault Response Control bit	0x0	0,0 = Flagging only (Default) 01 = Hiccup 10 = Latch-off 11 = Ignore
		7				

Figure 42. Portion of Control Regs (Hex) Tab Spreadsheet

Because many of these settings can have four to eight different combinations (combo selections), there can be hundreds of operator options when determining device setup.

5.3.1 Control Register Programming

[Figure 43 on page 35](#) shows the top section of the **Control Registers** tab. From the tab you can select which device (Master, Slave 1, Slave 2, or Slave 3) is read. The right side controls which (or all) devices are programmed during an update or write operation.

The **Auto Write** check box sets a flag so that the software updates registers as individual combo box selections are changed. When the **Auto Write** check is off, you can make several changes, but you can have them written only to the device registers when you click **Write Register Settings**.

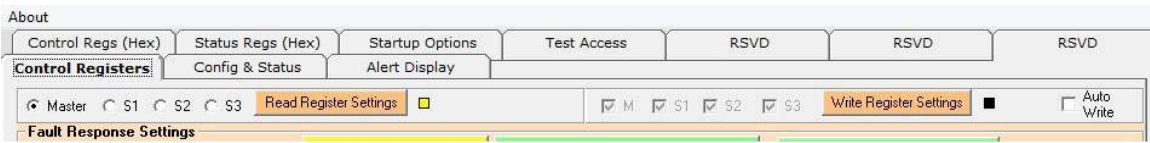


Figure 43. Control Register Programming

5.3.2 Combo Box Options

Flag: If a fault is detected, the fault response is to notify the user and continue operation.

Latch: If a fault is detected, the fault response is to shut the system down. The only way to recover is to cycle the supplies.

Hiccup: If a fault is detected, the fault response is to shut the system down and restart the system every 500ms. If a fault is still present, shut the system down and repeat until the fault is removed.

5.3.3 Fault Response Settings

A portion of the control registers in the digital domain select the actions to be taken when fault(s) occur. The software combo boxes have specific options for each register and guide you through the setup process.

5.3.4 Editing Startup Files for Fault Response

You can save fault responses in the startup file during the initial startup from the software. This option enables you to preload fault responses the next time you resume the project. Refer to the *Phase Dropping and Tracking* video to see this procedure ([“Quick Start Videos” on page 6](#)). The selection discussing saving fault responses to a file is at the end of the video.

Complete the following steps to set the fault responses for the input and output UV and OV limits from the **Control Registers** tab.

- (1) You can set the fault response for the input and output UV and OV limits from the **Control Registers** tab ([Figure 39 on page 33](#)). In the **Fault Response Settings** section of the **Control Registers** tab, change the combo box from **Disabled** to **Enabled** and click the yellow **Write / Update B0-7 Individual Fault Response** button beside the **Enable/Disable** combo box. This setting enables all the fault responses to be changed from their individual combo boxes.
- (2) When the fault responses have been set, click **Write Register Settings** (top right of the **Control Registers** tab) to save the fault responses.
- (3) Click **Read Register Settings** (top left of the **Control Register** tab) to verify the settings have been saved.
- (4) To save these settings to a file for later use, click the **Control Regs (Hex)** tab ([Figure 38 on page 32](#)).
- (5) Click **Save Configuration File** (lower right side of the **Control Regs (Hex)** tab).
- (6) A pop-up window prompts you to save the file on the C: drive. If the default locations are selected when the software is loaded, click **Open** to save the file to this location on the C: drive (C:\PC8\Users\Public\ISL78226).

Complete the following steps to reload the fault response settings at startup.

- (7) Click **Read Startup File Option** (yellow button) in the **Startup Options** tab ([Figure 26 on page 22](#)).
- (8) Check the box beside **Update Device Control Registers from File**.
- (9) Check the box beside **Read Control and Status Registers (I²C)**.
- (10) Click the yellow **Execute Startup** button. The saved fault responses are now loaded into the controller.

Complete the following steps to confirm the fault responses have been loaded into the registers.

- (11) Click the **Control Registers** tab ([Figure 39 on page 33](#)).
- (12) In the **Fault Response Setting** section, change the combo box from **Disabled** to **Enabled**.
- (13) Click the yellow **Write / Update B0-7 Individual Fault Response** button beside the **Enable/Disable** combo box. The fault responses for the individual faults are now indicated in the combo boxes.

5.3.5 Configuration Register Settings

From a device operation viewpoint, several parameters can be varied based on your application. These options can modify analog thresholds or set digital mode options. The combo boxes allow only combinations recognized by the device.

The **Control Registers** tab enables programming of many device settings with hundreds of options. The drop-down combo boxes shown in [Figure 44 on page 36](#) provide an English language indication of each possible option.

Note that each description label contains a reference to a hex value coupled with a bit value as well. For example, “B9-2” designates location 0xB9, and Bit 2 designates a location definition. This information helps clarify specifically which register bits are read or written in the associated combo box.

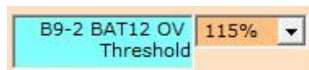


Figure 44. Description Label in Control Reg Tab

In [Figure 44](#), the label and combo box refer to the entry in [Figure 45](#) from the Excel register definitions file.

Name	Address	Bit	R/W	Name/ Purpose	Default Value	Description
BAT12 Over Voltage Setting Register	0xB9	2:0	R/W	BAT12 Over Voltage Threshold Control	0x0	BAT12 is higher than the Target Voltage 000=115% (Default), 001=110%, 010=120%, 011=125%, 100=130%, 101=135%, 110=140%, 111=145%.

Figure 45. Excel Register Definitions File

5.4 Status Regs (Hex) Tab

The second half of the ISL78226 and ISL78224 device registers address the important faults/alerts monitoring capability of the controllers. These registers address Fault detection (Fault Status: 0xD0 to 0xDA) and observation of dynamic operating conditions such as operating conditions that can change as the device runs (System Status: 0xDC, 0xDD, and 0xDF).

This tab also enables a quick and direct way for you to verify actual register contents, which is useful during development and verification work.

Each location can be individually read using the **R** button. The **Read All Status** button provides a read all function.

The I²C **ACK** indicator reveals if successful access occurs. Each location has an activity indicator that changes color whenever a register is accessed (see [Figure 46 on page 37](#)).

See the “Fault Index Register 0xC0” section in the datasheet or the Excel file [RegisterDefinitions](#). This fault register serves as a “Master Flag” indicator to signify a non-zero (active fault) condition in registers 0xD2 to 0xDF.

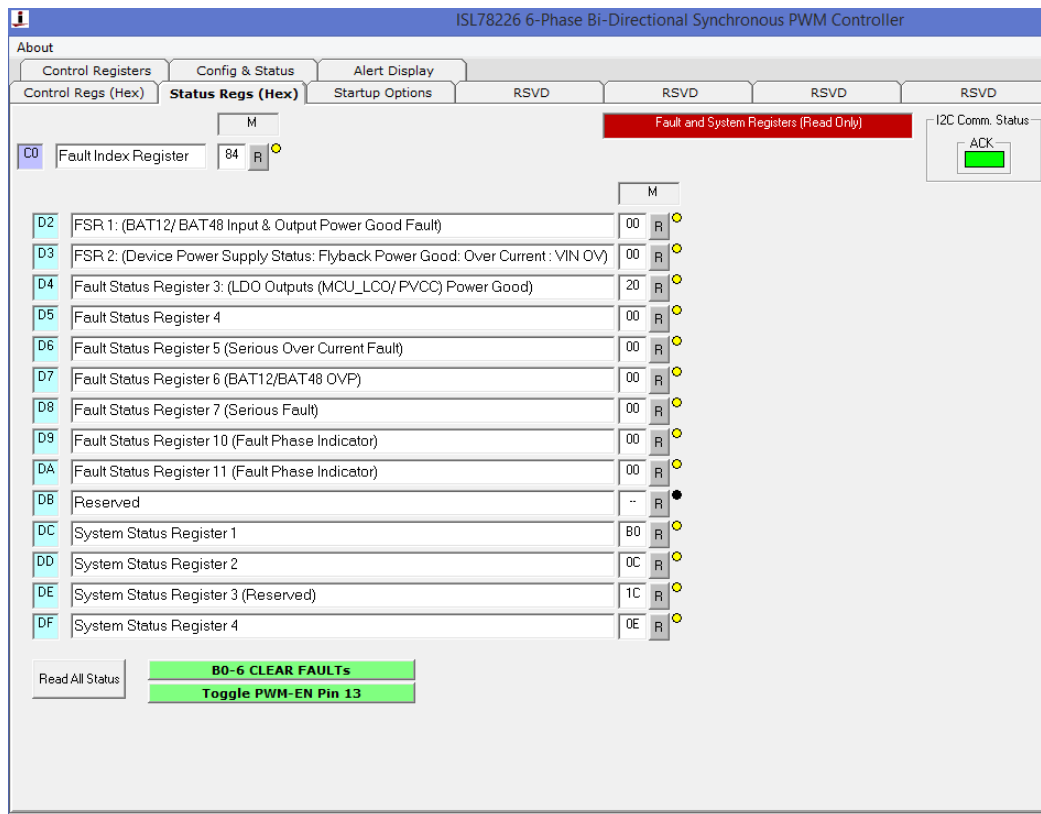


Figure 46. ISL78226 Status Regs (Hex) Tab

5.5 Alert Display Tab

The **Alert Display** and **Config & Status** tabs serve as the “next step up” to the Status Regs (Hex) tab.

Just as the **Control Registers** tab provides a user-friendly interface to control registers, the **Alert Display** and **Config & Status** tabs help you interpret the read only registers. Specifically, the **Alert Display** tab provides a visual indication of the Fault Registers (0xD2 to 0xDA).

5.5.1 Alert Display Tab Buttons

The **Alert Display** tab has several buttons for debugging the design. **Update Status** reads all registers and displays their values. **Clear Faults** and **Toggle PWM_EN** perform interconnect sequences as described in the datasheet. **Clear I²C Error** performs an internal device reset on the I²C state machine.

As polling runs, **Update Status** is executed automatically once per second. A red window indicates an active fault. [Figure 47 on page 38](#) shows the **Alert Display** tab with a single master configuration. The dark red cells indicate that a fault condition was detected.

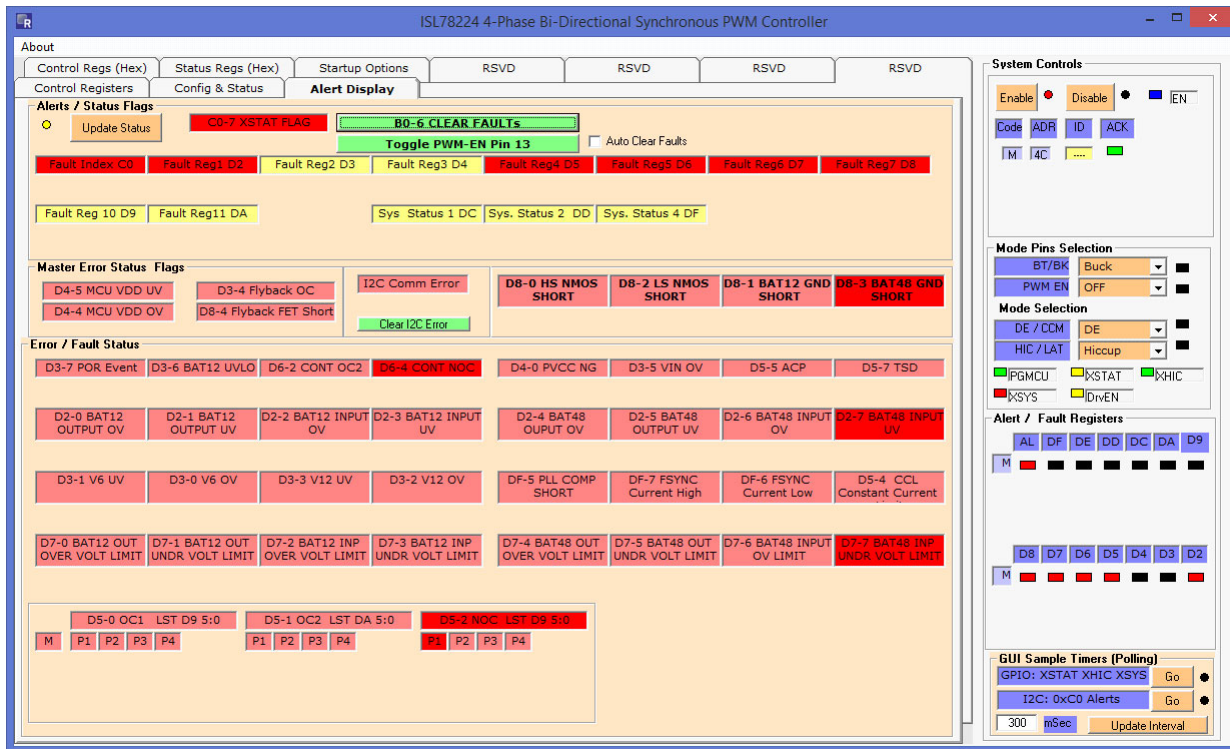


Figure 47. Alert Display Tab Buttons Master Only

Figure 48 shows the form operating with one master and three slaves.

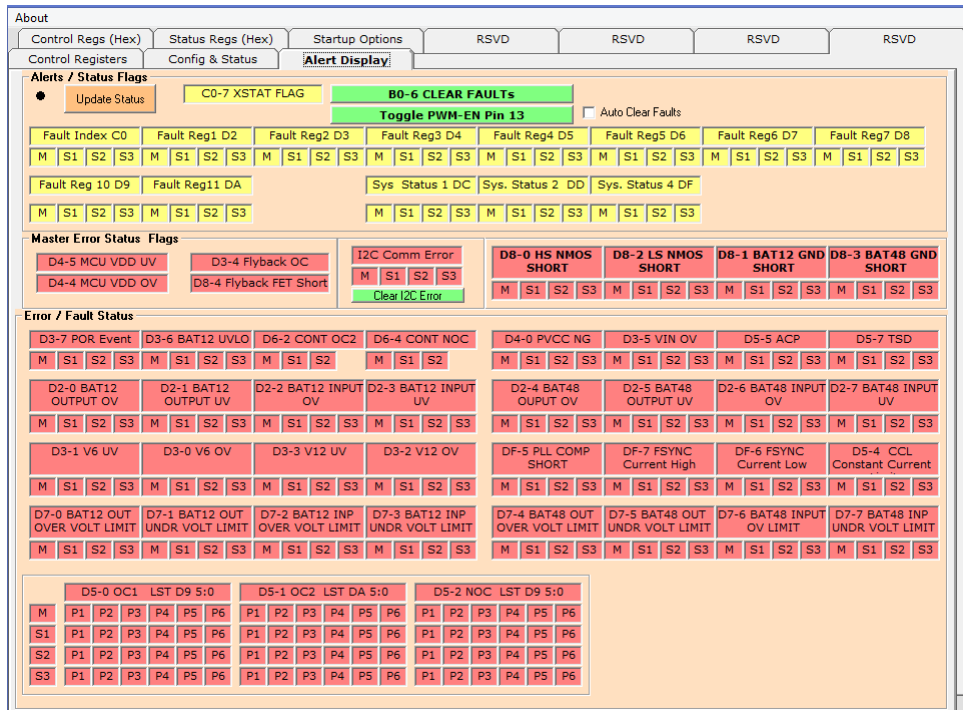


Figure 48. Alerts Display Tab with Four Active Devices

The **Auto Clear Faults** check box at the top of the form provides options during polling. **Auto Clear Faults** is used during testing to automatically clear faults, which is useful for simulating various faults when polling is active.

5.6 Config & Status Tab

The **Config & Status** tab shown in [Figure 49](#) deals specifically with the system status registers (0xDC, 0xDD, and 0xDF). Like the alert registers, these registers are read only. However, these registers are general information registers.

The screenshot shows the 'Config & Status' tab with the following data:

Control Regs (Hex)	Status Regs (Hex)	Startup Options	RSVD	RSVD	RSVD	RSVD		
Control Registers	Config & Status	Alert Display						
Update Status: B0-6 CLEAR FAULT FLAGS								
System Status Register 1 0xDC								
Device	DC-7 PWM Output Ready	DC-5 PWM Output Mode	DC-4 Protection Mode	DC-3 Switching Mode	DC-2 Position	DC-0 BT/BK		
M 0x4C	Driver Enabled	3 State	Hiccup	DE_Mode	Master	Buck Mode		
System Status Register 2 0xDD								
Device	DD-6 Maximum Phase	DD-3 Operating Phase	DD-0 Phase Drop Enable / Disable					
M 0x4C	000 6 Phase	110 2 Phase	Phase Drop Enabled					
System Status Register 4 0xDF								
Device	DF-7 FSYNC Low Current	DF-6 FSYNC High Current	DF-5 PLL Short	DF-4 Clock Source Change	DF-3 Soft On Done	DF-2 Soft Start Done	DF-1 PLL Lock	DF-0 Clock Source
M 0x4C	FSYNC Normal	FSYNC Normal	PLL NORMAL	CLK Stable	Normal	SS Done	Locked	Internal

Figure 49. Config & Status Tab

The system status registers provide two functions:

- (1) They provide a read-back that verifies how the setup programming has been interpreted. The part read-back indicates the processes mode selections are as desired.
- (2) They provide real-time feedback of device “on-the-fly” decision making. The ISL78226 or ISL78224 is constantly calculating proper mode adjustment as conditions change. The registers provide a real-time window of the functionality of the device internal mode controls and adjustments. Like the other step-up tabs, this tab provides an English language interpretation of the read hex value.

Review the register information about the system status registers. As [Figure 50 on page 40](#) shows, location 0xDD provides mode setting verification (Bits 6, 5, 4, and 0) and real time status (Bits 3, 2, and 1).

Name	Address	Bit	R/W	Name/Purpose	Default Value	Description	Comment
System Status Register 2	0xDD	0	R	Phase Drop Enable/Disable	0x0	-1 = Phase Drop Disabled 0 = Phase Drop Enabled	Reflecting PD_CTRL pin configuration
		1	R	Operating Phase (While in Operation)	0x0	1,1,1 = 6-phase 1,0,1 = 4-phase 0,1,1 = 3-phase 0,0,1 = not assigned	Operating Phase count indication (Master) and Reflecting PD_0 and PD_1 pin status for Slave
		2				1,1,0 = 2-phase 1,0,0 = 1-phase 0,1,0 = not assigned	
		3				0,0,0 = No Phase Drop (Phase Drop disabled)	
		4	R	Maximum Phase Setting	0x0	0,0,0 = 6-Phase 0,0,1 = 4-Phase 0,1,0 = 3-Phase 0,1,1 = 2-Phase 1,0,0 = 1-Phase 1,1,1 = Setting Error (1,1,0 and 1,0,1 are not used)	Reflecting PWM Pin Configuration at Initialization Phase. If PWM5 or PWM6 = VCC, 4-Phase If PWM4 = Vcc, 3-Phase If PWM3 = VCC, 2-Phase If PWM2 = VCC, 1-Phase If PWM1 = VCC, Error and Latch Off
		5					
		6					
7			Reserved				

Figure 50. System Status Registers

The **Update Status** button calls the same routine as the **Update Status** button on the **Alerts Display** tab. A duplicate is on this tab for your convenience.

The **Clear Faults Flags** button is a duplicate of the same function on the **Alerts Display** tab.

6. Alternate Configurations

The ISL78224EVAL2Z and ISL78226EVAL1Z evaluation boards can be configured to operate without the support of the flyback converter or without the support of the external computer and GUI.

The ISL78224EVAL2Z and ISL78226EVAL1Z can be configured in buck or boost operation. Each of those can be configured without a flyback and with or without the GUI dongle.

- Buck operation of the ISL78224EVAL2Z without flyback and with the GUI
- Buck operation of the ISL78224EVAL2Z without flyback and without GPIO from the GUI
- Boost operation of the ISL78224EVAL2Z without flyback and with the GUI
- Boost operation of the ISL78224EVAL2Z without flyback and without GPIO from the GUI
- Buck operation of the ISL78226EVAL1Z without flyback and with the GUI
- Buck operation of the ISL78226EVAL1Z without flyback and without GPIO from the GUI
- Boost operation of the ISL78226EVAL1Z without flyback and with the GUI
- Boost operation of the ISL78226EVAL1Z without flyback and without GPIO from the GUI

6.1 Buck Operation of the ISL78224EVAL2Z without Flyback and with the GUI

- (1) Configure the phase drop, jumper J₁ to disable phase drop and leave it open to enable phase drop.
- (2) Connect a disabled ~48V source to the BAT48 terminal lug.
- (3) Connect a disabled electronic load to the BAT12 terminal lug.
- (4) Connect a disabled ~6V bias (~0.5A) to the BAT_IN node (TP₁₃).
- (5) All Bode plot functions are already disabled on the ISL78224EVAL2Z.
- (6) Address is already set to 0 on the ISL78224EVAL2Z.
- (7) Driver DRV_EN pins are already connected on the ISL78224EVAL2Z.
- (8) PWM_TRI is already connected to VCC on the ISL78224EVAL2Z.
- (9) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (10) Connect V6 (TP₁₉) to a disabled external 6V source.
- (11) Connect VIN (TP₁₄) and V12 (TP₁₈) to a disabled external 12V source.
- (12) Connect the GUI dongle to J₇₇ (GPIO) and J₇₄ (I²C). Note the Pin 1 locations.
- (13) Enable the BAT48, BAT_IN, V6, VIN, and V12 voltage sources.
- (14) Use the GUI to exercise the converter in buck mode and EN.
- (15) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (16) Use the GUI to exercise PWM_EN.
- (17) Observe 12V at the unloaded BAT12 output.
- (18) BAT12 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (19) The I²C connections at J₇₄ is available using the GUI.
- (20) The 6V bias to BAT_IN is no longer needed and can be turned off at this point.
- (21) To shut down the converter:
 - (a) Turn off the BAT_IN 6V bias if present.
 - (b) Remove the BAT12 load.
 - (c) Disable PWM_EN using the GUI.
 - (d) Disable EN using the GUI.
 - (e) Turn off the V6, VIN, and V12 sources.
 - (f) Turn off the BAT48 source.

- (g) Disconnect V6 and V12.
- (22) To reconfigure for buck, flyback, and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
 - (a) J₁ (Phase Drop), J₄ (VIN_FLY), J₈₀ (2-3) (TRACK), TP₂₃ (BAT48 Bode), and TP₂₄ (BAT12 Bode).

6.2 Buck operation of the ISL78224EVAL2Z without flyback and without GPIO from the GUI

- (1) Configure the phase drop, jumper J₁ to disable phase drop and leave it open to enable phase drop.
- (2) Connect a disabled ~48V source to the BAT48 terminal lug.
- (3) Connect a disabled electronic load to the BAT12 terminal lug.
- (4) Connect a disabled ~6V bias (~0.5A) to the BAT_IN node (TP₁₃).
- (5) All Bode plot functions are already disabled on the ISL78224EVAL2Z.
- (6) Address is already set to 0 on the ISL78224EVAL2Z.
- (7) Driver DRV_EN pins are already connected on the ISL78224EVAL2Z.
- (8) PWM_TRI is already connected to VCC on the ISL78224EVAL2Z.
- (9) Jumper J₇₀ Pin 2 to J₇₀ Pin 3 (PGND) to command buck operation.
- (10) Jumper J₈₈ Pin 2 to J₈₈ Pin 1 (VCC) to command continuous conduction mode (CCM) or J₈₈ Pin 2 to J₈₈ Pin 3 (GND) to command diode emulation mode (DE).
- (11) Jumper J₈₉ Pin 2 to J₈₉ Pin 1 (VCC) to command Latch off Fault protection (LAT) or J₈₉ Pin 2 to J₈₉ Pin 3 (GND) to command hiccup fault protection (HIC).
- (12) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (13) Connect V6 (TP₁₉) to a disabled external 6V source.
- (14) Connect VIN (TP₁₄) and V12 (TP₁₈) to a disabled external 12V source.
- (15) Enable the BAT48, BAT_IN, V6, VIN, and V12 voltage sources.
- (16) Jumper J₅₈ to command enable.
- (17) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (18) Jumper J₇₇ Pin 5 to J₇₇ Pin 6 to command PWM_EN, see [Figure 51](#). Avoid bounce to this connection.



Figure 51.

- (19) Observe 12V at the unloaded BAT12 output.
- (20) BAT12 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (21) The I²C connections at J₇₄ remains available for use, with or without the GUI dongle.
- (22) The 6V bias to BAT_IN is no longer needed and can be turned off at this point.
- (23) To shut down the converter:
 - (a) Turn off the BAT_IN 6V bias if present.
 - (b) Remove the BAT12 load.
 - (c) Remove the J₇₇ jumper to terminate PWM_EN.
 - (d) Remove the J₅₈ jumper to terminate EN.
 - (e) Turn off the V6, VIN, and V12 sources.

- (f) Turn off the BAT48 source.
 - (g) Disconnect V6 and V12.
- (24) To reconfigure for buck, flyback, and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
- (a) J₁ (Phase Drop, J₄ (VIN_FLY), J₈₀ (2-3) (TRACK), TP₂₃ (BAT48 Bode), and TP₂₄ (BAT12 Bode).

6.3 Boost Operation of the ISL78224EVAL2Z without Flyback and with the GUI

- (1) Configure the phase drop, jumper J₁ to disable phase drop and leave it open to enable phase drop.
- (2) Connect a disabled ~12V source to the BAT12 terminal lugs.
- (3) Connect a disabled electronic load to the BAT48 terminal lugs.
- (4) A 6V BAT_IN (TP₁₃) bias is not needed in Boost mode.
- (5) All Bode plot functions are already disabled on the ISL78224EVAL2Z.
- (6) Address is already set to 0 on the ISL78224EVAL2Z.
- (7) Driver DRV_EN pins are already connected on the ISL78224EVAL2Z.
- (8) PWM_TRI is already connected to VCC on the ISL78224EVAL2Z.
- (9) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (10) Connect V6 (TP₁₉) to a disabled external 6V source.
- (11) Connect VIN (TP₁₄) and V12 (TP₁₈) to a disabled external 12V source.
- (12) Connect the GUI dongle to J₇₇ (GPIO) and J₇₄ (I²C). Note Pin 1 locations.
- (13) Enable the BAT12, V6, VIN, and V12 voltage sources.
- (14) Use the GUI to exercise the converter in Boost mode and EN.
- (15) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (16) Use the GUI to exercise PWM_EN.
- (17) Observe 48V at the unloaded BAT48 output.
- (18) BAT48 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (19) The I²C connections at J₇₄ is available using the GUI.
- (20) To shut down the converter:
 - (a) Disable the BAT48 load.
 - (b) Disable PWM_EN using the GUI.
 - (c) Disable EN using the GUI.
 - (d) Turn off the V6, VIN, and V12 sources.
 - (e) Turn off the BAT12 source.
 - (f) Disconnect V6 and V12.
- (21) To reconfigure for boost and flyback and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
 - (a) J₁ (Phase Drop, J₄ (VIN_FLY), J₈₀ (2-3) (TRACK), TP₂₃ (BAT48 Bode), and TP₂₄ (BAT12 Bode).

6.4 Boost Operation of the ISL78224EVAL2Z without Flyback and without GPIO from the GUI

- (1) Configure the phase drop, jumper J₁ to disable phase drop and leave it open to enable phase drop.
- (2) Connect a disabled ~12V source to the BAT12 terminal lugs.
- (3) Connect a disabled electronic load to the BAT48 terminal lugs.
- (4) A 6V BAT_IN (TP₁₃) bias is not needed in Boost mode.
- (5) All Bode plot functions are already disabled on the ISL78224EVAL2Z.
- (6) Address is already set to 0 on the ISL78224EVAL2Z.
- (7) Driver DRV_EN pins are already connected on the ISL78224EVAL2Z.
- (8) PWM_TRI is already connected to VCC on the ISL78224EVAL2Z.
- (9) Jumper J₇₀ Pin 2 to J₇₀ Pin 3 (VCC) to command boost operation.
- (10) Jumper J₈₈ Pin 2 to J₈₈ Pin 1 (VCC) to command continuous conduction mode (CCM) or J₈₈ Pin 2 to J₈₈ Pin 3 (GND) to command diode emulation mode (DE).
- (11) Jumper J₈₉ Pin 2 to J₈₉ Pin 1 (VCC) to command Latch off Fault protection (LAT) or J₈₉ Pin 2 to J₈₉ Pin 3 (GND) to command hiccup fault protection (HIC).
- (12) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (13) Connect V6 (TP₁₉) to a disabled external 6V source.
- (14) Connect VIN (TP₁₄) and V12 (TP₁₈) to a disabled external 12V source.
- (15) Enable the BAT12, V6, VIN, and V12 voltage sources.
- (16) Jumper J₅₈ to command enable.
- (17) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (18) Jumper J₇₇ Pin 5 to J₇₇ Pin 6 to command PWM_EN, see [Figure 52](#). Avoid bounce to this connection.



Figure 52.

- (19) Observe 48V at the unloaded BAT48 output.
- (20) BAT48 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (21) The I²C connections at J₇₄ remains available for use, with or without the GUI dongle.
- (22) To shut down the converter:
 - (a) Disable the BAT48 load.
 - (b) Remove the J₇₇ jumper to terminate PWM_EN.
 - (c) Remove the J₅₈ jumper to terminate EN.
 - (d) Turn off the V6, VIN, and V12 sources.
 - (e) Turn off the BAT12 source.
 - (f) Disconnect V6 and V12.
- (23) To reconfigure for boost and flyback and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
 - (a) J₁ (Phase Drop, J₄ (VIN_FLY), J₈₀ (2-3) (TRACK), TP₂₃ (BAT48 Bode), and TP₂₄ (BAT12 Bode).

6.5 Buck Operation of the ISL78226EVAL1Z without Flyback and with the GUI

- (1) Configure the Phase Drop Switch SW₁ on for no phase drop, off for phase drop.
- (2) Connect a disabled ~48V source to the BAT48 terminal lugs.
- (3) Connect a disabled electronic load to the BAT12 terminal lugs.
- (4) Connect a disabled ~6V bias (~0.5A) to the BAT12_IN node (J₅₀ banana socket).
- (5) Place a jumper on J₁₄ to disable the BAT48 Bode plot function.
- (6) Place a jumper on J₁₅ to disable the BAT12 Bode plot function.
- (7) Place a jumper on J₂₆ to disable the MCUVDD Bode plot function.
- (8) Jumper J₈₁ Pin 2 to J₈₁ Pin 3 (GND) to command ADDR1 low.
- (9) Jumper J₈₂ Pin 2 to J₈₂ Pin 3 (GND) to command ADDR2 low.
- (10) Verify that JP₃₁₀, JP₄₁₀, JP₅₁₀, and JP₆₁₀ are installed. Install them if they are not already present.
- (11) Jumper J₇₁ Pin 2 to J₇₁ Pin 1 (VCC) to command PWM_TRI operation.
- (12) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (13) Connect V6 (TP₈ banana) to a disabled external 6V source.
- (14) Connect VIN (J₅₅ banana) and V12 (TP₇ banana) to a disabled external 12V source.
- (15) Connect the GUI dongle to J₇₇ (GPIO) and J₇₄ (I²C). Note Pin 1 locations.
- (16) Enable the BAT48, BAT12_IN, V6, VIN, and V12 voltage sources.
- (17) Use the GUI to exercise the converter in buck mode and EN.
- (18) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (19) Use the GUI to exercise PWM_EN.
- (20) Observe 12V at the unloaded BAT12 output.
- (21) BAT12 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (22) The I²C connections at J₇₄ is available using the GUI.
- (23) The 6V bias to BAT12_IN (J₅₀) is no longer needed and can be turned off at this point.
- (24) To shut down the converter:
 - (a) Turn off the BAT12_IN 6V bias if present.
 - (b) Disable the BAT12 load.
 - (c) Disable PWM_EN using the GUI.
 - (d) Disable EN using the GUI.
 - (e) Turn off the V6, VIN, and V12 sources.
 - (f) Turn off the BAT48 source.
 - (g) Disconnect V6 and V12.
- (25) To reconfigure for buck, flyback, and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
 - (a) J₄ (VIN_FLY), J₁₄ (BAT48 Bode), J₁₅ (BAT12 Bode), J₂₆ (MCUVDD Bode), J₇₁ (1-2) (PWM_TRI), J₈₀ (2-3) (TRACK), J₈₁(2-3) (ADDR1), J₈₂(2-3) (ADDR2), JP₃₁₀ (DRV_EN), JP₄₁₀ (DRV_EN), JP₅₁₀ (DRV_EN), and JP₆₁₀ (DRV_EN).
 - (b) Set phase drop switch SW₁ to on.

6.6 Buck Operation of the ISL78226EVAL1Z without Flyback and without GPIO from the GUI

- (1) Configure the Phase Drop Switch SW₁ on for no phase drop, off for phase drop.
- (2) Connect a disabled ~48V source to the BAT48 terminal lugs.
- (3) Connect a disabled electronic load to the BAT12 terminal lugs.
- (4) Connect a disabled ~6V bias (~0.5A) to the BAT12_IN node (J₅₀ banana socket).
- (5) Place a jumper on J₁₄ to disable the BAT48 Bode plot function.
- (6) Place a jumper on J₁₅ to disable the BAT12 Bode plot function.
- (7) Place a jumper on J₂₆ to disable the MCUVDD Bode plot function.
- (8) Place a jumper on J₆₂.
- (9) Jumper J₈₁ Pin 2 to J₈₁ Pin 3 (GND) to command ADDR1 low.
- (10) Jumper J₈₂ Pin 2 to J₈₂ Pin 3 (GND) to command ADDR2 low.
- (11) Verify that JP₃₁₀, JP₄₁₀, JP₅₁₀, and JP₆₁₀ are installed. Install them if they are not already present.
- (12) Jumper J₇₁ Pin 2 to J₇₁ Pin 1 (VCC) to command PWM_TRI operation.
- (13) Jumper J₇₀ Pin 2 to J₇₀ Pin 3 (GND) to command buck operation.
- (14) Jumper J₈₈ Pin 2 to J₈₈ Pin 1 (VCC) to command continuous conduction mode (CCM) or J₈₈ Pin 2 to J₈₈ Pin 3 (GND) to command diode emulation mode (DE).
- (15) Jumper J₈₉ Pin 2 to J₈₉ Pin 1 (VCC) to command Latch off Fault protection (LAT) or J₈₉ Pin 2 to J₈₉ Pin 3 (GND) to command hiccup fault protection (HIC).
- (16) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (17) Connect V6 (TP₈ banana) to a disabled external 6V source.
- (18) Connect VIN (J₅₅ banana) and V12 (TP₇ banana) to a disabled external 12V source.
- (19) Enable the BAT48, BAT12_IN, V6, VIN, and V12 voltage sources.
- (20) Jumper J₅₈ to command enable.
- (21) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCUVDD, and CLK_OUT.
- (22) Jumper J₇₇ Pin 5 to J₇₇ Pin 6 to command PWM_EN. See [Figure 53](#). Avoid bounce to this connection.

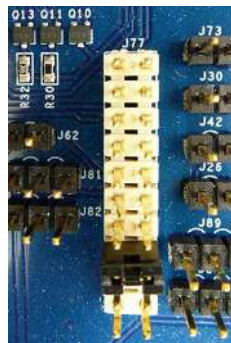


Figure 53.

- (23) Observe 12V at the unloaded BAT12 output.
- (24) BAT12 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (25) The I²C connections at J₇₄ remains available for use, with or without the GUI dongle.
- (26) The 6V bias is no longer needed and can be turned off at this point.
- (27) To shut down the converter:
 - (a) Turn off the BAT12_IN 6V bias if present.
 - (b) Disable the BAT12 load.

- (c) Remove the J₇₇ jumper to terminate PWM_EN.
 - (d) Remove the J₅₈ jumper to terminate EN.
 - (e) Turn off the V6, VIN, and V12 sources.
 - (f) Turn off the BAT48 source.
 - (g) Disconnect V6 and V12.
- (28) Do not reinstall the GUI dongle after these connections have been made as the dongle provides drive to some of the above mentioned signals and bus contention occurs.
- (29) To reconfigure for buck, flyback, and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
- (a) J₄ (VIN_FLY), J₁₄ (BAT48 Bode), J₁₅ (BAT12 Bode), J₂₆ (MCUVDD Bode), J₇₁(1-2) (PWM_TRI), J₈₀ (2-3) (TRACK), J₈₁(2-3) (ADDR1), J₈₂(2-3) (ADDR2), JP₃₁₀ (DRV_EN), JP₄₁₀ (DRV_EN), JP₅₁₀ (DRV_EN), and JP₆₁₀ (DRV_EN).
 - (b) Set phase drop switch SW₁ to on.

6.7 Boost Operation of the ISL78226EVAL1Z without Flyback and with the GUI

- (1) Configure the Phase Drop Switch SW₁ on for no phase drop, off for phase drop.
- (2) Connect a disabled ~12V source to the BAT12 terminal lugs.
- (3) Connect a disabled electronic load to the BAT48 terminal lugs.
- (4) A 6V BAT12_IN (J₅₀ banana) bias is not needed in Boost mode.
- (5) Place a jumper on J₁₄ to disable the BAT48 Bode plot function.
- (6) Place a jumper on J₁₅ to disable the BAT12 Bode plot function.
- (7) Place a jumper on J₂₆ to disable the MCVDD Bode plot function.
- (8) Jumper J₈₁ Pin 2 to J₈₁ Pin 3 (GND) to command ADDR1 low.
- (9) Jumper J₈₂ Pin 2 to J₈₂ Pin 3 (GND) to command ADDR2 low.
- (10) Verify that JP₃₁₀, JP₄₁₀, JP₅₁₀, and JP₆₁₀ are installed. Install them if they are not already present.
- (11) Jumper J₇₁ Pin 2 to J₇₁ Pin 1 (VCC) to command PWM_TRI operation.
- (12) Remove jumper J₄ to disconnect VIN_FLY from VIN.
- (13) Connect V6 (TP₈ banana) to a disabled external 6V source.
- (14) Connect VIN (J₅₅ banana) and V12 (TP₇ banana) to a disabled external 12V source.
- (15) Connect the GUI dongle to J₇₇ (GPIO) and J₇₄ (I²C). Note Pin 1 locations.
- (16) Enable the BAT12, V6, VIN, and V12 voltage sources.
- (17) Use the GUI to exercise the converter in Boost mode and EN.
- (18) Enable can be verified by observing the presence of voltages at PVCC, VCC, MCVDD, and CLK_OUT.
- (19) Use the GUI to exercise PWM_EN.
- (20) Observe 48V at the unloaded BAT48 output.
- (21) BAT48 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (22) The I²C connections at J₇₄ is available using the GUI.
- (23) To shut down the converter:
 - (a) Disable the BAT48 load.
 - (b) Disable PWM_EN using the GUI.
 - (c) Disable EN using the GUI.
 - (d) Turn off the V6, VIN, and V12 sources.
 - (e) Turn off the BAT12 source.
 - (f) Disconnect V6 and V12.

- (24) To reconfigure for boost and flyback and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
- J₄ (VIN_FLY), J₁₄ (BAT48 Bode), J₁₅ (BAT12 Bode), J₂₆ (MCUVDD Bode), J₇₁(1-2) (PWM_TRI), J₈₀ (2-3) (TRACK), J₈₁(2-3) (ADDR1), J₈₂(2-3) (ADDR2), JP₃₁₀ (DRV_EN), JP₄₁₀ (DRV_EN), JP₅₁₀ (DRV_EN), and JP₆₁₀ (DRV_EN).
 - Set phase drop switch SW₁ to on.

6.8 Boost Operation of the ISL78226EVAL1Z without Flyback and without GPIO from the GUI

- Configure the Phase Drop Switch SW₁ on for no phase drop, off for phase drop.
- Connect a disabled ~12V source to the BAT12 terminal lugs.
- Connect a disabled electronic load to the BAT48 terminal lugs.
- A 6V BAT12_IN (J₅₀ banana) bias is not needed in Boost mode.
- Place a jumper on J₁₄ to disable the BAT48 Bode plot function.
- Place a jumper on J₁₅ to disable the BAT12 Bode plot function.
- Place a jumper on J₂₆ to disable the MCVDD Bode plot function.
- Place a jumper on J₆₂.
- Jumper J₈₁ Pin 2 to J₈₁ Pin 3 (GND) to command ADDR1 low.
- Jumper J₈₂ Pin 2 to J₈₂ Pin 3 (GND) to command ADDR2 low.
- Verify that JP₃₁₀, JP₄₁₀, JP₅₁₀, and JP₆₁₀ are installed. Install them if they are not already present.
- Jumper J₇₁ Pin 2 to J₇₁ Pin 1 (VCC) to command PWM_TRI operation.
- Jumper J₇₀ Pin 2 to J₇₀ Pin 1 (VCC) to command boost operation.
- Jumper J₈₈ Pin 2 to J₈₈ Pin 1 (VCC) to command continuous conduction mode (CCM) or J₈₈ Pin 2 to J₈₈ Pin 3 (GND) to command diode emulation mode (DE).
- Jumper J₈₉ Pin 2 to J₈₉ Pin 1 (VCC) to command Latch off Fault protection (LAT) or J₈₉ Pin 2 to J₈₉ Pin 3 (GND) to command hiccup fault protection (HIC).
- Remove jumper J₄ to disconnect VIN_FLY from VIN.
- Connect V6 (TP₈ banana) to a disabled external 6V source.
- Connect VIN (J₅₅ banana) and V12 (TP₇ banana) to a disabled external 12V source.
- Enable the BAT12, V6, VIN, and V12 voltage sources.
- Jumper J₅₈ to command enable.
- Enable can be verified by observing the presence of voltages at PVCC, VCC, MCVDD, and CLK_OUT.
- Jumper J₇₇ Pin 5 to J₇₇ Pin 6 to command PWM_EN, see [Figure 54](#). Avoid bounce to this connection.

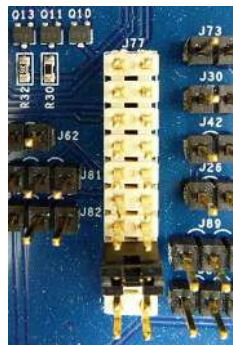


Figure 54.

- Observe 48V at the unloaded BAT48 output.

- (24) BAT48 can now be loaded. Maintain the FET surface temperatures below 100°C with fans.
- (25) The I²C connections at J₇₄ remains available for use, with or without the GUI dongle.
- (26) To shut down the converter:
 - (a) Disable the BAT48 load.
 - (b) Remove the J₇₇ jumper to terminate PWM_EN.
 - (c) Remove the J₅₈ jumper to terminate EN.
 - (d) Turn off the V6, VIN, and V12 sources.
 - (e) Turn off the BAT12 source.
 - (f) Disconnect V6 and V12.
- (27) Do not reinstall the GUI dongle after these connections have been made as the dongle provides drive to some of the above mentioned signals and bus contention occurs.
- (28) To reconfigure for boost and flyback and GUI operation disconnect all of the jumpers and reconfigure with the following jumpers:
 - (a) J₄ (VIN_FLY), J₁₄ (BAT48 Bode), J₁₅ (BAT12 Bode), J₂₆ (MCUVDD Bode), J₇₁(1-2) (PWM_TRI), J₈₀ (2-3) (TRACK), J₈₁ (2-3) (ADDR1), J₈₂(2-3) (ADDR2), JP₃₁₀ (DRV_EN), JP₄₁₀ (DRV_EN), JP₅₁₀ (DRV_EN), and JP₆₁₀ (DRV_EN).
 - (b) Set phase drop switch SW₁ to on.

7. PCB Layout Guidelines

The AC performance of this circuit depends greatly on the care taken in designing the Printed Circuit Board (PCB). The following are recommendations to achieve optimum high performance from the PCB.

ISL78226EVAL1Z evaluation board: six layers, 0.125 inch thick FR4 material, +125°C maximum temperature, 2oz copper top/bottom, 4oz copper layers 2 through 5.

ISL78224EVAL2Z evaluation board: eight layers, 0.125 inch thick FR4 material, +125°C maximum temperature, 2oz copper top/bottom, 4oz copper layers 2 through 7.

- The use of low inductance components, such as chip resistors and chip capacitors, is strongly recommended.
- Minimize signal trace lengths, especially for the VDD, charge pump decoupling, CS1, CS2, and VC0 to VC8 inputs. Trace inductance and capacitance can easily affect circuit performance. Avoid placing vias in the signal lines because they add inductance at high frequency.
- Match channel-to-channel analog I/O trace lengths and layout symmetry, especially for the CS1 and CS2 lines, because their inputs are normally very low voltage.
- Maximize use of AC decoupled PCB layers. Route all signal I/O lines over continuous ground planes (for example, no split planes or PCB gaps under these lines). Avoid vias in the signal I/O lines.
- When testing, use good quality connectors and cables, matching cable types, and keep cable lengths to a minimum.
- Caution: Avoid flexing the board because this can cause stress on the capacitors, resulting in either a short or open capacitor.

7.1 Maximum Operating Power for Evaluation Boards

7.1.1 ISL78226

Conditions: No heatsink, +24°C ambient, phase balance enabled, Forced CCM mode, no phase drop.

- 2.4kW without airflow
- 3kW with airflow (airflow ~5M/s)

7.1.2 ISL78224

Conditions: No heatsink, +24°C ambient, phase balance enabled, Forced CCM mode, no phase drop.

- 1.2kW without airflow
- 2kW with airflow (airflow ~3.3M/s)

7.2 Evaluation Boards

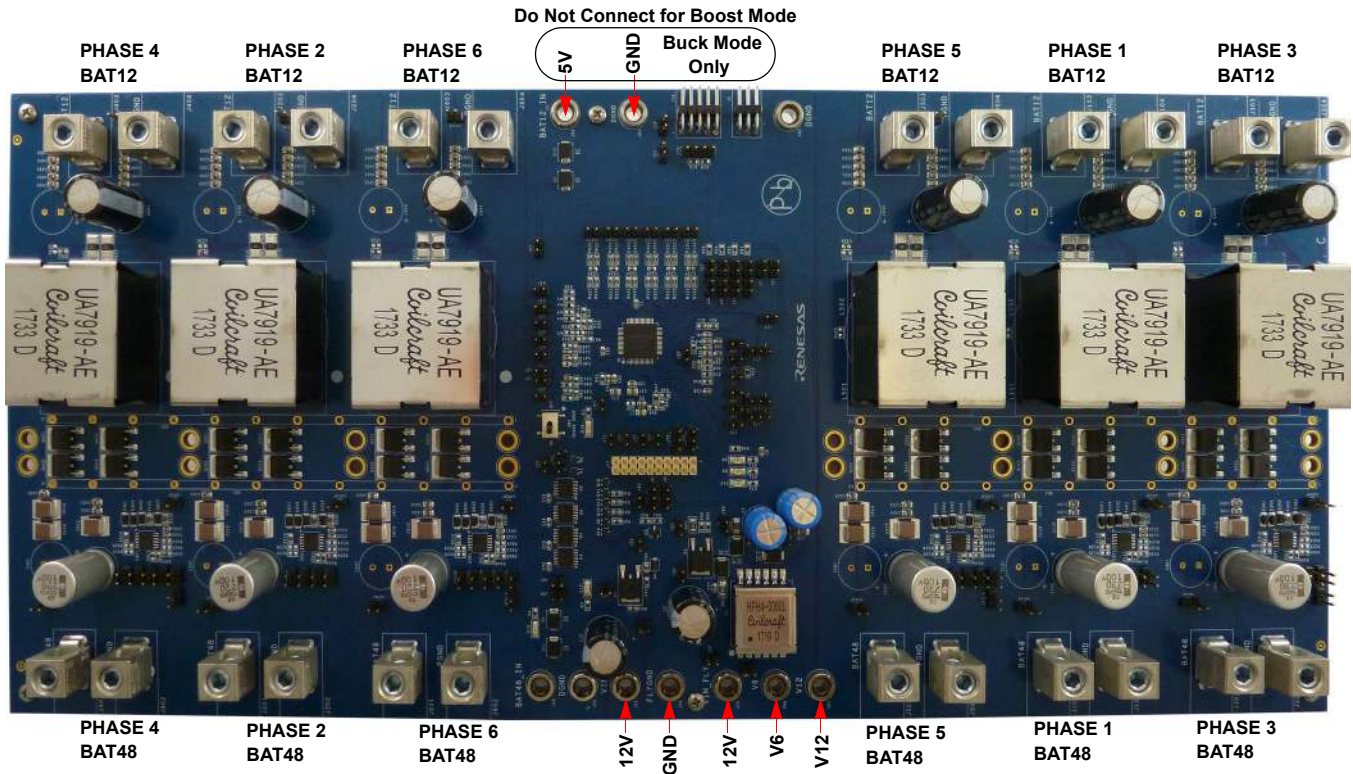


Figure 55. ISL78226EVAL1Z 12V to 48V Bidirectional Customer Evaluation Board

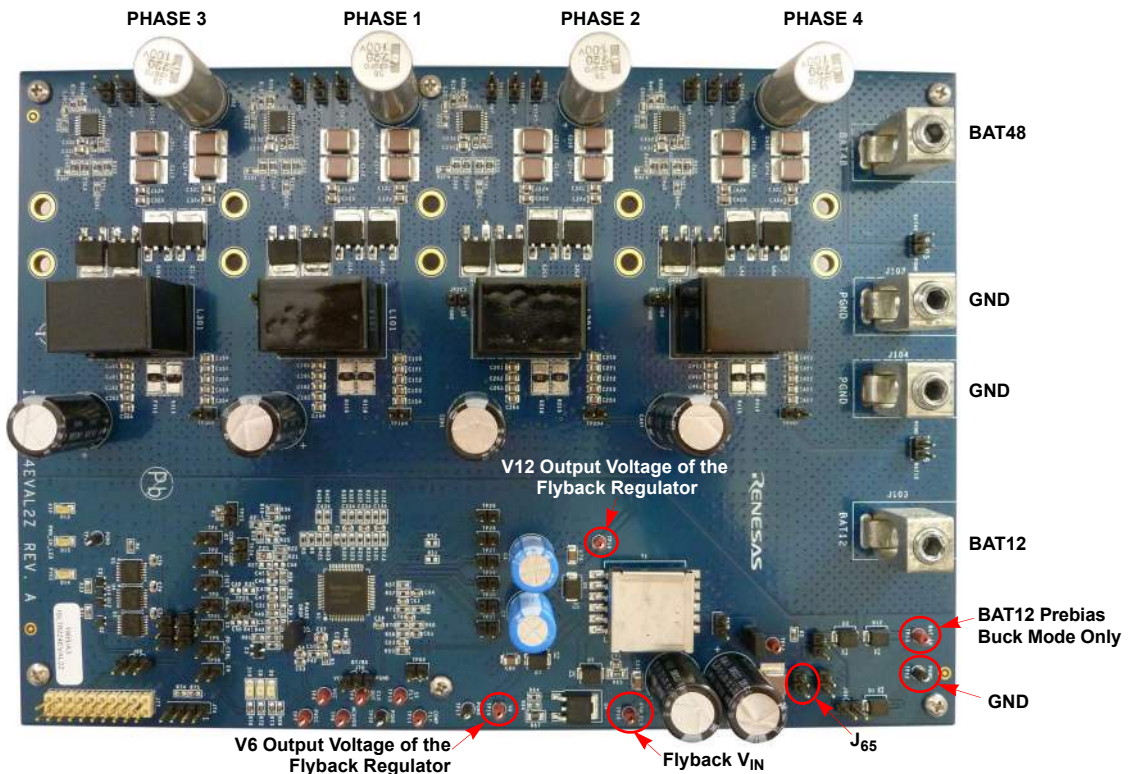


Figure 56. ISL78224EVAL2Z 12V to 48V Bidirectional Customer Evaluation Board

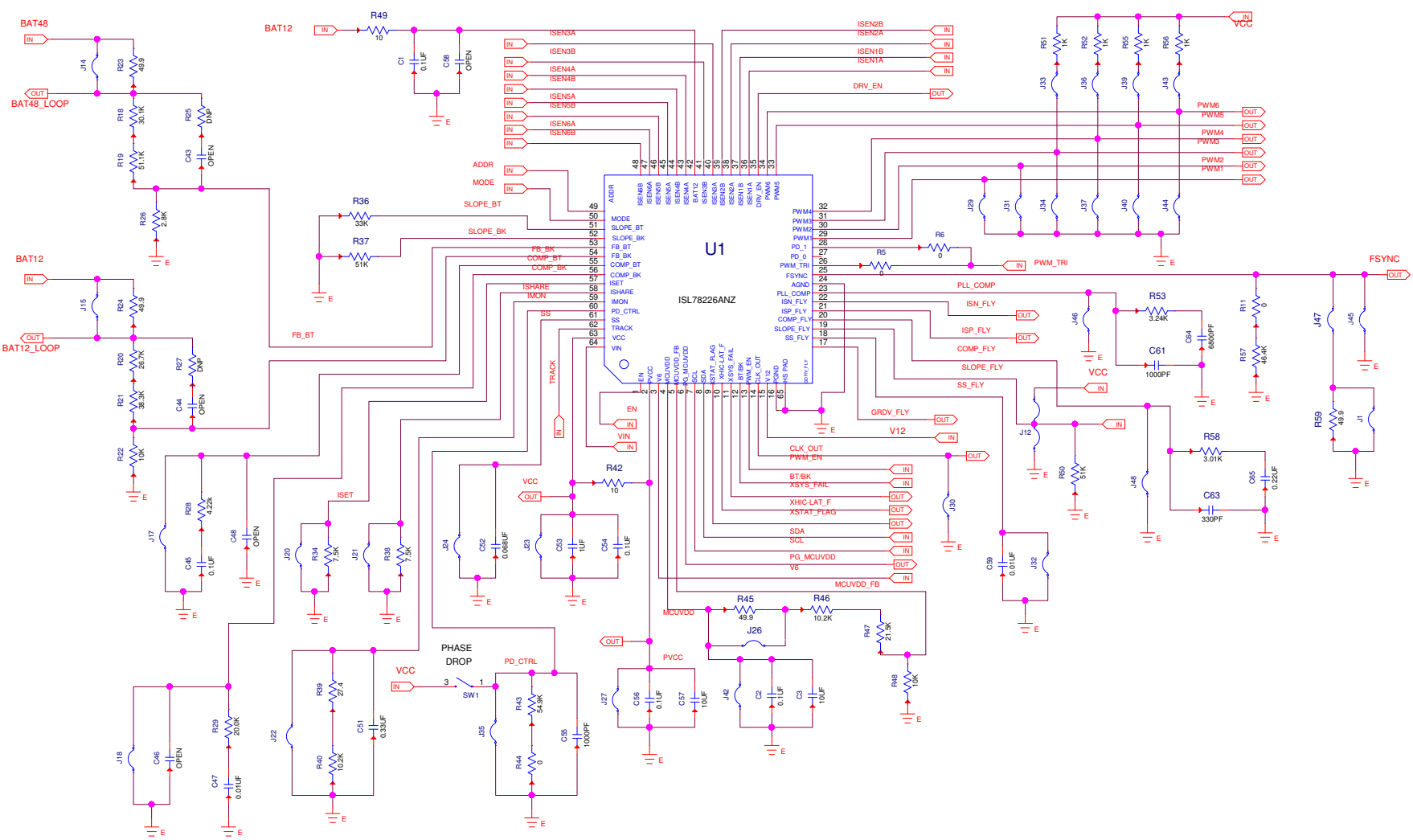


Figure 57. ISL78226EVAL1Z Schematic Page 1 of 10

7.3 ISL78226EVAL1Z Circuit Schematics

PHASE 1 OF 6

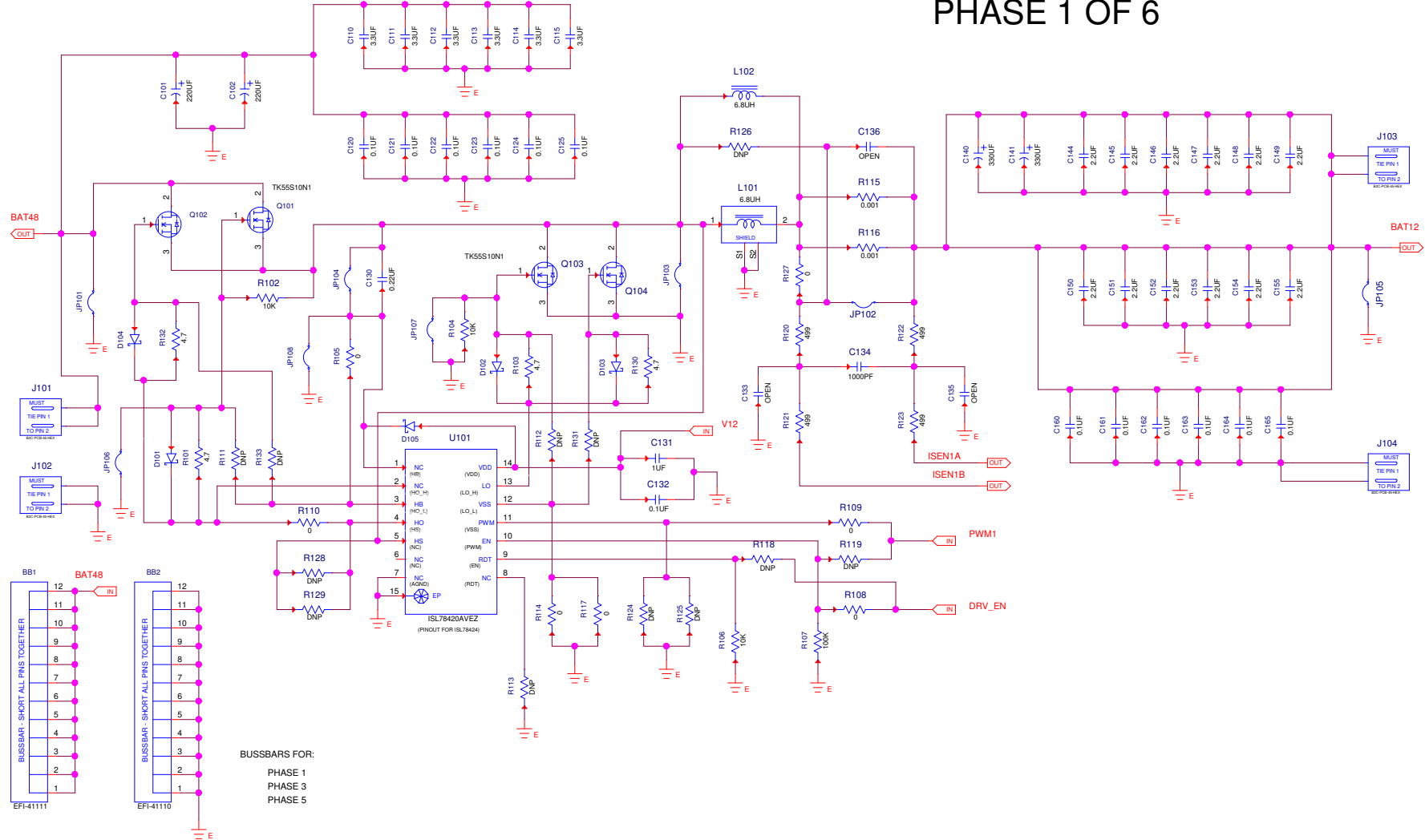


Figure 58. ISL78226EVAL1Z Schematic Page 2 of 10

PHASE 2 OF 6

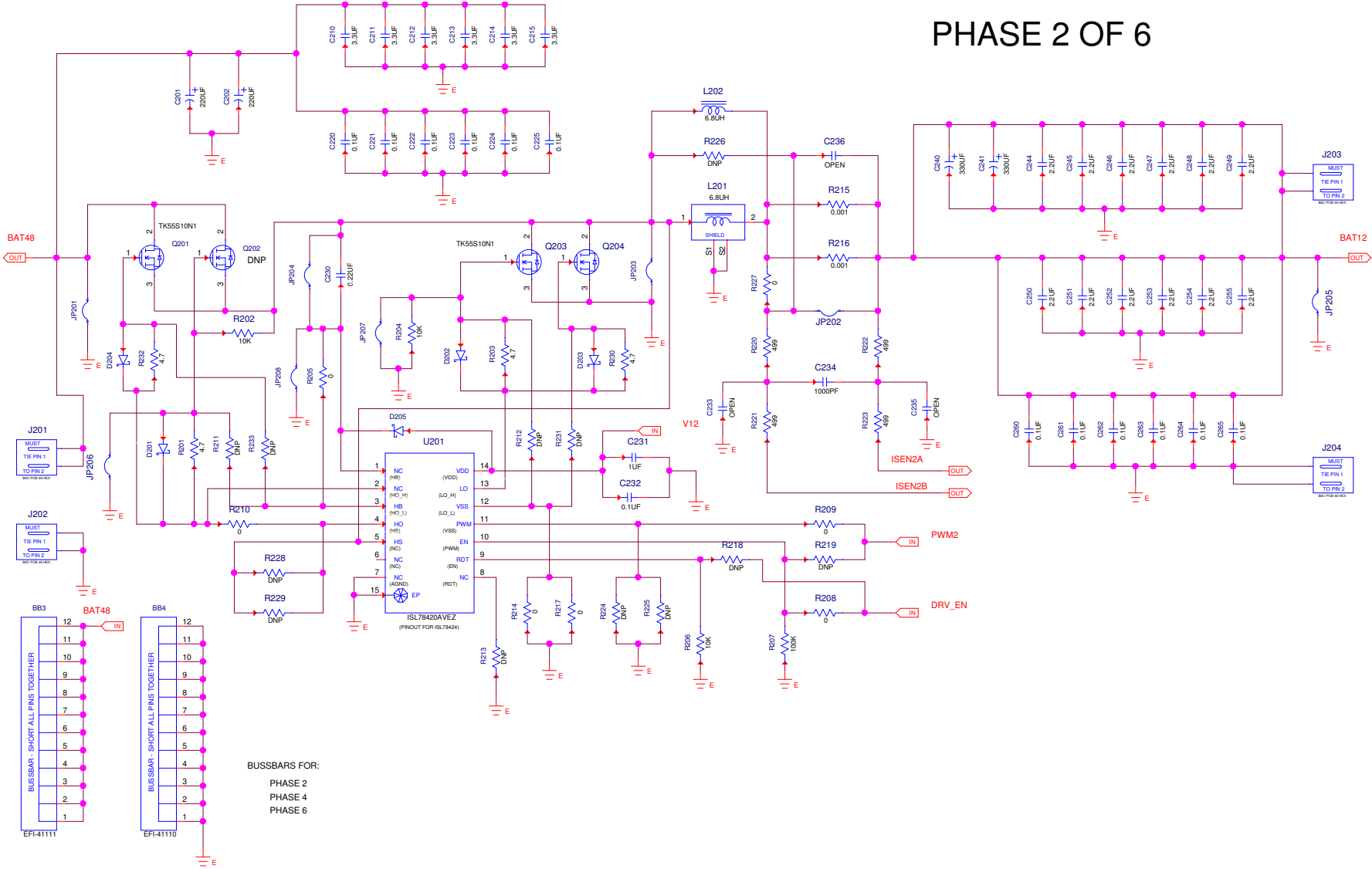


Figure 59. ISL78226EVAL1Z Schematic Page 3 of 10

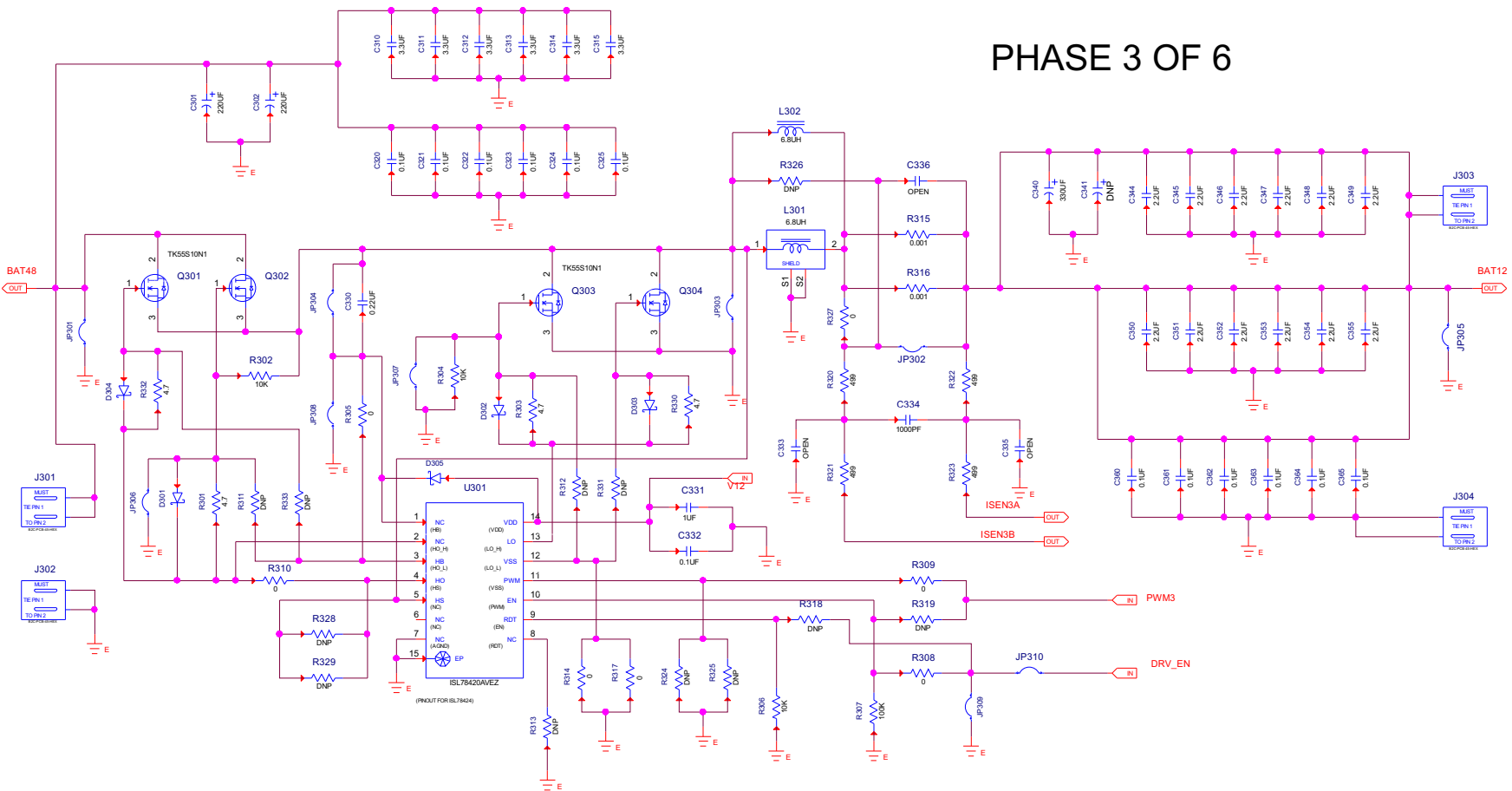


Figure 60. ISL78226EVAL1Z Schematic Page 4 of 10

PHASE 4 OF 6

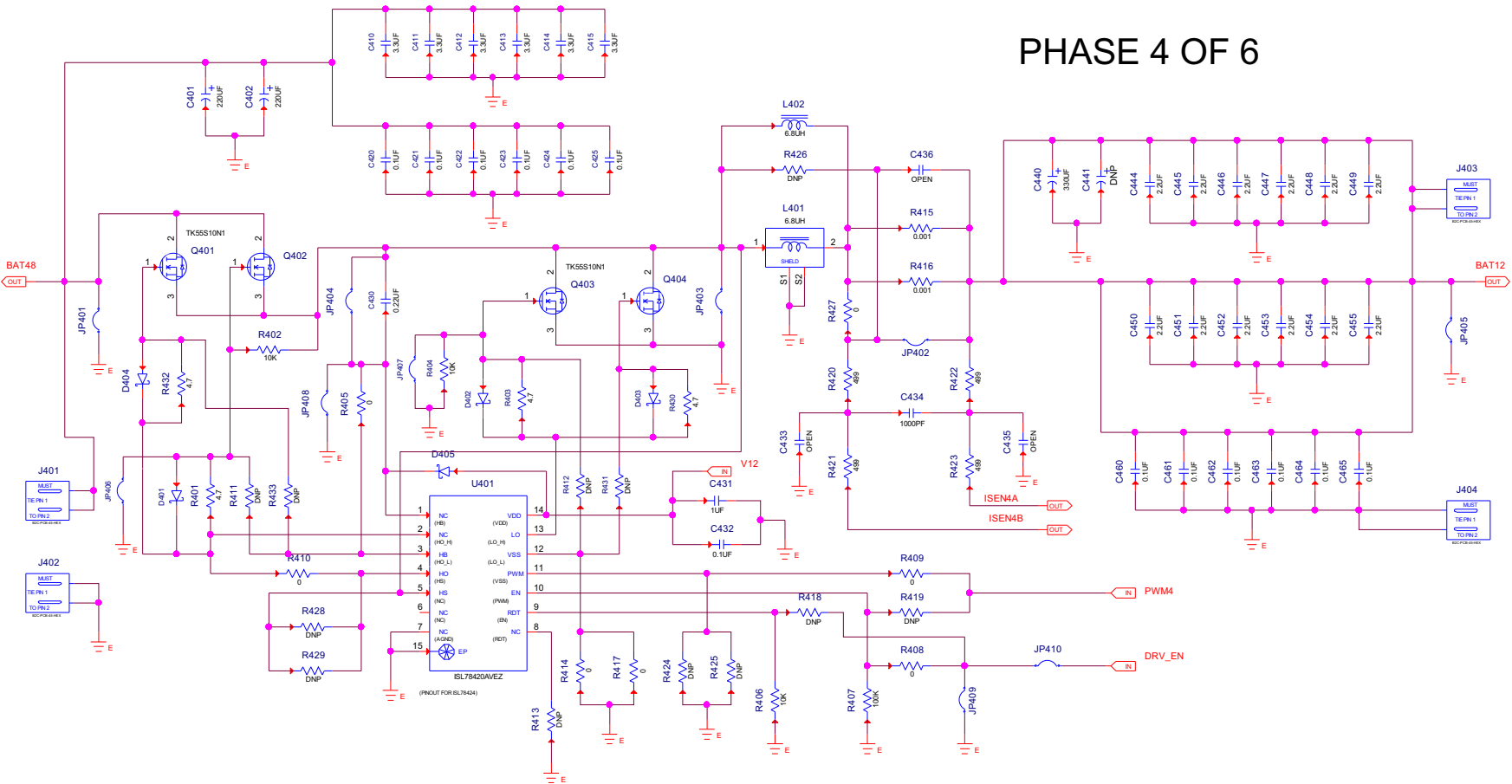
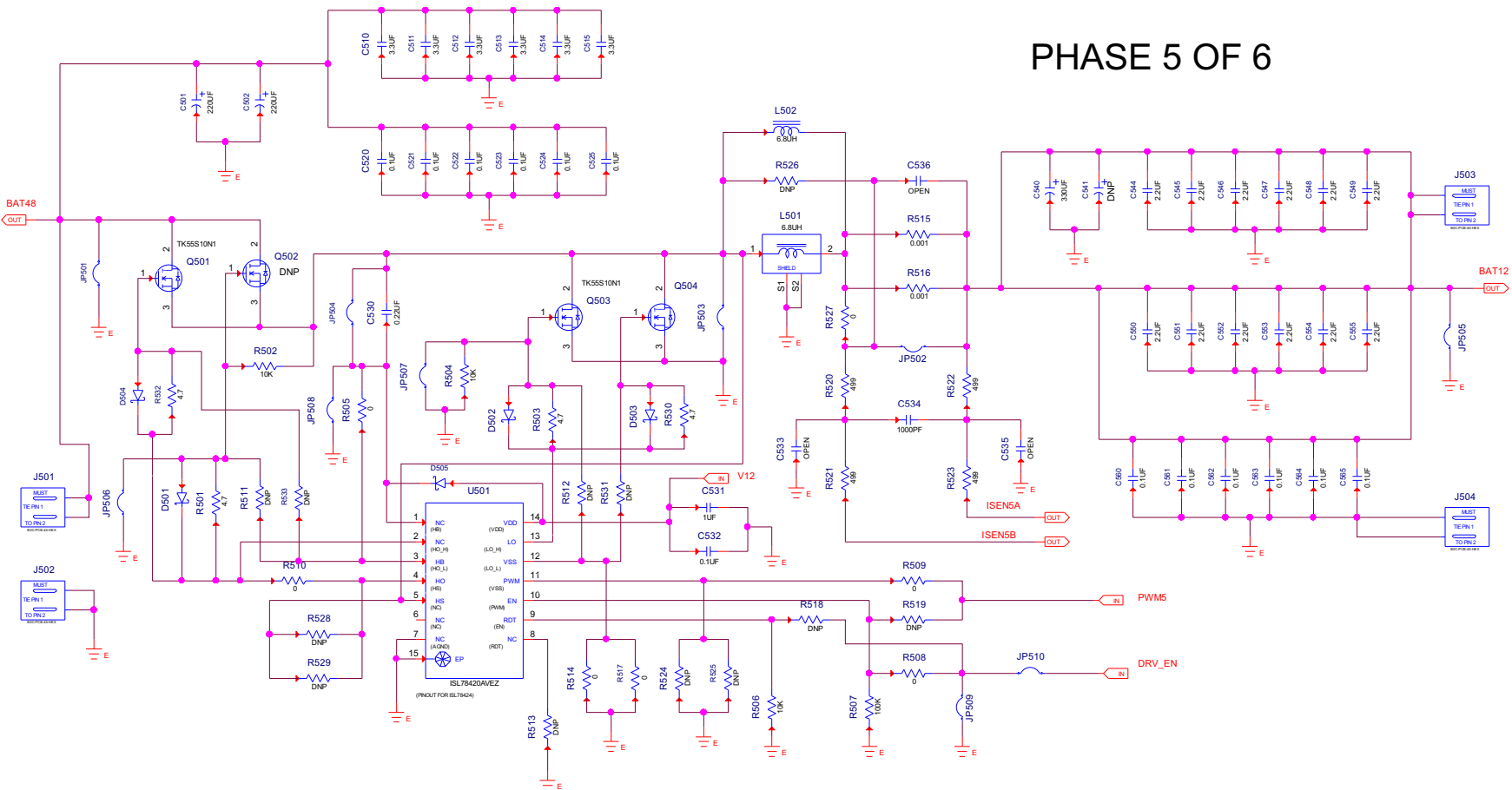


Figure 61. ISL78226EVAL1Z Schematic Page 5 of 10



PHASE 5 OF 6

Figure 62. ISL78226EVAL1Z Schematic Page 6 of 10

PHASE 6 OF 6

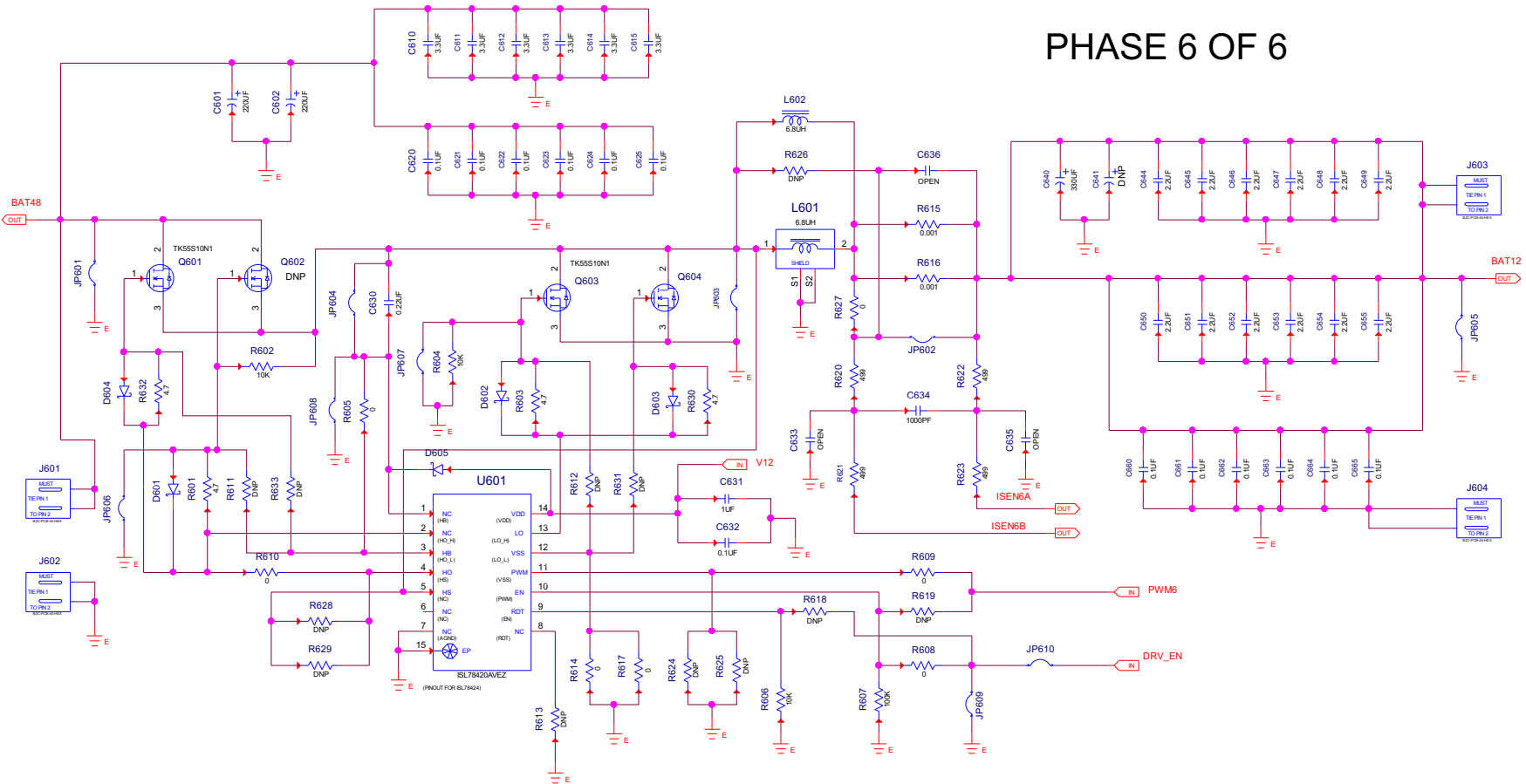


Figure 63. ISL78226EVAL1Z Schematic Page 7 of 10

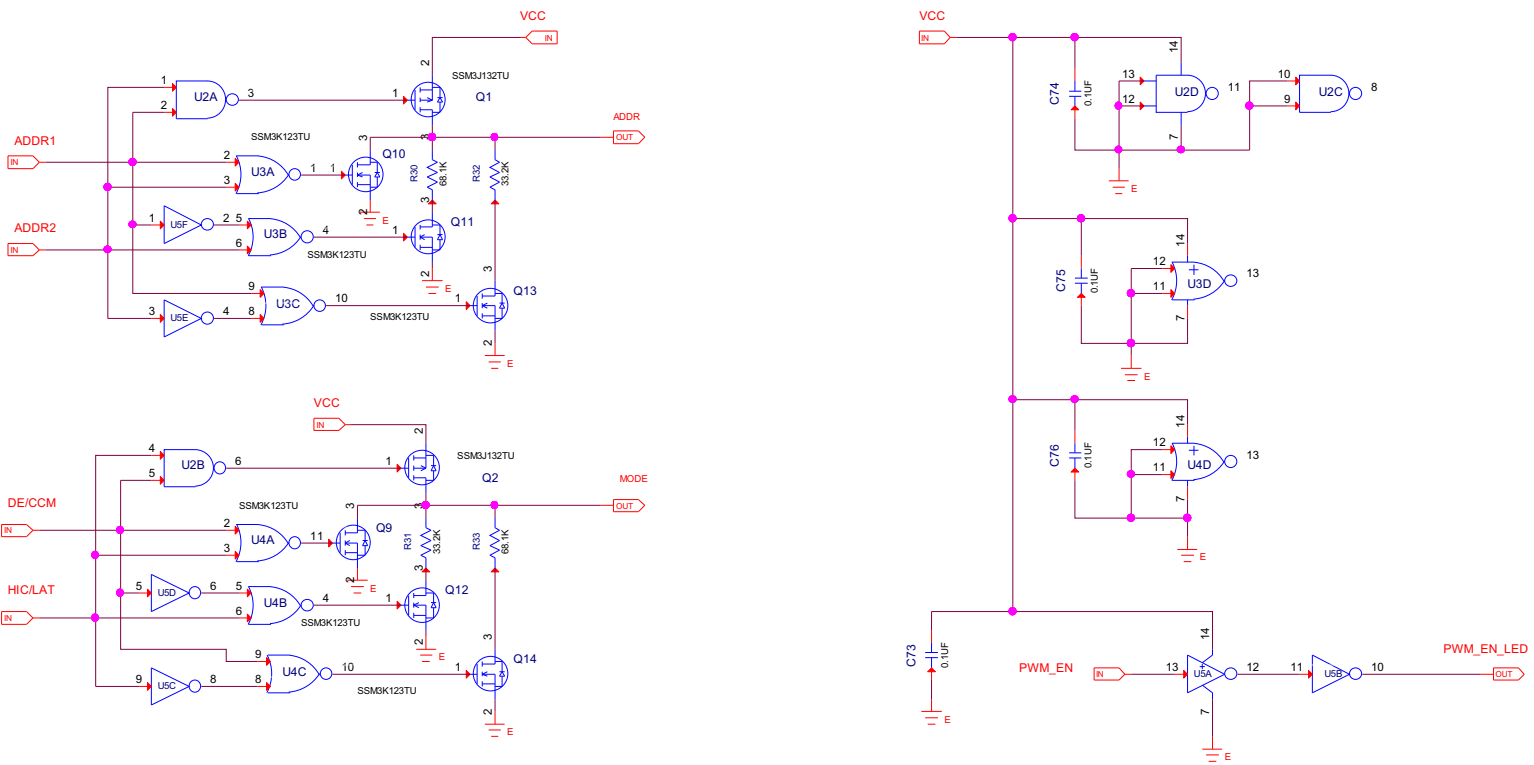


Figure 64. ISL78226EVAL1Z Schematic Page 8 of 10

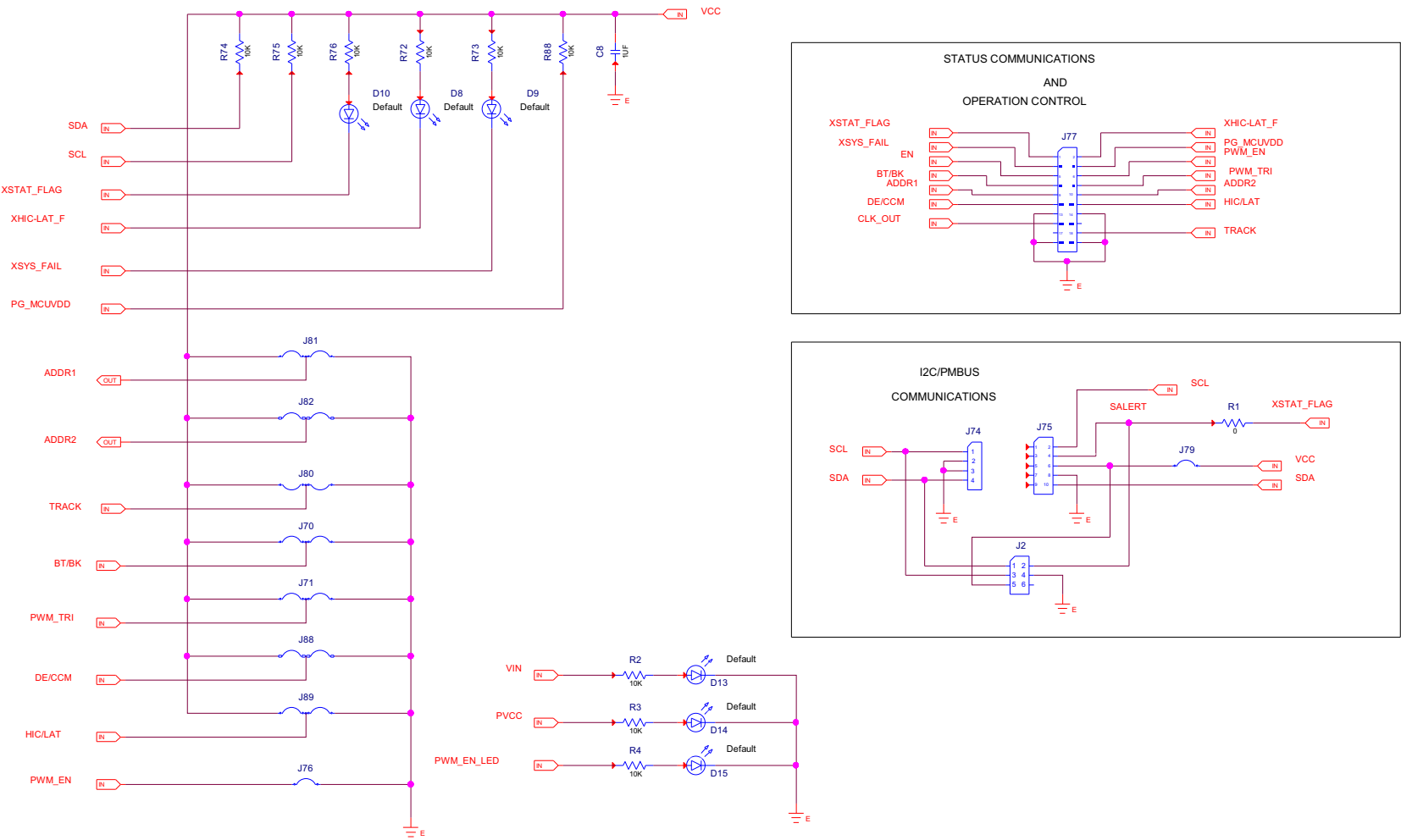


Figure 65. ISL78226EVAL1Z Schematic Page 9 of 10

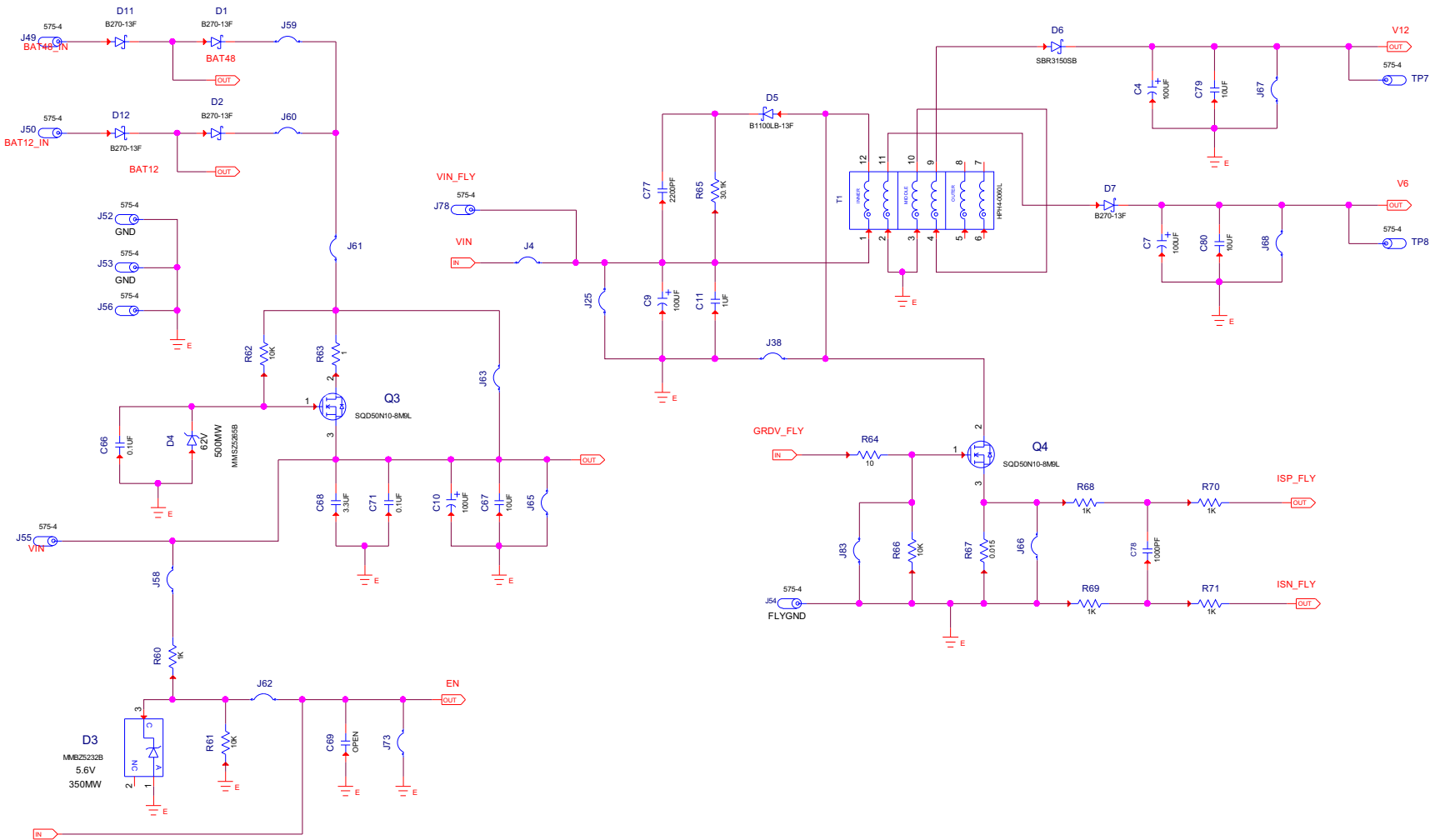


Figure 66. ISL78226EVAL1Z Schematic Page 10 of 10

7.4 ISL78224EVAL2Z Circuit Schematics

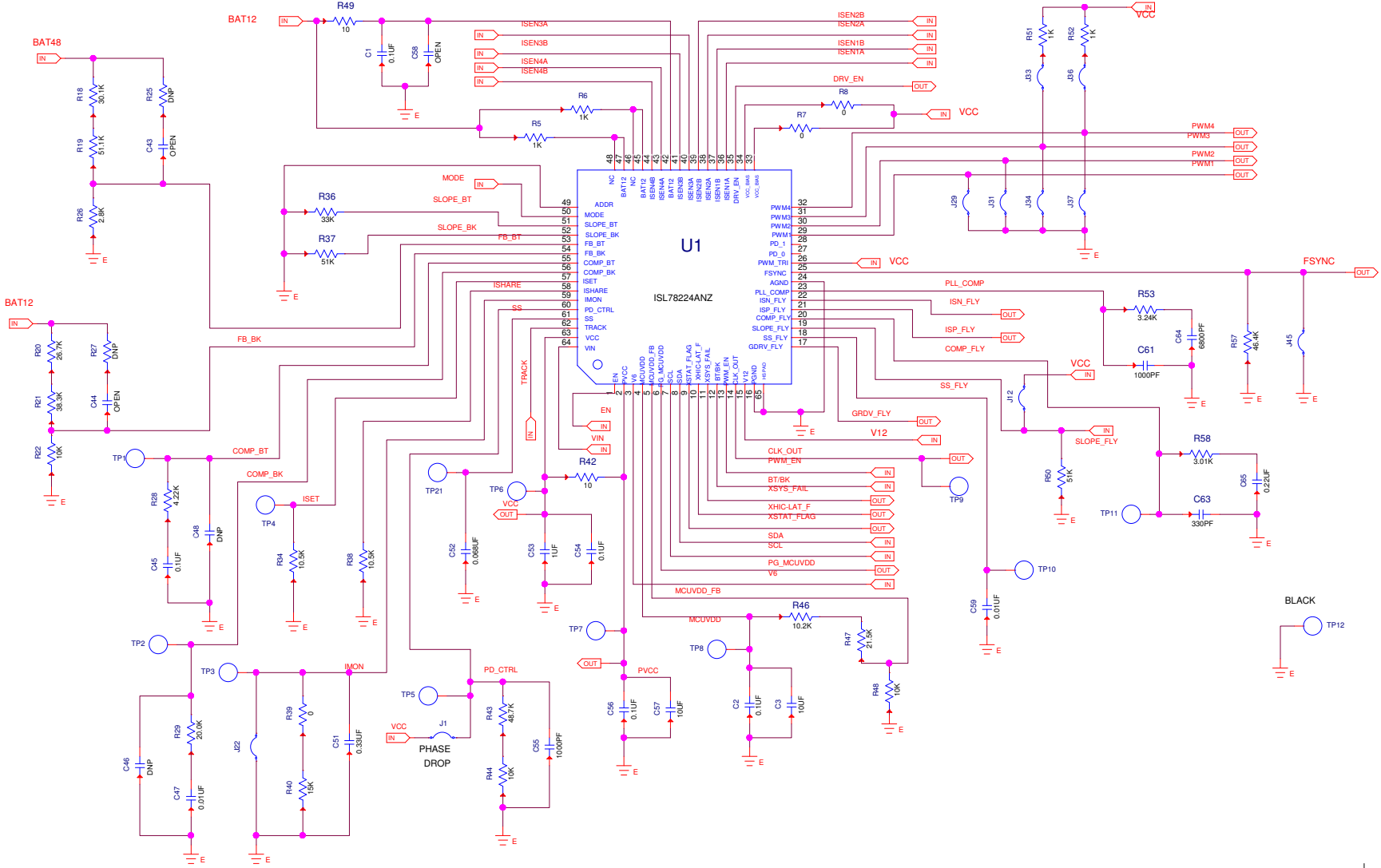


Figure 67. ISL78224EVAL2Z Schematic Page 1 of 8

PHASE 1 OF 4

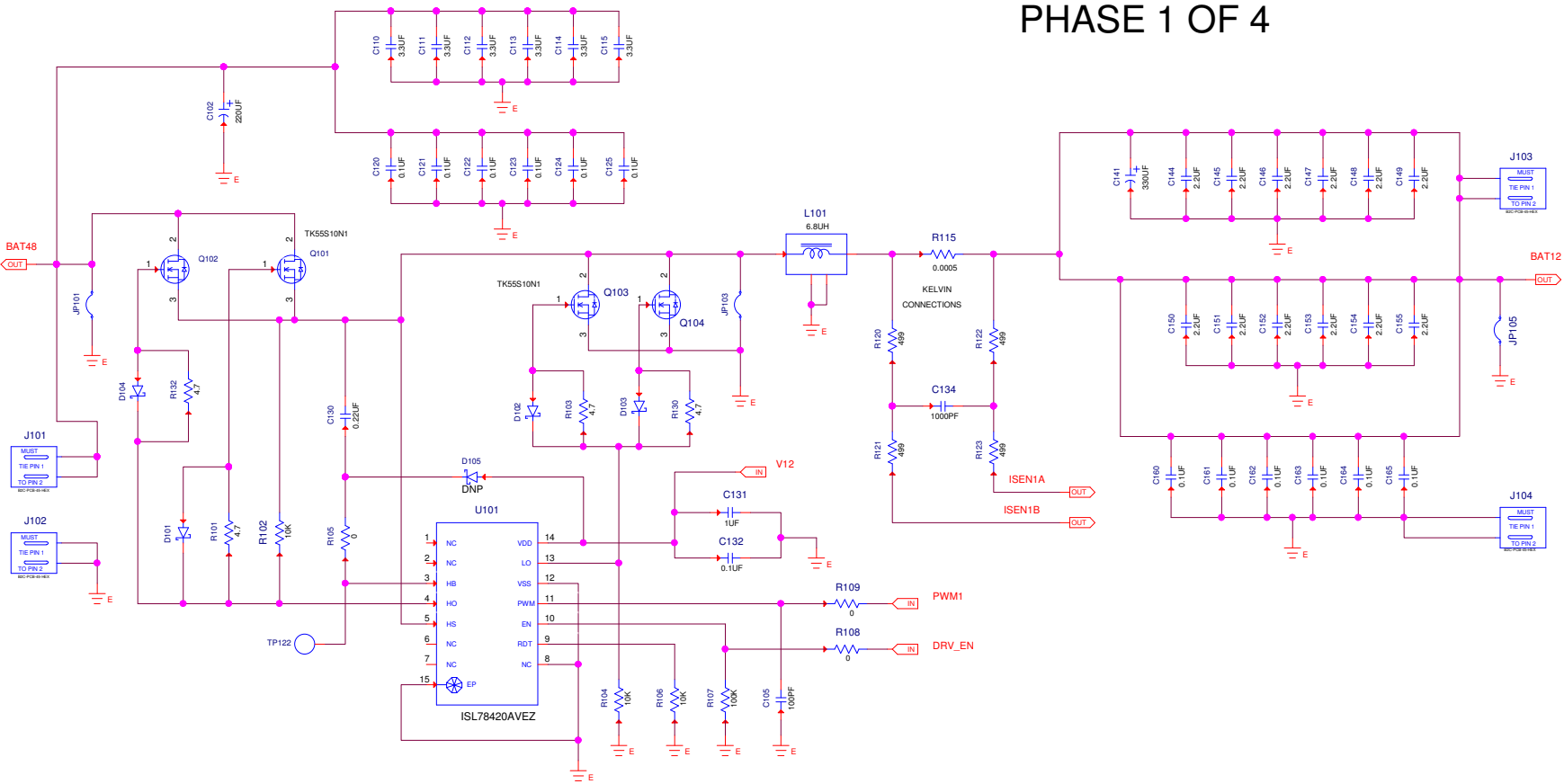


Figure 68. ISL78224EVAL2Z Schematic Page 2 of 8

PHASE 2 OF 4

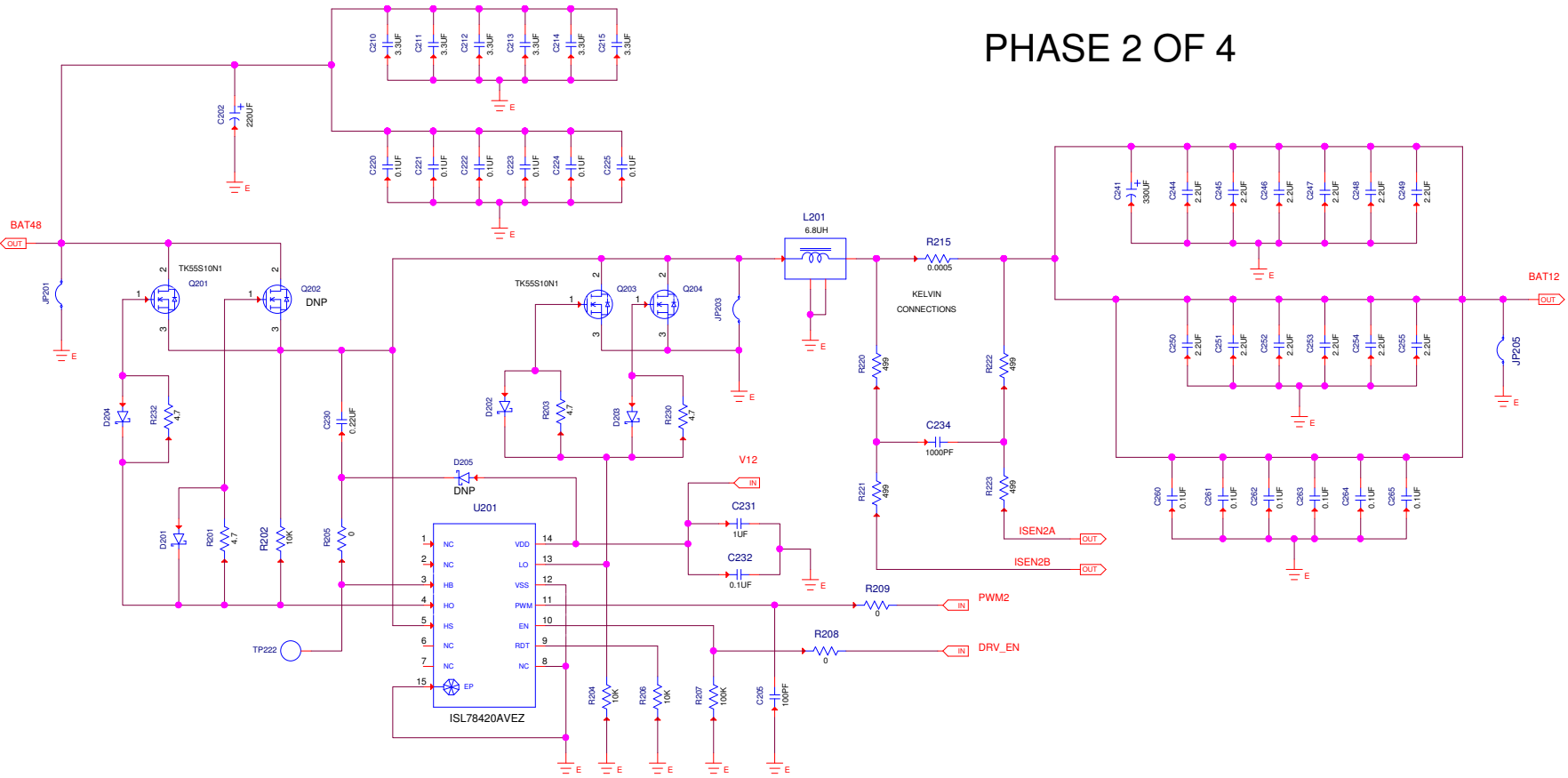
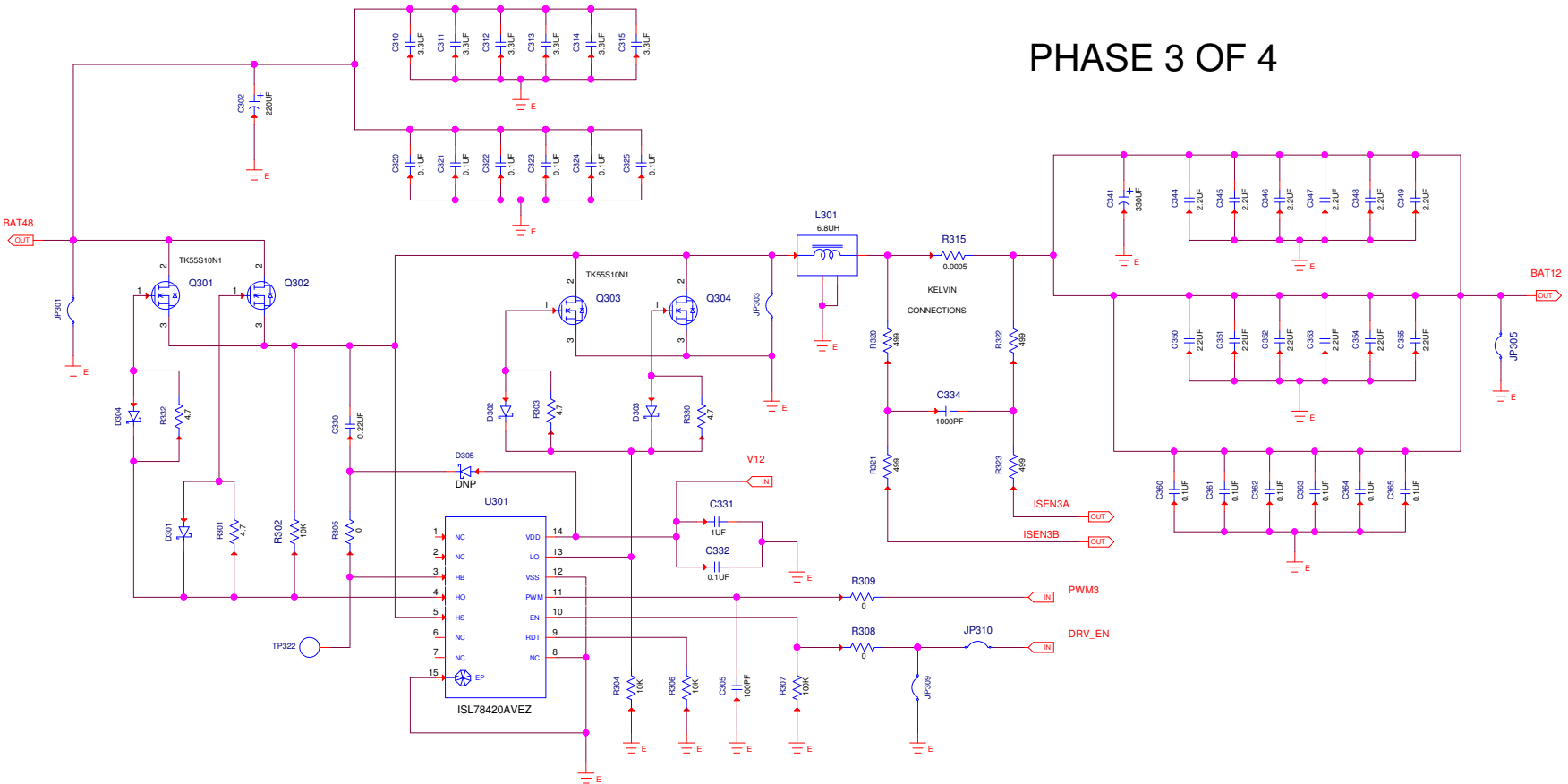
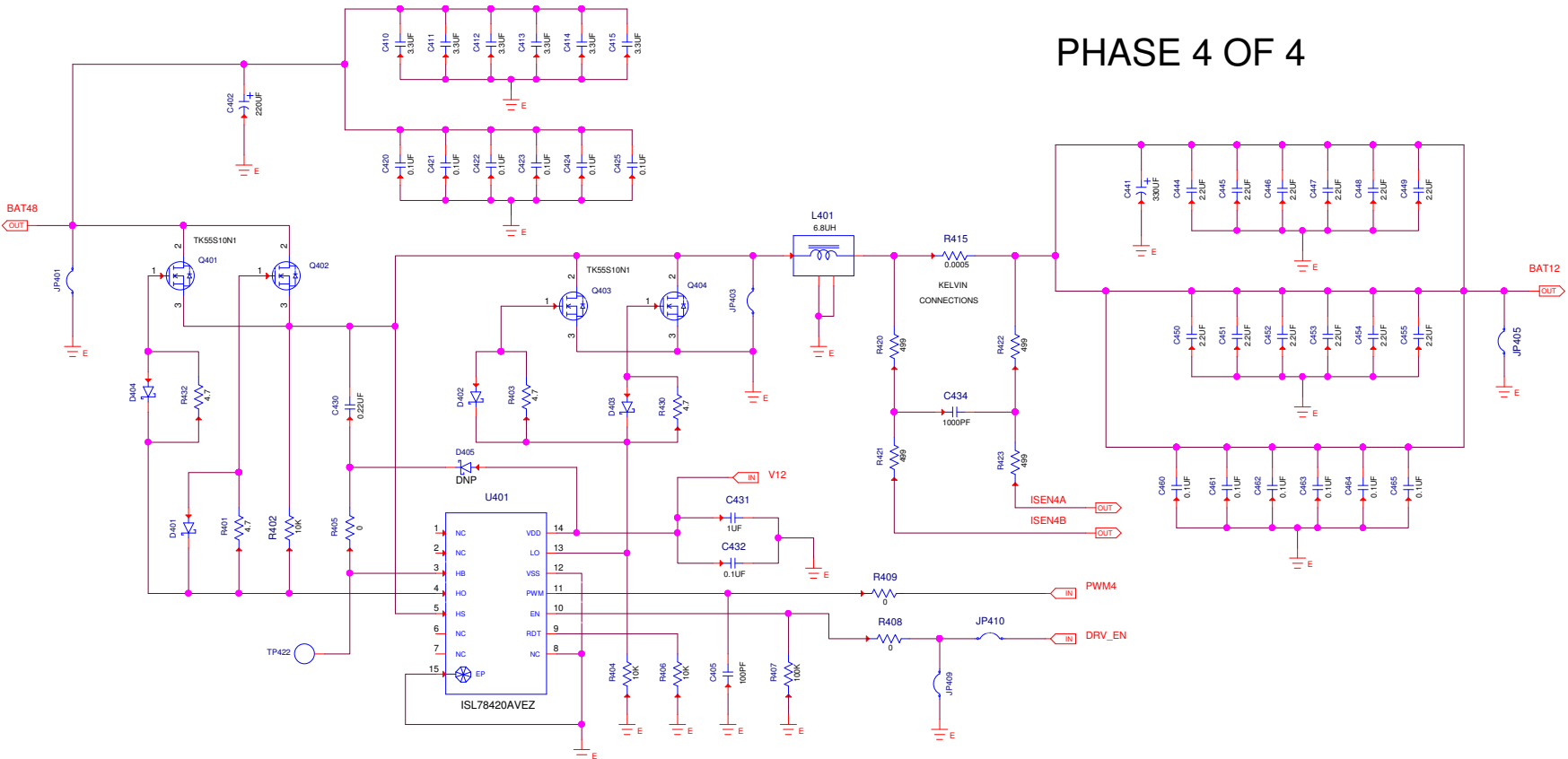


Figure 69. ISL78224EVAL2Z Schematic Page 3 of 8



PHASE 3 OF 4

Figure 70. ISL78224EVAL2Z Schematic Page 4 of 8



PHASE 4 OF 4

Figure 71. ISL78224EVAL2Z Schematic Page 5 of 8

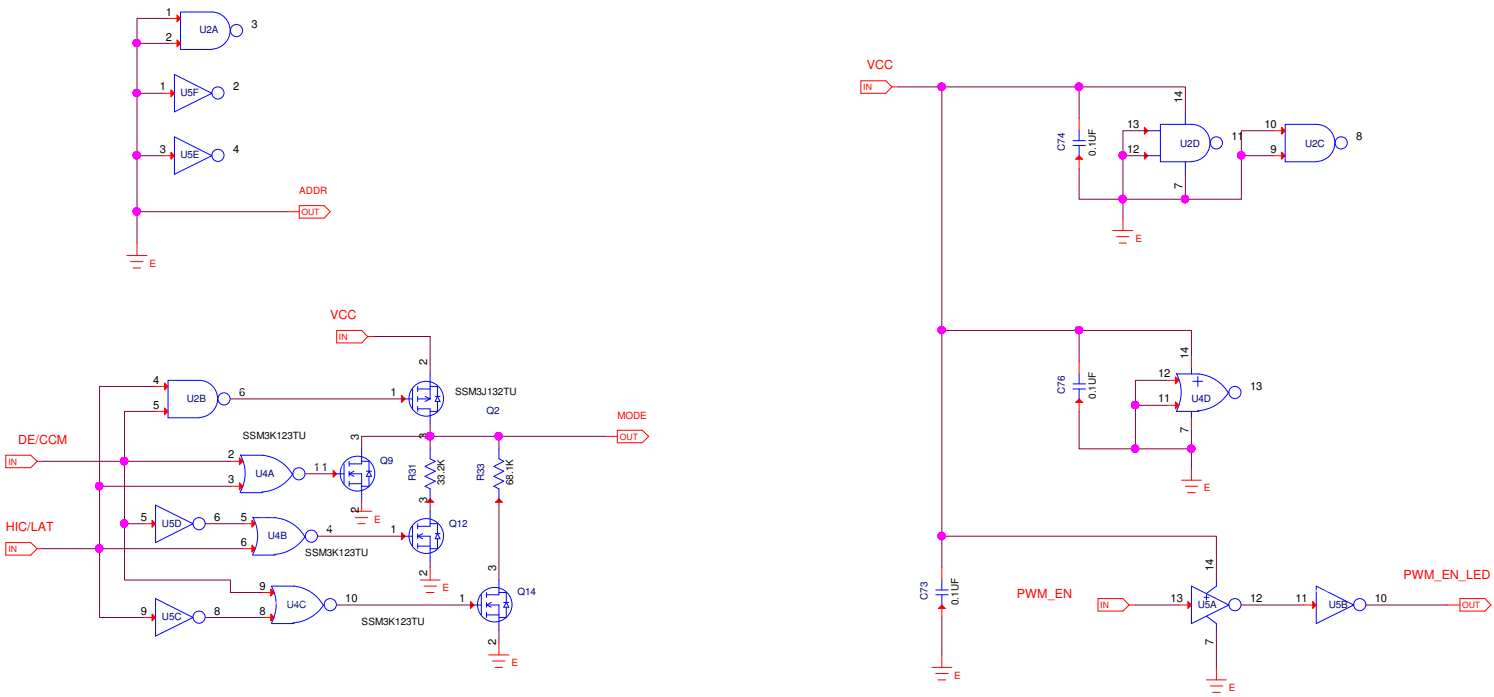


Figure 72. ISL78224EVAL2Z Schematic Page 6 of 8

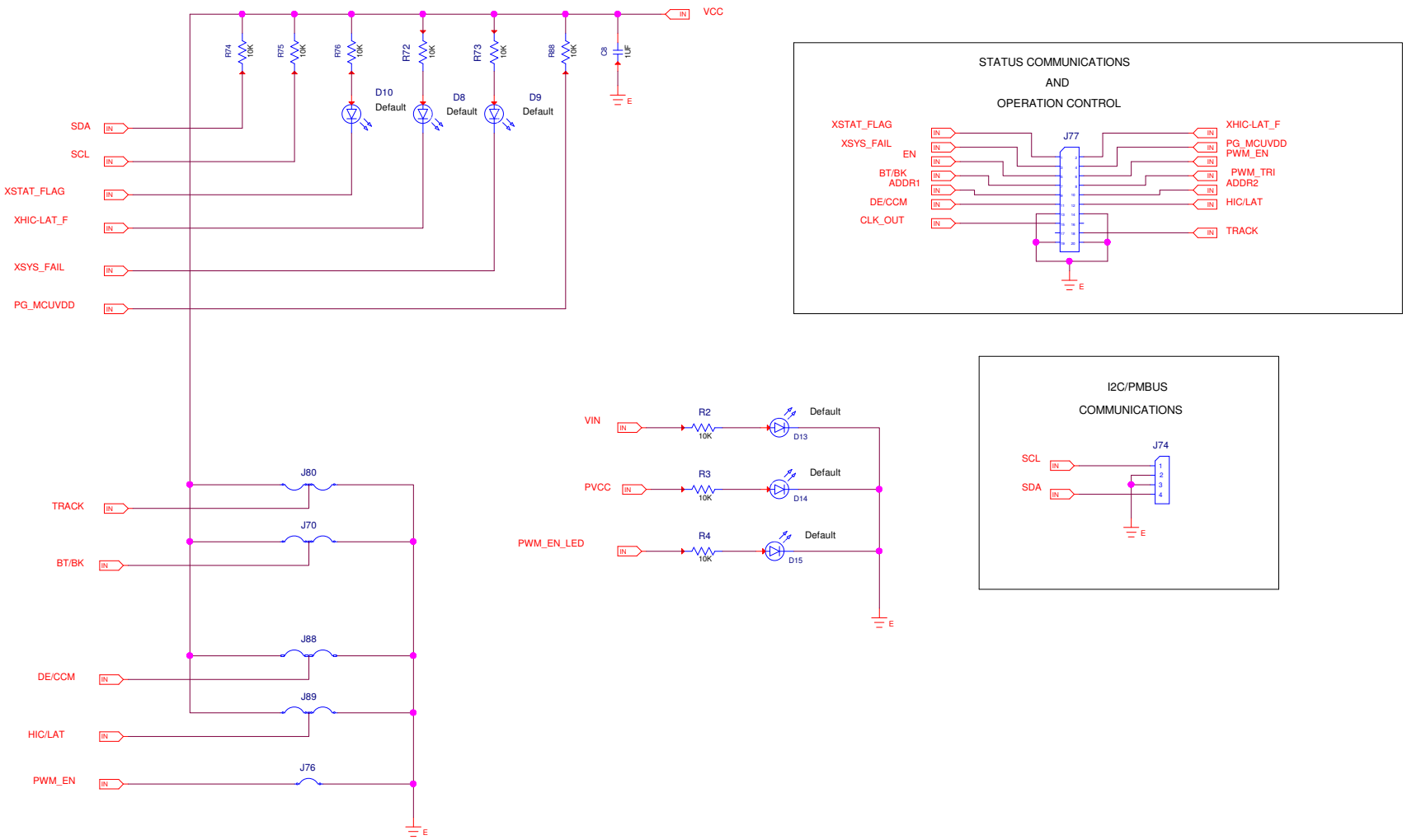


Figure 73. ISL78224EVAL2Z Schematic Page 7 of 8

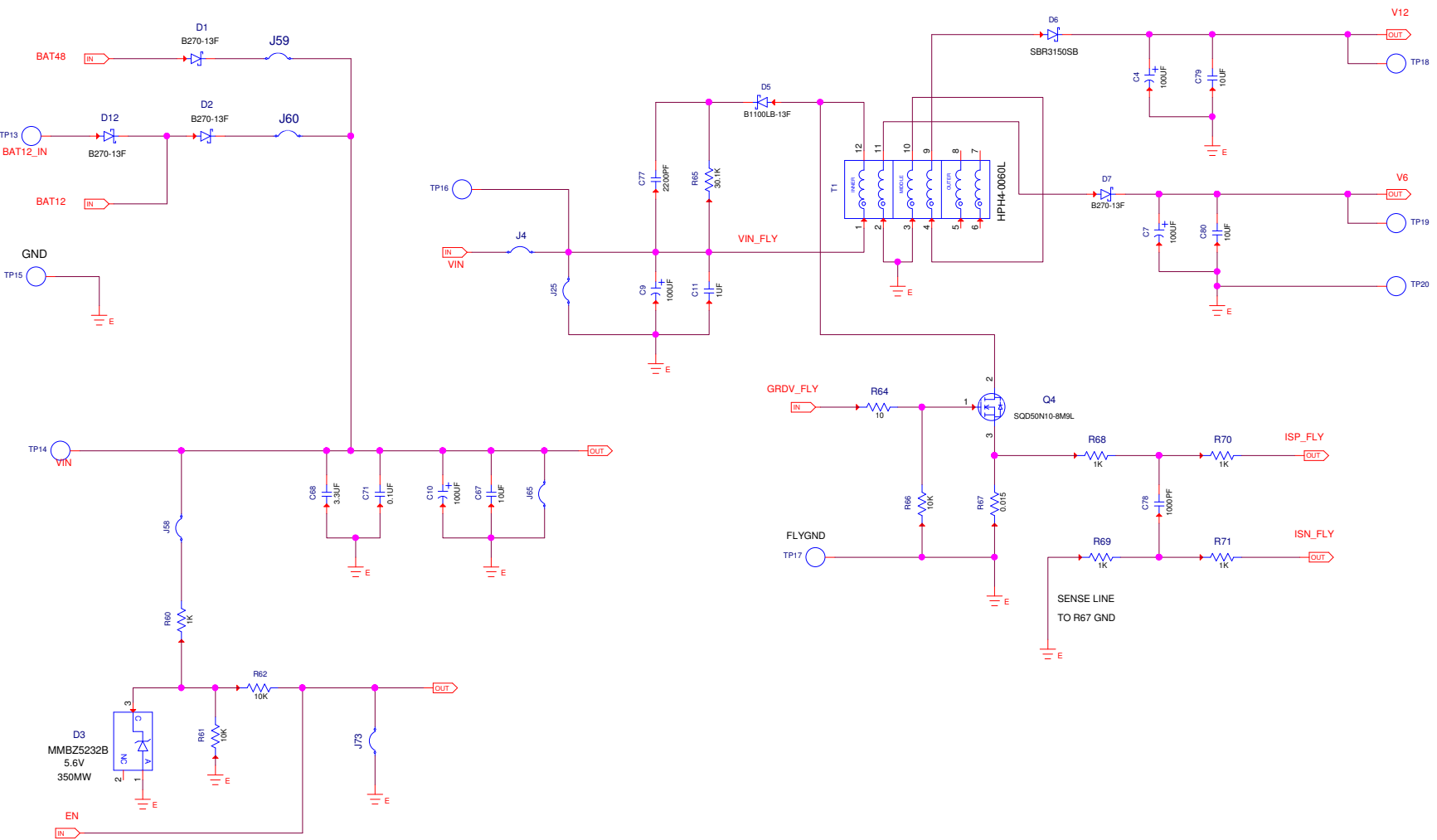


Figure 74. ISL78224EVAL2Z Schematic Page 8 Of 8

7.5 ISLUSBADAPT-EVZ Schematic

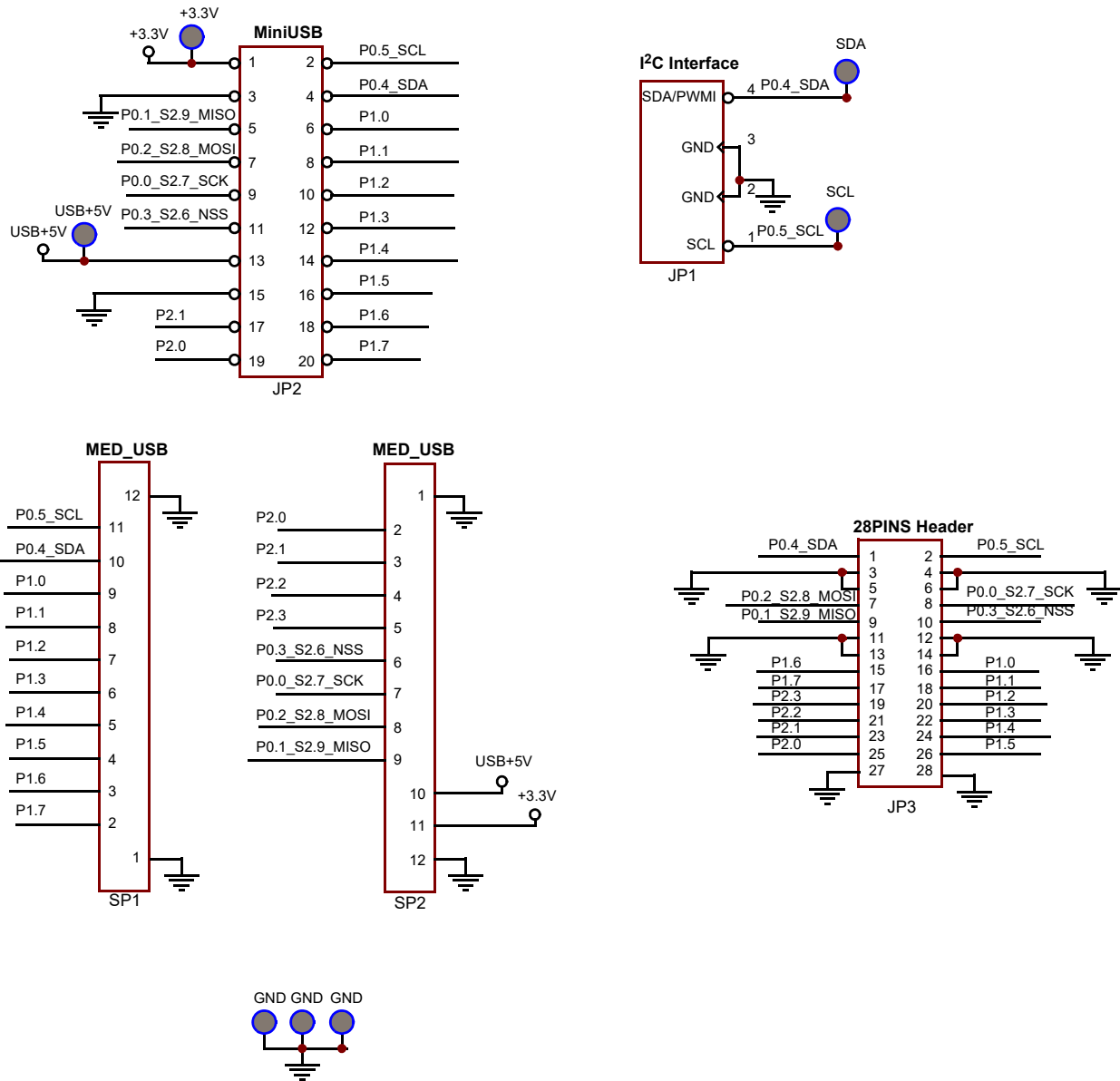


Figure 75. Schematic ISLUSBADAPT-EVZ Page 1 of 1

7.6 ISL78226EVAL1Z Bill of Materials

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage	Package Type	Manufacturer	Manufacturer Part Number
1	0	BB1, BB3	DNP				E-Fab, Inc.	EFI-41111
2	0	BB2, BB4	DNP				E-Fab, Inc.	EFI-41110
3	10	C1, C2, C54, C56, C132, C232, C332, C432, C532, C632	0.1µF	10	50V	0603	Generic	Various
4	6	C102, C202, C302, C402, C502, C602	220µF	20	100V	Radial	Nippon	EGPD101ELL221MK25H
5	0	C101, C201, C301, C401, C501, C601	DNP					
6	1	C11	1µF	10	100V	1206	Generic	Various
7	37	C68, C110-C115, C210-C215, C310-C315, C410-C415, C510-C515, C610-C615	3.3µF	10	100V	2220	TDK	CGA9N2X7R2A335K230KA
8	38	C66, C71, C120-C125, C220-C225, C320-C325, C420-C425, C520-C525, C620-C625	0.1µF	10	100V	805	TDK	CGA4J2X7R2A104K125AA
9	6	C134, C234, C334, C434, C534, C634	1000pF	10	100V	0603	Generic	Various
10	6	C141, C241, C341, C441, C541, C641	330µF	20	63V	Radial	NIC Components	NRE-WY331M63V12.5X25
11	0	C140, C240, C340, C440, C540, C640	DNP					
12	72	C144-C155, C244-C255, C344-C355, C444-C455, C544-C555, C644-C655	2.2µF	10	50V	0805	TDK	CGA4J3X7R1H225K125AB
13	36	C160-C165, C260-C265, C360-C365, C460-C465, C560-C565, C660-C665	0.1µF	10	50V	0805	TDK	CGA4J2X7R1H104K125AA
14	11	C1, C2, C45, C54, C56, C132, C232, C332, C432, C532, C632	0.1µF	10	50V	0603	Generic	Various
15	2	C3, C57	10µF	10	25V	0805	Generic	Various
16	2	C4, C7	100µF	20	50V	Radial	Nichicon	UBT1H101MPD1TD
17	0	C43, C44, C46, C48, C58, C69, C133, C135, C136, C233, C235, C236, C333, C335, C336, C433, C435, C436, C533, C535, C536, C633, C635, C636	DNP			0603		Various
18	1	C51	0.33µF	10	50V	0805	Generic	Various
19	7	C65, C130, C230, C330, C430, C530, C630	0.22µF	10	50V	0603	Generic	Various
20	1	C52	0.068µF	10	50V	0603	TDK	C1608X7R1H683K
21	3	C55, C61, C78	1000pF	10	50V	0603	Generic	Various
22	2	C47, C59	0.01µF	10	50V	0603	Generic	Various
23	1	C63	330pF	10	50V	0603	Generic	Various
24	1	C64	6800pF	10	50V	0603	Generic	Various
25	38	C66, C71, C120-C125, C220-C225, C320-C325, C420-C425, C520-C525, C620-C625	0.1µF	10	100V	0805	TDK	CGA4J2X7R2A104K125AA
26	1	C67	10µF	10	100V	2220	TDK	CGA9N3X7S2A106K230KB

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage	Package Type	Manufacturer	Manufacturer Part Number
27	4	C73-C76	0.1 μ F	10	25V	0603	Kemet	C0603X104K3RACTU
28	1	C77	2200pF	10	50V	0603	Generic	Various
29	2	C79, C80	10 μ F	10	25V	1206	Taiyo Yuden	TMK316B7106KL-TD
30	8	C8, C53, C131, C231, C331, C431, C531, C631	1 μ F	10	25V	0603	Murata	GRM188R71E105KA12
31	2	C9, C10	100 μ F	20	100V	Radial	NIC Components	NRE-WY101M100V12.5X20
32	5	D1, D2, D7, D11, D12	2A		70V	SMD2	Diodes	B270-13F
33	24	D101-D104, D201-D204, D301-D304, D401-D404, D501-D504, D601-D604	2A		30V	SOD123	Diodes	MBR230S1F
34	6	D105, D205, D305, D405, D505, D605	2A		80V	SMD2	Diodes	B280-13F
35	3	D13-D15	GREEN	LED		SMD	Dialight	597-3311-407NF
36	1	D3	225mW		5.6V	SM3	On Semi	MMBZ5232B
37	1	D4	500mW		62V	SM2	On Semi	MMSZ5265B
38	1	D5	1A		100V	SMD2	Diodes	B1100LB-13F
39	1	D6	3A		150V	SMD2	Diodes Inc	SBR3150SB
40	3	D8-D10	RED	LED		SMD	Dialight	597-3111-407
41	103	J1, J4, J14, J15, J17, J18, J20-J27, J29-J40, J42-J48, J58-J63, J65-J68, J73, J76, J79, J83, JP101-JP108, JP201-JP208, JP301-JP310, JP401-JP410, JP501-JP510, JP601-JP610				THOLE	Generic	JUMPER2_100
42	24	J101-J104, J201-J204, J301-J304, J401-J404, J501-J504, J601-J604				B2C	IHI Connectors	B2C-PCB-45-HEX
43	8	J12, J70, J71, J80-J82, J88, J89				THOLE	Generic	JUMPER-3-100
44	1	J2				2COLSX3ROWS	Samtec	TSW-103-08-T-D-RA
45	10	J49, J50, J52-J56, J78, TP7, TP8				CONN	Keystone	575-4
46	1	J74				IN-LINE	Generic	CONN-1X4
47	1	J75				THOLE	Generic	JUMPER-3-100
48	1	J77				HDR	Samtec	HTSW-110-07-G-D
49	6	L101, L201, L301, L401, L501, L601	6.8 μ H		UA7919-AE	Custom	Coilcraft	UA7919-AE
50	0	L102, L202, L302, L402, L502, L602	DNP		IHTH1500TZER6R8M5A		Vishay	IHTH1500TZER6R8M5A
51	2	Q1, Q2	5.4A	P-CH	-12V	2-2U1A	Toshiba	SSM3J132TU
52	24	Q101-Q104, Q201-Q204, Q301-Q304, Q401-Q404, Q501-Q504, Q601-Q604	55A	N-CH	100V	DPAK	Toshiba	TK55S10N1
53	2	Q3, Q4	50A	N-CH	100V	TO252	VISHAY	SQD50N10-8M9L

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage	Package Type	Manufacturer	Manufacturer Part Number
54	6	Q9-Q14	4.2A	N-CH	20V	2-2U1A	Toshiba	SSM3K123TU
55	47	R1, R5, R6, R11, R44, R105, R108, R109, R110, R114, R117, R127, R205, R208, R209, R210, R214, R217, R227, R305, R308, R309, R310, R314, R317, R327, R405, R408, R409, R410, R414, R417, R427, R505, R508, R509, R510, R514, R517, R527, R605, R608, R609, R610, R614, R617, R627	0			0603	Generic	Various
56	24	R101, R103, R130, R132, R201, R203, R230, R232, R301, R303, R330, R332, R401, R403, R430, R432, R501, R503, R530, R532, R601, R603, R630, R632	4.7	10		0805	Generic	Various
57	6	R107, R207, R307, R407, R507, R607	100k	1		0603	Generic	Various
58	0	R111, R112, R131, R133, R211, R212, R231, R233, R311, R312, R331, R333, R411, R412, R431, R433, R511, R512, R531, R533, R611, R612, R631, R633	DNP			0805	Generic	Various
59	12	R115, R116, R215, R216, R315, R316, R415, R416, R515, R516, R615, R616	0.001	1		2512	Vishay	WSLP25121L000FEA
60	24	R120-R123, R220-R223, R320-R323, R420-R423, R520-R523, R620-R623	499	1		0603	Generic	S0603CPX4990F10
61	0	R128, R129, R228, R229, R328, R329, R428, R429, R528, R529, R628, R629	DNP			0603	Generic	Various
62	1	R18	30.1k	1		0603	Generic	Various
63	1	R19	51.1k	1		0603	Generic	Various
64	1	R20	26.7k	1		0603	Generic	Various
65	1	R21	38.3k	1		0603	Generic	Various
66	32	R2, R3, R4, R22, R48, R61, R62, R66, R72, R73, R74, R75, R76, R88, R102, R104, R106, R202, R204, R206, R302, R304, R306, R402, R404, R406, R502, R504, R506, R602, R604, R606	10.0k	1		0603	Generic	Various
67	4	R23, R24, R45, R59	49.9	1		0603	Generic	Various
68	0	R25, R27, R113, R118, R119, R124-R126, R128, R129, R213, R218, R219, R224-R226, R228, R229, R313, R318, R319, R324-R326, R328, R329, R413, R418, R419, R424-R426, R428, R429, R513, R518, R519, R524-R526, R528, R529, R613, R618, R619, R624-R626, R628, R629	DNP			0603	Generic	Various
69	1	R26	2.8k	1		0603	Generic	Various
70	1	R28	4.22K	1		0603	Generic	Various
71	1	R29	20.0k	1		0603	Generic	Various
72	2	R30, R33	68.1k	1		0603	Generic	Various
73	2	R31, R32	33.2k	1		0603	Generic	Various
74	2	R34, R38	7.5k	1		0603	Generic	Various
75	1	R36	33k	1		0603	Generic	CRCW060333K0FKEA
76	2	R37, R50	51k	1		0603	Generic	CRCW060351K0FKEA

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage	Package Type	Manufacturer	Manufacturer Part Number
77	1	R39	27.4	1		0603	Generic	Various
78	1	R40	10.2k	0.1		0603	Generic	Various
79	1	R43	54.9k	1		0603	Generic	Various
80	1	R46	10.2k	1		0603	Generic	Various
81	1	R47	21.5k	1		0603	Generic	Various
82	3	R42, R49, R64	10	1		0603	Generic	S0603CPZ10R0F10
83	9	R51, R52, R55, R56, R60, R68-R71	1.00k	1		0603	Generic	Various
84	1	R53	3.24k	1		0603	Generic	Various
85	1	R57	46.4k	1		0603	Generic	Various
86	1	R58	3.01k	1		0603	Generic	Various
87	1	R63	1 Ω	1		0603	Generic	Various
88	1	R65	30.1k	1		1206	Generic	Various
89	1	R67	0.015	1		1206	Vishay	WSLP12065L000FEA
90	1	SW1				SPST	C&K	GT12MSCBETR
91	1	T1	4.9 μ H	10		HPH4-0060L	Coilcraft	HPH4-0060LB
92	1	U1	ISL78226ANZ			64TQFP	Renesas	ISL78226ANZ
93	6	U101, U201, U301, U401, U501, U601	ISL78420AVEZ			14HTSSOP	Renesas	ISL78420AVEZ
94	1	U2	MM74HC00MTCX-T			14TSSOP	Fairchild	MM74HC00MTC
95	2	U3, U4	MM74HC02MTCX-T			14TSSOP	Fairchild	MM74HC02MCT
96	1	U5	MM74HC04MTCX-T			14TSSOP	Fairchild	MM74HC04MCT

7.7 ISL78224EVAL2Z Bill of Materials

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage (V)	Package Type	Manufacturer	Manufacturer Part Number
1	6	C2, C54, C56, C73, C74, C76	0.1µF	10	25	0603	Kemet	C0603X104K3RACTU-T
2	24	C160-C165, C260-C265, C360-C365, C460-C465	0.1µF	10	50	0805	TDK	CGA4J2X7R1H104K125AA-T
3	33	C71, C120-C127, C220-C227, C320-C327, C420-C427	0.1µF	10	100	0805	TDK	CGA4J2X7R2A104K125AA-T
4	48	C144-C155, C244-C255, C344-C355, C444-C455	2.2µF	10	50	0805	TDK	CGA4J3X7R1H225K125AE-T
5	29	C68, C110-C116, C210-C216, C310-C316, C410-C416	3.3µF	10	100	2220	TDK	CGA9N2X7R2A335K230KA-T
6	1	C67	10µF	10	100	2220	TDK	CGA9N3X7S2A106K230KB-T
7	2	C8, C53	1µF	10	25	0603	Murata	GRM188R71E105KA12D-T
8	4	C131, C231, C331, C431	4.7µF	10	25	0805	TDK	CGA4J1X7R1E475K125AC
9	4	C105, C205, C305, C405	100pF	10	50	0603	Generic	Various
10	4	C134, C234, C334, C434	1000pF	10	100	0603	Generic	Various
11	3	C55, C61, C78	1000pF	10	50	0603	Generic	Various
12	2	C47, C59	0.01µF	10	50	0603	Generic	Various
13	6	C1, C45, C132, C232, C332, C432	0.1µF	10	50	0603	Generic	Various
14	1	C77	2200pF	10	50	0603	Generic	Various
15	5	C65, C130, C230, C330, C430	0.22µF	10	50	0603	Generic	Various
16	1	C63	330pF	10	50	0603	Generic	Various
17	1	C64	6800pF	10	50	0603	Generic	Various
18	1	C52	0.068µF	10	50	0603	Generic	Various
19	0	C43, C44, C46, C48, C50, C58					Do Not Populate	Do Not Populate
20	2	C3, C57	10µF	10	25	0805	Generic	Various
21	1	C51	0.33µF	10	50	0805	Generic	Various
22	1	C11	1µF	10	100	1206	Generic	Various
23	2	C79, C80	10µF	10	25	1206	Taiyo Yuden	TMK316B7106KL-TD
24	4	C102, C202, C302, C402	220µF	20	100	RADIAL	Nippon Chemi-Con	EGPD101ELL221MK25H
25	1	T1	4.9µH	10		CUSTOM	Coilcraft	HPH4-0060LB
26	2	C9, C10 *(ALT:UBT2A101MHD1TO)	100µF	20	100	RADIAL	NIC Comp Corp.	NRE-WY101M100V12.5X20F
27	4	C141, C241, C341, C441	330µF	20	63	RADIAL	NIC Comp Corp.	NRE-WY331M63V12.5X25F
28	2	C4, C7	100µF	20	50V	RADIAL	Nichicon	UBT1H101MPD
29	4	L101, L201, L301, L401	6.8µH			CUSTOM	Cyntec Co.,ltd.	VCHH2324AF-6R8MS6-87
30	11	TP6-TP11, TP13, TP14, TP16, TP18, TP19					Keystone	5000

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage (V)	Package Type	Manufacturer	Manufacturer Part Number
31	4	TP12,TP15,TP17,TP20					Keystone	5001
32	1	J77					Samtec	HTSW-110-07-G-D
33	2	J1, J4					Sullins	SPC02SYAN
34	46	J1, J4, J58-J60, J65, JP103, JP203, JP303, JP403, TP1-TP5, TP21, TP23-TP31, TP50, TP51, TP80, TP101-TP106, TP201-TP204, TP301-TP304, TP401-TP404					Samtec	TSW-150-08-F-S-1X2
35	4	J70, J80, J88, J89					Samtec	TSW-150-08-F-S-1X3
36	1	J74					Samtec	TSW-150-08-F-S-1X4
37	1	D5	1A		100	2P	Diodes Inc.	B1100LB-13-F-T
38	4	D1, D2, D7, D12	2A		70	2P	Diodes Inc.	B270-13-F-T
39	0	D101-D104, D201-D204, D301-D304, D401-D404					Do Not Populate	
40	1	D3	225mW		5.6	SOT-23	On Semiconductor	MMBZ5232BLT1G-T
41	1	D6	3A		150	2P	Diodes Inc.	SBR3150SB-13-T
42	3	D8, D9, D10	30mA	RED		1206	Dialight	597-3111-407F-T
43	3	D13, D14, D15	75mW	GREEN		1206	Dialight	597-3311-407NF-T
44	1	U1				TQFP-EP	Intersil	ISL78224ANZ
45	4	U101, U201, U301, U401			100	HTSSOP	Intersil	ISL424AVEZ
46	1	U2				TSSOP	Fairchild	MM74HC00MTCX-T
47	1	U4				TSSOP	Fairchild	MM74HC02MTCX-T
48	1	U5				TSSOP	Fairchild	MM74HC04MTCX-T
49	1	Q4					Vishay/Siliconix	SQD50N10-8M9L-GE3-T
50	1	Q2					Toshiba	SSM3J132TU-T
51	3	Q9, Q12, Q14	4.2A		20V		Toshiba	SSM3K123TU,LF-T
52	16	Q101-Q104, Q201-Q204, Q301-Q304, Q401-Q404	55A		100		Toshiba	TK55S10N1, LQ-T
53	1	R67	0.015Ω	1		1206	Panasonic	ERJ-8CWFR015V-T
54	0	R25, R27, R35, R41, R52		0.1		0603	Do Not Populate	DO NOT POPULATE
55	3	R42, R49, R64	10Ω	1		0603	Generic	VARIOUS
56	13	R1, R7, R8, R9, R39, R105, R109, R205, R209, R305, R309, R405, R409	0Ω			0603	Generic	VARIOUS
57	7	R5, R6, R60, R68, R69, R70, R71	1k	1		0603	Generic	Various
56	22	R2, R3, R4, R44, R48, R61, R62, R66, R72-R76, R88, R102, R104, R202, R204, R302, R304, R402, R404	10k	1		0603	Generic	Various
59	4	R107, R207, R307, R407	100k	1		0603	Generic	Various

Item	Qty	Reference Designator	Value	Tol. (%)	Voltage (V)	Package Type	Manufacturer	Manufacturer Part Number
60	1	R46	10.2k	1		0603	Generic	Various
61	2	R34,R38	7.5k	1		0603	Generic	Various
62	1	R29	20.0k	1		0603	Generic	Various
63	1	R40	15k	0.1		0603	Generic	Various
64	1	R47	21.5k	1		0603	Generic	Various
65	1	R20	0Ω	1		0805	Generic	Various
66	1	R26	2.80k	0.1		0603	Generic	Various
67	1	R58	3.01k	1		0603	Generic	Various
68	1	R18	30.1k	0.1		0603	Generic	Various
69	1	R53	3.24k	1		0603	Generic	Various
70	1	R36	33k	1		0603	Generic	Various
71	1	R31	33.2k	1		0603	Generic	Various
72	1	R21	64.9k	0.1		0603	Generic	Various
73	1	R57	46.4k	1		0603	Generic	Various
74	1	R43	42.2k	1		0603	Generic	Various
75	16	R120-R123, R220-R223, R320-R323, R420-R423	499Ω	1		0603	Generic	Various
76	2	R37, R50	51k	1		0603	Generic	Various
77	1	R19	51.1k	0.1		0603	Generic	Various
78	1	R28	4.22kΩ	1		0603	Generic	Various
79	1	R33	68.1k	1		0603	Generic	Various
80	32	R101, R103, R111, R113, R130, R132, R140, R142, R201, R203, R211, R213, R230, R232, R240, R242, R301, R303, R311, R313, R330, R332, R340, R342, R401, R403, R430, R411, R413, R432, R440, R442	4.7Ω	1		0805	Generic	Various
81	1	R65	30.1k	1		1206	Generic	Various
82	8	R115, R116, R215, R216, R315, R316, R415, R416	1.0mΩ	1		2512	Vishay/Dale	WSLP2512L000FEA
83	4	J101-J104					International Hydraulics Inc	B2C-PCB-HEX
84	6	Perimeter of PCB					4-40 SCREW	
85	6	Perimeter of PCB					4-40 STANDOFF	
86	1	Place assy in bag					Renesas Common Stock	8X12-STATIC-BAG

7.8 ISL78226EVAL1Z Board Layout (Six Layers)

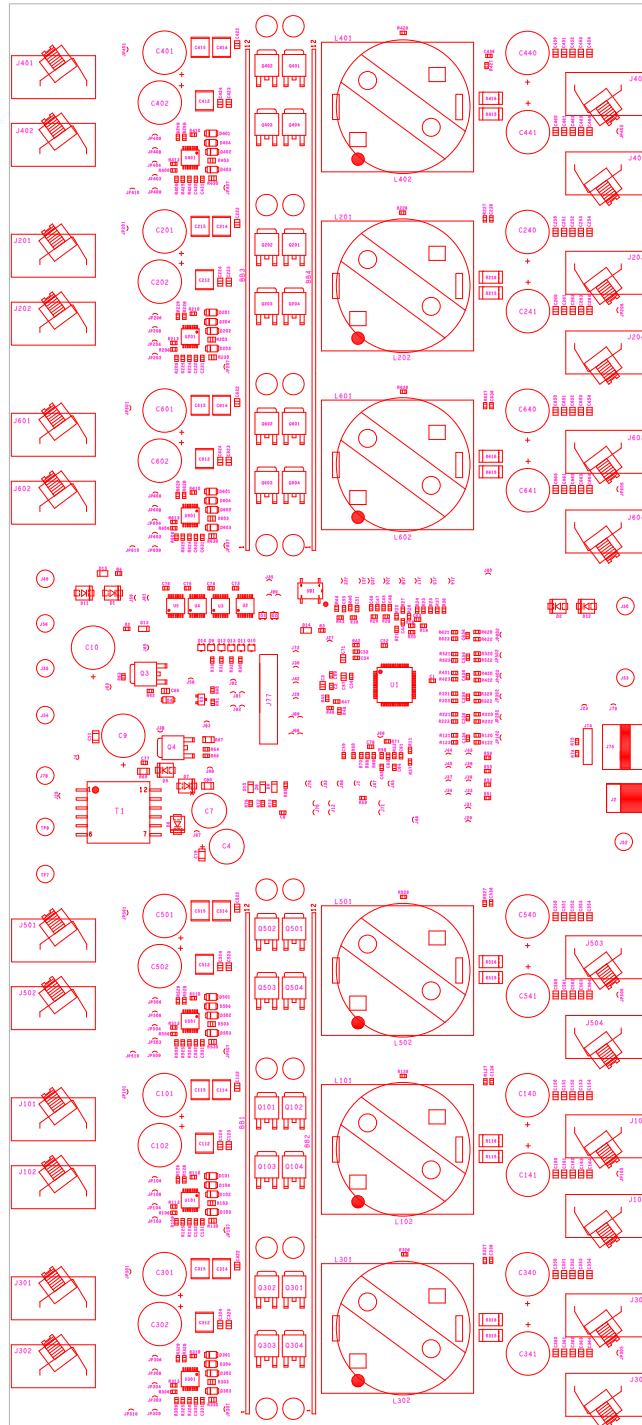


Figure 76. Assembly Top

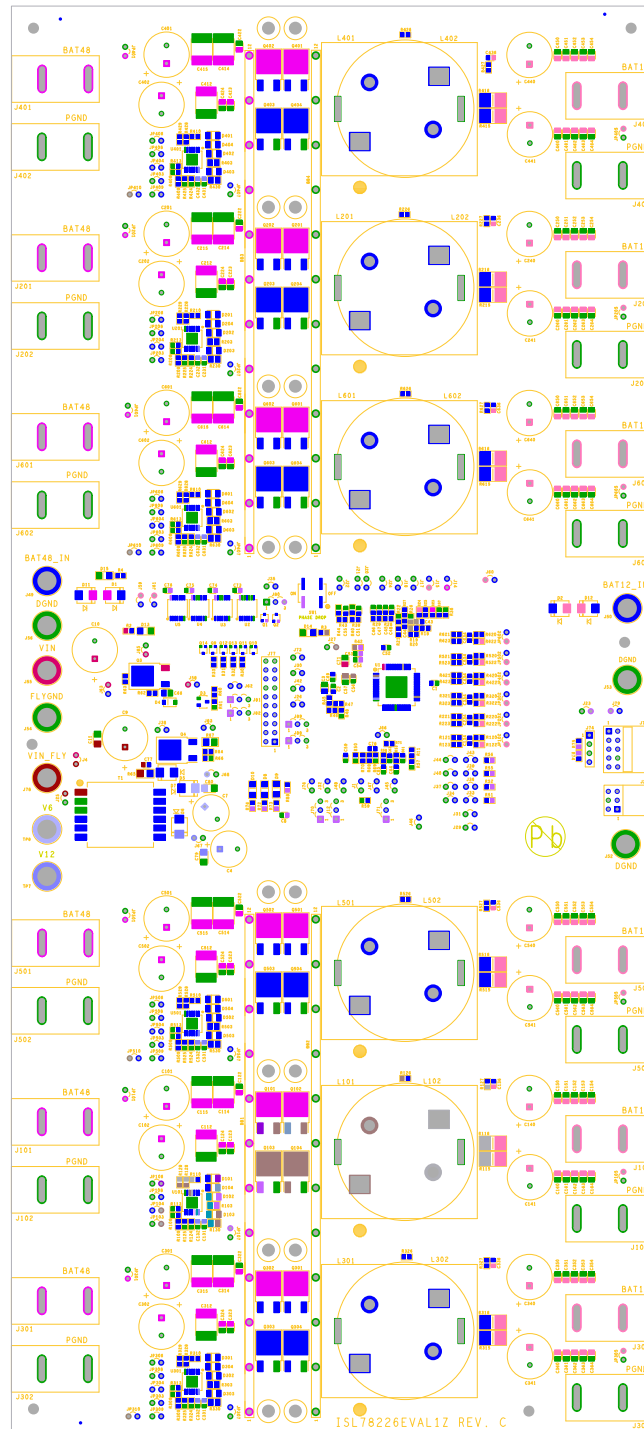


Figure 77. Silkscreen Top

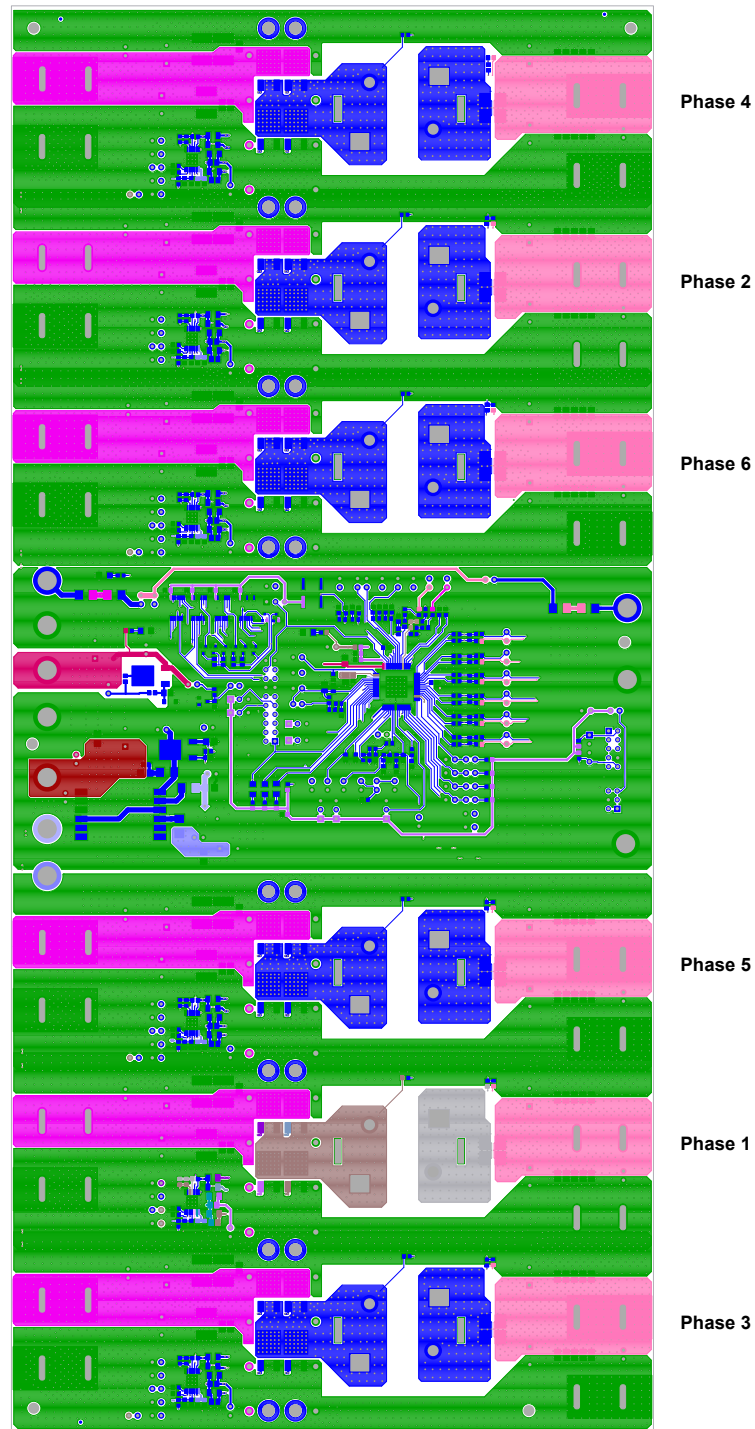


Figure 78. Top Layer

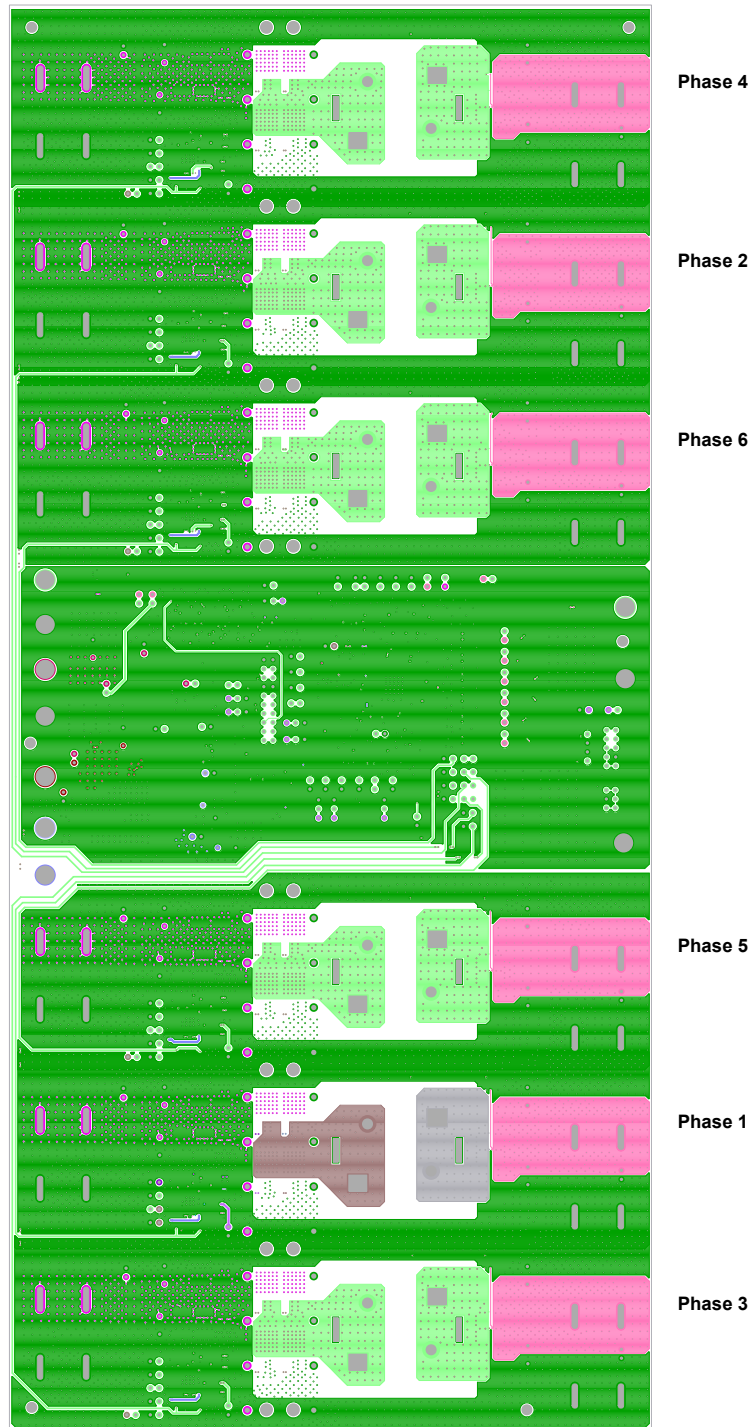


Figure 79. PCB – Inner Layer 2 (Viewed from Top)

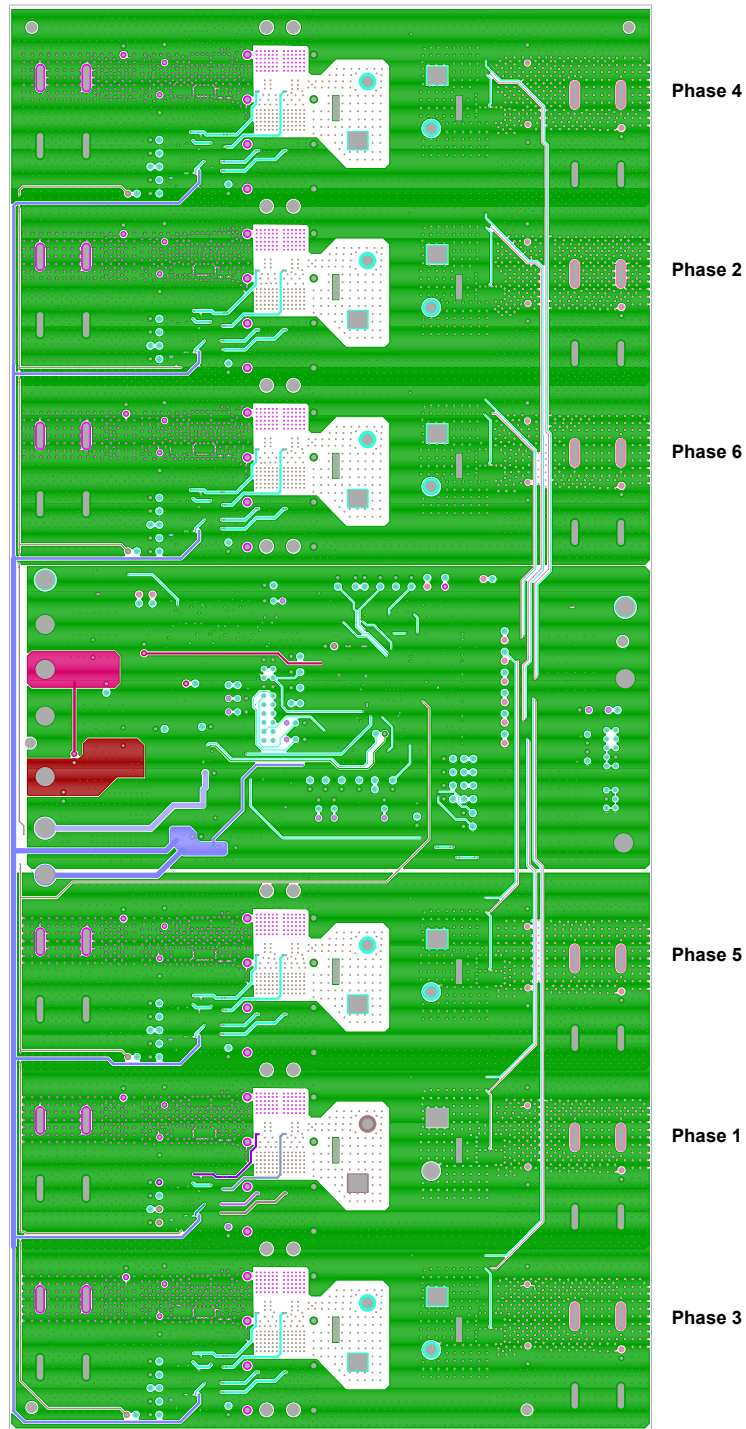


Figure 80. PCB – Inner Layer 3 (Viewed from Top)

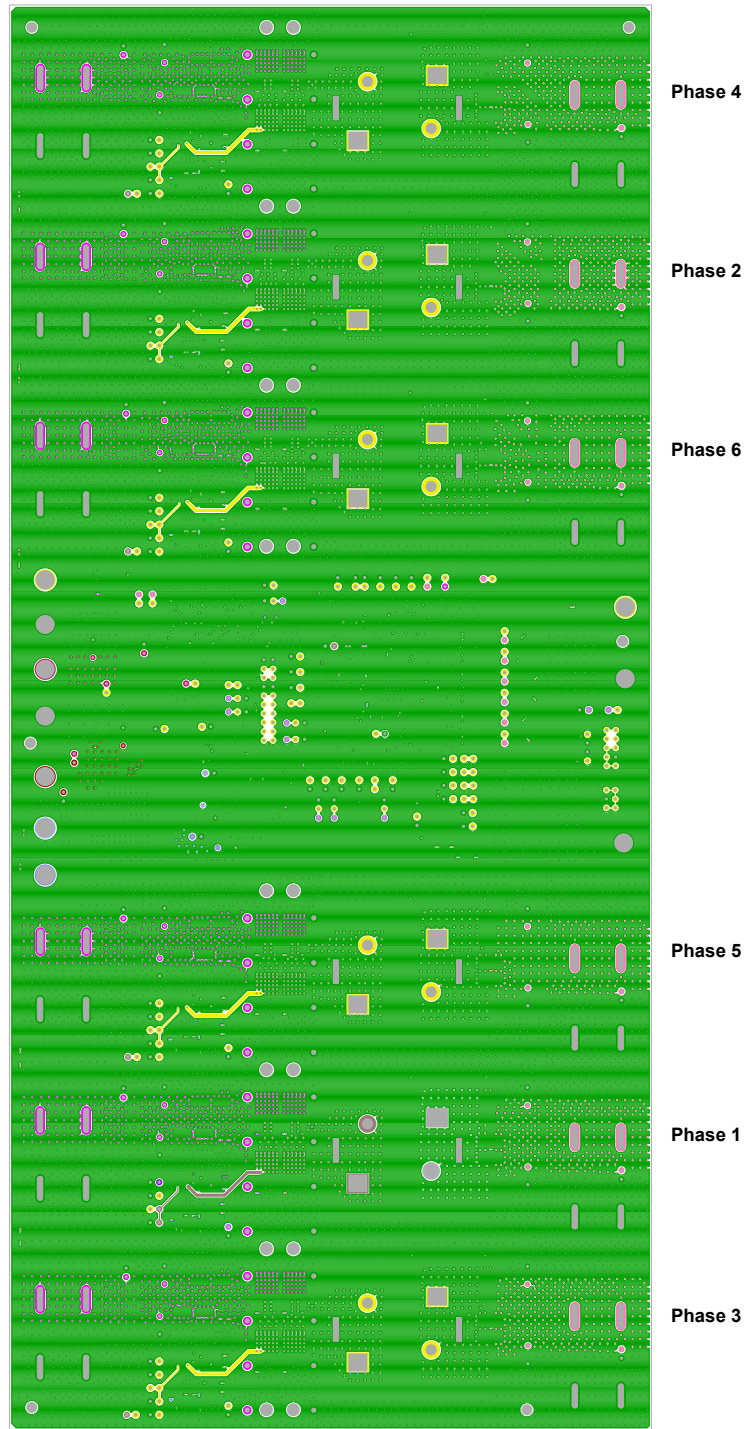


Figure 81. PCB – Inner Layer 4 (Viewed from Top)

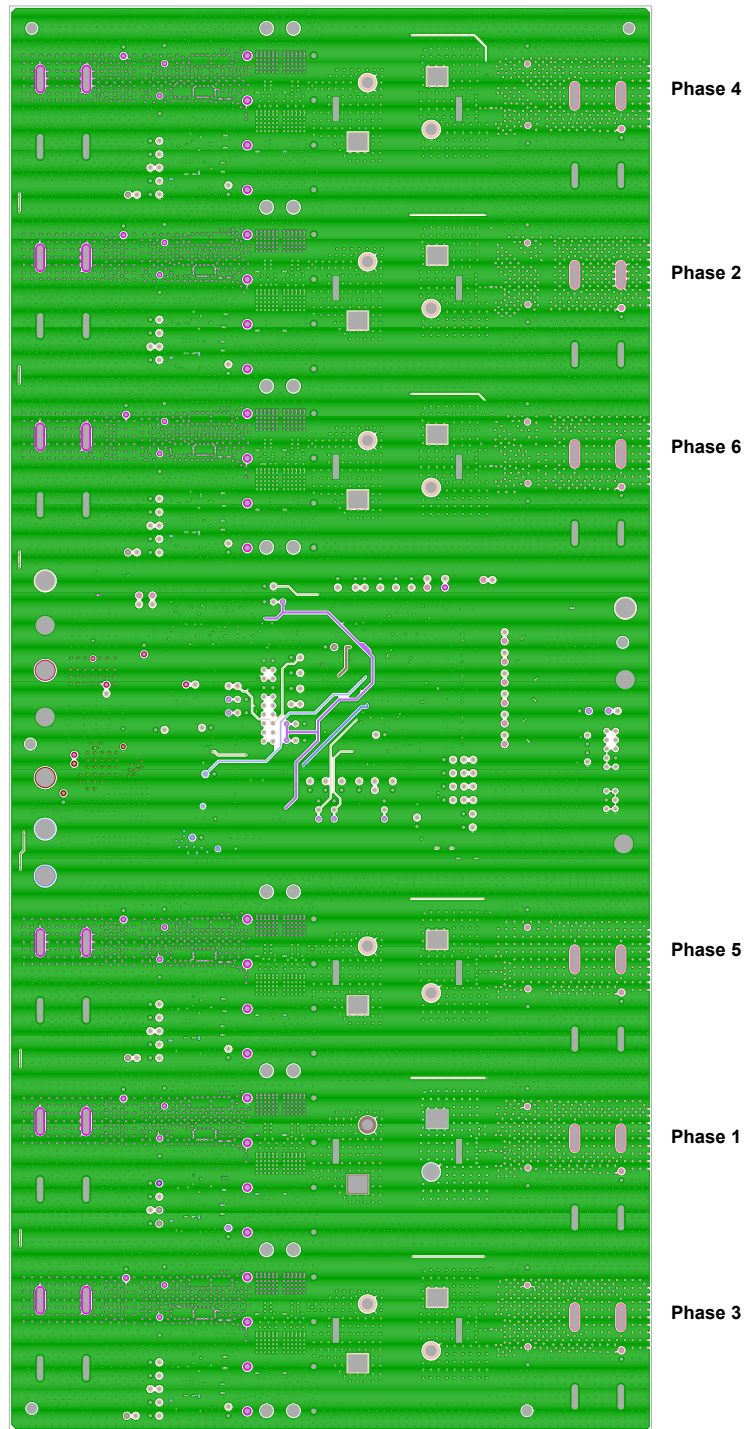


Figure 82. PCB – Inner Layer 5 (Viewed from Top)

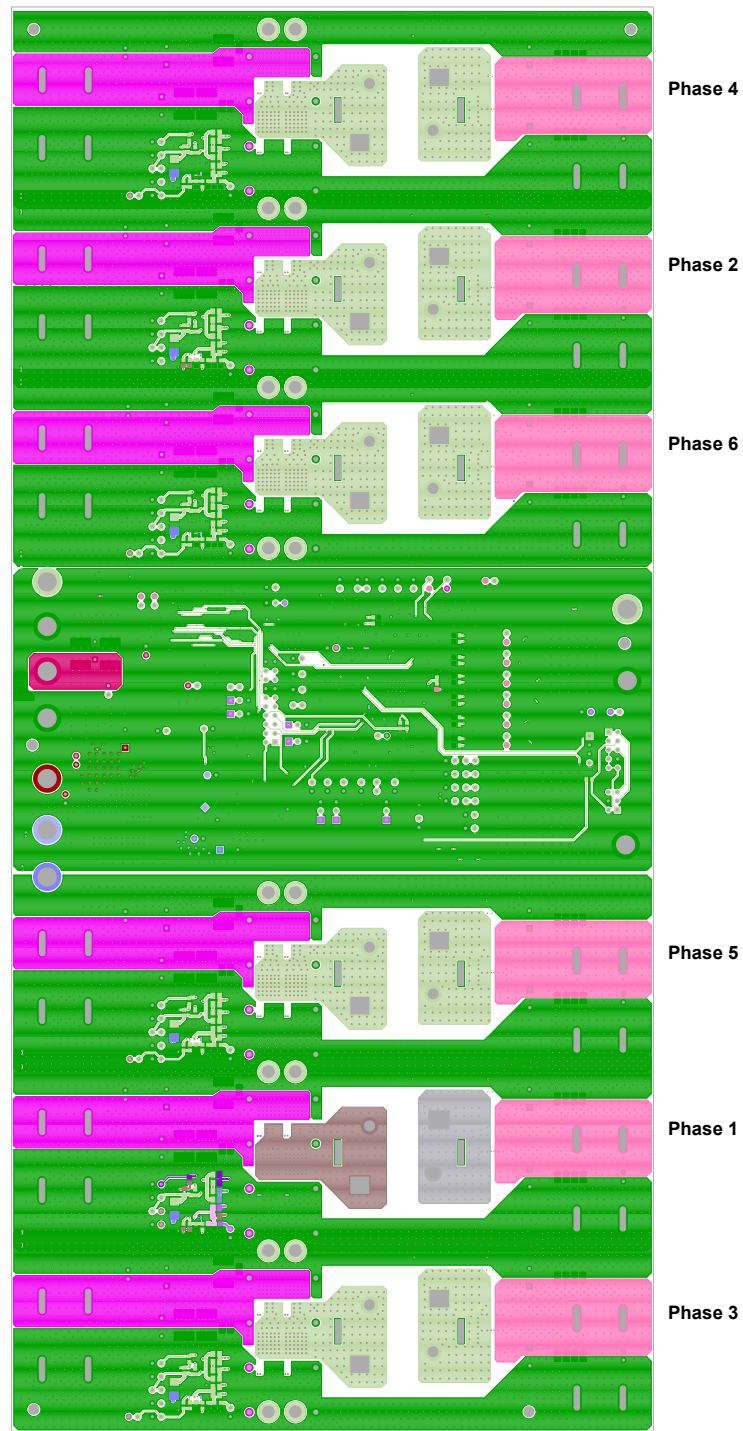


Figure 83. PCB – Bottom Layer (Viewed from Top)

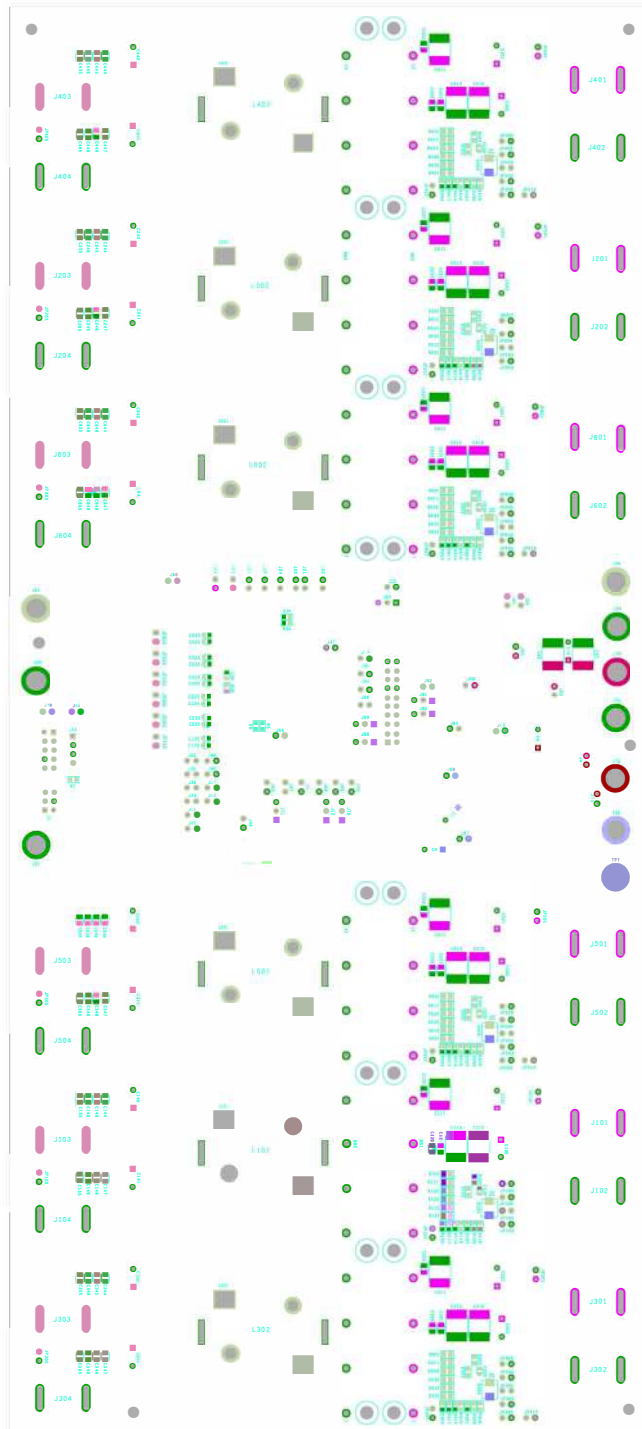


Figure 84. Silkscreen Bottom

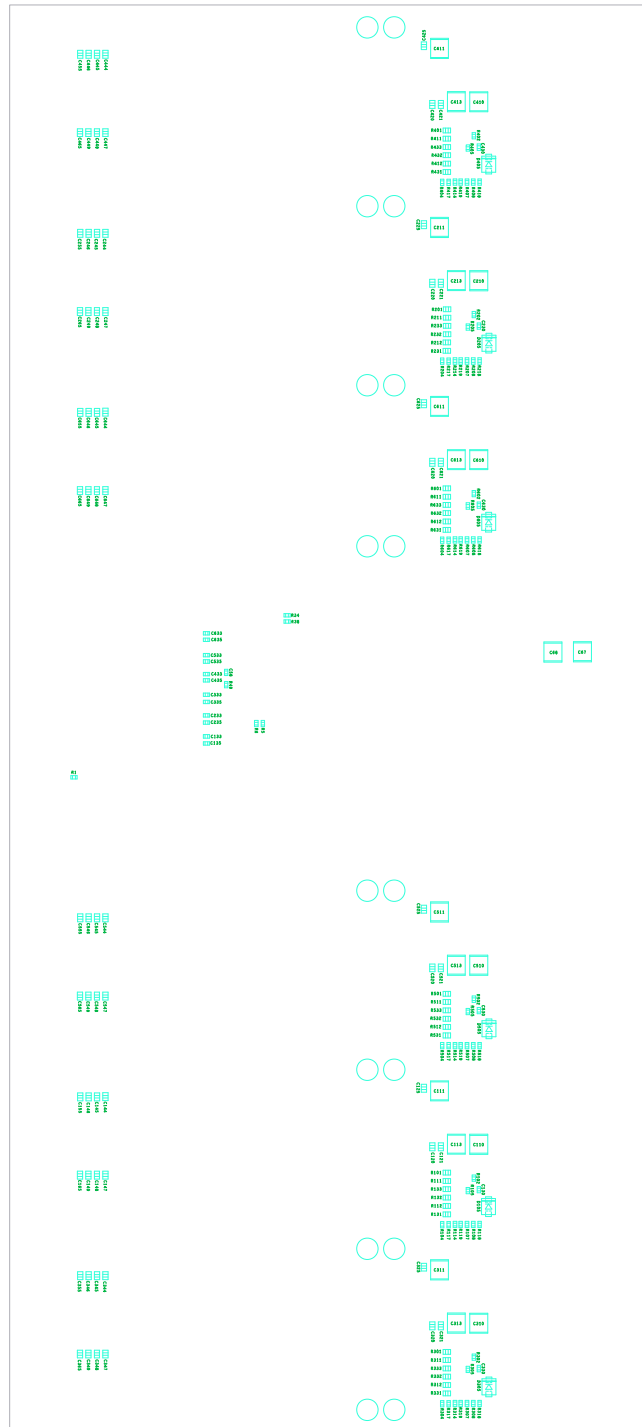


Figure 85. Bottom Assembly

7.9 ISL78224EVAL2Z Board Layout (Eight Layers)

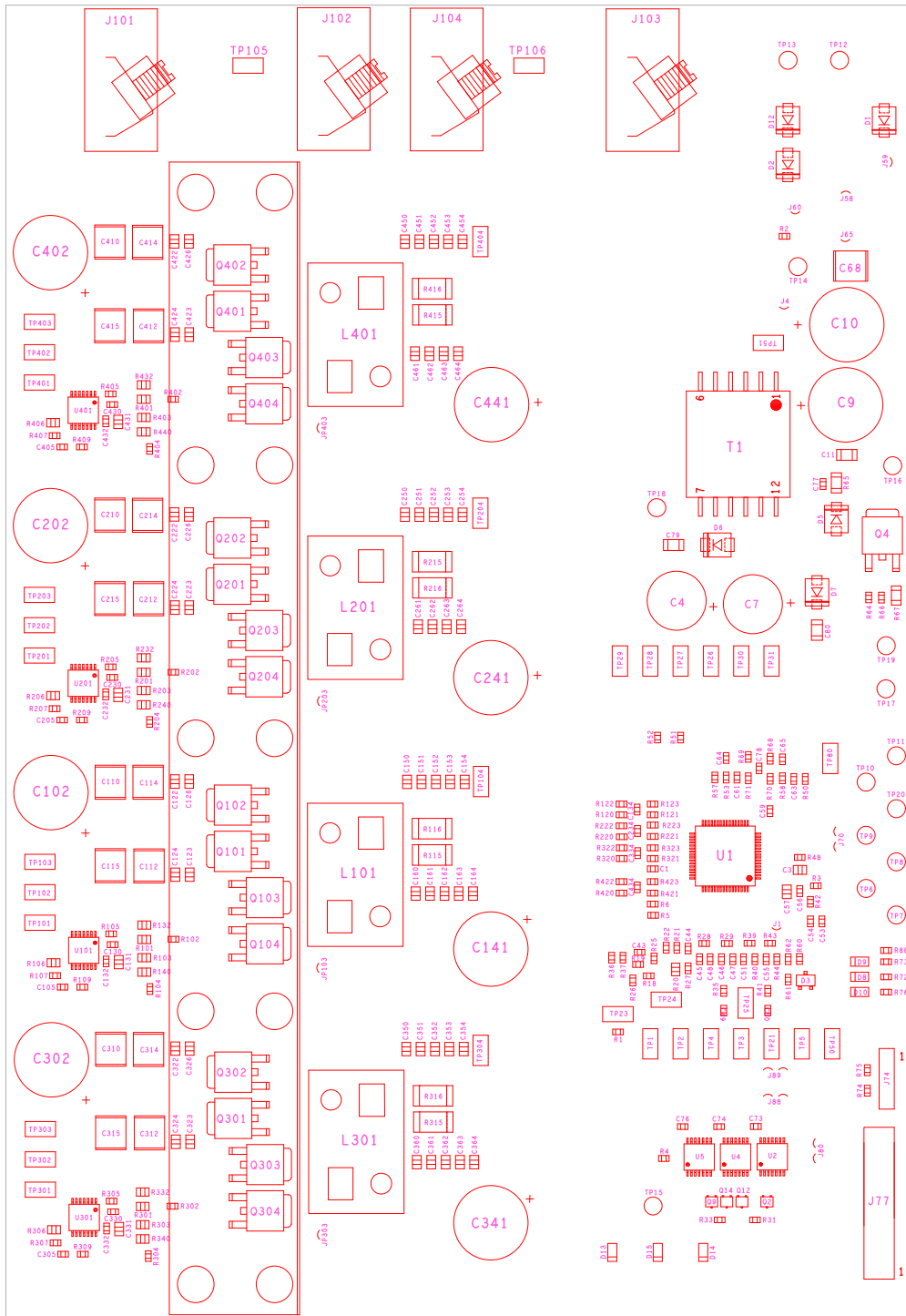


Figure 86. Assembly Top

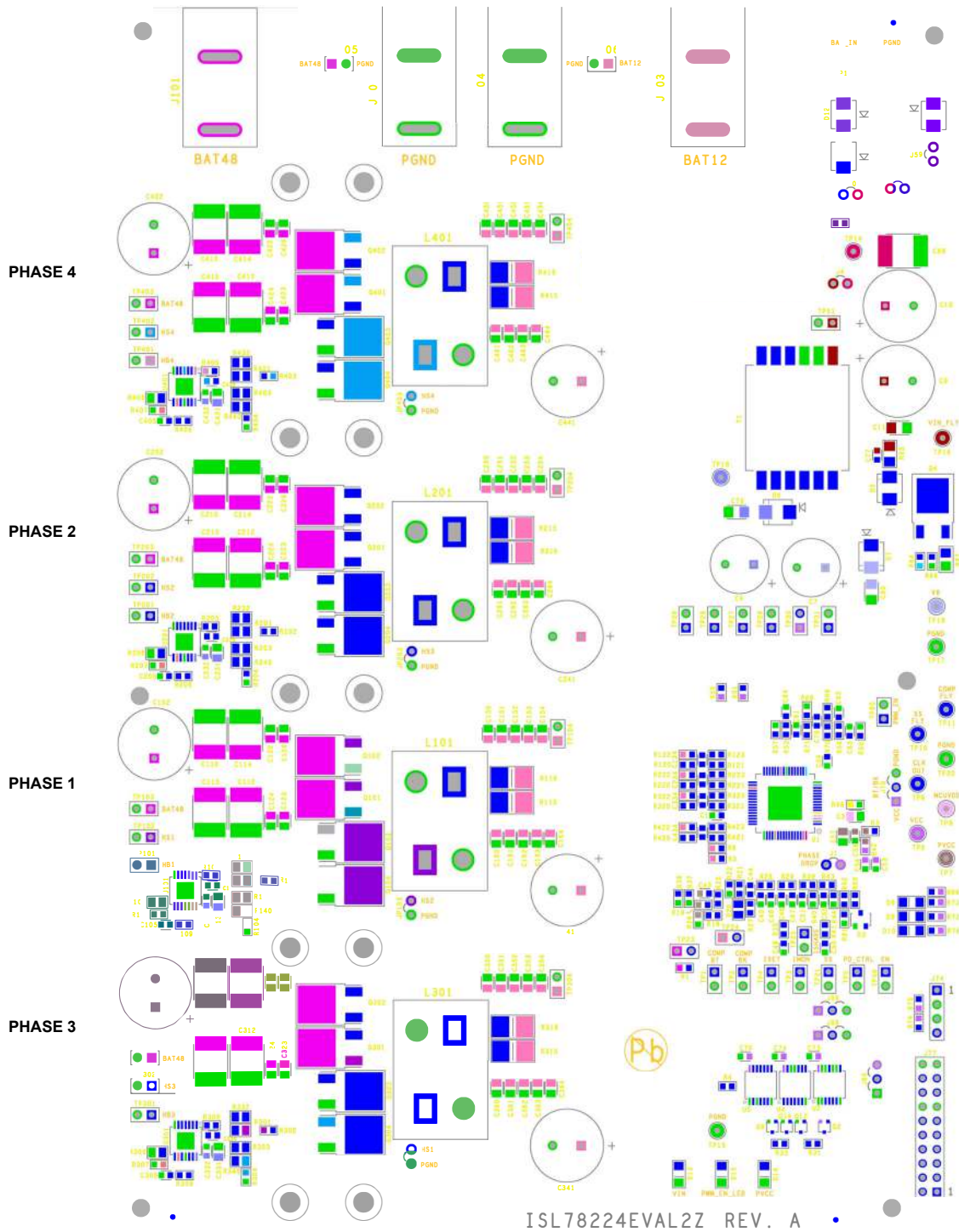


Figure 87. Silkscreen Top

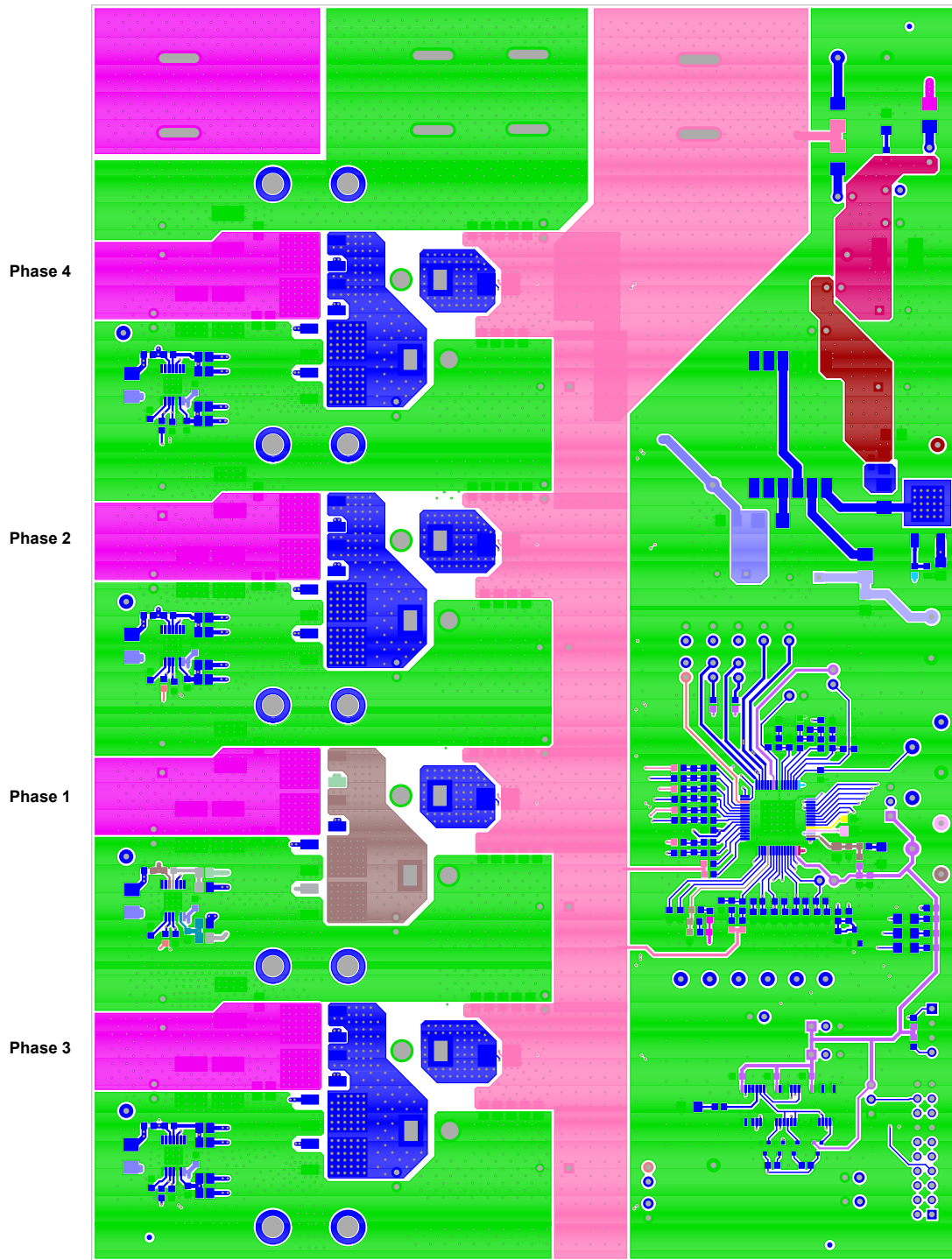


Figure 88. PCB – Top Layer

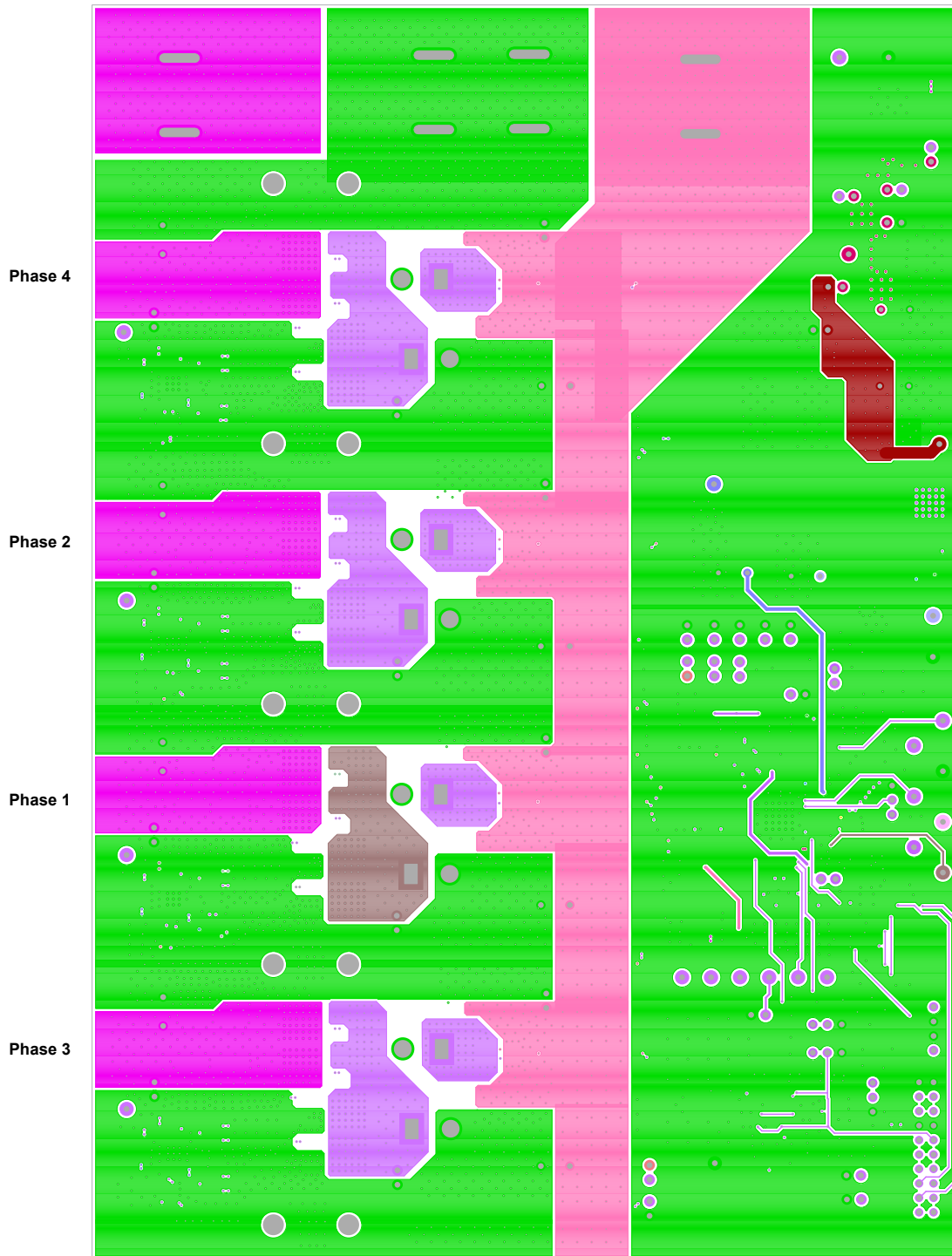


Figure 89. PCB – Inner Layer 2 (Viewed from Top)

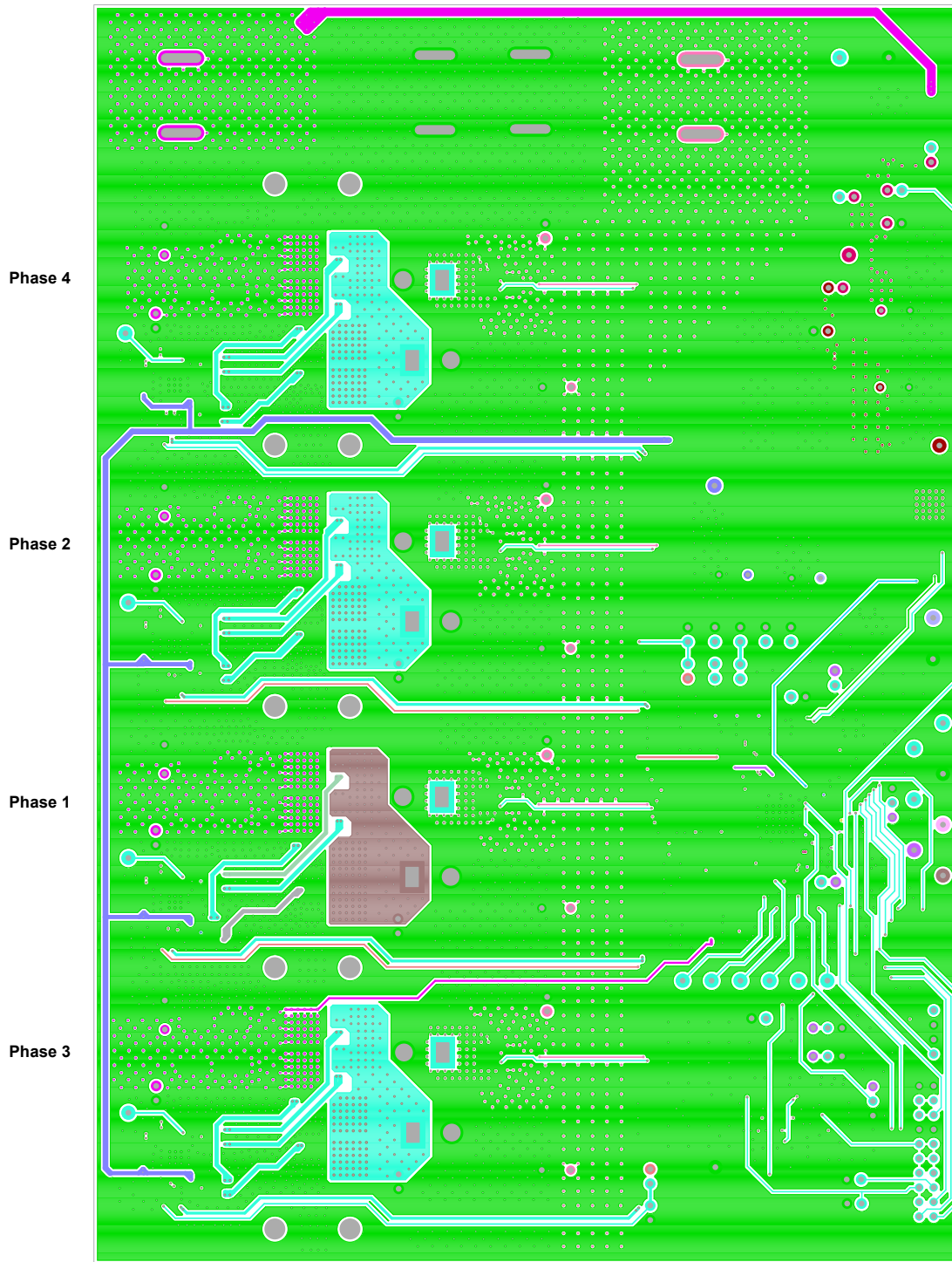


Figure 90. PCB – Inner Layer 3 (Viewed from Top)

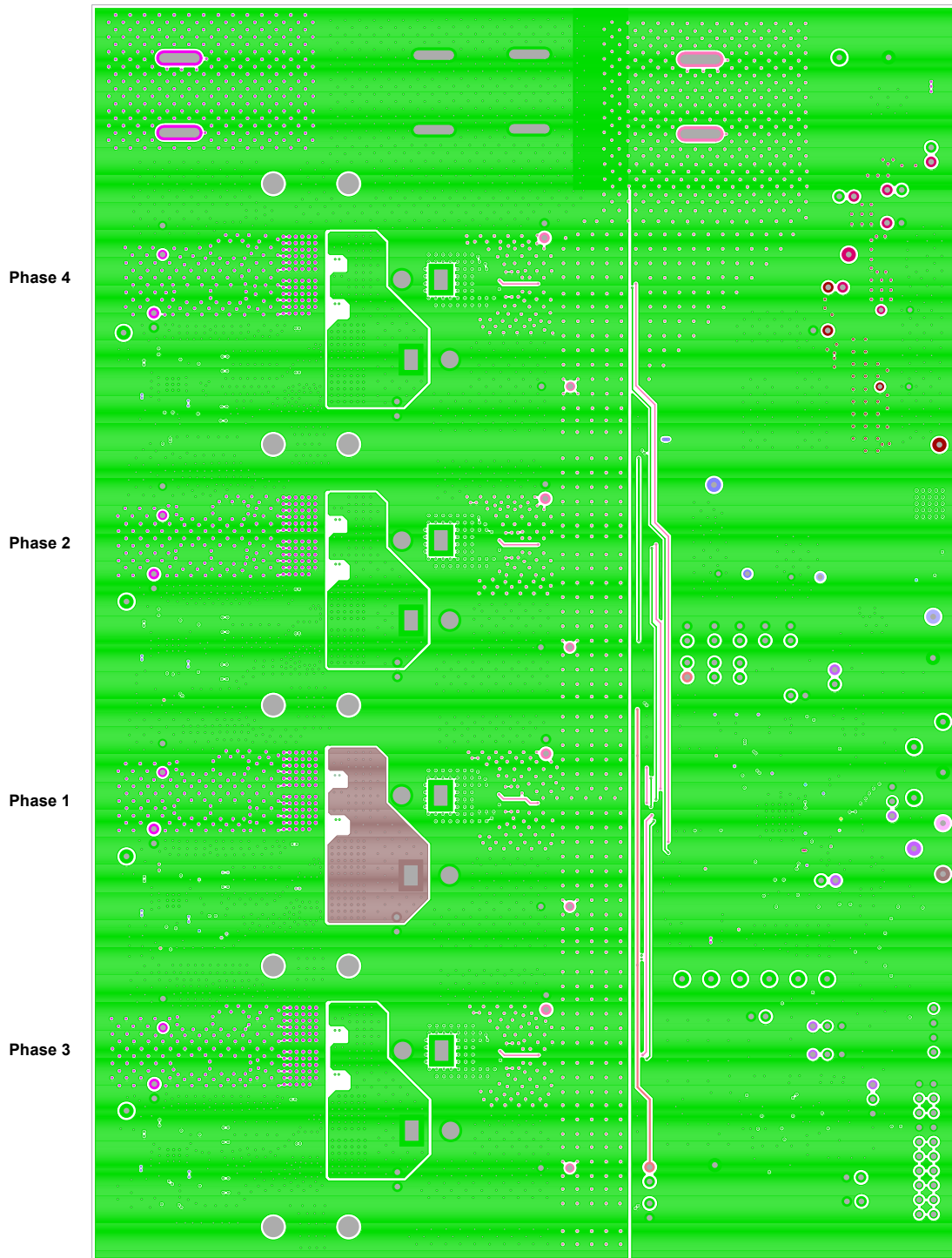


Figure 91. PCB – Inner Layer 4 (Viewed from Top)

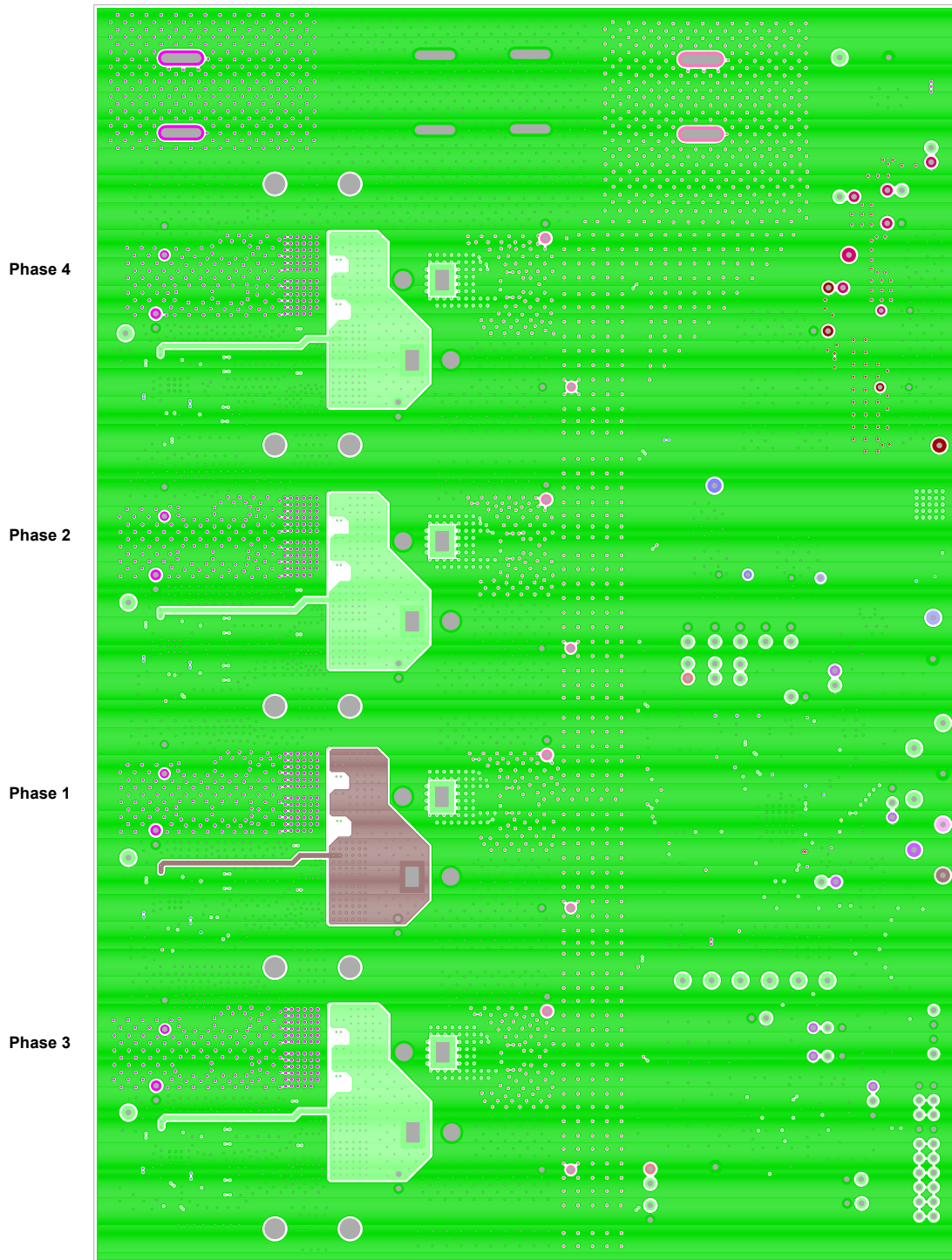


Figure 92. PCB – Inner Layer 5 (Viewed from Top)

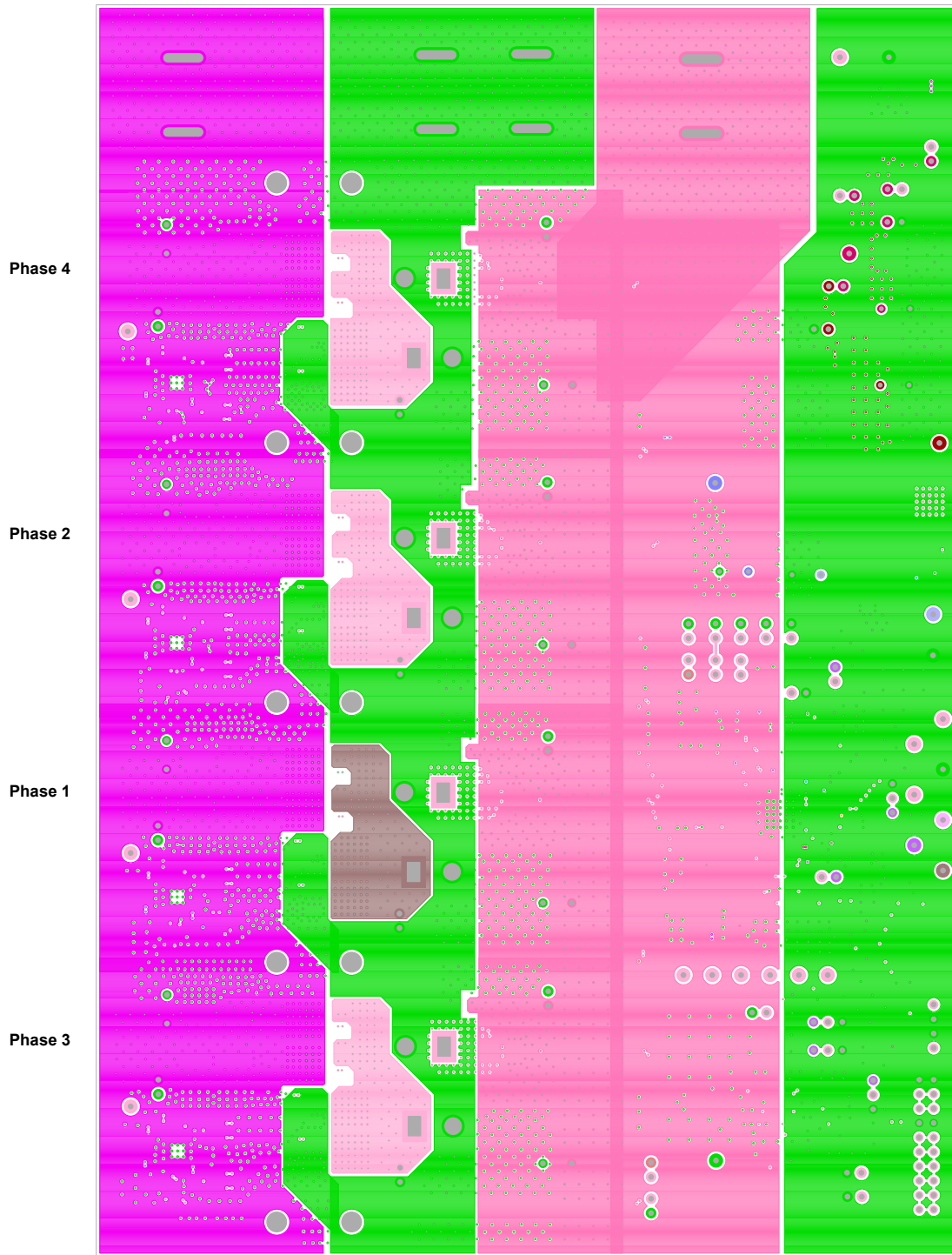


Figure 93. PCB – Inner Layer 6 (Viewed from Top)

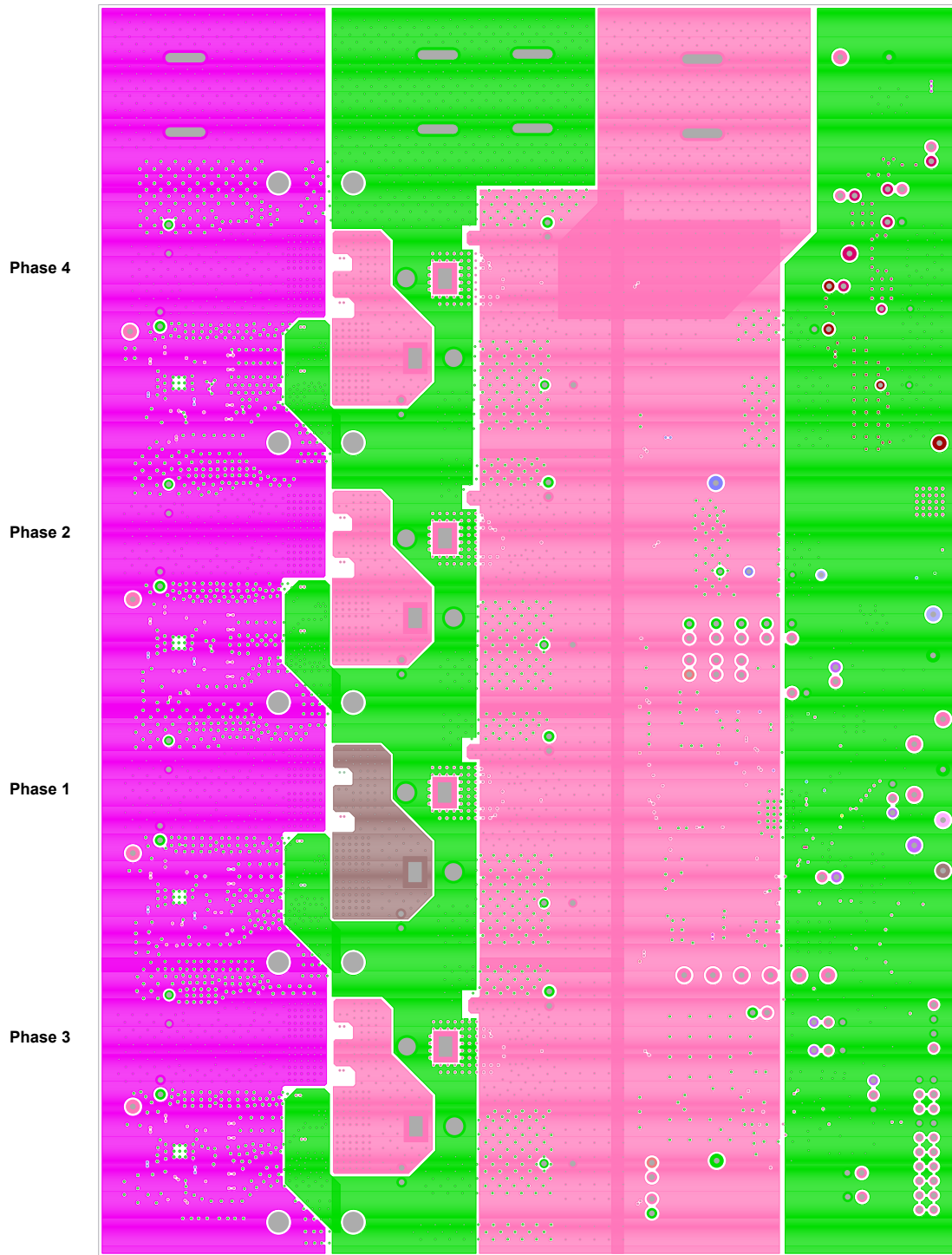


Figure 94. PCB – Inner Layer 7 (Viewed from Top)

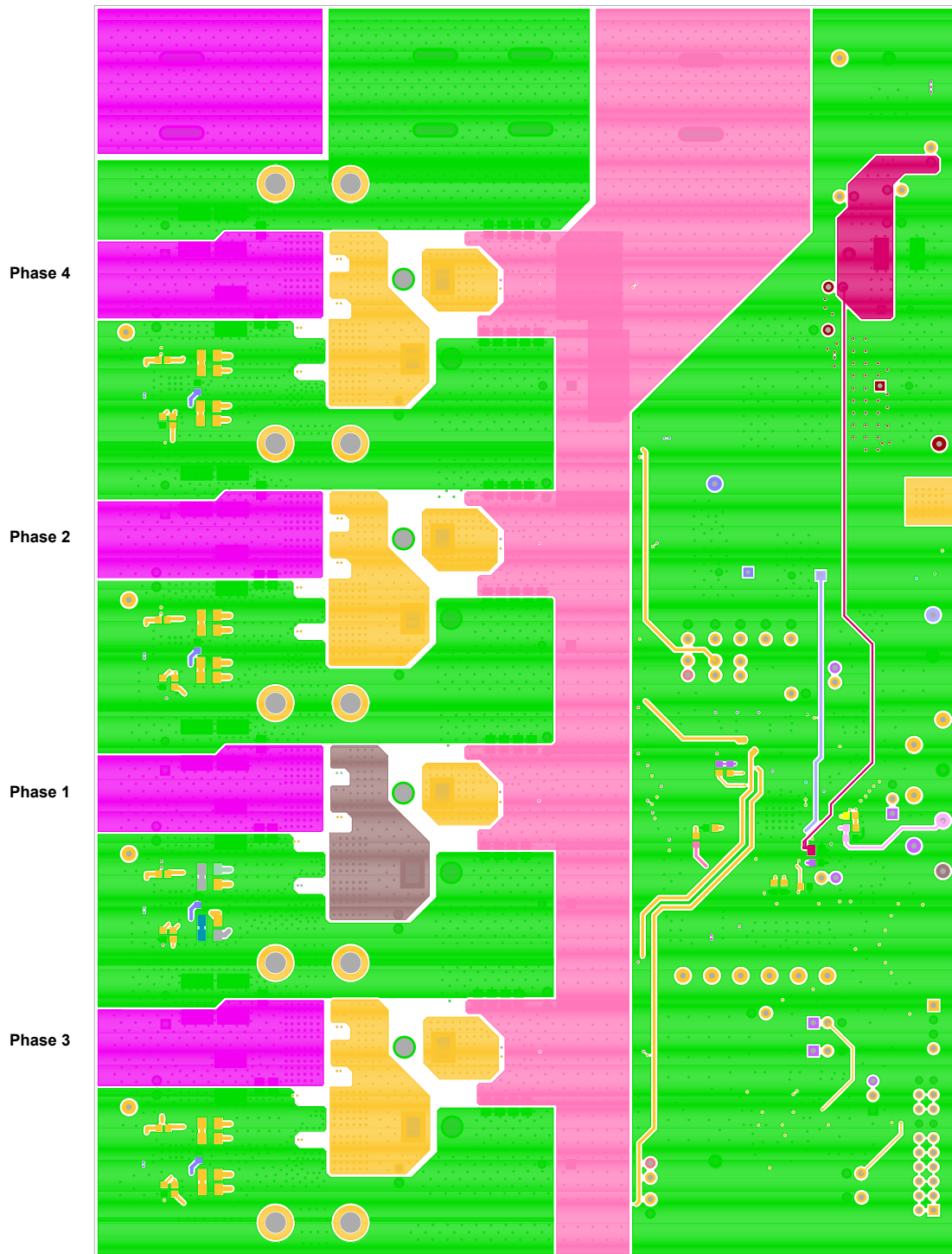


Figure 95. PCB – Bottom Layer (Viewed from Top)

8. Typical Performance Curves

8.1 Gain Phase Plots, Buck and Boost

BAT12 = 12V, BAT48 = 48V, $V_{IN} = V_{IN_FLY} = 12V$, BAT12_IN = 5V

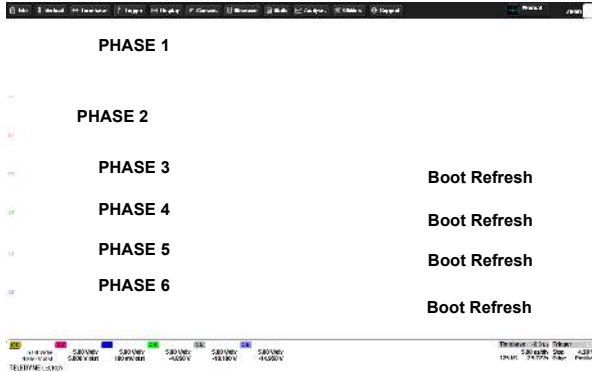


Figure 98. 2-Phase Load Current 0A CCM Mode

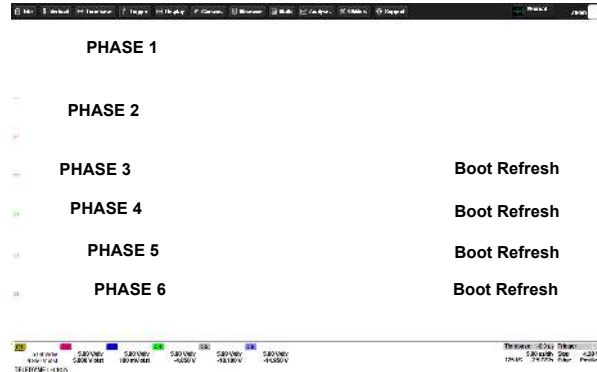


Figure 99. 2-Phase Load Current 0A DE Mode

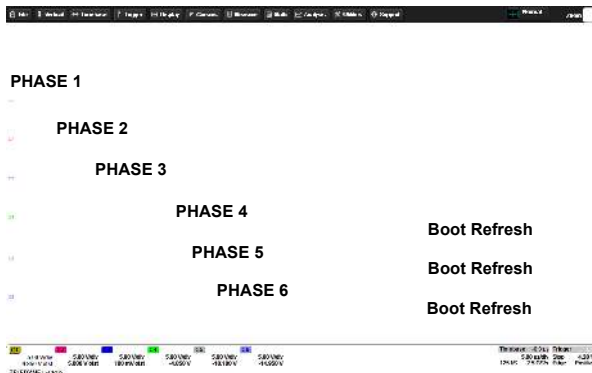


Figure 100. 3-Phase Load Current 85A

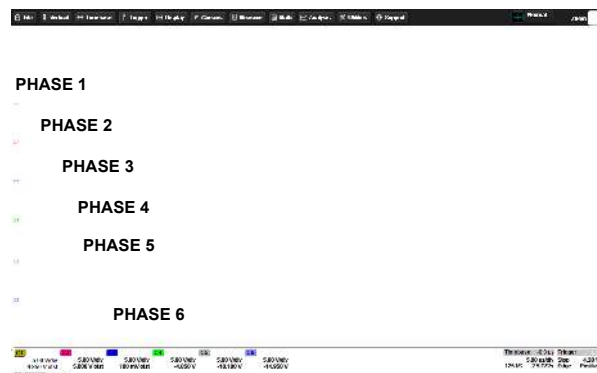


Figure 101. 6-Phase Load Current 120A

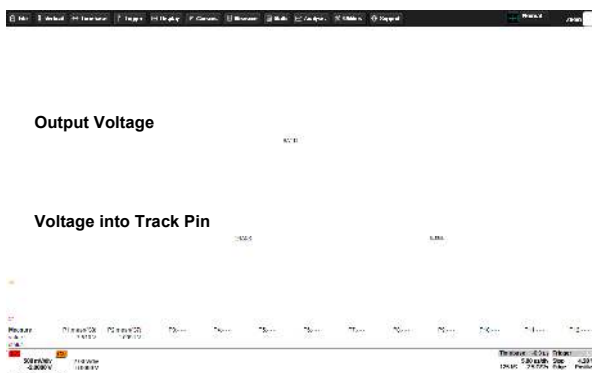


Figure 102. Analog Tracking

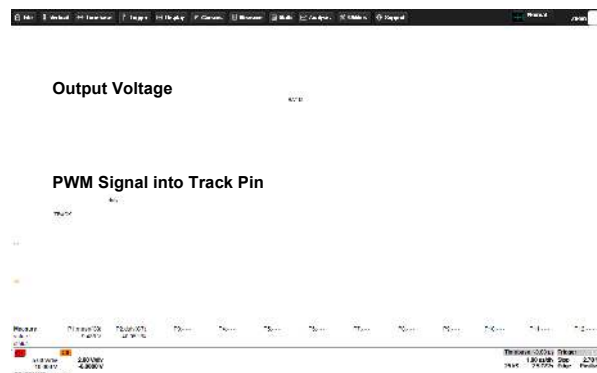


Figure 103. Digital Tracking

BAT12 = 12V, BAT48 = 48V, $V_{IN} = V_{IN_FLY} = 12V$, BAT12_IN = 5V (Continued)

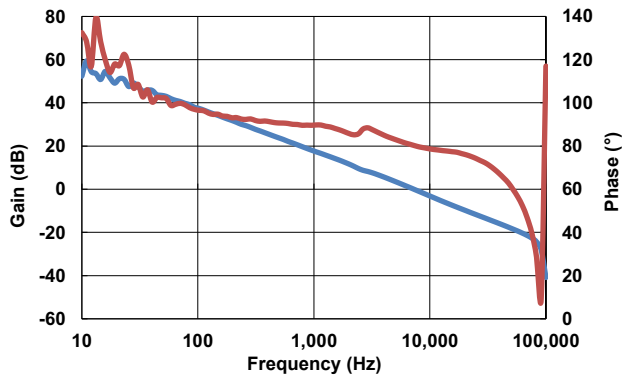


Figure 104. Buck Bode Plot, BAT48 Input = 48V, 12V at 250A

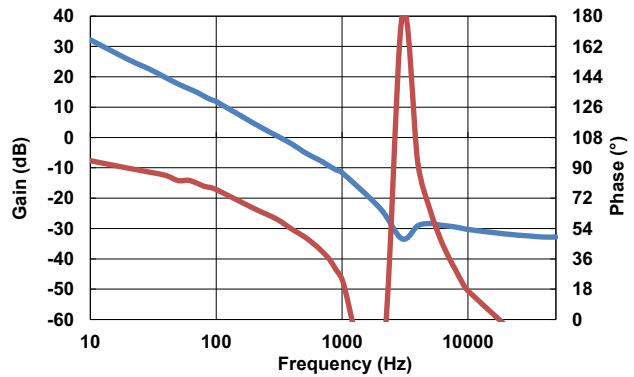


Figure 105. Boost Bode Plot, BAT12 Input = 12V, 48V at 55A

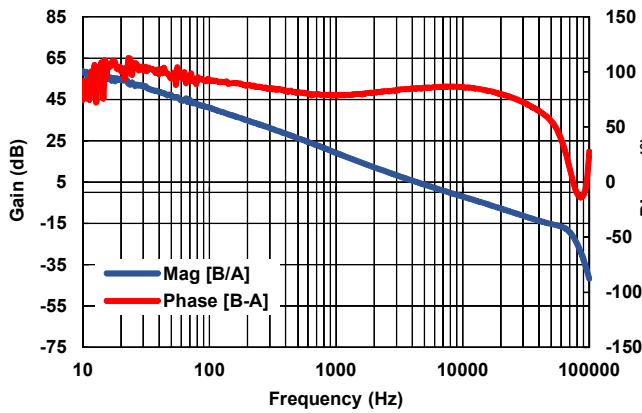


Figure 106. Buck Gain Phase Low Power ISL78224

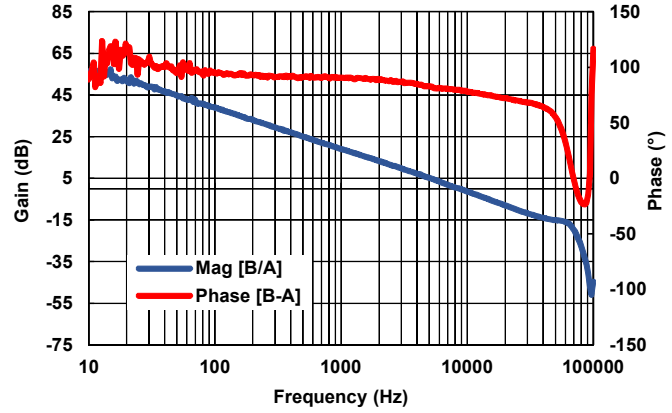


Figure 107. Buck Gain Phase High Power ISL78224

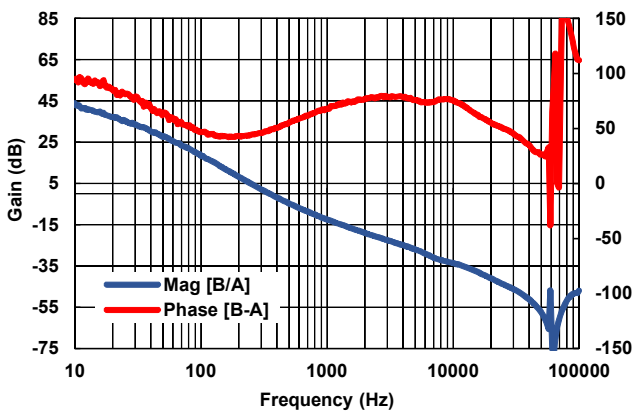


Figure 108. Boost Gain Phase Low Power ISL78224

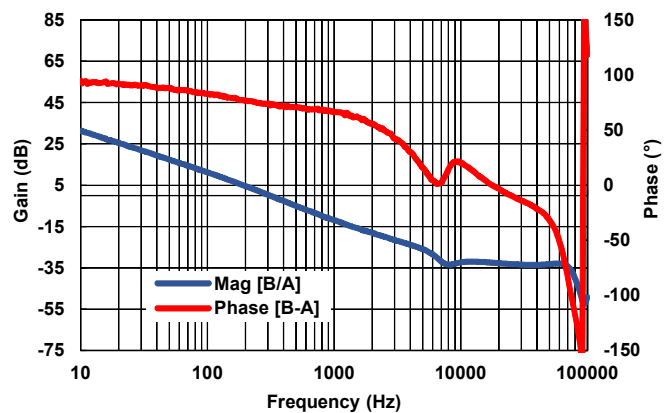


Figure 109. Boost Gain Phase High Power ISL78224

BAT12 = 12V, BAT48 = 48V, $V_{IN} = V_{IN_FLY} = 12V$, BAT12_IN = 5V (Continued)

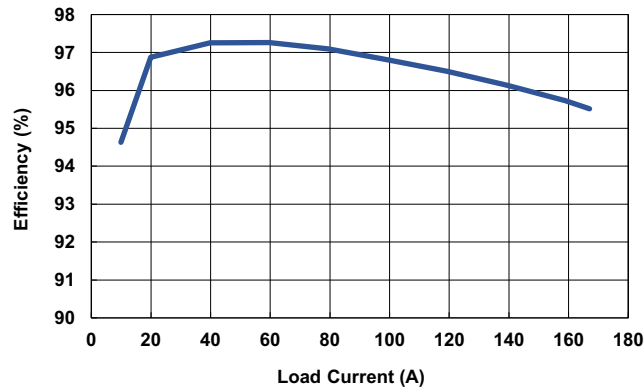


Figure 110. Efficiency Plot - ISL78224

8.2 Efficiency Curves, Buck and Boost

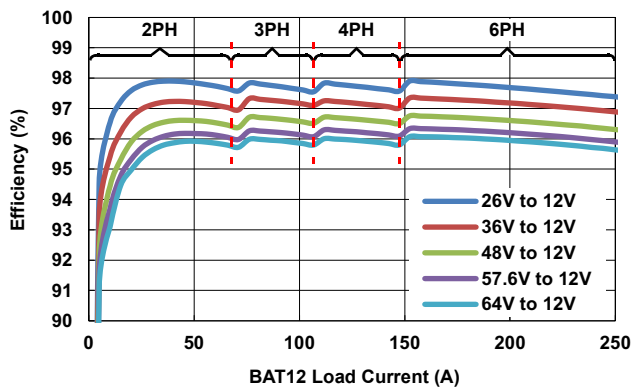


Figure 111. Buck Efficiency (6-Phase, Buck Mode, DE Mode, Phase Drop Enabled, $f_{CLK} = 100kHz$)

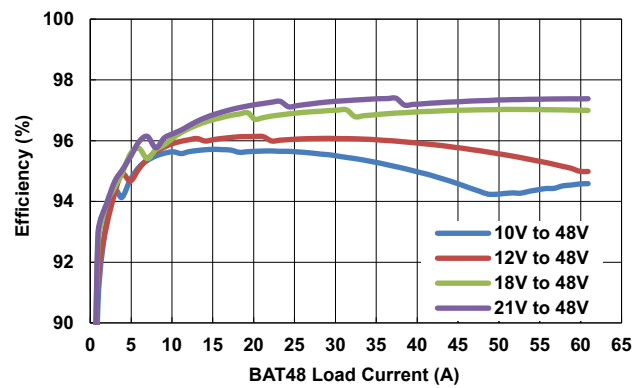


Figure 112. Boost Efficiency (6-Phase, Boost Mode, DE Mode, Phase Drop Enabled, $f_{CLK} = 100kHz$). 10V to 48V Curve Goes into Current Limit at ~48A.

9. Revision History

Rev.	Date	Description
4.00	Jun 7, 2019	Added "Alternate Configurations" section. Updated board photos for ISL78224EVAL2Z and ISL78226EVAL1Z from red board to blue board.
3.00	Nov 26, 2018	Added information about ISL78224EVKIT2Z evaluation board throughout document. Added Revision History. Updated disclaimer.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
 - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

ISL78226EVKIT1Z, ISL78224EVKIT2Z

