Si3459 SMART24 KIT USER'S GUIDE

1. Introduction

The Si3483 power management controller interoperates with Si3459 PSE controllers to enable the use of a smaller, lower-cost, and more efficiently-utilized power supplies in managed or unmanaged Power over Ethernet (PoE) Power Sourcing Equipment (PSE) with up to 64 ports and up to three parallel power supplies. The Si3459 SMART24 kit demonstrates the use of the Si3483 in a 24-port system. Figure 1 shows the assembled kit.

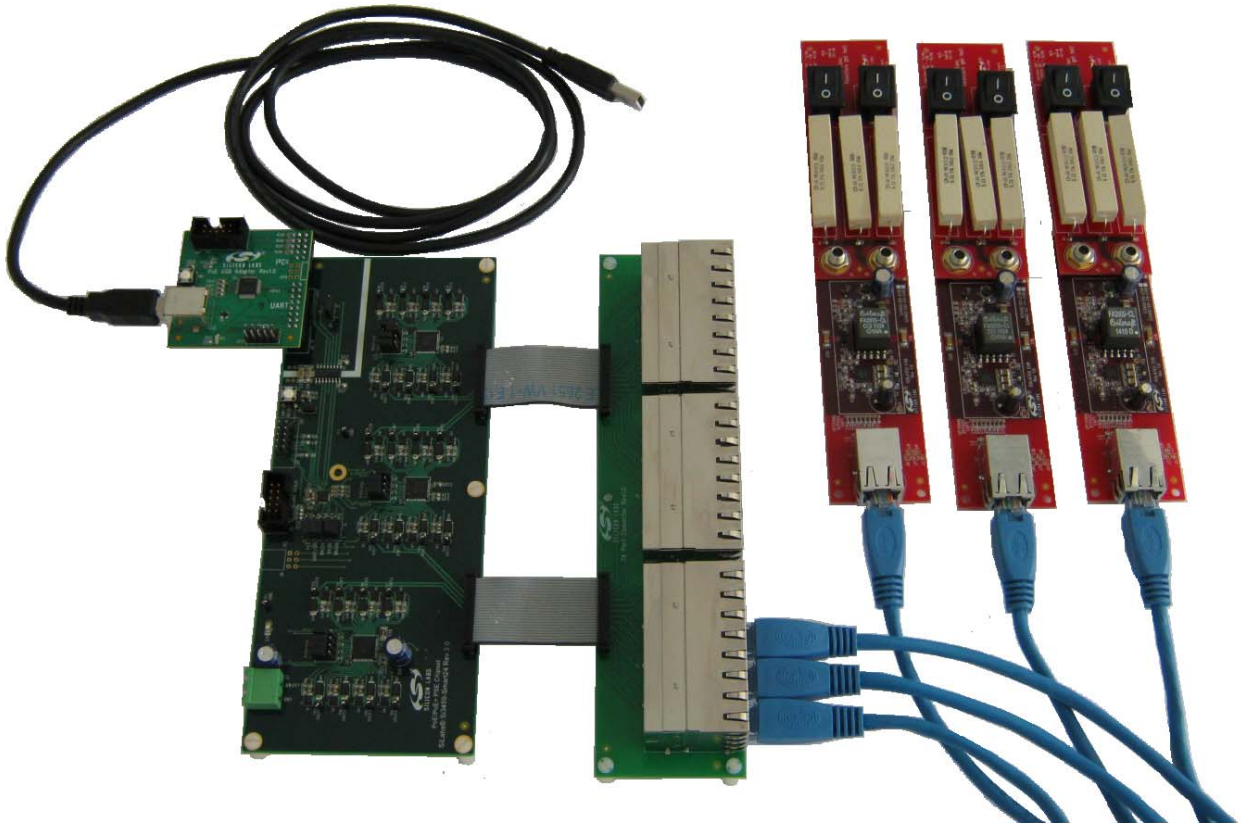


Figure 1. Si3459 Smart24 Kit

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2. Si3459 SMART24 Kit Contents

Table 1 lists the contents of the kit.

Table 1. Si3459 SMART24 Kit Contents

Item	Contents
1	The Si3459 SMART24 EVB, which includes the Si3483, three Si3459 PoE controllers, isolation for UART communications, and an alternative (non-isolated) SPI interface.
2	Two Si3402ISO-EVB powered device evaluation boards. The boards are configured to provide a Class 3 signature.
3	One Si3402ISO-C4- EVB. This board is configured to supply a Class 4 signature. The Class 4 boards are marked Class 4 and can also be identified by the diodes on the back of the board.
4	Three switchable loads. The switchable loads draw approximately 6.5, 13, or 19.5 W from the PSE.
5	One 24-port connector board to bring the Si3459 power to Ethernet jacks. The connector board does not have Ethernet data functionality.
6	PoE USB adapter. This adapter supports USB to UART, SPI or I^2C. It provides a UART connection to the Si3459 SMART24 Kit.
7	Three Ethernet cables, one USB cable, and two 24-wire ribbon cables.

3. Using the Si3459 SMART24 kit

3.1. Hardware Configuration

The boards are connected as shown in Figure 1. The PoE USB Adapter card's UART connector (labeled "UART" on the top side and "J817" on the bottom side) should be connected to J2 (UART) on the Si3459 SMART24 EVB. A nominal 50 V power supply is connected to J7 (note the polarity). For high-power support according to the IEEE standard, the supply voltage should be between 51 and 57 V. For normal power levels, the power supply can be 45 to 57 V. The total required power supply wattage can be as high as 720 W to apply full power at all ports. Effective evaluation can be done with a power supply of 40 W or more. Once configured, the Si3483 manages the available power. The large diode, D1 will be forward-biased in case of incorrect input polarity.

Note: It is recommended that the power supply be connected to the board and then turned on to reduce large inrush current charging the 33 µF filter capacitor on the board.

Table 2 lists the jumper settings. The evaluation board schematic pages (Figures 10 through 16) also indicate jumper placement.

Table 2. Si3459 SMART24 Jumper Settings

Jumper	Function	Initial Setting
JP1	select reset state in absence of PoE-USB	ON (1,2)
JP2	UART baud selection, default 115.2 kHz	ON (1,2)
JP3	UART baud selection, default 115.2 kHz	ON (1,2)
JP4	UART baud selection, default 115.2 kHz	ON (1,2)
JP5	Power Supply 3 Status, Default not present	ON (2,3)
JP6	SPI/UART select	ON (1,2)
JP7	Si3483 reset	off
J8	U2 Si3459 Address	ON (addr=0,0,0,0)
J9	U3 Si3459 Address	ON (addr=0,0,0,1)
J10	U4 Si3459 Address	ON (addr=0,0,1,0)

3.2. Installing the PoE USB Adapter

Note: Before the PoE USB adapter is plugged in, the device driver should be installed.

If you have previously installed the PoEUSB device, depending on your operating system, you may need to uninstall the previous version before installing the new version. To uninstall the previous version, select “Programs and Features” or “Add or Remove Programs” from the Control Panel and then uninstall “Windows Driver Package - Silicon Labs (WinUSB) MultiPortSerial”.

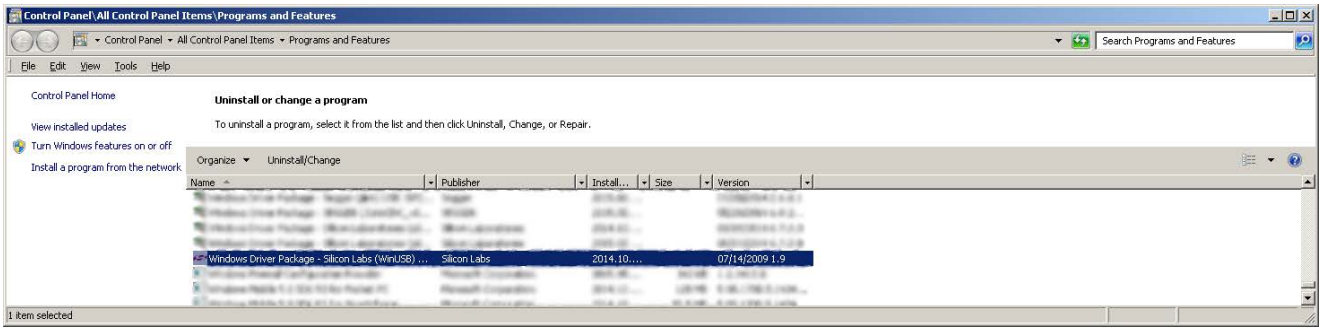


Figure 2. Programs and Features Screen

To install the PoE USB adapter drivers, run PoEUSBSetup_v1.1.exe from the supplied disk, and follow the instructions including accepting the end user license agreement. The PoE USB adapter supplied with the Si3459 SMART24 kit has been tested to be compatible with Windows XP®, Windows Vista®, and Windows 7® operating systems.

After successful installation, plug in the USB cable; the PoE USB device should be recognized. For Windows XP, select “No not at this time” when Windows prompts to search for software, and select “Install the software automatically” on the next screen. After successful installation, a PC reboot may be required.

4. Demonstration Use of the Power Manager GUI

The Silicon Labs power manager GUI is used to configure and observe the Si3459 SMART24 via the supplied PoE USB adapter. Note that once the Si3483 has been configured, it can run in hardware only mode without the GUI or PoE USB-to-UART adapter.

The demonstration assumes the Power Manager GUI has been configured as follows:

- 40 W of power available on Power Supply 2. Set Power Supply 1 to zero for demonstration in the standalone mode. This is because, in the standalone mode, the control line for Power Supply 1 status is low (disabled) when the USB cable is unplugged.
- Port 1 High Power (PoE+, 30 W) all other ports standard PoE (15.4 W)
- Port 1 critical priority; all other ports low priority
- Consumption-based power management
- Retry after reconnect for overloads
- Leave Legacy and Midspan boxes unchecked.
- Jumpers should be set to “Initial Setting” as shown in Table 2.

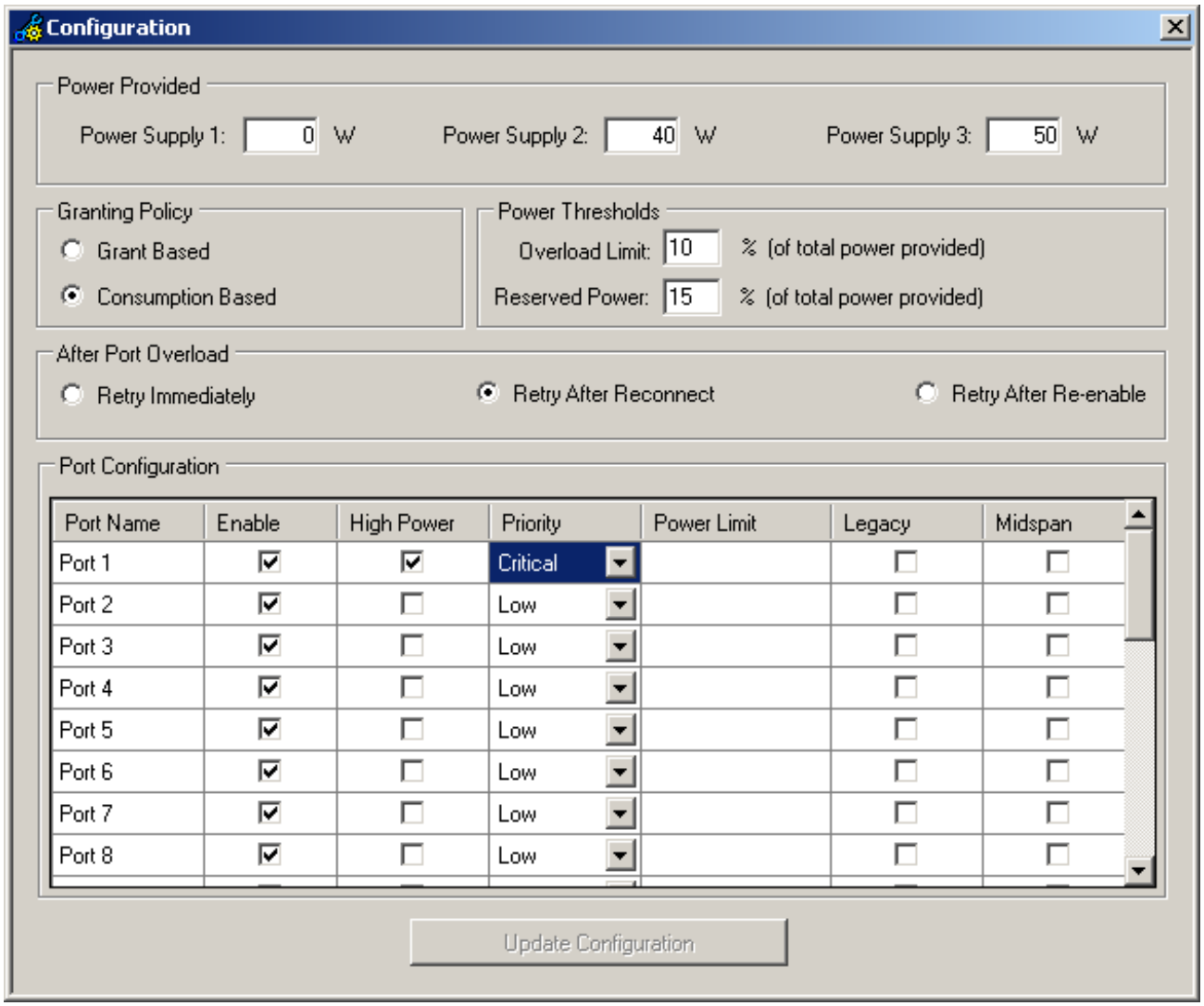


Figure 3. Configuration Screen

- Power Supply 2 is inserted and will be used for the demonstration.

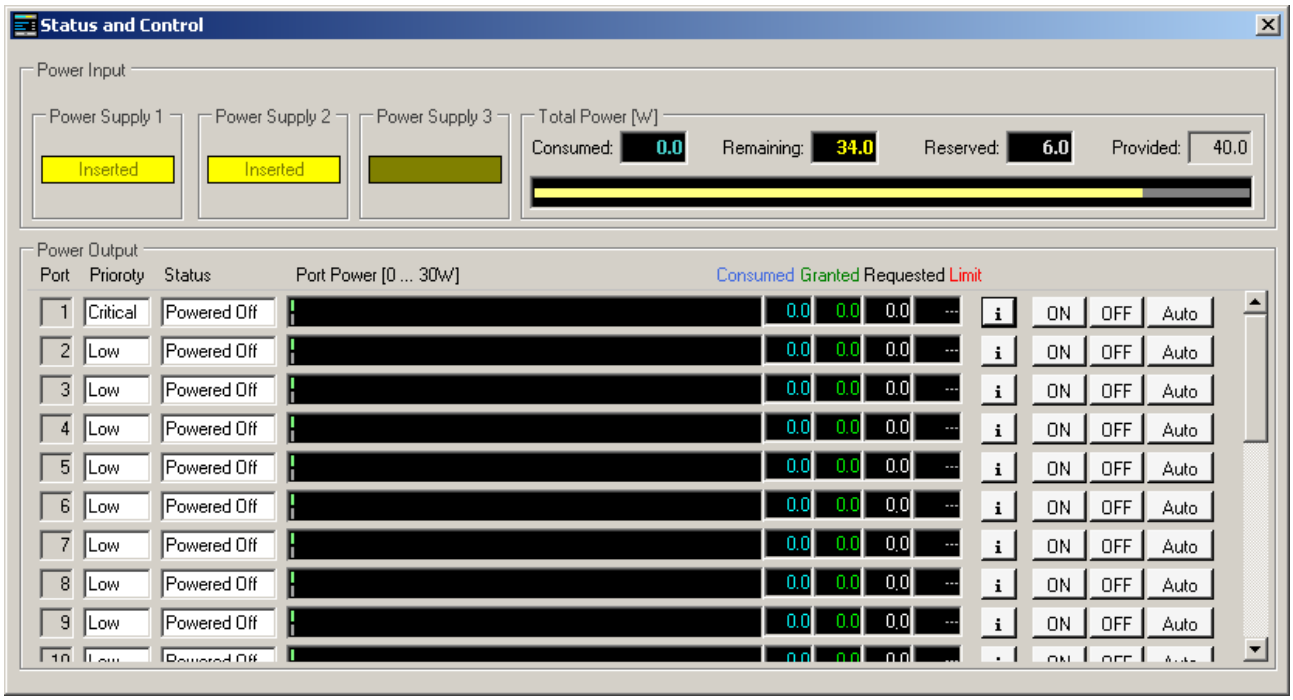


Figure 4. Initial Screen Status

The Si3459 SMART24 kit ships with three powered devices based on the Si3402 with loads for up to approximately 19.5 W of input power. The loads are arranged as one to three 5 W resistors, which draw 5 W each at the PD output voltage of 5 V. Due to the PD input diode bridge and the dc-to-dc conversion efficiency, each resistor causes approximately 6.5 W of power to be drawn from the PSE.

This means that the PD will draw approximately 6.5, 13, or 19.5 W from the PSE, depending on the number of load resistors connected.

Perform the following steps:

1. Connect a Class 3 PD with a 6.5 W load (switches off) into Port 1 and a Class 4 PD with a 6.5 W load into Port 2. The status window is shown in Figure 5. Since sufficient power is available, both ports are granted power. Because Port 2 was not enabled as PoE+, the Class 4 PD is only granted 15.4 W.

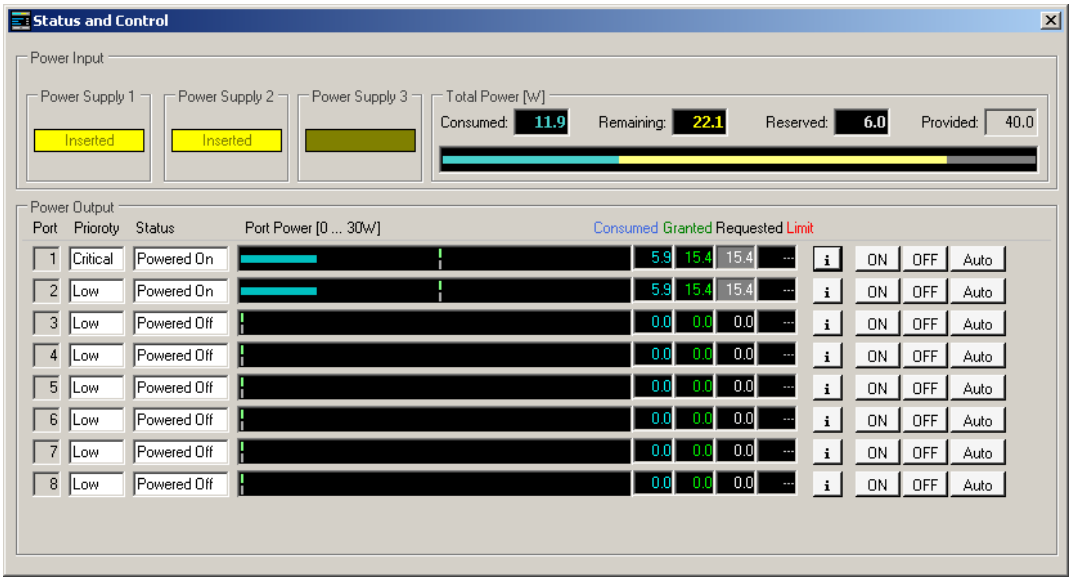


Figure 5. Status Screen with Class 3 PD on Port 1 and Class 4 PD on Port 2

2. Disconnect the PDs from Step 1, and connect the Class 4 PD to Port 1 and Class 3 PDs to each of Ports 2 and 3. Initially, use a 6.5 W load on each PD.
   All three ports are granted power. Port 1 is now granted 30 W since Port 1 is enabled for high power (PoE+). Since only one resistor is connected, approximately 6.5 W is drawn on each port.

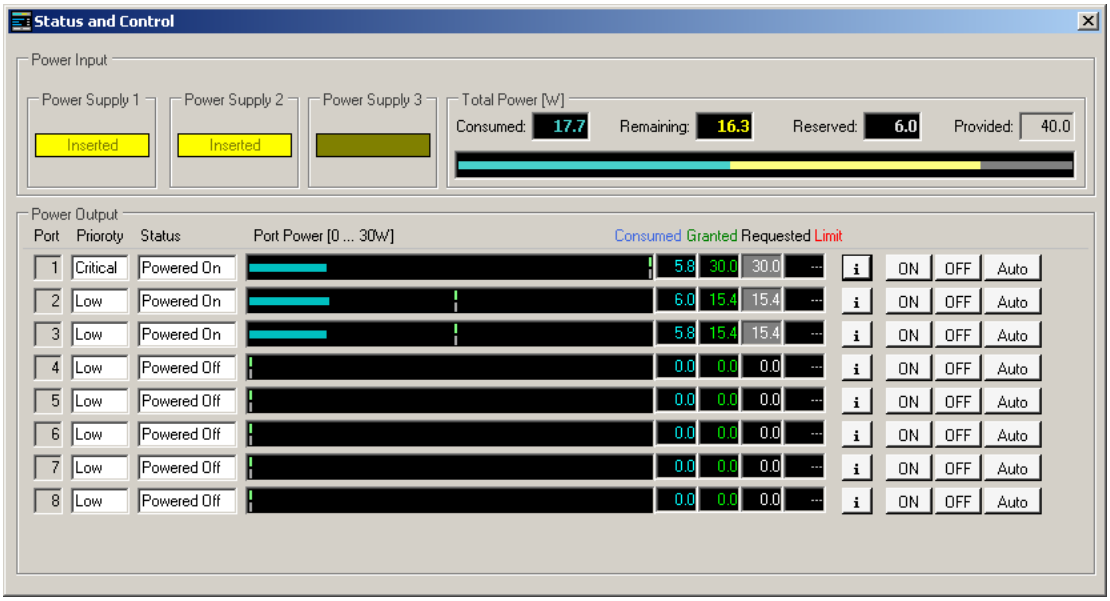


Figure 6. Status Screen with Class 4 PD on Port 1 and Class 3 PDs on Ports 2 and 3

3. Increase the Load on the ports to create a port overload by switching in more load resistors.
   For Port 2 or Port 3 (with Class 3 PDs), the port overload condition occurs with the three resistors, which corresponds to about 19.5 W of input power. The following screen shot shows the result of an overload (indicated by the status “blocked”) on Port 3.
   To reset the port, decrease the load back to one resistor; unplug the PD, and plug it back in. This demonstrates “retry after reconnect”.
   For Port 1 (PoE+ port with Class 4 PD), the overload does not happen even with 19.5 W being drawn by the PD.

Note: Use caution because the load resistors and PD can get **HOT!**.

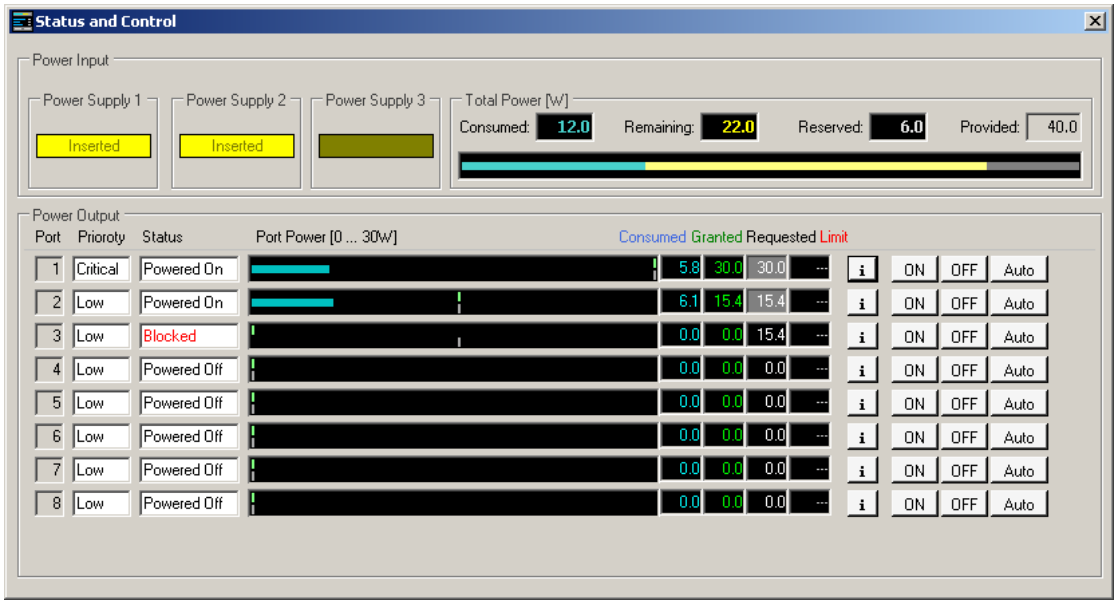


Figure 7. Status Screen after an Overload on Port 3

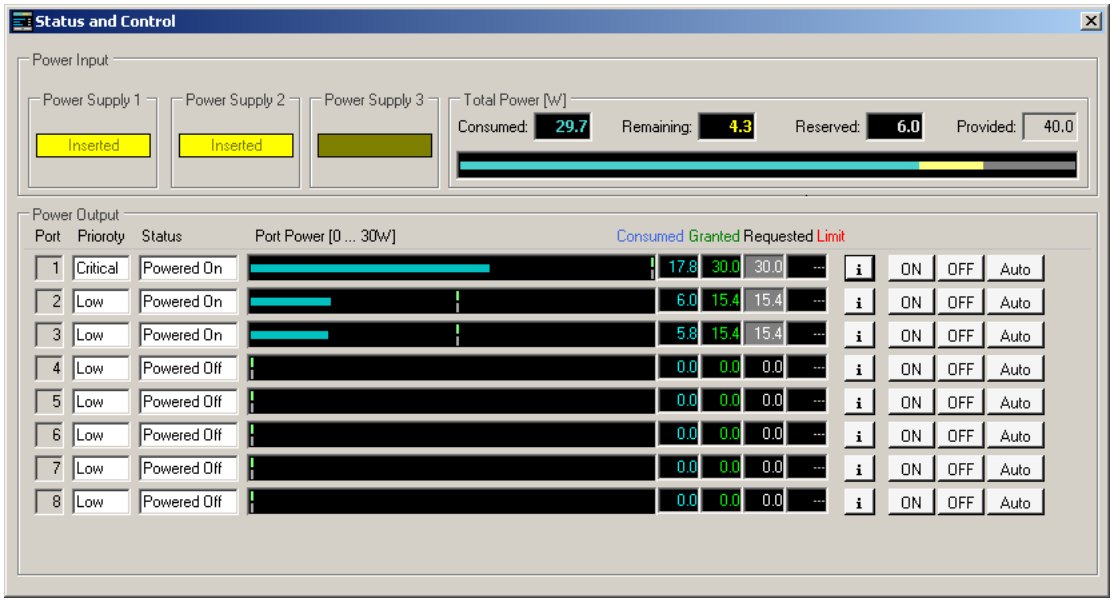


Figure 8. Status Screen Showing Class 4 PD on Port 1 Drawing 18 W

4. Demonstrate the port priority and system overload protection features.
   Disconnect all PDs, and then connect the Class 3 PDs to Ports 2 and 3 with two load resistors so that they draw 13 W each (26 W total power).
   Connect the Class 4 PD with three resistors (19.5 W) to Port 1. Port 1 is granted power, and a system-level overload is created with approximately 45.5 W. Either Port 3 or Ports 2 and 3 will be turned off depending on whether the Si3483 reported a severe overload (>44 W). Because the PDs have a soft start circuit, it is possible that only Port 3 is turned off when the power exceeds 40 W. The ports that are turned off will not turn back on until the load on Port 1 is reduced. This is because there is not enough power available to grant 15.4 W from the Class 3 PD.

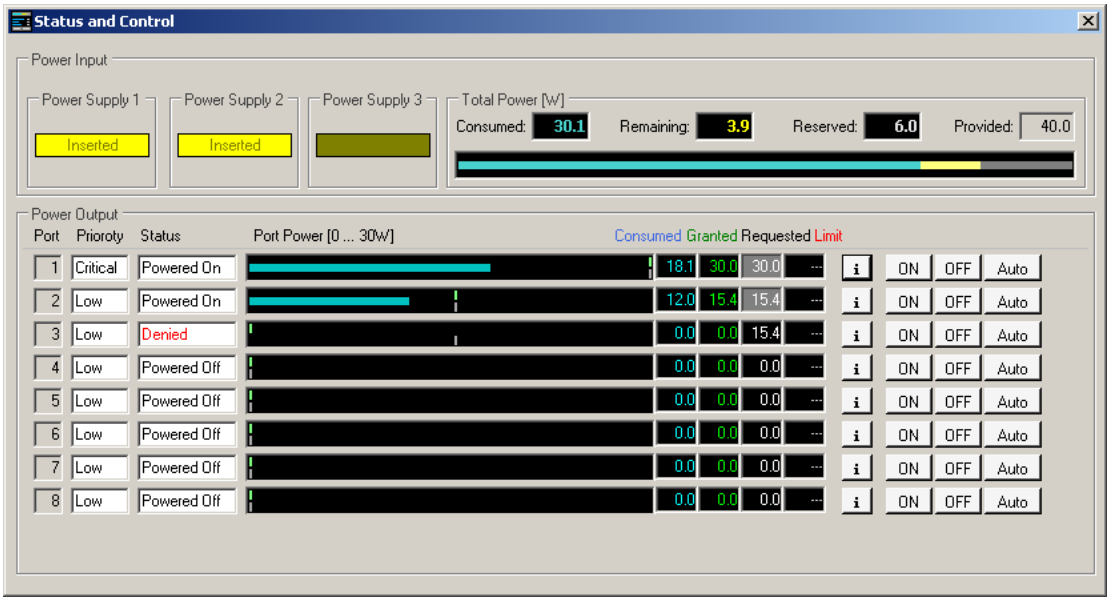


Figure 9. Status Screen Showing Port 3 Denied Power Due to Insufficient Power Available

The Si3483 will manage power on all Si3459 devices to which it is connected. The number of Si3459 devices connected is discovered upon power up. This means that the Si3483 can manage power on up to 64 ports.

Once configured, the Si3483 will continue to manage the power even when the host is disconnected. To demonstrate this, exit the GUI, disconnect the PoE USB adapter, and repeat the above tests. While there is no visual display, the behavior is the same. The PD status can be seen by looking at the LEDs on the Si3402 evaluation boards located on the RJ-45 connector. These LEDs glow steadily if power is supplied.

Note that, in the schematics shown in Figure 6, the Reset and Pgood2 signals are routed through an Si8651 isolator. The Si8651 default state is high so that, when the USB connector is removed, the Si3483 is not held in reset, and Power Supply 2 is still configured as inserted. This is why Power Supply 2 was chosen to be inserted in the above examples.

5. Easing Software Development with the Serial Packet Protocol SDK

A host MCU uses the Serial Packet Protocol (SPP) to communicate with an Si3483 Power Management Controller. A Serial Packet Client in the host MCU implements the client side of the Serial Packet Protocol. A reference implementation of a Serial Packet Client (available upon request) greatly reduces the software development effort needed to use the Si3483.

Please refer to the Si3483 data sheet for further details on taking the next step in development with the Si3483 power management controller.

6. Unmanaged Operation

The Si3459 SMART24 demonstrator was designed to operate in conjunction with the PoE-USB and GUI monitor program. It may be desirable to demonstrate and verify standalone unmanaged operation of the Si3482. If the PoE-USB adapter is removed, it is necessary to replace signals driven by the PoE-USB. A practical method is to temporarily jumper between the PoE-domain host domain power supplies across the isolator.

Connect as follows:

1. J2 pin 16 to J5 pin 9 (GND_host bridged to GND_PoE)
2. J2 pin 6 to J5 pin 1 (3.3V host powered from 3.3V_PoE)
3. J2 pin 8 to J2 pin 13 (sets PGOOD1 high)

If these connections are made, the Si3459 SMART24 board may be powered without a PoE-USB adapter attached. The Si3483 will operate from configuration settings stored in its nonvolatile memory.

Note that the PoE power supply must be isolated according to the PoE standard. If jumpered in this manner, do not otherwise connect to J2.

7. Circuit Board

The following pages contain the detailed schematics, BOM, and layout for the Si3459 SMART24 Evaluation Board.

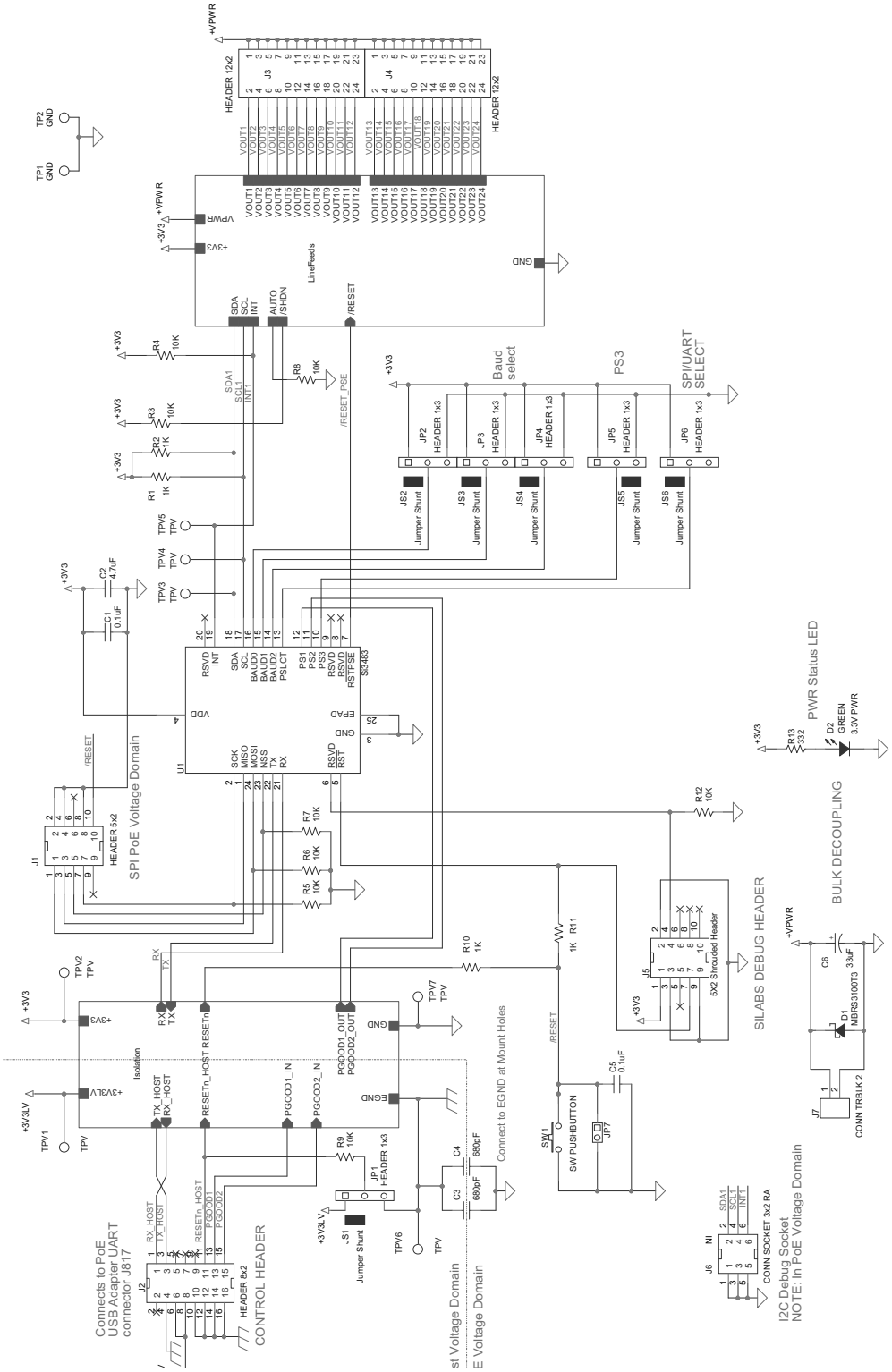


Figure 10. Si3483 Power Manager and Top-Level Board Schematic

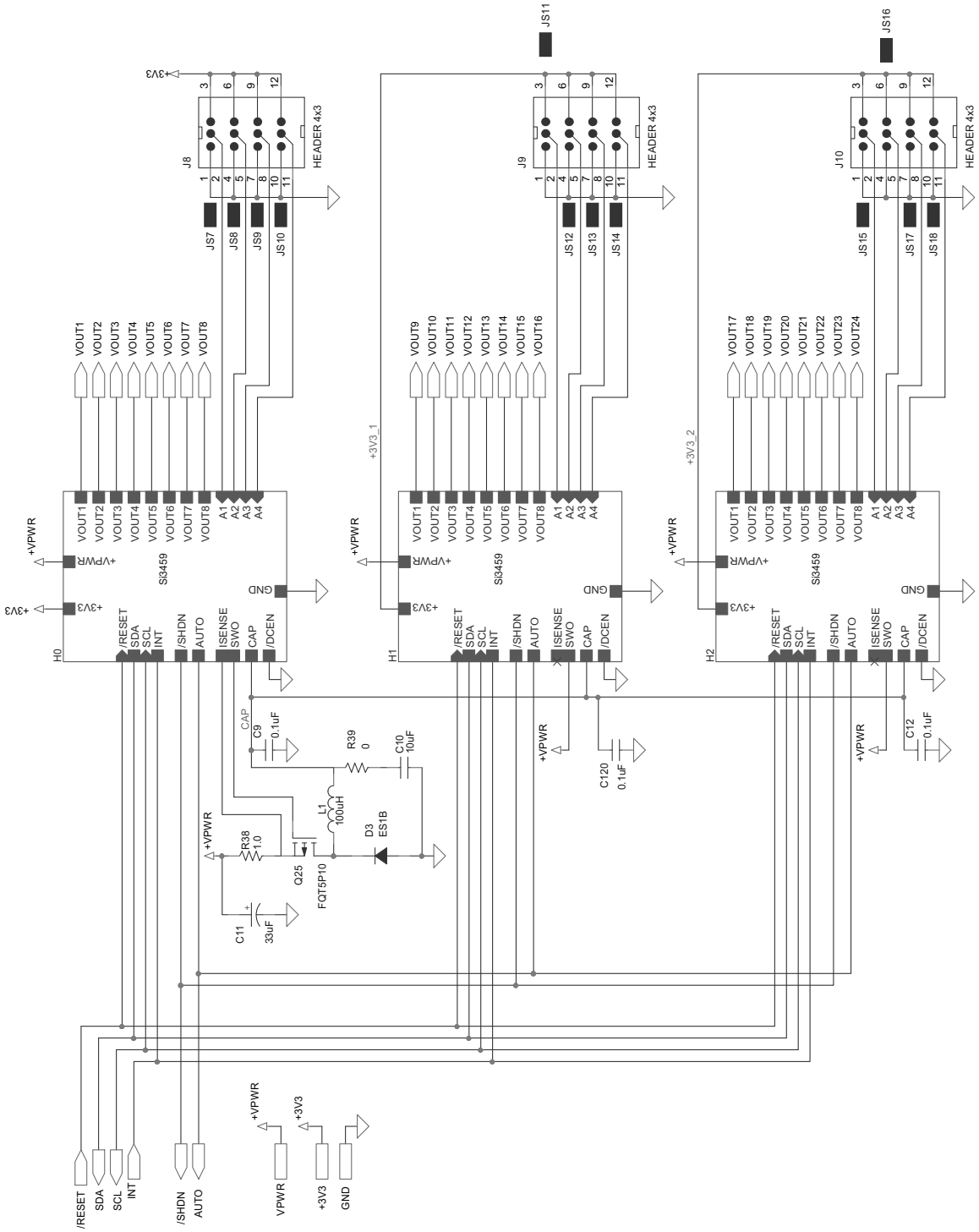


Figure 11. Si3459 PSE Controller Bank Schematic

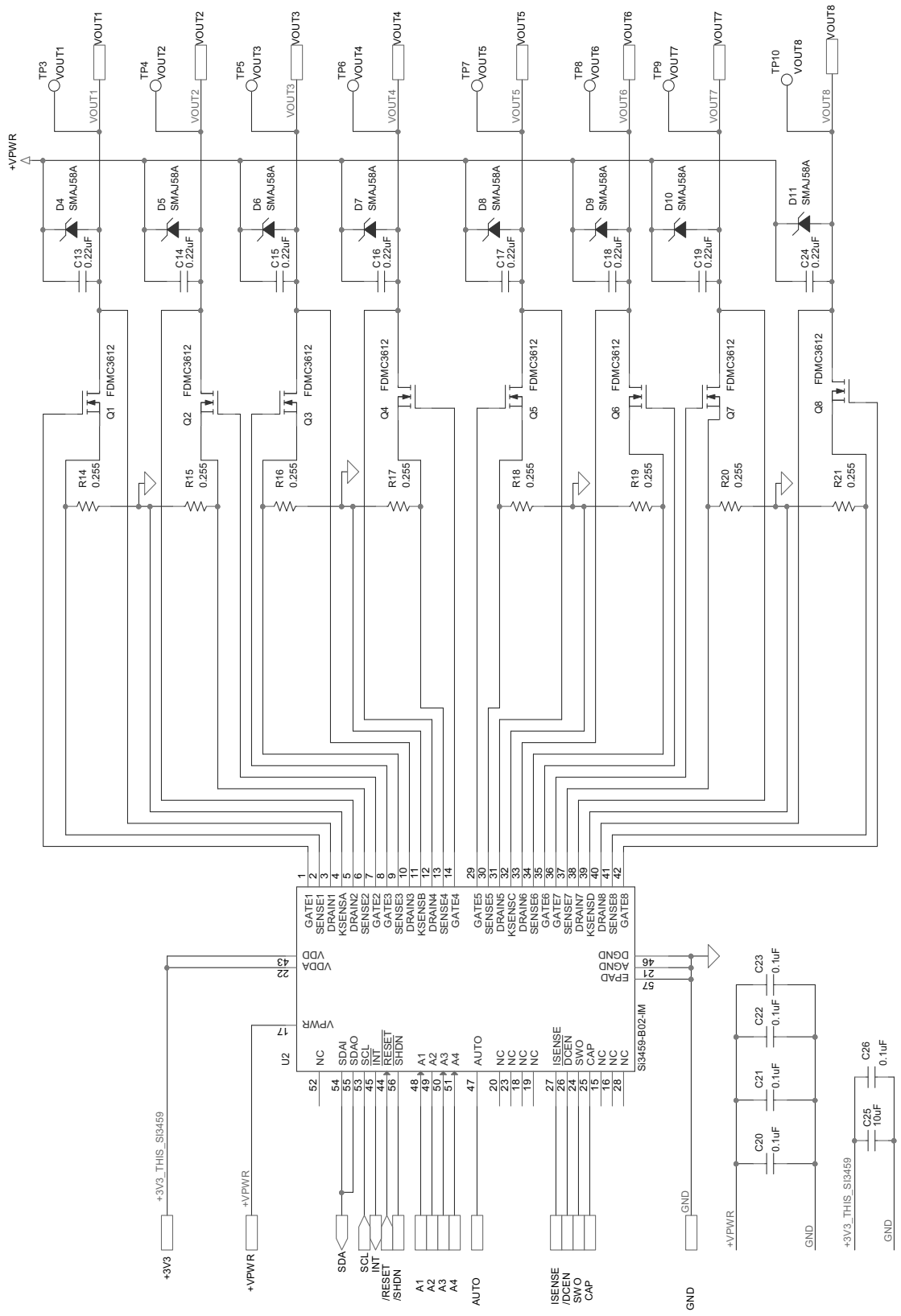


Figure 12. Si3459 PSE Schematic Detail (1 of 3)

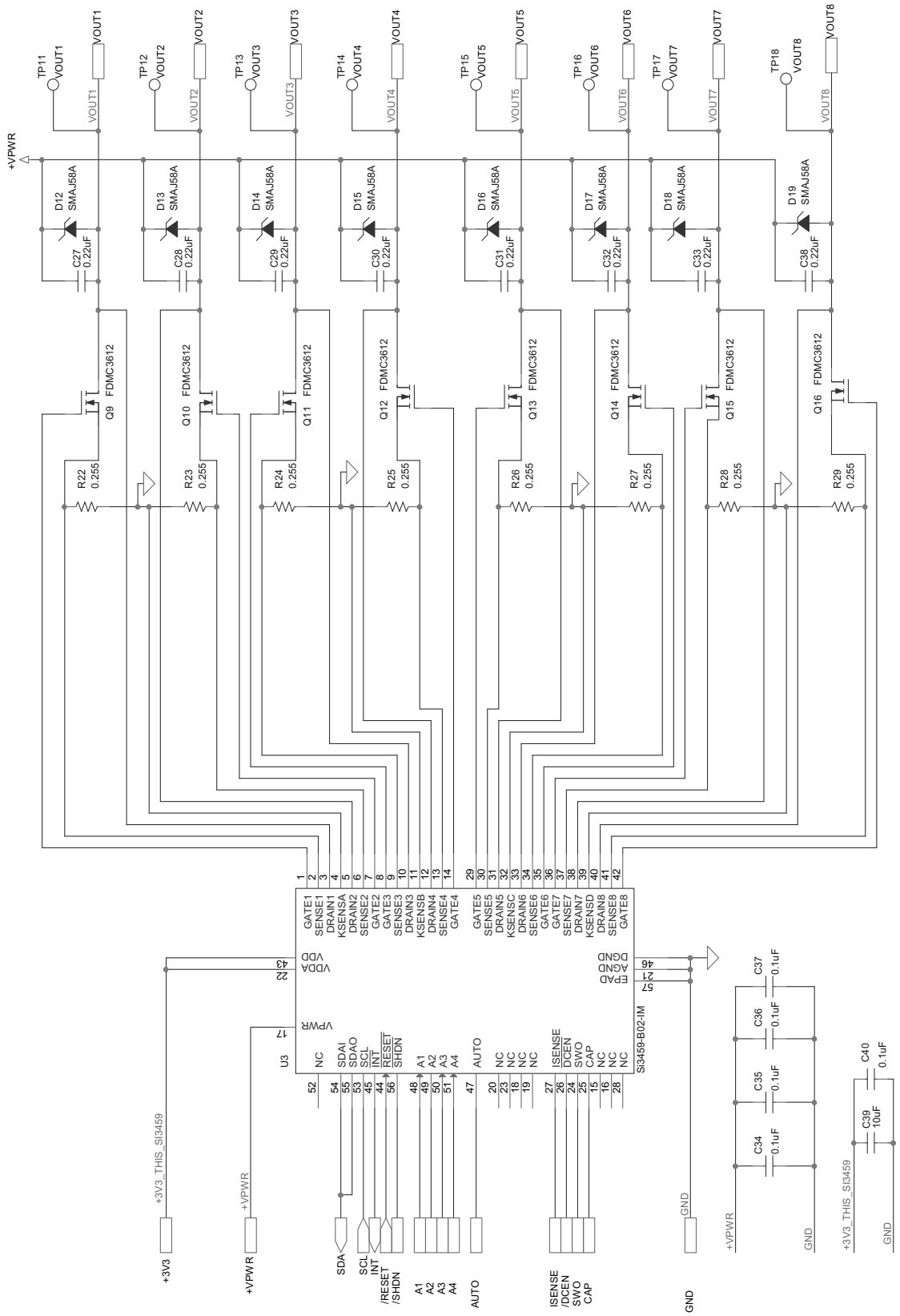


Figure 13. Si3459 PSE Schematic Detail (2 of 3)

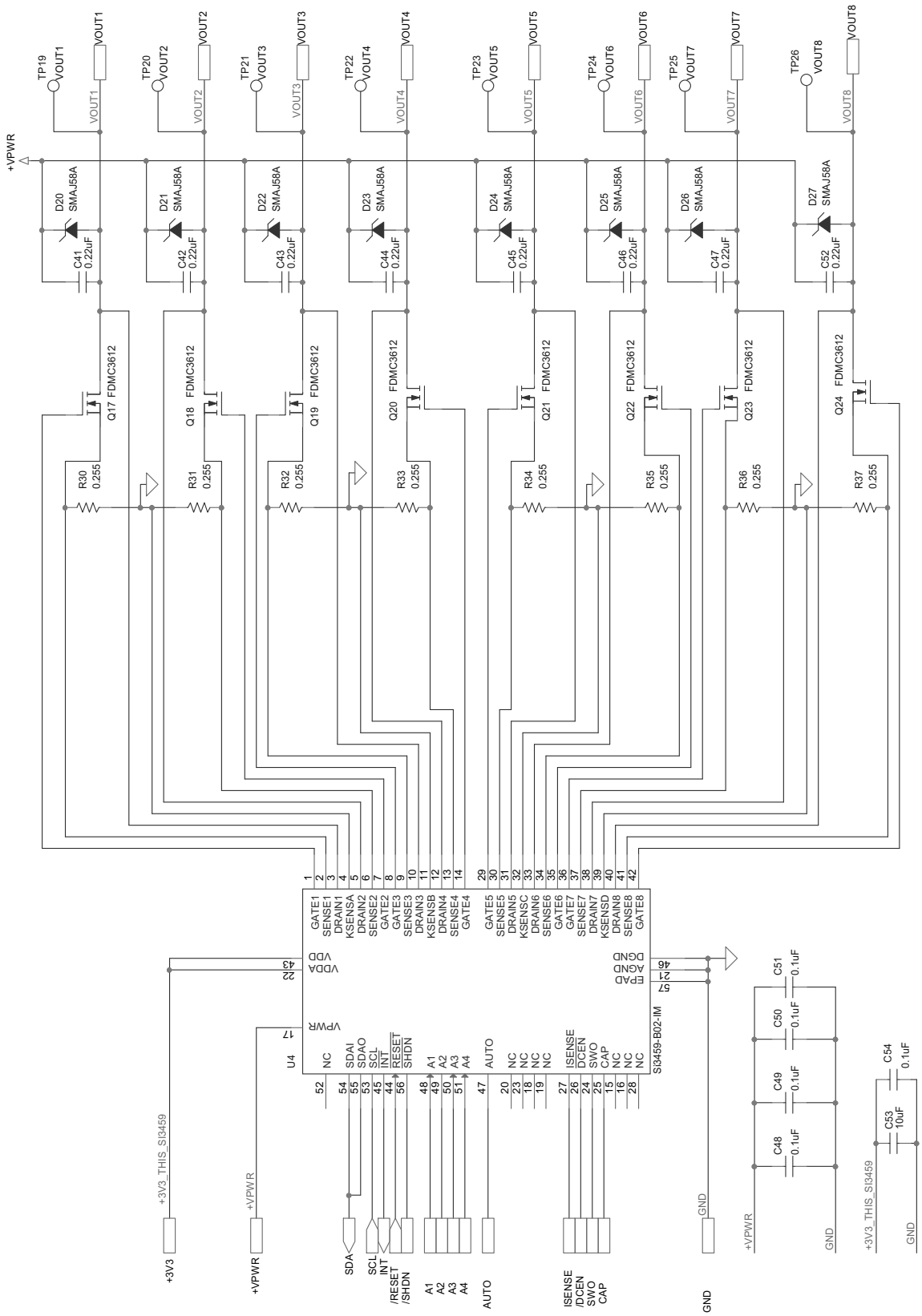


Figure 14. Si3459 PSE Schematic Detail (3 of 3)

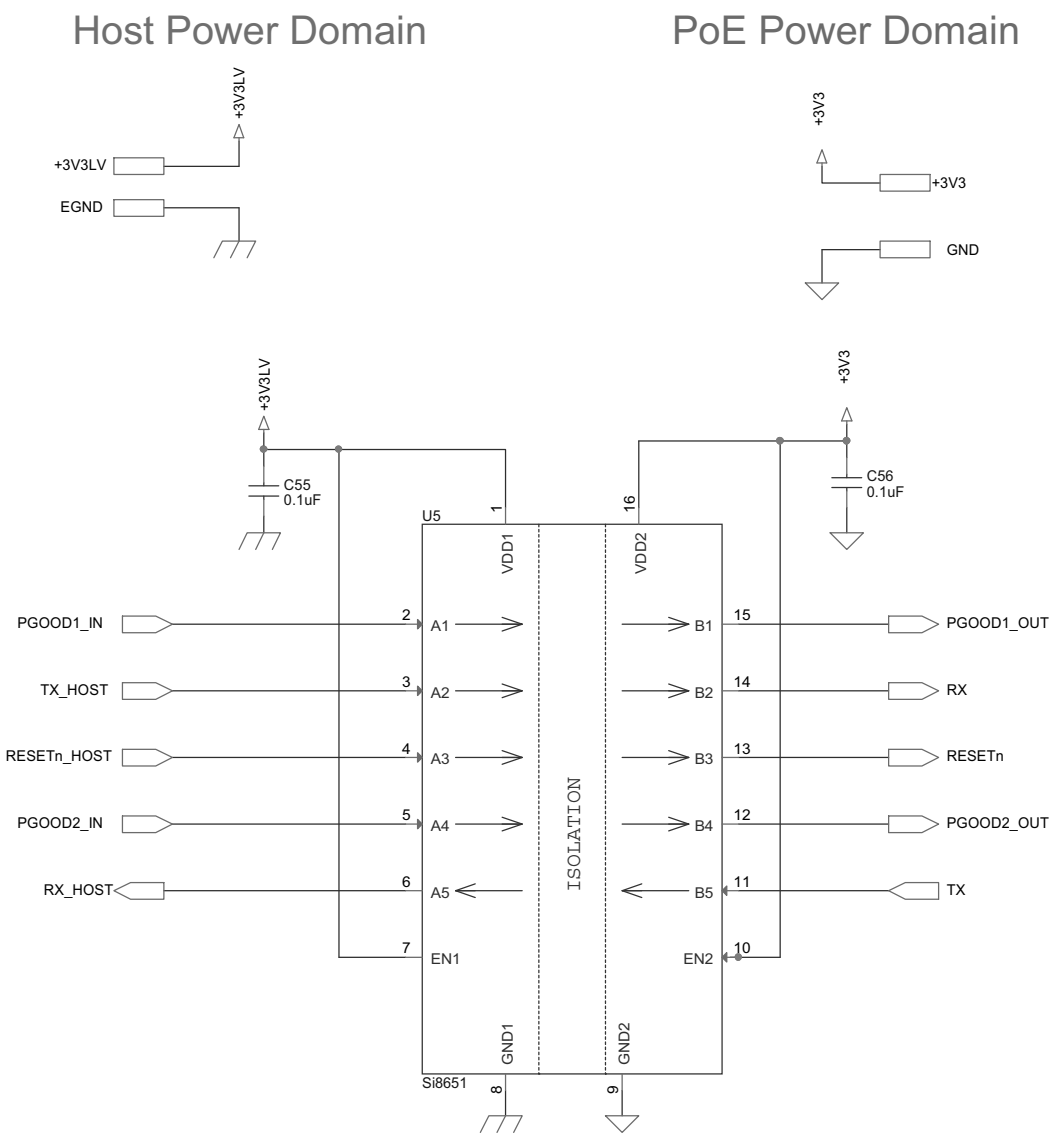


Figure 15. UART Isolator

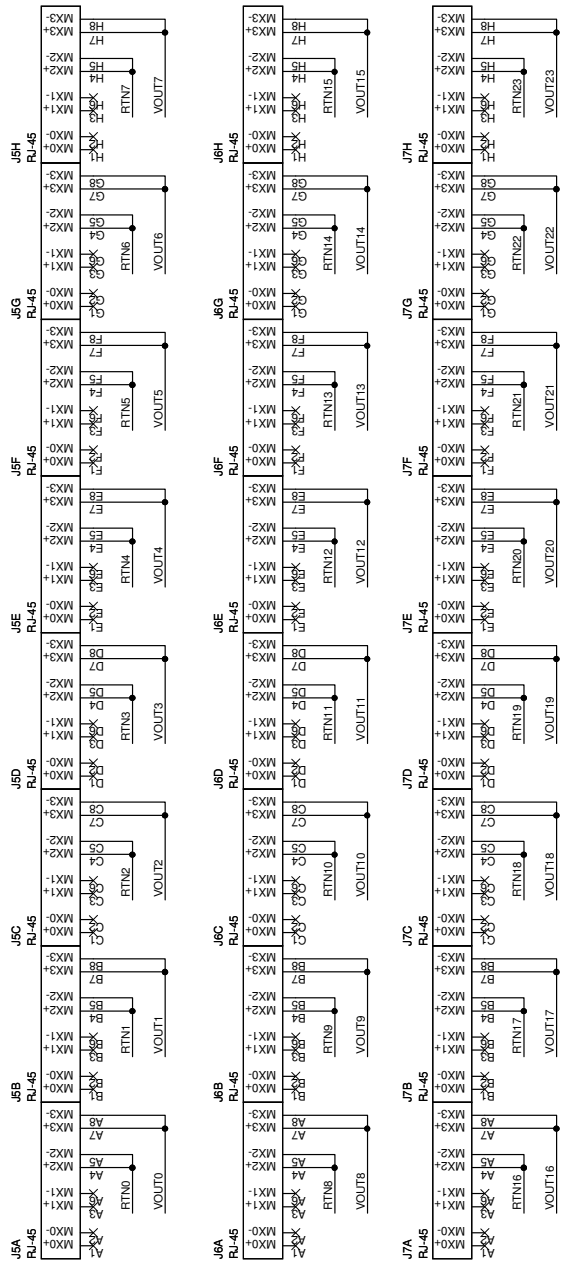


Figure 16. RJ45 Ethernet Connector Board

7.1. Bill of Materials

Table 3. Si3459Smart24 Bill of Materials

Qty	Value	Ref	Rating	Voltage	Tol	Type	PCB Footprint	Mfr Part Number	Mfr
4	0.1uF	C1,C26,C40,C54		16V	±20%	X7R	C0603	C0603X7R160-104M	Venkel
1	4.7uF	C2		10V	±20%	X7R	C1206	C1206X7R100-475M	Venkel
2	680pF	C3,C4	Y3	250V	±15%	Y3	C1808	GA342QR7GD681KW01L	MuRata
1	0.1uF	C5		16V	±20%	X7R	C0805	C0805X7R160-104M	Venkel
2	33uF	C6,C11		100V	±20%	Alum_Elec	C3.5X8MM-RAD	ECA2AM330	Panasonic
15	0.1uF	C9,C12,C20,C21,C22,C23,C34,C35,C36,C37,C48,C49,C50,C51,C120		100V	±20%	X7R	C0603	C0603X7R101-104M	Venkel
4	10uF	C10,C25,C39,C53		10V	±10%	X5R	C0603	C0603X5R100-106K	Venkel
24	0.22uF	C13,C14,C15,C16,C17,C18,C19,C24,C27,C28,C29,C30,C31,C32,C33,C38,C41,C42,C43,C44,C45,C46,C47,C52		100V	±10%	X7R	C0805	C0805C224K1RACTU	Kemet
2	0.1uF	C55,C56		16V	±10%	X7R	C0805	C0805X7R160-104K	Venkel
1	MBRS3100T3	D1	3A	100V		Schottky	DO-214AB	MBRS3100T3	On Semi
1	GREEN	D2	30mA	2.2V		SMT	LED-0805-K	LTST-C170GKT	LITE_ON INC
1	ES1B	D3	1.0A	100V		Fast	DO-214AC	ES1B	Diodes Inc.
24	SMAJ58A	D4,D5,D6,D7,D8,D9,D10,D11,D12,D13,D14,D15,D16,D17,D18,D19,D20,D21,D22,D23,D24,D25,D26,D27	400W	58V		GP	DO-214AC	SMAJ58A	Littelfuse
6	HEADER 1x3	JP1,JP2,JP3,JP4,JP5,JP6				Header	CONN-1X3	TSW-103-07-T-S	Samtec
1	JUMPER	JP7				Header	CONN1X2	TSW-102-07-T-S	Samtec
18	Jumper Shunt	JS1,JS2,JS3,JS4,JS5,JS6,JS7,JS8,JS9,JS10,JS11,JS12,JS13,JS14,JS15,JS16,JS17,JS18				Shunt	N/A	SNT-100-BK-T	Samtec

Table 3. Si3459Smart24 Bill of Materials

Qty	Value	Ref	Rating	Voltage	Tol	Type	PCB Footprint	Mfr Part Number	Mfr
1	HEADER 5x2	J1				Header	CONN2X5	TSW-105-07-T-D	Samtec
1	HEADER 8x2	J2				Header	CONN2X8	TSW-108-07-S-D	Samtec
2	HEADER 12x2	J3,J4				Header	CONN2X12-2MM	TMM-112-01-T-D	Samtec
1	5X2 Shrouded Header	J5				Shrouded	CONN2X5-4W	5103309-1	Tyco
1	CONN SOCKET 3x2 RA	J6				Socket	CONN2X3-FRA	SSQ-103-02-G-D-RA	Samtec
1	CONN TRBLK 2	J7				TERM BLK MALE	CONN-TB-1757242	1757242	PHOENIX CONTACT
3	HEADER 4x3	J8,J9,J10				Header	CONN3X4	TSW-104-07-G-T	Samtec
1	100uH	L1	1.0 A		±20%	Shielded	IND-CTSLF1045	CTSLF1045-101M	Central Tech
6	4-40	MH1,MH2,MH3,MH4,MH5,MH6				HDW	MH-125NP	NSS-4-4-01	Richco Plastic Co
1	Si3459-SMART24 REV 3.0	PCB1				BARE PCB	N/A	Si3459-SMART24 REV 3.0	Silicon Labs
24	FDMC3612	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9,Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17,Q18,Q19,Q20,Q21,Q22,Q23,Q24	12A	100V		N-CHNL	POWER33	FDMC3612	Fairchild
1	FQT5P10	Q25	1.0A	100V		P-CHNL	SOT223-GDS	FQT5P10	Fairchild
4	1K	R1,R2,R10,R11	1/10W		±1%	Thick-Film	R0603	CR0603-10W-1001F	Venkel
8	10K	R3,R4,R5,R6,R7,R8,R9,R12	1/10W		±1%	Thick-Film	R0603	CR0603-10W-1002F	Venkel
1	332	R13	1/10W		±1%	Thick-Film	R0603	CR0603-10W-3320F	Venkel

Table 3. Si3459Smart24 Bill of Materials

Qty	Value	Ref	Rating	Voltage	Tol	Type	PCB Footprint	Mfr Part Number	Mfr
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1	1.0	R38	1/4W		±1%	Thick-Film	R1206	CR1206-4W-1R00F	Venkel
1	0	R39	1A			Thick-Film	R0603	CR0603-16W-000	Venkel
6	STAND-OFF	SO1,SO2,SO3, SO4,SO5,SO6				HDW		4810	Keystone Electronics
1	SW PUSH-BUTTON	SW1	50mA	12Vdc		Tactile	SW4N6.5X4.5-PB	101-0161-EV	Mountain Switch
7	TPV	TPV1,TPV2,TPV3, TPV4,TPV5,TPV6, TPV7				PCB Feature	VIA-TP	N/A	N/A
26	BLACK	TP1,TP2,TP3,TP4, TP5,TP6,TP7,TP8, TP9,TP10,TP11, TP12,TP13,TP14, TP15,TP16,TP17, TP18,TP19,TP20, TP21,TP22,TP23, TP24,TP25,TP26				Loop	TESTPOINT	151-203-RC	Kobiconn
1	Si3483	U1				MCU	QFN24N4X4P0.5	Si3483-A01-GM	Silicon Labs
3	Si3459-B02-IM	U2,U3,U4				PSE	QFN56M8X8P0.5E5.85	Si3459-B02-IM	Silicon Labs
1	Si8651	U5	2500 VRMS			Isolator	SO16N6.0P1.27	Si8651BB-B-IS1	Silicon Labs

7.2. Circuit Board Layout

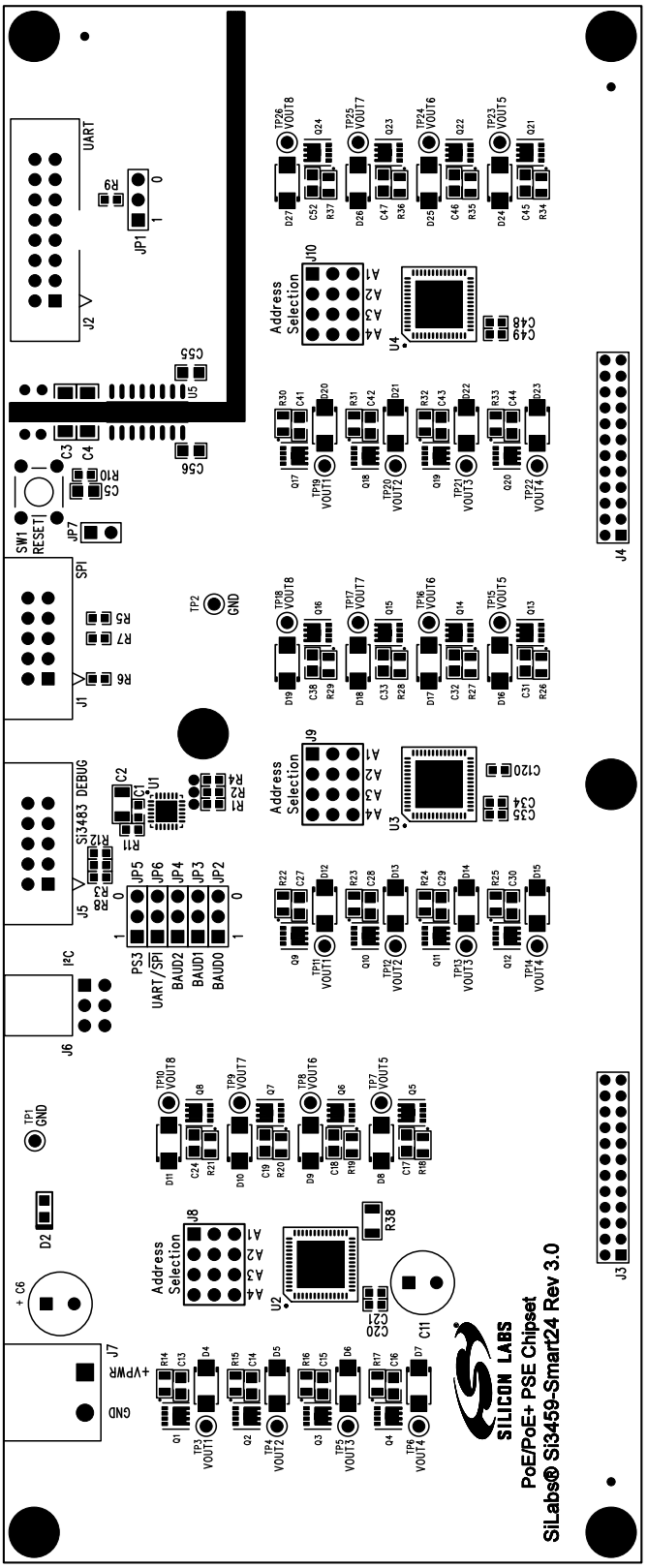


Figure 17. Si3459 SMART24 Silkscreen

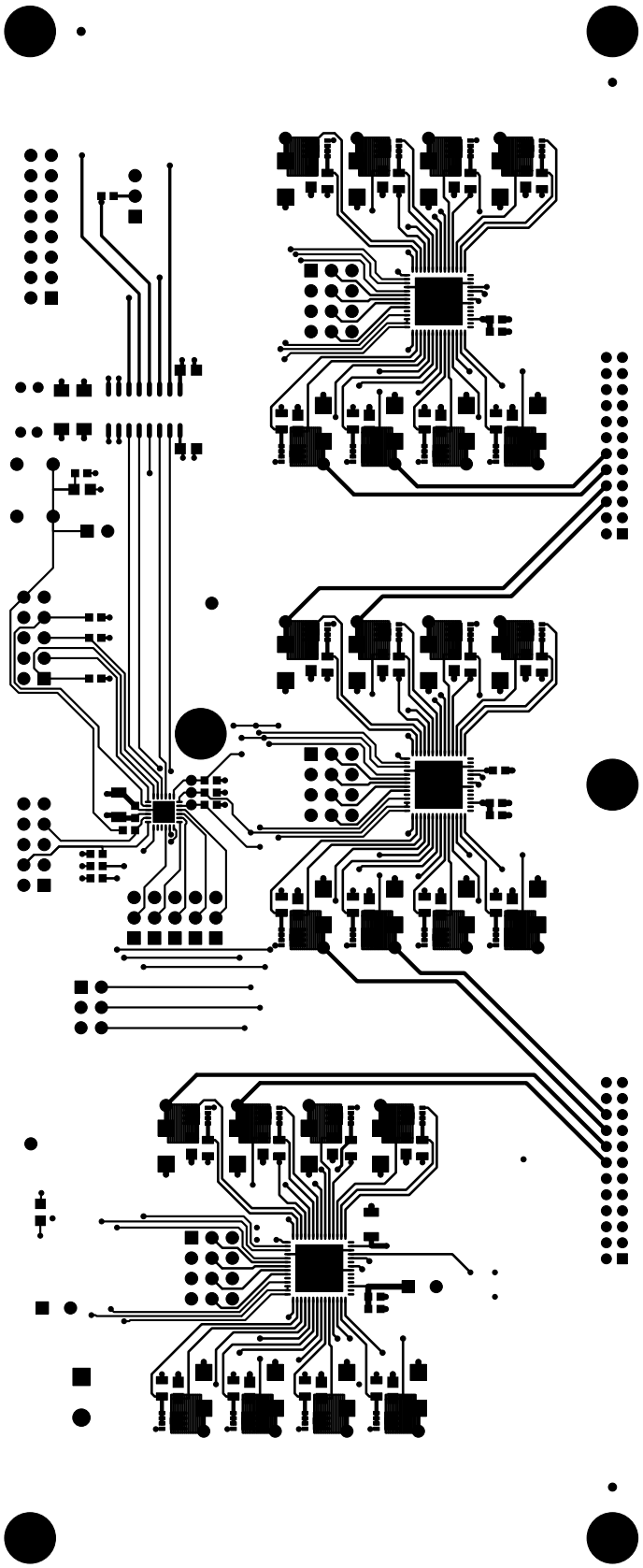


Figure 18. Si3459 SMART24 Top Layer

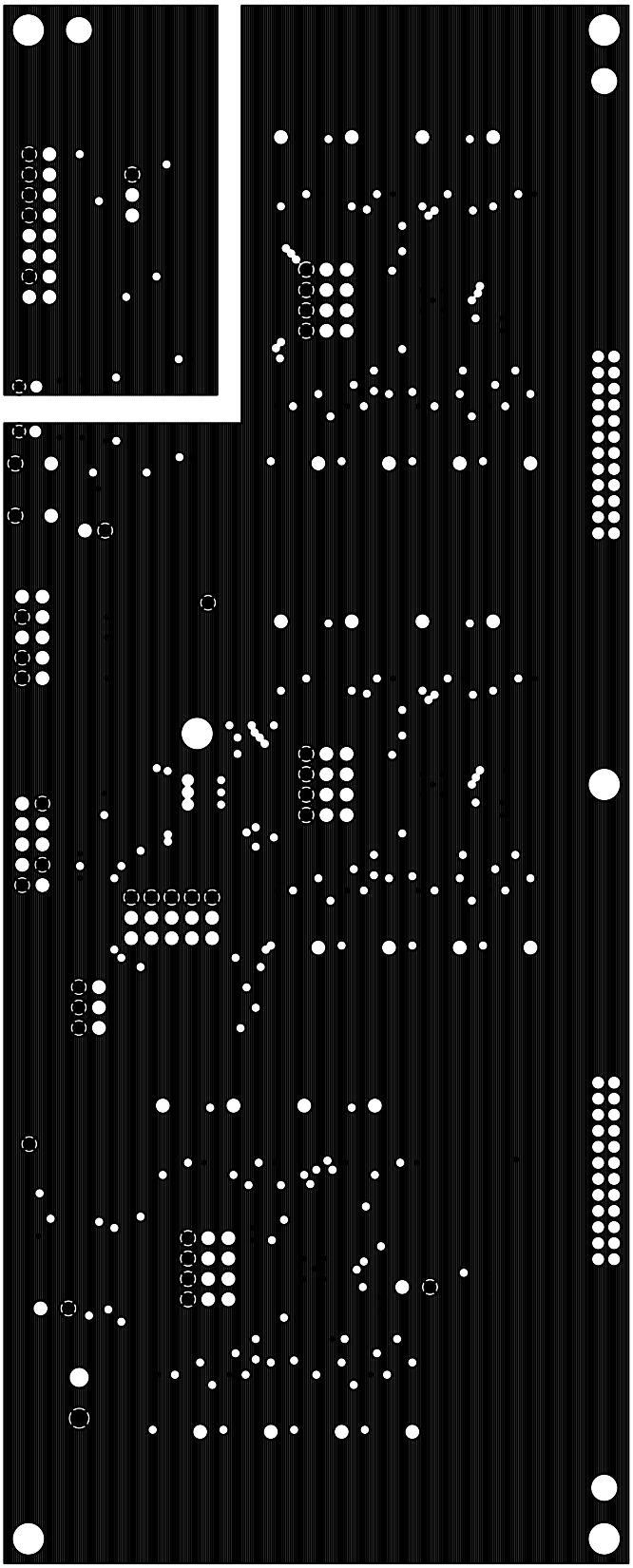


Figure 19. Si3459 SMART24 Ground Layer

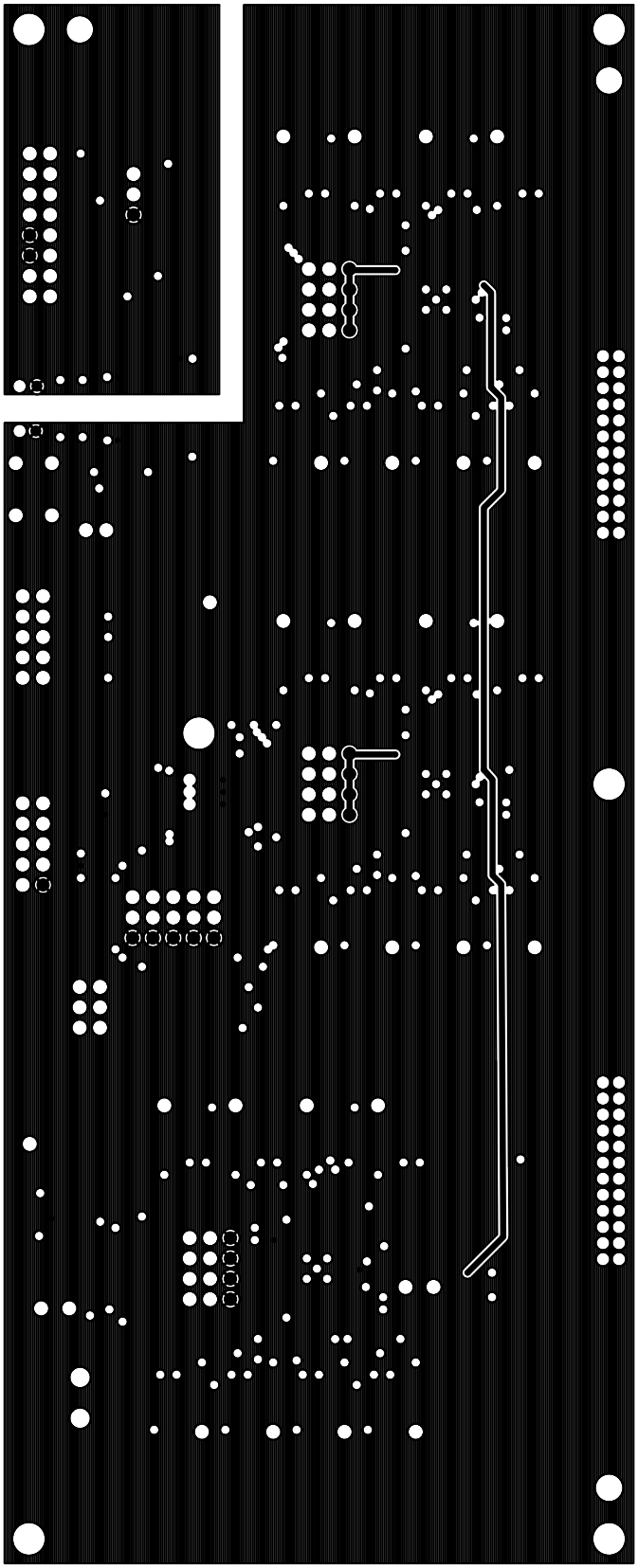


Figure 20. Si3459 SMART24 Power Plane

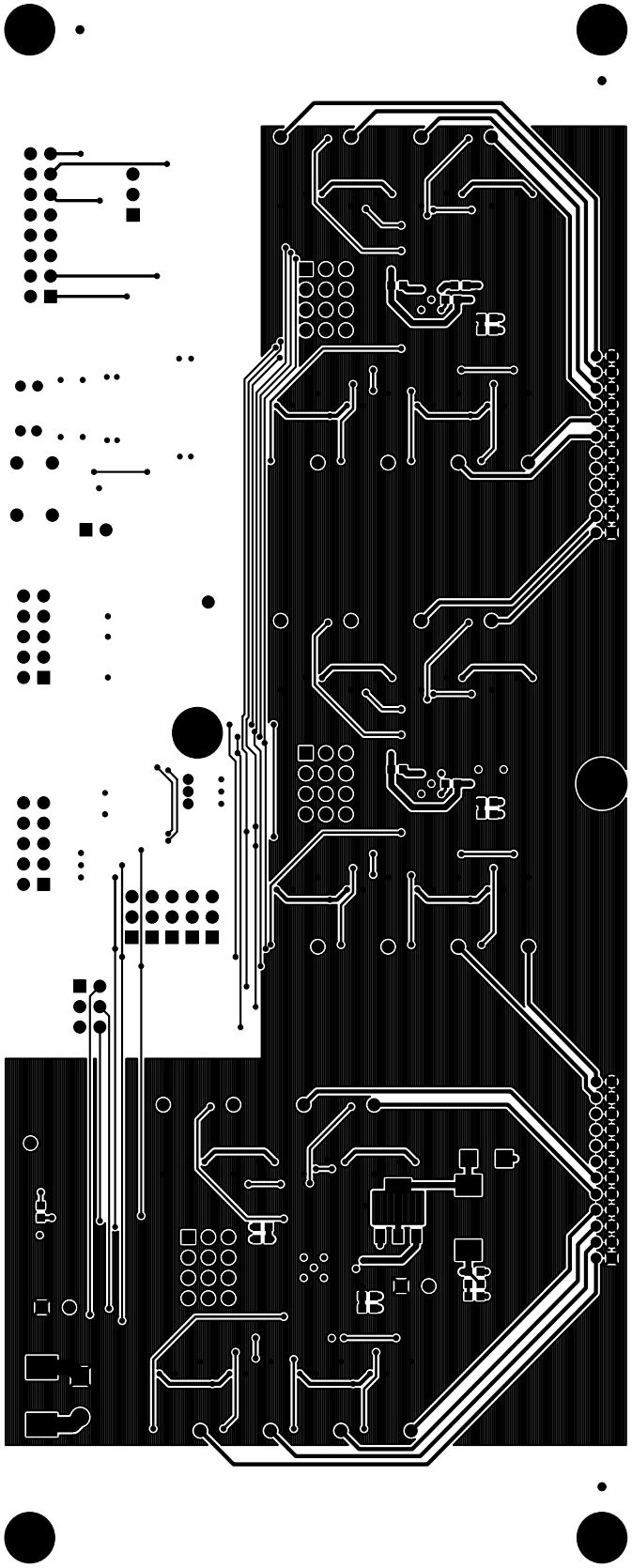
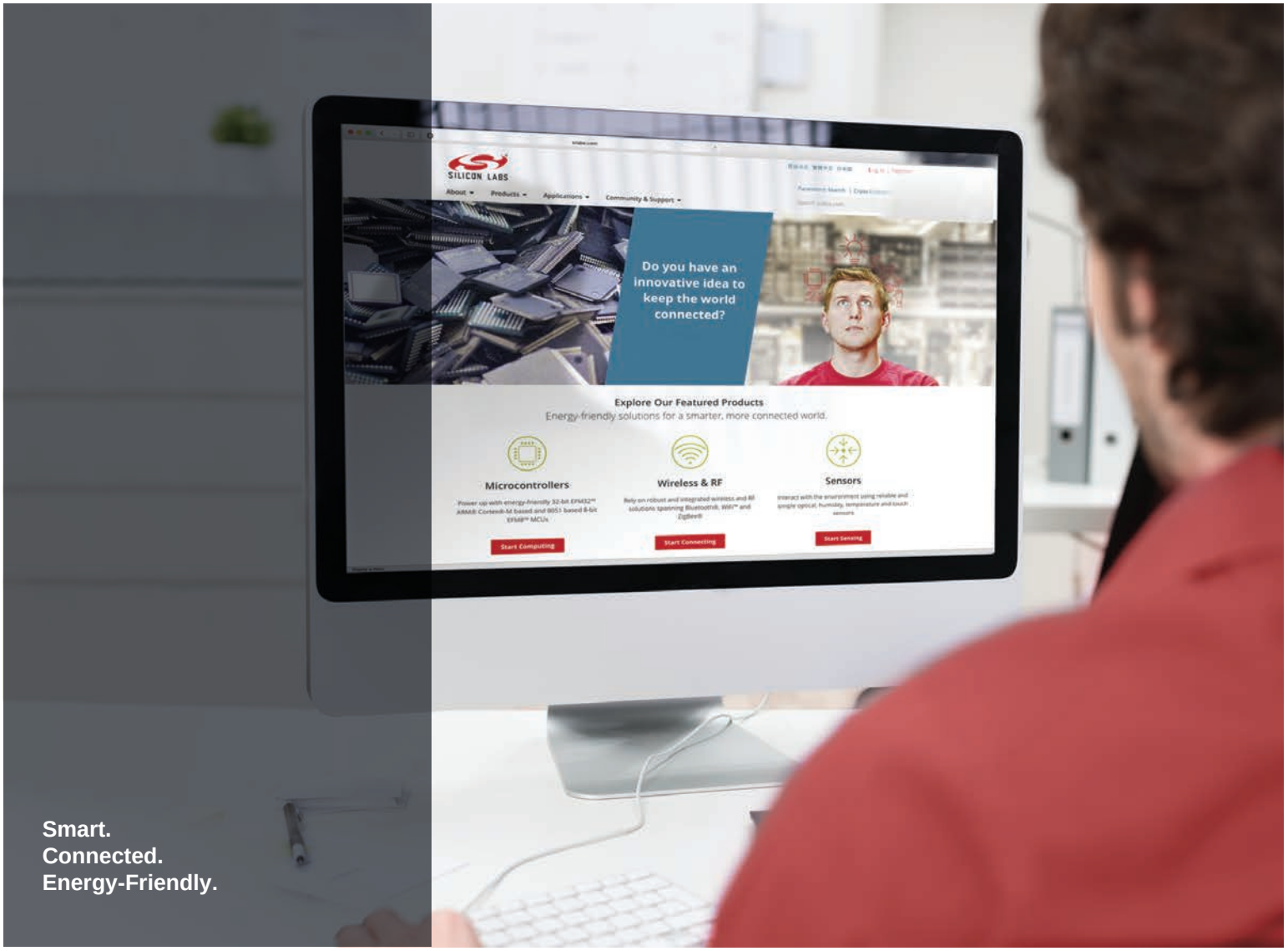


Figure 21. Si3459 SMART24 Bottom Layer



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