Reference Design High Power

Title	**RDHP-2250Q Adapter Board**
Application	Electrical Interface for "SCALE EV"
Author	System Engineering Automotive
Date	06-Feb-23
Revision	1.4

Feature Set

- Compatible for operation of "SCALE EV" boards
- On-board bit stream reader for bit stream analysis
- 4-bit LED counter for SO fault event
- Accessible oscilloscope probe point, input and output interface for signal measurement
- Available BNC sockets for PWM signal IN and ASC_AD
- Alternate fiber optic connection for PWM signal IN and SO fault trigger
- Input Common Mode Choke provision and LED indicator for power supply input

Power Integrations
5245 Hellyer Avenue, San Jose, CA 95138 USA.
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

Table of Contents

Disclaimer:

The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. All parameters, numbers, values and other technical data included in the technical information were calculated and determined to our best knowledge in accordance with the relevant technical norms (if any). They may base on assumptions or operational conditions that do not necessarily apply in general. We exclude any representation or warranty, express or implied, in relation to the accuracy or completeness of the statements, technical information and recommendations contained herein.

No responsibility is accepted for the accuracy or sufficiency of any of the statements, technical information, recommendations, or opinions communicated and any liability for any direct, indirect or consequential loss or damage suffered by any person arising therefrom is expressly disclaimed.

1 Scope

This document provides a detailed information about RHDP-2250Q (may be referred as adapter board in this document). This will cover the circuit schematic, PCB layout, board assembly, bill of materials, input / output pin details and bit stream reader user manual.

2 Introduction

The adapter board is designed to aid in interfacing the SCALE EV boards (e.g. 2SP02152FQC0-FF900R12ME7W_B11) to an electrical and measurement set-up.

It provides the input and output ports for both low and high voltage tests. Accessible oscilloscope probing points are provided for ease of analyzing signals. The board also includes common mode chokes, line drivers, pull-up / down resistors and alternate fiber optic connection to enhance its noise immunity. On-board bit stream readers and SO fault counters are available for bit stream analysis.

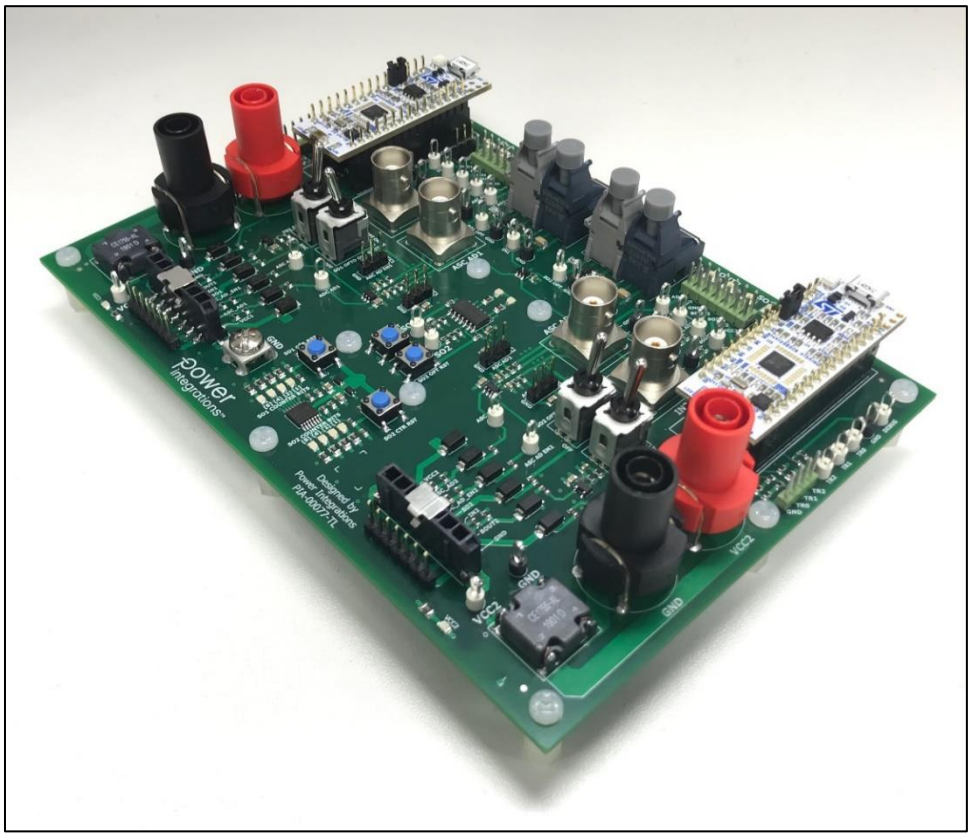


Figure 1 – RDHP-2250Q Adapter Board.

3 Circuit Schematic

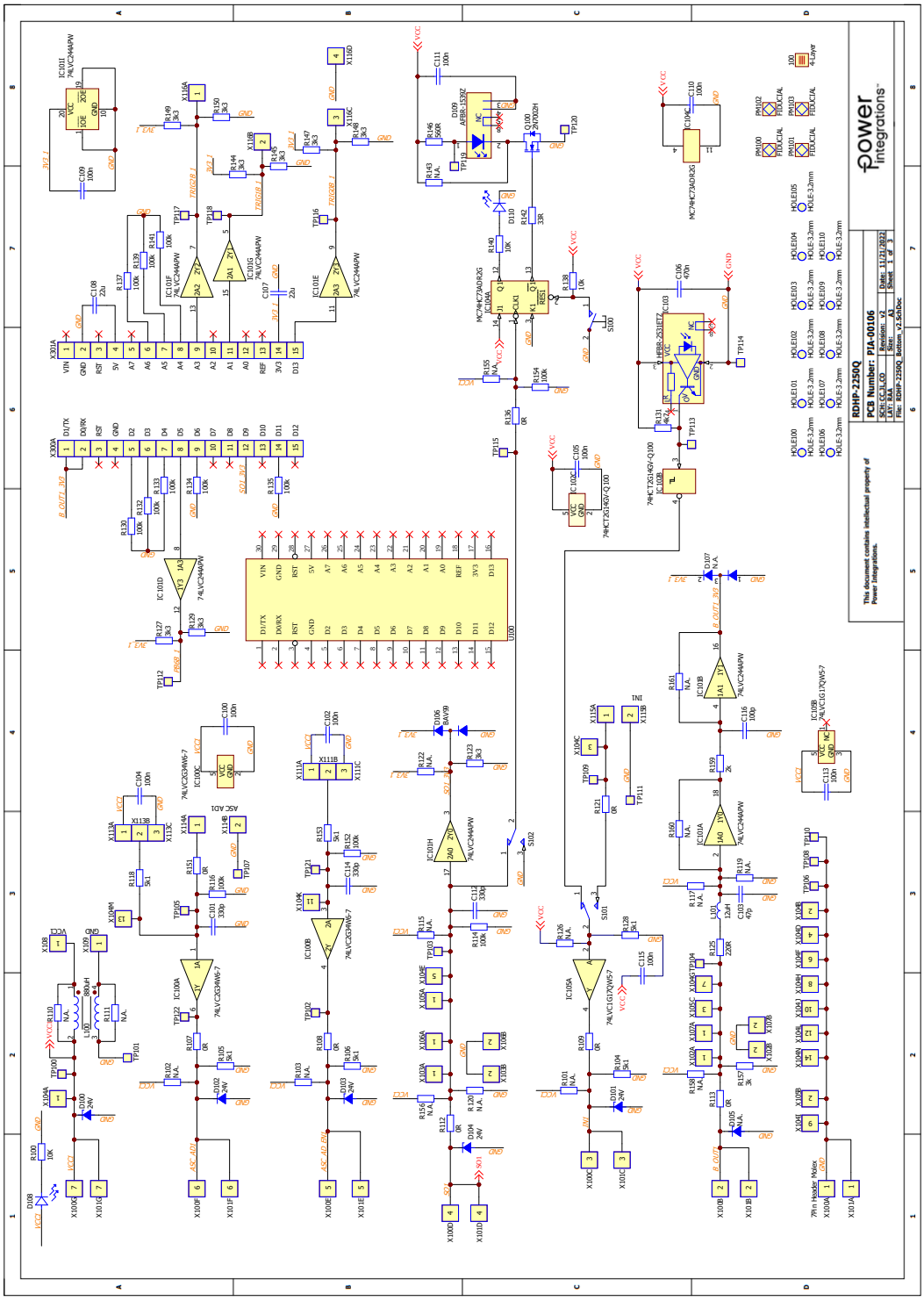


Figure 2 – Schematic Diagram (Bottom Channel).

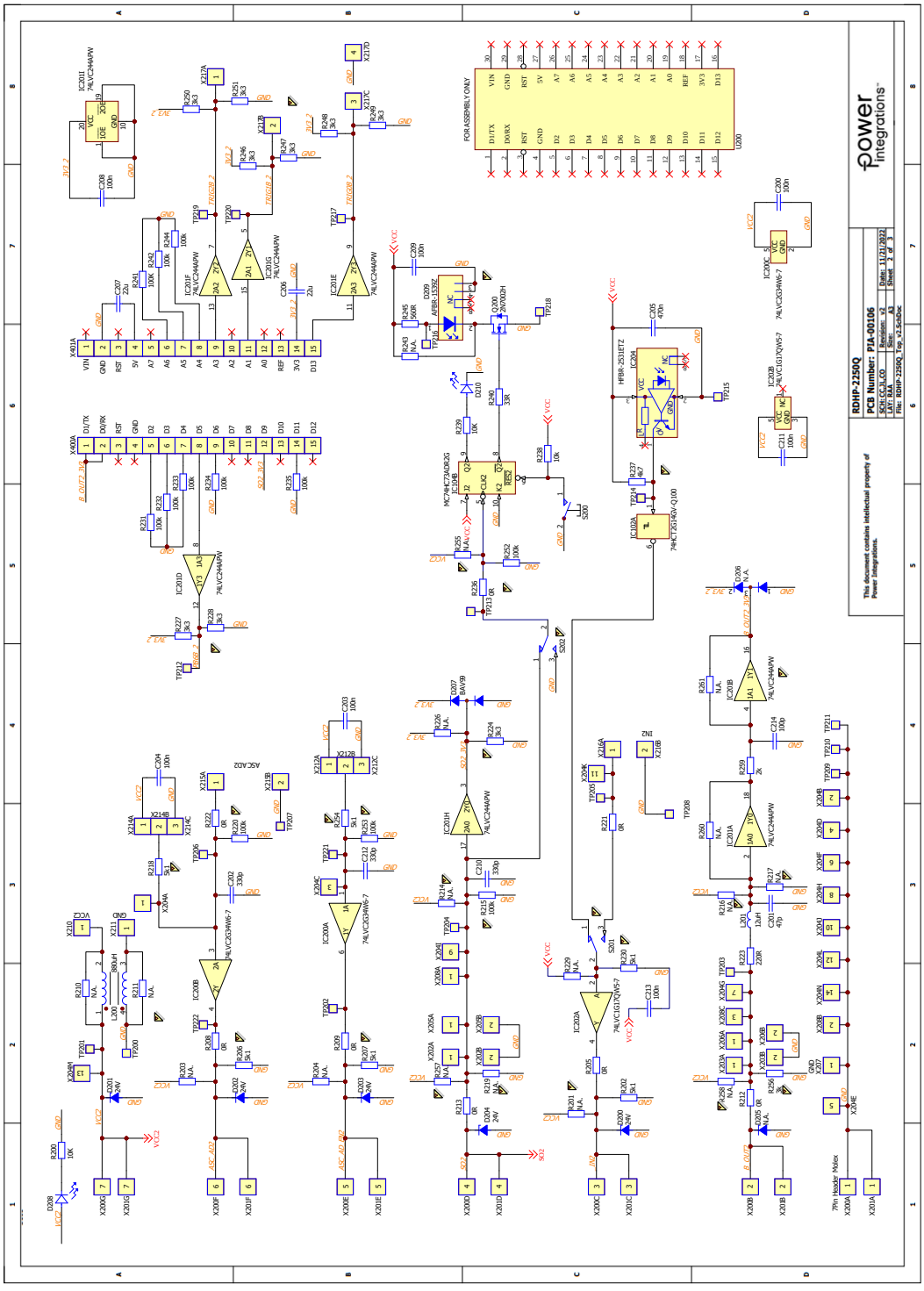


Figure 3 – Schematic Diagram (Top Channel).

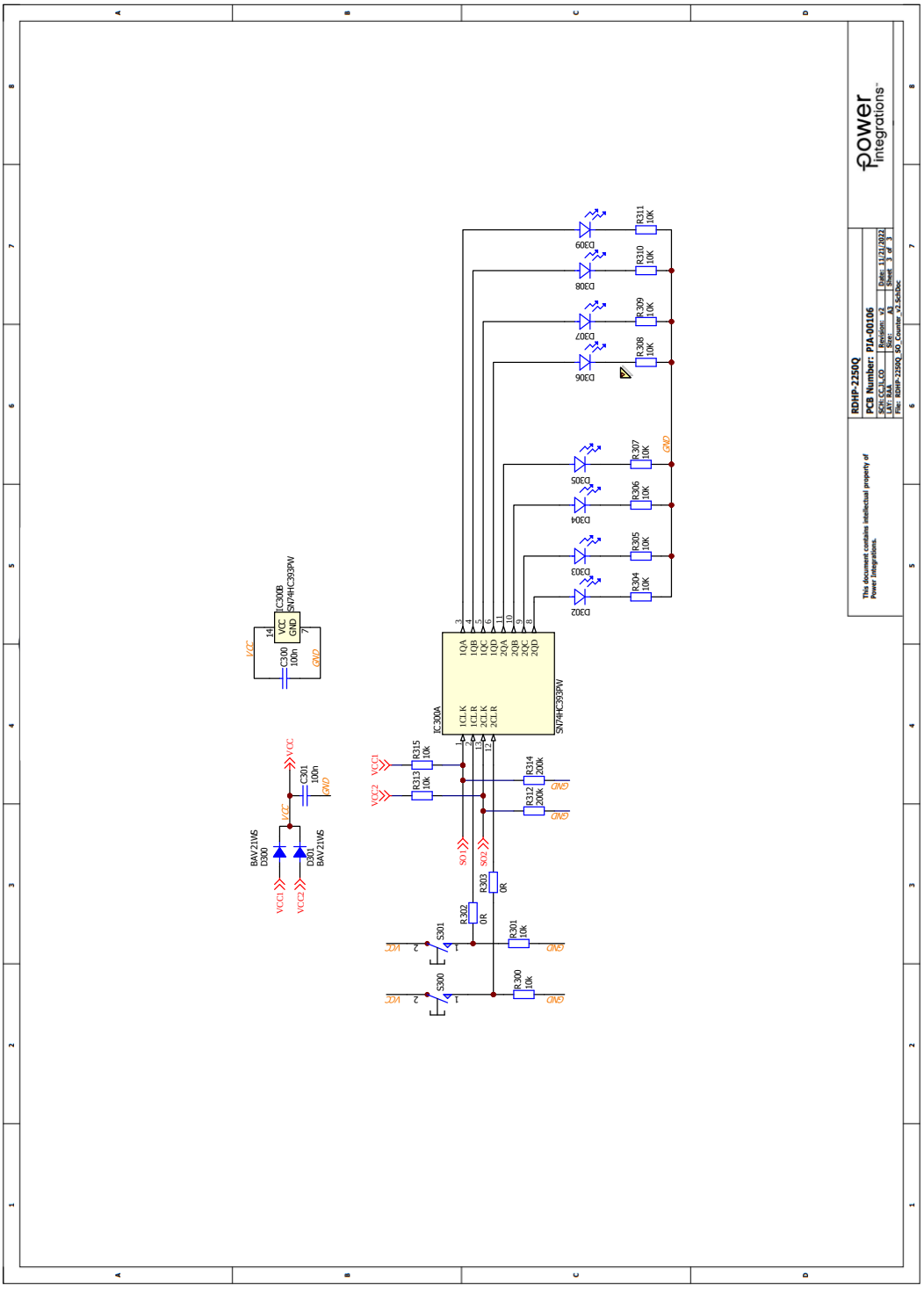


Figure 4 – Schematic Diagram (SO Fault Counter).

4 PCB Layout

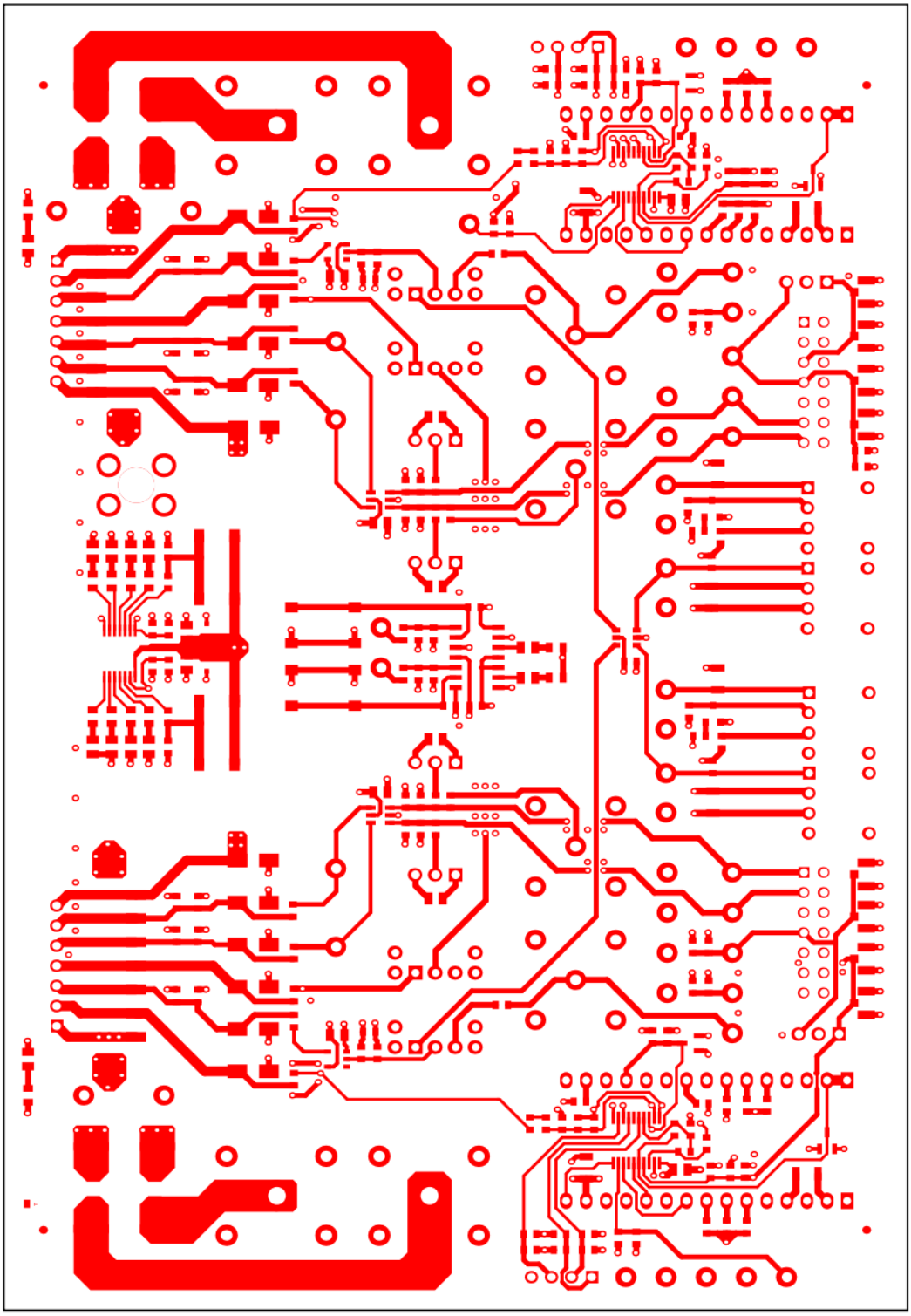


Figure 5 – PCB Layout (Top Layer).

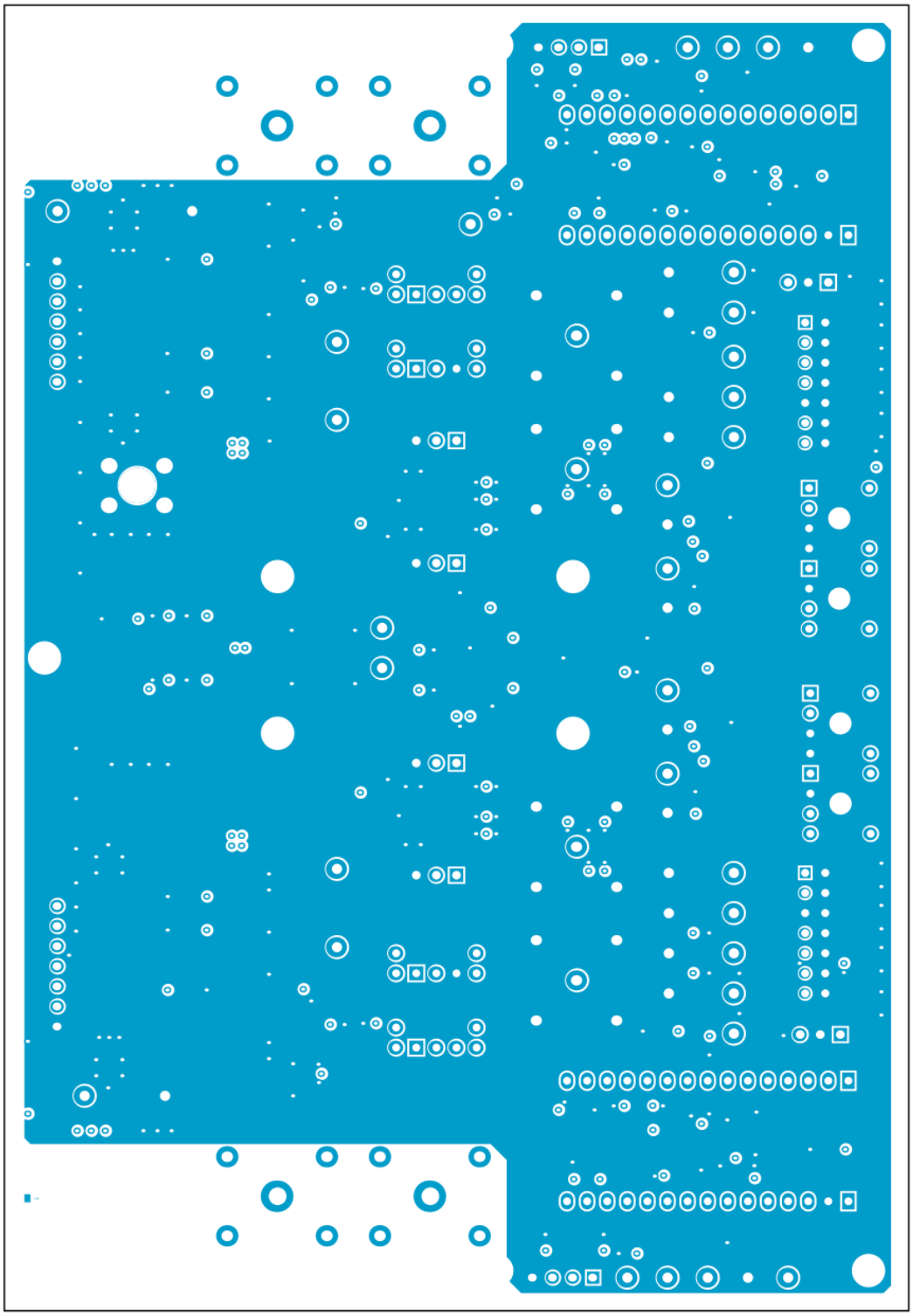


Figure 6 – PCB Layout (Middle Layer 1).

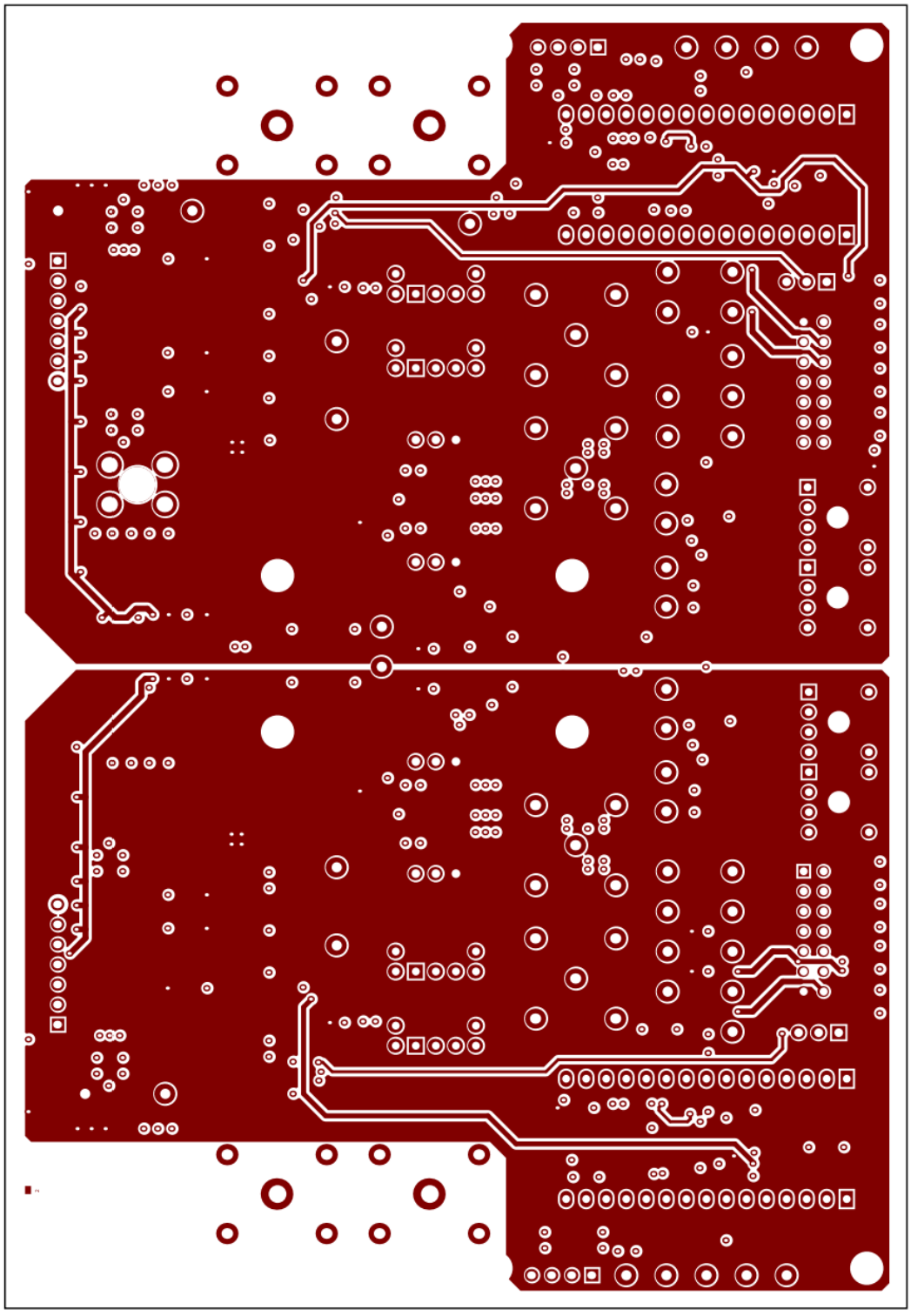


Figure 7 – PCB Layout (Middle Layer 2).

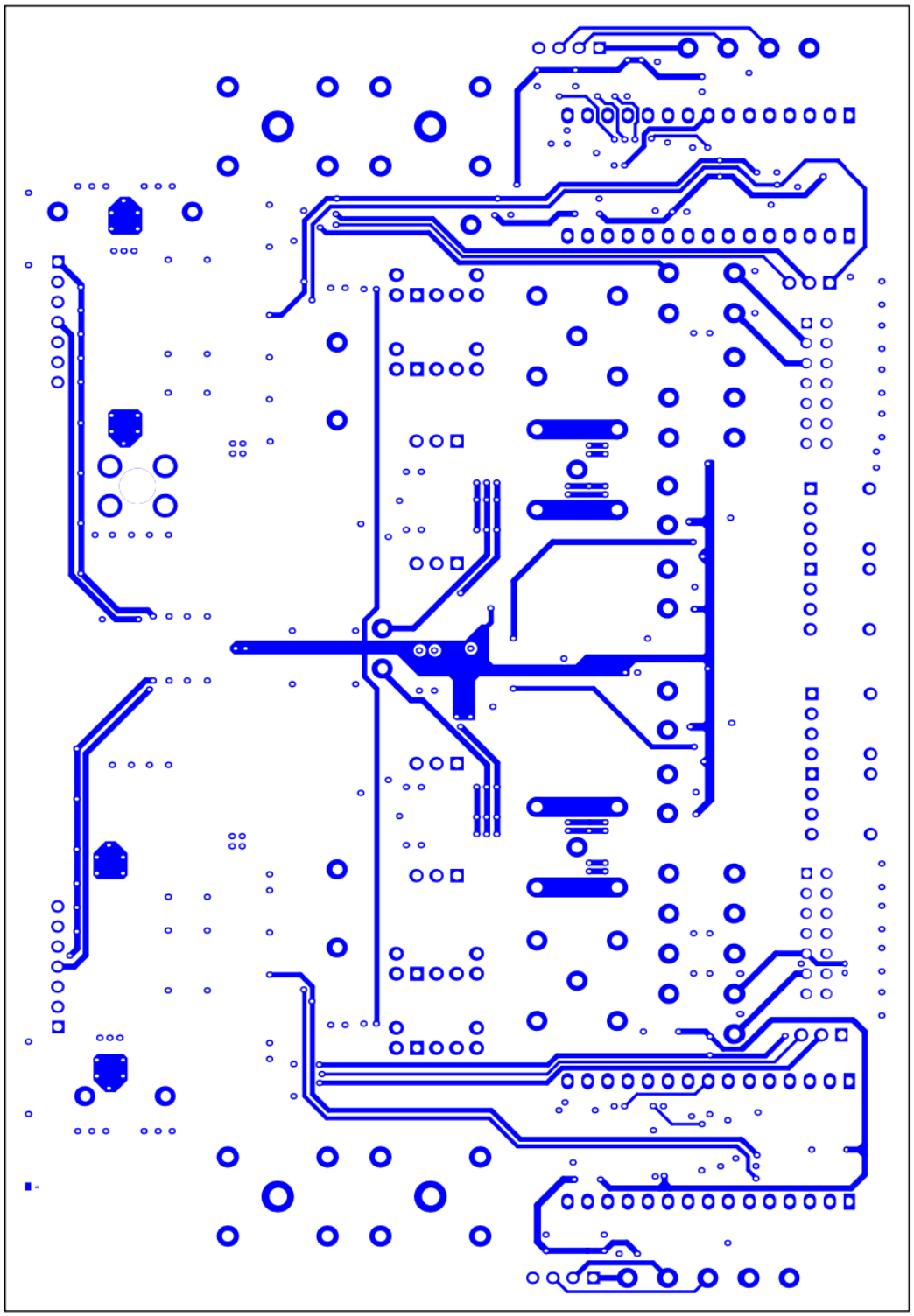


Figure 8 – PCB Layout (Bottom Layer).

5 Board Assembly

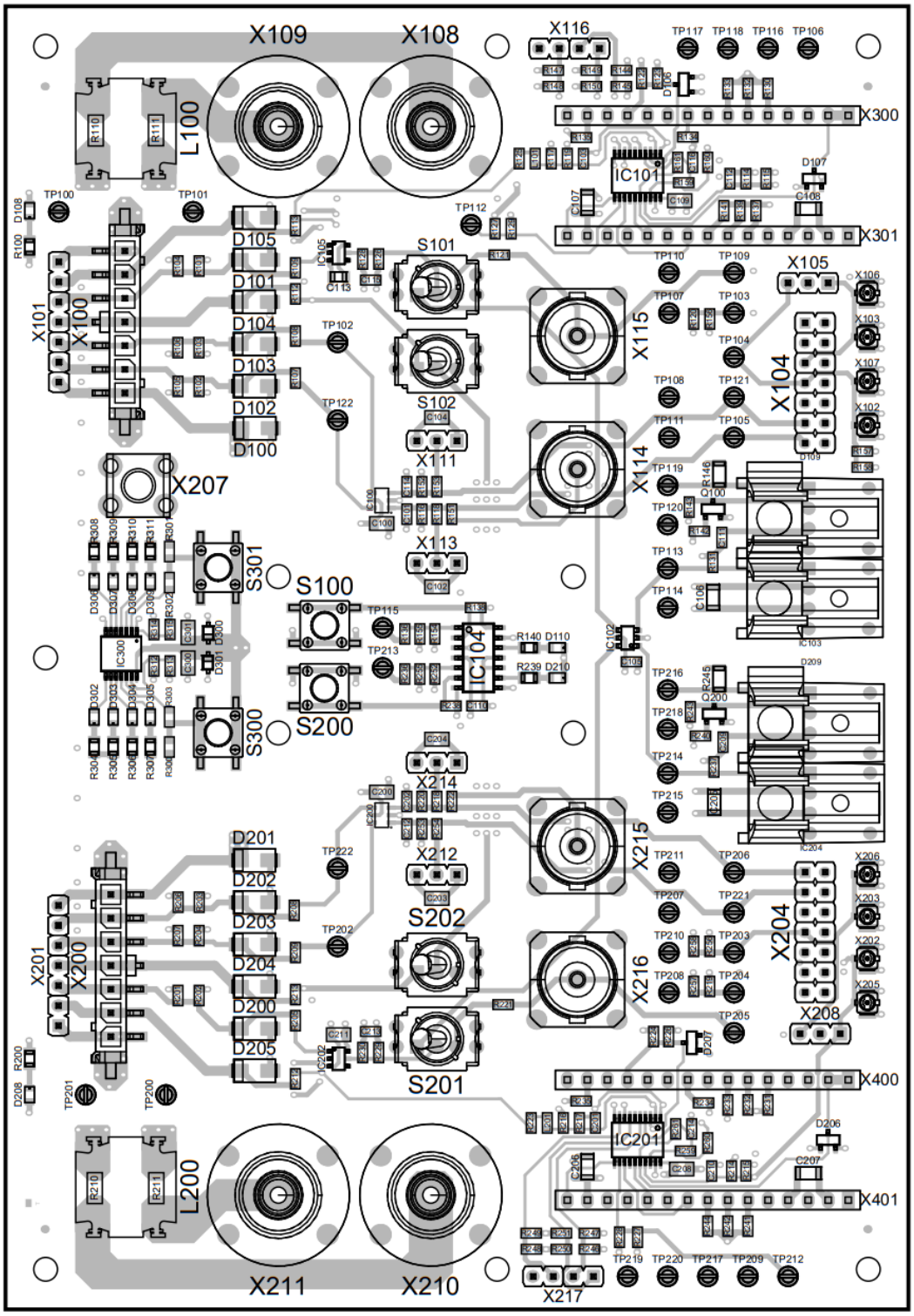


Figure 9 – Board Assembly.

6 Bill of Materials

#	Qty	Designator	Value	Part Description	Parameters	Manufacturer
1	12	C100, C102, C104, C109, C113, C200, C203, C204, C208, C211, C300, C301	100n / 0805	Ceramic Chip Capacitor	X7R / 100V / 10%	
2	6	C101, C112, C114, C202, C210, C212	330p / 0603	Ceramic Chip Capacitor	NP0,C0G / 100V / 5%	
3	2	C103, C201	47p / 0603	Ceramic Chip Capacitor	NP0,C0G / 100V / 5%	
4	6	C105, C110, C111, C115, C209, C213	100n / 0603	Ceramic Chip Capacitor	X7R / 50V / 10%	
5	2	C106, C205	470n / 1206	Ceramic Chip Capacitor	X7R / 100V / 10%	
6	4	C107, C108, C206, C207	22u / 1206	Ceramic Chip Capacitor	X7R / 10V / 10%	
7	2	C116, C214	100p / 0603	Ceramic Chip Capacitor	NP0,C0G / 50V / 2%	
8	10	D100, D101, D102, D103, D104, D200, D201, D202, D203, D204	SZ1SMA24AT3G	TVS DIODE 24VWM 38.9VC SMA	24V / 10.3A Ipp	Diodes Incorporated
9	2	D106, D207	BAV99	High-speed switching diodes	100V / 215mA / 250mW	Nexpiria
10	2	D109, D209	AFBR-1539Z	Fiber Optic Transmitter	650nm / Vertical / 10MBd	Avago
11	2	D300, D301	BAV21WS	High Voltage Diode	150V / 250mA / 200mW / 1.0V @ If = 100mA	Diodes
12	2	IC100, IC200	74LVC2G34W6-7	Buffers & Line Drivers LVC 2 Gates LOGIC	1.65V to 5.5V	DIODE
13	2	IC101, IC201	74LVC244APW	Buffers & Line Drivers Octal w / Tri-St Out	1.65V to 3.6V	Nexperia
14	1	IC102	74HCT2G14GV-Q100	Dual inverting Schmitt trigger	4.5V to 5.5V	Nexperia
15	2	IC103, IC204	HFBR-2531ETZ	Fiber Optic Receiver	600nm / Vertical / 1MBd	Avago
16	1	IC104	MC74HC73ADR2G	Single Negative-Edge-Triggered JK-Type Flip-Flop	2.0V to 6.0V / 25mA	ON Semiconductor
17	2	IC105, IC202	74LVC1G17QW5-7	Buffers & Line Drivers Logic LVC 1 Gate SOT25 T&R 3K	1.65V to 5.5V	DIODE
18	1	IC300	SN74HC393PW	Counter ICs Dual 4-Bit Binary Counters	2V to 6V	Texas Instruments
19	2	L100, L200	880uH / CE1755-AL	Input Common Mode Choke		Coilcraft
20	2	L101, L201	12uH / 0603	Shielded Multilayer Inductor		TDK Corporation
21	12	D108, D110, D208, D210, D302, D303, D304, D305, D306, D307, D308, D309	HSMQ-C170-T0000	Standard LEDs - SMD Top Mt Green	GREEN	Broadcom Limited
22	2	Q100, Q200	2N7002H	60 V, N-channel Trench MOSFET	60V 300mA (Tc) 830mW (Tc)	Nexperia

23	12	R100, R140, R200, R239, R304, R305, R306, R307, R308, R309, R310, R311	10k / 0805	Thick Film Chip Resistor	1% / 0.125W / 150V	
24	12	R104, R105, R106, R118, R128, R153, R202, R206, R207, R218, R230, R254	5k1 / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
25	18	R107, R108, R109, R112, R113, R121, R136, R151, R205, R208, R209, R212, R213, R221, R222, R236, R302, R303	0R / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
26	24	R114, R116, R130, R132, R133, R134, R135, R137, R139, R141, R152, R154, R215, R220, R231, R232, R233, R234, R235, R241, R242, R244, R252, R253	100k / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
27	18	R123, R127, R129, R144, R145, R147, R148, R149, R150, R224, R227, R228, R246, R247, R248, R249, R250, R251	3k3 / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
28	2	R125, R223	220R / 0603	Thick Film Chip Resistor	1% / 0.1W / 150V	
29	2	R131, R237	4k7 / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
30	6	R138, R238, R300, R301, R313, R315	10k / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
31	2	R142, R240	33R / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
32	2	R146, R245	560R / 1206	Thick Film Chip Resistor	1% / 0.25W / 200V	
33	2	R157, R256	3k / 0603	Thick Film Chip Resistor	1% / 0.1W / 150V	
34	2	R159, R259	2k / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
35	2	R312, R314	200k / 0603	Thick Film Chip Resistor	1% / 0.1W / 75V	
36	4	S100, S200, S300, S301	Push button Switch	PCB Push switch	12VDC / 50mA	C&K
37	4	S101, S102, S201, S202	Toggle Switch	Switch on-on 1pol		Nikkai
38	46	TP100, TP101, TP102, TP103, TP104, TP105, TP106, TP107, TP108, TP109, TP110, TP111, TP112, TP113, TP114, TP115, TP116, TP117, TP118, TP119, TP120, TP121, TP122, TP200, TP201, TP202, TP203, TP204, TP205, TP206, TP207, TP208, TP209, TP210, TP211, TP212, TP213, TP214, TP215, TP216, TP217, TP218, TP219, TP220, TP221, TP222	PCB testpoint	PCB testpoint	Grid 3.2mm / PCB Hole 1.32mm	Vero Technologies Ltd.

39	2	U100, U200	NUCLEO-F042K6	Development Boards & Kits - ARM STM32 Nucleo-32 development board STM32F042K6 MCU, supports Arduino nano connect		ST Microelectronics
40	2	X100, X200	7Pin Header Molex	CONN HEADER SMD 7POS 3MM	125V / 3A / 7Pin / 3.0mm / 180°	Molex
41	2	X101, X201	1X07 POS VERT TIN	Headers & Wire Housings 1X07 POS VERT TIN		TE Connectivity
42	8	X102, X103, X106, X107, X202, X203, X205, X206	Coaxial Connector	Ultra Small Surface Mount Coaxial Connector	100V / 10mA / 2Pin / 180°	Hirose Electric
43	2	X104, X204	2X07 POS VERT TIN	Headers & Wire Housings 2X07 POS VERT TIN		TE Connectivity
44	6	X105, X111, X113, X208, X212, X214	Header 3Pin Wuerth	3Pin Header Wuerth-180°	250V / 3A / 3Pin / 2.54mm / 180°	WE Würth Elektronik
45	4	X108, X109, X210, X211	Socket for banana plug	Socket for banana plug with insulating sleeve	1000V / 24A / 1Pin / 90°	Multi-Contact
46	4	X114, X115, X215, X216	BNC Socket 180°	BNC Socket 180°, 50Ohm	50Ohm / 180°	Rosenberger
47	2	X116, X217	1X4Pin, Pitch 2.54	Headers & Wire Housings 1X04 POS VERT TIN		TE Connectivity
48	1	X207	SCREW Terminal	SCREW Terminal M4	1Pin / 180°	Ninigi
49	4	X300, X301, X400, X401	1X15Pin, Pitch 2.54	Pin Header Receptacle for Nucleo Board		Samtec

Table 1 – Bill of Materials.

7 3D Image

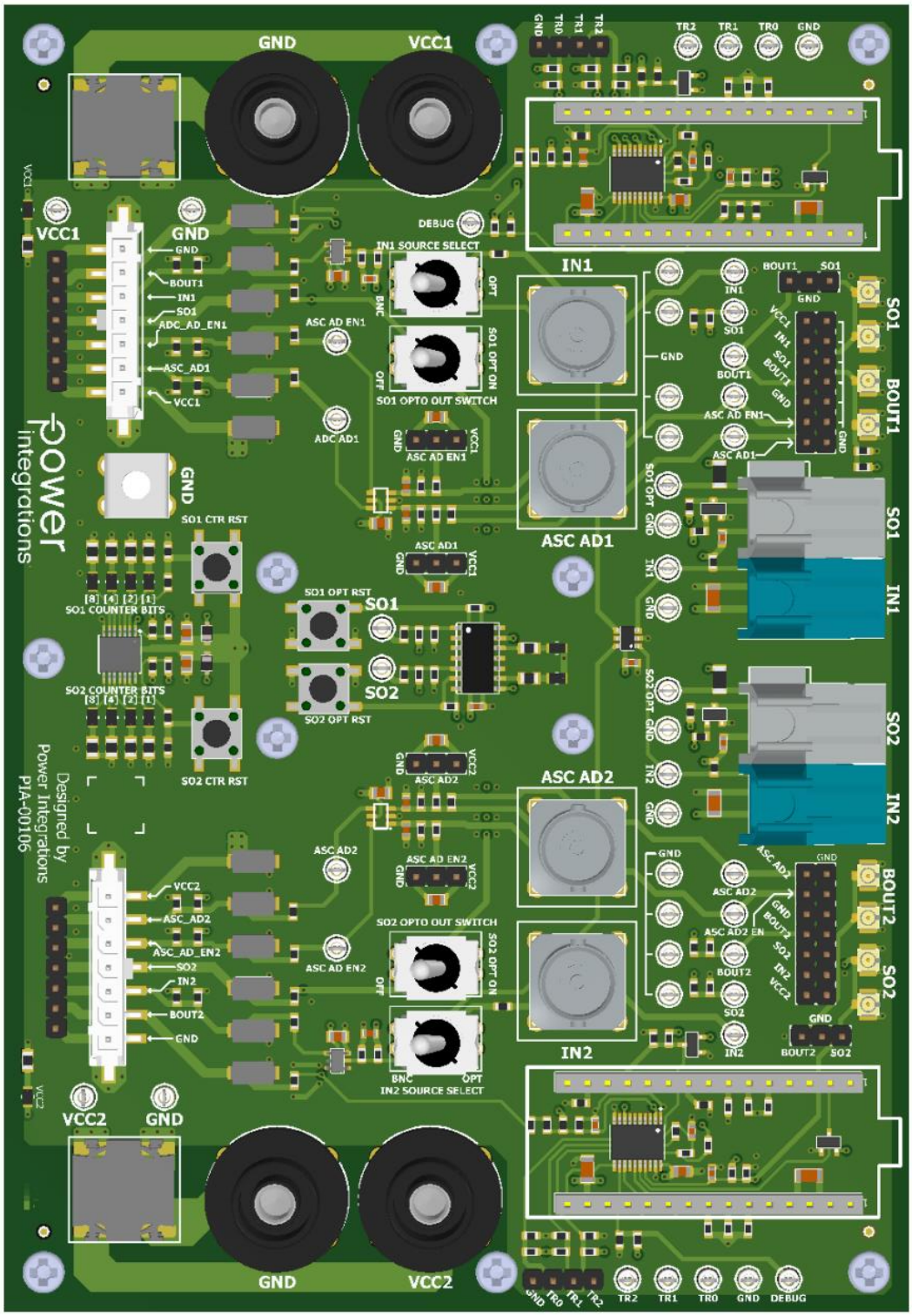


Figure 10 – Unit 3D Render (Top).

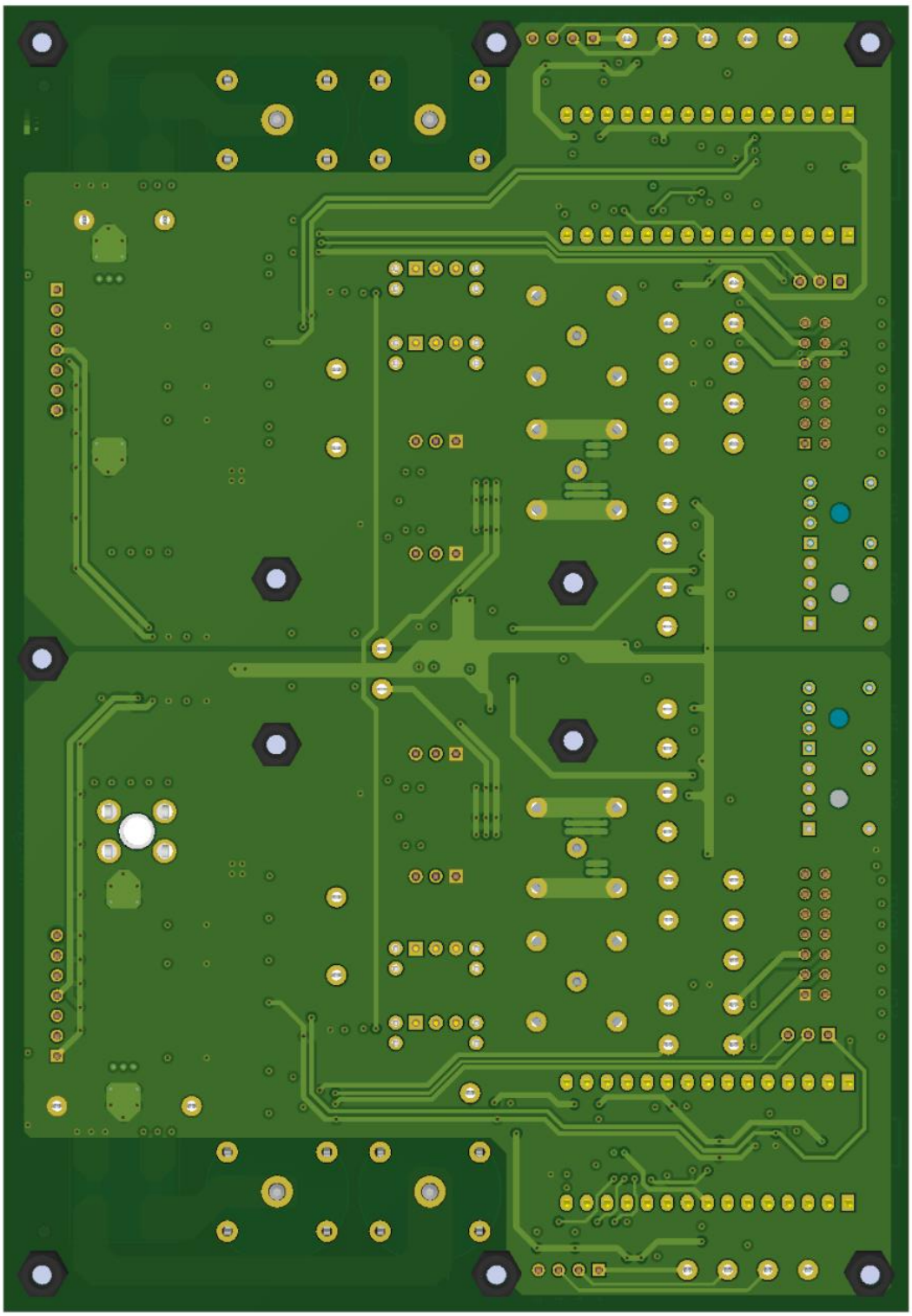


Figure 11 – Unit 3D Render (Bottom).

8 I / O Connector Details

8.1 Bottom Channel Connectors

Bottom Channel Gate Driver Connectors			
Connector	**Pin #**	**Symbol**	**Function**
X100	1	GND	Interface Connector to Gate Driver Board Mates with Molex 0436450700
	2	B_OUT1	
	3	IN1	
	4	SO1	
	5	ASC_AD_EN1	
	6	ASC_AD1	
	7	VCC_1	
X101	1	GND	Alternate Interface Connector to Gate Driver Board
	2	B_OUT1	
	3	IN1	
	4	SO1	
	5	ASC_AD_EN1	
	6	ASC_AD1	
	7	VCC_1	
X102	COAX	B_OUT1	Input micro-coaxial port for B_OUT1 Mates with Hirose UFL-2HF6-068N1T-AC-200
X103	COAX	SO1	Input micro-coaxial port for SO1 Mates with Hirose UFL-2HF6-068N1T-AC-200
X104	1	GND	Additional Pin Headers for General Purposes
	2	GND	
	3	B_OUT1	
	4	GND	
	5	ASC_AD1	
	6	GND	
	7	SO1	
	8	GND	
	9	ASC_AD_EN1	
	10	GND	
	11	IN1	
	12	GND	
	13	VCC1	
	14	GND	

X105	1	SO1	Additional Pin Headers for Bit stream signals
	2	GND	
	3	B_OUT1	
X106	COAX	SO1	Output micro-coaxial port for B_OUT1 Mates with Hirose UFL-2HF6-068N1T-AC-200
X107	COAX	B_OUT1	Output micro-coaxial port for SO1 Mates with Hirose UFL-2HF6-068N1T-AC-200
X108	BANANA	VCC_1	5V Supply Line
X109	BANANA	GND	Ground
X111	1	VCC1	ASC_AD_EN1 mode selection pins
	2	ASC_AD_EN1	
	3	GND	
X113	1	VCC2	ASC_AD1 mode selection pins
	2	ASC_AD1	
	3	GND	
X114	BNC	ASC_AD1	Input BNC port for ASC_AD1
X115	BNC	IN1	Input BNC port for IN1
X116	1	TR2	Bit stream Reader Trigger Outputs
	2	TR1	
	3	TR0	
	4	GND	
S101	1	IN1_OPT	IN1 source selection switch (fiber optic or BNC)
	2	IN1	
	3	IN1_BNC	
S102	1	SO1_OPT	SO1 fiber optic output enable switch
	2	SO1	
	3	GND	

Table 2 – Connector Details (Bottom Channel).

8.2 Top Channel Connectors

Top Channel Gate Driver Connectors			
Connector	**Pin #**	**Symbol**	**Function**
X200	1	GND	Interface Connector to Gate Driver Board Mates with Molex 0436450700
	2	B_OUT2	
	3	IN2	
	4	SO2	
	5	ASC_AD_EN2	
	6	ASC_AD2	
	7	VCC_2	
X201	1	GND	Alternate Interface Connector to Gate Driver Board
	2	B_OUT2	
	3	IN2	
	4	SO2	
	5	ASC_AD_EN2	
	6	ASC_AD2	
	7	VCC_2	
X202	COAX	SO2	Input micro-coaxial port for SO2 Mates with Hirose UFL-2HF6-068N1T-AC-200
X203	COAX	B_OUT2	Input micro-coaxial port for B_OUT2 Mates with Hirose UFL-2HF6-068N1T-AC-200
X204	1	GND	Additional Pin Headers for General Purposes
	2	GND	
	3	B_OUT2	
	4	GND	
	5	ASC_AD2	
	6	GND	
	7	SO2	
	8	GND	
	9	ASC_AD_EN2	
	10	GND	
	11	IN2	
	12	GND	
	13	VCC2	
	14	GND	
X205	COAX	SO2	Output micro-coaxial port for SO2 Mates with Hirose UFL-2HF6-068N1T-AC-200
X206	COAX	B_OUT2	Output micro-coaxial port for B_OUT2 Mates with Hirose UFL-2HF6-068N1T-AC-200
X207	SCREW TERMINAL	GND	M4 Screw Terminal for Earth Connection
X208	1	SO2	Additional Pin Headers for Bit stream signals
	2	GND	
	3	B_OUT2	
X210	BANANA	VCC_2	5V Supply Line
X211	BANANA	GND	Ground

X212	1	VCC2	ASC_AD_EN2 mode selection pins
	2	ASC_AD_EN2	
	3	GND	
X214	1	VCC2	ASC_AD2 mode selection pins
	2	ASC_AD2	
	3	GND	
X215	BNC	ASC_AD2	Input BNC port for ASC_AD2
X216	BNC	IN2	Input BNC port for IN2
X217	1	TR2	Bit stream Reader Trigger Outputs
	2	TR1	
	3	TR0	
	4	GND	
S201	1	IN2_OPT	IN2 source selection switch (fiber optic or BNC)
	2	IN2	
	3	IN2_BNC	
S202	1	SO2_OPT	SO2 fiber optic output enable switch
	2	SO2	
	3	GND	

Table 3 – Connector Details (Top Channel).

9 Interface Connector to Gate Driver Board

It is highly recommended to use X100 / X200 and X101 / X201 as the interface connector to a gate driver board especially during high voltage tests. These connectors have TVS diodes in parallel (Figure 12) as a protection of the adapter board for sudden high voltage transient.

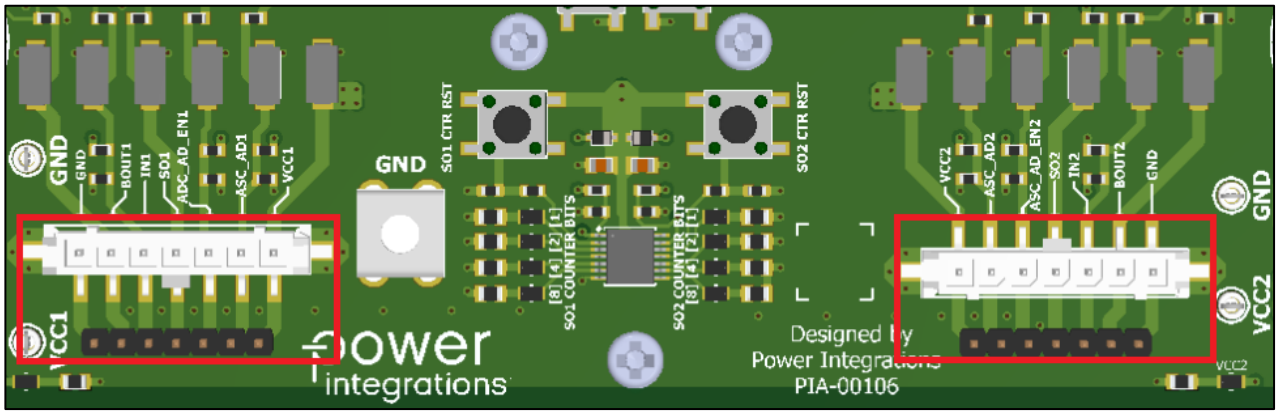


Figure 12 – Interface Connectors.

10 ASC_AD and ASC_AD_EN Mode Selection Pins

Mode selection pins are provided for both ASC_AD (X214 / X113) and ASC_AD_EN (X212 / X111) lines. This is a standard three pin header (Figure 13) where the middle pin can either be shorted to VCC or GND using a 2-pin jumper (Figure 14).

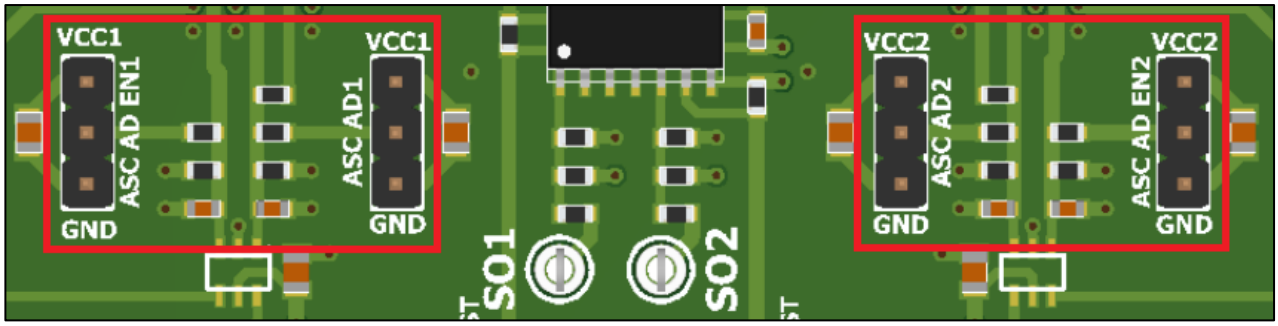


Figure 13 – ASC_AD and ASC_AD_EN Mode Selection Pins.

Figure 14 – 2-Pin Jumper.

11 Fiber Optic Interface

The adapter board includes fiber optic interface for PWM IN and SO signals (Figure 15). This can be utilized using fiber optic cable HFBR-RNS001Z (Figure 16).

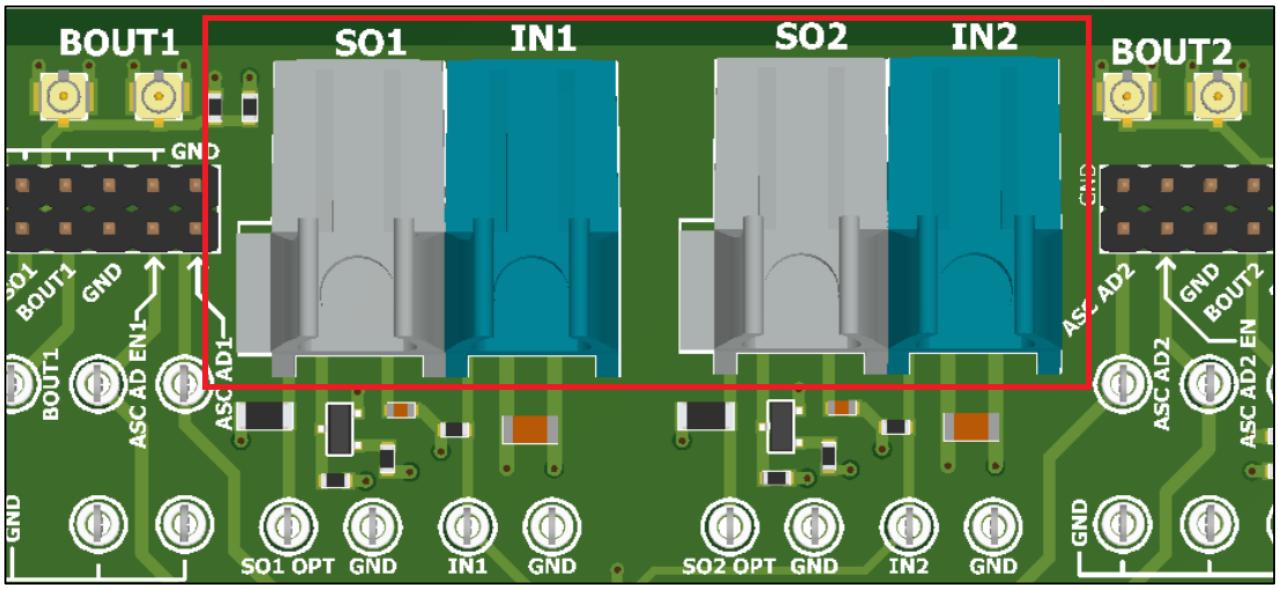


Figure 15 – Fiber Optic Interface.

Figure 16 – Fiber Optic Cable: HFBR-RNS001Z.

12 PWM Signal IN Source Select

The adapter board provides two options (via Fiber Optic or BNC) for the PWM signal IN. This can be selected using switch S101 / S201 as shown in Figure 17.

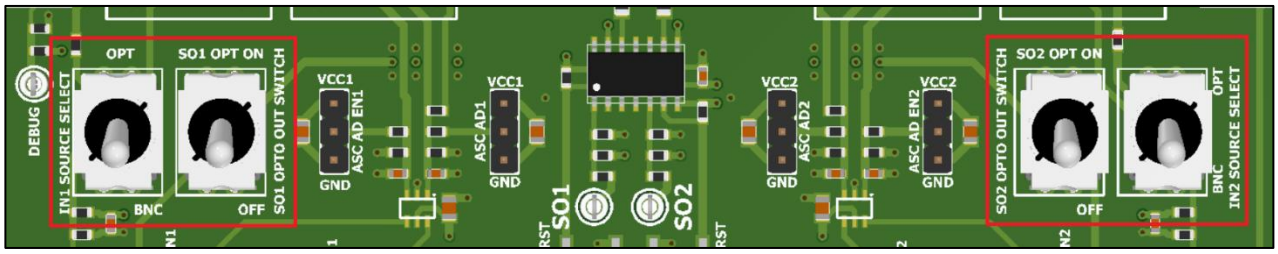


Figure 17 – Fiber Optic Selection Switch.

13 SO Output Select

The adapter board also provides an additional fiber optic output for the SO signal. This can be selected using switch S102 / S202 as shown in Figure 17. Make sure that the LED indicators D110 / D210 (Figure 18) are OFF prior to each test. This can be done using the reset buttons S100 / S200 (Figure 18). When an SO fault is detected, the circuit latches the LED indicator HIGH (fiber optic line LOW). As such, the circuit is a single fault event. A SO fault counter is also included in this board to provide the number of SO fault event.

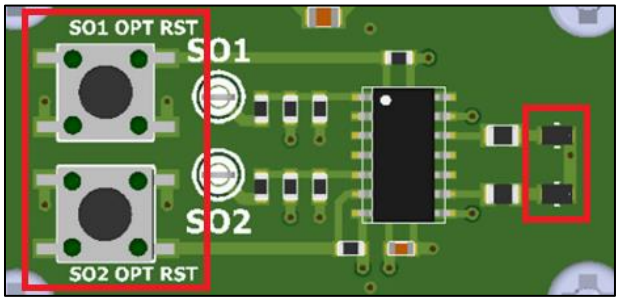


Figure 18 – SO Single Fault Trigger.

14 Earth Grounding Connection

An M4 screw terminal is provided for earth ground connection of the adapter board as shown in Figure 19.

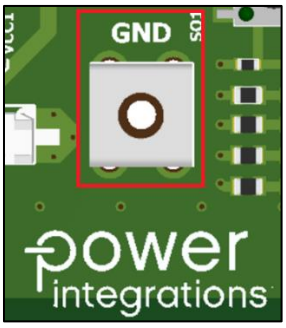


Figure 19 – M4 Screw Terminal for Earth Grounding.

15 SO Fault Counter

The adapter board features a 4-bit SO fault counter for each channel. D302-305 for the top channel and D306-309 for the bottom channel with D305 and D309 as its respective LSB (Figure 20). Each LED represents a bit with its ON state as logic '1'. Given the number of bits, the counter has a maximum count of 16. Switch S300 and S301 are reset buttons for the respective counter (Figure 20).

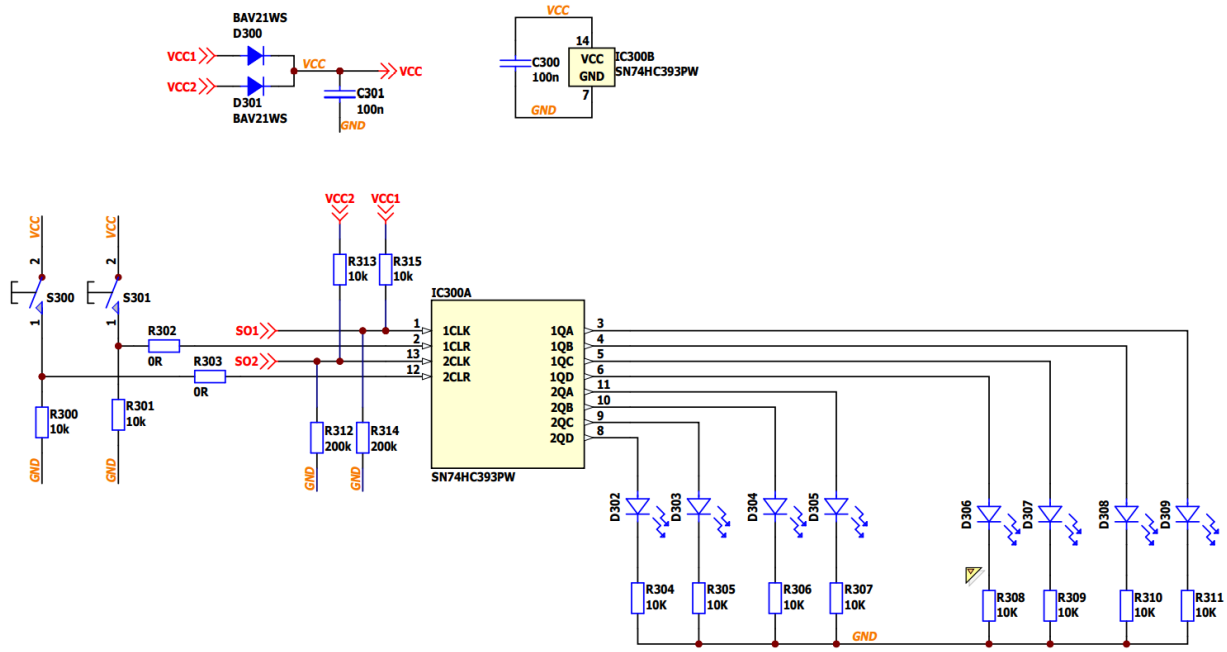


Figure 20 – SO Fault Counter Circuit Schematic.

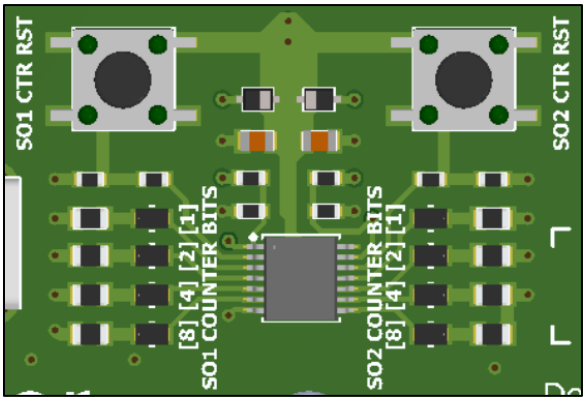


Figure 21 – SO Fault Counter.

16 Bit Stream User Manual

16.1 Failure and Status Monitoring of SCALE-iDriver2 IC

The gate driver IC used on SCALE EV boards features failure and status monitoring via a bit stream (B_OUT), containing status and measurement data, plus a dedicated fault pin (SO). This configuration allows an interrupt to be generated, via the SO pin on a fault, ensuring the status is read and immediately addressed by the system.

The information of the B_OUT frame consists of a Start Bit Logic High, 27 Payload bits and 1 Stop bit. Prior to the Start Bit a series of Logic Low bits (B_OUT[idle]) are sent. The number of idle bits is not fixed and is defined by the asynchronous frame time t_{B_OUT} minus the time required for the transmission of the Start Bit, Pay Load bits and the Stop Bit.

Idle Bits	B_OUT Frame			
	Start Bit	Pay Load Word		Stop Bit
		A / D Temperature Signal	Diagnostic and Monitoring Information	
B_OUT[idle]	B_OUT[1]	B_OUT[2:13]	B_OUT[14:28]	B_OUT[29]

The definition of a logic low or high condition of B_OUT bits is determined by the pulse width as shown.

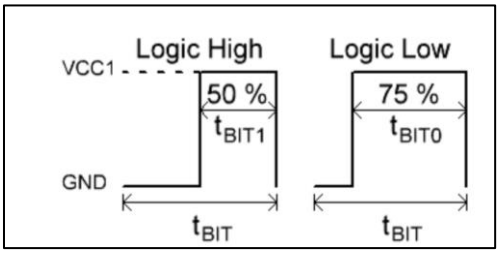


Figure 22 – Logic High and Low of B_OUT bits.

Refer to the SCALE EV Family data sheet for details of status feedback and temperature measurement.

16.2 **Installation Guide**

Below are the steps for installing the software (Note: Administrator permission may be required):

1. Download the SIC2192_Reader.msi file, then right-click to **Install**

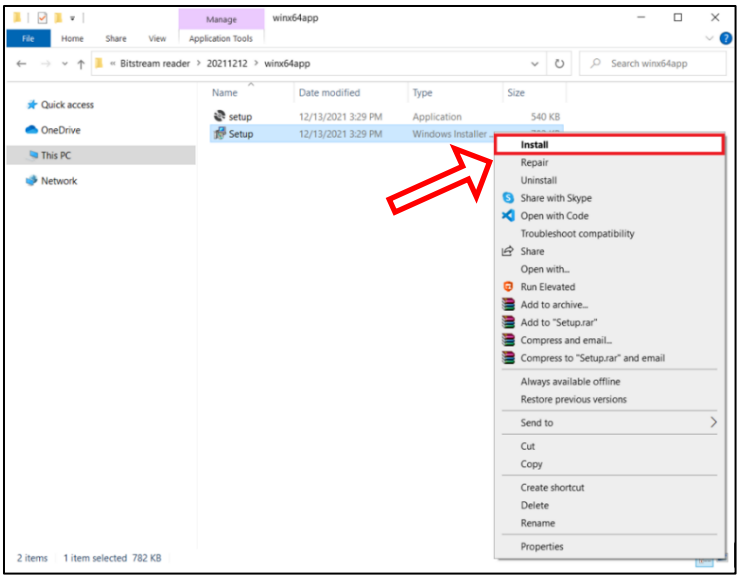


Figure 23 – Bit Stream Software Installer.

2. A setup wizard will open, click **Next**

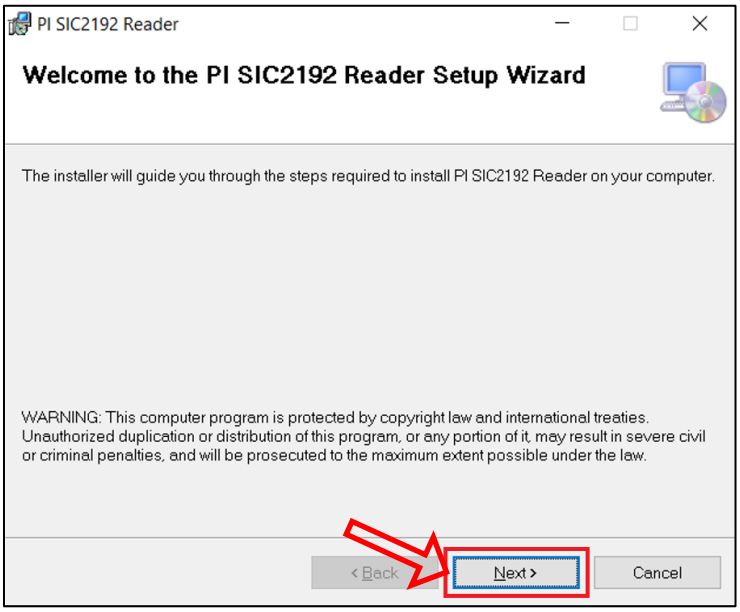


Figure 24 – Installer Setup Wizard: Welcome Screen.

3. Select installation directory, then click **Next**

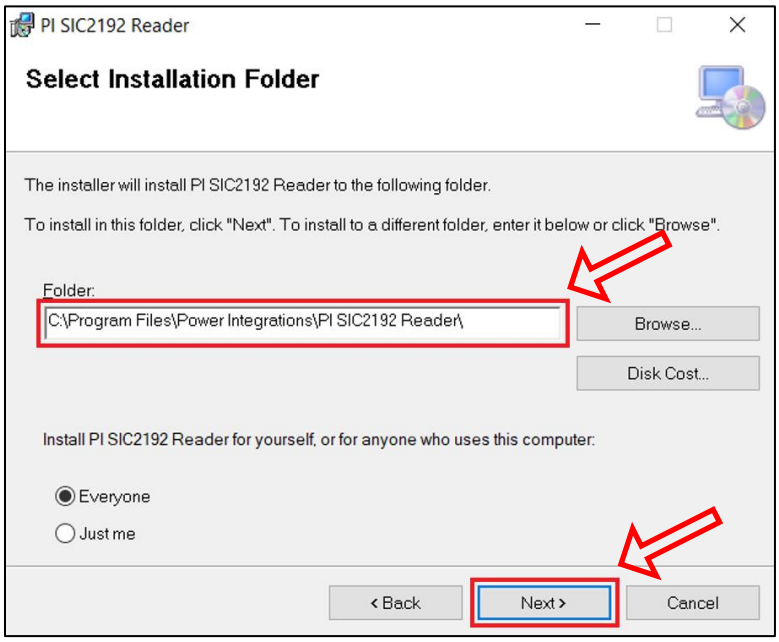


Figure 25 – Installer Setup Wizard: Select Installation Folder.

4. Click **Next** to start the installation

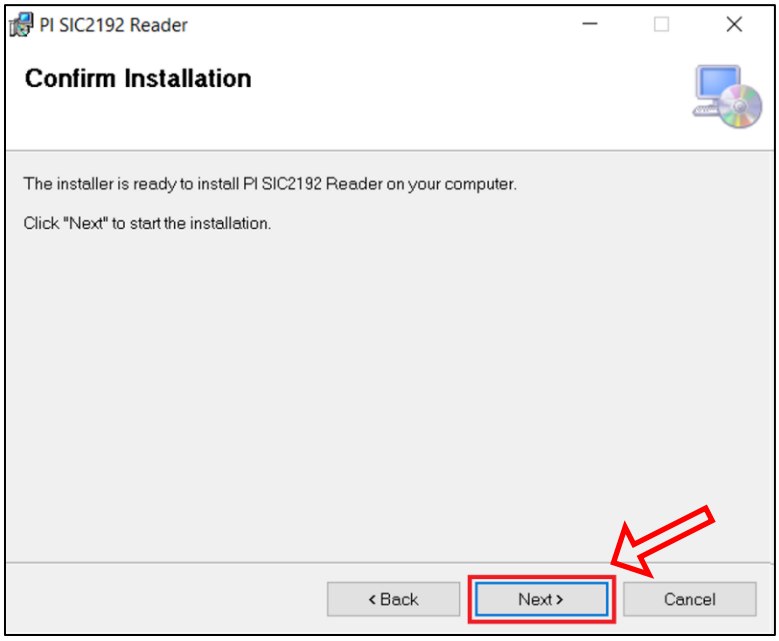


Figure 26 – Installer Setup Wizard: Confirm Installation.

5. Wait for the installation to complete

6. A confirmation will appear upon successful installation, click **Close** to finish

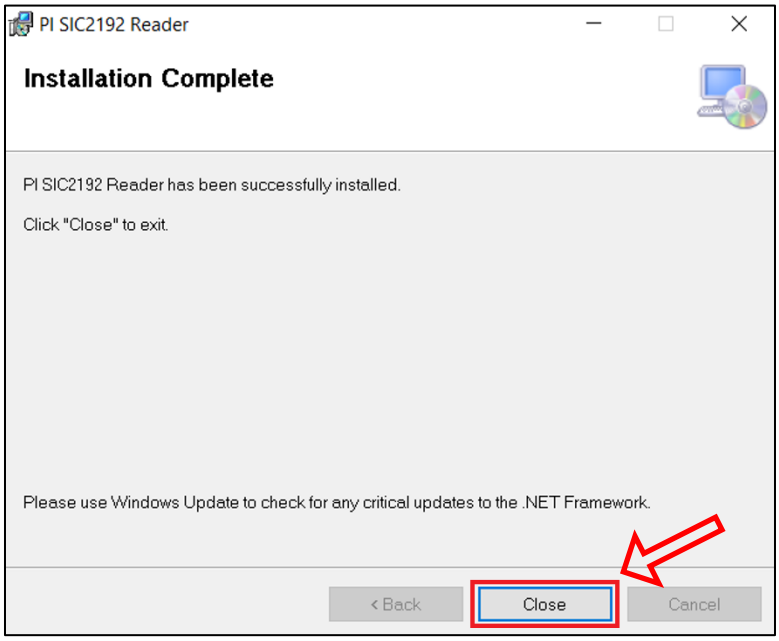


Figure 27 – Installer Setup Wizard: Installation Complete.

7. Bit Stream Reader software installation is done.

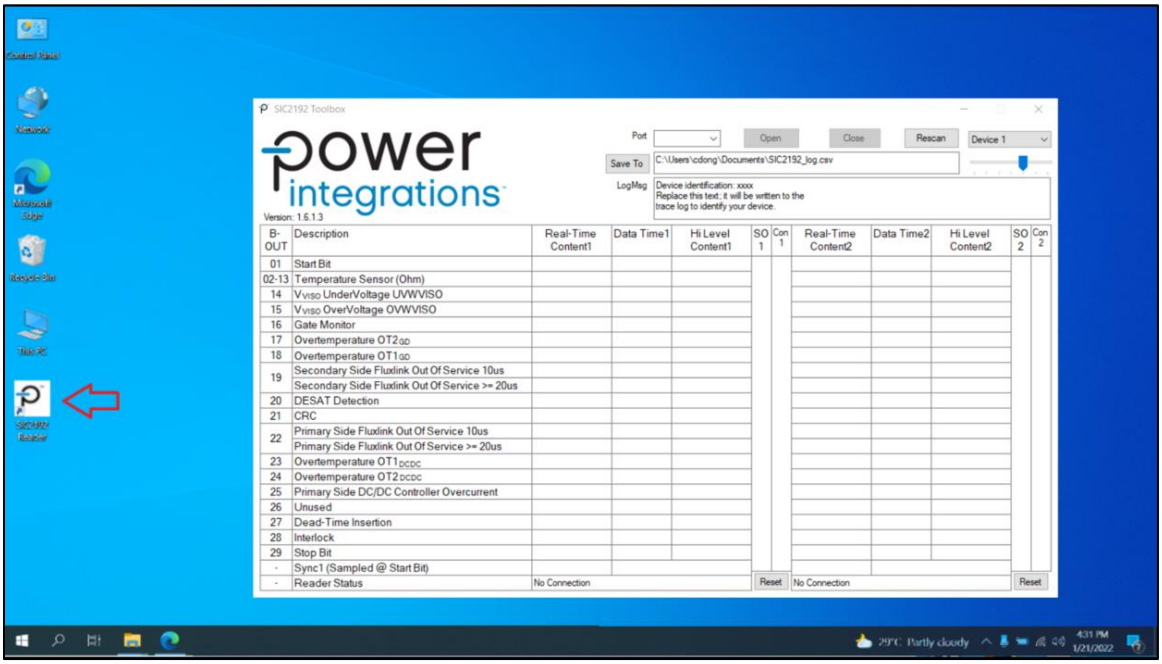


Figure 28 – Bit Stream Reader Software.

16.3 Bit Stream Reader Hardware

16.3.1 Microcontroller Module

The reader uses an STM32 Nucleo-32 development board with STM32L432KC µC as its data processing unit. Since the reader may be susceptible to certain interference / power supply drops, the on board RESET button (B1) allows to re-start the firmware at any time. Additional required modification from the standard Nucleo-32 development board is to short SB17 as shown below.

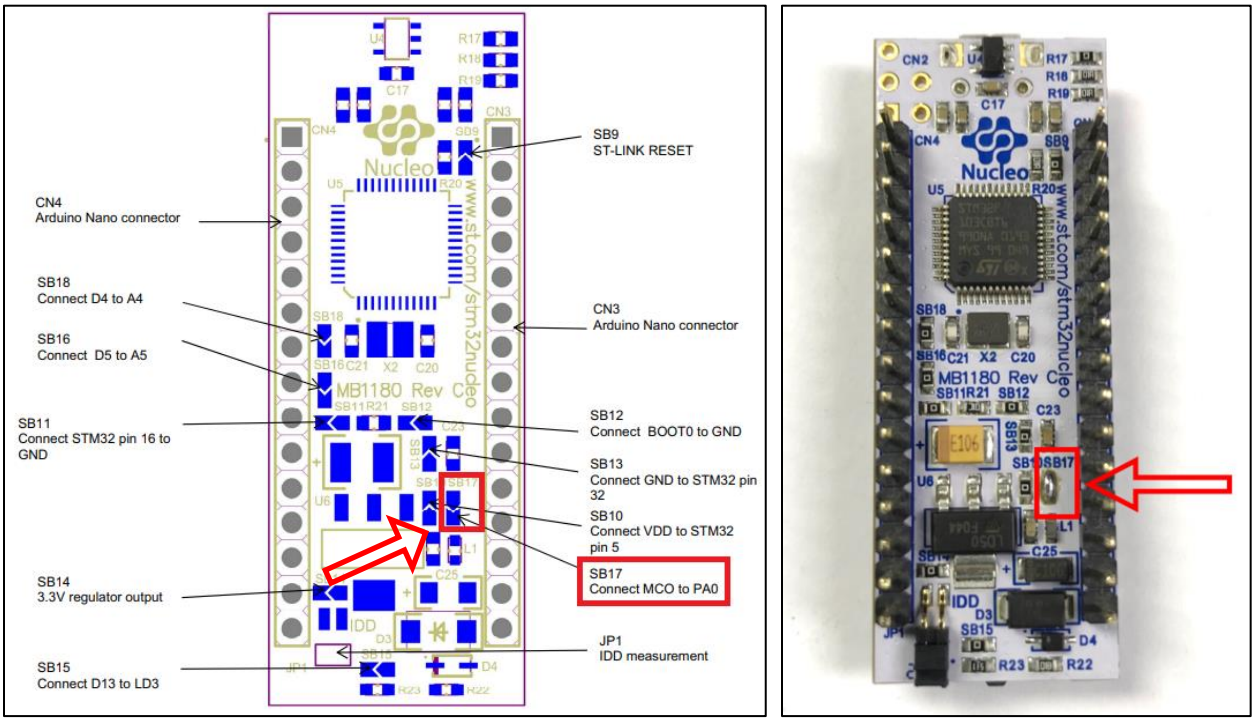


Figure 29 – Required Modification: Short SB17.

16.3.2 Trigger Output Signals

The reader has 3 trigger outputs with the following functionalities:

- TR0 is high during a B_OUT frame reception.
- TR1 is briefly high when a fault / warning is active in the received B-OUT frame.
- TR2 is briefly high if a CRC error is detected in the received B-OUT frame.

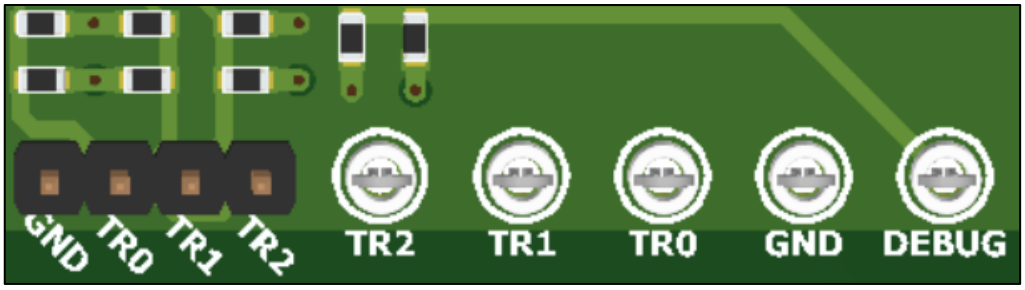


Figure 30 – Bit Stream Reader Triggers.

These triggers can be utilized when analyzing a bit stream frame, fault / warning or CRC error event using an oscilloscope. This can be done by probing the desired trigger to an oscilloscope channel. The signal can then be set as the signal trigger source with a signal level of around 1.5 V and rising edge polarity. In addition, single acquisition mode can be used on TR1 and TR2 to detect an occurrence of a fault, warning or CRC error. Note that TR1 and TR2 will be high about 160ms after a frame is received. This is the time the microcontroller module needs to process the received data.

As an example, TR0 can be utilized to analyze a B_OUT frame as shown in the snapshot.

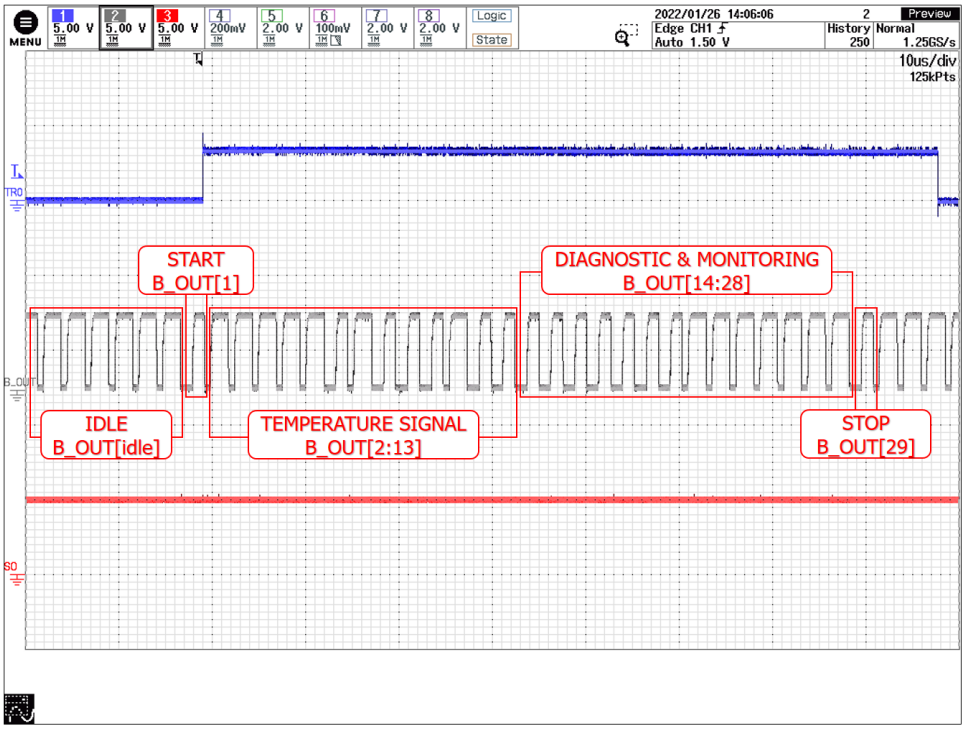


Figure 31 – Oscilloscope Snapshot of B_OUT and SO with TR0 as trigger source.

16.3.3 Hardware Usage

Below are the steps for setting up the bit stream reader connection:

1. Connect the reader to the PC via a **USB Cable Type A to Micro B**. Make sure that the USB cable has a data line and is not just a power cable.

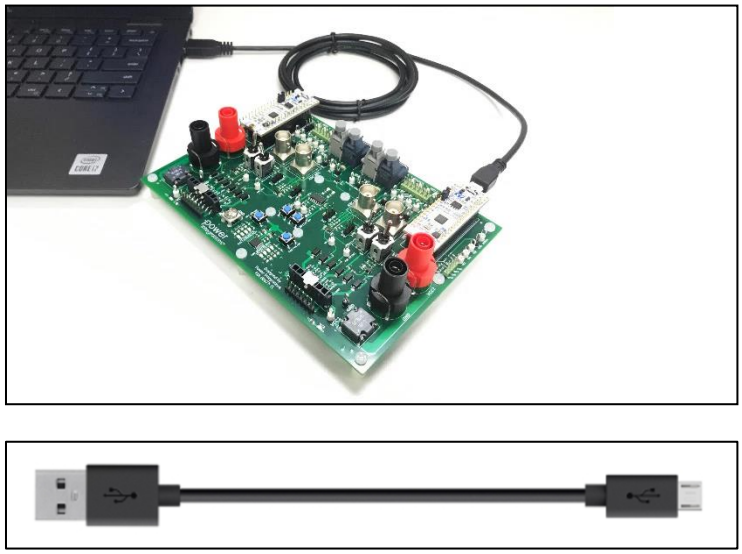
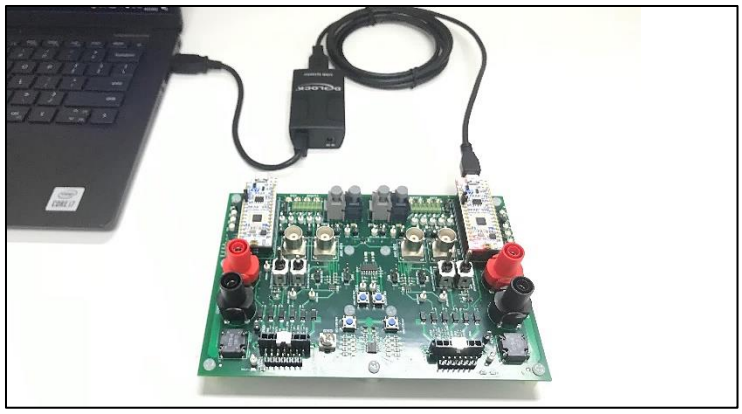


Figure 32 – USB Cable Type A to Micro B.

When performing high voltage tests on the SCALE EV gate drive board, it is highly recommended to use a **USB Isolator** as an additional safety for the PC USB port. As an example, 62588 Delock USB Isolator with 5 kV Isolation[1] can be used for this application.



[1] https://www.delock.de/produkte/G_62588/merkmale.html?setLanguage=en

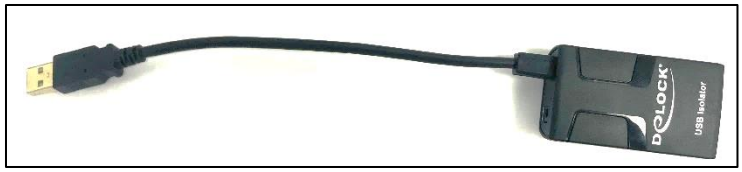


Figure 33 – Delock USB Isolator (Part Number: 62588).

2. The respective SO and B_OUT signals are already connected to the reader once the interface connectors X100 / X200 and X101 / X201 are used (refer to section 9). An additional option for a micro coaxial input and output port is also provided on the adapter board. As an example, UFL-2HF6-068N1T-AC-200 Hirose micro coaxial cable[2] can be used for this application.

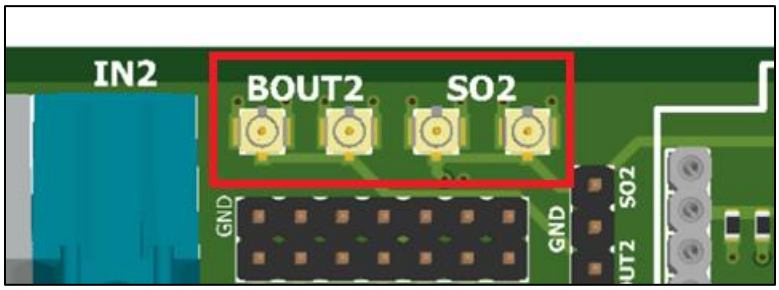


Figure 34 – Alternate Micro-coaxial Input and Output ports.

Figure 35 – U.FL Micro Coaxial Cable (Part Number: UFL-2HF6-068N1T-AC-200).

3. Hardware set-up is ready for use.

[2] https://www.hirose.com/product/p/CL0321-0573-0-18

16.4 **Bit Stream Reader Software**

16.4.1 Software Details

This section provides a detailed description for the functionality of each component of the reader software interface. Refer to Figure 36 for the item number.

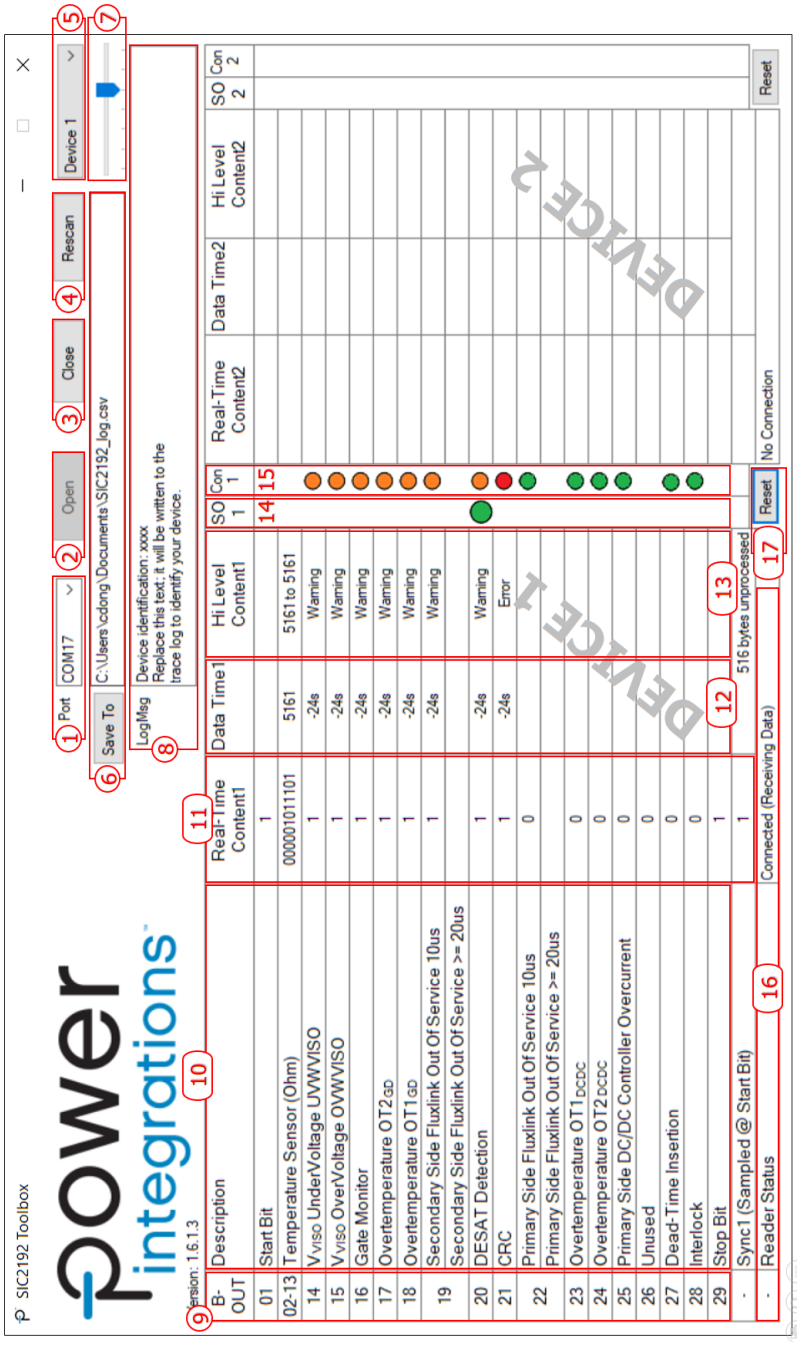


Figure 36 – Bit Stream Reader Software User Interface.

Item	Name	Details
1	Port	List of all available COM port on the PC. This is used to choose the appropriate COM port assigned to the bit stream reader. A maximum of 2 readers can be simultaneously connected in the software
2	Open	Button to connect the software to the selected COM port of the reader. This will open the connection to the reader and start the data acquisition and logging.
3	Close	Button to disconnect the communication and stop the data acquisition and logging from the selected COM port of the reader.
4	Rescan	Button to refresh all available COM ports in the port list. This can be used if a desired COM port does not reflect in the list.
5	Device	Assigns the selected device number to the COM port to be opened. This device identification will be used in the data log. It will also determine which device panel to display the data in the software user interface.
6	Save Settings	This is used to select the target directory and set the filename for logging. By default, the filename is set to *SIC2192_log.csv* and is saved in the local documents folder. Both devices can log in the same file. If a separate log file is needed for the 2nd reader, the save settings should be set accordingly before connecting the 2nd reader.
7	Screen Update	Slider to change the screen update time of the software user interface (slide to the left for faster refresh rate).
8	Log Message	Text box for additional information to be included at the beginning of the log file.
9	B_OUT	Bit number (1 to 29).
10	Description	Description of each B_OUT bit.
11	Real-Time Content	This column shows the latest received value of each bit. Note that the screen update time is much slower compared to the device's transmission rate. As such, the contents in this column may be delayed.
12	Data Time	The Data Time column shows the following: - The current NTC resistance value (temperature reading) - Blank if no fault / warning is detected since the start or latest Reset - Time elapsed since a fault / warning was detected under the following conditions: ○ If the time indicator resets continuously this means that the fault / warning is still active.

<table>
<tr><td></td><td></td><td>o If an increasing time indicator is shown this means that a fault / warning was detected in the past but is now resolved</td></tr>
<tr><td>13</td><td>High Level Content</td><td>The High Level Content column shows:
- Minimum and maximum NTC resistance value (temperature reading) since the connection was established or the reset was pressed
- “Warning” or “Error”, depending on the type of fault detected</td></tr>
<tr><td>14</td><td>SO Status</td><td>Virtual LED: Green indicates high SO were detected since the last screen update. Red indicates low SO was detected.</td></tr>
<tr><td>15</td><td>Content</td><td>Virtual LED: Green indicates normal operation (no fault / warning detected). Orange indicates a recent warning and red for recent error.</td></tr>
<tr><td>16</td><td>Reader Status</td><td>Shows one of the following messages:
<table>
<tr><td>No Connection</td><td>No open connection to a reader</td></tr>
<tr><td>Connected (Receiving Data)</td><td>Successful connection to a reader. Data is received</td></tr>
<tr><td>Connected (No Data received since Start / Reset)</td><td>No B_OUT data received after opening connection or pressing reset.</td></tr>
<tr><td>Connected (No Data available at this time)</td><td>No new B_OUT data received</td></tr>
<tr><td>Connected (Record Out Of Sync)</td><td>No sync / start bit detected.</td></tr>
</table></td></tr>
<tr><td>17</td><td>Reset</td><td>Refreshes all contents (data and timer) in the corresponding device’s panel display. The received data and logging is not affected by pressing this button.</td></tr>
</table>

16.4.2 Software Usage

Below are the steps for using the bit stream reader software.

1. Open **Device Manager** to check the assigned COM port for the bit stream reader

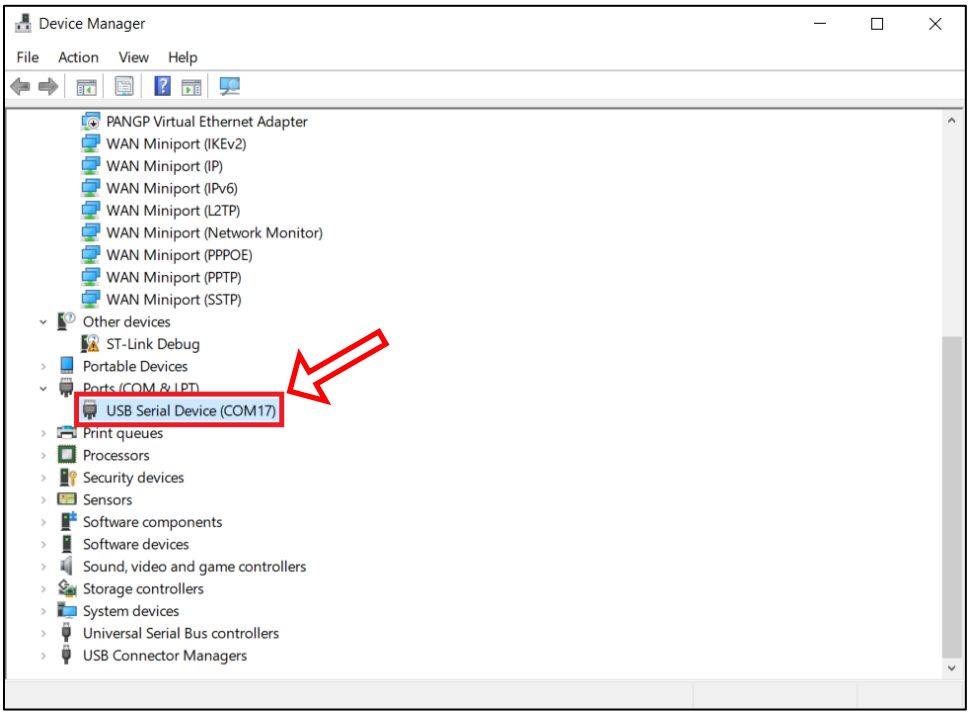


Figure 37 – Device Manger.

2. **Open** the bit stream reader software.

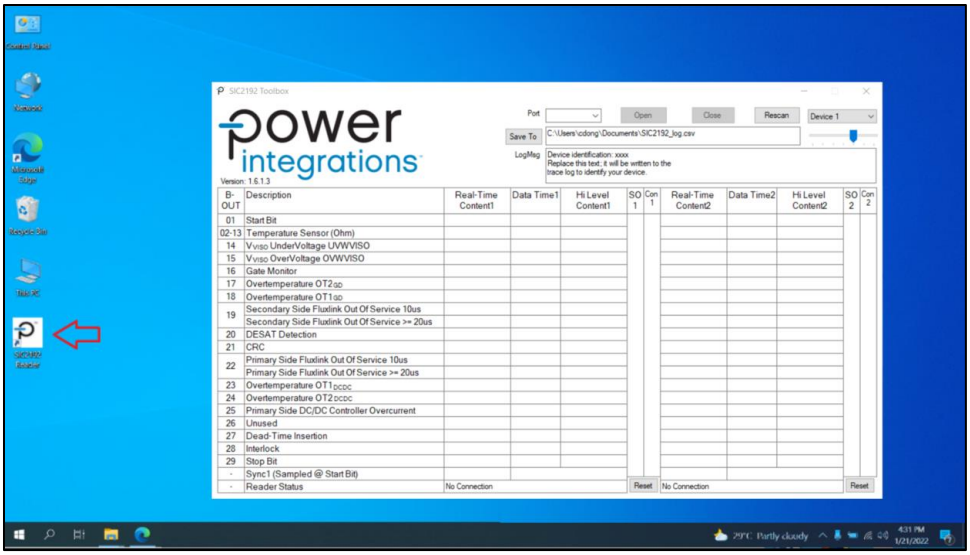


Figure 38 – Bit Stream Software.

3. Assign a **Device Number**

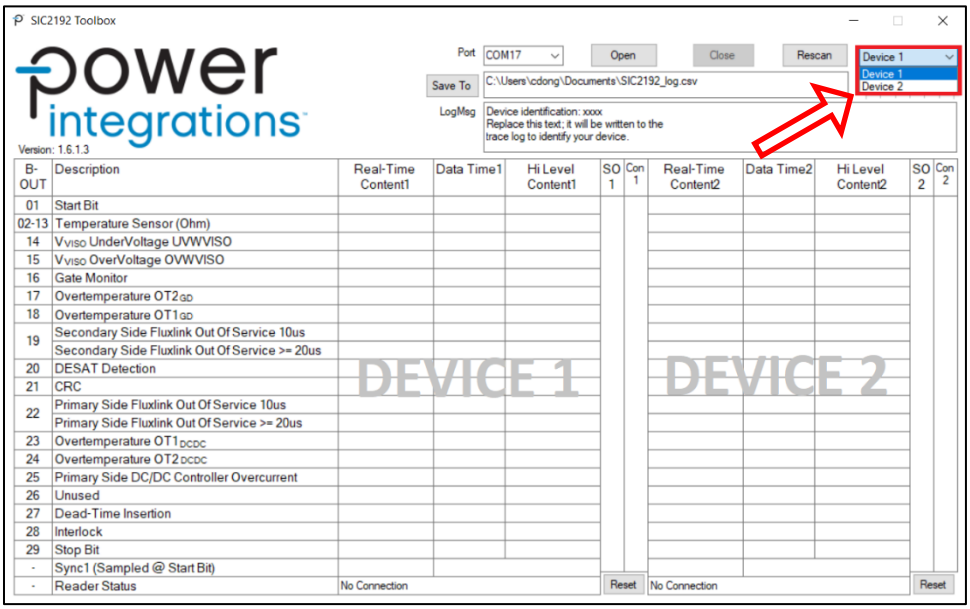


Figure 39 – Bit Stream Software: Device Selection.

4. Click **Save To** to modify the filename and folder directory of the log file. By default, the filename is set to *SIC2192_log.csv* and is saved in the local documents folder.

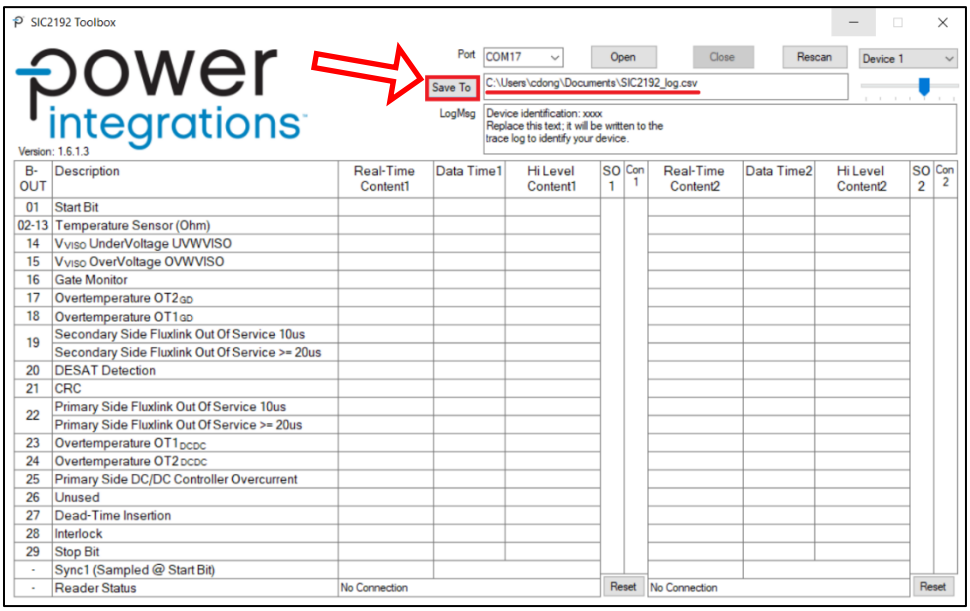


Figure 40 – Bit Stream Software: Save Settings.

5. **Log Message / Information** that will be included at the beginning of the log file may be provided through this text box.

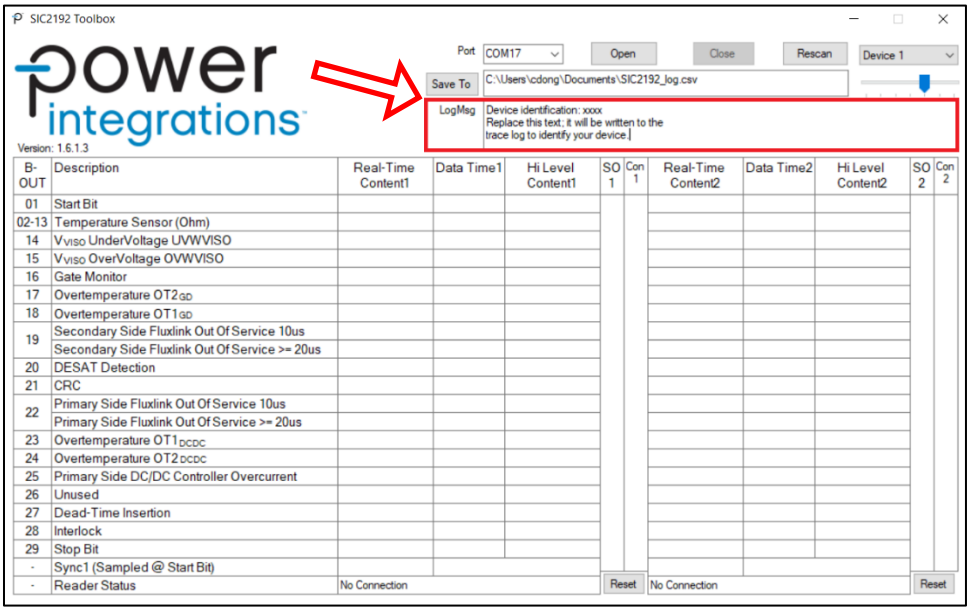


Figure 41 – Bit Stream Software: Log Message.

6. Choose the COM **Port** assigned to the bit stream reader. If the COM port is not in the list, click **Rescan**.

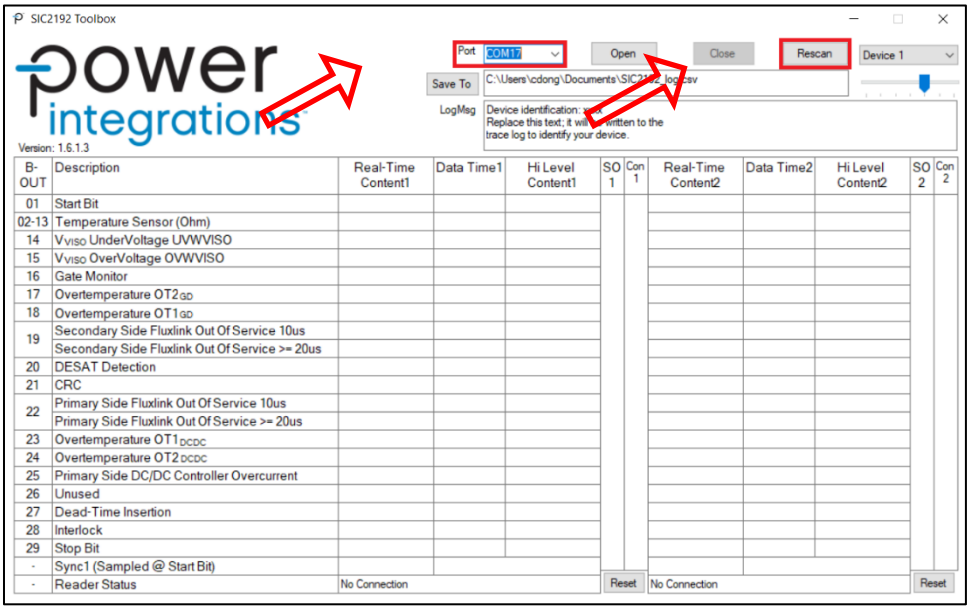


Figure 42 – Bit Stream Software: Port Selection.

7. Click **Open** to start connection.

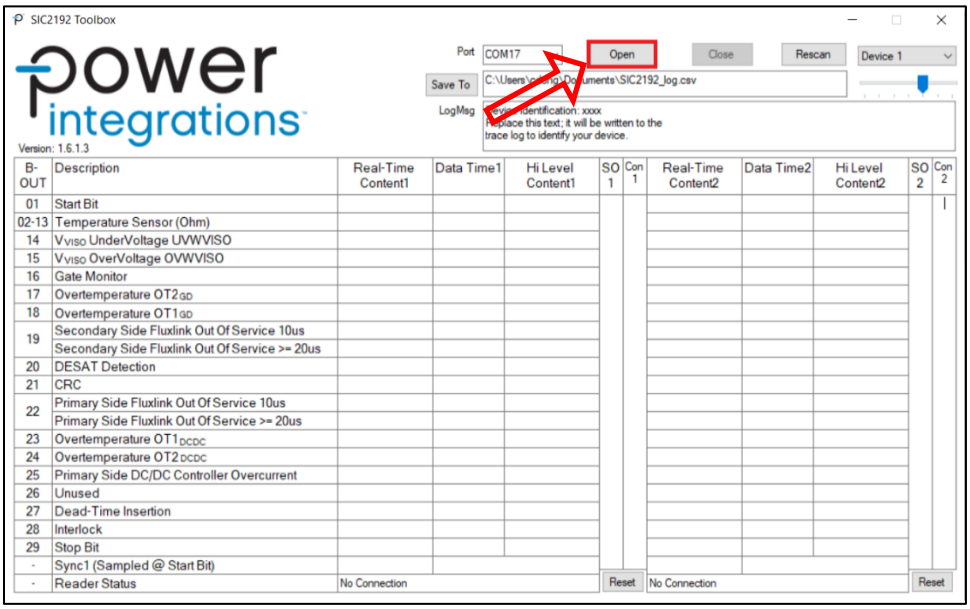


Figure 43 – Bit Stream Software: Open Connection.

8. An overwrite prompt may appear if the chosen log filename already exists. Click **Yes** to abort the connection or click **No** to overwrite the existing file and continue connection.

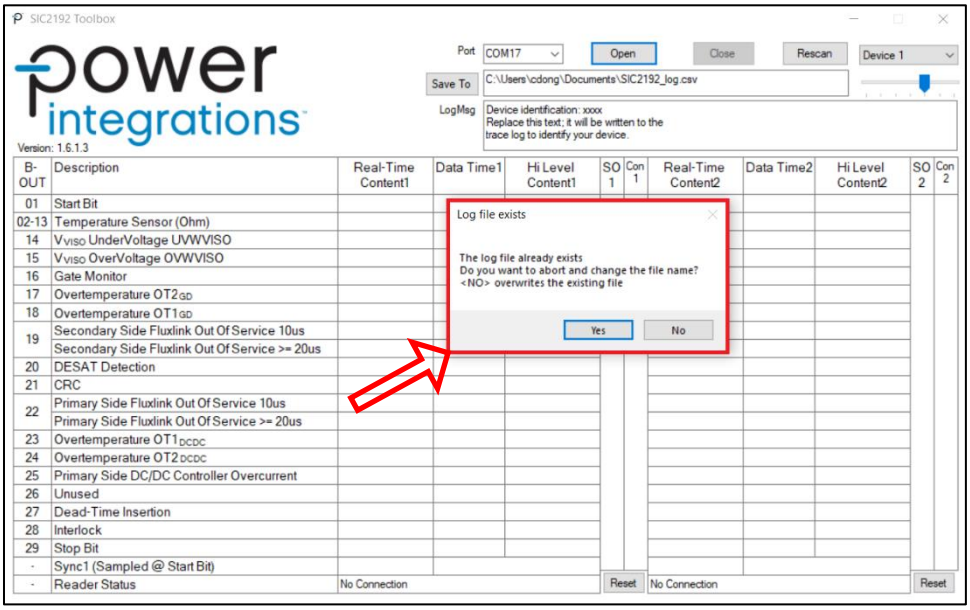


Figure 44 – Bit Stream Software: Overwrite Prompt.

9. Reader status must show **Connected (Receiving Data)** upon successful connection. Data is now being logged to the CSV file.

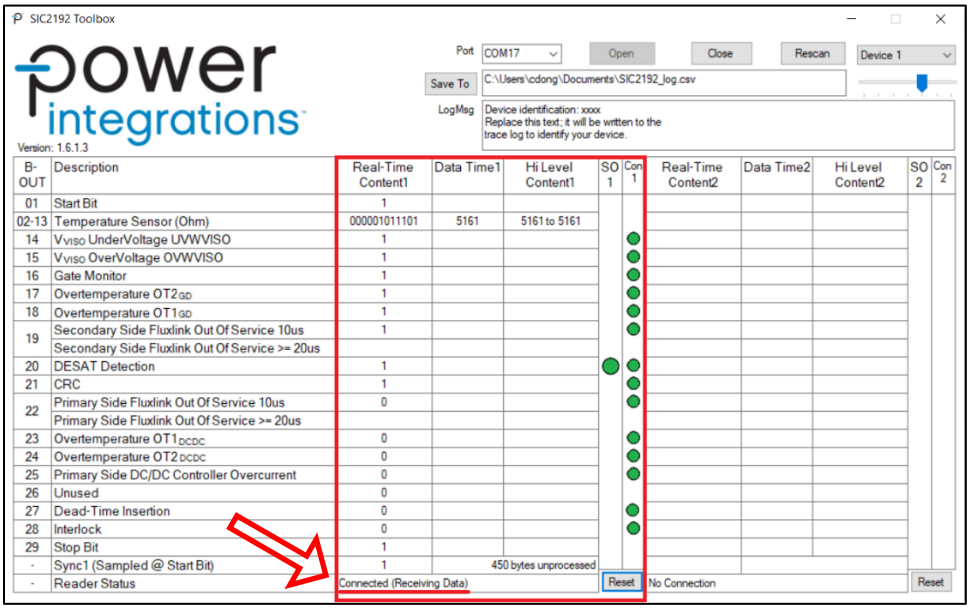


Figure 45 – Bit Stream Software: Successful Connection.

10. A fault may be simulated (e.g. VISO Under Voltage Warning by setting $V_{VISO-COM}$ = 12 V at IGBT Mode 1) to verify the connection.

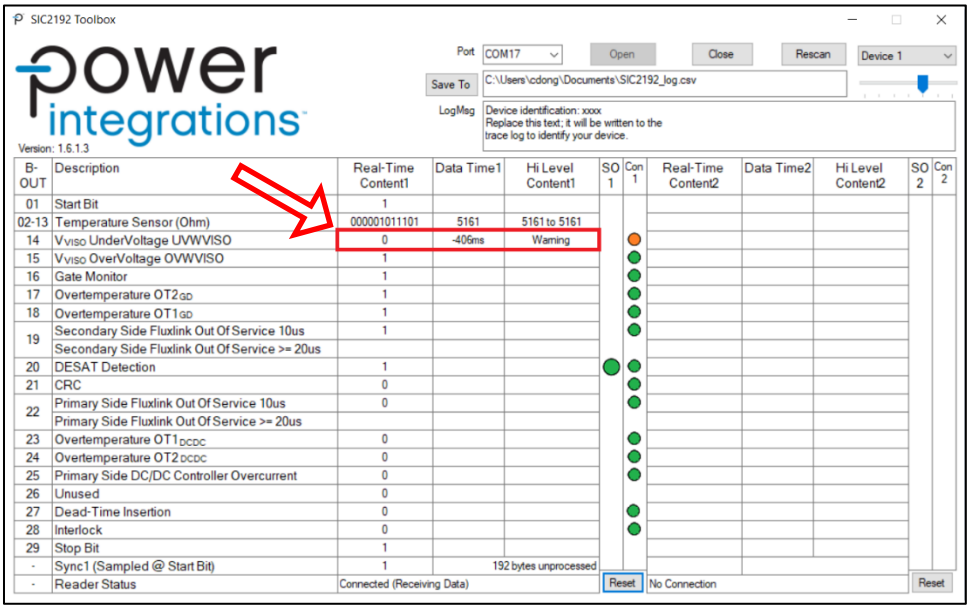


Figure 46 – Bit Stream Software: Fault Simulation.

11. Make sure to **Close** the connection every after test to avoid errors in logging.

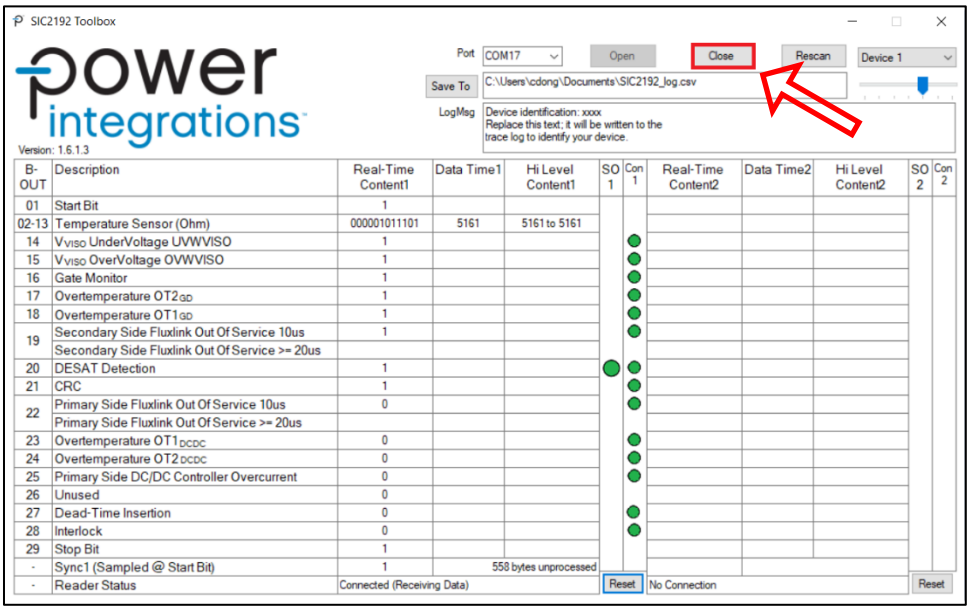


Figure 47 – Bit Stream Software: Close Connection

12. The same steps will apply when using the device 2 panel. Simply choose **Device 2** on step 3.

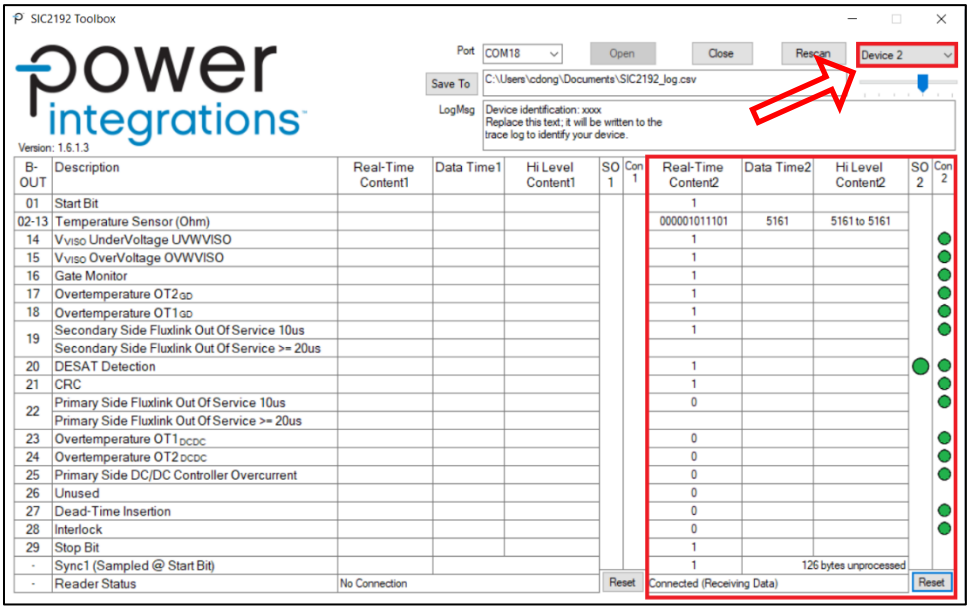


Figure 48 – Bit Stream Software: Device 2

16.5 **Firmware Update**

In case a firmware update becomes available, follow the steps below to re-flash the Bit Stream Reader hardware via ST-LINK Utility[3]:

1. Open ST-LINK Utility and connect the Bit Stream Reader to the PC via USB

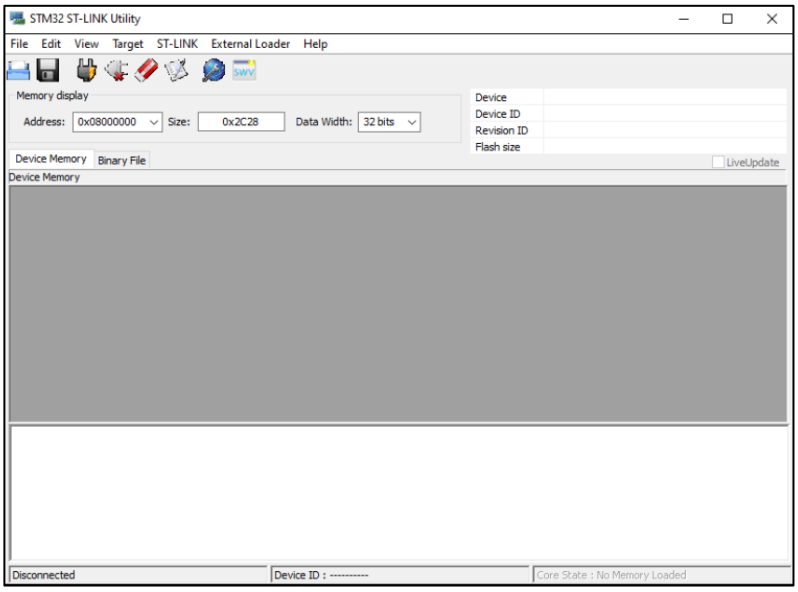


Figure 49 – ST LINK Utility.

2. Click File -> **Open File**

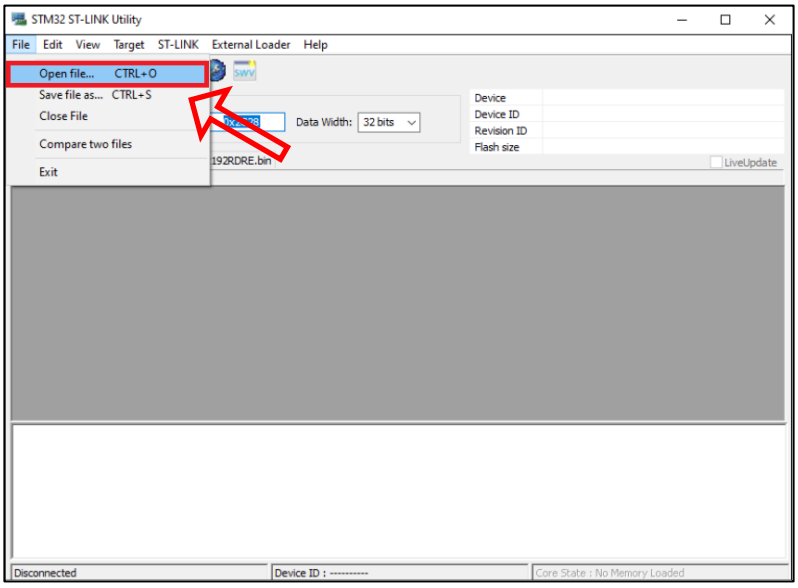


Figure 50 – ST LINK Utility: Open File.

[3] Download and install at: https://www.st.com/en/development-tools/stsw-link004.html

3. Browse for the new FW file, then click **Open**

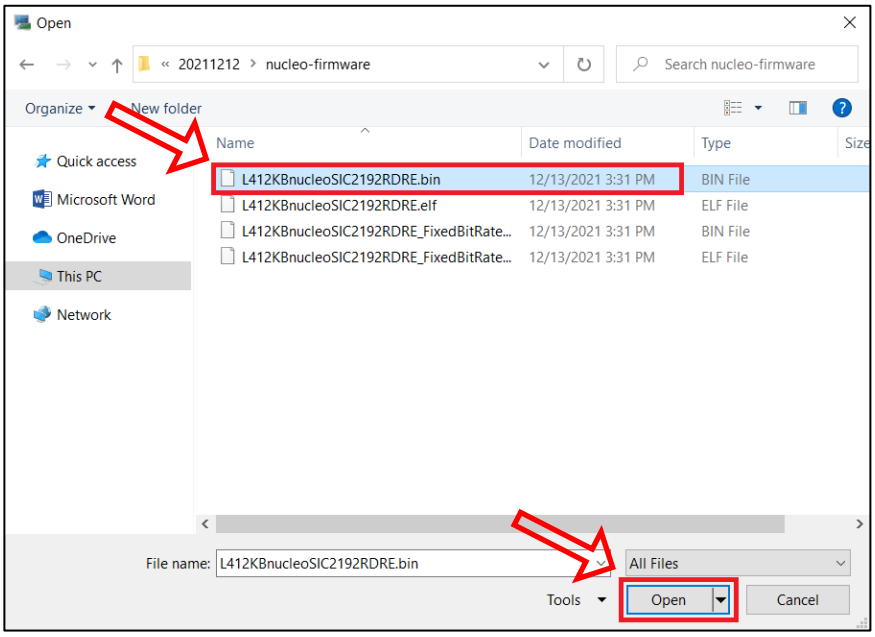


Figure 51 – ST LINK Utility: File Selection.

4. Click  for flash write operation.

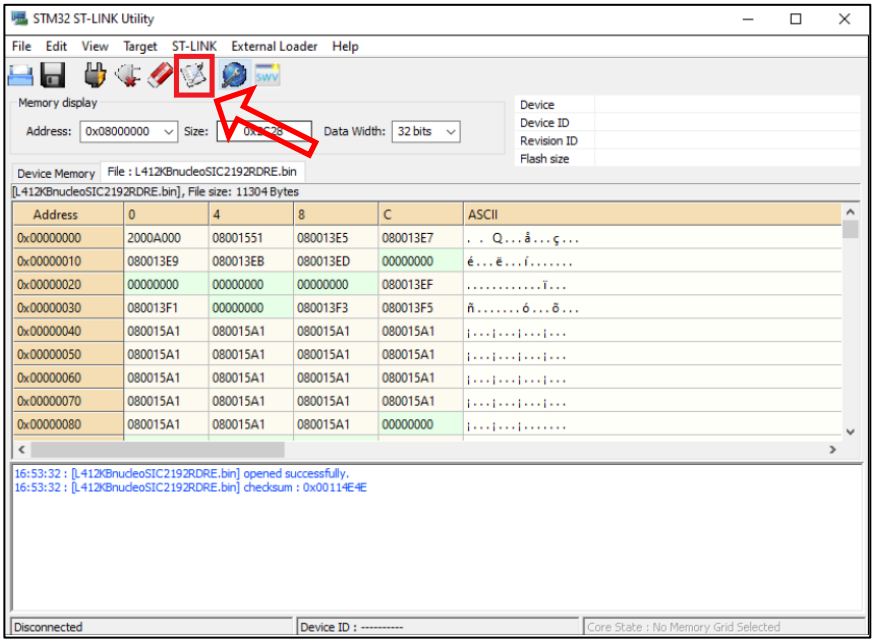


Figure 52 – ST LINK Utility: Flash Write Operation.

5. Click **Start** to begin re-flashing. Default settling will erase existing firmware, upload and verify the new one.

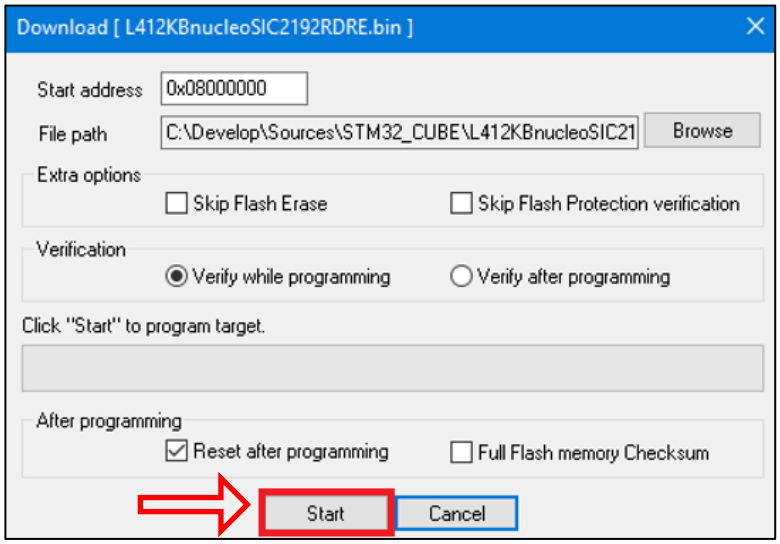


Figure 53 – ST LINK Utility: Start Flashing.

6. Re-flashing of new firmware is complete

16.6 **Data Log**

16.6.1 Log file Details

This section provides a detailed description for each component of the log file created by the software. Refer to figure 13 for the item number.

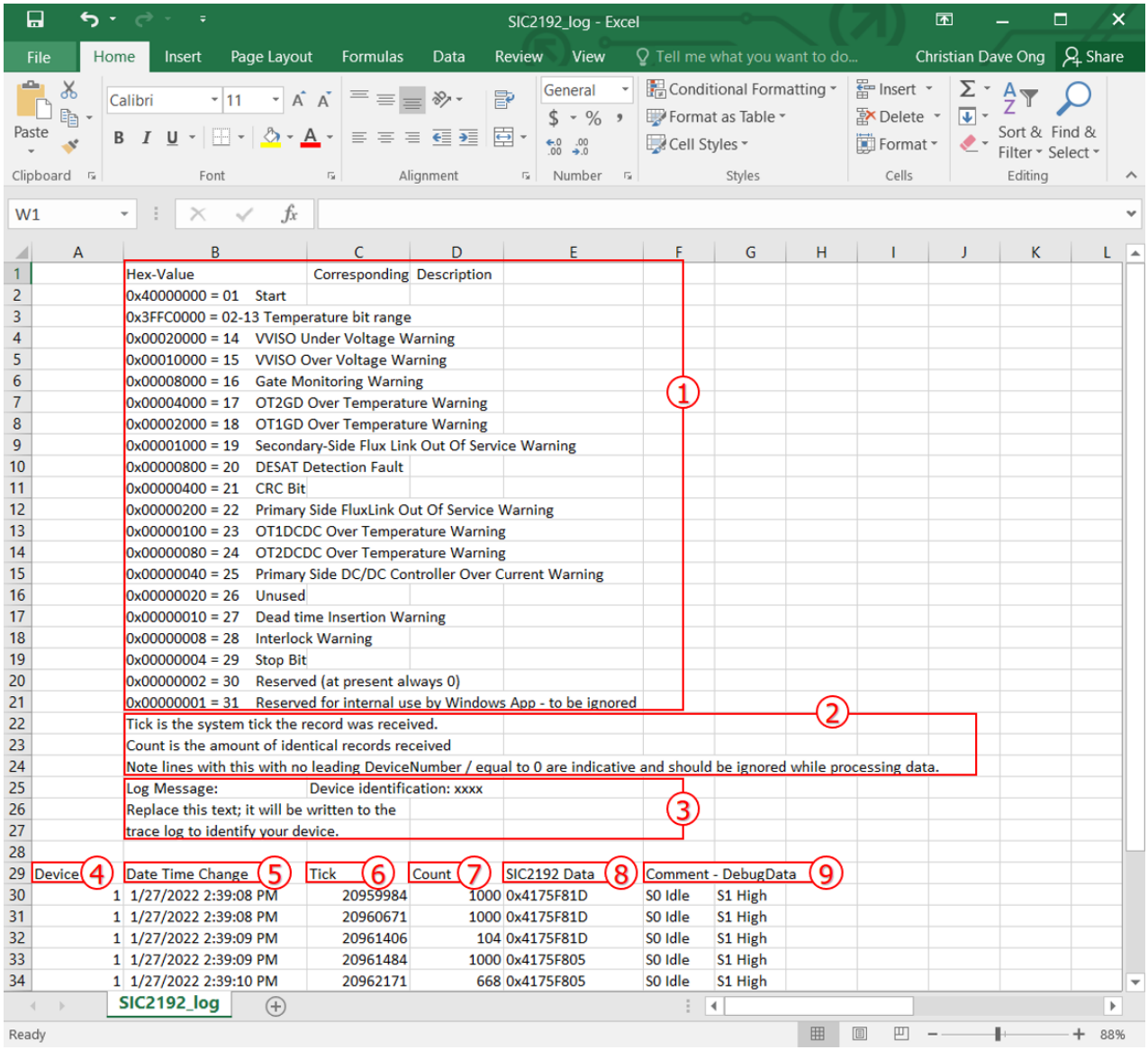


Figure 54 – Log File.

Item	Name	Details
1	B_OUT Information	a look up table with the description of each B_OUT bits
2	Log Notes	provides a short note about the log file
3	Log Message	information defined by the user from the Log Message text box in the software user interface
4	Device	'1' or '2' depending on the device number
5	Date Time Change	date and time record when the data was processed by the Windows PC
6	Tick	ms timer of the Windows PC. This is to provide more timing resolution to the date and time
7	Count	amount of times the frame repeats itself. A new line will be written if count reaches 1000
8	SIC2192 Data	actual data bits recorded from the IC. A new line will be written if the data changes
9	Comment – Debug Data	reflects the state of SYNC0, SYNC1 and INPUT

16.6.2 Example of Data Log Analysis

A sample data log is shown in Figure 55. The reader connection was opened with an in-phase IN+ and IN- signal, $V_{VISO-COM}$ = 12 V at IGBT Mode 1. These conditions should trigger 3 warnings: under voltage VISO, dead-time insertion and interlock warning. Logged data shows that all of these warnings were successfully captured. Note that the first bit and last two bits of the logged data is not part of the B_OUT bit stream.

Warnings were eventually resolved by turning off the IN- signal and then setting $V_{VISO-COM}$ = 25 V. These can be verified on the logged data. As shown, the dead-time insertion and interlock warnings were resolved initially followed by the resolution of the under voltage VISO.

Device	Date Time Change	Tick	Count	SIC2192 Data	Comment - DebugData		
1	1/27/2022 2:39:08 PM	20959984	1000	0x4175F81D	S0 Idle	S1 High	Simulated Under Voltage VISO,
1	1/27/2022 2:39:08 PM	20960671	1000	0x4175F81D	S0 Idle	S1 High	Dead-time Insertion and Interlock Warnings
1	1/27/2022 2:39:09 PM	20961406	104	0x4175F81D	S0 Idle	S1 High	
1	1/27/2022 2:39:09 PM	20961484	1000	0x4175F805	S0 Idle	S1 High	Resolved Dead-time Insertion
1	1/27/2022 2:39:10 PM	20962171	668	0x4175F805	S0 Idle	S1 High	and Interlock Warnings
1	1/27/2022 2:39:10 PM	20962609	1000	0x4177FC05	S0 Idle	S1 High	Resolved Under Voltage VISO Warning
1	1/27/2022 2:39:11 PM	20963359	1000	0x4177FC05	S0 Idle	S1 High	
1	1/27/2022 2:39:12 PM	20964093	1000	0x4177FC05	S0 Idle	S1 High	
1	1/27/2022 2:39:13 PM	20964796	1000	0x4177FC05	S0 Idle	S1 High	
1	1/27/2022 2:39:13 PM	20965546	250	0x4177FC05	S0 Idle	S1 High	

	Not Part on B_OUT Bits	Start	Temperature								VISO Under Voltage	VISO Over Voltage	Gate Monitoring	OT2GD Over Temperature	OT1GD Over Temperature	Secondary-side Flux Line Out-of-Service	DESAT Detection	CRC	Primary-side Flux Line Out-of-Service	OT1DCDC Over Temperature	OT2DCDC Over Temperature	Primary-side Flux Line Out-of-Service	Unused	Deadtime Insertion Warning	Interlock Warning	Stop	Not Part on B_OUT Bits	Not Part on B_OUT Bits
B_OUT	XX	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	XX	XX
Data Log		4			1				7				5				F				8				1				D			
Binary	0	1	0	0	0	0	0	1	0	1	1	1	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	0	1
Data Log		4			1				7				5				F				8				0				5			
Binary	0	1	0	0	0	0	0	1	0	1	1	1	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	1
Data Log		4			1				7				7				F				8				0				5			
Binary	0	1	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	1

Figure 55 – Example of Data Log Analysis.

16.7 **Troubleshooting**

Issue	Details
COM Port not in the list	- Check if the USB connection is plugged in properly - Check if the PC is able to detect the reader COM Port via Device Manager - Click the Rescan Button to refresh the list
No Log File Created	- Check if the filename and directory in the save settings is defined properly.
Reader Status: *No Connection*	- Click the Open Button to start connection
Reader Status: *Connected (No Data received since Start / Reset)*	- Check if the B_OUT and SO signal is connected properly - Check if the gate driver board is supplied with enough voltage (VCC = 5 V and $V_{ISO-COM}$ = 15 V to 30 V)
Reader Status: *Connected (No Data available at this time)*	- Check if the USB connection was unplugged - Check if the B_OUT and SO signal was disconnected
Reader Status: *Connected (Record Out Of Sync)*	- Check if the B_OUT signal is switching properly (low and high bits are observed)

17 Revision History

Date	Author	Revision	Description and changes	Reviewed
05-May-22	CO	1.1	Initial Release.	MH
27-Jul-22	CO	1.2	Updated Schematic Diagram and Bill of Materials. Included Disclaimer Information.	MH, CD
28-Jul-22	PV	1.3	Minor Typo Corrections	MH
06-Feb-23	CO	1.4	Additional filter stage on Bit stream signal for better noise immunity during inverter test	MH

For the latest updates, visit our website: www.power.com

Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

PATENT INFORMATION

The products and applications illustrated herein (including transformer construction and circuits' external to the products) may be covered by one or more U.S. and foreign patents, or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.power.com. Power Integrations grants its customers a license under certain patent rights as set forth at http://www.power.com/ip.htm.

Power Integrations Worldwide Sales Support Locations

WORLD HEADQUARTERS
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1-408-414-9200
Customer Service:
Worldwide: +1-65-635-64480
Americas: +1-408-414-9621
e-mail: *usasales@power.com*

CHINA (SHANGHAI)
Rm 2410, Charity Plaza, No. 88,
North Caoxi Road,
Shanghai, PRC 200030
Phone: +86-21-6354-6323
e-mail: *chinasales@power.com*

CHINA (SHENZHEN)
17/F, Hivac Building, No. 2,
Keji Nan 8th Road, Nanshan District, Shenzhen, China, 518057
Phone: +86-755-8672-8689
e-mail: *chinasales@power.com*

GERMANY (AC-DC/LED Sales)
Einsteinring 24
85609 Dornach/Aschheim
Germany
Tel: +49-89-5527-39100
e-mail: *eurosales@power.com*

GERMANY (Gate Driver Sales)
HellwegForum 3
59469 Ense
Germany
Tel: +49-2938-64-39990
e-mail: *igbt-driver.sales@power.com*

INDIA
#1, 14th Main Road
Vasanthanagar
Bangalore-560052
India
Phone: +91-80-4113-8020
e-mail: *indiasales@power.com*

ITALY
Via Milanese 20, 3rd. Fl.
20099 Sesto San Giovanni (MI)
Italy
Phone: +39-024-550-8701
e-mail: *eurosales@power.com*

JAPAN
Yusen Shin-Yokohama 1-chome Bldg.
1-7-9, Shin-Yokohama, Kohoku-ku
Yokohama-shi,
Kanagawa 222-0033 Japan
Phone: +81-45-471-1021
e-mail: *japansales@power.com*

KOREA
RM 602, 6FL
Korea City Air Terminal B/D, 159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728 Korea
Phone: +82-2-2016-6610
e-mail: *koreasales@power.com*

SINGAPORE
51 Newton Road,
#19-01/05 Goldhill Plaza
Singapore, 308900
Phone: +65-6358-2160
e-mail:
singaporesales@power.com

TAIWAN
5F, No. 318, Nei Hu Rd., Sec. 1
Nei Hu District
Taipei 11493, Taiwan R.O.C.
Phone: +886-2-2659-4570
e-mail:
taiwansales@power.com

UK
Building 5, Suite 21
The Westbrook Centre
Milton Road
Cambridge
CB4 1YG
Phone: +44 (0) 7823-557484
e-mail: *eurosales@power.com*