10BASE-T to 10BASE-T1L Media Converter Including SPoE/APL, Featuring ADIN1100 and ADIN1200 Ethernet PHYs and LTC4296-1 PSE Controller

FEATURES

- 10BASE-T to 10BASE-T1L media converter
- SPoE PSE controller compatible with IEEE 802.3cg
- Power source for APL devices
- System level diagnostics over USB COM port

EVALUATION KIT CONTENTS

- DEMO-ADIN1100D2Z board
- 2 × plugin screw terminal connectors
- Ethernet cable with RJ45 connectors (1 m)
- USB A to USB C cable (1 m)

EQUIPMENT NEEDED

- 10BASE-T1L data only device, SPoE PD device or APL powered device
- 10BASE-T1L compatible, single pair cable (1.5 mm^2 maximum/AWG 16 to fit connector)
- Host device with standard RJ45 Ethernet port capable of 10BASE-T full duplex
- DC power supply with output voltage and current relevant to power class
- Optional: host with USB interface for management, monitoring, and diagnostics (also power supply for some classes)

SOFTWARE (OPTIONAL)

- FTDI USB virtual COM port driver for selected host
- Serial COM port terminal software

GENERAL DESCRIPTION

The DEMO-ADIN1100D2Z is a media converter board that provides connection between a standard 10BASE-T RJ45 Ethernet port and a 10BASE-T1L device.

The DEMO-ADIN1100D2Z includes a power sourcing equipment (PSE) controller and it can power the connected 10BASE-T1L or advanced physical layer (APL) device. The PSE controller is configurable for power over data line (PoDL)/single pair power over Ethernet (SPoE) power Class 10, Class 11, Class 12, Class 13, Class 14, and Class 15, and APL power Class A, Class C, and Class 3.

The board requires an external DC power supply with output voltage and maximum output current relevant to the selected power class. For a subset of power classes (Class 10, APL A, and APL C), the board can also be powered from a USB host.

The board requires a minor modification and external power coupling inductors when used for the highest power Class 15 and APL 3.

The DEMO-ADIN1100D2Z can be used as an autonomous device, configurable by a set of switches and jumpers, indicating its status on LEDs.

The DEMO-ADIN1100D2Z can also be connected via USB to a host PC. The 10BASE-T1L link status, power status, and diagnostics are then accessible using a simple set of text commands and messages exchanged over the USB COM port interface using a serial terminal software on a PC.

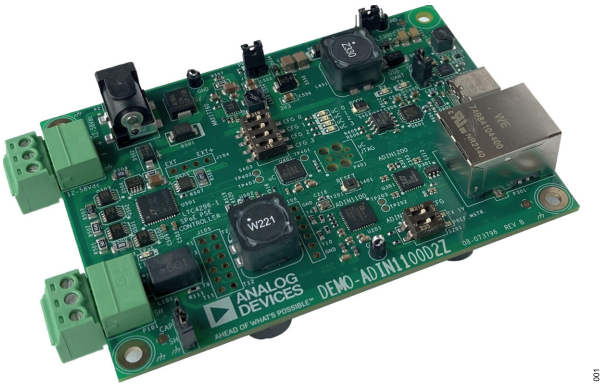

Figure 1. Evaluation Board Photo

TABLE OF CONTENTS

REVISION HISTORY

6/2024—Revision 0: Initial Version

OVERVIEW

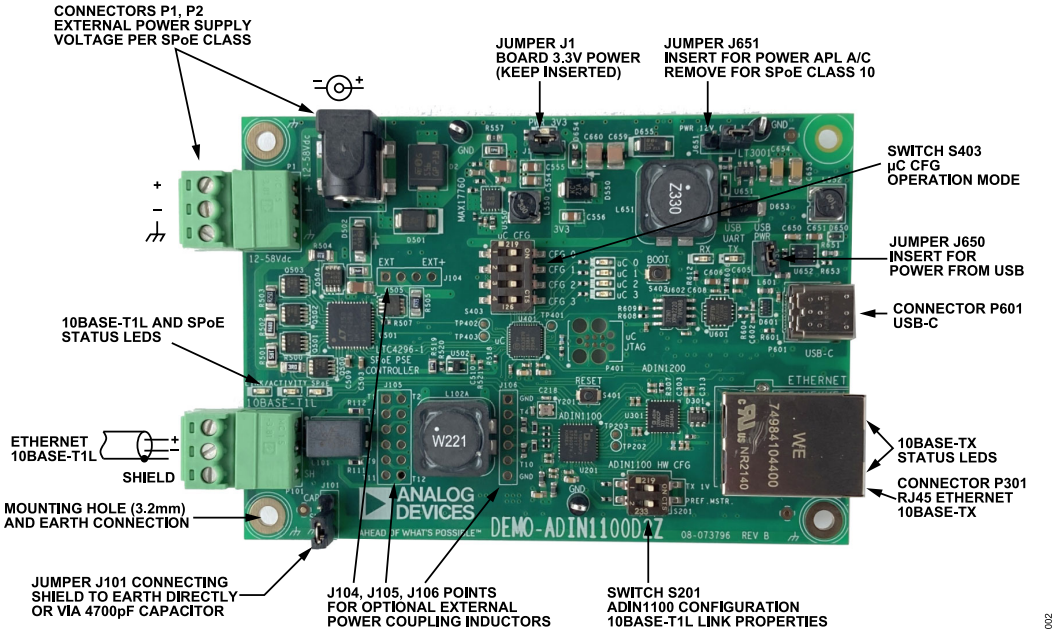

Figure 2. Board Connectors and Controls

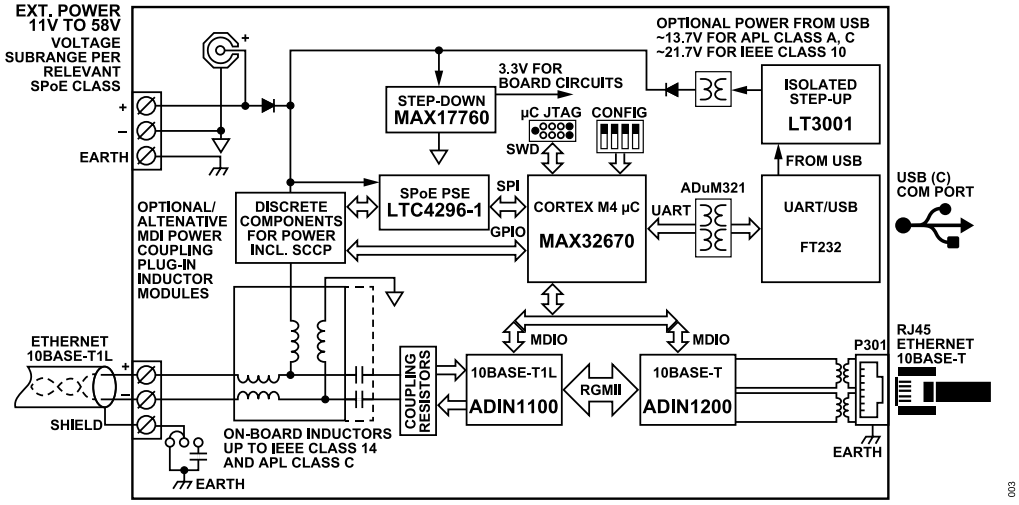

Figure 3. Simplified Block Diagram

OVERVIEW

FIRMWARE MODES OF OPERATION

Table 1. Firmware Modes of Operation[1]

	Microcontroller Configuration					Class Specification			Power for Board[2]				
Mode	0	1	2	3	Name	V_{MIN} (V)	V_{MAX} (V)	I_{MAX} (mA)	V_{MIN} (V)	V_{MAX} (V)	P_{MAX} (W)	Power Supply from USB	Note
0	Off	Off	Off	Off	SPoE Class 10	20	30	92	20.7	30	2.5	Yes[3]	If USB can supply the power
1	On	Off	Off	Off	SPoE Class 11	20	30	240	20.8	30	5.4	No	
2	Off	On	Off	Off	SPoE Class 12	20	30	632	21.1	30	13.2	No	
3	On	On	Off	Off	SPoE Class 13	50	58	231	50.8	58	12.2	No	
4	Off	Off	On	Off	SPoE Class 14	50	58	600	51.0	58	31	No	
5	On	Off	On	Off	SPoE Class 15[4]	50	58	1579	53.0	58	80	No	Additional inductors required
6	Off	On	On	Off	APL Class A	9.6	15	56	10.2	15	1.1	Yes	
7	On	On	On	Off	APL Class A NoAutoneg[5]	9.6	15	56	10.2	15	1.1	Yes	Do not normally use
8	Off	Off	Off	On	APL Class C	11.6	15	95	11.6	15	1.7	Yes	
9	On	Off	Off	On	APL Class 3[4]	46	50	1250	47	50	59	No	Additional inductors required
10	Off	On	Off	On	Production power test[6]	9.6	15		N/A	N/A	0.6	Yes	Used for board production
11	On	On	Off	On	APL Class A old demo[7]	9.6	15	56	10.2	15	1.1	Yes	Do not use
12	Off	Off	On	On	SPoE off	N/A	N/A	N/A	9	58	0.6	Yes	Media converter only, no power to cable
13	On	Off	On	On	Production data test	N/A	N/A	N/A	N/A	N/A	N/A	No	Used for board production
14	Off	On	On	On	Reserved	N/A	N/A	N/A	N/A	N/A	0.6	N/A	Reserved for future use
15	On	On	On	On	Debug[8]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use with terminal commands

1 N/A means not applicable.

2 The board requires power supply with minimum voltage and maximum power slightly higher than the relevant power class.

3 Most USB 3.0 hosts, but only some USB 2.0 hosts can supply enough power for the device Class 10 and the board itself.

4 For full use of SPoE Class 15 and APL Class 3, follow the Board Modification for SPoE Class 15 and APL Class 3 section.

5 The 10BASE-T1L normal autonegotiation is disabled and the PHY is set to forced leader or follower mode depending on position of Switch S201 during reset. The mode must be used only for debug and tests. Do not use it for normal operation.

6 Mode 10 and Mode 13 are very specific and used during board production test. Do not use them for normal operation.

7 The mode is included for compatibility with (very) old APL demos, and it may be removed in future firmware versions.

8 The mode is meant for system level debugging for experts with deep knowledge. The power class and associated power supply requirements depend on previously operated mode. When the microcontroller is reset with Mode 15 selected, or placed to Mode 15 via a COM port command, the firmware will not perform any configuration or reconfiguration of the Ethernet PHYs and SPoE controller. The Ethernet PHYs are reset after power-up or by pressing the board hardware reset button, S401. However, the SPoE controller does not have a hardware reset pin. Therefore, the SPoE controller stays in the latest state of operation, but the power delivery it is no longer supervised by the microcontroller firmware. As result, the connected cable and device may no longer be protected against all system fault conditions.

OVERVIEW

BOARD CONTROL COMPONENTS

Table 2. Board Control Components

Reference	Name	Description
J1	PWR 3V3	The jumper for local 3.3 V power. Keep inserted for normal operation.
J101		The jumper for 10BASE-T1L cable shield to connect to earth ground directly or via a 4700 pF capacitor.
J601	USB PWR	The jumper for enabling board power from the USB port. Note that this is possible only for some power classes. For details refer to Table 1.
J651	PWR 12V (APL)	The jumper selecting voltage generated from the USB port. Insert for APL Class A and Class C, remove for SPoE Class 10.
S201	ADIN1100 HW CFG Switch (TX 1V)	On. 10BASE-T1L operates with 1 V signal level. Use this option for APL Class A and Class C. Off. 10BASE-T1L can operate with 2.4 V signal level. The switch must be set to desired position before power-up or reset. The switch is sampled only when the ADIN1100 chip is coming out of reset.
S201	ADIN1100 HW CFG Switch (PREF.MSTR)	On. This side prefers to be leader on the 10BASE-T1L link. Off. This side prefers to be follower on the 10BASE-T1L link. The switch must be set to desired position before power-up or reset. The switch is sampled only when the ADIN1100 chip is coming out of reset.
S401	RESET	The push button for board hardware reset.
S402	BOOT	The push button for entering microcontroller boot load mode used for firmware update.
S403	µC CFG	The switch for microcontroller firmware mode of operation, refer to Table 1. The switch must be set to desired combination before power-up or reset. The switch is sampled by firmware only once, short time after the microcontroller reset.

Table 3. Board Indicator Components

Reference	Name	Color	Description
LED1	PWR 3V3	Green	Board local 3.3 V power. Must turn on when board powered from any source.
LED200	Link	Green	10BASE-T1L Ethernet link up.
LED201	Activity	Yellow	10BASE-T1L Ethernet link (data) activity.
LED500	SPoE	Blue	Power present on the cable connector.
P301	Ethernet	Green	10BASE-T Ethernet link up (LED integrated in the RJ45 connector).
P301	Ethernet	Yellow	10BASE-T Ethernet link (data) activity (LED integrated in the RJ45 connector).
LED400	µC 0	Blue	Special status indicator, presently used only in board production test.
LED401	µC 1	Yellow	Heartbeat. Yellow LED blinking indicates that the microcontroller firmware is operating.
LED402	µC 2	Red	Error. Red LED turned on indicates an error detected by the firmware. Messages with more error details and can be observed via the USB COM port if the board is connected to a host via USB.
LED403	µC 3	Green	Correct operation. Green LED turned on indicates that both the 10BASE-T1L and 10BASE-T Ethernet links are up in media converter modes.

CONFIGURATIONS

CONFIGURATION FOR SPOE CLASS 10

Set Switch S403 for firmware operation Mode 0. Set Switch S201 for the desired 10BASE-T1L link operation. When supplying the board from the USB port, insert Jumper J650 and remove Jumper J651. When supplying the board from another power supply, Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect the P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect the P101 screw terminal connector via a 10BASE-T1L cable to a powered device (PD) Class 10.

The board can be supplied from the USB port, if the USB host can supply up to 0.5 A at 5 V.

The board can also be supplied from a (nominal 24 V) power supply source connected to the board P1 or P2 power supply connectors. For voltage range and required power details, refer to Table 1.

Regardless of the power supply option, the USB port can be optionally used with a COM port terminal software for management and diagnostics.

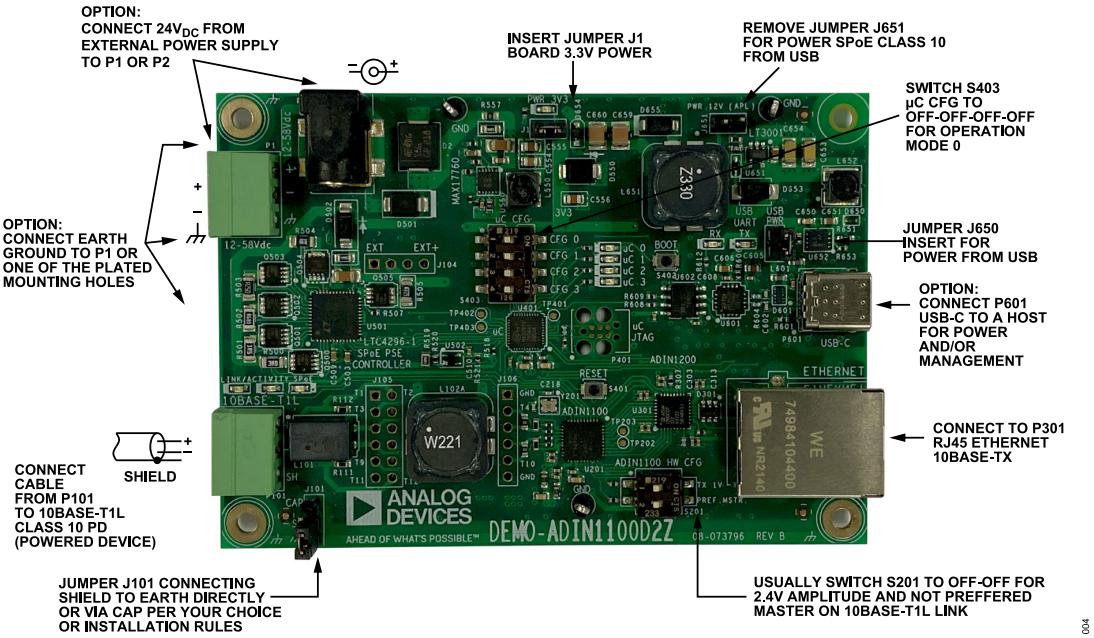

Figure 4. Board Setup for SPoE Class 10

CONFIGURATIONS

CONFIGURATION FOR SPOE CLASS 11

Set Switch S403 for firmware operation Mode 1, and for the rest of the setup, follow the Configuration for SPoE Class 12 section.

CONFIGURATION FOR SPOE CLASS 12

Set Switch S403 for firmware operation Mode 2. Set Switch S201 for the desired 10BASE-T1L link operation. Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect the P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect the P101 screw terminal connector via a 10BASE-T1L cable to a compatible PD Class 12, Class 11, or Class 10.

Power supply the board from a (nominal 24 V) power supply source connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Optionally connect the USB port to a host PC and use the COM port terminal software for management and diagnostics.

(Note that the board cannot be supplied via the USB port; the isolated DC/DC flyback converting power from the USB port on this board can only provide sufficient power for SPoE Class 10.)

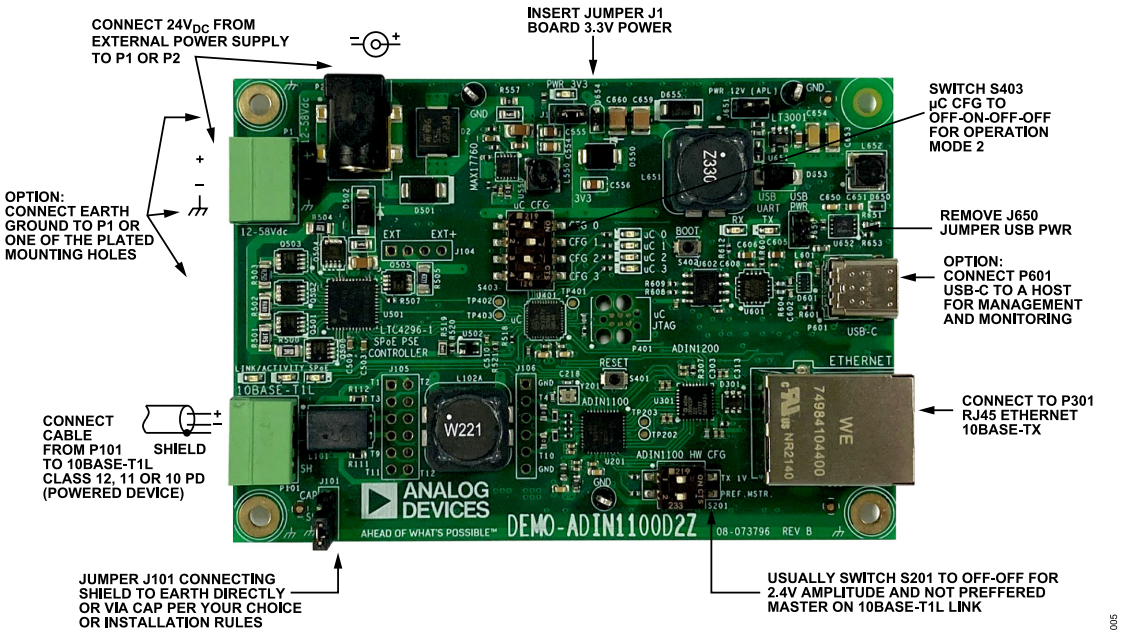

Figure 5. Board Setup for SPoE Class 12

CONFIGURATIONS

CONFIGURATION FOR SPOE CLASS 13

Set Switch S403 for firmware operation Mode 3. Set Switch S201 for desired 10BASE-T1L link operation. Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect P101 screw terminal connector via a 10BASE-T1L cable to a PD Class 13.

Power supply the board from a (nominal 54 V) power supply source connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Optionally connect the USB port to a host PC and use the COM port terminal software for management and diagnostics.

(Note that the board cannot be supplied via the USB port; the isolated DC/DC flyback converting power from the USB port on this board can only provide sufficient power for SPoE Class 10.)

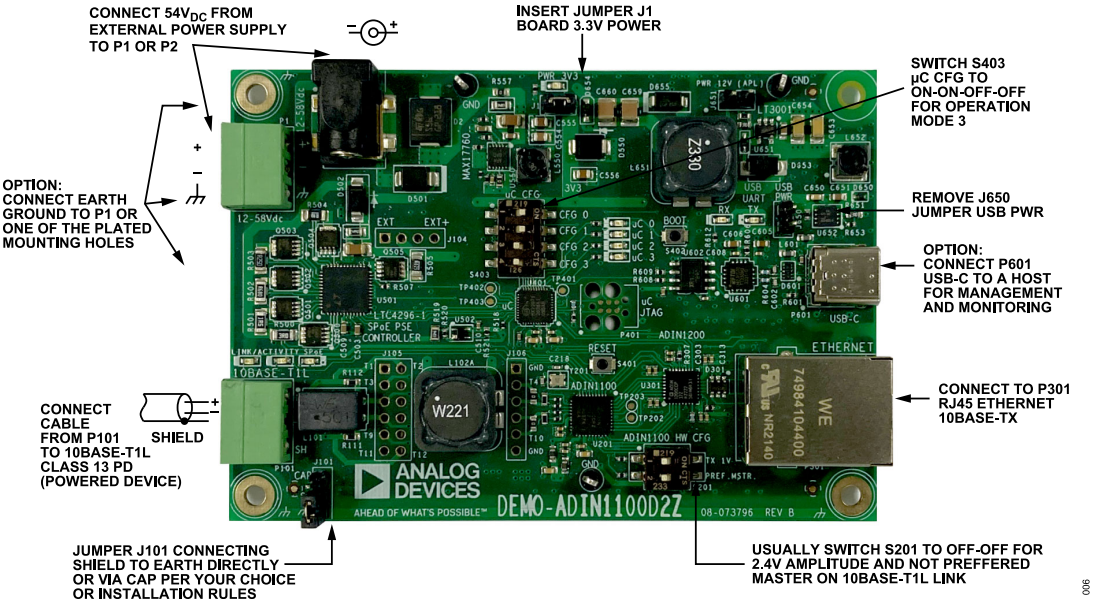

Figure 6. Board Setup for SPoE Class 13

CONFIGURATION FOR SPOE CLASS 14

Set Switch S403 for firmware operation Mode 4. For the rest of the setup, follow the Configuration for SPoE Class 13 section.

CONFIGURATIONS

BOARD MODIFICATION FOR SPOE CLASS 15 AND APL CLASS 3

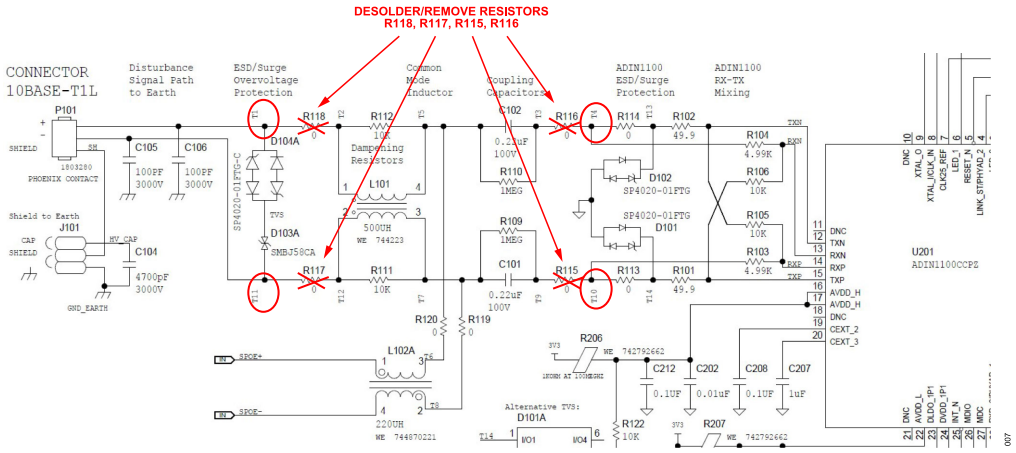

Figure 7. Modification for SPoE Class 15/APL Class 3—Schematics Snapshot

The default power coupling inductor and common-mode inductor on the board have a 900 mA maximum rated current. For the full use of SPoE Class 15 and APL Class 3 with the maximum current, the board needs a minor modification, and additional power coupling and common-mode inductors must be added to the board and used instead of the default inductors. See the following steps:

1. Disconnect the on-board default power coupling circuit.

   For this, remove the R115, R116, R117, and R118 resistors from the bottom of the board, as marked in the schematics snapshot in Figure 7 and photo in Figure 8.

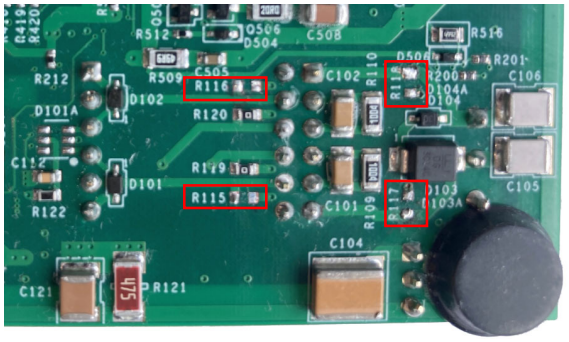

Figure 8. Modification for SPoE Class 15/APL Class 3—Board with 4 Resistors Removed

2. Add and solder a set of headers to the J104, J105, and J106 positions on top of the board, as shown in Figure 9. Use standard 2.54 mm/0.1 in pitch headers, 4-pin single row for J104, 6-pin single row for J106, and 12-pin double row for position J105 (or 2 × 6-pin single row if that is what you have).

   Take care when assembling the headers to be perpendicular to the board. If you already have a module, you can insert the headers into matching connectors on the module and solder the entire assembly—this way the module perfectly fits the headers. You can unplug the module afterward.

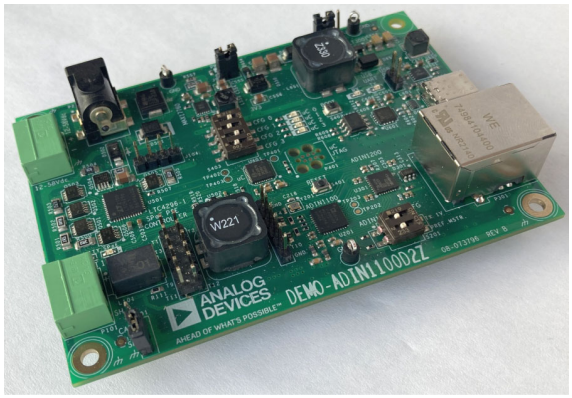

Figure 9. Modification for SPoE Class 15/APL Class 3—Board with Assembled Headers

3. Add a new coupling circuit suitable for the power class—power coupling inductor(s), common-mode inductor and/or transformer, and signal coupling capacitors. The details of the coupling circuit and selection of the components is beyond the scope of this document. One example of a suitable coupling circuit is the TDK module EVB-DLA-006.

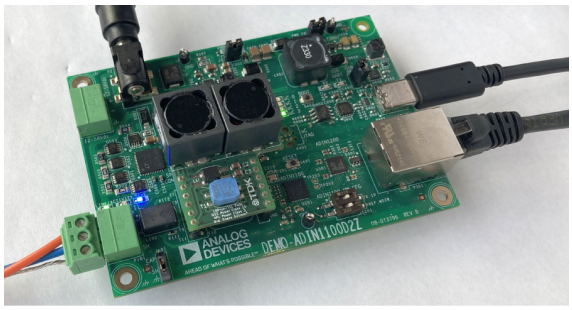

Figure 10. Modification for SPoE Class 15/APL Class 3—Board with TDK Module EVB-DLA-006

CONFIGURATIONS

CONFIGURATION FOR SPOE CLASS 15

Perform modifications as described in the Board Modification for SPoE Class 15 and APL Class 3 section.

Set Switch S403 for firmware operation Mode 5. Set Switch S201 for desired 10BASE-T1L link operation. Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect P101 screw terminal connector via a 10BASE-T1L cable to a compatible PD Class 15, Class 14, or Class 13.

Power supply the board from a (nominal 54 V) power supply source connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Optionally connect the USB port to a host PC and use the COM port terminal software for management and diagnostics.

CONFIGURATION FOR APL CLASS A

Set Switch S403 for firmware operation Mode 6. Set Switch S201 (TX 1V) to the on position for a 1 V amplitude required on APL spurs. Set Switch S201 (PREF.MSTR) to the on position, typical for the APL power supplying device. When supplying the board from the USB port, insert Jumper J650 and Jumper J651. When supplying the board from another power supply, Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with the J650 jumper removed.)

Connect the P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect the P101 screw terminal connector via an APL spur cable to an APL device Class A.

On the power sourcing side of the APL spur cable, connect the shield to the earth ground via a capacitor by inserting the jumper to the J101 position labeled CAP. If earth ground is required in the demonstration setup, connect the system earth ground to the ground pin of Connector P1, or to one of the metal plated mounting holes in the corners of the board.

The board can be supplied from USB, if the USB host can supply up to 0.25 A at 5 V.

The board can also be supplied from a (nominal 12 V) power supply source connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Regardless of the power supply option, the USB port can be optionally used with a COM port terminal software for management and diagnostics.

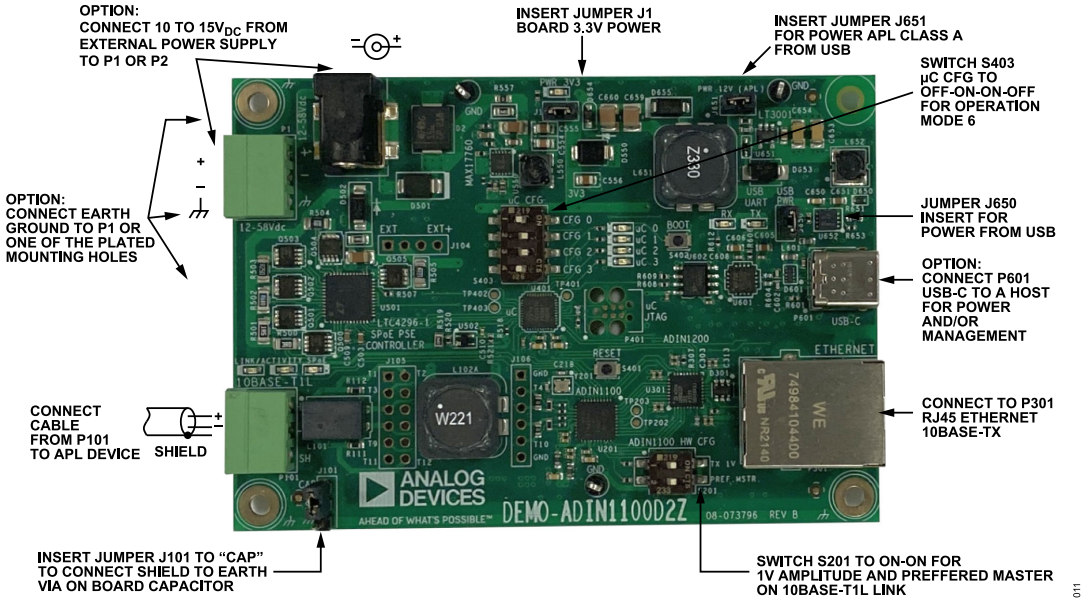

Figure 11. Board Setup for APL Class A

CONFIGURATIONS

CONFIGURATION FOR APL CLASS C

Set Switch S403 for firmware operation Mode 8. For all other settings and connections, see the Configuration for APL Class A section.

CONFIGURATION FOR APL CLASS 3

Perform the modifications as described in the Board Modification for SPoE Class 15 and APL Class 3 section.

Set Switch S403 for firmware operation Mode 9. Set Switch S201 (TX 1V) to off position for 2.4 V amplitude required on APL trunks. Set Switch S201 (PREF.MSTR) for the desired 10BASE-T1L link operation. Jumper J650 can be removed to make sure the board power does not come from the USB port. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect the P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect the P101 screw terminal connector via an APL trunk cable to an APL 3-compatible powered field switch.

Power supply the board from a (nominal 48 V) power supply source connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Optionally connect the USB port to a host PC and use the COM port terminal software for management and diagnostics.

CONFIGURATION FOR MEDIA CONVERTER WITH NO POWER

The board works as a media converter only, the SPoE/APL PSE is reset, and the power output to the port is disabled.

Set Switch S403 for firmware operation Mode 12. Set Switch S201 for the desired 10BASE-T1L link operation.

When the board is powered from the USB port, insert Jumper J650 and remove Jumper J651. Alternatively, when the board is powered from an external power supply and not through the USB port, Jumper J650 can be removed to make sure the board gets power from the intended source. (The USB COM port still works for monitoring and diagnostic with Jumper J650 removed.)

Connect the P301 RJ45 connector to an Ethernet switch or a host such as a PC, industrial or building controller, or any other device with an Ethernet port capable of autonegotiating 10 Mb full duplex Ethernet link.

Connect the P101 screw terminal connector via a 10BASE-T1L cable to a device that does not require power over 10BASE-T1L.

The board can be supplied from the USB port, if the USB host can supply up to 0.12 A at 5 V.

The board can also be supplied from a power supply source with a DC voltage between 9 V to 58 V connected to the P1 or P2 board power supply connectors. For details, refer to Table 1.

Regardless of the power supply option, the USB port can be optionally used with a COM port terminal software for management and diagnostics.

DETAILED DESCRIPTION

MEDIA CONVERSION

The DEMO-ADIN1100D2Z performs media conversion between a standard 10BASE-T RJ45 Ethernet port and a 10BASE-T1L Ethernet port. This is implemented as a back to back connection using the reduced gigabit media independent interface (RGMII) between the ADIN1100 (U201) and ADIN1200 (U301). The data—Ethernet frames—are passed directly from one PHY to the other PHY. There is no media access controller (MAC), no buffer, or speed conversion in the data path on the board.

The ADIN1200 is configured by the board firmware, via management data input/output (MDIO) interface. It is set to regenerate the incoming frame preambles. The ADIN1200 is also configured to advertise, through autonegotiation, 10 Mb full duplex as the only capability on the RJ45 Ethernet port.

When the DEMO-ADIN1100D2Z is connected to a 10BASE-T/100BASE-Tx/1000BASE-T port of another device, the devices agree through autonegotiation to link up at 10 Mb full duplex, to match exactly the speed and mode of the 10BASE-T1L link. Most of the common devices, such as PCs, USB to Ethernet adapters, Ethernet switches, or industrial controllers, have the Ethernet port set by default for autonegotiation, and therefore the Ethernet link usually works correctly with the DEMO-ADIN1100D2Z.

SPOE PSE

The DEMO-ADIN1100D2Z provides SPoE or APL power to a 10BASE-T1L or APL device over the same single pair cable as the data.

The board firmware configures the LTC4296-1 PSE controller (U501) to the relevant mode of operation via a serial peripheral interface (SPI). The firmware checks the correct input power supply voltage using the LTC4296-1 on-chip A/D converter, and subsequently enables one of its 5 output channels to set the appropriate current limit level. See details in Table 1.

The board includes an additional circuitry, controlled directly by the microcontroller general-purpose input/output (GPIO) pins, for serial communication classification protocol (SCCP), to communicate with the connected PD. The SCCP is used when the board is set to operate in one of the IEEE 802.3 defined power classes. The SCCP is not used when the board is set to operate in one of the APL power classes.

The firmware state machine assists the PSE controller, but the LTC4296-1 autonomously performs the time critical operations such as ramping up the voltage during port power-up, short-circuit protection, or PD disconnection.

The firmware periodically reads via SPI the power status from the LTC4296-1, including the measured port output voltage and output current. This information can be sent via the USB COM port if the board is connected to a PC.

MICROCONTROLLER

The low-power Arm® Cortex-M4 MAX32670 microcontroller (U401) and the firmware that is programmed to it during board manufacturing provide all the control, diagnostics, and other functionalities described in this user guide.

Note that the microcontroller is not in the data path for the Ethernet frames passing through the media converter. The firmware does not see or handle the Ethernet frames. Therefore, the firmware does not include any Ethernet stack.

Future firmware updates can be programmed to the microcontroller via the USB COM port. Instructions on how to do it and the appropriate tools are provided together with the future updated code.

10BASE-T1L/APL CABLE CONNECTION

The 10BASE-T1L/APL cable connects via a pluggable screw terminal block to the P101 connector. The pluggable connector is from Phoenix Contact, part number 1803581, 3-way, 3.81 mm pitch, for cable with conductors AWG 28 to AWG 16 (maximum 1.5 mm^2).

10BASE-T/ETHERNET CONNECTION

The 10BASE-T cable with a standard 8-pin RJ45 Ethernet connector connects to the P301 connector.

USB COM PORT

The DEMO-ADIN1100D2Z USB C connector can be connected to a PC or other host USB ports, using either a USB A/USB C cable (provided in the demo kit), or a USB C/USB C cable (presently not provided in the kit).

The PC USB port needs to be Version 2.0 or higher for using the USB COM port management and diagnostics function. It is recommended to use USB 3.0 or higher when using the USB port as a power supply source for the board.

The USB COM port on the board is utilizing the FT232 USB to universal asynchronous receiver transmitter (UART) converter. The USB port is galvanically isolated from the rest of the board by the *i*Coupler® ADuM321N in the UART signal path to the microcontroller.

POWER SUPPLY

The board is supplied from an external power supply source connected via the pluggable screw terminal block to the P1 connector, or via a 2 mm/5.50 mm power barrel to the P2 connector. The required voltage and power depend on the board mode of operation. In some modes of operation, the board can also be supplied from a USB host. Refer to Table 1.

If the the USB port is connected and the USB power to the board enabled by inserted Jumper J650, the power is converted from USB 5 V to a higher voltage needed for the relevant power class by the isolated flyback converter LT3001. The converter output

DETAILED DESCRIPTION

voltage is set either to approximately 12 V for APL Class A and Class C by inserting Jumper J651, or to approximately 22 V by removing Jumper J651. Jumper J651 must be set appropriately for the relevant mode of operation.

The output from the flyback converter and the external power source are connected via two diodes. If both power from the USB port and power from an external source are connected, then the source with a higher voltage supplies the board.

When the board input power supply voltage is incorrect for the selected board mode of operation, the board firmware detects it, the red LED (µC 2) indicates the error, and the USB COM port receives an error message.

The Ethernet PHYs, the microcontroller, and most of the other circuits on the board are supplied from 3.3 V output from the step-down switching buck regulator MAX17760.

GROUND CONNECTIONS

The DEMO-ADIN1100D2Z board has an earth node. Although this node may or may not be electrically connected to the earth ground, in a real device, this node is typically connected to the device metal housing or chassis. This earth node can be connected as required in a wider demonstration system via the earth terminal of the power supply connector, P1, or via an exposed metal plating of three mounting holes in the corners of the DEMO-ADIN1100D2Z board. (The fourth hole does not have a metal plating, and has no earth connection.)

The shield of the 10BASE-T1L/APL cable can be disconnected from this earth node, connected directly, or connected via a 4700 pF capacitor (C104). The required connection is selected by position of Jumper J101.

The 10BASE-T earth connection and metal body of the RJ45 connector (P301) are connected directly to the earth node.

The local circuit ground, including the (−) terminal of the external power supply is connected to the earth node via approximately 3000 pF of capacitance, for good electromagnetic compatibility (EMC) performance, and approximately 4.7 MΩ of resistance, for preventing buildup of charge on the capacitance.

The USB connection has functional isolation from the rest of all other circuits, up to approximately 60 V. The USB ground is connected to the board earth node via approximately 1000 pF of capacitance and approximately 4.7 MΩ of resistance. In addition, the USB ground is connected to the local circuit ground via approximately 2000 pF of capacitance and approximately 4.7 MΩ of resistance.

Note that the DEMO-ADIN1100D2Z has been designed only as a demo board. It has not been designed nor tested for electrical safety. Any equipment, device, wire, or cable connected to the DEMO-ADIN1100D2Z board must be already protected and safe to touch without danger of electric shock.

SOFTWARE

The DEMO-ADIN1100D2Z can be used as a standalone board, with the firmware already programmed in the microcontroller flash memory. The firmware mode of operation can be set by the µC CFG Switch S403 (see Table 1), and other switches and jumpers (see Table 2). The basic status of the board is indicated by LEDs (see Table 3). There is no software needed for this standalone use case.

The DEMO-ADIN1100D2Z can also be connected to a PC via a USB port. The Ethernet links and power status monitoring and some diagnostics are then available using a simple set of American Standard Code for Information Interchange (ASCII) text commands and messages exchanged over the USB COM port and a serial port terminal software.

DRIVER FOR USB COM PORT

The DEMO-ADIN1100D2Z uses the FTDI FT232 for the USB COM port connectivity.

Make sure that the appropriate virtual COM port driver is included or installed on the host platform before connecting the DEMO-ADIN1100D2Z to that host via a USB cable.

FTDI virtual COM port drivers are available from the FTDI website.

SERIAL COM PORT AND TERMINAL SETTINGS

When the DEMO-ADIN1100D2Z is connected to the host, it becomes available in the host system as a USB COM port, and it is assigned a COM port number. The number depends on the system settings, on the COM port devices previously connected and assigned in the system, and on the FTDI driver settings.

The DEMO-ADIN1100D2Z microcontroller firmware communicates over a standard UART interface, with the following settings:

- Speed = 115,200 baud rate
- One start bit
- Eight data bits
- No parity
- One stop bit

The protocol is based on ASCII text commands and messages. Each message sent from the firmware to the host is finished by both <CR> and <LF> characters. For the commands received from the host, the firmware expects <CR> or <LF>, or both <CR> and <LF> as <new line> (see Table 4).

Table 4. Board Indicator Components

Character	ASCII Code	Description
<CR>	0x0D (13 decimal)	Carriage return
<LF>	0x0A (10 decimal)	Line feed

TERMINAL SOFTWARE

The DEMO-ADIN1100D2Z firmware works with common serial terminals. It has been tested on the Windows platform with PuTTY, RealTerm, TeraTerm, Termite, and the old HyperTerminal.

The examples in the following sections were captured using CompuPhase Termite.

INITIAL WELCOME MESSAGE

When the DEMO-ADIN1100D2Z is connected to the terminal software using the serial COM port settings defined in the Serial COM Port and Terminal Settings section, the firmware sends the following initial welcome message after power on or after pressing the DEMO-ADIN1100D2Z S401 RESET button:

```
================================================
ANALOG DEVICES 10BASE-T1L and SPOE DEMO
================================================
(c)2023-24 Analog Devices Inc.All rights reserved
================================================
Firmware ver. : 1.2.0
Hardware type : DEMO-ADIN1100D2Z
uC CFG-3-2-1-0 : OFF-OFF-OFF-OFF (Mode 0)
Firmware Mode : Media converter PSE class 10
================================================
Type '<?><new line>' for a list of commands
================================================
LTC4296-1 reset
ADIN1100 MDIO address 0
ADIN1100 HW CFG: autoneg, prefer Slave, Tx 2.4V
================================================
ADIN1200 MDIO address 4
ADIN1200 SW CFG: autoneg 10Mbit Full Duplex Only
================================================
PSE initiated ...
LTC4296-1 Port1 Vin 20.4V
```

TERMINAL COMMANDS

The most important command is **<?><new line>**.

On the host keyboard, type the character **?**, followed by the ENTER key, and the firmware sends a list of all commands implemented in this version of firmware, as follows:

```
?
================================================
List of Commands
================================================
* MDIO (Clause 22) read from Phy, all numbers in hex.
'mdioread <PhyAddr>,<RegAddr>'<newLine>
* MDIO (Clause 22) write to Phy, all numbers in hex.
'mdiowrite <PhyAddr>,<RegAddr>,<Data>'<newLine>
* MDIO (Clause 45) read from Phy, all numbers in hex.
'mdiord_cl45 <PhyAddr>,<RegAddr>'<newLine>
* MDIO (Clause 45) write to Phy, all numbers in hex.
'mdiowr_cl45 <PhyAddr>,<RegAddr>,<Data>'<newLine>
```

The list continues.

SOFTWARE

STATUS AND DIAGNOSTICS

To see repeated welcome message including the firmware mode of operation, use the command **info**.

For the status of the Ethernet links, use the command **phystatus**. Note that the **Link was Down** condition is latched by the PHYs, and therefore, the first time this command is called after reset or after link down is reported.

```
phystatus
ADIN1100 Link was Down, is Up Autoneg, Master, 2.4V
ADIN1200 Link was Down, is Up
```

For the status of the SPoE, use the command **powerstatus**.

```
powerstatus
PSE in Classification mode, SPOE CLASS 10
Vout 23.7V, Iout 42.6mA
PD CLASS 10 Connected
```

For a continuous update, use the commands **start** and **stop**. The firmware periodically, every 1 second, sends an update that in the present firmware version includes the following:

- **MSE**. 10BASE-T1L mean square error in, which indicates link quality (a negative value of signal-to-noise ratio (SNR)).
- **SLCRERR**. 10BASE-T1L slicer error, which again indicates link quality (a slicer error value of 0.5 causes an incorrect slicer decision and results in error in data).
- **Rx**. The number of Ethernet frames received from the 10BASE-T1L link since the last board or firmware reset, or after the use of the command **clear**.
- **Err**. The number of Ethernet frames with error received from the 10BASE-T1L link since the last board or firmware reset, or after the use of the command **clear**.
- **Vout**. Voltage on the output of PSE controller, approximately equal to the voltage on the 10BASE-T1L connector.
- **Iout**. Current from the output of PSE controller, approximately equal to the current to the 10BASE-T1L connector.

```
start
OK
MSE -37.22 dB, SLCRERR 0.199, Rx 50, Err 0, Vout 23.
9V, Iout 68.8mA
MSE -37.22 dB, SLCRERR 0.048, Rx 50, Err 0, Vout 23.
9V, Iout 50.8mA
MSE -37.22 dB, SLCRERR 0.048, Rx 50, Err 0, Vout 23.
9V, Iout 62.8mA
MSE -37.22 dB, SLCRERR 0.050, Rx 50, Err 0, Vout 23.
9V, Iout 72.4mA
MSE -37.22 dB, SLCRERR 0.049, Rx 50, Err 0, Vout 23.
9V, Iout 62.4mA
MSE -37.22 dB, SLCRERR 0.048, Rx 50, Err 0, Vout 23.
9V, Iout 50.4mA
MSE -37.22 dB, SLCRERR 0.048, Rx 50, Err 0, Vout 23.
9V, Iout 50.4mA
stop
OK
```

ERROR MESSAGES

The firmware sends various status and error messages to the USB COM port, which can help to understand the operation of the board and debug various issues from incorrect configuration or incorrect power supply, through incompatible SPoE PD, to other conditions such as overload or short circuit on the 10BASE-T1L cable. The following shows a couple of error examples:

```
PSE initiated ...
LTC4296-1 Port3 Vin 13.5V out of range, expected  20.0V to  30.0V
LTC4296-1 Port3 Vin 13.2V out of range, expected  20.0V to  30.0V
LTC4296-1 Port3 OVERLOAD_DETECTED_IPOWERED, too high output current
LTC4296-1 Port3 disabling output
```

PHY LOOPBACKS AND FRAME GENERATOR

The ADIN1100 and ADIN1200 Ethernet PHYs include a range of features to help system level diagnostics. The demo firmware makes some of them available through the following dedicated commands:

- The command **adin1100loopback** sets the ADIN1100 to a MAC remote loopback mode. Every frame received from the 10BASE-T1L link is immediately transmitted back to the same link. The normal ADIN1100 transmit MAC data path is disconnected. On this board, any frames coming from the 10BASE-T link via the ADIN1200 are ignored in this mode.
- The command **adin1200loopback** sets the ADIN1200 to a MAC remote loopback mode. Every frame received from the 10BASE-T link is immediately transmitted back to the same link. The normal ADIN1200 transmit MAC data path is disconnected. On this board, any frames coming from the 10BASE-T1L link via the ADIN1100 are ignored in this mode.
- The command **adin1100framegen** sets the ADIN1100 on-chip frame generator to send a burst of 500 frames, each with random data 1500 bytes payload. The destination MAC address is set to 00:05:f7:00:00:00, the source address 00:05:f7:00:00:e0. The firmware then reactivates the frame generator periodically every 1 second.

As part of the continuous update, the firmware also reads the ADIN1100 on-chip frame checker and calculates a difference between the number of frames sent by the frame generator and the number of frames received. The difference counter is meant to be used in conjunction with a 10BASE-T1L link partner set to remote loopback, sending the frames back. This feature can be used for

SOFTWARE

example for assessing frame error rate on a link in EMC or other system level tests.

```
adin1100framegen
ADIN1100 frame generator enabled
starOKt
OK
MSE -37.22 dB, SLCRERR 0.198, Tx 2500, Rx 2500,
Diff 0, Err 0, Vout
13.2V, Iout 3.2mA
MSE -37.22 dB, SLCRERR 0.048, Tx 3000, Rx 3000,
Diff 0, Err 0, Vout
13.2V, Iout 3.1mA
```

The easiest way to stop the loopback modes and/or to stop the frame generator is to reset the firmware.

NOTES

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.