

TI Designs Copper-to-Fiber Ethernet Media Converter



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[DP83849IVS-EVK](#)

EVM Folder



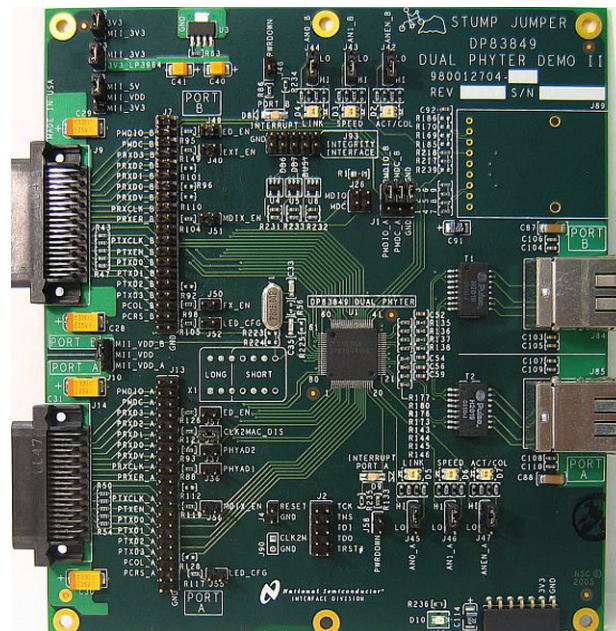
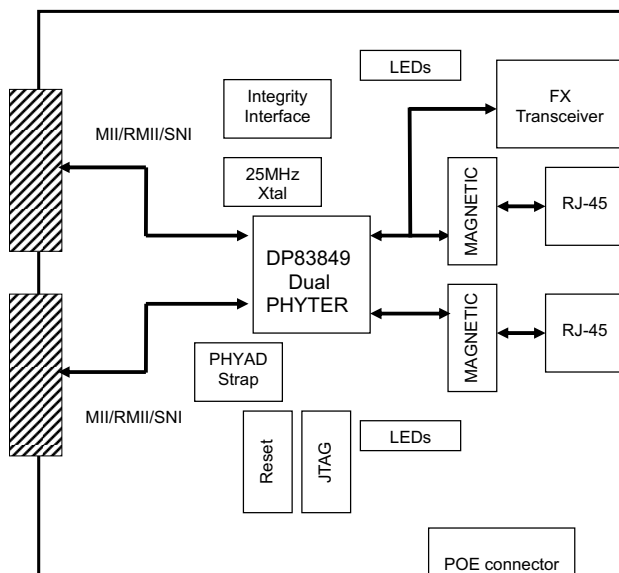
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Design Features

- Does Not Require Software or Programming for the Board to Function as a Copper-to-Fiber Media Converter
- Configured with Jumper Settings Only
- Provides for Dual Ethernet PHY with RJ-45 10/100 Ethernet Interface
- Provides One Fiber-Optic (FO) Ethernet Interface

Featured Applications

- Smart Grid Substation Automation
- Protection Relays
- Power Quality Meters



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1 System Description

Ethernet Connectivity in Smart Grid

The smart grid and automation industry is swiftly adopting ethernet. Ethernet addresses many of the requirements of proprietary buses with the added advantages of widespread usage and lower costs due to high volumes.

Why Fiber Optics?

Fiber optics (FO) can be found in many applications, ranging from network backbones that power the Internet to manufacturing facilities to subsea communication networks on drilling rigs. The information carrying capacity of an optical fiber is far greater than copper wire, coaxial cables, and microwave links. Optical fibers are very small, lightweight, corrosion resistant, and are immune to electrical noise from lightning storms, electromagnetic interference (EMI), and radio-frequency interference (RFI). In addition, FO cables do not carry electrical energy and are approved for hazardous locations. The cost of FO cable, its associated connectors, and hardware have decreased steadily over the years. Today, the benefits of FO can far outweigh the costs, making FO communications the preferred choice for smart grid and automation industry.

Most substations have unique requirements for communications networks that differ from those of a commercial network. These substations must withstand harsher environmental conditions such as extreme temperature ranges, lightning strikes, electromagnetic interference, and hazardous locations. Mounting and space requirements are also an issue because substation networking components must be mounted in the same control panel with other control equipment.

1.1 Why Ethernet over Fiber?

If high interference immunity is needed or long transmission distances are involved, then FO cables are advisable. Another advantage of using FO cabling is the insensitivity to lightning or voltage surges. The use of FO-based systems is already established in the process industry, plant engineering, substations, energy distribution, and wind energy. An FO cable is the only medium that can support a virtually limitless bandwidth. As the demand for more bandwidth grows and the price of fiber declines, fiber is making inroads where copper has been traditionally used. Ethernet over fiber makes sense because of its low cost, simplicity and scalability.

1.1.1 Speed

Applications are getting more demanding, web sites are getting more complex, and everything is going to the cloud—all factors that drive the demand for network bandwidth. To accommodate the high network speeds needed to meet this demand, copper cable has evolved in a series of steps from the CAT3 that carried 10-Mbps 10BASE-T Ethernet all the way to CAT6a, which can carry 10-Gb 10GBASE-T. UTP has gone through at least five generations to keep up with increasing bandwidth requirements. On the other hand, fiber has a much higher innate carrying capacity, so when network speeds increase, fiber can handle the demand without the need for costly upgrades.

1.1.2 Security

Fiber is more difficult for hackers to tap into. Because a copper cable “leaks” electromagnetic signals, a hacker can read data nearby without actually touching the cable. A fiber cable, on the other hand, uses light that stays within the cable, so a hacker must physically tap into it to gain access to data. Fiber is immune to electrical noise such as EMI and RFI caused by items such as transmission lines and transformers.

1.1.3 Distance

Most common copper Ethernet standards have a maximum segment length of only 328 feet (100 M). Fiber, on the other hand, has distance limitations measured in kilometers, not meters. Although distances vary, multimode fiber cable routinely supports distances of two kilometers. Single-mode fiber can support distances over 10 kilometers, with some implementations going to 80 kilometers or more.

1.1.4 Cost

At one time, fiber was universally more expensive than copper. Today, however, because manufacturing costs are down and terminations are easier, fiber may be less expensive than the equivalent copper infrastructure.

1.2 Advantages and Disadvantages of Fiber Optics

Advantages:

- Galvanic isolated and robust communication interface
- Cabling distance is greater than UTP cable to meet the demand of wide ranges (to communicate over longer distance) and reduced communication failures
- Harsh environment capability: able to withstand EMI, high temperature, high pressure, and high voltage
- No grounding required
- Intrinsically safe
- Small size and lightweight
- Integrated telemetry: fiber itself is a data link
- Wide bandwidth
- High sensitivity to inputs

Disadvantages:

- More challenging to install cable
- Must use expensive FO cables and connectors
- Needs more expensive optical transmitters and receivers
- Cannot carry electricity to operate or power terminal devices

1.3 Physical Media Considerations

1.3.1 Fiber-Optic Standards

Table 1. Standard Fiber-Optic Wavelengths and Modes

WAVELENGTH	MODE
850 nm	Multi-mode
1300 nm	Multi-mode
1310 nm	Single-mode
1550 nm	Single-mode

These wavelengths were chosen because they best match the transmission properties of available light sources with the transmission qualities of optical fiber.

1.3.2 Fiber Types

Three basic fiber media types are:

- OM1: 62.5/125 μm graded index multi-mode
- OM2: 50/125 μm graded index multi-mode
- OM3: 50/125 μm graded index multi-mode
- OM4: 50/125 μm graded index multi-mode
- OS1: 9/125 μm single-mode

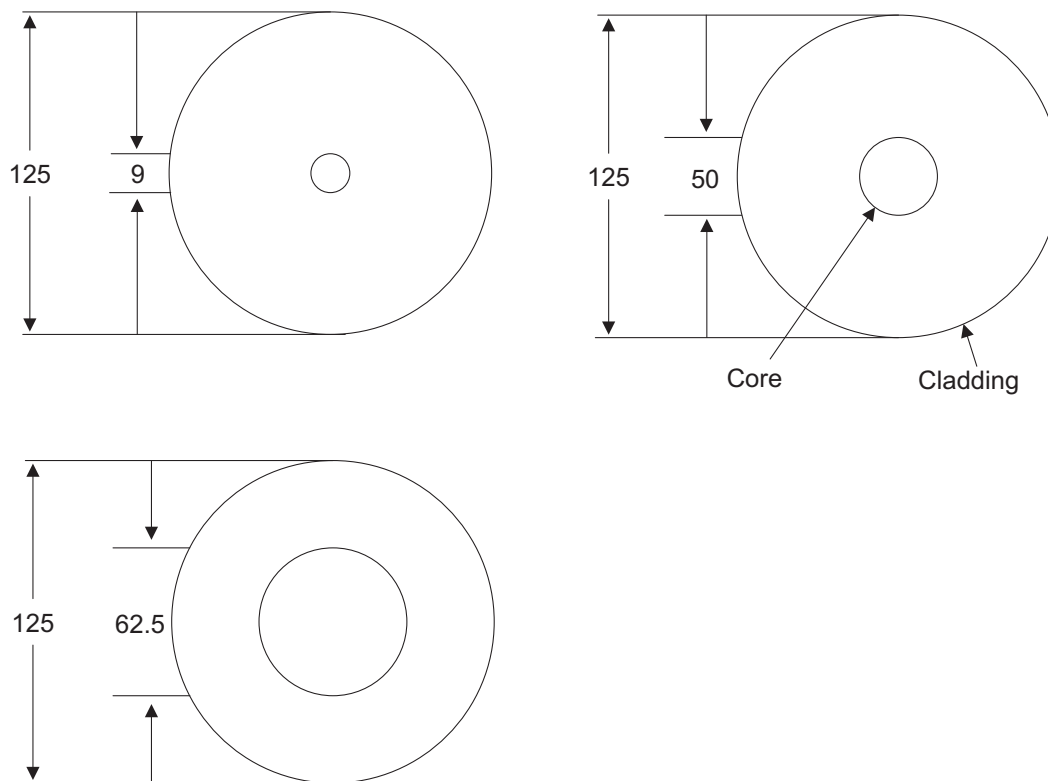


Figure 1. Fiber Media Types

The capability of each fiber in terms of its bandwidth (and distance) is a function of transceiver type and the optical properties of the fiber used. In general, fiber is commonly used in backbone installations in the following situations:

- Faster convergence for network resiliency recovering from faults or changes
- Outdoor or between buildings
- When the distance is beyond the reach of copper (100 m)
- For immunity from EMI

Single-mode fiber electronics are much more expensive than multimode equivalents and are generally deployed in long-distance applications that are beyond the capability of their multi-mode counterparts (see [Table 2](#)). Also, fibers with a smaller multi-mode core size (50 μm versus 62.5 μm) support higher bandwidth and longer distances for applications.

Table 2. Fiber Optics Modes

MULTIMODE		SINGLE MODE	
PROS	CONS	PROS	CONS
<ul style="list-style-type: none"> • Lower total system cost • Lower cost transceivers • Lower cost connectors • Less complex to terminate in field 	<ul style="list-style-type: none"> • Higher fiber media cost 	<ul style="list-style-type: none"> • Higher bandwidth capabilities • Longer distance • Lower fiber media cost 	<ul style="list-style-type: none"> • Higher total system cost • Higher cost transceivers • Higher cost connectors • More complex to terminate in field



The ST connector for fiber uses a bayonet locking system.



The SC connector for fiber features a molded body and a push-pull locking system.

Figure 2. ST and SC Connector Descriptions

1.4 Media Converters: The Migration Tool for Copper-to-Fiber Connectivity

With the considerable cost and performance advantages of fiber, in theory every network would have a completely fiber horizontal structure running from a fiber port on a data center switch to a fiber port on a PC. But in practice, copper is often installed simply because it is more familiar. Plus, many network devices have copper ports, and organizations cannot afford to replace the most expensive components of their networks: the electronics to install fiber.

One simple and inexpensive solution is offered by the media converter. The media converter connects the Ethernet through an RJ-45 port to an FO cable port with SC or ST glass fiber connections. This connection retains the collision domain between the two Ethernet participants and means that status transparency exchanges between the two Ethernet interfaces. The port status multi-mode glass fibers allow distances of up to 5,000 m to be bridged without intermediate repeaters. Single-mode fibers can be used over distances of up to 40 km. Network backbone and long-distance applications have long taken advantage of FO cable. However, horizontal fiber cabling has been widely regarded as impractical and too expensive for an application that doesn't need to cover long distances or move vast amounts of data. Fiber is regarded as expensive and difficult to install while copper is still the dominant cable type in local networks. But times have changed and fiber is gaining an edge over copper, especially for new installations, and is now often the first choice even for horizontal cabling, which has traditionally been copper.

Media converters are the key to integrating fiber into a copper infrastructure, making it possible to migrate a local network to fiber while extending the productive life of existing infrastructure. On the most basic level, media converters are simple networking devices that make it possible to connect two dissimilar media types. Although the most common type of media converter connects UTP to FO cable, media converters may also connect other cable types such as coax. Media converters are often used to connect legacy Ethernet equipment with copper ports to new fiber cabling. The converters may also be used in pairs to insert a fiber segment into a copper network to increase cabling distance.

1.5 Media Converter Features and Options

Media converters may be simple devices, but they come in a dizzying array of types. Newer media converters are often really a switch, which confuses the issue even more. Ethernet media converters are available in many configurations, with the most common being UTP to multi-mode or single-mode fiber, although UTP to thin coax (thinnet), UTP to thick coax (standard Ethernet), thin coax to fiber, and UTP to SFP are also available. On the copper side, most media converters have an RJ-45 connector for 10BASE-T, 100BASE-TX connectivity. The fiber side usually has a pair of ST or SC connectors, although newer compact connectors such as LC and MT-RJ are becoming increasingly common.

Media converters may support network speeds from 10 Mbps to 10 Gbps. Traditional media converters are purely Layer 1 devices that only convert electrical signals and physical media and do not do anything to the data coming through the link so they're totally transparent to data. These converters have only two ports—one port for each media type—and support one speed. Some media converters are more advanced Layer 2 Ethernet devices that, like traditional media converters, provide Layer 1 electrical and physical conversion. But unlike traditional media converters, these converters also provide Layer 2 services—in other words, they're really switches. This kind of media converter often has more than two ports, enabling the user to extend two or more copper links across a single-fiber link. These media converters usually feature auto-sensing ports on the copper side, making them useful for linking segments operating at different speeds. The introduction of Layer 2 converters has blurred the line between media converters and switches. The same device may be called a media converter or a switch by different vendors.

Form Factor

Media converters are available in standalone models that convert between two different media types, in chassis-based models that connect many different media types in a single housing, and in hybrid systems that feature standalone modules that also work in a chassis. Standalone converters have their own enclosure and power supply. These media converters are used individually to convert between two cable types. The converters are used either in pairs to extend a network over fiber or as remote units to a modular chassis-based system. Small standalone media converters easily tuck behind a PC to bring fiber to the desktop. These compact converters are ideal for use in small networks and for connecting remote sites but can quickly be outgrown as the network expands.

Chassis-based or modular media converter systems consist of chassis that house media converter modules. Chassis are usually rack mountable although desktop chassis are also available and provide power to the media converters. Chassis-based media converters are used primarily in data centers when many Ethernet segments of different media types need to be connected in a central location. These media converter systems offer great port density, but modules cannot be used on their own without a chassis. To use an individual module, install it in a compatible chassis. These systems are usually SNMP manageable.

Chassis systems provide unparalleled flexibility and enable mixing slide-in converters as required. For example, when combined with a 10/100/1000 Ethernet switch, LAN administrators can use modular converters to satisfy a wide range of requirements in network connectivity and distance, converting copper switch ports to multi-mode or single-mode fiber as needed. Modules in chassis systems can usually hot-swap, enabling quick network changes without taking the chassis offline. Hybrid media converter systems feature standalone media converters that can also be used in a rack mount chassis. Although these blended systems generally do not offer the high-end management features of enterprise-level chassis-based systems, they do offer a great deal of versatility and value because each media converter can be used and reused where it is needed most, whether mounted in a rack in a data center or working as an individual standalone unit on a desktop.

Power Options

Standard media converters come with an AC power supply that plugs into a standard wall outlet. It may be 120-V AC for domestic U.S. power only or may be an auto-sensing 120 to 240-V AC power supply that can be used domestically or easily converted to European power with a simple plug adapter. When media converters are used in areas that do not have convenient power outlets, they may be powered by Power over Ethernet (PoE), which provides power to network devices over the same Category 5 or higher UTP cable used for data. PoE media converters may also provide power through PoE to a PoE-powered device such as a security camera or wireless AP.

Small standalone media converters intended mainly for fiber-to-desktop applications may be USB powered, enabling them to draw their power from a PC's USB port. In chassis-based media converter systems, media converters or media converter modules draw their power from the chassis, which avoids the clutter of individual media converters that must be individually powered. Industrial media converters have demanding power requirements. Because the power supplied to industrial sites varies greatly, industrial media converters are either sold entirely separately from their power supply or are available with a choice of power supplies. Unlike standard networking devices, industrial media converters often require you to select the correct power supply for both device and application.

Hardening

Hardened, or industrial, media converters are intended for use outdoors or in areas that may be exposed to temperature fluctuations, moisture, dirt, and EMI. Hardened media converters are rated for a specific temperature range. Temperature tolerances from -13°F to 140°F (-25°C to 60°C) are common, and some media converters are rated for extreme temperatures from -40°F to 167°F (-40°C to 75°C). These media converters are usually housed in hardened metal cases that are sealed against contaminants including particulates such as airborne dust, moisture, and sometimes chemicals. Conformal coating is a special film or coating applied to electronic circuitry to provide additional protection from contaminants. Hardened media converters are often designed to be DIN rail mounted or have separate brackets for DIN rail mounting. Media converters for industrial applications are usually built to withstand higher EMI than those intended for office or data center use.

Link Loss Pass Through

When a network device such a switch detects that a link is broken, the *Link* indicator on its front panel goes out, alerting the network administrator that the connection is lost. The situation becomes a bit more complicated, however, when the switch has a media converter between it and its primary link. In this case, the switch can detect that the link to the media converter is broken but can't detect a broken link on the other side of the media converter. If the fiber link goes down, the switch does not notice because it still "sees" the media converter.

To counteract this problem, media converters commonly have a feature called link loss pass through, which simply means that the media converter passes the news of a broken link onward. In other words, when either a twisted-pair or a fiber link is broken, the information about this link loss is transferred to the other media link.

1.6 Media Converter Applications

Fiber is already established for LAN backbone applications, and now fiber is making inroads in horizontal cabling. Fiber carries more data than copper, making it more suitable for high throughput applications such as streaming media and VoIP. Additionally, as the price of copper rises, the price of installing fiber continues to fall, making it an economical choice as well. Copper-to-fiber media converters help to ease the financial shock of migrating network equipment to fiber. These media converters are a simple, inexpensive solution for matching copper ports to fiber infrastructure. From the data center to the desktop, from the CO to the home, media converters are bringing fiber connectivity to areas where copper has long been the medium of choice.

In the data center, media converters extend the productive life of existing copper-based switches, providing a gradual migration path from copper to fiber. Chassis-based media converters mount in racks alongside network switches, enabling the conversion of copper ports on legacy switches to fiber. Media converters can also be used with new copper switches that have fixed RJ-45 ports, which are significantly less expensive than the equivalent fiber switches. Here, network managers can convert only selected copper ports for multi-mode or single-mode fiber as needed, bringing versatility to the data center while bringing overall costs down.

But factors stand in the way of migrating copper infrastructure to fiber. First of all, there is the familiarity factor; if an IT staff is familiar with copper, they are likely to continue to install copper even if copper is not the best choice. Another major factor preventing the migration to fiber is the cost of changing network devices out for fiber versions. An enterprise switch is a major investment, and there is also the cost of adding fiber NICs to desktop PCs as well as other networked devices such as printers and wireless access points.

1.7 Copper-to-Fiber Media Converter with TI DP83849

NOTE: In this TI design, the DP83849 Demo II board is used as the media converter to demonstrate copper and fiber communication. This design has RJ-45 connectors for connecting the copper inputs and FO transceivers to connect the FO input. Provision to connect the required power supply from an external source is also provided on the EVM. Additionally, jumpers to configure the PHYTER™ to function as a media converter without the need for any software programming has been provided on this board.

Texas Instruments' innovative port switching offers system developers a host of unique, customizable features to meet the needs for specific applications. This novel feature is available in TI's multi-port Ethernet chips, starting with the PHYTER dual 10/100 Ethernet physical layer (PHY) transceiver (DP83849). The concept behind flexible port switching is to allow the system developer to configure each of the internal data paths independently. This approach offers significant advantages over other multi-port physical layer devices. In particular, the flexible assignment of the ports enables many options not available in multi-component PHY designs, including media conversion, cable extension, and port mirroring.

2 Design Features

The media converter board (DP83849 Demo II board) features:

- Multiple PHY addresses: Defaults are 00h (Port A), 01h (Port B) with increment even values through 30h (Port A) and odd values through 31h (Port B)
- Nine LEDs: One power, Two INTERRUPT, and six others (two LINK, two SPEED, two ACT/COL) dependent on the LED mode selected
- Strap options for ports (A and B): ED_EN, MDIX_EN, LED_CFG, and autonegotiation
- FX_EN jumper: Port B only
- SNI_MODE resistor: Works with MII_MODE pin to set 10-Mb SNI mode. See [Section 3.9: Strap Options of the DP83849IF datasheet](#) for details
- MII_MODE resistor: To set RMII mode. See [Section 3.9: Strap Options of the DP83849IF datasheet](#) for details
- EXTENDER_EN jumper: To set into Extender mode that DP83849IVS and DP83849IFVS support. See the [DP83849IF datasheet](#) for details
- CLK2MAC_DIS jumper: To disable clock to MAC output
- RESET_N jumper: To allow external reset
- PWR_DWN/INT jumper: To set the device into Interrupt mode

3 Block Diagram

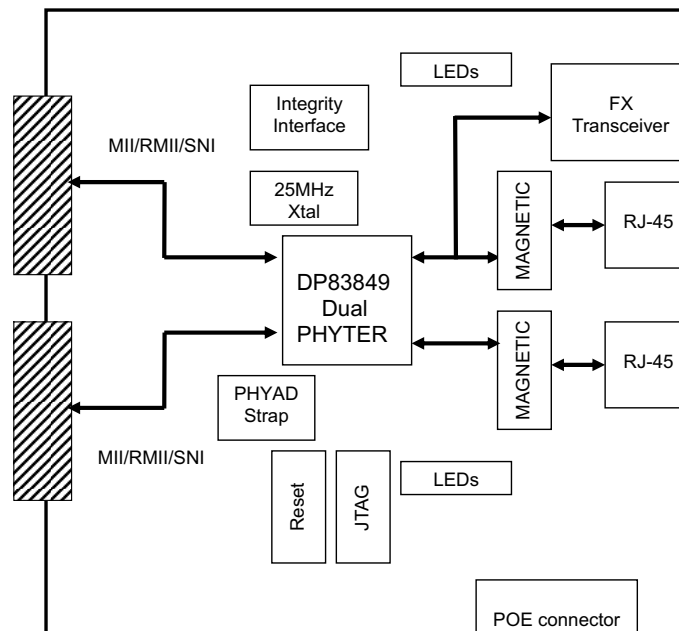


Figure 3. DP83849 Demo Board Block Diagram

The DP83849 demo board is used to test the media conversion. The demo board consists of

- Dual Ethernet PHY
- LEDs
- Jumper settings
- Power supply

3.1 DUAL Ethernet PHY

The PHY used as media converter is the DP83849IF. The DP83849IF is a DUAL industrial temperature PHY with fiber support (FX), which does not need any software conflagration to function as a copper-to-fiber media converter.

3.2 LEDs

Nine LEDs have been provided on the EVM.

Table 3. Parameters for the LEDs Provided in TIDA-00306

PARAMETER	NUMBER OF LEDs
Power	1
Interrupt	2
2 LINK, 2 SPEED, 2 ACT/COL, dependent on the LED mode selected	6

3.3 Jumper Settings for Media Converter

Jumpers have been provided onboard to configure the Ethernet PHY for different functionalities.

3.4 Power Supply

External 3.3-V power supply can be applied to the EVM for normal operation.

4 Circuit Design

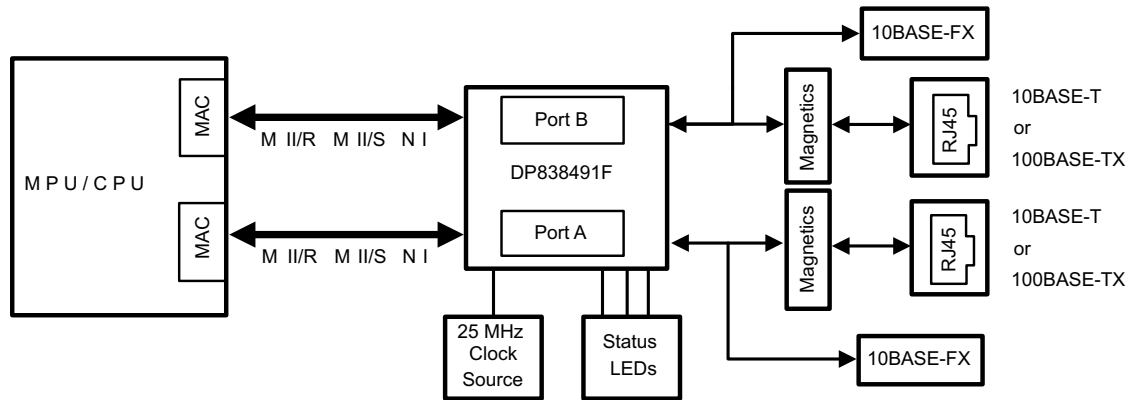
4.1 Dual Ethernet PHY

The Dual Ethernet PHY features:

- Low-power 3.3-V, 0.18- μ m CMOS technology detection
- Low power consumption: <600 mW typical
- 3.3-V MAC interface and filters
- Auto-MDIX for 10/100 Mbps
- IEEE 802.3u PCS, 100BASE-TX transceivers
- IEEE 802.3u 100BASE-FX fiber interface
- Dynamic link quality monitoring
- Flexible MII port assignment
- Integrated ANSI X3.263-compliant TP-PMD
- TDR-based cable diagnostic and cable length physical sub-layer with adaptive equalization detection and baseline wander compensation
- Optimized latency for real-time Ethernet
- Programmable LED support for link, 10/100-Mbps operation mode, activity, duplex, and collision
- Single register access for complete PHY
- SNI interface (configurable) status
- MII serial management interface (MDC and MDIO)
- 80-pin TQFP package (12 \times 12 mm)

The DP83849IF pins are classified into the following interface (See the [DP83849IF datasheet](#) for details):

- Serial management interface
- MAC data interface
- Clock interface
- LED interface
- JTAG interface
- Reset and power down
- Strap options
- 10/100-Mbps PMD interface
- Special connect pins
- Power and ground pins



Typical Application

Figure 4. Typical Application Using DP83849IF

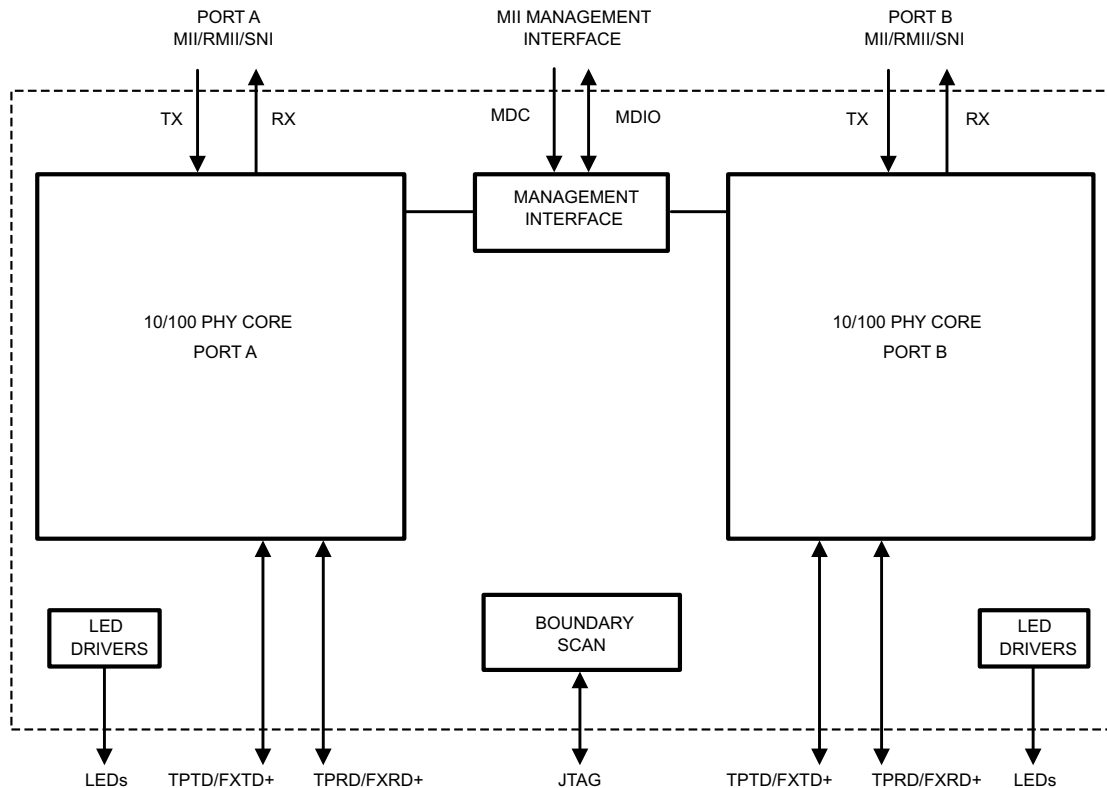


Figure 5. Function Block Diagram for DP83849IF

4.1.1 Media Converter Configuration

The DP83849IF supports both twisted pair (100BASE-TX and 10BASE-T) and fiber (100BASE-FX) media. Each port may be independently configured for twisted pair (TP) or fiber (FX) operation by strap option or by register access.

At power-up or reset, the state of the COL_A and COL_B pins select the media for ports A and B, respectively. The default selection is TP mode while an external pull-up selects FX mode. Strapping a port into FX mode also automatically sets the far-end fault enable, bit 3 of PCSR (16h), the scramble bypass, bit 1 of PCSR (16h), and the descrambler bypass, bit 0 of PCSR (16h). In addition, the media selection may be controlled by writing to bit 6, FX_EN, of PCSR (16h).

4.1.2 LED Interface

The DP83849IF supports three configurable LED pins for each port. Several functions can be multiplexed onto the three LEDs using three different modes of operation. The LED operation mode can be selected by writing to the LED_CFG[1:0] register bits in the PHY Control Register (PHYCR) at address 19h, bits [6:5]. In addition, LED_CFG[0] for each port can be set by a strap option on the CRS_A and CRS_B pins. LED_CFG[1] is only controllable through register access and cannot be set by as strap pin.

Table 4. LED Mode Selection

MODE	LED_CFG[1]	LED_CFG[0]	LED_LINK	LED_SPEED	LED_ACT/LED_COL
1	Don't care	1	ON for good link OFF for no link	ON in 100 Mbps OFF in 10 Mbps	ON for activity OFF for no activity
2	0	0	ON for good link BLINK for activity	ON in 100 Mbps OFF in 10 Mbps	ON for collision OFF for no collision
3	1	0	ON for good link BLINK for activity	ON in 100 Mbps OFF in 10 Mbps	ON for full duplex OFF for half duplex

The LED_LINK pin in Mode 1 indicates the link status of the port. In 100BASE-T mode, a link is established as a result of input received amplitude compliant with the TP-PMD specifications, which results in internal generation of signal detect. A 10-Mbps link is established as a result of the reception of at least seven consecutive normal link pulses or the reception of a valid 10BASE-T packet. This reception causes LED_LINK to assert. LED_LINK will de-assert in accordance with the link loss timer as specified in the IEEE 802.3 specifications.

The LED_LINK pin in Mode 1 will be *OFF* when no link is present. The LED_LINK pin in Mode 2 and Mode 3 will be *ON* to indicate that the link is good and *BLINK* to indicate activity is present on activity. The *BLINK* frequency is defined in BLINK_FREQ, bits [7:6] of register LEDCR (18h).

Activity is defined as configured in LEDACT_RX, bit 8 of register LEDCR (18h). If LEDACT_RX is 0, activity is signaled for either transmit or receive. If LEDACT_RX is 1, activity is only signaled for receive. The LED_SPEED pin indicates a 10- or 100-Mbps data rate of the port. The LED is on when operating in 100Mbps mode and off when operating in 10-Mbps mode. The functionality of this LED is independent of mode selected.

The LED_ACT/LED_COL pin in Mode 1 indicates the presence of either transmit or receive activity. The LED will be on for activity and off for no activity. In Mode 2, this pin indicates the collision status of the port. The LED will be on for collision and off for no collision. The LED_ACT/LED_COL pin in Mode 3 indicates duplex status for 10- or 100-Mbps operation. The LED will be on for full duplex and off for half duplex. In 10-Mbps half-duplex mode, the collision LED is based on the COL signal. Since these LED pins are also used as strap options, the polarity of the LED is dependent on whether the pin is pulled up or down.

4.1.3 Strapped Extender and Media Converter Mode

The DP83849IF provides a simple strap option to automatically configure both channels for extender and media converter mode with no device register configuration necessary. The EXTENDER_EN strap can be used in conjunction with the autonegotiation straps (AN_EN, AN0, AN1), the RMII mode strap, and the fiber mode (FX_EN) strap to allow many possible configurations. If extender mode is strapped but RMII mode is not, both channels automatically configure for single-clock MII receive and transmit modes. The optional use of RMII mode in conjunction with extender mode allows flexibility in the system design.

Table 5. Common Configuration Modes

MODE	AUTONEGOTIATION STRAPS	FIBER MODE STRAPS
100-Mb Copper Extender	Both channels are forced to 100-Mb full duplex	Disabled for both channels
100-Mb Fiber Extender	N/A	Enabled for both channels
10-Mb Copper Extender	Both channels are forced to 10-Mb full duplex	Disabled for both channels
100-Mb Media Converter	One channel is forced to 100-Mb full duplex	Enabled for the other channel

4.1.4 Notes and Restrictions

For an extender and media converter, both channels must be operating at the same speed (10 or 100 Mbps). This match can be accomplished by using straps or channel register controls. Both channels must be in full-duplex mode. Both channels must either be in RMII mode (RBR:RMII_EN = 1) or full single-clock MII mode (RBR:SCMII_RX = 1 and RBR:SCMII_TX = 1) to ensure synchronous operation. If only one RX to TX path is enabled, SCMII_RX in the RX channel (RBR register 17h bit 7) and SCMII_TX in the TX channel (RBR register 17h bit 6) must be set to 1. Media conversion is only supported in 100-Mb modes; one channel must be in fiber mode (100Base-FX) and the other channel must be in copper mode (100BASE-TX).

4.2 LEDs

Table 6. LEDs Used in TIDA-00306

FUNCTION	LED	JUMPER	SETTING
PLED_ACT/COL_B	D2	J42	Strapped-low
PLED_SPEED_B	D3	J43	Strapped-low
PLED_LINK_B	D4	J44	Strapped-high
PLED_LINK_A	D5	J45	Strapped-high
PLED_SPEED_A	D6	J46	Strapped-high
PLED_ACT/COL_A	D7	J47	Strapped-high

4.3 Jumper Settings for Media Converter

Table 7 describes the different jumpers, names, functions and settings for configuring the board for the media converter.

Table 7. Jumper Settings for TIDA-00306

JUMPER	NAME	FUNCTION	SETTING ⁽¹⁾
AUTONEGOTIATION			
J42	ANEN_B	Port B: Enable or disable autonegotiation	Strapped-low
J43	AN1_B	Port B: Forced or advertised operation mode in autonegotiation	Strapped-low
J44	AN0_B	Port B: Forced or advertised operation mode in autonegotiation	Strapped-high
J45	AN0_A	Port A: Forced or advertised operation mode in autonegotiation	Strapped-high
J46	AN1_A	Port A: Forced or advertised operation mode in autonegotiation	Strapped-high
J47	ANEN_A	Port A: Enable or disable autonegotiation	Strapped-high
FUNCTION			
J40	XTENDER_EN	Allow extender mode (For DP83849IVS/IFVS)	Strapped
J41	CLK2MAC_DIS	Disable clock to MAC output	
J48	PWRDOWN_INT_B	Port B: Allow power down and interrupt mode	
J49	ED_EN_B	Port B: Enable energy detect mode	
J50	FX_EN_B	Port B: Enable fiber mode (For DP83849IDVS/IFVS)	Strapped
J51	MDIX_EN_B	Port B: Enable or disable MDIX mode (default enables)	Strapped-high
J52	LED_CFG_B	Port B: Allow LED configuration. See the DP83849IF datasheet	
J55	LED_CFG_A	Port A: Allow LED configuration. See the DP83849IF datasheet	
J56	MDIX_EN_A	Port A: Enable or disable MDIX mode (default enables)	Strapped-high
J57	ED_EN_A	Port A: Enable energy detect mode	
J58	PWRDOWN_INT_A	Port A: Allow power down and interrupt mode	
J13	PCOL_A		Strapped
J92	3V3	Remove jumper on connector J92 in case an external 3.3-V power has to be applied. Use J13 ground pins	

⁽¹⁾ All blank settings are not applicable.

4.4 Power Supply

To apply an external 3.3 V, remove jumper J92 and use pin 1, labeled as 3V3, for (+) and pick the nearest ground pin for (-) connections.

Table 8. Power Consumption at 3.3-V Supply

PARAMETERS	POWER (mW)
Ethernet PHY: Single supply	600
FO: Transmit	600
FO: Receive	250
Total	1450

4.5 Fiber-Optic Cords for Ethernet Applications



Figure 6. Fiber-Optic Cords Examples

FO patch cords are ideal for high data-rate systems including FDDI, multimedia, Ethernet backbone, ATM, or any network that requires the transfer of large and time-consuming files.

Features include:

- Perfect for use in Ethernet applications
- High bandwidth supporting longer distances

[Table 9](#) lists the major specifications:

Table 9. Fiber-Optic Cable Specifications for TIDA-00306

HEADING 1	HEADING 2
First connector	SC duplex
Second connector	SC duplex
Cable diameter	0.12" (3.0 mm)
Cable type	Buffered fiber
Fiber type	62.5/125
Overall length	16.4' (5.0 m)
Type	Multimode, duplex

NOTE: The SC connector is an FO connector with a push-pull latching mechanism, which provides quick insertion and removal while also ensuring a positive connection.

5 Test Setup

5.1 Communication Interface Testing (Computer to Device)

Media converter mode, shown in Figure 7, allows conversion of copper to fiber and vice-versa at 100 Mbps. This configuration allows longer run fiber to be used in situations where fiber support is not built into the end device. This configuration can also be combined with power over Ethernet on the copper side.

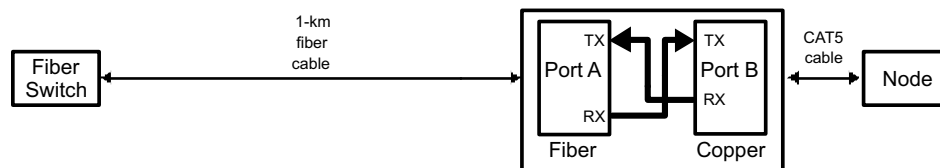


Figure 7. Media Converter Example

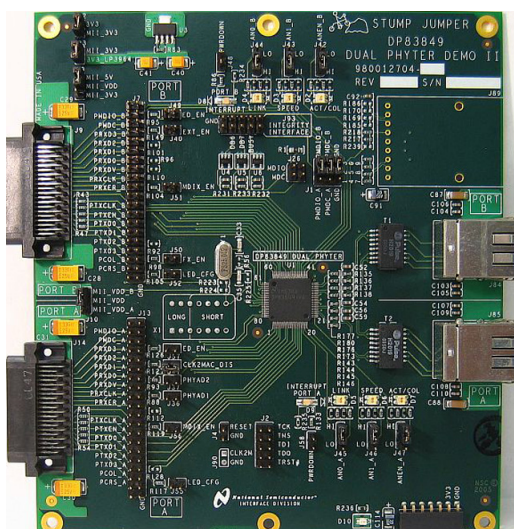


Figure 8. DP83849IVS-EVK with Copper and Fiber Options



Figure 9. DP83849IVS-EVK Connected with Fiber-Optic Brick

5.2 Media Converter Implementation

The PHYTER dual incorporates two methods of configuring the extender and media converter mode: through a simple strap option or register control. Note that the definitions of an extender and media converter only differ in their physical (copper or fiber) interfaces; the port swapping is the same. The optional use of RMI mode in conjunction with the extender and media converter mode allows flexibility in the system design.

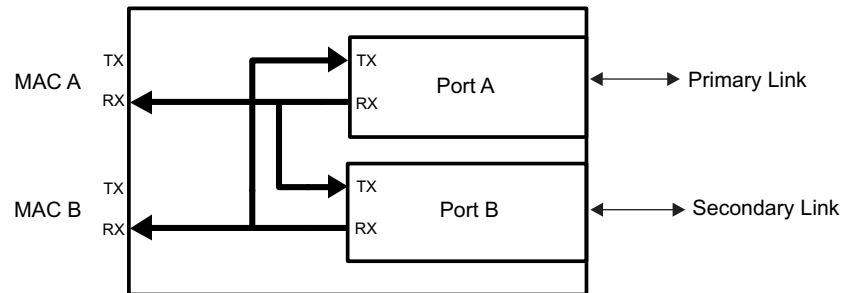


Figure 10. Media Converter (Strapped)

Several common configurations are shown in [Table 10](#). Note that either single-clock MII or RMI can be configured independently from the flexible port mode; however, both ports must be configured to the same common-clock mode. Because the EXTENDER_EN strap forces full-duplex mode (including autonegotiation advertisement), the AN0 (duplex) strap is not shown. If the receive MII ports are to be monitored, disable the energy detect and power-down modes.

Table 10. Common Strapped Extender and Media Converter Mode Configurations

MODE	AUTONEGOTIATION STRAPS				FIBER MODE STRAPS		NOTES
	AN_EN_A	AN1_A	AN_EN_B	AN1_B	FX_EN_A	FX_EN_B	
100-Mb Copper Extender	1	1	1	1	0	0	Advertise 10/100-Mb full duplex
	0	1	0	1	0	0	Force 100-Mb full duplex
100-Mb Fiber Extender	Don't care	Don't care	Don't care	Don't care	1	1	No autonegotiation
10-Mb Copper Extender	1	0	1	0	0	0	Advertise 10-Mb full duplex
	0	0	0	0	0	0	Force 10-Mb full duplex
100-Mb Media Converter	Don't care	Don't care	1	1	1	0	Port A fiber, B is copper with autonegotiation
	1	1	Don't care	Don't care	0	1	Port A is copper with autonegotiation, B is fiber
	Don't care	Don't care	0	1	1	0	Port A is fiber, B is copper forced
	0	1	Don't care	Don't care	0	1	Port A is copper forced, B is fiber

6 Test Results

The media converter interface connectivity tests have been tested as below.

6.1 Ping Test

A ping test can be used to determine whether the board can communicate with other devices and computers over the Ethernet network and is commonly used to troubleshoot network and LAN cable problems. Ping uses ICMP protocol to send the request to a target IP address at periodic intervals and measure the time it takes for a response to arrive. Ping results can confirm whether the connection succeeds or not.

If Ethernet communication is established, the result also displays the communication latency. The latency results can vary depending on the network traffic.

Ping test can be invoked from command prompt on windows using the following format:

- **ping <IP address> <options>**

Example: ping 172.168.0.1 -t

This command pings the IP address *172.168.0.1*. The option *-t* is used to ping the IP address repeatedly and periodically until it is stopped. By default, a ping command invocation sends four requests periodically.

If the ping request does not receive a response, check the Ethernet LEDs.

- If the link or activity LEDs do not blink, check if the Ethernet cable is properly inserted.
- Ensure that the board (DUT) and test PC have the IP address in the same subnet range.

If an Ethernet switch or hub is used to connect the DUT and test PC, ensure the appropriate link or activity LEDs are glowing.

NOTE: Link LEDs glow when the Ethernet cable is properly inserted.

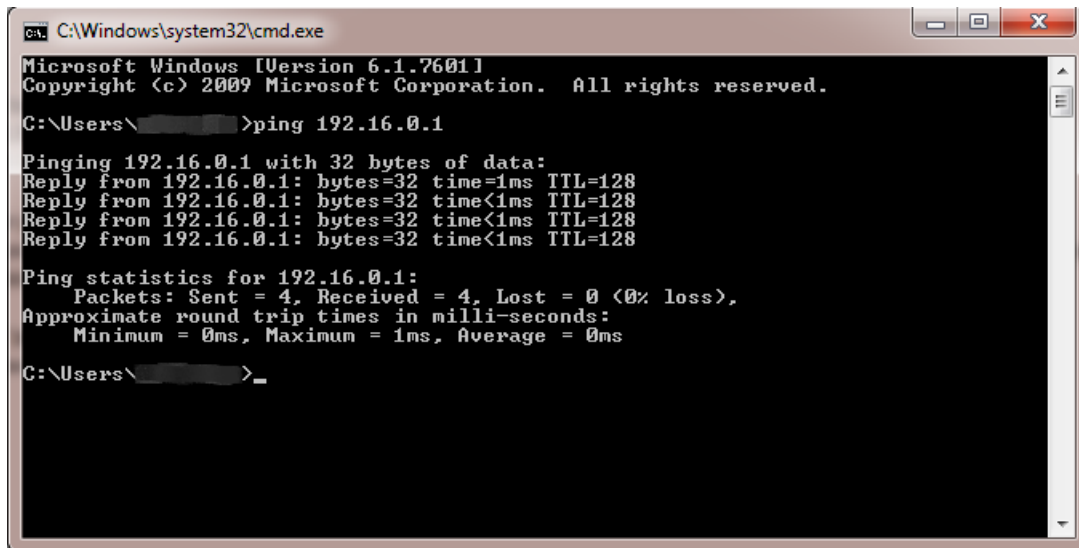
Activity LEDs glow when there is network traffic. For example, ping can be used to generate the traffic.

6.1.1 Communication Interface Testing (Computer to Device)—Ping Test

The ping test is done while both the boards are setup as [Section 5](#). Network connection settings for ping test are:

1. Go to *Network Connections*.
2. Go to *Local Area Connection*.
3. Right click for *Properties*.
4. Select *Internet Protocol Version 4 (TCP/IPv4)*.
5. Go to *Properties*.
6. Select *Use the following IP Address*.
7. Enter the IP address "192.16.0.100" and click on *Subnet Mask* (It should show 255.255.255.0).
8. Click *OK*.
9. Click *Close*.

Go to *Start*→*Run*→Type "cmd"→Type "ping 192.16.0.1" and click *Enter*. A window similar to [Figure 11](#) and show four replies.



```

C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\>ping 192.16.0.1

Pinging 192.16.0.1 with 32 bytes of data:
Reply from 192.16.0.1: bytes=32 time=1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128

Ping statistics for 192.16.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\>_

```

Figure 11. Ping Test

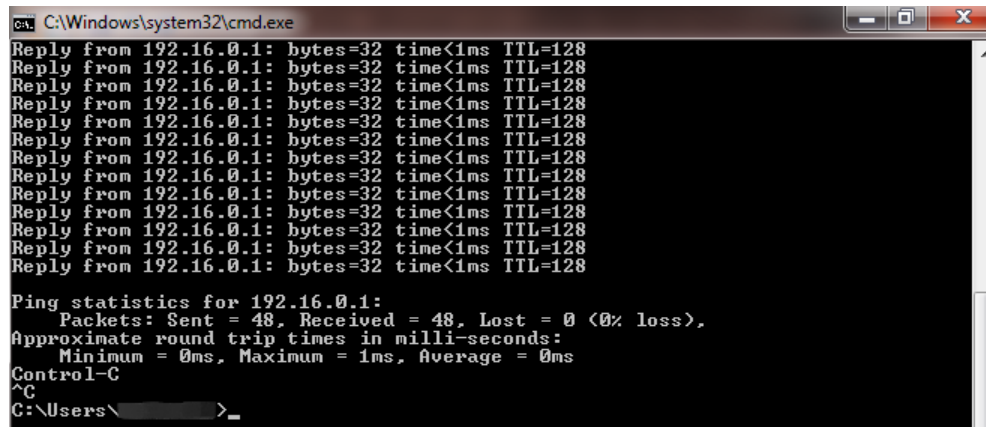
The replies from the IP address indicate the interface works well. Because the number of sent and received packets is the same, there is no packet loss. Now test this interface with the `-t` option over a period of time to check if there is a packet loss over a period of time.

For continued replies, type “ping 192.16.0.1 -t” and click the *Enter* key to show the following window and show continuous replies for the ping (see [Figure 12](#)).

[illegible]

Figure 12. Ping Test (for Continuous Replies)

To stop the ping requests, press **CTRL+C** or close the command prompt window. The command window shows the following window and the replies are stopped (see [Figure 13](#)).



```

C:\Windows\system32\cmd.exe
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128
Reply from 192.16.0.1: bytes=32 time<1ms TTL=128

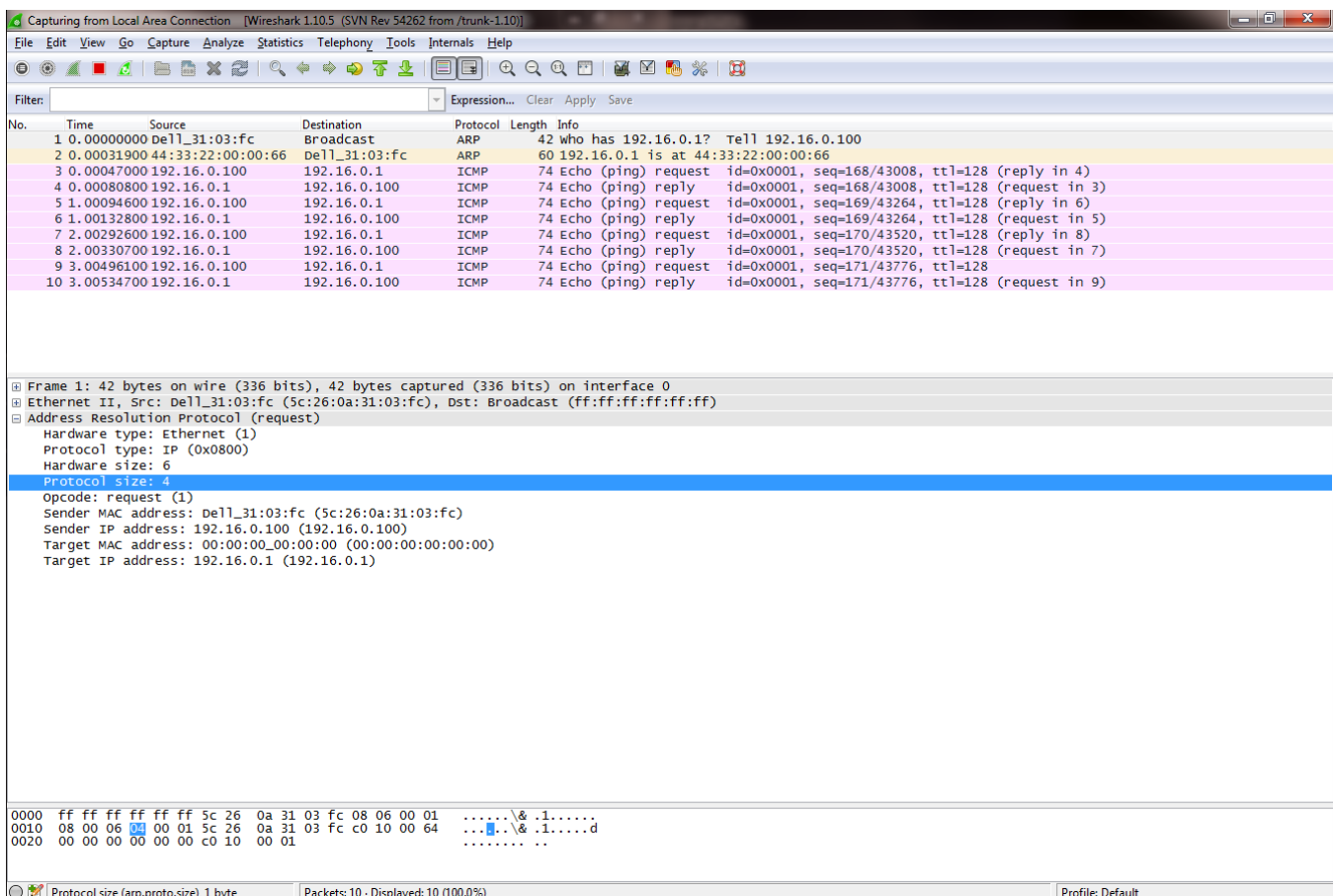
Ping statistics for 192.16.0.1:
    Packets: Sent = 48, Received = 48, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms
Control-C
^C
C:\Users\>

```

Figure 13. Ping Test Stopped

The results indicate no packet loss and the time to respond is less than or equal to 1 ms.

The data traffic can also be monitored using the Wireshark tool. To begin, open the Wireshark software, select the network *Local Area Connection*, go to the *Capture* menu, and click on *Start*. The window shows the requests and replies as shown in [Figure 14](#).



No.	Time	Source	Destination	Protocol	Length	Info
1	0.00000000	Dell_31:03:fc	Broadcast	ARP	42	who has 192.16.0.1? Tell 192.16.0.100
2	0.00031900	44:33:22:00:00:66	Dell_31:03:fc	ARP	60	192.16.0.1 is at 44:33:22:00:00:66
3	0.00047000	192.16.0.100	192.16.0.1	ICMP	74	Echo (ping) request id=0x0001, seq=168/43008, ttl=128 (reply in 4)
4	0.00080800	192.16.0.1	192.16.0.100	ICMP	74	Echo (ping) reply id=0x0001, seq=168/43008, ttl=128 (request in 3)
5	1.00094600	192.16.0.100	192.16.0.1	ICMP	74	Echo (ping) request id=0x0001, seq=169/43264, ttl=128 (reply in 6)
6	1.00132800	192.16.0.1	192.16.0.100	ICMP	74	Echo (ping) reply id=0x0001, seq=169/43264, ttl=128 (request in 5)
7	2.00292600	192.16.0.100	192.16.0.1	ICMP	74	Echo (ping) request id=0x0001, seq=170/43520, ttl=128 (reply in 8)
8	2.00330700	192.16.0.1	192.16.0.100	ICMP	74	Echo (ping) reply id=0x0001, seq=170/43520, ttl=128 (request in 7)
9	3.00496100	192.16.0.100	192.16.0.1	ICMP	74	Echo (ping) request id=0x0001, seq=171/43776, ttl=128
10	3.00534700	192.16.0.1	192.16.0.100	ICMP	74	Echo (ping) reply id=0x0001, seq=171/43776, ttl=128 (request in 9)

Frame 1: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0	
Ethernet II, Src: Dell_31:03:fc (5c:26:0a:31:03:fc), Dst: Broadcast (ff:ff:ff:ff:ff:ff)	
Address Resolution Protocol (Request)	
Hardware type: Ethernet (1)	
Protocol type: IP (0x0800)	
Hardware size: 6	
Protocol size: 4	
Opcode: request (1)	
Sender MAC address: Dell_31:03:fc (5c:26:0a:31:03:fc)	
Sender IP address: 192.16.0.100 (192.16.0.100)	
Target MAC address: 00:00:00:00:00:00 (00:00:00:00:00:00)	
Target IP address: 192.16.0.1 (192.16.0.1)	

Offset	Hex	ASCII
0000	ff ff ff ff ff 5c 26 0a 31 03 fc 08 06 00 01&.1.....
0010	08 00 06 00 00 01 5c 26 0a 31 03 fc c0 10 00 64	...&.1.....d
0020	00 00 00 00 00 00 c0 10 00 01

Figure 14. Wireshark Results for Data Traffic

The results on a sniffer like Wireshark can be used for troubleshooting and debugging.

6.2 Web Server Interface

The web server is used to demonstrate a real application (TCP/IP layer). The web page can be refreshed manually (F5 key) to reload the web page, thus creating traffic on Ethernet. The ability to invoke traffic on Ethernet as and when required can be very useful when performing EMI/EMC tests.

6.2.1 Communication Interface Testing (Computer to Device)—Web Server Test

The web server test is done with the same setup as [Section 5](#). The settings for web server test are:

1. Launch *Internet Explorer*®.
2. Go to *Tools*.
3. Click on the *Internet Options* tab.
4. Go to the *Connections* tab.
5. Go to *LAN Settings*.
6. Unclick *Use automatic configuration script* and click *Automatically detect settings*.
7. Click *OK* and then *OK* again.

Type the IP address "http://192.16.0.1/" in the browser and click *Enter* to show the following window ([Figure 15](#)).

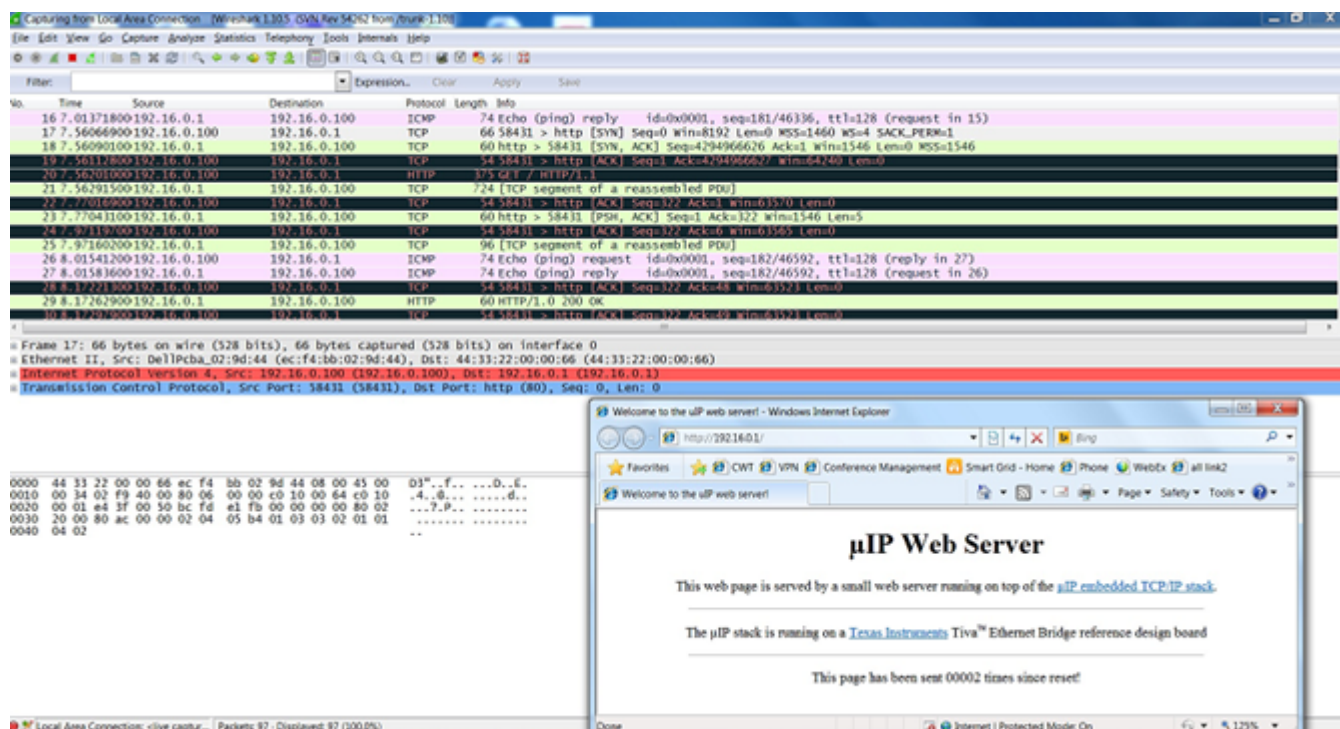


Figure 15. Web Server Test

The data traffic can also be monitored using the Wireshark tool. To begin, open the Wireshark software, select the network *Local Area Connection*, go to *Capture* menu, and click on *Start*. The window shows the requests and replies as shown in [Figure 16](#).

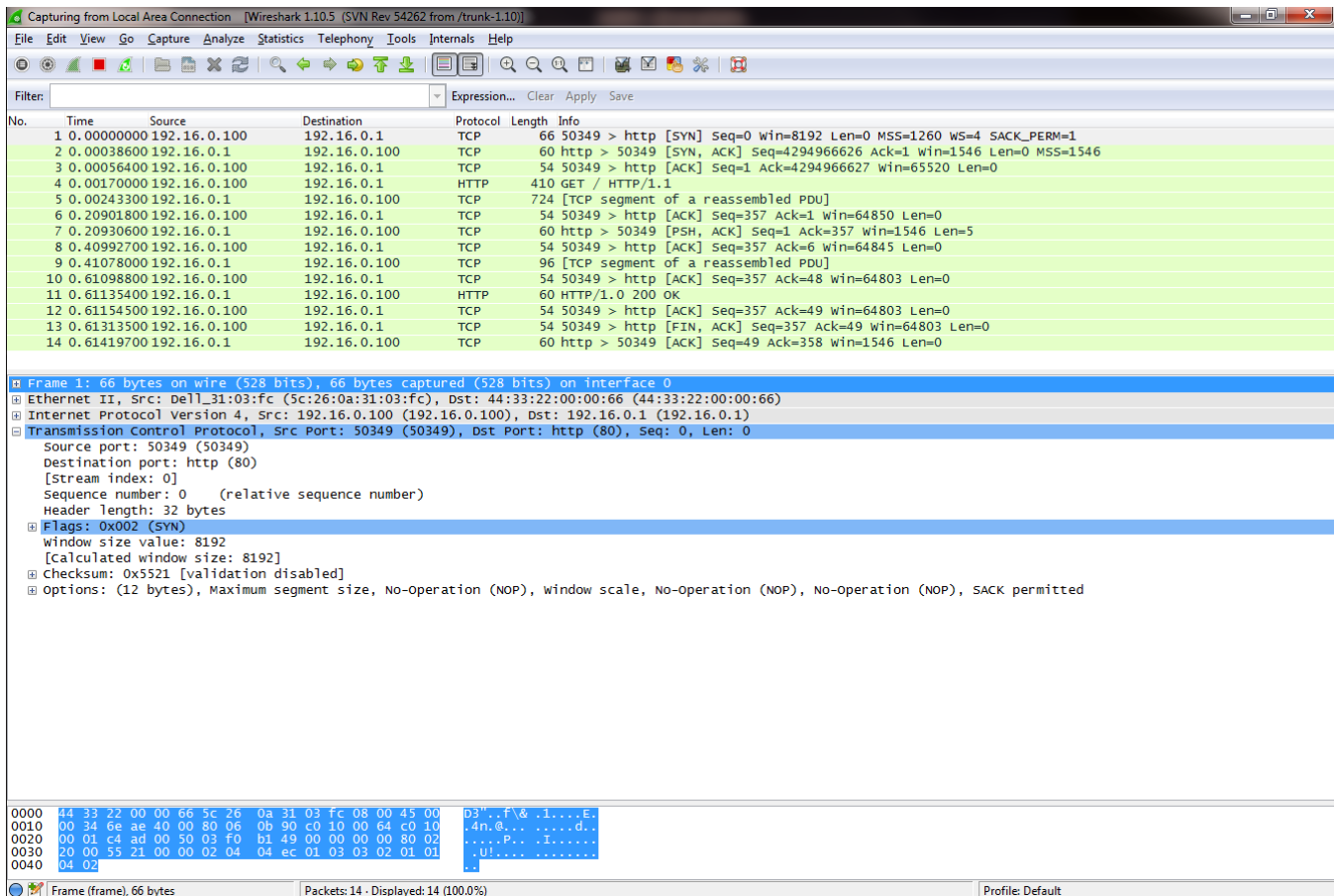


Figure 16. Data Traffic Capture for Web Server Test

Each time the page is refreshed, the count on the web page will be incremented. If the refresh count on the web page does not increase even after pressing F5, check the connectivity.

7 Design Files

7.1 Schematics

To download the schematics, see the design files at [TIDA-00306](#).

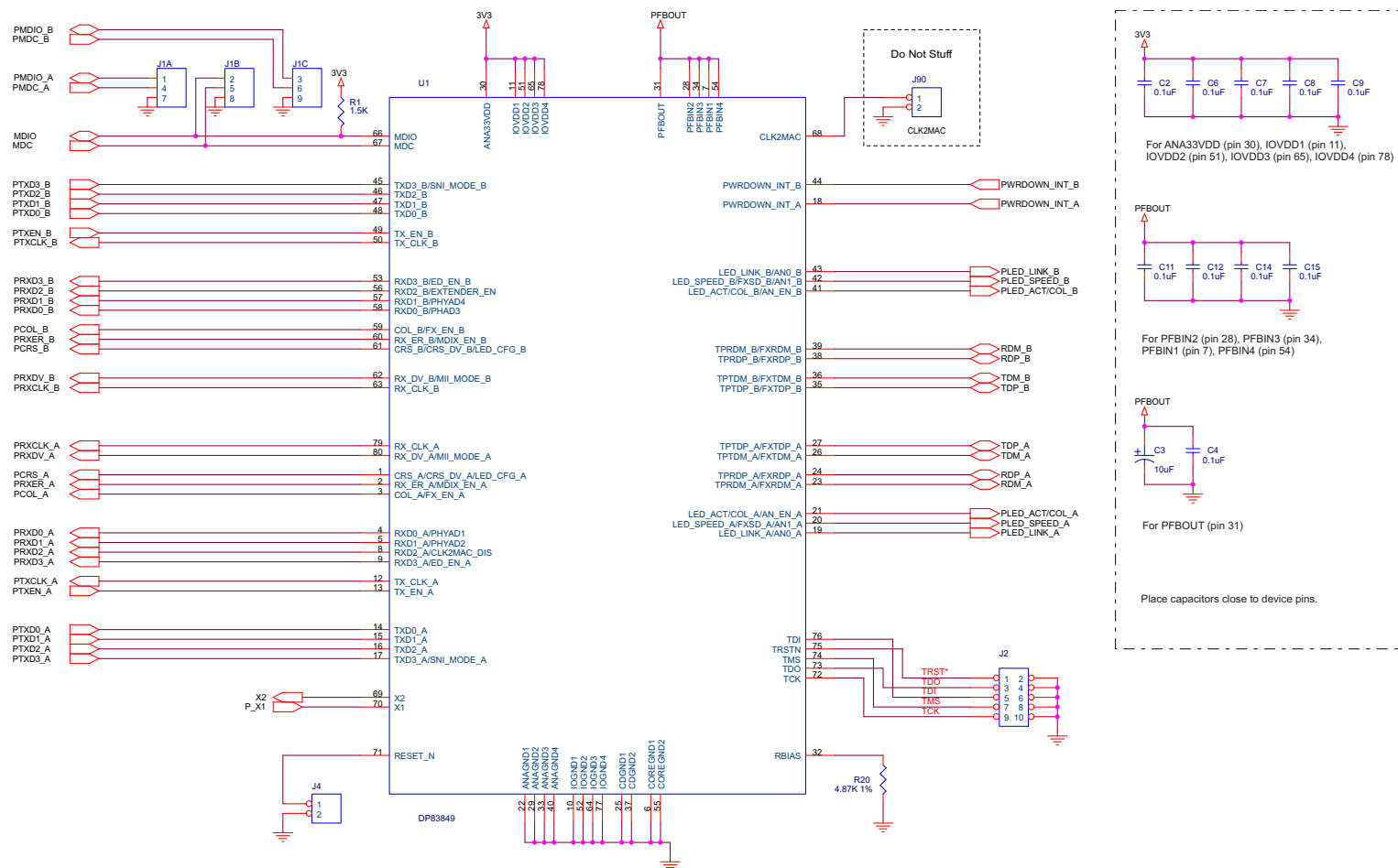




Figure 19. Port A TP Schematic

Note:

- For fiber operation, populate all items on this page.
- For copper operation, do not populate all items on this page.

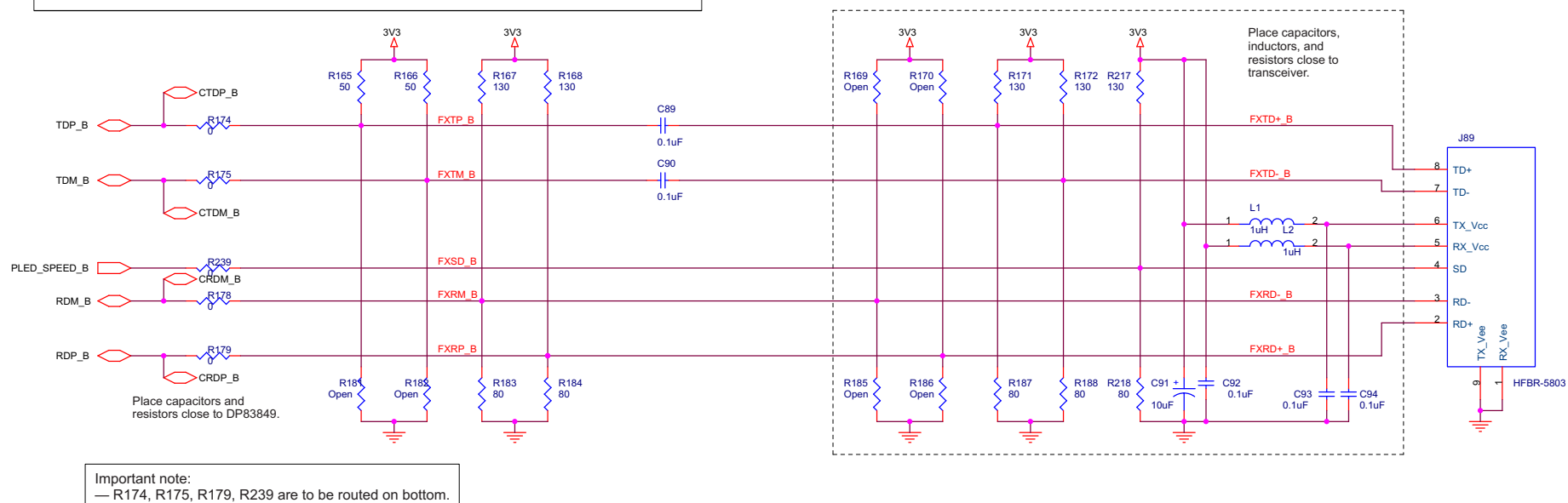


Figure 20. Port B FX Schematic

Note:
If using PoE switch, use port A.
The operation also requires baby board (to that effect).

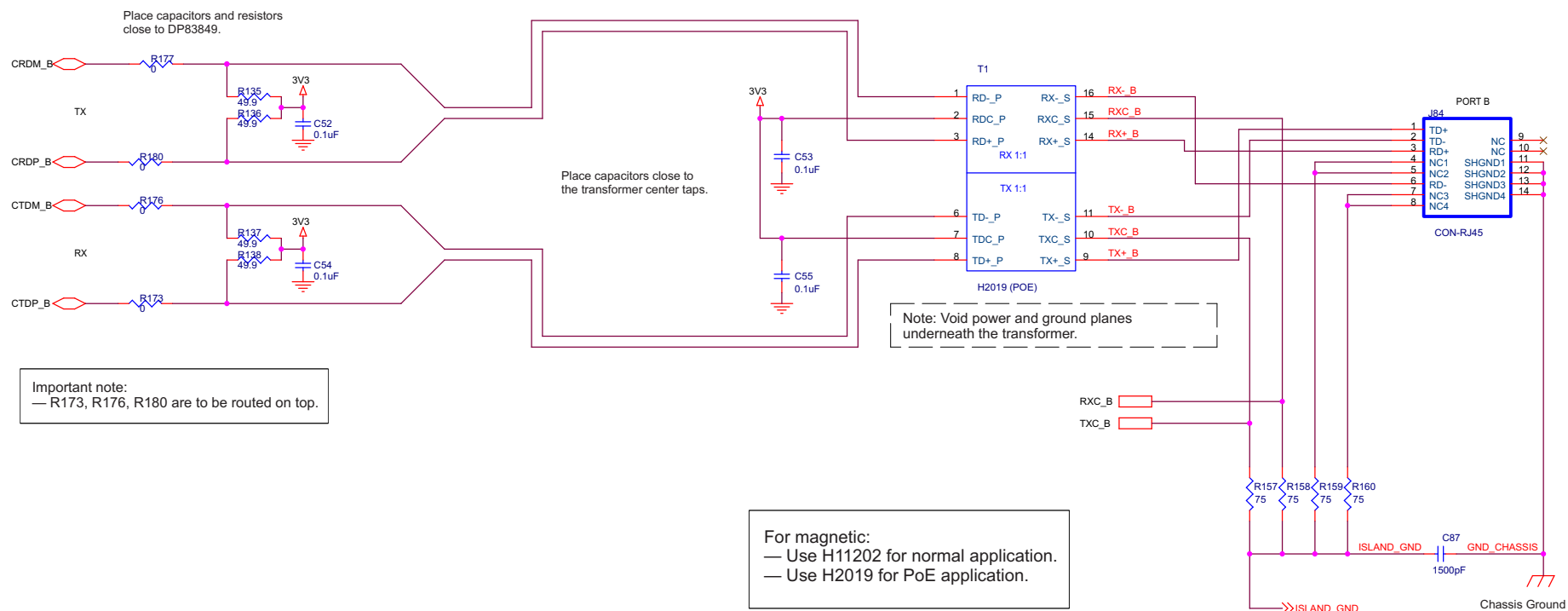
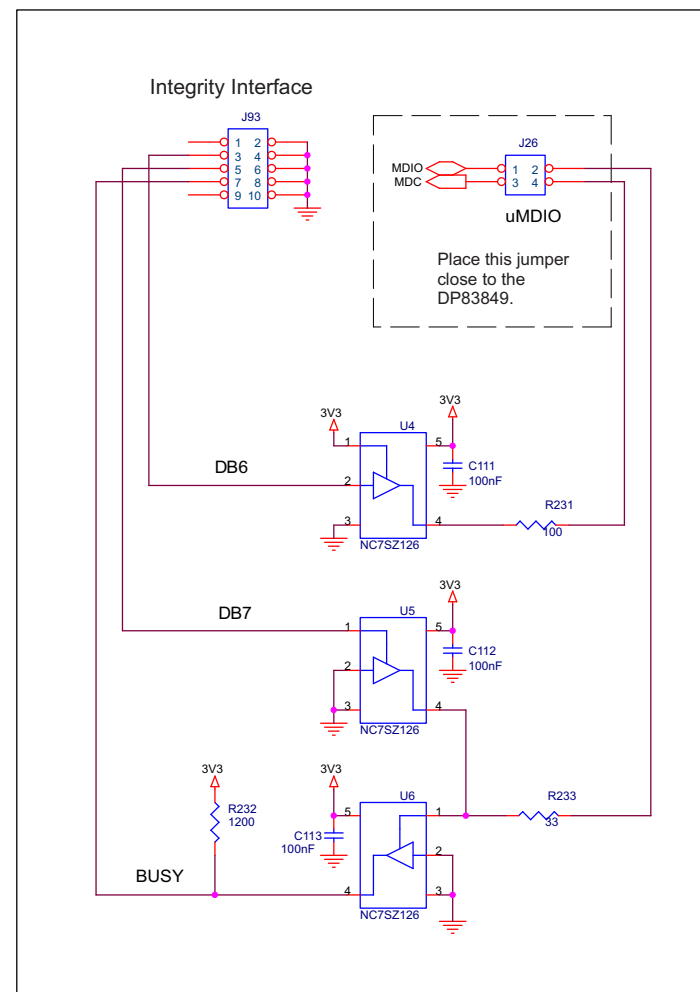


Figure 21. Port B TP Schematic



Copyright © 2014, Texas Instruments Incorporated

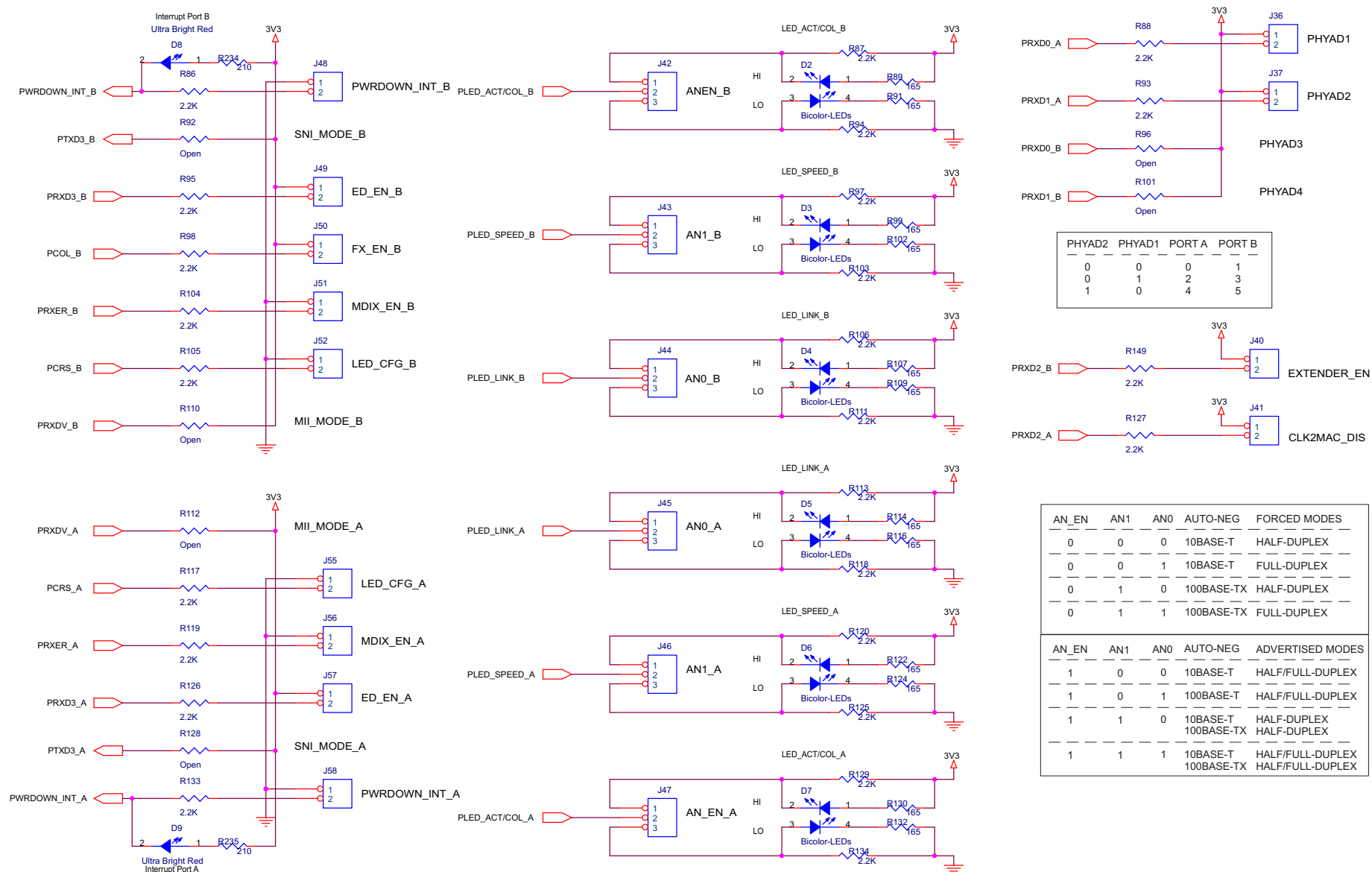


Figure 23. Strap Options Schematic

7.2 Bill of Materials

To download the bill of materials (BOM), see the design files at [TIDA-00306](#).

Table 11. BOM

ITEM	INSTALL	QTY	REFERENCE	DESCRIPTION	PACKAGE
1		27	C2, C4, C6, C7, C8, C9, C11, C12, C14, C15, C52, C53, C54, C55, C56, C57, C59, C60, C89, C90, C92, C93, C94, C103, C104, C107, C108	0.1 μ F, CAP, SMD, Ceramic, 0603 20% 16 V	SMD0603-A-1
2		1	C3	10 μ F, 7343 SMD, Tan, 20% 25 V	SMD07343
3		4	C28, C29, C30, C31	33U-7343 SMD, Tan, 20% 25 V	SMD07343
4		2	C33, C35	33 pF CAP, SMD, Ceramic, 0805 10% 50 V	SMD0805-A-1
5		1	C40	33 μ F, Tantalum, \pm 10%, 16 V 3528	SMD3528-B-1
6		1	C41	68 μ F, Tantalum, \pm 10%, 16 V 3528	SMD3528-B-1
7		2	C87, C88	1500 pF CAP, SMD, Ceramic, 1808 10% 2 KV	
8		1	C91	10 μ F CAP, SMD, Tant, 3528 10% 16 V	SMD3528-B-1
9		4	C105, C106, C109, C110	0.001 μ F CAP, SMD, Ceramic, 0603 20% 16 V	SMD0603-A-1
10		3	C111, C112, C113	100 nF CAP, SMD, Ceramic, 0603, 20%, 16 V	SMD0603-A-1
11		1	C114	10 μ F, Tantalum, \pm 10%, 16 V 3528	SMD3528-B-1
12		6	D2, D3, D4, D5, D6, D7	Bicolor-LEDs 7011X5/7	Digikey L61057CT_ND
13		2	D9, D8	Ultra-Bright Red Panasonic LNJ211R82RA	
14		1	D10	LTM673 OSRAM LTM673 Hyper-Bright LED	OSRAM/LTM673-R1S2-35
15		1	J1	HDR-3X3	HDR-3X3
16		1	J2	CON2x5_TH	CN-HDR2x5
17		17	J4, J23, J36, J37, J40, J41, J48, J49, J50, J51, J52, J55, J56, J57, J58, J90, J92	HDR-1X2	CN-HDR1X2
18		2	J13, J7	HDR-2X20	CN-MII-40P-RA-M
19		2	J8, J10	HDR-1X3	CN-HDR1X3
20	DNP	2	J9, J14	CON-MII-MALE	CN-MII-40P-RA-M
21		1	J26	HDR2X2	CN-HDR2X2
22		6	J42, J43, J44, J45, J46, J47	HDR_1X3	CN-HDR1X3
23		1	J85	CON-RJ45	CN-PHONE8P8C-RA-SHLD RJ-45 Connector
23a	DNP	1	J84	CON-RJ45	CN-PHONE8P8C-RA-SHLD RJ-45 Connector
24		1	J89	HFBR-5803	HFBR-5803 SC Connector
25		1	J91	POE Connector	Sullins PPPC071LGBN
26		1	J93	HDR2X5	CN-HDR2X5
27		2	L1, L2	1 μ H Murata LQM21N Series	LQM21NN1R0K10D Ferrite Inductor
28		1	R1	1.5 K, SMD, 0805 1/10 W 1%	SMD805-A-1 RES
29		1	R20	4.87 K 1% RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
30		10	R43, R44, R45, R46, R47, R50, R51, R52, R53, R54	33 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
31	DNP	7	R56, R92, R96, R101, R110, R112, R128	RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
32		1	R63	10 K, RES, SMD, 0603 1/16 W, 5%	SMD0603-A-1
33		25	R86, R87, R88, R93, R94, R95, R97, R98, R103, R104, R105, R106, R111, R113, R117, R118, R119, R120, R125, R126, R127, R129, R133, R134, R149	2.2 K RES, SMD, 0603 1/16 W 5%	SMD0603-A-1

Table 11. BOM (continued)

ITEM	INSTALL	QTY	REFERENCE	DESCRIPTION	PACKAGE
34		13	R89, R91, R99, R102, R107, R109, R114, R116, R122, R124, R130, R132, R236	165, RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
35		8	R135, R136, R137, R138, R143, R144, R145, R146	RES, 49.9 , SMD, 0603 1/16 W 1%	SMD0603-A-1
36		8	R157, R158, R159, R160, R161, R162, R163, R164	75 RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
37		2	R66, R165	50 RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
38		5	R167, R168, R171, R172, R217	130 RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
39	DNP	12	R169, R170, R181, R182, R185, R186, R226, R227, R228, R229, R237, R238	RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
40		9	R173, R174, R175, R176, R177, R178, R179, R180, R239	0 SRES, SMD, 0603 1/16 W 1%	SMD0603-A-1
41		5	R183, R184, R187, R188, R218	80 RES, SMD, 0603 1/16 W 1%	SMD0603-A-1
42		2	RR223, R224	22 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
43		1	R225	10 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
44		1	R231	100 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
45		1	R232	1200 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
46		1	R233	33 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
47		2	R234, R235	210 RES, SMD, 0603 1/16 W 5%	SMD0603-A-1
48	DNP	1	T1, T2	H2019 (POE) Magnetic Pulse/H1102/H2019	Pulse H1102/H2019
49		1	U1	DP83849 DUAL Industrial Temperature Ethernet PHY with Fiber Support (FX)	VHB80A
50		1	U3	LP3964, 3.3 V, 800 mA Voltage Regulator 5-to-3.3 V NSC/LP3964EMP-3.3	SOT223-5
51		3	U4, U5, U6	NC7SZ126 is a single buffer with 3-STATE output	SOT223-5
52	DNP	1	X1	50-MHz Oscillator (50 ppm), 3.3 V	50 MHz OSC14-4P
53		1	Y1	XTAL - Crystal, 25.000M	25M HC49-US
54		14	J1: 2-3, 5-6, 8-9; J8 MII_5V J23 MII_3V3; J92 MII_3V3 J10: MII_VDD_B J41; J42 HI; J43 HI; J44 HI J45 HI; J46 HI; J47 HI	Jumper 2Pos , 2.54-mm Pitch	Jumper setting

Table 12. Evaluation Board Configuration for MII/RMII

OPTION	REFERENCE
MII with copper configuration Do not stuff components	X1 R223, R224, R225 J90 R174, R175, R178, R179, R239 J89
MII with fiber configuration Do not stuff components	X1 R223, R224, R225 J90 R173, R176, R177, R180
RMII with copper configuration Do not stuff components	Y1 C33, C35 J90 R174, R175, R178, R179, R239 J89
RMII with fiber configuration Do not stuff components	X1 R223, R224, R225 J90 R173, R176, R177, R180

NOTE: FO interface cables that can be used for testing are:

- A36340-ND 6374039-3 CABLE ASSY SC-SC DUPLEX MM 3M
- AE10442-ND DK-2622-05 CABLE FIBER OPTIC DUAL SC-SC

7.3 Layer Plots

To download the layer plots, see the design files at [TIDA-00306](http://www.ti.com/lit/zip/TIDA-00306).

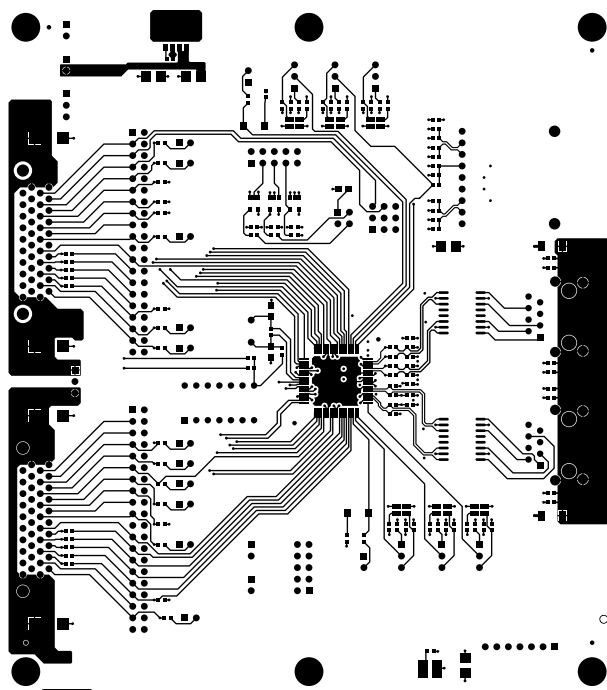


Figure 24. Top Etch

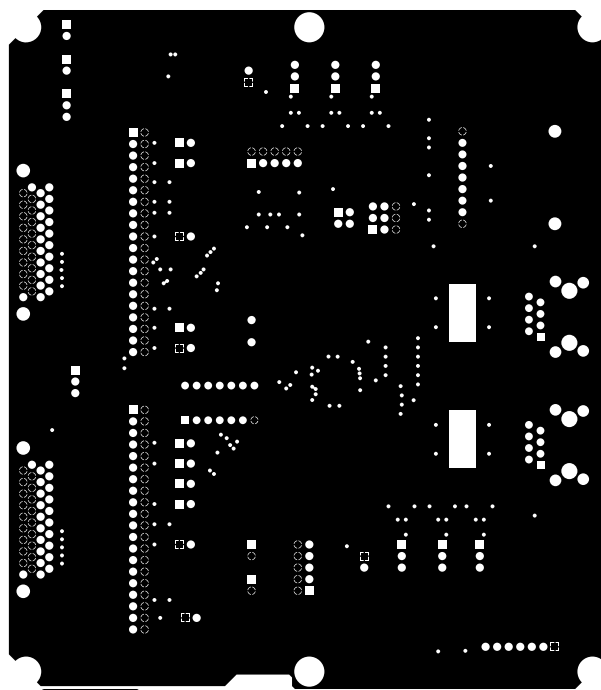


Figure 25. GND

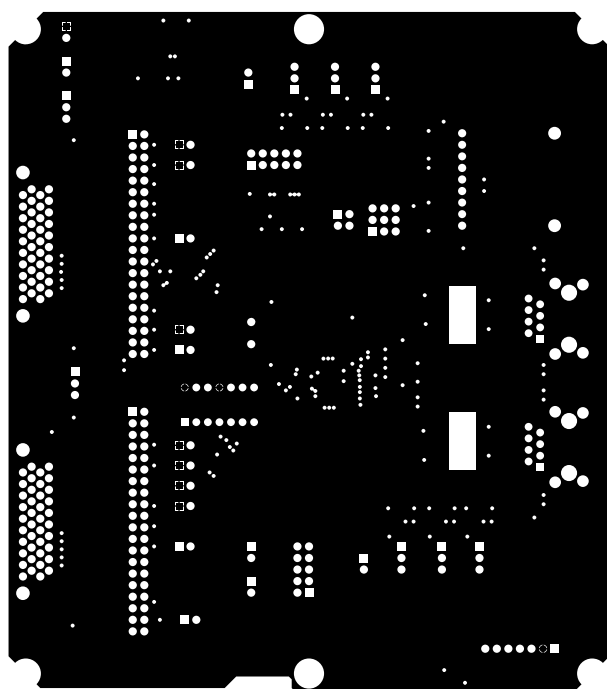


Figure 26. 3V3

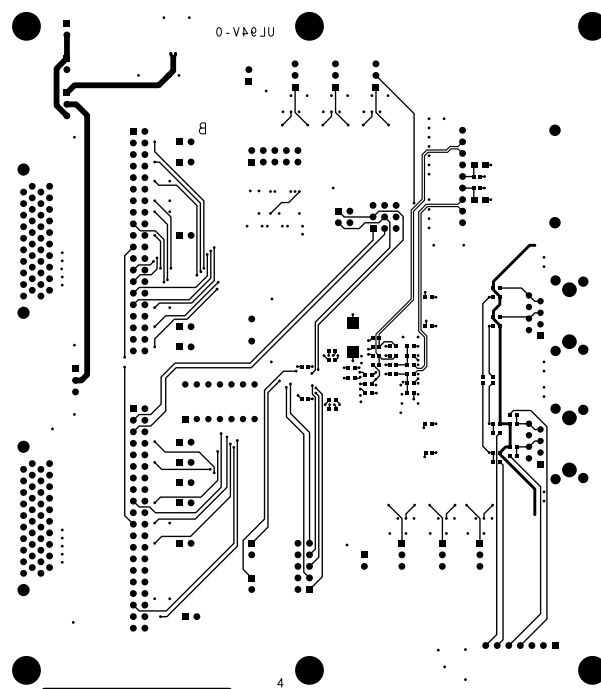


Figure 27. Bottom Etch

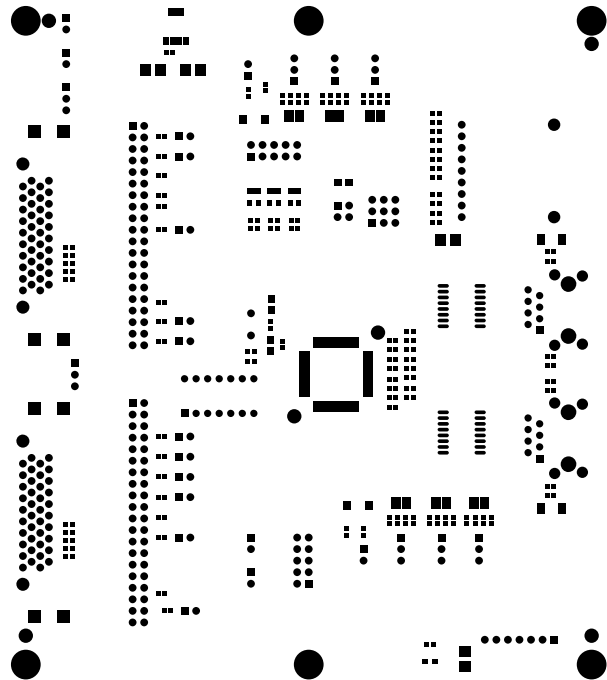


Figure 28. Top Solder Mask

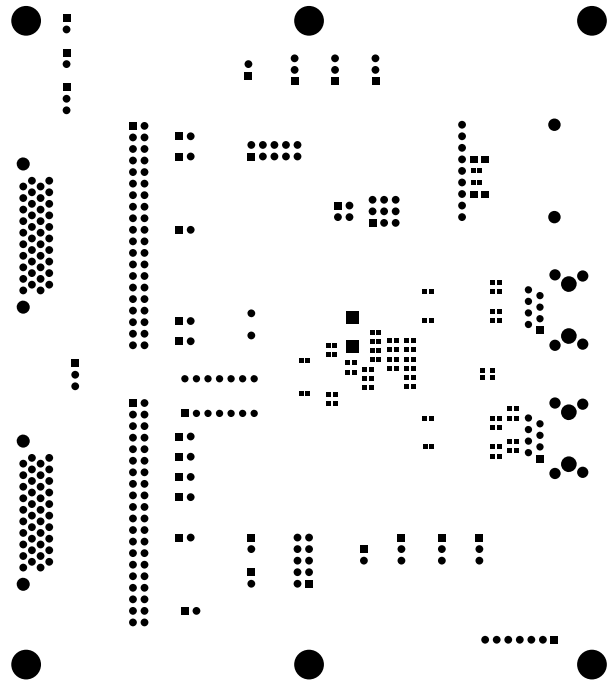


Figure 29. Bottom Solder Mask

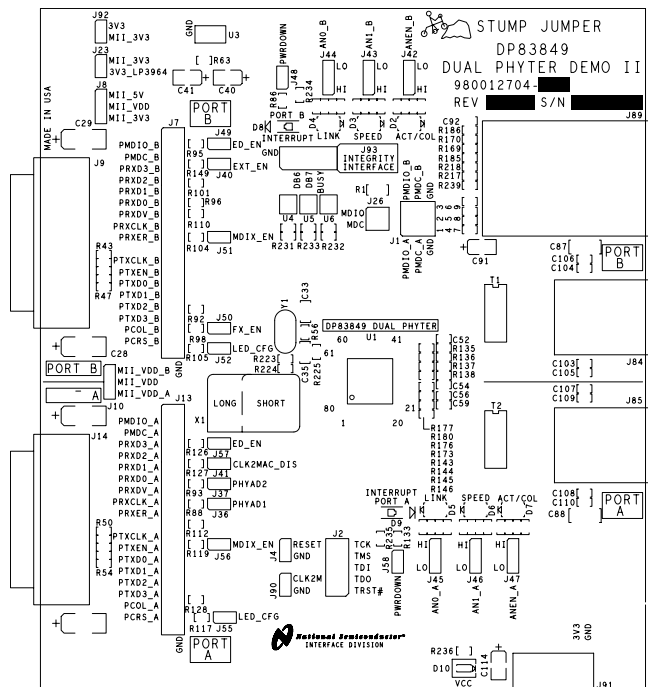


Figure 30. Top Silkscreen

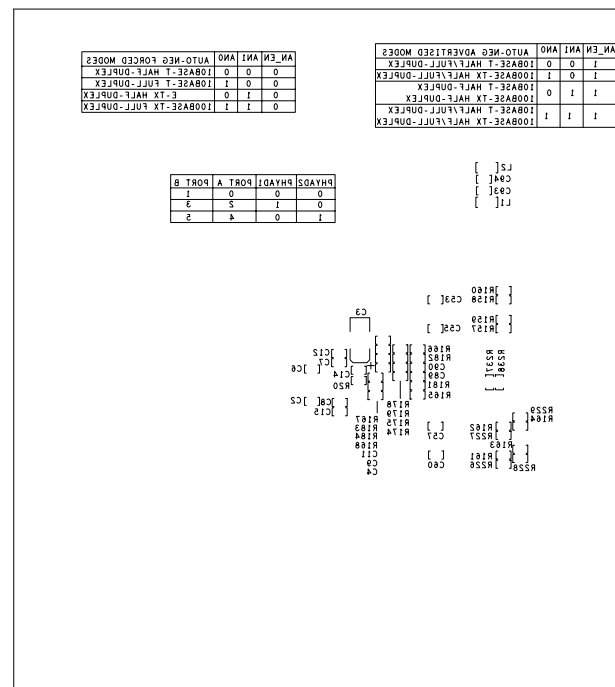


Figure 31. Bottom Silkscreen

7.4 Gerber Files

To download the Gerber files, see the design files at [TIDA-00306](#).

7.5 Assembly Drawings

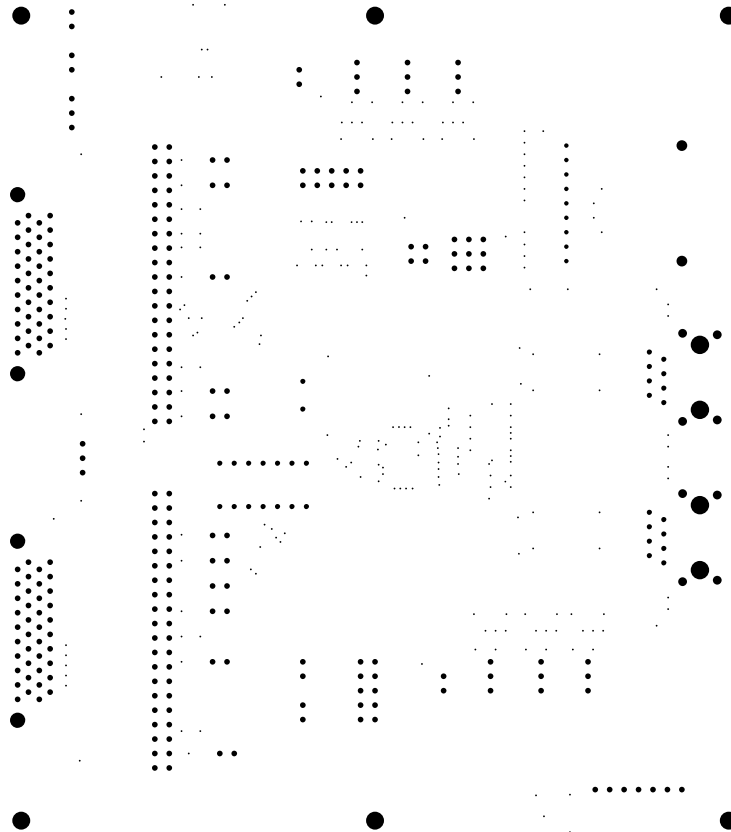


Figure 32. Drill Drawing

8 References

1. AN-1509 PHYTER Dual Flexible Port Switching ([SNLA086A](#))
2. Datasheet for DP83849IF PHYTER DUAL Industrial Temperature with Fiber Support (FX) and Flexible Port Switching Dual Port 10/100 Mbps Ethernet Physical Layer Transceiver ([DP83849IF](#))
3. DP83849IVS-EVK Purpose and Contents ([SNLU088](#))

9 About the Author

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