

Design Guide: TIDA-00306

Copper-to-Fiber 100BASE-FX or 1000BASE-X Media Converter Reference Design for Grid Applications



Description

This reference design details a methodology to use the DP83849 EVM to implement a 100BASE-TX to 100BASE-FX and the DP83869HM EVM to implement 100BASE-T to 100BASE-FX and 1000BASE-T to 1000BASE-X media converter, which enables copper-based legacy equipment to be easily connected to a fiber network in grid infrastructure applications. When reliable communication is required for longer distances or in harsh environments, near breakers or transformers in a substation switch yard, using fiber optic (FO) interface is preferred.

Resources

[TIDA-00306](#)

[DP83849I](#), [DP83849IF](#), [DP83869HM](#)

[MSP430F5529](#), [TPS732](#), [TPS709](#), [TPS735](#)

[TPS74701](#), [TL1963A](#), [TPD4E05U06D](#), [TPS737](#)

[DP83849IVS-EVK](#), [DP83869EVM](#)

Tool Folder

Product Folder

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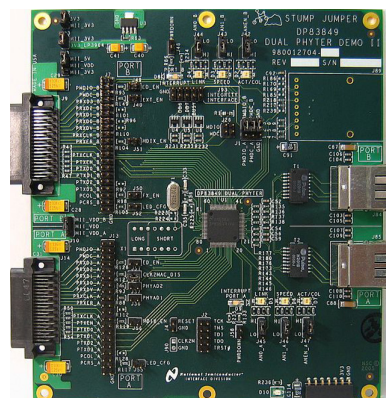
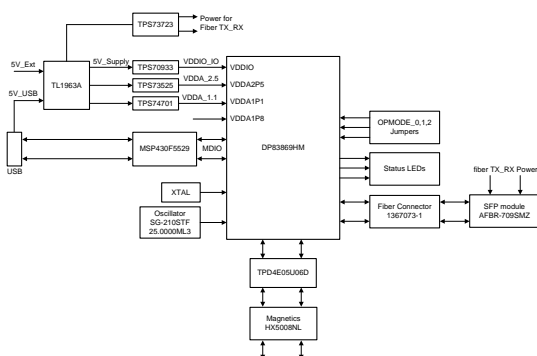
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Features

- Single-chip solution for 100BASE-FX or 1000BASE-X copper-to-FO media conversion
- Works as a media converter using pin straps without:
 - Interface to MCU or MPU
 - Software programming
- Media converter functionality configured by pin strapping of I/Os
- Well-suited for small size 100BASE-TX to 100BASE-FX or 1000Base-T to 1000Base-X media converter
- Same design (DP83849) can be used as dual 10/100 copper ethernet interface
- Supports three configurable LEDs for diagnostics
- Operates from a single 3.3-V (DP83849) or two (DP83869) power supply
- Temperature rating available up to 125°C
- Tested for EMI (DP83869) with 100BASE-T to 100BASE-FX and 1000BASE-T to 1000BASE-X configuration

Applications

- Ethernet-to-fiber media converters
- Substation automation controllers
- Protection relays
- Merging unit
- Terminal units





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1 System Description

Substation automation and distribution automation are key components in power transmission and distribution for utilities to reduce cost and improve the utilization of an existing network. Reliable communication infrastructure is critical for automation and, at the time of this publication, FO-based communication is currently being used in common applications. Most of the present automation systems have copper as the standard Ethernet interface port and replacing copper with fiber is expensive. Media converters provide a solution for low-cost Ethernet copper-to-FO conversion. This design uses the DP83849 PHYTER to implement a 10/100BASE-TX to 10/100BASE-FX media converter without a microcontroller (MCU) interface, which simplifies the design. The media converter enables the copper-based legacy equipment to easily connect to a newer, fiber-based system. The TIDA-00306 TI Design works with a single 3.3-V power supply. The board has been interfaced to the TIDA-00226 (serial-to-Ethernet converter) for communication and performance testing.

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

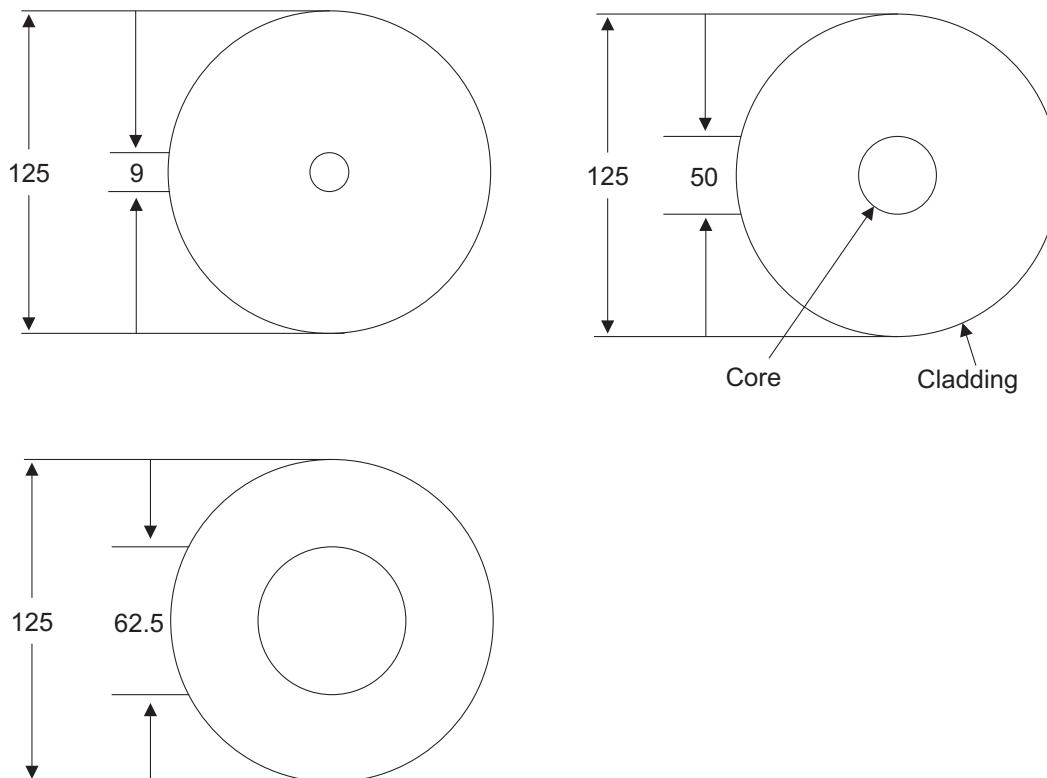


Figure 1. Fiber Media Types

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.

1.8 Copper-to-Fiber Media Converter With TI DP83869HM

The DP83869HM device is a robust, fully-featured Gigabit Physical Layer (PHY) transceiver with integrated PMD sublayers that supports 10BASE-Te, 100BASE-TX and 1000BASE-T Ethernet protocols. The DP83869 also supports 1000BASE-X and 100BASE-FX fiber protocols. Optimized for ESD protection, the DP83869HM exceeds 8-kV IEC 61000-4-2 (direct contact). This device interfaces to the MAC layer through reduced GMII (RGMII) and SGMII. In 100-M mode, the device uses MII for lower latency. Programmable integrated termination impedance on RGMII/MII helps reduce system BOM.

The DP83869HM supports media conversion in managed mode. In this mode, the DP83869HM can run 1000BASE-X-to-1000BASE-T and 100BASE-FX-to-100BASE-TX conversions. The DP83869HM can also generate IEEE 1588 Sync Frame Detect indications to MAC. This can reduce the jitter in time synchronization and help the system account for asymmetric delays in transmission and reception of packets. The DP83869 can also be used in media convertor mode, in RGMII-to-SGMII bridge applications, and in SGMII-RGMII bridge applications. Other key features include:

- Maximum ambient temperature of 125°C

- Exceeds 8-kV IEC61000-4-2 ESD
- Low power consumption of < 150 mW for 1000BASE-X and < 500 mW for 1000BASE-T
- Recovered clock output for SyncE
- Selectable synchronized clock output: 25 MHz and 125 MHz
- IEEE1588 support through SFD
- Configurable IO voltages: 1.8 V, 2.5 V, and 3.3 V
- Jumbo frame support for 1000-M and 100-M speeds
- Compatible to IEEE 802.3 1000BASE-T, 100BASE-TX, 10BASE-Te, 1000BASE-X, 100BASE-FX

2 Design Features

2.1 DP83849-Based Media Converter

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

2.2 DP83869-Based Media Converter

The media converter board (DP83869EVM) features:

- Multiple operating modes including media support: Copper and fiber, media conversion: Copper-to-fiber and bridge conversion: RGMII to SGMII, SGMII to RGMII
- RGMII and SGMII MAC Interfaces
- USB-2-MDIO support through onboard MSP430 for easy register access
- Onboard LDO and external power supply options
- Status LEDs including link, activity and power
- Bootstraps for hardware configuration

3 Block Diagram

3.1 Block Diagram for DP83869 Based Media Converter

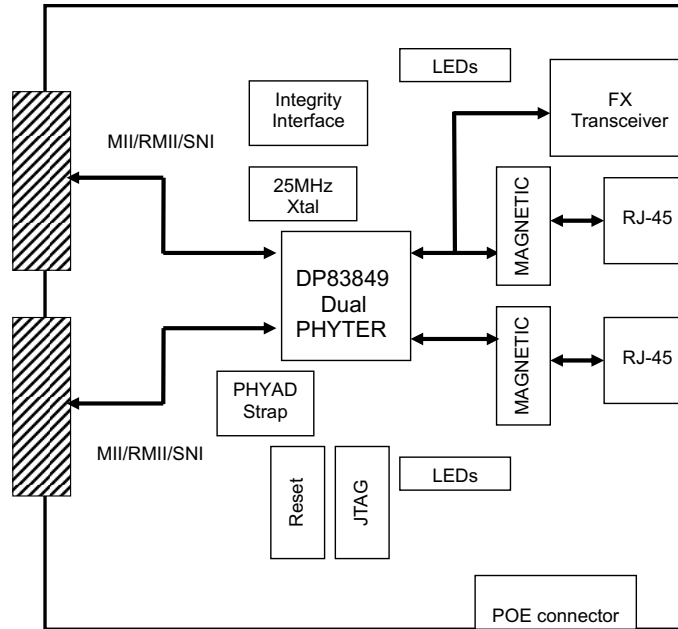


Figure 3. DP83849 Demo Board Block Diagram

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

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

3.1.1 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 configuration to function as a copper-to-fiber media converter.

3.1.2 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 |

3.1.3 Jumper Settings for Media Converter

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

3.1.4 Power Supply

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

3.2 Block Diagram for DP83869HM Based Media Converter

The DP83869HM EVM based media converter block diagram consists of

- DP83869HM, high-immunity 10/100/1000 Ethernet physical layer transceiver with copper and fiber interface
- MCU MSP430F5529 with USB interface for MDIO and BIST operation of DP83869HM
- Power supply rails generated using multiple LDOs
- Copper interface connector with ESD protection
- SFP module based fiber interface

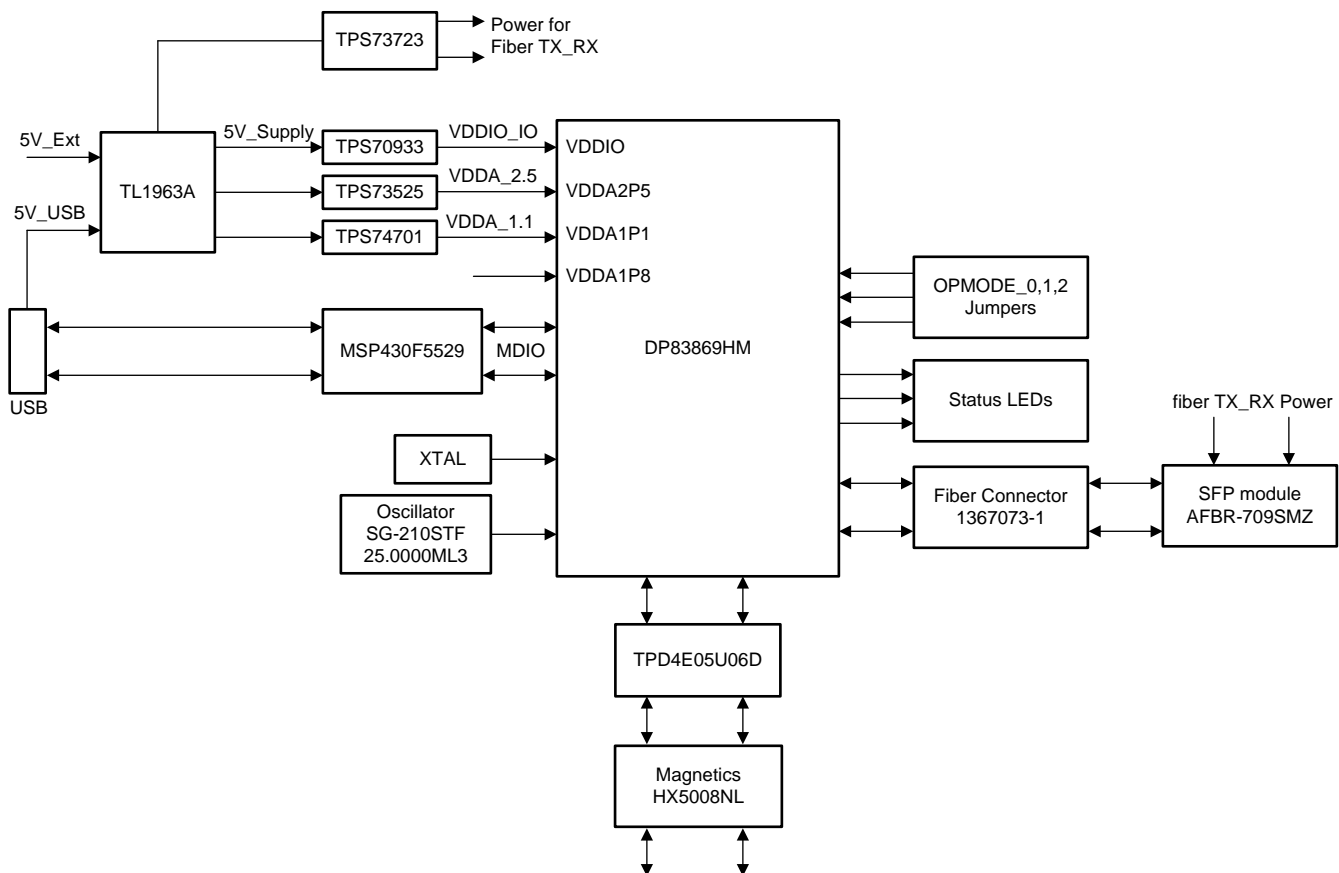


Figure 4. DP83869HMEVM Block Diagram

The DP83869HM is capable of operating with as few as two or three supplies. The I/O power supply can also be operated independently of the main device power supplies to provide flexibility for the MAC interface. There are two possible supply configurations that can be used: two supply and three supply. In a two supply configuration, no power rail is connected to VDDA1P8_x pins (pin 13, 48). When unused, pin 13 and 48 should be left floating with no components attached to them.

4 Circuit Design for DP83849 Based Media Converter

4.1 Circuit Design for DP83849 Based Media Converter

This section provides details of the DP83849EVM used for testing the media converter functionality.

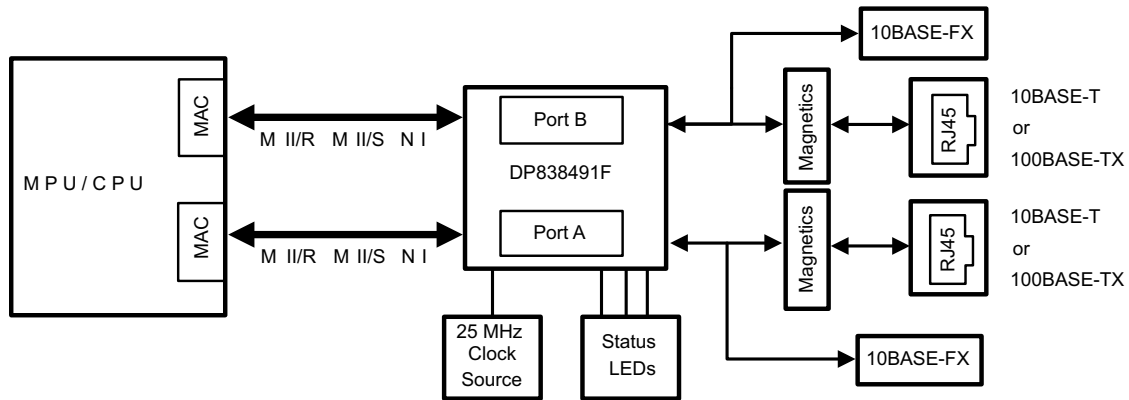
4.1.1 Dual Ethernet PHY

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 5. Typical Application Using DP83849IF

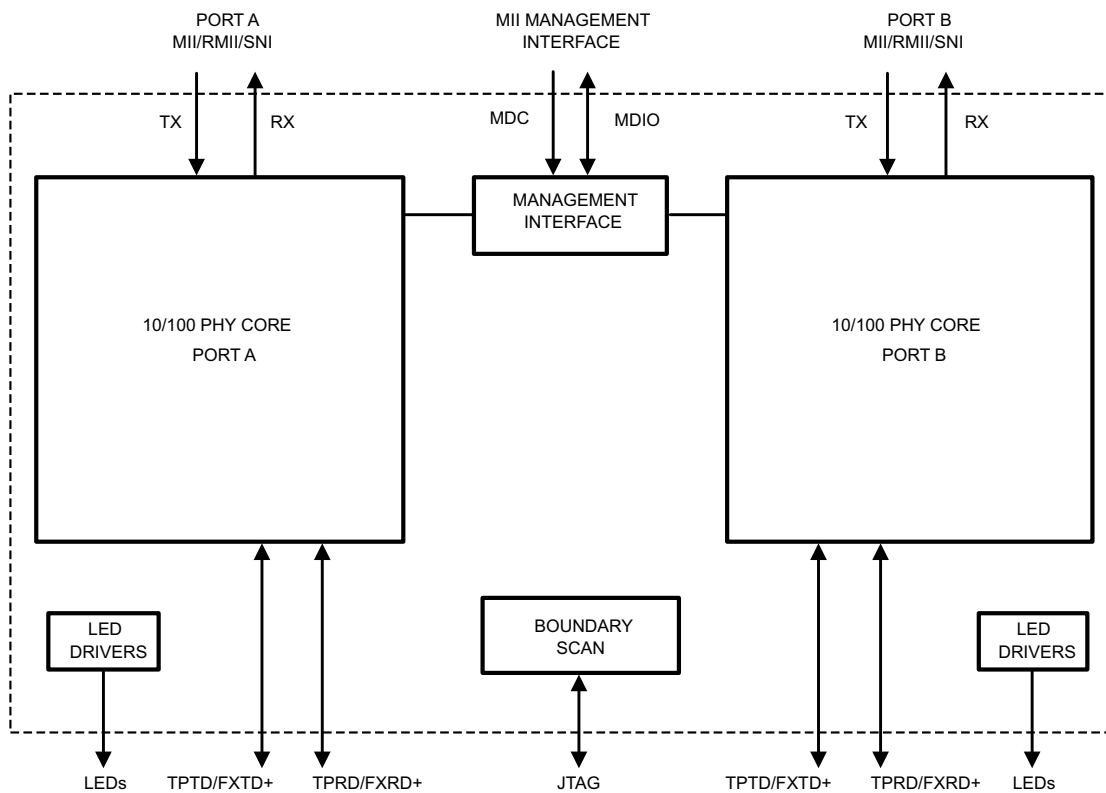


Figure 6. Function Block Diagram for DP83849IF

4.1.1.1 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).

4.1.1.2 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.

4.1.1.3 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 |

4.1.1.4 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).

4.1.2 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 |

4.1.3 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.

4.1.4 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 |

4.1.5 Fiber-Optic Cords for Ethernet Applications



Figure 7. 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.

4.2 Circuit Design for the DP83869 Based Media Converter

This section provides design details of the devices used with the DP83869EVM used as media converter.

4.2.1 DP83869HM High Immunity Gigabit Ethernet PHY With Copper and Fiber Interface

The DP83869 is a low-power, fully-featured, physical layer transceiver with integrated PMD sublayers to support 10BASE-Te, 100BASE-TX, and 1000BASE-T Ethernet protocols. It also supports fiber protocols 1000BASE-X and 100BASE-FX. Optimized for ESD protection, the DP83869 exceeds 8-kV IEC 61000-4-2 (direct contact). This device interfaces to the MAC layer through reduced GMII (RGMII) and SGMII. Integrated termination impedance on RGMII helps reduce system BOM. The DP83869EVM demonstrates all features of the DP83869. The EVM supports copper ethernet protocols like 10BASE-Te, 100BASE-TX, and 1000BASE-T. It also supports fiber protocols 1000BASE-X and 100BASE-FX. The EVM has connections to use the DP83869 MAC Interface in RGMII and SGMII mode. The EVM will also be optimized to demonstrate the robust EMI, EMC, and ESD performance of the DP83869 device.

4.2.2 EVM High-Level Summary

The DP83869EVM supports SMI through J2 using pin 26 for MDIO and 28 for MDC. These pins can be connected to an MSP430 Launchpad, which can be used for USB-2-MDIO control.

Table 10. EVM Applications for Media Converter

| Number | DP83869 MODE | APPLICATIONS | HOW TO USE |
|--------|-----------------------|---|---|
| 1 | 100M Media Converter | Demonstrate 100M functionality on EVM | Use SFP and RJ45 connector for fiber and copper ethernet. Straps will be used for unmanaged mode and MDIO for managed mode. |
| | | Demonstrate FAR End fault capability | |
| | | Demonstrate unmanaged mode of Media converter | |
| 2 | 1000M Media Converter | Demonstrate 1000M functionality on EVM | Use SFP and RJ45 connector for fiber and copper ethernet. Straps will be used for unmanaged mode and MDIO for managed mode. |
| | | Demonstrate Link Loss Pass Thru Capability | |
| | | Demonstrate unmanaged mode of Media Converter | |

4.2.3 Power Supply

The DP83869HM is capable of operating with as few as two or three supplies. The I/O power supply can also be operated independently of the main device power supplies to provide flexibility for the MAC interface. There are two possible supply configuration that can be used: two supply and three supply. In a two supply configuration, no power rail is connected to VDDA1P8_x pins (pin 13, 48). When unused, pin 13 and 48 should be left floating with no components attached to them.

4.2.4 Layout Guidelines

PCB traces are lossy and long traces can degrade the signal quality. Traces must be kept as short as possible. Unless mentioned otherwise, all signal traces should be 50-Ω, single-ended impedance. Differential traces should be 50-Ω, single-ended and 100-Ω differential. Take care that the impedance is constant throughout. Impedance discontinuities cause reflections leading to EMI and signal integrity problems. Stubs must be avoided on all signal traces, especially the differential signal pairs

Within the differential pairs, the trace lengths must run parallel to each other and matched in length. Matched lengths minimize delay differences, avoiding an increase in common-mode noise and increased EMI. Length matching is also important on MAC interface. All transmit signal trace lengths must match to each other and all Receive signal trace lengths must match to each other. Ideally, there should be no crossover or via on the signal paths. Vias present impedance discontinuities and should be minimized. Route an entire trace pair on a single layer if possible.

5 Test Setup

5.1 Communication Interface Testing (Computer to Device)

Media converter mode, shown in [Figure 8](#), 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.

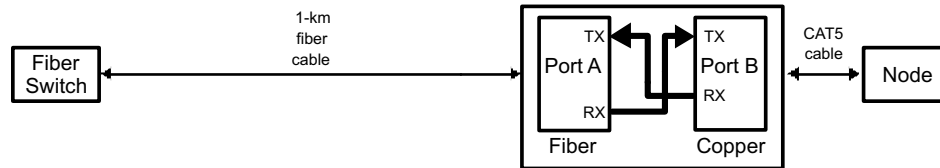


Figure 8. Media Converter Example

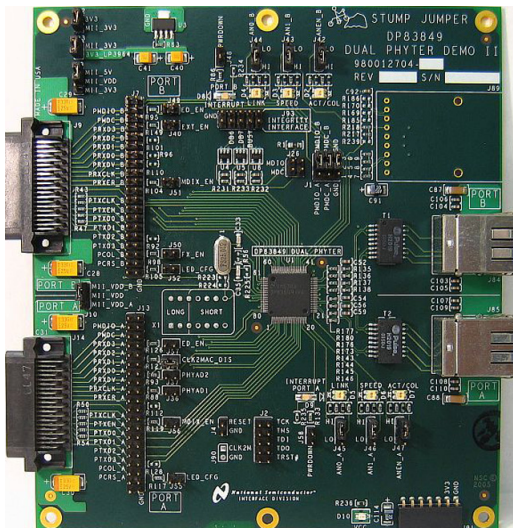


Figure 9. DP83849IVS-EVK with Copper and Fiber Options



Figure 10. 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.

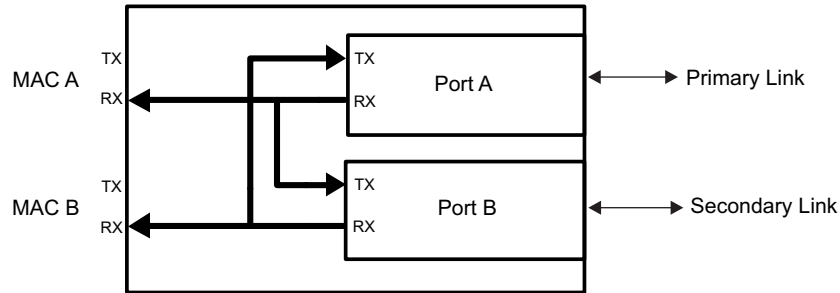


Figure 11. Media Converter (Strapped)

Several common configurations are shown in Table 11. 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 11. 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 |

5.3 Test Setup for DP83869 Media Converter Testing

The DP83869HM supports media convertor mode to interface between copper and fiber Ethernet interface. Media convertor is available for 100M and 1000M speeds. In media convertor mode, DP83869HM will translate data between copper and fiber interface for 1000M and 100M speeds. Media convertor mode can be activated through the straps. SGMII is not available in Fiber Ethernet mode and Media Convertor mode because the SGMII pins are multipurpose pins which carry Fiber Ethernet signals.

5.3.1 Test Description for Media Converter

The device incorporates an internal PRBS (Pseudo Random Bit Sequence) Built-In Self Test (BIST) circuit to accommodate in-circuit testing or diagnostics. The BIST circuit can be used to test the integrity of the transmit and receive data paths.

5.3.2 Built-In Self Test (BIST) Configuration

The BIST can be performed using both internal loopback (digital or analog) or external loopback using a cable fixture. The BIST simulates pseudo-random data transfer scenarios in format of real packets and Inter-Packet Gap (IPG) on the lines. The BIST allows full control of the packet lengths and of the IPG. The BIST is implemented with independent transmit and receive paths, with the transmit block generating a continuous stream of a pseudo-random sequence. The device generates a 15-bit pseudo-random sequence for the BIST. The received data is compared to the generated pseudo-random data by the BIST Linear Feedback Shift Register (LFSR) to determine the BIST pass or fail status. The number of error bytes that the PRBS checker received is stored in the PRBS_TX_CHK_CTRL register (0x39). The status of whether the PRBS checker is locked to the incoming receive bit stream, whether the PRBS has lost sync, and whether the packet generator is busy, can be read from the GEN_STATUS2 register (0x17h). While the lock and sync indications are required to identify the beginning of proper data reception, for any link failures or data corruption, the best indication is the contents of the error counter in the PRBS_TX_CHK_CTRL register (0x39). The number of received bytes are stored in PRBS_TX_CHK_BYTE_CNT (0x3A). The PRBS test can be put in a continuous mode by using the BIST_CONTROL register (0x16h). In continuous mode, when one of the PRBS counters reaches the maximum value, the counter starts counting from zero again. PRBS mode is not applicable in Bridge Modes and should not be used.

5.3.2.1 BIST_CONTROL Register Field Descriptions

PRBS enable using BIST_CONTROL Register 0X 0016 H and Data F000 : These bits controls PRBS generator. Other values are not applicable. 0x0 = Disable PRBS 0xF = Enable Continuous PRBS.

5.3.3 DP83869 Media Converter Testing Using Loop Back With Pin Strap

This section provides details of the setup and the functional tests done to test 100Base-T to 100Base-FX and 1000Base-T to 1000Base-X media converter functionality.

5.3.3.1 Setup for Testing

The following section provides details of 100BASE-T to 100BASE-FX and 1000BASE-T to 1000BASE-X connection for testing the media converter functionality.

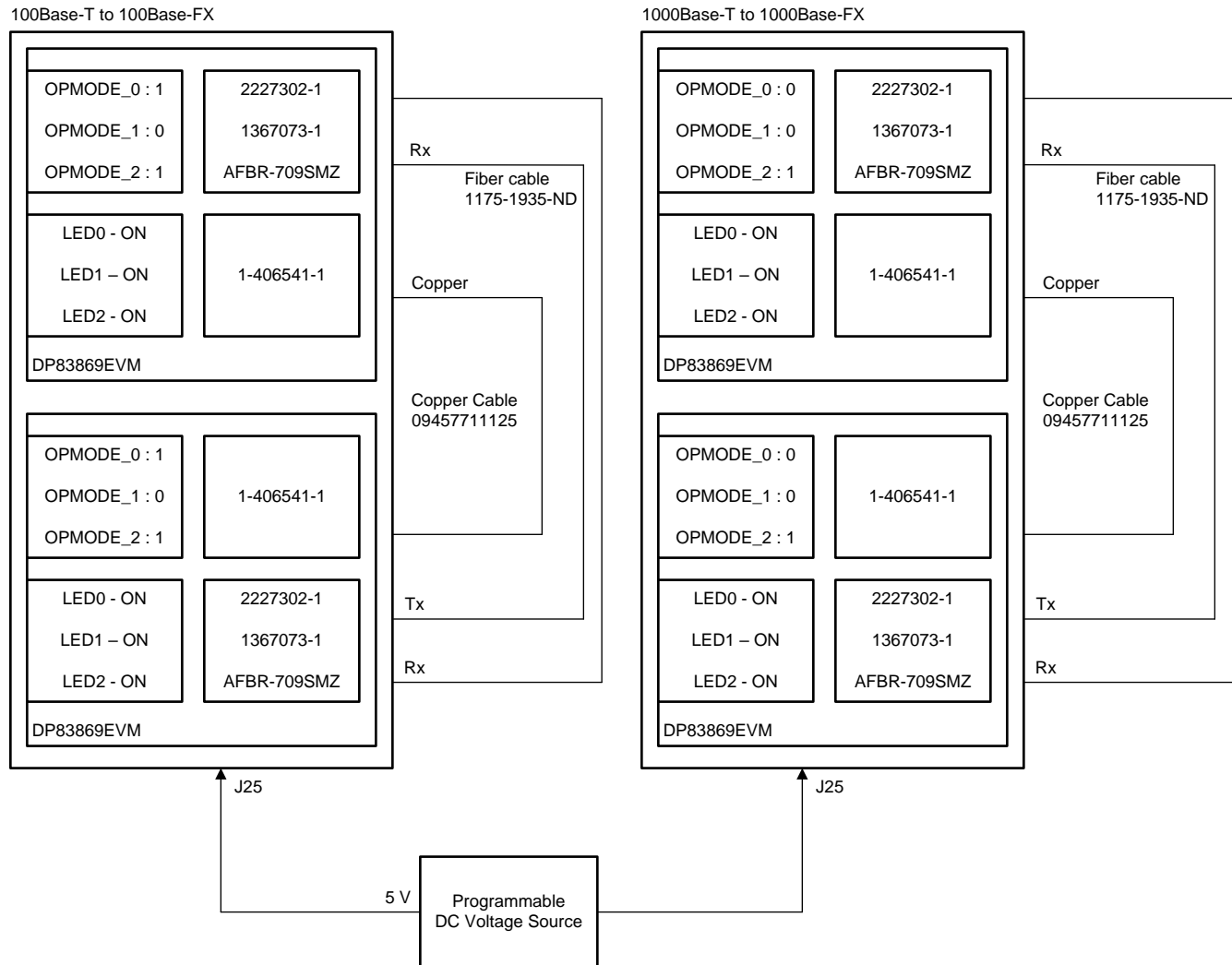


Figure 12. DP83869 Media Converter Test Setup

6 Test Results for Media Converter Using the DP83849

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.

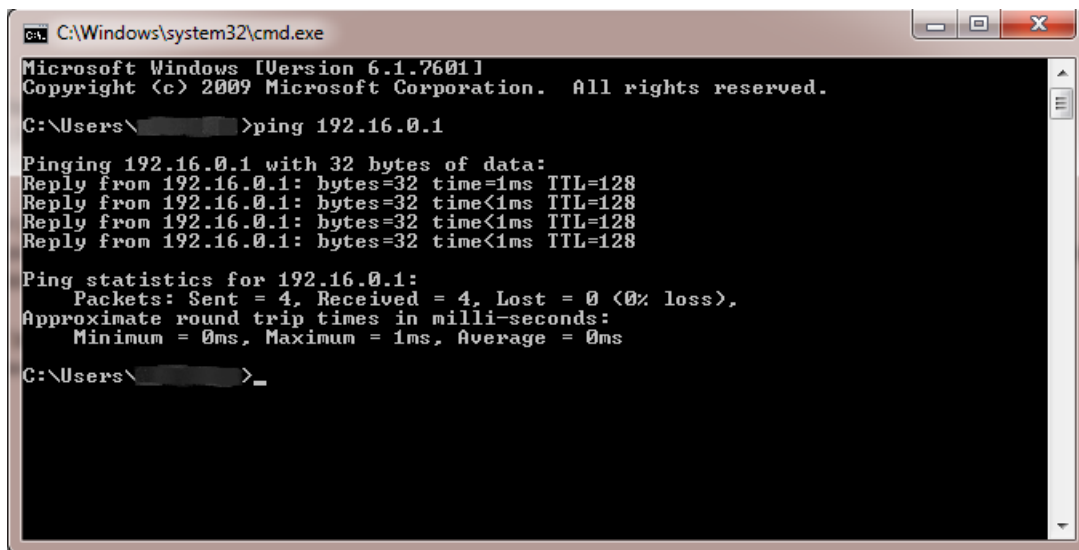
Activity LEDs glow when there is network traffic. For example, ping can be used to generate the traffic.

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 13](#) 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 13. 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.

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 15](#)).

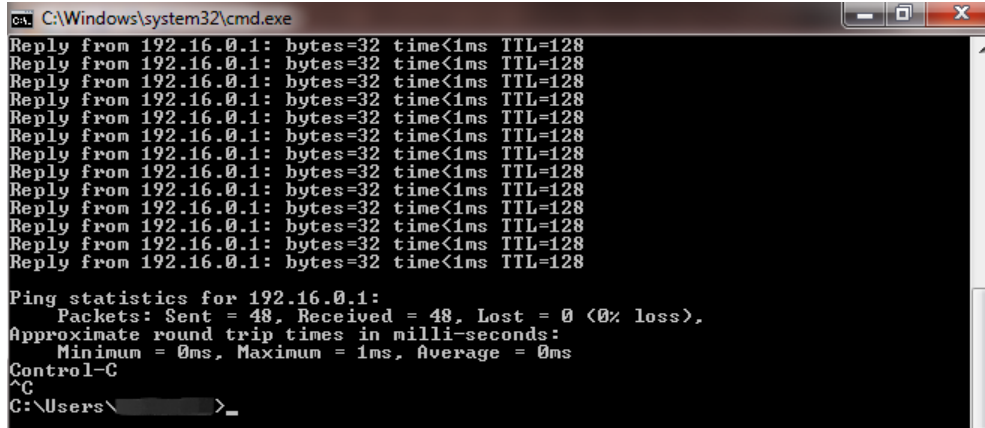


Figure 15. Ping Test Stopped

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 16](#).

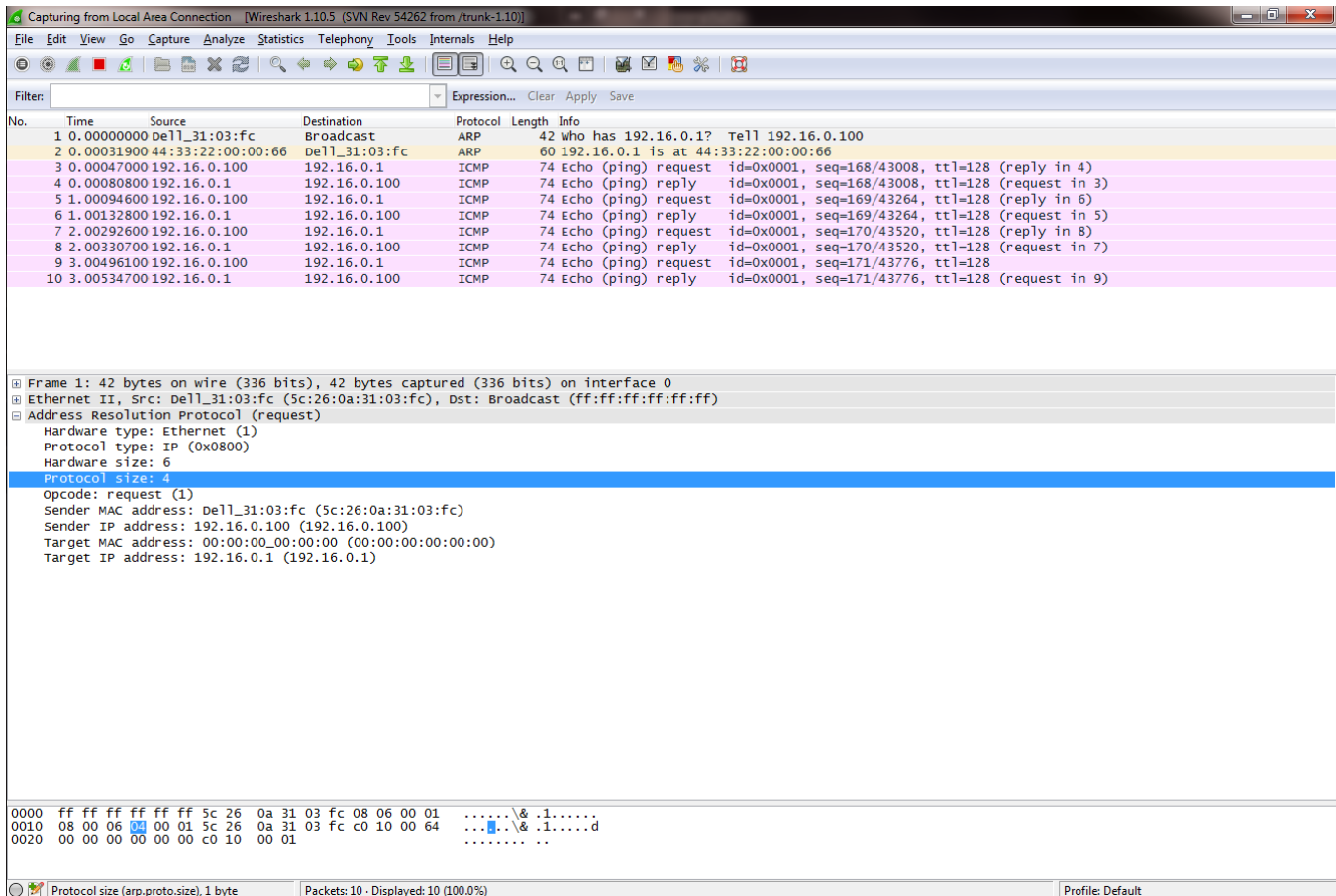


Figure 16. Wireshark Results for Data Traffic

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. Uncheck *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 17).

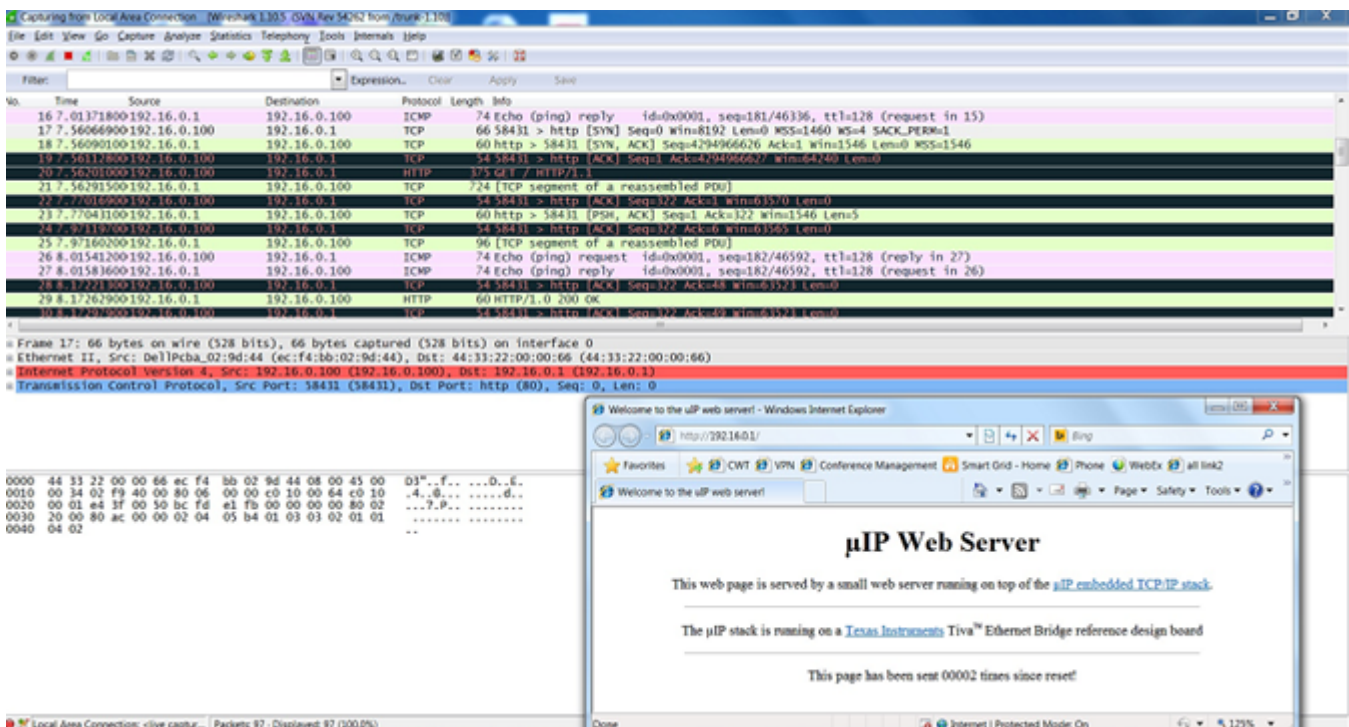


Figure 17. Web Server Test

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 18](#).

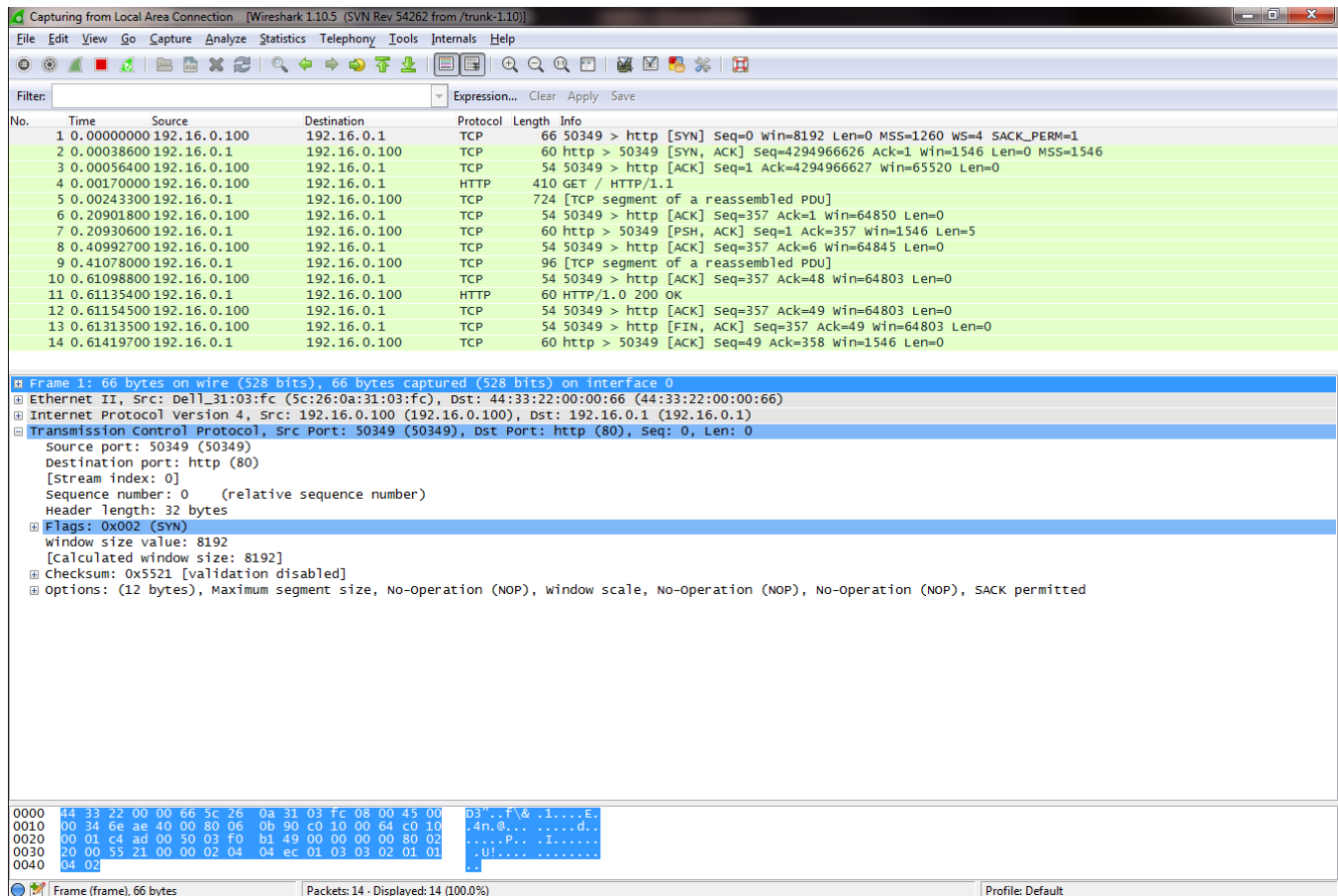


Figure 18. Data Traffic Capture for Web Server Test

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 Test Results for Media Converter Using the DP83869

7.1 GUI Interface for Testing Media Converter Using USB-2-MDIO Software and Configuration

The following steps are used to test the media converter:

1. Download the software from [usb-2-mdio](#). The Web page also contains a User's Guide for installing and using the software.
2. The MSP430 is on board the EVM, so it is not required to purchase a separate MSP430 Launchpad kit and connect to the PHY using wires. The entire EVM can be powered and controlled through a USB connector. MSP430 and USB2MDIO utility can be used even when power is not supplied through a USB.

[Figure 19](#) shows the user interface.

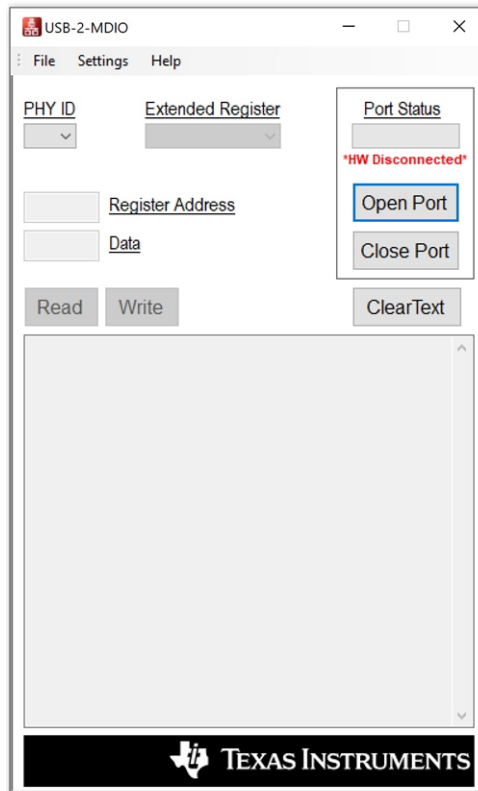


Figure 19. USB2MDIO User Interface

Table 12 provides the USB2MDIO settings needed to test the media converter functionality.

Table 12. USB2MDIO Setting and Test Observations

| SETTINGS | 100BASE-FX | 1000BASE-X |
|---|--|--|
| Pin Strapping OPMODE_2, OPMODE_1, OPMODE_0 | 101 | 100 |
| Selection of Port | Select comport13 or comport14 or other ports displayed | Select comport13 or comport14 or other ports displayed |
| Baud rate | 9600 | 9600 |
| Port Status | Open | Open |
| PHY ID | 0 | 0 |
| Media converter mode , read OP_MODE_DECODE register 0x01df | 0x0005 0x5 = 100Base-T to 100Base-FX | 0x0004 0x4 = 1000Base-T to 1000Base-X |
| LEDs for indication LED2, activity LED1, fiber link LED0, copper link | 011 | 011 |
| PRBS enable (Write) | Address 0016 Data F000 | Address 0016 Data F000 |
| LEDs indication after PRBS write, LED2, activity LED1, fiber link LED0, copper link | 111 | 111 |

7.2 Test Setup for DP83869 EMI Testing

The test setup used for testing media converter functionality is shown in [Figure 20](#). The communication cables are placed inside of the chamber, and the power supply is placed outside of the chamber.

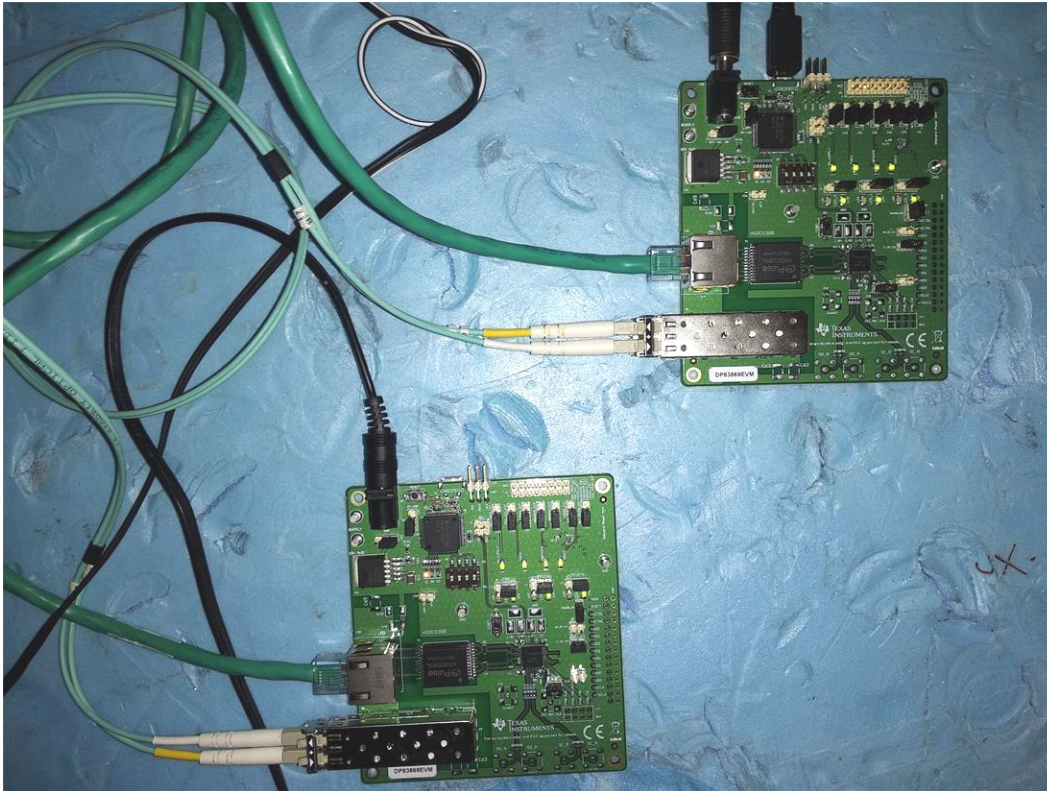


Figure 20. Media_Converter_EMI_Setup

7.2.1 EMI Plot for 100BASE-T to 100BASE-FX

The EMI testing was done in a 3-M chamber and 10 db limits are added to 10-M requirements. The EMI scan for 100BASE-FX was done with class B limits line drawn for reference shown in blue.



Figure 21. Media_Converter_100Base-T to 100Base-FX_ClassB

7.2.2 EMI Plot for 1000BASE-T to 1000BASE-X

The EMI testing was done in a 3-M chamber and 10 db limits are added to 10-M requirements. The EMI scan for 100BASE-FX was done with class A limits line drawn for reference.

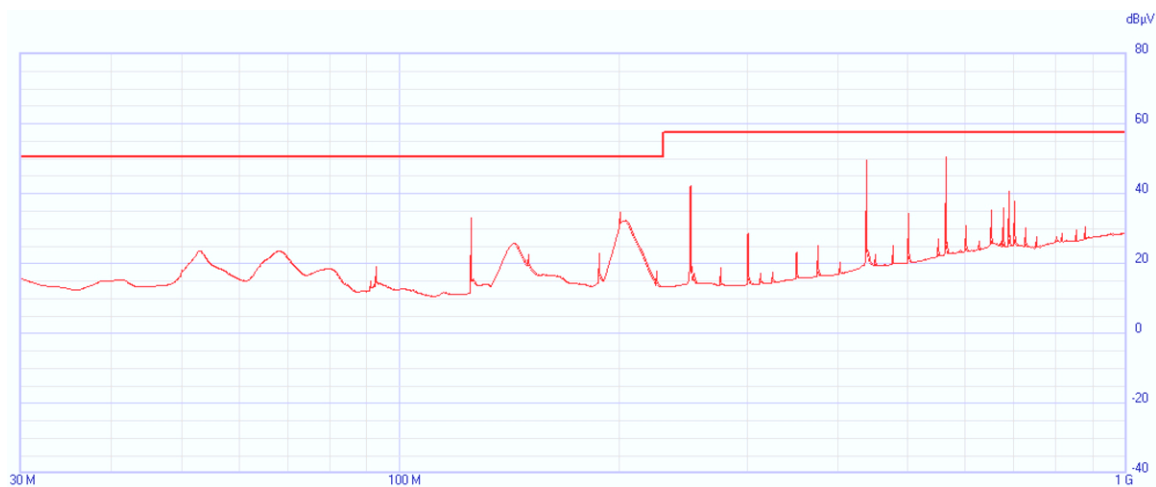


Figure 22. Media_Converter_1000Base-T to 1000Base-X_ClassA

8 Design Files

8.1 Schematics

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

8.2 Bill of Materials

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

Table 13. 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

8.3 Layer Plots

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

8.4 Gerber Files

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

8.5 Assembly Drawings

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

9 Related Documentation

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](#))
4. Copper and fiber industrial ethernet PHY evaluation module ([DP83869EVM](#)) DP83869EVM

9.1 Trademarks

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10 About the Author

KALLIKUPPA MUNIYAPPA SREENIVASA is a systems architect at Texas Instruments where he is responsible for developing reference design solutions for the industrial segment. Sreenivasa brings to this role his experience in high-speed digital and analog systems design. Sreenivasa earned his Bachelor of Electronics (BE) in electronics and communication engineering (BE-E&C) from VTU, Mysore, India.

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from A Revision (July 2016) to B Revision | Page |
|---|-------------|
| • Changed document title from <i>Ethernet Copper-to-Fiber Media Converter Reference Design for Substation and Distribution Automation</i> to <i>Copper-to-Fiber 100BASE-FX or 1000BASE-X Media Converter Reference Design for Grid Applications</i> . | 1 |
| • Changed Description..... | 1 |
| • Added DP83869HM, MSP430F5529, TPS732, TPS735, TPS737, TPS709, TPS74701, TL1963A, DP83869EVM and TPD4E05U06D to Resources | 1 |
| • Changed Features | 1 |
| • Added <i>Copper-to-Fiber Media Converter With TI DP83869HM</i> section | 8 |
| • Added DP83869EVM media converter board features | 10 |
| • Added <i>Block Diagram for DP83869HM Based Media Converter</i> section | 12 |
| • Changed title of <i>Circuit Design</i> section to <i>Circuit Design for DP83849 Based Media Converter</i> | 13 |
| • Added <i>Circuit Design for the DP83869 Based Media Converter</i> section..... | 19 |
| • Added <i>Test Setup for DP83869 Media Converter Testing</i> section..... | 21 |
| • Changed title of <i>Media Converter Testing Using Loop Back With Pin Strap</i> section to <i>DP83869 Media Converter Testing Using Loop Back With Pin Strap</i> | 22 |
| • Changed title of <i>Test Results</i> section to <i>Test Results for Media Converter Using the DP83849</i> | 24 |
| • Added <i>Copper and fiber industrial ethernet PHY evaluation module DP83869EVM</i> to Related Documentation | 34 |

| Changes from Original (September 2014) to A Revision | Page |
|---|-------------|
| • Changed title from <i>Copper-to-Fiber Ethernet Media Converter</i> to <i>Ethernet Copper-to-Fiber Media Converter Reference Design for Substation and Distribution Automation</i> | 1 |
| • Changed <i>TI Designs</i> summary to new title <i>Description</i> and updated the description paragraph..... | 1 |
| • Changed Features to an updated list | 1 |
| • Changed Applications to an updated list | 1 |
| • Changed from "10/100BASE-TX to 10/100BASE-FX Media Converter" to "10/100BASE-TX to 100BASE-FX Media Converter" | 1 |
| • Deleted "Pink" from "Pink LEDs" | 1 |
| • Added descriptive paragraph directly after Section 1 | 2 |

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