

How to use the TDR Feature of DP83822

Aniruddha Khadye

ABSTRACT

This document describes the TDR functionality of Ethernet PHYs with focus on DP83822. The application report explains TDR in brief and then describes how to use this feature for cable diagnostics.

Contents

1	Introduction	2
2	Time Domain Reflectometry	2
3	Conclusion	5

List of Figures

1	Open Circuit Cable	2
2	Short Circuit Cable	3
3	Inactive Link Partner	3
4	Cross-Wired Cable	4

1 Introduction

As Ethernet networks grow more and more complex, detecting link and cable faults becomes more difficult. The need for cable diagnostics tools is more important than ever. The cables used can be very long in length and the topologies can be complicated so the cable diagnostics tools need to be non-intrusive. TI's ethernet PHYs provide solution to this problem with diagnostic tools integrated in the PHY.

2 Time Domain Reflectometry

2.1 TDR

TDR can be used for cable diagnostics when the Link is down. TDR involves sending a pulse on TX and RX pair and observe results on either pair. By measuring voltage amplitude, polarity, and time interval the PHY can determine the nature and position of the fault. This feature works under certain conditions like;

- Cable Open
- Cable Short
- Link Partner Down
- TX/RX pair cross-wired
- Impedance discontinuity

TDR works for only for twisted pair connections. TDR generator will send pulse on the TX and RX channel and then monitor both channels to observe reflections. It will send a pulse on one channel at a time and if reflections are observed on the other channel then the PHY realizes that the wires have been crossed. DP83822 can detect 5 peaks on TX and RX channels each.

2.2 Example Connections

Following are the example connections where TDR can be used.

2.2.1 Open Circuit Cable

Open cable is easy to diagnose as it will generate a strong reflection. No reflection will be observed on the other channel. The reflection due to open circuit will be in-phase with the transmitted pulse (positive polarity). Any kind of inductive impedance discontinuity will generate in-phase reflection and the amplitude will depend on the amount of impedance discontinuity.

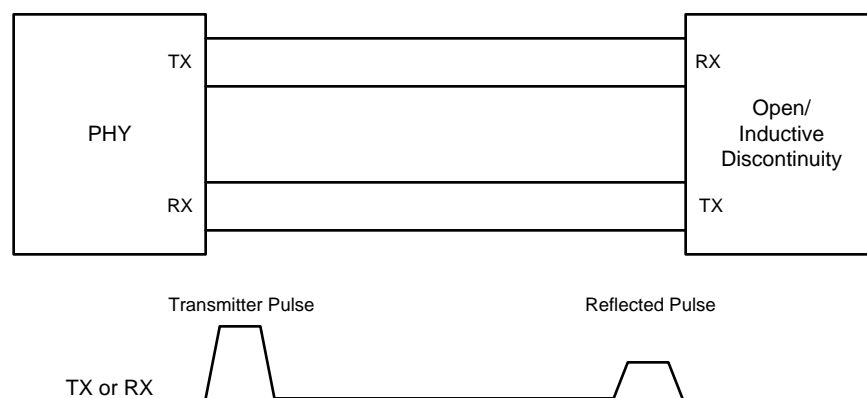


Figure 1. Open Circuit Cable

2.2.2 Short Circuit Cable

Short Circuited cable will also generate a strong reflection but this reflection will be out of phase with the original pulse (negative polarity). Any kind of capacitive impedance discontinuity will generate out of phase reflection and the amplitude will depend on the amount of impedance discontinuity.

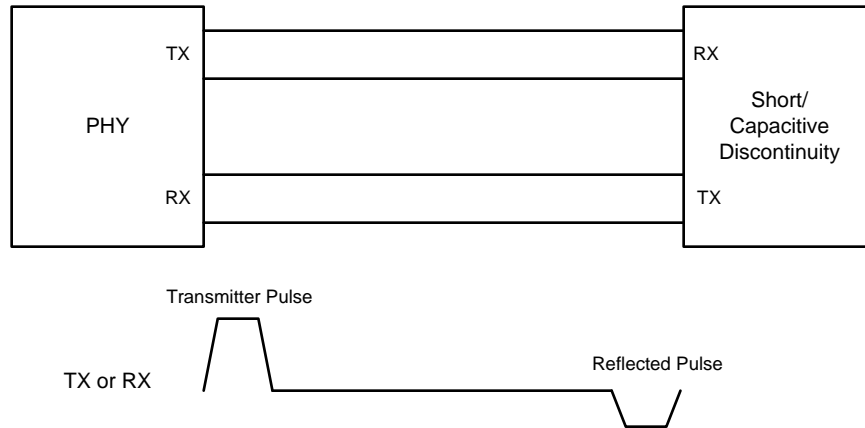


Figure 2. Short Circuit Cable

2.2.3 Link Partner Down

When the Link partner is in power down mode or inactive the line will be terminated. In an ideal scenario, the termination will be perfectly matched with no reflection but this is very difficult to achieve. In reality there will be small reflections due to some impedance mismatch. For longer cables, this reflection is not strong enough to make cable length measurements.

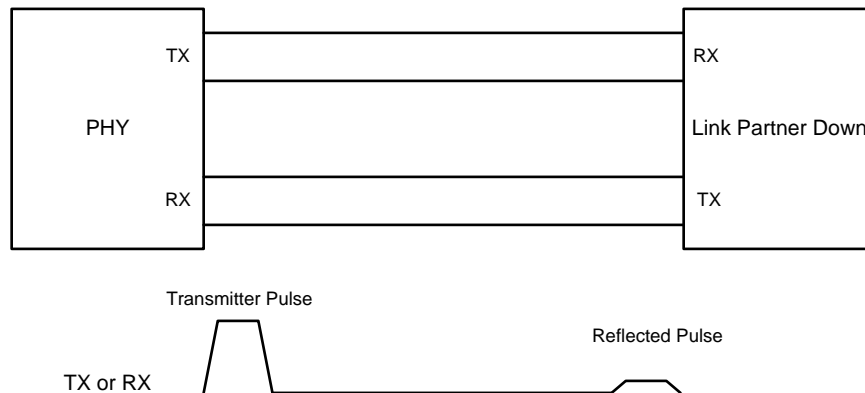


Figure 3. Inactive Link Partner

2.2.4 Cross-Wired Cable

Due to incorrect cable or connector assembly, a single wire from TX or RX differential pair is routed to the opposite channel. This results in an unexpected return pulse on the channel not being tested. For e.g. If transmit channel is being tested in a cross-wired cable then a unexpected return pulse will be observed on the receive channel. To check for this, the PHY observes both the channels even if sends a pulse on one channel at a time. In addition to return pulse on the other channel there can be a return pulse on the channel under test.

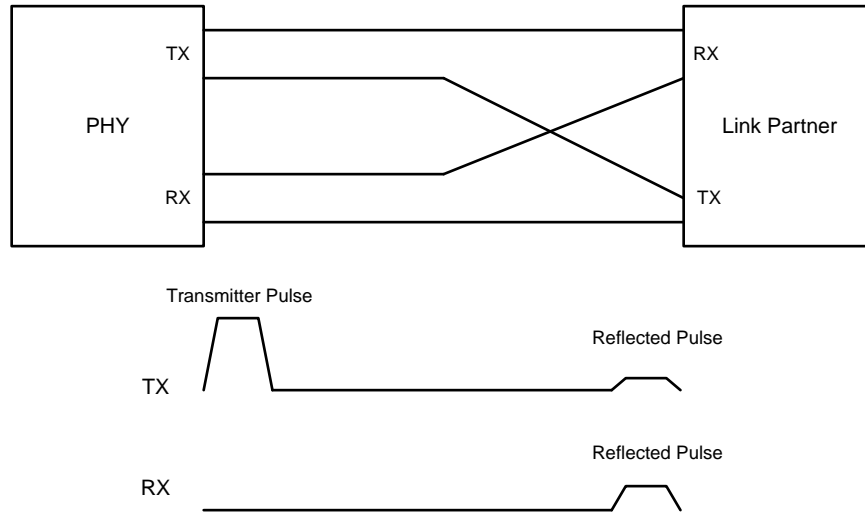


Figure 4. Cross-Wired Cable

2.3 TDR Implementation

For the purpose of this document, TDR implementation in DP83822 will be discussed.

2.3.1 TDR Configuration

TDR can be configured to run automatically after Link Drop through Register 0x0009 bit 8 or run manually from Register 0x001E bit 15.

For using TDR, following register writes are required.

- Write 0b1100 to bits [3:0] of register 0x0171
- Write 0b11111111 to bits [15:8] in register 0x0173
- Write 0b000011000 to bits [12:8] in register 0x0177
- TDR Auto-run from bit [8] in register 0x0009 or manually start TDR using bit [15] of register 0x001E

TDR status is stored in bits [1:0] of register 0x001E. TDR results are stored in registers 0x0180 to 0x018A. Basic software processing is required for converting register values to physical quantities. Ignore values in Cable Diagnostics Registers that read 0b1100.

2.3.2 Cable Length and Fault Location

DP83822 can detect 5 peaks on TX and RX channels each. Running TDR on a open ended cable will let users estimate the cable length. Any impedance discontinuity in the cable will generate reflections which can be used for detecting the location fo the fault. Peak locations are stored in registers 0x0180 to 0x0184. Every register contains 2 peaks with 8 bits allocated for every peak. Following process can be used for finding the peak location in meters.

- Read bit [1:0] from Register 0x001E to ensure that TDR was successfully completed.
- Read registers 0x0180 to 0x0184 to get TX and RX peak locations.
- Convert Hex Value of a peak to Decimal Value(DV).
- Find the Intermediate Location (IL) = $(DV \times 0.8621) - 8$
- Find Final Location(FL) in meters = $IL + ((70 - IL) \times 0.01)$

For e.g lets assume that after running TDR, only one peak was observed on the Transmit path. Register 0x180 reads 0x0033.

- Convert peak 1 location from hexadecimal to decimal. 0x33(hex) -> 51(dec)
- $IL = (51 \times 0.8621) - 8 = 35.97$
- $FL = 35.97 + ((70 - 35.97) \times 0.01) = 36.31m$

This is now the location of the fault. If it is known that this is a open ended cable with no breaks then the length obtained is the length of the cable.

2.3.3 Peak Amplitude and Polarity

Peak amplitude is stored in registers 0x0185 to 0x0189. Every register contains amplitudes for 2 peaks with 8 bits allocated for every peak. Convert the register value from Hexadecimal to Decimal and divide it by 256.

Polarity of all peaks is stored in Register 0x018A bit [15:6]. Bit value of '0' indicates a positive peak and bit value of '1' indicates a negative value. Register 0x18A also has bits to indicate if the TX and RX channels have been cross wired. Bits [3:2] will indicate if more than 5 peaks were detected on TX and RX channel respectively.

3 Conclusion

This app note explains the basics of TDR and how to use the TDR functionality of the DP83822 Industrial Ethernet PHY.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com