Industrial Fiber Optic Link/Repeaters*

Models 5845HRT and 5846HRT
Models 5845SHRT and 5846SHRT

User Manual

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25 Commerce Way North Andover, MA 01845
(978) 688-8807 • FAX (978) 688-8771
www.garrettcom.com

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Warnings, Cautions, and Notes as Used in this Publication

WARNING

Warning notices are used in this publication to emphasize that hazardous voltages, currents, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either injury or damage to equipment, a Warning notice is used.

CAUTION

Caution notices are used where equipment malfunction is possible if care is not taken.

NOTE

APPLICATION NOTE

Notes and Application Notes call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations, nor to provide for every possible contingency in connection with installation, operation, or maintenance. DYMEC assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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* Link/Repeater is used exclusively to describe DYMEC's unique family of Fiber Optic Data Links.

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1. INTRODUCTION

DYMEC Models 5845HRT, 5845SHRT, 5846HRT and 5846SHRT are data communication Link/Repeaters which allow the replacement of copper wire with fiber optic cable. Link/Repeaters simply convert electrical signals to light for transmission, then, when received, convert the light signals to electrical. This is done in EIA 422 and EIA 485 formats.

Link/Repeaters are passive to software protocol. They are not addressable in communication protocols and do not provide any control logic capability to support communication protocols. Link/Repeaters are designed with several features that allow easy installation and flexibility in configuring for various communication systems.

Models 5845HRT and 5846HRT are similar except for the voltages by which they can be powered.

Models 5845SHRT and 5846SHRT have the same features and functionality described for the Models 5845HRT and 5846HRT respectively with the exception that they have single mode optics for use with single mode fiber cable.

NOTE

This manual makes reference to the Model 5845HRT and Model 5846HRT when describing features and functionality of the Link/Repeaters. These descriptions generally apply to the Model 5845SHRT and Model 5846SHRT as well. When different, a specific reference is made identifying the particular model(s) and their variation.

The User should read this entire manual to fully understand how to use the many features of the Link/Repeaters in an effective communication system.

1.1 DEFINITIONS

The following terms are used in this manual:

IED:
An IED is any intelligent electrical device capable of EIA 422 and/or EIA 485 data communications, such as; a computer, RTU, PLC, "smart" meter, relay, etc. The IED must have resident software or firmware that manages the data communication logic, including protocol (formatting and timing), addressing capability (if required), control logic software "handshaking", and scheduling.

Point-to-Point Configuration:
Two Link/Repeaters connected directly to each other.

Master/Slave Loop Configuration:
More than two Link/Repeaters connected together where the FOC connects the T optical port of one device to the R optical port of the next unit in the loop. One IED is designated as the Master and controls all the communication and the other IEDs act as Slaves and respond only when specifically polled by the Master.

Peer-to-Peer Loop Configuration:
More than two Link/Repeaters connected together where the FOC connects the T optical port of one device to the R optical port of the next unit in the loop. Each IED has the capability of becoming loop Master as allowed by the controlling software.

Echo:
The return of the Master's transmission back to the Master after traveling around the optical loop.

Optical Bus Configuration:
More than two Link/Repeaters connected together in a “linear” topology and there is no returning echo of a transmission.

Optical Star Configuration:
More than two Link/Repeaters connected together in a “Hub and Spoke” topology and there is no returning echo of a transmission**.**

Master:
The Master is the IED that controls the network in a Master/Slave configuration. This IED is responsible for the control of the network, the polling of the Slaves for information, and the prevention of data collisions. In a loop configuration, the Master’s communication is echoed back to and stops at the Master. The Master's Repeat Switch is always in the "OFF" position.

Slave:
A Slave is an IED that is passive in a Master/Slave configuration. A Slave's communication is under the control of the Master, and only responds to specific poll requests from the Master.

Peer:
Peers are IEDs that have equal status and each may initiate a communication when allowed by the system software by a time slot, token, etc.

FOC:
Fiber Optic Cable.

Single-mode:
Single-mode fibers generally have diameters of 5µm to 13µm. Because of this small core, only one axial path for light propagation is available through the fiber. The optics required to drive single-mode fiber have to be highly focused so that minimum dispersion occurs. Though requiring more expensive optic emitters, the benefit is that longer transmission distances (<35 km) can be achieved.

Multi-mode:
Multi-mode fibers have core diameters of 50µm and larger. This larger core allows the light rays to be propagated along several different paths down the fiber. The different paths include an axial component as well as reflected components. Multi-mode units are economical and effective for transmission over distances up to 6 km.

Repeat Switch:
The Repeat Switch enables (REP) or disables (OFF) the repeater function of the Link/Repeater.

HD / FD Switch:
This switch adapts the Link/Repeater to accept independent transmit and receive channels (4 wire normally associated with EIA 422) or a shared transmit/receive channel (2 wire, generally EIA 485).

Data Coupling Switch:
This Switch adapt the Link/Repeater for either DC or AC electrical input data coupling. With AC data coupling, the minimum input data rate is 1600 baud. With DC data coupling there is no minimum input data rate, but a signal stuck high on the input will lock up a loop, bussed or star network.

Test Mode Switch:

Models 5845 and 5846 are provided with this switch to allow users who wish to test the fiber connections of the link with a built in diagnostic mode. This mode sends a 1KHz signal out the transmit port as well as looping back the copper port (pins 1 to 3 and 2 to 4) for diagnostic purposes. For the electrical connection this only works in Full Duplex Mode.

Enable Holdover Switch 0 and 1:

Models 5845 and 5846 provide two switch positions for the user to select one of four enable holdover times: 4uS (8 bit times at 2MBPS, the same as the previous generation 5845/46 links), 71uS (8 bit times at 112kBPS), 833uS (8 bit times at 9.6kBPS), and 8mS (8 bit times at 1kBPS) for the user. The factory default setting is 4uS.

Biasing Resistor Switch:

This switch allows the Link/Repeater to easily add or remove the device input bias resistors to reduce the loading on a copper bus network. The Bias resistors are 330 Ohms.

Simplex Communication:

Transmit only or receive only communications.

Half Duplex Communication:

Sequential transmit and receive communications.

Full Duplex Communication:

Simultaneous transmit and receive communications.

T:

Transmit optical port.

TE:

Diagnostic LED that illuminates when the Link/Repeater is receiving an electrical transmit from its IED.

TO:

Diagnostic LED that illuminates when the Link/Repeater is transmitting a signal optically.

R:

Receive optical port.

RE:

Diagnostic LED that illuminates when the Link/Repeater is delivering a received optical signal electrically to the IED.

RO:

Diagnostic LED that illuminates when the Link/Repeater is receiving a signal optically.

Optical Budget:

The optical budget is expressed in dB and is the amount of light loss tolerated for communication. The total distance between two devices that a signal can be transmitted is determined by subtracting all the losses of the optical circuit from the optical budget. Various factors in the optical circuit attenuate the light transmission and must be accounted for to assure a reliable optical circuit. Key factors include cable attenuation (expressed as dB per unit length), cable aging, and cable fittings (terminations, splices, splitters, etc.).

Non-Return to Zero (NRZ):

This type of encoding scheme does not require the voltage potential of each data bit to return to the zero potential. No clock or timing recovery is provided with this type of communication except in the start and stop bits usually found on each data word.

Return to Zero (RZ):

This type of encoding scheme requires the voltage potential of each data bit to return to the zero potential. This allows timing recovery with each bit instead of just the start and stop bits of the data word.

Number of Repeats:

The Number of Repeats is the number of Link/Repeaters that may be connected in a network when the Repeat function is required such as in loop configurations. The sum of Slaves in a Master/Slave loop is the number of repeats for that type of loop. The number of Peers minus one is the number of repeats in a Peer-to-Peer loop.

Asynchronous Communication:

This type of communication does not transmit a separate clock signal with the data signal. Link/Repeaters support asynchronous communication. A communication scheme where the clock needs to be transmitted (Synchronous Communication) is not supported unless the clock is embedded with the data.

1.2 MODEL 5845HRT AND MODEL 5846HRT LINK/REPEATERS

NOTE

Link/Repeaters contain no serviceable parts. Opening the unit will void the warranty.

Each Link/Repeater consists of the following elements shown in Figure 1.

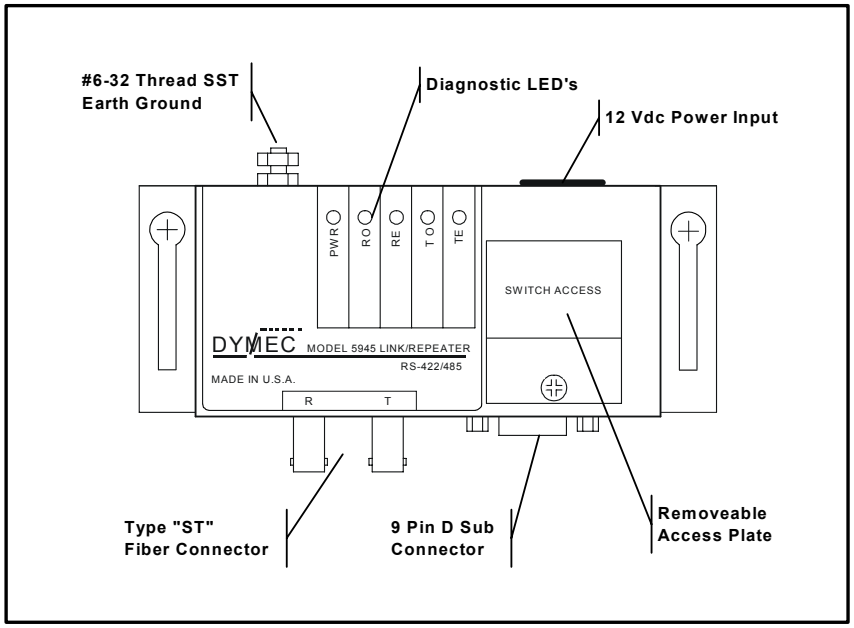


FIGURE 1. Elements of the Link/Repeater (5845HRT or 5845SHRT)

1.2.1 9 Pin Data Port D-connector

The Link/Repeater connects to an IED's EIA 422 or 485 communication port. The pin out configuration of the Link/Repeater is shown in Figure 2. If the IED's port is not a 9 Pin D-connector or if the IED's pin out configuration differs, an adapter is required.

HD Mode

1	Trans/Rec Data – [B/B'](I/O)
2	Trans/Rec Data + [A/A'] (I/O)
3	*No Connect*
4	*No Connect*
5	Signal Ground
6	Earth Ground
7	Repeat Enable/Disable
8	Optical Enable/Disable
9	+9-15 Vdc Power (Pin 5 GND)

FD Mode

1	Transmitted Data – [B] (Link Input)
2	Transmitted Data + [A] (Link Input)
3	Received Data – [B'] (Link Output)
4	Received Data + [A'] (Link Output)
5	Signal Ground
6	Earth Ground
7	Repeat Enable/Disable
8	Optical Enable/Disable
9	+9-15 Vdc Power (Pin 5 GND)

FIGURE 2. Data Port Pin Assignments

1.2.2 HD/FD Switch

The HD/FD Switch adapts the Link/Repeater to accept independent transmit and receive channels or a single shared transmit/receive channel.

HD: In this position, the Link/Repeater accepts a shared transmit/receive communication channel such as normally associated with EIA 485 2 wire standards. When in the HD position, the Link/Repeater is "listening" for data signals both optically and electrically and automatically switches to the correct state. This position is normally used for EIA 485 2 wire connections and only half-duplex or simplex communication is available. Multi-drop networks may be either Peer-to- Peer or Master / Slave.

FD: When independent transmit and receive electrical channels are available, select the FD position. This will normally be used for EIA 422 or EIA 485 4 wire standards. The Link/Repeater can support full duplex, half duplex or simplex communication in this position. Multi-drop networks may only be Master / Slave.

1.2.3 Repeat Switch

The Repeat switch enables the repeater function in the "ON" position and disables it in the "OFF" position.

REP: The repeater function available in the Link/Repeater is enabled. This function converts the optical signal received on the R optical port to an electrical signal and delivers this signal to the appropriate pins of the 9 Pin connector, as well as, re-transmits the signal optically out the Link/Repeater's T optical port.

OFF: The repeater function available in the Link/Repeater is disabled. The Link/Repeater converts the optical signal received on the R optical port to an electrical signal and delivers this signal to the appropriate pin of the 9 Pin connector, and does not re-transmit the signal optically out the Link/Repeater's T optical port.

1.2.4 Logic Inversion Switch

Use of this feature is required when optically interconnecting IEDs using RS-232 to IEDs using EIA 422 or 485 or IEDs that have biasing that pulls the “A” (+) line high and the “B” (-) line low during the quiescent state. (Refer to Section 3.5)

1.2.5 Input Bias Switch

The Biasing resistor switch selects electrical input biasing. Biasing on RS422/485 inputs provides the ability for the inputs to a device (the Link/Repeater) to be in a known electrical state if the outputs that are connected to it go into a Tri-State (non driving) condition. Pins marked B or - are pulled to +5 volts and pins marked A or + are pulled to Signal Ground. The default for the biasing resistors is 330 Ohms, optionally no biasing can be selected.

Bias: 330 Ohm Biasing resistors. This is equivalent to 9 loads when configuring a bus network configuration.

Out: No biasing resistors. This is the equivalent to 1 load when configuring a bus network. This setting should be used on at least one Link/Repeater if there are 2 or more electrically connected IED’s in a copper bus network segment.

1.2.6 Input Data Coupling Switch

The Data Coupling switch selects the electrical input conditioning, the AC position selects capacitively coupled, the DC position is directly coupled.

AC: AC coupling has a minimum incoming data requirement of 1600 baud due to the capacitive coupling. This option blocks DC electrical levels should the device connected fail and 'stick in a high level'. There is a 35 mS timeout for "stuck" output pins, after this time out the link returns to LED off state.

DC: DC coupling allows DC logic levels to be transmitted over the fiber network, care must be taken to guarantee that when any device stops transmitting packets that the input level returns to a state that allows the T receptacle (emitter) to turn off. If it does not and the IED is part of a loop, bussed or star network, the first device to transmit blocks all other devices on the network from transmitting. *Single-Mode units cannot be DC coupled.

1.2.8 Enable Holdover Switch

Since the 5845/46 Link/Repeaters are protocol and baud rate independent, we have no way of determining the end of a word or packet, and therefore, when to tri-state the EIA-422/485 driver. To overcome this obstacle, we drive '1' data bits for the full length of the bit and we drive '0' data bits for a pre-determined time. After that, the bias resistors hold the line in the '0' state. In most installations, the bias resistor circuit provides enough current for reliable communications, but in some cases (e.g. when our Link is electrically connected to many receivers) data errors can occur. We provide two dipswitch positions for the user to select one of four enable holdover times: 4uS (8 bit times at 2MBPS, the same as the previous generation 5845/46 links), 71uS (8 bit times at 112kBPS), 833uS (8 bit times at 9.6kBPS), and 8mS (8 bit times at 1kBPS) for the user to rectify this situation (See Figure 3). Extending the enable holdover time can improve the reliability of communications, but care must be taken to ensure that the enable holdover time does not exceed the minimum interpacket gap in that particular installation The factory default setting is 4uS.

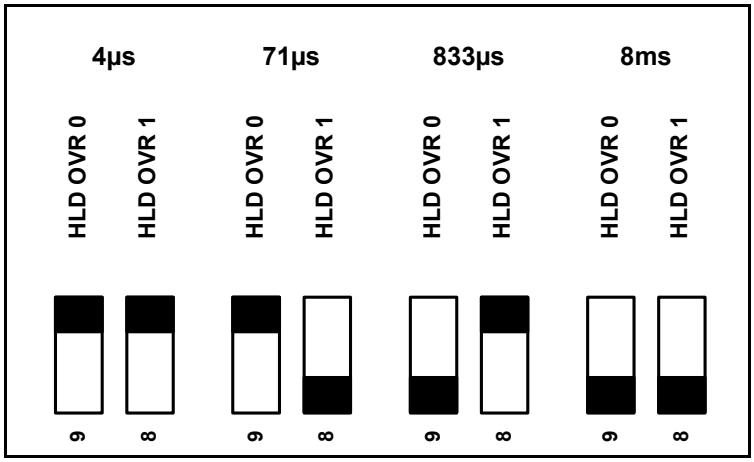


Figure 3 Enable Holdover Switch Settings

1.2.9 Test Mode Option Switch

Models 5845 and 5846 Links/Repeater are provided with this switch to allow users who wish to test the fiber connections of the link with a built in diagnostic mode. This mode sends a 1KHz signal out the transmit port as well as looping back the copper port (pins 2 to 4 and pins 1 to 3) for diagnostic purposes. The loop back option for the copper/electrical port of the Link/Repeater is only available for Full Duplex mode.

1.2.10 Optical Ports

There are two optical ports, T and R. The T optical port transmits data signals optically to the next Link/Repeater. The R port receives the optical data signal from another Link/Repeater's T optical port. Each port is fitted with an "ST" type receptacle for connecting the FOC. (See Figure 4).

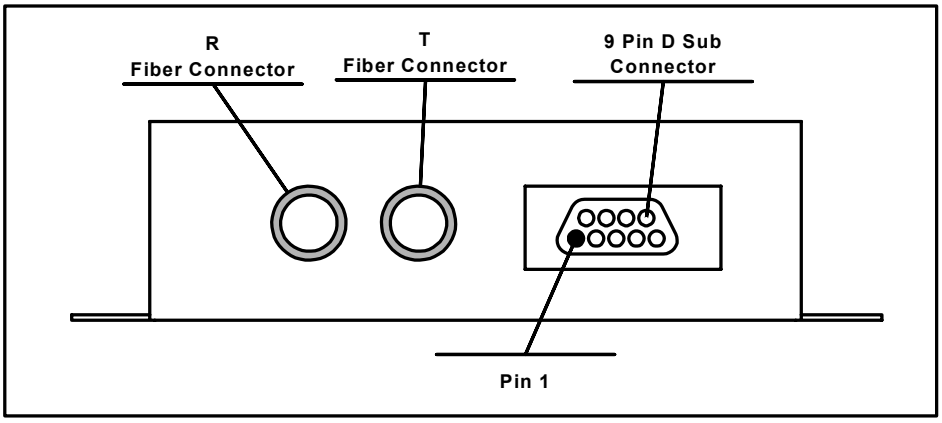


FIGURE 4. Optical Ports and 9 Pin Data Connection

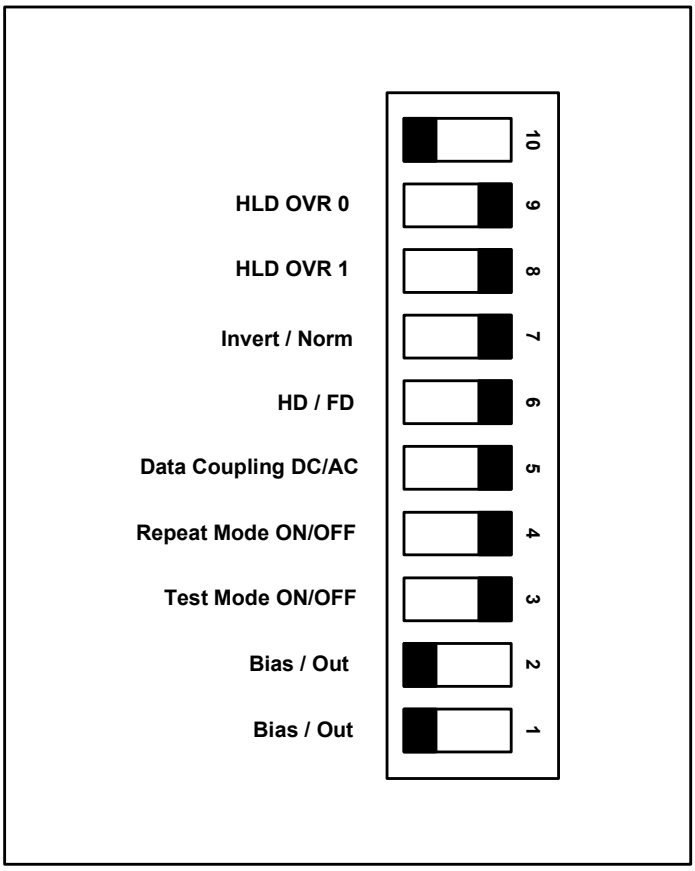


FIGURE 5. Switch Settings (Factory Defaults)

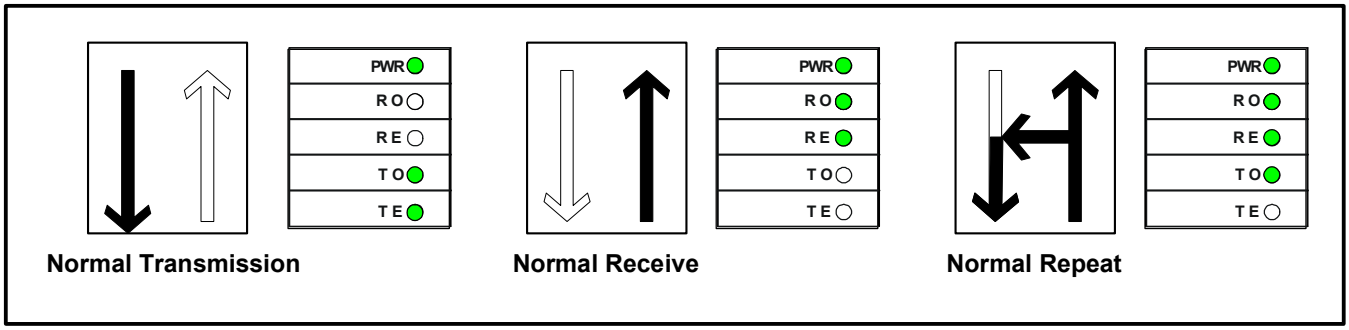


FIGURE 6. Diagnostic LED's and Data Signal Path

1.2.11 Diagnostic LEDs

Each Link/Repeater is equipped with four green diagnostic LEDs. They represent the electrical transmit (TE), optical transmit (TO), electrical delivery (RE), and optical receive (RO) paths. These LEDs, when illuminated, show that the appropriate path is active. When the Link/Repeater is transmitting, both TE and TO LEDs will illuminate to show the transmit path active. When the Link/Repeater is receiving light signals, both RO and RE LEDs will illuminate. If the unit is in the repeat mode and receiving light, the RO, RE and TO LEDs will illuminate because the signal is being re-transmitted out the optical port, as well as, being delivered to the D-connector. LEDs only

illuminate when the path is active; powering of the unit does not illuminate these LEDs unless their path is active. When data is present on the paths, the LEDs may "flicker"; this is normal. The diagnostic LEDs may be used for trouble shooting by observing that the illumination of the LEDs corresponds with activity in the unit. See Figure 6 for LED patterns and signal paths.

NOTE

The diagnostic LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times. If during quiet time, TE and TO are illuminated, it suggests either a polarity reversal (pins 1 & 2) or that the IED is biased pulling the "A" (+) line with respect to the "B" (-) line. After checking the polarity on the connections, refer to Section 3.5.

The diagnostic LEDs may "flicker" when data is passing. This is normal operation.

1.2.12 Power Connections

1.2.12.1 Powering Model 5845HRT and 5845SHRT

Model 5845HRT may be powered either through pin 9 of the 9 Pin D-connector or the power connector on the side of the unit:

1) When powering the 5845HRT via pin 9 (pin 9 + with pin 5 as GND) of its D-connector, the IED must supply at least 250 mA (340mA for the 5845SHRT). The voltage should be noise free and regulated within a range of 9 to 15 Vdc.

2) When powering the 5845HRT via its power connector the device requires regulated voltage within a range of 9 to15 Vdc. DYMEC offers a 110 Vac to 12 Vdc adapter, Model 4310S (Model 4320S for 220 Vac 50 Hz) that is designed specifically for 5845HRT & 5845SHRT. Model 4310S assures reliable power over the temperature range of 0°C to + 70°C.

CAUTION

Regardless of the power connection used, Model 5845HRT requires 250 mA within a range of 9 to 15 VDC. The 5845SHRT requires 340 mA. An inadequate power supply not capable of supplying this current over the entire operating temperature range may cause the device to malfunction.

1.2.12.2 Powering the Model 5846HRT and 5846SHRT

Model 5846HRT and the 5846SHRT may be powered either through pin 9 of the 9 Pin D-connector or the power connector located on the side of the unit:

1) When powering Model 5846HRT via pin 9 (Pin 9 + with pin 5 as GND) of its D-connector, the IED must supply at least 250 mA (340mA for the 5846SHRT). The voltage should be regulated and within a range of 9 to 15 Vdc.

2) Model 5846HRT has an internal regulated switching power supply that may be connected directly to ac or dc station power. The station power may be 90 to 250 Vac, 50/60 Hz or 90 to 250 Vdc. The station voltage may be unregulated, but the circuit must be capable of providing a minimum of 45mA (60 mA for the Model 5846SHRT) continuously. Model 5846HRT has a ground stud (#6-32 bolt) and a power connector on the side of the case. If a Model 5846HRT is powered through

the power connector, then connect a suitable earth ground to the grounding stud on the side of the Link/Repeater. Loosen the captive screws and remove the power plug from the power connector of the Link/Repeater. Connect the power lines to the power plug being careful not to leave any wire strands exposed.

NOTE

Model 5846HRT can be ordered to accommodate 24 - 48 Vdc (requires 250 mA)

This power input to the Model 5846HRT-L is Surge Withstand Protected to IEEE 1613 for all input voltages.

WARNING

When installing a Model 5846HRT or 5846SHRT Link/Repeater, an earth Ground must be attached to the Ground Stud on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

1.2.13 Peripheral Equipment

1.2.13.1 IED

An IED is any intelligent electrical device such as; a computer, RTU, PLC, "smart" meter, relay, etc., that has the ability to communicate data via EIA 422 or EIA 485 format. The IED should have a communication port for the connection of the Link/Repeater. If the IED's communication port connector does not accept the Link/Repeater to be plugged in directly, an adapter must be made to accommodate the connection. Care should be taken to assure that the correct signals are connected to each other. See Figure 2 for the Link/Repeater's pin signal assignments. Check your IED's equipment manual for its signal assignments.

The IED must also have intelligent software to execute the data communication. This intelligence needs to logically manage the data and signal traffic, including any addressing, token passing, "handshaking", data formatting and scheduling.

1.2.13.2 Fiber Optic Cable (FOC)

The selection of the fiber optic cable is important. High quality cable can assure the maximum performance of your Link/Repeater. Important factors to consider are the manufacturer's specification on attenuation per unit length, attenuation due to aging, diameter, and tensile strength. Choosing the best quality FOC for your installation is important.

NOTE

DYMEC can supply multi-mode glass FOC in Simplex, Duplex, or Breakout construction, cut to length, terminated, polished and tested. The specifications for all DYMEC supplied cables are as follows:

Fiber Diameter:	**62.5/125µm**
Tensile Strength:	**100 kpsi**
Loss:	**3 dB per kilometer**
Aging Loss:	**less than 3 dB**

Model 5845HRT and Model 5846HRT Link/Repeater optical ports are designed for ST type terminations and are compatible with multi-mode FOC ranging from 50 µm to 200 µm.

Model 5845SHRT and Model 5846SHRT Link/Repeater optical ports are designed for ST type terminations and are compatible with single-mode FOC ranging from 5 µm to 13 µm.

2. CONFIGURATIONS, OPERATION, AND INSTALLATION

Model 5845HRT and Model 5846HRT Link/Repeaters can be connected in; a Point-to-Point configuration, an Optical Bus network, an Optical Star network, a Master/Slave Loop, or a Peer-to-Peer Loop configuration depending on the needs of the overall communication system.

Model 5845HRT and Model 5846HRT are designed to accept differential electrical inputs per EIA 422 and EIA 485 standards. Various implementations of these electrical standards can result in different types of electrical circuits. The EIA 422 standard and the EIA 485 4 wire standard are normally associated with independent and separate transmit and receive channels. In Multi-drop networks, these standards allow Master / Slave operation only.

The EIA 485 2 wire standard generally uses a bi-directional, shared transmit/receive channel. In multi-drop networks, either Peer-to-Peer or Master / Slave operation is possible. The HD/FD switch on each Model 5845HRT and Model 5846HRT configures the Link/Repeater to accept either condition.

When the HD/FD switch is in the HD position, the Link/Repeater operates in half duplex mode only and both transmit and receive signals share pins 2 (A) and 1 (B).

In the FD position, Link/Repeater pins 2 (A) and 1 (B) connect to the IED's transmit channel. Link/Repeater pins 4 (A') and 3 (B') connect to the IED's receive channel.

NOTE

Some IEDs use "+" and "-" labels for their signals. A and A' are "+" and B and B' are "-".

It is possible to optically connect Link/Repeaters together which are connected to IEDs with different electrical formats, i.e. EIA 422, EIA 485 4 wire and EIA 485 2 wire. It is also possible to optically interconnect Models 5845HRT and 5846HRT to DYMEC Models 5843HRT and 5844HRT which are connected to IEDs operating RS 232 or TTL formats. See section 3.5.

APPLICATION NOTE

DYMEC Models 5843HRT, 5844HRT, 5845HRT and 5846HRT can optically communicate to each other, eliminating the need for format translation interfaces, provided all connected devices are operating at the same data rate and using the same protocol. (Refer to Section 3.5).

2.1 POINT-TO-POINT CONFIGURATION

For Point-to-Point operation, two Link/Repeaters are optically connected to each other. The HD/FD switch is set to the position that satisfies the IED that is connected to the Link/Repeater.

This configuration permits half duplex communication (sequential transmitting and receiving) and simplex (transmitting or receiving only) when the HD/FD switch is in either position. Full duplex is only available for circuits with independent transmit and receive channels where the HD/FD switch is placed in the FD position.

APPLICATION NOTE

In Point-to-Point operation, the communication logic (control software) of the IEDs must manage:

1) **The transmission of data signals.**
2) **The receipt of data signals.**
3) **Any "handshaking" required must be accomplished through software.**

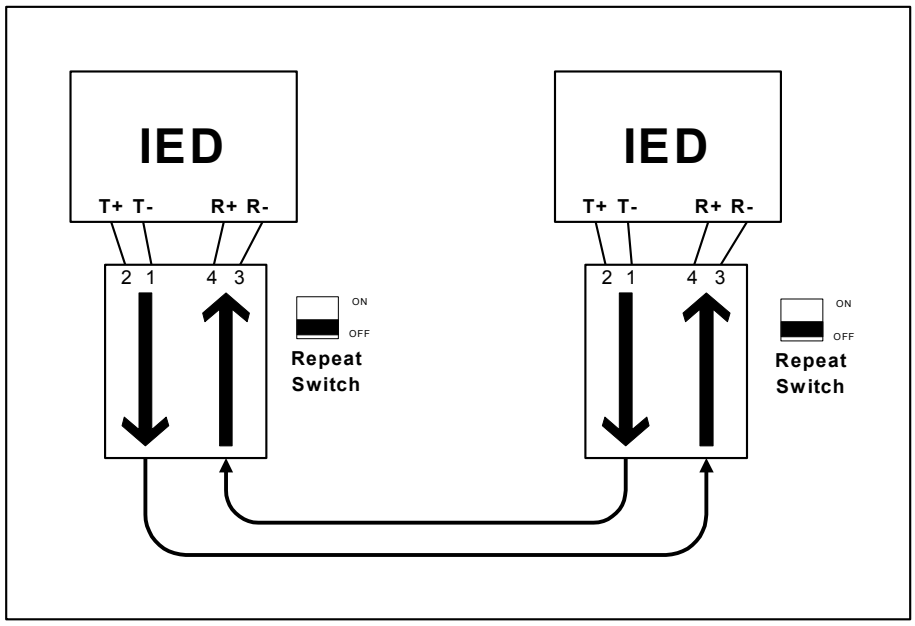


FIGURE 7. Point-to-Point Configuration

2.1.1 Installation

1. Set the HD/FD Switch to the appropriate position for each Link/Repeater and its respective IED.
2. Set the Repeat Switch on all of the units to the "OFF" position.
3. Connect the Link/Repeater to the IED's EIA 422 or 485 communication port (including any adapter that may be needed).
4. Connect the Fiber Optic Cables (T of one device to R of the second device).
5. Connect power to the Link/Repeater as follows:

   A) If the unit is to be powered through the D-connector (+ 9 to + 15 VDC on pin 9 with pin 5 used as GND), then the unit is energized when it is connected to the D-connector and the green “POWER” LED illuminates.

   B) If the unit is to be powered through power connector, connect the appropriate power source and energize the power source. The unit is now powered and the green “POWER” LED illuminates.

WARNING

When installing a Model 5846HRT or 5846SHRT Link/Repeater, an earth Ground must be attached to the Ground Stud on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

6. The units are now installed and operating.
7. Verify operation using the diagnostic LEDs. (See Figure 5).

NOTE

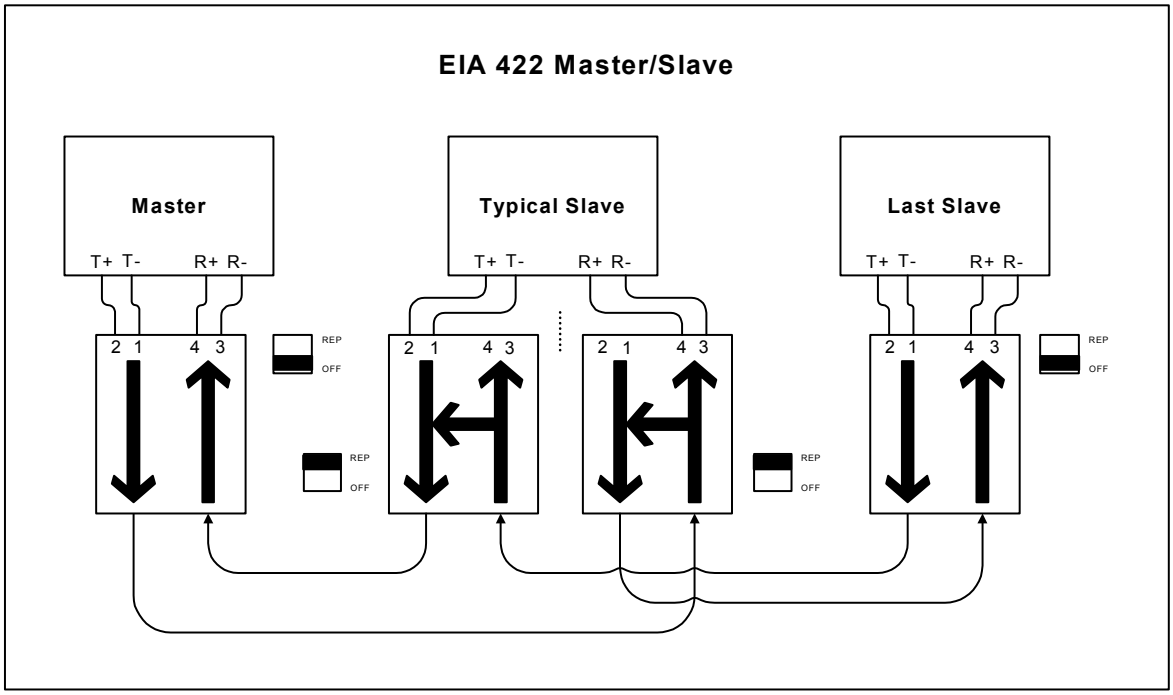
The diagnostic LEDs only illuminates when there is signal traffic and are not illuminated during signal "quiet" times. If during quiet time, TE and TO are illuminated, it suggests either a polarity reversal (pins 1 & 2) or that the IED is biased pulling the "A" (+) line with respect to the "B" (-) line. After checking the polarity on the connections, refer to Section 3.5.

The diagnostic LEDs may "flicker" when data is passing. This is normal operation.

APPLICATION NOTE

The Point-to-Point concept can be used to create an "optical bus" network. This can be useful for those situations where the software in the Master has not been written in such a way that it can handle the return of the transmitted echo that occurs in loop networks.

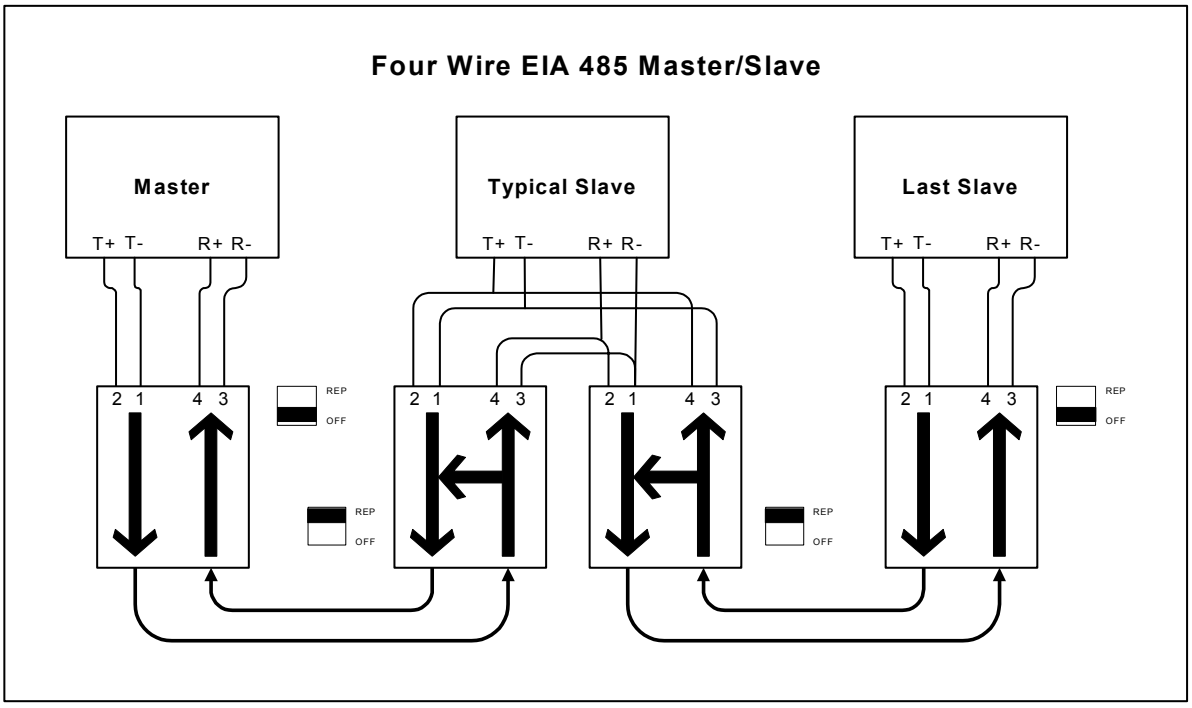
Figure 8 shows the connections for a Master/Slave EIA 422 "optical bus". Note that EIA 422 Standards do not permit multiple transmitters to be connected together as they are not tri-stated. In this configuration, all Slaves hear the Master's transmission, but only the Master hears the response from the addressed slave. The Master must always be the first IED in the network.



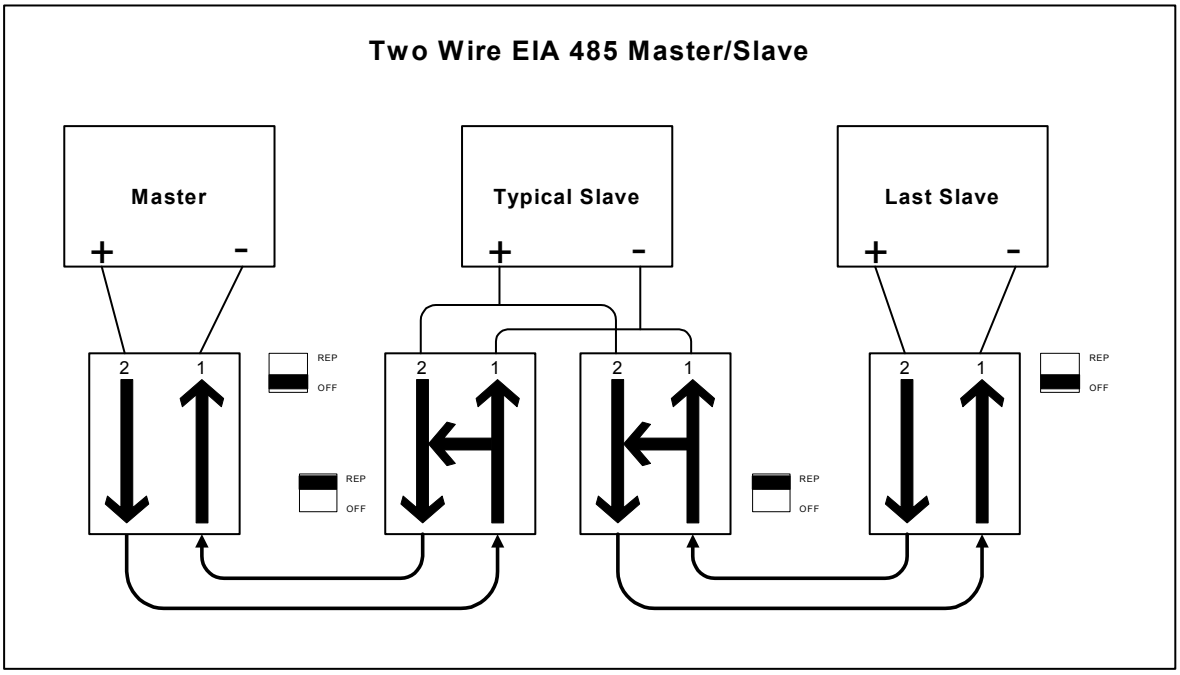
FD is selected on all Link/Repeaters
All Slaves hear the Master's Poll, only the Master hears the response

FIGURE 8. EIA 422 Bus Configuration

Figure 9 depicts an EIA 485 multiple drop "optical bus" for both 4 wire and 2 wire systems. The 4-wire system is a Master/ Slave configuration. All the Slaves hear the Master's poll, but only the Master can hear the addressed Slave's response and the Master must be the first IED in the network. However, in the 2-wire configuration, the system is capable of operating as Peer to Peer or Master/Slave. All IEDs hear all communications and the Master may be located at any point in the network.



All Slaves hear the Master's Poll, only the Master hears the response
FD is selected on all Link/Repeaters



All IEDs have the ability to hear and to respond to each other
HD is selected on all Link/Repeaters

Figure 9. EIA 485 Bus Configurations

APPLICATION NOTE

Another variation of the point-to-point concept is the Optical Star network. This topology may be created using the Dymec Optical Star OS5M or OS9M. This topology creates a "Hub and Spoke" configuration that can be useful in solving a network configuration based upon the physical positioning of the nodes.

The Dymec Optical Stars can also be used to create a multi-drop Master / Slave Optical Star network. The Model 5845HRT and 5846HRT are optically compatible with the OS5M and OS9M Master and Slave ports. Figure 10 shows a typical connection of an Optical Star network.

The master IED must always be connected to the Master port of the Optical Star. The slave IED's must always be connected to the Slave ports of the Optical Star.

Variations of this configuration are as follows:

- The optical star may be the last node of an optical bus configuration. One may create an Optical Bus configuration starting with the Master IED to a series of Slave IEDs and then connect the fiber network to the Master port of the OS4M or OS8M to continue the network in a "Hub and Spoke" topology.

- A Master IED may be connected to the master port of an OS5M or OS9M and then an Optical Bus network may be created from any Slave Port of the Optical Star.

- The Optical Stars maybe "cascaded". Cascading means optically connecting a Slave Port of one Optical Star to the Master Port of the next Optical Star.

- IEDs of different electrical formats (i.e., RS-232, EIA 422, EIA 485 2-wire or EIA 485 4-wire) may also be interconnected optically in the Star Configuration. Refer to section 3.5.

NOTE

It is not recommended that a "loop network" be connected to an Optical Stars Slave Port

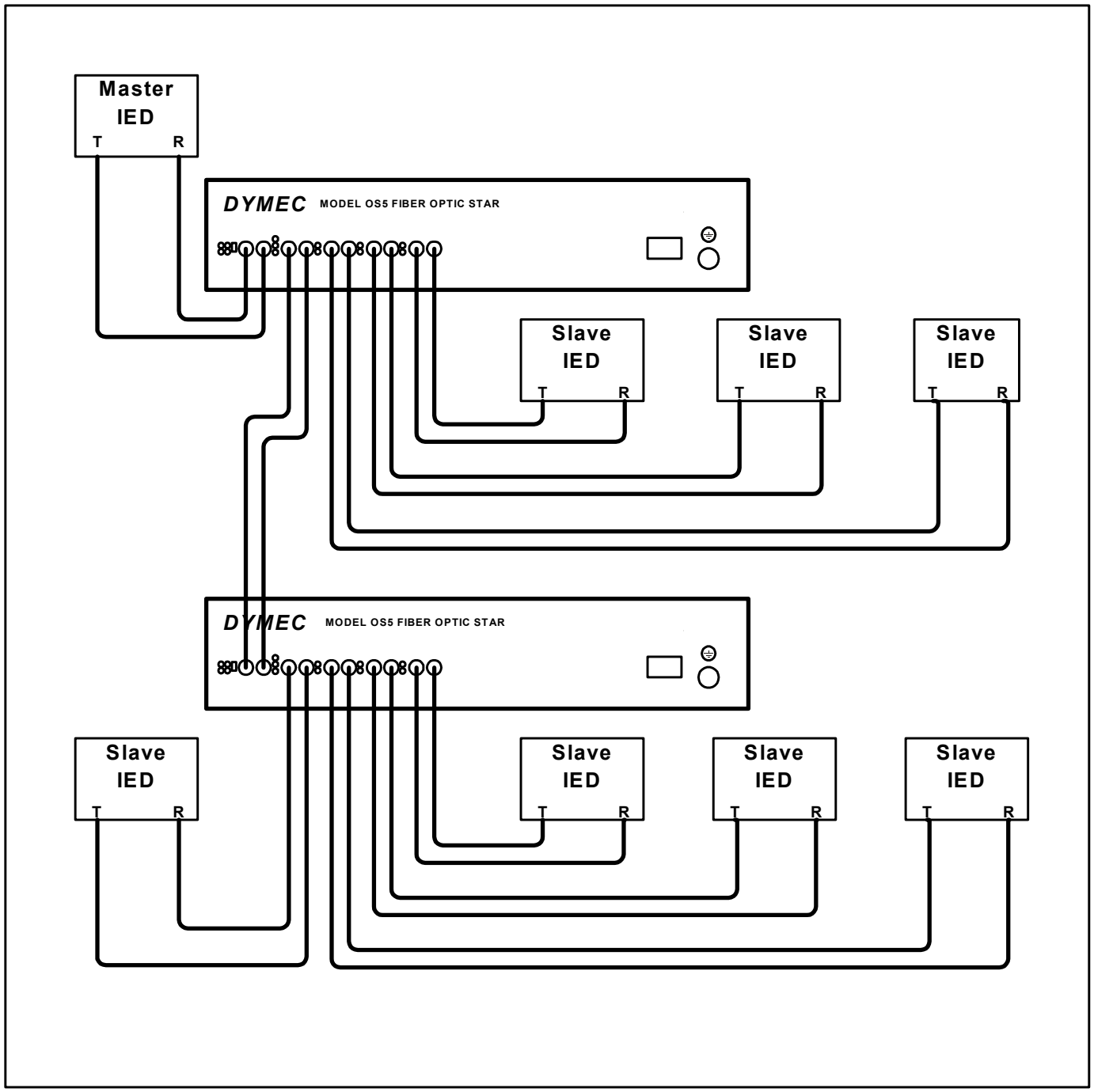


FIGURE 10. Optical Star Configuration
(OS5M cascaded to an OS5M)

2.2 LOOP OPERATION - MASTER/SLAVE CONFIGURATION

NOTE

Before constructing a loop network, be sure that the software protocol of the Master is capable of managing the receipt of its own echoed transmission. If it cannot, then use either an Optical Bus or Optical Star configuration.

This configuration supports a system that requires more than two IEDs to be communicating. In a Master/Slave loop system, one IED acts as a Master at all times and addresses or "polls" each of the other connected IEDs individually. Each Slave receives the same transmission from the Master IED but only responds when it recognizes its address in the polling message.

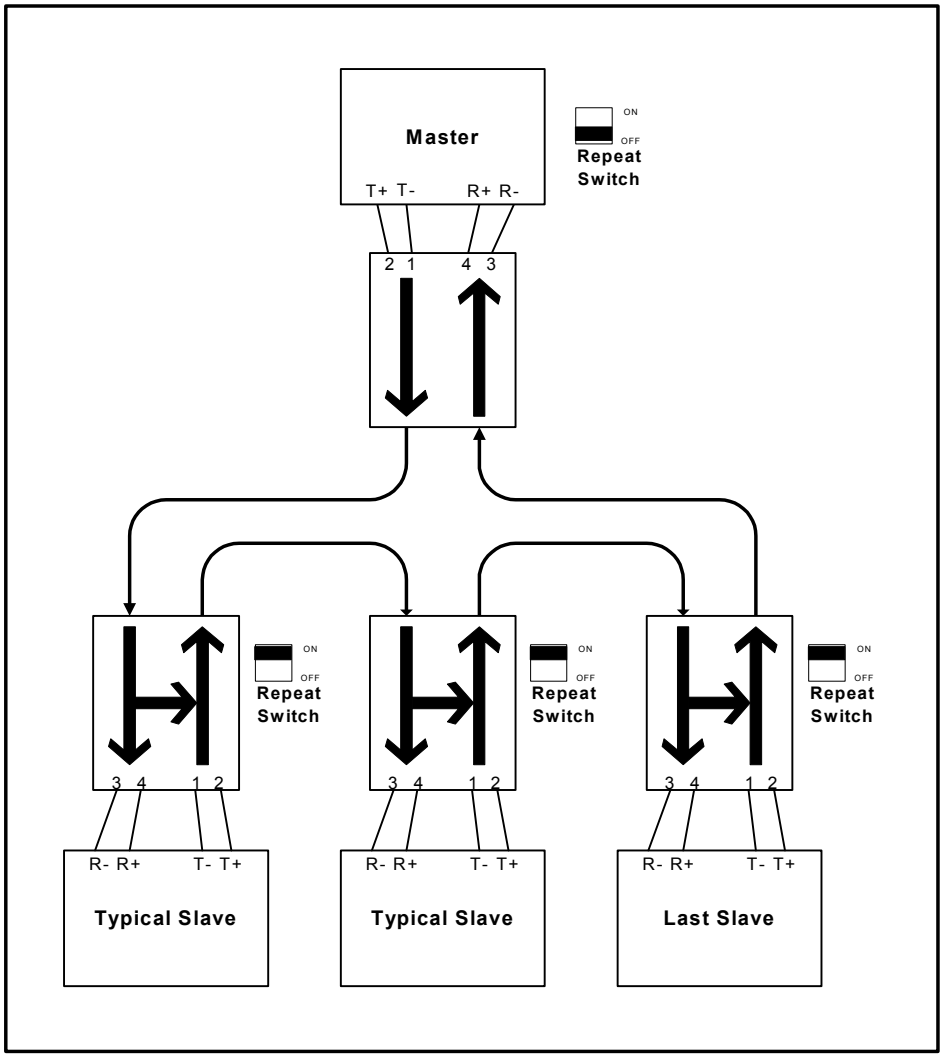


FIGURE 11. Master/Slave Loop Configuration

The Master must have its Repeat Switch in the "OFF" position. When it transmits a request out its T optical port, it will receive the echo of its request at its R optical port. This request has gone around the loop, and has been repeated by each Slave in the loop. However, the Master does not repeat (re-transmit) any of these received signals optically back around the loop, because its Repeat Switch is in the "OFF" position.

NOTE

The communication logic and control software of the Master IED must be able to manage the receipt of its echoed request. In the FD Mode, the receipt of the echo can be used in conjunction with a watchdog timer to continuously verify loop integrity.

When addressed, the Slave will transmit the appropriate response. Each Link/Repeater connected to a Slave IED must have its Repeat Switch set in the "ON" position. In this mode, all signals received on a Slave's R optical port are delivered to the IEDs communication port and at the same time repeated out the T optical port to the next device in the loop. If an IED determines that this request requires a response, then the Link/Repeater transmits the IEDs response out the T optical port. The response is repeated at each Slave device, until it arrives at the Master.

When an IED is a Slave, it should not attempt to initiate a transmission while it is receiving a signal. Since signals being received are also being repeated at the same time, any attempts to transmit its response while still receiving can corrupt both transmissions due to a data collision.

CAUTION

If a Slave IED attempts to transmit while receiving a message, a data collision will occur.

In Master/Slave Loop Operation, half duplex communication (sequential transmit and receive functions) is available. Only the Master can communicate full duplex (simultaneous transmit and receive) in a Master/Slave loop, provided its IED has independent Transmit and Receive channels, and the Link/Repeater HD/FD Switch is placed in the FD position.

CAUTION

If the Master IED operates in half duplex mode, special steps must be taken to control the echo. (Refer to Section 3.6.)

APPLICATION NOTE

In a Master/Slave Loop Operation, the communication logic (control software) and the Master IED must manage:

1) **The transmission to Slaves (including addressing).**
2) **The receipt of the echo of its transmissions.**
3) **The receipt of the Slave's response to its transmission.**
4) **The control of the Slaves to prevent the initiation of a transmission while receiving a signal.**

2.2.1 Installation

1. Set the HD/FD Switch to the appropriate position for each Link/Repeater and its respective IED.

2. Set the Repeat Switch to the "OFF" position on the Master. Set the Repeat Switch to the “ON” position on each Slave.

3. Connect the Link/Repeater to the IED's EIA 422 or 485 communication port (Including any adapter that may be needed).

4. Connect the Fiber Optic Cables (T of one device to R of the next device in the loop). Continue around the loop back to the Master to close the loop.

5. Connect power to the Link/Repeater as follows:

   A) If the unit is to be powered through the D-connector (9 to 15 VDC on pin 9 with pin 5 used as GND), then the unit is energized when it is connected to the D-connector of the IED and the green “POWER” led illuminates.

   B) If the unit is to be powered through the power connector, connect the appropriate power source and energize the power source. The unit is now powered and the green “POWER” LED will illuminates.

WARNING

When installing a Model 5846HRT or 5846SHRT Link/Repeater, an earth Ground must be attached to the Ground Stud on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

6. The units are now installed and operating.

7. Verify operation using the diagnostic LEDs. (See Figure 5)

NOTE

The diagnostic LEDs only illuminates when there is signal traffic and are not illuminated during signal "quiet" times. If during quiet time, TE and TO are illuminated, it suggests either a polarity reversal (pins 1 & 2) or that the IED is biased pulling the “A” (+) line with respect to the “B” (-) line. After checking the polarity on the connections, refer to Section 3.5.

The diagnostic LEDs may "flicker" when data is passing. This is normal operation.

2.3 LOOP OPERATION - PEER-TO-PEER CONFIGURATION

NOTE

Before constructing a loop network, be sure that the software protocol is capable of managing the receipt of the echo of its own transmission. If it cannot, then use either an Optical Bus or Optical Star configuration.

A Peer-to-Peer loop configuration is similar to the Master/Slave loop configuration except that each IED in the loop is capable of Mastering the loop in a pseudo-Master/Slave loop. To achieve this, Models 5845HRT and 5846HRT provide an electrical means of controlling the "OFF/REP" function.

In this system, all Link/Repeaters are connected in a loop with their Repeat Switch in the "OFF" position. Each IED must be able to control pin 7 of the D-connector to enable and disable the “REP” function. When an IED applies a high potential (greater than 2.4 Vdc – but less than 30V) it enables the repeat function of the Link/Repeaters. This is equivalent to the Repeat Switch being in the “REP” position. When an IED wishes to become the loop Master, it lowers the potential on pin 7 to a voltage less than 0.8 Vdc. This disables the Link/Repeaters' repeat function as if the Repeat Switch were in the "OFF" position.

NOTE

The communication logic and control software of the Master IED must be able to manage the receipt of its echoed request. In the FD Mode, the receipt of the echo can be used in conjunction with a watchdog timer to continuously verify loop integrity.
The voltage levels to enable and disable the repeat functions is opposite the levels used in the previous generation of Dymec Link/Repeaters.

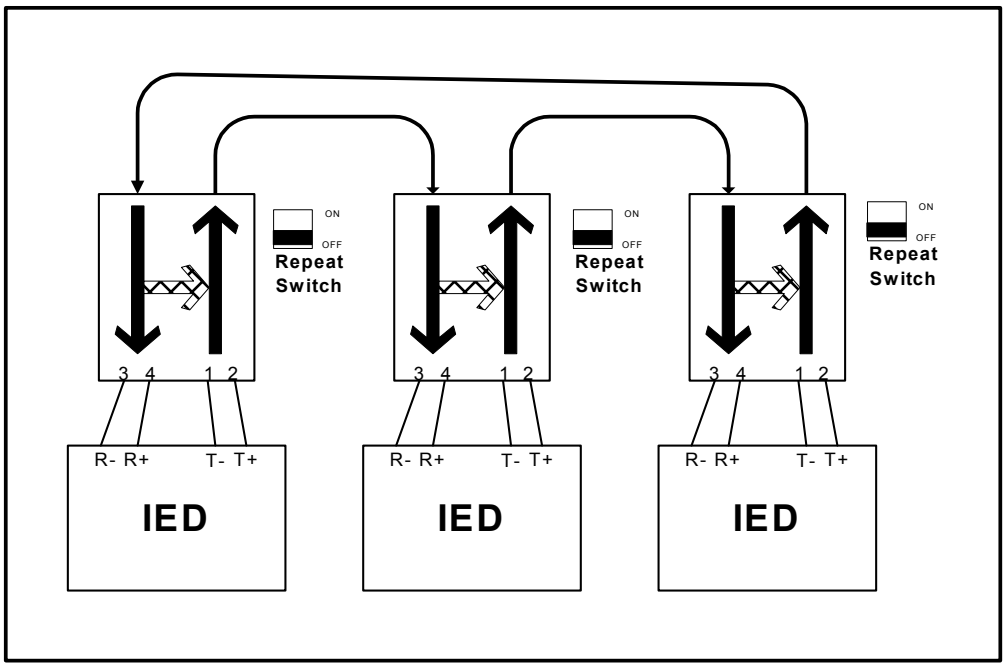


FIGURE 12. Peer-to-Peer Loop Configuration

When the potential on pin 7 is high, signals received on the R optical port are delivered to the IED and are repeated out the T optical port to the next device in the loop. A low potential on pin 7 causes signals received on the R optical

port to be delivered to the IED only and are not repeated out the T port. It is not necessary for a Slave to lower the potential of its pin 7 to transmit.

After an IED has completed its tasks mastering the loop, it must return its pin 7 to a high potential enabling its repeater function to establish loop continuity for the next IED that becomes loop Master.

NOTE

Powering and Controlling pin 7 can be ignored in all configurations except Peer-to-Peer loop operation.

Only half duplex communication is available with this configuration.

When an IED is in the Slave state, it should not attempt to initiate a transmission while it is receiving a signal. Since signals being received are also being repeated at the same time, any attempt to transmit its response while still receiving, can corrupt both transmissions due to a data collision.

NOTE

Any Link/Repeater that has its Repeat Switch in the "OFF" position and has a low potential on pin 7 will not repeat signals received on its R optical port out of its T port. Only transmissions initiated by its IED are transmitted out its T optical port.

CAUTION

If any IED operates as a Master and is 2 wire EIA 485 (half duplex), special steps must be taken to control the echo. (Refer to Section 3.6)

APPLICATION NOTE

In Peer-to-Peer loop operation, the communication logic (control software) and the Master IED must manage:

1) **The transmission to Slaves.**
2) **The receipt of the echo of its transmissions.**
3) **The receipt of the Slave's response to its transmission.**
4) **The control of pin 8 of D-connector.**
5) **The control of the Slaves to prevent the initiation of a transmission while receiving a signal.**

2.3.1 Installation

1. Set the HD/FD Switch to the appropriate position for each Link/Repeater and its respective IED.

2. Set the Repeat Switch on all the units to the "OFF" position.

3. Connect the Link/Repeater to the IED's EIA 422 or 485 communication port (Including any adapter that may be needed).

4. Connect the Fiber Optic Cables (T of one device to R of the second device). Continue around the loop to complete the loop.