Industrial Fiber Optic Links*

Models 5941 and 5942
Models 5941S and 5942S

User Manual

UM5941
REV AD

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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.

DYMEC makes no representation or warranty, expressed, implied, or statutory with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein. No warranties of merchantability or fitness for purpose shall apply.

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

Table of Contents

1. INTRODUCTION

DYMEC Models 5941, 5941S, 5942 and 5942S are multi channel (maximum of 4 channels) data communication Links that allow the replacement of copper wire with fiber optic cable. Links simply convert electrical signals to light for transmission, then, when received, convert the light signals to electrical. This is done in RS-232 formats.

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

There are two families of the 5941 and 5942. In the standard family (designated by a D1 suffix, e.g. 5941D1) channel 1 supports up to a full 64K baud data rate and channels 2, 3 and 4 support a maximum of 4K baud date rates each. This combination of data rates is more than adequate to support such functions as Full Handshaking, IRIG-B unmodulated timing synchronization signals or additional slow data rate IED's.
The extended family (designated by a D4 suffix, e.g. 5941D4) supports 64K baud data rates for all four data channels. These models can be used for 4 Asynchronous RS232 devices (if located in a single cabinet and not separated from the link by more than 3 Meters or 10 feet) or 1 or 2 Synchronous RS232 devices (If the devices only require 1 transmit and receive clock per device).

Models 5941 and 5942 are similar except for the method in which they are powered.

Models 5941S and 5942S have the same features and functionality described for the Models 5941 and 5942 respectively except that they have single mode optics for use with single mode fiber cable.

NOTE

This manual makes reference to the Model 5941 and Model 5942 when describing features and functionality of the Links. These descriptions generally apply to the Model 5941S and Model 5942S as well. When different, a specific reference is made identifying the particular model(s) and their variation.

The user should read this manual to fully understand how to use the many features of the Links 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 RS-232 and/or TTL 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), and scheduling.

Point-to-Point Configuration:

Two Links connected directly to each other. Only configuration supported with 5941 or 5942's

Master/Slave Loop Configuration:

More than two Links 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 IED's act as Slaves and respond only when specifically polled by the Master. Not supported with 5941 or 5942's

Peer-to-Peer Loop Configuration:

More than two Links 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. Not supported with 5941 or 5942's

Echo:

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

Optical Bus Configuration:

More than two Links connected together in a manner where the Master's transmission is heard by all IED's and there is no returning echo of this transmission. Not supported with 5941 or 5942's.

Optical Star Configuration:

More than two Links connected together in a "hub and spoke" topology where the Master's transmission is heard by all IED's and only the Master hears the polled Slave's response and there is no returning echo of the transmissions. Not supported with 5941 or 5942's.

Master:

The Master is the IED which controls the loop in a Master/Slave loop. This IED is responsible for the control of the loop, the polling of the Slaves for information, and the prevention of data collisions. All loop communication is echoed back to and stops at the Master. The Master's mode switch is always in the "OFF" position. Not supported with 5941 or 5942's.

Slave:

A Slave is an IED that is passive in a Master/Slave loop. A Slave's communication is under the control of the Master, and should be controlled to prevent data collision in the loop. All communication generated by the Master will be repeated through each Slave and back to the Master. A Slave's mode switch is always in the "REP" position. Not supported with 5941 or 5942's.

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 (~ 30 km, 18 miles or 98K feet) 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 5 km (3 miles or 16K feet).

Data Coupling Switch:

Some Link models are provided with this jumper to easily adapt the device for either DC or AC electrical Input data coupling. With AC data coupling the minimum input data rate is 1200 baud with DC data coupling there is no minimum input data rate but a signal stuck on the input will lock up a loop, bussed or star network. Not supported with 5941 or 5942's.

Mode Switch:

The mode switch enables (ON) or disables (OFF) the repeater function of some models of Link. Not supported with 5941 or 5942's.

DTE/DCE Switch:

Some Links are provided with this switch to easily adapt the device for either the DTE or DCE configuration of the equipment that it connects. Not supported with 5941 or 5942's.

Channel 4 Output Option Switch: (Switch 1)

Models 5941 and 5942 Links are provided with this switch to allow users who do not require 4 data channels to use pin 9 as a sync indicator. If the connection between the 2 Links is good the output on this pin will be high, if the connection between the 2 devices is lost the output of this pin will be low.

Channel 3 Output Option Switch: (Switch 2)

Models 5941 and 5942 Links are provided with this switch to allow users who require more drive current on a single data channel to use data channel 3 (pin 8) to accomplish this. If the switch is set to IRIG-B higher drive current is available (up to 20ma also selectable).

Current Output Option Switch: (Switch 3)

Models 5941 and 5942 Links are provided with this switch to allow users who have selected the IRIG-B option for channel 3 (pin 8) to further select one of 2 output current values. Selections are 10ma or 20ma. Consideration should be given that the current value selected is appropriate for the input of the device being connected to this data channel.

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. Also the diagnostic LED that illuminates when the Link is receiving an electrical transmit from its IED.

R:

Receive optical port. Also the diagnostic LED that illuminates when the Link is receiving an optical signal.

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 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, 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 Links that may be connected in a loop configuration. 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. Links support asynchronous communication. A communication scheme where the clock needs to be transmitted (Synchronous Communication) is not supported unless the data and clock are transmitted together on the same pin.

Synchronous Communication:

This type of communication does transmit a separate clock signal with the data signal. Under special circumstances the Model 5941 and 5942 Links support up to 2 Synchronous communication devices in the same cabinet over 1 pair of fiber.

Hardware Handshaking:

Hardware handshaking is a method for 2 RS232 devices with different data buffering capabilities to communicate reliably with each other via an RS232 electrical port. Extra signals are defined to control the flow of information between devices.

IRIG-B:

IRIG-B is a serial time synchronization standard. The Dymec links support unmodulated or Manchester encoded IRIG-B time streams at RS232 electrical levels.

Sync:

The design of the 5941 and 5942 support an internal diagnostic that monitors the fiber link between the two devices and allows the devices to synchronize (sync) the data streams transferred.

1.2 MODEL 5941 AND MODEL 5942 LINKS

NOTE

The 5941 and 5942 links contain no serviceable parts. Opening the unit will void the warranty.

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

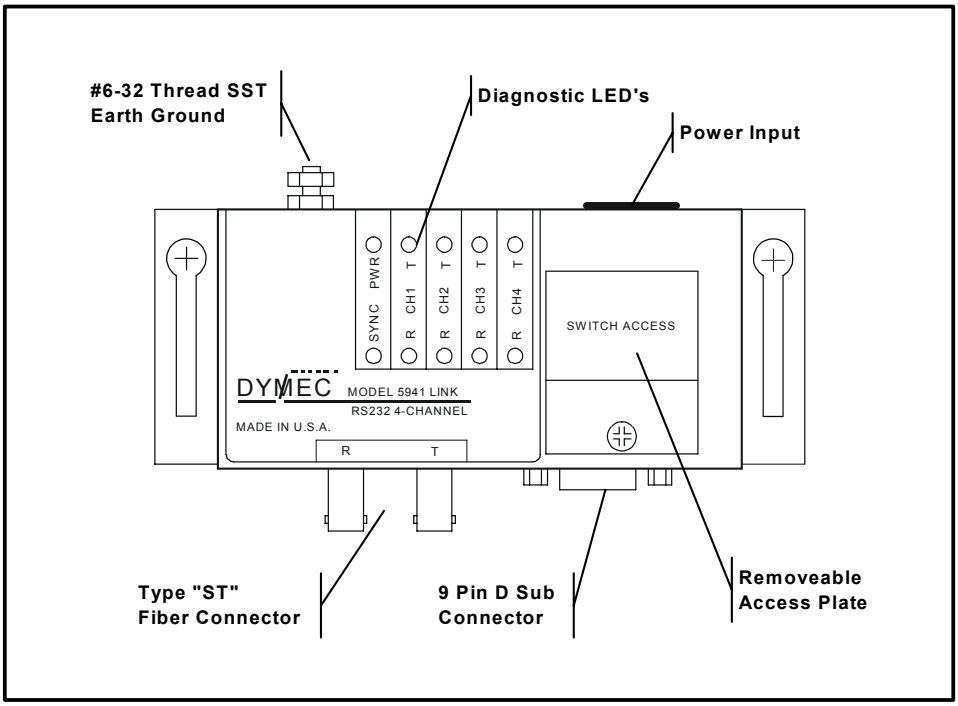


FIGURE 1. Elements of the Link

1.2.1 9 Pin Data Port D-connector

The Link connects to an IED's RS-232 communication port. The pin out configuration of the Link is shown in Figure 2. An adapter is required to connect individual IED's RS232 ports to one of the Model 5941 or Model 5942 4 data channels. Pin 1 is indicated in Figure 4. Receive ports are device input pins and Transmit is a device output pin on the links.

	Primary Pin Definition	Optional Pin Definition
• 1	Channel 1 Receive (Data In)	
• 2	Channel 2 Receive (Data In)	
• 3	Channel 3 Receive (Data In)	
• 4	Channel 4 Receive (Data In)	
• 5	Signal Common	
• 6	Channel 1 Transmit (Data Out)	
• 7	Channel 2 Transmit (Data Out)	
• 8	Channel 3 Transmit (Data Out)	IRIG-B
• 9	Channel 4 Transmit (Data Out)	Sync Indicator

Figure 2 Device Pin out

1.2.2 DTE/DCE Switch

The DTE/DCE Switch is not implemented on the Model 5941 or Model 5942.

1.2.3 Mode Switch

The Mode switch is not implemented on the Model 5941 or Model 5942

1.2.4 Channel 4 Output Option Select Switch 1:

Models 5941 and 5942 Links are provided with this switch to allow users who do not require 4 data channels to use pin 9 as a sync indicator. If the connection between the 2 Links is good the output on this pin will be high, if the connection between the 2 devices is lost due to cut fiber or device failure the output of this pin will be low on both devices.

1.2.5 Channel 3 Output Option Select Switch 2:

Models 5941 and 5942 Links are provided with this switch to allow users who require more drive current on a single data channel to use data channel 3 (pin 8) to accomplish this. If the switch is set to IRIG-B, higher drive current is available (up to 20ma also selectable).

1.2.6 Channel 3 Current Output Option Switch 3:

Models 5941 and 5942 Links are provided with this switch to allow users who have selected the IRIG-B option for channel 3 to further select one of 2 output current values. Selections are 10ma or 20ma. Consideration should be given that the current value selected is appropriate for the input of the device being connected to this data channel.

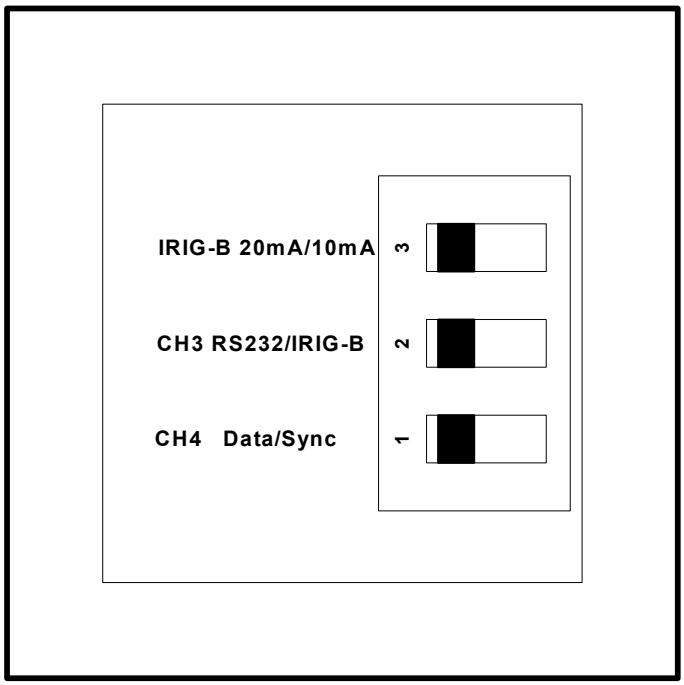


FIGURE 3. Option Switches (Factory Default Positions)

1.2.7 Handshaking Signals

With the standard Model 5941D1 and Model 5942D1, handshaking signals can be supported on any combination of channel 2, 3 or 4. The standard handshaking signals used on the majority of devices are an RTS/CTS pair (Request To Send/Clear To Send) and/or a DTR/DSR pair (Data Terminal Ready/Data Set Ready). All known combination of handshaking signals can be supported by the low data rate (4K baud channels).

1.2.8 Optical Ports

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

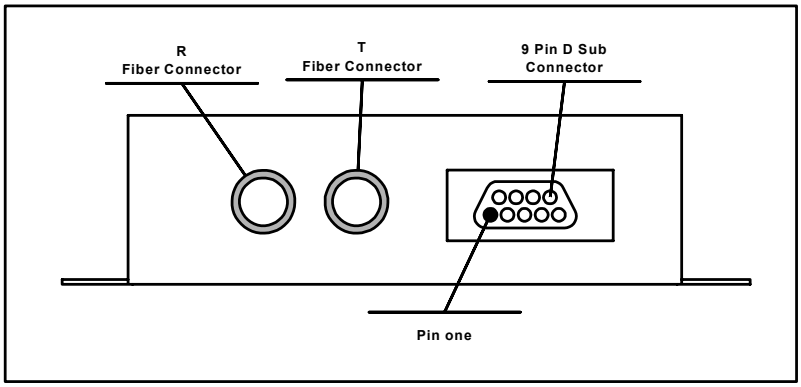


FIGURE 4. Optical Ports

1.2.9 Diagnostic LEDs

Each Model 5941 or Model 5942 Link is equipped with ten diagnostic LEDs. Eight of the LED's represent the transmit (T) and receive (R) paths for each of the four channels. These LEDs, when illuminated, show that the appropriate path is active (passing data). When a Link channel is transmitting, the T LED will illuminate to show the transmit path active. When a Link channel is receiving light signals, the R LED will illuminate. LEDs only illuminate when the path is active; powering of the unit does not illuminate the 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 5 for LED patterns and signal paths.

The Sync LED reflects the status of the fiber connection plus the health of the two links. Status information is constantly exchanged between the two links, if these status messages show a fault or are not received, this Sync LED will not be illuminated (if Ch4 Output option is selected, pin 9 will reflect the state of this LED). Whenever two 5941 or 5942's are connected via fiber and powered up, the Sync LED should be illuminated.

The final diagnostic LED is the PWR LED, this LED will illuminate whenever the appropriate power is connected to the device.

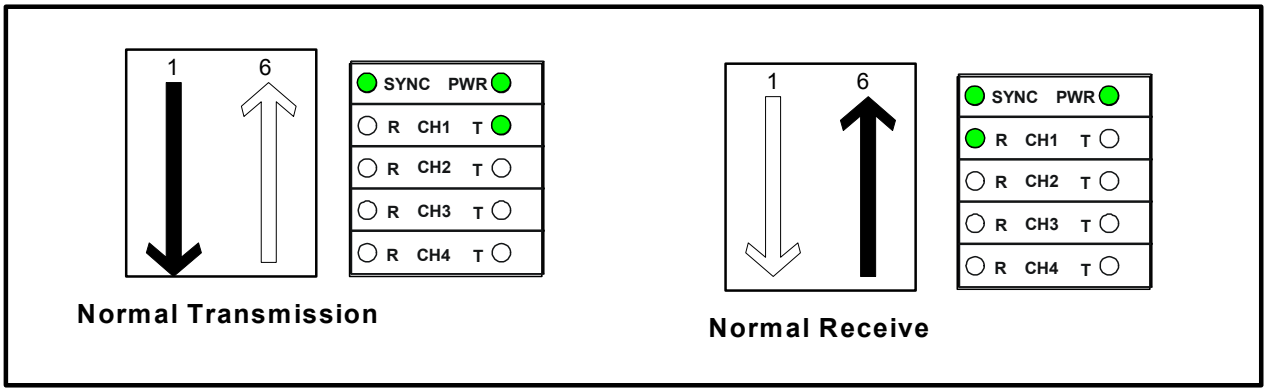


FIGURE 5. Diagnostic LED patterns and signal paths

NOTE

The CH or DATA LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times.

The LEDs may "flicker". This is normal operation.

1.2.10 Power Connections

1.2.10.1 Powering Model 5941 or Model 5941S

Model 5941 or Model 5941S is powered through an external power connector located on the side opposite the optical ports:
When powering the 5941 via its external connector, DYMEC offers a 110 Vac to 12 Vdc adapter (Model 4310S). Model 4310S assures reliable power over the temperature range of 0°C to + 70°C.

CAUTION

The Model 5941 requires 200 mA within a range of 9 to 15 VDC. An inadequate power supply not capable of supplying 150 mA over the entire operating temperature range may cause the Link to malfunction.

CAUTION

The Model 5941S requires 250 mA within a range of 9 to 15 VDC. An inadequate power supply not capable of supplying 220 mA over the entire operating temperature range may cause the Link to malfunction.

1.2.10.2 Powering the Model 5942 or Model 5942S

Model 5942 or 5942S must be powered through the power connector located on the side of the unit:

The Model 5942 and Model 5942S has an internal regulated 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 60 mA continuously. Model 5942 has a ground stud (#6-32 bolt) and a power connector on the side of the case. A suitable earth ground (minimum 14 gauge wire up to 5 foot in length) connected to the grounding stud on the side of the Link is required for safe operation. Remove the power plug from the power jack of the Link. Connect the power lines to the power plug being careful not to leave any wire strands exposed.

This power input to the Model 5942 or Model 5942S is Surge Withstand Protected to IEC EN61000-4-4 and EN61000-4-5 Standard ANSI/IEEE C37.90.1-1989.

NOTE

Model 5942 and Model 5942S can be ordered to accommodate 24 Vdc to 48 Vdc power.

WARNING

When installing a Model 5942 Link, an Earth Ground must be attached to the Ground Stud (minimum 14 gauge wire up to 5 foot in length) on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

1.2.11 Peripheral Equipment

1.2.11.1 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 RS-232 format. The IED should have a communication port for the connection of the Link. 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'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, data formatting and scheduling.

1.2.11.2 Fiber Optic Cable (FOC)

The selection of the fiber optic cable is important. High quality cable can assure the maximum performance of your Link. 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 either Simplex, Duplex, or Breakout construction, cut to length, terminated, polished and tested. The specification 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 5941 and Model 5942 Link optical ports are designed for ST type terminations and are compatible with multi-mode FOC ranging from 50 µm to 200 µm.

Model 5941S and Model 5942S Link 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 5941 and Model 5942 Links can only be connected in a Point-to-Point configuration.

These models are designed to accept electrical inputs per RS-232 and TTL standards.

CAUTION

Although the Dymec Links can recognize TTL levels on its inputs, the RS232 standard output voltages will damage TTL input pins as the RS232 standard calls for negative voltage levels beyond the specifications for TTL inputs.

RS-232 data communication signals are always paired. A transmit and receive pin is assigned to each channel on the 9 pin D-connector.

When the Link has a high TTL potential (above 2.0 volts) on its receive pin, it will transmit optically.

All signal voltage levels on the 9 pin D-connector are referenced to pin 5 (Signal Common) of the D-connector.

2.1 POINT-TO-POINT CONFIGURATION

For Point-to-Point operation, two Links are optically connected to each other.

This configuration permits full duplex communication (simultaneous transmitting and receiving), half duplex communication (sequential transmitting and receiving), and simplex (transmitting or receiving only).

Point to Point configurations are the only applications supported by the design of the Model 5941 and 5942 Links

CAUTION

Dymec does not recommend copper cable distances exceed 3 meters (10 Feet) to any single device connected to the Model 5941 or Model 5942. This restriction is imposed to minimize the potential for noise adversely affecting the signal quality before it is converted to Optical.

APPLICATION NOTE

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

1) **the transmission of data signals.**
2) **the receipt of data signals.**

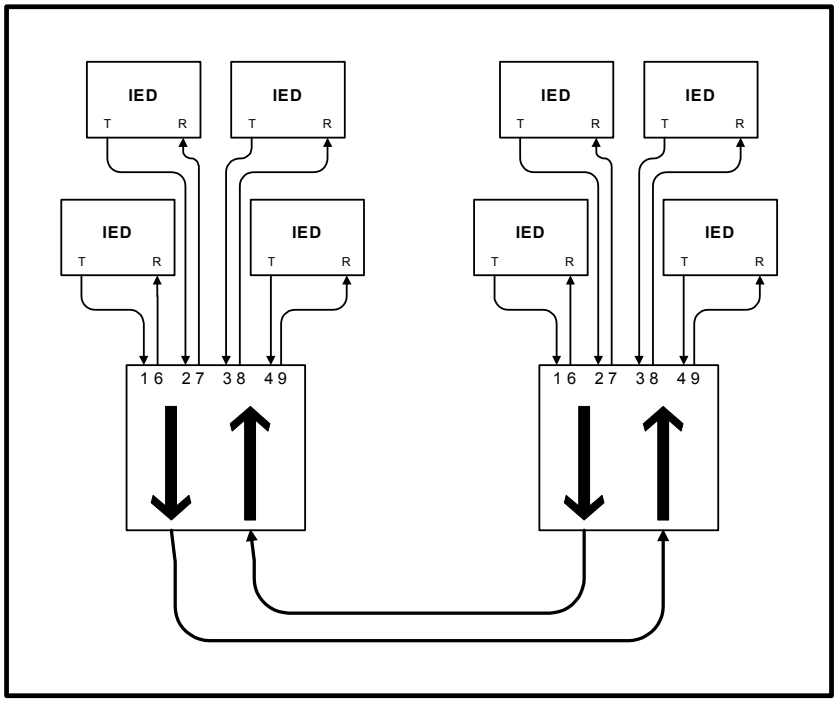


FIGURE 6. Point-to-Point Configuration 4 Channel Operation

2.1.1 4 Channel Configuration

The Model 5941 and Model 5942 can support up to 4 RS232 devices, each connected to one of the 4 available channels, see Figure 6. Any two IED's connected via a single channel on the Model 5941 or Model 5942 must be set to transmit at the same baud rate and be running the same protocol. This is not a requirement for all devices connected on different channels in the same Link. Each individual channel can support different protocols and baud rates. As an example: 2 IED's connected via channel 1 on a pair of 5941's could be transmitting at 64K baud communicating using the DNP3 protocol, while 2 IED's connected via channel 2 on the same pair of 5941's could be transmitting at 1200 baud communicating using a bit oriented protocol and the channel 3 IED's could be transmitting at 2400 baud communicating using the ModBus protocol. None of these IED's would interfere or communicate with the others IED's connected to a different channel.
For the standard family of the Model 5941 and Model 5942 (D1 suffix) devices only the IED's connected to channel 1 can have a data rate higher than 4K baud, channel 1 only will support device data rates up to a maximum of 64K baud.
For the extended family of the Model 5941 and Model 5942 (D4 suffix) devices, any or all IED's on all 4 channels can have a data rate of up to 64K baud.

2.1.1.1 Installation for a Single Channel

1) Connect a channel (transmit and receive pins) of the Link to the IED's RS-232 communication port (including the adapter)[repeat these connections for each additional channel used]. Pin 5 signal common is shared for all device channels.

2) Connect the Fiber Optic Cables (T of one device to R of the second device).

3) Connect power to the Link as follows:
   (a) The unit can only be powered through the power connector:
   (b) Connect power leads to the power connector and then energize the power source. The unit is now powered.

WARNING

When installing a Model 5942 or 5942S Link, an earth Ground must be attached to the Ground Stud (minimum 14 gauge wire up to 5 foot in length) on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

4) The units are now installed and operating.

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

NOTE

The Data Channel LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times.

The LEDs may "flicker". This is normal operation.

2.1.2 IRIG-B Configuration

The Model 5941 and Model 5942 can support an unmodulated RS232 IRIG-B signal on channel 3, see Figure 7. Any remote IED that requires an IRIG-B timing signal and has a separate IRIG-B input pin can connect the IRIG-B signal via a channel 3 on the Model 5941 or Model 5942. The source for the IRIG-B signal can be the master IED (if it has an IRIG-B output pin) or an additional device that is dedicated to IRIG-B signals. The IRIG-B source must be connected to pin 3 of the local 5941 or 5942 (the IRIG-B configuration switches do not need to be set on the local 5941 or 5942). For the 5941 or 5942 connected to the remote IED (that requires the IRIG-B input) the IRIG-B configuration switch must be set if the input pin does not meet the requirements of the RS232 standard (high impedance, +/-30 Vdc). The Model 5941 or Model 5942 offers 2 options when required to drive a low impedance (56 or 75 Ohm load input). When the Channel 3 Output Option Switch is set for IRIG-B there is an additional switch setting that allows the choice of 10mA or 20mA drive current to assure proper output voltage levels can be achieved. At the 10mA setting a 56 Ohm load will be driven from 0 volts to 2.5 volts, the 20mA setting will drive the same 56 Ohm load from 0 to 3 volts. Be careful to choose a current level that does not damage the input pin of the device it is connected to.
For the standard family of the Model 5941 and Model 5942 (D1 suffix) devices only, the IED's connected to channel 1 can have a data rate higher than 4K baud. Channel 1 only will support device data rates up to a maximum of 64K baud.
For the extended family of the Model 5941 and Model 5942 (D4 suffix) devices any or all IED's on all 4 channels can have a data rate of up to 64K baud.

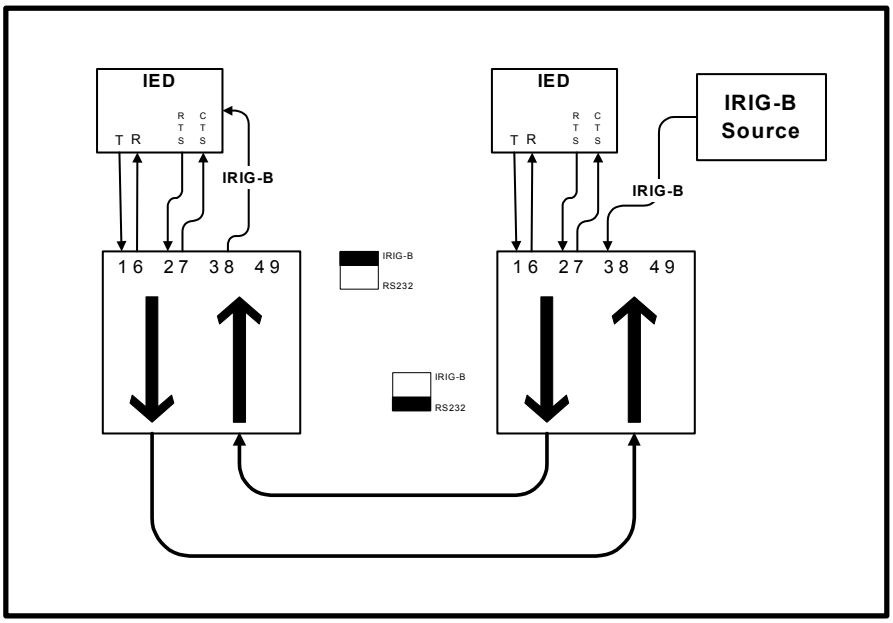


Figure 7 IRIG-B Configuration Point to Point

2.1.2.1 Installation for a Single Channel and IRIG-B signal

1) Connect a data channel (transmit and receive pins) of the Link to the IED's RS-232 communication port (including the adapter).

2) Connect the IRIG-B source to pin 3 of the local 5941 or 5942

3) Connect pin 8 of the remote 5941 or 5942 to the IRIG-B input pin of the remote IED.

4) Set the CH4 Output Option Switch of the remote 5941 or 5942 to IRIG-B if the input on the remote IED does not conform to the RS232 input specification.

5) Connect the Fiber Optic Cables (T of one device to R of the second device).

6) Connect power to the Link as follows:
   (a) The unit can only be powered through the power connector:
   (b) Connect power leads to the power connector and then energize the power source. The unit is now powered.

WARNING

When installing a Model 5942 or 5942S Link, an Earth Ground (minimum 14 gauge wire up to 5 foot in length) 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.

7) The units are now installed and operating.

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

9) If the voltage levels are too low on the IRIG-B input pin of the remote IED set the Current Option switch to the 20mA setting on that 5941 or 5942.

NOTE

The Data LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times.

The LEDs may "flicker". This is normal operation.

2.1.3 Contact Configuration

A pair of Model 5941 and/or Model 5942's can support up to 4 wet contacts at each end of a pair of fiber strands. The direct input voltages from the contacts are limited to +/- 30 Volts, if the source contact voltage is greater than 30 volts a dividing resistor or a buffer circuit is required in order not to damage the 5941 or 5942. This dividing resistor must also limit the current to a maximum of 6 mA. On the outputs of the Link, the drive current is restricted to driving a high impendence load thus if a relay actuator is expected to be driven directly an optical coupler or drive buffer circuitry is required between the output of the Link and the relay actuator so as to not damage the 5941 or 5942 output circuitry, see figure 8.
For the standard family of the Model 5941 and Model 5942 (D1 suffix) devices only the IED's connected to channel 1 can have a data rate higher than 4K baud, channel 1 only will support device data rates up to a maximum of 64K baud.
For the extended family of the Model 5941 and Model 5942 (D4 suffix) devices any or all IED's on all 4 channels can have a data rate of up to 64K baud.

2.1.3.1 Installation for a Single Channel Contact

1) Connect a relay contact to a channel input pin of the local Link (including the current limiting resistor).

2) Connect the corresponding channel output of the remote Link to the drive circuitry necessary for the relay contact to be actuated.

3) Connect the Fiber Optic Cables (T of one device to R of the second device).

4) Connect power to the Link as follows:
   (a) The unit can only be powered through the power connector.
   (b) Connect power leads to the power connector and then energize the power source. The unit is now powered.

WARNING

When installing a Model 5942 or 5942S Link, an Earth Ground must be attached to the Ground Stud (minimum 14 gauge wire up to 5 foot in length) on the side of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

5) The units are now installed and operating.

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

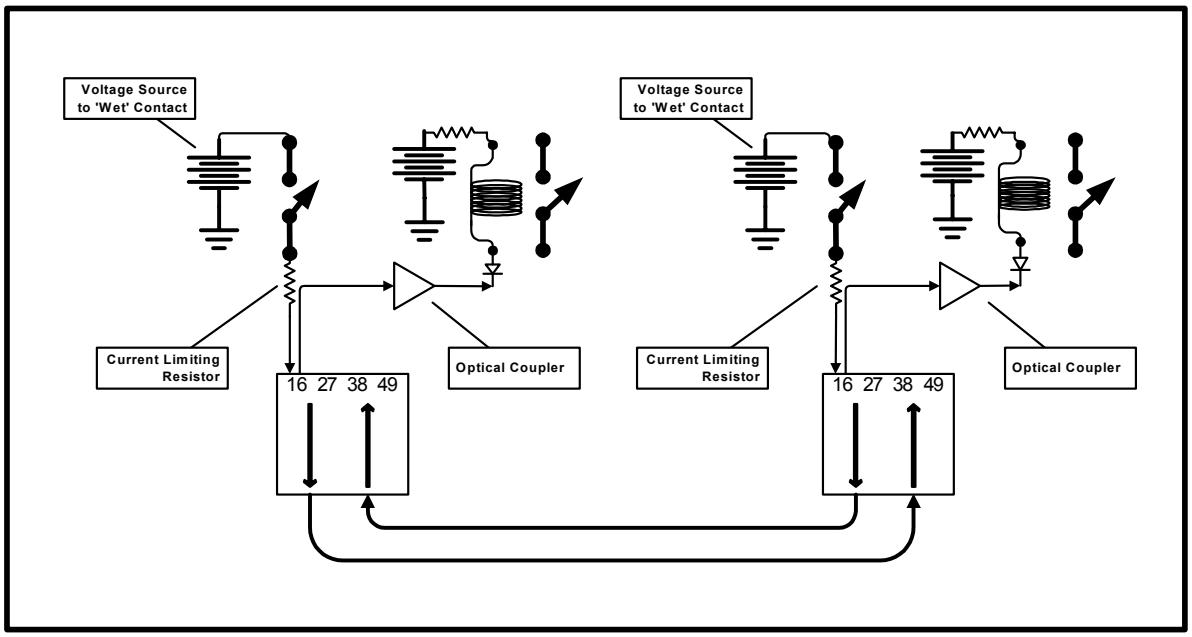


Figure 8 Relay Contact Configuration Single Contact Channel

NOTE

The Data Channel LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times.

The LEDs may "flicker". This is normal operation.

2.1.4 Handshaking Configuration

A pair of Model 5941 and/or Model 5942's can support hardware handshaking between 2 RS232 IED's. Channel 1 of the Links should be reserved for Data transmission as this would require the highest speed channel. The Handshaking signals are switching at a much lower data rate, thus the 3 additional channels of the D1 family of links will have enough bandwidth to cover these requirements.

Hardware handshaking covers 3 popular implementation methods, the most popular implementation uses RTS (Request To Send) and CTS (Clear to Send) signals. RTS is connected to CTS on the device on the other end of the fiber. RTS is sent by the transmitting device asking if the receiving device is ready to accept data. CTS is the receiving devices acknowledgement that it is ready to receive data and these signals are held in the active state until all data is sent. Channel 2, 3 or 4 can be chosen to be used for the handshaking signals, see Figure 9.
The second implementation method uses the DTR (Data Terminal Ready on the receiving IED) and DSR (Data Set Ready on the transmitting IED) signals. These signals perform the same functions as the previous example and can be connected via the other 3 channels as shown in Figure 9.
The third implementation is the one that is described in the RS232 standard and uses both sets of signals (RTS, CTS; DTR, DSR) The DTR/DSR signal pair is used to signal device status and RTS/CTS is used for Data traffic control. Using channel 2 and channel 3 of the 5941 and/or 5942 this implementation can be supported.

For the standard family of the Model 5941 and Model 5942 (D1 suffix) devices only the IED's connected to channel 1 can have a data rate higher than 4K baud, channel 1 only will support device data rates up to a maximum of 64K baud.
For the extended family of the Model 5941 and Model 5942 (D4 suffix) devices any or all IED's on all 4 channels can have a data rate of up to 64K baud.

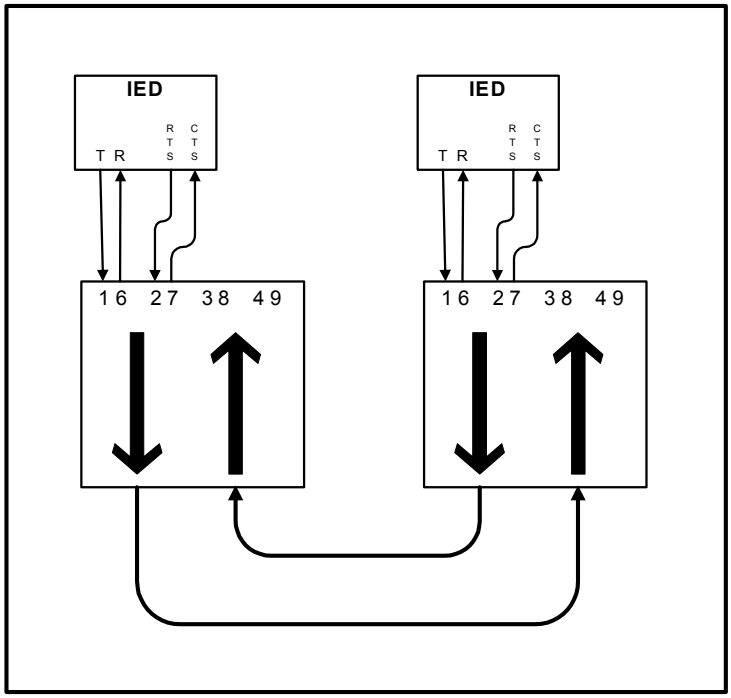


Figure 9 Typical Hardware Handshaking Setup

2.1.4.1 Installation for Hardware Handshaking using RTS/CTS Signals

1) Connect a data channel (transmit and receive pins) of the Link to the IED's RS-232 communication port (including the adapter).

2) Connect the Handshaking Signals to be used to channel 2 of the Link (using the adapter in step one)

3) Connect the Fiber Optic Cables (T of one device to R of the second device).

4) Connect power to the Link as follows:
   (a) The unit can only be powered through the power connector.
   (b) Connect power leads to the power connector and then energize the power source. The unit is now powered.

WARNING

When installing a Model 5942 or 5942S Link, an Earth Ground (minimum 14 gauge wire up to 5 foot in length) 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.

5) The units are now installed and operating.

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

3. APPLICATIONS

When planning a system using Model 5941 and Model 5942 Links, the following considerations should be reviewed:

- Data Rate
- Optical Budget and the distance between connected units
- Powering the Links
- Type of communication including format
- Selection of Fiber Optic Cable (FOC)

3.1 DATA RATE

Model 5941 and Model 5942 Links automatically support all data rates from DC levels to 64 Kilobits per second. No internal selection nor setting is required. However, it is necessary that all connected IED's on a particular channel be set at the same data rate.

3.2 OPTICAL BUDGET

The optical budget is a ratio of the receiver sensitivity to launched optical power, i.e. amount of light loss available from the transmitter to the receiver. It is calculated on a log scale so that a 3 dB loss is equal to half of the original power, 10 dB is one tenth of the original power, 20 dB is one hundredth, etc. Many different elements in the optical circuit can induce losses to the power of the signal. This attenuation must be taken into account when determining the distance that the signal can be transmitted. The major factor is the attenuation of the fiber optic cable. Cable attenuation is expressed as "X" dB per kilometer. Other factors of attenuation include FOC fittings (terminations, splitters, etc.) FOC diameter, and FOC aging.

Optical budget is the result of the expression:

$$\text{Optical Budget [dB]} = 10 \times \log 10 \frac{\text{Receiver sensitivity [µw]}}{\text{Launch Power [µw]}}$$

Each Model 5941 or 5942 Link has an available optical budget of 19.5 dB.

Each Model 5941S or 5942S Link has an available optical budget of 19 dB.

3.2.1 Cable Attenuation Factors

The following cable factors must be applied as corrections to the optical budget.

3.2.1.1 Diameter

Multi-mode:
FOC of different diameters will vary the available optical budget of a system due to different FOC core diameters. The 19.5 dB optical budget is applicable to 62.5 µm diameter FOC. Table 1 shows the correction factors to use on the available optical budget for different diameter cable.

Table 1

FOC Diameter	Factor
50µm	-3 dB
100µm	+4 dB
200µm	+7 dB

Single-mode:
19 dB of optical budget is available and is essentially consistent for fiber diameters.

3.2.1.2 Fittings

Adding additional splices, feed throughs, or patches to the FOC will add losses to the available optical budget. When using multi-mode Fiber Optic Cable terminated and supplied by DYMEC, optical connector losses can be ignored because the cable is tested after the terminations are added. If you are using fittings not supplied by DYMEC, you can get the optical budget loss information from their manufacturer(s).

3.2.1.3 Aging

As FOC ages, tiny cracks will form in the glass core of the fiber. These will cause the attenuation of the cable to increase. The optical emitters age over time causing a reduction in their optical launch power.

DYMEC suggests that a buffer be applied to the optical budget to assure proper operation of the unit over a 20-year life. A 2.5 dB to 3 dB loss factor is suggested to compensate for system aging over 20 years.

EXAMPLE:

FOC is 62.5/125 µm multi-mode (DYMEC supplied)
100 kpsi rated 3 dB/km and 3 dB for aging
No other attenuating items in the circuit

initial:	*19.5 dB Optical Budget*
less:	*3 dB aging*
less:	*0 dB for other circuit attenuation fittings*
equals:	*16.5 dB*
divided by:	*3 dB/km*
equals:	*5.5 km maximum distance of FOC between transmitter and receiver*

NOTE

FOC extends communication beyond normal RS-232 Standards limits. The distance allowable between Links must be calculated using the factors listed above.

3.3 POWERING THE LINK

3.3.1 Model 5941 (only)

Model 5941 can only be powered by means of the power connector located on the back of the unit. The unit has an input voltage range of 9 to 15 Vdc and requires a maximum of 200 mA over the entire operating temperature range. DYMEC's Model 4310 ac to dc power adapter is designed specifically for this purpose. It connects directly into a normal 110 volt power receptacle and has an operating temperature range of -0°C to +70°C.

3.3.2 Model 5941S (only)

Model 5941S can only be powered by means of the power connector located on the side of the unit. The unit has an input voltage range of 9 to 15 Vdc at the power connector and requires a maximum of 250 mA over the entire operating temperature range. DYMEC's Model 4310S ac to dc power adapter is designed specifically for this purpose. It connects directly into a normal 110 volt power receptacle and has an operating temperature range of -0°C to +70°C.

3.3.3 Model 5942 or Model 5942S

Model 5942 or Model 5942S is designed with an internal universal regulated power supply for environments where unregulated ac or dc voltages are available. It accepts ac voltages in a range of 90 to 250 volts, 50 or 60 hertz, or dc voltages in a range of 90 to 250 volts. These power sources must be capable of supplying 60 mA over the entire operating range.

NOTE

The Model 5942 can be ordered to accommodate 24 to 48 Vdc power.

Model 5942 or Model 5942S is provided with a ground stud on the side of the case. An appropriate earth ground (minimum 14 gauge wire up to 5 foot in length) must be connected to this stud before power is applied to the unit. The internal surge withstand protection inside of the unit uses this ground stud as a sink for power surges. If the unit is not properly grounded, it may store a charge until a path to ground becomes available. The lowest impedance to ground is recommended to avoid a ground potential rise.

WARNING

When installing a Model 5942 and Model 5942S Link, an earth Ground must be attached to the Ground Stud (minimum 14 gauge wire up to 5 foot in length) on the face of the case before connecting to power. Failure to follow this procedure may result in electrical shock to personnel.

3.4 OPTIONAL STATION POWER VOLTAGES

Models 5942 and 5942S can be ordered to be powered by 24 to 48 Vdc. This modification is indicated by the suffix -L added to the Model number (i.e. 5942D1HRT-L). When ordered with either of these options, the unit has that DC voltage rating only and is Surge Withstand Protected to IEC 61000-4-4 , 61000-4-5 and Standard ANSI IEEE C37.90.1-1989.

3.5 TYPE OF COMMUNICATION

Model 5941 and Model 5942 Links support the following types of asynchronous communications:

Simplex - Transmission only or receive only
Half Duplex - Sequential transmit and receive
Full Duplex - Simultaneous transmit and receive

3.6 SELECTION OF FIBER OPTIC CABLE (FOC)

Fiber optical cable is available in several formats; simplex, duplex, and breakout. FOC is also available in various diameters and tensile strengths. Tensile strength is important for longer life expectancy.

Simplex FOC is desirable for loop operations. It has one optical conductor and can be connected from the transmitter of one Link to the receiver of the next Link in the loop.

Duplex FOC has two optical conductors and is a convenient form when connecting two units Point-to-Point.

Breakout cable is a duplex FOC that has extra strength members added and is suitable for burial.

The following are the specifications of multi-mode FOC offered by DYMEC and is the recommended minimum standard for optimum performance.

		Simplex	**Duplex**	**Breakout**
Fiber Count		1	2	2
Fiber Material		Glass	Glass	Glass
Attenuation	[dB/km]	3	3	3
Diameter	[mm]	3.0	3.0 x 6.5	7.0
Weight	[kg/km]	8.0	16.0	50
Tensile load - Short Term	[N]	500	1000	1200
Minimum Bend Radius - With Load	[cm]	5	5	14
Minimum Bend Radius - No Load	[cm]	3	3	7
Crush Resistance	[N/cm]	750	750	2200
Impact Resistance	[Cycles]	1000	1000	2500
Flex Resistance	[Cycles]	7500	7500	2000
Operating Temperature	[^{o}C]	-40^{o} to +85^{o}	-40^{o} to +85^{o}	-40^{o} to +85^{o}
Storage Temperature	[^{o}C]	-55^{o} to +85^{o}	-55^{o} to +85^{o}	-55^{o} to +85^{o}

METRIC-TO-ENGLISH UNIT CONVERSIONS

			MULTIPLY BY				**MULTIPLY BY**
Millimeters	→	Inches	0.03937	Kilograms	→	Pounds	2.2046
Centimeters	→	Inches	0.3937	Kg/Km	→	Pounds/1,000 Ft	0.67197
Meters	→	Feet	3.2808	Newtons	→	Pounds	0.22481
Kilometers	→	Feet	3280.8	N/Cm	→	Pounds/inch	0.57101
Kilometers	→	Miles	0.62137				

4. TESTING AND TROUBLESHOOTING

4.1 TESTING

Models 5941 and 5942 lend themselves to easy installation and testing. Testing the units only requires that the units are powered and connected via fiber (due to the design of the 5941/5942 both fibers are required to be connected for this test). Once the fiber is connected and the units powered if the fiber connection is good the SYNC LED will illuminate and remain on. Testing the data channels requires transmitting and receiving data while observing that the diagnostic LEDs are illuminating in the proper sequence.

To test whether a standalone unit is transmitting and receiving correctly, insert a short fiber jumper between its T and R optical ports, note if the SYNC LED is illuminated, then transmit a signal and note that both diagnostic LEDs on the channel being tested should illuminate during communication (refer to Figure 5).

4.2 TROUBLESHOOTING

- If the unit does not work properly, use the following check list:
  - Is the unit properly powered?
- Verify the unit is receiving the correct power.
  - Check that the diagnostic LEDs are responding to the data activity of the channels connected to IED's.
  - Is the unit mated properly to the IED? If an adapter is used, check that pin assignments are connected correctly and that the data channels connect the intended devices.
- Are the fiber cables connected properly? T to R; not R to R nor T to T.
  - Determine that the IED's originating signal is within standards.

NOTE

If the Link is not connected directly to an IED, determine that the electrical signal received by the Link is not corrupt. The Link only repeats the signal it is given, it does not re-clock or re-generate the signal.

- Review the IED's software and protocols. Does the IED have physical "handshaking" requirements and have the appropriate settings on the IED been made to compensate for these requirements?
- Consult factory.

NOTE

The LEDs only illuminate when there is signal traffic and are not illuminated during signal "quiet" times. The LEDs may "flicker". This is normal operation.

NOTE

Links contain no serviceable parts. Opening the unit will void the warranty.

5. SPECIFICATIONS

5.1 Electrical and Optical Specifications (All Specifications over entire Operating Temperature Range)

5941D1 RS232 (4 Channel) Multimode	5941SD1 Single-mode
Optical Parameters	
Optical Budget Typical 19.5 dB	19 dB
Output power Typical -10.5 dBm peak	-14.5 dBm peak
Receiver Sensitivity Typical -30 dBm peak	-33.5 dBm peak
62.5µ/125 Multimode	9µ/125 Single-mode
Wavelength 850nm	1310nm
Connector Type ST	ST
Compatible Fiber Type Multi-Mode (50-200µm)	Single-Mode (9-13µm)
Configuration (Switches) CH 3 IRIG-B Output/Standard	CH 3 IRIG-B Output/Standard
CH 3 Drive Current Select	CH 3 Drive Current Select
CH 4 Sync Indicator/Data Out	CH 4 Sync Indicator/Data Out
Data Rate DC to 64K bps 1 Channel	DC to 64K bps 1 Channel
DC to 4K bps 3 Channel	DC to 4K bps 3 Channel
Data Transmission Asynchronous, simplex	Asynchronous, simplex
Half or Full Duplex	Half or Full Duplex
Transmission Distance up to 5000 meters	~ 30K meters
62.5µ/125 Cable@3dB/km	9µ/125 Cable@0.5dB/km
Bit Error Rate 10-E9 Max.	10-E9 Max.
Point to Point Latency Typical 25µS Channel 1	25µS Channel 1
100µS Channels 2,3,4	100µS Channels 2,3,4
Jitter Typical 1µS Channel 1	1µS Channel 1
12µS Channels 2,3,4	12µS Channels 2,3,4
Electrical Parameters	
Inputs	
I/O Data Format EIA RS232; CCITT v24	EIA RS232; CCITT v24
Data Connector 9 pin D-Type Female	9 pin D-Type Female
>3000Ohms	>3000Ohms
Input Voltage +/- 30 Volts Max	+/- 30 Volts Max
Outputs	
Output Impedance >300 Ohms	>300 Ohms
Driver Output +/- 5 V min into 3000 Ohms	+/- 5 V min into 3000 Ohms
IRIG-B Mode Ch 3 0 to 2.5V @ 10mA	0 to 2.5V @ 10mA
0 to 3V @ 20mA	0 to 3V @ 20mA
Ambient Temperature	
Operating Temperatures -40° to +85° C	-40° to +70° C
Storage Temperature -40° to +85° C	-40° to +85° C
Power Required 2.4 Watts	3.0 Watts
200 mA @ 9-15 Vdc	250 mA @ 9-15 Vdc
Weight ~8 Ozs.	~8 Ozs.
Power Dissipation BTU/H 10.2 BTU	12.8 BTU
Dimensions Inches 2.0W X 5.14L X 1.25H	2.0W X 5.14L X 1.25H
Indicators Power	Power
Sync Status	Sync Status
Transmit each channel	Transmit each channel
Receive each channel	Receive each channel

All Specifications are subject to change without notice.

5941D4 RS232 (4 Channel)

5941SD4

	Multimode	Single-mode
Optical Parameters		
Optical Budget Typical	19.5 dB	19 dB
Output power Typical	-10.5 dBm peak	-14.5 dBm peak
Receiver Sensitivity Typical	-30 dBm peak	-33.5 dBm peak
	62.5µ/125 Multimode	9µ/125 Single-mode
Wavelength	850nm	1310nm
Connector Type	ST	ST
Compatible Fiber Type	Multi-Mode (50-200µm)	Single-Mode (9-13µm)
Configuration (Switches)	CH 3 IRIG-B Output/Standard	CH 3 IRIG-B Output/Standard
	CH 3 Drive Current Select	CH 3 Drive Current Select
	CH 4 Sync Indicator/Data Out	CH 4 Sync Indicator/Data Out
Data Rate	DC to 64K bps 4 Channels	DC to 64K bps 4 Channels
Data Transmission	Asynchronous, simplex	Asynchronous, simplex
	Half or Full Duplex	Half or Full Duplex
Transmission Distance	up to 5000 meters	~ 30K meters
	62.5µ/125 Cable@3dB/km	9µ/125 Cable@0.5dB/km
Bit Error Rate	10-E9 Max.	10-E9 Max.
Point to Point Latency Typical	25µS All Channels	25µS All Channels
Jitter Typical	1µS All Channels	1µS All Channels
Electrical Parameters		
Inputs		
I/O Data Format	EIA RS232; CCITT v24	EIA RS232; CCITT v24
Data Connector	9 pin D-Type Female	9 pin D-Type Female
	>3000Ohms	>3000Ohms
Input Voltage	+/- 30 Volts Max	+/- 30 Volts Max
Outputs		
Output Impedance	>300 Ohms	>300 Ohms
Driver Output	+/- 5 V min into 3000 Ohms	+/- 5 V min into 3000 Ohms
IRIG-B Mode Ch 3	0 to 2.5V @ 10mA	0 to 2.5V @ 10mA
	0 to 3V @ 20mA	0 to 3V @ 20mA
Ambient Temperature		
Operating Temperatures	-40° to +85° C	-40° to +70° C
Storage Temperature	-40° to +85° C	-40° to +85° C
Power Required	2.4 Watts	3.0 Watts
	200 mA @ 9-15 Vdc	250 mA @ 9-15 Vdc
Weight	~8 Ozs.	~8 Ozs.
Power Dissipation BTU/H	10.2 BTU	12.8 BTU
Dimensions Inches	2.0W X 5.14L X 1.25H	2.0W X 5.14L X 1.25H
Indicators	Power	Power
	Sync Status	Sync Status
	Transmit each channel	Transmit each channel
	Receive each channel	Receive each channel

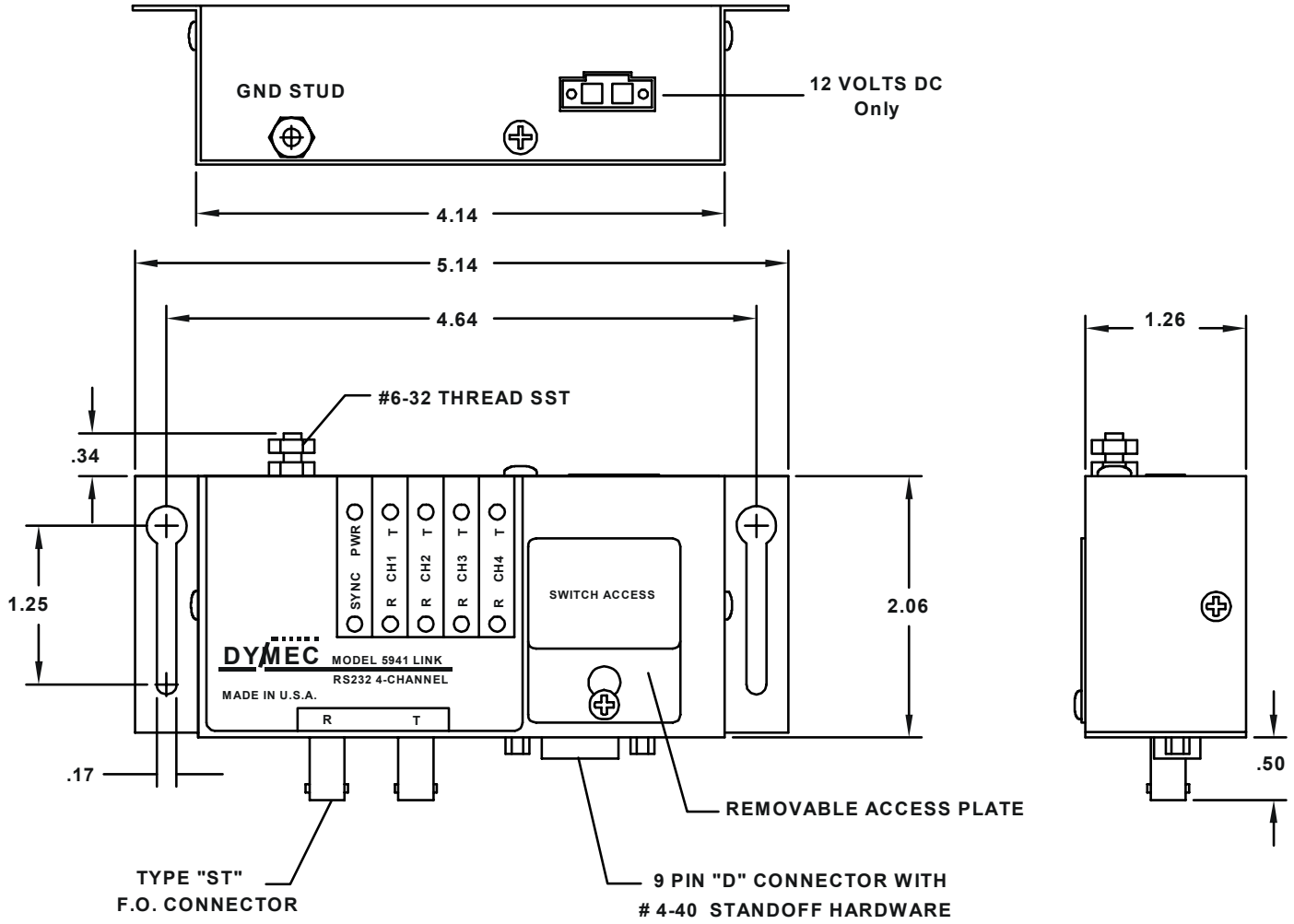
5942D1 RS232 (4 Channel)	Multimode	5942SD1 Single-mode
Optical Parameters		
Optical Budget Typical	19.5 dB	19 dB
Output power Typical	-10.5 dBm peak	-14.5 dBm peak
Receiver Sensitivity Typical	-30 dBm peak	-33.5 dBm peak
	62.5µ/125 Multimode	9µ/125 Single-mode
Wavelength	850nm	1310nm
Connector Type	ST	ST
Compatible Fiber Type	Multi-Mode (50-200µm)	Single-Mode (9-13µm)
Configuration (Switches)	CH 3 IRIG-B Output/Standard	CH 3 IRIG-B Output/Standard
	CH 3 Drive Current Select	CH 3 Drive Current Select
	CH 4 Sync Indicator/Data Out	CH 4 Sync Indicator/Data Out
Data Rate	DC to 64K bps 1 Channel	DC to 64K bps 1 Channel
	DC to 4K bps 3 Channel	DC to 4K bps 3 Channel
Data Transmission	Asynchronous, simplex	Asynchronous, simplex
	Half or Full Duplex	Half or Full Duplex
Transmission Distance	up to 5000 meters	~ 30K meters
	62.5µ/125 Cable@3dB/km	9µ/125 Cable@0.5dB/km
Bit Error Rate	10-E9 Max.	10-E9 Max.
Point to Point Latency Typical	25µS Channel 1 100µS Channels 2,3,4	25µS Channel 1 100µS Channels 2,3,4
Jitter Typical	1µS Channel 1 12µS Channels 2,3,4	1µS Channel 1 12µS Channels 2,3,4
Electrical Parameters		
Inputs		
I/O Data Format	EIA RS232; CCITT v24	EIA RS232; CCITT v24
Data Connector	9 pin D-Type Female	9 pin D-Type Female
	>3000Ohms	>3000Ohms
Input Voltage	+/- 30 Volts Max	+/- 30 Volts Max
Outputs		
Output Impedance	>300 Ohms	>300 Ohms
Driver Output	+/- 5 V min into 3000 Ohms	+/- 5 V min into 3000 Ohms
IRIG-B Mode Ch 3	0 to 2.5V @ 10mA	0 to 2.5V @ 10mA
	0 to 3V @ 20mA	0 to 3V @ 20mA
Ambient Temperature		
Operating Temperatures	-40° to +85° C	-40° to +70° C
Storage Temperature	-40° to +85° C	-40° to +85° C
Power Required	5.4 Watts	5.4 Watts
	300 mA @ 24-48 Vdc	300 mA @ 24-48 Vdc
	60 mA @ 90-250 Vdc/Vac	60 mA @ 90-250 Vdc/Vac
Weight	~11 Ozs.	~11 Ozs.
Power Dissipation BTU/H	18.4 BTU	18.4 BTU
Dimensions Inches	2.0W X 5.14L X 1.25H	2.0W X 5.14L X 1.25H
Indicators	Power	Power
	Sync Status	Sync Status
	Transmit each channel	Transmit each channel
	Receive each channel	Receive each channel

5942D4 RS232 (4 Channel)

5942SD4

	Multimode	Single-mode
Optical Parameters		
Optical Budget Typical	19.5 dB	19 dB
Output power Typical	-10.5 dBm peak	-14.5 dBm peak
Receiver Sensitivity Typical	-30 dBm peak	-33.5 dBm peak
	62.5µ/125 Multimode	9µ/125 Single-mode
Wavelength	850nm	1310nm
Connector Type	ST	ST
Compatible Fiber Type	Multi-Mode (50-200µm)	Single-Mode (9-13µm)
Configuration (Switches)	CH 3 IRIG-B Output/Standard	CH 3 IRIG-B Output/Standard
	CH 3 Drive Current Select	CH 3 Drive Current Select
	CH 4 Sync Indicator/Data Out	CH 4 Sync Indicator/Data Out
Data Rate	DC to 64K bps 4 Channels	DC to 64K bps 4 Channels
Data Transmission	Asynchronous, simplex	Asynchronous, simplex
	Half or Full Duplex	Half or Full Duplex
Transmission Distance	up to 5000 meters	~ 30K meters
	62.5µ/125 Cable@3dB/km	9µ/125 Cable@0.5dB/km
Bit Error Rate	10-E9 Max.	10-E9 Max.
Point to Point Latency Typical	25µS All Channels	25µS All Channels
Jitter Typical	1µS All Channels	1µS All Channels
Electrical Parameters		
Inputs		
I/O Data Format	EIA RS232; CCITT v24	EIA RS232; CCITT v24
Data Connector	9 pin D-Type Female	9 pin D-Type Female
	>3000Ohms	>3000Ohms
Input Voltage	+/- 30 Volts Max	+/- 30 Volts Max
Outputs		
Output Impedance	>300 Ohms	>300 Ohms
Driver Output	+/- 5 V min into 3000 Ohms	+/- 5 V min into 3000 Ohms
IRIG-B Mode Ch 3	0 to 2.5V @ 10mA	0 to 2.5V @ 10mA
	0 to 3V @ 20mA	0 to 3V @ 20mA
Ambient Temperature		
Operating Temperatures	-40° to +85° C	-40° to +70° C
Storage Temperature	-40° to +85° C	-40° to +85° C
Power Required	5.4 Watts	5.4 Watts
	300 mA @ 24-48 Vdc	300 mA @ 24-48 Vdc
	60 mA @ 90-250 Vdc/Vac	60 mA @ 90-250 Vdc/Vac
Weight	~11 Ozs.	~11 Ozs.
Power Dissipation BTU/H	18.4 BTU	18.4 BTU
Dimensions Inches	2.0W X 5.14L X 1.25H	2.0W X 5.14L X 1.25H
Indicators	Power	Power
	Sync Status	Sync Status
	Transmit each channel	Transmit each channel
	Receive each channel	Receive each channel

5.2 Mechanical Dimensions of the 5941



NOTE: DIMENSIONS ARE IN INCHES.

5.3 Mechanical Dimensions of the 5942