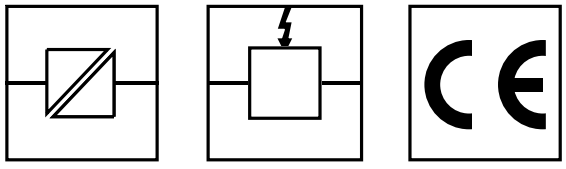
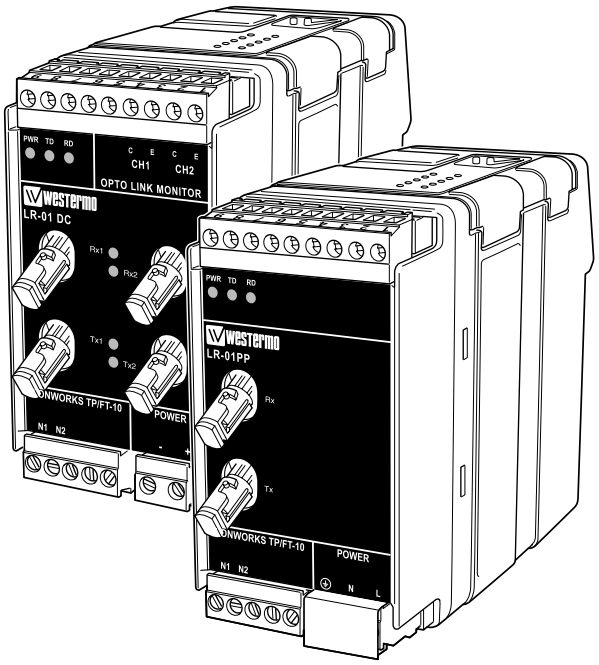
LR-01
LR-01PP

INSTALLATION MANUAL

6608-2201



Galvanic Isolation | Transient Protection | CE Approved



Fibre optic repeater for TP/FT-10

westermo®
www.westermo.se

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Contents

1 SPECIFICATIONS LR-01/LR-01PP

GENERAL

FIBRE

Standard	**Maximum fibre length**	**Number of LR-01 units**
Normal	25 000 m	10
EIA-709.3	4 000 - 5 600 m	2–10

TECHNICAL DATA

Transmission	Transparent conversion of LonTalk® packets
Interface 1	LONWORKS® TP/FT, FTT-10A, 5-position screw block
Interface 2	See model specific data
Indicators	See model specific data
Transmission rate	78 kbit/s
Weight, kg	See model specific data
Mounting	On 35 mm DIN-rail

POWER SUPPLY ALTERNATIVES

Model description	**LR-01/LR-01PP AC**	**LR-01/LR-01PP DC**
Power supply	230 V AC +15/–10%	24V DC ±50%
Frequency	48–62 Hz	–
Fuse, F2	100 mA S 5x20 mm Littlefuse	1.6 A S 5x20 mm Littlefuse
Power consumption	See model specific data	See model specific data
Transient protection		
Power/Line	Yes/Yes	–/Yes
Isolation RMS		
Power supply	3 000 V	1 500 V

MODEL SPECIFIC DATA

	LR-01	**LR-01PP**
Interface 2	Fibre optic, 4 ST-connectors, See table on page 15	Fibre optic, 2 ST-connectors, See table on page 15
Indicators	PWR, TD, RD, Tx1, Tx2, Rx1, Rx2	PWR, TD, RD
Weight, kg	AC 0.6 / DC 0.3	AC 0.6 / DC 0.3
Power consumption	AC 25 mA / DC 3 W	AC 25 mA / DC 3 W

LED INDICATION

LED	**FUNCTION**
PWR	Indicates that the units has power
TD	Indicates receiving data on TP/FT side
RD	Indicates transmitting data on TP/FT side
Rx1	Indicates receiving data on fibre receiver 1
Tx1	Indicates transmitting data on fibre transmitter 1 from TP/FT side
Rx2	Indicates receiving data on fibre receiver 2
Tx2	Indicates transmitting data on fibre transmitter 2 from TP/FT side

2 INTRODUCTION

The LR-01 offers an easy way to extend the distance between LONWORKS® 78 kbit/s TP/FT network segments using a fibre optic link. The complete transparent conversion to and from the fibre optic media facilitates the installation procedure by eliminating the need for any additional network addressing or software configuration.

An LR-01 link acts as a TP/FT-10 physical layer repeater with the following additional features:

- The channel can be extended to a much longer distances using fibre optic cables
- Up to ten network segments
- Offers immunity against electrical interference

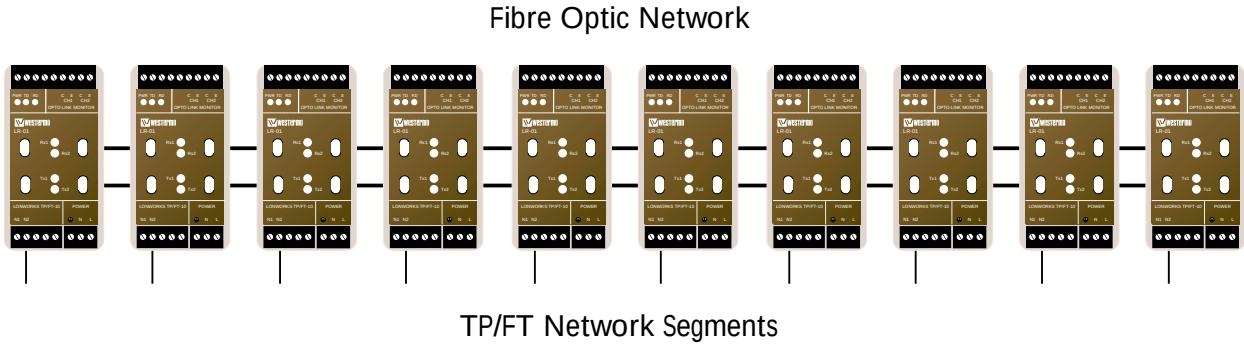


Figure 2.1 Up to ten network segments

The EIA-709.3 specification states a maximum delay of 36 µs and a maximum of one repeater between any two nodes. Using the LR-01 this delay restriction will normally be met if the total fibre cable length between the two units is restricted to 5.6 km thus two LR-01 units form one physical layer repeater. The recommended maximum number of LR-01's connected together is ten, however as more units are connected together the total length of fibre has to be reduced to keep within the delay budget (please see 3.4 channel delay).

The LR-01 is equipped with either one (PP-version) or two pairs of fibre optic receiver and transmitter. This allows the user to build either point to point-, bus- or ring topology fibre links.

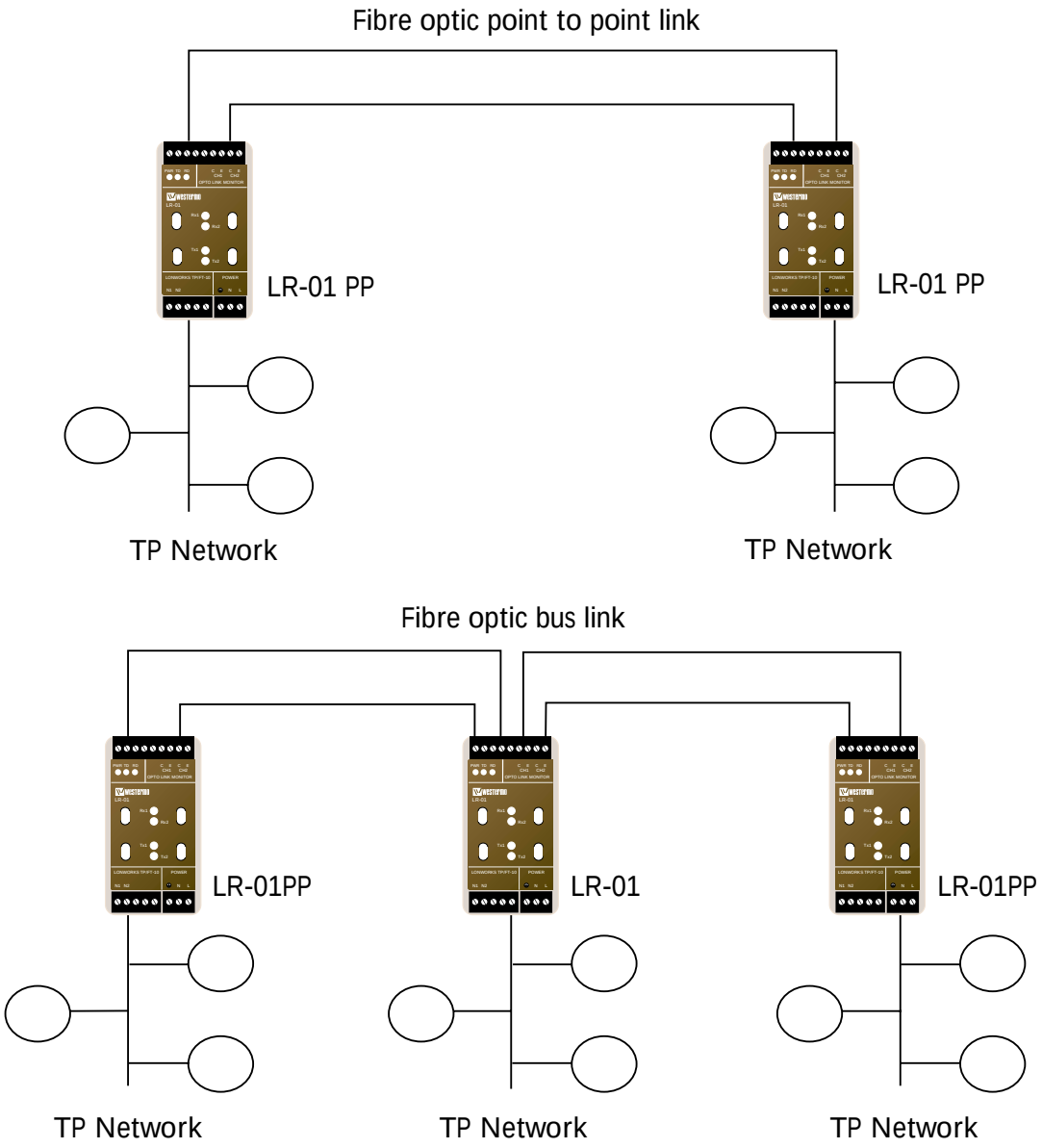


Figure 2.2 Network topologies

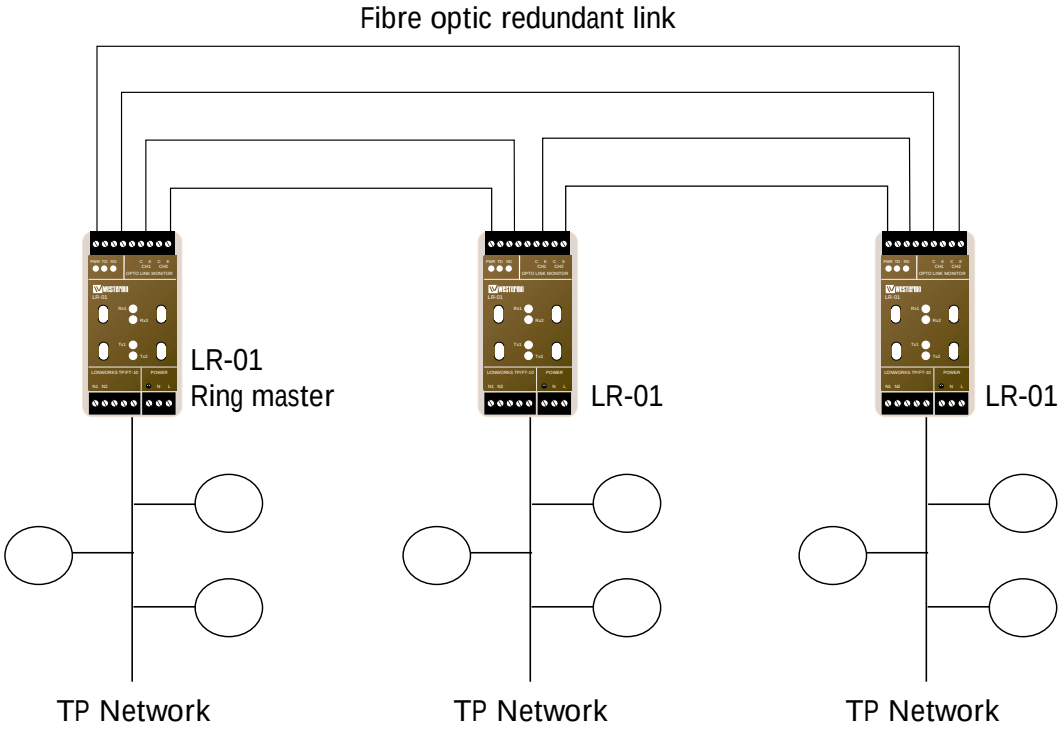


Figure 2.3 Network topologies

In a fibre ring, one of the LR-01 units will be assigned as a ring master and then having the responsibility to stop messages from looping around the ring. The LR-01 has a built-in redundancy scheme that provides for fault tolerance in the fibre rings.

There is a maximum transmission distance on the fibre link depending on the available power budget of the LR-01 units and losses due to attenuation in cables, connectors and splice joints. With single mode fibre, distances up to 25 km can be reached.

In addition to the physical limitation there will also be a logical protocol specific limitation that needs to be considered. The extension of the TP/FT network over a fibre optic channel will impose a certain propagation delay across the network segments. Imposing a propagation delay on a standard FT-10 channel will affect the Layer 1 timing and the over-all channel media access. Significant propagation delay could result in packet collisions and packet re-transmission, and thus network performance will decrease.

As always, it is recommended to analyse the network under worst-case condition using a LONWORKS® protocol analyser. This is even more important if very long fibre cables are used with many segments and many nodes. To increase performance and distance further, the 1 250 kbit/s LR-11 router is recommended. Please see section 3.4 further discussions and recommendation regarding this issue.

3 COMMUNICATIONS

The LR-01 consists of either one (PP-version) or two sets of fibre optic ports, each with its separate transmitter and receiver, and one LONWORKS® FTT-10A transceiver for the TP network. Figure 3.1 illustrates the communication ports on the LR-01.

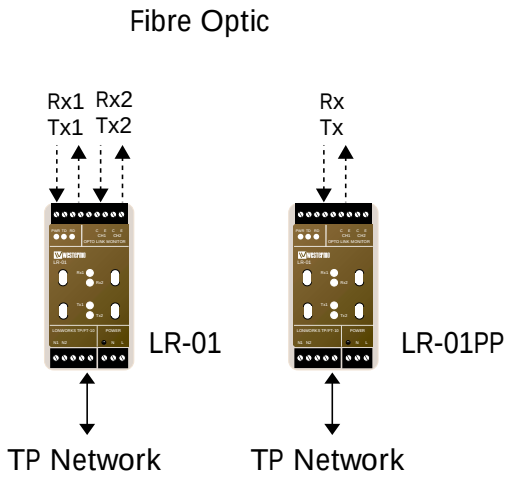


Figure 3.1. Ports on LR-01 and LR-01 PP (point to point)

If there are only two network segments that are to be connected, the point to point version of LR-01 could be used. If the network contains of more than two segments, the data needs to be retransmitted onto the fibre link to other connected network segments.

The LR-01 with its two sets of fibre optic ports can then be used to build bus or ring topology fibre links.

Figure 3.2 illustrates the general data flow when data is received from a TP segment.

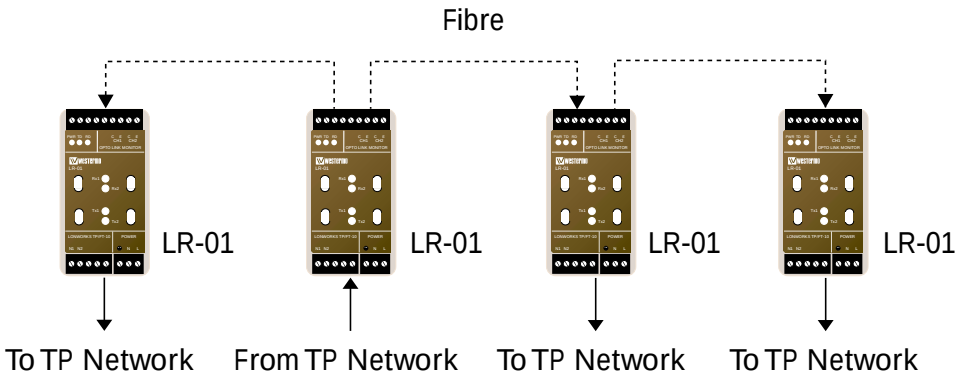


Figure 3.2. Ports on LR-01

Incoming data on a fibre link is transmitted onto the LONWORKS® TP network as well as forwarded to the next unit on the fibre link.

3.1 Point to point topology

With only two network segments, the most cost effective solution is to use two point to point (LR-01PP) units to create a fibre optic connection.

The user could however still choose not to use the point to point units and have the additional link unconnected. In this way the user have the possibility to easily add more units and network segments at a later time.

The point to point connection provides a totally transparent fibre link which means that all data received on one units TP port will be forwarded unchanged to the other port, as illustrated in figure 3.3. This could be regarded as Two-Way physical repeater link.

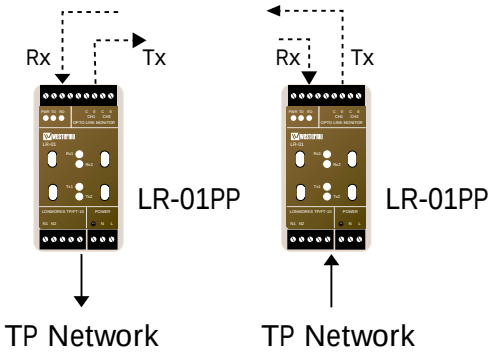


Figure 3.3. Point to point communication

3.2 Bus topology

The normal mode for communication is a transparent mode referred to as Y-mode. The data flow in Y-mode is schematically illustrated in figure 3.4.

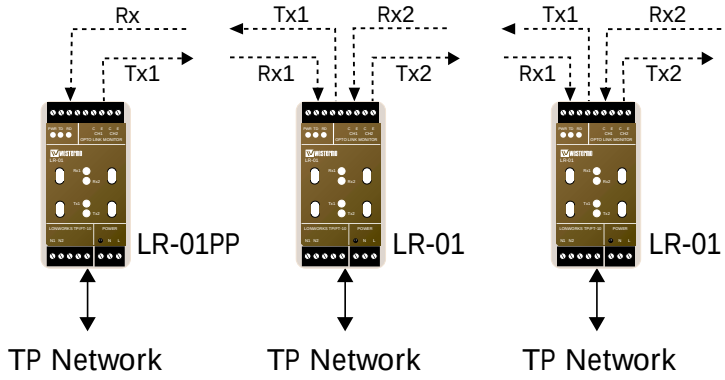


Figure 3.4. Transparent Y-mode

When data is received from a TP network, the corresponding LR-01 unit will transmit the data onto both F/O links. All data received by an LR-01 unit on either Rx1 or Rx2 is transmitted over to the corresponding TP network as well as forwarded by the opposite transmitter, Tx2 or Tx1. The units used at the endpoints does not need to forward data on both fibre links, and thus only one fibre link is required (PP version).

Y-mode provides totally transparent communication. All LONWORKS® nodes will be able to send and receive data to and from all TP segments. This could be regarded as N-Way physical repeater link.

There is an additional mode that could be used to reduce network traffic between different TP network segments. This mode is referred to as V-mode. The data flow in V-mode is schematically illustrated in figure 3.5.

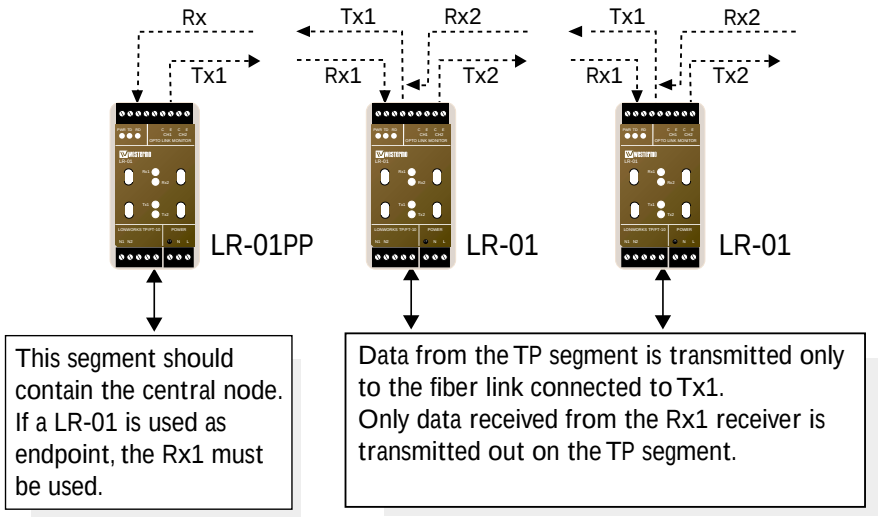


Figure 3.5. Centralized communication architecture with isolated TP segments (V-mode)

In this mode, data received on the Rx2 receiver is not transmitted onto the corresponding TP segment. It is however forwarded to the next unit on the fibre link via Tx1. Data received from a TP segment is transmitted only on Tx1. As shown in figure 3.4 only the first TP segment can send and receive data to and from all the other TP segments.

A single central management node could be placed in the main TP segment. With this architecture, it could cycle around and do something to each node (such as network management, polling etc.). Any background peer-to-peer activity or noise within other TP segments would not be spread to other TP segments except the one containing the central node.

3.3 Ring topology

The LR-01 units could be linked together to form a fibre optic ring. The ring topology requires one dedicated LR-01 unit (ring master) to stop all messages on the fibre ring, thus preventing message looping.

With ring topology, a built-in redundancy scheme offers communication fault tolerance. If a fault is detected on one of the fibre links, the data flow will automatically be re-routed to make a new communication path that reaches all units in the ring. The time to set-up the new communication path could take up to 4 ms. Any data that is transmitted during that time may be lost. The LR-01 can handle a fault on one fibre or a fibre pair, and still be able re-route the communication. The LR-01 unit has two alarm outputs for fault detection, one for each fibre link.

The redundancy scheme requires the fibre optic links to be connected as follow:

F/O Link 1: Tx2 ⏩ Rx1 ⏩ Tx2 ⏩ Rx1 ⏩ Tx2 etc.

F/O Link 2: Tx1 ⏩ Rx2 ⏩ Tx1 ⏩ Rx2 ⏩ Tx1 etc.

Figure 3.6 illustrates schematically how the fibre links are connected to form two rings.

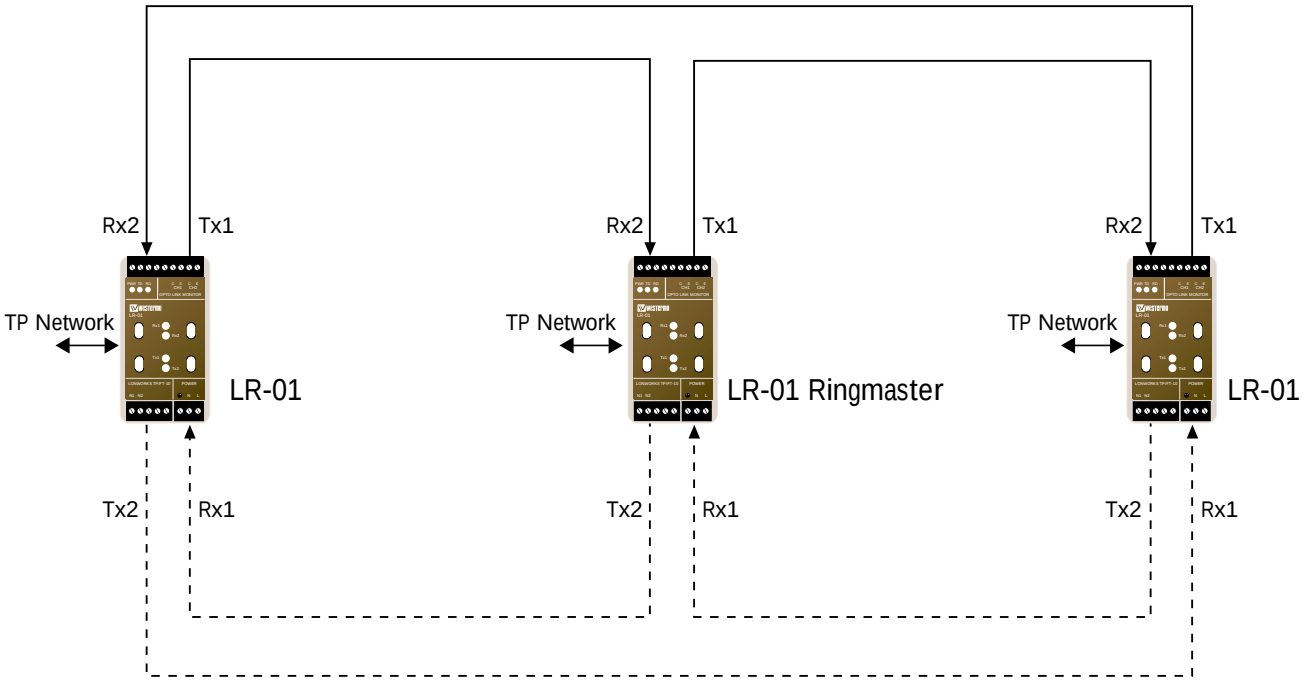


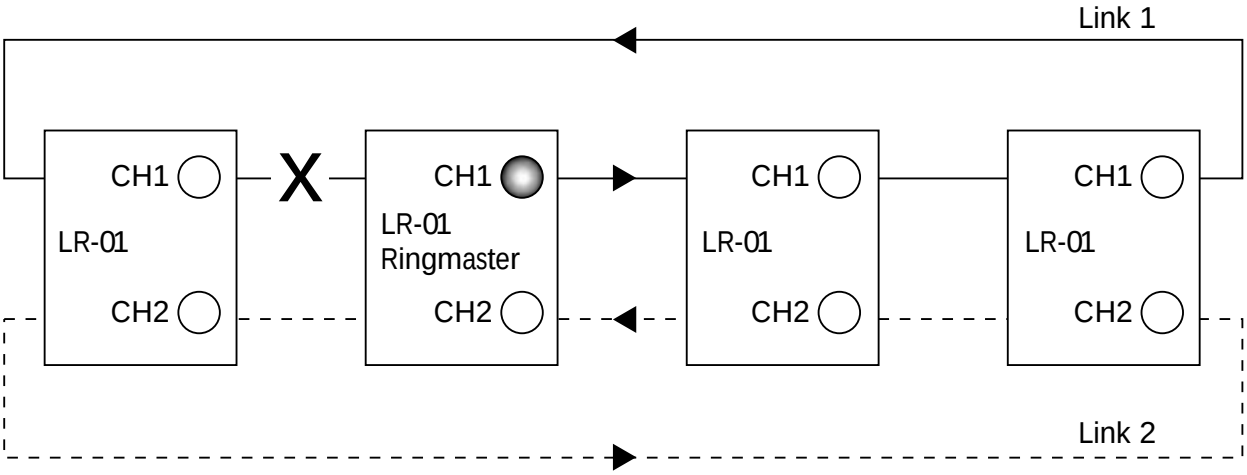
Figure 3.6. Ring communication

3.3.1 Alarm indications

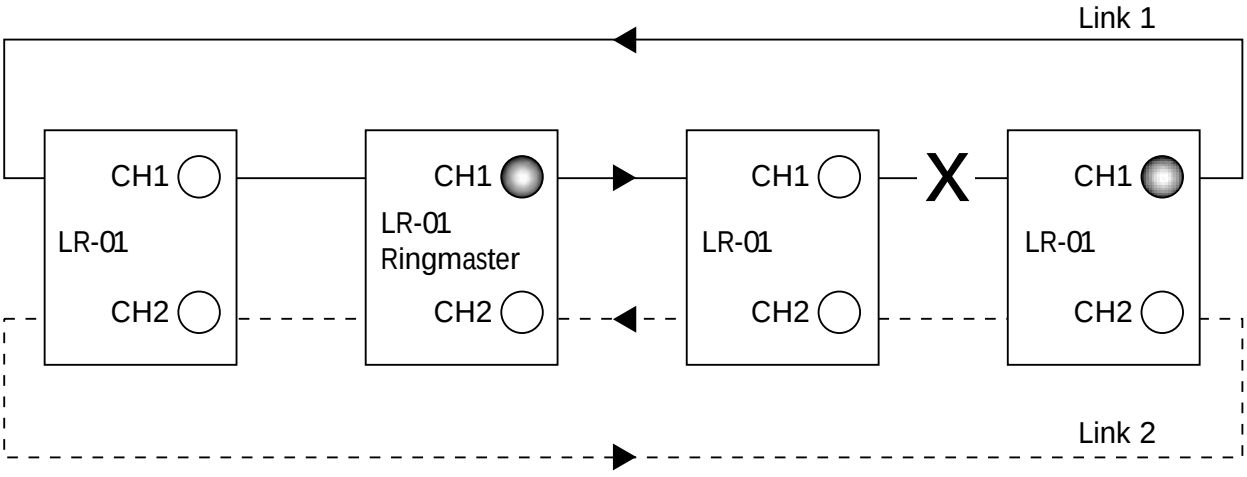
The units have two alarm outputs marked as CH1 and CH2. When a unit detects a fault on a fibre optic link the circuit between the contacts "C" and "E" is opened. See section 4.2 for an example how to connect the alarm output to an external relay.

In case of a fault on a fibre link, the receiver on the closest downstream unit will detect the fault and assert a receive failure alarm. The ring master will also be aware of the fault and assert the link failure alarm corresponding to the faulty fibre link. In that way a monitoring system only needs to monitor the ring master to obtain the over-all status of the two fibre links. To find which fibre segment that is broken the alarm status on each unit must be investigated.

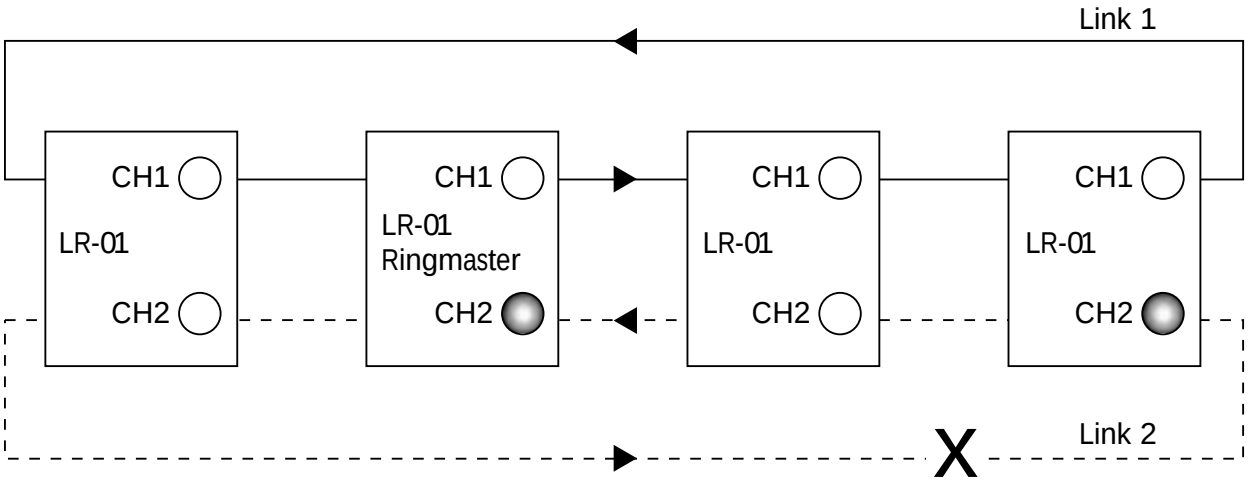
Below are some examples of LR-01 alarm indications when fault is detected on the fibre link. The break is indicated with a **X** and an asserted alarm output with a filled circle. The faults showed in these examples are recovered by the built-in redundancy scheme within 4 ms. An alarm will remain asserted until the fault is repaired, i.e. when communication on both fibre links operates normally.



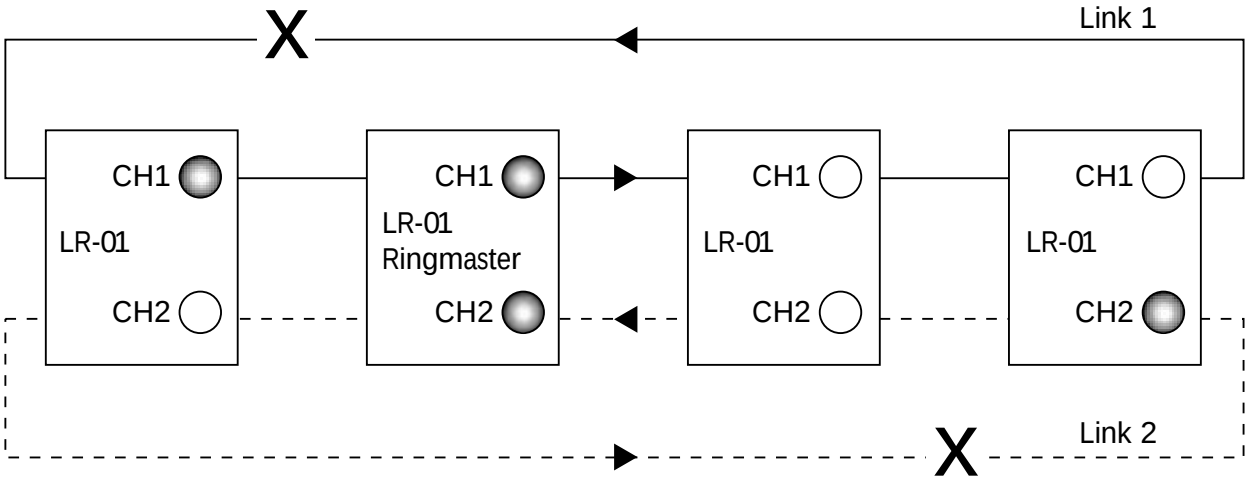
The receiver Rx1 on the ring master unit detects a break on Link 1.
Alarm CH1 is asserted on the ring master unit.



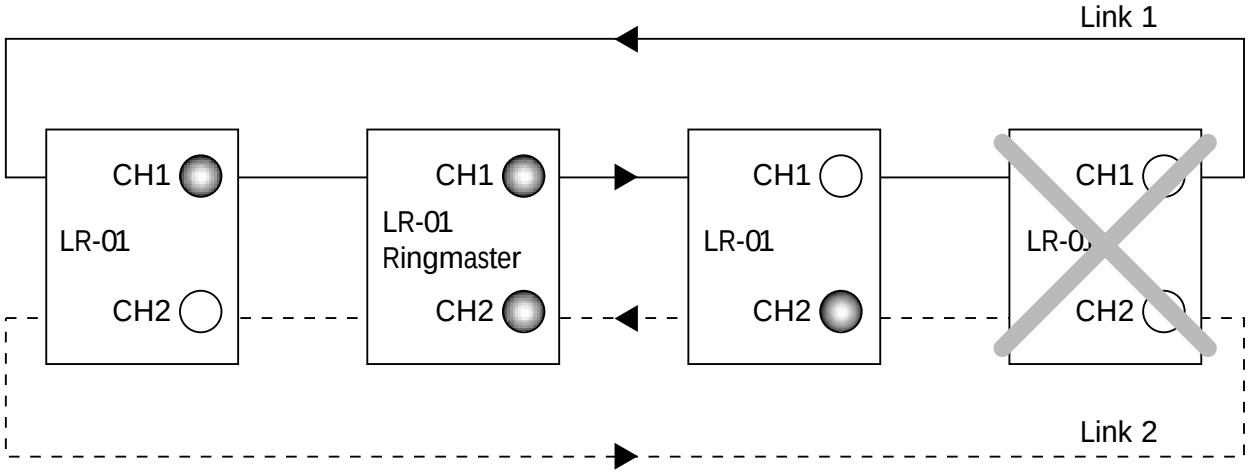
The receiver Rx1 on the rightmost LR-01 unit detects a break on Link 1.
Alarm CH1 is asserted on both local unit and the ring master unit.



The receiver Rx2 on the rightmost LR-01 unit detects a break on Link 2.
Alarm CH2 is asserted on both local unit and the ring master unit.



The receiver Rx2 on the rightmost LR-01 unit detects a break on Link 2, which results in an assertion of CH2. The receiver Rx1 on the leftmost LR-01 unit detects a break on Link 1, which results in an assertion of CH1. The ring master asserts both CH1 and CH2.



The rightmost LR-01 unit does not function due to power loss or some internal error.
Receivers on the LR-01 units one step downstream the broken unit will detect a fault on the fibre links.
They will both assert their corresponding alarm output. The ring master asserts both CH1 and CH2.

3.4 Channel delay

When two or more LR-01 units are used on a LonWorks free topology network they form a physical repeater link. As with a normal FTT-FTT physical repeater, the LR-01 link also forms a new channel segment and regenerates the signal allowing more nodes to be installed.

It is important that the user is aware of the limitations involved with a physical extension of an FTT channel. The LR-01 units can transparently forward the LonTalk® packets and also assure that the required signal level is kept throughout the channel extension. However, cable length between the units will impose an extra propagation delay on the channel that could conflict with the media access timing used by the LonTalk® protocol. Increasing the propagation delay results in a higher probability for packet collisions, especially for a busy channel.

A normal FTT channel is dimensioned for one physical repeater allowing a maximum distance of 5 400 metres (2 x 2 700 metres).

For a busy channel it is better to use the LR-11 router instead of the LR-01. With the LR-11 router the delay is not a problem since it uses a fibre optic channel where the propagation delay is accounted for.

It is recommended to use a LONWORKS® protocol analyser to verify the network performance during high peak channel access. If an increased number of packet collisions and retries are detected, the options are to either use the router model (LR-11) or modify the communication parametres on the nodes to allow for an extra propagation delay. The trade-off for changing the communication parametres is a reduced channel performance. See application notes AN-01201A for details about changing communication parametres on the nodes.

Having the above limitations in mind, we recommend using any of following equations to determine total fibre distance and number of units:

Fibre distance (m) / 200 + Number of units < 127

Max number of units = 10

For example, the above equation would allow 10 LR-01 units to use a maximum fibre optic cable length of 23.4 km.

According to the EIA-709.3, the delay through a repeater link must not exceed 36 microseconds. In many cases this requirement is met if the following relation equation is used:

Fibre distance (m) / 200 + Number of units < 30

Max number of units = 10

For example, the above equation would allow two LR-01 units to use a maximum fibre optic cable length of 5.6 km.

The above discussion considers the limitation in maximum distance due to protocol parametres involving media access and network idle detection. As with all fibre optic products, the maximum distance is also dependent on the available power budget between the nodes (see section 3.5).

3.5 Power budget

Min. budget

Fibre	Unit		
	820 nm	1300 nm	single mode
50/125	10.7 dB	8.1 dB	
62,5/125	14.5 dB	11.6 dB	
100/140	20.6 dB		
9/125			6.3 dB

Typ. budget

Fibre	Unit		
	820 nm	1300 nm	single mode
50/125	16.6 dB	14.6 dB	
62,5/125	18.6 dB	15.1 dB	
100/140	25.9 dB		
9/125			12.3 dB

”Min. budget” states the minimum guaranteed power budget. Experience shows however that the typical value is in the range of the indicated ”Typ. budget”.

Attenuation in fibre cable

The values below can differ depending on quality and manufacturer of the fibre optic cable.

Fibre	Attenuation at 820 nm	Attenuation at 1300 nm	Attenuation at single mode (1300 nm)
50/125 µm	3.0 dB/km	1.0 dB/km	
62,5/125 µm	3.5 dB/km	1.2 dB/km	
100/140 µm	4.0 dB/km		
9/125 µm			0.5 dB/km

Attenuation in connectors

0.2–0.4 dB

Attenuation in splice

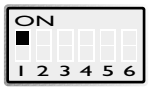
Fusion	0.1 dB
Mechanical	0.2 dB

4 SETTINGS AND CONNECTIONS

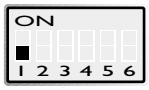
4.1 Switch settings

The following switch settings will be used:

Bus/Ring configuration (not PP version)

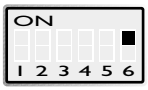
S1 

Ring

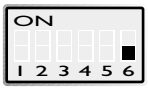
S1 

Bus

Transmitted power link 1

S1 

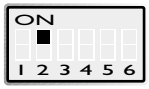
Low power

S1 

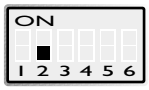
High power

S1: 3, 4 and 5 is not used

Y/V-mode alt. Ring master/Slave-mode (not PP version)
(depending on S1:1)

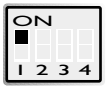
S1 

V-mode / Ring master

S1 

Y-mode / Slave

Transmitted power link 2 (not PP version)

S3 

Low power

S3 

High power

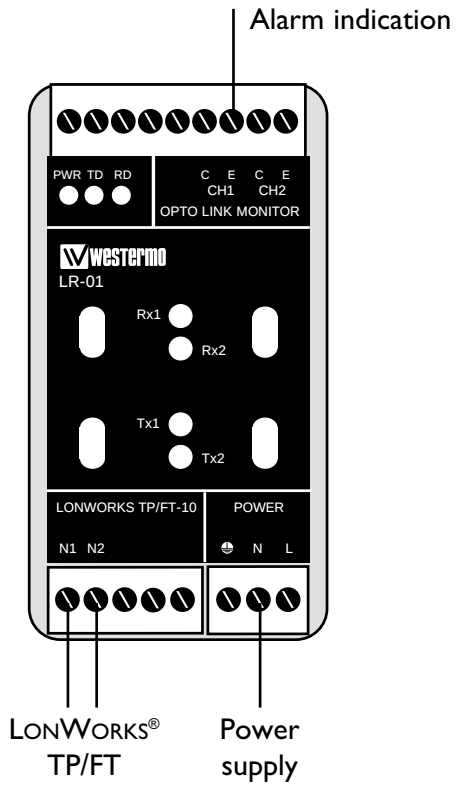
S3: 2–4 is not used

Factory settings

S1 

S3 

4.2 Connections



Network connection (LONWORKS® TP/FT)

(5-position screw terminal)

Connection no.	Description
1	N 1
2	N 2

Power connection

(2-position screw terminal)

Connection	Description
1	– Voltage
2	+ Voltage

Power connection

(3-position screw terminal)

Connection	Description
L	230 V AC power
N	
⏚	Earth

Alarm connection

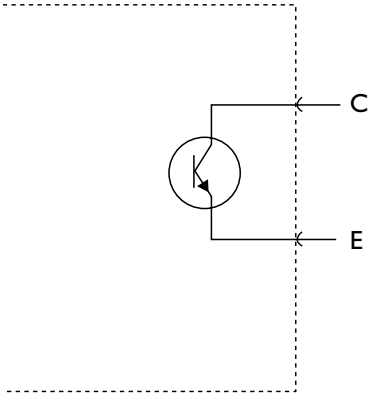
(9-position screw terminal)

Connection	Description	Polarity
1	CH2, E	–
2	CH2, C	+
3	CH1, E	–
4	CH1, C	+

Alarm signals

Upon failure the circuit between the contacts "C" and "E" is opened. This circuit can be used to generate an external alarm signal by connecting an external relay as shown on page 18. Please note that the maximum allowed voltage/current is 30 V/80 mA.

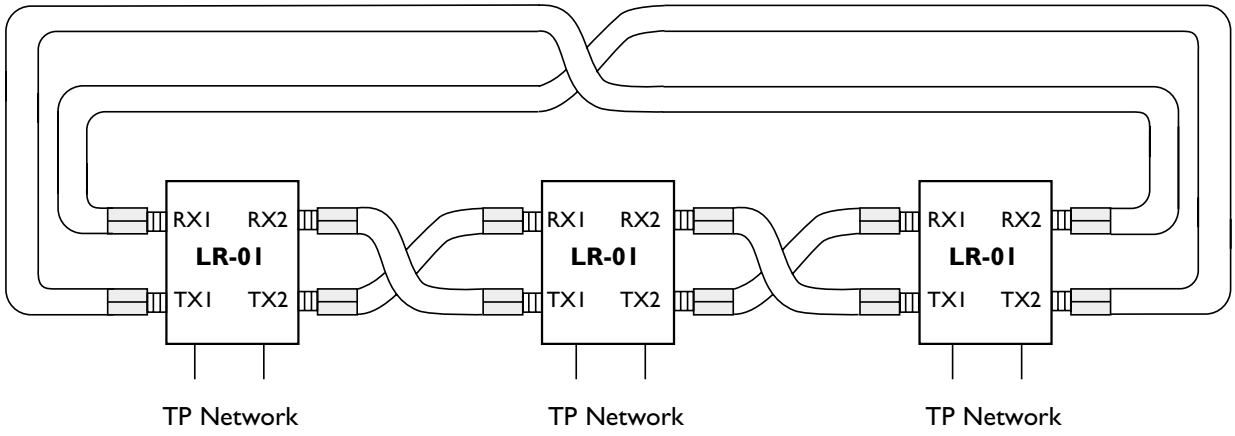
⚠ Note



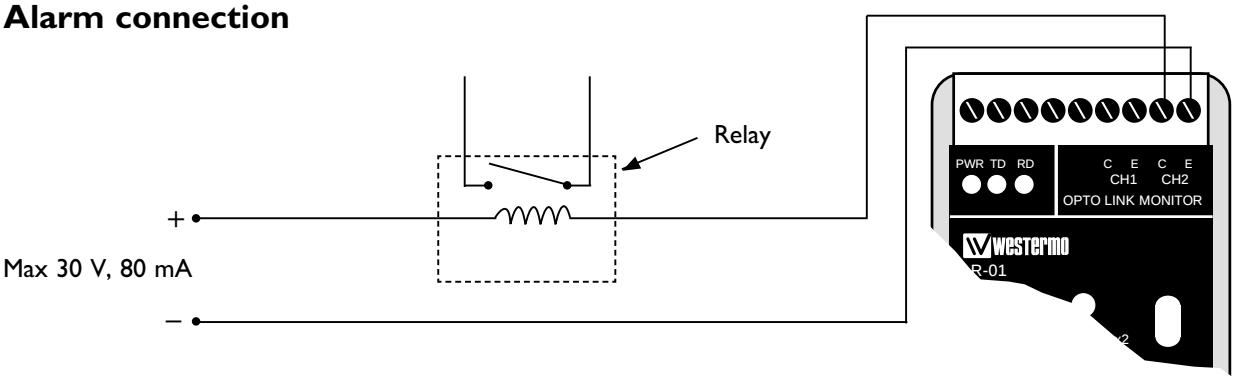
Alarm connectors are polarity depended.

4.3 How to connect

Fibre connection (Ring configuration)

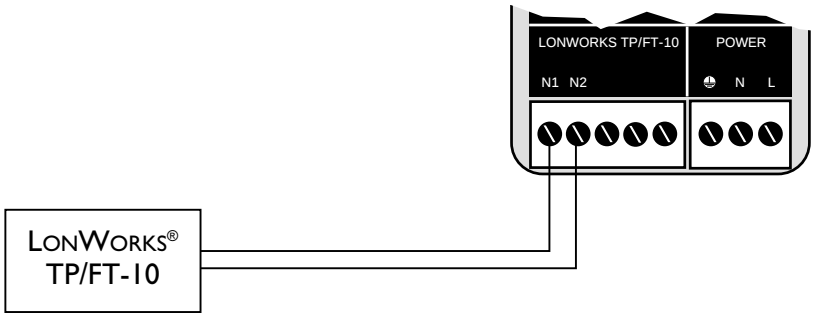


Alarm connection



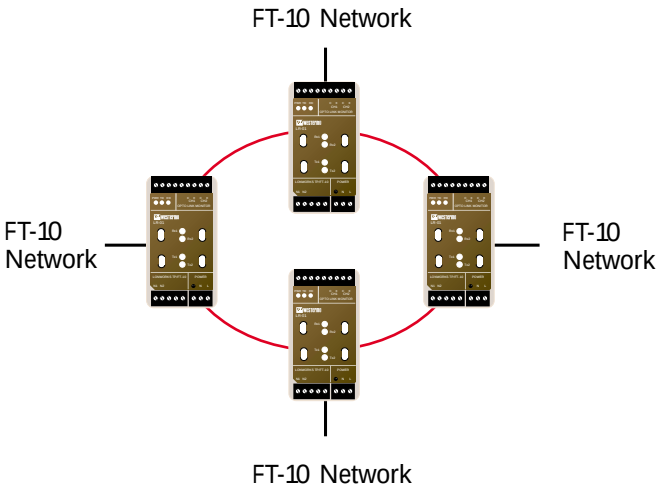
In this example only channel 2 is connected.
Under normal operation channel 1 **and** channel 2 should be connected

Network connection

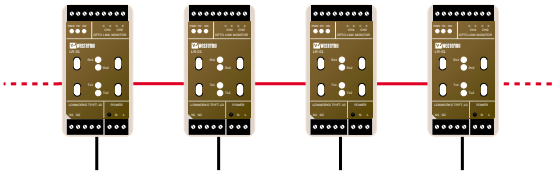


Application examples

Redundant fibre ring



Multidrop



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