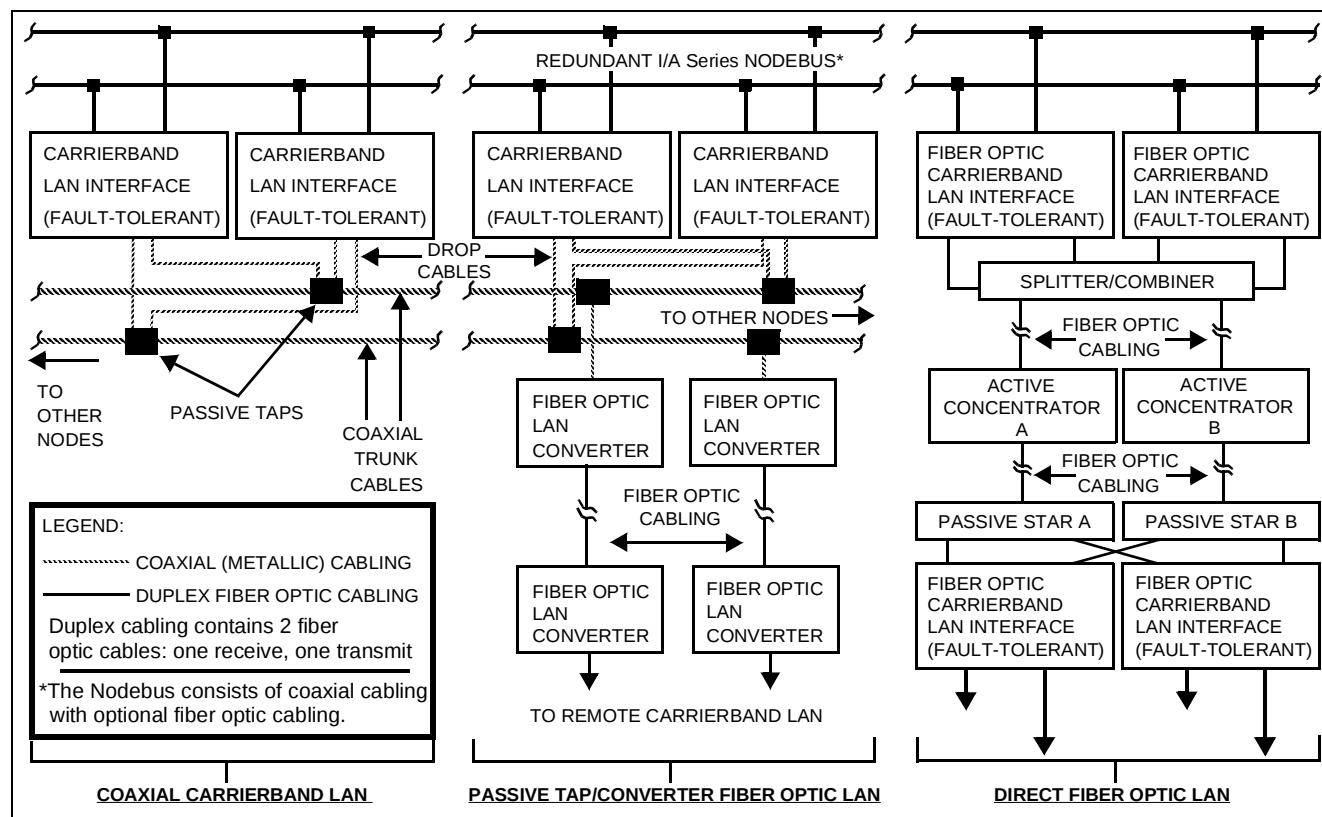


I/A Series[®] Hardware Local Area Network



The I/A Series Local Area Network (LAN) provides redundant communication among I/A Series system nodes. For versatility of applications, three basic LAN interface configurations are possible (see diagram above):

- Coaxial (metallic) Carrierband LAN – uses passive taps and Carrierband LAN Interfaces for interfacing the coaxial trunk cables to the Nodebus.
- Passive Tap/Converter fiber optic LAN – uses Carrierband LAN Interfaces, passive taps, and fiber optic converters for interfacing fiber optic cabling to the Nodebus.

- Direct fiber optic LAN – uses Fiber Optic Carrierband LAN Interfaces for interfacing fiber optic cabling to the Nodebus.

The Coaxial Carrierband LAN provides five megabit per second communications, conforming to the IEEE 802.4 token passing bus standard. It uses standard RG-11 or CATV cables for its trunk cabling and RG-6 cables for its drop cabling, and supports redundant cable paths for communications reliability.

The Passive Tap/Converter fiber optic LAN allows fiber optic cabling to be incorporated into a coaxial Carrierband LAN. The Passive Tap/Converter fiber optic LAN can be configured to either use fiber optic cabling⁽¹⁾ with or without coaxial trunk cabling.

The Direct fiber optic LAN operates through fiber optic cabling without the need for any coaxial equipment or conversion devices (such as passive taps, drop cables, or Fiber Optic LAN Converters).

These basic LAN configurations are interchangeable, provided that no two I/A Series nodes in the LAN have more than 20 km of cabling and equipment between them.

Fiber optic cabling provides the same performance as coaxial Carrierband LAN cabling, but with added distance, application versatility, and security. Unaffected by electrical noise (EMI, RFI, and lightning), fiber optic cabling can be installed in areas containing rotating machinery, arc welders, etc. It can also be installed in cable trays containing high voltage power lines, or in outdoor areas exposed to lightning hazards. Its electrical isolation characteristics provide protection from voltage differentials and ground loops.

COAXIAL CARRIERBAND LAN

The coaxial Carrierband LAN consists of the following components:

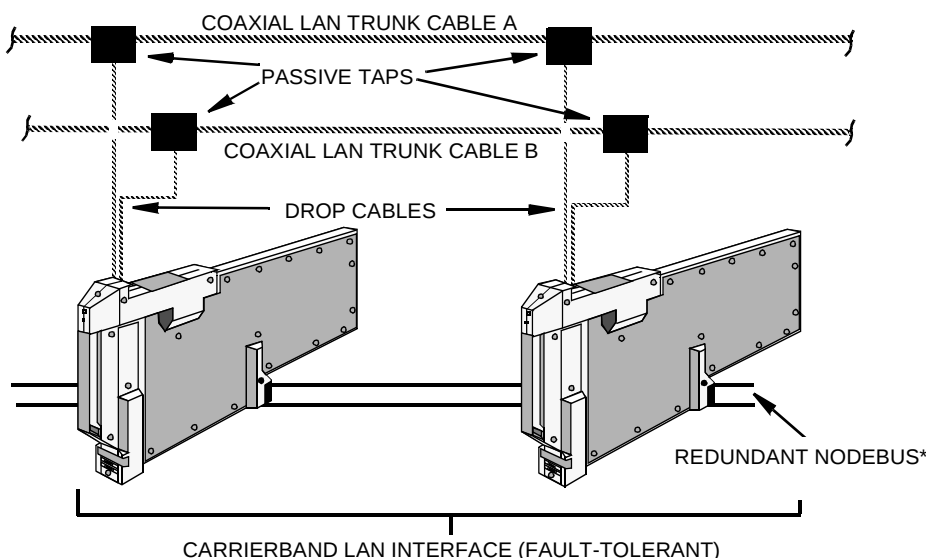
- Carrierband LAN Interfaces
- Coaxial Carrierband LAN Cabling
- LAN Trunk Cable(s)
- Drop Cables
- Passive Taps

Carrierband LAN Interface

The Carrierband LAN Interface (see Figure 1) is an I/A Series station packaged as a single-width processor module for installation in I/A Series enclosures. It interfaces with the Carrierband LAN on one side and the Nodebus on the other. The Carrierband LAN Interface is optionally fault tolerant. In this configuration, it is installed adjacent to another Carrierband LAN Interface, which is connected to the same redundant pair of LAN trunk cables (see Figure 1). One Carrierband LAN Interface occupies one mounting structure slot, while a fault-tolerant pair occupy two adjacent slots.

Coaxial Carrierband LAN Cabling

The coaxial Carrierband LAN trunk cables can be either of two types: RG-11 type cable with foam dielectric, or 7/8 inch CATV cable. Either cable type has 75 ohm characteristic impedance.



*The Nodebus consists of coaxial cabling with some optional fiber optic cabling.

Figure 1. Coaxial Carrierband LAN Interfaces

(1) As described subsequently, the fiber-only configuration includes the use of passive taps, coaxial drop cables, Fiber Optic LAN Converters, and Carrierband LAN Interface modules. No coaxial trunk cables are employed.

The RG-11 type cable provides a semi-flexible medium that is easier to install but allows fewer connections and shorter distances. The CATV cable provides a semi-rigid medium with greater capability, both in the number of connections and distance. It also provides better protection from physical damage. Various types of CATV cables are available for aerial or buried construction.

RG-6 type coaxial drop cables connect the coaxial Carrierband LAN trunk cable to the Carrierband LAN Interfaces. Two drop cables are required to connect the one Carrierband LAN Interface to redundant LAN trunk cables. Passive taps are used to connect the drop cables to the coaxial Carrierband LAN trunk cable. The ends of the trunk cable are terminated, and the trunk cable must be grounded at every tap.

The maximum allowable coaxial Carrierband LAN cabling distance depends on various hardware and software constraints, such as the type of trunk cable used, numbers and types of passive taps used, and software address limits. Consult your Foxboro representative for additional information.

PASSIVE TAP/CONVERTER FIBER OPTIC LAN

The Passive Tap/Converter fiber optic LAN consists of the following components:

- Carrierband LAN Interface Module – Same as that used with Coaxial Carrierband LAN
- Fiber Optic Cabling
- Fiber Optic LAN Converters
- Drop Cables
- Passive Taps
- Passive Stars (Optional)

Carrierband LAN Interface

The Carrierband LAN Interface module used in this fiber optic LAN configuration is the same as that used with the coaxial Carrierband LAN. The Carrierband LAN Interface is optionally fault tolerant. In this configuration, it is installed adjacent to another Carrierband LAN Interface, which is connected to the same redundant pair of LAN trunk cables.

One Carrierband LAN Interface occupies one mounting structure slot, while a fault-tolerant pair occupies two adjacent slots. Connection between the Fiber Optic LAN Converters and the LAN trunk cables is via passive taps and drop cables (see Figure 2).

Fiber Optic LAN Cabling

Fiber optic cabling is purchased by the customer. The recommended fiber optic cable is a multimode, graded-index glass fiber with a 62.5 micron core and 125 micron cladding. Maximum allowable signal loss is 1 db per km at a wavelength of 1300 nm. Cables with different characteristics can be used, but cabling distance capabilities will be affected. Four optical fibers are required for basic configurations, since each Carrierband LAN Interface has two sets of transmit and receive connectors (to allow for redundancy). For this reason, it is recommended that the customer purchase duplex cabling, which consists of two fibers intertwined in a single cable. The cables must be terminated with ST-type connectors matching those on the Fiber Optic LAN Converter and should not exceed 10 km (6.2 mi) in length. Other cable requirements (such as flexibility, or durability) depend on the particular application. Check with your cable vendor/installer for a listing of application-specific cable characteristics.

Network Topology

The Passive Tap/Converter fiber optic LAN can be configured with two different topologies, point-to-point or star.

Point-to-Point Topology

The Passive Tap/Converter fiber optic LAN point-to-point topology is used where required cabling distances exceed those offered by the coaxial Carrierband LAN, or where there is need to interconnect multiple coaxial Carrierband LANs over significant distances.

Figure 2 shows a typical point-to-point fiber optic cabling configuration. Using this configuration, cabling distances up to 10 km (6.2 mi) are possible.

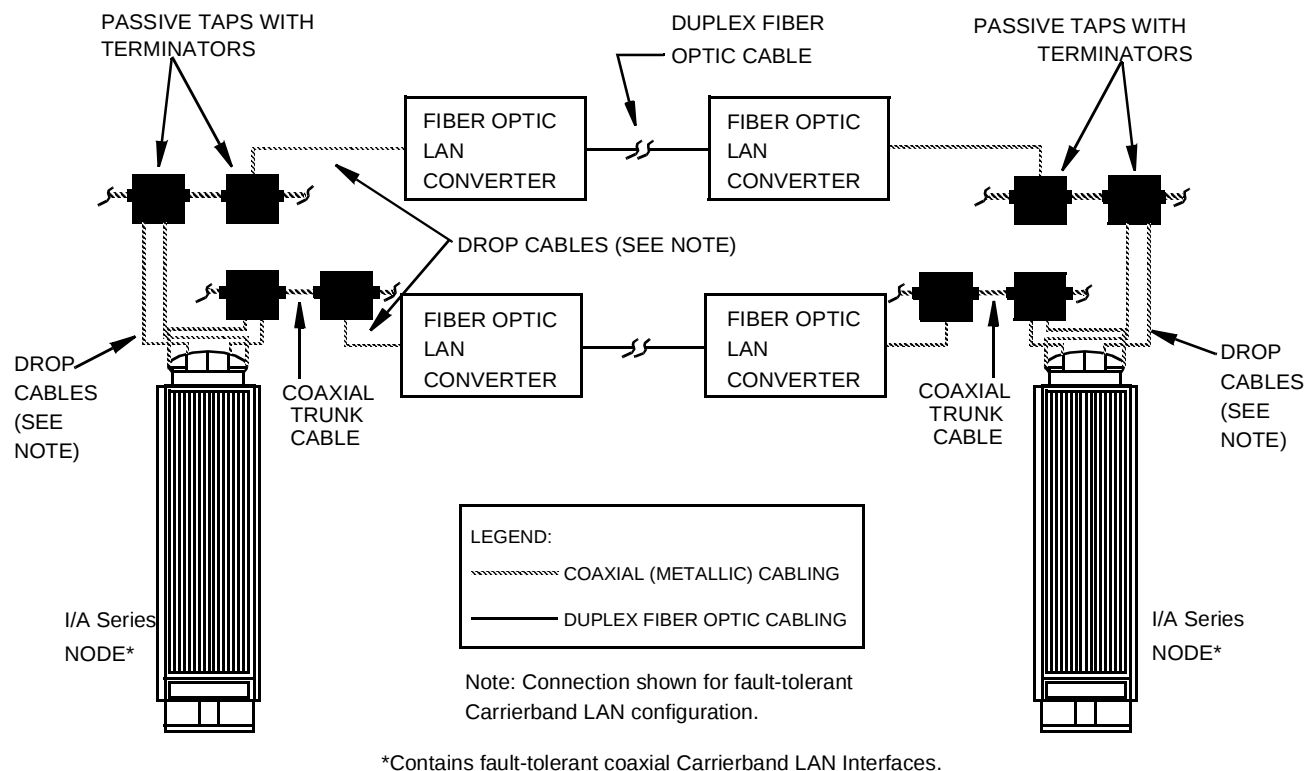


Figure 2. Typical Passive Tap/Converter Fiber Optic LAN Point-to-Point Fiber Optic Cabling Configuration

Passive Star Topology

The Passive Tap/Converter fiber optic LAN passive star topology offers the most flexible topology for multi-node applications, and is thus widely used in fiber optic installations.

Figure 3 shows a typical passive star fiber optic topology. It incorporates a passive star, which is used to interconnect distributed I/A Series nodes. Passive stars are available as multi-port interfaces with either four ports or eight ports. Since the stars are passive devices, there is no need for maintenance, and there are no failure modes associated with them.

In the passive star topology, the node to node cabling distance is a function of the number of passive star ports used:

Number of Ports On Passive Star	Maximum Distance Between Any Two Nodes
4	4 km (2.48 mi)
8	1 km (1.24 mi)

Combined Fiber Optic and Coaxial LAN

Figure 4 shows a cabling configuration in which combined fiber optic cabling and coaxial Carrierband LAN cabling are used. Using this type of configuration, total (combined) cable lengths up to 20 km (12.4 mi) are possible.

For all of the cabling configurations, the number of nodes allowed and the maximum allowable cabling distance for a particular installation depend on various hardware and software constraints. Consult your Foxboro representative for more information.

Fiber Optic LAN Converter

The Fiber Optic LAN Converter (Figure 5) provides interfacing between the coaxial Carrierband LAN and a pair of fiber optic cables when the coaxial Carrierband LAN Interface is employed. It interfaces to the Carrierband LAN via a standard passive tap and drop cable, and to the fiber optic cable pair via ST-type connectors. The fiber optic cabling must be terminated with ST-type connectors matching those on the Fiber Optic LAN Converter and should not exceed 10 km (6.2 mi) in length. Other cable requirements (such as flexibility, or durability) depend on the particular application. Check with your cable vendor/installer for a listing of application-specific cable characteristics.



Figure 5. Fiber Optic LAN Converter

The two fibers within the optical cable provide two separate communication paths, one each for transmitting and receiving. When transmitting, the Fiber Optic LAN Converter converts electrical signals from the Carrierband LAN into light pulses and transmits them over one of the fiber optic cables.

When receiving, it performs the operation in reverse, converting light pulses from the other fiber optic cable into electrical signals. As part of its signal conversion task, the Fiber Optic LAN Converter provides the necessary wave shaping, bit timing, and signal amplitude functions for stable, secure communications.

For redundant point-to-point fiber optic communications, four converters are required; two for each fiber optic cable pair. The Fiber Optic LAN Converter is a self-contained unit designed for mounting in a standard 19-inch EIA rack.

Fiber Optic LAN Enclosures

The optional Fiber Optic LAN Enclosures provide for housing of the Fiber Optic LAN Converters. The enclosures are made of steel and are equipped with 19-inch EIA rails for mounting of the converters, a power strip for plugging in the converter power cords, and a junction box for connecting customer ac power wiring. Enclosures can provide redundant power input. The enclosures are available in three sizes:

- Fiber Optic LAN Enclosure 4 – 800 mm (32 in) high by 600 mm (24 in) wide. Houses one to four converters.
- Fiber Optic LAN Enclosure 6 – 1200 mm (48 in) high by 600 mm (24 in) wide. Houses one to six converters.
- Fiber Optic LAN Enclosure 8 - 1600 mm (64 in) high by 600 mm (24 in) wide. Houses one to eight converters.

DIRECT FIBER OPTIC LAN

The Direct fiber optic LAN consists of the following components:

- Fiber Optic Carrierband LAN Interface Module
- Fiber Optic Cabling
- Active Concentrator (If necessary)
- Passive Star (If necessary)
- Splitter/Combiner (Optional)

Fiber Optic Carrierband LAN Interface

The Fiber Optic Carrierband LAN Interface (see Figure 6) is an I/A Series station packaged as a single-width processor module for installation in I/A Series enclosures. It interfaces with the fiber optic LAN on one side and the Nodebus on the other. The Fiber Optic Carrierband LAN Interface is optionally fault tolerant. In this configuration, it is installed adjacent to another Fiber Optic Carrierband LAN Interface. One Fiber Optic Carrierband LAN Interface occupies one mounting structure slot, while a fault-tolerant pair occupy two adjacent slots.

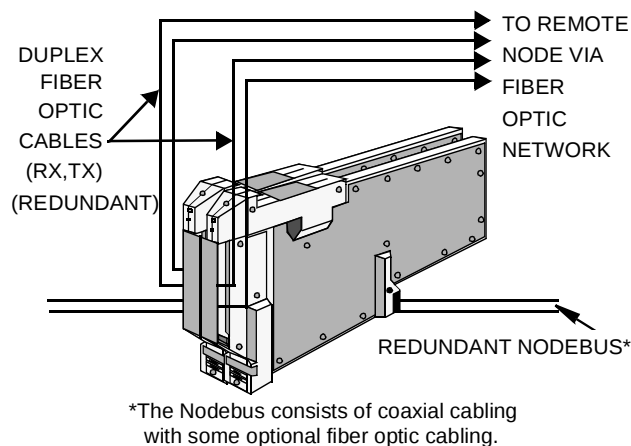


Figure 6. Fiber Optic Carrierband LAN Interface (Fault-Tolerant Configuration Shown)

Fiber Optic LAN Cabling

Fiber optic cabling is purchased by the customer. The recommended fiber optic cable is a multimode, graded-index glass fiber with a 62.5 micron core and 125 micron cladding.

Maximum allowable signal loss is 1 dB per km at a wavelength of 1300 nm. Cables with different characteristics can be used, but cabling distance capabilities will be affected. Four optical fibers are required for basic configurations, since each Fiber Optic Carrierband LAN Interface has two sets of transmit and receive connectors (to allow for redundancy).

For this reason, it is recommended that the customer purchase duplex cabling, which consists of two fibers intertwined in a single cable. The cables must be terminated with ST-type connectors and may not exceed 10 km (6.2 mi) in length.

The nodes furthest apart in the LAN must have a communication distance of 20 km or less between them. The maximum distance a signal can travel among these nodes should not exceed 20 km.

Other cable requirements (such as flexibility, or durability) depend on the particular application. Check with your cable vendor/installer for a listing of application-specific cable characteristics.

Network Topology

The Fiber Optic LAN used in this system can be configured to use four different topologies, depending on the size and arrangement of the network. Small centralized networks that do not require signal amplification can use a passive star topology. Larger centralized networks that require signal amplification can use either a Star or a Tree topology. Non-centralized networks that spread out over long distances can use a Bus topology. These topologies can be combined for specific customer applications.

Passive Star Topology

Figure 7 shows the Direct fiber optic LAN using a typical passive star fiber optic topology, in which a passive star interconnects distributed I/A Series nodes. Passive stars are available as multi-port interfaces with either four or eight ports. Since the stars are passive devices, there is no need for maintenance, and there are no failure modes associated with them. Passive stars work well in small LANs where the power budget of each communication is unlikely to exceed 17 db. Signal loss is directly related to the number of ports in the star. Passive stars require 2 ports to directly connect each fault-tolerant node. The following are common examples of passive stars.

Number of Ports On Passive Star	Maximum Distance Between Any Two Nodes
4	4 km (2.48 mi)
8	1 km (1.24 mi)

Figure 7 shows a four node fault-tolerant network, linked by a redundant passive star with eight ports. If the network contains more nodes with/or greater distances than the passive star can handle (see above table), the star must be replaced with an active concentrator. A table on page 11 compares the passive star's and active concentrator's attributes.

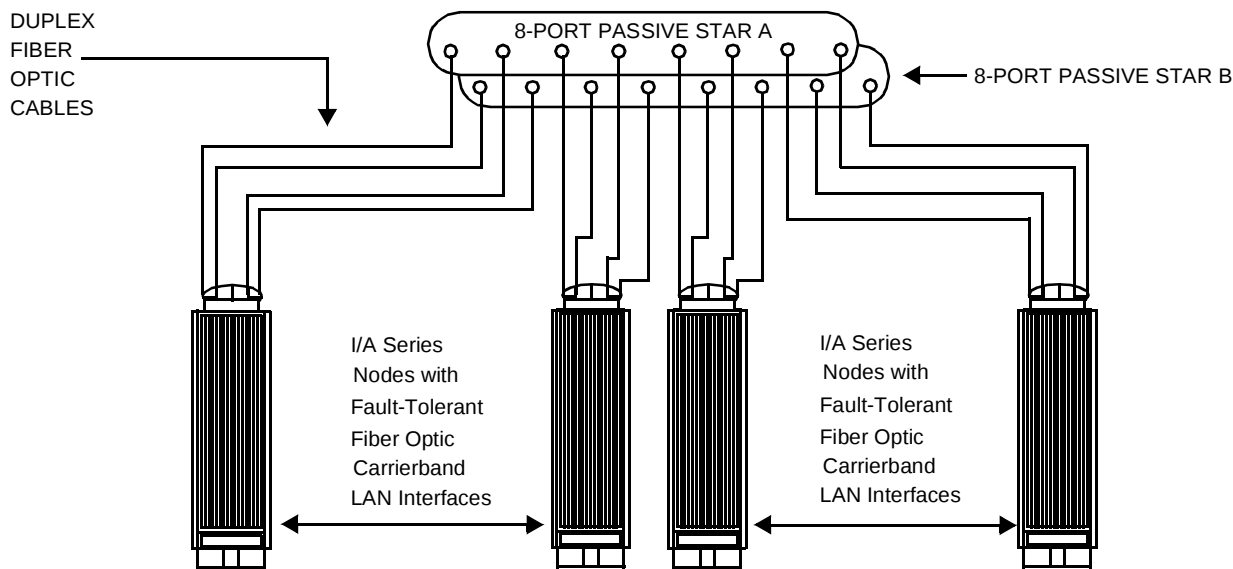


Figure 7. Typical Direct Fiber Optic LAN Using a Basic Passive Star Fiber Optic LAN Topology

Star Topology

Figure 8 shows the Direct fiber optic LAN used in a typical Star topology, with redundant active concentrators, passive stars, and splitter/combiners. The active concentrator interconnects distributed I/A Series nodes, and can transmit data at 5 megabits per second, up to 10 km (6.2 mi) per leg. It has nine ports, each with duplex ST type connectors. It can directly interconnect up to four fault-tolerant, or nine non-fault-tolerant I/A Series nodes. Additional I/A Series nodes can be connected in this topology by using splitter/combiners and/or passive stars in conjunction with the concentrators.

The splitter/combiner reduces signal connections between a fault-tolerant pair of Fiber Optic Carrierband LAN Interfaces and a pair of active concentrators (redundant). It maintains redundancy in the network, while eliminating the need for a second pair of redundant cables to connect the fault-tolerant Interfaces to the concentrators. This approach can yield significant cable savings and allows up to nine fault-tolerant I/A Series nodes to interconnect through each concentrator, at a cost of 5.3 db per cable to the power budget.

This active concentrator/splitter/combiner configuration can support fiber optic LAN cabling up to 7 km (4.3 mi) in length. For fiber optic LAN cables from 7 to 10 km in length, the splitter/combiner cannot be used. In its place, redundant cabling must be used to connect the fault-tolerant Interfaces to the active concentrators.

Redundant passive stars, described in detail above, can be used in place of the splitter/combiners.

The passive star can interconnect multiple fault-tolerant or non-fault-tolerant nodes to one port on each redundant active concentrator. It is best used to interconnect groups of nodes located close to each other. At least two passive stars are required – one for each redundant cable. Passive stars cause greater attenuation to the power budget than splitter/combiners, so communication distances are significantly impacted (see above table for details).

Tree Topology

Figure 9 shows the Direct fiber optic LAN used in a typical Tree topology in which multiple active concentrators are linked through redundant passive stars, to expand the number of distributed I/A Series nodes connected into the network. See above table for the distance between links of a passive star.

If longer distances are required, a redundant active concentrator can be used in place of the redundant passive star. This configuration can extend over a longer distance and interconnect more I/A Series nodes than if it used passive stars.

Length of communication in both the Star and Tree topologies depends on the length of cable, type of stations mounted, and type of devices.

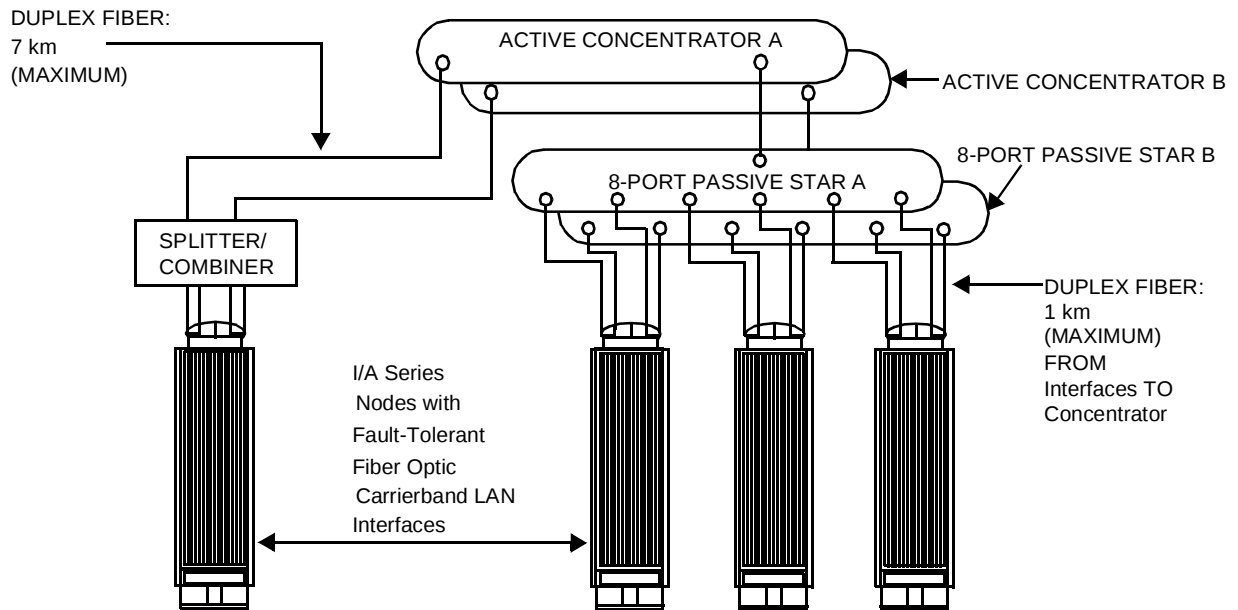


Figure 8. Typical Direct Fiber Optic LAN Using Star Topology with Redundant Active Concentrators, Splitter/Combiners, and Passive Stars

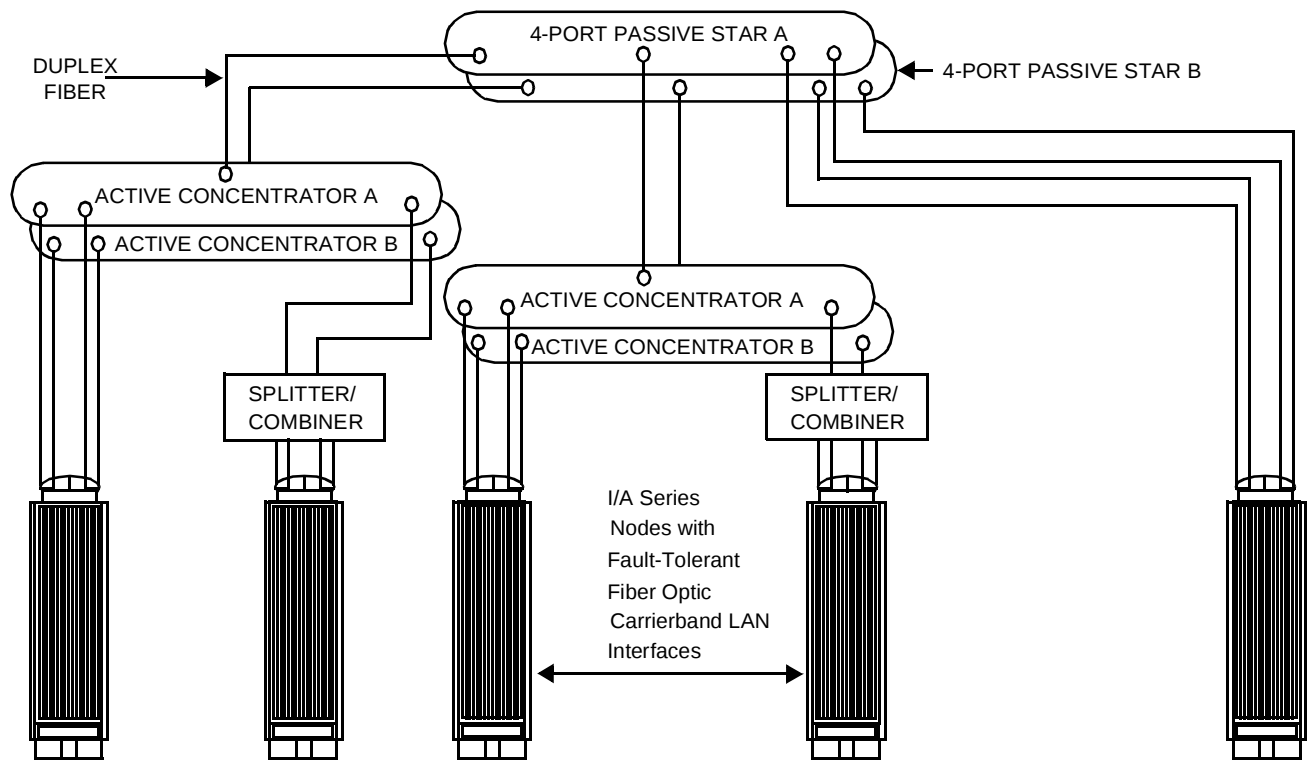


Figure 9. Typical Direct Fiber Optic LAN using Tree Topology with Active Concentrators and Splitter/Combiners Linked by Passive Stars

Bus Topology

Figure 10 shows the Direct fiber optic LAN used in a Bus topology, in which multiple nodes are interconnected via a series of active concentrators daisy-chained together in a bus formation. It is designed to link individual or small groups of nodes over long distances without routing all signals to a central source, like the other Direct fiber optic topologies. Bus topology is structurally similar to the coaxial Carrierband LAN: the concentrators connect the nodes to the fiber optic LAN in a structure similar to the way passive taps connect the nodes to the coaxial Carrierband LAN. However, the Bus topology can operate over longer distances than the coaxial Carrierband LAN.

Bus topology does not require long runs of cable from each node to a central source, as in the other Direct fiber optic topologies. This significantly reduces the amount of fiber optic cabling required in the fiber optic LAN.

The number of nodes that this topology can maintain varies depending on the number of concentrators used in the fiber optic LAN. Each concentrator has seven or eight ports available (one or two must be reserved to connect to other concentrators). Splitter/combiners and passive stars can be used in conjunction with the concentrators, the same as in Star topology, to connect additional nodes.

As in the other fiber optic LAN topologies, the nodes farthest apart in the LAN are limited to a communication distance of 20 km or less between them. Due to signal retiming, this communication distance is reduced by 1.25 km (0.77 mi) for each concentrator a signal must pass through.

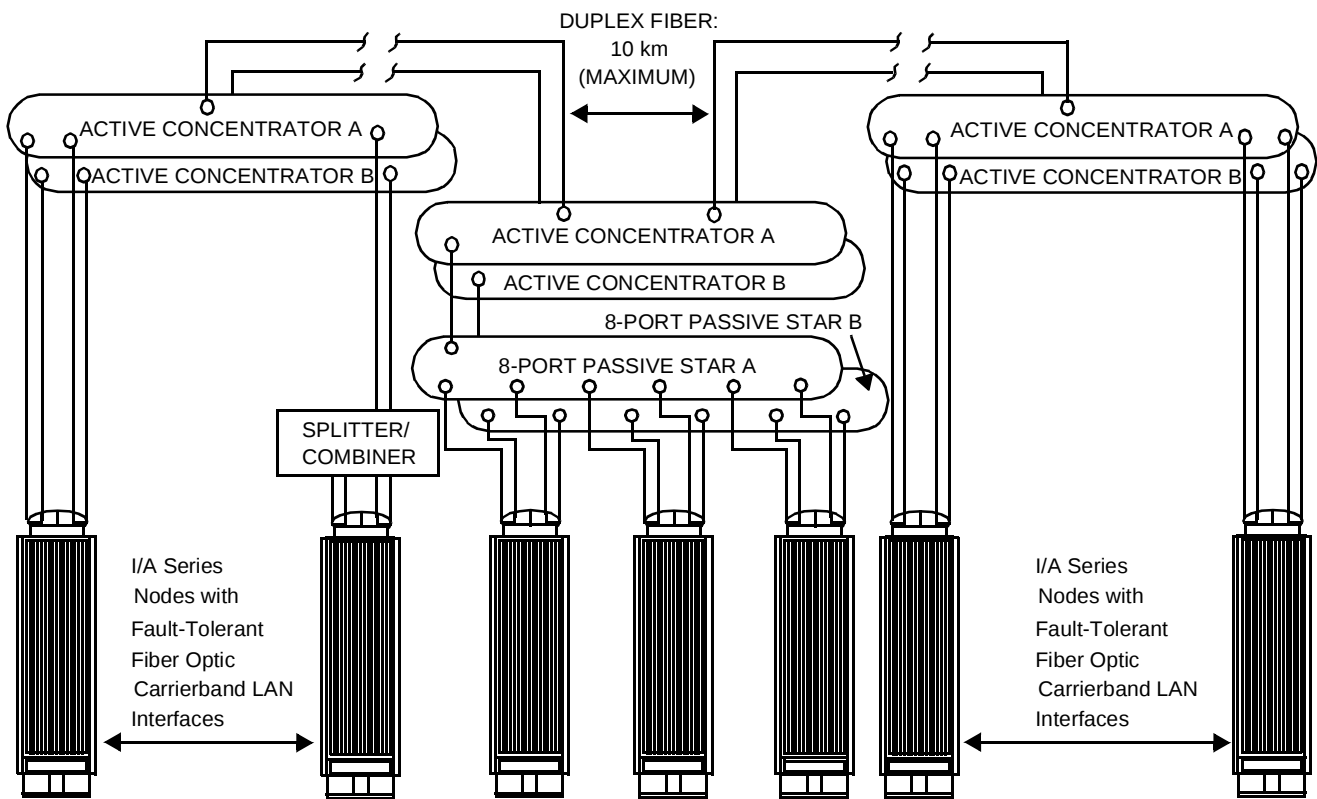


Figure 10. Example of Direct Fiber Optic LAN Using Bus Topology

Active Concentrator/Passive Star Comparison

The active concentrator and passive star are both signal distribution units for fiber optic LANs. However, each is designed to perform under different conditions.

The following table compares the two devices' attributes which primarily affect their usage in the fiber optic LAN.

Attribute	Active Concentrator	Passive Star
Maximum Distance Supported Between Any Two Interfaces in a Fiber Optic System	20 km (12.4 mi)	4x4 – 4 km (2.48 mi) 8x8 – 1 km (0.62 mi)
dB Loss to Power Budget for Each Signal	None – provides 17 dB power budget to each transmitted signal	4x4 – 10 dB loss 8x8 – 13.5 dB loss (Includes loss for two mated connector pairs)
Distance Loss due to Retiming Delays	1.25 km (0.77 mi) for each additional concentrator a signal must pass through	None
Fiber Optic Devices It Can Connect To	First eight ports: all fiber optic LAN devices Ninth port: splitter/combiner Fiber Optic Carrierband LAN Interface	Active Concentrator Fiber Optic Carrierband LAN Interface Fiber Optic LAN Converter
Number of Ports	9	4x4 – 4 8x8 – 8
Energy Use	Powered (80 to 264 V ac)	Not powered – passive
Minimum required	2 (for redundancy)	2 (for redundancy)
Mounting required	Standard 19-inch EIA rack or Fiber Optic LAN Enclosure	Standard 19-inch EIA rack or Fiber Optic LAN Enclosure

Fiber Optic LAN Enclosures

The optional Fiber Optic LAN Enclosures provide for housing of the passive stars, active concentrators, and splitter/combiners. The enclosures are made of steel and are equipped with 19-inch EIA rails for mounting of these devices, a power strip for plugging in the active concentrator's power cords, and a junction box for connecting customer ac power wiring.

The enclosures provide redundant power input, and are available in three sizes:

- Fiber Optic LAN Enclosure 4 – 800 mm (32 in) high by 600 mm (24 in) wide.
- Fiber Optic LAN Enclosure 6 – 1200 mm (48 in) high by 600 mm (24 in) wide.
- Fiber Optic LAN Enclosure 8 - 1600 mm (64 in) high by 600 mm (24 in) wide.

COMBINED LAN CONFIGURATIONS

The three basic LAN configurations – Coaxial Carrierband LAN, Passive Tap/Converter fiber optic LAN, and Direct fiber optic LAN – can interconnect with each other, enabling fiber optic cabling and equipment to interconnect with coaxial LANs.

These combined LAN configurations are functional providing they maintain the limitations on distances and signal attenuation mentioned above.

The nodes in a combined LAN configuration require a communication distance of 20 km or less between any two of them. Active devices, such as the Fiber Optic LAN Converter and active concentrator, decrease this communication distance by 1.25 km, each time a signal passes through one, due to retiming delays.

An example of a combined LAN configuration is shown in Figure 11. An active concentrator can replace the passive star, if the network contains more nodes and/or greater cabling distances than the star can handle.

The redundant passive star shown in Figure 11 is a four-port device; therefore, in the configuration shown, it has an extra port which can be used to connect to an active concentrator, an additional pair of Fiber Optic LAN Converters, or a non-fault-tolerant Fiber Optic Carrierband LAN Interface.

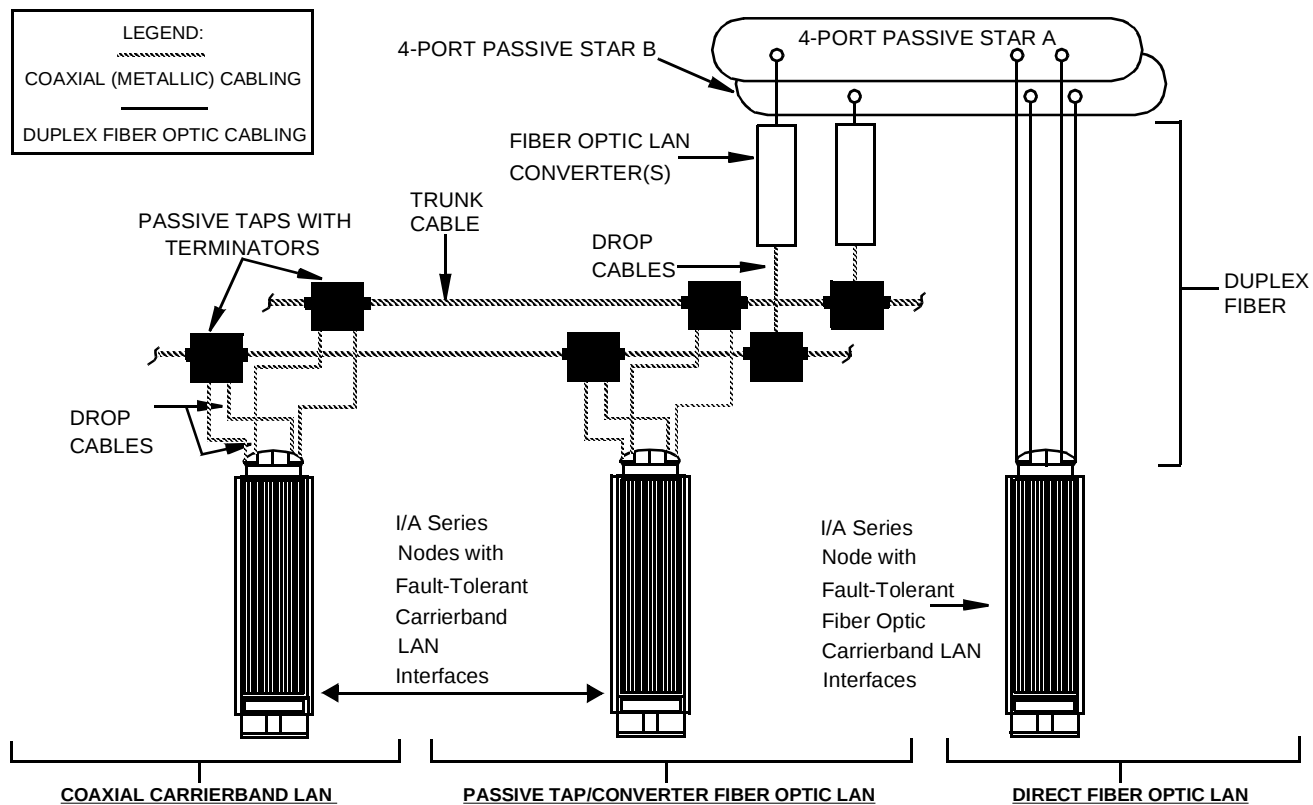


Figure 11. Basic LAN Configuration Combining Elements of the Three Basic LAN Configurations

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