Overview of SynchLink

This chapter provides an overview of SynchLink and how it works.

What is SynchLink?

SynchLink is a fiber optic communication link that allows its users to implement distributed motion and drive systems based on ControlLogix and PowerFlex700S products.

SynchLink should be used in conjunction with a standard control network, such as ControlNet or Ethernet/IP. A standard network is used for general control interlocking and transfer of diagnostic data across the system. SynchLink does not function as a standard control network (e.g. it only broadcasts data).

You can use the following products on SynchLink:

- ControlLogix SynchLink module (1756-SYNCH)
- ControlLogix Drive modules (1756-DMxxx series)
- PowerFlex 700S drives (DriveLogix)

For more information on these products, see Chapter 3, Using Specific Products on SynchLink.

SynchLink Operation

In the simplest terms, you can use SynchLink to:

- synchronize time
- transfer data, including axis data for synchronized mtion control and general data

Time Synchronization

SynchLink uses a time master-slave mechanism to achieve time synchronization. Time synchronization in a SynchLink system is required to:

- transfer motion and drive control data.
- synchronize distributed 1756-DMxxx series modules in separate chassis.
- synchronize distributed PowerFlex 700S drives for highly coordinated drive control.
- synchronize multiple distributed motion control planners across separate chassis for highly coordinated motion control.

SynchLink Node Clock

The SynchLink node clock is a base-line requirement of any product incorporating SynchLink and integral to all devices that contain SynchLink circuitry. The SynchLink node clock has a 1µS resolution and serves as the system clocking mechanism.

During system configuration, you configure one SynchLink node as the time master and all other SynchLink nodes as time slaves. The time master becomes the system clock for the entire control system. As such, the SynchLink time master broadcasts its time reference to the SynchLink time slaves; the time slaves, in turn, adjust their node clocks to match the master clock.

Transmitted Direct Words

The devices that operate on SynchLink can be configured to transmit data from the following direct word sources:

- Output Direct Words (0-3) - The local host (e.g. ControlLogix controller) passes these words to the 1756-SYNCH module in its local chassis. The module then transmits the data to the SynchLink fiber.
- Received Direct Words (0-3) - The 1756-SYNCH receives these words from the SynchLink fiber and copies the data back onto the fiber (via its transmit port) without any local host controller interaction with the data.
- Multiplier - This is the product of an upstream direct word and a user-configured multiplier for re-transmission to a downstream node. A typical application for this function would be for real time drawing applications where section-to-section speed ratios are required for precise process control.

Direct Words

Direct words are data delivered in a single message. These can be read from the module input data and sent to the module output data. A SynchLink message can contain a maximum of four direct data words; each word is 32 bits in length. Direct data can be automatically forwarded to the next SynchLink node in a daisy chain or ring configuration if necessary.

Multiplier

The Multiplier feature multiplies one Direct Word on the receive port by a user-defined value (0.5 to 2.0) before transmitting it out the transmit port. This feature is used to manipulate specific data from node to node. This feature is set during configuration. For the 1756-SYNCH module, you must configure the Multiplier in RSLogix 5000. For the 1756-DMxxx series modules and the PowerFlex 700S drives, you must set this feature in DriveExecutive in the DriveTools 2000 suite.

EXAMPLE A drawing application might use the Multiplier to modify data from section to section throughout the process.

Although you can configure the multiplier for any of the Direct Words, it can only be used with one Direct Word at a time.

The multiplier can only transmit the same word it received (i.e. this feature does not allow your module to receive direct word 0 and transmit it as direct word 1). The multiplier output is limited to 16 bits; any value generated by the multiplier larger than 65535 is truncated to 16 bits, and a Multiplier Overflow error is reported by the Synchlink module. Make sure any data that is passed to the Output word is less than 65535; if the data is greater, you receive incorrect output data.

Multiplier Overflow

The Multiplier Overflow bit is a data tag that is set whenever the multiplier value exceeds 65535. This value is set in the input data tags.

IMPORTANT

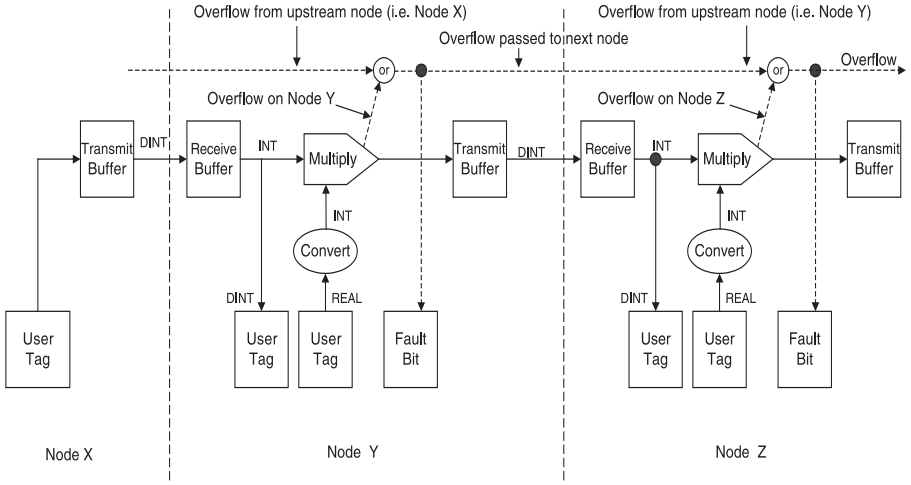
If you want to pass a Multiplier Overflow value (received from an upstream node) to a third node downstream but not locally change the direct word data transmitted to the downstream node, you must:

1. Enable the Multiplier feature
2. Use a Multiplier value = 1

If you perform these steps, data received from the upstream node on the Receive port is sent out through the Transmit port to the next downstream node. This process informs the downstream node that a Multiplier Overflow condition exists upstream and any data received is invalid.

Follow the steps described above for all SynchLink nodes in the system that need to know about the Multiplier Overflow condition. Figure 1.5 shows how a Multiplier Overflow condition is sent downstream.

Figure 1.5



SynchLink Transmitted Axes

Before SynchLink became available, all coordinated motion axes had to be controlled from the same ControlLogix chassis. However, SynchLink allows you to coordinate axes between multiple chassis. The 1756-SYNCH module can consume up to two axes from a master chassis and broadcast the data to other chassis over SynchLink.

Slave chassis consume the broadcast axis data and redistribute it to their local motion planners (i.e. the Logix controller in their local chassis). The controller in the slave chassis must be configured to consume axis data from the local 1756-SYNCH module. With this configuration, you can control multiple axes synchronously throughout the system.

SynchLink is typically used by the 1756-SYNCH module for axis data and CST synchronization. The 1756-DMxxx series modules and the PowerFlex 700S products typically use SynchLink to pass drive data (via direct data or buffered data).

Chapter Summary

In this chapter you read about:

- what SynchLink is.
- what SynchLink is used for.

Chapter 2 explains the SynchLink Topologies.

Using Specific Products on SynchLink

This chapter describes the products that can be used on SynchLink.

ControlLogix SynchLink Module (1756-SYNCH)

A ControlLogix SynchLink module resides in a ControlLogix chassis and connects the chassis to SynchLink. You can use this module to implement:

- time synchronization
- distributed motion control
- coordinated drive control

based on the ControlLogix and PowerFlex 700S platforms. In a distributed control system, the SynchLink module broadcasts reference data and synchronizes time from a single ControlLogix chassis to multiple other chassis at a high speed.

ControlLogix Drive Modules (1756-DMxxx Series)

The 1756-DM Drive Module is a single slot ControlLogix-based module for interface to Reliance Electric Distributed Power System (DPS) drive equipment. Each drive module interfaces with an individual Power Module Interface (PMI) chassis, performing velocity, position, and torque control.

There are six types of drive modules, one for each type of DPS drive equipment. Table 3.1 lists the ControlLogix Drive modules.

Table 3.1
ControlLogix (1756-DMxxx Series) Drive Modules

Drive Module:	DPS Equipment:	Description:
1756-DMD30	SD3000 6 Pulse	DC Drive S6 and S6R
	SD3000 12 Pulse	DC Drive S12 and S12R
1756-DMF30	SF3000	Three Phase Field Supply
1756-DMA30 (Not released as of this publication date)	SA3000	AC Drive
	SA3000 Parallel Inverters	AC Parallel Drive
1756-DMA50 (Not released as of this publication date)	SA500	Servo Drive
1756-DMB30 (Not released as of this publication date)	SB3000	DC Bus Supply
1756-DMA31	SA3100	AC Drive

Interface to Distributed Power System Drive Equipment

The first function of the Drive module is to interface to Reliance Electric Distributed Power System (DPS) drive equipment, enabling control of the drive equipment from a ControlLogix chassis. A ControlLogix controller performs higher level control algorithms and drive coordination. The Drive module performs outer control loop processing, and the Power Module Interface (PMI) controller performs real-time control of the Power Module.

Each drive module interfaces with an individual Power Module Interface (PMI) chassis. It resides in a ControlLogix chassis and connects to a PMI chassis via a fiber-optic Drive Communication cable. This communication protocol is the same protocol used by a Universal Drive Controller (UDC) (in an AutoMax environment) to interface to a PMI controller.

Transferring Data With the Drive Modules

The Drive modules transfer two types of data:

- Direct - Data delivered in a single message. A SynchLink message can contain a maximum of four direct data words; each word is 32 bits in length. Direct data can be automatically forwarded to the next SynchLink node in the daisy chain or ring configurations.
- Buffered - Data that exceeds the four word limit of a direct data transfer. Buffered data is appropriately segmented at the transmitting device and reassembled at the receiving device. Buffered data cannot be automatically forwarded to the next SynchLink node in the daisy chain and ring configurations.
- Axis data - Not supported by 1756-DMxxx Series modules.

ControlLogix Drive Module Features

The Drive module offers the following features:

- Velocity, position, and torque control
- Control loops are not synchronized to SynchLink through on-board connections. The 1756-SYNCH module is required to synchronize the Drive module to SynchLink.
- Motor Control capability for the respective Reliance Electric Distributed Power drive
- Fiber optic connection to the Power Module Interface
- Time synchronization of the SynchLink node clocks
- Removal and insertion under power (RIUP) - Allows you to remove and insert the module while power is applied
- Class I Division 2, UL, CSA, and CE Agency Certification

Related Documents

For more information on the ControlLogix Drive modules (1756-DMxx Series), including a full description of all features and how to electronically configure the module, see the following publications:

- ControlLogix Drive Modules installation instructions, publication 1756-IN577
- ControlLogix Drive Modules user manual, publication 1756-UM522

PowerFlex 700S Drive

The PowerFlex 700S is a highly functional, cost-effective and flexible drive control. The drive offers:

- selectable, high performance motor control algorithms.
- velocity, position and torque control
- control loops synchronized to SynchLink
- an array of feedback options, including encoder, resolver and high resolution encoder to optimize the accuracy of speed and position regulators.
- on-board high performance I/O.
- SynchLink as a high performance, high speed, drive-to-drive link that synchronizes the drives and transmits application data.

Transferring Data With the PowerFlex 700S Drives

The PowerFlex 700S Drives transfer two types of data between drives, including:

- Direct - Data delivered in a single message. A SynchLink message can contain a maximum of four direct data words; each word is 32 bits in length. Direct data can be automatically forwarded to the next SynchLink node in the daisy chain or ring configurations.
- Buffered - Data that exceeds the four word limit of a direct data transfer. Buffered data is appropriately segmented at the transmitting device and reassembled at the receiving device. Buffered data cannot be automatically forwarded to the next SynchLink node in the daisy chain and ring configurations.
- Axis data - Not supported by the PowerFlex 700S drives.

PowerFlex 700S Drive Features

The PowerFlex 700S drive offers the following features:

- Adaptive, field-oriented control FOC maintains torque control accuracy without external motor sensors
- Inertia compensation reduces dynamic tracking errors
- Adjustable backlash compensation for both feedback and forward signal paths
- Registration Inputs for Time or Position
- Resonant Frequency Compensation
- S-Ramp and Lead-Lag Filters for Velocity Signal Conditioning of user inputs
- Automatic Speed Feedback Loss/Recovery
- Coarse to Fine Interpolation for position applications
- Current Limit, Process Trim, Slip Compensation
- Electronic Gear Ratio

Related Documents

For more information on the PowerFlex 700S Drives, including a full description of all features and how to electronically configure the module, see the following publications:

- PowerFlex 700S Drives user manual, publication 20D-UM001

SynchLink Functionality in Each Device

Table 4.1 gives a summary of the various levels of functionality for the devices that use SynchLink. More detailed descriptions of each level of functionality follow the table.

Table 4.1
SynchLink Functionality in SynchLink Devices

Device:	SynchLink Node Clock:	Coordinated System Time:	CST/SynchLink Time Relay:	Axis Support:	Synchronize to Host Processor:
1756-SYNCH	✓	✓	✓	✓	
1756-DMxxx	✓	✓(1)			
PowerFlex 700S	✓				✓

(1) The 1756-DMxxx series drive modules cannot set the CST on a ControlLogix backplane.

1756-SYNCH Module

SynchLink Node Clock

The 1756-SYNCH module employs the SynchLink node clock, allowing the module to be the SynchLink time master or a SynchLink time slave; in this way, the module can either set time on the fiber, or, receive time from the fiber.

Coordinated System Time

In addition to setting and receiving time on the SynchLink fiber, the 1756-SYNCH module can also set or receive Coordinated System Time (CST) data. The CST clock is the main time reference on a ControlLogix backplane. Many 1756 I/O modules use the CST to take snapshots of real-time samples, and controllers use it to execute motion control instructions. Because a SynchLink module can act as CST master and broadcast CST time reference information to SynchLink modules in the other chassis, an entire ControlLogix system can be synchronized, allowing for relevant timestamping of data and distributed, synchronized motion control.

CST/SynchLink Time Relay

A time relay is any device that passes a time reference along. The 1756-SYNCH module passes the CST reference in the master chassis from the chassis backplane to the fiber optic media. Slave nodes in other chassis receive the CST reference value from the media, and relay the value to their respective backplanes. In this manner, although the SynchLink modules in the slave chassis are configured as slaves on the SynchLink fiber, they are configured as masters in their chassis, establishing the received CST value as the master reference for that chassis. Thus, all chassis that use the 1756-SYNCH module can be synchronized to the same CST reference.

Axis Support

The 1756-SYNCH module can transmit and receive axis data types that are used in the motion engine (of the local controller) to produce motion profiles. Since the motion planner uses the CST clock as its main time reference, all devices that consume motion axis data information from a motion master must also use the same time reference to interpolate the motion data in a meaningful way. This is true both inside a single chassis as well as among a distributed system where multiple chassis are using the same data.

IMPORTANT Keep in mind that a 1756-SYNCH module should never follow a PowerFlex 700S drive in any SynchLink configuration.

1756-DMxxx Drive Modules

SynchLink Node Clock

The 1756-DMxxx drive modules employ the SynchLink node clock, allowing the modules to be the SynchLink time master or a SynchLink time slave; in this way, the module can either set time on the fiber, or, receive time from the fiber. The 1756-DMxxx drive modules also implement the VPLs used in the PowerFlex 700S drives.

Coordinated System Time

The 1756-DMxxx drive modules use the CST differently than the 1756-SYNCH module. You should be aware of two significant differences before implementing these modules in a control scheme.

First, the 1756-DMxxx drive modules are intelligent processing modules that regulate Reliance Electric Distributed Power type drives. Each 1756-DMxxx drive module has integrated Velocity and Position Loops (VPL) that are a part of the module's firmware for controlling the drives. As with any digital control scheme, the control loops are scanned on a periodic basis, as measured against a given clock in the system. In the case of the 1756-DMxxx drive modules, the clocking mechanism is the CST clock on the ControlLogix backplane.

Since the 1756-DMxxx modules use the CST clock, as multiple modules are placed in a single chassis, their VPLs are automatically synchronized because they share the same clock.

CST/ SynchLink Time Relay

The second difference between the 1756-SYNCH and the 1756-DMxxx drive modules is that the 1756-DMxxx drive modules do not act as time relays. With this module, the SynchLink connection is for high speed data transfer only. This also means that if a distributed drive control system is installed where there are multiple 1756-DMxxx drive modules distributed across multiple chassis, 1756-SYNCH modules must also be installed in those chassis if tight synchronization between drives is important from chassis to chassis.

Axis Support

The 1756-DMxxx drive modules do not support the motion engine or profiler. They do not produce or consume axis data. They cannot be configured with communications protocols which include axis data types.

PowerFlex 700S Drive

SynchLink Node Clock

The PowerFlex 700S drive employs the SynchLink node clock, allowing the drive to be the SynchLink time master or a SynchLink time slave; in this way, the drive can either set time on the fiber, or, receive time from the fiber.

One difference in the implementation, though, is that while the 1756-DMxxx drive modules use CST as the synchronizing mechanism to coordinate VPL execution among multiple 1756-DMxxx drive modules, the PowerFlex 700S drive uses the SynchLink node clock to coordinate VPL execution among the distributed drives. The reason for this difference in synchronizing mechanisms is that most applications using the 1756-DMxxx drive modules are likely to coordinate multiple drives out of a single chassis, while the PowerFlex 700S is inherently distributed in its architecture.

Coordinated System Time

The PowerFlex 700S drive does not implement or utilize the Coordinated System Time clock.

CST/ SynchLink Time Relay

The PowerFlex 700S drive does not support any notion of a CST / SynchLink time relay, since it does not support a CST clock.

Axis Support

The PowerFlex 700S drive does not support the motion engine or profiler. It does not produce or consume axis data. It cannot be configured with communications protocols which include axis data types.

IMPORTANT Keep in mind that a PowerFlex 700S drive should never precede a 1756-SYNCH module in any SynchLink configuration.

Daisy Chain Topology Configurations

In the daisy chain topology, the SynchLink system starts at the master node and ends at an end node but may also include center nodes that receive and transmit data; the only difference between center and end nodes is their physical location.

Daisy Chain Topology Configuration #1

In this configuration, a ControlLogix SynchLink module is the master node, and ControlLogix SynchLink or Drive modules are the center and end nodes.

Figure 4.4

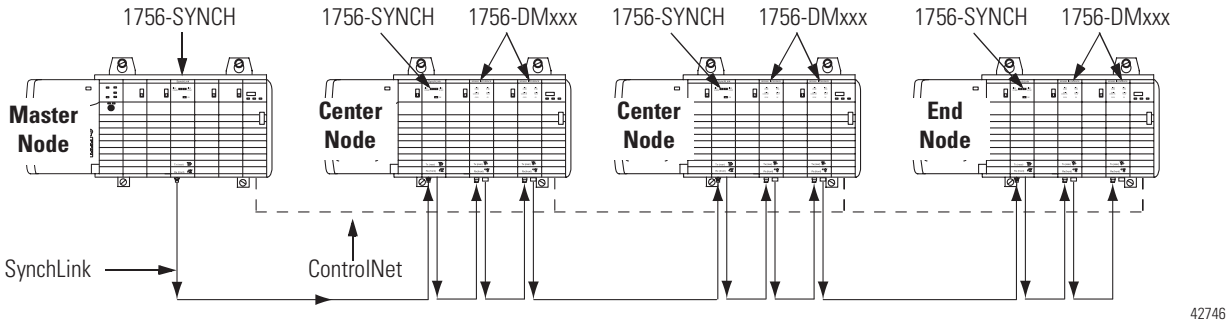


Table 4.5 lists more information about this configuration.

Table 4.5

Category:	Explanation:
Time synchronization	Master - 1756-SYNCH module Slaves - 1756-SYNCH modules and 1756-DMxxx series modules The SynchLink node clocks and the CST clocks are synchronized across all nodes. The VPL values are synchronized across all 1756-DMxxx series modules because the modules are synchronized by the respective CST values in each chassis.
Data transfer	• Typically, this configuration is used to transfer direct data. • If you want to pass buffered data, the local controller at each node must pass the data.(1)
Restrictions	• Axis data is not supported in the configuration. • A 1756-SYNCH module must be the time master. • A 1756-SYNCH module is required in each chassis to synchronize the CST. The Drive modules then synchronize their VPLs with the CST. • You can use a maximum of 10 SynchLink connections.
Typical applications	Multi-Section Drive Synchronization

(1) The local ControlLogix controller must move the buffered data for a 1756-SYNCH module. For the 1756-DMxxx module, the module's VPL microprocessor must move the data. For more information, see page 1-7.

Ring Topology Configurations

The ring topology is a permutation of the daisy chain configuration. In the ring topology, the end node's transmitter is connected to the master node's receiver. This topology can include center nodes; the only difference between the center and end nodes is their physical location.

Ring Topology Configuration #1

In this configuration, a ControlLogix SynchLink module is the master node, and ControlLogix SynchLink Drive modules are the center and end nodes.

Figure 4.8

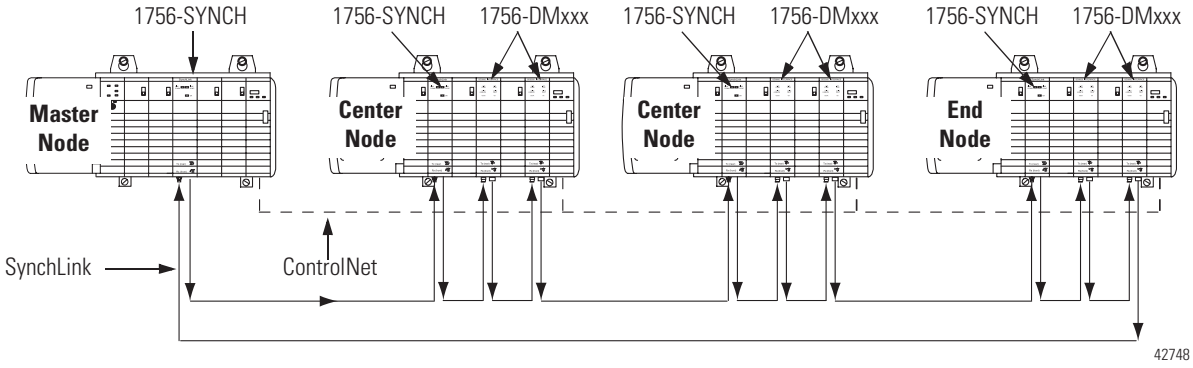


Table 4.9 lists more information about this configuration.

Table 4.9

Category:	Explanation:
Time synchronization	Master - 1756-SYNCH module Slaves - 1756-SYNCH modules and 1756-DMxxx series modules The SynchLink node clocks and the CST clocks are synchronized across all nodes. The VPL values are synchronized across all 1756-DMxxx series modules because the modules are synchronized by the respective CST values in each chassis.
Data transfer	• Typically, this configuration is used to transfer direct data. • If you want to pass buffered data, the local controller at each node must pass the data.(1) • Data can be passed back to the master node.
Restrictions	Axis data is not supported in the configuration.
Typical applications	Progressive draw

(1) The local Logix controller must move the buffered data for a 1756-SYNCH module. For the 1756-DMxxx module, the module's VPL microprocessor must move the data. For more information, see page 1-7.

Drive Module/PowerFlex 700s Drives Combination

In this configuration, a SynchLink module acts as a time relay and synchronizes the CST with the beacon to communicate data to the Drive modules and the PowerFlex 700s drives. The Drive modules use the CST to synchronize their VPLs, and the PowerFlex 700S drives use the SynchLink node clock to synchronize their VPLs.

Figure 4.13

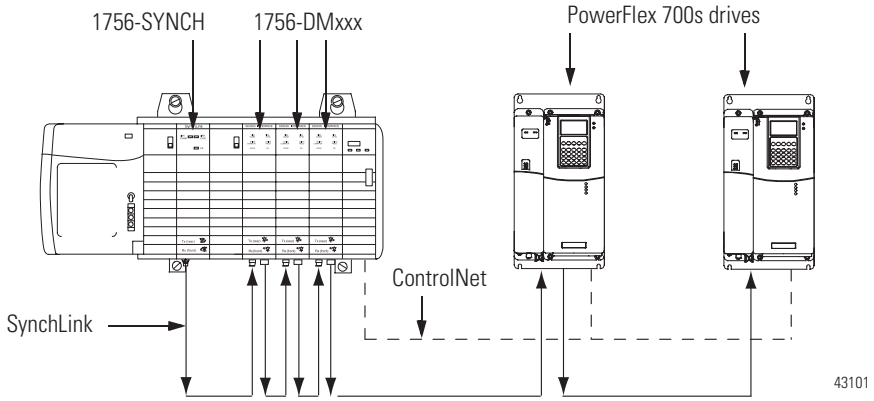


Table 4.14 lists more information about this configuration.

Table 4.14

Category:	Explanation:
Time synchronization	Master - 1756-SYNCH Slave - 1756-DMxxx series modules and PowerFlex 700S drives. The 1756-SYNCH module synchronizes the CST and SynchLink node clocks.
Data transfer	• Typically, this configuration is used to transfer direct data. • If you want to pass buffered data, the local controller at each node must pass the data.(1)
Restrictions	Axis data is not supported in the configuration.
Typical applications	Draw

(1) The local Logix controller must move the axis or buffered data for a 1756-SYNCH module. For the 1756-DMxxx module or PowerFlex 700S drives, the device's VPL microprocessor must move the data. For more information, see page 1-7.

Table 1.2
1756-DMxxx Drive Module Specifications

Operating Wavelength	
SynchLink	650nM (red)
Drive Communication	820nM (red)
Data Rate	
SynchLink	5M bit/s
Drive Communication	10M bit/s
SynchLink Connecting Cable	
Fiber Type	200/230 micron HCS (Hard Clad Silica)
Fiber Termination Type	Versalink V-System
Assemblies	Cable assemblies can be ordered from Rockwell Automation, catalog number 1403-CFxxx (xxx = length in meters); or from Lucent Technologies, Specialty Fiber Technologies division.
Maximum Length	300m
Minimum Length	1m
Drive Communication Cable	
Fiber Type	1mm Plastic or 200M Glass Fiber
Assemblies	Cable assemblies can be ordered from Rockwell Automation, catalog number 1756-DMCFxxx (xxx = length in meters); or from Belden P/N 225362 or Mohawk P/N M92021, 62.5 micron Duplex Fiber Optic cable.
Maximum Length	300m
Minimum Length	1m
SynchLink Maximum Node Count	10 - daisy chain, 256 - star configuration (w/ multiplexing blocks)
Drive Communication Maximum Node Count	1 - PMI chassis
Backplane Current	1.35A @ 5.1V dc 3.0 mA @ 24V dc
Power Dissipation	6.96W maximum, 23.7 BTU/hour
Environmental Conditions	
Operating Temperature	0°C - 60°C (32°F - 140°F)
Storage Temperature	-40°C - 85°C (-40°F - 185°F)
Relative Humidity	5 to 95%
Shock Operating	30g peak acceleration, 11 (± 1)ms pulse width
Non-Operating	50g peak acceleration, 11 (± 1)ms pulse width
Vibration	Tested 2g @ 10-500Hz per IEC 68-2-6
Agency Certifications	Listed Industrial Control Equipment Non-Hazardous Certified Class I, Division 2, Groups A, B, C, D Marked for all applicable directives