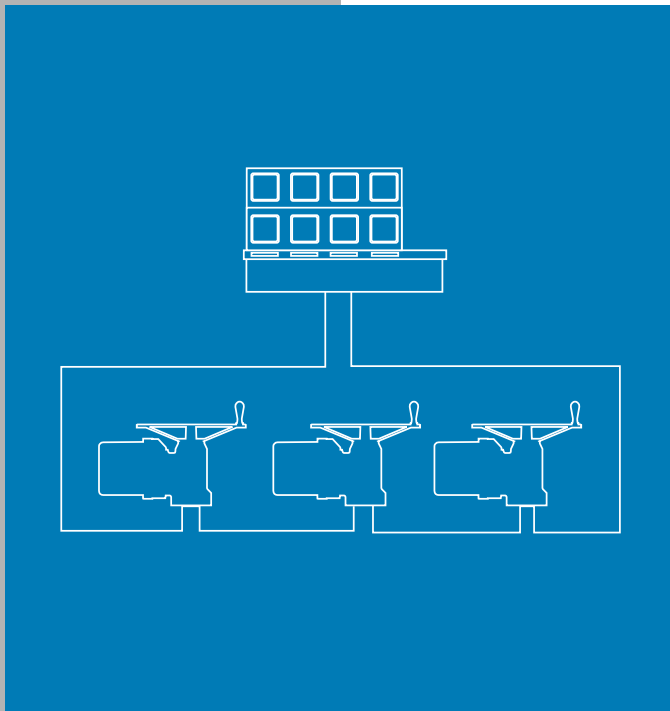


Specification for
Valve Actuation
Digital Control Systems



DDC-100: A microprocessor-based digital control and monitoring system offered by Limitorque for motorized valve actuators, pumps, mixers or other controlled devices.



The control room supervisory system is linked to the field devices with a highly reliable and secure digital data network based on widely

accepted, non-proprietary industrial protocols and electrical standards. Twisted-pair or fiber optic connections are available and can be mixed in the same system.

The four major elements of the DDC-100 system are:

Control Room Devices

The DDC-100 system can be directly connected to a DCS, PLC, or a PC. This connection is referred to as direct-to-host. Control room devices by most major manufacturers have been tested and certified for operation with the DDC-100 System.

Network

The DDC-100 Network provides a secure, redundant, non-proprietary interconnection between the Network Master and the Field Units. The network can be specified as DDC-100M with Modbus® (either ASCII or RTU) protocol or DDC-100B with BITBUS® protocol. Twisted-pair wiring (RS-485) or fiber optic cable can be specified to fit the application. Network topologies include loop, multi-drop, and dual multi-drop configurations.

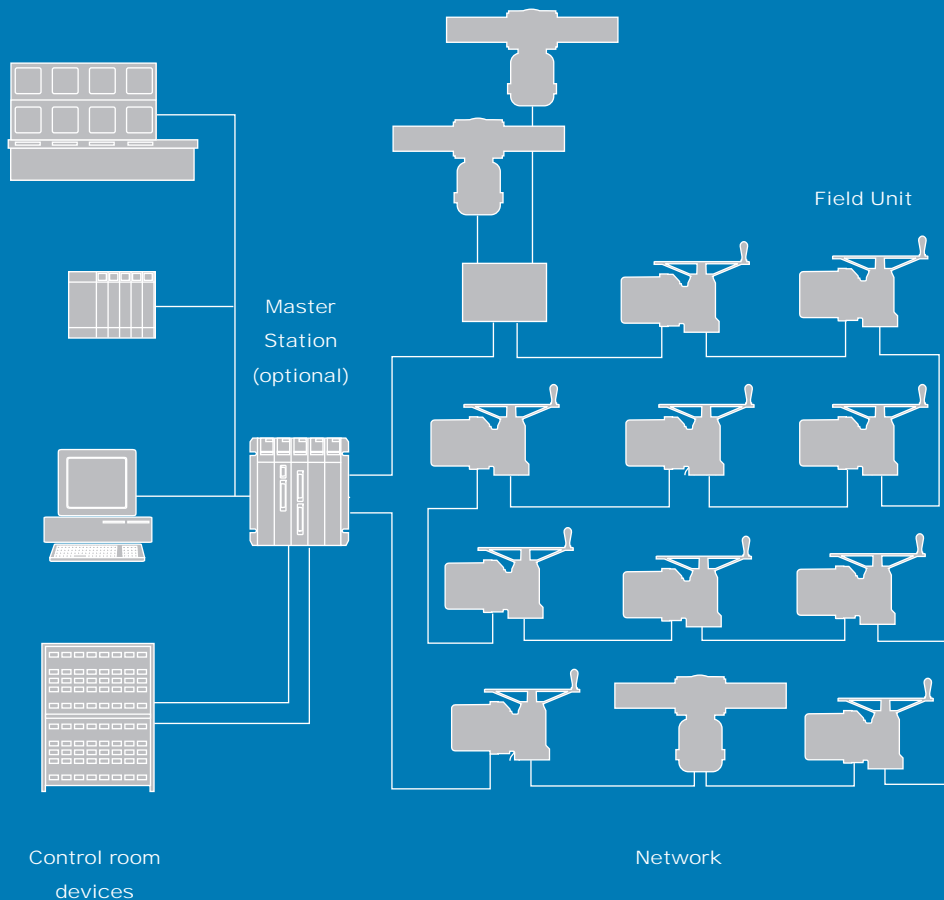
Field Unit

The DDC-100 Field Unit is installed inside Limitorque valve actuators, and communicates with the Master Station over the Network. The Field Unit may also be installed in separate enclosures to control pumps, solenoids, or other devices. Existing motorized actuators by Limitorque and all other suppliers may be networked through the use of Limitorque Field Units.

Master Station (optional)

The DDC-100 Master Station provides network control, field device status, fault annunciation, data concentration, data logging, and diagnostic access in the DDC-100 System. Some control room devices are able to provide these functions for the Modbus protocol DDC-100 System, eliminating the need for a Master Station.

A typical DDC-100 system



The benefits of the DDC-100 System are:

Cost

- Reduced cable and installation costs through use of a single twisted-pair cable.
- Simplified system engineering and documentation.
- Elimination of control room discrete and analog I/O.
- Reduced maintenance cost through advanced actuator diagnostics and preventive maintenance.

Connectivity

- DDC-100 has been installed globally and connected to control room devices and supervisory control systems by all major manufacturers (see page 6).
- Configurations are available without the need for a Master Station for direct connection to a DCS or PLC.

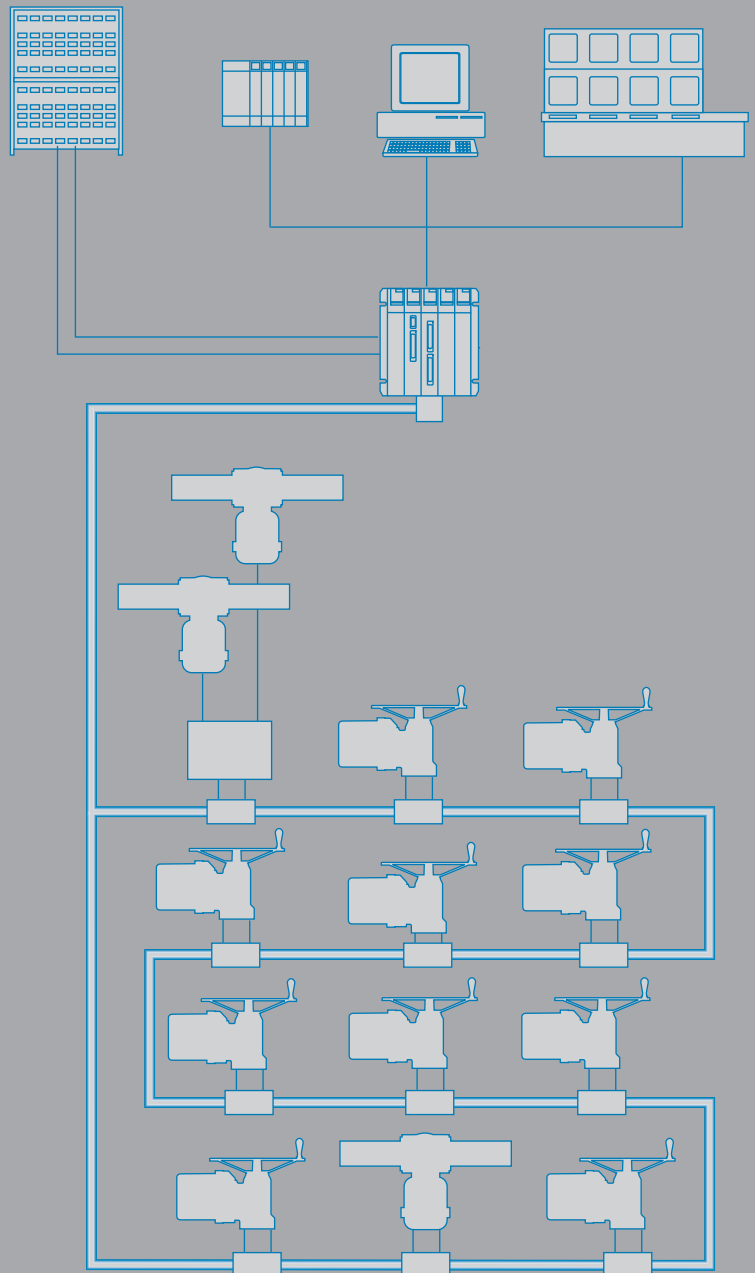
Reduced maintenance downtime

- Actuator data for the entire network is available in the control room on a real-time basis. This level of visibility can be used to detect problems before they disable a process and create downtime.
- Actuator data can be logged for use in a preventive maintenance program. Torque trending data, for example, can be recorded. Increasing torque trends may indicate future problems.

Increased ease of upgrade

- Field Units can be added to an existing DDC-100 system or they can be relocated with a minimum of wiring changes. The configuration of Field Units can be accomplished through simple interactive field procedures.

Fiber Optic Network



Control Room Devices

DCS/PLC/PC/Pushbutton control Limitorque's DDC-100 System can be controlled by a DCS, PLC, PC or Pushbuttons (local or remote I/O). Each option provides control and monitoring of all devices on the digital network. The DDC-100 System is certified for operation with any major manufacturer's control room equipment.

DDC-100 offers open protocols and standard electrical configuration for communication between the control room device and the DDC-100 Master Station:

- Modbus protocol (ASCII or RTU).
- RS-232 or RS-485.
- Point-to-point or multi-drop configurations.
- Single or redundant (hot standby) configurations.
- Data security through error detection and correction (CRC or LRC check sum with retransmit and alarm on error detect).

The DDC-100 System provides the control room operator with detailed status information from each valve actuator or other device including:

- Valve and actuator status
- Actuator or network faults
- I/O Status

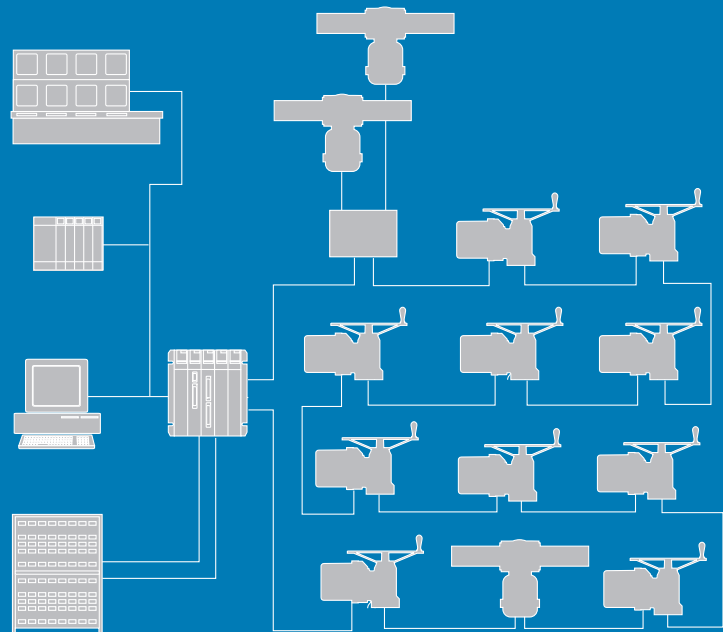
In addition, more detailed data is available from each actuator, including diagnostics and torque trending. The user can specify which status and fault conditions are to be reported and how often they are to be reported for each device.

DDC-100 Systems provide a maximum data transfer rate of 19.2 k bits/sec. for transfers between the control room equipment and the Limitorque Master Station.

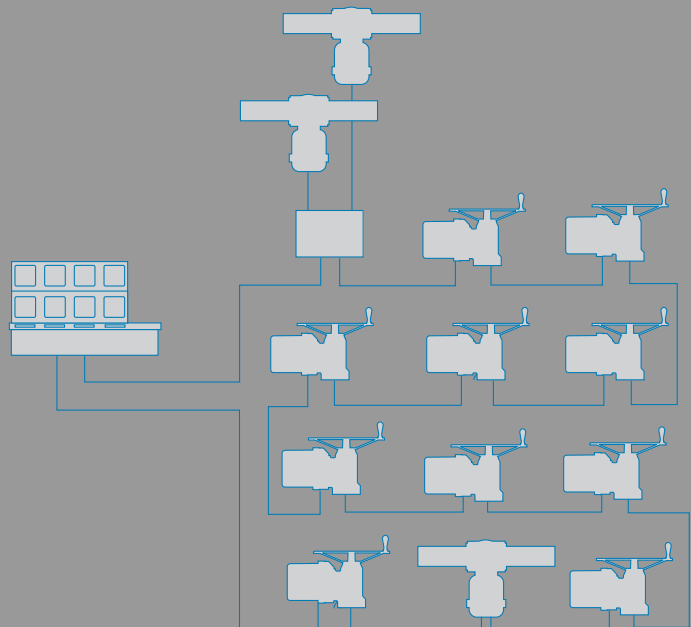
Control options

There are two methods of connection to the DDC-100 System. The first method is intended for applications where the control room device can function as a Modbus Master and be programmed to perform Master Station functionality. No additional Master Station is required. This configuration permits loop or multi-drop network topologies while eliminating the cost of a Master Station. The second method uses the Limitorque Master Station and can interface with most control room devices.

Control room connections, direct-to-host topology



Control room connections, Master Station topology



Control Room Equipment Compatibility

	with Master Station	with Direct-to-Host
PC-based Systems		
Ci Technologies	yes	no
Gensym	no	no
Intellution	no	no
National Instruments	no	no
Rockwell Software	no	no
Steeplechase Software	no	no
Taylor Industrial Software	no	no
US Data/Factory Link	no	no
Wonderware	no	no
PC Software	no	no
PLC Systems		
Allen Bradley	yes	yes
B&R Industrial Automation	no	no
Bristol-Babcock	no	no
Control Technology, Inc	no	yes
GE-Fanuc	no	yes
Modicon	no	yes
Omron	no	no
Prosoft	no	yes
Siemens	no	yes
Square D	no	yes
Telemecanique	no	yes
Texas Instruments	no	yes
DCS Control Options		
Asea Brown Boveri	yes	no
Autolog 2000	no	yes
Control Systems International	no	no
Elsag Bailey	no	yes
Fisher-Rosemount	no	yes
Foxboro	no	yes
Fuji Electric	no	yes
Hathaway Industrial Automation	yes	yes
Honeywell	no	yes
Moore Process Automation (APACS)	no	yes
Yokogawa	no	yes
Westinghouse	no	yes

Master Station

The DDC-100 Master Station provides network control, Field Unit status, fault annunciation, data concentration, data logging, and diagnostic access in the DDC-100 System. It is a combination of standard Allen-Bradley 1771 Series modules with application-specific Limitorque software which provides:

Polling and commands

The Master Station continually polls each Field Unit to obtain the status, fault or alarm condition. Prioritized polling may be implemented for critical tasks or applications. Commands interrupt polling to immediately direct the action of the specified Field Unit. The elapsed time from the beginning of a DCS command to the transmission of the command to the Field Unit is 74 msec. for a Modbus network. For a BITBUS network the time is 41 msec.

Operating system

OS-9[®] is a true multi-tasking operating system which efficiently manages the various tasks of the Master Station. It is one of the most widely used operating systems for real-time control applications.

Configurable Network Parameters

The network can be user configured to suit the application and to accommodate future changes. Configurable parameters include:

- Address of first and last Field Units. Field Units are consecutively addressed in the range of 1 to 250.
- Field Unit polling priority. Determines if a Field Unit will be polled each polling cycle, every second polling cycle, etc.
- Polling cycle separation. This is the time between the end of one polling cycle and the beginning of the next. Can be specified from 1 to 10 seconds.
- For unresponding Field Units, the user may choose values of parameters which determine how often the Master Station will try to scan the unresponsive Field Unit.
- Each Field Unit has up to 44 registers of status and alarm information. For each Field Unit the user can select a contiguous block of 1 to 44 registers to be included in the scan.
- Communications Channel Parameters
 - DCS Port Mode (Modbus, ASCII or RTU).
- Network Port Protocol (Modbus ASCII or RTU, or BITBUS) and Baud Rate.
- DCS interface configuration parameters -
 - Network address of Master Station.
 - Number of analog channels per Field Unit.
 - Number of coils per Field Unit.

- DCS Modbus register map parameters -
 - Number of the first Field Unit registers to include in polling table.
 - Number of consecutive Field Unit registers to include (maximum of 125 registers per request).
- Digital input bit mask selects status bits from the Field Units into Master Station bit map.
- Simulative network value allows the Master Station to simulate network polling up to the last Field Unit with fewer actual Field Units attached to the network.

Modbus compatible DCS, PLC, or Host PC Port (COMM1)

This is an RS-232 port (25 pin Female D-connector) which supports Modbus protocol (ASCII or RTU). Master Stations may be connected point-to-point or multi-dropped. Port defaults are given below:

Baud Rates	9600
Data Bits	8
Parity	None
Stop Bits	1

Data Logging/Diagnostic Port (COMMO)

This is an RS-232 port (9 pin Male D-connector) which can be used to perform extensive configuration and diagnostic functions with a Personal Computer and software supplied by Limitorque. This port can also be used with a printer (RS-232, ASCII compatible) to log system diagnostic data such as alarms and status information.

Port options are given below:

Baud Rate	9600
Data Bits	8
Parity	None
Stop Bits	1

Two isolated DDC-100 Network ports (COMM2 and COMM3)

The two network ports are surge protected and isolated RS-485 ports. They are provided by RS-232/RS-485 converters connected to COMM2 and COMM3 of the Master Station. Port options are given below:

Baud Rates	38.4k (default) or 9600 for Modbus or 62.5k for BITBUS
Data Bits	8
Parity	None
Stop Bits	1

LED's and status display

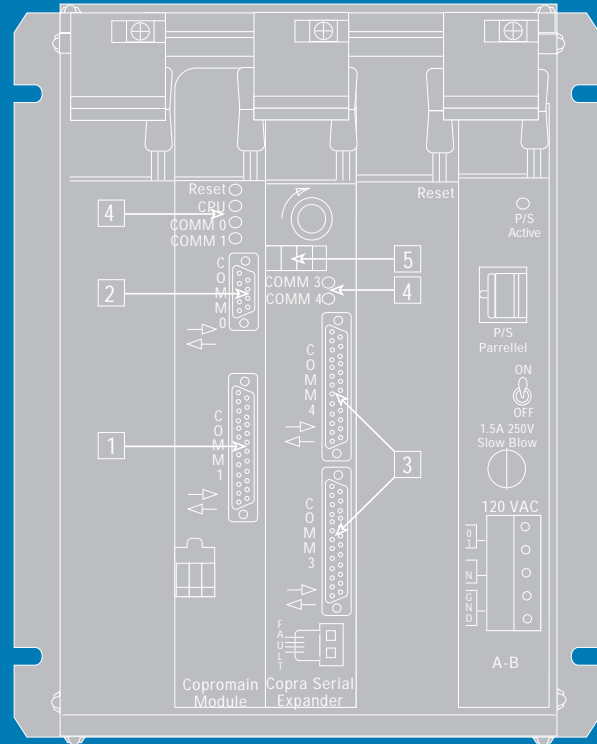
Control Coprocessor Module LED Indicators

- CPU—Indicates processor running normally or fault status
- COMM0—Receiving, transmitting, or idle
- COMM1—Receiving, transmitting, or idle

Serial Expander Module LED Indicators and Display

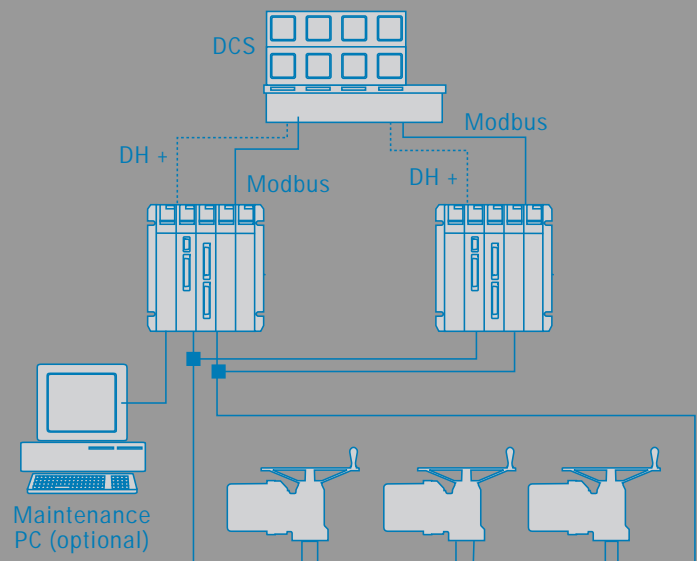
- Display—four character display which indicates network and field unit status, DCS updates, and annunciates faults
- COMM2—Receiving, transmitting, or idle
- COMM3—Receiving, transmitting, or idle

DDC-100 Master Station



1. DCS, PLC, or Host PC Port
2. Data Logging/Diagnostic Port
3. Network Ports
4. LED Indicators
5. Status Display

System with "Hot Standby" Redundant Master Station



High-speed network scanning and DCS updating

Times given below are valid regardless of internode distance or quantity of devices on the network and are based on averages of test data.

Modbus Network with Master Station

- Scan time/Field Unit (3 registers) – 114 msec.
- Response to DCS request (1 register) – 42 msec.
- Response to DCS request (32 registers) – 115 msec.
- Average time from DCS issuing a command to reception of Field Unit Status Response:
 - Modbus (9600 bits/sec.) – 495 msec.

BITBUS Network

- Scan time/Field Unit (1 to 42 registers) – 20 msec.
- Response to DCS request (1 register) – 47 msec.
- Response to DCS request (32 registers) – 145 msec.
- Average time from DCS issuing a command to reception of Field Unit Status Response:
 - BITBUS (38.4k bits/sec.) – 113 msec.

Extended Master Station

Sequencing and Interlocking are both internal functions of a DCS host. Through the addition of a PLC-5 module and third-party programming software, the A-B Master Station is also capable of performing these functions.

Power supply

Rack mountable with a wide range of input power options: Input Power Options–100 Vac, 120 Vac, 200 Vac, 220 Vac, 24 Vdc, 125 Vdc. All power supplies are surge protected.

Fault relay

Fault relay to indicate Master Station CPU fault with contacts rated at 30 Vac or Vdc at 500 mA. Normally open and normally closed contacts are provided.

Capabilities of the Master Station

The following standard Modbus function codes are supported:

- (01) Read Coil Status
- (02) Read Input Status
- (03) Read Holding Register
- (04) Read Input Register
- (05) Force Single Coil
- (06) Preset Single Register
- (08) Diagnostics
- (15) Force Multiple Coils*
- (16) Preset Multiple Registers*

*These function codes are not fully supported.

For enhanced reliability, Master Stations can be supplied in a “Hot Standby” configuration using two Master Stations. One Master Station controls the network and the other functions in a “Hot Standby” mode so that the current status data for each Field Unit is maintained by both Masters. If the controlling Master Station can no longer control the network, control is automatically transferred to the “Hot Standby” Master Station. Transfer may also be initiated locally or via the control room device. Hot Standby Master Stations may be multi-dropped via RS-485 connection to the DCS to minimize DCS port requirements.

Network Emergency Shutdown (ESD) may be initiated by the control room device or locally through optional discrete inputs.

Network

The DDC-100 Network is a secure and reliable digital data network based on industry standard open protocols and electrical specifications. Network protocol options are Modbus (ASCII or RTU) or BITBUS. Transmission media options are shielded twisted-pair cable or fiber optic cable. Versatile communications capabilities facilitate several network topologies which can accommodate different reliability requirements.

Polling

Modbus The Master Station functions as a Modbus “master” and the individual Field Units are “slaves.” The Master Station issues “polls” and “commands” and the Field Units provide “responses” in return. Polling is continuous and sequential. Field Unit response to the poll contains the contents of the registers which have been selected by the user. The Modbus data rate is 9600 bits/sec. (ASCII and RTU) and is adjustable.

BITBUS (utilizes a Limitorque Master Station) The Master Station functions as a BITBUS “master” and the individual Field Units are “slaves.” The BITBUS protocol is a synchronous serial communications standard (IEEE-1118) which was originally formulated by the Intel Corp, and uses the RS-485 electrical standard. BITBUS provides rapid Field Unit polling, an efficient data transfer rate and it is widely used and supported. BITBUS data rates are 38.4k bits/sec. or 62.5k bits/sec.

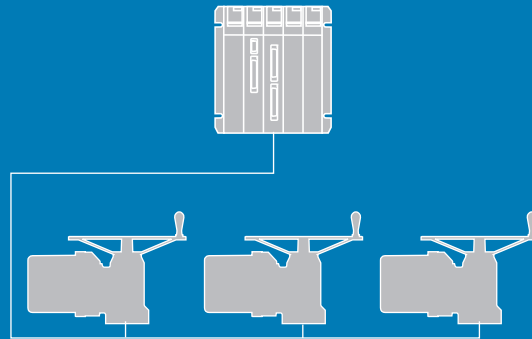
Network features

Limitorque hardware and software supports Multi-drop, Dual Multi-drop, and Loop topologies.

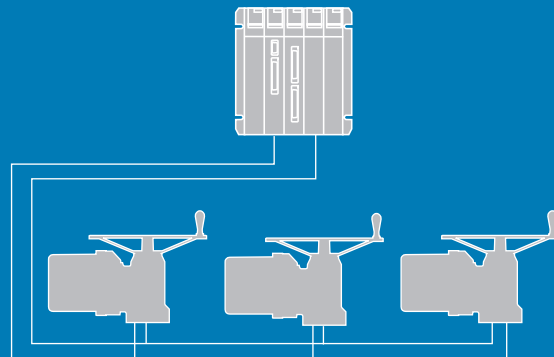
Multi-drop The Multi-drop network requires the minimum amount of cabling. It is the least fault tolerant of the three topologies. This type of network would normally be used to minimize cabling cost or to take advantage of existing cabling in a small system.

Dual Multi-drop The Dual Multi-drop topology provides a higher level of fault tolerance than Multi-drop because, in the event of a line break or a line short, the network traffic is automatically routed over the second path.

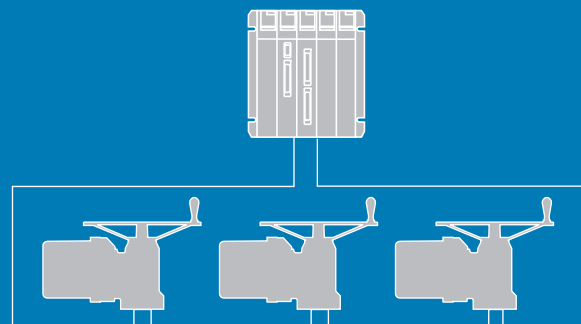
DDC-100 Network: Multi-drop



DDC-100 Network: Dual-multi-drop



DDC-100 Network: Loop



Loop A loop network can tolerate a communication line break or short between any two Field Units and still function while maintaining communications to all field units. The location of the fault is easily determined. This is possible because the Field Units and Master Station have dual communication channels.

Network Protection

Electrical surge protection is provided on all Limitorque supplied networked devices including Master Stations and Field Units (see General Specifications for details).

Network Cable

Belden 9841, Belden 3105A and Belden 3074F shielded twisted-pair cables are recommended by Limitorque. Other cables may be used but this may result in a reduction of internodal distances or increased error rate.

Network Performance

- Maximum number of Field Units that can be attached to a network:
 - Loop-250.
 - Multi-drop-up to 250 with a loop connected Field Unit after each segment of 28 multi-drop Field Units.
 - Dual Multi-drop-up to 250 with loop connected Field Units after each segment of 28 multi-drop Field Units.
- Maximum continuous distance between Master Station and Field Units or between directly connected Field Units - is shown in the chart below.

The network cable connects the field units to the host system or Master Station. Either Belden 9841, 3105A, or 3074F shielded twisted-pair cable should be used. The use of other cables may result in a reduction of internodal distances or increased error rate.

Topology	Belden 9841 Cable	Belden 3105A Cable	Belden 3074F
Multi-drop	1500 ft./segment	1500 ft./segment	1500 ft./segment
Dual Multi-drop	1500 ft./segment	1500 ft./segment	1500 ft./segment
Loop	2500 ft.	3500 ft.	2500 ft.

Belden 9841 Specifications

Total Cable Length between repeaters or nodes with repeaters:

- @ 9.6 kbps: 6560' (2 km)
- @ 19.2 kbps: 3.3 kft (1 km)

For loop mode, this is the total length between operating field units. If a field unit loses power, then the relays internal to the field unit connect the A1 channel to the A2 channel, which effectively doubles the length of the cable (assuming a single field unit fails). If you need to assure operation within specs in the event of power failure to field units, then this consideration must be added. Example: To assure operation within specification when any two consecutive field units lose power, then the maximum length on cable is 9.6 kbps: 6560' (2 km) or 19.2 kbps: 3.3 kft (1 km) per every 4 field units. See Section 3.1.2.3, Network Cable Connection to Host System or Master Station.

Key Specs

- Resistance/1000 ft = 24 AWG (7 x 32)
24 ohms each conductor
(48 ohms for the pair)
- Capacitance/ft = 12.8 pF
(conductor-to-conductor)
- Capacitance/ft = 23 pF
(conductor-to-shield)

Belden 3105A Specifications

Total Cable Length between repeaters or nodes with repeaters:

- @ 9.6 kbps: 11.5 kft (3.5 km)
- @ 19.2 kbps: 5.75 kft (1.7 km)

For loop mode, this is the total length between operating field units. If a field unit loses power, then the relays internal to the field unit connect the A1 channel to the A2 channel, which effectively doubles the length of the cable (assuming a single field unit fails). If you need to assure operation within specs in the event of power failure to field units, then this consideration must be added. Example: To assure operation within specification when any two consecutive field units lose power, then the maximum length on cable is 9.6 kbps: 11.5 kft (3.5km) or 19.2 kbps: 5.75 kft (1.7km) per every 4 field units. See Section 3.1.2.3, Network Cable Connection to Host System or Master Station.

Key Specs

- Resistance/1000 ft = 22 AWG (7 x 30)
14.7 ohms each conductor
(29.4 ohms for the pair)
- Capacitance/ft = 11.0 pF
(conductor-to-conductor)
- Capacitance/ft = 20.0 pF
(conductor-to-shield)

Belden 3074F Specifications

Total Cable Length between repeaters or nodes with repeaters:

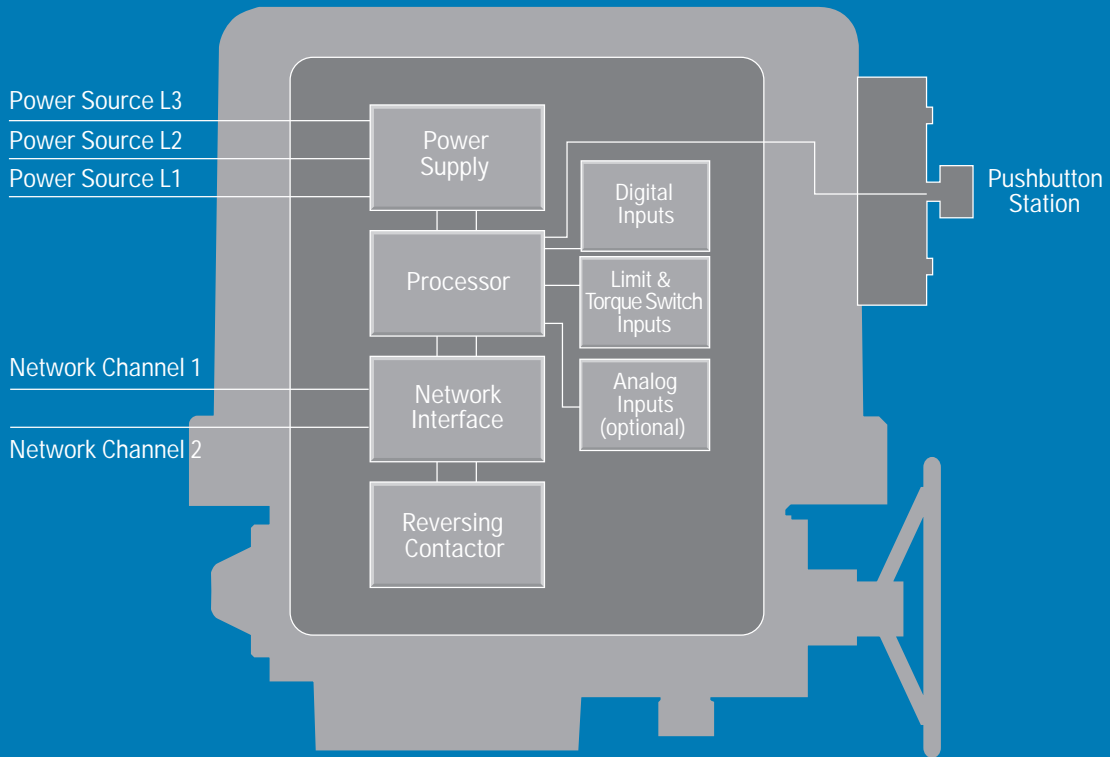
- @ 9.6 kbps: 15 kft: 15 kft (4.5 km)
- @ 19.2 kbps: 7.5 kft (2.2 km)

For loop mode, this is the total length between operating field units. If a field unit loses power, then the relays internal to the field unit connect the A1 channel to the A2 channel, which effectively doubles the length of the cable (assuming a single field unit fails). If you need to assure operation within specs in the event of power failure to field units, then this consideration must be added. Example: To assure operation within specification when any two consecutive field units lose power, then the maximum length on cable is 9.6 kbps: 11.5 kft (3.5 km) or 19.2 kbps: 5.75 kft (1.7 km) per every 4 field units. See Section 3.1.2.3, Network Cable Connection to Host System or Master Station.

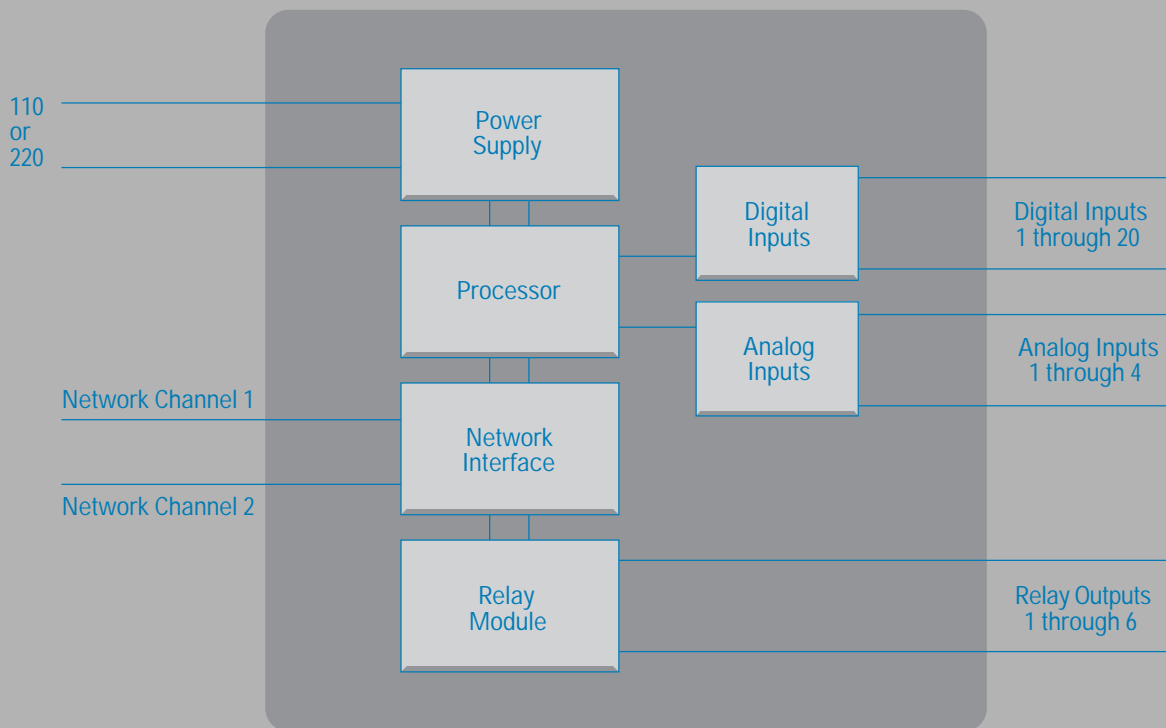
Key Specs

- Resistance/1000 ft = 18 AWG (7x 26)
6.92 ohms each conductor
(13.84 ohms for the pair)
- Capacitance/ft = 14 pF
(conductor-to-conductor)
- Capacitance/ft = 14 pF
(conductor-to-shield)

Modular Actuator Field Unit



Modular I/O Field Unit



Field Units

There are two types of Field Units which are compatible with the DDC-100 System:

- Modular Actuator Field Unit is a modular field unit for the control of Limitorque valve actuators. This field unit mounts inside the enclosure of Limitorque L120 actuators or it can be retrofitted to Limitorque actuators which were provided with other controls.
- I/O Field Unit is a modular field unit intended primarily for the control of valve actuators or other control devices from other manufacturers. The I/O Field Unit is normally provided without an enclosure for maximum flexibility in mounting inside actuator (or other) enclosures. The I/O Field Unit can also be used for other devices which can be controlled by six Form C relays rated up to 250 Vac, 10A.

Modular Actuator

Field Unit features

Control features OPEN-STOP-CLOSE control (network or local pushbutton), Valve position control (option), Industry standard network protocols, Remote or local configuration, Network polling priority, Two-speed valve opening or closing, Network or local ESD (Emergency Shutdown) - configurable action, Selectable CW or CCW to CLOSE, Lockout local operation, Instantaneous reversal protection, Configurable network baud rates, Valve or non-valve service, Torque or position seating and torque profiling (option), Configurable alarm variables and built-in timers, Configurable user inputs.

Field Unit features are summarized in the chart below:

DDC-100 Field Unit Features

Feature	Modular Actuator Field Units	Modular I/O Field
Versions for Modbus or BITBUS	standard	standard
Surge protected network inputs (Note 1)	standard	standard
Opto Isolated User Inputs	standard	standard
Open-Stop-Close valve control	standard	Note 2
Proportional valve control	option	n/a
Local pushbutton control	standard	option
Local configuration	standard	standard
Field Unit configuration over network	standard	standard
Local diagnostic capability	standard	standard
Diagnostics over network	standard	standard
Field Unit status available over network	standard	standard
Actuator status available over network	standard	standard
Selectable CW or CCW to close	standard	n/a
Local ESD (Emerg. Shutdown)	standard	option
Network ESD	standard	option
Selectable ESD action	standard	option
Torque or Position seating	option	n/a
Torque Profiling	option	n/a
Configurable alarm variables	standard	standard
Automatic phase correction	standard	n/a
Loss of phase protection	standard	n/a
Anti-hammer protection	standard	n/a
Jammed valve protection	standard	n/a
Jammed valve retry	standard	n/a
Instantaneous reversal protection	standard	n/a
EMI Field Immunity	standard	standard
Radiated electromagnetic field immunity	standard	standard
Variable Baud Rate	standard	standard

Notes:

1. See general specifications at the end of this bulletin.
2. Implemented using Modbus(05) Force Coil command.

Indication and Alarm Features

- Diagnostic LEDs locally indicate: Power correctly phased, all phases present, operational power, controller reset, network activity—channels A and B
- Network report of actuator status: opened, opening, closed, closing, stopped in mid-travel, continuous valve position (option), open torque switch, close torque switch, local ESD active, digital input status, analog input status, valve-operated manually, actuator in LOCAL mode
- Local indication of actuator status: Open - red LED, Opening - flashing red LED, Closed - green LED, Closing - flashing green LED, Mid-travel - both LEDs (reversed LEDs are available as an option)
- Network report of Alarms and Faults: local STOP activated, actuator motor overtemperature, network channel A or B fault, torque switch faults, valve jammed, failure to energize, failure to deenergize, phase errors, and others. (See Bulletins 440-20013 or 440-20014 for complete list.)

Protection Features

- CCW/CW torque and limit switches
- Instantaneous reversal protection
- Automatic phase correction
- Lost phase protection
- Jammed valve protection and retry
- Selectable action on ESD (Emergency Shutdown) activation
- Anti-hammer protection
- Auto resetting monitor relay for activating alarm devices
- Anti-condensation heater power
- Dual transformer primary fuses
- Control power fuses
- I/O power fuse
- All digital inputs optically isolated
- Network inputs surge protected *
- EMI field immunity *

Power options

- Modular Actuator Field Unit - 115/230 Vac single-phase
- Modular Actuator Field Unit (standard transformer) - 230/380/415/460 Vac three-phase

- Modular Actuator Field Unit (optional transformer) - 525/575 Vac three-phase
 - Modular I/O Field Unit - 115/230 Vac single-phase
- * See Abbreviated General Specifications section for more detail.

Abbreviated General Specifications

Environmental Specifications

- Ambient Operating Temperature (Modular Field Units): -40° C to +85° C
- Ambient Operating Temperature (Master Station): 0° C to +60° C

Electromagnetic Compatibility (Modular Field Units)

The Modular Field Units comply with the emissions immunity requirements set forth by the European Community under the requirements of the EMC Directive (89/336/EEC).

Reference standard includes:

- Emissions - Conducted and radiated emissions per CFR47 and EN 55011 and EN 50081-1 and 2.
- Immunity - Electrostatic discharge (ESD) per IEC 801-2, Level 4 and EN 50082-1 and 2. Susceptibility to field immersion per IEC 801-3 Level 3 (10 V/m from 16 Hz to 2 GHz) and electromagnetic field requirements EN 50082-1 and 2.
- Electrical fast transients - IEC 801-4 Level 3 for power lines and EN 50082-2 for transients.
- Surge immunity - IEC801-5 levels 1-4, EN 50082-2, and ANSI/IEEE C62.41.
- Mains (power) harmonic distortion - MIL-STD-462, method CS01 and CS02 (to 150 kHz).

Vibration and Seismic

Per MIL-STD-167, IEC68-2-6, and IEEE STD 344-1975. Vibration consists of 5-200 Hz sweeps at 0.75g acceleration in three axes and 2-35 Hz sweeps at 1.0g acceleration in three axes. Seismic is 5.0g acceleration from 2 to 35 Hz sine dwells in three axes.

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