80-8801-20

SUPPLEMENT TO MANUALS:

- 80-8801-00
- 80-8801-10
- 80-9000-00

MODEL 88-109

MODBUS INTERFACE

QUICK IMPLEMENTATION GUIDE

C US

ELECTRIC ACTUATORS FOR INDUSTRIAL PROCESS CONTROL

INSTALLATION

PRECAUTIONARY INFORMATION

WARNING

Repeated changes to actuator configuration parameters within a control algorithm may result in process instability and actuator damage.

NOTE: When network security is a concern, the actuator should be placed in write protect mode.

TERMINAL BLOCK ASSIGNMENTS

Terminal Block Assignments		
Terminal	**Common Name**	**Modbus Name**
33	Data+	D1
32	Data-	D0
37	Feedback	Common

RECOMMENDED CABLE

The following cable has been documented as meeting Modbus interface requirements:

- Belden 3106A
- Alpha Wire 6454

TERMINATION AND LINE POLARIZATION

For error-free data exchange, line termination and line polarization (as specified in the Modbus standard) are required. The rules of termination in the Modbus specification are:

- Line termination shall be placed at the two ends of the bus that are the greatest wire-length distance apart.
- Line polarization shall be provided at only one location on the bus, typically near the Modbus client.

INTERFACE SETUP

MODBUS CONFIGURATION INTERFACES

The DCM has two configuration interfaces available for Modbus setup: the Pushbuttons and the Serial port.

Pushbuttons

Two pushbutton combinations are available to reset the Modbus interface to standard and factory defaults (see the “Modbus Defaults Pushbutton Combinations” section).

Serial Port

CAUTION

Changes made to the actuator through Serial communications may not necessarily be reflected in asset management systems. Be sure to verify any changes made Serially and make manual corrections to the asset management system if necessary.

The Serial port interface is accessible by connecting a computer to the DCM using the DB9 connector (see the “SERIAL COMMUNICATIONS” Section, manual 80-8801-10). Basic Modbus Serial commands are listed in the “Communications Configuration Commands” table, manual 80-8801-10.

MODBUS PHYSICAL INTERFACE

Modbus is a Serial digital interface that transmits information over a twisted pair of wires plus a common wire. The electrical interface for Modbus is a 5V level differential signal scheme called RS- 485 (or EIA-485). The Modbus terminology for this interface is Modbus “Two-wire” (2W-MODBUS).

BASIC MODBUS COMMUNICATIONS SETUP

Polling Address

Each actuator on the Modbus network must be assigned a unique polling address. This address is a number that ranges from 1 to 247. There are two ways to configure the polling address:

- Using the Serial command “modpolladdr”.
- Using the Modbus address holding register: *40018*.

Note that address 246 is the default.

Data Rate

The actuator must be set to the same data rate as the control system. Beck Modbus actuators support the following data rates: 300, 600, 1200, 2400, 4800, 9600, 19200 and 38400 bps. There are 2 ways to select the Modbus baudrate:

- Using the Serial command “modbaud” followed by the desired baudrate.
- Using the Modbus baudrate holding register *40016* with the following codes*:*

Code	Baudrate
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6*	19200
7	38400

* default setting

BASIC MODBUS COMMUNICATIONS SETUP *(cont'd)*

Parity

Parity is used as a means of error checking individual Modbus characters. The actuator must be set to the same parity format as the control system.

EVEN, ODD or NO parity is available. Parity can be set through the “modparity” Serial command or the modbus parity register (40017). Both of these options use the following codes:

Code	Parity/Stop Bit
0*	Even Parity/One Stop Bit
1	Odd Parity/One Stop Bit
2	NO Parity/Two Stop Bits
3	NO Parity/One Stop Bit

* default setting

ADDITIONAL MODBUS SETUP SERIAL COMMANDS

In addition to the “modbaud”, “modparity” and “modpolladdr” commands described earlier, there are additional commands available to configure other aspects of the Modbus interface. These additional commands are shown below.

MODENDIAN Command

This command sets byte order for modbus floating point and 32 bit register sets. More information is available in the "Modbus Network Stack Interface Manual for Beck Digital Control Modules" (80-9000-00).

MODSCALING Command

This command sets the scaling factors for scaled integers types. The default value is modscaling 0 where 0–10000 counts represents 0.00% to 100.00%.

MODCONFIG Command

This command takes two arguments. The first argument controls whether Modbus client broadcast messages are ignored. The second argument controls whether the demand status value is forced to “good”.

The default configuration is: **modconfig 1 0: Broadcast messages are accepted. Demand status ignored.**

Configuration Lockdown Serial Command (Write Protect)

When the DCM is placed in configuration lockdown, all attempts to change Modbus configuration parameters will be rejected. Modbus process parameters will still be writable.

The default state of conguration lockdown/write protection is OFF (i.e., writes are allowed).

Conguration lockdown/write protection can be switched on or off using the “wrprot” serial command:

- **wrprot 0**: writes are allowed
- **wrprot 1**: writes are blocked

Network Configuration Serial Command

The Beck DCM has built-in support for multiple communication protocols. In most cases, a DCM will be set at the factory to operate as a Modbus server; however, in some cases when the DCM is setup from scratch, it is necessary to manually turn on the Modbus interface.

The basic Serial command for accomplishing this is the “network” command.

- network 4: (Modbus hardware active)

Modbus Default Settings

Factory and Standard Defaults

When a Modbus actuator ships from the factory, the Modbus interface will be configured to match customer requirements for baudrate, parity and server address. These customer-supplied defaults are stored in the DCM as *factory defaults*.

In the absence of a customer directive, *standard defaults* are stored. Standard Default settings are the same for all DCMs:

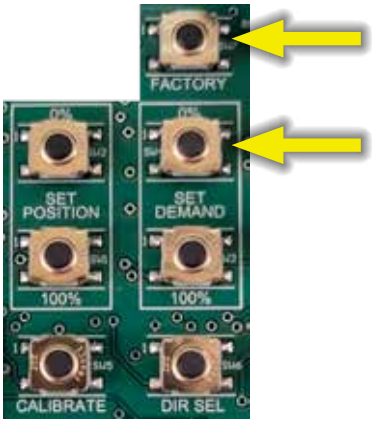
- Server Address: The standard default server address is **246**.
- Baud Rate: The standard default baud rate is **19200**.
- Parity: The standard default parity is **EVEN**.

Modbus Defaults Pushbutton Combinations

Because access to the Serial command port is not always available, the DCM pushbutton interface has been expanded to support resetting Modbus communication parameters to factory or standard default values.

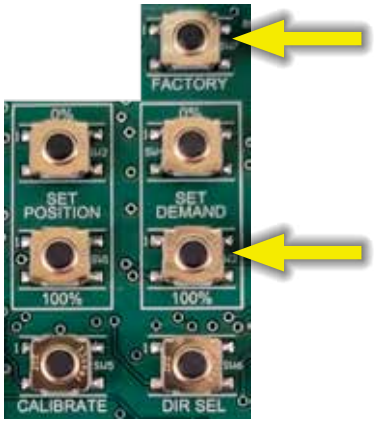
Restore Standard Modbus Defaults: Standard defaults will be restored with the following pushbutton combination:

[FACTORY] + [0% SET DEMAND]



Restore Factory Modbus Defaults: Factory defaults will be restored with the following pushbutton combination:

[FACTORY] + [100% SET DEMAND]



NETWORK ACTIVITY LED

The Modbus Network Activity LED is located on the DCM board. The Network Activity LED blinks only when a Modbus message addressed to the DCM with a proper CRC-16 value is received.

EXAMPLE OF MODBUS PROCESS VARIABLE INTERFACE

The full Modbus Parameter set for Beck Actuators contains hundreds of parameters that cover every aspect of configuration and control. This set is described in the "Modbus Network Stack Interface Manual for Beck Digital Control Modules" (80-9000-00).

The decision of what Modbus parameters are best for a given application is as varied as the applications themselves as well as the fact that some control systems are licensed by the number of Device Signal Tags (DSTs)—which means there is an added cost for each Modbus parameter incorporated.

Since most control systems can function with a minimum group of standardized process variables to be available for cyclic data exchange, this section describes an example of such a minimized setup.

PROCESS VARIABLE REGISTERS

Input Registers	
30008 position_scaled	Type: UNSIGNED_INTEGER The output shaft position expressed in percent of span scaled to the range chosen by the 'scaling_type' parameter.
30009 torque_scaled	Type: UNSIGNED_INTEGER Torque/Thrust: The load Torque/Thrust measured at the output shaft- expressed as percentage of the maximum rated Torque/Thrust scaled to the range chosen by the 'scaling_type' parameter.
30032 ambient_value_degc	Type: INTEGER Ambient Value Degrees C: The ambient temperature in Celsius measured at the DCM circuit board expressed as a single signed 16 bit integer with no scaling.

Holding Registers	
40007 demand_scaled	Type: INTEGER The effective demand value. If in 'HOLD' (Modbus) Mode-editing this value will control the motor set point unless an alarm condition exists. It is expressed in percent of span scaled to the range chosen by the 'scaling_type' parameter.

PROCESS VARIABLE DEFAULT SCALED INTEGER FORMAT

The default Demand, Position and Torque scaled integer format is:

- UNITS: For Demand and Position the number represents the percentage of the actuator configured full number of turns. For Torque, the number represents the percentage of the actuator full rated torque. For temperature, the units is degrees C with no scaling.
- NUMERIC SCALING: For Demand, Position and Torque: The number is a signed integer ranging from 0 to 10,000. This integer represents the percentage multiplied by 100. For example, 5000 equals 50%, 10000 equals 100% and 7525 equals 75.25%. For temperature, the number is the direct degrees C with no scaling (i.e. 55 equals 55C).

PARAMETER MAPS

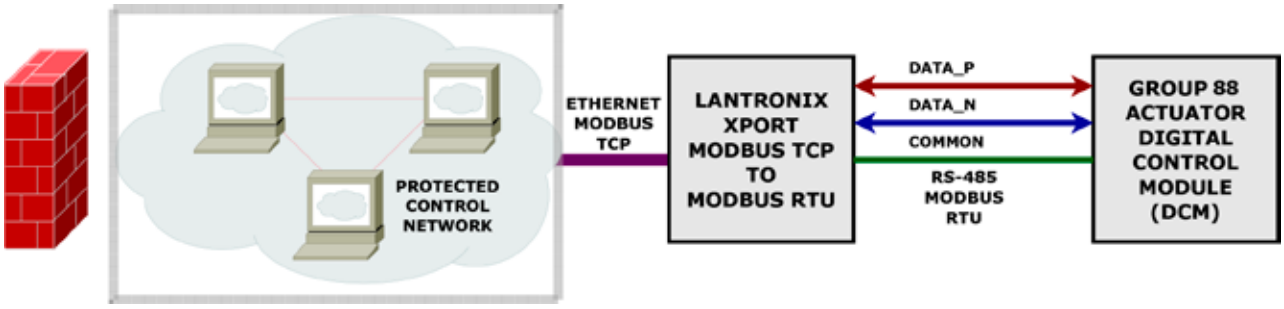
The full Modbus Parameter map is available in the "Modbus Network Stack Interface Manual for Beck Digital Control Modules" (80-9000-00).

OPTIONAL MODBUS TCP

OVERVIEW

Modbus TCP is a version of the Modbus messaging protocol that is transmitted over standard Ethernet (TCP/IP) interfaces.

The Beck Modbus TCP Ethernet Communications Option provides a gateway to modern Ethernet-based control systems for the Group 88 actuator. It converts Modbus TCP Ethernet messages directly to RS-485 Modbus RTU messages which are transmitted directly to the actuator Digital Control Module (DCM).



The Modbus TCP Ethernet Communications Option is available with all Group 88 actuators in two formats:

Modbus TCP Ethernet Terminal Block

The Lantronix xPort device is incorporated directly onto the terminal block with the RJ-45 Ethernet jack on the side of the Lantronix Port.

BECK MODBUS TCP DEVICE INSTALLED ON THE TERMINAL BLOCK

OPTIONAL MODBUS TCP

MODULE SETUP

Setup Overview

WARNING

This product is intended only for use on properly secured and firewall-protected industrial control system networks.

The Beck Modbus TCP module is based on the Lantronix xPort device. Lantronix recommended best practices for secure operation of this device should be reviewed prior to installation: https://cdn.lantronix.com/wp-content/uploads/pdf/Best-Practices-for-IoT-Device-Security.pdf.

The latest Lantronix security notices are available at: https://www.lantronix.com/support/security-updates/.

Setup Overview

The Modbus TCP Ethernet Communications Module must be configured such that:

1. The Modbus RTU side of the module must match the Group 88 actuator configuration.
2. The Modbus Ethernet side of the module must match the control system network.

Standard Module Configuration Defaults

The following table lists standard configuration defaults for Beck Lantronix Modbus-TCP xPort-05 based products:

OPTION	DEFAULT VALUE
IP Address	STATIC IP: 192.168.100.64
Default Gateway	STATIC IP: 192.168.100.1
Netmask	255.255.255.0
Modbus RTU RS-485 Serial Interface	19200,8,E,1,RS485

Modbus RTU Polling Address

The Modbus TCP Ethernet Module default configuration is a pass-through gateway which transmits the underlying Modbus message without modification. Consequently, the polling address field in the message must match that of the target Group 88 actuator.

To simplify control system programming, it is recommended that the default Modbus RTU polling address of **246** be used in all Modbus TCP applications so that the same underlying messages can be used for all actuators in the network.

Mandatory xPort Module Configuration Settings

Each xPort Modbus TCP Module is set at the factory to certain mandatory configuration settings with no changes required by the user.

The xPort module mandatory settings required for proper operation are:

- The serial interface MUST be set for "**RS485**".
- The "Protocol" MUST be configured as "**Modbus/RTU, Server(s) attached**".
- Pin CP1 MUST be configured as "**RS_485 Output Enable, non-inverted**".

Modbus TCP Module Configuration Tools

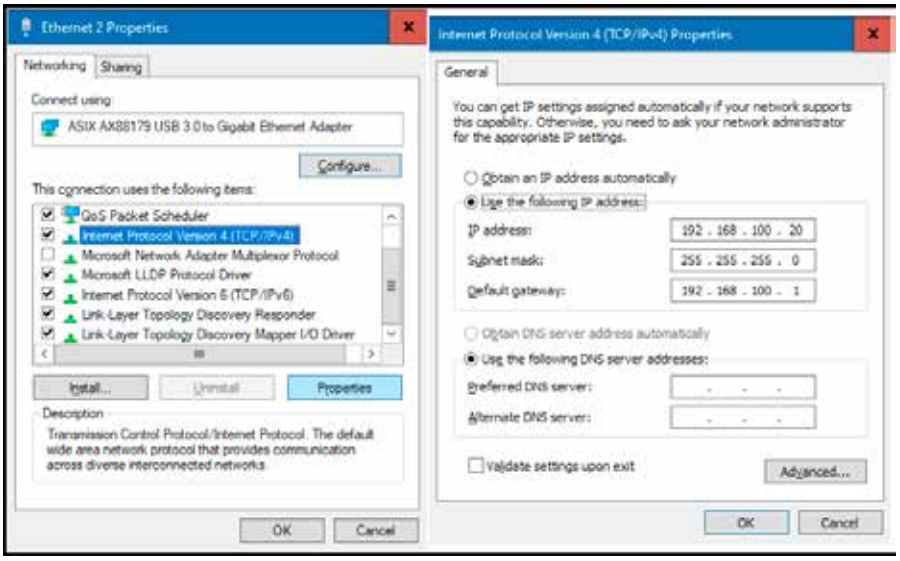
The Lantronix Modbus-TCP xPort-05 is configured using free software and inexpensive hardware.

Hardware: USB-to-Ethernet Communications Adapter

A typical built-in PC Ethernet adapter is configured for the company network and will not be usable to communicate with the Modbus TCP Module. Inexpensive USB-to-Ethernet Communications Adapters can be used for this purpose.

The USB-to-Ethernet adapter settings under Windows should match the default settings of the Modbus TCP Module. It is recommended that the Windows device manager be used to set the interface to an address in the 192.168.100.XX/24 Subnet such as 192.168.100.20. *NOTE: The USB-to-Ethernet adapter must NOT use Address 192.168.100.64 as this is the default Modbus TCP Ethernet Module address*.

The following screenshot shows the IPV4 setup of a USB-to-Ethernet adapter set to address 192.168.100.20:



Software: Configuration Tools

There are two tools available for configuration of the Modbus TCP Ethernet Module, both of which are free:

- **Lantronix deviceInstaller Software**:

  This is a free windows application from Lantronix which is available at: **https://www.lantronix.com/products/deviceinstaller/**

- **Telnet Command**:

  The Telnet command is a standard command line utility provided by all operating systems. The standard Telnet port for the Lantronix xPort is 9999. For a Modbus TCP Ethernet Module at the default address, the correct Telnet command would be "**telnet 192.168.100.64 9999**". *NOTE: The Telnet command may require additional user privileges under Windows.*

DCM Restoration of Modbus RTU RS-485 Serial Default Values

See page 5, "Modbus Default Settings".

TROUBLESHOOTING

Communications Failure Troubleshooting Checklist

The main symptom of a communications failure is when the Modbus controller is transmitting to the actuator, and the Network Activity LED is not blinking. Here are some suggestions to solve this problem:

- Check the communications link for shorts and opens.
- Verify that the terminal connections are correct: Modbus RTU is polarity sensitive. If the data lines are reversed, communications cannot occur. A signal ground connection is mandatory and must be connected to the proper terminal.
- Verify that line termination at both ends of the network is installed. Termination is installed between the DATA+ and DATA- lines. Paragraph 3.4.5 of the Modbus Serial specification suggests that either a 150 Ohm resistor or a 1nF Capacitor in series with a 120 Ohm resistor are appropriate terminations.
- Two Line polarization resistors should be installed at the Modbus controller. Paragraph 3.4.6 of the Modbus Serial specification recommends a value between 450 and 650 Ohms. A 650 Ohm value supports a greater number of devices on the segment.
- Use an appropriate tool such as an oscilloscope to verify correct signal levels at the actuator terminals. The differential voltage between DATA+ and DATA- should be between 1.5V and 6V. Long cable runs may require the use of a repeater.
- Verify that the Actuator baudrate, parity and polling address settings match the Modbus controller settings.
- Verify the actuator DCM is configured for Modbus using the “network” Serial command. The network setting must be four (network 4).
- Verify that the Modbus controller is transmitting frequently enough to the actuator to keep the Network Activity LED blinking. If the controller transmits a Modbus message at a rate of less than every 15 seconds, the Network Activity LED will stop blinking despite the fact that there is nothing wrong with the connection.

Communications Errors Troubleshooting Checklist

Diagnostics built into modern control systems are capable of reporting communications errors, including:

- Message Retries: More than one transmission of a particular request was required for a successful response from the actuator.
- Message Timeouts: A message request was abandoned because the actuator never responded.
- CRC Errors: A message from the actuator contained a CRC value that did not match the Modbus controller calculated value.

Many of the causes of communications failures can contribute to communications errors, so it is a good idea to verify the items in the previous checklist with the emphasis on confirming proper line termination, polarization, signal levels and link settings. Other possible communications error sources are:

- Verify that there is only one Modbus device for each polling address on each communications link. Actuators configured with duplicate polling addresses will interfere with each other.
- Verify that there are no additional line terminators installed other than the two connected at the far ends of the network. Adding a third line terminator may allow some devices to communicate and block others.
- Line polarization is important for error-free communications. A separately powered RS-485 polarization and termination module may be required for control systems with optically isolated RS-485 ports.
- For shielded cable, verify that the shield is connected on only one end to Earth. Connecting both ends can sometimes result in a circulating ground current that can interfere with communications.
- Verify that the parity setting on the actuator matches the setting on the Modbus controller.
- Long communication links can introduce sporadic errors. A repeater may be required to strengthen signal levels to eliminate the errors.
- Verify that there is only one active Modbus client of a given link at one time. Simultaneous client requests cause errors.
- Use of transmission cables not designed for RS-485 can be the cause of communications errors.
- Communication links that pass near sources of strong electromagnetic waves may be susceptible to communications errors. Relocate them to solve the problem.

SERVICES

PRODUCT DEMONSTRATIONS

Each of Beck's Sales Engineers has access to a complete set of actuator models so that he can demonstrate virtually any of their features at your location. In order to arrange to see a Beck actuator in your plant or office, contact Beck's Sales Department.

SITE SURVEYS

Beck Sales Engineers are available to discuss your process control requirements. Often a visit to your location is the best way to gain a thorough understanding of your needs, in order to meet them most accurately and completely.

Mounting hardware, torque requirements, linkage, control signal information, and optional equipment can be analyzed most effectively at the work site. Beck's analysis at the job site can help ensure that specifications are accurate, especially in the case of complex applications.

APPLICATION REVIEWS

By sharing your needs with a Beck Sales Engineer you can take advantage of the best application advice for the type of control you need. This review will yield a better understanding of the versatility of Beck actuators for your installations, as well as complete details on options and accessories to make the process as effective as possible.

SPECIFICATION WRITING

Beck provides specification writing assistance in order to help you specify and order the right actuators for your applications. Beck Sales Engineers will work with you to make it easier for you to obtain the proper equipment and give you confidence that no details are overlooked.

HOW TO OBTAIN SERVICE

Factory repair of actuators or subassemblies is available for both normal and emergency service. To assure prompt processing, contact the factory to receive a Returned Material Authorization (RMA) number. If a repair estimation is desired, please send the name and phone number of your contact for service authorization. It is helpful to include a description of the work desired with the shipment or, in the event of a problem, the malfunction being experienced.

THREE YEAR LIMITED EQUIPMENT WARRANTY

Beck warrants to Buyer that: (i) for a period of 3 years from the date of shipment, the Equipment manufactured by Beck shall materially conform to Beck's published standard specifications in effect as of the date of shipment; and (ii) the Beck Equipment will be free from defects in materials and workmanship. This warranty does not apply to normal wear and tear, or where Beck Equipment failure is a result of improper installation, improper storage, misuse or improper maintenance, or water ingress related to Buyer or its agents failing to apply the stated torque requirements to fasteners when attaching covers or failing to replace temporary conduit plugs as stated in the installation instructions, or entry through conduits.

During the Limited Warranty Period, Buyer shall notify Beck of any alleged warranty claim within 30 days from the date Buyer discovers, or upon reasonable inspection should have discovered, such alleged claim (but in any event prior to the end of the Limited Warranty Period), and Buyer shall return the Beck Equipment in question, at Buyer's expense, to Beck for evaluation, in compliance with the terms stated in the "Return of Equipment" article in the Sales Contract. If Beck determines that the Beck Equipment fails to conform to the limited warranty, then, at Beck's sole discretion and its expense (subject to Buyer's conformity with the warranty), Beck will either: (i) repair or replace the Beck Equipment, without charge, at Beck's factory, or (ii) refund the purchase price of such Beck Equipment, less any applicable discounts, rebates, or credits. In no event will Beck's liability exceed the contract price actually paid for such Beck Equipment subject to a warranty claim. Beck makes no warranty, express or implied, with respect to any Buyout Item. This limited warranty is not transferable or assignable to any transferees of the Beck Equipment.

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