BECKWITH ELECTRIC CO. INC.

BECO2200
Digital Communication Protocol
Revision: 5 Last Modified: 06/05/96

Specifications presented herein are thought to be accurate at the time of publication but are subject to change without notice

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1. Introduction and Scope

A number of protective relays and controls developed by Beckwith Electric for its integrated protection systems and volt/VAr management controls incorporate a digital communications interface. These systems and controls are collectively designated as intelligent electronic devices (IEDs). The digital communications interface permits connection of the IEDs to RTUs, PLCs, data concentrators, SCADA or other computer systems for on-line data acquisition and control. Generally, all the data and control functions which are available to an operator using an integral human-machine interface or PC/Palm device connected to the IED programming port are available using the SCADA/control interface port supported by this document.

This document supports the BECO 2200 protocol.

This protocol operates on databases that are unique for each particular IED. A separate document, oriented toward a specific IED, lists the data points, control points, data scaling and communications particulars for each IED. These documents may support one or more protocols.

2. Electrical and Mechanical Interface

The protocol implements full-duplex*, serial, byte-oriented, asynchronous communications. A number of physical interfaces are appropriate for use with this protocol, and may be selected based on other criteria. Accessory equipment to implement several interface standards, such as fiber optic, is available from Beckwith Electric.

* While the protocol supports full-duplex operation, Beckwith Electric controls only implement half-duplex operation.

3. Data Communications Protocol

3.1 General Description

The communications facility of controls using this protocol assumes the SLAVE role of a MASTER/SLAVE SYSTEM. That is, all communications to and from the control are initiated and controlled by the host system connected to it. Error-handling is the responsibility of the host system.

Each command to the control includes a control address. Using the addressability feature, controls may be applied in ring, multi-drop, or other party-line systems in which a single master serves a number of slaves. Provisions are made for "broadcast" and "wild-card" addresses, where system characteristics make them desirable. Controls can also be addressed on a group basis.

Data is structured and addressed as several sets of "points" of different "types." There may be, for a given device, up to 15 different point types, and up to 256 different points of each type, for a total of 3840 points. Each point consists of a 2-byte (16-bit) data word with pre-defined format or scaling. Individual points may be either read-only or read/write, or read/resettable, and each "type" and "point" is uniquely defined for a particular model of control.

The following paragraphs define general communication format and protocol. Specific point definitions for each control or instrumentation device are defined in separate specifications for each device. Other restriction may apply, consult the controls specific document for further information.

This communication interface is patterned after the Cooper Power Systems Digital Communication Protocol Data 2200 revision 1. No attempt was made to be completely compatible with Cooper's implementation.

3.2 Character format.

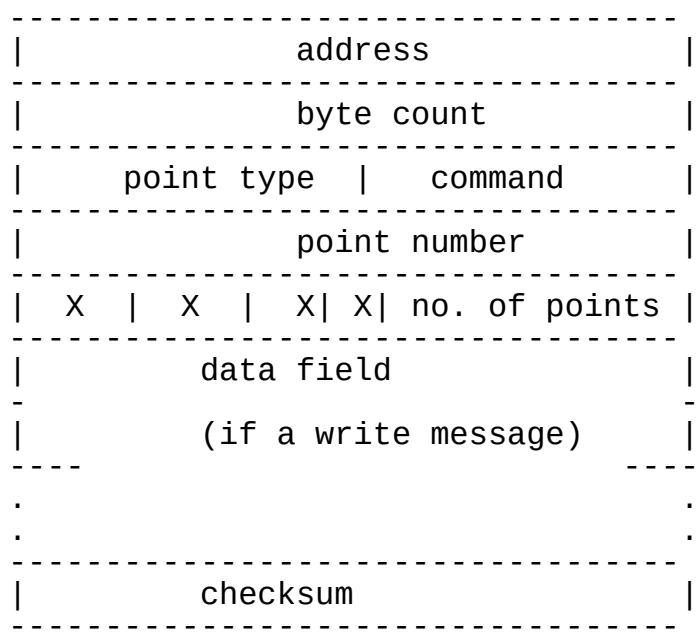
All communications is asynchronous, by character (byte). Each character consists of

start bit
8 data bits, least significant first
parity bit, for even parity*
one stop bit

When two-byte data words are transmitted, the most significant (Hi-order) byte is transmitted first.*

3.3 Receive message format

The received data message is a variable-length byte string of format as follows:



*Certain relays have this byte ordering reversed. Also some controls do not support parity. See Communications Points document for individual control.

where:

address:
The address of the control to which the message is directed. Integers 1-200 are valid individual addresses. Integer 255 is the "broadcast" address. All controls execute broadcast commands, but do not sent a response message. Integer zero is the "wildcard" address. A control responds to a wildcard address as though it were the control's own unique address. Integers 201-254 is the device type, group address range. The group address is dependent upon the device type. The device type is unique to a particular line of controls developed by Beckwith Electric Co. For example, the M-0420 multifunction relay may be device type 25, if so, its group address would be 255-25=230. Any message set to address 230 causes all connected M-0420 controls to listen and change as commanded, with no response. This capability allows regulator, recloser, protective relays and future Beckwith Electric Co. controls to be connected on the same communication loop from the RTU and each "group" of devices can be selected by a single message.

byte count:
excluding the The number of bytes in the message, including the byte-count, but address.

point type:
An integer from 0 to 14, identifying the point type referenced by the command. Point types may be different and uniquely defined for each control model. Type 15 may not be used.

command code:
The operation to be performed in response to this message. Command codes are listed and defined in table 3.3-1.

point number:
An integer from 0 to 255, identifying the first point number of the selected type to be operated on by this message.

no.of points:
The number of points to be operated on by this message. This value may not be zero, and may not be greater than 15.

data field:
Data input, if this is a WRITE message. Two bytes per point to be written. Negative numbers are expressed in two's complement form.

checksum:
The two's complement of the modulo-256 sum of all the other bytes in the message. (i.e., the number which causes the least significant byte of the sum of all the bytes of this message to be zero).

Table 3.3-1 Command Code Definition

Code	Operation
0	Read. Return the numerical values of <no. of points> points, of point type <point type>, beginning with point <point number>.
1	Write. Set the values of <no. of points> consecutive points, of point type <point type>, beginning with point <point number>, to the values contained in the data section of this message.
2	Point reset. Reset the value of point <point number> of point type <point type>, to its reset value. This value is uniquely defined for each point, which is resettable. See the appropriate individual control point specification. For a reset command message, <no. of points> should be set equal to one. Reset of multiple points with one command is permitted only through the Master reset facility.
3	Master reset. Reset the values of all master-resettable points of point type <point type> to their respective reset values. The points, which are master-resettable, and the values to which they are reset, are uniquely defined for each device. The <point number> specifications for master reset command is not meaningful, and should be set to zero.
4	Reserved for factory use only.
6-15	Reserved for future implementation. Presently results in "invalid command" error response.

3.4 Transit message formats

When a control receives a properly formatted message with valid parity, checksum, and byte count, and when the received message contains the control's unique address or the wildcard address, the control executes the command and assembles and transmits a return message.

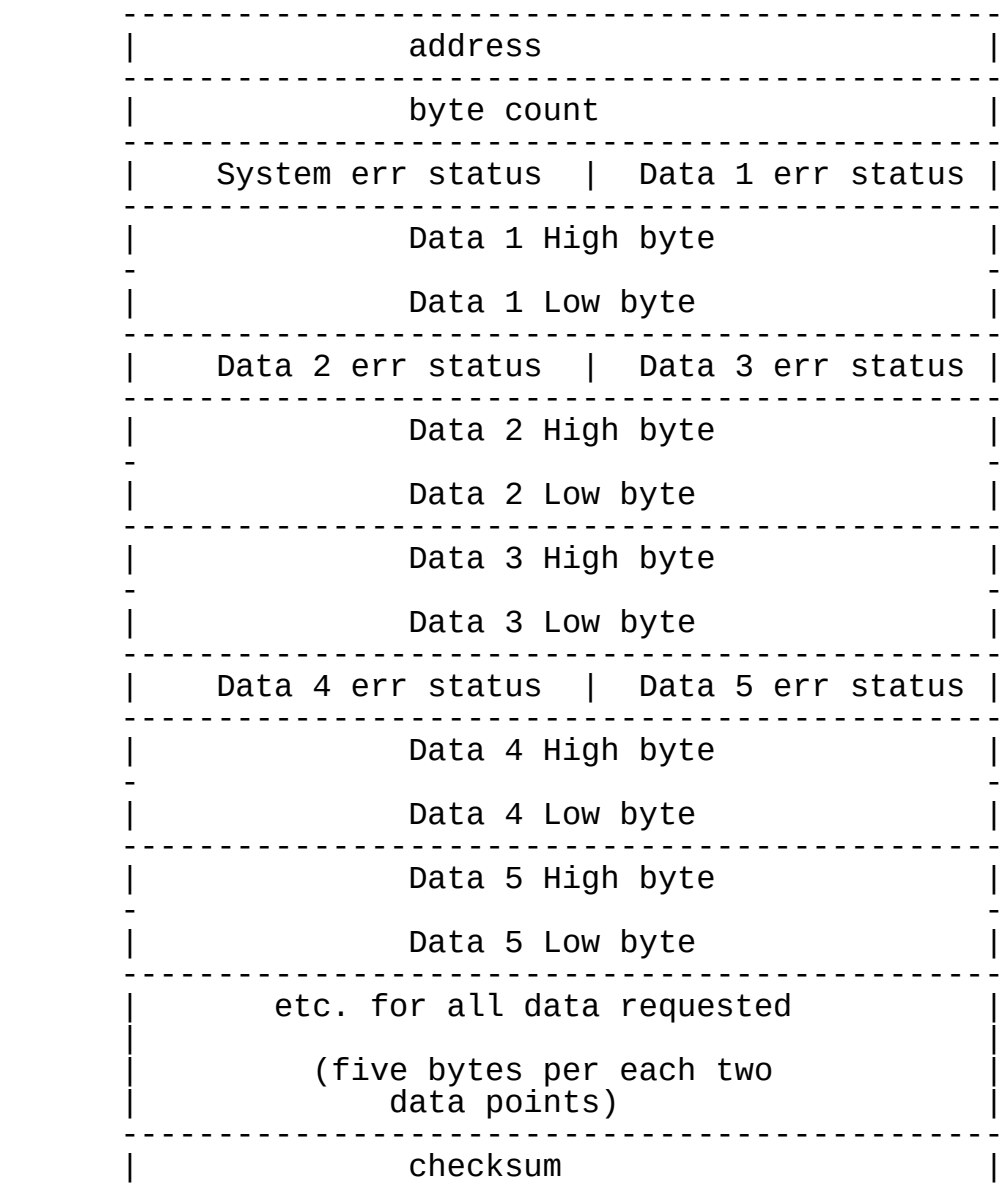
When a message with the broadcast address is received, and the message is properly formatted with valid parity, checksum, and byte count, the control executes the command, but does not send a return message.

When a control receives a message not addressed to it, or when the message has format, parity, checksum, or byte count errors, the control ignores the message and does not respond.

The structure of the transmitted message varies with the type of command that caused the message to be transmitted, as defined below.

3.4.1 Read-response message format

The response to a READ DATA message is a variable-length byte string of format as allows:



where:

address:
An echo of the received address, used to indicate to the master which device is responding.

byte count:
The number of bytes in the message, including the byte-count, but excluding the address.

system error status:
The error status for the system and prior received message. System error codes are defined in table 3.4-1.

Data error status:
The error status for the specific data point referred to. Data error codes are defined in table 3.4-2. If the total number of points requested is even, then the error status for the unused position should be ignored by the receiving system.

checksum:
The two's complement of the modulo-256 sum of all the other bytes in the message. (i.e., the number which causes the least significant byte of the sum of all the bytes in the message to be zero).

Table 3.4-1 System Error Status Code Definition

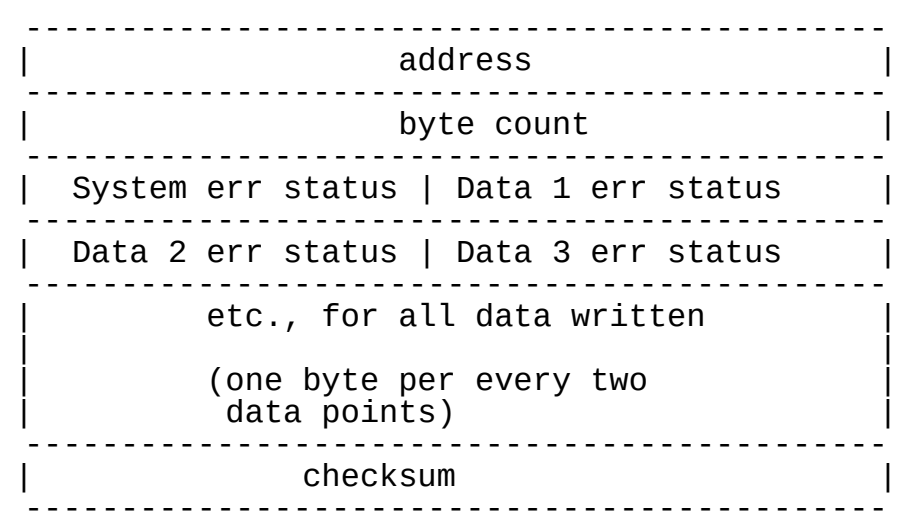
	code	System Error Status
	0	OK. no errors.
	1	Control in local mode. The hierarchy gives priority to front-panel local operation. Local control has been established, and control by remote communication is prohibited.
	2	Reserved
	3	Reserved
	4	Reserved
	5	Reserved
*	6	Communication locked. Communication channel is password protected, access was attempted with communication port locked.
	7	Invalid point type. The point type specified in the previous message is not defined for this device.
*	8	Invalid command in received message. The command specified in the previous message is not defined for this device, or type.
	9	Invalid point number. A point number specified in the previous message does not exist, or the command specified has no meaning for the specified point.
	10	Invalid number of points specified in received message.
	11	Mechanism operation error. Mechanism does not respond to prior operating command.
	12-15	Reserved for future implementation.

Note: If more than one system error condition prevails on a single transmission, then the error code transmitted will be the first error encountered by the receiving device.

* See 4.0

3.4.2 Write-response message format

The response to a WRITE DATA message is a variable-length byte string of format as follows:



where:

address:
An echo of the received address, used to indicate to the master which device is responding.

byte count:
The number of bytes in the message, including the byte-count, but excluding the address.

system error status:
The error status for the system and prior received message. System error codes are defined in table 3.4-1.

Data error status:
The error status for the specific data point referred to. Data error codes are defined in table 3.4-2. If the total number of points written is even, then the data error status for the unused position should be ignored by the receiving system.

Checksum:
The two's complement of the modulo-256 sum of all the other bytes in the message. (i.e., the number which causes the least significant byte of the sum of all the bytes in the message to be zero).

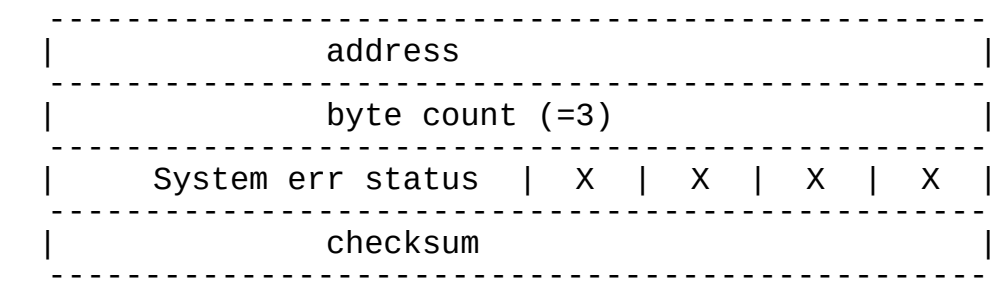
Table 3.4-2 Data Error Status Code Definition

	code	Data Error status
	0	OK. No errors.
	1	Default Data. This data point is set to a default value. If the point was previously set by local or communications control, then that set data has been lost.
	2	Invalid Data. The requested data is not valid due to an internal condition of the control.
	3	Invalid and default. This code identifies the presence of both errors 1 and 2.
*	4	Wrong value increment. Data for the write command is not of the proper increment.
	5	Value too large. Data for the write command is outside the allowable range of values.
	6	Value too small. Data for the write command is outside the allowable range of values.
*	7	Point not used. The point requested is not used at present. If more than one not used point is called for in a multi-point read command, then the read response returns this error code for each not used point along with a zeroed data field.
	8-15	Reserved for future implementation.

* See 4.0

3.4.3 Reset-response and Error-response message format

The response to a POINT RESET or to a MASTER RESET, and to a message received with an error in it, are all of a fixed-length format as follows:



where:

address:
An echo of the received address, used to indicate to the master which device is responding.

byte count:
The number of bytes in the message, including the byte-count, but excluding the address. For this case, always equals three.

system error status:
The error status for the system and prior received message. System error codes are defined in table 3.4-1.

checksum:
The two's complement of the modulo-256 sum of all the other bytes in the message. (i.e., the number which causes the least significant byte of the sum of all the bytes in the message to be zero).

4.0 Certain functions may be implemented slightly different or not used in Cooper Power Systems protocol definition.