OPTROL PROTOCOL EMULATION

1.1 GENERAL DESCRIPTION

This section briefly describes the Applied Automation OPTROL® 3600communication protocol for reference purposes only. The appropriate Applied Automation documentation should be consulted for complete details of the OPTROL protocol.

The Applied Automation OPTROL® 3600 protocol is a bit synchronous protocol. Each S message block is either 28 or 44 bits in length. Multiple messages may be sent sequentially by a remote to complete a response message exchange. The protocol may be used in a point to point environment or a multidrop configuration. The protocol may be used in either a full or half duplex operation. Communications security is provided by sync bit checking and a 7-bit Bose'-Chaudhuri (BCH) error code.

All communication exchanges in OPTROL protocol are initiated by the host. The remote cannot initiate any exchange with the host nor can the remote directly address or communicate with another remote. The remote transmits a response to the host for all valid messages sent by the host and addressed to the remote. The remote will not respond to any messages not containing a valid sync bit or BCH.

All message blocks from either the host to the remote or from the remote to the host are either 28 or 44 bits long depending on whether or not the message contains a data field. Responses from the remote are one or more message blocks constituting a single remote response.

Figure F-1 OPTROL Message Format

A typical OPTROL message exchange between a host computer and the Comm-Troller is shown below.

The sync field is always a fixed pattern and is further described in Section 1.4.1. The 'V' field is a 3-bit Op Code for master to remote transmissions and a 3 bit Device Status field in remote to master transmissions. The op codes and their meanings are described in Section 1.2 below. The Device Status bits are defined in Section 1.3. The U field is a 5-bit Unit Address which specifies one of up to 31 possible RTUs on a line. The request message channel and point fields are 4-bit binary numbers which define the OPTROL channel/point address to be used. The data field, if included is 16 bits in length. The data field contains the bit pattern which will be stored at the specified channel/point in the case of a write command (op codes 0,1 or 2) or the data read from the specified channel/point in the case of a read command (op codes 4 or 5). The last 7 bits of all message blocks are always the BCH code.

Figure F-2 Typical Message Transaction

Figure A-3 Command Message

Op Code	Description	Implemented
0	Write/No Echo	Y
1	Write/Echo	Y
2	Write/Readl	Y
3	Test	Y
4	Read	Y
5	Streamt	Y
6	Block	N
7	Not Assigned	N

Figure F-4 OPTROL Op Codes

1.2 MESSAGE TYPES

The OPTROL protocol as implemented on the Comm-Troller provides for 4 message exchange types using 8 op codes (0-7). These types are Write, Test, Read and Data Streaming. The Block function code is not implemented. Figures A-1 thru A-3 illustrate the basic message formats.

The Write message exchange is used to control both analog and digital outputs of the RTU. There are three different types of Write commands. A Write/No Echo command causes the 16 bit value stored in the Data Field to be stored in the specified channel/point. There is no response to the master for this command. A Write/Echo command causes the 16 bit value stored in the Data Field to be stored in the specified channel/point and a response returned to the host which contains the Status Bit field plus an exho of the Unit, Channel and Point fields. The host can determine from the status field if any errors were detected which could have inhibited the control action. A Write/Read command works like the Write/Echo command except that a copy of the data is returned as well.

The Test message is used to verify or test the communications channel. The test message is merely echoed back to the host as received except for the substitution of the status bits in place of the op code field.

The Read command is used to read a single 16-bit data value from the specified channel/point.

The Stream command is used to request the value of multiple channel/points inputs. The Stream op code requires the Comm-Troller to return data from each available point between the channels designated in the channel address and point address feilds of the received message. The channel address is interpreted as the starting channel address and the point addres is interpreted as the ending channel. The starting point number is always 0 and the ending point number is always F. The remote responds with a sequential stream of data blocks until all the data requested has been transmitted.

1.3 DATA ADDRESSING

The OPTROL protocol provides the capability to directly address any measurement point in the system or to stream classes of data. The point address capability is arranged as a matrix of 15 channels with up to 16 points per channel. All channels contain 16 points each excopt for analog channels which have only 8 points each. The assignment of data types to channel numbers is variable and defined by the user by entering the starting channel/point number for each data type in the Comm-Troller Configuration Table Header as detailed in Section xxxx It should be noted that each point of either digital status inputs or digital control outputs contains 16 data points.

All commands use the channel and point numbers to directly address the desired data. Data streaming requests use the start channel, stop channel to address a series of sequential points.

1.4 MESSAGE SECURITY

The OPTROL 3600 protocol provides message security checks through the use of sync bits and a Bose'-Chaudhuri (BCH) cyclic error code. The OPTROL message security provides error detection but no error correction.

1.4.1 Sync Field

The 4-bit Sync Field indicates the start of all message blocks. It is itentical regardless of the direction of transmission. That is the Master to Remote Sync field is identical to the Remote to Master Sync Field. The Sync field consists of three level changes on the serial line. The first change is from the inactive (mark) condition to the active (space) condition. The line stays in the space condition for 1.5 bit times. The line then returns to the mark condition for 1.5 bit times. The final transition is back to a space condition for 1 bit time. The Comm-Troller times the line transitions at the beginning of each message block to determine if a valid sync condition exists. If the sync field is valid then the remainder of the data is clocked in. If the sync field is invalid the Comm-troller returns to the wait for sync state.

1.4.2 Bose'-Chaudhuri Calculation

OPTROL 3600 utilizes a Bose'-Chaudhuri (BCH) cyclic error detection code for message security. The basic information content of a message is either 8 or 16 bits and the error detecting code is 7 bits. This 7-bit error detection code is the remainder resulting from dividing the data bits of message information by the primitive polynomial x7 + x3 + 1. This 7-bit remainder is added to the end of each message block form the complete message. The receiving entity divides all the bits following the sync field including the BCH remainder by the same primitive polynomial. If this remainder is zero then no detectable errors have occurred. If the remainder is non-zero an error in transmission has occurred and the message is discarded.

1.5 OPTROL CONFIGURATION TABLE

The OPTROL configuration table layout is shown in the following tables.

BYTE	DESCRIPTION
0	RTU Number
1	Number of PLC's
2,3	Not Used
4	Baud Rate
5	Not Used
6	Not Used
7	Must be 01_{Hex}
8-14	Not Used (Set to 00_{Hex})
15	Swap Enable Flag (1=enable)
16,17	RTS/CTS Delay Time (6.3uS/Count)
18,29	Not Used
30-43	Starting Channel/Point definitions
	for each Comm-Troller Data Type
44-49	Not Used

Figure F-5 Configuration Header

BYTE	DESCRIPTION
0	PLC Address
1	# Bytes per Discrete Input Card
2	# Discrete Input Cards
3,4	Start Address Discrete Input Cards
5	# Bytes per Analog Input
6	# Analog Inputs
7,8	Start Address Analog Inputs
9	# Bytes per Accumulator Input
10	# Accumulator Inputs
11,12	Start Address Accumulator Inputs
13	# Bytes per Discrete Output Card
14	# Discrete Output Cards
15,16	Start Address Discrete Output Cards
17	# Bytes per Analog Output Card
18	# Analog Output Cards
19,20	Start Address Analog Outputs

Figure F-6 PLC Data Configuration

1.5.1 OPTROL 3600 Configuration Header

The Remote Unit Number to which the Comm-Troller will respond when communicating with the OPTROL host is defined by the first byte (byte #0) in the configuration header section. This entry is a 5-bit binary number which is right justified in the byte. The valid range for this number is from 0 to 31 (00000000 to 00011111).

The number of PLCs in the system is defined by byte #1. This entry is a 4 bit binary number which is right justified in the byte. The valid range for this number is from 1 to 8 (00000001 to 00001000). This number is used to determine the number of Data Configuration Blocks to read.

Bytes #2 and 3 are reserved for use as a Radio Delay Timer. The current implementation of the OPTROL protocol in the Comm-Troller ignores these bytes.

Byte #4 is used to define the baud rate which will be used while communicating to the RDACS Host. This entry is a binary number which is right justified in the byte. Valid selections are: 300 baud (00000100), 600 baud (00000101), 1200 baud (00000110) and 2400 baud (00001000)

Bytes #5 and 6 are reserved for use in other Comm-Troller implementation and are ignored.

Bytes #7 and 8 are

Byte #9 is used

Bytes #10, 11, 12 and 13 are

Bytes to 14 are not used and should be set to zero.

Byte 15 is a "Swap Enable Flag". If this byte is non-zero any failure detected by the Comm-Troller while communicating with the PLC will result in an automatic switch-over to a backup PLC. The backup PLC address must be address $0B_{HEX}$. If the backup PLC subsequently fails the Comm-Troller will attempt to switch back to the primary unit. If this byte is a zero then a switch will not be attempted.

Bytes 16 and 17 are used to define the modem RTS/CTS delay time. The timer value is equal to the binary count stored in bytes 16 and 17 times 6.313 uSec.

Bytes 18 thru 29 are not used and should be set to zero

Bytes 30 thru 43 are used to define the starting Channel and Point number for each data type. Byte 30 is used to define the starting channel/point for data type 0 (status inputs), byte 31 for data type 1 (analog input) and so on up to data type 13. The OPTROL protocol only uses data types 0 thru 4. The other data types are undefined. Set their starting channel./point definition to 0. The high order four bits (nibble) is the starting channel number. The low order four bits are used to define the starting point. Thus if analog inputs are to be assigned to channel 5 starting at point 0 then byte 31 would be set to 50_{Hex}.

1.5.2 PLC Data Configuration for OPTROL Protocol

The PLC Data Configuration section(s) are each 57 bytes long. There is one table required for each PLC connected to the Comm-Troller. Up to 8 PLCs can be connected to each Comm-Troller. The number of sections to read is defined by byte #1 in the header section.

Byte #0 is used to define the address of the PLC on the data highway. This address will be used to read the data as defined by the remaining bytes in the Configuration table.

Byte #1 is used to define the number of bytes of data for each status input point. This byte must be set to 2 (00000010) for this application. The OPTROL protocol sets the number of points per status input point to 16. The Comm-Troller assigns the first status input word to the starting channel and point as defined in the header section (byte offset 30). The next status point is assigned to the next point. This assignment continues until point number F is assigned. The next status input point is assigned to the next channel point 0.

Byte #2 is used to define the number of status input points assigned to this PLC.

Bytes #3 and 4 define the starting address in the PLC for the status input data. The data contained in bytes 3 and 4 will be inserted exactly as read in the address portion of the read data command when the PLC is polled for data.

Byte #5 is used to define the number of bytes of data for each analog input point. It must be set to 2 (00000010) for this application. The OPTROL protocol sets the number of bits of data for each analog input channel to 16. The Comm-Troller forms the response by reading two bytes for each analog input point. The bytes will be read most significant byte first.

Byte #6 defines the number of analog input points assigned to this PLC. The first point is assigned to the starting channel and point number defined the the header section. The second as the next point 1 and so on. This progression continues up to point 7. The next analog input point is assigned to the next channel point 0.

Bytes #7 and 8 define the starting address for the analog input data. Since all the data for all data types within a PLC is read with a single poll request, this address must be exactly equal to the starting address of the status input channels plus 2 times the number of status input channels. That is, the data must be contiguous.

Byte #9 defines the number of bytes of data for each accumulator input channel. It must be set to 2 (00000010) for this application. The first accumulator point is assigned to the starting channel/point number. The next accumulator is assigned to the next point and so on up to channel 15 (F). The next accumulator is assigned to the next channel point 0.

Byte #10 defines the number of accumulator input channels.

Bytes #11 and 12 define the start address of the accumulator input data. Since the data must be contiguous this address must be exactly equal to the start address of the analog inputs plus 2 times the number of analog inputs.

Byte #13 defines the number of bytes of data for each digital output point. For the OPTROL application byte #13 must be set to 2 (00000010).

Byte #14 defines the number of digital output points. There are 16 control outputs per OPTROL output point. The first digital output point is assigned to the starting channel/point as defined in the header at byte offset 33. The next output will be assigned to the next point until point number 15 has been assigned. The next output point will be assigned to the next channel point 0. The control output word received from the host is written to the Allen-Bradley exactly as received.

Bytes #15 and 16 define the start address of the control output channels. Since the data must be contiguous this address must be exactly equal to the start address of the accumulator inputs plus 4 times the number of accumulator inputs.

Byte #17 defines the number of bytes of data for each analog output (setpoint) channel. For the OPTROL application byte #17 must be set to 2 (00000010).

Byte #18 defines the number of analog output points defined for this PLC. The first analog output point will be assigned to the starting channel/point number as defined in the header at byte offset 34. The next analog output will be assigned the the next point until point number 15 (F) has been assigned. The next point will be assigned to the next channel point 0.

Bytes #19 and 20 define the start address of the setpoint data. Since the data must be contiguous this address must be exactly equal to the start address of the control output channel plus 2 times the number of control outputs.

Bytes #21 thru 56 are not used in the OPTROL Comm-Troller. Set all bytes to zero.

1.6 JUMPER SELECTIONS FOR OPTROL PROTOCOL

The Comm-Troller jumper selections and EPROM selections for OPTROL 3600 operation is detailed in the following figure.

JUMPER	POSITION	JUMPER	POSITION
J2	1-2	J10	1-3, 11,13
J3	1-2	J11	1-2
J4	NOT USED	J12	1-2
J5	NOT USED	J13	1-2
J6	1-2	J14	1-2
J7	1-2	J15	1-2
J8	1-2	J16	1-2
J9	1-2	J17	1-2

Figure F-8 Jumper Selections for OPTROL

OPTROL Protocol Communication in on Port P3 (bototom port), Allen-Bradley Communication is on Port P2 (center port).
U13 = #169-001-0
U16 = #169-002-0

Figure F-7 OPTROL EPROM Part Numbers

1.7 EXAMPLE CONFIGURATION FILE

The following figures detail a sample configuration file for a typical OPTROL protocol application. The configuration information is based on the following information:

Protocol	OPTROL 3600
PLC Type	PLC-5/15
Comm. Data	Leased Line, 600 baud
Num. of PLCs	One
Num. of Status Inputs	32 Start Channel 5 Pt. 0
Num. of Analog Inputs	8 Start Channel 1 Pt. 0
Num. of Accums.	2 Start Channel 3 Pt. 0
Num. of Controls	16 Start Channel 4 Pt. 0
Num. of Setpoints	4 Start Channel 2 Pt. 0
Desired location of configuration table at word 0_{10}	
Desired starting location of data at word 59_{10}	
Desired location for Config. Table address Pointer 128_{10}	
Allen-Bradley RS232 Interface module address is 11_{8}	

Figure A-9 Example System Info.

1.7.1 Comm-Troller Switch Settings

The location of the word which points to the start of the configuration table must be specified by setting the three (3) address selection switches on the Comm-Troller. For this example the switch selections are:

Pointer Address = 128_{10} (decimal word address)

= 256_{10} (decimal byte address)

= 100_{H} (hex byte address)

Set Comm-Troller switches to 010 (least significant 0 is implied)

1.7.2 Example Table Entries

PLC WORD	
128	0000
000	0C01
001	0000
002	0500
003	0001
004-014	
015	5010
016	3040
017	2000
018-024	

Figure F-10 Example OPTROL Header

PLC WORD	
025	0A02
026	0200
027	7602
028	0800
029	7A02
030	0200
031	8A02
032	0100
033	8E02
034	0400
035	9000
036-052	
053	00XX

Figure F-11 Example OPTROL Data Table