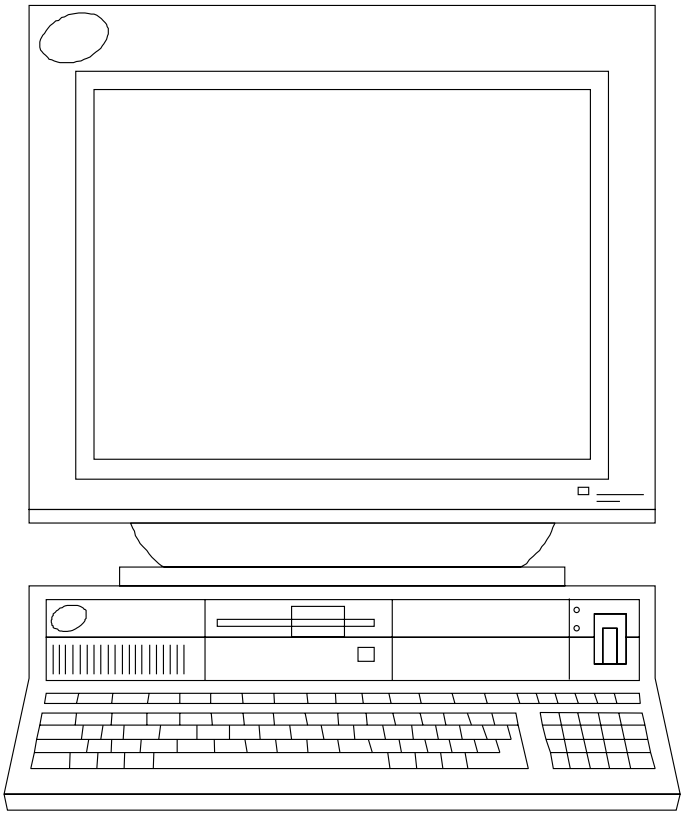
COMMUNICATIONS PROTOCOL FOR MICROBASED INSTRUMENTS

RS-485



Description
Specifications
Application Notes

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QUALITY INSTRUMENTATION DESIGNED & MANUFACTURED IN THE USA

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General - 1

1.1

RS-485 communications is an option that can be provided on the MIC 2000, 6000, 8000, and 8200, and MRC 7000, 7700, and 7800 microbased instruments. The communications option allows an instrument to be connected in a network monitored or controlled by a supervisory computer. In a typical network the supervisory computer would be able to communicate with any instrument in the network, one at a time, to interrogate its status, change its status, retrieve parameter values, or change parameter values.

1.2

RS-485 refers to the electrical characteristics of the communications line or link. Compared to RS-232, it allows for communications over longer distances and can be used in a multi-drop network, where many units can communicate over common lines. Compared to RS-422, it does not limit the system to a single driver / multiple receiver architecture. It allows multiple transmitters and receivers to operate over a two-wire bus. However, the term RS-422 has been used in the industry where the network is actually RS-485. The Partlow communications option allows up to 32 instruments to be networked on a single RS-485 hardware loop. With the use of repeaters, this can be extended to 100 instruments on a single comm port. Only one unit can be transmitting at any given time. When that unit, be it an instrument or supervisory computer, completes its transmission, it will disable its transmitter and allow another unit to transmit on the common lines. Isolation, if required, must be accomplished with hardware external to the instrument.

1.3

“Master” or “slave” status, as used herein, refers to the units status with respect to the protocol, and not to who is transmitting or receiving on the line. The terms “sender” and “receiver” refer to who is transmitting or receiving data respectively.

1.4

Each instrument must have the communications parameters, which are accessed via the Program Mode, appropriately set for proper operation. The parameters specify whether the communications is enabled, and if so, whether the supervisory computer can only retrieve information from the instrument, or change status and parameters as well. If communications is selected, the instruments address and the network data transmission rate must be specified.

1.5

The data transmission rates, specified in bits per second, which is bits of data per second, are listed in Section 2.0. The address is a two digit number allowing up to 100 units in the network. The instrument address must be unique when used in a multi-drop system. MRC 7000, 7700, and 7800 instruments, which have more than one pen or controller, will have two addresses and each pen will be considered a separate instrument for communications purposes. Instruments will only respond when addressed and when in the Off, Operate, Control, Stand-By, Tune, or Alarm Set modes, or when executing a profile.

1.6

All communications with the instruments are initiated by the supervisory computer and the protocol used corresponds to ANSI-X3.28, revision 1976, subcategories 2.5 and A4. This corresponds to prescribed message formats operating in a half-duplex mode.

There are two sequences associated with this protocol:

1. Polling Sequence - Supervisory computer requires information from an instrument.
2. Selection Sequence - Supervisory computer wishes to send new data to an instrument.

The protocol defines the standard control procedures to perform the communication functions necessary for:

1. Establish Connection - Clear line, address instrument, and if data request, a command/ parameter code.
2. Message Transfer - Data read - data from instrument. Data write - data to instrument
3. Terminate Connection - Clear line.

1.7

Beyond adherence to any protocol specification, the data transferred is dependent on the manufacturer and also the particular instrument. For example, a MIC 2000 will not process commands which are unique to the profiling capability of a MIC 6000. However, adherence to a common protocol specification makes it easier for conversion from one manufacturer to another, which uses the same protocol, and will allow various manufacturer's equipment to be connected into the same network.

1.8

Partlow's "Standard Communications" option provides access to parameters and values that we felt would suffice for the vast majority of applications. Even with this "limited" accessibility, status and some fifty parameters and values can be read, modes changed and some thirty parameters and values modified, and profile data can be sent and received on profiling units.

In conjunction with some applicatins where about one hundred instruments were used, customers desired the ability to retreive all parameters, store them in the computer, and if and instrumet was replaced, down-load all data to the new instrument. We took this a bit further, providing the ability to up-load and down-load the order matrix number and calibraiton data, hence, "Total Access Communications".

In a unit provided with the Total Access Communications option, the Communications Configuration parameter, **CCon** has four selections instead of two.

CCon 0 = Off
1 = Monitor only mode - only retrievals allowed
2 = Normal mode - retrievals and updates allowed
3 = Full Access with Limit Checking
4 = Full Access without Limit Checking

With 3 selected, the supervisory computer can also access software tab number, order matrix number, and all parameters. With 4 selected, it can also access calibration values.

With **CCon** equal to 3, the calibration values can be read, but not sent to the unit. With **CCon** equal to 4, no limit checking is done to increase throughout.

Specifications - 2

2.1 MULTI-DROP SUPERVISORY LINK

Transmission Standard	:	RS-485, two wire; bidirectional
Protocol	:	ANSI-X3.28-2.5-A4
Data Rates	:	300, 600, 1200, 2400, 4800, or 9600 bits per second
Character Format	:	1 start bit (logic 0 on RS-485 line) 7 data bits - ASCII 1 parity bit 1 stop bit
Parity	:	Even

Sequence To Read Data From An Instrument - 3

Instruments are polled for data by the supervisory computer using the polling sequence illustrated in Figure 1 (Page 6). The sequence can be divided up into three distinctive procedures: Establish connection, Message transfer, and Termination.

3.1 ESTABLISH CONNECTION PROCEDURE

The supervisory computer initially has master status and begins by transmitting a 9 character polling sequence. This message identifies a single instrument and the data requested, while the ENQ control character defines the end of the message. The 9 character message is in the following format:

(EOT) (AL) (AL) (AH) (AH) (C1) (C2) (C3) (ENQ)

(EOT)
The EOT control character, End-of-Transmission, resets the link and causes the instruments to examine the next 4 transmitted characters to see if they correspond to their own address.

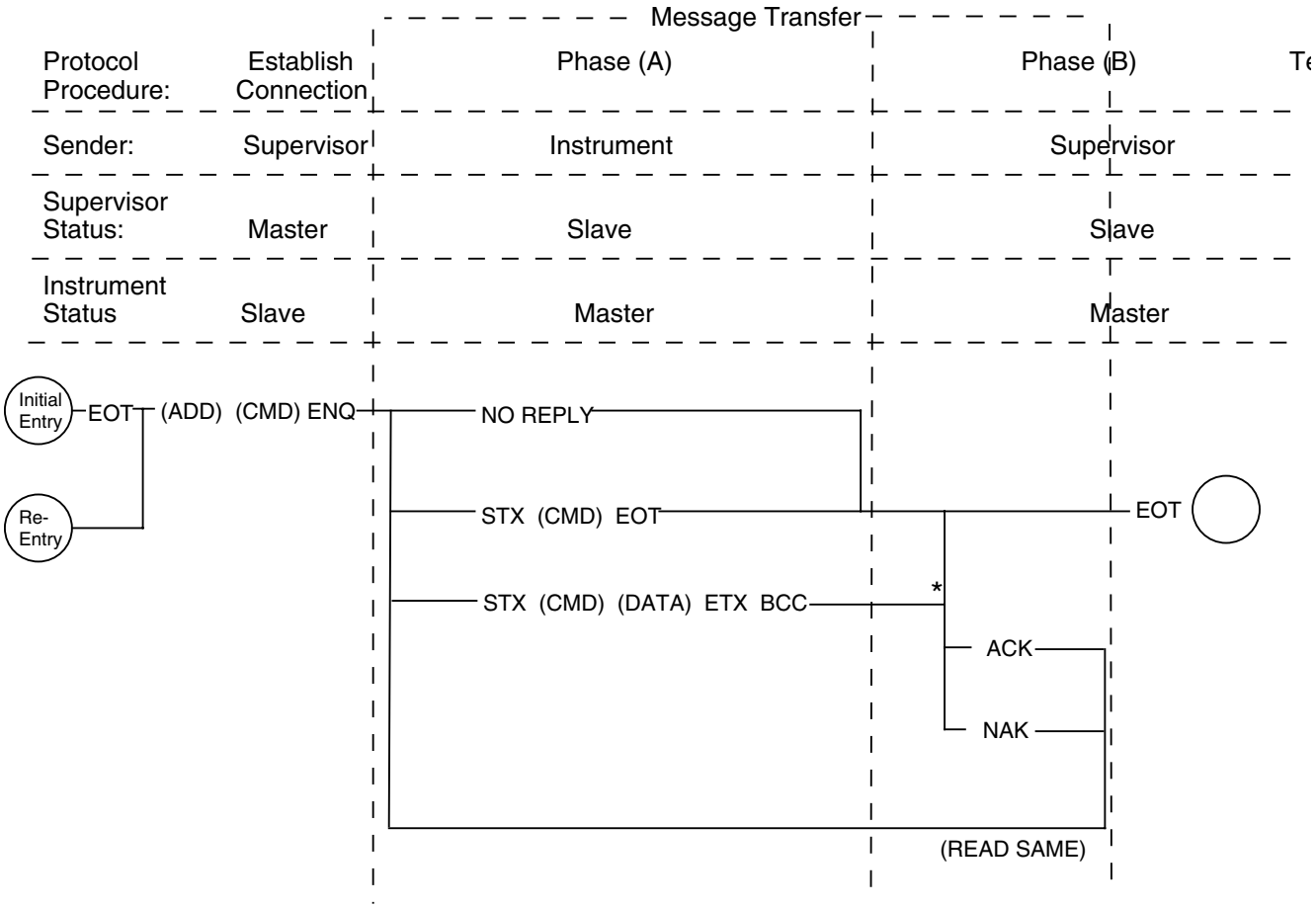
(AL) (AL) (AH) (AH)
These data characters specify the instrument address, repeated twice for reliability. Each address character can vary from 0 to 9 and is transmitted as the ASCII code for the digits. Thus, the supervisory computer can address a maximum of 100 instruments.

Note: The least significant digit of the address (AL) is sent first, then the most significant digit (AH).

(C1) (C2) (C3)
These three characters specify the status or parameter within the instrument to be interrogated by the supervisory computer. A full list of the 3 digit command/parameter codes is given in Appendix 3 (Page 17).

(ENQ)
Finally the polling sequence ends with the ENQ control character.

Figure 1 - Polling Sequence for Transmitting Data from an Instrument to the Supervisor



Refer to Appendix 1

Figure 1 shows that the initial entry point of the polling sequence starts off with the supervisory computer transmitting an EOT character to reset the instruments. However, the polling sequence may be re-entered after the EOT, as shown, provided that an EOT character has been transmitted within a previous termination procedure, per Section 3.2.3 (Page 9).

3.2 MESSAGE TRANSFER PROCEDURE

After the supervisory computer has transmitted the ENQ character at the end of the establish connection procedure, the protocol enters the message transfer procedure. It can be seen from Figure 1 (Page 6) that the message transfer procedure itself can be divided into 2 phases according to which device is acting as the sending station.

3.2.1 Phase A - Instrument is the Sender

Figure 1 shows that upon initial entry to the message transfer procedure there are three possible replies that an instrument can make:

3.2.1.1 No Reply

Under certain circumstances the supervisory computer may not receive any message in response to a polling sequence. This can be due to any of the following reasons:

a. Address is not recognized.
b. An error (e.g. parity) is found in one of the characters up to and including the ENQ.
c. Polled instrument has wrong baud set.
d. Noise on the communications links or link failure.
e. Hardware failure in the polled instrument.

In these cases the supervisory computer will “time-out”, retain master status, and enter the termination procedure of Section 3.2.3 (Page 9).

3.2.1.2 Invalid Reply - Reply to an Invalid Command

A polled instrument may recognize the address transmitted by the supervisory computer, but could find that the 3 command characters do not correspond to any of the valid combination listed in its appropriate command/parameter code list in Appendix 3 (Page 16). In this case, the instrument will terminate its master status by sending the following sequence:

(STX) (C1) (C2) (C3) (EOT)

(STX)
The STX control character, Start-of-Text, identifies the start of message.

(C1) (C2) (C3)
These characters are the command/ parameter code sent from the supervisory computer.

(EOT)
The EOT control character signifies the end of transmission and terminates the logical connection.

This sequence echos the invalid command and terminates the logical connection. Master status then reverts to the supervisory computer which may then poll or select another instrument after entering termination procedure of Section 3.2.3 (Page 9).

3.2.1.3 Valid Reply - Reply to a Valid Command

Once an instrument has successfully recognized its address and command code and it has a message to send, it assumes master status and initiates the message transfer procedure. The supervisory computer assumes slave status for the duration of this procedure and the instrument starts off by transmitting the following sequence:

(STX) (C1) (C2) (C3) (D1) (D2) (D3) (D4) (D5) (D6) (ETX) (BCC)

The sequence is broken down as follows:

(STX)
The STX control character identifies the start of the message.

(C1) (C2) (C3)
These characters are a repeat of the requested command/parameter code specified in the establish connection phase. They are repeated for security and are listed in Appendix 3 (Page 16).

(D1) (D2) (D3) (D4) (D5) (D6)
These characters represent the value of the requested parameter transmitted in engineering units with a sign digit and a decimal point as appropriate.
Refer to Appendix 4.

(ETX)
The ETX control character, End-of-Text, terminates the transmission of the textual part of the message.

(BCC)
This character is transmitted by the instrument at the end of its message to be used by the supervisory computer for data verification purposes. The BCC is a longitudinal redundancy BLock Check Character generated by taking the exclusive-OR of all the characters transmitted after the STX character up to and including the ETX character.

3.2.2 Phase B - Supervisory Computer is the Sender

After the polled instrument has transmitted a valid message, in Phase A of the message transfer procedure, the protocol enters Phase B where the supervisory computer becomes the sender. At this point, indicated by * in Fig. 1 (Page 6), the instrument will ignore all characters on the data link other than those shown along a specific path. It therefore remains at this point until one of the 3 valid replies are received, as follows.

3.2.2.1 NAK - Negative Acknowledgement

If the supervisory computer transmits a NAK response it causes the polled instrument to remain in the message transfer procedure, retain master status and re-transmit the last parameter polled. This response can be due to any of the following reasons:

1. An error (e.g. parity) is found in any of the characters up to and including the BCC.

2. The BCC character may not correspond with the data actually received by the supervisory computer.

3.2.2.2 ACK - Positive Acknowledgement

If the supervisory computer transmits an ACK response it causes the polled instrument to remain in the message transfer procedure, retain master status, and re-transmit the last parameter. This response saves time when the supervisory computer needs to continuously monitor the same parameter from a particular instrument because it is not necessary to repeat the establish connection procedure.

3.2.2.3 EOT - Termination Reply

Figure 1 shows that if the supervisory computer wishes to stop polling a particular instrument after the message transfer procedure, then it may enter the termination procedure of Section 3.2.3 directly and break the logical connection.

3.2.3 Termination Procedure

The termination procedure of the protocol is entered whenever the supervisory computer wishes to stop communicating with a particular instrument and establish a new connection. Referring to Figure 1, this can occur if an instrument does not respond to a poll or if it replies with an invalid reply, refer to paragraph 3.2.1.1, during Phase A of the message transfer procedure. In these cases the supervisory computer first assumes master status and then transmits an EOT to reset the link. After transmitting the EOT the supervisory computer may perform a polling sequence or a selection sequence via re-entry points, which does not require the initial EOT to be sent, or wait.

Sequence To Send Data To An Instrument - 4

The supervisory computer transmits data to an instrument using the Selection Sequence illustrated in Figure 2. The sequence can be divided up into the three distinctive procedures: Establish Connection, Message Transfer and Termination.

4.1 ESTABLISH CONNECTION PROCEDURE

The supervisory computer retains master status throughout the whole of the selection sequence, as it is the originator of all data transfers. The selection sequence is initiated by the supervisory computer transmitting the following 5 character message: (on following page)

(EOT) (AL) (AL) (AH) (AH)

Referring back to Section 3.1 (Page 5), this sequence of characters is identical to the first 5 characters of the polling sequence.

(EOT)
The EOT control character resets the link.

(AL) (AL) (AH) (AH)
These characters specify the instrument address.

Note: The least significant digit of the address (AL) is sent first, then the most significant digit (AH).

Figure 2 shows that the initial entry point of the selection sequence starts off with the supervisory computer transmitting an EOT character to reset all the instruments. However, the selection sequence may be re-entered after the EOT character, as shown, provided that an EOT character has been transmitted within a previous termination procedure, per Section 3.2.3 (Page 9).

4-2 MESSAGE TRANSFER PROCEDURE

After the supervisory computer has transmitted the 5 character message of the establish connection procedure directly. It can be seen from Figure 2 (Page 11) that the message transfer procedure itself can be divided up into two phases according to which device is acting as the sender.

4.2.1 Phase A - Supervisory Computer is the Sender

Figure 2 (Page 11) shows that upon initial entry to the message transfer procedure the supervisory computer transmits the new parameter value by means of the following message:

(STX) (C1) (C2) (C3) (D1) (D2) (D3) (D4) (D5) (D6) (ETX) (BCC)

Referring back to Section 3.2.1, the message format is identical to that transmitted by the instrument in response to a poll. The sequence is broken down as follows:

(STX)
The STX control character identifies the start of the message.

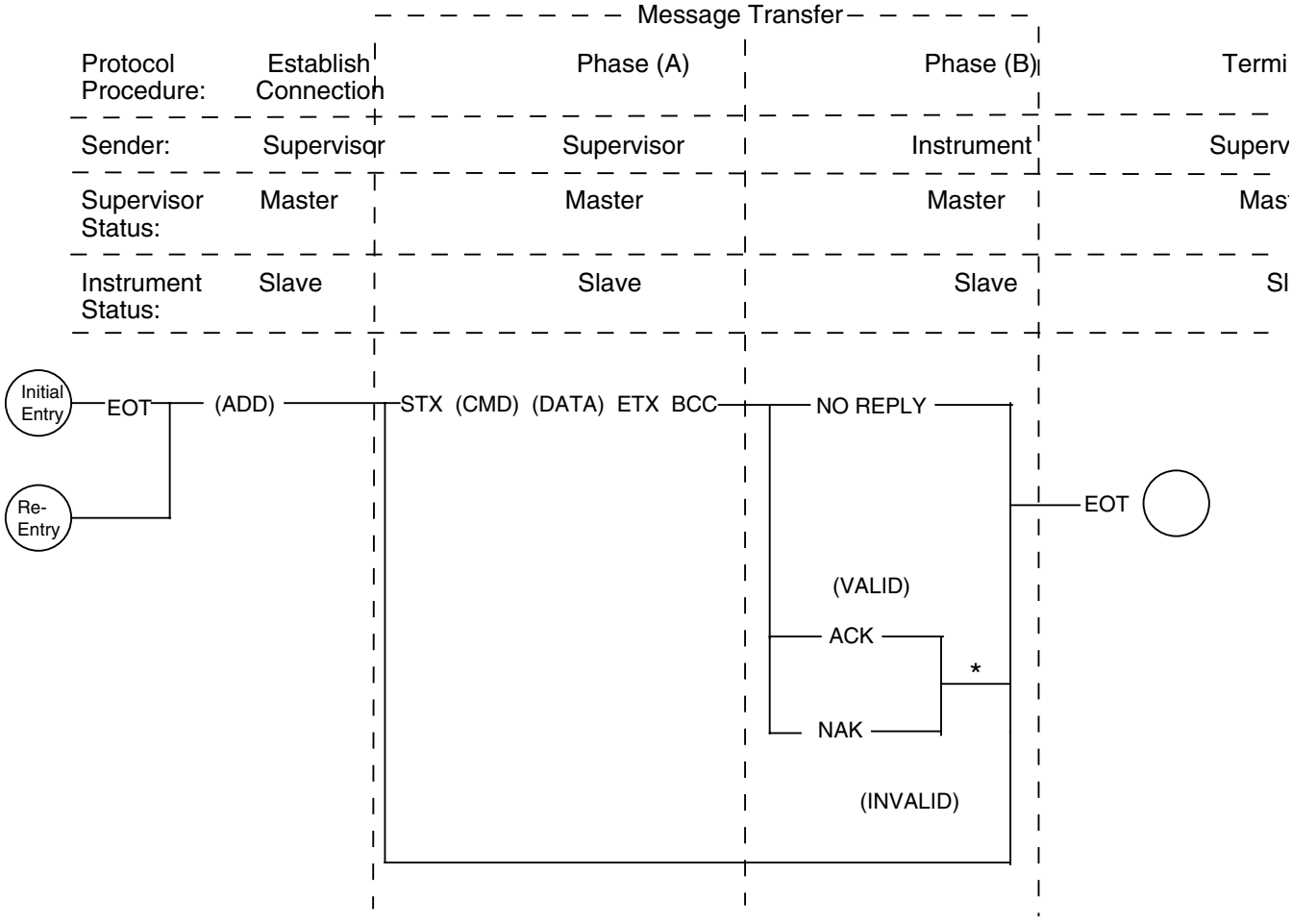
(C1) (C2) (C3)
These characters are the command/parameter code for the parameter to be updated by the transfer and can be any one of those listed in Appendix 3 (Page 17), provided that it is not a monitor-only parameter.

(D1) (D2) (D3) (D4) (D5) (D6)
These characters represent the value of the selected parameter to be updated in engineering units with sign digit and decimal point positioned appropriately. The format for the data is specified in Appendix 4 (Page 32).

(ETX)
The ETX control character indicates that transmission of the textual part of the message has been completed.

(BCC)
The BCC character is formed in exactly the same manner as described in Section 3.2.1.3(Page 8).

Figure 2 - Selection Sequence for Transmitting Data from the Supervisor to an Instrument



Refer to Appendix 1

4.2.2 Phase B - Instrument is the Sender

After the supervisory computer has transmitted the message in Phase A of the message transfer procedure, the protocol enters Phase B where the instrument becomes the sender. Figure 2 shows that there are three possible replies the instrument can make at this stage, which are as follows.

4.2.2.1 ACK - Positive Acknowledgement

When the instrument identified by the address in the establish connection procedure has received the message transmitted by the supervisory computer during Phase A of the message transfer procedure, it performs the following tasks:

1. Verifies that the BCC character corresponds to the data pattern actually received and looks for parity error. If no errors then it:

2. Verifies that the (C1) (C2) (C3) command code is valid as listed in Appendix 3. If so then it:

3. Verifies that the data specified by the (D1), (D2), (D3), (D4), (D5), and (D6) characters contain valid data. If so it then:

4. Updates the selected parameter with new value contained in the data field of the message.

Only when all of these tasks have been successfully completed does the instrument send the ACK response back to the supervisory computer. This signifies that the message was correctly received, verified, and the parameter updated by the instrument. Upon receipt of the ACK, the supervisory computer may enter the termination procedure of Section 4.3 (Page 13) or may remain in the message transfer procedure. If the supervisory computer stays in the message transfer procedure it may send another message to the same instrument without having to re-establish the logical connection. This is know as a “fast select” sequence andsaves time when the supervisory computer wishes to continuously update parameters in the same instrument. It is not necessary to enter the establish connection procedure before each update.

4.2.2.2 NAK - Negative Acknowledgement

The instrument selected by the establish connection procedure may detect an error in the message transmitted by the supervisory computer during Phase A of the message transfer procedure. An error may occur for one or more of the following reasons:

1. The command/parameter code defined by the (C1) (C2) (C3) characters may not be valid.

2. The command parameter specified by the (C1) (C2) (C3) characters may be monitor-only parameter, or the instrument may be in the monitor only mode.

3. The data field specified by the (D1), (D2), (D3), (D4), (D5), and (D6) characters may be invalid or out of range.

4. The BCC character may not correspond with the data actually received by the instrument.

If any of these conditions are detected by the instrument, it sends back a NAK response to the supervisory computer. This signifies that the message received by the instrument contained an error. Upon receipt of the NAK the supervisory computer may enter the termination procedure of Section 4.3, or may remain in the message transfer procedure and transmit the same or a new message by means of the “fast select" sequence. If the supervisory computer stays in the message transfer procedure, it may send a message to the same instrument without having to re-establish the logical connection.

The use of this “fast select” sequence saves time when the supervisory computer wishes to transmit re-tries on a message after an instrument has found an error because it is not necessary to enter the establish connection before each re-try.

Referring to Figure 2, after an ACK or NAK reply, the instrument will ignore all transmitted characters except STX or EOT. This point is identified by the “*” in the diagram.

4.2.2.3 No Response

Under certain circumstances the supervisory computer may not receive any message at all in response to a selection sequence. This can be due to any of the following reasons:

1. Address not recognized.
2. An error (e.g. parity) is found in any of the characters up to and including the BCC.
3. Selected instrument has wrong baud rate set.
4. Noise on the communications link, or link failure.
5. Hardware failure in the selected instrument.

In these cases the supervisory computer should “time out” and must enter the termination procedure.

4.3 TERMINATION PROCEDURE

The termination procedure of the protocol is entered whenever the supervisory computer wishes to stop communicating with a particular instrument and establish a new logical connection.

4.3.1 Break Logical Connection

Figure 2 (Page 11)shows that after the instrument has transmitted an ACK or NAK response in Phase B of the message transfer procedure. The supervisory computer retains master status and transmits an EOT character to reset all instruments back to looking for the next address. After transmitting the EOT, the supervisory computer may perform a polling sequence or a selection sequence via re-entry points, which does not require the initial EOT to be sent, or wait.

4.3.2 Re-Establish the Link

Figure 2 (Page 11) also shows that if the instrument does not respond to the selection sequence, the supervisory computer also enters the termination procedure. It retains master status, transmits an EOT character, and may then perform a polling sequence or selection sequence via re-entry points, or wait.

APPENDIX 1 Flowchart Terminology

The symbols used in the flowchart sequences have the following meanings:

EOT, ENQ, STX, ETX, ACK and NAK are ASCII control characters.

(ADD) is the address of the instrument being accessed by the supervisory computer. The address format is (AL) (AL) (AH) (AH) and is transmitted as ASCII. Each address character is repeated for reliability.

Note: (AL) is the units digit and (AH) is the tens digit of the address, and (AL) is sent first.

(CMD) is the three character command/parameter code. The command format is (C1), (C2), (C3) and is transmitted as ASCII. Refer to Appendix 3 for definitions.

(DATA) consists of a variable number of ASCII characters. These characters, referred to as (D1), (D2), (D3), (D4), (D5), (D6) represent the parameter value per Appendix 4.

(BCC) is the longitudinal redundancy Block Check Character and is generated by taking the exclusive -OR of all the characters transmitted after the STX character up to and including the ETX character.

APPENDIX 2 Control Characters

EOT - End of Transmission (ASCII code 04 hex) (Control D)

This is effectively a reset character and terminates the message transfer procedure. When used, it restores order to the link and makes all instruments examine the next four characters for their address. The supervisory computer usually transmits the EOT as it initially enters an establish connection procedure or during the termination procedure. An instrument may transmit an EOT as the last character of an "invalid reply" (refer to paragraph 3.2.1.2), Page 7.

ENQ - Enquiry (ASCII code 05 hex) (Control E)

This character terminates the establish connection procedure of the polling sequence and passes master status to the addressed instrument.

STX - Start of Text (ASCII code 02 hex) (Control B)

This character denotes the beginning of the message that is being passed to the station that holds slave status.

ETX - End of Text (ASCII code 03) (Control C)

This character denotes the end of the message, in particular, the end of the data field. It also informs the receiving station that the next byte will be a BCC character.

ACK - Acknowledge (ASCII code 06 hex) (Control F)

This is the reply character sent by the station that holds slave status when the message had: no parity errors, proper format, a BCC character that is correct, and valid parameter codes with relevant data. The supervisory computer can use this reply to re-examine the value of a parameter without having to establish a new connection with the same instrument.

NAK - Negative Acknowledge (ASCII code 15 hex) (Control U)

APPENDIX 3 Command/Parameter Codes

C/P CODE	DESCRIPTION	VALUE/RANGE
0XX	Status Inquiry	
001	Status Word 1	See Appendix 4, Page 32
002	Status Word 2	See Appendix 4, Page 32
003	Status Word 3	See Appendix 4, Page 32
004	Error Status	0 = No Error Condition N = Error Number
005	Engineering Units	0 = C 1 = F 2 = Units
1XX	Procedure	
101	Set Mode	0 = Off 1 = Control (or Operate) 2 = Manual (Stand-By)
102	Set Keypad Lock	0 = Unlocked 1 = Locked
103	Set Enable	See Appendix 4, Page 32
104	* Set Local/Remote	0 = Local 1 = Remote
105	** Initiate Profile	0 = Profile Continue N = Profile Number 1 to 8
106	*** Set Run/Hold	0 = Hold 1 = Run

* Invalid command if remote setpoint not selected in Program Mode.
** Invalid command if a profile is being executed or the unit is not a profiler.
*** Invalid command if a profile is not being executed or the unit is not a profiler.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
2XX	Read Only	Parameters							
201	Proc	Process Value - Filtered	•	•	•	•	•	•	•
202	inPS	Input Select	•	•	•	•	•		•
202	iSi1	Input Select, Input 1						•	
203	iCor	Input Correction	•	•	•	•	•		•
203	iCi1	Input Correction, Input 1						•	
204	out1	Output 1	•	•	•	•	•	•	
205	out2	Output 2	•	•	•	•	•	•	
206	out3	Output 3	•	•	•	•			
206	AL1	Alarm 1					•	•	•
207	AL2	Alarm 2					•	•	•
208	dPoS	Decimal Position	•	•	•	•	•	•	•
209	Euu	Engineering Units Upper Value	•	•	•	•	•	•	•
210	EuL	Engineering Units Lower Value	•	•	•	•	•	•	•
211	rSP	Remote Setpoint	•		•	•	•	•	
212	rSPu	Remote Setpoint Upper Value	•		•	•	•	•	
213	rSPL	Remote Setpoint Lower Value	•		•	•	•	•	
214	rrH	Remote Run/Hold		•			•	•	
215	Crt	Chart Rotation Time					•	•	•
216	Cru	Chart Range Upper Value					•	•	•
217	CrL	Chart Range Lower Value					•	•	•
218	PEnS	Pen Select						•	
219	rHC	RH Correction						•	
220	iSi2	Input Select Input 2						•	
221	iCi2	Input Correction Input 2						•	

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
3XX	Read/Write Parameters								
301	SPrd	Spread/Second Output Position	•	•					
301	SoP	Spread/Seconds Output Position			•	•	•	•	
302	PAL	Process Alarm	•	•	•	•			
302	PAL1	Process Alarm					•	•	•
303	dAL	Deviation Alarm	•	•	•	•			
303	dAL1	Deviation Alarm					•	•	
304	dbAL	Deviation Alarm	•	•	•	•			
304	bAL1	Deviation Alarm					•	•	
305	PAL2	Process Alarm 2					•	•	•
306	dAL2	Deviation Alarm 2					•	•	
307	bAL2	Deviation Band Alarm 2					•	•	
308	Pb1	1st Out Band Width	•	•	•	•	•	•	
309	Pb2	2nd Out Band Width	•	•	•	•	•	•	
310	rSEt	Manual Reset	•	•	•	•	•	•	
311	ArSt	Auto Reset	•	•			•		
311	ArS1	Auto Reset, Output 1			•	•		•	
312	rAtE	Rate	•	•			•		
312	rt1	Rate, Output 1			•	•		•	
313	Ct1	Cycle Time - 1st Output	•	•	•	•	•	•	
314	Ct2	Cycle Time - 2nd Output	•	•	•	•	•	•	
315	SEnS	P. P. Sensitivity	•	•	•	•	•	•	
316	FoP	First Out Position	•	•	•	•	•	•	
317	o1PL	Output 1 Percent Upper Limit	•	•					
317	o1uL	Output 1 Percent Upper Limit			•	•	•	•	
318	o1LL	Output 1 Percent Lower Limit			•	•	•	•	
319	o2PL	Output 2 Percent Upper Limit	•	•					
319	o2uL	Output 2 Percent Upper Limit			•	•	•	•	

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
3XX	Read/Write	Parameters							
320	o2LL	Output 2 Percent Lower Limit			•	•	•	•	
321	diSP	Display Select	•	•	•	•	•	•	
322	HySt	Hysteresis	•	•	•				
322	HyCo	Hysteresis				•	•	•	
323	HyAo	Hysteresis For Alarm Outputs				•	•	•	•
324	SPL	Setpoint Upper Limit	•	•					
324	SPuL	Setpoint Upper Limit			•	•	•	•	
325	SPLL	Setpoint Lower Limit			•	•	•	•	
326	AtFr	Automatic Transfer	•	•	•	•	•	•	
327		Not Assigned							
328		Not Assigned							
329	SPrr	Setpoint Ramp Rate	•		•	•			
330	PFF	Process Filter Factor	•	•	•	•	•	•	•
331	P1EC	Proportional Output 1 Action on Error Condition			•	•	•	•	
332	P2EC	Proportional Output 2 Action on Error Condition			•	•	•	•	
333	ArS2	Auto Reset - Output 2			•	•		•	
334	rt2	Rate Output 2			•	•		•	
335	bAro	Barometeric Pressure						•	•
336	CCon	Communication Configuration	•	•	•	•	•	•	•

C/P CODE	DISPLAY CODE	DESCRIPTION	VALUE/RANGE	
4XX	READ/WRITE-SOMETIMES PARAMETERS (SEE CONDITIONS BELOW)			
401	SP	Setpoint		
402	Po1	Percent Output 1	PER INSTRUMENT OPERATOR MANUAL	
403	Po2	Percent Output 2		
404	SP2	Setpoint 2 (8200 only)		
5XX	READ/WRITE-SOMETIMES PARAMETERS FOR PROFILE CONTINUE ONLY			
501	rtr	Ramp Time Remaining		
502	Str	Soak Time Remaining		
503	Pn	Profile Number	PER INSTRUMENT OPERATOR MANUAL	
504	Sn	Segment Number		
505*	PLCt	Profile Loop Count		
506	Ptb	Profile Time Base		
507	PiA	Profile Interrupt Action		

C/P CODE	CONDITIONS UNDER WHICH WRITE IS PERMITTED
401 & 404	Remote Setpoint Not Active No Profile Active
402	Operating in Manual Mode
403	Operating in Manual Mode
501 thru } 507	No Profile Active

Parameters which do not apply to a particular instrument will be considered invalid.

* This Profile Loop Count applies to the profile status or Profile Continue mode and not the value stored in the profile data table accessible by Profile Entry mode.

C/P CODE	DISPLAY CODE	DESCRIPTION	VALUE/RANGE
6XX	Read/Write	Profile Date Parameters	
601*	Pn	Profile Number	
602	nS	Number of Segments	
603	PLCt	Profile Loop Count	
604	dhru	Deviation Hold After Ramp Up For Pen 1	
605	dhrd	Deviation Hold After Ramp Down For Pen 1	
606	dhru	Deviation Hold After Ramp Up For Pen 2	
607	dhrd	Deviation Hold After Ramp Down For Pen 2	
608	PEnd	Profile End Control	
609*		Segment Number	
610	rt	Ramp Time	
611	SP	Setpoint (For Pen 1 on 7XXX)	
612	SP	Setpoint For Pen 2**	
613	E1	Event Output 1 During Ramp	0 = Off 1 = On
614	E2	Event Output 2 During Ramp	0 = Off 1 = On
615	E3	Event Output 3 During Ramp	0 = Off 1 = On
616	St	Soak Time	
617	E1	Event Output 1 During Soak	0 = Off 1 = On
618	E2	Event Output 2 During Soak	0 = Off 1 = On
619	E3	Event Output 3 During Soak	0 = Off 1 = On
620**	E4	Event Output 4 During Ramp	0 = Off 1 = On
621**	E5	Event Output 5 During Ramp	0 = Off 1 = On
622**	E6	Event Output 6 During Ramp	0 = Off 1 = On
623**	E4	Event Output 4 During Soak	0 = Off 1 = On
624**	E5	Event Output 5 During Soak	0 = Off 1 = On
625**	E6	Event Output 6 During Soak	0 = Off 1 = On

* The Profile Number and Segment Number parameter values specify to which profile and segment subsequent data, via commands 602 thru 625 apply. None of the above codes or parameters apply to profile status or the Profile Continue mode. They only apply to sending or retrieving profile data as it is stored via the Profile Entry mode.

** MRC 7XXX instruments only.

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The following parameters/information will not be accessible via the "standard" communications option.

DISPLAY CODE	DESCRIPTION
CCon	Communications Configuration
CbS	Communications Baud Select
CAd	Communications Address
CAd1	Communications Address, Pen 1
CAd2	Communications Address, Pen 2
FScn	Fast Scan
Prnd	Process Rounding
rLyA	Relay A Assignment
rLyb	Relay B Assignment
rLyC	Relay C Assignment
rLyd	Relay D Assignment
rLyE	Relay E Assignment
rLyF	Relay F Assignment
rLyg	Relay G Assignment
rLyH	Relay H Assignment
CurA	Current Output A Assignment
Curb	Current Output B Assignment
CurC	Current Output C Assignment
Curd	Current Output D Assignment
Co1r	Current Output 1 Range
Co2r	Current Output 2 Range
CoAr	Current Output A Range
Cobr	Current Output B Range
CoCr	Current Output C Range
Codr	Current Output D Range
Pout	Process Output
Pou	Process Output Upper Value
PoL	Process Output Lower Value
PorA	Percent Output relay Actuation
PoAP	Percent Output Actuation Point
dFF	Display Filter Factor
PAEC	Pen Action on Error Condition
PPC	Pen Profiling Configuration
Coo	Chart operation in Off Mode
SPC	Setpoint Configuration
AduL	Autotune Deviation Upper Limit
AdLL	Autotune Deviation Lower Limit
ASuL	Autotune Setpoint Upper Limit
ASLL	Autotune Setpoint Lower Limit
CrC	Control Response Criteria
CAC	Control Algorithm Choice
AAo	Autotune Abort Option
AtL	Autotune Time Limit
ASo	Aututune Select Option

7XX and 8XX Commands apply to the "Total Access" communications option only.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
7XX									
701		Tab Number Verification	•	•		•	•	•	•
702		Matrix Number	•	•		•	•	•	•
703		Matrix Number	•	•		•	•	•	•
704		Matrix Number	•	•		•	•	•	•
705	dPoS	Decimal Position	•	•		•	•	•	•
706	inPS	Input Select	•	•		•	•		•
707	iCor	Input Correction	•	•		•	•		•
708	PEnS	Pen Select						•	
709	rHC	Relative Humidity						•	
710	out1	Output 1	•	•		•	•	•	
711	o1PL	Output 1 (percent upper limit)	•	•					
711	o1uL	Output 1 (percent upper limit)				•	•	•	
712	o1LL	Output 1 (percent lower limit)				•	•	•	
713	out2	Output 2	•	•		•	•	•	
714	o2PL	Output 2 (percent upper limit)	•	•					
714	o2uL	Output 2 (percent upper limit)				•	•	•	
715	o2LL	Output 2 (percent lower limit)				•	•	•	
716	out3	Output 3	•	•		•			
716	AL1	Alarm 1					•	•	•
717	AL2	Alarm 2					•	•	•
718	diSP	Display Select	•	•		•	•	•	
719	Euu	Engineering Units Upper	•	•		•	•	•	•
720	EuL	Engineering Units Lower	•	•		•	•	•	•
721	HySt	Hysteresis, Control outputs	•	•					
721	HyCo	Hysteresis, Control outputs				•	•	•	
722	HyAo	Hysteresis, Alarm Outputs				•	•	•	•

7XX and 8XX Commands apply to the "Total Access" communications option only.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
7XX									
723	rSP	Remote Setpoint	•				•	•	
723	SPC	Setpoint Configuration				•			
724	rSPu	Remote Setpoint Upper Value	•			•	•	•	
725	rSPL	Remote Setpoint Lower Value	•			•	•	•	
726	SPL	Setpoint Limit	•	•					
726	SPuL	Setpoint Upper Limit				•	•	•	
727	SPLL	Setpoint Lower Limit				•	•	•	
728	AtFr	Auto Transfer	•	•		•	•	•	
729	FSCn	Fast Scan	•			•			•
730	Prnd	Process Value Rounding	•			•	•	•	•
731	dFF	Display Filter Factor	•	•		•	•	•	•
732	PFF	Process Filter Factor	•	•		•	•	•	•
733	Pout	Process Output	•	•		•	•	•	•
734	Pou	Process Output Upper Value	•	•		•	•	•	•
735	PoL	Process Output Lower Value	•	•		•	•	•	•
736	Cru	Chart Range Upper					•	•	•
737	CrL	Chart Range Lower					•	•	•
738	PorA	Percent Output Relay Actuation	•						
739	PoAP	Percent Output Actuation Point							
740	P1EC	Percent Output 1 on error cond.	•			•	•	•	
741	P2EC	Percent Output 1 on error cond.				•	•	•	
742	PAEC	Pen Action on Error Condition					•	•	•
743	SPrr	Setpoint Ramp Rate	•			•			
744	rLyA	Relay A Assignment	•	•		•	•	•	•

7XX and 8XX Commands apply to the "Total Access" communications option only.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
7XX									
745	rLyb	Relay B Assignment	•	•		•	•	•	•
746	rLyC	Relay C Assignment	•	•		•	•	•	•
747	rLyd	Relay D Assignment					•	•	•
748	rLyE	Relay E Assignment					•	•	•
749	rLyF	Relay F Assignment					•	•	•
750	rLyg	Relay G Assignment					•	•	•
751	rLyh	Relay H Assignment					•	•	•
752	CurA	Current Output A Assignment					•	•	•
753	Curb	Current Output B Assignment					•	•	•
754	CurC	Current Output C Assingment					•	•	•
755	Curd	Current Output D Assignment					•	•	•
756	Co1r	Current Output 1 range	•	•		•			
756	CoAr	Current Output A range					•	•	•
757	Co2r	Current Output 2 range	•	•		•			
757	Cobr	Current Output B range					•	•	•
758	CoCr	Current Output C Range					•	•	•
759	Codr	Current Output D Range					•	•	•
760	Ptb	Profile Time Base		•			•	•	
761	PiA	Profile Interrupt Action		•			•	•	
762	rrh	Remote Run Hold		•			•	•	
763	PPC	Pen Profile Configuration					•	•	
764	Crt	Chart Rotation Time					•	•	•
765	Coo	Chart Operation in OFF mode					•	•	•
766	SPrd	Spread	•	•					
766	SoP	Spread				•	•	•	

7XX and 8XX Commands apply to the "Total Access" communications option only.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
7XX									
767	PAL	Process Alarm	•	•		•			
767	PAL1	Process Alarm Pen 1					•	•	•
768	dAL	Deviation Alarm	•	•		•			
768	dAL1	Deviation Alarm Pen 1					•	•	
769	dbAL	Deviation Band Alarm	•	•		•			
769	bAL1	Deviation Band Alarm 1					•	•	
770	PAL2	Process Alarm 2					•	•	•
771	dAL2	Deviation Alarm 2					•	•	
772	bAL2	Deviation Band Alarm 2					•	•	
773	Pb1	1st Out Bandwidth	•	•		•	•	•	
774	Pb2	2nd Out Bandwidth	•	•		•	•	•	
775	rSEt	Manual Reset	•	•		•	•	•	
776	ArSt	Auto Reset	•	•			•		
776	ArS1	Auto Reset Output 1				•		•	
777	ArS2	Auto Reset Output 2				•		•	
778	rAtE	Rate	•	•			•		
778	rt1	Rate Output 1				•		•	
779	rt2	Rate Output 2				•		•	
780	Ct1	Cycle Time 1st Output	•	•		•	•	•	
781	Ct2	Cycle Time 2nd Output	•	•		•	•	•	
782	SEnS	Position Prop. Sensitivity	•	•		•	•	•	
783	FoP	First Output Position	•	•		•	•	•	
784	bAro	Barometrix Pressure						•	•
785	iSi1	Input Select for Input 1						•	
786	iCi1	Input Correction for Input 1						•	

7XX and 8XX Commands apply to the "Total Access" communications option only.

C/P CODE	DISPLAY CODE	DESCRIPTION	2000	6000	8000	8200	7000	7700	7800
7XX									
787	iSi2	Input Select for Input 2						•	
788	iCi2	Input Correction for Input 2						•	
789	AduL	Autotune Deviation Upper Limit				•			
790	AdLL	Autotune Deviation Lower Limit				•			
791	ASuL	Autotune Setpoint Upper Limit				•			
792	ASLL	Autotune Setpoint Lower Limit				•			
793	CrC	Control Response Criteria				•			
794	CAC	Control Algorithm				•			
795	AAo	Autotune Abort Option				•			
796	AtL	Autotune Time Limit				•			
797	ASo	Autotune Selection Option				•			
798	SET ENABLE	*1	•	•		•	•	•	•
799	SET LOCAL/REMOTE	*2 0=Local, 1=Remote	•	•		•	•	•	
"									
"									
"									
"									
899	PRG CHK SUM	Program Parameter Checksum							

Note *1 - Command 798, Set Enable is transmitted and received as a decimal number from 000 to 255.

Note *2 - Command 799 is transmitted as a single byte 0 or 1.

9XX Commands apply to the "Total Access" communications option only.

Calibration Values

COMMAND CODE	DESCRIPTION	
901	CALBYTE1	:First byte of calibration values
902	CALBYTE2	:Second byte of calibration values
903	CALBYTE3	
904	CALBYTE4	
905	CALBYTE5	
906	CALBYTE6	
907	CALBYTE7	
908	CALBYTE8	
909	CALBYTE9	
910	CALBYTE10	
911	CALBYTE11	
912	CALBYTE12	
913	CALBYTE13	
914	CALBYTE14	
915	CALBYTE15	
916	CALBYTE16	
917	CALBYTE17	
918	CALBYTE18	
919	CALBYTE19	
920	CALBYTE20	
921	CALBYTE21	
922	CALBYTE22	
923	CALBYTE23	
924	CALBYTE24	
925	CALBYTE25	
926	CALBYTE26	
927	CALBYTE27	
928	CALBYTE28	
929	CALBYTE29	
930	CALBYTE30	
931	CALBYTE31	
932	CALBYTE32	
933	CALBYTE33	
934	CALBYTE34	:Last cal. value for 2000,6000,8200
935	CALBYTE35	
936	CALBYTE36	
937	CALBYTE37	
938	CALBYTE38	
939	CALBYTE39	
940	CALBYTE40	
941	CALBYTE41	
942	CALBYTE 42	
943	CALBYTE43	
944	CALBYTE44	
945	CALBYTE45	
946	CALBYTE46	
947	CALBYTE47	
948	CALBYTE48	
949	CALBYTE49	

COMMAND CODE	DESCRIPTION	
950	CALBYTE50	
951	CALBYTE51	
952	CALBYTE52	
953	CALBYTE53	
954	CALBYTE54	
955	CALBYTE55	
956	CALBYTE56	
957	CALBYTE57	
958	CALBYTE58	
959	CALBYTE59	
960	CALBYTE60	
961	CALBYTE61	
962	CALBYTE62	
963	CALBYTE63	
964	CALBYTE64	
965	CALBYTE65	
966	CALBYTE66	
967	CALBYTE67	:Last calibration value for 7000,7700, 7800
"		:Reserved
"		:Reserved
"		:Reserved
999	CALCHK	:Calibration Checksum

The following parameters/information will not be accessible via the "Total Access" communication option.

DISPLAY CODE	DESCRIPTION
Cbs	Communications Baud Select
CAd	Communications Address
CAd1	Communications Address Pen 1
CAd2	Communications Address Pen 2

APPENDIX 4 Data Formats

The instruments support a free format, with respect to parameter values, using a variable number of data characters, referred to as (D1), (D2), (D3), (D4), (D5), and (D6), representing parameter values.

Decimal - Integer and floating point numbers for parameter values

DATA SENT TO THE INSTRUMENT
The data character count can be anything between 1 and 6 characters. Leading or trailing spaces or zeros are allowed. For whole numbers or if the decimal place is not required, the decimal point can be omitted. For negative numbers, the minus sign must precede the value, but spaces may be inserted either side of it.

In the examples below, spaces are spaces, and "X"'s are absence of a character, that is, fewer than six characters in the data field.

EXAMPLE NUMBER	CHARACTERS 1	2	3	4	5	6
13.9			1	3	.	9
	1	3	.	9		
		1	3	.	9	
	1	3	.	9	X	X
	0	0	1	3	.	9
	1	3	.	9	0	0
	0	1	3	.	9	0
-2		-	2	.	0	
	-	2	.	0		
			-	2		
		-	0	.	2	0
	-	2	X	X	X	X

DATA SENT FROM THE INSTRUMENT

When a value is returned from an instrument, its decimal point is positioned to match the position as it would be seen on the display.

VALUE RANGE			CHARACTERS					
			1	2	3	4	5	6
-99,999	TO	-1,000	-	N	N	N	N	N
-999.9	TO	-100.0	-	N	N	N	.	N
-99.99	TO	-10.00	-	N	N	.	N	N
-9.999	TO	-1.000	-	N	.	N	N	N
-.9999	TO	-.1000	-	.	N	N	N	N
-.0999	TO	-.0100	-	.	0	N	N	N
-.0099	TO	-.0010	-	.	0	0	N	N
-.0009	TO	-.0001	-	.	0	0	0	N
-.00009	TO	.000009	0	.	0			
.00001	TO	.00009	.	0	0	0	0	N
.00010	TO	.00099	.	0	0	0	N	N
.00100	TO	.00999	.	0	0	N	N	N
.01000	TO	.09999	.	0	N	N	N	N
.10000	TO	.99999	.	N	N	N	N	N
1.0000	TO	9.9999	N	.	N	N	N	N
10.000	TO	99.999	N	N	.	N	N	N
100.00	TO	999.99	N	N	N	.	N	N
1,000.01	TO	9,999.9	N	N	N	N	.	N
10,000	TO	999,999	N	N	N	N	N	N

Positive numbers do not have a plus (+) sign included in the data, but minus signs (-) and decimal points (.) do require a character position, and therefore decrease the number of positions available for digits.

Decimal - For Status

When the supervisory computer requests a “Status Word” or updates the Enable Mode Status, the data must be a decimal number from 0 to 255. The data will represent an eight bit number, with each bit corresponding to a status as follows.

DESCRIPTION	BIT POSITION	MEANING	
STATUS WORD 1	7	1 = Error Exists	0 = No Errors
	6	1 = Alarm 1 On	
	5	1 = Alarm 2 On	
	4	1 = Remote Setpoint	0 = Local Setpoint
	3	1 = In Off Mode	0 = In Control Mode
	2	1 = In Manual	
	1	1 = Profiling	
	0	1 = Run	0 = Hold
STATUS WORD 2	7	1 = Keypad locked	
	6	1 = Setpoint 2*	0 = Setpoint 1
	5	1 = Event 6 On**	
	4	1 = Event 5 On**	
	3	1 = Event 4 On**	
	2	1 = Event 3 On	
	1	1 = Event 2 On	
	0	1 = Event 1 On	
STATUS WORD 3 or SET ENABLE	7	1 = Test Mode Enabled	
	6	1 = Calibration Mode Enabled	
	5	1 = Program Mode Enabled	
	4	1 = Tune Mode Enabled	
	3	1 = Stand-By Mode Enabled	
	2	1 = Profile Continue Mode Enabled for 6000, 73XX, 773X, 776X = Setpoint Select Mode Enabled for 2000, and all other 7XXX's, 8000, 8200	
	1	1 = Profile Entry Mode Enabled for 6000, 73XX, 773X, 776X = Setpoint Changes Enabled for 8000, 8200 = Not assigned for 2000, all other 7XXX's	
	0	1 = Setpoint Changes Enabled for 2000, 6000, 7XXX = Autotune Enabled for 8000, 8200	

Bit 7 is the most significant bit and bit 0 is the least significant bit.

* MIC 8200 only
** MRC 7XXX only

EXAMPLES

If the instrument has no errors or alarms, is in local setpoint, and in normal Control Mode, Status Word 1 would be:

00000000 Binary = 00 Hex = 0 Decimal

If the instrument has no errors or alarms, is in remote setpoint, and is in manual (Stand by Mode), Status Word 1 would be:

00010100 Binary = 14 Hex = 20 Decimal

If the instrument is a profiler and has no errors or alarms, (remote setpoint doesn't apply), is executing a profile, and is in the run condition, Status Word 1 would be:

00000011 Binary = 03 Hex = 3 Decimal

If the supervisory computer wanted to have only Tune, Stand-By, and Setpoint Changes enabled, it would send command/parameter code of 103 and a value of :

00011001 Binary = 19 Hex = 25 Decimal

If it then requested Status Word 3, it would have the same value returned.

APPENDIX 5 Instrument Program Mode Parameters For Communications

CODE	PARAMETER/VALUE	DEFAULT
CCon	Communications Configuration 0 = Off 1 = Monitor - Only Mode 2 = Normal Mode *3 = Full Access with Limit Checking - Checksum Calc. *4 = Full Access without Limit Checking - Checksum Calc.	0 (4**)
CbS	Communications Band Select 1 = 300 2 = 600 3 = 1200 4 = 2400 5 = 4800 6 = 9600	6
CAd 2000, 6000, 8000, 8200	Communications Address 0 to 99	0 (1**)
CAd1 7000, 7700, 7800	Communications Address Pen 1 0 to 99	0 (1**)
CAd2 7000, 7700, 7800	Communications Address Pen 2 0 to 99	1 (2**)

*See Appendix 6, Notes 6, 7, 8, & 9.

**Default values for Total Access Com.

APPENDIX 6 Application Notes

1. When the keypad is locked by the supervisory computer, the keypad will be deactivated and all key depressions will be ignored. If the instrument is de-powered, upon power-on the keypad is unlocked, in order to gain access to the instrument should the computer go down. Therefore, if an application requires that the keypad always be locked, the computer should monitor the status periodically and lock it when necessary.

2. All time values applicable to profiles are assumed to be in the time base currently selected. That is, if Ptb = 1, corresponding to a time base of hours and tenths, a time value of 75 hours and 4 tenths of hours would be displayed on the instrument as “75.4” and transmitted as “754”. If Ptb is changed to 2, corresponding to hours and minutes, the internal value is converted to module 60 and displayed as “12.34”, for 12 hours and 34 minutes, and transmitted as “1234”.

Profiles may be stored and executed in different time bases, but care must be taken to be sure that the time base is set accordingly when the profile is executed and when time values are viewed or communicated.

The supervisory computer must take into account that the time values transmitted are whole numbers which must have a decimal point or colon placed appropriately.

3. Since Partlow instruments work on a two-wire multi-drop line, the supervisory computer or interface hardware must ensure that the transmitter is enabled while the computer is sending data. Many RS-485 cards or RS-232 to RS-485 interface adapters require special handling of the RTS (Request To Send) line or some other signal to accomplish this, which usually requires an assembly level communications routine. The standard DOS (Disk Operating System) routines don’t support this. The supervisory computer must manage this function.

The Partlow CommLink 2000, RS-232 to RS-485 converter, automatically handles the transmitter enabling, as well as providing signal conversion and electrical isolation between the computer and the network.

4. During address transmission in the Establish Connection Procedure, the ones digit of the instrument is actually sent first (referred to as AL) and the tens digit (referred to as AH) is send second. Note that each digit is sent twice.

5. Program parameter CCon = 3 or 4 will allow access to all Program and Tune parameters except CbS, CAd, CAd1, and CAd2.

6. If CCon = 3 or 4, and a Read command is received by an instrument that does not support that particular command, then the instrument will respond by transmitting a zero.

7. If a CCon = 3 or 4, and a Write command is received by an instrument that does not support that particular command, then the instrument will respond by transmitting an ACK and ignore the write request.

(Continued on next page)

8. Operation with CCon = 3 is the normal mode of operation for access to all parameters.

With CCon = 3:

a. All supported writes will be checked to verify that the values are within the limits documented in the appropriate instrument specification.

b. If the value to be written to the instrument is valid, then the value will be changed in the instrument and a new checksum calculated.

c. The calibration bytes will be available as read only. All other commands supported for an instrument type (i.e. 2000 communications commands) will be available.

9. **Operation with CCon=4 should not be the normal mode of operation. This mode should only be used when absolute fastest operation is needed, or when downloading the entire configuration to the instrument. In the latter case, CCon should be set to 3 after the download**.

With CCon = 4:

a. A value written to an instrument with a 7XX or 8XX command will be stored **without checking the limits** of the value defined in the instrument specification, and a **new checksum will not be calculated and stored**.

b. The only commands which will calculate a new checksum are 702, 703, and 704 (the matrix numbers) and this is the calibration checksum only.

c. Program and Tune Parameter Write (CCon = 4:)
The values written to the instrument with a 7XX or 8XX command are expected to match a previous read value from the controller. **Therefore, if a partial download is performed, (not all parameters are written to the instrument, including the checksum, command 899) the checksum may not match and will result in an error 16 during the periodic test of the parameters, and restoration of the old values.**

d. Calibration Parameter Write (CCon = 4):
If a partial calibration download is performed, (not all calibration values are written to the instrument) the checksum may not match and will result in an error 17 during the periodic test of the controller. It is recommended that the supported calibration byte commands for that controller be sent sequentially with the 999 write (write checksum value) last. It is not necessary to transmit calibration bytes beyond what the controller needs. For example, the 2000 has 34 calibration bytes, all 9XX commands could be used, but commands greater than 934 and less than 999 would transmit a zero for a Read command, and ACK and ignore a Write command.

10. Tab Number Verification:
It is recommended that before a download, the Tab number be the first command/ data sent over the communication link (command 701). This will verify that the commands are for the correct instrument type. If the Tab number does not match the internal Tab number stored:

a. CCon will be modifed to a 2 (two).
b. The instrument will respond with a NAK.
c. Only commands 0XX through 6XX defined in the communication specification for that instrument type will be subsequently supported, since CCon now equals 2.

11. After the Tab number has been validated, the periodic test counter will be cleared, which will allow fifteen minutes for all the parameters to be transferred to the instrument. If for any reason the data is not transferred within a fifteen minute interval, the instrument may post an error 16 (program checksum error) or error 17 (calibration checksum error), or may restore old values.

12. CCon will be accessible over the communication link. The only limitation is that the host will not be able to set CCon equal to zero (CCon = 0, communication link off).

13. Transmission Interrupt
In an event the transmission is interrupted, (i.e. power loss) and there is a question as to whether all the data has been transferred to the instrument, the parameters should be retransmitted.

14. The communication configuration command will not allow the computer to change to a read only status (CCon = 1) if the keypad is locked out. The command will receive a negative acknowledge.

APPENDIX 7 Read and Write Examples

WRITE FORMAT

Description of the bytes required to make up a write request message to a unit.

EOT	Indicates to unit that next four bytes are address.
ADDRESS LOW	Address byte one, units digit of CAD.
ADDRESS LOW	Address byte two, units digit of CAD.
ADDRESS HIGH	Address byte three, tens digit of CAD.
ADDRESS HIGH	Address byte four, tens digit of CAD.
STX	Start of Text signals beginning of message.
CMD BYTE 1	Most significant (Hundreds) digit of command byte.
CMD BYTE 2	Tens digit of command byte.
CMD BYTE 3	Least significant (units) digit of command byte.
DATA BYTE 1	* Most significant byte of data
DATA BYTE 2	*
DATA BYTE 3	* Data length is variable from 1 to 6 bytes.
DATA BYTE 4	*
DATA BYTE 5	*
DATA BYTE 6	* Least significant byte
ETX	Signals end of message and next byte will be block check character.
BCC	Block Check Character

WRITE EXAMPLE

Send unit 01 a command to change the setpoint to150. Program mode parameter settings required:

CAd = 01 : Communication Address
CCon = 02 : Communication Configuration
CbS = 06 : Communication Baud Select (9600 assumed)

Referencing the setpoint request command in Appendix 3 indicates the setpoint request is command 401. Note that the command sequence is shown in ASCII and hexidecimal format.

The command sequence is:

	EOT	ADL	ADL	ADH	ADH	STX	CMD1	CMD2	CMD3	D1	D2	D3	ETX	BCC
ASCII	EOT	1	1	0	0	STX	4	0	1	1	5	0	ETX	(STX)
HEX	04	31	31	30	30	02	34	30	31	31	35	30	03	02

The BCC calculation is an Exclusive-Or of all bytes after the STX character up to and including the ETX (03). In this example, the BCC is a hex OZ, which just happens to be the ASCII control code STX. Refer to the ASCII Code Chart on Page 16.

ASCII	HEX		Binary format 8421	8421	
34			0011	0100	
30	EXCLUSIVE-OR	^	0011	0000	
			0000	0100	
31		^	0011	0001	
			0011	0101	
31		^	0011	0001	
			0000	0100	
35		^	0011	0101	
			0011	0001	
30		^	0011	0000	
			0000	0001	
03		^	0000	0011	
			0000	0010	= BCC 02H

The message is checked for Parity as each byte is received. If a parity error is detected, an error code will be displayed at the instrument and remainder of the message is ignored.

Once the entire message is assembled, the BCC character is verfied. The unit then checks to ensure the data is valid and the command does not have restrictions (i.e. the value is within present limits). If the command is found acceptable, then the unit will issue an ACK to the computer to Ackowledge the change. If for any reason the command request is found unacceptable, the unit will issue a NAK (Negative-Acknowledge) and the data will be ignored.

READ FORMAT

Send unit 01 a request for its setpoint value.

EOT	Indicates to unit that next four bytes are address.
ADDRESS LOW	Address byte one, units digit of CAD
ADDRESS LOW	Address byte two, units digit of CAD
ADDRESS HIGH	Address byte three, tens digit of CAD
ADDRESS HIGH	Address byte four, tens digit of CAD.
CMD BYTE 1	Hundreds digit of command byte.
CMD BYTE 2	Tens digit of command byte.
CMD BYTE 3	Units digit of command byte.
ENQ	Read request from the computer.

When the unit recognizes that the request is a READ, a message will be assembled containing the data requested. The message is sent to the computer in the following format:

STX	Start of Text
CMD BYTE 1	Hundreds digit of command byte.
CMD BYTE 2	Tens digit of command byte.
CMD BYTE 3	Units digit of command byte.
DATA BYTE1	*Most significant byte of data.
DATA BYTE 2	*
DATA BYTE 3	* Data length is variable from 1 to 6 bytes.
DATA BYTE 4	*
DATA BYTE 5	*
DATA BYTE 6	* Least significant byte.
ETX	End of Text
BCC	Block Check Character

READ EXAMPLE

Read the setpoint from unit 01:

	EOT	ADL	ADL	ADH	ADH	CMD1	CMD2	CMD3	ENQ
ASCII	EOT	1	1	0	0	4	0	1	ENQ
NEX	04	31	31	30	30	34	30	31	05

If for example, a setpoint request is made after issuing the write request example, the controller would respond as follows:

	STX	CMD1	CMD2	CMD3	D1	D2	D3	D4	D5	D6	ETX	BCC
ASCII	STX	4	0	1	1	5	0	.	0	0	ETX	1C
HEX	02	34	30	31	31	35	30	2E	30	30	03	1C

Setpoint = 150.00
Note that the 2E is the ASCII code for a decimal point and the BCC is hex IC, which corresponds to the ASCII control code FC. Refer to the ASCII Code Chart on page 16.

APPENDIX 8 Communications Software

1. Communications software may be available from Partlow to meet your application needs.

2. Molygraphics is a Partlow SCADA program available for use with primarily Partlow products, including the Molytek line. It offers excellent value and capability and takes full advantage of the capabilities of our instruments, including uploading and downloading of all calibration and configuration data.

3. Communications drivers are available for the Genesis Control Series software by IICONICS, Inc.

4. Communications drivers may be available for other programs. Consult the factory.

5. Communciations routines have been written in GW BASIC and Quick BASIC to run with instruments connected to an IBM PC or compatible via our CommLink 2000 converter. These can be used directly if programming in these languages, or used as a guide for writing routines in another language.

6. Consult the Price Book or the factory for availability, pricing, and ordering information.

APPENDIX 9 RS-485 Communication Port Wiring

1.0 GENERAL

Partlow RS-485 Communications uses a half-duplex scheme requiring a single two-wire connection at each instrument. Terminal connections for Partlow instrumentation are made at the rear of the instrument for MIC 2000, 6000, 8000 and 8200 units, and at terminal block TB2 for MRC 7000, 7700, and 7800 instruments.

2.0 WIRING GUIDELINES

2.1 Wiring should be done using a single twisted pair shielded cable. The shield(s) should be connected together at each instrument, but grounded only at one end, nearest the supervisory computer.

2.2 To eliminate "ground shift potential" problems, the purchase of Optical Isolators for installation at least at the computer is recommended. Others may be required between groups of instruments located on different panels or equipment. Partlow's CommLink 2000 is available as an RS-232 to RS-485 converter or an RS-485 Repeater, both providing optical isolation.

2.3 The twisted pair cable must be isolated from all electrical noise generating sources. Wiring must not be run in the same conduit or bundle as any AC or relay wiring. Good wiring practices must be followed to ensure optimum performance. Recommend cable is Belden No. 8451. This is 22 ga. stranded copper with shield and vinyl jacket.

3.0 WIRING

3.1 Up to 32 Partlow instruments may be placed on a single RS-485 loop. Wiring connections should be as shown in Figure 3 (Page 45).

3.2 The Shield should be grounded at the supervisory computer. All cable shields must be connected together at each instrument, but not connected to the instrument or ground.

3.3 Terminal connections to Partlow instrumentation are “Serial A (+)” and “Serial B (-)”.

3.4 Terminating resistors should be installed at the last instrument on the loop, and at the supervisory computer as shown. Terminating resistors should be 120 ohms.

3.5 Make terminal connections as shown in Figure 3 (Page 45).

Figure 3 - Digital Communications Wiring

* The Converters and Repeaters include internal 120 ohm line terminating resistors. When the line ends at an instrument, a terminating resistor must be installed. The Converters and Repeaters also provide proper line biasing on the RS-485 output ports.