MICROMOTE PROTOCOL EMULATION

1.1 GENERAL DESCRIPTION

This section briefly describes the MICROMOTE communication protocol for reference purposes only. The appropriate SYSTRONICS documentation should be consulted for complete details of the MICROMOTE protocol.

The MICROMOTE standard protocol is an asynchronous protocol designed to connect a Systronics compatible RTU directly to a host computer communication port. The protocol may be used either in a point-to-point or in a multi-drop configuration. The protocol can be used in either half or full-duplex operation. Communications security is provided by a 16-bit calculated cyclic redundancy check (CRC).

All communications exchanges in MICROMOTE 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 will return a response to the host for all valid messages sent by the host and addressed to the remote. Also, all messages received by the remote are validated by checking the Station Number (RTU Address) and CRC. If these bytes are not valid, the remote will ignore the message; no action or response will be initiated.

Typical Request

RTU Address High Bit ON	File Number	Data As Required	CRC High Byte	CRC Low Byte

Typical Response

RTU Address High Bit OFF	File Number	Data As Required	CRC High Byte	CRC Low Byte

Figure D-1 Typical MICROMOTE Message

1.2 MESSAGE STRUCTURE

A MICROMOTE message consists of a string of 8-bit binary characters. Each character is transmitted in a standard asynchronous serial format, least significant bit first. The first character of a message is defined to be the first character received following either the successful receipt of a previous MICROMOTE message or the expiration of an inter-character time-out timer (user configurable). The first character must always have the MSB (bit 8) set to indicate that the message was sent by the Master. The first byte of any message is a 7-bit station number. The second byte is a 7-bit file number indicating the type of data to return or in the case of controls what type of output to perform. The subsequent bytes in the message (if any) are used in various ways depending on the type of command. The last two bytes of all messages are a 16-bit CRC. Each 8-bit byte is transmitted exactly with no encoding. Figure D-1 shows the general format of a RTU message exchange between a host and the Comm-Troller.

Micromote File #	Description
14H	Analog Inputs
19H	Digital (status) Inputs
1AH	Pulse Acccumulators
3FH	Read All Data
9DH	Select Momentary Control
9FH	Select Continuous Control
A1H	Select Set Point Control
A3H	Execute Selected Control
B0H	All Data Configure Control

Figure D-2 MICROMOTE File Numbers

1.3 Message Types

MICROMOTE protocol communications exchanges can be divided into two types: data requests and control requests. In data requests, the host transmits a message requesting data values from the remote. The remote responds by transmitting the requested data values. These data values may be discrete (status), analog, accumulator, calculated variables, remote parameters, RTU status, analog outputs or discrete outputs. The format of the data types are as required by the host. Some variations may exist from site to site provided the host and remote are consistent in the data format (e.g. if the host expects BCD accumulator values, the remote must transmit BCD accumulator values). Note that the Comm-Troller does not do any processing on the data collected from the PLC. The PLC ladder logic must perform any data formatting that is required prior to placing the information in the data area which is read by the Comm-Troller.

Control requests are defined as any message from the host requesting the remote to change the state of a field device or to change or modify an internal condition of the remote.

1.4 MICROMOTE ADDRESS MAPPING

The MICROMOTE file numbers used in the message transactions between the host and the Comm-Troller are related to the Allen-Bradley I/O ports as defined in Figure D-2.

1.4.1 Status Inputs

The current status (OFF/ON) of discrete inputs is determined by status input modules in the Allen-Bradley PLC(s). The state of the inputs is read by the MICROMOTE master using a "File Read Request Message" for file 19_{hex}. When this command is received the Comm-Troller will form the response from data collected from its status input cards. The mapping of MICROMOTE input points to Allen-Bradley inputs is one-to-one. That is, the first input of the first status input card is input 0001, the second is input 0002 and so on, up to the maximum number defined for the system.

1.4.2 Analog Inputs

The current value of each analog input is determined by analog input modules in the Allen-Bradley PLC(s). The value of the inputs is read by the MICROMOTE master using a "File Read Request Message" for file 14_{hex}. When this command is received the Comm-Troller will form the response from data collected from the PLC analog input cards. The mapping of MICROMOTE analog points to Allen-Bradley inputs is one-to-one. That is, the first input of the first analog input card is input 0001, the second is input 0002 and so on, up to the maximum number defined for the system. Each analog input is 16-bits wide; however, only the 12 least significant bits are valid for a MICROMOTE message. All analog input scaling is done in the PLC prior to moving the data to the buffer area for the Comm-Troller.

1.4.3 Accumulator Inputs

The current value of each accumulator input is determined by accumulator input modules or by ladder logic counters in the Allen-Bradley PLC(s). The state of the counters is read by the MICROMOTE master using a "File Read Request Message" for file $1A_{hex}$. When this command is received the Comm-Troller will form a response from data collected from the PLC's accumulator inputs. The mapping of MICROMOTE input points to Allen-Bradley inputs is one-to-one. That is, the first input of the first accumulator input card is input 0001, the second is input 0002 and so on, up to the maximum number defined for the system. Each accumulator input is 16-bits wide.

1.4.4 Read All Data

Status, Analog and Accumulator data can all be returned in one message using a "File Read Request Message" for file $3F_{hex}$. When this command is received the Comm-Troller will form its response from the data collected from the PLC Status, Analog and Accumulator inputs. The amount of data to be returned and the order in which the data will appear in the response is determined by an All Data Configure Control Message (see Section 1.4.7).

1.4.5 Digital Control Outputs

The Allen-Bradley digital outputs are controlled as either momentary or latched outputs depending on the type of MICROMOTE message. All digital control commands use a select before execute command sequence to prevent accidental control operation. In a Select-Before-Execute sequence a select command is first sent to the RTU by the Master. The remote will check the command for validity and if all data is correct and the selected point is configured and on scan, a response will be sent back to the master. If any of the checks fail, the remote will not respond to the request. A timer will be started to wait for a subsequent execute message from the master. If a proper execute command is received within the time-out period, a command will be sent to the PLC from the Comm-Troller to set or reset the appropriate output. The select/execute time out timer value is user selectable by changing values in the configuration table header.

Each digital output can be controlled in two (2) different ways: Latched or Momentary. The mode of operation (latched or momentary) is determined by the file number used in the control command. Latched outputs use file $9F_{hex}$. Momentary outputs use file $9D_{hex}$. Note that the first address in each group controls the same physical output; the only difference is in the way in which the output from the PLC is controlled. For a latched output (File $9F_{hex}$) the output is changed to the state defined by the command. For a momentary output (File $9D_{hex}$) the output is first set ON and then a short time later the output is turned back OFF. The time duration of the output (control output dwell time) is determined by a word in the configuration table.

l.4.6 Setpoint Outputs

Setpoint outputs are analog outputs from the Allen- Bradley. The outputs are controlled using the MICROMOTE "Setpoint Control Commands". All setpoint control commands use a select before execute command sequence to prevent accidental control operation. In a Select-Before-Execute sequence a select command is first sent to the RTU by the Master. The remote will check the command for validity and if all data is correct and the selected point is configured and on scan, a response will be sent back to the master. If any of the checks fail, the remote will not respond to the request. A timer will be started to wait for a subsequent execute message from the master. If a proper execute command is received within the time-out period a command will be sent to the PLC from the Comm-Troller to set the output value into the output register. The select/execute time out timer value is user selectable by changing values in the configuration table header. Setpoint commands use file $A1_{hex}$.

1.4.7 All Data Configure Control

The All Data Configure Control message is also a control output command. This command only modifies internal tables in the Comm-Troller. The command does not use the select-before-execute sequence. The All Data Configure Command is a variable length command which specifies the order of the data which the Comm-Troller will return when it receives a file 3F Read Command (Read All)

1.5 MICROMOTE CONFIGURATION TABLE

1.5.1 MICROMOTE Configuration Header

Byte # 0 in the configuration header is used to define the RTU address to which the Comm-Troller will respond when communicating with the host. This entry is an 8-bit binary number in the range of 1 to 127 (00000000 to 01111111).

Byte # 1 is used to define the number of PLCs in the system. 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). The Comm-Troller will use this number to determine the number of PLC Configuration blocks to read.

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

Byte # 4 is used to define the baud rate which will be used while communicating with the 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), 2400 baud (00001000), 4800 baud (00001001) and 9600 baud (00001011).

Byte # 5 is used to select the host communication line parity bit. Valid settings for this byte are: No Parity (00000000), Odd Parity (00000001) and Even Parity (00000010).

Byte # 6 is used to select the number of Stop Bits to use when communicating with the host. Valid selections are: 1 Stop Bit (00000001) or 2 Stop Bits (00000010)

Bytes # 7 and 8 are used to specify the Control De-Select Time. This is the amount of time that the Comm-Troller will wait after a valid select has been recognized. A control command for the selected point must be received before the timer times out in order to be valid. The timer is specified in 10ms increments. To set the Control De-Select time out period to 1 min., a value of 1770_{hex} (6000_{10}) should be entered in bytes 7 and 8.

Bytes 9 thru 14 are not recognized by the Comm-Troller for the MICROMOTE protocol.

Byte # 15 is the PLC "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 must have exactly the same configuration information as the primary PLC and be installed on the same data highway as the primary 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 zero then a switch will not be attempted.

Bytes 16 and 17 are used to difine the RTS/CTS delay time. The length of time that the Comm-Troller will wait after setting the RTS line true before transmitting data. The delay time will be 10ms per count. To set the RTS/CTS delay to 2 seconds a value of $00C8_{hex}$ (200_{10}) should be entered in bytes 16 and 17.

Bytes 18 and 19 are not used for the MICROMOTE Comm-Troller.

Bytes # 20 and 21 are used to specify the momentary contact output "dwell" time. The amount of time that a momentary output will remain active (closed) can be set using this word. The dwell time is specified in 10ms increments.

Bytes # 22 and 23 are used to specify the message re-sync time out period. Normally this value will be set to approximately 2 to 3 character times. The time is set in 10ms increments.

Byte # 24 is used as a "re-select" enable flag. Normally, a MICROMOTE will only allow a single select command to be active at any time. The only way that the select will be canceled is for the remote to either receive a valid execute command or for the time out period to expire. If byte # 24 is a 0, the Comm-Troller operates in exactly this way. If byte # 24 is non-zero however, the Comm-Troller will accept select commands received after the first. The second select command will override the first. A valid execute must still be received before any control actions will occur.

Bytes # 25 thru 27 are used to implement an anti-streaming option to prevent the Comm-Troller from accidentally disrupting communication to other RTUs on the same communication channel. This function is implemented using ladder logic programming in the PLC. Whenever the Comm-Troller is ready to return a message to the host, one of the first things that occur is the activation of the Request To Send (RTS) modem control line. Normally the RTU modem will then bring up its carrier and return the Clear To Send (CTS) signal to the Comm-Troller and the message will be transmitted. A failure in the Comm-Troller could occur in such a way that the RTS line would remain in the active state. The carrier signal would then knock out communication with any other remotes on the same communication line. The MICROMOTE Comm- Troller will set a bit in the PLC memory whenever it sets the RTS line active. PLC programming can then start a timed output on the change of state. The output will be used to drive a relay with a contact wired in series with the RTS line. Thus, unless the relay is closed the RTU modem will never see the RTS input and the carrier will never come on. If a failure occurs the RTS signal will be removed when the PLC output timer times out. Logic could also be installed to prevent the re-activation of the signal within a pre-defined period. Byte # 25 is used to specify the PLC address to which the RTS flag will be written. Bytes # 26 and 27 are used to specify the address of the word to use for the RTS flag. The RTS flag will set bit 0 (least significant) in the specified word. Note that the ladder logic must control the resetting of this bit.

BYTE	DESCRIPTION
0	RTU Number
1	Number of PLC's
2,3	Not Used
4	Baud Rate
5	Parity
6	Number of Stop Bits (1 or 2)
7,8	Control De-Select Time (10ms inc)
9-14	Not Used
15	PLC Swap Enable Flag
16-19	Not Used
20,21	Momentary Contact Dwell Time
22-23	Message Re-Sync Timer
24	Re-Select Enable Flag
25	PLC to Receive RTS Flag
26,27	Address To Receive RTS Flag
28,29	Flag Address to Set
30-49	Not Used

Figure D-3 Configuration Header

BYTE	DESCRIPTION
0	PLC Address
1	# Bytes per Status Input Card
2	# Status Input Cards
3,4	Start Address for Status Inputs
5	# Bytes per Analog Input Card
6	# Analog Input Cards
7,8	Start Address Analog Inputs
9	# Bytes per Accumulator Input
10	# Accumulator Inputs
11,12	Start Address Accum. Inputs
13	# Bytes per Digital Output
14	# Digital Output Cards
15,16	Start Address Digital Outputs
17	# Bytes per Analog Output
18	# Analog Output Cards
19,20	Start Address Analog Output
21-56	Not Used

Figure D-4 PLC Data Section

Bytes # 28 and 29 are used to point to an address in the PLC which will be set whenever the RTS flag has been written.

Bytes # 30 thru 49 are not used for the MICROMOTE Comm-Troller.

1.5.2 PLC Data Configuration for MICROMOTE Protocol

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

Byte # 0 is used to define the address of the PLC on the Data Highway. The first PLC must be at address $0A_{HEX}$.

Byte # 1 is used to define the number of bytes of data for each status input card. Normally it will be set to 2 because each input card in an Allen-Bradley provides 16 bits of status information. In special applications however, PLC ladder logic could be used to form "cards" of any width.

Byte # 2 is used to define the number of status input cards associated with this PLC. A total of 256 bytes of status input information can be defined per Comm-Troller.

Bytes # 3 and 4 define the starting address in the PLC for the status input data.

Bytes # 5, 6, 7 and 8 are used in a similar fashion to define the Analog input cards for the PLC. A total of 256 bytes of analog input information can be defined per Comm-Troller.

Bytes # 9, 10, 11 and 12 are used to define accumulator inputs. A total of 256 bytes of accumulator information can be defined per Comm-Troller.

Bytes 13, 14, 15 and 16 are used to define control outputs. A total of 64 bytes of control output information can be defined per Comm-Troller

Bytes # 17, 18, 19 and 20 are used to define analog outputs. A total of 64 bytes of analog output information can be defined per Comm-Troller.

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

1.6 JUMPER SELECTIONS FOR MICROMOTE PROTOCOL

The Comm-Troller jumper selections and EPROM part numbers for MICROMOTE protocol operation is detailed in the following figure.

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

MICROMOTE Protocol Communication is on Port P1 (top port), Allen-Bradley Communication is on Port P2 (center port)
U13 = # 145-002-3 (02/19/90)
U23 = # 145-001-3 (02/19/90)

Figure D-5 Jumper Option Selections

1.7 EXAMPLE CONFIGURATION FILE FOR PLC 5

The following figures detail a sample configuration file for a typical MICROMOTE protocol application. The configuration information is based on the information shown in Figure D-6

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 (decimal word address)

= 256 (decimal byte address)

= 100_H (hex byte address)

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

Protocol	MICROMOTE (RTU Address = 01)
PLC Type	PLC-5/15
Comm. Data	Leased Line, 1200 baud, 1 stop, No Parity
Num. of PLCs	One
Num. of Status	144
Num. of Analogs	5
Num. of Accums	6
Num. of Controls	112
Num. of Setpoints	6
Desired location of configuration table at word 0000_{10}	
Desired starting location of data at word 200_{10}	
Desired location for Config. Table address pointer 128_{10}	
Interface module address is 11_8	
RTS Signal bit at PLC A_{16}, Address 16_{10}	
RTS Flag at PLC A_{16}, Address 15_{10}	
Control De-Select Time Out = 1 min.	
Momentary Output Dwell Time = .5 Sec.	
Message Re-Sync Time = .5 Sec.	
RTS/CTS Delay Time = 2 Sec.	

Figure D-6 Example System Info.

1.7.2 Example Table Entries

PLC WORD	VALUE (HEX)	PLC WORD	VALUE (HEX)
128	0000	025	0A02
000	0101	026	0901
001	0000	027	9002
002	0602	028	0501
003	0117	029	A202
004	7000	030	0601
005	0000	031	AC02
006	0000	032	0701
007	0000	033	B802
008	00C8	034	0601
009	0000	035	C600
010	0032	036-53	0000
011	0032	054	00XX
012	010A		
013	0010		
014	000F		
015	0000		
016	0000		
17-24	Not Used		

FIgure D-7 Example Table Entries