DF-1 PROTOCOL EMULATION

1.1 GENERAL DESCRIPTION

This section briefly describes the Allen-Bradley DF-1 half-duplex communication protocol for reference purposes only. The appropriate Allen-Bradley documentation should be consulted for complete details of the protocol.

The DF-1 protocol is an asynchronous byte oriented protocol that is used to communicate with most Allen-Bradley RS232 interface modules. The protocol may be used to provide either peer-to-peer communication through a full-duplex (unpolled) protocol or in a multi-dropped configuration using the half-duplex (polled) protocol. The Comm-Master uses DF-1 half-duplex protocol to communicate with equipment connected to its "RTU" port and DF-1 full-duplex protocol to communicate with PLC equipment connected to its "HOST" port. Communication between the Comm-Master and the local PLC equipment operates at 9600 baud using 8 data bits, 1 stop bit and no parity. Communication security is provided by a 16-bit calculated cyclic redundancy check (CRC).

The communication parameters used for transferring information between the Comm-Master and the RTU equipment can be set by the user as required. The Comm-Master can be operated at any baud rate from 300 to 9600 baud with any combination of data, parity and stop bits. The message security field can be selected as either BCC or CRC. Section 1.4.1 provides the detailed information for setting the RTU communication parameters.

All communications exchanges in DF-1 half-duplex protocol are initiated by the host, in this case the Comm-Master. The remote cannot initiate any exchange with the host nor can the remote directly address or communicate with another remote.

1.2 MESSAGE STRUCTURE

1.2.1 DF-1 Half-Duplex Protocol

Half-duplex protocol is a multi-drop protocol used for communication between one master and one or more slave devices. The Comm-Master is the master device and the slave devices are Allen-Bradley (or compatible) modules that have DF-1 slave mode capability. The Comm-Master can communicate with from 1 to 254 stations on a single communication link.

1.2.2 Transmission Symbols

DF-1 half-duplex protocol is a character oriented protocol. It uses the ASCII control characters shown in Figure C-1. The control characters are combined to make control and data symbols. A symbol is a sequence of one or more bytes having a specific meaning to the protocol. The characters of a symbol must be sent one after another with no other characters inserted between them. Figure C-2 defines the symbols used in DF-1 half-duplex protocol.

Code	Abbreviation	Hexadecimal
	SOH	01
	STX	02
	ETX	03

Figure C-1 DF-1 Control Characters

1.2.3 Typical Message Transaction

Symbol	Type	Description
DLE SOH	Control	Master Symbol That Indicates The Start Of A Message
DLE STX	Control	Indicates The Start Of The Data Field
DLE ETX BCC	Control	Message Termination With BCC Error Check
DLE ETX CRC	Control	Message Termination With CRC Error Check
DLE ACK	Control	Acknowledge Good Receipt Of A Message
DLE NAK	Control	Negative Acknowledge Signifying An Error In A Received Message
DLE ENQ	Control	Issued By Master To Request (poll) Data From A Remote
DLE EOT	Control	Issued By Remote When It Has No More Data To Send
Data	Data	Single Characters Having Values From 00 To FF (hex) Except 10 (hex)
Dle Dle	Data	Represents The Data Value 10 (hex)

Figure C-2 Half-Duplex Protocol Symbols

Comm-Master™ DF-1 Protocol with PLC-5 Addressing

The following diagram details the messages sent between the Comm-Master and a remote to read a block of data in the remote. This typical "poll" message starts with the Comm-Master issuing a "Master Message Link Packet" which contains the address of the remote device which is to receive the message, the message itself and the BCC/CRC check field at the end of the message. The addressed slave device receives the message, checks it for errors and returns an acknowledge packet. The Comm-Master then issues an Enquiry command. The addressed slave then sends the data requested by the Comm-Master. The Comm-Master will check the received data and return an acknowledge to the slave. The master will then send another enquiry message. The slave will respond with either more data if available or an end of transmission message. The Comm-Master will transfer the data received into the local PLC's memory and proceed with the next poll message.

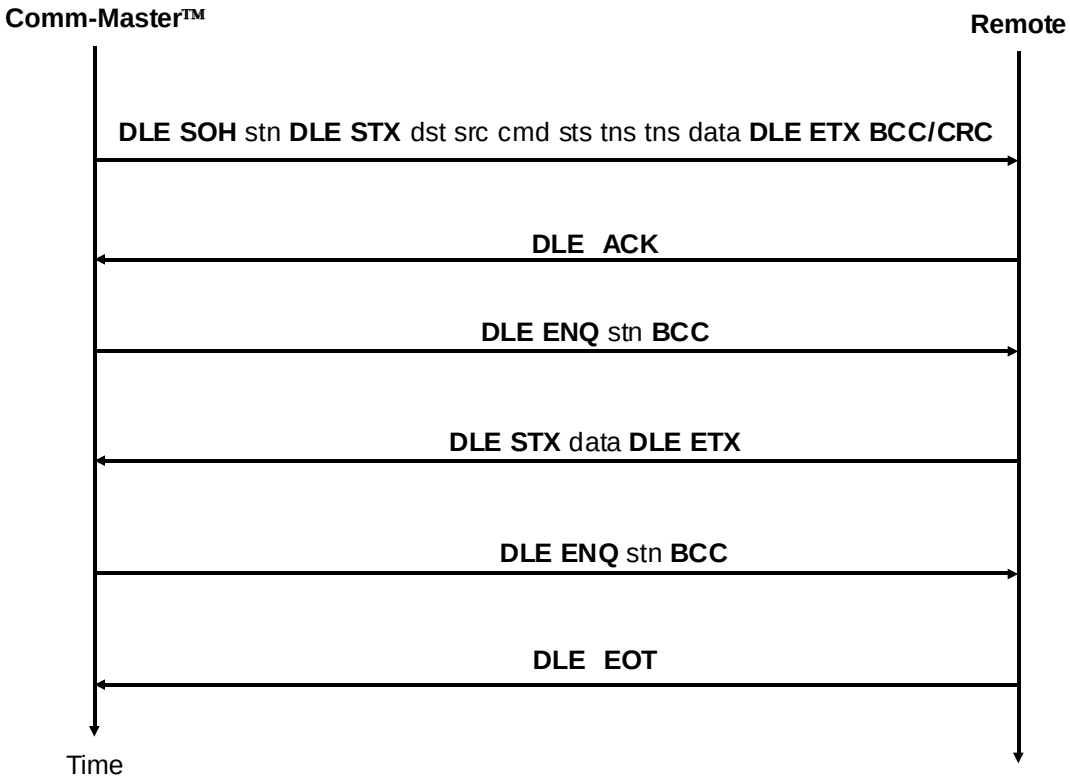

Figure C-3 Typical Message Exchange (no errors)

1.3 Message Types

DF-1 protocol communication exchanges can be divided into two types: data requests (polls) and control commands. In data requests (poll requests), the Comm-Master 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 must be as required by the master PLC. Note that the Comm-Master does not do any processing on the data collected from the remote. The PLC ladder logic must perform any data formatting that is required prior to using the data that is transferred by the Comm-Master.

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

1.4 COMM-MASTER DF-1 CONFIGURATION TABLE

The following paragraphs detail the organization of the configuration table for a Comm-Master with DF-1 communication protocol installed on the RTU side.

Word	Byte Numbers	Function
0	00,01	Comm-Master Address; Number of Polling tables
1	02,03	Radio turn-on Delay (x 10 msec)
2	04,05	Radio turn-off Delay (x 10 msec)
3	06,07	RTS/CTS Delay (x 10 msec- starts after Radio turn-on delay)
4	08,09	Remote Baud Rate; # Data Bits
5	10,11	Remote Parity; # Stop BIts
6	12,13	Reserved
7	14,15	Reserved
8	16,17	BCC Enable (BCC = 1, CRC = 0); Reserved
9	18,19	Reserved
10	20,21	Radio Key Address
11-19	22-39	Spare

Figure C-4 Comm-Master Configuration Header

1.4.1 Comm-Master DF-1 Configuration Header

Word offset 0 is used for 2 functions: Byte # 0 is used to define the Allen-Bradley Data Highway address of the interface module that is connected to the Comm-Master. This address is typically 11_8 but may be assigned to other values depending on the final system configuration. The address of the data highway interface module is used as the file address when reading or writing data to a PLC-5 system. The interface module can be assigned any address from 1 thru $77_{8.;}$ Byte # 1 is used to define the number of RTU Polling Tables that are defined in the system. The Comm-Master will use this number to determine the number of Polling Table Entries to read.

Word offset 1 is used for a Radio Turn-On Delay Timer. This is the time that the Comm-Master will delay (hold-off) sending data after issuing "radio key" command to the PLC. See definition for word 10 for more details. The delay time will be 10ms times the number stored in word 1.

Word offset 2 is used for a Radio Turn-Off Delay Timer. This is the time that the Comm-Master will hold the line quiescent after transmitting the last byte of data. This delay is sometimes required when using the Comm-Master with some types of radio systems in order to insure the proper reception at the remote end. The delay time will be 10ms times the number stored in word 2.

Word offset 3 is used for a RTS/CTS Delay timer. This is the time that the Comm-Master will delay (hold-off) sending data after raising the Request To Send line (RTS). The delay time will be 10ms times the number stored in word 3.

Word offset 4 is used for two functions. Byte # 0 is used to select the RTU port Baud Rate. Valid settings for this byte are: 04_H= 300, 05_H= 600, 06_H= 1200, 08_H= 2400, 09_H= 4800, $0A_H$= 7200 and $0B_H$= 9600 . Byte 1 is used to select the RTU Port Number of data Bits option. Valid selections are: 07_H and 08_H, corresponding to seven and eight data bits respectively.

Word offset 5 is used for two options. Byte 0 is used to select the RTU Port Parity option and byte 1 is used to select the number of stop bits to use. Valid selections for byte 0 are 00_H= no parity, 01_H= odd parity and 02_H= even parity. Valid selections for byte 1 are 01_H and 02_H, corresponding to one or 2 stop bits.

Word offsets 6 and 7 are reserved for future use. Set to 0000_H.

Word offset 8 is used for two functions. Byte 0 is used to select either BCC or CRC error checking. Set byte 0 to 0 for CRC and to 1 for BCC. Byte 1 is reserved for future use, set it to 0.

Word offset 9 is reserved for future use. Set word 9 to 0.

Word offset 10 is used to define a "radio key address". The radio key address is an address in the master PLC which will be written to when the Comm-Master has data to send on its RTU communications port. The address is entered in decimal notation. In some applications it may be necessary to switch on or "key" a radio transmitter for subsequent transmission of data. A PLC relay output module could be used for this function. If a radio key address is defined (word is non zero) then the contents of this word are interpreted as a radio key address. The Comm-Master will set bit 0 ON whenever it wishes to transmit data. The Comm-Master will clear this bit when it has no more data to send.

Word offset 11 thru 19 are reserved for future use. Set to zero.

1.4.2 Polling Table Entry for DF-1 Protocol

The Polling tables start immediately following the end of the configuration table header section. The polling tables are contiguous, one immediately following the other. Each Polling table is 20 words long. There is a polling table for each poll message that the Comm-Master is required to send. The number of polling tables to read is specified in the Configuration header word 0 byte 1 entry as described above.

Word offset 0 is used for two functions. Byte 0 (high byte) is used to define the Station address of the interface module that is connected to the RTU that is to be accessed with the poll command. It can be any number from 0 to 255 (0 to FF_H). Note that this number is the Hexadecimal equivalent of the station address which is set in Octal (station address 17_8 = $0F_H$). Byte 1 is used to select the type of addressing to use when communicating with the remote device. Set this byte to 2 if a PLC-2 is used (or any other PLC using PLC-2 addressing modes); set it to 5 if a PLC-5 is used and to FA_H (250) if a 5/250 is used.

Word offset 1 is used to store the data point count (amount of data to be returned). All 16 bits can be used to specify the data point count. Byte 0 is the high order byte; byte 1 is the low order byte. The data point count is specified in words.

Word	Byte Numbers	Function
0	00,01	Station Address; PLC Type
1	02,03	Data Point Count (words)
2	04,05	Source PLC Highway Address
3	06,07	Source PLC L.P., File Type
4	08,09	Source PLC File Number
5	10,11	Source PLC Starting File Element
6	12,13	Destination PLC Station Address, PLC Type
7	14,15	Destination PLC Highway Address
8	16,17	Destination PLC L.P., File Type
9	18,19	Destination PLC File Number
10	20,21	Destination PLC Starting File Element
11	22,23	Scan Update Frequency (x 10 msec)
12	24,25	Scan Error Timeout (x 10 msec)
13	26,27	Reserved
14	28,29	Error PLC Highway Address (STN and Type same as Dest PLC)
15	30,31	Error PLC L.P., File Type
16	32,33	Error PLC File Number
17	34,35	Error PLC File Element
18,19	36,39	Spare

Figure C-5 Comm-Master Polling Table Entry

Word offset 2 thru 5 are used to store the data source address (starting point). The first word is used to define the PLC data highway address. Word 3 is used to define the Logical Processor (PLC5-250 only) in byte 0 and the file type in byte 1. The hexadecimal equivalent of the ASCII logical processor and the file type fields is entered in word 3. For example if the file which contains the data to be read is an integer file (file type N) then enter a $4E_H$ in byte 1 of word 3. If the data source PLC is a PLC-2 then these fields are not used for addressing. Set word 3 to 0000_H for PLC-2. Word 4 is used to specify the file number. Enter the hexadecimal equivalent of the data source file number. If the source data is in file N10 then enter 0AH in word 4. Word 4 is not used for PLC-2 addressing. Word 5 is used to specify the file element that marks the start of the data to be returned. Enter the hexadecimal equivalent of the starting word address.

Word offset 6 thru 10 is used to specify the destination PLC type, Data Highway Address, Logical Processor, File Type, File Number and Element in the same manner as words 2 thru 5 . The Destination PLC is the location that the Comm-Master will use to store the data returned from an RTU poll.

Word offset 11 is used to specify the interval between polls. Polls will be issued by the Comm-Master at the rate specified by the contents of this word. The polling interval can be specified in 10 ms increments. That is an entry of 200 (decimal) would result in the Comm-Master polling for the data specified in this table entry once every 2 seconds (200 X 10ms per count = 2000 ms = 2 sec)

Word offset 12 is used to specify the message time-out time. The message time out will be set to the number stored in this word times 10ms.

Word offset 13 is reserved for future use. Set to 0000H.

Word offsets 14 thru 17 are used to specify an Error PLC Poll Message Error Address. This address will be updated by the Comm-Master at the conclusion of the poll request. The poll request is ended whenever either the RTU responds with the requested data or an error occurs. Word 14 will be updated with the latest status available to the Comm-Master.

Words 18 and 19 are reserved. Set to 0000_H.

Word	Byte Numbers	Function
0	00,01	Command Message Time-out (X10msec)
1	02,03	Destination Station Address, PLC Type
2	04,05	Message FNC, Message CMD
3	06,07	Destination Highway Address
4	08,09	Destination L.P., File Type
5	10,11	Destination File Number
6	12,13	Destination File Starting Element
7-N	14-N	Data for command

Figure C-6 Command Message Data

1.4.3 COMMAND MESSAGE INSTRUCTION

Control commands are sent from the Comm-Master to an RTU using standard ladder logic MSG instruction. The MSG instruction must be a WRITE command addressed to the Comm-Master (the data highway address of the RS-232 interface module that is connected to the Comm-Master). The processor type must be set to PLC-2 and the Local/Remote mode set to LOCAL. The destination data table address is not used and can be set to any value. The MSG instruction references a data table address and length. The contents of the data table referenced by the MSG instruction will be sent to the Comm-Master. The Comm- Master interprets this data to form the actual command sent to the RTU. The following figure details the contents of the data block for a command MSG instruction.

Word offset 0 is used to specify the time out value to be used for the command. The time out value is 10msec times the value stored in word 0.

Word 1 is used to specify the command destination station address and PLC type. The station address is the highway address of the RS-232 interface module connected to the remote (if set to local mode) or the address of the destination PLC itself if a 1785-KE Series B operating in the Remote mode is used as an interface device. The PLC type field should be set to 02_H for a PLC-2, 05_H for a PLC-5 or FA_H for a 5-250 PLC.

Word 2 is used to specify the command FNC and CMD fields. The FNC and CMD field entries are specified in the Allen-Bradley Data Highway reference manual. All CMD and FNC codes that specify an OUTPUT command can be used. The Comm-Master does not allow input commands to be built using the MSG instruction.

Word 3 is used to specify the destination PLC highway address

Word 4 is used to specify the destination PLC Logical Processor number and File type. The data entered in word 4 should be the hexadecimal equivalent of the ASCII character required for specification of the Logical Processor and File Type. Set this word to 0000H for PLC-2 type processors.

Word 5 is used to specify the command destination file number. Enter the hexadecimal equivalent of the file number in this word. Set this word to 0000H for PLC-2 processors.

JUMPER	POSITION
J2	1-2
J3	NOT USED
J4	NOT USED
J5	NOT USED
J6	1-2
J7	1-2
J8	NOT USED

JUMPER	POSITION
J10	NOT USED
J11	1-2
J12	1-2
J13	NOT USED
J14	NOT USED
J15	1-2
J16	NOT USED

DF-1 Half Duplex Protocol Communication is on Port P1 (top port), Allen-Bradley Communication is on Port P2 (center port)

U13 = # 166-004-0 2/5/91

U23 = # 166-003-0 2/5/91

U16 = PCMAID50 2/19/90

Figure C-7 Jumper Settings

Word 6 is used to specify the command starting file element. Enter the hexadecimal equivalent of the starting element number in word 6

Word 7 thru N are used to contain the actual data that is to be sent as part of the command.

1.5 JUMPER SELECTIONS FOR DF-1 PROTOCOL

The Comm-Master jumper settings and EPROM part numbers for Comm-Master DF-1 protocol operation is detailed in the following figure.

