MC³ Configuration and Troubleshooting for DF-1

Serial port Comm 2 in an MC³ can be configured to support Allen-Bradley DF-1 point to point protocol. This allows for establishing direct communications to Allen-Bradley PLCs, using

- Ch0, usually the built-in serial port,
- DeviceNet using the 1761-NET-DNI interfaces,
- EtherNet/IP using 1761-NET-ENI interfaces, or
- Data Highway Plus using KF2 or similar interfaces.

Merrick currently support all methods described above.

The host can take control over and/or monitor the MC³, using CIT data table exchange. For details of the CIT structure, see http://www2.merrick-inc.com/mct/CIT.PDF

System Requirements

Later versions of Merrick's MC³ controller supports Allen-Bradley (A-B) DF-1 Serial Communications (DF-1) and exposes a standardized Common Interface Table (CIT), compatible with the A-B "Common Interface File" (CIF) specification. PCCC functions 1 (PLC2 Unprotected Read, 485CIF Read), 8 (PLC2 Unprotected Write, 485CIF Write) and 6 (PLC-2 Diagnostic Status) are supported.

The information in this document applies to the following MC³ firmware versions:

Firmware	Used for	Released	Comm Ver
20.10.EX.F	Belt Feeder	03/28/02	1
20.20.EX (All)	Belt feeder	04/17/03	2
24.10.EX.H	Pressurized Coal Feeder	08/02/02	1
24.10.EX.I and later	Pressurized Coal Feeder	08/12/03	1
30.00.EX.C and later	Loss-In-Weight	04/25/02	1
30.10.EX.E and later	Enhanced Loss-In-Weight	06/06/04	2
40.10.EX.A and later	Impact Flow Meter	04/14/03	2
90.10.EX.Y and later	MasterSet	01/02/03	2

Other Merrick firmware releases may also support DF-1 communications.

The physical interface is normally 3-wire RS232, but 4-wire RS-422 can also be used. The host or interface is assumed to maintain a cyclic conversation with the MC³, which exposes a Common Interface Table (CIT), making it possible to monitor and/or supervise the MC³ completely.

Different data types are used for control/status bits, integer numbers and floating-point numbers. Control/Status bits and Integer numbers are organized in 16 bit words. Parameters are organized as IEEE 32 bit floating point numbers, located in two consecutive 16 bit words. For PLCs that don't support floating point numbers, it is possible to split parameters into two 16 bit integers, one containing the integer part and one containing the fractional part multiplied by 10,000 (four implied decimal places).

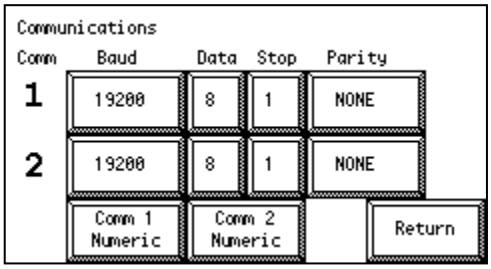
Configuring the MC³

Configuring the MC³ controllers include setting up communications parameters, register tags, warnings, faults and external inputs and outputs. The register tags are set to make any internal MC³ parameter appear in Tag 1 R to Tag 5 R values. Standard feeder parameters are always available. MC³ warnings and faults are user preference qualified, associated with any logical I/O point in the MC³. This configuration is done regardless if communications is used or not. Any logical inputs you want to control from the PLC must be mapped to an external input. In the same way, logical outputs must be mapped to external outputs for monitoring purposes.

The following menu references and screen shots were taken using the MC³ 20.20.EX.B Belt Feeder Controller application. Operation and Maintenance Manuals as well as register specifications are available in MC³ Firmware Overview at the Merrick Web Site:

http://www2.merrick-inc.com/mct/MC3Apps/MC3Apps.htm

Setting the MC³ communications parameters



To get to the **Communications** screen from the main screen, touch **Action Menu**, **Settings Menu**, enter the password, **Inputs & Outputs** and finally **Comm Settings**. DF-1 runs on COM 2. In this example, we use 19200 baud, 8 data bits, 1 stop bit and no parity. These parameters must agree with the settings in the device we are connecting to.

Touching the **Comm 2 Numeric** button takes you to the **DF1/DNI Params** screen. Set the parameters as follows:

Parameter	Value	Comment
Prtr/0 DF1/1	1	Selects DF1 for Comm 1 (as opposed to printer).
DF1 Timeout	20.0	The MC³ times incoming, valid DF1 telegrams, and turns on the DF1 Timeout logical output if this time expires. You typically let this output qualify a Warning. Also, DF1 timeout condition will turn off all External Inputs. A value of Zero defies the timeout function so that a timeout condition never occurs.
DF1 Uses BCC	0	Use BCC checksum instead of the preferred CRC. Some older PLC-5 PLCs only supports BCC.
Write Prot	3071	BFF hex. All registers write protected except Primary Setpoint.
Word Order	4095	FFF hex. All REAL variables have reversed word order. This has to be found by trial and error. The PLC-5 and SLC-5 PLC's have the floating point words backwards. (As opposed to the ControlLogix family of PLCs, set to 0 for those).
Int/Frac FP	0	Floating Point transfer is supported. Integer/Fraction is not needed.
Tag Reg 1	0	Use 0 for unused tags. Enter a register number for a register you want to monitor
Tag Reg 2	0	
Tag Reg 3	0	
Tag Reg 4	0	
Tag Reg 5	0	

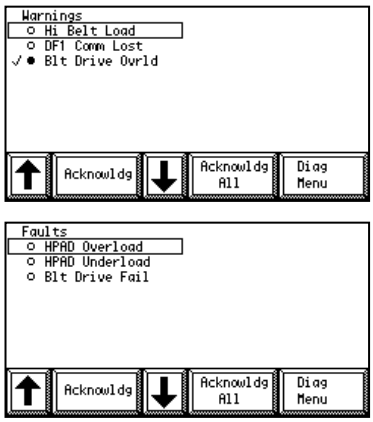
Configuring Warnings and Faults

Warnings and Faults are qualifiers to logical inputs and outputs, normally set by the user. Warnings are considered to require attention. Faults are considered to be fatal for the feeder operation, and the controller will attempt to stop the feeder. See O&M, page 56. In this example the warnings and faults are set up according to the following table:

Logical I/O	Qualifier	Comment
HPAD Overload	Fault	Invalid Load Cell Signal
HPAD Underload	Fault	Invalid Load Cell Signal
Blt Drive Fail	Fault	Signal from the belt motor VFD, connected to an MC³ input.
High Belt Load	Warning	Too much material on the belt

Logical I/O	Qualifier	Comment
Blt Drive Ovrld	Warning	Signal from the belt motor drive, connected to an MC³ input.

The qualifiers are set up in the Digital Inputs (O&M Page 56) and Digital Outputs (O&M Page 60) screens. With the settings above, the Warnings and Faults screens look like this.



The state of the checkmark is transferred to the Warnings [18] and Faults [19] word in the CIT. The bit order is the same as the displayed order on the screen. It is important to note that the bits in the Warnings and Faults registers reflect the state of the checkmark, not the dot. In this warning screen, both are on for the logical input Blt Drive Ovrld. Bit 2 of the Warnings word is on. If the Blt Drive Ovrld input is turned off, then the dot goes away, but the checkmark stays until the warning is acknowledged, either on this screen or by the "Clear Warnings Command" bit [8] in the Control [44] register.

Note that the bit order in the CIT words for Warnings and Faults are not configurable. It is derived from the order of logical outputs and logical inputs in the Digital Outputs and Digital Inputs screens. If you add or remove a warning or fault qualifier to a logical output or input, the bit order changes.

Configuring External Inputs and Outputs

Logical inputs and outputs can be mapped in three ways:

1. To a physical input or output. In this example the logical input Belt Drive Ovrld is mapped to Rack 1 Input 2, which, in turn, is connected to the Overload output of the belt motor VFD. The physical output Rack 1 Output 1 is mapped to the logical output Drive Enable. The output is then connected to the Start input of the belt motor VFD.
2. To an external input or output. In this example, the Run Permission logical input is mapped to External Input 1. This allows the PLC to start and stop the feeder through the External Inputs register, CIT Word 45, bit 0.
3. Unused Logical Inputs are typically connected to the Physical Input Always On or Always Off.

The PLC controls inputs to the MC³ as bits in the External Inputs register, CIT Word 45. They are then mapped to Logical Inputs in the MC³. Note that the External Inputs are numbered 1 - 16. Bits in the External Inputs word are typically numbered 0 - 15 in the PLC.

It is possible to have a physical input wrapped around to an external output (for monitoring purposes) by first map the input to an Available I/O point, and then map the same Available I/O point to an external output.

In this example, we use 4 inputs. Two are physical connections from the VFD to the MC³, one is a physical connection to the emergency stop circuit (Feeder Block), and one input is controlled from the PLC (Run Permission).

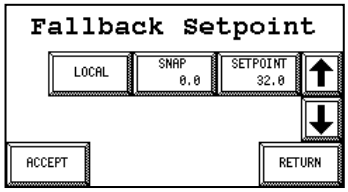
This is how the digital inputs were mapped in the MC³ for this example:

Logical	Physical	Warning/Fault	Word:Bit in the CIT
Run Permission	External Input 1		45:0 to MC³
Feeder Block	Rack 1 Input 1		41:0 from MC³
Belt Drive Ovrld	Rack 1 Input 2	Warning	41:1 from MC³
Belt Drive Fail	Rack 1 Input 3	Fault	41:2 from MC³

Digital output mapping:

Physical	Logical	Warning/Fault	Word:Bit in the CIT
Rack 1 Output 1	Fdr Drv Enable		42:0 from MC³
External Output 1	Fault		17:0
External Output 2	Warning		17:1
External Output 3	Ready		17:2
External Output 4	Hi Belt Load	Warning	17:3
External Output 5	HPAD Overload	Fault	17:4
External Output 6	HPAD Underload	Fault	17:5

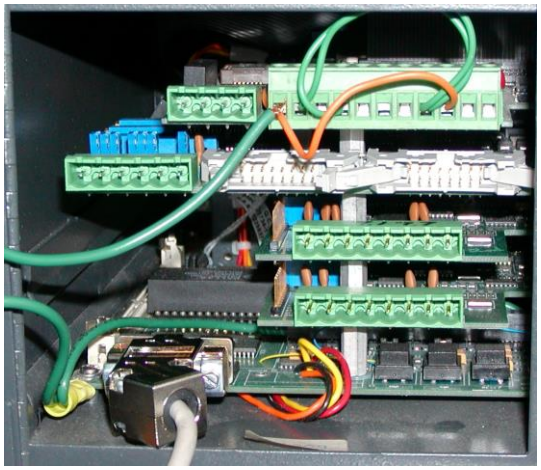
Setting up the Setpoint Source



The MC³ Setpoint Method should be set to **Serial**. See O&M, Page 27. The setpoint is taken from CIT word 46 and 47.There is a way to make the MC³ fall back to another Setpoint method in case of communications failure. By mapping the Logical Input **Frc Comm Setpt** to **Always On**, Serial Setpoint will be used regardless of the setpoint method, until serial communication fails, setting the **Comm Timeout** logical output. When this scheme in effect, the Setpoint Screen looks like this. If the controller has not received a telegram, addressed to it, for 5 seconds (**Comm Timeout** parameter, see "Setting the MC³ communications parameters" (page 2), the setpoint method and value will fall back to the settings in this screen. Furthermore, all External Inputs will be set to zero.

Connect the Serial cable and check communications

Locate the COM2 serial port on the MC³. It is the only DB9-S (Female) connector on the bottom (CPU) board in the card stack. There are two versions of the board, new and old.



Old Board

New Board, A-B 1761-CBL-PM02

COM2 is in the lower left on both boards.

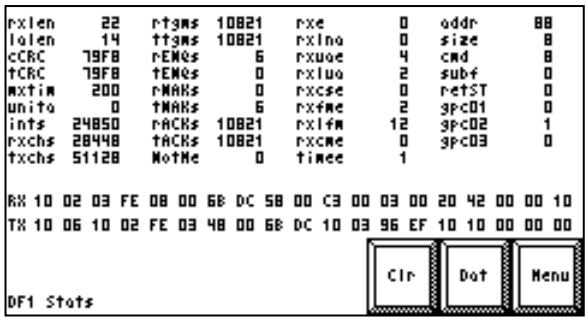
Allen-Bradley equipment uses DB-9P, DB25-S or a special, round 8 pin connector.

Use a straight DB9-P to DB9-S, with pins 2, 3 and 5 connected for equipment with a DB9-P connector. If you need to connect to a PLC-5, connect pins 2-3, 3-2 and 7-5 (DB25-DB9).

For the round 8 pin connector, you need to buy a cable (A-B 1761-CBL-PM02 Series B or C). Unfortunately, that cable has a female DB-9S connector, so you need a Male-To-Male plug. The plug must have pins 2 and 3 crossed and pin 5 straight through.

You can also use the RS-422 interface with a new CPU board, especially if long cables are required. Use the green four-pin Phoenix connector to the right of the DB9-S. Use a cable designed for RS-422. There should be two pairs, individually shielded, with a characteristic impedance of around 150Ω. Belden 9368 or equivalent is a good alternative. Connect the shields at the DF-1 port and at the MC³. Add 121Ω terminating resistors at both ends of the RS485 line. Connect one between Rx+ and Rx- and one between terminals Tx+ and TX- at each end of the cable for a total of four resistors. The pin numbering is left to right as you look at the connector. The MC³ receives data on 3 and 4 (Rx+ and Rx-), and transmits, after being correctly addressed, on terminals 1 and 2 (Tx+ and Tx-).

If your configuration is successful and enabled, you will see the Tx/Rx LEDs on MC³ CPU card blink. See the MC³ hardware manual http://www2.merrick-inc.com/mct/MC3HW/mc3hw_3b.pdf, page 14.



Cycle the MC³ power and push **Action Menu**, **Diag Display**, **DF1 Diag**.

You should see “rtgms”, “ttgms”, “rACKs” and “tACKs” increment when communicating. If not, refer to Troubleshooting tips on page 5

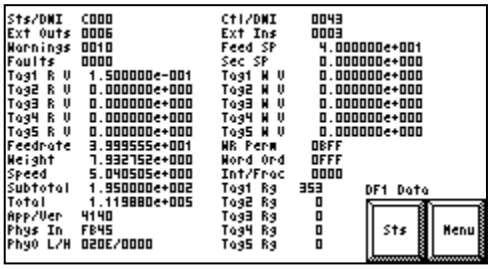
Troubleshooting tips

Setting up industrial networks can sometimes be a daunting task. In this example, you may have to deal with several mapping layers and communication protocols. Fortunately, there are excellent troubleshooting tools available.

Look at the LED's on the New MC³ CPU board.

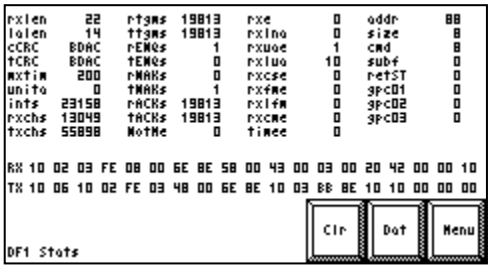
The LED indicators 1 and 2 on the new MC³ CPU board are connected to the serial Receive Data and Transmit Data, respectively. They should be constantly blinking. LED1 is to the left in this picture.

Check data in the CIT Screen against data in the PLC.



The CIT can be inspected in the MC³, by touching Action Menu, Diag Display, DF-1 Diag, Dat. Note that the values are only updated on valid DF-1 telegrams. If no telegrams have been received, most values are zero. As you can see, the layout follows the CIT exactly. All integer values are presented in hexadecimal format except the Tag register numbers. The 'e' format for the floating points can help troubleshooting Floating Point transfers. You are typically reading from the columns to the left, and writing to the first three rows in the column to the right. If you succeed with the integrity bit, you should see bit 7 in the Sts/DNI and Ctl/DNI toggle.

Check error counters in the Communication Diagnostic screen.



Communications status and statistics can be inspected in the MC³, by touching Action Menu, Diag Display, DF-1 Diag. The screen looks like this.

In this shot, out of 19813 successful exchanges, there was one lost to a break detected UART error. This caused a NAK to be transmitted, followed by an ENQ from the host.

Label	Meaning
rxlen	Length, in bytes, of the last incoming telegram
lalen	Length, in bytes, of the last outgoing telegram
cCRC	CRC16 value calculated out of the incoming telegram. Hex.
tCRC	CRC16 value received in the incoming telegram. Hex. Should be the same as cCRC.
mxtim	DF-1 timeout in 100 ms ticks. Set in MC³ communication parametes.
unita	Unit Address. Should be Zero for DF-1 Point-To-Point.
ints	UART Interrupt counter. Counts all incoming and outgoing bytes over the serial port, even if the line parameters don't match.
rxchs	Received bytes counter.
txchs	Transmitted bytes counter
rtgms	Received, complete telegrams counter
ttgms	Transmitted telegrams counter
rENQs	Received ENQ's. In DF1, the host will send an ENQ telegram to make the MC³ repeat the last response. Used when bit or CRC errors occur.
tENQs	Transmitted ENQ's. The MC³ will send an ENQ telegram to make the host repeat the last command. Used when bit or CRC errors occur.
rNAKs	Counter for Received NAKs. Negative Acknowledgements are received when the host encounters errors in responses.
tNAKs	Counter for Transmitted NAKs. Negative Acknowledgements are transmitted when the MC³ encounters errors in commands.
rACKs	Counter for Received ACKs. Acknowledgements are received when the DNI receives a correctly formatted response.
tACKs	Counter for Transmitted ACKs. Acknowledgements are transmitted when the MC³ receives a correctly formatted command.

Label	Meaning
NotMe	Counter for Received telegrams intended for other nodes. Normally Zero, since this is a Point-to-point protocol.
rxe	Counter for Erroneous Received telegrams. Any telegram received with an error other than a UART error increments this counter.
rxuae	Received bytes with UART errors counter. UART errors include Parity, Overrun and Framing errors.
rxlua	Last encountered UART error. See note 1.
rxcse	Received telegrams with CRC16 error counter
rxfme	Received telegrams with format error counter
rxlfm	Last format error encountered. See note 2.
rxcme	Non-supported command received counter
timee	Comm timeouts counter
addr	Starting data byte in CIT in received command. Should toggle between 32 (corresponding to CIT word 16) and 88 (corresponding to CIT word 44).
size	Number of data bytes in received command. Should toggle between 56 and 8
cmd	DF-1 command received. Should toggle between 1 (PLC-2 Unprotected Read) and 8 (PLC-2 Unprotected Write).
subf	Not used in DF-1
retST	DF-1 Exception Code. Zero of no problems. 51 (hex) for CIT addresses outside legal limits. Note that the legal limits are different for telegrams 1 and 8.
gpcXX	Internal debugging. May or may not be present. The meaning varies.
RX	Beginning part of the received telegram. Bytes in hex format
TX	Beginning part of the transmitted telegram. Bytes in hex format.

Note 1 This is the UART status register, bit encoded. Bit 0: Not Used. Bit 1: Overrun error. Bit 2: Parity error. Bit 3: Framing error. Bit 4: Break detected.

Note 2 Format errors have a decimal numerical value:

11 MC³ Receiver buffer overrun - more than 255 bytes in telegram.

12 Something else than STX, ENQ, NAK or ACK following the initial DLE in a telegram.

Use the integrity bit.

The DNI will toggle the integrity bit (CIT word 44, bit 7) every time it writes data to the MC³. Monitor the integrity echo bit (CIT word 16, bit 7). If they stop toggling, communications has failed, and appropriate steps can be taken. The integrity bit can be monitored in the MC³ Data Table screen.