

# APPLICATION NOTE

## DL2000-CMX MODBUS MASTER/SLAVE

This application note contains information on the Multi-Protocol DL2000-CMX Modbus/DF1 to DH+ interface. The -CMX model contains three protocols Modbus Master, Modbus Slave and A-B DF1 protocols all selectable by PC menu. The information contained in this application note is supplementary information specific to Modbus not contained in the regular User's Guide. If you configure the DL2000-CMX DataLink in Standard A-B DF1 to DH+ mode (Mode 0) the standard configuration contained in the User's Guide should be used.

This Modbus application note is in two parts DL2000-CMX Modbus Master and DL2000-CMX Modbus Slave. The DataLink unit is first configured for Modbus Mode ( MODE 2 ) and then Modbus Master or Modbus Slave is selected. Follow the configuration procedures for the specific Modbus protocol required.

The application notes generally assume that a PLC is the DH+ device originating commands to Modbus via a DL2000-CMX master, or responding to Modbus commands via a DL2000-CMX slave. Only devices capable of transmitting DH+ message commands in PLC5 (or PLC3) format and able to receive DH+ message commands in PLC5 format can be used with the DL2000-CMX including PLC-3s, PLC-5s, SLC5/04s and HMIs as well as other intelligent devices.

Due to differences between DH+ and Modbus protocols and the universal design of the DataLink there are differences between the lengths of messages, error handling and addressing which have to be carefully considered by the Systems Designer, Programmer and Installer. As an example Modbus uses decimal addressing, DH+ uses octal addresses and the DataLink uses hexadecimal addressing.

Additional literature regarding DH+, Modbus and PLC products should be obtained from Allen-Bradley and Modicon. Reference materials for A-B serial DF1 and DH+ protocols are shown in section 1.7 of the User's Guide.

### **CAUTION:**

**Incorrect configuration may result in unsafe operation, damage to equipment or safety hazard to personnel.**

Read the DL2000 User's Guide and the appropriate application notes carefully before putting a DL2000 on-line.

The DataLink hardware and software must be fully tested off-line in a safe "TEST" environment prior to putting the DataLink on-line in an operational environment.

### **DL2000-CMX MODBUS MASTER TO A-B DH+ CONFIGURATION**

**Use this protocol when the DataLink is required to be the master on a Modbus network.**

The Modbus Master application notes contain configuration information for firmware version 2.1X or above of the DL2000-CMX protocol and should be used in conjunction with the DL2000 User's Guide.

### **DL2000-CMX MODBUS SLAVE TO A-B DH+ CONFIGURATION**

**Use this protocol when the DataLink is required to be a slave device on a Modbus network.**

The Modbus Slave application notes contain configuration information for firmware version 2.1X of the DL2000-CMX protocol and should be used in conjunction with the DL2000 User's Guide.

# APPLICATION NOTE

## DL2000-CMX MODBUS MASTER PROTOCOL

These application notes contain configuration, system design and programming information on the Multi-Protocol DL2000-CMX Modbus to DH+ interface. The -CMX model contains three protocols selectable by PC menu: Modbus Master, Modbus Slave and A-B DF1.

The information contained in this application note is for the Modbus Master protocol only, and is supplementary to the information in the User's Guide. To use the DataLink in Standard A-B DF1 to DH+ mode follow the standard configuration procedures in 3.5.1 of the main User's Guide. To use the DataLink in Modbus Slave Mode follow the procedures in the Modbus Slave application notes. **There are significant differences between the configuration, programming and operational requirements of Modbus Master and Modbus Slave protocols.**

The application notes generally assume that a PLC is the DH+ device originating commands to Modbus via a DL2000-CMX Modbus Master, or responding to Modbus commands via a DL2000-CMX Modbus Slave. Only devices capable of transmitting DH+ message commands in PLC5 (or PLC3) format and able to receive DH+ message commands in PLC5 format can be used with the DL2000-CMX. This includes PLC-3s PLC-5s, SLC5/04s, HMIs PCs and other intelligent devices.

### NOTES:

1. The DataLink unit that you have received can be configured as Modbus Master or Modbus Slave (or A-B DF1). Ensure that you understand and carefully follow the specific configuration procedures for the Modbus (or A-B DF1) protocol desired.
2. **There are significant differences between the configuration, programming and operational requirements of Modbus Master and Modbus Slave protocols.**
3. If you configure the DataLink for Modbus Master operation it must be the only master on the Modbus network. A station on DH+ originates commands to the DL2000-CMX Modbus Master which then re-transmits them over Modbus to a Modbus Slave device. Other intelligent DH+ devices capable of initiating DH+ messages in PLC5 (or PLC3) format and able to receive PLC5 message commands could also be used as the DH+ "master".
4. Be sure to fully test the DataLink hardware and software off-line to ensure that you understand its configuration and operation. Prior to putting the DataLink on-line in an production process, the operation of the complete system should be fully tested on-line in a safe "test" environment.
5. Due to differences between DH+, Modbus and the DataLink hardware and software there are differences between the lengths of messages, error handling and addressing which have to be carefully considered by the Systems Designer, Programmer and Installer. As an example Modbus uses decimal addressing, DH+ uses octal addresses and the DataLink uses hexadecimal addressing.
6. Additional literature regarding DH+, Modbus and PLC products can be obtained from Modicon and A-B. Suggested reference materials for A-B DH+ and A-B DF1 protocol is shown in section 1.7 of the User's Guide.

### CAUTION:

**Incorrect configuration may result in unsafe operation, damage to equipment or safety hazard to personnel.**

Read the DL2000 User's Guide and the appropriate application notes carefully before putting a DL2000 on-line. The DataLink hardware and software must be fully tested off-line in a safe "TEST" environment prior to putting the DataLink on-line in an operational environment.

**DL2000-CMX**

**MODBUS MASTER**

**CONFIGURATION GUIDE**

# INDEX FOR DL2000-CMX

## MODBUS MASTER TO DH+

<b>1.0 GENERAL</b> .....	1
1.1 ADDRESS MAPPING BETWEEN DH+ AND MODBUS.....	1
1.2 DH+ AND MODBUS COMMANDS.....	2
1.3 MODBUS ADDRESS RANGE CAPABILITIES .....	4
1.4 DH+ MESSAGE COMMAND .....	4
1.5 COMMUNICATIONS SEQUENCE.....	6
1.6 MODBUS MESSAGE DATA LENGTH CONSIDERATIONS .....	6
1.7 MODBUS MASTER USING BM85 MODBUS PLUS / MODBUS BRIDGE MUX .....	6
1.8 DH+ AND MODBUS - GENERAL.....	7
<b>2.0 DH+ NETWORK TO MODBUS COMMUNICATIONS CONFIGURATION</b> .....	8
2.1 MAIN MENU .....	8
2.2 MODBUS - CONFIGURATION .....	9
2.2.1 CONFIGURE OR VIEW COMMUNICATIONS FILE .....	9
2.2.2 MODBUS - INTERFACE TYPE SELECTION.....	9
2.2.3 MODBUS - ADDRESS AND MODE CONFIGURATION .....	10
2.2.4 MODBUS - CHANNEL B COMMUNICATIONS CONFIGURATION .....	10
2.2.5 DATALINK - CHANNEL C COMMUNICATIONS CONFIGURATION.....	11
2.2.6 DF1 PROTOCOL PARAMETER CONFIGURATION.....	11
2.2.7 MODBUS - PROTOCOL PARAMETER CONFIGURATION.....	11
2.3 TRANSFER COMMUNICATIONS FILE TO EEPROM.....	12
<b>3.0 DATALINK TO MODBUS INTERFACE CABLES</b> .....	13
3.1 RS232C - DATALINK FRONT PORT B TO 9 PIN MODBUS PORT.....	13
3.2 RS232C - DATALINK FRONT PORT B TO 25 PIN MODBUS PORT .....	13
3.3 RS232 - DATALINK REAR PORT B' TO 9 PIN MODBUS PORT .....	14
3.4 RS422 - FRONT PORT B TO MODBUS RS422 PORT.....	14
<b>4.0 MODBUS MASTER APPLICATIONS</b> .....	15
4.1 DATALINK MASTER TO MODBUS SLAVE NETWORK.....	15
4.2 DATALINK MASTER TO MODBUS PLUS VIA MODBUS BRIDGE.....	15

## 1.0 GENERAL

The DL2000-CMX can be configured as a Modbus network "Master". In this mode it enables PLCs and other devices on a DH+ network to initiate various commands to read and write coils, inputs and registers of slave devices on a Modbus network. The DataLink Modbus interface can be set for RS232 or RS422/RS485. Communication between Modbus and the DL2000 must be initiated from a DH+ stations such as a PLC.

The DL2000 must be the only Master on the Modbus network and does not require a Modbus address. The DL2000 is an active station on DH+ and requires a unique DH+ station address number. **The DL2000 can accept PLC3 Word Range Read/Write or PLC5 Typed Read/Write DH+ message commands but always responds with PLC5 message commands.** The DL2000 can accept either PLC3 Word Range Read/Write or PLC5 Typed Read/Write commands from any station on DH+. Typical DH+ stations that can communicate with Modbus via the DataLink include devices such as PLC3s, PLC5s, SLC5/04s, PCs, HMIs and other intelligent OEM devices.

The Destination Data Table Address is normally used to address a specific File and Word in another PLC on the DH+ network. This address is interpreted by the DL2000-CMX in a specific way and permits data to be mapped from a DH+ station (PLC) and a Modbus slave device. This allows the PLC programmer to directly address a specific register in a Modbus slave device without any previous configuration being necessary in the DataLink.

## 1.1 ADDRESS MAPPING BETWEEN DH+ AND MODBUS

The design of the DL2000-CMX Modbus Master and the SLC5/04, PLC-5 and PLC-3 DH+ message command structure allows the DataLink to use the Destination Data Table Address structure of the PLC for direct address mapping to Modbus. The DL2000 decodes the Destination DT Address to access to various Modbus Slave stations, commands and addresses. The actual Modbus station number and addresses ranges that can be accessed depends on the PLC type, DH+ message type and Programming software used.

The Destination Data Table Address format shown below holds the Modbus Slave Station number (1 - 255), the specific Modbus command and the Modbus Address (x0001 - x9999). A PLC typically uses bit and integer files in its own Data Table store the data that is to be written (or read) to (or from) a Modbus slave device.

If a PLC is being used to generate messages to DL2000-CMX to be sent to a Modbus network, values are entered into the Destination Data Table Address of the PLC's DH+ Message Command in the format below. MMIs and other applications would have a similar destination address structure for reading and writing data to from a PLC - refer to OEM application specific documentation.

### DESTINATION DATA TABLE ADDRESS FORMAT

The usual format of destination data table address (DDTA) is: **X y : z**

When communicating with another PLC over DH+, the DDTA has the following meaning:

X = File type (single alphabetic character)

y = File number (0 - 63, 0 - 999 and 0 - 9999 depends on PLC type)

z = Word number (0 - 255, 0 - 999 or 0 - 9999 depends on PLC type)

If the same destination address is received by a DL2000-CMX Modbus Master, the it means the following:

X = Modbus Command ie. Modbus commands 01 to 06, 15 and 16

y = Modbus slave station address ie. max Modbus range 1 - 255

Either z = Modbus (bit/register) address ie. max Modbus range 1 - 9999)

Or z = Sub-function code for Modbus 08 Diagnostic Command

## 1.2 DH+ AND MODBUS COMMANDS

### 1.2.1 DH+ MESSAGE COMMANDS

The DL2000-CMX set to Modbus Master mode can generate Modbus protocol functions on receipt of the following DH+ message commands:

- PLC-3 Word Range Read or Word Range Write Commands
- PLC-5 Typed Read or Typed Write Commands

A-B PLCs can generate the following commands:

- SLC-5/04 PLC-5 Typed Read/Write Commands
- PLC-3 PLC-3 Word Range Read/Write Commands
- PLC-5 PLC-3 Word Range Read/Write Commands and PLC-5 Typed Read/Write Commands

### 1.2.2 MODBUS COMMANDS

The Modbus commands and addresses that can be generated depend on the specific DH+ message command generated. The DL2000-CMX in Master Mode is designed to work with DH+ message commands including PLC-5 Typed Read and Write and PLC-3 Word Range Read and Write. Use the PLC-3 Word Range Read and Write commands whenever possible because the larger address field of these commands provides the additional flexibility necessary to generate the full range of Modbus commands and addresses.

#### **MODBUS DATA AND CONTROL COMMANDS IF PLC-3 WORD RANGE READ / WRITE COMMANDS USED**

On receiving a PLC-3 Word Range Read or Word Range Write DH+ Message Command (MC) a DL2000-CMX Modbus Master decodes the command's Destination Data Table Address (DDTA) File type (character). Then, dependent on whether the DH+ message is a read or a write it can generate the following Modbus command as below:

<u>DATA HIGHWAY PLUS</u>				<u>MODBUS</u>			
<u>MC</u> <u>R / W</u>	<u>File</u> <u>Type</u>	<u>Destination D.T. Address</u>		<u>Modbus</u> <u>Command</u>	<u>Description</u>	<u>Slave</u> <u>Address</u>	<u>Data Address</u>
		<u>Decimal</u> <u>File</u> <u>Value</u>	<u>Decimal</u> <u>Word</u> <u>Value</u>				
Read	B	1-255	1-9999	01	Read Coil Status	1 -255	00001 - 09999
Read	F	1-255	1-9999	02	Read Input Status	1 - 255	10001 - 19999
Read	N	1-255	1-9999	03	Read Holding Registers	1 - 255	40001 - 49999
Read	S	1-255	1-9999	04	Read Input Registers	1 - 255	30001 - 39999
Write	F	1-255	1-9999	05	Force Single Coil	1 - 255	00001 - 09999 Note 1
Write	S	1-255	1-9999	06	Preset Single Register	1 - 255	40001 - 49999
Write	B	1-255	1-9999	15	Force Multiple Coils	1 - 255	00001 - 09999
Write	N	1-255	1-9999	16	Preset Multiple Registers	1 - 255	40001 - 49999
Write F, S, B & N	0	1-9999	1-9999	5, 6, 15 & 16	Broadcast Command	1 - 255	x0001 - x9999

#### **NOTE:**

1. For the Modbus 05 command the first word of data in the PLC data table is FF00 (hex) to turn the coil **ON** and 0 to turn the coil **OFF**.

**MODBUS DIAGNOSTIC COMMANDS IF PLC-3 WORD RANGE READ / WRITE COMMANDS USED**

<b><u>DATA HIGHWAY PLUS</u></b>				<b><u>MODBUS</u></b>		
<b><u>MC</u></b>	<b><u>File</u></b>	<b><u>Destination D.T. Address</u></b>		<b><u>Modbus</u></b>	<b><u>Sub-Function</u></b>	<b><u>Diagnostic Command Function</u></b>
		<b><u>Decimal</u></b>	<b><u>Decimal</u></b>			
<b><u>R / W</u></b>	<b><u>Type</u></b>	<b><u>File</u></b>	<b><u>Word</u></b>	<b><u>Cmd</u></b>	<b><u>Code</u></b>	
Read	D	00	Data Value	08	00	Return Data Query (Loopback)
Write	D	00	00 / 255	08	01	Restart Communications
Read	D	09	02	08	02	Return Diagnostic Register
Write	D	01	Char (dec)	08	03	Change Ascii Input Delimiter
Write	D	09	04	08	04	Force Listen Only Mode
Write	D	09	10	08	10	Clear Counters and Diagnostic Registers
Read	D	09	11	08	11	Return Bus Message Count
Read	D	09	12	08	12	Return Bus Communication Error Count
Read	D	09	13	08	13	Return Bus Exception Error Count
Read	D	09	14	08	14	Return Slave Message Count
Read	D	09	15	08	15	Return Slave No Response Count
Read	D	09	16	08	16	Return Slave NAK Count
Read	D	09	17	08	17	Return Slave Busy Count
Read	D	09	18	08	18	Return Bus Character Overrun Count
Read	D	09	19	08	19	Return IOP Overrun Count (884)
Write	D	09	20	08	20	Clear Overrun Counter and Flag (884)

**MODBUS DATA AND CONTROL COMMANDS IF PLC-5 TYPED READ / WRITE COMMANDS USED**

On receiving a PLC-5 Typed Read or Word Range Write DH+ Message Command (MC) a DL2000-CMX Modbus Master decodes the command's Destination Data Table Address (DDTA) File type (character). Then, dependent on whether the DH+ message is a read or a write it can generate the following Modbus command:

<b><u>DATA HIGHWAY PLUS</u></b>		<b><u>MODBUS</u></b>		
<b><u>MC</u></b>	<b><u>DDTA</u></b>	<b><u>Modbus</u></b>	<b><u>Description</u></b>	<b><u>Address</u></b>
<b><u>R / W</u></b>	<b><u>File</u></b>	<b><u>Cmd</u></b>		
	<b><u>Type</u></b>			
Read	N	03	Read Holding Registers	40001 - 49999
Write	N	16	Preset Multiple Regidsters	40001 - 49999
Write	N	16	Broadcast Command	Note: Slave Address = 0

**1.2.3 BROADCAST COMMAND**

A-B's DH+ network does not typically support Broadcast. However, using a PLC message command with the Destination Data Table Address containing a File Address of 0 in the write commands specified in sections 1.3.1 and 1.3.2 above will generate a Modbus Broadcast command to all Modbus Slave stations. The DL2000-CMX will not get an "ACK" response to a Broadcast command from any Modbus slave device.

### 1.3 MODBUS ADDRESS RANGE CAPABILITIES

The Modbus address and range that can be programmed via a PLC's Destination Data Table Address (DDTA) depend on the type of DH+ station originating the DH+ message, the communication command type and PLC programming software used. The table below is a list of addresses in some of the tested configurations.

<u>Source PLC Type</u>	<u>DH+ Message Cmd</u>	<u>PLC Program Software Used</u>	<u>Modbus Slave Address</u>	<u>Modbus Addr Prefix</u>	<u>Modbus Addr Range</u>
SLC5/04	PLC5 Typed R/W	A-B	1 - 63	4	0001 - 0255
PLC3	PLC3 Word Range R/W	A-B / ICOM (RS)	1 - 255	0, 1, 3 & 4	0001 - 9999
PLC5	PLC3 Word Range R/W	A-B / ICOM (RS)	1 - 255	0, 1, 3 & 4	0001 - 9999
PLC5	PLC5 Typed R/W	A-B 6200	9 - 255	0, 1, 3 & 4	0001 - 0999
PLC5	PLC5 Typed R/W	ICOM (RS)	1 - 255	0, 1, 3 & 4	0001 - 9999

#### NOTES:

1. Use the PLC3 message command set if possible to reduce potential programming software restrictions on the DDTA numeric values that can be entered when A-B programming software is used.
2. A-B Bulletin 6200 PLC programming software limits the maximum register address entry value that can be entered dependent on the DH+ message instruction's Communication Command type: ie. 1 - 255 for SLC-5/04s and 1 - 999 for PLC5 commands.
3. A-B PLC programming software may not allow a user to select an "illegal" file number for the file type being used. For instance it may limit File type "N" to file numbers 7 and 9 - 999. This restricts the lower values of Modbus slave addresses that can be selected.

### 1.4 DH+ MESSAGE COMMAND

To read and write to slave devices on Modbus it is necessary to program DH+ message instructions in one (or more) active PLCs on the DH+ network. Either PLC-3 Word Range Read / Write or PLC-5 Typed Read / Write communication commands can be used.

<b>MESSAGE INSTRUCTION DATA ENTRY FOR CONTROL BLOCK N99 : 0</b>	
<b>Communication Command</b>	<b>PLC-5 Typed Read / Write (or PLC-3 Word Range Read / Write)</b>
<b>PLC-5 Data Table Address:</b>	<b>N 100 : 000</b>
<b>Size in Elements:</b>	<b>100</b>
<b>Local/Remote:</b>	<b>LOCAL</b>
<b>Remote Station:</b>	<b>N/A</b>
<b>Link ID:</b>	<b>N/A</b>
<b>Remote Link Type:</b>	<b>N/A</b>
<b>Local Node Address:</b>	<b>01</b>
<b>Destination Data Table Address:</b>	<b>N 1 : 1</b>

Entering either a "PLC-5 Typed Read" or "PLC-3 Word Range Read" in the "Communication Command" block of the message instruction to the DL2000-CMX Modbus Master and an "N" as the Destination Data Table Address File type character will cause a Modbus function code of "03" to be generated if the message command is sent to the DH+ station address of a DL2000-CMX set to Modbus Master mode. Entering a "PLC-5 Typed Write" or "PLC-3 Word Range Write"

Master and an "N" as the Destination Data Table Address File type character will cause the DL2000-CMX to generate a Modbus function code of "16".

Enter the starting address of the A-B File : Word(s) to be used for read or write in the "PLC-5 Data Table Address" block of the DH+ message instruction. Enter the number of words or registers to be transmitted in the "Size in Elements" field of the message function block. This value can be 1 - 999 for PLC5s but is limited to 1 - 255 for SLC 5/04s. Enter the DH+ station address configured in the DL2000-CMX in the "Local Node Address" field.

The Modbus command, Modbus slave station address and Modbus start address are entered in the "Destination Data Table" field in File : Word format X yyy : zzzz. Where N is the file type identifier, yyy is the Modbus Slave station address (1 - 255), and xxxx the least significant digits of the Modbus starting address (x0001 - x9999).

Check that the Modbus Slave Station address and Modbus Registers required can be entered into the specific PLC's Destination Data Table Address field using PLC programming software. See section 1.1 of this application note for some typical addressing limitations.

### **A-B PLC-5 TO MODBUS EXAMPLE**

Devices such as PLC-5's can initialte PLC-5 Typed Read and Write or PLC-3 Word Range Read and Write commands to the DL2000-CMX over the DH+. The DataLink then issues an appropriate Modbus read or write command to read or write the data to a Slave device on a Modbus Network. For example a PLC-5 initiates a PLC-3 Word Range read command using an N File type in the DDTA - this is translated to a Modbus Read Holding Register command (03). This command reads data from the Modbus Slave 4xxxx register address(es) specified in the DDTA and writes it to the file / word(s) specified in the PLC-5 Data Table Address. Conversely a PLC-3 Word Range write command generates a Modbus Preset Multiple Holding Registers command (16) which reads data from the PLC-5 file / word(s) specified and writes it to a Modbus Slave station's 4xxxx register(s).

<b><u>Modbus Slave Address</u></b>	<b><u>Modbus Command Code</u></b>	<b><u>Modbus Command Description</u></b>	<b><u>Modbus Address Range</u></b>
1-255	03	Read Holding Register	40001 - 49999
1-255	16	Preset Multiple Holding Registers	40001 - 49999
0	16	Broadcast Preset Mult Hold Regs	

### **DH+ TO MODBUS HOLDING REGISTER COMMAND TRANSLATION EXAMPLES**

<b><u>PLC-5 DH+ MESSAGE INSTRUCTION</u></b>			<b><u>MODBUS NETWORK MESSAGES GENERATED</u></b>			
<b><u>COMMN CMD</u></b>	<b><u>SIZE IN ELEMENTS</u></b>	<b><u>DESTN DT ADDR FILE:WORD</u></b>	<b><u>SLAVE ADDR</u></b>	<b><u>FUNCTION CODE</u></b>	<b><u>REG ADDR START</u></b>	<b><u>REG ADDR END</u></b>
WRITE	1	N 1 : 1	1	16	40001	40001
READ	10	N 10 : 100	10	03	40100	40109
WRITE	100	N 255 : 9800	255	16	49800	49899
WRITE	20	N 0 : 200	0	16	40200	40219

## 1.5 COMMUNICATIONS SEQUENCE

The DL2000-CMX receives message commands from a PLC on its synchronous DH+ port, converts them to the appropriate Modbus message and sends them out on its serial port. The Modbus Slave response is received, translated into an appropriate DH+ response and then returned to the originating PLC.

Modbus Master/Slave protocol does not permit multiple messages on the Modbus network. The DataLink processes one message at a time out of its Modbus port, although it can handle multiple requests from PLC-5s on the DH+ network. The DL2000 unit will respond to the DH+ interface with appropriate error messages in the event of detectable errors on Modbus such as timeouts.

## 1.6 MODBUS MESSAGE DATA LENGTH CONSIDERATIONS

The following shows the maximum number of holding registers that can be sent or received in a single Modbus message when using the DataLink gateway. The limits are because of the different structure of Modbus and A-B DH+ protocols, and also due to the internal memory structure of the DL2000-CMX.

- Up to 100 Modbus Holding Registers can be read in a single transaction
- Up to 100 Modbus Holding Registers can be written in a single transaction

## 1.7 MODBUS MASTER USING BM85 MODBUS PLUS / MODBUS BRIDGE MUX

The DL2000-CMX Modbus Master will also communicate with Modicon PLCs and other devices on Modbus Plus when connected to one of the four Modbus ports of a NW-BM85-000 Modbus Plus/Modbus Network Bridge Mux (see configuration layout in section 4.2 and Modbus to DL2000 cable drawings in section 3).

If PLCs and other stations on DH+ are required to initiate communications with one or more Modicon PLCs on Modbus Plus then the BM85's Bridge Mux port connecting it to the DL2000-CMX must be configured in **Slave mode**.

The serial communications parameters for the Bridge Mux Modbus port interface to the DL2000-CMX must be the same as those set in the DataLink.

## 1.8 DH+ AND MODBUS - GENERAL

Each addressed slave station must be a unique address on Modbus and the DL2000-CMX must be the only Master Station on the Modbus network. Any station on the DH+ network can be a “Master” that can address any Modbus Slave Station from 1 - 255. This means that effectively the Modbus network can have multiple A-B PLC Modbus Masters with the DataLink acting as a traffic cop.

Modbus (Slave) station address numbers may be the same as DH+ station address numbers provided that all Slave Station addresses are unique on Modbus, and all DH+ network addresses are unique on the DH+ network.

The following table provides a reference between the different radices used on Modbus (MB), Data Highway Plus (DH+) and the DataLink (DL):

**DECIMAL TO OCTAL TO HEXADECIMAL ADDRESS CONVERSION TABLE**

<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>
00	00	00	16	20	10	32	40	20	48	60	30
01	01	01	17	21	11	33	41	21	49	61	31
02	02	02	18	22	12	34	42	22	50	62	32
03	03	03	19	23	13	35	43	23	51	63	33
04	04	04	20	24	14	36	44	24	52	64	34
05	05	05	21	25	15	37	45	25	53	65	35
06	06	06	22	26	16	38	46	26	54	66	36
07	07	07	23	27	17	39	47	27	55	67	37
08	10	08	24	30	18	40	50	28	56	70	38
09	11	09	25	31	19	41	51	29	57	71	39
10	12	0A	26	32	1A	42	52	2A	58	72	3A
11	13	0B	27	33	1B	43	53	2B	59	73	3B
12	14	0C	28	34	1C	44	54	2C	60	74	3C
13	15	0D	29	35	1D	45	55	2D	61	75	3D
14	16	0E	30	36	1E	46	56	2E	62	76	3E
15	17	0F	31	37	1F	47	57	2F	63	77	3F

## 2.0 DH+ NETWORK TO MODBUS COMMUNICATIONS CONFIGURATION

This section contains an example configuration for a DL2000-CMX set for Modbus Master RTU protocol operation. The User's Guide sections referred to give general information on how to save a set of communication parameters to a PC disk file and then how these parameters may be transferred and saved in the EEPROM of a DL2000.

The general parameters required for the DL2000 include: Interface Type, Source Network, Network Address and On-Line Mode. Modbus parameters required include Master or Slave, RTU or ASCII, baud rate, parity and other serial communication parameters. DH+ communication parameters must also be selected. These parameters must be configured before on-line operation is attempted.

Follow the User's Guide sections referenced for general information on configuration, and the following DL2 program menu displays for specific information on how to configure your DataLink for Modbus Master operation.

The DL2 program configuration screen dumps provided with this application note show the typical parameters used to set the DataLink for a Modbus Master operation using RTU protocol.

### 2.1 MAIN MENU

Section 3.0 to 3.2 of the DL2000 User's Guide provides an overview of the general configuration process and details the use of the "DL2" PC menu program provided to set-up your unit for standard operations. After following the User's Guide instructions the main menu will be displayed on the PC's screen and you will be prompted to make your selection. The first step is to configure the DL2 program so it knows which serial COM port and IRQ that the DL2000-CMX will be connected to.

Then select C to configure a communications file and follow the prompts.

<b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - DL2 - Release 3.08</b>		
<b>MAIN MENU</b>		
(S) <b>S</b> et DL2 Program for Specific DataLink Model and COM Port		
(C) <b>C</b> onfigure/View Configuration Disk File		
(T) <b>T</b> ransfer Configuration (Disk File to EEPROM)		
(U) <b>U</b> pload Configuration (EEPROM to Disk File)		
(N) <b>O</b> nLine Programs - DF1 to DH+ Network Diagnostic Tests		
(O) <b>O</b> ff-Line Programs - Revision Level and Diagnostic Tests		
(Q) <b>Q</b> UIT to DOS and End Session		
Enter Function Letter <b>C</b>		
<b>File Selected : EEPROM.001</b>	<b>Network Address : 01</b>	
<b>Model Type: DL2000</b>	<b>Protocol : MODBUS</b>	<b>Network : DH+</b>
		<b>COM: 1 IRQ: 4</b>

## 2.2 MODBUS - CONFIGURATION

Section 3.5 of the DL2000 User's Guide shows how to generate and save a standard configuration file for the DataLink to a PC disk file for later transfer to a DataLink's EEPROM configuration storage. After selecting the Configure/View option on the Main Menu the following menu will be displayed on the PC.

### 2.2.1 CONFIGURE OR VIEW COMMUNICATIONS FILE

Select an EEPROM file number between 01 and 99. Then follow the screen instructions and prompts.

<b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - DL2 - Release 3.08</b>		
<b>CONFIGURE OR VIEW COMMUNICATIONS FILE</b>		
This selection will OPEN/CREATE an EEPROM communications file with the name EEPROM.OXY ( where XY is any value 1 - 99 ) This file can be VIEWED/MODIFIED and then transferred to the DL2000 using MAIN MENU selection "Transfer to EEPROM".		
Enter Numeric File Extension <u>1</u>		
File Selected : EEPROM.001	Network Address : 01	
Model Type: DL2000	Protocol : MODBUS	Network : DH+ COM: 1 IRQ: 4

### 2.2.2 MODBUS - INTERFACE TYPE SELECTION

The following screen provides the capability of selecting between various manufacturers networks. For Modbus Master or Modbus Master protocols select MODICON for the INTERFACE Type and A-B DH+ for the Source Network.

<b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - DL2 - Release 3.08</b>		
<b>SERIAL CHANNEL B AND NETWORK PROTOCOL SELECTION</b>		
<b>SERIAL CHANNEL B PROTOCOL</b>	<b>NETWORK PROTOCOL</b>	
0 = A-B DF1	0 = A-B Data Highway Plus	
1 = Modicon	1 = A-B Remote I/O Link	
2 = Siemens	2 = Modicon Modbus	
3 = Toshiba		
Enter Protocol Type: <u>1</u>	Enter Network Type: <u>0</u>	
File Selected : EEPROM.001	Network Address : 01	
Model Type: DL2000	Protocol : MODBUS	Network : DH+ COM: 1 IRQ: 4

### 2.2.3 MODBUS - ADDRESS AND MODE CONFIGURATION

Enter the desired DH+ station address of the DL2000 in the Base Address field.

**Then select On-Line MODE 1** for Modbus protocol (either Modbus Master or Modbus Slave).

**DL2000 PARAMETER CONFIGURATION**

**DL2000 Base Address (00-3F) 01 (Hexadecimal)**  
**DL2000 High Address (00-3F) 00 (Hexadecimal)**

**The Following Selection Determines the DL2000's On-Line MODE**

**O = MODE 0 Standard DF1 to DH+      2 = MODE 2 Not Used**  
**1 = MODE 1 Modbus Master/Slave      3 = MODE 3 Executes in Ram**

**Select On-Line Mode ( 0-3 ) : 1**

**Enter <PgDn> to proceed the next screen**

**NOTES:**

1. DL2000 Base Address is the station address of the DataLink on DH+. Legal values are between 00-3F (Hex). ie. 00-77 (Oct).
2. DL2000 High Address parameter is not used and is ignored by the Modbus protocol.

### 2.2.4 MODBUS - CHANNEL B COMMUNICATIONS CONFIGURATION

This menu is used to set the general communications parameters for DataLink Channel B which is brought out to both front Port B and rear Port B'. This channel is used interface the DataLink to a Modbus network. The parameters set on the screen display below set the Modbus interface to Even parity, 8 Data bits, 1 Stop bit, No handshaking and 9600 baud.

**CHANNEL B - PARAMETER CONFIGURATION**

**The following require a Y or N to be entered**

<b>Parity:</b>	N = None	Y = Yes	(y/N) <u>Y</u>
	N = Odd	Y = Even	(y/N) <u>Y</u>
<b>Data Bits:</b>	N = 8	Y = 7	(y/N) <u>N</u>
<b>Stop Bits:</b>	N = 1	Y = 2	(y/N) <u>N</u>
<b>Handshaking:</b>	N = Ignore	Y = Active	(y/N) <u>N</u>
<b>Duplex:</b>	N = Full	Y = Half	(y/N) <u>N</u>

**Enter decimal value for ASYNC SPEED 8**  
**Entering an unassigned value will default to 9600 Baud**

2 - 150 Baud	7 - 4800 Baud	12 - 115.2 Kbaud
3 - 300 Baud	8 - 9600 Baud	13 - 230.4 Kbaud
4 - 600 Baud	9 - 19.2 KBaud	16 - Ext Xtal/64
5 - 1200 Baud	10 - 38.4 KBaud	17 - Ext Xtal/96
6 - 2400 Baud	11 - 57.6 KBaud	18 - Ext Xtal/128

**Enter <PgDn> to proceed to the next screen**

### 2.2.5 DATALINK CHANNEL C - COMMUNICATIONS CONFIGURATION

The CHANNEL C - Parameter Configuration screen may automatically appear next.  
**Communications Channel C is not used by Modbus. Press <PgDn> to bypass this screen.**

### 2.2.6 DF1 PROTOCOL PARAMETER CONFIGURATION

The DF1 Protocol Parameter Configuration screen will automatically appear. This allows DF1 and DH+ protocol parameters to be configured. This screen is shown at the end of User's Guide section 3.5.1. The default parameters set are normally O.K. for Modbus. **Press <PgDn> to bypass or exit this screen.**

### 2.2.7 MODBUS - PROTOCOL PARAMETER CONFIGURATION

Modbus Master only requires the following entries:

- Mode of Operation - Select ASCII or RTU dependent upon the mode required
- Device Type - Select Master for Modbus Master protocol
- Half Duplex - Select Y for half duplex and N for full duplex modes

The Protocol Selections shown below set the DataLink to be a Modbus Master using RTU Protocol.

MODBUS PROTOCOL PARAMETER CONFIGURATION			
<b>Mode of Operation:</b>	<b>N = RTU</b>	<b>Y = ASCII</b>	<b>(y/N) <u>N</u></b>
<b>Device Type :</b>	<b>N = Slave</b>	<b>Y = Master</b>	<b>(y/N) <u>Y</u></b>
<b>Half Duplex :</b>	<b>N = No</b>	<b>Y = Yes</b>	<b>(y/N) <u>N</u></b>
<b>Broadcast Message:</b>	<b>N = No</b>	<b>Y = Yes</b>	<b>(y/N) <u>N</u></b>
<b>Broadcast START Address :</b>	<b><u>00</u> (Hex)</b>	<b>and END Address :</b>	<b><u>00</u> (Hex)</b>
<b>MODBUS SLAVE to A-B Address Translation Table</b>			
<b>Modicon Start Address</b>	<b>Modicon End Address</b>	<b>A-B Starting Address</b>	
<b>XXXXX</b>	<b>XXXXX</b>	<b>(File: Word)</b>	
<b>0</b>	<b>0</b>	<b>0: 0</b>	
<b>0</b>	<b>0</b>	<b>0: 0</b>	
<b>THIS AREA DOES NOT NEED TO BE PROGRAMMED IF</b>			
<b>ABOVE CONFIGURATION IS SET TO MODBUS MASTER</b>			
<b>0</b>	<b>0</b>	<b>0: 0</b>	
<b>0</b>	<b>0</b>	<b>0: 0</b>	
<b>0</b>	<b>0</b>	<b>0: 0</b>	
<b>Enter &lt;PgDn&gt; to proceed to the next screen</b>			

#### NOTES:

1. The program returns to the Main Menu after completion of the parameter entries.
2. When the "Device Type" field has been set to (Modbus) Master "Y" the DL2000-CMX Modbus Master does not require any entries in Broadcast Message, Broadcast START and END addresses, or in the MODBUS SLAVE to A-B Address Translation Table. See sections 1.2 and 1.3 for information on Broadcast and DH+ to Modbus Address Translation applicable to the Modbus Master mode.

## 2.3 TRANSFER COMMUNICATIONS FILE TO EEPROM

Section 3.6 of the DataLink User's Guide shows how to transfer a configuration file from a PC file, configured as per section 2.2 above, to the DataLink's EEPROM. Transfer to EEPROM is performed using a PC connected as described in section 3.2 of the User's Guide together with the "DL2" PC program provided on disk with each DataLink. This configuration software program is menu-driven for ease of use.

Select the **T** option on the DL2 program main menu to enable the configuration parameters previously saved in a disk file to be Transferred to a DataLink and automatically written and saved to that unit's EEPROM memory.

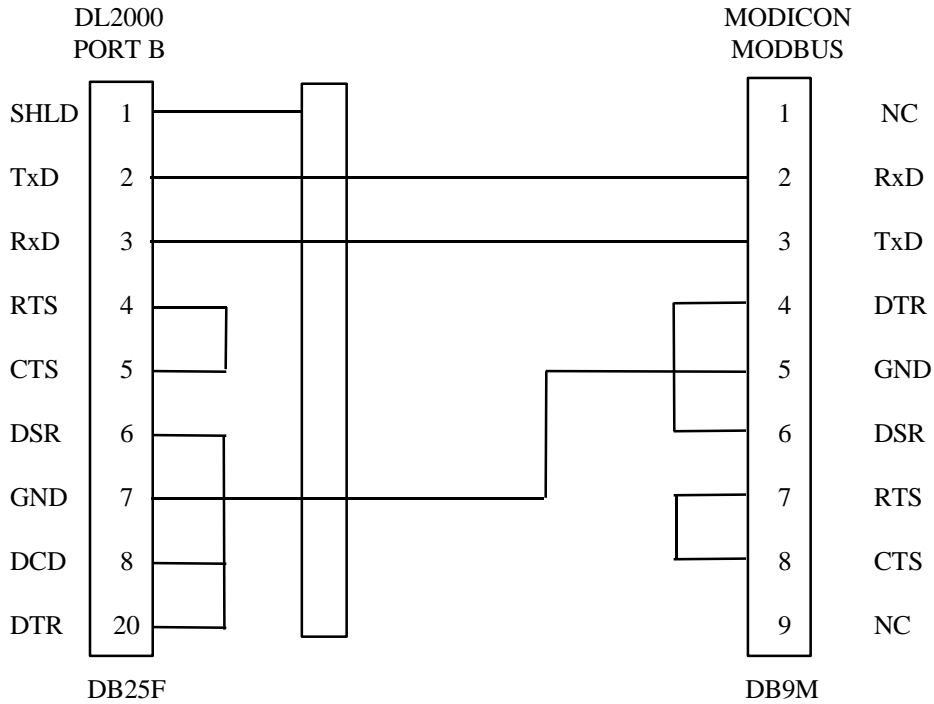
<b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - DL2 - Release 3.08</b>			
<b>TRANSFER CONFIGURATION PARAMETERS TO DATALINK EEPROM</b>			
Choose ( <b>R</b> ) estore to Factory Settings or ( <b>T</b> ) ransfer Configuration <u>F</u> ile: <b>T</b>			
DATALINK is connected to computer serial port: <b>1</b>			
The DATALINK must be in Config. / Diagnostic Mode to enable file Transfer (Press CFG pushbutton on the rear of the DL2000)			
Enter Numeric File Extension <b>1</b> ( 1 - 99 )			
<b>File Selected : EEPROM.001</b>	<b>Network Address : 01</b>		
<b>Model Type: DL2000</b>	<b>Protocol : MODBUS</b>	<b>Network : DH+</b>	<b>COM: 1 IRQ: 4</b>

### NOTES:

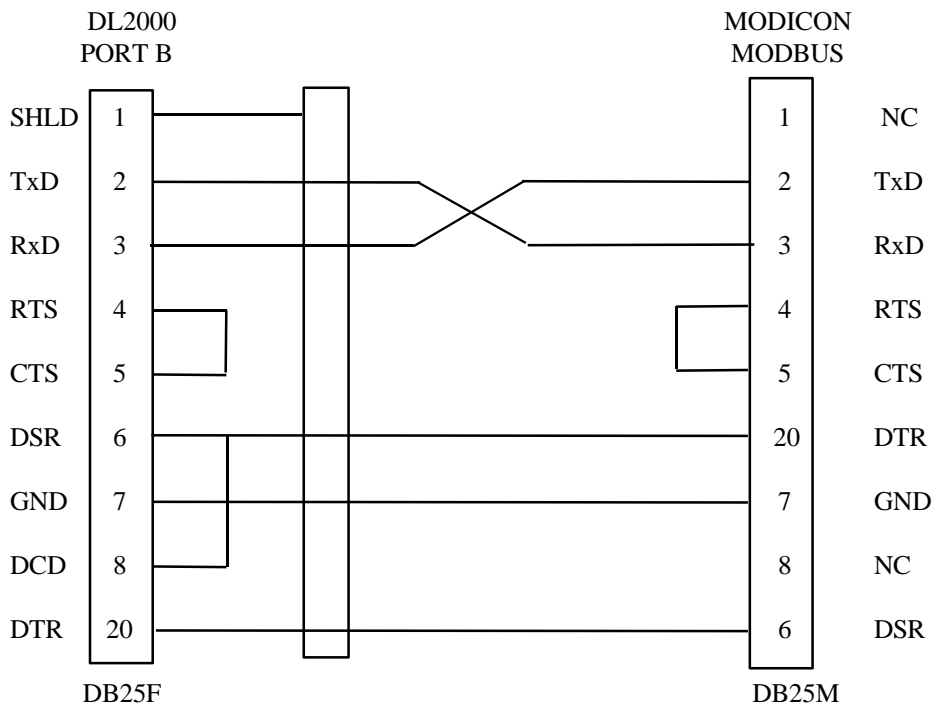
1. Prior to executing Transfer to EEPROM press the **CFG** switch located on the rear of the DataLink to set it into configuration mode ready to receive the configuration file.
2. To ensure that the transfer occurred correctly watch the bottom of the PC screen. Successful transfer will display **\*\*A-OK\*\***. If a successful transfer does not occur a fault message will be briefly displayed and the program will return to the main menu.
3. While the configuration data is being transferred from the PC file to the DataLink EEPROM, the CHAN 1 IN and CHAN 1 OUT LEDs on the DataLink will flash.

### 3.0 DATALINK TO MODBUS INTERFACE CABLES

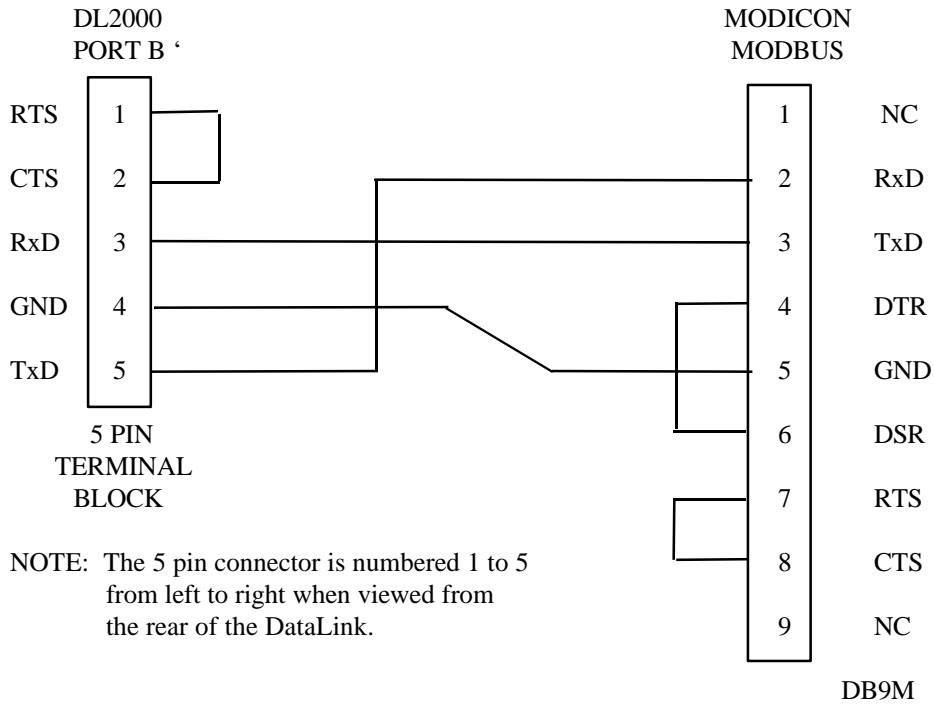
#### 3.1 RS232C - DATALINK FRONT PORT B TO 9 PIN MODBUS PORT



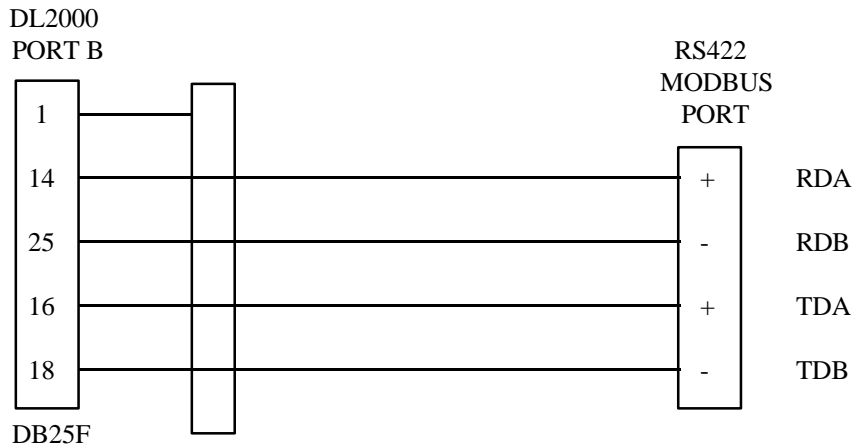
#### 3.2 RS232C - DATALINK FRONT PORT B TO 25 PIN MODBUS PORT



### 3.3 RS232 - DATALINK REAR PORT B' TO 9 PIN MODBUS PORT



### 3.4 RS422 - FRONT PORT B TO MODBUS RS422 PORT

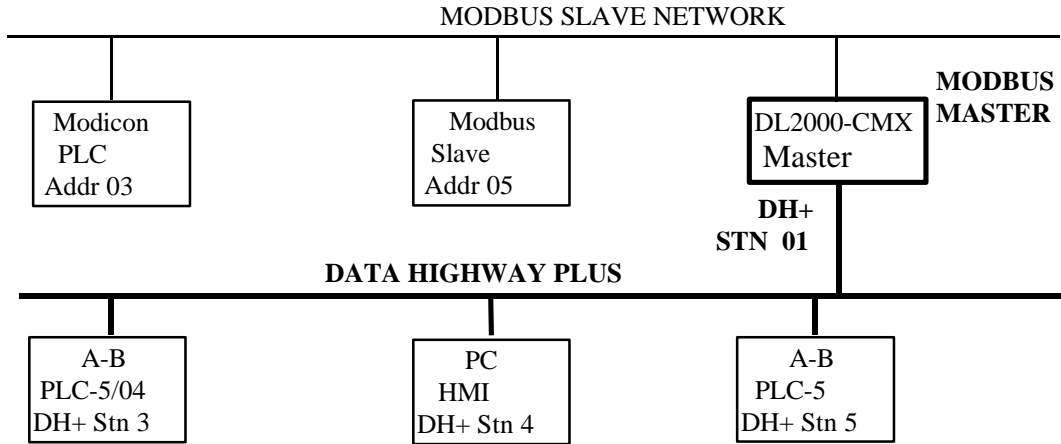


**NOTES:**

1. Other Modbus interfaces such as RS422/RS485 out of rear PORT B' are available.
2. User's Guide sections 4.2 and 6.3 contains the information required to select PORT B' for RS422 and RS485 interface modes.

## 4.0 MODBUS MASTER APPLICATIONS

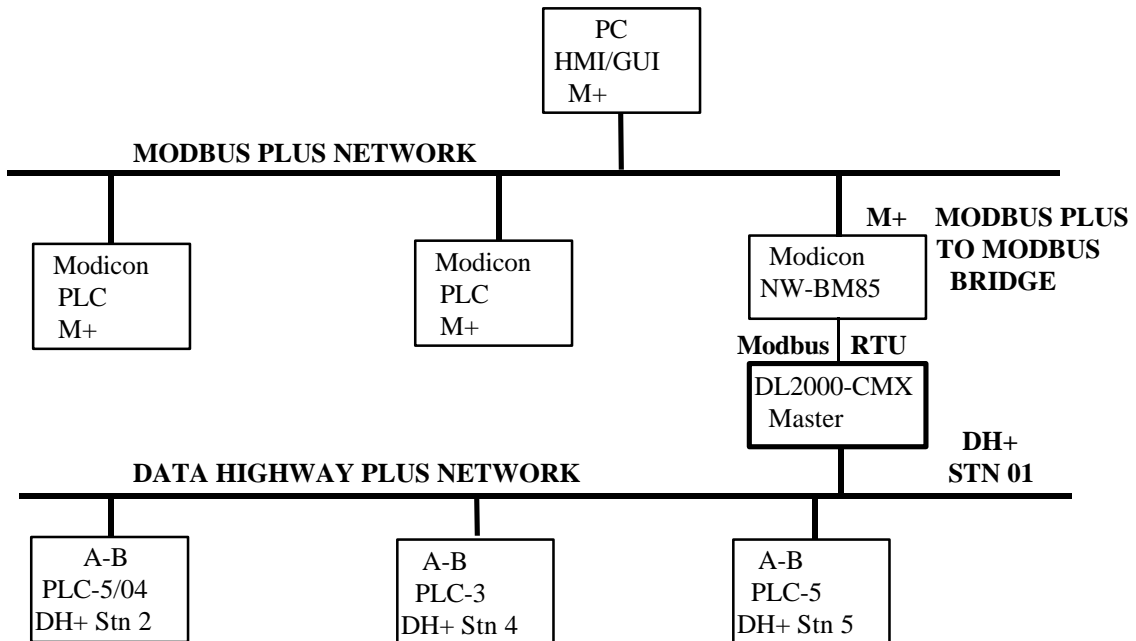
### 4.1 DATALINK MASTER TO MODBUS SLAVE NETWORK



**NOTE:**

PLC5s, SLC5/04s and HMIs on the A-B DH+ network can be programmed to communicate with any Slave device on the Modbus Slave network. Modbus and DH+ addresses can be the same.

### 4.2 DATALINK MASTER TO MODBUS PLUS VIA BM85 MODBUS BRIDGE



**NOTE:**

PLC5s, SLC5/04s and HMIs on the DH+ network can be programmed to communicate with any station on the Modbus Plus network.

# APPLICATION NOTE

## DL2000-CMX MODBUS SLAVE PROTOCOL

These application notes contain configuration, system design and programming information on the Dual Modbus Protocol DL2000-CMX Modbus to DH+ interface. The -CMX model contains three protocols selectable by PC menu: Modbus Master, Modbus Slave and A-B DF1. The information contained in this configuration guide is for the Modbus Slave protocol only, and is supplementary to the information in the User's Guide. If you require to use the DataLink in Standard A-B DF1 to DH+ mode follow the configuration procedures in 3.5.1 of the main User's Guide.

The application notes generally assume that a PLC is the DH+ device responding to Modbus commands via a DL2000-CMX Modbus Slave. Only DH+ stations capable of receiving DH+ message commands in PLC5 format can be used with the DL2000-CMX Modbus Slave. This includes devices such as PLC-3s, PLC-5s, SLC5/04s, PCs, HMIs and intelligent devices.

### NOTES:

1. The DataLink unit that you have received can be configured as Modbus Master or Modbus Slave (or A-B DF1). Ensure that you understand and carefully follow the specific configuration procedures for the Modbus (or A-B DF1) protocol desired.
2. **There are significant differences between the configuration, programming and operational requirements of Modbus Master and Modbus Slave protocols.**
3. If you configure the DataLink for Modbus Slave operation the Modbus network must have a Modbus Master device capable of originating commands to the DL2000-CMX Modbus Slave which then re-transmits the messages over DH+ to a PLC5. Other intelligent DH+ devices capable of responding to messages in PLC5 format could also be used as the DH+ destination instead of the PLC5.
4. Be sure to fully test the DataLink hardware and software off-line to ensure that you understand its configuration and operation. Prior to putting the DataLink on-line in a production process, the operation of the complete system should be fully tested on-line in a safe "test" environment.
5. Due to differences between DH+, Modbus and the DataLink hardware and software there are differences between the lengths of messages, error handling and addressing which have to be carefully considered by the Systems Designer, Programmer and Installer. As an example Modbus uses decimal addressing, DH+ uses octal addresses and the DataLink uses hexadecimal addressing.
6. Additional literature regarding DH+, Modbus and PLC products can be obtained from Modicon and A-B. Suggested reference materials for A-B DH+ and A-B DF1 protocol is shown in section 1.7 of the User's Guide.

### CAUTION:

**Incorrect configuration may result in unsafe operation, damage to equipment or safety hazard to personnel.**

Read the DL2000 User's Guide and the appropriate application notes carefully before putting a DL2000 on-line.

The DataLink hardware and software must be fully tested off-line in a safe "TEST" environment prior to putting the DataLink on-line in an operational environment.

**DL2000-CMX**

**MODBUS SLAVE**

**CONFIGURATION GUIDE**

# INDEX FOR DL2000-CMX

## MODBUS SLAVE TO DH+

<b>1.0 GENERAL</b> .....	1
1.1 MODBUS COMMAND CAPABILITIES .....	1
1.2 BROADCAST COMMAND.....	1
1.3 COMMUNICATIONS SEQUENCE.....	2
1.4 MODBUS MESSAGE DATA LENGTH CONSIDERATIONS .....	2
1.5 MODBUS TO DH+ - GENERAL .....	2
1.6 MODICON MODBUS TO A-B PLC ADDRESS MAPPING .....	3
1.7 MODBUS MASTER USING BM85 MODBUS PLUS/MODBUS BRIDGE MUX .....	5
<b>2.0 MODBUS TO DH+ NETWORK AND COMMUNICATIONS CONFIGURATION</b> .....	6
2.1 MAIN MENU .....	6
2.2 DATALINK CONFIGURATION FOR MODBUS SLAVE.....	7
2.2.1 CONFIGURE OR VIEW COMMUNICATIONS FILE .....	7
2.2.2 DATALINK INTERFACE TYPE SELECTION .....	7
2.2.3 DH+ STATION ADDRESS AND MODE SELECTION .....	8
2.2.4 DATALINK SERIAL CHANNEL B COMMUNICATIONS CONFIGURATION.....	8
2.2.5 DATALINK CHANNEL C COMMUNICATIONS CONFIGURATION .....	9
2.2.6 DF1 PROTOCOL PARAMETER CONFIGURATION.....	9
2.2.7 MODBUS TO A-B PROTOCOL AND ADDRESS TRANSLATION.....	9
2.3 TRANSFER COMMUNICATIONS FILE TO EEPROM.....	10
<b>3.0 DATALINK TO MODBUS INTERFACE CABLES</b> .....	11
3.1 RS232C - DATALINK FRONT PORT B TO 9 PIN MODBUS PORT .....	11
3.2 RS232C - DATALINK FRONT PORT B TO 25 PIN MODBUS PORT .....	11
3.3 RS232 - DATALINK REAR PORT B' TO 9 PIN MODBUS PORT .....	12
3.4 RS422 - FRONT PORT B TO MODBUS RS422 PORT.....	12
<b>4.0 MODBUS SLAVE APPLICATIONS</b> .....	13
4.1 MODBUS MASTER TO DH+ VIA DATALINK SLAVE .....	13
4.2 M PLUS NETWORK TO DH+ VIA MODBUS BRIDGE AND DATALINK SLAVE.....	13

## 1.0 GENERAL

The DL2000-CMX Modbus Slave module facilitates communication between a Modbus Master and an Allen-Bradley Data Highway Plus network. DataLink provides for serial communications to Modbus with RS232C, RS232 or RS422/RS485 interface capabilities. Interface cable drawings are in section 3. Communication between Modbus and the DL2000-CMX can only be initiated from a Modbus Master (not from the DH+).

The Modbus serial port on the DL2000-CMX is transparent to Modbus and does not require an address. The DH+ network side of the DL2000 unit is an active station on the DH+ and requires its own DH+ address that must be different than the DH+ station address(es) that the Modbus Master needs to communicate with. Any other station on the DH+ except station 00 can be addressed by Modbus as if they were slave Modicon PLCs (see section 1.2 re. DH+ Station address 00). Station 00 is a valid address for the DataLink.

A Modbus Master can read and write to any PLC on DH+ that can handle PLC5 message commands without the need for any programming in the PLC, however the PLC addresses used must not be "protected" and the full range of addresses that the Modbus Master requires to read from or write to must have been previously created in the PLC's Data Table. Modbus read and write bit/coil commands are used with A-B PLC Binary (B) files and Modbus read and write word/register commands are used with A-B PLC's Integer (N) files.

## 1.1 MODBUS COMMAND CAPABILITIES

The DL2000-CMX firmware module is compatible with the following Modbus commands: -

DH+ Station #	Modbus Command Code	Modbus Command Description	Modbus Address
01-63	01	Read Coil Status	00001 - 09999
01-63	02	Read Input Status	10001 - 19999
01-63	03	Read Holding Register	40001 - 49999
01-63	04	Read Input Register	30001 - 39999
01-63	05	Force Single Coil	00001 - 09999
01-63	06	Preset Single Holding Register	40001 - 49999
01-63	16	Preset Multiple Holding Registers	40001 - 49999
00	05,06,16	Broadcast Command.	

## 1.2 BROADCAST COMMAND

Modbus protocol uses the Broadcast command (ie commands 05, 06 and 16 with a station address of 00) to write to all slave devices on a Modbus network simultaneously, no response is expected by the Master. Allen-Bradley DH+ protocol does not support Broadcast. A-B PLCs are not capable of responding to a single "Broadcast" command over the DH+ network. DL2000s can be configured to ignore or to execute Broadcasts. Broadcasting is accomplished by splitting the command into separate messages for retransmission one at a time to each DH+ station within pre-configured range of stations. Because of the time taken to send out multiple messages over the DH+, Broadcasts commands are normally restricted to an absolute minimum range of DH+ stations.

A PLC-5 or other device at DH+ station address 00 cannot be addressed by Modbus read or write commands as 00 is normally the Broadcast command. DH+ station 00 may be used as the DH+ station address for the DataLink.

### NOTES:

1. Restrict the DH+ stations receiving a Modbus broadcast to prevent writing to unintended DH+ destinations.
2. Valid Modbus Slave addresses of devices on the DH+ are 01 to 77 Octal (ie. Slave station addresses 1 to 63 dec).

### 1.3 COMMUNICATIONS SEQUENCE

The DL2000 module receives a Modbus query on its asynchronous serial port, converts it into the appropriate DH+ message and sends it out on the DH+ network. The DH+ response is received, converted into the corresponding Modbus response and sent back to the Modbus Master. Modbus protocol does not allow messages to be buffered so the DataLink processes one message at a time. The DL2000 unit will respond to the Modbus interface with the appropriate Modbus exception codes in the event of detectable errors.

#### MODBUS EXCEPTION CODE RESPONSES

ERROR CODE	GENERAL DESCRIPTION	DESCRIPTION OF MODBUS AND DH+ INTERFACE ERRORS AS APPLICABLE TO THE DL2000-CMX
1	Illegal Function	DataLink does not recognise Modbus Function field
2	Illegal Data Address	Cannot translate the Modbus address to DH+ format Ensure that the address is in the range 1 - 63 dec.
3	Illegal Data Value	Modbus message is longer than the DH+ can handle

### 1.4 MODBUS MESSAGE DATA LENGTH CONSIDERATIONS

The following shows the maximum number of coils/registers that can be sent or received in a single Modbus message. The limits are because of the different structure of Modbus and A-B DH+ protocols, and also due to the internal memory structure of the DL2000. These values have only a limited relationship to the Modbus/DH+ address mapping ranges configured in the DataLink (section 1.6).

- The maximum number of coils that can be read in a single transaction is 1600. (Normal Modbus allows 2000)
- The maximum number of registers that can be read in a single transaction is 100. (Normal Modbus allows 125)
- The maximum number of registers that can be written in a single transaction is 100. (Normal Modbus allows 100)

#### CAUTIONS:

1. Ensure that your communications program design prevents self-optimising Modbus Master communications programs (ie. some MMIs and Operator Interfaces) from requesting data in packets larger than the above limits.
2. Ensure that the Modbus program does not generate Modbus commands with addresses that can bridge across more than one of the address range entries configured in the DataLink.
3. Any of the above conditions could cause indeterminate errors.

### 1.5 MODBUS TO DH+ - GENERAL

The DL2000 unit is transparent to valid Modbus commands addressed to station numbers corresponding to active stations on DH+. The DataLink will only accept commands to DH+ station addresses 1 to 63 decimal (1 - 77 octal). Modbus commands using address 0 are broadcast commands and are handled differently by the DataLink.

After formatting and converting the Modbus message to DH+ protocol the command is sent out to the addressed DH+ (slave) device. If the station is inactive the query is disregarded. Each addressed slave station must be a unique address on Modbus or on the DH+ network ie. do not duplicate an address used on the Modbus network with a station address on the DH+. If duplicate addresses exist then the situation will arise where two or more stations could accept the query resulting in multiple responses which would cause communications errors and perhaps writing to unintended destinations.

**NOTE:**

Special consideration should be given to the Modbus and DH+ addressing to avoid duplication of network addresses. Confusion could arise because A-B uses an "octal" addressing scheme for DH+ network stations and Modbus uses "decimal". Ensure use of a common numbering scheme (see section 1.6 for cross-references).

The following table provides a reference between the different radices used between Modbus (MB - decimal), Data Highway Plus (DH+ - octal) and the DataLink (DL - hexadecimal) :

**DECIMAL TO OCTAL TO HEXADECIMAL ADDRESS CONVERSION TABLE**

<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HEX</b>	<b>MB DEC</b>	<b>DH+ OCT</b>	<b>DL HE</b>
00	00	00	16	20	10	32	40	20	48	60	30
01	01	01	17	21	11	33	41	21	49	61	31
02	02	02	18	22	12	34	42	22	50	62	32
03	03	03	19	23	13	35	43	23	51	63	33
04	04	04	20	24	14	36	44	24	52	64	34
05	05	05	21	25	15	37	45	25	53	65	35
06	06	06	22	26	16	38	46	26	54	66	36
07	07	07	23	27	17	38	47	27	55	67	37
08	10	08	24	30	18	40	50	28	56	70	38
09	11	09	25	31	19	41	51	29	57	71	39
10	12	0A	26	32	1A	42	52	2A	58	72	3A
11	13	0B	27	33	1B	43	53	2B	59	73	3B
12	14	0C	28	34	1C	44	54	2C	60	74	3C
13	15	0D	29	35	1D	45	55	2D	61	75	3D
14	16	0E	30	36	1E	46	56	2E	62	76	3E
15	17	0F	31	37	1F	47	57	2F	63	77	3F

**1.6 MODICON MODBUS TO A-B PLC ADDRESS MAPPING**

The relationship between Modicon Modbus and Allen-Bradley PLC addresses is programmed by the user and is stored in the DL2000's EEPROM. The DL2000-CMX can be programmed for eight different address ranges. Each Modicon address range that you wish to set-up may be mapped to a unique A-B address range. The length of the A-B field required is the same as that defined by the Modicon address range. All Modbus/DH+ A-B files should be either Binary or Integer files. These A-B files must be created by the A-B PLC programmer to the full length required by the Modbus Address Translation and Mapping parameters specified. No logic is needed in the A-B PLC to respond to commands received from the Modbus network.

To define how a range of Modicon addresses maps over to Allen-Bradley addresses, the user enters the following information.

- Modicon Start Address: Specifies the starting address of a range of Modbus addresses that will be converted to A-B. Valid entries are 00000 to 09999, 10000 to 19999, 30001 to 39999 and 40001 to 49999.
- Modicon End Address: Specifies the end address of a range of Modbus Addresses that will be converted to A-B. The range of entries is shown above.
- A-B Starting Address: Specifies the A-B PLC starting file number for the Modbus data.

Valid entries are 009:000 to 999 : 999 (ensure that data length does not exceed file boundary). **Coils/discretes must use A-B Binary (B) files. Registers/words use A-B Integer (N) files.**

**Coils/discretes:**

The bit address range of an A-B Binary file is 1000 words or 16,000 bits (ie. 0 - 15,999 decimal). This means that one A-B file is more than sufficient to hold the largest Modbus coil address possible. An A-B binary file/bit address starts at bit 0 and the first “legal” Modbus coil address starts at 1, which means that normally the first Modbus coil address 00001 (or 10001) will correspond to bit 0 in A-B word 0. If a Modbus address of 00000 (or 10000) is entered in the Starting Address field it causes the first (legal) Modbus coil addresses ie. bit 1 to correspond to an A-B file/word bit 1. This technique makes it easy to compare and match the Modbus and A-B memory maps, and easier to bit search the A-B program. When a Modbus coil /bit address is defined in the Start Address field ie. 0XXXX or 1XXXX), then the first A-B Starting Address that can be used is Binary file 9 word 000 (B9:0).

**Registers/words:**

The word address range of an A-B Integer file is 0 - 999 ie., only 1000 words (registers). Therefore if a Modbus address range greater than 1000 registers is required, it is necessary to use more than one A-B Integer (N) file, which will require multiple configuration parameter entries. The first A-B address that can be used for 3xxxx and 4xxxx register/word transfers is an A-B Integer file at file/word address N9:0.

**Address Ranges:**

The Modicon Address Range (ie., Start Address less End Address), and the A-B Start Address selected, must not overflow the maximum A-B file address limit. This means that if A-B Starting Address of word 250 is used then the maximum register range for mapping must be 1000 minus 250, ie. 750.

**Address Mapping Example**

<b>Modicon Start Address</b> xxxxx	<b>Modicon End Address</b> xxxxx	<b>A-B Starting Address</b> <b>(File:Word)</b>
00000	09999	009:000 (Binary File)
10000	19999	010:000 (Binary File)
30001	30999	030:001 (Integer File)
32001	32999	032:001 (Integer File)
40001	40999	040:001 (Integer File)
41250	41999	041:250 (Integer File)
43555	43999	043:555 (Integer File)
49750	49999	049:750 (Integer File)

**NOTES:**

1. The (Binary File) and (Integer File) text after the A-B File:Word address does not appear on the configuration screen and is provided here for reference only.
2. The A-B file corresponding to Modbus Coil addresses should have been previously configured in the PLC as a Binary (B) file and its size configured for the largest coil address.
3. The A-B file corresponding to Modbus Register addresses should have been previously configured in the PLC as an Integer (N) file and its size configured for the largest register address.

Modbus protocol generally permits a maximum of about 125 registers or 2000 coils to be read in a single transaction (the maximum number is dependent on the Modbus driver). When specifying multiple address translation ranges within the same type of Modbus address ( either 0xxxx, 1xxxx, 3xxxx or 4xxxx) it is essential to establish a buffer region of at least 125 registers or 2000 coils between each address type’s range. Failure to do

this may allow a self-optimising MMI interface program to write (or read) data to/from two different areas of the Allen-Bradley PLC with undesired and indeterminate results.

The examples above define a similar A-B word address to the Modbus start address which allows easier comparison between the Modbus A-B addresses used. For example a Modbus start address of 40001 can be represented in A-B PLC-5 file format by using A-B integer file N 40:001. Address mapping using this technique is recommended for a user's convenience only, as it provides a very useful method for record-keeping, cross-reference and recognition. This technique is not mandatory and any Modbus address can be written to any A-B file.

When considering use of the above technique note that the the first available open A-B file address for a PLC-5 controller is file 9. Modbus address 0xxxx cannot be displayed similarly in A-B format as A-B output file 0 should not be used. In this case for easy recognition use an A-B Binary file for Modbus output coils such as 9, 99, 999 or any other convenient file number is easily recognisable.

DataLink firmware permits the entry of 00000 and 10000 values in the Modicon Start Address field even though strictly speaking these are not legal Modbus addresses. This feature allows a programmer to align an A-B Binary file bit 1 with the first legal Modbus Bit / Coil address 1. For example mapping Modicon Start Address 00000 to A-B Start Address (B) 009:000, or Modicon Start Address 10000 to A-B Start Address (B) 010:000 aligns Modbus bit 1 with A-B bit 1. The "B" for Binary file is implied but not displayed.

**NOTES:**

1. Enough space must have been configured and be available in the A-B file to contain the full range of Modbus addresses specified or it will cause over-writing existing A-B files and data.
2. Do not transmit Modbus messages to the DL2000 to read or write more than 1600 coils or 100 registers in a single Modbus read or write command (see section 1.4 above).
3. Ensure that all A-B addresses specified have been created in the destination PLC on DH+.
4. Set all unused Modbus to A-B addresses to zero.

## **1.7 MODBUS MASTER USING BM85 MODBUS PLUS/MODBUS BRIDGE MUX**

The DL2000-CMX will communicate with Modicon PLCs and other devices via Modbus Plus when it is connected to one of the four Modbus ports of a NW-BM85-000 Modbus Plus/Modbus Network Bridge Mux (see configuration layout in section 4.2 and Modbus to DataLink interface cable drawings in section 3).

If a Modicon PLC (or other device) on Modbus Plus requires to communicate with a single A-B PLC on DH+ then the selected Bridge Mux Port connected to the DL2000 can be configured as **SLAVE** in which case it must have the same Modbus station number as the target PLC-5's station address on DH+.

If a Modicon PLC (or other device) on Modbus Plus requires to communicate with multiple A-B PLCs on DH+ then the selected Bridge/Mux Port connected to the DL2000 should be set for **NETWORK (slave)** in which case the station number routing of the destination A-B PLC must be programmed into the appropriate Modicon PLC Ladder Logic Master Function Blocks (or command string) for the Modbus Plus network.

Ensure that the serial communications parameters for the Bridge Mux Modbus port are the same as the DataLink's.

**NOTE:**

Allen-Bradley station addresses are represented in octal, and Modbus addresses in decimal. Be sure to convert to a common numbering convention when developing your configuration. Section 1.5 of this application note contains an cross-reference table for different radices.

## 2.0 MODBUS TO DH+ NETWORK AND COMMUNICATIONS CONFIGURATION

This section contains a sample configuration for a DL2000-CMX set for Modbus Slave RTU protocol operation. The User's Guide sections referred to provide general procedures for configuring and saving a communication parameter file in a PC and how these parameters are then transferred and saved in the EEPROM memory of a DL2000.

The general parameters required for the DL2000-CMX include: Interface Type, Source Network, Network Address and On-Line Mode. Modbus parameters required include Master or Slave, RTU or ASCII, baud rate, parity and other serial communication parameters. DH+ station addresses and other communication parameters must also be selected. All parameters must be configured before on-line operation is attempted.

Follow the User's Guide sections referred to for general information on configuration, and use the following DL2 program menu displays for specific information on configuring a DataLink for Modbus Slave operation. The DL2 program configuration screen dumps provided with this application note show the typical parameters used to set the DataLink for a Modbus Slave operation using RTU protocol.

### 2.1 MAIN MENU

Section 3.0 to 3.2 of the DL2000 User's Guide provides an overview of the general configuration process and details the use of the "DL2" PC menu program for setting-up your DataLink for standard operations.

After following the User's Guide instructions above, the main menu will be displayed on the PC's screen and you will be prompted to make your selection.

Select "C" to configure a communications file in the menu below and then follow the prompts.

<b>DL2000 CONFIGURATION AND DIAGNOSTIC SOFTWARE - Release 2.00</b>		
<b>MAIN MENU</b>		
(O) <u>O</u> ffline Diagnostics / Revision Level (C) <u>C</u> onfigure/View Communications File (T) <u>T</u> ransfer Communications File to EEPROM (U) <u>U</u> pload Communications File from EEPROM (N) <u>O</u> nLine Diagnostic Tests (S) <u>S</u> elect Operating Parameters  (Q) <u>Q</u> UIT to DOS and End Session		
Enter Function Letter <u>C</u>		
<b>File Selected : EEPROM.001</b>	<b>Station Address :</b>	
<b>DL2000 Type :</b>	<b>Network :</b>	<b>COM:1</b>

## 2.2 DATALINKCONFIGURATION FOR MODBUS SLAVE

Section 3.5 of the DL2000 User's Guide shows how to generate and save a standard configuration file for the DataLink to a PC disk file for later transfer to a DataLink's EEPROM configuration storage.

After selecting the Configure/View option on the Main Menu the following will be displayed on the PC's screen. Select an EEPROM file number between 01 and 99. Then follow the instructions and prompts on the PC screen.

### 2.2.1 CONFIGURE OR VIEW COMMUNICATIONS FILE

Select an EEPROM file number between 01 and 99. Then follow the screen instructions and prompts.

<b>DL2000</b> <b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - Release 2.00</b>		
<b>CONFIGURE OR VIEW COMMUNICATIONS FILE</b>		
This selection will OPEN/CREATE an EEPROM communications file with the name EEPROM.OXY ( where XY is any value 1 - 99 ) This file can be VIEWED/MODIFIED and then transferred to the DL2000 using MAIN MENU selection "Transfer to EEPROM".		
Enter Numeric File Extension <u>1</u>		
<b>File Selected : EEPROM.001</b>	<b>Station Address :</b>	
<b>DL2000 Type : MODICON</b>	<b>Network : A-B DH+</b>	<b>COM:1</b>

### 2.2.2 DATALINK INTERFACE TYPE SELECTION

The following screen provides the capability of selecting between various manufacturers networks. For Modbus Master or Modbus Master protocols select 1 ie. MODICON for the INTERFACE Type and 0 ie. A-B DH+ for the Source Network.

<b>DL2000</b> <b>CONFIGURATION AND DIAGNOSTIC SOFTWARE - Release 2.00</b>		
<b>DL2000 INTERFACE TYPE SELECTION</b>		
<b>0 = ALLEN-BRADLEY</b>	<b>0 = A-B DH+</b>	
<b>1 = MODICON</b>	<b>1 = A-B R-I/O</b>	
<b>2 = SIEMENS</b>	<b>3 = MODICON MODBUS</b>	
<b>3 = TOSHIBA</b>		
<b>Choose INTERFACE Type: <u>1</u>    Choose SOURCE Network: <u>0</u></b>		
<b>File Selected : EEPROM.001</b>	<b>Station Address :</b>	
<b>DL2000 Type : MODICON</b>	<b>Network : A-B DH+</b>	<b>COM:1</b>

### 2.2.3 DH+ STATION ADDRESS AND MODE CONFIGURATION

Enter the desired DH+ station address of the DL2000 in the Base Address field.

**Then select On-Line MODE 1** for Modbus protocol (either Modbus Master or Modbus Slave).

<p style="text-align: center;"><b>DL2000 PARAMETER CONFIGURATION</b></p> <p style="text-align: center;"><b>DL2000 Base Address (00-3F) <u>01</u> (Hexadecimal)</b> <b>DL2000 High Address (00-3F) <u>00</u> (Hexadecimal)</b></p> <p style="text-align: center;"><b>The Following Selection Determines the DL2000's On-Line MODE</b></p> <p style="text-align: center;"><b>O = MODE 0 Standard DF1 to DH+      2 = MODE 2 Not Used</b> <b>1 = MODE 1 Modbus Master / Slave      3 = MODE 3 Executes in Ram</b></p> <p style="text-align: center;"><b>Select On-Line Mode ( 0-3 ) : <u>1</u></b> <b>Enter &lt;PgDn&gt; to proceed the next screen</b></p>
--

#### NOTES:

1. DL2000 Base Address is the station address of the DataLink on DH+. Legal values are between 00-3F (Hex). ie. 00-77 (Oct).
2. DL2000 High Address parameter is not used and is ignored by the Modbus protocol.

### 2.2.4 DATALINK SERIAL CHANNEL B COMMUNICATIONS CONFIGURATION

This menu is used to set the general communications parameters for DataLink Channel B which may be accessed through either front Port B or rear Port B'. This channel is used interface the DataLink to a Modbus network. The parameters set on the screen display below show the Modbus interface set to typical values of Even parity, 8 Data bits, 1 Stop bit, No handshaking and 9600 baud.

<b>CHANNEL B - PARAMETER CONFIGURATION</b>			
<b>The following require a Y or N to be entered</b>			
<b>Parity:</b>	<b>N = None</b>	<b>Y = Yes</b>	<b>(y/N) <u>Y</u></b>
	<b>N = Odd</b>	<b>Y = Even</b>	<b>(y/N) <u>Y</u></b>
<b>Data Bits:</b>	<b>N = 8</b>	<b>Y = 7</b>	<b>(y/N) <u>N</u></b>
<b>Stop Bits:</b>	<b>N = 1</b>	<b>Y = 2</b>	<b>(y/N) <u>N</u></b>
<b>Handshaking:</b>	<b>N = Ignore</b>	<b>Y = Active</b>	<b>(y/N) <u>N</u></b>
<b>Duplex:</b>	<b>N = Full</b>	<b>Y = Half</b>	<b>(y/N) <u>N</u></b>
<b>Enter decimal value for ASYNC SPEED <u>8</u></b> <b>Entering an unassigned value will default to 9600 Baud</b>			
<b>2 - 150 Baud</b>	<b>7 - 4800 Baud</b>	<b>12 - 115.2 Kbaud</b>	
<b>3 - 300 Baud</b>	<b>8 - 9600 Baud</b>	<b>13 - 230.4 Kbaud</b>	
<b>4 - 600 Baud</b>	<b>9 - 19.2 KBaud</b>	<b>16 - Ext Xtal/64</b>	
<b>5 - 1200 Baud</b>	<b>10 - 38.4 KBaud</b>	<b>17 - Ext Xtal/96</b>	
<b>6 - 2400 Baud</b>	<b>11 - 57.6 KBaud</b>	<b>18 - Ext Xtal/128</b>	
<b>Enter &lt;PgDn&gt; to proceed to the next screen</b>			

**NOTE:** The Duplex parameter is not used. A DataLink will operate in half or full-duplex as required by the application software.

### 2.2.5 DATALINK CHANNEL C - COMMUNICATIONS CONFIGURATION

The CHANNEL C - Parameter Configuration screen will usually appear next. **Communications Channel C is not used by Modbus. Press <PgDn> to bypass and exit this screen.**

### 2.2.6 DF1 PROTOCOL PARAMETER CONFIGURATION

The DF1 Protocol Parameter Configuration screen will automatically appear next. This screen allows DF1 and DH+ protocol parameters to be configured. This screen is shown at the end of User's Guide section 3.5.1. In most cases the default values are O.K. for Modbus configurations. **Press <PgDn> to bypass and exit this screen.**

### 2.2.7 MODBUS TO A-B PROTOCOL AND ADDRESS TRANSLATION

The following Protocol Selections set the DataLink to be a Modbus Slave using RTU Protocol and with no Broadcast over the DH+. Strictly speaking the translation table Bit mapping scheme of the first two entries ie. Modbus addresses 0 and 10000 are illegal Modbus starting address values. The DL2000-CMX will interpret these values as a request to align bit 1 of the first Modbus output or input coil address with bit 1 in an A-B word for the convenience of the programmer and for ease of bit comparison.

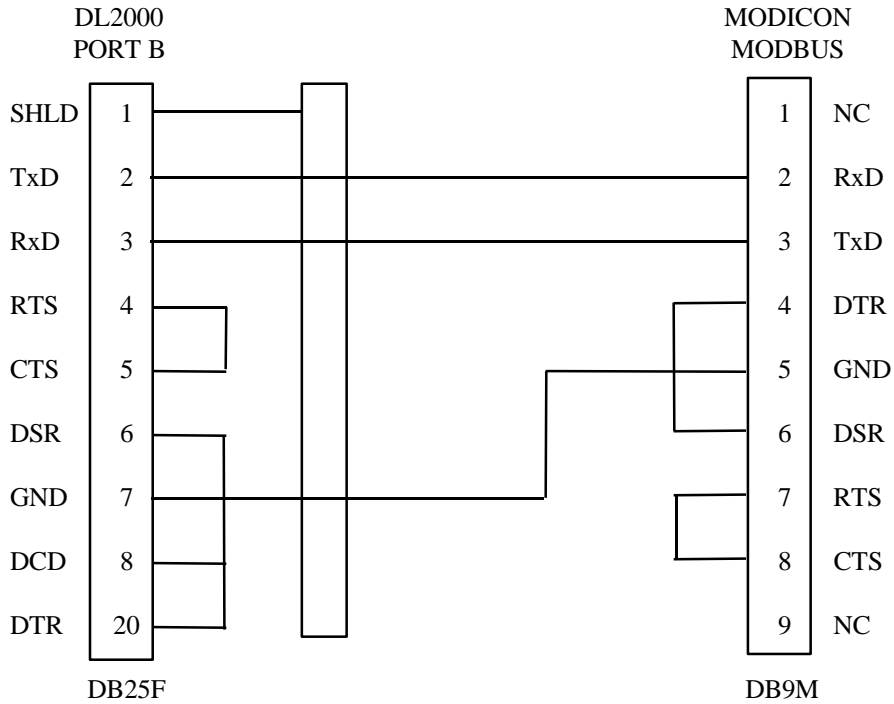
The address entry display moves from left to right and then down. At each address selection you may enter a new numeric value, or press <ENTER> to accept the existing value displayed. In case a mistake is made pressing <Shift> <Tab> will move the cursor backwards through the translation table. Completion of the last entry or pressing <PgDn> will writes the values entered to the PC configuration file . The Protocol Selections shown below configures the DataLink as a Modbus Slave using RTU Protocol, half-duplex and no broadcast capability.

<b>MODBUS PROTOCOL PARAMETER CONFIGURATION</b>			
<b>Mode of Operation:</b>	N = RTU	Y = ASCII	(y/N) <u>N</u>
<b>Device Type :</b>	N = Slave	Y = Master	(y/N) <u>N</u>
<b>Half Duplex :</b>	N = No	Y = Yes	(y/N) <u>N</u>
<b>Broadcast Message:</b>	N = No	Y = Yes	(y/N) <u>N</u>
<b>Broadcast START Address :</b>	00 (Hex) and END Address :		00 (Hex)
<b>MODBUS SLAVE to A-B Address Translation Table</b>			
<b>Modicon Start Address</b>	<b>Modicon End Address</b>	<b>A-B Starting Address</b>	
xxxxx	xxxxx	(File: Word)	
0	09999	9: 0	
10000	19999	10: 0	
30001	30999	30: 0	
40001	40999	40: 0	
0	0	0: 0	
0	0	0: 0	
0	0	0: 0	
0	0	0: 0	
<b>Enter &lt;PgDn&gt; to proceed to the next screen</b>			

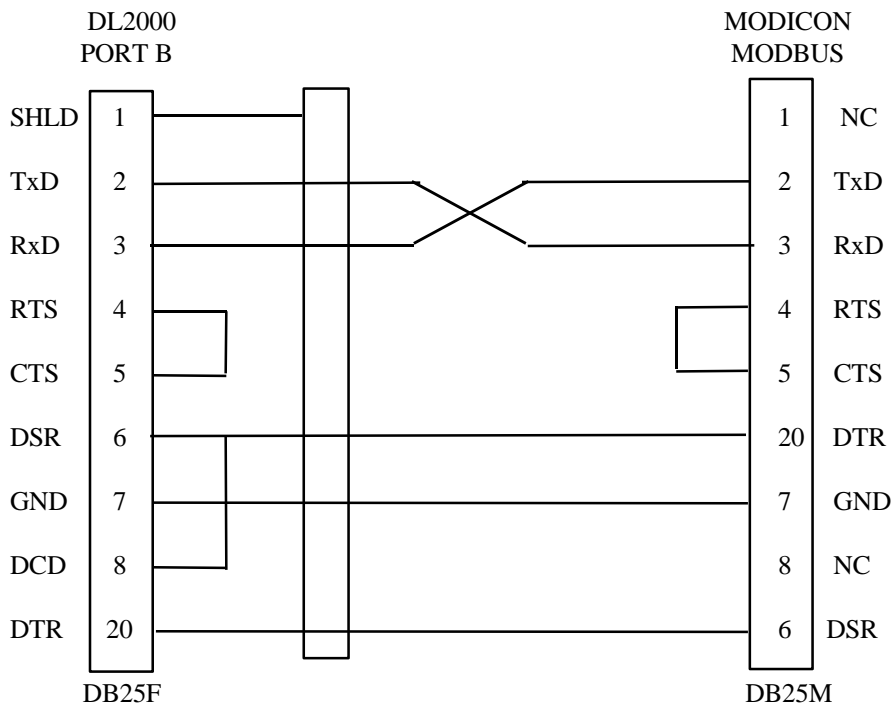


### 3.0 DATALINK TO MODBUS INTERFACE CABLES

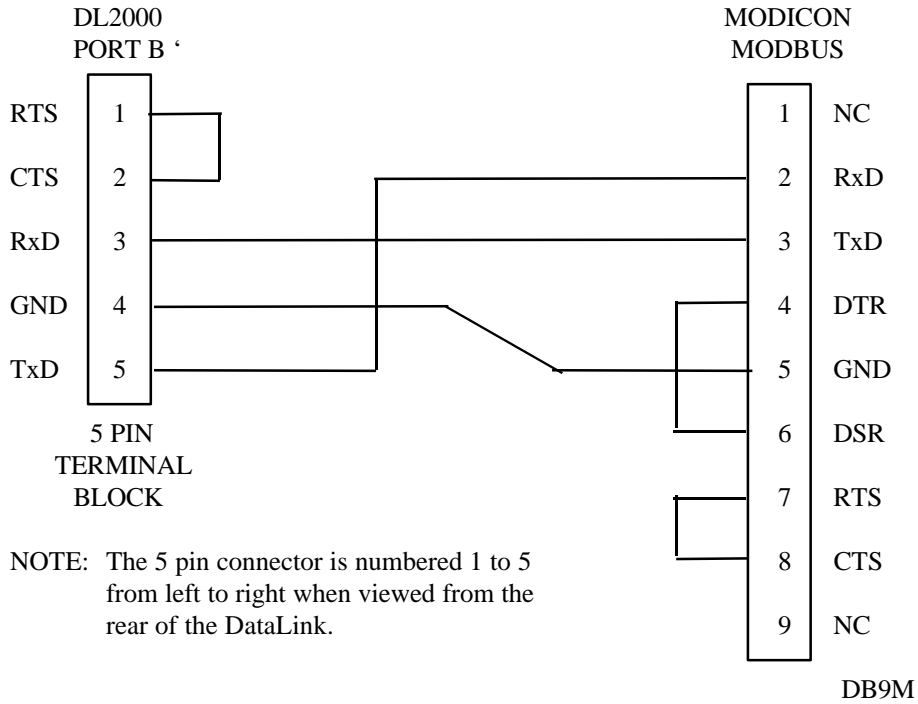
#### 3.1 RS232C - DATALINK FRONT PORT B TO 9 PIN MODBUS PORT



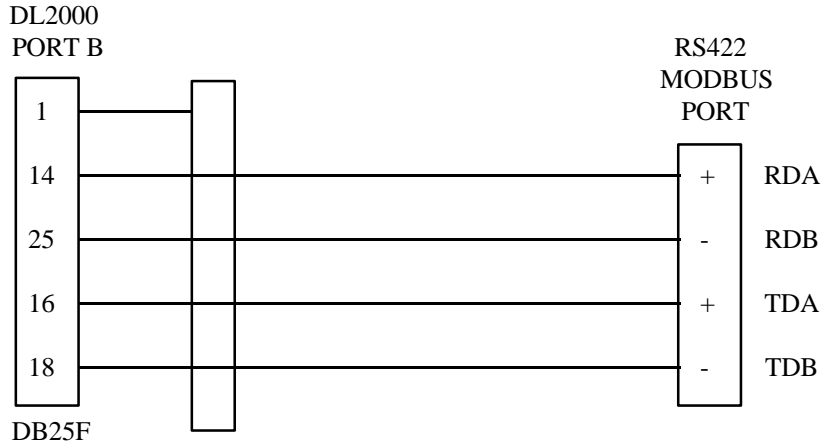
#### 3.2 RS232C - DATALINK FRONT PORT B TO 25 PIN MODBUS PORT



### 3.3 RS232 - DATALINK REAR PORT B' TO 9 PIN MODBUS PORT



### 3.4 RS422 - FRONT PORT B TO MODBUS RS422 PORT

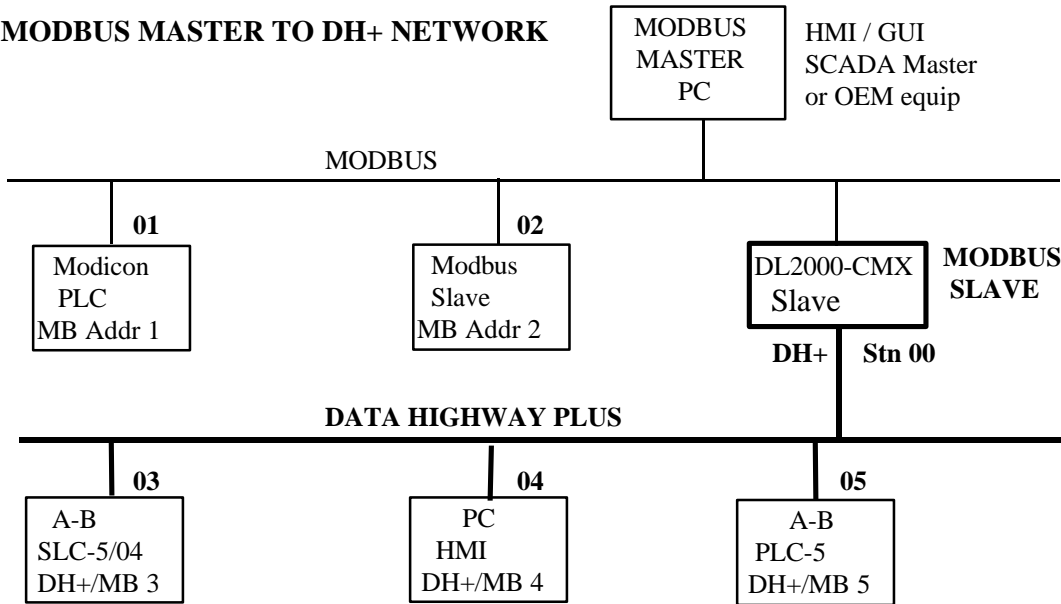


**NOTES:**

1. Modbus interfaces such as RS422/RS485 are also available.
2. User's Guide sections 4.2 and 6.3 contains the information required to select rear PORT B' for other serial interface modes.

## 4.0 MODBUS APPLICATIONS

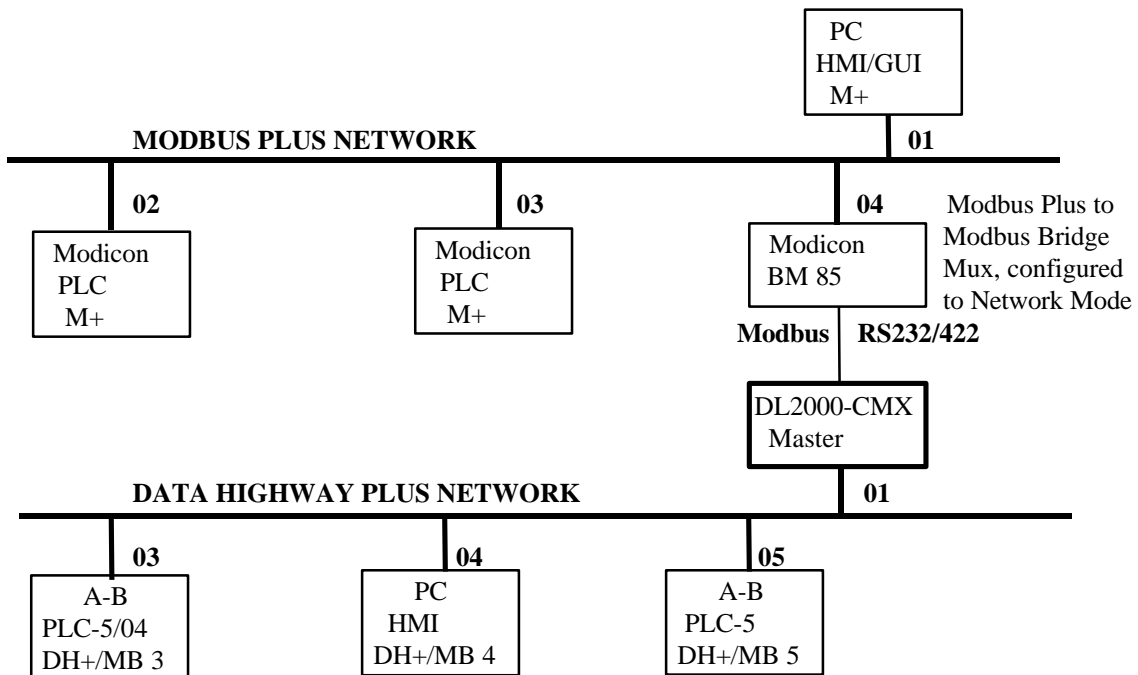
### 4.1 MODBUS MASTER TO DH+ NETWORK



#### NOTE:

The Modbus Master can communicate with any Slave device on the Modbus Slave network (01 and 02, and any PLC5, SLC5/04 or HMI station on DH+, ie. devices capable of receiving PLC5 message commands. Modbus and DH+ addresses must not be duplicated (convert to the same radix) or the Master will receive two responses. The DL2000 can be any station number on DH+ including Station 00 (not used on Modbus).

### 4.2 MODBUS PLUS TO DH+ VIA BM85 MODBUS BRIDGE



**NOTE:**

PLCs and HMIs etc. on Modbus Plus can be programmed to communicate with PLC5s, SLC5/04s and HMIs on DH+, ie. any devices capable of handling PLC-5 DH+ message commands.