System design and Configuration

In This Chapter...

DL06 System Design Strategies

I/O System Configurations

The DL06 PLCs offer a number of different I/O configurations. Choose the configuration that is right for your application, and keep in mind that the DL06 PLCs offer the ability to add I/O with the use of option cards. Although remote I/O isn't available, there are many option cards available. For instance:

- Various A/C and D/C I/O modules
- Combination I/O modules
- Analog I/O modules
- Combination Analog I/O modules

A DL06 system can be developed using several different arrangements using the option modules. See our DL05/06 Options Modules User Manual (D0-OPTIONS-M) on the website, **www.automationdirect.com** for detailed selection information.

Networking Configurations

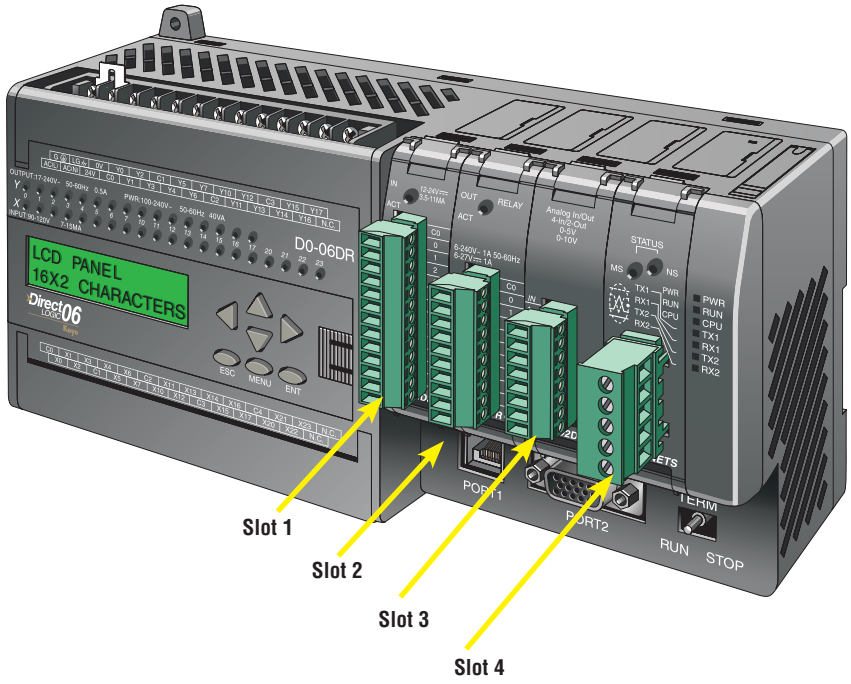
The DL06 PLCs offers the following ways to add networking:

- Ethernet Communications Module s connects a DL06 to high-speed peer-to-peer networks. Any PLC can initiate communications with any other PLC or operator interfaces, such as C-more, when using the ECOM modules.
- Data Communications Modules s connects a DL06 to devices using either DeviceNet or Profibus to link to master controllers, as well as a D0-DCM.
- Communications Port 1 s The DL06 has a 6-pin RJ12 connector on Port 1 that supports (as slave) K-sequence, MODBUS RTU or DirectNET protocols.
- Communications Port 2 s The DL06 has a 15-pin connector on Port 2 that supports either master/slave MODBUS RTU or DirectNET protocols, or K-sequence protocol as slave. (MRX and MWX instructions allow you to enter native MODBUS addressing in your ladder program with no need to perform octal to decimal conversions). Port 2 can also be used for ASCII IN/OUT communications.

Module Placement

Slot Numbering

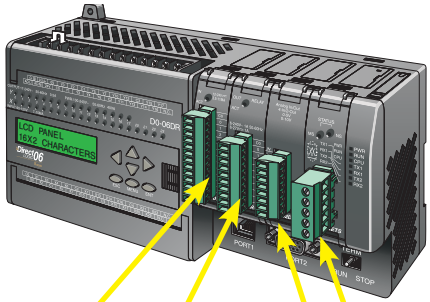
The DL06 has four slots, which are numbered as follows:



Automatic I/O Configuration

The DL06 CPUs automatically detect any installed I/O modules (including specialty modules) at powerup, and establish the correct I/O configuration and addresses. This applies to modules located in the local base. For most applications, you will never have to change the configuration.

I/O addresses use octal numbering, starting at X100 and Y100 in the slot next to the CPU. The addresses are assigned in groups of 8, or 16 depending on the number of points for the I/O module. The discrete input and output modules can be mixed in any order. The following diagram shows the I/O numbering convention for an example system. Both the Handheld Programmer and *Direct*SOFT 5 provide AUX functions that allow you to automatically configure the I/O. For example, with the Handheld Programmer AUX 46 executes an automatic configuration, which allows the CPU to examine the installed modules and determine the I/O configuration and addressing. With *Direct*SOFT 5, the PLC Configure I/O menu option would be used.



	Slot 1	Slot 2	Slot 3	Slot 4
Automatic	8pt. Input X100–X107	16pt. Output Y100–Y117	16pt. Input X110–X127	8pt. Input X130–X137
Manual	8pt. Input X100–X107	16pt. Output Y100–Y117	16pt. Input X200–X217	8pt. Input X120–X127

Manual I/O Configuration

It may never become necessary, but DL06 CPUs allow manual I/O address assignments for any I/O slot(s) . You can manually modify an auto configuration to match arbitrary I/O numbering. For example, two adjacent input modules can have starting addresses at X100 and X200.Use *Direct*SOFT 5 PLC Configure I/O menu option to assign manual I/O address. In automatic configuration, the addresses are assigned on 8-point boundaries. Manual configuration, however, assumes that all modules are at least 16 points, so you can only assign addresses that are a multiple of 20 (octal). You can still use 8 point modules, but 16 addresses will be assigned and the upper eight addresses will be unused.

WARNING: If you manually configure an I/O slot, the I/O addressing for the other modules may change. This is because the DL06 CPUs do not allow you to assign duplicate I/O addresses. You must always correct any I/O configuration errors before you place the CPU in RUN mode. Uncorrected errors can cause unpredictable machine operation that can result in a risk of personal injury or damage to equipment.

Power Budgeting

The DL06 has four option card slots. To determine whether the combination of cards you select will have sufficient power, you will need to perform a power budget calculation.

Power supplied

Power is supplied from two sources, the internal base unit power supply and, if required, an external supply (customer furnished). The D0-06xx (AC powered) PLCs supply a limited amount of 24VDC power. The 24VDC output can be used to power external devices.

For power budgeting, start by considering the power supplied by the base unit. All DL06 PLCs supply the same amount of 5VDC power. Only the AC units offer 24VDC auxiliary power. Be aware of the trade-off between 5VDC power and 24VDC power. The amount of 5VDC power available depends on the amount of 24VDC power being used, and the amount of 24VDC power available depends on the amount of 5VDC power consumed. Determine the amount of internally supplied power from the table on the following page.

Power required by base unit

Because of the different I/O configurations available in the DL06 family, the power consumed by the base unit itself varies from model to model. Subtract the amount of power required by the base unit from the amount of power supplied by the base unit. Be sure to subtract 5VDC and 24VDC amounts.

Power required by option cards

Next, subtract the amount of power required by the option cards you are planning to use. Again, remember to subtract both 5VDC and 24VDC. If your power budget analysis shows surplus power available, you should have a workable configuration.

DL06 Power Supplied by Base Units		
Part Number	5 VDC (mA)	24 VDC (mA)
D0-06xx	<1500mA	300mA
	<2000mA	200mA
D0-06xx-D	1500mA	none

If the 5VDC loading is less than 2000mA, but more than 1500mA, then available 24VDC supply current is 200mA. If the 5VDC loading is less than 1500mA, then the available 24VDC current is 300mA.

DL06 Base Unit Power Required		
Part Number	5 VDC (mA)	24 VDC (mA)
D0-06AA	800mA	none
D0-06AR	900mA	none
D0-06DA	800mA	none
D0-06DD1	600mA	280mA, note 1
D0-06DD2	600mA	none
D0-06DR	950mA	none
D0-06DD1-D	600mA	280mA, note 1
D0-06DD2-D	600mA	none
D0-06DR-D	950mA	none

Power Budgeting Example			
Power Source		5VDC power (mA)	24VDC power (mA)
D0-06DD1 (select row A or row B)	A	1500mA	300mA
	B	2000mA	200mA
Current Required		5VDC power (mA)	24VDC power (mA)
D0-06DD1		600mA	280mA, note 1
D0-16ND3		35mA	0
D0-10TD1		150mA	0
D0-08TR		280mA	0
F0-4AD2DA-2		100mA	0
D0-06LCD		50mA	0
Total Used		1215mA	280mA
Remaining	A	285mA	20mA
	B	785mA	note 2

NOTE: *See the DL05/DL06 OPTIONS manual for the module data for your project.*

DL06 Power Consumed by Option Cards		
Part Number	5 VDC (mA)	24 VDC (mA)
D0-07CDR	130mA	none
D0-08CDD1	100mA	none
D0-08TR	280mA	none
D0-10ND3	35mA	none
D0-10ND3F	35mA	none
D0-10TD1	150mA	none
D0-10TD2	150mA	none
D0-16ND3	35mA	none
D0-16TD1	200mA	none
D0-16TD2	200mA	none
D0-DCM	250mA	none
D0-DEVNETS	45mA	none
F0-04TRS	250mA	none
F0-08NA-1	5mA	none
F0-04AD-1	50mA	none
F0-04AD-2	75mA	none
F0-04DAH-1	25mA	150mA
F0-04DAH-2	25mA	30mA
F0-08ADH-1	25mA	25mA
F0-08ADH-2	25mA	25mA
F0-08DAH-1	25mA	220mA
F0-08DAH-2	25mA	30mA
F0-2AD2DA-2	50mA	30mA
F0-4AD2DA-1	100mA	40mA
F0-4AD2DA-2	100mA	none
F0-04RTD	70mA	none
F0-04THM	30mA	none
F0-CP128	150mA	none
H0-CTRIO(2)	250mA	none
H0-ECOM	250mA	none
H0-ECOM100	300mA	none
H0-PSCM	530mA	none

DL06 Power Consumed by Other Devices		
Part Number	5 VDC (mA)	24 VDC (mA)
D0-06LCD	50mA	none
D2-HPP	200mA	none
DV-1000	150mA	none
EA1-S3ML	210mA	none
EA1-S3MLW	210mA	none

NOTE 1: *Auxiliary 24VDC used to power V+ terminal of D0-06DD1/-D sinking outputs.*
NOTE 2: *If the PLC's auxiliary 24VDC power source is used to power the sinking outputs, use power choice A, above.*

Configuring the DL06's Comm Ports

This section describes how to configure the CPU's built-in networking ports for either MODBUS or *Direct*NET. This will allow you to connect the DL06 PLC system directly to MODBUS networks using the RTU protocol, or to other devices on a *Direct*NET network. MODBUS masters on the network must be capable of issuing the MODBUS commands to read or write the appropriate data. For details on the MODBUS protocol, please refer to the Gould MODBUS Protocol reference Guide (P1–MBUS–300 Rev. B). In the event a more recent version is available, check with your MODBUS supplier before ordering the documentation. For more details on *Direct*NET, order our *Direct*NET manual, part number DA–DNET–M.

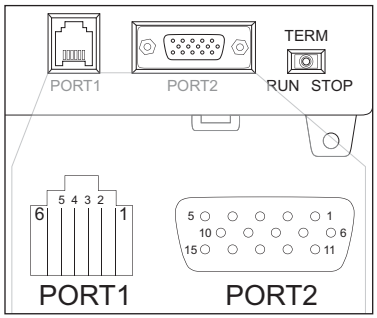
NOTE: *For information about the MODBUS protocol see the Group Schneider Web site at: www.schneiderautomation.com. At the main menu, select Support/Services, Modbus, Modbus Technical Manuals, PI-MBUS-300 Modbus Protocol Reference Guide or search for PIMBUS300. For more information about the DirectNET protocol, order our DirectNET user manual, part number DA–DNET–M, or download it free from our Web site: www.automationdirect.com. Select Documentation/Misc./DA-DNET-M.*

DL06 Port Specifications

Communications Port 1	
Port 1	Connects to HPP, ***Direct***SOFT 5, operator interfaces, etc.
	6-pin, RS232C
	Communication speed (baud): 9600 (fixed)
	Parity: odd (fixed)
	Station Address: 1 (fixed)
	8 data bits
	1 start, 1 stop bit
	Asynchronous, half-duplex, DTE
	Protocol (auto-select): K-sequence (slave only), ***Direct***NET (slave only), MODBUS (slave only)

Communications Port 2	
Port 2	Connects to HPP, ***Direct***SOFT 5, operator interfaces, etc.
	15-pin, multifunction port, RS232C, RS422, RS485
	Communication speed (baud): 300, 600, 1200, 2400, 4800, 9600, 19200, 38400
	Parity: odd (default), even, none
	Station Address: 1 (default)
	8 data bits
	1 start, 1 stop bit
	Asynchronous, half-duplex, DTE
	Protocol (auto-select): K-sequence (slave only), ***Direct***NET (master/slave), MODBUS (master/slave), non-sequence/print/ASCII in/out

DL06 Port Pinouts



Port 1 Pin Descriptions		
1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive data (RS-232C)
4	TXD	Transmit data (RS-232C)
5	5V	Power (+) connection
6	0V	Power (-) connection (GND)

Port 2 Pin Descriptions		
1	5V	Power (+) connection
2	TXD	Transmit data (RS-232C)
3	RXD	Receive data (RS-232C)
4	RTS	Ready to send (RS-232C)
5	CTS	Clear to send (RS232C)
6	RXD-	Receive data (-) (RS-422/485)
7	0V	Power (-) connection (GND)
8	0V	Power (-) connection (GND)
9	TXD+	Transmit data (+) (RS-422/485)
10	TXD-	Transmit data (-) (RS-422/485)
11	RTS+	Ready to send (+) (RS-422/485)
12	RTS-	Ready to send (-) (RS-422/485)
13	RXD+	Receive data (+) (RS-422/485)
14	CTS+	Clear to send (+) (RS-422/485)
15	CTS-	Clear to send (-) (RS-422/485)

Choosing a Network Specification

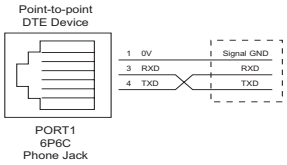
The DL06 PLC's multi-function port gives you the option of using RS-232C, RS-422, or RS-485 specifications. First, determine whether the network will be a 2-wire RS–232C type, a 4-wire RS–422 type, or a 2-wire/4-wire RS-485 type.

The RS–232C specification is simple to implement for networks of shorter distances (15 meters max) and where communication is only required between two devices. The RS–422 and RS-485 signals are for networks that cover longer distances (1000 meters max.) and for multi-drop networks (from 2 to 247 devices).

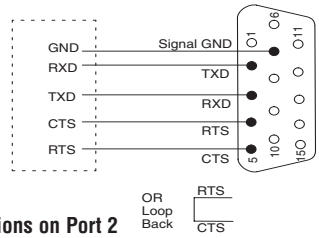
NOTE: *Termination resistors are required at both ends of RS–422 and RS-485 networks. It is necessary to select resistors that match the impedance rating of the cable (between 100 and 500 ohms).*

RS-232 Network

Normally, the RS-232 signals are used for shorter distances (15 meters maximum), for communications between two devices.



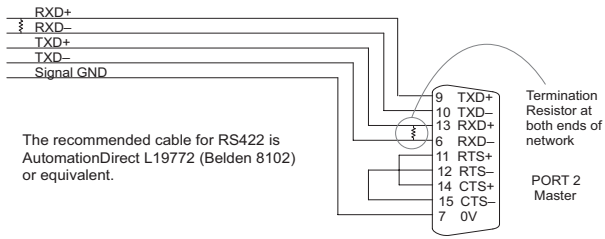
Connections on Port 1



Connections on Port 2

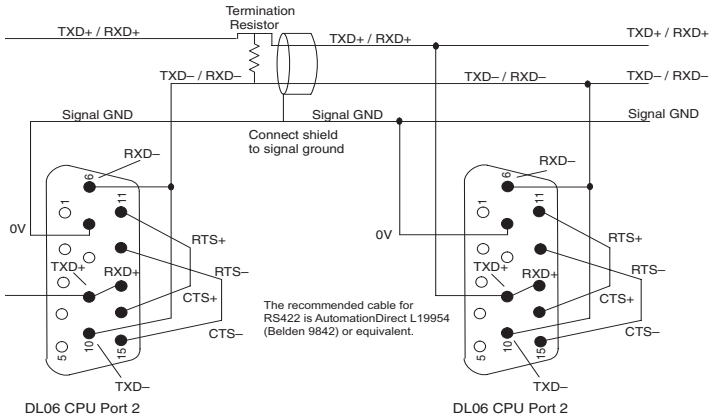
RS-422 Network

RS-422 signals are for long distances (1000 meters maximum). Use terminator resistors at both ends of RS-422 network wiring, matching the impedance rating of the cable (between 100 and 500 ohms).



RS-485 Network

RS-485 signals are for longer distances (1000 meters max) and for multi-drop networks. Use termination resistors at both ends of RS-485 network wiring, matching the impedance rating of the cable (between 100 and 500 ohms).

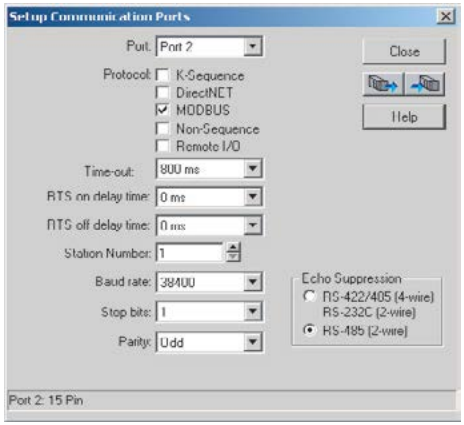


Connecting to MODBUS and DirectNET Networks

MODBUS Port Configuration

In *Direct*SOFT, choose the PLC menu, then Setup, then "Secondary Comm Port".

- **Port**: From the port number list box at the top, choose "Port 2".
- **Protocol**: Check the box to the left of "MODBUS" (use AUX 56 on the HPP, and select "MBUS"), and then you'll see the box below.



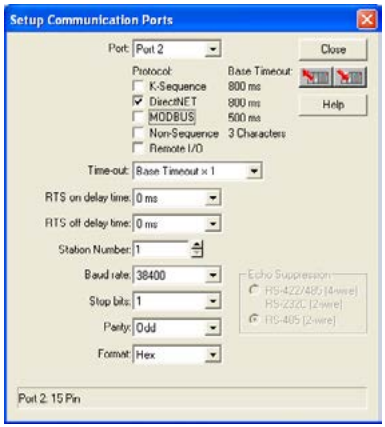
- **Timeout**: amount of time the port will wait after it sends a message to get a response before logging an error.
- **RTS ON / OFF Delay Time:** The RTS ON Delay Time specifies the time the DL06 waits to send the data after it has raised the RTS signal line. The RTS OFF Delay Time specifies the time the DL06 waits to release the RTS signal line after the data has been sent. *When using the DL06 on a multi-drop network, the RTS ON Delay time must be set to **5ms** or more and the RTS OFF Delay time must be set to **2ms** or more. If you encounter problems, the time can be increased.*
- **Station Number**: For making the CPU port a MODBUS master, choose "1". The possible range for MODBUS slave numbers is from 1 to 247, but the DL06 network instructions used in Master mode will access only slaves 1 to 99. Each slave must have a unique number. At powerup, the port is automatically a slave, unless and until the DL06 executes ladder logic network instructions which use the port as a master. Thereafter, the port reverts back to slave mode until ladder logic uses the port again.
- **Baud Rate**: The available baud rates include 300, 600, 1200, 2400, 4800, 9600, 19200, and 38400 baud. Choose a higher baud rate initially, reverting to lower baud rates if you experience data errors or noise problems on the network. Important: You must configure the baud rates of all devices on the network to the same value. Refer to the appropriate product manual for details.
- **Stop Bits**: Choose 1 or 2 stop bits for use in the protocol.
- **Parity**: Choose none, even, or odd parity for error checking.
- **Echo Suppression:** Select the appropriate wiring configuration used on Port 2.

Then click the button indicated to send the Port configuration to the CPU, and click Close.

DirectNET Port Configuration

In *Direct*SOFT, choose the PLC menu, then Setup, then "Secondary Comm Port".

- **Port**: From the port number list box, choose "Port 2 ".
- **Protocol**: Check the box to the left of "*Direct*NET" (use AUX 56 on the HPP, then select "DNET"), and then you'll see the dialog below.



- **Timeout**: Amount of time the port will wait after it sends a message to get a response before logging an error.
- **RTS ON / OFF Delay Time:** The RTS ON Delay Time specifies the time the DL06 waits to send the data after it has raised the RTS signal line. The RTS OFF Delay Time specifies the time the DL06 waits to release the RTS signal line after the data has been sent. *When using the DL06 on a multi-drop network, the RTS ON Delay time must be set to **5ms** or more and the RTS OFF Delay time must be set to **2ms** or more. If you encounter problems, the time can be increased.*
- **Station Number**: For making the CPU port a *Direct*NET master, choose "1". The allowable range for *Direct*NET slaves is from 1 to 90 (each slave must have a unique number). At powerup, the port is automatically a slave, unless and until the DL06 executes ladder logic instructions which attempt to use the port as a master. Thereafter, the port reverts back to slave mode until ladder logic uses the port again.
- **Baud Rate**: The available baud rates include 300, 600, 1200, 2400, 4800, 9600, 19200, and 38400 baud. Choose a higher baud rate initially, reverting to lower baud rates if you experience data errors or noise problems on the network. Important: You must configure the baud rates of all devices on the network to the same value.
- **Stop Bits**: Choose 1 or 2 stop bits for use in the protocol.
- **Parity**: Choose none, even, or odd parity for error checking.
- **Format**: Choose between hex or ASCII formats.

Then click the button indicated to send the Port configuration to the CPU, and click Close.

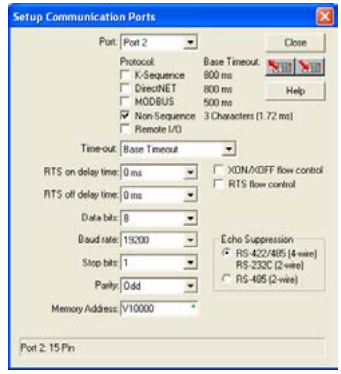
Non–Sequence Protocol (ASCII In/Out and PRINT)

Non-Sequence Port Configuration

Configuring port 2 on the DL06 for Non–Sequence allows the CPU to use port 2 to either read or write raw ASCII strings using the ASCII instructions. See the ASCII In/Out instructions and the PRINT instruction in chapter 5.

In *Direct*SOFT, choose the PLC menu, then Setup, then "Secondary Comm Port".

- Port: From the port number list box at the top, choose "Port 2".
- Protocol: Check the box to the left of "Non–Sequence".
- Timeout: Amount of time the port will wait after it sends a message to get a response before logging an error.
- RTS On Delay Time: The amount of time between raising the RTS line and sending the data.
- RTS Off Delay Time: The amount of time between resetting the RTS line after sending the data.
- Data Bits: Select either 7–bits or 8–bits to match the number of data bits specified for the connected devices.



- Baud Rate: The available baud rates include 300, 600, 900, 2400, 4800, 9600, 19200, and 38400 baud. Choose a higher baud rate initially, reverting to lower baud rates if you experience data errors or noise problems on the network. Important: You must configure the baud rates of all devices on the network to the same value. Refer to the appropriate product manual for details.
- Stop Bits: Choose 1 or 2 stop bits to match the number of stop bits specified for the connected devices.
- Parity: Choose none, even, or odd parity for error checking. Be sure to match the parity specified for the connected devices.
- Echo Suppression: Select the appropriate radio button based on the wiring configuration used on port 2.
- Xon/Xoff Flow Control: Choose this selection if you have Port 2 wired for Hardware Flow Control (Xon/Xoff) with RTS and CTS signal connected between all devices.
- RTS Flow Control: Choose this selection if you have Port 2 RTS signal wired between all devices.
- Memory Address: Please choose a memory address with 64 words of contiguous free memory for use by Non-Sequence Protocol.

Click the button indicated to send the port configuration to the CPU, and click Close.

Network Slave Operation

This section describes how other devices on a network can communicate with a CPU port that you have configured as a *Direct*NET slave or MODBUS slave (DL06). A MODBUS host must use the MODBUS RTU protocol to communicate with the DL06 as a slave. The host software must send a MODBUS function code and MODBUS address to specify a PLC memory location the DL06 comprehends. The *Direct*NET host uses normal I/O addresses to access applicable DL06 CPU and system. No CPU ladder logic is required to support either MODBUS slave or *Direct*NET slave operation.

NOTE: *For more intformation on DirectNET proprietary protocol, see the DirectNET reference manual, DA-DNET-M, available on our website.*

MODBUS Function Codes Supported

MODBUS Function Code	Function	DL06 Data Types Available
01	Read a group of coils	Y, CR, T, CT
02	Read a group of inputs	X, SP
05	Set / Reset a single coil	Y, CR, T, CT
15	Set / Reset a group of coils Y,	CR, T, CT
03, 04	Read a value from one or more registers	V
06	Write a value into a single register	V
16	Write a value into a group of registers	V

The MODBUS function code determines whether the access is a read or a write, and whether to access a single data point or a group of them. The DL06 supports the MODBUS function codes described below.

Determining the MODBUS Address

There are typically two ways that most host software conventions allow you to specify a PLC memory location. These are:

- By specifying the MODBUS data type and address
- By specifying a MODBUS address only

Word Data Types			
Registers	**PLC Range (Octal)**	**Input/Holding (484 Mode)***	**Input/Holding (584/984 Mode)***
V-Memory (Timers)	V0 - V377	3001 / 4001	30001 / 40001
V-Memory (Counters)	V1000 - V1177	3513 / 4513	30513 / 40513
V-Memory (Data Words)	V400 - V677	3257 / 4257	30257 / 40257
	V1200 - V7377	3641 / 4641	30641 / 40641
	V10000 - V17777	-	34097 / 44097
*** Modbus: Function 04**			

If Your Host Software Requires the Data Type and Address

Many host software packages allow you to specify the MODBUS data type and the MODBUS address that corresponds to the PLC memory location. This is the easiest method, but not all packages allow you to do it this way.

The actual equation used to calculate the address depends on the type of PLC data you are using. The PLC memory types are split into two categories for this purpose.

- Discrete – X, SP, Y, CR, S, T, C (contacts)
- Word – V, Timer current value, Counter current value

In either case, you basically convert the PLC octal address to decimal and add the appropriate MODBUS address (if required). The table below shows the exact equation used for each group of data.

DL06 Memory Type	QTY (Decimal)	PLC Range (Octal)	MODBUS Address Range (Decimal)	MODBUS Data Type
For Discrete Data Types …. Convert PLC Addr. to Dec. + Start of Range + Data Type				
Inputs (X)	512	X0 – X777	2048 – 2559	Input
Special Relays(SP)	512	SP0 – SP777	3072 – 3583	Input
Outputs (Y)	512	Y0 – Y777	2048 – 2559	Coil
Control Relays (CR)	1024	C0 – C1777	3072 – 4095	Coil
Timer Contacts (T)	256	T0 – T377	6144 – 6399	Coil
Counter Contacts (CT)	128	CT0 – CT177	6400 – 6527	Coil
Stage Status Bits(S)	1024	S0 – S1777	5120 – 6143	Coil
For Word Data Types …. Convert PLC Addr. to Dec. + Data Type				
Timer Current Values (V)	256	V0 – V377	0 – 255	Input Register
Counter Current Values (V)	128	V1000 – V1177	512 – 639	Input Register
V-Memory, user data (V)	3200	V1200 – V7377	640 – 3839	Holding Register
	4096	V10000 - V17777	4096 - 8191	Holding Register
V-Memory, non-volatile (V)	128	V7400 – V7577	3840 – 3967	Holding Register

The following examples show how to generate the MODBUS address and data type for hosts which require this format.

Example 1: V2100

Find the MODBUS address for User V location V2100.

1. Find V-memory in the table.
2. Convert V2100 into decimal (1088).
3. Use the MODBUS data type from the table.

Holding Reg 1088

V-memory, user data (V)	3200	V1200 – V7377	640 – 3839	Holding Register

Example 2: Y20

Find the MODBUS address for output Y20.

1. Find Y outputs in the table.
2. Convert Y20 into decimal (16).
3. Add the starting address for the range (2048).
4. Use the MODBUS data type from the table.

Coil 2064

Outputs (V)	256	Y0 – Y377	2048 - 2303	Coil

Example 3: T10 Current Value

Find the MODBUS address to obtain the current value from Timer T10.

1. Find Timer Current Values in the table.
2. Convert T10 into decimal (8).
3. Use the MODBUS data type from the table.

Input Reg. 8

Timer Current Values (V)	128	V0 – V177	0 - 127	Input Register

Example 4: C54

Find the MODBUS address for Control Relay C54.

1. Find Control Relays in the table.
2. Convert C54 into decimal (44).
3. Add the starting address for the range (3072).
4. Use the MODBUS data type from the table.

Coil 3116

Control Relays (CR)	512	C0 – C77	3072 – 3583	Coil

If Your MODBUS Host Software Requires an Address ONLY

Some host software does not allow you to specify the MODBUS data type and address. Instead, you specify an address only. This method requires another step to determine the address, but it's still fairly simple. Basically, MODBUS also separates the data types by address ranges as well. So this means an address alone can actually describe the type of data and location. This is often referred to as "adding the offset". One important thing to remember here is that two different addressing modes may be available in your host software package. These are:

- 484 Mode
- 584/984 Mode

We recommend that you use the 584/984 addressing mode if your host software allows you to choose. This is because the 584/984 mode allows access to a higher number of memory locations within each data type. If your software only supports 484 mode, then there may be some PLC memory locations that will be unavailable. The actual equation used to calculate the address depends on the type of PLC data you are using. The PLC memory types are split into two categories for this purpose.

- Discrete – X, SP, Y, CR, S, T (contacts), C (contacts)
- Word – V, Timer current value, Counter current value

In either case, you basically convert the PLC octal address to decimal and add the appropriate MODBUS addresses (as required). The table below shows the exact equation used for each group of data.

Discrete Data Types				
DL06 Memory Type	**PLC Range (Octal)**	**Address (484 Mode)**	**Address (584/984 Mode)**	**MODBUS Data Type**
Global Inputs (GX)	GX0-GX1746	1001 - 1999	10001 - 10999	Input
	GX1747-GX3777	–	11000 - 12048	–
Inputs (X)	X0 – X777	–	12049 - 12304	Input
Special Relays (SP)	SP0 – SP777	–	13073 - 13584	Input
Global Outputs (GY)	GY0 - GX3777	1 - 2048	1 - 2048	–
Outputs (Y)	Y0 – Y777	2049 - 2560	2049 - 2560	Output
Control Relays (CR)	C0 – C1777	3073 - 4096	3073 - 3584	Output
Timer Contacts (T)	T0 – T377	6145 - 6400	6145 - 6400	Output
Counter Contacts (CT)	CT0 – CT177	6401 - 6656	6401 - 6656	Output
Stage Status Bits (S)	S0 – S1777	5121 - 6144	5121 - 6144	Output

Word Data Types			
Registers	**PLC Range (Octal)**	**Input/Holding (484 Mode)***	**Input/Holding (584/984 Mode)***
V-memory (Timers)	V0 - V377	3001/4001	30001/40001
V-memory (Counters)	V1000 - V1177	3513/4513	30513/40513
V-memory (Data Words)	V1200 - V1377	3641/4641	30641/40641
	V1400 - V1746	3769/4769	30769/40769
	V1747 - V1777	---	31000/41000
	V2000 - V7377	---	41025
	V10000 - V17777	---	44097

***MODBUS: Function 04**

1. Refer to your PLC user manual for the correct memory mapping size of your PLC. Some of the addresses shown above might not pertain to your particular CPU.

2. For an automated MODBUS/Koyo address conversion utility, go to our website w**ww.automationdirect.com**, and down load download the EXCEL file **modbus_conversion.xls** located at: Tech Support > Technical Support Home page.

Example 1: V2100 584/984 Mode

Find the MODBUS address for User V location V2100. PLC Address (Dec.) + Mode Address

1. Find V-memory in the table. V2100 = 1088 decimal
2. Convert V2100 into decimal (1088). 1088 + 40001 = **41089**
3. Add the MODBUS starting address for the mode (40001).

For Word Data Types….	PLC Address (Dec.)		+	Appropriate Mode Address		
Timer Current Values (V)	128	V0 – V177	0 – 127	3001	30001	Input Register
Counter Current Values (V)	128	V1200 – V7377	640 – 3839	3001	30001	Input Register
V-memory, user data (V)	1024	V2000 – V3777	1024 – 2047	4001	40001	Holding Register

Example 2: Y20 584/984 Mode

Find the MODBUS address for output Y20. PLC Addr. (Dec.) + Start Address + Mode

1. Find Y outputs in the table. Y20 = 16 decimal
2. Convert Y20 into decimal (16). 16 + 2048 + 1 = **2065**
3. Add the starting address for the range (2048).
4. Add the MODBUS address for the mode (1).

Outputs (Y)	320	Y0 - Y477	2048 – 2367	1	1	Coil
Control Relays (CR)	256	C0 - C377	3072 – 3551	1	1	Coil
Timer Contacts (T)	128	T0 - T177	6144 – 6271	1	1	Coil

Example 3: T10 Current Value 484 Mode

Find the MODBUS address to obtain the Current value from Timer T10.

PLC Address (Dec.) + Mode Address

TA10 = 8 decimal

1. Find Timer Current Values in the table.
2. Convert T10 into decimal (8).
3. Add the MODBUS starting address for the mode (3001).

8 + 3001 = **3009**

For Word Data Types....	PLC Address (Dec.)		+	Appropriate Mode Address		
Timer Current Values (V)	128	V0 – V177	0 – 127	3001	30001	Input Register
Counter Current Values (V)	128	V1200 – V7377	512 – 639	3001	30001	Input Register
V-memory, user data (V)	1024	V2000 – V3777	1024 – 2047	4001	40001	Holding Register

Example 4: C54 584/984 Mode

Find the MODBUS address for Control Relay C54.

PLC Addr. (Dec.) + Start Address + Mode

1. Find Control Relays in the table.
2. Convert C54 into decimal (44).
3. Add the starting address for the range (3072).
4. Add the MODBUS address for the mode (1).

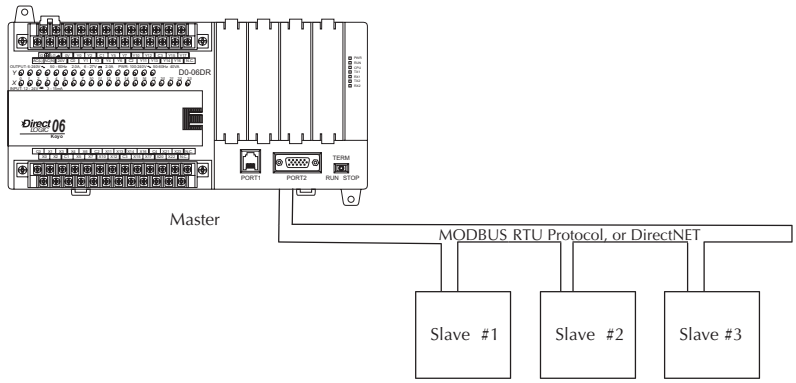
C54 = 44 decimal

44 + 3072 + 1 = **3117**

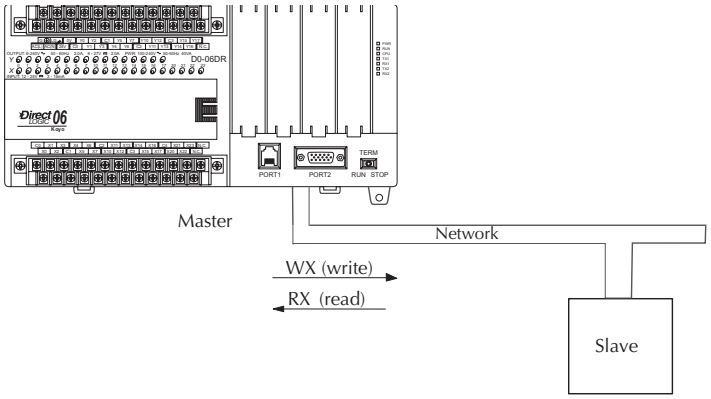
Outputs (Y)	320	Y0 – Y477	2048 – 2367	1	1	Coil
Control Relays (CR)	256	C0 – C377	3072 – 3551	1	1	Coil
Timer Contacts (T)	128	T0– T177	6144 – 6271	1	1	Coil

Network Master Operation

This section describes how the DL06 can communicate on a MODBUS or *Direct*NET network as a master. For MODBUS networks, it uses the MODBUS RTU protocol, which must be interpreted by all the slaves on the network. Both MODBUS and *Direct*Net are single master/multiple slave networks. The master is the only member of the network that can initiate requests on the network. This section teaches you how to design the required ladder logic for network master operation.



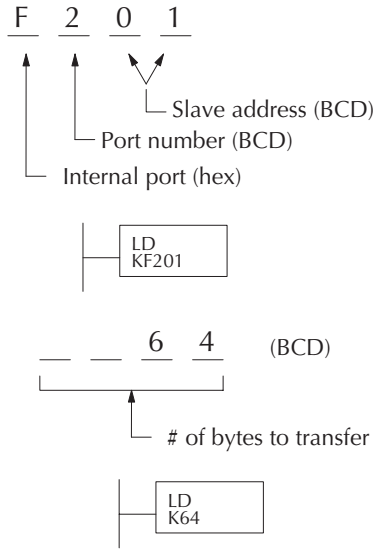
When using the DL06 PLC as the master station, simple RLL instructions are used to initiate the requests. The WX instruction initiates network write operations, and the RX instruction initiates network read operations. Before executing either the WX or RX commands, we will need to load data related to the read or write operation onto the CPU's accumulator stack. When the WX or RX instruction executes, it uses the information on the stack combined with data in the instruction box to completely define the task, which goes to the port.



The following step-by-step procedure will provide you the information necessary to set up your ladder program to receive data from a network slave.

Step 1: Identify Master Port # and Slave

The first Load (LD) instruction identifies the communications port number on the network master (DL06) and the address of the slave station. This instruction can address up to 99 MODBUS slaves, or 90 ***Direct***NET slaves. The format of the word is shown to the right. The "F2" in the upper byte indicates the use of the right port of the DL06 PLC, port number 2. The lower byte contains the slave address number in BCD (01 to 99).



Step 2: Load Number of Bytes to Transfer

The second Load (LD) instruction determines the number of bytes which will be transferred between the master and slave in the subsequent WX or RX instruction. The value to be loaded is in BCD format (decimal), from 1 to 128 bytes.

The number of bytes specified also depends on the type of data you want to obtain. For example, the DL06 Input points can be accessed by V-memory locations or as X input locations. However, if you only want X0 – X27, you'll have to use the X input data type because the V-memory locations can only be accessed in 2-byte increments. The following table shows the byte ranges for the various types of *Direct*LOGIC products.

DL05 / 06 / 205 / 350 / 405 Memory	Bits per unit	Bytes
V-memory T / C current value	16 16	2 2
Inputs (X, SP)	8	1
Outputs (Y, C, Stage, T/C bits)	8	1
Scratch Pad Memory	8	1
Diagnostic Status	8	1

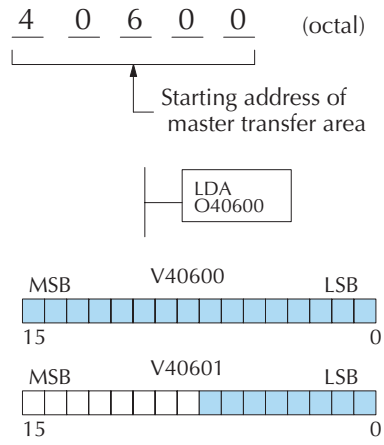
DL330 / 340 Memory	Bits per unit	Bytes
Data registers T / C accumulator	8 16	1 2
I/O, internal relays, shift register bits, T/C bits, stage bits	1	1
Scratch Pad Memory	8	1
Diagnostic Status(5 word R/W)	16	10

Step 3: Specify Master Memory Area

The third instruction in the RX or WX sequence is a Load Address (LDA) instruction. Its purpose is to load the starting address of the memory area to be transferred. Entered as an octal number, the LDA instruction converts it to hex and places the result in the accumulator.

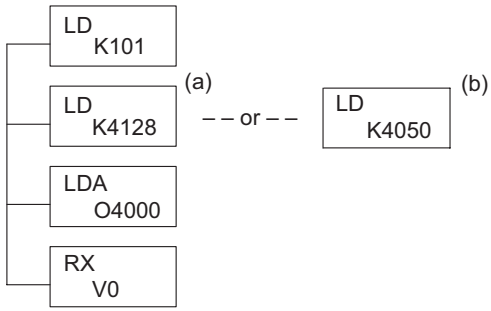
For a WX instruction, the DL06 CPU sends the number of bytes previously specified from its memory area beginning at the LDA address specified.

For an RX instruction, the DL06 CPU reads the number of bytes previously specified from the slave, placing the received data into its memory area beginning at the LDA address specified.



NOTE: *Since V-memory words are always 16 bits, you may not always use the whole word. For example, if you only specify 3 bytes and you are reading Y outputs from the slave, you will only get 24 bits of data. In this case, only the 8 least significant bits of the last word location will be modified. The remaining 8 bits are not affected.*

When using MODBUS, the RX instructions use function 3 by default, to read MODBUS holding registers (Address 40001). The DL05/DL06, DL250-1/260, DL350, DL454 support function 04, read input register (Address 30001). To use function 04, put the number "4" into the most significant position (4xxx) of the total number of bytes. Four digits must be entered for the instruction to work properly with this mode.

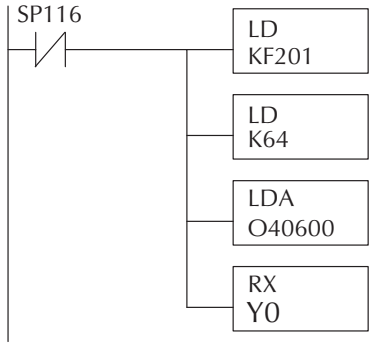


The (a) K4128 indicates the instruction will read 128 bytes of MODBUS input registers (30001). The (b) K4050 indicates the instruction will read 50 bytes of MODBUS input registers (30001). The value of 4 in the most significant position will cause the RX to use MODBUS function 4 (30001 range).

Step 4: Specify Slave Memory Area

The last instruction in our sequence is the WX or RX instruction itself. Use WX to write to the slave, and RX to read from the slave. All four of our instructions are shown to the right. In the last instruction, you must specify the starting address and a valid data type for the slave.

- DirectNET slaves – specify the same address in the WX and RX instruction as the slave's native I/O address
- MODBUS DL405, DL205, or DL06 slaves – specify the same address in the WX and RX instruction as the slave's native I/O address
- MODBUS 305 slaves – use the following table to convert DL305 addresses to MODBUS addresses



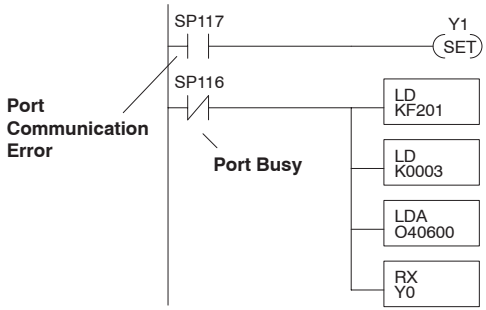
DL305 Series CPU Memory Type–to–MODBUS Cross Reference (excluding 350 CPU)					
PLC Memory Type	**PLC Base Address**	**MODBUS Base Address**	**PLC Memory Type**	**PLC Base Address**	**MODBUS Base Address**
TMR/CNT Current Values	R600	V0	TMR/CNT Status Bits	CT600	GY600
I/O Points	IO 000	GY0	Control Relays	CR160	GY160
Data Registers	R401,R400	V100	Shift Registers	SR400	GY400
Stage Status Bits (D3-330P only)	S0	GY200			

Communications from a Ladder Program

Typically network communications will last longer than 1 scan. The program must wait for the communications to finish before starting the next transaction.

Port 2, which can be a master, has two Special Relay contacts associated with it (see Appendix D for comm port special relays). One indicates "Port busy"(SP116), and the other indicates "Port Communication Error"(SP117). The example above shows the use of these contacts for a network master that only reads a device (RX). The "Port Busy" bit is on while the PLC communicates with the slave. When the bit is off the program can initiate the next network request.

The "Port Communication Error" bit turns on when the PLC has detected an error. Use of this bit is optional. When used, it should be ahead of any network instruction boxes since the error bit is reset when an RX or WX instruction is executed

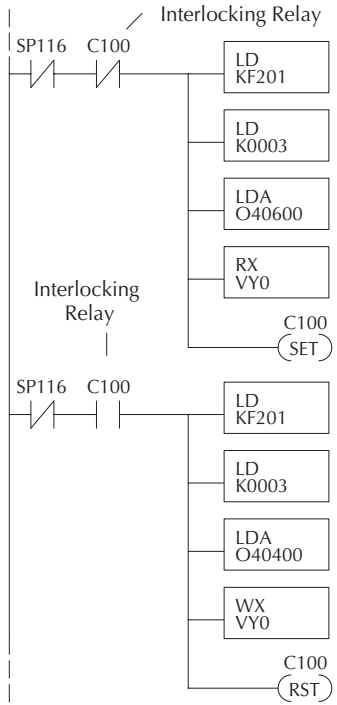


Multiple Read and Write Interlocks

If you are using multiple reads and writes in the RLL program, you have to interlock the routines to make sure all the routines are executed. If you don't use the interlocks, then the CPU will only execute the first routine. This is because each port can only handle one transaction at a time.

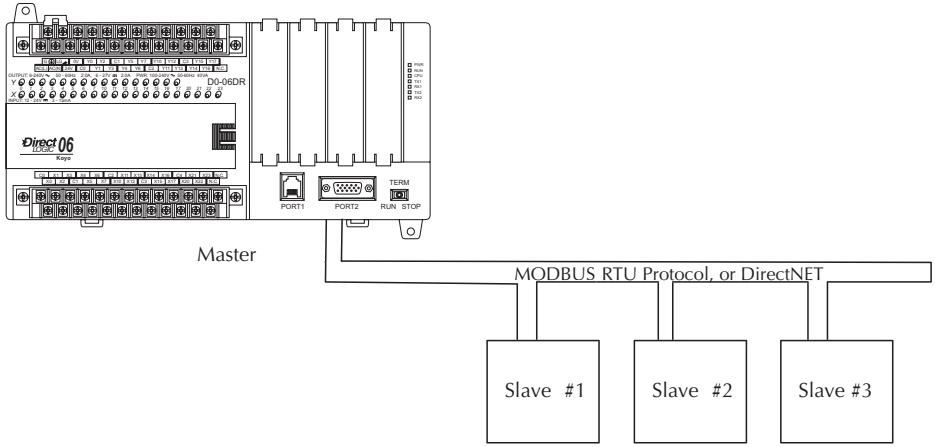
In the example to the right, after the RX instruction is executed, C100 is set. When the port has finished the communication task, the second routine is executed and C100 is reset.

If you're using RLL^{PLUS} Stage Programming, you can put each routine in a separate program stage to ensure proper execution and switch from stage to stage allowing only one of them to be active at a time.



Network Master Operation (using MRX and MWX Instructions)

This section describes how the DL06 can communicate on a MODBUS RTU network as a master using the MRX and MWX read/write instructions. These instructions allow you to enter native MODBUS addressing in your ladder logic program with no need to perform octal to decimal conversions. MODBUS is a single master/multiple slave network. The master is the only member of the network that can initiate requests on the network. This section teaches you how to design the required ladder logic for network master operation.



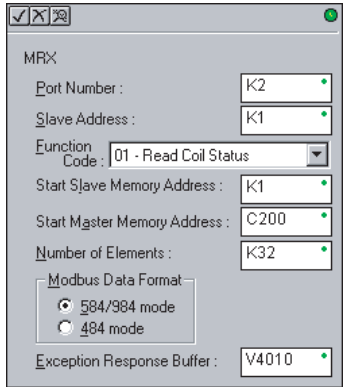
MODBUS Function Codes Supported

The MODBUS function code determines whether the access is a read or a write, and whether to access a single data point or a group of them. The DL06 supports the MODBUS function codes described below.

MODBUS Function Code	Function	DL06 Data Types Available
01	Read a group of coils	Y, CR, T, CT
02	Read a group of inputs	X, SP
05	Set / Reset a single coil (slave only)	Y, CR, T, CT
15	Set / Reset a group of coils	Y, CR, T, CT
03, 04	Read a value from one or more registers	V
06	Write a value into a single register (slave only)	V
07	Read Exception Status	V
08	Diagnostics	V
16	Write a value into a group of registers	V

MODBUS Read from Network(MRX)

The MODBUS Read from Network (MRX) instruction is used by the DL06 network master to read a block of data from a connected slave device and to write the data into V–memory addresses within the master. The instruction allows the user the to specify the MODBUS Function Code, slave station address, starting master and slave memory addresses, number of elements to transfer, MODBUS data format and the Exception Response Buffer.



- **Port Number:** must be DL06 Port 2 (K2)
- **Slave Address:** specify a slave station address (0–247)
- **Function Code**: The following MODBUS function codes are supported by the MRX instruction:

  01 – Read a group of coils

  02 – Read a group of inputs

  03 – Read holding registers

  04 – Read input registers

  07 – Read Exception status

  08 – Diagnostics
- **Start Slave Memory Address**: specifies the starting slave memory address of the data to be read. See the table on the following page.
- **Start Master Memory Address**: specifies the starting memory address in the master where the data will be placed. See the table on the following page.
- **Number of Elements**: specifies how many coils, input, holding registers or input register will be read. See the table on the following page.
- **MODBUS Data Format**: specifies MODBUS 584/984 or 484 data format to be used
- **Exception Response Buffer**: specifies the master memory address where the Exception Response will be placed. See the table on the following page.

MRX Slave Memory Address

MRX Slave Address Ranges		
Function Code	**MODBUS Data Format**	**Slave Address Range(s)**
01 – Read Coil	484 Mode	1–999
01 – Read Coil	584/984 Mode	1–65535
02 – Read Input Status	484 Mode	1001–1999
02 – Read Input Status	584/984 Mode	10001–19999 (5 digit) or 100001–165535 (6 digit)
03 – Read Holding Register	484 Mode	4001–4999
03 – Read Holding Register	584/984	40001–49999 (5 digit) or 4000001–465535 (6 digit)
04 – Read Input Register	484 Mode	3001–3999
04 – Read Input Register	584/984 Mode	30001–39999 (5 digit) or 3000001–365535 (6 digit)
07 – Read Exception Status	484 and 584/984 Mode	n/a
08 – Diagnostics	484 and 584/984 Mode	0–65535

MRX Master Memory Addresses

MRX Master Memory Address Ranges	
Operand Data Type	**DL06 Range**
Inputs X	0–1777
Outputs Y	0–1777
Control Relays C	0–3777
Stage Bits S	0–1777
Timer Bits T	0–377
Counter Bits CT	0–377
Special Relays SP	0–777
V–memory V	All
Global Inputs GX	0–3777
Global Outputs GY	0–3777

MRX Number of Elements

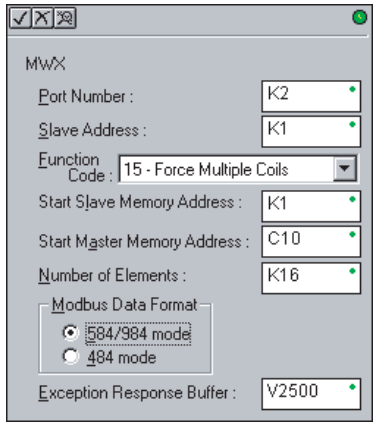
MRX Number of Elements		
Operand Data Type		**DL06 Range**
V–memory	V	All
Constant	K	1–2000

MRX Exception Response Buffer

MRX Exception Response Buffer		
Operand Data Type		**DL06 Range**
V–memory	V	All

MODBUS Write to Network (MWX)

The MODBUS Write to Network (MWX) instruction is used to write a block of data from the network masters's (DL06) memory to MODBUS memory addresses within a slave device on the network. The instruction allows the user to specify the MODBUS Function Code, slave station address, starting master and slave memory addresses, number of elements to transfer, MODBUS data format and the Exception Response Buffer.



- **Port Number**: must be DL06 Port 2 (K2)
- **Slave Address**: specify a slave station address (0–247)
- **Function Code**: The following MODBUS function codes are supported by the MWX instruction:

  05 – Force Single coil

  06 – Preset Single Register

  08 – Diagnostics

  15 – Force Multiple Coils

  16 – Preset Multiple Registers
- **Start Slave Memory Address**: specifies the starting slave memory address where the data will be written.
- **Start Master Memory Address:** specifies the starting address of the data in the master that is to written to the slave.
- **Number of Elements**: specifies how many consecutive coils or registers will be written to. This field is only active when either function code 15 or 16 is selected.
- **MODBUS Data Format**: specifies MODBUS 584/984 or 484 data format to be used.
- **Exception Response Buffer**: specifies the master memory address where the Exception Response will be placed.

MWX Slave Memory Address

MWX Slave Address Ranges		
Function Code	**MODBUS Data Format**	**Slave Address Range(s)**
05 – Force Single Coil	484 Mode	1–999
05 – Force Single Coil	584/984 Mode	1–65535
06 – Preset Single Register	484 Mode	4001–4999
06 – Preset Single Register	84/984 Mode	40001–49999 (5 digit) or 400001–465535 (6 digit)
08 – Diagnostics	484 and 584/984 Mode	0–65535
15 – Force Multiple Coils	484	1–999
15 – Force Multiple Coils	585/984 Mode	1–65535
16 – Preset Multiple Registers	484 Mode	4001–4999
16 – Preset Multiple Registers	584/984 Mode	40001–49999 (5 digit) or 4000001–465535 (6 digit)

MWX Master Memory Addresses

MWX Master Memory Address Ranges		
Operand Data Type		**DL06 Range**
Inputs	X	0–777
Outputs	Y	0–777
Control Relays	C	0–1777
Stage Bits	S	0–1777
Timer Bits	T	0–377
Counter Bits	CT	0–177
Special Relays	SP	0–777
V–memory	V	All
Global Inputs	GX	0–3777
Global Outputs	GY	0–3777

MWX Number of Elements

MWX Number of Elements		
Operand Data Type		**DL06 Range**
V–memory	V	All
Constant	K	1–2000

MWX Exception Response Buffer

MWX Exception Response Buffer		
Operand Data Type		DL06 Range
V–memory	V	All

MRX/MWX Example in DirectSOFT

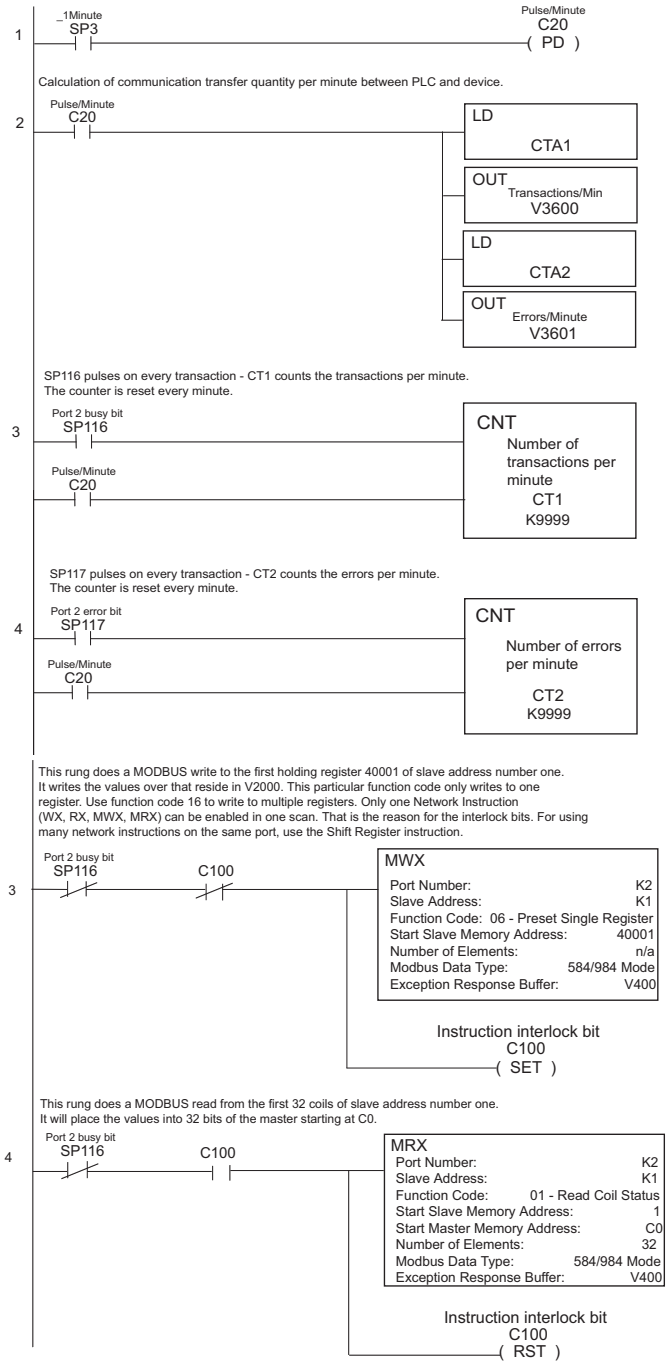
DL06 port 2 has two Special Relay contacts associated with it (see Appendix D for comm port special relays). One indicates “Port busy”(SP116), and the other indicates ”Port Communication Error”(SP117). The “Port Busy” bit is on while the PLC communicates with the slave. When the bit is off the program can initiate the next network request. The “Port Communication Error” bit turns on when the PLC has detected an error and use of this bit is optional. When used, it should be ahead of any network instruction boxes since the error bit is reset when an MRX or MWX instruction is executed. Typically network communications will last longer than 1 CPU scan. The program must wait for the communications to finish before starting the next transaction.

The “Port Communication Error” bit turns on when the PLC has detected an error. Use of this bit is optional. When used, it should be ahead of any network instruction boxes since the error bit is reset when an RX or WX instruction is executed.

Multiple Read and Write Interlocks

If you are using multiple reads and writes in the RLL program, you have to interlock the routines to make sure all the routines are executed. If you don’t use the interlocks, then the CPU will only execute the first routine. This is because each port can only handle one transaction at a time. In the example below, after the MRX instruction is executed, C100 is set. When the port has finished the communication task, the second routine is executed and C100 is reset. If you’re using RLL^{PLUS} Stage Programming, you can put each routine in a separate program stage to ensure proper execution and switch from stage to stage allowing only one of them to be active at a time.

See example on the next page.


1
_1Minute
SP3
Pulse/Minute
C20
(PD)
Calculation of communication transfer quantity per minute between PLC and device.
2
Pulse/Minute
C20
LD
CTA1
OUT
Transactions/Min
V3600
LD
CTA2
OUT
Errors/Minute
V3601
SP116 pulses on every transaction - CT1 counts the transactions per minute.
The counter is reset every minute.
3
Port 2 busy bit
SP116
Pulse/Minute
C20
CNT
Number of transactions per minute
CT1
K9999
SP117 pulses on every transaction - CT2 counts the errors per minute.
The counter is reset every minute.
4
Port 2 error bit
SP117
Pulse/Minute
C20
CNT
Number of errors per minute
CT2
K9999
This rung does a MODBUS write to the first holding register 40001 of slave address number one.
It writes the values over that reside in V2000. This particular function code only writes to one
register. Use function code 16 to write to multiple registers. Only one Network Instruction
(WX, RX, MWX, MRX) can be enabled in one scan. That is the reason for the interlock bits. For using
many network instructions on the same port, use the Shift Register instruction.
3
Port 2 busy bit
SP116
C100
MWX
Port Number: K2
Slave Address: K1
Function Code: 06 - Preset Single Register
Start Slave Memory Address: 40001
Number of Elements: n/a
Modbus Data Type: 584/984 Mode
Exception Response Buffer: V400
Instruction interlock bit
C100
(SET)
This rung does a MODBUS read from the first 32 coils of slave address number one.
It will place the values into 32 bits of the master starting at C0.
4
Port 2 busy bit
SP116
C100
MRX
Port Number: K2
Slave Address: K1
Function Code: 01 - Read Coil Status
Start Slave Memory Address: 1
Start Master Memory Address: C0
Number of Elements: 32
Modbus Data Type: 584/984 Mode
Exception Response Buffer: V400
Instruction interlock bit
C100
(RST)