SYSTEM DESIGN AND CONFIGURATION

CHAPTER 4

In This Chapter...

NOTE: As of 07/2021 CPU D2-260 has been retired.
Please consider CPU D2-262 as a replacement.

DL205 System Design Strategies

I/O System Configurations

The DL205 PLCs offer the following ways to add I/O to the system:

Local I/O: consists of I/O modules located in the same base as the CPU.

Local Expansion I/O: consists of I/O modules in expansion bases located close to the CPU local base. Expansion cables connect the expansion bases and CPU base in daisy–chain format.

Ethernet Remote Master: provides a low-cost, high-speed Ethernet Remote I/O link to Ethernet Remote Slave I/O.

Ethernet Base Controller: provides a low-cost, high-speed Ethernet link between a network master to AutomationDirect Ethernet Remote Slave I/O.

Remote I/O: consists of I/O modules located in bases which are serially connected to the local CPU base through a Remote Master module, or may connect directly to the bottom port on a D2-250-1, D2-260 or D2-262 CPU.

A DL205 system can be developed using many different arrangements of these configurations. All I/O configurations use the standard complement of DL205 I/O modules and bases. Local expansion requires using (–1) bases.

Networking Configurations

The DL205 PLCs offers the following way to add networking to the system:

Ethernet Communications Module: connects DL205 systems (D2-240, D2-250-1, D2-260 or D2-262 CPUs only) and DL405 CPU systems in high–speed, peer–to–peer networks. Any PLC can initiate communications with any other PLC when using either the ECOM or ECOM100 modules.

Data Communications Module: connects a DL205 (D2-240, D2-250–1, D2-260 or D2-262 only) system to devices using the DirectNET protocol, or connects as a slave to a Modbus RTU network.

D2-250-1 Communications Port: The D2-250-1 CPU has a 15–Pin connector on Port 2 that provides a built–in Modbus RTU or DirectNET master/slave connection.

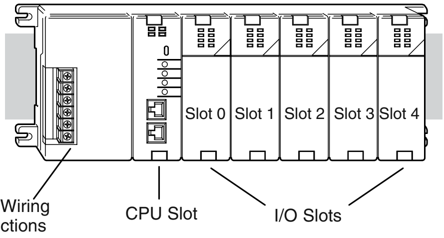
D2-260/D2-262 Communications Port: The D2-260 and D2-262 CPUs have a 15–Pin connector on Port 2 that provides a built–in DirectNET master/slave or Modbus RTU master/slave connection with more Modbus function codes than the D2-250-1. The D2-260 and D2-262 MRX and MWX instructions allow you to enter native Modbus addressing in your ladder program with no need to perform octal to decimal conversions. Port 2 can also be used for ASCII IN or ASCII OUT communications.

Module/Unit	Master	Slave
D2-240 CPU		DirectNet, K–Sequence
D2-250-1 CPU	DirectNet, Modbus RTU	DirectNet, K–Sequence, Modbus RTU
D2-260, D2-262 CPU	DirectNet, Modbus RTU, ASCII	DirectNet, K–Sequence, Modbus RTU, ASCII
ECOM	Ethernet	Ethernet
ECOM100	Ethernet, Modbus TCP	Ethernet, Modbus TCP
DCM	DirectNet	DirectNet, K–Sequence, Modbus RTU

Module Placement

Slot Numbering

The DL205 bases each provide different numbers of slots for use with the I/O modules. You may notice the bases refer to 3-slot, 4-slot, etc. One of the slots is dedicated to the CPU, so you always have one less I/O slot. For example, you have five I/O slots with a 6-slot base. The I/O slots are numbered 0 – 4. The CPU slot always contains a CPU or a base controller (EBC) or Remote Slave and is not numbered.



Module Placement Restrictions

The following table lists the valid locations for all types of modules in a DL205 system.

Module/Unit	Local CPU Base	Local Expansion Base	Remote I/O Base
CPUs	CPU Slot Only		
DC Input Modules	A	A	A
AC Input Modules	A	A	A
DC Output Modules	A	A	A
AC Output Modules	A	A	A
Relay Output Modules	A	A	A
Analog Input and Output Modules	A	A	A
Local Expansion			
Base Expansion Unit	A	A	
Base Controller Module		CPU Slot Only	
Serial Remote I/O			
Remote Master	A (not Slot O)		
Remote Slave Unit			CPU Slot Only
Ethernet Remote Master	A (not Slot O)		
Ethernet Slave (EBC)	CPU Slot Only		
CPU Interface			
Ethernet Base Controller	CPU Slot Only		CPU Slot Only*
WinPLC	CPU Slot Only		
DeviceNet	CPU Slot Only		A
Profibus	CPU Slot Only		
SDS	CPU Slot Only		
Specialty Modules			
Counter Interface (CTRINT)	Slot 0 Only		
Counter I/O (CTRIO)	A		A *
Data Communications	A (not Slot O)		
Ethernet Communications	A (not Slot O)		
BASIC CoProcessor	A (not Slot O)		
Simulator	A	A	A
Filler	A	A	A

**When used in H2–ERM(100) Ethernet Remote I/O systems.*

Automatic I/O Configuration

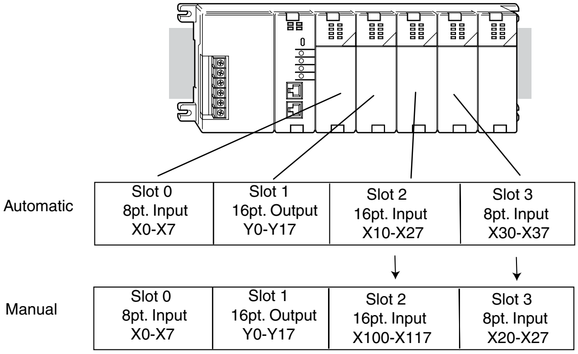
☑ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

The DL205 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 local and local expansion I/O bases. For most applications, you will never have to change the configuration.

I/O addresses use octal numbering, starting at X0 and Y0 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, but there may be restrictions placed on some specialty modules. The following diagram shows the I/O numbering convention for an example system.

Both the Handheld Programmer and DirectSOFT 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 DirectSOFT, the PLC Configure I/O menu option would be used.

Manual I/O Configuration



Automatic	Slot 0 8pt. Input X0-X7	Slot 1 16pt. Output Y0-Y17	Slot 2 16pt. Input X10-X27	Slot 3 8pt. Input X30-X37
Manual	Slot 0 8pt. Input X0-X7	Slot 1 16pt. Output Y0-Y17	Slot 2 16pt. Input X100-X117	Slot 3 8pt. Input X20-X27

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

It may never become necessary, but D2-250–1, D2-260 and D2-262 CPUs allow manual I/O address assignments for any I/O slot(s) in local or local expansion bases. You can manually modify an auto configuration to match arbitrary I/O numbering. For example, two adjacent input modules can have starting addresses at X20 and X200. Use DirectSOFT 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). For example, X30 and Y50 are not valid starting addresses. 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 D2-250–1, D2-260 and D2-262 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.

Removing a Manual Configuration

After a manual configuration, the system will automatically retain the new I/O addresses through a power cycle. You can remove (overwrite) any manual configuration changes by changing all of the manually configured addresses back to automatic.

Power–On I/O Configuration Check

The DL205 CPUs can also be set to automatically check the I/O configuration on power-up. By selecting this feature, you can detect any changes that may have occurred while the power was disconnected. For example, if someone places an output module in a slot that previously held an input module, the CPU will not go into RUN mode and the configuration check will detect the change and print a message on the Handheld Programmer or DirectSOFT screen (use AUX 44 on the HPP to enable the configuration check).

If the system detects a change in the PLC/Setup/I/O configuration check at power-up, error code E252 will be generated. You can use AUX 42 (HPP) or DirectSOFT I/O diagnostics to determine the exact base and slot location where the change occurred. When a configuration error is generated, you may actually want to use the new I/O configuration. For example, you may have intentionally changed an I/O module to use with a program change. You can use PLC/Diagnostics/I/O Diagnostics in DirectSoft or AUX 45 to select the new configuration, or, keep the existing configuration stored in memory.

WARNING: You should always correct any I/O configuration errors before you place the CPU into RUN mode. Uncorrected errors can cause unpredictable machine operation that can result in a risk of personal injury or damage to equipment.
WARNING: Verify that the I/O configuration being selected will work properly with the CPU program. Always correct any I/O configuration errors before placing 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.

I/O Points Required for Each Module

Each type of module requires a certain number of I/O points. This is also true for some specialty modules, such as analog, counter interface, etc.

DC Input Modules	Number of I/O Pts. Required	Specialty Modules, etc.	Number of I/O Pts. Required
D2–08ND3	8 Input	H2–ECOM(–F)	None
D2–16ND3–2	16 Input	D2–DCM	None
D2–32ND3(–2)	32 Input	H2–ERM(100,–F)	None
AC Input Modules		H2–EBC(–F)	None
D2–08NA–1	8 Input	D2–RMSM	None
D2–08NA–2	8 Input	D2–RSSS	None
D2–16NA	16 Input	F2–CP128	None
DC Output Modules		H2–CTRIO(2)	None
D2–04TD1	8 Output (Only the first four points are used)	D2–CTRINT*	8 Input 8 Output
D2–08TD1	8 Output	F2–DEVNETS–1	None
D2–16TD1–2 (2-2)	16 Output	H2–PBC	None
D2–16TD1(2)P	16 Output	F2–SDS–1	None
D2–32TD1(–2)	32 Output	D2–08SIM	8 Input
AC Output Modules		D2-EM	None
D2–08TA	8 Output	D2-CM	None
F2–08TA	8 Output	H2-ECOM(100)	None
D2–12TA	16 Output (See note 1)	**D2-CTRINT not supported by D2-262.*	
Relay Output Modules			
D2–04TRS	8 Output (Only the first four points are used)		
D2–08TR	8 Output		
F2–08TRS	8 Output		
F2–08TR	8 Output		
D2–12TR	16 Output (See note 1)		
Combination Modules			
D2–08CDR	8 In, 8 Out (Only the first four points are used for each type)		
Analog Modules			
F2–04AD–1 & 1L	16 Input		
F2–04AD–2 & 2L	16 Input		
F2–08AD–1	16 Input		
F2–02DA–1 & 1L	16 Output		
F2–02DA–2 & 2L	16 Output		
F2–08DA–1	16 Output		
F2–08DA–2	16 Output		
F2–02DAS–1	32 Output		
F2–02DAS–2	32 Output		
F2–4AD2DA	16 Input & 16 Output		
F2–8AD4DA-1	32 Input & 32 Output		
F2–8AD4DA-2	32 Input & 32 Output		
F2–04RTD	32 Input		
F2–04THM	32 Input		

NOTE: *12pt modules consume 16 points. The first 6 points are assigned, two are skipped, and then the next 6 points are assigned. For example, a D2–12TA installed in slot 0 would use Y0–Y5, and Y-10-Y15. Y6–Y7 and Y16–Y17 would be unused.*

Calculating the Power Budget

Managing Your Power Resource

When you determine the types and quantities of I/O modules you will be using in the DL205 system, it is important to remember there is a limited amount of power available from the power supply. We have provided a chart to help you easily see the amount of power available with each base. The following chart will help you calculate the amount of power you need with your I/O selections. At the end of this section is an example of power budgeting and a worksheet for your own calculations.

If the I/O you choose exceeds the maximum power available from the power supply, you may need to use local expansion bases or remote I/O bases.

WARNING: It is extremely important to calculate the power budget. If you exceed the power budget, the system may operate in an unpredictable manner, which may result in a risk of personal injury or equipment damage.

CPU Power Specifications

The following chart shows the amount of current available for the two voltages supplied from the DL205 base. Use these currents when calculating the power budget for your system. The Auxiliary 24V Power Source mentioned in the table is a connection at the base terminal strip allowing you to connect to devices or DL205 modules that require 24VDC.

Module Power Requirements

Bases	5V Current Supplied	Auxiliary 24VDC Current Supplied
D2–03B–1	2600mA	300mA
D2–04B–1		
D2–06B–1		
D2–09B–1		
D2–03BDC1–1	2600mA	None
D2–04BDC1–1		
D2–06BDC1–1		
D2–09BDC1–1		
D2–06BDC2–1	2600mA	300mA
D2–09BDC2–1		

Use the power requirements shown on the next page to calculate the power budget for your system. If an External 24VDC power supply is required, the external 24VDC from the base power supply may be used as long as the power budget is not exceeded.

Power Consumed		
Device	**5V (mA)**	**24V Auxilliary (mA)**
CPUs		
D2–230	120	0
D2–240	120	0
D2–250–1	330	0
D2–260	330	0
D2–262	336	0
DC Input Modules		
D2–08ND3	50	0
D2–16ND3–2	100	0
D2–32ND3(–2)	25	0
AC Input Modules		
D2–08NA–1	50	0
D2–08NA–2	100	0
D2–16NA	100	0
DC Output Modules		
D2–04TD1	60	20
D2–08TD1(–2)	100	0
D2–16TD1–2	200	80
D2–16TD2–2	200	0
D2–32TD1(–2)	350	0
AC Output Modules		
D2–08TA	250	0
F2–08TA	250	0
D2–12TA	350	0
Relay Output Modules		
D2–04TRS	250	0
D2–08TR	250	0
F2–08TRS	670	0
F2–08TR	670	0
D2–12TR	450	0
Analog Modules		
F2–04AD–1	50	80
F2–04AD–1L	100	5mA @ 10-30V
F2–04AD–2	110	5mA @ 10-30V
F2–04AD–2L	60	90mA @ 12V**
F2–08AD–1	100	5mA @ 10-30V
F2–08AD–2	100	5mA @ 10-30V
F2–02DA–1	40	60**
F2–02DA–1L	40	70mA @ 12V**
F2–02DA–2	40	60
F2–02DA–2L	40	70mA @ 12V**
F2–08DA–1	30	50mA**
F2–08DA–2	60	140

Power Consumed		
Device	**5V (mA)**	**24V Auxilliary (mA)**
Combination Modules		
D2–08CDR	200	0
Specialty Modules		
H2–PBC	530	0
H2–ECOM	450	0
H2–ECOM100	300	0
H2–ECOM-F	640	0
H2–ERM(100)	320	0
H2–ERM–F	450	0
H2–EBC	320	0
H2–EBC–F	450	0
H2–CTRIO(2)	275	0
D2–DCM	300	0
D2–RMSM	200	0
D2–RSSS	150	0
D2–CTRINT	50*	0
D2–08SIM	50	0
D2–CM	100	0
D2–EM	130	0
F2–CP128	235	0
F2–DEVNETS–1	160	0
F2–SDS–1	160	0
F2–02DAS–1	100	50mA per channel
F2–02DAS–2	100	60mA per channel
F2–4AD2DA	90	80mA**
F2–8AD4DA-1	35	100
F2–8AD4DA-2	35	80
F2–04RTD	90	0
F2–04THM	110	60

**requires external 5VDC for outputs*
***add an additional 20mA per loop*

Power Budget Calculation Example

The following example shows how to calculate the power budget for the DL205 system.

Base # 0	Module Type	5 VDC (mA)	Auxiliary Power Source 24 VDC Output (mA)
Available Base Power	D2–09B–1	2600	300
CPU Slot	D2–260	+ 330	
Slot 0	D2–16ND3–2	+ 100	+ 0
Slot 1	D2–16NA	+ 100	+ 0
Slot 2	D2–16NA	+ 100	+ 0
Slot 3	F2–04AD–1	+ 50	+ 80
Slot 4	F2–02DA–1	+ 40	+ 60
Slot 5	D2–08TA	+ 250	+ 0
Slot 6	D2–08TD1	+ 100	+ 0
Slot 7	D2–08TR	+ 250	+ 0
Other			
Handheld Programmer	D2–HPP	+ 200	+ 0
Total Power Required		**1520**	**140**
Remaining Power Available		**2600-1520 = 1080**	**300 - 140 = 160**

1. Use the power budget table to fill in the power requirements for all the system components. First, enter the amount of power supplied by the base. Next, list the requirements for the CPU, any I/O modules, and any other devices, such as the Handheld Programmer, C-more HMI or the DV–1000 operator interface. Remember, even though the Handheld Programmer or the DV–1000 are not installed in the base, they still obtain their power from the system. Also, make sure you obtain any external power requirements, such as the 24VDC power required by the analog modules.
2. Add the current columns starting with CPU slot and put the total in the row labeled “Total Power Required.”
3. Subtract the row labeled “Total Power Required” from the row labeled “Available Base Power.” Place the difference in the row labeled “Remaining Power Available.”
4. If “Total Power Required” is greater than the power available from the base, the power budget will be exceeded. It will be unsafe to use this configuration, and you will need to restructure your I/O configuration.

WARNING: It is extremely important to calculate the power budget. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

Power Budget Calculation Worksheet

This blank chart is provided for you to copy and use in your power budget calculations.

Base # 0	Module Type	5 VDC (mA)	Auxiliary Power Source 24 VDC Output (mA)
Available Base Power			
CPU Slot			
Slot 0			
Slot 1			
Slot 2			
Slot 3			
Slot 4			
Slot 5			
Slot 6			
Slot 7			
Other			
Total Power Required			
Remaining Power Available			

1. Use the power budget table to fill in the power requirements for all the system components. This includes the CPU, any I/O modules, and any other devices, such as the Handheld Programmer, C-more HMI or the DV–1000 operator interface. Also, obtain all external power requirements, such as the 24VDC power required by the analog modules.
2. Add the current columns starting with CPU slot and put the total in the row labeled “Total Power Required.”
3. Subtract the row labeled “Total Power Required” from the row labeled “Available Base Power.” Place the difference in the row labeled “Remaining Power Available.”
4. If “Total Power Required” is greater than the power available from the base, the power budget will be exceeded. It will be unsafe to use this configuration, and you will need to restructure your I/O configuration.

WARNING: It is extremely important to calculate the power budget. If you exceed the power budget, the system may operate in an unpredictable manner which could result in personal injury or equipment damage.

Local Expansion I/O

Use local expansion when you need more I/O points, a greater power budget than the local CPU base provides or when placing an I/O base at a location away from the CPU base, but within the expansion cable limits. Each local expansion base requires the D2–CM controller module in the CPU slot. The local CPU base requires the D2–EM expansion module, as well as each expansion base. All bases in the system must be the (–1) bases. These bases have a connector on the right side of the base to which the D2–EM expansion module attaches. All local and local expansion I/O points are updated on every CPU scan.

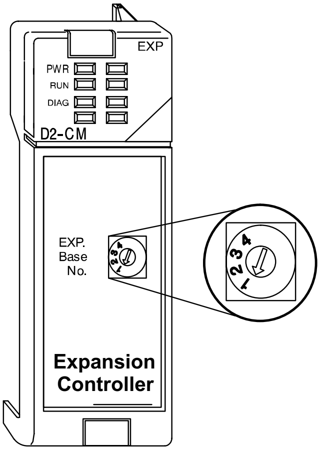
Use the DirectSOFT PLC Configure I/O menu option to view the local expansion system automatic I/O addressing configuration. This menu also allows manual addresses to be assigned if necessary.

Description	D2-230	D2-240	DL250	D2-250-1	D2-260/ D2-262
Total number of local / expansion bases per system	These CPUs do not support local expansion systems			3	5
Maximum number of expansion bases				2	4
Total I/O (includes CPU base and expansion bases)				768	1280
Maximum inputs				512	1024
Maximum outputs				512	1024
Maximum expansion system cable length				30m (98ft.)	

D2–CM Local Expansion Module

The D2–CM module is placed in the CPU expansion base. The rotary switch is use the expansion base number. The expans addressing (Xs and Ys) is based on the n the rotary switch selection and is recogn power–up. Duplicate expansion base nu recognized by the CPU.

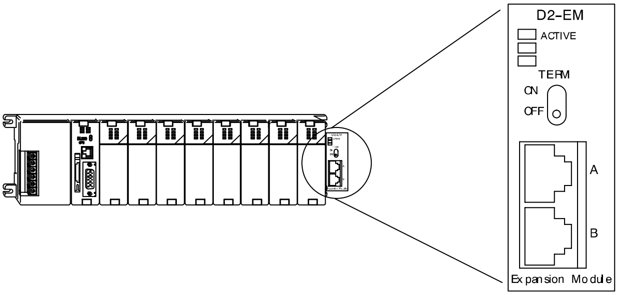
The status indicator LEDs on the D2–CM panels have specific functions which can programming and troubleshooting.



D2–CM Indicators	Status	Meaning
PWR (Green)	ON	Power good
	OFF	Power failure
RUN (Green)	ON	D2–CM has established communication with PLC
	OFF	D2–CM has not established communication with PLC
DIAG (Red)	ON	Hardware watch–dog failure
	ON/OFF	I/O module failure (ON 500ms / OFF 500ms)
	OFF	No D2–CM error

D2–EM Local Expansion Module

The D2–EM expansion unit is attached to the right side of each base in the expansion system, including the local CPU base. (All bases in the local expansion system must be the (–1) bases). The D2–EMs on each end of the expansion system should have the TERM (termination) switch placed in the ON position. The expansion units between the endmost bases should have the TERM switch placed in the OFF position. The CPU base can be located at any base position in the expansion system. The bases are connected in a daisy–chain fashion using the D2–EXCBL–1 (category 5 straight–through cable with RJ45 connectors). Either of the RJ45 ports (labelled A and B) can be used to connect one expansion base to another.



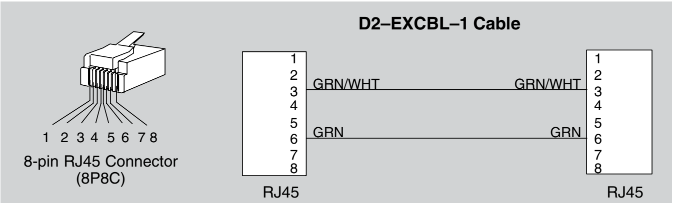
The status indicator LEDs on the D2–EM front panels have specific functions which can help in programming and troubleshooting.

D2–EM Indicator	Status	Meaning
ACTIVE (Green)	ON	D2–EM is communicating with other D2–EM
	OFF	D2–EM is not communicating with other D2–EM

WARNING: Connect/disconnect the expansion cables with the PLC power turned OFF in order for the ACTIVE indicator to function normally.

D2–EXCBL–1 Local Expansion Cable

The category 5 straight–through D2–EXCBL–1 (1m) is used to connect the D2–EM expansion modules together. If longer cable lengths are required, we recommend that you purchase a commercially manufactured cable with RJ45 connectors already attached. The maximum total expansion system cable length is 30m (98ft). Do not use Ethernet hubs to connect the local expansion network together.

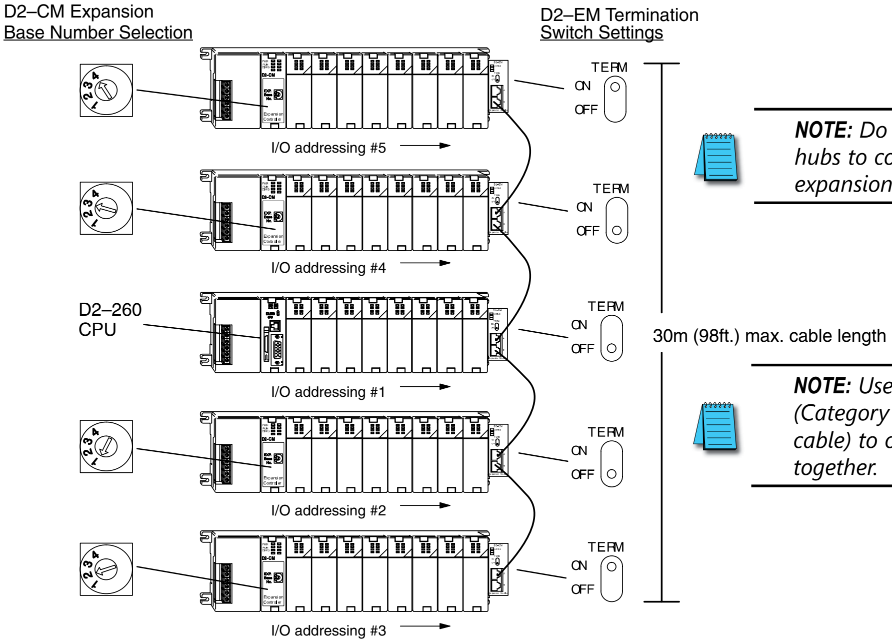


NOTE: *Commercially available Patch (Straight–through) Category 5, UTP cables will work in place of the D2–EXCBL–1. The D2–EM modules only use the wires connected to pins 3 and 6 as shown above.*

D2-260/D2-262 Local Expansion System

The D2-260 and D2-262 support local expansion up to five total bases (one CPU base + four local expansion bases) and up to a maximum of 1280 total I/O points. An example local expansion system is shown below. All local and expansion I/O points are updated on every CPU scan. No specialty modules can be located in the expansion bases (refer to the Module Placement Table earlier in this chapter for restrictions).

The CPU base can be located at any base position in the expansion system.



NOTE: *Do not use Ethernet hubs to connect the local expansion system together.*

NOTE: *Use D2-EXCBL-1 (1m) (Category 5 straight-through cable) to connect the D2-EMs together.*

All discrete and analog modules are supported in the expansion bases. Specialty modules are not supported in the expansion bases.

The D2–CMs do not have to be in successive numerical order; however, the numerical rotary selection determines the X and Y addressing order. The CPU will recognize the local and expansion I/O on power–up. Do not duplicate numerical selections.

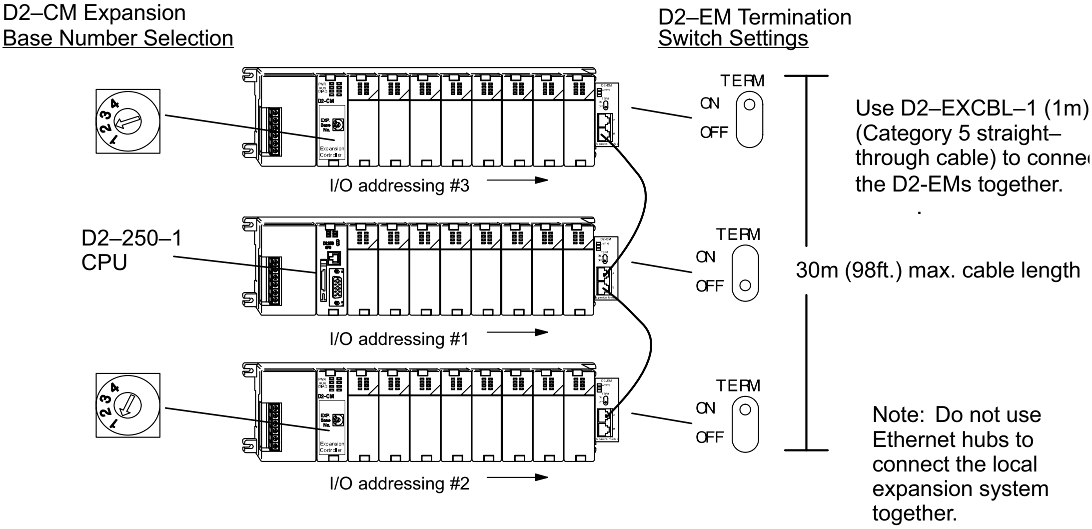
The TERM (termination) switch on the two endmost D2–EMs must be in the ON position. The other D2–EMs in between should be in the OFF position.

Use the D2–EXCBL–1 or equivalent cable to connect the D2–EMs together. Either of the RJ45 ports (labeled A and B) on the D2–EM can be used to connect one base to another.

NOTE: *When applying power to the CPU (D2-250-1, D2-260 or D2-262) and local expansion bases, make sure the expansion bases power up at the same time or before the CPU base. Expansion bases that power up after the CPU base will not be recognized by the CPU. (See chapter 3 Initialization Process timing specifications).*

D2-250-1 Local Expansion System

The D2–250–1 supports local expansion up to three total bases (one CPU base + two local expansion bases) and up to a maximum of 768 total I/O points. An example local expansion system is shown below. All local and expansion I/O points are updated on every CPU scan. No specialty modules can be located in the expansion bases (refer to the Module Placement Table earlier in this chapter for restrictions).



Use D2–EXCBL–1 (1m) (Category 5 straight–through cable) to conne the D2-EMs together.

Note: Do not use Ethernet hubs to connect the local expansion system together.

The CPU base can be located at any base position in the expansion system.

All discrete and analog modules are supported in the expansion bases. Specialty modules are not supported in the expansion bases.

The D2–CMs do not have to be in successive numerical order, however, the numerical rotary selection determines the X and Y addressing order. The CPU will recognize the local and expansion I/O on power–up. Do not duplicate numerical selections.

The TERM (termination) switch on the two endmost D2–EMs must be in the ON position. The other D2–EMs in between should be in the OFF position.

Use the D2–EXCBL–1 or equivalent cable to connect the D2–EMs together. Either of the RJ45 ports (labelled A and B) on the D2–EM can be used to connect one base to another.

Expansion Base Output Hold Option

The bit settings in V–memory registers V7741 and V7742 determine the expansion bases' outputs response to a communications failure. The CPU will exit the RUN mode to the STOP mode when an expansion base communications failure occurs. If the Output Hold bit is ON, the outputs on the corresponding module will hold their last state when a communication error occurs. If OFF (default), the outputs on the module unit will turn off in response to an error. The setting does not have to be the same for all the modules on an expansion base.

The selection of the output mode will depend on your application. You must consider the consequences of turning off all the devices in one or all expansion bases at the same time vs. letting the system run "steady state" while unresponsive to input changes. For example, a conveyor system would typically suffer no harm if the system were shut down all at once. In a way, it is the equivalent of an "E–STOP". On the other hand, for a continuous process such as waste water treatment, holding the last state would allow the current state of the process to continue until the operator can intervene manually. V7741 and V7742 are reserved for the expansion base Output Hold option. The bit definitions are as follows:

Bit = 0 Output Off (Default)

Bit = 1 Output Hold

D2–CM Expansion Base Hold Output

Expansion Base No.	V–memory Register		Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
Exp. Base 1	V7741	Bit	0	1	2	3	4	5	6	7
Exp. Base 2			8	9	10	11	12	13	14	15
Exp. Base 3	V7742	Bit	0	1	2	3	4	5	6	7
Exp. Base 4			8	9	10	11	12	13	14	15

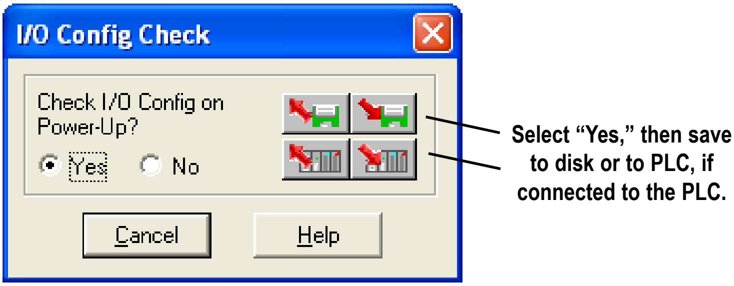
WARNING: Selecting "HOLD LAST STATE" means that outputs on the expansion bases will not be under program control in the event of a communications failure. Consider the consequences to process operation carefully before selecting this mode.

Enabling I/O Configuration Check using DirectSOFT

Enabling the I/O Config Check will force the CPU, at power up, to examine the local and expansion I/O configuration before entering the RUN mode. If there is a change in the I/O configuration, the CPU will not enter the RUN mode. For example, if local expansion base #1 does not power up with the CPU and the other expansion bases, the I/O Configuration Check will prevent the CPU from entering the RUN mode. If the I/O Configuration check is disabled and automatic addressing is used, the CPU would assign addresses from expansion base #1 to base #2 and possibly enter the RUN mode. This is not desirable, and can be prevented by enabling the I/O Configuration check.

Manual addressing can be used to manually assign addresses to the I/O modules. This will prevent any automatic addressing re–assignments by the CPU. The I/O Configuration Check can also be used with manual addressing.

To display the I/O Config Check window, use DirectSOFT>PLC menu>Setup>I/O Config Check.



Check I/O Config on Power-Up?

● Yes ○ No

Select "Yes," then save to disk or to PLC, if connected to the PLC.

Expanding DL205 I/O

I/O Expansion Overview

Expanding I/O beyond the local chassis is useful for a system which has a sufficient number of sensors and other field devices located a relatively long distance from the CPU. Two forms of communication can be used to add remote I/O to your system: either an Ethernet or a serial communication network. A discussion of each method follows.

Ethernet Remote Master, H2-ERM(100, -F)

☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

The Ethernet Remote Master, H2-ERM(100, -F), is a module that provides a low-cost, high-speed Ethernet Remote I/O link to connect either a D2-240, a D2-250-1, a D2-260 or a D2-262 CPU to slave I/O over a high-speed Ethernet link.

Each H2-ERM(100) module can support up to 16 additional H2-EBC(100) systems, 16 Terminator I/O EBC systems, or 16 fully expanded H4-EBC systems.

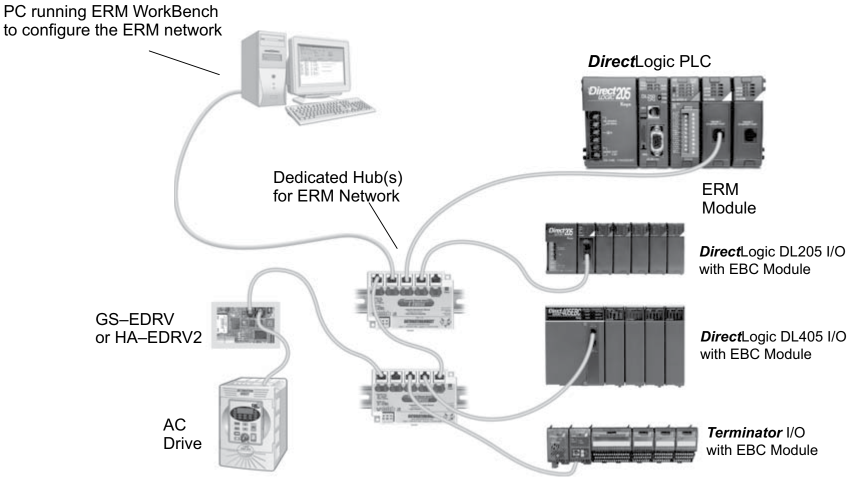
The H2-ERM(100) connects to your control network using Category 5 UTP cables for distances up to 100m (328ft). Repeaters are used to extend the distances and to expand the number of nodes. The fiber optic version, H2-ERM-F, uses industry standard 62.5/125 ST-style fiber optic cables and can be run up to 2000m (6560ft).

The PLC, ERM and EBC slave modules work together to update the remote I/O points. These three scan cycles are occurring at the same time, but asynchronously. We recommend that critical I/O points that must be monitored every scan be placed in the CPU base.

Specifications	H2-ERM	H2-ERM100	H2-ERM-F
Communications	10BaseT Ethernet	10/100BaseT Ethernet	10BaseFL Ethernet
Data Transfer Rate	10Mbps	100Mbps	10Mbps
Link Distance	100 meters (328ft)		2000 meters (6560ft)
Ethernet Port	RJ45		ST-style fiber optic
Ethernet Protocols	TCP/IP, IPX	TCP/IP, IPX, Modbus TCP/IP, DHCP, HTML configuration	TCP/IP, IPX
Power Consumption	320mA @ 5VDC		450mA @ 5VDC

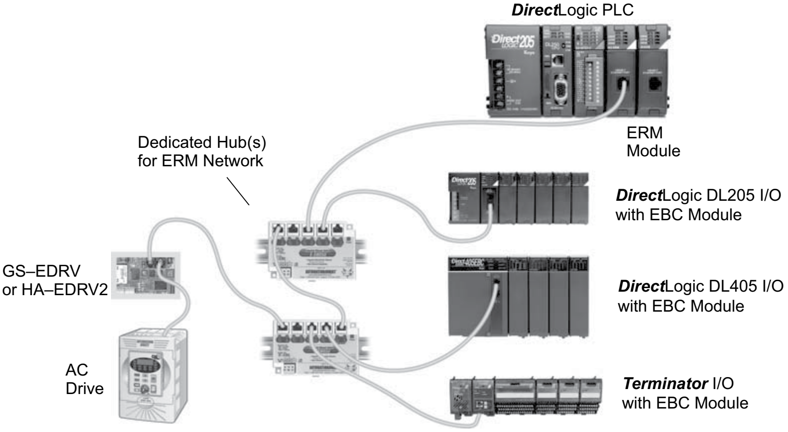
Ethernet Remote Master Hardware Configuration

Use a PC equipped with a 10/100BaseT or a 10BaseFL network adapter card and the Ethernet Remote Master (ERM) Workbench software configuration utility (the ERM Workbench software and the ERM manual, H24-ERM-M, are both available for download on the AutomationDirect.com website) to configure the ERM module and its slaves over the Ethernet remote I/O network.



When networking ERMs with other Ethernet devices, we recommend that a dedicated Ethernet remote I/O network be used for the ERM and its slaves. While Ethernet networks can handle an extremely large number of data transactions, and normally very quickly, heavy Ethernet traffic can adversely affect the reliability of the slave I/O and the speed of the I/O network. Keep ERM networks, multiple ERM networks and ECOM/office networks isolated from one another.

Once the ERM remote I/O network is configured and running, the PC can be removed from the network.



Installing the ERM Module

This section will briefly describe the installation of the ERM module. More detailed information is available in the Ethernet Remote Master Module manual, H24-ERM-M, which will be needed to configure the communication link to the remote I/O.

In addition to the manual, configuration software will be needed. The ERM Workbench software utility must be used to configure the ERM and its slave modules. The ERM user manual, H24-ERM-M and the ERM Workbench utility are available for download at the AutomationDirect.com website. The ERM module can be identified by two different methods, either by Module ID (dip switch) or by Ethernet address. Whichever method is used, the ERM Workbench is all that is needed to configure the network modules.

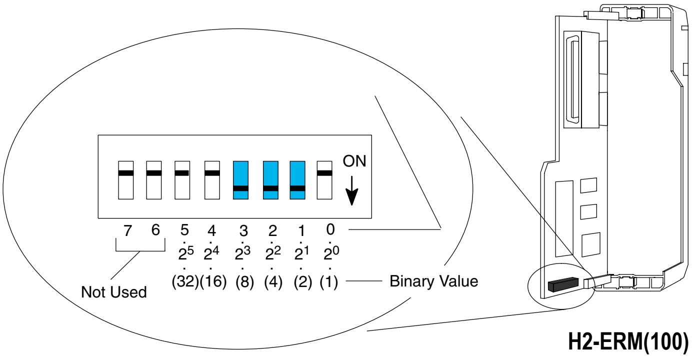
If IP addressing (UDP/IP) is necessary or if the Module ID is set with software, the NetEdit software utility (included with the ERM Workbench utility) will be needed in addition to the ERM Workbench.

ERM Module ID

Set the ERM Module ID before installing the module in the DL205 base. Always set the module ID to 0. A Module ID can be set in one of two ways:

- Use the DIP switches on the module (1-63)
- Use the configuration tools in NetEdit

Use the DIP switch to install and change slave modules without using a PC to set the Module ID. Set the module's DIP switch, insert the module in the base, and connect the network cable. The Module ID is set on power up, and it is ready to communicate on the network.

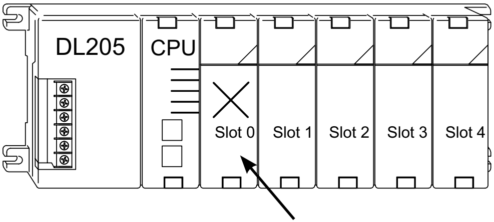


The Module IDs can also be set or changed on the network from a single PC by using the tools in NetEdit.

The Module ID equals the sum of the binary values of the slide switches set in the ON position. For example, if slide switches 1, 2 and 3 are set to the ON position, the Module ID will be 14. This is found by adding 8+4+2=14. The maximum value which can be set on the DIP switch is 32+16+8+4+2=63. This is achieved by setting switches 0 through 5 to the ON position. The 6 and 7 switch positions are inactive.

Insert the ERM Module

The DL205 system only supports the placement of the ERM module in the CPU base. It does not support installation of the ERM module in either local expansion or remote I/O bases. The number of usable slots depends on how many slots the base has. All of the DL205 CPUs support the ERM module, except the D2-230.



Do not install the ERM in Slot 0.

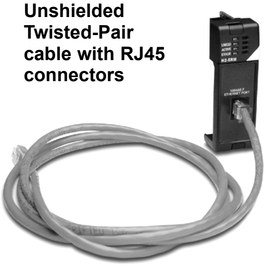
NOTE: *The module will not work in slot 0 of the DL205 series PLCs, the slot next to the CPU.*

Network Cabling

Of the three types of ERM modules available, one supports the 10BaseT standard, another supports 10/100BaseT and the other one supports the 10BaseFL standard. The 10/100BaseT standard uses twisted pairs of copper wire conductors and the 10BaseFL standard is used with fiber optic cabling.

10/100BaseT

Unshielded Twisted-Pair cable with RJ45 connectors



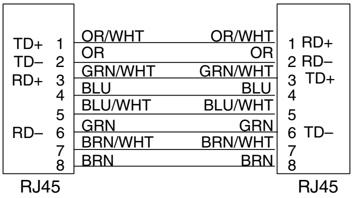
10BaseFL

62.5/125 MMF fiber optics cable with ST-style connectors

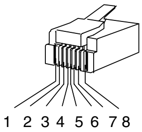
10/100BaseT Networks

A patch (straight-through) cable is used to connect a PLC (or PC) to a hub or to a repeater. Use a crossover cable to connect two Ethernet devices (point-to-point) together. It is recommended that pre-assembled cables be purchased for convenient and reliable networking.

Patch (Straight–through) Cable

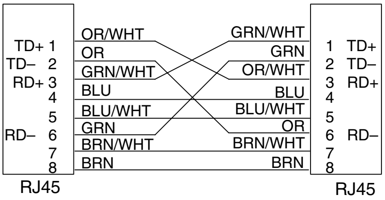


10/100BaseT



8-pin RJ45 Connector
(8P8C)

Crossover Cable



The above diagram illustrates the standard wire positions of the RJ45 connector. It is recommended that Catagory 5, UTP cable be used for all ERM 10/100BaseT cables.

Refer to the ERM manual for using the fiber optic cable with the H2-ERM-F.

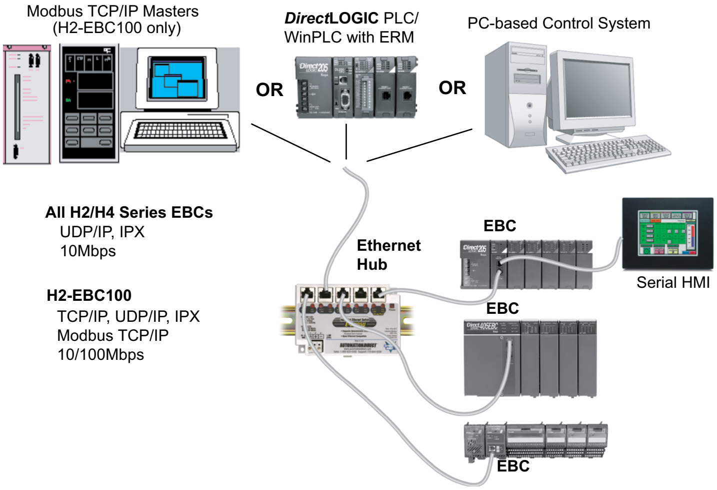
An explanation of the use of the ERM Workbench software is too lengthy for this manual. The full use of the workbench and NetEdit utilities is discussed in the ERM manual.

Ethernet Base Controller, H2-EBC(100)(-F)

The Ethernet Base Controller module H2-EBC(100)(-F) provides a low-cost, high-performance Ethernet link between a network master controller and an DirectLOGIC PLC I/O slave system. Also, the H2-EBC100 supports the Modbus TCP/IP server protocol.

The Ethernet Base Controller (EBC) serves as an interface between the master control system and the DL205/405 I/O modules. The control function is performed by the master controller, not the EBC slave. The EBC occupies the CPU slot in the base and communicates across the backplane to input and output modules. Various master controllers with EBC slaves are shown in the diagram below.

Example EBC Systems: Various Masters with EBC Slaves



The H2-EBC module supports industry standard 10BaseT Ethernet communications, the H2-EBC100 module supports industry standard 10/100BaseT Ethernet communications and the H2-EBC-F module supports 10BaseFL (fiber optic) Ethernet standards.

Specifications	H2-EBC	H2-EBC100	H2-EBC-F
Communications	10BaseT Ethernet	10/100BaseT Ethernet	10BaseFL Ethernet
Data Transfer Rate	10 Mbps max.	100 Mbps max.	10 Mbps max.
Link Distance	100m (328ft)	100m (328ft)	2000m (6560ft)
Ethernet Port	RJ45	RJ45	ST-style fiber optic
Ethernet Protocols	TCP/IP, IPX	TCP/IP, IPX/Modbus TCP/IP, DHCP, HTML configuration	TCP/IP, IPX
Serial Port	RJ12	RJ12	None
Serial Protocols*	K-Sequence, ASCII IN/OUT	K-Sequence, ASCII IN/OUT, Modbus RTU	None
Power Consumption	450mA @ 5VDC	300mA @ 5VDC	640mA @ 5VDC

** Serial communications support available with PC based control master (Think n Do). It does not support HMI communications.*

Install the EBC Module

Like the ERM module discussed in the previous section, this section will briefly describe the installation of the H2 Series EBCs. More detailed information is available in the Ethernet Base Controller manual, H24-EBC-M, which will be needed to configure the remote I/O.

Each EBC module must be assigned at least one unique identifier to make it possible for master controllers to recognize it on the network. Two methods for identifying the EBC module give it the flexibility to fit most networking schemes. These identifiers are:

- Module ID (IPX protocol only)
- IP Address (for TCP/IP and Modbus TCP/IP protocols)

Set the Module ID

The two methods which can be used to set the EBC module ID are either by DIP switch or by software. One software method is to use the NetEdit3 program which is is installed with DirectSOFT or available for download at AutomationDirect.com website. To keep the set-up discussion simple here, only the DIP switch method will be discussed. Refer to the EBC manual for the complete use of NetEdit3.

It is recommended to use the DIP switch to set the Module ID because the DIP switch is simple to set, and the Module ID can be determined by looking at the physical module, without reference to a software utility.

The DIP switch can be used to set the Module ID to a number from 1-63. Do not use Module ID 0 for communication.

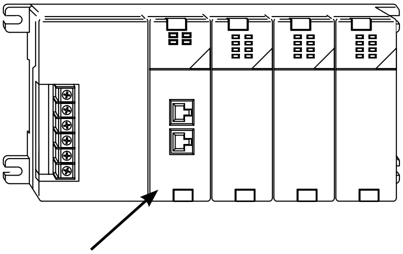
If the DIP switch is set to a number greater than 0, the software utilities are disabled from setting the Module ID. Software utilities will only allow changes to the Module ID if the DIP switch setting is 0 (all switches OFF).

NOTE: *The DIP switch settings are read at powerup only. The power must be cycled each time the DIP switches are changed.*

Setting the Module ID with the DIP switches is identical to setting the DIP switches on the H2-ERM(100) module. Refer to page 4-19 in this chapter.

Insert the EBC Module

Once the Module ID DIP switches are set, insert the module in the CPU slot of any DL205 base.

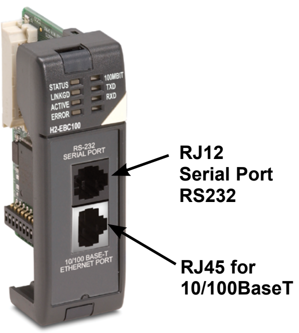


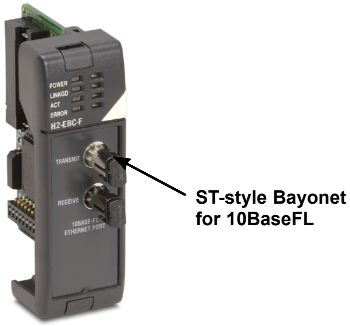
Insert H2-EBC in CPU slot

Network Cabling

Of the two types of EBC modules available, one supports the 10/100BaseT standard and the other one supports the 10BaseFL standard. The 10/100BaseT standard uses twisted pairs of copper wire conductors and the 10BaseFL standard is used with fiber optic cabling.

10/100BaseT

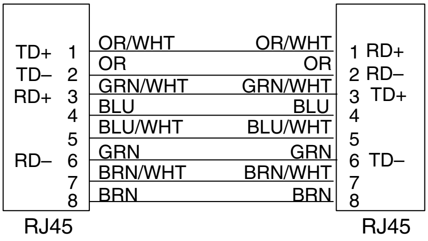




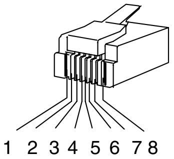
The 10BaseT and 100BaseT EBCs have an eight-pin modular jack that accepts RJ45 connectors. UTP Category 5 (CAT5) cable is highly recommended for use with all Ethernet 10/100BaseT connections. For convenient and reliable networking, purchase commercially manufactured cables which have the connectors already installed.

To connect an EBC, or a PC, to a hub or repeater, use a patch cable (sometimes called a straight-through cable). The cable used to connect a PC directly to an EBC or to connect two hubs is referred to as a crossover cable.

Patch (Straight–through) Cable

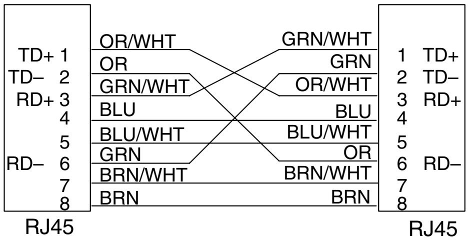


10/100BaseT



8-pin RJ45 Connector
(8P8C)

Crossover Cable



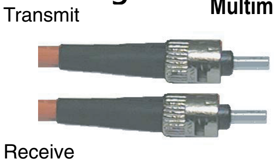
10BaseFL Network Cabling

The H2-EBC-F and the H2-ERM-F modules have two ST-style bayonet connectors. The ST-style connector uses a quick release coupling which requires a quarter turn to engage or disengage. The connectors provide mechanical and optical alignment of fibers.

Each cable segment requires two strands of fiber; one to transmit data and one to receive data. The ST-style connectors are used to connect the H2-Exx-F module to a PC or a fiber optic hub or repeater. The modules themselves cannot act as repeaters.

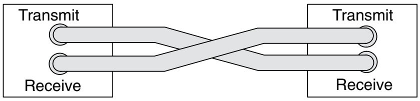
The H2-EBC-F and the H2-ERM-F modules accept 62.5/125 multimode fiber optic (MMF) cable. The glass core diameter is 62.5 micrometers, and the glass cladding is 125 micrometers. The fiber optic cable is highly immune to noise and permits communications over much greater distances than 10/100BaseT.

Maximum Cable Length



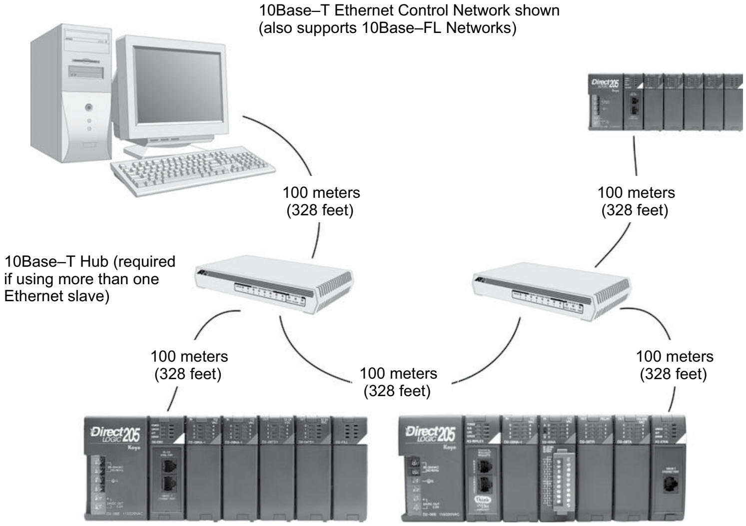
62.5/125 MMF cable with bayonet ST-style connectors

Multimode Fiber Optic (MMF) Cable



Connecting your fiber optic EBC to a network adapter card or fiber optic hub

The maximum distance per 10/100BaseT cable segment is 100 meters (328 feet). Repeaters extend the distance. Each cable segment attached to a repeater can be 100 meters. Two repeaters connected together extend the total range to 300 meters. The maximum distance per 10BaseFL cable segment is 2,000 meters (6,560 feet or 1.2 miles). Repeaters extend the distance. Each cable segment attached to a repeater can be 2,000 meters. Two repeaters connected together extend the total range to 6,000 meters.



Add a Serial Remote I/O Master/Slave Module (No longer available for new applications)

☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

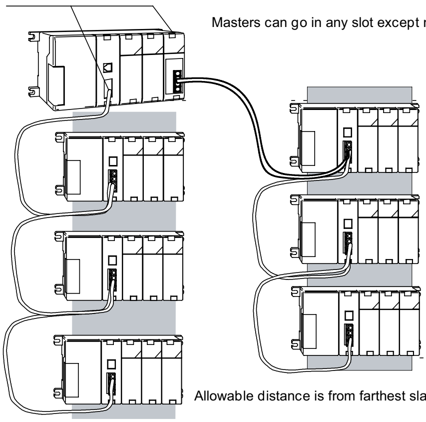
In addition to the I/O located in the local base, adding remote I/O can be accomplished via a shielded twisted-pair cable linking the master CPU to a remote I/O base. The methods of adding serial remote I/O are:

- D2-240 CPUs: Remote I/O requires a remote master module (D2–RMSM) to be installed in the local base. The CPU updates the remote master, then the remote master handles all communication to and from the remote I/O base by communicating to a remote slave module (D2–RSSS) installed in each remote base.
- D2-250-1, D2–260 and D2-262 CPU: The CPU comm port 2, features a built-in Remote I/O channel. You may also use up to seven D2–RMSM remote masters in the local base as described above (you can use either or both methods).

Description	D2-230	D2-240	D2-250-1	D2-260/ D2-262
Maximum number of Remote Masters supported in the local CPU base (1 channel per Remote Master)	None	2	7	7
CPU built-in Remote I/O channels	None	None	1	1
Maximum I/O points supported by each channel	None	2048	2048	2048
Maximum Remote I/O points supported	None	Limited by total references available		
Maximum number of Remote I/O bases per channel(RM–NET)	None	7	7	7
Maximum number of Remote I/O bases per channel (SM–NET)	None	31	31	31

Remote I/O points map into different CPU memory locations, therefore it does not reduce the number of local I/O points. Refer to the DL205 Remote I/O manual for details on remote I/O configuration and numbering. Configuring the built-in remote I/O channel is described in the following section.

The figure below shows one CPU base, and one remote I/O channel with six remote bases. If the CPU is a D2-250-1, D2-260 or D2-262, adding the first remote I/O channel does not require installing a remote master module (use the CPU's built-in remote I/O channel).



Remote Masters

Maximum of:
2 per CPU base (D2-240)
7 per CPU base (D2-250-1, D2-260 and D2-262)
(for D2-250-1, D2-260 and D2-262 the bottom port of the CPU can serve as an eighth master)

Remote Slaves

Maximum of:
7 Remote bases per channel

Masters can go in any slot except next to CPU.

Allowable distance is from farthest slave to the remote master.

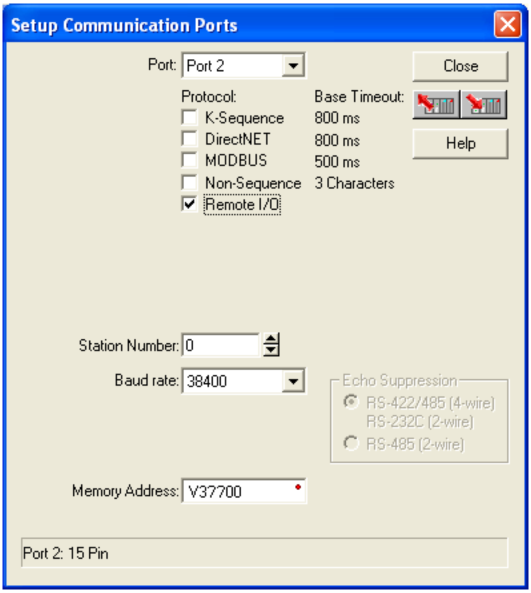
Configuring the CPU's Remote I/O Channel

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

This section describes how to configure the D2-250-1, D2-260 and D2-262 CPU built-in remote I/O channel. Additional information is in the Remote I/O manual, D2–REMIO–M, which you will need in configuring the Remote slave units on the network. You can use the D2–REMIO–M manual exclusively when using regular Remote Masters and Remote Slaves for remote I/O in any DL205 system.

The D2-250-1, D2-260 and D2-262 CPUs have a built-in remote I/O channel which supports RM–Net allowing it to communicate with up to seven remote bases containing a maximum of 2048 I/O points per channel, at a maximum distance of 1000 meters. If required, you can still use Remote Master modules in the local CPU base (2048 I/O points on each channel).

You may recall from the CPU specifications in Chapter 3 that the D2-250–1, D2-260 and D2-262's Port 2 is capable of several protocols. To configure the port using the Handheld Programmer, use AUX 56 and follow the prompts, making the same choices as indicated below on this page. To configure the port in DirectSOFT, choose the PLC menu, then Setup, then Setup Secondary Comm Port.



Setup Communication Ports

Port: Port 2

Protocol:	Base Timeout:
☐ K-Sequence	800 ms
☐ DirectNET	800 ms
☐ MODBUS	500 ms
☐ Non-Sequence	3 Characters
☑ Remote I/O	

Station Number: 0

Baud rate: 38400

Echo Suppression
● RS-422/485 (4-wire) RS-232C (2-wire)
○ RS-485 (2-wire)

Memory Address: V37700

Port 2: 15 Pin

Port: From the port number list box at the top, choose "Port 2."

Protocol: Click the check box to the left of "Remote I/O" (called "M–NET" on the HPP), and then you'll see the dialog box shown below.

Station Number: Choose "0" as the station number, which makes the D2-250-1, D2-260 or D2-262 CPU the master. Station numbers 1–7 are reserved for remote slaves.

Baud Rate: The baud rates 19200 and 38400 are available. Choose 38400 initially as the remote I/O baud rate, and revert to 19200 baud if you experience data errors or noise problems on the link.

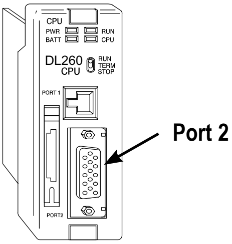
Memory Address: Choose a V-memory address to use as the starting location of a Remote I/O configuration table (V37700 is the default). This table is separate and independent from the table for any Remote Master(s) in the system, and it is 32 words in length.

Then click the button indicated to send the Port 2 configuration to the CPU, and click Close.

***NOTE:** You must configure the baud rate on the Remote Slaves with DIP switches to match the baud rate selection for the CPU's Port 2.*

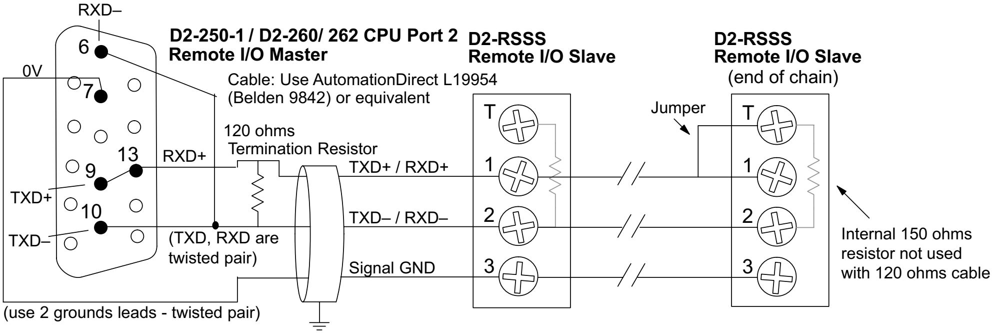
The next step is to make the connections between all devices on the Remote I/O link.

Port 2 location for the D2-250-1, D2-260 and D2-262 is the 15-pin connector, as pictured to the right.



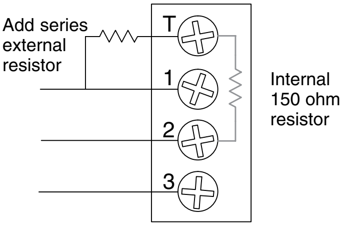
Pin 7	Signal GND
Pin 9	TXD+
Pin 10	TXD–
Pin 13	RXD+
Pin 6	RXD–

Now we are ready to discuss wiring the D2-250-1, D2-260 or D2-262 to the remote slaves on the remote base(s). The remote I/O link is a 3-wire, half-duplex type. Since Port 2 of the D2-250–1, D2-260 and D2-262 CPU is a 5-wire full duplex–capable port, we must jumper its transmit and receive lines together as shown below (converts it to 3-wire, half-duplex).



The twisted/shielded pair connects to the D2-250-1, D2-260 or D2-262 Port 2 as shown. A termination resistor must be added externally to the CPU, as close as possible to the connector pins. Its purpose is to minimize electrical reflections that occur over long cables. A termination resistor must be present at both physical ends of the network.

Ideally, the two termination resistors at the cable's opposite ends and the cable's rated impedance will all match. For cable impedances greater than 150 ohms, add a series resistor at the last slave as shown to the right. If less than 150 ohms, parallel a matching resistance across the slave's pins 1 and 2 instead. Remember to size the termination resistor at Port 2 to match the cables rated impedance. The resistance values should be between 100 and 500 ohms.



***NOTE:** To match termination resistance to AutomationDirect L19827 (Belden 9841), use a 120 ohm resistor across terminals 1 and 2.*

***NOTE:** See the transient suppression for inductive loads information in Chapter 2 of this manual for further information on wiring practices.*

Configure Remote I/O Slaves

After configuring either the D2-250-1, D2-260 or D2-262 CPU Port 2 and wiring it to the remote slave(s), use the following checklist to complete the configuration of the remote slave(s). Full instructions for these steps are in the Remote I/O manual.

- Set the baud rate to match CPU Port 2 setting.
- Select a station address for each slave, from 1 to 7. Each device on the remote link must have a unique station address. There can be only one master (address 0) on the remote link.

Configuring the Remote I/O Table

The beginning of the configuration table for the built-in remote I/O channel is the memory address we selected in the Port 2 setup.

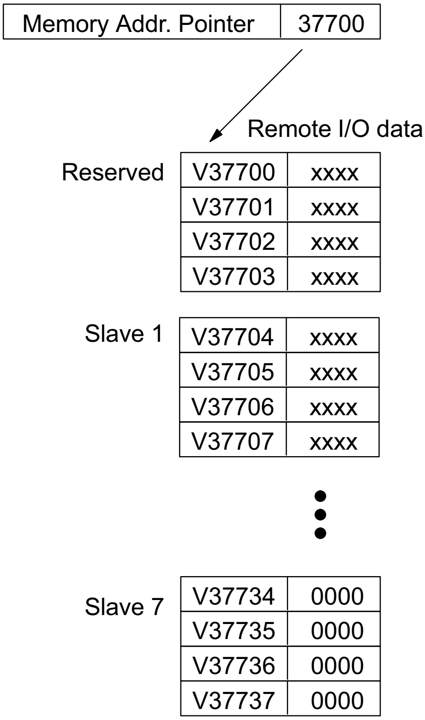
The table consists of blocks of four words which correspond to each slave in the system, as shown to the right. The first four table locations are reserved.

The CPU reads data from the table after powerup, interpreting the four data words in each block with these meanings:

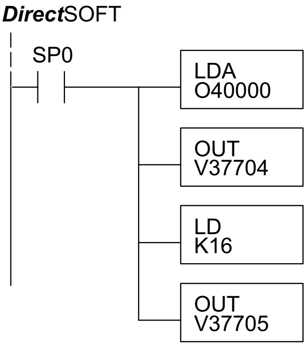
1. Starting address of slave input data
2. Number of slave input points
3. Starting address of outputs in slave
4. Number of slave output points

The table is 32 words long. If your system has fewer than seven remote slave bases, then the remainder of the table must be filled with zeros. For example, a three–slave system will have a remote configuration table containing four reserved words, 12 words of data and 16 words of "0000."

A portion of the ladder program must configure this table (only once) at powerup. Use the LDA instruction as shown to the right, to load an address to place in the table. Use the regular LD constant to load the number of the slave's input or output points. The following page gives a short program example for one slave.

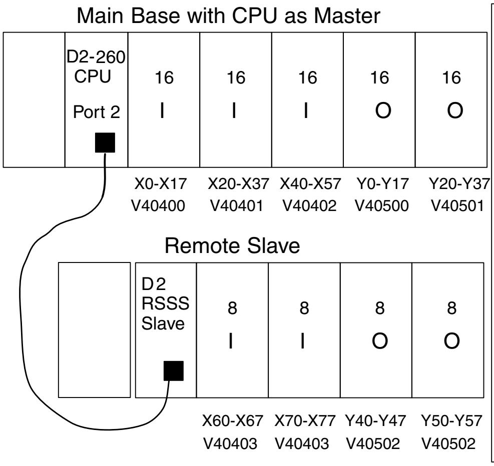


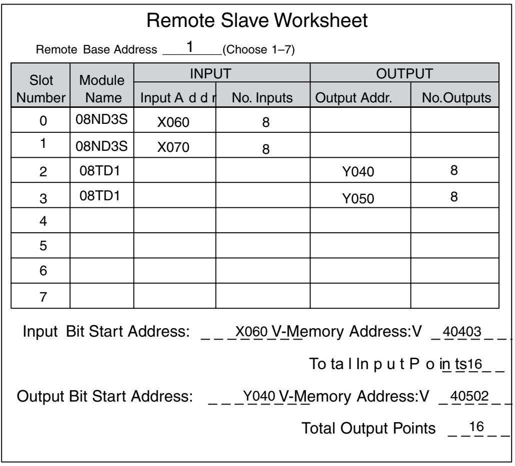
Reserved	V37700	xxxx
	V37701	xxxx
	V37702	xxxx
	V37703	xxxx
Slave 1	V37704	xxxx
	V37705	xxxx
	V37706	xxxx
	V37707	xxxx
Slave 7	V37734	0000
	V37735	0000
	V37736	0000
	V37737	0000



Consider the simple system featuring Remote I/O shown below. The D2-250-1, D2-260 or D2-262's built-in Remote I/O channel connects to one slave base, which we will assign a station address=1. The baud rates on the master and slave will be 38.4KB.

We can map the remote I/O points as any type of I/O point, simply by choosing the appropriate range of V-memory. Since we have plenty of standard I/O addresses available (X and Y), we will have the remote I/O points start at the next X and Y addresses after the main base points (X60 and Y40, respectively).




Remote Slave Worksheet

Remote Base Address 1 (Choose 1–7)

Slot Number	Module Name	INPUT		OUTPUT	
		Input Addr	No. Inputs	Output Addr.	No.Outputs
0	08ND3S	X060	8		
1	08ND3S	X070	8		
2	08TD1			Y040	8
3	08TD1			Y050	8
4					
5					
6					
7					

Input Bit Start Address: X060 V-Memory Address:V 40403

Total Input Points 16

Output Bit Start Address: Y040 V-Memory Address:V 40502

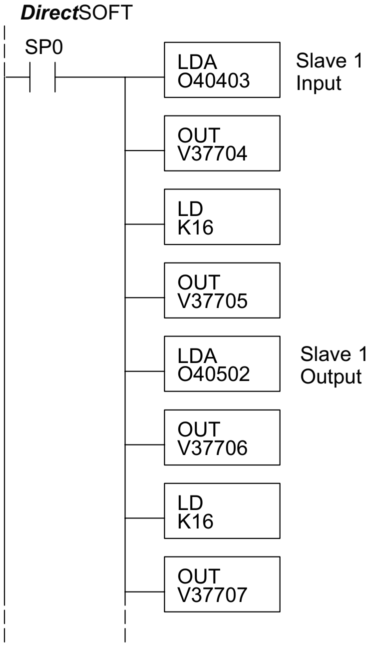
Total Output Points 16

Remote I/O Setup Program

Using the Remote Slave Worksheet shown above can help organize our system data in preparation for writing our ladder program (a blank full-page copy of this worksheet is in the Remote I/O Manual). The four key parameters we need to place in our Remote I/O configuration table are in the lower right corner of the worksheet. You can determine the address values by using the memory map given at the end of Chapter 3, CPU Specifications and Operation.

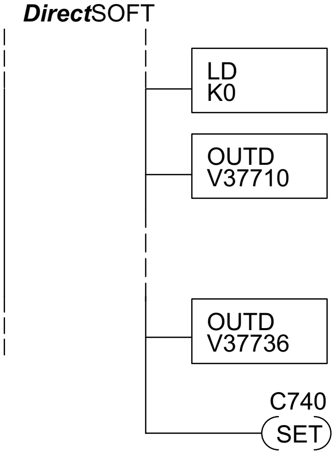
The program segment required to transfer our worksheet results to the Remote I/O configuration table is shown to the right. Remember to use the LDA or LD instructions appropriately.

The next page covers the remainder of the required program to get this remote I/O link up and running.



When configuring a Remote I/O channel for fewer than 7 slaves, we must fill the remainder of the table with zeros. This is necessary because the CPU will try to interpret any non-zero number as slave information.

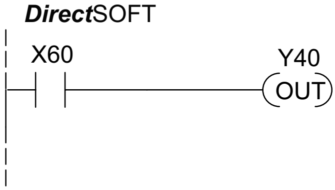
We continue our set-up program from the previous page by adding a segment which fills the remainder of the table with zeros. The example to the right fills zeros for slave numbers 2–7, which do not exist in our example system.



On the last rung in the example program above, we set a special relay contact C740. This particular contact indicates to the CPU the ladder program has finished specifying a remote I/O system. At that moment, the CPU begins remote I/O communications. Be sure to include this contact after any Remote I/O set-up program.

Remote I/O Test Program

Now we can verify the remote I/O link and set-up program operation. A simple quick check can be done with one rung of ladder, shown to the right. It connects the first input of the remote base with the first output. After placing the PLC in RUN mode, we can go to the remote base and activate its first input. Then its first output should turn on.



Network Connections to Modbus and DirectNET

Configuring Port 2 For DirectNET

☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

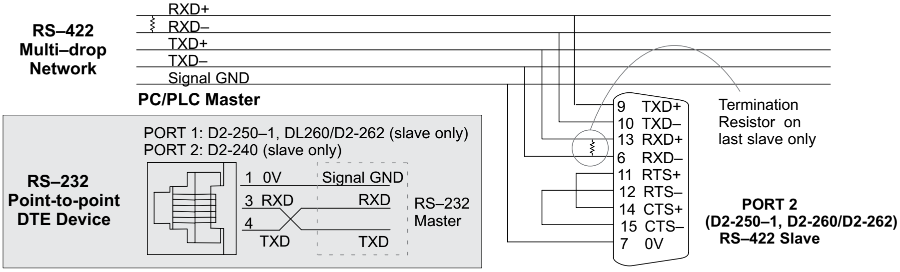
This section describes how to configure the CPU's built-in networking ports for either Modbus or DirectNET. This will allow you to connect the DL205 PLC system directly to Modbus networks using the RTU protocol, or to other devices on a DirectNET network. For more details on DirectNET, order our DirectNET manual, part number DA–DNET–M.

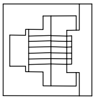
Configuring Port 2 For Modbus RTU

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

Modbus hosts system on the network must be capable of issuing the Modbus commands to read or write the appropriate data. For details on the Modbus protocol, refer to the Modicon Modbus Protocol Reference Guide, PI-MBUS-300, found at Modbus.org. In the event a more recent version is available, check with your Modbus supplier before ordering the documentation.

You will need to determine whether the network connection is a 3-wire RS–232 type, or a 5-wire RS–422 type. Normally, the RS–232 signals are used for shorter distance (15 meters (50 feet) maximum) communications between two devices. RS–422 signals are for longer distance (1000 meters (3280ft) maximum) multi-drop networks (from two to 247 devices). Use termination resistors at both ends of RS–422 network wiring, matching the impedance rating of the cable (between 100 and 500 ohms).





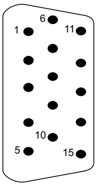
6-pin Female
Modular Connector

Port 1 Pinouts (D2-250–1 / D2-260*)

1	0V	Power (–) connection (GND)
2	5V	Power (+) conection
3	RXD	Receive Data (RS-232)
4	TXD	Transmit Data (RS-232)
5	5V	Power (+) conection
6	0V	Power (–) connection (GND)

Port 2 Pin Descriptions (D2-240 only)

1	0V	Power (–) connection (GND)
2	5V	Power (+) conection
3	RXD	Receive Data (RS-232)
4	TXD	Transmit Data (RS-232)
5	RTS	Request to Send
6	0V	Power (–) connection (GND)



15-pin Female
D-Sub connector

Port 2 Pin Descriptions (D2-250–1 / D2-260*)

1	5V	5 VDC
2	TXD2	Transmit Data (RS-232)
3	RXD2	Receive Data (RS-232)
4	RTS2	Ready to Send (RS–232)
5	CTS2	Clear to Send (RS–232)
6	RXD2–	Receive Data – (RS–422) (RS–485 D2-260)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422) (RS–485 D2-260)
10	TXD2 –	Transmit Data – (RS–422) (RS–485 D2-260)
11	RTS2 +	Request to Send + (RS–422) (RS–485 D2-260)
12	RTS2 –	Request to Send – (RS–422)(RS–485 D2-260)
13	RXD2 +	Receive Data + (RS–422) (RS–485 D2-260)
14	CTS2 +	Clear to Send + (RS422) (RS–485 D2-260)
15	CTS2 –	Clear to Send – (RS–422) (RS–485 D2-260)

* Applies to D2-262 CPU also.

The recommended cable for RS-232 or RS-422 is AutomationDirect L19772 (Belden 8102) or equivalent. The recommended cable for RS-485 is AutomationDirect L19827 (Belden 9841) or equivalent.

Note: The D2-260/D2-262 supports RS–485 multi–drop networking. See the Network Master Operation (D2-260/D2-262 only) section later in this chapter for details.

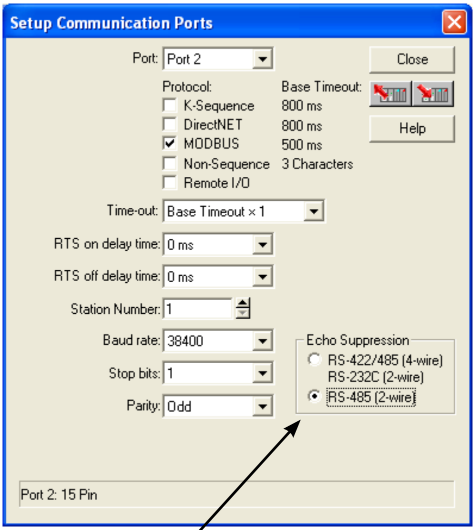
Modbus Port Configuration

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

In DirectSOFT, choose the PLC menu, then Setup, then “Secondary Comm Port.”

Port: From the port number list box at the top, choose “Port 2.”

Protocol: Click the check box to the left of “MODBUS” (use AUX 56 on the HPP, and select “MBUS”), and then you’ll see the dialog box below.



Port: Port 2

Protocol:	Base Timeout:
☐ K-Sequence	800 ms
☐ DirectNET	800 ms
☑ MODBUS	500 ms
☐ Non-Sequence	3 Characters
☐ Remote I/O	

Time-out: Base Timeout x 1

RTS on delay time: 0 ms

RTS off delay time: 0 ms

Station Number: 1

Baud rate: 38400

Stop bits: 1

Parity: Odd

Echo Suppression
○ RS-422/485 (4-wire)
RS-232C (2-wire)
● RS-485 (2-wire)

Port 2: 15 Pin

Timeout: The 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.

NOTE: *The D2-250-1 does not support the Echo Suppression feature*

Station Number: To make the CPU port a Modbus master, choose “1.” The possible range for Modbus slave numbers is from 1 to 247, but the D2-250–1, D2-260 and D2-262 WX and RX network instructions used in Master mode will access only slaves 1 to 90. Each slave must have a unique number. At powerup, the port is automatically a slave, unless and until the D2-250-1, D2-260 or D2-262 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, 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 for use in the protocol.

Parity: Choose none, even, or odd parity for error checking.

Echo Suppression: Select the appropriate radio button based on the wiring configuration used on port 2.

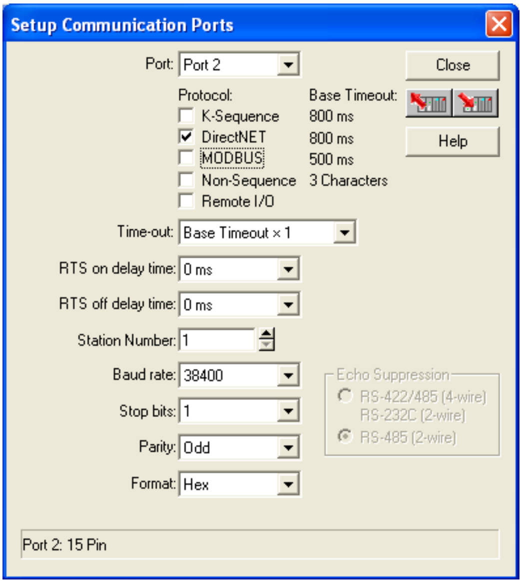
Then click the button indicated to send the Port configuration to the CPU, and click Close.

DirectNET Port Configuration

☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

In DirectSOFT, choose the PLC menu, then Setup, then “Secondary Comm Port.”

Port: From the port number list box, choose “Port 2.”



Setup Communication Ports

Port: Port 2

Protocol:	Base Timeout:
☐ K-Sequence	800 ms
☑ DirectNET	800 ms
☐ MODBUS	500 ms
☐ Non-Sequence	3 Characters
☐ Remote I/O	

Time-out: Base Timeout x 1
RTS on delay time: 0 ms
RTS off delay time: 0 ms
Station Number: 1
Baud rate: 38400
Stop bits: 1
Parity: Odd
Format: Hex

Echo Suppression
○ RS-422/485 (4-wire) RS-232C (2-wire)
● RS-485 (2-wire)

Port 2: 15 Pin

Protocol: Click the check box to the left of “DirectNET” (use AUX 56 on the HPP, then select “DNET”), and then you’ll see the dialog box below.

Timeout: The 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.

Station Number: To make the CPU port a DirectNET master, choose “1”. The allowable range for DirectNET 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 D2-250-1, D2-260 or D2-262 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, 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.

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 hex or ASCII formats.

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

Network Slave Operation

☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

This section describes how other devices on a network can communicate with a CPU port that you have configured as a DirectNET slave (D2-240, 250–1, D2-260 and D2-262) or Modbus slave (D2-250–1, D2-260 and D2-262). A Modbus host must use the Modbus RTU protocol to communicate with the D2-250-1, D2-260 or D2-262 as a slave. The host software must send a Modbus function code and Modbus address to specify a PLC memory location the D2-250-1, D2-260 or D2-262 comprehends. The DirectNET host uses normal I/O addresses to access applicable DL205 CPU and system information. No CPU ladder logic is required to support either Modbus slave or DirectNET slave operation.

Modbus Function Codes Supported

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

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 D2-250–1, D2-260 and D2-262 support the Modbus function codes described below.

Modbus Function Code	Function	DL205 Data Types Available
01	Read a group of coils	Y, C, T, CT
02	Read a group of inputs	X, SP
05	Set / Reset a single coil (slave only)	Y, C, T, CT
15	Set / Reset a group of coils	Y, C, T, CT
03, 04	Read a value from one or more registers	V
06	Write a value into a single register (slave only)	V
16	Write a value into a group of registers	V

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.

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 correspond 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, C, S, T (contacts), CT (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 on the following page shows the exact equation used for each group of data.

***NOTE:** For information about the Modbus protocol see www.Modbus.org and select Technical Resources. For more information about the DirectNET protocol, download the DirectNET User Manual, DA-DNET-M, for free from our website: www.automationdirect.com. Select Manuals/ Docs>Online User Manuals>Misc.>DA-DNET-M*

D2-250-1 Memory Type	QTY (Dec.)	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 – 2560	Input
Special Relays (SP)	512	SP0 – SP137 SP320 – SP717	3072 – 3167 3280 – 3535	Input
Outputs (Y)	512	Y0 – Y777	2048 – 2560	Coil
Control Relays (C)	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)	3072 4096	V1400 – V7377 V10000 – V17777	768 – 3839 4096 – 8191	Holding Register
V-Memory, system (V)	256	V7400 – V7777	3480 – 3735	Holding Register

D2-260/D2-262 Memory Type	QTY (Dec.)	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)	1024	X0 – X1777	2048 – 3071	Input
Remote Inputs (GX)	2048	GX0 – GX3777	3840 – 18431	Input
Special Relays (SP)	512	SP0 – SP777	3072 – 3583	Input
Outputs (Y)	1024	Y0 – Y777	2048 – 3071	Coil
Remote Outputs (GY)	2048	GY0 – GY3777	18432 – 20479	Coil
Control Relays (C)	2048	C0 – C377	3072 – 5159	Coil
Timer Contacts (T)	256	T0 – T177	6144 – 6399	Coil
Counter Contacts (CT)	256	CT0 – CT177	6400 – 6655	Coil
Stage Status Bits (S)	1024	S0 – S777	5120 – 6143	Coil
For Word Data Types .... Convert PLC Addr. to Dec.			**+**	**Data Type**
Timer Current Values (V)	256	V0 – V177	0 – 255	Input Register
Counter Current Values (V)	256	V1000 – V1177	512 – 767	Input Register
V-Memory, user data (V)	14.6K	V400 – V777 V1400 – V7377 V10000 – V35777	1024 – 2047	Holding Register
V-Memory, system (V)	256 1024	V7400 – V7777 V36000 – V37777	3480 – 4095 15360 – 16383	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 (1089).
3. Use the Modbus data type from the table.

PLC Address (Dec.) + Data Type

V2100 = 1088 decimal

1088 + Hold Reg. = **Holding Reg. 1089**

Timer Current Values (V)	128	V0 - V177	0 - 127	Input Register
Counter Current Values (V)	128	V1000 - V1177	512 - 639	Input Register
V Memory, user data (V)	1024	V2000 - -V3777	1024 - 2047	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 (2049).

Use the Modbus data type from the table.

PLC Addr. (Dec) + Start Addr. + Data Type

Y20 = 16 decimal

16 + 2049 + Coil = **Coil 2065**

Outputs (Y)	320	Y0 – Y477	2049 – 2367	Coil
Control Relays (CR)	256	C0 – C377	3072 - 3551	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.

PLC Address (Dec.) + Data Type

T10 = 8 decimal

8 + Input Reg. = **Input Reg. 9**

Timer Current Values (V)	128	V0 – V177	0 – 128	Input Register
Counter Current Values (V)	128	V1000 – V1177	512 – 639	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 (3073).
4. Use the Modbus data type from the table.

PLC Addr. (Dec) + Start Addr. +Data Type

C54 = 44 decimal

44 + 3073 + Coil = **Coil 3117**

Outputs (Y)	320	Y0 – Y477	2048 - 2367	Coil
Control Relays (C)	256	C0 – C377	3073 – 3551	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 is not difficult. Basically, Modbus 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, GX, SP, Y, R, S, T, CT (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

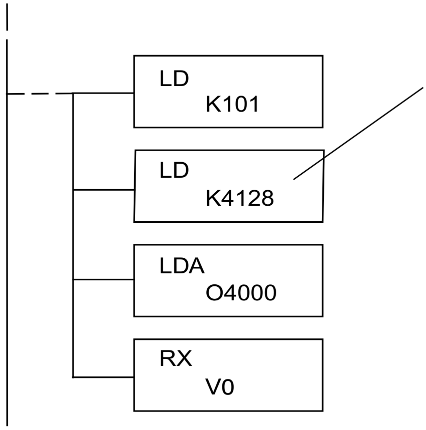
D2-260/D2-262 Memory Type	PLC Range (Octal)	Address Range (484 Mode)	Address Range (584/984 Mode)	Modbus Data Type
Global Inputs (GX)	GX0 – GX1746	1001 – 1999	10001 – 10999	Input
	GX1747 – GX3777	---	11000 – 12048	Input
Inputs (X)	X0 – X1777	---	12049 – 13072	Input
Special Relays (SP)	SP0 – SP777	---	13073 – 13584	Input
Global Outputs (GY)	GY0 – GY3777	1 – 2048	1 – 2048	Output
Outputs (Y)	Y0 – Y1777	2049 – 3072	2049 – 3072	Output
Control Relays (C)	C0 – C3777	3073 – 5120	3073 – 5120	Output
Timer Contacts (T)	T0 – T377	6145 – 6400	6145 – 6400	Output
Counter Contacts (CT)	CT0 – CT377	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 (585/984 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*

The D2-250-1, D2-260 and D2-262 support function 04 read input register (Address 30001). To use function 04, put the number '4' into the most significant position (4xxx) when defining the number of bytes to read. Four digits must be entered for the instruction to work properly with this mode.



The maximum constant possible is 4128. This is due to the 128 maximum number of Bytes that the RX/WX instruction can allow. The value of 4 in the most significant position of the word will cause the RX to use function 04 (30001 range).

Later in this chapter, a step-by-step procedure will provide the information necessary to set up the ladder program to receive data from a network slave.

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

For an automated Modbus/Koyo address conversion utility, search and download the file modbus_conversion.xls from the www.automationdirect.com website.

Example 1: V2100 584/984 Mode

Find the Modbus address for User V location V2100.

1. Find V memory in the table.
2. Convert V2100 into decimal (1088).
3. Add the Modbus starting address for the mode (40001).

PLC Address (Dec.) + Mode Address

V2100 = 1088 decimal

1088 + 40001 = $\boxed{41089}$

For Word Data Types...	PLC Address (Dec.)	+	Appropriate Mode Address			
Timer Current Value (V)	128	V0 - V177	0 - 127	3001	30001	Input Register
Counter Current Value (V)	128	V1000 - V1177	512 - 639	3001	30001	Input Register
V Memory, User Data (V)	1024	V2000 - V3777	1024 - 2047	4001	40001	Hold Register

Example 2: Y20 584/984 Mode

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. Add the Modbus address for the mode (1).

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

Y20 = 16 decimal

16 + 2048 + 1 = $\boxed{2065}$

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.

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

PLC Address (Dec.) + Mode Address

TA10 = 8 decimal

8 + 3001 = $\boxed{3009}$

For Word Data Types...	PLC Address (Dec.)	+	Appropriate Mode Address			
Timer Current Value (V)	128	V0 - V177	0 - 127	3001	30001	Input Register
Counter Current Value (V)	128	V1000 - V1177	512 - 639	3001	30001	Input Register
V Memory, User Data (V)	1024	V2000 - V3777	1024 - 2047	4001	40001	Hold Register

Example 4: C54 584/984 Mode

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. Add the Modbus address for the mode (1).

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

C54 = 44 decimal

44 + 3072 + 1 = $\boxed{3117}$

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

Determining the DirectNET Address

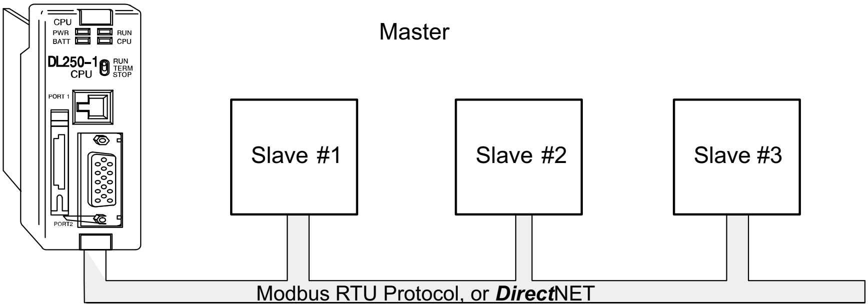
☒ 230
☑ 240
☑ 250-1
☑ 260
☑ 262

Addressing the memory types for DirectNET slaves is very easy. Use the ordinary native address of the slave device itself. To access a slave PLC's memory address V2000 via DirectNET, for example, the network master will request V2000 from the slave.

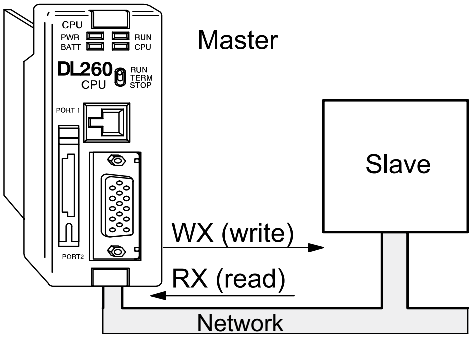
Network Master Operation

☒ 230
☒ 240
☑ 250-1
☑ 260
☑ 262

This section describes how the D2-250–1, D2-260 and D2-262 can communicate on a Modbus or DirectNET 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 DirectNET 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.



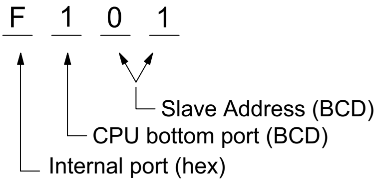
When using the D2-250-1, D2-260 or D2-262 CPU as the master station, you use simple RLL instructions to initiate the requests. The WX instruction initiates network write operations, and the RX instruction initiates network read operations. Before executing either the WX or RX commands, we will need to 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.

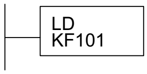


The following step-by-step procedure will provide the information necessary to set up your ladder program to receive data from a network slave.

Step 1: Identify Master Port # and Slave

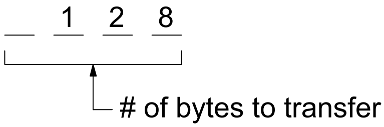
The first Load (LD) instruction identifies the communications port number on the network master (D2-250-1/D2-260/D2-262) and the address of the slave station. This instruction can address up to 99 Modbus slaves, or 90 DirectNET slaves. The format of the word is shown to the right. The “F1” in the upper byte indicates the use of the bottom port of the D2-250-1, D2-260 and D2-262 PLC, port number 2. The lower byte contains the slave address number in BCD (01 to 99).

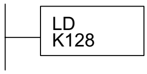




Step 2: Load Number of Bytes to Transfer

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 DL205 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 DirectLOGIC™ products.

DL205/405 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

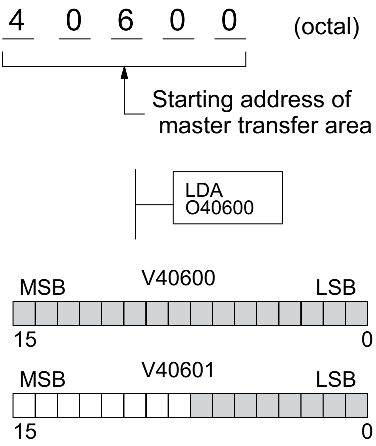
DL305 Memory	Bits per unit	Bytes
Data registers T / C accumulator	8 16	1 2
I/O, internal relays, shift register bits, T/C bits, stage bits	1	1
Scratch Pad Memory	8	2
Diagnostic Status (5 word R/W)	16	10

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 D2-250-1, D2-260 or D2-262 CPU sends the number of bytes previously specified from its memory area beginning at the LDA address specified.

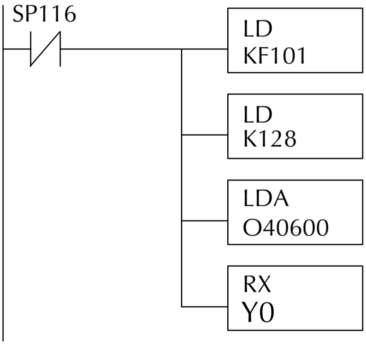
For an RX instruction, the D2-250-1, D2-260 or D2-262 CPU reads the number of bytes previously specified from the slave, placing the received data into its memory area beginning at the LDA address specified.



__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.

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 or DL205 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

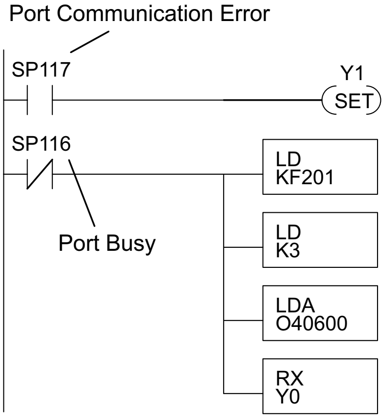
PLC Memory Type	PLC Base Address	Modbus Base Address	PLC Memory Type	PLC Base Address	Modbus Base Address
TMR/CNT Current Values	R600	V0	TMR/CNT Status Bits	CT600	GY600
I/O Points	IO 000	GY0	Control Relays	CR160	GY160
Data Registers	R401,R400	V100	Shift Registers	SR400	GY400
Stage Status Bits (D3-330P only)	S0	GY200			

Communications from a Ladder Program

Typically, network communications will last longer than one 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. One indicates "Port busy"(SP116), and the other indicates "Port Communication Error"(SP117). The example 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.

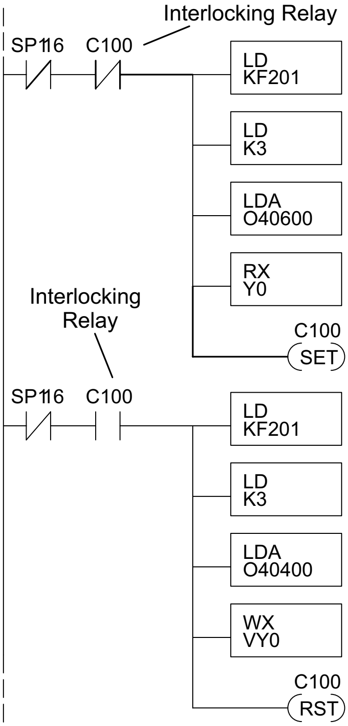


Multiple Read and Write Interlocks

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.

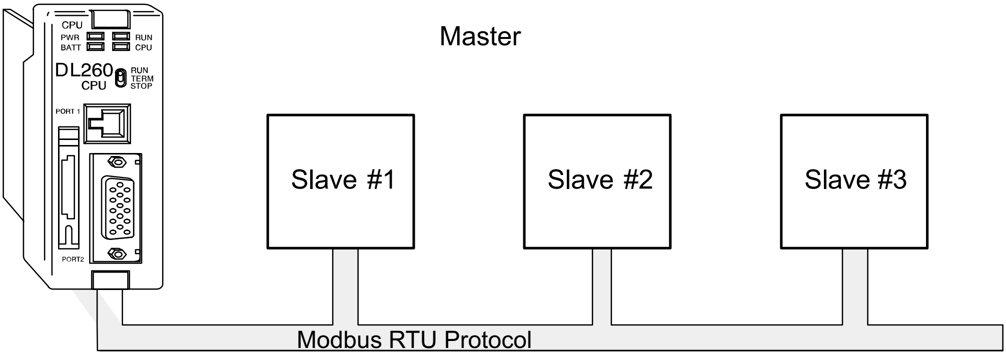
If you're using RLLPLUS Stage Programming, you can put each routine in a separate program stage to ensure proper execution and switch from stage to stage allowing only one of them to be active at a time.



Network Modbus RTU Master Operation (D2-260 and D2-262 only)

☒ 230
☒ 240
☒ 250-1
☑ **260**
☑ **262**

This section describes how the D2-260 and D2-262 CPUs 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 D2-260 and D2-262 CPUs supports the Modbus function codes described below.

Modbus Function Code	Function	DL205 Data Types Available
01	Read a group of coils	Y, C, T, CT
02	Read a group of inputs	X, SP
05	Set / Reset a single coil (slave only)	Y, C, T, CT
15	Set / Reset a group of coils	Y, C, 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 Port Configuration

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

☒ 230
☒ 240
☒ 250-1
☑ 260
☑ 262

Port: From the port number list box at the top, choose "Port 2."

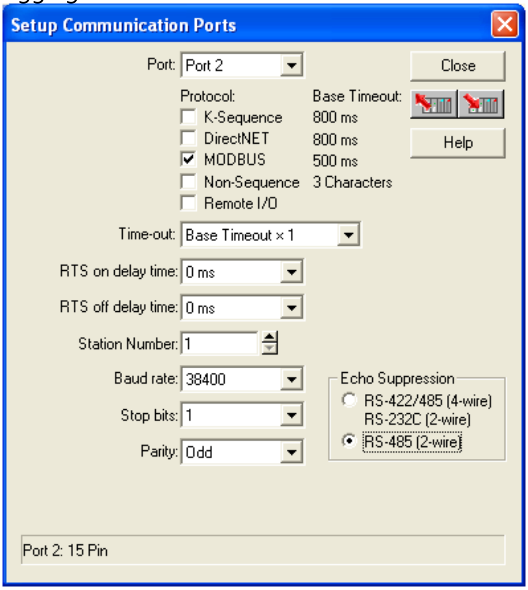
Protocol: Click the check box to the left of "MODBUS" (use AUX 56 on the HPP, and select "MBUS"), and then you'll see the dialog box below.

Timeout: Amount of time the port will wait after it sends a message to get a response before logging an error.

RTS On 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.

Station Number: For making the CPU port a Modbus master, choose "1." The possible range for Modbus slave numbers is from 1 to 247. Each slave must have a unique number. At powerup, the port is automatically a slave, unless and until the D2-260 or D2-262 CPUs execute ladder logic with MWX/MRX network instructions, which use the port as a communications master. Thereafter, the port reverts back to slave mode until ladder logic uses the port again.



Port: Port 2

Protocol:	Base Timeout:
☐ K-Sequence	800 ms
☐ DirectNET	800 ms
☑ MODBUS	500 ms
☐ Non-Sequence	3 Characters
☐ Remote I/O	

Time-out: Base Timeout × 1
RTS on delay time: 0 ms
RTS off delay time: 0 ms
Station Number: 1
Baud rate: 38400
Stop bits: 1
Parity: Odd

Echo Suppression
○ RS-422/485 (4-wire)
RS-232C (2-wire)
● RS-485 (2-wire)

Port 2: 15 Pin

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 for use in the protocol.

Parity: Choose none, even, or odd parity for error checking.

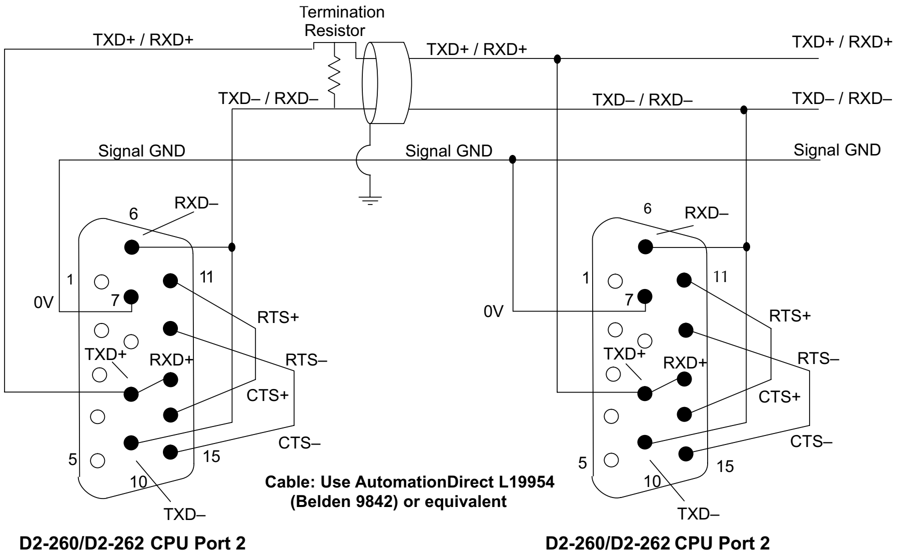
Echo Suppression: Select the appropriate radio button based on the wiring configuration used on port 2.

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

RS–485 Network (Modbus Only)

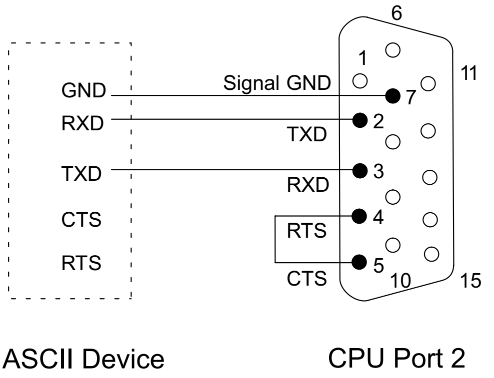
☒ 230
☒ 240
☒ 250-1
☑ 260
☑ 262

RS–485 signals are for longer distances (1000 meters maximum), 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).



RS–232 Network

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



Port 2 Pin Descriptions (D2-260/D2-262 only)

1	5V	5 VDC
2	TXD2	Transmit Data (RS-232)
3	RXD2	Receive Data (RS-232)
4	RTS2	Ready to Send (RS–232)
5	CTS2	Clear to Send (RS–232)
6	RXD2–	Receive Data – (RS–422/RS-485)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422/RS–485)
10	TXD2 –	Transmit Data – (RS–422/RS–485)
11	RTS2 +	Request to Send + (RS–422/RS–485)
12	RTS2 –	Request to Send – (RS–422/RS–485)
13	RXD2 +	Receive Data + (RS–422/RS–485)
14	CTS2 +	Clear to Send + (RS422/RS–485)
15	CTS2 –	Clear to Send – (RS–422/RS–485)

Modbus Read from Network (MRX)

☒ 230
☒ 240
☒ 250-1
☑ 260
☑ 262

The Modbus Read from Network (MRX) instruction is used by the D2-260 or D2-262 network master to read a block of data from a connected slave device and to write the data into memory addresses within the master. 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.

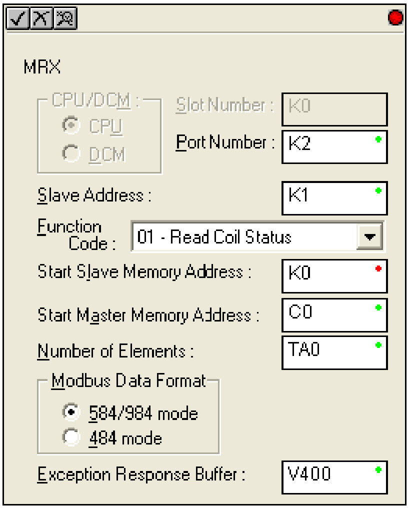
Port Number: must be Port 2 (K2)

Slave Address: specify a slave station address (1–247)

Function Code: the MRX instruction supports the following Modbus function codes:

01 – Read a group of coils
02 – Read a group of inputs
03 – Read holding registers
04 – Read input registers
07 – Read Exception status

Start Slave Memory Address: specifies the starting slave memory address of the data to be read. See the table on the following page.



MRX

CPU/DCM :
● CPU
○ DCM

Slot Number : K0

Port Number : K2

Slave Address : K1

Function Code : 01 - Read Coil Status

Start Slave Memory Address : K0

Start Master Memory Address : C0

Number of Elements : TA0

Modbus Data Format
● 584/984 mode
○ 484 mode

Exception Response Buffer : V400

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, discrete inputs, holding registers or input registers 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

MRX Master Memory Addresses

MRX Master Memory Address Ranges

Operand Data Type		D2-260/D2-262 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

Number of Elements

Operand Data Type		D2-260/D2-262 Range
V–memory	V	All (see page 3-56)
Constant	K	Bits:1–2000 Registers: 1-125

MRX Exception Response Buffer

Exception Response Buffer

Operand Data Type		D2-260/D2-262 Range
V–memory	V	All (see page 3-56)

Modbus Write to Network (MWX)

☒ 230
☒ 240
☒ 250-1
☑ 260
☑ 262

The Modbus Write to Network (MWX) instruction is used by the D2-260 or D2-262 network master to write a block of data 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 Port 2 (K2).

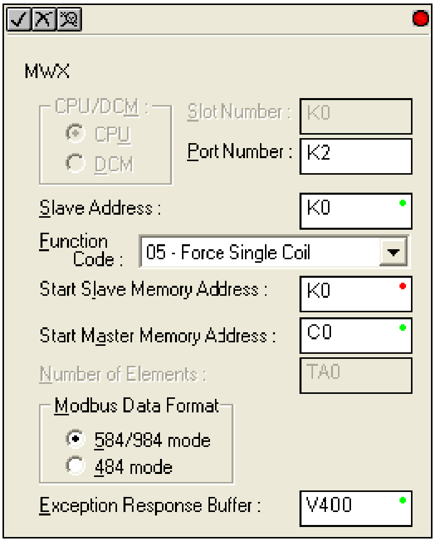
Slave Address: specify a slave station address (0–247).

Function Code: the MWX instruction supports the following Modbus function codes:

- 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.



MWX

CPU/DCM: ● CPU ○ DCM

Slot Number: K0

Port Number: K2

Slave Address: K0

Function Code: 05 - Force Single Coil

Start Slave Memory Address: K0

Start Master Memory Address: C0

Number of Elements: TA0

Modbus Data Format: ● 584/984 mode ○ 484 mode

Exception Response Buffer: V400

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	584/984 Mode	40001–49999 (5 digit) or 400001–465535 (6 digit)
15 – Force Multiple Coils	484	1–999
15 – Force Multiple Coils	584/984 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

MRX Master Memory Address Ranges		
Operand Data Type		D2-260/D2-262 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 (see page 3-56)
Global Inputs	GX	0–3777
Global Outputs	GY	0–3777

Number of Elements		
Operand Data Type		D2-260/D2-262 Range
V–memory	V	All (see page 3-56)
Constant	K	Bits:1–2000 Registers: 1-125

MWX Number of Elements

Exception Response Buffer		
Operand Data Type		**D2-260/D2-262 Range**
V–memory	V	All (see page 3-56)

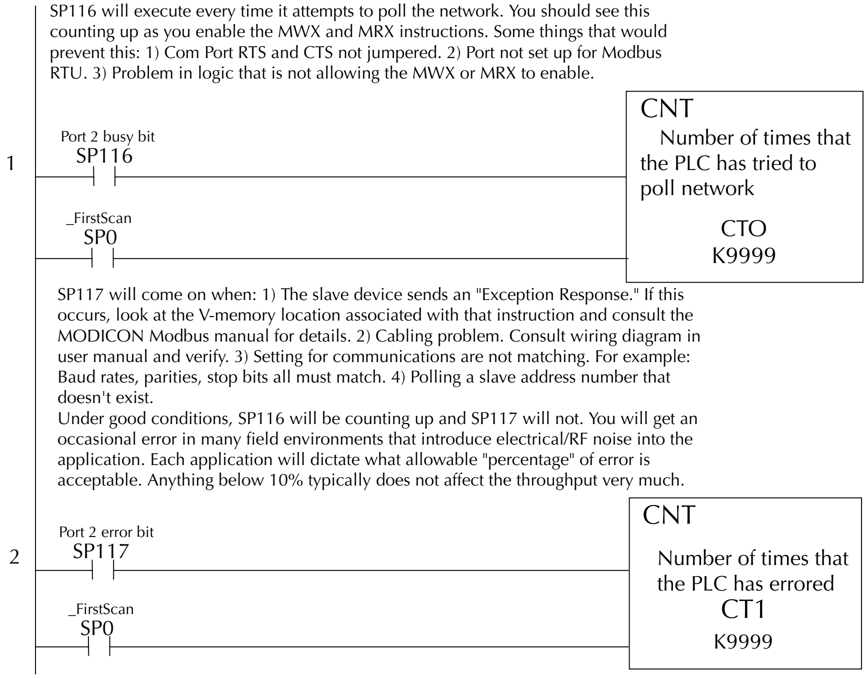
MWX Exception Response Buffer

MRX/MWX Example in DirectSOFT

D2-260 and D2-262 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 one CPU scan. The program must wait for the communications to finish before starting the next transaction.

Multiple Read and Write Interlocks

If you are using multiple reads and writes in the RLL program, you need 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, rungs 3 and 4 show that C100 will get set after the RX instruction has been executed. When the port has finished the communication task, the second routine is executed and C100 is reset. If you’re using RLLPLUS 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.



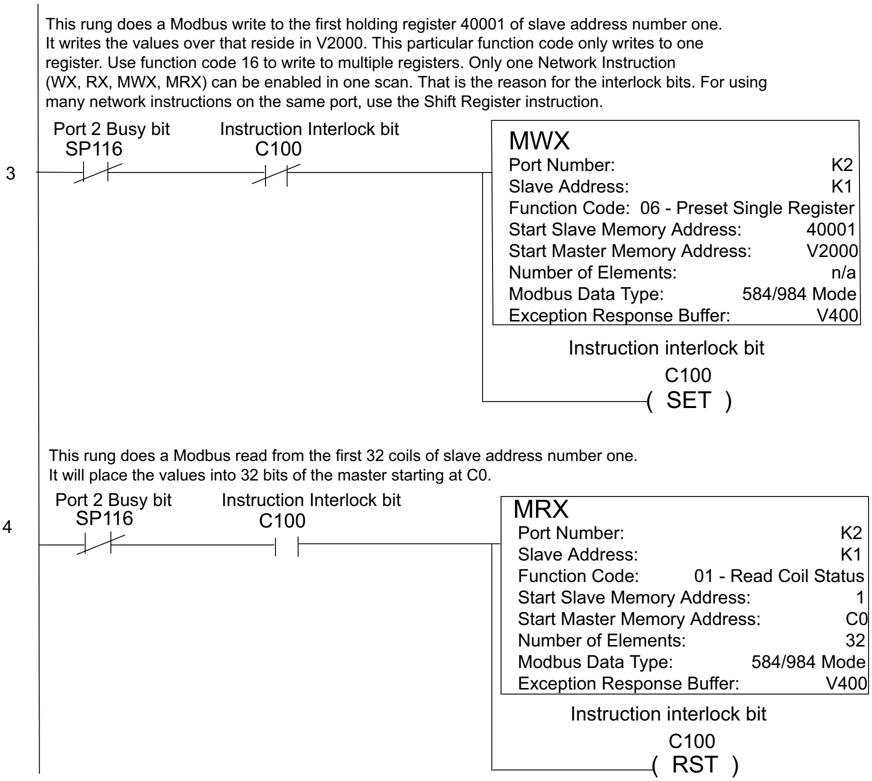
SP116 will execute every time it attempts to poll the network. You should see this counting up as you enable the MWX and MRX instructions. Some things that would prevent this: 1) Com Port RTS and CTS not jumpered. 2) Port not set up for Modbus RTU. 3) Problem in logic that is not allowing the MWX or MRX to enable.

SP117 will come on when: 1) The slave device sends an "Exception Response." If this occurs, look at the V-memory location associated with that instruction and consult the MODICON Modbus manual for details. 2) Cabling problem. Consult wiring diagram in user manual and verify. 3) Setting for communications are not matching. For example: Baud rates, parities, stop bits all must match. 4) Polling a slave address number that doesn't exist.

Under good conditions, SP116 will be counting up and SP117 will not. You will get an occasional error in many field environments that introduce electrical/RF noise into the application. Each application will dictate what allowable "percentage" of error is acceptable. Anything below 10% typically does not affect the throughput very much.

(Ladder continued on next page.)

Continued from previous page.



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.

MWX

Port Number:	K2
Slave Address:	K1
Function Code:	06 - Preset Single Register
Start Slave Memory Address:	40001
Start Master Memory Address:	V2000
Number of Elements:	n/a
Modbus Data Type:	584/984 Mode
Exception Response Buffer:	V400

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.

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

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

Configure the D2-260 and D2-262 CPUs for Non-Sequence

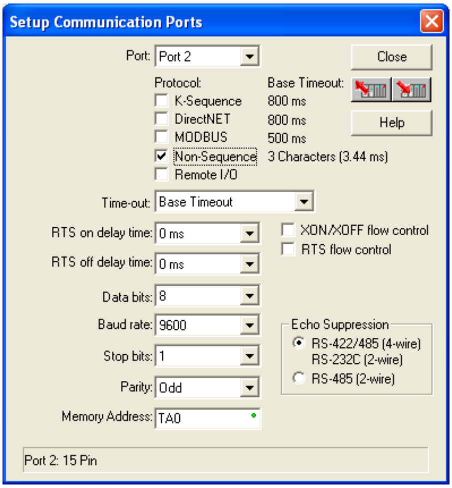
☒ 230
☒ 240
☒ 250-1
☑ 260
☑ 262

Configuring port 2 on the D2-260 and D2-262 CPUs for Non–Sequence allows the CPUs 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 DirectSOFT, choose the PLC menu, then “Setup Secondary Comm Port.”

Port: From the port number list box at the top, choose “Port 2.”

Protocol: Click the check box to the left of “Non–Sequence.”



Setup Communication Ports

Port: Port 2

Protocol: Base Timeout:
☐ K-Sequence 800 ms
☐ DirectNET 800 ms
☐ MODBUS 500 ms
☑ Non-Sequence 3 Characters (3.44 ms)
☐ Remote I/O

Time-out: Base Timeout
RTS on delay time: 0 ms
RTS off delay time: 0 ms
☐ XON/XOFF flow control
☐ RTS flow control
Data bits: 8
Baud rate: 9600
Stop bits: 1
Parity: Odd

Echo Suppression
● RS-422/485 (4-wire) RS-232C (2-wire)
○ RS-485 (2-wire)

Memory Address: TA0

Port 2: 15 Pin

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.

Memory Address: Starting V-memory address for ASCII In data storage. This location is the start of protocol memory buffer. It should not be used for other purposes.

- Buffer size = 2 + (Max receiving data size / 2), or to allocate the maximum allowable space, buffer size = 66 Words (for example V2000-V2102).

XON/XOFF Flow Control: When this function is enabled, the PLC will send data (PRINT command) until it receives a XOFF (0x13) Pause transmission command. It will continue to wait until it then sees a XON (0x11) Resume transmission command. This selection is only available when the “Non-Sequence(ASCII)” option has been selected and only functions when the PLC is sending data (not receiving with AIN command).

RTS Flow Control: When this function is enabled, the PLC will assert the RTS signal(s) of the port and wait to see the CTS signal(s) go true before sending data (PRINT command). This selection is only available when the “Non-Sequence(ASCII)” option has been selected and only functions when the PLC is sending data (not receiving with AIN command).

Echo Suppression: Select the appropriate radio button based on the wiring configuration used on port 2.

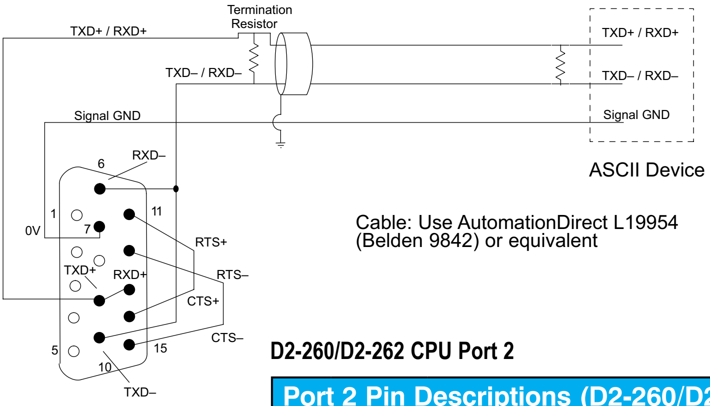
Then click the button indicated to send the Port configuration to the CPU, and click Close.

RS–485 Network

RS–485 signals are for long distances (1000 meters maximum). Use termination resistors at both ends of RS–485 network wiring, matching the impedance rating of the cable (between 100 and 500 ohms).

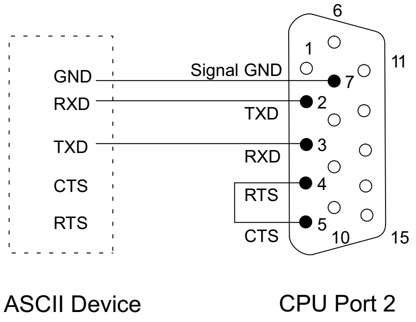
RS–232 Network

RS–232 signals are used for shorter distances (15 meters maximum) and limited to communications between two devices.



Cable: Use AutomationDirect L19954 (Belden 9842) or equivalent

D2-260/D2-262 CPU Port 2



Port 2 Pin Descriptions (D2-260/D2-262 only)		
1	5V	5 VDC
2	TXD2	Transmit Data (RS-232)
3	RXD2	Receive Data (RS-232)
4	RTS2	Ready to Send (RS–232)
5	CTS2	Clear to Send (RS–232)
6	RXD2–	Receive Data – (RS–422/RS-485)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422/RS–485)
10	TXD2 –	Transmit Data – (RS–422/RS–485)
11	RTS2 +	Request to Send + (RS–422/RS–485)
12	RTS2 –	Request to Send – (RS–422/RS–485)
13	RXD2 +	Receive Data + (RS–422/RS–485)
14	CTS2 +	Clear to Send + (RS-422/RS–485)
15	CTS2 –	Clear to Send – (RS–422/RS–485)

Configure the D2-250-1 Port 2 for Non-Sequence

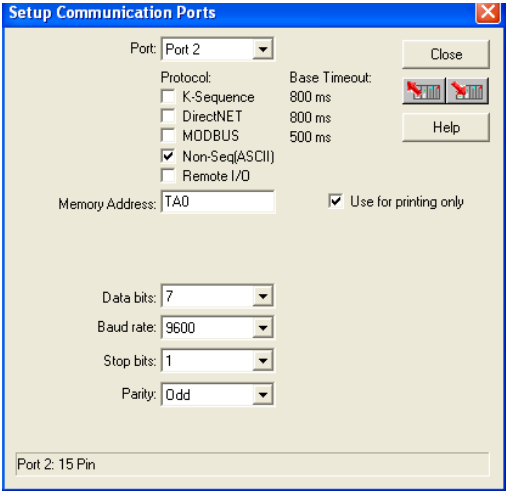
Configuring port 2 on the D2-250-1 for Non–Sequence enables the CPU to use the PRINT instruction to print embedded text or text/data variable message from port 2. See the PRINT instruction in chapter 5.

☒ 230
☒ 240
☑ **250-1**
☒ 260

In DirectSOFT, choose the PLC menu, then "Setup Secondary Comm Port."

Port: From the port number list box at the top, choose "Port 2."

Protocol: Click the check box to the left of "Non–Sequence."



Setup Communication Ports

Port: Port 2

Protocol: Base Timeout:
☐ K-Sequence 800 ms
☐ DirectNET 800 ms
☐ MODBUS 500 ms
☑ Non-Seq(ASCII)
☐ Remote I/O

Memory Address: TA0

☑ Use for printing only

Data bits: 7

Baud rate: 9600

Stop bits: 1

Parity: Odd

Port 2: 15 Pin

Memory Address: Choose a V-memory address to use as the starting location for the port set-up parameters listed below. This location is the start of protocol memory buffer. It should not be used for other purposes.
Buffer size = 2 + (Max receiving data size) / 2 or to allocate the maximum allowable space buffer size = 66 Words (for example V2000-V2102).

Use For Printing Only: Check the box to enable the port settings described below. Match the settings to the connected device.

Data Bits: Select either 7–bits or 8–bits to match the number of data bits specified for the connected device.

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 device.

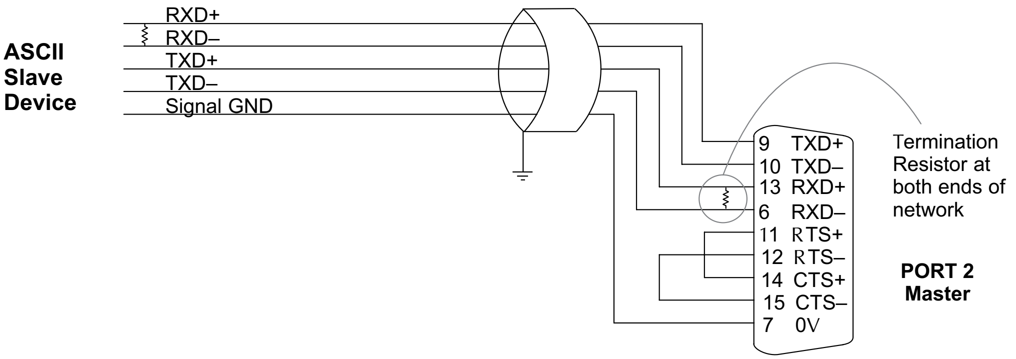
Parity: Choose none, even, or odd parity for error checking. Be sure to match the parity specified for the connected device.

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

RS–422 Network

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

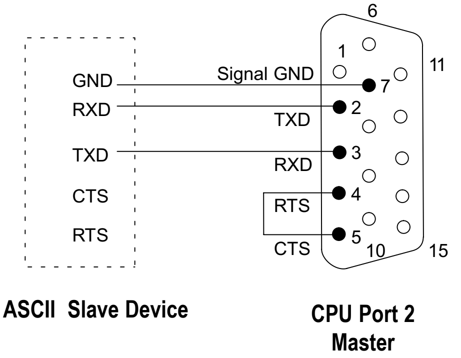
***NOTE:** For RS–422 cabling, we recommend AutomationDirect L19853 (Belden 8103) or equivalent.*



RS–232 Network

RS–232 signals are used for shorter distances (15 meters maximum) and limited to communications between two devices.

***NOTE:** For RS–232 cabling, we recommend AutomationDirect L19772 (Belden 8102) or equivalent.*



Port 2 Pin Descriptions (D2-260/D2-262 only)

1	5V	5 VDC
2	TXD2	Transmit Data (RS-232)
3	RXD2	Receive Data (RS-232)
4	RTS2	Ready to Send (RS–232)
5	CTS2	Clear to Send (RS–232)
6	RXD2–	Receive Data – (RS–422/RS-485)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422/RS–485)
10	TXD2 –	Transmit Data – (RS–422/RS–485)
11	RTS2 +	Request to Send + (RS–422/RS–485)
12	RTS2 –	Request to Send – (RS–422/RS–485)
13	RXD2 +	Receive Data + (RS–422/RS–485)
14	CTS2 +	Clear to Send + (RS-422/RS-485)
15	CTS2 –	Clear to Send – (RS–422/RS–485)