AUTOMATIONDIRECT.com

D0–DCM Data Communications Module

Manual Number D0–DCM–M

WARNING

Thank you for purchasing automation equipment from ***Automationdirect.com***™, doing business as, **AutomationDirect**. We want your new ***Direct***LOGIC™ automation equipment to operate safely. Anyone who installs or uses this equipment should read this publication (and any other relevant publications) before installing or operating the equipment.

To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and usually change with time. It is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

At a minimum, you should follow all applicable sections of the National Fire Code, National Electrical Code, and the codes of the National Electrical Manufacturer's Association (NEMA). There may be local regulatory or government offices that can also help determine which codes and standards are necessary for safe installation and operation.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

Our products are not fault–tolerant and are not designed, manufactured or intended for use or resale as on–line control equipment in hazardous environments requiring fail–safe performance, such as in the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines, or weapons systems, in which the failure of the product could lead directly to death, personal injury, or severe physical or environmental damage ("High Risk Activities"). **AutomationDirect** *specifically disclaims any expressed or implied warranty of fitness for High Risk Activities.*

For additional warranty and safety information, see the Terms and Conditions section of our Desk Reference. If you have any questions concerning the installation or operation of this equipment, or if you need additional information, please call us at 770–844–4200.

This publication is based on information that was available at the time it was printed. At **AutomationDirect** we constantly strive to improve our products and services, so we reserve the right to make changes to the products and/or publications at any time without notice and without any obligation. This publication may also discuss features that may not be available in certain revisions of the product.

Trademarks

This publication may contain references to products produced and/or offered by other companies. The product and company names may be trademarked and are the sole property of their respective owners. **AutomationDirect** disclaims any proprietary interest in the marks and names of others.

AVERTISSEMENT

Nous vous remercions d'avoir acheté l'équipement d'automatisation de **Automationdirect.com™**, en faisant des affaires comme, **AutomationDirect**. Nous tenons à ce que votre nouvel équipement d'automatisation ***Direct***LOGIC™ fonctionne en toute sécurité. Toute personne qui installe ou utilise cet équipement doit lire la présente publication (et toutes les autres publications pertinentes) avant de l'installer ou de l'utiliser.

Afin de réduire au minimum le risque d'éventuels problèmes de sécurité, vous devez respecter tous les codes locaux et nationaux applicables régissant l'installation et le fonctionnement de votre équipement. Ces codes diffèrent d'une région à l'autre et, habituellement, évoluent au fil du temps. Il vous incombe de déterminer les codes à respecter et de vous assurer que l'équipement, l'installation et le fonctionnement sont conformes aux exigences de la version la plus récente de ces codes.

Vous devez, à tout le moins, respecter toutes les sections applicables du Code national de prévention des incendies, du Code national de l'électricité et des codes de la National Electrical Manufacturer's Association (NEMA). Des organismes de réglementation ou des services gouvernementaux locaux peuvent également vous aider à déterminer les codes ainsi que les normes à respecter pour assurer une installation et un fonctionnement sûrs.

L'omission de respecter la totalité des codes et des normes applicables peut entraîner des dommages à l'équipement ou causer de graves blessures au personnel. Nous ne garantissons pas que les produits décrits dans cette publication conviennent à votre application particulière et nous n'assumons aucune responsabilité à l'égard de la conception, de l'installation ou du fonctionnement de votre produit.

Nos produits ne sont pas insensibles aux défaillances et ne sont ni conçus ni fabriqués pour l'utilisation ou la revente en tant qu'équipement de commande en ligne dans des environnements dangereux nécessitant une sécurité absolue, par exemple, l'exploitation d'installations nucléaires, les systèmes de navigation aérienne ou de communication, le contrôle de la circulation aérienne, les équipements de survie ou les systèmes d'armes, pour lesquels la défaillance du produit peut provoquer la mort, des blessures corporelles ou de graves dommages matériels ou environnementaux ("activités à risque élevé"). La société **AutomationDirect** nie toute garantie expresse ou implicite d'aptitude à l'emploi en ce qui a trait aux activités à risque élevé.

Pour des renseignements additionnels touchant la garantie et la sécurité, veuillez consulter la section Modalités et conditions de notre documentation. Si vous avez des questions au sujet de l'installation ou du fonctionnement de cet équipement, ou encore si vous avez besoin de renseignements supplémentaires, n'hésitez pas à nous téléphoner au 770–844–4200.

Cette publication s'appuie sur l'information qui était disponible au moment de l'impression. À la société **AutomationDirect**, nous nous efforçons constamment d'améliorer nos produits et services. C'est pourquoi nous nous réservons le droit d'apporter des modifications aux produits ou aux publications en tout temps, sans préavis ni quelque obligation que ce soit. La présente publication peut aussi porter sur des caractéristiques susceptibles de ne pas être offertes dans certaines versions révisées du produit.

Marques de commerce

La présente publication peut contenir des références à des produits fabriqués ou offerts par d'autres entreprises. Les désignations des produits et des entreprises peuvent être des marques de commerce et appartiennent exclusivement à leurs propriétaires respectifs. **AutomationDirect™** nie tout intérêt dans les autres marques et désignations.

Manual Revisions

If you contact us in reference to this manual, please remember to include the revision number.

Title: DL05/06 Data Communications Module
Manual Number: D0–DCM–M

Issue	Date	Description of Changes
Original	8/05	Original Issue

Table of Contents

Chapter 1: Introduction

Chapter 2: Installation, Network Cabling and Module Specifications

Chapter 3: D0–DCM Module Configuration Registers

Chapter 4: RLL Programming for Communications

Chapter 5: D0–DCM Using MODBUS® RTU

1

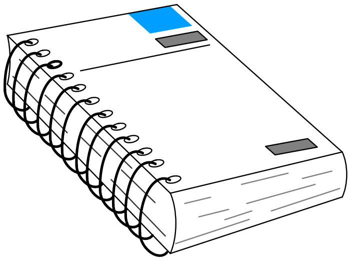
Introduction

In This Chapter. . . .

Manual Overview

The Purpose of this Manual

This manual is designed to allow you to setup and install your DL05/06 Data Communications Module (D0–DCM). This is the only manual you will need if you are using the D0–DCM as an extra general purpose communication port for your DL05/06 PLC system. If you plan on using the D0–DCM as a network master or slave for a ***Direct***NET/MODBUS RTU network, this manual covers the basic steps for setting up the D0–DCM and the RX/WX instructions needed in your RLL program.



If you plan on using a PC as the network master, it may be helpful to read the ***Direct***NET manual first. In either case, the ***Direct***NET manual can be useful because it provides detailed descriptions of network configurations, various cable connections, etc.

Supplemental Manuals

Depending on which products you have purchased, there may be other manuals that are necessary or helpful for your application. These are some suggested manuals:

User Manuals

• ***Direct***NET Network Guide	part number	DA–DNET–M
• ***Direct***Soft32 Programming Software	part number	PC–DSOFT32–M

If you plan to use your D0–DCM to communicate with another PLC, you will need the appropriate user manual for the other PLC.

If you plan to use your D0–DCM module as an interface to HMI or PC Control software or to an Operator Interface panel, you will need to refer to the documentation for that product.

Who Should Read this Manual

If you need an additional communications port for your DL05/06 PLC and you understand the basics of installing and programming PLCs, this is the right manual for you. This manual gives you the information you need to set up an active port on the D0–DCM module.

Technical Support

We strive to make our manuals the best in the industry and rely on your feedback in reaching our goal. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call us at

770–844–4200.

Our technical support team is glad to work with you in answering your questions. They are available **weekdays from 9:00 a.m. to 6:00 p.m. Eastern Time**. We also encourage you to visit our website where you can find technical and nontechnical information about our products and our company.

www.automationdirect.com

Conventions Used

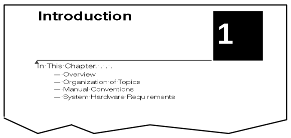
The “light bulb” icon in the left-hand margin indicates a **tip** or **shortcut**.

The “note pad” icon in the left–hand margin indicates a **special note**.

The “exclamation mark” icon in the left-hand margin indicates a **warning** or **caution**. These are very important because the information may help you prevent serious personal injury or equipment damage.

Key Topics for Each Chapter

The beginning of each chapter will list the key topics that can be found in that chapter.



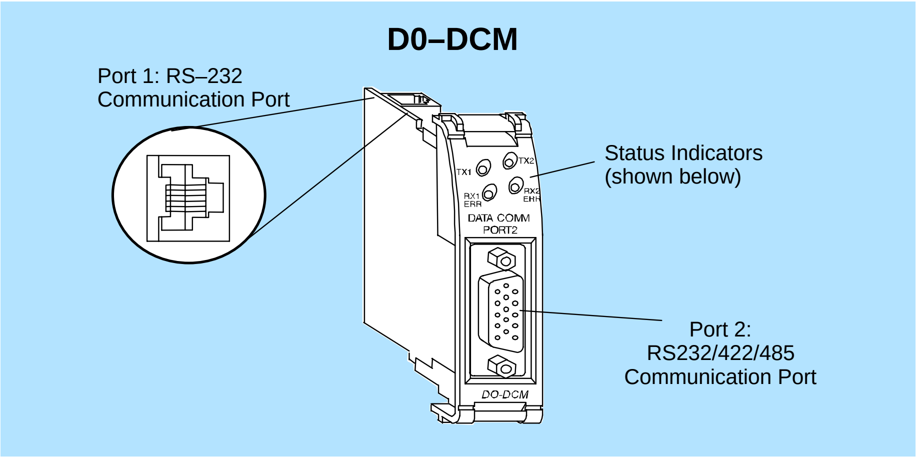
Introduction 1

In This Chapter. . . .
— Overview
— Organization of Topics
— Manual Conventions
— System Hardware Requirements

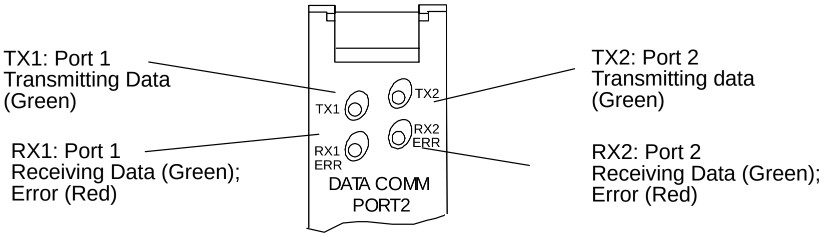
D0–DCM Hardware Features

The following diagram shows the D0–DCM hardware components. The communication parameters are configured using ***Direct***SOFT32. There are no DIP switches to set on this module.

The D0–DCM requires ladder logic programming to configure its communication parameters, unless the default settings are acceptable for the application. If the D0–DCM is to be used as a network master, you must use ladder logic code to configure this parameter.



Status Indicators



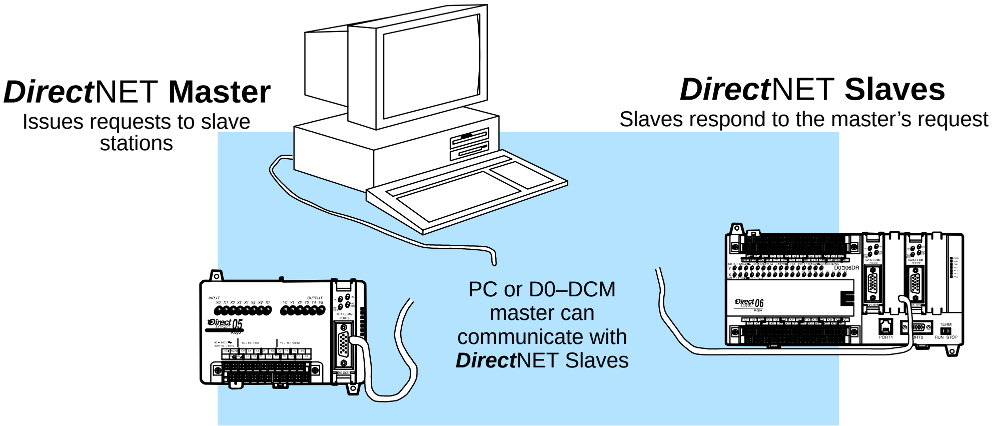
The D0–DCM Data Communications Module is a general purpose communications interface that can be used in a DL05/06 PLC system. The module can go in any option slot. This module is primarily used for several reasons:

- As an extra general purpose communications port to connect to a personal computer or operator interface
- As a network master or slave interface to a ***Direct***NET network (port 2); port 1 functions as a ***Direct***NET slave only
- As a network master or slave interface to a MODBUS® RTU network (port 2); port 1 functions as a MODBUS® RTU slave only
- As a K–sequence slave (both ports)

Applications

As a *Direct*NET Interface

The D0–DCM can be used as a network interface for applications that require data to be shared between PLCs, or between PLCs and an intelligent device (such as a host computer). The D0–DCM can be configured as either a master or slave station and allows you to upload or download virtually any type of system data including Timer/Counter data, I/O information, and V-memory information.


*Direct*NET **Master**
Issues requests to slave stations
*Direct*NET **Slaves**
Slaves respond to the master’s request
PC or D0–DCM master can communicate with ***Direct***NET Slaves

Using a D0–DCM as a network Master

The D0–DCM can be used with a DL05 or DL06 CPU to serve as a network master. A master is the network station that *initiates* requests for data from other stations on the network). You simply use special RLL instructions (RX and WX) inside of your RLL program to initiate the data exchange. The D0–DCM takes communication requests issued by the PLC program instructions and automatically converts these requests into network commands that read data from or write data to another network station.

Possible Slaves

- DL05/DL06 CPU (either port)
- DL05/DL06 CPU w/D0–DCM
- D2–240/250–1/260 CPU (either port)
- D2–240/250–1/260 w/ D2–DCM
- D3–330/330P w/ DCU
- D3–340/350 (either port)
- D4–430/440 (bottom port)
- D4–450 (phone jack or bottom port)
- Any DL405 CPU w/ D4–DCM

Using a D0–DCM as a network Slave

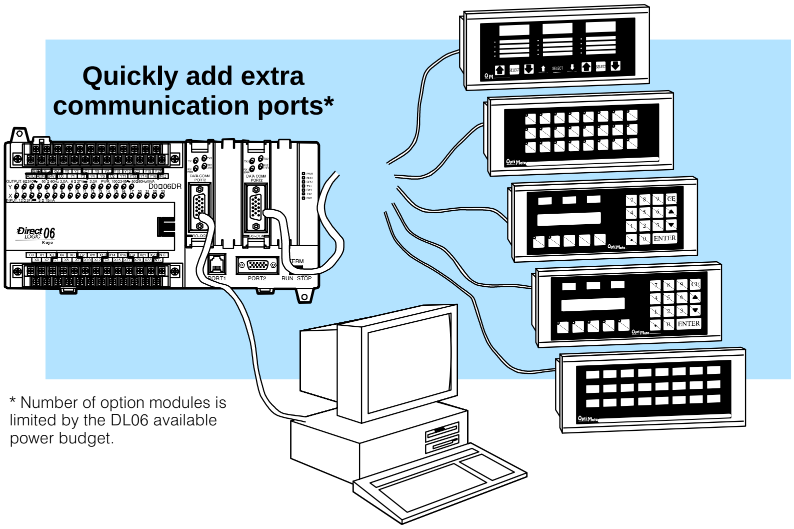
The D0–DCM can also be used with a DL05 or DL06 CPU to serve as a network slave station. In this case, the D0–DCM “listens” to the network for any messages that contain the D0–DCM’s address. The D0–DCM deciphers the network commands, carries out the request to read or write data, and sends confirmation and/or information to the master station.

Possible Masters

- DL05/06 CPU (port 2)
- DL05/06 CPU w/ D0–DCM
- 250–1/260 CPU (bottom port)
- D2–240/250–1/260 CPU w/ D2–DCM
- D3–340/350 CPU (bottom port)
- Any DL405 CPU w/ D4–DCM
- D4–450 CPU (bottom port)
- Host computer w/KEPDirect for PLCs

As an Extra Communication Port

The D0–DCM ports are similiar to the ports on the DL05 and DL06 CPUs. In general, if you can connect a device to the CPU ports, then you can also connect the same device to the D0–DCM. These devices can be a variety of things, such as operator interfaces or personal computers.



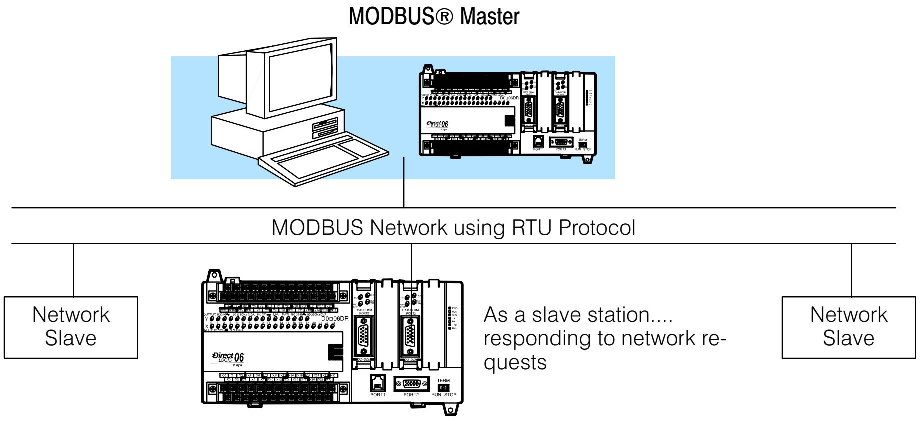
Quickly add extra communication ports*

* Number of option modules is limited by the DL06 available power budget.

As a MODBUS□RTU Network Interface

The D0–DCM can be used as a master or slave interface to connect your DL05/06 system to a MODBUS RTU network. Port 1 can only serve as a MODBUS RTU slave. Port 2 can serve as a MODBUS RTU master or slave. This manual does not describe the MODBUS protocol. We recommend that you reference the Gould MODBUS Protocol Reference Guide (P1-MBUS-300 Rev. B) for details on the protocol. There may be more recent editions of this manual, so check with your MODBUS supplier before ordering the documentation.

For information about the MODBUS protocol see the Group Schneider Web site at: www.schneiderautomation.com. At the main menu, select Support/Services, Modbus, Modbus Technical Manuals, PI–MBUS–300 Modbus Protocol Reference Guide or search for PIMBUS300.



MODBUS® Master

MODBUS Network using RTU Protocol

Network Slave

As a slave station.... responding to network requests

Network Slave

DL06 Slave with D0–DCM

2

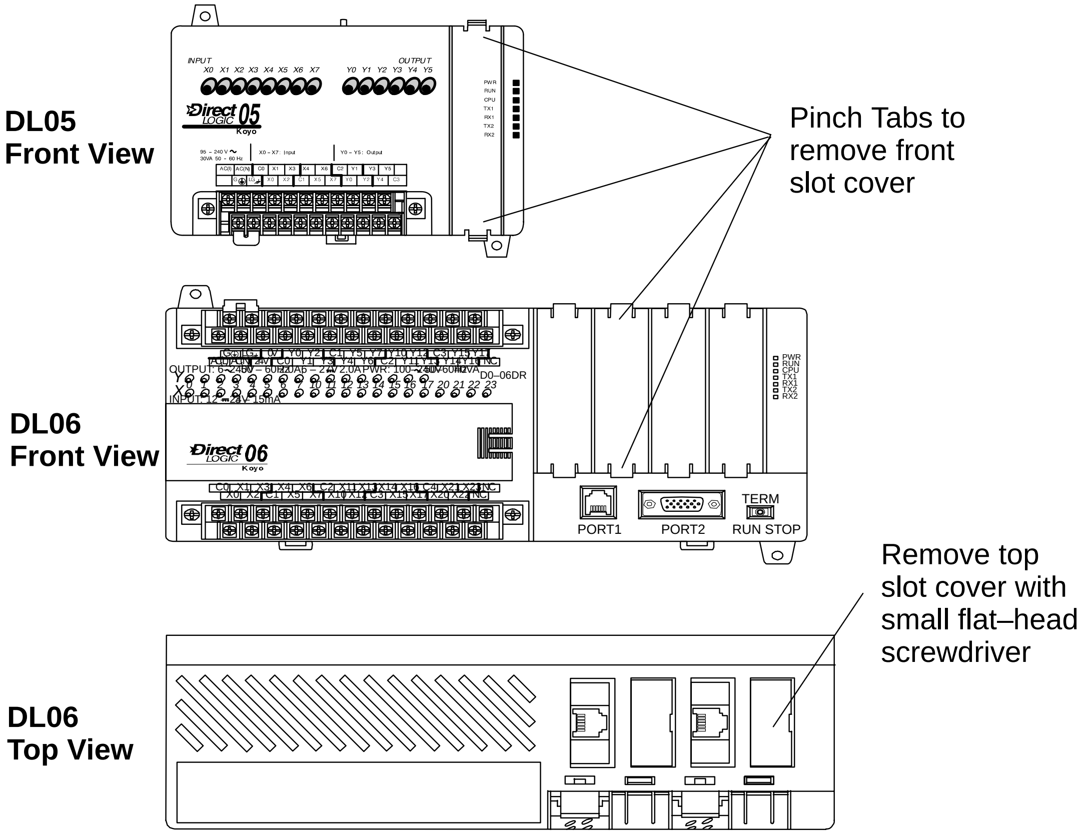
Installation, Network Cabling and Module Specifications

In This Chapter. . . .

Inserting the D0–DCM into the PLC

D0–DCM Module Installation

Remove the front protective option slot cover by squeezing the pinch tabs and lifting the cover off. Remove the top option slot cover using small flat–head screwdriver or similiar device. Be sure PLC power is off when installing the D0–DCM module.



Insert the module into the open slot in the DL05 or into any one of the four slots in the DL06. Locate the module so the printed information is oriented in the same direction as the markings on the PLC. Be careful to align the female connector on the printed circuit board of the module with the male connector on the PLC mother board. Press the module into the slot until the front of the module is flush with the front of the PLC. Check the DL06 power budget to be sure that it remains within the power supply limits before installing more modules.

NOTE: The DL05 CPU’s communication feature for the D0–DCM requires ***Direct***SOFT32 Version 3.0c (or later) and firmware version 5.00 (or later). The DL06 requires ***Direct***SOFT32 version V4.0, build 16 (or later) and firmware version 1.90 (or later). See our website for more information: **www.automationdirect.com**.

Building the Communication Cable

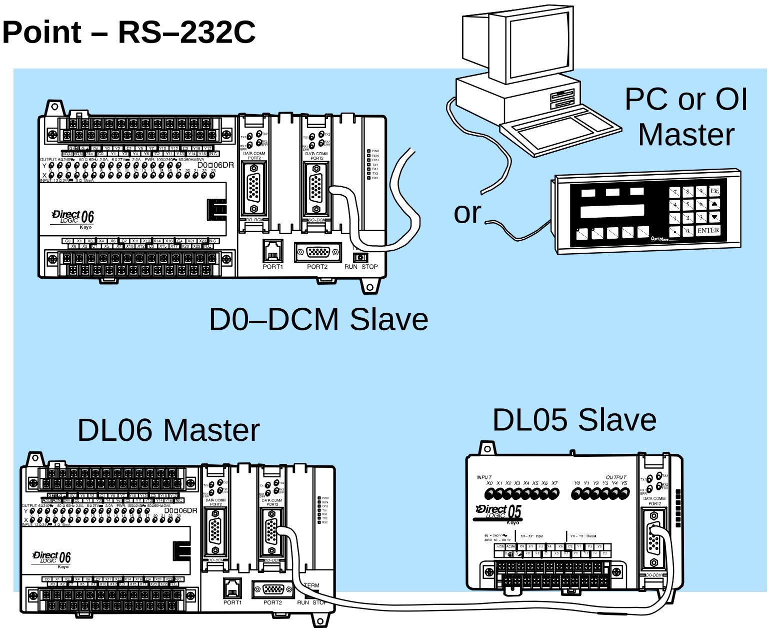
There are several considerations that help determine the type of cable needed for your D0–DCM application. The next few pages discuss these considerations in detail.

Consideration 1: Physical Configuration

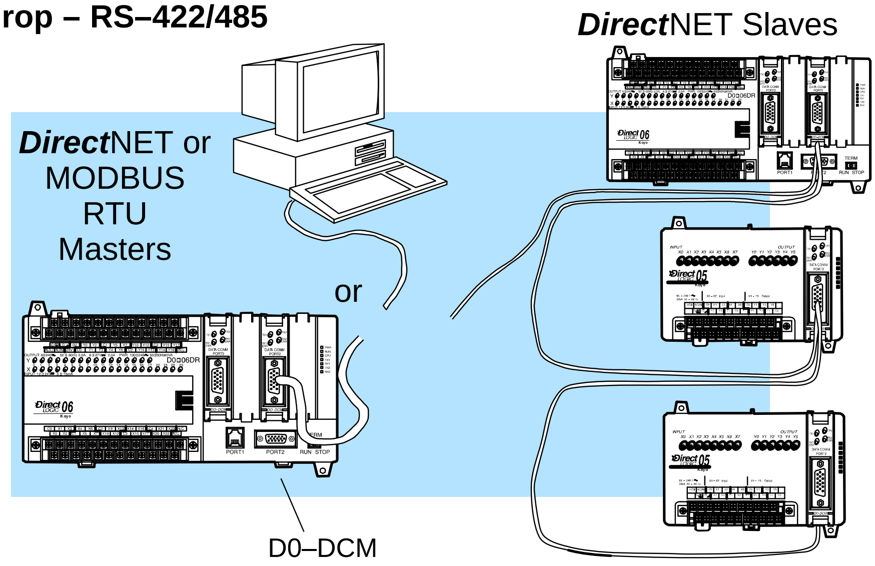
The D0–DCM can be used in either a point-to-point or multi-drop configuration. A point-to-point connection only has two stations, a master and a slave. Use the point-to-point configuration to connect a personal computer, an operator interface, or an intelligent device to a single D0–DCM. You must also use this configuration when you want to connect a ***Direct***NET master station to a single ***Direct***NET slave station.

Use the multi-drop configuration to connect one master to two or more slaves (90 slave maximum).

Point to Point – RS–232C



Multi-drop – RS–422/485



Consideration 2: Electrical Specification RS232C or RS422/485

The D0–DCM can support RS–232 (ports 1 and 2) or RS–422/485 (port 2) communication. Your application and configuration choice will help determine which electrical specification is best for you. If you are using multi-drop, you must use RS–422 or RS–485. If you are using point-to-point, you may have a choice between RS–232C and RS–422/485.

You can use RS–232 if the cable length is less than 50 feet and if the cable will not be subjected to induced electrical noise that is commonly found near welders, large motors, or other devices that create large magnetic fields.

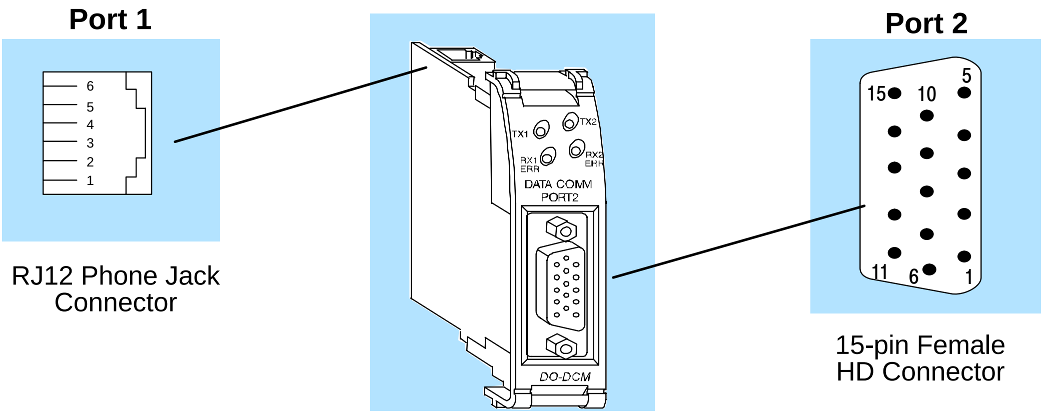
You must use RS–422/485 for all other applications. RS–422/485 allows longer cable distances (up to 3300 feet) and provides higher noise immunity.

Consideration 3: Cable Schematics

Although the network configuration and electrical specification are important, the type of devices being connected to the D0–DCM are just as important. The exact cable schematic needed really depends on a combination of all three things.

The following diagram shows the port pinouts for the D0–DCM.

D0–DCM Pinouts



Port 1 Pin Descriptions		
1	0V	
2	5V	
3	RXD	Receive Data (RS–232)
4	TXD	Transmit Data (RS–232)
5	RTS	Request to Send
6	0V	

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

Consideration 4: Cable Specifications

Although many types of cables may work for your application, we recommend you use a cable that is constructed to offer a high degree of noise immunity. The following specifications are to be used as a guideline.

Structure	Shielded, twisted-pair (RS232 only uses two wires and a ground)
Conductor size	24 AWG or larger
Insulation	Polyethylene
Shield	Copper braid or aluminum foil
Impedance	100Ω @ 1MHz
Capacitance	60pf / meter or less

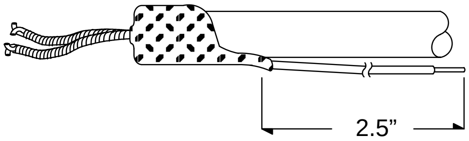
Consideration 5: Installation Guidelines

Your company may have guidelines for cable installation. If so, you must check those before you begin the installation. Here are some general things to consider.

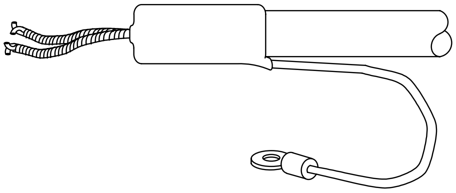
- Don’t run cable next to larger motors, high current switches, or transformers. This may cause noise problems.
- Route the cable through an approved cable housing to minimize the risk of accidental cable damage. Check local and national codes to choose the correct method for your application.
- Consider redundant cabling if the application data is critical. This allows you to quickly reconnect all stations while the primary cable is being repaired.

Cable Shield Grounding — It is important to ground the cable shield to minimize the possibility of noise. The preferred method is to connect one end of the cable shield to the connector housing. If noise problems are still present and you have a good earth ground for the cabinet, you must connect one end of the shield to the cabinet earth ground. *Don’t* ground both ends of the shield because this will create induced noise on the cable.

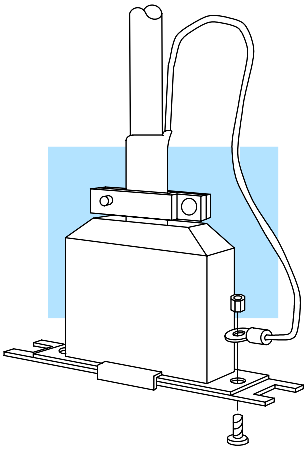
Step 1: Strip back about 2.5” of the shield.



Step 2: Crimp a ring connector onto the shield.

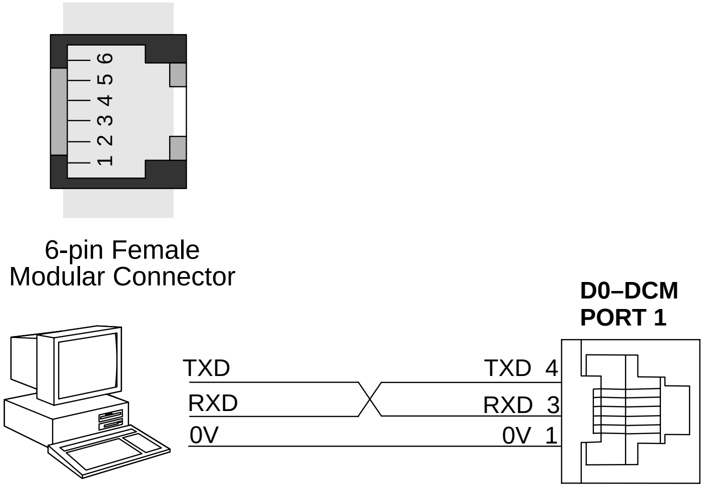


Step 3: Secure the shield to the connector shell.

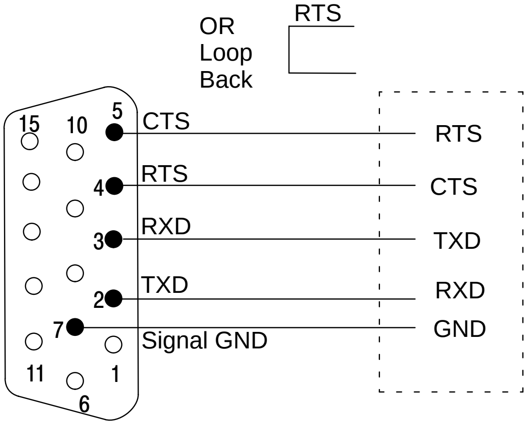


Wiring Diagrams

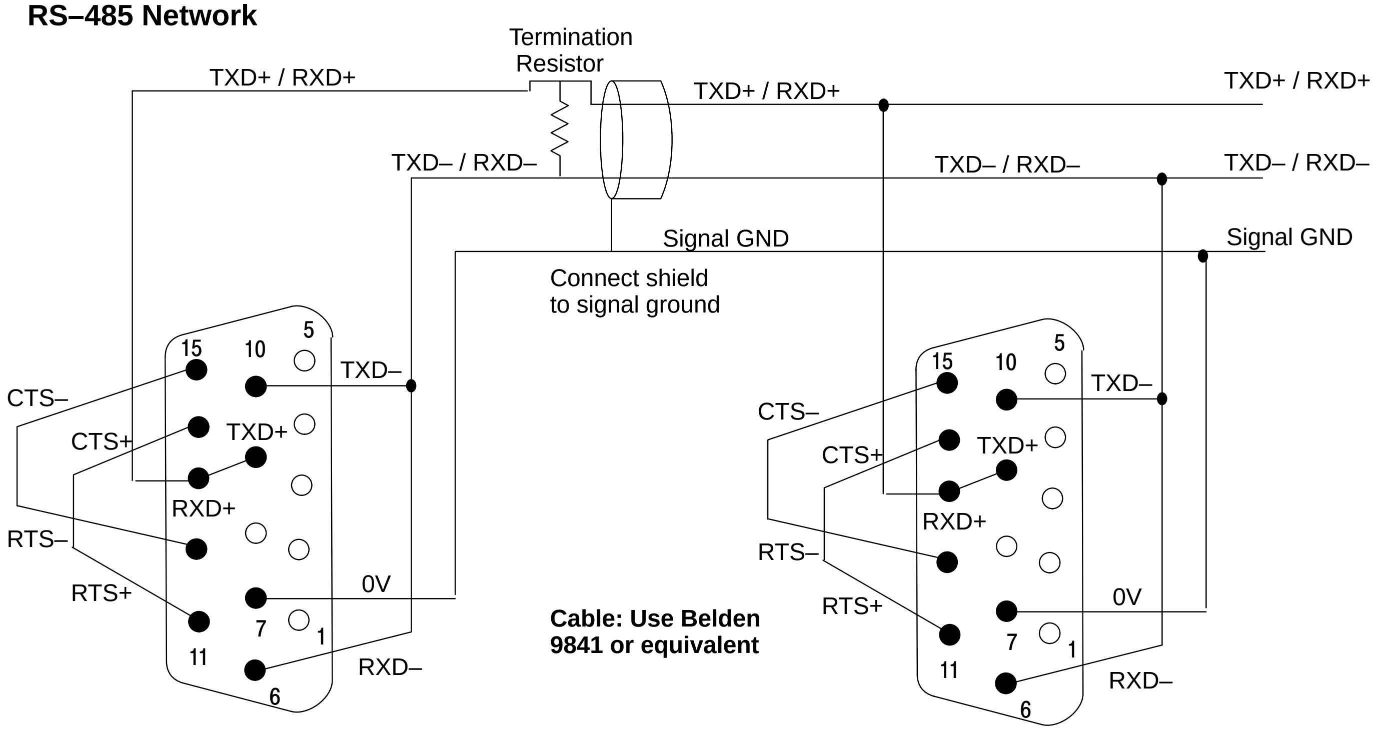
D0–DCM Port 1
RS–232 Network



D0–DCM Port 2
RS–232 Network

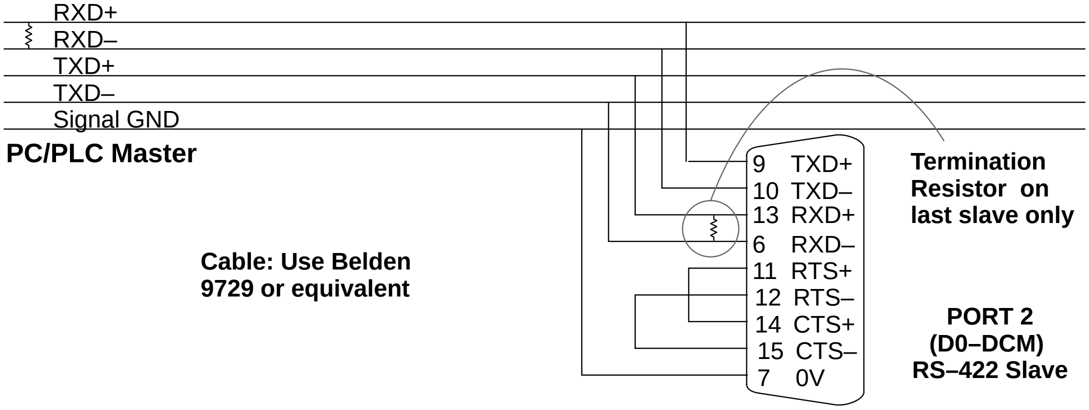


D0–DCM Port 2
RS–485 Network



Cable: Use Belden 9841 or equivalent

D0–DCM Port 2 RS–422 Network


RXD+
RXD–
TXD+
TXD–
Signal GND
PC/PLC Master
Cable: Use Belden 9729 or equivalent
9 TXD+
10 TXD–
13 RXD+
6 RXD–
11 RTS+
12 RTS–
14 CTS+
15 CTS–
7 0V
Termination Resistor on last slave only
PORT 2 (D0–DCM) RS–422 Slave

RS–422/485 Multi-drop Termination Resistors — It is important you add termination resistors at each end of the RS422/485 line. This helps reduce data errors during data transmission. You must select resistors that match the cable impedance. For example, a typical 22 AWG solid conductor cable with 4.5 twists per foot has a typical impedance of about 120 ohm.

There are two ways to actually connect the resistors.

- Line-to-Line — this method balances the receive data lines (IN+ and IN–) and requires one resistor at each end of the line. (The cable diagrams we've provided show this method, but you can use either).
- Line-to-Ground — this method also balances the receive data lines, but common mode noise rejection is improved significantly. This method requires two resistors at each end of the line. Also, since there are two resistors, the sum total of both resistors must match the cable impedance.

Module Specifications

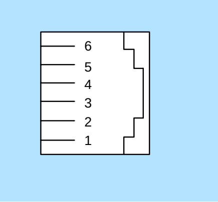
General Specifications

Power Budget Requirement	250mA @ 5 VDC (not including external 5VDC consumption)
Maximum Number of Modules	DL05: 1; DL06: 4
Operating Temperature	32° F to 131° F (0° to 55° C)
Storage Temperature	–4° F to 158° F (–20° to 80° C)
Operating Humidity	5 to 95% (non-condensing)
Air Composition	No corrosive gases permitted
Vibration	MIL STD 810C, Method 514.2
Shock	MIL STD 810C, Method 516.2
Voltage Isolation	1000 VAC, 1 minute duration
Insulation Resistance	10M ohms at 500 VDC
Noise Immunity	NEMA ICS3–304, UL, CE, (FCC Class A) Class 1, Division 2 (C1D2)
Weight	1.75 oz. (50g)

Port 1 Specifications

Connector	6–pin female modular (RJ12)
Communications	RS–232
Protocol (auto–dectection)	***Direct***NET slave K-sequence slave MODBUS® RTU slave
Station Number	0 – 247
Communication Data	8 data bits, 1 start bit, 1 stop bit (fixed)
Parity Bit	None, Odd
Baud Rates	9600, 19200, 38400, 57600, 115200 bps
Transmit Mode	ASCII, Hex
Maximum Distance	RS–232: 50ft (15 meters)

Port 1

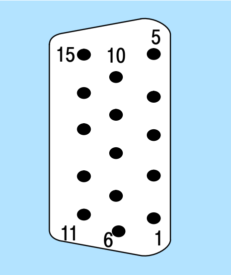


Port 1 Pin Descriptions		
1	0V	
2	5V	
3	RXD	Receive Data (RS–232)
4	TXD	Transmit Data (RS–232)
5	RTS	Request to Send
6	0V	

Port 2 Specifications

Connector	15–pin female high–density D–shell
Communications	RS–232 RS–422/485
Protocol (auto–dectection)	***Direct***NET master/slave K-Sequence slave MODBUS® RTU master/slave Non–sequence (ASCII IN/OUT)
Station Number	0 – 247
Communication Data	8/7 data bits, 1 start bit, 1/2 stop bits
Parity Bit	None, Odd, Even
Baud Rates	300, 600, 1200, 4800, 9600, 19200, 38400, 57600, 115200 bps
Transmit Mode	ASCII, Hex
Communications Time–out	Base time x (1–50)
Response Delay Time	0/2/5/10/20/50/100/500ms
Character Time–out	0–9999ms
Maximum Distance	RS232 – 15 m RS422/485 – 1000m

Port 2



Port 2 Pin Descriptions		
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–422/485)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422/485)
10	TXD2 –	Transmit Data – (RS–422/485)
11	RTS2 +	Request to Send + (RS–422/485)
12	RTS2 –	Request to Send – (RS–422/485
13	RXD2 +	Receive Data + (RS–422/485)
14	CTS2 +	Clear to Send + (RS422/485)
15	CTS2 –	Clear to Send – (RS–422/485)

Status Indicators

Indicator	State	Definition
TX1 (Green)	ON	Port 1 transmitting data
RX1 (Green) ERR (Red)	ON ON	Port 1 receiving data Port 1 Timeout, NAK or Exception Response
TX2 (Green)	ON	Port 2 transmitting data
RX2 (Green) ERR (Red)	ON ON	Port 2 receiving data Port 2 Timeout, NAK or Exception Response

3

D0–DCM Module Configuration Registers

In This Chapter. . . .

DCM Port Configuration Registers

Module Configuration Registers

The table below lists the special V-memory locations used by the DL05 and DL06 PLCs for the D0–DCM module. The following pages define each registers function.

Module Configuration Parameters		DL05 and DL06 Option Slot					
		Word Offset	DL05	DL06 Slot 1	DL06 Slot 2	DL06 Slot 3	DL06 Slot 4
A	**Port 1**–Transmit Mode (ASCII/Hex), Protocol	+0000	V7700	V700	V710	V720	V730
B	**Port 1**–Station Address, Baud Rate , Parity	+0001	V7701	V701	V711	V721	V731
C	**Port 2**–RTS On/Off Delay, Transmit Mode (ASCII/ Hex), Protocol, Comm Time–out, RS–485 Mode Select	+0002	V7702	V702	V712	V722	V732
D	**Port 2**–Station Address, Baud Rate, Data Bit , Stop Bit , Parity	+0003	V7703	V703	V713	V723	V733
E	**Port 2**–Character Time–out	+0006	V7706	V706	V716	V726	V736
F	**Port1/Port 2** – Setup Completion Code	+0007	V7707	V707	V717	V727	V737
G	**Port 1/Port 2**– Reset Time–out		V7730	V7730	V7731	V7732	V7733

Comm Port Default Configuration Parameters

On power up, the DCM will write the necessary data to the V–memory configuration registers to result with the following default port communications parameters. If you need to change any of the default settings, you must use ladder logic code to update the appropriate configuration register.

Default Settings		
Parameter	Port 1	Port 2
Baud Rate	9600bps	19200bps
Parity	Odd	
Protocol	K–Sequence/DirectNet/MODBUS (auto–detect)	
Station Address	1	
Data Bits	8 (fixed)	8
Stop Bits	1 (fixed)	1

Protocol Selection:

*Communications Port for **Direct**SOFT32 Programming:* If you plan to program the CPU through the D0–DCM, then you can use either ***Direct***NET protocol or our proprietary K-sequence protocol.

Computer or Operator Interface: If you're using the D0–DCM to connect a computer or operator interface, check your documentation to see which protocol the PC or OI is using.

MODBUS® RTU: The D0–DCM can serve as a MODBUS® slave (port1 and 2) or as a MODBUS▯master (port 2 only).

Communication Timeout: Communication Timeout Disable is normally used *only* if you're developing your own ***Direct***NET programs. By disabling the timeout, you can send one ***Direct***NET component without any communication timeout problems. If you have this timeout disabled and a communication error does occur, you must restart communications by sending a retry or an End of Transmission (EOT) command. If you want to know more, see the ***Direct***NET manual for details.

Transmit Mode: Select between ASCII and HEX modes of data representation. If you want the fastest communication possible, use HEX mode, which is the default. The difference is in the way the data is represented. The same data is twice as long in ASCII format, so if there's more data, it takes longer to transfer. If you have a device on the network that requires ASCII mode, then configure the DCM for ASCII mode, otherwise, use HEX mode.

Baud Rate: There are several baud rate selections available ranging from 300bps to 115.2Kbps. **All stations must have the same baud rate before the communications will operate correctly.** Usually, you should use the highest baud rate possible unless noise problems appear. If noise problems appear, try reducing the baud rates.

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

RTS Delay Times: On Delay – The delay time specifies the amount of time the D0–DCM waits to send the data after it has raised the RTS signal line. This is normally set to 0, and is typically only adjusted if you are using the D0–DCM with a radio modem. If you are using the D0–DCM with a radio modem, check your modem documentation to help you choose the proper setting. Also, if you're considering the use of a modem, check out Appendix D. It may be of some help. RTS Off Delay – the delay time specifies the amount of time the D0–DCM will wait to reset the RTS line after sending the data.

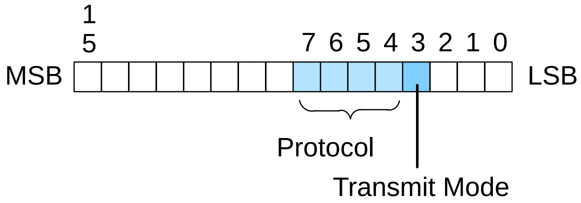
Address Selection: The addresses do not have to be consecutive, but each station must have a unique address. If you're using the D0–DCM as a master, make sure you select address 0. For example, a RLL communications program, the ***Direct***SOFT32 Programming Software, and our KEPDirect for PLCs all use the decimal equivalent of the HEX address. It's easy to convert from hex to decimal.

A: Port 1 – Transmit Mode, Protocol

Use word +0000 to set Port 1:

- K–Sequence slave, ***Direct***NET slave or MODBUS RTU slave protocol (or auto–detect for all three protocols)
- HEX or ASCII transmit mode

word +0000



Set all unused bits to zero.

Port 1: Transmit Mode	
Mode	Bit 3
HEX Mode	0
ASCII Mode	1

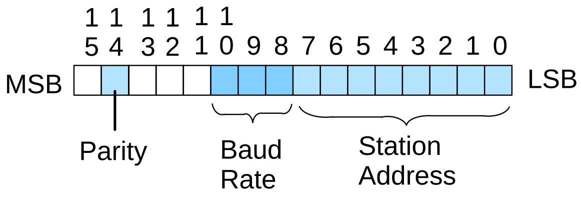
Port 1: Protocol					
Protocol	Bit 7–4 (Hex)	Bit 7	Bit 6	Bit 5	Bit 4
K–Sequence	8	1	0	0	0
DirectNet	4	0	1	0	0
MODBUS RTU	2	0	0	1	0
K–Seq / D–Net /MODBUS RTU	E	1	1	1	0

B: Port 1 – Station Address, Baud Rate, Parity

Use word +0001 to set Port 1:

- Station address ranges from 0–247 (00–F7 Hex)
- Baud rates ranging from 9.6K to 115.2K bps
- Odd or No parity

word +0001



Set all unused bits to zero.

Port 1: Station Address								
Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	1
02	0	0	0	0	0	0	1	0
– – – – –								
F6	1	1	1	1	0	1	1	0
F7	1	1	1	1	0	1	1	1

Port 1: Baud Rate			
Baud Rate	Bit 10	Bit 9	Bit 8
9.6 K bps	0	0	0
19.K bps	0	0	1
38.4K bps	0	1	0
57.6K bps	0	1	1
115.2K bps	1	0	0

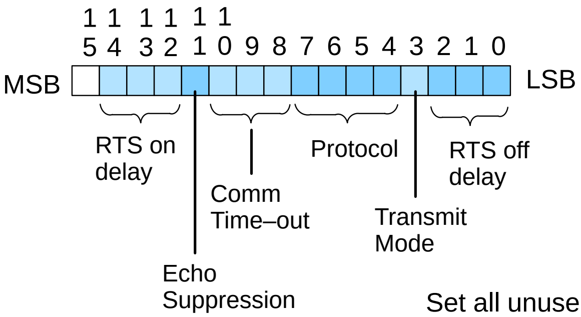
Port 1: Parity	
Parity	Bit 14
No Parity	0
Odd Parity	1

C: Port 2 – RTS On/Off delay, Transmit Mode, Protocol, Comm Time–out, RS–485 Mode

Use word +0002 to set Port 2:

- K–Sequence slave, ***Direct***NET slave or MODBUS RTU slave protocol (or auto–detect for all three protocols)
- HEX or ASCII transmit mode
- RTS On and Off delay times
- Communication Time–out
- Echo Suppression

word +0002



Set all unused bits to zero.

Port 2: RTS Off Delay			
Time (ms)	Bit 2	Bit 1	Bit 0
0	0	0	0
2	0	0	1
5	0	1	0
10	0	1	1
20	1	0	0
50	1	0	1
100	1	1	0
500	1	1	1

Base Time–out for K–Seq/D–Net = 800ms
Base Time–out for MODBUS = 500ms

Port 2: Transmit Mode	
Mode	Bit 3
HEX Mode	0
ASCII Mode	1

Port 2: Protocol					
Protocol	Bit 7–4 (Hex)	Bit 7	Bit 6	Bit 5	Bit 4
K–Sequence	8	1	0	0	0
DirectNet	4	0	1	0	0
MODBUS RTU	2	0	0	1	0
Non–Sequence	1	0	0	0	1
K–Seq / D–Net /MODBUS RTU	E	1	1	1	0

Port 2: Communication Time–out (ms)				
K–Seq, D–Net, MODBUS RTU	Non–Sequence Protocol	Bit 10	Bit 9	Bit 8
Base Time x 1	0	0	0	0
Base Time x 1.2	2	0	0	1
Base Time x 1.5	5	0	1	0
Base Time x 2	10	0	1	1
Base Time x 5	20	1	0	0
Base Time x 10	50	1	0	1
Base Time x 20	100	1	1	0
Base Time x 50	500	1	1	1

DCM Port Configuration

Port 2: Echo Suppression	
Mode	Bit 11
RS–422/485: 4–wire RS–232	0
RS–485: 2–wire	1

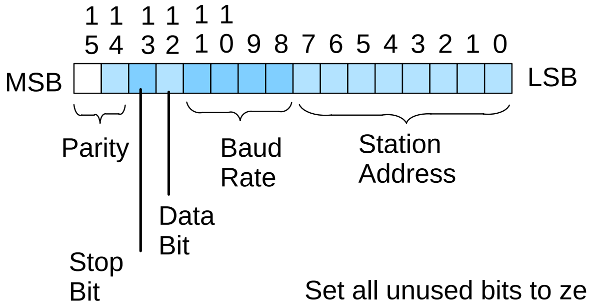
Port 2: RTS On Delay			
Time (ms)	Bit 14	Bit 13	Bit 12
0	0	0	0
2	0	0	1
5	0	1	0
10	0	1	1
20	1	0	0
50	1	0	1
100	1	1	0
500	1	1	1

D: Port 2 – Station Address, Baud Rate, Data Bit, Stop Bit, Parity

Use word +0003 to set Port 2:

- Station address ranges from 0–247 (00–F7 Hex)
- Baud rates ranging from 9.6K to 115.2K bps
- Data Bit Length (7 or 8 bits)
- Stop Bit Length (1 or 2 bits)
- Odd, Even or No Parity

word +0003



Set all unused bits to zero.

Port 2: Station Address								
Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	1
02	0	0	0	0	0	0	1	0
———								
F6	1	1	1	1	0	1	1	0
F7	1	1	1	1	0	1	1	1

Port 2: Baud Rate				
Baud Rate	Bit 11	Bit 10	Bit 9	Bit 8
300 bps	0	0	0	0
600 bps	0	0	0	1
1200 bps	0	0	1	0
2400 bps	0	0	1	1
4800 bps	0	1	0	0
9600 bps	0	1	0	1
19.K bps	0	1	1	0
38.4K bps	0	1	1	1
57.6K bps	1	0	0	0
115.2K bps	1	0	0	1

Port 2: Data Bit	
Length	Bit 12
8 Bit	0
7 Bit	1

Port 2: Stop Bit	
Length	Bit 13
1 Bit	0
2 Bit	1

Port 2: Parity		
Parity	Bit 15	Bit 14
No Parity	0	0
Odd Parity	0	1
Even Parity	1	0

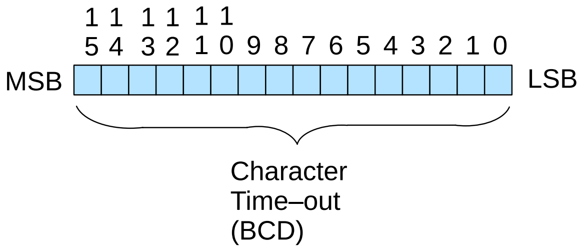
E: Port 2 – Character Time–out

Use word +0006 to set Port 2:

- Character Time–out (BCD)

This parameter is used when the DCM is used as a MODBUS RTU master.

word +0006



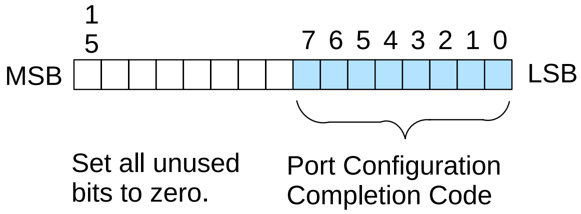
Port 2: Character Time–out	
Bit 15–0	time
0	3.5 characters
1–9999 (BCD)	time–out (ms)

F: Port 1 and 2 Setup and Completion Code

Word +0007 is used for Port 1 and Port 2 to :

- request that the DCM recognizes changes in the port(s) communication parameters from default or previous settings
- confirm that Port 1 and Port 2 configuration is complete

word +0007


1
5
7 6 5 4 3 2 1 0
MSB
LSB
Set all unused bits to zero.
Port Configuration Completion Code

Loading a K0055 (BCD) into word +0007 will request that the DCM recognizes (looks for) new or desired port communication parameters that are written to the DCM port configuration registers. If the requested changes are valid, a 00AA (hex) will then be written to word +0007. If the desired or new communications are invalid or out of range, an error code 00E* (Hex) will be written to word +0007. The last digits indicate the address that has an error. For example, error code 00E2 means that word +0002 has an error.

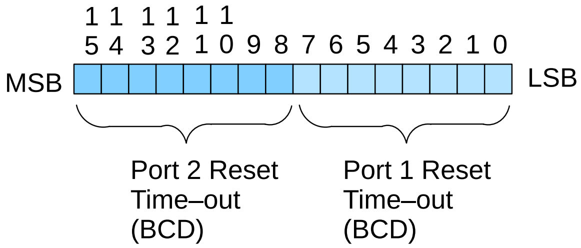
G: Port 1 and 2 Reset Time–out

Use word +0024 to set Port 1 and Port 2:

- Reset Time–out in seconds

The communication port will reset after the specified time after the port goes from the BUSY state to the IDLE state.

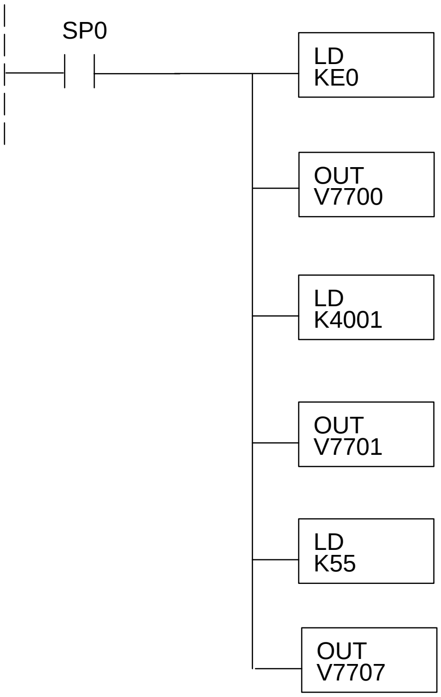
word +0024



Reset Time–out		
Port	Time(s)	Function
Port 1: Bit 0–7 Port 2: Bit 15–8	0	Disable
	1–99	Enable

DL05 Port Setup Examples

Port 1 Example: (This port can serve as slave only)



Selects auto–detect protocol mode (K–seq, D–Net and MODBUS) and HEX transmit mode.

Write configuration data into V7700.

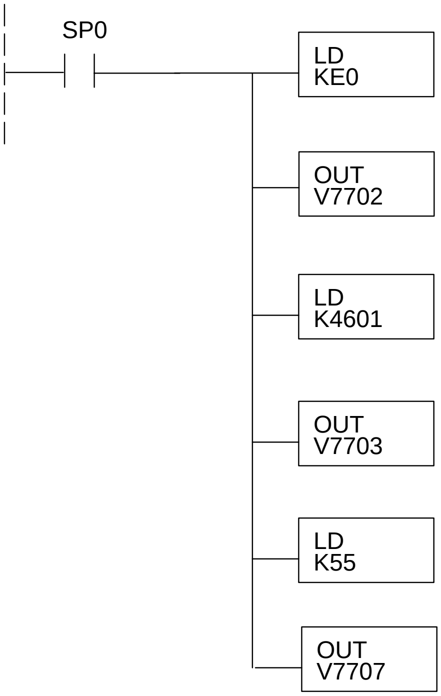
Selects station address 1, baud rate of 9600bps and odd parity.

Write configuration data into V7701.

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V7707.

Port 2 Example: Slave Mode



Selects auto–detect protocol mode (K–seq, D–Net and MODBUS), HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232

Write configuration data into V7702.

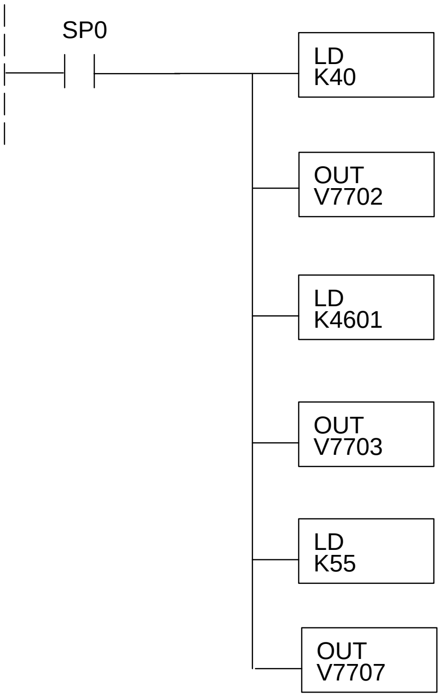
Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V7703.

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V7707.

Port 2 Example: DirectNet Master



Selects DirectNet protocol, HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232

Write configuration data into V7702.

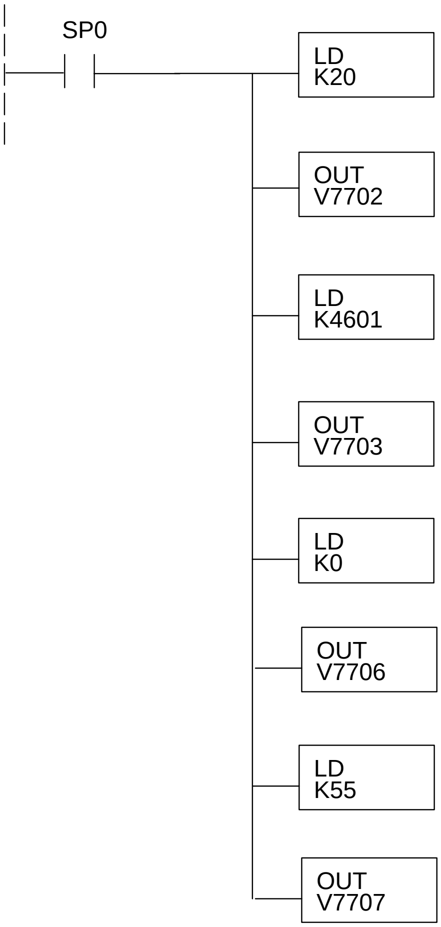
Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V7703.

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V7707.

Port 2 Example: MODBUS RTU Master



Selects MODBUS protocol, HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232

Write configuration data into V7702.

Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V7703.

Selects 3.5 characters length time–out.

Write configuration data into V7706.

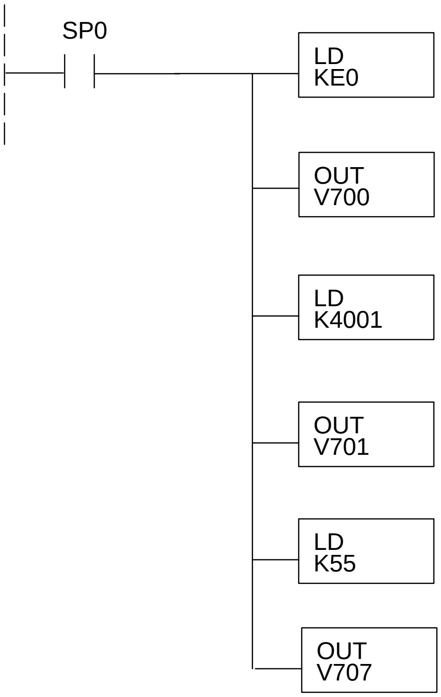
K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V7707.

DL06 Port Setup Examples

The following examples assumes the D0–DCM is installed in slot 1.

Port 1 Example: Slave Mode Only



Selects auto–detect protocol mode (K–seq, D–Net and MODBUS) and HEX transmit mode.

Write configuration data into V700 (based on module slot location).

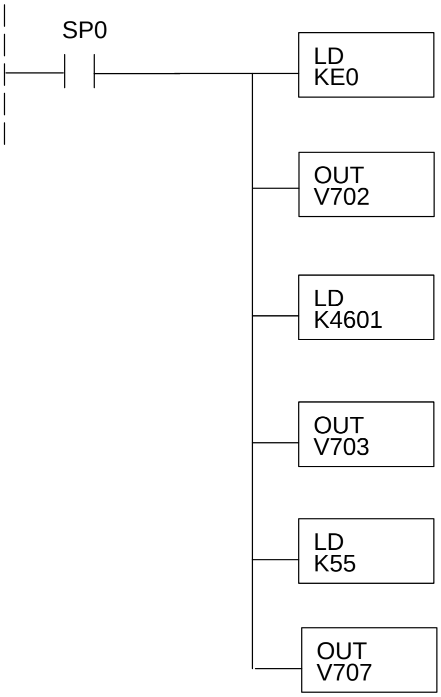
Selects station address 1, baud rate of 9600bps and odd parity.

Write configuration data into V701 (based on module slot location).

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V707 (based on module slot location).

Port 2 Example: Slave Mode



Selects auto–detect protocol mode (K–seq, D–Net and MODBUS), HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232

Write configuration data into V702 (based on module slot location).

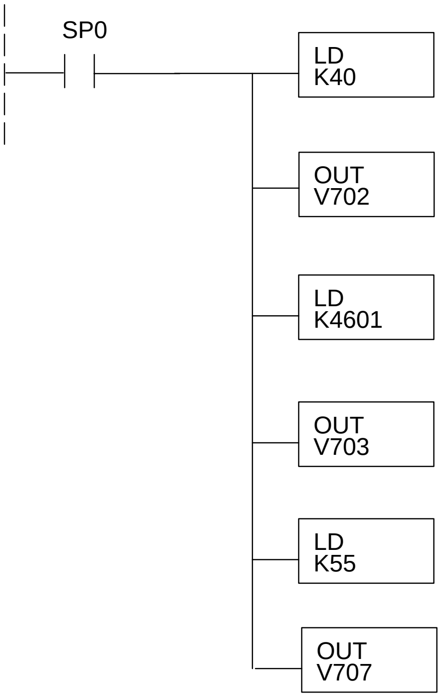
Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V703 (based on module slot location).

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V707 (based on module slot location).

Port 2 Example: DirectNet Master



Selects DirectNet protocol, HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232

Write configuration data into V702 (based on module slot location).

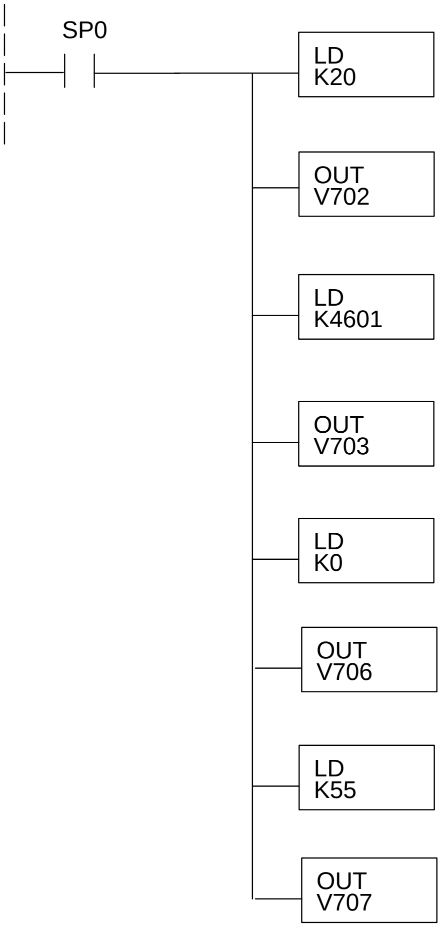
Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V703 (based on module slot location).

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V707 (based on module slot location).

Port 2 Example: MODBUS RTU Master



Selects MODBUS protocol, HEX transmit mode, RTS On/Off delay times are set to zero and RS–422/485 (4–wire) / RS–232C

Write configuration data into V702 (based on module slot location).

Selects station address 1, baud rate of 19200bps, odd parity, 8–bit data length and 1 stop bit.

Write configuration data into V703 (based on module slot location).

Selects 3.5 characters length time–out.

Write configuration data into V706 (based on module slot location).

K55 is the port setup completion code that must be used to request that the CPU recognizes the new/desired port parameters

Write configuration data into V707 (based on module slot location).

4

RLL Programming for Communications

In This Chapter. . . .

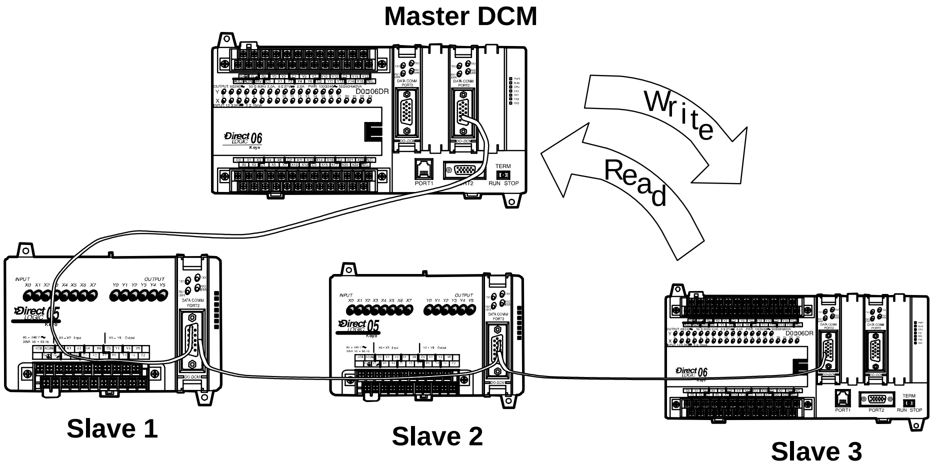
PLC-to-PLC Communications

This chapter steps you through the development of a Relay Ladder Logic (RLL) program to enable one PLC to communicate with another PLC. For the experienced programmer of ***Direct***LOGIC PLCs, the communication programs presented in this chapter will be simple to follow. If you have never programmed a ***Direct***LOGIC PLC, you may want to refer to the ***Direct***SOFT32 Programming Software User Manual and the User Manual for your PLC for additional information.

NOTE: The programs described in this chapter are not used for communication between a PC and a PLC. For PC-to-PLC communications, please see the product documentation for the PC software you are using.

How RLL is Used for Communications

DirectSOFT32 Programming Software provides **Read** and **Write** instructions (RX/WX) for PLC-to-PLC communication over a network. The Read and Write instructions are part of the ladder logic program running in the CPU of the *initiating*, or master, PLC. These instructions tell the initiating CPU to send a message over the serial network to a *responding*, or slave, PLC. The initiating PLC's Read or Write communication finds its destination by the slave address of the responding PLC.



NOTE: When all slave's addresses are set to 0 (zero), the master D0–DCM can write data to all slaves at the same time using the WX instruction. This is referred to as "**broadcast mode**". If this mode is used, the master DCM cannot use the RX instruction to read data from individual slaves.

Network Instructions

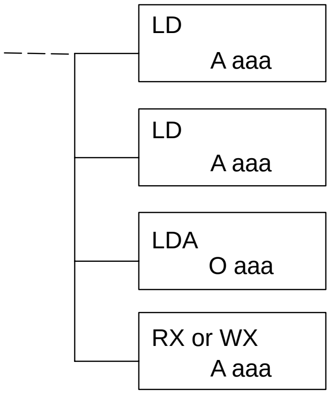
Read (RX) and Write (WX) Instructions

The Read (**RX**) and Write (**WX**) instructions are used by the master PLC to Read a block of data *from* another PLC or Write a block of data *to* another PLC. To perform their functions, the RX and WX *boxes* must be **preceded** in the ladder logic program by two Load instructions and one Load Address instruction.

The Load and Load Address instructions load communication parameters into the **accumulator** and the first and second level of the **accumulator stack**. The RX or WX instruction takes these parameters from the stack and the accumulator and prepares the data to be sent over the network. If you need to know more about the function of the accumulator and the accumulator stack, refer to the User Manual for your PLC.

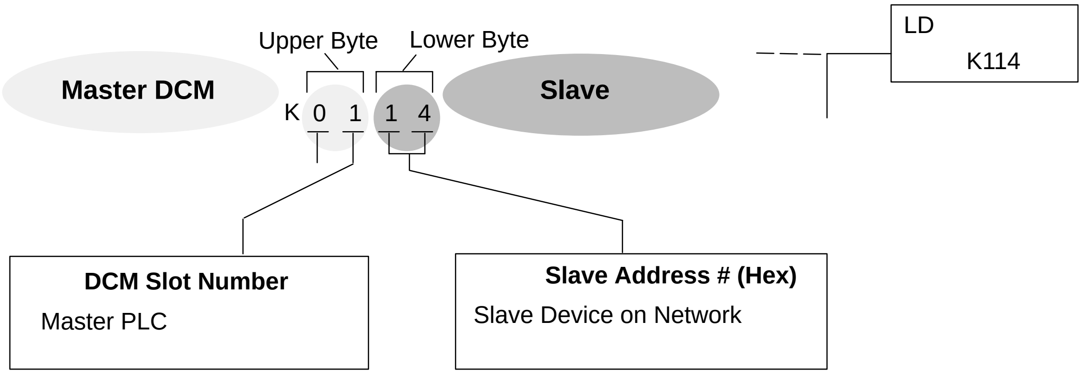
Building the Read (RX) or Write (WX) Routine

For network communications, you build the Read (RX) or Write (WX) instructions into a **routine** which requires the four instructions you see to the right. The function of each of these instructions is explained below or on the next page. They must be used in the sequence shown.



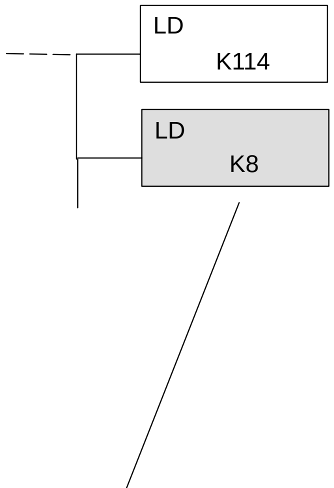
The First LD Instruction

The first Load (LD) instruction accepts either a constant or a variable. Use a “K” to designate the number as a constant. Use a “V” if you are entering the address of a register. The contents of that register perform the same function as the constant shown below. For example, you could use V2000 in place of K0114. If the contents of V2000 is the number “114,” the function would be the same. Using a variable allows changing parameters while the program is running. It is recommended, however, to use a constant when possible.

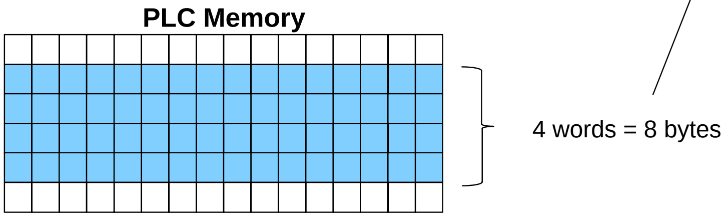


The Second LD Instruction

The second Load (LD) instruction determines the length of the data block to be transmitted during the Read or Write communication. This instruction will also accept two data types. Use a “K” to designate the number as a constant. Use a “V” if you are entering the address of a register.

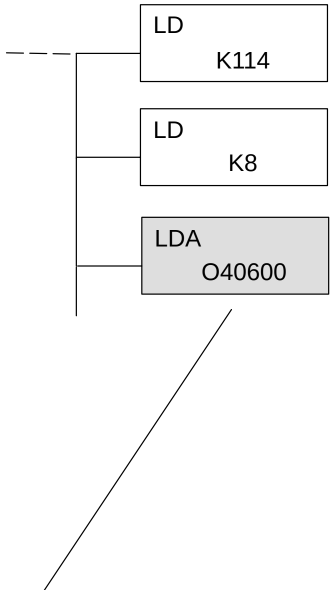


For Word Memory data, you must use a multiple of two bytes between 2 and 128. For Bit Memory data, you can use any multiple of one byte between 1 and 128. For more information about addressing Word and Bit Memory, see page 4-6.



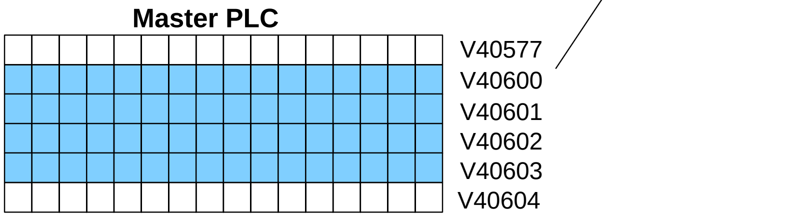
The LDA Instruction

The Load Address (LDA) instruction specifies the V-memory address of the *beginning* memory register in the master PLC. The data block to be transmitted will begin at this address and extend the number of bytes specified in the preceding LD instruction. The leading “O” indicates this is an octal number. Simply substitute the letter “O” for the “V” in the V-memory designation. For example, V40600 becomes O40600.



Read instructions copy the data block from the slave PLC memory into the master PLC memory.

Write instructions copy the data block from the master PLC memory into the slave PLC memory.

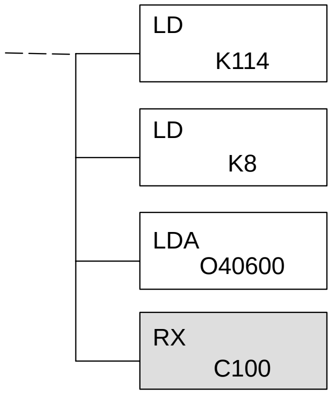


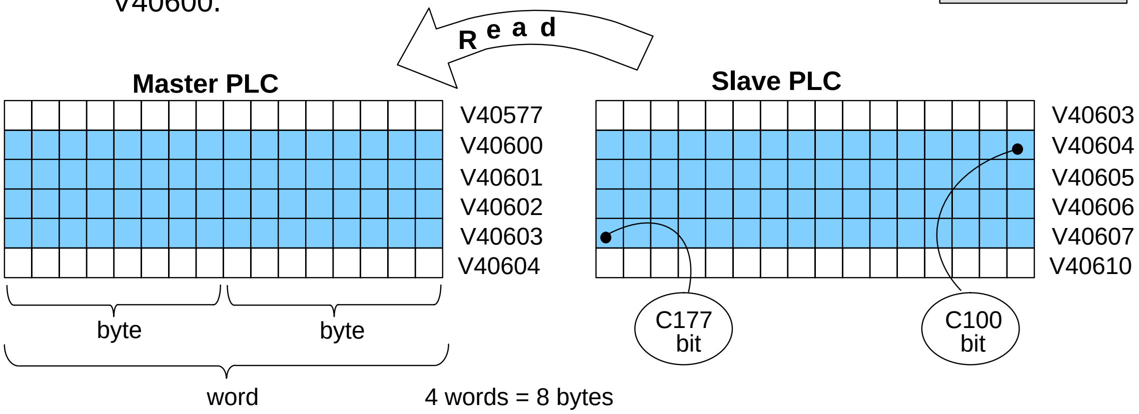
Read (RX) Instruction

The Read (RX) instruction specifies the memory location to be *read from* the slave PLC.

A block of data is read that begins at the specified memory location and extends the number of bytes specified in the second LD instruction.

In this example, the eight byte block of data beginning at C100 and ending at C177 in the slave PLC is read (copied) into the master PLC's memory beginning at V40600.



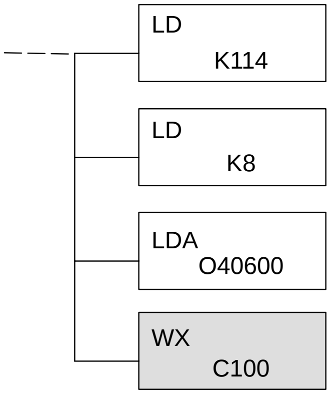


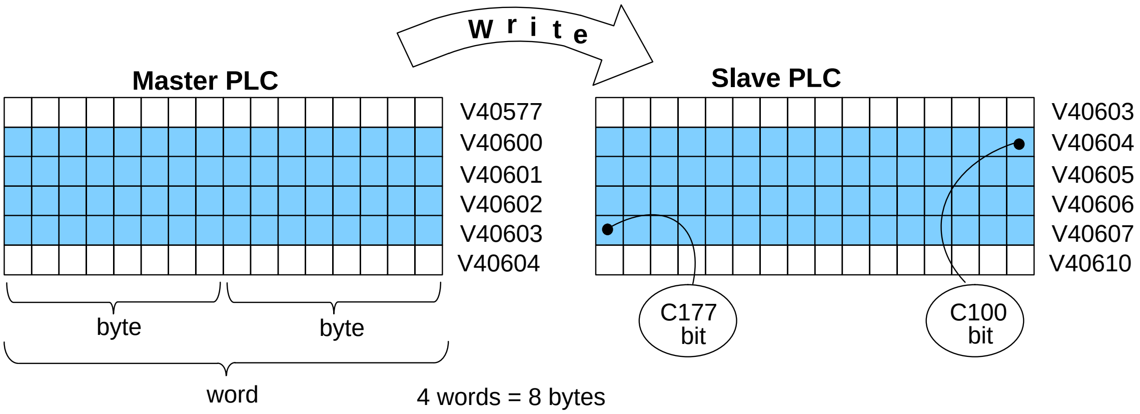
Write (WX) Instruction

The Write (WX) instruction specifies the memory location to be *written to* in the slave PLC.

A block of data is written that begins at the specified memory location and extends the number of bytes specified in the second LD instruction.

In the example, the 8-byte block of data beginning at V40600 and ending at V40603 in the master PLC is written (copied) into the slave PLC's memory beginning at C100 and ending at C177.





Addressing the Different Memory Types

Some data types are inherently 16 bits long, for example timer and counter current values. Other data types are 1 bit long, for example: discrete inputs and outputs. Word-length and bit-length data are mapped into Word Memory, also known as V-memory, which allows you to address *any* of the different memory types as 16-bit words.

Bit Memory

Bit memory can be addressed in Read and Write instructions by the name of the first bit of any byte. If your second LD instruction contains the constant K8, eight bytes will be transmitted. If you use C0 in your RX or WX instruction, you will transmit the eight bytes from C0 through C77.

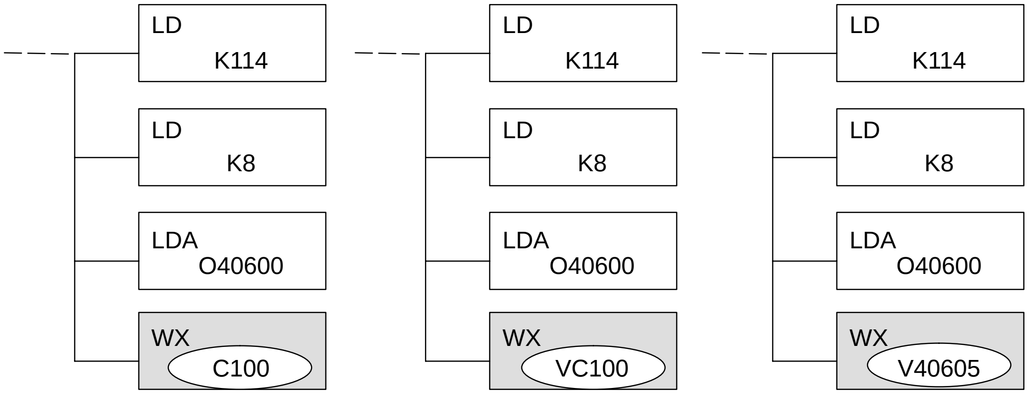
Word Memory and Aliases

In the example below, V40600 is the V-memory designation for the sixteen bits from C0 through C17. *Aliases* are a convenient substitute for V-memory designations, and can be used interchangeably in Read and Write instructions. VC0 is the alias for V40600. Either nomenclature addresses the same 16 bits.

The alias is simply the name of the first bit in a group of sixteen bits, with V added as a prefix. For example, VC0 represents the 16 bits beginning with C0. Word Memory, Bit Memory and Aliases all use the **octal** numbering system.

Word Memory Address V40600 = VC0 (Alias)	C17	C16	C15	C14	C13	C12	C11	C10	C7	C6	C5	C4	C3	C2	C1	C0
V40601 = VC20	C37	C36	C35	C34	C33	C32	C31	C30	C27	C26	C25	C24	C23	C22	C21	C20
V40602 = VC40	C57	C56	C55	C54	C53	C52	C51	C50	C47	C46	C45	C44	C43	C42	C41	C40
V40603 = VC60	C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	C62	C61	C60

The following Write routines are all equivalent. ***Direct***SOFT32 gives you the flexibility to identify the responding PLC's memory area in three different ways, as shown below.



*Direct*SOFT32 is Flexible

You can address the different data types by any available convention shown in the tables that follow. The largest block of data that can be sent in a single Read or Write operation is 128 bytes. The smallest block of data is one byte for Bit Memory types and two bytes, or one word for Word Memory types. The **octal** numbering system is used for all addresses in these tables.

DL05 CPU

DL05 CPU			
Data Types	**Bit Memory**	**Word Memory**	**Alias**
Timer Current Values	None	V0 – V177	TA0 – TA177
Counter Current Values	None	V1000 – V1177	CTA0 – CTA177
User Data Words	None	V1200 – V7377	None
Input Points	X0 – X377	V40400 – V40417	VX0 – VX360
Output Points	Y0 – Y377	V40500 – V40517	VY0 – VY360
Control Relays	C0 – C777	V40600 – V40677	VC0 – VC760
Special Relays	SP0 – SP777	V41200 – V41237	VSP0 – VSP760
Timer Status Bits	T0 – T177	V41100 – V41107	VT0 – VT160
Counter Status Bits	CT0 – CT177	V41140 – V41147	VCT0 – VCT160
Stages	S0 – S377	V41000 – V41017	VS0 – VS360

DL06 CPU

DL06 CPU			
Data Types	**Bit Memory**	**Word Memory**	**Alias**
Timer Current Values	None	V0 – V377	TA0 – TA177
Counter Current Values	None	V1000 – V1177	CTA0 – CTA177
User Data Words	None	V400 – V677 V1200 – V7377 V10000 – V17777	None
Input Points	X0 – X777	V40400 – V40437	VX0 – VX760
Output Points	Y0 – Y777	V40500 – V40537	VY0 – VY760
Control Relays	C0 – C1777	V40600 – V40677	VC0 – VC1760
Special Relays	SP0 – SP777	V41200 – V41237	VSP0 – VSP760
Timer Status Bits	T0 – T377	V41100 – V41117	VT0 – VT160
Counter Status Bits	CT0 – CT177	V41140 – V41147	VCT0 – VCT160
Stages	S0 – S1777	V41000 – V41077	VS0 – VS1760
Remote I/O	GX0 – GX3777 GY0 – GY3777	V40000 – V40177 V40200 – V40377	VGX0 – VGX3760 VGY0 – VGY3760

Special Relays for Communications

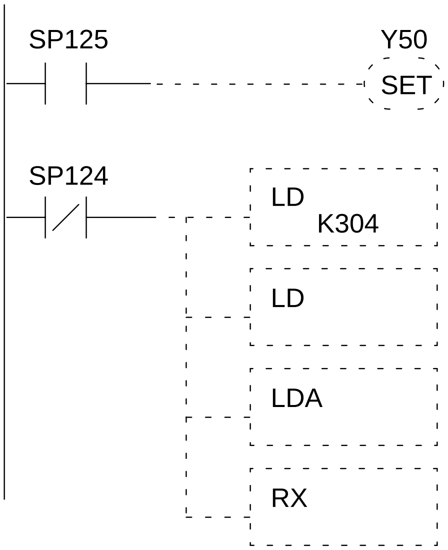
The ***Direct***LOGIC PLCs provide internal contacts (bits) for monitoring the status of communications. The internal contacts are called Special Relays (there are other Special Relays used for other purposes). There are two Special Relays for each slot in the PLC that will be used by DCM module. The two relays perform the following functions:

- **Communication Busy** – This bit is on when the communication module is busy transmitting or receiving. You **must** use this bit, or relay contact, to prevent overwriting your Read or Write (RX/WX) instructions.
- **Communication Error** – This bit is on when an error occurred in the last RX or WX communication. This error automatically clears (the bit resets to zero) when another RX or WX instruction executes.

For example, Special Relays SP124 and SP125 correspond to an DCM module in **slot 3** of the DL06 PLC.

The Special Relay SP125 is used in the example to energize the output Y50, indicating a **communication error** has occurred. This Special Relay must appear earlier in the program than your RX or WX instruction because it is turned off (reset to zero) when a subsequent Read or Write instruction is executed.

The Special Relay SP124 indicates the DCM is **busy**. When SP124 is on, the normally closed contact opens to prevent executing another RX or WX instruction until the last one is completed. The appropriate busy bit **must** be used as a NC contact on every RX/WX instruction rung in the program.



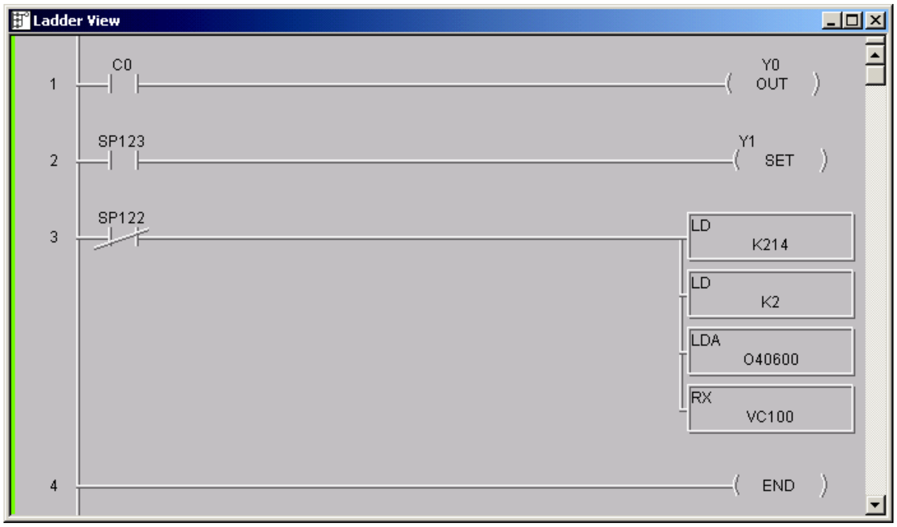
DL05 Special Relays	
Relay	Option Slot
Communication busy	SP120
Communication error	SP121

DL06 Special Relays				
Relay	Slot 1	Slot 2	Slot 3	Slot 4
Communication busy	SP120	SP122	SP124	SP126
Communication error	SP121	SP123	SP125	SP127

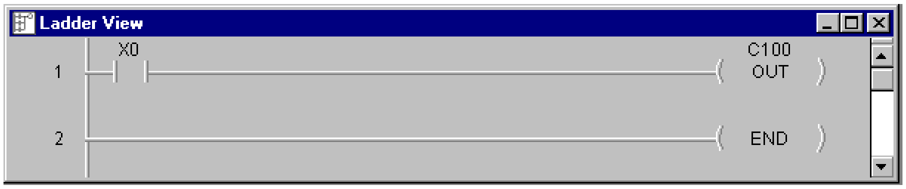
Program with One Read Instruction

The Ladder View screen below is the program development screen in ***Direct***SOFT32 Programming Software. This four rung program is explained in detail on page 4–10. This is a complete program although its function is very limited. There is also a two rung program that runs in the slave PLC, and it is also explained on page 4–10. This example assumes the DCM is in slot 2 of a DL06 PLC.

Program for the Master PLC



Program for the Slave PLC



When the input (X0) to the slave PLC is turned on (transitions from 0 to 1), the C0 bit in the master PLC also transitions from 0 to 1. The program in the master PLC causes Y0 to turn on in response to the C0 bit.

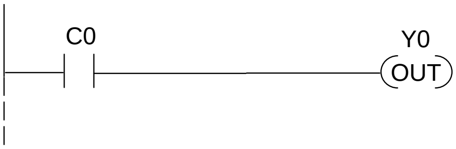
For example DL05/06 communications programs, go to **www.automationdirect.com** technical support website > Example programs> Coummunications> example # EP–COM–005.

Master example: This project contains simple logic for reading the inputs from a DL05/06 slave and placing their status in C0–C17 in the master. It also writes C17–C37 to the outputs on the slave.

Slave example: This project can be used in conjunction with the master project to setup the slave to turn off its outputs if the master PLC stops communicating with it.

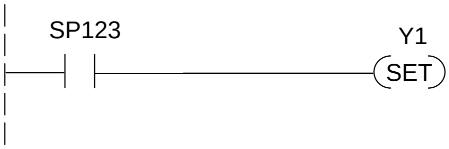
Program for the Master PLC: Rung 1

In our example, the normally open contact labeled **C0** is an internal control relay. When C0 is on, discrete output **Y0** is energized.



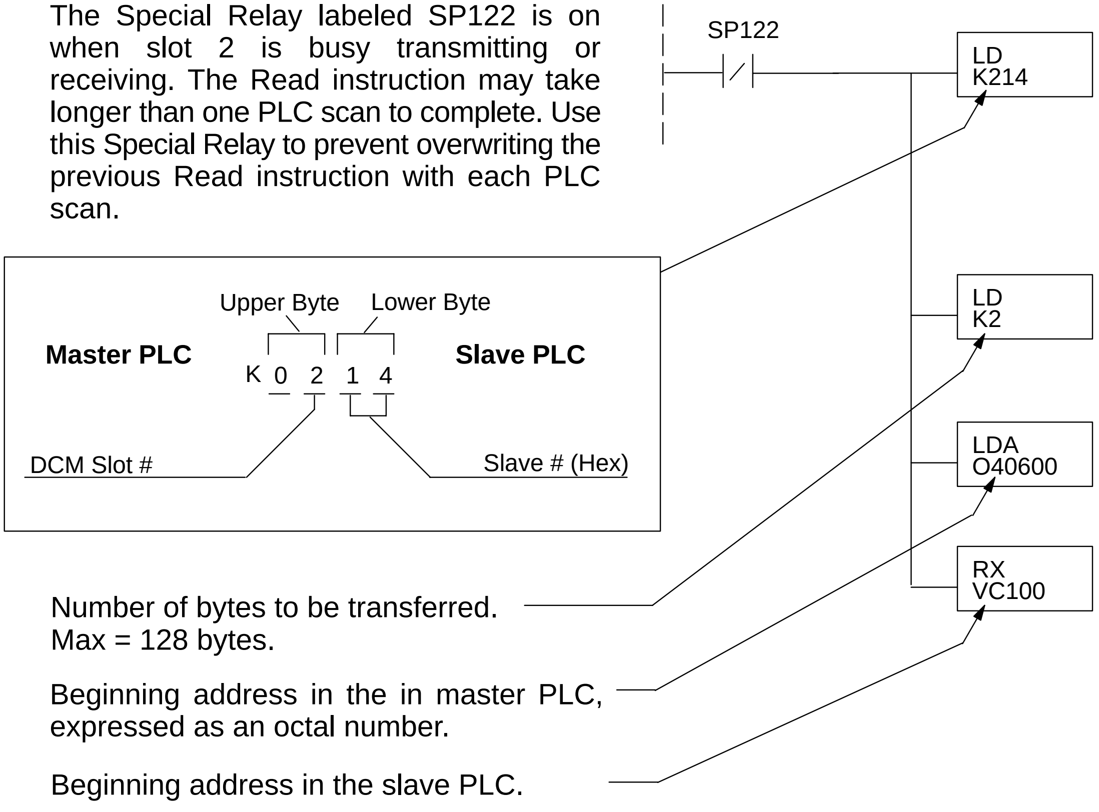
Rung 2

The second rung uses a Special Relay to identify a communication error. In the example, **SP123** is on if a communication error is present for *slot two*. Use different Special Relays if your DCM module is in a different slot (see page 4-8). We use SP123 to turn on an indicator light connected to a discrete output.



Rung 3

The Special Relay labeled SP122 is on when slot 2 is busy transmitting or receiving. The Read instruction may take longer than one PLC scan to complete. Use this Special Relay to prevent overwriting the previous Read instruction with each PLC scan.



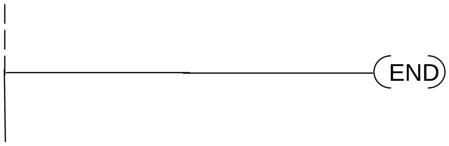
Number of bytes to be transferred.
Max = 128 bytes.

Beginning address in the in master PLC, expressed as an octal number.

Beginning address in the slave PLC.

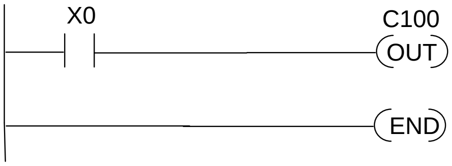
Rung 4

All ***Direct***LOGIC PLCs use an END statement to identify the final rung of the main body of the program.



Program for the Slave PLC

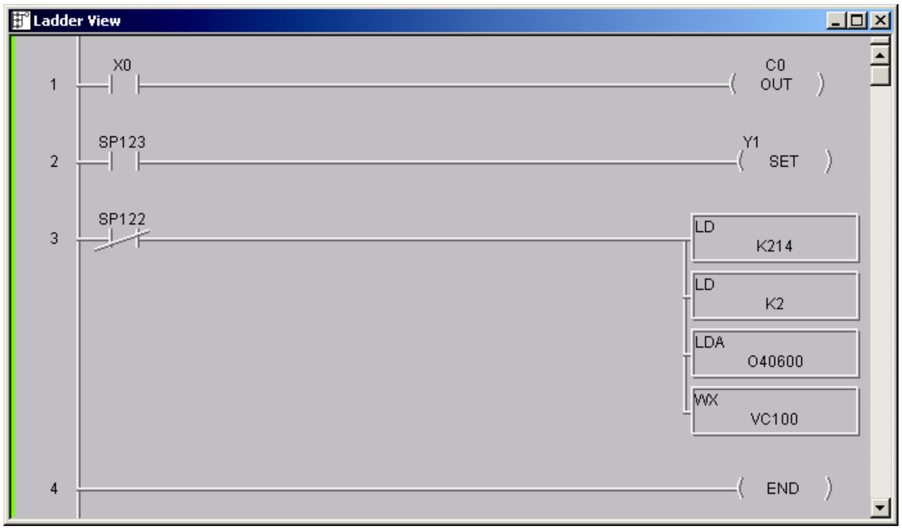
This two-rung program resides in the slave PLC's CPU. Its function is simply to use the X0 contact to turn on the internal control relay, C100.



Example Program with One Write Instruction

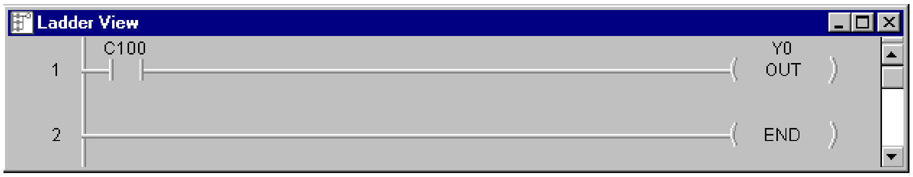
The Ladder View screen below is the program development screen in ***Direct***SOFT32 Programming Software. This four-rung program is explained in detail on page 4–12. This is a complete program although its function is very limited. There is also a two-rung program that runs in the responding PLC. It is also explained on page 4–12.This example assumes the DCM is in slot 2 of a DL06 PLC.

Program for the Master PLC



```
1   X0 (NO contact)               C0 OUT
2   SP123 (NO contact)            Y1 SET
3   SP122 (NC contact)            LD   K214
                                  LD   K2
                                  LDA  O40600
                                  WX   VC100
4                                 END
```

Program for the Slave PLC



```
1   C100 (NO contact)             Y0 OUT
2                                 END
```

When the input (X0) to the master PLC is turned on (transitions from 0 to 1), the C100 bit in the slave PLC also transitions from 0 to 1. The program in the slave PLC causes Y0 to turn on in response to the C100 bit.

NOTE: The slave PLC logic is a basic example only. If the master/slave communication fails, the bits written to the slaves from the master will remain in the same state last written from the the master.

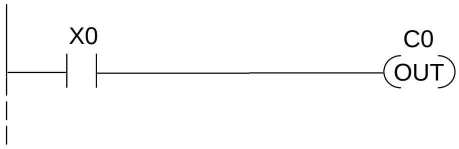
For example DL05/06 communications programs, go to **www.automationdirect.com** technical support website > Example programs> Coummunications> example # EP–COM–005.

Master example: This project contains simple logic for reading the inputs from a DL05/06 slave and placing their status in C0–C17 in the master. It also writes C17–C37 to the outputs on the slave.

Slave example: This project can be used in conjunction with the master project to setup the slave to turn off its outputs if the master PLC stops communicating with it.

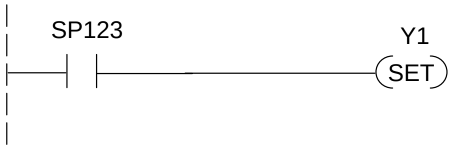
Program for the Master PLC: Rung 1

In our example, the normally open contact labeled **X0** is a toggle switch input to a discrete input module. When X0 is on, Control Relay **C0** is energized.



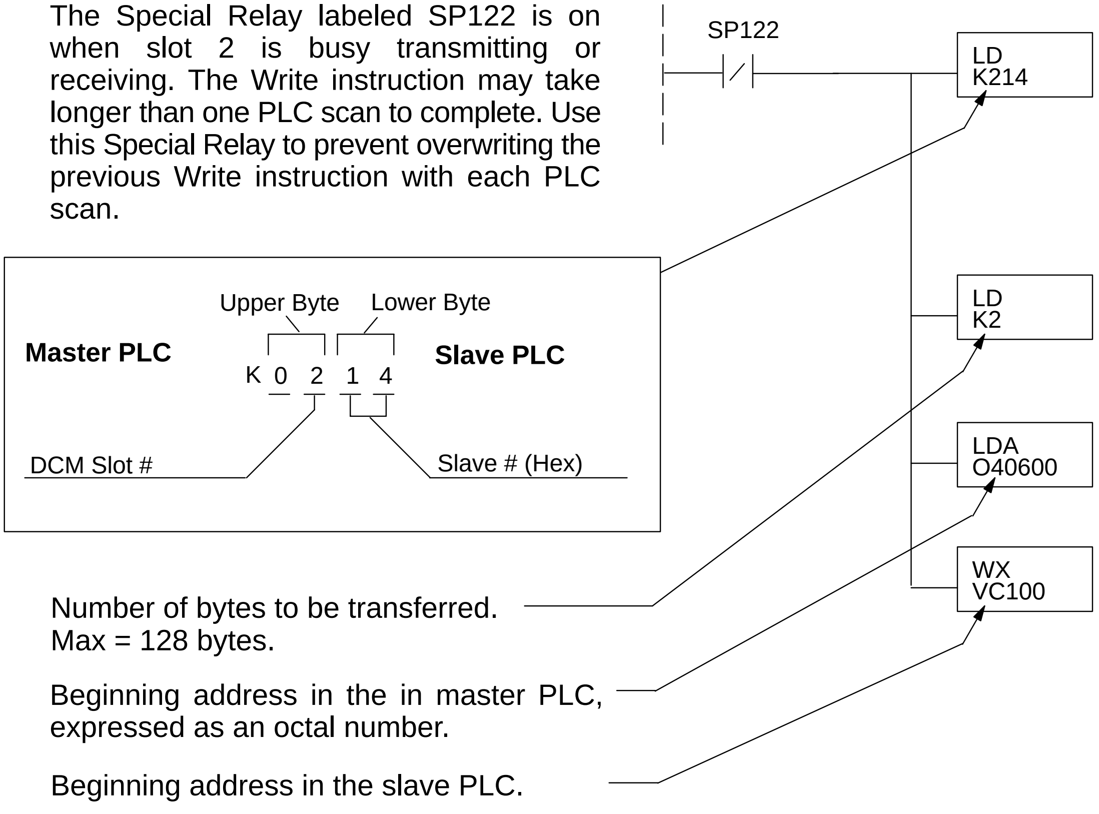
Rung 2

The second rung uses a Special Relay to identify a communication error. In the example, **SP123** is on if there is a communication error present *in slot 2*. Use different Special Relays if your DCM module is in a different slot (see page 4-8). We use SP123 to turn on an indicator light connected to a discrete output.



Rung 3

The Special Relay labeled SP122 is on when slot 2 is busy transmitting or receiving. The Write instruction may take longer than one PLC scan to complete. Use this Special Relay to prevent overwriting the previous Write instruction with each PLC scan.



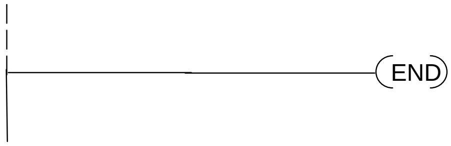
Number of bytes to be transferred. Max = 128 bytes.

Beginning address in the in master PLC, expressed as an octal number.

Beginning address in the slave PLC.

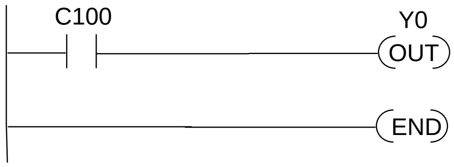
Rung 4

All ***Direct***LOGIC PLCs use an END statement to identify the final rung of the main body of the program.



Program for the Slave PLC

This two-rung program resides in the slave PLC's CPU. Its function is simply to take the C100 contact and convert it to a real output, Y0.



Integrating Multiple Read and Write Instructions

Multiple Read and Write instructions require *interlocks* for sequencing because only one RX/WX instruction can be processed at once. Using interlocks, one RX/WX instruction is processed in each scan until all RX/WX instructions have been executed. After the last instruction, the sequence then begins again at the first RX/WX instruction.

Without interlocks, the RX/WX instructions would be executed in an unpredictable order, and some might be executed many times before others are executed once. The interlocks serve to *open* (disconnect) the ladder circuits for all Read and Write instructions except the one that should be processed on the current CPU scan.

We show two methods of creating the interlocks necessary for sequencing multiple Read and Write instructions:

- Sequenced Internal Control Relays
- Shift Register

We will step you through the development of the interlocks using both methods. The two examples shown perform the same function. Only the interlocks are different.

NOTE: To fully understand the material in this section, you will first need to understand the Example Programs on pages 4–9 and 4–11, as well as the material in the Network Instructions section, beginning on page 4–3.

The following program segment sequences through three RX/WX instructions (two Write instructions and one Read instruction). You can develop your own program incorporating either of the two interlocking control strategies and expanding the number of interlocks to accommodate the number of RX/WX instructions in your program.

Interlocking Relays

It is easy to see the function of the interlocking relays if we construct a *truth table* first.

Truth Table	C52	C51	C50
First RX/WX	0	0	0
Second RX/WX	0	0	1
Third RX/WX	0	1	0
Fourth RX/WX	0	1	1
Fifth RX/WX	1	0	0
Sixth RX/WX	1	0	1
Seventh RX/WX	1	1	0
Eighth RX/WX	1	1	1

Across the top of the truth table we show internal control relays that we are considering using for our sequencing strategy. We have used C50 through C52 for our chart, but any contacts that are not used for other purposes in your program will work just as well.

Down the left side of the chart, we list the number of RX/WX instructions we may want to use in our RLL program.

The three contacts in this truth table will accommodate as many as eight Read or Write instructions. Our program only has three RX/WX instructions so we only need to use two contacts (see why on page 4-14). We will use C50 and C51. One additional contact (C53) would give us 32 combinations since the number of combinations expands as the power of 2.

Our three RX/WX instructions can be sequenced by the two contacts C50 and C51. Two contacts provide four different binary states:

- both off
- C50 on and C51 off
- C50 off and C51 on
- both on

We only need to use three of the four binary states (circled) since we only have three RX/WX instructions to sequence.

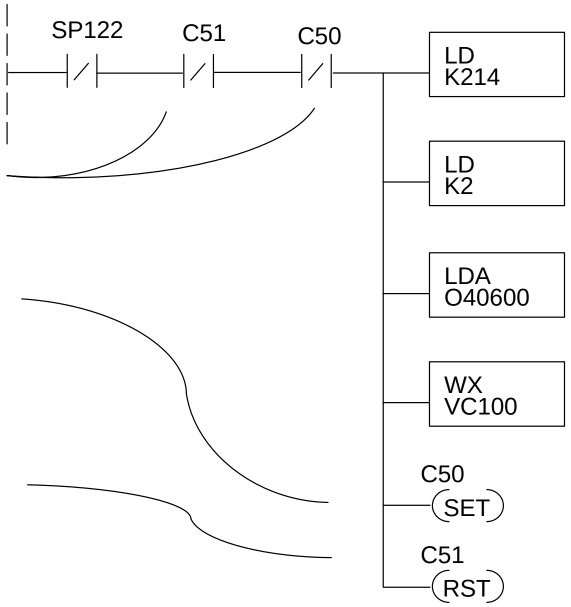
Truth Table	C52	C51	C50
First RX/WX	0	0	0
Second RX/WX	0	0	1
Third RX/WX	0	1	0
Fourth RX/WX	0	1	1
Fifth RX/WX	1	0	0
Sixth RX/WX	1	0	1
Seventh RX/WX	1	1	0
Eighth RX/WX	1	1	1

First RX/WX Instruction

C50 and C51 are interlocking contacts. They are normally closed in this rung to permit power flow to the first WX instruction. Both bits are off, corresponding to the first row of the truth table.

After the WX instruction is executed C50 is SET (turned on) which opens the contact in this rung and closes the C50 contact in the next rung.

C51 is RESET (turned off) which leaves the C51 contact closed for the next rung.

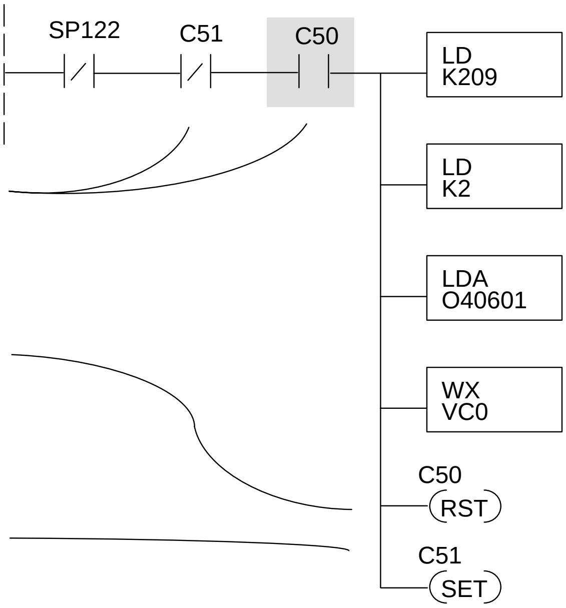


Second RX/WX Instruction

C50 is normally open and C51 is normally closed. For this rung to be executed, the C50 bit must be on and the C51 bit must be off, corresponding to the second row of the truth table. C50 was turned on in the previous rung. C51 was turned off in the previous rung.

After the WX instruction is executed C50 is RESET (turned off) which opens the C50 contact in this rung and closes it in the next rung.

C51 is SET (turned on), which closes the normally open C51 contact in the next rung.

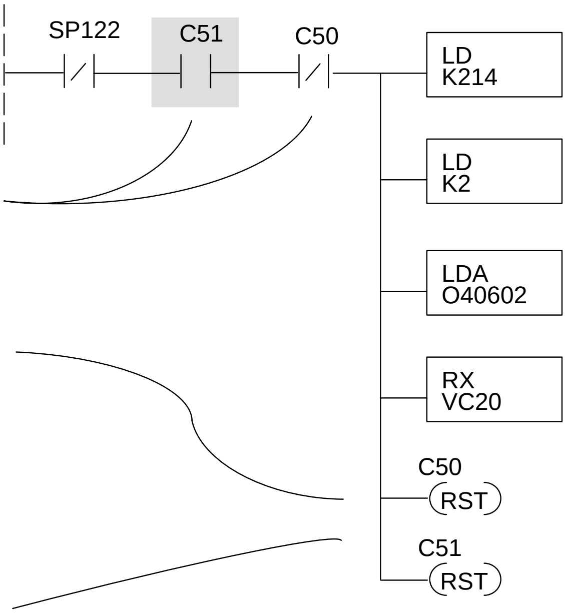


Third RX/WX Instruction

In this last rung, C50 is normally closed and C51 is normally open. For this rung to be executed, the C50 bit must be off and the C51 bit must be on, corresponding to the third row of the truth table. C51 was turned on in the previous rung.

After the RX instruction is executed, C50 is RESET which opens the C50 contact in this rung and allows it to close in preparation for repeating the first communication rung on the next CPU scan (page 4-14).

C51 is also RESET, which allows the C51 contact to close in preparation for repeating the first communication rung on the next CPU scan (page 4-14).



Returning to the First RX/WX Instruction

At the end of the third RX/WX instruction, we cycle back to the top row of the truth table on page 4–14. Both C50 and C51 are off, and the next CPU scan executes the first RX/WX instruction.

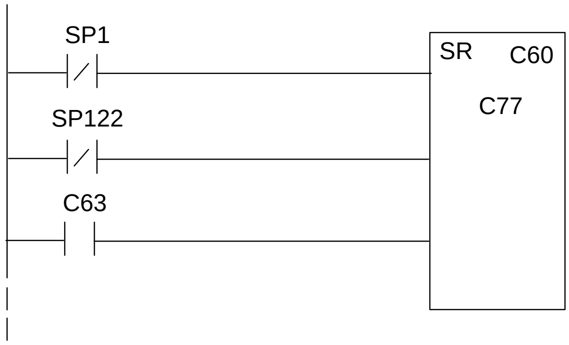
Shift Register

The Shift Register can be used for creating interlocks, as an alternative to using control relays. For a complete explanation of the function of the Shift Register, see the User Manual for your PLC. If you have more than a few RX/WX instructions, using control relays can become cumbersome. The Shift Register allows a single contact to be used in each communication rung as an interlock.

The data input to the Shift Register (SR) is Special Relay SP1. SP1 is the always-on bit. Combined with a normally closed contact it sends zeros to the Shift Register data input.

The clock input to the Shift Register is SP122, the communication busy bit. Each time one of the RX/WX instructions executes, the Shift Register moves the set bit over one place.

C63 is used in this example to reset the Shift Register to all zeros.



C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	C62	C61	C60

Shift Register after first scan.

C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	C62	C61	**C60**

Shift Register after second scan.

C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	C62	**C61**	C60

Shift Register after first RX/WX.

C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	**C62**	C61	C60

Shift Register after second RX/WX.

C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	**C63**	C62	C61	C60

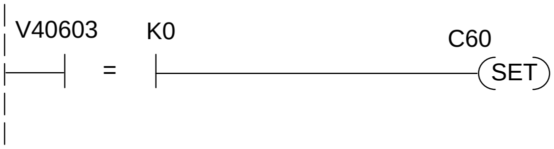
Shift Register after third RX/WX.

C77	C76	C75	C74	C73	C72	C71	C70	C67	C66	C65	C64	C63	C62	C61	C60

Shift Register after third RX/WX plus one scan.

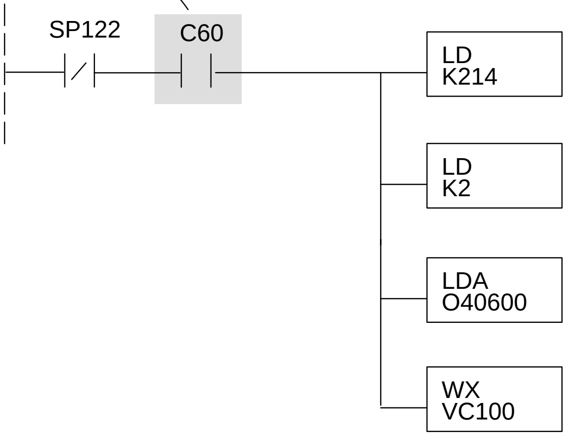
Store If Equal

The Store If Equal instruction detects when the Shift Register is reset to zeros. When that condition is true the C60 bit is SET by this rung. The C60 bit becomes the high bit shifted by the Shift Register until each RX/WX instruction is executed in turn.



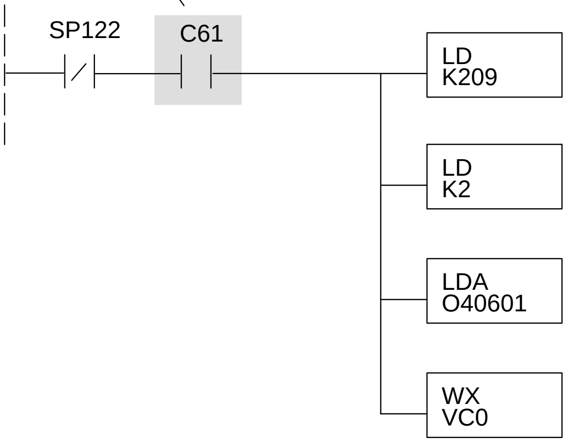
First RX/WX Instruction

C60 is the interlocking contact. It is turned on by the Store If Equal rung preceding this one.



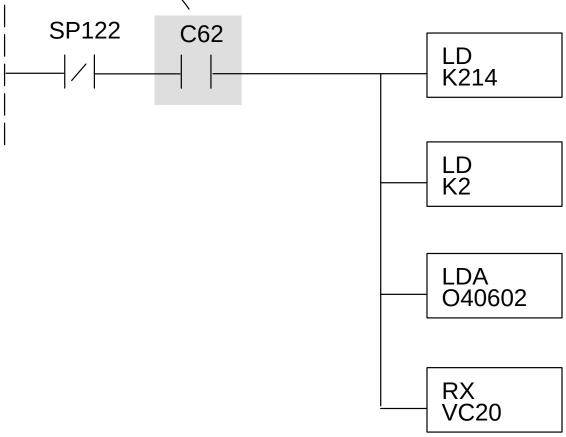
Second RX/WX Instruction

C61 is the interlocking contact. It is turned on by the sequencing steps of the Shift Register in a preceding rung.



Third RX/WX Instruction

C62 is the interlocking contact. It is turned on by the sequencing steps of the Shift Register in a preceding rung.



After this rung is executed, the Shift Register shifts the high bit from C62 to C63 on the next CPU scan. C63 resets the Shift Register to zeros, the Store If Equal sets the C60 bit, and the CPU executes the first RX/WX instruction.

5

D0–DCM Using MODBUS® RTU

In This Chapter. . . .

Network Slave Operation

This section describes how a MODBUS RTU master on a network can communicate with a D0–DCM using the MODBUS RTU protocol. A network master must send a MODBUS function code and MODBUS address to specify a PLC memory location in the DL05/06 CPU. No CPU ladder logic is required to support MODBUS slave operation.

MODBUS Function Codes Supported

The D0–DCM supports the following MODBUS function codes when acting as a MODBUS slave.

MODBUS Function Code	Function	DL05/06 Data Types Available
01	Read Output Table	Y, C, T, CT
02	Read Input Table	X, SP
03	Read Holding Registers (when addressing mode is 584/984, this function is used to access analog output registers)	V
04	Read Input Registers (when addressing mode is 584/984, this function is used to access analog input registers)	V
05	Force Single Output	Y, C, T, CT
06	Preset Single Registers	V
08	Loop back / Maintenance	
15	Force Multiple Outputs	Y, C, T, CT
16	Preset Multiple Registers	V

Determining the MODBUS Address

There are typically two ways that most MODBUS addressing 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 or Master Requires the Data Type and Address

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

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

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

In either case, you basically convert the PLC octal address to decimal and add the appropriate MODBUS starting address (as required). The following tables show the exact range used for each group of data.

For an automated MODBUS/Koyo address conversion utility, download the file **modbus_conversion.xls** from the **www.automationdirect.com** technical support website > Technical and Application notes> PLC hardware> Coummunications> app note # AN–MISC–010.

DL05 Memory Type	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	MODBUS Data Type
For Discrete Data Types	**Convert PLC Addr. to Dec.**	**+**	**Start of Range +**	**Data Type**
Inputs (X)	256	X0 – X377	2048 – 2303	Input
Special Relays (SP)	512	SP0 – SP777	3072 – 3583	Input
Outputs (Y)	256	Y0 – Y377	2048 – 2303	Coil
Control Relays (C)	512	C0 – C777	3072 – 3583	Coil
Timer Contacts (T)	128	T0 – T177	6144 – 6271	Coil
Counter Contacts (CT)	128	CT0 – CT177	6400 – 6527	Coil
Stage Status Bits (S)	256	S0 – S377	5120 – 5375	Coil
For Word Data Types	**Convert PLC Addr. to Dec.**		**+**	**Data Type**
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)	3072	V1400 – V7377	768 – 3839	Holding Register

DL06 Memory Type	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	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 – SP777	3072 – 3583	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
Global Inputs (GX)	2048	GX0 – GX3777	0 – 2047	Input
Global Outputs (GY)	2048	GY0 – GY3777	0 – 2047	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)	256 3072 4096	V400 – V677 V1400 – V7377 V10000 – V17777	256 – 511 768 – 3839 4096 – 8191	Holding Register

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

Example 1: V2100

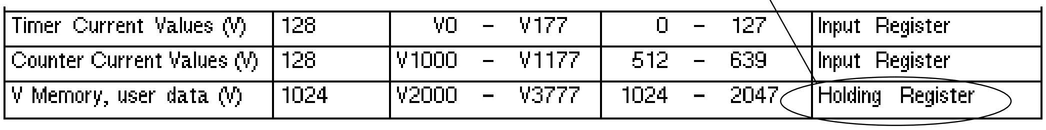
Find the MODBUS address for User V location V2100.

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

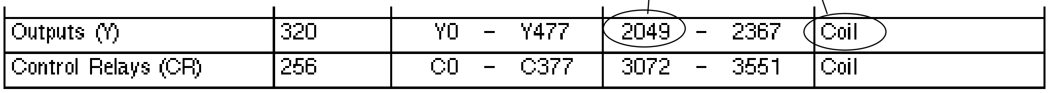
Find the MODBUS address for output Y20.

1. Find Y outputs in the table.
2. Convert Y20 into decimal (16).
3. Add the starting address for the range (2049).
4. 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

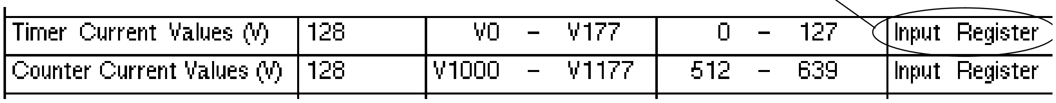
Find the MODBUS address to obtain the current value from Timer T10.

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

TA10 = 8 decimal

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



Timer Current Values (V)	128	V0 – V177	0 – 127	Input Register
Counter Current Values (V)	128	V1000 – V1177	512 – 639	Input Register

Example 4: C54

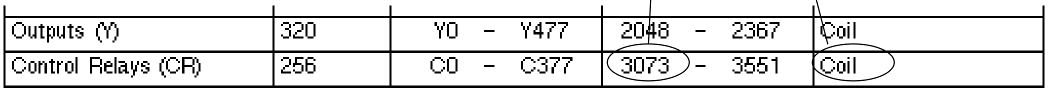
Find the MODBUS address for Control Relay C54.

1. Find Control Relays in the table.
2. Convert C54 into decimal (44).
3. Add the starting address for the range (3072).
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 (CR)	256	C0 – C377	3073 – 3551	Coil

If the Host Software or Master Requires an Address ONLY

Some MODBUS masters do 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 also separates the data types by address ranges as well. This means an address alone can actually describe the type of data and location. This is often referred to as “adding the offset”.

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, C, S, T, CT (contacts)
- Word – V memory , Timer current value, Counter current value

In either case, you basically convert the PLC octal address to decimal and add the appropriate MODBUS starting address (as required). The following tables show the exact range used for each group of data.

For an automated MODBUS/Koyo address conversion utility, download the file **modbus_conversion.xls** from the **www.automationdirect.com** technical support website > Technical and Application notes> PLC hardware> Coummunications> app note # AN–MISC–010.

DL05 Discrete Data Types

PLC Memory Type	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	Access
Inputs (X)	256	X0 – X377	12049 – 12304	Read only
Special Relays (SP)	512	SP0– SP777	13073 – 13584	
Reserved	–	–	13585 – 20000	
Outputs (Y)	256	Y0 – Y377	2049 – 2304	Read/ Write
Control Relays (C)	512	C0 – C777	3073 – 3584	
Timer Contacts (T)	128	T0 – T177	6145 – 6272	
Counter Contacts (CT)	128	CT0 – CT177	6401 – 6528	
Stage Status Bits (S)	256	S0 – S377	5121 – 5376	
Reserved	–	–	6529 – 10000	

DL05 Word Data Types

Registers (Word)	QTY (Dec.)	PLC Range (Octal)	MODBUS 40001 Address Range	MODBUS 30001 Address Range	Access
V Memory (Timers)	128	V0 – V177	40001 – 40128	30001 – 30128	Read/ Write
V Memory (Counters)	128	V1000 – V1177	40513 – 40640	30513 – 30640	Read/ Write
V Memory (Data Words)	3072	V1400 – 7377	40769 – 43840	30769 – 33840	

DL06 Discrete Data Types				
PLC Memory Type	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	Access
Global Inputs (GX)	2048	GX0–GX1746	10001 – 10999	Read only
		GX1747 – GX3777	11000 – 12048	
Inputs (X)	512	X0 – X777	12049 – 12560	
Special Relays (SP)	512	SP0– SP777	13073 – 13584	
Reserved	–	–	13585 – 20000	
Global Outputs (GY)	2048	GY0– GY3777	1 – 2048	Read/ Write
Outputs (Y)	512	Y0 – Y777	2049 – 2560	
Control Relays (C)	1024	C0 – C1777	3073 – 4096	
Timer Contacts (T)	256	T0 – T377	6145 – 6400	
Counter Contacts (CT)	128	CT0 – CT177	6401 – 6528	
Stage Status Bits (S)	1024	S0 – S1777	5121 – 6144	
Reserved	–	–	6529 – 10000	

DL06 Word Data Types					
Registers (Word)	QTY (Dec.)	PLC Range (Octal)	MODBUS 40001 Address Range	MODBUS 30001 Address Range	Access
V Memory (Timers)	256	V0 – V377	40001 – 40256	30001 – 30256	Read/ Write
V Memory (Counters)	128	V1000 – V1177	40513 – 40640	30513 – 30640	Read/ Write
V Memory (Data Words)	256	V400 – V777	40257 – 40512	30257 – 30512	Read/ Write
	3072	V1400 – 7377	40769 – 43840	30769 – 33840	
	4096	V10000 – V17777	44097 – 48192	34097 – 38192	

Example 1: V2100

Find the MODBUS address for User V location V2100.

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

PLC Address (Dec.) + Mode Address

V2100 = 1088 decimal

1088 + 40001 = **41089**

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

Example 2: Y20

Find the MODBUS address for output Y20.

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

PLC Addr. (Dec) + Start Address + Mode

Y20 = 16 decimal

16 + 2048 + 1 = **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: C54

Find the MODBUS address for Control Relay C54.

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

PLC Addr. (Dec) + Start Address + Mode

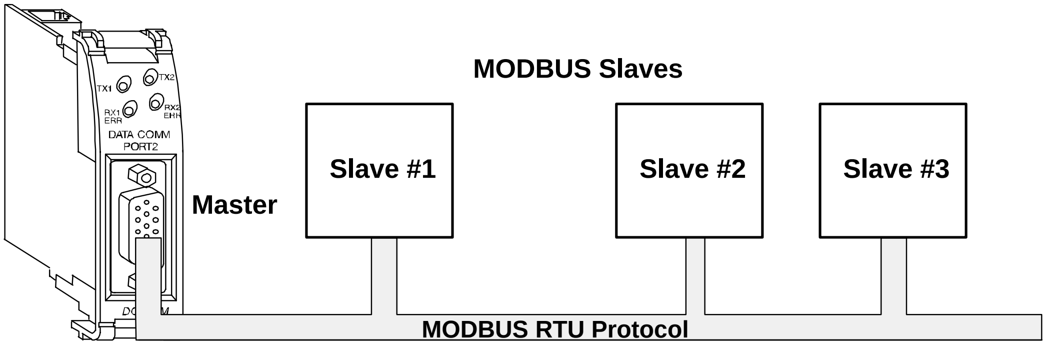
C54 = 44 decimal

44 + 3072 + 1 = **3117**

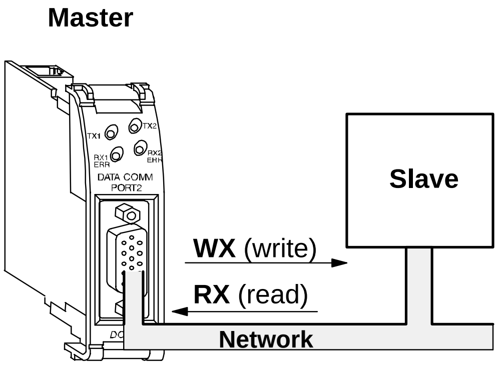
Outputs (Y)	320	Y0 – Y477	2048 – 2367	1	1	Coil
Control Relays (CR)	256	C0 – C377	3072 – 3551	1	1	Coil
Timer Contacts (T)	128	T0 – T177	6144 – 6271	1	1	Coil

Network Master Operation

This section describes how the DL05/06 CPU can serve as a master on a MODBUS RTU network using the D0–DCM. This section discusses how to design the required ladder logic for network master operation.



When using the DCM as a master on the network, 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 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.



MODBUS Function Codes Supported

The D0–DCM supports the following MODBUS function codes when acting as a MODBUS RTU master.

MODBUS Function Code	Function	DL05/06 Data Types Available
01	Read Output Table	Y, C, T, CT
02	Read Input Table	X, SP
03	Read Holding Registers (when addressing mode is 584/984, this function is used to access analog output registers)	V
06	Preset Single Registers	V
15	Force Multiple Outputs	Y, C, T, CT
16	Preset Multiple Registers	V

Note: The D0–DCM, as a master, does not support function code 4. Thus, 30001 address ranges cannot be read from a slave device.

PLC Memory Supported for Master Operation

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 three categories for this purpose.

- Discrete – X, GX, SP
- Discrete – Y, C, S, T, CT
- Word – Timer current value, Counter current value, Data Words

In either case, you basically take the MODBUS address you are trying to target, subtract the starting MODBUS of that range, convert the result to octal and add the octal number to the begining PLC address in the appropriate PLC range. See the conversion examples on the following page. The following tables show the exact range used for each group of data.

For an automated MODBUS/Koyo address conversion utility, download the file **modbus_conversion.xls** from the **www.automationdirect.com** technical support website > Technical and Application notes> PLC hardware> Coummunications> app note # AN–MISC–010.

DL06 Discrete Data Types*

PLC Memory Type	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	Access
Global Inputs (GX)	2048	GX0–GX1746	10001 – 10999	Read only
		GX1747 – GX3777	11000 – 12048	
Inputs (X)	512	X0 – X777	12049 – 12560	
Special Relays (SP)	512	SP0– SP777	13073 – 13584	
Reserved	–	–	13585 – 20000	
Global Outputs (GY)	2048	GY0– GY3777	1 – 2048	Read/ Write
Outputs (Y)	512	Y0 – Y777	2049 – 2560	
Control Relays (C)	1024	C0 – C1777	3073 – 4096	
Timer Contacts (T)	256	T0 – T377	6145 – 6400	
Counter Contacts (CT)	128	CT0 – CT177	6401 – 6528	
Stage Status Bits (S)	1024	S0 – S1777	5121 – 6144	
Reserved	–	–	6529 – 10000	

DL06 Word Data Types*

Registers (Word)	QTY (Dec.)	PLC Range (Octal)	MODBUS Address Range	Access
V Memory (Timers)	256	V0 – V377	40001 – 40256	Read/ Write
V Memory (Counters)	128	V1000 – V1177	40513 – 40640	Read/ Write
V Memory (Data Words)	256	V400 – V777	40257 – 40512	Read/ Write
	3072	V1400 – 7377	40769 – 43840	
	4096	V10000 – V17777	44097 – 48192	

***** Refer to page 5–6 for memory mapping size for the DL05 CPUs. The DL06 has a larger memory in some areas.

Your PC’s Windows calculator can be used for number conversions (i.e. decimal to octal). The Windows calculator must be in Calculator>View>Scientific mode to enable number conversions capability.

Example 1: Calculating Word PLC Address

Find the PLC address to use to target MODBUS address **41025** in a server device.

1. Subtract the begining of the MODBUS word address range (40001) from the desired MODBUS address to target.
2. Convert decimal result into octal.
3. Add octal result to begining PLC range (Input, Output or Word).

1. 41025 – 40001 = 1024 decimal

2. 1024 decimal = 2000 octal

3. V0 (octal) + 2000 (octal) = **V2000** octal

Example 2: Calculating Discrete Input PLC Address

Find the PLC address to use to target MODBUS address **12060** in a server device.

1. Subtract the begining of the MODBUS Input address range (12049) from the desired MODBUS address to target.
2. Convert decimal result into octal.
3. Add octal result to begining PLC range (Input, Output or Word).

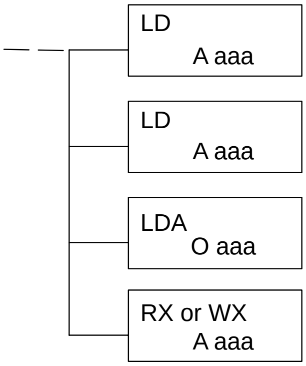
1. 12060 – 12049 = 11 decimal

2. 11 decimal = 13 octal

3 X0 (octal) + 13 (octal) = **X13** octal

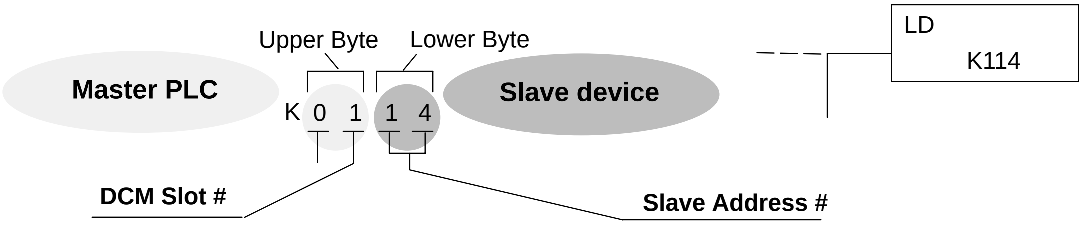
Building the Read (RX) or Write (WX) Routine

For network communications, you build the Read (RX) or Write (WX) instructions into a **routine** which requires the four instructions you see to the right. They must be used in the sequence shown. The following step-by-step procedure will provide you the information necessary to set up your ladder program to receive data from a network server.



Step 1: Identify DCM Slot Location and Slave

The first Load (LD) instruction accepts either a constant or a variable. Use a “K” to designate the number as a constant. Use a “V” if you are entering the address of a register. The contents of that register perform the same function as the constant shown below. For example, you could use V2000 in place of K0114. If the contents of V2000 is the number “114,” the function would be the same. Using a variable allows changing parameters while the program is running.

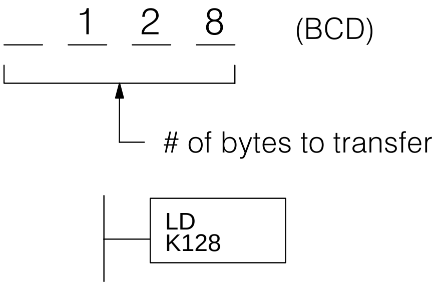


DL05 Special Relays	
Relay	Option Slot
Communication busy	SP120
Communication error	SP121

DL06 Special Relays				
Relay	Slot 1	Slot 2	Slot 3	Slot 4
Communication busy	SP120	SP122	SP124	SP126
Communication error	SP121	SP123	SP125	SP127

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.

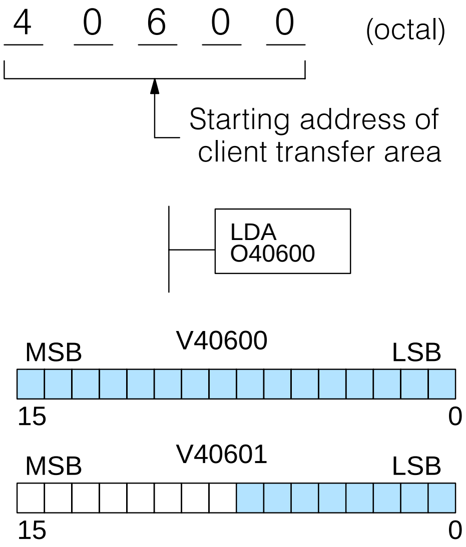


Step 3: Specify Master Memory Area

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 DL05/06 CPU sends the number of bytes previously specified from its memory area beginning at the LDA address specified.

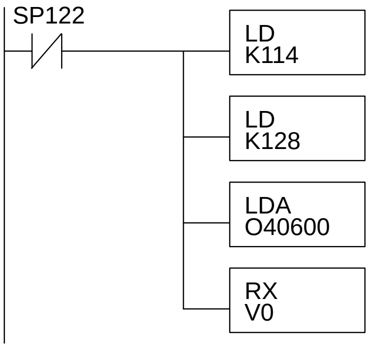
For an RX instruction, the DL05/06 CPU reads the number of bytes previously specified from the server, placing the received data into its memory area beginning at the LDA address specified.



Note: Since V memory words are always 16 bits, you may not always use the whole word. For example, if you only specify to read 3 bytes, 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.

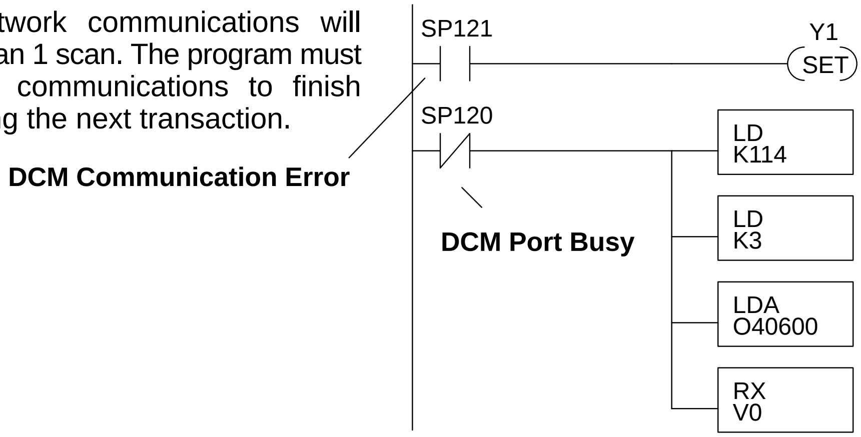
Step 4: Specify Slave Memory Area

The last instruction in our sequence is the WX or RX instruction itself. Use WX to write to the server, and RX to read from the server. 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 server.



Communications from a Ladder Program

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



Depending on which slot the DCM is in, it has two Special Relay contacts associated with it (see page 5–12 for special relays). One indicates “Port busy”, and the other indicates “Port Communication Error”. The example above shows the use of these contacts for an ECOM that is in slot 1. 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.

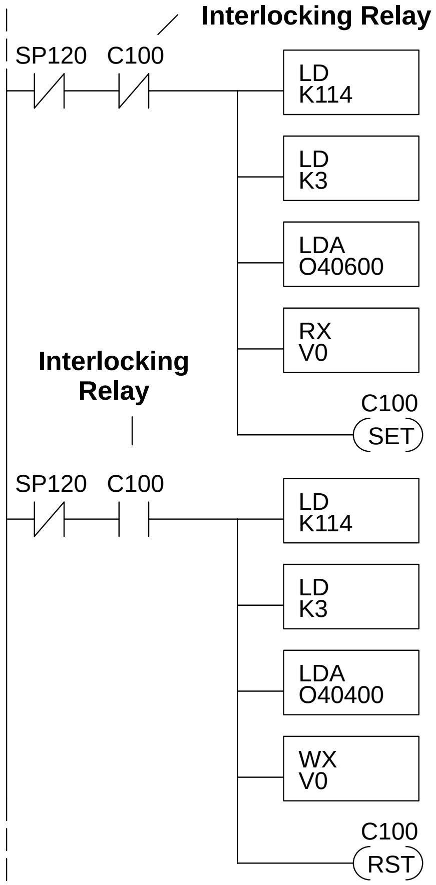
The “Port Communication Error” bit turns on when the PLC has detected an error. Use of this bit is optional. When used, it should be ahead of any network instruction boxes since the error bit is reset when an RX or WX instruction is executed.

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, C0 is set. When the port has finished the communication task, the second routine is executed and C0 is reset.

If you are using RLL^{PLUS} Stage Programing, 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.


Interlocking Relay
SP120
C100
LD
K114
LD
K3
LDA
O40600
RX
V0
Interlocking
Relay
C100
SET
SP120
C100
LD
K114
LD
K3
LDA
O40400
WX
V0
C100
RST