D2–DCM
Data Communications Module

Manual Number D2–DCM–M

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Manual Revisions

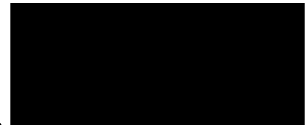*If you contact us in reference to this manual, please remember to include the revision number.*

Title: DL205 Data Communications Module
Manual Number: D2–DCM–M

Issue	Date	Description of Changes
Original	5/96	Original Issue
Rev. A	5/98	Downsize to spiral Rev. A Minor changes
2nd Edition	2/03	Upgrade with DL06 and **Direct**SOFT32; added MDM–TEL information

Table of Contents

Introduction

D2–DCM
# Data Communication
Module

In This Manual. . . .

— Introduction
— Building the Communication Cable
— Setting the D2–DCM Switches
— Installing the D2–DCM and Starting the Network
— Verification and Troubleshooting

Overview

The Purpose of this Manual

This manual is designed to allow you to setup and install your DL205 Data Communications Module (D2–DCM). This is the only manual you will need if you are using the D2–DCM as an extra general purpose communication port for your DL205 PLC system. If you plan on using the D2–DCM as a network master or slave for a *Direct*NET network, this manual covers the basic steps for setting up the D2–DCM and the RX/WX instructions needed in your RLL program.
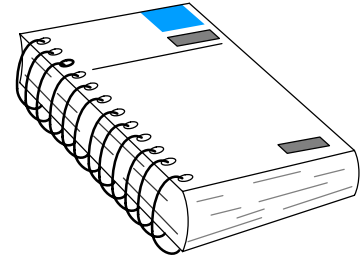
If you plan on using a personal computer as the network master, it may be helpful to read the *Direct*NET manual first. In either case, the *Direct*NET manual can be useful because it provides detailed descriptions of network configurations, various cable connections, etc.

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 D2–DCM to communicate with another PLC, you will need the appropriate user manual for the other PLC.

If you plan to use your D2–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 DL205 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 D2–DCM module.

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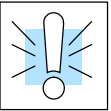
The "exclamation mark" icon in the left-hand margin indicates a **warning** or **caution**. These are very important because the information may help you prevent serious personal injury or equipment damage.

Key Topics for Each Chapter

The beginning of each chapter will list the key topics that can be found in that chapter.
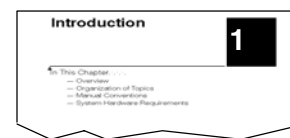
D2–DCM Hardware

The following diagram shows the major D2–DCM components. The address selection switches and the communication dipswitches are of special importance.

Online/Offline Switch

Status Indicators (shown below)

Base Connector

RS232C/RS422 Communication Port

Address Selection Switches

DIP Switches for communications and protocol parameters

Module Power: ON

NK: ON if a NAK is either sent or received

TO: ON if a timeout has occurred in the D2–DCM

Master Mode: ON if master OFF if slave

Self Test Indicator: ON

Send/Receive Enquiry: FLASHING*

Send/Receive Header: FLASHING*

Send/Receive Data Packet: FLASHING*

Status Indicators

* During communications only

The DL205 Data Communications Module (D2–DCM) is a general purpose communications interface that can be used in a DL205 system that has a D2–240/250–1/260 Central Processing Unit (CPU). **The D2–DCM cannot be used with a DL230 CPU.** The module can go in any base slot, except for Slot 0, which is next to the CPU. This module is primarily used for three reasons.

- As a network master or slave interface to a **Direct**NET network

- As an extra general purpose communications port to connect a personal computer or operator interface

- As a network interface to a MODBUS® network using the RTU protocol

Applications

As a *Direct*NET Interface

The D2–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 D2–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 **Masters**
Issue requests to slave stations

*Direct*NET **Slaves**
Slaves respond to the master's request

Response

PC or D2–DCM master can communicate with *Direct*NET Slaves
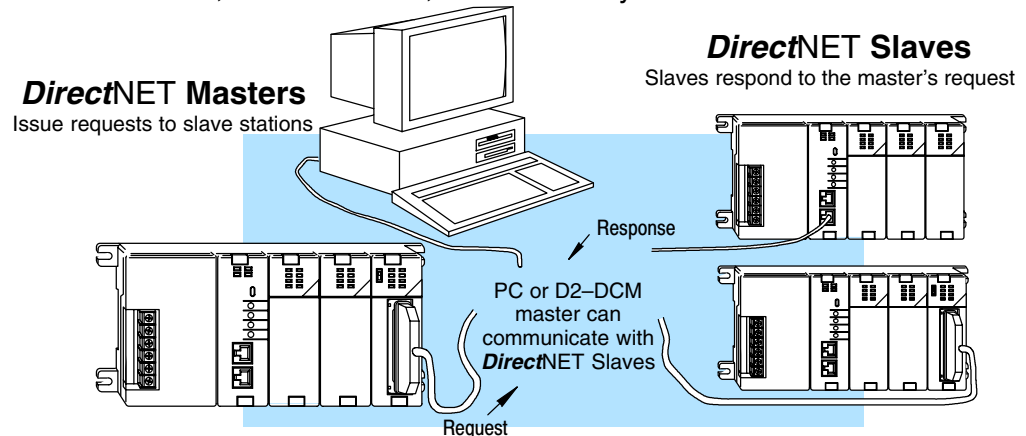
Request

Using a D2–DCM as a Network Master
The DL205 D2–DCM can be used with a D2–240/250–1/260 CPU to serve as a network master. Your CPU must have firmware V1.8 or later. **It cannot be used with a DL230 CPU.** (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 D2–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
- D2–240/250–1/260 CPU (bottom port)
- D2–240/250–1/260 w/ D2–DCM
- D3–330 or D3–330P w/ DCU
- D3–340 (either port)
- D4–430 (bottom port)
- D4–440 (bottom port)
- D4–450 (phone jack or bottom port)
- Any DL405 CPU w/ D4–DCM

The PLC program is really very simple and only requires a few instructions. Appendix A provides an overview of the instructions. Or, see the *Direct*NET Manual for network details.

Using a D2–DCM as a Network Slave
The D2–DCM can also be used with a D2–240/250–1/260 CPU to serve as a network slave station. **It cannot be used with a DL230 CPU.** In this case, the D2–DCM "listens" to the network for any messages that contain the D2–DCM's address. The D2–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
- D2–240/250–1/260 w/ D2–DCM
- D3–340 CPU (bottom port)
- Any DL405 CPU w/ D4–DCM
- D4–450 CPU (bottom port)
- Host computer w/*Direct*SOFT DSData Server
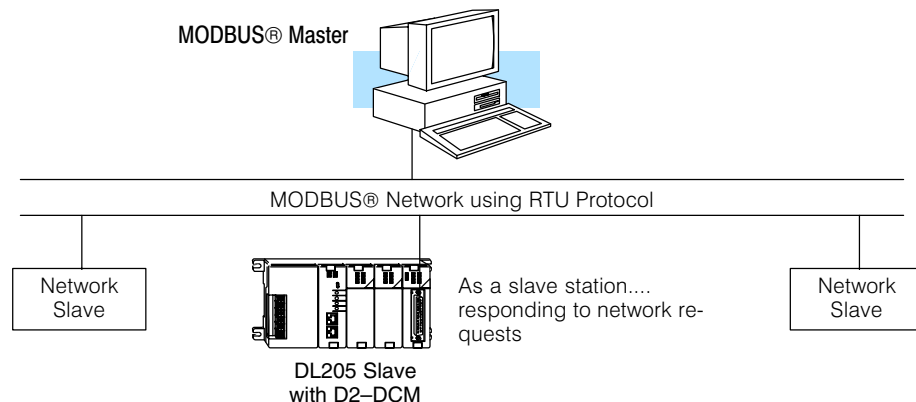
As an Extra Communication Port

As an extra communication port, the D2–DCM supports the *Direct*NET protocol just like the bottom port on the D2–240/250–1/260 CPU, but at higher baud rates. In general, if you can connect a device to the bottom port on the D2–240/250–1/260 CPU, then you can also connect the same device to the D2–DCM. These devices can be a variety of things, such as operator interfaces or personal computers.

Since the D2–DCM does not require any programming, you can simply set the D2–DCM communication parameters, connect the appropriate RS232C or RS422 cables, and start transferring data.

Quickly add extra communication ports*

* Number of D2–DCMs is limited by the available power budget
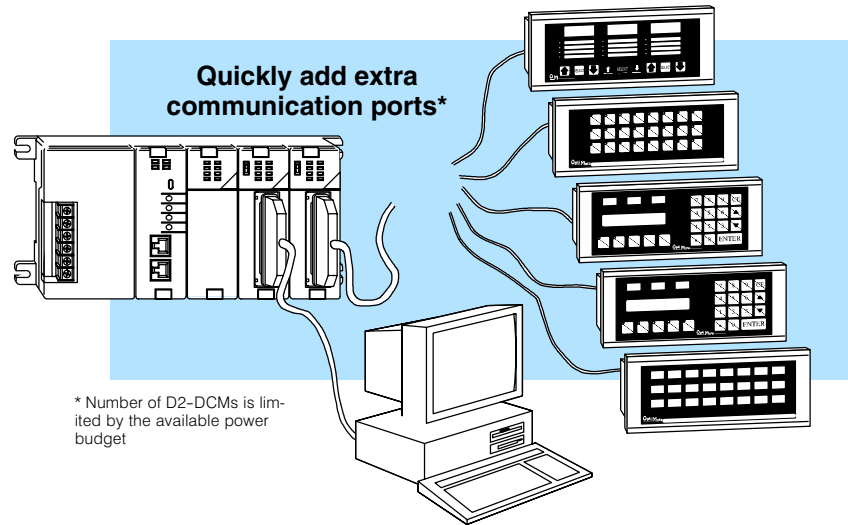
As a MODBUS® Network Interface

The D2–DCM can be used as a slave interface to connect your DL205 system to a MODBUS® network using the MODBUS® RTU protocol. The host system must be capable of issuing the MODBUS® commands to read or write the appropriate data. **Appendix C provides additional information on using the D2–DCM as a MODBUS slave interface.** 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.

MODBUS® Master

MODBUS® Network using RTU Protocol

Network Slave

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

Network Slave

DL205 Slave with D2–DCM

Specifications

Environmental Specifications

|	
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	JIS C0040
Shock	JIS C0041
Voltage Isolation	1500 VAC, 1 minute duration
Insulation Resistance	10M ohms at 500 VDC
Noise	NEMA ICS3–304

Operating Specifications

|	
Power Budget Requirement	300ma @ 5 VDC
Maximum number of modules	limited only by power budget
CPU Required	D2–240/250–1/260 minimum firmware V1.8 or later
Location of module	CPU base only any slot except Slot 0 or CPU slot
Interface	Serial RS232C / RS422 half-duplex, DTE, Asynchronous, 8 bits/character, odd or no parity
Baud Rates	300 to 38.4K baud, switch selectable
Maximum Distance	RS232C – 49ft (15 meters) RS422 – 3300 feet (1000 meters)
Protocol	**Direct**NET[1] K-sequence (proprietary) MODBUS® RTU
Diagnostics	Automatic check of ROM/RAM, communications, switch settings, and LEDs

Note 1: Also compatible with Hostlink and/or CCM2 protocols. These names were used by previous vendors of compatible Koyo designed products.
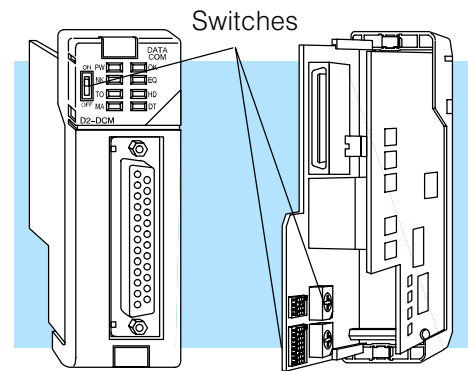
Using your D2–DCM– Five Steps

STEP 1. Familiarize yourself with the communications options of D2–DCM in the Introduction.
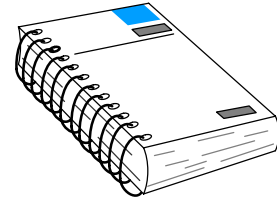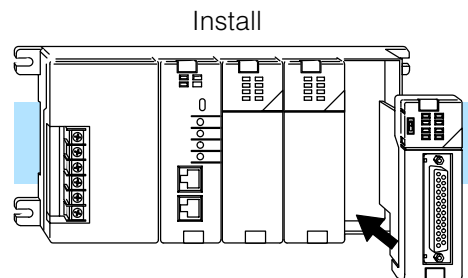
Cable

STEP 2. Build the communication cable that fits your needs.
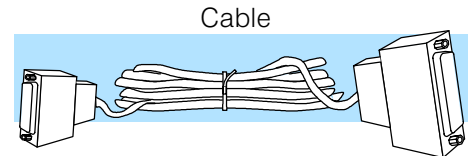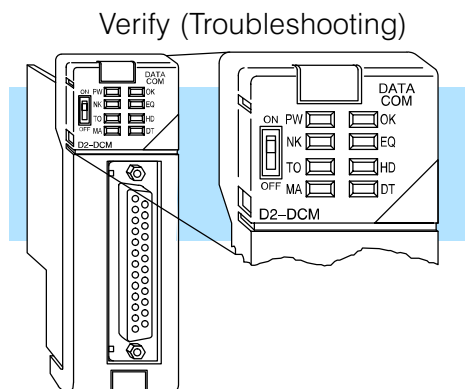
Switches

STEP 3. Set the D2–DCM switches. (Baud rate, parity, etc).

Install

STEP 4. Install the D2–DCM in any slot except for Slot 0, which is next to the CPU.

Verify (Troubleshooting)

STEP 5. Verify correct network operation by using the indicators and the troubleshooting chart.

Building the Communication Cable

There are several considerations that help determine the type of cable needed for your D2–DCM application.

1. Will the D2–DCM be physically connected in a point-to-point configuration or multi-drop configuration?
2. What electrical specification is best for your application? RS232C or RS422?
3. What is the cable schematic?
4. What are the relevant cable specifications?
5. What installation guidelines are necessary?

The next few pages discuss these considerations in detail.

Tip: If you need a quick test cable you may want to try our FA–CABKIT which allows you to quickly build several different types of cables. (See page 15 for more information). If you're fairly comfortable with network or communications cabling requirements, see Appendix A for detailed diagrams.
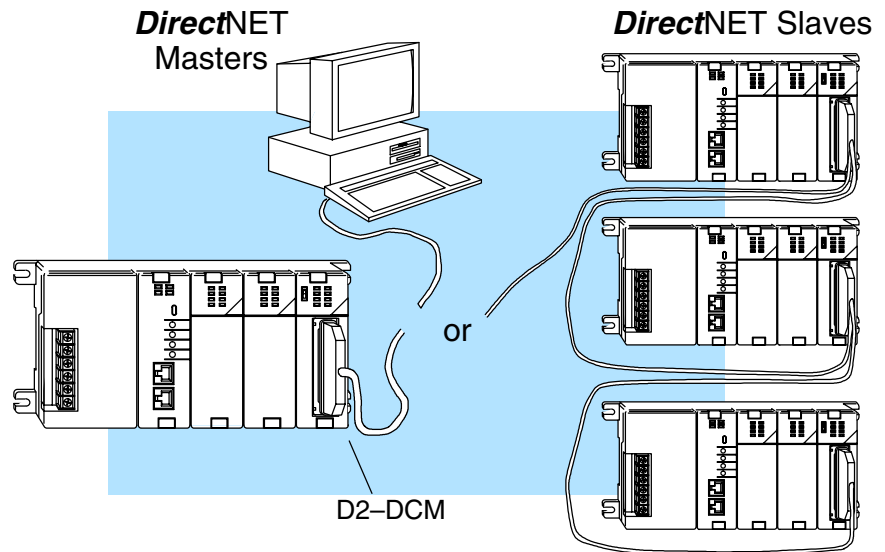
**Consideration 1:
Physical
Configuration**

The D2–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 D2–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

D2–DCM

DL205 Master   *Direct*NET PLC Slave

Multi-drop

*Direct*NET
Masters   *Direct*NET Slaves
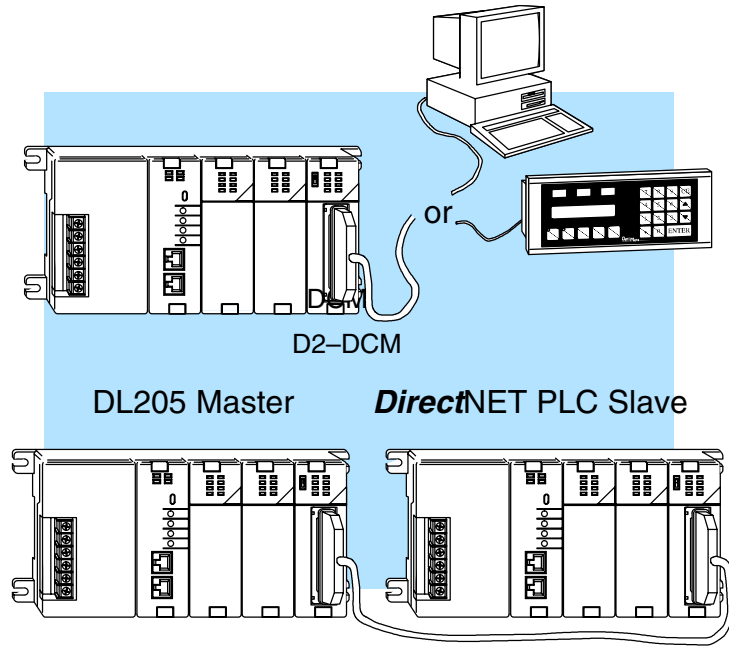
D2–DCM

**Consideration 2:
Electrical
Specification
RS232C or RS422**

The D2–DCM can support RS232C or RS422 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 RS422. If you are using point-to-point, you may have a choice between RS232C and RS422.

You can use RS232C 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 RS422 for all other applications. RS422 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 D2–DCM are just as important. The exact cable schematic needed really depends on a combination of all three things. There are a wide range of possibilities when you consider that all three product families, the DL205, DL305, and DL405 all offer *Direct*NET communication capabilities.
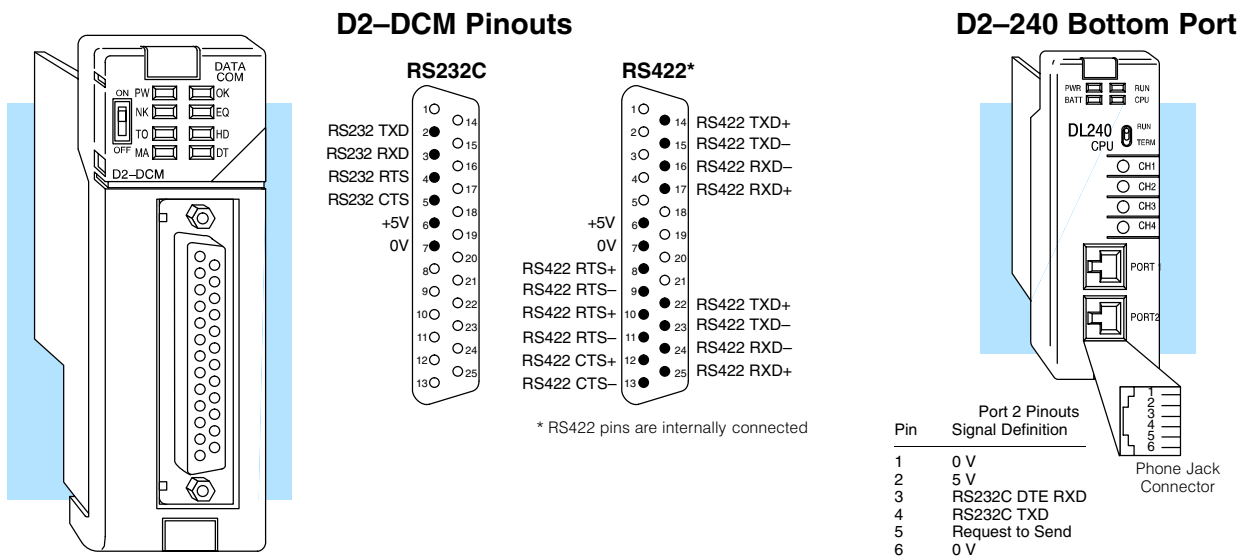
Hint: Look at Appendix A to determine a cable possibility. Some of these examples may need to be combined to design a cable for your application.

NOTE: If you are using the D2–DCM to connect an OptiMation operator interface, you must order our standard pre-made cable, part number OP–4CBL–2. If you are using a DV–1000, you must build a custom cable. See the cable diagram at the end of Appendix A.

The following diagram shows the port pinouts for the D2–DCM and the bottom port of the DL240 CPU. These are the two most likely combinations that you will use. Notice that the D2–DCM has two sets of RS422 pins. These pins are internally connected and can make it easier to wire multidrop connections.

D2–DCM Pinouts

RS232C

RS232 TXD	2	
RS232 RXD	3	
RS232 RTS	4	
RS232 CTS	5	
+5V	6	
0V	7	
RS422 RTS+	8	
RS422 RTS–	9	
RS422 RTS+	10	
RS422 RTS–	11	
RS422 CTS+	12	
RS422 CTS–	13	

RS422*

14	RS422 TXD+
15	RS422 TXD–
16	RS422 RXD–
17	RS422 RXD+
+5V	6	
0V	7	
22	RS422 TXD+
23	RS422 TXD–
24	RS422 RXD–
25	RS422 RXD+

* RS422 pins are internally connected

D2–240 Bottom Port

Port 2 Pinouts

Pin	Signal Definition
1	0 V
2	5 V
3	RS232C DTE RXD
4	RS232C TXD
5	Request to Send
6	0 V

Phone Jack Connector

NOTE: The DL205 CPU ports only support RS232C signal levels. If you are going to have more than one slave station, you will have to use RS422 and a FA–UNICON RS232 to RS422 converter for each slave station. See the cable diagrams shown in Appendix A for detailed diagrams.

**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. A cable constructed equivalent to Belden 9855 is sufficient. The following specifications are to be used as a guideline.

Structure . . . . Shielded, twisted-pair
(RS232C 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.
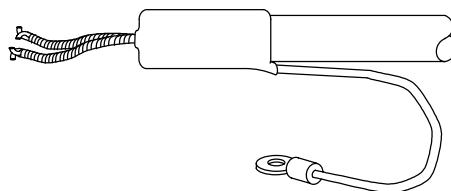
- Don't run cable next to larger motors, high current switches, or transformers. This may cause noise problems.

- 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.
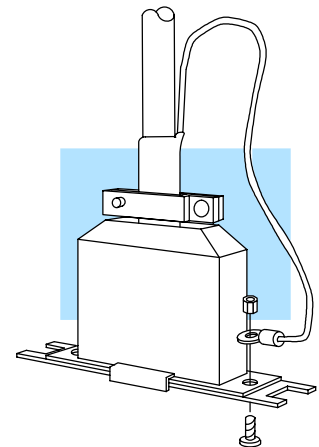
Step 1: Strip back about 2.5" of the shield.

2.5"

Step 3: Secure the shield to the connector shell.

**Step 2: Crimp a ring connector onto the shield.**

Multi-drop Termination Resistors — It is important you add termination resistors at each end of the RS422 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.
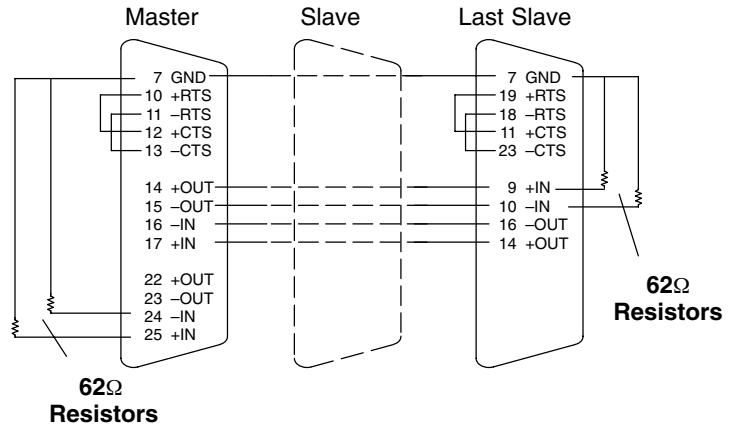
The following diagram illustrates the two options.
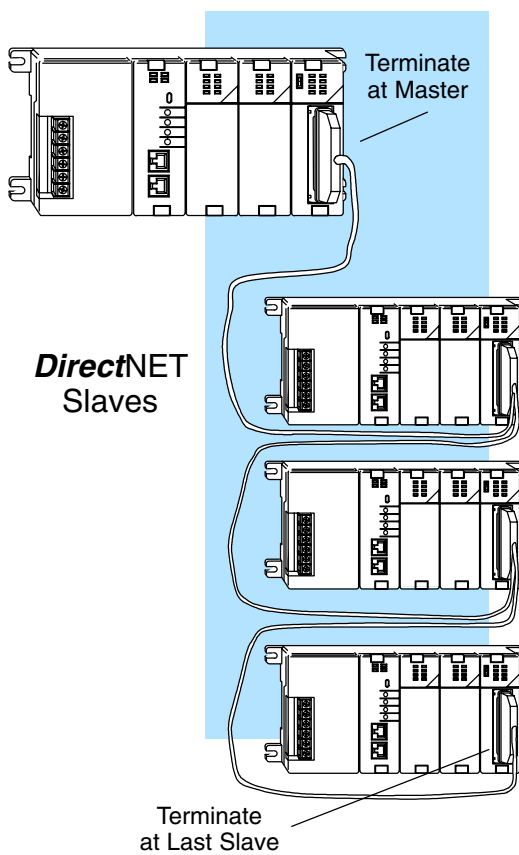

Line-to-Line Termination for the D2–DCM
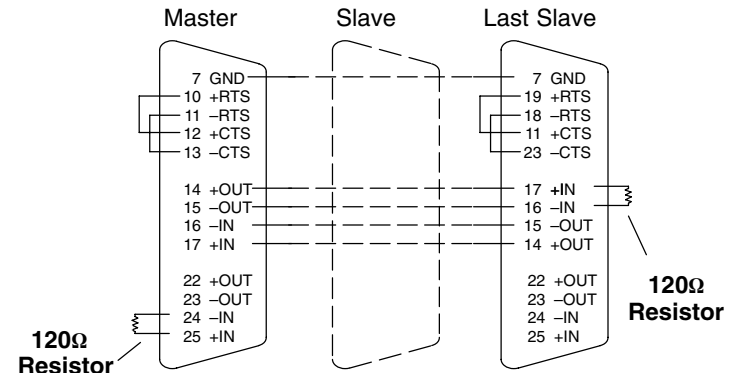
**Line-to-Ground Termination for the D2–DCM**

Network Amplifiers — If you have more than 16 slave stations, you must use an RS422 amplifier to maintain the signal levels. The best amplifiers are regenerative, that is, they try to improve signal quality by reducing any noise signals that are present. (They amplify the signal and not the noise if possible.) Some amplifiers are not regenerative and amplify the noise as well as the signal. You can purchase amplifiers from several sources. The Black Box catalog is one of many good places to start; they sell direct. Call 1–800–555–1212 and ask the 800 directory assistance operator for their phone number. You can also look for a amplifier supplier on the internet. One web site to look at is www.idealsolution.com, or search for other RS422 amplifier web sites. The following diagram illustrates some instances where an amplifier is necessary.

Serial Slave Connection
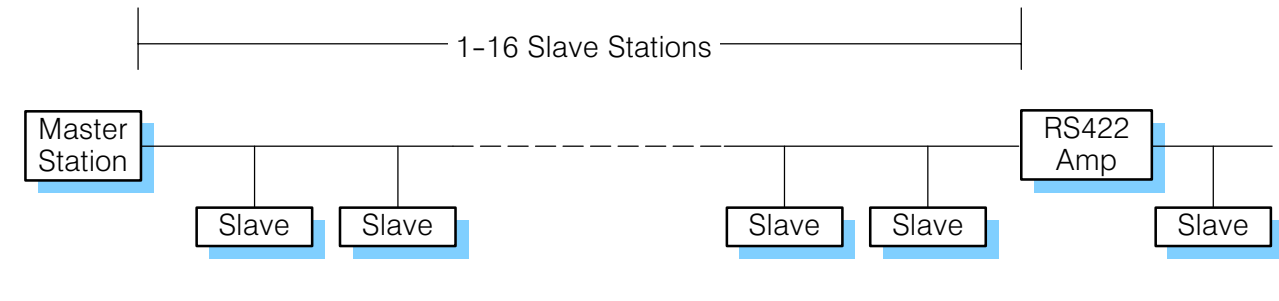
Parallel Slave Connection
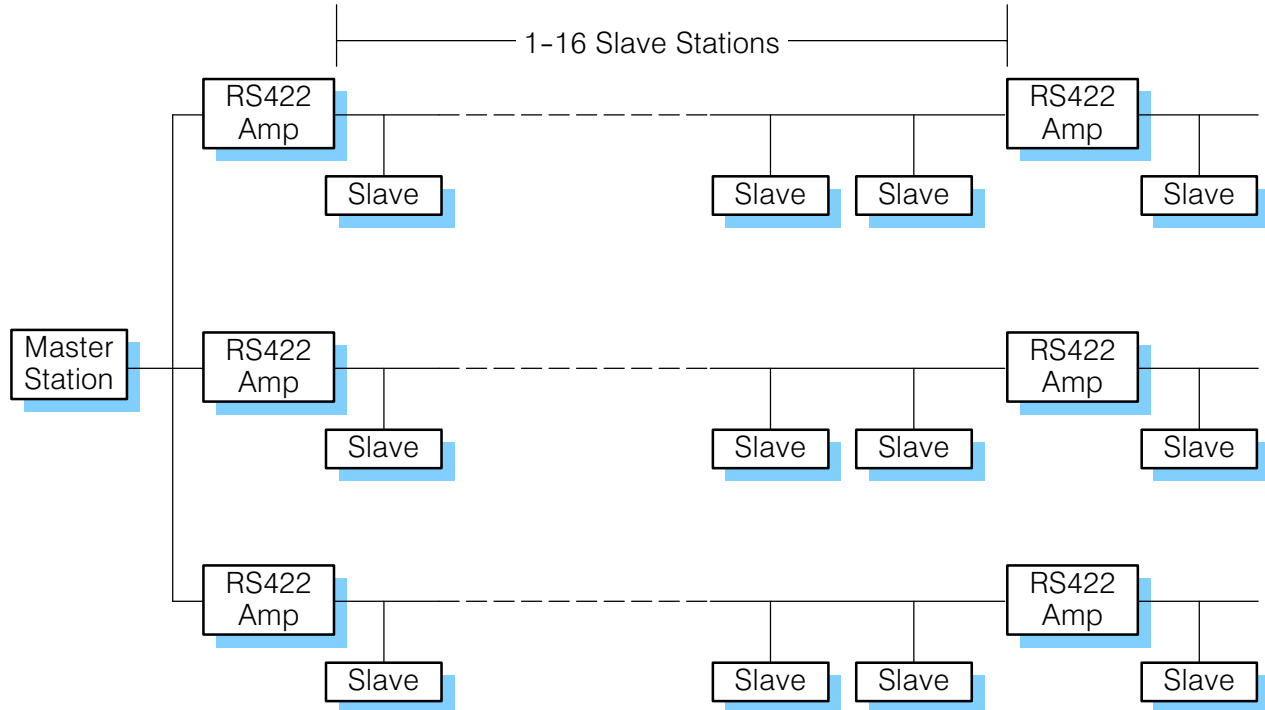
A Quick Test Cable   **AutomationDirect** offers a Universal Cable Kit (part number FA–CABKIT). This cable kit allows you to connect various types of **Direct**LOGIC products with an RS232C cable. The kit consists of cable (phone cable with male plugs already attached) and several specially wired connectors. The special connectors are a D-sub style with built-in female phone jacks. The kit includes a wide variety of the special connectors so you can use one kit to connect products from the different **Direct**LOGIC family of products. To use the kit with the D2–DCM, just follow these steps.
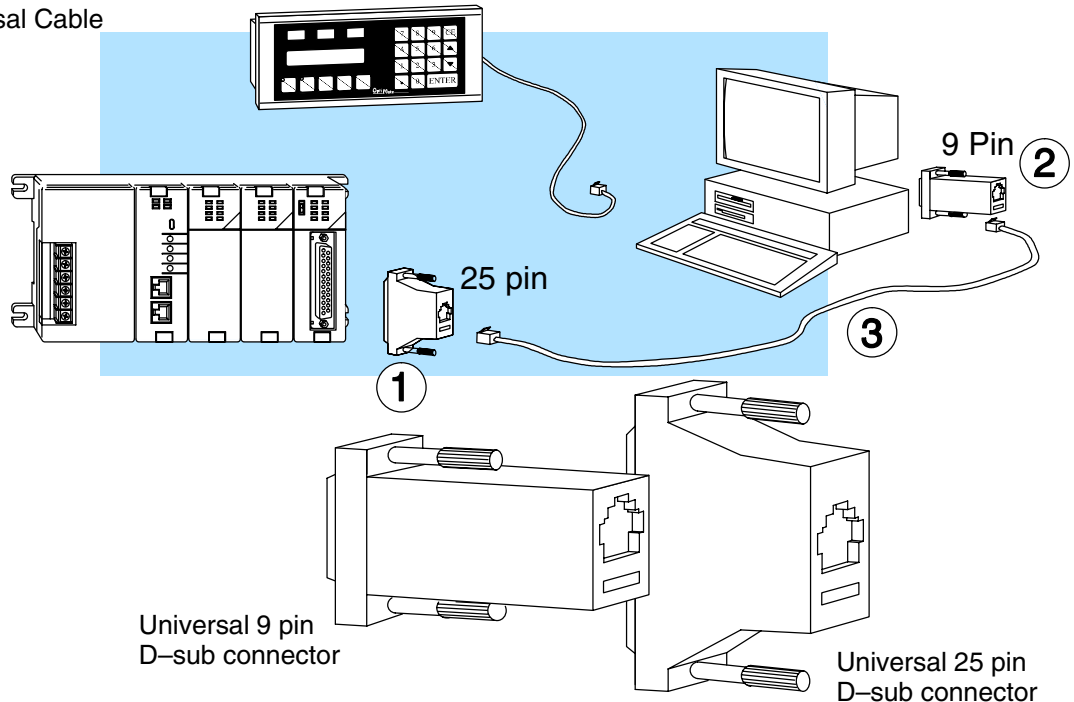
1. Plug the appropriate D-sub connector onto the D2–DCM.
2. Plug the appropriate D-sub connector onto the other device you are connecting to the D2–DCM.
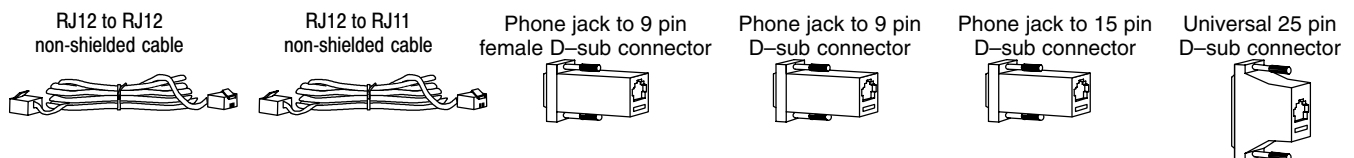3. Connect the cable to the two D-sub connectors.

WARNING: This cable is suitable for quick testing situations and must not be used in actual applications. This cable is not shielded and is highly susceptible to electrical noise. Electrical noise can cause unpredictable operation that may result in a risk of personal injury or damage to equipment. Use the cable specifications described earlier in this manual to select a cable suitable for actual applications.

Build A Test Cable In 30 Seconds

1. Attach Universal Cable Adapter to the D2–DCM
2. Attach another Universal Cable Adapter to the Device which will connect to the D2–DCM
3. Attach the Universal Cable

9 Pin ②

25 pin

③

①

Universal 9 pin
D–sub connector

Universal 25 pin
D–sub connector

Cable Kit Contains one (1) each of:

RJ12 to RJ12 non-shielded cable	RJ12 to RJ11 non-shielded cable	Phone jack to 9 pin female D–sub connector	Phone jack to 9 pin D–sub connector	Phone jack to 15 pin D–sub connector	Universal 25 pin D–sub connector

Setting the D2–DCM switches

The D2–DCM has two banks of dipswitches that allow you to select the communication parameters necessary for your application. In quite a few cases, you may not have to change the switches at all. The D2–DCM comes set from the factory for:

- *Direct*NET Slave operation
- 9600 Baud
- Station Address 1
- Odd Parity
- Hex Mode

Host Computer or Operator Interface Connection

If you're using a host computer or operator interface as the master station you should set the D2–DCM to match the master station parameters. Check the documentation that came with your computer or operator interface panel to determine the available communication parameters.

You'll need to know the following things.

- Baud rate
- Parity settings
- Protocol required

Your operator interface must use one of the following protocols.

- *Direct*NET
- K-sequence
- Hostlink (*Direct*NET was called Hostlink on the old TI™ or Simatic® TI products. Some Operator Interface manufacturers may still refer to it this way.)
- MODBUS® RTU

Direct*NET Interface Connection

If you're using the D2–DCM as a *Direct*NET interface, you'll need to know whether the D2–DCM is being used in a master station, slave station, or peer station. Once you've determined how the D2–DCM will be used, proceed with the dipswitch settings.
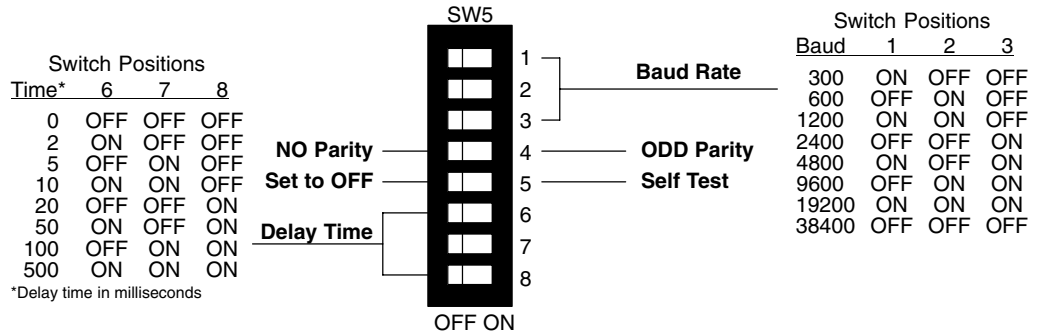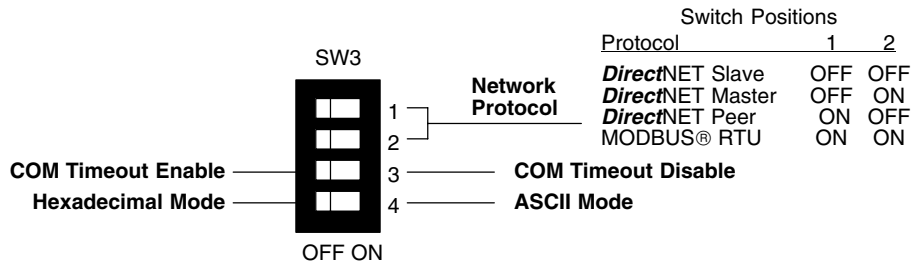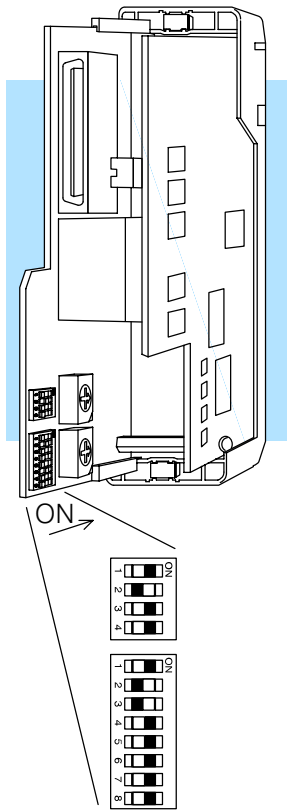
Master – Slave Network

Peer as Master Network

D2–DCM as Master

D2–DCM as Peer   **D2–DCM as Peer**

D2–DCM as Slave
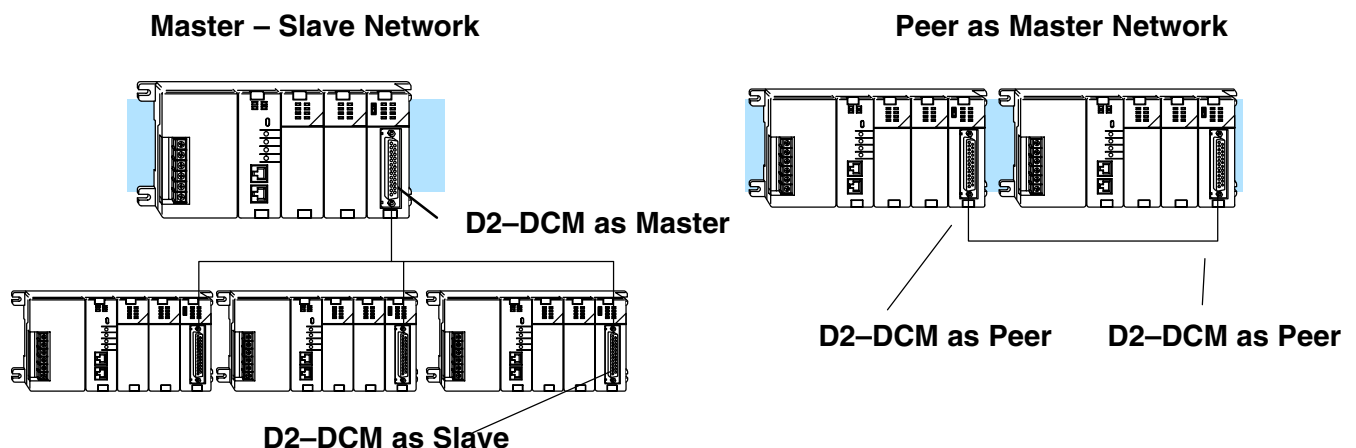
**D2–DCM
Switch Settings**

Once again, the switches should be set at the factory for the following type of operation.

- *Direct*NET Slave
- 9600 Baud
- Station Address 1
- Odd Parity
- Hex Mode

If these settings are acceptable, then you can go ahead and install the D2–DCM into the base. If not, you'll have to change the switch settings.

There are two small banks of switches located next to the blue rotary switches on the one of the D2–DCM circuit boards. These dipswitches are used to select the communications settings. The following diagram shows the switch locations and their purpose.

SW3

Switch Positions		
Protocol	1	2
*Direct*NET Slave	OFF	OFF
*Direct*NET Master	OFF	ON
*Direct*NET Peer	ON	OFF
MODBUS® RTU	ON	ON

Network Protocol — 1, 2

COM Timeout Enable — 3 — **COM Timeout Disable**

Hexadecimal Mode — 4 — **ASCII Mode**

OFF ON

SW5

Switch Positions			
Baud	1	2	3
300	ON	OFF	OFF
600	OFF	ON	OFF
1200	ON	ON	OFF
2400	OFF	OFF	ON
4800	ON	OFF	ON
9600	OFF	ON	ON
19200	ON	ON	ON
38400	OFF	OFF	OFF

Baud Rate — 1, 2, 3

Switch Positions			
Time*	6	7	8
0	OFF	OFF	OFF
2	ON	OFF	OFF
5	OFF	ON	OFF
10	ON	ON	OFF
20	OFF	OFF	ON
50	ON	OFF	ON
100	OFF	ON	ON
500	ON	ON	ON

*Delay time in milliseconds

NO Parity — 4 — **ODD Parity**

Set to OFF — 5 — **Self Test**

Delay Time — 6, 7, 8

OFF ON

ON

Protocol Selection: Positions 1 and 2 on SW3 select the D2–DCM protocol and the master or slave settings. The D2–DCM primarily uses two protocols, *Direct*NET and MODBUS® RTU protocol. Here's some information to help you choose.

Communications Port for Direct SOFT32 Programming: If you plan to program the CPU through the D2–DCM, then you can use either *Direct*NET protocol or our proprietary protocol, called K-sequence. Although it is not listed in the switch settings, K-sequence is also available whenever the D2–DCM is set for *Direct*NET slave operation.

Computer or Operator Interface: If you're using the D2–DCM to connect a computer or operator interface, check your documentation to see which protocol is being used. Since the D2–DCM is always a slave station when it's connected to a computer or operator interface, you should select *Direct*NET slave or MODBUS® RTU slave. Note, there are also a handful of operator interfaces that have been designed to use our proprietary K-sequence protocol. If you have one of these, or if you need to use K-sequence for some reason, make sure you set the D2–DCM for *Direct*NET Slave operation. Peer to Peer works in Hexadecimal mode only.

*Direct*NET *Master / Slave:* In a *Direct*NET master / slave network, one D2–DCM should be set as a master and the rest should be set as slaves.

*Direct*NET *Peer as Master:* This is a variation of the master / slave protocol and should be selected when you only have two stations that can each initiate requests. Each station must have a D2–DCM as the network interface.

MODBUS® RTU Slave: The D2–DCM can also be a MODBUS® slave (in the RTU or HEX mode). The D2–DCM cannot be a MODBUS® master station. If you're going to use MODBUS®, make sure your software package supports the DL205 products. See Appendix C for more information.

Communication Timeout: Position 3 on SW3 selects the communication timeout. For most cases, you should leave this switch in the OFF position. 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.

ASCII / HEX Mode: Position 4 on SW3 selects 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 set the switch for ASCII mode, otherwise, use HEX mode.

Baud Rate: Positions 1 – 3 on SW5 are used to set the baud rate for the D2–DCM. There are eight baud rate selections available ranging from 300bps to 38.4Kbps. **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: Position 4 on SW5 selects between the two parity options, odd or none. If you're using all DL205 equipment, you should use odd parity. Odd parity uses eleven bits total (1 start bit, 8 data bits, 1 stop bit, and 1 parity bit).

Some devices require no parity, which uses only 10 bits (1 start bit, 8 data bits, and 1 stop bit).

Self-Test: Position 5 on SW5 selects the factory self-test and should <u>always</u> be switched off. If the self-test is on, the module will not operate correctly.

Response Delay Time: Positions 6–8 on SW4 set the response delay time. The delay time specifies the amount of time the D2–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 D2–DCM with a radio modem. If you are using the D2–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.

Address Selection Switch

The D2–DCM station address is set by the two rotary switches located on one of the D2–DCM's circuit boards. **Addresses are in hexadecimal format with valid addresses from 0 (only used for the master station) to hexadecimal 5A**. The addresses do not have to be consecutive, but each station must have a unique address.

The top rotary switch is used to set the most significant digit of the HEX address. The bottom switch is used to set the least significant digit of the HEX address. For example, to set a D2–DCM address of HEX 10 (decimal 16), set the top rotary switch to 1 and the bottom rotary switch to 0. If you're using the D2–DCM as a master, make sure you select address 0.

Even though the D2–DCM address is set in hexadecimal, it's a good idea to remember the decimal equivalent. This is because the decimal address is used most often. For example, a RLL communications program, the *Direct*SOFT32 Programming Software, and our DSData Server all use the decimal equivalent of the HEX address. It's easy to convert from hex to decimal.

Example: Switches set for 3C

HEX Format

```
0 1 2 3 4 5 6 7 8 9 A B C D E F
                      | | | | | |
                     10 11 12 13 14 15
```

HEX 3C

3 x 16 = 48   +   **C** = 12   = 60 decimal

X10

X1
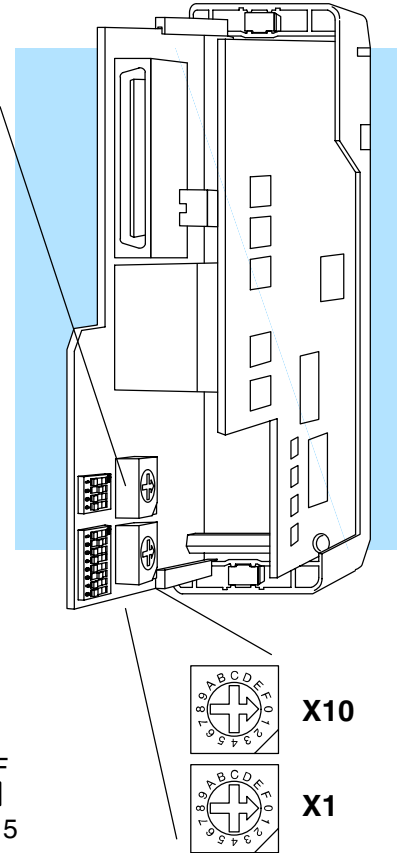
Warning: The D2–DCM address switch settings are only read at power up. If you want to change the address, you must remove the module from the base to access the switches. Your system can be damaged if you install or remove system components before disconnecting the system power. To minimize the risk of equipment damage, electrical shock, or personal injury, always disconnect the system power before installing or removing any system component.

**Online / Offline
Switch**

On the front of the unit, just to the left of the LEDs, you'll notice a small slide switch. This switch is labeled ON (for online) and OFF (for offline). If you want to communicate through the D2–DCM, make sure this switch is in the ON position.

In the OFF position, this switch logically disconnects the D2–DCM from the network (just as if you pulled the cable from the connector). Once this switch is moved to the OFF position, the D2–DCM will not communicate with the network. If you move the switch to the ON position, the D2–DCM will communicate with the network, but not until the master sends another request for communication. This does not operate like the reset switch on many personal computers.
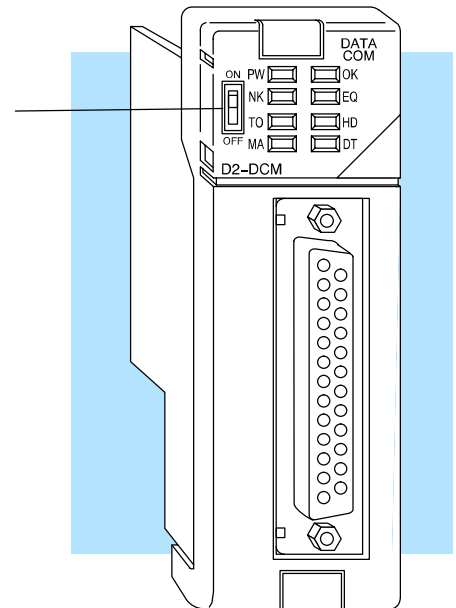
Install the D2–DCM and Starting the Network

Install the D2–DCM   The D2–DCM can go in any slot of a DL205 base **except** Slot 0, which is right next to the CPU. The D2–DCM will not work in Slot 0.

If you're using a D2–DCM as the network interface in a PLC master station, remember to make a note of the slot location. (You will have to refer to this address at some point.)

NOTE: The D2–DCM *can not* be mounted in a base that does not contain a D2–240/250–1/260 CPU. Also, the D2–DCM requires 300mA of +5V base power. Make sure you will not exceed the available base power budget by installing the D2–DCM. See the DL205 User Manual for complete details on power budget calculations.
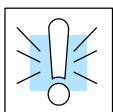
WARNING: Your system can be damaged if you install or remove system components before disconnecting the system power. To minimize the risk of equipment damage, electrical shock, or personal injury, always disconnect the system power before installing or removing any system component.

To insert the module into the base, align the circuit board(s) with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector. Once the module is inserted into the base, push in the retaining clips (located at the top and bottom of the module) to firmly secure the module to the base.

Align module to slots in base and slide in

Push the retaining clips in to secure the module to the DL205 base
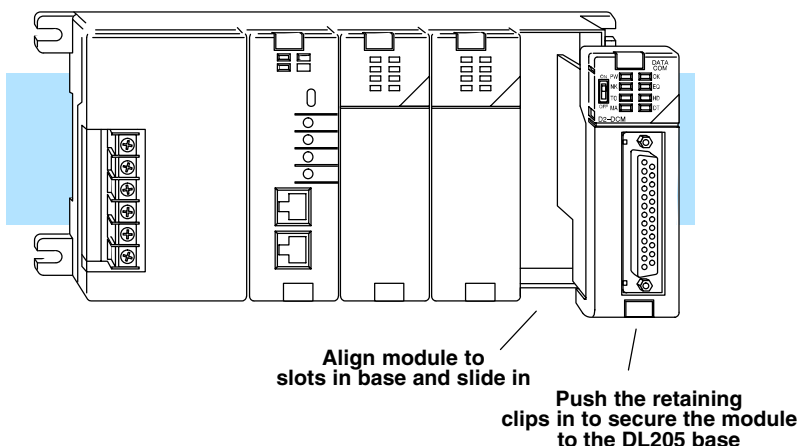
Connect the Cables   Make sure you have all the cables connected and that all the network devices have the same communication parameters (baud rate, parity, etc).

If you're using *Direct*NET...   The PLC master station must contain an RLL program that has the appropriate RX or WX instructions necessary to initiate the communications. (See Appendix B for details on the RX and WX instructions). The master station CPU must be in Run mode in order to execute the communications program. The slave station CPUs do not absolutely have to be in Run mode because the D2–DCM will still transfer the data. Whether you put the slave stations in Run mode depends on your application requirements.

If you're using an Operator Interface or Host Computer...
Connect the cables and follow the procedures outlined in the documentation that came with your host computer software or operator interface. You'll have to execute your host or operator interface program before the communications can begin. For example, if you're using *Direct*SOFT32, you can just specify the station address and start working!

If you're using MODBUS®...
Connect the cables and follow the procedures outlined in your MODBUS® Host software package to start the communications. See Appendix C for more information on using the D2–DCM with MODBUS protocol.

Verification and Troubleshooting

If you have used the guidelines shown previously in Step 3, Starting the Network, you are now ready to verify that the unit is operating properly. Check the D2–DCM indicators to verify the D2–DCM is operating correctly. The following diagram shows the proper indicator conditions.

Note: Online/Offline switch has been removed from the drawing for clarity.

Module Power: ON

NK: ON if a NAK is either sent or received

TO: ON if a timeout has occurred in the D2–DCM

MA: ON if master OFF if slave

DATA COM

PW

NK

TO

MA

OK

EQ

HD

DT

D2–DCM

OK: ON if self test is OK

EQ: Send/Receive Enquiry FLASHING*

HD: Send/Receive Header FLASHING*

DA: Send/Receive Data Packet: FLASHING*
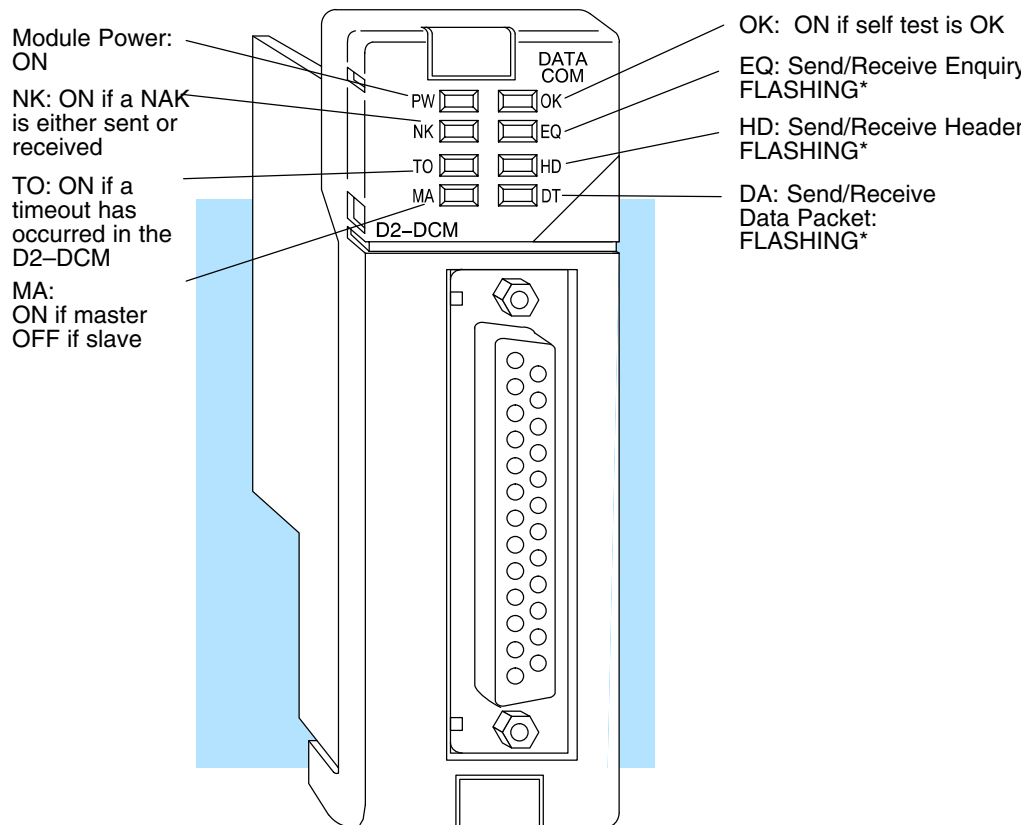
* During Communication only

Troubleshooting Quick Steps

If the D2–DCM does not seem to be working correctly, check the following items. These items represent the problems found most often.

1. Cable and connections. Incorrectly wired cables and loose connectors cause the majority of problems. Verify you've selected the proper cable configuration and check the cable making sure it is wired correctly.

2. Dipswitch settings. Make sure you've set the D2–DCM to match the communication parameters required by the master station (D2–DCM, operator interface or host computer).

3. Incorrect protocol. Make sure your operator interface or personal computer software can use the *Direct*NET, Hostlink, CCM2, or MODBUS® RTU protocol.

4. Communications program. Check the communications program for errors. Consult the *Direct*NET Manual or the manuals that came with your host computer software or operator interface for details.
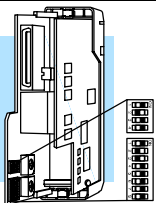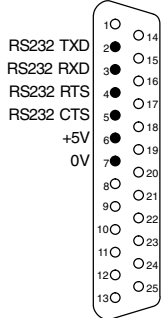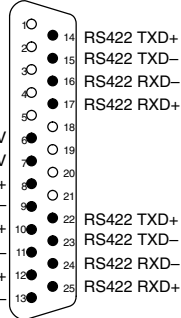
NOTE: If you need more in depth troubleshooting, see the chart on the next page. It provides several different indicator patterns that may help identify your exact problem.

Troubleshooting Chart

off   on   flash

The following chart identifies the indicator status, possible cause, and corrective action for a wide variety of commonly found problems.

Master Station Indicators	Slave Station Indicators	Possible Cause
Power or OK is off.		1.Master PLC power is disconnected ⟹ 1. 2.D2–DCM is defective
Power and OK are on. Master indicator is off.		1.Switch setting on master station is incorrect ⟹ 2.
Power, OK, and MA are on. EQ does not come on when the communications program is executed.		1.The master station CPU not in RUN. ⟹ 3. 2.Online/Offline switch is set to OFF. 3.Communications program is not correct.
Power, OK, and MA are on. EQ stays on, but NK, TO, or HD indicators do not come on at all.		1.COM Timeout is disabled. ⟹ 4. 2.RTS and CTS signals are not looped back on the D2–DCM end of the cable.
Power, OK, and MA are on. EQ stays on, and TO flashes.	Only PW and OK OR EQ flashes.	1.RLL Communications program is incorrect. ⟹ 5. 2.Settings are different. 3.Cable problem.
Power, OK, and MA are on. EQ stays on, and NK flashes.	EQ & NK come on OR EQ and HD flash.	1.Settings are different. ⟹ 6. 2.Cable problem or Slave is offline.
Power, OK, and MA are on. EQ and HD come on. TO flashes.	EQ & HD come on	1.Settings are different. ⟹ 7.
Power, OK, and MA are on. EQ and HD come on. EQ goes off. HD stays on, and NK flashes or stays on.	EQ & HD come on THEN EQ goes off, HD and NK are on	1.RLL Communications program is incorrect. ⟹ 8. 2.Settings are different.
Power, OK, and MA are on. DT is on, but NK flashes on occasion.		1.Electrical noise. ⟹ 9.

Corrective Action	Switch Settings & Port Pinouts

Switch Settings

1.
1. Check the master PLC source power.
2. Replace the D2–DCM.

2.
1. Disconnect the master station PLC power, remove the D2–DCM and check positions 1 & 2 on SW3.

3.
1. Place the CPU in RUN mode.
2. Set the switch to the ON position.
3. Make sure the RX or WX instruction is being executed. Check the address, slot number, and amount and type of data used in the RX/WX instructions.

4.
1. Disconnect the PLC power, remove the D2–DCM and check position 3 on SW3.
2. Remove master station connector, ensure that RTS & CTS are connected according to the cable diagram.

5.
1. Check the address, slot number, and amount and type of data used in the RX/WX instructions.
2. Make sure baud rate, parity, and mode (HEX/ASCII) match between the master and slave.
3. Verify that the cable is wired properly.

6.
1. Make sure baud rate, parity, and mode (HEX/ASCII) match between the master and slave.
2. Verify that the cable is wired properly. Also, make sure slave is online.

7.
1. Make sure baud rate, parity, and mode (HEX/ASCII) match between the master and slave.

8.
1. Check the amount and type of data being transferred. (Byte count may be set to 1 or an odd number for a data type that requires 2 bytes.)
2. Make sure baud rate, parity, and mode (HEX/ASCII) match between the master and slave.

9.
1. Make sure the system has good earth grounds. Only one end of the cable shield must be grounded.
2. If you're using RS232C, try RS422.

SW3

COM Timeout Enable — 1 Network Protocol
Hexadecimal Mode — 2
3 — COM Timeout Disable
4 — ASCII Mode

OFF ON

Switch Positions
Protocol	1	2
*Direct*NET Slave	OFF	OFF
*Direct*NET Master	OFF	ON
*Direct*NET Peer	ON	OFF
MODBUS® RTU	ON	ON

SW5

1
2 Baud Rate
3
NO Parity — 4 — ODD Parity
Set to OFF — 5 — Self Test
6
7 Delay Time
8

OFF ON

Switch Positions
Baud	1	2	3
300	ON	OFF	OFF
600	OFF	ON	OFF
1200	ON	ON	OFF
2400	OFF	OFF	ON
4800	ON	OFF	ON
9600	OFF	ON	ON
19200	ON	ON	ON
38400	OFF	OFF	OFF

Switch Positions
Time*	6	7	8
0	OFF	OFF	OFF
2	ON	OFF	OFF
5	OFF	ON	OFF
10	ON	ON	OFF
20	OFF	OFF	ON
50	ON	OFF	ON
100	OFF	ON	ON
500	ON	ON	ON

*Delay time in milliseconds

Port Pinouts

DATA COM
ON PW OK
NK EQ
TO HD
OFF MA DT
D2–DCM

RS232C

RS232 TXD 2
RS232 RXD 3
RS232 RTS 4
RS232 CTS 5
+5V 6
0V 7

1 14
2 15
3 16
4 17
5 18
6 19
7 20
8 21
9 22
10 23
11 24
12 25
13

RS422*

1 14 RS422 TXD+
2 15 RS422 TXD–
3 16 RS422 RXD–
4 17 RS422 RXD+
5 18
+5V 6 19
0V 7 20
RS422 RTS+ 8 21
RS422 RTS– 9 22 RS422 TXD+
RS422 RTS+ 10 23 RS422 TXD–
RS422 RTS– 11 24 RS422 RXD–
RS422 CTS+ 12 25 RS422 RXD+
RS422 CTS– 13

* RS422 pins are internally connected

Cable Diagrams

A

**Point-to-Point
RS232C
D2–DCM as Master**

These diagrams show the D2–DCM being used as the network master. The cable diagram is the same when the D2–DCM is being used as a slave (for those connections that could have the master/slave roles reversed). This is true for the:

- D2–DCM to D4–DCM connection
- D2–DCM to DL305 CPU with RS232C DCU (or a D3–340 bottom port)
- D2–DCM to DL405 CPU connection when used with a D4–450 CPU.
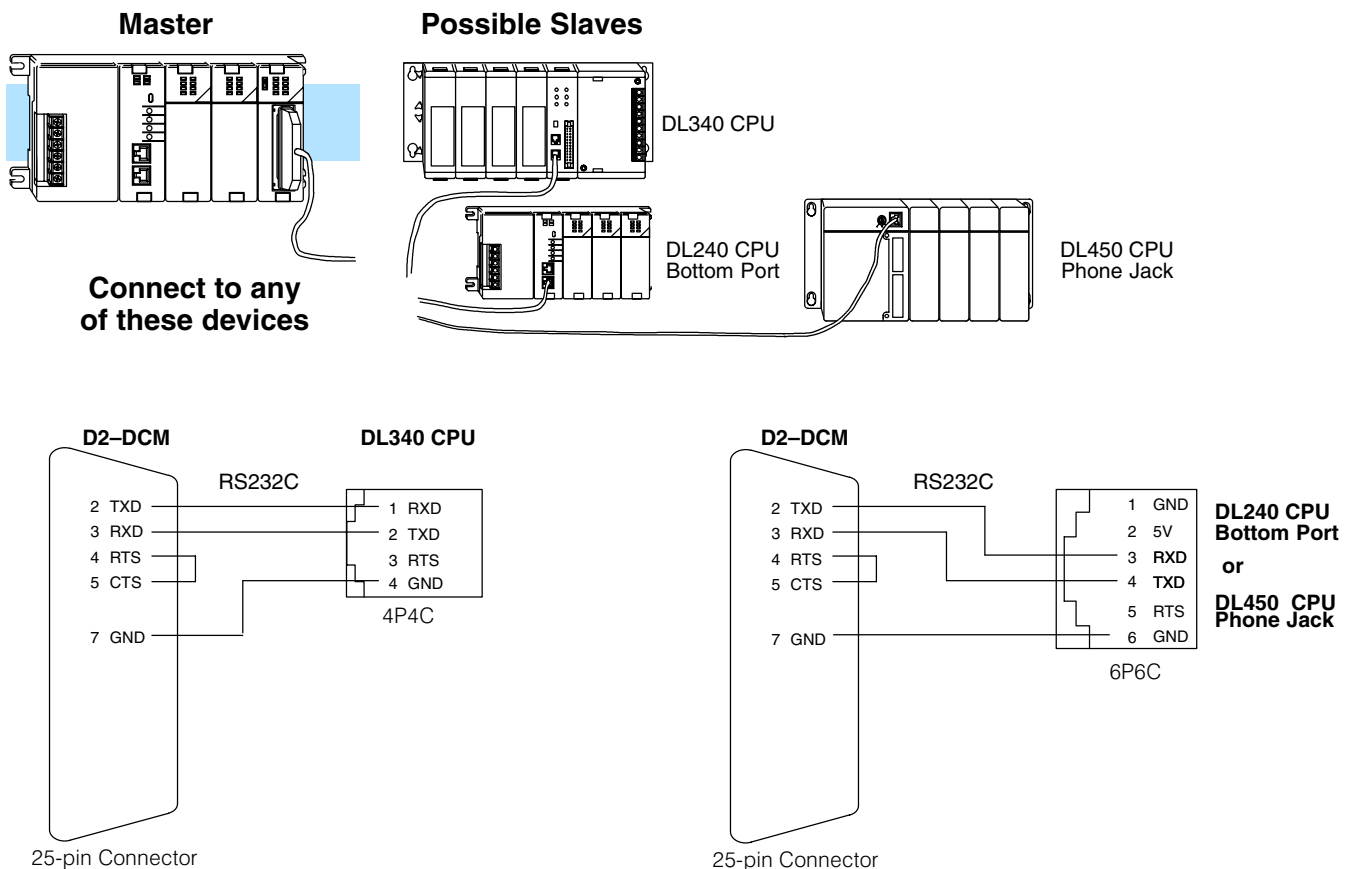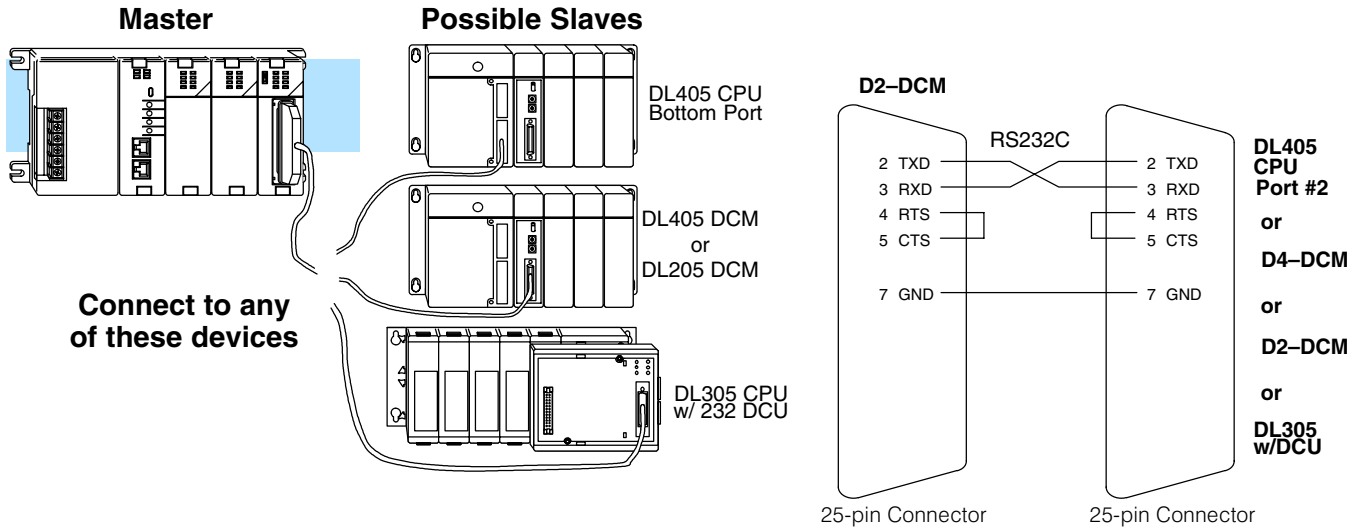
**Point-to-Point
RS232C
PC as Master**

These diagrams show the D2–DCM being used as a slave to a personal computer. The personal computer would have to be capable of issuing commands using either *Direct*NET or MODBUS RTU protocol. A good example of this would be a personal computer running an Excel spreadsheet connected through our DSData Server. (Sounds complicated, but it's really quite simple! Check out our catalog for more information on our powerful DSData Server.)

Master   **Slave**

DL205 DCM

Personal Computer   **D2–DCM**

RS232C

2 RXD	2 TXD
3 TXD	3 RXD
5 GND	7 GND
1 DCD	4 RTS
4 DTR	5 CTS
6 DSR	
7 RTS	
8 CTS	

9-pin
Connector

25-pin Connector

Personal Computer   **D2–DCM**

RS232C

2 TXD	2 TXD
3 RXD	3 RXD
7 GND	7 GND
4 RTS	4 RTS
5 CTS	5 CTS
6 DSR	
8 DCD	
20 DTR	

25-pin DTE
Connector

25-pin Connector
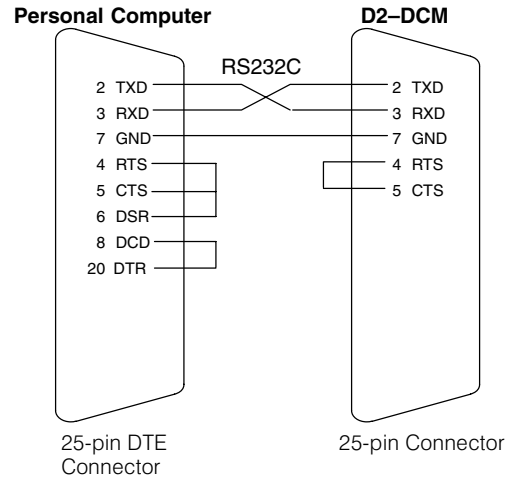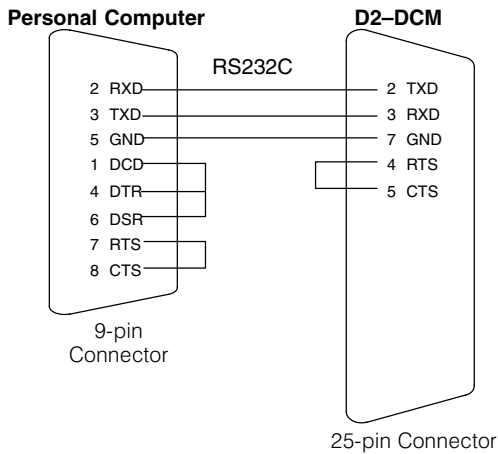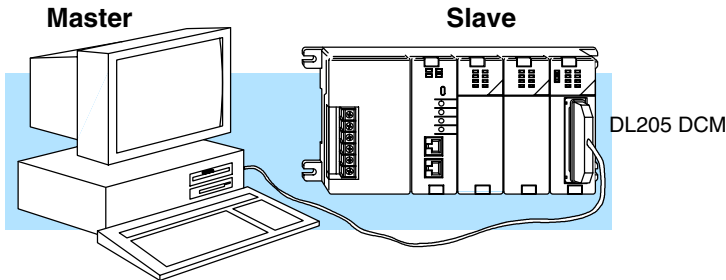
**Point-to-Point
RS422
D2–DCM as Master**

These diagrams show the D2–DCM being used as the network master. The cable diagram is the same when the D2–DCM is being used as a slave (for those connections that could have the master/slave roles reversed). This is true for the:

- D2–DCM to D4–DCM connection
- D2–DCM to DL405 CPU connection when used with a D4–450

Master   **Possible Slaves**

DL405 CPU
Bottom Port

DL405
DCM
(or DL205
DCM)

**Connect to any
of these devices**

DL305
with
RS422 DCU

D2–DCM

RS422

	D2–DCM			DL405 CPU Port
7	GND		7	GND
10	+RTS		10	+RTS
11	–RTS		11	–RTS
12	+CTS		12	+CTS
13	–CTS		13	–CTS
14	+OUT		9	+IN
15	–OUT		10	–IN
16	–IN		16	–OUT
17	+IN		14	+OUT

25-pin Connector   25-pin Connector

Note: Pin numbers are correct. Pins are shown out of order because it makes the drawing easier to comprehend.

D2–DCM

RS422

	D2–DCM			D4–DCM or D2–DCM or DL305 w/DCU
7	GND		7	GND
10	+RTS		10	+RTS
11	–RTS		11	–RTS
12	+CTS		12	+CTS
13	–CTS		13	–CTS
14	+OUT		17	+IN
15	–OUT		16	–IN
16	–IN		15	–OUT
17	+IN		14	+OUT

25-pin Connector   25-pin Connector

Note: Pin numbers are correct. Pins are shown out of order because it makes the drawing easier to comprehend.

Master   **Possible Slaves**

DL340 CPU

FA–UNICON RS232/422 Converter

DL240 CPU
Bottom Port

**Connect to any
of these devices**

DL450 CPU
Phone Jack

Slave Connection

D2–DCM	**FA–UNICON Converter**

RS422

**DL340
CPU Port**

DCE

D2–DCM		FA–UNICON	
7	GND	7	GND
10	+RTS	10	+RTS
11	–RTS	11	–RTS
12	+CTS	12	+CTS
13	–CTS	13	–CTS
14	+OUT	14	+IN
15	–OUT	15	– IN
16	–IN	16	–OUT
17	+IN	17	+OUT

TXD	2	1	RXD
RXD	3	2	TXD
GND	7	3	RTS
DTR	20	4	GND

4P4C

25-pin Connector

Note: RTS/CTS are looped back internally

Slave Connection

D2–DCM	**FA–UNICON Converter**

RS422

DCE

D2–DCM		FA–UNICON	
7	GND	7	GND
10	+RTS	10	+RTS
11	–RTS	11	–RTS
12	+CTS	12	+CTS
13	–CTS	13	–CTS
14	+OUT	14	+IN
15	–OUT	15	– IN
16	–IN	16	–OUT
17	+IN	17	+OUT

1	GND
2	5V
3	RXD
4	TXD
5	RTS
6	GND

TXD	2
RXD	3
GND	7
DTR	20

**DL240 CPU
Bottom Port**

or

**DL450 CPU
Phone Jack**

6P6C

25-pin Connector
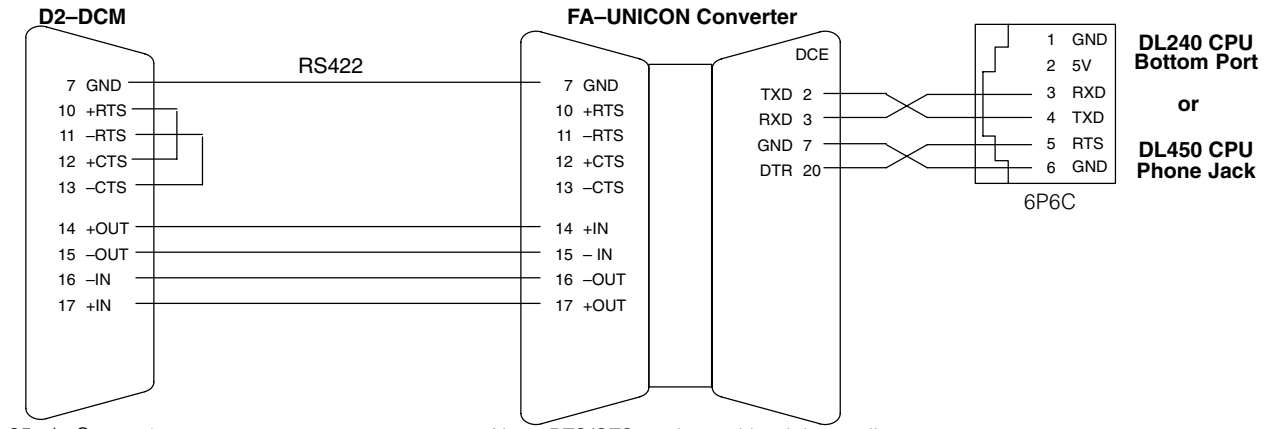
Note: RTS/CTS are looped back internally

Point-to-Point
RS422
PC as Master

These diagrams show the D2–DCM being used as a slave to a personal computer. Since most personal computers come with RS232C communication cards, we have shown an FA–UNICON RS232/422 Converter being used to convert the signal. The personal computer would have to be capable of issuing commands using either *Direct*NET or MODBUS RTU protocol.

Master   **Slave**

DL205 DCM

FA–UNICON RS232/422 Converter

Personal Computer   **FA–UNICON Converter**   **D2–DCM**

DTE
2 RXD	RS232C
3 TXD	
5 GND	
1 DCD	
4 DTR	
6 DSR	
7 RTS	
8 CTS	

9-pin DTE Connector

DCE
2 TXD
3 RXD
7 GND
20 DTR
25 +5V

GND 7
+RTS 10
−RTS 11
+CTS 12
−CTS 13

+IN 14   RS422
− IN 15
−OUT 16
+OUT 17

7 GND
10 +RTS
11 −RTS
12 +CTS
13 −CTS
14 +OUT
15 −OUT
16 −IN
17 +IN

25-pin Connector

Note: 1. You must connect pin 20 to pin 25
2. RTS/CTS are looped back internally and do not require external wiring.

Personal Computer   **FA–UNICON Converter**   **D2–DCM**

DTE
2 TXD   RS232C
3 RXD
7 GND
4 RTS
5 CTS
6 DSR
8 DCD
20 DTR

25-pin DTE Connector

DCE
2 TXD
3 RXD
7 GND
20 DTR
25 +5V

GND 7
+RTS 10
−RTS 11
+CTS 12
−CTS 13

+IN 14   RS422
− IN 15
−OUT 16
+OUT 17

7 GND
10 +RTS
11 −RTS
12 +CTS
13 −CTS
14 +OUT
15 −OUT
16 −IN
17 +IN

25-pin Connector

Note: 1. You must connect pin 20 to pin 25
2. RTS/CTS are looped back internally and do not require external wiring.

**Multidrop
RS422
D2–DCM as Master**

These diagrams show the D2–DCM being used as the network master for a network consisting of various PLC stations using D2–DCMs, CPU ports, etc..

Master

Slaves

**DL405 or
DL205 DCM**

**DL305
RS422 DCU**

DL205 D2–DCM Master		DL205 D4–DCM		D2–DCM		DL305 w/ DCU
	RS422		RS422		RS422	
7 GND		7 GND		7 GND		7 GND
10 +RTS		10 +RTS		10 +RTS		10 +RTS
11 –RTS		11 –RTS		11 –RTS		11 –RTS
12 +CTS		12 +CTS		12 +CTS		12 +CTS
13 –CTS		13 –CTS		13 –CTS		13 –CTS
14 +OUT		17 +IN		17 +IN		17 +IN
15 –OUT		16 –IN		16 –IN		16 –IN
16 –IN		15 –OUT		15 –OUT		15 –OUT
17 +IN		14 +OUT		14 +OUT		14 +OUT
22 +OUT		22 +OUT		22 +OUT		22 +OUT
23 –OUT		23 –OUT		23 –OUT		23 –OUT
24 –IN		24 –IN		24 –IN		24 –IN
25 +IN		25 +IN		25 +IN		25 +IN

Termination Resistor   Termination Resistor

Master

Slaves

**DL405 CPU
Bottom Port**

**DL405
CPU
Bottom Port**

**DL405 CPU
Bottom Port**

DL205 D2–DCM Master		DL405 CPU Port #2		DL405 CPU Port #2		DL405 CPU Port #2
	RS422		RS422		RS422	
7 GND		7 GND		7 GND		7 GND
10 +RTS		19 +RTS		19 +RTS		19 +RTS
11 –RTS		18 –RTS		18 –RTS		18 –RTS
12 +CTS		11 +CTS		11 +CTS		11 +CTS
13 –CTS		23 –CTS		23 –CTS		23 –CTS
14 +OUT		9 +IN		9 +IN		9 +IN
15 –OUT		10 –IN		10 –IN		10 –IN
16 –IN		16 –OUT		16 –OUT		16 –OUT
17 +IN		14 +OUT		14 +OUT		14 +OUT
22 +OUT						
23 –OUT						
24 –IN						
25 +IN						

Termination Resistor   Termination Resistor

Master

Slaves

**DL340
CPU**

**DL240 CPU
Bottom Port**

**DL450
Phone Jack**

**DL205
D2–DCM
Master**

RS422 — — —

GND	7
+RTS	10
–RTS	11
+CTS	12
–CTS	13
+OUT	14
–OUT	15
–IN	16
+IN	17
+OUT	22
–OUT	23
–IN	24
+IN	25

Termination
Resistor

**DL340
CPU**

RXD	1
TXD	2
RTS	3
GND	4

RS232

FA–UNICON Converter

DCE

2	TXD
3	RXD
7	GND
20	DTR

RS422

GND	7
+RTS	10
–RTS	11
+CTS	12
–CTS	13
+IN	14
–IN	15
–OUT	16
+OUT	17

Note: RTS/CTS are looped back internally

**DL240 CPU
Bottom Port
or DL450
Phone Jack**

GND	1
5V	2
RXD	3
TXD	4
RTS	5
GND	6

RS232

FA–UNICON Converter

DCE

2	TXD
3	RXD
7	GND
20	DTR

RS422

GND	7
+RTS	10
–RTS	11
+CTS	12
–CTS	13
+IN	14
–IN	15
–OUT	16
+OUT	17

RS422

Note: RTS/CTS are looped back internally

Termination Resistor

**Multidrop
RS422
PC as Master**

These diagrams show how to connect a network of D2–DCMs to a personal computer.

Master   **Slaves**

D2–DCM   D2–DCM

FA–UNICON RS232/422 Converter

Personal Computer   **FA–UNICON Converter**   **D2–DCM**   **D2–DCM**

DTE		DCE			
2 RXD	RS232C	2 TXD	GND 7	RS422	7 GND
3 TXD		3 RXD	+RTS 10		10 +RTS
5 GND		7 GND	–RTS 11		11 –RTS
1 DCD		20 DTR	+CTS 12		12 +CTS
4 DTR		25 +5V	–CTS 13		13 –CTS
6 DSR					
7 RTS			+IN 14		14 +OUT
8 CTS			–IN 15		15 –OUT
			–OUT 16		16 –IN
			+OUT 17		17 +IN

RS422

7 GND
10 +RTS
11 –RTS
12 +CTS
13 –CTS

14 +OUT
15 –OUT
16 –IN
17 +IN

22 +OUT
23 –OUT
24 –IN
25 +IN

9-pin DTE
Connector

Note: 1. You must connect pin 20 to pin 25
2. RTS/CTS are looped back internally
and do not require external wiring.

25-pin Connector   25-pin Connector

22 +OUT
23 –OUT
24 –IN
25 +IN

Termination Resistor

Personal Computer   **FA–UNICON Converter**   **D2–DCM**   **D2–DCM**

DTE		DCE			
2 TXD	RS232C	2 TXD	GND 7	RS422	7 GND
3 RXD		3 RXD	+RTS 10		10 +RTS
7 GND		7 GND	–RTS 11		11 –RTS
4 RTS		20 DTR	+CTS 12		12 +CTS
5 CTS		25 +5V	–CTS 13		13 –CTS
6 DSR					
8 DCD			+IN 14		14 +OUT
20 DTR			–IN 15		15 –OUT
			–OUT 16		16 –IN
			+OUT 17		17 +IN

RS422

7 GND
10 +RTS
11 –RTS
12 +CTS
13 –CTS

14 +OUT
15 –OUT
16 –IN
17 +IN

22 +OUT
23 –OUT
24 –IN
25 +IN

25-pin DTE
Connector

Note: 1. You must connect pin 20 to pin 25
2. RTS/CTS are looped back internally
and do not require external wiring.

25-pin Connector   25-pin Connector

22 +OUT
23 –OUT
24 –IN
25 +IN

Termination Resistor

DV–1000 Cable   Use the following cable diagram to connect a DV–1000 to D2–DCM. This is still a simple master/slave connection, but the DV–1000 is the master and initiates the data exchange with the D2–DCM.

DV–1000   **D2–DCM**

Phone Jack style connector
(RJ12) on the back of the
DV–1000

DV–1000

1	GND
2	5V
3	RXD
4	TXD
5	RTS
6	GND

6P6C

RS232C

D2–DCM

TXD	2
RXD	3
RTS	4
CTS	5
+5V	6
GND	7

25-pin Connector
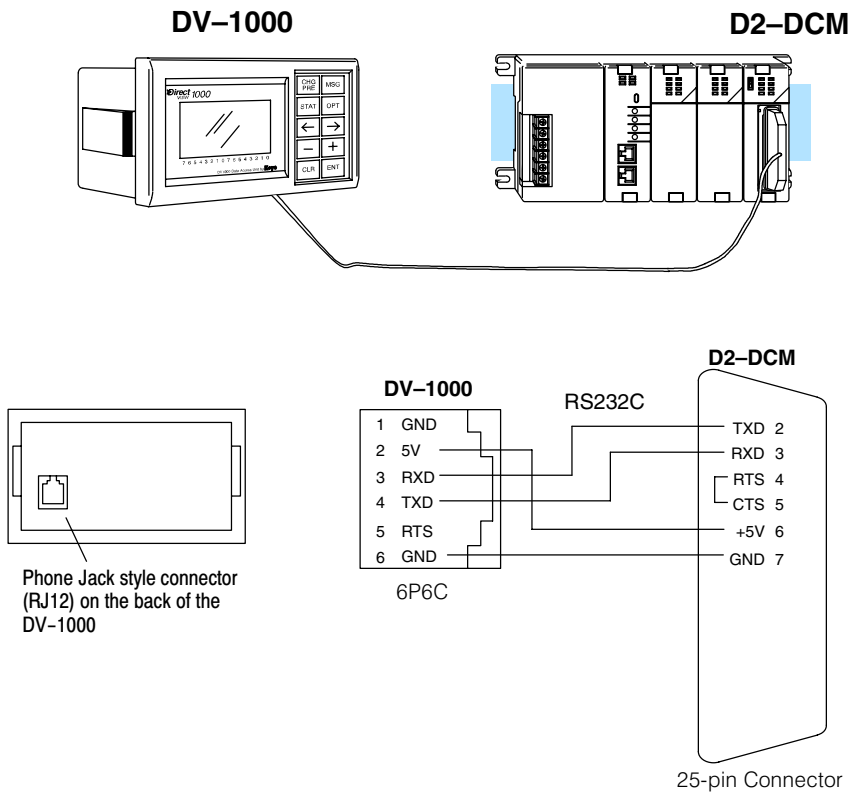
RLL Communications Programs

B

Why are networking instructions needed in your RLL?

The Master Initiates Requests
Since *Direct*NET is a master/slave network, the master station must initiate requests for network data transfers. If you're using a PLC as the master station, you use simple RLL instructions to initiate the requests.

Why Ladder Logic?
Since the D2–DCM network interface does not contain a program, you have to use the PLC to issue the commands to tell the D2–DCM where to read or write data. The D2–DCM gets information from the PLC and then converts the information into the appropriate *Direct*NET commands. The RLL instructions use or identify the following items.

1. Uses the special relays assigned to the slot to control the communications.
2. Slot location of the D2–DCM master and the slave station address. (LD instruction)
3. Amount of data (in bytes, decimal) you want to transfer. (LD instruction)
4. Area of memory to be used by the master. (LDA instruction, see the DL205 User Manual for a detailed memory map.)
5. Area of memory to be used by the slave, and whether it is a read or write operation. (RX or WX instruction)
6. Interlocks for communication timing and multiple RX and WX routines.

This example reads 3 bytes of data from Slave Address #1,(starting at Y0), into the Master PLC starting at V40600 (Control Relays).
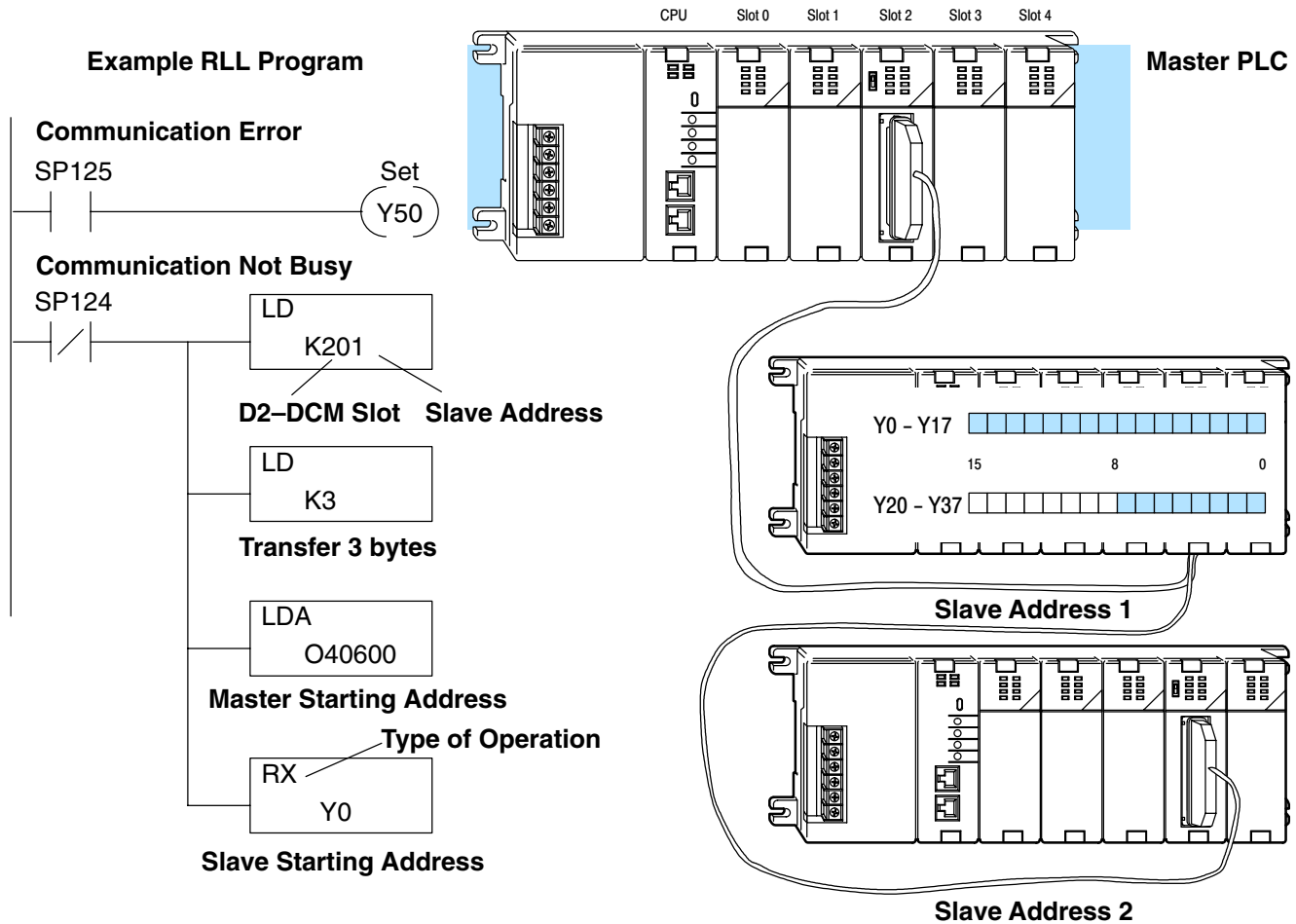
This example writes 3 bytes of data from the Master Station (starting at V40600) to Y0 – Y27 in Slave Station #1.

Master PLC

CPU   Slot 0   Slot 1   Slot 2   Slot 3   Slot 4

V40600

V40601

DCM

Slave Address 1

16pt Output
Y0
–
Y17

16pt Output
Y20
–
Y37

Slave Address 2

Example RLL Program

Communication Error

SP131   Set
──┤ ├──   (Y50)

Communication Not Busy

SP130
──┤/├──

| LD |
| K401 |

D2–DCM Slot   **Slave Address**

| LD |
| K3 |

Transfer 3 bytes

| LDA |
| O40600 |

Master Starting Address

Type of Operation

| WX |
| Y0 |

Slave Starting Address
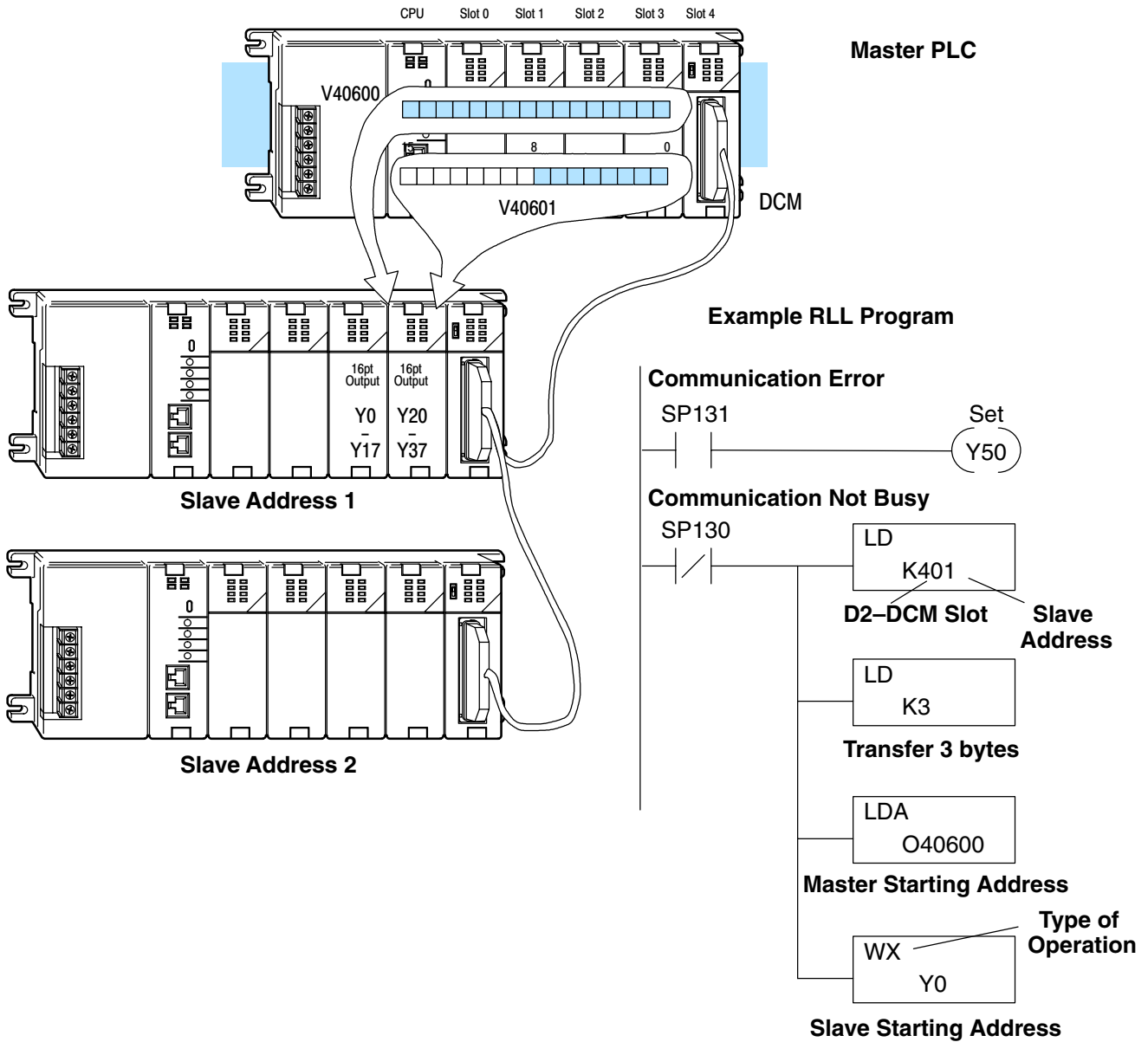
The following paragraphs explain each operation and provide some helpful hints to make your programs simple and easy to follow.

Identifying the master and slave locations & addresses

The first Load (LD) instruction identifies the slot location of the D2–DCM master and the address of the slave station. (Remember, the slot numbers start at 0.)

The constant (K) portion of the instruction actually contains two pieces (bytes) of information. The first two digits specify the D2–DCM master location and the second two digits specify the slave station address.

It is necessary to specify both the master slot location and slave address because you can have more than one D2–DCM master in the base and you can have up to 90 slave stations for each master.

Conversion Hints!

Valid Slot Range: 0–7

Valid Slave Address: 1–90

Example

Master in Slot: 2

Slave Address: 3C HEX (60 decimal)

Convert the HEX address to decimal

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	HEX
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	DEC

HEX 3C

3 x 16 = 48   +   **C** = 12   = 60 decimal

NOTE: The LD instruction K value is entered in decimal, but the D2–DCM master and slave addresses are in HEX. The HEX addresses must be converted to their decimal equivalent for this instruction. See the conversion hints above.

This example is showing three slaves. In this case the address conversions are simple. Check the Conversion Hints shown above for a more complex example.

Slot of D2–DCM

LD
K260

Slave Address

Slave 1   Slave 2   Slave 60

X10 = 3

X1 = C
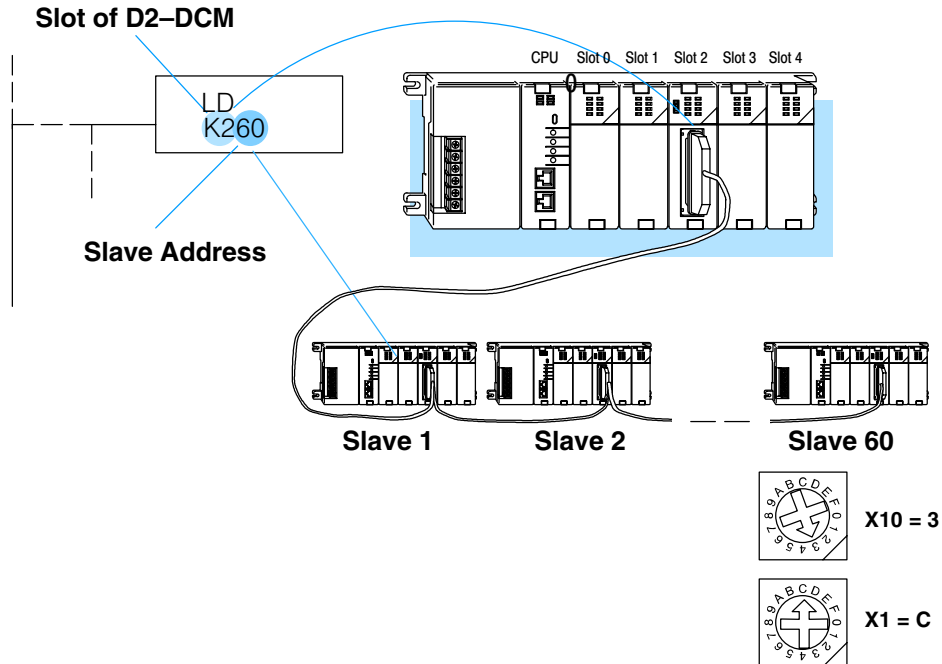
Specifying the amount of data to transfer

The second LD instruction indicates the amount of data that needs to be transferred (in bytes, 128 maximum). You have to specify the amount of data in complete bytes. For example, Y0 – Y27 would be three bytes of data. There are 24 bits for the output range of Y0–Y27 (these I/O addresses are in octal). From the charts below we see that we can obtain 8 bits per byte for this type of memory. Therefore, 24 bits yields 3 bytes, of 8 bits each.

The charts below can be very helpful. Notice that the different PLC families do not always use the same types of memory or the same byte boundaries. For example, the DL305 does not use a separate data type for input and output points.

```
┌─────────┐
│ LD      │
│    K201 │
└─────────┘
┌─────────┐
│ LD      │
│    K3   │
└─────────┘
```

Number of Bytes in decimal
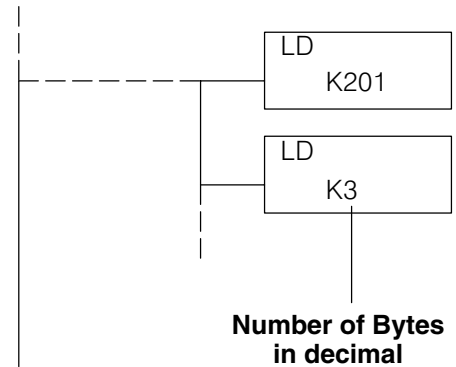
Example:

3 bytes of data to be transferred

The number of bytes specified also depends on the type of data you want to obtain. For example, the DL405 Input points can be accessed by V-memory locations or as X input locations. However, if you only want X0 – X27, you'll have to use the X input data type because the V-memory locations can only be accessed in 2-byte increments. The following table shows the byte ranges for the various types of *Direct*LOGIC™ products.

DL 205 / 405 Memory	Bits per unit	Bytes
V memory	16	2
T / C current value	16	2
Inputs (X, GX, SP)	8	1
Outputs (Y, C, Stage, T/C bits)	8	1
Diagnostic Status	8	1

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

Designating the master station memory area

The Load Address (LDA) instruction specifies the V memory area of the master that will be used. This is the starting address. Additional sequential locations may be used, depending on the number of bytes that are being transferred. Since all DL405 data is mapped into V memory, you can easily access the data you need.

If you are reading information from the slave station, this is the destination area, or, the area where the master will store the information.

If you are writing information to the slave station, this is the source area, or, the area where the master will obtain the information that will be transferred to the slave.

```
┌──────────────┐
│ LD           │
│     K201     │
└──────────────┘

┌──────────────┐
│ LD           │
│     K3       │
└──────────────┘

┌──────────────┐
│ LDA          │
│     O40600   │
└──────────────┘
```

Letter "O" specifies an Octal Address

V memory Address
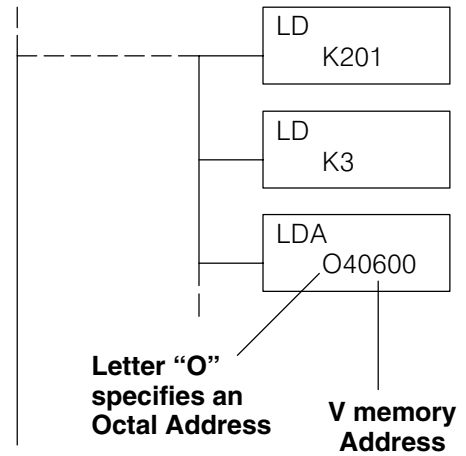
Example:

V memory location 40600 will be the starting point of the data transfer area for the master. The following locations will be used to store the data.

MSB   V40600   LSB

15   0

MSB   V40601   LSB

15   0
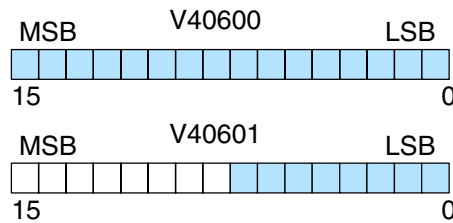
NOTE: Since V memory words are always 16 bits, you may not always use the whole word. For example, if you only specify 3 bytes and you are reading Y outputs from the slave, you will only get 24 bits of data. In this case, only the 8 least significant bits of the last word location will be modified. The remaining 8 bits are not affected.

Identifying the slave station memory area to read or write

The Read Network (RX) or Write Network (WX) is the last instruction in the routine. Use the RX if you want to read data from the slave, or use the WX instruction if you want to write data to the slave.

You have to specify the data type and the starting address for the slave. (Remember, you have to specify a data type that will work correctly with the number of bytes specified.)

If you use the RX instruction, the data will be read from the slave starting at the address specified. If you use the WX instruction, the data will be written to the slave starting at the address specified.

```
        LD
          K201

        LD
          K3

        LDA
          O40600

        RX
          Y0
```

Data Type and Address
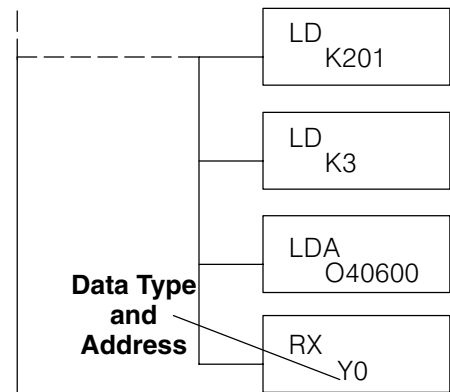
Example:

Read from slave starting at Y0.

NOTE: If you are exchanging data with a DL305 system, it is important to understand how to reference the DL305 memory locations. For example, the DL305 I/O points are accessed with the V data type or the GY data type, even though the DL305 does not actually have those data types present in the CPU. The table on the next page provides a detailed cross reference.

Master PLC

Y0 – Y17

15   8   0

Y20 – Y37

Slave Address 1

Slave Address 2

D3–330 / D3–340 CPUs					
To get ... **TMR/CNT Current Values**	**use...**	**TMR / CNT Status Bits**	**use...**	**Data Registers**	**use...**
R600	V0	CT600	GY600[1]	R401, R400[2]	V100
R601	V1	CT601	GY601[1]	R403, R402[2]	V101
— — —	— — —	— — —	— — —	— — —	— — —
R677	V77	CT677	GY677[1]	R777, R776[2]	V237
To get ... **I/O Points**	**use...**	**Control Relays**	**use...**	**Shift Registers**	**use...**
IO 000	GY0[1]	CR160	GY160[1]	SR400	GY400
IO 001	GY1[1]	CR161	GY161[1]	SR401	GY401
— — —	— — —	— — —	— — —	— — —	— — —
IO 157	GY157[1]	CR377	GY377[1]	SR577	GY577

D3–330P CPUs					
To get ... **TMR/CNT Current Values**	**use...**	**TMR / CNT Status Bits**	**use...**	**Data Registers**	**use...**
R600	V0	CT600	GY600[1]	R401, R400[2]	V100
R601	V1	CT601	GY601[1]	R403, R402[2]	V101
— — —	— — —	— — —	— — —	— — —	— — —
R677	V77	CT677	GY677[1]	R777, R776[2]	V237
To get ... **I/O Points**	**use...**	**Control Relays**	**use...**	**Shift Registers**	**use...**
IO 000	GY0[1]	CR160	GY160[1]	SR200	GY400
IO 001	GY1[1]	CR161	GY161[1]	SR201	GY401
— — —	— — —	— — —	— — —	— — —	— — —
IO 157	GY157[1]	CR277	GY277[1]	SR277	GY477

To get ... **Stage Status Bits**	**use...**
S0	GY200[1]
S1	GY201[1]
— — —	— — —
S177	GY277[1]

1. You must have CPU firmware V1.9 or greater to use the GY data type in the RX/WX instructions.

2. Two bytes of DL305 register data are returned with one DL205 V memory location.

Example:

Read current value from R400 into memory location V2000.

If you're just obtaining I/O or Timer/Counter values, the task is fairly simple. But when you work with data registers, it's a bit more involved. Here's why.

To get R400, you examine the table and find that you must use reference V0. You will also notice that you always get at least 2 registers! So you get R400 *and* R401. Since you only want the contents of R400, you have to add some ladder logic to get rid of the data from R401.

LD K201	
LD K2	Read 2 bytes
LDA O2000	Store in V2000
RX V100	To get R400, use V100
LD V2000	Load V2000
ANDD KFF	Use ANDD to remove R401
OUT Vxxxx	Store the result in a different V location
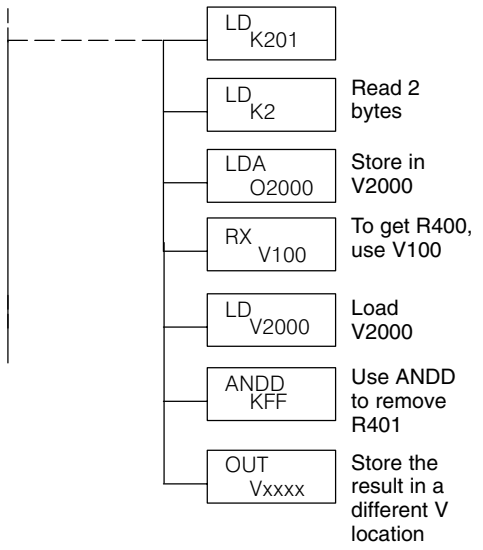
Controlling the communications

Communications Special Relays

Whenever communication is executed with a D2–DCM, chances are the communication will take longer than the actual PLC scan. If the D2–DCM is busy, another request should not be initiated until it is finished. Fortunately, there is an easy solution for this.

There are two SPs for each slot in the CPU base which are used only with the D2–DCM. For example, slot 0 has SP120 and SP121. SP120 is the D2–DCM Busy relay and, when turned on, indicates the D2–DCM is busy. SP121 indicates there is a communication error for slot 0.

You should always use the D2–DCM Busy SP in your RLL programs to ensure the D2–DCM is ready.

The communication error SP is optional, but it is a good way to monitor the communication status in the RLL program. If you use the communication error SP, make sure you place it at the beginning of your communication routines. This is because the communication error relay is always reset (turned off) whenever an RX or WX instruction is executed.

```
         SP125                              Y50
          ─┤ ├─                            ─( Set )─
               Communication Error
         SP124                    ┌──────────┐
          ─┤ ├─/├─                │   LD     │
                                  │   K201   │
            D2–DCM                └──────────┘
            Busy                  ┌──────────┐
                                  │   LD     │
                                  │   K3     │
                                  └──────────┘
                                  ┌──────────┐
                                  │   LDA    │
                                  │   O40600 │
                                  └──────────┘
                                  ┌──────────┐
                                  │   RX     │
                                  │   Y0     │
                                  └──────────┘
```
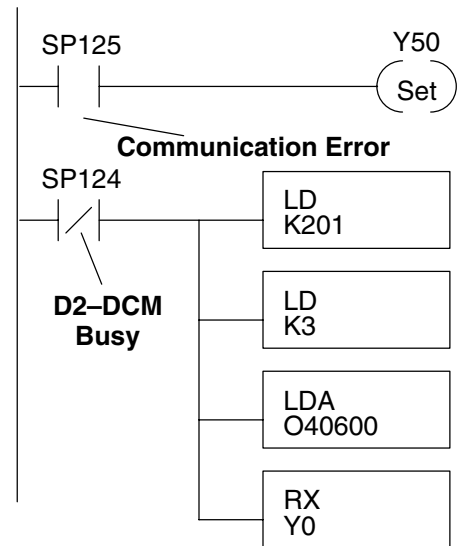
Special Purpose Communication Relays								
I/O Slot Location	0	1	2	3	4	5	6	7
Communication Busy	N/A	SP122	SP124	SP126	SP130	SP132	SP134	SP136
Communication Error	N/A	SP123	SP125	SP127	SP131	SP133	SP135	SP137

DL205

0 1 2 3 4 5 6 7
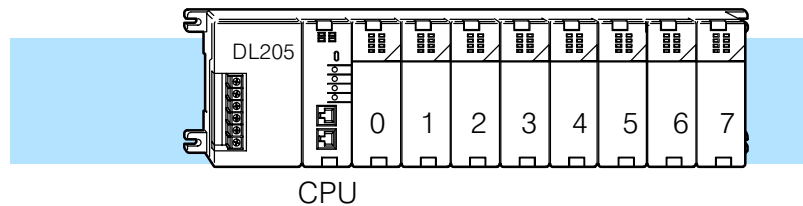
CPU

Multiple Read and Write Interlocks

If you're using multiple reads and writes in the RLL program, the routines need to be interlocked to be certain that all the routines are executed. If the interlocks are not used, then the CPU will only execute the first routine. This is because the D2–DCM can only handle one transaction at a time.

In the example, once the RX instruction is executed, C0 is set. When the D2–DCM has finished the communication task, the second routine is executed and C0 is reset.

If you're using RLL^{PLUS}, you can just put each routine in a separate program stage to ensure proper execution. In most all cases, RLL^{PLUS} can be a more efficient way to create an automation program.

The **Direct**NET manual provides a master / slave example with both RLL and RLL^{PLUS} program descriptions.

Interlocking Relay

```
SP124  C0
  |/|  |/|      LD
                  K201

                LD
                  K3

                LDA
                  O40600

                RX
                  Y0
                          C0
                        ( Set )
```

Interlocking Relay

```
SP124  C0
  |/|  | |      LD
                  K201

                LD
                  K3

                LDA
                  O40400

                WX
                  Y0
                          C0
                        ( RST )
```
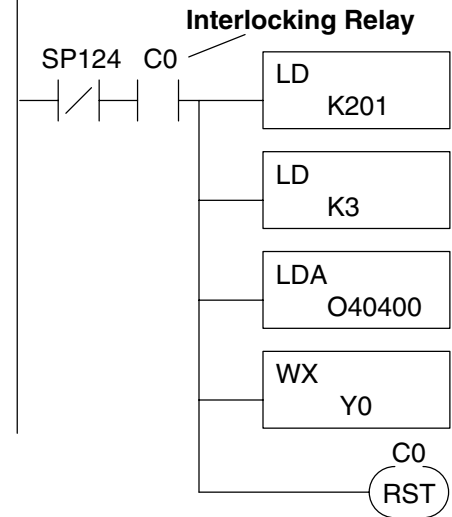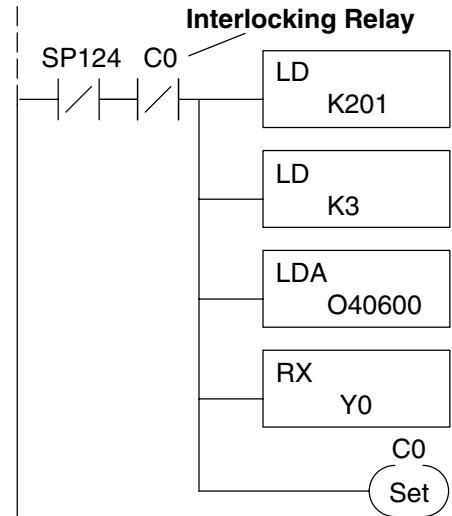
Multiple Read and Write Interlocks

This example is showing three slaves. In this case the address conversions are very simple. Check the Conversion Hints shown above for a more complex example.

Slot of D2–DCM

LD
K260

Slave Address

CPU Slot 0 Slot 1 Slot 2 Slot 3 Slot 4

Slave 1   **Slave 2**   **Slave 60**

X10 = 3

X1 = C

Using the D2–DCM with MODBUS

C
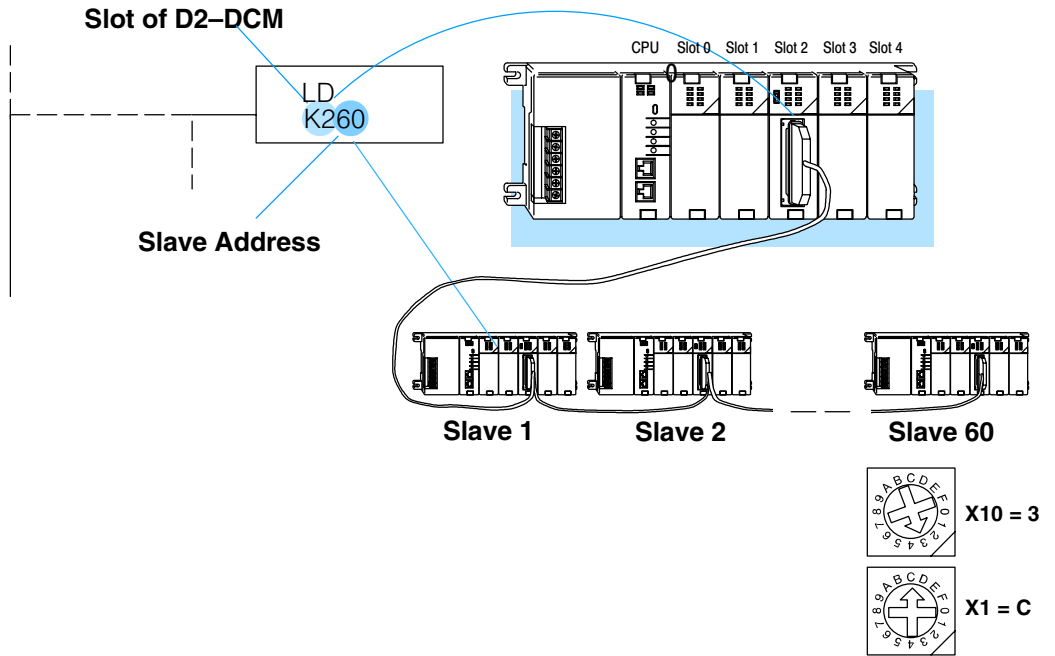
Introduction

How Does the D2–DCM work with MODBUS?

The D2–DCM can be used as a slave interface to a network using the MODBUS RTU protocol. To use the D2–DCM with MODBUS, your host software must send a MODBUS function code and a MODBUS address to specify a PLC memory location that is understood by the D2–DCM.

Host sends a MODBUS request...

What's the status of Y0?

D2–DCM responds "Y0 is ON"

... D2–DCM responds with data
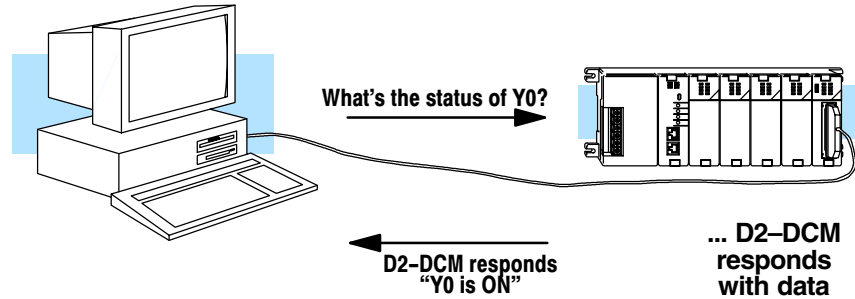
It would be quite difficult to discuss all of the ins and outs of MODBUS in this document. Instead, the purpose of this Appendix is to:

- provide a quick overview of MODBUS Data Types and Function Codes.
- how to determine the proper MODBUS address necessary to allow the host software to access various memory locations in the DL205 system.

One key point to remember is that not all host software packages using MODBUS drivers operate exactly the same way. That is, there are a couple of different ways to achieve the same result, especially when it comes to specifying the needed address for the PLC memory location. *Therefore, it is important that you follow the instructions for your particular software package or network master.*

MODBUS Function Codes Supported

The host software package reads or writes information by sending a MODBUS function code to the D2–DCM. The following table provides a description of the MODBUS function codes supported by the D2–DCM.

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

NOTE: The maximum MODBUS secondary address supported by the D2–DCM is 60 (5A hex).

MODBUS Data Types Supported

You are probably accustomed to seeing data types like X input, Y output, C control relay, V memory data registers, etc. for the various types of memory in a DL205 system. For example, if you need to know the status of Y12, then you ask for Y12. MODBUS does not use these same data types, so you have to determine which MODBUS data type corresponds to the PLC memory location that you need. The following table will help.

DL205 Memory Type	Quantity[1] (Decimal)	PLC Range (Octal)	Corresponding MODBUS Data Type
Inputs (X)	320	X0 – X477	Input
Special Relays (SP)	144	SP0 – SP137 SP540 – SP617	Input
Outputs (Y)	320	Y0 – Y477	Coil
Control Relays (CR)	256	C0 – C377	Coil
Timer Contacts (T)	128	T0 – T177	Coil
Counter Contacts (CT)	128	CT0 – CT177	Coil
Stage Status Bits (S)	512	S0 – S777	Coil
Timer Current Values (V)	128	V0 – V177	Input Register
Counter Current Value (V)	128	V1000 – V1177	Input Register
V Memory, user data (V)	1024	V2000 – V3777	Holding Register
V Memory, user data (V) Non–volatile	256	V4000 – V4377	Holding Register
V Memory, system (V)	106	V7620 – V7737 V7746 – V7777	Holding Register

Determining the MODBUS Address

There are typically two ways that most host software packages 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 the Host Software Requires the Data Type and Address...

Many host software packages allow you to specify the MODBUS data type and the MODBUS address that corresponds to the PLC memory location. This is the easiest method, but not all packages allow you to do it this way. The various MODBUS data types were presented earlier, but they have been included again in the following table.

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

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

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

DL205 Memory Type	QTY[1] (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)	320	X0 – X477	2048 – 2367	Input
Special Relays (SP)	144	SP0 – SP137 SP540 – SP617	3072 – 3167 3280 – 3471	Input
Outputs (Y)	320	Y0 – Y477	2048 – 2367	Coil
Control Relays (CR)	256	C0 – C377	3072 – 3551	Coil
Timer Contacts (T)	128	T0 – T177	6144 – 6271	Coil
Counter Contacts (CT)	128	CT0 – CT177	6400 – 6527	Coil
Stage Status Bits (S)	512	S0 – S777	5120 – 5631	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)	1024	V2000 – V3777	1024 – 2047	Holding Register
V Memory, user data (V) non–volatile	256	V4000 – V4377	2048 – 2303	Holding Register
V Memory, system (V)	106	V7620 – V7737 V7746 – V7777	3984 – 4063 4070 – 4095	Holding Register

DL250–1 Memory Type	QTY[1] (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 – SP137 SP320 – SP717	3072 – 3167 3280 – 3535	Input
Outputs (Y)	512	Y0 – Y777	2048 – 2560	Coil
Control Relays (CR)	1024	C0 – C1777	3072 – 4095	Coil
Timer Contacts (T)	256	T0 – T377	6144 – 6399	Coil
Counter Contacts (CT)	128	CT0 – CT177	6400 – 6527	Coil
Stage Status Bits (S)	1024	S0 – S1777	5120 – 6143	Coil
For Word Data Types	Convert PLC Addr. to Dec.		+	Data Type
Timer Current Values (V)	256	V0 – V377	0 – 255	Input Register
Counter Current Values (V)	128	V1000 – V1177	512 – 639	Input Register
V Memory, user data (V)	3072 4096	V1400 – V7377 V10000 – V17777	768 – 3839 4096 – 8192	Holding Register
V Memory, system (V)	320	V700 – V777 V7400 – V7777	448 – 768 3840 – 3735	Holding Register

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 Requires an Address ONLY

Some host software packages 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". One important thing to remember here is that two different addressing modes may be available in your host software package. These are:

- 484 Mode
- 584/984 Mode

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

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

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

Discrete Data Types				
Memory Type	**PLC Range (Octal)**	**Address (484 Mode)**	**Address (584/984 Mode)**	**Data Type**
Global Inputs (GX)	GX0–GX1746	1001 – 1999	10001–10999	Input
	GX1747 – GX3777	——	11000–12048	Input
Inputs (X)	X0 – X1777	——	12049 – 13072	Input
Special Relays (SP)	SP0– SP777	——	13073 – 13584	Input
Global Outputs (GY)	GY0– GY3777	1 – 2048	1 – 2048	Output
Outputs (Y)	Y0 – Y1777	2049 – 3072	2049 – 3072	Output
Control Relays (CR)	C0 – C3777	3073 – 5120	3073 – 5120	Output
Timer Contacts (T)	T0 – T377	6145 – 6400	6145 – 6400	Output
Counter Contacts (CT)	CT0 – CT377	6401 – 6656	6401 – 6656	Output
Stage Status Bits (S)	S0 – S1777	5121 – 6144	5121 – 6144	Output

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

* MODBUS: Function 04 (New Feature)

The DL–250, DL–350 and DL450 will support **function 04** read input register **(Address 30001)**. To use function 04, put the number '4' into the most significant position (4xxx). Four digits must be entered for the instruction to work properly with this mode.

```
          ┌──────────┐
          │ LD       │
          │    K101  │
          └──────────┘
          ┌──────────┐
          │ LD       │
          │    K4128 │
          └──────────┘
          ┌──────────┐
          │ LDA      │
          │    O4000 │
          └──────────┘
          ┌──────────┐
          │ RX       │
          │      Y0  │
          └──────────┘
```
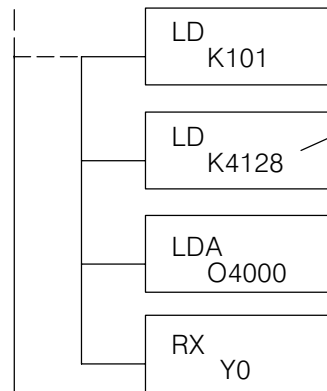
The Maximum constant possible is 4128. This is due to the 128 maximum number of Bytes that the RX/WX instruction can allow. The value of 4 in the most significant position of the word will cause the RX to use function 04 (30001 range).

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

2. For an automated MODBUS/Koyo address conversion utility, download the file **modbus_conversion.xls** from the **www.automationdirect.com** website.

**Example 1: V2100
584/984 Mode**

Find the MODBUS address for User V location V2100.

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

PLC Address (Dec.) + Mode Address

V2100 = 1088 decimal

$1088 + 40001 = \boxed{41089}$

For Word Data Types		PLC Address (Dec.)			+		Appropriate Mode Address		
Timer Current 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
584/984 Mode**

Find the MODBUS address for output Y20.

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

PLC Addr. (Dec) + Start Address + Mode

Y20 = 16 decimal

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

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

**Example 3: T10
Current Value
484 Mode**

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

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

PLC Address (Dec.) + Mode Address

TA10 = 8 decimal

$8 + 3001 = \boxed{3009}$

For Word Data Types		PLC Address (Dec.)			+		Appropriate Mode Address		
Timer Current 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 4: C54
584/984 Mode**

Find the MODBUS address for Control Relay C54.

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

PLC Addr. (Dec) + Start Address + Mode

C54 = 44 decimal

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

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

Using the D2–DCM with Modems

D

Introduction

There are some applications that require a remote connection to the PLC. These remote connections require you to use a modem to communicate between the Personal Computer and the PLC system. Although this manual tends to focus on using the D2–DCM in networking applications, there are a tremendous number of people who simply use the D2–DCM as an extra communications port. The D2–DCM provides additional flexibility in configuration and baud rates compared to the built-in port on the CPU, so it's a logical choice for use with a modem.

It is not hard to establish remote communications with a PLC system via a modem. This appendix provides some guidelines to help you setup the communications link.

System Components There are typically two types of communication paths for modem applications.

- Telephone modems
- Radio modems

Both serve the same basic function, which is to enable data communications over a long distance. However, your choice really depends on your particular application. Radio modems are typically more expensive and can be more difficult to use in some situations. But if you don't have phone lines or dedicated cabling in the area, your choice may be restricted to radio modems anyway.

For the DL205 family of products, any system that is designed to handle modem communications usually contains components from the following list.

- DL240 PLC System with D2–DCM
- PLC System with DL250–1/260 CPU bottom port
- Personal Computer
- 2 modems (one on each end)

Telephone Modems

Radio Modems
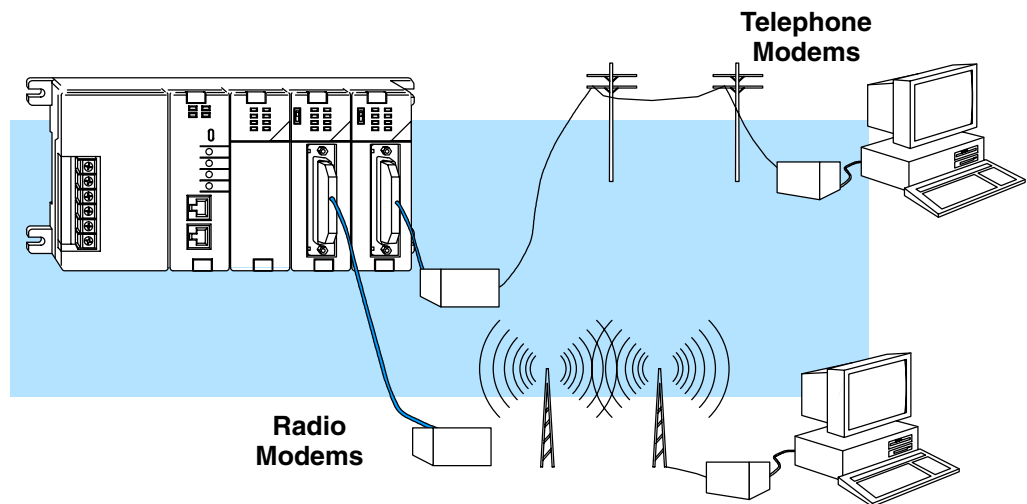
Possible Configurations

Even though most all systems have one or more of the system components, there are a couple of ways that they can be used.

PC Master — Some people need to use modems between a personal computer and the PLC system so that they can perform remote programming and/or data monitoring tasks with PC-based software, such as *Direct*SOFT32 or a SCADA system. In this case, the personal computer is the master and the PLC system is the remote slave station.

D2–DCM Master — In other situations, you may be using a D2–DCM as the remote communications master instead of a personal computer. If you are considering this, you **must** have one of the following situations.

- **You have a Leased-line** — You can have a leased (dedicated) phone line if modems are used. A dedicated line is necessary because the D2–DCM cannot issue the dial-up commands, so the carrier must be active at all times.

- **You have a Radio Link** — You also have the option of using radio modems. This is useful when it is not feasible to have hard-wired communications cabling between the remote stations.

- **You have a MDM–TEL** — It has the capability of on contact initiated dialing.

In either case, the cabling and setup requirements share many similarities, which are covered later in this Appendix.

PC as Master   **D2–DCM as Slave**

D2–DCM as Master   **D2–DCM as Slave**
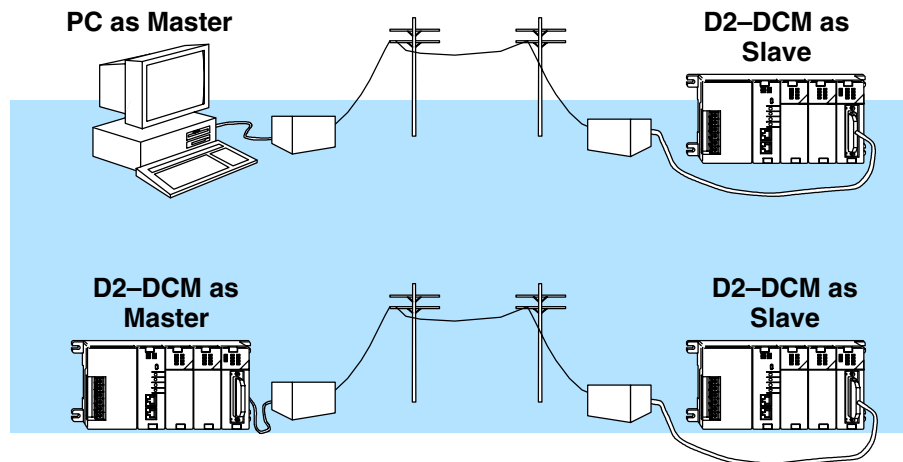
Choosing a Modem

With today's prices, it is possible to buy a high quality modem for a reasonable price. It is recommended that you purchase a modem not because it is inexpensive, but because it has a good reputation. This will save you money (and time) over the long run. It is also suggested that you spend a few extra dollars to get an external modem if possible. The internal versions typically do not have status indicator lights and are much harder to debug during setup, or modem communication failure.

We recommend using **AutomationDirect's MDM–TEL**, Industrial Telephone Modem. It is an external modem which is DIN–rail mounted. This is a rugged industrial telephone modem which has been designed for operation in electrical enclosures which are installed in harsh environments. This MDM–TEL supports all standard Hayes AT commands, Fax Class 1 and Class 2 commands and S–registers, therefore it can be setup as an external modem on any PC. This industrial modem is compatible with any telecommunications or dial–up networking software. The MDM–TEL is also fully supported by **AutomationDirect's** technical support team. More detailed information can be located at **www.automationdirect.com**.

Set the D2–DCM Switches

For the most part, we suggest that you follow the setup instructions shown earlier in this manual. That is, choose the protocol you're using, set the station address, etc. However, there are a couple of important differences which are discussed here.

Baud Rate & Parity

It is important that you select the following communications parameters when you use the D2–DCM for remote communications.

- 9600 baud
- NO parity

The parity setting is most important. Most popular modems cannot transmit an odd number of bits per character. If parity is enabled, each character would consist of 1 start bit, 8 data bits, 1 parity bit and 1 stop bit, making a total of 11 bits per character. Since this is an odd number, the modem would not work properly. You can experiment with the baud rate settings, but make sure all components are set to the same baud rate.

Delay Time

If you're using a radio modem, you may have to set a delay time for the communications. This time is necessary to allow time for the radio to "key-up" before the data is transmitted. You must match the settings required by your modem.

SW5

Switch Positions

Baud	1	2	3
300	ON	OFF	OFF
600	OFF	ON	OFF
1200	ON	ON	OFF
2400	OFF	OFF	ON
4800	ON	OFF	ON
9600	OFF	ON	ON
19200	ON	ON	ON
38400	OFF	OFF	OFF

Baud Rate
(9600 shown)

NO Parity

Set to OFF

Delay Time
(see modem manual)

OFF ON

Switch Positions

Time*	6	7	8
0	OFF	OFF	OFF
2	ON	OFF	OFF
5	OFF	ON	OFF
10	ON	ON	OFF
20	OFF	OFF	ON
50	ON	OFF	ON
100	OFF	ON	ON
500	ON	ON	ON

*Delay time in milliseconds

ON
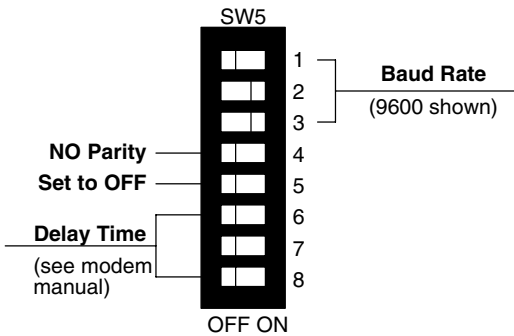
Delay Time Considerations for Networks with DL240 Slaves

A couple of scenarios have been mentioned where you may be using a D2–DCM connected to a modem as the master station and a DL240 CPU connected to a modem as the slave station. If you have such a situation, there are a couple of things that you may have to take into consideration.

If you are using a radio modem connected to the bottom port of a DL240, you will probably have to set a delay time for the CPU port. You can do this by loading a BCD value into V7632. This is a special V-memory location which defines the baud rate and/or time delay for the bottom port. It is recommended that you do this on the first scan within your ladder program. The following diagram provides a table of the settings and an example of some simple setup logic that could be included in your RLL program.

V7632

MSB		LSB	
X	X	X	X

Delay Codes	Baud Rate Codes
00 No delay	00: 300 baud
01 2ms delay	01: 1200 baud
02 5ms delay	02: 9600 baud
03 10ms delay	03: 19200 baud
04 20ms delay	
05 50ms delay	
06 100ms delay	
07 500ms delay	

Example:
First Scan Only, Load Delay Time of 5ms & Baud Rate of 19200 for Bottom Port

V7632

Delay Time		Baud Rate		Delay Codes	Baud Rate Codes

Bit 15 14 13 12 11 10 9 8   7 6 5 4 3 2 1 0
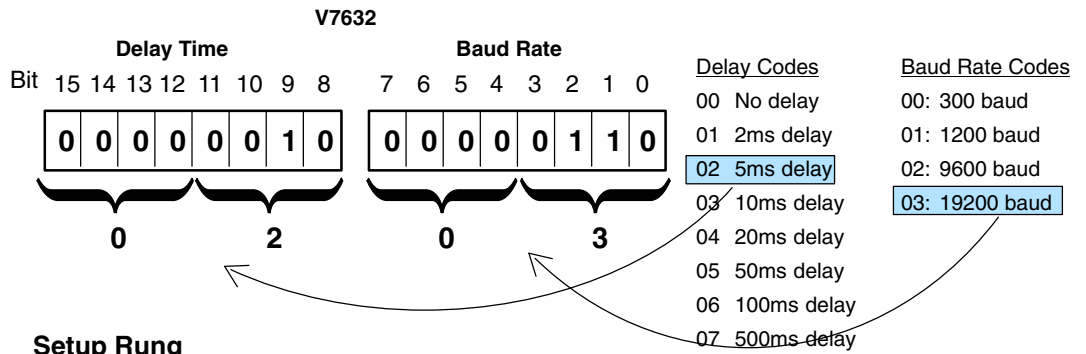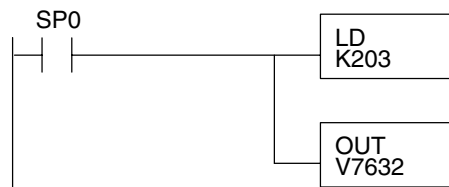
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

     0   2   0   3

Delay Codes	Baud Rate Codes
00 No delay	00: 300 baud
01 2ms delay	01: 1200 baud
02 5ms delay	02: 9600 baud
03 10ms delay	03: 19200 baud
04 20ms delay	
05 50ms delay	
06 100ms delay	
07 500ms delay	

Setup Rung

```
SP0
─┤├──────────────────┐  LD
                      │  K203
                      │
                      └  OUT
                         V7632
```

Use the LD (Load) instruction to load the BCD codes for each parameter into the accumulator. The number 0203 is just the code used for our particular example, which is a 5ms delay, 19.2K baud.

Place the value in memory location V7632

Main Ladder Program Begins

```
 X    X
─┤├──┤├──────────────┐  XX
                      │  KKVV
                      │
                      └──────( )
                              Y
```
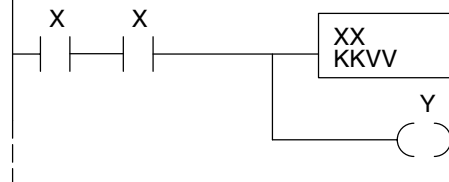
After the parameter setup rung(s) above, we begin the normal ladder program. Use your actual program for this and the following rungs.

Choose the Proper Cables

The exact cables needed really depend on your particular application. In any case, you will probably use one or more of the following connections.

- Personal Computer to modem connection
- Modem to D2–DCM connection
- Modem to DL240 connection

Connecting a Modem to your Personal Computer

Your choice of cable for connecting the modem to your personal computer depends on whether you have a 9-pin port or a 25-pin port on your COM card. In either case, it's usually easier to buy a cable rather than make one. It is suggested that you check your modem documentation to see what the manufacturer recommends. If your documentation does not recommend a cable, you could try the following sources.
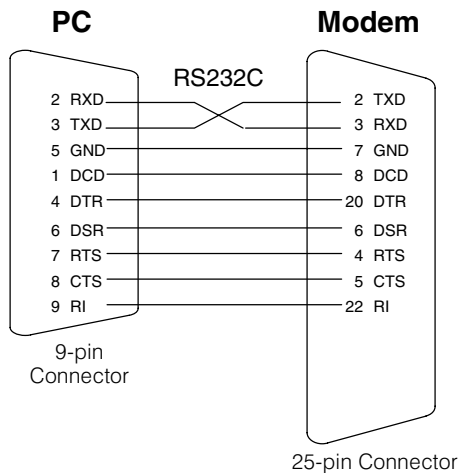
- Radio Shack
- Black Box Catalog

Some users prefer to build their own cable. Here are the pinouts that are usually required. Again, check your modem documentation for the exact requirements.

NOTE: The 9-pin diagram can be confusing because it shows TXD – TXD and RXD – RXD connections. This is actually correct because the 9-pin connector conforms to the IBM standard for DTE and the 25-pin side conforms to the standard for DCE. This results in the slight confusion over the terminology used to label the TXD and RXD pins.

9 to 25 Pin Cable

PC		Modem
	RS232C	
2 RXD		2 TXD
3 TXD		3 RXD
5 GND		7 GND
1 DCD		8 DCD
4 DTR		20 DTR
6 DSR		6 DSR
7 RTS		4 RTS
8 CTS		5 CTS
9 RI		22 RI

9-pin Connector

25-pin Connector

25 to 25 Pin Cable

PC		Modem
	RS232C	
2 TXD		2 TXD
3 RXD		3 RXD
7 GND		7 GND
4 RTS		4 RTS
5 CTS		5 CTS
6 DSR		6 DSR
8 DCD		8 DCD
20 DTR		20 DTR

25-pin Connector

25-pin Connector
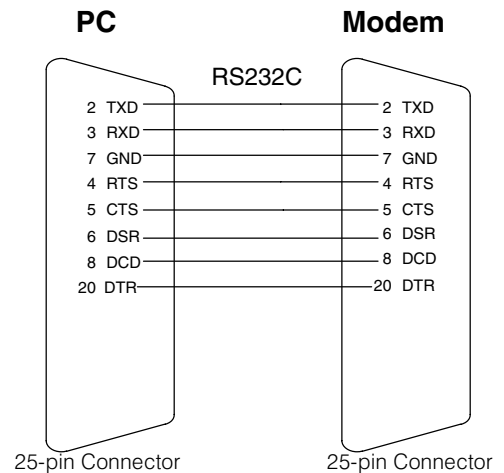
Connecting a Modem to the D2–DCM   The PLC is on the other end of the remote communication link and will typically have a D2–DCM as the communications interface. Just as you needed a cable to connect your personal computer to the modem, you'll also need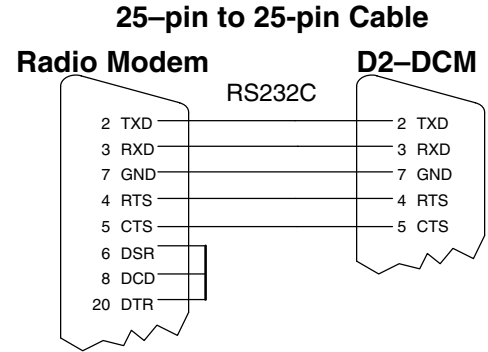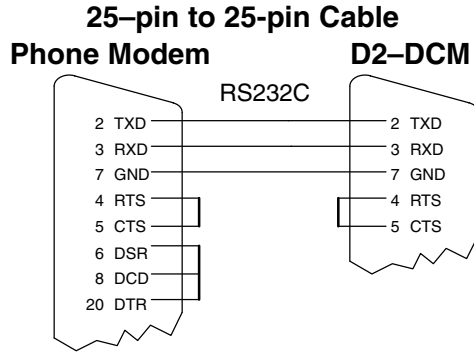 a cable between the PLC system (D2–DCM) and the receiving modem. Since the D2–DCM and the modem have 25-pin connectors, use the straight-through 25-pin to 25-pin cable diagram shown here.
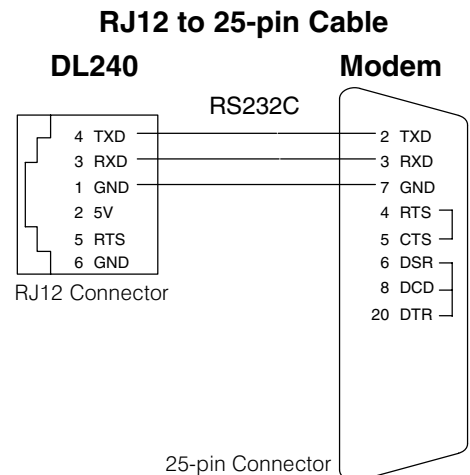
25–pin to 25-pin Cable

Phone Modem   **D2–DCM**

RS232C

2 TXD —	— 2 TXD
3 RXD —	— 3 RXD
7 GND —	— 7 GND
4 RTS	4 RTS
5 CTS	5 CTS
6 DSR	
8 DCD	
20 DTR	

25–pin to 25-pin Cable

Radio Modem   **D2–DCM**

RS232C

2 TXD —	— 2 TXD
3 RXD —	— 3 RXD
7 GND —	— 7 GND
4 RTS —	— 4 RTS
5 CTS —	— 5 CTS
6 DSR	
8 DCD	
20 DTR	

Tip: You can use our D3–DSCBL–2 with a null modem adapter to quickly build a cable which can connect the modem to the D2–DCM (also used with the MDM–TEL modem). You'll need the following parts, which can be obtained at most any electronics store. Since there seems to be a Radio Shack on every corner, we've included their part numbers.

- **D3–DSCBL–2** — **Automationdirect** DL305 Programming Cable
- **26–1496** — Radio Shack DB25 Null Modem Adapter
- **26–1388** — Radio Shack DB25 Male to DB9 Male Adapter

25 to 25 Pin Null Modem Adapter

9 to 25 Pin Adapter

9 Pin Adapter
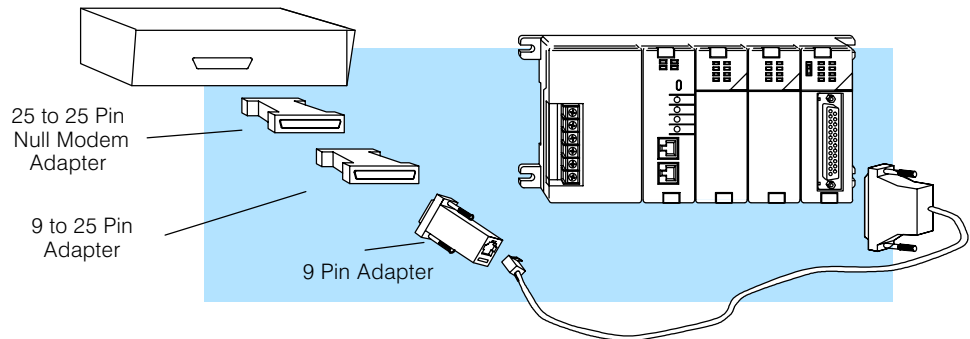
Connecting a Modem to the DL240   Use the cable diagram shown here to connect a modem to the bottom port of a DL240 CPU.

RJ12 to 25-pin Cable

DL240   **Modem**

RS232C

4 TXD —	— 2 TXD
3 RXD —	— 3 RXD
1 GND —	— 7 GND
2 5V	4 RTS
5 RTS	5 CTS
6 GND	6 DSR
	8 DCD
	20 DTR

RJ12 Connector

25-pin Connector
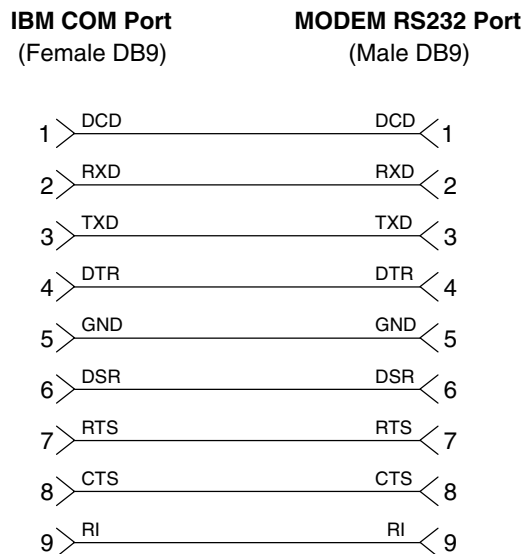
Using the MDM–TEL

The MDM–TEL industrial modem, which is fully supported by **AutomationDirect**, is a sensible choice for your application. The MDM–TEL User Manual, which can be downloaded from the **AutomationDirect** website, will provide more detailed information.

RS232 Connections   Use a straight–through or equivalent serial cable to connect the modem's RS232 female port (DB9 cable male end) to the RS232 male port on a PC or other "Data Terminal Equipment" (DTE) device (DB9 cable female end). The diagram below details the pin–out of a straight–through serial communications cable suitable for connecting a DCE device (MDM–TEL) to a DTE device (PC, PLC or other device). A sutable DB9 RS–232 cable is provided with the MDM–TEL.

MODEM RS232 Connections

Cable for MODEM to IBM COM Port

IBM COM Port	MODEM RS232 Port
(Female DB9)	(Male DB9)

1	DCD	DCD	1
2	RXD	RXD	2
3	TXD	TXD	3
4	DTR	DTR	4
5	GND	GND	5
6	DSR	DSR	6
7	RTS	RTS	7
8	CTS	CTS	8
9	RI	RI	9

MODEM CABLE WIRING

(Standard DB9 Cable)

To simplify the connection between the D2–DCM and the MDM–TEL modem purchase a D3–DSCBL–2 cable available from **AutomationDirect**. The null modem adapter supplied with the modem is required when using this cable.

NOTE: A suitable serial cable and a null modem adapter are provided with the MDM–TEL. The provided null modem adapter is not required for normal serial communications between the MDM–TEL and a PC.

The MDM–TEL Setup Wizard   A modem setup utility is provided on the MDM–TEL CD to help you quickly configure the modem. In most applications, no knowledge of modem AT commands or S register contents is necessary. Pre–configured profiles, for common situations, are provided for convenience.

D2–DCM as Master

If You are Using a D2–DCM as Master

If you are using the D2–DCM as a master connected directly to a modem, then you must be using one of two types of modems. In either case, there are no special procedures that are required.

- **Leased-line Modem** — If you have a leased line modem, it tries to establish communications with the remote modem as soon as the power is turned on. The carrier stays active as long as the power is on. (That's why they call them "dedicated" lines.) After they are connected, the RX or WX instruction in the RLL program controls the data transmission between the stations. That is, when the RX or WX is executed, it automatically causes the D2–DCM's Request to Send line to go high. The modem responds with a Clear to Send and the communications begins.

- **Radio Modems** — If you have a radio modem, the RX or WX instruction in the RLL program controls the data transmission between the stations. That is, when the RX or WX is executed, it automatically causes the D2–DCM's Request to Send line to go high. The modem responds with a Clear to Send and the communications begins. The radio modem broadcasts the request and (hopefully) the remote station will receive it and respond accordingly.

- **MDM–TEL** — If you have a MDM–TEL modem, you can have the modem dial a preconfigured phone number by applying +24VDC to the "From PLC" terminal on the modem. When the modem connects to another modem and establishes communications, the modem will then apply +24VDC to the "to PLC" terminal. This input to the PLC is used to initiate RX or WX commands from the RLL program. If you do not have either a sourcing DC output or a sinking DC input, you will need to add a D2–08CDR module to your system in order to control the signals to/from the modem.

Using *Direct*SOFT32

Creating a Modem Link

*Direct*SOFT32 uses Telephony Application Programming Interface (TAPI) for modem configurations. The TAPI protocol allows applications to control modems or other telephony devices for operations such as dialing, answering, or disconnecting a connection. With the TAPI protocol, all of the modem support is centralized by the Windows operating system.

By using the TAPI interface, you will use the Windows modem setup utilities to configure the modem. Configuring the modem in this matter should simplify the setup process and allow you to select the most recent drivers for your modem.

If there is an existing modem connected to your PC for Internet or fax use, the modem setup will have to be changed. Some of the features will have to be disabled in order to communicate to the PLCs. To avoid making any changes to the existing modem configuration, you will need to install the same modem a second time. Windows will change the name by adding a number to the end i.e., "*modemname#2*" each time you add the same modem to your PC. Refer to your PC and/or modems installation manual for additional information on setting up your modem.

Modem Setup

The first series of examples were performed in Windows 2000 and will illustrate how to configure the modem connected to your PC. The examples may differ depending on your Windows operating system.

1. Install the modem if not already installed. Refer to the modem's documentation for installation information. If the modem is to be used for other devices you will need to install it a second time.

2. Once you have successfully installed the modem, you will need to edit its properties. In the Windows **Start** field, select **Settings > Control Panel**.
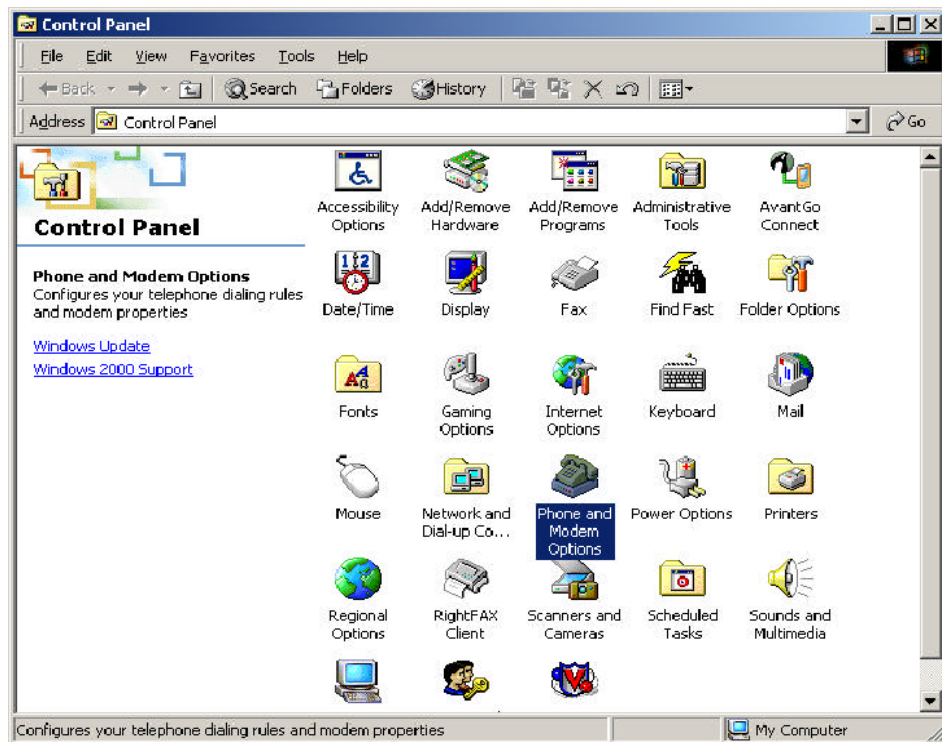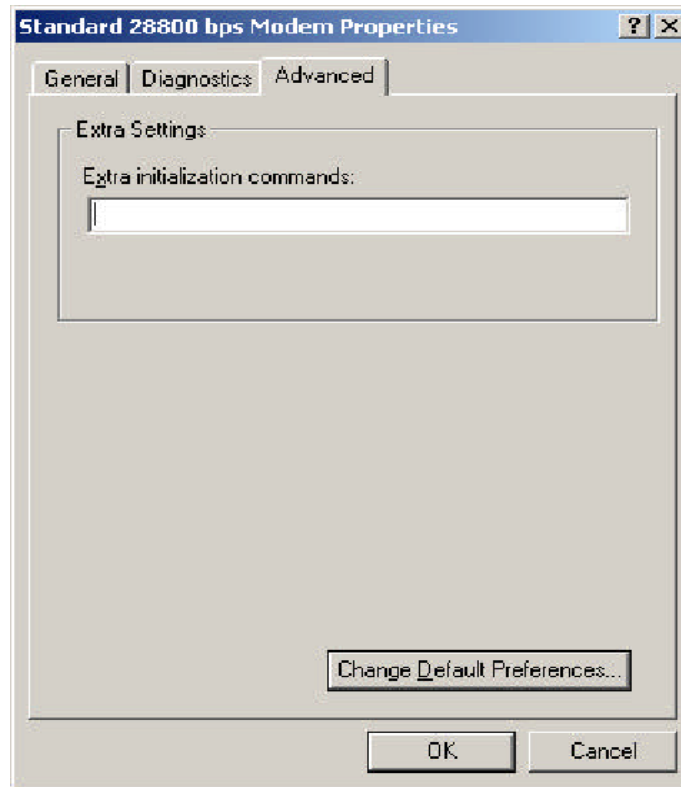
3. Select the **Phone and Modem Options** icon. A dialog box with all available modems installed will appear.
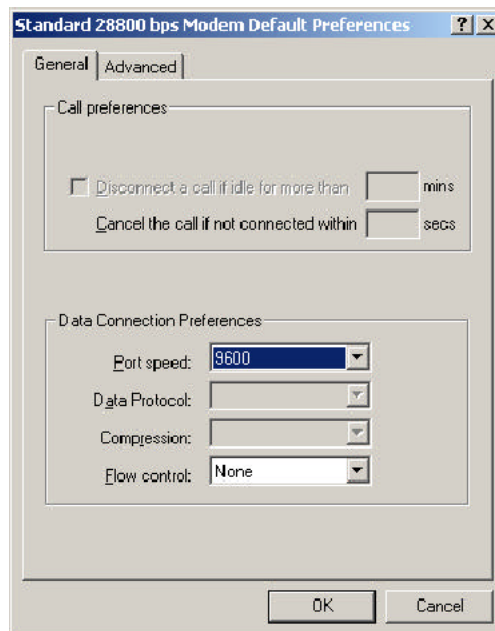4. Choose the **Modems** tab, then click on **Properties** at the bottom.
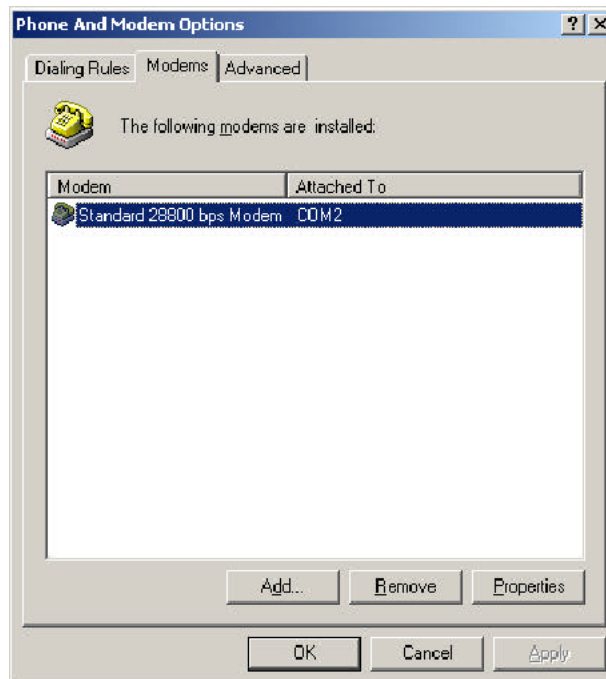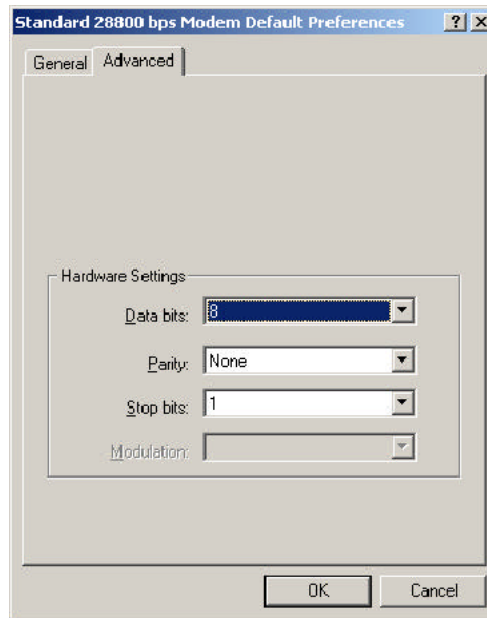

5. Choose 9600 as the **Maximum Port Speed.**
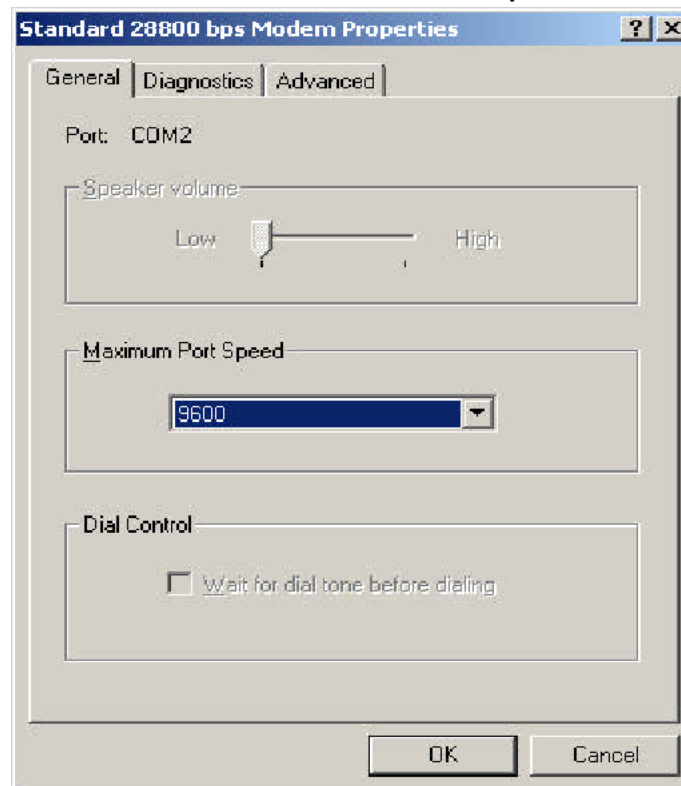
6. Select the **Advanced** tab and click on **Change Default Preferences**.

7. Make **Port speed** 9600, and choose None for **Flow control.**

8. Click on the **Advanced** tab and choose 8 **Data bits,** None **Parity** and 1 **Stop bits**.

9. Click **OK** until all dialog boxes are closed. This will setup your Windows driver so *Direct*SOFT32 can use the Windows TAPI control when accessing the modem.

Configuring the Link

With the modem configured correctly, the link to the PLC can now be established. The next series of steps will provide the information necessary for configuring the link using *Direct*SOFT32.

1. The LinkWizard can automatically determine the majority of the communication settings; however, you will need to manually setup the modem specific information (modem type, phone number, etc.). To activate the Link Wizard in the Launch Window, right click on the **Comm Links** icon in the **DSLaunch** tree and select **Add Link**.

**Right Click to select Add Link**
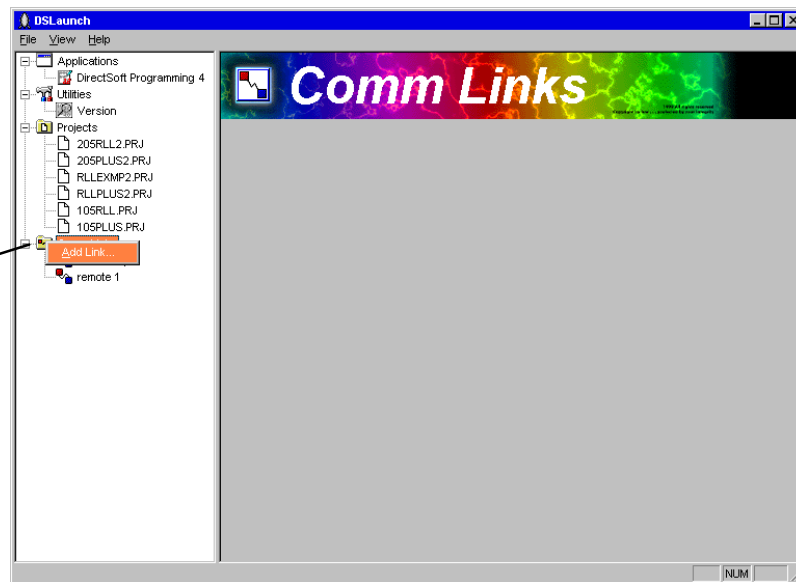
2. Select **Modem** as the device and click the **Next** button.
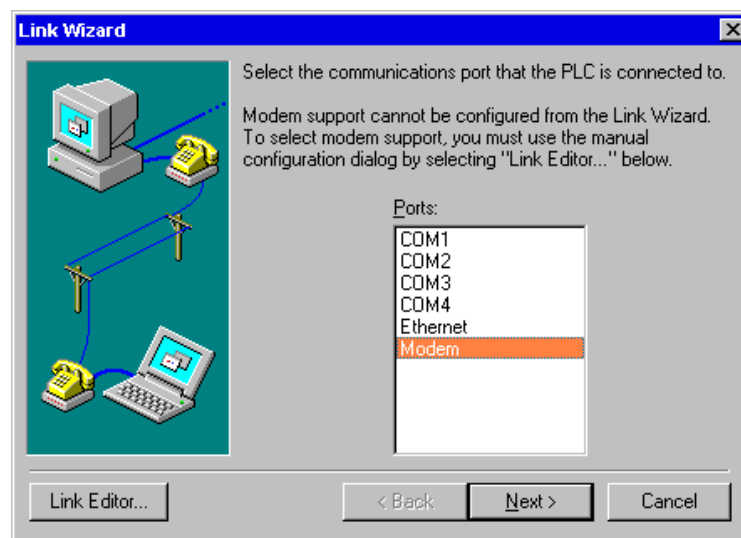
3. The Configure Link dialog box should now be present. First, choose the PLC family and the PLC CPU Type. Click once on the appropriate item in the **PLC Family** and a list of available CPUs for that family will appear to the right. Click once to select the appropriate **PLC Type**. Also give the link a name and description.
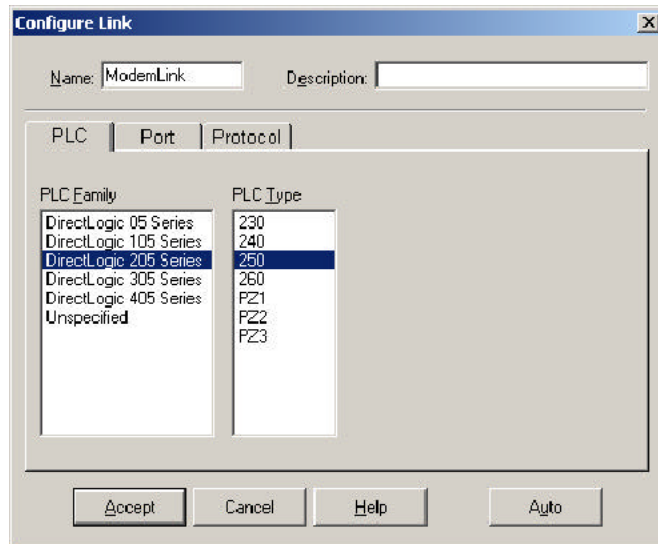

4. Click the **Port** tab of the dialog to display the port configuration dialog. This dialog allows you to setup up the port to match your modem's configuration. Follow the steps below:

    ● Select **Modem** in the **Devices** column.

    ● Select the modem type that you configured earlier in this procedure. You can verify or modify the settings by clicking on the **Properties** button or you can create a new modem by clicking on the **Add** button.

    ● Enter the dialing information for your modem.
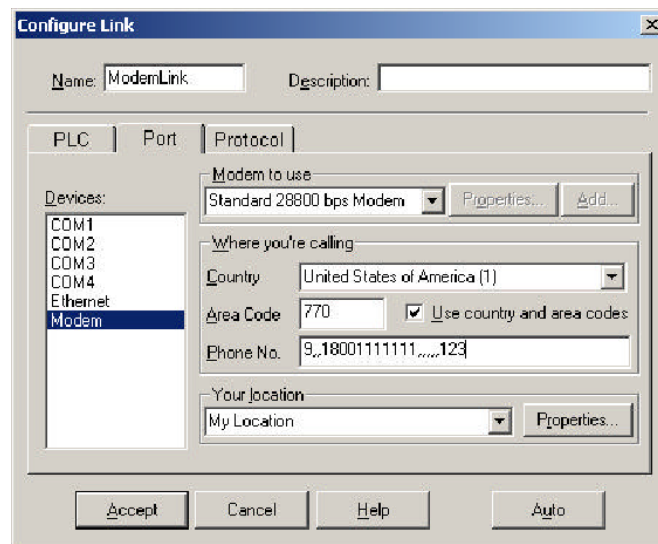
5. Click the **Protocol** tab to display the communication protocol dialog box. This dialog allows you to further define the communication parameters.
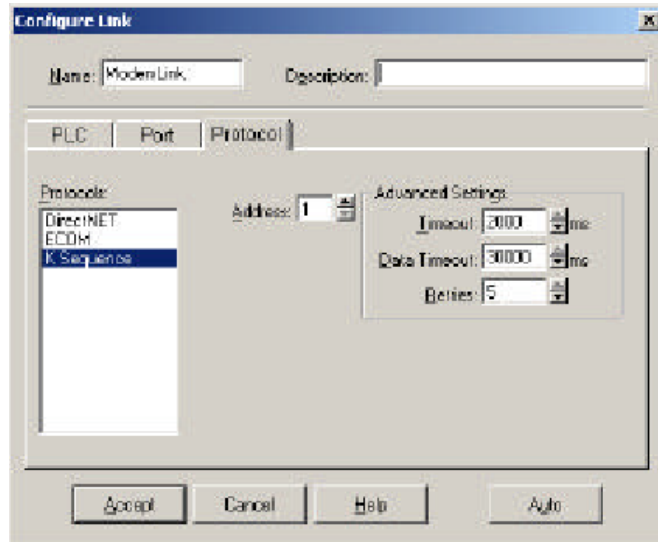
- Select the communication protocol to use. Refer to the chart in Appendix A for a breakdown of the various CPUs, and which protocols are supported on which ports.

- If the PLC has been given a node **Address** other than 1, enter the new address now.

- You can adjust the time–outs and retries on this dialog, however, the default values should work for you.

6. Click the **Accept** button to save this link configuration. The following dialog will appear. If you click **Yes,** *Direct*SOFT32 will dial the modem and attempt to verify that it can communicate with the PLC connected to the other modem using the parameters defined in the link. *Direct*SOFT32 will hang–up once the connection is made. If you click **No,** the link configuration will simply be saved to disk.
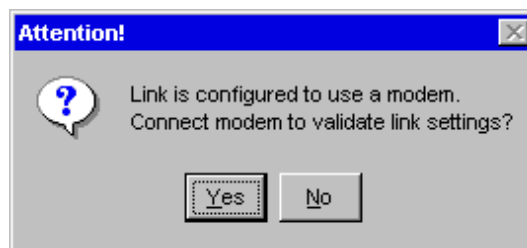
7. After successfully creating a link, the Launch Window will have an entry for the link that you have created. The name that you assigned to the link should appear in the menu tree under the **Comm Links** icon. If the link is highlighted, the main launch window screen will change with all of the links information displayed.