Terminator I/O

*Direct*Logic Remote I/0

Base Controller

User Manual

Manual Number T1K–RSSS–M

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Manual Revisions

If you contact us in reference to this manual, be sure to include the revision number.

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Manual Number: T1K–RSSS–M

Issue	Date	Description of Changes
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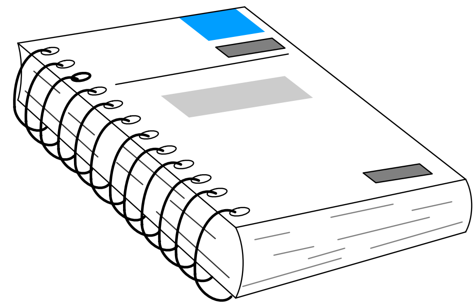
Getting Started

Introduction

The Purpose of this Manual

Thank you for purchasing the Terminator Remote I/O system. This manual shows you how to install, program, and maintain the equipment. It also helps you understand the system operation characteristics.



This manual contains important information for personnel who will install remote I/O, and for the PLC programmer. If you understand PLC systems our manuals will provide all the information you need to get and keep your system up and running.

Where to Begin

If you already understand the basics of remote I/O systems, you may only want to skim this chapter. Be sure to keep this manual handy for reference when you run into questions. If you are a new customer, we suggest you read this manual completely so you can understand the remote modules, configurations, and procedures used. We believe you will be pleasantly surprised with how much you can accomplish with ***Automationdirect***™ products.

Supplemental Manuals

Depending on the products you have purchased, there may be other manuals necessary for your application. You will need to supplement this manual with the manuals that are written for those products. You will need the User Manual for the PLC sytem that you have chosen to use with the Terminator I/O.

Technical Support

We realize that even though we strive to be the best, we may have arranged our information in such a way you cannot find what you are looking for. First, check these resources for help in locating the information:

- **Table of Contents** – chapter and section listing of contents, in the front of this manual
- **Quick Guide to Contents** – chapter summary listing on the next page
- **Appendices** – reference material for key topics, near the end of this manual

If you still need assistance, please call us at 770–844–4200 or visit our web site at **www.automationdirect.com**. Our technical support group is glad to work with you in answering your questions. They are available Monday through Friday from 9:00 A.M. to 6:00 P.M. Eastern Standard Time.

Chapters The main contents of this manual are organized into the following four chapters:

1	**Getting Started**	introduces the basic components of the remote I/O system, an explanation of who needs such a system, and an overview of the steps necessary to develop a working system.
2	**D2–RMSM / T1K–RSSS Remote I/O System**	shows you how to design your system by using worksheets to keep track of system parameters and the address and range assignments for remote I/O, needed for programming and hardware setup. Includes switch settings and wiring information.
3	**D2–RMSM Setup Programming and Troubleshooting**	shows you how to use DirectSoft to write the remote I/O setup program when using the D2–RMSM. This chapter takes the information developed from your worksheets and helps you write a working setup program.
4	**DL250 / DL350 / DL450 Remote I/O System, Setup Programming and Troubleshooting**	shows you how to use DirectSoft to write the setup program when using the DL250, DL350 or DL450 CPU bottom port as a remote master. The examples take the information from your worksheets and help you write a working setup program. Includes switch settings and wiring information.

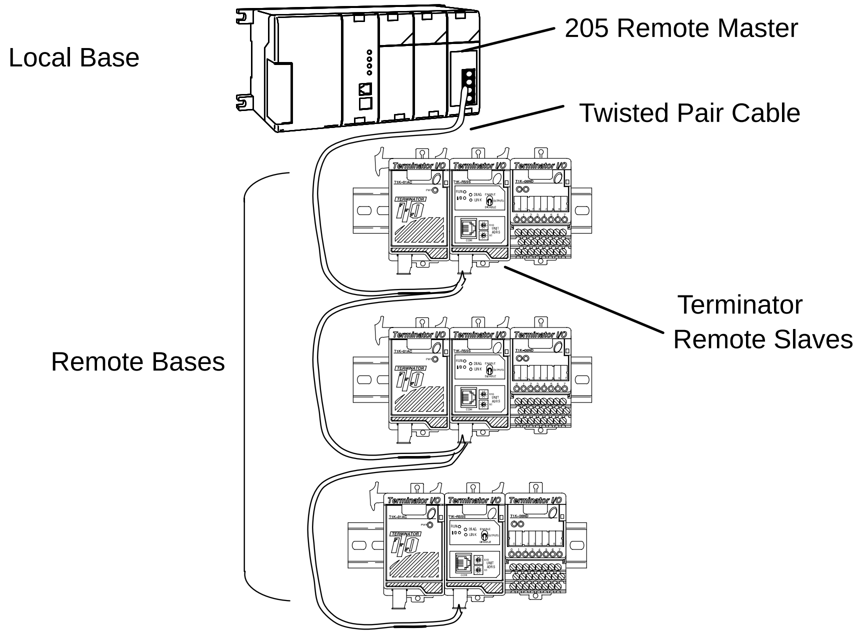
Appendices Additional reference information on remote I/O is in the following three appendices:

A	**Remote I/O Worksheets**	included are blank worksheets that you can copy and use to design your system.
B	**Terminator Analog I/O**	provides specific information on analog I/O module resolution and includes scaling examples.
C	**Determining I/O Update Time**	shows you how to calculate the amount of delay inherent with the transfer of data back and forth between the master and its remote slaves. Provides tables for all baud rates, based on the protocol selected and number of I/O points used.
D	**I/O Module Hot Swap**	explains the T1K–RSSS I/O module Hot Swap feature.

What is Remote I/O?

A remote I/O system allows you to locate I/O modules in bases at some remote distance from the CPU base, but still under its control. These remote bases have no CPU of their own, and are completely controlled by the CPU in the main base via a special module called a **remote master**. Each remote base unit has a **remote slave** that allows the exchange of data with the CPU in the main base via the master module. The communications link between the master and its slaves is provided by twisted-pair cable, with baud rates ranging between 19.2 to 614.4 kBaud, depending on the configuration. For example, up to 2048 remote I/O points can be supported by the DL205 Remote I/O Masters.

One Master in CPU Base (one channel)



When Do You Need Remote I/O?

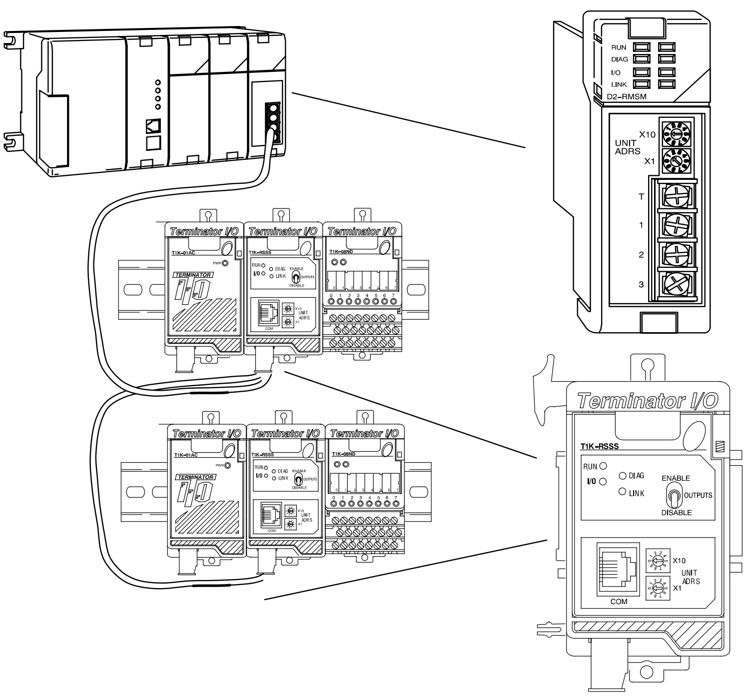
The main advantage of Terminator Remote I/O is that it expands the I/O capability beyond the local CPU base. Remote I/O can also offer tremendous savings on wiring materials and labor costs for larger systems in which the field devices are in clusters at various locations. With the CPU in a main control room or some other central area, only the remote I/O cable is brought back to the CPU base. This avoids the use of a large number of field wires over greatly separated distances to all the various field devices. By locating the remote bases and their respective I/O modules close to the field devices, wiring costs are reduced significantly.

Another inherent advantage of remote I/O is the ability to add or remove slave bases, or temporarily take a base off line without disrupting the operation of the remaining system.

Remote I/O Communication Protocols

The Remote I/O system supports two different remote I/O communications protocols:

- The Remote Master protocol **(RM–NET)** is supported by the DL205 system as well as the bottom ports on the DL250, DL350 and DL450 CPUs. This means that the remote I/O slaves (set for RM–NET mode) connected to a RM–NET master can be a combination of T1K–RSSS and D2–RSSS slave modules up to the maximum allowed number of remote units and I/O points. Remote communications baud rates of 19.2K and 38.4K are supported.
- The Slice Master protocol **(SM–NET)** is also supported by the DL205 system (the CPU bottom ports do not support SM–NET). This means that the remote I/O slaves (set for SM–NET mode) connected to a SM–NET master can be a combination of T1K–RSSS and D2–RSSS and up to the maximum allowed number of remote units and I/O points. Up to 614.4K baud rate is supported by SM–NET. This protocol supports the built in RS–232 communications port on the remote slave units.



Remote Master : The master module(s) are mounted in the CPU base.
The bottom port of the DL250, DL350 and DL450 can serve as a RM–NET master.

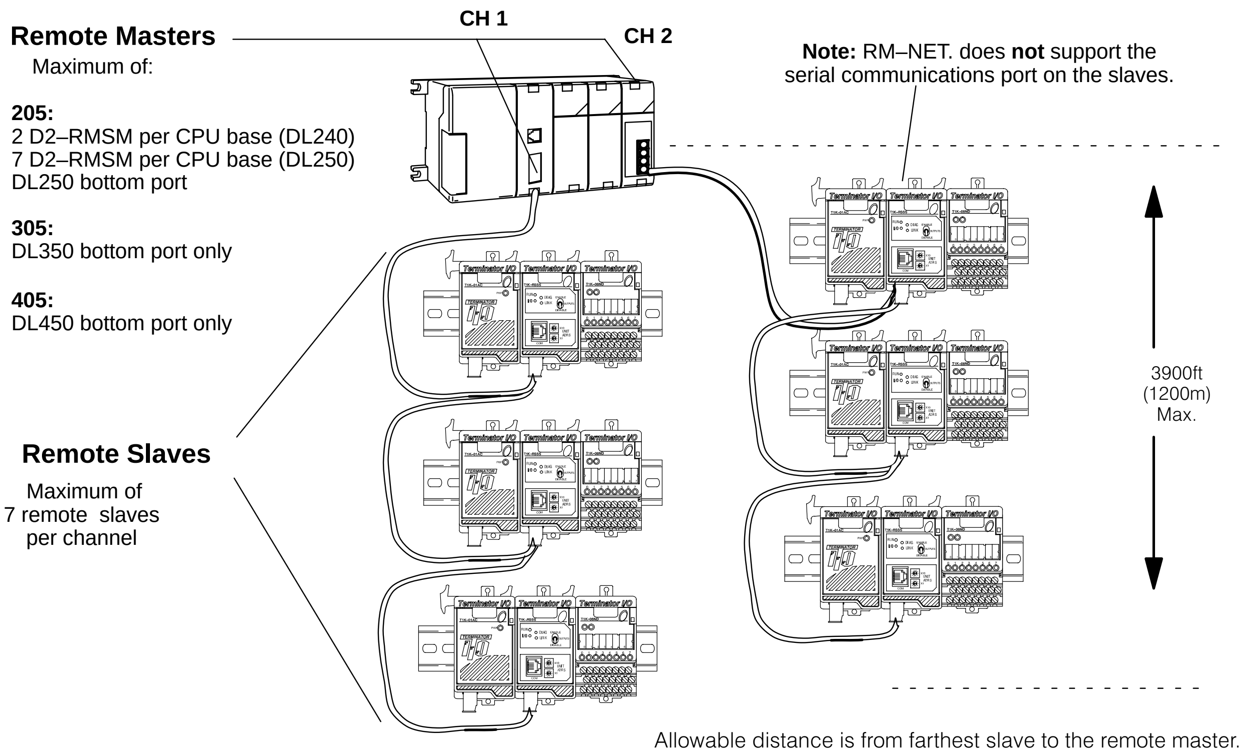
Remote Slave – The T1K–RSSS controllers are placed in each remote slave location. Each slave has the I/O circuitry required to be linked to the master module via twisted pair cable.

NOTE: The Remote I/O Masters that support the T1K–RSSS are the D2–250, D3–350, D4–450, D2–RMSM, D4–RM and D4–SM. The D4–RM and D4–SM will be included in the next revision of this manual. The manuals for the D4–RM and D4–SM accompanied by this manual will provide enough information to setup and program the remote I/O system. The D4–RM and D4–SM are limited to 512 I/O points per channel.

Number of Masters and Slaves Allowed (RM–NET)

In its simplest form, you may want to use only one master in your CPU base and then attach from one to seven remote slaves. However, in addition to the simple configuration, more than one master can be used in the CPU. You may use a maximum of two (with DL240) and seven (with DL250) masters per CPU base, all of which have to be the D2–RMSM module. Here is an example where we have used two masters in the CPU base (one of which is the bottom port on the DL250 CPU) and then attached a total of six remote I/O racks.

Two Masters in the Same Base (two channels, RM–NET)



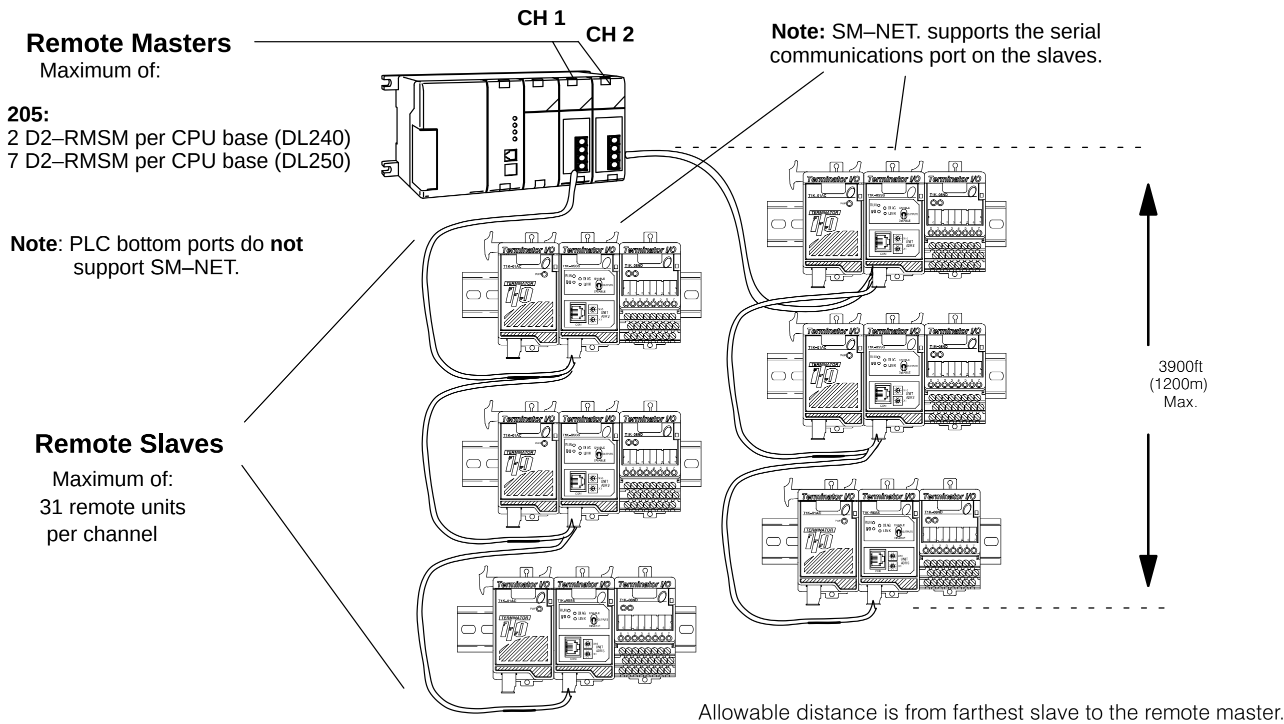
Distance Between Slaves and Master, Baud Rates (RM–NET)

Each slave belonging to the same master is connected in a daisy chain using a shielded twisted pair cable. The last slave unit in the daisy chain cannot be further than 3900 feet from the CPU base. You must set rotary switches that designate the slaves as No. 1, No. 2, etc. There is a DIP switch on each unit to set the baud rate for communication. You have a choice of either 19.2 kB or 38.4 kB. The slaves and master must be set to the same baud rate.

Number of Masters and Slaves Allowed (SM–NET)

In the *SM–NET* mode, one master in your CPU base will allow you to attach from 1 to 31 remote I/O units. You may use a maximum of two (with DL240) and seven (with DL250) masters per CPU base, all of which have to be the D2–RMSM module. Below is a SM–NET example where we have placed two masters in the CPU base and then attached a total of six remote I/O units.

Two Masters in the Same Base (two channels, SM–NET)



Distance Between Slaves and Master, Baud Rates (SM–NET)

Each slave belonging to the same master is connected together in a daisy chain using a shielded twisted pair cable. At the lowest baud rate, the last slave unit in the daisy chain cannot be farther than 3900 feet from the CPU base. You set rotary switches that designate the slaves as No. 1, No. 2, etc. There is a DIP switch on each unit to set the baud rate for communication. You have a choice of 19.2 kB, 38.4 kB,153.6 kB, 307.2kB, or 614.4 kB. The slaves and master must be set to the same baud rate. The T1K–RSSS serial communications port is active in SM–NET mode.

Choosing the Protocol Mode – RM–NET vs. SM–NET

The two protocols, RM–NET and SM–NET, each have features which may be of importance to your configuration. The system layout affects this choice, since there is a difference in the number of slaves allowed, the possible baud rates, and the total I/O link distance. First, let's review the specifications for the two protocol modes:

Specification	RM–NET	SM–NET
Maximum # of Slaves (per channel)	7	31
Maximum # of I/O pts. per channel (see note below)	2048* D2–RMSM 2048* DL250 CPU port 2048* DL350 CPU port 2048* DL450 CPU port	2048* D2–RMSM Note: CPU ports do not support SM–NET
Baud Rates	19.2K or 38.4K baud	19.2K, 38.4K, 153.6K, 307.2K, or 614.4K baud
Transmission Distance	3900 ft (1.2Km)	3900 ft (1.2Km) @ 19.2K or 38.4K baud 1968 ft (600m) @ 153.6K baud 984 ft (300m) @ 307.2K baud 328 ft (100m) @ 614.4K baud

*Requires CPU firmware version: D2–250 version 1.51 or later, D3–350 version 1.30 or later, D4–450 version (SH)1.460 or (SH)2.460 or later and D2–RMSM version 1.55 or later. Earlier firmware version supports 512 I/O points per channel.

NOTE: Remote I/O Capacity – Total remote I/O available is actually limited by the total references available.The DL250 CPU supports 512 X inputs and 512 Y outputs, so 1024 points is the limit for X and Y I/O references for local and remote I/O. It is possible to map remote I/O into V memory to achieve more I/O points.

Based on system layout, there may be advantages in choosing one protocol over the other. The comparison chart below lists these advantages in practical terms.

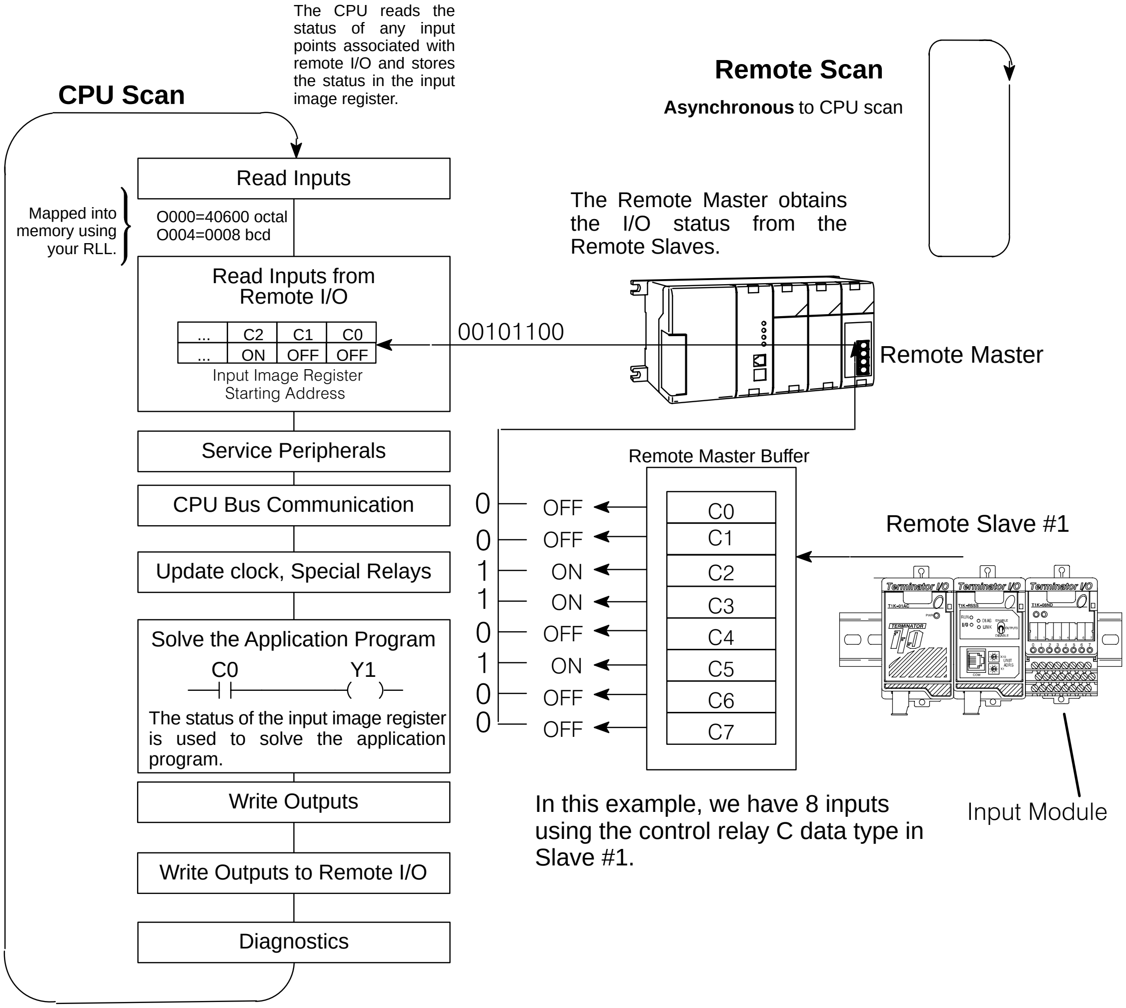
Reasons to Choose RM–NET vs SM–NET

RM–NET Advantages	SM–NET Advantages
Cost savings for system if first/only channel is attached to CPU Port Can use T1K–RSSS Remote Slave units with DL450 for cost & space savings over DL405 Remote I/O	Supplies high speed I/O expansion When Remote I/O must be highly distributed – need more slaves per channel **Desire programming port or operator interface port at remote slave location(s)**

How the CPU Updates Remote I/O Points

The CPU and remote master work together to update the remote I/O points. Below is an example showing how scanning and updating takes place. Notice that there are two independent scan cycles occuring at the same time, but **asynchronously**. The CPU module is doing its scan which includes looking at the information that the remote master is writing to its internal buffers.

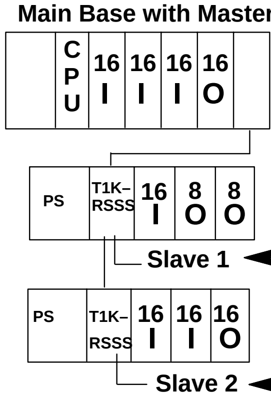
During every CPU scan, the CPU examines the internal buffers of the remote master, and updates input and output data from the remote I/O. It is very possible for the CPU to be scanning faster than the remote master can do its scan. It is largely dependent on the size of the application program, the baud rate you have selected for the data transfer between the slaves and master, as well as the number of I/O points being monitored. Therefore, if you have I/O points that must be monitored on every CPU scan, it's a good idea to place these critical I/O points in the local base.



3 Easy Steps for Setting Up Remote I/O

1
Design the Remote I/O System

Figure out how much remote I/O you will need. This will, in turn, tell you which CPU and the number of remote masters and slaves you will need. In the following chapters, we will show you how to use worksheets to plan and keep track of your data type assignments. We'll also show you how to determine the correct addresses for reading and writing remote I/O data, as well as how to choose other remote I/O system parameters. **If analog remote I/O modules are used in the application, it is recommended to use a DL250 CPU and V memory addressing for the remote I/O. The analog modules consume either 256 and 512 discrete I/O points each. The DL250 CPU supports "Bit–of–Word" instructions to access the bits in the V memory data words.**



Remote Slave Worksheet

Remote Base Address 1 (Choose 1–7 for RM–NET or 1–31 for SM–NET)

Slot Number	Module Name	INPUT Input Address	INPUT No. of Inputs	OUTPUT Output Address	OUTPUT No. of Outputs
0	16ND3	X060	16		
1	08TD1			Y020	8
2	08TD1			Y030	8
3					
4					
5					
6					
7					

Input Bit Start Address: X060 V-Memory Address*:V40403
Total Input Points 16

Output Bit Start Address: Y020 V-Memory Address*:V40501
Total Output Points 16

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350 CPU port setup program requires these addresses for each slave.

Remote Slave Worksheet

Remote Base Address 2 (Choose 1–7 for RM–NET or 1–31 for SM–NET)

Slot Number	Module Name	INPUT Input Address	INPUT No. of Inputs	OUTPUT Output Address	OUTPUT No. of Outputs
0	16ND3	X100	16		
1	16ND3	X120	16		
2	16TD1			Y040	16
3					
4					
5					
6					
7					

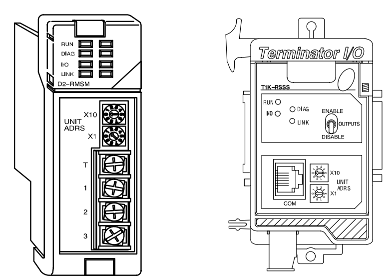
Input Bit Start Address: X100 V-Memory Address*:V40404
Total Input Points 32

Output Bit Start Address: Y040 V-Memory Address*:V40502
Total Output Points 16

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350 CPU port setup program requires these addresses for each slave.

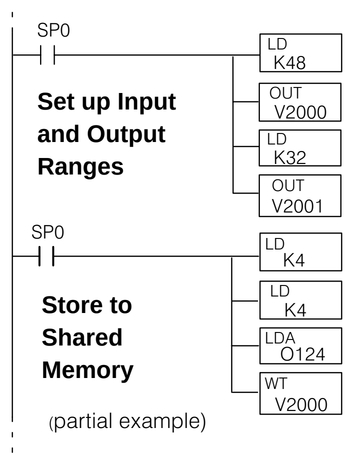
2
Install the Components

Install the master(s) and the remote slaves. Wire all of your I/O to match your information in Step 1. Set the hardware switches so that the CPU can identify the master and slave units. This also will set the baud rate for data transfer, protocol selection, and other parameters.



3
Write the Setup Program

Write the RLL setup program. Complete programming examples are provided in the following chapters.



Frequently Asked Questions

Q. How much remote I/O can I have?

A. The physical limitation depends on the CPU and the protocol you select (i.e. number of channels and number of slaves per channel). In terms of addressing the remote I/O, you can use up to the maximum X input and Y output addresses allowed for the CPU chosen (640 for the DL240, 1024 for the DL250) if you have no local I/O. If you need more I/O points, you can define remote I/O to use the C (control relay) memory type or V memory type, up to the maximum address available.

Q. What if I want to add remote I/O after I have programmed the system?

A. Your D2–RMSM setup program can allot unused I/O at the end of a slave, which you can install at a later date. If the local base has blank slots, you can install a D2–RMSM to add a new channel.

Q. Can I use a programmer or operator interface on the remote I/O link?

A. Yes, in the SM–NET protocol mode, the communications port on the T1K–RSSS remote slave supports a handheld programmer, ***Direct***Soft, or an operator interface. Note that since the bottom port of the DL250, DL350 and DL450 CPUs support the RM–NET mode only, you *cannot* use the serial communications port on slaves which are attached to the CPU.

Q. What if my cable routing causes the channel communication cable to exceed the maximum allowed distance?

A. You may need to reconsider the physical layout of your system. For example, you could split one large channel into two channels whose individual cable lengths would be acceptable. Or you could locate the local rack that contains the master modules in the “center” of the system, and radiate multiple channel communications cables in many directions.

2

D2–RMSM/ T1K– RSSS Remote I/O System

In This Chapter. . . .

Remote Master (D2-RMSM) Features

Remote Master

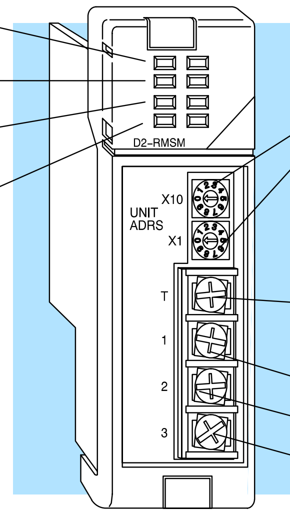
RUN--Turns ON when the module is operating correctly.

DIAG--Turns ON when there is a hardware failure.

I/O--Turns ON when the setup program is wrong

LINK--Turns ON when there is a communications error.

DIP SWITCH--On rear of module for setting baud rate and other parameters.



UNIT ADRS--Rotary switches for setting the module to be the master – **always set to 0**

T-–Terminating point that is connected to point 1 with a jumper at the master and final slave unit.

1--1st wire of twisted pair (+ Txd/Rxd)

2--2nd wire of twisted pair (– Txd/Rxd)

3--Shield connection

Functional Specifications

# of Masters (channels) per CPU	2 max. for DL240, 7 + 1 max. for DL250 (built–in RM–NET master feature in DL250 bottom port can be the eighth master). The DL230 does not support Remote I/O.
Channel Specifications:	<u>RM–NET</u> / <u>SM–NET</u>
I/O Points per Master (channel)	2048 (requires firmware version 1.55 or later. Earlier firmware versions support 512 I/O points per channel. (see “Remote I/O Capacity” Note on following page)
Maximum # of Slaves	RM–NET: 7 SM–NET: 31
Baud Rates	RM–NET: Selectable 19.2K or 38.4K baud SM–NET: Selectable 19.2K, 38.4K, 153.6K, 307.2K, or 614.4Kbaud
Transmission Distance	RM–NET: 3900 feet (1.2Km) SM–NET: 3900 feet (1.2Km) @ 19.2K or 38.4Kbaud 1968 feet (600m) @ 153.6Kbaud 984 feet (300m) @ 307.2Kbaud 328 feet (100m) @ 614.4Kbaud
CPU Memory Type available for Remote I/O **Note: 8 channel analog modules consume 256 discrete I/O pts. and 16 channel analog modules consume 512 I/O pts. The DL250 CPU and V memory addressing is recommended when using analog I/O modules.**	<u>DL240</u> / <u>DL250</u> X Inputs: 320 / 512 Y Outputs: 320 / 512 Control Relays: 256 / 1024 V Memory (words): 1024 / 7186
Module Type	Intelligent
Digital I/O Consumed	None
Communication Method	Asynchronous (half-duplex)

NOTE: **Remote I/O Capacity** – Total remote I/O available is actually limited by the total references available.The DL250 CPU supports 512 X inputs and 512 Y outputs, so 1024 points is the limit for X and Y I/O references for local/remote I/O. It is possible to map remote I/O into other types of memory, such as control relays or V memory to achieve more I/O points.

The following specifications define the operating characteristics of the D2–RMSM module.

Physical Specifications

Installation Requirements	CPU base only, any slot except adjacent to CPU
Internal Power Consumption	200 mA maximum
Communication Cabling	RS-485 twisted pair, Belden 9841 or equivalent
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304

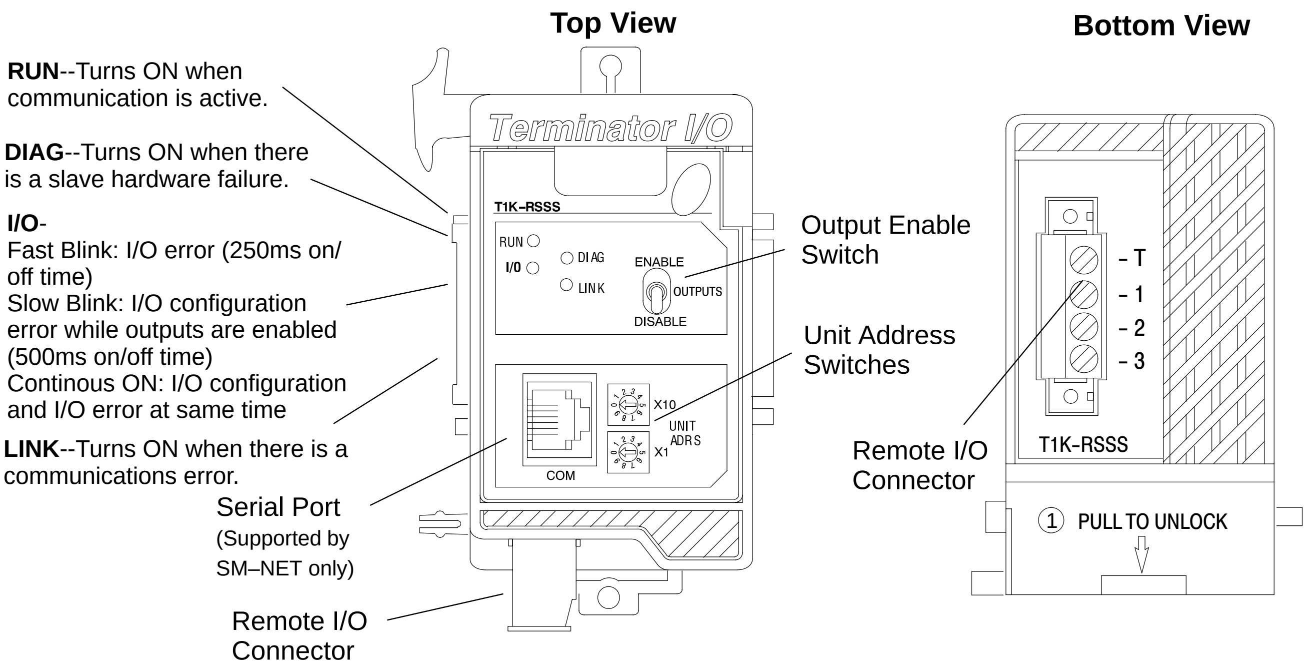
Auto Return to Network Option

The remote master queries the channel to detect which slaves are present in three instances:

- on power up
- on transition from CPU Program Mode to Run Mode
- when user logic commands the remote master to log its parameters to EEPROM

If an offline slave comes on after the master powers up, the master may never know that a slave has returned to the network. If you select the Auto Return to Network mode, the master can detect reinstated slaves at any time.

Remote Slave (T1K-RSSS) Features



Functional Specifications

Max. # of Slaves per channel	RM–NET 7	SM–NET 31
Maximum I/O Modules per Slave	16 (be sure to check power budget)	
Maximum Remote I/O Points per CPU **Note: 8 channel analog modules consume 256 discrete I/O pts. and 16 channel analog modules consume 512 I/O pts. The DL250 CPU and V memory addressing is recommended when using analog I/O modules.**	No remote I/O for DL230 DL240, DL250, support a maximum of 2048 points per channel. The actual I/O available is limited by total available references. The DL240 has a total of 320 X inputs and 320 Y outputs available to share between local and remote I/O. The DL250 has a total of 512 X inputs and 512 Y outputs. Mapping remote I/O into control relays or V memory of could allow more I/O points for the DL240 or DL250.	
Module Type	Non–intelligent slave	
Digital I/O Consumed	Consumes remote I/O points at a rate equal to the number of I/O points configured in each unit.	
Communication Baud Rates	RM–NET Selectable 19.2K or 38.4K baud	SM–NET Selectable 19.2K, 38.4K, 153.6K, 307.2K, or 614.4K baud
Communication Failure Response	Selectable to clear or hold last state of outputs	

The following specifications define the operating characteristics of the T1K–RSSS module.

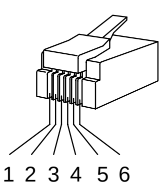
Physical Specifications

Installation Requirements	mount to right of first power supply
Base Power Requirement	250 mA maximum
Communication Cabling	for remote I/O, RS-485 twisted pair, Belden 9841 or equivalent
Slave Serial Communications Port (active in SM–NET mode only)	RS232C (K–Sequence) Dip switch selectable: Baud rate: 4800–38400bps Parity: odd (default), none Fixed settings: 8 data bits, 1 start bit, 1 stop bit
Operating Temperature	32 to 131° F (0 to 55° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases, pollution level = 2 (UL 840)
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304 Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz, 10W, 10cm)

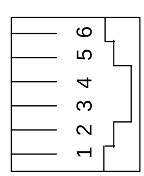
Serial Port Pinout

The port pinout is shown below: (The port is active in SM–NET only).

RJ12 plug on cable



RJ12 socket on T1K–RSSS

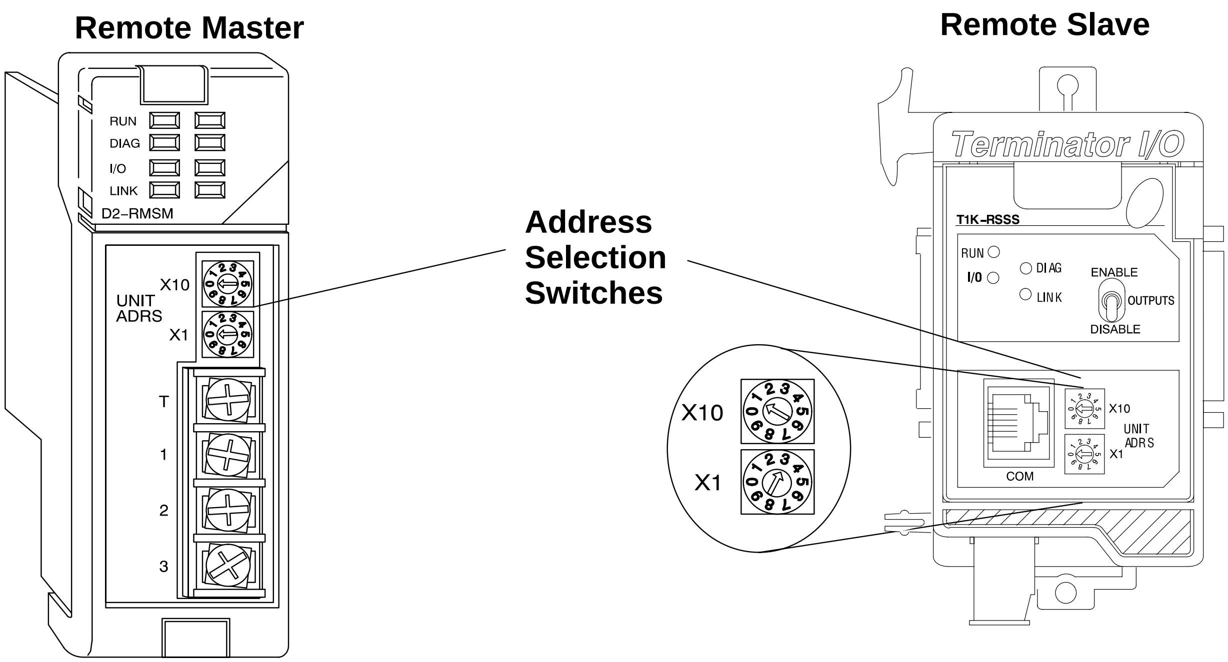


Port Pinout

Pin	Signal Definition
1	0 V
2	5 V
3	RS232C Data In
4	RS232C Data Out
5	5 V
6	0 V

Setting the Rotary Switches

Both the remote master and slave have two small rotary switches to set the unit address. They are on the face of the module, with the label "UNIT ADRS" beside it. Adjust the switches by rotating them with a small flathead screwdriver.

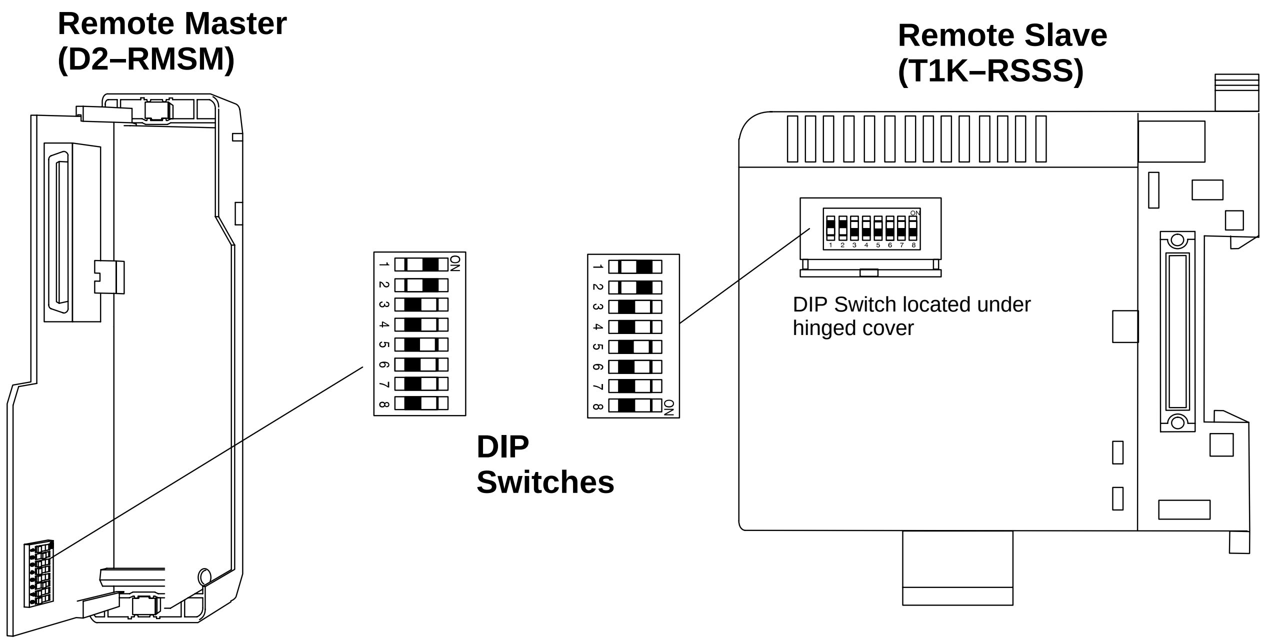


One switch is marked X1 and the other X10. Don't confuse these with the conventional data type labeling – *these do not refer to inputs* X1 and X10. Instead, these set the address in decimal for each unit. X1 is the "one's" position and X10 is the "ten's" position. For example, set address 13 by turning the X10 switch to 1 and the X1 switch to 3 (10+3=13).

Align the arrows on the switches to 0 to use the module as a **master** (D2–RMSM only). Set them to any number (1–7 for RM–NET mode or 1–31 for SM–NET mode) if it will be a **slave** (T1K-RSSS). Two slaves cannot have the same number if they are linked to the same master. **Always use consecutive numbers for slaves, starting with Address 1—don't skip numbers**.

Setting the DIP Switches

The remote master (D2–RMSM) has an 8-position DIP switch labeled “SW3” that is mounted toward the rear of the module on the PC board. The remote slave (T1K–RSSS) also has an 8–position DIP switch labeled “SW1” that is located on the side of the module under a hinged cover. Set these switches to configure the protocol mode, the baud rate, the output response on communication failure and the slave serial port settings. The word “ON” appears beside the switch to indicate the ON position.



DIP Switch Settings

Module	DIP Position					
	1	**2,3,4**	**5**	**6**	**7**	**8**
Master (RMSM)	**Mode** OFF=SM–NET ON=RM–NET	**Baud Rate** Switch Position Baud Rate 2 3 4 19.2K O O O 38.4K X O O 153.6K O X O 307.2K X X O 614.4K O O X where X=ON, O=OFF- Note: Baud rates above 38.4K for SM–NET only	Always OFF	Always OFF	Always OFF	**Diagnostics** OFF=Normal ON=Diagnostic
Slave (T1K–RSSS)	**Mode** Same as Master	**Baud Rate** Same as Master	**Output Default** OFF=Clear ON=Hold	**Serial Port Parity** OFF = Odd ON = None (Active in SM–NET only)	**Serial Port Baud Rate** (Active in SM–NET Only) Baud Rate 4.8K 9.6K 19.2K 38.4K where X=ON, O=OFF	DIP position- 7 8 X O O O O X X X

__Mode:__ DIP switch Position 1 on both the master and slave unit selects the protocol mode for the remote I/O link. The Terminator remote I/O can use one of two protocols, **RM–NET** or **SM–NET.** Chapters 1 and 2 discussed the features of these protocols and the considerations for using each. Position 1 of the master and all slaves linked to it must be set to the same setting in order to communicate. If there are multiple masters in the system, each can use a different protocol if necessary.

__Baud Rate:__ DIP switch Positions 2,3, and 4 on both the master and slave unit select the baud rate for the remote I/O link. If you have selected the **RM–NET** protocol mode, only Switch 2 selects the baud rate, either 19.2K or 38.4K baud. In this mode, be sure to set switches 3 and 4 OFF. If you have selected the **SM–NET** protocol mode, you set switches 2, 3, and 4 to select among five baud rates ranging from 19.2K to 614.4K baud. The higher the baud rate, the less distance is allowed between the master and the end slave. See the D2–RMSM Functional Specifications earlier in this chapter for the allowable distance at each baud rate. All stations on a remote I/O link must have the same baud rate before the communications will operate properly. If there are multiple masters in the system, each can use a different baud rate if necessary.

__Output Default:__ DIP switch Position 5 on the slave determines the outputs' response to a communications failure. If DIP switch 5 is ON, the outputs in that slave unit will hold their last state when a communication error occurs. If OFF, the outputs in that slave unit will turn off in response to an error. The setting does not have to be the same for all the slaves on an output channel.

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

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

__Diagnostics:__ DIP switch Position 8 on the master selects the factory diagnostic mode, and should always be OFF. If the diagnostic mode is active, the module will not operate correctly. Turning the diagnostic switch to the ON position and applying power to the CPU base will clear the shared memory in the remote master module. Be sure to remove the master module from the base and return the switch to the OFF position for normal operation.

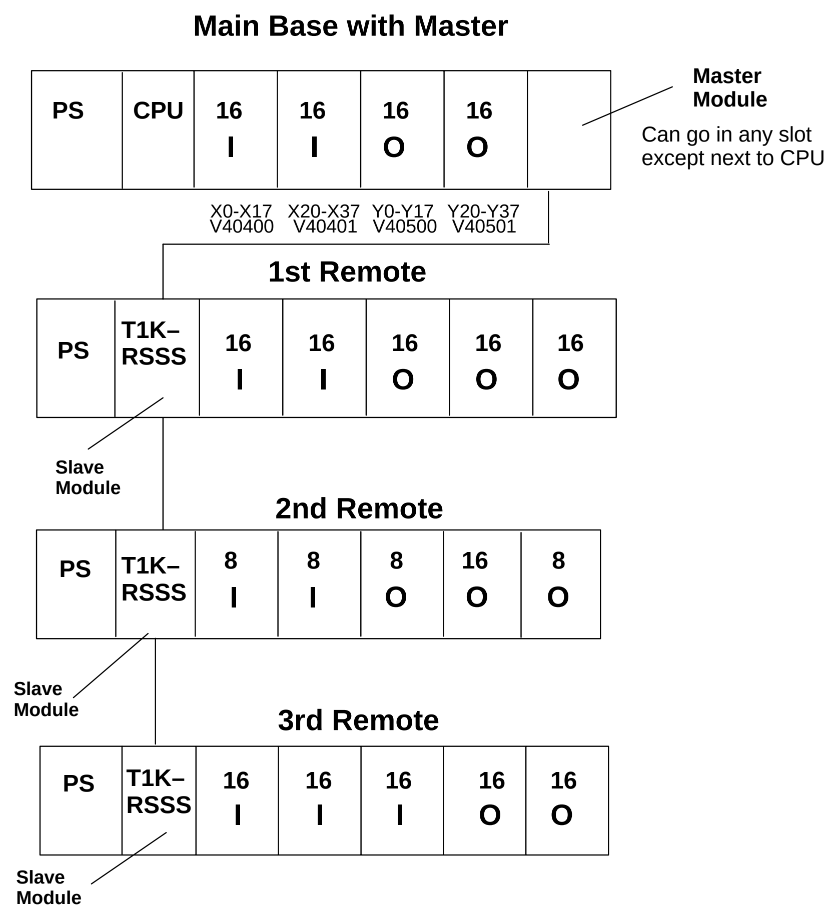
__Slave Serial Port:__ DIP switch Positions 6, 7 and 8 on the slave select the parity and baud rate for the slave's serial communications port. *The port is active only if the remote I/O link is set for* ***SM–NET*** *protocol*. Switch 6 selects the parity and switches 7 and 8 select the baud rate.

Determine the System Layout

Determine I/O Needed and How Many Masters & Slaves

Once you choose the hardware configuration you need, create a diagram of the system I/O to help determine the amount and locations of remote bases. Below is a drawing of a typical system with:

- one master module in the main base.
- main base has two input modules and two output modules, each with 16 points.
- first remote base has two input and three output modules, each with 16 points.
- second remote base has two 8-point input modules, two 8-point output modules and one 16-point output module.
- third remote base has three 16-point input modules, and two 16-point output modules.



This layout might be typical of a system which requires additional I/O at the CPU location (beyond the local rack capacity), as well as a remote location or two.

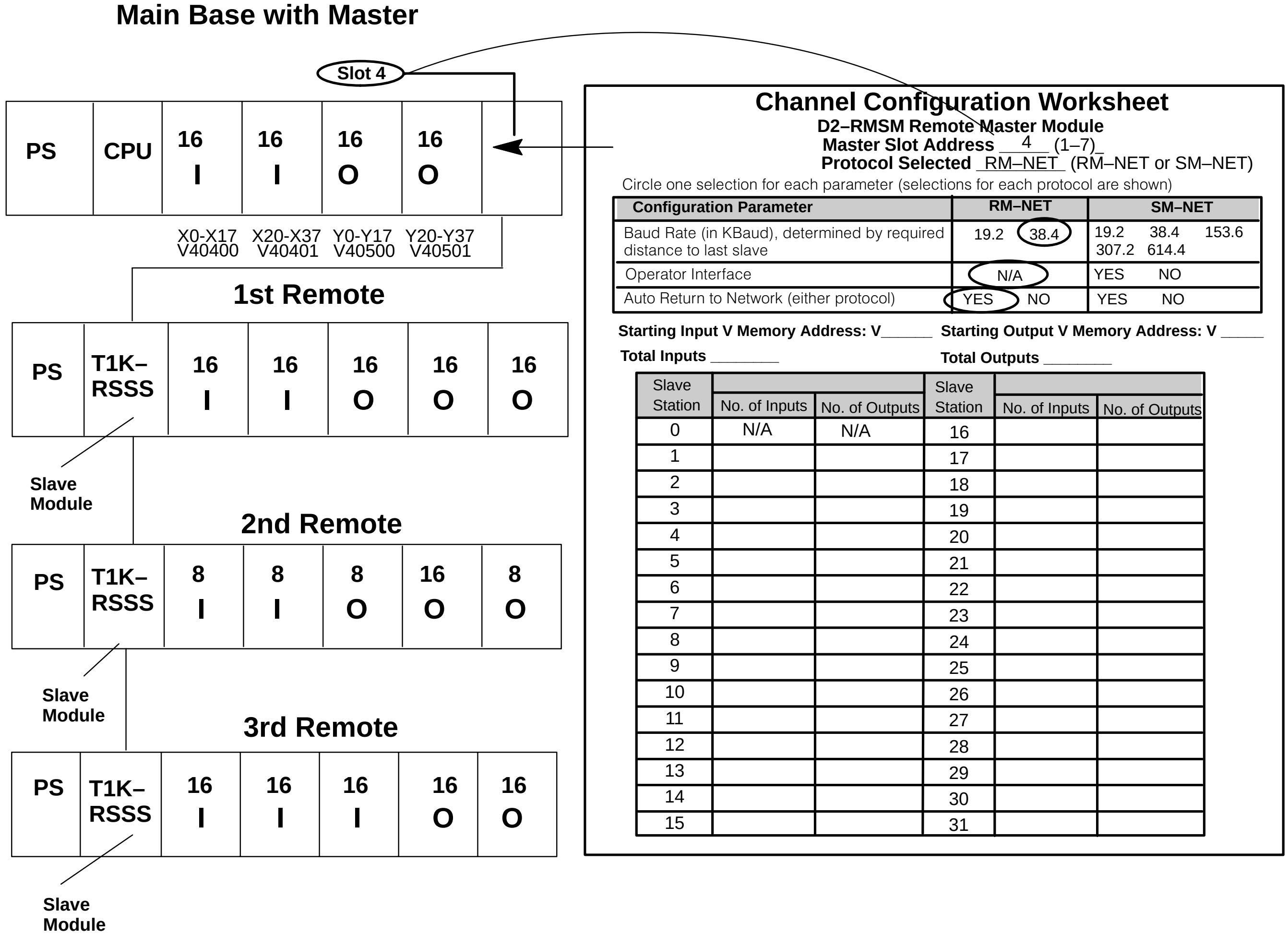
Define the System Details By Using Worksheets

In Appendix A of this manual you will find worksheets for designing the remote I/O system and defining its parameters. We suggest that you photocopy these sheets and use them to map out the details of your system. Assuming this will be your procedure, this chapter will walk you through the process using the example system. The Channel Configuration Sheet defines the operating parameters for a channel. The Remote Slave Worksheet records the amount and addresses of the I/O for each slave. First, select the Channel Configuration Worksheet to determine the characteristics for each channel (master) in the system.

Completing the Channel Configuration Worksheet (top half)

The top half of the following Channel Configuration Worksheet shows the parameter choices for the single master in our example system. This helps determine the hardware settings and the setup program data. We chose RM–NET for illustration purposes.

Main Base with Master



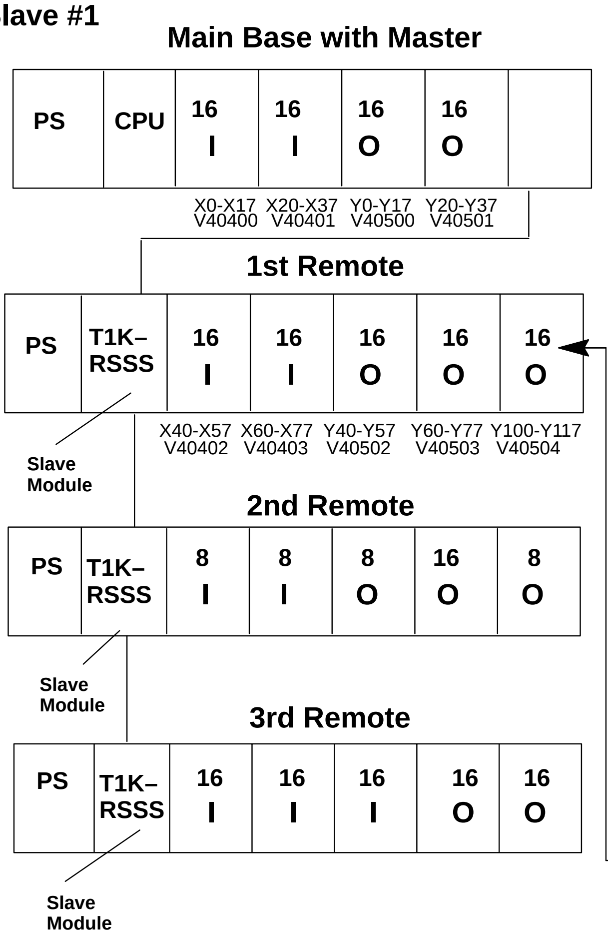
Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

NOTE: The slot number of the master is important because the setup program uses it to address the master module.

Now that we have determined the hardware layout and the channel parameters, we can fill in the details for the three remote units

Completing the Remote Slave Worksheet for Slave #1

We have filled in the following remote slave worksheet to match the first remote I/O base of the example system.



Remote Slave Worksheet

Remote Unit Address 1 **(Choose 1–7 for RM–NET or 1–31 for SM–NET)**

Slot Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0	16ND3	X40	16		
1	16ND3	X60	16		
2	16TD1			Y40	16
3	16TD1			Y60	16
4	16TD1			Y100	16
5					
6					
7					

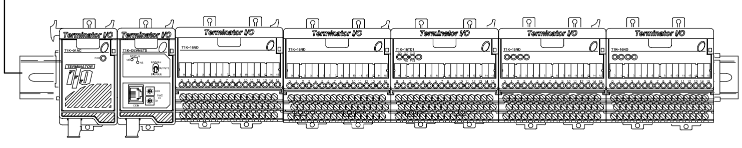
Input Bit Start Address: X040 **V-Memory Address*:V** 40402

Total Input Points 32

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

Total Output Points 48

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350/DL450 port setup program requires these addresses for each slave.



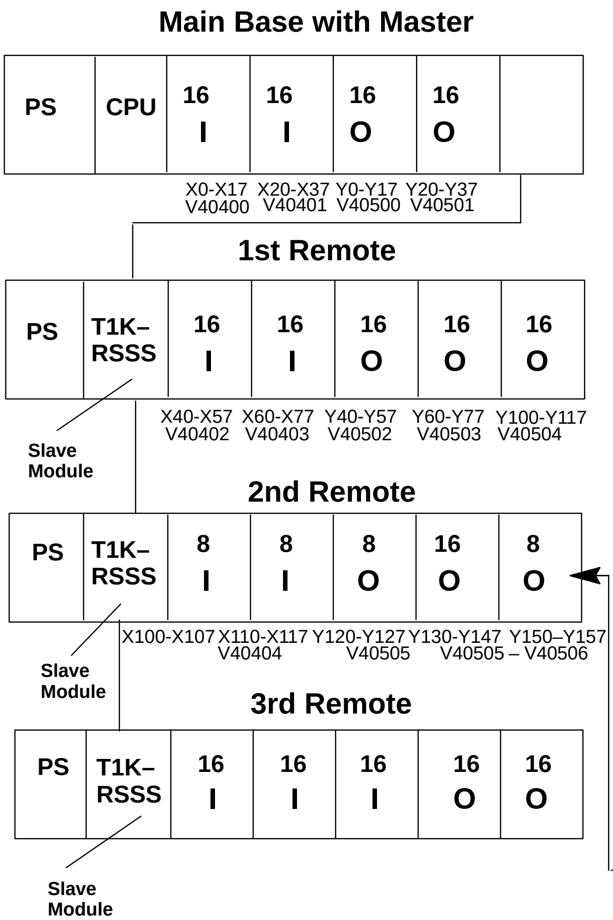
Starting Addresses From Appendix B = V40402 Input   V40502 Output

In this example, the CPU base has 64 points allocated to its input and output modules, which the CPU automatically configures as points X0 thru X37 and Y0 thru Y37. Thus, the starting address for the *first remote base* inputs can start at X40 (or higher) and the starting address for outputs can be Y40 (or higher). The far right-hand column of each of these charts shows the "bit start" address. For example, for the bit start address for input X40, you look for X40 on the chart. There you find the cross-referenced register address: 40402. On the output chart, you cross-reference Y40 with 40502. Enter these numbers on the worksheet, as you will use them later in your setup logic.

Now let's do the same thing for the *second* remote I/O base.

Completing the Remote Slave Worksheet for Slave #2

We have filled in the following remote slave worksheet to match the second remote I/O base of the example system.



Remote Slave Worksheet

Remote Unit Address 2 **(Choose 1–7 for RM–NET or 1–31 for SM–NET)**

Slot Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0	08ND3	X100	8		
1	08ND3	X110	8		
2	08TD1			Y120	8
3	16TD1			Y130	16
4	08TD1			Y150	8
5					
6					
7					

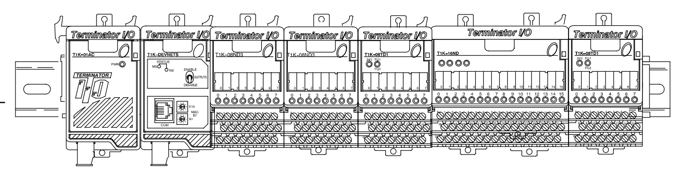
Input Bit Start Address: X100 **V-Memory Address*:V** 40404

Total Input Points 16

Output Bit Start Address: Y120 **V-Memory Address*:V** 40505

Total Output Points 32

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350/DL450 CPU port setup program requires these addresses for each slave.

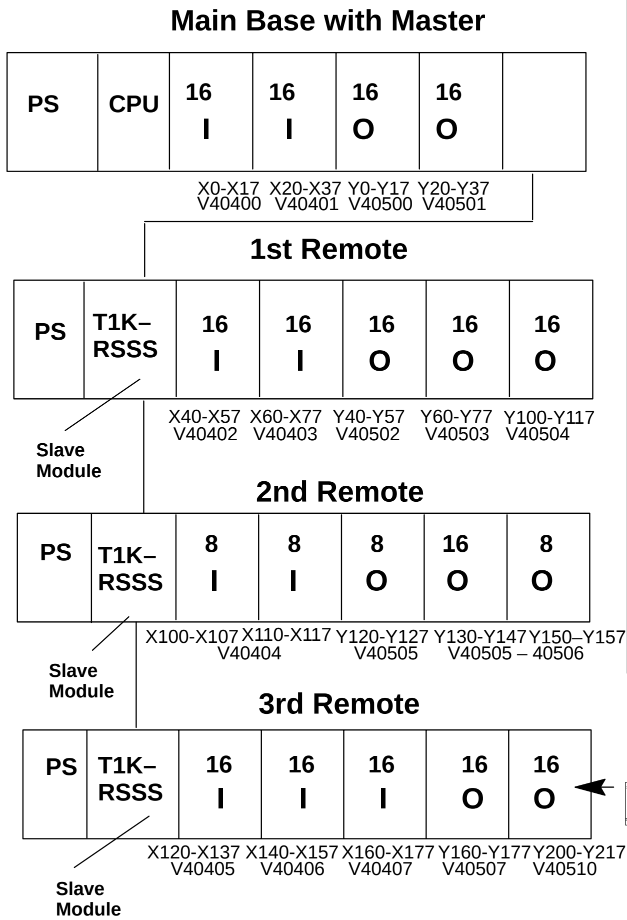


Based on the V-memory addresses we chose, the D2–RMSM allocated points X40 to X77 to Remote Slave #1's inputs, and Y40 to Y117 to its outputs. This means the starting address for the *second remote base inputs* is X100 (assigned automatically by the remote master) and the starting address for *outputs* is Y120 (assigned automatically).

Now let's do the same thing for the *third* remote I/O base.

Completing the Remote Slave Worksheet for Slave #3

We have filled in the following remote slave worksheet to match the third remote I/O base of the example system.



Remote Slave Worksheet

Remote Unit Address 3 **(Choose 1–7 for RM–NET or 1–31 for SM–NET)**

Slot Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0	16NA	X120	16		
1	16NA	X140	16		
2	16NA	X160	16		
3	16TA			Y160	16
4	16TA			Y200	16
5					
6					
7					

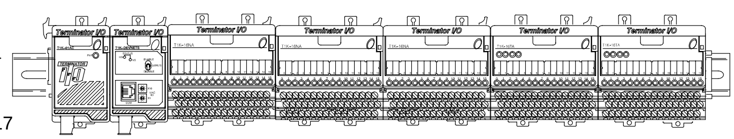
Input Bit Start Address: X120 **V-Memory Address*:V** 40405

Total Input Points 48

Output Bit Start Address: Y160 **V-Memory Address*:V** 40507

Total Output Points 32

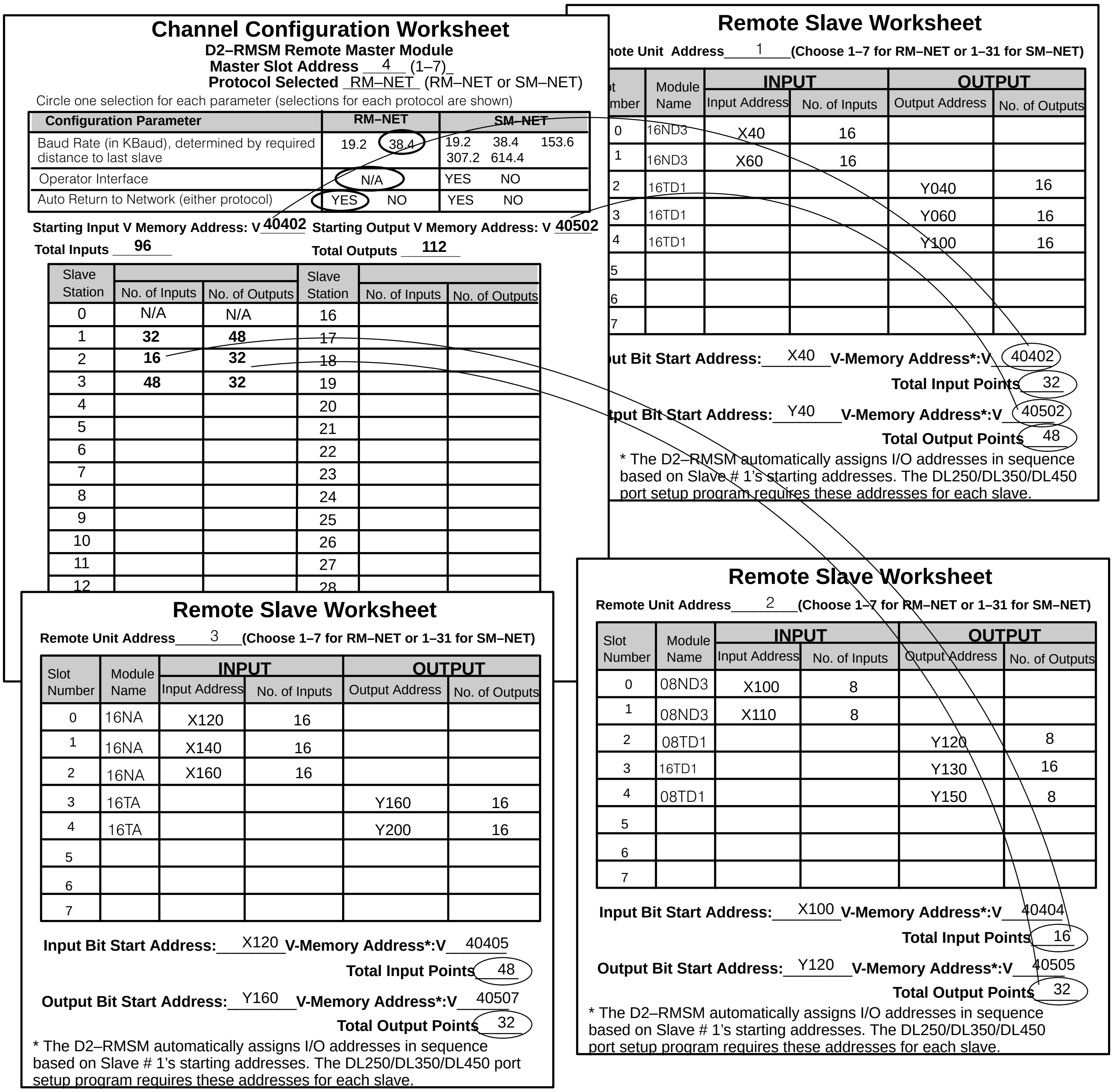
* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350/DL450 CPU port setup program requires these addresses for each slave.



The D2–RMSM allocated X100 to X117 to Remote Slave #2's inputs, and Y120 to Y157 to its outputs. This means the starting address for the *third base inputs* is X120 (assigned automatically) and the starting address for *outputs* is Y160 (assigned automatically).

Completing the Channel Configuration Worksheet (bottom half)

To complete the Channel Configuration Worksheet, we retrieve information from the Remote Slave Worksheets. Transfer the V-memory addresses for the inputs and outputs of Remote Slave # 1, and the input and output range for each slave to the Channel Worksheet to prepare to write the setup program.



Add the input and output ranges for the slaves to find the total input and output ranges for the channel. Enter the totals as shown on the Configuration Worksheet.

Connecting the Wiring

General Wiring Guidelines

Consider the following wiring guidelines when wiring the communication cabling in your system:

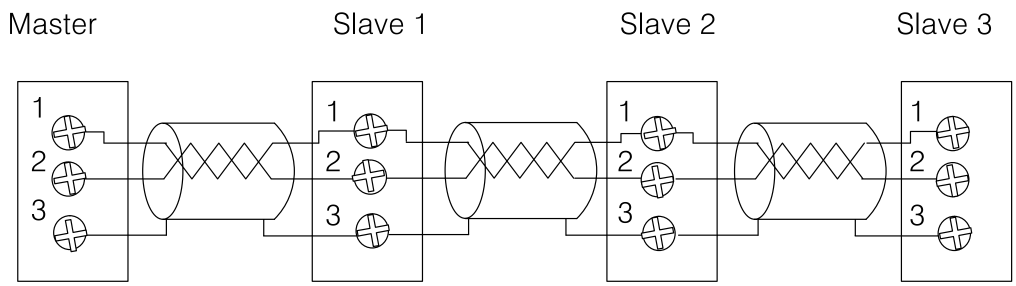
1. Always use a continuous length of cable. Do not combine cables to attain a needed length.
2. Use the shortest possible cable length.
3. Where possible, use conduit for cable routing.
4. Avoid running cable near high energy wiring.
5. Where possible, avoid running communications cabling in close proximity to AC wiring.
6. Avoid creating sharp bends in the cables.
7. Label all wires.

Cable Recommendation

The recommended cable for connecting the master and slaves is a single twisted pair cable, Belden 9841 or equivalent. This cable meets the RS-485 standard for communications. Its impedance specification is 120 ohms per thousand feet.

Cabling Between the Master and Slaves

The diagram shown below depicts the cabling between the D2-RMSM master and its slaves. The two inner wires are connected to terminals 1 and 2 of each module. The shield wire is connected to terminal 3. *Make sure the the connections between master and all slaves are always 1 to 1, 2 to 2 and 3 to 3*.

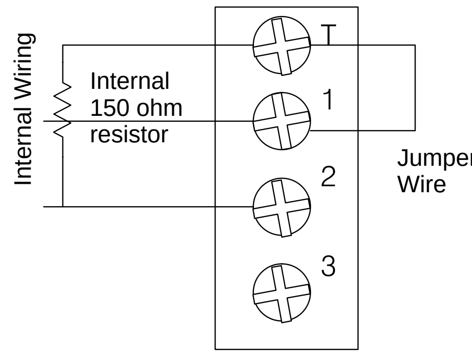


Termination Resistors

At each end of a master/slave system, it is necessary to have a *termination resistor* to prevent signal reflections from interfering with the communications. Although the modules have a 150 ohm resistor built in for this purpose, there are three options to consider:

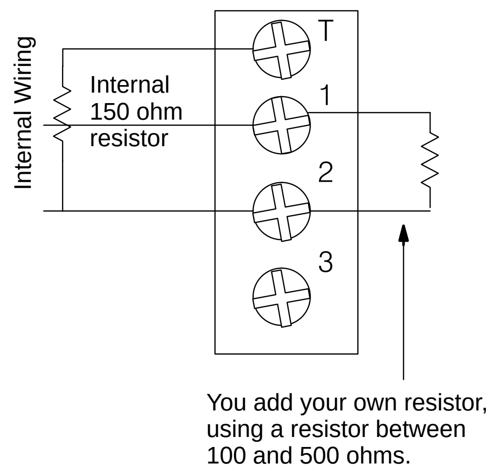
Option 1:
Use Internal Resistor Only

With this configuration, you use the internal resistor of the module to provide all the terminating resistance necessary. Place a jumper wire between the terminating terminal and terminal 1.



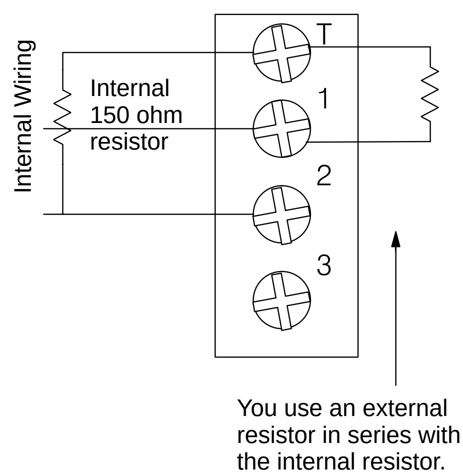
Option 2:
Use Internal Resistor and Balance Resistor

To better match the impedance of the cabling, you can elect not use the internal resistor; and instead, use a resistor of your choice externally. Connect this resistor between terminals 1 and 2. You do not use the jumper wire in this case.



Option 3:
External Resistor in Series

With this option, you use an external resisor in series with the internal resistor. The sum resistance should match the cabling impedance.



3

D2–RMSM Setup Programming and Troubleshooting

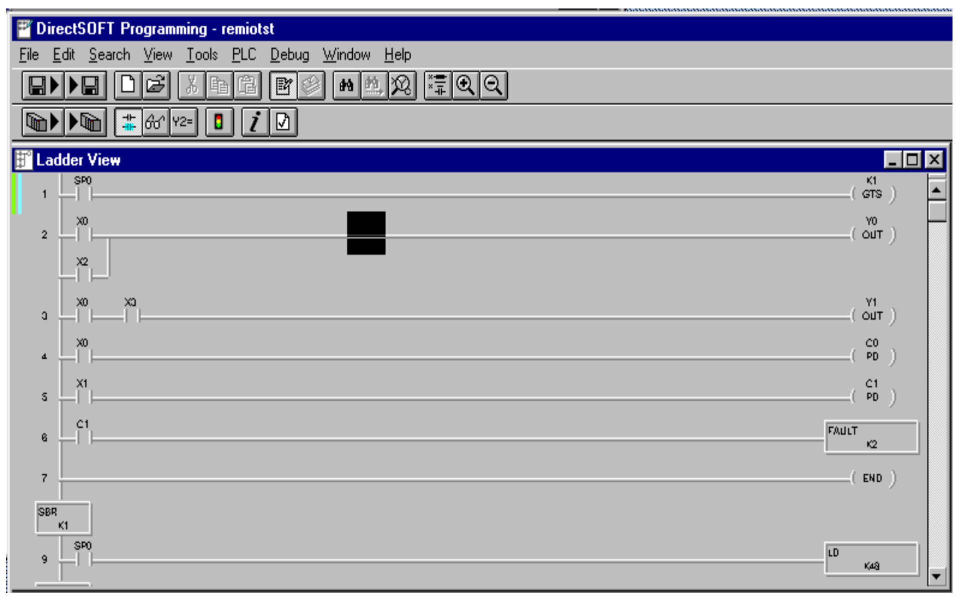
In This Chapter. . . .

Getting Started with the Programming

You can write your program using either a handheld programmer or a PC loaded with software such as ***Direct***SOFT. The examples that follow will show you how to do it using ***Direct***SOFT.

To get started, enter ***Direct***SOFT and carry out the normal ***Direct***SOFT setup procedures for communicating with your DL205 CPU. If you do not know how to do this, refer to your ***Direct***SOFT Manual. Your DL205 User's Manual has a very good coverage of the basic commands available and examples of using the commands to write general ladder logic. We will be showing you in this chapter only those commands that pertain to setting up your remote I/O initialization and its successful utilization.

First open ***Direct***SOFT from Windows and establish a link with your CPU. Then enter the Edit Mode for programming. You should now be looking at a screen similar to the one shown below:



The ***Direct***SOFT window shown above depicts a program that has already been written. Your window, of course, will be empty when you first enter it. The pages that follow will show you how to write each part of your initialization program.

Writing the Remote I/O Setup

Step 1: Decide How You Are Going to Call Your Program

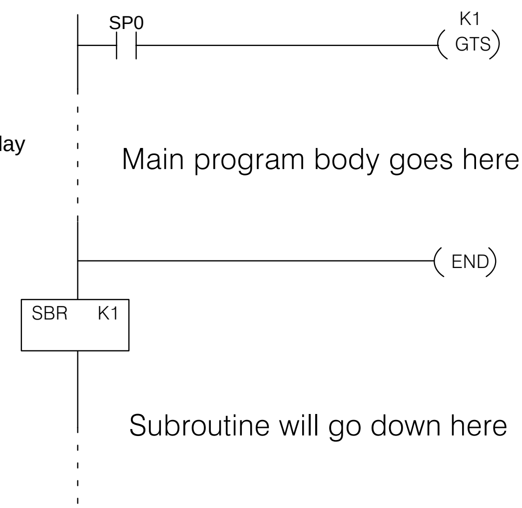
Is your setup logic going to be in the main program body or is it going to be in a subroutine?

A subroutine for your remote I/O setup has an advantage over writing the code into the program's main body. Some remote I/O setup logic becomes quite lengthy. By putting the setup in a subroutine, you don't have to scroll through extra logic during routine troubleshooting procedures. We advise you to use a subroutine for your remote I/O initialization. Here's how:

Using the GTS Command for the Setup Logic

Note: SP0 is a special relay contact which energizes only on the first scan of the program

*Direct*SOFT Display



**Step 2:
Write the Setup Logic for Each Channel**

Whether you choose to write the remote I/O setup program as a subroutine or as a part of the main program, the procedure is still the same. You have several things you must do for each channel of remote I/O:

- Tell the remote master to initiate setup, and define the auto return to network option.
- Tell the remote master the starting V-memory address for inputs and outputs, and the total number of each for the channel. You do this with address *pointers* and constant data.
- Tell the remote master how many input and output points are located in each base.
- Tell the remote master to save the parameters in EEPROM (setup is complete).

To write the setup logic, we use the CPU instructions described below. If you are not familiar with these instructions, you may want to refer to the DL205 User Manual for more details and examples.

The Load instruction is a 16-bit instruction that loads the value (Aaaa), which is either a V-memory location or a 4-digit constant, into the lower 16 bits of the accumulator. The upper 16 bits of the accumulator are set to 0.

```
LD
  A aaa
```

The Load Address instruction is a 16 bit instruction. It converts any octal value or address to the HEX equivalent value and loads the HEX value into the accumulator.

```
LDA
  O aaa
```

The OUT instruction is a 16 bit instruction that copies the values in the lower 16 bits of the accumulator to a specified V-memory location (Aaaa).

```
OUT
  A aaa
```

The WT instruction writes a block of data (1–128 bytes max.) to an intelligent I/O module from a block of V-memory in the CPU. The function parameters (module base/slot address, number of bytes, and the intelligent I/O module memory address) are loaded into the first and second level of the accumulator stack, and the accumulator by three additional instructions. In the WT instruction, Aaaa specifies the starting V-memory address where the data will be written from in the CPU.

```
WT
  A aaa
```

You use these instructions to set up the configuration data in a block of V-memory which serves as a buffer. Use WT instructions to store the data to various shared memory locations in the Remote Master module. Use your worksheets to assist you in creating the setup logic.

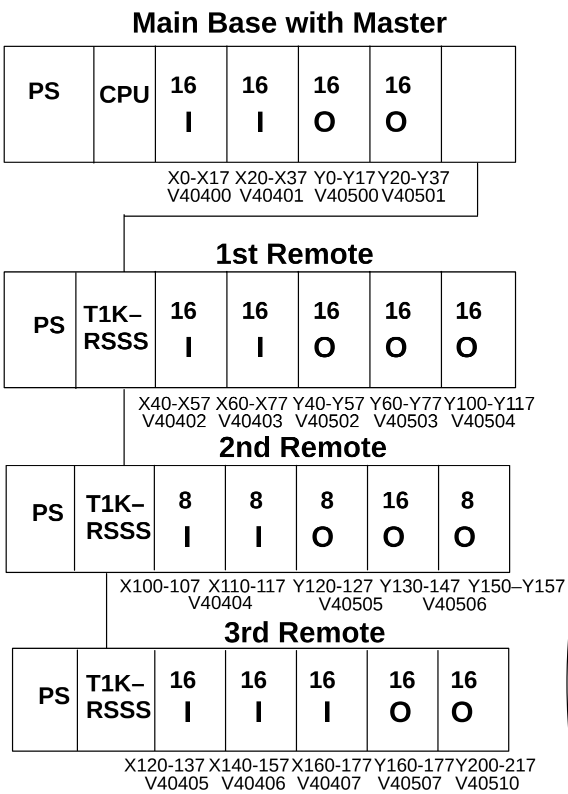
Example Program Using Discrete I/O Modules

Example 1: Addressing using X and Y Memory

To illustrate the setup program for a system using X's as remote inputs and Y's as remote outputs, we will use the example system from Chapter 2, shown here with a completed Channel Configuration Worksheet.

The first block of logic tells the remote master to initiate the setup, and to enable the Auto Return to Network option. To find the D2–RMSM shared memory addresses used in the setup program, refer to the Shared Memory Table at the end of this chapter.

Write Configuration Byte



Channel Configuration Sheet

D2–RMSM Remote Master Module

Master Slot Address 4 (1–7)

Protocol Selected RM–NET (RM–NET or SM–NET)

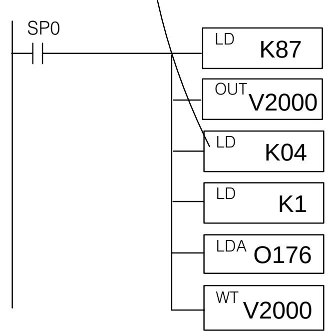
Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES	NO

Starting Input V Memory Address: V 40402 **Starting Output V Memory Address: V** 40502

Total No. Inputs 96 **Total No. Outputs** 112

Slave Station	No. Inputs	No. Outputs	Slave Station	No. Inputs	No. Outputs
0	N/A	N/A	16		
1	32	48	17		
2	16	32	18		
3	48	32	19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		



Bits 0,1,2 ON initiates the setup
Bit 7 defines Auto Return to Network (ON=Yes)

Choose a word of available V memory to use as a buffer

Master address: High byte is rack (0), low byte is slot (4)

Number of bytes to write to shared memory (1 byte)

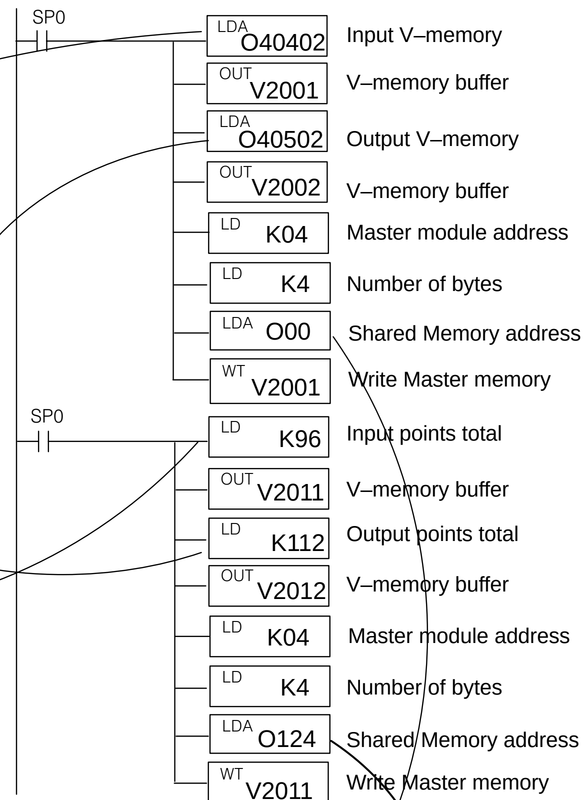
Shared memory address of configuration byte

Write value in lower byte of V2000 to Master memory

This block of logic tells the remote master the starting V-memory addresses for the inputs and outputs, and the total number of each for the channel. Use the LD, LDA, and OUT commands to load the starting addresses and point totals into temporary memory, then write the values to the master's shared memory. The Quick Reference Table shows the correct shared memory addresses in octal.

Write Input and Output Pointers, and Input and Output Ranges for Channel

The LDA instruction uses octal numbers, designated by the capital O in front of the number.



Channel Configuration Worksheet

D2–RMSM Remote Master Module
Master Slot Address 4 (1–7)
Protocol Selected RM–NET (RM–NET or SM–NET)

Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES NO	YES NO

Starting Input V Memory Address: V 40402 **Starting Output V Memory Address:** V 40502
Total Inputs 96 **Total Outputs** 112

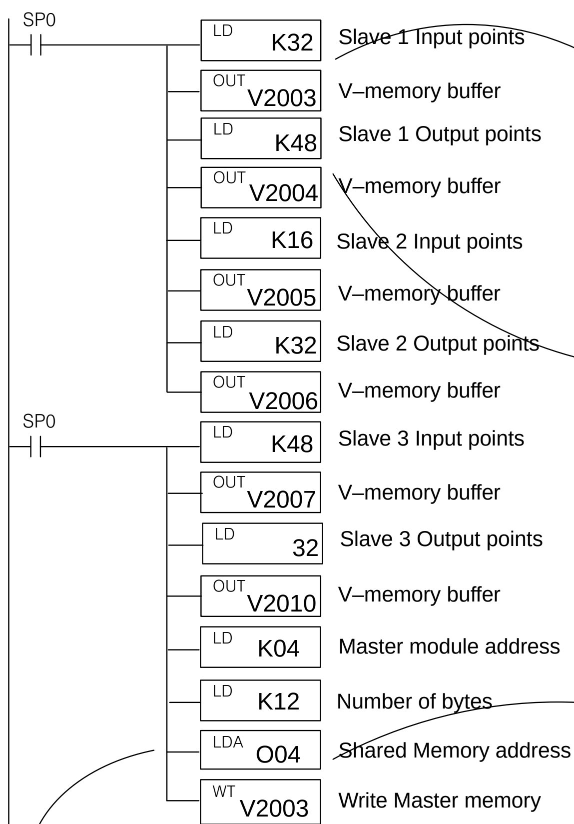
Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1	**32**	**48**	17		
2	**16**	**32**	18		
3	**48**	**32**	19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Setup Initiation Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

This block of logic tells the remote master how many input and output points are located in each base. Each group of four instructions loads the I/O ranges for a slave into temporary memory, the values for which are retrieved from the Remote Slave Worksheets. The WT instruction stores the entire buffer area to the master's shared memory. The Quick Reference Table shows the correct shared memory addresses in octal.

Write Input and Output Ranges for each Slave



The last four instructions write the slaves' range data to the Master's shared memory. Address 004 is the *start* of the slave data; the byte length of 12 writes 6 consecutive words of data.

Channel Configuration Worksheet

D2–RMSM Remote Master Module
Master Slot Address 4 (1–7)
Protocol Selected RM–NET (RM–NET or SM–NET)

Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES NO	YES NO

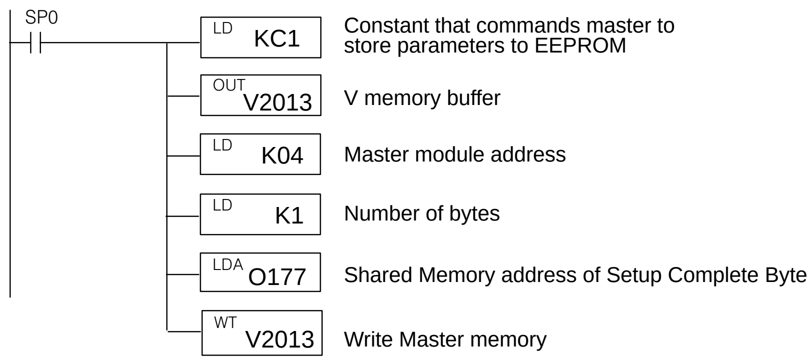
Starting Input V Memory Address: V 40402 **Starting Output V Memory Address: V** 40502
Total Inputs 96 **Total Outputs** 112

Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1	**32**	**48**	17		
2	**16**	**32**	18		
3	**48**	**32**	19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Configuration Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

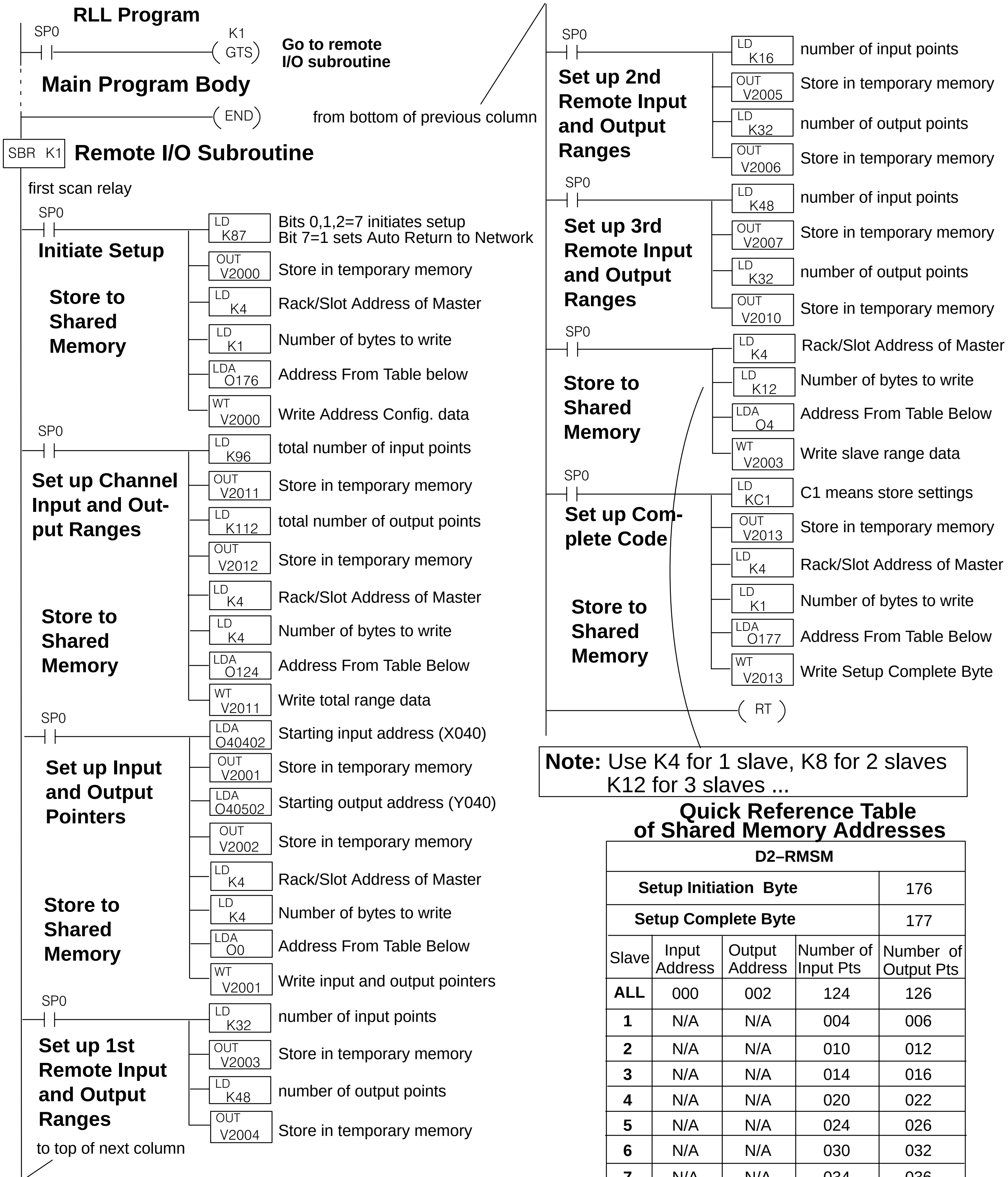
Write Setup Complete (store channel parameters to EEPROM)



We can now complete the setup program.This last block of logic tells the remote master to save the parameters in EEPROM (setup is complete). The setup complete logic structure is the same for any channel using a D2–RMSM as a master.

The completed setup program for this example is shown on the next page.

Completed Setup Program for X and Y Addressing



Note: Use K4 for 1 slave, K8 for 2 slaves K12 for 3 slaves ...

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Setup Initiation Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

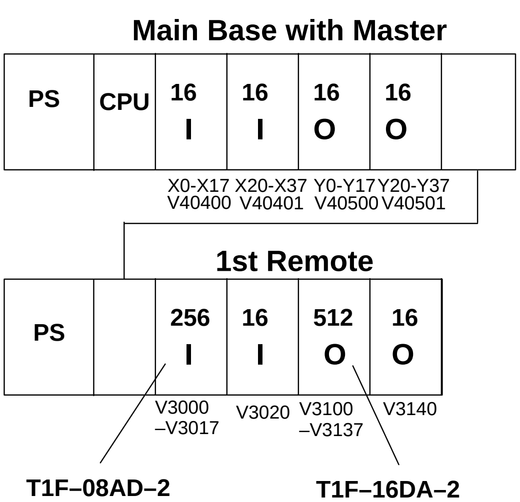
Example Program Using Analog I/O Modules

Example 2: Addressing using V–Memory

The following example uses Terminator I/O discrete and analog I/O modules. **It is recommended to use V memory addressing when using analog modules since each analog I/O channel uses a double (two) word each.** Thus, an 8 channel analog I/O module uses 256 discrete points and a 16 channel analog I/O module uses 512 discrete points. **Analog output modules are configured using the Module Control Byte** located in the most significant byte of the most significant word of channel 1 of the module. **V memory addressing requires the use of "Bit–of–Word" (DL250 only) instructions to address the I/O points.**

The first block of logic tells the remote master to initiate the setup, and to enable the Auto Return to Network option. To find the D2–RMSM shared memory addresses used in the setup program, refer to the Shared Memory Table at the end of this chapter.

Write Configuration Byte



Use Bit–of–Word instructions to address the I/O points when mapping the remote I/O to V memory.

Channel Configuration Sheet

D2–RMSM Remote Master Module

Master Slot Address 4 (1–7)

Protocol Selected RM–NET (RM–NET or SM–NET)

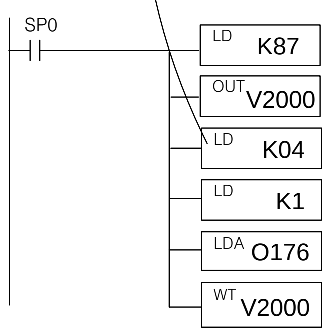
Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES NO	

Starting Input V Memory Address: V 3000 **Starting Output V Memory Address: V** V3100

Total No. Inputs 272 **Total No. Outputs** 528

Slave Station	No. Inputs	No. Outputs	Slave Station	No. Inputs	No. Outputs
0	N/A	N/A	16		
1	272	528	17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		



Bits 0,1,2 ON initiates the setup
Bit 7 defines Auto Return to Network (ON=Yes)

Choose a word of available V memory to use as a buffer

Master address: High byte is rack (0), low byte is slot (4)

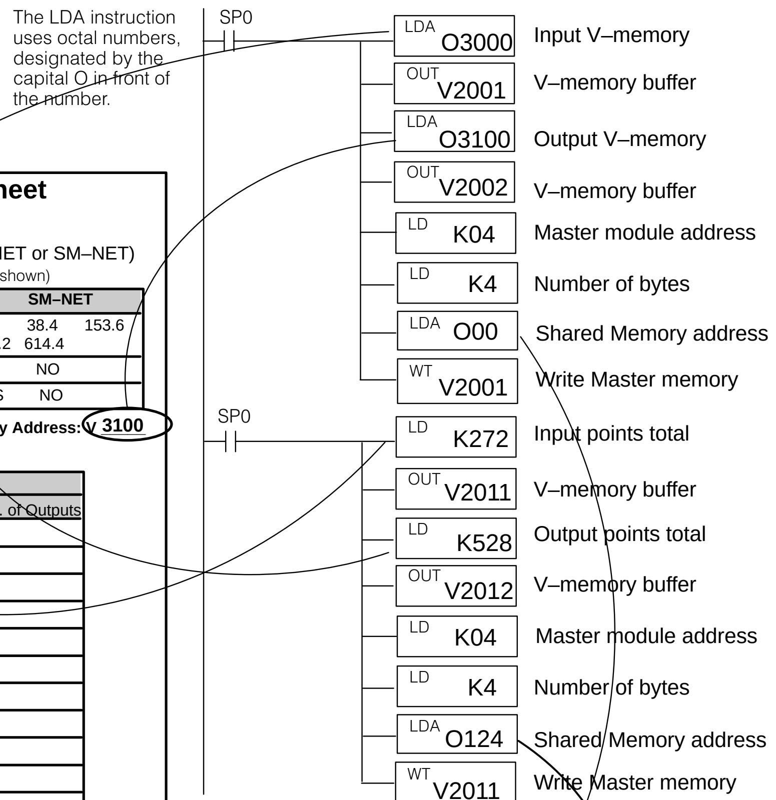
Number of bytes to write to shared memory (1 byte)

Shared memory address of configuration byte

Write value in lower byte of V2000 to Master memory

This block of logic tells the remote master the starting V-memory addresses for the inputs and outputs, and the total number of each for the channel. Use the LD, LDA, and OUT commands to load the starting addresses and point totals into temporary memory, then write the values to the master's shared memory. The Quick Reference Table shows the correct shared memory addresses in octal.

Write Input and Output Pointers, and Input and Output Ranges for Channel



Channel Configuration Worksheet

D2–RMSM Remote Master Module
Master Slot Address 4 (1–7)
Protocol Selected RM–NET (RM–NET or SM–NET)

Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES NO	YES NO

Starting Input V Memory Address: V 3000 **Starting Output V Memory Address:** V 3100
Total Inputs 272 **Total Outputs** 528

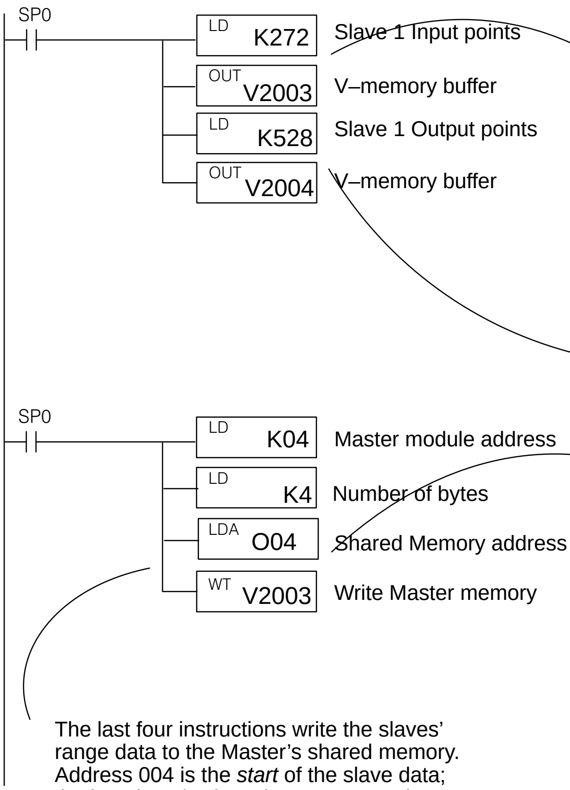
Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1	**272**	**528**	17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Setup Initiation Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

This block of logic tells the remote master how many input and output points are located in each base. Each group of four instructions loads the I/O ranges for a slave into temporary memory, the values for which are retrieved from the Remote Slave Worksheets. The WT instruction stores the entire buffer area to the master's shared memory. The Quick Reference Table shows the correct shared memory addresses in octal.

Write Input and Output Ranges for each Slave



The last four instructions write the slaves' range data to the Master's shared memory. Address 004 is the *start* of the slave data; the byte length of 4 writes 2 consecutive words of data.

Channel Configuration Worksheet

D2–RMSM Remote Master Module
Master Slot Address 4 (1–7)
Protocol Selected RM–NET (RM–NET or SM–NET)

Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network (either protocol)	YES NO	YES NO

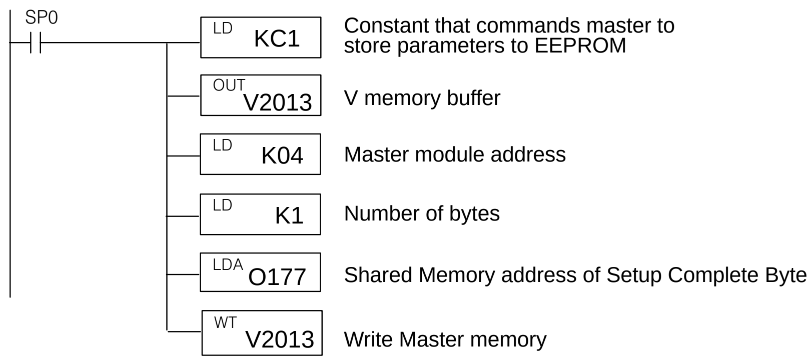
Starting Input V Memory Address: V 3000 **Starting Output V Memory Address:** V 3100
Total Inputs 272 **Total Outputs** 528

Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1	272	528	17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Configuration Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

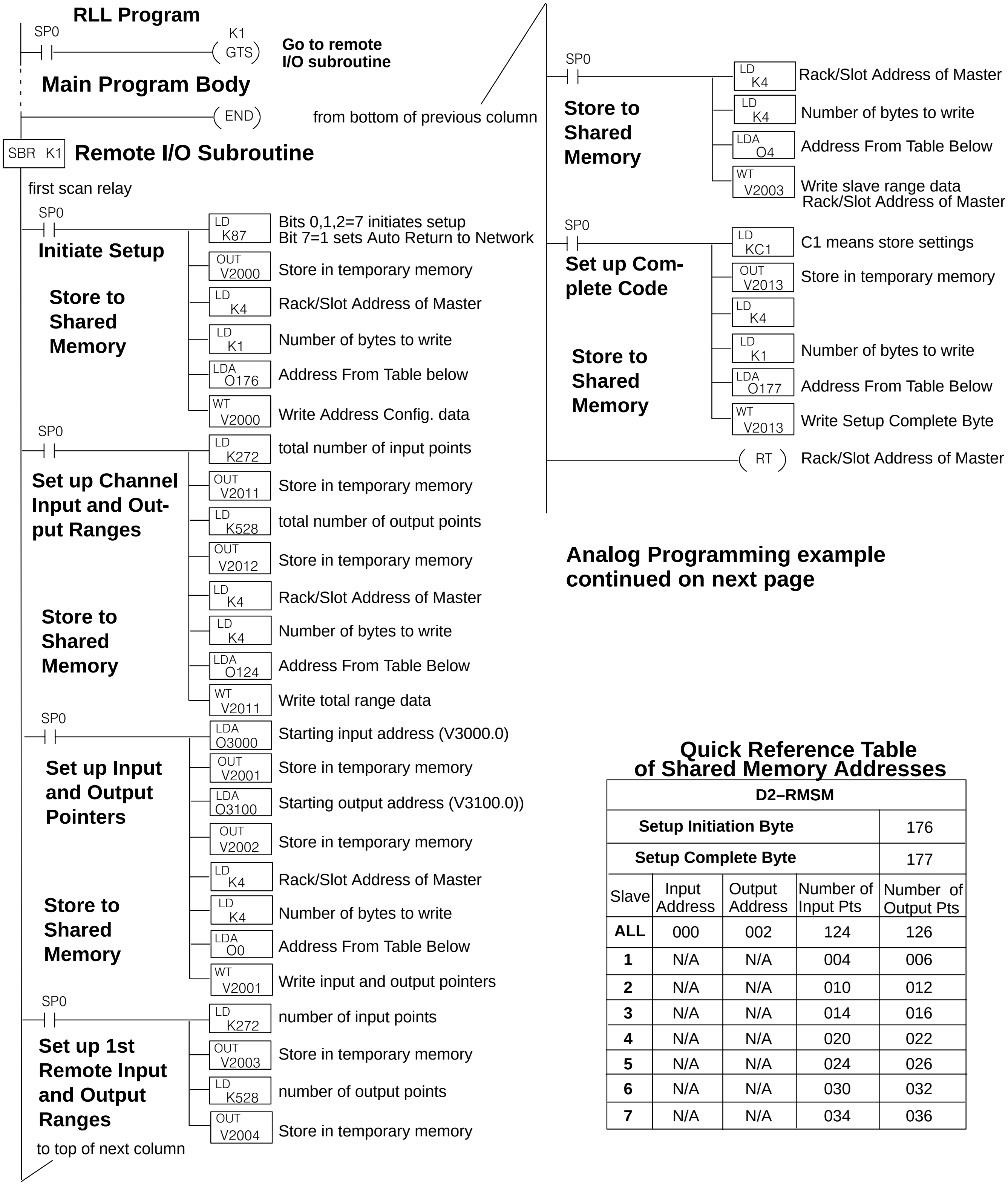
Write Setup Complete (store channel parameters to EEPROM)



We can now complete the setup program.This last block of logic tells the remote master to save the parameters in EEPROM (setup is complete). The setup complete logic structure is the same for any channel using a D2–RMSM as a master.

The completed setup program for this example is shown on the next page.

Completed Setup Program for V–Memory Addressing



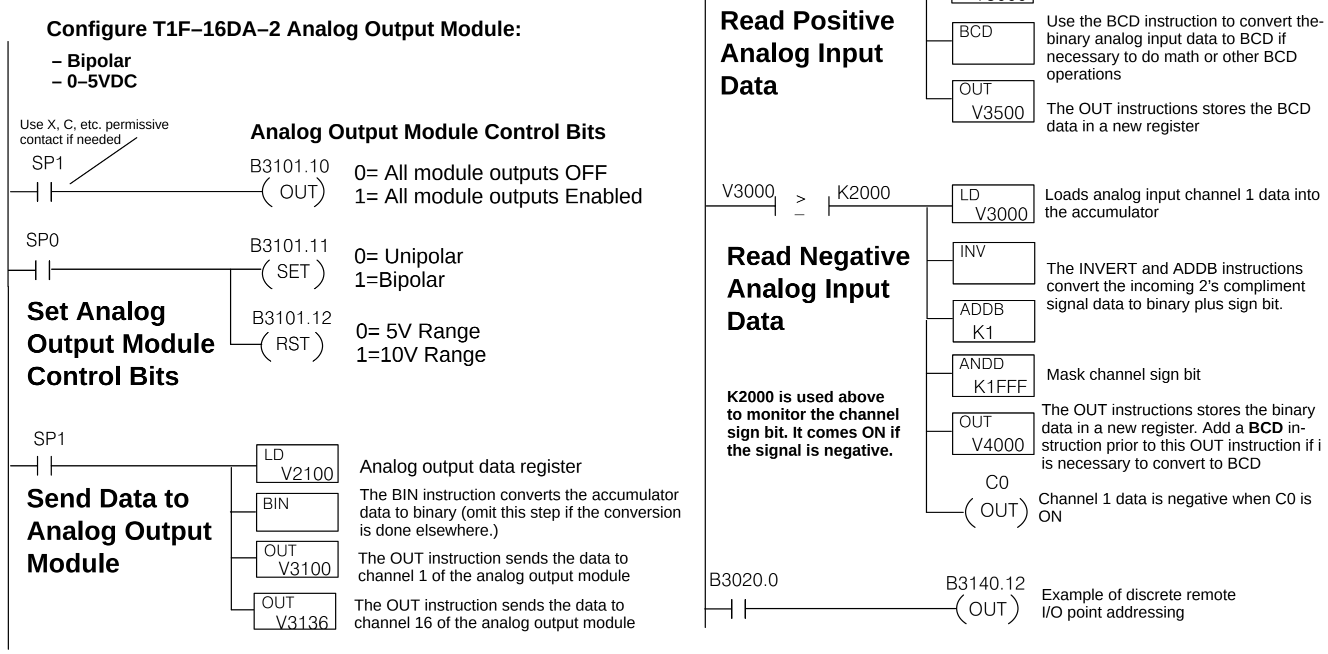
Analog Programming example continued on next page

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Setup Initiation Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Pts	Number of Output Pts
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036

Completed Setup Program for V–Memory Addressing (con't)

Main Program Body



The Control Bits of an Analog Output module are located in the most significant byte of the most significant word of the first output channel (channel 1).

Channel 1 Memory Map of 8&16-Channel Analog Output Module (T1F–08DA, T1F–016DA)									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Write Byte 3
	Module Control Byte								Write Byte 4

Module Control Byte of 8&16-Channel Analog Output Module (T1F–08DA, T1F–16DA)									
Decimal Bit	31	30	29	28	27	26	25	24	Read/Write
Octal Bit	37	36	35	34	33	32	31	30	
Bit 24	**Outputs Enable** 0 = All outputs OFF 1 = All outputs Enabled								Write
Bit 25	**Unipolar / Bipolar** 0 = Unipolar selected 1 = Bipolar selected								Write
Bit 26	**5V / 10V Range** 0 = 5V range 1 = 10V range								Write
Bit 27	**0 – 20mA / 4–20mA Range** 0 = 0 – 20mA range 1 = 4 – 20mA range								Write
Bit 28 – 31	Reserved for system use								–

Changing Configurations

If you have stored a configuration to the D2–RMSM via the setup program and need to change it, follow these guidelines to ensure the module accepts the new configuration:

1. Change the constants in the setup program that are affected by the new system configuration. For example, if you add an I/O module to a remote slave unit, you must change the input or output range for that slave, as well as the range total for the channel. If the new range totals do not match the sum of the individual slave ranges, the D2–RMSM *will not* accept the new configuration. It will retain the old configuration, and give you an I/O error.
2. If you are removing a slave from the channel, you must change the logic of the setup program to clear that slave's range data in the D2–RMSM shared memory. Otherwise it will still see the old data from the previous configuration. For example, if you remove the third slave from our example system, you would load a constant of zero into the slave's input and output range data, located at buffer memory addresses V2007 and V2010. If removing I/O, remember to reduce the total I/O range values also.
3. After you have modified the setup program, cycle CPU power, or transition from the STOP to RUN mode to execute the new setup logic. This is necessary if the setup logic executes on the first CPU scan.
4. **If you get an error after making the appropriate set up program changes, it may be necessary to clear the shared memory in the remote master module**. To clear the shared memory in the master module, you will need to:
   1) Remove CPU base power and remove the remote master module from the base.
   2) Turn on Dip switch 8 on the master module and return it to the base.
   3) Apply power to the CPU base noting that the master module LEDs cycle through and then all come ON.
   4) Remove CPU base power and remove the remote master module from the base.
   5) Turn off Dip switch 8 on the master module and return it to the base.
   6) Apply power to the CPU base and check for proper remote I/O operation.

Shared Memory Table for D2–RMSM Remote Master

OCTAL ADDRESS	FUNCTION (Slaves 1–15)	FUNCTION (Slaves 16–31)	# Bytes
For memory addresses 000 to 077, the user's setup program must store the correct values into these locations.			
000	Starting V–memory address for inputs on the channel (in octal)	Number of input points for Slave 16	2
002	Starting V–memory address for outputs on the channel (in octal)	Number of output points for Slave 16	2
004	Number of input points for Slave 1	Number of input points for Slave 17	2
006	Number of output points for Slave 1	Number of output points for Slave 17	2
010	Number of input points for Slave 2	Number of input points for Slave 18	2
012	Number of output points for Slave 2	Number of output points for Slave 18	2
014	Number of input points for Slave 3	Number of input points for Slave 19	2
016	Number of output points for Slave 3	Number of output points for Slave 19	2
020	Number of input points for Slave 4	Number of input points for Slave 20	2
022	Number of output points for Slave 4	Number of output points for Slave 20	2
024	Number of input points for Slave 5	Number of input points for Slave 21	2
026	Number of output points for Slave 5	Number of output points for Slave 21	2
030	Number of input points for Slave 6	Number of input points for Slave 22	2
032	Number of output points for Slave 6	Number of output points for Slave 22	2
034	Number of input points for Slave 7	Number of input points for Slave 23	2
036	Number of output points for Slave 7	Number of output points for Slave 23	2
040	Number of input points for Slave 8	Number of input points for Slave 24	2
042	Number of output points for Slave 8	Number of output points for Slave 24	2
044	Number of input points for Slave 9	Number of input points for Slave 25	2
046	Number of output points for Slave 9	Number of output points for Slave 25	2
050	Number of input points for Slave 10	Number of input points for Slave 26	2
052	Number of output points for Slave 10	Number of output points for Slave 26	2
054	Number of input points for Slave 11	Number of input points for Slave 27	2
056	Number of output points for Slave 11	Number of output points for Slave 27	2
060	Number of input points for Slave 12	Number of input points for Slave 28	2
062	Number of output points for Slave 12	Number of output points for Slave 28	2
064	Number of input points for Slave 13	Number of input points for Slave 29	2
066	Number of output points for Slave 13	Number of output points for Slave 29	2
070	Number of input points for Slave 14	Number of input points for Slave 30	2
072	Number of output points for Slave 14	Number of output points for Slave 30	2
074	Number of input points for Slave 15	Number of input points for Slave 31	2
076	Number of output points for Slave 15	Number of output points for Slave 31	2

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
100 – 121	Reserved		18
122	Status of Rotary Switches on module – **Read Only**	Data is 00 to 1F hex, representing the address of the module set by the rotary switches.	1
123	Status of DIP Switches on module – **Read Only**	Bit status represents the setting of each switch on the module's DIP Switch , which sets configuration parameters. 0=OFF, 1=ON. Bit 0 SW1 status Bit 1 SW2 status Bit 2 SW3 status Bit 3 SW4 status Bit 4 SW5 status Bit 5 SW6 status Bit 6 SW7 status Bit 7 SW8 status	1
124	Number of input points committed to the entire channel	User's setup program stores the correct BCD value to this memory location.	2
126	Number of output points committed to the entire channel	User's setup program stores the correct BCD value to this memory location.	2

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
130 – 131	Communication stop mode selection (communication stops when any specified slave fails)	In communication stop mode, the master stops updating the entire channel when a communication error occurs with any specified slave station. To select this mode for each slave, turn ON the corresponding bit of the shared memory shown below. Address 130 / Address 131 Bit 0: Entire channel stops when any slave fails / Slave 16 Bit 1: Slave 1 / Slave 17 Bit 2: Slave 2 / Slave 18 Bit 3: Slave 3 / Slave 19 Bit 4: Slave 4 / Slave 20 Bit 5: Slave 5 / Slave 21 Bit 6: Slave 6 / Slave 22 Bit 7: Slave 7 / Slave 23 Bit 8: Slave 8 / Slave 24 Bit 9: Slave 9 / Slave 25 Bit 10: Slave 10 / Slave 26 Bit 11: Slave 11 / Slave 27 Bit 12: Slave 12 / Slave 28 Bit 13: Slave 13 / Slave 29 Bit 14: Slave 14 / Slave 30 Bit 15: Slave 15 / Slave 31	2

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
132 – 133	Slave removal mode selection (communication stops to only the slave(s) with a communication error)	In slave removal mode, the master stops updating only the slave(s) with a communication error. It continues updating the I/O for the other slaves on the channel. To select this mode for each slave, turn ON the corresponding bit of the shared memory shown below. Address 132 — Address 133 Bit 0 — Not used — Slave 16 Bit 1 — Slave 1 — Slave 17 Bit 2 — Slave 2 — Slave 18 Bit 3 — Slave 3 — Slave 19 Bit 4 — Slave 4 — Slave 20 Bit 5 — Slave 5 — Slave 21 Bit 6 — Slave 6 — Slave 22 Bit 7 — Slave 7 — Slave 23 Bit 8 — Slave 8 — Slave 24 Bit 9 — Slave 9 — Slave 25 Bit 10 — Slave 10 — Slave 26 Bit 11 — Slave 11 — Slave 27 Bit 12 — Slave 12 — Slave 28 Bit 13 — Slave 13 — Slave 29 Bit 14 — Slave 14 — Slave 30 Bit 15 — Slave 15 — Slave 31	2
134	Communication hold or resume mode	The program can cause the communications on a channel to stop by setting the first bit in this byte ON. After communication stops, only a mode transition of the CPU (from STOP to RUN) will restart the communications. The bit is not cleared automatically, so if using this mode, the user program should clear this byte on the first scan.	1
135 – 137	Reserved		3
140	Network Error Flags – **Read Only**	Bit status represents network errors detected by the D2–RMSM. 0=OK, 1=ERROR Bit 0 — Configuration Error (see Address 142 for details) Bit 1 — Communication Error (see Address 144 for details) Bit 2 — Diagnostics Error (see Address 150 for details)	2

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
142	Configuration Error Code – **Read Only**	Error code in BCD 20 Total inputs exceeds 512 21 Total outputs exceeds 512 24 I/O address out of I/O range 25 I/O address allocated to bad range 29 A slave has more than 512 points 70 Discrepancy between current configuration and old one 71 A module is in the wrong slot 72 Slave configuration is different from old one 73 Different slave is there	1
143	Station Number of Configuration Error – **Read Only**	Station number in BCD	1
144	Communication Error Code – **Read Only**	Error code in BCD 01 slave does not respond 02 wrong I/O information 03 I/O update error : CRC check error	1
145	Station Number of Communication Error Code – **Read Only**	Station number in BCD	1
146	Communication Error Counter – **Read Only**	Number of communication errors detected since CPU went into RUN mode, in BCD	2
150	Diagnostics Error Code	Error code in BCD 0201 Terminal block removed 0202 module not present 0203 Blown fuse 0206 Low battery voltage 0226 Power capacity exceeded	2
152	Reserved		1
153	Station number of Diagnostics error – **Read Only**	Station number in BCD	1

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
154 – 157	Reserved		4
160	Current bus scan time – **Read Only**	BCD value of current bus scan, in msec	2
162	Bus scan time upper limit	User can store BCD value of bus scan upper limit, in msec. Default is 100 msec.	2
164	Shortest bus scan time – **Read Only**	BCD value of shortest bus scan detected since CPU went into RUN mode, in msec	2
166	Longest bus scan time – **Read Only**	BCD value of longest bus scan detected since CPU went into RUN mode, in msec	2
170	Bus scan counter – **Read Only**	BCD value of number of bus scans detected since CPU went into RUN mode	2
172	Overlimit Bus scan counter – **Read Only**	BCD value of number of bus scans which have exceeded the scan time upper limit	2
174 – 175	Reserved		2
176	Setup Initiation Byte (includes Auto Return to Network)	User's setup program stores the correct bit pattern to this memory location to configure the following modes: Bits 0,1, and 2 must be ON to initiate setup of remote slave addressing Bit 7 ON=Specifies that offline slaves can return to the network without cycling CPU	1
177	Copy Configuration to EEPROM (Setup Complete)	User's setup program stores a BCD value to this location to log the parameters stored by the setup program to the Master's EEPROM. C1 – Signifies that setup is complete. Hint: This should be the last function of your setup program.	1
200 – 374	Reserved		125

OCTAL ADDRESS	FUNCTION	DETAIL	# Bytes
375	Slave Page Selection	User's setup program stores a BCD value to this location to select the page of slave parameters for setup programming: 81 Slaves 1–15 82 Slaves 16–31	1
376 – 377	Reserved		2

Quick Reference Table of Shared Memory Addresses

D2–RMSM				
Setup Initiation Byte				176
Setup Complete Byte				177
Slave	Input Address	Output Address	Number of Input Points	Number of Output Points
ALL	000	002	124	126
1	N/A	N/A	004	006
2	N/A	N/A	010	012
3	N/A	N/A	014	016
4	N/A	N/A	020	022
5	N/A	N/A	024	026
6	N/A	N/A	030	032
7	N/A	N/A	034	036
8	N/A	N/A	040	042
9	N/A	N/A	044	046
10	N/A	N/A	050	052
11	N/A	N/A	054	056
12	N/A	N/A	060	062
13	N/A	N/A	064	066
14	N/A	N/A	070	072
15	N/A	N/A	074	076
2nd page of slave range data				
16	N/A	N/A	000	002
17	N/A	N/A	004	006
18	N/A	N/A	010	012
19	N/A	N/A	014	016
20	N/A	N/A	020	022
21	N/A	N/A	024	026
22	N/A	N/A	030	032
23	N/A	N/A	034	036
24	N/A	N/A	040	042
25	N/A	N/A	044	046
26	N/A	N/A	050	052
27	N/A	N/A	054	056
28	N/A	N/A	060	062
29	N/A	N/A	064	066
30	N/A	N/A	070	072
31	N/A	N/A	074	076

Troubleshooting Remote I/O

Troubleshooting Quick Steps

If the remote I/O channel does not seem to be working correctly, check the following items. These items represent the problems found most often.

1. 1. Cable and connections. Incorrectly wired cables and loose terminations cause the majority of problems. Verify you’ve selected the proper cable configuration and check the cable, making sure it is wired correctly. Also check the cable routing to ensure that the installation guidelines in Chapter 2 were followed.
1. 2. Incorrect Baud Rate. Make sure you’ve set all T1K–RSSS units to match the communication parameters set on the master station.
1. 3. Incorrect protocol. Make sure you’ve set all T1K–RSSS units to match the protocol setting on the master station.
1. 4. Setup program. Check the setup program for errors such as incorrect pointers or constants, or writing to the wrong module address. Be sure that the total inputs and outputs values match the sum of the individual slave input and output ranges; otherwise, the D2–RMSM *will not* accept the setup data. If program errors were corrected and the remote I/O channel still does not seem to be working correctly, it may be necessary to clear the shared memory in the remote master module. Refer to step 4 in the Changing Configurations section earlier in this chapter.

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 variety of commonly found problems.

Master Station Indicators	Slave Station Indicators	Possible Cause	Corrective Action
RUN DIAG I/O LINK RUN is off.	RUN DIAG I/O LINK	1. Master PLC power is disconnected. 2. Remote Master is defective.	1. Check the PLC power source. 2. Replace the Remote Master.
RUN DIAG I/O LINK RUN is on.	RUN DIAG I/O LINK LINK is on.	1. Switch setting on master or slave station is incorrect. 2. Communications wiring is incorrect.	1. Check the DIP switches on Remote Master and slaves to ensure their baud rate and protocol settings match. 2. Check the communications wiring and termination resistors.
RUN DIAG I/O LINK RUN is flashing, I/O is on.	RUN DIAG I/O LINK	1. Setup program is not correct. 2. I/O totals do not match values in D2–RMSM shared memory 124 and 126.	1. Check the setup program to ensure pointer values and configuration constants are correct. 2. Check the I/O totals against the sum of the individual slave ranges in the setup program.
RUN DIAG I/O LINK LINK is on.	RUN DIAG I/O LINK I/O is flashing	1. I/O module failure at slave. 2. Slave module is missing 24VDC power. 3. Slave base pwer budget overloaded.	1. Check the I/O modules in the slave unit for failures.
RUN DIAG I/O LINK Lights blink in sequence, then all lights turn on.	RUN DIAG I/O LINK Lights blink in sequence, then all lights turn on	1. Module's Diagnostic DIP switch is ON.	1. Check the Diagnostic DIP switch on Master or slave to ensure that it is off.
RUN DIAG I/O LINK RUN is on.	RUN DIAG I/O LINK I/O is on.	1. Rotary switches' setting for slave ID exceeds valid address for chosen protocol.	1. Check rotary switches on slave for valid unit number: must be 31 or less for SM–NET, must be 7 or less for RM–NET

Special CPU Memory for Diagnostics

Communication Status Flags in V-memory

This table provides a listing of the individual flags in V-memory for communication status. The corresponding bit of V-memory turns ON when the slave is communicating. Station 0 represents the master; its bit turns on when communication begins with its slaves. You may use ***Direct***SOFT or the application program to monitor these flags. If there is a communications error, this memory may not show the correct data.

Station	Master in Slot No.:							
	0	1	2	3	4	5	6	7
	N/A	V7661	V7662	V7663	V7664	V7665	V7666	V7667
0	Bit 0							
1	Bit 1							
2	Bit 2							
3	Bit 3							
4	Bit 4							
5	Bit 5							
6	Bit 6							
7	Bit 7							
8	Bit 8							
9	Bit 9							
10	Bit 10							
11	Bit 11							
12	Bit 12							
13	Bit 13							
14	Bit 14							
15	Bit 15							

Error Flags in V-memory

This table provides a listing of the individual flags in V–memory for slave errors. The corresponding bit of V-memory turns ON when the slave has an error. Station 0 represents the master; its bit turns on when an error occurs with any slave. You may use ***Direct***SOFT or the application program to monitor these flags. If there is a communications error, this memory may not show the correct data.

Station	Master in Slot No.:							
	0	1	2	3	4	5	6	7
	N/A	V7671	V7672	V7673	V7674	V7675	V7676	V7677
0	Bit 0							
1	Bit 1							
2	Bit 2							
3	Bit 3							
4	Bit 4							
5	Bit 5							
6	Bit 6							
7	Bit 7							
8	Bit 8							
9	Bit 9							
10	Bit 10							
11	Bit 11							
12	Bit 12							
13	Bit 13							
14	Bit 14							
15	Bit 15							

D2–RMSM Memory for Diagnostics

Status and error information about the D2–RMSM Remote Master module and its attached remote I/O network are available in the Remote Master shared memory described earlier in this chapter.

Hardware Status

Octal address status bytes 122 – 123 available in the D2–RMSM shared memory report the hardware settings. You can implement logic to read these bytes to check your configuration without having to remove the module.

Bus Scan Status

Octal address status bytes 160–172 available in the D2–RMSM shared memory provide information on bus performance. You can implement logic to read these bytes to check your configuration without having to remove the module.

Network Errors

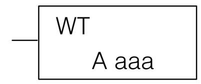
Octal address status bytes 140 – 146 available in the D2–RMSM shared memory provide information on network errors and their location. You can implement logic to read these bytes to check your configuration without having to remove the module.

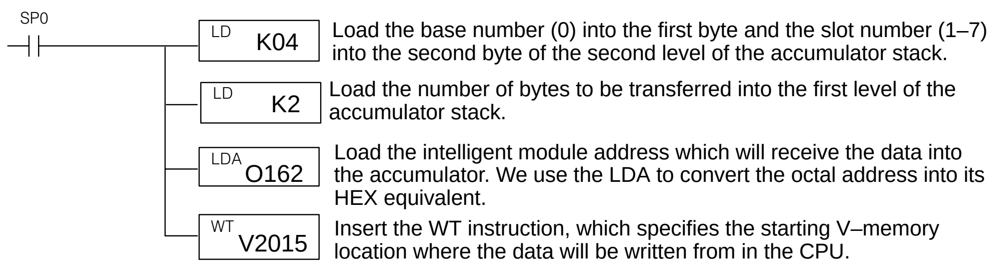
The next section provides specific examples on how to read status data from the Master module.

How to Access Diagnostics Information

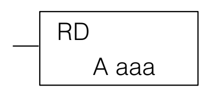
To access diagnostics information, we exchange data with the D2–RMSM module. The remote master unit is an intelligent module, which means it operates asyncronously from the CPU, and it has its own memory. We use the CPU instructions described below to communicate with an intelligent module.

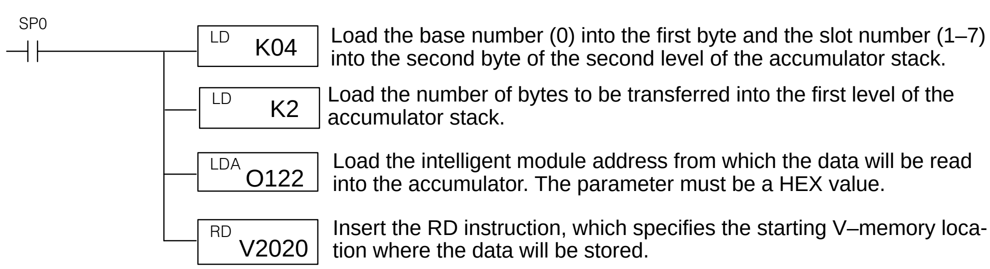
The WT instruction writes a block of data (1–128 bytes max.) to an intelligent I/O module from a block of V-memory in the CPU. The function parameters (module base/slot address, number of bytes, and the intelligent I/O module memory address) are loaded into the first and second level of the accumulator stack, and the accumulator by three additional instructions. In the WT instruction, Aaaa specifies the starting V-memory address where the data will be written from in the CPU. Listed below are the steps to program the WT instruction:





The RD instruction reads a block of data (1–128 bytes max.) from an intelligent I/O module into the CPU's V–memory. The function parameters (module base/slot address, number of bytes, and the intelligent I/O module memory address) are loaded into the first and second level of the accumulator stack, and the accumulator by three additional instructions. In the RD instruction, Aaaa specifies the starting V–memory address where the intelligent module stores the data in the CPU. Listed below are the steps to program the RD instruction:

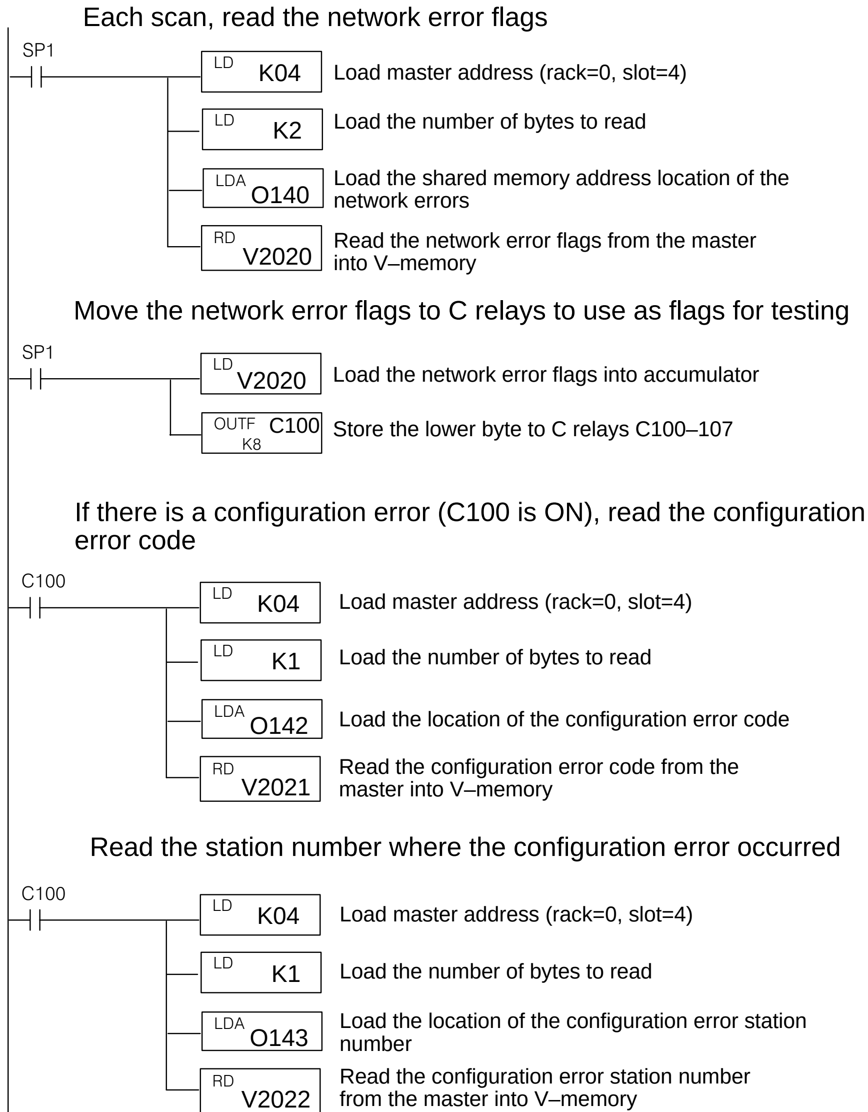




Example 1: Reading Diagnostic Errors

The diagnostic error information can assist you in locating errors on a remote I/O network, either during installation or for a previously operating system. During installation, we might expect configuration errors caused by incorrect switch settings or an invalid setup program. For a previously operating system, the diagnostics can help locate such faults as a slave not responding, an I/O module not present, or a loose terminal block.

In this example, we read the network error flags each scan, and if there is a configuration error present, we read the error details.



To read communication errors (C101 ON) and diagnostic errors (C102 ON), implement similar logic to check the flag and read the error details.

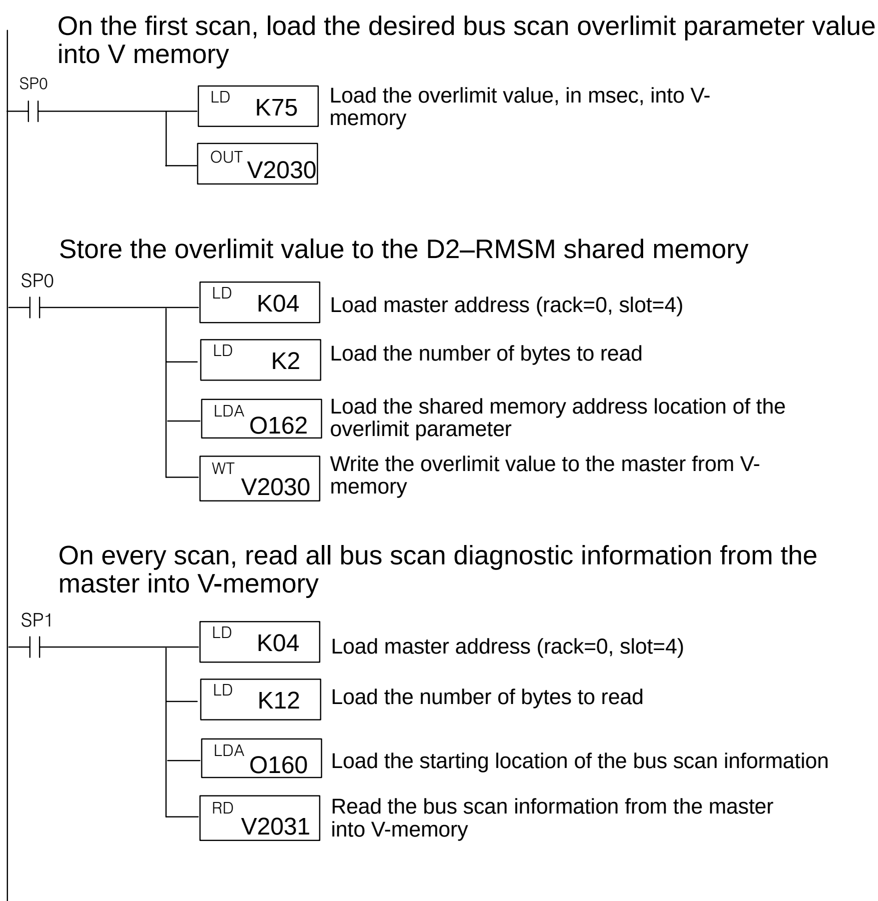
You can then use the retrieved data in logic or display it in a Dataview in ***Direct***SOFT to determine the nature and location of the error. The Network Error Table describes the error codes.

Example 2: Writing Bus Scan Overlimit and Reading Bus Scan Status

In certain applications, the scan time of the remote I/O bus can be an important factor in the response time of the system. Factors which affect the scan time include number of slaves on the bus and the baud rate. Required bus performance may dictate your system layout. For example, you may want to increase the number of remote channels in the system to decrease the number of slaves on each channel. Or you may need to choose SM–NET as the protocol to operate at a higher baud rate.

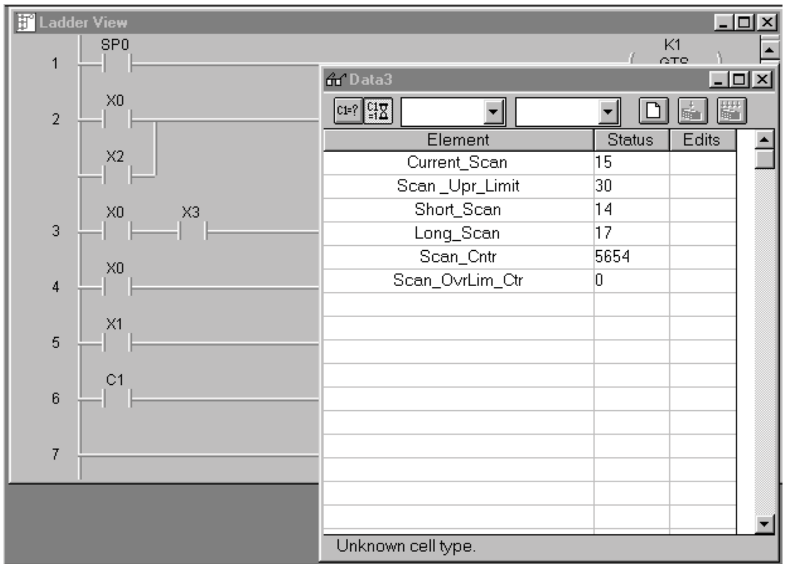
Bus scan performance data includes current bus scan time, the longest and shortest scans detected, a scan counter, and a scan overlimit counter. The overlimit counter records the number of times the scan has exceeded the overlimit value. The overlimit value, in msec, can be set by the user's logic; the default is 100 msec.

In this example, we demonstrate how to set the bus scan overlimit parameter, and then read the bus scan data to check performance.



You can then use the retrieved data in logic or display it in a Dataview in ***Direct***SOFT (shown on the next page) to monitor bus performance. The Bus Scan Status Table describes the definitions of the status values.

Bus scan performance data displayed in a Dataview



4

DL250 / DL350 / DL450 CPU With T1K–RSSS Remote I/O System

In This Chapter. . . .

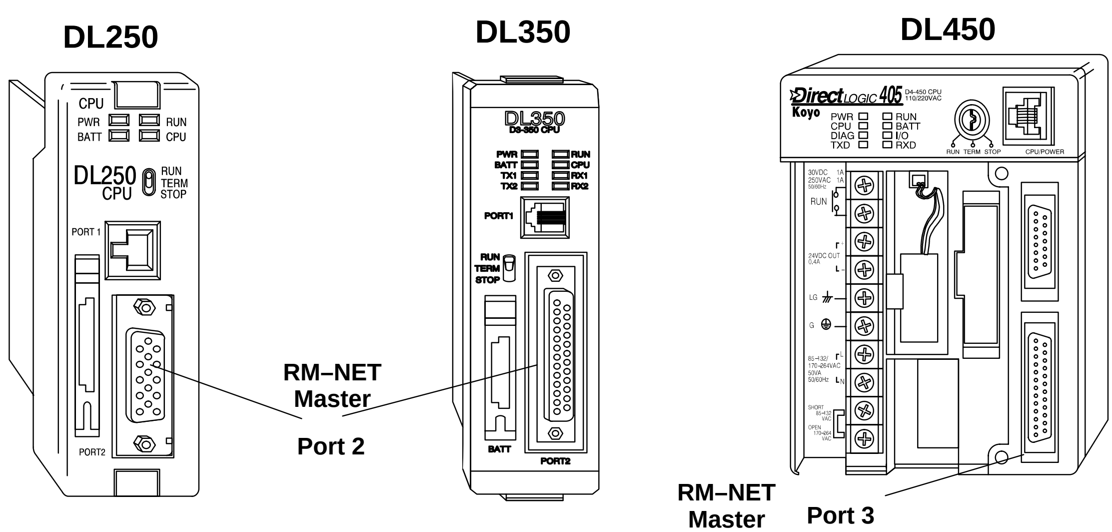
DL250/DL350/DL450 CPU Bottom Port as Remote Master

For the D2–250, D3–350 CPU or D4–450, the most cost-effective way to add remote I/O is to use the bottom port of the CPU as a remote master. The restriction is that it operates in the RM–NET protocol only, which means a maximum of seven slaves at a maximum baud rate of 38.4 kBaud. Also, the slave serial communications port is not active in RM–NET protocol.

This configuration requires some setup programming for the CPU. You can write your program using either a handheld programmer or ***Direct***SOFT Programming Software. The examples that follow will show you how to do this using ***Direct***SOFT.

To get started, launch ***Direct***SOFT and carry out the normal ***Direct***SOFT setup procedures for communicating with your DL250, DL350 or DL450 CPU. If you do not know how to do this, refer to your ***Direct***SOFT User Manual. Your PLC User Manuals have very good coverage of the basic commands available and examples of using the commands to write general ladder logic. We will be showing you in this chapter only those commands that pertain to setting up your remote I/O initialization.

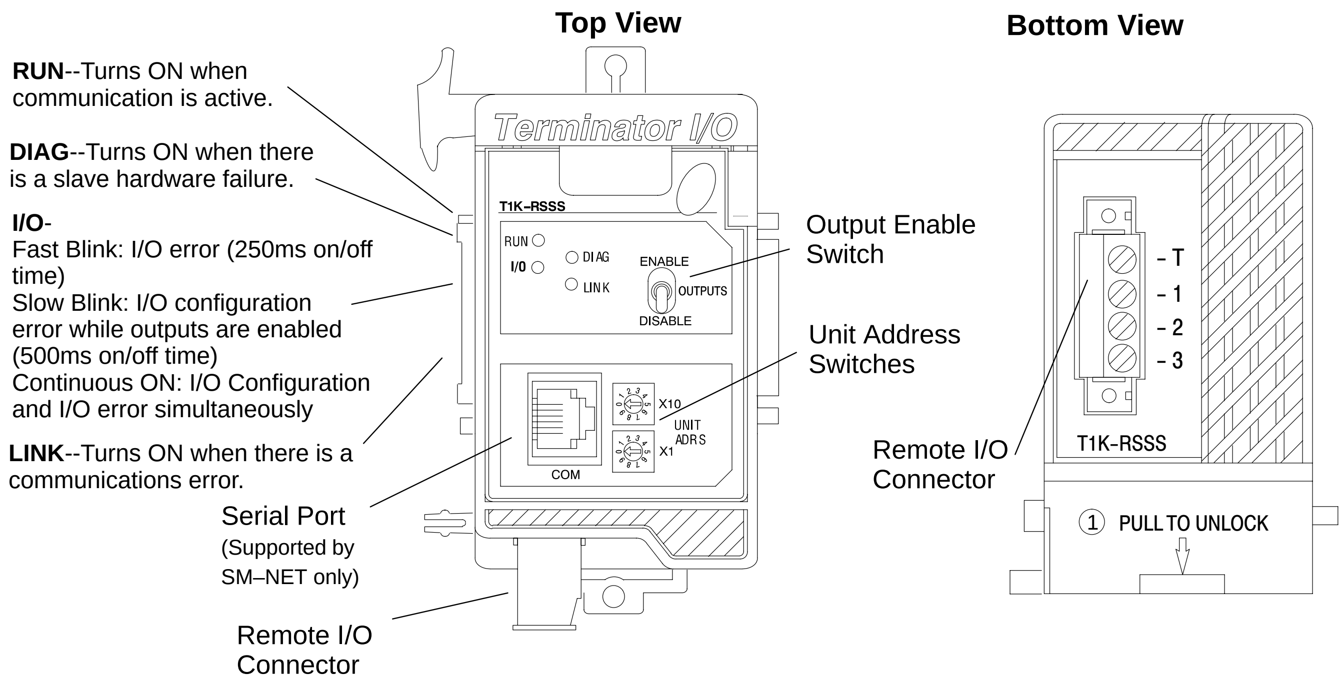
Built In Remote I/O Master Port



Remote I/O Master Functional Specifications	DL250	DL350	DL450
CPU built-in Remote I/O channels	1	1	1
Maximum I/O points supported by each channel	2048*	2048*	2048*
Maximum number of remote I/O slaves per channel	7	7	7
Transmission Distance (max.)	3900 feet (1.2Km)		
Communication Method	Asynchronous (half–duplex)		
X Inputs available for Remote I/O	512	512	1024
Y Outputs available for Remote I/O	512	512	1024
Control Relays available for Remote I/O	1024	1024	2048
V Memory (words) available for Remote I/O	7168	7168	14848

*Requires CPU firmware version: D2–250 version 1.51 or later, D3–350 version 1.30 or later, and D4–450 version (SH)1.460 or (SH)2.460 or later. Earlier firmware version supports 512 I/O points per channel.

Remote Slave (T1K-RSSS) Features



Functional Specifications

Max. # of Slaves per channel	<u>RM–NET</u> 7
Maximum # of I/O Modules per Slave	16 (be sure to check power budget)
Maximum Remote I/O Points per CPU **Note: 8 channel analog modules consume 256 discrete I/O pts. and 16 channel analog modules consume 512 I/O pts. V memory addressing is recommended when using analog I/O modules.**	DL250, DL350 and DL450 support a maximum of 2048 points per channel. The actual I/O available is limited by total available references. For example, the DL250 has a total of 512 X inputs and 512 Y outputs. Mapping remote I/O into control relays or V memory of could allow more I/O points for the DL250.
Module Type	Non–intelligent slave
Digital I/O Consumed	Consumes remote I/O points at a rate equal to the number of I/O points configured in each unit.
Communication Baud Rates	<u>RM–NET</u> Selectable: 19.2K baud 38.4k baud
Communication Failure Response	Selectable to clear or hold last state of outputs

The following specifications define the operating characteristics of the T1K–RSSS module.

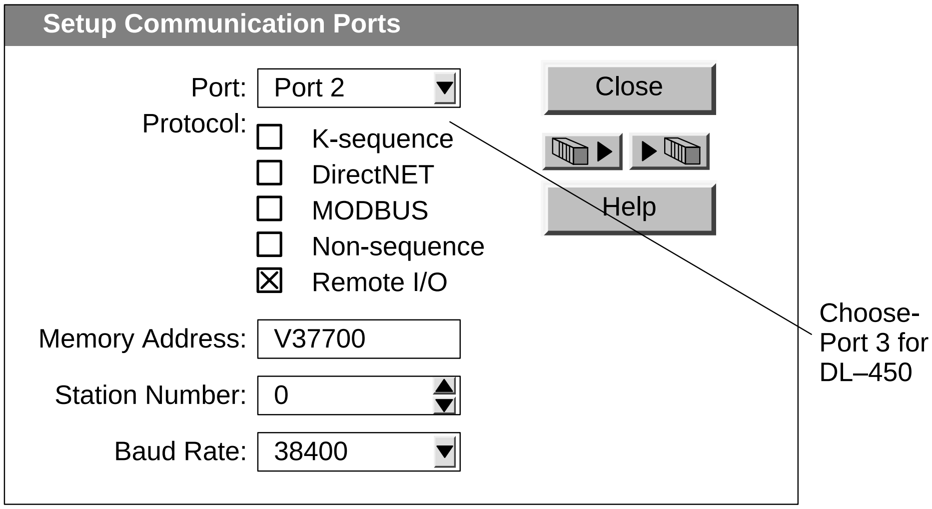
Physical Specifications

Installation Requirements	mount to right of first power supply
Base Power Requirement	250 mA maximum
Communication Cabling	for remote I/O, RS-485 twisted pair, Belden 9841 or equivalent
Slave Serial Communications Port	not active in RM–NET mode
Operating Temperature	32 to 131° F (0 to 55° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases, pollution level = 2 (UL 840)
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304 Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz, 10W, 10cm)

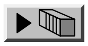
Configuring the Bottom Port of the DL250/DL350/DL450 CPU

To configure the port using the Handheld Programmer, use AUX 56 and follow the prompts, making the same choices as indicated below on this page. To configure the port in ***Direct***SOFT, choose the PLC menu, then Setup, then Setup Secondary Comm Port. The port can also be configured using ladder logic code.

- **Port:** From the port number list box at the top, choose "Port 2" for the DL250 and DL350. Choose **"Port 3" for the DL450.**
- **Protocol:** Click the check box to the left of "Remote I/O" (called "M–NET" on the HPP), and then you'll see the dialog box shown below.



- **Memory Address:** Choose a V-memory address to use as the starting location of a Remote I/O configuration table (V37700 is the default). This table is separate and independent from the table for any Remote Master(s) in the system.
- **Station Number:** Choose "0" as the station number, which makes the DL250, DL350 or DL–450 the master. Station numbers 1–7 are reserved for remote slaves.
- **Baud Rate:** The baud rates 19200 and 38400 baud are available. Choose 38400 initially as the remote I/O baud rate, and revert to 19200 baud if you experience data errors or noise problems on the link. Important: You must configure the baud rate on the Remote Slaves (via DIP switches) to match the baud rate selection for the CPU's Port 2 (DL450 port 3).

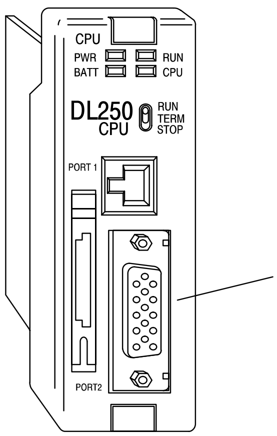


Then click the button indicated to send the Port 2 or Port 3 configuration to the CPU, and click Close.

Setting the T1K–RSSS Rotary Switches

The slave has two small rotary switches to set the unit address. They are on the face of the module, with the label “UNIT ADRS” beside it. Adjust the switches by rotating them with a small flathead screwdriver.

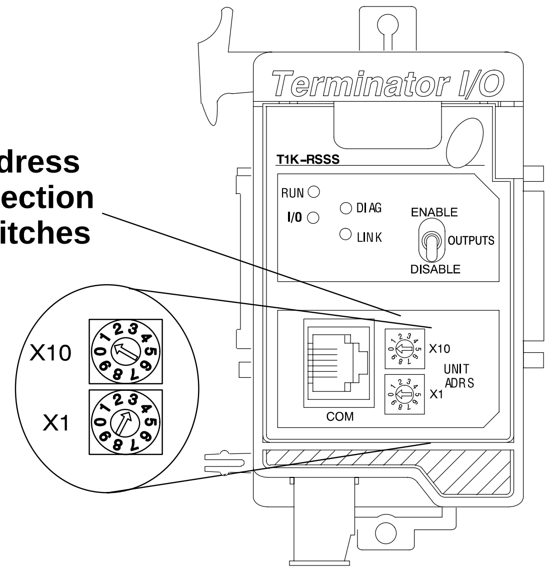
Remote Master (DL250, 350 or 450)



Set Port 2 (Port 3 DL450) Address to 0 using ***Direct***Soft or ladder logic code

Remote Slave

Address Selection Switches

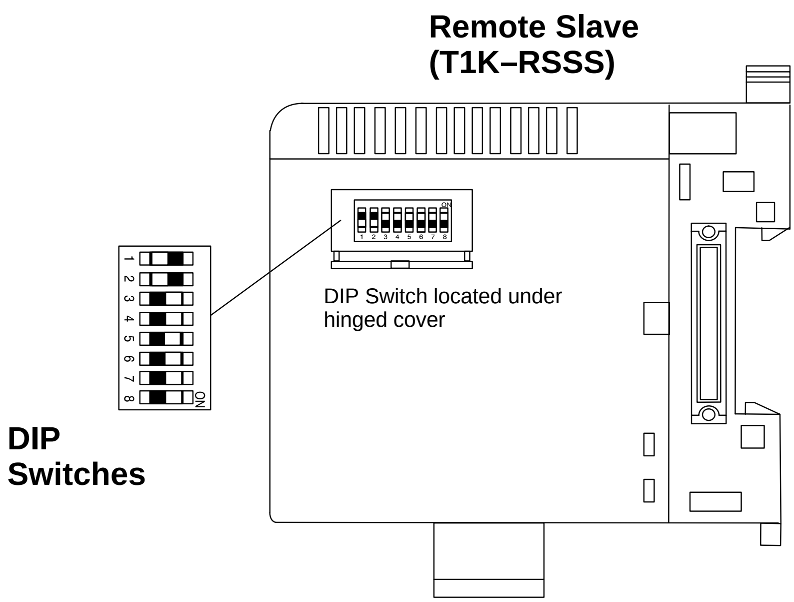


One switch is marked X1 and the other X10. Don’t confuse these with the conventional data type labeling – *these do not refer to inputs* X1 and X10. Instead, these set the address in decimal for each unit. X1 is the “one’s” position and X10 is the “ten’s” position. For example, set address 7 by turning the X10 switch to 0 and the X1 switch to 7.

Set them to any number 1–7 for RM–NET. Two slaves cannot have the same number if they are linked to the same master. **Always use consecutive numbers for slaves, starting with Address 1—don’t skip numbers**.

Setting the T1K–RSSS DIP Switches

The remote slave has an 8–position DIP switch labeled “SW1” that is located on the side of the module under a hinged cover. Set these switches to configure the protocol mode, the baud rate, the output response on communication failure. The slave serial port is not active in RM–NET mode. The word “ON” appears beside the switch to indicate the ON position.



DIP Switch Settings

Module	DIP Position			
	1	2,3,4	5	6,7,8
Slave (T1K–RSSS)	**Mode** OFF=SM–NET ON=RM–NET	**Baud Rate** Switch Position Baud Rate 2 3 4 19.2K O O O 38.4K X O O Note: Higher baud rate are not supported by RM–NET	**Output Default** OFF=Clear ON=Hold	Serial Port not active in RM–NET mode

Mode: DIP switch Position 1 on both the master and slave unit selects the protocol mode for the remote I/O link. Since the CPU port only supports the **RM–NET** protocol**,** Position 1 of the master and all slaves linked to it must be set to the ON position in order to communicate.

Baud Rate: **RM–NET** protocol mode supports either 19.2K or 38.4K baud. In this mode, only switch Position 2 is used to set the baud rate. Be sure to set switches 3 and 4 OFF. All stations on a remote I/O link must have the same baud rate before the communications will operate properly.

Output Default: DIP switch Position 5 on the slave determines the outputs' response to a communications failure. If DIP switch 5 is ON, the outputs in that slave unit will hold their last state upon a communication error. If OFF, the outputs in that slave unit will turn off in response to an error. The setting does not have to be the same for all the slaves on an output channel.

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

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

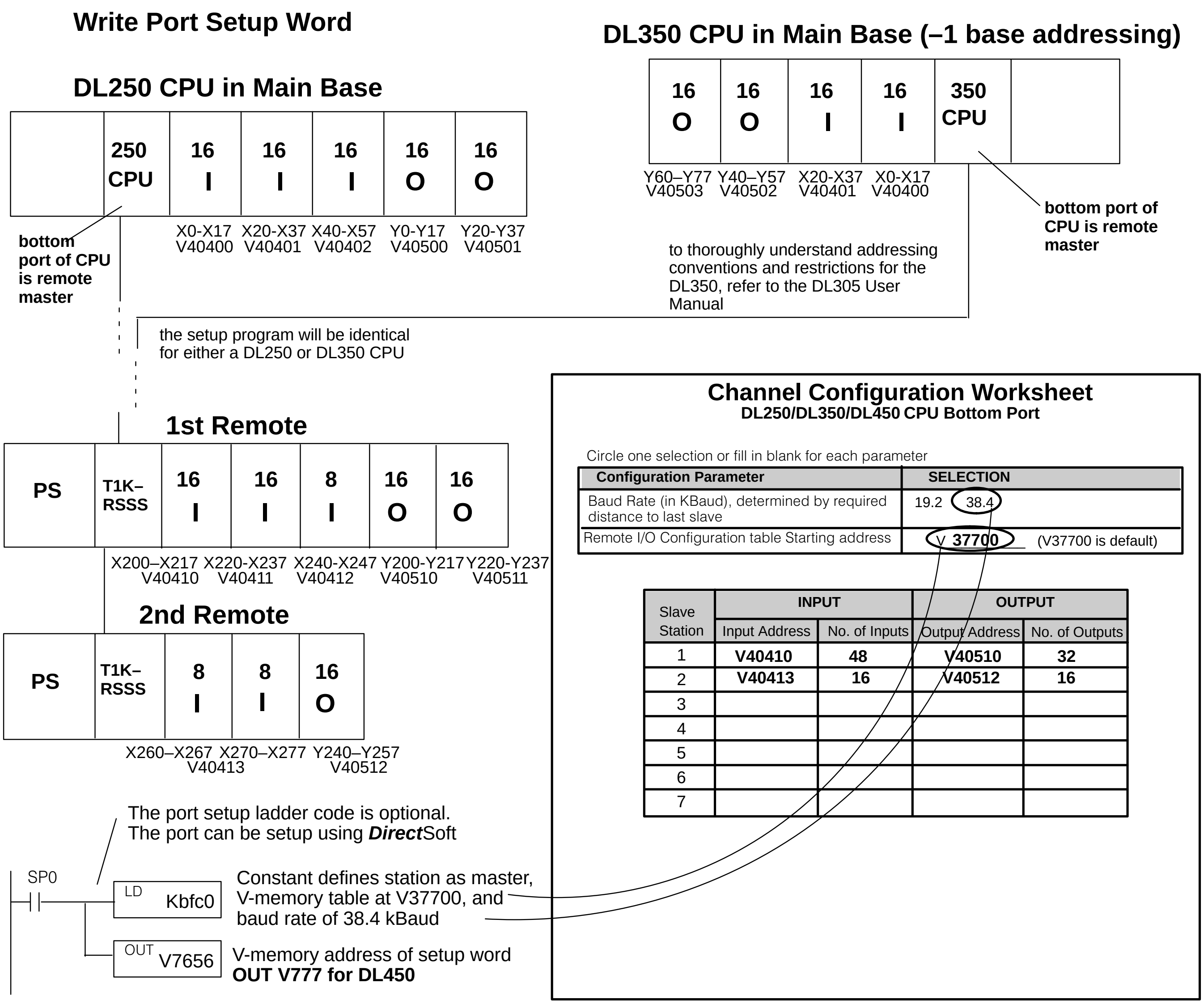
Example Program Using Discrete I/O Modules

Example 1: Using X and Y Addresses as the Remote I/O Memory Types

A typical system uses X and Y memory types for the inputs and outputs on the remote I/O channel.

To illustrate the setup program for this configuration, we will use the remote I/O system below, shown with the completed Channel Configuration Worksheet.

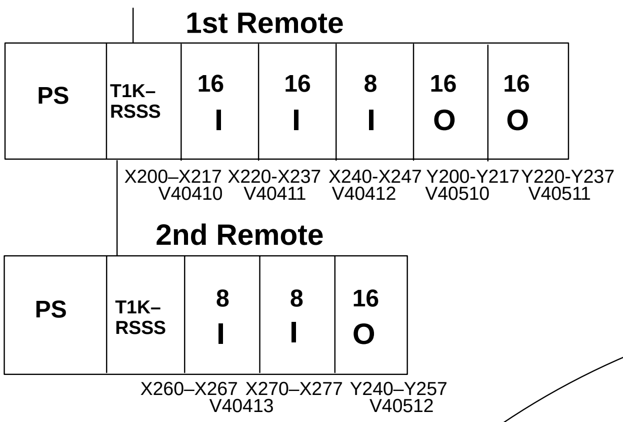
The first block of logic tells the CPU the station number of the port, communication V-memory address, and the baud rate setting. Define the constant value based on these selections (see DL250/DL350/DL450 Reserved Memory Table at the end of this chapter), and then write the value to the reserved V-memory address in the CPU. You can also perform this function interactively with ***Direct***SOFT (see “Configuring the Bottom Port of the CPU“, earlier in this chapter).



See Port Setup Registers later in this chapter for more information

To calculate the input and output addresses and ranges, complete the Remote Slave Worksheets and fill in the V-memory addresses *for each slave*, not just the first one. You can transfer this data to the Channel Configuration Worksheet to condense it, or fill in the Channel Worksheet directly if you choose not to use the Remote Slave Worksheets.

Calculate input and output addresses and ranges for each remote base



Remote Slave Worksheet

Remote Base Address 1 **(Choose 1–7 for RM–NET or 1–31 for SM–NET)**

Slot Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0	16ND3	X200	16		
1	16ND3	X220	16		
2	08ND3	X240	16 (8 used)		
3	16TD1			Y200	16
4	16TD1			Y220	16
5					
6					
7					

Input Bit Start Address: X200 **V-Memory Address*:V** 40410
Total Input Points 48
Output Bit Start Address: Y200 **V-Memory Address*:V** 40510
Total Output Points 32

D2–RMSM automatically assigns I/O addresses in sequence based on # 1's starting addresses. The DL250/DL350/DL450 CPU port setup m requires these addresses for each slave.

Channel Configuration Worksheet
DL250/DL350/DL450 CPU Bottom Port

Circle one selection or fill in blank for each parameter

Configuration Parameter	SELECTION
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4
Remote I/O Configuration table Starting address	V 37700 (V37700 is def

Slave Station	INPUT		OUTPUT	
	Input Address	No. of Inputs	Output Address	No. of Outputs
1	V40410	48	V40510	32
2	V40413	16	V40512	16
3				
4				
5				
6				
7				

Remote Slave Worksheet

Remote Base Address 2 **(Choose 1–7 for RM–net or 1–31 for SM–NET)**

Slot Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0	08ND3	X260	8		
1	08ND3	X270	8		
2	16TD1			Y240	16
3					
4					
5					
6					
7					

Input Bit Start Address: X260 **V-Memory Address*:V** 40413
Total Input Points 16
Output Bit Start Address: Y240 **V-Memory Address*:V** 40512
Total Output Points 16

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave # 1's starting addresses. The DL250/DL350/DL450 CPU port setup program requires these addresses for each slave.

NOTE: Configuring remote I/O for the DL250, DL350 DL450 CPU port requires *both* the starting addresses and the number of input and output points for each slave. The starting addresses for each slave must be on a 16-point boundary. In this example, this means that X250–X257 in Slave # 1 are unused.

The second block of logic tells the CPU, *for each slave*, the starting V-memory addresses for the inputs and outputs, and the total number of each. The CPU has reserved memory locations, called pointers, that accomplish this task. Use the values from the Remote Slave Worksheets or the Channel Configuration Sheet and the pointer addresses from the DL250/DL350/DL450 Reserved Memory Table to complete this logic.

Write Input and Output Pointers and Ranges for each remote base

Channel Configuration Worksheet
DL250/DL350/DL450 CPU Bottom Port

Circle one selection or fill in blank for each parameter

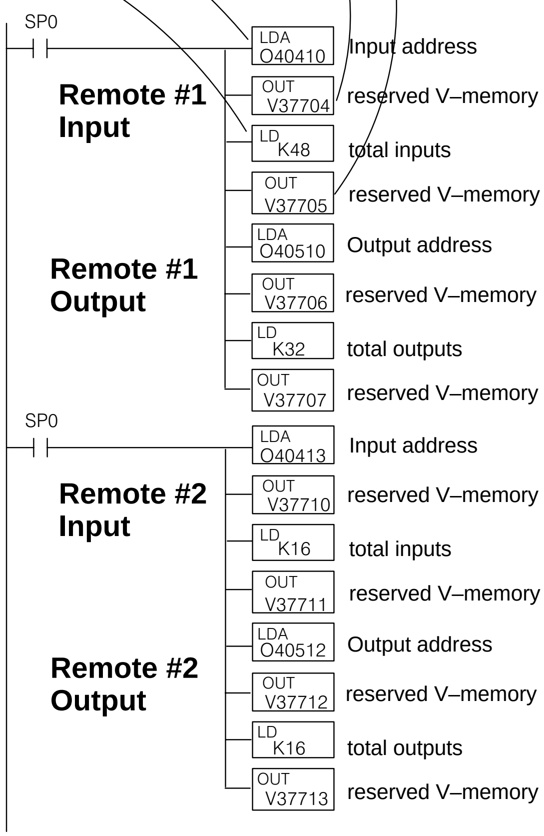
Configuration Parameter	SELECTION
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4
Remote I/O Configuration table Starting address	V 37700 (V37700 is default)

Slave Station	INPUT		OUTPUT	
	Input Address	No. of Inputs	Output Address	No. of Outputs
1	V40410	48	V40510	32
2	V40413	16	V40512	16
3				
4				
5				
6				
7				

DL250/DL350/DL450 Reserved Memory Table

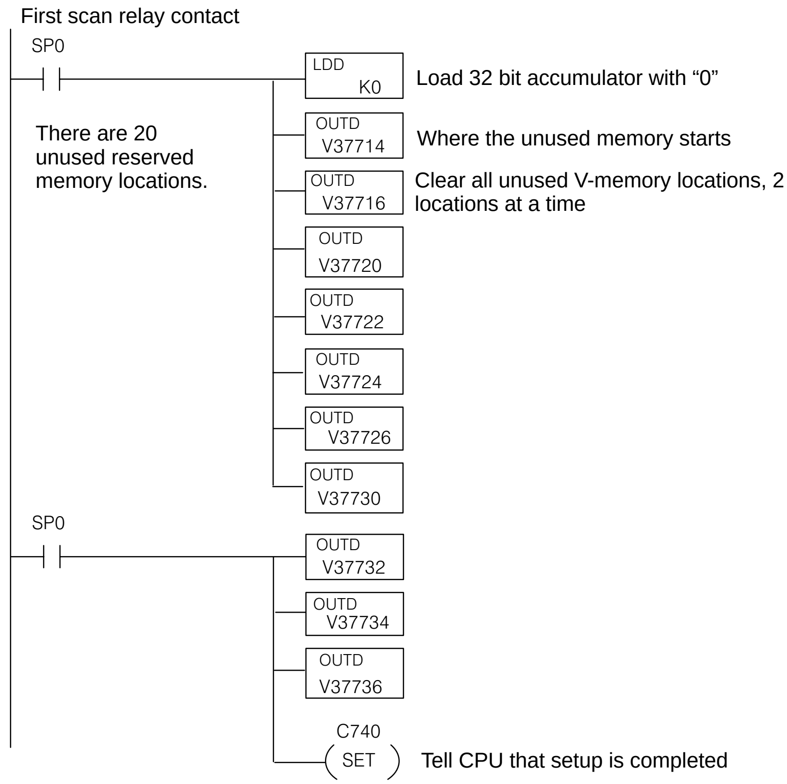
Port Setup Word			V7656	
Setup Complete Flag			C740	
Slave	Input Address	Number of Input Pts	Output Address	Number of Output Pts
1	V37704	V37705	V37706	V37707
2	V37710	V37711	V37712	V37713
3	V37714	V37715	V37716	V37717
4	V37720	V37721	V37722	V37723
5	V37724	V37725	V37726	V37727
6	V37730	V37731	V37732	V37733
7	V37734	V37735	V37736	V37737

V777 for DL450

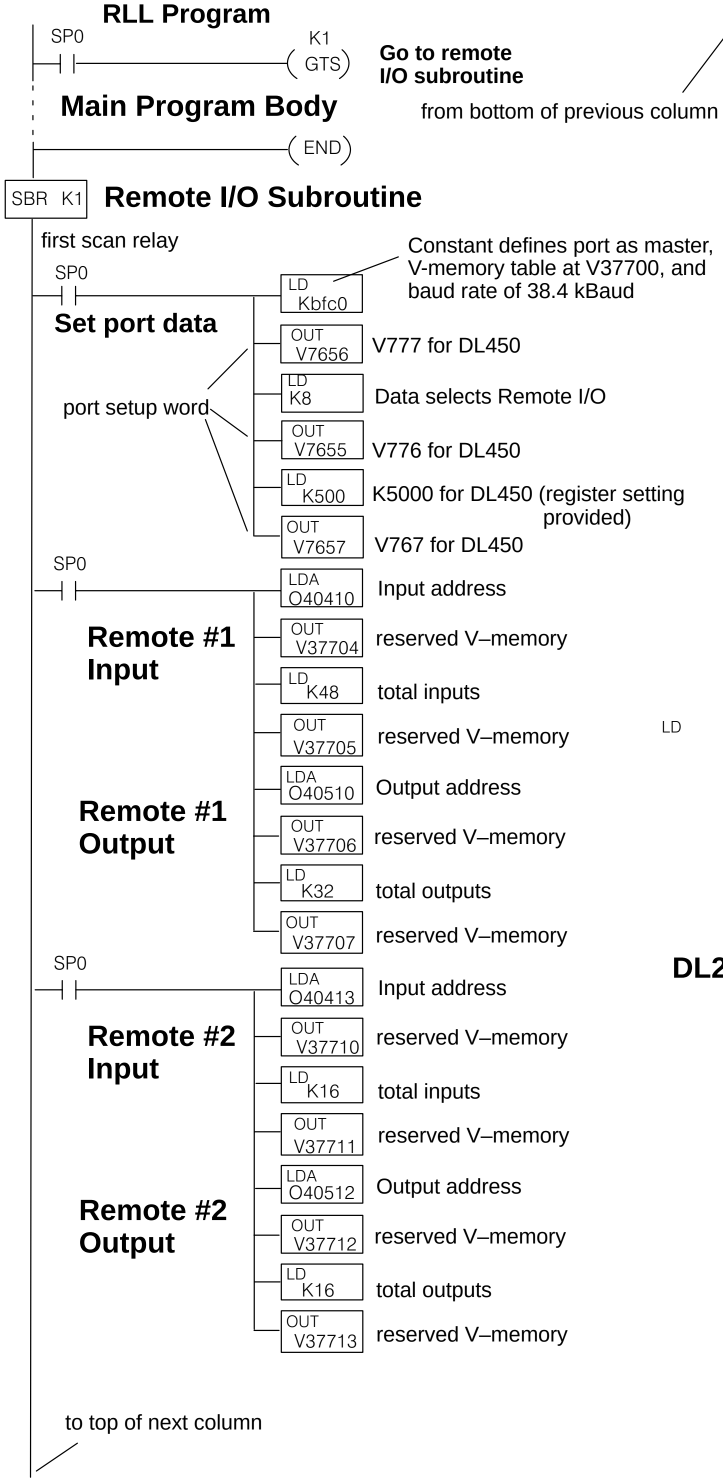


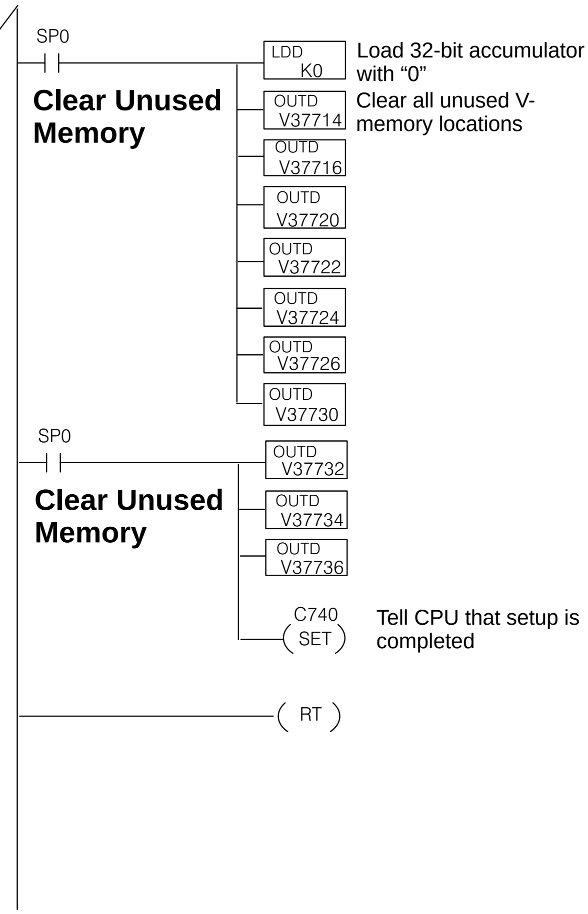
Once you have written all of the logic to map the starting addresses and point totals for each remote base, you have to zero out all of the reserved memory locations you are not going to use and then tell the CPU that you are finished with the setup. If you don't insert zeros in the unused areas, the CPU will assume that every pointer address V37714 through V37736 is pointing to a read or write start address. This could cause problems; you may have garbage in these locations. At the very least, it will take up unnecessary scan time.

The most efficient method for zeroing out the unused memory is to use LDD and OUTD instructions (load and store double) to clear two consecutive memory locations at a time. The following logic shows how to finish the setup program for this example.



Completed Setup Program for DL250/DL350/DL450 as Remote Master using X and Y Memory Addressing





DL250/DL350/DL450 Reserved Memory Table

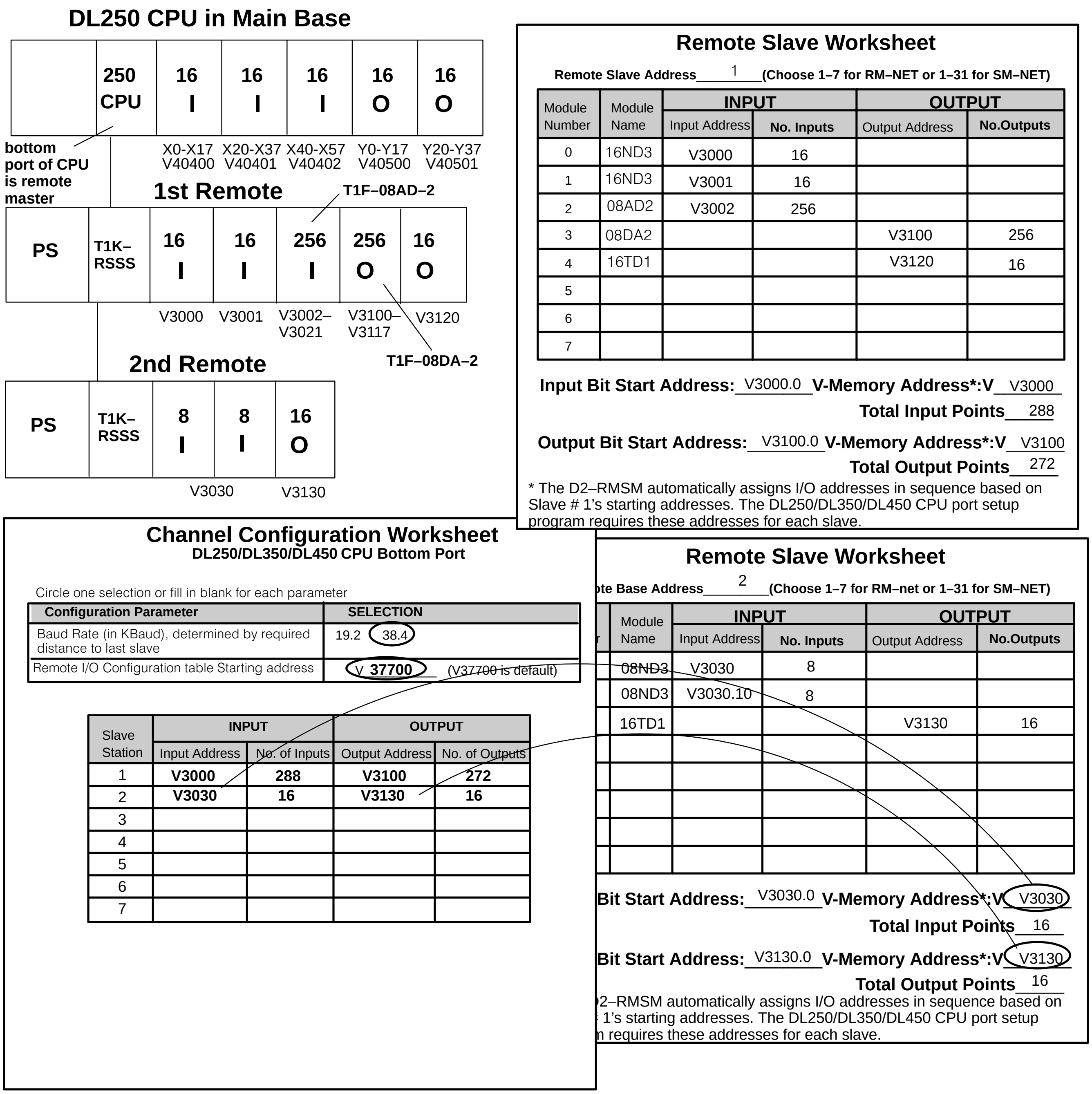
Port Setup Word				V7656
Setup Complete Flag				C740
Slave	Input Address	Number of Input Pts	Output Address	Number of Output Pts
1	V37704	V37705	V37706	V37707
2	V37710	V37711	V37712	V37713
3	V37714	V37715	V37716	V37717
4	V37720	V37721	V37722	V37723
5	V37724	V37725	V37726	V37727
6	V37730	V37731	V37732	V37733
7	V37734	V37735	V37736	V37737

V777 for DL450

Example Program Using Analog I/O Modules

Example 2: Using V Memory Addresses as the Remote I/O Memory Type

The following example uses Terminator discrete and analog I/O modules. **It is recommended to use V memory addressing when using analog modules since each analog I/O channel uses a double (two) word each.** Thus, an 8 channel analog I/O module uses 256 discrete points and a 16 channel analog I/O module uses 512 discrete points. **Analog output modules are configured using the Module Control Byte** located in the most significant byte of the most significant word of channel 1 of the module. **V memory addressing requires the use of “Bit–of–Word” instructions to address the I/O points.**



This block of logic tells the CPU, *for each slave*, the starting V-memory addresses for the inputs and outputs, and the total number of each. Use the values from the Remote Slave Worksheets or Channel Configuration Worksheet and the pointer addresses from the DL250/DL350/DL450 Reserved Memory Table to complete the logic.

Write Input and Output Pointers and Ranges for each remote base

DL250/DL350DL450 Reserved Memory Table

Port Setup Word				V7656
Setup Complete Flag				C740
Slave	Input Address	Number of Input Pts	Output Address	Number of Output Pts
1	V37704	V37705	V37706	V37707
2	V37710	V37711	V37712	V37713
3	V37714	V37715	V37716	V37717
4	V37720	V37721	V37722	V37723
5	V37724	V37725	V37726	V37727
6	V37730	V37731	V37732	V37733
7	V37734	V37735	V37736	V37737

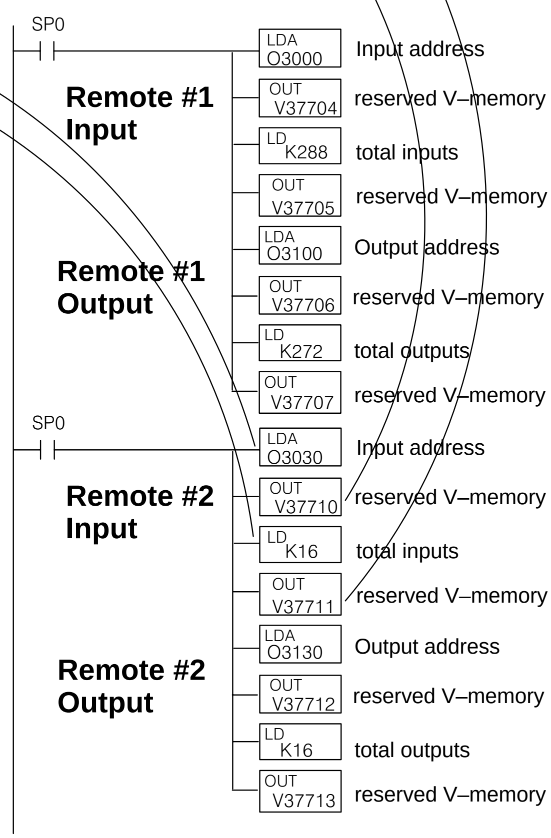
V777 for DL450

Channel Configuration Worksheet
DL250/DL350/DL450 CPU Bottom Port

Circle one selection or fill in blank for each parameter

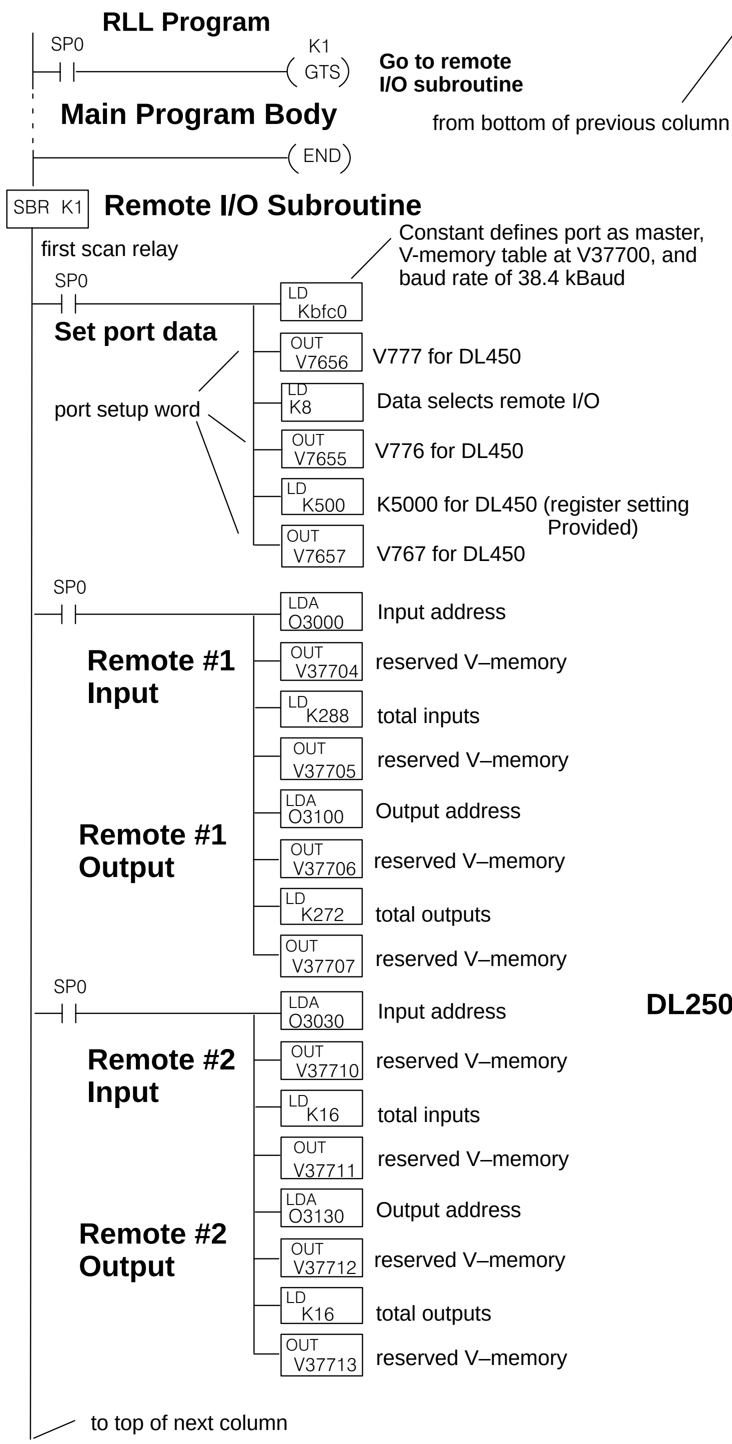
Configuration Parameter	SELECTION
Baud Rate (in KBaud), determined by required distance to last slave	19.2 38.4
Remote I/O Configuration table Starting address	V **37700** (V37700 is default)

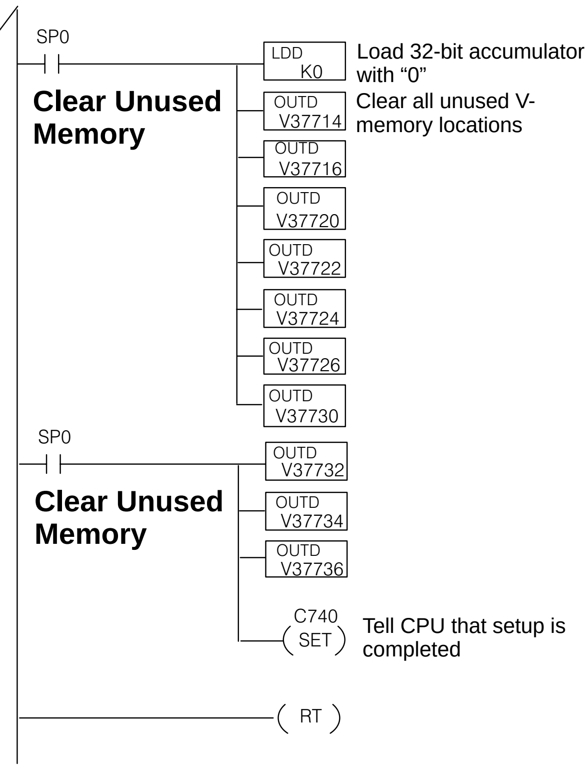
Slave Station	INPUT		OUTPUT	
	Input Address	No. of Inputs	Output Address	No. of Outputs
1	**V3000**	**288**	**V3100**	**272**
2	**V3030**	**16**	**V3130**	**16**
3				
4				
5				
6				
7				



Since the rest of the logic is identical to Example 1, we will now show the completed setup program.

Completed Setup Program for DL250/DL350/DL450 as Remote Master using V Memory Addressing





Analog Programming example continued on next page

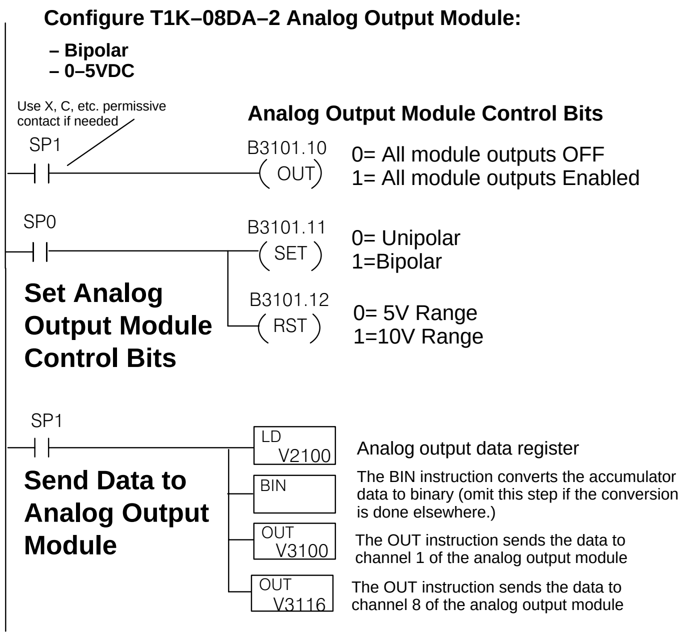
DL250/DL350/DL450 Reserved Memory Table

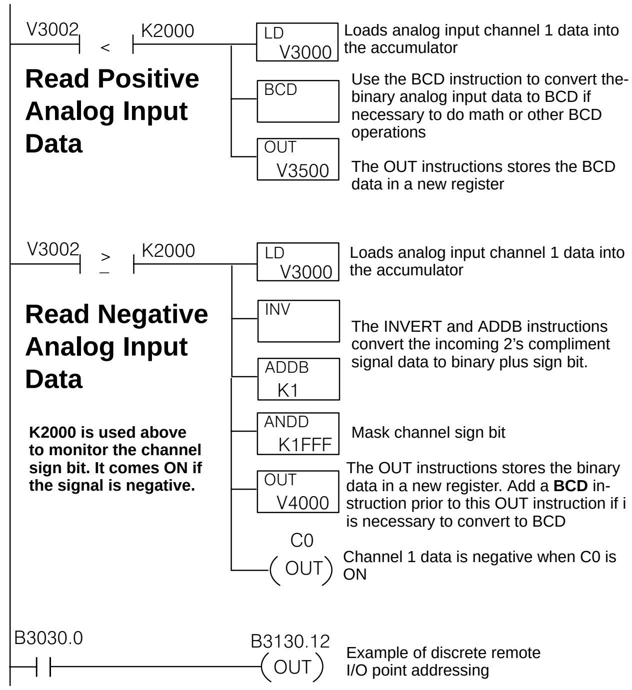
Port Setup Word				V7656
Setup Complete Flag				C740
Slave	Input Address	Number of Input Pts	Output Address	Number of Output Pts
1	V37704	V37705	V37706	V37707
2	V37710	V37711	V37712	V37713
3	V37714	V37715	V37716	V37717
4	V37720	V37721	V37722	V37723
5	V37724	V37725	V37726	V37727
6	V37730	V37731	V37732	V37733
7	V37734	V37735	V37736	V37737

V777 for DL450

Completed Setup Program for V–Memory Addressing (con't)

Main Program Body





The Control Bits of an Analog Output module are located in the most significant byte of the most significant word of the first output channel (channel 1).

Channel 1 Memory Map of 8&16-Channel Analog Output Module (T1F–08DA, T1F–016DA)									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Write Byte 3
	Module Control Byte								Write Byte 4

Module Control Byte of 8&16-Channel Analog Output Module (T1F–08DA, T1F–16DA)									
Decimal Bit	31	30	29	28	27	26	25	24	Read/Write
Octal Bit	37	36	35	34	33	32	31	30	
Bit 24	**Outputs Enable** 0 = All outputs OFF 1 = All outputs Enabled								Write
Bit 25	**Unipolar / Bipolar** 0 = Unipolar selected 1 = Bipolar selected								Write
Bit 26	**5V / 10V Range** 0 = 5V range 1 = 10V range								Write
Bit 27	**0 – 20mA / 4–20mA Range** 0 = 0 – 20mA range 1 = 4 – 20mA range								Write
Bit 28 – 31	Reserved for system use								–

DL250/DL350/DL450 Reserved Memory for Bottom Port as Remote Master

This table provides a listing of the reserved memory addresses in the DL250/ DL350/DL450 CPU to program the pointer addresses and ranges for slaves attached to the bottom port of the CPU.

DL250/DL350/DL450 Reserved Memory Table

Port Setup Word				V7656 V777(DL450)
Setup Complete Flag				C740
Slave	Input Address	Number of Input Points	Output Address	Number of Output Points
Reserved	V37700	V37701	V37702	V37703
1	V37704	V37705	V37706	V37707
2	V37710	V37711	V37712	V37713
3	V37714	V37715	V37716	V37717
4	V37720	V37721	V37722	V37723
5	V37724	V37725	V37726	V37727
6	V37730	V37731	V37732	V37733
7	V37734	V37735	V37736	V37737

This table provides a listing of the control relay flags available for the setup and monitoring of remote I/O attached to the bottom port of the DL250, DL350 and DL450 CPU.

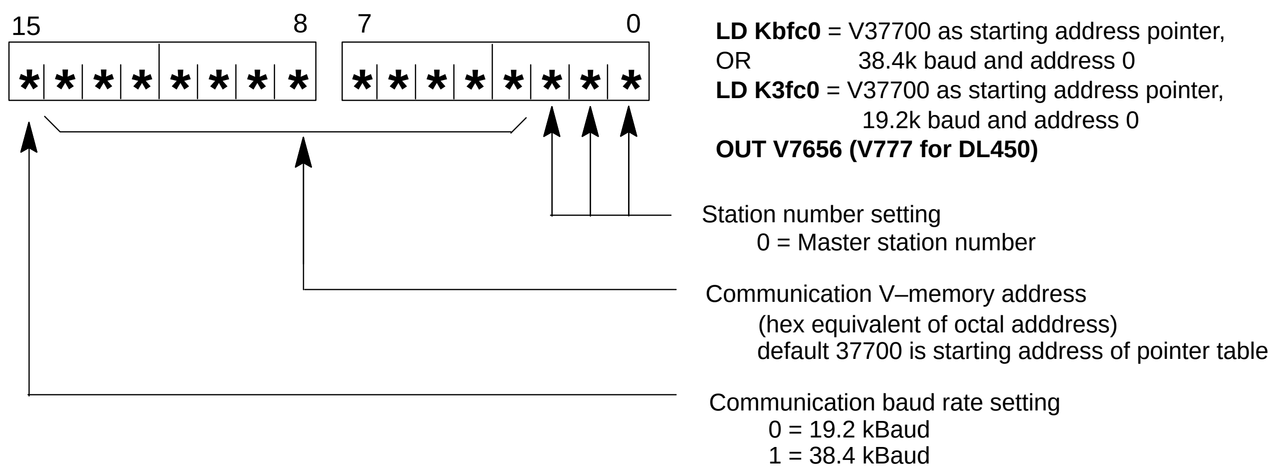
Control Relays Used For Remote I/O

FLAG ADDRESS	FUNCTION	DETAIL
C740	Setup Complete Flag	Set ON to command CPU to read and check parameters loaded into setup memory
C741	Communications Error Response Flag	This flag determines the CPU’s response if there is a communications error. Set ON to hold last state of received inputs; set OFF to clear the status of the received inputs.

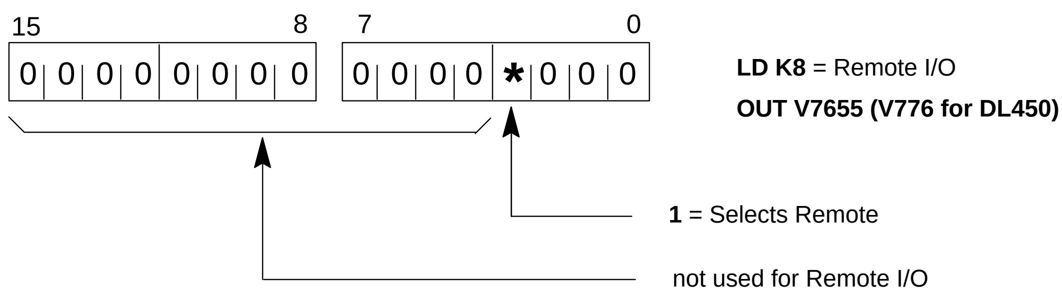
DL250/DL350/DL450 V Memory Port Setup Registers

When configuring the bottom port of the DL250, DL350 or DL450 CPU via ***Direct***Soft or the Handheld Programmer, you are actually loading a reserved V-memory adddresses with configuration data. The following diagrams define the meaning of the bits in the registers. The previous ladder logic examples include logic in the setup program to set these parameters so they are not lost or accidentally changed.

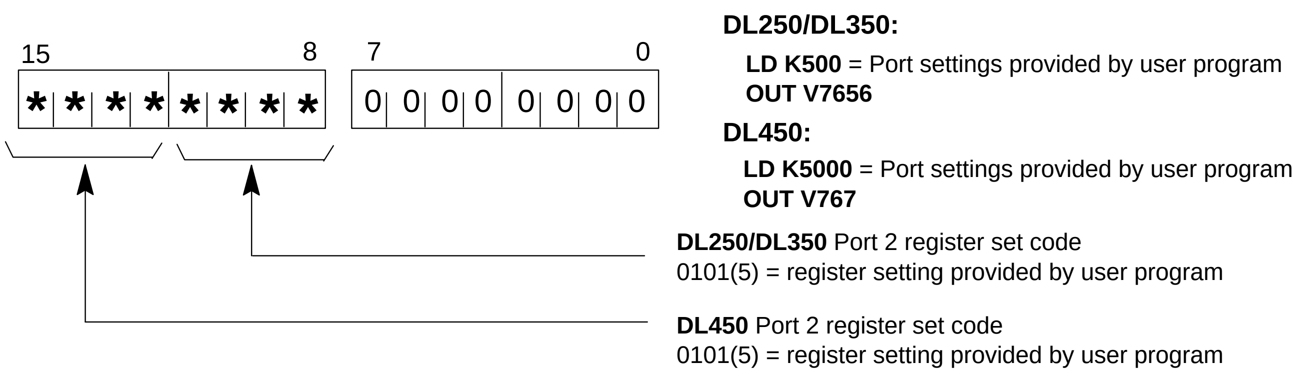
Remote I/O Communication Port Settings: DL250/DL350 (V7656); DL450 (V777)



Port 2 Protocol Setup: DL250/DL350 (V7655)
Port 3 Protocol Setup: DL450 (V776)



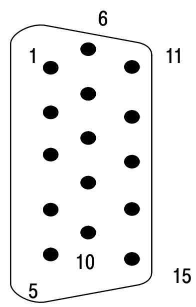
Register Set Code: DL250/DL350 (V7657); DL450 (V767)



Connecting the Wiring

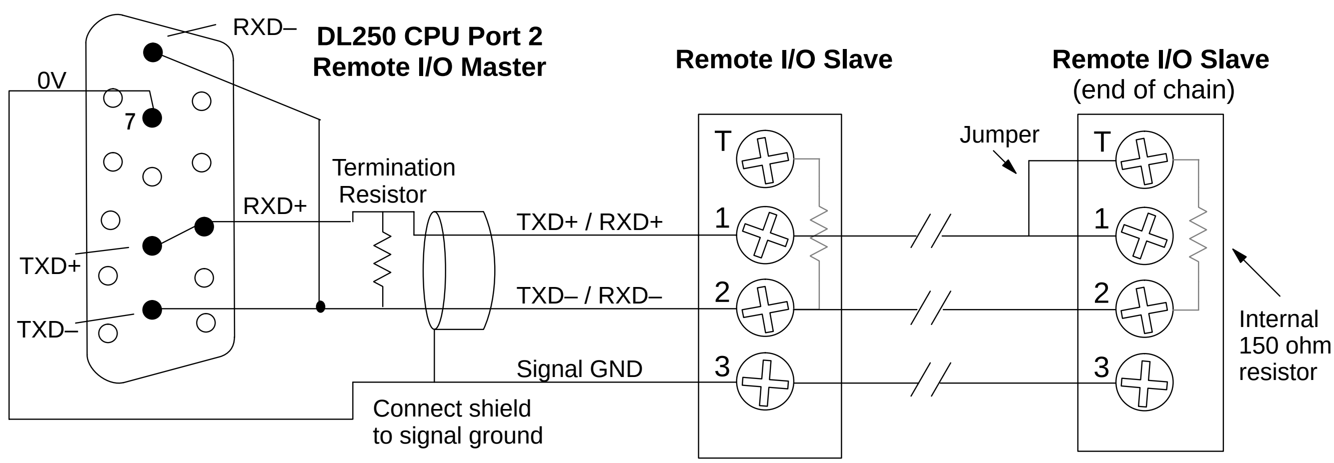
Cabling Between the D2–250 CPU Bottom Port and Slaves

The standard remote I/O link is a 3-wire, half-duplex type. Since Port 2 of the DL250 CPU is a 5-wire full duplex-capable port, we must jumper its transmit and receive lines together as shown below (converts it to 3-wire, half-duplex). The recommended cabling for connecting the master and slaves is the single twisted pair cable, Belden 9841 or equivalent. The diagram also depicts the port pinout for the D2–250 CPU bottom port.



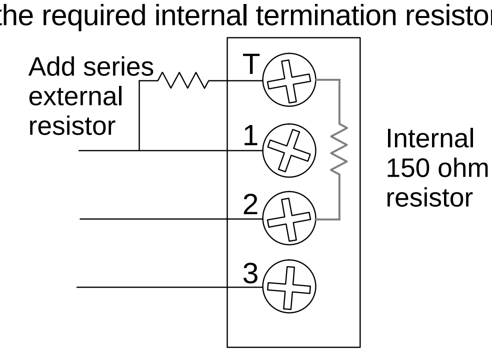
15-pin Female
D Connector

Port 2 Pin Descriptions (DL250 CPU)		
1	5V	5 VDC
2	TXD	Transmit Data (RS232C)
3	RXD	Receive Data (RS232C)
4	RTS	Ready to Send (RS–232C)
5	CTS	Clear to Send (RS–232C)
6	RXD2–	Receive Data – (RS–422)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422)
10	TXD2 –	Transmit Data – (RS–422)
11	RTS2 +	Request to Send + (RS–422)
12	RTS2 –	Request to Send – (RS–422)
13	RXD2 +	Receive Data + (RS–422)
14	CTS2 +	Clear to Send + (RS422)
15	CTS2 –	Clear to Send – (RS–422)



The twisted/shielded pair connects to the DL250's Port 2 as shown. Be sure to connect the cable shield wire to the signal ground connection. A termination resistor must be added externally to the CPU, as close as possible to the connector pins. Its purpose is to minimize electrical reflections that occur over long cables. Be sure to add the jumper at the last slave to connect the required internal termination resistor.

Ideally, the two termination resistors at the cable's opposite ends and the cable's rated impedance will all three match. For cable impedances greater than 150 ohms, add a series resistor at the last slave as shown to the right. If less than 150 ohms, parallel a matching resistance across the slave's pins 1 and 2 instead.

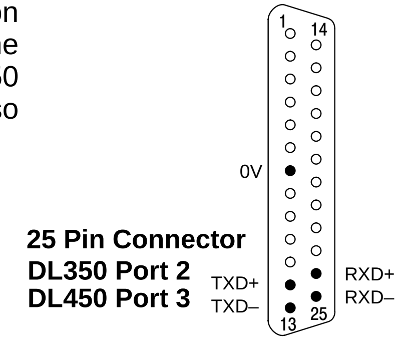


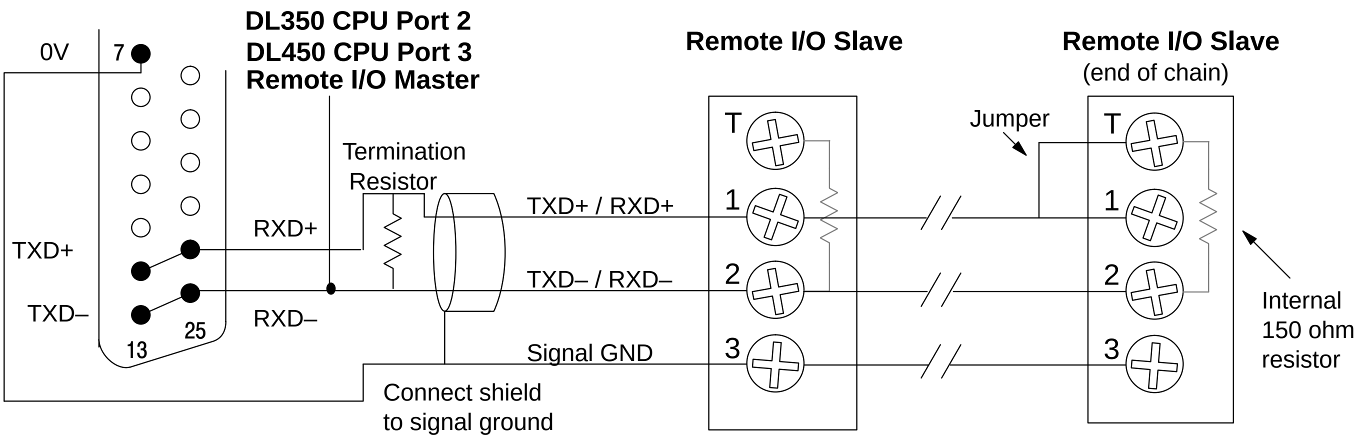
Cabling Between the D3–350/D4–450 CPU Bottom Port and Slaves

The remote I/O link is a 3-wire, half-duplex type. Since Port 2 of the DL350 and Port 3 of the DL450 CPU is a 5-wire full duplex-capable port, we must jumper its transmit and receive lines together as shown below (converts it to 3-wire, half-duplex). The recommended cabling for connecting the master and slaves is the single twisted pair cable, Belden 9841 or equivalent. The diagram depicts the port pinout for the D3–350 and D4–450 CPU bottom port.

The location of Port 2 on the DL350 is on the 25-pin connector , as pictured to the right. The location of Port 3 on the DL450 is on the 25–pin connector, which is also shared by Port 1.

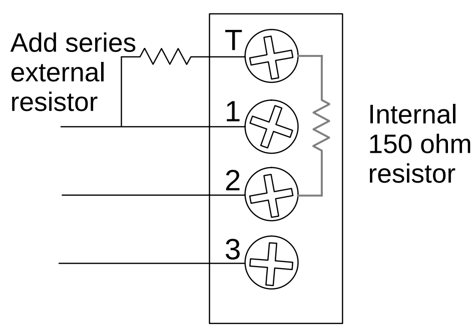
- Pin 7 Signal GND
- Pin 12 TXD+
- Pin 13 TXD–
- Pin 24 RXD+
- Pin 25 RXD–





The twisted/shielded pair connects to the DL350/DL450's Port as shown. Be sure to connect the cable shield wire to the signal ground connection. A termination resistor must be added externally to the CPU, as close as possible to the connector pins. Its purpose is to minimize electrical reflections that occur over long cables. Be sure to add the jumper at the last slave to connect the required internal termination resistor.

Ideally, the two termination resistors at the cable's opposite ends and the cable's rated impedance will all three match. For cable impedances greater than 150 ohms, add a series resistor at the last slave as shown to the right. If less than 150 ohms, parallel a matching resistance across the slave's pins 1 and 2 instead.



Remember to size the termination resistor at Port 2 (Port 3 DL450) to match the cable's rated impedance. *The resistance values should be between 100 and 500 ohms.*

Special CPU Memory for Diagnostics

This table provides a listing of the control relay flags available in the DL250/DL350/DL450 for remote I/O troubleshooting.

Remote I/O System Control Relays

FLAG ADDRESS	FUNCTION
C750 to C757	Setup Error– The corresponding relay will be ON if the setup table contains an error (C750 =master, C751 = slave 1.....C757 = slave 7)
C760 to C767	Communications Ready – – The corresponding relay will be ON if the setup table is valid (C760 =master, C751 = slave 1.....C767 = slave 7)

Appendix A
Remote I/O Worksheets

A

Remote Slave Worksheet

Remote Slave Address ___________ (Choose 1-7 for RM-NET or 1–31 for SM-NET)

Module Number	Module Name	INPUT		OUTPUT	
		Input Address	No. of Inputs	Output Address	No. of Outputs
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Input Bit Start Address: _____V-Memory Address*: V___________

Total Input Points________

Output Bit Start Address: _____V-Memory Address*: V___________

Total Output Points________

* The D2–RMSM automatically assigns I/O addresses in sequence based on Slave #1's starting addresses. The DL250/DL350/DL450 CPU port setup program requires these addresses for each slave.

Channel Configuration Worksheet

D2–RMSM Remote Master Module

Master Slot Address ________ (1 – 7)

Protocol Selected ___________ (RM–NET or SM–NET)

Circle one selection for each parameter (selections for each protocol are shown)

Configuration Parameter	RM–NET	SM–NET
Baud Rate (in KBaud, determined by required distance to last slave)	19.2 38.4	19.2 38.4 153.6 307.2 614.4
Operator Interface	N/A	YES NO
Auto Return to Network	YES NO	YES NO

Starting Input V-Memory Address: V__________ **Starting Output V-Memory Address: V** ___________

Total Inputs ___________ **Total Outputs** ___________

Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0			16		
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

Channel Configuration Worksheet

DL250/DL350/DL450 CPU Bottom Port

Circle one selection or fill in blank for each parameter

Configuration Parameter	SELECTION
Baud Rate (in KBaud, determined by required distance to last slave)	19.2 38.4
Remote I/O configuration table starting address	V ___________ (V37700 is default)

Slave Station	INPUT		OUTPUT	
	Input Address	No. of Inputs	Output Address	No. of Outputs
1				
2				
3				
4				
5				
6				
7				

B

Appendix B
Analog I/O
Scaling Examples

— Analog Input Module
— Analog Output Module

Analog Input Module

Scaling the Input Data

Most applications usually require measurements in engineering units, which provide more meaningful data. This is accomplished by using the conversion formula shown.

You may have to make adjustments to the formula depending on the scale you choose for the engineering units.

$$\text{Units} = A\,\frac{H - L}{8191}$$

H = high limit of the Engineering unit range

L = low limit of the Engineering unit range

A = Analog value (0 – 8191)

For example, if you wanted to measure pressure (PSI) from 0.0 to 99.9 then you would have to multiply the analog value by 10 in order to imply a decimal place when you view the value with the programming software or a handheld programmer. Notice how the calculations differ when you use the multiplier.

Analog Value of 4047, slightly less than half scale of 8191, should yield 49.4 PSI

Example without multiplier

$$\text{Units} = A\,\frac{H - L}{8191}$$

$$\text{Units} = 4047\,\frac{100 - 0}{8191}$$

$$\text{Units} = 49$$

Example with multiplier

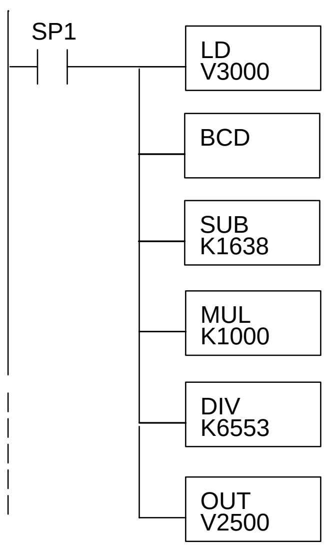
$$\text{Units} = 10\,A\,\frac{H - L}{8191}$$

$$\text{Units} = 40470\,\frac{100 - 0}{8191}$$

$$\text{Units} = 494$$

Example 1: Scaling 4–20mA Input Signal

Here’s how you would write the program to perform the engineering unit conversion for a 4 – 20mA input signal. This example uses SP1 which is always on. You could also use an X, C, etc. permissive contact.



When C0 is on, channel 1 data is loaded into the accumulator.

Converts the binary analog data to BCD to perform math operations. Omit this instruction if binary data is to be used for binary math operations.

Subtracts 1638 from the incoming signal to adjust the 4mA offset.

Multiplies the accumulator data by 1000 (to start the conversion).

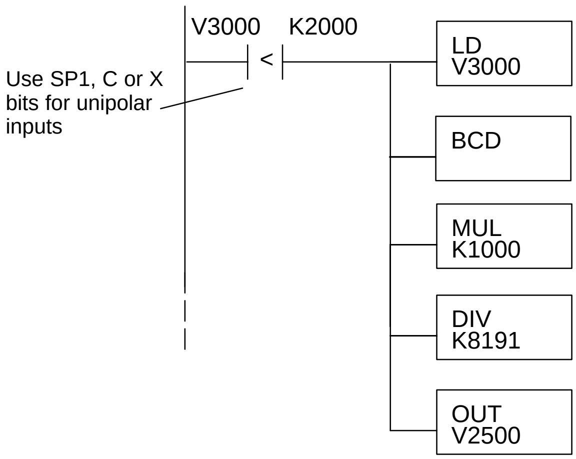
Divides the accumulator data by 6553. (8191 – 1638)

Stores the result in location V2500.

Example 2: Scaling Unipolar and Bipolar Input Signals

Here's how you would write the program to perform the engineering unit conversion for a 0–5V, 0–10V, ±5, ±10, 0–20mA or ±20mA input signal. The example assumes the analog data is in V3000.

This rung executes if the channel data is positive



Channel 1 data is loaded into the accumulator.

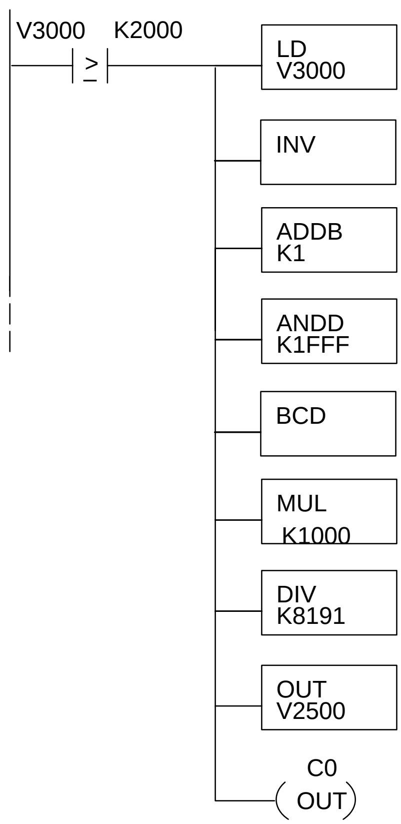
Converts the binary analog data to BCD to perform math operations. Omit this instruction if binary data is to be used for binary math operations.

Multiplies the accumulator data by 1000 (to start the conversion).

Divides the accumulator data by 8191. **Divide by 4095 for 0–5V or ±5V input signal ranges.**

Stores the result in location V2500.

This rung executes if the channel data is negative. It can be omitted for unipolar inputs.



Channel 1 data is loaded into the accumulator.

The INV and ADDB instructions convert the incoming 2's complement analog data into binary

Masks the channel sign bit

Converts the binary analog data to BCD to perform math operations. Omit this instruction if binary data is to be used for binary math operations.

Multiplies the accumulator data by 1000 (to start the conversion).

Divides the accumulator data by 8191. **Divide by 4095 for 0–5V or ±5V input signal ranges.**

Stores the result in location V2500.

C0 is ON when the input signal is negative

Analog Output Module

Calculating the Digital Value

Your program has to calculate the digital value to send to the analog module. There are many ways to do this, but most applications are understood more easily if you use measurements in engineering units. This is accomplished by using the conversion formula shown.

You may have to make adjustments to the formula depending on the scale you choose for the engineering units.

$$A = U \frac{4095}{H - L}$$

A = Analog value (0 – 4095)

U = Engineering units

H = High limit of the engineering unit range

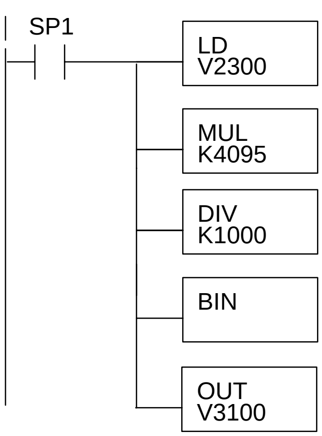
L = Low limit of the engineering unit range

Consider the following example which controls pressure from 0.0 to 99.9 PSI. By using the formula you can easily determine the digital value that should be sent to the module. The example shows the conversion required to yield 49.4 PSI. Notice the formula uses a multiplier of 10. This is because the decimal portion of 49.4 cannot be loaded, so you must adjust the formula to compensate for it.

$$A = 10U \frac{4095}{10(H - L)} \qquad A = 494 \frac{4095}{1000 - 0} \qquad A = 2023$$

Engineering Unit Conversion

The following example program shows how you would write the program to perform the engineering unit conversion to output data formats 0–4095. This example assumes you have calculated or loaded the engineering unit values in BCD format and stored it in V2300. It is usually easier to perform any math calculations in BCD and then convert the value to binary before you send the data to the module.



The LD instruction loads the engineering units used with channel 1 into the accumulator. This example assumes the numbers are BCD. Since SP1 is used, this rung automatically executes on every scan. You could also use an X, C, etc. permissive contact.

Multiply the accumulator by 4095 (to start the conversion).

Divide the accumulator by 1000 (because we used a multiplier of 10, we have to use 1000 instead of 100).

Convert the data to binary format before sending it to the module

Send the binary data to channel 1 of the module

C

Appendix C Determining I/O Update Time

— Overview
— Remote I/O Update Table
— Calculating Total Delay for the System

Overview

Since the Remote Master and the CPU operate **asynchronously** from one another, it is possible that the remote I/O points may not be updated on every CPU scan. Therefore, in some applications it may helpful to understand the amount of time required to update the remote I/O points. Depending on the number of I/O points used in your remote configuration and the baud rate you have selected for communication, your update time requirements will vary. This appendix will show you how to estimate the total delay time for your system.

NOTE: In most situations, this delay will be so small that either it makes no difference to the particular application, or the mechanical speeds of the field devices are slower than the delay itself.

If you have an application that requires a thorough understanding of the time delay, you can use the following information in order to calculate the delay:

- **Baud Rate —** this is the communication baud rate that you selected with the DIP switch settings on the remote master and remote slaves.
- **CPU Scan Time —** this is the total CPU scan time. The easiest way is to use AUX53 from a DL205/DL405 Handheld Programmer, or use the Diagnostics option under the PLC menu in our ***Direct***SOFT Programming Software. You can also use the PLC User Manual to calculate the scan time, but this is often very time consuming. If you use the User Manual, you will have to estimate this time, because it is dependent on the main program length, and the number of I/O points in the local base as well.
- **Remote Master Scan —** this is the time required for the Remote Master to scan the individual Slave stations to update the status of the I/O modules. Use the formula and table shown on the following page.
- **Module ON to OFF, OFF to ON Response Time —** this is the amount of time that the module requires to see a transition in status. For example, when a switch connected to an input module closes, it can take a few milliseconds (1–12 typical) before the module actually makes the transition from OFF to ON. The easiest way to find this information is from the module specifications in the respective User Manuals. This basic information is also available in the specifications of the Sales Catalog.
- **Total Delay Time —** this is the total delay time that takes all of the above factors into consideration. There are several formulas that you can use to calculate this delay time. See the formulas on Page C5 of this appendix. Once you have selected the formula applicable to your system, you will use the information you have gathered for the above items to calculate the total system delay time.

Since each application is different, we cannot possibly show all of the options for the CPU scan time or the possible module response delays. You can easily find this information in other publications. However, the next few pages *will* show you how to calculate the delay time for the Remote Master Scan. Also, we show the total delay time for our example system that was used earlier in this manual.

Remote I/O Update Table

The table shown below shows you how much time is required for the Remote Master Module to update its I/O data to its internal buffers. Remember from earlier reading in this appendix that the remote I/O scan and CPU scan are **asynchronous.** The CPU may be looking at the master module's internal buffers several times before the master actually has enough time to store new data. This chart shows the maximum amount of delay based on the number of I/O points on the channel.

# of Remote I/O Points	Update Time Required (in ms)				
	19.2 kB	38.4 kB	153.6 kB	307.2 kB	614.4 kB
16	3.64	1.82	.45	.23	.12
32	5.72	2.86	.72	.36	.18
64	9.88	4.94	1.24	.62	.31
128	18.20	9.10	2.28	1.14	.57
160	22.36	11.18	2.80	1.40	.70
192	26.52	13.26	3.32	1.66	.83
224	30.68	15.34	3.84	1.92	.96
256	34.84	17.42	4.36	2.18	1.09
288	39.00	19.50	4.88	2.44	1.22
320	43.16	21.58	5.40	2.70	1.35
352	47.32	23.66	5.92	2.96	1.48
384	51.48	25.74	6.44	3.22	1.61
416	55.64	27.82	6.96	3.48	1.74
448	59.80	29.90	7.48	3.74	1.87
480	63.96	31.98	8.00	4.00	2.00
512	68.12	34.06	8.52	4.26	2.13

Remote Scan Time Formula

Use the following formula to calculate the amount of time required for the remote I/O scan update:

$$\mathbf{T_{RS} = \text{Time from Above Table} + (2\ \text{ms} \times \text{No. of Slaves})}$$

Example: Given a 38.4 kB system with a total of 128 remote points and 3 slaves:

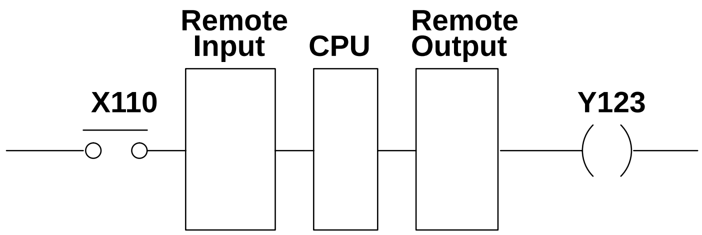
$$\mathbf{T_{RS} = 9.10\ \text{ms} + (2\ \text{ms} \times 3) = 15.10\ \text{ms}}$$

D2–RMSM: Calculating Total Delay for the System

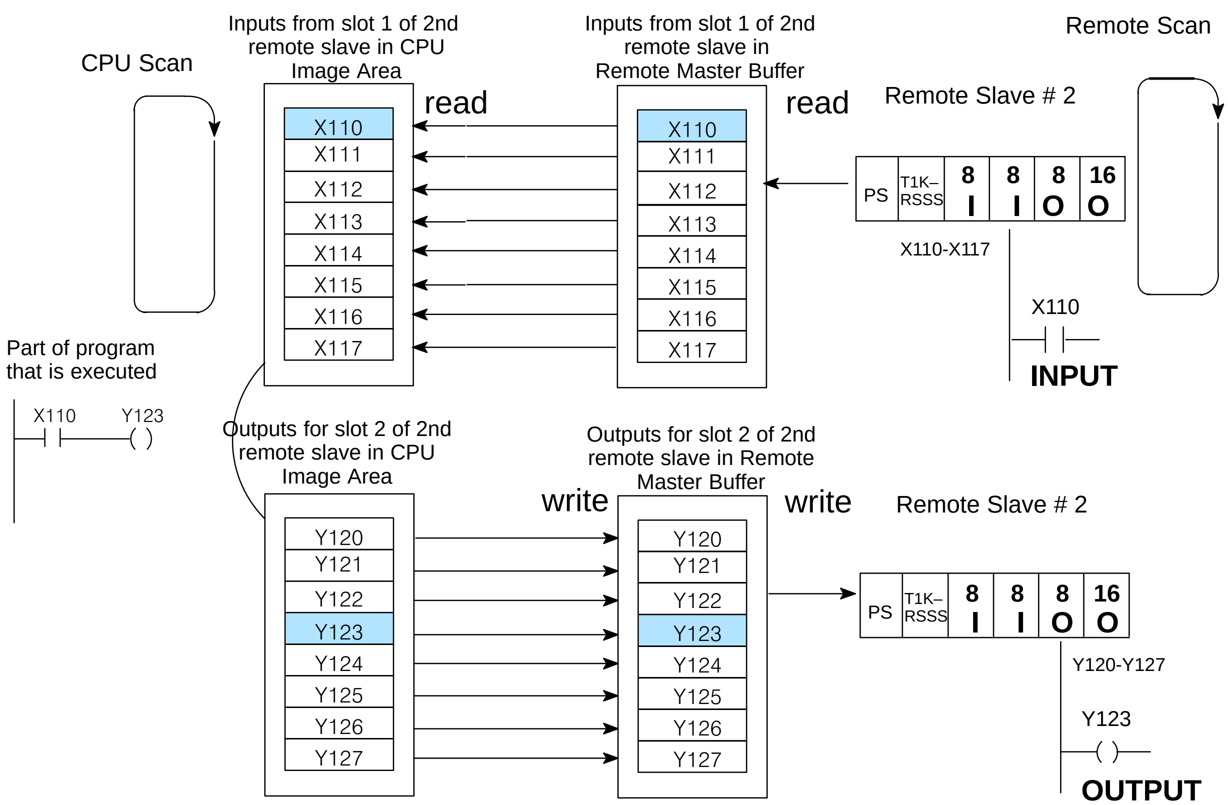
Now that you have calculated the time required for the Remote Master to go through its scan cycle and update its internal buffer area, we need to add this time to other delay times inherent in the overall system. Below is an example of a remote input changing a remote output.

Example of a Remote Input Changing a Remote Output

This example can be simplified schematically to look like this:



The drawing below shows the details of the CPU and Remote Master interaction .

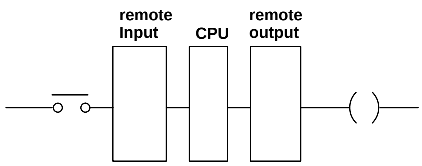
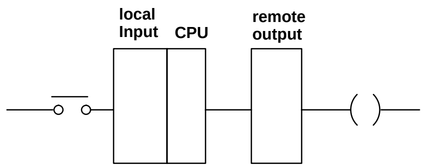
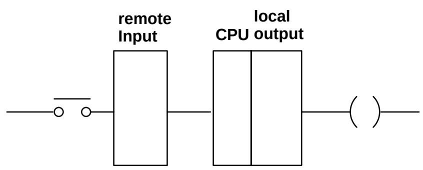


The table on the adjacent page shows the formula for calculating the overall system delay for this scenario. It also shows you formulas for two other possible scenarios.

Total Delay Time Formulas

The following table provides delay formulas for three different configuration scenarios. Notice the two sets of formulas for each scenario. The formula chosen depends on whether the CPU scan time is greater than or less than the Remote Master scan time. There are several variables used in the formulas. The following descriptions will help you understand them.

- **T_{CS}** — CPU scan time. You can use ***Direct***SOFT or a Handheld Programmer to determine this time, or you can estimate the time required by using the PLC User Manual.
- **T_{RS}** — Remote Master scan time. Use the table and formula shown previously to determine this time.
- **T_{IN}** and **T_{OUT}** — Module response delay time. You can find this information from the module specifications tables which you will find in the User Manual.

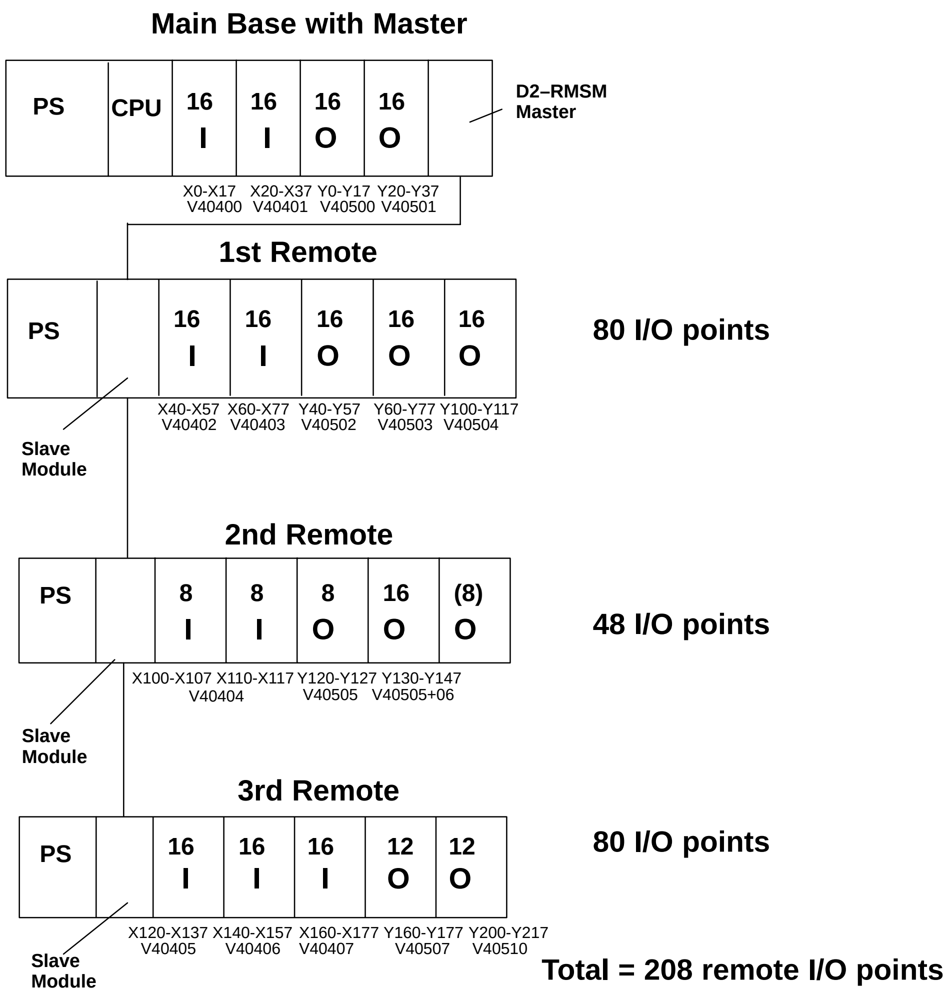
<table>
<tr><th>Remote Input to Remote Output
</th><th>$T_{RS} \le T_{CS}$</th><th>$T_{RS} > T_{CS}$</th></tr>
<tr><td></td><td>$T_{IN} + 6(T_{CS}) + T_{OUT}$</td><td>$T_{IN} + 4(T_{RS}) + 6(T_{CS}) + T_{OUT}$</td></tr>
<tr><td>Local Input to Remote Output

Remote Input to Local Output
</td><td>$T_{IN} + 4(T_{CS}) + T_{OUT}$</td><td>$T_{IN} + 2(T_{RS}) + 4(T_{CS}) + T_{OUT}$</td></tr>
</table>

The following page will show you how to use one of the formulas to calculate the delay time for our example system.

D2–RMSM Delay Time Example

The following example shows you how to calculate the total time required for reading a remote input,solving the CPU logic, then changing an output at the remote base. We have used the following configuration, which features 3 remote slaves, 1 master and 208 remote I/O points, communicating at 38.4 kBaud.

EXAMPLE:
38.4 kBaud, D2-240, X110 causing a change in Y123.



Given that the CPU scan (T_{CS}) is estimated to be 25 ms, the results of the calculations are:

T_{IN} = Maximum response input module time (16ND3) = 8 ms
T_{OUT} = Maximum response output module time (16TD1) = 10us
T_{RS} = 15.34 ms + (2ms x3) = 21.34 ms $<$ T_{CS}

Total Delay for Configuration = $T_{IN} + 6(T_{CS}) + T_{OUT}$

= 8 ms + 6(25 ms) + .01 ms
= 158.01 ms

D

Appendix D I/O Module Hot Swap

In This Appendix. . . .

— T1K–RSSS I/O Module Hot Swap Feature

T1K–RSSS I/O Module Hot Swap Feature

The “Hot Swap” feature allows Terminator I/O modules to be replaced with Terminator I/O system power ON. Be careful not to touch the terminals with your hands or any conductive material to avoid the risk of personal injury or equipment damaged. *Always remove power if it is equally convenient to do so.*

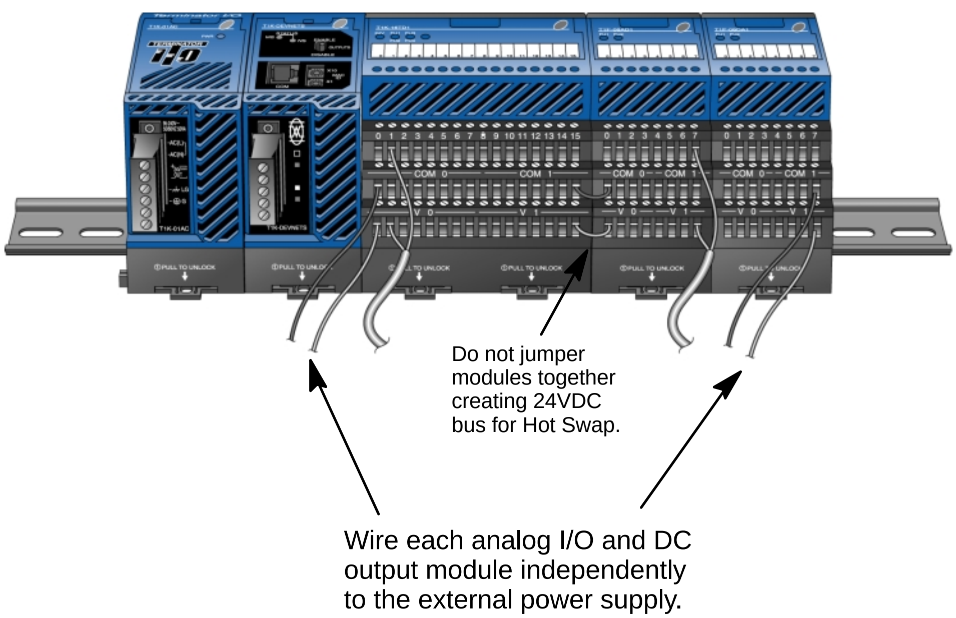
WARNING: Only authorized personnel fully familiar with all aspects of the application should replace an I/O module with system power ON.

The following module types can be “Hot Swapped”.

Module	
Power Supply	No
Base Controller	No
I/O Modules (discrete / analog)	Yes

Check External 24VDC Wiring Before Hot Swapping!

Before “Hot Swapping” an analog I/O module or a DC output module in a Terminator I/O system, make sure that each of the analog I/O and DC output module’s 24VDC and 0VDC base terminals are wired directly to the external power supply individually (see diagram below). If the external 24VDC / 0VDC is jumpered from base to base in a daisy chain fashion, and an analog I/O or DC output module is removed from its base, the risk of disconnecting the external 24VDC to the subsequent I/O modules exists.



Hot Swap: I/O Module Replacement

The following steps explain how to “Hot Swap” an I/O module.

1. Remove I/O module from base. (If necessary, refer to the Terminator I/O Installation & I/O Manual for steps on removing an I/O module).
2. The T1K–RSSS I/O LED will begin to *slow blink* at 500ms on/off time. (I/O LED status information is listed on the T1K–RSSS Data Sheet and in the T1K–RSSS Features section in this manual).
3. Install a new I/O module with the **exactly the same part number**.
4. Verify that the T1K–RSSS Base Controller LEDs have returned to normal.

Outputs Enable/Disable Switch

A feature that may be used in a non–continuous process application is the Outputs Enable/Disble switch. The switch is located on the front of the T1K–RSSS base controller. When the switch is in the Disable position all outputs are disabled (OFF), although discrete and analog input data continues to be read. This option may be used at a convenient time during the process application to replace an I/O module.