2

Designing a Remote I/O System

In This Chapter. . . .

Determining the System Layout

Determine the Hardware Configuration

The first step in putting any system together is to establish a picture of the system components. The DL205 remote I/O gives you the flexibility to build a system which takes advantage of the features you need. The possibilities are endless, but the table below shows some combinations that will fit the majority of applications. And if you need a combination of features, remember that you can configure each remote master in a system differently.

Products	Configuration	Advantages
D2–240 D2–250 D2–RMSM D2–RSSS D4–RS	DL205 CPU with Remote Master(s) to rack-based DL205 Remote I/O and/or DL405 remote I/O	Uses RM–NET mode; efficient way to expand I/O for DL205 (the remote I/O racks may be located with the CPU base). You can use the bottom port of the DL250 CPU as the first master for a cost savings.
D4–440 D4–450 D4–RM D4–RS D2–RSSS	DL405 CPU with Remote Master(s) to rack-based DL205 and rack-based DL405 Remote I/O	Uses RM–NET mode; this gives you remote I/O which is smaller and less expensive than the DL405 I/O, as long as the DL205 I/O selection meets your needs
D2–240 D2–250 D2–RMSM D2–RSSS D4–SS–X	DL205 CPU with Remote Master(s) to rack-based DL205 Remote I/O and/or DL405 Slice I/O units	Uses SM–NET mode; this gives you a way to distribute small amounts of I/O to many locations, as well as locating operator interfaces at any of those locations. Also allows higher baud rates.Slice I/O unit addresses are limited to 1 to 15 only.
D4–440 D4–450 D4–SM D4–SS–X D2–RSSS	DL405 CPU with Slice I/O Master(s) to rack-based DL205 Remote I/O and/or DL405 Slice I/O units	Uses SM–NET mode; this can distribute small amounts of less expensive I/O to many locations, as well as locating operator interfaces at any of those locations. The DL405 CPU gives you the most advanced programming instruction set for more complex applications, as long as the DL205 I/O selection for remote I/O meets your needs.
D3–350 D4–RS D2–RSSS	DL350 CPU with built in bottom port as remote master to rack-based DL205 and/or rack-based DL405 Remote I/O	Uses RM–NET mode; this gives you remote I/O expansion for a DL350 system to extend the amount and distance of I/O

Which Modules can go in the Remote Bases

The remote I/O bases accept the most commonly used I/O modules for the DL205 system (AC, DC, AC/DC, Relay and Analog). The table below lists by category those modules that you may use in a remote I/O base.

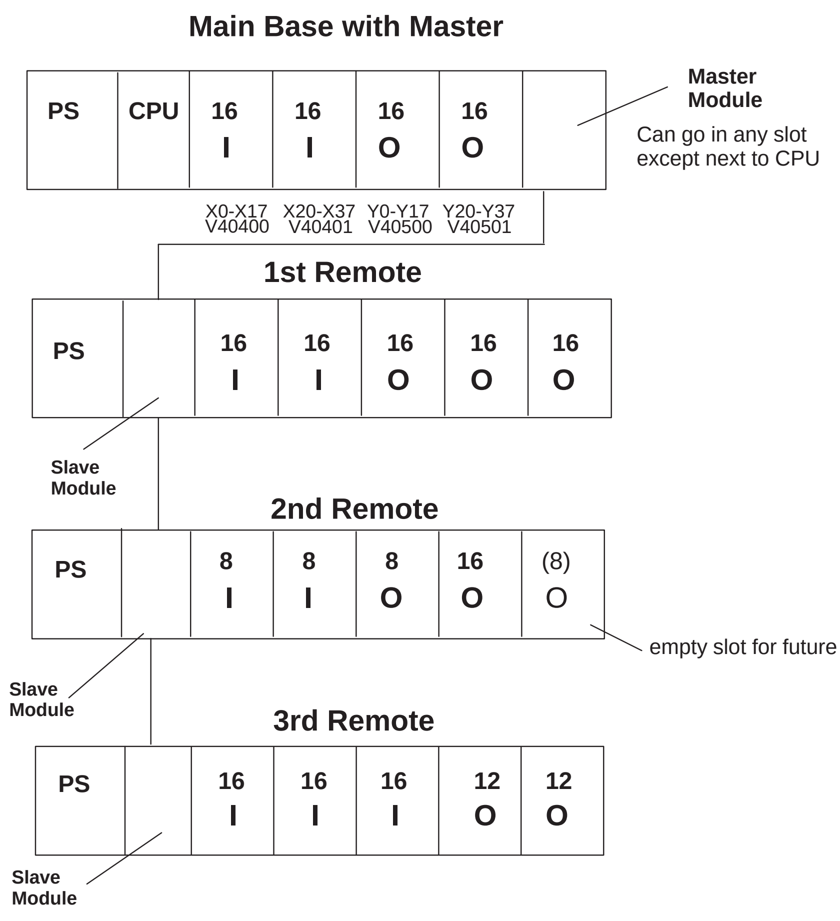
Module/Unit	Remote Base
CPUs	No
DC Input Modules	Yes
AC Input Modules	Yes
AC/DC Input Modules	Yes
DC Output Modules	Yes
AC Output Modules	Yes
Relay Output Modules	Yes
Analog Modules	Yes
Thermocouple Module	Yes
RTD Module	Yes
Remote I/O	
Remote Master	No
Remote Slave Unit	CPU Slot Only
Communications and Networking Modules	No
Specialty Modules	
High Speed Counter	No
I/O Simulator	Yes
Filler	Yes

NOTE: The User Manual for Analog I/O Modules discusses scan times for updating analog I/O data for modules installed in *local bases.* Please be aware that the **scan times for updating are different for remote I/O modules installed in remote bases**. The CPU scan is asynchronous with the remote scan by the master module. Thus, an analog input module installed in a remote base, for example, may not have its data updated by the CPU “once every scan per channel” as stated in the user manual. The CPU scan may, in fact, cycle several times while the remote scan is taking place. Take this into account in applications where the timing is critical.

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, one 8-point output module, and one 16-point output module. It also contains space for a future output module.
- third remote base has three 16-point input modules, and two 12-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.

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

The most important decision you must make is to choose the protocol mode for each master in the system. 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 per channel	512	512
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

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 D2–250 system if first/ only channel is attached to CPU Port 2 Can use D2–RSSS Remote Slave units with DL405 Remote Master 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, can use Slice I/O if needed Desire programming port or operator interface port at remote base location(s)

Choosing the Output Default Mode – Hold Last State vs. Clear

The hardware selection for the output default mode determines the outputs' response to a communications failure. A DIP switch setting on the slave modules defines the default mode for each slave. "Hold Last State" causes the outputs in that slave unit to remain in their last state upon a communication error. "Clear Outputs" sets the outputs in that slave unit to OFF (0).

NOTE: The Output Default mode does not have to be the same for all slaves on a 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.

Auto Return to Network Option

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

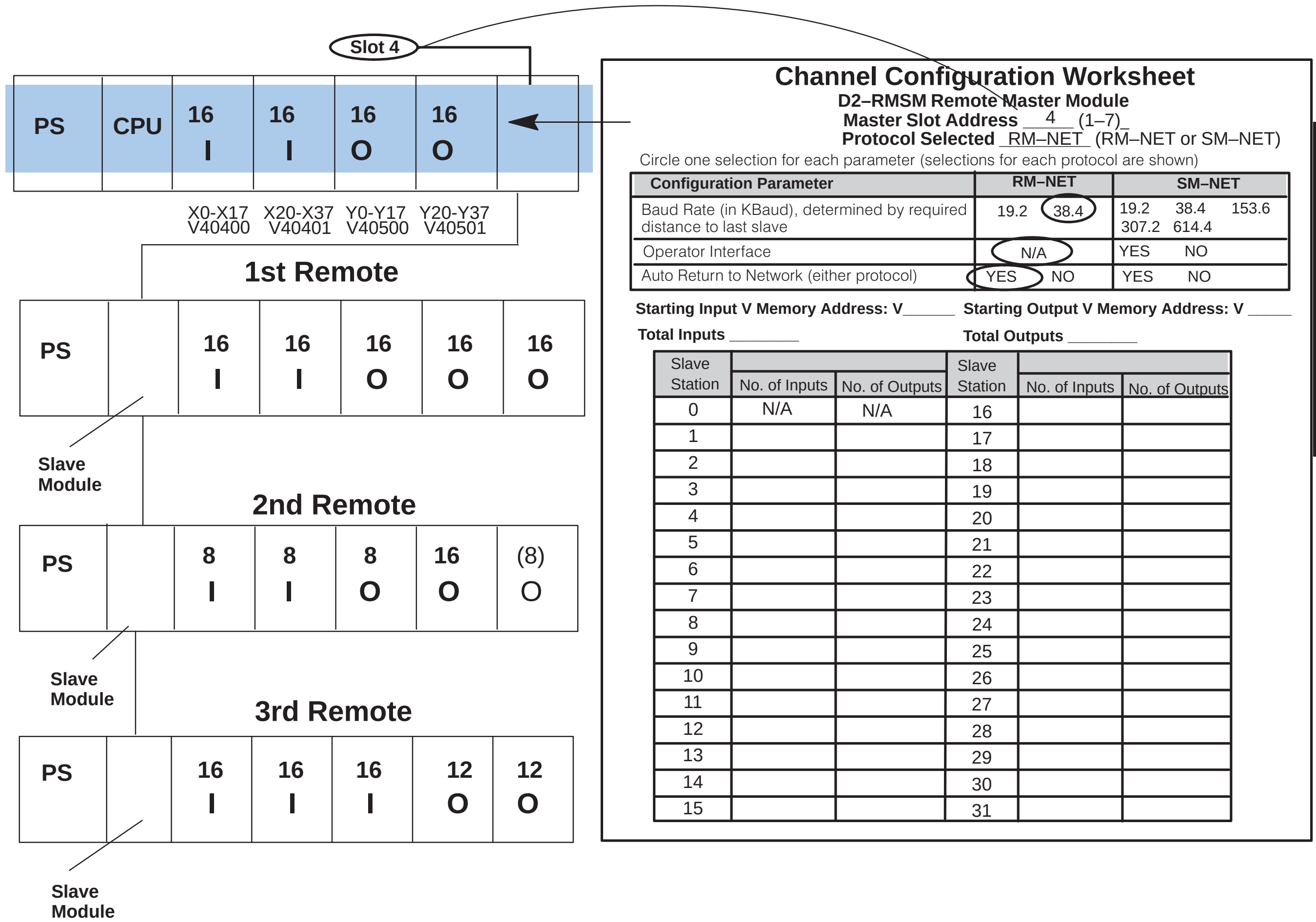
- on power up
- on transition from CPU Program Mode to Run Mode
- when user logic commands the remote master to log its parameters to EEPROM

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.

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



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______ **Starting Output V Memory Address: V _____**
Total Inputs ________ **Total Outputs ________**

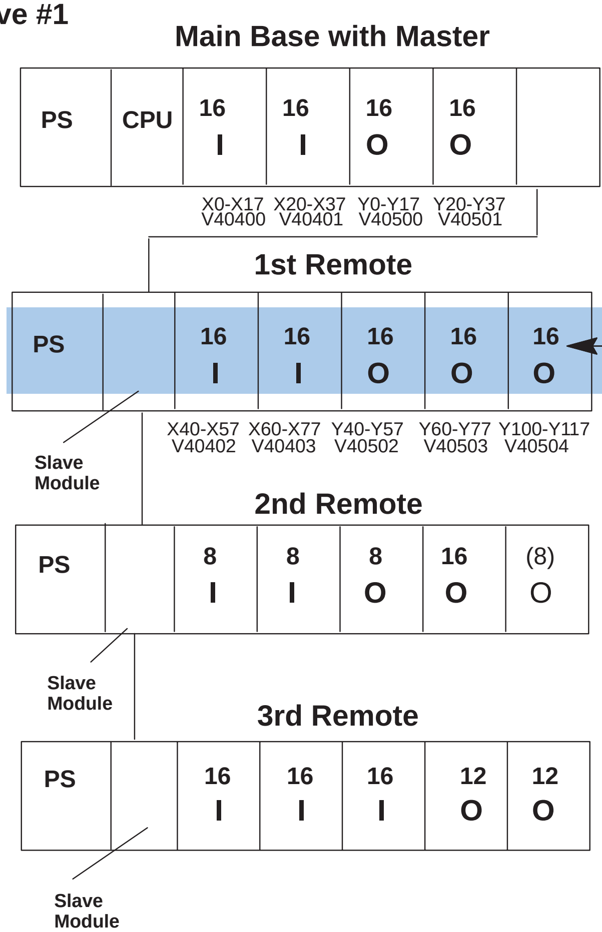
Slave Station	No. of Inputs	No. of Outputs	Slave Station	No. of Inputs	No. of Outputs
0	N/A	N/A	16		
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		

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 bases.

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 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	16ND3-2	X040	16		
1	16ND3-2	X060	16		
2	16TD1-2			Y040	16
3	16TD1-2			Y060	16
4	16TD1-2			Y100	16
5					
6					
7					

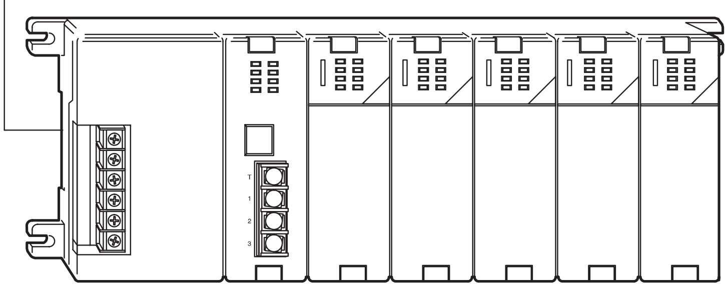
Input Bit Start Address: ___X040___ **V-Memory Address*:V** ___40402___

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 port setup program requires these addresses for each slave.



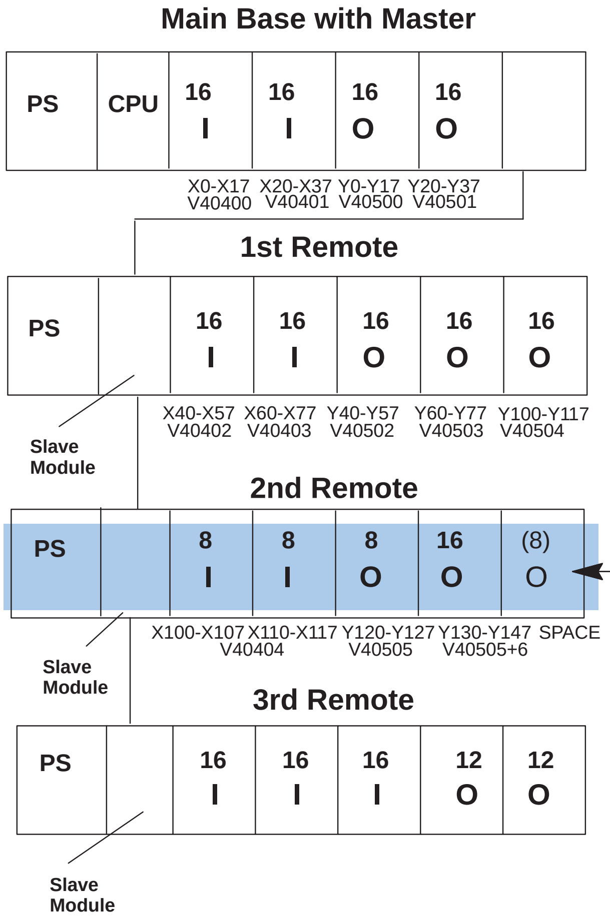
Starting Addresses From Appendix B = V40402 Input V40502 Output

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 X040 (or higher) and the starting address for outputs can be Y040 (or higher). Turning to Appendix B, you look up the V-memory addresses for these points in their respective input and output memory address charts. The far right-hand column of each of these charts shows the "bit start" address. For example, for the bit start address for input X040, you look for 040 on the chart. There you find the cross-referenced register address: 40402. On the output chart, you cross-reference Y040 with 40502. Enter 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 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	X100	8		
1	08ND3	X110	8		
2	08TD1			Y120	8
3	16TD1-2			Y130	16
4	SPACE			Y150	8
5					
6					
7					

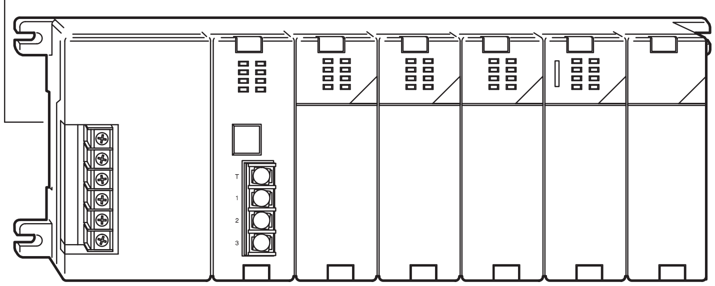
Input Bit Start Address: X100 **V-Memory Address*:V** 40404

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 CPU port setup program requires these addresses for each slave.

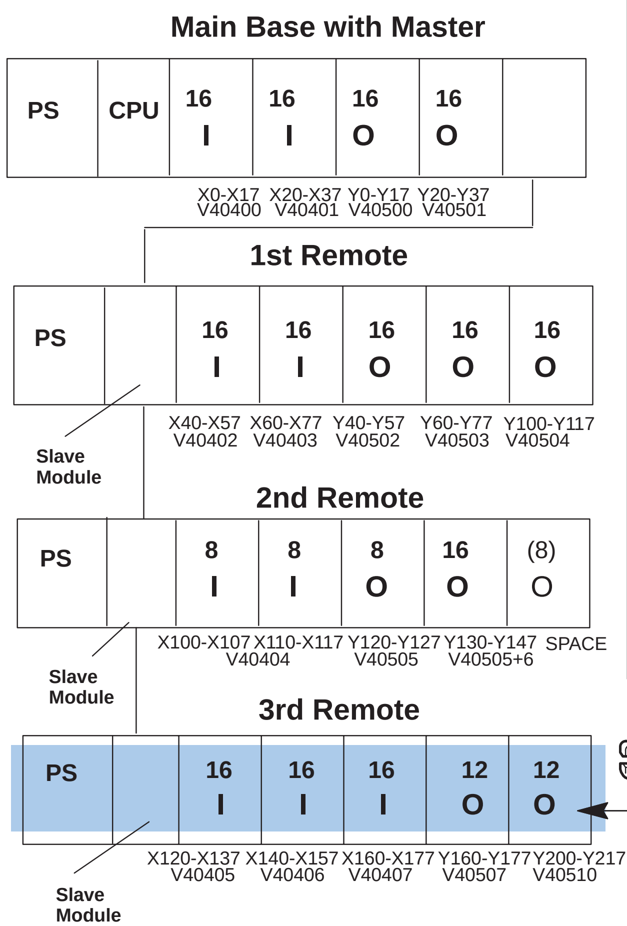


Based on the V-memory addresses we chose, the D2–RMSM allocated points X040 to X077 to Remote Slave #1's inputs, and Y040 to Y117 to its outputs. This means the starting address for the *second remote base inputs* is X100 (assigned automatically by the remote master) and the starting address for *outputs* is Y120 (assigned automatically). This remote slave has an empty slot to which we have allotted 8 future output points. The output points total on the worksheet includes the empty slot.

Completing the Remote Slave Worksheet for Slave #3

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

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 Base Address 3 **(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	16NA	X120	16		
1	16NA	X140	16		
2	16NA	X160	16		
3	12TA			Y160	16
4	12TA			Y200	16
5					
6					
7					

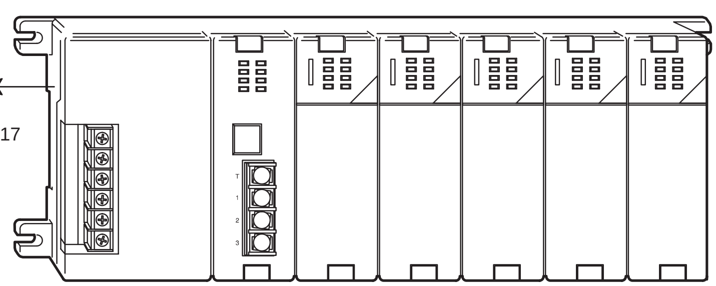
Input Bit Start Address: X120 **V-Memory Address*:V** 40405

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 CPU port setup program requires these addresses for each slave.

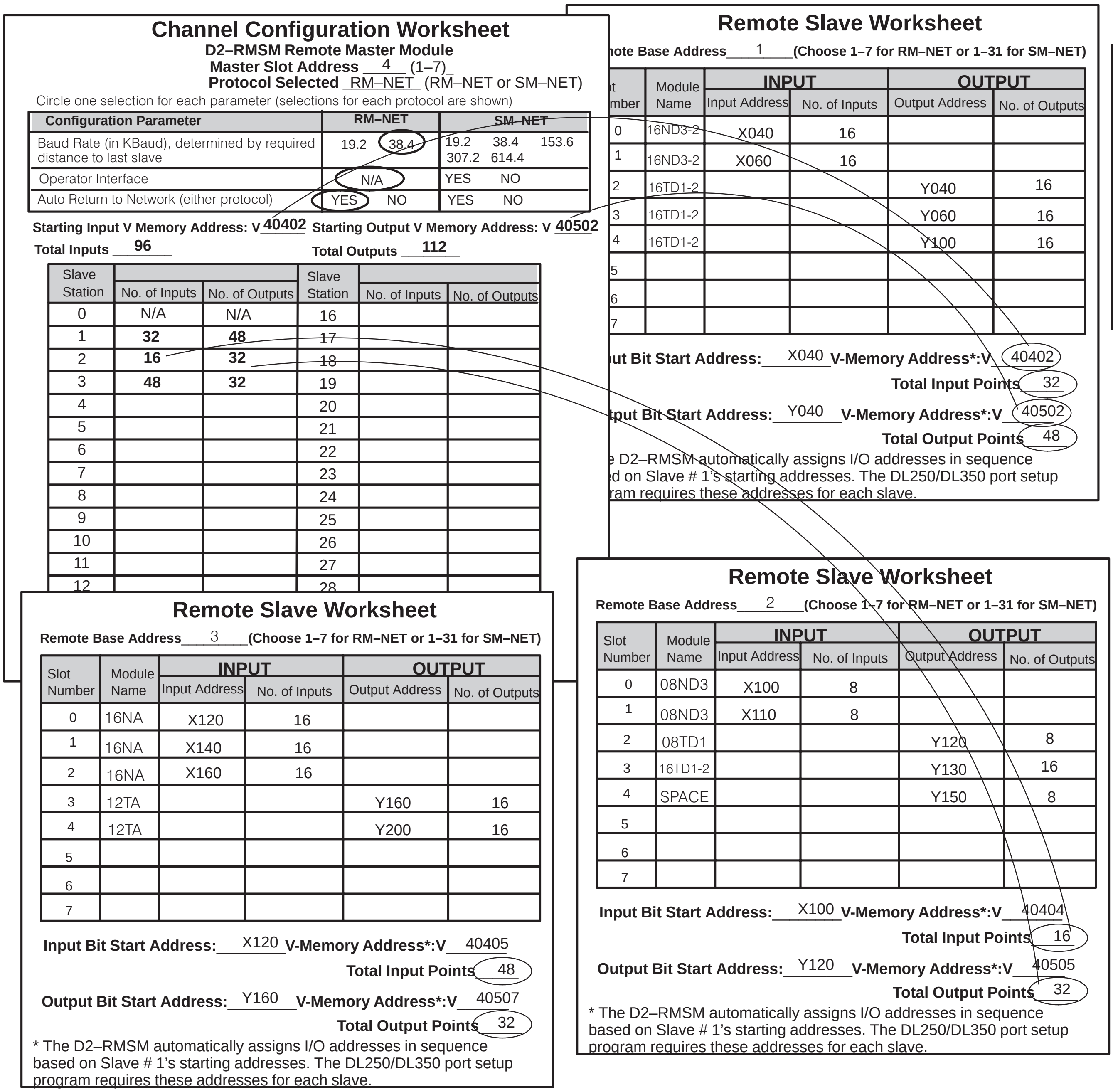


The D2–RMSM allocated X100 to X117 to Remote Slave #2's inputs, and Y120 to Y157 to its outputs. This means the starting address for the *third base inputs* is X120 (assigned automatically) and the starting address for *outputs* is Y160 (assigned automatically).

NOTE: The 12-point modules actually consume 16 points each since the memory allottment for a module must be on an 8-bit boundary.

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. If using the DL250/DL350 CPU version of the configuration worksheet, transfer both the starting addresses and quantities from each slave sheet onto the chart.



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.

Calculating the Power Budget

Managing your Power Resource

When determining the types and quantity of I/O modules you will be using in the DL205 system, it is important to remember there is a limited amount of power available from the power supply to the system. We have provided a chart to help you easily see the amount of power you will have with your base selection. At the end of this section you will also find an example of power budgeting and a worksheet showing sample calculations. Appendix A contains a blank worksheet.

If the I/O you chose exceeds the maximum power available from the power supply you can resolve the problem by adding another remote base.

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

Base Power Specifications

The following chart shows the amount of current **supplied** by the DL205 base units. Use this to calculate the power budget for your system. The Auxiliary 24V Power Source mentioned in the table can be used to power field devices or DL205 modules that require an external 24VDC. (Check the DL205 User Manual for the location of these terminals.)

Base Units	5V Current Supplied in mA (internal)	Auxiliary 24V Power Source Current Supplied in mA.	Base Units	5V Current Supplied in mA. (internal)	Auxiliary 24V Power Source Current Supplied in mA.
D2–03B	1550	200	D2–06B	1550	200
D2–03BDC–1	1550	None	D2–06BDC–1	1550	None
D2–03BDC–2	1550	200	D2–06BDC–2	1550	200
D2–04B	1550	200	D2–09B	2600	300
D2–04BDC–1	1550	None	D2–09BDC–1	2600	None
D2–04BDC–2	1550	200	D2–09BDC–2	2600	300

Module Power Requirements

This chart shows the amount of maximum current **required** for each of the DL205 modules. Use this information to calculate the power budget for your system. If an external 24VDC power source is required, you can use the built-in 24VDC auxiliary supply from the base (if available) as long as you do not exceed the power budget.

Device	5V Current Required in mA. (internal)	External 24V Current Required in mA.
CPUs		
D2–230	120	None
D2–240	120	None
D2–250	330	None
DC Input Modules		
D2–08ND3	50	None
D2–16ND3–2	100	None
AC Input Modules		
D2–08NA–1	50	None
D2–16NA	100	None
D2–02NA–2	100	None
DC Output Modules		
D2–04TD1	60	20
D2–08TD1	100	None
D2–16TD1–2	200	80
D2–16TD2–2	200	None
AC Output Modules		
D2–08TA	250	None
D2–12TA	350	None
Relay Output Modules		
D2–04TRS	250	None
D2–08TR	250	None
D2–08TRS	670	None
D2–12TR	450	None
Combination In/Out Modules		
D2–08CDR	200	None

Device	5V Current Required in mA. (internal)	External 24V Current Required in mA.
Analog Modules		
F2–04AD–1	50	80
F2–04AD–1L	60	90 (12VDC)
F2–04AD–2	60	80
F2–04AD–2L	60	90 (12 VDC)
F2–08AD–1	50	80
F2–02DA–1	40	100
F2–02DA–2	40	60
F2–04AD2DA	60	100
F2–04THM	110	None
F2–04RTD	90	None
Remote I/O		
D2–RMSM	200	None
D2–RSSS	150	None
Communications		
FA–UNICON	External 24V or 5V @ 100mA	
F2–UNICON	Internal 5V @ 100mA (bottom port of CPU)	
FA–ISONET	Internal 5V (bottom port of CPU) or external 24V @ 100mA	
Specialty Modules		
F2–08SIM	50	None
D2–CTRINT	50*	None
D2–DCM	300	None
Programming		
D2–HPP	200	None
Operator Interface		
DV–1000	150	None

* requires external 5VDC for outputs

NOTE: Not all of the modules shown in the above table can be used in a remote base. Check page 2–3 for module placement restrictions.

Power Budget Calculation Example

The following example shows how to calculate the power budget for the first slave unit of a remote I/O system.

Slave # 1	Part Number	5 VDC (mA) (supplied or used)	Auxiliary Power Source 24 VDC Output (mA) (supplied or used)
Base Used	D2–06B	**1550**	**200**
CPU Slot	D2–RSSS	150	0
Slot 0	D2–08ND3	50	0
Slot 1	D2–08ND3	50	0
Slot 2	D2–08TD1	100	0
Slot 3			
Slot 4			
Slot 5			
Slot 6			
Slot 7			
Other			
		0	0
Maximum power required		**350**	**0**
Remaining Power Available		1550–350 =**1200**	200 – 0 = **200**

1. Using the tables at the beginning of the Power Budgeting section of this chapter, fill in the information for the CPU/Remote Slave, I/O modules, and any other devices that will use system power, including devices that use the 24 VDC output. Devices which fall into the "**Other**" category are devices such as the handheld programmer which also have power requirements but do not directly plug into a slot in the base.
2. Add the current columns starting with the CPU SLot and put the total in the row labeled "**Maximum power required**"**.**
3. Subtract the row labeled "**Maximum power required**" from the row labeled "**Base Used**". Place the difference in the row labeled **"Remaining Power Available**".
4. If **"Maximum Power Required"** is greater than "**Base Used**" in either of the two columns, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your I/O configuration.