

Appendix C

Determining I/O Update Time

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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 be 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 *DirectSOFT* 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:

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

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

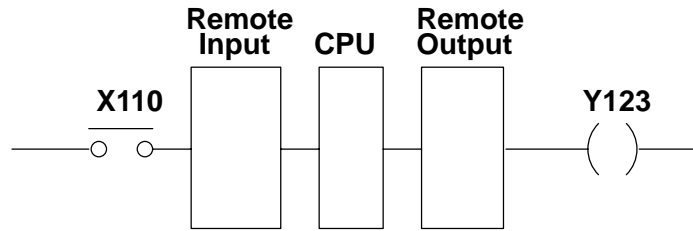
$$T_{RS} = 9.10 \text{ ms} + (2 \text{ ms} \times 3) = 15.10 \text{ ms}$$

D2-RMSM: Calculating Total Delay for the System

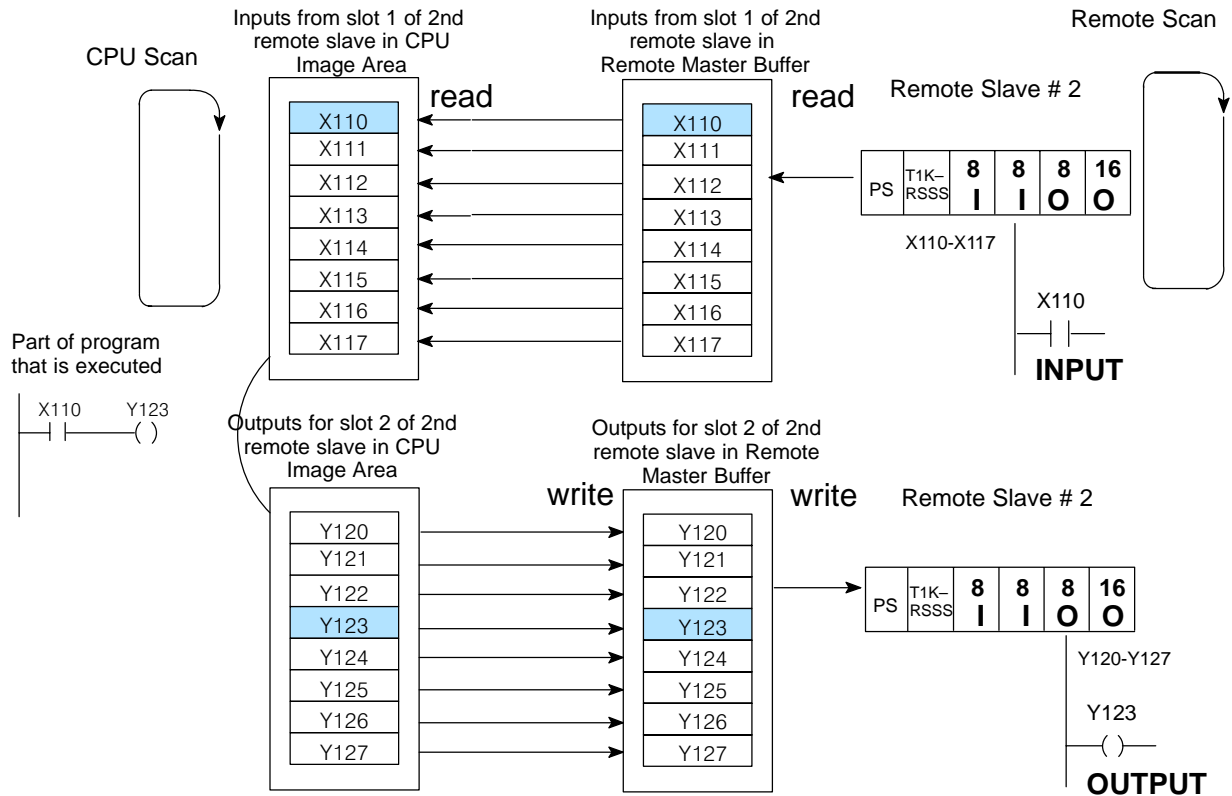
Now that you have calculated the time required for the Remote Master to go through its scan cycle and update its internal buffer area, we need to add this time to other delay times inherent in the overall system. Below is an example of a remote input changing a remote output.

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 .

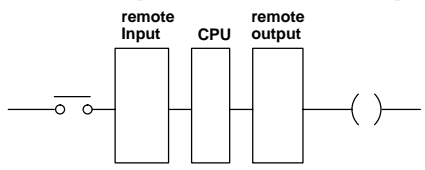
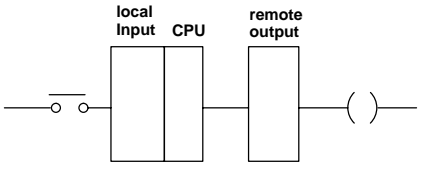
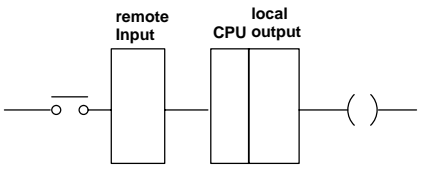


The table on the adjacent page shows the formula for calculating the overall system delay for this scenario. It also shows you formulas for two other possible scenarios.

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 *DirectSOFT* 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.

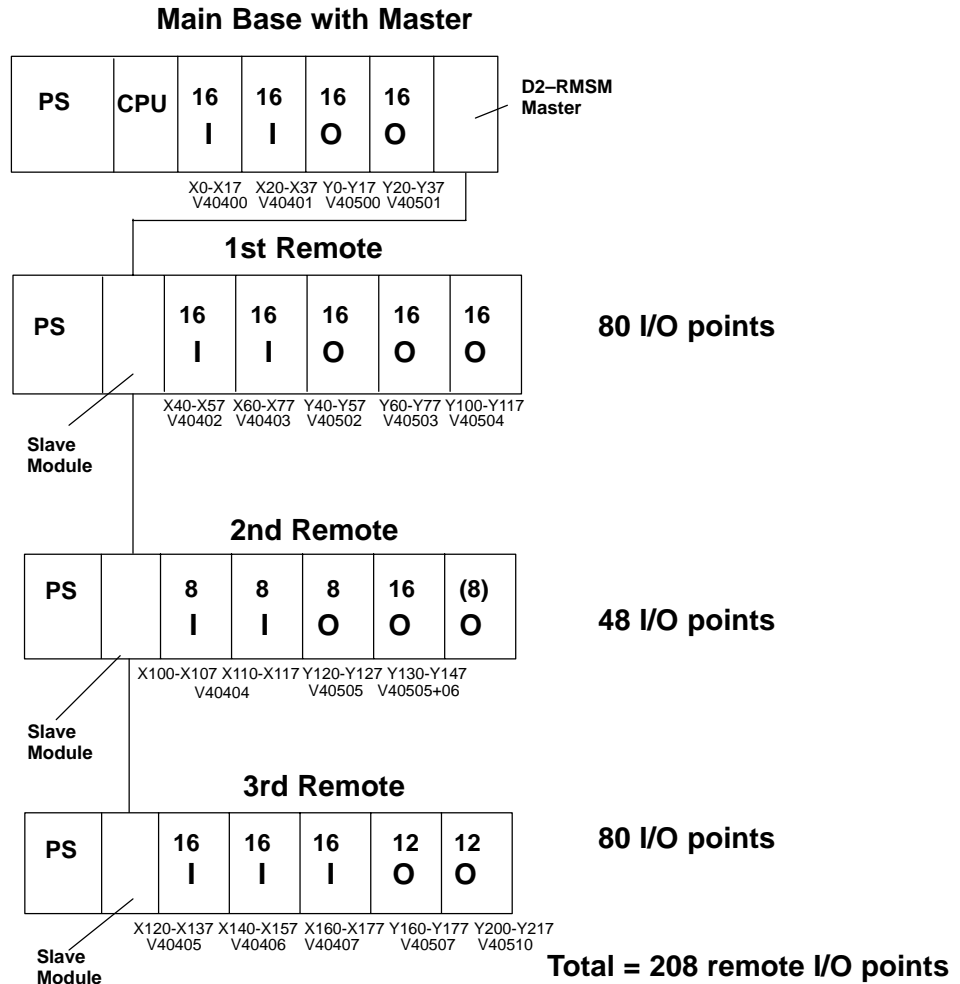
	$T_{RS} \leq T_{CS}$	$T_{RS} > T_{CS}$
<p>Remote Input to Remote Output</p> 	$T_{IN} + 6(T_{CS}) + T_{OUT}$	$T_{IN} + 4(T_{RS}) + 6(T_{CS}) + T_{OUT}$
<p>Local Input to Remote Output</p> 	$T_{IN} + 4(T_{CS}) + T_{OUT}$	$T_{IN} + 2(T_{RS}) + 4(T_{CS}) + T_{OUT}$
<p>Remote Input to Local Output</p> 		

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:

$$T_{IN} = \text{Maximum response input module time (16ND3)} = 8 \text{ ms}$$

$$T_{OUT} = \text{Maximum response output module time (16TD1)} = 10 \mu\text{s}$$

$$T_{RS} = 15.34 \text{ ms} + (2 \text{ ms} \times 3) = 21.34 \text{ ms} < T_{CS}$$

$$\begin{aligned} \text{Total Delay for Configuration} &= T_{IN} + 6(T_{CS}) + T_{OUT} \\ &= 8 \text{ ms} + 6(25 \text{ ms}) + .01 \text{ ms} \\ &= 158.01 \text{ ms} \end{aligned}$$