

# **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.

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**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.

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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 dipswitch 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 DL405 Handheld Programmer, or use the Diagnostics option under the PLC menu in our *DirectSOFT* Programming Software. This Use the respective specifications in the User's Manual. You can also use the DL405 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 number of I/O points in the local and expansion bases 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 can be used 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 chapter 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 write new data there. This chart shows the maximum amount of delay based on the number of I/O points being used.

No. of Remote I/O Points	Update Time Required	
	19.2 kBaud	38.4 kBaud
16	3.64ms	1.82ms
32	5.72 ms	2.86 ms
64	9.88 ms	4.94 ms
128	18.20 ms	9.10 ms
160	22.36 ms	11.18 ms
192	26.52 ms	13.26 ms
224	30.68 ms	15.34 ms
256	34.84 ms	17.42 ms
288	39.00 ms	19.50 ms
320	43.16 ms	21.58 ms
352	47.32 ms	23.66 ms
384	51.48 ms	25.74 ms
416	55.64 ms	27.82 ms
448	59.80 ms	29.90 ms
480	63.96 ms	31.98 ms
512	68.12 ms	34.06 ms

### Remote Scan Time Formula

You can figure out the amount of time required for the remote I/O scan update with the following formula:

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

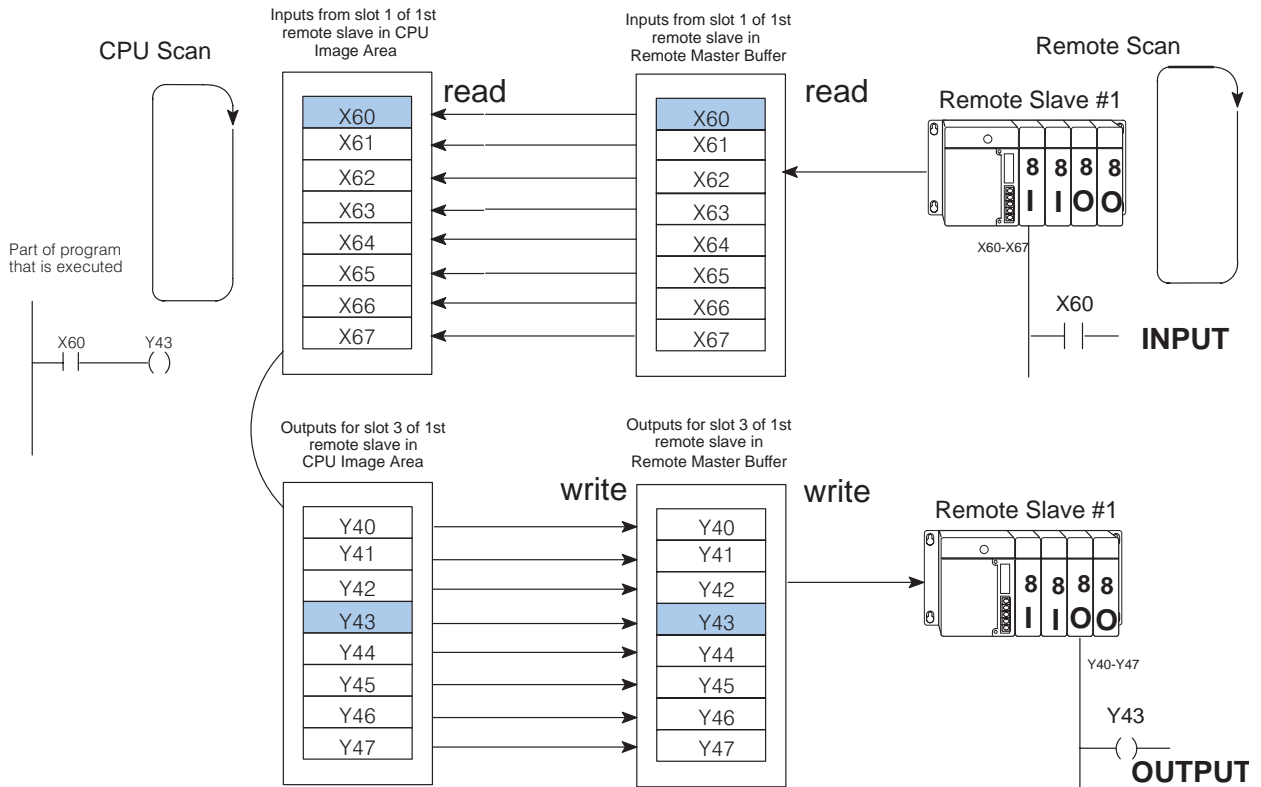
**Example:** Given a 38.4 kB system with a total of 128 remote points and 3 slaves.

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

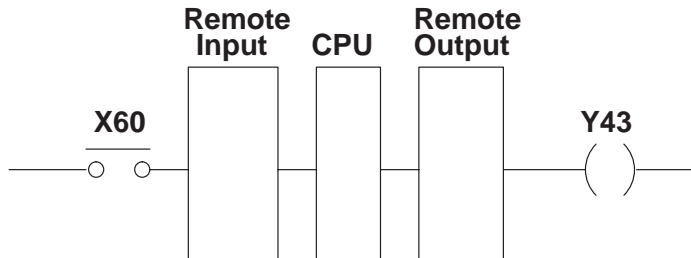
# Calculating Total Delay for the System

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 where a remote input changes a remote output.

## Example Where A Remote Input Changes a Remote Output



The above drawing could be simplified schematically to look like this:

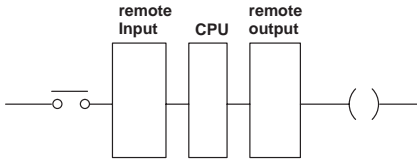
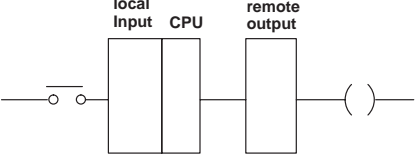
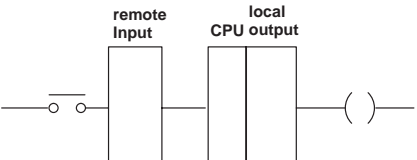


The table on the adjacent page gives you a table that shows the formula for calculating the overall system delay for this scenario. It also shows you formulae for two other possible scenarios.

**Total Delay Time Formulas**

The following table provides delay formulas for three different configuration scenarios. Notice that there are 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<sub>CS</sub>** — 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 DL405 User Manual.
- **T<sub>RS</sub>** — Remote Master scan time. Use the table and formula shown previously to determine this time.
- **T<sub>IN</sub>** and **T<sub>OUT</sub>** — Module response delay time. You can find this information from the module specifications tables which are usually found in the DL405 User Manual.

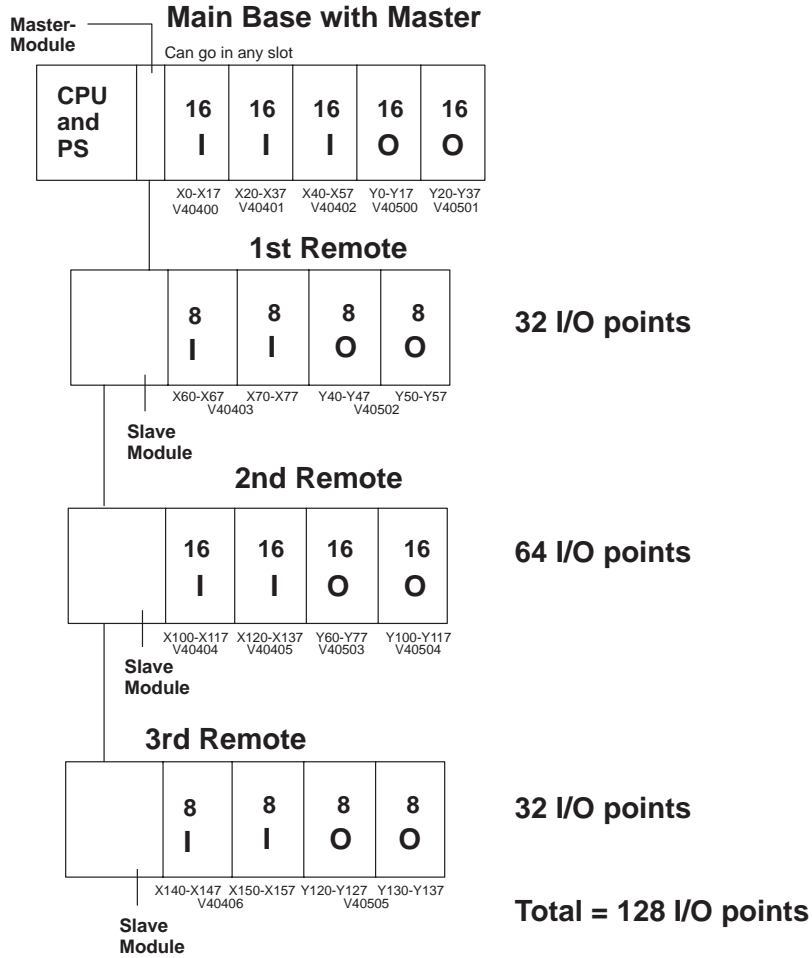
	$T_{RS} \leq T_{CS}$	$T_{RS} > T_{CS}$
<p><b>Remote Input to Remote Output</b></p> 	$T_{IN} + 6(T_{CS}) + T_{OUT}$	$T_{IN} + 4(T_{RS}) + 6(T_{CS}) + T_{OUT}$
<p><b>Local Input to Remote Output</b></p> 	$T_{IN} + 4(T_{CS}) + T_{OUT}$	$T_{IN} + 2(T_{RS}) + 4(T_{CS}) + T_{OUT}$
<p><b>Remote Input to Local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

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

### Delay Time Example

The following example shows you how to calculate the total time it takes for a remote input to be read and later updated by the CPU scan; and then, a remote output taking place at the remote base. We have used the same configuration as shown throughout this text which features 3 remote slaves, 1 master and 128 remote I/O points, communicating at 38.4 kBaud.

**EXAMPLE:**  
38.4 kBaud, D4-440, X60 causing a response by Y43.



Given that CPU scan ( $T_{CS}$ ) is estimated to be 50 ms.

$T_{IN}$  = Maximum response input module time (08ND3S) = 12 ms

$T_{OUT}$  = Maximum response output module time (08TD1) = 1 ms

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

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

= 12 ms + 6(50 ms) + 1 ms

= 313 ms