Application Note

DH-485
Network Throughput Timing

Introduction

Using an example DH-485 network, this application note demonstrates how to determine network throughput timing. Four application examples show how to adjust the timing calculations when the network is changed.

Other timing considerations are also discussed to help you optimize your DH-485 network applications.

General Information

To determine DH-485 network throughput time, you must consider:

- the number of nodes and gaps on the network
- program scan time at each node
- DH-485 timing specifications

The calculations will let you know the worst-case value for network throughput.

The DH-485 network passes a token to control communications between nodes. When an SLC™ processor receives a message from another node, it will immediately acknowledge (ACK) the sender, but wait 1 program scan to process the command and place the response into its output buffer awaiting the token.

For example, when node 1 sends a command to node 2, node 1 will, upon receiving the ACK, pass the token to node 2. This token pass takes 7 ms. So, the scan time of node 2 must be less than 7 ms or it will not be ready to respond when it receives the token and will merely pass the token to the next node. The command response will then be sent by node 2 the next time it receives the token. This amounts to one additional full network token pass time.

Continuing this example, when node 1 sends a message to node 3, node 3's scan time must be less than 14 ms to respond when receiving the token the very next time.

Finally, it matters how many nodes and/or gaps are between a sending and receiving DH-485 device for the receiver to have enough time to respond during the next token pass, or it will need to wait for a subsequent pass of the token.

The timing specifications shown below will be used throughout the application examples which begin on page 3. A network baud rate of 19.2k baud is assumed.

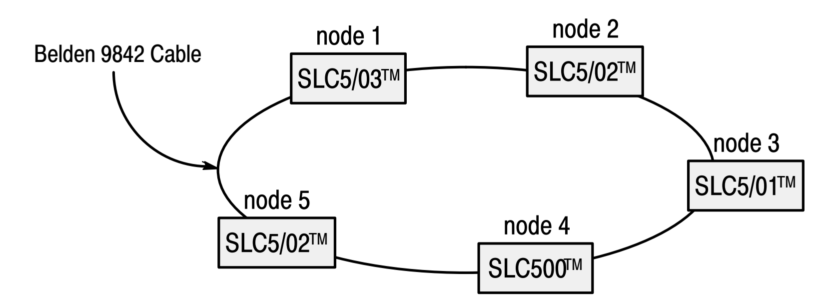
Timing Specifications	
Token pass time per existing device (node)	7 ms
Token pass time per gap in the network ①	30 ms
write command – 1 data word ②	12 ms (max.) + 15 ms for ACK
write command reply	8 ms (max.) + 15 ms for ACK
read command	11 ms (max.) + 15 ms for ACK
read command reply – 1 data word ②	9 ms (max.) + 15 ms for ACK

① A gap in a DH-485 network is where 1 or more successive node numbers do not have active devices connected. Each node number within a gap will be solicited, but not necessarily on every token pass cycle. This allows new devices to be added to the network at any time at any open node address, while the network throughput is maintained at an optimum level.

② Each additional word of data takes about 1 ms at 19.2k baud.

Example Network Description

DH-485 Network Diagram



Network Description

The example DH-485 network has 5 SLC processors on nodes 1 thru 5. Node 0 is left open for a personal computer using programming software.

Network characteristics:

- 19.2k baud network data rate
- maximum node address of 31
- token hold factor of 1 for all devices
- no noise related retries

Network Timing

1. Token pass time for devices on network

= token pass time per device x number of devices

= 7 ms x 5 = 35 ms

2. Token pass time for gaps on network

= token pass time per gap x number of gaps

= 30 ms x 1 gap = 30 ms

3. Total network token pass time

= token pass time for devices + token pass time for gaps

= 35 ms + 30 ms = 65 ms

4. 5 data word write command = 16 ms (max.) + 15 ms for ACK

5. Write command reply = 8 ms (max.) + 15 ms for ACK

6. Read command = 11 ms

7. 5 data word read command reply = 13 ms (max) + 15 ms for ACK

Application Example #1

Problem

Send a 5 word write command from node 1 to node 2. Given the network description on page 3 and assuming that node 2 has a scan time greater than 7 ms, what is the worst-case throughput of this command/reply?

Solution

Add time for all events on network.

1 network token pass	=	65 ms	(token at node 1)①
5 word write command	=	16 ms	(from node 1 to node 2)
ACK	=	15 ms	(from node 2 to node 1)
1 token pass + 7 ms	=	72 ms	(network token pass + node token pass)②
write command reply	=	8 ms	(from node 2 to node 1)
ACK	=	15 ms	(from node 1 to node 2)
TOTAL THROUGHPUT	**=**	**191 ms (max.)**	

Application Example #2

Problem

Send a 5 word read command from node 1 to node 2. Given the network description on page 4 and assuming that node 2 has a scan time greater than 7 ms, what is the worst-case throughput of this command/reply?

Solution

Add time for all events on network.

1 network token pass	=	65 ms	(token at node 1)①
read command	=	11 ms	(from node 1 to node 2)
ACK	=	15 ms	(from node 2 to node 1)
1 token pass + 7 ms	=	72 ms	(network token pass + node token pass)②
5 word read command reply	=	13 ms	(from node 2 to node 1)
ACK	=	15 ms	(from node 1 to node 2)
TOTAL THROUGHPUT	**=**	**191 ms (max.)**	

① One token pass is added because this is a worst-case calculation. When the sending processor's program enables the MSG instruction and is ready to send the command, the token could have, in a worst-case scenario, just been passed and therefore, the processor would need to wait for a full network token pass time before sending the command.

② If the scan time of node 2 was less than 7 ms, then 1 token pass time could be subtracted from the total throughput. This is because the processor at node 2 would perform one complete scan from the time it receives the command to the time it receives the token. Therefore, it would generate the response and send it upon receiving the token. The revised throughput time would be: 191 ms – 65 ms = 126 ms.

Application Example #3

Problem

This example is the same as Application Example #1 except node 3 is no longer an active node on the network. Now 2 gaps are found on the DH-485 network, which adds more time to the total token pass time.

Solution

Determine new total network token pass time.

1. Token pass time for gaps on network

= token pass time per gap x number of open nodes

= 30 ms x 2 gaps = 60 ms

2. Total network token pass time

= token pass time for devices + token pass time for gaps

= 35 ms + 60 ms = 95 ms

3. Add time for all events on network.

1 network token pass	=	95 ms	(token at node 1)①
5 word write command	=	16 ms	(from node 1 to node 2)
ACK	=	15 ms	(from node 2 to node 1)
1 token pass + 7 ms	=	102 ms	(network token pass + node token pass)②
write command reply	=	8 ms	(from node 2 to node 1)
ACK	=	15 ms	(from node 1 to node 2)
TOTAL THROUGHPUT	**=**	**251 ms (max.)**	

① One token pass is added because this is a worst-case calculation. When the sending processor's program enables the MSG instruction and is ready to send the command, the token could have, in a worst-case scenario, just been passed and therefore, the processor would need to wait for a full network token pass time before sending the command.

② If the scan time of node 2 was less than 7 ms, then 1 token pass time could be subtracted from the total throughput. This is because the processor at node 2 would perform one complete scan from the time it received the command to the time it passed the token. Therefore, it would generate the response and send it upon receiving the token. The revised throughput time would be: 251 ms – 95 ms = 156 ms.

As you can see, DH-485 network nodes should be assigned node numbers in successive order, resulting in only one gap for optimum network throughput. In examples 1 and 2, the single gap is from node 6 to node 31 and node 0. Therefore, changing the network maximum node address from 31 to 5 for the above examples does not increase the network throughput because one gap would still exist at node 0. Node 0 must be left open for a programming device.

Application Example #4

Problem

This example is the same as Application Example #1 except node 2 will send a 5 word write command to node 1. Now, what is the worst-case throughput of the command/reply if node 1 has a scan time of 20 ms?

Solution

Add time for all events on network.

1 network token pass	=	65 ms	(token at node 1)①
5 word write command	=	16 ms	(from node 2 to node 1)
ACK	=	15 ms	(from node 1 to node 2)
4 token passes + 1 gap	=	58 ms	(4 node token passes + 1 gap)
write command reply	=	8 ms	(from node 1 to node 2)
ACK	=	15 ms	(from node 2 to node 1)
TOTAL THROUGHPUT	**=**	**177 ms (max.)**	

① One token pass is added because this is a worst-case calculation. When the sending processor's program enables the MSG instruction and is ready to send the command, the token could have, in a worst-case scenario, just been passed and therefore, the processor would need to wait for a full network token pass time before sending the command.

Note that the command/reply throughput is slightly faster in this example because node 1 had 58 ms to process the command and build a reply before the token was passed to it. Therefore, as long as node 1 has a scan time less that 58 ms, it will be prepared with a reply the very next time it receives the token. This scenario saves two node token passes, or 14 ms, over the scenario in Application Example #1.

Optimizing Throughput - Other Considerations

Programming Devices

In the application examples, node 0 was left open for a programming device. However, if APS programming software is connected and the WHO ACTIVE screen is invoked, the network throughput will be significantly reduced due to increased network activity from the programming device.

SLC5/02 and SLC5/03 Data Bits

The following bits can be used to optimize DH-485 throughput for SLC5/02 and SLC5/03 processors. In addition, the SVC and REF instructions can also be used to increase communication throughput. However, the use of these bits and instructions to increase communication throughput can also increase your program scan time. Therefore, they should be used with care to optimize both communication throughput and program scan time for each specific application.

Status Bits	
S:2/15	S:33/0
	S:33/1
	S:33/2
	S:33/3
	S:33/4
	S:33/5
	S:33/6
	S:33/7

Refer to the SLC 500™ and MicroLogix 1000™ Instruction Set Reference Manual (catalog number 1747-6.15) for information on how these bits function.

Rockwell Automation

Allen-Bradley

Allen-Bradley, a Rockwell Automation Business, has been helping its customers improve productivity and quality for more than 90 years. We design, manufacture and support a broad range of automation products worldwide. They include logic processors, power and motion control devices, operator interfaces, sensors and a variety of software. Rockwell is one of the world’s leading technology companies.

Worldwide representation.

Argentina • Australia • Austria • Bahrain • Belgium • Brazil • Bulgaria • Canada • Chile • China, PRC • Colombia • Costa Rica • Croatia • Cyprus • Czech Republic • Denmark • Ecuador • Egypt • El Salvador • Finland • France • Germany • Greece • Guatemala • Honduras • Hong Kong • Hungary • Iceland • India • Indonesia • Ireland • Israel • Italy • Jamaica • Japan • Jordan • Korea • Kuwait • Lebanon • Malaysia • Mexico • Netherlands • New Zealand • Norway • Pakistan • Peru • Philippines • Poland • Portugal • Puerto Rico • Qatar • Romania • Russia–CIS • Saudi Arabia • Singapore • Slovakia • Slovenia • South Africa, Republic • Spain • Sweden • Switzerland • Taiwan • Thailand • Turkey • United Arab Emirates • United Kingdom • United States • Uruguay • Venezuela • Yugoslavia

Allen-Bradley Headquarters, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414 382-2000 Fax: (1) 414 382-4444

Publication 1747-2.20 – January 1996