

## Optimizing Serial Bus Operations with Proper Write Cycle Times

### SERIAL EEPROM WRITE TIME REQUIREMENTS

#### Elements of the Write Cycle Time

The total write operation time for a Serial EEPROM is determined by three main elements:

- Number of bytes to load for each write operation
- Bus clock speed at which the write operation is loaded
- Fixed internal write cycle timer required for the programming operation

The load component of the write command consists of the control byte, address, and the data of up to 16 bytes. The time required to load the operation depends on the number of bytes to load at one time and the bus clock speed. After this load is complete, the part commences the internally controlled write cycle and the bus and system are free to perform other tasks. The internal write cycle timer is a fixed time delay which is required to program the EEPROM memory cells. Table 1 gives examples of total write time for 1 and 16 bytes for various parts at fast and normal clock speeds.

- **Load time (time at bus free)** is the time the part is being loaded with the instruction, address, and data. The bus is free after this time interval, and the part commences the internally controlled write cycle sequence.

- **Write timer (worse case)** indicates the time the part is in the internally controlled write cycle allowing for the maximum specified datasheet requirements.
- **Write timer (typical)** indicates the time the part is in the internally controlled write cycle assuming nominal conditions and utilizing write cycle polling.
- **Total write time** is the combined load time and typical internal write cycle time.

### MINIMIZING SERIAL BUS COMMUNICATION TIME IN A SYSTEM

#### Utilizing the Page Write Option

The original Microchip Serial EEPROM products, though utilizing a page buffer, only write bytes sequentially. This means the time required to write 8 bytes is 8 ms, worse case. The new 24LCXX products incorporate a page mode that allows simultaneous writes of up to 16 bytes. This allows the programming of up to 16 bytes in one write cycle (10 ms) compared to 16 write cycles (16 ms) for the original 24CXX products. Microchip uses an 8 byte page in the 24LC01 and 24LC02, and a 16 byte page in the 24LC04 and higher densities. What this means to a system designer is a write of 8 bytes in a 24LC01 or 24LC02 would take 10 ms, worse case,

**TABLE 1 - WRITE OPERATION TIME COMPARISON**

Product	Page Width	# Bytes to load	Speed (KHz)	Load time (ms) time at bus free	Write timer (ms) Worse case	Write timer (ms) Typical (25C)	Typical total write time (ms)
24C01A	2	1	100	0.28	1	0.4	0.68
		8 (4 x 2)	100	1.12	1	0.4	4.32
24LC01	8	1	100	0.28	10	3	3.28
		8	100	0.91	10	3	3.91
		1	400	0.07	10	3	3.07
		8	400	0.23	10	3	3.23
24C04A	8	1	100	0.28	1	0.4	0.68
		16 (2 x 8)	100	1.82	1	0.4	8.22
24LC04	16	1	100	0.28	10	3	3.28
		16	100	1.63	10	3	4.63
		1	400	0.07	10	3	3.07
		16	400	0.41	10	3	3.41

# Minimizing Serial Bus Communication Time

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versus 8 ms, worse case, in either a 24C01A or 24C02A. Loading the entire memory of an original 24C04A takes 512 ms, but the same operation on a new 24LC04 is reduced to only 320 ms, assuming worse case. As Table 1 shows, the difference is even greater using typical numbers.

The 93LCXX products do not utilize a page mode. However, in 16 bit mode, all 16 bits are written simultaneously. The original 93CXX products write the 16 bits in 2 write cycles, so the write cycle time increase of the new products is only 5 X (3.5 X typical).

## Utilizing Write Cycle Polling

One powerful method of increasing programming efficiency is by periodically polling the part to determine if the write cycle has completed. To poll the 24LCXX series products, a control byte is sent and the acknowledge bit from the part is read. If the part acknowledges (pulls SDA low), it is ready to accept a new command. The part will not acknowledge while in the internally timed write cycle.

To poll the 93LCXX series products, the chip select is pulled high after the write cycle commences, and the data out line is read for the ready/busy status. If the part is still busy, it will pull the data line low. When the internally timed write cycle is complete, the part will pull the data line high, indicating it is ready for a new command.

## Serial EEPROM System Optimization

Serial EEPROMs are used in systems for two purposes: storing data and reading back data. Read operations are at full clock speed, so the only methods for optimization are to run the clock at maximum frequency and to utilize sequential read whenever possible. Sequential read allows a continuous output data stream on one command.

The write operation, with its internal write timer component, needs special consideration when designing the control software. Efficient operation can be accomplished using both the page mode and write cycle polling. The following example shows a typical fetch-store operation in a system and how optimization can be incorporated. In the example system, the microcontroller must fetch bytes of data from a sensor and send the bytes to a EEPROM for storage. Two cases are shown in Figure 2: case 1 uses a 24C01A with no optimization; case 2 uses a 24LC01B with the available page mode and write cycle polling.

By utilizing the available page write mode and by polling for the write cycle completion, nearly four times as many bytes can be initially loaded to the serial EEPROM in the same time interval. Continuous operation for the optimized case 2 takes only 0.49 ms per byte compared to 1.28 ms per byte for the non-optimized case 1.

# Minimizing Serial Bus Communication Time

**FIGURE 2 - CASE COMPARISON**

<b>CASE 1 (NO OPTIMIZATION):</b>		<b>CASE 2 (USING PAGE MODE AND POLLING):</b>	
Operation	Serial Bus Time	Operation	Serial Bus Time
fetch byte		fetch byte	
load to serial	0.28 ms	fetch byte	
fetch byte		fetch byte	
wait for write timer	1 ms	fetch byte	
load to serial	0.28 ms	fetch byte	
fetch byte		fetch byte	
wait for write timer	1 ms	fetch byte	
load to serial	0.28 ms	fetch byte	
fetch byte		load 8 bytes to serial	0.91 ms
wait for write timer	1 ms	fetch byte	
load to serial	0.28 ms	fetch byte	
fetch byte		fetch byte	
wait for write timer	1 ms	fetch byte	
load to serial	0.28 ms	fetch byte	
fetch byte		fetch byte	
wait for write timer	1 ms	fetch byte	
load to serial	0.28 ms	poll for write timer	<3 ms typical
fetch byte		load 8 bytes to serial	0.91 ms
wait for write timer	1 ms		
load to serial	0.28 ms		
fetch byte			
wait for write timer	1 ms		
load to serial	0.28 ms		
First <b>8 bytes</b> loaded in 9.24 ms		First <b>16 bytes</b> loaded in 4.82 ms	

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*Author: Lenny French  
Memory Products Division*

# Minimizing Serial Bus Communication Time

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NOTES:

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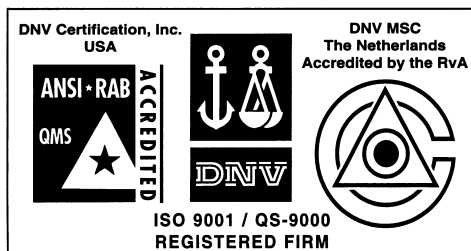
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2355 West Chandler Blvd.  
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#### New York

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Hauppauge, NY 11788  
Tel: 631-273-5305 Fax: 631-273-5335

#### San Jose

Microchip Technology Inc.  
2107 North First Street, Suite 590  
San Jose, CA 95131  
Tel: 408-436-7950 Fax: 408-436-7955

#### Toronto

6285 Northam Drive, Suite 108  
Mississauga, Ontario L4V 1X5, Canada  
Tel: 905-673-0699 Fax: 905-673-6509

### ASIA/PACIFIC

#### Australia

Microchip Technology Australia Pty Ltd  
Suite 22, 41 Rawson Street  
Epping 2121, NSW  
Australia  
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

#### China - Beijing

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Beijing Liaison Office  
Unit 915  
Bei Hai Wan Tai Bldg.  
No. 6 Chaoyangmen Beidajie  
Beijing, 100027, No. China  
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Microchip Technology Consulting (Shanghai)  
Co., Ltd., Chengdu Liaison Office  
Rm. 2401, 24th Floor,  
Ming Xing Financial Tower  
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Co., Ltd., Fuzhou Liaison Office  
Unit 28F, World Trade Plaza  
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#### China - Shanghai

Microchip Technology Consulting (Shanghai)  
Co., Ltd.  
Room 701, Bldg. B  
Far East International Plaza  
No. 317 Xian Xia Road  
Shanghai, 200051  
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

#### China - Shenzhen

Microchip Technology Consulting (Shanghai)  
Co., Ltd., Shenzhen Liaison Office  
Rm. 1315, 13/F, Shenzhen Kerry Centre,  
Renminnan Lu  
Shenzhen 518001, China  
Tel: 86-755-2350361 Fax: 86-755-2366086

#### Hong Kong

Microchip Technology Hongkong Ltd.  
Unit 901-6, Tower 2, Metroplaza  
223 Hing Fong Road  
Kwai Fong, N.T., Hong Kong  
Tel: 852-2401-1200 Fax: 852-2401-3431

#### India

Microchip Technology Inc.  
India Liaison Office  
Divyasree Chambers  
1 Floor, Wing A (A3/A4)  
No. 11, O'Shaugnessey Road  
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Microchip Technology Japan K.K.  
Benex S-1 6F  
3-18-20, Shinyokohama  
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Tel: 81-45-471- 6166 Fax: 81-45-471-6122

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Microchip Technology Korea  
168-1, Youngbo Bldg. 3 Floor  
Samsung-Dong, Kangnam-Ku  
Seoul, Korea 135-882  
Tel: 82-2-554-7200 Fax: 82-2-558-5934

### Singapore

Microchip Technology Singapore Pte Ltd.  
200 Middle Road  
#07-02 Prime Centre  
Singapore, 188980  
Tel: 65-334-8870 Fax: 65-334-8850

### Taiwan

Microchip Technology Taiwan  
11F-3, No. 207  
Tung Hua North Road  
Taipei, 105, Taiwan  
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

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Regus Business Centre  
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Microchip Technology SARL  
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Batiment A - 1er Etage  
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Microchip Technology GmbH  
Gustav-Heinemann Ring 125  
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Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

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Microchip Technology SRL  
Centro Direzionale Colleoni  
Palazzo Taurus 1 V. Le Colleoni 1  
20041 Agrate Brianza  
Milan, Italy  
Tel: 39-039-65791-1 Fax: 39-039-6899883

#### United Kingdom

Arizona Microchip Technology Ltd.  
505 Eskdale Road  
Winnersh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44 118 921 5869 Fax: 44-118 921-5820

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