

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

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

CASE 1 (NO OPTIMIZATION):		CASE 2 (USING PAGE MODE AND POLLING):	
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 8 bytes loaded in 9.24 ms		First 16 bytes loaded in 4.82 ms	

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*Author: Lenny French
Memory Products Division*

Minimizing Serial Bus Communication Time

NOTES:

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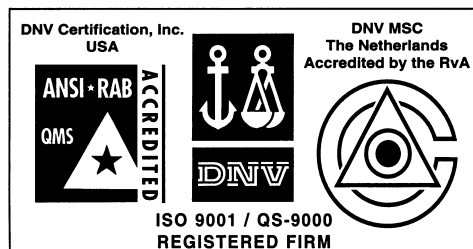
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MICROCHIP

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office

2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: <http://www.microchip.com>

Rocky Mountain

2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta

500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston

2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago

333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas

4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Detroit

Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo

2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles

18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

New York

150 Motor Parkway, Suite 202
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
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu

Microchip Technology Consulting (Shanghai)
Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou

Microchip Technology Consulting (Shanghai)
Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

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
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan

Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea

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

EUROPE

Denmark

Microchip Technology Nordic ApS
Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France

Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - 1er Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany

Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy

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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