MICROCHIP

AN559

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

8

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.

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	fetch byte	
fetch byte		poll for write timer	<3 ms typical
wait for write timer	1 ms	load 8 bytes to serial	0.91 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	

8

Author: *Lenny French*
                 Memory Products Division

DS00559A-page 3

Minimizing Serial Bus Communication Time

NOTES:

WORLDWIDE SALES & SERVICE

AMERICAS

Corporate Office
Microchip Technology Inc.
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 602 786-7200 Fax: 602 786-7277
Technical Support: 602 786-7627
Web: http://www.mchip.com/microhip

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

Boston
Microchip Technology Inc.
5 Mount Royal Avenue
Marlborough, MA 01752
Tel: 508 480-9990   Fax: 508 480-8575

Chicago
Microchip Technology Inc.
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 708 285-0071 Fax: 708 285-0075

Dallas
Microchip Technology Inc.
14651 Dallas Parkway, Suite 816
Dallas, TX 75240-8809
Tel: 214 991-7177 Fax: 214 991-8588

Dayton
Microchip Technology Inc.
35 Rockridge Road
Englewood, OH 45322
Tel: 513 832-2543 Fax: 513 832-2841

Los Angeles
Microchip Technology Inc.
18201 Von Karman, Suite 455
Irvine, CA 92715
Tel: 714 263-1888 Fax: 714 263-1338

New York
Microchip Technology Inc.
150 Motor Parkway, Suite 416
Hauppauge, NY 11788
Tel: 516 273-5305 Fax: 516 273-5335

AMERICAS (continued)

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

ASIA/PACIFIC

Hong Kong
Microchip Technology
Unit No. 3002-3004, Tower 1
Metroplaza
223 Hing Fong Road
Kwai Fong, N.T. Hong Kong
Tel: 852 2 401 1200 Fax: 852 2 401 3431

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

Singapore
Microchip Technology
200 Middle Road
#10-03 Prime Centre
Singapore 188980
Tel: 65 334 8870 Fax: 65 334 8850

Taiwan
Microchip Technology
10F-1C 207
Tung Hua North Road
Taipei, Taiwan, ROC
Tel: 886 2 717 7175 Fax: 886 2 545 0139

EUROPE

United Kingdom
Arizona Microchip Technology Ltd.
Unit 6, The Courtyard
Meadow Bank, Furlong Road
Bourne End, Buckinghamshire SL8 5AJ
Tel: 44 0 1628 851077 Fax: 44 0 1628 850259

France
Arizona Microchip Technology SARL
2 Rue du Buisson aux Fraises
91300 Massy - France
Tel: 33 1 69 53 63 20 Fax: 33 1 69 30 90 79

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

Italy
Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Pegaso Ingresso No. 2
Via Paracelso 23, 20041
Agrate Brianza (MI) Italy
Tel: 39 039 689 9939 Fax: 39 039 689 9883

JAPAN

Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shin Yokohama
Kohoku-Ku, Yokohama
Kanagawa 222 Japan
Tel: 81 45 471 6166 Fax: 81 45 471 6122

9/22/95