



# **Application Note**

## **1Mb ~ 64Mb SPI MRAM**

- S3R1016/08V1M
- S3R2016/08V1M
- S3R4016/08V1M
- S3R8016/08V1M
- S3R1616/08V1M
- S3R3216V1M
- S3R6416V1M
- S3R1016/08R1M
- S3R2016/08R1M
- S3R4016/08R1M
- S3R8016/08R1M
- S3R1616/08R1M
- S3R3216R1M
- S3R6416R1M

**Parallel Peripheral Interface MRAM  
3.3V/1.8V**

**Revision 1.1**

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## General Description

The device is a Spin-Transfer-Torque Magneto-resistive Random Access Memory (STT-MRAM).

Data is always non-volatile and the device can replace FRAM, low-power SRAM or nvSRAM with same functionality and help to simplify system design. Due to the non-volatility and virtually unlimited endurance characteristics of STT-MRAM, it is suited for code storage, data logging, backup memory and working memory in industrial designs.

It is offered in density ranging from 1Mbit to 16Mbit. It is a fully random-access memory with parallel asynchronous interface. x16 or x8 I/O mode are supported. And x16 I/O mode allows that lower and upper byte access by data byte control ( $\overline{LB}$ ,  $\overline{UB}$ ).

It supports the asynchronous page mode function to enhance the read and write performance. The page size of x16 I/O mode and x8 I/O mode is 4 words and 8 words. A page size of 64Mb density of x16 I/O mode(S3R6416V(R)1M) is 8-words.

**Table 1: Part Number**

Voltage	3.3V		1.8V	
Density	x16 I/O	X8 I/O	x16 I/O	X8 I/O
64Mb	S3R6416V1M	-	S3R6416R1M	-
32Mb	S3R3216V1M	-	S3R3216R1M	-
16Mb	S3R1616V1M	S3R1608V1M	S3R1616R1M	S3R1608R1M
8Mb	S3R8016V1M	S3R8008V1M	S3R8016R1M	S3R8008R1M
4Mb	S3R4016V1M	S3R4008V1M	S3R4016R1M	S3R4008R1M
2Mb	S3R2016V1M	S3R2008V1M	S3R2016R1M	S3R2008R1M
1Mb	S3R1016V1M	S3R1008V1M	S3R1016R1M	S3R1008R1M

## Solder Reflow

Netsol recommends the solder reflow condition as follows :

1. The peak temperature must not exceed 260 °C.
2. The time above 255 °C must not exceed 30 seconds.
3. The reflow cycles must not exceed 3 times.

**Table 2: Solder Reflow Condition**

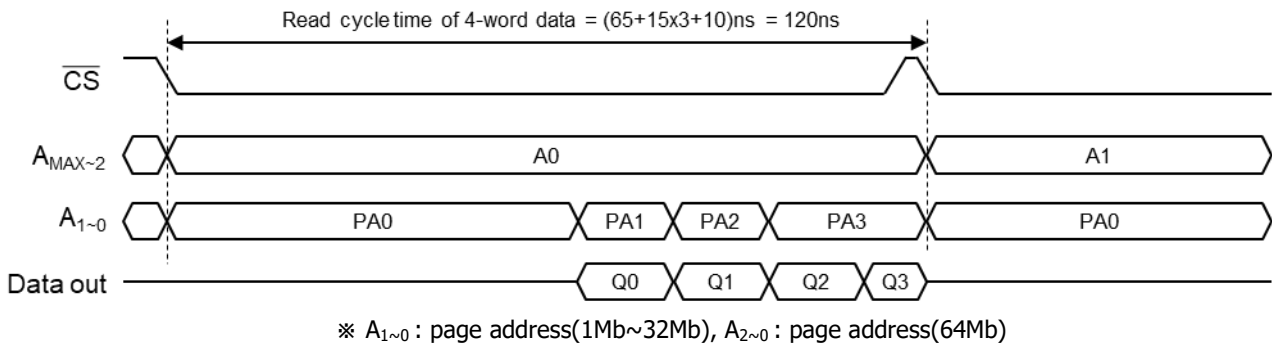
Solder Reflow Process	Max.	Units
Reflow profiles	JEDEC J-STD-020 reflow profiles	
Peak Temperature	260°C	°C
Time above 255°C	30	seconds
Reflow cycles	3	times

## Asynchronous Page Read Function – x16 I/O mode

The device supports the page mode read function to enhance the read performance. It reads a page data from memory array and latches the data into an internal page buffer. The first data is output after  $t_{CO}$ . When the next page address is input, subsequent data is output from the page buffer after  $t_{PAA}$ . A page consists of 4-words and page address is  $A_1$  and  $A_0$  in x16 I/O mode.

A page of 64Mb density(S3R6416V(R)1M) consists of 8-words and page address is  $A_2$ ,  $A_1$  and  $A_0$ .

**Figure 1: Asynchronous Page Read Operation**



**Figure 2: Asynchronous Normal Read Operation**

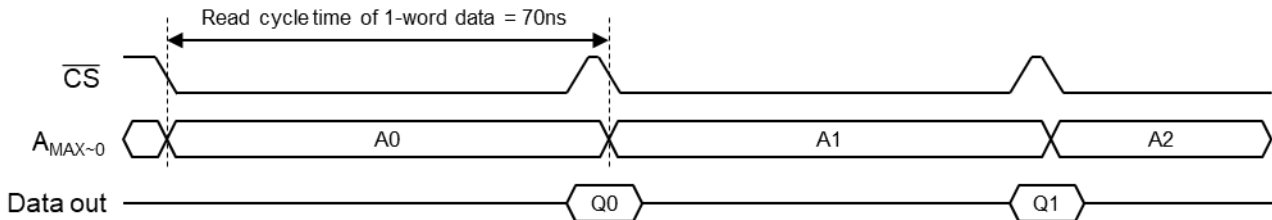


Figure 1 & 2 shows that the device can read 4-words data every 120ns in page read operation, but it can read 4 words data every 280ns in normal read operation. The performance of page read operation is up to 2.33 times that of normal read operation.

**Figure 3: Asynchronous Normal Read Operation -  $t_{RC}=35ns$  case of other product**

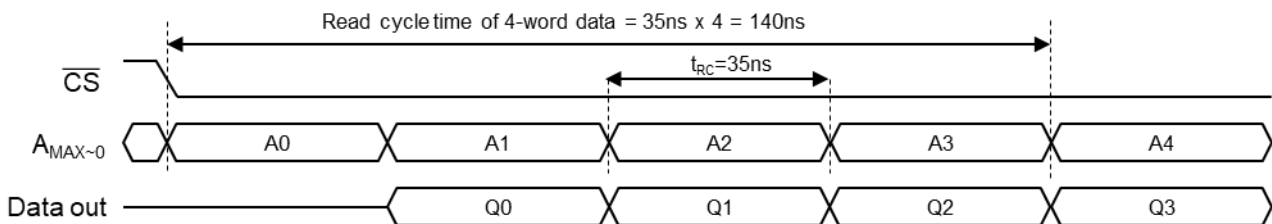
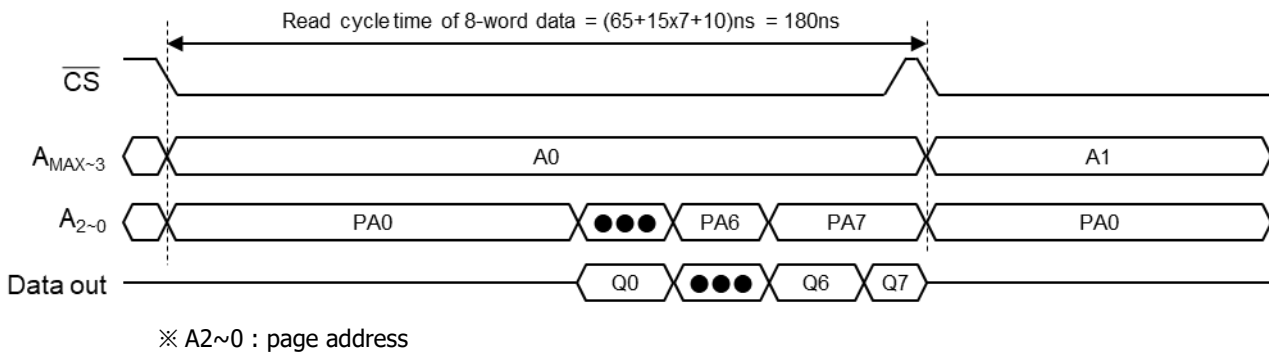


Figure 3 shows that other products which have read cycle time 35ns can read 4 words data every 140ns. So, S3Rxx16x1M has the higher read performance using page read operations.

## Asynchronous Page Read Function – x8 I/O mode

The device supports the page mode read function to enhance the read performance. It reads a page data from memory array and latches the data into an internal page buffer. The first data is output after  $t_{CO}$ . When the next page address is input, subsequent data is output from the page buffer after  $t_{PAA}$ . A page consists of 8-words and page address is  $A_2$ ,  $A_1$  and  $A_0$  in x8 I/O mode.

**Figure 4: Asynchronous Page Read Operation**



**Figure 5: Asynchronous Normal Read Operation**

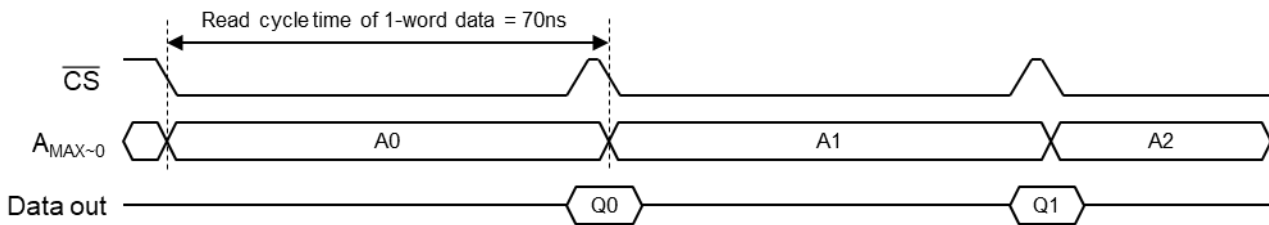


Figure 4 & 5 shows that the device can read 8-words data every 180ns in page read operation, but it can read 8 words data every 560ns in normal read operation. The performance of page read operation is up to 3.11 times that of normal read operation.

**Figure 6: Asynchronous Normal Read Operation -  $t_{RC}=35ns$  case of other product**

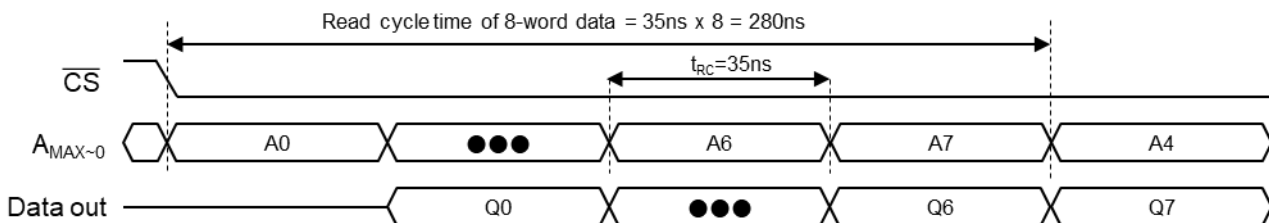
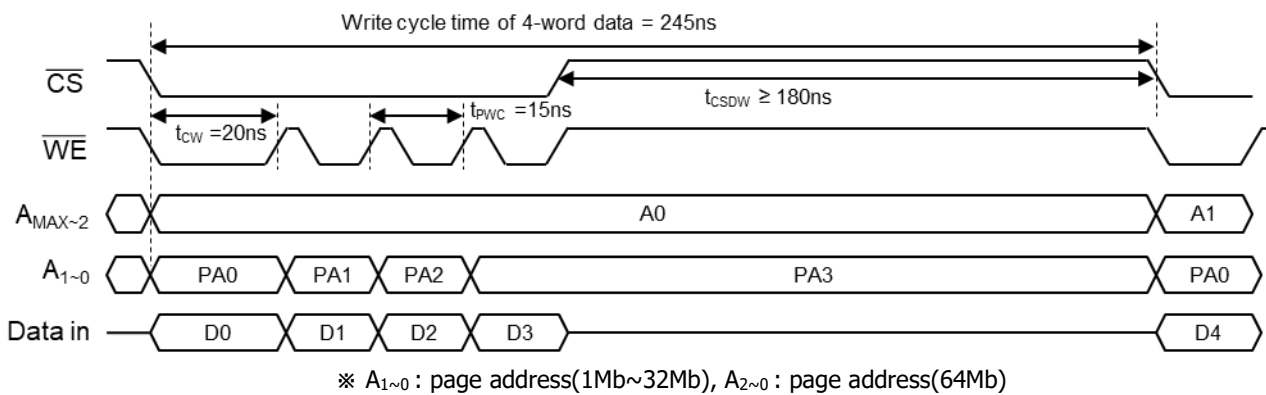


Figure 6 shows that other products which have read cycle time 35ns can read 8 words data every 280ns. So, S3Rxx08x1M has the higher read performance using page read operations.

## Asynchronous Page Write Function – x16 I/O mode

The device supports the page mode write function to enhance the write performance. It latches a page address every falling edge of  $\overline{WE}$ . It latches the lower byte data on every rising edge of  $\overline{WE}$  or  $\overline{LB}$  and the upper byte data on every rising edge of  $\overline{WE}$  or  $\overline{UB}$  for x16 I/O mode. The rising edge of  $\overline{CS}$  causes the device to transfer the input data to memory array. A page consists of 4-words and page address is  $A_1$  and  $A_0$  in x16 I/O mode.

**Figure 7: Asynchronous Page Write Operation**



**Figure 8: Asynchronous Normal Write Operation**

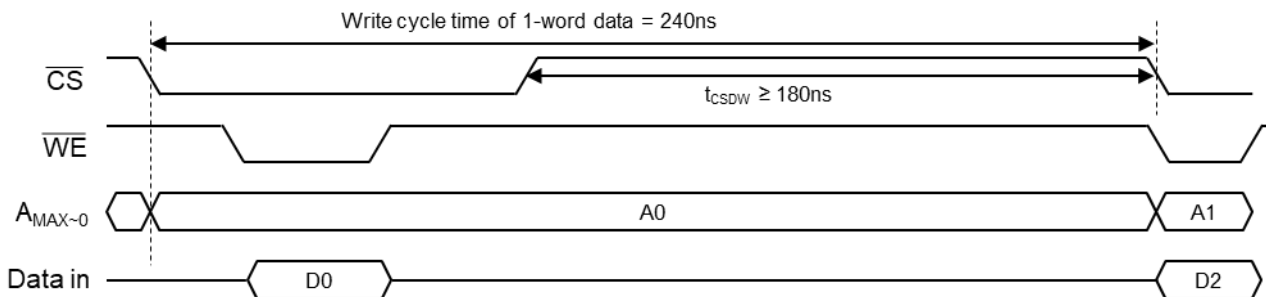
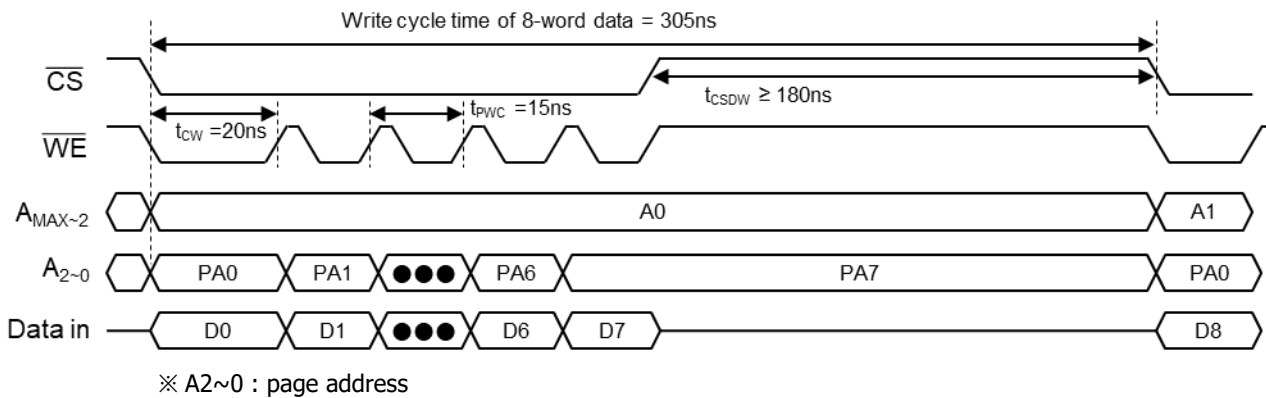


Figure 7 & 8 shows that the device can write 4-words data every 245ns in page write operation, but it can write one word data every 240ns in normal write operation. The performance of page write operation is up to 3.9 times that of normal write operation.

## Asynchronous Page Write Function – x8 I/O mode

The device supports the page mode write function to enhance the write performance. It latches a page address every falling edge of  $\overline{WE}$ . It latches the data on every rising edge of  $\overline{WE}$  for x8 I/O mode. The rising edge of  $\overline{CS}$  causes the device to transfer the input data to memory array. A page consists of 8-words and page address is  $A_2, A_1$  and  $A_0$  in x8 I/O mode.

**Figure 9: Asynchronous Page Write Operation**



**Figure 10: Asynchronous Normal Write Operation**

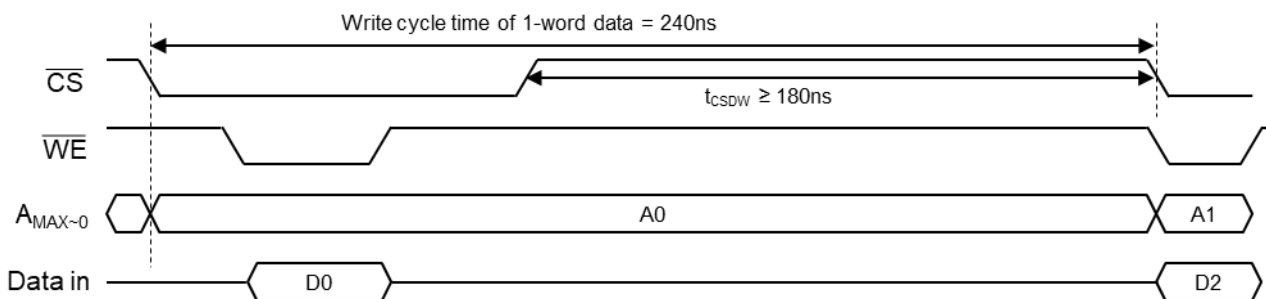


Figure 9 & 10 shows that the device can write 8-words data every 305ns in page write operation, but it can write one word data every 240ns in normal write operation. The performance of page write operation is up to 6.3 times that of normal write operation.

## Revision History

Revision	Date	Description
0.0	Nov, 2022	Initial Release, Preliminary
1.0	Apr, 2023	1. Removed Preliminary status 2. Add 32Mb/64Mb density
1.1	Mar. 2024	Write Cycle Time Change - Asynchronous Page Write Operation, Asynchronous Normal Write Operation

\* Products and specifications discussed herein are subject to change by Netsol without notice.