1Mb ~ 16Mb PPI MRAM

- **S3R1016R1M**
- **S3R2016R1M**
- **S3R4016R1M**
- **S3R8016R1M**
- **S3R1616R1M**

- **S3R1008R1M**
- **S3R2008R1M**
- **S3R4008R1M**
- **S3R8008R1M**
- **S3R1608R1M**

Parallel Peripheral Interface MRAM
1.8V

Revision 0.0

Feature

- Interface
  - Parallel Asynchronous and Page Mode Interface

- Page Mode Read Access
  - Interpage read access : 70ns
  - Intrapage read access : 15ns

- Page Mode Write Access
  - Interpage write access : 320ns
  - Intrapage write access : 15ns

- Page Size
  - x16 I/O Mode : 4-word page size
  - x8   I/O Mode : 8-word page size

- Low Power Consumption
  - Read current   : 15mA
  - Write current   : 15mA
  - Standby current   : 300uA

- Data Byte Control(x16 I/O Mode)
  - $\overline{LB}$: $DQ_7 \sim DQ_0$, $\overline{UB}$: $DQ_{15} \sim DQ_8$

- Memory cell : STT-MRAM
  - nonvolatile

- Density
  - 16Mb, 8Mb, 4Mb, 2Mb and 1Mb

- Data Integrity : No external ECC required

- Data Endurance
  - Unlimited read cycle
  - 10^{14} write cycles

- Data Retention
  - 10 years at 85°C

- Single Power Supply Operation
  - S3RxxxxR1M: 1.71V~1.98V

- Operating Temperature Range
  - Industrial Temperature : -40°C to 85°C

- RoHS compliant packages
  - 44TSOP2 (10㎜ x 18㎜)
  - 48FBGA   (6㎜ x 8㎜)
  - 54TSOP2 (10㎜ x 22㎜)

Performance

Operation		Symbol	Typical Values	Units
Interpage Read Cycle Time		t_{RC}	70(Max.)	ns
Intrapage Read Cycle Time		t_{PRC}	15(Max.)	ns
Interpage Write Cycle Time		t_{WC}	320(Max.)	ns
Intrapage Write Cycle Time		t_{PWC}	15(Max.)	ns
Standby Current	16Mb	I_{SB}	300	uA
	1Mb~8Mb		185	
Interpage Read Current		I_{CCR}	14	mA
Intrapage Read Current		I_{CCRP}	14	mA
Interpage Write Current		I_{CCW}	14	mA
Intrapage Write Current		I_{CCWP}	14	mA

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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.

The S3Rxx16V1M is packaged in industrial standard 44TSOP2, 54TSOP2 and 48FBGA.
The S3Rxx08V1M is packaged in industrial standard 44TSOP2 and 48FBGA. These packages are
compatible with similar low-power volatile and non-volatile products.
The device is offered with industrial (-40°C to 85°C) operating temperature range.

Pin Description – x16 I/O mode

Figure 1 : Functional Block Diagram – x16 I/O mode
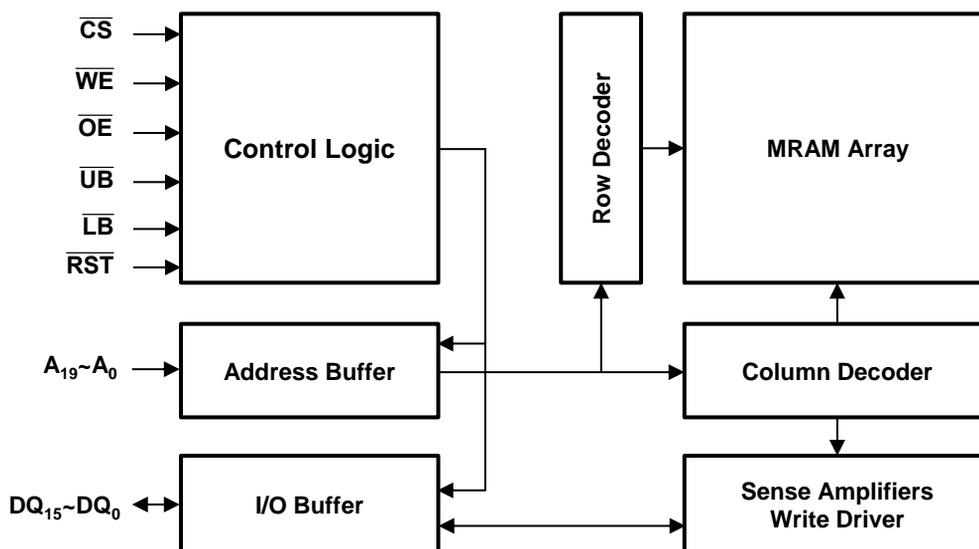
Table 1 : Pin Description – x16 I/O mode

Pin	Type	Description
$\overline{CS}$	Input	**Chip Select:** When $\overline{CS}$ is driven Low, read or write operation are initiated. When $\overline{CS}$ is driven High, the device enters standby mode, and all other input pins are ignored and the output pins are tri-stated. $\overline{CS}$ should be High at power-up to prevent abnormal write operation. This pin does not have internal pullup resistor.
$\overline{WE}$	Input	**Write Enable:** When $\overline{CS}$ and $\overline{WE}$ are driven Low, write operation is initiated. The rising edge of $\overline{CS}$ causes the device to transfer the data to memory array. The rising edge of $\overline{WE}$ latches the input data. And, the falling edge of $\overline{WE}$ latches a new page address for write cycles.
$\overline{OE}$	Input	**Output Enable**
$\overline{LB}$	Input	**Lower Byte Control:** $DQ_7 \sim DQ_0$
$\overline{UB}$	Input	**Upper Byte Control:** $DQ_{15} \sim DQ_8$
$A_{19} \sim A_0$	Input	**Address** The LSB address $A_1 \sim A_0$ are used for page mode read and write operation.
$DQ_{15} \sim DQ_0$	Bidirectional	**Data Input/Outputs**
$\overline{RST}$	Input	**Reset** $\overline{RST}$ pin is a hardware RESET signal. When $\overline{RST}$ is driven High, the device is in the normal operation mode. When $\overline{RST}$ is driven Low, the device enters in the initialization mode. This pin has an internal pullup resistor.
Vcc	Supply	Power pin
Vss	Supply	Ground pin
NC	-	Not Connected
DNU	-	Do Not Use : DNUs must be left unconnected.

Pin Description – x8 I/O mode

Figure 2 : Functional Block Diagram – x8 I/O mode
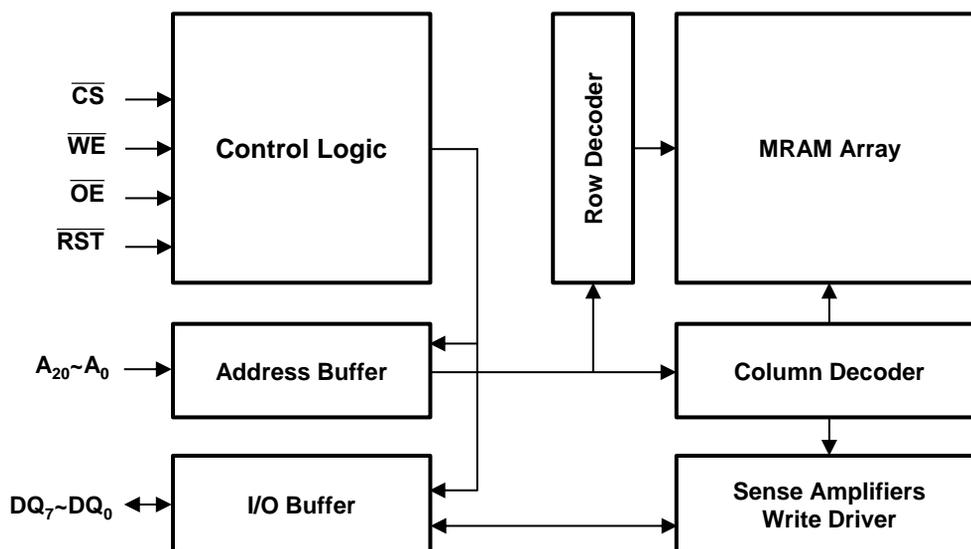
Table 2 : Pin Description – x8 I/O mode

Pin	Type	Description
$\overline{CS}$	Input	**Chip Select:** When $\overline{CS}$ is driven Low, read or write operation are initiated. When $\overline{CS}$ is driven High, the device enters standby mode, and all other input pins are ignored and the output pins are tri-stated. $\overline{CS}$ should be High at power-up to prevent abnormal write operation. This pin does not have internal pullup resistor.
$\overline{WE}$	Input	**Write Enable:** When $\overline{CS}$ and $\overline{WE}$ are driven Low, write operation is initiated. The rising edge of $\overline{CS}$ causes the device to transfer the data to memory array. The rising edge of $\overline{WE}$ latches the input data. And, the falling edge of $\overline{WE}$ latches a new page address for write cycles.
$\overline{OE}$	Input	**Output Enable**
$A_{20} \sim A_0$	Input	**Address** The LSB address $A_2 \sim A_0$ are used for page mode read and write operation.
$DQ_7 \sim DQ_0$	Bidirectional	**Data Input/Outputs**
$\overline{RST}$	Input	**Reset** $\overline{RST}$ pin is a hardware RESET signal. When $\overline{RST}$ is driven High, the device is in the normal operation mode. When $\overline{RST}$ is driven Low, the device enters in the initialization mode. This pin has an internal pullup resistor.
Vcc	Supply	Power pin
Vss	Supply	Ground pin
NC	-	Not Connected
DNU	-	Do Not Use : DNUs must be left unconnected.

Package Pin Configuration – x16 I/O mode

54 TSOP2-X16 (16Mb/8Mb)

Pin	Signal		Pin	Signal
1	NC		54	NC
2	A19		53	A18
3	A0		52	A17
4	A1		51	A16
5	A2		50	A15
6	A3		49	$\overline{OE}$
7	A4		48	$\overline{UB}$
8	$\overline{CS}$		47	$\overline{LB}$
9	DQ0		46	DQ15
10	DQ1		45	DQ14
11	DQ2		44	DQ13
12	DQ3		43	DQ12
13	V_{CC}		42	V_{SS}
14	V_{SS}		41	V_{CC}
15	DQ4		40	DQ11
16	DQ5		39	DQ10
17	DQ6		38	DQ9
18	DQ7		37	DQ8
19	$\overline{WE}$		36	$\overline{RST}$
20	A5		35	A14
21	A6		34	A13
22	A7		33	A12
23	A8		32	A11
24	A9		31	A10
25	NC		30	NC
26	NC		29	NC
27	NC		28	NC

44 TSOP2-X16 (4Mb/2Mb/1Mb)

Pin	Signal		Pin	Signal
1	A0		44	A17
2	A1		43	A16
3	A2		42	A15
4	A3		41	$\overline{OE}$
5	A4		40	$\overline{UB}$
6	$\overline{CS}$		39	$\overline{LB}$
7	DQ0		38	DQ15
8	DQ1		37	DQ14
9	DQ2		36	DQ13
10	DQ3		35	DQ12
11	V_{CC}		34	V_{SS}
12	V_{SS}		33	V_{CC}
13	DQ4		32	DQ11
14	DQ5		31	DQ10
15	DQ6		30	DQ9
16	DQ7		29	DQ8
17	$\overline{WE}$		28	$\overline{RST}$
18	A5		27	A14
19	A6		26	A13
20	A7		25	A12
21	A8		24	A11
22	A9		23	A10

48 Ball FBGA(16Mb~1Mb, X16)

	1	2	3	4	5	6
A	$\overline{LB}$	$\overline{OE}$	A0	A1	A2	NC
B	DQ8	$\overline{UB}$	A3	A4	$\overline{CS}$	DQ0
C	DQ9	DQ10	A5	A6	DQ1	DQ2
D	V_{SS}	DQ11	A17	A7	DQ3	V_{CC}
E	V_{CC}	DQ12	$\overline{RST}$	A16	DQ4	V_{SS}
F	DQ14	DQ13	A14	A15	DQ5	DQ6
G	DQ15	NC	A12	A13	$\overline{WE}$	DQ7
H	A18	A8	A9	A10	A11	A19

Table 3 : DNU Pin Description – x16 I/O mode

Package	Density	Part Number	DNU pin
54 TSOP2	8Mb	S3R8016R1M	#2(A19)
44 TSOP2	2Mb	S3R2016R1M	#44(A17)
	1Mb	S3R1016R1M	#44(A17),#43(A16)
48 FBGA	8Mb	S3R8016R1M	H6(A19)
	4Mb	S3R4016R1M	H6(A19),H1(A18)
	2Mb	S3R2016R1M	H6(A19),H1(A18), D3(A17)
	1Mb	S3R1016R1M	H6(A19),H1(A18), D3(A17),E4(A16)

Package Pin Configuration – x8 I/O mode

44 TSOP2-X8 (16Mb~1Mb)

Pin	Signal		Signal	Pin
1	NC		NC	44
2	A20		A19	43
3	A0		NC	42
4	A1		A18	41
5	A2		A17	40
6	A3		A16	39
7	A4		A15	38
8	$\overline{CS}$		$\overline{OE}$	37
9	DQ0		DQ7	36
10	DQ1		DQ6	35
11	V_{CC}		V_{SS}	34
12	V_{SS}		V_{CC}	33
13	DQ2		DQ5	32
14	DQ3		DQ4	31
15	$\overline{WE}$		$\overline{RST}$	30
16	A5		A14	29
17	A6		A13	28
18	A7		A12	27
19	A8		A11	26
20	A9		A10	25
21	NC		NC	24
22	NC		NC	23

48 Ball FBGA(16Mb~1Mb, X8)

|	1	2	3	4	5	6
A	NC	$\overline{OE}$	A0	A1	A2	$\overline{RST}$
B	NC	NC	A3	A4	$\overline{CS}$	NC
C	DQ0	NC	A5	A6	NC	DQ4
D	V_{SS}	DQ1	A17	A7	DQ5	V_{CC}
E	V_{CC}	DQ2	NC	A16	DQ6	V_{SS}
F	DQ3	NC	A14	A15	NC	DQ7
G	NC	A20	A12	A13	$\overline{WE}$	NC
H	A18	A8	A9	A10	A11	A19

Table 4 : DNU Pin Description – x8 I/O mode

Package	Density	Part Number	DNU pin
44 TSOP2	8Mb	S3R8008R1M	#2(A20)
	4Mb	S3R4008R1M	#2(A20),#43(A19)
	2Mb	S3R2008R1M	#2(A20),#43(A19),#41(A18)
	1Mb	S3R1008R1M	#2(A20),#43(A19),#41(A18),#40(A17)
48 FBGA	8Mb	S3R8008R1M	G2(A20)
	4Mb	S3R4008R1M	G2(A20),H6(A19)
	2Mb	S3R2008R1M	G2(A20),H6(A19),H1(A18)
	1Mb	S3R1008R1M	G2(A20),H6(A19),H1(A18),D3(A17)

Functional Description

Functional Description - x16 I/O mode

Table 5 : Functional Description - x16 I/O mode

$\overline{CS}$	$\overline{WE}$	$\overline{OE}$	$\overline{LB}$	$\overline{UB}$	$DQ_7 \sim DQ_0$	$DQ_{15} \sim DQ_8$	Modes	Supply Current
H	X	X	X	X	High-Z	High-Z	Not Selected	I_{SB}
L	H	H	X	X	High-Z	High-Z	Output disable	I_{CCR}
L	H	L	H	H	High-Z	High-Z	Output disable	I_{CCR}
L	H	L	L	H	Dout	High-Z	Lower Byte Read	I_{CCR}
L	H	L	H	L	High-Z	Dout	Upper Byte Read	I_{CCR}
L	H	L	L	L	Dout	Dout	Word Read	I_{CCR}
L	L	X	H	H	High-Z	High-Z	Input disable	I_{CCW}
L	L	X	L	H	Din	High-Z	Lower Byte Write	I_{CCW}
L	L	X	H	L	High-Z	Din	Upper Byte Write	I_{CCW}
L	L	X	L	L	Din	Din	Word Write	I_{CCW}

Functional Description - x8 I/O mode

Table 6 : Functional Description - x8 I/O mode

$\overline{CS}$	$\overline{WE}$	$\overline{OE}$	$DQ_7 \sim DQ_0$	Modes	Supply Current
H	X	X	High-Z	Not Selected	I_{SB}
L	H	H	High-Z	Output disable	I_{CCR}
L	H	L	Dout	Word Read	I_{CCR}
L	L	X	Din	Word Write	I_{CCW}

Notes:
1. H = High, L = Low, X = don't care, High-Z : high impedance

Address Pin

Table 7 : Address Pin

Density	Address Pin x16 I/O mode	Address Pin x8 I/O mode
16Mb	A[19:0]	A[20:0]
8Mb	A[18:0]	A[19:0]
4Mb	A[17:0]	A[18:0]
2Mb	A[16:0]	A[17:0]
1Mb	A[15:0]	A[16:0]

Parameter	x16 I/O mode	x8 I/O mode
Page Address	$A_1 \sim A_0$	$A_2 \sim A_0$

Electrical Specifications

Absolute Maximum Ratings

Stresses greater that those listed may cause permanent damage to the device. This is a stress rating only. Exposure to maximum rating for extended periods may adversely affect reliability.

Table 8 : Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Voltage on Vcc Supply Relative to VSS	-0.5	2.35	V
Voltage on Any Pin relative to VSS	-0.5	2.35	V
Storage Temperature	-55	150	°C
Operating Ambient Temperature	-40	85	°C
ESD HBM (Human Body Model)	≥ |2000 V|		V
ESD CDM (Charged Device Model)	≥ |500 V|		V
Solder Reflow Process	JEDEC J-STD-020 reflow profiles - Peak temperature ≤ 260°C - The time above 255°C ≤ 30 seconds - Reflow cycles ≤ 3 times		

Endurance, Retention and Magnetic Immunity

Table 9 : Endurance, Retention and Magnetic Immunity

Parameter	Conditions	Min.	Max.	Units
Write Endurance	-25°C	10^{14}	-	Cycles/page
Data Retention	85°C	10	-	years
Magnetic Field During Write or Read	-	-	24,000	A/m

Recommended Operating Conditions

Table 10 : Recommended Operating Conditions

Parameter / Condition	Min.	Typ.	Max.	Units
Operating Temperature	-40	25	85	°C
Vcc Supply Voltage	1.71	1.8	1.98	V
Vss Supply Voltage	0.0	0.0	0.0	V

Pin Capacitance

Table 11 : Pin Capacitance

Parameter	Conditions	Typ.	Max.	Units
Input Pin Capacitance	TEMP = 25°C; f = 1 MHz; V_{IN} = 0V	-	4	pF
Input/Output Pin Capacitance	TEMP = 25°C; f = 1 MHz; $V_{I/O}$ = 0V	-	6	pF

* Capacitance is sampled and not 100% tested

AC Test Condition

Table 12 : AC Test Conditions

Parameter	Value
Input pulse levels	0.0V to Vcc
Input rise and fall times	1ns/1V
Input and output measurement timing levels	Vcc/2
Output Load	CL = 30pF

DC Characteristics

Table 13 : DC Characteristics

Parameters		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Leakage Current		I_{LI}	V_{IN} = V_{SS} to V_{CC}	-2	-	+2	uA
Output Leakage Current		I_{LO}	$\overline{CS}$=V_{IH} or $\overline{OE}$=V_{IH} or $\overline{WE}$=V_{IL} V_{OUT} = V_{SS} to V_{CC}	-2	-	+2	uA
$\overline{RST}$ Pin Leakage Current		I_{LI}	V_{IN} = V_{SS} to V_{CC}	-100	-	+2	uA
Read Current	Random	I_{CCR}	V_{CC} (max), I_{OUT}=0mA	-	14	TBD	mA
	Page mode	I_{CCRP}	V_{CC} (max), I_{OUT}=0mA	-	14	TBD	mA
Write Current	Random	I_{CCW}	V_{CC} (max)	-	14	TBD	mA
	Page mode	I_{CCWP}	V_{CC} (max)	-	14	TBD	mA
Standby Current	16Mb	I_{SB}	V_{CC} (max), $\overline{CS}$≤V_{CC}-0.2V	-	300	TBD	uA
	1Mb~8Mb			-	185	TBD	uA
Input High Voltage		V_{IH}	-	0.7xV_{CC}	-	V_{CC}+0.3	V
Input Low Voltage		V_{IL}	-	-0.2	-	0.3xV_{CC}	V
Output High Voltage		V_{OH}	I_{OH}=-1mA	1.4	-	-	V
Output Low Voltage		V_{OL}	I_{OL}=2mA	-	-	0.4	V

AC Timing Parameters

Table 14 : Read AC Timing Parameter

Parameter	Symbol	Min.	Max.	Units
Read Cycle Time (Interpage)	t_{RC}	70	-	ns
Page Read Cycle Time (Intrapage)	t_{PRC}	15	-	ns
$\overline{CS}$ Read Active Time	t_{RCA}	65	-	ns
$\overline{CS}$ Falling to Valid Output Time	t_{CO}	-	65	ns
Address Access Time [2]	t_{AA}	-	80	ns
Page Address Access Time	t_{PAA}	-	15	ns
$\overline{CS}$ Rising to Output Hold Time	t_{COH}	3	-	ns
Address change to Output Hold Time [2]	t_{OH}	30	-	ns
Page address change to Output Hold Time	t_{POH}	5	-	ns
$\overline{OE}$ Falling to Valid Output Time	t_{OE}	-	15	ns
$\overline{UB}$, $\overline{LB}$ Falling to Valid Output Time [1]	t_{BA}	-	15	ns
$\overline{CS}$ Rising to High-Z Output Time	t_{CHZ}	-	8	ns
$\overline{OE}$ Rising to High-Z Output Time	t_{OHZ}	-	8	ns
$\overline{UB}$, $\overline{LB}$ Rising to High-Z Output Time [1]	t_{BHZ}	-	8	ns
Address Transition to $\overline{CS}$ falling Time [2]	t_{CAS}	0	-	ns
$\overline{CS}$ Rising to Address Transition Time [2]	t_{CAH}	0	-	ns
$\overline{WE}$ Rising to $\overline{CS}$ Falling Time	t_{WES}	0	-	ns
$\overline{CS}$ Rising to $\overline{WE}$ Falling Time	t_{WEH}	0	-	ns
$\overline{CS}$ High Time for Read End	t_{CSDR}	5	-	ns
Address Transition Interval Time	t_{AX}	-	5	ns

* Note:

1. Those parameters are applied for x16 I/O mode only.
2. Address except for page address

AC Timing Parameters

Table 15 : Write AC Timing Parameter

Parameters	Symbol	Min	Max	Unit
Write Cycle Time (Interpage)	t_{WC}	320	-	ns
$\overline{CS}$ Write Active Time [3]	t_{WCA}	20	-	ns
$\overline{CS}$ Falling to End of Write Time	t_{CW}	20	-	ns
Page Write Cycle Time (Intrapage)	t_{PWC}	15	-	ns
$\overline{WE}$ Falling to End of Write (invalid output does not appear)	t_{WP}	10	-	ns
$\overline{WE}$ Falling to End of Write (invalid output appears)	t_{WP1}	20	-	ns
$\overline{UB}$, $\overline{LB}$ Falling to End of Write Time [1]	t_{BW}	10	-	ns
$\overline{WE}$ Falling to Output High-Z Time	t_{WHZ}	-	8	ns
Valid Input Data to End of Write Time	t_{DS}	8	-	ns
End of Write to Vaild Input Data Time	t_{DH}	0	-	ns
Address Transition Time to $\overline{CS}$ falling [2]	t_{CAS}	0	-	ns
$\overline{CS}$ Rising to Address Transition Time [2]	t_{CAH}	0	-	ns
Page Address Transition to $\overline{WE}$ falling Time	t_{PAS}	0	-	ns
$\overline{WE}$ falling to Page Address Transition Time	t_{PAH}	10	-	ns
$\overline{WE}$ High Time for Page Write	t_{PWH}	3	-	ns
$\overline{CS}$ High Time for Write End [3]	t_{CSDW}	250	-	ns

* Note:

1. Those parameters are applied for x16 I/O mode only.
2. Address except for page address
3. $t_{WCA} + t_{CSDW} \geq t_{WC}$

Power On/Off Sequence

- When power-up, power-down or power-loss, $\overline{CS}$ must follow Vcc to provide data protection.
- It is recommended that $\overline{CS}$ must follow Vcc when Vcc is below Vcc(minimum) and during t_{PU}.
- A 10KΩ pull-up resistor between Vcc and $\overline{CS}$ pin is recommended.
- Reset operation is required after t_{PU}.
- Normal operation must start after t_{RST}.

Figure 3 : Power-up/down Behavior
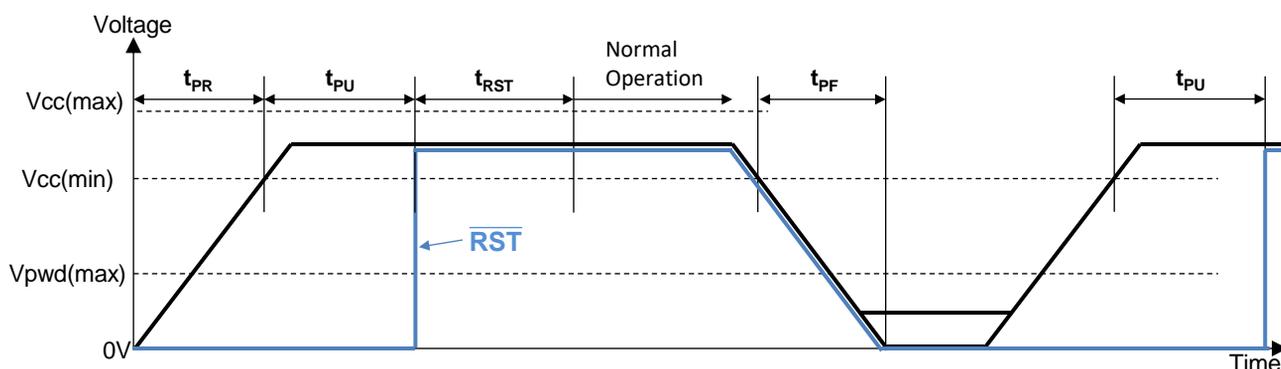
Table 16 : Power Up/Down Timing

Parameter	Symbol	Min	Max	Units
Vcc Range	Vcc	1.71	1.98	V
Vcc rising time	t_{PR} [1]	30	-	µs/V
Vcc falling time	t_{PF} [1]	30	-	µs/V
Vcc(min) to $\overline{RST}$ Low (first instruction) time	t_{PU} [1]	1.0	-	ms
$\overline{RST}$ High to $\overline{CS}$ Low (first instruction) time	t_{RST} [1]	2.0	-	ms
Vcc needed to below Vpwd for ensuring initialization will occur	V_{PWD} [1]	-	0.8	V
Reset Time	t_{RST} [1]	2.0	-	ms

Notes:
1: These parameters are guaranteed by characterization; not tested in production.

Device Operation

Read Operation : Interpage

Read operation is initiated when $\overline{CS}$ goes to low and $\overline{WE}$ is high. The falling edge of $\overline{CS}$ latches the address and starts to read data from memory array. The output data are available after t_{CO} . The minimum random read cycle time is t_{RC}. The data remains in High-Z until the valid data is output.

Figure 4 : Timing Waveform of Read Cycle : x16 I/O mode
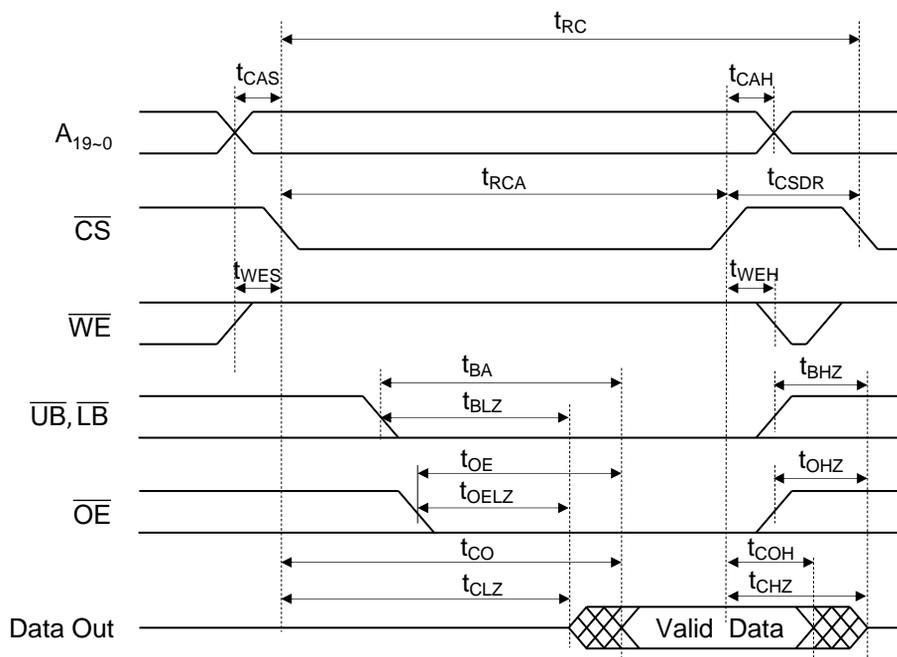
Figure 5 : Timing Waveform of Read Cycle : x8 I/O mode
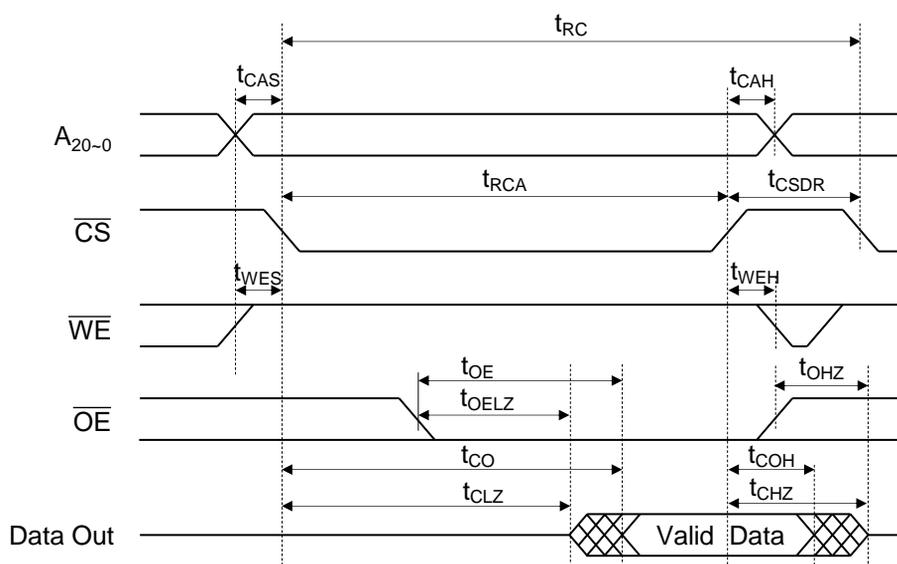
Page Mode Read Operation : Intrapage

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}. The sequence and length of page address are not restricted. For example, the sequence A2-A0-A1 is available.

Parameter	x16 I/O mode	x8 I/O mode
Page Address	$A_1 \sim A_0$	$A_2 \sim A_0$
Page size	4-word (8-bytes)	8-word (8-bytes)

Figure 6 : Timing Waveform of Page Mode Read Cycle : x16 I/O mode
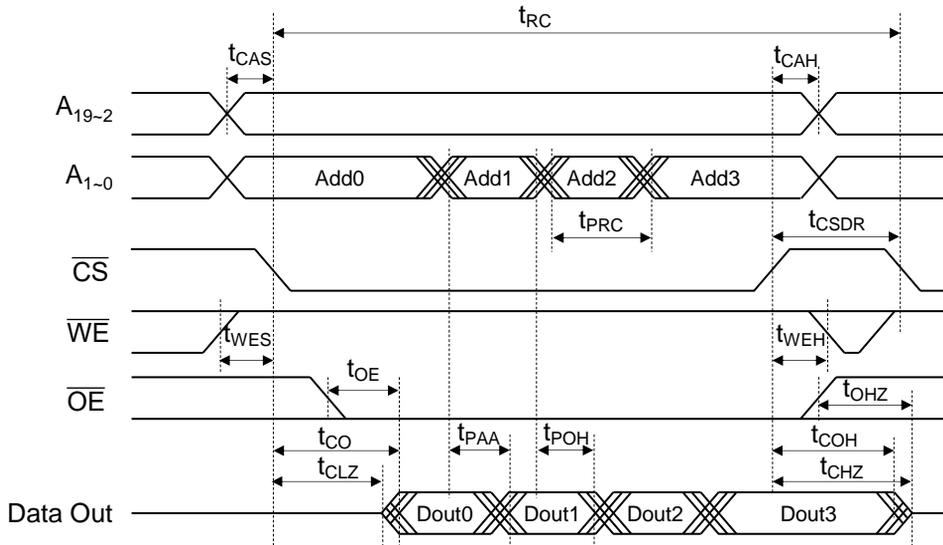
Figure 7 : Timing Waveform of Page Mode Read Cycle : x8 I/O mode
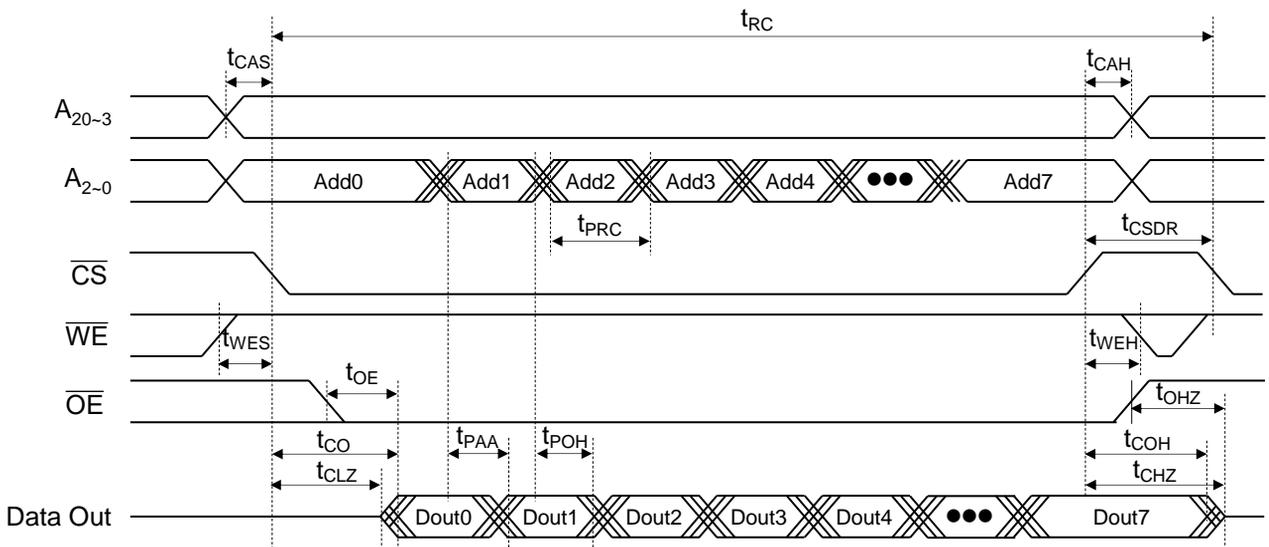
Address Access Read Operation

During $\overline{CS}$ is low and $\overline{WE}$ is high, if a random address (except for the page address) are changed,
the device reads a page data from memory array of a new address and latches the data into
an internal page buffer. The first data is output after t_{AA}. When the next page address is input,
subsequent data is output from the page buffer after t_{PAA}. The random address transition time should
not exceed t_{AX}.

Figure 8 : Timing Waveform of Address Access Read Cycle : x16 I/O mode
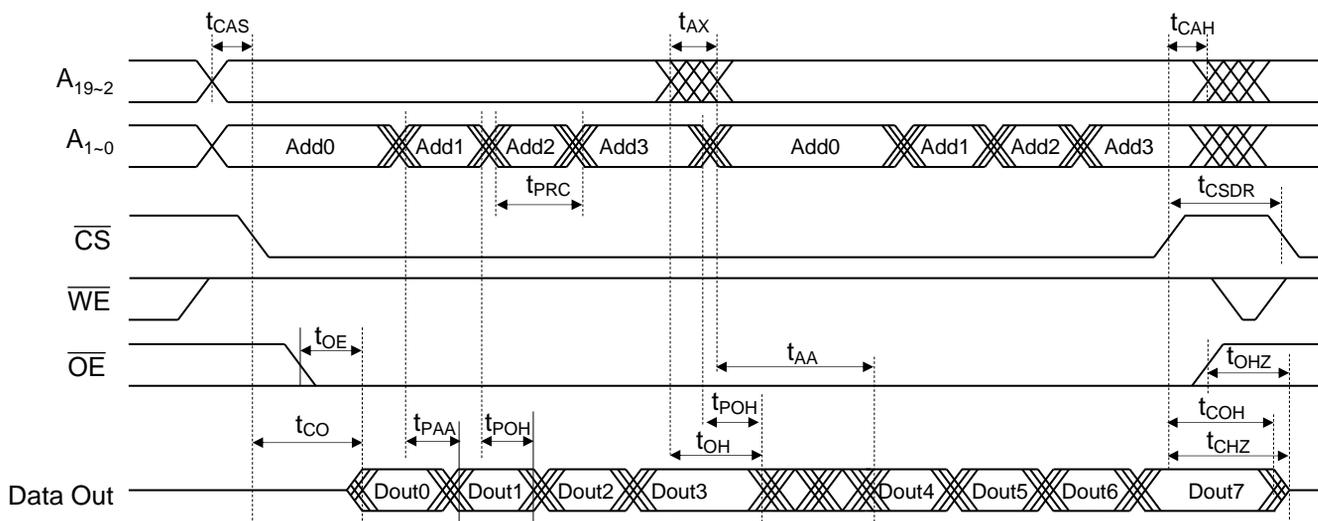
Figure 9 : Timing Waveform of Address Access Read Cycle : x8 I/O mode
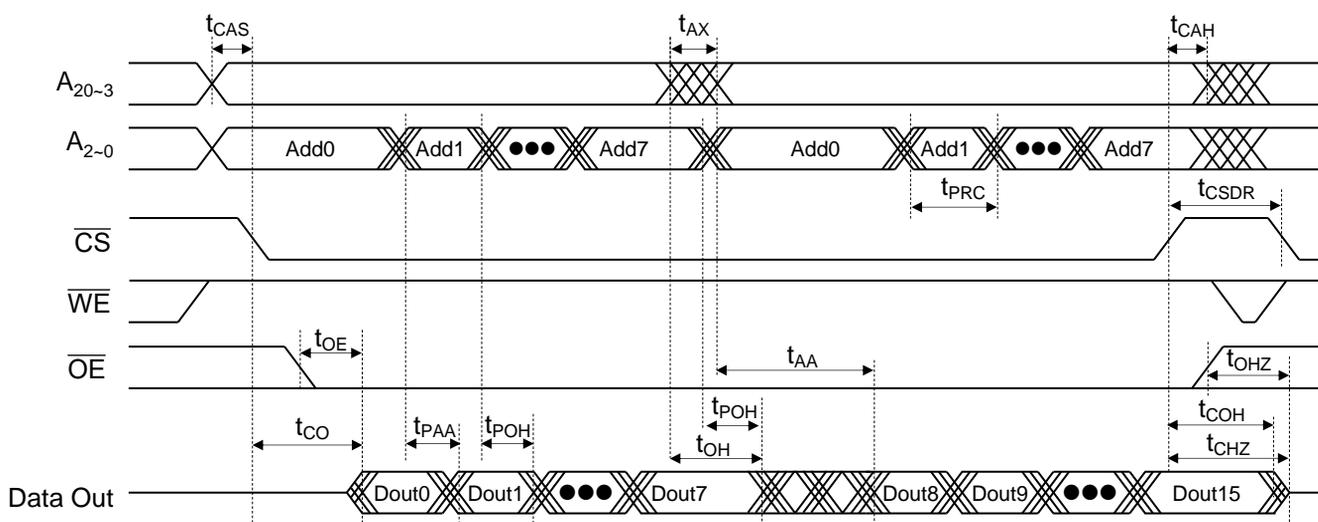
Write Operation ($\overline{WE}$ control) : Interpage

Write operation is initiated when $\overline{WE}$ goes to low and $\overline{CS}$ is low.
The device latches address on the falling edge of $\overline{CS}$. It latches the lower byte data on the rising edge of $\overline{WE}$ or $\overline{LB}$ and the upper byte data on the rising edge of $\overline{WE}$ or $\overline{UB}$ for x16 I/O mode.
It latches the data on the 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.

Figure 10 : Timing Waveform of Write Cycle ($\overline{WE}$ control) : x16 I/O mode
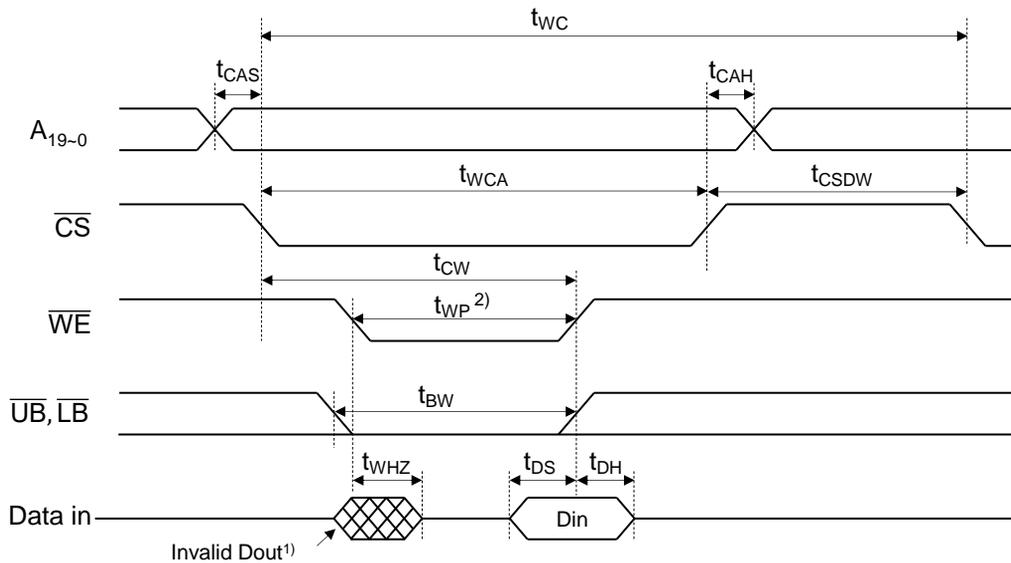
Figure 11 : Timing Waveform of Write Cycle ($\overline{WE}$ control) : x8 I/O mode
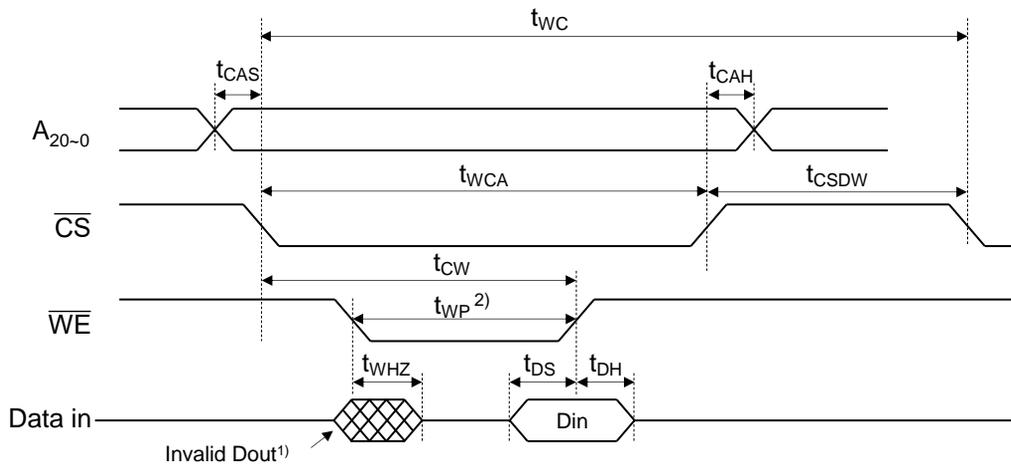
Note :
1. The data pins remain in High-Z state if the time of $\overline{CS}$ falling to $\overline{WE}$ falling is smaller than 30ns or $\overline{OE}$ is High.
2. In case that the data pins do not remains in High-Z state, t_{WP} should be t_{WP1}
3. $t_{WCA} + t_{CSDW} \geq t_{WC}$

Write Operation ($\overline{CS}$ control) : Interpage

Write operation is initiated when $\overline{CS}$ goes to low and $\overline{WE}$ is low.
The device latches address on the falling edge of $\overline{CS}$. It latches the lower byte data on the rising edge of $\overline{CS}$ or $\overline{LB}$ and the upper byte data on the rising edge of $\overline{CS}$ or $\overline{UB}$ for x16 I/O mode.
It latches the data on the rising edge of $\overline{CS}$ for x8 I/O mode.
The rising edge of $\overline{CS}$ causes the device to transfer the input data to memory array.

**Figure 12 : Timing Waveform of Write Cycle ($\overline{CS}$ control) : x16 I/O mode**
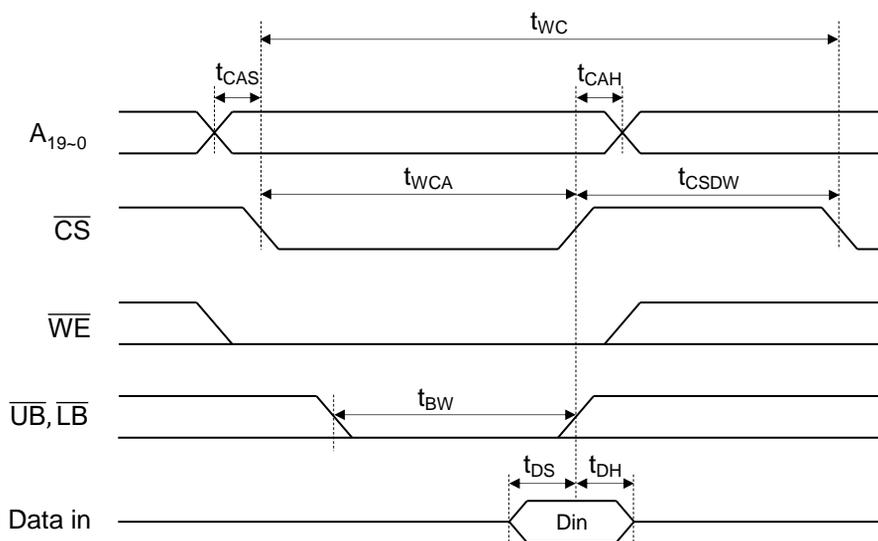
Figure 13 : Timing Waveform of Write Cycle ($\overline{CS}$ control) : x8 I/O mode
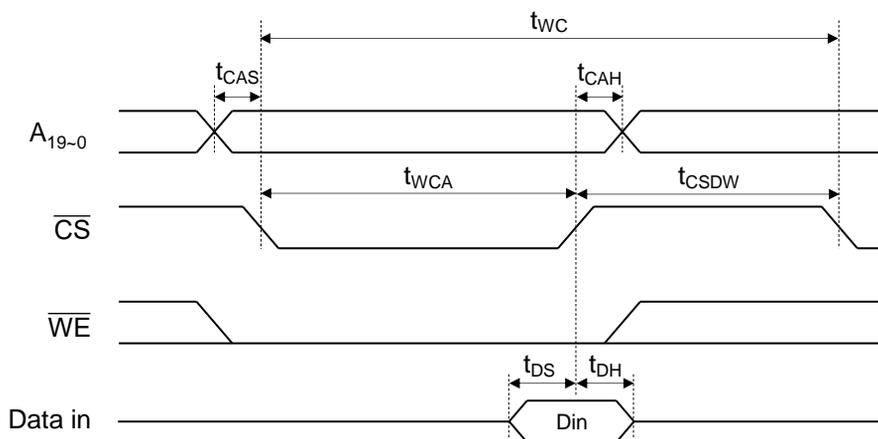
Page Mode Write Operation : Intrapage

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. 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. The sequence and length of page address are not restricted. For example, the sequence A2-A0-A1 is available.

**Figure 14 : Timing Waveform of Page Mode Write Cycle : x16 I/O Mode**
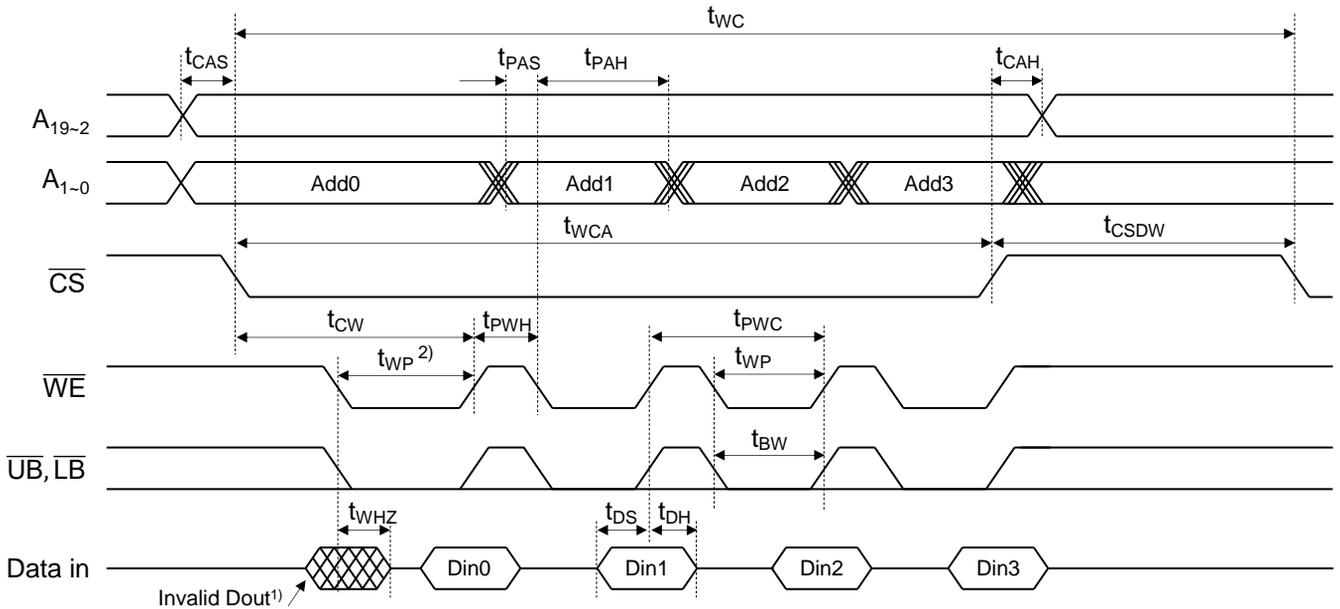
Figure 15 : Timing Waveform of Page Mode Write Cycle : x8 I/O Mode
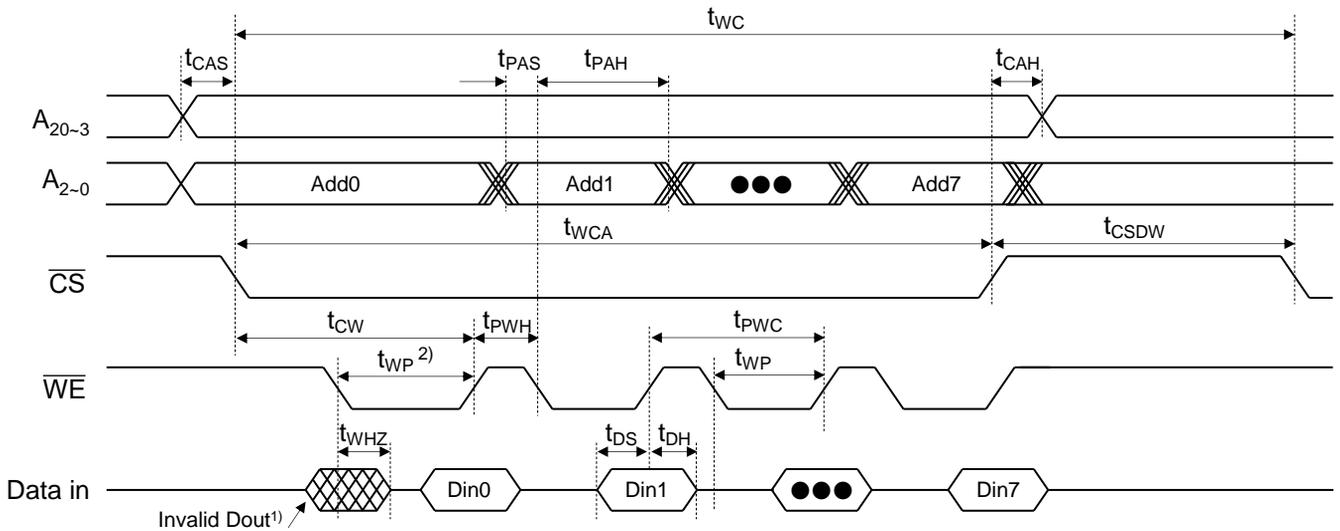
Note :
- While $\overline{CS}$ is Low, once $\overline{WE}$ goes to Low, output remains in High-Z state even if $\overline{WE}$ goes to High thereafter.

Thermal Resistance

Table 17 : Thermal Resistance

Parameter	Description	48FBGA	54TSOP2	44TSOP2	Unit
θ_{JA}	Thermal resistance (junction to ambient)	69.4	50.3	65.2	°C/W
θ_{JC}	Thermal resistance (junction to case)	31.1	14.4	15.9	

Notes:
1: These parameters are guaranteed by characterization; not tested in production.

Part Numbering System

S	3	R	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Netsol
Memory : S

MRAM : 3

Async Parallel
Interface : R

Density
1Mb : 10   2Mb : 20
4Mb : 40   8Mb : 80
16Mb : 16   32Mb : 32
64Mb : 64

I/O Organization
x8 : 08
x16 : 16

VCC
2.70~3.60V : V
1.71~1.98V : R

CS pin option
1CS pin   : 1

Special Code
by customer request
Default : 00

Packing Material
Tray : 0   T&R : T

Speed
70ns : 70

Temperature & Power
Commercial : C
Industrial : I

Package
44TSOP2 : U
54TSOP2 : P
48FBGA : X

Generation
1st Generation : M

Ordering Part Numbers

Table 18 : Ordering Part Numbers

Density	Org.	Temperature	Package	Packing Material	Part Number
1Mb	x16	-40°C ~ 85°C	44TSOP2	Tray	S3R1016R1M-UI70
				Tape and Reel	S3R1016R1M-UI70T
			48FBGA	Tray	S3R1016R1M-XI70
				Tape and Reel	S3R1016R1M-XI70T
	x8	-40°C ~ 85°C	44TSOP2	Tray	S3R1008R1M-UI70
				Tape and Reel	S3R1008R1M-UI70T
			48FBGA	Tray	S3R1008R1M-XI70
				Tape and Reel	S3R1008R1M-XI70T
2Mb	x16	-40°C ~ 85°C	44TSOP2	Tray	S3R2016R1M-UI70
				Tape and Reel	S3R2016R1M-UI70T
			48FBGA	Tray	S3R2016R1M-XI70
				Tape and Reel	S3R2016R1M-XI70T
	x8	-40°C ~ 85°C	44TSOP2	Tray	S3R2008R1M-UI70
				Tape and Reel	S3R2008R1M-UI70T
			48FBGA	Tray	S3R2008R1M-XI70
				Tape and Reel	S3R2008R1M-XI70T
4Mb	x16	-40°C ~ 85°C	44TSOP2	Tray	S3R4016R1M-UI70
				Tape and Reel	S3R4016R1M-UI70T
			48FBGA	Tray	S3R4016R1M-XI70
				Tape and Reel	S3R4016R1M-XI70T
	x8	-40°C ~ 85°C	44TSOP2	Tray	S3R4008R1M-UI70
				Tape and Reel	S3R4008R1M-UI70T
			48FBGA	Tray	S3R4008R1M-XI70
				Tape and Reel	S3R4008R1M-XI70T
8Mb	x16	-40°C ~ 85°C	54TSOP2	Tray	S3R8016R1M-PI70
				Tape and Reel	S3R8016R1M-PI70T
			48FBGA	Tray	S3R8016R1M-XI70
				Tape and Reel	S3R8016R1M-XI70T
	x8	-40°C ~ 85°C	44TSOP2	Tray	S3R8008R1M-UI70
				Tape and Reel	S3R8008R1M-UI70T
			48FBGA	Tray	S3R8008R1M-XI70
				Tape and Reel	S3R8008R1M-XI70T

* Continue to next page

Table 18 : Ordering Part Numbers

| Density	Org.	Temperature	Package	Packing Material	Part Number
16Mb	x16	-40°C ~ 85°C	54TSOP2	Tray	S3R1616R1M-PI70
				Tape and Reel	S3R1616R1M-PI70T
			48FBGA	Tray	S3R1616R1M-XI70
				Tape and Reel	S3R1616R1M-XI70T
	x8	-40°C ~ 85°C	44TSOP2	Tray	S3R1608R1M-UI70
				Tape and Reel	S3R1608R1M-UI70T
			48FBGA	Tray	S3R1608R1M-XI70
				Tape and Reel	S3R1608R1M-XI70T

Package Dimension

48 FBGA
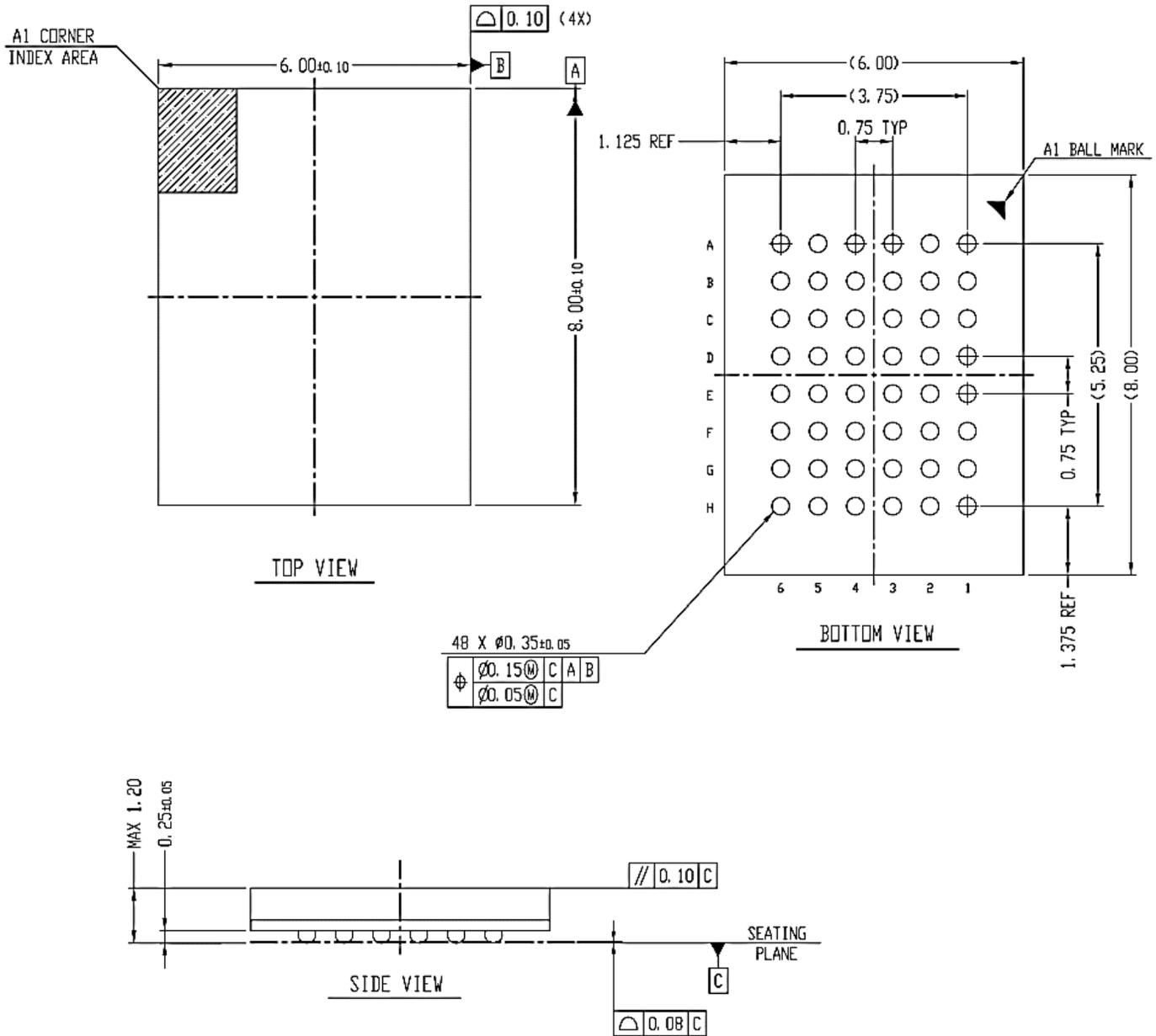
**[Notes]**

1. All Dimensions in Millimeters
2. Solder ball Diameter is post reflow diameter
   (Raw Solder ball size is Φ0.30mm)

54 TSOP2

PIN #1 IDENTIFIER(TOP AREA)

0.120 ~ 0.210

10.058 ~ 10.262
11.735 ~ 11.938

A

TOP VIEW

SIDE VIEW

0.991 ~ 1.194

0.800 BSC   0.220 - 0.320

22.123 ~ 22.327

SIDE VIEW

0.050 ~ 0.150 STAND OFF

0.406 ~ 0.597

0.250

0 ~ 5°
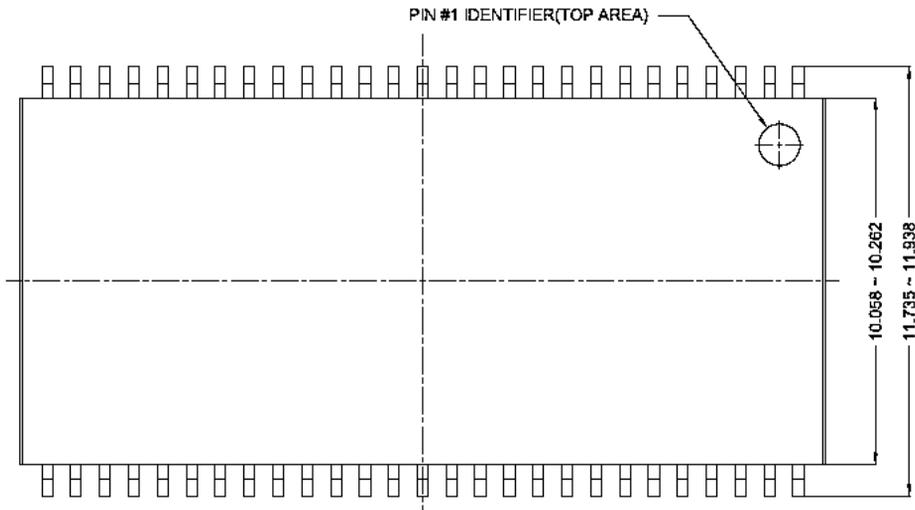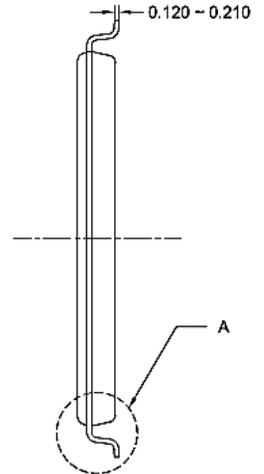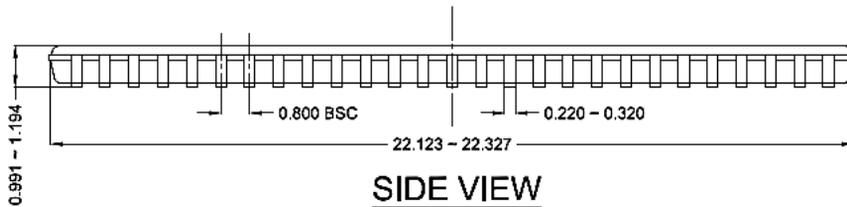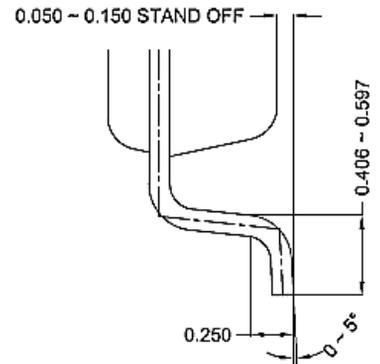
DETAIL "A"

[Notes]

1. Dimensions in Millimeters
2. Lead Finish : Solder Plated
3. Package dimensions refer to JEDEC MS-024

44 TSOP2
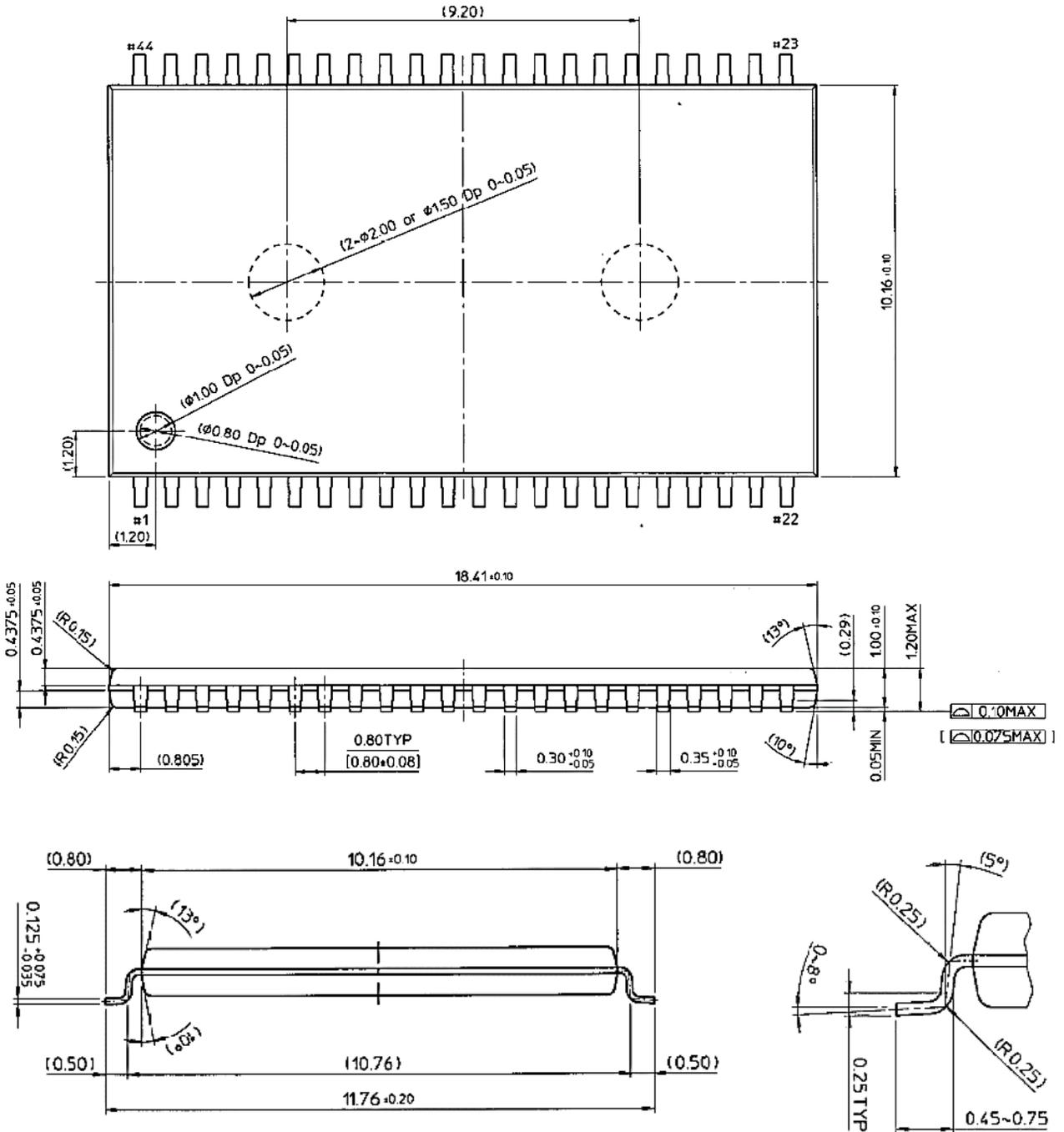
[Notes]

1. Dimensions in Millimeters/Inches
2. Lead Finish : Solder Plated
3. Package dimensions refer to JEDEC MS-024

Revision History

Revision	Data	Description
0.0	Jun, 2022	Initial Release, Preliminary