

TOSHIBA MOS DIGITAL INTEGRATED CIRCUIT SILICON GATE CMOS

1,048,576-WORD BY 16-BIT FULL CMOS STATIC RAM

Lead-Free

DESCRIPTION

The TC55VCM416B, TC55VEM416B, TC55YCM416B and TC55YEM416B is a 16,777,216-bit static random access memory (SRAM) organized as 1,048,576 words by 16 bits. Fabricated using Toshiba's CMOS Silicon gate process technology, this device operates from a single 2.3 to 3.6 V/1.65 to 2.2 V power supply. Advanced circuit technology provides both high speed and low power at an operating current of 2 mA/MHz and a minimum cycle time of 55 ns. It is automatically placed in low-power mode at 0.7 μ A standby current (at $V_{DD} = 3$ V, $T_a = 25^\circ\text{C}$, typical) when chip enable ($\overline{CE1}$) is asserted high or ($\overline{CE2}$) is asserted low. There are three control inputs. $\overline{CE1}$ and $\overline{CE2}$ are used to select the device and for data retention control, and output enable (\overline{OE}) provides fast memory access. Data byte control pin (\overline{LB} , \overline{UB}) provides lower and upper byte access. This device is well suited to various microprocessor system applications where high speed, low power and battery backup are required. And, with a guaranteed operating extreme temperature range of -40° to 85°C , the TC55VCM416B, TC55VEM416B, TC55YCM416B and TC55YEM416B can be used in environments exhibiting extreme temperature conditions. The TC55VCM416BTGN/BSGN, TC55YCM416BTGN/BSGN is available in a plastic 48-pin thin-small-outline package (TSOP). The TC55VEM416BXGN, TC55YEM416BXGN is available in a plastic 48-ball BGA.

FEATURES

- Low-power dissipation
Operating: 6 mW/MHz (typical)
- Power down features using $\overline{CE1}$ and $\overline{CE2}$
- Wide operating temperature range of -40° to 85°C
- Lead-Free

Part Number	Operating Supply Voltage	Package	Access time (MAX)		Supply Current		At Data Retention
			Supply Voltage 2.7~3.6 V	Supply Voltage 2.3~3.6 V	At Operating (MAX)	At Standby (MAX)	
TC55VCM416BTGN55	2.3~3.6 V	48-pin Plastic TSOP(I) (12×20mm) (0.5mm pin pitch) (Normal bent)	55 ns	70 ns	20 mA	15 μ A	1.5~3.6 V
TC55VCM416BSGN55		48-pin Plastic TSOP(I) (12×14mm) (0.5mm pin pitch) (Normal bent)	55 ns	70 ns			
TC55VEM416BXGN55		48-ball BGA (8×11mm) (0.75mm ball pitch)	55 ns	70 ns			

Part Number	Operating Supply Voltage	Package	Access time (MAX)		Supply Current		At Data Retention
			Supply Voltage 1.8~2.2 V	Supply Voltage 1.65~2.2 V	At Operating (MAX)	At Standby (MAX)	
TC55YCM416BTGN70	1.65~2.2 V	48-pin Plastic TSOP(I) (12×20mm) (0.5mm pin pitch) (Normal bent)	70 ns	85 ns	15 mA	15 μ A	1.0~2.2 V
TC55YCM416BSGN70		48-pin Plastic TSOP(I) (12×14mm) (0.5mm pin pitch) (Normal bent)	70 ns	85 ns			
TC55YEM416BXGN70		48-ball BGA (8×11mm) (0.75mm ball pitch)	70 ns	85 ns			

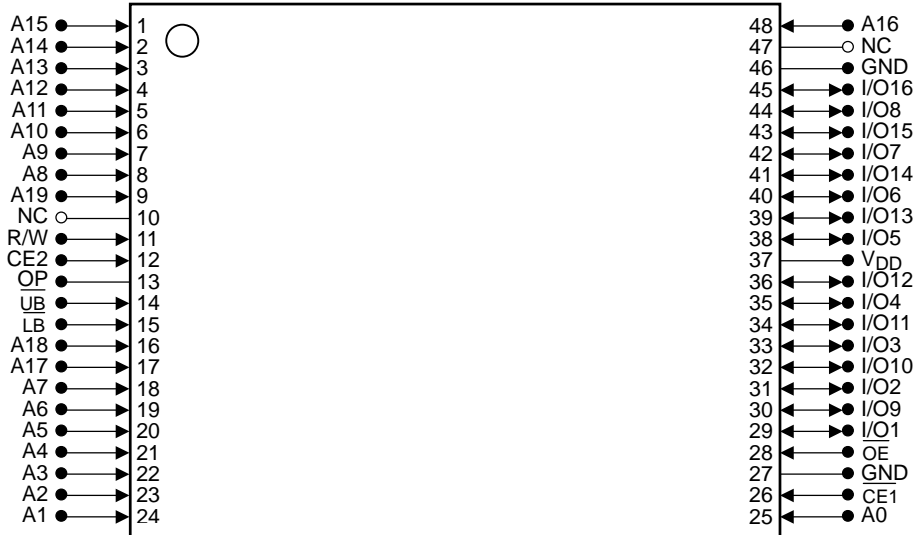
PIN ASSIGNMENT (TOP VIEW)

48-pin Plastic TSOP(I) (12×20mm) (0.5mm pin pitch) (Normal bent)

TC55VCM416BTGN
 TC55YCM416BTGN

48-pin Plastic TSOP(I) (12×14mm) (0.5mm pin pitch) (Normal bent)

TC55VCM416BSGN
 TC55YCM416BSGN



48-ball BGA (8×11mm) (0.75mm ball pitch)

TC55VEM416BXGN
 TC55YEM416BXGN

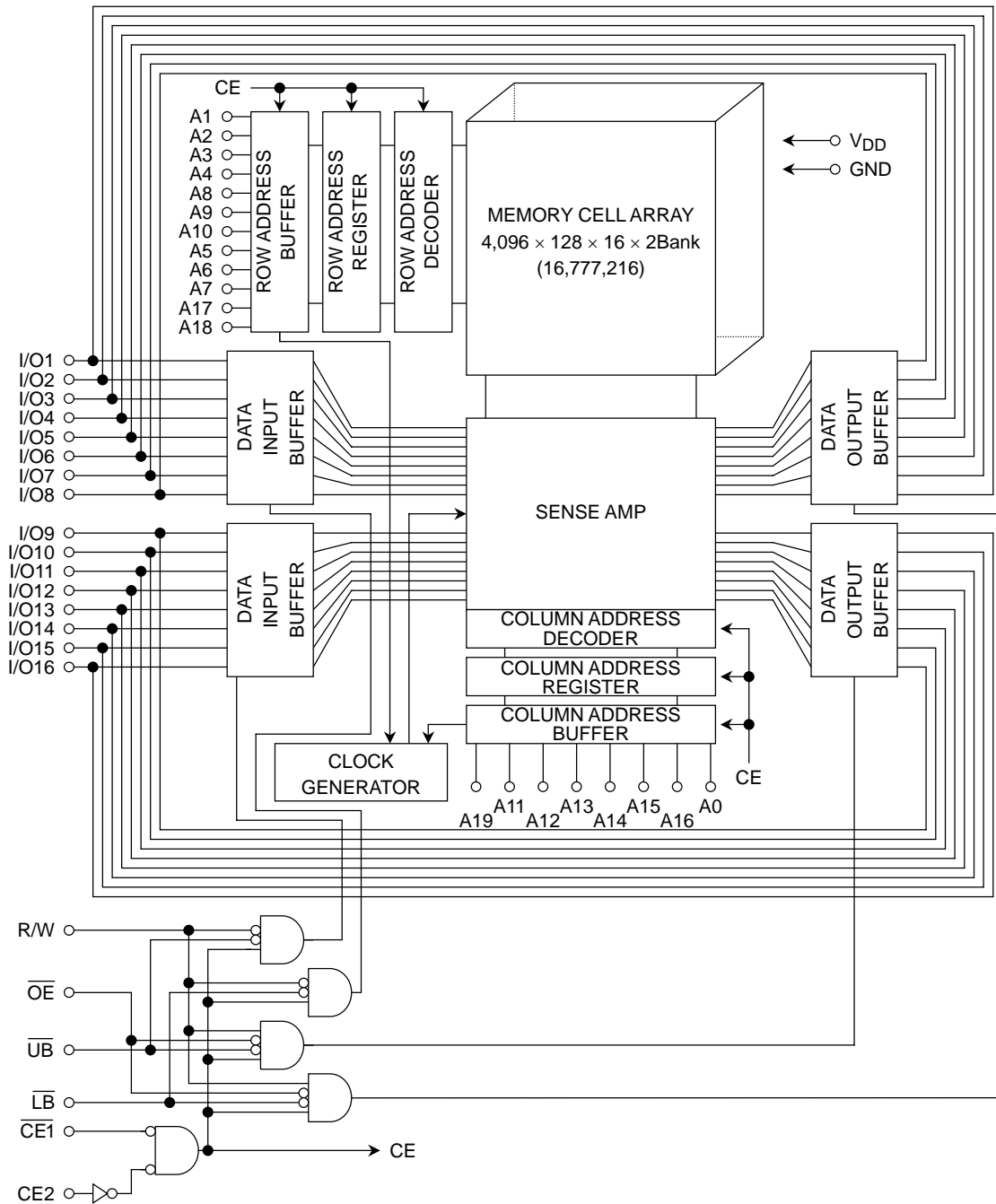
	1	2	3	4	5	6
A	LB	OE	A0	A1	A2	CE2
B	I/O9	UB	A3	A4	CE1	I/O1
C	I/O10	I/O11	A5	A6	I/O2	I/O3
D	GND	I/O12	A17	A7	I/O4	V _{DD}
E	V _{DD}	I/O13	OP	A16	I/O5	GND
F	I/O15	I/O14	A14	A15	I/O6	I/O7
G	I/O16	A19	A12	A13	R/W	I/O8
H	A18	A8	A9	A10	A11	NC

PIN NAMES

A0~A19	Address Inputs
CE1, CE2	Chip Enable
R/W	Read/Write Control
OE	Output Enable
LB, UB	Data Byte Control
I/O1~I/O16	Data Inputs/Outputs
V _{DD}	Power
GND	Ground
NC	No Connection
OP*	Option

*: OP pin must be open or connected to GND.

BLOCK DIAGRAM



OPERATING MODE

MODE	CE1	CE2	OE	R/W	LB	UB	I/O1~I/O8	I/O9~I/O16	POWER
Read	L	H	L	H	L	L	Output	Output	I _{DDO}
	L	H	L	H	H	L	High-Z	Output	I _{DDO}
	L	H	L	H	L	H	Output	High-Z	I _{DDO}
Write	L	H	*	L	L	L	Input	Input	I _{DDO}
	L	H	*	L	H	L	High-Z	Input	I _{DDO}
	L	H	*	L	L	H	Input	High-Z	I _{DDO}
Output Deselect	L	H	H	H	L	L	High-Z	High-Z	I _{DDO}
	L	H	H	H	H	L	High-Z	High-Z	I _{DDO}
	L	H	H	H	L	H	High-Z	High-Z	I _{DDO}
Standby	H	*	*	*	*	*	High-Z	High-Z	I _{DDS}
	*	L	*	*	*	*	High-Z	High-Z	I _{DDS}

* = don't care
H = logic high
L = logic low

MAXIMUM RATINGS

SYMBOL	RATING	VALUE		UNIT	
		TC55VCM416BTGN55 TC55VCM416BSGN55 TC55VEM416BXGN55	TC55YCM416BTGN70 TC55YCM416BSGN70 TC55YEM416BXGN70		
V _{DD}	Power Supply Voltage	-0.3~4.2	-0.3~2.5	V	
V _{IN}	Input Voltage	-0.3 ^{*1} ~4.2	-0.3 ^{*1} ~2.5	V	
V _{I/O}	Input/Output Voltage	-0.5~V _{DD} + 0.5	-0.5~V _{DD} + 0.5	V	
P _D	Power Dissipation	0.6	0.6	W	
T _{solder}	Soldering Temperature (10s)	260	260	°C	
T _{stg}	Storage Temperature	TSOP type	-55~150	-55~150	°C
		BGA type	-55~125	-55~125	°C
T _a	Operating Ambient Temperature	-40~85	-40~85	°C	

*1: -1.0 V when measured at a pulse width of 10ns

DC RECOMMENDED OPERATING CONDITIONS (T_a = -40° to 85°C)

SYMBOL	PARAMETER	TEST CONDITION	TC55VCM416BTGN55 TC55VCM416BSGN55 TC55VEM416BXGN55		TC55YCM416BTGN70 TC55YCM416BSGN70 TC55YEM416BXGN70		UNIT
			MIN	MAX	MIN	MAX	
V _{DD}	Power Supply Voltage	—	2.3	3.6	1.65	2.2	V
V _{IH}	Input High Voltage	2.3 V ≤ V _{DD} < 2.7 V	2.0	V _{DD} + 0.3	—	—	
		2.7 V ≤ V _{DD} ≤ 3.6 V	2.2	V _{DD} + 0.3	—	—	
		1.65 V ≤ V _{DD} < 1.8 V	—	—	1.4	V _{DD} + 0.3	
		1.8 V ≤ V _{DD} ≤ 2.2 V	—	—	1.6	V _{DD} + 0.3	
V _{IL}	Input Low Voltage	—	-0.3 ^{*2}	V _{DD} × 0.24	-0.3 ^{*2}	V _{DD} × 0.22	
V _{DH}	Data Retention Supply Voltage	—	1.5	3.6	1.0	2.2	

*2: -1.0 V when measured at a pulse width of 10ns

DC CHARACTERISTICS (Ta = -40° to 85°C, VDD = 2.3 to 3.6 V/1.65 to 2.2 V)

SYMBOL	PARAMETER	TEST CONDITION	TC55VCM416BTGN55			TC55YCM416BTGN70			UNIT		
			TC55VCM416BSGN55			TC55YCM416BSGN70					
			MIN	TYP	MAX	MIN	TYP	MAX			
IIL	Input Leakage Current	VIN = 0 V-VDD	—	—	±1.0	—	—	±1.0	μA		
IOH	Output High Current	VOH = VDD - 0.5 V	-0.5	—	—	-0.5	—	—	mA		
IOL	Output Low Current	VOL = 0.4 V	2.1	—	—	2.1	—	—	mA		
ILO	Output Leakage Current	$\overline{CE1} = V_{IH}$ or $CE2 = V_{IL}$ or $\overline{LB} = \overline{UB} = V_{IH}$ or $R/W = V_{IL}$ or $\overline{OE} = V_{IH}$, VOUT = 0 V-VDD	—	—	±1.0	—	—	±1.0	μA		
IDDO1	Operating Current	$\overline{CE1} = V_{IL}$ and $CE2 = V_{IH}$ and $R/W = V_{IH}$, IOUT = 0 mA, Other Input = VIH/VIL	t _{cycle}	MIN	—	—	20	—	—	12	mA
				1 μs	—	—	8	—	—	2	
IDDO2	Operating Current	$\overline{CE1} = 0.2$ V and $CE2 = V_{DD} - 0.2$ V and $R/W = V_{DD} - 0.2$ V, IOUT = 0 mA, Other Input = VDD - 0.2 V/0.2 V	t _{cycle}	MIN	—	—	20	—	—	12	mA
				1 μs	—	—	2	—	—	2	
IDDS1	Standby Current	$\overline{CE1} = V_{IH}$ or $CE2 = V_{IL}$		—	—	1	—	—	1	mA	
IDDS2		1) $\overline{CE1} = V_{DD} - 0.2$ V, $CE2 = V_{DD} - 0.2$ V	VDD = 2.3~3.6 V	Ta = -40~85°C	—	—	15	—	—	—	μA
			VDD = 3.0 V	Ta = 25°C	—	0.7	1.0	—	—	—	
				Ta = -40~40°C	—	—	2	—	—	—	
			VDD = 1.65~2.2 V	Ta = -40~85°C	—	—	—	—	—	15	
VDD = 1.8 V	Ta = 25°C	—	—	—	—	0.7	1.0				

Note: In standby mode with $\overline{CE1} \geq V_{DD} - 0.2$ V, these limits are assured for the condition $CE2 \geq V_{DD} - 0.2$ V or $CE2 \leq 0.2$ V. The other input pins are not restricted of input level.

CAPACITANCE (Ta = 25°C, f = 1 MHz)

SYMBOL	PARAMETER	TEST CONDITION	MAX	UNIT
CIN	Input Capacitance	VIN = GND	10	pF
COU	Output Capacitance	VOUT = GND	10	pF

Note: This parameter is periodically sampled and is not 100% tested.

AC CHARACTERISTICS AND OPERATING CONDITIONS (Ta = -40° to 85°C)

READ CYCLE

SYMBOL	PARAMETER	TC55VCM416BTGN/BSGN55 TC55VEM416BXGN55				UNIT
		V _{DD} = 2.7~3.6 V		V _{DD} = 2.3~3.6 V		
		MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	55	—	70	—	ns
t _{ACC}	Address Access Time	—	55	—	70	
t _{CO1}	Chip Enable($\overline{CE1}$) Access Time	—	55	—	70	
t _{CO2}	Chip Enable(CE2) Access Time	—	55	—	70	
t _{OE}	Output Enable Access Time	—	30	—	35	
t _{BA}	Data Byte Control Access Time	—	30	—	35	
t _{COE}	Chip Enable Low to Output Active	5	—	5	—	
t _{OEE}	Output Enable Low to Output Active	0	—	0	—	
t _{BE}	Data Byte Control Low to Output Active	0	—	0	—	
t _{OD}	Chip Enable High to Output High-Z	—	25	—	30	
t _{ODO}	Output Enable High to Output High-Z	—	25	—	30	
t _{BD}	Data Byte Control High to Output High-Z	—	25	—	30	
t _{OH}	Output Data Hold Time	10	—	10	—	

WRITE CYCLE

SYMBOL	PARAMETER	TC55VCM416BTGN/BSGN55 TC55VEM416BXGN55				UNIT
		V _{DD} = 2.7~3.6 V		V _{DD} = 2.3~3.6 V		
		MIN	MAX	MIN	MAX	
t _{WC}	Write Cycle Time	55	—	70	—	ns
t _{WP}	Write Pulse Width	40	—	50	—	
t _{CW}	Chip Enable to End of Write	45	—	55	—	
t _{BW}	Data Byte Control to End of Write	45	—	55	—	
t _{AS}	Address Setup Time	0	—	0	—	
t _{WR}	Write Recovery Time	0	—	0	—	
t _{ODW}	R/W Low to Output High-Z	—	25	—	30	
t _{OEW}	R/W High to Output Active	0	—	0	—	
t _{DS}	Data Setup Time	25	—	30	—	
t _{DH}	Data Hold Time	0	—	0	—	

Note: t_{OD}, t_{ODO}, t_{BD} and t_{ODW} are specified in time when an output becomes high impedance, and are not judged depending on an output voltage level.

AC CHARACTERISTICS AND OPERATING CONDITIONS (Ta = -40° to 85°C)

READ CYCLE

SYMBOL	PARAMETER	TC55YCM416BTGN/BSGN70 TC55YEM416BXGN70				UNIT
		V _{DD} = 1.8~2.2 V		V _{DD} = 1.65~2.2 V		
		MIN	MAX	MIN	MAX	
t _{RC}	Read Cycle Time	70	—	85	—	ns
t _{ACC}	Address Access Time	—	70	—	85	
t _{CO1}	Chip Enable($\overline{CE1}$) Access Time	—	70	—	85	
t _{CO2}	Chip Enable(CE2) Access Time	—	70	—	85	
t _{OE}	Output Enable Access Time	—	35	—	45	
t _{BA}	Data Byte Control Access Time	—	35	—	45	
t _{COE}	Chip Enable Low to Output Active	5	—	5	—	
t _{OEE}	Output Enable Low to Output Active	0	—	0	—	
t _{BE}	Data Byte Control Low to Output Active	0	—	0	—	
t _{OD}	Chip Enable High to Output High-Z	—	30	—	35	
t _{ODO}	Output Enable High to Output High-Z	—	30	—	35	
t _{BD}	Data Byte Control High to Output High-Z	—	30	—	35	
t _{OH}	Output Data Hold Time	10	—	10	—	

WRITE CYCLE

SYMBOL	PARAMETER	TC55YCM416BTGN/BSGN70 TC55YEM416BXGN70				UNIT
		V _{DD} = 1.8~2.2 V		V _{DD} = 1.65~2.2 V		
		MIN	MAX	MIN	MAX	
t _{WC}	Write Cycle Time	70	—	85	—	ns
t _{WP}	Write Pulse Width	50	—	60	—	
t _{CW}	Chip Enable to End of Write	55	—	65	—	
t _{BW}	Data Byte Control to End of Write	55	—	65	—	
t _{AS}	Address Setup Time	0	—	0	—	
t _{WR}	Write Recovery Time	0	—	0	—	
t _{ODW}	R/W Low to Output High-Z	—	30	—	35	
t _{OEW}	R/W High to Output Active	0	—	0	—	
t _{DS}	Data Setup Time	30	—	35	—	
t _{DH}	Data Hold Time	0	—	0	—	

Note: t_{OD}, t_{ODO}, t_{BD} and t_{ODW} are specified in time when an output becomes high impedance, and are not judged depending on an output voltage level.

AC TEST CONDITIONS (Ta = -40 to 85°C, VDD = 2.3 to 3.6 V/1.65 to 2.2 V)

PARAMETER		TEST CONDITION	
		TC55VCM416BTGN55 TC55VCM416BSGN55 TC55VEM416BXGN55	TC55YCM416BTGN70 TC55YCM416BSGN70 TC55YEM416BXGN70
Input pulse level	High	$V_{DD} \times 0.7 + 0.2 \text{ V}$	$V_{DD} - 0.2 \text{ V}$
	Low	0.2 V	0.2 V
Input rise and fall time (Fig.1)	t _R	1 V/ns	1 V/ns
	t _F	1 V/ns	1 V/ns
Timing measurements		$V_{DD} \times 0.5$	$V_{DD} \times 0.5$
Reference level		$V_{DD} \times 0.5$	$V_{DD} \times 0.5$
Output load (Fig.2)	V _{TM}	2.3 V	1.65 V
	R1	810 Ω	470 Ω
	R2	1610 Ω	740 Ω
	C _L	30 pF	30 pF

Fig.1 : Input rise and fall time

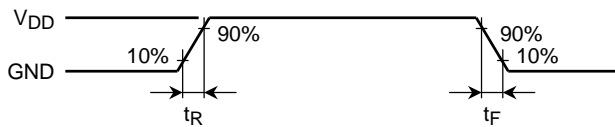
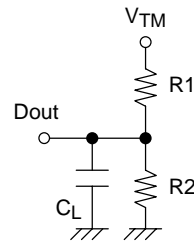
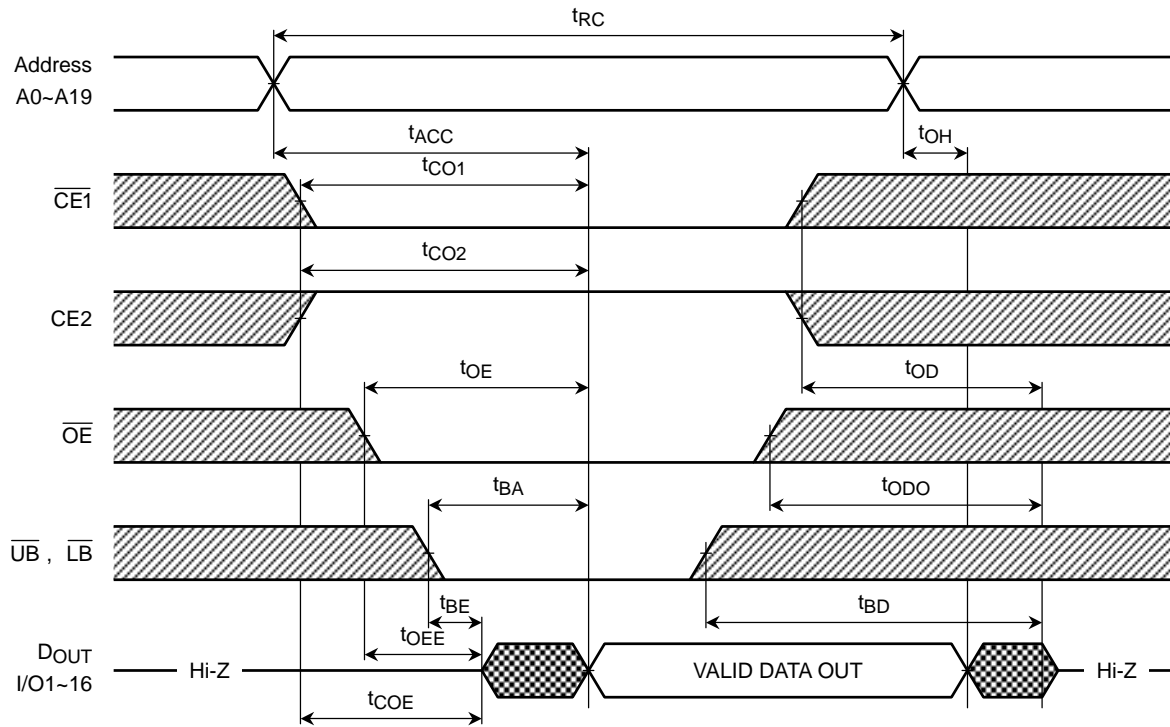


Fig.2 : Output load

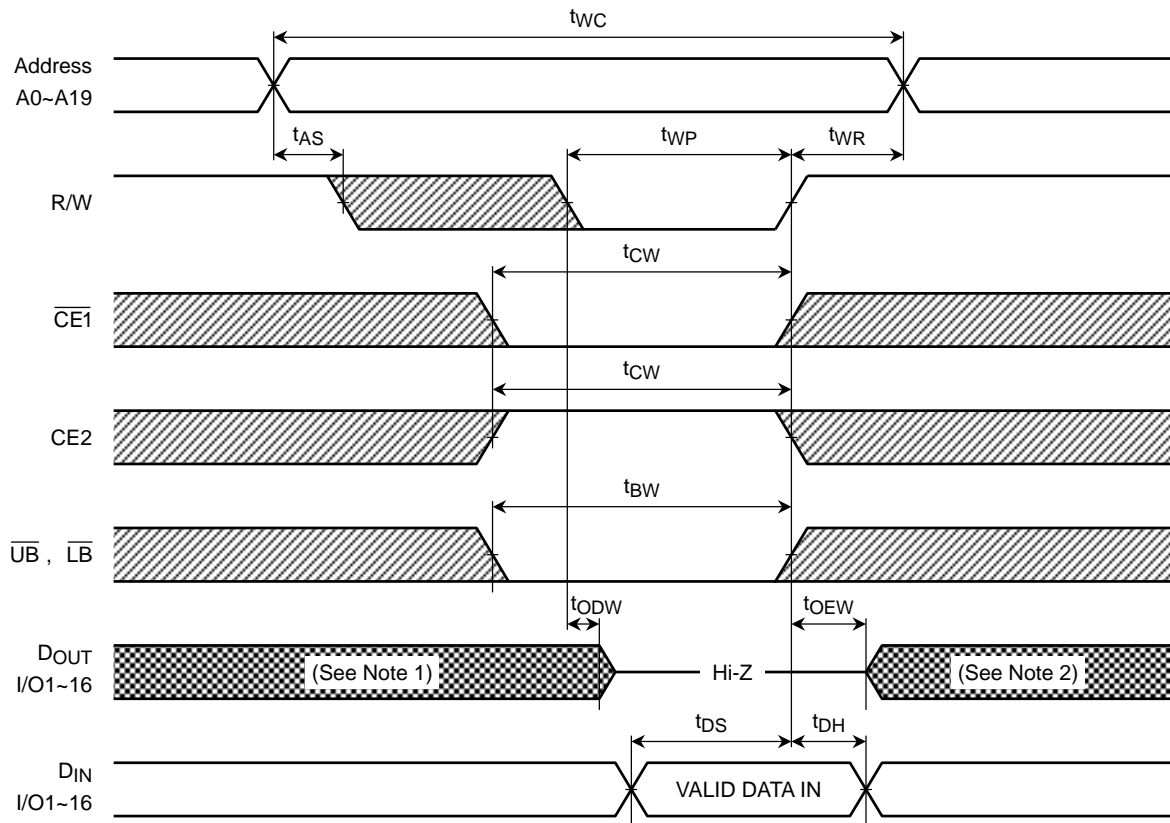


TIMING DIAGRAMS

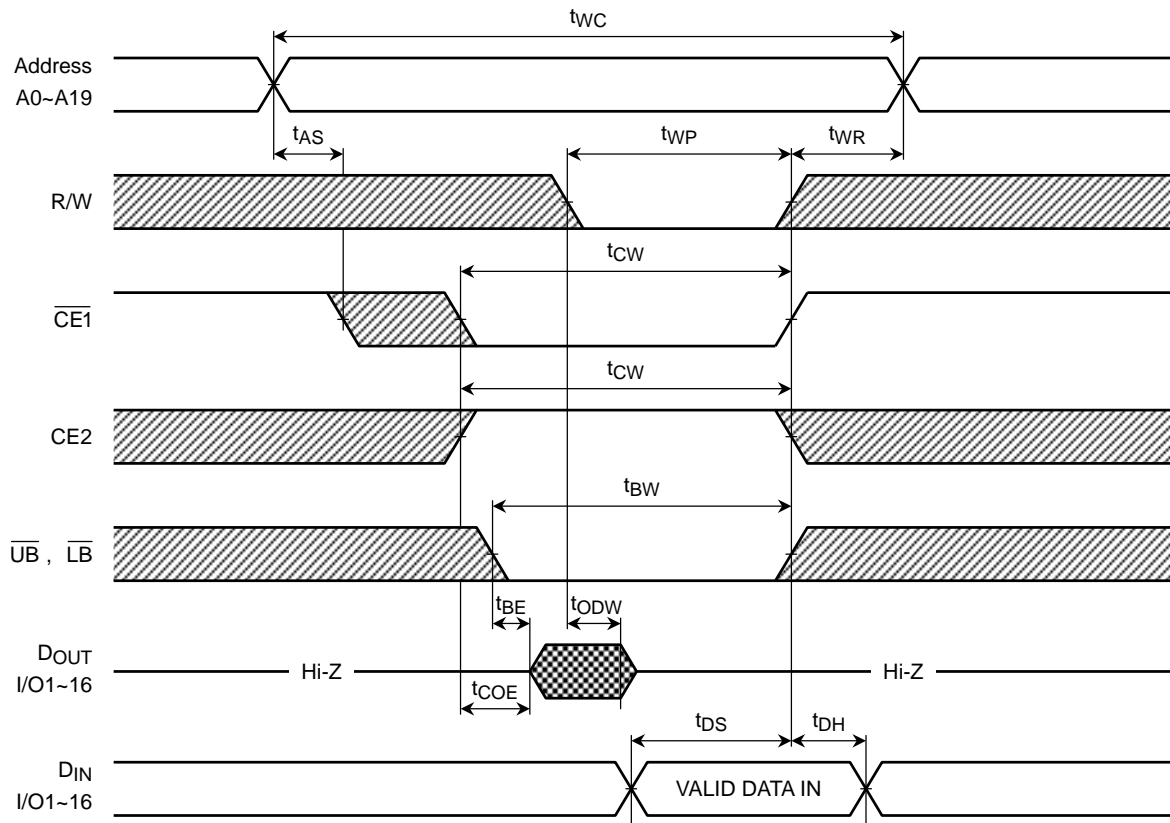
READ CYCLE



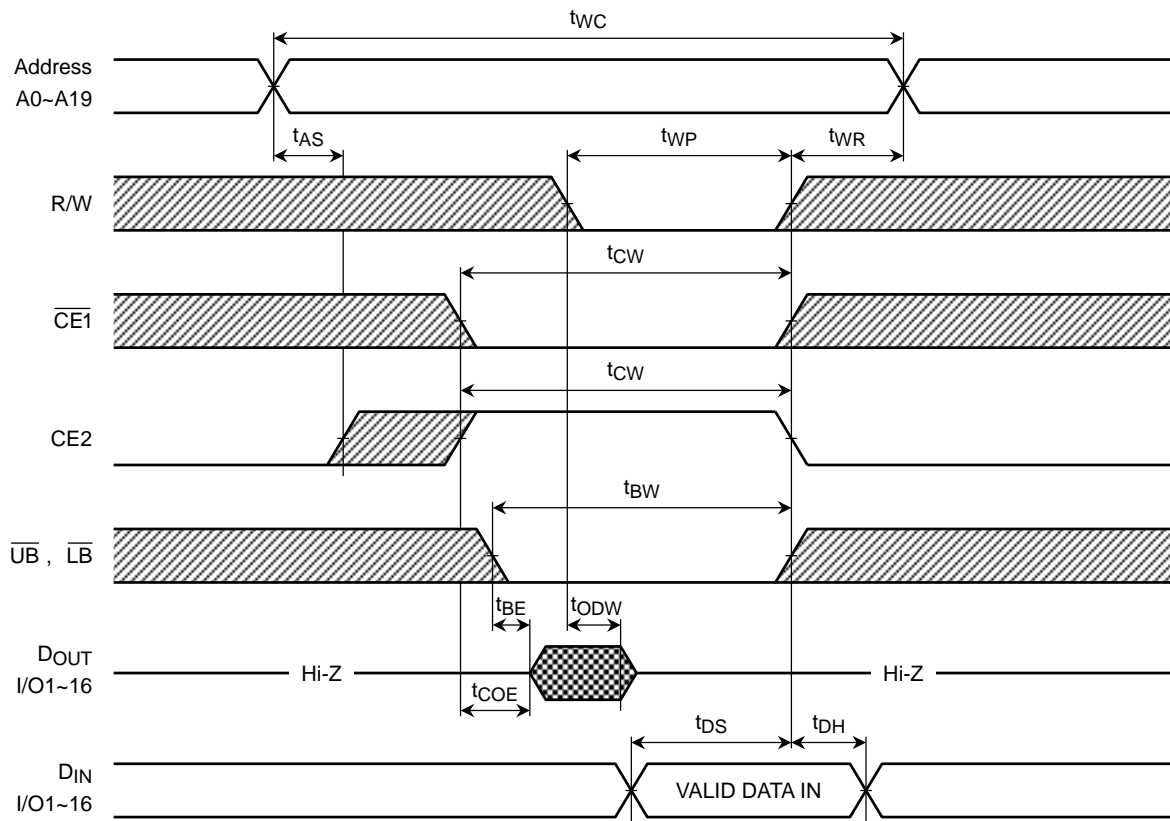
WRITE CYCLE 1 (R/W CONTROLLED)



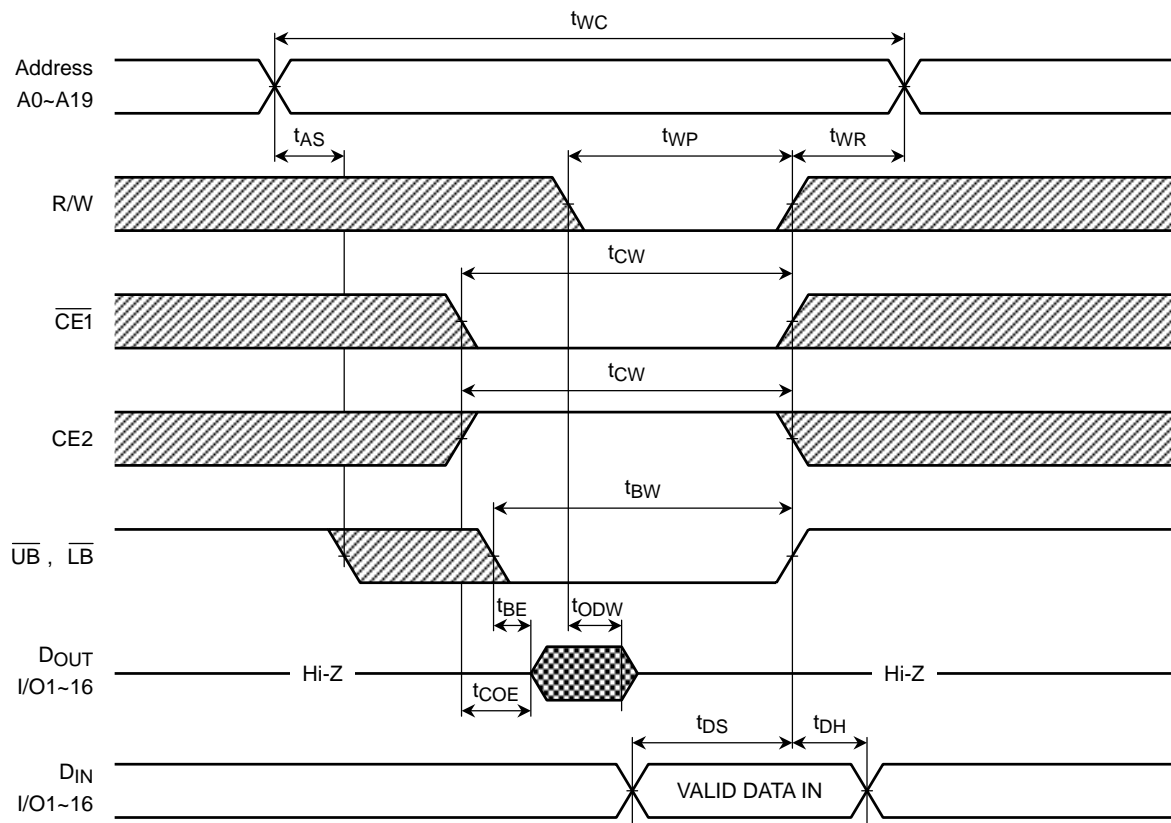
WRITE CYCLE 2 (CE1 CONTROLLED)



WRITE CYCLE 3 (CE2 CONTROLLED)



WRITE CYCLE 4 (\overline{UB} , \overline{LB} CONTROLLED)



Note:

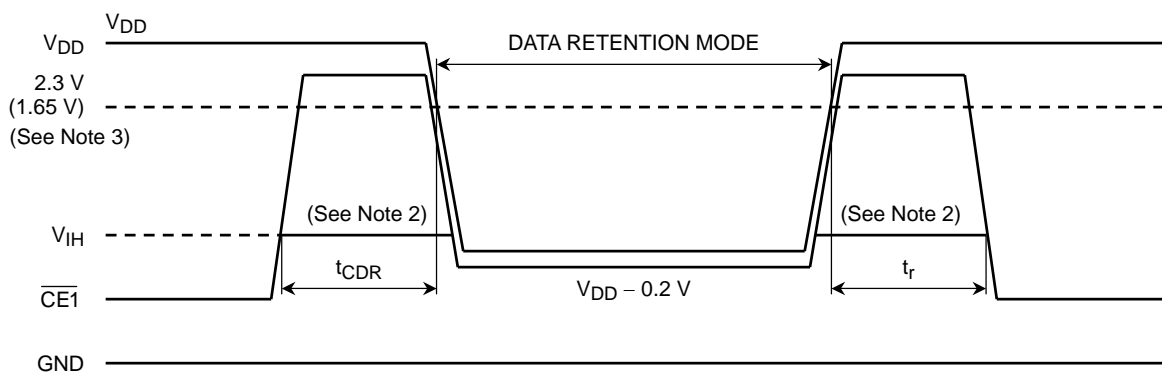
- Read cycle
 R/W remains HIGH for the read cycle.
- Write cycle1
 - (1) If $\overline{CE1}$ (or \overline{UB} or \overline{LB}) goes LOW (or CE2 goes HIGH) coincident with or after R/W goes LOW, the outputs will remain at high impedance.
 - (2) If $\overline{CE1}$ (or \overline{UB} or \overline{LB}) goes HIGH (or CE2 goes LOW) coincident with or before R/W goes HIGH, the outputs will remain at high impedance.

Don't input the same polarity signal as a R/W signal into a \overline{OE} during the write cycle.
- Write cycle1 to 4
 If \overline{OE} is HIGH during the write cycle, the outputs will remain at high impedance.
 Because I/O signals may be in the output state at this time, input signals of reverse polarity must not be applied.

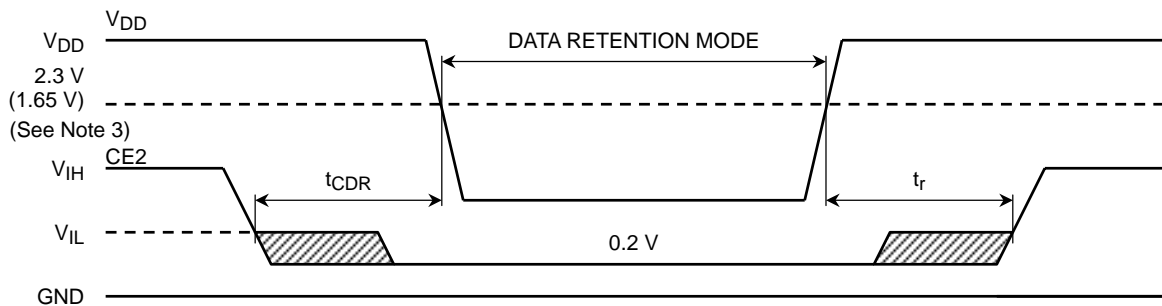
DATA RETENTION CHARACTERISTICS (Ta = -40° to 85°C)

SYMBOL	PARAMETER		TC55VCM416BTGN55 TC55VCM416BSGN55 TC55VEM416BXGN55		TC55YCM416BTGN70 TC55YCM416BSGN70 TC55YEM416BXGN70		UNIT
			MIN	MAX	MIN	MAX	
V _{DH}	Data Retention Supply Voltage		1.5	3.6	1.0	2.2	V
I _{DD} S2	Standby Current	V _{DH} = 3.6 V Ta = -40~85°C	—	15	—	—	μA
		V _{DH} = 3.0 V Ta = -40~40°C	—	2	—	—	
		V _{DH} = 2.2 V Ta = -40~85°C	—	—	—	15	
t _{CDR}	Chip Deselect to Data Retention Mode Time		0	—	0	—	ns
t _r	Recovery Time		5	—	5	—	ms

CE1 CONTROLLED DATA RETENTION MODE (See Note 1)



CE2 CONTROLLED DATA RETENTION MODE (See Note 4)

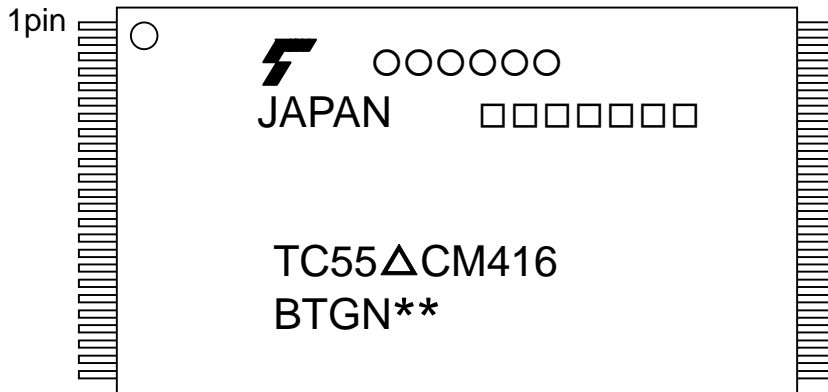


Note:

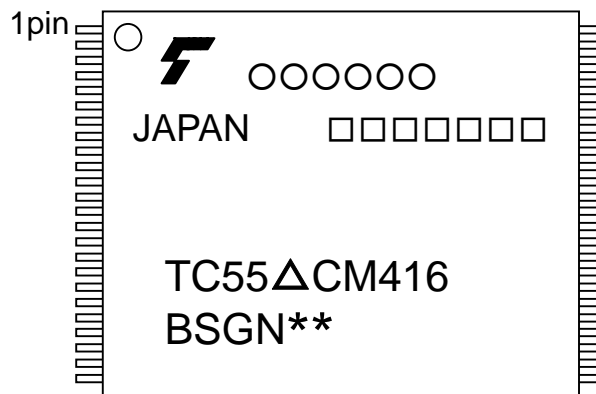
- (1) In $\overline{\text{CE1}}$ controlled data retention mode, minimum standby current mode is entered when $\text{CE2} \leq 0.2 \text{ V}$ or $\text{CE2} \geq \text{V}_{\text{DD}} - 0.2 \text{ V}$.
- (2) When $\overline{\text{CE1}}$ is operating at the V_{IH}(min.) level, the operating current is given by I_{DD}S1 during the transition of V_{DD} from 2.3(2.7) to 2.2 V(2.4 V). (TC55VCM416B, TC55VEM416B)
- (3) When $\overline{\text{CE1}}$ is operating at the V_{IH}(min.) level, the operating current is given by I_{DD}S1 during the transition of V_{DD} from 1.65 to 1.6 V. (TC55YCM416B, TC55YEM416B)
- (4) In CE2 controlled data retention mode, minimum standby current mode is entered when CE2 ≤ 0.2 V.

MARKING (Example)

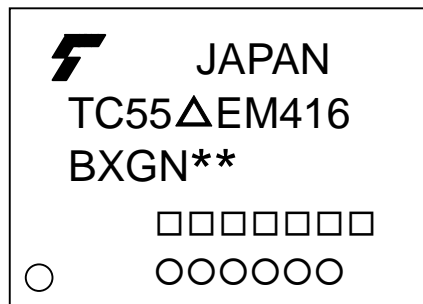
TC55VCM416BTGN/TC55YCM416BTGN Family



TC55VCM416BSGN/TC55YCM416BSGN Family



TC55VEM416BXGN/TC55YEM416BXGN Family



EXPLANATION

△ : Operating supply voltage (V:V_{DD} = 2.3 to 3.6 V, Y: V_{DD} = 1.65 to 2.2 V)

** : Speed version

○ ○ ○ ○ ○ ○ : Key code

□ □ □ □ □ □ : Lot code

Control code

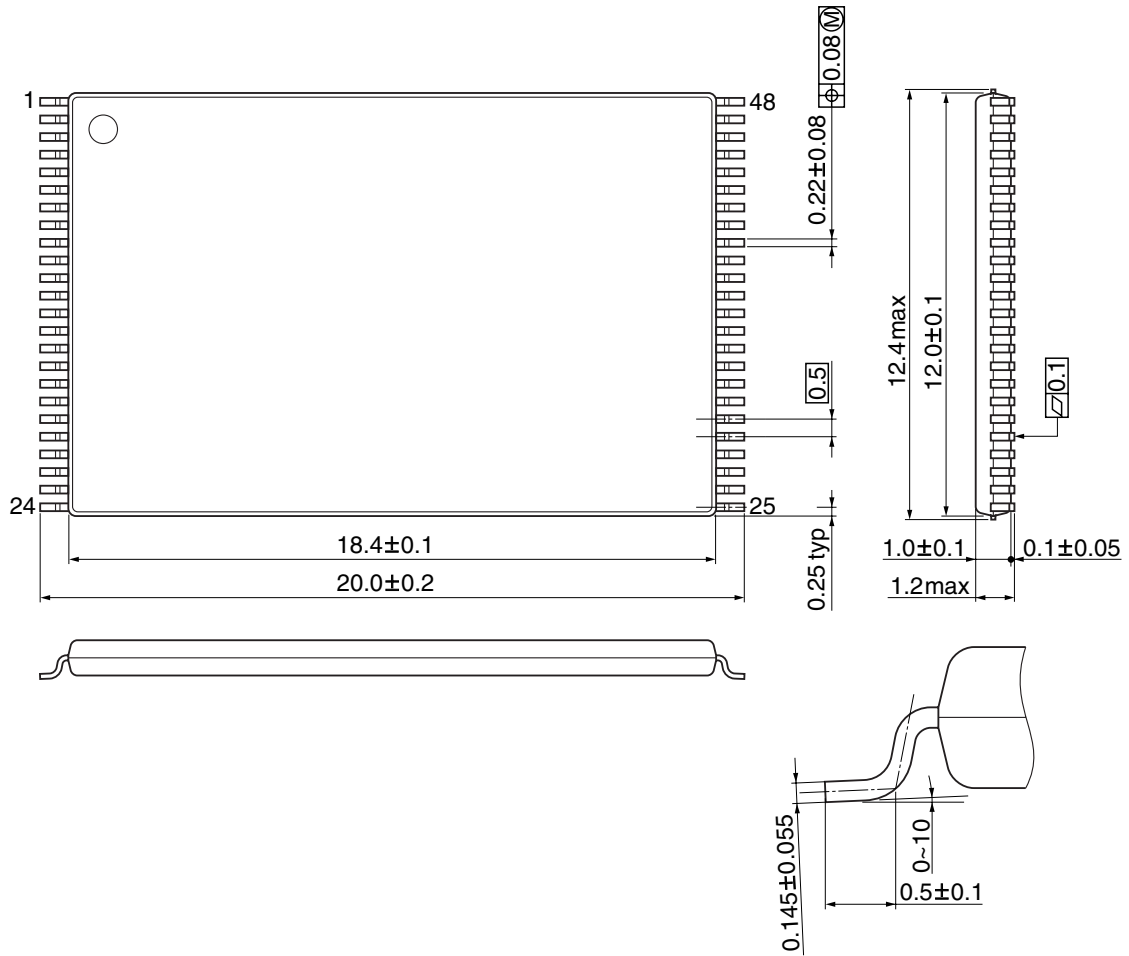
Week code

Year code

PACKAGE DIMENSIONS

TSOP I 48-P-1220-0.50

Unit:mm

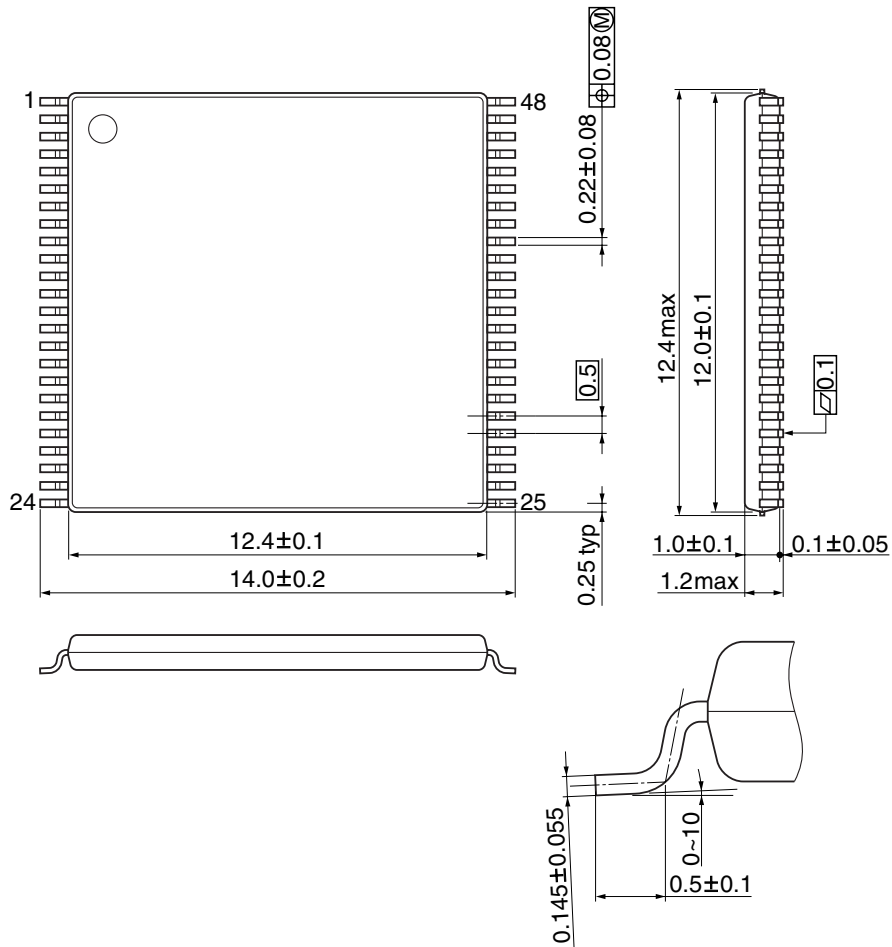


Weight:0.510 g (typ)

PACKAGE DIMENSIONS

TSOP I 48-P-1214-0.50

Unit:mm

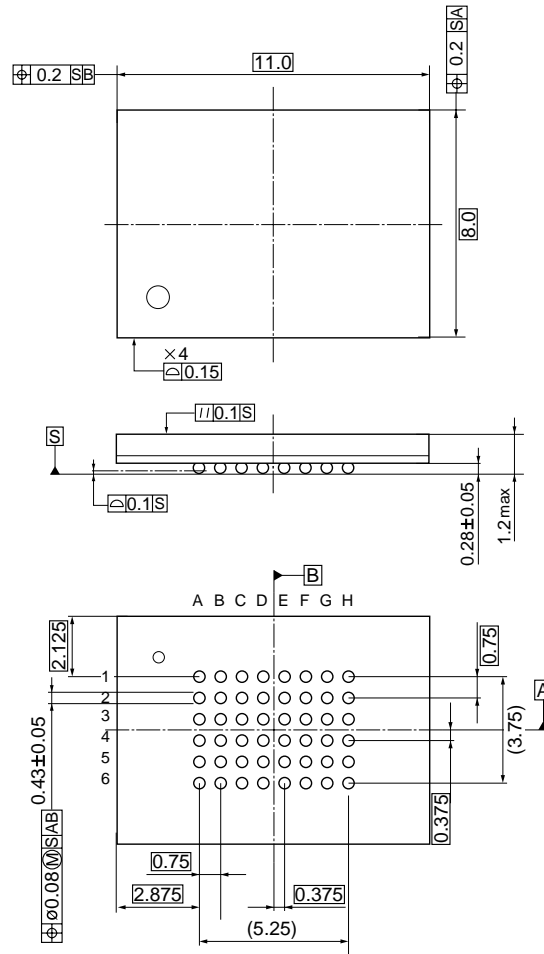


Weight:0.353 g (typ)

PACKAGE DIMENSIONS

Unit:mm

P-TFBGA48-0811-0.75BZ



Weight:0.154 g (typ)

REVISION HISTORY

Draft Date	Revision Page		Type	Passage	Content
	After	Before			

RESTRICTIONS ON PRODUCT USE

030619EBA

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