

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			

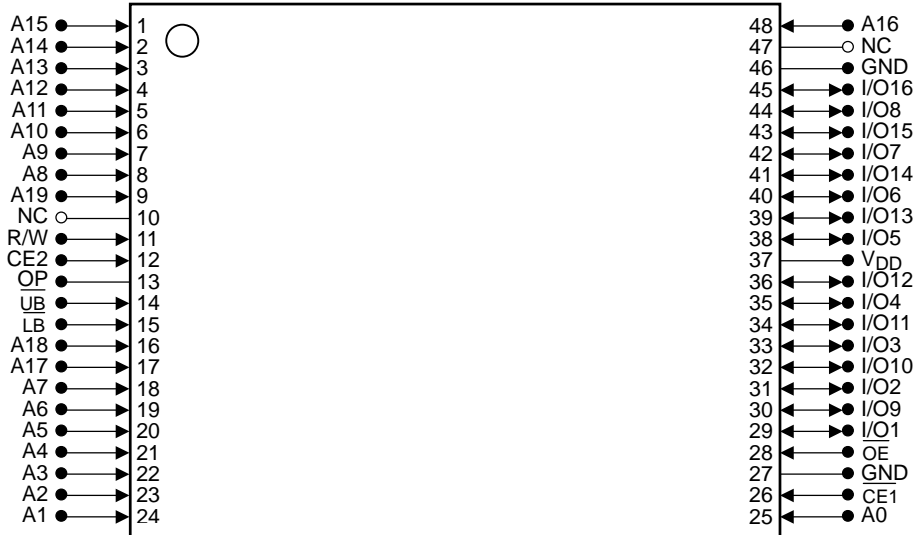
PIN ASSIGNMENT (TOP VIEW)

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

TC55VCM416BTGN
 TC55YCM416BTGN

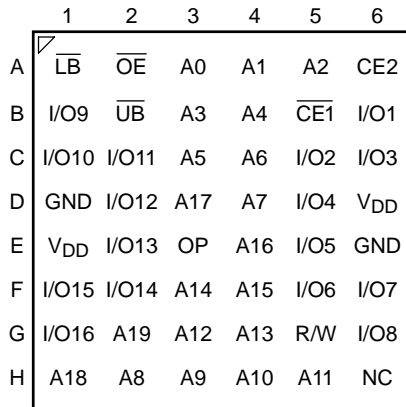
48-pin Plastic TSOP(I) (12×14mm) (0.5mm pin pitch) (Normal bent)

TC55VCM416BSGN
 TC55YCM416BSGN



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

TC55VEM416BXGN
 TC55YEM416BXGN

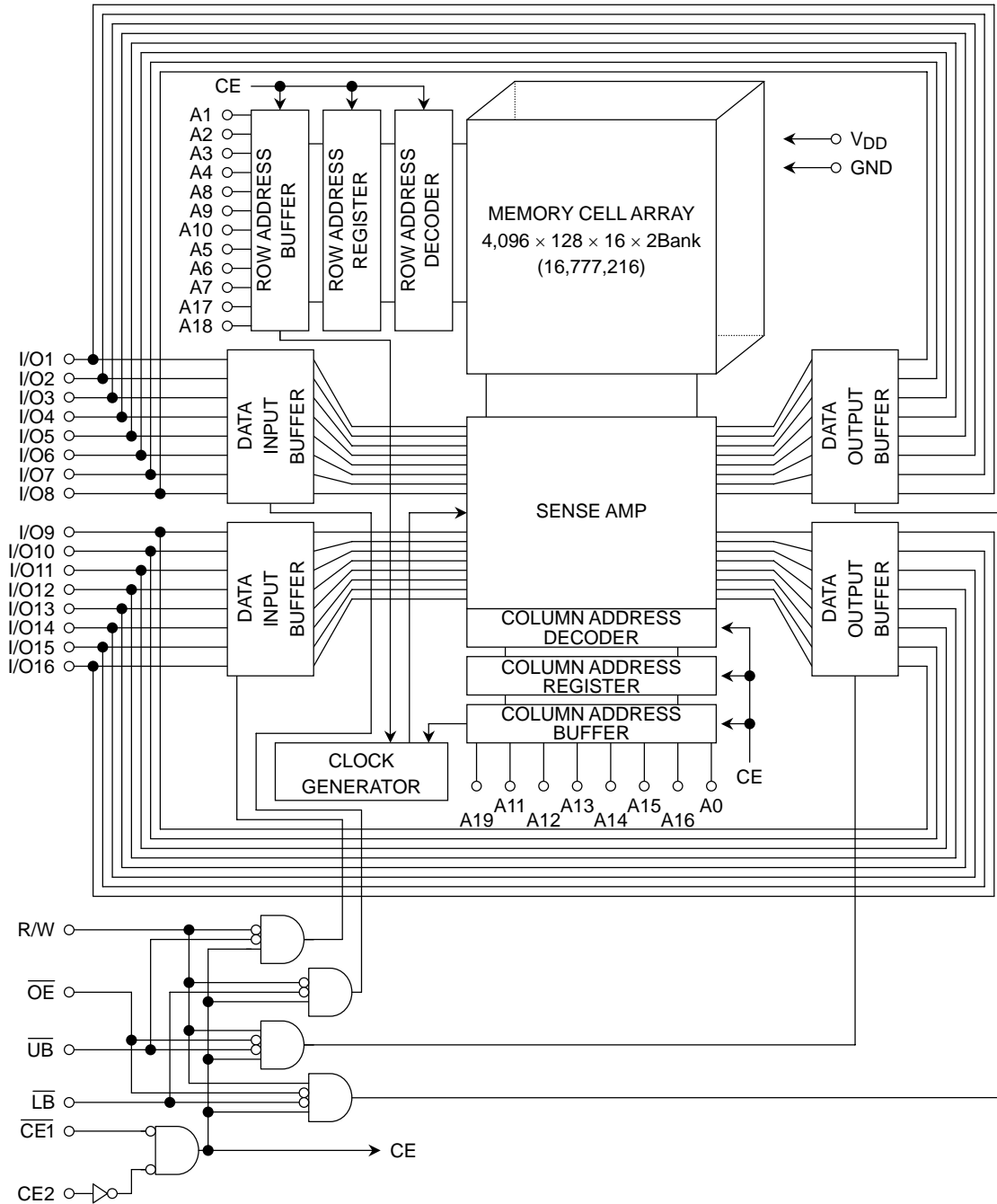


PIN NAMES

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	°C
		BGA type	-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	CE1 = VIH or CE2 = VIL or LB = UB = VIH or R/W = VIL or OE = VIH, VOUT = 0 V-VDD	—	—	±1.0	—	—	±1.0	μA		
IDDO1	Operating Current	CE1 = VIL and CE2 = VIH and R/W = VIH, IOUT = 0 mA, Other Input = VIH/VIL	t _{cycle}	MIN	—	—	20	—	—	12	mA
				1 μs	—	—	8	—	—	2	
IDDO2	Operating Current	CE1 = 0.2 V and CE2 = VDD - 0.2 V and R/W = VDD - 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	CE1 = VIH or CE2 = VIL		—	—	1	—	—	1	mA	
IDDS2		1) CE1 = VDD - 0.2 V, CE2 = VDD - 0.2 V	VDD = 2.3~3.6 V	Ta = -40~85°C	—	—	15	—	—	—	μA
				Ta = 25°C	—	0.7	1.0	—	—	—	
			VDD = 3.0 V	Ta = -40~40°C	—	—	2	—	—	—	
				Ta = 25°C	—	—	—	—	—	15	
	2) CE2 = 0.2 V	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

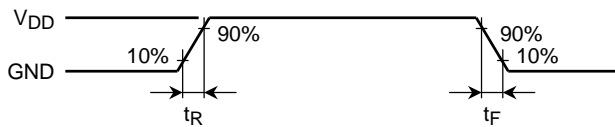
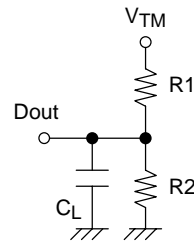
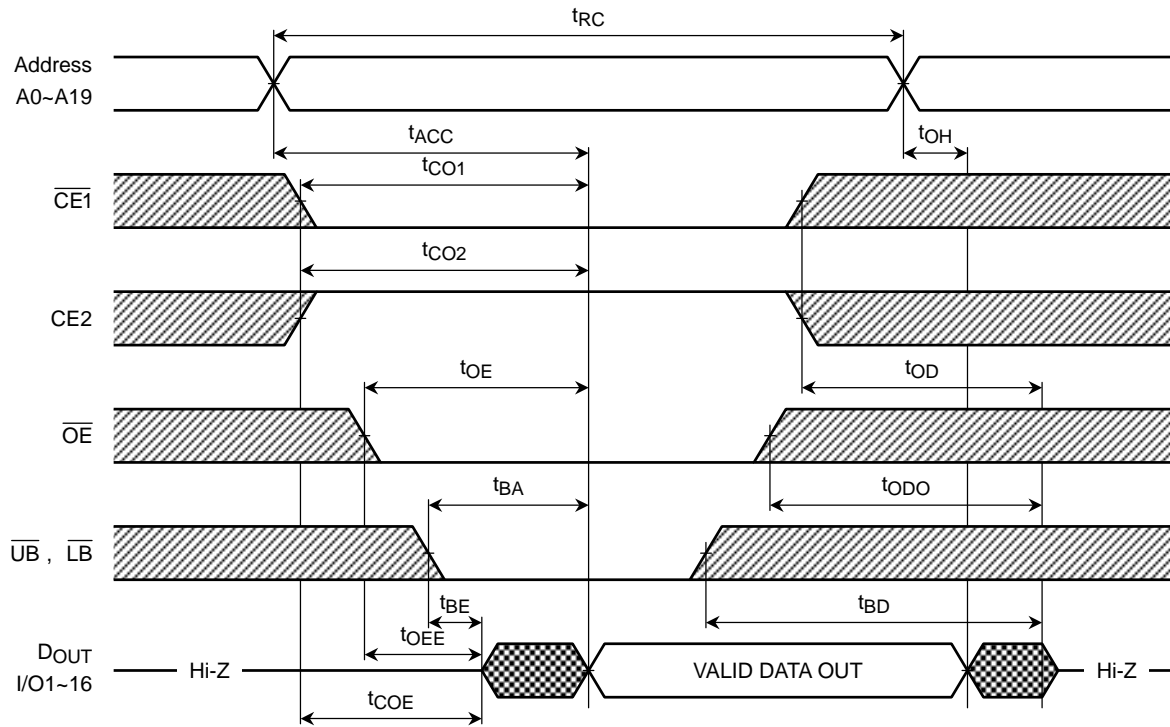


Fig.2 : Output load

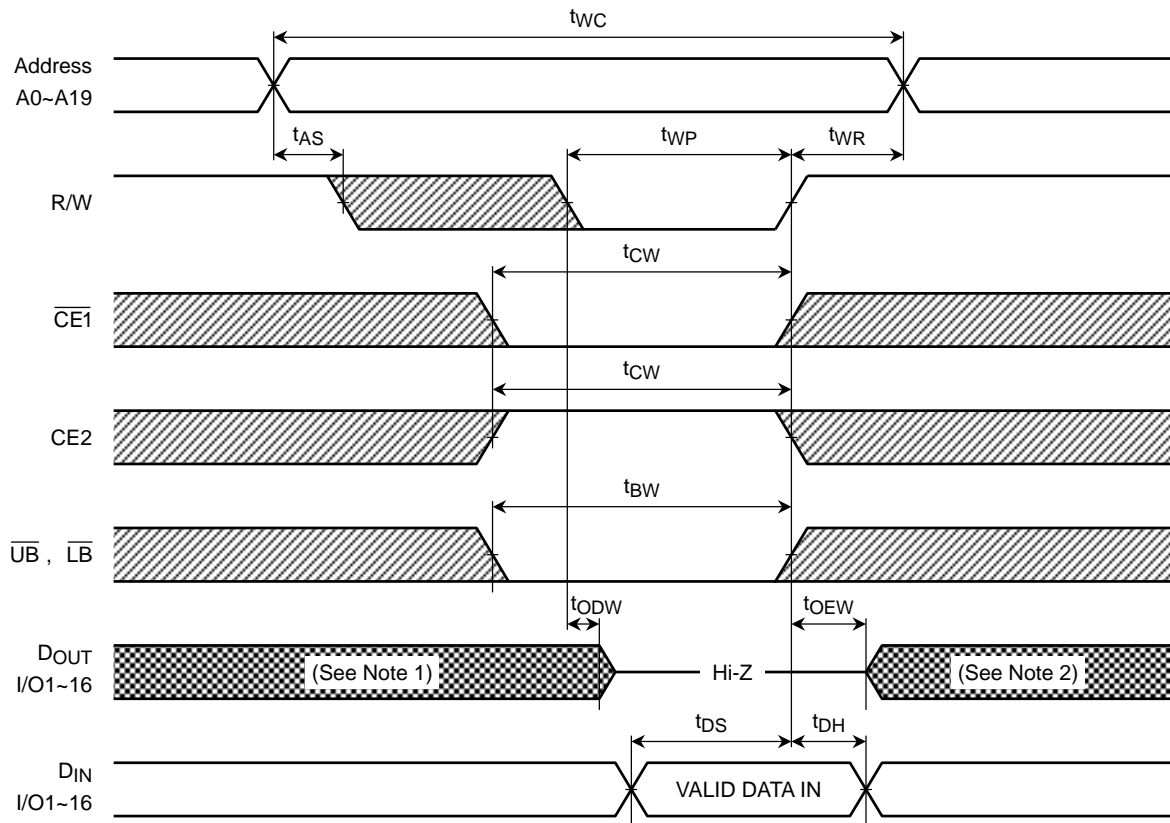


TIMING DIAGRAMS

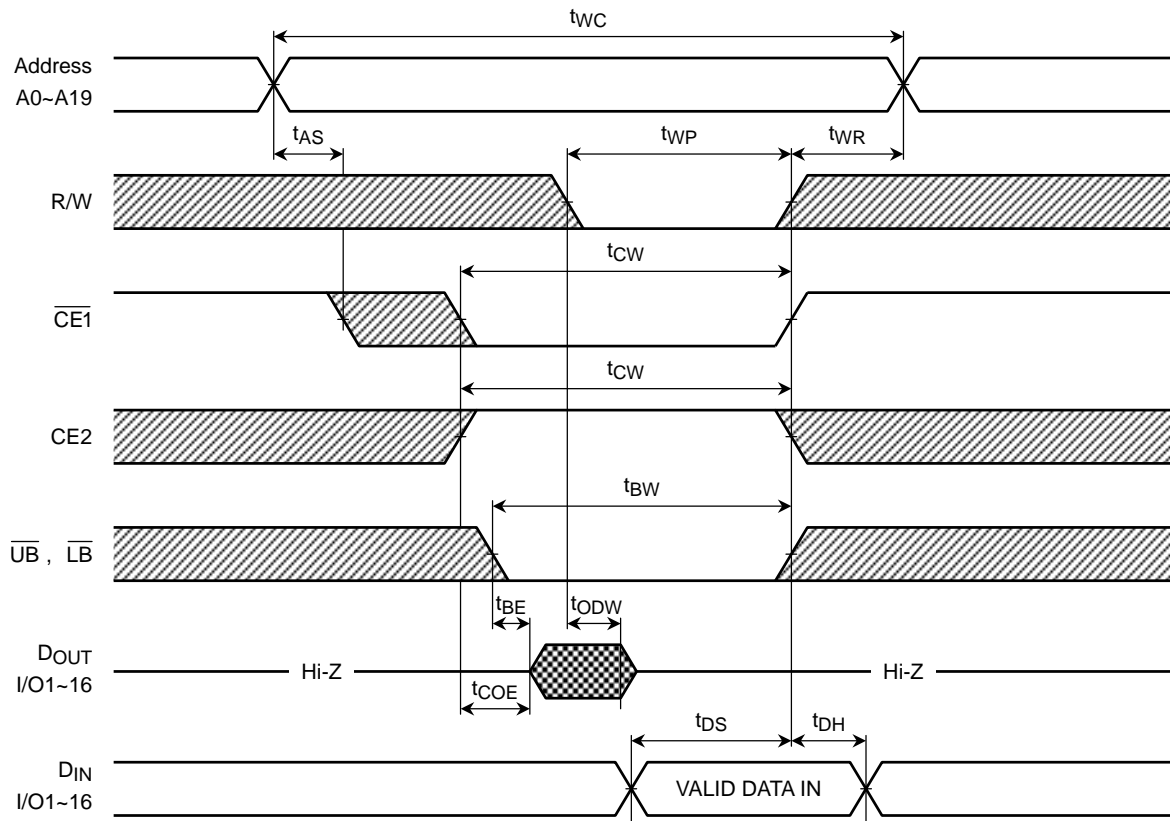
READ CYCLE



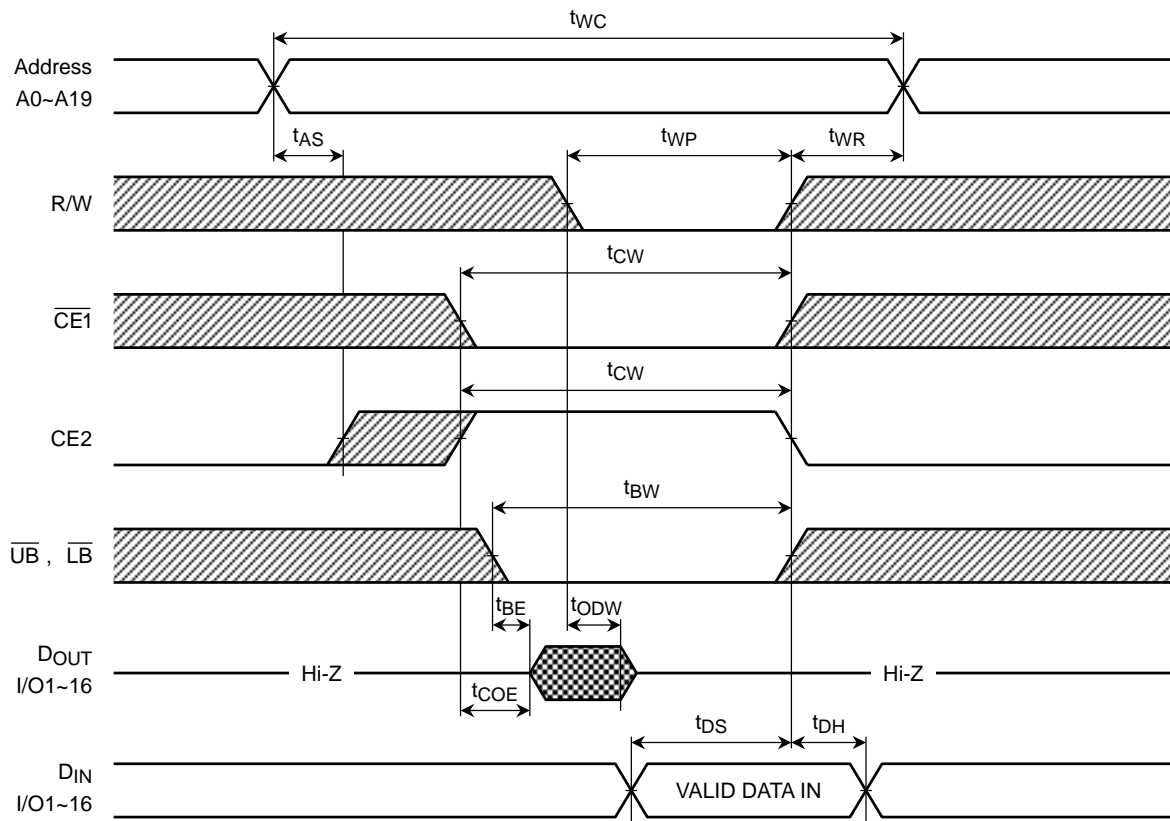
WRITE CYCLE 1 (R/W CONTROLLED)



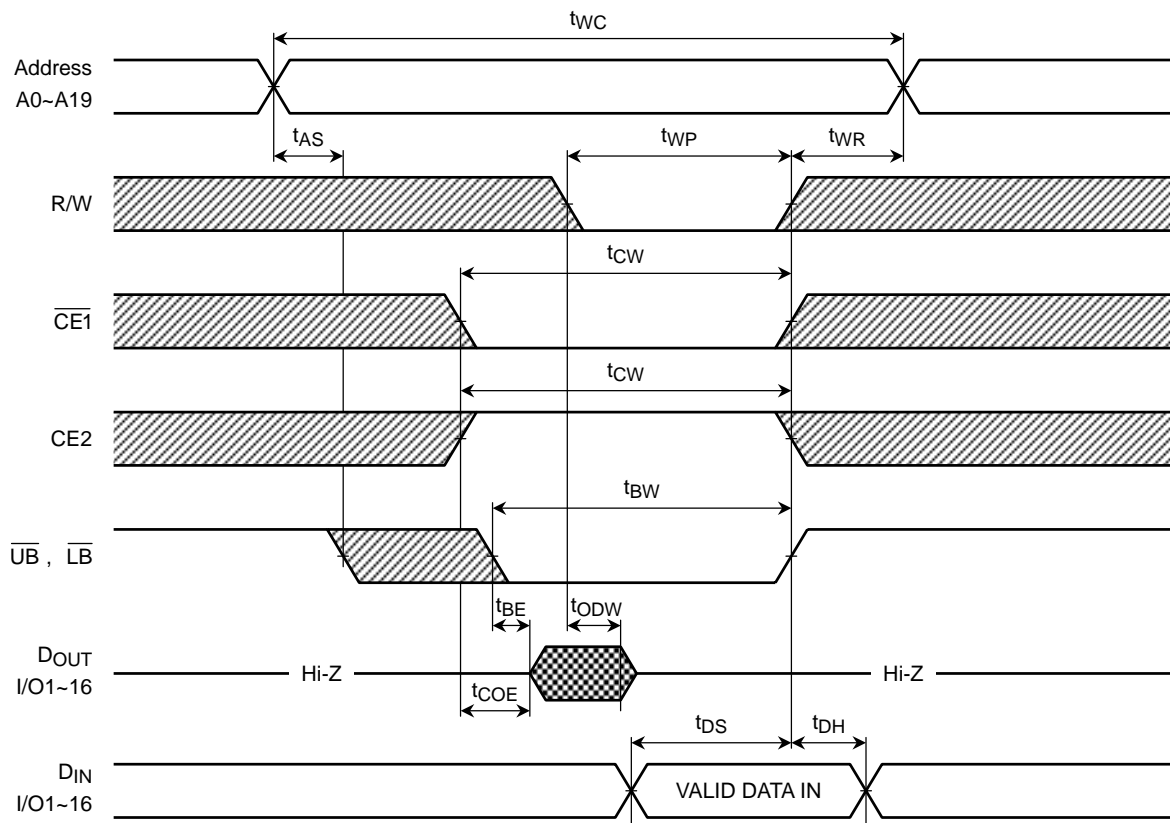
WRITE CYCLE 2 ($\overline{CE1}$ CONTROLLED)



WRITE CYCLE 3 (CE2 CONTROLLED)



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



Note:

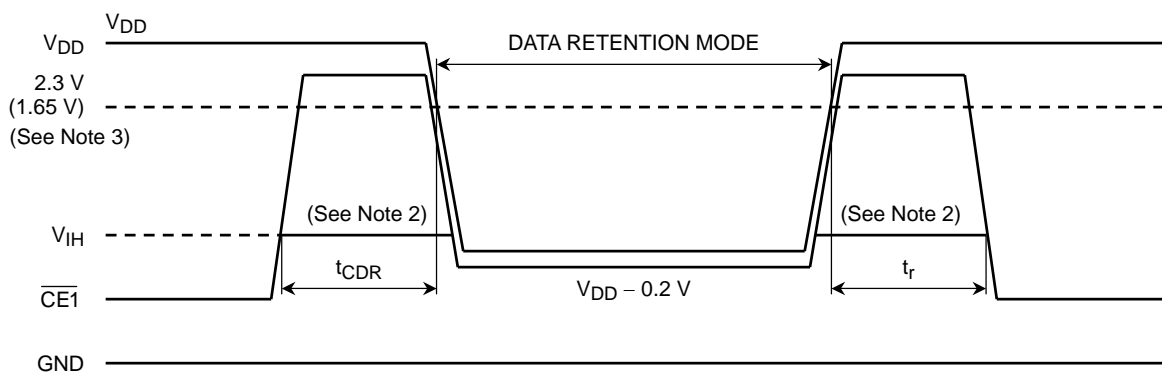
- Read cycle
 R/W remains HIGH for the read cycle.
- Write cycle1
 - (1) If $\overline{CE1}$ (or \overline{UB} or \overline{LB}) goes LOW (or CE2 goes HIGH) coincident with or after R/W goes LOW, the outputs will remain at high impedance.
 - (2) If $\overline{CE1}$ (or \overline{UB} or \overline{LB})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

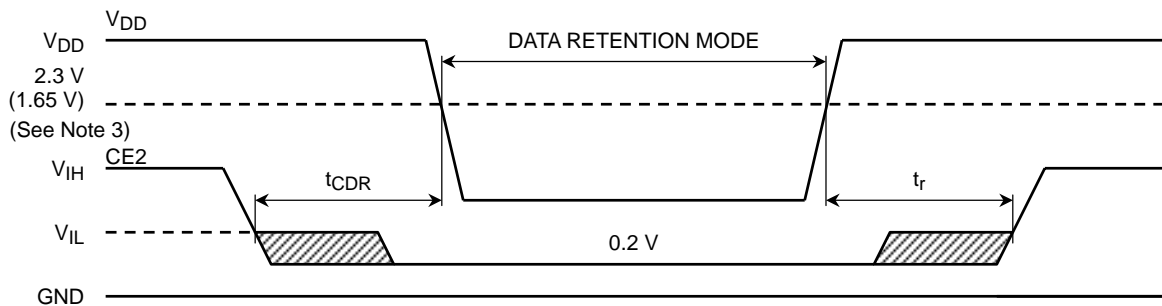
DATA RETENTION CHARACTERISTICS (Ta = -40° to 85°C)

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)

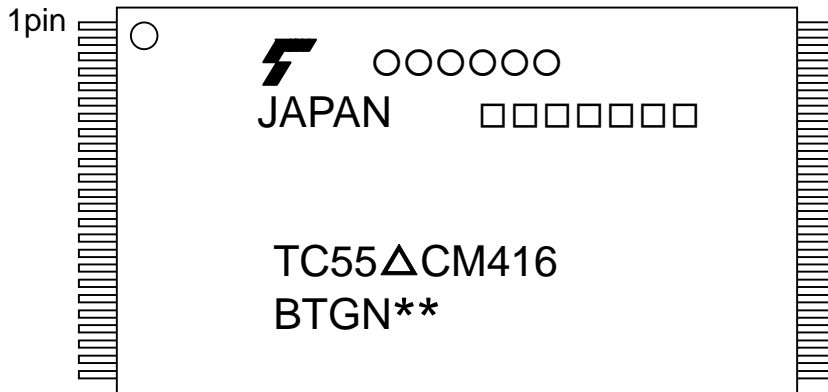


Note:

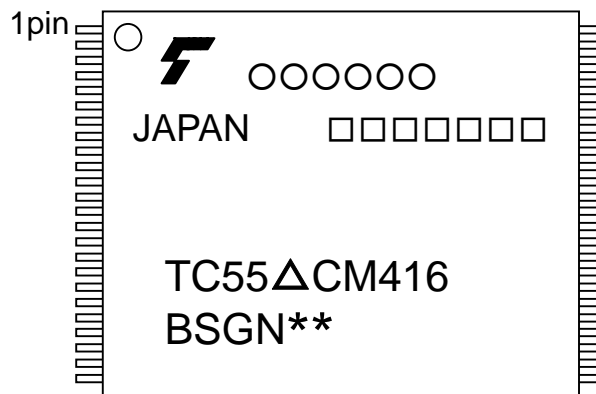
- (1) In $\overline{\text{CE1}}$ controlled data retention mode, minimum standby current mode is entered when $\text{CE2} \leq 0.2 \text{ V}$ or $\text{CE2} \geq \text{V}_{\text{DD}} - 0.2 \text{ V}$.
- (2) When $\overline{\text{CE1}}$ is operating at the V_{IH}(min.) level, the operating current is 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 $\text{CE2} \leq 0.2 \text{ V}$.

MARKING (Example)

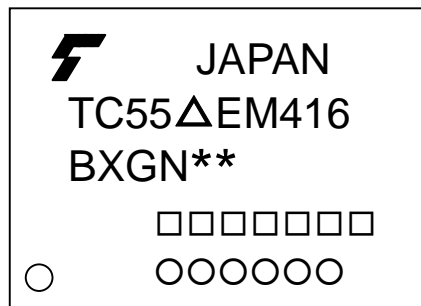
TC55VCM416BTGN/TC55YCM416BTGN Family



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

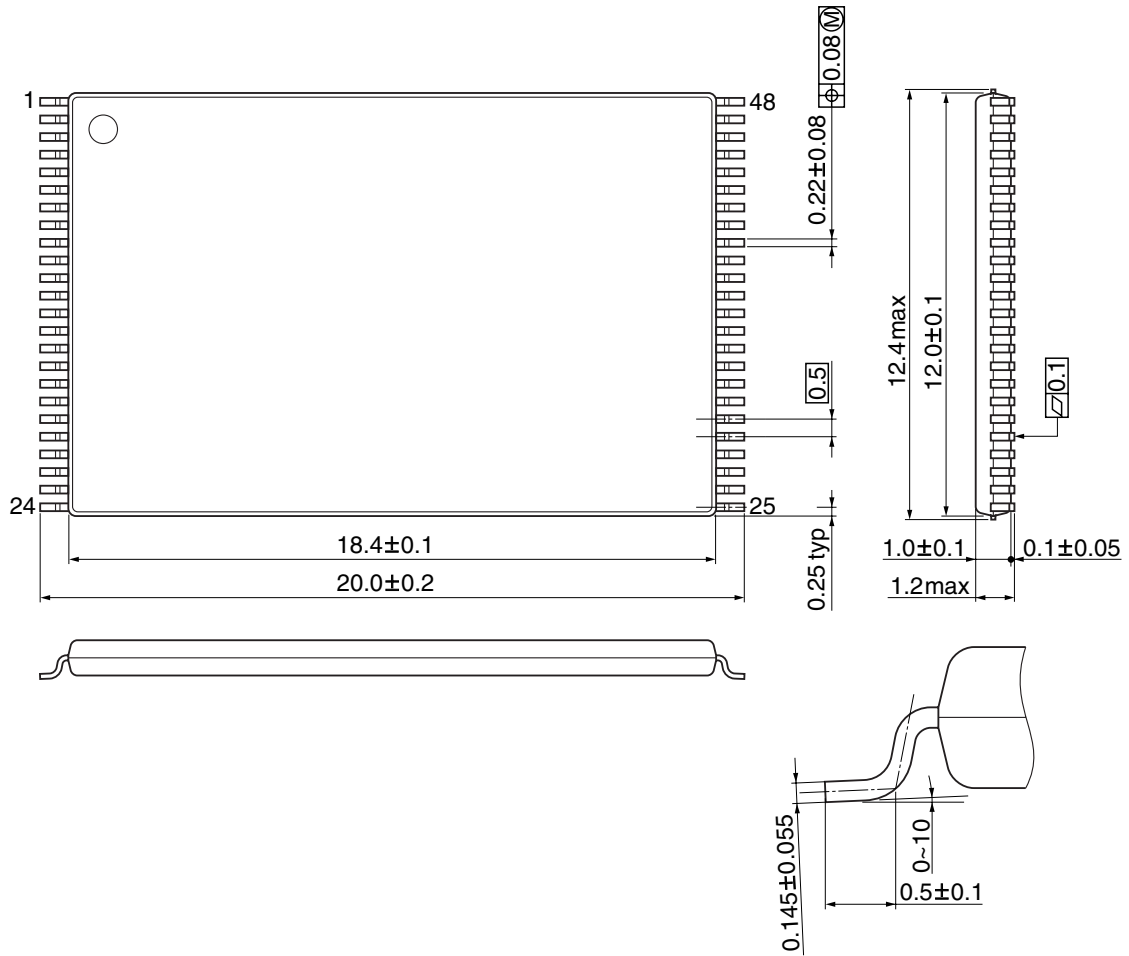
Week code

Year code

PACKAGE DIMENSIONS

TSOP I 48-P-1220-0.50

Unit:mm

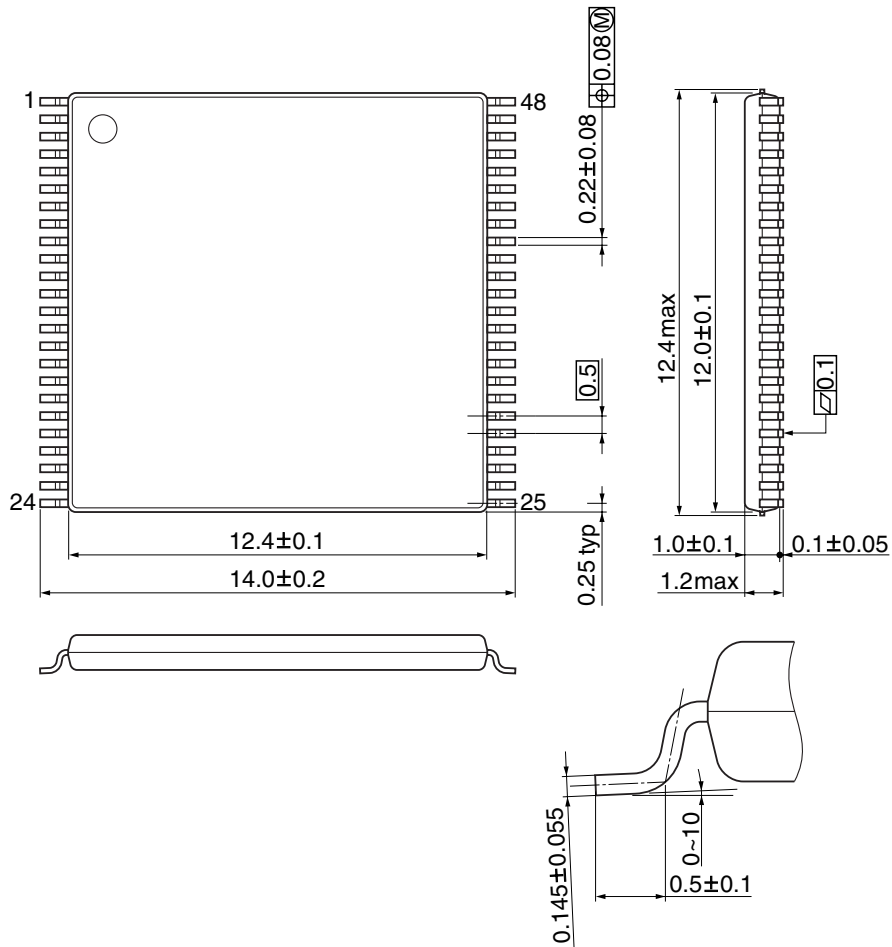


Weight:0.510 g (typ)

PACKAGE DIMENSIONS

TSOP I 48-P-1214-0.50

Unit:mm

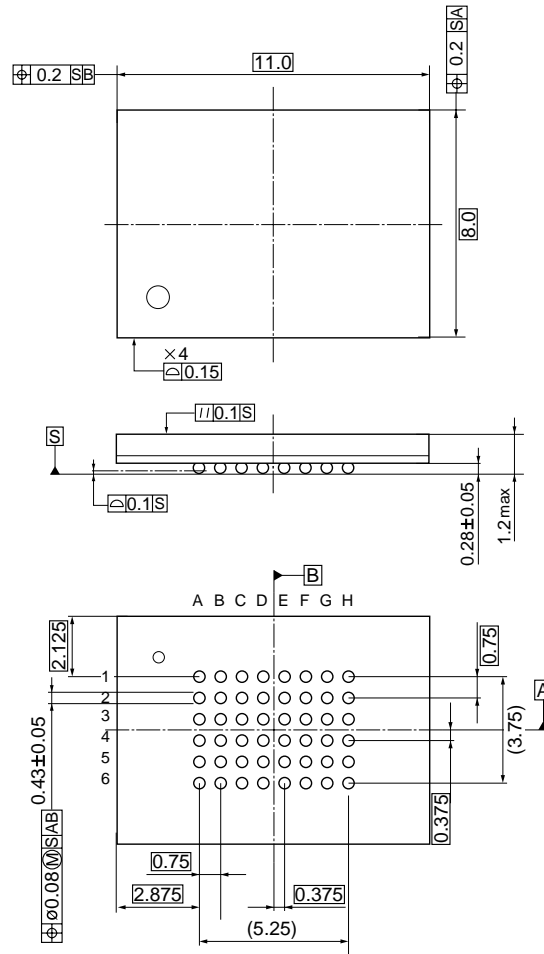


Weight:0.353 g (typ)

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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- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
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