Preliminary
Notice: This is not final specification.
Some parametric limits are subject to change.

M5M5T5636GP –20,16,13

18874368-BIT(524288-WORD BY 36-BIT) NETWORK SRAM

DESCRIPTION

The M5M5T5636GP is a family of 18M bit synchronous SRAMs organized as 524288-words by 36-bit. It is designed to eliminate dead bus cycles when turning the bus around between reads and writes, or writes and reads. Renesas's SRAMs are fabricated with high performance, low power CMOS technology, providing greater reliability. M5M5T5636GP operates on a single 2.5V power supply and are 2.5V CMOS compatible.

FEATURES

- **Fully registered inputs and outputs for pipelined operation**
- **Fast clock speed: 200MHz, 167MHz, 133MHz**
- **Fast access time: 3.2ns, 3.8ns, 4.2ns**
- **Single 2.5V -5% and +5% power supply V_{DD}**
- **Individual byte write (BWa# - BWd#) controls may be tied LOW**
- **Single Read/Write control pin (W#)**
- **CKE# pin to enable clock and suspend operations**
- **Internally self-timed, registers outputs eliminate the need to control G#**
- **Snooze mode (ZZ) for power down**
- **Linear or Interleaved Burst Modes**
- **Three chip enables for simple depth expansion**

Package

100pin TQFP

APPLICATION

High-end networking products that require high bandwidth, such as switches and routers.

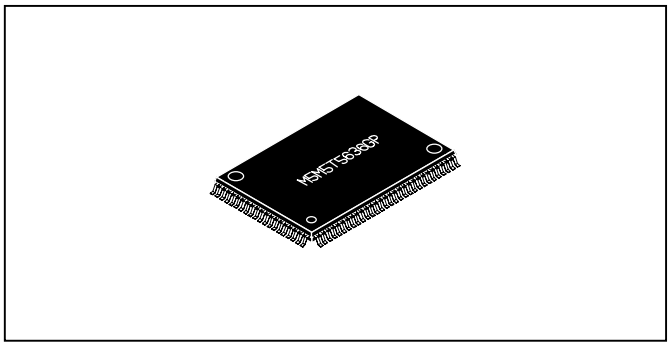
FUNCTION

Synchronous circuitry allows for precise cycle control triggered by a positive edge clock transition.

Synchronous signals include : all Addresses, all Data Inputs, all Chip Enables (E1#, E2, E3#), Address Advance/Load (ADV), Clock Enable (CKE#), Byte Write Enables (BWa#, BWb#, BWc#, BWd#) and Read/Write (W#). Write operations are controlled by the four Byte Write Enables (BWa# - BWd#) and Read/Write(W#) inputs. All writes are conducted with on-chip synchronous self-timed write circuitry.

Asynchronous inputs include Output Enable (G#), Clock (CLK) and Snooze Enable (ZZ). The HIGH input of ZZ pin puts the SRAM in the power-down state.The Linear Burst order (LBO#) is DC operated pin. LBO# pin will allow the choice of either an interleaved burst, or a linear burst.

All read, write and deselect cycles are initiated by the ADV LOW input. Subsequent burst address can be internally generated as controlled by the ADV HIGH input.

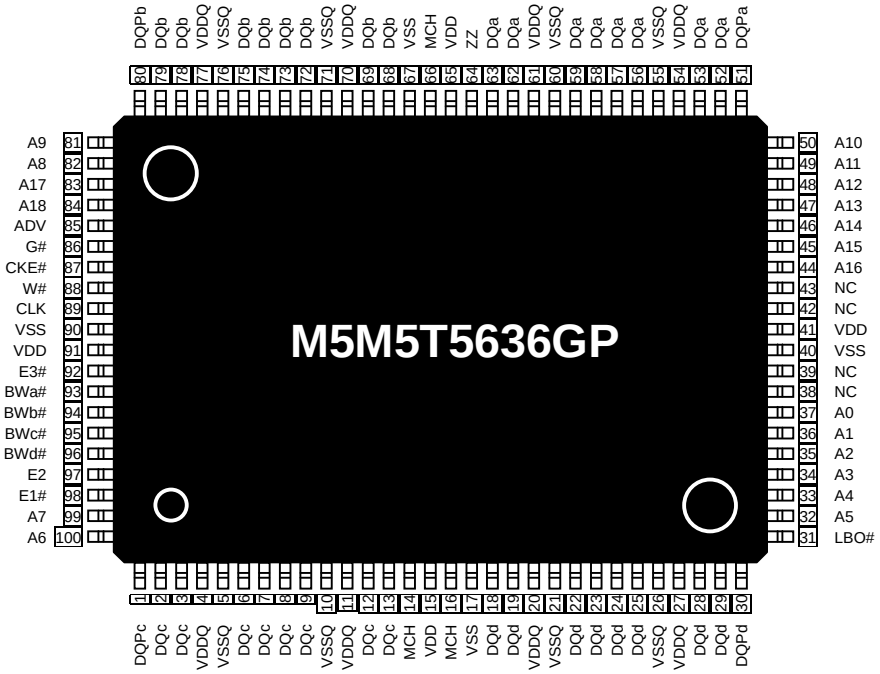


PART NAME TABLE

Part Name	Access	Cycle	Active Current (max.)	Standby Current (max.)
M5M5T5636GP - 20	3.2ns	5.0ns	450mA	30mA
M5M5T5636GP - 16	3.8ns	6.0ns	380mA	30mA
M5M5T5636GP - 13	4.2ns	7.5ns	350mA	30mA

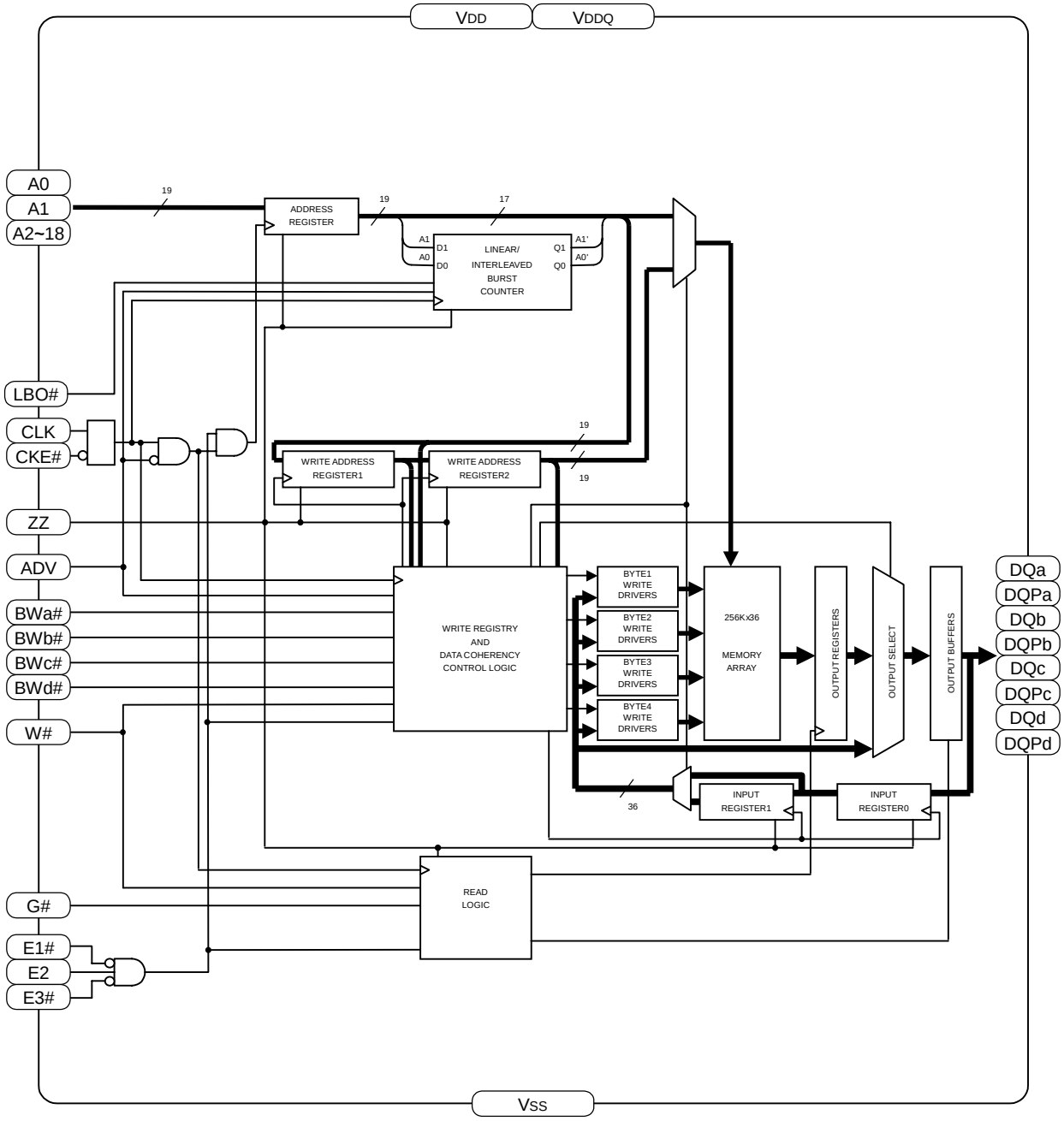
PIN CONFIGURATION(TOP VIEW)

100pin TQFP



Note1. MCH means "Must Connect High". MCH should be connected to HIGH.

BLOCK DIAGRAM



Note2. The BLOCK DIAGRAM does not include the Boundary Scan logic.
Note3. The BLOCK DIAGRAM illustrates simplified device operation. See TRUTH TABLE, PIN FUNCTION and timing diagrams for detailed information.

PIN FUNCTION

Pin	Name	Function
A0~A18	Synchronous Address Inputs	These inputs are registered and must meet the setup and hold times around the rising edge of CLK. A0 and A1 are the two least significant bits (LSB) of the address field and set the internal burst counter if burst is desired.
BWa#, BWb#, BWc#, BWd#	Synchronous Byte Write Enables	These active LOW inputs allow individual bytes to be written when a WRITE cycle is active and must meet the setup and hold times around the rising edge of CLK. BYTE WRITEs need to be asserted on the same cycle as the address. BWs are associated with addresses and apply to subsequent data. BWa# controls DQa, DQPa pins; BWb# controls DQb, DQPb pins; BWc# controls DQc, DQPc pins; BWd# controls DQd, DQPd pins.
CLK	Clock Input	This signal registers the address, data, chip enables, byte write enables and burst control inputs on its rising edge. All synchronous inputs must meet setup and hold times around the clock's rising edge.
E1#	Synchronous Chip Enable	This active LOW input is used to enable the device and is sampled only when a new external address is loaded (ADV is LOW).
E2	Synchronous Chip Enable	This active High input is used to enable the device and is sampled only when a new external address is loaded (ADV is LOW). This input can be used for memory depth expansion.
E3#	Synchronous Chip Enable	This active Low input is used to enable the device and is sampled only when a new external address is loaded (ADV is LOW). This input can be used for memory depth expansion.
G#	Output Enable	This active LOW asynchronous input enable the data I/O output drivers.
ADV	Synchronous Address Advance/Load	When HIGH, this input is used to advance the internal burst counter, controlling burst access after the external address is loaded. When HIGH, W# is ignored. A LOW on this pin permits a new address to be loaded at CLK rising edge.
CKE#	Synchronous Clock Enable	This active LOW input permits CLK to propagate throughout the device. When HIGH, the device ignores the CLK input and effectively internally extends the previous CLK cycle. This input must meet setup and hold times around the rising edge of CLK.
ZZ	Snooze Enable	This active HIGH asynchronous input causes the device to enter a low-power standby mode in which all data in the memory array is retained. When active, all other inputs are ignored. When this pin is LOW or NC, the SRAM normally operates.
W#	Synchronous Read/Write	This active input determines the cycle type when ADV is LOW. This is the only means for determining READs and WRITEs. READ cycles may not be converted into WRITEs (and vice versa) other than by loading a new address. A LOW on the pin permits BYTE WRITE operations and must meet the setup and hold times around the rising edge of CLK. Full bus width WRITEs occur if all byte write enables are LOW.
DQa,DQPa,DQb,DQPb DQc,DQPc,DQd,DQPd	Synchronous Data I/O	Byte “a” is DQa , DQPa pins; Byte “b” is DQb, DQPb pins; Byte “c” is DQc, DQPc pins; Byte “d” is DQd,DQPd pins. Input data must meet setup and hold times around CLK rising edge.
LBO#	Burst Mode Control	This DC operated pin allows the choice of either an interleaved burst or a linear burst. If this pin is HIGH or NC, an interleaved burst occurs. When this pin is LOW, a linear burst occurs, and input leak current to this pin.
V_{DD}	V_{DD}	Core Power Supply
V_{SS}	V_{SS}	Core Ground
V_{DDQ}	V_{DDQ}	I/O buffer Power supply
V_{SSQ}	V_{SSQ}	I/O buffer Ground
MCH	Must Connect High	These pins should be connected to HIGH
NC	No Connect	These pins are not internally connected and may be connected to ground.

DC OPERATED TRUTH TABLE

Name	Input Status	Operation
LBO#	HIGH or NC	Interleaved Burst Sequence
	LOW	Linear Burst Sequence

Note4. LBO# is DC operated pin.
Note5. NC means No Connection.
Note6. See BURST SEQUENCE TABLE about interleaved and Linear Burst Sequence.

BURST SEQUENCE TABLE

Interleaved Burst Sequence (when LBO# = HIGH or NC)

Operation	A18~A2	A1,A0			
First access, latch external address	A18~A2	0 , 0	0 , 1	1 , 0	1 , 1
Second access(first burst address)	latched A18~A2	0 , 1	0 , 0	1 , 1	1 , 0
Third access(second burst address)	latched A18~A2	1 , 0	1 , 1	0 , 0	0 , 1
Fourth access(third burst address)	latched A18~A2	1 , 1	1 , 0	0 , 1	0 , 0

Linear Burst Sequence (when LBO# = LOW)

Operation	A18~A2	A1,A0			
First access, latch external address	A18~A2	0 , 0	0 , 1	1 , 0	1 , 1
Second access(first burst address)	latched A18~A2	0 , 1	1 , 0	1 , 1	0 , 0
Third access(second burst address)	latched A18~A2	1 , 0	1 , 1	0 , 0	0 , 1
Fourth access(third burst address)	latched A18~A2	1 , 1	0 , 0	0 , 1	1 , 0

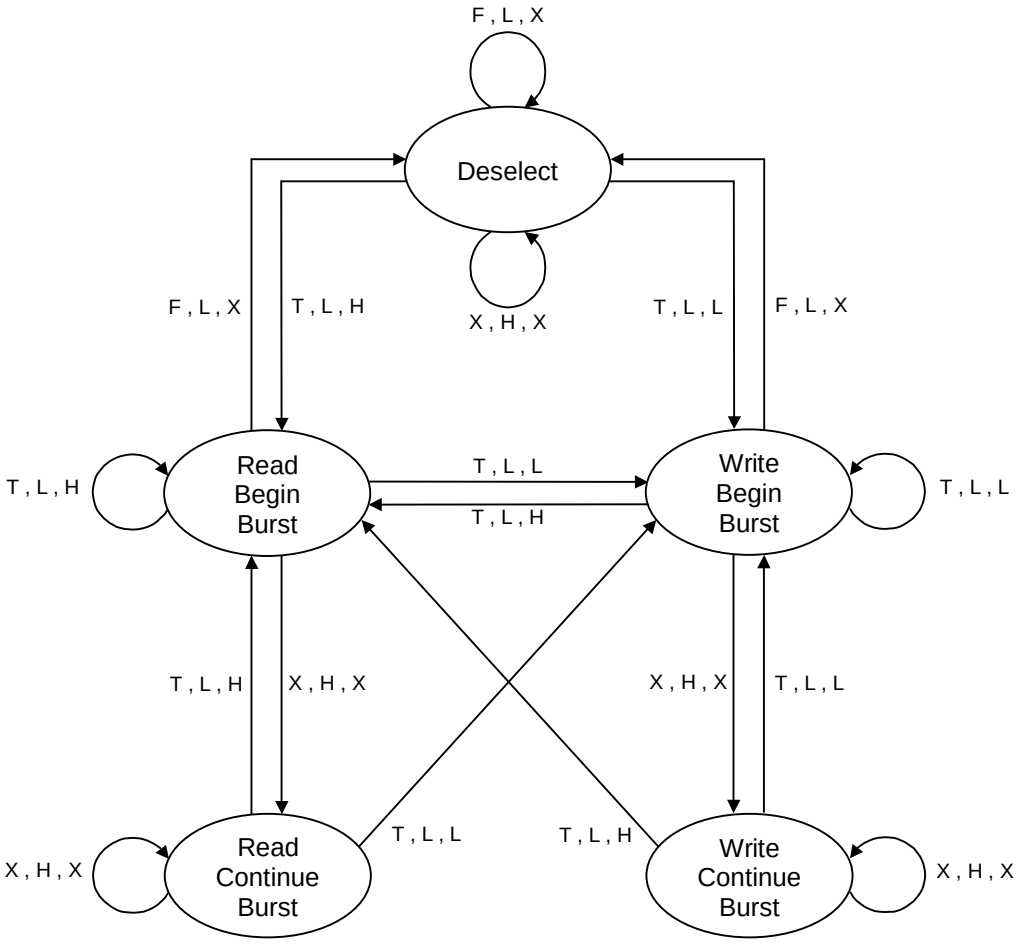
Note7. The burst sequence wraps around to its initial state upon completion.

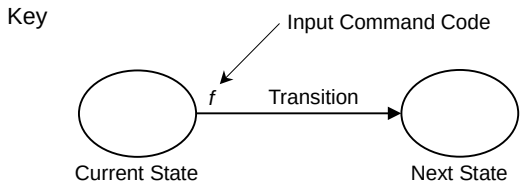
TRUTH TABLE

E1#	E2	E3#	ZZ	ADV	W#	BWx#	G#	CKE#	CLK	DQ	Address used	Operation
H	X	X	L	L	X	X	X	L	L->H	High-Z	None	Deselect Cycle
X	L	X	L	L	X	X	X	L	L->H	High-Z	None	Deselect Cycle
X	X	H	L	L	X	X	X	L	L->H	High-Z	None	Deselect Cycle
X	X	X	L	H	X	X	X	L	L->H	High-Z	None	Continue Deselect Cycle
L	H	L	L	L	H	X	L	L	L->H	Q	External	Read Cycle, Begin Burst
X	X	X	L	H	X	X	L	L	L->H	Q	Next	Read Cycle, Continue Burst
L	H	L	L	L	H	X	H	L	L->H	High-Z	External	NOP/Dummy Read, Begin Burst
X	X	X	L	H	X	X	H	L	L->H	High-Z	Next	Dummy Read, Continue Burst
L	H	L	L	L	L	L	X	L	L->H	D	External	Write Cycle, Begin Burst
X	X	X	L	H	X	L	X	L	L->H	D	Next	Write Cycle, Continue Burst
L	H	L	L	L	L	H	X	L	L->H	High-Z	None	NOP/Write Abort, Begin Burst
X	X	X	L	H	X	H	X	L	L->H	High-Z	Next	Write Abort, Continue Burst
X	X	X	L	X	X	X	X	H	L->H	-	Current	Ignore Clock edge, Stall
X	X	X	H	X	X	X	X	X	X	High-Z	None	Snooze Mode

Note8. “H” = input VIH; “L” = input VIL; “X” = input VIH or VIL.
Note9. BWx#=H means all Synchronous Byte Write Enables (BWa#,BWb#,BWc#,BWd#) are HIGH. BWx#=L means one or more Synchronous Byte Write Enables are LOW.
Note10. All inputs except G# and ZZ must meet setup and hold times around the rising edge (LOW to HIGH) of CLK.

STATE DIAGRAM





Note11. The notation "x , x , x" controlling the state transitions above indicate the state of inputs E, ADV and W# respectively.
Note12. If (E1# = L and E2 = H and E3# = L) then E="T" else E="F".
Note13. "H" = input VIH; "L" = input VIL; "X" = input VIH or VIL; "T" = input "true"; "F" = input "false".

WRITE TRUTH TABLE

W#	BWa#	BWb#	BWc#	BWd#	Function
H	X	X	X	X	Read
L	L	H	H	H	Write Byte a
L	H	L	H	H	Write Byte b
L	H	H	L	H	Write Byte c
L	H	H	H	L	Write Byte d
L	L	L	L	L	Write All Bytes
L	H	H	H	H	Write Abort/NOP

Note14. “H” = input VIH; “L” = input VIL; “X” = input VIH or VIL.
Note15. All inputs except G# and ZZ must meet setup and hold times around the rising edge (LOW to HIGH) of CLK.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Power Supply Voltage	With respect to V_{SS}	-1.0*~3.6	V
V_{DDQ}	I/O Buffer Power Supply Voltage		-1.0*~3.6	V
V_I	Input Voltage		-1.0~V_{DDQ}+1.0**	V
V_O	Output Voltage		-1.0~V_{DDQ}+1.0**	V
PD	Maximum Power Dissipation (V_{DD})		945	mW
T_{OPR}	Operating Temperature		0~70	°C
$T_{STG(bias)}$	Storage Temperature(bias)		-10~85	°C
T_{STG}	Storage Temperature		-65~150	°C

Note16.* This is –1.0V when pulse width≤2ns, and –0.5V in case of DC.
** This is –1.0V~V_{DDQ}+1.0V when pulse width≤2ns, and –0.5V~V_{DDQ}+0.5V in case of DC.

DC ELECTRICAL CHARACTERISTICS (Ta=0~70°C, V_{DD}=2.375~2.625V, unless otherwise noted)

Symbol	Parameter	Condition		Limits		Unit
				Min	Max	
V_{DD}	Power Supply Voltage			2.375	2.625	V
V_{DDQ}	I/O Buffer Power Supply Voltage			2.375	2.625	V
V_{IH}	High-level Input Voltage			1.7	V_{DDQ}+0.3*	V
V_{IL}	Low-level Input Voltage			-0.3*	0.7	V
V_{OH}	High-level Output Voltage	I_{OH} = -2.0mA		V_{DDQ}-0.4		V
V_{OL}	Low-level Output Voltage	I_{OL} = 2.0mA			0.4	V
I_{LI}	Input Leakage Current except ZZ and LBO#	V_I = 0V ~ V_{DDQ}			10	µA
	Input Leakage Current of LBO#	V_I = 0V ~ V_{DDQ}			100	
	Input Leakage Current of ZZ	V_I = 0V ~ V_{DDQ}			100	
I_{LO}	Off-state Output Current	V_I (G#) ≥ V_{IH}, V_O = 0V ~ V_{DDQ}			10	µA
I_{CC1}	Power Supply Current : Operating	Device selected; Output Open, $V_I \le V_{IL}$ or $V_I \ge V_{IH}$, ZZ≤V_{IL}	5.0ns cycle(200MHz)		450	mA
			6.0ns cycle(167MHz)		380	
			7.5ns cycle(133MHz)		350	
I_{CC2}	Power Supply Current : Deselected	Device deselected $V_I \le V_{IL}$ or $V_I \ge V_{IH}$, ZZ≤V_{IL}	5.0ns cycle(200MHz)		180	mA
			6.0ns cycle(167MHz)		160	
			7.5ns cycle(133MHz)		130	
I_{CC3}	CMOS Standby Current (CLK stopped standby mode)	Device deselected; Output Open $V_I \le V_{SS}$+0.2V or $V_I \ge V_{DDQ}$-0.2V CLK frequency=0Hz, All inputs static			30	mA
I_{CC4}	Snooze Mode Standby Current	Snooze mode ZZ≥V_{DDQ}-0.2V, LBO#≥V_{DD}-0.2V			30	mA
I_{CC5}	Stall Current	Device selected; Output Open, CKE#≥V_{IH} $V_I \le V_{SS}$+0.2V or $V_I \ge V_{DDQ}$-0.2V	5.0ns cycle(200MHz)		140	mA
			6.0ns cycle(167MHz)		130	
			7.5ns cycle(133MHz)		120	

Note17.*V_{ILmin} is –1.0V and $V_{IH\ max}$ is V_{DDQ}+1.0V in case of AC(Pulse width≤2ns).
Note18."Device Deselected" means device is in power-down mode as defined in the truth table.

CAPACITANCE

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
C_I	Input Capacitance	V_I=GND, V_I=25mVrms, f=1MHz			6	pF
C_O	Input / Output(DQ) Capacitance	V_O=GND, V_O=25mVrms, f=1MHz			8	pF

Note19.This parameter is sampled.

THERMAL RESISTANCE

4-Layer PC board mounted (70x70x1.6mmT)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
θJA	Thermal Resistance Junction Ambient	Air velocity=0m/sec		28		°C/W
		Air velocity=0.5m/sec		24		°C/W
		Air velocity=1m/sec		22		°C/W
		Air velocity=2m/sec		20		°C/W
		Air velocity=5m/sec		18		°C/W
θJC	Thermal Resistance Junction to Case			6.6		°C/W

Note20.This parameter is sampled.

AC ELECTRICAL CHARACTERISTICS (Ta=0~70°C, VDD=VDDQ=2.375~2.625V, unless otherwise noted)

(1)MEASUREMENT CONDITION

Input pulse levels ····· VIH=VDDQ, VIL=0V
Input rise and fall times ····· faster than or equal to 1V/ns
Input timing reference levels ····· VIH=VIL=0.5*VDDQ
Output reference levels ·····VIH=VIL=0.5*VDDQ
Output load ····· Fig.1

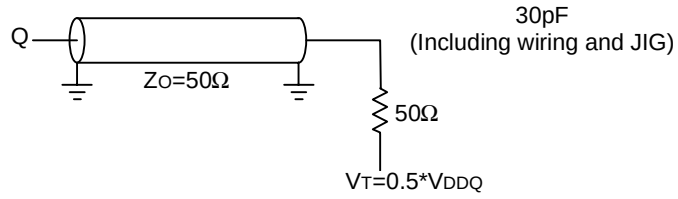


Fig.1 Output load

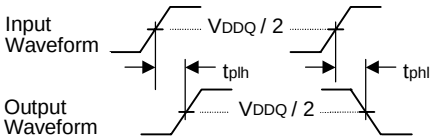


Fig.2 Tdly measurement

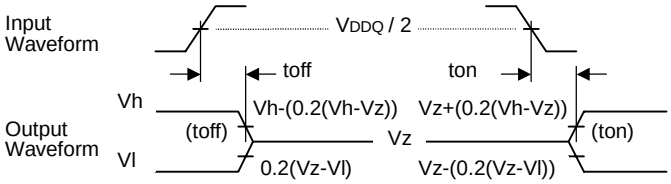


Fig.3 Tri-State measurement

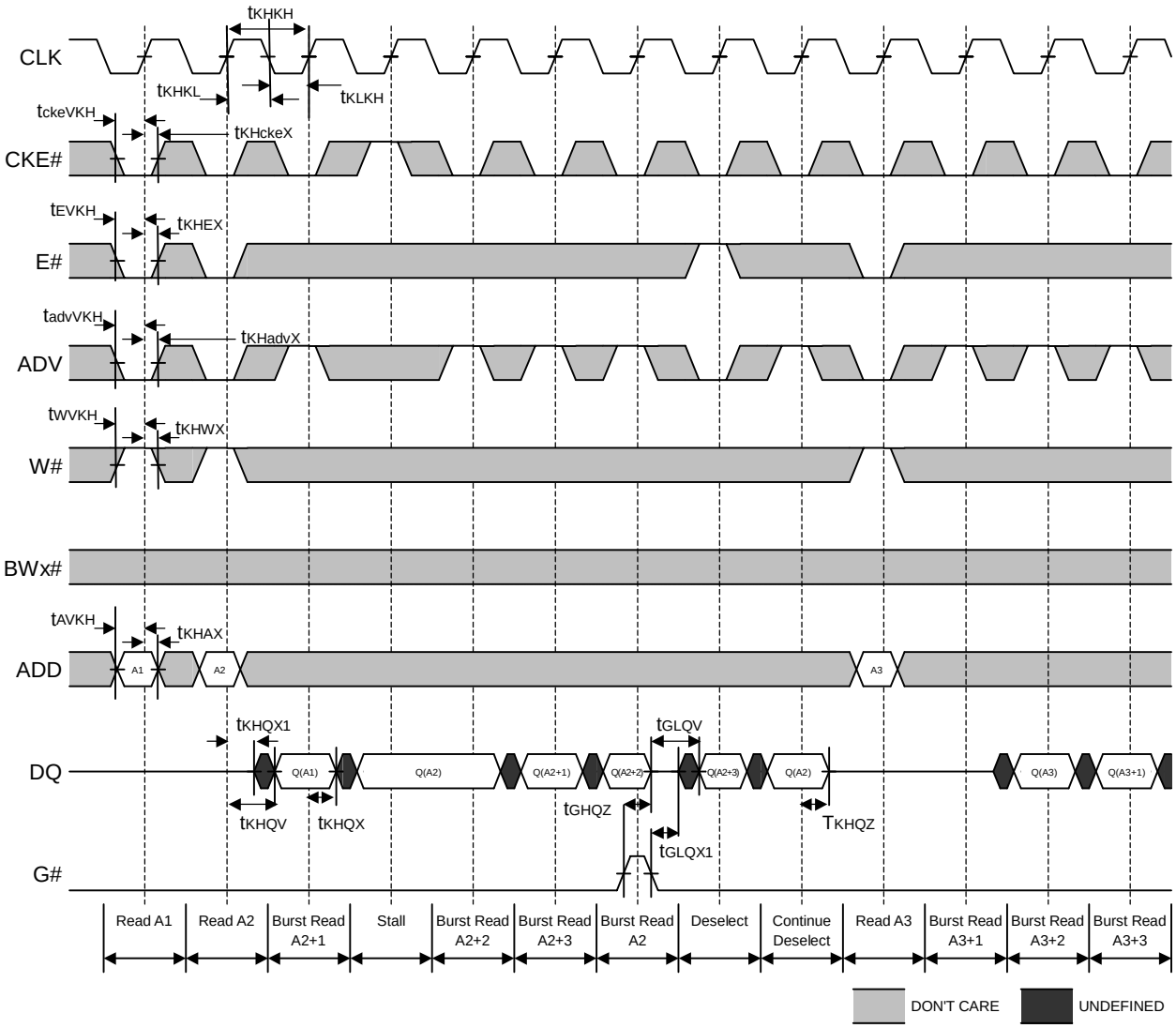
Note21.Valid Delay Measurement is made from the VDDQ/2 on the input waveform to the VDDQ/2 on the output waveform.
Input waveform should have a slew rate of faster than or equal to 1V/ns.
Note22.Tri-state toff measurement is made from the VDDQ/2 on the input waveform to the output waveform moving 20% from its initial to final Value VDDQ/2.
Note:the initial value is not VOL or VOH as specified in DC ELECTRICAL CHARACTERISTICS table.
Note23. Tri-state ton measurement is made from the VDDQ/2 on the input waveform to the output waveform moving 20% from its initial Value VDDQ/2 to its final Value.
Note:the final value is not VOL or VOH as specified in DC ELECTRICAL CHARACTERISTICS table.
Note24.Clocks,Data,Address and control signals will be tested with a minimum input slew rate of faster than or equal to 1V/ns.

(2)TIMING CHARACTERISTICS

Symbol	Parameter	Limits						Unit
		200MHz		167MHz		133MHz		
		-20		-16		-13		
		Min	Max	Min	Min	Max	Min	
Clock								
t_{KHKH}	Clock cycle time	5.0		6.0		7.5		ns
t_{KHKL}	Clock HIGH time	2.0		2.7		3.0		ns
t_{KLKH}	Clock LOW time	2.0		2.7		3.0		ns
Output times								
t_{KHQV}	Clock HIGH to output valid		3.2		3.8		4.2	ns
t_{KHQX}	Clock HIGH to output invalid	1.5		1.5		1.5		ns
t_{KHQX1}	Clock HIGH to output in LOW-Z	1.5		1.5		1.5		ns
t_{KHQZ}	Clock HIGH to output in High-Z	1.5	3.2	1.5	3.8	1.5	4.2	ns
t_{GLQV}	G# to output valid		3.2		3.8		4.2	ns
t_{GLQX1}	G# to output in Low-Z	0.0		0.0		0.0		ns
t_{GHQZ}	G# to output in High-Z		3.2		3.8		4.2	ns
Setup Times								
t_{AVKH}	Address valid to clock HIGH	1.0		1.2		1.2		ns
t_{ckeVKH}	CKE# valid to clock HIGH	1.0		1.2		1.2		ns
t_{advVKH}	ADV valid to clock HIGH	1.0		1.2		1.2		ns
t_{WVKH}	Write valid to clock HIGH	1.0		1.2		1.2		ns
t_{BVKH}	Byte write valid to clock HIGH (BWa#~BWd#)	1.0		1.2		1.2		ns
t_{EVKH}	Enable valid to clock HIGH (E1#,E2,E3#)	1.0		1.2		1.2		ns
t_{DVKH}	Data In valid clock HIGH	1.0		1.2		1.2		ns
Hold Times								
t_{KHAX}	Clock HIGH to Address don't care	0.8		0.8		0.8		ns
t_{KHckeX}	Clock HIGH to CKE# don't care	0.8		0.8		0.8		ns
t_{KHadvX}	Clock HIGH to ADV don't care	0.8		0.8		0.8		ns
t_{KHWX}	Clock HIGH to Write don't care	0.8		0.8		0.8		ns
t_{KHBX}	Clock HIGH to Byte Write don't care (BWa#~BWb#)	0.8		0.8		0.8		ns
t_{KHEX}	Clock HIGH to Enable don't care (E1#,E2,E3#)	0.8		0.8		0.8		ns
t_{KHDX}	Clock HIGH to Data In don't care	0.8		0.8		0.8		ns
ZZ								
t_{ZZS}	ZZ standby		2*t_{KHKH}		2*t_{KHKH}		2*t_{KHKH}	ns
t_{ZZREC}	ZZ recovery		2*t_{KHKH}		2*t_{KHKH}		2*t_{KHKH}	ns

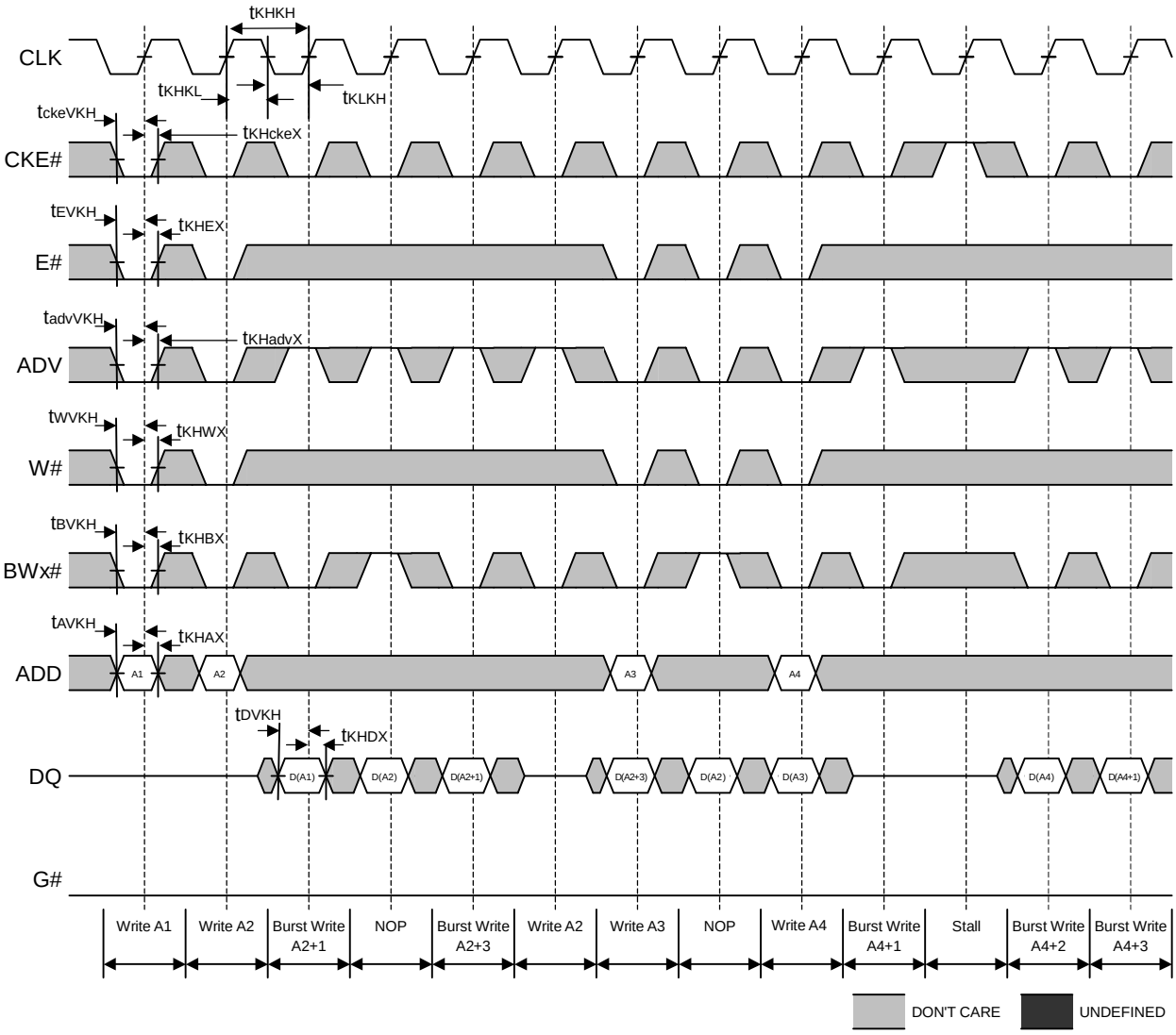
Note25.All parameter except t_{ZZS}, t_{ZZREC} in this table are measured on condition that ZZ=LOW fix.
Note26.Test conditions is specified with the output loading shown in Fig.1 unless otherwise noted.
Note27. t_{KHQX1}, t_{KHQZ}, t_{GLQX1}, t_{GHQZ} are sampled.
Note28.LBO# is static and must not change during normal operation.

(3)READ TIMING



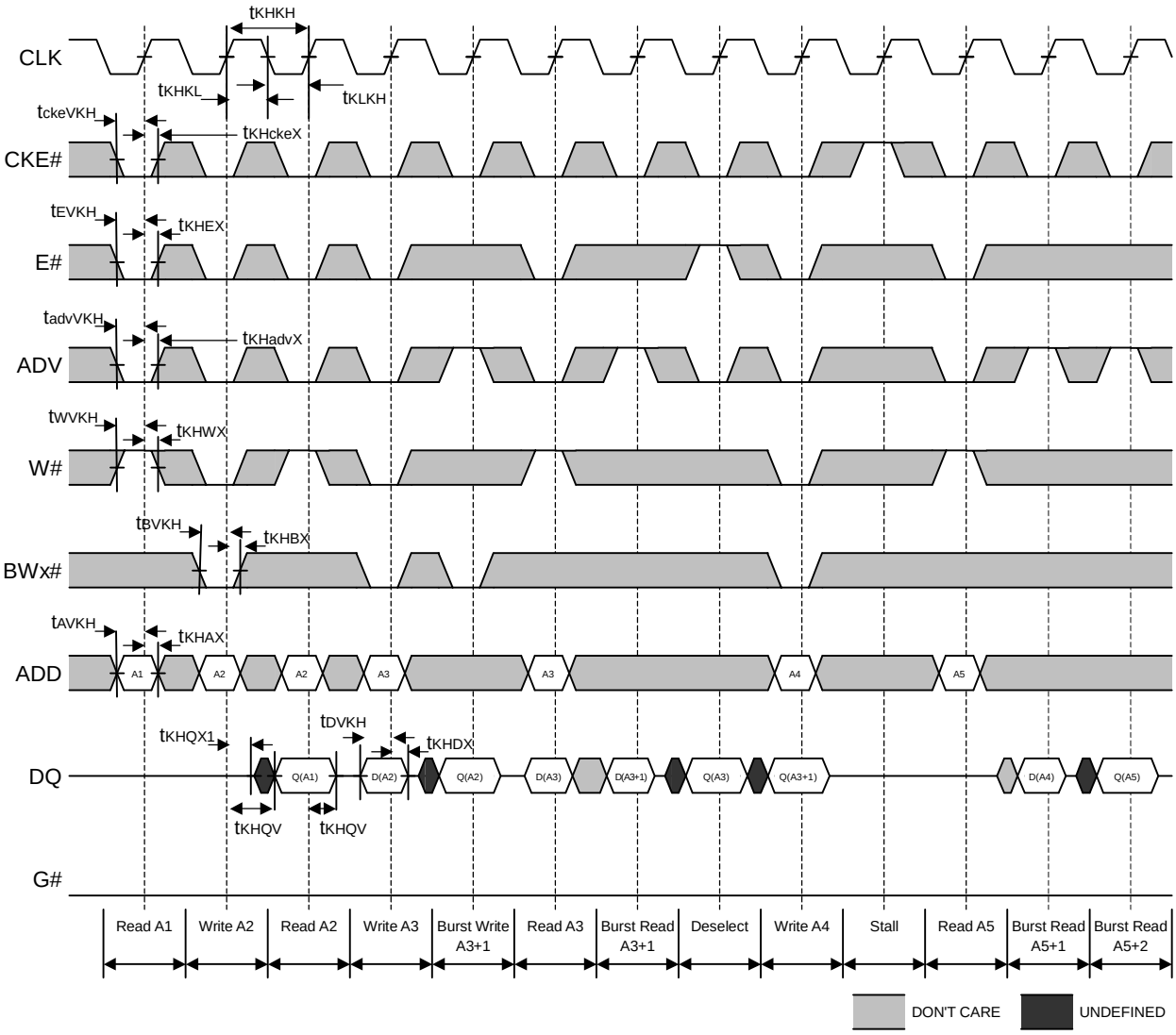
Note29.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note30. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note31.ZZ is fixed LOW.

(4)WRITE TIMING



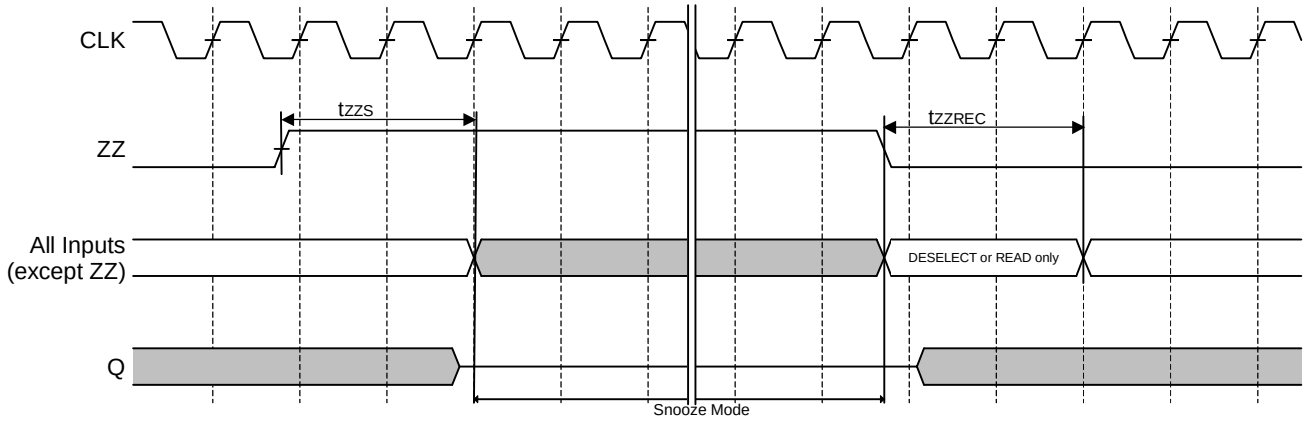
Note32.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note33. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note34.ZZ is fixed LOW.

(5)READ/WRITE TIMING



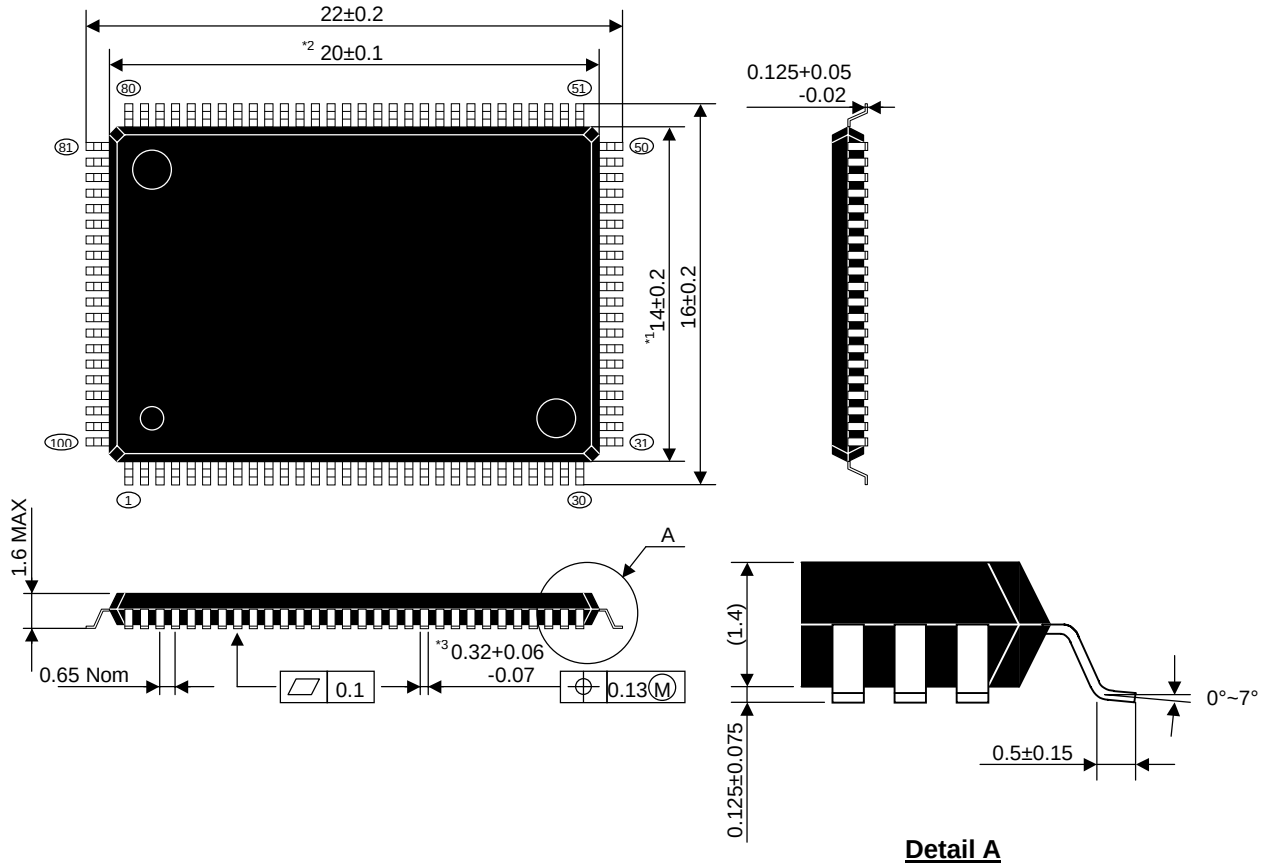
Note35.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note36. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note37.ZZ is fixed LOW.

(6)SNOOZE MODE TIMING



PACKAGE OUTLINE

Plastic 100pin 14x20 mm body



Detail A

Note38. Dimensions *1 and *2 don't include mold flash.
Note39 Dimension *3 doesn't include trim off set.
Note40.All dimensions in millimeters.

REVISION HISTORY

Rev. No.	History	Date	
0.0	First revision	June 4, 2001	Advanced Information
0.1	Fixed WRITE TRUTH TABLE	July 16, 2001	Advanced Information
0.2	Fixed Note8,13 and 14	March 28, 2002	Advanced Information
0.3	Add –13(133MHz) Fixed THERMAL RESISTANCE	July 5, 2002	Preliminary
0.4	DC ELECTRICAL CHARACTERISTICS Changed VIH limit from 0.65VDDQ to 1.7 at 2.5V VDDQ Changed VIL limit from 0.35VDDQ to 0.7 at 2.5V VDDQ Changed ICC1 limit from 360mA to 440mA at 200MHz(-20) Changed ICC2 limit from 100mA to 180mA at 200MHz(-20) Changed ICC5 limit from 50mA to 140mA at 200MHz(-20) AC ELECTRICAL CHARACTERISTICS Changed tKHQX limit from 0.7ns to 1.5ns at 200MHz(-20) Changed tKHQX1 limit from 0.7ns to 1.5ns at 200MHz(-20) Changed tKHQZ limit from 0.7ns to 1.5ns at 200MHz(-20)	August 7, 2002	Preliminary
0.5	DC ELECTRICAL CHARACTERISTICS Changed ILI limit from 10uA to 100uA (Input Leakage Current of ZZ and LBO#) Changed Icc3 and Icc4 limit from 20mA to 30mA . (Standby Current)	January 14, 2003	Preliminary
0.6	Added –25(250MHz)	January 31, 2003	Preliminary
1.0	The semiconductor operations of HITACHI and MITSUBISHI Electric were transferred to RENESAS Technology Corporation on April 1st 2003. Fixed PART NAME TABLE DC ELECTRICAL CHARACTERISTICS Changed ICC1 limit from 440mA to 450mA . AC ELECTRICAL CHARACTERISTICS (2)TIMING CHARACTERISTICS Changed tKHKL limit from 1.8ns to 2.0ns. Changed tKLKH limit from 1.8ns to 2.0ns. Changed all Setup times from 1.2ns to 1.0ns. Changed all Hold times from 0.5ns to 0.8ns.	August 1, 2003	Preliminary

Renesas LSIs

M5M5T5636GP –20,16,13

18874368-BIT(524288-WORD BY 36-BIT) NETWORK SRAM

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