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

M5M5T5672TG – 20

18874368-BIT(262144-WORD BY 72-BIT) NETWORK SRAM

DESCRIPTION

The M5M5T5672TG is a family of 18M bit synchronous SRAMs organized as 262144-words by 72-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. M5M5T5672TG 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: 200 MHz**
- **Fast access time: 3.2 ns**
- **Single 2.5V –5% and +5% power supply V_{DD}**
- **Individual byte write (BWa# - BWh#) controls may be tied LOW**
- **Single Read/Write control pin (W#)**
- **Snooze mode (ZZ) for power down**
- **Linear or Interleaved Burst Modes**
- **JTAG boundary scan support**

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), Byte Write Enables (BWa#, BWb#, BWc#, BWd#, BWe#, BWf#, BWg#, BWh#) and Read/Write (W#).

Write operations are controlled by the eight Byte Write Enables (BWa# - BWh#) 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.

PACKAGE

	Bump	Body Size	Bump Pitch
M5M5T5672TG	209(11X19) bump BGA	14mm X 22mm	1mm

PART NAME TABLE

Part Name	Access	Cycle	Active Current (max.)	Standby Current (max.)
M5M5T5672TG -20	3.2ns	5.0ns	450mA	30mA

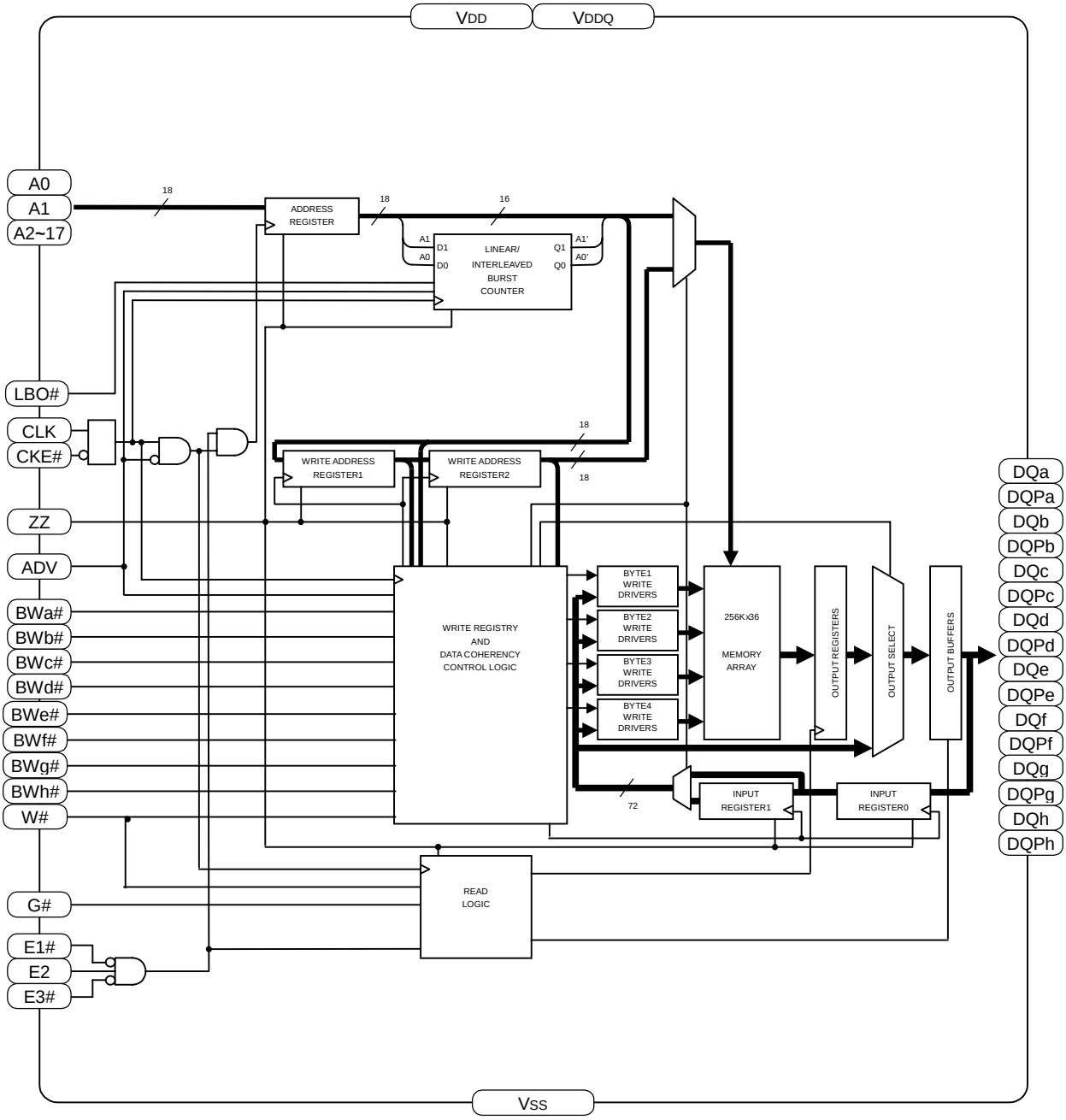
BUMP LAYOUT(TOP VIEW)

209 bump BGA

	1	2	3	4	5	6	7	8	9	10	11
A	DQg	DQg	A_6	E2	A_7	ADV	A_8	E3#	A_9	DQb	DQb
B	DQg	DQg	BWc#	BWg#	NC	W#	A_{17}	BWb#	BWf#	DQb	DQb
C	DQg	DQg	BWh#	BWd#	NC	E1#	NC	BWe#	BWa#	DQb	DQb
D	DQg	DQg	V_{SS}	NC	NC	G#	NC	NC	V_{SS}	DQb	DQb
E	DQPg	DQPc	V_{DDQ}	V_{DDQ}	V_{DD}	V_{DD}	V_{DD}	V_{DDQ}	V_{DDQ}	DQPf	DQPb
F	DQc	DQc	V_{SS}	V_{SS}	V_{SS}	NC	V_{SS}	V_{SS}	V_{SS}	DQf	DQf
G	DQc	DQc	V_{DDQ}	V_{DDQ}	V_{DD}	NC	V_{DD}	V_{DDQ}	V_{DDQ}	DQf	DQf
H	DQc	DQc	V_{SS}	V_{SS}	V_{SS}	NC	V_{SS}	V_{SS}	V_{SS}	DQf	DQf
J	DQc	DQc	V_{DDQ}	V_{DDQ}	V_{DD}	MCH	V_{DD}	V_{DDQ}	V_{DDQ}	DQf	DQf
K	NC	NC	CLK	NC	V_{SS}	CKE#	V_{SS}	NC	NC	NC	NC
L	DQh	DQh	V_{DDQ}	V_{DDQ}	V_{DD}	MCH	V_{DD}	V_{DDQ}	V_{DDQ}	DQa	DQa
M	DQh	DQh	V_{SS}	V_{SS}	V_{SS}	MCH	V_{SS}	V_{SS}	V_{SS}	DQa	DQa
N	DQh	DQh	V_{DDQ}	V_{DDQ}	V_{DD}	NC	V_{DD}	V_{DDQ}	V_{DDQ}	DQa	DQa
P	DQh	DQh	V_{SS}	V_{SS}	V_{SS}	ZZ	V_{SS}	V_{SS}	V_{SS}	DQa	DQa
R	DQPd	DQPh	V_{DDQ}	V_{DDQ}	V_{DD}	V_{DD}	V_{DD}	V_{DDQ}	V_{DDQ}	DQPa	DQPe
T	DQd	DQd	V_{SS}	NC	NC	LBO#	NC	NC	V_{SS}	DQe	DQe
U	DQd	DQd	NC	A_3	NC	A_{15}	NC	A_{11}	NC	DQe	DQe
V	DQd	DQd	A_5	A_4	A_{16}	A1	A_{13}	A_{12}	A_{10}	DQe	DQe
W	DQd	DQd	TMS	TDI	A_2	A0	A_{14}	TDO	TCK	DQe	DQe

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. See Boundary Scan chapter.
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~A17	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#, Bwe#, BWf#, BWg#, BWh#	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; BWe# controls DQe, DQPe pins; BWf# controls DQf, DQPf pins; BWg# controls DQg, DQPg pins; BWh# controls DQh, DQPh 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.
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.
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.
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, DQe,DQPe,DQf,DQPf, DQg,DQPg,DQh,DQPh	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; Byte “e” is DQe, DQPe pins; Byte “f” is DQf, DQPf pins; Byte “g” is DQg, DQPg pins; Byte “h” is DQh, DQPh 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}	Ground
V_{DDQ}	V_{DDQ}	I/O buffer Power supply
TDI	Test Data Input	These pins are used for Boundary Scan Test.
TDO	Test Data Output	
TCK	Test Clock	
TMS	Test Mode Select	
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

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

Operation	A17~A2	A1,A0			
First access, latch external address	A17~A2	0 , 0	0 , 1	1 , 0	1 , 1
Second access(first burst address)	latched A17~A2	0 , 1	0 , 0	1 , 1	1 , 0
Third access(second burst address)	latched A17~A2	1 , 0	1 , 1	0 , 0	0 , 1
Fourth access(third burst address)	latched A17~A2	1 , 1	1 , 0	0 , 1	0 , 0

(2) Linear Burst Sequence (when LBO# = LOW)

Operation	A17~A2	A1,A0			
First access, latch external address	A17~A2	0 , 0	0 , 1	1 , 0	1 , 1
Second access(first burst address)	latched A17~A2	0 , 1	1 , 0	1 , 1	0 , 0
Third access(second burst address)	latched A17~A2	1 , 0	1 , 1	0 , 0	0 , 1
Fourth access(third burst address)	latched A17~A2	1 , 1	0 , 0	0 , 1	1 , 0

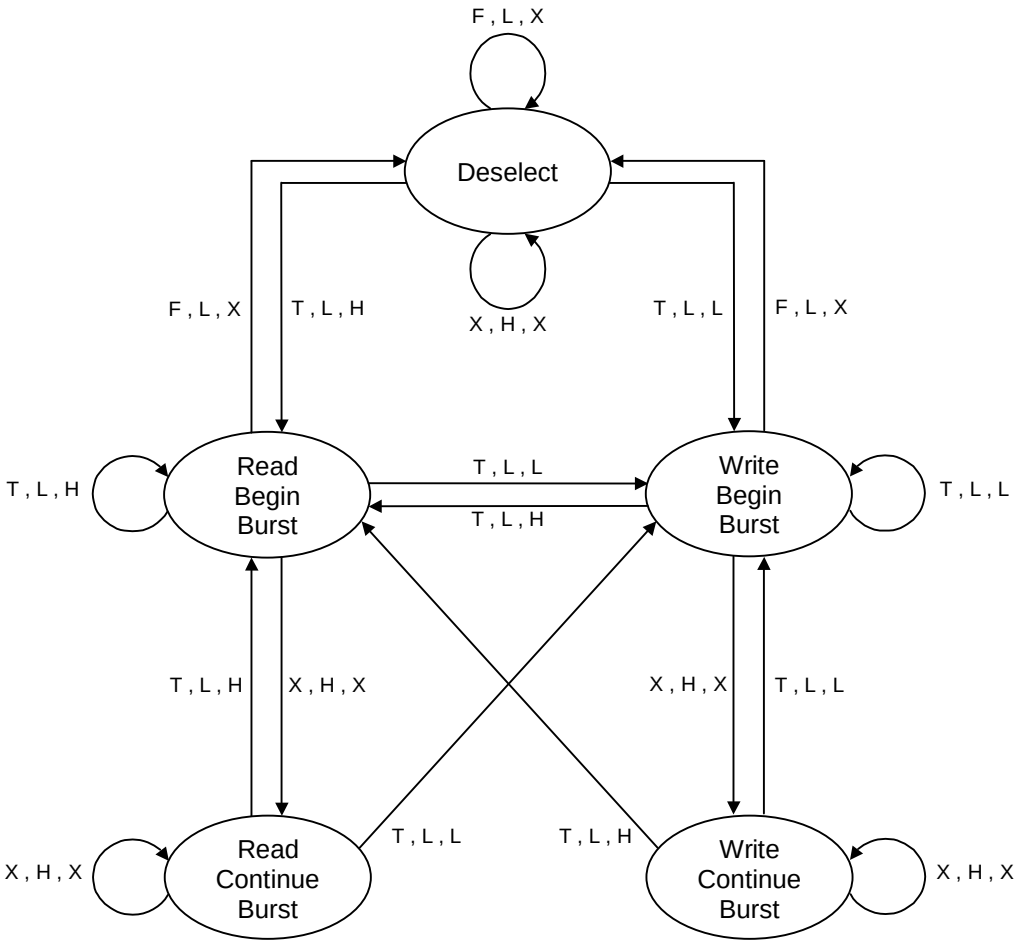
Note7. The burst sequence wraps around to its initial state upon completion.

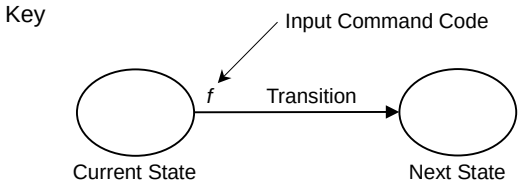
TRUTH TABLE

E1#	E2	E3#	ADV	W#	BWx#	G#	CKE#	ZZ#	CLK	Address used	Operation
H	X	X	L	X	X	X	L	L	L->H	None	Deselect Cycle
X	L	X	L	X	X	X	L	L	L->H	None	Deselect Cycle
X	X	H	L	X	X	X	L	L	L->H	None	Deselect Cycle
X	X	X	H	X	X	X	L	L	L->H	None	Continue Deselect Cycle
L	H	L	L	H	X	L	L	L	L->H	External	Read Cycle, Begin Burst
X	X	X	H	X	X	L	L	L	L->H	Next	Read Cycle, Continue Burst
L	H	L	L	H	X	H	L	L	L->H	External	NOP/Dummy Read, Begin Burst
X	X	X	H	X	X	H	L	L	L->H	Next	Dummy Read, Continue Burst
L	H	L	L	L	L	X	L	L	L->H	External	Write Cycle, Begin Burst
X	X	X	H	X	L	X	L	L	L->H	Next	Write Cycle, Continue Burst
L	H	L	L	L	H	X	L	L	L->H	None	NOP/Write Abort, Begin Burst
X	X	X	H	X	H	X	L	L	L->H	Next	Write Abort, Continue Burst
X	X	X	X	X	X	X	H	L	L->H	Current	Ignore Clock edge, Stall
X	X	X	X	X	X	X	X	H	X	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 OE# 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#	BWe#	BWf#	BWg#	BWh#	Function
H	X	X	X	X	X	X	X	X	Read
L	L	H	H	H	H	H	H	H	Write Byte “a”
L	H	L	H	H	H	H	H	H	Write Byte “b”
L	H	H	L	H	H	H	H	H	Write Byte “c”
L	H	H	H	L	H	H	H	H	Write Byte “d”
L	H	H	H	H	L	H	H	H	Write Byte “e”
L	H	H	H	H	H	L	H	H	Write Byte “f”
L	H	H	H	H	H	H	L	H	Write Byte “g”
L	H	H	H	H	H	H	H	L	Write Byte “h”
L	L	L	L	L	L	L	L	L	Write All Bytes
L	H	H	H	H	H	H	H	H	Write Abort / NOP

Note14. “H” = input VIH; “L” = input VIL; “X” = input VIH or VIL.
Note15. All inputs 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})		1050	mW
T_{OPR}	Operating Temperature		0~70	°C
$T_{STG(bias)}$	Storage Temperature(bias)		-10~85	°C
T_{STG}	Storage Temperature		-55~125	°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

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}	Output Leakage Current	$V_{I/O}$ = 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}		450	mA
I_{CC2}	Power Supply Current : Deselected	Device deselected $V_I \le V_{IL}$ or $V_I \ge V_{IH}$, ZZ≤V_{IL}		180	mA
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		140	mA

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	Condition	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	Condition	Limits			Unit
			Min	Typ	Max	
θ_{JA}	Thermal resistance Junction Ambient	Air velocity=0m/sec		26		°C/W
		Air velocity=2m/sec		18		°C/W
θ_{JC}	Thermal resistance Junction to Case			6		°C/W

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

(1) MEASUREMENT CONDITION

Input pulse levels ····· V_{IH}=V_{DDQ}, V_{IL}=0V
Input rise and fall times ····· faster than or equal to 1V/ns
Input timing reference levels ····· V_{IH}=V_{IL}=V_{DDQ} / 2
Output reference levels ····· V_{IH}=V_{IL}=V_{DDQ} / 2
Output load ····· Fig.1

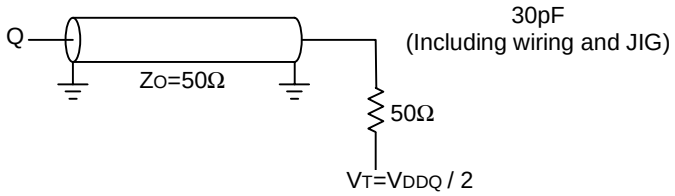


Fig.1 Output load

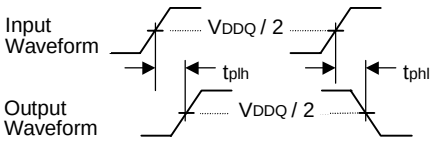


Fig.2 Tdly measurement

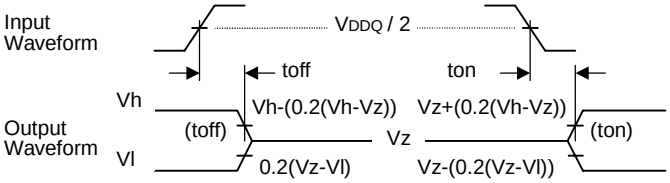


Fig.3 Tri-State measurement

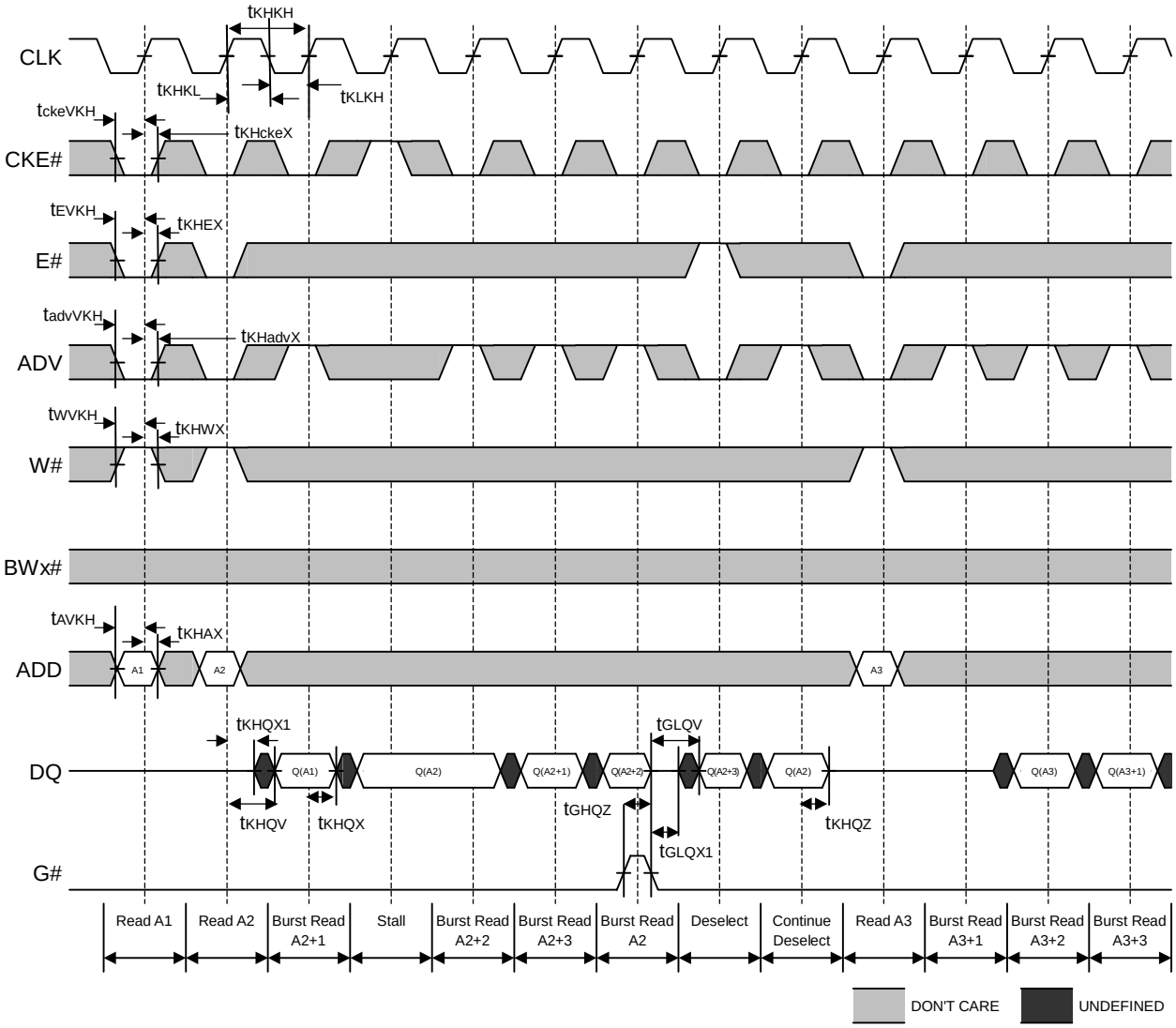
Note20.Valid Delay Measurement is made from the V_{DDQ}/2 on the input waveform to the V_{DDQ}/2 on the output waveform. Input waveform should have a slew rate of faster than or equal to 1V/ns.
Note21.Tri-state toff measurement is made from the V_{DDQ}/2 on the input waveform to the output waveform moving 20% from its initial to final Value V_{DDQ}/2.
Note:the initial value is not V_{OL} or V_{OH} as specified in DC ELECTRICAL CHARACTERISTICS table.
Note22. Tri-state ton measurement is made from the V_{DDQ}/2 on the input waveform to the output waveform moving 20% from its initial Value V_{DDQ}/2 to its final Value.
Note:the final value is not V_{OL} or V_{OH} as specified in DC ELECTRICAL CHARACTERISTICS table.
Note23.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 200MHz -20		Unit
		Min	Max	
Clock				
t_{KHKH}	Clock Cycle Time	5.0		ns
t_{KHKL}	Clock HIGH Time	2.0		ns
t_{KLKH}	Clock LOW Time	2.0		ns
Output times				
t_{KHQV}	Clock HIGH to Output Valid		3.2	ns
t_{KHQX}	Clock HIGH to Output Invalid	1.5		ns
t_{KHQX1}	Clock HIGH to Output in Low-Z	1.5		ns
t_{KHQZ}	Clock HIGH to Output in High-Z	1.5	3.2	ns
t_{GLQV}	G# to output valid		3.2	ns
t_{GLQX1}	G# to output in Low-Z	0.0		ns
t_{GHQZ}	G# to output in High-Z		3.2	ns
Setup Times				
t_{AVKH}	Address Valid to Clock HIGH	1.0		ns
t_{advVKH}	ADV Valid to Clock HIGH	1.0		ns
t_{WVKH}	Write Valid to Clock HIGH	1.0		ns
t_{BxVKH}	Byte Write Valid to Clock HIGH (BWa#~BWh#)	1.0		ns
t_{EVKH}	Enable Valid to Clock HIGH (E1#,E2,E3#)	1.0		ns
t_{DVKH}	Data In Valid Clock HIGH	1.0		ns
Hold Times				
t_{KHAX}	Clock HIGH to Address don't care	0.8		ns
t_{KHadvX}	Clock HIGH to ADV don't care	0.8		ns
t_{KHWX}	Clock HIGH to Write don't care	0.8		ns
t_{KHBxX}	Clock HIGH to Byte Write don't care (BWa#~BWh#)	0.8		ns
t_{KHEX}	Clock HIGH to Enable don't care (E1#,E2,E3#)	0.8		ns
t_{KHDX}	Clock HIGH to Data In don't care	0.8		ns
ZZ				
t_{ZZS}	ZZ standby		$2*t_{KHKH}$	ns
t_{ZZREC}	ZZ recovery		$2*t_{KHKH}$	ns

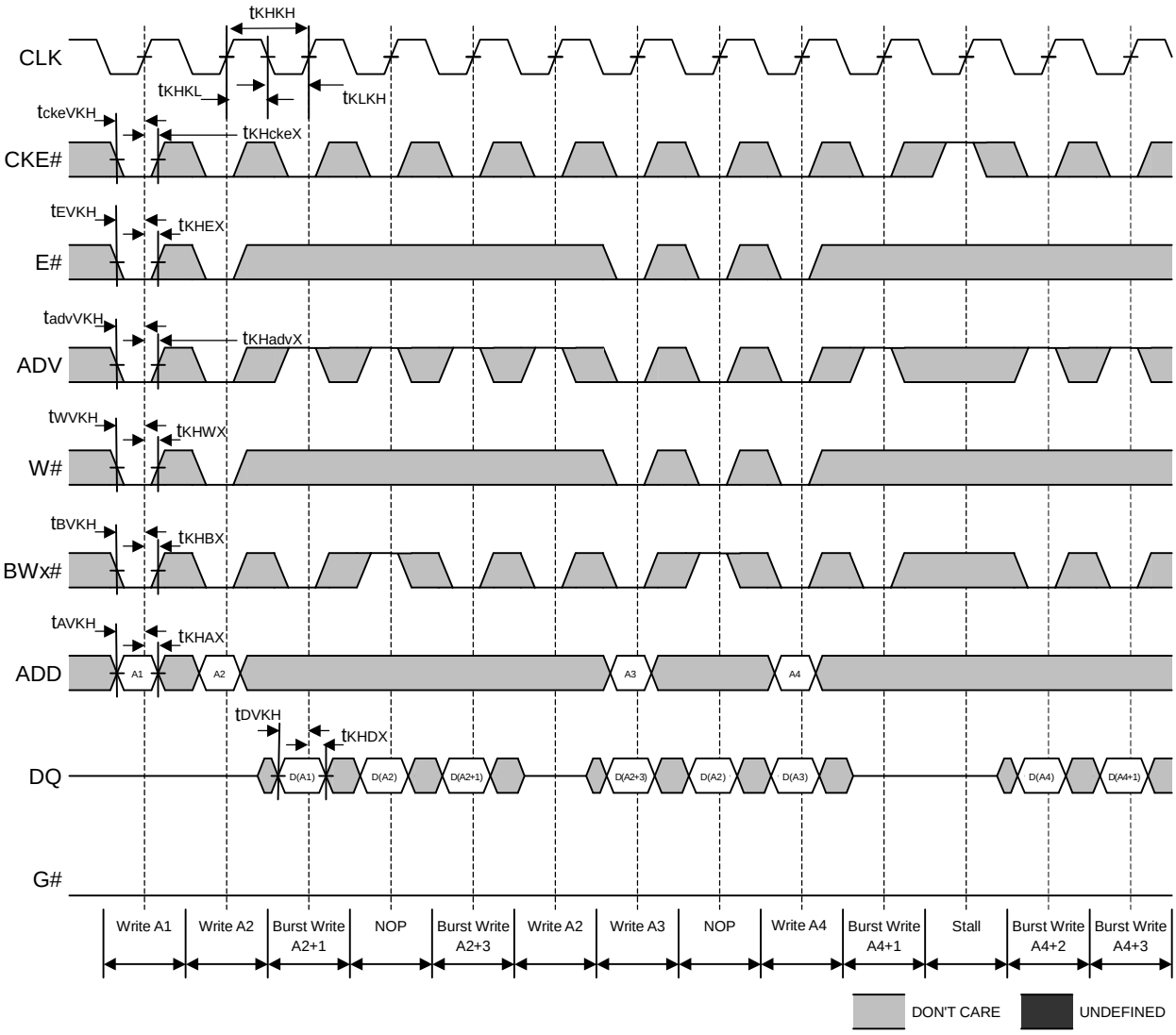
Note24.All parameter except t_{ZZS}, t_{ZZREC} in this table are measured on condition that ZZ=LOW fix.
Note25.Test conditions is specified with the output loading shown in Fig.1 unless otherwise noted.
Note26. t_{KHQX1}, t_{KHQZ}, t_{GLQX1}, t_{GHQZ} are sampled.
Note27.LBO# is static and must not change during normal operation.

(3)READ TIMING



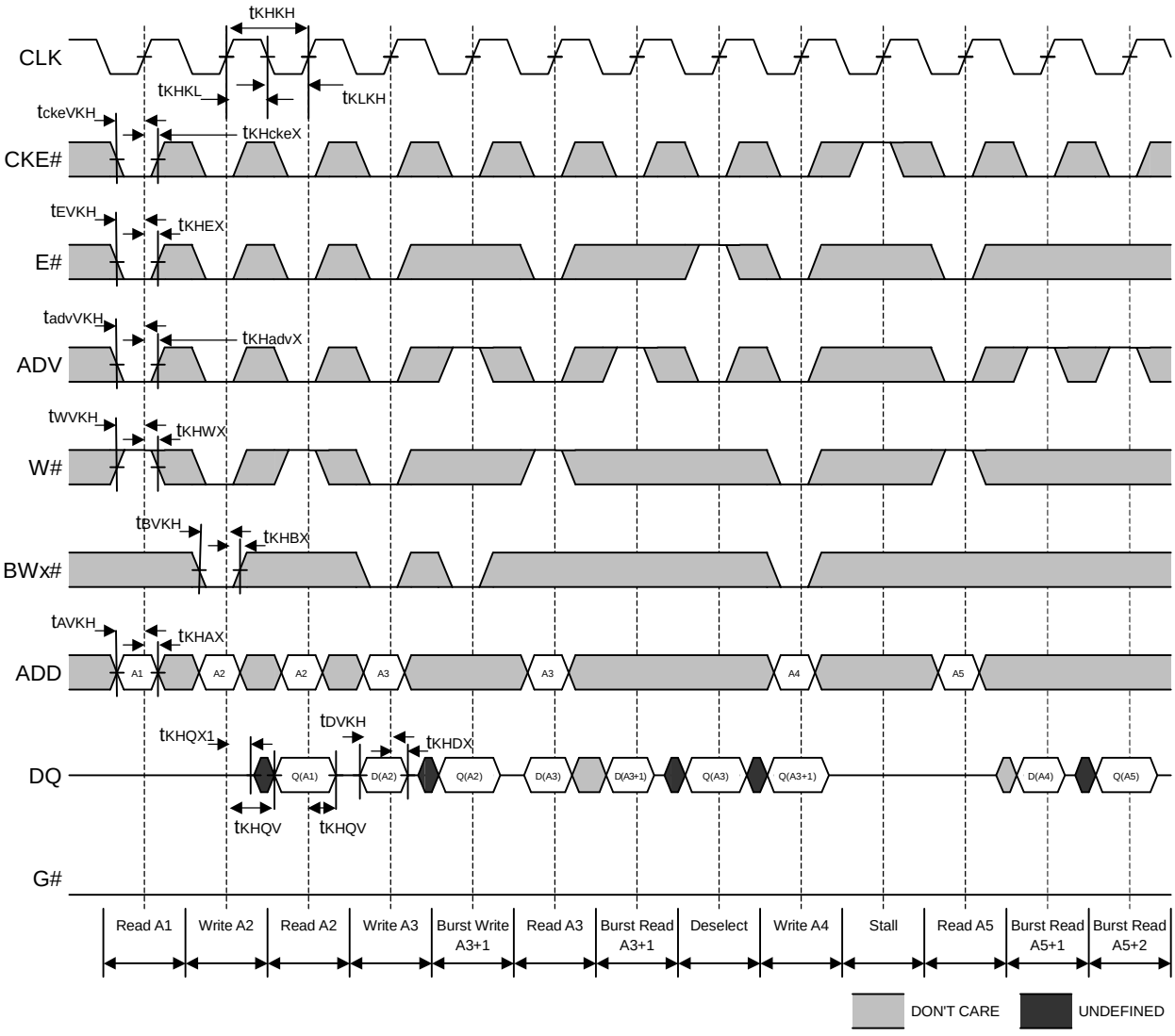
Note28.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note29. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note30.ZZ is fixed LOW.

(4)WRITE TIMING



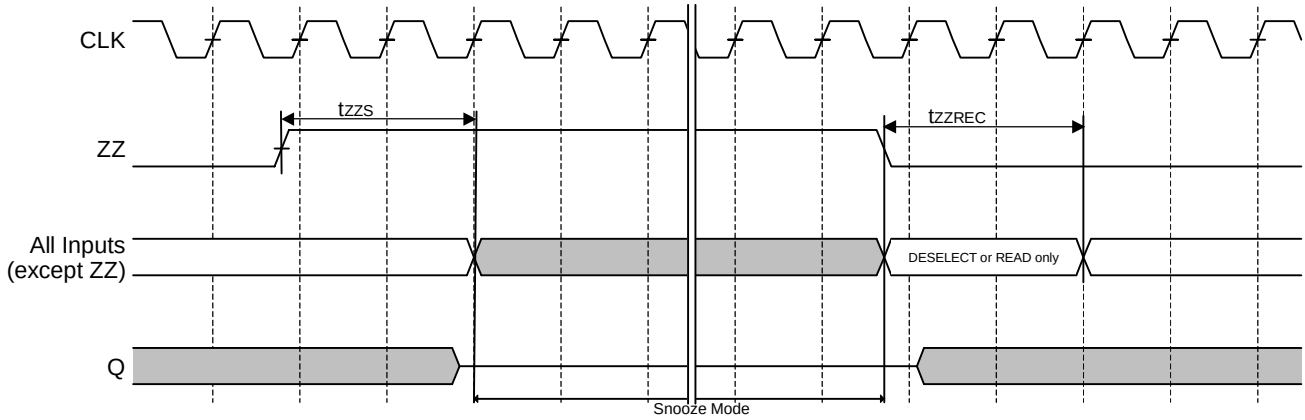
Note31.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note32. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note33.ZZ is fixed LOW.

(5)READ/WRITE TIMING



Note34.Q(An) refers to output from address An. Q(An+1) refers to output from the next internal burst address following An.
Note35. E# represents three signals. When E# is LOW, it represents E1# is LOW, E2 is HIGH and E3# is LOW.
Note36.ZZ is fixed LOW.

(6)SNOOZE MODE TIMING



JTAG PORT OPERATION

Overview

The JTAG Port on this SRAM operates in a manner consistent with IEEE Standard 1149.1-1990, a serial boundary scan interface standard (commonly referred to as JTAG), but dose not implement all of the function required for 1149.1 compliance. Unlike JTAG implementations that have been common among SRAM vendors for the last several years, this implementation dose offer a form of EXTEST, known as Clock Assisted EXTEST, reducing or eliminating the "hand coding" that has been required to overcome the test program compiler errors caused by previous non-compliant implementation. The JTAG Port interfaces with conventional CMOS logic level signaling.

Disabling the JTAG port

It is possible to use this device without utilizing the JTAG port. The port is reset at power-up and will remain inactive unless clocked. To assure normal operation of the SRAM with the JTAG Port unused, the TCK, TDI and TMS pins may be left floating or tied to High. The TDO pin should be left unconnected.

JTAG Pin Description

Pin	Name	Function
TCK	Test Clock	The TCK input is clock for all TAP events. All inputs are captured on the rising edge of TCK and the Test Data Out (TDO) propagates from the falling edge of TCK.
TMS	Test Mode Select	The TMS input is sampled on the rising edge of TCK. This is the command input for the TAP Controller state machine. An undriven TMS input will produce the same result as a logic one input level.
TDI	Test Data In	The TDI input is sampled on the rising edge of TCK. This is the input side of the serial registers placed between the TDI and TDO pins. the register placed between the TDI and TDO pins is determined by the state of the TAP Controller state machine and the instruction that is currently loaded in the TAP Instruction Resister (refer to the TAP Controller State Diagram). An undriven TDI Input will produce the same result as a logic one input level.
TDO	Test Data Out	The TDO output is active depending on the state of the TAP Controller state machine. Output changes in response to the falling edge of TCK. This is the output side of the serial registers placed between the TDI and TDO pins.

Note:
This device dose not have a TRST (TAP Reset) pin. TRST is optional in IEEE 1149.1. The Test-Logic-Reset state is entered while TMS is held high for five rising edges of TCK. The TAP Controller is also reset automatically at power-up.

JTAG Port Registers

Overview

The various JTAG registers, referred to as Test Access Port or TAP Registers, are selected (one at a time) via the sequence of 1s and 0s applied to TMS as TCK is strobed. Each of TAP Registers are serial shift registers that capture serial input data on the rising edge of TCK and push serial data out on the next falling edge of TCK. When a register is selected, it is placed between the TDI and TDO pins.

Instruction Register

The Instruction Register holds the instructions that are executed by the TAP Controller when it is moved into the Run-Test/Idle, or the various data register states. Instructions are 3 bits long. The Instruction Resister can be loaded when it is placed between the TDI and TDO pins. The Instruction Resister is automatically preloaded with the IDCODE instruction at power-up or whenever the controller is placed in the Test-Logic-Reset state.

Bypass Register
The Bypass resister is a single-bit register that can be placed between the TDI and TDO pins. It allows serial test data to be passed through the SRAM's JTAG Port to another device in the scan chain with as little delay as possible.

Boundary Scan Register
The Boundary Scan Register is a collection of flip flops that can be preset by the logic level found on the SRAM's input or I/O pins. The flip flops are then daisy chained together so the levels found can be shifted serially out of the JTAG Port's TDO pins. The Boundary Scan Register also includes a number of place holder flip flops (always set to a logic 1). The relationship between the device pins and the bits in the Boundary Scan Register is described in the Scan Order Table following. The Boundary Scan Register, under the control of the TAP Controller, is loaded with the contents of the SRAM's I/O ring when the controller is in the Capture-RD state and then is placed between the TDI and TDO pins when the controller is moved to the Shift-DR state. SAMPLE-Z, SAMPLE/PRELOAD and EXTEST instruction can be used to activate the Boundary Scan Register.

Identification (ID) Register
The ID register is a 32-bit register that is loaded with a device and vender specific 32-bit code when the controllers put in the Capture-DR state with the IDCODE Instruction loaded in the Instruction Register. The code is loaded from 32-bit on-chip ROM. It describes various attributes of the SRAM (see page 25). The register is then placed between the TDI and TDO pins when the controller is moved into the Shift-DR state. Bit 0 in the register is the LSB and the first to reach the TDO pin when shifting begins.

TAP Controller Instruction Set

Overview
There are two classes of instructions defined in the Standard 1149.1-1990; standard (Public) instructions, and device specific (Private) instructions. Some Public instructions are mandatory for 1149.1 compliance. Optional Public instructions must be implemented in prescribed ways. Although the TAP Controller in this device follows the 1149.1 conventions, it is not 1194.1-compliant because one of the mandatory instructions, EXTEST, is uniquely implemented. The TAP on this device may be used to monitor all input and I/O pads. This device will not perform INTEST but can perform the preload portion of the SAMPLE/PRELOAD command.
When the TAP controller is placed in the Capture-IR state, the two least significant bits of the instruction register are loaded with 01. When the TAP controller is moved to the Shift-IR state, the Instruction Register is placed between the TDI and TDO pins. In this state the desired instruction is serially loaded through the TDI input (while the previous contents are shifted out at the TDO output). For all instructions, the TAP executes newly loaded instructions only when the controller is moved to the Update-IR state. The TAP Instruction Set for this device is listed in the following table.

Instruction Descriptions

BYPASS
When the BYPASS instruction is loaded in the Instruction Register, the Bypass Register is placed between the TDI and TDO pins. This occurs when the TAP Controller is moved to the Shift-DR state. This allows the board level scan path to be shortened to facilitate testing of other devices in the scan path.

SAMPLE/PRELOAD
SAMPLE/PRELOAD is a Standard1149.1 mandatory public instruction. When the SAMPLE/PRELOAD instruction is loaded in the Instruction Register, moving the TAP Controller into the Capture-DR state loads the data in the SRAM's input and I/O buffers into the Boundary Scan Register. Some Boundary Scan Register locations are not associated with an input or I/O pin, and are loaded with the default state identified in the BSDL file. Because the SRAM clock is independent from the TAP Clock (TCK) it is possible for the TAP to attempt to capture the I/O ring contents while the input buffers are in transition (i.e. in a metastable state). Although allowing the TAP to sample metastable inputs will not harm the device, repeatable results cannot be expected. SRAM input signals must be stabilized for long enough to meet the TAP's input data capture set-up plus hold time (tTS plus tTH). The SRAM's clock inputs need not be paused for any other TAP operation except capturing the I/O ring contents into the Boundary Scan Register. Moving the controller to the Shift-DR state then places the Boundary Scan Register between the TDI and TDO pins.

EXTEST

EXTEST is an IEEE 1149.1 mandatory public instruction. It is to be executed whenever the Instruction Register is loaded with all logic 0s. EXTEST is not implemented in the TAP Controller, and therefore this device is not compliant to the 1149.1 Standard. When the EXTEST instruction is loaded into the Instruction Register, the device responds as if the SAMPLE/PRELOAD instruction has been loaded. There is one difference between the two instructions. Unlike the SAMPLE/PRELOAD instruction, EXTEST place the SRAM outputs in a High-Z state.

IDCODE

The IDCODE instruction cause the ID ROM to be loaded into the ID register when the controller is in the Capture-DR state and places the ID Register between the TDI and TDO pins in the Shift-DR state. The IDCODE instruction is the default instruction loaded in at power-up and any time the controller is placed in the Test-Logic-Reset state.

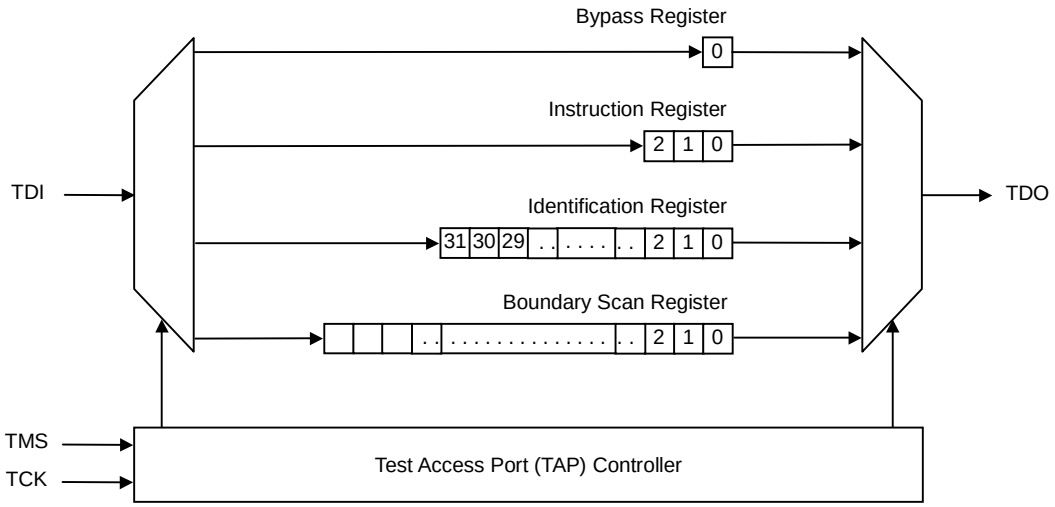
SAMPLE-Z

If the SAMPLE-Z instruction is loaded in the Instruction Register, all SRAM outputs are forced to an inactive drive state (High-Z) and the Boundary Scan Register is placed between the TDI and TDO pins when the TAP Controller is moved to the Shift-DR state.

RFU

These instructions are reserved for future use. Do not use these instructions.

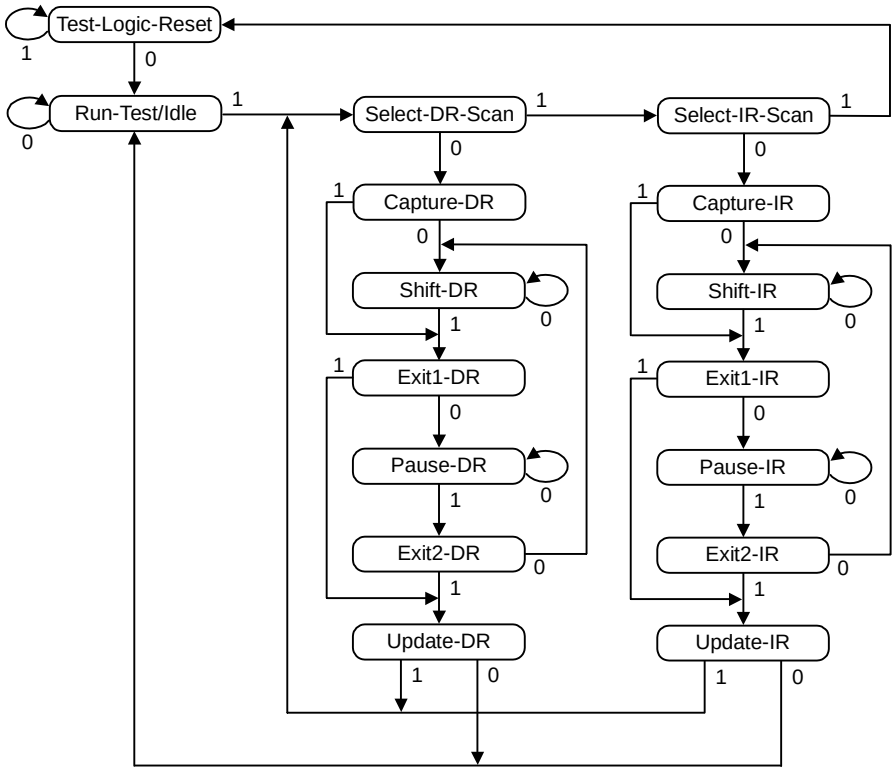
JTAG TAP BLOCK DIAGRAM



BOUNDARY SCAN ORDER

Bit	Bump	Pin Name	Bit	Bump	Pin Name	Bit	Bump	Pin Name
0	5V	A16	40	11B	DQb	80	1H	DQc
1	6U	A15	41	11A	DQb	81	2H	DQc
2	8U	A11	42	10C	DQb	82	1J	DQc
3	7V	A13	43	10B	DQb	83	2J	DQc
4	7W	A14	44	10A	DQb	84	6L	MCH
5	8V	A12	45	9A	A9	85	6M	MCH
6	9V	A10	46	7A	A8	86	2L	DQh
7	10W	DQe	47	7B	A17	87	1L	DQh
8	10V	DQe	48	8C	BWe#	88	2M	DQh
9	10U	DQe	49	9C	BWa#	89	1M	DQh
10	11W	DQe	50	9B	BWf#	90	2N	DQh
11	11V	DQe	51	8B	BWb#	91	1N	DQh
12	11U	DQe	52	6A	ADV	92	2P	DQh
13	11T	DQe	53	6D	G#	93	1P	DQh
14	10T	DQe	54	6K	CKE#	94	2R	DQPh
15	11R	DQPe	55	6B	W#	95	1R	DQPd
16	10R	DQPa	56	3K	CLK	96	2T	DQd
17	11P	DQa	57	8A	E3#	97	1T	DQd
18	10P	DQa	58	4B	BWg#	98	1U	DQd
19	11N	DQa	59	3B	BWc#	99	1V	DQd
20	10N	DQa	60	3C	BWh#	100	1W	DQd
21	11M	DQa	61	4C	BWd#	101	2U	DQd
22	10M	DQa	62	4A	E2	102	2V	DQd
23	11L	DQa	63	6C	E1#	103	2W	DQd
24	10L	DQa	64	5A	A7	104	6T	LBO#
25	6P	ZZ	65	3A	A6	105	3V	A5
26	6J	MCH	66	2A	DQg	106	4V	A4
27	10J	DQf	67	2B	DQg	107	4U	A3
28	11J	DQf	68	2C	DQg	108	5W	A2
29	10H	DQf	69	1A	DQg	109	6V	A1
30	11H	DQf	70	1B	DQg	110	6W	A0
31	10G	DQf	71	1C	DQg			
32	11G	DQf	72	1D	DQg			
33	10F	DQf	73	2D	DQg			
34	10E	DQPf	74	1E	DQPg			
35	11F	DQf	75	1F	DQc			
36	11E	DQPb	76	2E	DQPc			
37	10D	DQb	77	2F	DQc			
38	11D	DQb	78	1G	DQc			
39	11C	DQb	79	2G	DQc			

JTAG TAP CONTROLLER STATE DIAGRAM



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

Symbol	Parameter	Condition	Limits		Unit
			Min	Max	
V_{IHT}	Test Port Input High Voltage		1.7	V_{DDQ}+0.3 **	V
V_{ILT}	Test Port Input Low Voltage		-0.3 **	0.7	V
V_{OHT}	Test Port Output High Voltage	I_{OH}=-100µA	V_{DDQ}-0.1	-	V
V_{OLT}	Test Port Output Low Voltage	I_{OL}=+100µA	-	0.1	V
I_{INT}	TMS, TCK and TDI Input Leakage Current		-10	10	µA
I_{OLT}	TDO Output Leakage Current	Output Disable, V_{OUT}=0V~V_{DDQ}	-10	10	µA

Note37. **Input Undershoot/Overshoot voltage must be –1.0V<Vi<V_{DDQ}+1V with a pulse width not to exceed 20% tTCK.

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

(1)MEASUREMENT CONDITION

Input pulse levels ····· $V_{IH}=V_{DDQ}$, V_{IL}=0V
Input rise and fall times ····· faster than or equal to 1V/ns
Input timing reference levels ····· $V_{IH}=V_{IL}=V_{DDQ}$ / 2
Output reference levels ····· $V_{IH}=V_{IL}=V_{DDQ}$ / 2
Output load ····· Fig.4

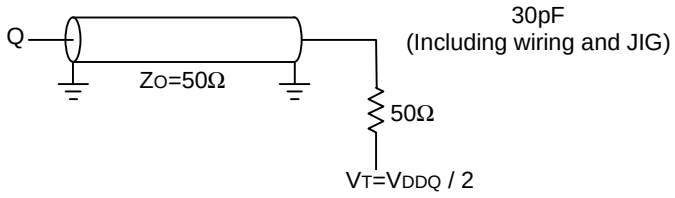
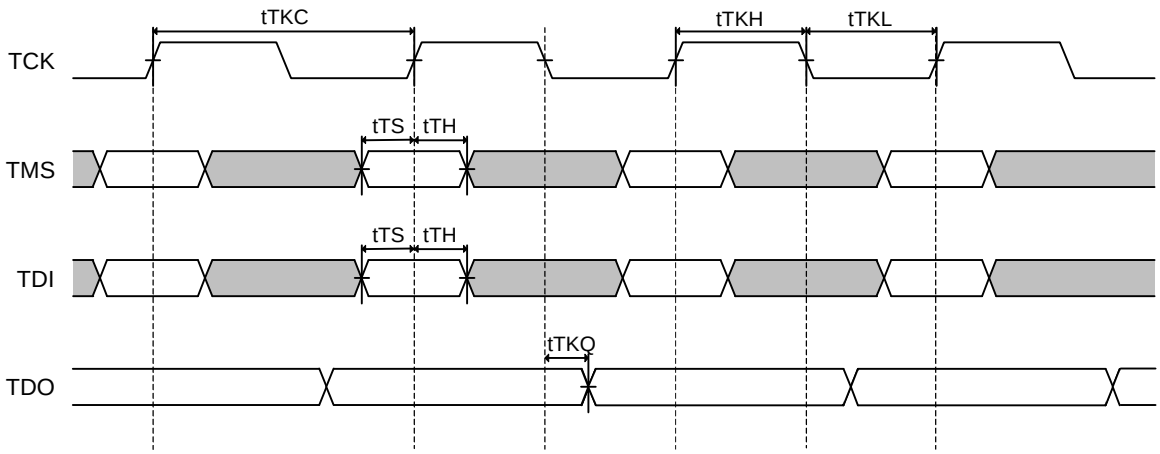


Fig.4 Output load

(2)TIMING CHARACTERISTICS

Symbol	Parameter	Limits		Unit
		Min	Max	
tTF	TCK Frequency		20	MHz
tTKC	TCK Cycle Time	50		ns
tTKH	TCK High Pulse Width	20		ns
tTKL	TCK Low Pulse Width	20		ns
tTS	TDI, TMS setup time	10		ns
tTH	TDI, TMS hold time	10		ns
tTKQ	TCK Low to TDO valid		20	ns

(3) TIMING



JTAG TAP INSTRUCTION SET SUMMARY

Instruction	Code	Description
EXTEST	000	Captures I/O ring contents. Places the Boundary Scan Register between TDI and TDO. Forces all SRAM outputs to High-Z state. This instruction is not 1149.1-compliant.
IDCODE	001	Preloads ID Register and places it between TDI and TDO
SAMPLE-Z	010	Captures I/O ring contents. Places the Boundary Scan Register between TDI and TDO. Forces all Data and Clock output drivers to High-Z
RFU	011	Do not use this instruction; Reserved for Future Use.
SAMPLE/PRELOAD	100	Captures I/O ring contents. Places the Boundary Scan Register between TDI and TDO.
RFU	101	Do not use this instruction; Reserved for Future Use.
RFU	110	Do not use this instruction; Reserved for Future Use.
BYPASS	111	Places the BYPASS Register between TDI and TDO.

STRUCTURE OF IDENTIFICATION REGISTER

	Revision				Device Information																JEDEC Vendor Code of RENESAS											
Bit No.	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
M5M5T5672	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	1	1

MSB LSB

PACKAGE OUTLINE

209(11x19) bump Ball Grid Array(BGA) Pin Pitch 1.0mm

Refer to JEDEC Standard MS-028, Variation BC,

which can be seen at:

http://www.jedec.org/download/search/MS-028C.pdf

REVISION HISTORY

<table>
<tr><th>Rev.No.</th><th>History</th><th>Date</th><th></th></tr>
<tr><td>0.0</td><td>First revision</td><td>September 25, 2002</td><td>Preliminary</td></tr>
<tr><td>0.1</td><td>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)</td><td>January 31, 2003</td><td>Preliminary</td></tr>
<tr><td>1.0</td><td>Fixed PART NAME TABLE

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.

STRUCTURE OF IDENTIFICATION REGISTER
Fixed JEDEC Vender Code as follows.
The semiconductor operations of HITACHI and MITSUBISHI Electric were transferred to RENESAS Technology Corporation on April 1st 2003.
Both RENESAS and MITSUBISHI JEDEC vendor code are as follows
<table>
<tr><td>Bit No.</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>RENESAS</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>MITSUBISHI</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
</table></td><td>August 1, 2003</td><td>Preliminary</td></tr>
</table>

Renesas LSIs

M5M5T5672TG – 20

18874368-BIT(262144-WORD BY 72-BIT) NETWORK SRAM

Renesas Technology Corp.
Nippon Bldg.,6-2,Oteamchi 2-chome,Chiyoda-ku,Tokyo,100-0004 Japan

REJ03C0072

New publication, effective August 2003.
Specifications subject to change without notice.

RENESAS
Renesas Technology Corp.