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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

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HM62G18512A Series

9M Synchronous Fast Static RAM
(512k-word × 18-bit)

ADE-203-1268B (Z)
Preliminary
Rev. 0.2
Sep. 12, 2001

Description

The HM62G18512A is a synchronous fast static RAM organized as 512-kword × 18-bit. It has realized high speed access time by employing the most advanced CMOS process and high speed circuit designing technology. It is most appropriate for the application which requires high speed, high density memory and wide bit width configuration, such as cache and buffer memory in system. It is packaged in standard 119-bump BGA.

Note: All power supply and ground pins must be connected for proper operation of the device.

Features

- 2.5 V ± 5% and 3.3 V ± 5% operation and 0.9 V (V_{REF})
- Internal self-timed late write
- Byte write control (2 byte write selects, one for each 9-bit)
- Optional ×36 configuration
- HSTL compatible I/O
- Programmable impedance output drivers
- User selective input trip-point
- Differential, HSTL clock inputs
- Asynchronous $\overline{G}$ output control
- Asynchronous sleep mode
- Limited set of boundary scan JTAG IEEE 1149.1 compatible
- Protocol: Single clock register-register mode

Preliminary: The specification of this device are subject to change without notice. Please contact your nearest Hitachi's Sales Dept. regarding specification.

Ordering Information

Type No.	Access time	Cycle time	Package
HM62G18512ABP-30	1.7 ns	3.0 ns	119-bump 1. 27 mm
HM62G18512ABP-33	1.7 ns	3.3 ns	14 mm × 22 mm BGA (BP-119C)
HM62G18512ABP-40	2.0 ns	4.0 ns	

Pin Arrangement

	1	2	3	4	5	6	7
A	V_{DDQ}	SA0	SA1	NC	SA13	SA12	V_{DDQ}
B	NC	NC	SA2	NC	SA14	SA11	NC
C	NC	SA3	SA4	V_{DD}	SA5	SA6	NC
D	DQb5	NC	V_{SS}	ZQ	V_{SS}	DQa0	NC
E	NC	DQb3	V_{SS}	$\overline{SS}$	V_{SS}	NC	DQa4
F	V_{DDQ}	NC	V_{SS}	$\overline{G}$	V_{SS}	DQa1	V_{DDQ}
G	NC	DQb6	$\overline{SWEb}$	NC	V_{SS}	NC	DQa8
H	DQb7	NC	V_{SS}	NC	V_{SS}	DQa2	NC
J	V_{DDQ}	V_{DD}	V_{REF}	V_{DD}	V_{REF}	V_{DD}	V_{DDQ}
K	NC	DQb2	V_{SS}	K	V_{SS}	NC	DQa7
L	DQb8	NC	V_{SS}	$\overline{K}$	$\overline{SWEa}$	DQa6	NC
M	V_{DDQ}	DQb1	V_{SS}	$\overline{SWE}$	V_{SS}	NC	V_{DDQ}
N	DQb4	NC	V_{SS}	SA8	V_{SS}	DQa3	NC
P	NC	DQb0	V_{SS}	SA10	V_{SS}	NC	DQa5
R	NC	SA7	M1	V_{DD}	M2	SA15	NC
T	NC	SA18	SA9	NC	SA17	SA16	ZZ
U	V_{DDQ}	TMS	TDI	TCK	TDO	NC	V_{DDQ}

(Top view)

Pin Description

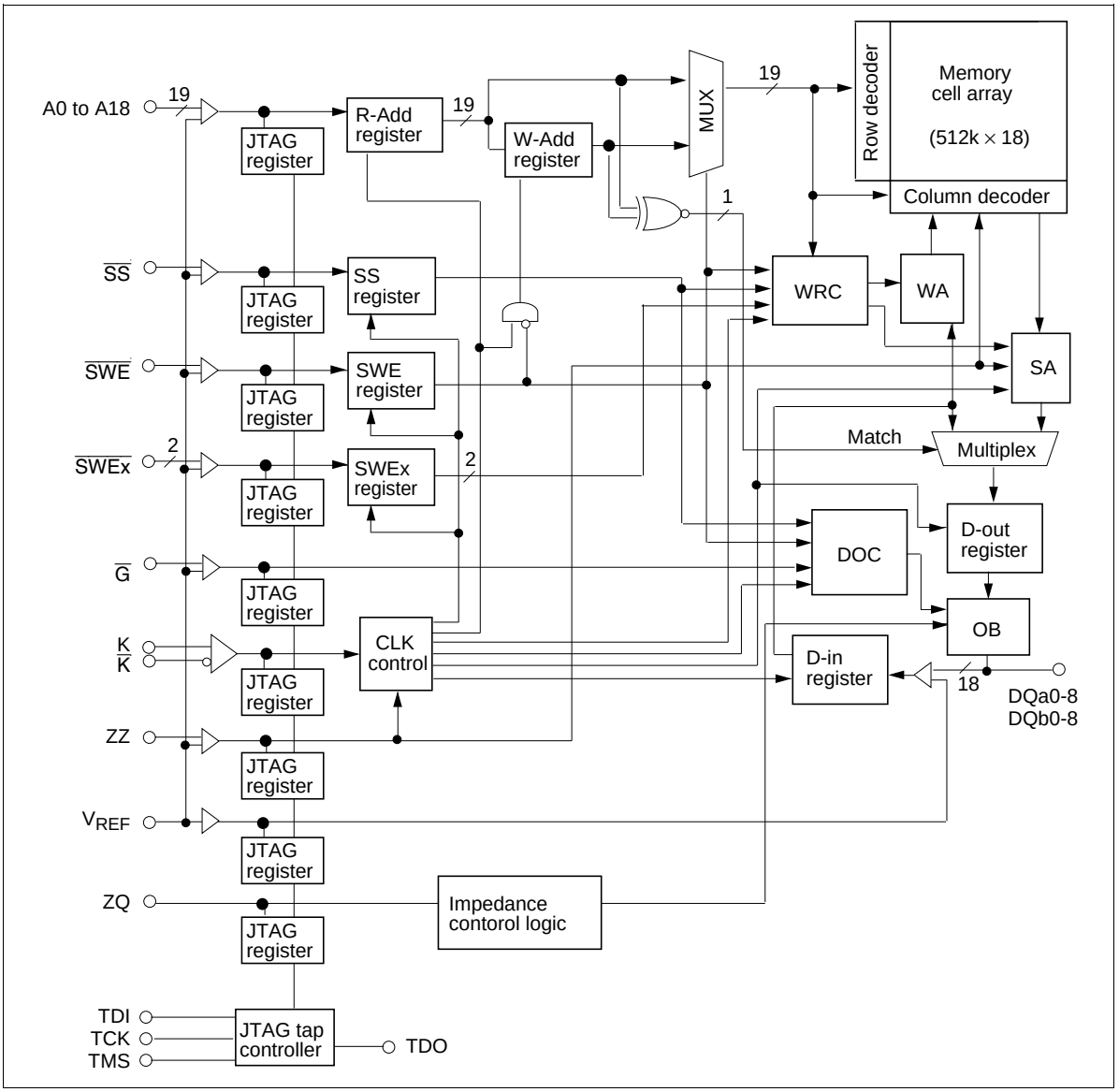
Name	I/O type	Descriptions	Notes
V_{DD}	Supply	Core power supply	
V_{SS}	Supply	Ground	
V_{DDQ}	Supply	Output power supply	
V_{REF}	Supply	Input reference: provides input reference voltage	
K	Input	Clock input. Active high.	
$\overline{K}$	Input	Clock input. Active low.	
$\overline{SS}$	Input	Synchronous chip select	
$\overline{SWE}$	Input	Synchronous write enable	
SAn	Input	Synchronous address input	n = 0-18
$\overline{SWEx}$	Input	Synchronous byte write enables	x = a, b
$\overline{G}$	Input	Asynchronous output enable	
ZZ	Input	Power down mode select	
ZQ	Input	Output impedance control	1
DQxn	I/O	Synchronous data input/output	x = a, b n = 0, 1, 2...8
M1, M2	Input	Output protocol mode select	
TMS	Input	Boundary scan test mode select	
TCK	Input	Boundary scan test clock	
TDI	Input	Boundary scan test data input	
TDO	Output	Boundary scan test data output	
NC	—	No connection	

M1	M2	Protocol	Notes
V_{SS}	V_{DD}	Synchronous register to register operation	2

Notes: 1. ZQ is to be connected to V_{SS} via a resistance RQ where 225 Ω ≤ RQ ≤ 275 Ω. If ZQ = V_{DDQ} or open, output buffer impedance will be maximum.

2. There is 1 protocol with mode pin. For this application, M1 and M2 need to connect to V_{SS} and V_{DD}, respectively. The state of the Mode control inputs must be set before power-up and must not change during device operation. Mode control inputs are not standard inputs and may not meet V_{IH} or V_{IL} specification. This SRAM is tested only in the synchronous register to register operation.

Block Diagram



Operation Table

ZZ	$\overline{SS}$	$\overline{G}$	$\overline{SWE}$	$\overline{SWEa}$	$\overline{SWEb}$	K	$\overline{K}$	Operation	DQ (n)	DQ (n + 1)
H	×	×	×	×	×	×	×	sleep mode	High-Z	High-Z
L	H	×	×	×	×	L-H	H-L	Dead (not selected)	×	High-Z
L	×	H	×	×	×	×	×	Dead (Dummy read)	High-Z	High-Z
L	L	L	H	×	×	L-H	H-L	Read	×	Dout (a,b)0-8
L	L	×	L	L	L	L-H	H-L	Write a, b byte	High-Z	Din (a,b)0-8
L	L	×	L	L	H	L-H	H-L	Write a byte	High-Z	Din (a)0-8
L	L	×	L	H	L	L-H	H-L	Write b byte	High-Z	Din (b)0-8

Notes: 1. × means don't care for synchronous inputs, and H or L for asynchronous inputs.

2. $\overline{SWE}$, $\overline{SS}$, $\overline{SWEa}$ to $\overline{SWEb}$, SA are sampled at the rising edge of K clock.

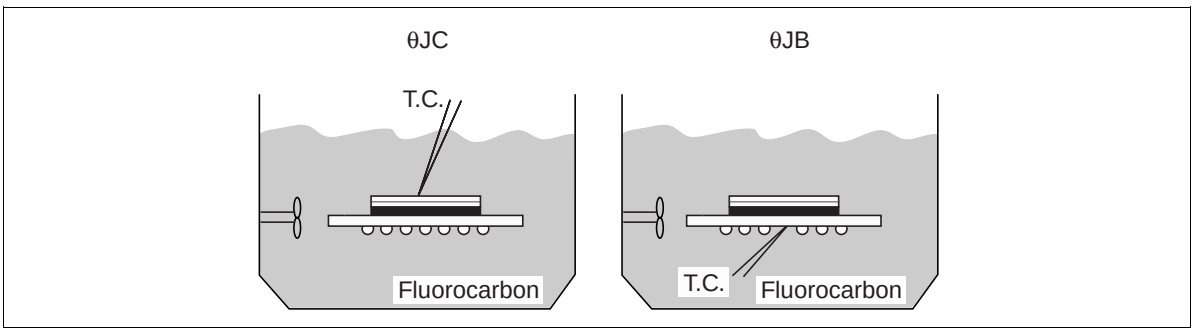
3. Although differential clock operation is implied, this SRAM will operate properly with one clock phase (either K or $\overline{K}$) tied to V_{REF}. Under such single-ended clock operation, all parameters specified within this document will be met.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Notes
Input voltage on any pin	V_{IN}	–0.5 to V_{DDQ} + 0.5	V	1, 4
Core supply voltage	V_{DD}	–0.5 to 3.9	V	1
Output supply voltage	V_{DDQ}	–0.5 to 2.2	V	1, 4
Operating temperature	T_{OPR}	0 to 70	°C	
Storage temperature	T_{STG}	–55 to 125	°C	
Output short–circuit current	I_{OUT}	25	mA	
Latch up current	I_{LI}	200	mA	
Package junction to case thermal resistance	θJC	2	°C/W	5, 7
Package junction to ball thermal resistance	θJB	5	°C/W	6, 7

Notes: 1. All voltage is referred to V_{SS}.

2. Permanent device damage may occur if Absolute Maximum Ratings are exceeded. Functional operation should be restricted the Operation Conditions. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.
3. These CMOS memory circuits have been designed to meet the DC and AC specifications shown in the tables after thermal equilibrium has been established.
4. The following supply voltage application sequence is recommended: V_{SS}, V_{DD}, V_{DDQ}, V_{REF} then Vin. Remember, according to the Absolute Maximum Ratings table, V_{DDQ} is not exceed 2.2 V, whatever the instantaneous value of V_{DDQ}.
5. θJC is measured at the center of mold surface in fluorocarbon (See Figure “Definition of Measurement”).
6. θJB is measured on the center ball pad after removing the ball in fluorocarbon (See Figure “Definition of Measurement”).
7. These thermal resistance values have error of ± 5°C/W.



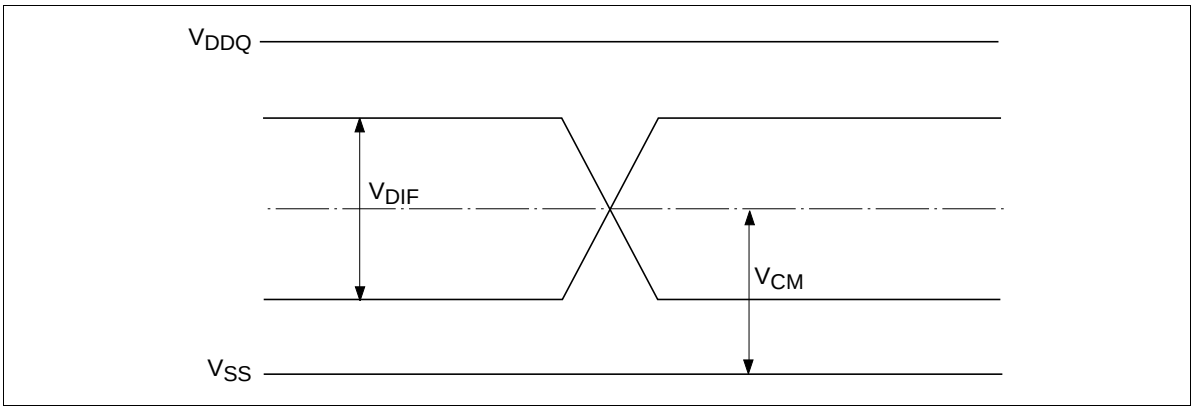
Definition of Measurement

Note: The following the DC and AC specifications shown in the Tables, this device is tested under the minimum transverse air flow exceeding 500 linear feet per minute.

DC Operating Conditions (Ta = 0 to 70°C)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply voltage (Core)	V_{DD}	2.38	2.5	2.63	V	2.5 V part
	V_{DD}	3.14	3.3	3.47	V	3.3 V part
Supply voltage (I/O)	V_{DDQ}	1.6	1.8	2.0	V	
Input reference voltage (I/O)	V_{REF}	0.8	0.9	1.0	V	1
Input high voltage	V_{IH}	V_{REF} + 0.1	—	V_{DDQ} + 0.3	V	
Input low voltage	V_{IL}	–0.3	—	V_{REF} – 0.1	V	
Clock differential voltage	V_{DIF}	0.1	—	V_{DDQ} + 0.3	V	2, 3
Clock common mode voltage	V_{CM}	0.6	—	0.90	V	3

Notes: 1. Peak to peak AC component superimposed on V_{REF} may not exceed 5% of V_{REF}.
2. Minimum differential input voltage required for differential input clock operation.
3. See following figure.



Differential Voltage/Common Mode Voltage

DC Characteristics (Ta = 0 to 70°C, V_{DD} = 2.5 V ± 5%, 3.3 V ± 5%)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Input leakage current	I_{LI}	—	—	2	µA	1
Output leakage current	I_{LO}	—	—	5	µA	2
Standby current	I_{SBZZ}	—	—	100	mA	3
V_{DD} operating current, excluding output drivers 4 ns cycle	I_{DD4}	—	—	400	mA	4
V_{DD} operating current, excluding output drivers 3 ns and 3.3 ns cycle	I_{DD3}	—	—	500	mA	4
Quiescent active power supply current	I_{DD2}	—	—	200	mA	5
Maximum Power Dissipation, including output data	P	—	—	2.3 at 2.5 V part	W	6
		—	—	2.8 at 3.3 V part	W	6
Output low voltage (Programmable impedance Mode)	V_{OL1}	V_{SS}	—	$V_{DDQ/2}$	V	
Output High voltage (Programmable impedance Mode)	V_{OH1}	$V_{DDQ/2}$	—	V_{DDQ}	V	
Output low voltage	V_{OL2}	V_{SS}	—	V_{SS} + 0.4	V	7
Output high voltage	V_{OH2}	V_{DDQ} – 0.4	—	V_{DDQ}	V	8
ZQ pin connect resistance	RQ	225	250	275	Ω	
Output low current	I_{OL}	(V_{DDQ}/2)/ [{(RQ/5 – 5 Ω)}-15%]	—	(V_{DDQ}/2)/ [{(RQ/5 – 5Ω)}+15%]	mA	9, 11, 12
Output high current	I_{OH}	(V_{DDQ}/2)/ [{(RQ/5 – 5 Ω)} +15%]	—	(V_{DDQ}/2)/ [{(RQ/5 – 5Ω)}-15%]	mA	10, 11, 12

Notes:
1. $0 \le Vin \le V_{DDQ}$ for all input pins (except V_{REF}, ZQ, M1, M2 pin).
2. $0 \le Vout \le V_{DDQ}$, DQ in High-Z.
3. All inputs (except clock) are held at either V_{IH} or V_{IL}, ZZ is held at V_{IH}, Iout = 0 mA. Spec is guaranteed at 75°C junction temperature.
4. Iout = 0 mA, read 50%/write 50%, $V_{DD} = V_{DD}$ max, $V_{IN} = V_{IH}$ or V_{IL}, Frequency = minimum cycle.
5. Iout = 0 mA, read 50%/write 50%, $V_{DD} = V_{DD}$ max, $V_{IN} = V_{IH}$ or V_{IL}, Frequency = 3 MHz.
6. Output drives a 12pF load and switches every cycle. This parameter should be used by the SRAM designer to determine electrical and package requirements for the SRAM device.
7. I_{OL} = 6 mA (RQ = 175 Ω).
8. I_{OH} = –6 mA (RQ = 175 Ω).
9. V_{OL} = 1/2 V_{DDQ}.
10. V_{OH} = 1/2 V_{DDQ}.
11. Parameter tested with RQ = 250 Ω and V_{DDQ} = 1.8 V.

12. Output buffer impedance can be programmed by terminating the ZQ pin to V_{SS} through a precision resister (RQ). The value of RQ is five times the output impedance desired. The allowable range of RQ to guarantee impedance matching with a tolerance of 15% is 250 typical. If the status of ZQ pin is open, output impedance is maximum. Maximum impedance occurs with ZQ connected to V_{DDQ}. The impedance update of the output driver occurs when the SRAM is in High-Z. Write and Deselect operations will synchronously switch the SRAM into and out of High-Z, therefore triggering an update. The user may choose to invoke asynchronous $\overline{G}$ updates by providing a $\overline{G}$ setup and hold about the K clock to guarantee the proper update. At power-up, the output impedance defaults to minimum impedance. It will take 1024 cycles for the impedance to be completely updated if the programmed impedance is much higher than minimum impedance. The total external capacitance of ZQ pin must be less than 7.5 pF.

Capacitance (Ta = 25°C, f = 1 MHz)

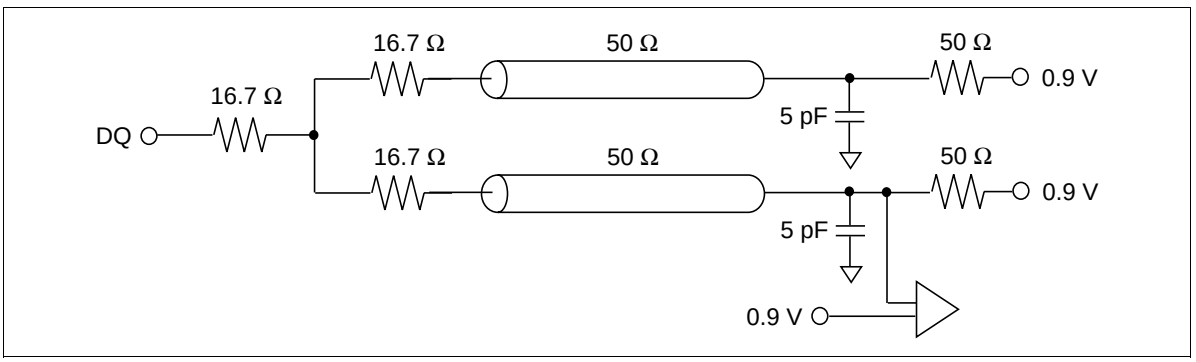
Parameter	Symbol	Min	Max	Unit	Note
Input capacitance (SAn, $\overline{SS}$, $\overline{SWE}$, $\overline{SWEx}$)	C_{IN}	—	4	pF	1
Input capacitance (K, $\overline{K}$, $\overline{G}$)	C_{CLK}	—	5	pF	1
Input/Output capacitance (DQxn)	C_{IO}	—	5	pF	1

Note: 1. This parameter is sampled and not 100% tested.

AC Characteristics (Ta = 0 to 70°C, V_{DD} = 2.5 V ± 5% and 3.3 V ± 5%)

Test Conditions

- Input pulse levels (K, $\overline{K}$): V_{DIF} = 0.75 V, V_{CM} = 0.9 V
- Input timing reference level (K, $\overline{K}$): Differential cross point
- Input pulse levels (except K, $\overline{K}$): V_{IL} = 0.3 V, V_{IH} = 1.5 V
- Input and output timing reference levels (except K, $\overline{K}$): V_{REF} = 0.9 V
- Input rise and fall time: 0.5 ns (10% to 90%)
- Output load: See figure
- Parameters are tested with RQ = 250 Ω and V_{DDQ} = 1.8 V



AC Characteristics (Ta = 0 to 70°C, V_{DD} = 2.5 V ± 5% and 3.3 V ± 5%)

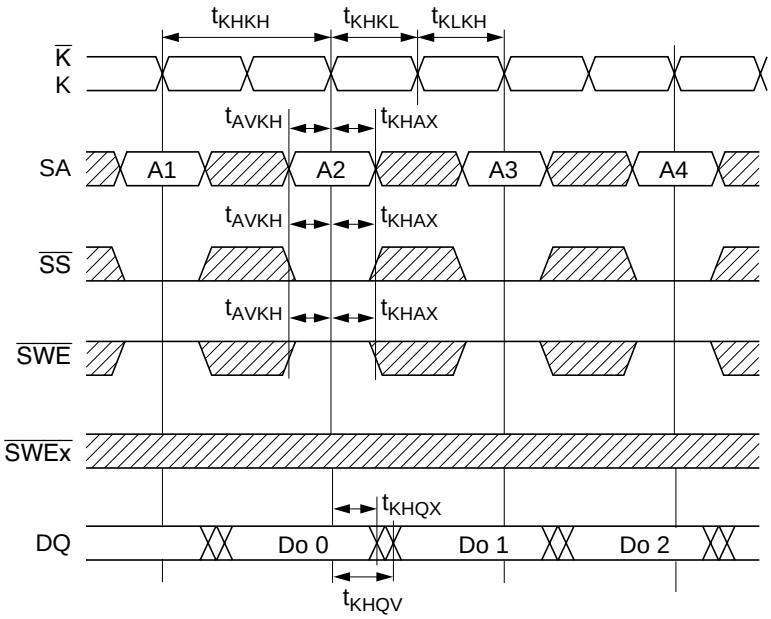
Single Differential Clock Register-Register Mode (M1 = V_{SS}, M2 = V_{DD})

		HM62G18512A							
		-30		-33		-40			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
CK clock cycle time	t_{KHKH}	3.0	—	3.3	—	4.0	—	ns	
CK clock high width	t_{KHKL}	1.2	—	1.3	—	1.5	—	ns	
CK clock low width	t_{KLKH}	1.2	—	1.3	—	1.5	—	ns	
Address setup time	t_{AVKH}	0.5	—	0.5	—	0.5	—	ns	2
Data setup time	t_{DVKH}	0.5	—	0.5	—	0.5	—	ns	2
Address hold time	t_{KHAX}	0.5	—	0.5	—	0.5	—	ns	2
Data hold time	t_{KHDX}	0.5	—	0.5	—	0.5	—	ns	2
Clock high to output valid	t_{KHQV}	—	1.7	—	1.7	—	2.0	ns	1
Clock high to output hold	t_{KHQX}	0.5	—	0.5	—	0.5	—	ns	1, 2
Clock high to output Low-Z ($\overline{SS}$ control)	t_{KHQX2}	0.5	—	0.5	—	0.5	—	ns	1, 5
Clock high to output High-Z	t_{KHQZ}	—	2.0	—	2.0	—	2.0	ns	1, 3
Output enable low to output Low-Z	t_{GLQX}	0.3	—	0.3	—	0.3	—	ns	1, 2, 5
Output enable low to output valid	t_{GLQV}	—	1.7	—	1.7	—	2.0	ns	1, 3
Output enable low to output High-Z	t_{GHQZ}	—	1.5	—	1.5	—	1.5	ns	1, 3
Sleep mode recovery time	t_{ZZR}	10.0	—	10.0	—	10.0	—	ns	6
Sleep mode enable time	t_{ZZE}	—	9.0	—	9.0	—	9.0	ns	1, 3, 6

Notes: 1. See AC Test Loading figure.
2. Parameter is guaranteed by design.
3. Transitions are measured at start point of output high impedance from output low impedance.
4. Output driver impedance update specifications for $\overline{G}$ induced updates. Write and deselected cycles will also induce output driver updates during High-Z.
5. Transitions are measured ±200 mV from steady state voltage.
6. When ZZ is switching, clock input K must be at same logic levels for reliable operation.

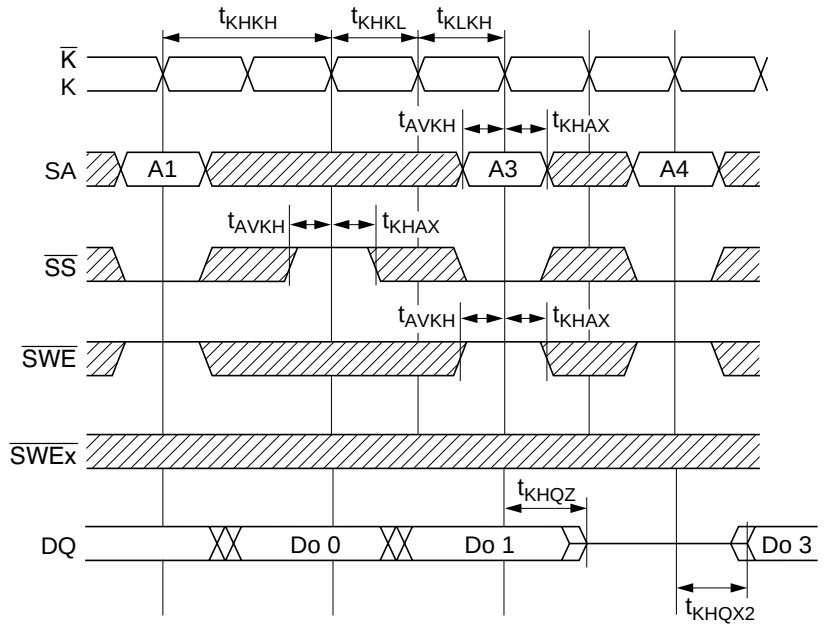
Timing Waveforms

Read Cycle-1



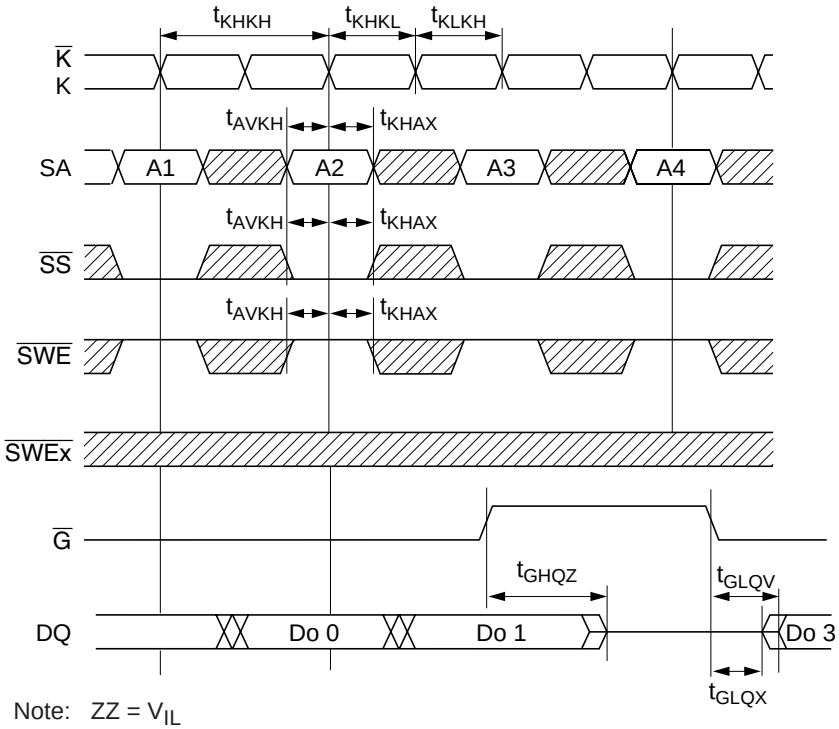
Note: $\overline{G}$, ZZ = V_{IL}

Read Cycle-2 ($\overline{SS}$ Controlled)



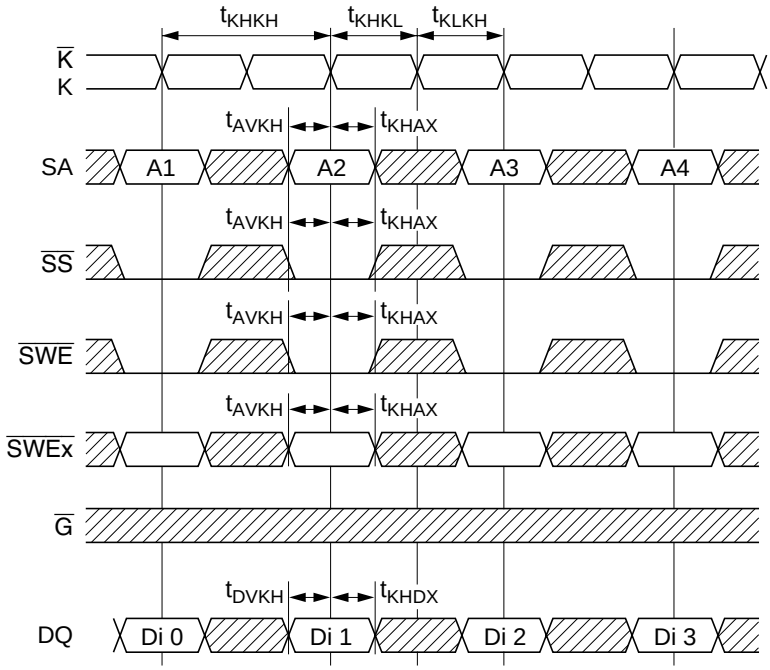
Note: $\overline{G}$, ZZ = V_{IL}

Read Cycle-3 ($\overline{G}$ Controlled)



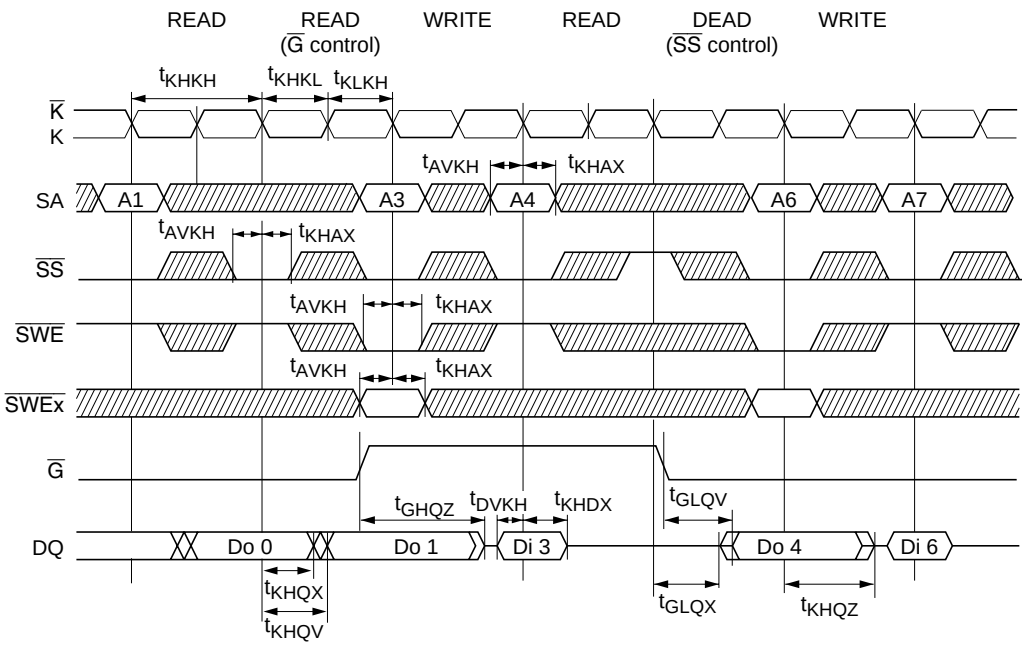
Note: ZZ = V_{IL}

Write Cycle



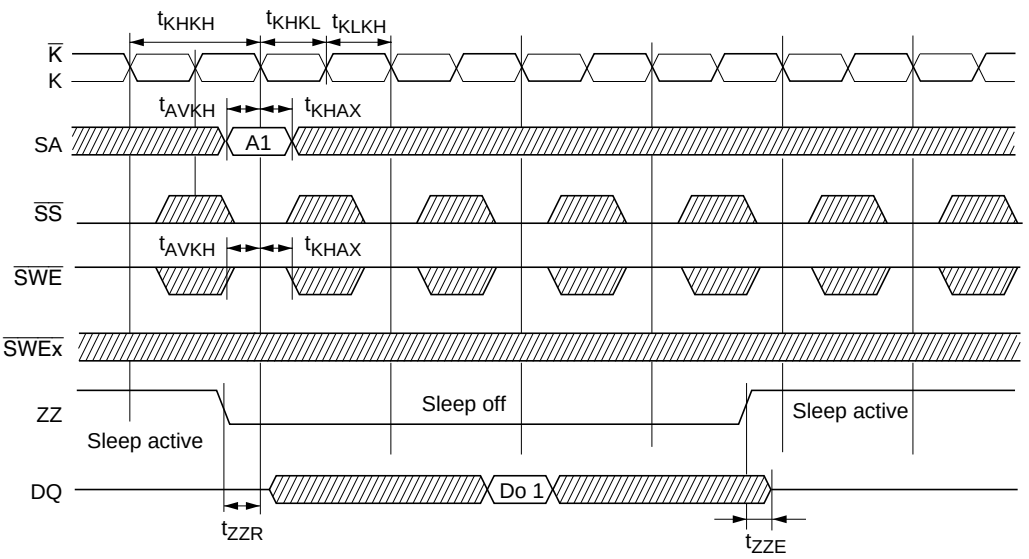
Note: ZZ = V_{IL}

Read-Write Cycle



Note: ZZ = V_{IL}

ZZ Control



Note: $\overline{G}$ = V_{IL}

Boundary Scan Test Access Port Operations

In order to perform the interconnect testing of the modules that include this SRAM, the serial boundary scan test access port (TAP) is designed to operate in a manner consistent with IEEE Standard 1149.1 - 1990. But does not implement all of the functions required for 1149.1 compliance The HM62G series contains a TAP controller. Instruction register, Boundary scans register, Bypass register and ID register.

Test Access Port Pins

Symbol I/O	Name
TCK	Test clock
TMS	Test mode select
TDI	Test data in
TDO	Test data out

Note: This Device does not have a TRST (TAP Reset) pin. TRST is optional in IEEE 1149.1.
To disable the TAP, TCK must be connected to V_{SS}. TDO should be left unconnected.
To test Boundary scan, ZZ pin need to be kept below V_{REF} – 0.4 V.

TAP DC Operating Conditions (Ta = 0 to 70°C)

Parameter	Symbol	Min	Max	Unit	Notes
Boundary scan input high voltage	V_{IH}	2.0	3.6	V	
Boundary scan input low voltage	V_{IL}	–0.3	0.8	V	
Boundary scan input leakage current	I_{LI}	–5	5	µA	1
Boundary scan output low voltage	V_{OL}	—	0.4	V	2
Boundary scan output high voltage	V_{OH}	2.4	—	V	3

Notes: 1. $0 \le Vin \le V_{DD}$ for all logic input pin.
2. I_{OL} = 8 mA at V_{DD} = 3.3 V.
3. I_{OH} = –8 mA at V_{DD} = 3.3 V.

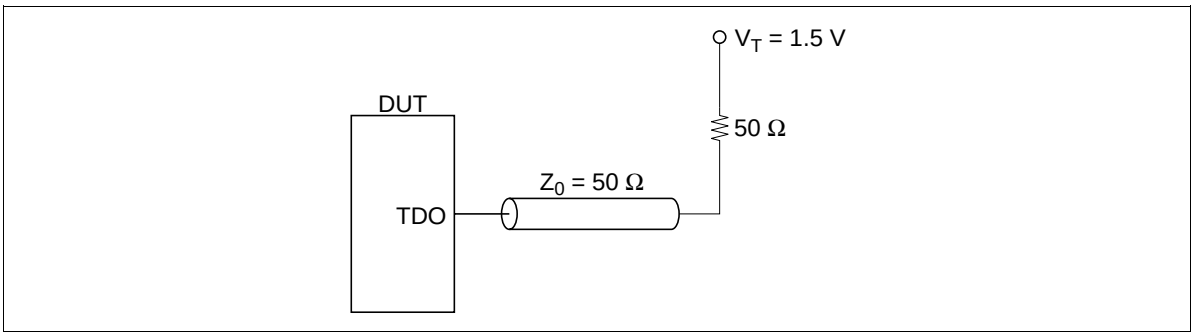
TAP AC Characteristics (Ta = 0 to 70°C)

Parameter	Symbol	Min	Max	Unit	Note
Test clock cycle time	t_{THTH}	67	—	ns	
Test clock high pulse width	t_{THTL}	30	—	ns	
Test clock low pulse width	t_{TLTH}	30	—	ns	
Test mode select setup	t_{MVTH}	10	—	ns	
Test mode select hold	t_{THMX}	10	—	ns	
Capture setup	t_{CS}	10	—	ns	1
Capture hold	t_{CH}	10	—	ns	1
TDI valid to TCK high	t_{DVTH}	10	—	ns	
TCK high to TDI don't care	t_{THDX}	10	—	ns	
TCK low to TDO unknown	t_{TLQX}	0	—	ns	
TCK low to TDO valid	t_{TLQV}	—	20	ns	

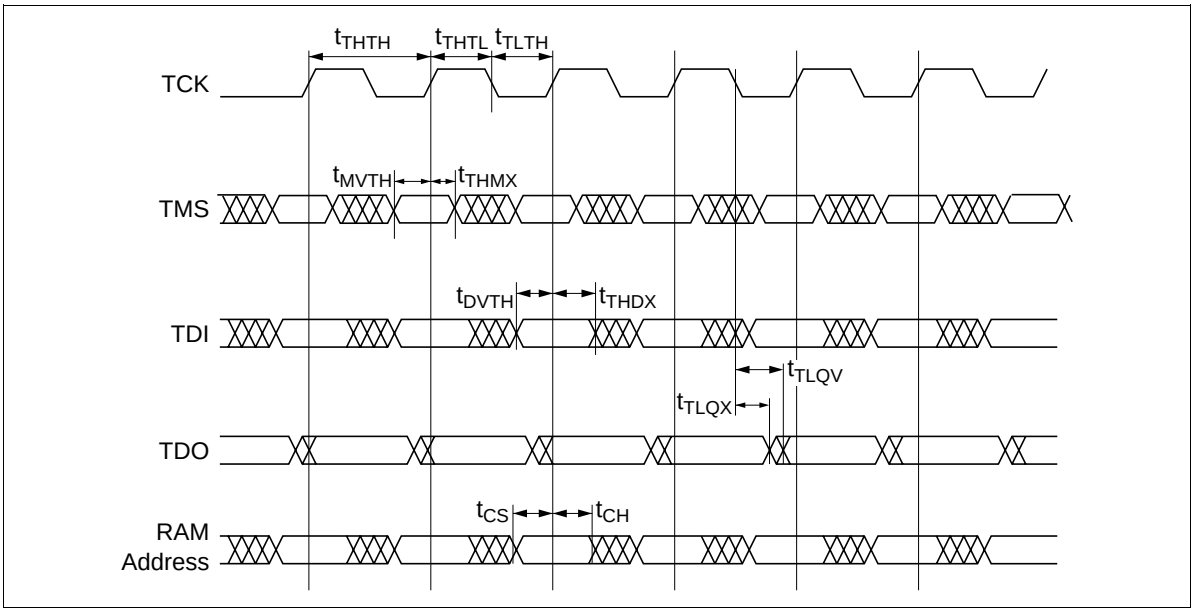
Note: 1. $t_{CS} + t_{CH}$ defines the minimum pause in RAM I/O pad transitions to assure pad data capture.

TAP Test Conditions (V_{DD} = 3.3 V)

- Tempreture: 0°C ≤ Ta ≤ 70°C
- Input timing measurement reference level: 1.5 V
- Input pulse levels: 0 to 3.0 V
- Input rise and fall time: 2.0 ns typical (10% to 90%)
- Output timing measurement reference level: 1.5 V
- Test load termination supply voltage (V_T): 1.5 V
- Output Load: See figures



TAP Controller Timing Diagram



Test Access Port Registers

Register name	Length	Symbol	Note
Instruction register	3 bits	IR [0;2]	
Bypass register	1 bit	BP	
ID register	32 bits	ID [0;31]	
Boundary scan register	51 bits	BS [1;51]	

TAP Controller Instruction Set

IR2	IR1	IR0	Instruction	Operation
0	0	0	SAMPLE-Z	Tristate all data drivers and capture the pad value
0	0	1	IDCODE	
0	1	0	SAMPLE-Z	Tristate all data drivers and capture the pad value
0	1	1	BYPASS	
1	0	0	SAMPLE	
1	0	1	BYPASS	
1	1	0	BYPASS	
1	1	1	BYPASS	

Note: This Device does not perform EXTEST, INTEST or the preload portion of the PRELOAD command in IEEE 1149.1.

Boundary Scan Order

Bit No.	Bump ID	Signal name	Bit No.	Bump ID	Signal name
1	5R	M2	27	2B	NC
2	6T	SA	28	3A	SA
3	4P	SA	29	3C	SA
4	6R	SA	30	2C	SA
5	5T	SA	31	2A	SA
6	7T	ZZ	32	1D	DQb
7	7P	DQa	33	2E	DQb
8	6N	DQa	34	2G	DQb
9	6L	DQa	35	1H	DQb
10	7K	DQa	36	3G	$\overline{\text{SWEb}}$
11	5L	$\overline{\text{SWEa}}$	37	4D	ZQ
12	4L	$\overline{\text{K}}$	38	4E	$\overline{\text{SS}}$
13	4K	K	39	4G	NC
14	4F	$\overline{\text{G}}$	40	4H	NC
15	6H	DQa	41	4M	$\overline{\text{SWE}}$
16	7G	DQa	42	2K	DQb
17	6F	DQa	43	1L	DQb
18	7E	DQa	44	2M	DQb
19	6D	DQa	45	1N	DQb
20	6A	SA	46	2P	DQb
21	6C	SA	47	3T	SA
22	5C	SA	48	2R	SA
23	5A	SA	49	4N	SA
24	6B	SA	50	2T	SA
25	5B	SA	51	3R	M1
26	3B	SA			

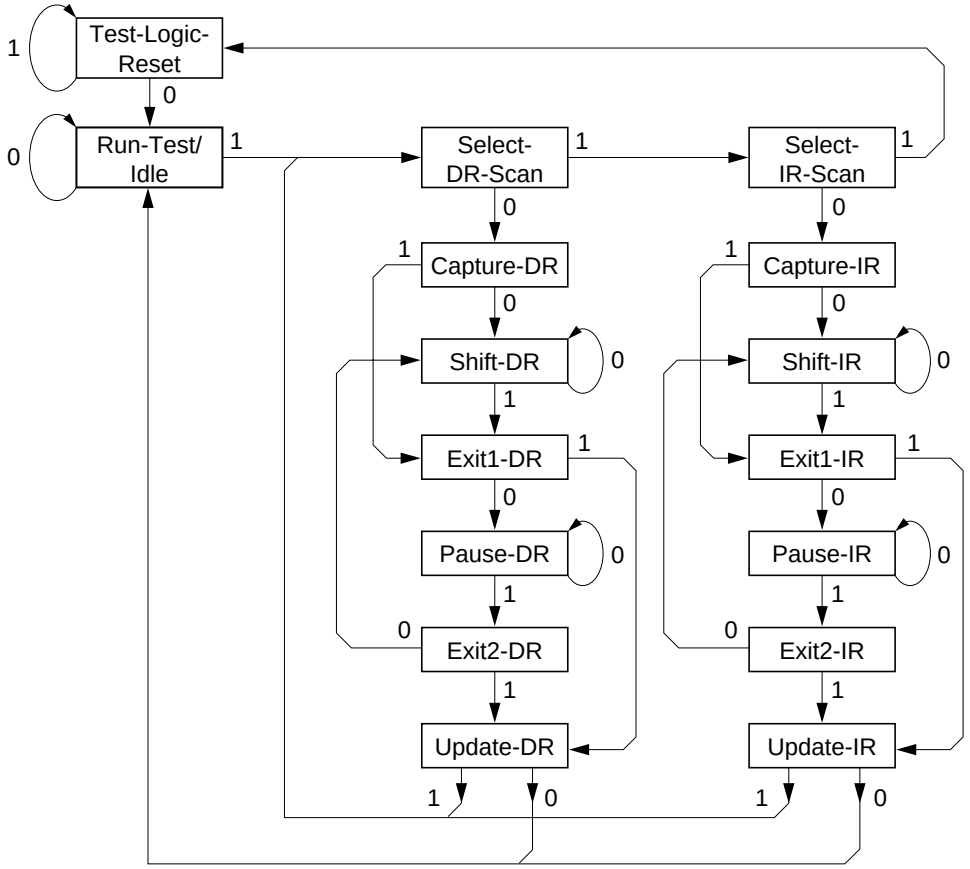
Notes: 1. Bit#1 is the first scan bit to exit the chip.

2. The NC pads listed in this table are indeed no connects, but are represented in the boundary scan register by a “Place Holder”. Placeholder registers are internally connected to V_{SS}.
3. In Boundary scan mode, differential input K and $\overline{\text{K}}$ are referenced to each other and must be at opposite logic levels for reliable operation.
4. ZZ must remain at V_{IL} during boundary scan.
5. In boundary scan mode, ZQ must be driven to V_{DDQ} or V_{SS} supply rail to ensure consistent results.
6. M1 and M2 must be driven to V_{DD} or V_{SS} supply rail to ensure consistent results.

ID register

Part	Revision Number (31:28)	Device Density and Configuration (27:18)	Vendor Definition (17:12)	Vendor JEDEC Code (11:1)	Smart Bit (0)
HM62G18512A	0010	0011100011	xxxxxx	00000000111	1

TAP Controller State Diagram

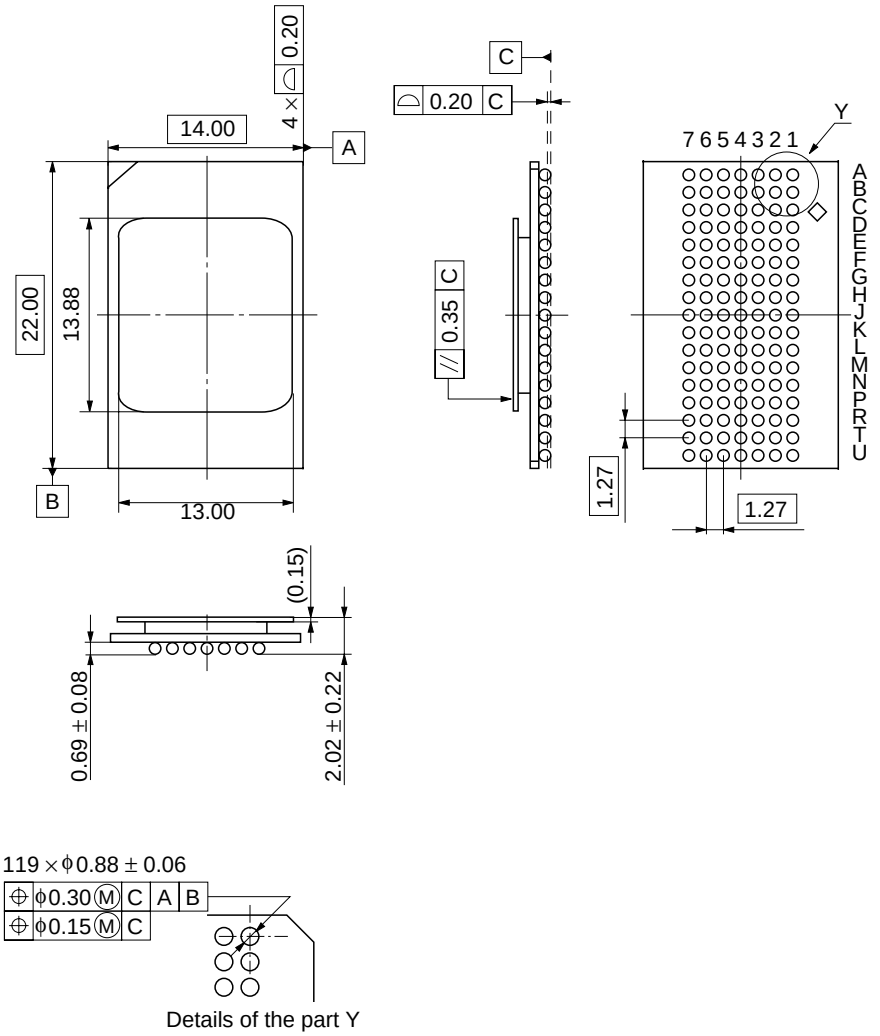


Note: The value adjacent to each state transition in this figure represents the signal present at TMS at the time of a rising edge at TCK.
No matter what the original state of the controller, it will enter Test-Logic-Reset when TMS is held high for at least five rising edges of TCK.

Package Dimensions

HM62G18512ABP Series (BP-119C)

Unit: mm



Hitachi Code	BP-119C
JEDEC	—
EIAJ	—
Mass	1.0 g

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