HM67S36130 Series

4M Synchronous Fast Static RAM (128k-words × 36-bits)

HITACHI

ADE-203-659B(Z)
Product Preview, Rev. 2
Nov. 18, 1997

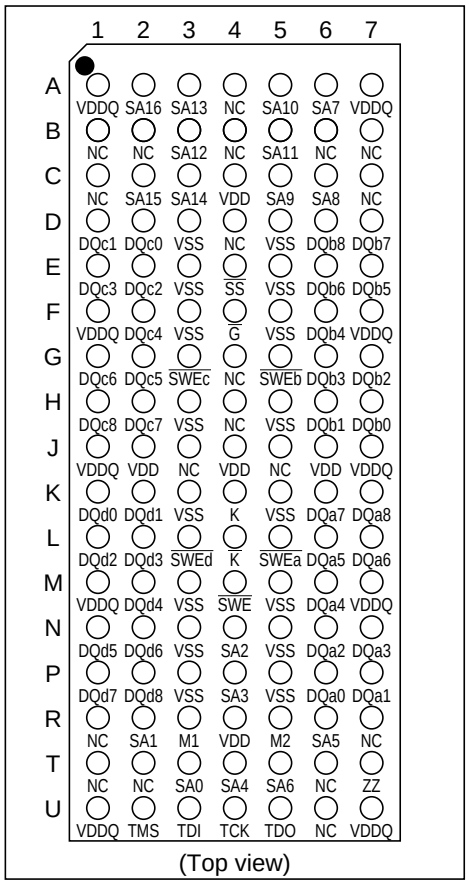
Features

- 3.3V ± 5% Operation
- LVCMOS Compatible Input and Output
- Synchronous Operation
- Internal self-timed Late Write
- Asynchronous $\overline{G}$ Output Control
- Byte Write Control
  (4 byte write selects, one for each 9 bits)
- Power down mode is provided
- Differential PECL Clock Inputs
- Boundary Scan
- Protocol Single Clock Register-Latch Mode

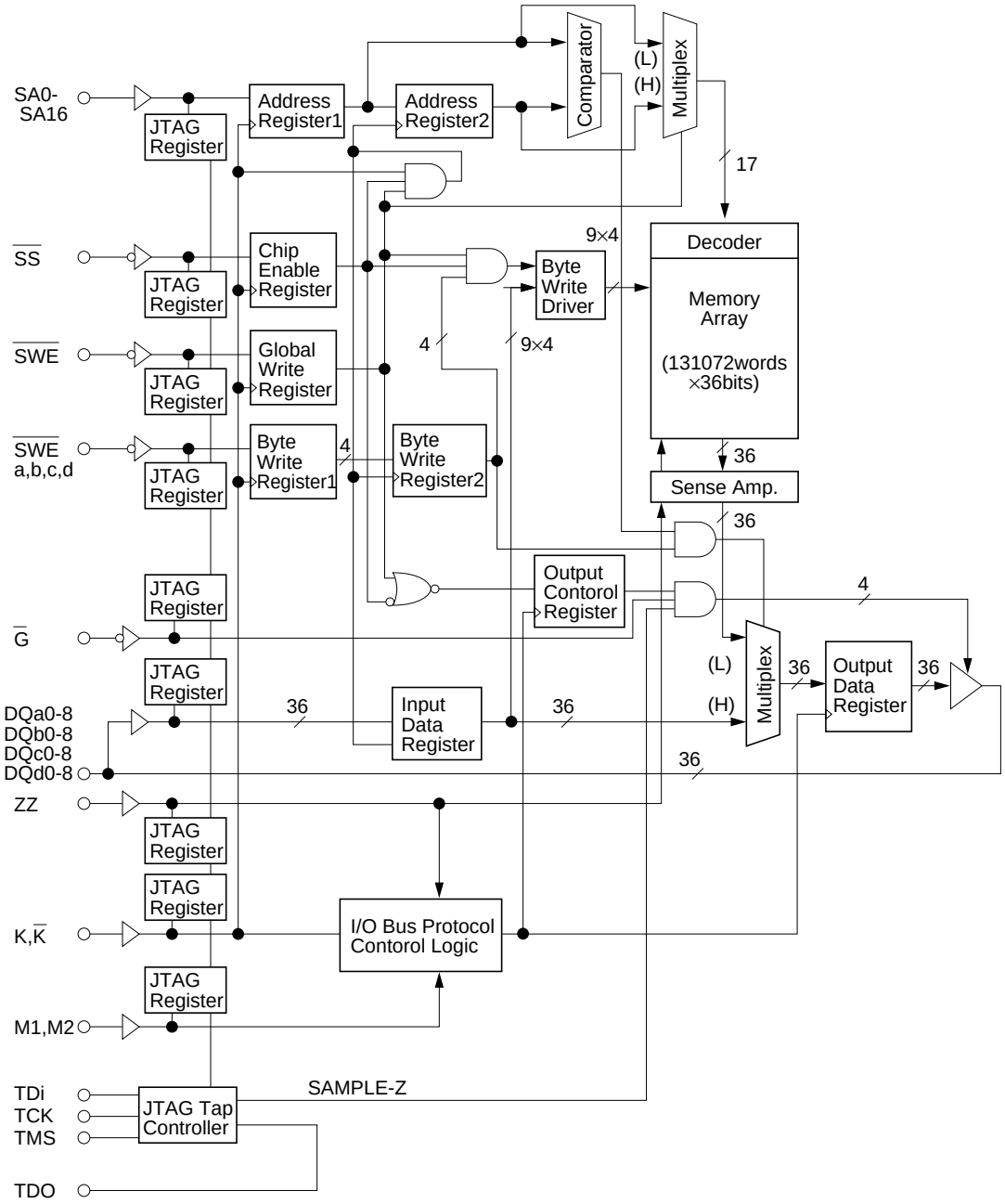
Ordering Information

Type Number	Cycle Time	Package
HM67S36130BP-7	7.0 ns	119 Bump 1. 27 mm 14 mm × 22 mm BGA (BP-119A)

Pin Arrangement



Block Diagram



Note: The functional block diagram illustrates simplified device operation. See truth table, pin descriptions and timing diagrams for detailed information.

Pin Descriptions

Name	I/O Type	Descriptions	Note
V_{DD}		Power Supply	
V_{SS}		Ground	
V_{DDQ}		Output Power Supply	
K	Input	Input Clock	
$\overline{K}$	Input	Input Clock	
$\overline{SS}$	Input	Synchronous Chip Select	
$\overline{SWE}$	Input	Synchronous Write Enable	
SAn	Input	Synchronous Address	n = 0, 1, 2, ... 16
$\overline{SWEx}$	Input	Synchronous Byte Select	x = a, b, c, d
$\overline{G}$	Input	Asynchronous Output Enables	
ZZ	Input	Power Down Mode Select	
DQxm	I/O	Synchronous Data Input/Output	x = a, b, c, d m = 0, 1, 2, ... 8
M1, M2	Input	Output Protocol Mode Select	1
TMS	Input	Boundary Scan Test Mode Select	
TCK	Input	Boundary Scan Test Clock	
TDI	Input	Boundary Scan Test Data In	
TDO	Output	Boundary Scan Test Data Out	
NC		No Connection	

Notes: 1. There is 1 protocol with using mode pins. Mode control pins (M1, M2) are to be tied to either V_{DD} or V_{SS}. 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} specifications.

M1	M2	Protocol
V_{DD}	V_{SS}	Single Clock Register Latch

Truth Table

$\overline{SS}$	$\overline{G}$	$\overline{SWE}$	$\overline{SWEa}$	$\overline{SWEb}$	$\overline{SWEc}$	$\overline{SWEd}$	K	$\overline{K}$	Operation	DQa	DQb	DQc	DQd
H	X	X	X	X	X	X	L-H	H-L	Dead (not selected)	High-Z	High-Z	High-Z	High-Z
L	H	H	X	X	X	X	L-H	H-L	Dead (Dummy read)	High-Z	High-Z	High-Z	High-Z
L	L	H	X	X	X	X	L-H	H-L	Read	Dout	Dout	Dout	Dout
L	X	L	L	L	L	L	L-H	H-L	Write a, b, c, d byte	Din	Din	Din	Din
L	X	L	H	L	L	L	L-H	H-L	Write b, c, d byte	High-Z	Din	Din	Din
L	X	L	L	H	L	L	L-H	H-L	Write a, c, d byte	Din	High-Z	Din	Din
L	X	L	L	L	H	L	L-H	H-L	Write a, b, d byte	Din	Din	High-Z	Din
L	X	L	L	L	L	H	L-H	H-L	Write a, b, c byte	Din	Din	Din	High-Z
L	X	L	H	H	L	L	L-H	H-L	Write c, d byte	High-Z	High-Z	Din	Din
L	X	L	L	H	H	L	L-H	H-L	Write a, d byte	Din	High-Z	High-Z	Din
L	X	L	L	L	H	H	L-H	H-L	Write a, b byte	Din	Din	High-Z	High-Z
L	X	L	H	L	L	H	L-H	H-L	Write b, c byte	High-Z	Din	Din	High-Z
L	X	L	H	H	H	L	L-H	H-L	Write d byte	High-Z	High-Z	High-Z	Din
L	X	L	H	H	L	H	L-H	H-L	Write c byte	High-Z	High-Z	Din	High-Z
L	X	L	H	L	H	H	L-H	H-L	Write b byte	High-Z	Din	High-Z	High-Z
L	X	L	L	H	H	H	L-H	H-L	Write a byte	Din	High-Z	High-Z	High-Z

Notes: 1. X means don't care for synchronous inputs, and H or L for asynchronous inputs.
2. $\overline{SWE}$, $\overline{SS}$, $\overline{SWEa}$ to $\overline{SWEd}$, SA are sampled at the rising edge of K clock.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Note
Supply voltage	V_{DD}	–0.5 to +4.6	V	1
Output Supply Voltage	V_{DDQ}	–0.5 to V_{DD}+0.5	V	1, 4
Voltage on any pin	V_{IN}	–0.5 to V_{DD}+0.5	V	1, 4
Operating Temperature	Ta	0 to 70 (Tj max = 110)	°C	
Storage Temperature	Tstg (bias)	–55 to 125	°C	
Input Latchup Current	I_{LI}	±200	mA	
Output Current per pin	Iout	±25	mA	

Notes: 1. All voltage are referenced 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 Bi-CMOS memory circuits have been designed to meet the DC and AC specifications shown in the tables after thermal equilibrium has been established.
4. Not exceed 4.6 V
5. Power Up Initialization

   The following supply voltage application sequence is recommended: V_{SS}, V_{DD} then V_{DDQ}.

   Remember according to the Absolute Maximum Ratings table, V_{DDQ} is not to exceed V_{DD} + 0.5 V, whatever the instantaneous value of V_{DD}.

Recommended DC Operating Conditions (Ta = 0 to 70°C [Tj max = 110°C])

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Supply voltage	V_{DD}	3.135	3.3	3.465	V	
Output Supply voltage	V_{DDQ}	3.135	3.3	3.465	V	1
		2.375	2.5	2.75	V	2
Input voltage Logic High Level	V_{IH}	2.0	—	V_{DDQ} + 0.3	V	1
Logic Low Level	V_{IL}	–0.5	—	0.8	V	1
Logic High Level	V_{IH}	1.85	—	V_{DDQ} + 0.3	V	2
Logic Low Level	V_{IL}	–0.5	—	1.15	V	2
PECL Logic High Level	V_{IH}(PECL)	2.135	—	2.420	V	
PECL Logic Low Level	V_{IL}(PECL)	1.490	—	1.825	V	

Notes: 1. For V_{DDQ} = 3.3 V supply.

2. For V_{DDQ} = 2.5 V supply.

DC Characteristics (Ta = 0 to 70°C, [Tjmax-110°C], V_{DD} = 3.3 V± 5%)

Parameter		Symbol	Min	Typ	Max	Unit	Note
Input Leakage Current		I_{LI}	–1	—	1	µA	1
Output Leakage Current		I_{LO}	–1	—	1	µA	2
PECL Input Leakage Current Low		I_{LI} (PECL)		—	50	µA	
PECL Input Leakage Current High		I_{LI} (PECL)		—	150	µA	
V_{DD} Operating Current excluding output drivers		I_{DD}	—	—	600	mA	3
Power Dissipation including output drivers		P_d	—	—	2.7	W	3, 8
Standby Current (Power down mode)		I_{SB}	—	—	100	mA	5
Output Voltage	Logic Low	V_{OL}	0	—	0.4	V	4
	Logic High	V_{OH}	2.4 V_{DDQ}-0.4	—	V_{DDQ} V_{DDQ}	V V	4, 6 4, 7

Note: 1. $0 \le Vin \le V_{DD}$
2. $0 \le VI/O \le V_{DD}$, Tristate I/O
3. I(I/O) = 0 mA, Address increment read 50% / write 50%, $V_{DD} = V_{DD}$ max, Frequency = 125 MHz
4. I_{OH} = –2 mA or I_{OL} = 2 mA
5. All inputs (except clock) are held at either V_{SS} or V_{DDQ}, and ZZ is held at V_{DDQ}
6. for V_{DDQ} = 3.3 V supply
7. for V_{DDQ} = 2.5 V supply
8. Output Load Capacitance = 29 pF

Input Capacitance (Ta = 25°C, f = 1 MHz)

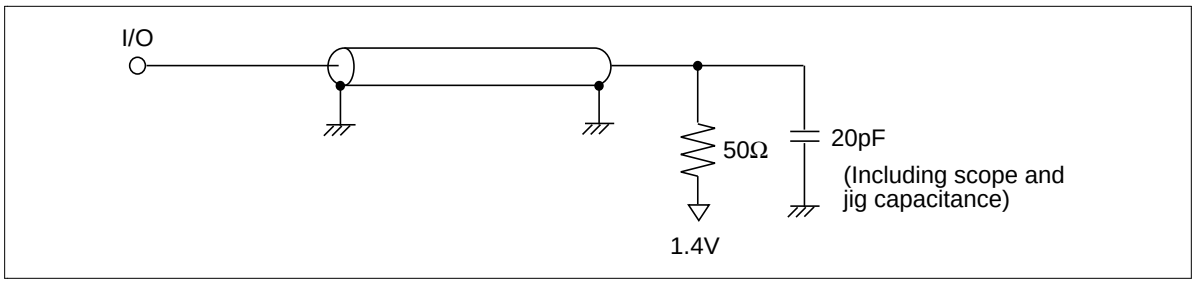
Parameter	Symbol	Min	Max	Unit	Pin Name	Note
Address Input Capacitance	C_{INA}	—	5	pF	SAn, $\overline{SS}$, $\overline{SWE}$, $\overline{SWEx}$	1
Clock Input Capacitance	C_{INC}	—	8	pF	K, $\overline{K}$, $\overline{G}$	1
I/O Capacitance	C_{INIO}	—	7	pF	DQxm	1

Note: 1. This value is measured by sampling and not 100% tested.

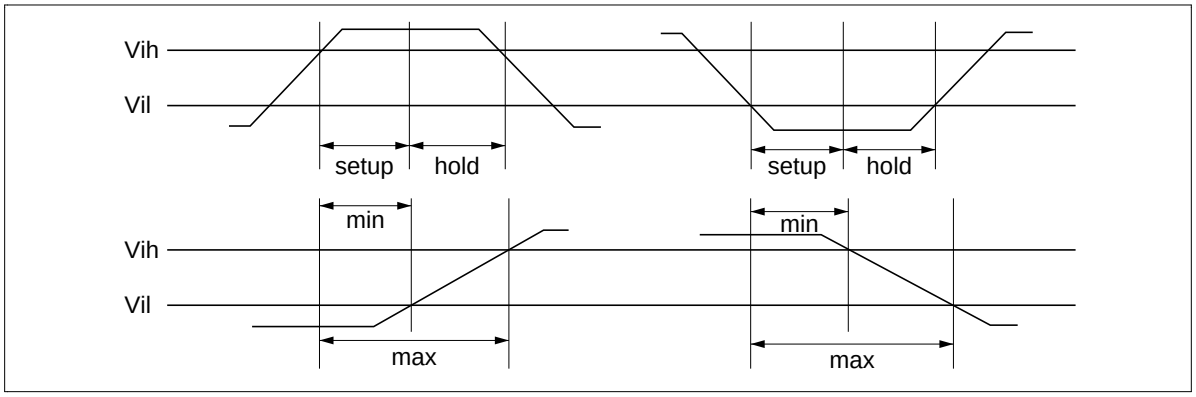
AC Test Conditions

		Note
• Temperature	0°C ≤ Ta ≤ 70°C (Tj max = 110°C)	
• Input Reference Point for Differential Signals	Differential Cross-Over Point	
• Input pulse levels	0 to 2.5 V	
• Clock Input pulse levels	1.8 to 2.1 V	
• Input Rise/Fall Time	0.5 to 1.5 ns (10% to 90%)	
• Clock input Rise/Fall Time	0.3 to 1.0 ns (10% to 90%)	
• Output timing reference (vih/vil)	2.0 V/0.8 V for V_{DDQ} = 3.3 V	1
	1.65 V/1.15 V for V_{DDQ} = 2.5 V	1
• Output load	See figures	

Note: These levels are efficient under open termination. load condition. These vih/vil levels under termination load will be determined by correlation between open load and termination load.



AC Timing Measurement



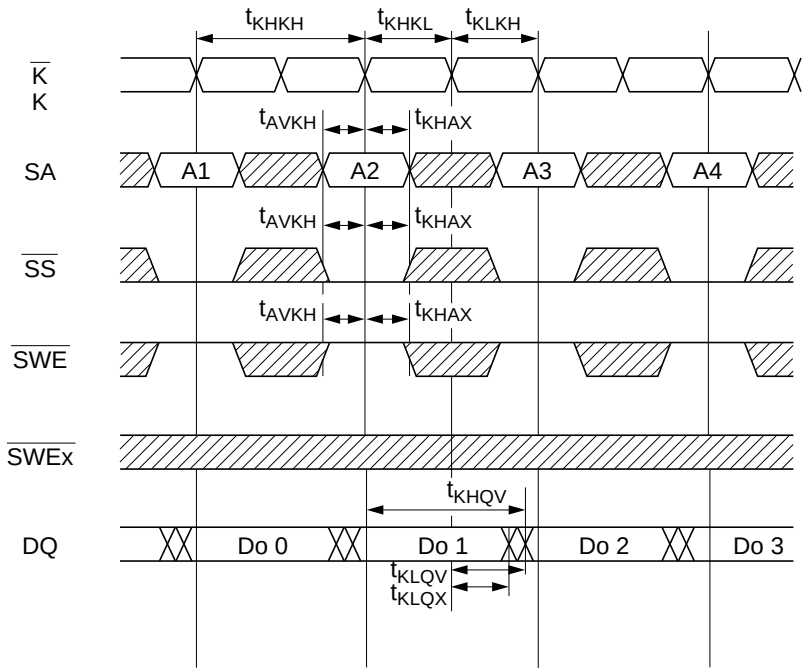
AC Characteristics ($0°C \le Ta \le 70°C$ [Tj max = 110°C], V_{DD}= 3.3V± 5%)

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

		-7			
Parameter	**Symbol**	**Min**	**Max**	**Unit**	**Notes**
Clock Control					
Clock Cycle	t_{KHKH}	8.0	—	ns	
Clock High Width	t_{KHKL}	2.0	—	ns	
Clock Low Width	t_{KLKH}	2.0	—	ns	
Read Control					
K Clock Access	t_{KHQV}	—	7.0	ns	
K Clock Access	t_{KLQV}	—	3.0	ns	
Output Enable Access	t_{GLQV}	—	3.5	ns	
K Low to Q Change	t_{KLQX}	1.0	—	ns	
Output Buffer Control					
K Low to Low-Z	t_{KLQX2}	1.0	—	ns	1
Output Enable to Low-Z	t_{GLQX}	1.0	—	ns	1
K Clock High to Hi-Z	t_{KHQZ}	1.0	3.0	ns	2
Output Enable to Hi-Z	t_{GHQZ}	0.0	3.5	ns	2
Setup Times					
Address Setup Time	t_{AVKH}	0.5	—	ns	SA, $\overline{SS}$, $\overline{SWE}$,
Data Setup Time	t_{DVKH}	0.5	—	ns	$\overline{SWEa}$ – $\overline{SWEd}$
Hold Times					
Address Hold Time	t_{KHAX}	1.0	—	ns	SA, $\overline{SS}$, $\overline{SWE}$,
Data Hold Time	t_{KHDX}	1.0	—	ns	$\overline{SWEa}$ – $\overline{SWEd}$

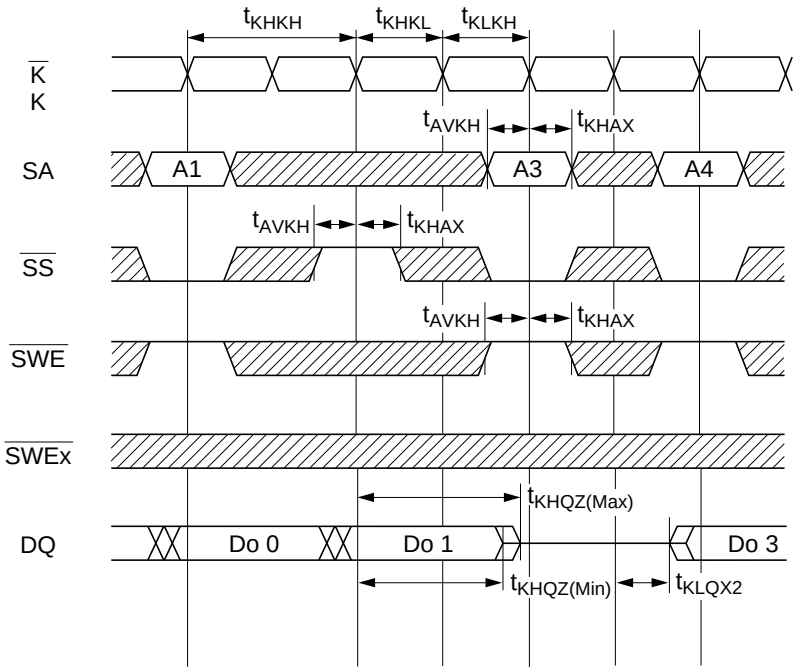
Notes: 1. Transition is measured ±200 mV from steady voltage with specified loading in Test Load.
2. Transition is measured start point of output high impedance from output Low impedance.

Read Cycle 1



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

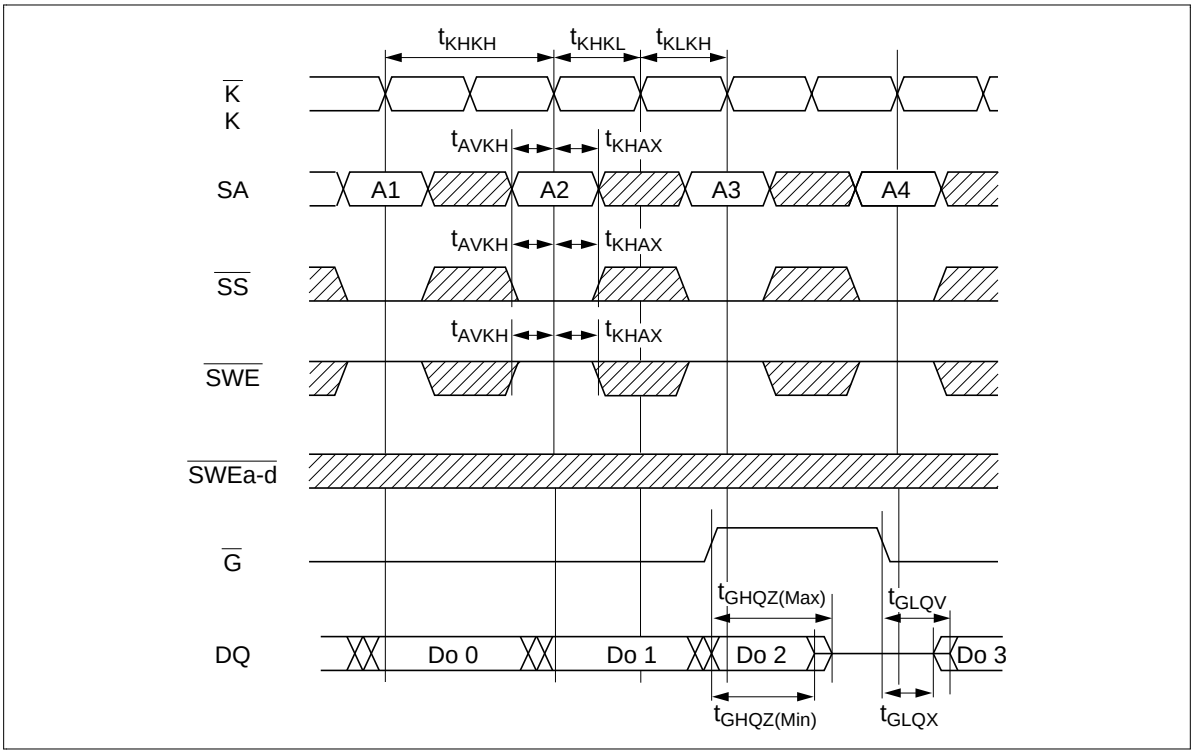
Read Cycle 2 ($\overline{SS}$ Controlled)



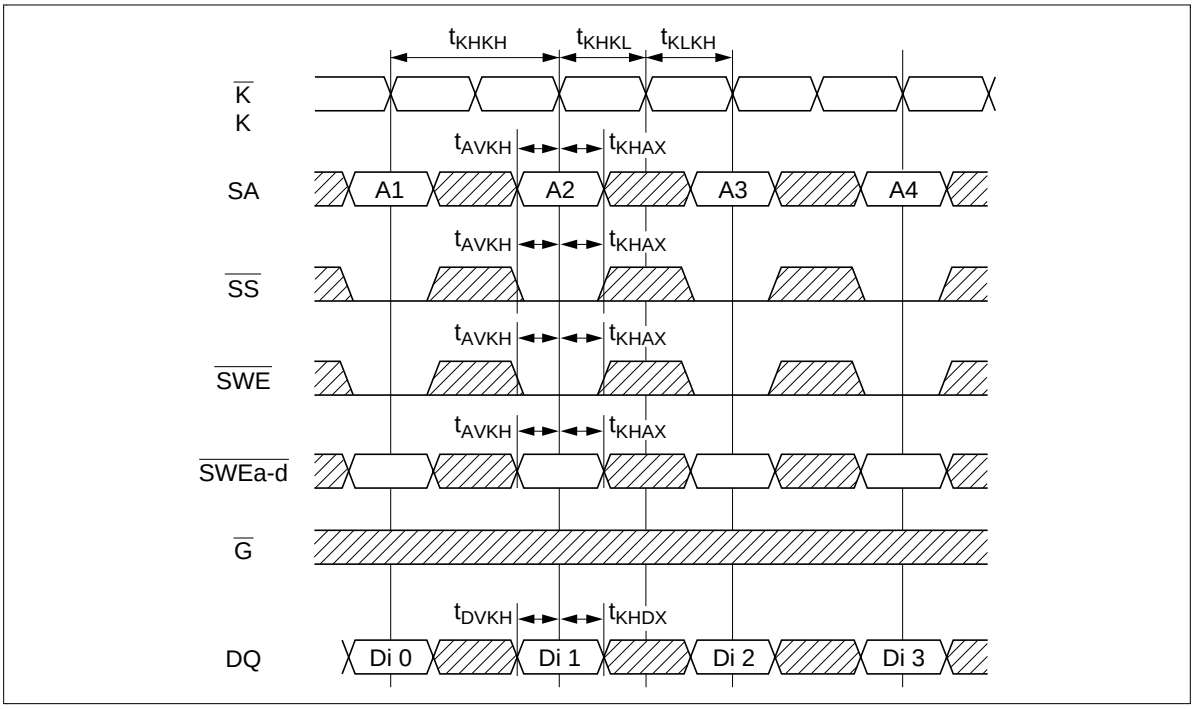
Note: 1. $\overline{G} = V_{IL}$

2. Do1 represents the output data for the input address A1.

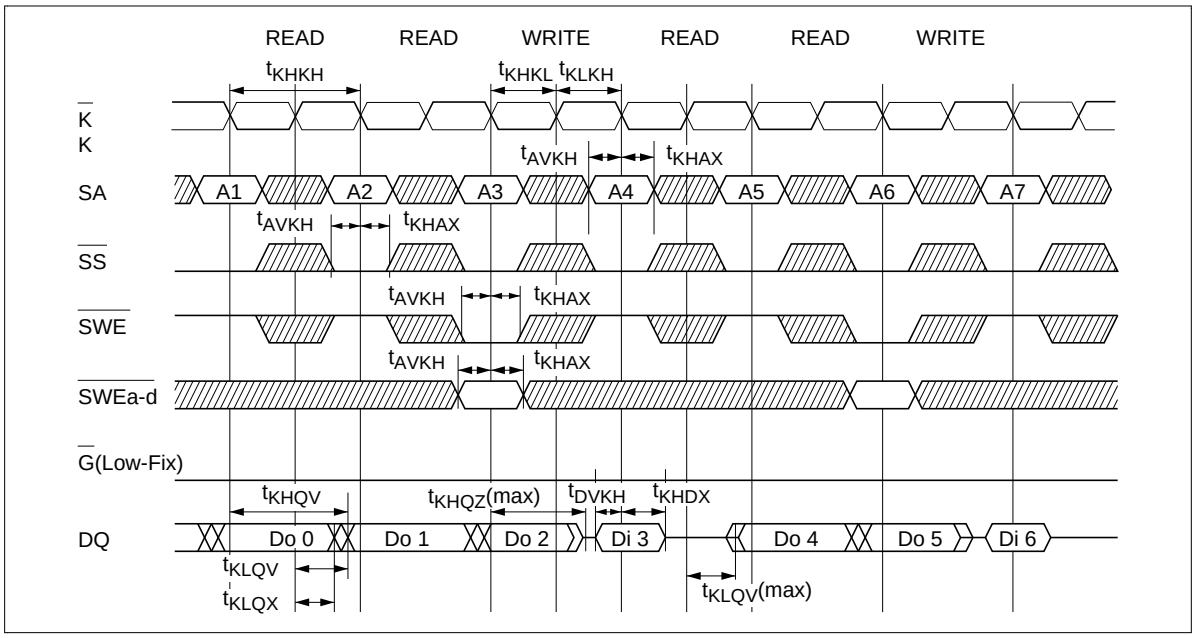
Read Cycle 3 ($\overline{G}$ Controlled)



Write Cycle


tKHKH
tKHKL
tKLKH
K
K
tAVKH
tKHAX
SA
A1
A2
A3
A4
SS
SWE
SWEa-d
G
tDVKH
tKHDX
DQ
Di 0
Di 1
Di 2
Di 3

Read-Write Cycle



Note: During this period DQ pins are in the output state so that the input signal of opposite phase to the outputs must not be applied.

Boundary Scan Test Access Port Operations

overview

In order to perform the interconnect testing of the modules that include this SRAM, the serial boundary 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. the HM67S36130 contains a TAP controller. Instruction register, Boundary scan register, Bypass 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

Notes: 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.

TAP DC Operating Characteristics (Ta = 0°C to 70°C [Tj max = 110°C])

Parameter	Symbol	Min	Max	Note
Boundary scan Input High voltage	V_{IH}	2.0 V	V_{DD} + 0.3 V	
Boundary scan Input Low voltage	V_{IL}	–0.5 V	0.8 V	
Boundary scan Input Leakage Current	I_{LI}	–1µA	+1µA	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. $0 \leq Vin \leq V_{DD}$
2. I_{OL} = 2 mA
3. I_{OH} = –2 mA

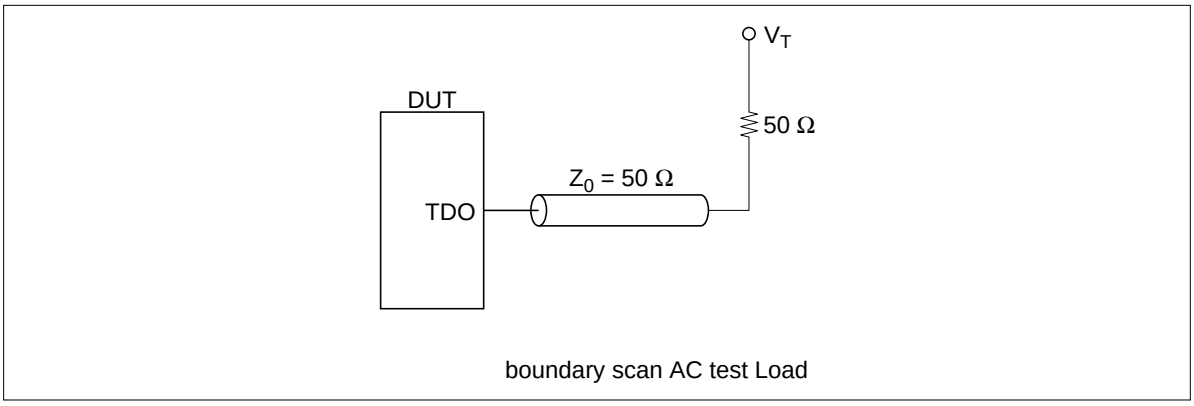
TAP AC Operating Characteristics (Ta = 0°C to 70°C [Tj max = 110 °C])

Parameter	Symbol	Min	Max	Unit
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
Capture Hold	t_{CH}	10	—	ns
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

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

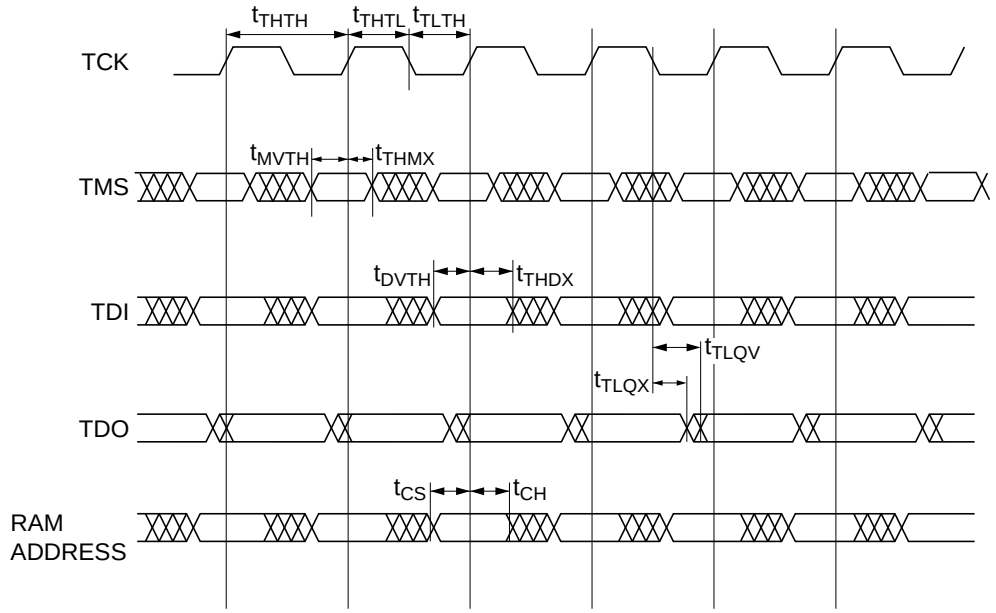
TAP AC Test Conditions

- Temperature — 0°C ≤ Ta ≤ 70°C [Tj max = 110°C]
- Input Reference Point for Single-Ended Signals — 1.5 V
- Input pulse levels — 0 to 2.5 V
- Input Rise/Fall Time — 2.0 ns typical (10% to 90%)
- Output timing reference — 1.5 V
- Test load termination supply voltage (V_T) — 1.5 V
- Output Load — See figures



boundary scan AC test Load

TAP Timing Diagram



TAP Timing Diagram

Test Access Port Registers

Register Name	Length	Symbol	Note
Instruction Register	3 bits	IR [0;2]	
Bypass Register	1 bits	BP	
ID Register	32 bits	ID [0;31]	
Boundary Scan Register	70 bits	BS [1;70]	

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 #	Bump ID	Signal Name	Bit #	Bump ID	Signal Name
1	5R	M2	36	3B	SA12
2	4P	SA3	37	2B	NC
3	4T	SA4	38	3A	SA13
4	6R	SA5	39	3C	SA14
5	5T	SA6	40	2C	SA15
6	7T	ZZ	41	2A	SA16
7	6P	DQa0	42	2D	DQc0
8	7P	DQa1	43	1D	DQc1
9	6N	DQa2	44	2E	DQc2
10	7N	DQa3	45	1E	DQc3
11	6M	DQa4	46	2F	DQc4
12	6L	DQa5	47	2G	DQc5
13	7L	DQa6	48	1G	DQc6
14	6K	DQa7	49	2H	DQc7
15	7K	DQa8	50	1H	DQc8
16	5L	$\overline{\text{SWEa}}$	51	3G	$\overline{\text{SWEc}}$
17	4L	$\overline{\text{K}}$	52	4D	NC
18	4K	K	53	4E	$\overline{\text{SS}}$
19	4F	$\overline{\text{G}}$	54	4G	NC
20	5G	$\overline{\text{SWEb}}$	55	4H	NC
21	7H	DQb0	56	4M	$\overline{\text{SWE}}$
22	6H	DQb1	57	3L	$\overline{\text{SWEd}}$
23	7G	DQb2	58	1K	DQd0
24	6G	DQb3	59	2K	DQd1
25	6F	DQb4	60	1L	DQd2
26	7E	DQb5	61	2L	DQd3
27	6E	DQb6	62	2M	DQd4
28	7D	DQb7	63	1N	DQd5
29	6D	DQb8	64	2N	DQd6
30	6A	SA7	65	1P	DQd7
31	6C	SA8	66	2P	DQd8
32	5C	SA9	67	3T	SA0
33	5A	SA10	68	2R	SA1
34	6B	NC	69	4N	SA2
35	5B	SA11	70	3R	M1

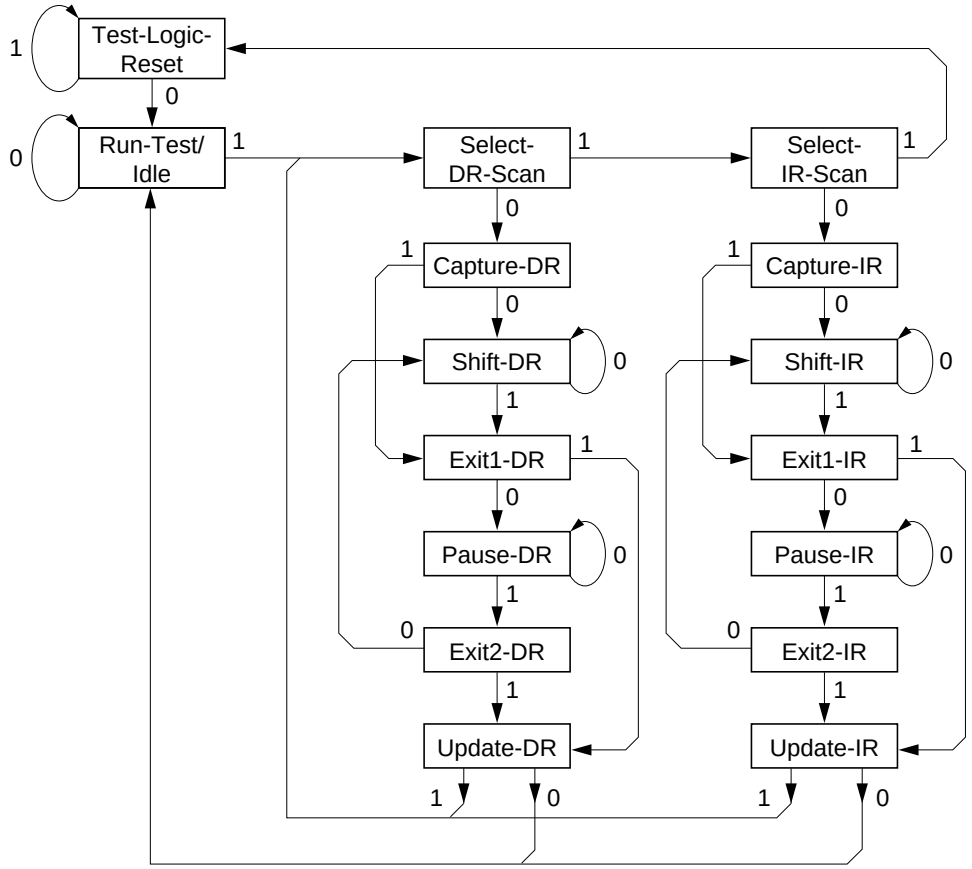
Notes: 1. Bit#1 is the first scan bit to exit the chip.

2. NC pads listed in the TABLE are represented in the Boundary Scan Register by a Place Holder. Place Holder registers are internally connected to V_{SS}.
3. The clock pins (K and $\overline{K}$) are needed as PECL differential levels. And, clock receiver generated single clock signal. This signal and its inverted signal are used for Boundary Scan Register input signal.

ID register

Bit#	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
Value	X	X	X	X	0	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	Vendor Revision No.				4M, 16M Depth		Depth			4M, 16M Width		Width			Use in the future						Vendor ID No.											Fix

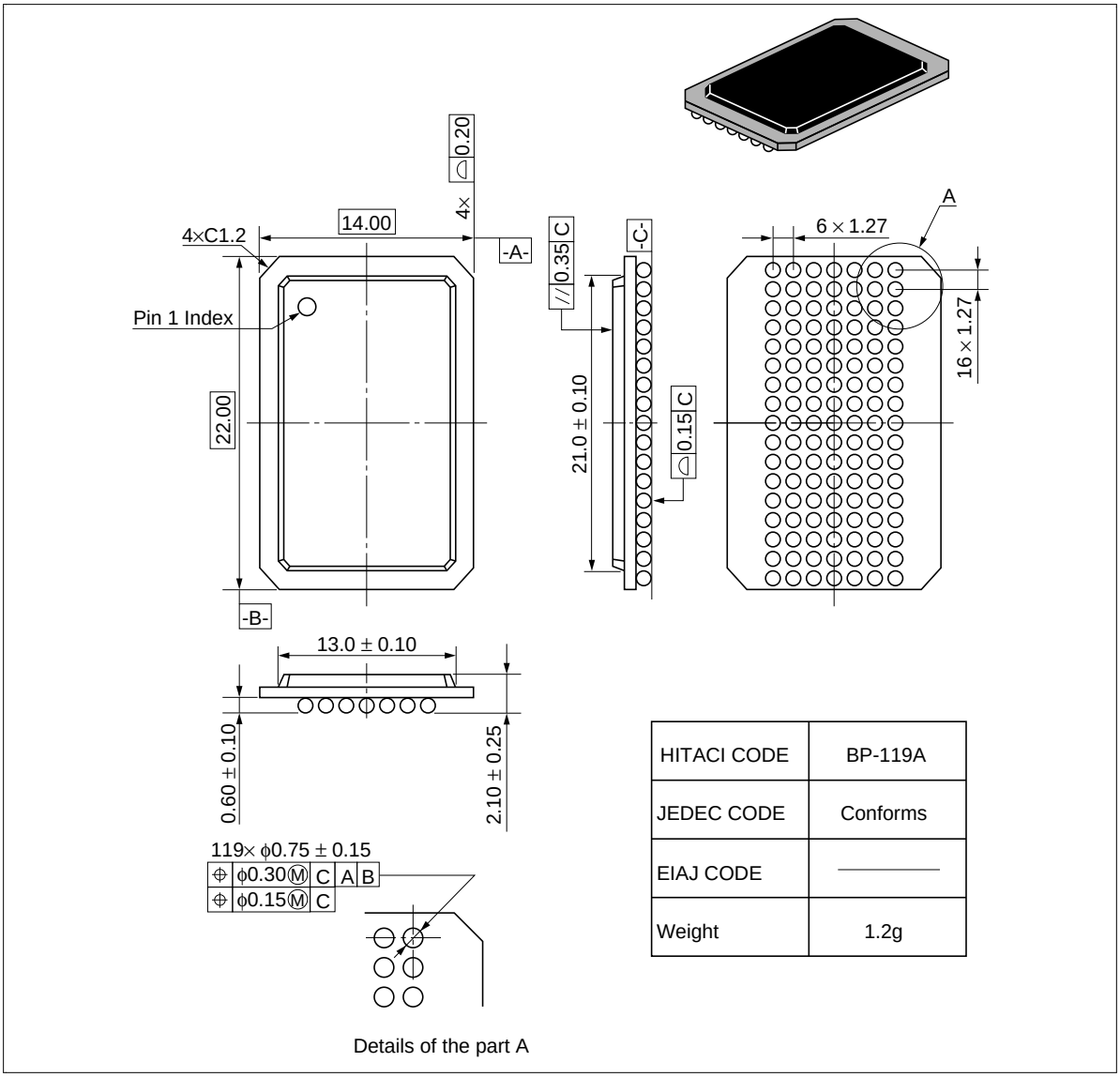
TAP Controller State Diagram



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 Outline

HM67S36130BP (BP-119A) Unit : mm



HITACI CODE	BP-119A
JEDEC CODE	Conforms
EIAJ CODE	———
Weight	1.2g

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Hitachi, Ltd.
Semiconductor & IC Div.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100, Japan
Tel: Tokyo (03) 3270-2111
Fax: (03) 3270-5109

For further information write to:

Hitachi America, Ltd.
Semiconductor & IC Div.
2000 Sierra Point Parkway
Brisbane, CA. 94005-1835
U S A
Tel: 415-589-8300
Fax: 415-583-4207

Hitachi Europe GmbH
Electronic Components Group
Continental Europe
Dornacher Straße 3
D-85622 Feldkirchen
München
Tel: 089-9 91 80-0
Fax: 089-9 29 30 00

Hitachi Europe Ltd.
Electronic Components Div.
Northern Europe Headquarters
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA
United Kingdom
Tel: 0628-585000
Fax: 0628-778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 0104
Tel: 535-2100
Fax: 535-1533

Hitachi Asia (Hong Kong) Ltd.
Unit 706, North Tower,
World Finance Centre,
Harbour City, Canton Road
Tsim Sha Tsui, Kowloon
Hong Kong
Tel: 27359218
Fax: 27306071

Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0	Oct. 1, 1996	Initial issue	—	K.Mitsumoto
1	Feb. 21, 1997	P1. 3.3V± 0.1V Operation to 3.3V ± 5% Operation Change HM67S18258BP-7H to HM67S18258BP-7 V_{DD}min 3.2 to 3.135 V_{DD}max 3.4 to 3.465 V_{DDQ}min 3.2/.6 to 3.135/2.375 V_{DDQ}max 3.4/2.6 to 3.465/2.75 I_{DD}max 500 to 600 I_{OH} 2mA to -2mA I_{OL} -2mA to 2mA P.7 Change termination load t_{KHKL} 3.2 to 2.0 t_{KLKH} 3.2 to 2.0 Add t_{KHQZ}min Add Note 2 Delete Soft Error Rate	(Y.Matsui)	S.Nakazato
2	Nov. 18, 1997	BP-119 to BP-119A	(Y. Matsui)	S. Nakazato