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# HM628512AI Series

524288-word  $\times$  8-bit High Speed CMOS Static RAM

# HITACHI

ADE-203-791 (Z)

Preliminary

Rev. 0.0

Jun. 20, 1997

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## Description

The Hitachi HM628512AI is a 4-Mbit static RAM organized 512-kword  $\times$  8-bit. It realizes higher density, higher performance and low power consumption by employing 0.5  $\mu$ m Hi-CMOS process technology. The device, packaged in a 525-mil SOP (foot print pitch width) or 400-mil TSOP TYPE II or 600-mil plastic DIP, is available for high density mounting. L-version is suitable for battery backup system.

## Features

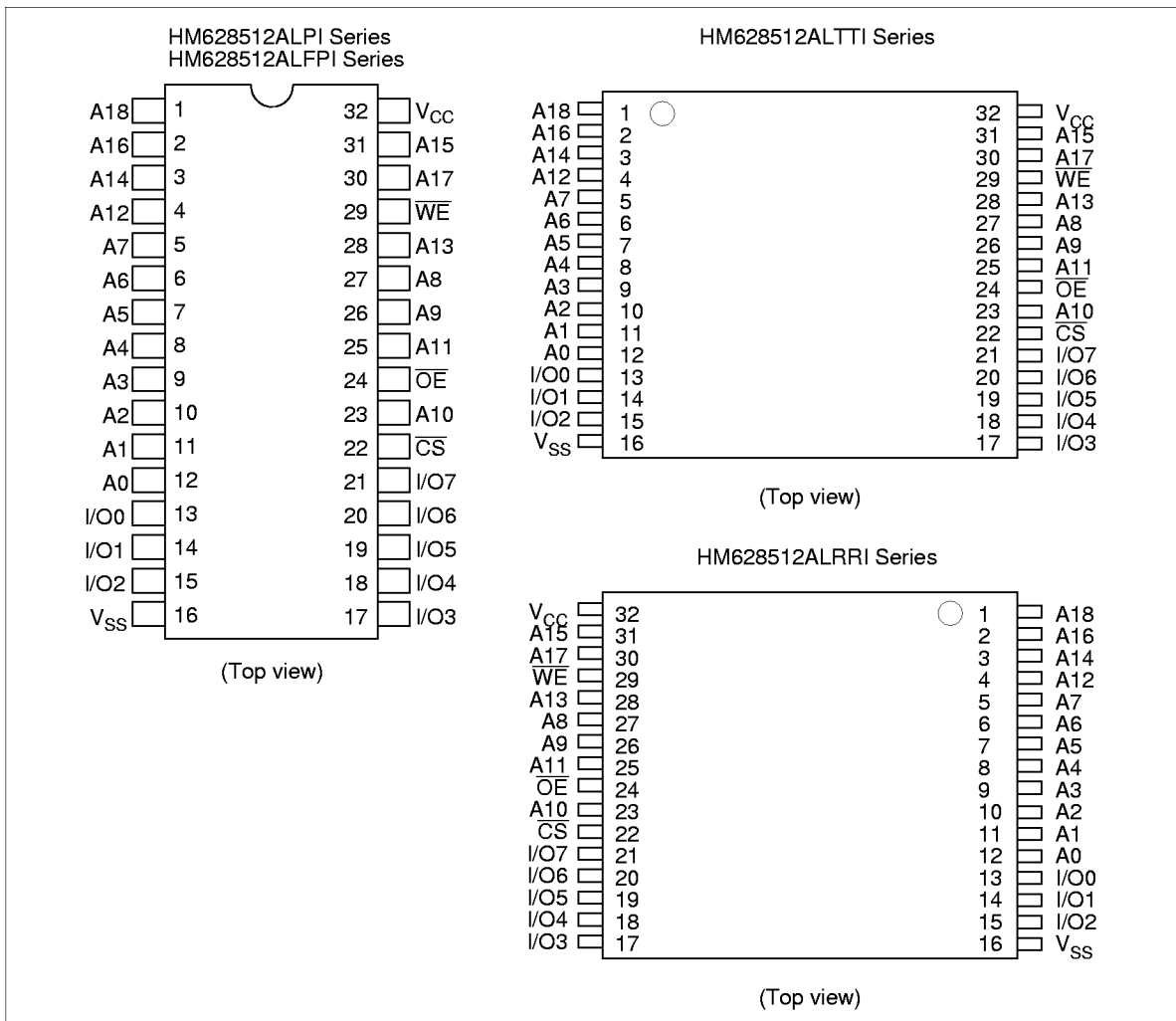
- Single 5 V supply: 5.0 V  $\pm$  10%
- Access time: 70/85 ns (max)
- Power dissipation
  - Active: 50 mW/MHz (typ)
  - Standby: 10  $\mu$ W (typ)
- Completely static memory
  - No clock or timing strobe required
- Equal access and cycle times
- Common data input and output
  - Three state output
- Directly TTL compatible
  - All inputs and outputs
- Battery backup operation
- Operating temperature:  $-40$  to  $85^{\circ}\text{C}$

# HM628512AI Series

## Ordering Information

Type No.	Access time	Package
HM628512ALPI-7	70 ns	600-mil 32-pin plastic DIP (DP-32)
HM628512ALPI-8	85 ns	
HM628512ALFPI-7	70 ns	525-mil 32-pin plastic SOP (FP-32D)
HM628512ALFPI-8	85 ns	
HM628512ALTTI-7	70 ns	400-mil 32-pin plastic TSOP II (TTP-32D)
HM628512ALTTI-8	85 ns	
HM628512ALRRI-7	70 ns	400-mil 32-pin plastic TSOP II reverse (TTP-32DR)
HM628512ALRRI-8	85 ns	

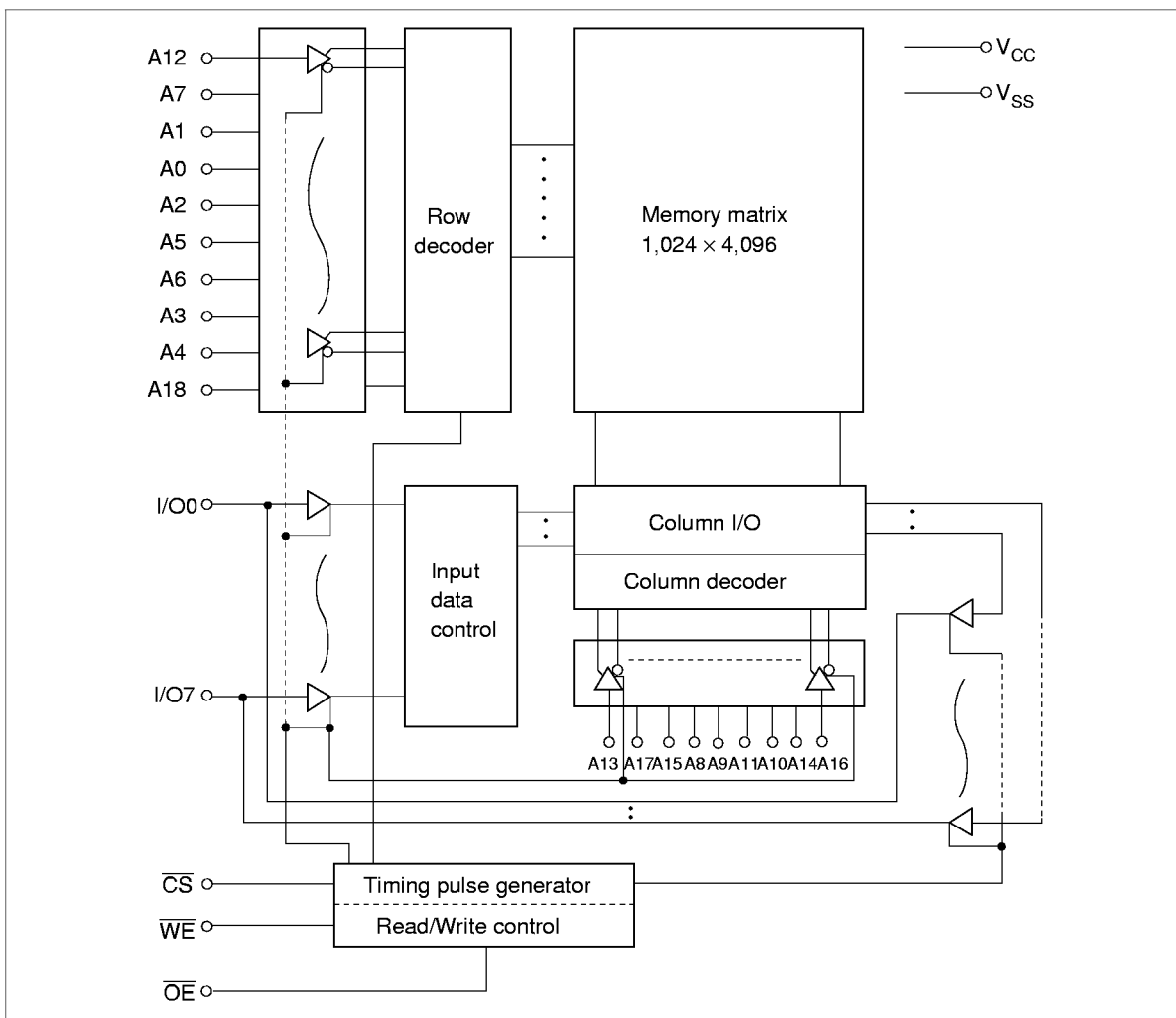
## Pin Arrangement



Pin Description

Pin name	Function
A0 to A18	Address input
I/O0 to I/O7	Data input/output
$\overline{CS}$	Chip select
$\overline{OE}$	Output enable
$\overline{WE}$	Write enable
$V_{CC}$	Power supply
$V_{SS}$	Ground

Block Diagram



## HM628512AI Series

### Function Table

$\overline{WE}$	$\overline{CS}$	$\overline{OE}$	Mode	$V_{CC}$ current	Dout pin	Ref. cycle
×	H	×	Not selected	$I_{SB}, I_{SB1}$	High-Z	—
H	L	H	Output disable	$I_{CC}$	High-Z	—
H	L	L	Read	$I_{CC}$	Dout	Read cycle
L	L	H	Write	$I_{CC}$	Din	Write cycle (1)
L	L	L	Write	$I_{CC}$	Din	Write cycle (2)

Note: ×: H or L

### Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Power supply voltage relative to $V_{SS}$	$V_{CC}$	-0.5 to +7.0	V
Terminal voltage on any pin relative to $V_{SS}$	$V_T$	-0.5* <sup>1</sup> to $V_{CC} + 0.3$ * <sup>2</sup>	V
Power dissipation	$P_T$	1.0	W
Operating temperature	$T_{opr}$	-40 to +85	°C
Storage temperature	$T_{stg}$	-55 to +125	°C
Storage temperature under bias	$T_{bias}$	-40 to +85	°C

Notes: 1. -3.0 V for pulse half-width ≤ 30 ns  
 2. Maximum voltage is 7.0 V

### Recommended DC Operating Conditions ( $T_a = -40$ to +85°C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	$V_{CC}$	4.5	5.0	5.5	V
	$V_{SS}$	0	0	0	V
Input high voltage	$V_{IH}$	2.4	—	$V_{CC} + 0.3$	V
Input low voltage	$V_{IL}$	-0.3* <sup>1</sup>	—	0.6	V

Note: 1. -3.0 V for pulse half-width ≤ 30 ns

## HM628512AI Series

### DC Characteristics (Ta = -40 to +85°C, V<sub>CC</sub> = 5 V ±10% , V<sub>SS</sub> = 0 V)

Parameter	Symbol	Min	Typ* <sup>1</sup>	Max	Unit	Test conditions
Input leakage current	I <sub>L</sub>	—	—	1	μA	V <sub>in</sub> = V <sub>SS</sub> to V <sub>CC</sub>
Output leakage current	I <sub>LO</sub>	—	—	1	μA	$\overline{CS} = V_{IH}$ or $\overline{OE} = V_{IH}$ or $\overline{WE} = V_{IL}$ , V <sub>I/O</sub> = V <sub>SS</sub> to V <sub>CC</sub>
Operating current	I <sub>CC</sub>	—	8	15	mA	$\overline{CS} = V_{IL}$ , others = V <sub>IH</sub> /V <sub>IL</sub> , I <sub>I/O</sub> = 0 mA
Average operating current	I <sub>CC1</sub>	—	45	70	mA	Min cycle, duty = 100% CS = V <sub>IL</sub> , others = V <sub>IH</sub> /V <sub>IL</sub> I <sub>I/O</sub> = 0 mA
	I <sub>CC2</sub>	—	10	20	mA	Cycle time = 1 μs, duty = 100% I <sub>I/O</sub> = 0 mA, $\overline{CS} \leq 0.2$ V V <sub>IH</sub> ≥ V <sub>CC</sub> - 0.2 V, V <sub>IL</sub> ≤ 0.2 V
Standby current	I <sub>SB</sub>	—	1	3	mA	$\overline{CS} = V_{IH}$
	I <sub>SB1</sub>	—	2	100	μA	V <sub>in</sub> ≥ 0 V, $\overline{CS} \geq V_{CC} - 0.2$ V
Output low voltage	V <sub>OL</sub>	—	—	0.4	V	I <sub>OL</sub> = 2.1 mA
Output high voltage	V <sub>OH</sub>	2.4	—	—	V	I <sub>OH</sub> = -1.0 mA

Notes: 1. Typical values are at V<sub>CC</sub> = 5.0 V, Ta = +25°C and specified loading, and not guaranteed.

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

Parameter	Symbol	Typ	Max	Unit	Test conditions
Input capacitance* <sup>1</sup>	C <sub>in</sub>	—	8	pF	V <sub>in</sub> = 0 V
Input/output capacitance* <sup>1</sup>	C <sub>I/O</sub>	—	10	pF	V <sub>I/O</sub> = 0 V

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

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## HM628512AI Series

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**AC Characteristics** ( $T_a = -40$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10$ )

### Test Conditions

- Input pulse levels: 0.5 V to 2.5 V
- Input rise and fall time: 5 ns
- Input and output timing reference levels: 1.5 V  
Output load: 1 TTL Gate +  $C_L$  (100 pF)  
(Including scope & jig)

### Read Cycle

Parameter	Symbol	HM628512AI				Unit	Notes
		-7		-8			
		Min	Max	Min	Max		
Read cycle time	$t_{RC}$	70	—	85	—	ns	
Address access time	$t_{AA}$	—	70	—	85	ns	
Chip select access time	$t_{CO}$	—	70	—	85	ns	
Output enable to output valid	$t_{OE}$	—	35	—	45	ns	
Chip select to output in low-Z	$t_{LZ}$	10	—	10	—	ns	2
Output enable to output in low-Z	$t_{OLZ}$	5	—	5	—	ns	2
Chip deselect to output in high-Z	$t_{HZ}$	0	25	0	30	ns	1, 2
Output disable to output in high-Z	$t_{OHZ}$	0	25	0	30	ns	1, 2
Output hold from address change	$t_{OH}$	10	—	10	—	ns	

**Write Cycle**

Parameter	Symbol	HM628512AI				Unit	Notes
		-7		-8			
		Min	Max	Min	Max		
Write cycle time	$t_{WC}$	70	—	85	—	ns	
Chip select to end of write	$t_{CW}$	60	—	75	—	ns	4
Address setup time	$t_{AS}$	0	—	0	—	ns	5
Address valid to end of write	$t_{AW}$	60	—	75	—	ns	
Write pulse width	$t_{WP}$	50	—	55	—	ns	3, 12
Write recovery time	$t_{WR}$	0	—	0	—	ns	6
$\overline{WE}$ to output in high-Z	$t_{WHZ}$	0	25	0	30	ns	1, 2, 7
Data to write time overlap	$t_{DW}$	30	—	35	—	ns	
Data hold from write time	$t_{DH}$	0	—	0	—	ns	
Output active from output in high-Z	$t_{OW}$	5	—	5	—	ns	2
Output disable to output in high-Z	$t_{OHZ}$	0	25	0	30	ns	1, 2, 7

Notes: 1.  $t_{HZ}$ ,  $t_{OHZ}$  and  $t_{WHZ}$  are defined as the time at which the outputs achieve the open circuit conditions and are not referred to output voltage levels.

2. This parameter is sampled and not 100% tested.

3. A write occurs during the overlap ( $t_{WP}$ ) of a low  $\overline{CS}$  and a low  $\overline{WE}$ . A write begins at the later transition of  $\overline{CS}$  going low or  $\overline{WE}$  going low. A write ends at the earlier transition of  $\overline{CS}$  going high or  $\overline{WE}$  going high.  $t_{WP}$  is measured from the beginning of write to the end of write.

4.  $t_{CW}$  is measured from  $\overline{CS}$  going low to the end of write.

5.  $t_{AS}$  is measured from the address valid to the beginning of write.

6.  $t_{WR}$  is measured from the earlier of  $\overline{WE}$  or  $\overline{CS}$  going high to the end of write cycle.

7. During this period, I/O pins are in the output state so that the input signals of the opposite phase to the outputs must not be applied.

8. If the  $\overline{CS}$  low transition occurs simultaneously with the  $\overline{WE}$  low transition or after the  $\overline{WE}$  transition, the output remain in a high impedance state.

9. Dout is the same phase of the write data of this write cycle.

10. Dout is the read data of next address.

11. If CS is low during this period, I/O pins are in the output state. Therefore, the input signals of the opposite phase to the outputs must not be applied to them.

12. In the write cycle with  $\overline{OE}$  low fixed,  $t_{WP}$  must satisfy the following equation to avoid a problem of data bus contention.  $t_{WP} \geq t_{DW} \text{ min} + t_{WHZ} \text{ max}$

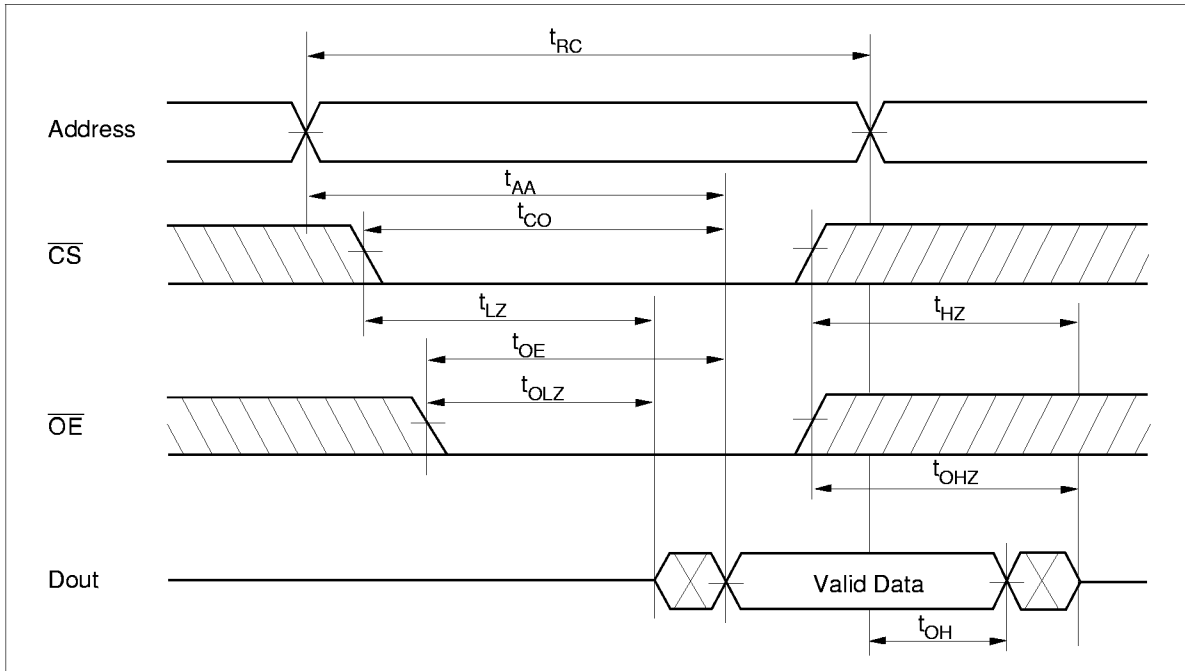
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## HM628512AI Series

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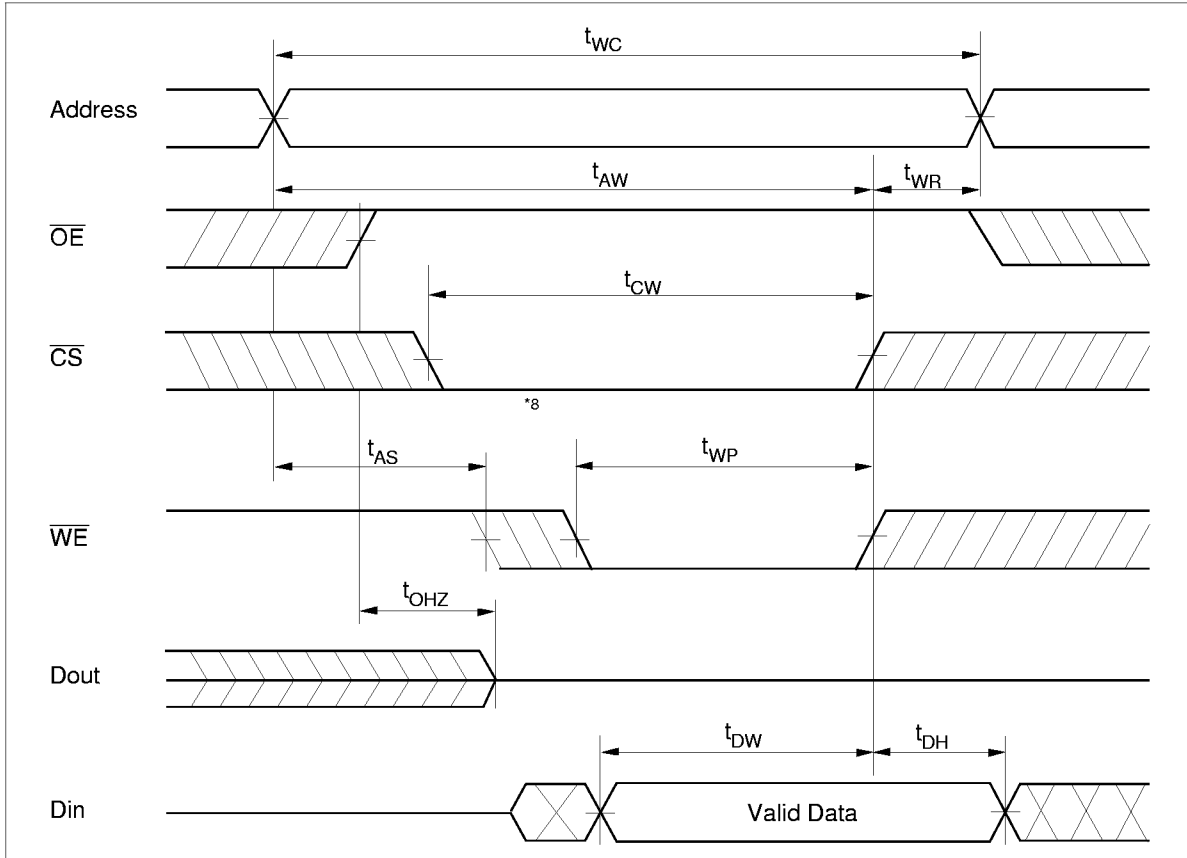
### Timing Waveforms

Read Timing Waveform ( $\overline{WE} = V_{IH}$ )



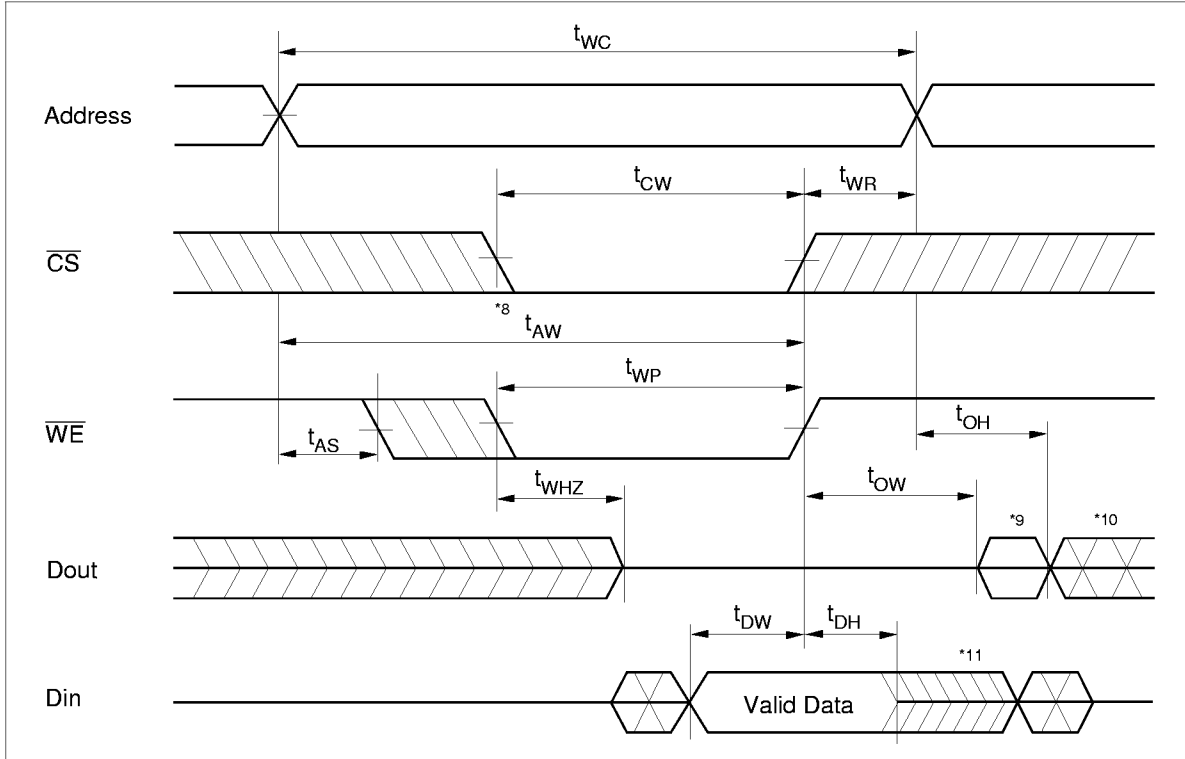


Write Timing Waveform (1) ( $\overline{\text{OE}}$  Clock)



# HM628512AI Series

## Write Timing Waveform (2) ( $\overline{\text{OE}}$ Low Fixed)

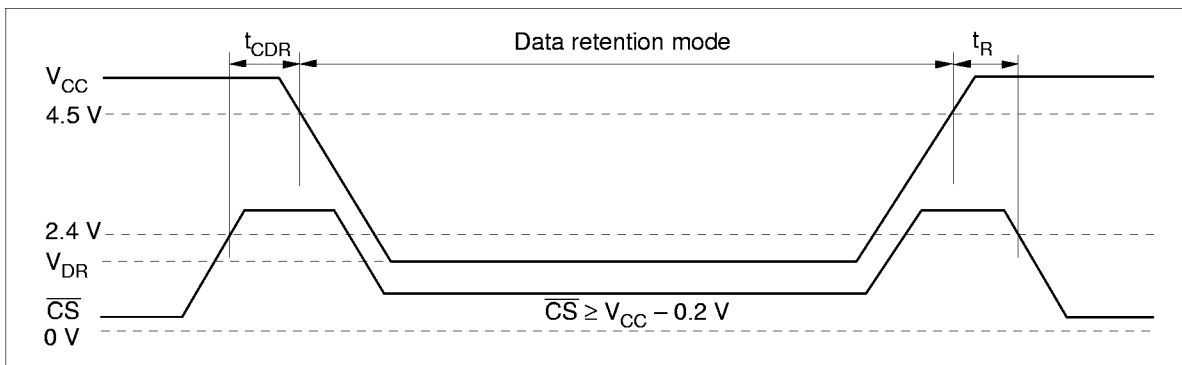


Low  $V_{CC}$  Data Retention Characteristics ( $T_a = -40$  to  $+85^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions*2
$V_{CC}$ for data retention	$V_{DR}$	2	—	—	V	$\overline{CS} \geq V_{CC} - 0.2 \text{ V}, V_{in} \geq 0 \text{ V}$
Data retention current	$I_{CCDR}$	—	1*3	50*1	$\mu\text{A}$	$V_{CC} = 3.0 \text{ V}, V_{in} \geq 0 \text{ V}$ $\overline{CS} \geq V_{CC} - 0.2 \text{ V}$
Chip deselect to data retention time	$t_{CDR}$	0	—	—	ns	See retention waveform
Operation recovery time	$t_R$	5	—	—	ms	

- Notes: 1. 20  $\mu\text{A}$  (max) at  $T_a = -40$  to  $40^\circ\text{C}$   
 2.  $\overline{CS}$  controls address buffer,  $\overline{WE}$  buffer,  $\overline{OE}$  buffer, and  $D_{in}$  buffer. In data retention mode,  $V_{in}$  levels (address,  $\overline{WE}$ ,  $\overline{OE}$ ,  $I/O$ ) can be in the high impedance state.  
 3. Typical values are at  $V_{CC} = 3.0 \text{ V}$ ,  $T_a = 25^\circ\text{C}$  and specified loading, and not guaranteed.

Low  $V_{CC}$  Data Retention Timing Waveform ( $\overline{CS}$  Controlled)

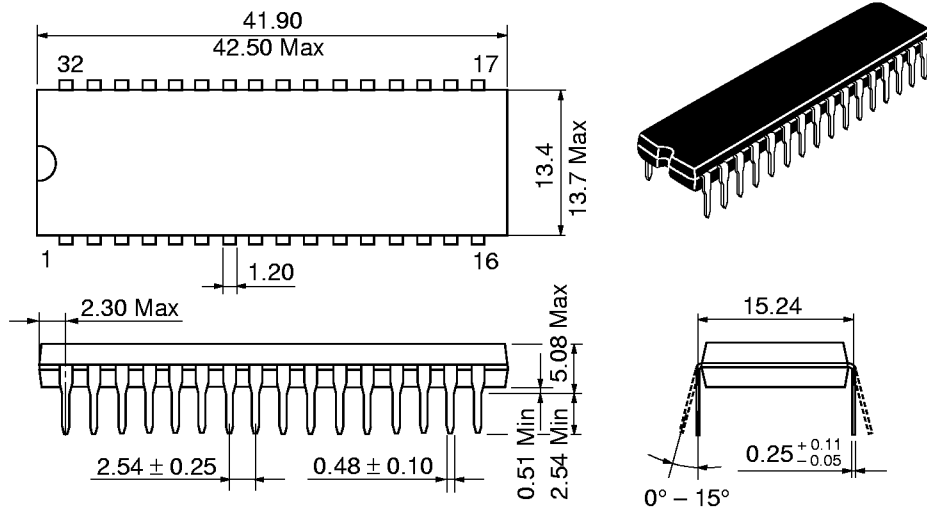


# HM628512AI Series

## Package Dimensions

HM628512ALPI Series (DP-32)

Unit: mm

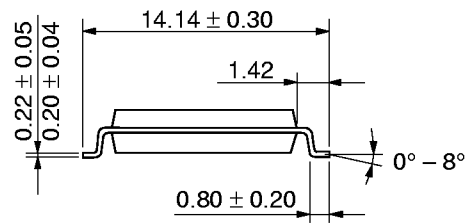
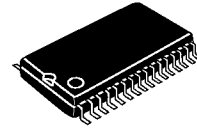
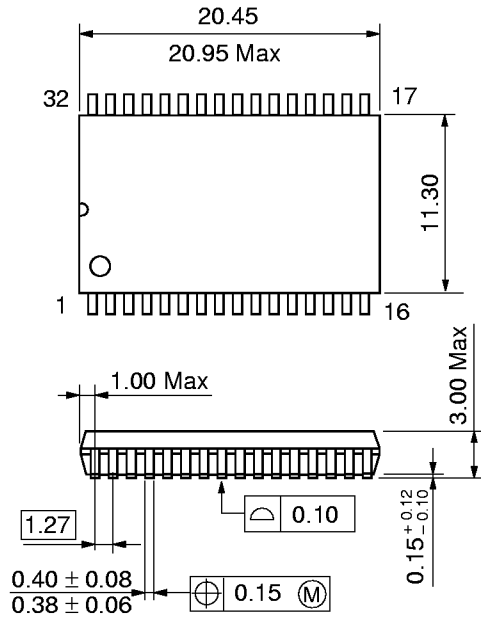


Hitachi Code	DP-32
JEDEC Code	—
EIAJ Code	SC-613
Weight (reference value)	5.1 g

# HM628512AI Series

## HM628512ALFPI Series (FP-32D)

Unit: mm



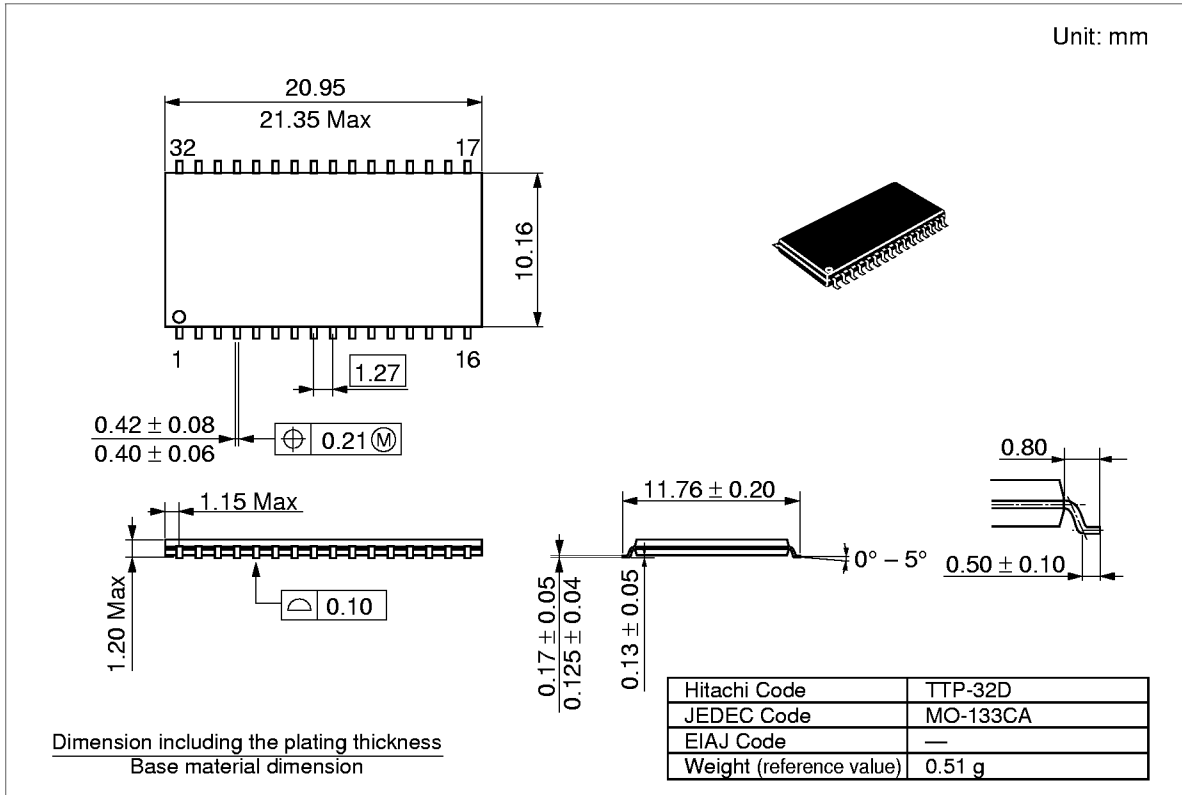
Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-32D
JEDEC Code	MO-099AB
EIAJ Code	—
Weight (reference value)	1.3 g

# HM628512AI Series

## HM628512ALTTI Series (TTP-32D)

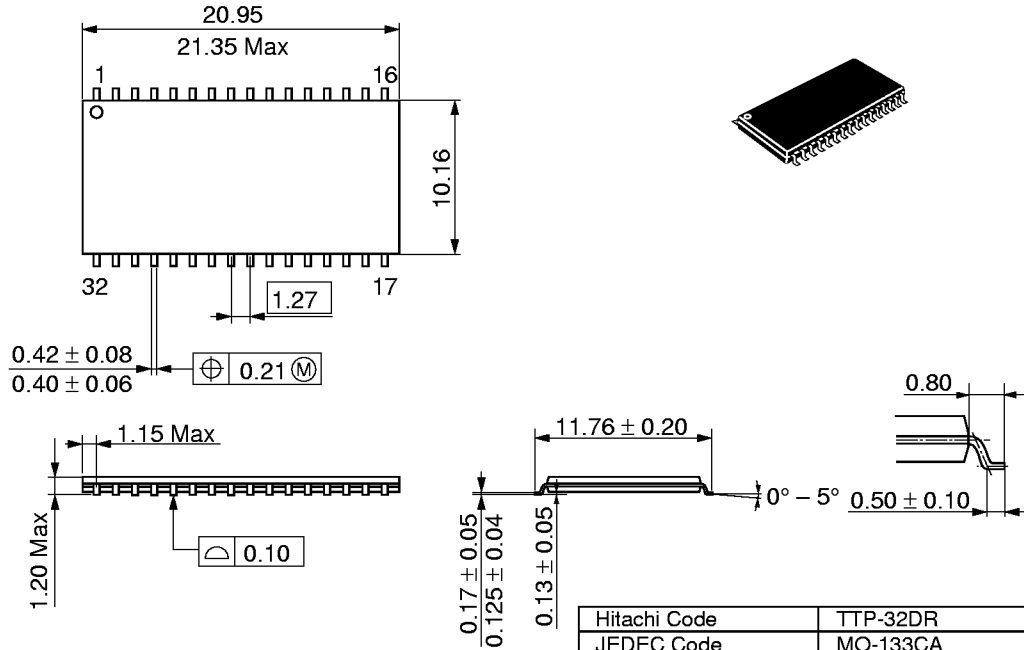
Unit: mm



# HM628512AI Series

## HM628512ALRRI Series (TTP-32DR)

Unit: mm



Dimension including the plating thickness  
Base material dimension

Hitachi Code	TTP-32DR
JEDEC Code	MO-133CA
EIAJ Code	—
Weight (reference value)	0.51 g

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## HM628512AI Series

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## HM628512AI Series

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### Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Jun. 20, 1997	Initial issue		

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