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# HM628512 Series

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

# HITACHI

ADE-203-236E (Z)

Rev. 5.0

Nov. 23, 1994

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The Hitachi HM628512 is a 4M-bit static RAM organized 524288-word  $\times$  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. LP-version is suitable for battery back up system.

## Features

- High speed: Fast access time:
  - 55/70/85/100 ns (max)
- Low power
  - Standby: 10  $\mu$ W (typ) (L/L-SL version)
  - Operation: 75 mW (typ) (f=1 MHz)
- Single 5 V supply
- 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
- Capability of battery back up operation (L/L-SL version)

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## HM628512 Series

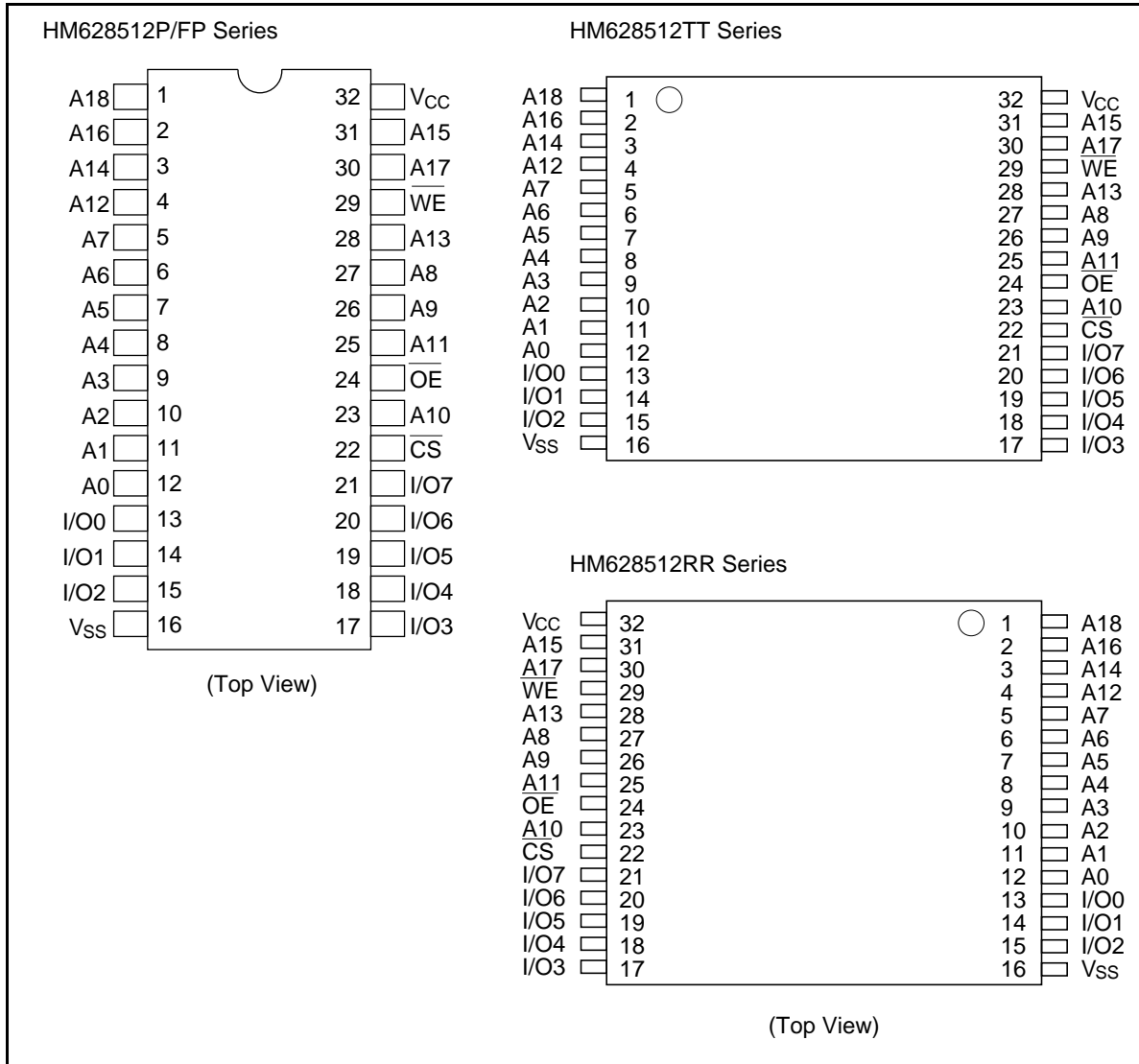
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### Ordering Information

Type No.	Access Time	Package
HM628512P-5	55 ns	600-mil 32-pin plastic DIP (DP-32)
HM628512P-7	70 ns	
HM628512P-8	85 ns	
HM628512P-10	100 ns	
HM628512LP-5	55 ns	600-mil 32-pin plastic DIP (DP-32)
HM628512LP-7	70 ns	
HM628512LP-8	85 ns	
HM628512LP-10	100 ns	
HM628512LP-5SL	55 ns	600-mil 32-pin plastic DIP (DP-32)
HM628512LP-7SL	70 ns	
HM628512LP-8SL	85 ns	
HM628512LP-10SL	100 ns	
HM628512FP-5	55 ns	525-mil 32-pin plastic SOP (FP-32D)
HM628512FP-7	70 ns	
HM628512FP-8	85 ns	
HM628512FP-10	100 ns	
HM628512LFP-5	55 ns	525-mil 32-pin plastic SOP (FP-32D)
HM628512LFP-7	70 ns	
HM628512LFP-8	85 ns	
HM628512LFP-10	100 ns	
HM628512LFP-5SL	55 ns	525-mil 32-pin plastic SOP (FP-32D)
HM628512LFP-7SL	70 ns	
HM628512LFP-8SL	85 ns	
HM628512LFP-10SL	100 ns	
HM628512LTT-5	55 ns	400-mil 32-pin plastic TSOP II (TTP-32D)
HM628512LTT-7	70 ns	
HM628512LTT-8	85 ns	
HM628512LTT-10	100 ns	
HM628512LTT-5SL	55 ns	400-mil 32-pin plastic TSOP II (TTP-32D)
HM628512LTT-7SL	70 ns	
HM628512LTT-8SL	85 ns	
HM628512LTT-10SL	100 ns	
HM628512LRR-5	55 ns	400-mil 32-pin plastic TSOP II reverse (TTP-32DR)
HM628512LRR-7	70 ns	
HM628512LRR-8	85 ns	
HM628512LRR-10	100 ns	
HM628512LRR-5SL	55 ns	400-mil 32-pin plastic TSOP II reverse (TTP-32DR)
HM628512LRR-7SL	70 ns	
HM628512LRR-8SL	85 ns	
HM628512LRR-10SL	100 ns	

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## Pin Arrangement

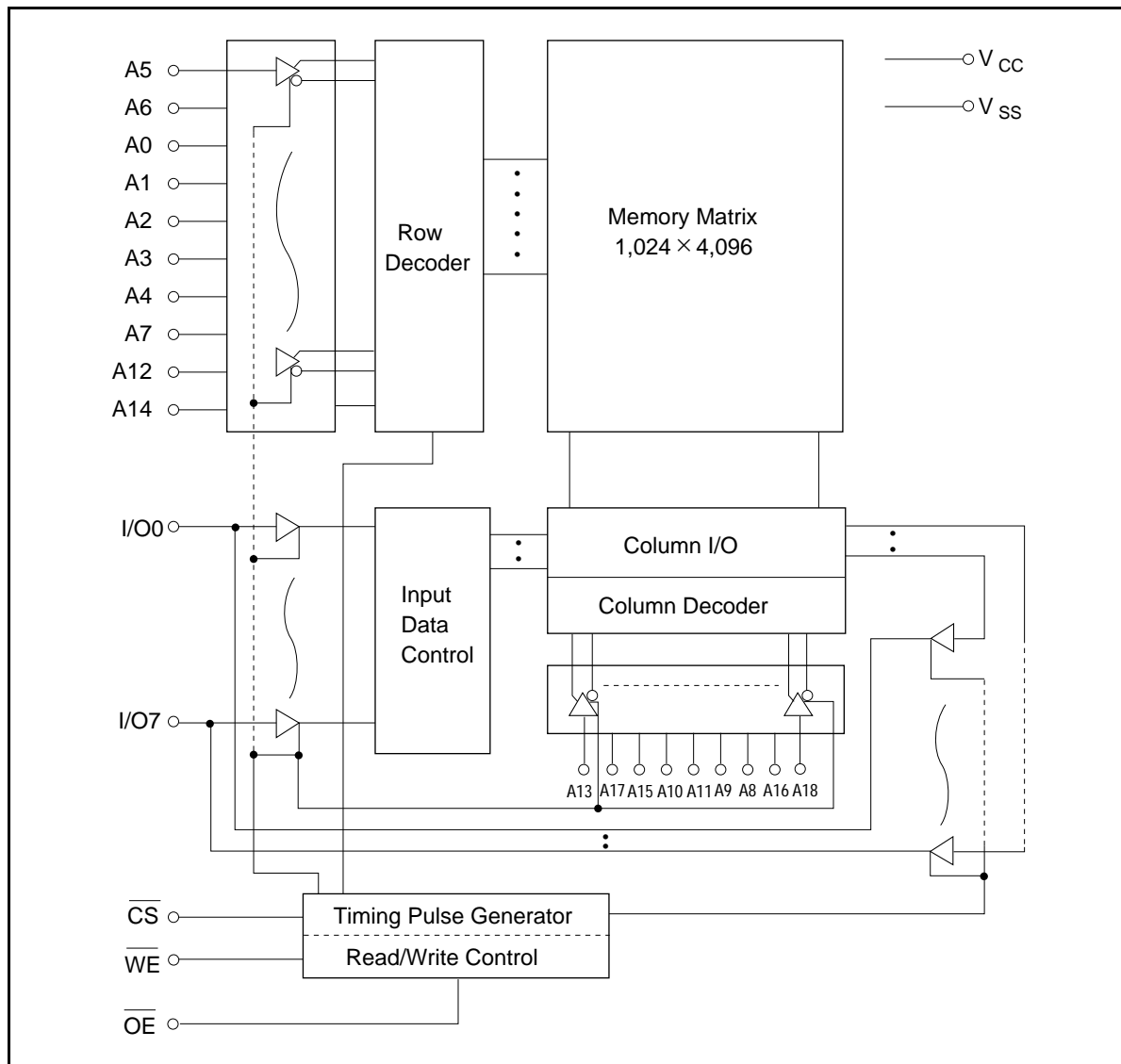


## Pin Description

Symbol	Function
A0 – A18	Address
I/O0 – I/O7	Input/output
$\overline{CS}$	Chip select
$\overline{WE}$	Write enable
$\overline{OE}$	Output enable
V <sub>CC</sub>	Power supply
V <sub>SS</sub>	Ground

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### Block Diagram



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### Function Table

WE	CS	OE	Mode	V <sub>CC</sub> Current	Dout Pin	Ref. Cycle
X	H	X	Not selected	I <sub>SB</sub> , I <sub>SB1</sub>	High-Z	—
H	L	H	Output disable	I <sub>CC</sub>	High-Z	—
H	L	L	Read	I <sub>CC</sub>	Dout	Read cycle
L	L	H	Write	I <sub>CC</sub>	Din	Write cycle (1)
L	L	L	Write	I <sub>CC</sub>	Din	Write cycle (2)

Note: X: H or L

### Absolute Maximum Ratings

Parameter	Symbol	Value <sup>1</sup>	Unit
Voltage on any pin relative to V <sub>SS</sub>	V <sub>T</sub>	−0.5 to +7.0	V
Power dissipation	P <sub>T</sub>	1.0	W
Operating temperature	T <sub>opr</sub>	0 to +70	°C
Storage temperature	T <sub>stg</sub>	−55 to +125	°C
Storage temperature under bias	T <sub>bias</sub>	−10 to +85	°C

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

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

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V <sub>CC</sub>	4.5	5.0	5.5	V
Supply voltage	V <sub>SS</sub>	0	0	0	V
Input high (logic 1) voltage	V <sub>IH</sub>	2.2 * <sub>1</sub>	—	6.0	V
Input low (logic 0) voltage	V <sub>IL</sub>	−0.3	—	0.8	V

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

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### DC Characteristics (Ta = 0 to +70°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>LI</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 power supply current: DC	I <sub>CC READ</sub>	—	15	25	mA	$\overline{CS} = V_{IL}$ , $\overline{WE} = V_{IH}$ others = V <sub>IH</sub> /V <sub>IL</sub> , I <sub>I/O</sub> = 0 mA
Operating power supply current: DC	I <sub>CC WRITE</sub>	—	20	45	mA	$\overline{CS} = V_{IL}$ , $\overline{WE} = V_{IL}$ others = V <sub>IH</sub> /V <sub>IL</sub> , I <sub>I/O</sub> = 0 mA
Operating power supply current	-5 I <sub>CC1</sub>	—	70	100	mA	Min cycle, duty = 100% $\overline{CS} = V_{IL}$ , others = V <sub>IH</sub> /V <sub>IL</sub> I <sub>I/O</sub> = 0 mA
Operating power supply current	-7 I <sub>CC1</sub>	—	60	90	mA	Min cycle, duty = 100% $\overline{CS} = V_{IL}$ , others = V <sub>IH</sub> /V <sub>IL</sub> I <sub>I/O</sub> = 0 mA
Operating power supply current	-8/10 I <sub>CC1</sub>	—	55	80	mA	Min cycle, duty = 100% $\overline{CS} = V_{IL}$ , others = V <sub>IH</sub> /V <sub>IL</sub> I <sub>I/O</sub> = 0 mA
Operating power supply current	I <sub>CC2</sub>	—	15	30	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 power supply current: DC	I <sub>SB</sub>	—	1	3	mA	$\overline{CS} = V_{IH}$
Standby power supply current (1): DC	I <sub>SB1</sub>	—	0.02	2	mA	V <sub>in</sub> ≥ 0 V, $\overline{CS} \geq V_{CC} - 0.2$ V
Standby power supply current (1): DC	—	—	2	100 <sup>*2</sup>	μA	V <sub>in</sub> ≥ 0 V, $\overline{CS} \geq V_{CC} - 0.2$ V
Standby power supply current (1): DC	—	—	2	50 <sup>*3</sup>	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.

2. These characteristics are guaranteed only for L version.

3. These characteristics are guaranteed only for L-SL version.

### Capacitance (Ta = 25°C, f = 1 MHz)<sup>\*1</sup>

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

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

**AC Characteristics (Ta = 0 to +70°C, V<sub>CC</sub> = 5 V ± 10%, unless otherwise noted.)**
**Test Conditions**

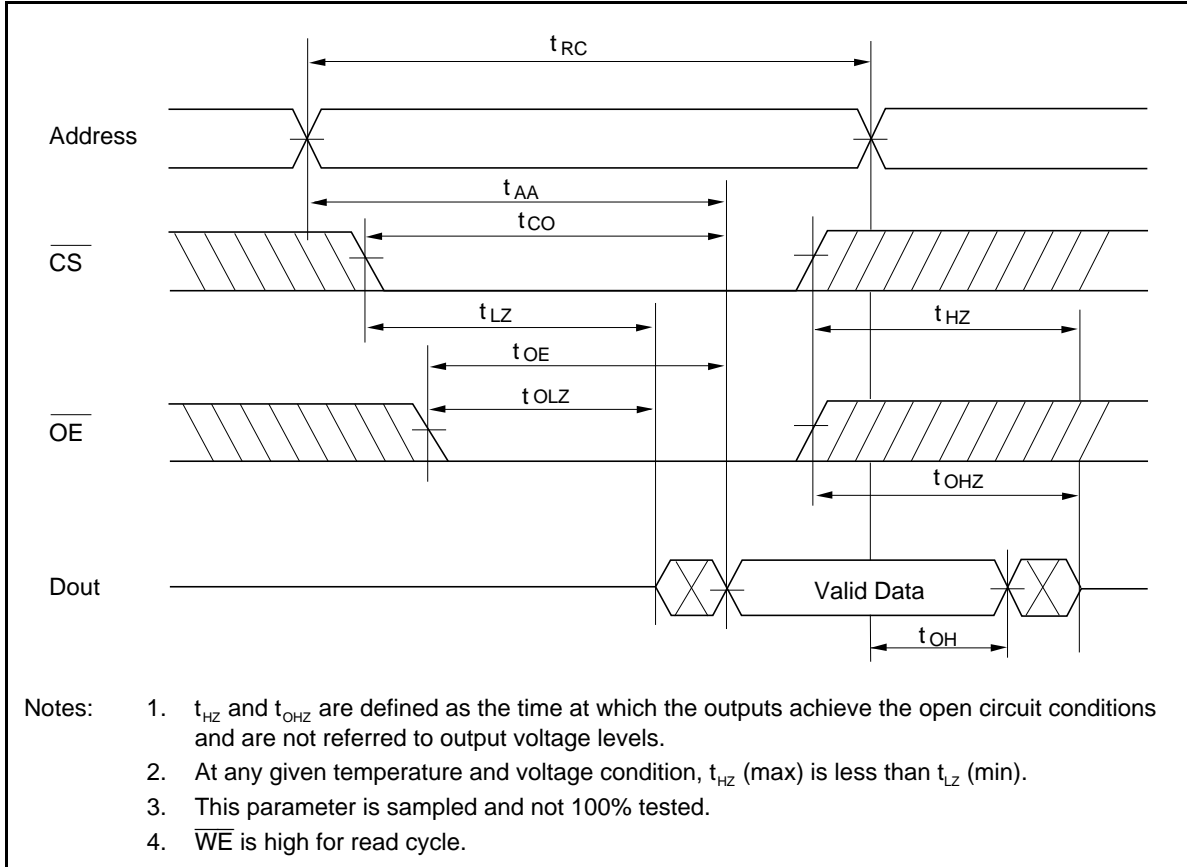
- Input pulse levels: 0.8 V to 2.4 V
- Input rise and fall times: 5 ns
- Input and output timing reference levels: 1.5 V
- Output load: 1 TTL Gate + C<sub>L</sub> (100 pF)  
(HM628512-7/8/10)  
1 TTL Gate + C<sub>L</sub> (50 pF)  
(HM628512-5)  
(Including scope & jig)

**Read Cycle**

		HM628512									
		-5		-7		-8		-10			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Min	Max	Unit	Note
Read cycle time	t <sub>RC</sub>	55	—	70	—	85	—	100	—	ns	
Address access time	t <sub>AA</sub>	—	55	—	70	—	85	—	100	ns	
Chip select access time	t <sub>CO</sub>	—	55	—	70	—	85	—	100	ns	
Output enable to output valid	t <sub>OE</sub>	—	25	—	35	—	45	—	50	ns	
Chip selection to output in low-Z	t <sub>LZ</sub>	10	—	10	—	10	—	10	—	ns	2, 3
Output enable to output in low-Z	t <sub>OLZ</sub>	5	—	5	—	5	—	5	—	ns	2, 3
Chip deselection to output in high-Z	t <sub>HZ</sub>	0	20	0	25	0	30	0	35	ns	1, 2, 3
Output disable to output in high-Z	t <sub>OHZ</sub>	0	20	0	25	0	30	0	35	ns	1, 2, 3
Output hold from address change	t <sub>OH</sub>	10	—	10	—	10	—	10	—	ns	

## HM628512 Series

### Read Timing Waveform<sup>\*4</sup>





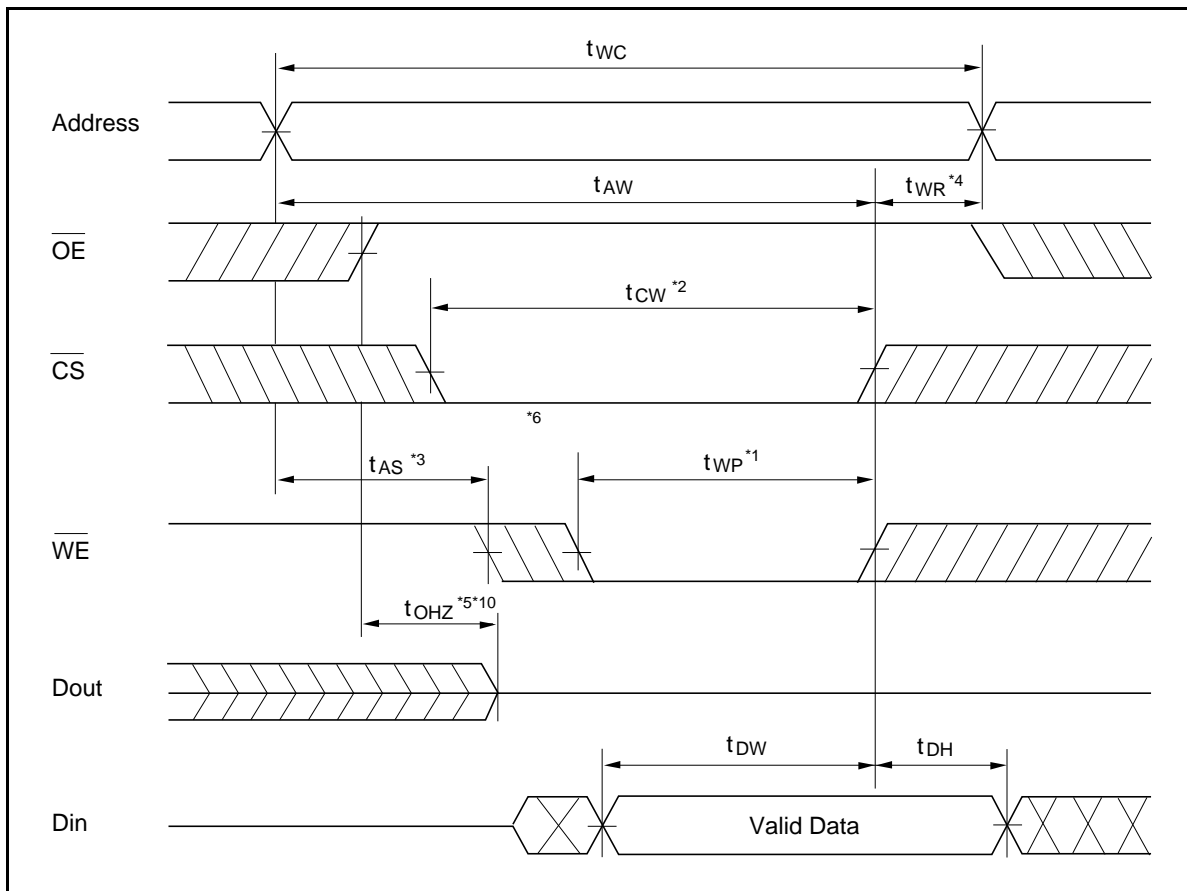
## HM628512 Series

### Write Cycle

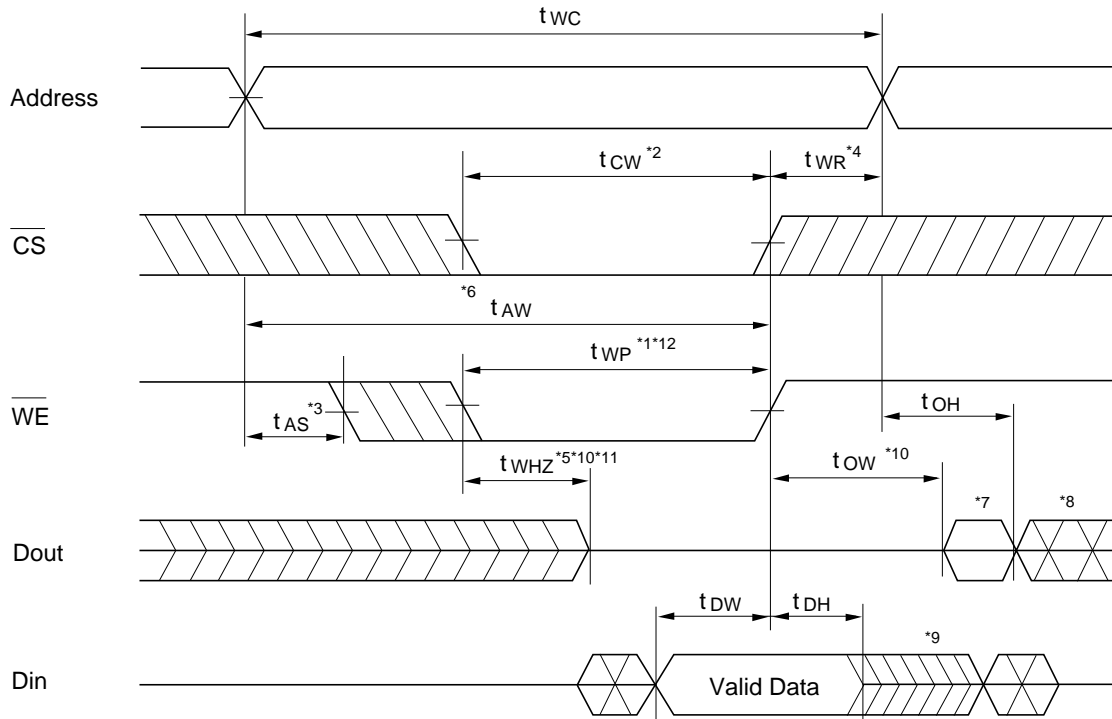
HM628512											
		-5		-7		-8		-10			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Min	Max	Unit	Note
Write cycle time	$t_{WC}$	55	—	70	—	85	—	100	—	ns	
Chip selection to end of write	$t_{CW}$	50	—	60	—	75	—	80	—	ns	2
Address setup time	$t_{AS}$	0	—	0	—	0	—	0	—	ns	3
Address valid to end of write	$t_{AW}$	50	—	60	—	75	—	80	—	ns	
Write pulse width	$t_{WP}$	40	—	50	—	55	—	60	—	ns	1, 12
Write recovery time	$t_{WR}$	5	—	5	—	5	—	5	—	ns	4
$\overline{WE}$ to output in high-Z	$t_{WHZ}$	0	20	0	25	0	30	0	35	ns	10, 11
Data to write time overlap	$t_{DW}$	25	—	30	—	35	—	40	—	ns	
Data hold from write time	$t_{DH}$	0	—	0	—	0	—	0	—	ns	
Output active from end of write	$t_{OW}$	5	—	5	—	5	—	5	—	ns	10

## HM628512 Series

### Write Timing Waveform (1) (OE Clock)



Write Timing Waveform (2) (OE Low Fixed)



- Notes:
1. 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.
  2.  $t_{CW}$  is measured from  $\overline{CS}$  going low to the end of write.
  3.  $t_{AS}$  is measured from the address valid to the beginning of write.
  4.  $t_{WR}$  is measured from the earlier of  $\overline{WE}$  or  $\overline{CS}$  going high to the end of write cycle.
  5. 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.
  6. 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.
  7.  $D_{out}$  is the same phase of the write data of this write cycle.
  8.  $D_{out}$  is the read data of next address.
  9. If  $\overline{CS}$  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.
  10. This parameter is sampled and not 100% tested.
  11.  $t_{WHZ}$  is defined as the time at which the outputs achieve the open circuit conditions and is not referred to output voltage levels.
  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.  $t_{WP} \geq t_{DW} \min + t_{WHZ} \max$

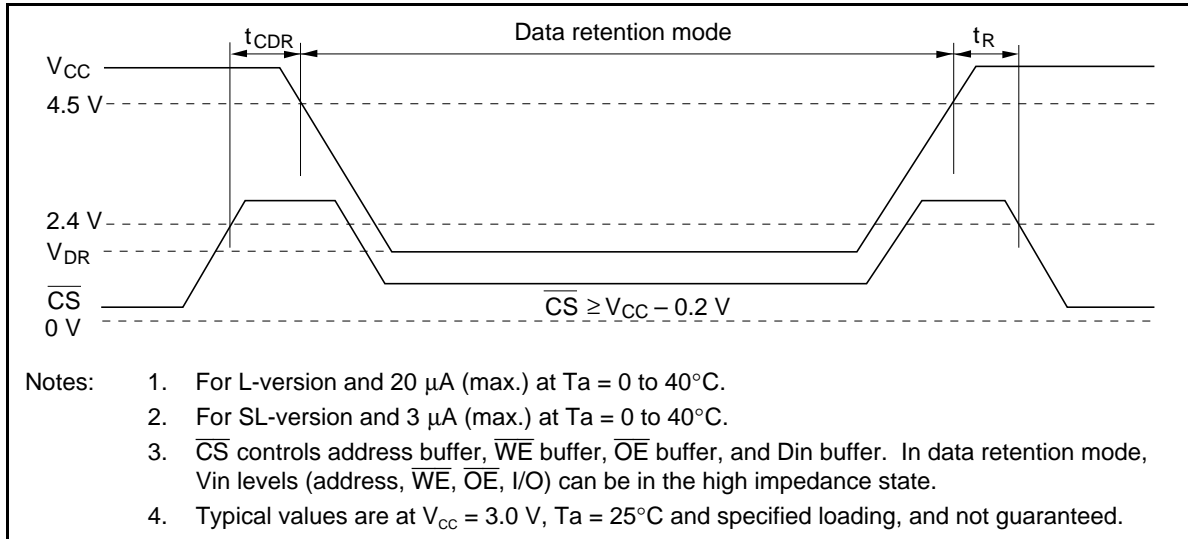
## HM628512 Series

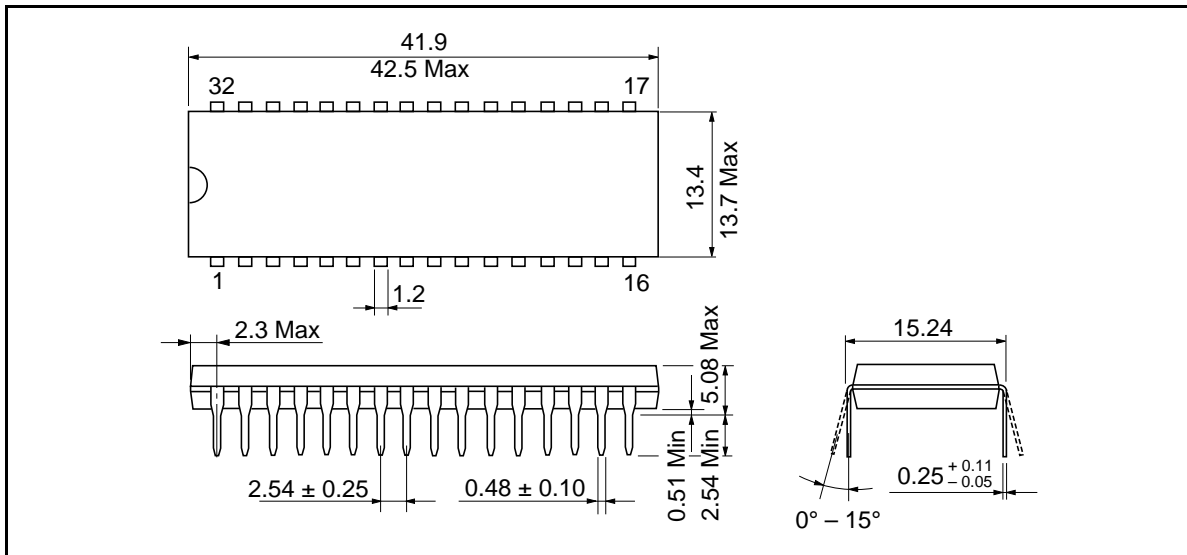
### Low $V_{CC}$ Data Retention Characteristics ( $T_a = 0$ to $+70^\circ\text{C}$ )

These characteristics are guaranteed only for L/L-SL version.

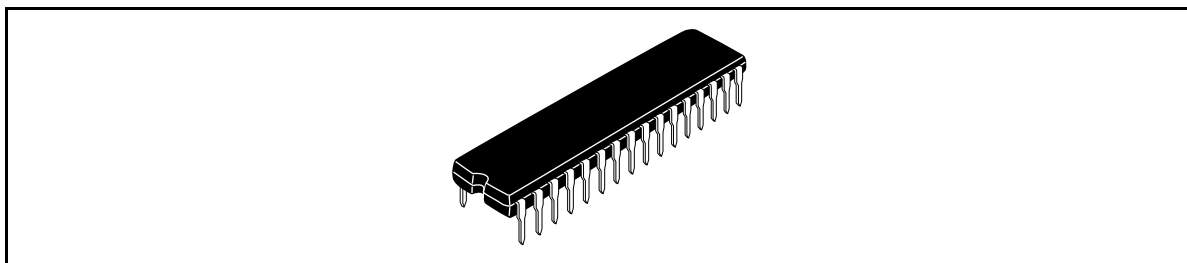
Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions <sup>*3</sup>
$V_{CC}$ for data retention	$V_{DR}$	2	—	—	V	$\overline{CS} \geq V_{CC} - 0.2 \text{ V}$ , $V_{in} \geq 0 \text{ V}$
Data retention current	$I_{CCDR}$	—	$1^{*4}$	$50^{*1}$	$\mu\text{A}$	$V_{CC} = 3.0 \text{ V}$ , $V_{in} \geq 0 \text{ V}$
Data retention current	$I_{CCDR}$	—	$1^{*4}$	$15^{*2}$	$\mu\text{A}$	$\overline{CS} \geq V_{CC} - 0.2 \text{ V}$
Chip deselect to data retention time	$t_{CDR}$	0	—	—	ns	See retention waveform
Operation recovery time	$t_R$	5	—	—	ms	See retention waveform

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



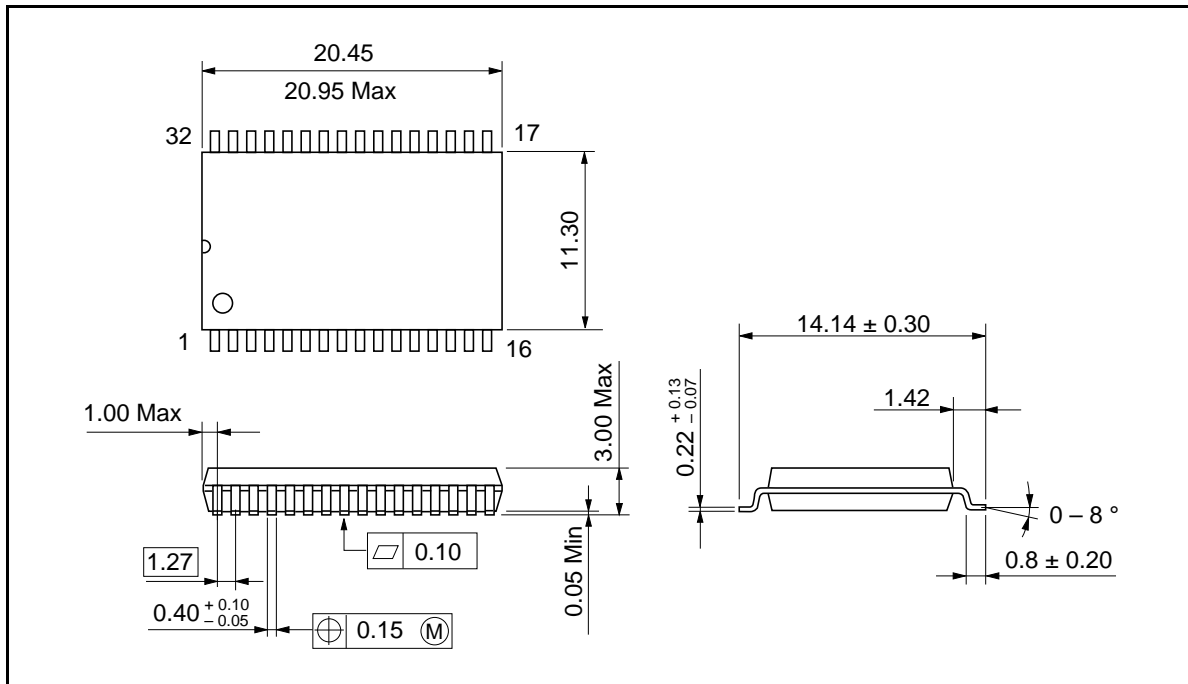
**Package Information**

**HM628512P, LP -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 600-mil 32-pin Plastic DIP (DP-32) —  
Mechanical**

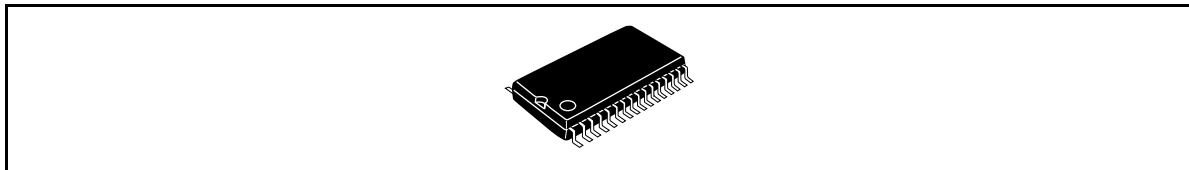


**HM628512P, LP -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 600-mil 32-pin Plastic DIP (DP-32) —  
Isometric**

## HM628512 Series

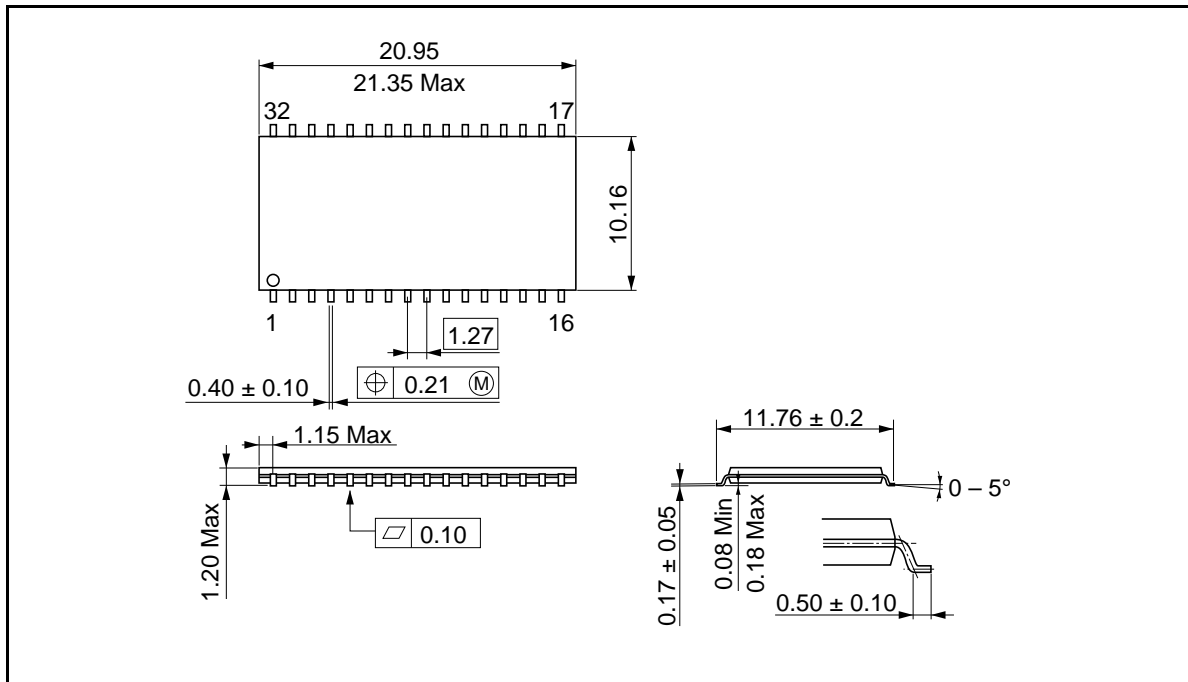


HM628512FP, LFP -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 525-mil 32-pin Plastic SOP (FP-32D) —  
Mechanical

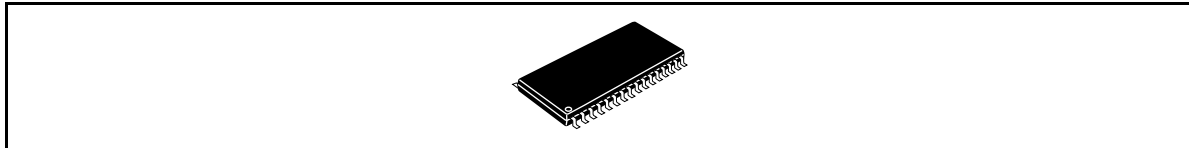


HM628512FP, LFP -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 525-mil 32-pin Plastic SOP (FP-32D) —  
Isometric

## HM628512 Series

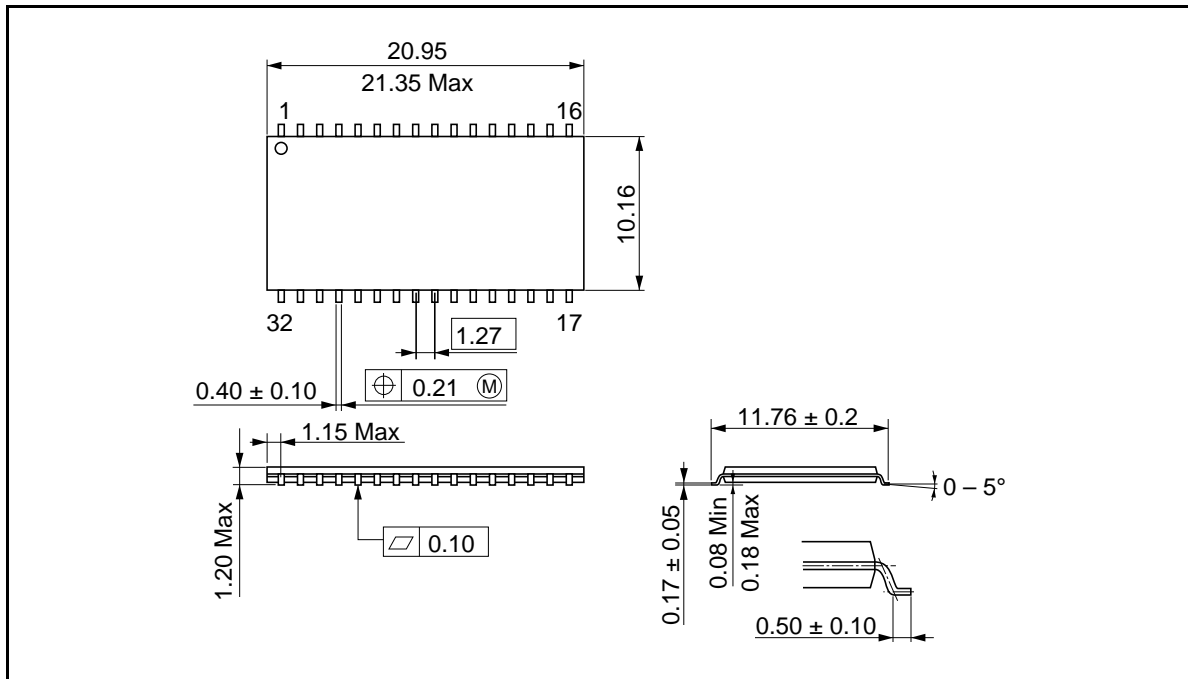


HM628512LTT -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 400-mil 32-pin Plastic TSOP II (TTP-32D) —  
Mechanical

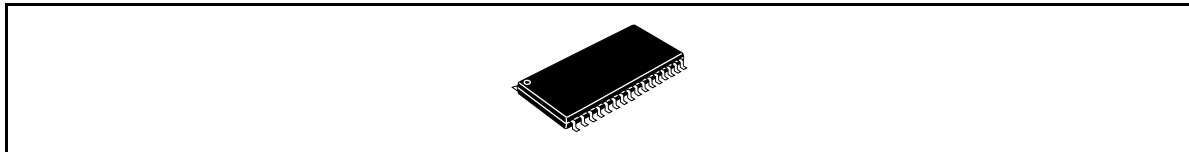


HM628512LTT -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 400-mil 32-pin Plastic TSOP II (TTP-32D) —  
Isometric

## HM628512 Series



HM628512LRR -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 400-mil 32-pin Plastic TSOP II reverse (TTP-32DR) — Mechanical



HM628512LRR -5, -7, -8, -10, -5SL, -7SL, -8SL, -10SL 400-mil 32-pin Plastic TSOP II reverse (TTP-32DR) — Isometric