

# HM658128A Series

131072-word  $\times$  8-bit High Speed CMOS Pseudo Static  
RAM

# HITACHI

Rev. 8.0  
Jun. 5, 1995

The Hitachi HM658128A is a pseudo-static RAM organized as 131,072-word  $\times$  8-bit. HM658128A realizes low power consumption and high speed access time by employing 1.3  $\mu$ m CMOS process technology. The HM658128A supports 3 refresh functions: address refresh, auto refresh and self refresh. Low power version dissipates only 350  $\mu$ W (typ)/500  $\mu$ W (typ) in self refresh mode and retains the data with battery. The HM658128A is pin-compatible with 1-Mbit static RAM.

## Features

- Single 5 V ( $\pm$  10%)
- High speed
  - Access time  
CE Access time: 80/100/120 ns
  - Cycle time  
Random read/  
Write cycle time: 130/160/190 ns
- Low power:
  - Active: 300 mW (typ)
  - Standby: 350  $\mu$ W (typ) (LL-version)  
500  $\mu$ W (typ) (L-version)
- All inputs and outputs TTL compatible
- Non multiplexed address
- 512 refresh cycles (8 ms)
- Refresh functions
  - Address refresh
  - Automatic refresh
  - Self refresh

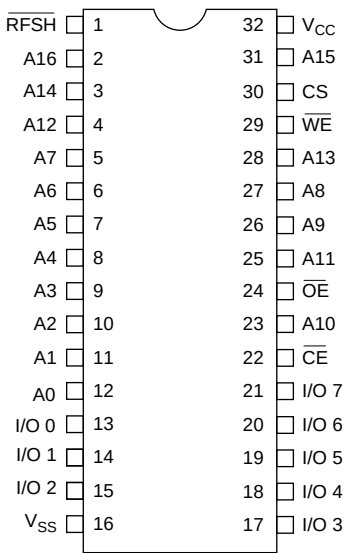
## Ordering Information

| Type No.         | Access time | Package                                           |
|------------------|-------------|---------------------------------------------------|
| HM658128ALP-8    | 80 ns       | 600-mil 32-pin plastic DIP (DP-32)                |
| HM658128ALP-10   | 100 ns      |                                                   |
| HM658128ALP-12   | 120 ns      |                                                   |
| HM658128ALP-8L   | 80 ns       | 32-pin plastic SOP (FP-32D)                       |
| HM658128ALP-10L  | 100 ns      |                                                   |
| HM658128ALP-12L  | 120 ns      |                                                   |
| HM658128ALFP-8   | 80 ns       | 32-pin plastic SOP (FP-32D)                       |
| HM658128ALFP-10  | 100 ns      |                                                   |
| HM658128ALFP-12  | 120 ns      |                                                   |
| HM658128ALFP-8L  | 80 ns       | 8 mm $\times$ 20 mm 32-pin plastic TSOP (TFP-32D) |
| HM658128ALFP-10L | 100 ns      |                                                   |
| HM658128ALFP-12L | 120 ns      |                                                   |
| HM658128ALT-8    | 80 ns       | 8 mm $\times$ 20 mm 32-pin plastic TSOP (TFP-32D) |
| HM658128ALT-10   | 100 ns      |                                                   |
| HM658128ALT-12   | 120 ns      |                                                   |
| HM658128ALT-8L   | 80 ns       | reverse type (TFP-32DR)                           |
| HM658128ALT-10L  | 100 ns      |                                                   |
| HM658128ALT-12L  | 120 ns      |                                                   |
| HM658128ALR-8    | 80 ns       | 8 mm $\times$ 20 mm 32-pin plastic TSOP           |
| HM658128ALR-10   | 100 ns      |                                                   |
| HM658128ALR-12   | 120 ns      |                                                   |
| HM658128ALR-8L   | 80 ns       | reverse type (TFP-32DR)                           |
| HM658128ALR-10L  | 100 ns      |                                                   |
| HM658128ALR-12L  | 120 ns      |                                                   |

# HM658128A Series

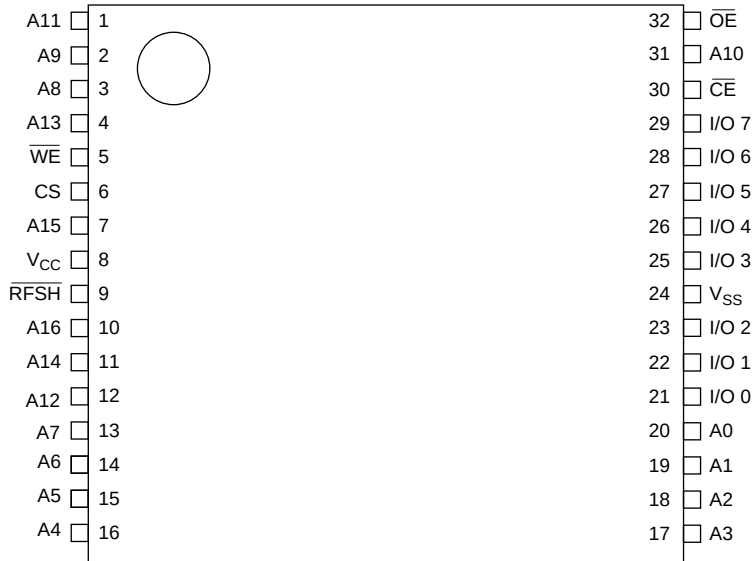
## Pin Arrangement

### HM658128ALP/ALFP Series



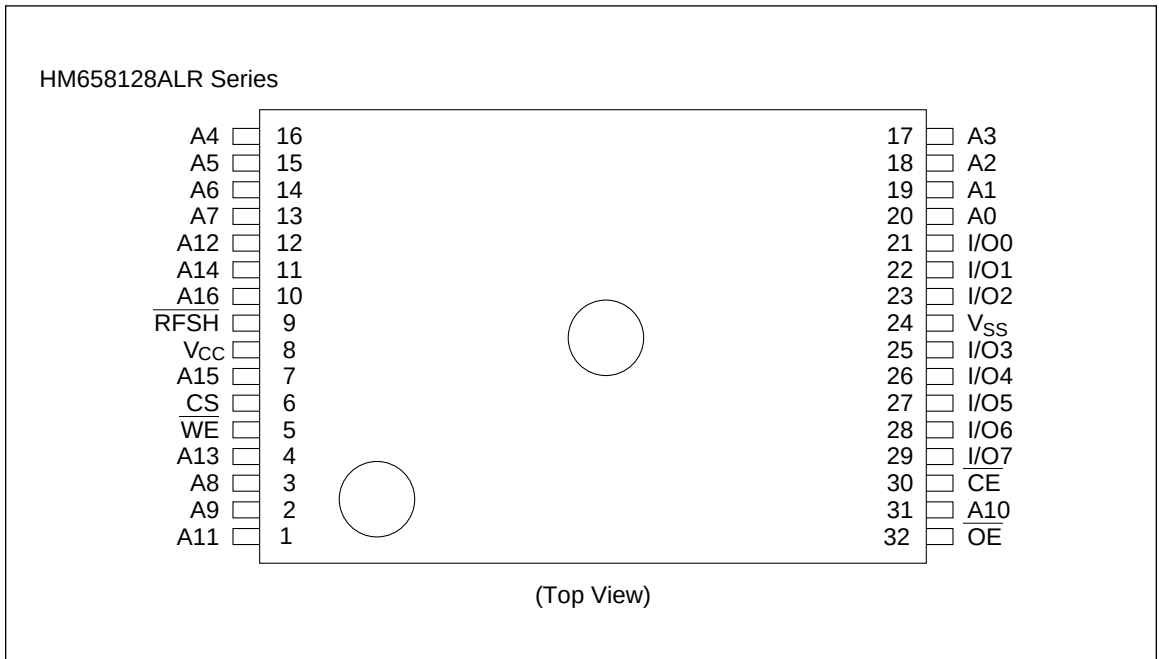
(Top View)

### HM658128ALT Series



(Top View)

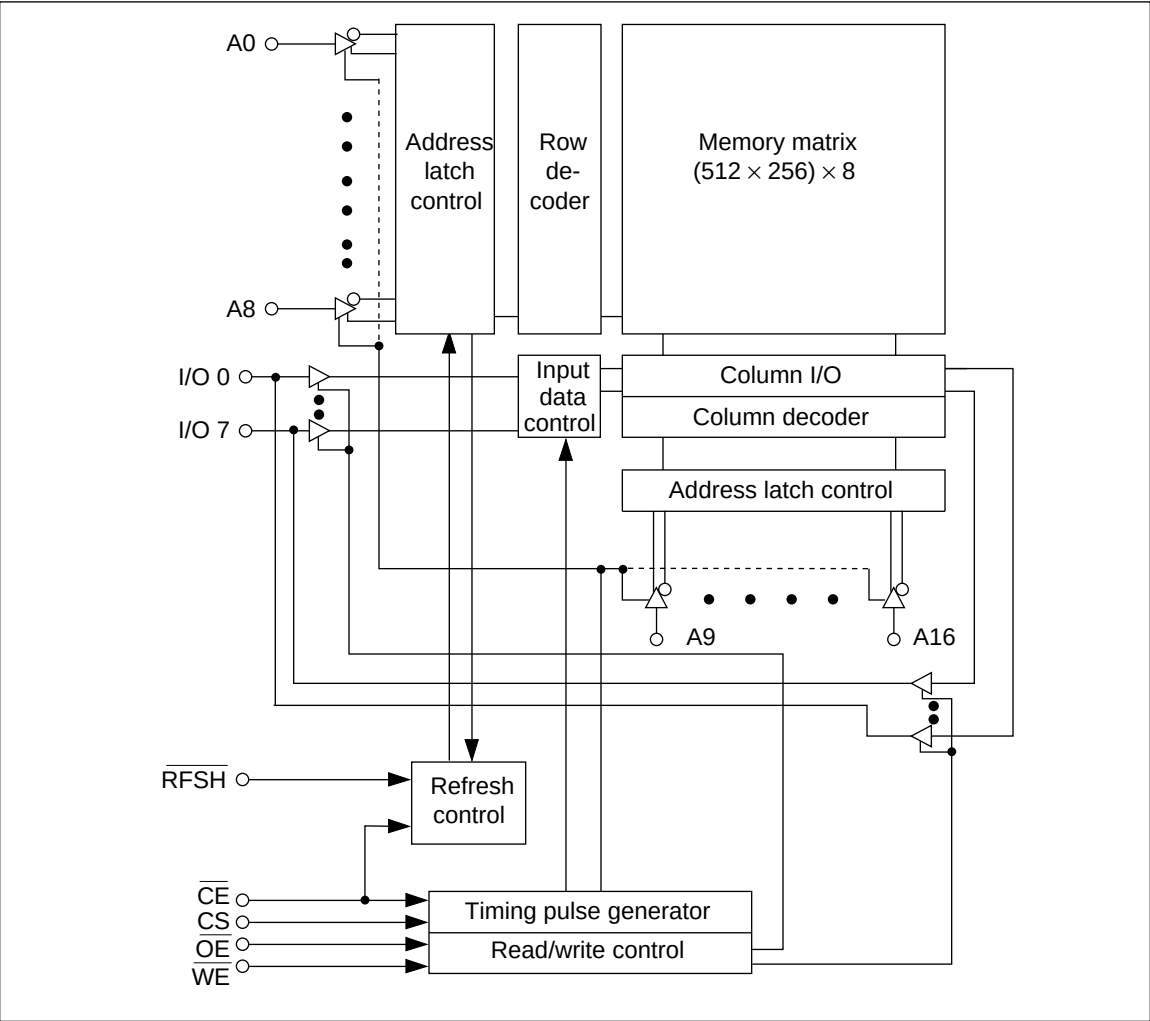
## Pin Arrangement (cont)



## Pin Description

| Symbol          | Pin name          |
|-----------------|-------------------|
| A0 to A16       | Address inputs    |
| I/O0 to I/O7    | Data input/output |
| RFSH            | Refresh           |
| CE              | Chip enable       |
| OE              | Output enable     |
| WE              | Write enable      |
| CS              | Chip select       |
| V <sub>CC</sub> | Power supply      |
| V <sub>SS</sub> | Ground            |

Block Diagram



Truth Table

| $\overline{CE}$ | CS at $\overline{CE}$ going low | $\overline{RFSH}$ | $\overline{OE}$ | $\overline{WE}$ | I/O pin | Mode       |
|-----------------|---------------------------------|-------------------|-----------------|-----------------|---------|------------|
| L               | H                               | X*1               | L               | H               | Low-Z   | Read       |
| L               | H                               | X                 | X               | L               | High-Z  | Write      |
| L               | H                               | X                 | H               | H               | High-Z  | —          |
| L               | L                               | X                 | X               | X               | High-Z  | CS Standby |
| H               | X                               | L                 | X               | X               | High-Z  | Refresh    |
| H               | X                               | H                 | X               | X               | High-Z  | Standby    |

Notes: 1. X means H or L.

### Absolute Maximum Ratings

| Parameter                                 | Symbol     | Rating       | Unit |
|-------------------------------------------|------------|--------------|------|
| Terminal voltage with respect to $V_{SS}$ | $V_T$      | −1.0 to +7.0 | V    |
| Power dissipation                         | $P_T$      | 1.0          | W    |
| Operating temperature                     | $T_{opr}$  | 0 to +70     | °C   |
| Storage temperature                       | $T_{stg}$  | −55 to +125  | °C   |
| Storage temperature under bias            | $T_{bias}$ | −10 to +85   | °C   |

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

| Parameter      | Symbol   | Min  | Typ | Max | Unit | Note |
|----------------|----------|------|-----|-----|------|------|
| Supply voltage | $V_{CC}$ | 4.5  | 5.0 | 5.5 | V    |      |
|                | $V_{SS}$ | 0    | 0   | 0   | V    |      |
| Input voltage  | $V_{IH}$ | 2.2  | —   | 6.0 | V    |      |
|                | $V_{IL}$ | −0.5 | —   | 0.8 | V    | 1    |

Note: 1.  $V_{IL}$  min = −3.0 V for pulse width ≤ 10 ns.

## HM658128A Series

### DC Characteristics (Ta = 0 to +70°C, V<sub>CC</sub> = 5 V ± 10%)

| Parameter                                           | Symbol           | Min | Typ | Max | Unit | Test conditions                                                                   | Notes |
|-----------------------------------------------------|------------------|-----|-----|-----|------|-----------------------------------------------------------------------------------|-------|
| Operating power supply current                      | I <sub>CC1</sub> | —   | 60  | 85  | mA   | I <sub>I/O</sub> = 0 mA<br>t <sub>cyc</sub> = min.                                |       |
| Standby power supply current                        | I <sub>SB1</sub> | —   | 1   | 2   | mA   | $\overline{CE} = V_{IH}$<br>RFSH = V <sub>IH</sub> , Vin ≥ 0 V                    |       |
| Standby power supply current                        | I <sub>SB2</sub> | —   | 100 | 200 | μA   | $\overline{CE} \geq V_{CC} - 0.2$ V<br>RFSH ≥ V <sub>CC</sub> - 0.2 V, Vin ≥ 0 V  | 1     |
|                                                     |                  | —   | 70  | 100 | μA   | $\overline{CE} \geq V_{CC} - 0.2$ V<br>RFSH ≥ V <sub>CC</sub> - 0.2 V, Vin ≥ 0 V  | 2     |
| Operating power supply current in self refresh mode | I <sub>CC2</sub> | —   | 1   | 2   | mA   | $\overline{CE} = V_{IH}$<br>RFSH = V <sub>IL</sub> , Vin ≥ 0 V                    | 1, 2  |
|                                                     | I <sub>CC3</sub> | —   | 100 | 200 | μA   | $\overline{CE} \geq V_{CC} - 0.2$ V<br>RFSH ≤ 0.2 V, Vin ≥ 0 V                    | 1     |
|                                                     |                  | —   | 70  | 100 | μA   | $\overline{CE} \geq V_{CC} - 0.2$ V<br>RFSH ≤ 0.2 V, Vin ≥ 0 V                    | 2     |
| Input leakage current                               | I <sub>LI</sub>  | -10 | —   | 10  | μA   | V <sub>CC</sub> = 5.5 V<br>Vin = V <sub>SS</sub> to V <sub>CC</sub>               |       |
| Output leakage current                              | I <sub>LO</sub>  | -10 | —   | 10  | μA   | $\overline{OE} = V_{IH}$<br>V <sub>I/O</sub> = V <sub>SS</sub> to V <sub>CC</sub> |       |
| Output voltage                                      | V <sub>OL</sub>  | —   | —   | 0.4 | V    | I <sub>OL</sub> = 2.1 mA                                                          |       |
|                                                     | V <sub>OH</sub>  | 2.4 | —   | —   | V    | I <sub>OH</sub> = -1 mA                                                           |       |

Notes: 1. This characteristics is guaranteed only for L-version.  
2. This characteristics is guaranteed only for LL-version.

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

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

Note: This Parameter is sampled and not 100% tested.

**AC Characteristics** ( $T_a = 0$  to  $+70^{\circ}\text{C}$ ,  $V_{CC} = 5\text{ V} \pm 10\%$ )**Test Conditions**

- Input pulse levels: 2.4 V, 0.4 V
- Input rise and fall times: 5 ns
- Timing measurement level: 2.2 V, 0.8 V
- Reference level:  $V_{OH} = 2.0\text{ V}$ ,  $V_{OL} = 0.8\text{ V}$
- Output load: 1 TTL and 100 pF (including scope and jig)

|                                                 |                  | HM658128A |      |       |      |       |      |      |      |
|-------------------------------------------------|------------------|-----------|------|-------|------|-------|------|------|------|
|                                                 |                  | -8        |      | -10   |      | -12   |      |      |      |
| Parameter                                       | Symbol           | Min       | Max  | Min   | Max  | Min   | Max  | Unit | Note |
| Random read or write cycle time                 | t <sub>RC</sub>  | 130       | —    | 160   | —    | 190   | —    | ns   |      |
| Random read-modify-write cycle time             | t <sub>RWC</sub> | 190       | —    | 220   | —    | 260   | —    | ns   |      |
| Chip enable access time                         | t <sub>CEA</sub> | —         | 80   | —     | 100  | —     | 120  | ns   |      |
| Output enable access time                       | t <sub>OEA</sub> | —         | 30   | —     | 30   | —     | 40   | ns   |      |
| Chip disable to output in high-Z                | t <sub>CHZ</sub> | 0         | 30   | 0     | 30   | 0     | 35   | ns   | 1, 2 |
| Chip enable to output in low-Z                  | t <sub>CLZ</sub> | 20        | —    | 20    | —    | 20    | —    | ns   | 2    |
| Output disable to output in high-Z              | t <sub>OHZ</sub> | —         | 25   | —     | 25   | —     | 30   | ns   | 1, 2 |
| Output enable to output in low-Z                | t <sub>OLZ</sub> | 0         | —    | 0     | —    | 0     | —    | ns   | 2    |
| Chip enable pulse width                         | t <sub>CE</sub>  | 80 n      | 10 μ | 100 n | 10 μ | 120 n | 10 μ | s    |      |
| Chip enable precharge time                      | t <sub>P</sub>   | 40        | —    | 50    | —    | 60    | —    | ns   |      |
| Address setup time                              | t <sub>AS</sub>  | 0         | —    | 0     | —    | 0     | —    | ns   |      |
| Address hold time                               | t <sub>AH</sub>  | 30        | —    | 30    | —    | 35    | —    | ns   |      |
| Read command setup time                         | t <sub>RCS</sub> | 0         | —    | 0     | —    | 0     | —    | ns   |      |
| Read command hold time                          | t <sub>RCH</sub> | 0         | —    | 0     | —    | 0     | —    | ns   |      |
| $\overline{\text{RFSH}}$ hold time              | t <sub>RHC</sub> | 15        | —    | 15    | —    | 15    | —    | ns   |      |
| $\overline{\text{RFSH}}$ delay time for standby | t <sub>RCD</sub> | —         | 5    | —     | 5    | —     | 5    | ns   | 10   |
| Chip select setup time                          | t <sub>CSS</sub> | 0         | —    | 0     | —    | 0     | —    | ns   |      |
| Chip select hold time                           | t <sub>CSH</sub> | 30        | —    | 30    | —    | 35    | —    | ns   |      |
| Write command pulse width                       | t <sub>WP</sub>  | 30        | —    | 30    | —    | 35    | —    | ns   |      |
| Chip enable to end of write                     | t <sub>CW</sub>  | 80        | —    | 100   | —    | 120   | —    | ns   |      |
| Data in to end of write                         | t <sub>DW</sub>  | 25        | —    | 25    | —    | 30    | —    | ns   |      |
| Data in hold time for write                     | t <sub>DH</sub>  | 0         | —    | 0     | —    | 0     | —    | ns   |      |
| Output active from end of write                 | t <sub>OW</sub>  | 5         | —    | 5     | —    | 5     | —    | ns   | 2    |
| Write to output in high-Z                       | t <sub>WHZ</sub> | —         | 25   | —     | 25   | —     | 30   | ns   | 1, 2 |
| Transition time (rise and fall)                 | t <sub>T</sub>   | 3         | 50   | 3     | 50   | 3     | 50   | ns   | 6    |

## HM658128A Series

### AC Characteristics (Ta = 0 to +70°C, V<sub>CC</sub> = 5 V ± 10%) (cont)

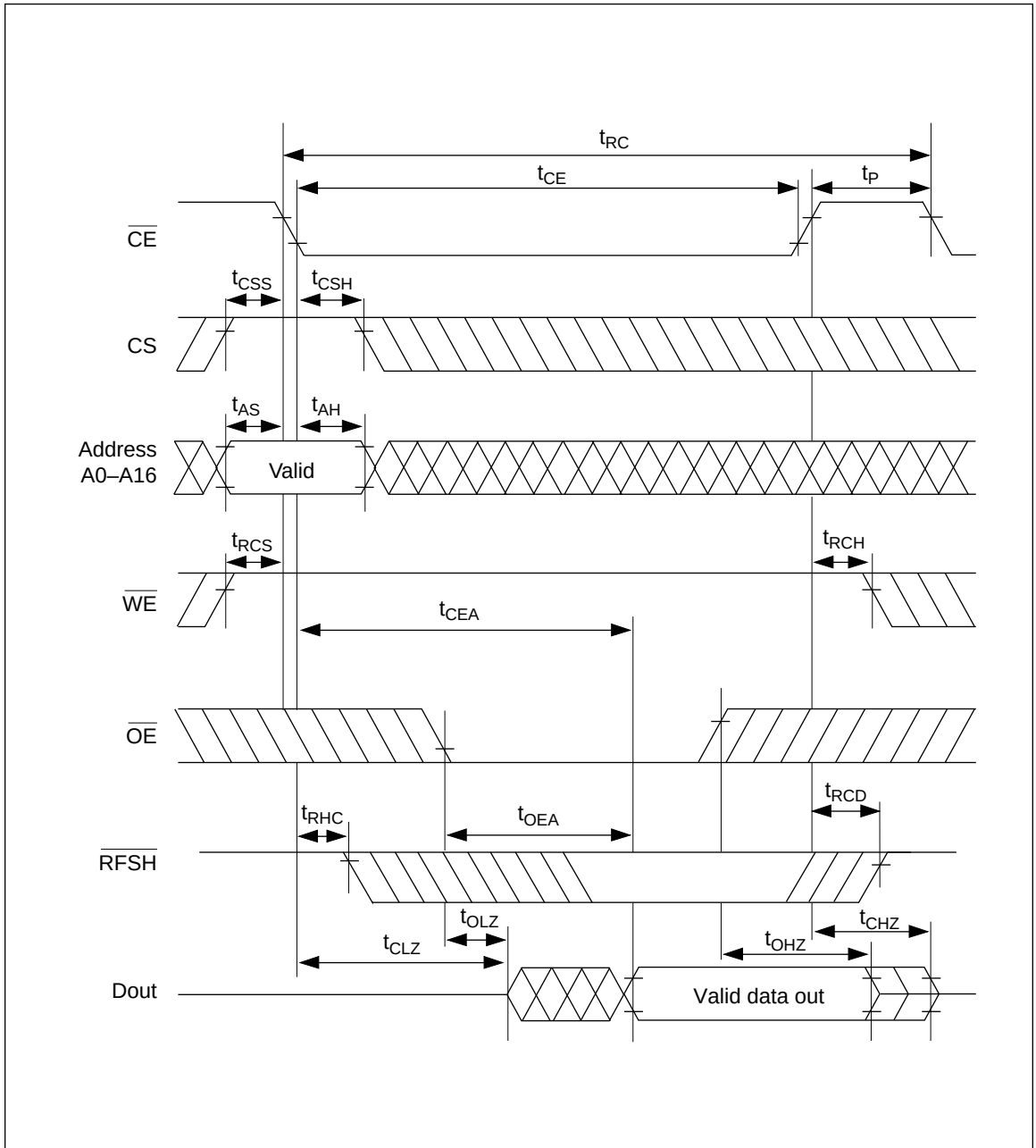
|                                                   |                  | HM658128A |     |      |     |      |     |      |      |
|---------------------------------------------------|------------------|-----------|-----|------|-----|------|-----|------|------|
|                                                   |                  | -8        |     | -10  |     | -12  |     |      |      |
| Parameter                                         | Symbol           | Min       | Max | Min  | Max | Min  | Max | Unit | Note |
| Refresh command delay time                        | t <sub>RFD</sub> | 40        | —   | 50   | —   | 60   | —   | ns   |      |
| Refresh precharge time                            | t <sub>FP</sub>  | 40        | —   | 40   | —   | 40   | —   | ns   |      |
| Refresh command pulse width for automatic refresh | t <sub>FAP</sub> | 80 n      | 8 μ | 80 n | 8 μ | 80 n | 8 μ | s    |      |
| Automatic refresh cycle time                      | t <sub>FC</sub>  | 130       | —   | 160  | —   | 190  | —   | ns   |      |
| Refresh command pulse width for self refresh      | t <sub>FAS</sub> | 8         | —   | 8    | —   | 8    | —   | μs   |      |
| Refresh reset time for self refresh               | t <sub>RFS</sub> | 130       | —   | 160  | —   | 190  | —   | ns   |      |
| Refresh reset time for auto refresh               | t <sub>RFA</sub> | 0         | —   | 0    | —   | 0    | —   | ns   |      |
| Refresh period (512 cycles)                       | t <sub>REF</sub> | —         | 8   | —    | 8   | —    | 8   | ms   |      |

- Notes: 1. t<sub>CHZ</sub>, t<sub>OHZ</sub> and t<sub>WHZ</sub> are defined as the time at which the output achieves the open circuit conditions.
2. t<sub>CHZ</sub>, t<sub>CLZ</sub>, t<sub>OHZ</sub>, t<sub>OLZ</sub>, t<sub>WHZ</sub> and t<sub>OW</sub> are sampled under the condition of t<sub>T</sub> = 5 ns and not 100% tested.
3. A write occurs during the overlap of a low  $\overline{CE}$  and a low  $\overline{WE}$ . Write ends at the earlier of  $\overline{WE}$  going high or  $\overline{CE}$  going high.
4. If the  $\overline{CE}$  low transition occurs simultaneously with or latter from the  $\overline{WE}$  low transition, the output buffers remain in high impedance state.
5. In write cycle,  $\overline{OE}$  or  $\overline{WE}$  must disable output buffers prior to applying data to the device and at the end of write cycle data inputs must be floated prior to  $\overline{OE}$  or  $\overline{WE}$  turning on output buffers.
6. Transition time t<sub>T</sub> is measured between V<sub>IH</sub> min and V<sub>IL</sub> max.
7. After power-up, pause more than 100 μs and execute at least 8 initialization cycles.
8. 512 cycles of burst refresh or the first cycle of distributed automatic refresh must be executed within 15 μs after self refresh, in order to meet the refresh specification of 8 ms and 512 cycles.
9. At the end of self refresh, refresh reset time (t<sub>RFS</sub>) is required to reset the internal self refresh operation of the RAM. During t<sub>RFS</sub>,  $\overline{CE}$  and  $\overline{RFSH}$  must be kept high. If auto refresh follows self refresh, low transition of  $\overline{RFSH}$  at the beginning of auto refresh must not occur during t<sub>RFS</sub> period.
10. If t<sub>P</sub> is larger than 60 ns, t<sub>RCD</sub> can be 8 μs maximum.

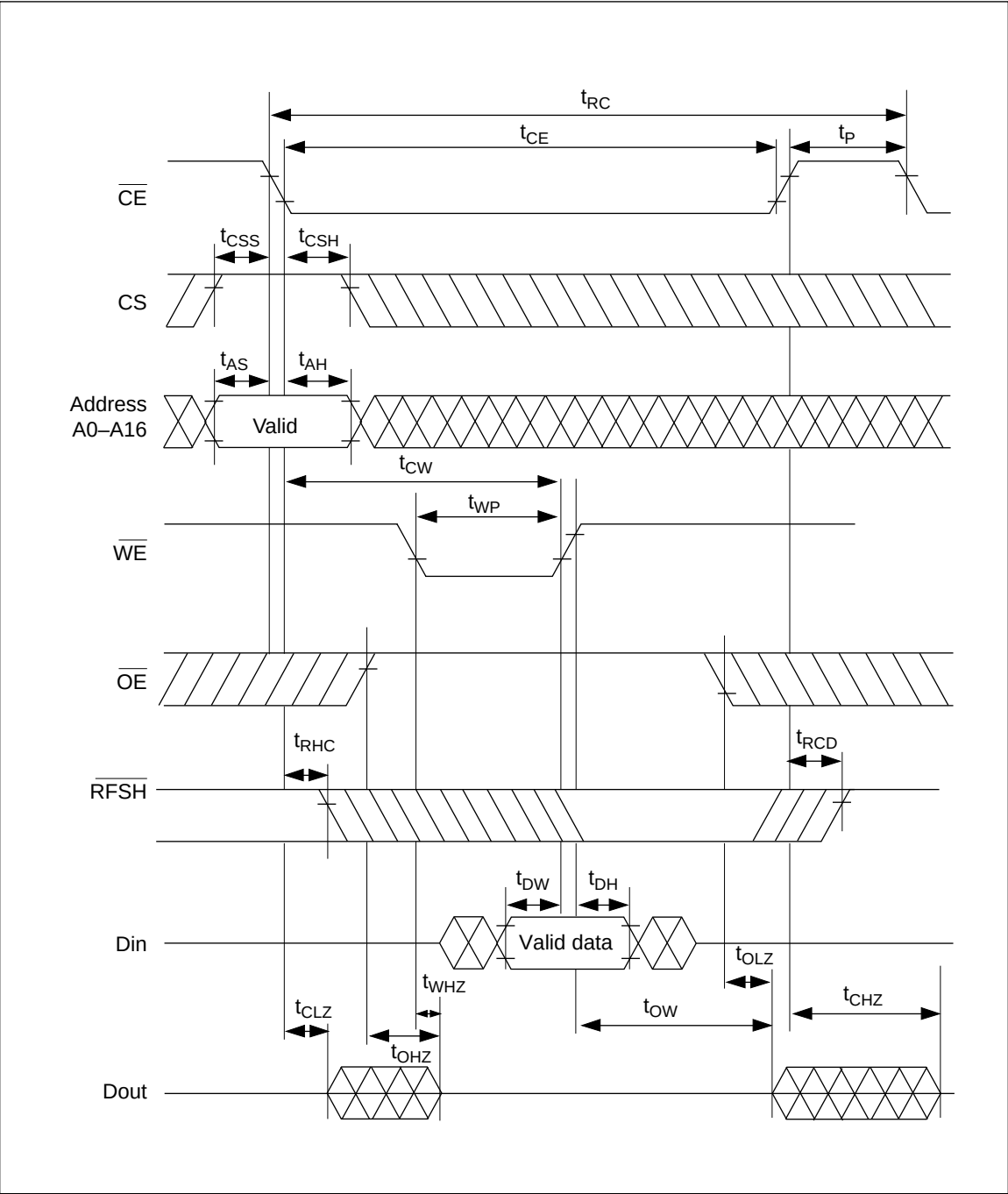


## Timing Waveforms

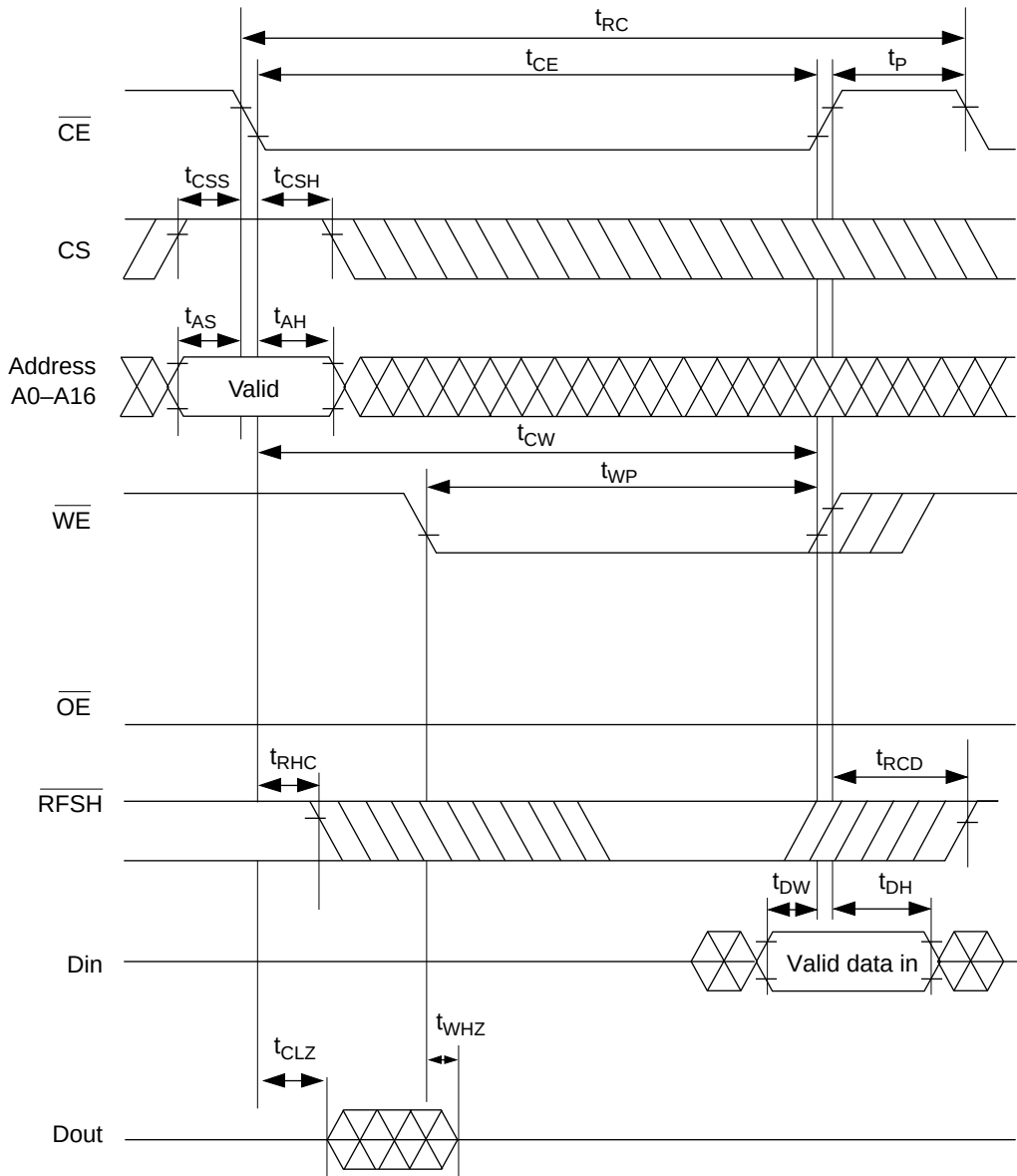
### Read Cycle



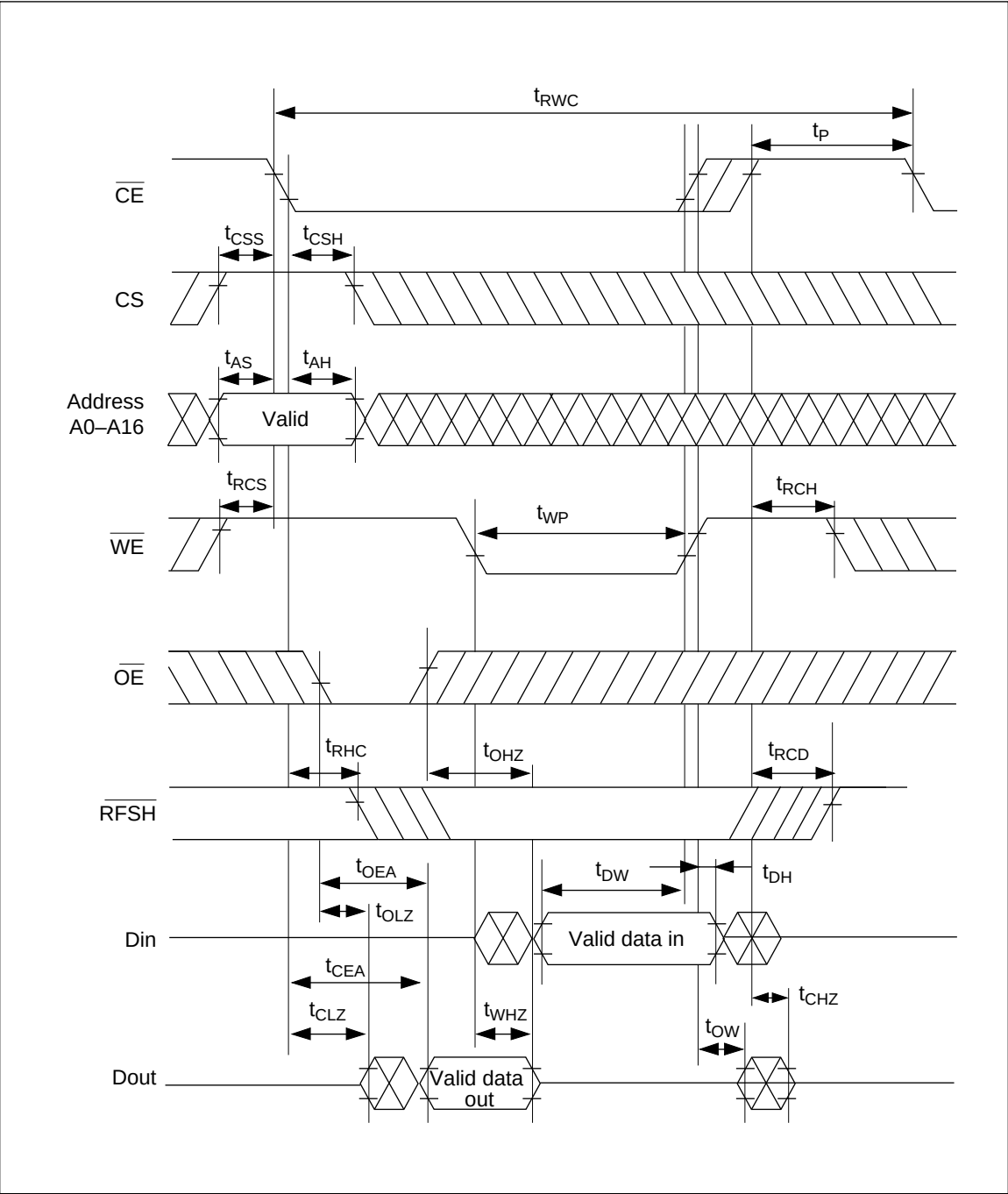
Write Cycle 1 (OE clock)



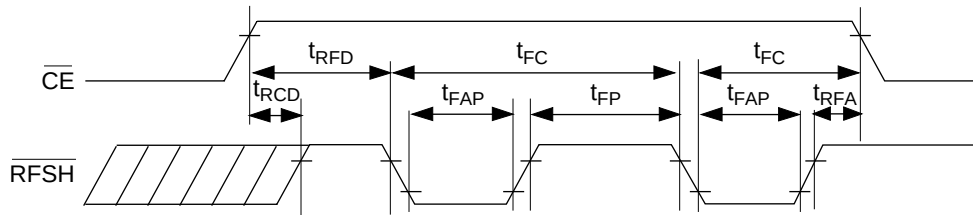
Write Cycle 2 ( $\overline{\text{OE}}$  Low Fix)



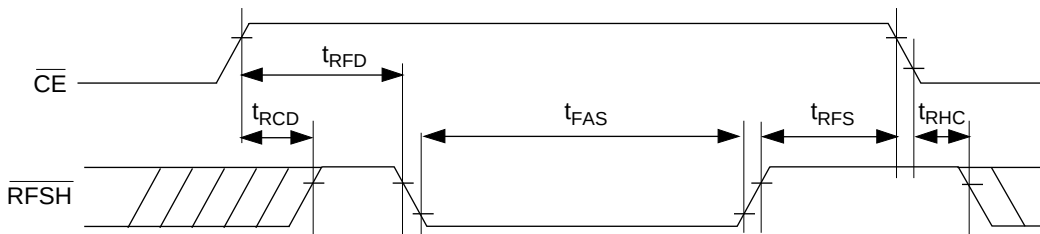
Read-Modify-Write Cycle



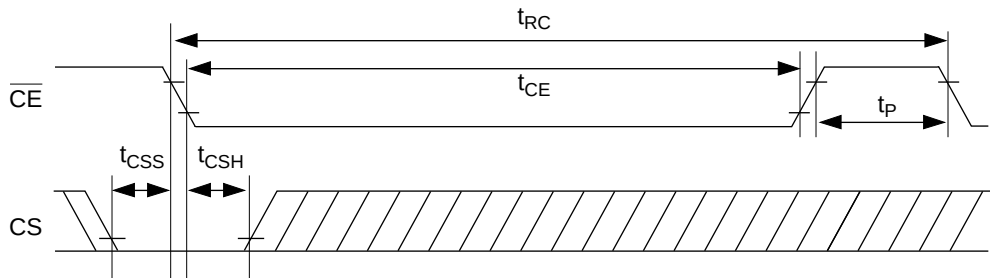
### Auto Refresh Cycle



### Self Refresh Cycle



### CS Standby Mode

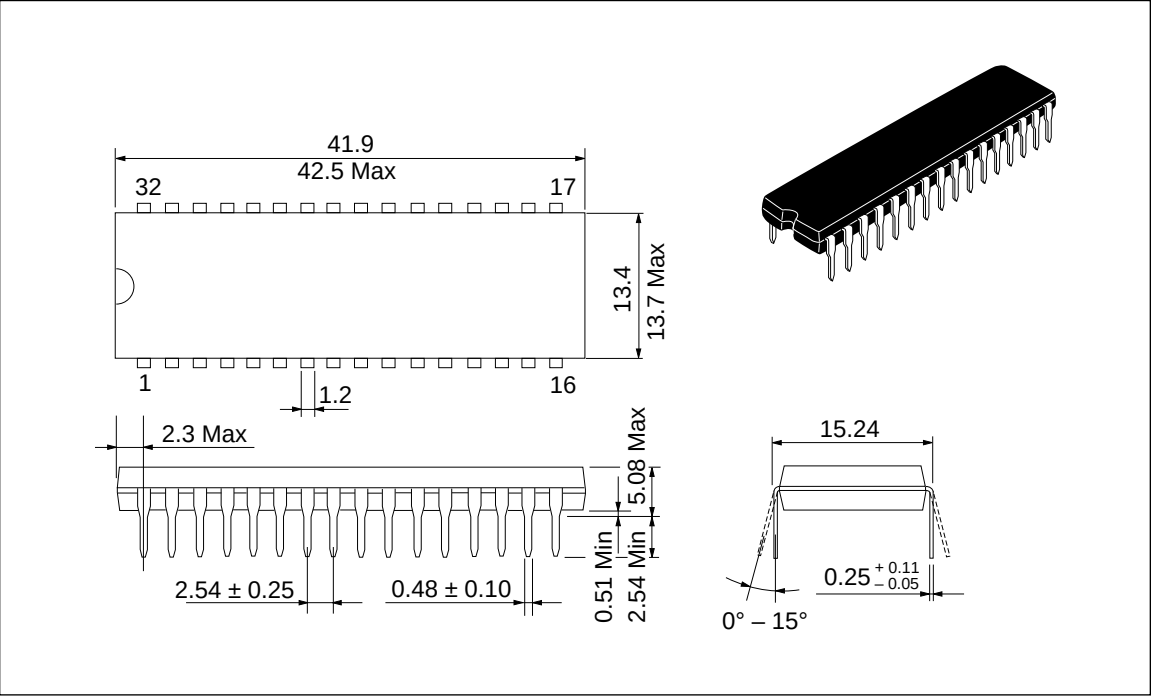


# HM658128A Series

## Package Dimensions

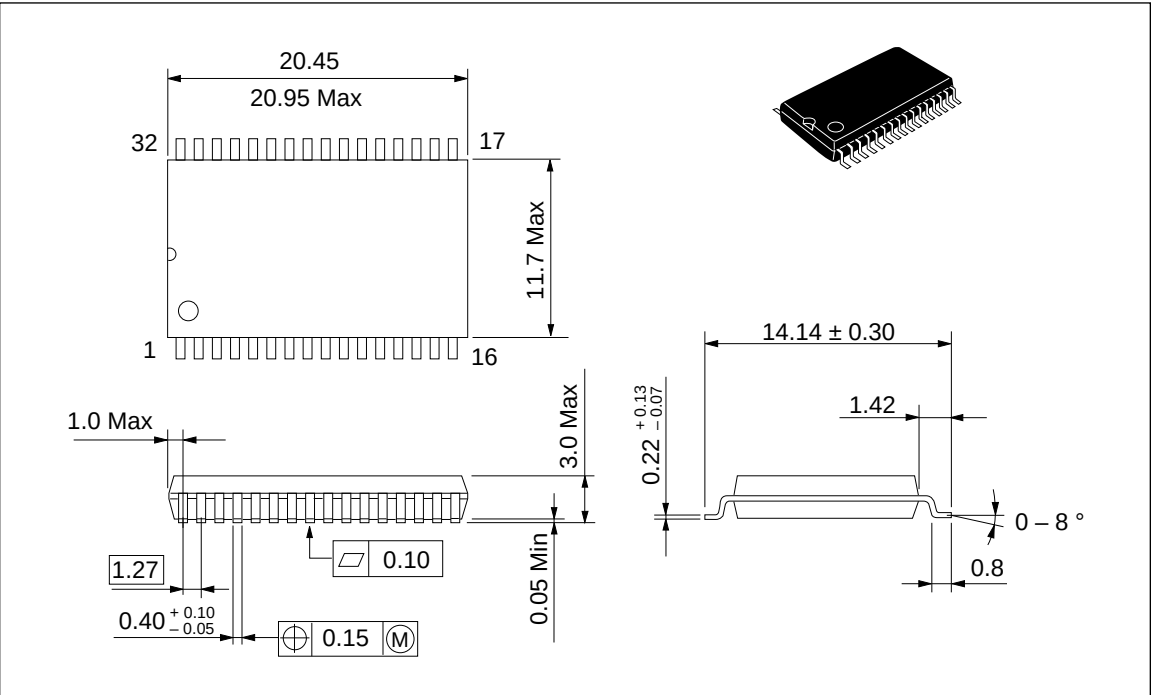
HM658128ALP Series (DP-32)

Unit: mm



HM658128ALFP Series (FP-32D)

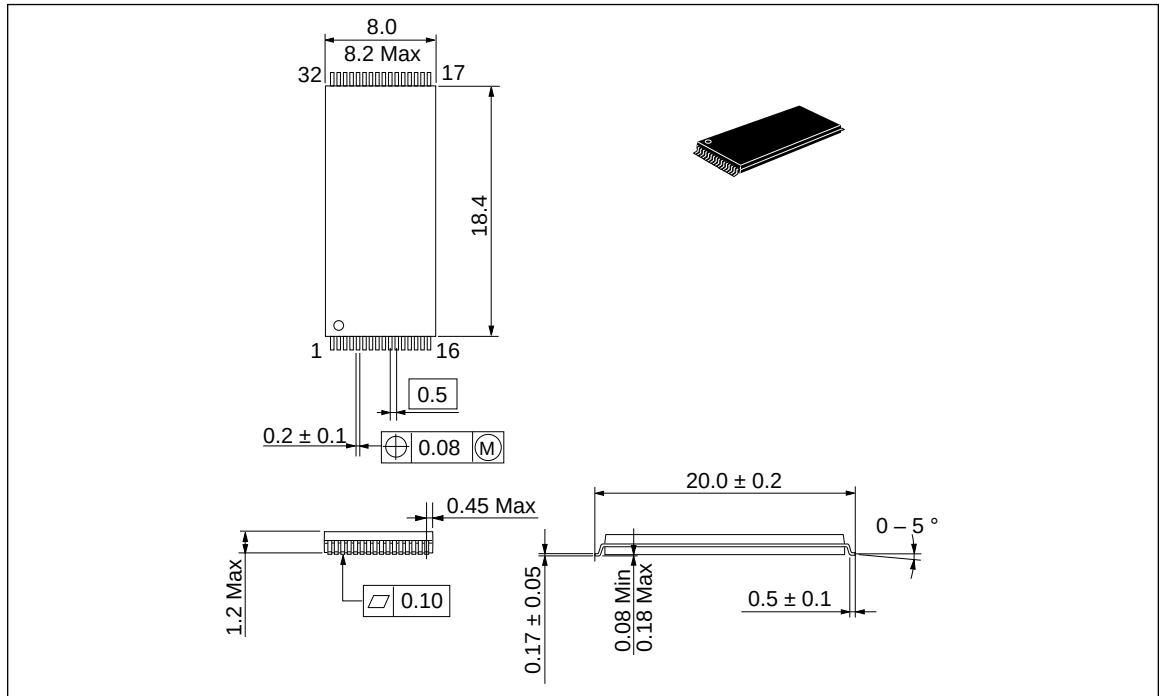
Unit: mm



Package Dimensions (cont)

HM658128ALT Series (TFP-32D)

Unit: mm



HM658128ALR Series (TFP-32DR)

Unit: mm

