



WS

Very Low Power/Voltage CMOS SRAM 512K X 8 bit

WS628512

FEATURES

- Wide Vcc operation voltage : 2.4V ~ 3.6V
- Very low power consumption :
 - Vcc = 3.0V 20mA (Max.) write current
5mA (Max.) read current
1uA (Typ.) CMOS standby current
 - Vcc = 3.6V 30mA (Max.) write current
5mA (Max.) read current
3uA (Typ.) CMOS standby current
- High speed access time :
-70 70ns (Max.)
- Input levels are CMOS-compatible
- Automatic power down when chip is deselected
- Three state outputs
- Fully static operation
- Data retention supply voltage as low as 1.5V
- Easy expansion with CE and OE options
- All I/O pins are 5V tolerant

GENERAL DESCRIPTION

The WS628512 is a high performance, very low power CMOS Static Random Access Memory organized as 524,288 words by 8 bits and operates from a wide range of 2.4V to 3.6V supply voltage. Advanced CMOS technology and circuit techniques provide both high speed and low power features with a typical CMOS standby current of 1uA and maximum access time of 70ns in 3V operation. Easy memory expansion is provided by an active LOW chip enable (CE), and active LOW output enable (OE) and three-state output drivers.

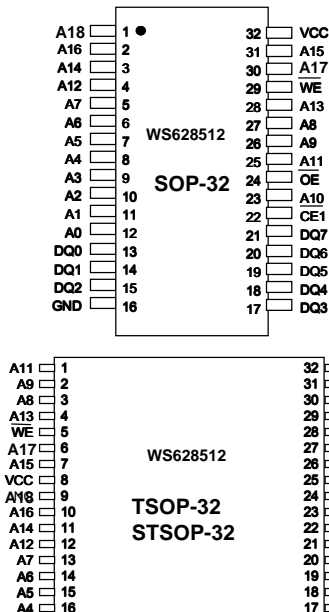
The WS628512 has an automatic power down feature, reducing the power consumption significantly when chip is deselected.

The WS628512 is available in the JEDEC standard 32 pin 450mil Plastic SOP, and 8mmx13.4mmSTSOP, 8mmx20mmTSOP

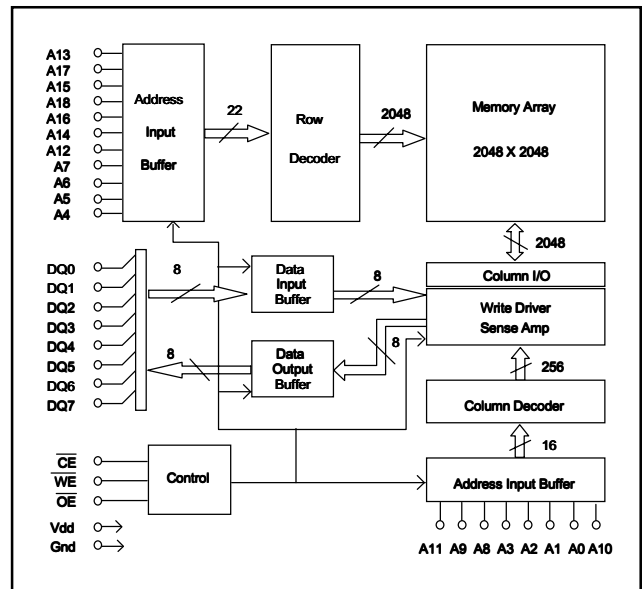
PRODUCT FAMILY

| PRODUCT FAMILY | OPERATING TEMPERATURE | Vcc RANGE | SPEED (ns) | POWER DISSIPATION | | | | PKG TYPE |
|-----------------|-----------------------|-------------|------------|-----------------------|-----------|----------------------|-----------|----------|
| | | | | STANDBY (Iccsb1, Max) | | Operating (Icc, Max) | | |
| | | | | Vcc= 3.6V | Vcc= 3.0V | Vcc= 3.6V | Vcc= 3.0V | |
| WS628512LLFP-70 | 0°C ~ +70°C | 2.4V ~ 3.6V | 70 | 15uA | 10uA | 30mA | 20mA | SOP-32 |
| WS628512LLT-70 | | | | | | | | TSOP-32 |
| WS628512LLST-70 | | | | | | | | STSOP-32 |

PIN CONFIGURATIONS



FUNCTIONAL BLOCK DIAGRAM



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■ PIN DESCRIPTIONS

| Name | Function |
|---|---|
| A0-A18 Address Input | These 19 address input select one of the 524,288 x 8-bit words in the RAM |
| \overline{CE} Chip Enable Input | \overline{CE} is active LOW. Chip enables must be active to read from or write to the device. If chip enable is not active, the device is deselected and is in a standby power mode. The DQ pins will be in the high impedance state when the device is deselected. |
| \overline{WE} Write Enable Input | The write enable input is active LOW and controls read and write operations. With the chip selected, when \overline{WE} is HIGH and \overline{OE} is LOW, output data will be present on the DQ pins; when \overline{WE} is LOW, the data present on the DQ pins will be written into the selected memory location. |
| \overline{OE} Output Enable Input | The output enable input is active LOW. If the output enable is active while the chip is selected and the write enable is inactive, data will be present on the DQ pins and they will be enabled. The DQ pins will be in the high impedance state when \overline{OE} is inactive. |
| DQ0 – DQ7 Data Input/Output Ports | These 8 bi-directional ports are used to read data from or write data into the RAM. |
| Vcc | Power Supply |
| Gnd | Ground |

■ TRUTH TABLE

| MODE | \overline{WE} | \overline{CE} | \overline{OE} | I/O OPERATION | Vcc CURRENT |
|-----------------|-----------------|-----------------|-----------------|---------------|-----------------------|
| Not selected | X | H | X | High Z | I_{CCSB}, I_{CCSB1} |
| Output Disabled | H | L | H | High Z | I_{CC} |
| Read | H | L | L | DOUT | I_{CC} |
| Write | L | L | X | DIN | I_{CC} |

■ ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| SYMBOL | PARAMETER | RATING | UNITS |
|--------|--------------------------------------|--------------|-------|
| VTERM | Terminal Voltage with Respect to GND | -0.5 to +4.0 | V |
| TBIAS | Temperature Under Bias | -40 to +125 | °C |
| TSTG | Storage Temperature | -60 to +150 | °C |
| PT | Power Dissipation | 1.0 | W |
| IOUT | DC Output Current | 20 | mA |

1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

■ OPERATING RANGE

| RANGE | AMBIENT TEMPERATURE | Vcc |
|------------|---------------------|-------------|
| Commercial | 0°C to +70°C | 2.4V ~ 3.6V |

■ CAPACITANCE ⁽¹⁾ (TA = 25°C, f = 1.0 MHz)

| SYMBOL | PARAMETER | CONDITIONS | MAX. | UNIT |
|--------|--------------------------|------------|------|------|
| CIN | Input Capacitance | VIN=0V | 6 | pF |
| CDQ | Input/Output Capacitance | V/I/O=0V | 8 | pF |

1. This parameter is guaranteed and not tested.

■ DC ELECTRICAL CHARACTERISTICS (over the operating range)

| PARAMETER NAME | PARAMETER | TEST CONDITIONS | MIN. | TYP. ⁽¹⁾ | MAX. | UNITS | |
|--------------------|--|---|-----------------------|---------------------|----------------------|-------|----|
| V _{IL} | Guaranteed Input Low Voltage ⁽²⁾ | | -0.5 | -- | 0.3V _{CC} | V | |
| V _{IH} | Guaranteed Input High Voltage ⁽²⁾ | | 0.7V _{CC} | -- | V _{CC} +0.2 | V | |
| I _{IL} | Input Leakage Current | V _{CC} = Max, V _{IN} = 0V to V _{CC} | -- | -- | 1 | uA | |
| I _{OL} | Output Leakage Current | V _{CC} = Max, $\overline{CE} = V_{IH}$, or $\overline{OE} = V_{IH}$, V _{IO} = 0V to V _{CC} | -- | -- | 1 | uA | |
| V _{OL} | Output Low Voltage | V _{CC} = Max, I _{OL} = 2mA | -- | -- | 0.4 | V | |
| V _{OH} | Output High Voltage | V _{CC} = Min, I _{OH} = -1mA | 2.4 | -- | -- | V | |
| I _{CC} | Operating Power Supply Current | $\overline{CE} = V_{IL}$, I _{DQ} = 0mA, F = F _{max} ⁽³⁾ | V _{CC} =3.0V | -- | -- | 20 | mA |
| | | | V _{CC} =3.6V | -- | -- | 30 | |
| I _{CCSB} | Standby Power Supply Current | $\overline{CE} = V_{IH}$, I _{DQ} = 0mA | V _{CC} =3.0V | -- | -- | 1 | mA |
| | | | V _{CC} =3.6V | -- | -- | 1 | |
| I _{CCSB1} | Power Down Supply Current | $\overline{CE} \geq V_{CC} - 0.2V$, V _{IN} $\geq V_{CC} - 0.2V$ or V _{IN} $\leq 0.2V$ | V _{CC} =3.0V | -- | 1 | 10 | uA |
| | | | V _{CC} =3.6V | -- | 3 | 15 | |

1. Typical characteristics are at T_A = 25°C.

2. These are absolute values with respect to device ground and all overshoots due to system or tester noise are included.

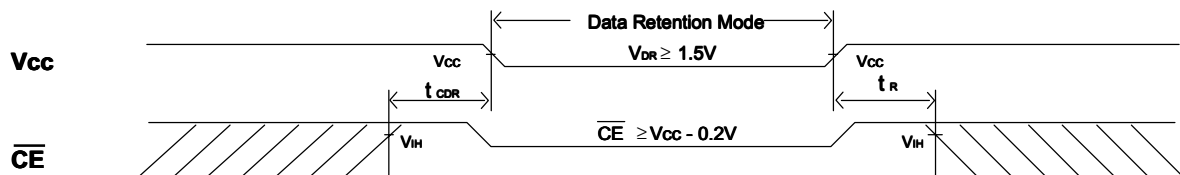
3. F_{max} = 1/t_{RC}.

■ DATA RETENTION CHARACTERISTICS (T_A = 0 to + 70°C)

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN. | TYP. ⁽¹⁾ | MAX. | UNITS |
|-------------------|--------------------------------------|---|--------------------------------|---------------------|------|-------|
| V _{DR} | V _{CC} for Data Retention | $\overline{CE} \geq V_{CC} - 0.2V$ V _{IN} $\geq V_{CC} - 0.2V$ or V _{IN} $\leq 0.2V$ | 1.5 | -- | -- | V |
| I _{CCDR} | Data Retention Current | $\overline{CE} \geq V_{CC} - 0.2V$ V _{IN} $\geq V_{CC} - 0.2V$ or V _{IN} $\leq 0.2V$ | -- | 0.05 | 5 | uA |
| t _{CDR} | Chip Deselect to Data Retention Time | See Retention Waveform | 0 | -- | -- | ns |
| t _R | Operation Recovery Time | | T _{RC} ⁽²⁾ | -- | -- | ns |

1. V_{CC} = 1.5V, T_A = + 25°C

2. t_{RC} = Read Cycle Time

■ LOW V_{CC} DATA RETENTION WAVEFORM (1) (\overline{CE} Controlled)


■ **AC TEST CONDITIONS**

| | |
|---|--------|
| Input Pulse Levels | Vcc/0 |
| Input Rise and Fall Times | 5ns |
| Input and Output Timing Reference Level | 0.5Vcc |

■ **AC TEST LOADS AND WAVEFORMS**

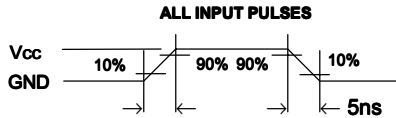
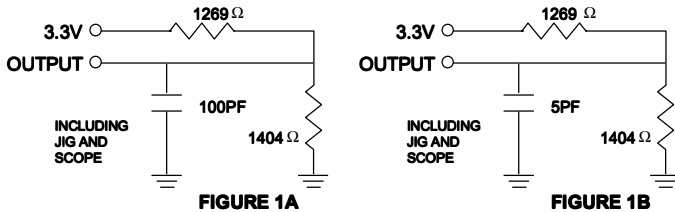


FIGURE 2

■ **KEY TO SWITCHING WAVEFORMS**

| WAVEFORM | INPUTS | OUTPUTS |
|----------|----------------------------------|---|
| | MUST BE STEADY | MUST BE STEADY |
| | MAY CHANGE FROM H TO L | WILL BE CHANGE FROM H TO L |
| | MAY CHANGE FROM L TO H | WILL BE CHANGE FROM L TO H |
| | DON'T CARE: ANY CHANGE PERMITTED | CHANGE : STATE UNKNOWN |
| | DOES NOT APPLY | CENTER LINE IS HIGH IMPEDANCE "OFF" STATE |

■ **AC ELECTRICAL CHARACTERISTICS (over the operating range)**

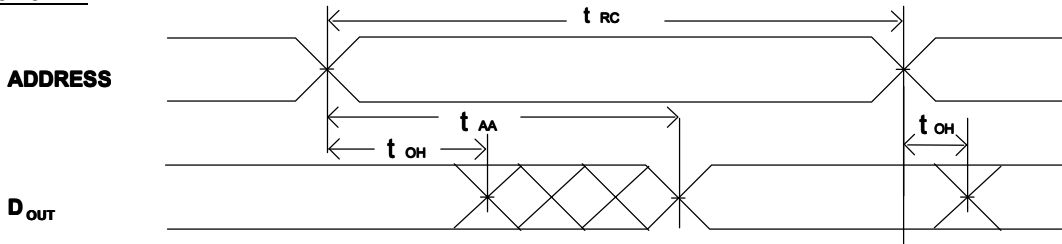
READ CYCLE

| JEDEC PARAMETER NAME | PARAMETER NAME | DESCRIPTION | WS628400 | | | UNIT |
|----------------------|------------------|---|----------|------|------|------|
| | | | MIN. | TYP. | MAX. | |
| t _{AVAX} | t _{RC} | Read Cycle Time | 70 | -- | -- | ns |
| t _{AVQV} | t _{AA} | Address Access Time | -- | -- | 70 | ns |
| t _{ELQV} | t _{ACS} | Chip Select Access Time | -- | -- | 70 | ns |
| t _{GLQV} | t _{OE} | Output Enable to Output Valid | -- | -- | 50 | ns |
| t _{ELQX} | t _{CLZ} | Chip Select to Output Low Z | 10 | -- | -- | ns |
| t _{GLQX} | t _{OLZ} | Output Enable to Output in Low Z | 5 | -- | -- | ns |
| t _{EHQZ} | t _{CHZ} | Chip Deselect to Output in High Z | 0 | -- | 30 | ns |
| t _{GHQZ} | t _{OHZ} | Output Disable to Output in High Z | 0 | -- | 25 | ns |
| t _{AXOX} | t _{OH} | Output Disable to Output Address Change | 10 | -- | -- | ns |

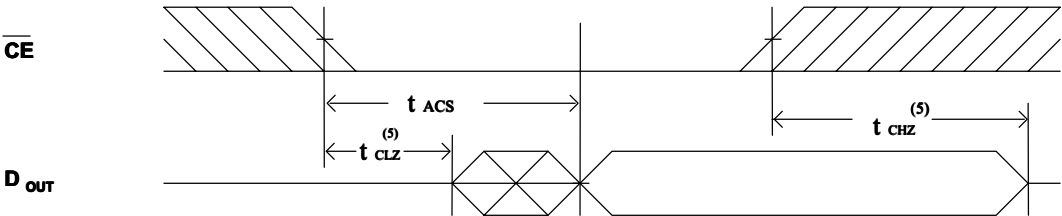
1. Typical characteristics are at Vcc = 3.3V, TA = 25°C.

■ SWITCHING WAVEFORMS (READ CYCLE)

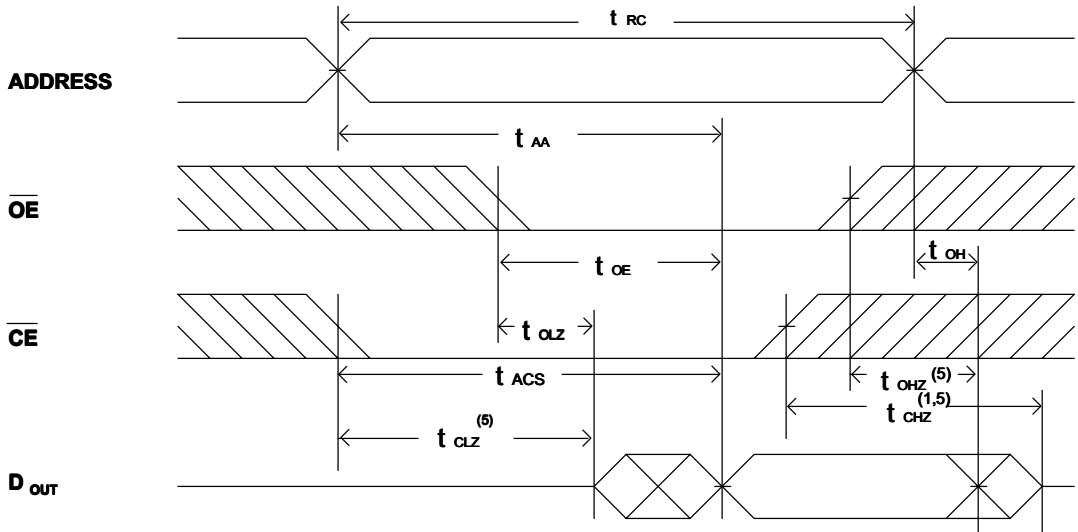
READ CYCLE1 (1,2,4)



READ CYCLE2 (1,3,4)



READ CYCLE3 (1,4)



NOTES:

1. \overline{WE} is high for read Cycle.
2. Device is continuously selected when $\overline{CE} = V_{IL}$.
3. Address valid prior to or coincident with \overline{CE} transition low.
4. $\overline{OE} = V_{IL}$.
5. Transition is measured $\pm 500mV$ from steady state with $C_L = 5pF$ as shown in Figure 1B. The parameter is guaranteed but not 100% tested.

■ AC ELECTRICAL CHARACTERISTICS (over the operating range)

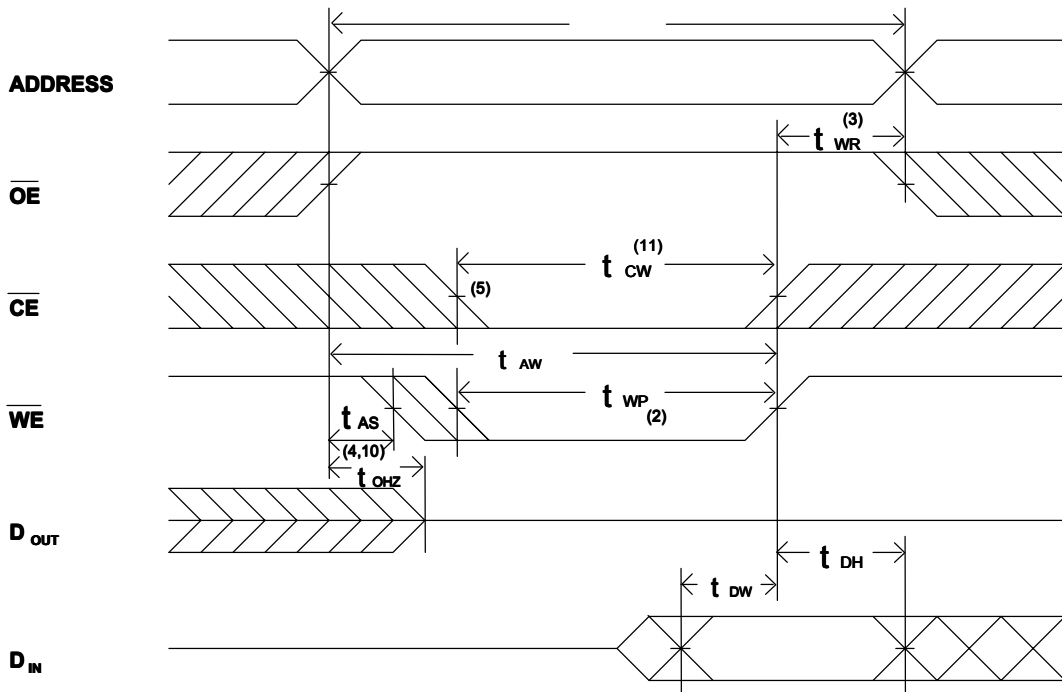
WRITE CYCLE

| JEDEC PARAMETER NAME | PARAMETER NAME | DESCRIPTION | WS628512-70 | | | UNIT |
|----------------------------|-------------------|------------------------------------|-------------|------|------|------|
| | | | MIN. | TYP. | MAX. | |
| t_{AVAX} | t_{WC} | Write Cycle Time | 70 | -- | -- | ns |
| t_{E1LWH} | t_{CW} | Chip Select to End of Write | 70 | -- | -- | ns |
| t_{AVWL} | t_{AS} | Address Set up Time | 0 | -- | -- | ns |
| t_{AVWH} | t_{AW} | Address Valid to End of Write | 70 | -- | -- | ns |
| t_{WLWH} | t_{WP} | Write Pulse Width | 60 | -- | -- | ns |
| t_{WHAX} | t_{WR} | Write Recovery Time (CE, WE) | 0 | -- | -- | ns |
| t_{WLOZ} | t_{WHZ} | Write to Output in High Z | -- | -- | 30 | ns |
| t_{DVWH} | t_{DW} | Data to Write Time Overlap | 35 | -- | -- | ns |
| t_{WHDX} | t_{DH} | Data Hold from Write Time | 0 | -- | -- | ns |
| t_{GHOZ} | t_{OHZ} | Output Disable to Output in High Z | 0 | -- | 30 | ns |
| t_{WHQX} | t_{OW} | End of Write to Output Active | 5 | -- | -- | ns |

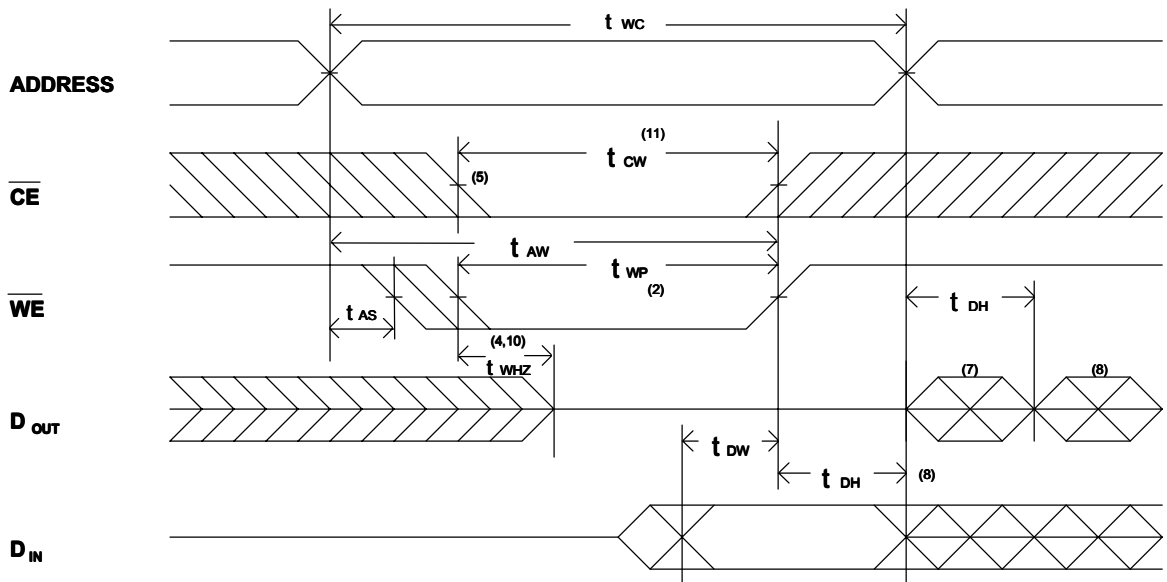
1. Typical characteristics are at Vcc = 3.3V, TA = 25°C.

■ SWITCHING WAVEFORMS (WRITE CYCLE)

WRITE CYCLE1 (1)



WRITE CYCLE2 (1,6)

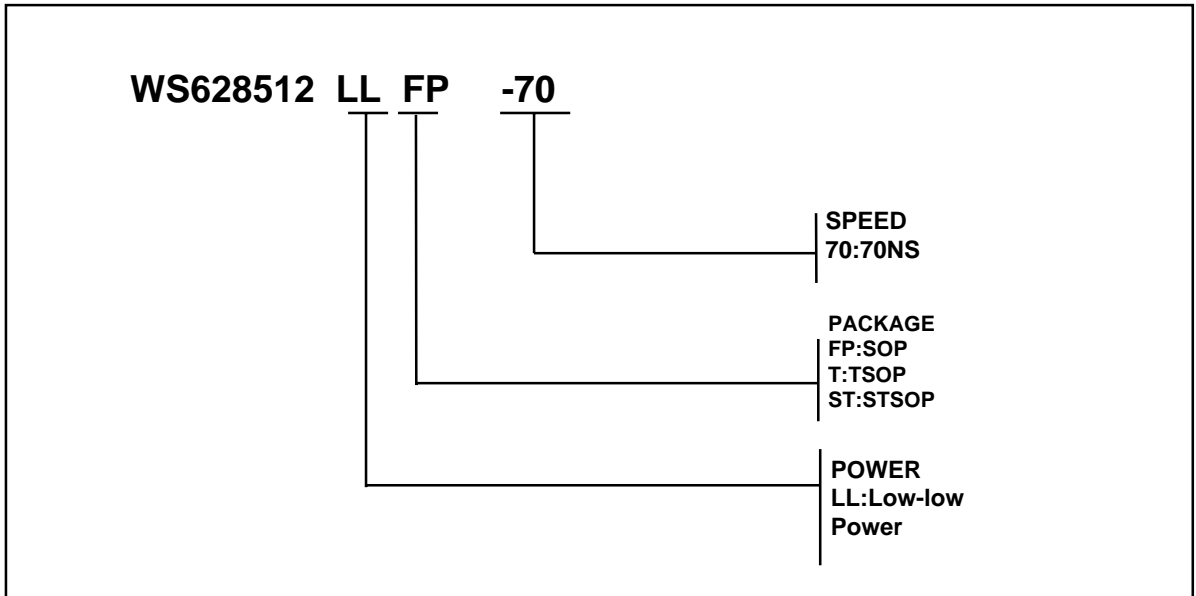


NOTES:

1. WE must be high during address transitions.
2. The internal write time of the memory is defined by the overlap of CE and WE low. All signals must be active to initiate a write and any one signal can terminate a write by going inactive. The data input setup and hold timing should be referenced to the second transition edge of the signal that terminates the write.
3. TWR is measured from the earlier of CE or WE going high at the end of write cycle.
4. During this period, DQ pins are in the output state so that the input signals of opposite phase to the outputs must not be applied.
5. If the CE low transition occurs simultaneously with the WE low transitions or after the WE transition, output remain in a high impedance state.
6. OE is continuously low (OE = V_{IL}).
7. D_{OUT} is the same phase of write data of this write cycle.
8. D_{OUT} is the read data of next address.
9. If CE is low during this period, DQ pins are in the output state. Then the data input signals of opposite phase to the outputs must not be applied to them.
10. Transition is measured ± 500mV from steady state with C_L = 5pF as shown in Figure 1B. The parameter is guaranteed but not 100% tested.
11. t_{CW} is measured from the later of CE going low to the end of write.



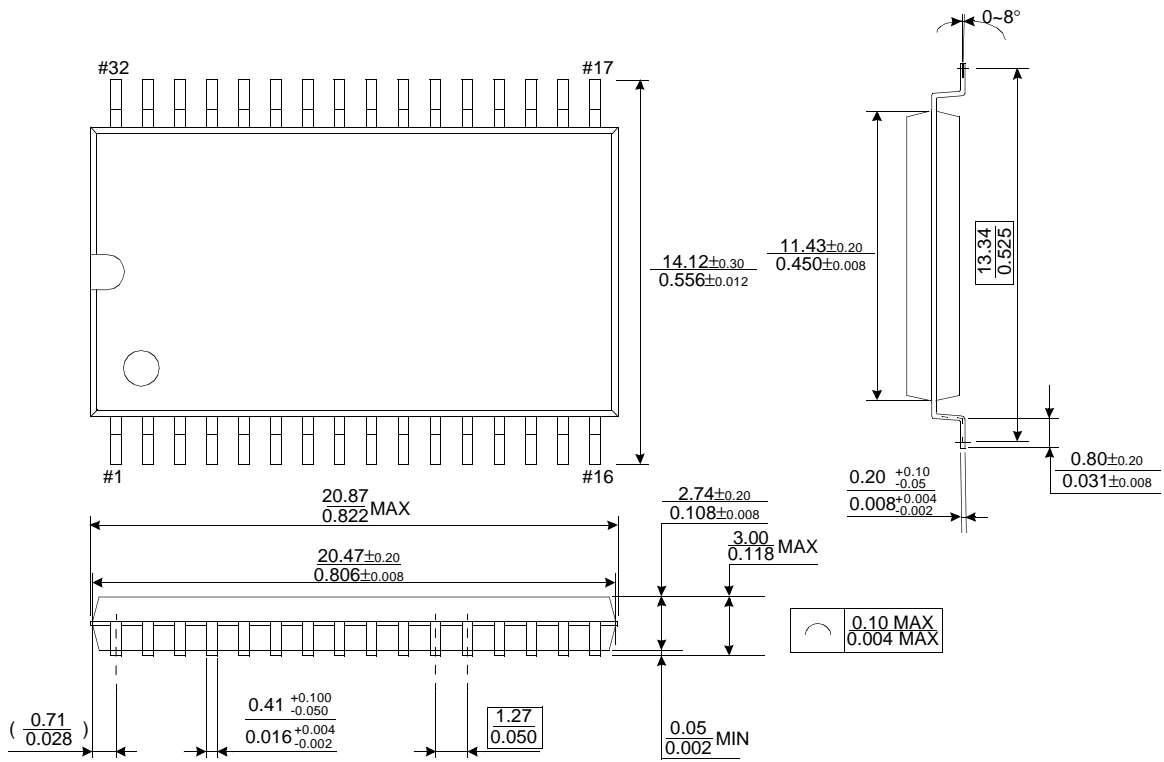
■ ORDERING INFORMATION



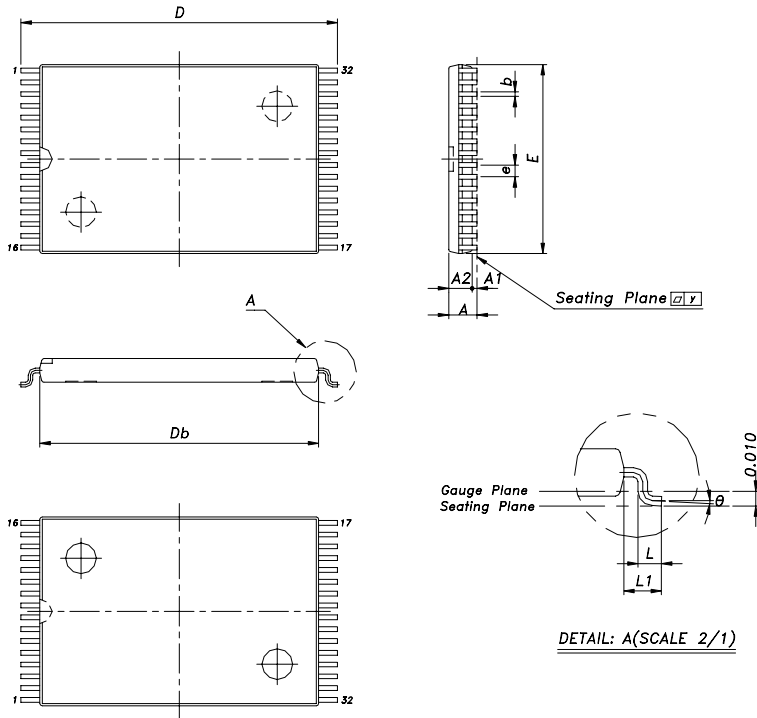
PACKAGE DIMENSIONS

Units: millimeters(inches)

32 PIN PLASTIC SMALL OUTLINE PACKAGE (450mil)

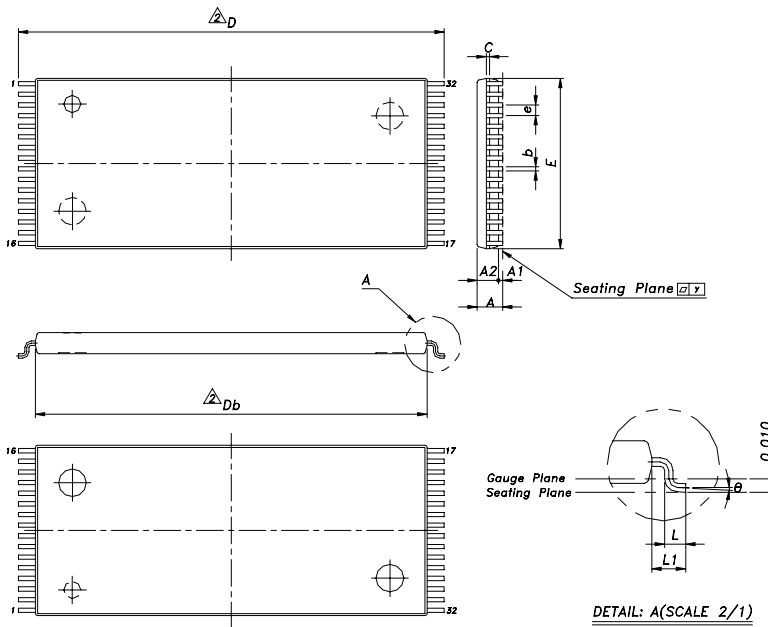


■ PACKAGE DIMENSIONS (continued)



| UNIT SYMBOL | INCH(BASE) | MM(REF.) |
|----------------|--------------|------------|
| A | 0.047(MAX) | 1.20(MAX) |
| A1 | 0.004±0.002 | 0.10±0.05 |
| A2 | 0.039±0.002 | 1.00±0.05 |
| b | 0.008(TYP) | 0.20(TYP) |
| C | 0.006(TYP) | 0.15(TYP) |
| Db | 0.465±0.004 | 11.80±0.10 |
| E | 0.315±0.004 | 8.00±0.10 |
| e | 0.020(TYP) | 0.50(TYP) |
| D | 0.528±0.008 | 13.40±0.20 |
| L | 0.020±0.004 | 0.50±0.10 |
| L1 | 0.0315±0.004 | 0.80±0.10 |
| y | 0.004(MAX) | 0.102(MAX) |
| θ | 0°-5° | 0°-5° |

STSOP-32



| UNIT SYMBOL | INCH(BASE) | MM(REF.) |
|----------------|--------------|------------|
| A | 0.047(MAX) | 1.20(MAX) |
| A1 | 0.004±0.002 | 0.10±0.05 |
| A2 | 0.039±0.002 | 1.00±0.05 |
| b | 0.008(TYP) | 0.20(TYP) |
| C | 0.006(TYP) | 0.15(TYP) |
| \triangle Db | 0.724±0.004 | 18.40±0.10 |
| E | 0.315±0.004 | 8.00±0.10 |
| e | 0.020(TYP) | 0.50(TYP) |
| \triangle D | 0.787±0.008 | 20.00±0.20 |
| L1 | 0.0315±0.004 | 0.80±0.10 |
| y | 0.004(MAX) | 0.102(MAX) |
| θ | 0°-5° | 0°-5° |

(Option 1)

| | | |
|---|-------------|-----------|
| L | 0.020±0.004 | 0.50±0.10 |
|---|-------------|-----------|

(Option 2)

| | | |
|---|-------------|-----------|
| L | 0.024±0.004 | 0.60±0.10 |
|---|-------------|-----------|

TSOP-32