

8 k × 8 NONVOLATILE SRAM (5 V, 3.3 V)

FEATURES

- Data Retention for at least 10 Years Without Power
- Automatic Write-Protection During Power-up/Power-down Cycles
- Conventional SRAM Operation, Including Unlimited Write Cycles
- Internal Isolation of Battery before Power Application
- 5-V or 3.3-V Operation
- Industry Standard 28-Pin DIP Pinout

GENERAL DESCRIPTION

The CMOS bq4010/Y/LY is a nonvolatile 65,536-bit static RAM organized as 8,192 words by 8 bits. The integral control circuitry and lithium energy source provide reliable nonvolatility coupled with the unlimited write cycles of standard SRAM.

The control circuitry constantly monitors the single supply for an out-of-tolerance condition. When V_{CC} falls out of tolerance, the SRAM is unconditionally write-protected to prevent an inadvertent write operation.

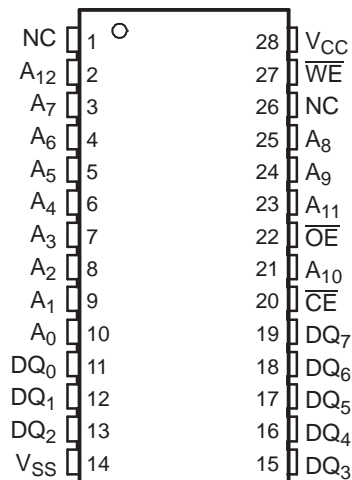
At this time the integral energy source is switched on to sustain the memory until after V_{CC} returns valid.

The bq4010/Y/LY uses extremely low standby current CMOS SRAMs, coupled with small lithium coin cells to provide nonvolatility without long write-cycle times and the write-cycle limitations associated with EEPROM.

The bq4010/Y/LY requires no external circuitry and is compatible with the industry-standard 64-Kb SRAM pinout.

PIN CONNECTIONS

28-Pin DIP Module
(TOP VIEW)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

DEVICE INFORMATION**Table 1. TERMINAL FUNCTIONS**

| TERMINAL | | I/O | DESCRIPTION |
|-----------------|--------|-----|----------------------|
| NAME | NUMBER | | |
| A ₀ | 10 | I | Address inputs |
| A ₁ | 9 | I | |
| A ₂ | 8 | I | |
| A ₃ | 7 | I | |
| A ₄ | 6 | I | |
| A ₅ | 5 | I | |
| A ₆ | 4 | I | |
| A ₇ | 3 | I | |
| A ₈ | 25 | I | |
| A ₉ | 24 | I | |
| A ₁₀ | 21 | I | |
| A ₁₁ | 23 | I | |
| A ₁₂ | 2 | I | |
| \overline{CE} | 20 | I | Chip-enable input |
| DQ ₀ | 11 | I/O | Data input/output |
| DQ ₁ | 12 | I/O | |
| DQ ₂ | 13 | I/O | |
| DQ ₃ | 15 | I/O | |
| DQ ₄ | 16 | I/O | |
| DQ ₅ | 17 | I/O | |
| DQ ₆ | 18 | I/O | |
| DQ ₇ | 19 | I/O | |
| NC | 1 | - | No connect |
| | 26 | | |
| \overline{OE} | 22 | I | Output enable input |
| V _{CC} | 28 | I | Supply voltage input |
| V _{SS} | 14 | - | Ground |
| \overline{WE} | 27 | I | Write enable input |

FUNCTIONAL DESCRIPTION

When power is valid, the bq4010/Y/LY operates as a standard CMOS SRAM. During power-down and power-up cycles, the bq4010/Y/LY acts as a nonvolatile memory, automatically protecting and preserving the memory contents.

Power-down/power-up control circuitry constantly monitors the V_{CC} supply for a power-fail-detect threshold V_{PFD}. The bq4010 monitors for V_{PFD} = 4.62 V typical for use in 5-V systems with 5% supply tolerance. The bq4010Y monitors for V_{PFD} = 4.37 V typical for use in 5-V systems with 10% supply tolerance. The bq4010LY monitors for V_{PFD} = 2.90 V (typ) for use in 3.3-V systems.

When V_{CC} falls below the V_{PFD} threshold, the SRAM automatically write-protects the data. All outputs become high impedance, and all inputs are treated as *don't care*. If a valid access is in process at the time of power-fail detection, the memory cycle continues to completion. If the memory cycle fails to terminate within time t_{WPT}, write-protection takes place.

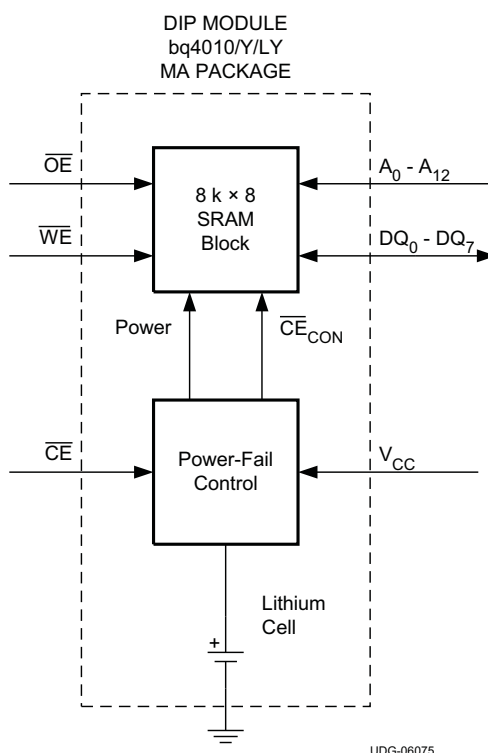
As V_{CC} falls past V_{PFD} and approaches V_{SO}, the control circuitry switches to the internal lithium backup supply, which provides data retention until valid V_{CC} is applied.

When V_{CC} returns to a level above the internal backup cell voltage, the supply is switched back to V_{CC} . After V_{CC} ramps above the V_{PFD} threshold, write-protection continues for a time t_{CER} (120 ms maximum in 5-V system, 85 ms maximum in 3.3-V system) to allow for processor stabilization. Normal memory operation may resume after this time.

The internal coin cells used by the bq4010/Y/LY have an extremely long shelf life and provide data retention for more than 10 years in the absence of system power.

As shipped from TI, the integral lithium cells of the MT-type module are electrically isolated from the memory. (Self-discharge in this condition is approximately 0.5% per year.) Following the first application of V_{CC} , this isolation is broken, and the lithium backup provides data retention on subsequent power-downs.

BLOCK DIAGRAM



TRUTH TABLE

| MODE | \overline{CE} | \overline{WE} | \overline{OE} | I/O OPERATION | POWER |
|----------------|-----------------|-----------------|-----------------|---------------|---------|
| Not selected | H | X | X | High-Z | Standby |
| Output disable | L | H | H | High-Z | Active |
| Read | L | H | L | D_{OUT} | Active |
| Write | L | L | X | D_{IN} | Active |

ORDERING INFORMATION

For the most current package and ordering information, see the Package Option Addendum at the end of the datasheet, or see the TI website at www.ti.com.

SELECTION GUIDE

| DEVICE NUMBER | MAXIMUM ACCESS TIME (ns) | NEGATIVE SUPPLY TOLERANCE (%) | NOMINAL INPUT VOLTAGE V _{CC} (V) | TEMPERATURE (°C) |
|----------------|--------------------------------|-------------------------------------|-------------------------------------------------|---------------------|
| bq4010MA-70 | 70 | -5 | 5 | 0 to 70 |
| bq4010MA-85 | 85 | | | |
| bq4010MA-150 | 150 | | | |
| bq4010MA-200 | 200 | | | |
| bq4010YMA-70 | 70 | -10 | | -40 to 85 |
| bq4010YMA-85 | 85 | | | |
| bq4010YMA-150 | 150 | | | |
| bq4010YMA-200 | 200 | | | |
| bq4010YMA-70N | 70 | | | |
| bq4010YMA-85N | 85 | | | |
| bq4010YMA-150N | 150 | | | |
| bq4010LYMA-70N | 70 | | 3.3 | |

PART NUMBERING

| PRODUCT LINE | MEMORY DENSITY | INPUT VOLTAGE (V) | NEGATIVE SUPPLY TOLERANCE | PACKAGE | SPEED (ns) | TEMPERATURE (°C) |
|--------------|-----------------|-------------------|---------------------------|-----------|------------|--------------------|
| bq40 | 10 | L | Y | MA | 70 | N |
| | 10 = 8 k × 8 | Blank = 5 | Blank = 5% | MA = DIP | 70 | Blank = Commercial |
| | 11 = 32 k × 8 | L = 3.3 | Y = 10% | | 85 | (0 to 70) |
| | 13 = 128 k × 8 | | | | 100 | |
| | 14 = 256 k × 8 | | | | 120 | N = Industrial |
| | 15 = 512 k × 8 | | | | 150 | (-40 to 85) |
| | 16 = 1024 k × 8 | | | | 200 | |
| | 17 = 2048 k × 8 | | | | | |

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| PARAMETER | | CONDITION | | VALUE | UNIT |
|---------------------|-------------------------------------------------------------|------------------------------------------|----------|---------------------------------|------|
| V _{CC} | DC voltage applied on VCC relative to VSS | | bq4010Y | −0.3 to 7.0 | V |
| | | | bq4010 | −0.3 to 7.0 | |
| | | | bq4010LY | −0.3 to 6.0 | |
| V _T | DC voltage applied on any pin excluding VCC relative to VSS | V _{VT} ≤ V _{CC} +0.3 V | bq4010Y | −0.3 to 7.0 | V |
| | | | bq4010 | −0.3 to 7.0 | |
| | | | bq4010LY | −0.3 to (V _{CC} + 0.3) | |
| T _{OPR} | Operating temperature | Commercial | | 0 to 70 | °C |
| | | Industrial | | −40 to 85 | |
| T _{STG} | Storage temperature | Commercial | | −10 to 70 | |
| | | Industrial | | −40 to 85 | |
| T _{BIAS} | Temperature under bias | Commercial | | −10 to 70 | |
| | | Industrial | | −40 to 85 | |
| T _{SOLDER} | Soldering temperature | For 10 seconds | | 260 | |

(1) Permanent device damage may occur if **Absolute Maximum Ratings** are exceeded. Functional operation should be limited to the Recommended DC Operating Conditions detailed in this data sheet. Exposure to conditions beyond the operational limits for extended periods of time may affect device reliability.

RECOMMENDED OPERATING CONDITIONS (T_A = T_{OPR})

| | | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|-----------------|--------------------------|----------|--------------------|-----------------------|------|
| V _{CC} | Supply voltage | bq4010Y | 4.50 | 5.00 | 5.50 |
| | | bq4010 | 4.75 | 5.00 | 5.50 |
| | | bq4010LY | 3.00 | 3.30 | 3.60 |
| V _{SS} | Supply voltage | 0 | 0 | 0 | V |
| V _{IL} | Low-level input voltage | –0.3 | | 0.8 | |
| V _{IH} | High-level Input voltage | 2.2 | | V _{CC} + 0.3 | |

(1) Typical values indicate operation at T_A = 25°C.

DC ELECTRICAL CHARACTERISTICS

T_A = T_{OPR}, V_{CC(min)} ≤ V_{CC} ≤ V_{CC(max)}

| PARAMETER | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|------------------|----------------------------|--------------------------------------------------------------------------------------------------------|--------------------|------|------|
| I _{LI} | Input leakage current | | | ±1 | μA |
| I _{LO} | Output leakage current | | | ±1 | μA |
| V _{OH} | Output high voltage | I _{OH} = –1.0 mA | 2.4 | | V |
| V _{OL} | Output low voltage | I _{OL} = 2.1 mA | | 0.4 | V |
| I _{SB1} | Standby supply current | CE = V _{IH} | 1 | 2 | μA |
| I _{SB2} | Standby supply current | CE ≥ V _{CC} – 0.2 V, 0V ≤ V _{IN} ≤ 0.2 V, or V _{IN} ≥ V _{CC} – 0.2 | 0.1 | 1 | mA |
| I _{CC} | Operating supply current | bq4010 | | 50 | mA |
| | | bq4010Y | | | |
| | | bq4010LY | | 30 | |
| V _{PFD} | Power-fail-detect voltage | bq4010 | 4.55 | 4.62 | 4.75 |
| | | bq4010Y | 4.30 | 4.37 | 4.50 |
| | | bq4010LY | 2.85 | 2.90 | 2.95 |
| V _{SO} | Supply switch-over voltage | bq4010 | 3 | | V |
| | | bq4010Y | 3 | | |
| | | bq4010LY | 2.9 | | |

(1) Typical values indicate operation at T_A = 25°C, V_{CC} = 5.0 V or V_{CC} = 3.3 V.

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CAPACITANCE ($T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$, $V_{CC} = 5.0\text{ V}$ or $V_{CC} = 3.3\text{ V}$)

| PARAMETER ⁽¹⁾ | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------------|--------------------------|----------------------|-----|-----|-----|------|
| $C_{I/O}$ | Input/output capacitance | Output voltage = 0 V | | | 8 | pF |
| C_{IN} | Input capacitance | Input voltage = 0 V | | | 10 | |

(1) Ensured by design. Not production tested.

AC TEST CONDITIONS

| PARAMETER | TEST CONDITIONS | |
|------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
| | 5 V | 3.3 V |
| Input pulse levels | 0 V to 3.0 V | 0 V to V_{CC} |
| Input rise and fall times | 5 ns | 5 ns |
| Input and output timing reference levels | 1.5 V (unless otherwise specified) | 50 % |
| Output load (including scope and jig) | See Figure 1 and Figure 2 | See Figure 3 and Figure 4 |

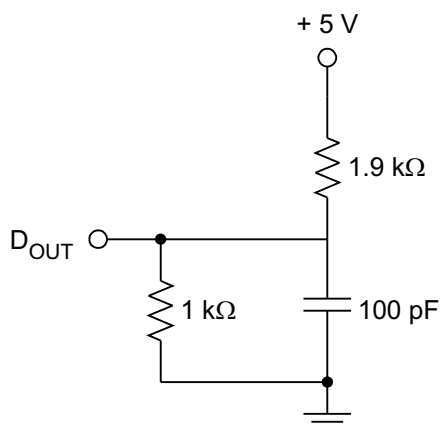
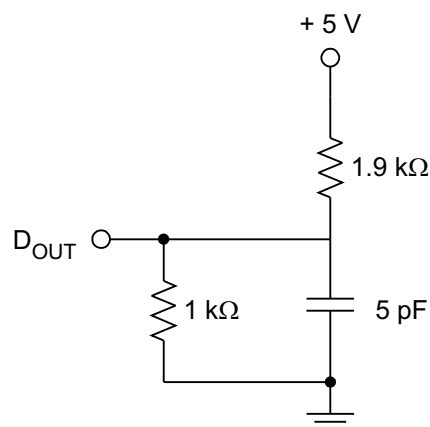
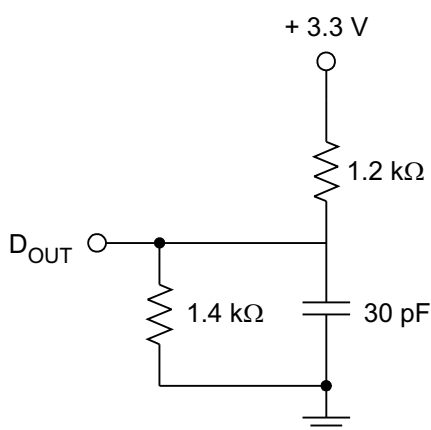
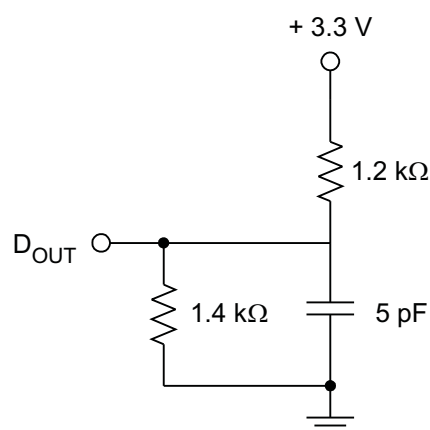
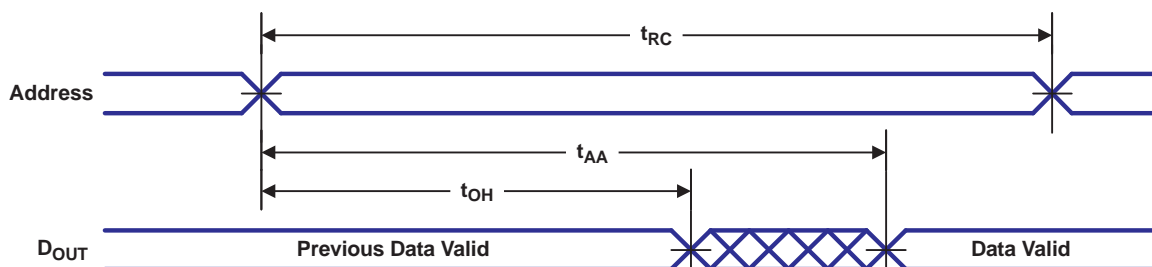
**Figure 1. 5-V Output Load A****Figure 2. 5-V Output Load B****Figure 3. 3.3-V Output Load A****Figure 4. 3.3-V Output Load B**

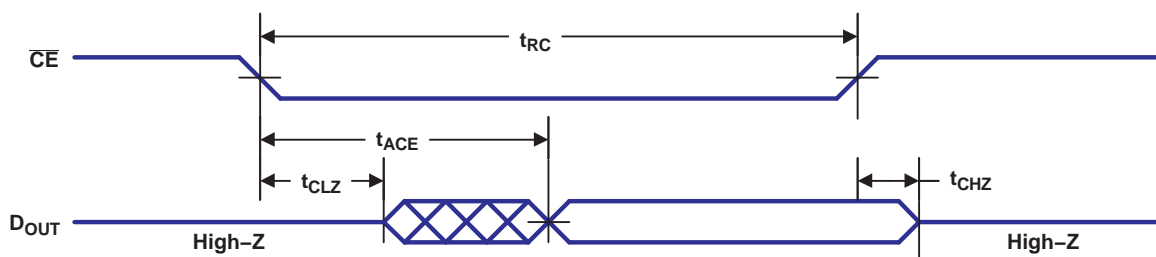
Table 2. READ CYCLE ($T_A = T_{OPR}$, $V_{CC(min)} \leq V_{CC} \leq V_{CC(max)}$)

| PARAMETER | | TEST CONDITIONS | -70 | | -85 | | -150 | | -200 | | UNIT |
|-----------|------------------------------------|-----------------|-----|-----|-----|-----|------|-----|------|-----|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| t_{RC} | Read cycle time | | 70 | | 85 | | 150 | | 200 | | ns |
| t_{AA} | Address access time | Output load A | | 70 | | 85 | | 150 | | 200 | |
| t_{ACE} | Chip enable access time | | | 70 | | 85 | | 150 | | 200 | |
| t_{OE} | Output enable to output valid | | | 35 | | 45 | | 70 | | 90 | |
| t_{CLZ} | Chip enable to output in low Z | Output load B | | 5 | | 5 | | 5 | | 5 | |
| t_{OLZ} | Output enable to output in low Z | | | 0 | | 0 | | 0 | | 0 | |
| t_{CHZ} | Chip disable to output in high Z | | | 0 | 25 | 0 | 25 | 0 | 25 | 0 | 25 |
| t_{OHZ} | Output disable to output in high Z | | | 0 | 25 | 0 | 25 | 0 | 25 | 0 | 25 |
| t_{OH} | Output hold from address change | Output load A | | 10 | | 10 | | 10 | | 10 | |



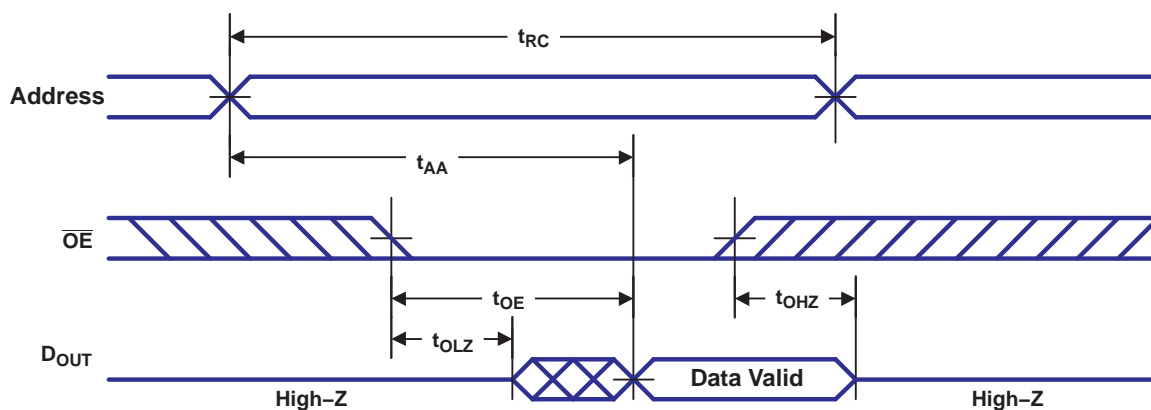
- (1) \overline{WE} is held high for a read cycle.
- (2) Device is continuously selected: $\overline{CE} = \overline{OE} = V_{IL}$.

Figure 5. Read Cycle No. 1 (Address Access) ⁽¹⁾⁽²⁾



- (1) \overline{WE} is held high for a read cycle.
- (2) Device is continuously selected: $\overline{CE} = \overline{OE} = V_{IL}$.
- (3) Address is valid prior to or coincident with \overline{CE} transition low.

Figure 6. Read Cycle No. 2 (\overline{CE} Access) ⁽¹⁾⁽²⁾⁽³⁾



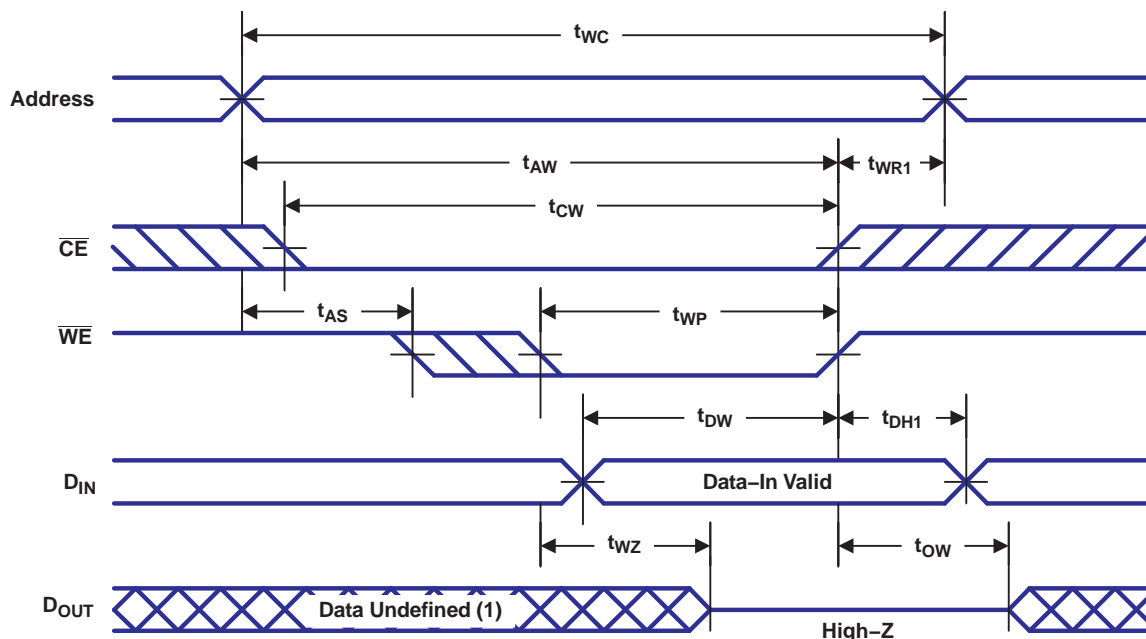
- (1) \overline{WE} is held high for a read cycle.
- (2) Device is continuously selected: $\overline{CE} = V_{IL}$.

Figure 7. Read Cycle No. 3 (\overline{OE} Access) ⁽¹⁾⁽²⁾

Table 3. WRITE CYCLE ($T_A = T_{OPR}$, $V_{CC(min)} \leq V_{CC} \leq V_{CC(max)}$)

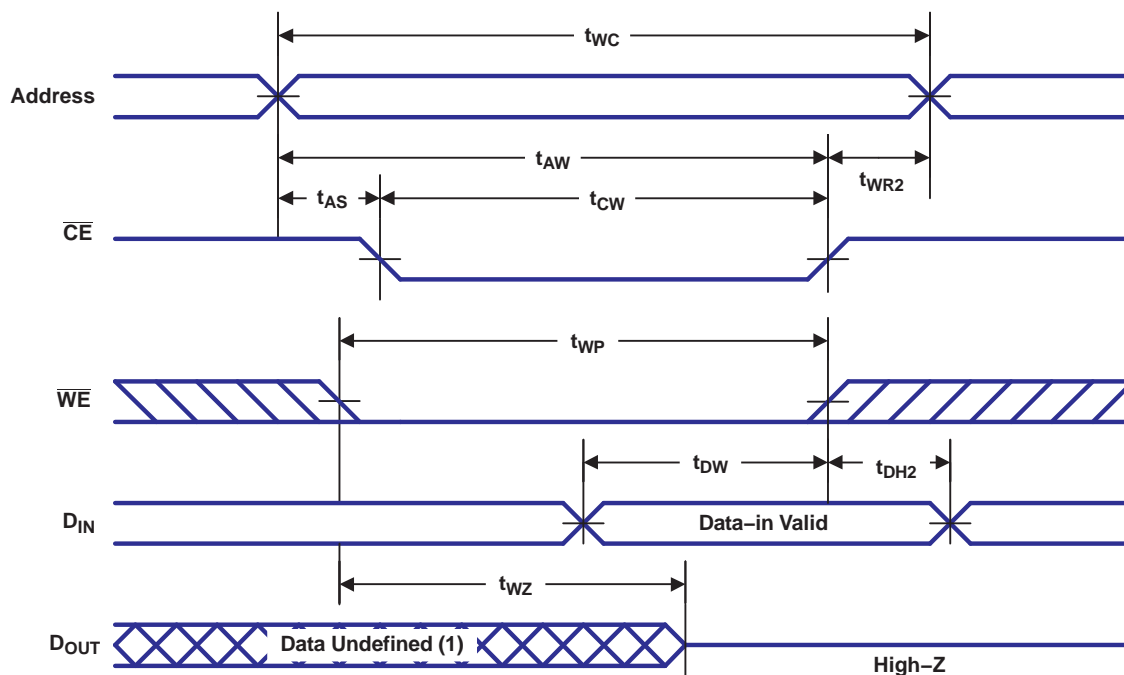
| PARAMETER | | TEST CONDITIONS | -70 | | -85 | | -150 | | -200 | | UNIT |
|-----------|-------------------------------------|-----------------------------------------------------------------------------------------|-----|-----|-----|-----|------|-----|------|-----|------|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| t_{WC} | Write cycle time | | 70 | | 85 | | 150 | | 200 | | ns |
| t_{CW} | Chip enable to end of write | See ⁽¹⁾ | 65 | | 75 | | 100 | | 150 | | |
| t_{AW} | Address valid to end of write | See ⁽¹⁾ | 65 | | 75 | | 90 | | 150 | | |
| t_{AS} | Address setup time | Measured from address valid to beginning of write. ⁽²⁾ | 0 | | 0 | | 0 | | 0 | | |
| t_{WP} | Write pulse width | Measured from beginning of write to end of write. ⁽¹⁾ | 55 | | 65 | | 90 | | 130 | | |
| t_{WR1} | Write recovery time (write cycle 1) | Measured from \overline{WE} going high to end of write cycle. ⁽³⁾ | 5 | | 5 | | 5 | | 5 | | |
| t_{WR2} | Write recovery time (write cycle 2) | Measured from \overline{CE} going high to end of write cycle. ⁽³⁾ | 15 | | 15 | | 15 | | 15 | | |
| t_{DW} | Data valid to end of write | Measured to first low-to-high transition of either \overline{CE} or \overline{WE} . | 30 | | 35 | | 50 | | 70 | | |
| t_{DH1} | Data hold time (write cycle 1) | Measured from \overline{WE} going high to end of write cycle. ⁽⁴⁾ | 0 | | 0 | | 0 | | 0 | | |
| t_{DH2} | Data hold time (write cycle 2) | Measured from \overline{CE} going high to end of write cycle. ⁽⁴⁾ | 0 | | 0 | | 0 | | 0 | | |
| t_{WZ} | Write enabled to output in high Z | I/O pins are in output state. ⁽⁵⁾ | 0 | 25 | 0 | 30 | 0 | 50 | 0 | 70 | |
| t_{OW} | Output active from end of write | I/O pins are in output state. ⁽⁵⁾ | 5 | | 5 | | 5 | | 5 | | |

- (1) A write ends at the earlier transition of \overline{CE} going high and \overline{WE} going high.
(2) A write occurs during the overlap of a low \overline{CE} and a low \overline{WE} . A write begins at the later transition of \overline{CE} going low and \overline{WE} going low.
(3) Either t_{WR1} or t_{WR2} must be met.
(4) Either t_{DH1} or t_{DH2} must be met.
(5) If \overline{CE} goes low simultaneously with \overline{WE} going low or after \overline{WE} going low, the outputs remain in high-impedance state.



- (1) \overline{CE} or \overline{WE} must be high during address transition.
(2) Because I/O may be active (\overline{OE} low) during this period, data input signals of opposite polarity to the outputs must not be applied.
(3) If \overline{OE} is high, the I/O pins remain in a state of high impedance.

Figure 8. Write Cycle No. 1 (\overline{WE} -Controlled) ⁽¹⁾⁽²⁾⁽³⁾



- (1) \overline{CE} or \overline{WE} must be high during address transition.
- (2) Because I/O may be active (\overline{OE} low) during this period, data input signals of opposite polarity to the outputs must not be applied.
- (3) If \overline{OE} is high, the I/O pins remain in a state of high impedance.
- (4) Either t_{WR1} or t_{WR2} must be met.
- (5) Either t_{DH1} or t_{DH2} must be met.

Figure 9. Write Cycle No. 2 ($\overline{\text{CE}}$ -Controlled) (1)(2)(3)(4)(5)

Table 4. 5-V POWER-DOWN/POWER-UP ($T_A = T_{OPR}$)

| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|-----------|---------------------------------------------|----------------------------------------------------------------------------------------|-----|--------------------|-----|---------|
| t_{PF} | V_{CC} slew, 4.75 to 4.25 V | | 300 | | | μs |
| t_{FS} | V_{CC} slew, 4.25 to V_{SO} | | 10 | | | μs |
| t_{PU} | V_{CC} slew, V_{SO} to V_{PFD} (max.) | | 0 | | | μs |
| t_{CER} | Chip enable recovery time | Time during which SRAM is write-protected after V_{CC} passes V_{PFD} on power-up. | 40 | 80 | 120 | ms |
| t_{DR} | Data-retention time in absence of V_{CC} | $T_A = 25^\circ C$ ⁽²⁾ | 10 | | | years |
| t_{WPT} | Write-protect time | Delay after V_{CC} slews down past V_{PFD} before SRAM is writeprotected. | 40 | 100 | 150 | μs |

(1) Typical values indicate operation at $T_A = 25^\circ C$, $V_{CC} = 5V$.

(2) Batteries are disconnected from circuit until after V_{CC} is applied for the first time. t_{DR} is the accumulated time in absence of power beginning when power is first applied to the device.

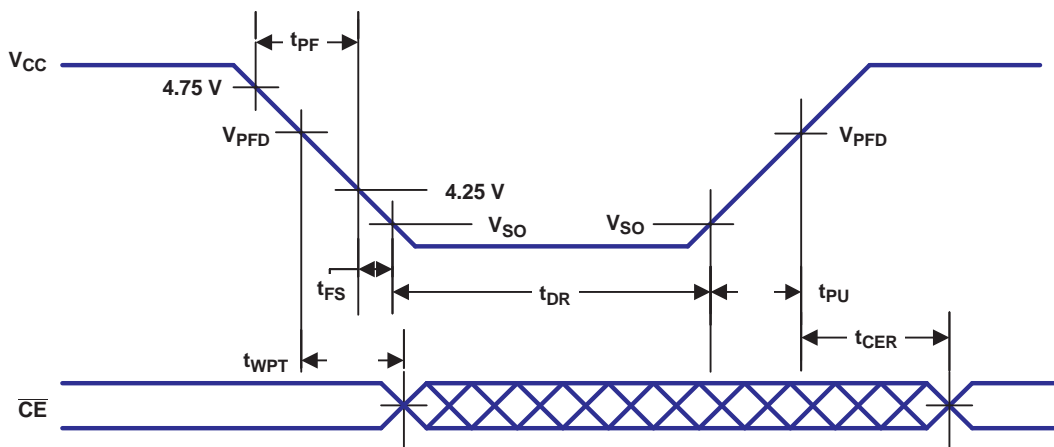


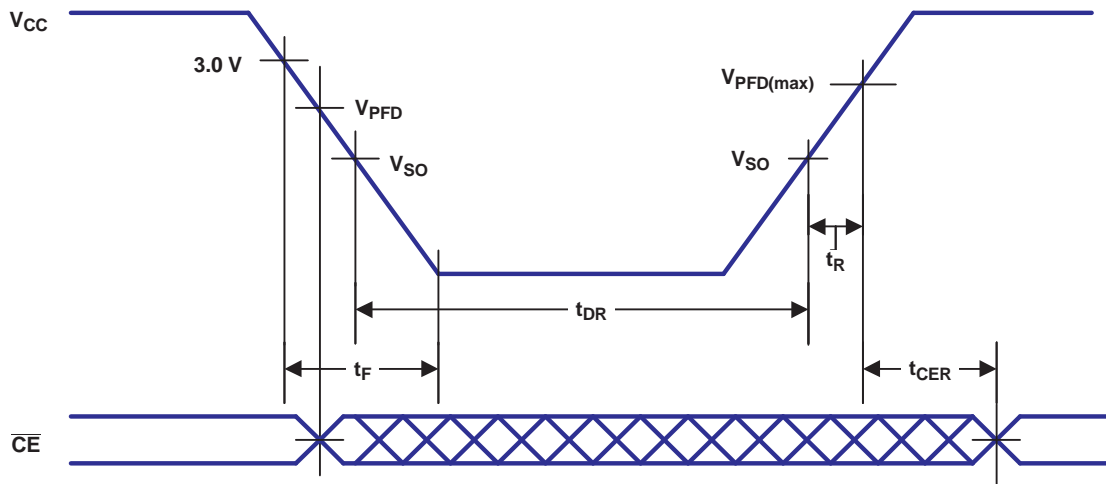
Figure 10. 5-V Power-Down/Power-Up Timing

Table 5. 3.3-V POWER-DOWN/POWER-UP ($T_A = T_{OPR}$)

| PARAMETER | | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|-----------|--------------------------------------------|----------------------------------------------------------------------------------------|-----|--------------------|-----|---------|
| t_F | V_{CC} slew, 3 V to 0 V | | 300 | | | μs |
| t_R | V_{CC} slew, V_{SO} to $V_{PFD(max)}$ | | 100 | | | |
| t_{CER} | Chip enable recovery time | Time during which SRAM is write-protected after V_{CC} passes V_{PFD} on power-up. | 10 | | 85 | ms |
| t_{DR} | Data-retention time in absence of V_{CC} | $T_A = 25^\circ C^{(2)}$ | 10 | | | years |

(1) Typical values indicate operation at $T_A = 25^\circ C$, $V_{CC} = 3.3$ V.

(2) Batteries are disconnected from circuit until after V_{CC} is applied for the first time. Data retention time (t_{DR}) is the accumulated time in absence of power beginning when power is first applied to the device.

**Figure 11. 3.3-V Power-Down/Power-Up Timing****CAUTION:**

Negative undershoots below the absolute maximum rating of -0.3 V in battery-backup mode may affect data integrity.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|-------------------------|----------------------|--------------|-------------------------|---------|
| BQ4010LYEBZ-70N | OBSOLETE | DIP MODULE | EBZ | 28 | | TBD | Call TI | Call TI | | | |
| BQ4010LYMA-70 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010LYMA-70N | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | -40 to 85 | | |
| BQ4010MA-150 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010MA-200 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010MA-70 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010MA-85 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010YMA-150 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010YMA-150N | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | -40 to 85 | | |
| BQ4010YMA-200 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010YMA-70 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010YMA-70N | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | -40 to 85 | | |
| BQ4010YMA-85 | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | 0 to 70 | | |
| BQ4010YMA-85N | OBSOLETE | DIP MODULE | MA | 28 | | TBD | Call TI | Call TI | -40 to 85 | | |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

⁽⁴⁾ There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽⁵⁾ Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

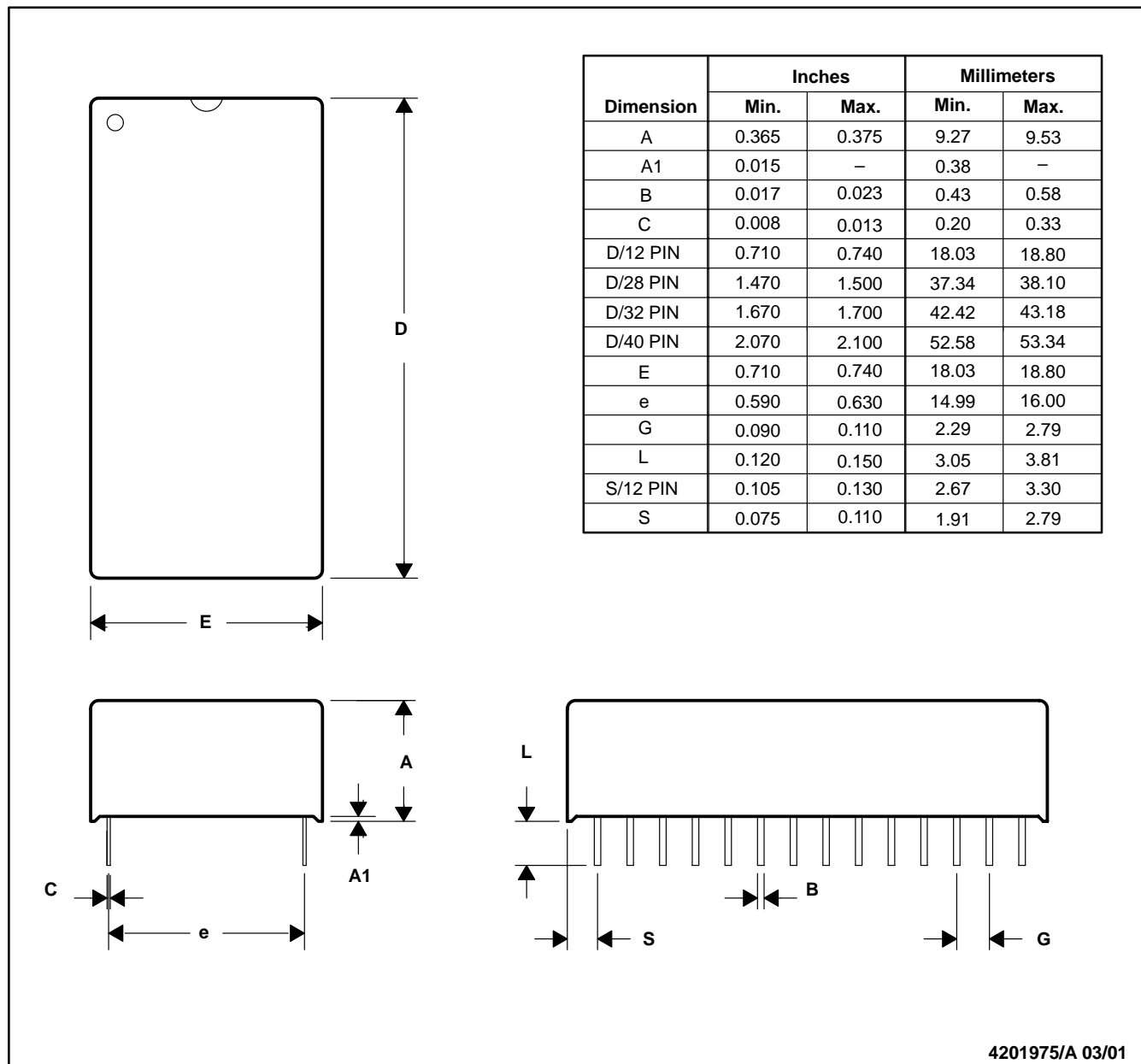
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MA (R-PDIP-T**)

PLASTIC DUAL-IN-LINE

28 PINS SHOWN



NOTES: A. All linear dimensions are in inches (mm).
 B. This drawing is subject to change without notice.

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