



M48T251Y M48T251V

5.0 or 3.3V, 4096K TIMEKEEPER[®] SRAM with PHANTOM

FEATURES SUMMARY

- 5.0V OR 3.3V OPERATING VOLTAGE
- REAL TIME CLOCK KEEPS TRACK OF TENTHS/HUNDREDTHS OF SECONDS, SECONDS, MINUTES, HOURS, DAYS, DATE OF THE MONTH, MONTHS, and YEARS
- AUTOMATIC LEAP YEAR CORRECTION VALID UP TO THE YEAR 2100
- AUTOMATIC SWITCH-OVER and DESELECT CIRCUITRY
- CHOICE OF POWER-FAIL DESELECT VOLTAGES:
(V_{PFD} = Power-fail Deselect Voltage):
 - M48T251Y: $4.25V \leq V_{PFD} \leq 4.50V$
 - M48T251V: $2.80V \leq V_{PFD} \leq 2.97V$
- FULL 10% V_{CC} OPERATING RANGE
- OVER 10 YEARS' DATA RETENTION IN THE ABSENCE OF POWER
- WATCH FUNCTION IS TRANSPARENT TO RAM OPERATION
- 512K x 8 NV SRAM DIRECTLY REPLACES VOLATILE STATIC RAM OR EEPROM

Figure 1. 32-pin, DIP Package

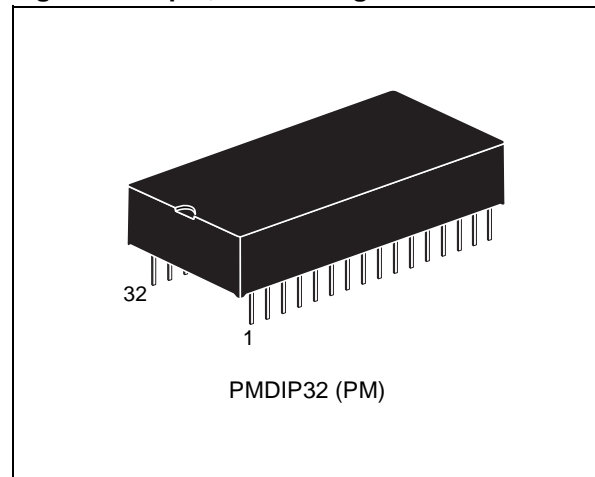


TABLE OF CONTENTS

SUMMARY DESCRIPTION 3

 Logic Diagram (Figure 2.) 3

 Signal Names (Table 1.) 3

 DIP Connections (Figure 3.) 3

 Block Diagram (Figure 4.) 4

MAXIMUM RATING. 5

 Absolute Maximum Ratings (Table 2.) 5

DC AND AC PARAMETERS. 6

 DC and AC Measurement Conditions (Table 3.) 6

 AC Testing Load Circuit (Figure 5.) 6

 Capacitance (Table 4.) 6

 DC Characteristics (Table 5.) 7

OPERATION MODES 8

 Operating Modes (Table 6.) 8

 READ. 8

 WRITE 8

 Memory READ Cycle (Figure 6.) 8

 Memory WRITE Cycle 1 (Figure 7.) 9

 Memory WRITE Cycle 2 (Figure 8.) 10

 Memory AC Characteristics, M48T251Y (Table 7.) 11

 Memory AC Characteristics, M48T251V (Table 8.) 12

 Data Retention Mode. 13

 Power Down/Up Mode AC Waveforms (Figure 9.) 13

 Power Down/Up Trip Points DC Characteristics (Table 9.) 13

PHANTOM CLOCK OPERATION. 14

 Comparison Register Definition (Figure 10.) 15

 Clock Register Information 16

 Clock Accuracy 16

 AM-PM/12/24 Mode. 16

 Oscillator and Reset Bits 16

 Zero Bits 16

 Phantom Clock Register Map (Table 10.) 16

 Phantom Clock READ Cycle (Figure 11.) 17

 Phantom Clock WRITE Cycle (Figure 12.) 17

 Phantom Clock Reset (Figure 13.) 17

 Phantom Clock AC Characteristics (M48T251Y) (Table 11.) 18

 Phantom Clock AC Characteristics (M48T251V) (Table 12.) 19

PART NUMBERING 20

PACKAGE MECHANICAL INFORMATION 21

REVISION HISTORY. 22

SUMMARY DESCRIPTION

The M48T251Y/V TIMEKEEPER® RAM is a 512Kbit x 8 non-volatile static RAM and real time clock organized as 524,288 words by 8 bits. The special DIP package provides a fully integrated battery back-up memory and real time clock solution. In the event of power instability or absence, a self-contained battery maintains the timekeeping operation and provides power for a CMOS static RAM. Control circuitry monitors V_{CC} and invokes write protection to prevent data corruption in the memory and RTC.

The clock keeps track of tenths/hundredths of seconds, seconds, minutes, hours, day, date, month,

and year information. The last day of the month is automatically adjusted for months with less than 31 days, including leap year correction.

The clock operates in one of two formats:

- a 12-hour mode with an AM/PM indicator; or
- a 24-hour mode

The M48T251Y/V is a 32-pin (PM) DIP module that integrates the RTC, the battery, and SRAM in one package.

The modules are shipped in plastic, anti-static tubes (see Table 13, page 20).

Figure 2. Logic Diagram

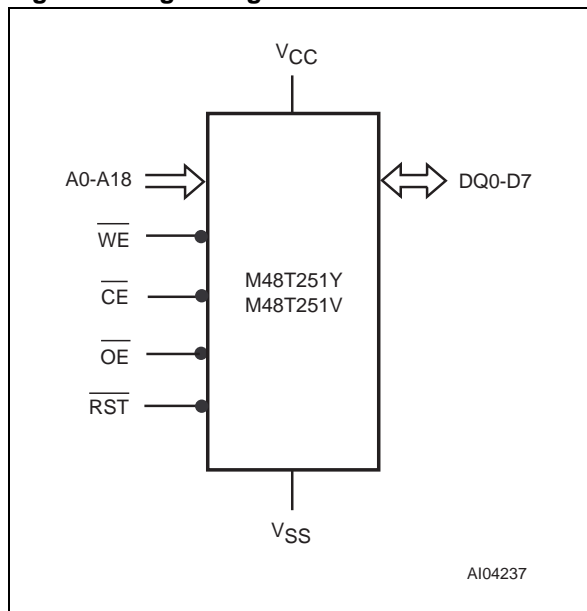


Table 1. Signal Names

| | |
|-------------------------|----------------------|
| A0–A18 | Address Input |
| $\overline{\text{RST}}$ | Reset Input |
| $\overline{\text{CE}}$ | Chip Enable |
| $\overline{\text{OE}}$ | Output Enable Input |
| $\overline{\text{WE}}$ | WRITE Enable Input |
| DQ0–DQ7 | Data Inputs/Outputs |
| V _{CC} | Supply Voltage Input |
| V _{SS} | Ground |

Figure 3. DIP Connections

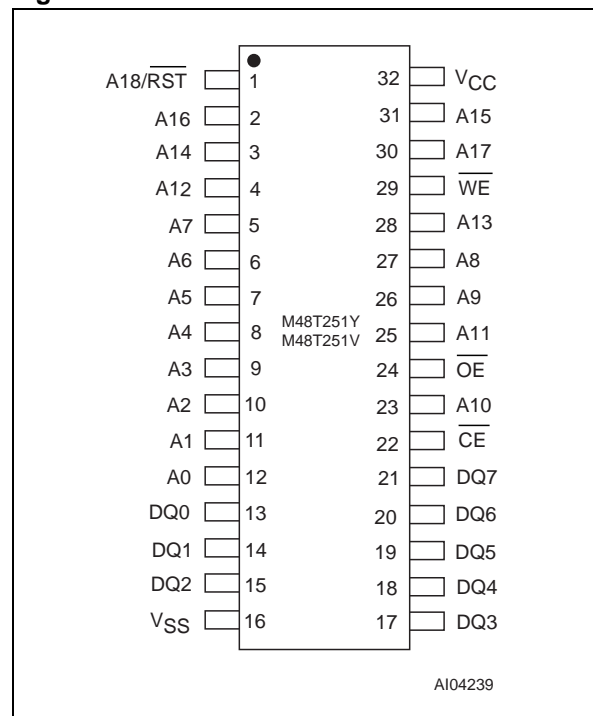
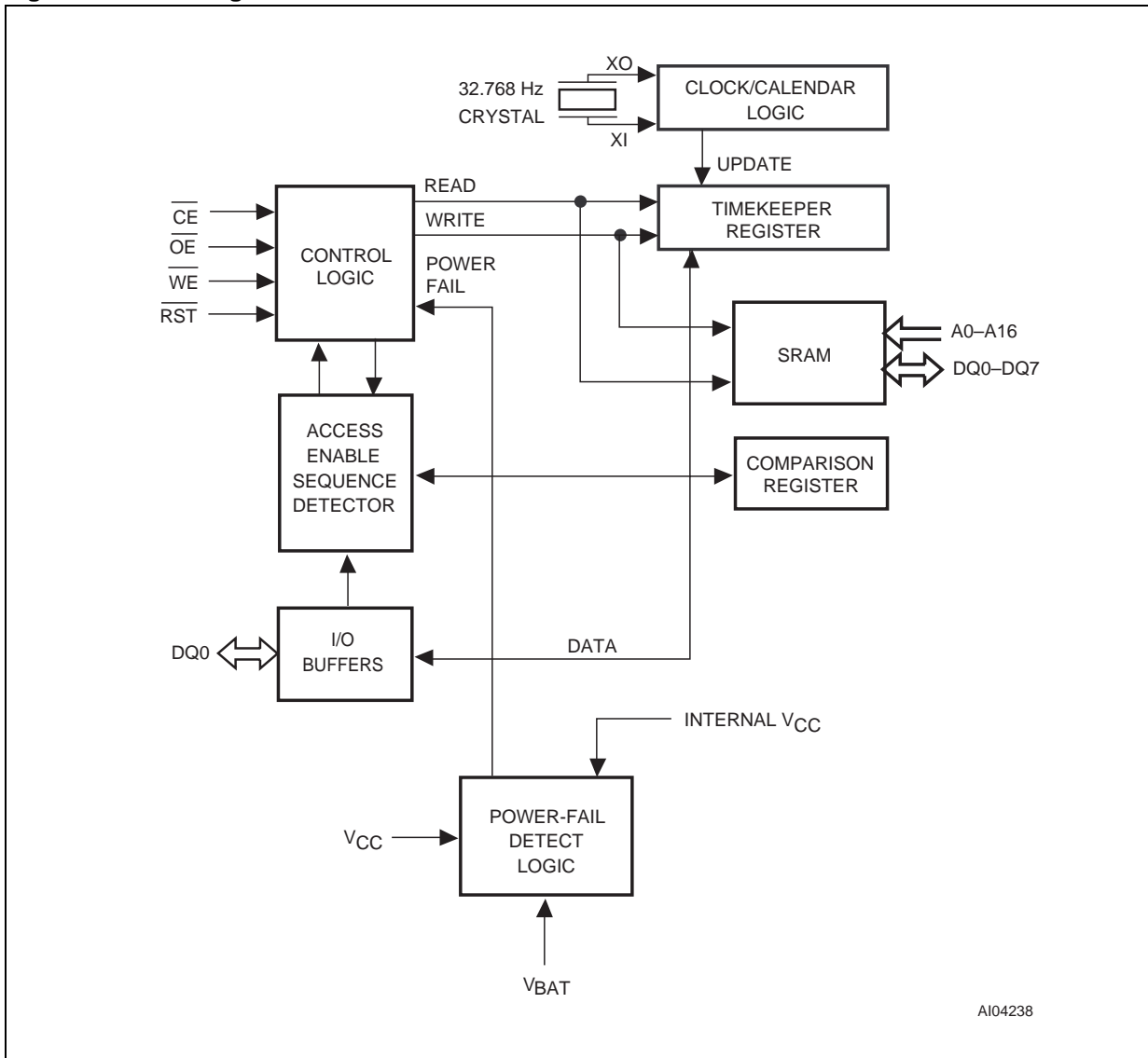


Figure 4. Block Diagram



MAXIMUM RATING

Stressing the device above the rating listed in the “Absolute Maximum Ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is

not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 2. Absolute Maximum Ratings

| Symbol | Parameter | | Value | Unit |
|---------------------------------|--------------------------------------------------------|----------|-------------------------------|------|
| T _A | Operating Temperature | | 0 to 70 | °C |
| T _{STG} | Storage Temperature (V _{CC} , Oscillator Off) | | -40 to 85 | °C |
| T _{SLD} ⁽¹⁾ | Lead Solder Temperature for 10 seconds | | 260 | °C |
| V _{CC} | Supply Voltage (on any pin relative to Ground) | M48T251Y | -0.3 to +7.0 | V |
| | | M48T251V | -0.3 to +4.6 | V |
| V _{IO} | Input or Output Voltages | | -0.3 to V _{CC} + 0.3 | V |
| I _O | Output Current | | 20 | mA |
| P _D | Power Dissipation | | 1 | W |

Note: 1. Soldering temperature not to exceed 260°C for 10 seconds (total thermal budget not to exceed 150°C for longer than 30 seconds).

CAUTION! Negative undershoots below -0.3V are not allowed on any pin while in the Battery Back-up Mode.

M48T251Y, M48T251V

DC AND AC PARAMETERS

This section summarizes the operating and measurement conditions, as well as the DC and AC characteristics of the device. The parameters in the following DC and AC Characteristic tables are derived from tests performed under the Measure-

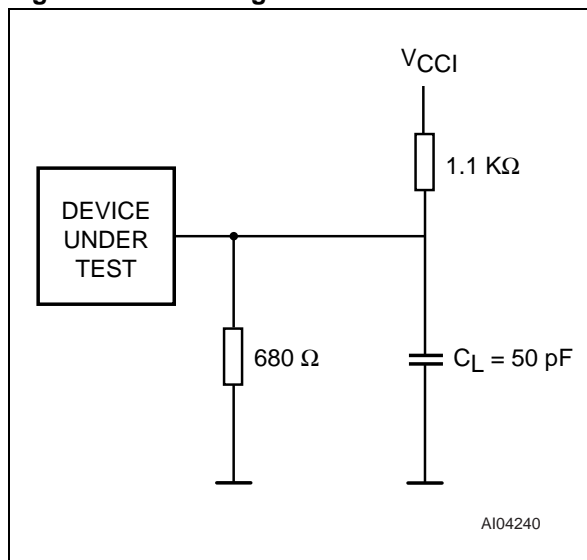
ment Conditions listed in the relevant tables. Designers should check that the operating conditions in their projects match the measurement conditions when using the quoted parameters.

Table 3. DC and AC Measurement Conditions

| Parameter | M48T251Y | M48T251V |
|---------------------------------------|-------------|-------------|
| V _{CC} Supply Voltage | 4.5 to 5.5V | 3.0 to 3.6V |
| Ambient Operating Temperature | 0 to 70°C | 0 to 70°C |
| Load Capacitance (C _L) | 100pF | 50pF |
| Input Rise and Fall Times | ≤ 5ns | ≤ 5ns |
| Input Pulse Voltages | 0 to 3V | 0 to 3V |
| Input and Output Timing Ref. Voltages | 1.5V | 1.5V |

Note: Output High Z is defined as the point where data is no longer driven (see Table 3, page 6).

Figure 5. AC Testing Load Circuit



Note: 50pF for M48T251V.

Table 4. Capacitance

| Symbol | Parameter ^(1,2) | Min | Max | Unit |
|--------------------------------|----------------------------|-----|-----|------|
| C _{IN} | Input Capacitance | | 10 | pF |
| C _{IO} ⁽³⁾ | Input / Output Capacitance | | 10 | pF |

Note: 1. Effective capacitance measured with power supply at 5V. Sampled only; not 100% tested.

2. At 25°C, f = 1MHz.

3. Outputs were deselected.

Table 5. DC Characteristics

| Sym | Parameter ⁽¹⁾ | Test Condition | M48T251Y | | | M48T251V | | | Unit |
|-----------------|--------------------------------------|---------------------------------|----------|-----------|----------------|----------|-----|----------------|---------|
| | | | -70 | | | -85 | | | |
| | | | Min | Typ | Max | Min | Typ | Max | |
| $I_{LI}^{(2)}$ | Input Leakage Current | $0V \leq V_{IN} \leq V_{CC}$ | | | ± 1 | | | ± 1 | μA |
| I_{LO} | Output Leakage Current | $0V \leq V_{OUT} \leq V_{CC}$ | | | ± 1 | | | ± 1 | μA |
| I_{CC1} | Supply Current | | | | 85 | | | 50 | mA |
| I_{CC2} | Supply Current (TTL Standby) | $\overline{CE} = V_{IH}$ | | 5 | 10 | | 5 | 7 | mA |
| I_{CC3} | V _{CC} Power Supply Current | $\overline{CE} = V_{CCI} - 0.2$ | | 3 | 5 | | 2 | 3 | mA |
| $V_{IL}^{(3)}$ | Input Low Voltage | | -0.3 | | 0.8 | -0.3 | | 0.6 | V |
| $V_{IH}^{(3)}$ | Input High Voltage | | 2.2 | | $V_{CC} + 0.3$ | 2.2 | | $V_{CC} + 0.3$ | V |
| V_{OL} | Output Low Voltage | $I_{OL} = 2.0 \text{ mA}$ | | | 0.4 | | | 0.4 | V |
| V_{OH} | Output High Voltage | $I_{OH} = -1.0 \text{ mA}$ | 2.4 | | | 2.4 | | | V |
| $V_{PFD}^{(3)}$ | Power Fail Deselect | | 4.25 | 4.37 | 4.50 | 2.80 | | 2.97 | V |
| $V_{SO}^{(3)}$ | Battery Back-up Switchover | | | V_{BAT} | | | 2.5 | | V |

Note: 1. Valid for Ambient Operating Temperature: $T_A = 0$ to $70^\circ C$; $V_{CC} = 4.5$ to $5.5V$ or 3.0 to $3.6V$ (except where noted).

2. RST (Pin 1) has an internal pull-up resistor.

3. All voltages are referenced to Ground.

OPERATION MODES

Table 6. Operating Modes

| Mode | V _{CC} | $\overline{\text{CE}}$ | $\overline{\text{OE}}$ | $\overline{\text{WE}}$ | DQ7-DQ0 | Power |
|----------|-----------------------------------------------------------|------------------------|------------------------|------------------------|------------------|-----------------|
| Deselect | 4.5V to 5.5V or 3.0V to 3.6V | V _{IH} | X | X | High-Z | Standby |
| WRITE | | V _{IL} | X | V _{IL} | D _{IN} | Active |
| READ | | V _{IL} | V _{IL} | V _{IH} | D _{OUT} | Active |
| READ | | V _{IL} | V _{IH} | V _{IH} | High-Z | Active |
| Deselect | V _{SO} to V _{PF} D (min) ⁽¹⁾ | X | X | X | High-Z | CMOS Standby |
| Deselect | ≤ V _{SO} ⁽¹⁾ | X | X | X | High-Z | Battery Back-Up |

Note: X = V_{IH} or V_{IL}; V_{SO} = Battery Back-up Switchover Voltage
 1. See Table 9, page 13 for details.

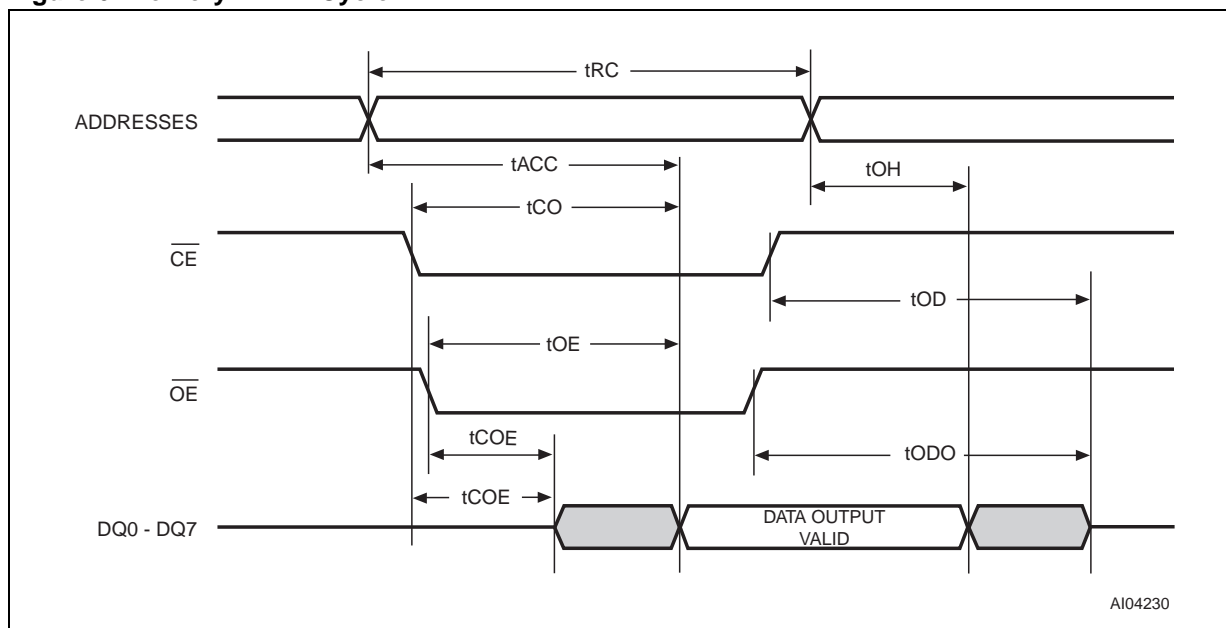
READ

A READ cycle executes whenever WRITE Enable ($\overline{\text{WE}}$) is high and Chip Enable ($\overline{\text{CE}}$) is low (see Figure 6). The distinct address defined by the 19 address inputs (A0-A18) specifies which of the 512K bytes of data is to be accessed. Valid data will be accessed by the eight data output drivers within the specified Access Time (t_{ACC}) after the last address input signal is stable, the CE and OE access times, and their respective parameters are satisfied. When $\overline{\text{CE}}$ t_{ACC} and $\overline{\text{OE}}$ t_{ACC} are not satisfied, then data access times must be measured from the more recent CE and OE signals, with the limiting parameter being t_{CO} (for CE) or t_{OE} (for OE) instead of address access.

WRITE

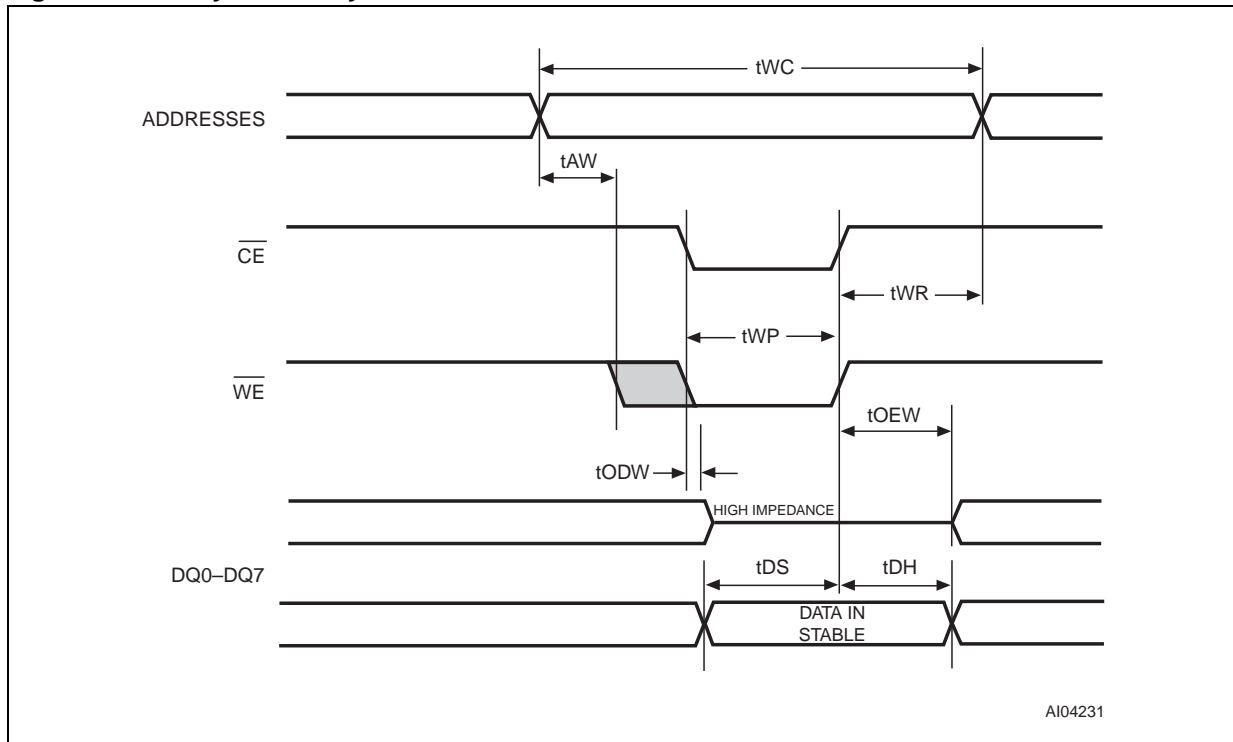
WRITE Mode (see Figure 7, page 9 and Figure 8, page 10) occurs whenever $\overline{\text{CE}}$ and $\overline{\text{WE}}$ signals are low (after address inputs are stable). The most recent falling edge of CE and WE will determine when the WRITE cycle begins (the earlier, rising edge of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ determines cycle termination). All address inputs must be kept stable throughout the WRITE cycle. WE must be high (inactive) for a minimum recovery time (t_{WR}) before a subsequent cycle is initiated. The OE control signal should be kept high (inactive) during the WRITE cycles to avoid bus contention. If CE and OE are low (active), WE will disable the outputs for Output Data WRITE Time (t_{ODW}) from its falling edge.

Figure 6. Memory READ Cycle



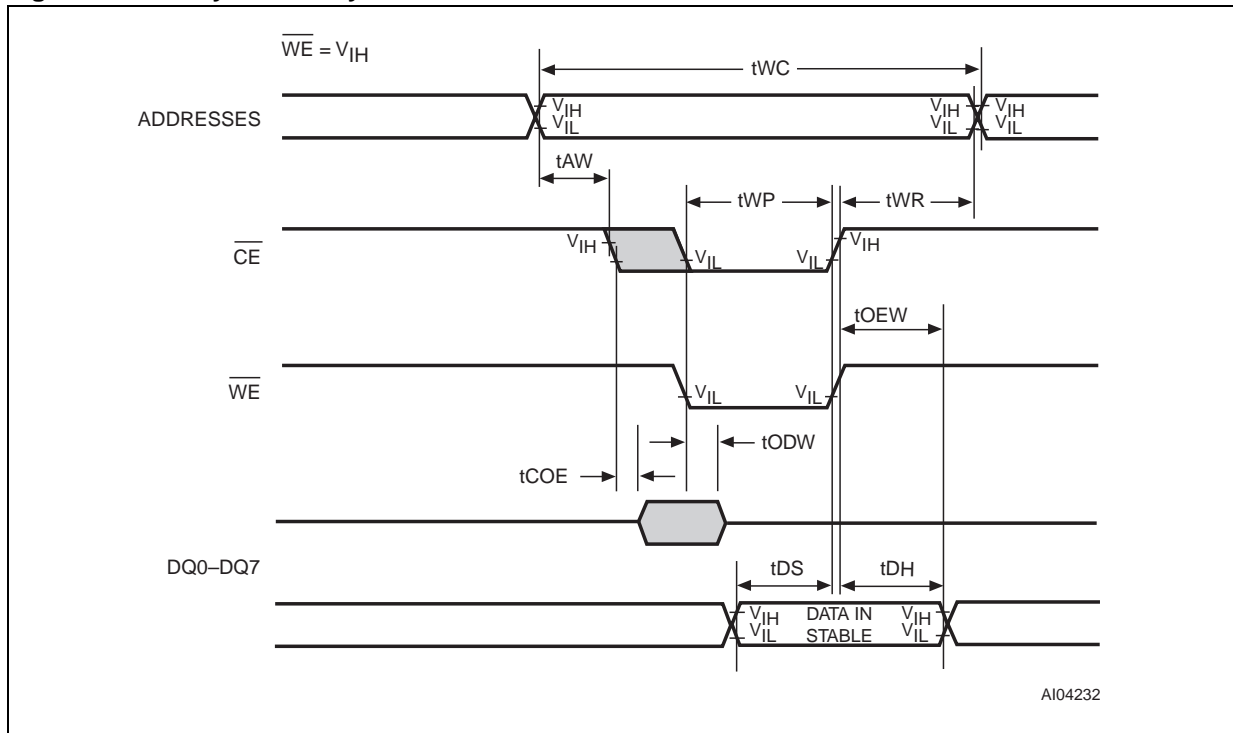
Note: $\overline{\text{WE}}$ is high for a READ cycle.

Figure 7. Memory WRITE Cycle 1



- Note:
1. $\overline{OE} = V_{IH}$ or V_{IL} . If $\overline{OE} = V_{IH}$ during a WRITE cycle, the output buffers remain in a high impedance state.
 2. If the \overline{CE} low transition occurs simultaneously with or later than the \overline{WE} low transition in WRITE Cycle 1, the output buffers remain in a high impedance state during this period.
 3. If the \overline{CE} high transition occurs simultaneously with the \overline{WE} high transition, the output buffers remain in a high impedance state during this period.

Figure 8. Memory WRITE Cycle 2



- Note: 1. $\overline{OE} = V_{IH}$ or V_{IL} . If $\overline{OE} = V_{IH}$ during a WRITE cycle, the output buffers remain in a high impedance state.
 2. If \overline{WE} is low or the \overline{WE} low transition occurs prior to or simultaneously with the \overline{CE} low transition, the output buffers remain in a high impedance state during this period.

Table 7. Memory AC Characteristics, M48T251Y

| Symbol | | Parameter ⁽¹⁾ | M48T251Y-70 | | Unit |
|----------------------------------------|---------------------------------|-------------------------------------------------------|-------------|-----|------|
| | | | Min | Max | |
| t _{AVAV} | t _{RC} | READ Cycle Time | 70 | | ns |
| t _{AVQV} | t _{ACC} | Access Time | | 70 | ns |
| t _{ELQV} | t _{CO} | Chip Enable Low to Output Valid | | 70 | ns |
| t _{GLQV} | t _{OE} | Output Enable Low to Output Valid | | 35 | ns |
| t _{ELQX} t _{GLQX} | t _{COE} | Chip Enable or Output Enable Low to Output Transition | 5 | | ns |
| t _{AXQX} | t _{OH} | Output Hold from Address Change | 5 | | ns |
| t _{EHQZ} t _{GHQZ} | t _{OD} ⁽²⁾ | Chip Enable or Output Enable High to Output Hi-Z | | 25 | ns |
| t _{WLQZ} | t _{ODW} ⁽²⁾ | Output Hi-Z from \overline{WE} | | 25 | ns |
| t _{AVAV} | t _{WC} | WRITE Cycle Time | 70 | | ns |
| t _{WLWH} t _{ELEH} | t _{WP} ⁽³⁾ | \overline{WE} , \overline{CE} Pulse Width | 50 | | ns |
| t _{AVEL} t _{AVWL} | t _{AW} | Address Setup Time | 0 | | ns |
| t _{EHAX} | t _{WR1} | WRITE Recovery Time | 15 | | ns |
| t _{WHAX} | t _{WR2} | Address Hold Time from \overline{WE} | 0 | | ns |
| t _{WHQX} | t _{OEW} | Output Active from \overline{WE} | 5 | | ns |
| t _{DVEH} t _{DVWH} | t _{DS} ⁽⁴⁾ | Data Setup Time | 30 | | ns |
| t _{WHDX} | t _{DH1} ⁽⁴⁾ | Data Hold Time from \overline{WE} | 0 | | ns |
| t _{EHDX} | t _{DH2} ⁽⁴⁾ | Data Hold Time from \overline{CE} | 10 | | ns |

Note: 1. Valid for Ambient Operating Temperature: T_A = 0 to 70°C; V_{CC} = 4.5 to 5.5V or 3.0 to 3.6V (except where noted).

2. These parameters are sampled with a 5 pF load are not 100% tested.

3. t_{WP} is specified as the logical AND of \overline{CE} and \overline{WE} . t_{WP} is measured from the latter of \overline{CE} or \overline{WE} going low to the earlier of \overline{CE} or \overline{WE} going high.

4. t_{DH} and t_{DS} are measured from the earlier of \overline{CE} or \overline{WE} going high.

M48T251Y, M48T251V

Table 8. Memory AC Characteristics, M48T251V

| Symbol | | Parameter ⁽¹⁾ | M48T251V-85 | | Unit |
|----------------------------------------|---------------------------------|-------------------------------------------------------|-------------|-----|------|
| | | | Min | Max | |
| t _{AVAV} | t _{RC} | READ Cycle Time | 85 | | ns |
| t _{AVQV} | t _{ACC} | Access Time | | 85 | ns |
| t _{ELQV} | t _{CO} | Chip Enable Low to Output Valid | | 85 | ns |
| t _{GLQV} | t _{OE} | Output Enable Low to Output Valid | | 45 | ns |
| t _{ELQX} t _{GLQX} | t _{COE} | Chip Enable or Output Enable Low to Output Transition | 5 | | ns |
| t _{AXQX} | t _{OH} | Output Hold from Address Change | 5 | | ns |
| t _{EHQZ} t _{GHQZ} | t _{OD} ⁽²⁾ | Chip Enable or Output Enable High to Output Hi-Z | | 35 | ns |
| t _{WLQZ} | t _{ODW} ⁽²⁾ | Output Hi-Z from \overline{WE} | | 30 | ns |
| t _{AVAV} | t _{WC} | WRITE Cycle Time | 85 | | ns |
| t _{WLWH} | t _{WP1} ⁽³⁾ | WRITE Enable Pulse Width | 65 | | ns |
| t _{ELEH} | t _{WP2} | Chip Enable Pulse Width | 75 | | ns |
| t _{AVEL} t _{AVWL} | t _{AW} | Address Setup Time | 0 | | ns |
| t _{EHAX} | t _{WR1} ⁽⁴⁾ | WRITE Recovery Time | 15 | | ns |
| t _{WHAX} | t _{WR2} | Address Hold Time from \overline{WE} | 5 | | ns |
| t _{WHQX} | t _{OE_W} | Output Active from \overline{WE} | 5 | | ns |
| t _{DVEH} t _{DVWH} | t _{DS} ⁽⁵⁾ | Data Setup Time | 35 | | ns |
| t _{WHDX} | t _{DH1} ⁽⁵⁾ | Data Hold Time from \overline{WE} | 0 | | ns |
| t _{EHD_X} | t _{DH2} | Data Hold Time from \overline{CE} | 15 | | ns |

- Note: 1. Valid for Ambient Operating Temperature: T_A = 0 to 70°C; V_{CC} = 4.5 to 5.5V or 3.0 to 3.6V (except where noted).
 2. These parameters are sampled with a 5 pF load are not 100% tested.
 3. t_{WP} is specified as the logical AND of \overline{CE} and \overline{WE} . t_{WP} is measured from the latter of \overline{CE} or \overline{WE} going low to the earlier of \overline{CE} or \overline{WE} going high.
 4. t_{WR} is a function of the latter occurring edge of \overline{WE} or \overline{CE} .
 5. t_{DH} and t_{DS} are measured from the earlier of \overline{CE} or \overline{WE} going high.

Data Retention Mode

Data can be read or written only when V_{CC} is greater than V_{PFD} . When V_{CC} is below V_{PFD} (the point at which write protection occurs), the clock registers and the SRAM are blocked from any access. When V_{CC} falls below the Battery Switch Over threshold (V_{SO}), the device is switched from V_{CC} to battery backup (V_{BAT}). RTC operation and SRAM data are maintained via battery backup until power is stable. All control, data, and address signals must be powered down when V_{CC} is powered down.

The lithium power source is designed to provide power for RTC activity as well as RTC and RAM

data retention when V_{CC} is absent or unstable. The capability of this source is sufficient to power the device continuously for the life of the equipment into which it has been installed. For specification purposes, life expectancy is ten (10) years at 25°C with the internal oscillator running without V_{CC} . Each unit is shipped with its energy source disconnected, guaranteeing full energy capacity. When V_{CC} is first applied at a level greater than V_{PFD} , the energy source is enabled for battery backup operation. The actual life expectancy will be much longer if no battery energy is used (e.g., when V_{CC} is present).

Figure 9. Power Down/Up Mode AC Waveforms

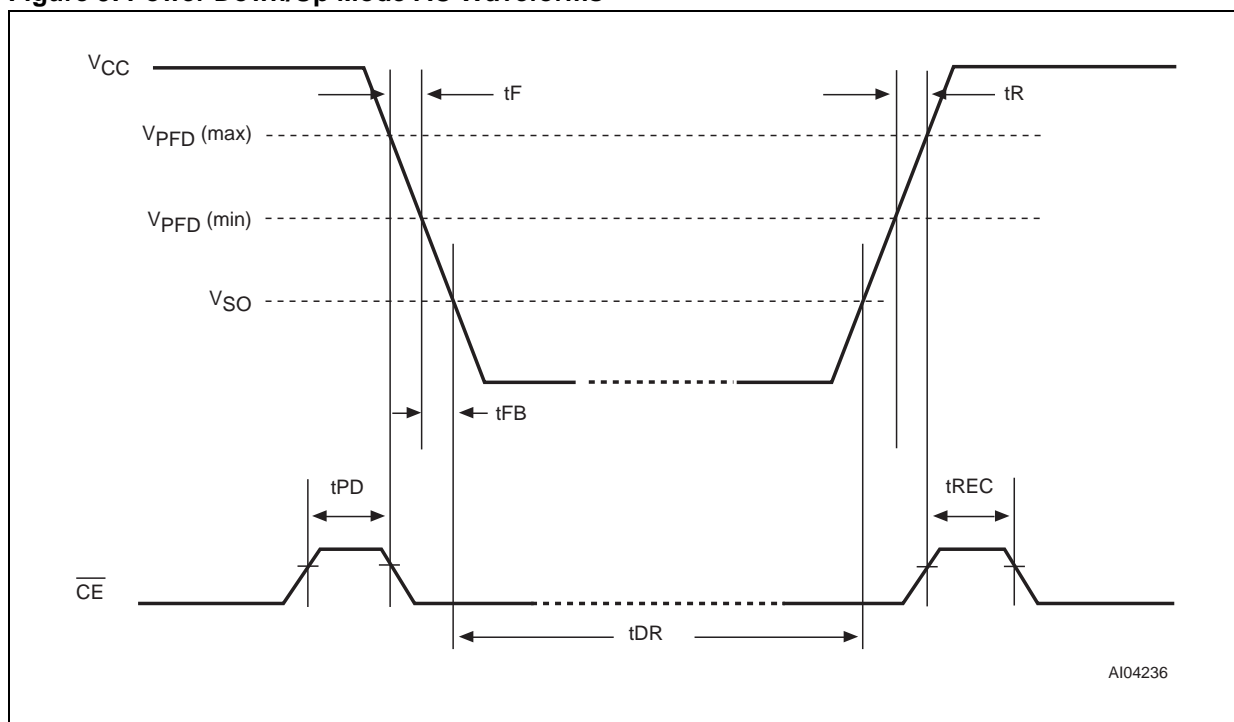


Table 9. Power Down/Up Trip Points DC Characteristics

| Symbol | Parameter ⁽¹⁾ | Min | Max | Unit |
|----------------|-------------------------------------------------------|-----|-----|---------------|
| t_{REC} | $V_{PFD}(\max)$ to \overline{CE} low | 1.5 | 2.5 | ms |
| t_F | $V_{PFD}(\max)$ to $V_{PFD}(\min)$ V_{CC} Fall Time | 300 | | μs |
| t_{FB} | $V_{PFD}(\min)$ to V_{SO} V_{CC} Fall Time | 10 | | μs |
| t_R | $V_{PFD}(\min)$ to $V_{PFD}(\max)$ V_{CC} Rise Time | 0 | | μs |
| t_{PD} | \overline{CE} High to Power-Fail | 0 | | μs |
| $t_{DR}^{(2)}$ | Expected Data Retention Time | 10 | | Years |

Note: 1. Valid for Ambient Operating Temperature: $T_A = 0$ to 70°C; $V_{CC} = 4.5$ to 5.5V or 3.0 to 3.6V (except where noted).

2. At 25°C, the expected t_{DR} is defined as cumulative time in the absence of V_{CC} with the clock oscillator running.

PHANTOM CLOCK OPERATION

Communication with the Phantom Clock is established by pattern recognition of a serial bit-stream of 64 bits which must be matched by executing 64 consecutive WRITE cycles containing the proper data on DQ0.

All accesses which occur prior to recognition of the 64-bit pattern are directed to memory.

After recognition is established, the next 64 READ or WRITE cycles either extract or update data in the clock while disabling the memory.

Data transfer to and from the timekeeping function is accomplished with a serial bit-stream under control of Chip Enable (\overline{CE}), Output Enable (\overline{OE}), and WRITE Enable (\overline{WE}). Initially, a READ cycle using the \overline{CE} and \overline{OE} control of the clock starts the pattern recognition sequence by moving the pointer to the first bit of the 64-bit comparison register (see Figure 10, page 15).

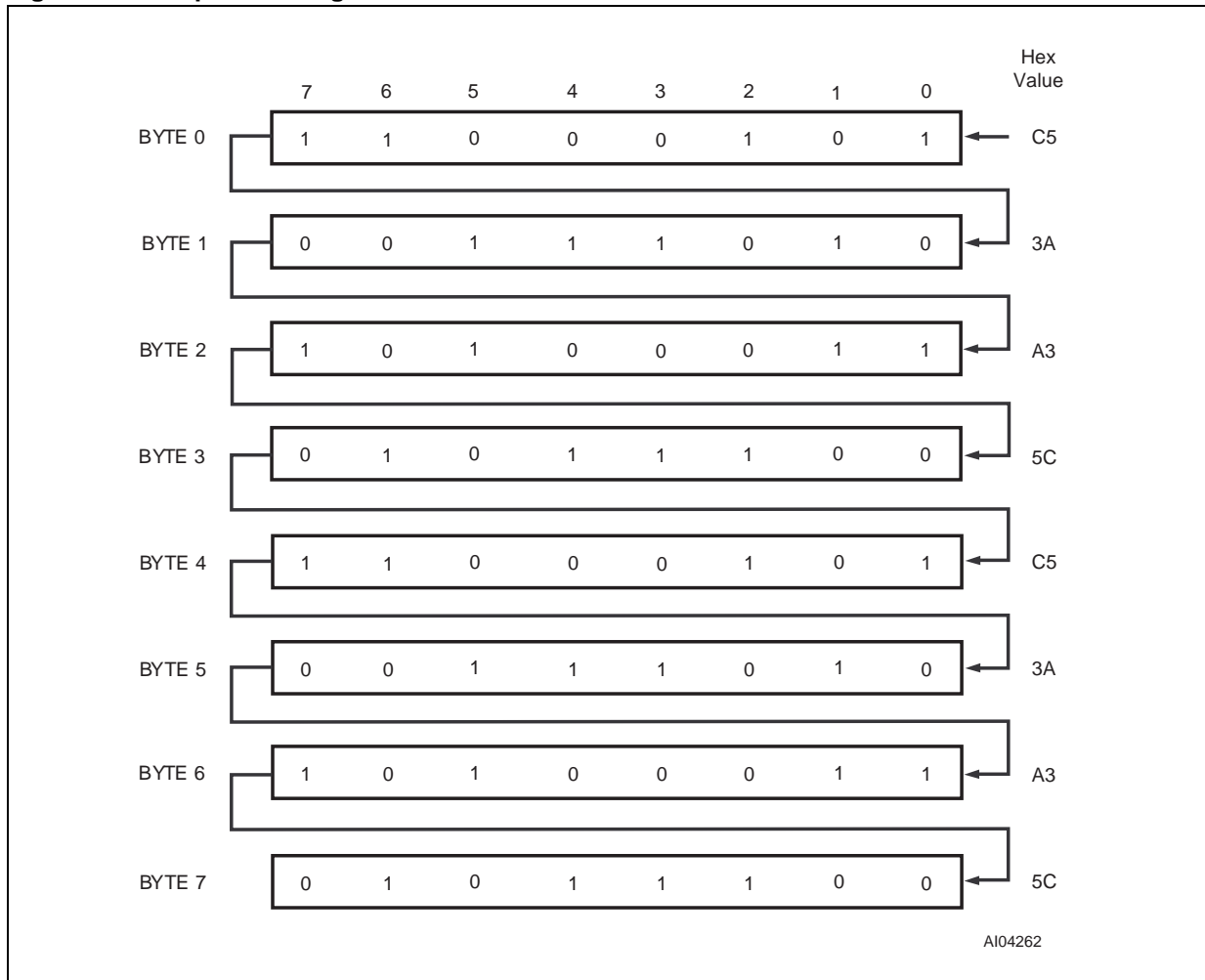
Next, 64 consecutive WRITE cycles are executed using the \overline{CE} and \overline{WE} control of the device. These 64 WRITE cycles are used only to gain access to the clock. Therefore, any address to the memory is acceptable. However, the WRITE cycles generated to gain access to the Phantom Clock are also writing data to a location in the mated RAM. The preferred way to manage this requirement is to set

aside just one address location in RAM as a Phantom Clock scratch pad.

When the first WRITE cycle is executed, it is compared to Bit 1 of the 64-bit comparison register. If a match is found, the pointer increments to the next location of the comparison register and awaits the next WRITE cycle.

If a match is not found, the pointer does not advance and all subsequent WRITE cycles are ignored. If a READ cycle occurs at any time during pattern recognition, the present sequence is aborted and the comparison register pointer is reset. Pattern recognition continues for a total of 64 WRITE cycles as described above until all of the bits in the comparison register have been matched. With a correct match for 64-bits, the Phantom Clock is enabled and data transfer to or from the timekeeping registers can proceed. The next 64 cycles will cause the Phantom Clock to either receive or transmit data on DQ0, depending on the level of the \overline{OE} pin or the \overline{WE} pin. Cycles to other locations outside the memory block can be interleaved with \overline{CE} cycles without interrupting the pattern recognition sequence or data transfer sequence to the Phantom Clock.

Figure 10. Comparison Register Definition



Note: The odds of this pattern being accidentally duplicated and sending aberrant entries to the RTC is less than 1 in 10^{19} . This pattern is sent to the clock LSB to MSB.

Clock Register Information

Clock information is contained in eight registers of 8 bits, each of which is sequentially accessed one (1) bit at a time after the 64-bit pattern recognition sequence has been completed. When updating the clock registers, each must be handled in groups of 8 bits. Writing and reading individual bits within a register could produce erroneous results. These READ/WRITE registers are defined in the clock register map (see Table 10).

Data contained in the clock registers is in Binary Coded Decimal format (BCD). Reading and writing the registers is always accomplished by stepping through all eight registers, starting with Bit 0 of Register 0 and ending with Bit 7 of Register 7.

Clock Accuracy

The RTC is guaranteed to keep time accuracy to with ±1 minute per month at 25°C. The clock is factory-tuned with special calibration elements, and does not require additional calibration. Moderate temperature deviation will have a negligible effect in most applications.

AM-PM/12/24 Mode

Bit 7 of the hours register is defined as the 12-hour or 24-hour mode select bit. When it is high, the 12-hour mode is selected. In the 12-hour mode, Bit 5 is the AM/PM bit with the logic high being “PM.” In the 24-hour mode, Bit 5 is the second 10-hour bit (20-23 hours).

Oscillator and Reset Bits

Bits 4 and 5 of the day register are used to control the reset and oscillator functions. Bit 4 controls the reset pin input. When the reset bit is set to logic '1,' the Reset Input pin is ignored. When the reset bit logic is set to '0,' a low input on the reset pin will cause the device to abort data transfer without changing data in the timekeeping registers. Reset operates independently of all other inputs. Bit 5 controls the oscillator. When set to logic '0,' the oscillator turns on and the RTC/calendar begins to increment.

Zero Bits

Registers 1, 2, 3, 4, 5, and 6 contain one (1) or more bits that will always read logic '0.' When writing to these locations, either a logic '1' or '0' is acceptable.

Table 10. Phantom Clock Register Map

| Register | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function/Range BCD Format | |
|----------|----------|------------|-------------------------|-------------------------|------------------------|-----------------|------|---------|------------------------------|-------------|
| | | | | | | | | | 0 | 0.1 Seconds |
| 1 | 0 | 10 Seconds | | | Seconds | | | Seconds | 00-59 | |
| 2 | 0 | 10 Minutes | | | Minutes | | | Minutes | 00-59 | |
| 3 | 12/24 | 0 | 10 / A/P | Hrs | Hours (24 Hour Format) | | | Hours | 01-12/ 00-23 | |
| 4 | 0 | 0 | $\overline{\text{OSC}}$ | $\overline{\text{RST}}$ | 0 | Day of the Week | | Day | 01-7 | |
| 5 | 0 | 0 | 10 date | | Date: Day of the Month | | | Date | 01-31 | |
| 6 | 0 | 0 | 0 | 10M | Month | | | Month | 01-12 | |
| 7 | 10 Years | | | Year | | | Year | 00-99 | | |

Keys: A/P = AM/PM Bit

12/24 = 12 or 24-hour mode Bit

$\overline{\text{OSC}}$ = Oscillator Bit

$\overline{\text{RST}}$ = Reset Bit

0 = Must be set to '0'



Figure 11. Phantom Clock READ Cycle

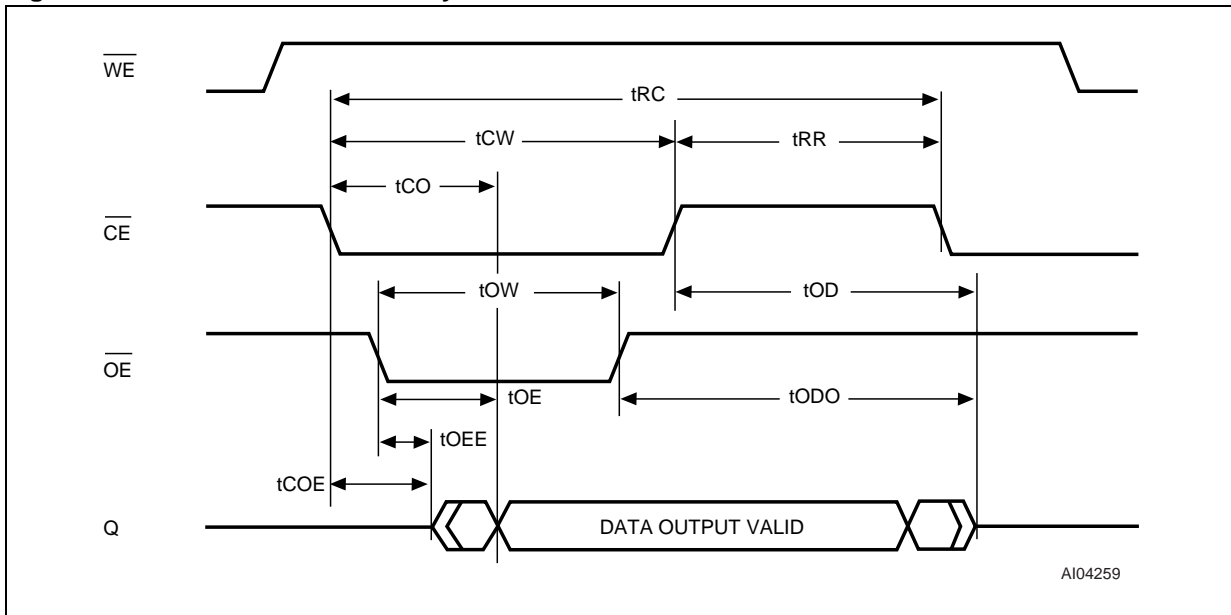


Figure 12. Phantom Clock WRITE Cycle

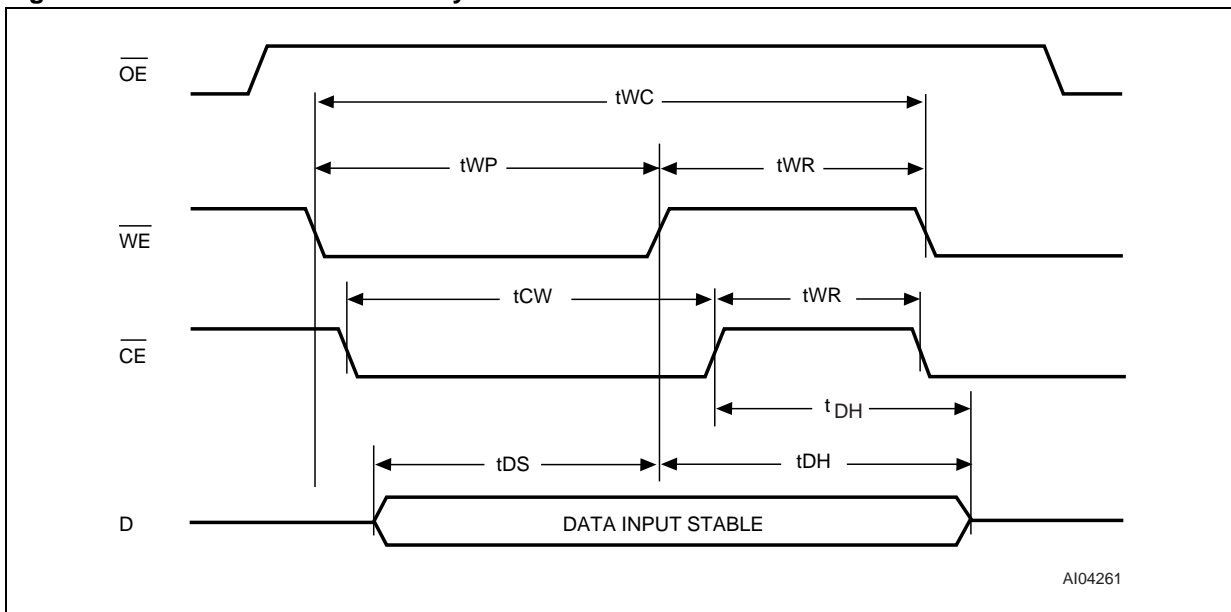


Figure 13. Phantom Clock Reset

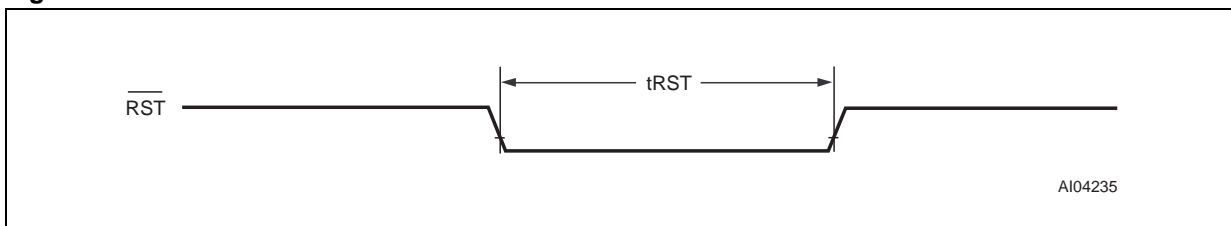


Table 11. Phantom Clock AC Characteristics (M48T251Y)

| Symbol | | Parameter ⁽¹⁾ | Min | Typ | Max | Unit |
|-------------------|---------------------------------|--------------------------------------------|-----|-----|-----|------|
| t _{AVAV} | t _{RC} | READ Cycle Time | 65 | | | ns |
| t _{ELQV} | t _{CO} | $\overline{\text{CE}}$ Access Time | | | 55 | ns |
| t _{GLQV} | t _{OE} | $\overline{\text{OE}}$ Access Time | | | 55 | ns |
| t _{ELQX} | t _{COE} | $\overline{\text{CE}}$ to Output Low Z | 5 | | | ns |
| t _{GLQX} | t _{OOE} | $\overline{\text{OE}}$ to Output Low Z | 5 | | | ns |
| t _{EHQZ} | t _{OD} ⁽²⁾ | $\overline{\text{CE}}$ to Output High Z | | | 25 | ns |
| t _{GHQZ} | t _{ODO} ⁽²⁾ | $\overline{\text{OE}}$ to Output High Z | | | 25 | ns |
| | t _{RR} | READ Recovery | 10 | | | ns |
| t _{AVAV} | t _{WC} | WRITE Cycle Time | 65 | | | ns |
| t _{WLWH} | t _{WP} ⁽³⁾ | WRITE Pulse Width | 55 | | | ns |
| t _{EHAX} | t _{WR} ⁽⁴⁾ | WRITE Recovery | 10 | | | ns |
| t _{DVEH} | t _{DS} ⁽⁵⁾ | Data Setup Time | 30 | | | ns |
| t _{WHDX} | t _{DH1} ⁽⁵⁾ | Data Hold Time from $\overline{\text{WE}}$ | 0 | | | ns |
| t _{EHDX} | t _{DH2} ⁽⁵⁾ | Data Hold Time from $\overline{\text{CE}}$ | 0 | | | ns |
| t _{ELEH} | t _{CW} | $\overline{\text{CE}}$ Pulse Width | 55 | | | ns |
| | t _{RST} | $\overline{\text{RST}}$ Pulse Width | 65 | | | ns |

Note: 1. Valid for Ambient Operating Temperature: T_A = 0 to 70°C; V_{CC} = 4.5 to 5.5V or 3.0 to 3.6V (except where noted).

2. These parameters are sampled with a 5 pF load and are not 100% tested.

3. t_{WP} is specified as the logical AND of $\overline{\text{CE}}$ and $\overline{\text{WE}}$. t_{WP} is measured from the latter of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going low to the earlier of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going high.

4. t_{WR} is a function of the latter occurring edge of $\overline{\text{WE}}$ or $\overline{\text{CE}}$.

5. t_{DH} and t_{DS} are measured from the earlier of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going high.

Table 12. Phantom Clock AC Characteristics (M48T251V)

| Symbol | | Parameter ⁽¹⁾ | Min | Typ | Max | Unit |
|-------------------|---------------------------------|--------------------------------------------|-----|-----|-----|------|
| t _{AVAV} | t _{RC} | READ Cycle Time | 85 | | | ns |
| t _{ELQV} | t _{CO} | $\overline{\text{CE}}$ Access Time | | | 85 | ns |
| t _{GLQV} | t _{OE} | $\overline{\text{OE}}$ Access Time | | | 85 | ns |
| t _{ELQX} | t _{COE} | $\overline{\text{CE}}$ to Output Low Z | 5 | | | ns |
| t _{GLQX} | t _{OOE} | $\overline{\text{OE}}$ to Output Low Z | 5 | | | ns |
| t _{EHQZ} | t _{OD} ⁽²⁾ | $\overline{\text{CE}}$ to Output High Z | | | 30 | ns |
| t _{GHQZ} | t _{ODO} ⁽²⁾ | $\overline{\text{OE}}$ to Output High Z | | | 30 | ns |
| | t _{RR} | READ Recovery | 20 | | | ns |
| t _{AVAV} | t _{WC} | WRITE Cycle Time | 85 | | | ns |
| t _{WLWH} | t _{WP} ⁽³⁾ | WRITE Pulse Width | 60 | | | ns |
| t _{EHAX} | t _{WR} ⁽⁴⁾ | WRITE Recovery | 20 | | | ns |
| t _{DVEH} | t _{DS} ⁽⁵⁾ | Data Setup Time | 35 | | | ns |
| t _{WHDX} | t _{DH1} ⁽⁵⁾ | Data Hold Time from $\overline{\text{WE}}$ | 0 | | | ns |
| t _{EHDX} | t _{DH2} ⁽⁵⁾ | Data Hold Time from $\overline{\text{CE}}$ | 0 | | | ns |
| t _{ELEH} | t _{CW} | $\overline{\text{CE}}$ Pulse Width | 65 | | | ns |
| | t _{RST} | $\overline{\text{RST}}$ Pulse Width | 85 | | | ns |

Note: 1. Valid for Ambient Operating Temperature: T_A = 0 to 70°C; V_{CC} = 4.5 to 5.5V or 3.0 to 3.6V (except where noted).

2. These parameters are sampled with a 5 pF load and are not 100% tested.

3. t_{WP} is specified as the logical AND of $\overline{\text{CE}}$ and $\overline{\text{WE}}$. t_{WP} is measured from the latter of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going low to the earlier of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going high.

4. t_{WR} is a function of the latter occurring edge of $\overline{\text{WE}}$ or $\overline{\text{CE}}$.

5. t_{DH} and t_{DS} are measured from the earlier of $\overline{\text{CE}}$ or $\overline{\text{WE}}$ going high.

M48T251Y, M48T251V

PART NUMBERING

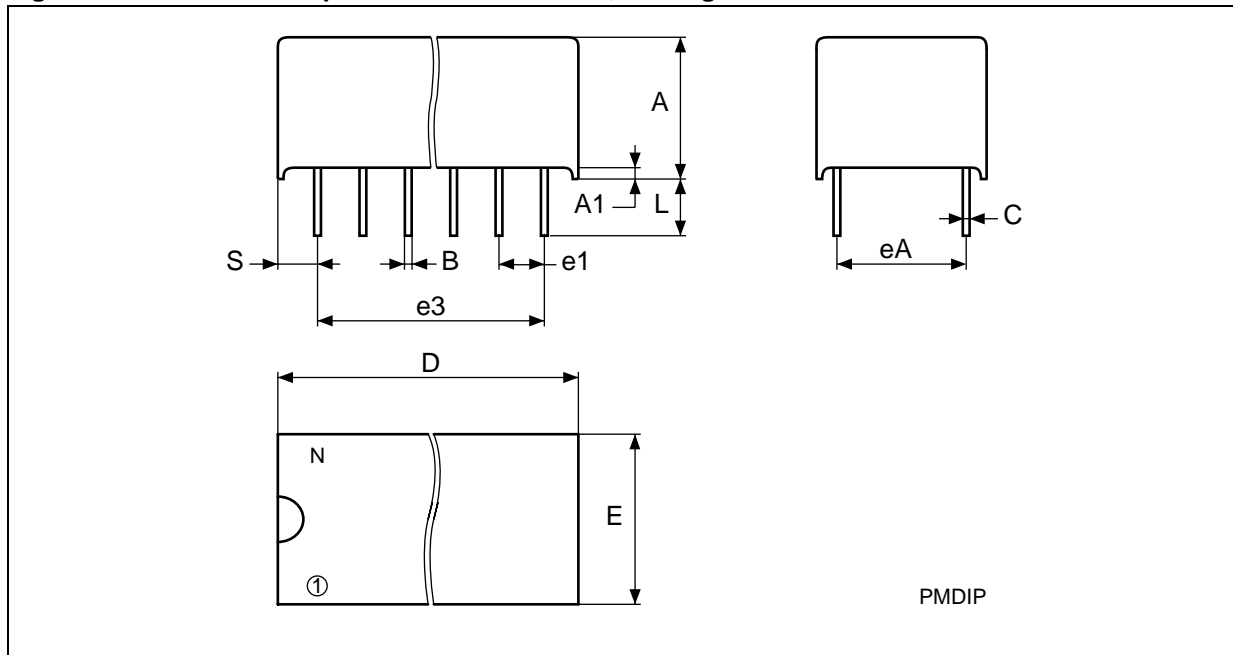
Table 13. Ordering Information Example

| Example: | M48T | 251Y | -70 | PM | 1 | TR |
|---------------------------------------------------------------|------|------|-----|----|---|----|
| Device Type | | | | | | |
| M48T | | | | | | |
| Supply Voltage and Write Protect Voltage | | | | | | |
| 251Y = $V_{CC} = 4.5$ to $5.5V$; $V_{PFD} = 4.25$ to $4.50V$ | | | | | | |
| 251V = $V_{CC} = 3.0$ to $3.6V$; $V_{PFD} = 2.80$ to $2.97V$ | | | | | | |
| Speed | | | | | | |
| -70 = 70ns (M48T251Y) | | | | | | |
| -85 = 85ns (M48T251V) | | | | | | |
| Package | | | | | | |
| PM = PMDIP32 | | | | | | |
| Temperature Range | | | | | | |
| 1 = 0 to 70°C | | | | | | |
| Shipping Method for SOIC | | | | | | |
| blank = Tubes | | | | | | |
| TR = Tape & Reel | | | | | | |

For a list of available options (e.g., Speed, Package) or for further information on any aspect of this device, please contact the ST Sales Office nearest to you.

PACKAGE MECHANICAL INFORMATION

Figure 14. PMDIP32 – 32-pin Plastic Module DIP, Package Outline



Note: Drawing is not to scale.

Table 14. PMDIP32 – 32-pin Plastic Module DIP, Package Mechanical Data

| Symb | mm | | | inches | | |
|------|-----|-------|-------|--------|-------|-------|
| | Typ | Min | Max | Typ | Min | Max |
| A | | 9.27 | 9.52 | | 0.365 | 0.375 |
| A1 | | 0.38 | – | | 0.015 | – |
| B | | 0.43 | 0.59 | | 0.017 | 0.023 |
| C | | 0.20 | 0.33 | | 0.008 | 0.013 |
| D | | 42.42 | 43.18 | | 1.670 | 1.700 |
| E | | 18.03 | 18.80 | | 0.710 | 0.740 |
| e1 | | 2.29 | 2.79 | | 0.090 | 0.110 |
| e3 | | 34.29 | 41.91 | | 1.350 | 1.650 |
| eA | | 14.99 | 16.00 | | 0.590 | 0.630 |
| L | | 3.05 | 3.81 | | 0.120 | 0.150 |
| S | | 1.91 | 2.79 | | 0.075 | 0.110 |
| N | | 32 | | | 32 | |

REVISION HISTORY

Table 15. Document Revision History

| Date | Revision Details |
|-----------|-----------------------------|
| June 2001 | First Issue |
| 05/20/02 | Add countries to disclaimer |

Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

The ST logo is registered trademark of STMicroelectronics
All other names are the property of their respective owners.

© 2002 STMicroelectronics - All Rights Reserved

STMicroelectronics GROUP OF COMPANIES
Australia - Brazil - Canada - China - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia -
Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - U.S.A.

www.st.com