

DALLAS

SEMICONDUCTOR

DS1589/DS1593

Serialized Real Time Clocks

FEATURES

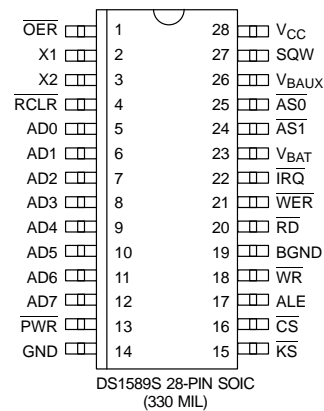
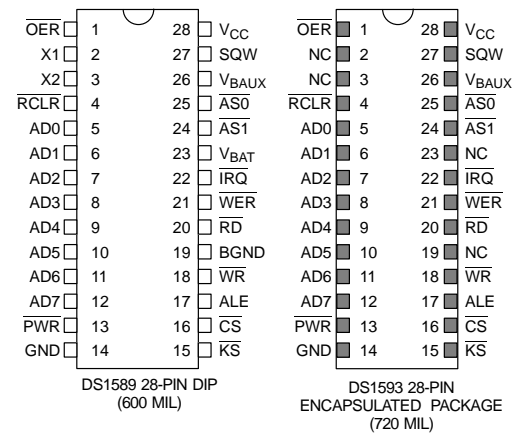
Incorporates industry standard DS1287 PC clock plus enhanced features:

- 64-bit Silicon serial number
- Power control circuitry supports system power on from date/time alarm or key closure
- 114 bytes user NVRAM
- 8K bytes additional NVRAM
- Auxiliary battery input
- RAM clear input
- Century register
- 32 kHz output for power management
- Compatible with existing BIOS for original DS1287 functions
- AD7–AD0 are open drain to allow interface to +3V logic
- Available as chip (DS1589) or stand-alone module (DS1593) with embedded lithium battery and crystal

PIN DESCRIPTION

| | |
|--------------------------|---|
| $\overline{\text{OER}}$ | - RAM output enable |
| X1 | - Crystal input |
| X2 | - Crystal output |
| $\overline{\text{RCLR}}$ | - RAM clear input |
| AD0-AD7 | - Mux'ed address/data bus; open drain |
| $\overline{\text{PWR}}$ | - Power on interrupt output; open drain |
| $\overline{\text{KS}}$ | - Kickstart input |
| $\overline{\text{CS}}$ | - RTC Chip select input |
| ALE | - RTC address strobe |
| $\overline{\text{WR}}$ | - RTC write data strobe |
| $\overline{\text{RD}}$ | - RTC read data strobe |
| $\overline{\text{WER}}$ | - RAM write data strobe |
| $\overline{\text{IRQ}}$ | - Interrupt request output |
| $\overline{\text{AS1}}$ | - RAM upper address strobe |
| $\overline{\text{AS0}}$ | - RAM lower address strobe |
| SQW | - Square wave output |
| V_{CC} | - +5V supply |
| GND | - Ground |
| V_{BAT} | - Battery + supply |
| V_{BAUX} | - Auxiliary battery supply |
| BGND | - Battery ground |

PIN ASSIGNMENT



ORDERING INFORMATION

| | |
|---------|------------------------|
| DS1589 | RTC Chip; 28-pin DIP |
| DS1589S | RTC Chip; 28-pin SOIC |
| DS1593 | RTC Module; 28-pin DIP |

DESCRIPTION

The DS1589 and DS1593 are RAMified real time clocks (RTC's) designed as upward-compatible successors to the industry standard DS1287, DS1387, and DS1488 PC real time clocks. As such, these devices incorporate a number of enhanced features including a silicon serial number, power on/off control circuitry, 114 bytes of user NVSRAM, and 8K bytes of additional NVSRAM.

The DS1589 is a clock/calendar chip with the features described above. An external crystal and battery are the only components required to maintain time-of-day and memory status in the absence of power. The DS1593 incorporates the DS1589 chip, a 32.768 kHz

crystal, and a lithium battery in a complete, self-contained timekeeping module. The entire unit is fully tested at Dallas such that a minimum of 10 years of timekeeping and data retention in the absence of V_{CC} is guaranteed.

The DS1589 chip and DS1593 module are identical in function to the DS1585 and DS1587, respectively, with the exception that the AD7–AD0 data bus pins are open drain. This allows easy interface to +3V logic in mixed supply systems. The operational characteristics specific to the DS1589/DS1593 are described in this data sheet. All other operational details are discussed in the DS1585/DS1587 data sheet.

ABSOLUTE MAXIMUM RATINGS*

| | |
|---------------------------------------|----------------------|
| Voltage on Any Pin Relative to Ground | -0.3V to +7.0V |
| Operating Temperature | 0°C to 70°C |
| Storage Temperature | -40°C to +70°C |
| Soldering Temperature | 260°C for 10 seconds |

* This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

RECOMMENDED DC OPERATING CONDITIONS

(0°C to 70°C)

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---------------------------|------------|------|-----|--------------|-------|-------|
| Power Supply Voltage | V_{CC} | 4.5 | 5.0 | 5.5 | V | 1 |
| Input Logic 1 | V_{IH} | 2.2 | | $V_{CC}+0.3$ | V | 1 |
| Input Logic 0 | V_{IL} | -0.3 | | +0.8 | V | 1 |
| Battery Voltage | V_{BAT} | 2.5 | | 3.7 | V | 10 |
| Auxiliary Battery Voltage | V_{BAUX} | 2.5 | | 3.7 | V | 10 |

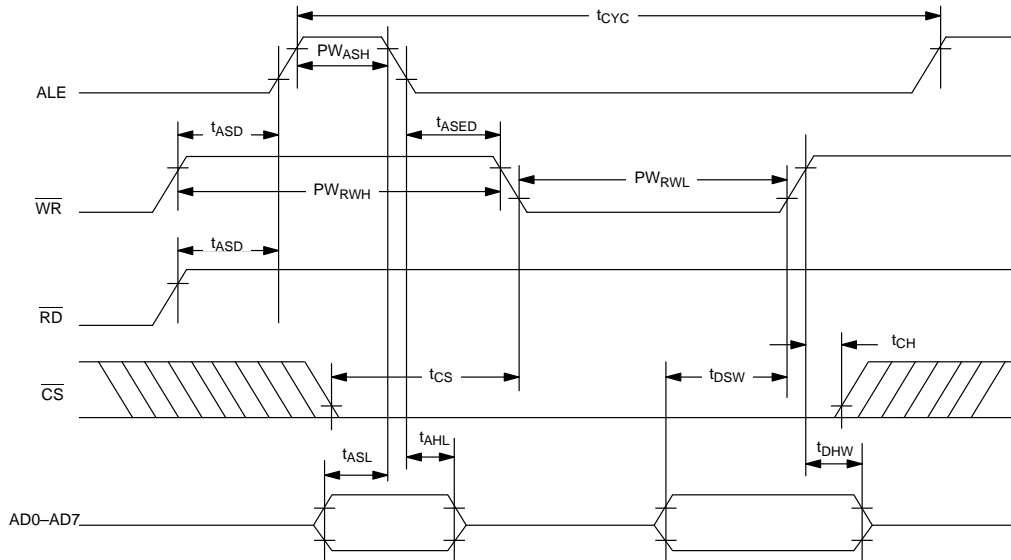
DC ELECTRICAL CHARACTERISTICS

(0°C to 70°C)

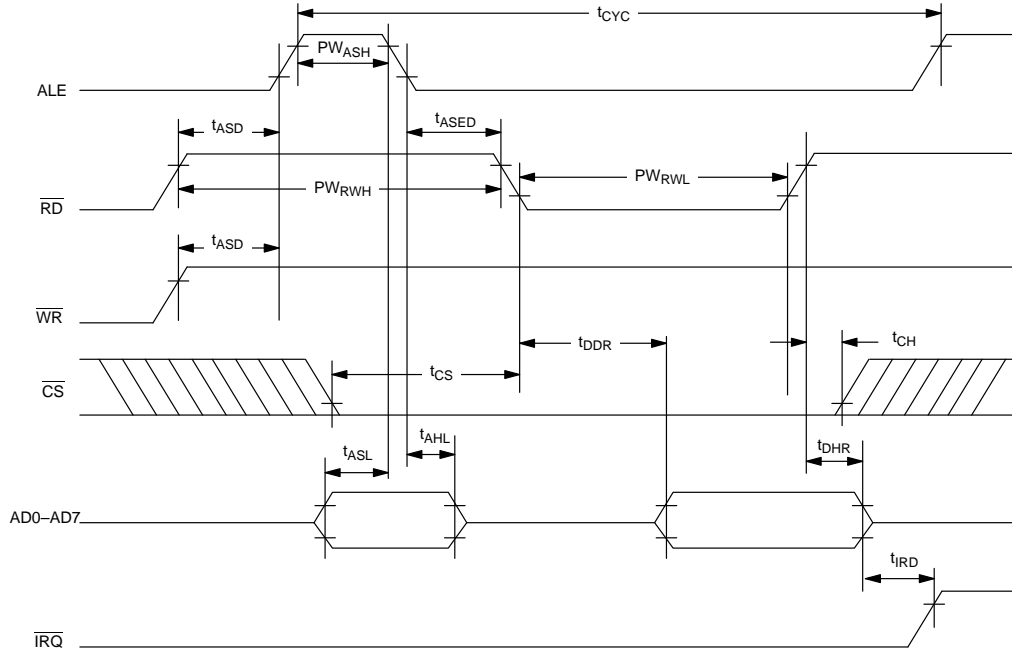
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---|-------------|------|------|------|---------|-------|
| Power Supply Current | I_{CC1} | | 35 | 50 | mA | 2 |
| Standby Current $\overline{CS} = V_{CC} - 0.3V$ | I_{CC2} | | 1 | 5.0 | mA | 6 |
| Input Leakage | I_{IL} | -1.0 | | +1.0 | μA | 3 |
| I/O Leakage | I_{LO} | -1.0 | | +1.0 | μA | 3, 4 |
| Output @ 2.4V | I_{OH} | -1.0 | | | mA | 1, 4 |
| Output @ 0.4V | I_{OL} | | | 2.0 | mA | 1 |
| Power Fail Trip Point | V_{PF} | | 4.25 | | V | 1 |
| PWR Output @ 0.4V | I_{OLPWR} | | | 10.0 | mA | 1 |

RTC AC TIMING CHARACTERISTICS(0°C to 70°C; $V_{CC} = 4.5V$ to $5.5V$)

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--|------------|-----|-----|-----|---------|-------|
| Cycle Time | t_{CYC} | 335 | | DC | ns | 5, 12 |
| Pulse Width, $\overline{RD}/\overline{WR}$ Low | PW_{RWL} | 155 | | | ns | 5, 12 |
| Pulse Width, $\overline{RD}/\overline{WR}$ High | PW_{RWH} | 150 | | | ns | 5, 12 |
| Input Rise and Fall Time | t_R, t_F | | | 30 | ns | |
| Chip Select Setup Time Before \overline{WR} , or \overline{RD} | t_{CS} | 20 | | | ns | |
| Chip Select Hold Time | t_{CH} | 0 | | | ns | |
| Read Data Hold Time | t_{DHR} | 10 | | 80 | ns | |
| Write Data Hold Time | t_{DHW} | 0 | | | ns | |
| Muxed Address Valid Time to ALE Fall | t_{ASL} | 30 | | | ns | |
| Muxed Address Hold Time from ALE fall | t_{AHL} | 10 | | | ns | |
| \overline{RD} or \overline{WR} High Setup to ALE Rise | t_{ASD} | 25 | | | ns | |
| Pulse Width ALE High | PW_{ASH} | 60 | | | ns | 5, 12 |
| ALE Low Setup to \overline{RD} or \overline{WR} Fall | t_{ASED} | 40 | | | ns | |
| Output Data Delay Time from \overline{RD} | t_{DDR} | 20 | | 150 | ns | 5, 12 |
| Data Setup Time | t_{DSW} | 100 | | | ns | |
| \overline{IRQ} Release from \overline{RD} | t_{IRD} | | | 2 | μs | |

DS1589/DS1593 BUS TIMING FOR WRITE CYCLE TO RTC

DS1589/DS1593 BUS TIMING FOR READ CYCLE TO RTC

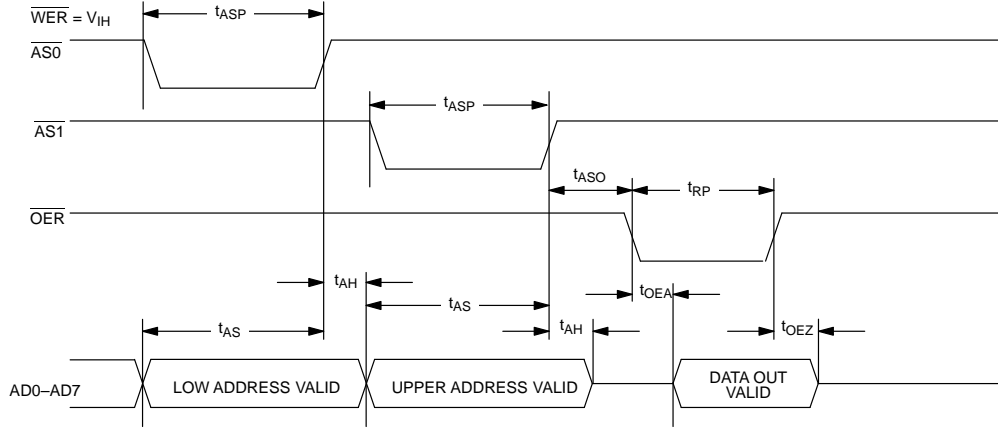
**NOTE:**

Input Levels = 0.8 volts and 2.2 volts.
Output Levels = 0.4 volts and 2.4 volts.

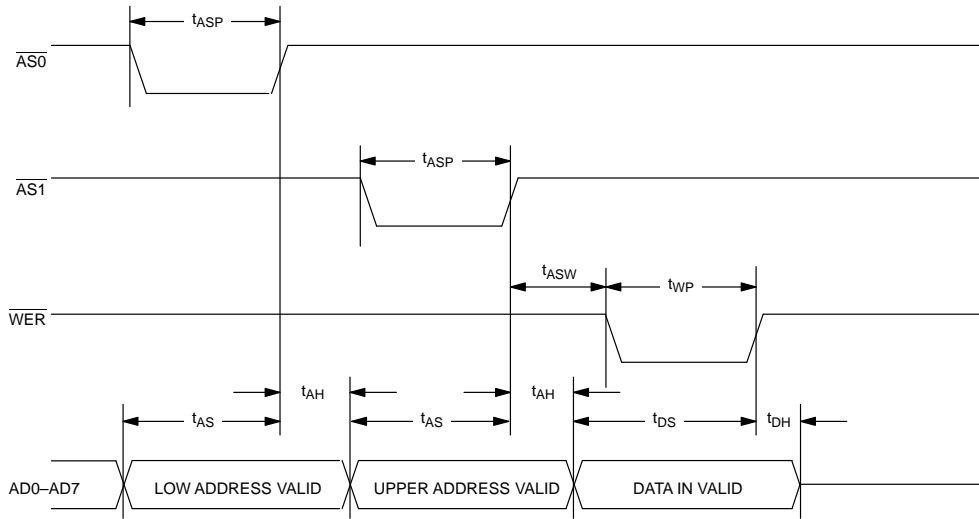
8K X 8 AC TIMING CHARACTERISTICS(0°C to 70°C; $V_{CC} = 5V \pm 10\%$)

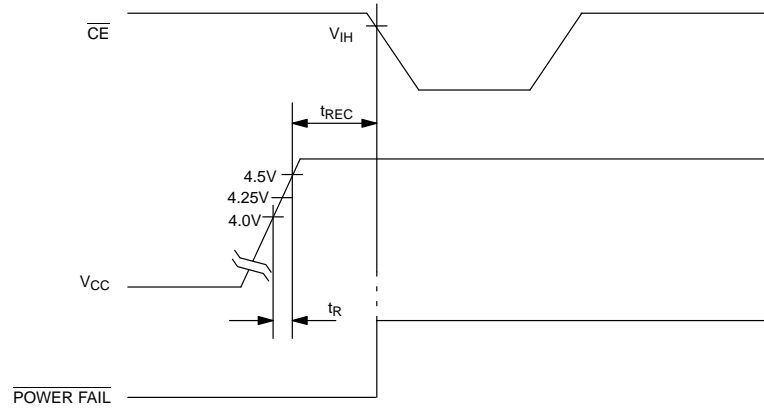
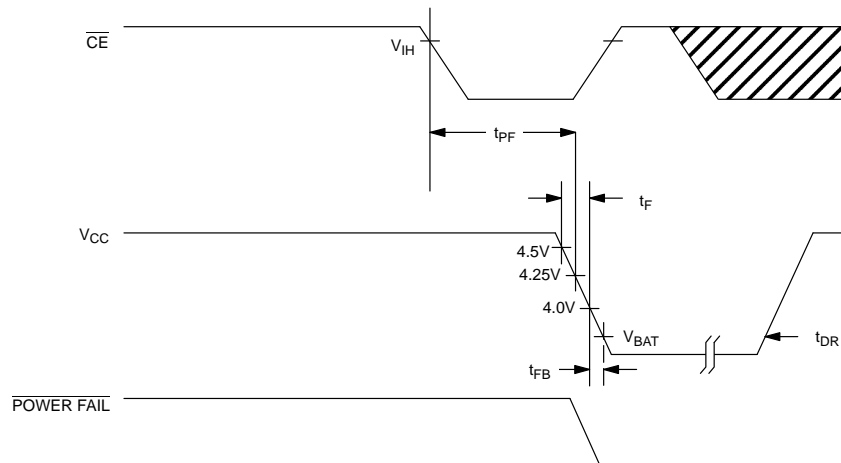
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--|-----------|-----|-----|-----|-------|-------|
| Address Setup Time | t_{AS} | 50 | | | ns | |
| Address Hold Time | t_{AH} | 0 | | | ns | |
| Data Setup Time | t_{DS} | 75 | | | ns | |
| Data Hold Time | t_{DH} | 0 | | | ns | |
| Output Enable Access Time | t_{OEA} | | | 200 | ns | 8 |
| Write Pulse Width | t_{WP} | 125 | | | ns | |
| \overline{OER} to Output in High Z | t_{OEZ} | | | 50 | ns | |
| \overline{OER} Pulse Width | t_{RP} | 200 | | | ns | |
| $\overline{AS0}$, $\overline{AS1}$ Pulse Width | t_{ASP} | 75 | | | ns | |
| $\overline{AS0}$, $\overline{AS1}$ High to \overline{OER} Low | t_{ASO} | 20 | | | ns | |
| $\overline{AS0}$, $\overline{AS1}$ High to \overline{WER} Low | t_{ASW} | 20 | | | ns | |

BUS TIMING FOR READ CYCLE TO 8K X 8 NV SRAM



BUS TIMING FOR WRITE CYCLE TO 8K X 8 SRAM



POWER-UP CONDITION**POWER-DOWN CONDITION**

POWER-UP POWER-DOWN TIMING $(t_A = 25^\circ\text{C})$

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|---|---|-----|-----|-----|---------------|-------|
| $\overline{\text{CE}}$ High to Power Fail | t_{PF} | | | 0 | ns | |
| Recovery at Power Up | t_{REC} | | 150 | | ms | |
| V_{CC} Slew Rate Power Down | t_{F} $4.0 \leq V_{\text{CC}} \leq 4.5\text{V}$ | 300 | | | μs | |
| V_{CC} Slew Rate Power Down | t_{FB} $3.0 \leq V_{\text{CC}} \leq 4.0\text{V}$ | 10 | | | μs | |
| V_{CC} Slew Rate Power Up | t_{R} $4.5\text{V} \geq V_{\text{CC}} \geq 4.0\text{V}$ | 0 | | | μs | |
| Expected Data Retention | t_{DR} | 10 | | | years | 9 |

WARNING:

Under no circumstances are negative undershoots, of any amplitude, allowed when device is in battery back-up mode.

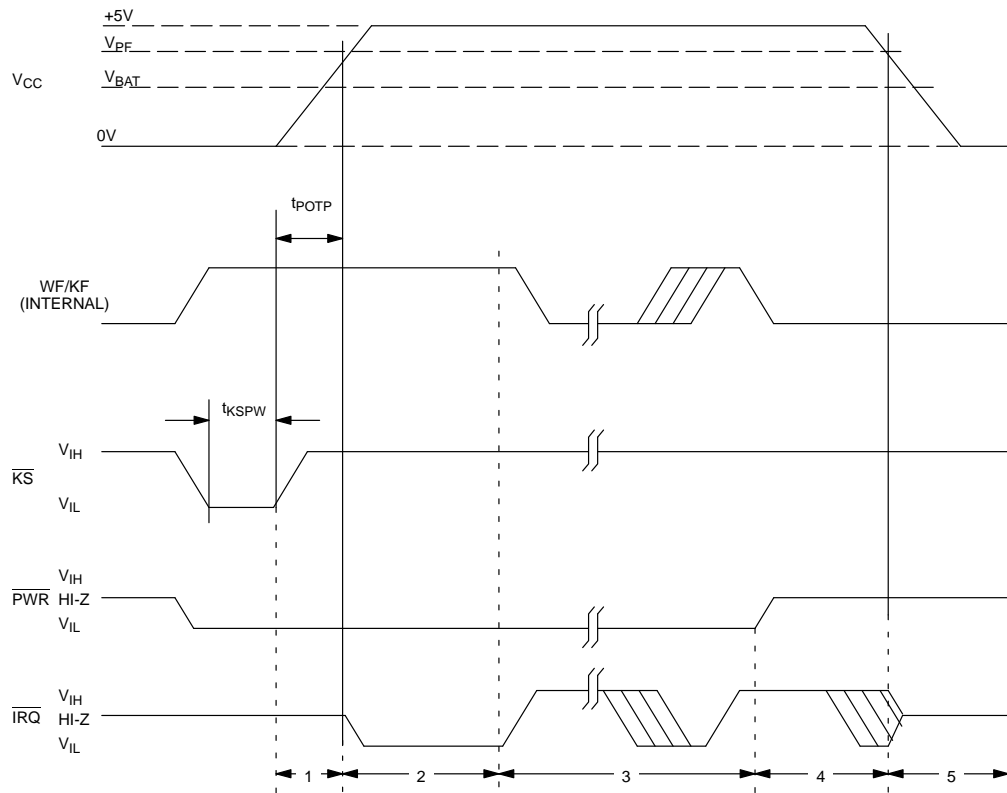
CAPACITANCE $(t_A = 25^\circ\text{C})$

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|--------------------|------------------|-----|-----|-----|-------|-------|
| Input Capacitance | C_{IN} | | | 12 | pF | |
| Output Capacitance | C_{OUT} | | | 12 | pF | |

WAKE UP/KICKSTART TIMING $(t_A = 25^\circ\text{C})$

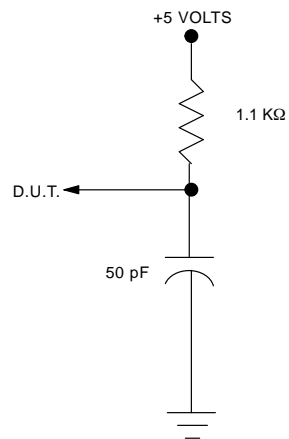
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | NOTES |
|------------------------------------|-------------------|-----|-----|-----|---------------|-------|
| Kickstart Input Pulse Width | t_{KSPW} | 2 | | | μs | |
| Wake up/Kickstart Power On Timeout | t_{POTO} | 2 | | | seconds | 11 |

WAKE UP/KICKSTART TIMING

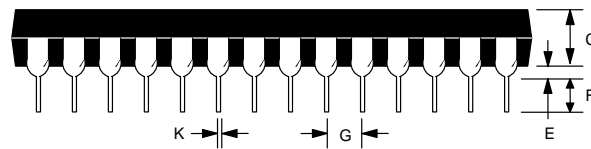
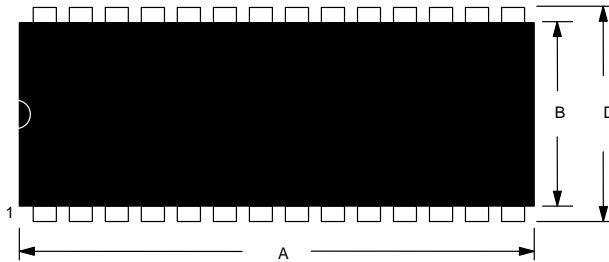


NOTES:

1. All voltages are referenced to ground.
2. All outputs are open.
3. Applies to the AD0-AD7 pins, and the SQW pin when each is in the high impedance state.
4. The $\overline{\text{IRQ}}$ and AD0-AD7 pins are open drain.
5. Measured with a load as shown in Figure 5.
6. All other inputs at CMOS levels.
7. Transition current only applies while input is switched from one state to the other. Quiescent input current given by input leakage current specification.
8. Measured with a load as shown in Figure 5.
9. The real-time clock will keep time to an accuracy of ± 1 minute per month during data retention time for the period of t_{DR} .
10. Applies to DS1589 only.
11. Wake up/Kickstart timeout generated only when the oscillator is enabled and the countdown chain is not reset.
12. Measurement is dependent upon RC time constant of output load.

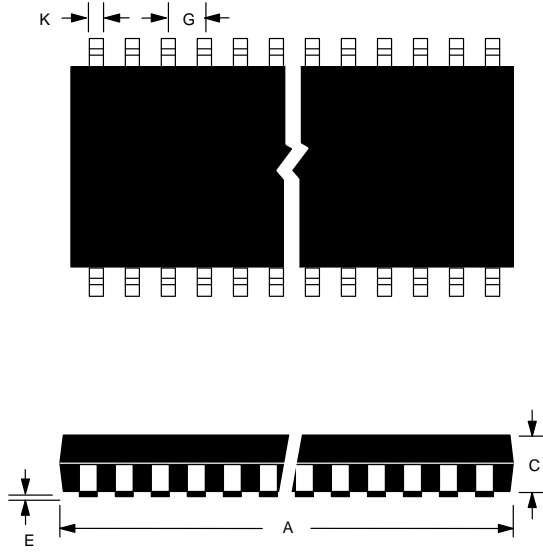
OUTPUT LOAD Figure 5

DS1589 28-PIN DIP

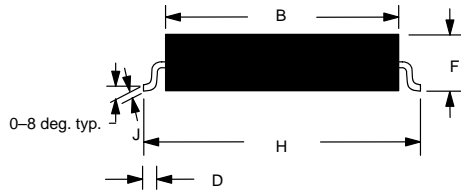


| PKG | 28-PIN | |
|-------|--------|-------|
| | DIM | MIN |
| A IN. | 1.445 | 1.470 |
| MM | 36.70 | 37.34 |
| B IN. | 0.530 | 0.550 |
| MM | 13.46 | 13.97 |
| C IN. | 0.140 | 0.160 |
| MM | 3.56 | 4.06 |
| D IN. | 0.600 | 0.625 |
| MM | 15.24 | 15.88 |
| E IN. | 0.015 | 0.040 |
| MM | 0.38 | 1.02 |
| F IN. | 0.120 | 0.145 |
| MM | 3.05 | 3.68 |
| G IN. | 0.090 | 0.110 |
| MM | 2.29 | 2.79 |
| H IN. | 0.625 | 0.675 |
| MM | 15.88 | 17.15 |
| J IN. | 0.008 | 0.012 |
| MM | 0.20 | 0.30 |
| K IN. | 0.015 | 0.022 |
| MM | 0.38 | 0.56 |

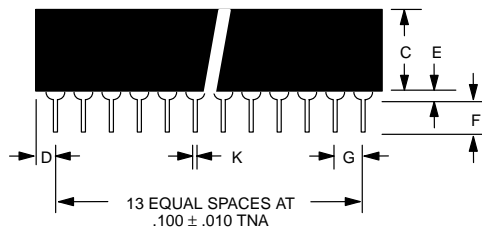
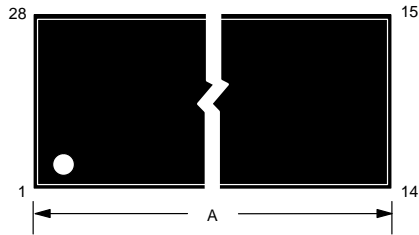
DS1589S 28-PIN SOIC



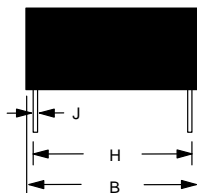
| PKG | 28-PIN | |
|-------|--------|-------|
| | DIM | MIN |
| A IN. | 0.706 | 0.728 |
| MM | 17.93 | 18.49 |
| B IN. | 0.338 | 0.350 |
| MM | 8.58 | 8.89 |
| C IN. | 0.086 | 0.110 |
| MM | 2.18 | 2.79 |
| D IN. | 0.020 | 0.050 |
| MM | 0.58 | 1.27 |
| E IN. | 0.002 | 0.014 |
| MM | 0.05 | 0.36 |
| F IN. | 0.090 | 0.124 |
| MM | 2.29 | 3.15 |
| G IN. | 0.050 | BSC |
| MM | 1.27 | |
| H IN. | 0.460 | 0.480 |
| MM | 11.68 | 12.19 |
| J IN. | 0.006 | 0.013 |
| MM | 0.15 | 0.33 |
| K IN. | 0.014 | 0.020 |
| MM | 0.36 | 0.51 |



DS1593 28-PIN 740 MIL MODULE



| PKG | 28-PIN | |
|-------|--------|-------|
| | DIM | MIN |
| A IN. | 1.520 | 1.540 |
| MM | 38.61 | 39.12 |
| B IN. | 0.695 | 0.720 |
| MM | 17.65 | 18.29 |
| C IN. | 0.350 | 0.375 |
| MM | 8.89 | 9.52 |
| D IN. | 0.100 | 0.130 |
| MM | 2.54 | 3.30 |
| E IN. | 0.015 | 0.030 |
| MM | 0.38 | 0.76 |
| F IN. | 0.110 | 0.140 |
| MM | 2.79 | 3.56 |
| G IN. | 0.090 | 0.110 |
| MM | 2.29 | 2.79 |
| H IN. | 0.590 | 0.630 |
| MM | 14.99 | 16.00 |
| J IN. | 0.008 | 0.012 |
| MM | 0.20 | 0.30 |
| K IN. | 0.015 | 0.021 |
| MM | 0.38 | 0.53 |



NOTE: PINS 2, 3, 19 AND 23 ARE MISSING BY DESIGN.