# M40Z111
# M40Z111W
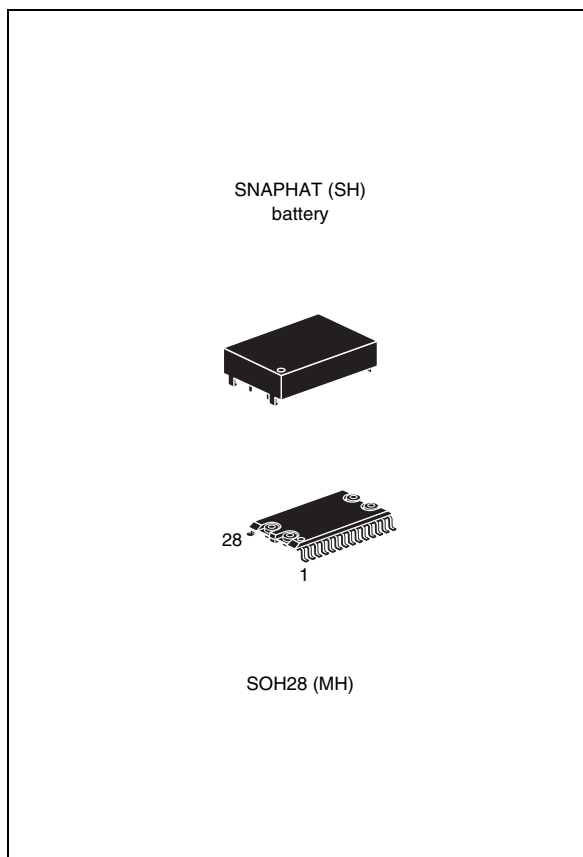
## 5V or 3V NVRAM supervisor for up to two LPSRAMs

## Features

■ Convert low power SRAMs into NVRAMs

■ Precision power monitoring and power switching circuitry

■ Automatic write-protection when $V_{CC}$ is out-of-tolerance

■ Choice of supply voltages and power-fail deselect voltages:
  – M40Z111: $V_{CC}$ = 4.5 to 5.5V
    THS = $V_{SS}$; $4.5 \leq V_{PFD} \leq 4.75V$
    THS = $V_{OUT}$; $4.2 \leq V_{PFD} \leq 4.5V$
  – M40Z111W: $V_{CC}$ = 3.0 to 3.6V
    THS = $V_{SS}$; $2.8 \leq V_{PFD} \leq 3.0V$
    $V_{CC}$ = 2.7 to 3.3V
    THS = $V_{OUT}$; $2.5 \leq V_{PFD} \leq 2.7V$

■ Less than 15ns chip enable access propagation delay (for 5.0v device)

■ Packaging includes a 28-lead SOIC and SNAPHAT® top (to be ordered separately)

■ SOIC package provides direct connection for a SNAPHAT top which contains the battery

■ RoHS compliant
  – Lead-free second level interconnect

SNAPHAT (SH) battery

SOH28 (MH)

28

1

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# 1 Description

The M40Z111/W NVRAM supervisor is a self-contained device which converts a standard low-power SRAM into a non-volatile memory.

A precision voltage reference and comparator monitors the $V_{CC}$ input for an out-of-tolerance condition.

When an invalid $V_{CC}$ condition occurs, the conditioned chip enable ($\overline{E}_{CON}$) output is forced inactive to write-protect the stored data in the SRAM.

During a power failure, the SRAM is switched from the $V_{CC}$ pin to the lithium cell within the SNAPHAT® to provide the energy required for data retention. On a subsequent power-up, the SRAM remains write protected until a valid power condition returns.

The 28-pin, 330mil SOIC provides sockets with gold plated contacts at both ends for direct connection to a separate SNAPHAT housing containing the battery. The unique design allows the SNAPHAT battery package to be mounted on top of the SOIC package after the completion of the surface mount process.

Insertion of the SNAPHAT housing after reflow prevents potential battery damage due to the high temperatures required for device surface-mounting. The SNAPHAT housing is keyed to prevent reverse insertion.

The SOIC and battery packages are shipped separately in plastic anti-static tubes or in Tape & Reel form. For the 28-lead SOIC, the battery package (e.g., SNAPHAT) part number is "M4Z28-BR00SH1" or "M4Z32-BR00SH1" (See *Table 11 on page 19*).

**Figure 1. Logic diagram**
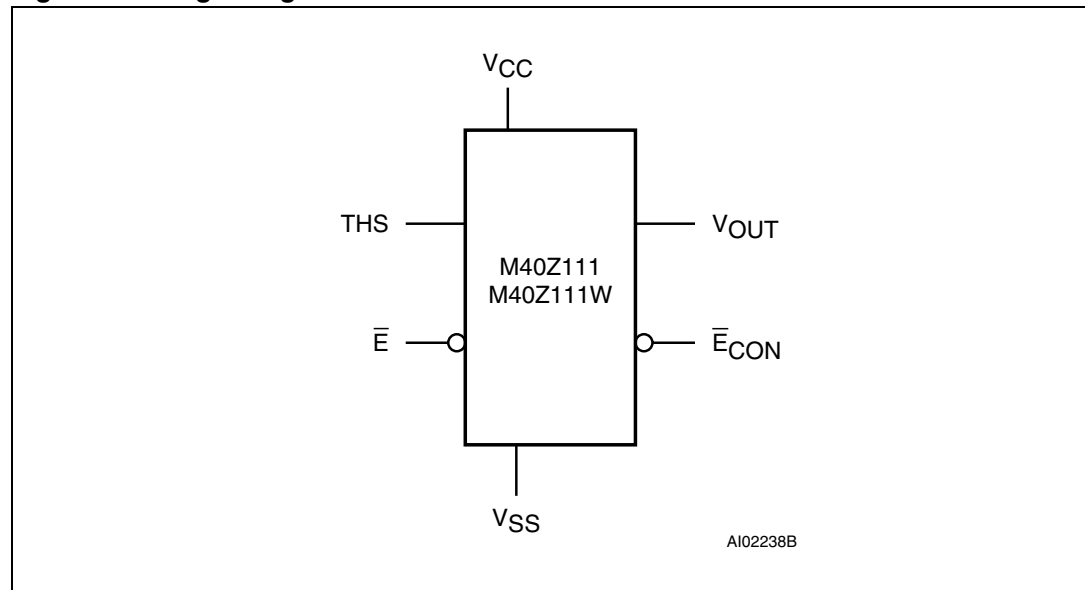
**Table 1.      Signal names**

| | |
|---|---|
| THS | Threshold select input |
| $\overline{E}$ | Chip enable input |
| $\overline{E}_{CON}$ | Conditioned chip enable output |
| $V_{OUT}$ | Supply voltage output |
| $V_{CC}$ | Supply voltage |
| $V_{SS}$ | Ground |
| NC | Not connected internally |

**Figure 2.      SOIC28 connections**



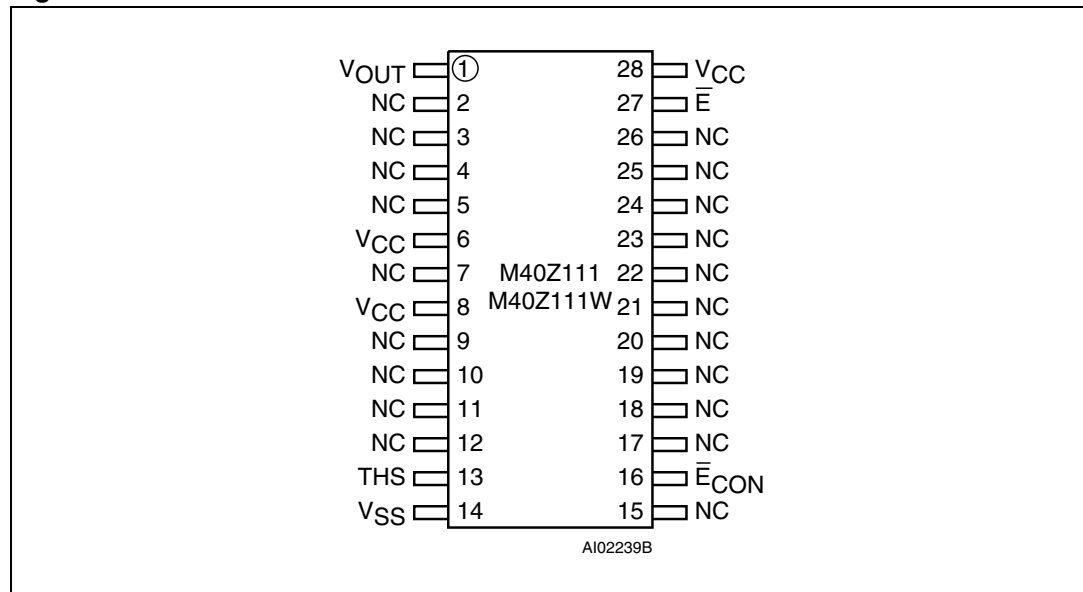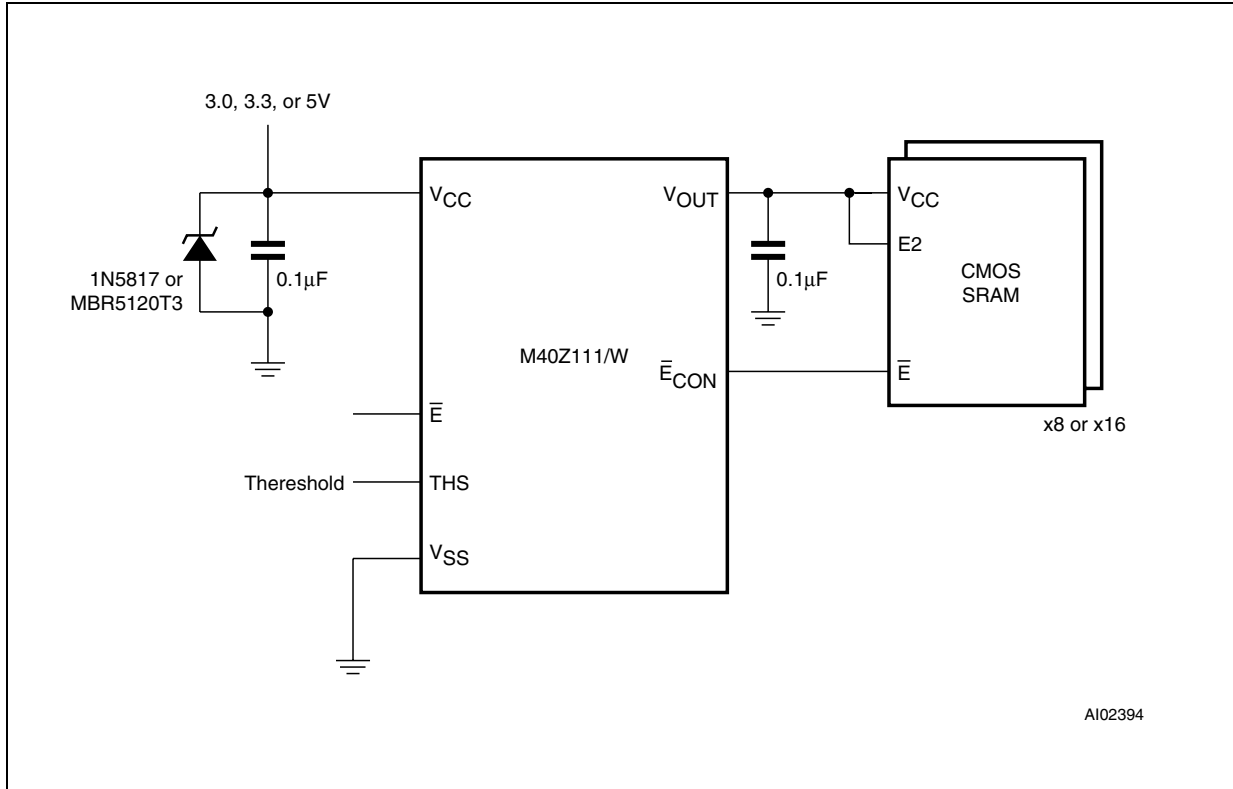| Left pin | | Right pin | |
|---|---|---|---|
| $V_{OUT}$ | 1 | 28 | $V_{CC}$ |
| NC | 2 | 27 | $\overline{E}$ |
| NC | 3 | 26 | NC |
| NC | 4 | 25 | NC |
| NC | 5 | 24 | NC |
| $V_{CC}$ | 6 | 23 | NC |
| NC | 7 | 22 | NC |
| $V_{CC}$ | 8 | 21 | NC |
| NC | 9 | 20 | NC |
| NC | 10 | 19 | NC |
| NC | 11 | 18 | NC |
| NC | 12 | 17 | NC |
| THS | 13 | 16 | $\overline{E}_{CON}$ |
| $V_{SS}$ | 14 | 15 | NC |

M40Z111
M40Z111W

AI02239B

**Figure 3.    Hardware hookup**

# 2 Operation

The M40Z111/W, as shown in *Figure 3 on page 7*, can control up to two standard low-power SRAMs. These SRAMs must be configured to have the chip enable input disable all other input signals. Most slow, low-power SRAMs are configured like this, however many fast SRAMs are not. During normal operating conditions, the conditioned chip enable ($\overline{E}_{CON}$) output pin follows the chip enable ($\overline{E}$) input pin with timing shown in *Table 2 on page 10*. An internal switch connects $V_{CC}$ to $V_{OUT}$. This switch has a voltage drop of less than 0.3V ($I_{OUT1}$).

When $V_{CC}$ degrades during a power failure, $\overline{E}_{CON}$ is forced inactive independent of $\overline{E}$. In this situation, the SRAM is unconditionally write protected as $V_{CC}$ falls below an out-of-tolerance threshold ($V_{PFD}$). The power fail detection value associated with $V_{PFD}$ is selected by the THS pin and is shown in *Table 6 on page 14*.

*Note:* **Note:** *The THS pin must be connected to either $V_{SS}$ or $V_{OUT}$.*

If chip enable access is in progress during a power fail detection, that memory cycle continues to completion before the memory is write protected. If the memory cycle is not terminated within time $t_{WP}$, $\overline{E}_{CON}$ is unconditionally driven high, write protecting the SRAM.

A power failure during a write cycle may corrupt data at the currently addressed location, but does not jeopardize the rest of the SRAM's contents. At voltages below $V_{PFD}$ (min), the user can be assured the memory will be write protected provided the $V_{CC}$ fall time exceeds $t_F$.

As $V_{CC}$ continues to degrade, the internal switch disconnects $V_{CC}$ and connects the internal battery to $V_{OUT}$. This occurs at the switchover voltage ($V_{SO}$). Below the $V_{SO}$, the battery provides a voltage $V_{OHB}$ to the SRAM and can supply current $I_{OUT2}$ (see *Table 6 on page 14*). When $V_{CC}$ rises above $V_{SO}$, $V_{OUT}$ is switched back to the supply voltage. Output $\overline{E}_{CON}$ is held inactive for $t_{ER}$ (200ms maximum) after the power supply has reached $V_{PFD}$, independent of the $\overline{E}$ input, to allow for processor stabilization (see *Figure 5 on page 9*).

## 2.1 Data retention lifetime calculation

Most low power SRAMs on the market today can be used with the M40Z111/W NVRAM SUPERVISOR. There are, however some criteria which should be used in making the final choice of which SRAM to use. The SRAM must be designed in a way where the chip enable input disables all other inputs to the SRAM. This allows inputs to the M40Z111/W and SRAMs to be "Don't Care" once $V_{CC}$ falls below $V_{PFD}$ (min). The SRAM should also guarantee data retention down to $V_{CC}$ = 2.0V. The chip enable access time must be sufficient to meet the system needs with the chip enable propagation delays included. If the SRAM includes a second chip enable pin (E2), this pin should be tied to $V_{OUT}$. If data retention lifetime is a critical parameter for the system, it is important to review the data retention current specifications for the particular SRAMs being evaluated. Most SRAMs specify a data retention current at 3.0V.

Manufacturers generally specify a typical condition for room temperature along with a worst case condition (generally at elevated temperatures). The system level requirements will determine the choice of which value to use. The data retention current value of the SRAMs can then be added to the $I_{CCDR}$ value of the M40Z111/W to determine the total current requirements for data retention.
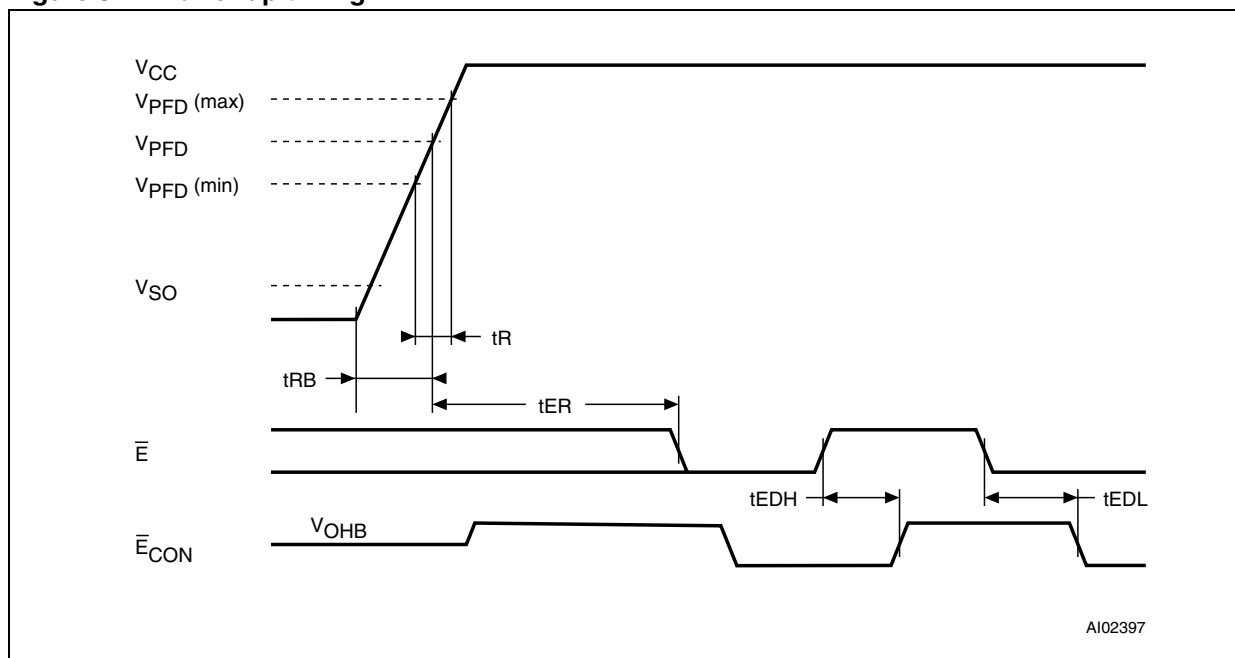
The available battery capacity for the SNAPHAT® of your choice can then be divided by this current to determine the amount of data retention available (see *Table 11 on page 19*). For more information on Battery Storage Life refer to the Application Note AN1012.

**Figure 4.    Power down timing**



AI02396
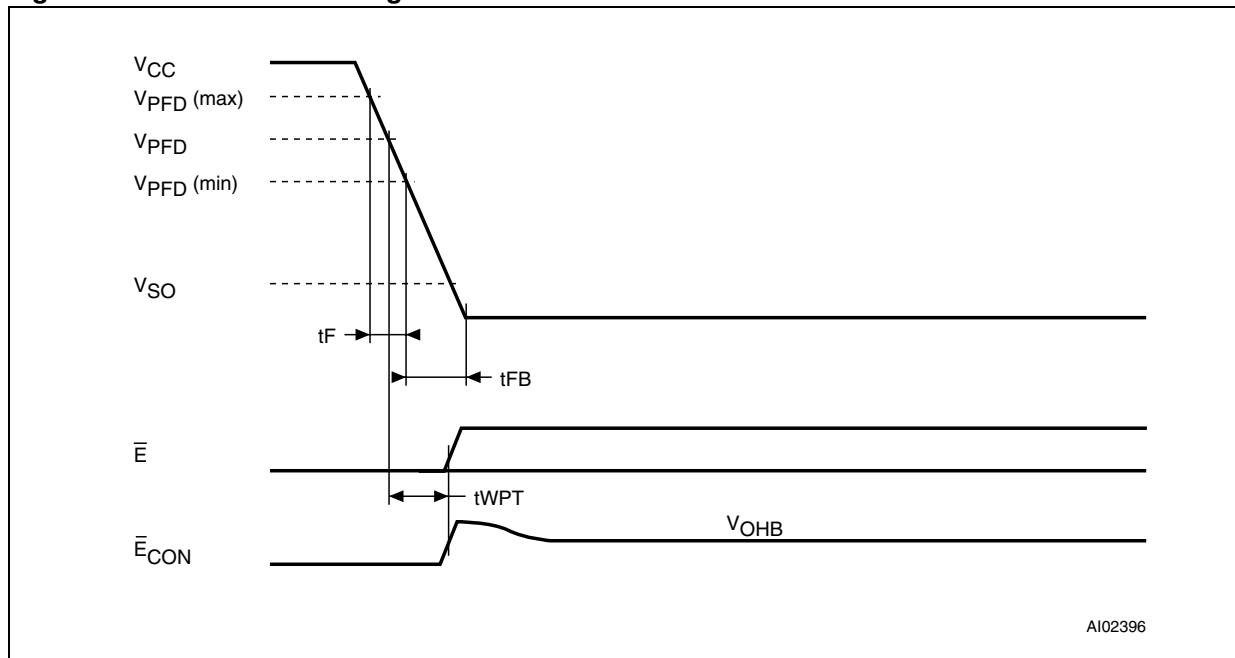
**Figure 5.    Power up timing**



AI02397

**Table 2.     Power down/up AC characteristics**

| Symbol | Parameter[1] | | Min | Max | Unit |
|---|---|---|---|---|---|
| $t_F$ [2] | $V_{PFD}$ (max) to $V_{PFD}$ (min) $V_{CC}$ fall time | | 300 | | μs |
| $t_{FB}$ [3] | $V_{PFD}$ (min) to $V_{SS}$ $V_{CC}$ fall time | | 10 | | μs |
| $t_R$ | $V_{PFD}$ (min) to $V_{PFD}$ (max) $V_{CC}$ rise time | | 10 | | μs |
| $t_{RB}$ | $V_{SS}$ to $V_{PFD}$ (min) $V_{CC}$ rise time | | 1 | | μs |
| $t_{EDL}$ | Chip enable propagation delay | M40Z111 | | 15 | ns |
| | | M40Z111W | | 20 | ns |
| $t_{EDH}$ | Chip enable propagation delay | M40Z111 | | 10 | ns |
| | | M40Z111W | | 20 | ns |
| $t_{ER}$ [4] | Chip enable recovery | | 40 | 200 | ms |
| $t_{WPT}$ | Write protect time | M40Z111 | 40 | 150 | μs |
| | | M40Z111W | 40 | 250 | μs |

1.   Valid for ambient operating temperature: $T_A$ = –40 to 85°C; $V_{CC}$ = 4.5 to 5.5V or 2.7 to 3.6V (except where noted).

2.   $V_{PFD}$ (max) to $V_{PFD}$ (min) fall time of less than $t_F$ may result in deselection/write protection not occurring until 200 μs after $V_{CC}$ passes $V_{PFD}$ (min).

3.   $V_{PFD}$ (min) to $V_{SS}$ fall time of less than $t_{FB}$ may cause corruption of RAM data.

4.   $t_{ER}$ (min) = 20ms for industrial temperature range - grade 6 device.

## 2.2      $V_{CC}$ noise and negative going transients

$I_{CC}$ transients, including those produced by output switching, can produce voltage fluctuations, resulting in spikes on the $V_{CC}$ bus. These transients can be reduced if capacitors are used to store energy which stabilizes the $V_{CC}$ bus. The energy stored in the bypass capacitors will be released as low going spikes are generated or energy will be absorbed when overshoots occur. A ceramic bypass capacitor value of 0.1μF (as shown in *Figure 6*) is recommended in order to provide the needed filtering.

In addition to transients that are caused by normal SRAM operation, power cycling can generate negative voltage spikes on $V_{CC}$ that drive it to values below $V_{SS}$ by as much as one volt. These negative spikes can cause data corruption in the SRAM while in battery backup mode. To protect from these voltage spikes, STMicroelectronics recommends connecting a schottky diode from $V_{CC}$ to $V_{SS}$ (cathode connected to $V_{CC}$, anode to $V_{SS}$). Schottky diode 1N5817 is recommended for through hole and MBRS120T3 is recommended for surface mount.

**Figure 6.    Supply voltage protection**
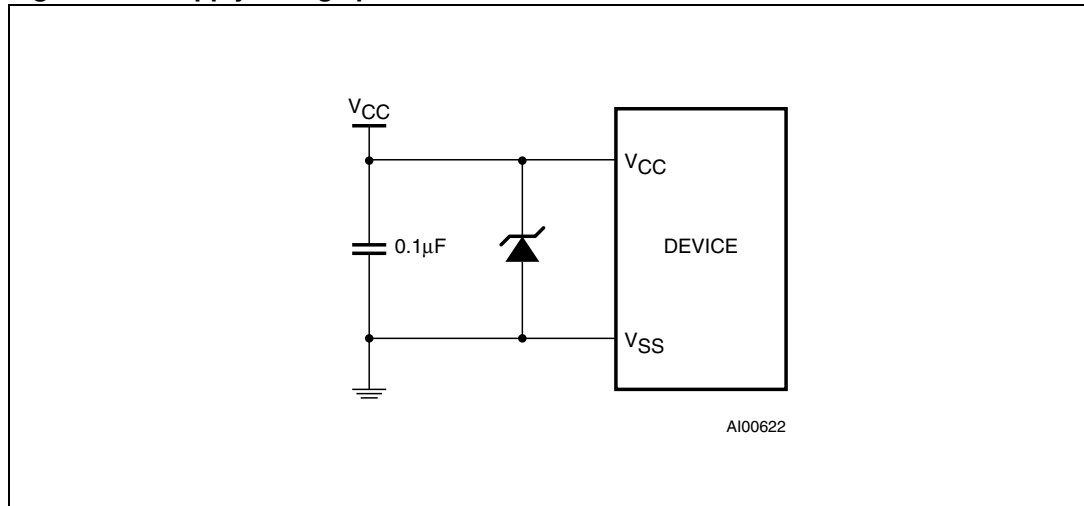
# 3 Maximum rating

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 3. Absolute maximum ratings**

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $T_A$ | Ambient operating temperature | Grade 6 | –40 to 85 | °C |
| $T_{STG}$ | Storage temperature ($V_{CC}$ off) | SNAPHAT® | –40 to 85 | °C |
| | | SOIC | –55 to 125 | °C |
| $T_{SLD}$[1] | Lead solder temperature for 10 seconds | | 260 | °C |
| $V_{IO}$ | Input or output voltages | | –0.3 to $V_{CC}$ +0.3 | V |
| $V_{CC}$ | Supply voltage | M40Z111 | –0.3 to 7.0 | V |
| | | M40Z111W | –0.3 to 4.6 | V |
| $I_O$ | Output current | | 20 | mA |
| $P_D$ | Power dissipation | | 1 | W |

1. For SO package, lead-free (Pb-free) lead finish: reflow at peak temperature of 260°C (total thermal budget not to exceed 245°C for greater than 30 seconds).

**Caution:** Negative undershoots below –0.3V are not allowed on any pin while in the Battery Back-up mode.

**Caution:** Do NOT wave solder SOIC to avoid damaging SNAPHAT sockets.

# 4    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 Measurement Conditions listed in *Table 4: DC and AC measurement conditions*. Designers should check that the operating conditions in their projects match the measurement conditions when using the quoted parameters.

**Table 4.    DC and AC measurement conditions**

| Parameter | M40Z111 | M40Z111W |
|---|---|---|
| $V_{CC}$ supply voltage | 4.5 to 5.5V | 2.7 to 3.6V |
| Ambient operating temperature | −40 to 85°C | −40 to 85°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:*       *Note that Output Hi-Z is defined as the point where data is no longer driven.*

**Figure 7.    AC testing load circuit**
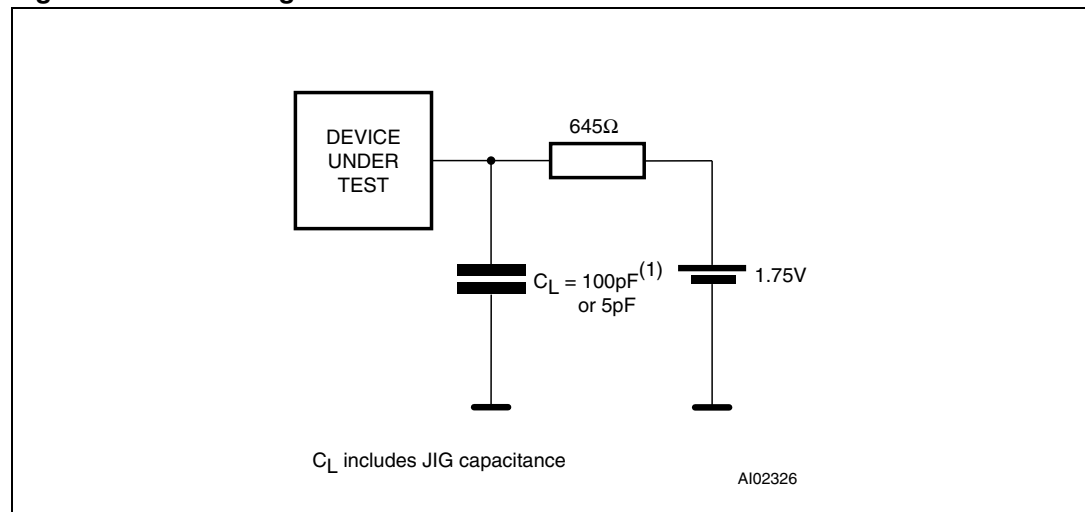


1.  50pF for M40Z111W.

**Table 5.    Capacitance**

| Symbol | Parameter[1][2] | Min | Max | Unit |
|---|---|---|---|---|
| $C_{IN}$ | Input capacitance | | 8 | pF |
| $C_{OUT}$[3] | Output capacitance | | 10 | pF |

1.  Effective capacitance measured with power supply at 5V (M40Z111) or 3.3V (M40Z111W); sampled only, not 100% tested.

2.  At 25°C, f = 1MHz.

3.  Outputs deselected

**Table 6.    DC characteristics**

| Sym | Parameter | Test condition[1] | M40Z111 | | | M40Z111W | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $I_{CC}$ | Supply current | Outputs open | | 3 | 6 | | 2 | 4 | mA |
| $I_{CCDR}$ | Data retention mode current | | | | 150 | | | 150 | nA |
| $I_{LI}$ | Input leakage current | $0V \leq V_{IN} \leq V_{CC}$ | | | ±1 | | | ±1 | μA |
| $I_{LO}$[2] | Output leakage current | $0V \leq V_{OUT} \leq V_{CC}$ | | | ±1 | | | ±1 | μA |
| $I_{OUT1}$ | $V_{OUT}$ current (active) | $V_{OUT} > V_{CC} -0.3$ | | | 160 | | | 100 | mA |
| | | $V_{OUT} > V_{CC} -0.2$ | | | 100 | | | 65 | mA |
| $I_{OUT2}$ | $V_{OUT}$ current (battery back-up) | $V_{OUT} > V_{BAT} -0.3$ | | 100 | | | 100 | | μA |
| $V_{BAT}$ | Battery voltage | | 2.0 | 3.0 | 3.5 | 2.0 | 3.0 | 3.5 | V |
| $V_{IH}$ | Input high voltage | | 2.2 | | $V_{CC} + 0.3$ | 2.0 | | $V_{CC} + 0.3$ | V |
| $V_{IL}$ | Input low voltage | | −0.3 | | 0.8 | −0.3 | | 0.8 | V |
| $V_{OH}$ | Output high voltage | $I_{OH} = -2.0mA$ | 2.4 | | | 2.4 | | | V |
| $V_{OHB}$ | $V_{OH}$ battery back-up | $I_{OUT2} = -1.0μA$ | 2.0 | 2.9 | 3.6 | 2.0 | 2.9 | 3.6 | V |
| $V_{OL}$ | Output low voltage | $I_{OL} = 4.0mA$ | | | 0.4 | | | 0.4 | V |
| THS | Threshold select voltage | | $V_{SS}$ | | $V_{OUT}$ | $V_{SS}$ | | $V_{OUT}$ | V |
| $V_{PFD}$ | Power-fail deselect voltage (THS = $V_{SS}$) | | 4.50 | 4.60 | 4.75 | 2.80 | 2.90 | 3.00 | V |
| | Power-fail deselect voltage (THS = $V_{OUT}$) | | 4.20 | 4.35 | 4.50 | 2.50 | 2.60 | 2.70 | V |
| $V_{SO}$ | Battery back-up switchover voltage | | | 3.0 | | | $V_{PFD} -$ 100mV | | V |

1.  Valid for ambient operating temperature: $T_A$ = −40 to 85°C; $V_{CC}$ = 4.5 to 5.5V or 2.7 to 3.6V (except where noted).

2.  Outputs deselected.

# 5 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

**Figure 8. SOH28 – 28-lead plastic small outline, 4-socket battery SNAPHAT, package outline**
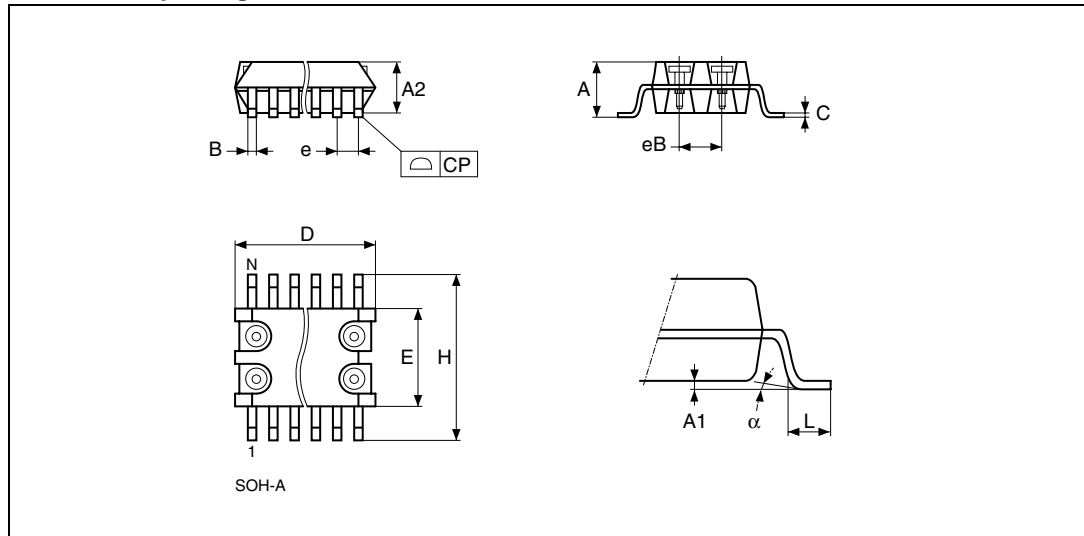


*Note:* *Drawing is not to scale.*

**Table 7. SOH28 – 28-lead plastic small outline, battery SNAPHAT, pack. mech. data**

| Symbol | mm | | | inches | | |
|---|---|---|---|---|---|---|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 3.05 | | | 0.120 |
| A1 | | 0.05 | 0.36 | | 0.002 | 0.014 |
| A2 | | 2.34 | 2.69 | | 0.092 | 0.106 |
| B | | 0.36 | 0.51 | | 0.014 | 0.020 |
| C | | 0.15 | 0.32 | | 0.006 | 0.012 |
| D | | 17.71 | 18.49 | | 0.697 | 0.728 |
| E | | 8.23 | 8.89 | | 0.324 | 0.350 |
| e | 1.27 | – | – | 0.050 | – | – |
| eB | | 3.20 | 3.61 | | 0.126 | 0.142 |
| H | | 11.51 | 12.70 | | 0.453 | 0.500 |
| L | | 0.41 | 1.27 | | 0.016 | 0.050 |
| a | | 0° | 8° | | 0° | 8° |
| N | 28 | | | 28 | | |
| CP | | | 0.10 | | | 0.004 |

**Figure 9.     4-pin SNAPHAT housing for 48mAh battery, package outline**



SHZP-A
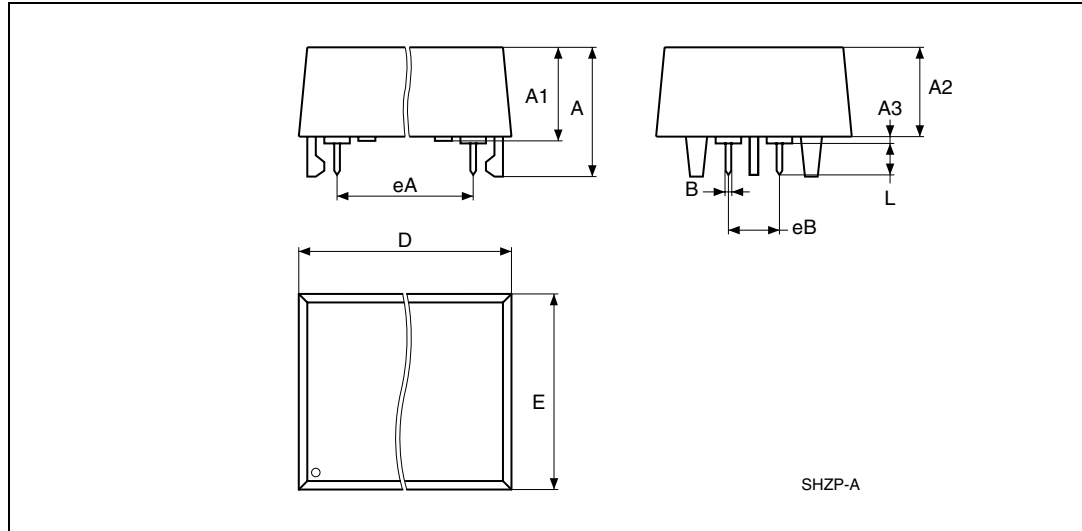
*Note:*        *Drawing is not to scale.*

**Table 8.        4-pin SNAPHAT housing for 48mAh battery, package mechanical data**

| Symbol | mm | | | inches | | |
|---|---|---|---|---|---|---|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 9.78 | | | 0.385 |
| A1 | | 6.73 | 7.24 | | 0.265 | 0.285 |
| A2 | | 6.48 | 6.99 | | 0.255 | 0.275 |
| A3 | | | 0.38 | | | 0.015 |
| B | | 0.46 | 0.56 | | 0.018 | 0.022 |
| D | | 21.21 | 21.84 | | 0.835 | 0.860 |
| E | | 14.22 | 14.99 | | 0.560 | 0.590 |
| eA | | 15.55 | 15.95 | | 0.612 | 0.628 |
| eB | | 3.20 | 3.61 | | 0.126 | 0.142 |
| L | | 2.03 | 2.29 | | 0.080 | 0.090 |

**Figure 10.    4-pin SNAPHAT housing for 120mAh battery, package outline**



SHZP-A
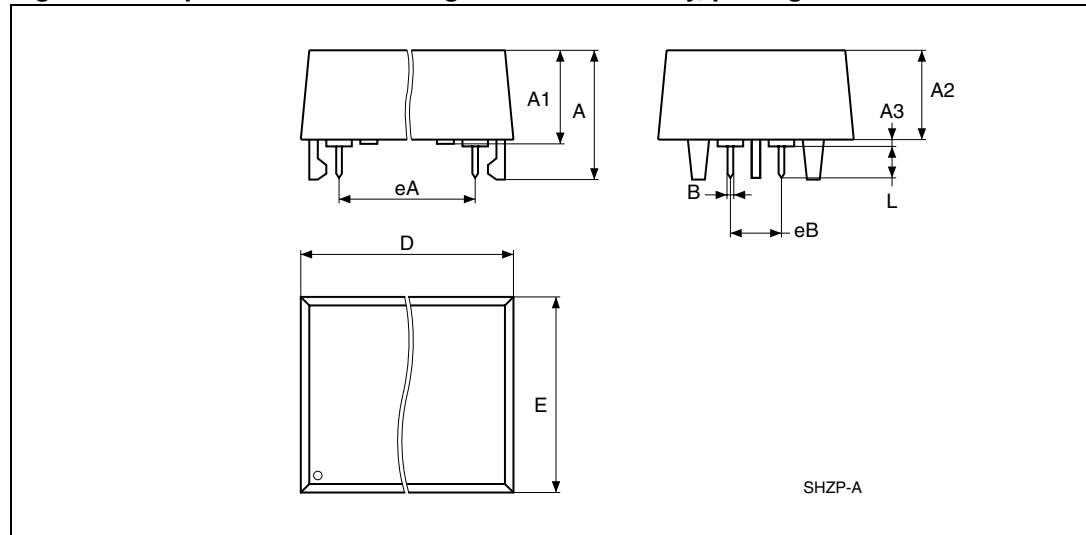
*Note:*        *Drawing is not to scale.*

**Table 9.       4-pin SNAPHAT housing for 120mAh battery, package mechanical data**

| Symbol | mm | | | inches | | |
|---|---|---|---|---|---|---|
| | Typ | Min | Max | Typ | Min | Max |
| A | | | 10.54 | | | 0.415 |
| A1 | | 8.00 | 8.51 | | 0.315 | 0.335 |
| A2 | | 7.24 | 8.00 | | 0.285 | 0.315 |
| A3 | | | 0.38 | | | 0.015 |
| B | | 0.46 | 0.56 | | 0.018 | 0.022 |
| D | | 21.21 | 21.84 | | 0.835 | 0.860 |
| E | | 17.27 | 18.03 | | 0.680 | 0.710 |
| eA | | 15.55 | 15.95 | | 0.612 | 0.628 |
| eB | | 3.20 | 3.61 | | 0.126 | 0.142 |
| L | | 2.03 | 2.29 | | 0.080 | 0.090 |

# 6 Part numbering

### Table 10. Ordering information scheme

| Example: | M40Z | 111W | MH | 6 | E |

**Device type**

M40Z

**Supply voltage and write protect voltage**

111 = $V_{CC}$ = 4.5 to 5.5V; $V_{PFD}$ = 4.3 to 4.5V

   THS = $V_{SS}$ = 4.5 ≤ $V_{PFD}$ ≤ 4.75V

   THS = $V_{OUT}$ = 4.2 ≤ $V_{PFD}$ ≤ 4.5V

111W = $V_{CC}$ = 2.7 to 3.6V; $V_{PFD}$ = 2.6 to 2.7V

   THS = $V_{SS}$ = 2.8 ≤ $V_{PFD}$ ≤ 3.0V

   $V_{CC}$ = 2.7 to 3.3V

   THS = $V_{OUT}$ = 2.5 ≤ $V_{PFD}$ ≤ 2.7V

**Package**

MH[(1)] = SOH28

**Temperature range**

6 = –40 to 85°C

**Shipping method for SOIC**

E = Lead-free ECOPACK® package, tubes

F = Lead-free ECOPACK® package, tape & reel

1. The SOIC package (SOH28) requires the battery package (SNAPHAT®) which is ordered separately under the part number "M4ZXX-BR00SHX" in plastic tubes or "M4ZXX-BR00SHXTR" in tape & reel form.

**Caution:** Do not place the SNAPHAT battery package "M4ZXX-BR00SH" in conductive foam as this will drain the lithium button-cell battery.

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.

### Table 11. Battery table

| Part number | Description | Package |
|---|---|---|
| M4Z28-BR00SH1 | SNAPHAT housing for 48mAh battery | SH |
| M4Z32-BR00SH1 | SNAPHAT housing for 120mAh battery | SH |

# 7    Revision history

**Table 12.    Document revision history**

| Date | Revision | Changes |
|---|---|---|
| Sep-2000 | 1 | First Draft Issue |
| 14-Sep-2001 | 2 | Reformatted, TOC added, changed DC Characteristics (*Table 6*); changed battery, ind. temperature information (*Table 3*, *2*, *10*, *11*, *Figure 9*, *10*); Corrected SOIC label (*Figure 2*); added E2 to Hookup (*Figure 3*) |
| 13-May-2002 | 3 | Modify reflow time and temperature footnote (*Table 3*) |
| 12-Nov-2007 | 4 | Reformatted document; added lead-free second level interconnect information to cover page and *Section 5: Package mechanical data*; updated *Figure 5*, *Table 3*, *10*, *11*. |

**Please Read Carefully:**