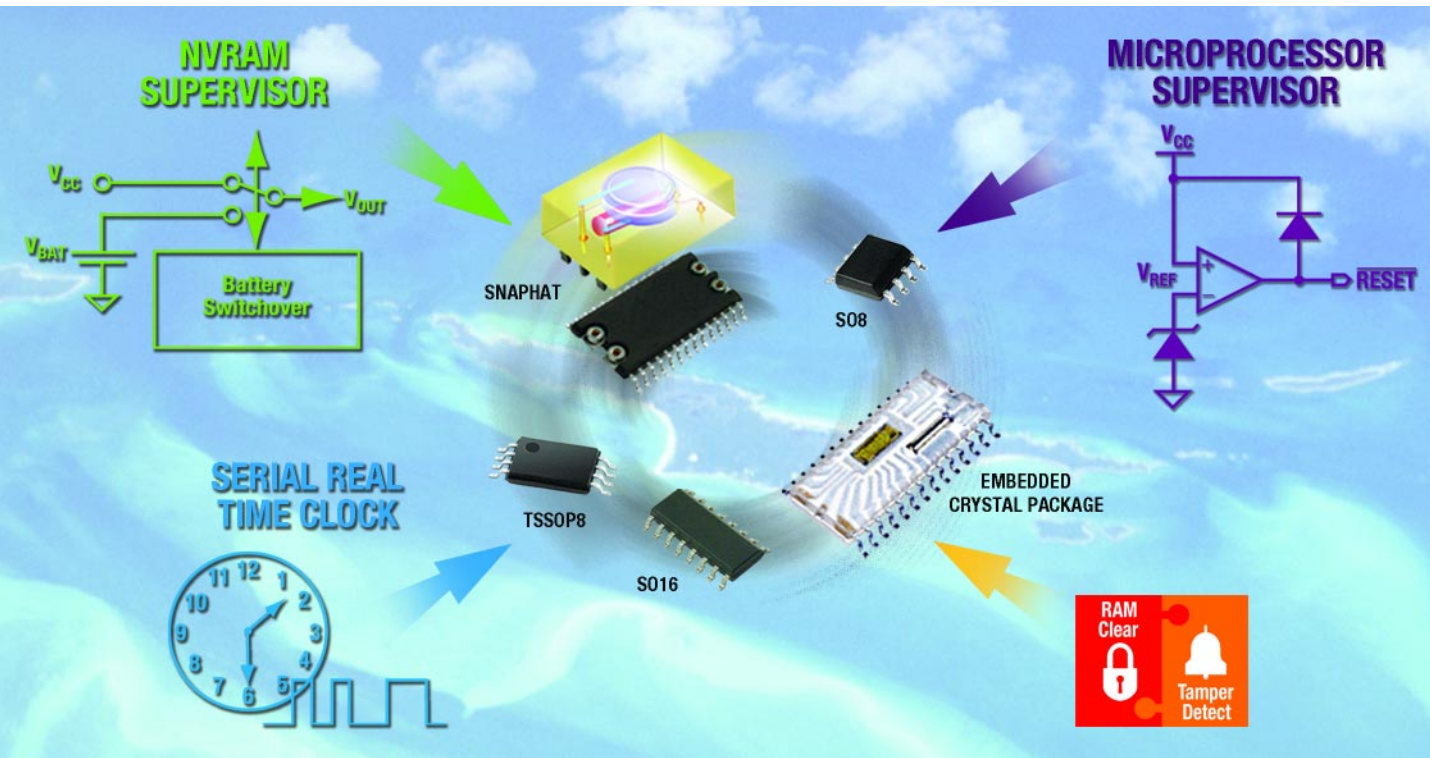


Serial real-time clocks

For timekeeping, data protection and supervision of microprocessors and NVRAM

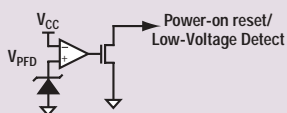


STMicroelectronics' serial real-time clocks (RTCs) range from low-cost devices providing time-of-day and date to highly integrated devices with features such as tamper detect with RAM clear, power-on reset/low-voltage detect, battery monitor and watchdog. Industry standard solutions with both I²C and SPI interfaces are available in small footprint packages including SO8 and TSSOP.

Microprocessor supervisor features

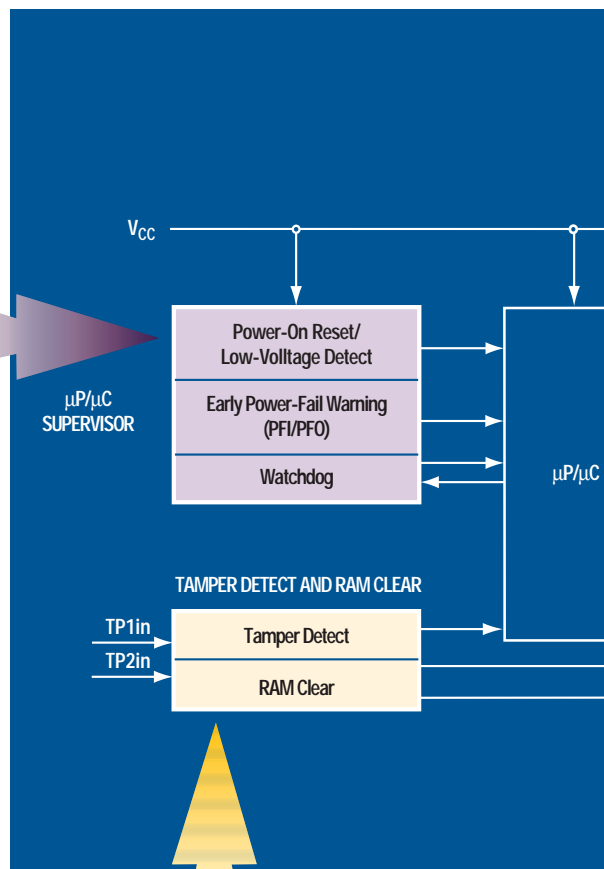
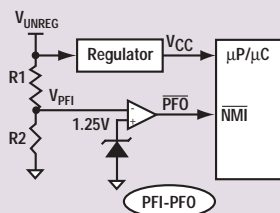
Power-on reset and low-voltage detect

Many of ST's Serial RTCs include a power-on reset/low-voltage detect output which can be used as a reset input to the processor.



Power-fail input/power-fail output

Power-fail input/power-fail output uses a precision reference and comparator to provide an early power-fail warning signal which enables the system to shut down smoothly. Key system parameters and data can be stored to NVRAM before power failure, ensuring that the system can be fully restored at power-up.

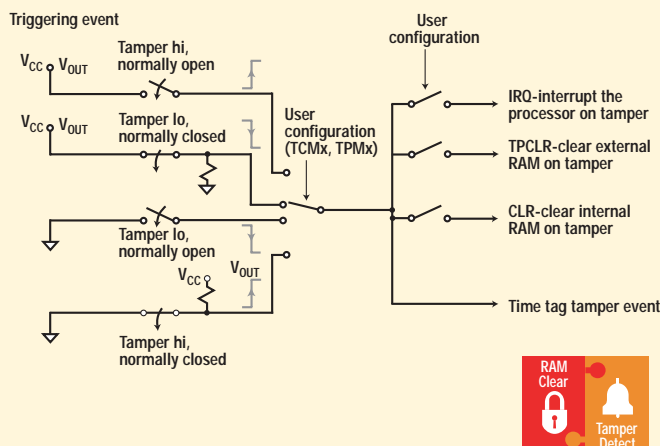


Tamper detect and RAM clear

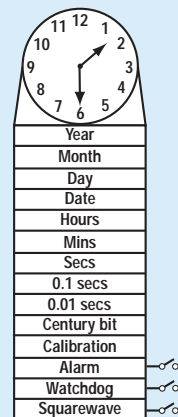
The tamper detect function is configurable for a variety of detect schemes including making or breaking a connection and low-to-high and high-to-low transitions.

RAM clear is one of several options in response to a tamper event. Besides automatically storing the time of the tamper event, M41ST87 can be configured by the user to do one or more of the following:

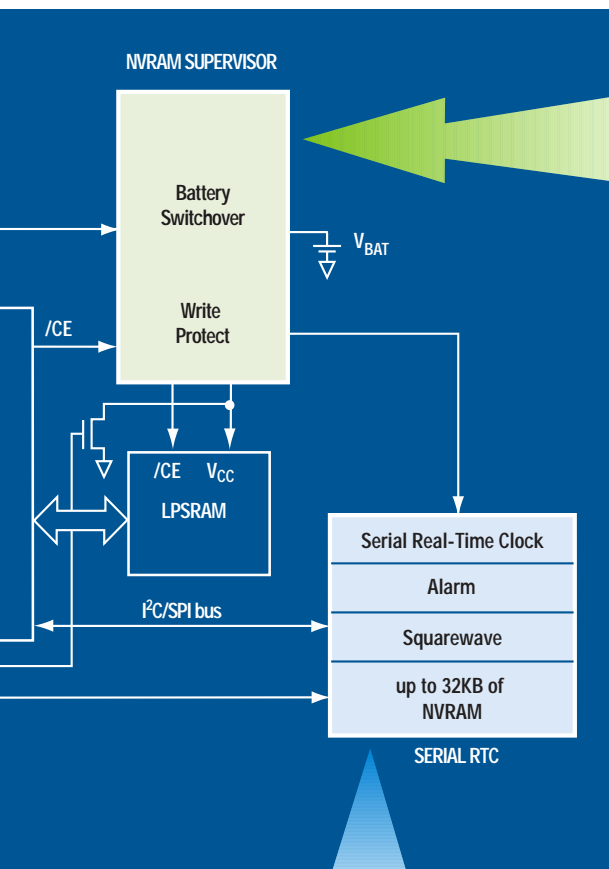
- Clear internal RAM
- Clear external RAM
- Interrupt the processor



Real-Time clock



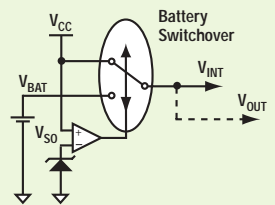
Real-Time Clocks: a wide range of features



NVRAM supervisor non-volatizes the LPSRAM

Battery switchover

Most ST RTCs include the battery switchover circuit. When power fails, this automatically connects the device to the battery to ensure the clock and the internal non-volatile RAM (NVRAM) is maintained.

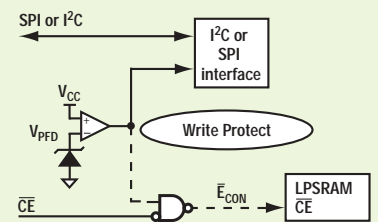


V_{OUT}

Some of ST's higher end devices output the switched voltage so that it can be used to non-volatize an external low-power SRAM (LPSRAM).

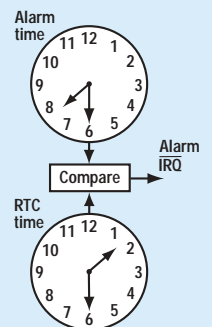
Write protect

Whenever power fails, the power-fail detect circuit provides a write protect mechanism which prevents possible corruption of the clock or internal NVRAM. This can occur as a result of inadvertent microprocessor writes while power is failing. Devices with the V_{OUT} feature also include a chip-enable gate to extend the write protection to the external LPSRAM.

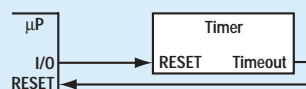


The RTC not only maintains the date and time, it also keeps track of the day of the week and tenths and hundredths of seconds. A common feature of ST RTCs is the calibration register which gives users the option of tuning clock accuracy to within 5 seconds per month.

The RTC also provides the basis for the other timing functions such as the **alarm**. The alarm functions just like an alarm clock. When the time of day matches the preset alarm time, an output is generated which signals the alarm condition to the system.



The **watchdog timer** is a standard building block used to protect systems against runaway software. ST's standard watchdog is user-programmable and supports timeout intervals from 62.5 milliseconds to 128 seconds.



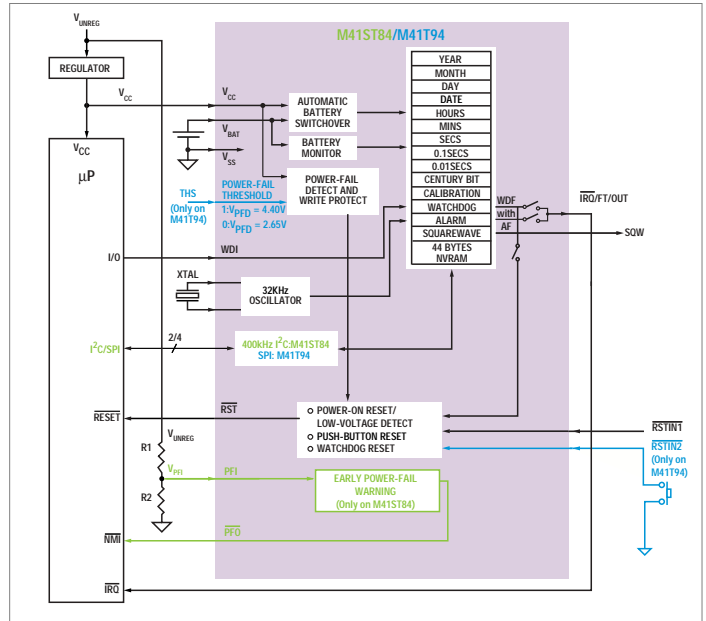
Many of our products include a **programmable squarewave** generator which can be programmed from 1Hz to 32KHz. Some products also include an additional full-time 32KHz output, ideal for microcontrollers which require a 32KHz reference for low-power modes and clock synthesis.

- Alarm
- Wdog
- Sq wave

M41T94 and M41ST84 microprocessor supervisors

These serial RTCs also include power-on reset/low-voltage detect outputs along with watchdog and can provide the microprocessor supervisor functions needed in all applications.

- 400kHz I²C interface (M41ST84)
- SPI interface (M41T94)
- Automatic battery switchover and write protect
- 44 bytes of NVRAM
- Programmable alarm
 - Functions in battery-backed mode
- Programmable square wave generator
 - 1Hz to 32kHz output
- Calibration - accuracy down to two seconds per month
- Power-on reset/low-voltage detect
- Programmable watchdog
 - 62.5 milliseconds to 128 seconds
- Battery monitor
- Early power-fail warning
- Both devices come in SO16 plus the M41T94 is available in ST's SOH28 SNAPHAT IC
- The M41ST84 comes in 3V and 5V versions
- The M41T94 operates from 2.7 to 5.5V



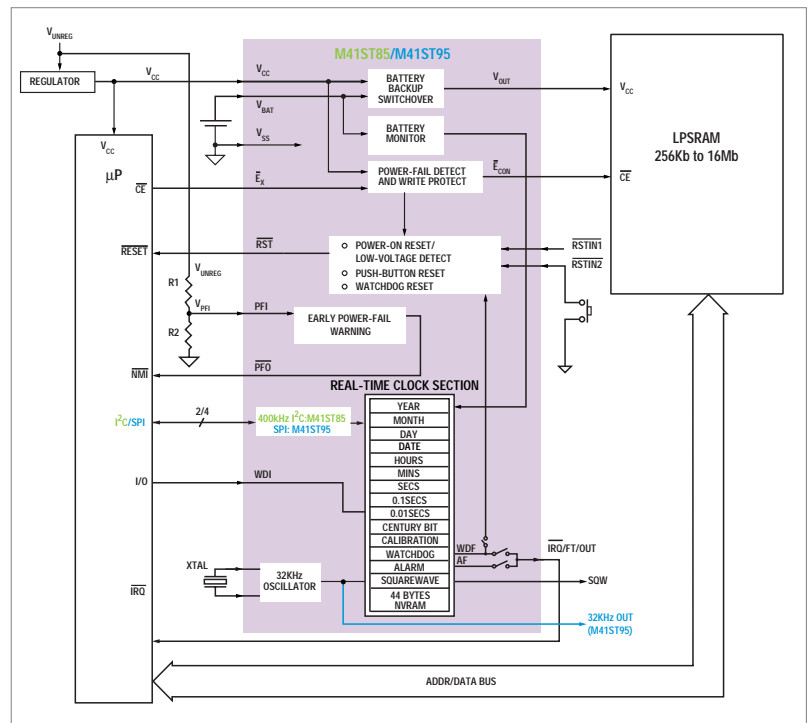
M41ST85 and M41ST95 non-volatizors and µP supervisors

The M41ST85 and M41ST95 extend the integration level of the M41ST84 and M41T94, respectively, by adding an NVRAM supervisor to each part.

The battery switchover circuit supplies V_{OUT} to an external LPSRAM while the write protect circuit provides a chip-enable gate. Together, these functions can be used to non-volitize an LPSRAM turning it into an NVRAM.

Both devices are available in ST's new low profile embedded crystal (SOX28) SOIC. Users need only to add a battery to get them running. The M41ST85 also comes in ST's SOH28 SNAPHAT IC.

The M41ST95WMX6 operates from 2.7 to 3.6V while the M41ST85 comes in 3 and 5V versions.



High integration serial real-time clocks

M41ST87 securitizor™

ST's M41ST87 is the flagship of the serial RTC family. It integrates a **tamper detect/RAM clear** circuit along with an NVRAM supervisor, an I²C serial RTC and a microprocessor supervisor. Its two independent tamper detect circuits can be used to detect and intercept an intrusion into any system where sensitive data must be safeguarded. The RAM clear functions can be configured to clear the M41ST87's internal non-volatile RAM and/or external RAM, as well as generate a processor interrupt. An oscillator fail circuit detects tampering with the crystal, and a unique serial number in each device provides the traceability required in secure applications.

Tamper detect and RAM clear

- Tamper detect circuit with two independent inputs
- Options on alarm:
 - Generate interrupt
 - Clear internal RAM
 - Clear external RAM and output reset
 - Store event time (always)

Serial RTC

- Counters for 10ths/100ths of seconds, seconds, minutes, hours, day, date, month, year, and century
- 128 bytes of NVRAM
- Programmable alarm with repeat modes
 - Functions in battery-backed mode
- Programmable squarewave generator
 - 1Hz to 32kHz
- Calibration - accuracy down to five seconds per month

Other features

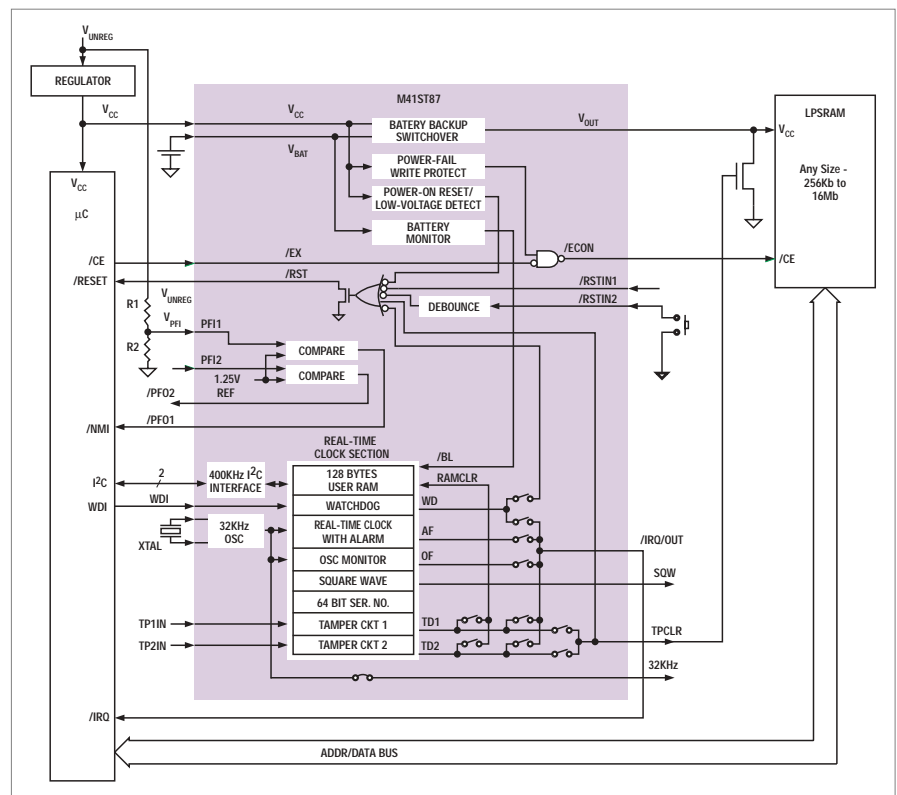
- 64-bit unique serial number
- Dedicated 32kHz output
- -40 to +85°C
- 3V, 3.3V and 5V operation
- 500nA battery current (typ.)
- 28-lead embedded crystal (SOX28) SOIC

NVRAM supervisor

- Automatic battery switchover for external LPSRAM backup
- Power-fail write protect function prevents corruption of non-volatile data
- Early power-fail warning
- Battery monitor

Microprocessor supervisor

- Programmable watchdog
 - 62 milliseconds to 128 seconds timeout
- Power-on reset/low-voltage detect
- Two reset input pins
- Two independent early power-fail warning circuits with 1.25V precision reference power-fail in/power-fail out (PFI /PFO)



Industry standard serial real-time clocks

For applications requiring cost effective serial real-time clocks, ST offers a complete set of small, industry standard, serial RTCs operating over a temperature range of -40 to 85°C. The range includes the M41T00, M41T11, M41T56 and M41T81 with key features including internal battery switchover, write protect and 400kHz I²C interface.

Features common to M41T00, M41T11, M41T56 and M41T81

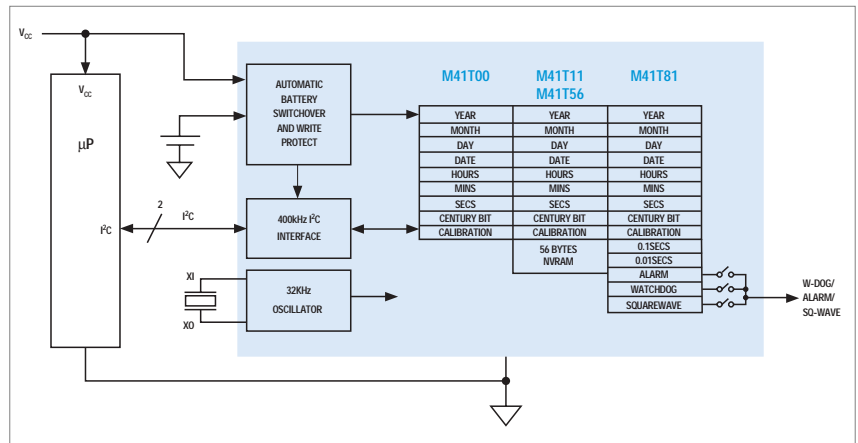
- Counters for seconds, minutes, hours, time-of-day and date
- Calibration - accuracy to five seconds per month
- Automatic battery switchover and write-protect

M41T81

- Counters for tenths and hundredths of a second
- Programmable watchdog – 62.5ms to 128s
- Programmable alarm with repeat modes
- Programmable squarewave generator from 1Hz to 32kHz
- 400kHz I²C

M41T11 and M41T56

- 56 bytes of internal NVRAM



Low-cost serial real-time clocks

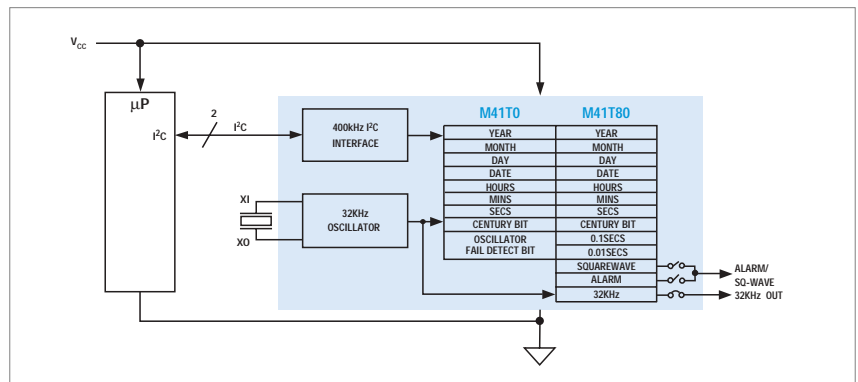
The M41T0 and M41T80 are small, serial RTC devices offering basic timekeeping functionality and available at low cost without the advanced watchdog and switchover features.

Features common to M41T0 and M41T80

- 400kHz I²C
- Counters for seconds, minutes, hours, time-of-day and date
- Clock calibration

M41T80

- Counters for tenths and hundredths of a second
- Alarm
- Programmable squarewave generator - 1Hz to 32kHz
- Dedicated 32kHz output



Serial real-time clock product selector

| Part number | NVRAM | Bus | Package | | V _{CC} | Internal switchover and write protect | µP and system supervisory features | | | | | Square wave | 32KHz output | Chip enable gate | V _{OUT} | -40 to 85°C | Comments | |
|-------------|-------|-------------------------|----------|------------------------------------|-----------------|---------------------------------------|------------------------------------|-----------------------------|----------------------|--------------|-----------------|-------------|--------------|------------------|------------------|-------------|-----------------------------------|----------------------------------|
| | | | SNAPHAT® | Other | | | Alarm and watchdog | POR-LVD ¹ output | PFI-PFO ² | Reset inputs | Battery monitor | | | | | | | |
| M41T256Y | 32KB | 400kHz I ² C | SOH44 | S044 | 4.5 to 5.5V | ● | | ● | | | | | | | | | Tamper detect | |
| M41ST95W | 44B | SPI | | SOX28 | 2.7 to 3.6V | ● | ● | ● | ● | 2 | ● | ● | ● | ● | ● | ● | 550 nA Ibat; NV supervisor | |
| M41ST87Y | 128B | 400kHz I ² C | | SOX28 | 4.5 to 5.5V | ● | ● | ● | 2 | 2 | ● | ● | ● | ● | ● | ● | Tamper detect; RAM clear | |
| M41ST87W | | | | | 2.7 to 3.6V | | | | | | | | | | | | | Unique serial no.; NV supervisor |
| M41ST85Y | 44B | 400kHz I ² C | SOH28 | SOX28 | 4.5 to 5.5V | ● | ● | ● | ● | 2 | ● | ● | ● | ● | ● | ● | 500 nA Ibat; NV supervisor | |
| M41ST85W | | | | | 2.7 to 3.6V | | | | | | | | | | | | | |
| M41T94 | 44B | SPI | SOH28 | S016 | 2.7 to 5.5V | ● | ● | ● | ● | 2 | ● | ● | | | | ● | 500 nA Ibat; THS pin ³ | |
| M41ST84Y | 44B | 400kHz I ² C | | S016 | 4.5 to 5.5V | ● | ● | ● | ● | 1 | ● | ● | | | | | ● | 500 nA Ibat |
| M41ST84W | | | | | 2.7 to 3.6V | | | | | | | | | | | | | |
| M41T81 | | 400kHz I ² C | | S08 SOX18 ⁴ SOX28 | 2.0 to 5.5V | ● | ● | | | | ● | | | | | | ● | |
| M41T56 | 56B | I ² C | SOH28 | S08 | 4.5 to 5.5V | ● | | | | | | | | | | | ● | 550 nA Ibat |
| M41T11 | 56B | I ² C | SOH28 | S08 | 2.0 to 5.5V | ● | | | | | | | | | | | ● | |
| M41T00 | | I ² C | | S08 | 2.0 to 5.5V | ● | | | | | | | | | | | ● | |
| M41T80 | | 400kHz I ² C | | S08 | 2.0 to 5.5V | | ● ⁵ | | | | | ● | ● | | | | ● | |
| M41T0 | | 400kHz I ² C | | S08 TSSOP8 | 2.0 to 5.5V | | | | | | | | | | | | ● | |

1. POR-LVD: Power-on reset/low-voltage detect
2. PFI-PFO: Power-fail In/power-fail output: Early power-fail warning
3. THS pin: Selects power-fail deselect threshold (2.65V or 4.40V for 3V or 5V operation)

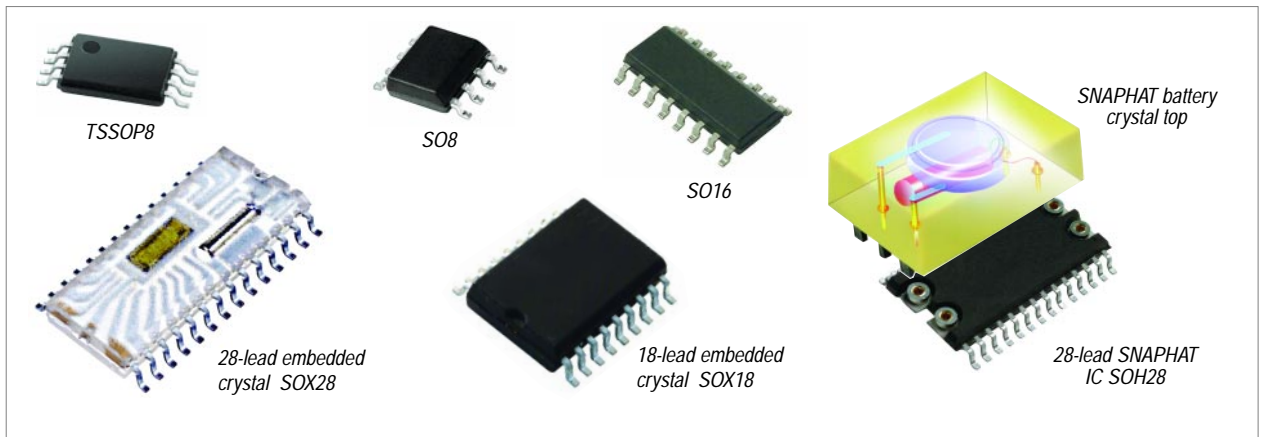
4. Contact ST sales office for availability
5. Alarm only. No watchdog on M41T80

Web tools and product support

www.st.com/rtc

- Product datasheets
- Presentations
- Selector guides
- Serial RTC battery life calculator
 - Allows calculation of the typical and worst case data retention lifetimes for the selected battery capacity
 - Also computes the backup life for devices backed up with SuperCaps
- Clock calibration calculator
 - Most ST serial RTCs include a clock calibration feature allowing the user to adjust the clock speed to within 5 seconds per month
- Underwriter's laboratories information
- Simulation model files

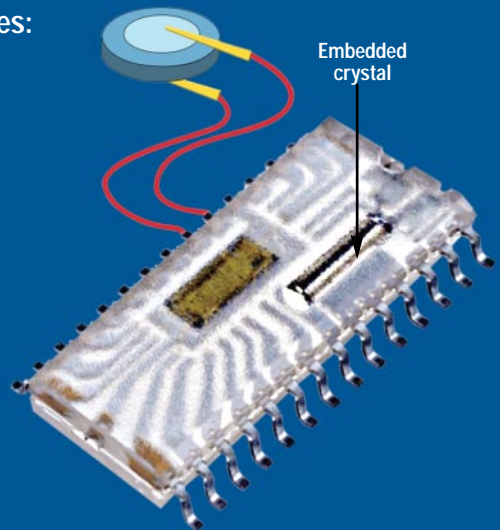
Packaging options



Embedded crystal packaging

ST's embedded crystal packaging offers many advantages:

- Smaller overall footprint
- Low-profile design solves board clearance problems
- Enhances security - crystal cannot be tampered with
- Fewer components reduces overall cost
- Faster design (crystal guaranteed to run with oscillator)
- No manual insertion (through-hole)
- Standard 28-lead JEDEC package
- Crystal shielded from environmental factors such as humidity
- Higher integration
- Batteries often included to reduce cost



Coming enhancements:

- Operation down to 1.3V. Timekeeping down to 1.0V
- Runs off 50/60Hz to save cost of crystal
- High accuracy oscillator
- Ultra-low standby currents
- 4x4 QFN packaging (3 x 3mm)
- 18-pin embedded crystal SOIC
- Tamper Detect
- Temperature sensor



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Full product information at www.st.com

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