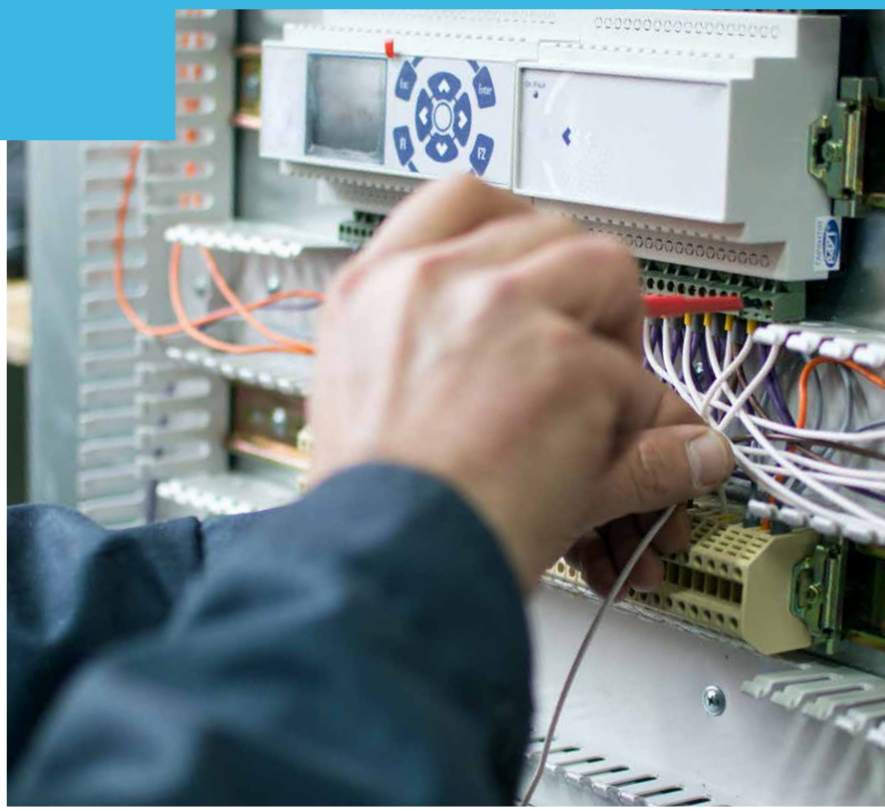
life.augmented

Serial real-time clock ICs

Contents

RTC ICs spectrum



An extended variety of products are available including ultra low-power devices, standard package with embedded crystal, and ST's SNAPHAT's* with lithium battery and crystal integrated. RTC functions include alarm management, battery switchover, reset, and special features such as time stamp, anti-tamper for secure applications.

Ultra low-power devices

- Low standby current
- SMD packages with embedded crystal
- Multiple communication interface: I^2C or SPI

M41T56, M41T82/83, M41ST85W/87W, M41T93/94

Enhanced industry-standard

- Automatic battery switchover
- Analog calibration
- Embedded crystal
- Very high speed SPI up to 10 MHz

M41T81S, M41T00S, M41T01, M41T80, M41T11, M41T82/83/93

Highly-integrated

- RTC with NVRAM and microprocessor supervisor functions
- Securitizor RTC with physical tamper detect

M41ST85W, M41T94, M41ST87W

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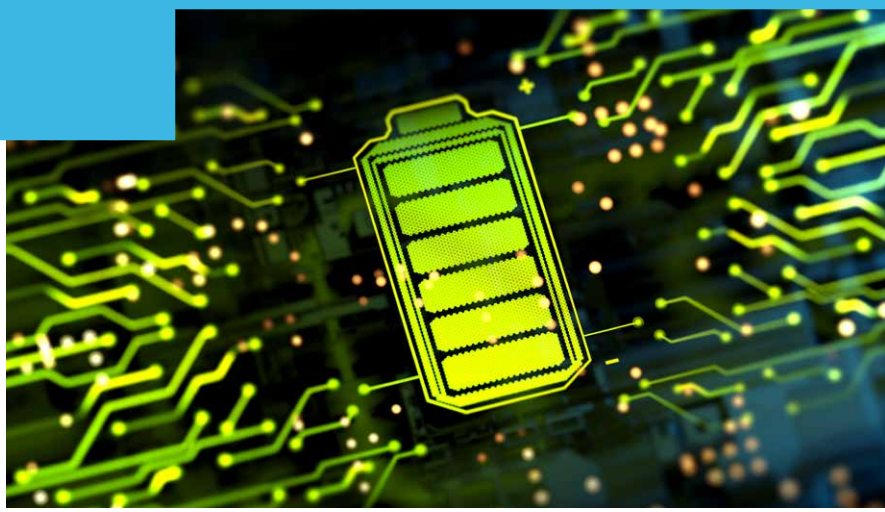
Low-power RTC ICs

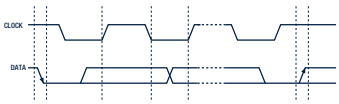


Special low-power RTC series available in small packages, from 365 nA, with battery switchover, and with or without an embedded crystal to best fit battery-operated device constraints and low thickness solutions.

APPLICATION EXAMPLES

- Digital cameras
- Portable media players
- Crypto POS and kiosk
- Medical instruments
- Point-of-sale terminals (POS)
- Test equipment
- Portable navigation
- HVAC smart controller

QFN16L (4x4 mm)
0.9mm thickness



Low-power RTCs for portable devices

Part number	Package	Battery supply current typical [nA]	Data bus type	Supply voltage range [V]	Time keeping min voltage [V]	Oscillator fail detect	Programmable alarms	Watchdog timer	Square wave output	Battery switchover
M41T56	SO8	450	I²C[1]	4.5-5.5	2.5	–	–	–	–	Yes
M41T82Z	SO8	365	I²C[2]	2.38-5.5	1.8	Yes	–	–	–	Yes
M41T82R	SO8	365	I²C[2]	2.7-5.5	1.8	Yes	–	–	–	Yes
M41T82S	SO8	365	I²C[2]	3.0-5.5	1.8	Yes	–	–	–	Yes
M41T83Z	SOX18 (emb.crystal) QFN16	365	I²C[2]	2.38-5.5	1.8	Yes	Yes	Yes	Yes (32kHz)	Yes
M41T83R	SOX18 (emb.crystal) QFN16	365	I²C[2]	2.7-5.5	1.8	Yes	Yes	Yes	Yes (32kHz)	Yes
M41T83S	SOX18 (emb.crystal) QFN16	365	I²C[2]	3.0-5.5	1.8	Yes	Yes	Yes	Yes (32kHz)	Yes
M41ST85W	SOH28[3], SOX28 (emb.crystal)	400	I²C[2]	2.7-3.6	–	Yes	Yes	Yes	–	Yes
M41ST87W	SSOP20, SOX28 (emb.crystal)	500	I²C[2]	2.7-3.6	–	Yes	Yes	Yes	–	Yes
M41T93Z	SOX18 (emb.crystal) QFN16	365	SPI	2.38-5.5	1.8	Yes	Yes	Yes	Yes (32kHz)	Yes
M41T94	SO16, SOH28[3]	400	SPI	2.7-5.5[4]	–	Yes	Yes	Yes	–	Yes

Note:
1: 100 kHz I²C
2: 400 kHz I²C
3: Package compatible with SNAPHAT (crystal and battery series M4T28-BR12SHx 48mAh or M4T32-BR12SHx 120mAh)
4: PFD (power fail selector) programmable: 2.6 or 4.4 V.

Enhanced industry-standard real-time clocks

Enhanced industry-standard RTC with fixed reference added for highly-reliable battery switchover threshold, plus analog calibration, embedded crystal and oscillator fail detect.

CLASS-LEADING RTCs FOR PRECISION APPLICATIONS

M41T00S

- Precision reference for battery switchover threshold
- Oscillator fail detect circuit
- 400 kHz I²C interface
- Automatic battery switchover and write-protect register - Accuracy to 5 seconds per month
- Binary calibration
- BCD registers: century, year, month, day, date, hours, minutes, seconds
- 2.7 to 5.5 V operation
- Automatic leap year adjustment
- Standard SO8 package

APPLICATION EXAMPLES

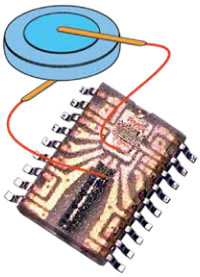
- Home multimedia
- Utility metering (gas, electricity, water)
- Multi-function printers
- Vehicle tracking systems

Calibration Register Map

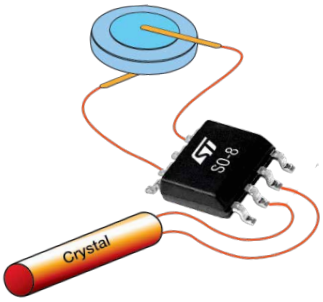
Addr	D7	D6	D5	D4	D3	D2	D1	D0	Function/range BCD format	
00h	ST	10 seconds			Seconds				Seconds	00-59
01h	OF	10 minutes			Minutes				Minutes	00-59
02h	CEB	CB	10 hours		Hours (24-hour format)				Century/hours	0-1/00-23
03h	0	0	0	0	0	Day of week			Day	01-07
04h	0	0	10 date		Date: day of month				Date	01-31
05h	0	0	0	10 M	Month				Month	01-12
06h	10 years				Year				Year	00-99
07h	OUT	FT	S		Calibration				Calibration	Binary format

M41T81S

- Programmable alarm with repeat modes
- Oscillator fail detect circuit
- Battery monitor
- Automatic battery switchover and write-protect with precision reference
- Calibration register - accuracy to 5 seconds per month
- BCD registers: century, year, month, day, date, hours, minutes, seconds
- 400 kHz I²C interface
- Programmable watchdog
  - 62.5 ms to 128 s time-out
- Programmable square-wave
  - 1 Hz to 32 KHz
- Automatic leap year adjustment



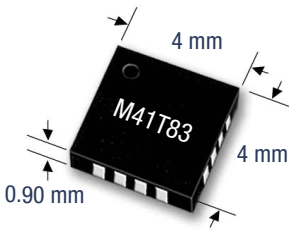
SOX18
Embedded crystal
(Internal view)



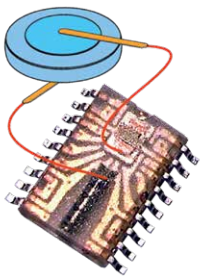
SO8

M41T83, Real-time clocks with analog calibration

- Factory-calibrated accuracy of ±5 ppm typical after 2 reflows (SOX18)
- Analog calibration allows in-application oscillator internal capacitors fine tuning (from +9.75 pF to –18 pF, 0.25 pF steps)
- 365 nA standby (typ) at 3.0 V
- Automatic battery switchover and write-protect with precision reference
  - Multiple precision references: 2.93 V, 2.63 V, 2.32 V
- 400 kHz I2C, 10 MHz SPI
- 12 bytes of NVRAM
  - 5 bytes shared with 2 alarm registers
- 2 programmable alarms with repeat modes
- Memory-mapped BCD year, month, day, date, hours, minutes, seconds, 10ths, 100ths of seconds
- 2.38 to 5.5 V operation
  - Timekeeping down to 1.8 V
- Programmable watchdog (62.5 ms to 128 s)
- Programmable squarewave output
  - 1 Hz to 32 KHz



QFN16



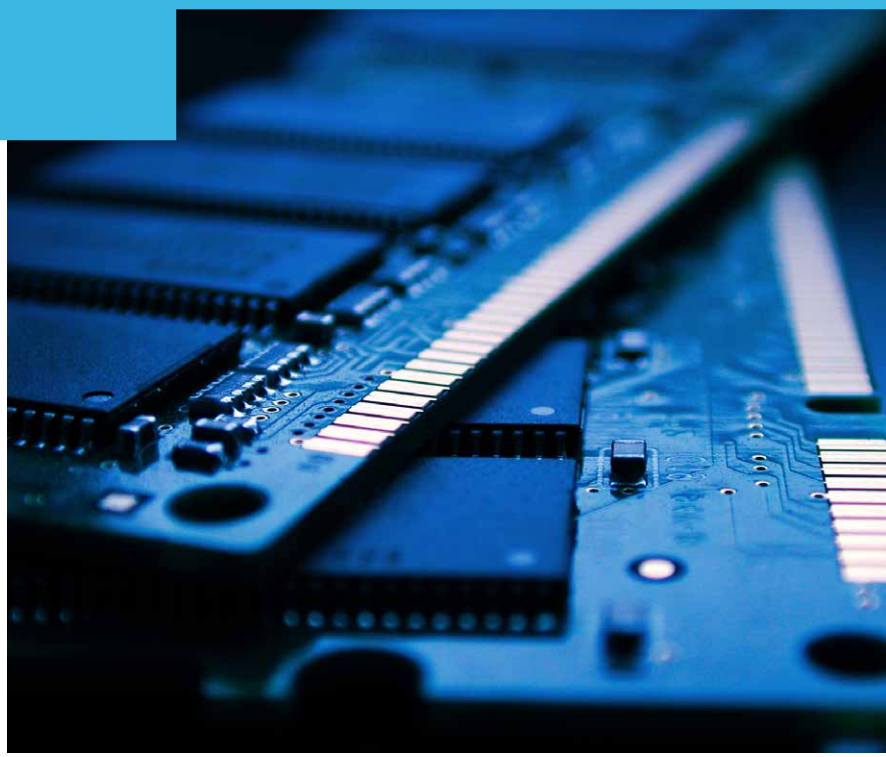
SOX18 Embedded crystal
(Internal view)

Enhanced industry-standard RTCs

Part number	Package	Battery supply current	NVRAM size	Data bus type	V_{CC}	Timekeeping min [V]	Battery switchover	Oscillator fail detect	Programmable alarms	Square wave output	Power-up output frequency [Khz]	Watchdog timer	Battery low detect	Power on Reset/low voltage detector output	Embedded crystal	Temperature compensated
		typ [nA]	[bytes]		min - max [V]											
M41T0	SO8	900	-	I^2C[1]	2 - 5.5	2	-	Yes	-	-	-	-	-	-	-	-
M41T00S	SO8	600	-	I^2C[1]	2.7 - 5.5	2	Yes[4]	Yes	-	-	-	-	-	-	-	-
M41T01	SO8	800	-	I^2C[1]	2 - 5.5	2.5	Yes	-	-	Yes	-	-	-	-	-	-
M41T11	SO8	800	56	I^2C	2 - 5.5	2	Yes[1]	-	-	-	-	-	-	-	-	-
	SOH28	800	56	I^2C	2 - 5.5	2	Yes	-	-	-	-	-	-	-	-	-
M41T56	SO8	450	56	I^2C	4.5 - 5.5	2.5	Yes	-	-	-	-	-	-	-	-	-
M41T80	SO8	1500	-	I^2C[1]	2 - 5.5	2	-	-	Yes[2]	Yes[2]	32[3]	-	-	-	-	-
M41T81S	SO8	600	-	I^2C[1]	2.7 - 5.5	2	Yes[4]	Yes[2]	Yes[2]	Yes[2]	-	Yes[2]	Yes	-	-	-
	SOX18	600	-	I^2C[1]	2.7 - 5.5	2	Yes[4]	Yes[2]	Yes[2]	Yes[2]	-	Yes[2]	Yes	-	Yes	-
M41T82	SO8	365	12	I^2C[1]	2.38 - 5.5	1.8	Yes[4]	Yes	-	-	-	-	Yes	Yes	-	-
M41T83	QFN16	365	12	I^2C[1]	2.38 - 5.5	1.8	Yes[4]	Yes[2]	Yes[2]	Yes[3]	32	Yes[2]	Yes	Yes	-	-
	SOX18	365	12	I^2C[1]	2.38 - 5.5	1.8	Yes[4]	Yes[2]	Yes[2]	Yes[3]	32	Yes[2]	Yes	Yes	Yes	-
M41T93	QFN16	365	12	SPI[5]	2.38 - 5.5	1.8	Yes[4]	Yes[2]	Yes[2]	Yes[3]	32	Yes[2]	Yes	Yes	-	-
	SOX18	365	12	SPI[5]	2.38 - 5.5	1.8	Yes[4]	Yes[2]	Yes[2]	Yes[3]	32	Yes[2]	Yes	Yes	Yes	-

Note:
1: 400 kHz
2: With IRQ output
3: Dedicated output
4: Fixed switchover reference
5: 10 MHz serial interface

Highly-integrated RTC



Highly-integrated RTCs with NVRAM and a large set of microprocessor supervisory functions, including battery monitor, power-on reset and low-voltage detect.

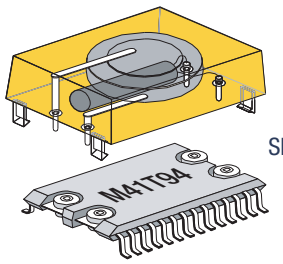
APPLICATION EXAMPLES

- Servers
- Medical equipment
- Point-of-sales (POS)
- Vending machines
- Gaming

M41T94

- Automatic battery switchover
- Power-fail detect and write-protect
- 2 MHz SPI bus
- THS pin selects 5 or 3/3.3 V operation
- 400 nA standby (typ) at 3.0 V
- 44 bytes of NVRAM
- Programmable alarm with repeat mode
- Programmable square-wave output
  - 1 Hz to 32 KHz
- 10 ths and 100 ths of seconds

SO16

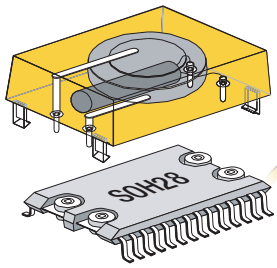


SNAPHAT battery top

SOH28

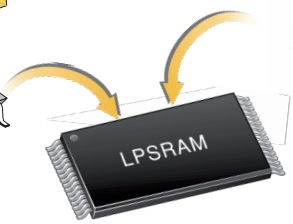
M41ST85W

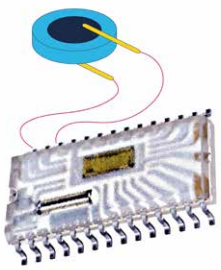
- 400 kHz I²C
- 400 nA standby (typ) at 3.0 V
- 2.7 to 3.6 V
- 28-lead SNAPHAT IC (SOH28)
- 28-lead embedded crystal SOIC (SOX28)
- Operating temperature: -40 to +85 °C
- 44 bytes of NVRAM
- Programmable alarm with repeat mode
- Programmable square-wave output
  - 1 Hz to 32 KHz
- 10 ths and 100 ths of seconds



SOH28 SNAPHAT IC

SNAPHAT battery top





SOX28 Embedded crystal (internal view)

Securitizor RTC with physical tamper detect

Combined real-time clock (RTC) IC including microprocessor supervisor, NVRAM supervisor, with physical tamper detect, plus internal and external RAM clear for secure applications.

APPLICATION EXAMPLES

- Black boxes
- Closed-circuit TV
- Financial security: ATM, cash, registers, POS, card readers
- Gaming machines
- Fire alarms
- Utility meter (gas, electricity, water)

M41ST87W

- 64-bit unique serial number
- -40 to +85 °C
- 3.0 V to 3.6 V operation
- 500 nA standby (typ) at 3.0 V
- 28-lead embedded crystal
- IC packages: standard SSOP20 and SOX28 with embedded crystal
- Counters for 10ths and 100ths of seconds, seconds, minutes, hours, day, date, month, year, and century
- 128 bytes of clearable NVRAM
- Programmable alarm with repeat mode functions in battery-backed mode
- Programmable square-wave output
  - 1 Hz to 32 KHz
- Dedicated 32 KHz output
- Microprocessor supervisor
- NVRAM supervisor
- Tamper detect functions

SOX28 Embedded crystal (internal view)

Highly-integrated RTCs

Part number	Package	Battery supply current	NVRAM size	Data bus type	V_{CC}	Battery switchover	Oscillator fail detect	Programmable alarms	Square wave output	Power-up output frequency [KHz]	Watchdog timer	Battery low detect	Power on Reset/low voltage detector output	Power fail comparator	Reset inputs	Embedded crystal
		typ [nA]	[bytes]		min - max [V]											
M41ST85W	SOX28	400	44	I^2C[1]	2.7 - 3.6	Yes[4]	-	Yes[3]	Yes	-	Yes[3]	Yes	Yes	Yes	Yes	Yes
	SOH28	400	44	I^2C[1]	2.7 - 3.6		-			-				Yes		-
M41ST87W	SSOP20	500	128	I^2C[1]	2.7 - 3.6		Yes[3]			32				Yes		-
	SOX28	500	128	I^2C[1]	2.7 - 3.6		Yes[3]			32				Yes		Yes
M41T94	SO16	400	44	SPI[2]	2.7 - 5.5		Yes			-				-		-
	SOH28	400	44	SPI[2]	2.7 - 5.5		Yes			-				-		-

Note:
1: 400 kHz
2: 2 MHz
3: With IRQ output
4: Fixed switchover reference

Serial real-time clocks

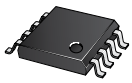
Part number	Package	Package size	V_{CC} min - max	I_{BAT} typ	Timekeeping min	NVRAM	Oscillator fail detect	Features
		[mm]	[V]	[nA]	[V]	[bytes]		
M41T56	SO8	3.9x4.9	4.5 - 5.5	450	2.5	56	-	
M41T0	SO8	3.9x4.9	2 - 5.5	900	2	-	Yes	
M41T01	SO8	3.9x4.9	2 - 5.5	800	2.5	-	-	
M41T00	SO8	3.9x4.9	2.7 - 5.5	600	2	-	Yes	
M41T11	SOH28 SO8	8.2x17.8 3.9x4.9	2 - 5.5	800	2	56	-	SNAPHAT (crystal and battery)
M41T80	SO8	3.9x4.9	2 - 5.5	1500	2	-	-	
M41T81S	SOX18 SO8	7.6x11.6 3.9x4.9	2.7 - 5.5	600	2	-	Yes	Crystal
M41T82	SO8	3.9x4.9	2.38 - 5.5	365	1.8	12	Yes	
M41T83	SOX18 QFN16	7.6x11.6 4.0x4.0	2.38 - 5.5	365	1.8	12	Yes	Crystal
M41T93	SOX18 QFN16	7.6x11.6 4.0x4.0	2.38 - 5.5	365	1.8	12	Yes	Crystal
M41ST85W	SOH28 SOX28	8.2x17.7 17.9x7.6	2.7 - 3.6	400	-	44	-	SNAPHAT (crystal and battery) Crystal
M41ST87W	SOX28 SSOP 20	7.6x17.9 5.3x7.2	2.7 - 3.6	500	-	128	Yes	Crystal
M41T94	SO16 SOH28	3.8x9.8 8.2x17.7	2.7 - 5.5	400	-	44	-	SNAPHAT (crystal and battery)

SNAPHAT tops, battery and crystal integrated

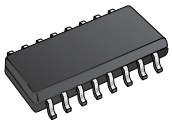
Part number	Package	Crystal frequency nom [Hz]	Battery Lithium coin cell [mAh]
M4T28-BR12SH1	SNAPHAT SOIC	32768	48
M4T32-BR12SH1/BR12SH6	SNAPHAT SOIC		120

Package options

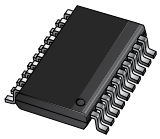
QFN16
4 mm x 4 mm



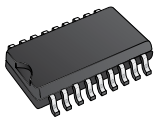
SO8
3.80 mm x 4.80 mm



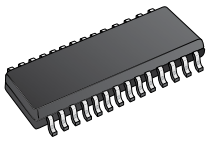
SO16
3.80 mm x 9.80 mm



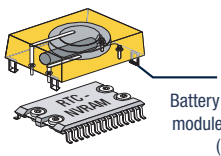
SSOP20
7.2 mm x 5.3 mm



SOX18
11.61 mm x 7.62 mm
Embedded crystal SOIC

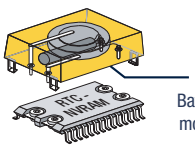


SOX28
18.01 mm x 7.67 mm
Embedded crystal



SNAPHAT
Battery and crystal snap on module to order separately (internal view)
(48 mAh size 21.46x14.6 mm)

SOH28
17.71 mm x 8.23 mm



SNAPHAT
Battery and crystal snap on module to order separately (internal view)
(120 mAh size 21.46x17.65 mm)

SOH28
17.71 mm x 8.23 mm

Design support

The documents describe the special features and functions of RTCs such as: tamper detection, time-stamps, and the century bit.

Other useful resources are available online to help estimate battery lifetime and capacity by part number as well as application notes on how to use the digital and analog calibration features to recover clock error events (ambient temperature variation or crystal drift).

Application notes	
AN923	Managing century information using serial real-time clocks and TIMEKEEPER* NVRAMs
AN1011	Battery technology used in NVRAM and real-time clock (RTC) products from ST
AN934	How to use the digital calibration feature in TIMEKEEPER and serial real-time clock (RTC) products
AN1012	Predicting the battery life and data retention period of NVRAMs and serial RTCs
AN1879	How to use M41ST87W tamper detect and RAM clear
AN1572	Power-down time-stamp function in serial real-time clocks (RTCs)
AN2678	Extremely accurate timekeeping over temperature using adaptive calibration
AN2971	Using the typical temperature characteristics of 32 KHz crystal to compensate the M41T83 and the M41T93 serial real-time clocks
AN3060	Applications guide for serial real-time clocks (RTCs)
AN1019	Second Source for “SNAPHAT” by Using a Dual Footprint
AN1009	“Negative Undershoot” NVRAM Data Corruption
AN1336	Power-Fail Comparator for NVRAM Supervisory Devices
AN1216	Implementing a periodic alarm with TIMEKEEPER and serial real-time clocks (RTCs)

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Product support at http://www.st.com/rtc

- Datasheets
- Application notes
- Selector tables
- Serial RTC example code
- Underwriters Laboratories (UL) information
- Clock calibration tools
- RTC and NVRAM model files
- Design support calculators : www.st.com/calculators
- Online technical support

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