



# bq4287

## Real-Time Clock Module With NVRAM Control

### Features

- ▶ Direct clock/calendar replacement for IBM® AT-compatible computers and other applications
- ▶ Functionally compatible with the DS1287/DS1287A and MC146818A
- ▶ 114 bytes of general nonvolatile storage
- ▶ Automatic backup supply and write-protection to make external SRAM nonvolatile
- ▶ Integral lithium cell and crystal
- ▶ 160 ns cycle time allows fast bus operation
- ▶ Intel bus timing
- ▶ 14 bytes for clock/calendar and control
- ▶ BCD or binary format for clock and calendar data
- ▶ Calendar in day of the week, day of the month, months, and years with automatic leap-year adjustment

- ▶ Time of day in seconds, minutes, and hours
  - 12- or 24-hour format
  - Optional daylight saving adjustment
- ▶ Programmable square wave output
- ▶ Three individually maskable interrupt event flags:
  - Periodic rates from 122  $\mu$ s to 500 ms
  - Time-of-day alarm once per second to once per day
  - End-of-clock update cycle
- ▶ Better than one minute per month clock accuracy

114 bytes of general nonvolatile storage.

The bq4287 write-protects the clock, calendar, and storage registers during power failure. The integral backup energy source then maintains data and operates the clock and calendar.

The bq4287 uses its integral battery-backup controller and battery to make a standard CMOS SRAM nonvolatile during power-fail conditions. During power-fail, the bq4287 automatically write-protects the external SRAM and provides a  $V_{CC}$  output sourced from its internal battery.

The bq4287 is a fully compatible real-time clock for IBM AT-compatible computers and other applications.

### General Description

The CMOS bq4287 is a low-power microprocessor peripheral providing a time-of-day clock and 100-year calendar with alarm features and battery operation. Other features include three maskable interrupt sources, square wave output, and

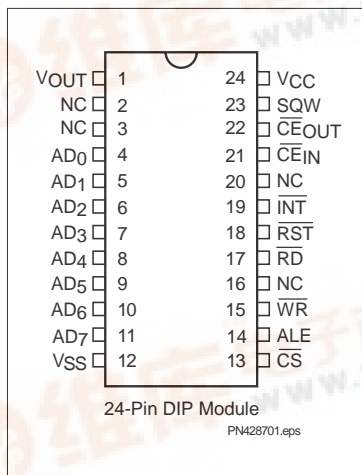
As shipped from Benchmarq, the backup cell is electrically isolated from the memory. Following the first application of  $V_{CC}$ , this isolation is broken, and the backup cell provides data retention to the clock, internal RAM,  $V_{OUT}$ , and  $CE_{OUT}$  on subsequent power-downs.

The bq4287 is functionally equivalent to the bq4285, except that the battery (16, 20) and crystal pins (2, 3) are not accessible. These pins are connected internally to a coin cell and quartz crystal. The coin cell provides 130mAh of capacity. For a complete description of features, operating conditions, electrical characteristics, bus timing, and pin descriptions, see the bq4285 data sheet.

#### Caution:

Take care to avoid inadvertent discharge through  $V_{OUT}$  and  $CE_{OUT}$  after battery isolation has been broken.

### Pin Connections



### Pin Names

AD <sub>0</sub> -AD <sub>7</sub>	Multiplexed address/data input/output
CS	Chip select input
ALE	Address strobe input
RD	Data strobe input
WR	Read/write input
INT	Interrupt request output
RST	Reset input
SQW	Square wave output
CE <sub>IN</sub>	RAM chip enable input
CE <sub>OUT</sub>	RAM chip enable output
NC	No connect
V <sub>OUT</sub>	Supply output
V <sub>CC</sub>	+5V supply
V <sub>SS</sub>	Ground

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### Absolute Maximum Ratings

Symbol	Parameter	Value	Unit	Conditions
V <sub>CC</sub>	DC voltage applied on V <sub>CC</sub> relative to V <sub>SS</sub>	-0.3 to 7.0	V	
V <sub>T</sub>	DC voltage applied on any pin excluding V <sub>CC</sub> relative to V <sub>SS</sub>	-0.3 to 7.0	V	V <sub>T</sub> ≤ V <sub>CC</sub> + 0.3
T <sub>OPR</sub>	Operating temperature	0 to +70	°C	Commercial
T <sub>STG</sub>	Storage temperature	-40 to +70	°C	Commercial
T <sub>BIAS</sub>	Temperature under bias	-10 to +70	°C	Commercial
T <sub>SOLDER</sub>	Soldering temperature	260	°C	For 10 seconds

**Note:** Permanent device damage may occur if **Absolute Maximum Ratings** are exceeded. Functional operation should be limited to the Recommended DC Operating Conditions detailed in this data sheet. Exposure to conditions beyond the operational limits for extended periods of time may affect device reliability.

### Recommended DC Operating Conditions (T<sub>A</sub> = T<sub>OPR</sub>)

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V <sub>CC</sub>	Supply voltage	4.5	5.0	5.5	V
V <sub>SS</sub>	Supply voltage	0	0	0	V
V <sub>IL</sub>	Input low voltage	-0.3	-	0.8	V
V <sub>IH</sub>	Input high voltage	2.2	-	V <sub>CC</sub> + 0.3	V

**Note:** Typical values indicate operation at T<sub>A</sub> = 25°C.

### DC Electrical Characteristics (T<sub>A</sub> = T<sub>OPR</sub>, V<sub>CC</sub> = 5V ± 10%)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Conditions/Notes
C	Battery capacity	-	130	-	mAh	Refer to graphs in Typical Battery Characteristics section
I <sub>LI</sub>	Input leakage current	-	-	± 1	μA	V <sub>IN</sub> = V <sub>SS</sub> to V <sub>CC</sub>
I <sub>LO</sub>	Output leakage current	-	-	± 1	μA	AD <sub>0</sub> -AD <sub>7</sub> , $\overline{\text{INT}}$ and SQW in high impedance
V <sub>OH</sub>	Output high voltage	2.4	-	-	V	I <sub>OH</sub> = -1.0 mA
V <sub>OL</sub>	Output low voltage	-	-	0.4	V	I <sub>OL</sub> = 4.0 mA
I <sub>CC</sub>	Operating supply current	-	7	15	mA	Min. cycle, duty = 100%, I <sub>OH</sub> = 0mA, I <sub>OL</sub> = 0mA
I <sub>CCB</sub>	Battery operation current	-	0.3	0.5	μA	V <sub>BC</sub> = 3V, T <sub>A</sub> = 25°C, no load on V <sub>OUT</sub> or CE <sub>OUT</sub>
V <sub>SO</sub>	Supply switch-over voltage	-	3.0	-	V	
V <sub>PFD</sub>	Power-fail-detect voltage	4.0	4.17	4.35	V	
V <sub>BC</sub>	Backup cell voltage	-	3.0	-	V	Internal backup cell voltage; refer to graphs in Typical Battery Characteristics section
V <sub>OUT1</sub>	V <sub>OUT</sub> voltage	V <sub>CC</sub> - 0.3V	-	-	V	I <sub>OUT</sub> = 100mA, V <sub>CC</sub> > V <sub>BC</sub>
V <sub>OUT2</sub>	V <sub>OUT</sub> voltage	V <sub>BC</sub> - 0.3V	-	-	V	I <sub>OUT</sub> = 100μA, V <sub>CC</sub> < V <sub>BC</sub>
I <sub>CE</sub>	Chip enable input current	-	-	100	μA	Internal 50K pull-up

**Note:** Typical values indicate operation at T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5V.

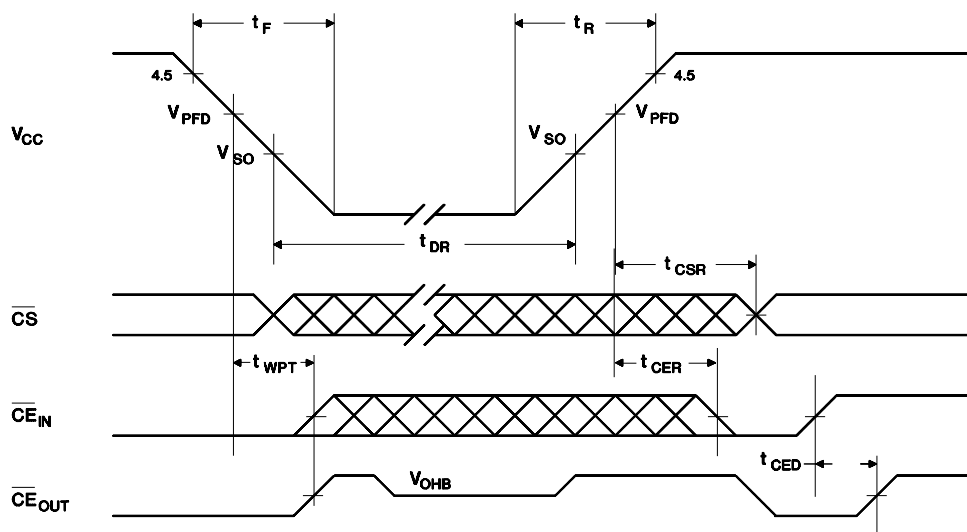
### Power-Down/Power-Up Timing ( $T_A = T_{OPR}$ )

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Conditions
$t_F$	$V_{CC}$ slew from 4.5V to 0V	300	-	-	$\mu\text{s}$	
$t_R$	$V_{CC}$ slew from 0V to 4.5V	100	-	-	$\mu\text{s}$	
$t_{CSR}$	$\overline{CS}$ at $V_{IH}$ after power-up	20	-	200	ms	Internal write-protection period after $V_{CC}$ passes $V_{PFD}$ on power-up.
$t_{DR}$	Data-retention and time-keeping time	10	-	-	years	$T_A = 25^\circ\text{C}$ , no load on $V_{OUT}$ or $CE_{OUT}$ .
$t_{WPT}$	Write-protect time for external RAM	10	16	30	$\mu\text{s}$	Delay after $V_{CC}$ slows down past $V_{PFD}$ before SRAM is write-protected.
$t_{CER}$	Chip enable recovery time	$t_{CSR}$	-	$t_{CSR}$	ms	Time during which external SRAM is write-protected after $V_{CC}$ passes $V_{PFD}$ on power-up.
$t_{CED}$	Chip enable propagation delay to external SRAM	-	7	10	ns	

**Note:** Clock accuracy is better than  $\pm 1$  minute per month at  $25^\circ\text{C}$  for the period of  $t_{DR}$ .

**Caution:** Negative undershoots below the absolute maximum rating of  $-0.3\text{V}$  in battery-backup mode may affect data integrity.

### Power-Down/Power-Up Timing

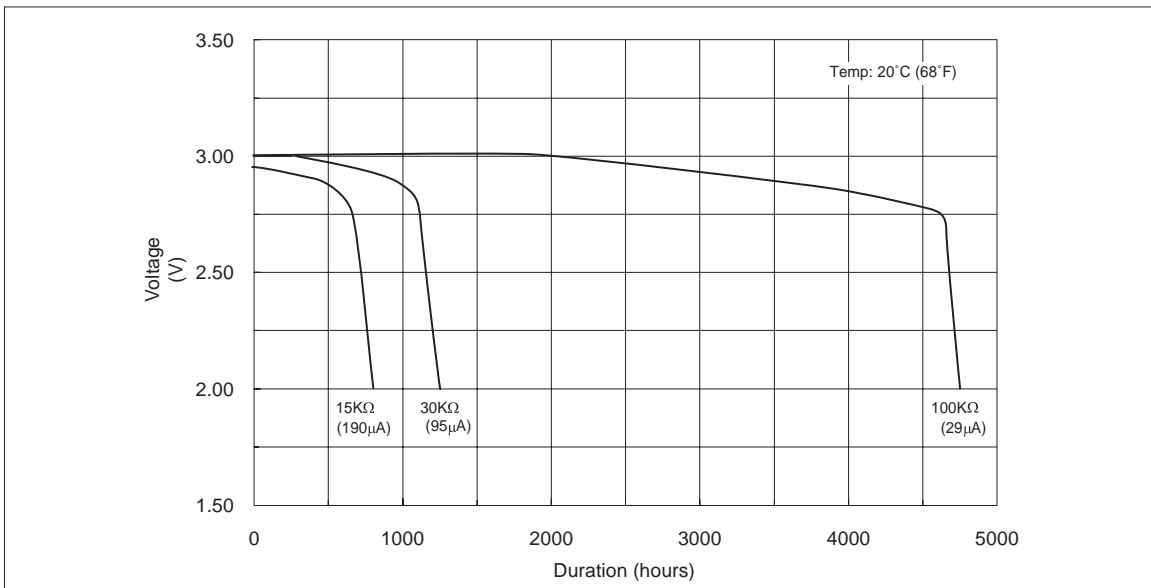


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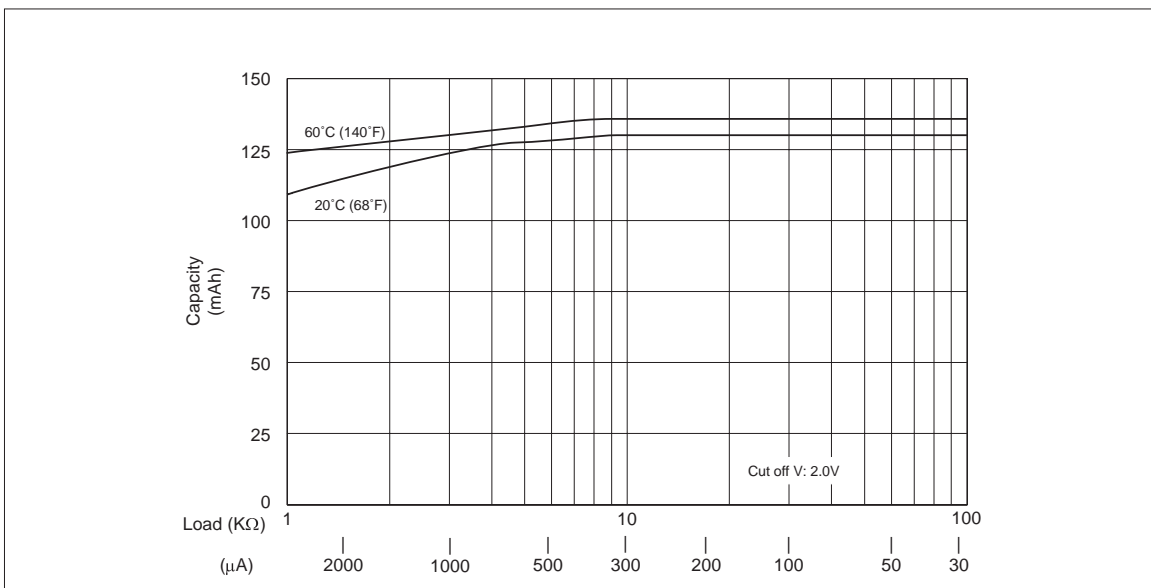
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## Typical Battery Characteristics (source = Panasonic)

### CR1632 Load Characteristics

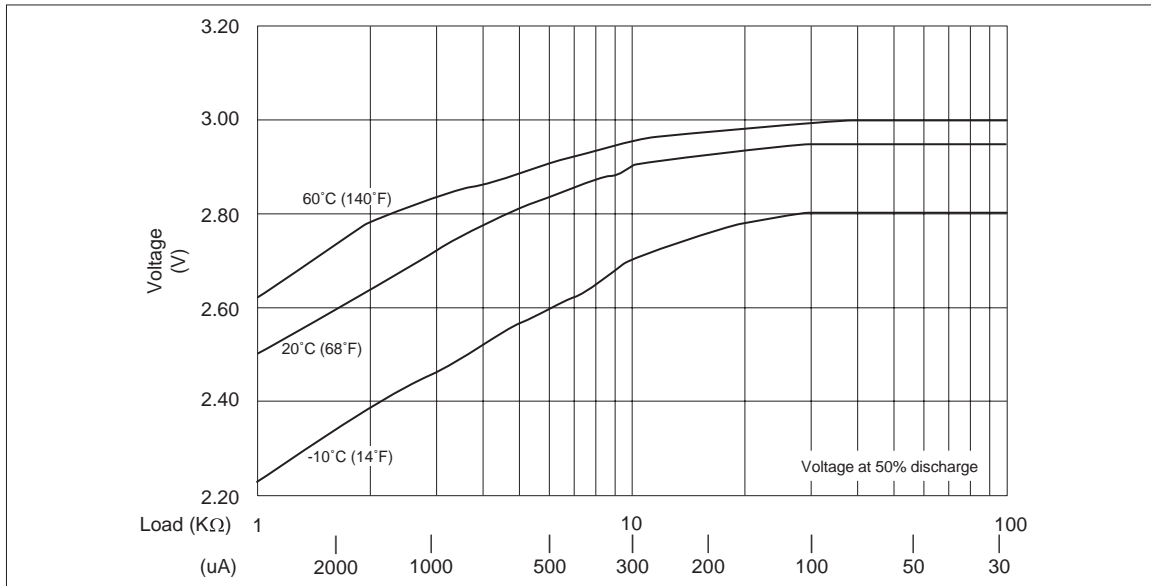


### CR1632 Capacity vs. Load Resistance

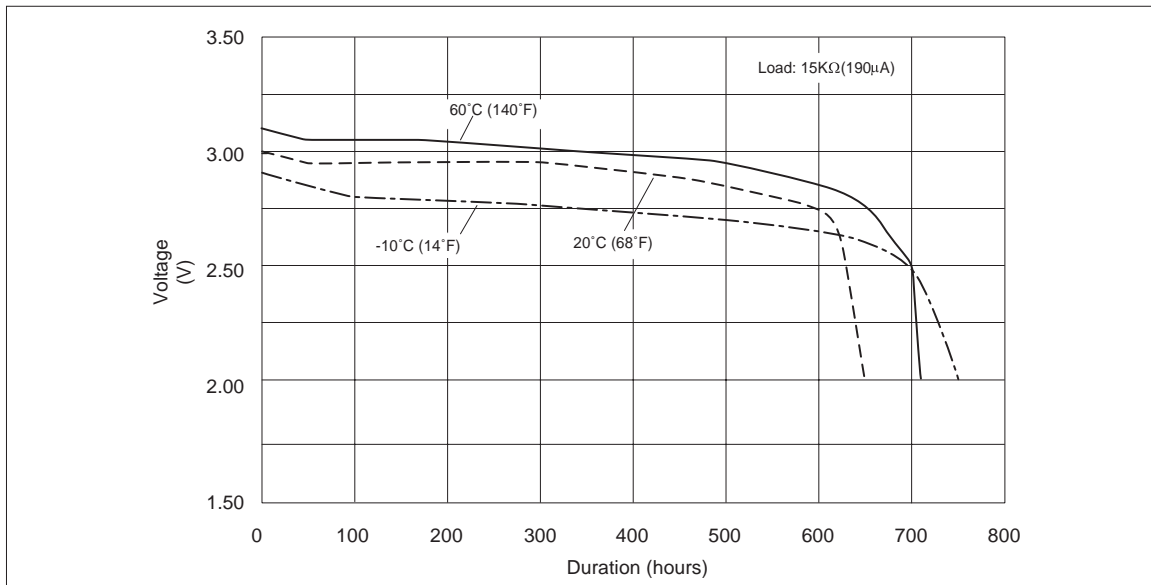


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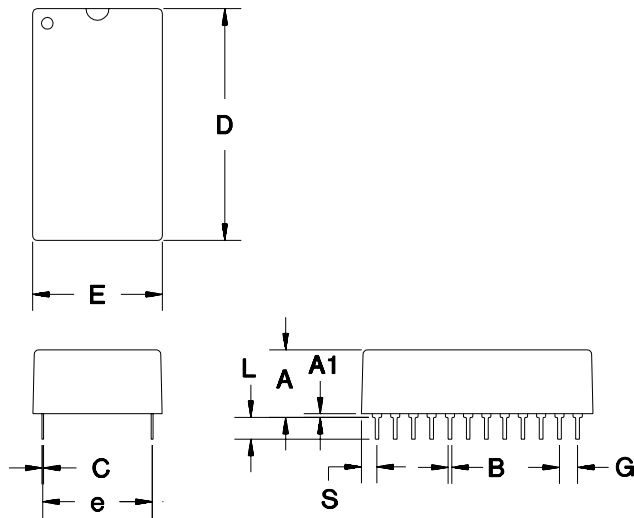
**CR1632 Operating Voltage vs. Load Resistance**



**CR1632 Temperature Characteristics**



24-Pin MT (T-type module)



24-Pin MT (T-type module)

Dimension	Minimum	Maximum
A	0.360	0.375
A1	0.015	-
B	0.015	0.022
C	0.008	0.013
D	1.320	1.335
E	0.685	0.700
e	0.590	0.620
G	0.090	0.110
L	0.120	0.130
S	0.100	0.120

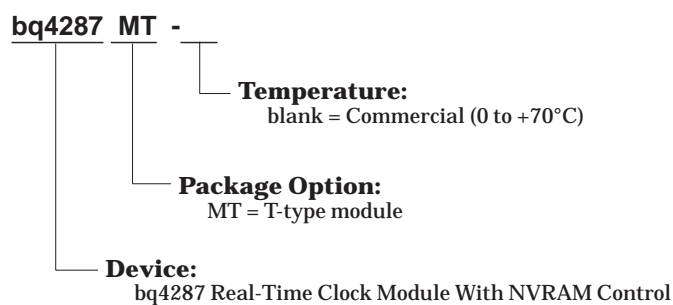
All dimensions are in inches.

**Data Sheet Revision History**

Change	Page No.	Description	Nature of Change
1	2	Power-fail detect voltage V <sub>PF</sub> D	Was 4.1 min, 4.25 max; is 4.0 min, 4.35 max
1	2	Chip enable input current	Additional specification
2	9	Was: "As shipped from Benchmarq, the backup cell is electrically isolated from the memory." Is: "As shipped from Benchmarq, the backup cell is electrically isolated from the active circuitry."	Clarification
2	14	Deleted specifications for t <sub>RWH</sub> and t <sub>RWS</sub>	Clarification; these parameters are not supported by the bq4287

**Notes:** Change 1 = Nov. 1992 B changes from June 1991 A.  
Change 2 = Nov. 1993 C changes from Nov. 1992 B.

**Ordering Information**



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