

DS2438

Smart Battery Monitor

Description

The DS2438 smart battery monitor provides several functions that are desirable to carry in a battery pack: a means of tagging a battery pack with a unique serial number, a direct-to-digital temperature sensor which eliminates the need for thermistors in the battery pack, an A/D converter which measures the battery voltage and current, an integrated current accumulator which keeps a running total of all current going into and out of the battery, an elapsed time meter, and 40 bytes of nonvolatile EEPROM memory for storage of important parameters such as battery chemistry, battery capacity, charging methodology and assembly date. Information is sent to/from the DS2438 over a 1-Wire® interface, so that only one wire (and ground) needs to be connected from a central microprocessor to a DS2438. This means that battery packs need only have three output connectors: battery power, ground, and the 1-Wire interface.

Because each DS2438 contains a unique silicon serial number, multiple DS2438s can exist on the same 1-Wire bus. This allows multiple battery packs to be charged or used in the system simultaneously.

Applications for the smart battery monitor include portable computers, portable/cellular telephones, and handheld instrumentation battery packs in which it is critical to monitor real-time battery performance. Used in conjunction with a microcontroller in the host system, the DS2438 provides a complete smart battery pack solution that is fully chemistry-independent. The customization for a particular battery chemistry and capacity is realized in the code programmed into the microcontroller and DS2438 EEPROM, and only a software revision is necessary should a designer wish to change battery pack chemistry.

NOTE: This product requires use of the following:

- [DS2438K Evaluation Kit Software](#)

Key Features

Applications/Uses

- Unique 1-Wire interface requires only one port pin for communication
- Provides unique 64-bit serial number to battery packs
- Eliminates thermistors by sensing battery temperature on-chip
- On-board A/D converter allows monitoring of battery voltage for end-of-charge and end-of-discharge determination
- On-board integrated current accumulator facilitates fuel gauging
- Elapsed time meter in binary format
- 40-byte nonvolatile user memory available for storage of battery-specific data
- Operating range -40°C to +85°C

Cell Phones
 Digital Still Cameras
 Digital Video Cameras
 Palmtops, Handy Terminals (incl. barcode)
 Pen Entry Palmtops, PDAs and Organizers
 Smart Battery Packs/Chargers

Key Specifications: Battery Protectors, Selectors and Monitors										
Part Number	Functions	Battery Type	Interface	User Data Storage (bytes)	Parameters Measured	Supply Voltage (min) (V)	Supply Voltage (max) (V)	Package	Operating Temp. Range (°C)	
DS2438	• Status Monitor	1/2 Cell Li-Ion 2-6 Cell NiMH	1-Wire	40 EEPROM	Current Temperature Time Voltage	2.4	10	SOIC/8	-40 to +85	
See All Battery Protectors, Selectors and Monitors (26)										

Notes:

**This pricing is BUDGETARY, for comparing similar parts. Prices are in U.S. dollars and subject to change. Quantity pricing may vary substantially and international prices may differ due to local duties, taxes, fees, and exchange rates. For volume-specific prices and delivery, please see the [price and availability page](#) or contact an authorized distributor.

Application Notes

- Application Note 27: Understanding and Using Cyclic Redundancy Checks with Maxim iButton Products - DS2438
- Application Note 123: Recommended ESD Protection and Circuit Placement for the DS2438 in Li-Ion Cell Pack Master - DS2438
- Application Note 125: Using Dallas Battery Management ICs with High Voltage Battery Packs - DS2438
- Application Note 126: 1-Wire® Communication Through Software - DS2438
- Application Note 131: Lithium-Ion Cell Fuel Gauging with Maxim Battery Monitor ICs - DS2438
- Application Note 148: Guidelines for Reliable Long Line 1-Wire® Networks - DS2438
- Application Note 158: 1-Wire Tagging with XML - DS2438
- Application Note 187: 1-Wire Search Algorithm - DS2438
- Application Note 192: Using the DS2480B Serial 1-Wire Line Driver - DS2438
- Application Note 214: Using a UART to Implement a 1-Wire Bus Master - DS2438
- Application Note 1097: White Paper 2: Using the 1-Wire® Public Domain Kit - DS2438
- Application Note 1100: White Paper 5: Using 1-Wire APIs for Data Sheet Commands - DS2438

Evaluation Kits

DS2438K

Design Guides

[Battery Management \(PDF\)](#)

[1-Wire® Products \(PDF\)](#)

Reliability Reports

Reliability Report: [DS2438](#).

[pdf](#)

Software/Models

[DS2438K Evaluation Kit Software](#)

Ordering Information

Notes:

1. Other options and links for purchasing parts are listed at:
2. [Didn't Find What You Need?](#) Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
3. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See [Full Data Sheet](#) or [Part Naming Conventions](#).
4. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses. Note that "+", "#", "-" in the part number suffix describes RoHS status. Package drawings may show a different suffix character.

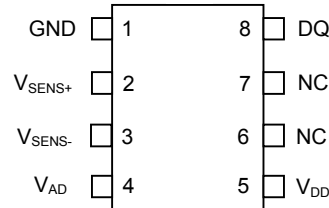
Devices: 1-7 of 7

DS2438	Free Sample	Buy	Package: TYPE PINS FOOTPRINT DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
DS2438Z			SOIC; 8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-5*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
DS2438Z/T&R			SOIC; 8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-5*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
DS2438Z+T&R			SOIC; 8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+5*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis
DS2438Z+			SOIC; 8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+5*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis

FEATURES

- Unique 1-Wire[®] interface requires only one port pin for communication
- Provides unique 64-bit serial number
- Eliminates thermistors by sensing battery temperature on-chip
- On-board A/D converter allows monitoring of battery voltage for end-of-charge and end-of-discharge determination
- On-board integrated current accumulator facilitates fuel gauging
- Elapsed time meter in binary format
- 40-byte nonvolatile user memory available for storage of battery-specific data
- Reverts to low-power sleep mode on battery pack disconnect (feature disabled on DS2438AZ)
- Operating range -40°C to +85°C
- Applications include portable computers, portable/cellular phones, consumer electronics, and handheld instrumentation

PIN ASSIGNMENT



DS2438Z, DS2438AZ
8-Pin SOIC (150-mil)

PIN DESCRIPTION

- | | | |
|--------|---|-----------------------------------|
| DQ | - | Data In/Out |
| VAD | - | General A/D input |
| VSENS+ | - | Battery current monitor input (+) |
| VSENS- | - | Battery current monitor input (-) |
| VDD | - | Power Supply (2.4V to 10.0V) |
| GND | - | Ground |
| NC | - | No connect |

DESCRIPTION

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ORDERING INFORMATION

PART	MARKING	PACKAGE INFORMATION
DS2438Z+	DS2438	8-Pin SOIC
DS2438Z+T&R	DS2438	DS2438Z+ on Tape-and-Reel
DS2438AZ+	DS2438A	8-Pin SOIC
DS2438AZ+T&R	DS2438A	DS2438AZ+ on Tape-and-Reel
DS2438Z	DS2438	8-Pin SOIC
DS2438Z/T&R	DS2438	DS2438Z on Tape-and-Reel
DS2438AZ	DS2438A	8-Pin SOIC
DS2438AZ/T&R	DS2438A	DS2438AZ on Tape-and-Reel

+ Denotes lead-free package.

DETAILED PIN DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1	GND	Ground
2	V _{SENS+}	Battery Input: connection for battery current to be monitored (see text)
3	V _{SENS-}	Battery Input: connection for battery current to be monitored (see text)
4	V _{AD}	ADC Input: input for general purpose A/D
5	V _{DD}	V_{DD} Pin: input supply voltage
6, 7	NC	No Connect
8	DQ	Data Input/Out: for 1-Wire operation: Open drain

OVERVIEW

The block diagram of Figure 1 shows the seven major components of the DS2438:

1. 64-bit lasered ROM
2. temperature sensor
3. battery voltage A/D
4. battery current A/D
5. current accumulators
6. elapsed time meter
7. 40-byte nonvolatile user-memory

Each DS2438 contains a unique 64-bit lasered ROM serial number so that several battery packs can be charged/monitored by the same host system. Furthermore, other Dallas products featuring the same 1-Wire bus architecture with a 64-bit ROM can reside on the same bus; refer to the [Dallas Automatic Identification Data book](#) for the specifications of these products.

Communication to the DS2438 is via a 1-Wire port. With the 1-Wire port, the memory and control functions will not be available until the ROM function protocol has been established. The master must first provide one of four ROM function commands: 1) Read ROM, 2) Match ROM, 3) Search ROM, or 4) Skip ROM. These commands operate on the 64-bit lasered ROM portion of each device and can singulate a specific device if many are present on the 1-Wire line as well as to indicate to the bus master how many and what types of devices are present. After a ROM function sequence has been successfully executed, the memory and control functions are accessible and the master may then provide any one of the six memory and control function commands.

NOTES:

1. Temperature conversion takes up to 10 ms.
2. A/D conversion takes up to 4 ms.
3. EEPROM writes take up to 10 ms.

SAMPLE COMMAND SEQUENCE Table 12

Example: Bus Master enables the ICA, CCA, and DCA on a single DS2438 and configures it such that the CCA/DCA information is shadowed to EEPROM. The voltage A/D is configured such that the DS2438 will perform voltage measurements on the battery (VDD) voltage.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
TX	Reset	Read pulse
RX	Presence	Presence pulse
TX	CCh	Skip ROM
TX	4Eh00h	Issue Write SP 00h command
TX	0Fh	Sets ICA, CA, EE, AD Bits active
TX	Reset	Reset pulse
RX	Presence	Presence pulse
TX	CCh	Skip ROM
TX	BEh00h	Issue Read SP 00h command
RX	<9 data bytes>	Read scratchpad data and CRC
TX	Reset	Reset pulse
RX	Presence	Presence pulse
TX	CCh	Skip ROM
TX	48h00h	Issue Copy SP 00h command
RX	Read Slots	DS2438 returns a "1" when Copy SP is complete
TX	Reset	Reset pulse
RX	Presence	Presence Pulse, done

ABSOLUTE MAXIMUM RATINGS*

Voltage on VDD and VAD, Relative to Ground	-0.3V to + 12V
Voltage on VSENS+, VSENS-, Relative to Ground	<±300 mV
Voltage on Any Other Pin Relative to Ground	-0.3V to + 7.0V
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +125°C
Soldering Temperature	See J-STD-020A specification

* 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

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Supply Voltage	V _{DD}		2.4		10.0	V	1
Data Pin	DQ		-0.3		+5.5	V	1
DQ Pull-up Voltage			2.4		5.5		

DC ELECTRICAL CHARACTERISTICS

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Input Logic High	V _{IH}		2.0			V	1
Input Logic Low	V _{IL}		-0.3		0.5	V	1
Shutdown Current	I _{DD1}	DQ=0, RTC Active		25		μA	
Active Current	I _{DD}	DQ=1, ICA Active <u>or</u> Temperature <u>or</u> Voltage Conversions <u>or</u> EEPROM write in progress		50	100	μA	
Input Resistance	R _I	DQ		500		kΩ	2

ELECTRICAL CHARACTERISTICS: DIGITAL THERMOMETER

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Thermometer Error ($T_{ACTUAL} - T_{MEASURED}$)	T_{ERR}				±2	°C	
Conversion Time	t_{CONVT}			3	10	ms	

ELECTRICAL CHARACTERISTICS: VOLTAGE A/D CONVERTER

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
A/D Error	VDD_{ERR}	VDD input		±10	±50	mV	
	VAD_{ERR}	VAD input		±25	±75		
V_{AD} Input Range	V_{ADR}		1.5V		10.0	V	1
V_{DD} Input Range	V_{DDR}		2.4		10.0	V	1
Conversion Time	t_{CONVV}			3	10	ms	
No Missing Code Temperature Range			-40		+85	°C	

ELECTRICAL CHARACTERISTICS: CURRENT A/D CONVERTER

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Current Measurement Input Range ($V_{SENS+} - V_{SENS-}$)	IAD_{RANGE}				250	mV	
Current Measurement Error	IAD_{ERR}	$ V_{SENS+} - V_{SENS-} \leq 125 \text{ mV}$			±2	LSB	3
					1	%	

ELECTRICAL CHARACTERISTICS: RTC COUNTER

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Clock Error	RTC_{ERR}	0°C to +70°C		1	3	%	
Resolution			1			sec	

AC ELECTRICAL CHARACTERISTICS: NV MEMORY

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
NV Write Cycle Time	t _{WR}			2	10	ms	
EEPROM Writes (copy scratchpad command)	N _{EEWR}	-20°C to +55°C	50k			writes	
EEPROM data retention	t _{EDR}	-20°C to +55°C	10			years	

AC ELECTRICAL CHARACTERISTICS: 1-WIRE INTERFACE

(-40°C to +85°C; 2.4V ≤ VDD ≤ 10.0V)

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS	NOTES
Time Slot	t _{SLOT}		60		120	μs	
Recovery Time	t _{REC}		1			μs	
Write 0 Low Time	t _{LOW0}		60		120	μs	
Write 1 Low Time	t _{LOW1}		1		15	μs	
Read Data Valid	t _{RDV}				15	μs	
Reset Time High	t _{RSTH}		480			μs	
Reset Time Low	t _{RSTL}		480		980	μs	
Presence Detect High	t _{PDH}		15		60	μs	
Presence Detect Low	t _{PDL}		60		240	μs	
DQ Capacitance	C _{DQ}				25	pF	

NOTES:

1. All voltages are referenced to GND.
2. Input load is to GND.
3. Current measurement accuracy is ±2 LSb or 1%, whichever is greater.