Ordering number : ENA2237E

LC709203F

ON Semiconductor®

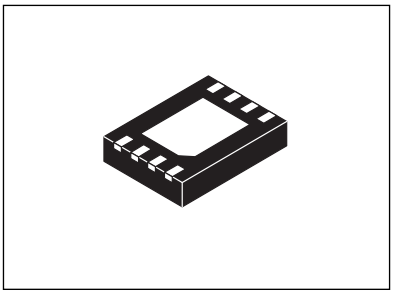
http://onsemi.com

CMOS LSI

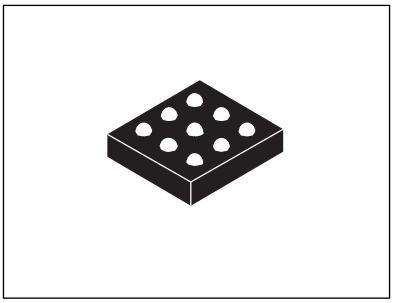
Battery Fuel Gauge LSI for 1-Cell Lithium-ion (Li+)

Overview

The LC709203F is an IC that measures the remaining power level of 1-cell lithium-ion (Li+) batteries used for portable equipment etc.
This product reduces fuel gauge errors with a unique correction technology during measurement of battery temperature and voltage.
This technology has inherent high precision without the need for an external sense resistor.



WDFN8 3x4, 0.65P



WLCSP9, 1.60x1.76

Applications

- Wireless Handsets
- Smartphones / PDA devices
- MP3 players
- Digital cameras
- Portable Game Players
- USB-related devices

Features

- High accuracy of remaining battery power measurements
- Precision Voltage Measurement
- No external sense resistor
- Alert function
- Interface
  - I^2C Interface (up to 400 kHz supported)
- Low power consumption
- Corresponding battery models for various battery electrode materials
- Ports
  - I^2C communication pin : 2 (SDA, SCL)
  - Battery temperature reading control pin : 1 (TSW)
  - Analog voltage input pin for battery temperature : 1 (TSENSE)
  - External alarm / Interrupt for Low-Battery warning : 1 (ALARMB)
  - Power supply pin : 2 (V_{SS}, V_{DD})
- Package form
  - WDFN8 3×4, 0.65P : Lead-free type
  - WLCSP9, 1.60×1.76 : Lead-free type

* I^2C Bus is a trademark of Philips Corporation.

ORDERING INFORMATION

See detailed ordering and shipping information on page 13 of this data sheet.

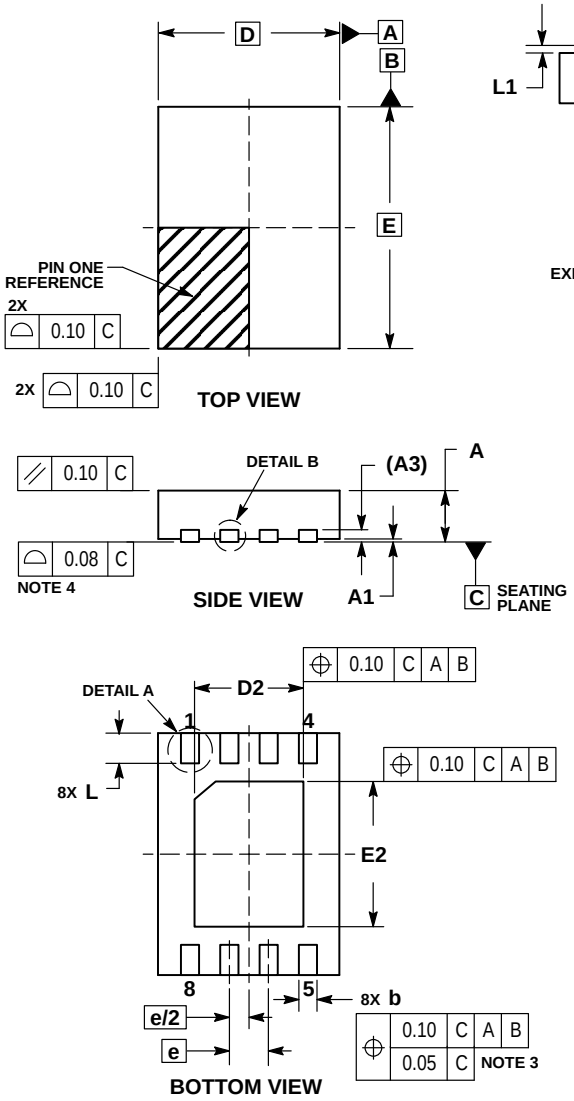
September, 2014 Ver. 0.19a

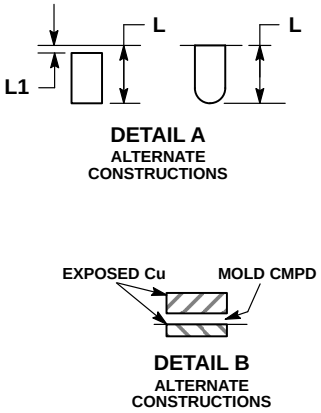
90414HK 20140820-S00032/22014HK /12814HK
/D1113HK/N1213HK/O2313HK No.A2237-1/13

Package Dimensions

unit : mm

WDFN8 3x4, 0.65P
CASE 509AF
ISSUE C

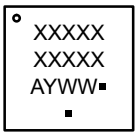




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM THE TERMINAL TIP.
4. PROFILE TOLERANCE APPLIES TO THE EXPOSED PAD AS WELL AS THE LEADS.

	MILLIMETERS	
DIM	MIN	MAX
A	----	0.80
A1	0.00	0.05
A3	0.20 REF	
b	0.20	0.30
D	3.00 BSC	
D2	1.70	1.90
E	4.00 BSC	
E2	2.30	2.50
e	0.65 BSC	
L	0.45	0.55
L1	----	0.10

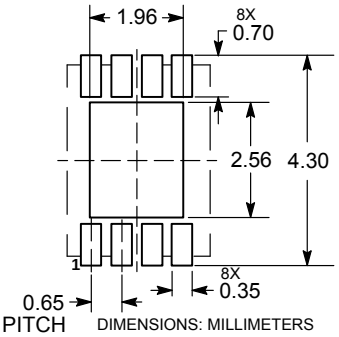
GENERIC MARKING DIAGRAM*



A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb-Free Package
(Note: Microdot may be in either location)

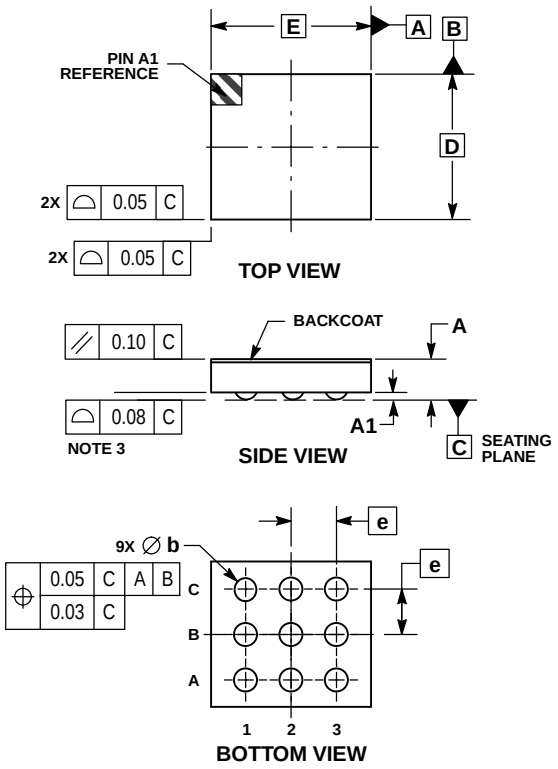
*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, “G” or microdot “ ▪ ”, may or may not be present.

RECOMMENDED SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

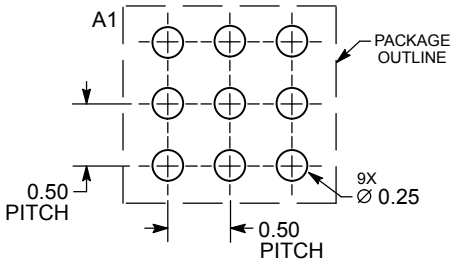
WLCSP9, 1.60x1.76
CASE 567JH
ISSUE B



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.

	MILLIMETERS	
DIM	MIN	MAX
A	---	0.51
A1	0.09	0.19
b	0.20	0.30
D	1.60 BSC	
E	1.76 BSC	
e	0.50 BSC	

RECOMMENDED SOLDERING FOOTPRINT*



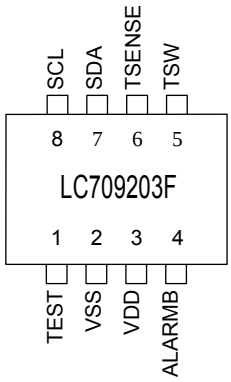
DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

Pin Assignment

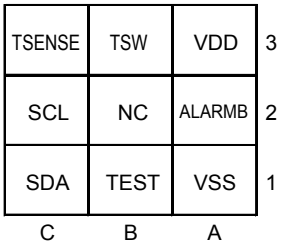
WDFN8 3x4, 0.65P "Lead-free Type"

Top view



WLCSP9, 1.60x1.76 "Lead-free Type"

Bottom view



Pin Function

WDFN8	WLP9	Pin Name	I/O	Description
1	1B	TEST	I	Factory Test pin *Connect to V_{SS}.
2	1A	V_{SS}	-	Connect to the - terminal of the battery.
3	3A	V_{DD}	-	Connect to the + terminal of the battery.
4	2A	ALARMB	O	Alert indication. An active low output used to indicate specified condition thresholds have been met. *When you do not use an alert function, please connect with V_{SS}. (Note 3)
5	3B	TSW	O	Battery temperature reading control pin (Note.1)
6	3C	TSENSE	I	Battery temperature analog voltage input pin (Note.2)
7	1C	SDA	I/O	I^2C data pin
8	2C	SCL	I/O	I^2C clock pin
-	2B	NC	-	Not used pin. *Recommend to connect to V_{SS}.
	-	EP	-	Exposed Pad, must not be connected.

(Note 1)
This pin provides power for the thermistor and goes high during a temperature read operation from Command code x08.

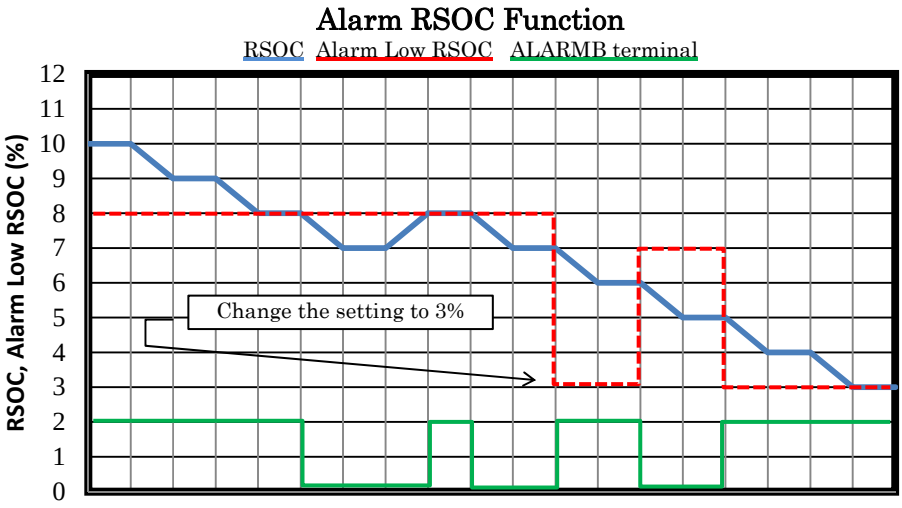
(Note 2)
If TSENSE is not used leave leads TSW and TSENSE disconnected, as in figure 4 and set bit 0 of command code register x16 low.
If TSENSE is utilized connect as in figure 5 with resistor network and set bit 0 of command code register x16 high.

(Note 3)
ALARMB indicates a low RSOC, or an under voltage battery.

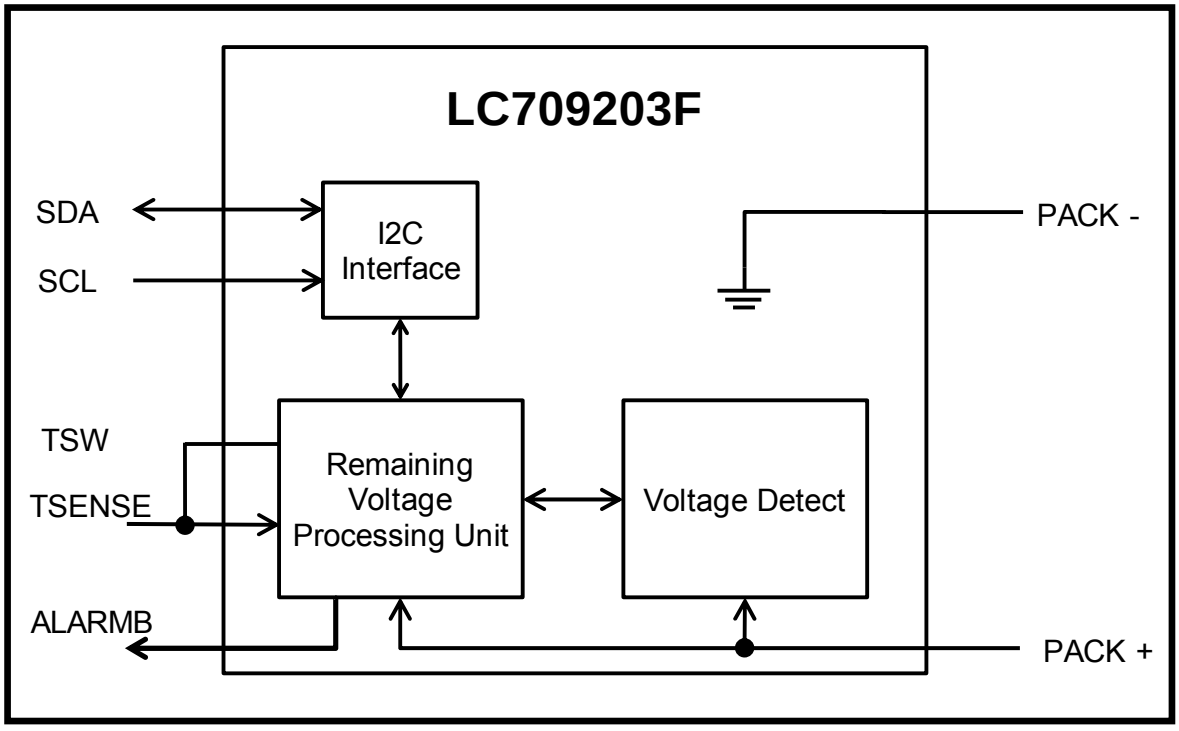
Alert Function

■ Configurable Alert Indicator

- Low RSOC
- Battery Under Voltage



Block Diagram



Absolute Maximum Ratings at Ta = 25°C, V_{SS} = 0V

Parameter	Symbol	Pin/Remarks	Conditions		Specification			Unit
				V_{DD} [V]	min	typ	max	
Maximum supply voltage	V_{DD} max	V_{DD}			−0.3		+6.5	V
Input voltage	V_I (1)	TSENSE			−0.3		V_{DD} +0.3	
Output voltage	V_O (1)	TSW			−0.3		V_{DD} +0.3	
	V_O (2)	ALARMB			−0.3			
Input/output voltage	V_{IO} (1)	SDA, SCL			−0.3		+5.5	
Allowable power dissipation	Pd max	WDFN8	Ta = −40 to +85°C				480	mW
		WLP9					210	
Operating ambient temperature	Topr				−40		+85	°C
Storage ambient temperature	Tstg				−55		+125	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Allowable Operating Conditions at Ta = −40 to +85°C, V_{SS} = 0V

Parameter	Symbol	Pin/Remarks	Conditions		Specification			unit
				V_{DD} [V]	min	typ	max	
Operating supply voltage	V_{DD} (1)	V_{DD}			2.5		4.5	V
High level input voltage	V_{IH} (1)	TSENSE		2.5 to 4.5	0.7V_{DD}		V_{DD}	
	V_{IH} (2)	ALARMB, SDA, SCL		2.5 to 4.5	1.4			
Low level input voltage	V_{IL} (1)	TSENSE		2.5 to 4.5	V_{SS}		0.25V_{DD}	
	V_{IL} (2)	ALARMB, SDA, SCL		2.5 to 4.5			0.5	

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Electrical Characteristics at Ta = –40 to +85°C, V_{SS} = 0V

Parameter	Symbol	Pin/Remarks	Conditions		Specification			Unit
				V_{DD}[V]	min	typ	max	
High level input current	I_{IH} (1)	SDA, SCL	$V_{IN} = V_{DD}$ (including output transistor off leakage current)	2.5 to 4.5			1	μA
Low level input current	I_{IL} (1)	SDA, SCL	$V_{IN} = V_{SS}$ (including output transistor off leakage current)	2.5 to 4.5	–1			
High level output voltage	V_{OH} (1)	TSW	I_{OH} = –0.4 mA	3.0 to 4.5	V_{DD}–0.4			V
	V_{OH} (2)		I_{OH} = –0.2 mA	2.5 to 4.5	V_{DD}–0.4			
Low level output voltage	V_{OL} (1)	TSW, ALARMB, SDA, SCL	I_{OL} = 3.0 mA	3.0 to 4.5			0.4	
	V_{OL} (2)		I_{OL} = 1.3 mA	2.5 to 4.5			0.4	
Hysteresis voltage	VHYS(1)	SDA, SCL		2.5 to 4.5		0.1V_{DD}		
Pin capacitance	CP	All pins	Pins other than the pin under test VIN = VSS Ta = 25°C	2.5 to 4.5		10		pF
Consumption current (Note 1)	I_{DD} (1)	V_{DD}	Testing Mode	2.5 to 4.5		15	26	μA
	I_{DD} (2)		Operational Mode	2.5 to 4.5		2	4.5	
	I_{DD} (3)		Sleep Mode	2.5 to 4.5		0.2	4	
Voltage measurement accuracy	V_{ME} (1)	V_{DD}	Ta = +25°C	3.6	–7.5		+7.5	mV/cell
	V_{ME} (2)		Ta = –20°C to +70°C	2.5 to 4.5	–20		+20	

Note 1 : Consumption current is a value in the range of –20°C to +70°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

I^2C Slave Characteristics at Ta = –40 to +85°C, V_{SS} = 0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification		unit
			V_{DD}[V]	min	Max	
Clock frequency	TSCL	SCL			400	kHz
Bus free time between STOP condition and START condition	TBUF	SCL, SDA	See Fig. 1.	1.3		μs
Hold time (repeated) START condition First clock pulse is generated after this interval	THD:STA	SCL, SDA	See Fig. 1.	0.6		μs
Repeated START condition setup time	TSU:STA	SCL, SDA	See Fig. 1.	0.6		μs
STOP condition setup time	TSU:STO	SCL, SDA	See Fig. 1.	0.6		μs
Data hold time	THD:DAT	SCL, SDA	See Fig. 1.	0	0.9	μs
Data setup time	TSU:DAT	SCL, SDA	See Fig. 1.	100		ns
Clock low period	TLOW	SCL		1.3		μs
Clock high period	THIGH	SCL		0.6		μs
Clock/data fall time	TF	SCL, SDA		20 + 0.1C_B	300	ns
Clock/data rise time	TR	SCL, SDA		20 + 0.1C_B	300	ns

2.5 to 4.5

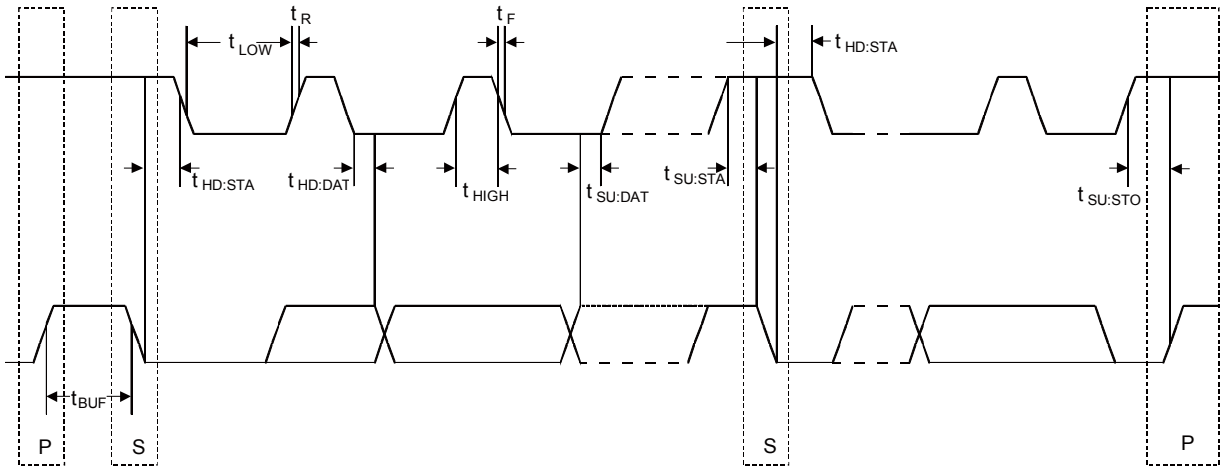


Figure 1 I^2C Timing

Discharge Characteristics

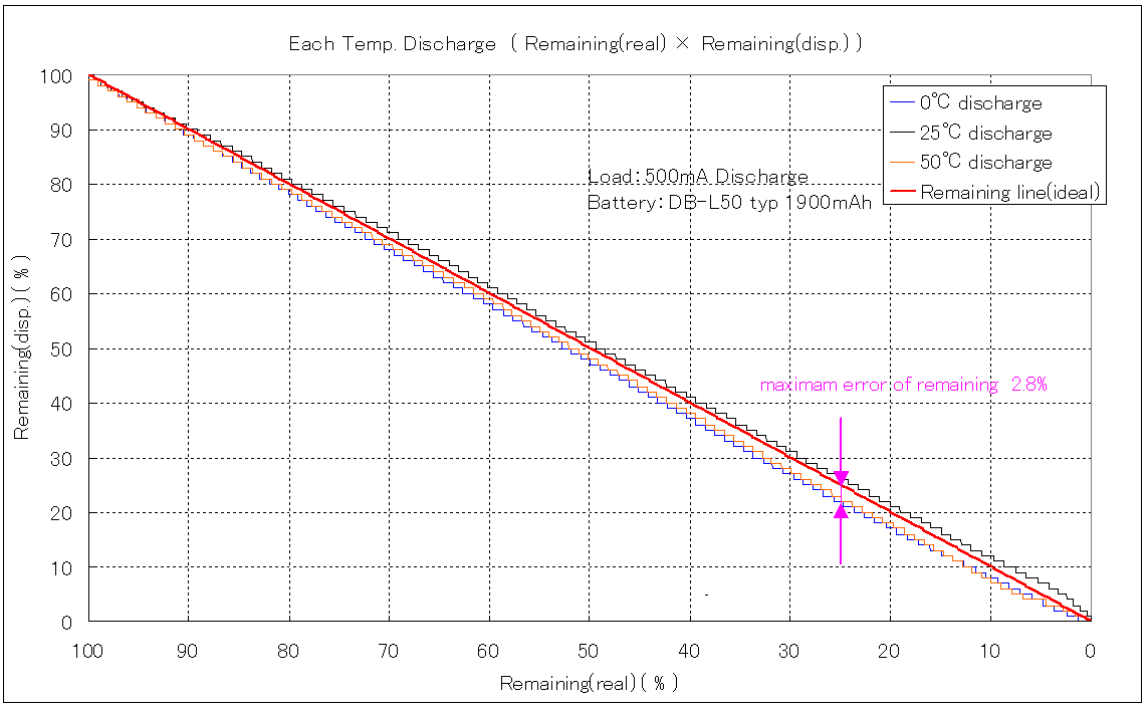


Figure 2 Discharge Characteristics by Temperature Change

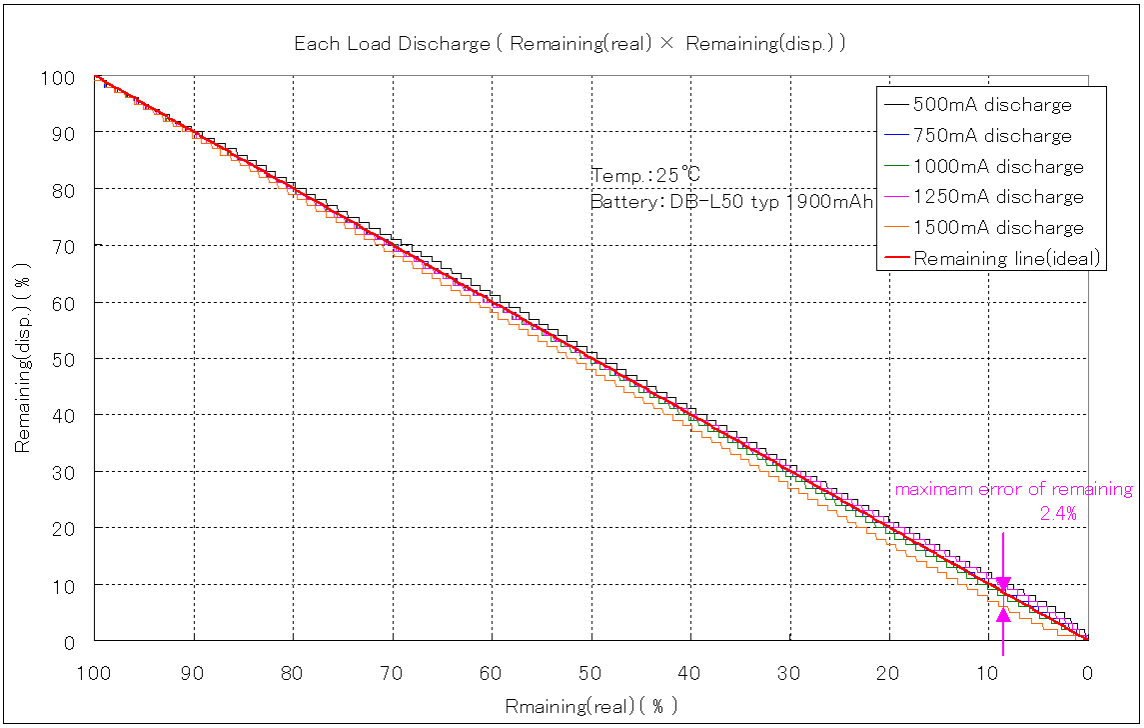


Figure 3 Discharge Characteristics by Load Change

Communication Protocol

Communication protocol type : I^2C

Frequency : to 400kHz

IC address : 0x16 (It becomes "0001011X" when you write a binary, because the slave address is 7 bits. [X]=Rd/Wr.)

Bus Protocols

S	:	Start Condition
Sr	:	Repeated Start Condition
Rd	:	Read (bit value of 1)
Wr	:	Write (bit value of 0)
A	:	ACK (bit value of 0)
N	:	NACK (bit value of 1)
P	:	Stop Condition
CRC-8	:	Slave Address to Last Data (CRC-8-ATM : ex.3778mV : 0x16,0x09,0x17,0xC2,0x0E →0x86)
	:	Master-to-Slave
	:	Slave-to-Master
…	:	Continuation of protocol

Read Word Protocol

S	Slave Address	Wr	A	Command Code	A	…
Sr	Slave Address	Rd	A	Data Byte Low	A	Data Byte High …
A	CRC-8	N	P			

*When you do not read CRC -8, there is not the reliability of data. CRC-8-ATM ex : (5 bytes) 0x16,0x09,0x17,0xC2,0x0E → 0x86

Write Word Protocol

S	Slave Address	Wr	A	Command Code	A	…
Data Byte Low	A	Data Byte High	A	CRC-8	A	P

*When you do not add CRC -8, the Written data (Data byte Low/High) become invalid.
CRC-8-ATM ex : (4 bytes) 0x16, 0x09, 0x55, 0xAA → 0x3B

Command Code	Slave Functions	Access	Range	Unit	Description	Initial Value
0x06	Thermistor β	R/W	0x0000 to 0xFFFF	β	Sets selected thermistor constant value β	0x0D34
0x07	Initial RSOC	W	0xAA55	Value	Sets RSOC to its initial value	-
0x08	Cell Temperature	R W	0x0000 to 0xFFFF (Thermistor Mode) 0x09E4 to 0x0D04 (Via I^2C)	0.1°K (0.0°C = 0x0AAC)	Displays the value of the Cell Temperature	0x0BA6 (25°C)
0x09	Cell Voltage	R	0x0000 to 0xFFFF	mV	Displays the value of the Cell Voltage	-
0x0A	Current Direction	R/W	0x0000: Auto 0x0001: Charge 0xFFFF: Discharge	Function that allows Fuel Gauge to report RSOC in various conditions		0x0000
0x0B	APA (Adjustment Pack Application)	R/W	0x0000 to 0xFFFF	Value	Compensate for total impedance between the Battery and Fuel Gauge	-
0x0C	APT (Adjustment Pack Thermistor)	R/W	0x0000 to 0xFFFF	Delay time to compensate thermistor value due to parallel capacitor & Pull-Up Resistor		0x001E
0x0D	RSOC (Relative State of Charge)	R	0x0000 to 0x0064	%	Displays RSOC value based on a 0-100 scale	-
0x0F	FG unit	R	0x0000 to 0x03E8	Displays remaining capacity of battery based on a 0-1000 scale		-
0x11	IC Version	R	0x0000 to 0xFFFF	Version	Displays the IC version	from 0x2717
0x12	Default or Alternative Profile Select	R/W	0x0000 or 0x0001	Allows to choose between stored battery profiles (Please refer to lower list)		0x0000
0x13	Alarm Low RSOC	R/W	0x0000 to 0x0064	% (activate under)	Allows the assignment of an alarm with a given RSOC value	0x0008
0x14	Alarm Low Cell Voltage	R/W	0x0000 to 0xFFFF	mV (activate under)	Allows the assignment of an alarm with a given voltage value	0x0000
0x15	IC Power Mode	R/W	0x0000 to 0x0002	0x0000 : Testing Mode 0x0001 : Operational Mode 0x0002 : Sleep Mode		0x0001
0x16	Thermistor Status Bit	R/W	bit 0 : Thermistor Mode bit 1 to 15 : Reserved (fix 0)	0 : disable 1 : enable	Displays whether thermistor is enabled or disabled	0x0000
0x1A	Profile Number	R	0x0301 or 0x0504	Displays battery profiles uploaded 301 or 504 (Please refer to lower list)		-

	Type Of The Battery	Number Of The Parameter	Change Of The Parameter
LC709203F-01	Normal Voltage3.8V, Charge Voltage 4.35V	0x0301	0x0000
	Normal Voltage3.7V, Charge Voltage 4.2V		0x0001
LC709203F-04	ICR18650-26H (SAMSUNG)	0x0504	0x0000
	UR18650ZY (Panasonic)		0x0001

RSOC = Relative State Of Charge
0xXXXX = Hexadecimal notation

(Note)
Initialization from Host :
- The IC will initialize reading the battery temperature until Initialization sequence with serial port is executed. (Please see EVB manual for sequences.)

Control from Host :
- The Remaining State of Charge (RSOC) is normally read periodically.
- To read temperature the part will need a sequence of instructions and then returned to RSOC reading.

Application Circuit Example

Figure 4 Example of an application schematic using LC709203F
(not use temperature detection function)

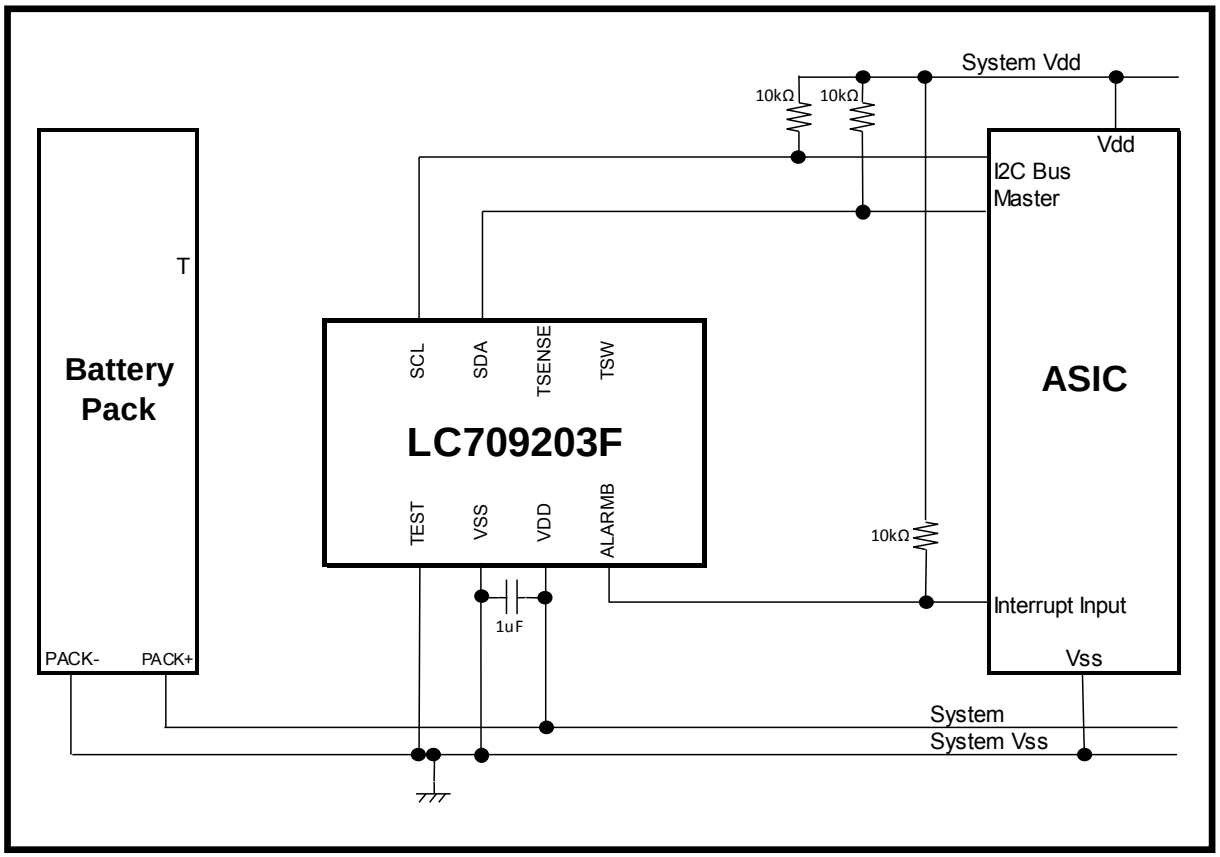
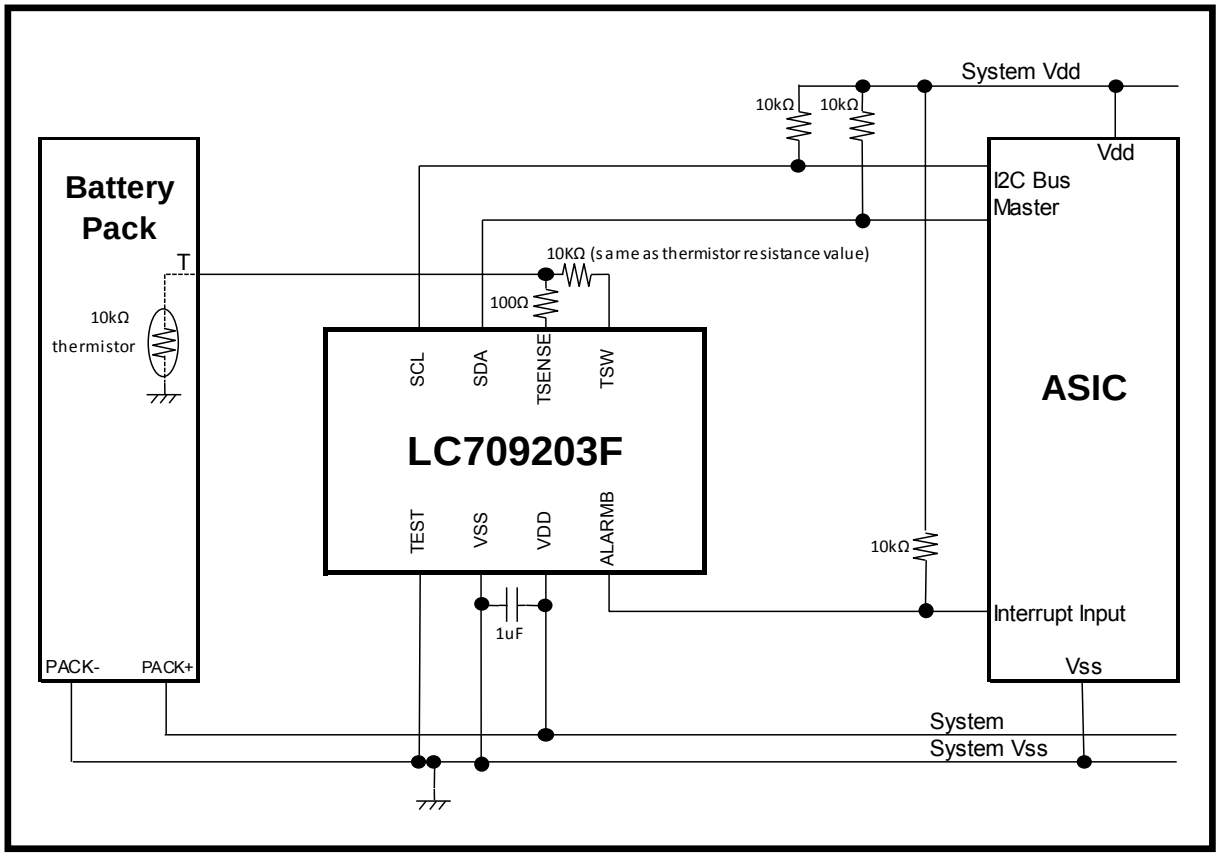


Figure 5 Example of an application schematic using LC709203F
(use temperature detection function)



ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
LC709203FQH-01TWG	WDFN8 3x4, 0.65P (Pb-Free / Halogen Free)	2000 / Tape & Reel
LC709203FQH-02TWG	WDFN8 3x4, 0.65P (Pb-Free / Halogen Free)	2000 / Tape & Reel
LC709203FQH-03TWG	WDFN8 3x4, 0.65P (Pb-Free / Halogen Free)	2000 / Tape & Reel
LC709203FQH-04TWG	WDFN8 3x4, 0.65P (Pb-Free / Halogen Free)	2000 / Tape & Reel
LC709203FXE-01MH	WLCSP9, 1.60x1.76 (Pb-Free / Halogen Free)	5000 / Tape & Reel
LC709203FXE-02MH	WLCSP9, 1.60x1.76 (Pb-Free / Halogen Free)	5000 / Tape & Reel
LC709203FXE-03MH	WLCSP9, 1.60x1.76 (Pb-Free / Halogen Free)	5000 / Tape & Reel
LC709203FXE-04MH	WLCSP9, 1.60x1.76 (Pb-Free / Halogen Free)	5000 / Tape & Reel

(Note)
The type of battery affects the performance to some degree. Contact your sales team for assistance in choosing the correct model.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

ON Semiconductor:

LC709203FXE-01MH LC709203FQH-01TWG LC709203FQH-04TWG LC709203FQH-02TWG LC709203FXE-02MH LC709203FXE-03MH LC709203FXE-04MH LC709203FQH-03TWG