LC709202F

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CMOS LSI
1-Cell Li+ (lithium-ion)
Battery Monitor IC

Overview

The LC709202F is an IC that measures the remaining power level of 1-cell lithium-ion (Li+) batteries used for a portable equipment etc.

This product is able to reduce a fuel gauge errors by implementing its unique correction technology for measurement value of battery temperature and voltage.

It is possible for this to realize high precision for measurement in battery power measurement IC that does not need a current sensing resistor. (±3% under certain conditions)

Applications

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

Package Dimensions

unit : mm (typ)
3318

VCT16(2.6X2.6)

Features

■ Accuracy of remaining battery power level measurement
  - ±3% (at an ambient operating temperature of 0°C to 50°C)
  Note: The accuracy above is the value of an experiment using the evaluation board.

■ Precision ±7.5mV/Cell Voltage Measurement

■ A current sensing resistor is unnecessary.

■ Alert function

■ Interface
  - I^2C Interface (up to 400 kHz supported)

■ Low power consumption
  - Normal Mode : 15μA
  - Sleep Mode : 0.1μA

■ Corresponding battery
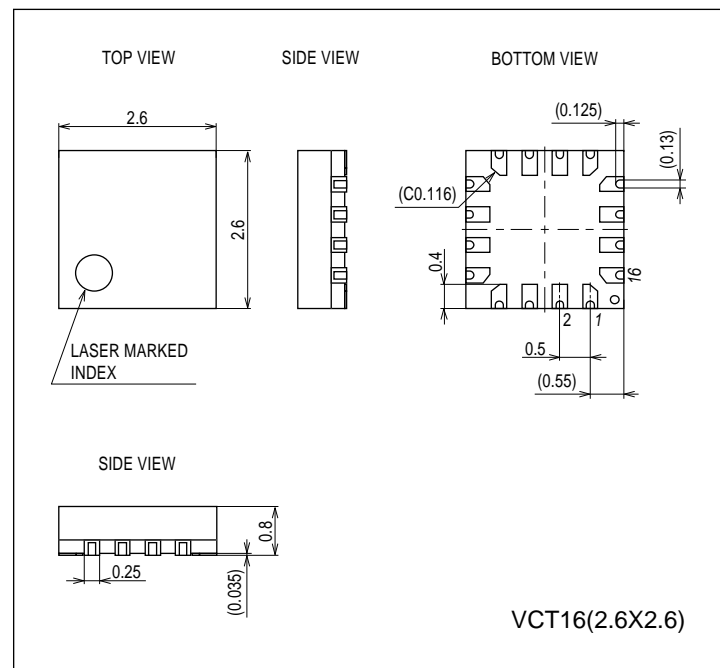 - Model to be used depending on the material of the electrode of the battery pack + is different.
    LC709202F-01: ternary system
    LC709202F-02: nickelic acid

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

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■ 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)
 • Reset pin 1 (RESB)
 • TEST pin 3 (TEST0, TEST1, TEST2)
 • Power supply pin 3 (V_{SS}, $V_{DD}1$, $V_{DD}2$)

■ Package form
 • VCT16 (2.6×2.6) : Lead-free type

Pin Assignment

Top view
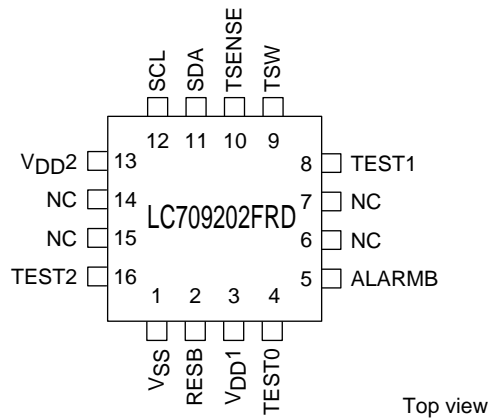
VCT16 (2.6×2.6) "Lead-free Type"

Pin Function

VCT16	Pin Name	I/O	Description
1	V_{SS}	-	Connect to the - terminal of the battery.
2	RESB	I	Reset pin
3	$V_{DD}1$	-	Connect to the + terminal of the battery.
4	TEST0	I	Test pin *Connect to V_{SS}.
5	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}.
8	TEST1	O	Set "OPEN"
9	TSW	O	Battery temperature reading control pin *Set high when reading in the temperature, held low at other times.
10	TSENSE	I	Battery temperature analog voltage input pin
11	SDA	I/O	I^2C data pin
12	SCL	I/O	I^2C clock pin
13	$V_{DD}2$	-	+ power pin for I^2C-Bus communication pin(SDA,SCL)
16	TEST2	O	Set "OPEN"

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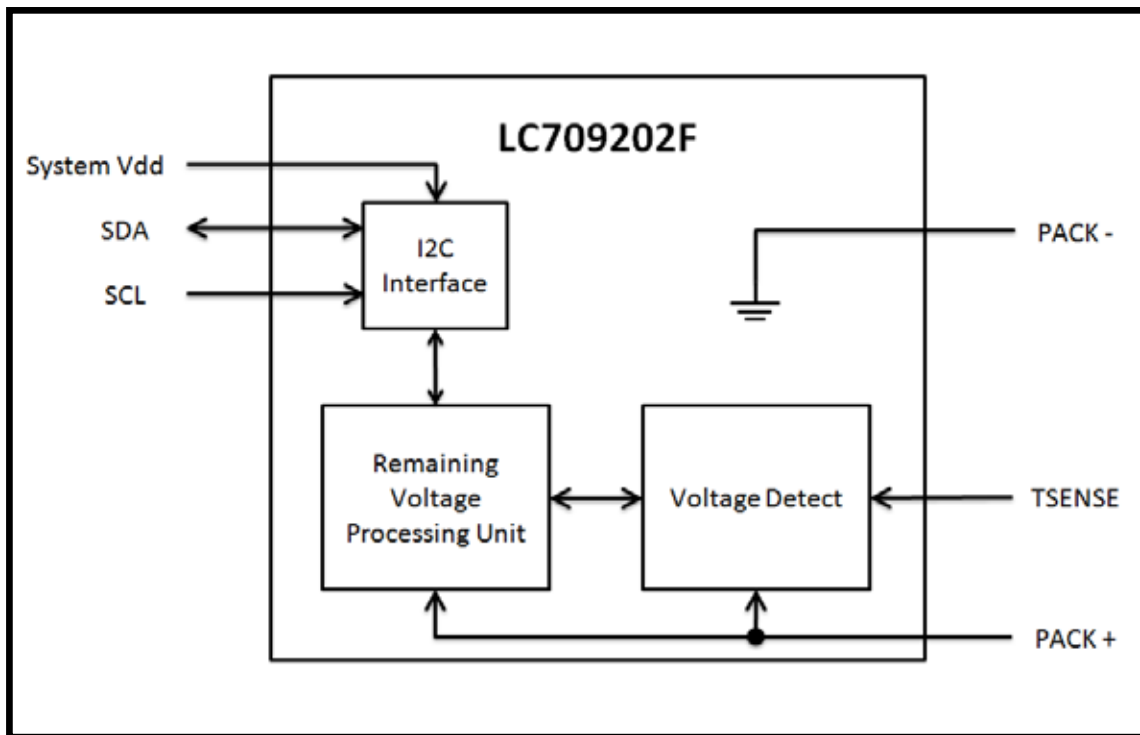
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Absolute Maximum Ratings at Ta=25°C, V_{SS}=0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification				Unit
				V_{DD}[V]	min	typ	max	
Maximum supply voltage	V_{DD} max	$V_{DD}1$, $V_{DD}2$			-0.3		+6.5	V
Input voltage	V_I (1)	RESB, TSENSE			-0.3		$V_{DD}1$ +0.3	
Output voltage	V_O (1)	TSW			-0.3		$V_{DD}1$ +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	VCT16	Ta=-40 to+85°C				55	mW
Operating ambient temperature	Topr				-40		+85	°C
Storage ambient temperature	Tstg				-55		+125	

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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)	$V_{DD}1$			2.5		4.5	V
High level input voltage	V_{IH} (1)	TSENSE		2.5 to 4.5	$0.70V_{DD}1$		$V_{DD}1$	
	V_{IH} (2)	RESB		2.5 to 4.5	$0.75V_{DD}1$		$V_{DD}1$	
	V_{IH} (3)	SDA, SCL	$V_{DD}2$=1.6V to 5.5V	2.5 to 4.5	$0.70V_{DD}2$		$V_{DD}2$	
Low level input voltage	V_{IL} (1)	TSENSE		2.5 to 4.5	V_{SS}		$0.25V_{DD}1$	
	V_{IL} (2)	RESB		2.5 to 4.5	V_{SS}		$0.25V_{DD}1$	
	V_{IL} (3)	SDA, SCL	$V_{DD}2$=1.6V to 5.5V	2.5 to 4.5	V_{SS}		$0.30V_{DD}2$	

LC709202F

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

Parameter	Symbol	Pin/Remarks	Conditions	V_{DD}[V]	min	typ	max	Unit
High level input current	I_{IH} (1)	RESB	$V_{IN}=V_{DD}1$ (including output transistor off leakage current)	2.5 to 4.5			1	μA
	I_{IH} (2)	SDA, SCL	$V_{IN}=V_{DD}2$ $V_{DD}2$=1.6V to 5.5V (including output transistor off leakage current)	2.5 to 4.5			1	
Low level input current	I_{IL} (1)	RESB	$V_{IN}=V_{SS}$ (including output transistor off leakage current)	2.5 to 4.5	-1			
	I_{IL} (2)	SDA, SCL	$V_{IN}=V_{SS}$ $V_{DD}2$=1.6V to 5.5V (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)	RESB		2.5 to 4.5		0.1V_{DD}1		
	VHYS(2)	SDA, SCL		2.5 to 4.5		0.1V_{DD}2		
Pin capacitance	CP	All pins	Pins other than the pin under test $V_{IN}=V_{SS}$ Ta=25°C	2.5 to 4.5		10		pF
Consumption current (Note 1)	I_{DD} (1)	V_{DD}1	Normal Mode	2.5 to 4.5		15	26	μA
	I_{DD} (2)		Auto Mode	2.5 to 4.5		2 to 15	4 to 26	
	I_{DD} (3)		Sleep Mode	2.5 to 4.5		0.1	5	
Voltage measurement accuracy	V_{ME} (1)	V_{DD}1	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

I²C 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.	2.5 to 4.5	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
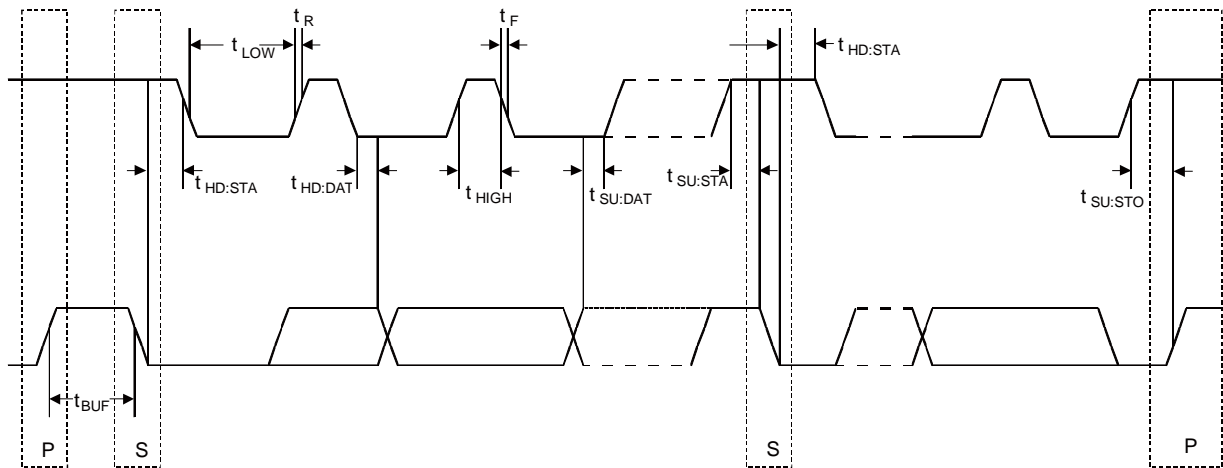
Figure 1 I²C Timing

Discharge Characteristics
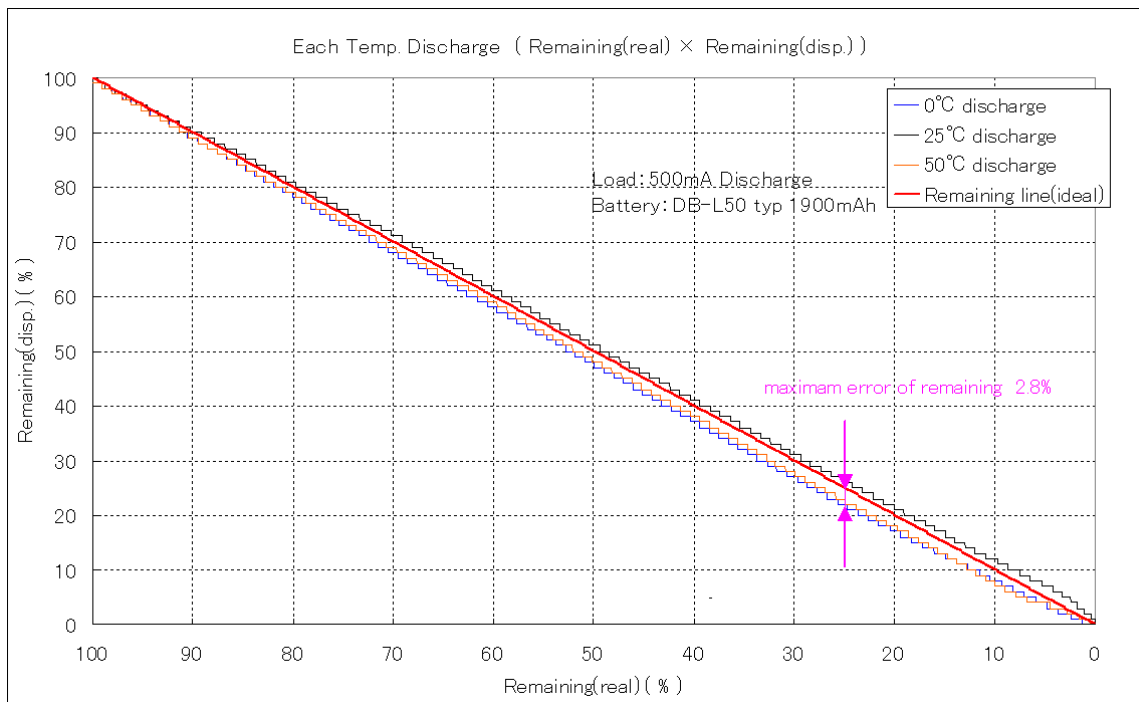
Figure 2 Discharge Characteristics by Temperature Change
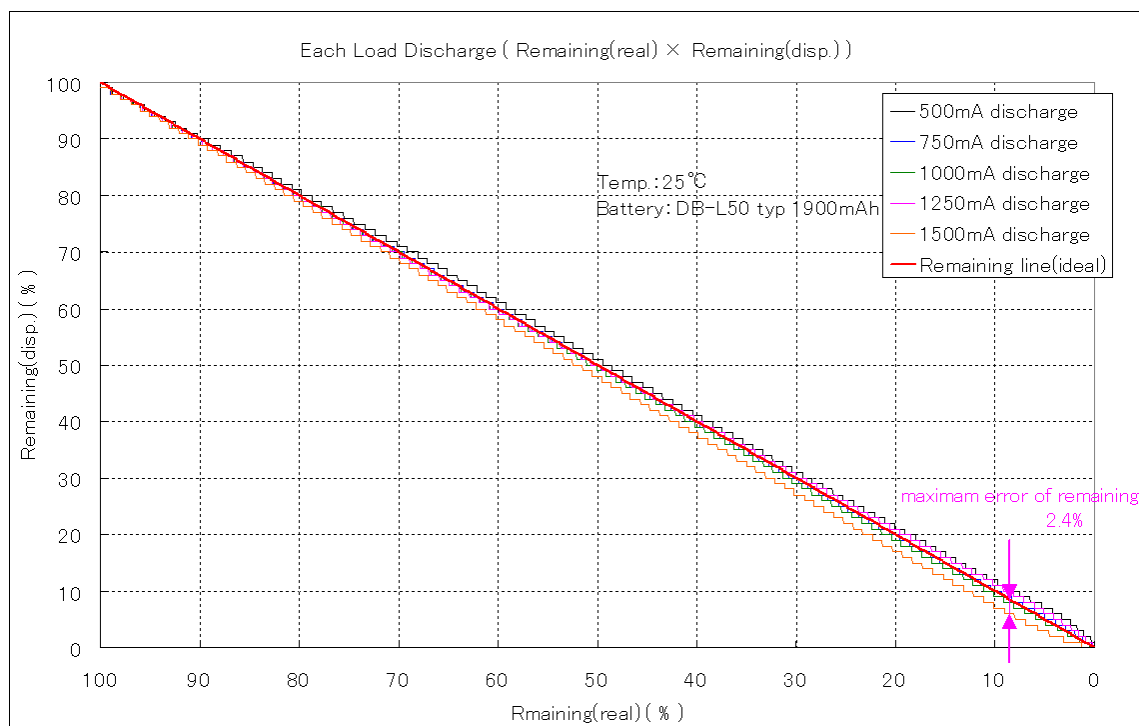
Figure 3 Discharge Characteristics by Load Change

Communication Protocol

Communication protocol type: I²C
Frequency: 400 kHz
Address: 0x16

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			

Write Word Protocol

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

Access	Slave Functions	Command Code	Range		Unit
Read	Cell Temperature	0x08	0 to 65535		0.1°K (0.0°C = 2732)
	Cell Voltage	0x09	0 to 65535		mV
	Current	0x0A	-32768 to 32767		mA
	Adjustment Pack 8	0x0B	0 to 255		Value
	Relative State Of Charge	0x0D	0 to 100		%
	Remaining Capacity	0x0F	0 to 1000		mAh
	Full Charge Capacity	0x10	1000		mAh
	IC Version	0x11	0 to 65535		Version
	Adjustment Thermistor	0x12	0 to 255		Value
	Hot Start	0x13	bit 0		disable: 0
	Sleep Mode		bit 1		or
	Auto Mode		bit 2		enable: 1
	Alarm Low Battery	0x14	High : 0 to 250		20mV
			Low : 0 to 100		%
	Adjustment B	0x15	0 to 65535		B
	System Mode	0x16	bit 0 to 3 :	data 0	Nomal Mode
				data 1	Sleep Mode
				data 2	Auto Mode
			bit 4 to 7 : data 0 to 6		Auto deep
Write	Adjustment Pack 0	0x00	0 to 32767		Value
	Adjustment Pack 1	0x01	0 to 32767		Value
	Adjustment Pack 2	0x02	0 to 32767		Value
	Adjustment Pack 3	0x03	0 to 32767		Value
	Adjustment Pack 4	0x04	0 to 32767		Value
	Adjustment Pack 5	0x05	0 to 32767		Value
	Set Relative State Of Charge	0x08	High : 0xA5		-
			Low : 0 to 100		%
	Adjustment Pack 8		High : 0x5A		-
			Low : 0 to 255		Value
	Adjustment Thermistor		High : 0xAA		-
			Low : 0 to 255		Value
	Hot Start		High : 0x55	Low : bit 0	disable: 0
	Sleep Mode			bit 1	or
	Auto Mode			bit 2	enable: 1
	Initial Relative State Of Charge	0x09	0xAA55		-
	Alarm Low Battery	0x0A	High : 0 to 250		20mV(activate under)
			Low : 0 to 100		% (activate under)
	Adjustment B	0x0B	0 to 65535		B
	Cell Temperature	0x0C	2532 to 3332 (I2C Write Mode)		0.1°K (0.0°C = 2732)
			0xAA55 (Thermistor Mode)		-

Application Circuit Example

Figure 4 Example of an application schematic using LC709202F
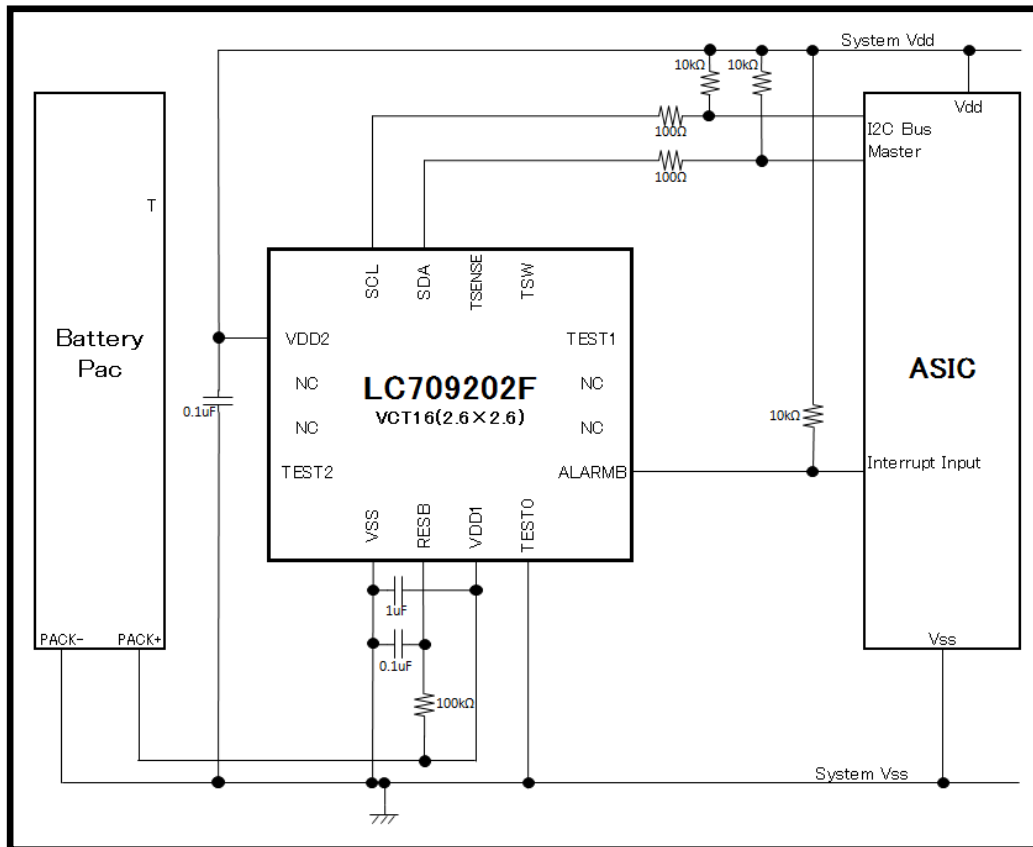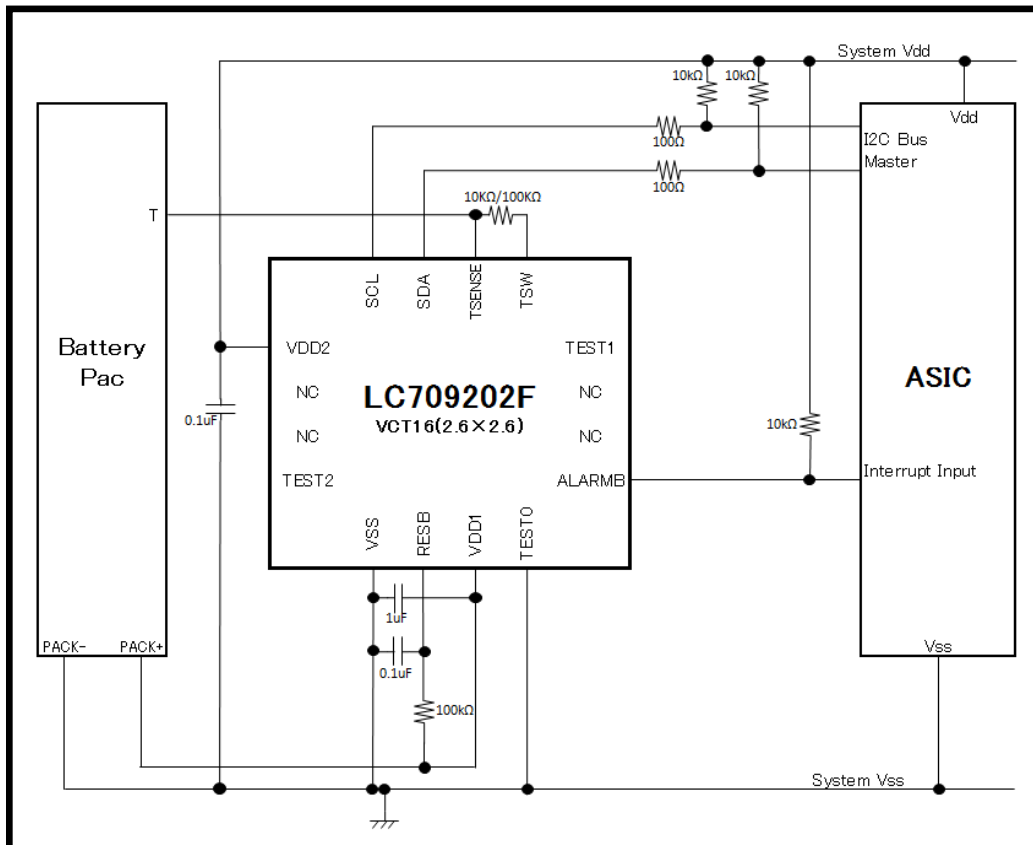(not use temperature detection function)

Figure 5 Example of an application schematic using LC709202F
(use temperature detection function)

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