



**SANYO Semiconductors**

# DATA SHEET

An ON Semiconductor Company

## LC709201F — CMOS IC Battery Monitor IC

### Overview

The LC709201F is an IC that measures the remaining power level of 1-cell lithium-ion secondary batteries by monitoring the battery voltage without an external sense resistor, and detects the remaining battery power level by current prediction. It monitors the battery voltage and realizes a function that precisely measures the remaining battery charge. In addition, the IC realizes the function for calculating the remaining battery power level even more accurately by utilizing a temperature correction function that makes use of the temperature input from a thermistor.

### Features

- Accuracy of remaining battery power level measurement
  - Accuracy of  $\pm 5\%$  during discharging from 100% to 0% (at an ambient operating temperature of 0°C to 50°C)
- Measurement of remaining battery power level
  - The remaining power level is measured four times a second and calculated with each measurement undertaken.
- Interface
  - I<sup>2</sup>Cbus, communication in slave mode up to 100kHz supported
- Ports
 

• I <sup>2</sup> C-bus communication pin	2 (SDA, SCL)
• Battery temperature reading control pin	1 (TSW)
• Analog voltage input pin for battery temperature	1 (TSENSE)
• Reset pin	1 (RESB)
• TEST pin	1 (TEST)
• Power supply pin	2 (VSS, VDD)
- Package form
  - MFP10S (225 mil): LC709201FM-01/02/03
  - VCT16 (2.6×2.6): LC709201FRD-01/02/03

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# LC709201F

## Applications

- Cell phones, PDA devices, MP3 players, cordless phones, digital cameras, USB-related devices, etc.

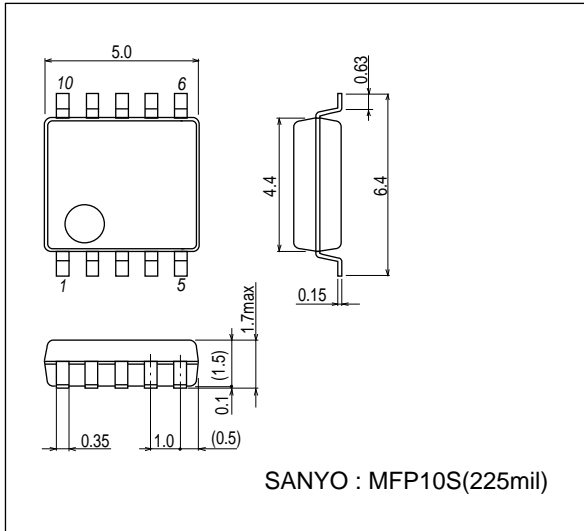
(Note) Depending on the kinds of battery, applicable model differs (LC709201F-01/02/03).

Please contact us for more detail information.

## Package Dimensions

unit : mm (typ)

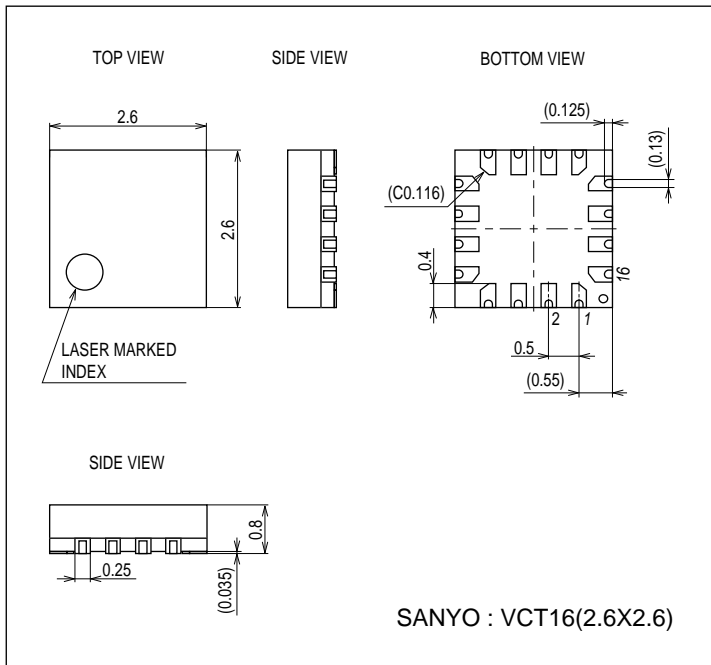
3086B



## Package Dimensions

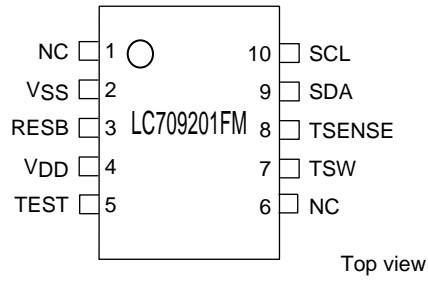
unit : mm (typ)

3318

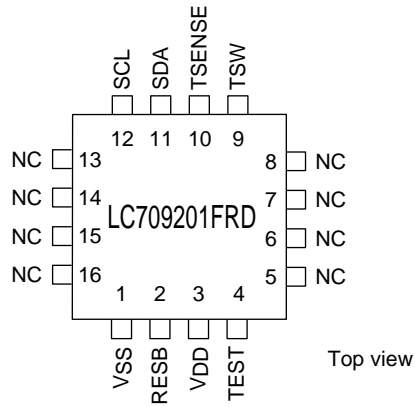


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## Pin Assignment

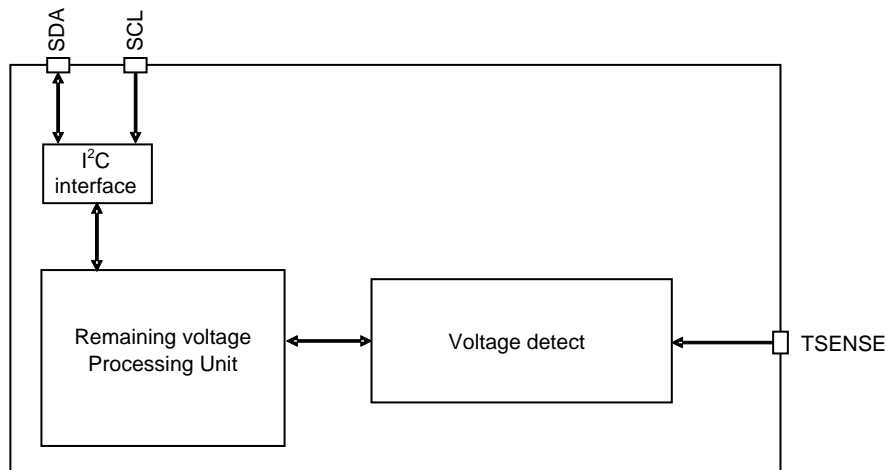


SANYO: MFP10S (225mil) "Lead-free Type"



SANYO: VCT16 (2.6x2.6) "Lead-free Type"

Block Diagram



Pin Function

Pin Name	I/O	Description
V <sub>SS</sub>	-	- power pin
V <sub>DD</sub>	-	+ power pin
RESB	I	Reset pin
TEST	I/O	Test pin *Connect an external 100kΩ pull-down resistor.
SDA	I/O	I²C data pin
SCL	I/O	I²C clock pin
TSW	O	Battery temperature reading control pin *Set high when reading in the temperature, held low at other times.
TSENSE	I	Battery temperature analog voltage input pin

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## Absolute Maximum Ratings at Ta=25°C, VSS=0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification			Unit	
				V <sub>DD</sub> [V]	min	typ		max
Maximum supply voltage	V <sub>DD</sub> max	V <sub>DD</sub>			-0.3		+6.5	V
Input voltage	V <sub>I</sub> (1)	RESB, TSENSE			-0.3		V <sub>DD</sub> +0.3	
Output voltage	V <sub>O</sub> (1)	TSW			-0.3		V <sub>DD</sub> +0.3	
Input/output voltage	V <sub>IO</sub> (1)	SDA, SCL, TEST			-0.3		V <sub>DD</sub> +0.3	
Allowable power dissipation	Pd max	MFP10S	Ta=-40 to +85°C				110	mW
		VCT16					55	
Operating ambient temperature	Topr				-40		+85	°C
Storage ambient temperature	Tstg				-55		-125	

## Allowable Operating Conditions at Ta=-40 to +85°C, VSS=0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification			unit	
				V <sub>DD</sub> [V]	min	typ		max
Operating supply voltage	V <sub>DD</sub> (1)	V <sub>DD</sub>			2.25		5.5	V
High level input voltage	V <sub>IH</sub> (1)	SDA, SCL		2.25 to 5.5	0.3V <sub>DD</sub> +0.7		V <sub>DD</sub>	
Low level input voltage	V <sub>IL</sub> (1)	SDA, SCL		4.0 to 5.5	V <sub>SS</sub>		0.1V <sub>DD</sub> +0.4	
	V <sub>IL</sub> (2)			2.25 to 4.0	V <sub>SS</sub>		0.2V <sub>DD</sub>	

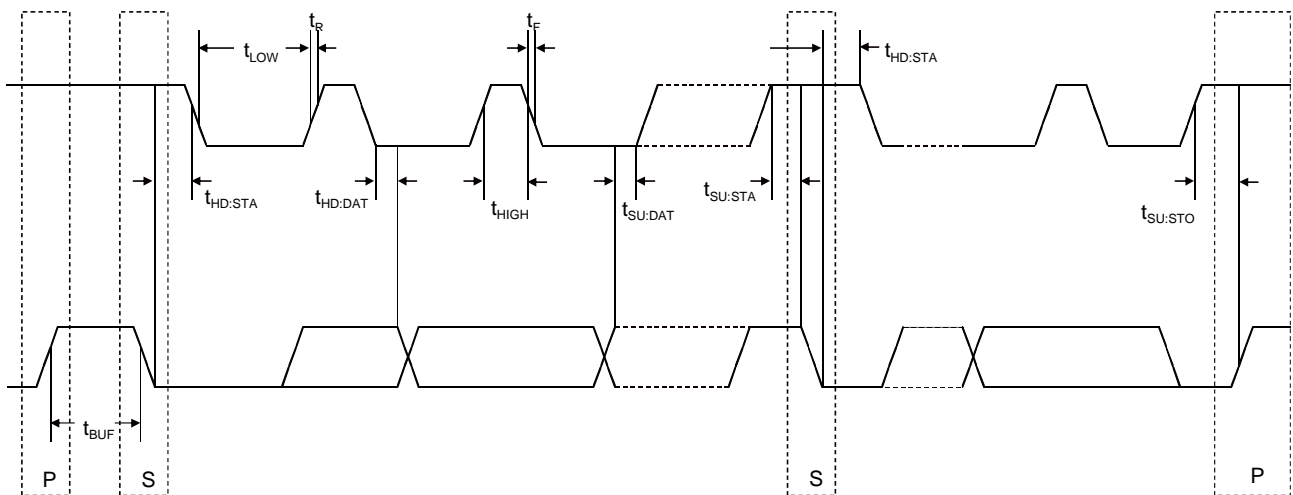
## Electrical Characteristics at Ta=-40 to +85°C, VSS=0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification			Unit	
				V <sub>DD</sub> [V]	min	typ		max
High level input current	I <sub>IH</sub> (1)	RESB, SDA, SCL	V <sub>IN</sub> =V <sub>DD</sub> (including output transistor off leakage current)	2.25 to 5.5			1	μA
Low level input current	I <sub>IL</sub> (1)	RESB, SDA, SCL	V <sub>IN</sub> =V <sub>SS</sub> (including output transistor off leakage current)	2.25 to 5.5	-1			
High level output voltage	V <sub>OH</sub> (1)	TSW	I <sub>OH</sub> =-0.4mA	3.0 to 5.5	V <sub>DD</sub> -0.4			V
	V <sub>OH</sub> (2)		I <sub>OH</sub> =-0.2mA	2.25 to 5.5	V <sub>DD</sub> -0.4			
Low level output voltage	V <sub>OL</sub> (1)	TSW, SDA, SCL	I <sub>OL</sub> =3.0mA	3.0 to 5.5			0.4	
	V <sub>OL</sub> (2)		I <sub>OL</sub> =1.3mA	2.25 to 5.5			0.4	
Hysteresis voltage	VHYS	RESB, SDA, SCL		2.25 to 5.5		0.1V <sub>DD</sub>		
Pin capacitance	CP	All pins	Pins other than the pin under test V <sub>IN</sub> =V <sub>SS</sub> f=1 MHz Ta=25°C	2.25 to 5.5		10		pF
Consumption current	I <sub>DD</sub> (1)	V <sub>DD</sub>	When detecting remaining capacity	2.25 to 5.5		8	16	μA
	I <sub>DD</sub> (2)		When not detecting remaining capacity	2.25 to 5.5		5	12	

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## I<sup>2</sup>C Slave Characteristics at Ta=-40 to+85°C, V<sub>SS</sub>=0V

Parameter	Symbol	Pin/Remarks	Conditions	Specification			unit		
				V <sub>DD</sub> [V]	min	typ		max	
Clock frequency	T <sub>SCL</sub>	SCL		2.25 to 5.5			100	kHz	
Bus free time between STOP condition and START condition	T <sub>BUF</sub>	SCL, SDA	See Fig. 1.		4.7				μs
Hold time (repeated) START condition First clock pulse is generated after this interval	T <sub>HD: STA</sub>	SCL, SDA	See Fig. 1.		4.0				μs
Repeated START condition setup time	T <sub>SU: STA</sub>	SCL, SDA	See Fig. 1.		4.7				μs
STOP condition setup time	T <sub>SU: STO</sub>	SCL, SDA	See Fig. 1.		4.0				μs
Data hold time	T <sub>HD: DAT</sub>	SCL, SDA	See Fig. 1.		300				ns
Data setup time	T <sub>SU: DAT</sub>	SCL, SDA	See Fig. 1.		250				ns
Clock low period	T <sub>LOW</sub>	SCL			4.7				μs
Clock high period	T <sub>HIGH</sub>	SCL			4.0				μs
Clock/data fall time	T <sub>F</sub>	SCL, SDA						300	ns
Clock/data rise time	T <sub>R</sub>	SCL, SDA						1000	ns



Discharge Characteristics

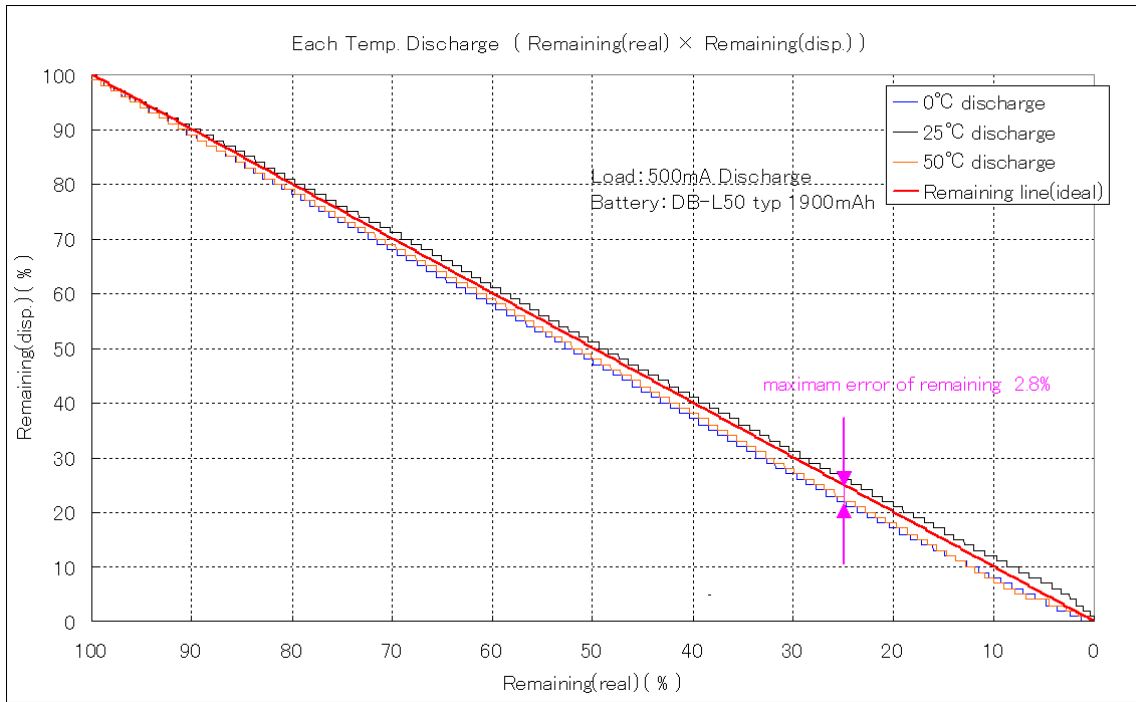


Figure2 Discharge Characteristics by Temperature Change

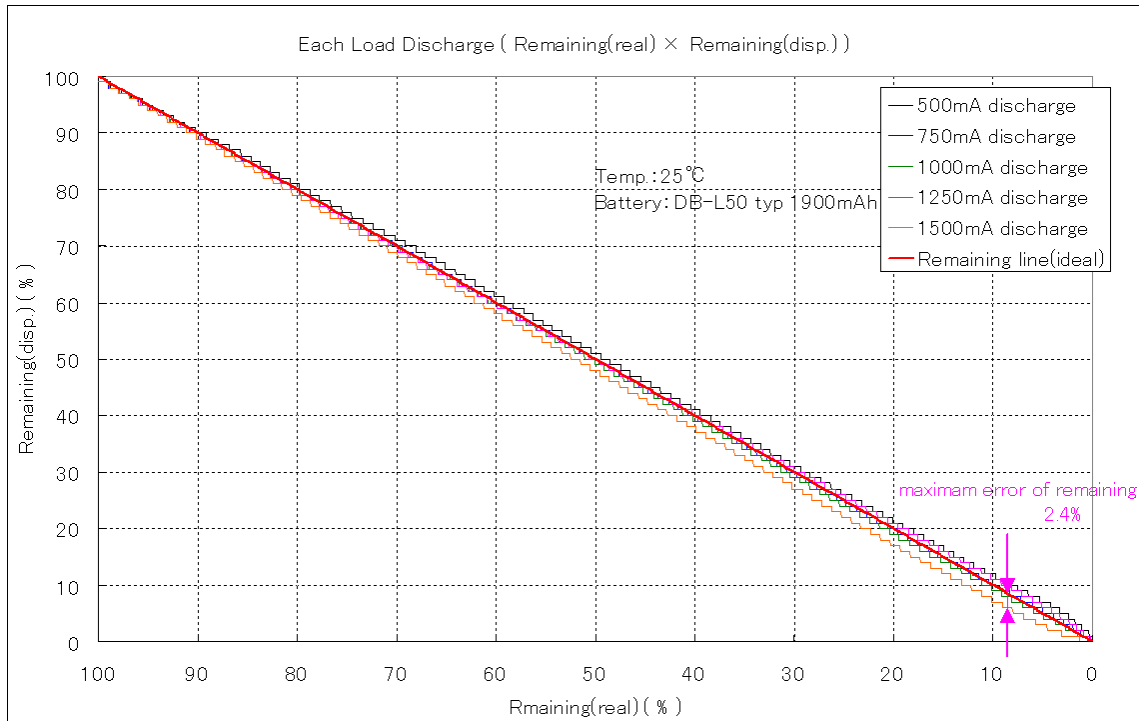


Figure 3 Discharge Characteristics by Load Change

**Communication Protocol**

Communication protocol type: I<sup>2</sup>C  
 Frequency: 100kHz  
 Address: 0x16

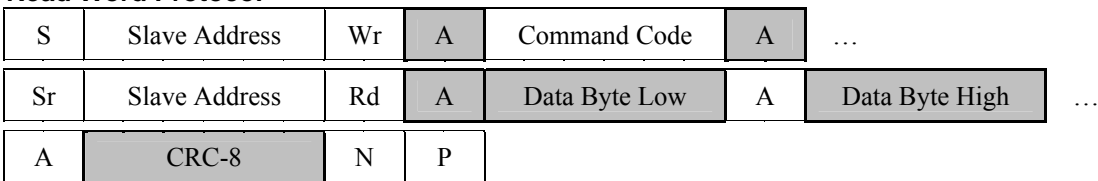
**Bus Protocols**

- 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 (ex.3778mV: 0x16, 0x09, 0x17, 0xC2, 0x0E → 0x86)
- |  |
|--|
|  |
|--|

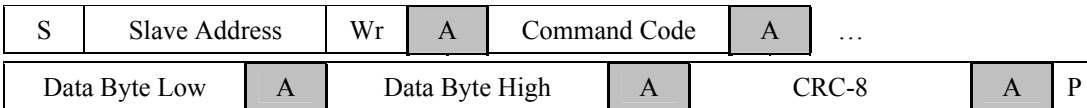
 : Master-to-Slave
- |  |
|--|
|  |
|--|

 : Slave-to-Master
- ... : Continuation of protocol

**Read Word Protocol**



**Write Word Protocol**



Slave Functions	Command Code	Range	Access	Unit
Cell Temperature	0x08	0 to 65535	R	0.1°K
Cell Voltage	0x09	0 to 65535	R	mV
Current	0x0A	-32768 to 32767	R	mA
Adjustment Pack	0x0B	0 to 255	R	Value
Relative State Of Charge	0x0D	0 to 100	R	%
Remaining Capacity	0x0F	0 to 65535	R	mAh
Full Charge Capacity	0x10	0 to 65535	R	mAh
IC Version	0x11	0 to 65535	R	Version
Adjustment Thermistor	0x12	0 to 255	R	Value
Set Relative State Of Charge	0x08	0xA500 + 0 to 100	W	0xA500 + %
Adjustment Pack	0x08	0x5A00 + 0 to 255	W	0x5A00 + Value
Adjustment Thermistor	0x08	0xAA00 + 0 to 255	W	0xAA00 + Value
Initial Relative State Of Charge	0x09	0xAA55	W	-



# LC709201F

## Application Circuit Example

Figure 4 Example of an application schematic using LC709201F

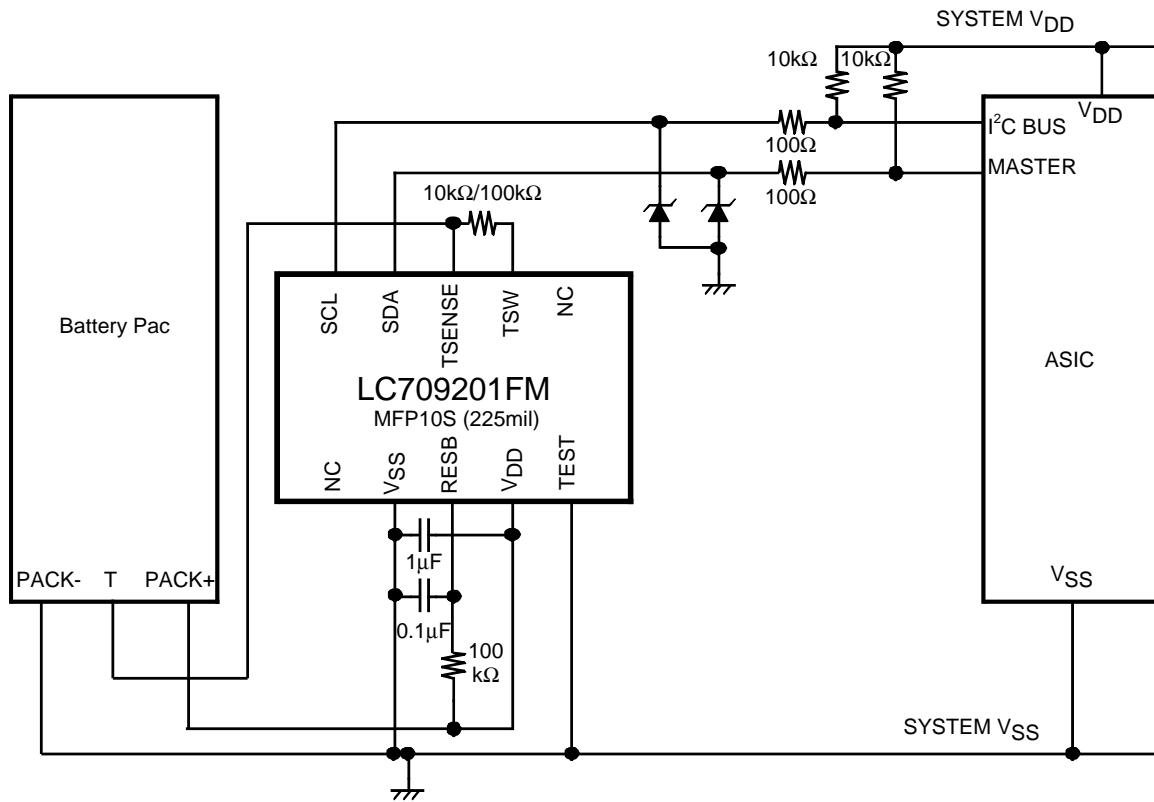
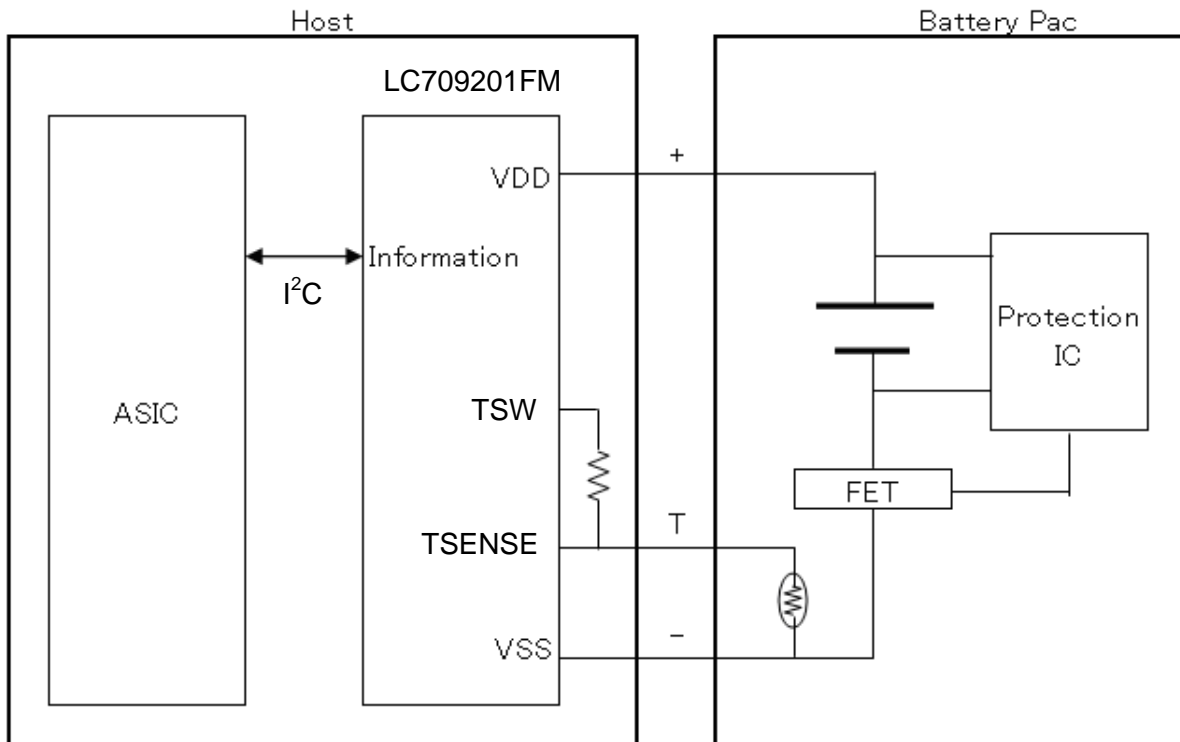


Figure 5 Conceptual diagram using LC709201F



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