Ordering number : ENA2031

SANYO Semiconductors
DATA SHEET

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# 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 ±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
- $I^2C$bus, communication in slave mode up to 100kHz supported

■Ports

| | |
|---|---|
| • $I^2C$-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 ($V_{SS}$, $V_{DD}$) |

■Package form
- MFP10S (225 mil): LC709201FM-01/02/03
- VCT16 (2.6×2.6): LC709201FRD-01/02/03

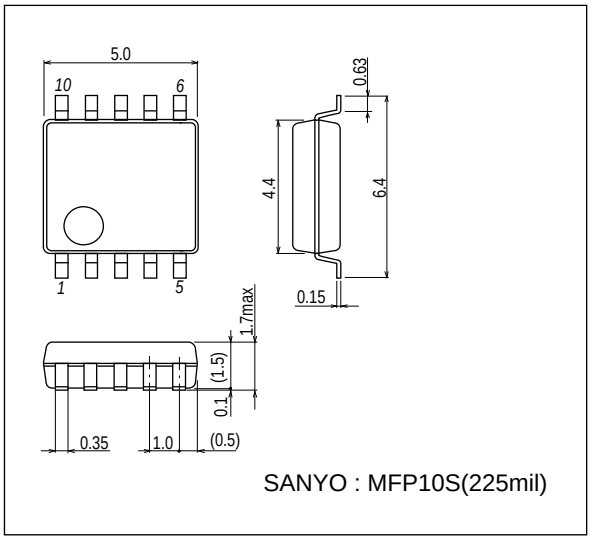
## Applications

- 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.

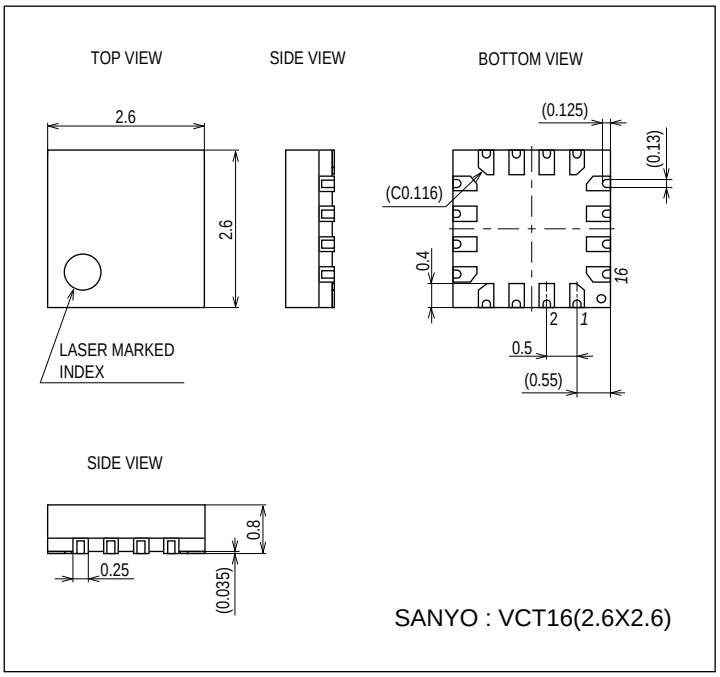
## Package Dimensions

unit : mm (typ)
3086B

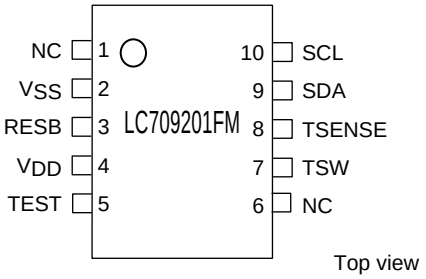



## Package Dimensions

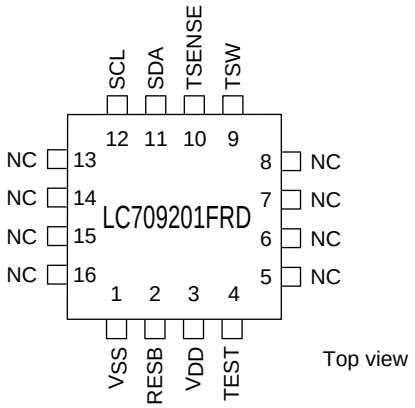
unit : mm (typ)
3318



## Pin Assignment

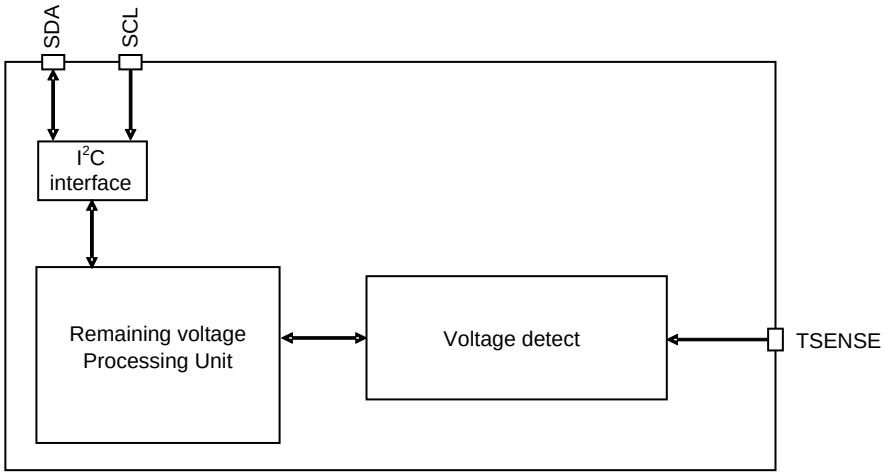



SANYO: MFP10S (225mil) “Lead-free Type”




SANYO: VCT16 (2.6×2.6) “Lead-free Type”

## Block Diagram




## Pin Function

| Pin Name | I/O | Description |
|---|---|---|
| $V_{SS}$ | - | - power pin |
| $V_{DD}$ | - | + power pin |
| RESB | I | Reset pin |
| TEST | I/O | Test pin<br>*Connect an external 100kΩ pull-down resistor. |
| SDA | I/O | $I^2C$ data pin |
| SCL | I/O | $I^2C$ clock pin |
| TSW | O | Battery temperature reading control pin<br>*Set high when reading in the temperature, held low at other times. |
| TSENSE | I | Battery temperature analog voltage input pin |

## 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) | RESB, TSENSE | | -0.3 | | $V_{DD}$ +0.3 | |
| Output voltage | $V_O$ (1) | TSW | | -0.3 | | $V_{DD}$ +0.3 | |
| Input/output voltage | $V_{IO}$ (1) | SDA, SCL, TEST | | -0.3 | | $V_{DD}$ +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, $V_{SS}$=0V

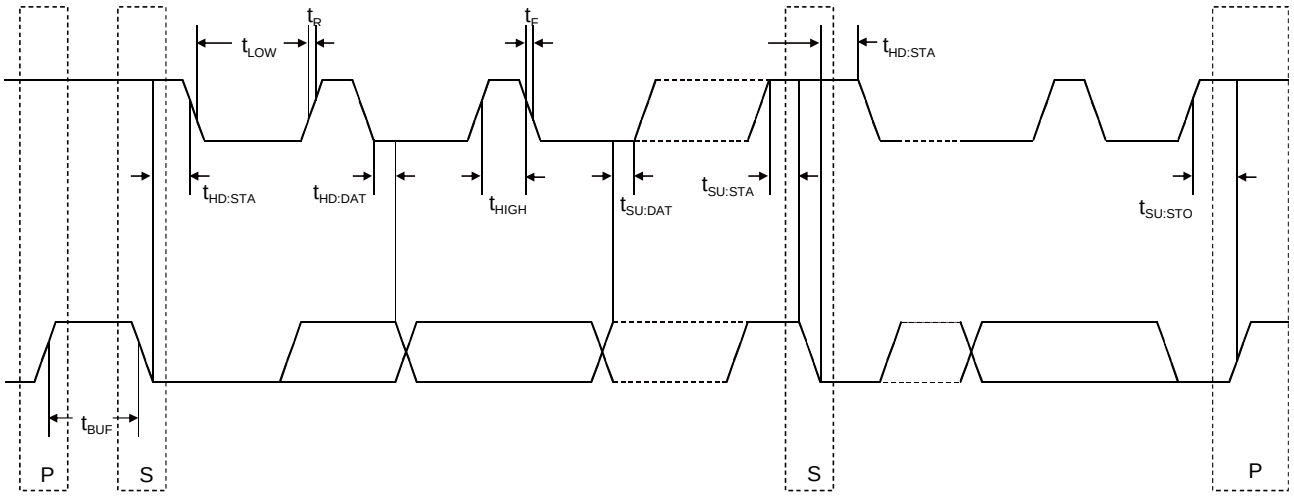
| Parameter | Symbol | Pin/Remarks | Conditions | Specification | | | unit |
|---|---|---|---|---|---|---|---|
| | | | $V_{DD}$[V] | min | typ | max | |
| Operating supply voltage | $V_{DD}$ (1) | $V_{DD}$ | | 2.25 | | 5.5 | V |
| High level input voltage | $V_{IH}$ (1) | SDA, SCL | 2.25 to 5.5 | 0.3$V_{DD}$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

## 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) | RESB, SDA, SCL | $V_{IN}$=$V_{DD}$ (including output transistor off leakage current) | 2.25 to 5.5 | | | 1 | µA |
| Low level input current | $I_{IL}$ (1) | RESB, SDA, SCL | $V_{IN}$=$V_{SS}$ (including output transistor off leakage current) | 2.25 to 5.5 | -1 | | |
| High level output voltage | $V_{OH}$ (1) | TSW | $I_{OH}$=-0.4mA | 3.0 to 5.5 | $V_{DD}$-0.4 | | | V |
| | $V_{OH}$ (2) | | $I_{OH}$=-0.2mA | 2.25 to 5.5 | $V_{DD}$-0.4 | | |
| Low level output voltage | $V_{OL}$ (1) | TSW, SDA, SCL | $I_{OL}$=3.0mA | 3.0 to 5.5 | | | 0.4 | |
| | $V_{OL}$ (2) | | $I_{OL}$=1.3mA | 2.25 to 5.5 | | | 0.4 | |
| Hysteresis voltage | VHYS | RESB, SDA, SCL | | 2.25 to 5.5 | | 0.1$V_{DD}$ | | |
| Pin capacitance | CP | All pins | Pins other than the pin under test $V_{IN}$=$V_{SS}$ f=1 MHz Ta=25°C | 2.25 to 5.5 | | 10 | | pF |
| Consumption current | $I_{DD}$ (1) | $V_{DD}$ | When detecting remaining capacity | 2.25 to 5.5 | | 8 | 16 | µA |
| | $I_{DD}$ (2) | | When not detecting remaining capacity | 2.25 to 5.5 | | 5 | 12 | |

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

| Parameter | Symbol | Pin/Remarks | Conditions | $V_{DD}$[V] | Specification min | typ | max | unit |
|---|---|---|---|---|---|---|---|---|
| Clock frequency | TSCL | SCL | | 2.25 to 5.5 | | | 100 | kHz |
| Bus free time between STOP condition and START condition | TBUF | SCL, SDA | See Fig. 1. | | 4.7 | | | µs |
| Hold time (repeated) START condition First clock pulse is generated after this interval | THD: STA | SCL, SDA | See Fig. 1. | | 4.0 | | | µs |
| Repeated START condition setup time | TSU: STA | SCL, SDA | See Fig. 1. | | 4.7 | | | µs |
| STOP condition setup time | TSU: STO | SCL, SDA | See Fig. 1. | | 4.0 | | | µs |
| Data hold time | THD: DAT | SCL, SDA | See Fig. 1. | | 300 | | | ns |
| Data setup time | TSU: DAT | SCL, SDA | See Fig. 1. | | 250 | | | ns |
| Clock low period | TLOW | SCL | | | 4.7 | | | µs |
| Clock high period | THIGH | SCL | | | 4.0 | | | µs |
| Clock/data fall time | TF | SCL, SDA | | | | | 300 | ns |
| Clock/data rise time | TR | SCL, SDA | | | | | 1000 | ns |



## Discharge Characteristics

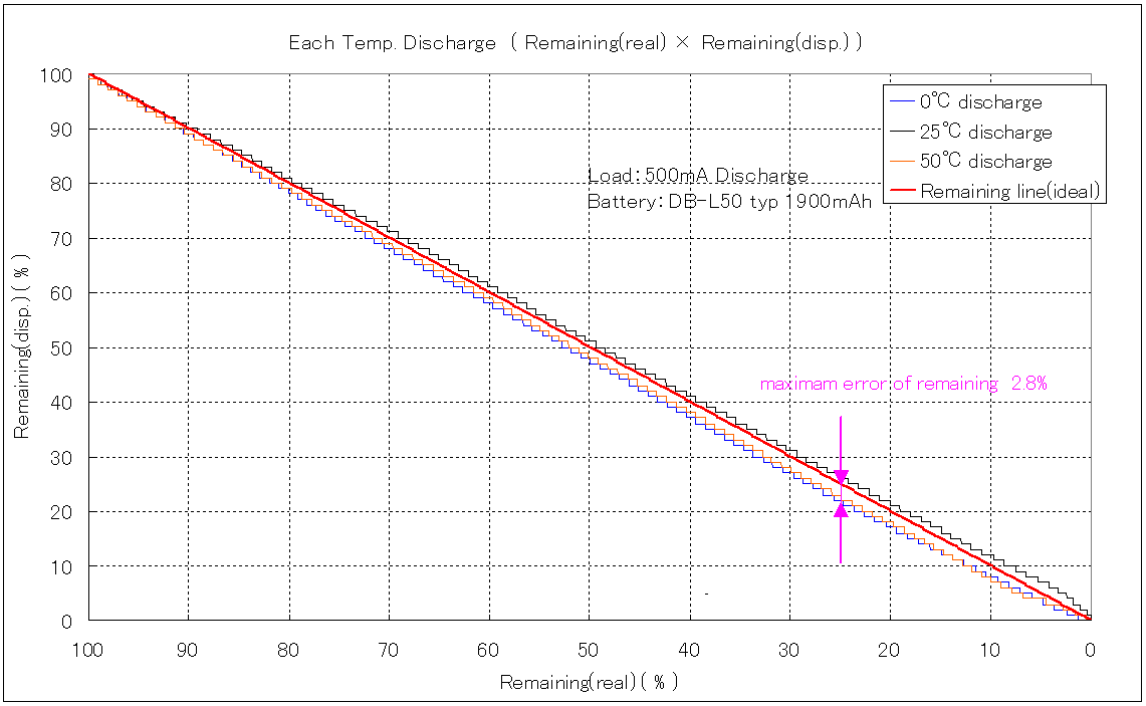



Figure2 Discharge Characteristics by Temperature Change

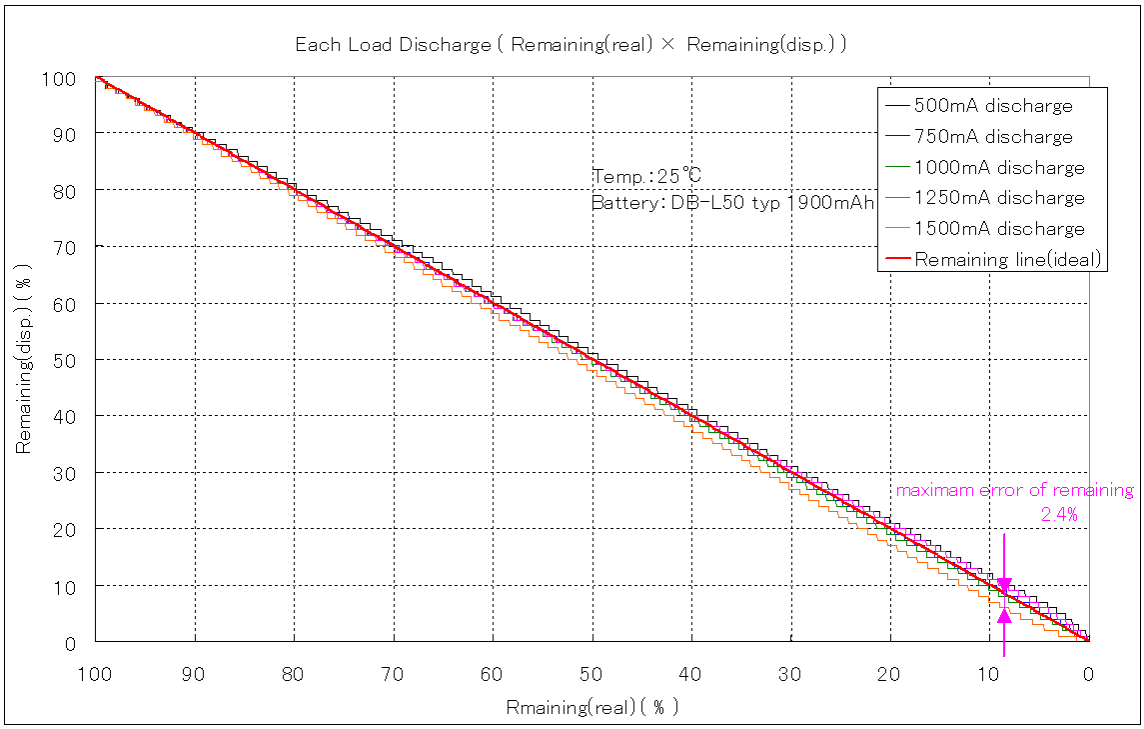



Figure 3 Discharge Characteristics by Load Change

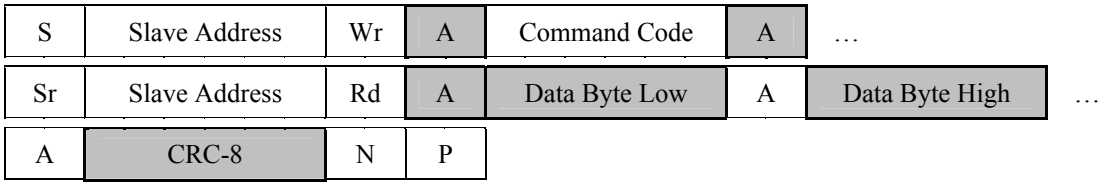
## Communication Protocol

Communication protocol type: $I^2C$
Frequency: 100kHz
Address: 0x16

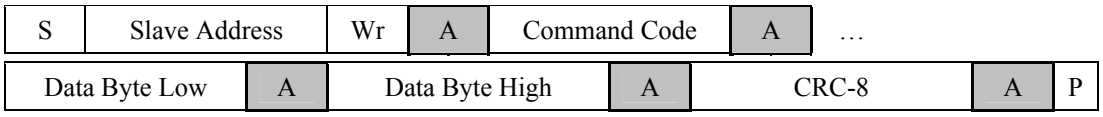
### Bus Protocols

| | | |
|---|---|---|
| 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 | - |

## Application Circuit Example

Figure 4 Example of an application schematic using LC709201F

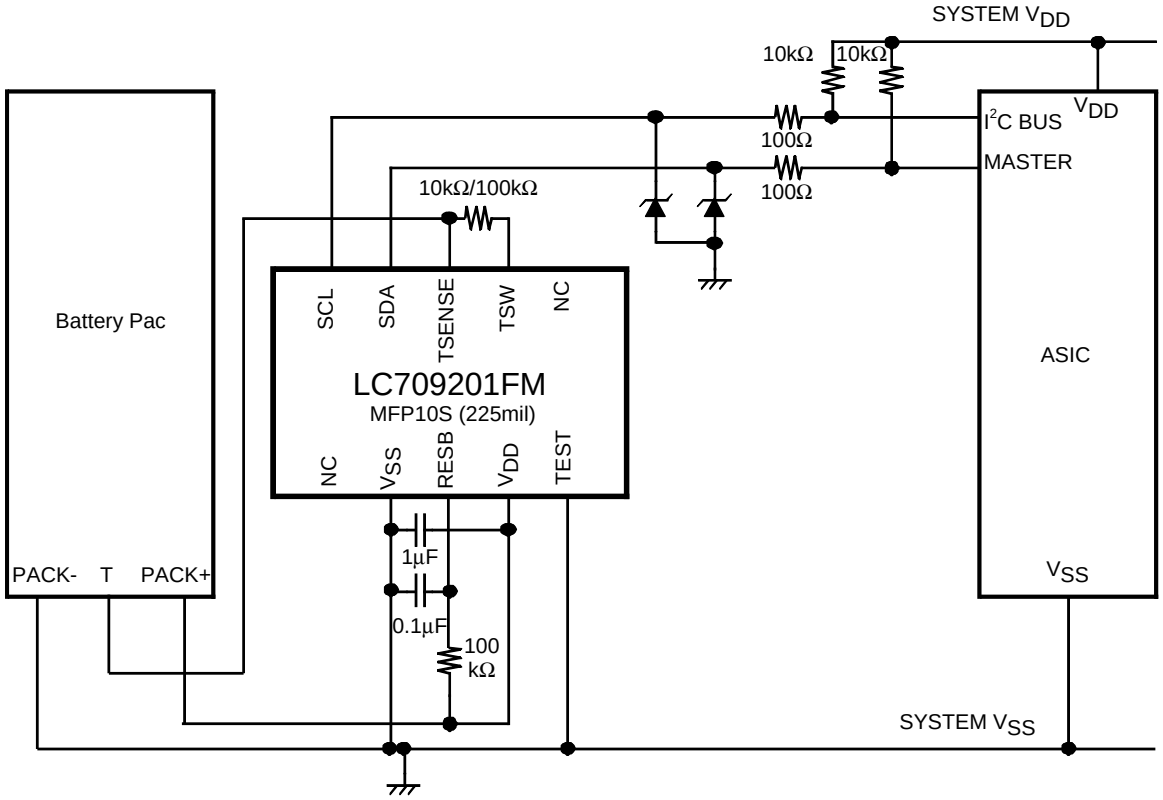
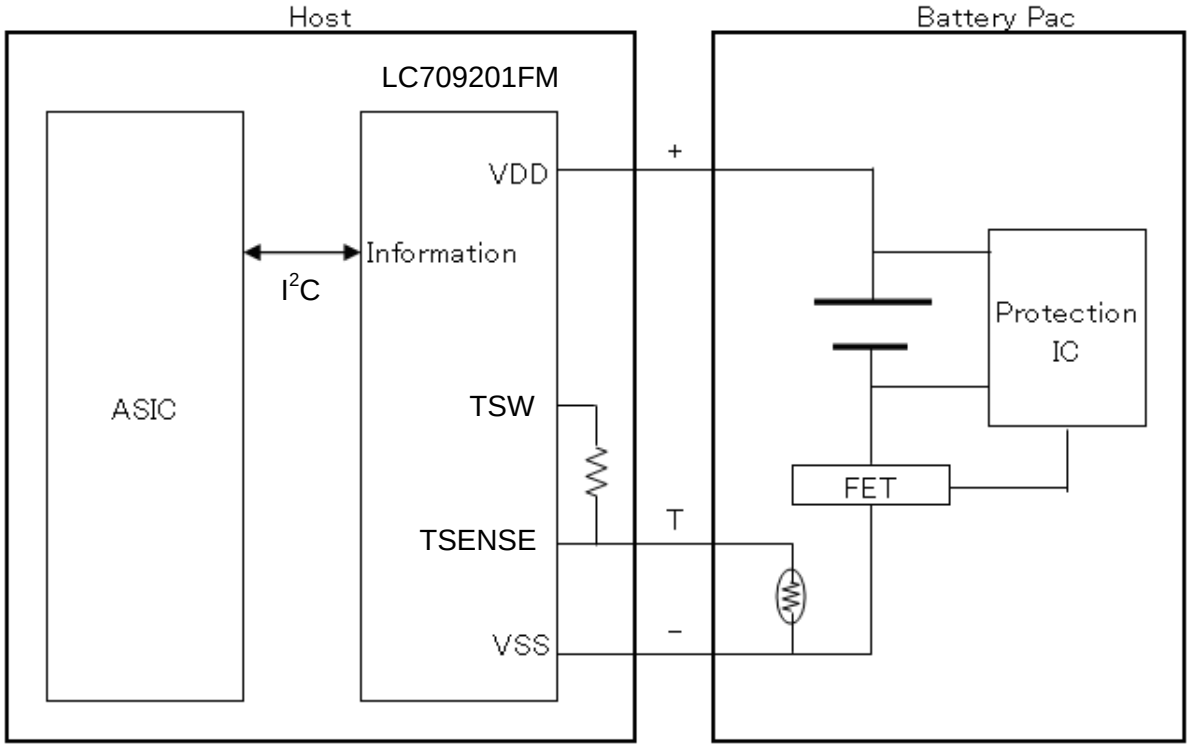



Figure 5 Conceptual diagram using LC709201F



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