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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 $\pm 5\%$ 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
 - I²Cbus, communication in slave mode up to 100kHz supported
- Ports
 - I²C-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

LC709201F

Applications

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

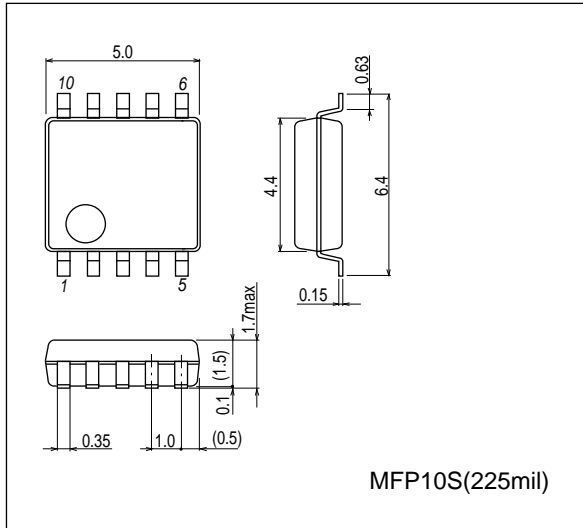
(Note) Depending on the kinds of battery, applicable model differs (LC709201F-01/02/03).

Please contact us for more detail information.

Package Dimensions

unit : mm (typ)

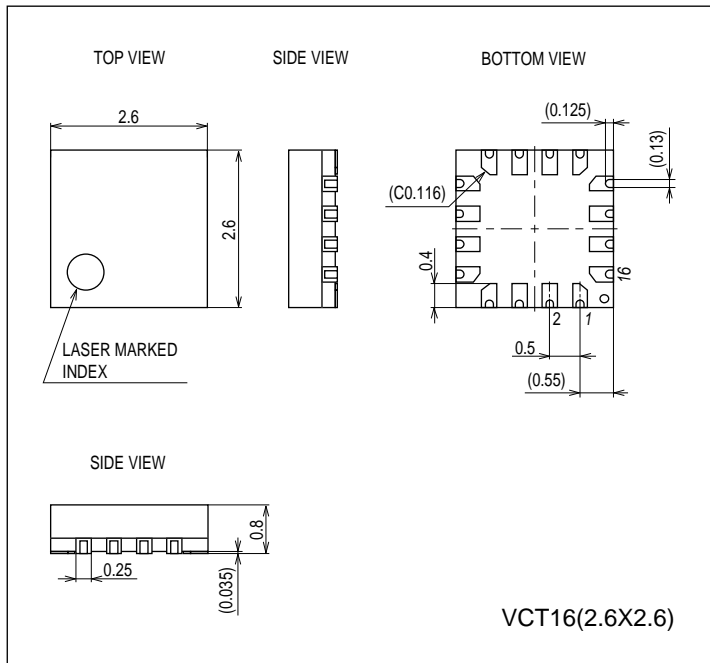
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Package Dimensions

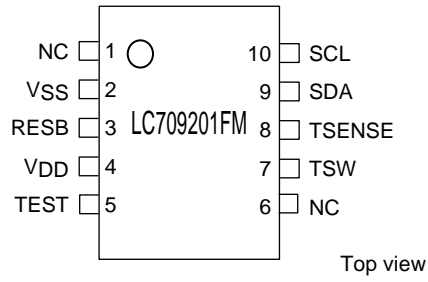
unit : mm (typ)

3318

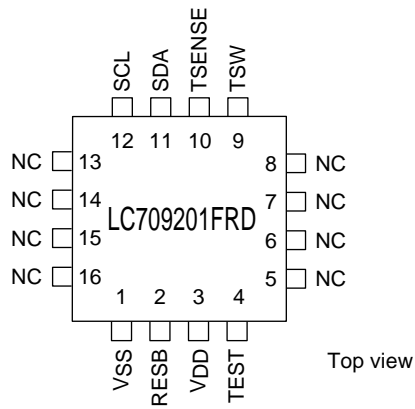


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Pin Assignment

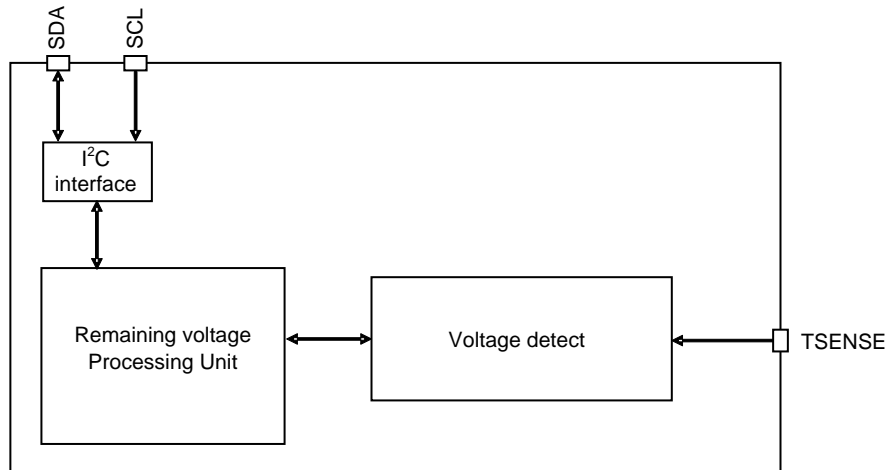


MFP10S (225mil) "Lead-free Type"



VCT16 (2.6x2.6) "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 *Connect an external 100kΩ pull-down resistor. |
| SDA | I/O | I ² C data pin |
| SCL | I/O | I ² C 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 _{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 | |

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, VSS=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 | 0.3V _{DD} +0.7 | | V _{DD} | |
| Low level input voltage | V _{IL} (1) | SDA, SCL | | 4.0 to 5.5 | V _{SS} | | 0.1V _{DD} +0.4 | |
| | V _{IL} (2) | | | 2.25 to 4.0 | V _{SS} | | 0.2V _{DD} | |

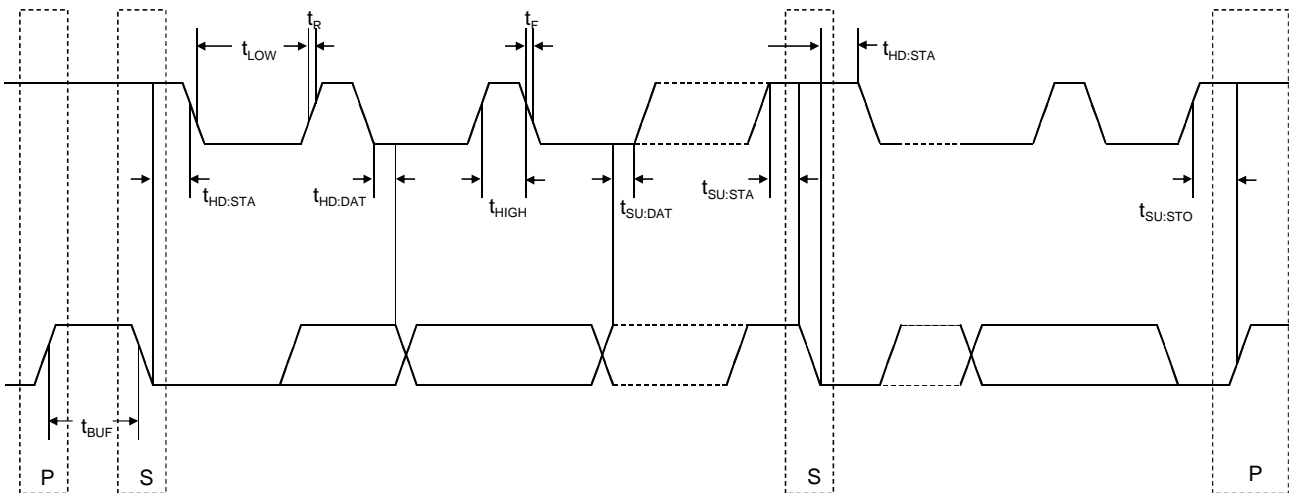
Electrical Characteristics at Ta=-40 to +85°C, VSS=0V

| 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 | | 0.1V _{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 | |

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I²C Slave Characteristics at Ta=-40 to+85°C, V_{SS}=0V

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



Discharge Characteristics

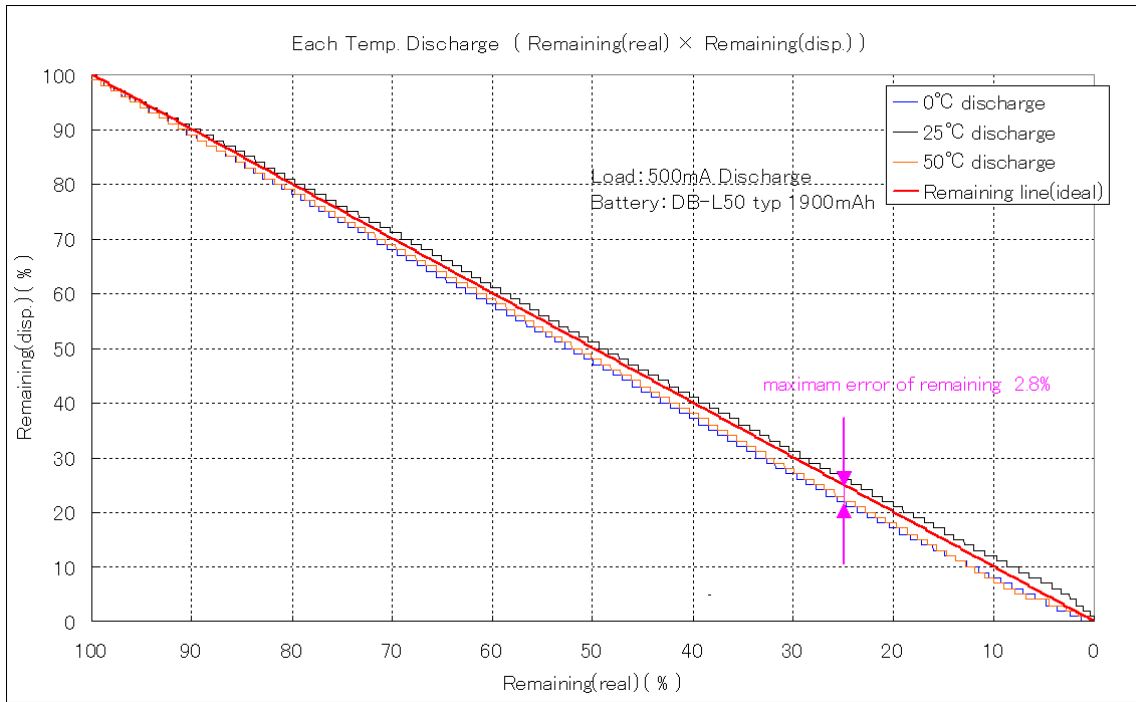


Figure2 Discharge Characteristics by Temperature Change

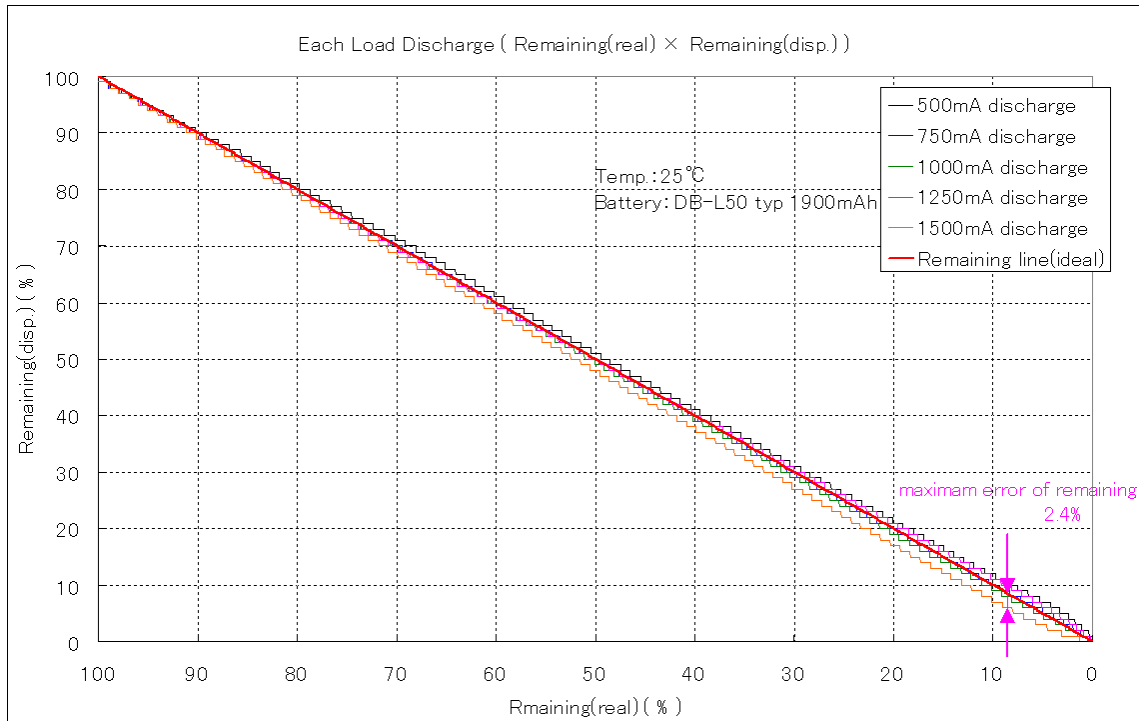


Figure 3 Discharge Characteristics by Load Change

Communication Protocol

Communication protocol type: I²C
 Frequency: 100kHz
 Address: 0x16

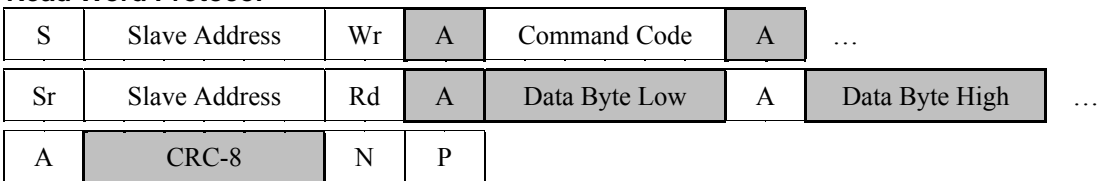
Bus Protocols

- 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)
- | |
|--|
| |
|--|

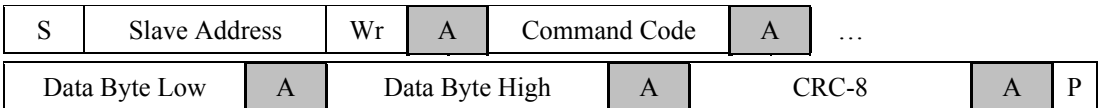
 : Master-to-Slave
- | |
|--|
| |
|--|

 : 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 | - |

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