



ON Semiconductor®

<http://onsemi.com>

# LC709202F

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. ( $\pm 3\%$  under certain conditions)

### Applications

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

### Features

- Accuracy of remaining battery power level measurement
- $\pm 3\%$  (at an ambient operating temperature of  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ )

Note: The accuracy above is the value of an experiment using the evaluation board.

- Precision  $\pm 7.5\text{mV/Cell}$  Voltage Measurement

- A current sensing resistor is unnecessary.

- Alert function

- Interface

- I<sup>2</sup>C Interface (up to 400 kHz supported)

- Low power consumption

- Normal Mode :  $15\mu\text{A}$
- Sleep Mode :  $0.1\mu\text{A}$

- Corresponding battery

- Model to be used depending on the material of the electrode of the battery pack + is different.

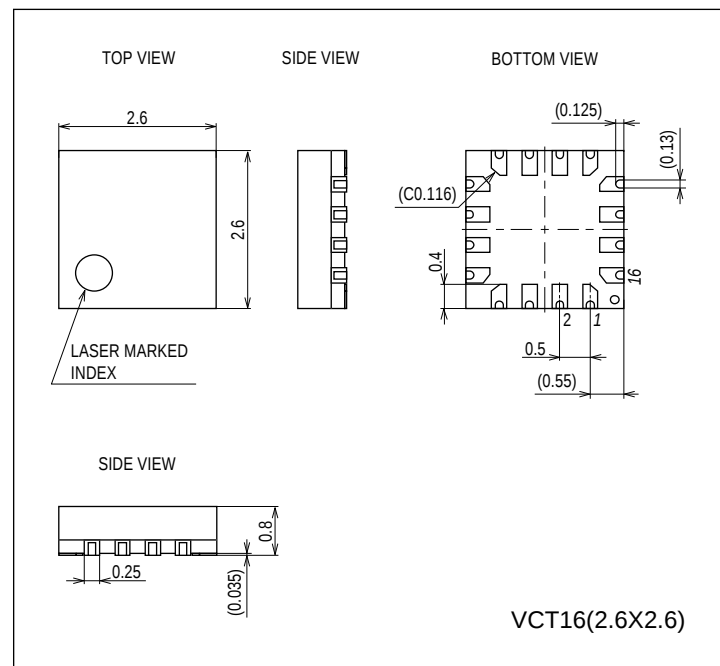
LC709202F-01: ternary system

LC709202F-02: nickelic acid

### Package Dimensions

unit : mm (typ)

3318



\* I<sup>2</sup>C Bus is a trademark of Philips Corporation.

## LC709202F

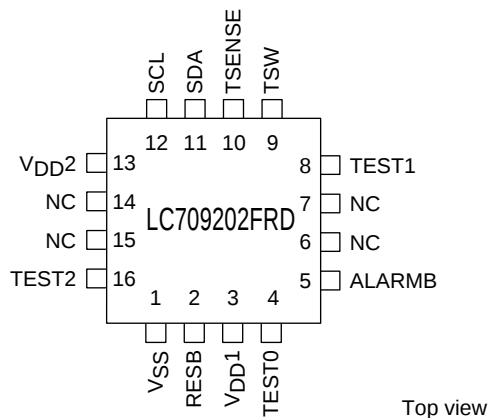
### ■ Ports

- I<sup>2</sup>C 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 (VSS, VDD1, VDD2)

### ■ Package form

- VCT16 (2.6×2.6) : Lead-free type

## Pin Assignment

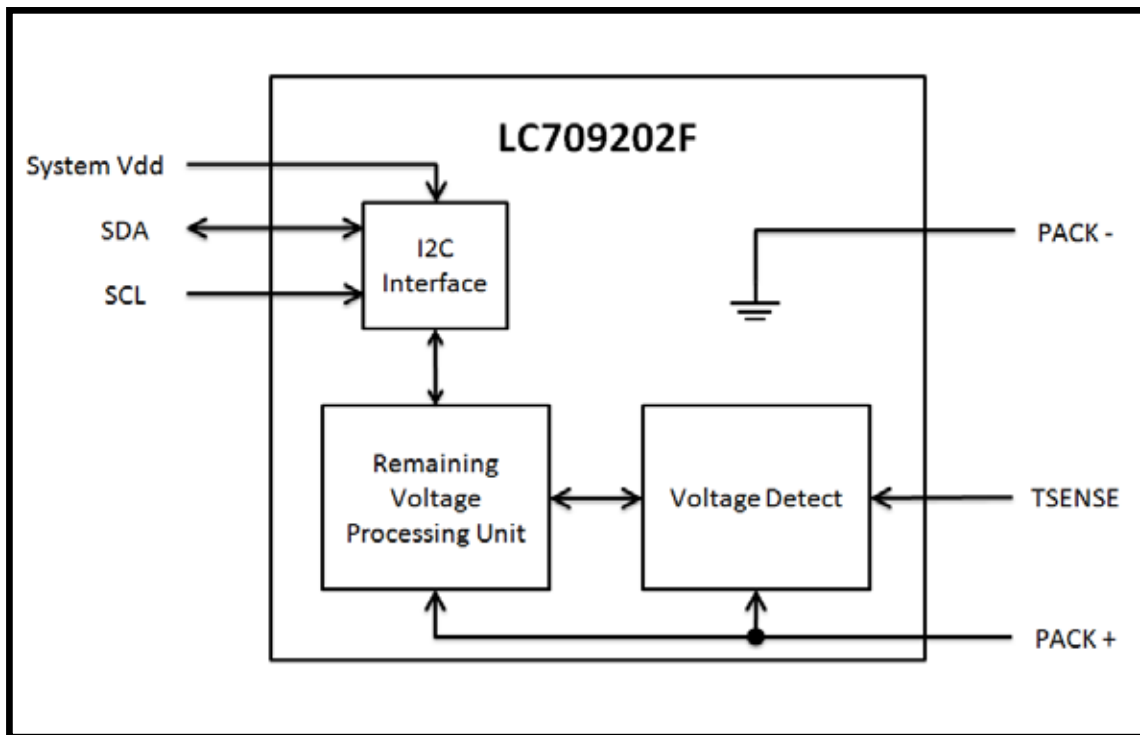


VCT16 (2.6×2.6) “Lead-free Type”

## Pin Function

| VCT16 | Pin Name | I/O | Description                                                                                                                                                               |
|-------|----------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | VSS      | -   | Connect to the - terminal of the battery.                                                                                                                                 |
| 2     | RESB     | I   | Reset pin                                                                                                                                                                 |
| 3     | VDD1     | -   | Connect to the + terminal of the battery.                                                                                                                                 |
| 4     | TEST0    | I   | Test pin<br>*Connect to VSS.                                                                                                                                              |
| 5     | ALARMB   | O   | Alert indication. An active low output used to indicate specified condition thresholds have been met.<br>*When you do not use an alert function, please connect with VSS. |
| 8     | TEST1    | O   | Set “OPEN”                                                                                                                                                                |
| 9     | TSW      | O   | Battery temperature reading control pin<br>*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 <sup>2</sup> C data pin                                                                                                                                                 |
| 12    | SCL      | I/O | I <sup>2</sup> C clock pin                                                                                                                                                |
| 13    | VDD2     | -   | + power pin for I <sup>2</sup> C-Bus communication pin(SDA,SCL)                                                                                                           |
| 16    | TEST2    | O   | Set “OPEN”                                                                                                                                                                |

# Block Diagram



## LC709202F

### Absolute Maximum Ratings at Ta=25°C, V<sub>SS</sub>=0V

| Parameter                     | Symbol              | Pin/Remarks                         | Conditions     | V <sub>DD</sub> [V] | Specification |     |                       | Unit |
|-------------------------------|---------------------|-------------------------------------|----------------|---------------------|---------------|-----|-----------------------|------|
|                               |                     |                                     |                |                     | min           | typ | max                   |      |
| Maximum supply voltage        | V <sub>DD</sub> max | V <sub>DD1</sub> , V <sub>DD2</sub> |                |                     | -0.3          |     | +6.5                  | V    |
| Input voltage                 | V <sub>I</sub> (1)  | RESB, TSENSE                        |                |                     | -0.3          |     | V <sub>DD1</sub> +0.3 |      |
| Output voltage                | V <sub>O</sub> (1)  | TSW                                 |                |                     | -0.3          |     | V <sub>DD1</sub> +0.3 |      |
|                               | V <sub>O</sub> (2)  | ALARMB                              |                |                     | -0.3          |     |                       |      |
| Input/output voltage          | V <sub>IO</sub> (1) | SDA, SCL                            |                |                     | -0.3          |     | +5.5                  |      |
| Allowable power dissipation   | P <sub>d</sub> max  | VCT16                               | Ta=-40 to+85°C |                     |               |     | 55                    | mW   |
| Operating ambient temperature | T <sub>opr</sub>    |                                     |                |                     | -40           |     | +85                   | °C   |
| Storage ambient temperature   | T <sub>stg</sub>    |                                     |                |                     | -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<sub>SS</sub>=0V

| Parameter                | Symbol              | Pin/Remarks      | Conditions                     | V <sub>DD</sub> [V] | Specification        |     |                      | unit |
|--------------------------|---------------------|------------------|--------------------------------|---------------------|----------------------|-----|----------------------|------|
|                          |                     |                  |                                |                     | min                  | typ | max                  |      |
| Operating supply voltage | V <sub>DD</sub> (1) | V <sub>DD1</sub> |                                |                     | 2.5                  |     | 4.5                  | V    |
| High level input voltage | V <sub>IH</sub> (1) | TSENSE           |                                | 2.5 to 4.5          | 0.70V <sub>DD1</sub> |     | V <sub>DD1</sub>     |      |
|                          | V <sub>IH</sub> (2) | RESB             |                                | 2.5 to 4.5          | 0.75V <sub>DD1</sub> |     | V <sub>DD1</sub>     |      |
|                          | V <sub>IH</sub> (3) | SDA, SCL         | V <sub>DD2</sub> =1.6V to 5.5V | 2.5 to 4.5          | 0.70V <sub>DD2</sub> |     | V <sub>DD2</sub>     |      |
| Low level input voltage  | V <sub>IL</sub> (1) | TSENSE           |                                | 2.5 to 4.5          | V <sub>SS</sub>      |     | 0.25V <sub>DD1</sub> |      |
|                          | V <sub>IL</sub> (2) | RESB             |                                | 2.5 to 4.5          | V <sub>SS</sub>      |     | 0.25V <sub>DD1</sub> |      |
|                          | V <sub>IL</sub> (3) | SDA, SCL         | V <sub>DD2</sub> =1.6V to 5.5V | 2.5 to 4.5          | V <sub>SS</sub>      |     | 0.30V <sub>DD2</sub> |      |

# LC709202F

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

| Parameter                       | Symbol               | Pin/Remarks           | Conditions                                                                                                               | V <sub>DD</sub> [V] | Specification        |                     |         | Unit    |
|---------------------------------|----------------------|-----------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|---------------------|---------|---------|
|                                 |                      |                       |                                                                                                                          |                     | min                  | typ                 | max     |         |
| High level input current        | I <sub>IH</sub> (1)  | RESB                  | V <sub>IN</sub> =V <sub>DD1</sub><br>(including output transistor off leakage current)                                   | 2.5 to 4.5          |                      |                     | 1       | μA      |
|                                 | I <sub>IH</sub> (2)  | SDA, SCL              | V <sub>IN</sub> =V <sub>DD2</sub><br>V <sub>DD2</sub> =1.6V to 5.5V<br>(including output transistor off leakage current) | 2.5 to 4.5          |                      |                     | 1       |         |
| Low level input current         | I <sub>IL</sub> (1)  | RESB                  | V <sub>IN</sub> =V <sub>SS</sub><br>(including output transistor off leakage current)                                    | 2.5 to 4.5          | -1                   |                     |         | μA      |
|                                 | I <sub>IL</sub> (2)  | SDA, SCL              | V <sub>IN</sub> =V <sub>SS</sub><br>V <sub>DD2</sub> =1.6V to 5.5V<br>(including output transistor off leakage current)  | 2.5 to 4.5          | -1                   |                     |         |         |
| High level output voltage       | V <sub>OH</sub> (1)  | TSW                   | I <sub>OH</sub> =-0.4 mA                                                                                                 | 3.0 to 4.5          | V <sub>DD</sub> -0.4 |                     |         | V       |
|                                 | V <sub>OH</sub> (2)  |                       | I <sub>OH</sub> =-0.2 mA                                                                                                 | 2.5 to 4.5          | V <sub>DD</sub> -0.4 |                     |         |         |
| Low level output voltage        | V <sub>OL</sub> (1)  | TSW, ALARMB, SDA, SCL | I <sub>OL</sub> =3.0 mA                                                                                                  | 3.0 to 4.5          |                      |                     | 0.4     |         |
|                                 | V <sub>OL</sub> (2)  |                       | I <sub>OL</sub> =1.3 mA                                                                                                  | 2.5 to 4.5          |                      |                     | 0.4     |         |
| Hysteresis voltage              | V <sub>HYS</sub> (1) | RESB                  |                                                                                                                          | 2.5 to 4.5          |                      | 0.1V <sub>DD1</sub> |         |         |
|                                 | V <sub>HYS</sub> (2) | SDA, SCL              |                                                                                                                          | 2.5 to 4.5          |                      | 0.1V <sub>DD2</sub> |         |         |
| Pin capacitance                 | CP                   | All pins              | Pins other than the pin under test<br>V <sub>IN</sub> =V <sub>SS</sub><br>Ta=25°C                                        | 2.5 to 4.5          |                      | 10                  |         | pF      |
| Consumption current<br>(Note 1) | I <sub>DD</sub> (1)  | V <sub>DD1</sub>      | Normal Mode                                                                                                              | 2.5 to 4.5          |                      | 15                  | 26      | μA      |
|                                 | I <sub>DD</sub> (2)  |                       | Auto Mode                                                                                                                | 2.5 to 4.5          |                      | 2 to 15             | 4 to 26 |         |
|                                 | I <sub>DD</sub> (3)  |                       | Sleep Mode                                                                                                               | 2.5 to 4.5          |                      | 0.1                 | 5       |         |
| Voltage measurement accuracy    | V <sub>ME</sub> (1)  | V <sub>DD1</sub>      | Ta= +25°C                                                                                                                | 3.6                 | -7.5                 |                     | +7.5    | mV/cell |
|                                 | V <sub>ME</sub> (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

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

| Parameter                                                                                  | Symbol  | Pin/Remarks | Conditions  | V <sub>DD</sub> [V] | Specification          |     | unit |
|--------------------------------------------------------------------------------------------|---------|-------------|-------------|---------------------|------------------------|-----|------|
|                                                                                            |         |             |             |                     | min                    | max |      |
| Clock frequency                                                                            | TSCL    | SCL         |             | 2.5 to 4.5          |                        | 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<br>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 <sub>B</sub> | 300 | ns   |
| Clock/data rise time                                                                       | TR      | SCL, SDA    |             |                     | 20 + 0.1C <sub>B</sub> | 300 | ns   |

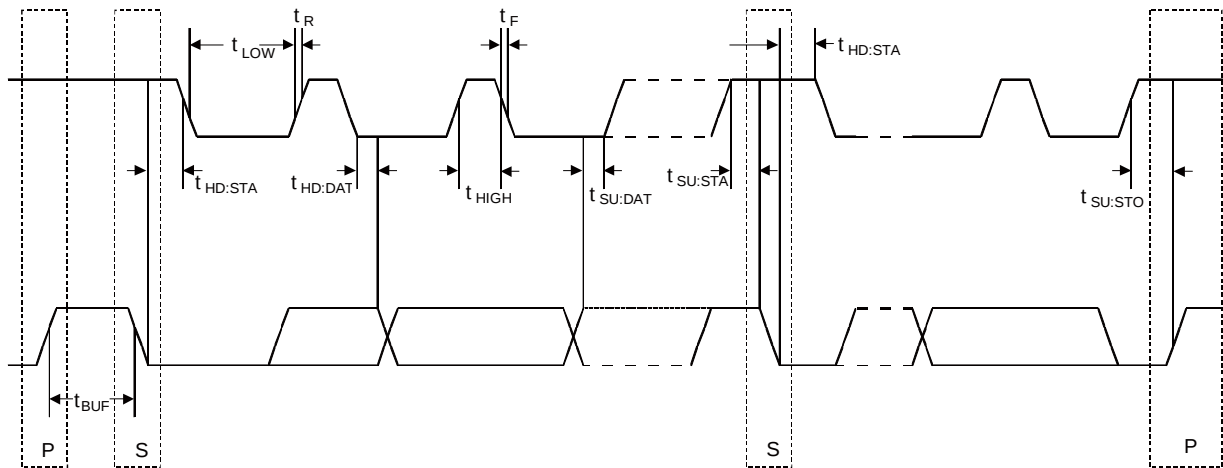


Figure 1 I<sup>2</sup>C Timing

## Discharge Characteristics

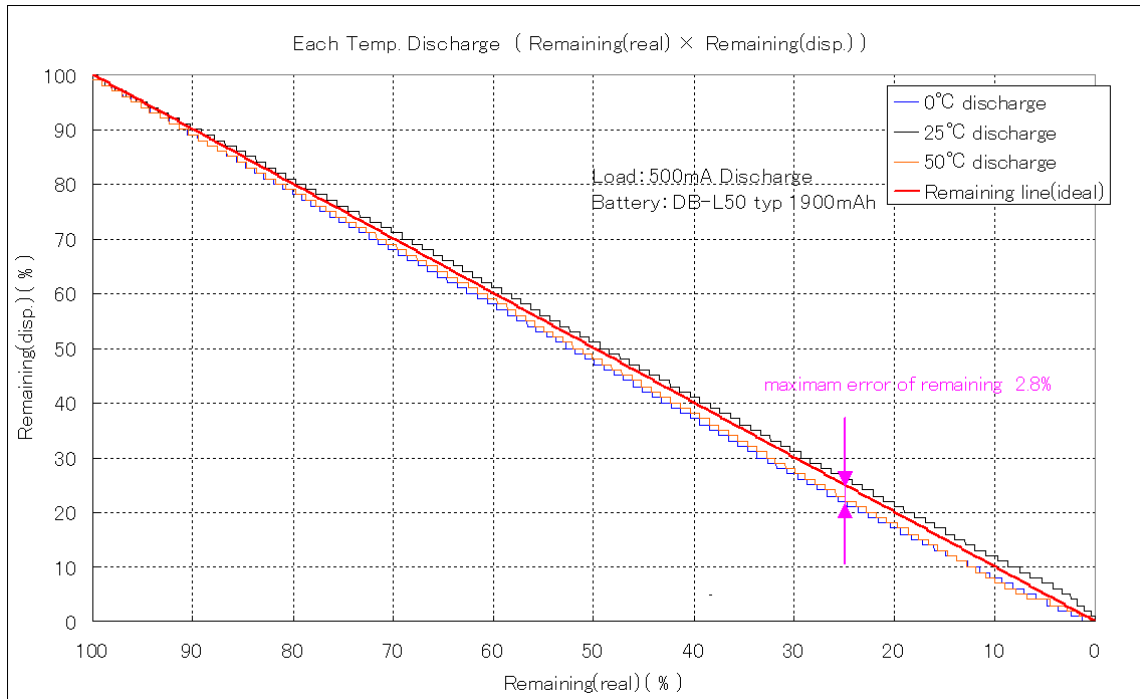


Figure 2 Discharge Characteristics by Temperature Change

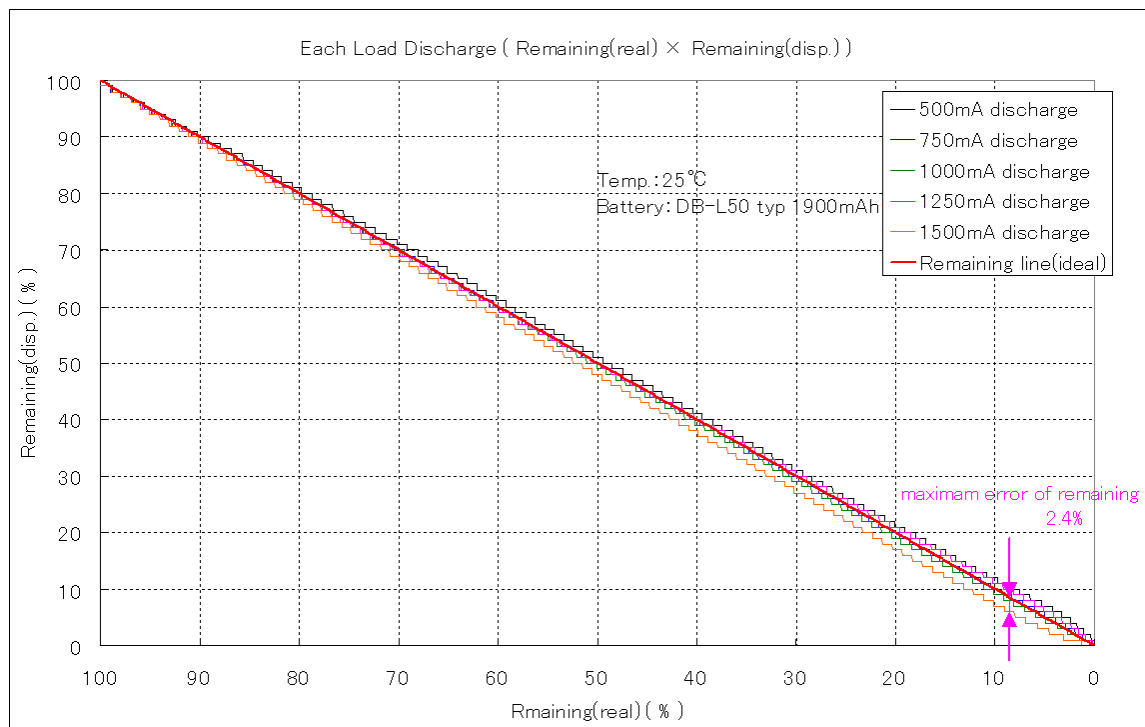


Figure 3 Discharge Characteristics by Load Change

## Communication Protocol

Communication protocol type: I<sup>2</sup>C

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<br>Sleep Mode<br>Auto Mode | 0x13         | bit 0<br>bit 1<br>bit 2                                   | disable: 0<br>or<br>enable: 1                      |
|        | Alarm Low Battery                    | 0x14         | High : 0 to 250<br>Low : 0 to 100                         | 20mV<br>%                                          |
|        | Adjustment B                         | 0x15         | 0 to 65535                                                | B                                                  |
|        | System Mode                          | 0x16         | bit 0to3 :<br>bit 4to7 : data 0 to 6                      | Nomal Mode<br>Sleep Mode<br>Auto Mode<br>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<br>Low : 0 to 100                             | -<br>%                                             |
|        | Adjustment Pack 8                    |              | High : 0x5A<br>Low : 0 to 255                             | -<br>Value                                         |
|        | Adjustment Thermistor                |              | High : 0xAA<br>Low : 0 to 255                             | -<br>Value                                         |
|        | Hot Start<br>Sleep Mode<br>Auto Mode |              | High : 0x55<br>Low : bit 0<br>bit 1<br>bit 2              | disable: 0<br>or<br>enable: 1                      |
|        | Initial Relative State Of Charge     |              | 0xAA55                                                    | -                                                  |
|        | Alarm Low Battery                    | 0x0A         | High : 0 to 250<br>Low : 0 to 100                         | 20mV(activate under)<br>%(activate under)          |
|        | Adjustment B                         | 0x0B         | 0 to 65535                                                | B                                                  |
|        | Cell Temperature                     | 0x0C         | 2532 to 3332 (I2C Write Mode)<br>0xAA55 (Thermistor Mode) | 0.1°K (0.0°C= 2732)<br>-                           |

## Application Circuit Example

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

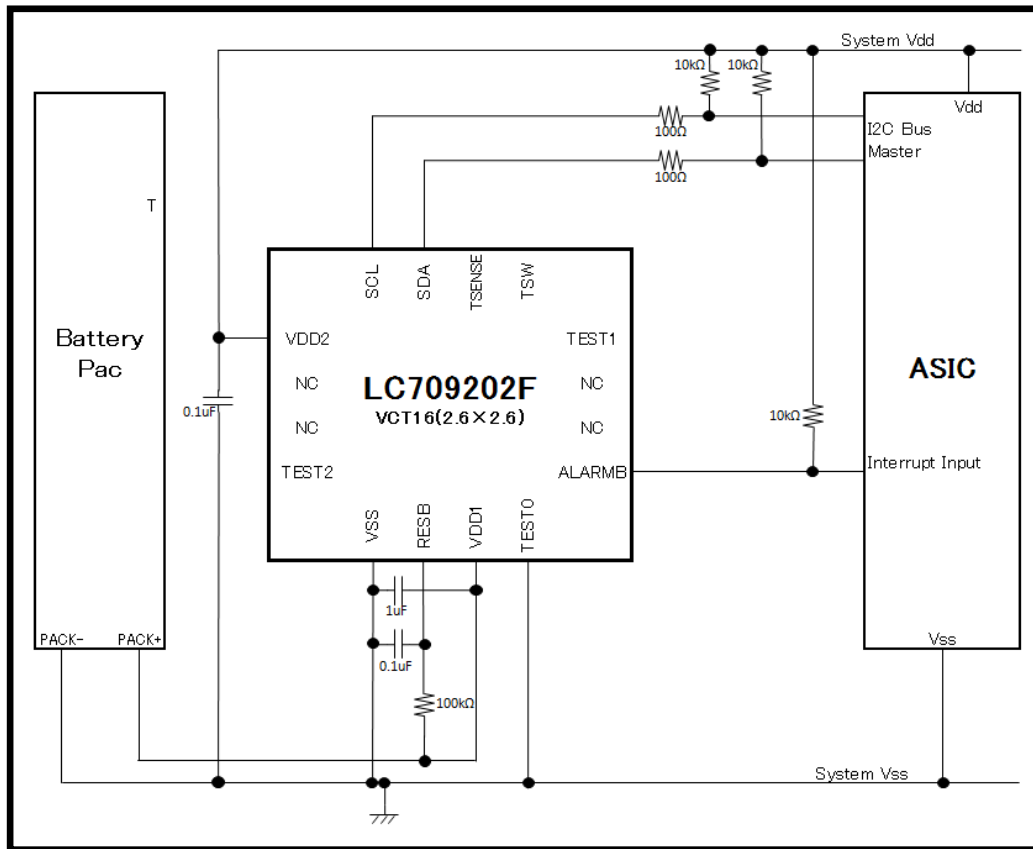
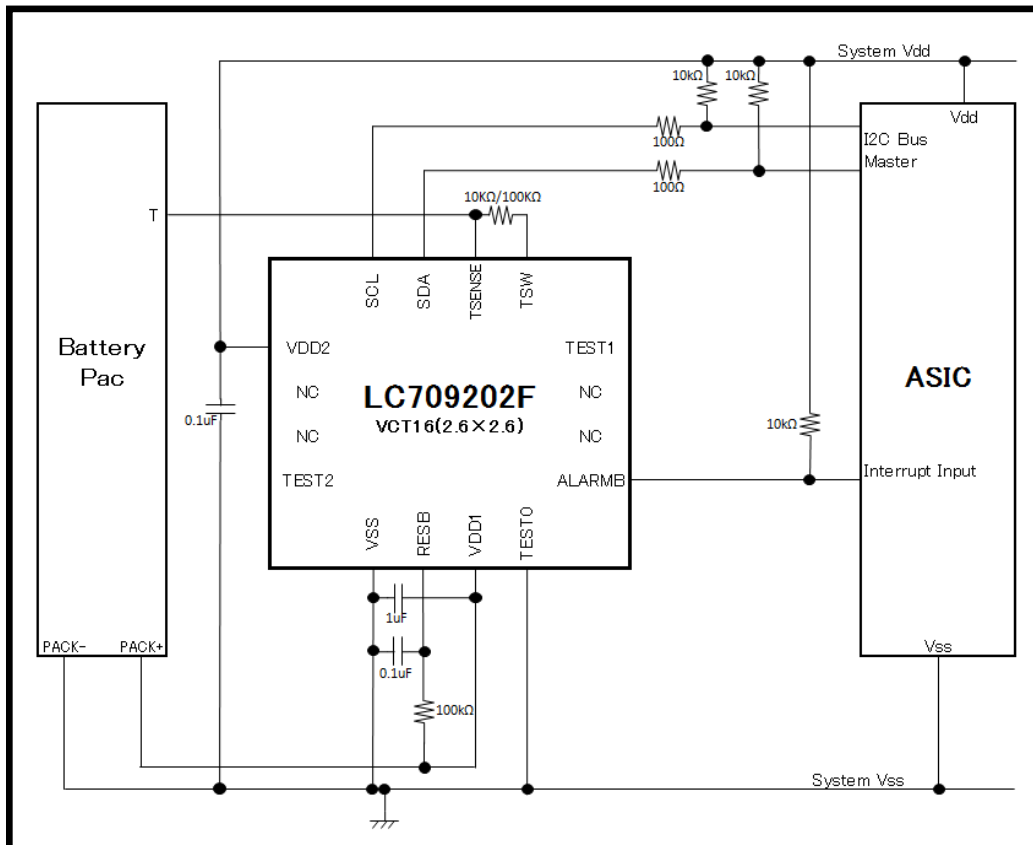


Figure 5 Example of an application schematic using LC709202F  
(use temperature detection function)



ON Semiconductor and the ON logo are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## Данный компонент на территории Российской Федерации

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

moschip.ru\_4

moschip.ru\_6

moschip.ru\_9