# Description

RRC2040-2

11.25V 6400mAh 72.0Wh

Lithium Ion Rechargeable Smart Battery Pack


## RRC power solutions part number: 100559-01

| Revision | Valid from | Revisions | Author |
|---|---|---|---|
| A-Draft1 | 04-Dec-2012 | First draft version | Dietmar Fischer |
| A-Draft2 | 06-Dec-2012 | Add review results | Dietmar Fischer |
| A | 07-Dec-2012 | First released version | Dietmar Fischer |
| B-Draft1 | 27-Jun-2013 | New cell type 32A | Dietmar Fischer |
| B-Draft2 | 28-Jun-2013 | New issue date of national standards | Dietmar Fischer |
| B-Draft3 | 17-Jul-2013 | Change nominal voltage, storage temperature recovery temp. at discharge and Jeita-Diagramm<br>Add national approvals | Dietmar Fischer |
| B-Draft4 | 26-Nov-2013 | Update according to URS and QTP | Dietmar Fischer |



| Germany/Headquarters | USA | Australia | Hong Kong/China |
|---|---|---|---|
| RRC power solutions GmbH<br>Technologiepark 1<br>D-66424 Homburg / Saar | RRC power solutions Inc.<br>18340 Yorba Linda Blvd., Suite 107-437<br>Yorba Linda, CA 92886-4104 | RRC power solutions<br>1 Queens Road<br>Melbourne<br>VIC 3004 | RRC power solutions Ltd.<br>9/F Park Tower, 15 Austin Road<br>Tsim Sha Tsui, Kowloon, Hong Kong |
| Tel.: +49 6841 98090<br>Fax: +49 6841 9809280<br>Email: sales@rrc-ps.de<br>Web: www.rrc-ps.de | Tel.: +1 714 777 3604<br>Fax: +1 714 777 3658<br>Email: usa@rrc-ps.com<br>Web: www.rrc-ps.com | Tel.: +61 3 9013 4111<br>Fax: +61 3 8621 0082<br>Email: apac@rrc-ps.com<br>Web: www.rrc-ps.com | Tel.: +852 2376 0106<br>Fax: +852 2376 0107<br>Email: hkrrc@rrc-ps.cn<br>Web: www.rrc-ps.com |

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# 1. Introduction

## 1.1. Scope

This document will describe the physical, mechanical, functional and electrical characteristics of the RRC2040-2 rechargeable Lithium Ion battery provided by RRC power solutions. This document will highlight the products characteristics and capabilities. If a customer wishes to create their own internal specification this document will be considered the main specification. The battery packs that RRC produces will meet this specification.

## 1.2. Manufacturer

RRC power solutions GmbH
Technologiepark 1
D-66424 Homburg/Saar
Germany

## 1.3. Applicable Documents and References

### 1.3.1. Industry Standards

System Management Bus Specification (Rev 1.1, Dec 11, 1998)
Smart Battery Data Specification (Rev 1.1, Dec 15, 1998)
Smart Battery Charger Specification (Rev 1.0, June 27, 1996)

## 1.4. Acronyms and Terminology

The following acronyms and terms are commonly used throughout this document

### 1.4.1. Product Specific Terms

CC/CV : Constant Current / Constant Voltage
LiCoO2 : Lithium-Cobalt(III)-Oxid
FET : Field Effect Transistor
LED : Light Emitting Diode
NTC : Negativ Temperature Coefficient
SBC : Smart Battery Charger
SBD : Smart Battery Data
SMBUS : System Management Bus
JEITA : Japan Electronics and Information Technology Industries Association
NCM : Nickel Cobalt Manganese
BMS : Battery Management System
AFE : Analog Front End

### 1.4.2. General Terms

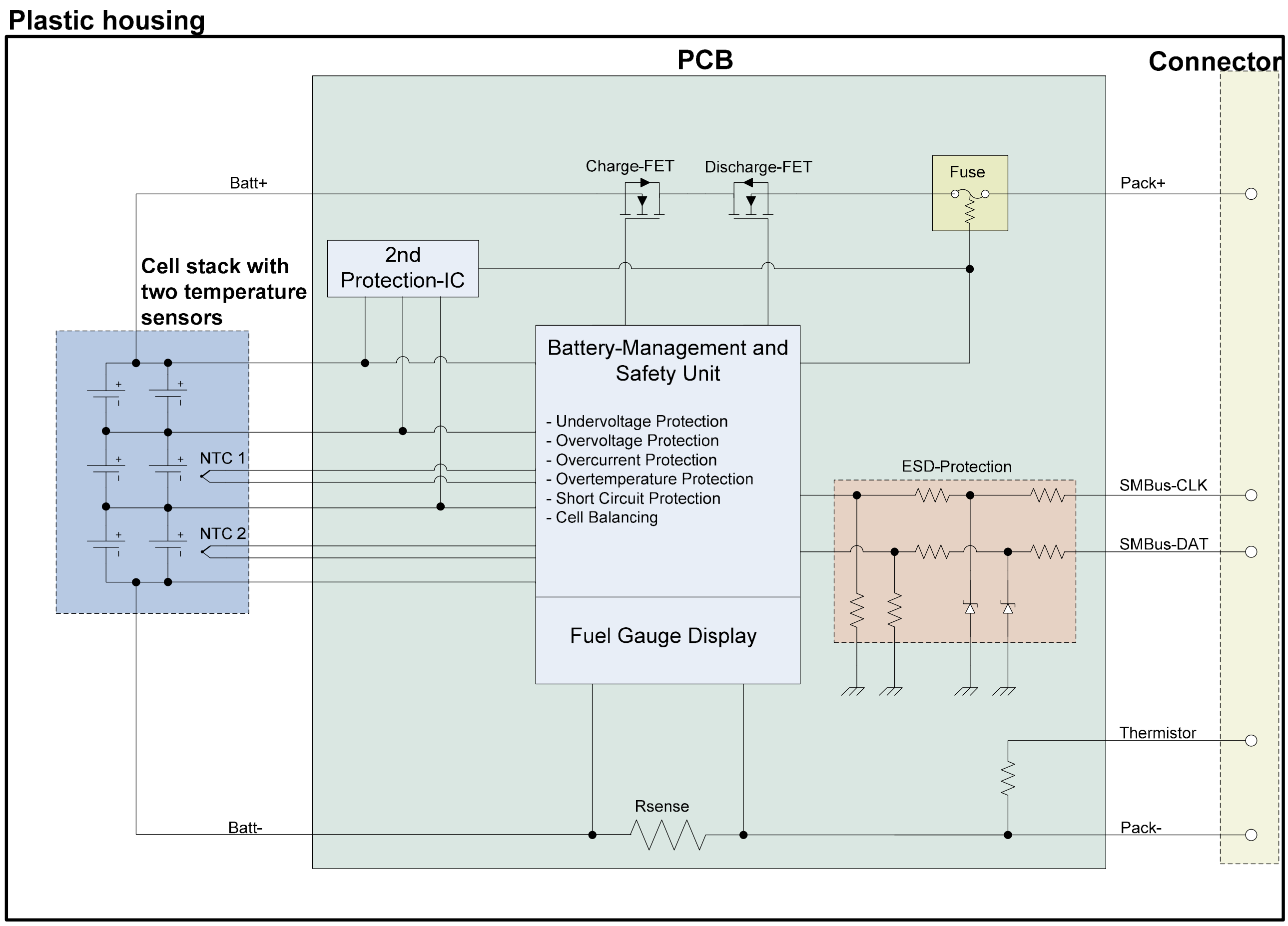
NA : Not Applicable
NC : Not Connected
PC : Performance Criteria
TBD : To Be Defined
TBC : To Be Confirmed

## 2. General Description

The specification describes the physical, mechanical, functional and electrical requirements for the smart rechargeable Lithium Ion battery pack from RRC power solutions, with article name RRC2040-2. The battery is comprised of six (6) Lithium Ion rechargeable 18650 cells, assembled in a 3 series / 2 parallel (3S/2P) design. Each cell has an average voltage of 3.75V and a nominal capacity of 3200mAh, providing a battery pack of 11.25V and 6400mAh nominal. The battery is designed to communicate with a host or a charger through the System Management Bus (SMBus) protocol. The battery is SMBus and SBDS Revision 1.1 compliant. The battery design includes protection for over charge, over discharge and short circuit. Additional safety measures are designed into the battery to protect against over temperature and over current situations.
The battery pack consists of the individual elements noted below.

- 18650 cells
- Mechanical components
- Smart battery electronics
- Protection circuitry and components
- Plastic housing and packaging

## 3. Block diagramm



## 4. General Specification

### 4.1. Battery Type

RRC2040-2 Smart Battery includes a rechargeable Lithium Ion battery pack and a Smart Battery Management Module.

### 4.2. Pack Configuration

The plastic encased battery pack has six 18650 Li-Ion cells in a 3s2p cell orientation.

### 4.3. Cell Type

Cell type is ICR 18650-32A from Samsung SDI Co Ltd. with improved safety by SFL(Safety Functional Layer) coated on anode electrode.

### 4.4. Nominal Voltage

11.25V

### 4.5. Nominal Capacity

6400mAh = 3200mAh/Cell

### 4.6. Minimum Capacity

6000mAh = 3000mAh/Cell

### 4.7. Charge Voltage

Max charge voltage: 13.05V

### 4.8. Charge Current

Max. charge current: 4480mA(0.7C)

### 4.9. Charge Time

Charge time with max. charge current < 3hrs at 25°C

### 4.10. Charge Method

Constant current - Constant voltage
Cut off at 15hrs or 260mA taper current

### 4.11. Discharge Current

Max continuous discharge current is 6500mA in the ambient temperature range from (-10 to +40°C)

### 4.12. External Connections

| Terminal | Legend | Description |
|---|---|---|
| 1 | (+) | Positive side of battery |
| 2 | (C) | SMBus Clock. Internally a 1M Ohm resistor is connected between (C) and (-). |
| 3 | (D) | SMBus Data. Internally a 1M Ohm resistor is connected between (D) and (-). |
| 4 | (T) | Thermistor. 300 Ohm ±5% resistor is connected between (T) and (-). |
| 5 | (-) | Negative side of battery |

See Mechanical Drawing for orientation of contacts.
A key slot is also present for mechanical alignment adjacent to the positive terminal.

### 4.13. Initial Impedance

The total impedance of the battery pack is max. 200mOhm initial, AC measured at 1kHz at 20℃ fully charged battery.

# 5. Functional Description

## 5.1. Protection Electronics

### 5.1.1. Overview

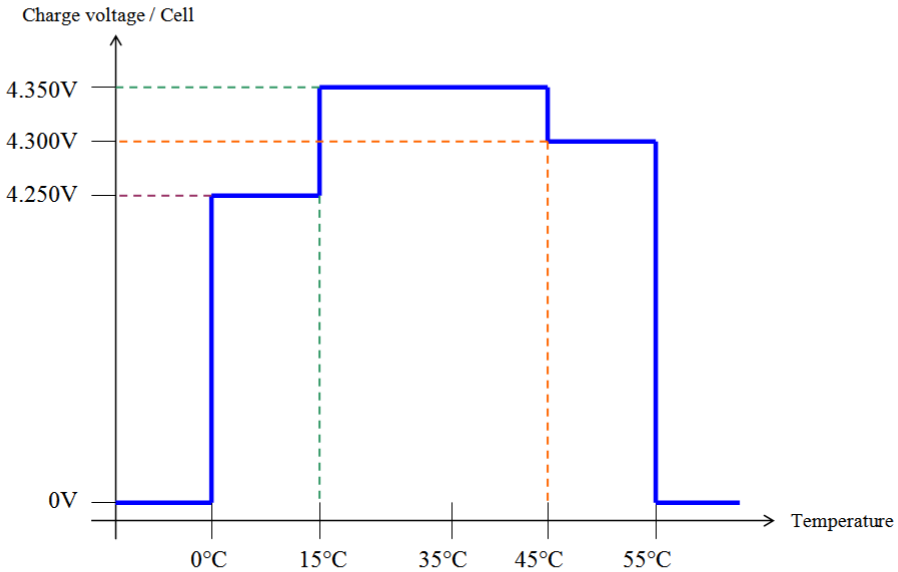
Electronic circuitry is connected within the battery to prevent damage to the battery due to failure of the charger and/or host device. The protection circuitry is also designed to protect the battery pack from short circuits - whether a current is placed across the terminals, or an unplanned load is connected. Several levels of redundant protection are also added to ensure a safe failure of the battery pack.
For temperature measurement two NTCs are placed on the cell stack on adequate positions.

### 5.1.2. Charge Protection

#### 5.1.2.1. Increased safety according JEITA

The battery supports JEITA guidelines which specify that charging voltage and charging current depend on the temperature.
It handles more complex charging profiles and allows for splitting the standard temperature range into sub-ranges for specifying both what the charging voltage and charging current should be.

JEITA safety charging parameters




#### 5.1.2.2. Over Voltage

The primary protection circuit prevents the battery from overcharging if any cell exceeds the over voltage threshold. If all the cell voltages drop below the cell over voltage recovery threshold, it will allow charging again. Per JEITA guidelines, the cell over voltage threshold changes depending on the temperature.
Three cell over voltage thresholds are specified, one for each operating temperature range.

Over Voltage 1st Level Protection

| Temperature Range | BMS Settings | | | Max Measured Detection Time [sec] |
|---|---|---|---|---|
| | OV Threshold [mV] | OV Time Limit [sec]* | OV Recovery Threshold [mV] | |
| 0℃ – 15℃ | 4350 | 1 | 4150 | < 3 |
| 15℃ - 45℃ | 4420 | 1 | 4200 | < 3 |
| 45℃ - 60℃ | 4400 | 1 | 4200 | < 3 |

* if time is set to 0 this function is disabled

The secondary protection circuit prevents the battery from charging if any cell voltage exceeds 4.450 ± 0.010 V which is protected by a fuse. The battery uses a non resettable fuse, which will render the battery pack non-functional.

### 5.1.2.3. Over Current

The protection circuit provides continuous over current protection and prevents the battery from over charging currents.
The battery will then check the current at periodic intervals to see if the over current has resided. Once the situation is removed, the battery allows charging again.

Over Current 1st Level Protection

| Protection | BMS Settings | | | | Max Measured Detection Time [sec] |
|---|---|---|---|---|---|
| | OC Threshold [mA] | OC Time Limit [sec]* | OC Recovery Threshold [mA] | Current Recovery Time [sec] | |
| Tier-1 | 5000 | 2 | 100 | 30 | < 4 |

* if time is set to 0 this function is disabled

### 5.1.2.4. Over Temperature

The protection circuit provides over temperature protection and prevents the battery from charging at higher temperatures. The battery will then check the temperature at periodic intervals, once the battery temperature has cooled to acceptable levels, the battery will be available for charging.

Over Temperature 1st Level Protection

| Temperature Sensor | BMS Settings | | | Max Measured Detection Time [sec] |
|---|---|---|---|---|
| | OT Threshold [°C] | OT Time Limit [sec]* | OT Recovery Threshold [°C] | |
| 1 | 55 | 1 | 45 | ≤ 3 |
| 2 | 55 | 1 | 45 | ≤ 3 |

* if time is set to 0 this function is disabled

If temperature is greater than 45°C and charging did not start, then charging is inhibited from starting.

## 5.1.3. Discharge Protection

### 5.1.3.1. Under Voltage

The protection circuit prevents deep discharging of the battery.
Once the battery voltage rises again by charging, it will then again allow the battery to discharge.

Under Voltage 1st Level Protection

| BMS Settings | | | Max Measured Detection Time [sec] |
|---|---|---|---|
| UV Threshold [mV] | UV Time Limit [sec]* | UV Recovery Threshold [mV] | |
| 2600 | 2 | 3000 | < 4 |

* if time is set to 0 this function is disabled

#### 5.1.3.2. Over Current

The protection circuit provides continuous over current protection. When the battery is in over current protection mode it will then check the current at periodic intervals to see if the over current has resided.
Once the situation is removed, the battery will allow discharging again.

Over Current 1st Level Protection

| Protection | BMS Settings | | | | Max Measured Detection Time [sec] |
|---|---|---|---|---|---|
| | OC Threshold [mA] | OC Time Limit [sec]* | OC Recovery Threshold [mA] | Current Recovery Time [sec] | |
| Tier-1 | 7500 | 2 | 200 | 30 | <4 |

* if time is set to 0 this function is disabled

#### 5.1.3.3. Over Load

An overload detection is used to detect abnormal currents in the discharge direction. This feature is used to protect the pass FETs, cells, and any other inline components from excessive discharge current conditions.
An overload delay should allow the system to momentarily accept a high current condition without disconnecting the supply to the load.

| BMS Settings | | | | Max Measured Detection Time [msec] |
|---|---|---|---|---|
| AFE OC Dsg Threshold [mA] | AFE OC Dsg Time [msec] | AFE OC Dsg Recovery Threshold [mA] | Current Recovery Time [sec] | |
| 14000 | 23 | 5 | 30 | < 35 |

#### 5.1.3.4. Over Temperature

The protection circuit provides over temperature protection and prevents the battery from discharging at higher temperatures. The battery will then check the temperature at periodic intervals, once the battery temperature has cooled to acceptable levels, the battery will be available for discharging.

Over Temperature 1st Level Protection

| Temperature Sensor | BMS Settings | | | Max Measured Detection Time [sec] |
|---|---|---|---|---|
| | OT Threshold [°C] | OT Time Limit [sec]* | OT Recovery Threshold [°C] | |
| 1 | 79 | 1 | 65 | ≤ 3 |
| 2 | 79 | 1 | 65 | ≤ 3 |

* if time is set to 0 this function is disabled

If temperature is greater than 55°C and discharging did not start, then discharging is inhibited from starting.

### 5.1.4. Short Current Protection

The protection circuit does not allow the charge or discharge of the battery if a short circuit is placed across the battery terminal (+ / -). When the battery is released from the short circuit mode, it will allow the battery to charge or discharge again (automatic reset).
A short current delay must allow the system to momentarily accept a high current condition without disconnecting the supply to the load.
This recovery requires AverageCurrent to be ≤ the AFE SC Recovery threshold and for the internal Current_Fault timer to be ≥ Current Revocery Time.

| Short Circuit | BMS Settings | | | | Max Measured Detection Time [µsec] |
|---|---|---|---|---|---|
| | AFE SC Threshold [mA] | AFE SC Delay Time [µsec] | AFE SC Recovery Threshold [mA] | Current Recovery Time [sec] | |
| Charge | 35000 | 915 | 5 | 30 | ≤ 2000 |
| Discharge | 35000 | 915 | 5 | 30 | ≤ 2000 |

#### 5.1.5. Passive Safety Protection

##### 5.1.5.1. Overview

The battery pack is also designed with additional components to protect against abusive charge and discharge operation. These components are separate from the main electronic protection.

##### 5.1.5.2. Current Fuse

The battery has a current fuse which has also a thermal cutoff functionality.
This type will heat itself and interrupts the current when the load becomes over 12A.
In addition, this fuse is integrated into the current circuit on the position of the power transistors and interrupts the flow when overheating of this parts leads to dangerous levels, 136℃(±3℃).

### 5.2. Fuel Gauge Electronics

#### 5.2.1. Operating Modes

##### 5.2.1.1. Normal Mode

The system stays in Normal mode till a condition occurs to switch in one of the following modes.

##### 5.2.1.2. Sleep Mode

The system enters in Sleep mode when the system senses no host or charger present for at least 20 seconds. While in this mode, battery parameters continue to be monitored at regular intervals and used for compensation (self-discharge). The system continues in this mode until it senses host activity.
The Charge-FET and DisCharge-FET are on during Sleep Mode.

##### 5.2.1.3. Shutdown Mode

The system enters in Shutdown mode when the battery voltage falls below 6V(2V/cell). In this mode, the micro controller and other associated circuitry will shut down to eliminate parasitic current draw. If the battery pack does enter shutdown mode, the unit will require an initial low current charge before normal operation will resume.

##### 5.2.1.4. Ship Mode

The system has the possibilty to switch all internal FET's off to cut the cell-stack voltage from the external connectors. RRC enables this mode to achieve safe shipment of the battery. The display is inactive in this mode. To exit the ship mode the battery must be charged first.

#### 5.2.2. Gas Gauging

The battery has a gas gauge electronic which uses the Impedance Track™ Technology from TI to measure and calculate the available charge in battery cells.
The error is better than 1% over the lifetime of the battery and no full charge discharge learning cycle is required.

#### 5.2.3. Cell Balancing

Each cell block in serie has a fuel gauge elctronic by using Impedance Track™ technology from TI to reduce the charge difference of these cell blocks in fully charged state of the battery pack gradually using cell balancing algorithm during charging. This prevents fully charged cells from overcharging and causing excessive degradation and also increases the usable pack energy by preventing premature charge termination.

### 5.2.4. Measurement Accuracy

#### 5.2.4.1. Voltage

The voltage measurement has a resolution of 1mV. The absolute accuracy of the reading is ±1% over the operating range.

#### 5.2.4.2. Current

The current measurement has a resolution of 1mA. The absolute accuracy of the reading is ±1% over the operating range.

#### 5.2.4.3. Temperature

Two NTC thermistors are attached to the cell stack to measure the internal pack temperature.
The temperature measurement has a resolution of 0.1°C. The error from -20°C to 80°C is <±3°C.

#### 5.2.4.4. LED Indication

The battery has a display to show the capacity information by using the push button. The battery capacity is displayed as a relative state of charge (RSOC). Each LED segment represents 25 percent of the full charge capacity. The LED pattern definition is given in the table below. The LED's illuminate for 4 seconds following switch activation. If the battery voltage is to low or the battery is inoperable (permanent fault), there will be no LED indication.

| Capacity | LED Indicators # | | | | Note |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| < 10% | | | | | Blinks |
| 10% - 25% | | | | | Lit for 4 seconds |
| 26% - 50% | | | | | Lit for 4 seconds |
| 51% - 75% | | | | | Lit for 4 seconds |
| 76% - 100% | | | | | Lit for 4 seconds |

### 5.2.5. Interface and Communication

#### 5.2.5.1. Overview

The battery is designed to communicate with a host or a charger through the System Management Bus (SMBus) protocol.
Refer to the following specifications when reading this section:

System Management Bus Specification (Rev 1.1, Dec 11, 1998)
Smart Battery Data Specification (Rev 1.1, Dec 15, 1998)
Smart battery Charger Specification (Rev 1.0, June 27, 1996)

Further information: www.SMBUS.org

#### 5.2.5.2. SMBus Logic Levels

| Symbol | Parameter | Limits | |
|---|---|---|---|
| | | Min | Max |
| Vil | Data/Clock input low voltage | -0,3V | 0,8V |
| Vih | Data/Clock input high voltage | 2,0V | 6,0V |
| Vol | Data/Clock output low voltage | | 0,4V |

#### 5.2.5.3. SMBus device address assignments(excerpt)

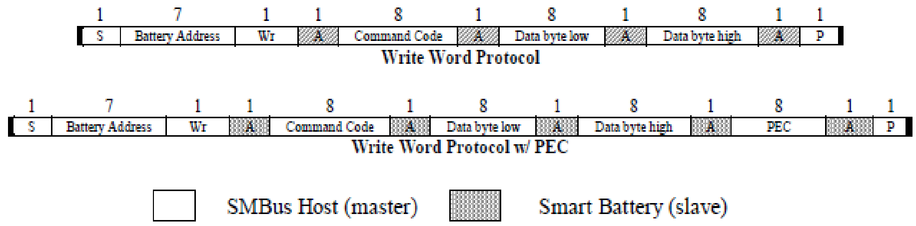
| Slave Address | Description | Specification |
|---|---|---|
| 0001 000 | SMBus Host | System Management Bus Specification V1.1 December 1998 |
| 0001 001 | Smart Battery Charger | Smart Battery Charger Specification V1.1 December 1998 |
| 0001 010 | Smart Battery Selector<br>Smart Battery System Manager | Smart Battery Selector Specification V1.1 December 1998<br>Smart Battery System Manager Specification V1.0B Aug. 1999 |
| 0001 011 | Smart Battery | Smart Battery Data Specification V1.1 December 1998 |

### 5.2.5.4. SMBus Data Protocols

SMBus Interface complies with SBS Specification Version 1.1. The battery communicates via a simple bi-directional serial data interface. A host processor uses the interface to access various battery pack registers. The Smart Battery should be a slave device and will respond to commands but will not initiate any commands. All commands are 8 bits (1 byte) long. Command arguments and return values can vary in length. Accessing a command that does not exist or is not supported provokes an error condition. In accordance with the I2C specification, the Most Significant Bit is transferred first.
The Smart Battery supports 3 different transfer protocols, **Write Word**, **Read Word** and **Read Block**. These protocols are described as follows and are referenced as function calls throughout this document.

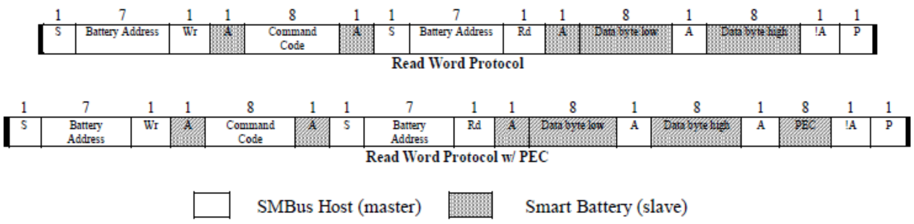
#### 5.2.5.4.1. Write Word

WriteWord(Input **Command**, Input **Data**)
The first byte of a Write Word access is the command code. The next 2 bytes are the data to be written. In this example, the master asserts the slave device address followed by the write bit. The device acknowledges and the master delivers the command code. The slave again acknowledges before the master sends the data word (low byte first). The slave acknowledges each byte according to the I2C specifications, and the entire transaction is finished with a stop condition.



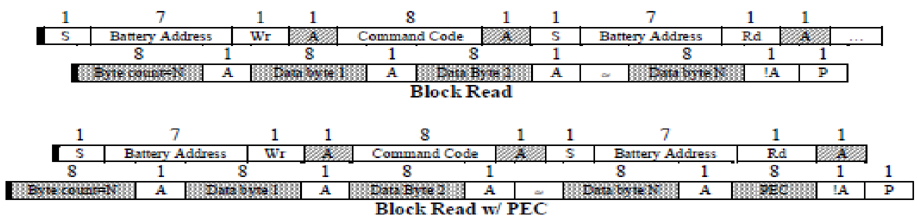

#### 5.2.5.4.2. Read Word

ReadWord(Input **Command,** Output **Response**)
Reading data is slightly more complicated than writing data. First the host must write a command to the slave device. Then it must follow that command with a repeated start condition to denote a read from that device's address. The slave then returns 2 bytes of data.
Note: There is no stop condition before the repeated start condition, and that a "Not ACKnowledge" signifies the end of the read transfer.




#### 5.2.5.4.3. Read Block

ReadBlock(Input **Command,** Output **Response**)
A block read operation is similar to the Read Word protocol except that the first data byte received from the slave contains the number of bytes that can be sent. This byte count may not be 0. A block read is allowed to transfer up to 32 data



#### 5.2.5.5. Messages

##### 5.2.5.5.1. Host-to-Battery Messages

The Host acting in the role of bus master uses the read word, write word, and read block protocols to communicate with the battery, which is operating in slave mode.

| Function | Command Code | Description | Unit | Access | Default (POR) |
|---|---|---|---|---|---|
| ManufacturerAccess() | 0x00 | | | r/w | |
| RemainingCapacityAlarm() | 0x01 | Remaining Capacity Alarm Threshold . | mAh | r/w | 640 |
| RemainingTimeAlarm() | 0x02 | Remaining Time Alarm Threshold. | minutes | r/w | 10 |
| BatteryMode() | 0x03 | Battery Operational Modes. | Bit flags | r/w | 0x0001 |
| AtRate() | 0x04 | This function is the first half of a two-function call-set used to set the AtRate value used in calculations made by the AtRateTimeToFull(), AtRateTimeToEmpty(), and AtRateOK() functions. | mA | r/w | 0 |
| AtRateTimeToFull() | 0x05 | Returns the predicted remaining time to fully charge the battery at the AtRate() value. | minutes | r | 65535 |
| AtRateTimeToEmpty() | 0x06 | Returns the predicted remaining operating time if the battery is discharged at the AtRate() value. | minutes | r | 65535 |
| AtRateOK() | 0x07 | Returns a Boolean value that indicates whether or not the battery can deliver the AtRate value of additional energy for 10 seconds. If the AtRate() value is zero or positive, the AtRateOK() function will ALWAYS return TRUE. | boolean | r | 1 |
| Temperature() | 0x08 | Returns the pack's internal temperature. | 0.1 K | r | |
| Voltage() | 0x09 | Returns the battery's voltage (measured at the cell stack) | mV | r | |
| Current() | 0x0a | Returns the current being supplied (or accepted) through the battery's terminals. | mA | r | 0 |
| AverageCurrent() | 0x0b | Returns a rolling average based upon the last 64 samples of current. | mA | r | 0 |
| MaxError() | 0x0c | Returns the expected margin of error. | percent | r | 1 |
| RelativeStateOfCharge() | 0x0d | Returns the predicted remaining battery capacity expressed as a percentage of FullChargeCapacity(). | percent | r | 0 |
| AbsoluteStateOfCharge() | 0x0e | Returns the predicted remaining battery capacity expressed as a percentage of DesignCapacity(). | percent | r | 0 |
| RemainingCapacity() | 0x0f | Returns the predicted remaining battery capacity. | mAh | r | 0 |
| FullChargeCapacity() | 0x10 | Returns the predicted battery capacity when fully charged. | mAh | r | 6340 |
| RunTimeToEmpty() | 0x11 | Returns the predicted remaining battery life at the present rate of discharge. | minutes | r | 65535 |
| AverageTimeToEmpty() | 0x12 | Returns the rolling average of the predicted remaining battery life. | minutes | r | 65535 |
| AverageTimeToFull() | 0x13 | Returns the rolling average of the predicted remaining time until the battery reaches full charge. | minutes | r | 65535 |
| ChargingCurrent() | 0x14 | Returns the battery's desired charging rate. | mA | r | 4480 |
| ChargingVoltage() | 0x15 | Returns the battery's desired charging voltage. | mV | r | 13050 |
| BatteryStatus() | 0x16 | Returns the battery's status word. | Bit flags | r | 0x0C0 |
| CycleCount() | 0x17 | Returns the number of charge/discharge cycles the battery has experienced. A charge/discharge cycle is defined as: an amount of discharge approximately equal to the value of DesignCapacity. | cycles | r | 0 |
| DesignCapacity() | 0x18 | Returns the theoretical capacity of the new battery. | mAh | r | 6400 |
| DesignVoltage() | 0x19 | Returns the theoretical voltage of a new battery. | mV | r | 11250 |
| SpecificationInfo() | 0x1a | Returns the version number of the SBDS the battery pack supports, as well as voltage and current scaling information. | Formatted word | r | 0x0031 |
| ManufacturerDate() | 0x1b | Returns the date the electronics were manufactured. | Formatted word | r | |
| SerialNumber() | 0x1c | Returns the electronics serial number. | number | r | |
| Reserved | 0x1d – 0x1f | | | r | |
| ManufacturerName() | 0x20 | Returns a character array containing the manufacture's name. | string | r | RRC |
| DeviceName() | 0x21 | Returns a character array that contains the battery's name. | string | r | RRC2040-2 |
| DeviceChemistry() | 0x22 | Returns a character array that contains the battery's chemistry. | string | r | LION |
| ManufacturerData() | 0x23 | Returns data specific to the manufacture. | | r | |

#### 5.2.5.5.2. Critical Messages

Whenever the Battery detects a critical condition, it takes the role of a bus master and sends AlarmWarning() message to the Host and/ or Charger. The Battery will broadcasts the AlarmWarning() message at 10 second intervals until the critical condition(s) has been corrected.

| Function | Command Code | Description | Unit | Access |
|---|---|---|---|---|
| AlarmWarning() | 0x16 | This message is to the host and/or charger to notify them that one or more alarm conditions exist. | Formatted word | w |

## 5.3. Data Logging

The electronic has a lifetime data logging, where important measurements are stored for warranty and analysis purposes. The data which is monitored include:
Lifetime maximum temperature
Lifetime over temperature count
Lifetime over temperature duration
Lifetime minimum temperature
Lifetime maximum cell voltage
Lifetime over cell voltage count
Lifetime over voltage duration
Lifetime minimum cell voltage
Lifetime maximum pack voltage
Lifetime minimum pack voltage
Lifetime maximum charge current
Lifetime maximum discharge current
Lifetime maximum charge power
Lifetime maximum discharge power
Lifetime average temperature

## 5.4. Data Storage

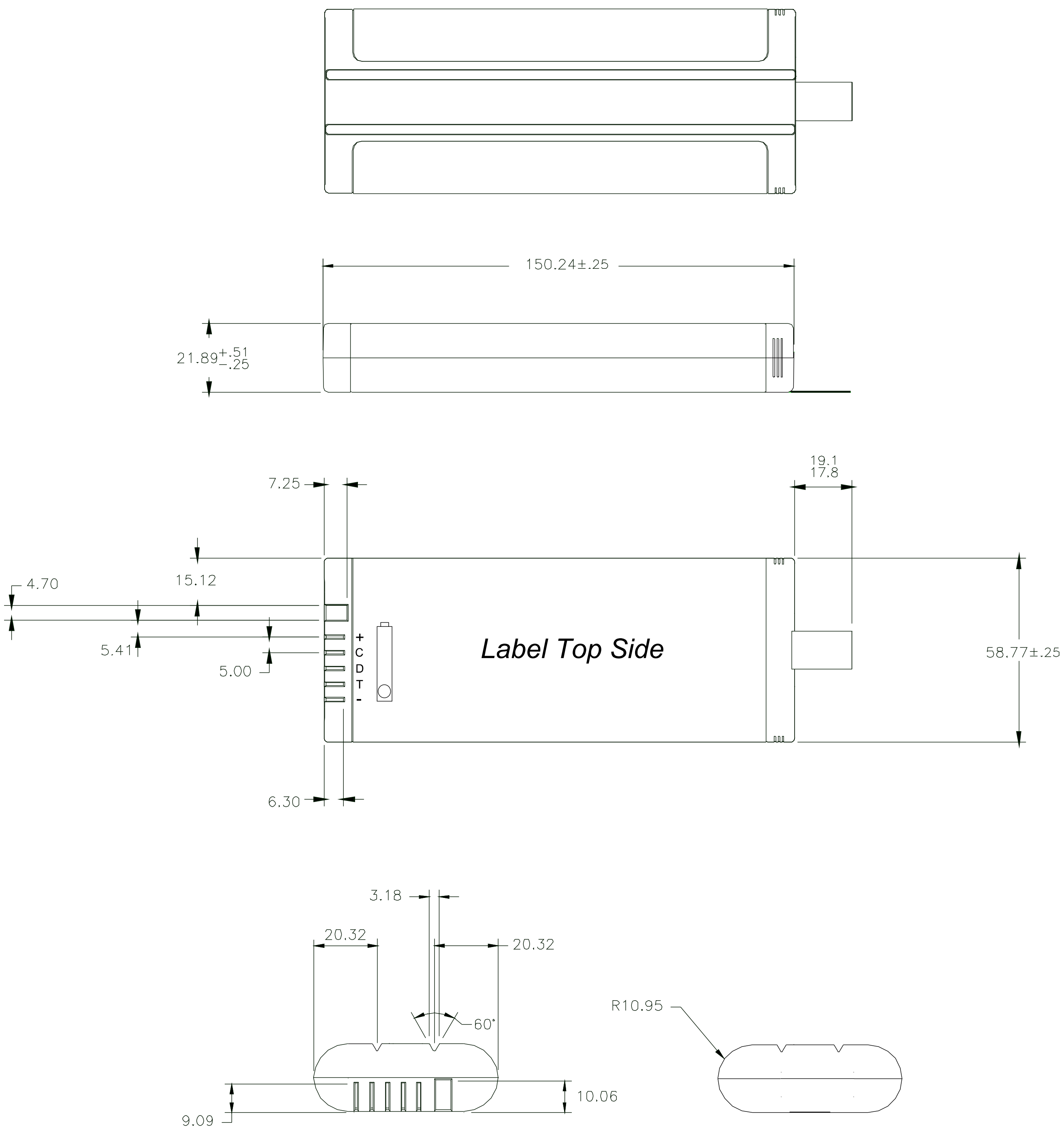
The following data is stored in the BMS:
Serial number in a readable format(hex-value) for a host system
Manufacturer name
Device name
Device chemistry
Manufacturer date
Revision of the firmware
Hardware revision
Cell type

## 5.5. Authentication

The battery supports authentication by the host using SHA-1 defined by RRC so that the usage of batteries not designed for this application can be prohibited.

## 6. Mechanical

### 6.1. Mechanical Drawing



### 6.2. Distortion

The maximum distortion of the pack is ≤ 0,5mm

### 6.3. Connector

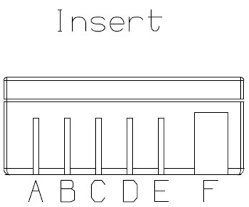
The connector has a current carrying capability of 8A(continuous).

#### 6.3.1. Suggested interconnection mating connectors

**AMP/Tyco**
#5787444-1
#5787446-1
#787428-1 not RoHS compliant
#787430-1 not RoHS compliant
#787441-1 not RoHS compliant
#787443-1 not RoHS compliant
#787444-1 not RoHS compliant
#787446-1 not RoHS compliant

**CEN Link**
#TSD1-01305-0xxxA

#### 6.3.2. Pinout




Terminals

A - Negative
B - Temperature
C - Data
D - Clock
E - Positive
F - Key

### 6.4. Weight

350g

### 6.5. Housing Material

PC/ABS

## 7. EMC and Safety Requirements

### 7.1. EMC

The battery complies with
EN55022:2010
EN55024:2010
FCC Title 47 CFR, Part 15 Class B/IECS-003, Issue 4

### 7.2. Safety

The battery complies with
EN60950-1:2006 + A11:2009 + A1:2010 + A12:2011
UL2054:2011 / UL1642:2012
IEC62133:2012

The battery is tested in accordance with the UN Manual of tests and criteria part III subsection 38.3 Rev 5:2009 + Amendment1:2011(ST-SG-AC10-11-Rev5-Amend1) - more commonly known as the UN T1-T8 transportation tests.

## 8. Regulatory Compliance / Certifications

### 8.1. National applicable Directives

The battery complies to all applicable directives and appropriate standards (e.g. safety, EMC, environmental, recycling, …) for all of below stated countries.
- Korea
- Japan
- Australia
- USA
- Canada
- Europe
- Taiwan

### 8.2. CE Requirements

The battery complies with
EMC Directive 2004/108/EC
Low Voltage Directive 2006/95/EC
RoHS II Directive 2011/65/EU

# 9. Environmental Requirements

## 9.1. Climatic

### 9.1.1. Operating Temperature

The following data relate to the cell

**Charge**
Initial temperature: 0°C to 45°C
During charge: 0°C to 55°C

**Discharge**
Initial temperature: -20°C to 55°C
During charge: -20°C to 79°C

### 9.1.2. Storage Temperature

Max: -20°C to 50°C
Recommended: -20°C to 25°C
Extended storage at temperature >40°C could degraded battery performance and life.

### 9.1.3. Altitude

No restrictions, battery can be stored, charged and discharged between 0 – 15000m

### 9.1.4. Humidity

Recommended: 10 – 90%
Max: 96%, no dew condensation

## 9.2. Mechanical

### 9.2.1. Vibration

The battery complies to
UN T3 Transportation test [USDOT-E7052] and
IEC62133:2012 Chapter 4.2.2

### 9.2.2. Shock

The battery complies to
UN T4 Transportation test [USDOT-E7052] and
IEC62133:2012 Chapter 4.3.4

### 9.2.3. Drop

The battery complies to IEC62133:2012 Chapter 4.3.3

## 10. Reliability Requirements

### 10.1. Life Expectancy

Given normal storage & usage, the battery delivers 80% or more of it's initial capacity after 300 charge/discharge cycles where the charge phase is CC/CV 3.2A, 13.05V and the discharge is 3.2A down to 9600mV pack voltage at 25℃.

### 10.2. Shelf Life

The battery provides a minimum of 6 months shelf life with initial charge state of 40%, when stored at 25℃.

### 10.3. Shipping

The battery will be shipped in max. 50~70% charged state.
Up to 24 batteries of the same type can be packed into an outer box to meet the 10kg(brutto) limitation of the transportation requirements.
In the standard RRC packaging there will be 12 batteries of RRC2040-2 inside the outer box.
Dimensions of the outer box(LxWxH): 375x255x155mm

## 11. Material Requirements

### 11.1. Dangerous Substances

All parts of the battery complies with
- RoHS II Directive 2011/65/EU
- REACH Directive 1907/2006/EC
- Battery Recycling Directive 2006/66/EC as amended