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pre engineered power solutions

Technical Specification

Document Number	CMX810M_TLS
Document Revision	3.0
Prepared By	NRO
Issue Date	20.07.16

Document Number

CMX810M_TLS

Description

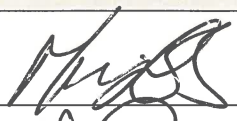
Rechargeable Smart Lithium Ion Battery

Accutronics Part Number

46A051AJ00008

Accutronics Product Name

CMX810M

Approvals		Name	Signature	Date
Electronics Review	Senior Electronics Engineer	Martin Gibbs		29/7/16.
Mechanical Review	Mechanical Engineering Manager	David Asplin		22.7.16
Software Review	Software Engineer	Scott Evans		28/7/16
Marketing Approval	Technical Marketing Manager	Neil Oliver		22.7.16

Revision History

Revision	Issue Date	Revisions	Prepared By
3.0	20.07.16	In §1.3, Figure 1 updated. In §1.3 & §7.2, UL 62133 was UL 2054. Label details in §5.4 and figure 7 revised. In §3.2, new row added for temperature range. '-10°C to +50°C' was -25°C to +75°C', '<3mA' was '<1500uA' and '<700uA' was '<600uA'. In §4.1.1, '2.0V' was '2.3V' and 'flashing fast' removed from <10% LCD segment. In §4.3.4 (table 7), 'During discharge when the battery RSOC <6%' was 'During discharge when the batter voltage drops <2.9V/cell for 5s or RSOC=0%' and 'When RSOC is >8%' was 'When RSOC rises above 5% or 3.2V/Cell'. In §4.3.4 (table 8), 'Battery RSOC ≤ 3%' was Battery RSOC = 0% OR ≤2.9V/cell for 5s' and 'Battery RSOC ≥ 5%' was 'Battery RSOC ≥5% OR ≥3.2V/cell'. In §4.4.2 (table 13), '900us' was '960us', '10000' was '8000' and '2000' was '2300'. In §4.4.4 (table 14), 'Any cell under voltage' row removed from table and '85' was '75'. In §5.4, Figure 8 updated. Format of tables in §4.4.3 and §4.4.4 revised.	NRO
2.0	14.03.16	Cell IEC 62133 2nd edition certifacte number added to section 3.1 Product labelling section updated DSG and CHG Over and Under Temperature Safety thresholds changed	DA MWG
1.0	26.06.15	Spell and grammar corrections	PWI
0.1	15.04.15	Initial release SIGNED-OFF	PWI/MWG

DEFINITIONS

Unless otherwise specified, the following acronyms will be used throughout this document:

C	Typical Nominal cell Capacity
CAD	Computer Aided Design
CC	Constant Current
CV	Constant Voltage
EMC	Electro Magnetic Compliance
ESD	Electro Static Discharge
LCD	Liquid Crystal Display
PEC	Packet Error Correction
POR	Power On Reset
RTV	Room Temperature Vulcanisation
SOC	State of Charge
SBD	Smart Bus Data
SBDS	Smart Bus Data Specification
SMBus	System Management Bus
SoC	State of Charge
TBA	To be Advised
TBD	To be Defined

REFERENCES

[1] “System Management Bus Specification", Rev 2.0, Aug 3, 2000
[2] "Smart Battery Data Specification", Rev 1.1, Dec 11, 1998
[3] "Smart Battery Data Specification Errata", Rev 1.1.a, June 7, 1999
[4] "Smart Battery Charger Specification", Rev 1.1, Dec 11, 1998
[5] E-One Moli Energy INR-18650A cell data sheet
[6] CMX810M marketing data sheet

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1 INTRODUCTION

1.1 Entellion

The CMX810M is part of the 'Entellion' range of batteries. Entellion products are smart, innovative portable power products, designed to meet the emerging needs of feature-laden devices in professional markets. Entellion combines our expertise in custom OEM battery products with our understanding of professional OEM requirements and market trends. Entellion products are available off the shelf and can also be customised for your application, getting you to market quickly and confidently.

1.2 Scope

This specification describes the physical, functional and electrical characteristics of the CMX810M rechargeable Lithium Ion smart battery. This specification is the Master interface document that controls the internal specifications from Accutronics. Battery packs produced will meet this specification.

1.3 Battery Pack Overview

The CMX810M consists of eight Lithium Ion rechargeable cells connected in an eight series, one parallel configuration. Each cell within the battery has a nominal voltage of 3.6V and a typical capacity of 2.55Ah. The CMX810M has a nominal voltage of 28.8V and a typical capacity of 2.55Ah (73.4Wh). The CMX810M can be discharged continuously at up to 220W.

The CMX810M includes a microprocessor based battery management module that provides fuel gauging and active protection. The module is capable of communicating with host or the charger through the System Management Bus (SMBus). The battery is fully SMBus and SBDS Revision 1.1 compliant and can provide a wide range of information about the battery status. Active protection is provided for over-charge, over-discharge, over-current and short circuit. A second, redundant protection IC provides additional protection against over-charge. Passive safety devices are included in the pack to protect against over-current. The battery includes a visual state of charge indicator in the form of a 5 bar LCD display.

The battery is terminated via a Mixed D-Sub connector which is shrouded to prevent accidental short circuit. The cells and electronics are housed in a two piece injection moulded case which is unitized through the use of internal mechanical clips and RTV adhesive. See Figure 1 for a CAD render of the battery.

The CMX810M is certified to UL 62133 (safety) , IEC 62133:2012 (safety) and UN 38.3 (transportation).

Figure 1 – CMX810M battery

1.4 Customisation

The CMX810M battery is available as a standard product with Entellion branding or can be easily customised to meet the specific needs of the OEM.

Customisation options include product labelling, case colour and software set-up. Customer versions of the CMX810M battery can also be programmed to include a unique 'authentication key' which allows the host device to interrogate the battery and determine if it is a valid part. Any battery not deemed to be valid can be rejected by the host device. SHA-1 authentication helps protect the OEMs aftermarket sales revenue and can prevent fraudulent warranty claims which may result from the use of non-approved batteries.

2 LITHIUM ION BATTERY GENERAL PRECAUTIONS

2.1 ⚠ DANGER!

1. Do not disassemble or modify the battery pack. The battery pack is equipped with built-in safety/protection features. Should these features be disabled, the battery pack can leak electrolyte, overheat, emit smoke, burst and/or ignite.

2. Do not connect the positive (+) and negative (-) terminals with a metal object such as wire. Do not place (unprotected) on a conductive surface. Do not transport or store the battery pack together with metal objects such as necklaces, hair pins, etc. Otherwise, short-circuiting will occur, over-current will flow, causing the battery pack to leak electrolyte, overheat, emit smoke, burst and/or ignite, or the metal object such as wire, necklace or hair pin can generate heat.

3. Do not discard the battery pack into fire or heat it. Otherwise, its insulation can melt down, its gas release vent or safety features will be damaged and/or its electrolyte can ignite, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition on it.

4. Do not use or leave the battery pack near a heat source such as a fire or a heater (+80ºC or higher). If the resin separator should be damaged owing to overheating, internal short-circuiting may occur to the battery pack, possibly leading to electrolyte leakage, smoke emission, bursting and/or ignition of the battery pack.

5. Do not immerse the battery pack in water or seawater and do not allow it to get wet. Otherwise, the protective features in it can be damaged, it can be charged with extremely high current and voltage, abnormal chemical reactions may occur in it, possibly leading to electrolyte leakage, smoke emission, bursting and/or ignition.

6. Do not recharge the battery pack near fire or in extremely hot weather. Otherwise, hot temperatures can trigger its built-in protective features, inhibiting recharging, or can damage the built-in protective features, causing it to be charged with an extremely high current and voltage and, as a result, abnormal chemical reactions can occur in it, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

7. To recharge the battery pack, uses the battery charger specifically designed for the purpose and observe the recharging conditions specified by ACCUTRONICS. A recharging operation under non-conforming recharging conditions (higher temperature and larger voltage/current than specified, modified battery charger, etc.) can cause the battery pack to be overcharged, or charged with extremely high current, abnormal chemical reaction can occur in it, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

8. Do not pierce the battery pack with a nail or other sharp objects, strike it with a hammer, or step on it, otherwise, the battery pack will become damaged and deformed, internal short-circuiting can occur, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

9. Do not subject the battery pack to sudden mechanical shock. The impact might cause leakage, overheating, smoke emission, bursting and/or ignition. Also, if the protective feature in it becomes damaged, it could become charged with an extremely high current and voltage, abnormal chemical reactions can occur, which can lead to electrolyte leakage, overheating smoke emission, bursting and/or ignition.

10. Do not use an apparently damaged or deformed battery pack. Otherwise, electrolyte leakage, overheating, smoke emission, bursting and/or ignition of the battery pack may occur.

11. Do not directly solder the battery pack. Otherwise, heat can melt down its insulation, damage its gas release vent or safety features, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

12. Do not reverse the positive (+) and negative (-) terminals. Otherwise, during recharging, the battery pack will be reverse-charged, abnormal chemical reactions then may occur, or excessively high current can flow during discharging, leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

13. The positive (+) and negative (-) terminals are arranged in a particular orientation. Do not force the connection if you cannot easily connect the battery pack terminals to the battery pack charger or other equipment. Confirm that the terminals are correctly oriented. Reversing the terminals will result in reverse-charging, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition of the battery pack.

14. Do not connect the battery pack to an electrical outlet, vehicle cigarette lighter, etc. When subjected to large voltage, over-current can flow on the battery pack, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

15. Do not use the battery pack for a purpose other than those specified. Otherwise, its guaranteed performance will be lost and/or its service life will be shortened. Depending on the equipment in which the battery pack is used, excessively high current can flow through battery pack, possibly damaging it and leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

16. If the battery pack leaks and electrolyte gets into the eyes, do not rub them. Instead, rinse the eyes with clean running water and immediately seek medical attention. Otherwise, eye injury may result.

2.2 ⚠ WARNING

1. Do not use the battery pack in combination with primary battery packs (such as dry-cell battery packs) or battery packs of different capacities or brands. Otherwise, the battery pack can be over-discharged during use or overcharged during recharging, abnormal chemical reactions may occur, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

2. If recharging operation fails to complete even when a specified recharging time has elapsed, immediately stop further recharging. Otherwise, electrolyte leakage, overheating, smoke emission, bursting and/or ignition can occur.

3. Do not put the battery pack into a microwave oven or pressurised container. Rapid heating or disrupted sealing can lead to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

4. If electrolyte leaks from the battery pack or gives off a bad odour, remove it from any exposed flame. Otherwise, the leaking electrolyte may catch fire and the battery pack may emit smoke, burst or ignite.

5. If the battery pack gives off an odour, generates heat, becomes discoloured or deformed, or in any way appears abnormal during use, recharging or storage, immediately remove it from the equipment or battery pack charger and stop using it. Otherwise, the problematic battery pack can develop electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

2.3 ⚠ CAUTION

1. Do not use or subject the battery pack to intense sunlight or hot temperatures, for example in a car during hot weather. Otherwise, electrolyte leakage, overheating and/or smoke emission can occur. Also, its guaranteed performance will be lost and/or its service life will be shortened.

2. The battery pack incorporates built-in safety devices. Do not use it in a location where static electricity (greater than the manufacturer's guarantee) may be present. Otherwise, the safety devices can be damaged, possibly leading to electrolyte leakage, overheating, smoke emission, bursting and/or ignition.

3. The guaranteed recharging temperature range is 10°C to +45°C. A recharging operation outside this temperature range can lead to electrolyte leakage and/or overheating of the battery pack and may cause damage to it.

4. If electrolyte leaking from the battery pack comes into contact with your skin or clothing, immediately wash it away with running water. Otherwise, skin inflammation can occur.

5. Store the battery pack in a location where children cannot reach it. Also, make sure that a child does not take the battery pack out of the battery pack charger or equipment.

6. Before use, study carefully these Precautions. For further information contact the nearest ACCUTRONICS distributor or representative. Retain the original product literature for future reference.

7. For recharging procedures, refer to the Operation Manual of your battery pack charger.

8. If you find rust, a bad odour, overheating and/or other irregularities when using the battery pack for the first time, return it to your supplier or vendor.

2.4 ✅ Recommendations to the End Users

The following represents a typical, but not exhaustive list of good advice to be provided by the equipment manufacturer to the end-user.

- Do not dismantle, open or shred secondary cells or batteries.
- Do not expose cells or batteries to heat or fire. Avoid storage in direct sunlight.
- Do not short-circuit a cell or a battery. Do not store cells or batteries haphazardly in a box or drawer where they may short-circuit each other or be short-circuited by other metal objects.
- Do not remove a cell or battery from its original packaging until required for use.
- Do not subject cells or batteries to mechanical shock.
- In the event of a cell leaking, do not allow the liquid to come in contact with the skin or eyes. If contact has been made, wash the affected area with copious amounts of water and seek medical advice.
- Do not use any charger other than that specifically provided for use with the equipment.
- Observe the plus (+) and minus (–) marks on the cell, battery and equipment and ensure correct use.
- Do not use any cell or battery which is not designed for use with the equipment.
- Do not mix cells of different manufacture, capacity, size or type within a device.
- Keep cells and batteries out of the reach of children.
- Seek medical advice immediately if material or content from a cell or a battery has been swallowed.
- Always purchase the correct cell or battery for the equipment.
- Keep cells and batteries clean and dry.
- Wipe the cell or battery terminals with a clean dry cloth if they become dirty.
- Secondary cells and batteries need to be charged before use. Always use the correct charger and refer to the manufacturer’s instructions or equipment manual for proper charging instructions.
- Do not leave a battery on prolonged charge when not in use.
- After extended periods of storage, it may be necessary to charge and discharge the cells or batteries several times to obtain maximum performance.
- Secondary cells and batteries give their best performance when they are operated at normal room temperature (+20°C ±5°C).
- Retain the original product literature for future reference.
- Batteries must be recycled or disposed of properly. Follow local regulations and ordinances for the disposal of the batteries. Recycle facilities may not be available in all areas.

3 DESIGN SPECIFICATION

3.1 Li Ion Cell Specification

Parameter	Value	Notes
Technology	Rechargeable Lithium Ion	
Manufacturer	E-One Moli Energy	
Manufacturer Part No.	INR-18650A (2.5Ah)	Accutronics Part Number PLI1ABD008S
Nominal Voltage	3.6V	Based on charging at CVCC 4.2V, 0.5C to a 50mA current taper (at +23°C), followed by a CC discharge at 0.2C to 2.75V (at +23°C)
Typical Capacity	2550mAh	
Minimum Capacity	2500mAh	
Dimensions	Diameter: 18.60mm max Height: 65.20mm max	
Weight	45.0g	Maximum according to data sheet
UL1642 UL File. No.	MH27672	
IEC62133 2nd Ed. Cert. No.	SE-79814	

Table 1 - Cell Specification

3.2 Battery Specification

Parameter	Value	Notes
Technology	Li Ion	Rechargeable Lithium Ion
Configuration	8S/1P	8 cells in series / 1 cell in parallel
Nominal Voltage	28800 mV	Based on charging at CV,CC 33.6V, 2.5A until the battery broadcasts a Terminate Charge Alarm (at +23°C), followed by a CC discharge at 0.2C to Terminate Discharge Alarm (at +23°C)
Capacity	2550 mAh (typical) 2500 mAh (minimum)	
Charging		
Charge Voltage	33600mV	Maximum voltage the battery will request (see section 3.4)
Maximum Charge Current	2500mA	Maximum current the battery will request (see section 3.4)
JEITA Charging Range	JT1 JT2 JT3 JT4 0°C 10°C 45°C 55°C	Four temperature settings defining three temperature ranges.
Discharging		
Discharge Temperature Range	-10°C to +50°C	Recommended ambient temperature range to obtain acceptable performance. Note that continuous discharge at high current and high temperature may cause the battery's over-temeprature protection to activate. Discharge at low temperatures may result in lower than expected energy delivery. Emperical testing is required to determine performance.
Maximum Discharge Current	10.0A	The battery's over-current protection will activate above this level.
End of Discharge Voltage	22.0V	
Quiescent Discharge Current		
Battery Current – Normal Operation Battery Current – Sleep Battery Current – Shutdown	< 3 mA < 700 µA < 20 µA	The average DC current drawn to power internal monitoring circuits when in these states.
Storage		
Temperature Humidity	-20°C to +60°C Max 95% (non-condensing)	See section 3.7

Table 2 - Battery Specification

3.3 Connector Specification

The battery is fitted with an FCI Electronics DAL7W2S543M40LF mixed power and signal female socket connector (pin-out as defined in table 1).

Battery Connector Host or Charger

Figure 2 – Battery Connection

The battery connector is designed to securely mate with a 7W2P male connector in the host equipment (or associated battery charger) - FCI Electronics, Amphenol, Norcomp, Harting and ITT Cannon manufacture suitable, mating male 7W2P connectors.

Terminal	Legend	Description
A1	(BATT+)	Positive Side Of Battery
1	(T)	300Ω ±5% 100mW resistor connected between (T) and BATT(-)
2	(PRES#)	Battery Present when shorted to BATT(-)
3	(SDATA)	SMBus Data. Internally a 1MΩ resistor is connected between (SDATA) and (BATT-)
4	(SCLK)	SMBus Clock. Internally a 1MΩ resistor is connected between (SCLK) and (BATT-)
5	(NC)	Do not connect to this pin
A2	(BATT-)	Negative side of battery

Table 3 - Connector Pin-out

The SMBus Clock and data lines require pull-ups to system logic voltage in the customer equipment, NOT the battery voltage. Typically a 15KΩ pull-up resistor is used, but please refer to the SMBus Specification for additional information. Internally they are weakly pulled down to (BATT-).

3.4 Charging

The battery is designed to be charged by a dedicated level II or level III smart battery charger. The battery will request appropriate charging Voltage and Current from the charger.

The battery conforms to JEITA guidelines. Charging voltage and current are modified depending on the internal temperature. Refer to section 4.4.1 for more information.

The Accutronics Limited manufactured Entellion CX9024 is a suitable desktop two-bay charger. Accutronics also manufacture an embedded single-bay charger module for permanent installation into the host equipment.

3.5 Discharging

Discharge shall be halted if the OVER_TEMP_ALARM alarm is broadcast.

Discharge shall terminate when the TERMINATE_DISCHARGE alarm is broadcast by the battery.

3.6 Calibration

Under normal operational circumstances (see Fuel Gauge Accuracy 3.8.3), the CMX810M battery does not require calibration. However the CX9024 charger has an in-built calibration function which can be used with any corresponding CMX series battery if recalibration is considered appropriate.

3.7 Storage and Transport

The battery pack is capable of being safely stored and transported over a temperature range of -20°C to +60°C. The battery pack should ideally be stored in an environment with low humidity free from corrosive gas within a temperature range of -20°C to +30°C. Batteries stored between +30°C and +60°C risk a deterioration of battery performance, although this is still within the commercial storage tolerance set by the cell manufacturer. Storage of fully charged batteries at high temperatures is not recommended.

Batteries are shipped from Accutronics Limited with <30% residual capacity and with the fuel gauge set to 'shutdown mode' which minimizes quiescent current drain from the fuel gauge. Batteries shipped in this status can be stored for a minimum of twelve months storage at less than +30°C without the need for maintenance by the customer. Storage that exceeds this time may result in the batteries discharging to a level where the active cell protection will remove the cells from circuit to reduce discharge rate and prevent cell damage. It should be noted that Accutronics Limited ship the batteries in a shut-down mode to minimize discharge on the battery. Any form of charging, discharging or connection to equipment will place the battery into its sleep mode which has a higher quiescent current drain.

3.8 Life Expectancy

3.8.1 Cycle Life

Each new battery is expected to deliver a minimum of 80% of its minimum rated capacity after 500 cycles where the charge and discharge phases are described in section 3.2.

3.8.2 Cell Life

This specification details the environmental temperature limits for storage, charge and discharge that the battery may safely tolerate. The battery will request the most appropriate charge regime for the prevailing environmental conditions and it will actively prevent charge or discharge if the environmental conditions are exceed. The extremes of temperature in this specification are not limits that the battery can be expected to operate at continuously and regular operation at extremes of temperature (especially elevated temperature) will degrade battery life and may result in the battery failing to deliver the specified capacity before the cycle life requirement or the warranty period have been reached. In addition, the life of a Lithium ion battery is degraded if it maintained at high states of charge (especially at elevated temperatures) and experiences infrequent discharge activity. If the application requires that the battery be maintained at high state of charge at elevated temperature then Accutronics can modify the charge regime to promote improved battery life. Such modifications usually result in a reduction in initial battery capacity which must be catered for in runtime requirements. Batteries which are returned within the warranty period and which exhibit poor performance due to regular exposure to elevated temperatures will not be accepted by Accutronics as valid warranty returns.

3.8.3 Fuel Gauge Accuracy

The fuel gauge within the battery uses both coulomb counting and the impedance tracking algorithms to calculate remaining battery capacity. Applications that operate full charge and discharge cycles or applications that have significant rest periods between charge and discharge allow the fuel gauge to make regular and accurate adjustments to the capacity prediction. Applications which keep the battery in high state of charge and have little or no discharge or rest activity may not allow the fuel gauge to update its battery capacity predictions and as a result, battery fuel gauge information may become unreliable. As part of the development and verification process the customer should satisfy themselves that the battery fuel gauge provides sufficient accuracy for their application requirements, either through empirical testing in the device or by providing Accutronics with specific use cases that can be verified as part of the battery verification process. Batteries which are returned within the warranty period and that exhibit poor fuel gauge accuracy will not be accepted by Accutronics as valid warranty returns unless they have had their use cases verified.

3.9 Warranty

A high quality standard is maintained by Accutronics Limited. All products are warranted against defects in design, workmanship, material and construction. The warranty period is 12 months from the date of shipment from Accutronics Limited (indicated by date code on the battery label).

4 SMART ELECTRONICS MODULE

4.1 Overview of Operation

The electronics embedded within the battery comprise four interconnected elements:

(i) An MSP430 microcontroller capable of communicating with host or the charger through the System Management Bus (SMBus), the fuel gauge and other ancillary electronics.

(ii) A Texas Instruments BQ34Z100 fuel gauge featuring impedance track fuel gauging technology which continuously analyses the battery impedance, resulting in superior gas-gauging accuracy.

(iii) 2nd level protection implemented with a Texas Instruments BQ77910 self-contained battery-protection and cell-balancing solution.

(iv) 3rd Level hardware protection against cell overvoltage implemented by three Texas Instruments BQ29410 devices that provide a high-accuracy precision overvoltage detector with programmable detection time.

4.1.1 LCD / State-of-Charge Indication

The battery displays the remaining capacity via a 5-segment LCD indicator. Each LCD segment represents 20 percent of the full charge capacity. The LCD pattern definition is given in Figure 3 below. If any cell falls below 2.0V there will be no LCD indication as the battery will be forced into shutdown. Recovery is only possible by connection to a charger.

During charging, the appropriate segment will flash on and off. Once the upper percentage of that charge is reached, that segment will become steady. As charging continues, the segment above it will begin to flash.

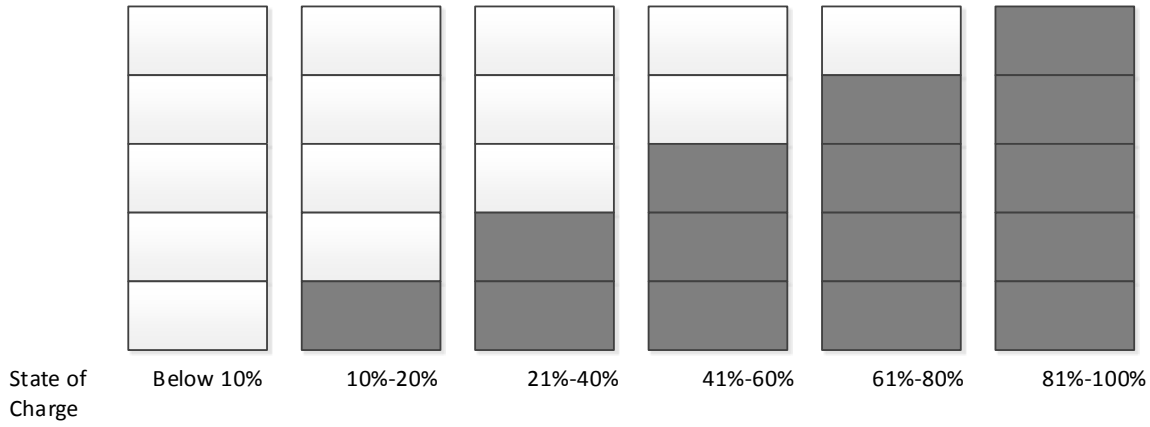

Figure 3 – State-of-Charge Indication

4.1.2 Block Diagram

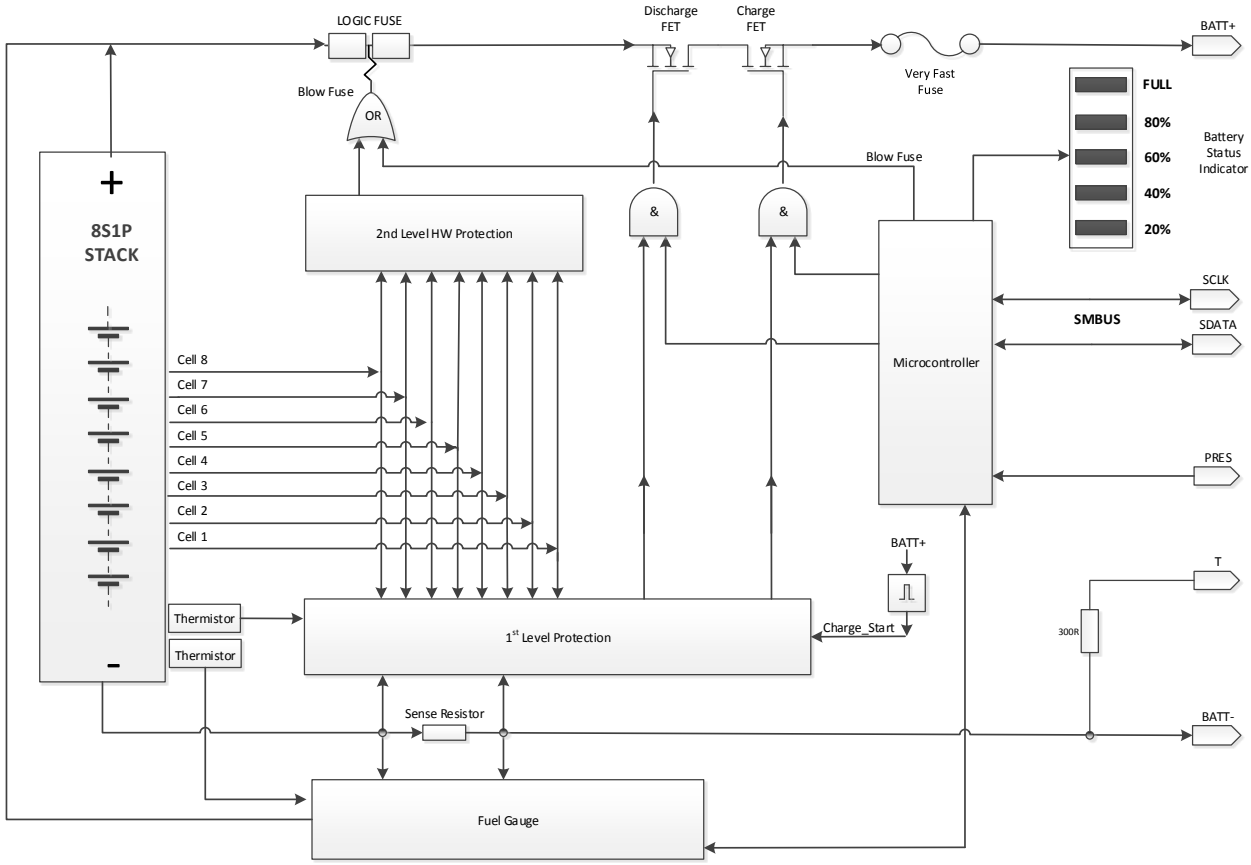

Figure 4 - Battery Pack Electronics Block Diagram

4.2 Measurement of Voltage, Current & Temperature

4.2.1 BQ34Z100 – Fuel Gauge

The BQ34Z100 impedance track fuel gauging technology continuously analyses battery impedance which results in superior gas-gauging accuracy.

Within the battery, the BQ34Z100 communicates with an MSP430 microcontroller via a single wire HDQ bus line. The MSP430 communicates with the host device or charger via SMBus.

4.2.2 System Present (PRES#) Pin

The battery includes a system present input on the connector (PRES#). This signal is used by the fuel gauge to indicate when it has been inserted into a system. This pin needs to be connected to the battery –ve or 0V signal inside the host.

The fuel gauge samples the PRES# input approximately once every second.

When the battery is removed from the system the PRES# pin will go high and the fuel gauge will switch off the charge and discharge MOSFETs and enter sleep mode.

4.2.3 SDATA and SCLK Pins

The physical layer for the SMBus is achieved by an I^2C compatible Interface using SDATA and SCLK available to the user host to communicate with the battery module.

4.2.4 THERM Pin

A 300 Ω 100mW resistor to BATT- provides the user host with a Battery_Fitted signal.

4.3 SMBus and SBD Parameters

4.3.1 Overview of Operations

The battery SMBus is compliant with the System Management Bus Specification, Revision 2.0 according to [1].

The battery SBD Parameters is compliant with the Smart Battery Data Specification, Revision 1.1.a according to [2] and [3].

The battery is compliant with the Smart Battery Charger Specification, Revision 1.1 according to [4].

4.3.2 Communication Protocol

The battery pack SMBus Interface complies with SBS Specification Version 1.1. A host processor uses the interface to access various battery pack registers.

The interface uses a command-based protocol, where the host processor sends the battery address command byte to the battery pack. The command directs the battery pack to either store the next data received to a register specified command byte or output the data specified by the command byte.

The Bus Host communicates with the battery pack using one of three protocols:

- Write Word
- Read Word
- Read Block

Refer to the SMBus specification version 2.0 (reference [1]) for further protocol details.

Host to Battery Message (Slave Mode)

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

Function	Command Code	Description	Unit	Access	Default (POR)
ManufacturerAccess()	0x00			r/w	-
RemainingCapacityAlarm()	0x01	Remaining Capacity Alarm Threshold.	mAh or 10mWh	r/w	255mAh
RemainingTimeAlarm()	0x02	Remaining Time Alarm Threshold.	minutes	r/w	10
BatteryMode()	0x03	Battery Operational Modes.	Bit flags	r/w	0x0081
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	-
AverageCurrent()	0x0b	Returns a one minute rolling average of the current flowing into or out of the battery	mA	r	-
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	-
AbsoluteStateOfCharge()	0x0e	Returns the predicted remaining battery capacity expressed as a percentage of DesignCapacity().	percent	r	-
RemainingCapacity()	0x0f	Returns the predicted remaining battery capacity.	mAh	r	-
FullChargeCapacity()	0x10	Returns the predicted battery capacity when fully charged.	mAh	r	-
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	2500
ChargingVoltage()	0x15	Returns the battery's desired charging voltage.	mV	r	33600
BatteryStatus()	0x16	Returns the battery's status word.	Bit flags	r	-
CycleCount()	0x17	Returns the number of charge/discharge cycles the battery has experienced.	cycles	r	0
DesignCapacity()	0x18	Returns the theoretical capacity of the new battery.	mAh	r	2550
DesignVoltage()	0x19	Returns the theoretical voltage of a new battery.	mV	r	28800
SpecificationInfo()	0x1a	Returns the version number of the SBDS the battery pack supports, as well as voltage and current scaling information. (v1.1 with PEC)	Formattedword	r	0x0031
ManufacturerDate()	0x1b	Returns the date the electronics was manufactured.	Formattedword	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. (Max 20 characters)	string	r	ACCUTRONICS
DeviceName()	0x21	Returns a character array that contains the battery's name. (Max 20 characters)	string	r	CMX810M
DeviceChemistry()	0x22	Returns a character array that contains the battery's chemistry.	string	r	LION
ManufacturerData()	0x23	Returns data specific to the manufacture.		r	-
Authenticate	0x2f	SHA-1 authentication	String	r/w	-

Table 4 - Host-to-Battery Messages

4.3.3 Battery to Charger Messages (Master Mode)

The battery, acting in the role of a bus master, uses the write word protocol to communicate with the charger, operating in slave mode. If the CHARGER_MODE bit in BatteryMode() is clear, the Battery will broadcast Charger request information at 10-second intervals.

Function	Command Code	Description	Unit	Access
ChargingCurrent()	0x14	Sends the desired charging rate to the battery charger	mA	W
ChargingVoltage()	0x15	Sends the desired charging voltage to the battery	mV	W

Table 5 - Battery-to-Charger Messages

4.3.4 Critical Messages (Master Mode)

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 broadcasts the AlarmWarning() message at 10 second intervals until the critical condition(s) has been corrected.

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

Table 6 - Battery Critical Messages

Hex	Battery Status	Status	Definition
8000	OVER_CHARGED_ALARM	ON	Battery is being charged beyond the maximum overcharge limit
		OFF	There is over 2mAh of continuous discharge
4000	TERMINATE_CHARGE_ALARM	ON	Battery is requesting 0 ChargingCurrent() and the charger continues to supply current.
		OFF	When either condition is removed.
1000	OVER_TEMP_ALARM	ON	During Charge: >55°C / During Discharge: >75°C
		OFF	During Charge: <50°C / During Discharge: <70°C
800	TERMINATE_DISCHARGE_ALARM	ON	During discharge when the battery RSOC <6%
		OFF	When RSOC is >8%
200	REMAINING_CAPACITY_ALARM (User settable)	ON	Battery detects that its RemainingCapacity() is less than that set by the RemainingCapacityAlarm().
		OFF	Either the value set by the RemainingCapacityAlarm() is lower than the RemainingCapacity() OR when the RemainingCapacity() in increases by charging the battery.
100	REMAINING_TIME_ALARM (User settable)	ON	Battery detects that the estimated remaining time at the present discharge rate is less than that set by the RemainingTimeAlarm().
		OFF	Either the value set by the RemainingTimeAlarm() is lower than the AverageTimeToEmpty() OR when the AverageTimeToEmpty() in increases by charging the battery.

Table 7 - Alarm Bit Definitions

Hex	Battery Status	Status	Definition
80	INITIALIZED	ON	Always
		OFF	
40	DISCHARGING	ON	Battery “Current()” is not positive
		OFF	Battery “Current()” is positive
20	FULLY_CHARGED	ON	When the battery is being charged and ”Current()” declines ≤ 50mA for >80s and “Voltage()” ≥ (ChargingVoltage() - 0.3V)
		OFF	When the SOC of the battery declines 5% from the “FULLY_CHARGED” detection point.
10	FULLY_DISCHARGED	ON	Battery RSOC ≤ 3%
		OFF	Battery RSOC ≥ 5%

Table 8 - Status Bit Definitions

4.3.5 Full_Charge_Capacity And Relative_State_Of_Charge Updates

The BQ34z100 fuel gauge device acquires and updates the battery-impedance profile during normal battery usage. It uses this profile, along with state-of-charge and the Qmax values, to determine FullChargeCapacity (FCC) and RelativeStateOfCharge (RSOC) specifically for the present load and temperature.

See the Texas Instruments Theory and Implementation of Impedance Track Battery Fuel-Gauging Algorithm in BQ34Z100 Product Family application report (SLUA364B) for further details.

4.3.6 Max Error

This read-word function returns an unsigned integer value of the expected margin of error, in %, in the state-of-charge calculation, with a range of 1% to 100%.

Max error is incremented internally by 0.05% for every increment of CycleCount after the last QMAX update. MaxError is incremented in the display by 1% for each increment of CycleCount.

Event	MaxError Setting
Full reset	Set to 100%
QMAX and Ra table update	Set to 1%
QMAX update	Set to 3%
Ra table update	Set to 5%

Table 9 - Max Error Events

4.3.7 SHA-1 Authentication

SHA-1 authentication is available on custom versions of the battery. Please contact us to discuss.

4.4 Protection Electronics

Level	Description	Protection Type
1st	MSP430 and BQ34Z100 Pack Monitoring	MOSFETS
2nd	BQ77910 - direct control Cell Monitoring	MOSFETS
3rd	BQ34Z100 via MSP430F5308 Pack Monitoring	Logic Fuse
	BQ29410 – direct control Cell Monitoring	
4th	PCB SM Single blow Fuse	Fast Blow Fuse
	PCB Logic Fuse	Logic Fuse

Table 10 – Protection Levels

4.4.1 MSP430 and BQ34Z100 – 1st Level Protection

The MSP430F5308 Microcontroller in conjunction with the Fuel Gauge IC, monitors current, voltage and temperature and if activated, will switch off the charge and discharge MOSFETs after 2-3 seconds of fault detection. 1st Level parameters are generally associated with whole pack monitoring and are set lower than 2nd level parameters.

Fault	FET Action	MSP430 and BQ34Z100 FET Control	Time	
Over Voltage (any cell)	Open CHG FET	>4300	2-3s	mV
Under Voltage (pack)	Open DSG FET	<22000	2-3s	mV
Over Temperature (CHG/DSG)	Open both FETs	>55 (CHG) / >75 (DSG)	2-3s	°C
Under Temperature (CHG)	Open both FETs	<0	2-3s	°C
Under Temperature (DSG)	Open both FETs	<-25	2-3s	°C
Discharge Over Current	Open DSG FET	>11500	2-3s	mA
Charge Over Current	Open both FETs	>3200	2-3s	mA

Table 11 – 1st Level Protection Parameters

Note: the term "1st Level Protection" and "2nd Level Protection" are simply recognised labels associated with that function. It is not necessarily the hierarchical order in which they will operate. Therefore if the criteria described in 4.4.2 occurred but the criteria described in 4.4.1 remained satisfactory, then the 2nd Level Protection would operate first.

The BQ34Z100 follows the JEITA guidelines which specify charge current dependent on temperature. The device requires four parameters for temperature JT1 to JT4. These define three distinct temperature ranges. Refer to Texas JEITA guidelines document SLUU387A.

In addition to JT1 to JT4 there is Charge Inhibit which prevents charge commencement.

Also either side of the JEITA charge rate profile are 2 charge preventers for very low and very high temperatures.

Charge inhibit prevents charge commencing and charge suspend halts charging whilst in progress.

< CHG_SUS	< CHG_INH	>JT1 & <JT2 JT2	>JT2 & <JT3 JT3	>JT3 & <JT4	> CHG_INH	> CHG_SUS
		Temp Range 1	Temp Range 2	Temp Range 3		
-5°C	0°C	1 -> 10°C	10 -> 45°C	45 -> 55°C	56°C	65°C
Suspend	Inhibit	Low Temp Charge	Normal Temp Charge	High Temp Charge	Inhibit	Suspend
0mA	0mA	100% of Charge Current	100% of Charge Current	25% of Charge Current	0mA	0mA

A hysteresis of 1°C is implemented between ranges.

Table 12 - Charge Characteristics Over Temperature

4.4.2 BQ77910 - 2nd Level Protection

The BQ77910 precision protector is a complete stand-alone, self-contained battery-protection and cell-balancing device intended for Li-ion/polymer battery packs.

The BQ77910 constantly monitors cell voltage, current and temperature to check they are within defined limits. Activation delays and recovery methods for each safety condition are factory set in non-volatile memory.

The precision protector device has a thermistor input that measures the cell pack temperature and is strategically located accordingly. It requires initial configuration of the EEPROM via an I^2C port from a computer.

A shorted-thermistor fault also puts the device into low-power / fault protection mode.

An under temperature fault is indistinguishable from an open-thermistor fault and has the same protection mechanism i.e. enter protection state but stay awake.

Temperature monitoring redundancy is provided by the BQ77910 (2nd level protection) and the BQ34Z100 (fuel gauge). Both monitor the cell pack temperature via separate thermistors.

The full conditions for 2nd level protection, are as follows:

Fault	FET Action	BQ77910 Hardware FET Control	Time	
Discharge Over Current	Open DSG FET	>18000	31ms	mA
Discharge Short-Circuit Current	Open DSG FET	>20000	900µs	mA
Charge Short-Circuit Current	Open both FETs	>10000	960µs	mA
Any cell Under Voltage	Open both FETs CHG FET closed when CHGR detected	<2000	2s	mV

Table 13 – 2nd Level Protection Parameters

Note: the term "1st Level Protection" and "2nd Level Protection" are simply recognised labels associated with that function. It is not necessarily the hierarchical order in which they will operate. Therefore if the criteria described in 4.4.2 occurred but the criteria described in 4.4.1 remained satisfactory, then the 2nd Level Protection would operate first.

4.4.3 MSP430 and BQ34Z100 – 3rd Level Protection (#1)

Using the same mechanism as the 1st Level Protection, the 3rd level monitors the Power Fail / Over Current condition (set to 20A) and will activate within 2-3 seconds. However unlike 1st and 2nd level switching off just the MOSFETs, if the 3rd level activates, then the chemical Logic Fuse will be blown open circuit (which is irreversible).

Fault	Logic Fuse Action	MSP430 and BQ34Z100 Software Control	Time	
Pack Over Temperature	Blow open circuit	>85	3-4s	°C
Charge FET fault		>20	3-4s	mA
Discharge FET fault		>20	3-4s	mA

Table 14 – 3rd Level Protection Parameters (SW)

4.4.4 BQ29410 – 3rd Level Hardware Protection (#2)

The BQ29410 is a secondary overvoltage protection device for multi-cell lithium-ion battery packs that incorporates a high-accuracy precision overvoltage detection circuit. It includes a programmed in delay circuit for an overvoltage detection time of ~300ms.

Each cell in a multiple-cell pack is compared to an internal reference voltage. If one cell reaches an overvoltage condition, the protection sequence begins. The BQ29410 device starts a programmable timer. When the timer reaches its programmed value an output is set which then initiates the chemical Logic Fuse to blow open circuit (which is irreversible).

Fault	Logic Fuse Action	BQ29410 Hardware Control	
Any Cell Over Voltage	Blow open circuit	>4300	mV

Table 15 – 3rd Level Protection Parameters (HW)

4.4.5 Over-Current – 4th Level Protection

Should an over-current typically of 70A be sustained for ≈1 seconds then the on-board 25A will blow open circuit (non-reversible).

The Logic Fuse described in the 3rd Level Protection, also provides a 4th Level Protection. It is capable of permitting short-period peaks of up to typically 100A.

Previous levels of protection should have activated, so these fuses are a final fail-safe mechanism and non-recoverable requiring return to the manufacturer.

Fault	Fuse Action	Fast Blow Fuse	Logic Fuse	Time	
Over Current (CHG or DSG)	Blows open circuit permanently	≈70	≈100	1s	mA

Table 16 – 4th Level Protection Parameters

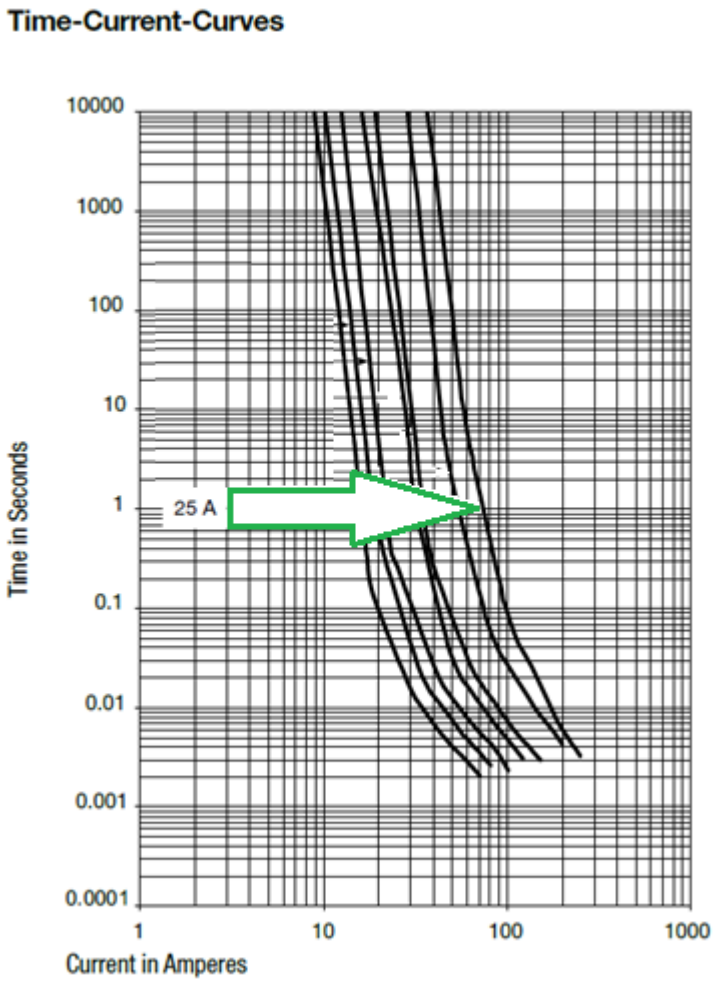

Figure 5 – Time-Current-Curves for Fast Blow Fuse

5 MECHANICAL SPECIFICATIONS

5.1 Case

The cells and electronics are housed in an injection moulded plastic case. The casing material meets the flammability requirements of UL94V-0 at the minimum wall thickness.

The case colour is Traffic White (RAL9016).

The overall dimensions of the battery are 170.5mm (±0.2mm) x 85.0mm (±0.2mm) x 28.0mm (±0.2mm).

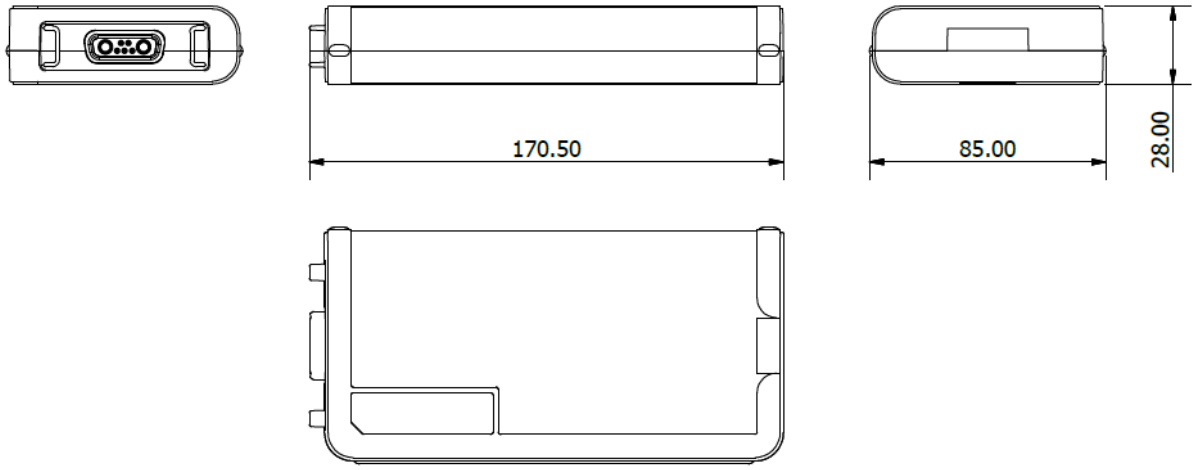

Figure 6 - Battery Dimensions

5.2 Weight

The typical weight is ~530g

5.3 Ingress Protection Rating

The battery has an ingress protection rating of IP41.

- Level 4 (solids)
  Ingress protected against a solid object with a diameter or thickness greater than 1.0mm, such as wire or thin strips.
- Level 1 (liquids / moisture)
  Protected against dripping water or condensation.

5.4 Label Details

The battery is fitted with two labels. The larger label carries all static information. Text and logos are black. The information on the larger label comprises:

- Logo: “Entellion”
- Text: “CMX810M Rechargeable Lithium Ion Battery”
- Text: “28.8V 2.55Ah 73.4Wh”
- Text: “Lithium ion rechargeable battery. Charge only with a SMBus compliant level 2 or 3 charger. Charge before use. Do not open, crush, heat above 80°C or dispose of battery in fire or short circuit - may ignite, explode, leak or get hot causing personal injury. Follow manufacturer’s instructions. Replace battery with same part number only. Use of another battery may present a risk of fire or explosion. Keep away from children. 0% Hg, 0% Cd, 0% Pb. Must be recycled or disposed of properly. Recycle facilities may not be available in all areas.”
- Text: “Avertissement: Batterie de Lithium-Ion rechargeable. Charger uniquement avec un chargeur conforme aux spécifications SMBus de niveau 2 ou 3. Charger avant utilisation. Ne pas ouvrir, écraser, chauffer au-dessus de 80°C, jeter dans un feu ni court-circuiter la batterie – risque de mise à feu, explosion, fuite ou surchauffe, qui pourrait causer des blessures corporelles. Suivre les instructions du fabricant. Remplacer la batterie seulement avec une batterie portant la même référence. L’utilisation d’une batterie différente peut présenter un risque d’incendie ou d’explosion. Ne pas laisser à la portée des enfants. 0% Hg, 0% Cd, 0% Pb. Doit être recyclée ou éliminée selon les règles. Des installations de recyclage peuvent ne pas être disponibles dans toutes les régions.”
- Text “Cette batterie remplit les exigences de test spécifiées dans les Recommendations sur le Transport des Marchandises Dangereuses, Manuel d’Epreuves et de Critères. Cette batterie remplie les exigences de la IEC 62133.”
- Text: “Fabriquée au Royaume Uni par Accutronics Ltd.”
- Text: “Battery designed & manufactured in the UK by Accutronics Ltd. To re-purchase visit www.accutronics.com”
- Text: “This battery meets the requirements of testing specified in the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria. This battery meets the requirements of IEC 62133.”
- Text: “8INR19/66”
- Symbol: Crossed out Wheelie Bin
- Symbol: ‘Japan Only’ Mobius Loop
- Symbol: Taiwanese Recycle symbol
- Symbol: China ‘5’ symbol (China RoHS)
- Symbol: CE Symbol
- Symbol: UL Listed (Canadian and US harmonised) with file number E485881 displayed underneath.

The label is shown in Figure 7.

Figure 7 - Battery Label

A second, smaller, silver polyester label carries the dynamic information relating to the revision and manufacture date of the battery. It is placed in a recess on the rear of the battery and measures 14mm x 50mm. The information on the label comprises:

(i) Text: “Part Number: 46A051AJ00008”.

(ii) Text: “Date of Manufacture: YYWW” (where YY is the year and WW is the ISO week number).

(iii) Text: “Revision: SW-aaa-xx-yy-zz - HW-bbb” where

aaa = Firmware revision (if firmware revision is 1.1, aaa = 011)

xx = Fuel Gauge revision (if revision is 1, xx = 01)

yy = 2nd Level Protection revision (if revision is 2, yy = 02)

zz = Accutronics config revision (if firmware revision is 3, zz = 03)

bbb = General assembly drawing revision (if drawing revision is D = bbb = 004)

(iv) Text: “Serial Number: NNNNN”. (where NNNNN is the battery electronic serial number).

(Note the Label serial number is a decimal, the SMBus serial number (when requested) is in hex.)

The label is shown in Figure 8.

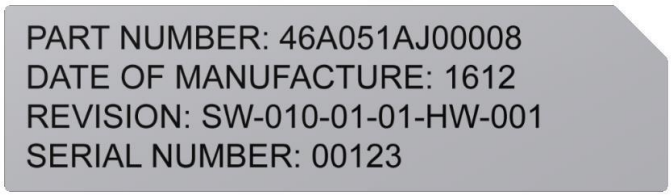

Figure 8 - Battery Label 2

6 PACKAGING

The battery is placed into an anti-static bag and then packaged in an individual white card carton. The outside of the carton is labelled with a white paper label that shows the part number, description, voltage, capacity, energy and date of manufacture (YYWW).

Ten cartons are placed inside an outer carton, for multiple shipping purposes.

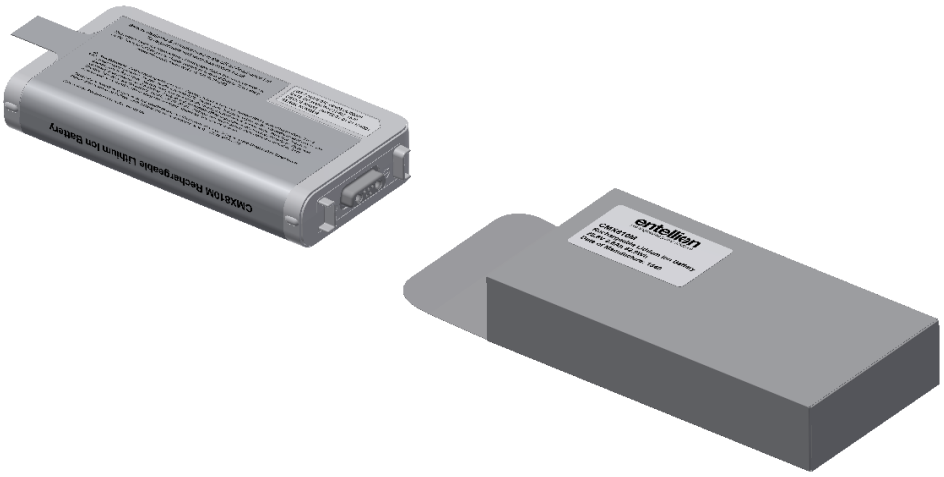

Figure 9 - Battery Individual Packaging

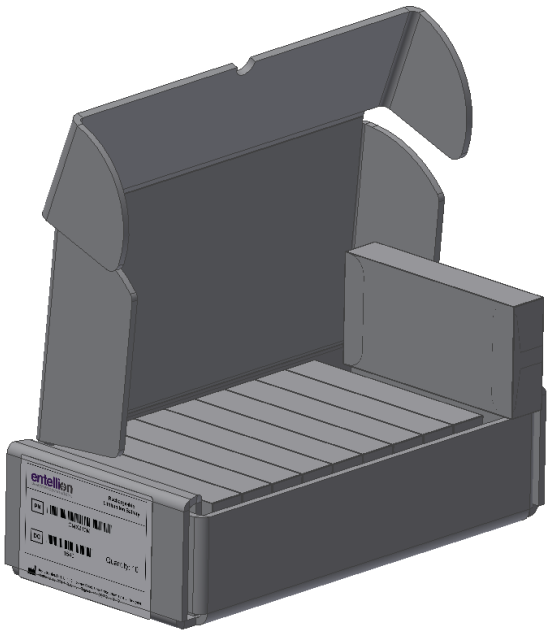

Figure 10 – Outer Carton

7 ENVIRONMENTAL/SAFETY SPECIFICATIONS

7.1 Transportation

The battery meets the requirements of testing specified in the third edition of the Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria (ST/SG/AC.10.11/Rev. 5).

7.2 UL 62133

The battery is certified to UL 62133 (plis CAN CSA E62133:13 for Canada).

7.3 IEC 62133

The battery meets the requirements of IEC 62133:2012 Second Edition (Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications).

7.4 Directives

The battery meets the requirements of Directive 2006/66/EC of the European Parliament and of the Council of 6 of September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.

7.5 Electro-Magnetic Compatibility

The battery meets the intent of the EMC Directive. Compliance was demonstrated by conformance to the following standards which have been listed in the Official Journal of the European Communities. EMC: Emissions EN55022:1998 +A1:2000 +A2:2003, Immunity EN55024:1998 +A1:2001 +A2:2003.

7.6 Restriction of Hazardous Substances (RoHS)

No RoHS banned materials are used (as per the Europa Chemical Candidate List). The battery meets the requirements of the RoHS Recast (RoHS2) *Directive 2011/65/EU* and original RoHS *Directive 2002/95/EC*.

7.7 Waste Electrical and Electronic Equipment (WEEE)

The battery is compliant with the *Waste Electronic & Electrical Equipment Regulations 2006 (UK) and* meet the requirements of the Waste Electronic & Electrical Equipment Directive (*2002/96/EC*, Amendment *2003/108/EC* and Recast *2012/19/EU*).

7.8 Registration, Evaluation, Authorisation & Restriction of Chemicals (REACH)

The battery is compliant with the *Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) - EU directive 1907/2006*. No substances as per the European chemical Candidate List (at the time of this specification document) are present in the battery or used during its manufacture.

7.9 CE Marking

Compliance with applicable EMC, RoHS and RoHS2 directive permits the battery to be CE Marked.

8 BATTERY PRODUCTION REQUIREMENTS

8.1 Quality Management System

Accutronics is certified to a recognised Quality Management System standard (ISO9001:2008 and ISO13485:2003 apply) for the design, manufacture, test and sale of battery products.

8.2 Battery Production Testing Requirements

8.2.1 PCBA

The PCBA is manufactured in accordance with IPC-A-610E class III. Accutronics shall ensure that the PCBA used within the battery has been fully functionally tested by the PCBA supplier. A test plan shall be created. Test records shall be maintained for traceability purposes.

8.2.2 Battery

As part of the assembly process, Accutronics shall ensure that the electronics within the battery function correctly:

(i) The fuel gauge is programmed correctly.
(ii) The fuel gauge temperature, current and voltage measurements are accurate.

Once assembled, the battery is subjected to a ‘burn in’ test which involves a full cycle of the battery. Once cycled the accuracy of the fuel gauge and the performance of the cells during the cycle are validated. Test records are maintained for traceability purposes.

9 ACCUTRONICS CONTACT DETAILS

Please contact Accutronics for customer service or technical assistance:

Customer Service Telephone: +44 (0) 1782 566688
Customer Service email sales@accutronics.co.uk
Technical Support email tech@accutronics.co.uk
Website www.accutronics.co.uk