REVISIONS	
REV	DESCRIPTION
G	Release Per EC080509

Battery Hardware Specification
PB520 PB540 PB560

Table of Contents

1.0 INTRODUCTION

1.1 Purpose

This document provides the electrical and mechanical specification for the internal battery used in the PB500 series of ventilators.

1.2 Scope

This specification describes the physical, functional and electrical requirements for the Lithium Ion Rechargeable batteries for the PB520, PB540, PB560.

2.0 REVISION HISTORY

Revision	Date	Author	Change Description
A	02 Jun 08	[redacted]	Initial Release of specification
B	24 Jul 08	[redacted]	Add cell manufacturer name
C	09 Oct 08	[redacted]	Update specification
D	20-Jan-2009	[redacted]	Incorporate modifications from Verification Review.
E	22-Apr-2009	[redacted]	Add cells supplier. Remove [redacted] diode protection. Update mechanical specifications
F	See Agile	[redacted]	Add 520 and 560 models to footer Title of document. Add additional cells supplier to section 3.1. Add additional case and end cap materials to section 3.26. Updated weight requirement for 71SP in section 3.31. Updated label requirements in section 3.35. Added Cert of Compliance requirements in section 4.0. Added memory details for new cell in section 5.0. Added ESD Protection requirements in section 6.0.
G	See Agile	[redacted]	Add a line to the HRD memory map on Appendix A to state “The manufacturer code is for eeprom programming only. Refer to the battery label for manufacturer details" Change the battery dimension width (section 3.24) to 34.00 (+/-0.25mm) from 34.5 (+ 0.5/-0.8mm) to ensure a better fit as a tolerance analysis has shown that the batteries are manufactured at the lower end of the tolerance. Update sec 3.35 with new [redacted] part numbers as follows: Product code (PT00053438 to the 7S2P or PT00053439 to the 7S1P) + Rev

2.1 PB540 & PB560 Battery

The battery consists of fourteen Lithium Ion rechargeable cells, assembled in a 7 series / 2 parallel (7S 2P) configuration. Each cell has an average voltage of 3.6V and a typical capacity of 2400mAh giving a battery of 25.2V and 4800mAh typical.

2.2 PB520 Battery:

The battery consists of seven Lithium Ion rechargeable cells, assembled in a 7 series / 1 parallel (7S1P) configuration. Each cell has an average voltage of 3.6V and a typical capacity of 2400mAh giving a battery of 25.2V and 2400mAh typical.

Protection is provided for over-charge, over-discharge and short circuit.

3.0 Requirements

3.1 Technology

HWSBAT1 The battery shall use rechargeable Lithium Ion cells:

- [redacted] 18650 A3 2.4Ah
OR
- [redacted] ICR18650-24E.2.4Ah
OR
- [redacted] Energy ICR-18650J

Warning: It's forbidden to mix different cells.

3.2 Configuration :

HWSBAT2 The 7S2P battery shall include 14 cells (7 cells in series, 2 in parallel).
HWSBAT3 The 7S1P battery shall include 7 cells (7 cells in series, 1 in parallel).

3.3 Nominal voltage:

HWSBAT4 The nominal voltage for the battery shall be 25.2V.

3.4 Maximum voltage (fully charged state)

HWSBAT5 The Maximum operating battery voltage shall not exceed 29.4V +/- 1%.

3.5 Minimum battery voltage (fully discharge state)

HWSBAT6 The minimum battery voltage shall not be less than 13.44 V. The ventilator will not discharge the battery below 20.75 V +/- 0.25 V.

3.6 Over-charge voltage protection: activation and cancellation

HWSBAT7 The Over-charge voltage protection shall cut the battery charge if the voltage of a cell reaches 4.350V +/- 50 mV (maximum 30.8V per battery) with an activation delay of 1 s +/- 700 ms.
HWSBAT8 The Over-charge voltage protection shall be cancelled and allow battery charging when cell voltages drop to 4.150V +/- 50 mV (maximum 29.4V per battery).

3.7 Over-discharge voltage protection activation and cancellation

HWSBAT9 The Over-discharge voltage protection shall prevent battery use (discharge) if the voltage of a cell drops to 2.0V ± 80mV. (The worst case condition would be all cells at maximum charge with one cell low as follows: ((29.4/7)*6 + 2) V per battery when only one cell is lower than 2V). The activation delay shall be 100ms ±70ms.
HWSBAT10 The Over-discharge voltage protection shall be cancelled and allow battery use (discharge) when a charger is connected and the cells are charged to 2.7V ±100mV.

3.8 Battery Capacity:

HWSBAT11 The 7S2P battery shall have a nominal capacity of 4.8 Ah +/-10%.
HWSBAT13 The 7S1P battery shall have a nominal capacity of 2.4 Ah +/-10%.
Note: Charge @29.4V, 1A, during 6h, 23°C +/-2°C, no rest, discharge @1A until 19.25V or battery cut-off.

3.9 Max Output current (Discharge current)

HWSBAT15 The maximum output current allowed shall be 3A during 10 minutes (maximum), start-up peak: 20 A / 1ms.

3.10 Maximal input current limit

HWSBAT16 The battery charge current shall be less than 1.5A

3.11 Over-Current protection 1

HWSBAT17 The Over-Current protection 1 shall suppress current peaks:
Peaks >6A +/- 1.5A
Peaks >10ms +/-7ms
RC Filtered with a time constant of 5ms +/- 2 ms.

3.12 Over-Current protection 2

HWSBAT18 The Over-Current protection 2 shall suppress discharge current peaks:
Peaks >15A +/- 6A
Peaks >1ms +/-0.6ms
RC Filtered with a time constant of 5ms +/-2 ms.

3.13 Over-Current protection 3

HWSBAT19 The Over-Current protection 3 shall suppress discharge current peaks:
Peaks >60A +/- 36A
Peaks >350µs +/- 250µs
A RC Filtered with a time constant of 1ms +/-0.4ms can be used.

3.14 Discharge temperature

HWSBAT20 The operating temperature range of the battery during discharge shall be 0°C to +50°C.

3.15 Charge temperature

HWSBAT21 The operating temperature range of the battery while charging shall be 0°C to +45°C

3.16 Thermal Protection 1

HWSBAT22 The battery shall include an internal thermal fuse which will be blown when the battery internal temperature exceed 93°C +2°c / -7°C. This protection is irreversible.

3.17 Thermal Protection 2

HWSBAT23 The battery shall include a thermal fuse located on battery board that will be blown when the battery circuit temperature exceed 126°C +/- 5°C. This protection is irreversible.

3.18 Storage temperature

HWSBAT24 The storage temperature range of the battery shall be -40°C to +70°C. See appendix 2.

3.19 Operating RH

HWSBAT25 The operating and storage humidity range of the battery shall be 10 to 95% HR.

3.20 Atmospheric Pressure

HWSBAT26 The operating and storage atmospheric pressure range of the battery shall be 600 to 1100 hPa.

3.21 Shock & vibration

HWSBAT27 The battery shall satisfy the following vibration constraints:
IEC68.2.27 Shock: 100G, 6ms, 3 successive shocks per axis in both directions, ½ sine wave.
IEC 68.2.6 Sinusoidal vibration: 1g, 10 cycles of sweeping per axis (thus 2h of endurance per axis) of 10Hz to 500Hz.
IEC 68.2.34 Random vibration: 0.02g²/Hz, of 20 to 500Hz, test duration of 9minutes/axis.

3.22 Temperature measurement

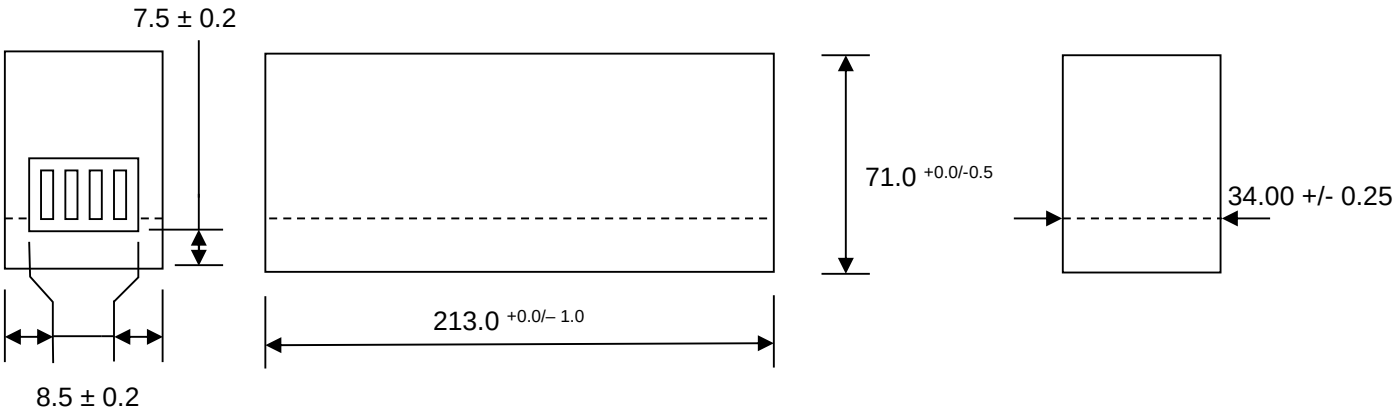
HWSBAT28 The Internal battery temperature shall be measured by a thermistor NTC 10KOhm – 1% - B3435 located internal to the battery.

3.23 Memory

The battery shall include a DS2431 memory (Dallas).
HWSBAT29 The memory access (write read) shall be performed through one wire connected to on MEM pin of connector.
HWSBAT30 The default information shall be loaded then protected by the supplier in page 0 of the memory.
HWSBAT31 The memory page 1, 2 and 3 shall be available in read / write access.
HWSBAT32 The battery shall be supplied in a programmed state.
The data to be stored are detailed in Appendix 1.

3.24 Dimensions

HWSBAT33 The battery shall have the following dimensions: 213.0mm (+0/-1.0mm) * 34.00mm (+/- 0.25mm) * 71.0mm (+0/-0.5mm).



3.25 Operational Positions

HWSBAT34 The battery shall be capable of operating in any position.

3.26 Case Material

HWSBAT35 The battery case shall be constructed with a combination of an extruded anodized aluminium body with injection ABSUL 94 VO PC molded caps.
OR
The battery case shall be constructed entirely with ABSUL 94 VO PC.
OR
The battery case shall be constructed from an extruded, black anodised aluminium body with coloured ABS/PC UL 94V-0 injection moulded end caps.

Color:
HWSBAT36 The 7S2P battery end caps and/or case color shall be: RAL5005 or RAL5010 (blue).
HWSBAT37 The 7S1P battery end caps and/or case color shall be: RAL7047 (grey).

3.27 Case sealing

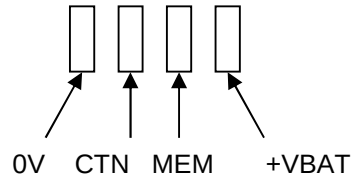
HWSBAT38 The battery case shall be sealed by gluing or screwing by 6 screws.

3.28 IP number

HWSBAT39 The battery shall comply with IP 31.

3.29 Interface Connector

HWSBAT40 The battery connector shall be: Bourns 704D with 4 contacts.



3.30 Internal components materials

HWSBAT41 The overall design shall comply with UL 60601-1 "Medical Electrical Equipment Part 1: General Requirements for Safety» 25-Apr-2003 and directives 2002/95/CE (RoHS), which implies:
PCB shall comply with UL796 17-Apr-2006 or recognised ZPMV2
Electrical wiring shall comply with UL83/UL758 24-Apr-2006 or recognised AVLV2
Connectors shall comply with UL486 15-Nov- 2003 or recognised ZMW2
Cells shall comply with UL 1642 19-Sep-2005.

3.31 Weight

HWSBAT42 The battery weight shall be < 1 kg for 7S2P.

HWSBAT43 The battery weight shall be < 0.55kg for 7S1P.

3.32 Battery Life

The battery inside the application shall support 300 full charge/discharge cycles without loosing more than 20% of its original capacity when full charged.

3.33 Maintenance

HWSBAT45 The battery shall not require preventative maintenance.

3.34 Transport

HWSBAT46 The battery shall conform to IATA (International Air Transport Association).

3.35 Labeling

HWSBAT47
A label shall be fixed under the connector and will carry the following info:

- Polarity indicators " - " & " +" in front of pins 0V & +Vbat unless already molded into the plastic.
- Name of manufacturer
- Cell technology
- Nominal Voltage of battery
- Nominal Capacity of battery
- Watt-hour rating of battery
- Recycling symbol of waste unless already molded into the plastic or present on a separate label.

- product code (2970500 to the 7S2P or 2970600 to the 7S1P) + Rev

  OR product code (2982400 to the 7S2P or 2982500 to the 7S1P) + Rev

  OR product code (PT00053438 to the 7S2P or PT00053439 to the 7S1P) + Rev

- Year & week of manufacturing.
- The following text: **Caution: Danger of explosion if battery is incorrectly replaced.**

Replace only with the same type recommended by the manufacturer.
Dispose of used batteries according to the manufacturers instructions.
DO NOT: open battery, dispose of in fire or short circuit.

The following optional information may be included on the label:

- Unique 6 digit serial number
- Revision of manufacturers specification

4.0 Certificate of Conformance

A Certificate Of Conformance is required.

5.0 Appendix 1 – Memory Specification

ADDRESS	VALUE	COMMENTS	
0x00	0x41	Character 'A'	AIROX identification coded by 5 characters
0x01	0x49	Character 'I'	
0x02	0x52	Character 'R'	
0x03	0x4F	Character 'O'	
0x04	0x58	Character 'X'	
0x05	0xXX	Character n°1	Supplier's battery identification coded by 3 characters. NOTE: The manufacturer code is for eeprom programming only. Refer to the battery label for manufacturer details
0x06	0xXX	Character n°2	
0x07	0xXX	Character n°3	
0x08	MSB_CAPACITE	MSB_CAPACITY = capacity / 256 LSB_CAPACITY = capacity modulo 256 Example to a 4.4Ah battery MSB_CAPACITY = 17 = 0x11 LSB_CAPACITY = 48 = 0x30	Nominal battery capacity in mah
0x09	LSB_CAPACITE		
0x0A	YEAR	Year of manufacture e.g. : for 2006 YEAR = 6 = 0X06	Unique identification of the battery by date of manufacture by 6 bytes This date will be generates by an internal clock in the programmer It will be loaded into battery automatically and not manually from this clock in order to guarantee the uniqueness of the battery ID.
0x0B	MONTH	Month of manufacture e.g. : for November MONTH = 11 = 0x0B	
0x0C	DAY	Day of manufacture e.g. : for 25th DAY = 25 = 0x19	
0x0D	HOUR	Hour of manufacture e.g. : for 13 hrs HOUR = 13 = 0x0D	
0x0E	MINUTE	Minute of manufacture e.g. : for 56 MINUTE = 56 = 0x38	
0x0F	SECOND	Second of manufacture e.g. : for 45 SECONDE = 45 = 0x2D	

ADDRESS	VALUE	COMMENTS
0x10	0xXX Cells type	Cells Manufacturer/type 0x00: LG 18650 A3 2.4Ah. 0x01: SAMSUNG ICR18650-24E.2.4Ah 0x02: MOLI ICR-18650J 2,4Ah
0x11	0x00	Not Used. Initialisation at 0 before protection
0x12	0x00	Not Used. Initialisation at 0 before protection
0x13	0x00	Not Used. Initialisation at 0 before protection
0x14	0x00	Not Used. Initialisation at 0 before protection
0x15	0x00	Not Used. Initialisation at 0 before protection
0x16	0x00	Not Used. Initialisation at 0 before protection
0x17	0x00	Not Used. Initialisation at 0 before protection
0x18	0x00	Not Used. Initialisation at 0 before protection
0x19	0x00	Not Used. Initialisation at 0 before protection
0x1A	0x00	Not Used. Initialisation at 0 before protection
0x1B	0x00	Not Used. Initialisation at 0 before protection
0x1C	0x00	Not Used. Initialisation at 0 before protection
0x1D	0x00	Not Used. Initialisation at 0 before protection
0x1E	0x00	Not Used. Initialisation at 0 before protection
0x1F	0x00	Not Used. Initialisation at 0 before protection
0x20	Ageing	Not programmed by the supplier.
0x21	MSB Impedance	Not programmed by the supplier.
0x22	LSB Impedance	Not programmed by the supplier.
0x23	MSB Discharge Cycle	Not programmed by the supplier.
0x24	LSB Discharge Cycle	Not programmed by the supplier.
0x25	First Battery use	Not programmed by the supplier.

After verifying values written in page N°0 of the DS2431 memory, it will be necessary to protect this last one writing 0x55 to the address 0x80.

Caution: The protection is not reversible

The other memory pages will not be protected thus the bytes contained in the addresses 0x81 to 0x87 inclusive will not be modified and different to 0x55 or 0xAA.

6.0 ESD Protection

ESD Protection: **The PCB includes suitable components to protect function against ESD events. The functionality shall be tested and verified by Airox (Covidien) in accordance with IEC61000-4-2**

Appendix 2 – Storage protocol

The battery must comply with storage and transport conditions as described in IEC 60 601 Article 10.1.

The test conditions are described below.

CHART 1 - Thermal Conditioning

One cycle shown. Repeat for a total of two cycles.

Note: Time scale is not linear. Humidity uncontrolled up to Hour 31.