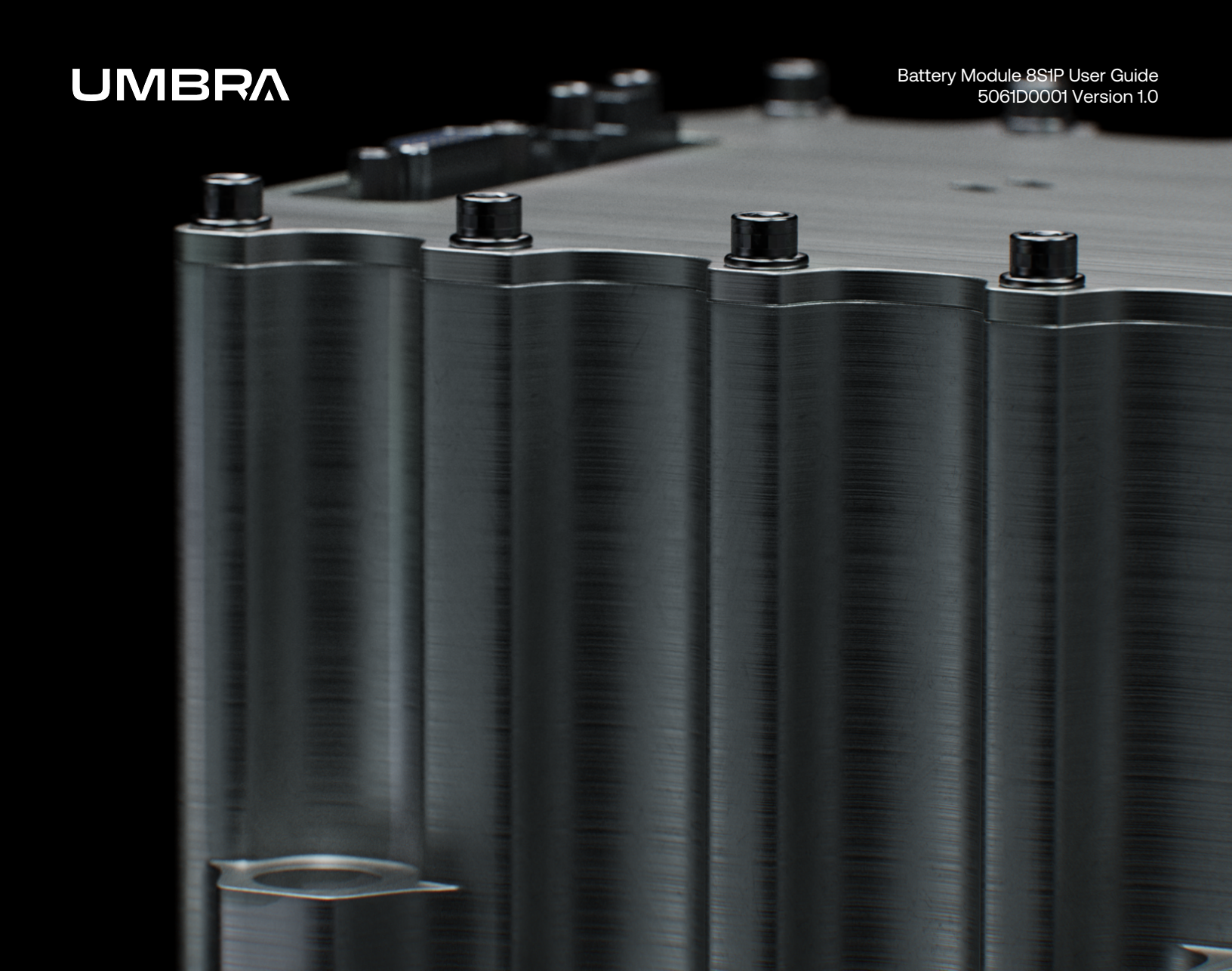
Battery Module User Guide

8S1P	8S2P
8-Cell Model	16-Cell Model

Click to quick navigate



Battery Module 8S1P User Guide

Distribution Statement	Export Control
No Restrictions	No US Export Control Information

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Figures

Tables

1.0 Objective

This document provides user guidance for the integration of the Umbra Battery Module 8S1P.

The Umbra Battery Module 8S1P is a battery module with eight lithium-ion battery cells in 8S1P configuration.

2.0 Document References

This section contains the document number and description for documents that are referenced herein.

2.1 Umbra Documents

5061H15000	8S1P BATTERY MODULE MICD

2.2 Standard Documents

ANSI/ESD S20.20-2021	PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES, AND EQUIPMENT
49 CFR B.1.C	CODE OF FEDERAL REGULATIONS: HAZARDOUS MATERIALS REGULATIONS
GSFC-STD-7000	GENERAL ENVIRONMENTAL VERIFICATION STANDARD (GEVS)
MIL-STD-461	MILITARY STANDARD: ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS REQUIREMENTS FOR EQUIPMENT
AS22759	WIRE, ELECTRICAL, FLUOROPOLYER-INSULATED, COPPER OR COPPER ALLOY
AS50881	WIRING, AEROSPACE VEHICLE
UN 38.3	UNITED NATIONS RECOMMENDATIONS ON THE TRANSPORT OF DANGEROUS GOODS: LITHIUM METAL AND LITHIUM ION BATTERIES

3.0 Document Authority

In the case of a conflict between any dimensional, mounting pattern, or pinout information defined within this document and other information sources, the released mechanical and electrical drawings in Appendix B shall supersede this document.

3.1 Revision Notes

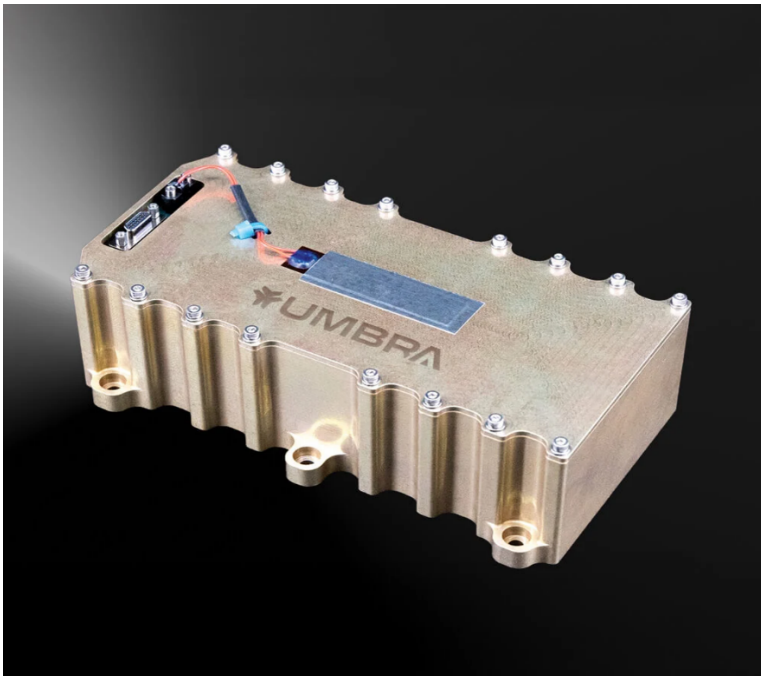
This document is Version 1.0.

3.2 Document Disclaimer

DISCLAIMER: This User Guide is intended to provide a brief summary of our knowledge and guidance regarding the use of this item. The information contained herein has been compiled from sources considered by Umbra Lab, Inc. to be dependable and is accurate to the best of the Company's knowledge. It is not meant to be an all-inclusive document on worldwide hazard communication regulations. This information is offered in good faith. Each user of this material needs to evaluate the conditions of use and design the appropriate protective mechanisms to prevent employee exposure, personal injury, property damage or release to the environment of any hazardous substances. Umbra Lab, Inc. assumes no responsibility for injury, damage, or loss sustained by the recipient or third persons or for any damage to any property resulting from misuse of the product. Purchase and use of the product(s) identified herein are governed by the terms of sale under which you purchase the product(s) from Umbra Lab, Inc.

4.0 Hardware Handling

Figure 1. Umbra Battery Module 8S1P



4.1 Mechanical Handling

The Lithium-Ion batteries contained in the Umbra Battery Module are volatile. Failure to read and follow the instructions contained in this User Guide may result in damage to the module, operators, and other property if stored, charged, or used improperly.

Contact Umbra if any Umbra Battery Module fails any procedure as described in this document. Do not recharge or continue use of any Umbra Battery Module with any suspected damage, including damage resulting from fire.

Ensure that any transportation of the Umbra Battery Module occurs in an environment described in Section 4.5 Storage and Transport Environment.

Umbra recommends users monitor the Umbra Battery Module throughout the charging process to ensure batteries are properly charged, including taking voltage readings periodically throughout the process. Do not overcharge the Umbra Battery Module. Only charge the Umbra Battery Module in a 10 °C to 45 °C environment.

Do not drop the Umbra Battery Module. Only lift Umbra Battery Modules by the chassis.

Always use a charger meeting the requirements described in this document to charge any Umbra Battery Module. Failure to do so may cause fire or damage the Umbra Battery Module, which may result in personal injury and property damage.

Do not disassemble the Umbra Battery Module.

4.1.1 Hazards

4.1.1.1 Hazardous Materials

The Umbra Battery Module 8S1P contains lithium-ion cells, which are considered hazardous materials. Customer shall follow all regulations for handling, disposal, transport, and any additional regulations relevant to Lithium batteries as pertains to their specific use case. Lithium cells are subject to the DOT's Hazardous Materials Regulations (HMR; 49 CFR Parts 171–180), and Umbra battery modules have been certified for transport under UN 38.3 testing.

Each Umbra Battery Module 8S1P is considered UN3481 equipment and must be transported safely per DOT regulations for equipment with this classification. See 4.5 Storage and Transport Environment for Umbra recommendations for transport of Umbra Battery Module 8S1P in addition to all safety requirements for UN3481 equipment.

4.1.1.2 Fire Hazards

Always have sufficient fire extinguishing agent available for emergency use. Always have a fireproof container available to store the Umbra Battery Module in case of fire. Only trained and qualified personnel should fight a Lithium-Ion fire.

If at any point a user witnesses the battery module leak smoke, swell up, or catch fire, immediately discontinue charging and usage then disconnect the battery and observe it in a safe place for at least 15 minutes. Touching the battery module with bare hands while in this failure mode may lead to injury. Observation should occur outside, away from any combustible material.

After this observation period, the Umbra Battery Module may become combustible again. Trained personnel should move the battery module to a fireproof container when safe to do so. The Umbra Battery Module should not be used after this failure mode is observed.

4.1.2 ESD Sensitivity

The Umbra Battery Module is electrostatic discharge (ESD) sensitive.

Failure to follow ESD requirements and recommendations may result in damage to components and/or personnel injury.

Follow ANSI/ESD S20.20 while handling ESD sensitive components.

4.1.3 Unpacking

- Check shock detection stickers
- Remove from protective case
- Perform visual inspection for damage
- Take pictures as received
- No cleanliness requirements or contamination risks

4.2 RBF/ Red Tag GSE

Items listed in

Table 1. RBF Items must be removed before flight.

Table 1. RBF Items

Item	Critical / Optional	Notes
Connector Dust Cap	Critical	Protects connector interface from debris on the ground

See Appendix B for more information.

4.3 Electrical Mate/Demate

Table 2. Electrical Connectors

Connector Designator	Assembly Connector	Mating Flight Connector
J1	MMDP-015	MMDS-015

The Umbra Battery Module will contain live batteries. Adequate precautions to prevent current flow on mating should be taken at all times.

See Section 5.1 Connector Pinouts for more information.

4.4 Connector Strain

It is recommended to secure all harnessing interfacing to the Umbra Battery Module per the guidance found in SAE-AS50881 which describes guidance on the installation of wiring harness.

4.5 Storage and Transport Environment

Do not store in direct sunlight.

Do not store in such a way that damages part markings.

Ensure that critical RBF components are in place during all transport of the Umbra Battery Module.

Store the Umbra Battery Module with heater side UP to prevent damage to the system.

Table 3. Recommended Storage Environment

Parameter	Value
Storage State of Charge	To maximize service life, store the Umbra Battery Module at a charge level between 40% charge to 90% charge.
Storage Temperature	-20°C to 50°C
Humidity	< 50% Relative Humidity
Maximum Storage Lifetime	10 years. See Section 8.4 On-Orbit Checkout for additional notes on depth of discharge.

4.6 Operating Environment

Table 4. Operating Environment

Parameter	Value
Operating Temperature (Charge)	10°C to 45°C
Operating Temperature (Discharge)	-20°C to 60°C

4.7 Survival Environment

Table 5. Survival Environment

Parameter	Value
Survival Temperature:	-20°C to 60°C
Random Vibration	Qualified to 14.16 Grms profile enveloping GEVS, Falcon 9, SpaceX Rideshare, and Electron levels
Shock	Qualified to 1000 g peak profile enveloping GEVS, Falcon 9, SpaceX Rideshare, and Electron levels
Minimum Survivable Total Ionizing Dose	Designed to withstand at least 30 krad TID

4.8 Mounting Information

See Appendix B for information on mounting the Umbra Battery Module 8S1P.

5.0 Electrical Properties

Table 6. Electrical Properties

Property	Typical Value	Notes
Operating Voltage Range	26.5 ± 4.5 V	Nominal Voltage: 28 V
Energy Capacity	125 Wh	4.25 Ah
Idle Power Draw	0 W	Heaters off
Maximum Power Draw	9.7 W	Heaters at maximum
Maximum Discharge Rate	12.5 A	

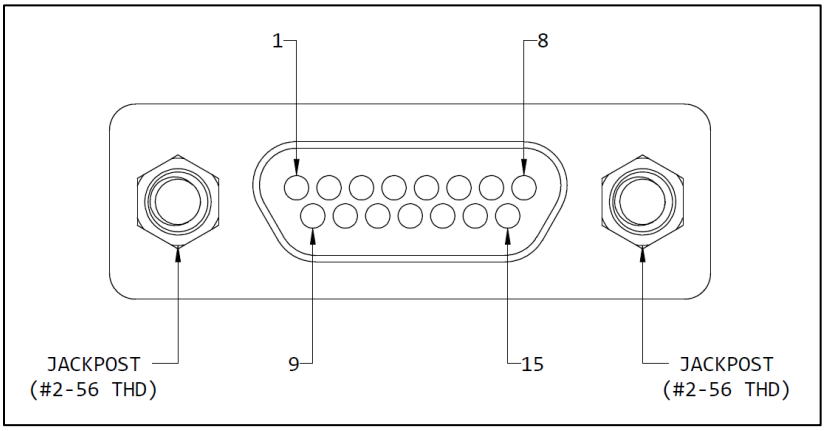
5.1 Connector Pinouts

The Umbra Battery Module J1 connector (MMDP-015) is described in Appendix B. Refer to Table 7 for pinout and Figure 2 for the mating face view.

Table 7. J1 Connector Pinout

PIN	SIGNAL
1	THERM P
2	THERM N
3	HEATER P
4	HEATER N
5	GND
6	POWER SUPPLY
7	POWER SUPPLY
8	POWER SUPPLY
9	GND
10	GND
11	GND
12	GND
13	POWER SUPPLY
14	POWER SUPPLY
15	POWER SUPPLY

Figure 2. MMDP-015 Connector Mating Face View



The assembly connector's body is not electrically connected to GND. The harness connector body and backshell should be isolated from GND as well – they will be electrically bonded to the assembly connector's body through the mating jackposts and jackscrews.

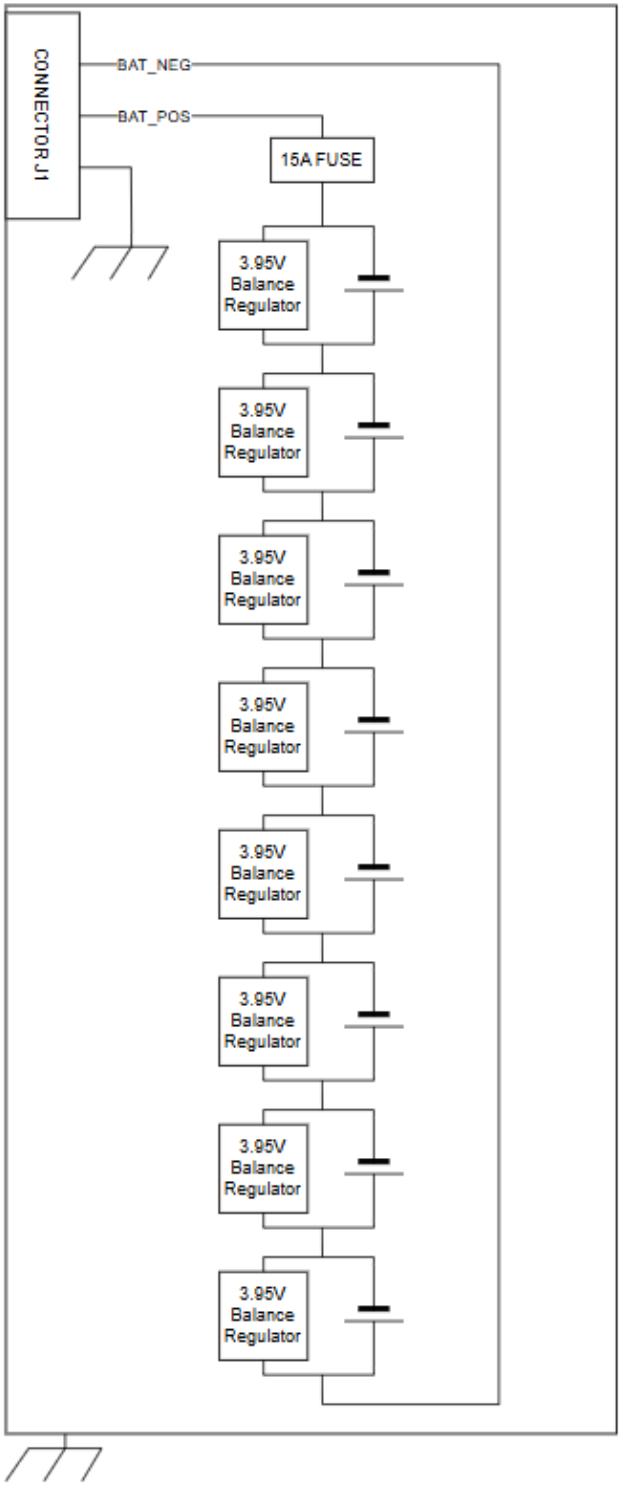
5.2 Harnessing Recommendations

Harnesses connecting to the Umbra Battery Module should use mating connector Female Socket MMDS-015 to connect to the connector described in Section 5.1 Connector Pinouts.

Space-rated harnesses connecting to the Umbra Battery Module should use wire conforming to SAE AS22759. Umbra recommends 24AWG wire.

5.3 Grounding Diagram

Figure 3. Umbra Battery Module 8S1P Electrical Block Diagram



5.4 EMI/EMC Properties

The Umbra Battery Module 8S1P has not been tested for Electromagnetic Interference (EMI) / Electromagnetic Compatibility (EMC) per MIL-STD-461. It has been successfully tested for self-compatibility with X-Band, S-Band, and L-Band radios. Contact Umbra for more information.

5.5 Material Properties

All Umbra components are manufactured from materials deemed space-rated based on low outgassing. See Appendix B for more information on material properties of the Umbra Battery Module 8S1P.

6.0 Software Properties

Not applicable.

7.0 Performance Specifications

7.1 Charge Balancing

Charge balancing systems ensure that battery cells within a system maintain the same state of charge (SOC). This ensures that a SOC reading from a battery system also applies to the individual battery cells within the system. Since each individual battery cell must remain within its safe charging range to maintain lifetime and allow for discharge without damage, cell balancing increases the lifetime of the battery system. This is especially important when using lithium-ion batteries due to the volatility of this failure mode with this battery chemistry.

The Umbra Battery Module includes a shunt regulator type cell balancing management system. In the 8S1P configuration, this system ensures that each of the eight batteries in series remain at the same voltage. Parallel cells naturally balance to the cells in series through their direct connection.

In the Umbra Battery Module cell balancing system, when additional power reaches the battery module while the SOC has reached its maximum safe threshold, the energy is shunted to heat. The Umbra Battery Module is not rated for overcharge protection safety, so users should take care to ensure that the voltage supplied to the Umbra Battery Module is within the limits noted in Table 6. Electrical Properties.

Cell unbalance within safety limits can occur. To rebalance all cells, charge the battery module to full state of charge.

7.2 Thermal Management

The Umbra Battery Module includes an onboard heater and resistance temperature detector (RTD). If voltage is provided to the heater as described in the Section 5.1 Connector Pinouts, the heater will activate.

7.2.1 Heater Information

Table 8. Heater Information

Property	Typical Value
Heater Part Number	HK6901
Heater Rating	NASA qualified, low outgassing
Heater Nominal Voltage	19.5 V
Heater Max Voltage	39.0 V
Heater Nominal Wattage	7.9 W
Heater Max Wattage	15.7 W

7.2.2 RTD Information

Table 8. RTD Information

Property	Typical Value
RTD Part Number	B57230V2103F260
RTD Nominal Resistance	10 kΩ at 25°C

7.3 Umbra Power Package Compatibility

The Umbra Battery Module 8S1P can be purchased as part of the modular Umbra Power Package, with the Umbra Power Management Unit included. See documentation on the Umbra Power Management Unit for more details about compatibility with this system.

7.4 Performance Verification

Customer recommended checkout and qualification testing is described in this document in the Section 8.0 Operational Procedures

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8.0 Operational Procedures

Follow all requirements and recommendations in Section 4.1 Mechanical Handling while carrying out all procedures in this section. The Umbra Battery Module may be damaged by carrying out any procedure listed in this section if mechanical handling requirements and recommendations are not followed.

8.1 Ground Support Equipment

To ensure operator and equipment safety, ensure Ground Support Equipment (GSE) follows the recommendations laid out in this section.

8.1.1 Charger Requirements

Umbra recommends the use of a qualified battery charger before integration with any payload. Ensure the charger is lithium-ion chemistry compatible. Ensure battery charger connector matches Section 5.2 Harnessing Recommendations before use. Umbra recommends the use of a battery charger capable of monitoring charge current and charge state voltage.

8.1.2 Thermal Sensor Recommendations

Umbra recommends the use of a monitoring circuit to take advantage of the internal temperature sensor. Alternatively, customers may use an external thermal camera or contact temperature sensor during all ground charging operations to monitor shunt heating of the Umbra Battery Module. The temperature sensor should measure the top of the Battery Module chassis for most accurate reading.

8.2 First Use Procedure

The following must be completed before any other procedures in this user guide are carried out.

8.2.1 Assembly

No customer assembly required.

8.2.2 Checkouts

Ensure there are no signs of lithium-ion battery damage upon receipt of the Umbra Battery Module. Check connectors and heater for damage before powering on.

8.2.3 Initial Configuration

The Umbra Battery Module will be shipped in a partially charged state to preserve cell lifetime.

8.3 Battery Charging Procedure

The objective of this procedure is to charge the Umbra Battery Module 8S1P.

8.3.1 Success Criteria

Measured cell voltage shall be 30.5 V ± 0.5 V.

8.3.2 Configuration and Equipment

This procedure shall be carried out with the following equipment in the listed configurations and quantities.

Table 9. Battery Charging Procedure

Part Number	Part Name	Configuration	Quantity
5061H0001	Umbra Battery Module	Charge State < 90%	x1
N/A	Battery Charger	8.1.1 Charger Requirements	x1
N/A	Temperature Sensor	8.1.2 Thermal Sensor Recommendations	Optional

8.3.3 Test Procedure

Overcharging the Umbra Battery Module 8S1P may result in damage to the module, operator harm, and/or fire. Ensure all safety recommendations in Section 4.0 Hardware Handling are followed as best practices throughout this procedure.

1. Connect the Umbra Battery Module 8S1P to the Battery Charger using a connector compatible with the Battery Module connector.
2. If available, monitor the charging process with a temperature sensor. The temperature sensor should measure the top of the Battery Module chassis for most accurate reading.
3. If the Battery Charger is capable of monitoring charge, record initial voltage reading if available. This charge voltage should be as stated in 8.2.3 Initial Configuration at first receipt of the battery module.
4. Begin charging if needed. Charging is considered to be complete when monitored voltage no longer rises, at a reading of 30.5 V ± 0.5 V.
5. Do not touch the battery module once measured voltage reaches 30.5 V ± 0.5 V. See Section 7.1 Charge Balancing for information on how additional energy is converted to heat.
6. Disconnect the charger, still careful to avoid touching the potentially hot surface of the battery modules.
7. Allow the cells to rest for at least 5 min to dissipate heat and reach their final SOC.
8. If desired, measure the final cell voltage.

8.4 On-Orbit Checkout

8.4.1 Depth of Discharge

Umbra recommends maintaining Umbra Battery Module 8S1Ps at a state of charge of 40% to 90% to preserve capacity to over 3.3 Ah over 600 cycles.

8.4.2 Multiple Module Usage

If multiple Umbra Battery Module 8SPs are connected in series, each module should have a similar current draw.

Appendix A

Acronyms and Abbreviations

A.1 Acronyms and Abbreviations

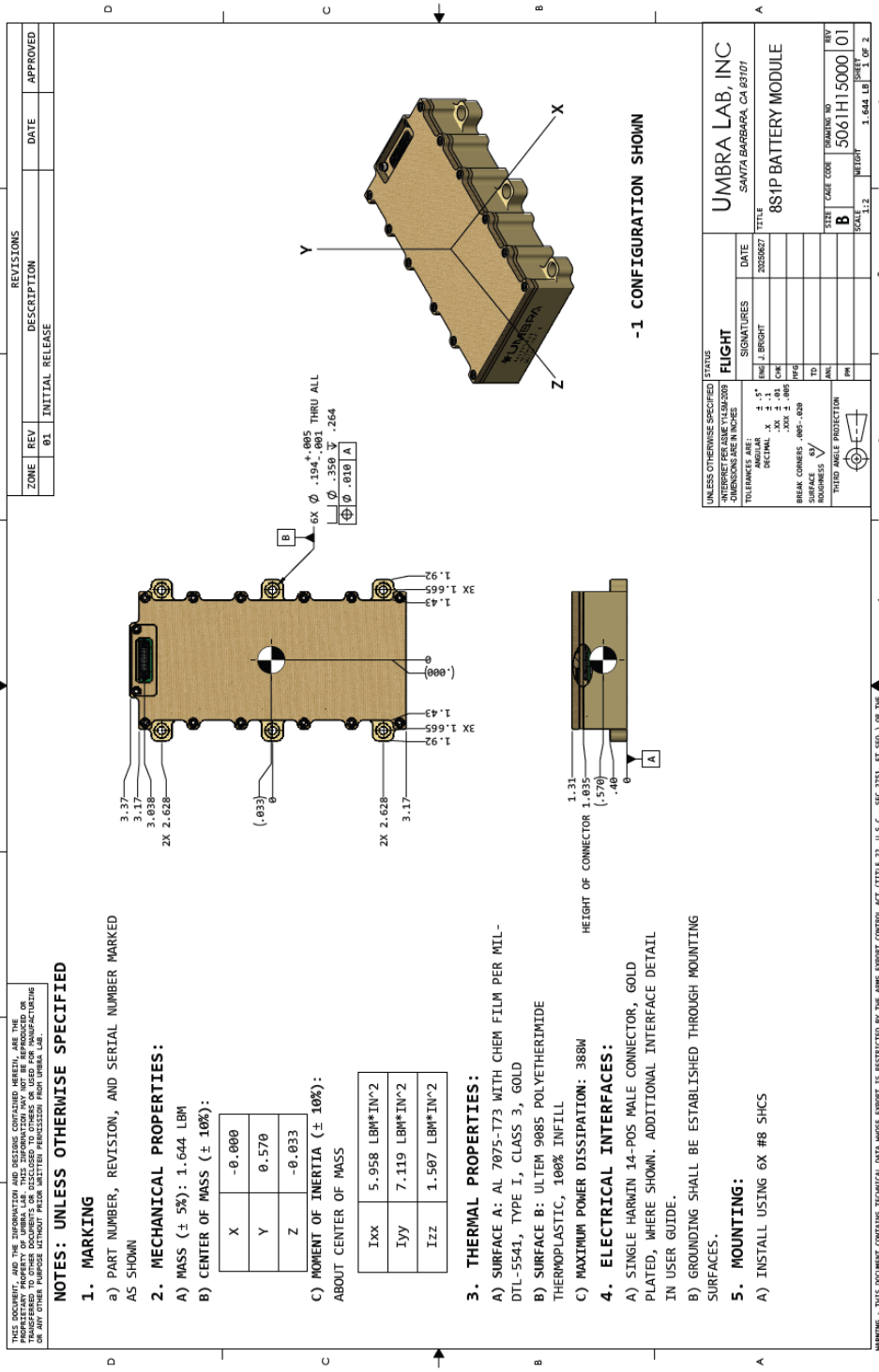
DOT	Department of Transportation
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
GEVS	General Environmental Verification Standard
GND	Ground
GSE	Ground Support Equipment
HMR	Hazardous Materials Regulations
N/A	Not Applicable
RBF	Remove Before Flight
RTD	Resistance Temperature Detector
SOC	State of Charge

A.2 Units

°C	Degrees Celsius
A	Ampere
Ah	Ampere Hours
Grms	root mean square acceleration
Hz	Hertz
kΩ	Kiloohms
krad	Kilorad
min	Minutes
ms	Millisecond
V	Volts
VAC	Volts Alternating Current
W	Watts
Wh	Watt Hours

Appendix B

Mechanical Interface Control Documentation



Battery Module 8S2P User Guide

Distribution Statement	Export Control
No Restrictions	No US Export Control Information

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1.0 Objective

This document provides user guidance for the integration of the Umbra Battery Module 8S2P.

The Umbra Battery Module 8S2P is a battery module with sixteen lithium-ion battery cells in 8S2P configuration.

2.0 Document References

This section contains the document number and description for documents that are referenced herein.

2.1 Umbra Documents

5062H16000	82SP BATTERY MODULE MICD

2.2 Standard Documents

ANSI/ESD S20.20-2021	PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES, AND EQUIPMENT
49 CFR B.1.C	CODE OF FEDERAL REGULATIONS: HAZARDOUS MATERIALS REGULATIONS
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3.1 Revision Notes

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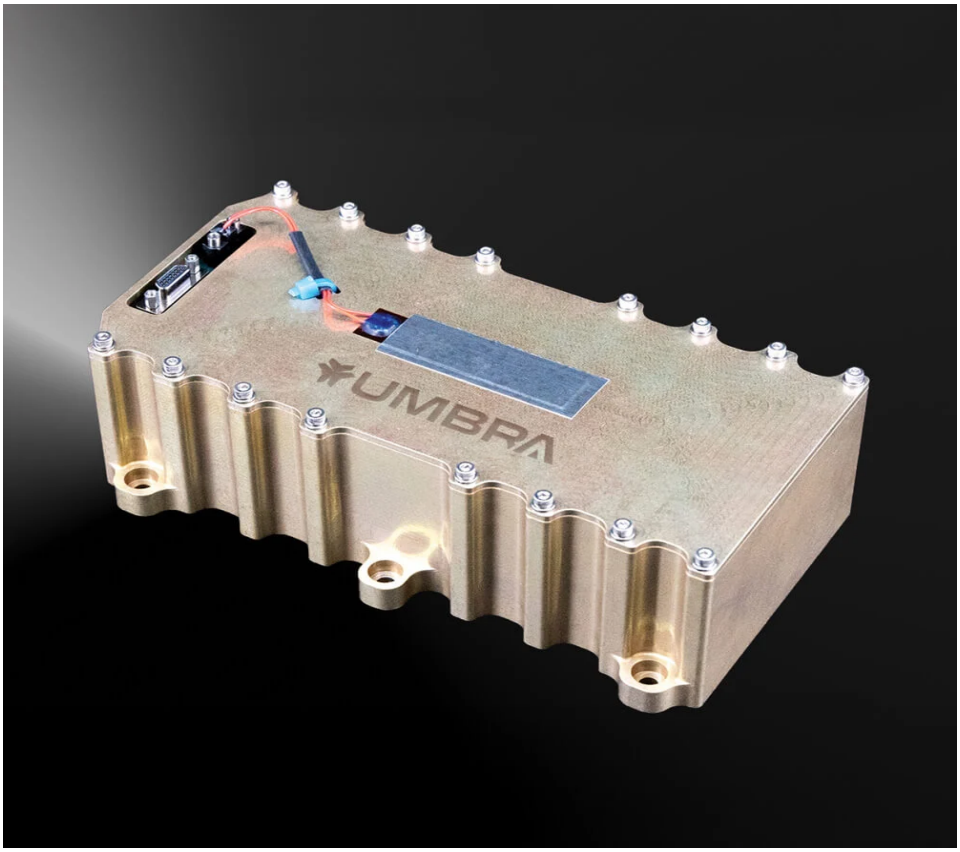
4.0 Hardware Handling

Figure 1. Umbra Battery Module 8S2P



4.1 Mechanical Handling

The Lithium-Ion batteries contained in the Umbra Battery Module are volatile. Failure to read and follow the instructions contained in this user guide may result in damage to the module, operators, and other property if stored, charged, or used improperly.

Contact Umbra if any Umbra Battery Module fails any procedure as described in this document. Do not recharge or continue use of any Umbra Battery Module with any suspected damage, including damage resulting from fire.

Ensure that any transportation of the Umbra Battery Module occurs in an environment described in 4.5 Storage and Transport Environment.

Umbra recommends users monitor the Umbra Battery Module throughout the charging process to ensure batteries are properly charged, including taking voltage readings periodically throughout the

process. Do not overcharge the Umbra Battery Module. Only charge the Umbra Battery Module in a 10 °C to 45 °C environment.

Do not drop the Umbra Battery Module. Only lift Umbra Battery Modules by the chassis.

Always use a charger meeting the requirements described in this document to charge any Umbra Battery Module. Failure to do so may cause fire or damage the Umbra Battery Module, which may result in personal injury and property damage.

Do not disassemble the Umbra Battery Module.

4.1.1 Hazards

4.1.1.1 Hazardous Materials

The Umbra Battery Module 8S2P contains lithium-ion cells, which are considered hazardous materials. Customer shall follow all regulations for handling, disposal, transport, and any additional regulations relevant to Lithium batteries as pertains to their specific use case. Lithium cells are subject to the DOT's Hazardous Materials Regulations (HMR; 49 CFR Parts 171–180), and Umbra battery modules have been certified for transport under UN 38.3 testing.

Each Umbra Battery Module 8S2P is considered UN3481 equipment and must be transported safely per DOT regulations for equipment with this classification. See 4.5 Storage and Transport Environment for Umbra recommendations for transport of Umbra Battery Module 8S2P in addition to all safety requirements for UN3481 equipment.

4.1.1.2 Fire Hazards

Always have sufficient fire extinguishing agent available for emergency use. Always have a fireproof container available to store the Umbra Battery Module in case of fire. Only trained and qualified personnel should fight a Lithium-Ion fire.

If at any point a user witnesses the battery module leak, smoke, swell up, or catch fire, immediately discontinue charging and usage then disconnect the battery and observe it in a safe place for at least 15 minutes. Touching the battery module with bare hands while in this failure mode may lead to injury. Observation should occur outside, away from any combustible material.

After this observation period, the Umbra Battery Module may become combustible again. Trained personnel should move the battery module to a fireproof container when safe to do so. The Umbra Battery Module should not be used after this failure mode is observed.

4.1.2 ESD Sensitivity

The Umbra Battery Module is electrostatic discharge (ESD) sensitive.

Failure to follow ESD requirements and recommendations may result in damage to components and/or personnel injury.

Follow ANSI/ESD S20.20 while handling ESD sensitive components.

4.1.3 Unpacking

- Check shock detection stickers
- Remove from protective case
- Perform visual inspection for damage
- Take pictures as received
- No cleanliness requirements or contamination risks

4.2 RBF/ Red Tag GSE

Item listed in Table 1 must be removed before flight.

Table 1. RBF Items

Item	Critical / Optional	Notes
Connector Dust Cap	Critical	Protects connector interface from debris on the ground

See referenced Appendix B for more information.

4.3 Electrical Mate/Demate

Table 2. Electrical Connectors

Connector Designator	Assembly Connector	Mating Flight Connector
J1	MMDP-015	MMDS-015

The Umbra Battery Module 8S2P contains live batteries. Adequate precautions to prevent current flow on mating should be taken at all times.

See Section 5.1 Connector Pinouts for more information.

4.4 Connector Strain

It is recommended to secure all harnessing interfacing to the Umbra Battery Module per the guidance found in SAE-AS50881 which describes guidance on the installation of wiring harness.

4.5 Storage and Transport Environment

Do not store the Umbra Battery Module in direct sunlight.

Do not store the Umbra Battery Module in such a way that damages part markings.

Ensure that critical RBF components are in place during all transport of the Umbra Battery Module.

Store the Umbra Battery Module with heater side UP to prevent damage to the system.

Table 3. Recommended Storage Environment

Parameter	Value
Storage State of Charge	To maximize service life, store the Umbra Battery Module at a charge level between 40% charge to 90% charge.
Storage Temperature	-20°C to 50°C
Humidity	< 50% Relative Humidity
Maximum Storage Lifetime	10 years. See Section 8.4 On-Orbit Checkout for additional notes on depth of discharge.

4.6 Operating Environment

Table 4. Operating Environment

Parameter	Value
Operating Temperature (Charge)	10°C to 45°C
Operating Temperature (Discharge)	-20°C to 60°C

4.7 Survival Environment

Table 5. Survival Environment

Parameter	Value
Survival Temperature:	-20°C to 60°C
Random Vibration	Qualified to 14.16 Grms profile enveloping GEVS, Falcon 9, SpaceX Rideshare, and Electron levels
Shock	Qualified to 1000 g peak profile enveloping GEVS, Falcon 9, SpaceX Rideshare, and Electron levels
Minimum Survivable Total Ionizing Dose	Designed to withstand at least 30 krad TID

4.8 Mounting Information

See Appendix B for information about mounting the Umbra Battery Module 8S2P.

5.0 Electrical Properties

Table 6. Electrical Properties

Property	Typical Value	Notes
Operating Voltage Range	26.5 ± 4.5 V	Nominal Voltage: 28 V
Energy Capacity	250 Wh	8.5 Ah
Idle Power Draw	0 W	Heaters off
Maximum Power Draw	9.7 W	Heaters at maximum
Maximum Discharge Rate	12.5 A	

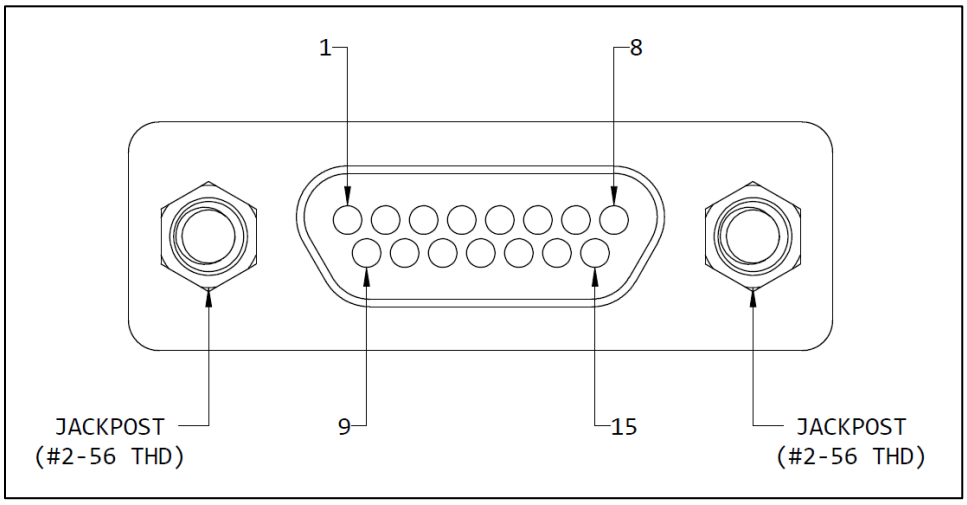
5.1 Connector Pinouts

The Umbra Battery Module J1 connector (MMDP-015) is described in Appendix B. Refer to Table 7 for pinout and Figure 2 for the mating face view.

Table 7. J1 Connector Pinout

PIN	SIGNAL
1	THERM P
2	THERM N
3	HEATER P
4	HEATER N
5	GND
6	POWER SUPPLY
7	POWER SUPPLY
8	POWER SUPPLY
9	GND
10	GND
11	GND
12	GND
13	POWER SUPPLY
14	POWER SUPPLY
15	POWER SUPPLY

Figure 2. MMDP-015 Connector Mating Face View



The assembly connector's body is not electrically connected to GND. The harness connector body and backshell should be isolated from GND as well – they will be electrically bonded to the assembly connector's body through the mating jackposts and jackscrews.

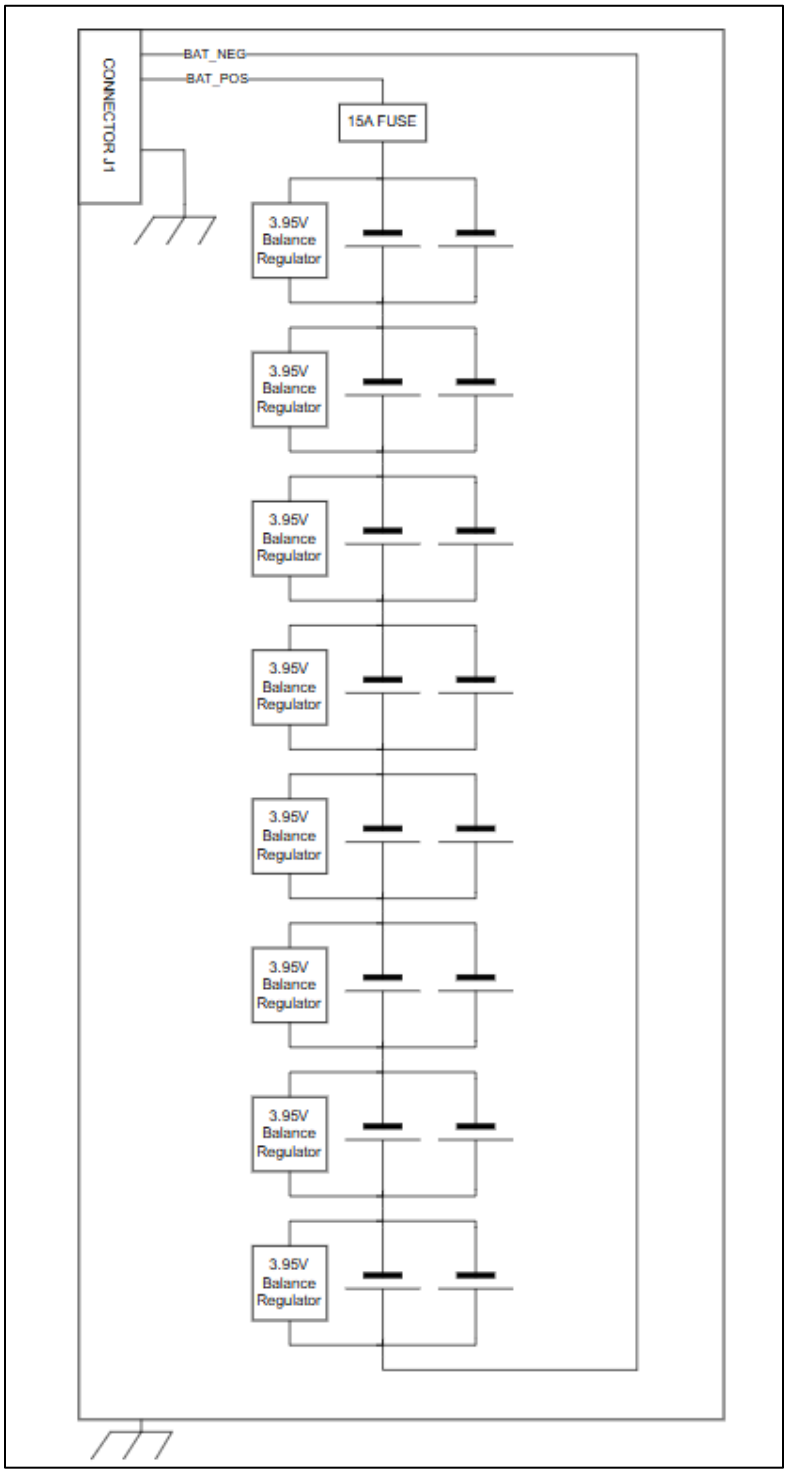
5.2 Harnessing Recommendations

Harnesses connecting to the Umbra Battery Module should use mating connector Female Socket MMDS-015 to connect to the connector described in Section 5.1 Connector Pinouts.

Space-rated harnesses connecting to the Umbra Battery Module should use wire conforming to SAE AS22759. Umbra recommends 24AWG wire.

5.3 Grounding Diagram

Figure 3. Umbra Battery Module 8S2P Electrical Block Diagram



5.4 EMI/EMC Properties

The Umbra Battery Module 8S2P has not been tested for Electromagnetic Interference (EMI) / Electromagnetic Compatibility (EMC) per MIL-STD-461. It has been successfully tested for self compatibility with X-Band, S-Band, and L-Band radios. Contact Umbra for more information.

5.5 Material Properties

All Umbra components are manufactured from materials deemed space-rated based on low outgassing. See Appendix B for more information about material properties of the Umbra Battery Module 8S2P.

6.0 Software Properties

Not Applicable

7.0 Performance Specifications

7.1 Charge Balancing

Charge balancing systems ensure that battery cells within a system maintain the same state of charge (SOC). This ensures that a SOC reading from a battery system also applies to the individual battery cells within the system. Since each individual battery cell must remain within its safe charging range to maintain lifetime and allow for discharge without damage, cell balancing increases the lifetime of the battery system. This is especially important when using lithium-ion batteries due to the volatility of this failure mode with this battery chemistry.

The Umbra Battery Module includes a shunt regulator type cell balancing management system. In the 8S2P configuration, this system ensures that each of the eight battery pairs in series remain at the same voltage. Parallel cells naturally balance to the cells in series through their direct connection.

In the Umbra Battery Module cell balancing system, when additional power reaches the battery module while the SOC has reached its maximum safe threshold, the energy is shunted to heat. The Umbra Battery Module is not rated for overcharge protection safety, so users should take care to ensure that the voltage supplied to the Umbra Battery Module is within the limits noted in Table 6. Electrical Properties.

Cell unbalance within safety limits can occur. To rebalance all cells, charge the battery module to full state of charge.

7.2 Thermal Management

The Umbra Battery Module includes an onboard heater and resistance temperature detector (RTD). If voltage is provided to the heater as described in the Section 5.1 Connector Pinouts, the heater will activate.

7.2.1 Heater Information

Table 8. Heater Information

Property	Typical Value
Heater Part Number	HK6901
Heater Rating	NASA qualified, low outgassing
Heater Nominal Voltage	19.5 V
Heater Max Voltage	39.0 V
Heater Nominal Wattage	7.9 W
Heater Max Wattage	15.7 W

7.2.2 RTD Information

Table 9. RTD Information

Property	Typical Value
RTD Part Number	B57230V2103F260
RTD Nominal Resistance	10 kΩ at 25°C

7.3 Umbra Power Package Compatibility

The Umbra Battery Module 8S2P can be purchased as part of the modular Umbra Power Package, with the Umbra Power Management Unit included. See documentation on the Umbra Power Management Unit for more details about compatibility with this system.

7.4 Performance Verification

Customer recommended checkout and qualification testing is described in this document in Section 8.0 Operational Procedures.

8.0 Operational Procedures

Follow all requirements and recommendations in Section 4.1 Mechanical Handling while carrying out all procedures in this section. The Umbra Battery Module may be damaged by carrying out any procedure listed in this section if mechanical handling requirements and recommendations are not followed.

8.1 Ground Support Equipment

To ensure operator and equipment safety, ensure Ground Support Equipment (GSE) follows the recommendations laid out in this section.

8.1.1 Charger Requirements

Umbra recommends the use of a qualified battery charger before integration with any payload. Ensure the charger is lithium-ion chemistry compatible. Ensure battery charger connector matches Section 5.2 Harnessing Recommendations before use. Umbra recommends the use of a battery charger capable of monitoring charge current and charge state voltage.

8.1.2 Thermal Sensor Recommendations

Umbra recommends the use of a monitoring circuit to take advantage of the internal temperature sensor. Alternatively, customers may use an external thermal camera or contact temperature sensor during all ground charging operations to monitor shunt heating of the Umbra Battery Module. The temperature sensor should measure the top of the Battery Module chassis for most accurate reading.

8.2 First Use Procedure

The following must be completed before any other procedures in this user guide are carried out.

8.2.1 Assembly

No customer assembly required.

8.2.2 Checkouts

Ensure there are no signs of lithium-ion battery damage upon receipt of the Umbra Battery Module. Check connectors and heater for damage before powering on.

8.2.3 Initial Configuration

The Umbra Battery Module will be shipped in a partially charged state to preserve cell lifetime.

8.3 Battery Charging Procedure

The objective of this procedure is to charge the Umbra Battery Module 8S2P.

8.3.1 Success Criteria

Measured cell voltage shall be 30.5 V ± 0.5 V.

8.3.2 Configuration and Equipment

This procedure shall be carried out with the following equipment in the listed configurations and quantities.

Table 10. Battery Charging Procedure

Part Number	Part Name	Configuration	Quantity
5062H0001	Umbra Battery Module	Charge State < 90%	x1
N/A	Battery Charger	See Section 8.1.1 Charger Requirements	x1
N/A	Temperature Sensor	See Section 8.1.2 Thermal Sensor Recommendations	Optional

8.3.3 Test Procedure

Overcharging the Umbra Battery Module 8S2P may result in damage to the module, operator harm, and/or fire. Ensure all safety recommendations in Section 4.0 Hardware Handling are followed as best practices throughout this procedure.

1. Connect the Umbra Battery Module 8S2P to the Battery Charger using a connector compatible with the Battery Module connector.
2. If available, monitor the charging process with a temperature sensor. The temperature sensor should measure the top of the Battery Module chassis for most accurate reading.
3. If the Battery Charger is capable of monitoring charge, record initial voltage reading if available. This charge voltage should be as stated in 8.2.3 Initial Configuration at first receipt of the battery module.
4. Begin charging if needed. Charging is complete when monitored voltage no longer rises, at a reading of 30.5 V ± 0.5 V.
5. Do not touch the battery module once measured voltage reaches 30.5 V ± 0.5 V. See Section 7.1 Charge Balancing for information on how additional energy is converted to heat.
6. Disconnect the charger, still careful to avoid touching the potentially hot surface of the battery modules.
7. Allow the cells to rest for at least 5 min to dissipate heat and reach their final SOC.
8. If desired, measure the final cell voltage.

8.4 On-Orbit Checkout

8.4.1 Depth of Discharge

Umbra recommends maintaining Umbra Battery Module 8S2Ps at a state of charge of 40% to 90% to preserve capacity to over 6.6 Ah over 600 cycles. See documentation on NCR20700B cells for more information.

8.4.2 Multiple Module Usage

If multiple Umbra Battery Module 8S2Ps are connected in series, each module should have a similar current draw.

Appendix A

Acronyms and Abbreviations

A.1 Acronyms and Abbreviations

DOT	Department of Transportation
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
GEVS	General Environmental Verification Standard
GND	Ground
GSE	Ground Support Equipment
HMR	Hazardous Materials Regulations
N/A	Not Applicable
RBF	Remove Before Flight
RTD	Resistance Temperature Detector
SOC	State of Charge

A.2 Units

°C	Degrees Celsius
A	Ampere
Ah	Ampere Hours
Grms	root mean square acceleration
Hz	Hertz
kΩ	Kiloohms
krad	Kilorad
min	Minutes
ms	Millisecond
V	Volts
VAC	Volts Alternating Current
W	Watts
Wh	Watt Hours

Appendix B

Mechanical Interface Control Documentation