

SWE SeaSafe Direct® 37V 28Ah 40Amp Subsea Battery Module Datasheet v2.0



SWE PN 46793728.3442

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Description and Benefits

SWE SeaSafe Direct Smart Battery Modules are designed to be autonomous (self-sufficient), easy to use battery system building blocks for subsea vehicles (AUV, MUV, ROV), oceanographic monitoring systems, and deep-sea oil and gas workover or monitoring infrastructure.



Specifications

Max State of Charge - 93% SOC Standard

Output Voltage @93% SOC

- 37.0 V –Nom
- 40.9 V – Max
- 30.0 V – Min

Capacity @ 93% SOC:

- 28 Ah – Nominal @ 93% SOC
- 1036 Wh – Nominal @ 93% SOC Std
- 1110 Wh – Nominal @ 100% SOC

CC/CV Charge Voltage Setting:

- 41.0 V - Suggested
- 42.0 V - Max
- -0.3 V - Min

Communication Supply Voltage:

- 5.0 V - Nominal
- 6.0 V - Max
- -0.5 V - Min

Operating Current:

- Discharge
 - 40 A – Max (Continuous)
 - 45 A – Max (30 second pulse)
 - 52 A – Max (20 ms pulse)
 - 90 A – Max (60 μ s pulse)
- Charge
 - 20 A – Suggested-Normal Temp
 - 40 A – Max- Normal Temp
 - 9 A – Max If $\leq 10^{\circ}\text{C}$ Low Temp
 - 0 A – Max If $\leq 0^{\circ}\text{C}$ Low Temp

Operating Temperature:

- Charge
 - $\geq 10^{\circ}\text{C}$ to $\leq 45^{\circ}\text{C}$ Normal Temp
 - $\leq 10^{\circ}\text{C}$ – Low temp $\leq 9\text{A}$ rate req.
 - $\leq 0^{\circ}\text{C}$ – NO Charge
- Discharge
 - -20°C to 60°C
- Storage
 - -40°C to 60°C

Module Dimensions:

- Height: 10.0 ± 0.1 in
- Length: 8.0 ± 0.1 in
- Width: 3.2 ± 0.1 in

Module Weight (Approximate):

- AIR: 17.4 lbs. (7.9 kg) $\pm$ 0.2 lbs Max
- WATER: 7.9 lbs. (3.6 kg) $\pm$ 0.2 lbs Max

Each module consists of pressure tolerant, high-performance Li-Polymer cells, a SWE Battery Management System (BMS) with patented safety protection and current paths, a thermally potted enclosure, and connectors for power and communications.

The battery modules have a proven record of delivering longer life and longer missions than lead-acid batteries:

- Up to 4x more energy
- Up to 6x more available energy at colder temperatures typical of the seabed
- Up to 8x longer cycle life
- Pressure tolerance to 6000 meters ocean depth
- No Pressure Vessel or PBOF Case required for SeaSafe Direct.

Certifications:

- **ABS PDA Certified**

SeaSafe has certification from the American Bureau of Shipping (ABS) Type Approval – Product Design Assessment (PDA) Revalidation; PDA Number 23-2400143-PDA, including UL And IEC tests passed.



National Standard	UL	UL 1642:2012
International Standard	IEC	IEC 62619:2017; IEC 61000-4-2:2008; IEC 61000-4-3:2010; IEC 61000-4-6:2013; IEC 61000-4-4:2012; CISPR 16-2:2016; UN 38.3:6th Edition

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- **ISO 9001-2015 Quality Certified**

SeaSafe Battery modules are built within ISO 9001 – 2015 quality certified manufacturing.



- **UN38.3 Transportation Certified**

SeaSafe Battery modules are UN38.3 Certified for safe Class 9 Hazmat Lithium Ion battery transportation by ground, vessel, or Air Cargo.



Features

Battery System “Building Block” Architecture

- The SWE SeaSafe battery modules are designed as building blocks to connect in series and/or parallel, as needed, to create the desired voltage, capacity, and maximum current requirements of the desired battery system.
 - Battery system Net Voltage is the net result of the number of SeaSafe Direct battery modules connected in series (PACK+ to PACK-) in the string.
 - Battery system Net Capacity or Net Power is the net result of the number of SeaSafe Direct battery strings connected in parallel (with Diode ORing Module protection) in increments of the battery module capacity and/or maximum current output. Appropriate peak current shared load derating should be applied.

Direct Use in Subsea Water:

- These SeaSafe Direct battery modules utilize a subsea tolerant circular subsea rubber molded connector for combined Power and RS485 Modbus Communications to enable easy subsea connection.
- No pressure vessel required
- No oil-filled, pressure equalization case required

Battery Module Cells:

- High-density, long lasting, pressure-tolerant, SWE-validated and supply-controlled Lithium-Polymer cells using safe NMC chemistry, rated at 30 Ah, 3.7 V nominal.
- When charged to 93% SOC default, and discharged to ~1% SOC, each cell delivers about 28Ah and 3.7 V nominal.

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Battery Module:

- Ten Series-Connected (10S x 3.7V) 30Ah (Li-Poly cells and BMS in a potted urethane case)
 - 37.0 VDC 28Ah @ 93% SOC.
- Pressure-tolerant to depth of 6000 meters.
- Patented Battery Management System built in for charge/discharge management, safety, and communications.

Configurable Maximum State of Charge % (SOC%):

- The Maximum State of Charge is the maximum percent of charge capacity to which the battery is charged.
 - Max SOC% is managed by the BMS, which allows charging to occur until the Battery Module Voltage represented by the estimated Max SOC% is achieved. Once this happens, the BMS automatically disconnects the charge until the SOC drops below the Max SOC voltage.
- The Max SOC% has a **Default Factory Setting: 93% MAX SOC%**
 - The Max SOC% can be custom set to a different SOC% at the factory if requested and aligned with SWE Sales contact prior to manufacturing of the battery modules.
 - Lower Max SOC% provides more charging cycles over the life of the battery, but less capacity-per-cycle. Higher Max SOC% provides more capacity-per-cycle, but fewer cycles over the life of the battery.

Potting:

- Thermally conductive, flexible urethane allows for shock and vibration isolation and large area heat dissipation.

Power and Communications Connector (Single, two-part connector):

- Standard Circular Subsea Connector, Rubber Molded, 16-pin, female
 - Examples:
 - Birns SCIL16F
 - MacArtney Subconn IL16F
 - SEACON IL-16-FS
- Standard Circular Subsea Connector, Locking Ring, female
 - Examples:
 - MacArtney Subconn DLSC-F
 - SEACON DLS-F
- Connector Mates for powered application are the Subsea Connector, Rubber Molded, 16-pin, Male with associated locking ring mate.

Battery Pack Protect Functions:

- The battery module's BMS protects against the following conditions:
 - Short circuit in charge
 - Short circuit in discharge
 - Charging outside of allowed temperature range
 - Discharging outside of allowed temperature range
 - Excessive charge
 - Excessive discharge
 - Excessive continuous current
- The battery module also possesses back-up over-current safety fuses that are not user-serviceable.

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Battery Cell Balancing Within the Module:

- The module's BMS automatically accomplishes automatic, periodic balancing of the cells within the module using a discharge balancing method. Balancing current is 80 to 100 mA.

Battery Module Balancing Within the String:

- Each battery module BMS automatically balances between series-connected modules at end of module charge.

Battery Module Charge Control:

- Each module's BMS contains a charge control circuit that allows a simple, current-limited, Constant Current/Constant Voltage (CC/CV) DC power source, set to the appropriate Charge Voltage and $\leq$ Max Charge Current for the battery module or battery string, to be connected to the battery module or connected to a series string of modules to charge the battery system unattended. Autonomous charge control completely interrupts charge current when full State of Charge (SOC) is achieved or safety thresholds are triggered to assure that no cell within the module can be over-charged even when charge power is connected and unattended.
- **TO MAINTAIN BATTERY LIFE, BATTERY MODULE SHOULD BE RE-CHARGED TO $\geq$ 80% SOC WHEN INITIALLY RECEIVED, OR WHEN APPROACHING 2% SOC, OR EVERY 6 MONTHS.**

Battery Module's BMS Communication method:

- Half-Duplex RS-485 on BMS's communication port.
- Communication is via Modbus ASCII (default) or RTU (software selectable) protocol.

Other example BMS Functions via Modbus:

- Relative and Absolute gas gauging
- Module voltage
- Individual cell voltages
- Bootable software update, etc.
- Module current
- Module temperature
- Module/cell's internal short circuit warning

Communication Port Isolation:

- The communication port on the battery module's BMS is electrically isolated from the battery module by galvanic isolation with a peak isolation working voltage of ± 560 V.

Communication Port Power:

- External +5 V power and ground must be supplied to the battery module's BMS communication port to support communications. The maximum current draw is 4.0 mA on the bus side with outputs unloaded.

Self-Discharge:

- Active Mode:
 - 1.5 mA from BMS plus $< 1\%$ cell self-discharge per month (at room temperature)
- Storage/Ship Mode:
 - < 0.15 mA from BMS plus $< 1\%$ cell self-discharge per month (at room temperature)

Energy Density (Approximate):

- Volumetric:
 - 247 Wh/l @ 93% SOC 265 Wh/l @ 100% SOC
- Gravimetric
 - 131 Wh/kg @ 93% SOC 141 Wh/kg @ 100% SOC

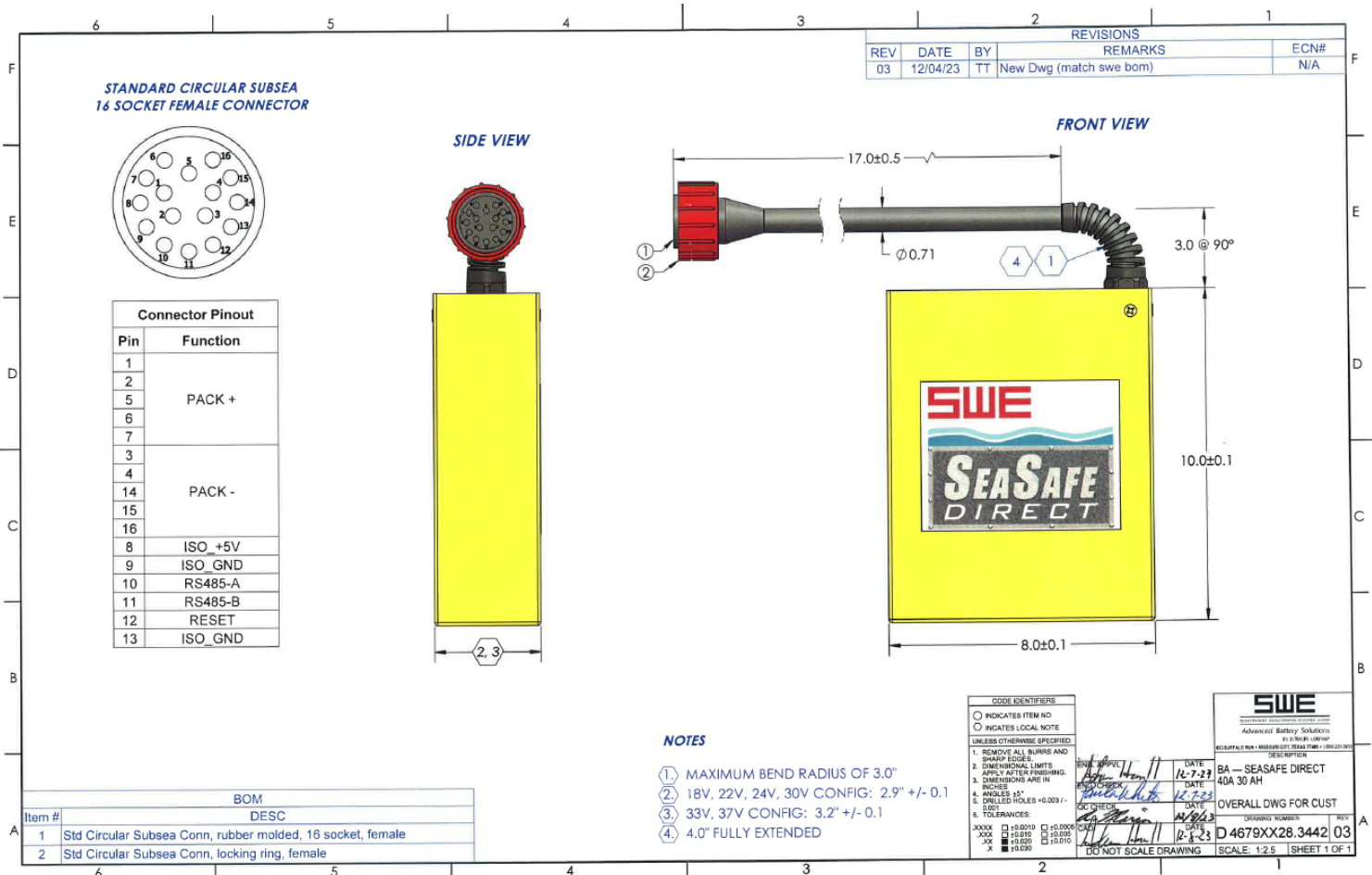
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Battery Module Dimension and Pinout Drawing:



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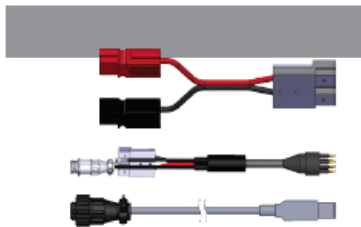
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SeaSafe Battery Accessories:



SWE SeaSafe® 24V Battery Module Charger

- Ease-of-use
- Harnesses available that mate with each battery model
- Connect it and forget it
- Monitor battery charge status using SeaSafe Observer® Software



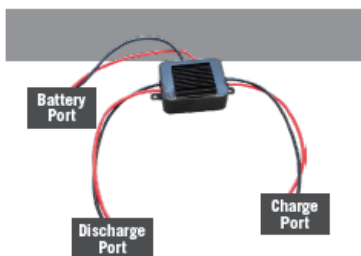
SWE SeaSafe® Charger Cables

- Power connection from charger to battery
- Y cable from SeaSafe® Direct to charger and comms
- Comms cable from battery to PC USB



SWE SeaSafe Observer® Support Software

- Graphical user interface
- Voltage
- Capacity
- Current
- Temperature
- Status, State of Health
- Data logging on CSV file



SWE SeaSafe® Diode OR-ing Module (DOM)

- Parallel connects module strings into a battery system
- Parallel integrates module string outputs into a single discharge bus
- Enables increased current and capacity via. SeaSafe® Battery Modules in parallel
- Electrically isolates module string charge ports
- Provides additional battery safety, reliability, and potential for faster charge time
- Supports high voltage – up to 600V Battery System