# DataSafe Noir™

## Energy Storage System
## User Guide

**Document ID:** AMER-EN-M-ENS-DSNOIR-ESS-0926
**Effective:** 09/2026

**Read this document carefully.**
Learn how to protect your equipment from damage and fully understand its functions.

**NOTICE**

For the product safety data sheet, visit our website, EnerSys.com and browse to **Resources > Safety Data Sheets (SDS)**.

**NOTICE**

The material contained in this document is for information only and is subject to change without notice.

# Contents

# 1. Safety

## Save these instructions

This document contains important safety instructions that must be followed during the installation, servicing, and maintenance of the product. Keep it in a safe place. Review the drawings and illustrations contained in this document before proceeding. If there are any questions regarding the safe installation or operation of this product, contact EnerSys or the nearest DataSafe Noir™ system representative.

## 1.1 Safety symbols

To reduce the risk of injury or death, prevent damage to equipment, and to ensure the continued safe operation of this product, the following symbols have been placed throughout this document. Where these symbols appear, use extra care and attention.

| Symbol | Type | Description |
|---|---|---|
|  | **WARNING** | Risk of serious injury or death<br>Equipment in operation poses a potential electrical hazard which could result in serious injury or death to personnel. This hazard may continue even when power is disconnected. |
|  | **CAUTION** | Cautions indicate the potential for injury to personnel or damage to equipment. |
|  | **CAUTION** | Risk of burns<br>A device in operation can reach temperature levels which could cause burns. |
|  | **ATTENTION** | The use of attention indicates specific regulatory or code requirements that may affect the placement of equipment or installation procedures. Follow the prescribed procedures to avoid equipment damage or service interruption. |
|  | **GROUNDING** | This symbol indicates the location or terminal intended for the connection to protective earth. An enclosure that is not properly connected to protective earth presents an electrical hazard. Only a licensed electrician can connect AC power and protective earth to the enclosure. |
|  | **NOTICE** | A notice provides additional information to help complete a specific task or procedure or general information about the product. |

## 1.2 General warnings and cautions

**WARNING**

**High-voltage energy storage system**

This system contains high-voltage circuits and lithium-ion energy storage modules capable of delivering hazardous energy levels. Contact with energized components can cause severe injury or death. Only qualified personnel may install, service, or operate this equipment.

**WARNING**

**Stored electrical energy**

Hazardous voltage may remain present even after the system is powered down. Always follow Lockout/Tagout procedures and verify zero energy before servicing.

**WARNING**

**Fire and explosion hazard**

Lithium-ion energy storage modules may vent, smoke, or ignite if damaged, improperly installed, or exposed to extreme temperatures. Do not crush, puncture, short-circuit, or disassemble energy storage modules.

**CAUTION**

**Hot surfaces**

Components inside the system may reach temperatures capable of causing burns. Allow adequate cooling time before accessing internal areas.

**NOTICE**

**Qualified personnel**

Installation and servicing must be performed by personnel trained in high-voltage electrical systems, energy storage module safety, and applicable codes.

## 1.3 Mechanical safety

**WARNING**

**Tip-over hazard**

The system enclosure must be anchored according to installation instructions. An unsecured enclosure may tip during installation or seismic activity, causing injury or equipment damage.

**CAUTION**

**Sharp edges and pinch points**

Use appropriate PPE when handling panels, busbars, and hardware. Avoid placing hands near moving or hinged components.

**CAUTION**

**Module handling**

Energy storage modules are heavy and must be supported during removal or installation. Dropping an energy storage module may cause internal damage or create a fire hazard.

## 1.4 Electrical safety

**WARNING**

**Live electrical parts**

Do not open the enclosure while energized. Internal components may remain live even when the front door is open.

**WARNING**

**Incorrect wiring**

Improper AC, DC, or communication wiring can cause equipment failure, arcing, or fire. Follow wiring diagrams and torque specifications exactly.

**GROUNDING**

**Protective earth**

The enclosure must be connected to a verified protective earth conductor. Improper grounding increases the risk of electric shock and equipment damage.

**ATTENTION**

**Code compliance**

All electrical work must comply with National Electrical Code, NFPA 70, the Canadian Electrical Code, Part I Safety Standard for Electrical Installations, CSA C22.1, the National Electrical Safety Code, IEEE C2, the International Fire Code, ICC IFC, the International Residential Code, ICC IRC, the National Fire Code of Canada, NRC NFC, the Fire Code, NFPA 1, and the Standard for the Installation of Stationary Energy Storage Systems, NFPA 855, local electrical codes, and authority-having-jurisdiction (AHJ) requirements.

## 1.5 Energy storage module safety

**WARNING**

**Thermal runaway risk**

If a energy storage module emits smoke, hisses, swells, or becomes excessively hot, evacuate the area and follow emergency shutdown and fire-response procedures.

**WARNING**

**Short-circuit hazard**

Never place tools or conductive objects on top of energy storage modules or busbars. Accidental short circuits can cause severe burns, arc flash, or fire.

**CAUTION**

**Temperature limits**

Operating or charging the system outside the specified temperature range may reduce performance or trigger protective shutdowns.

**NOTICE**

**Energy storage module chemistry**

This product uses lithium-iron-phosphate (LFP) cells with integrated monitoring and protection. Only EnerSys-approved energy storage modules may be installed.

## 1.6 Lifting and handling

**WARNING**

**Heavy equipment**

The enclosure and energy storage modules require mechanical lifting equipment or multiple personnel. Improper lifting can cause serious injury and dropped energy storage modules could introduce a fire hazard if damaged.

**CAUTION**

**Stability during transport**

Ensure the enclosure remains upright and secured during movement. Do not tilt beyond manufacturer limits.

**NOTICE**

**Use proper tools**

Use lifting straps, pallet jacks, or forklifts rated for the system's weight. Follow all site safety procedures.

## 1.7 California proposition 65 statement

**WARNING**

**California Proposition 65**

This product may expose users to chemicals including lead, nickel, and carbon black, substances known to the State of California to cause cancer, birth defects, or other reproductive harm.
For more information, visit www.P65Warnings.ca.gov.

## 1.8 Regulatory and code considerations

**ATTENTION**

**Installation location**

Placement of this system may be subject to local fire codes, ventilation requirements, and spacing rules for energy storage systems. Consult NFPA 855, UL 9540, National Electrical Code, NFPA 70, the Canadian Electrical Code, Part I Safety Standard for Electrical Installations, CSA C22.1, the National Electrical Safety Code, IEEE C2, the International Fire Code, ICC IFC, the International Residential Code, ICC IRC, the National Fire Code of Canada, NRC NFC, the Fire Code, NFPA 1, and the Standard for the Installation of Stationary Energy Storage Systems, and NFPA 855 installation guidelines, and local AHJ requirements.

**NOTICE**

**Emergency access**

Maintain clear access to the enclosure for emergency responders. Do not block aisles, disconnects, or ventilation paths.

# 2. Introduction

## 2.1 Document scope

This document explains the installation, interconnection, and operation of the DataSafe Noir™ energy storage system.

## 2.2 Product overview

DataSafe Noir™ is a high-density energy storage system engineered for three-phase UPS applications in mission-critical data-center environments. Engineered as an integrated energy storage platform, it delivers predictable performance under dynamic load conditions while supporting compact deployment at megawatt scale.

As data centers increase in density and rely on increasingly variable AI-driven workloads, operators require confidence not only in runtime and energy storage module chemistry, but in how systems behave under real operating conditions. The DataSafe Noir™ system is designed to maintain stable operation during load fluctuation, integration, commissioning, and operation in high-density environments.

A multi-level Battery Management System (BMS) architecture provides coordinated monitoring, protection, and control from the individual cell level through the full system. Each energy storage module incorporates high-accuracy voltage and temperature sensing, active cell balancing, and embedded protection mechanisms. System-level and group-level BMS controllers coordinate real-time monitoring, fault detection, and communication with the UPS and external monitoring systems.

The system uses high-rate lithium iron phosphate (LFP) chemistry providing thermal stability, operational reliability, and long service life in high-power UPS applications. Layered protection architecture — including fuse protection at cell, module, and system levels — supports stable operation during abnormal operating conditions. Integrated temperature monitoring and active cell balancing functions maintain module consistency and system stability over time.

The system is designed for indoor installation within controlled data-center electrical environments. The platform's high-strength mechanical structure is designed for predictable integration and service access while providing electromagnetic interference resistance and safe containment of high-voltage components. Isolated CAN and RS-485 communications support UPS integration, while dry-contact interfaces enable compatibility with facility monitoring and building management systems.

DataSafe Noir™ energy storage system supports scalable deployment through parallel system configurations, enabling use in both single-system and megawatt-scale UPS architectures. The system architecture supports reduced deployment complexity, improved space utilization, and stable operational performance in high-density data-center environments.

## 2.3 System architecture overview

The DataSafe Noir™ energy storage system uses a multi-layer Battery Management System (BMS) architecture to coordinate monitoring, protection, and communication across the full system.

### System components

- **Energy storage modules:** Each module includes cell-level monitoring, active cell balancing, and embedded protection.
- **Battery Module Units (BMUs):** Provide module-level voltage, temperature, and protection data.
- **Cabinet Battery Management System (CBMS)**: Aggregates BMU data, manages cabinet-level protection, and provides DC output control.
- **Group Battery Management System (GBMS):** Coordinates multiple cabinets, manages system-level protection, and provides communication to the UPS and external systems.
- **UPS:** Receives DC power and system-level status from the GBMS.
- **Combiner cabinet (if used):** Aggregates DC outputs from multiple cabinets before feeding the UPS.

### Communication paths

- **BMU » CBMS:** Isolated CAN bus
- **CBMS » CBMS:** Isolated CAN bus (parallel systems)
- **CBMS » GBMS:** Isolated CAN bus
- **GBMS » UPS:** RS-485, CAN, or dry contact (depending on UPS model)
- **GBMS » Facility monitoring:** Dry contact or TCP/IP (if enabled)

### Power paths

- **DC bus:** BAT+, BAT–, and N (if required by UPS)
- **AC supply:** 90 to 264V auxiliary power for CBMS and GBMS
- **24VDC auxiliary:** CBMS » GBMS control power

This architecture supports predictable operation, coordinated protection, and scalable parallel deployment.

# 3. Specifications

## 3.1 DataSafe Noir™ energy storage system

Table A: DataSafe Noir™ energy storage system specifications

| Electrical | DSN-500 | DSN-600 |
|---|---|---|
| **Nominal voltage** | 512 VDC | 614 VDC |
| **Working voltage range** | 410 to 590 VDC | 500 to 700 VDC |
| **Nominal capacity** | 120 Ah | |
| **Nominal energy (at 120 Ah and nominal voltage)** | 61.44 kWh | 73.68 kWh |
| **Maximum output power** | 500 kW | 600 kW |
| **Standard charge current** | 60 A | |
| **Maximum charge current** | 120 A | |
| **Maximum discharge current** | 1,200 A | |
| **Charge voltage range** | 544 to 552 VDC | 656 to 672 VDC |
| **Discharge cut-off voltage** | 448 V | 537.6 V |
| **Short-circuit current** | 9 kA | |
| **Internal resistance** | <55 milliohm | <60 milliohm |
| **Self-discharge** | <3% per month at 77°F (25°C) | |
| **Features** | **DSN-500** | **DSN-600** |
| **Protection functions** | For more information on protections, see the Protection features table. | |
| **LED indicator** | DC start and status (on system BMS panel). For more information, see the Energy storage system LED states table. | |
| **Backup runtime (SOI)** | 500 kW for 6 min; 430 kW for 7 min; 387 kW for 8 min; 310 kW for 10 min | 600 kW for 6 min; 516 kW for 7 min; 465 kW for 8 min; 373 kW for 10 min |
| **Backup runtime (EOL)** | 500 kW for 5 min; 366 kW for 7 min; 333 kW for 8 min; 270 kW for 10 min | 600 kW for 5 min; 440 kW for 7 min; 400 kW for 8 min; 325 kW for 10 min |
| **Energy storage module** | **DSN-500** | **DSN-600** |
| **Chemistry** | Lithium Iron Phosphate (LFP) | |
| **Module configuration** | 16S2P | |
| **Number of energy storage modules** | 10 | 12 |
| **Module balancing current** | Up to 3 A | |
| **Module protection** | Fuse protection at cell, module, and system levels | |
| **Dimensions (H × W × D)** | 7.5 × 13.0 × 25.7 in. (190 × 330 × 653 mm) | |
| **Enclosure** | **DSN-500** | **DSN-600** |
| **Ingress protection** | IP20 | |
| **Installation clearance** | ≥31.5 in. (800 mm) front; rear flush-mount allowed | |
| **Mounting** | Floor-standing, seismic-tested (ICC-ES AC156) | |
| **Fire protection** | Module-level standard; system-level optional | |
| **Mechanical structure** | Cold-rolled steel, EMI-resistant design | |

| | | |
|---|---|---|
| **Dimensions (H × W × D)** | 78.7 × 31.5 × 29.5 in. (2,000 × 800 × 750 mm) | |
| **Weight** | 2,196 lb (996 kg) | 2,491 lb (1,130 kg) |
| **Environmental** | **DSN-500** | **DSN-600** |
| **Operating temperature** | 32 to 113°F (0 to 45°C) | |
| **Recommended operating temperature** | 59 to 95°F (15 to 35°C) | |
| **Storage temperature** | 32 to 113°F (0 to 45°C) | |
| **Relative humidity** | 5 to 95% (non-condensing) | |
| **Maximum elevation** | ≤13,123 ft (≤4,000 m); derate above 3,280 ft (1,000 m) | |
| **Elevation derating factor** | 3,300 ft (1,000 m): Convection cooling: 1.000; Forced-air cooling: 1.000 | |
| | 4,000 ft (1,200 m): Convection cooling: 0.994; Forced-air cooling: 0.990 | |
| | 5,000 ft (1,500 m): Convection cooling: 0.985; Forced-air cooling: 0.975 | |
| | 6,600 ft (2,000 m): Convection cooling: 0.970; Forced-air cooling: 0.950 | |
| | 8,300 ft (2,500 m): Convection cooling: 0.955; Forced-air cooling: 0.925 | |
| | 10,000 ft (3,000 m): Convection cooling: 0.940; Forced-air cooling: 0.900 | |
| | 11,600 ft (3,500 m): Convection cooling: 0.925; Forced-air cooling: 0.875 | |
| | 12,000 ft (3,600 m): Convection cooling: 0.922; Forced-air cooling: 0.870 | |
| | 13,200 ft (4,000 m): Convection cooling: 0.910; Forced-air cooling: 0.850 | |
| | 14,000 ft (4,200 m): Convection cooling: 0.904; Forced-air cooling: 0.840 | |
| | 15,000 ft (4,500 m): Convection cooling: 0.895; Forced-air cooling: 0.825 | |
| | 16,500 ft (5,000 m): Convection cooling: 0.880; Forced-air cooling: 0.800 | |
| | **Note:** Values are derived from ANSI C57.96:2013. Interpolate for elevations not listed. | |
| **Indoor installation only** | Temperature-controlled, non-corrosive, non-conductive environment | |
| **Heat dissipation** | Varies by application; contact your DataSafe Noir™ applications engineering team for application-specific thermal calculations. | |
| **Cooling airflow requirement** | Varies by installation environment; contact your DataSafe Noir™ applications engineering team for detailed guidance. | |
| **Communication and integration** | **DSN-500** | **DSN-600** |
| **Communication interfaces** | RS-485, CAN, TCP/IP, dry contacts | |
| **UPS compatibility** | Compatible with all mainstream three-phase UPS systems | |
| **Parallel operation** | Supported; DIP-switch addressing (16 address codes) | |
| **BMU/CBMS/GBMS communication** | Isolated CAN bus; sequential module communication | |
| **Dry contact functions** | Charge enable, discharge enable, alarm signaling | |
| **Safety and compliance** | **DSN-500** | **DSN-600** |
| **Certifications** | UL 1973, UL 9540A, IEC 62619, IEC 62620, IEC 62477-1, EN 61000-6-2, EN 61000-6-4, UN 38.3, ICC-ES AC156 | |
| **High-voltage safety** | Internal energy source; hazardous voltage present even when UPS is disconnected | |
| **Grounding requirement** | Ground first due to high leakage current | |
| **PPE requirements** | Gloves, insulated tools, safety goggles, insulated footwear | |
| **Prohibited environments** | Explosive dust/gas, corrosive gases, moisture, vermin, salt-laden air | |
| **Lockout/Tagout** | Required before servicing | |
| **Module replacement rule** | Replace only with identical module type | |

| AC and DC wiring requirements | DSN-500 | DSN-600 |
|---|---|---|
| **DC connections** | BAT+, BAT-, N (if UPS requires neutral) | |
| **AC supply for BMS** | 90 to 264 V; 35 W | |
| **24VDC supply** | CBMS » GBMS | |
| **Recommended cable sizes** | **+/–/N:** 300 to 500 kcmil (150 to 240 mm²) depending on power | |
| | **PE:** 2/0 to 4/0 AWG (70 to 120 mm²) | |
| **Bolt sizes for DC terminals** | M16 × 50 — 89 ft·lb (120 N·m) for power | |
| | M12 × 30 — 35 ft·lb (47 N·m) for PE | |
| **System operation** | **DSN-500** | **DSN-600** |
| **Startup method** | DC start button (1 to 3 seconds) or AC activation.<br>The system will wait for the button to be pressed when AC is installed. | |
| **Parallel startup sequence** | Address 1 >Address 2 >… Address N | |
| **SoC calibration** | Required during commissioning | |
| **HMI functions** | Real-time monitoring, alarms, module data, CBMS/GBMS data, settings, IP config | |
| **BMS software** | Supports parameter configuration, history logs, communication logs, skins/languages | |

# 4. Features

## 4.1 High-voltage lithium-ion architecture

The energy storage system uses high-voltage LFP energy storage modules designed specifically for three-phase UPS applications. This architecture delivers high power output, fast response, and stable performance during short-duration backup events typical of data-center environments. The system maintains consistent voltage across a wide operating range to ensure compatibility with modern UPS rectifiers and inverters.

## 4.2 Modular system design

Each energy storage system contains multiple lithium-ion energy storage modules arranged in a stacked configuration. The modular approach simplifies installation, service, and replacement while enabling consistent thermal behavior and predictable electrical performance. Modules include integrated monitoring electronics that report voltage, temperature, and balancing status to the system-level controller.

## 4.3 Multi-layer Battery Management System

The system incorporates BMU (module-level), CBMS (system-level), and GBMS (group-level) controllers. These layers work together to monitor cell conditions, coordinate charging and discharging, manage balancing, and communicate with the UPS. This architecture ensures accurate data collection, fault isolation, and stable operation across the entire energy storage module string.

### 4.3.1 Battery module unit

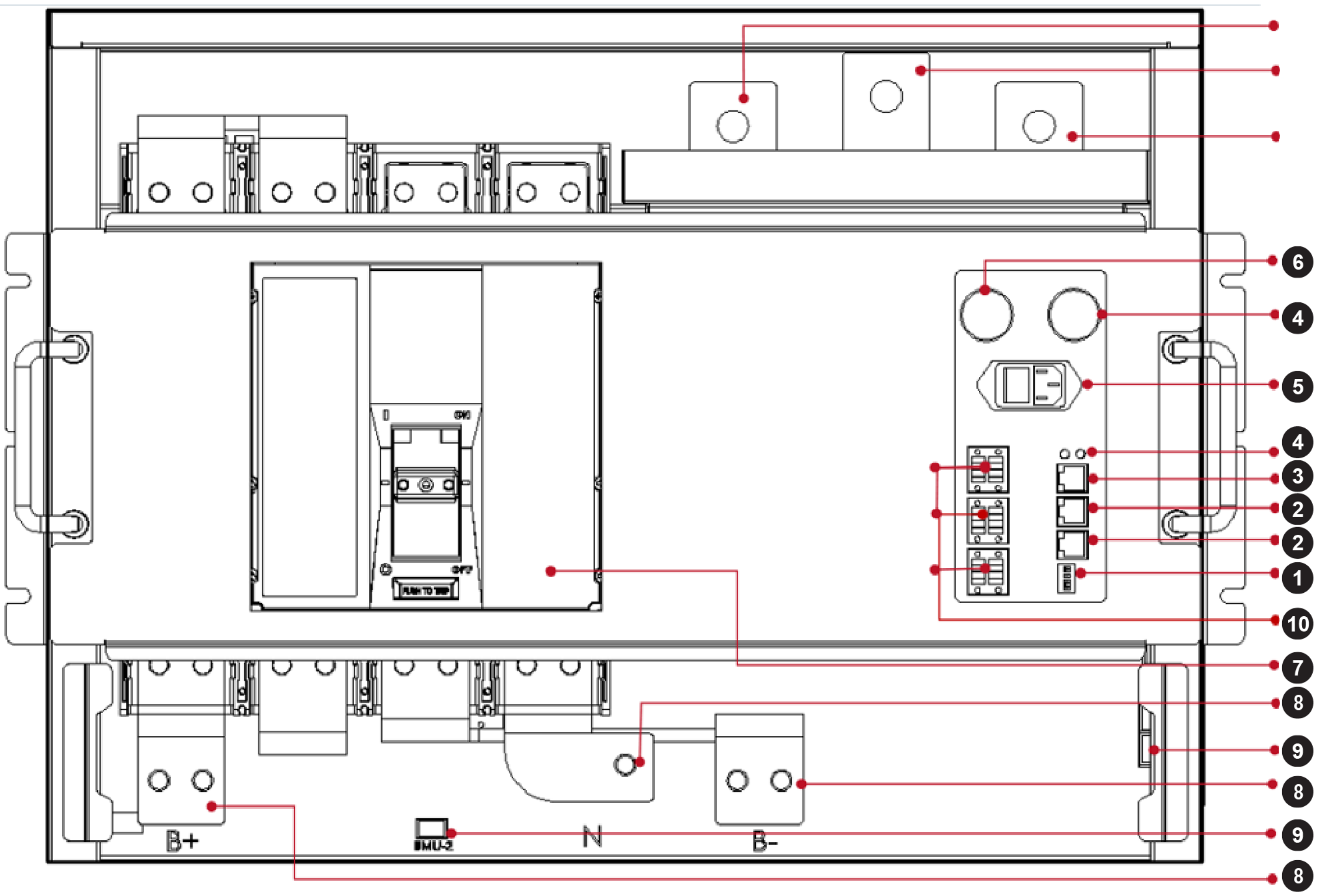
The Battery Module Unit (BMU) is the module-level control layer within the three-level Battery Management System architecture. Each BMU monitors the operating state of its associated battery module, including cell voltage, module voltage, current, and temperature. The BMU performs cell-level balancing, executes module-level protection actions, and reports real-time operating data to the cabinet-level CBMS.

The BMU provides localized protection for overvoltage, undervoltage, overtemperature, and overcurrent conditions, ensuring safe operation of each module. Through continuous monitoring and balancing, the BMU maintains module consistency and supports long-term system stability.

### 4.3.2 Cabinet BMS

The Cabinet BMS (CBMS) is the cabinet-level control layer within the three-level Battery Management System architecture. It performs real-time current measurement, data acquisition, system analysis, alarm handling, and protection control while coordinating communication with both the module-level BMUs and the system-level GBMS.

The CBMS incorporates the main DC output breaker, charge/discharge dual-loop control circuitry, high-voltage isolation detection, parallel-operation processing, high-voltage power supply, DC start circuitry, and associated wiring harnesses. The DC output breaker provides a safe means of isolating the cabinet from the UPS during installation, commissioning, or fault conditions. When the breaker is ON, the circuit is closed and the DC output is energized; when OFF, the circuit is open and the cabinet is electrically isolated. Through these functions, the CBMS manages system state and executes protective actions for overcharge, over-discharge, overcurrent, and short-circuit conditions, ensuring safe and reliable cabinet-level operation.




| Table B: CBMS panel functions and description | | | |
|---|---|---|---|
| **Item** | **Name** | **Description** | **Notes** |
| **1** | CBMS address DIP switch | Sets the cabinet's communication address for the GBMS. Each cabinet must have a unique address for parallel operation. | Address range 0 to 15. Set before power-up. |
| **2** | COM1/COM2 (CAN) | Isolated CAN ports used for CBMS-to-GBMS communication. Supports redundant or daisy-chain cabinet networking. | Either port may be used. Maintain shield continuity. |
| **3** | LAN port | Ethernet interface for firmware updates, diagnostics, and engineering access. Not used for UPS communication. | Reserved for service personnel. |
| **4** | Status indicators | LED indicators showing CBMS operating state, including charging, discharging, standby, and fault. | See Section 12.1 for LED definitions. |
| **5** | AC input | Auxiliary AC supply for CBMS operation. Required for BMS startup and continuous monitoring. | Accepts 90 to 264 VAC. |
| **6** | DC Start switch | Initiates CBMS startup sequence when pressed and held. Powers internal control electronics. | Press and hold for ≥3 s. |
| **7** | 1,200 A DC breaker | Controls cabinet DC output and provides shunt-trip protection during faults or EPO events. | Trips on short-circuit or protection command. |

| | | | |
|---|---|---|---|
| **8** | Battery input busbars | Connection points for the energy storage modules. Carry full cabinet DC current. | Torque to specification. Verify polarity. |
| **9** | BMU communication interface | CAN interface for communication with module-level BMUs. Supports cascading module topology. | Daisy-chain; maintain termination. |
| **10** | 24VDC Intercommunication port | Interface for fire-control, CO detector, or auxiliary interlock signals. | Site-specific use; optional. |

### MCCB function and reset behavior

Each cabinet includes a molded-case circuit breaker (MCCB) that controls the cabinet's DC output path. The MCCB must be closed before the CBMS can be started using either the AC or DC start method. When the MCCB is ON, the breaker is closed and the DC output is enabled; when OFF, the breaker is open and the cabinet is electrically isolated from the UPS. The MCCB provides both operational isolation and protection during installation, commissioning, and fault conditions.

If the MCCB trips, the CBMS will not start using either the AC or DC start method. To restore operation, the MCCB must be reset by rotating it to the reset position and then returning it to the ON position.
To prevent damage, the MCB must not be switched on again for at least five minutes after a trip event.

## 4.3.3 Group BMS

The Group BMS (GBMS) is the system-level control layer within the three-level Battery Management System architecture and provides the integrated display interface for the cabinet. The GBMS collects and processes operational data from the cabinet-level CBMS, performs real-time analysis, and presents system status and alarms through the front-panel display.

The GBMS manages system-level coordination and communicates with the UPS through CAN, RS-485, and dry-contact interfaces to support reliable operation throughout the system's service life. Through these functions, the GBMS ensures accurate system monitoring, coordinated protection behavior, and stable integration with external equipment.

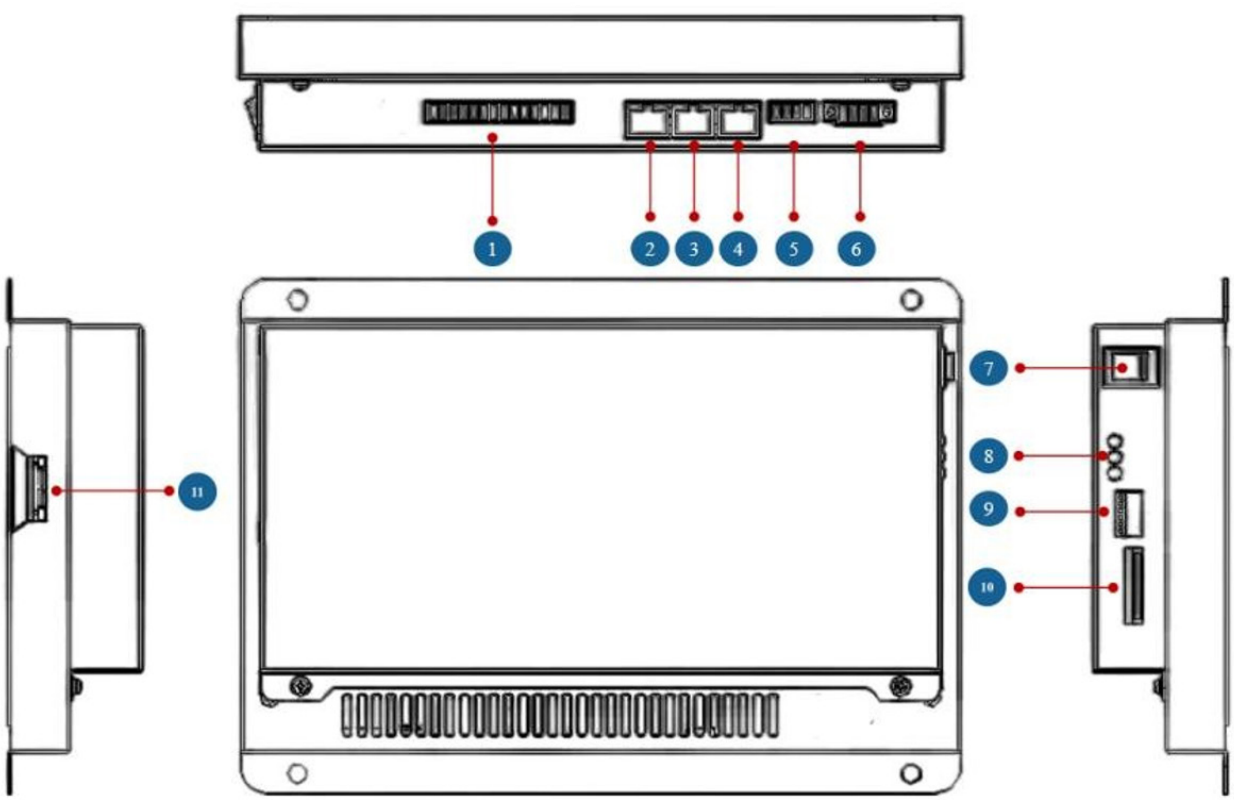


Table C: GBMS panel functions and description

| Item | Name | Description | Notes |
|---|---|---|---|
| **1** | External communication port | Provides isolated communication interfaces (CAN/RS-485/dry contact) for UPS and facility-monitoring integration. | Select interface based on UPS model and site requirements. |
| **2** | CBMS 1 interface | Primary CAN communication link to the cabinet-level CBMS. | Required for single-cabinet operation. |
| **3** | CBMS 2 interface | Secondary CAN communication link for multi-cabinet or redundant CBMS communication. | Used in parallel-cabinet configurations. |
| **4** | LAN | Ethernet interface for firmware updates, diagnostics, and optional TCP/IP monitoring. | Reserved for service personnel; not used for UPS control. |
| **5** | DC24V-IN (Cloud module) | Auxiliary 24VDC power input reserved for optional cloud-communication hardware. | Not used in standard DataSafe Noir™ configurations. |
| **6** | DC24V-IN (GBMS power) | 24VDC power input supplying the GBMS control electronics. | Powered by the CBMS; no external supply required. |
| **7** | ON/OFF | GBMS control-power switch used to energize or de-energize the GBMS. | Use only after verifying CBMS power availability. |
| **8** | Indicator | LED indicators showing GBMS operating state, communication status, and fault conditions. | See Section 12.1 for LED definitions. |
| **9** | Dial switch | Address selector used when multiple GBMS units operate in parallel. | Not used in single-system configurations. |
| **10** | SD card | Removable storage for system-level logs, cell data, and historical operating records. | 8 GB capacity; supports automatic data retention. |
| **11** | HMI Update | Service port for updating the HMI interface firmware. | Reserved for EnerSys service personnel. |

## 4.4 Active cell balancing

The modules use active call balancing to equalize cell voltages during operation and charging. This improves cycle life, maintains usable capacity, and prevents cell drift over time. The balancing system operates automatically and continuously, reducing maintenance requirements and ensuring long-term reliability.

## 4.5 High-rate LFP chemistry

The energy storage system uses high-rate LFP cells capable of supporting demanding UPS discharge profiles. LFP chemistry provides strong thermal stability, long cycle life, and predictable behavior under high load. It is well-suited for short-duration, high-power backup applications and offers a safer alternative to other lithium chemistries.

## 4.6 Integrated monitoring and HMI

A front-mounted display provides real-time visibility into system status, alarms, module data, and operating parameters. The interface supports configuration, diagnostics, and commissioning tasks. It also provides clear visual indicators for charge, discharge, standby, and fault conditions.

## 4.7 Remote communication and integration

The energy storage system supports RS-485, CAN, TCP/IP, and dry-contact interfaces for communication with UPS systems, building management systems, and remote monitoring platforms. This ensures compatibility with a wide range of data-center architectures and allows centralized oversight of energy storage module performance and alarms.

## 4.8 Parallel scalability

Multiple systems can be connected in parallel to increase total energy and power capacity. DIP-switch addressing and coordinated BMS communication allow the system to operate as a unified energy storage array. This enables deployment in small server rooms as well as large multi-megawatt data-center environments.

## 4.9 Cold-rolled steel enclosure

The energy storage system is built with a rigid, EMI-resistant steel enclosure designed for data-center electrical rooms. The structure supports safe containment of high-voltage components, provides mechanical protection, and maintains airflow paths for thermal stability. The enclosure is rated IP20 for indoor use.

## 4.10 Seismic-tested mechanical design

The energy storage system meets seismic performance requirements under ICC-ES AC156, ensuring stability and structural integrity in regions with elevated seismic activity. Anchoring points and installation procedures support secure mounting in mission-critical facilities.

## 4.11 Fire-protection options

The system includes module-level fire-protection features as standard, with optional system-level fire-suppression integration depending on site requirements. This supports compliance with data-center safety expectations and local fire-code requirements.

## 4.12 Flexible installation footprint

The energy storage system can be installed against a wall and requires only front access for operation and maintenance. This reduces the required floor space and simplifies layout planning in dense electrical rooms. Forklift access and anchoring points support safe handling during installation.

## 4.13 Low maintenance requirements

The lithium-ion system eliminates the frequent inspections, equalization charges, and replacement cycles associated with Valve-Regulated Lead-Acid (VRLA) batteries. Automated monitoring, balancing, and fault detection reduce operational overhead and extend service intervals.

## 4.14 Long service life

The system is designed for a 15-year service life under typical data-center conditions. LFP chemistry, active cell balancing, and multi-layer BMS control contribute to predictable aging behavior and reduced total cost of ownership compared to lead-acid systems.

## 4.15 Protection features

Table D: Protection features

| Feature | Description |
|---|---|
| **Overvoltage protection** | Prevents the energy storage system from exceeding safe voltage limits during charging or abnormal UPS conditions. |
| **Undervoltage protection** | Prevents excessive discharge that could damage cells or reduce service life. |
| **Overtemperature protection** | Monitors cell and module temperatures and limits operation if temperatures exceed safe thresholds. |
| **Undertemperature charging protection** | Blocks charging when temperatures are too low to avoid lithium plating and internal short-circuit risk. |
| **Overcurrent protection (charge)** | Limits charging current to prevent overheating or damage to internal components. |
| **Overcurrent protection (discharge)** | Limits discharge current to protect the system during high-load or fault conditions. |
| **Short-circuit protection** | Detects and isolates short-circuit events to prevent catastrophic failure. |
| **Cell-level fuse protection** | Individual cell fuses isolate faults at the smallest level to prevent propagation. |
| **Module-level fuse protection** | Module fuses protect against internal faults and isolate affected modules. |
| **System-level fuse protection** | System-level fusing protects the entire energy storage module string from high-energy faults. |
| **Active cell balancing** | Maintains consistent cell voltages to improve performance, safety, and cycle life. |
| **Isolation monitoring** | Detects insulation faults between high-voltage components and the system chassis. |
| **Breaker trip protection** | Automatically disconnects the energy storage system during severe faults or abnormal conditions. |
| **High-voltage interlock** | Prevents access to energized components and ensures safe maintenance conditions. |
| **Ground-fault detection** | Identifies unintended connections between the energy storage module and ground to prevent shock hazards. |

# 5. Energy storage module performance characteristics

## 5.1 Charge and discharge performance

Figure 1 illustrates how the module's voltage responds during a full charge and discharge cycle at a constant 10C rate and a stable temperature of 77°F (25°C). The charge curve rises gradually as capacity increases, then climbs sharply near the upper end of the state-of-charge window, reflecting the characteristic voltage plateau and final-stage voltage rise of LFP chemistry. The discharge curve begins at a higher voltage, then declines smoothly as capacity is used, followed by a steep drop as the cell approaches depletion. The horizontal cut-off line marks the minimum allowable voltage, below which the system will disconnect to protect the cells. Together, these curves show the usable voltage window, the efficiency of charge and discharge at high rates, and the predictable behavior of the chemistry under controlled thermal conditions.

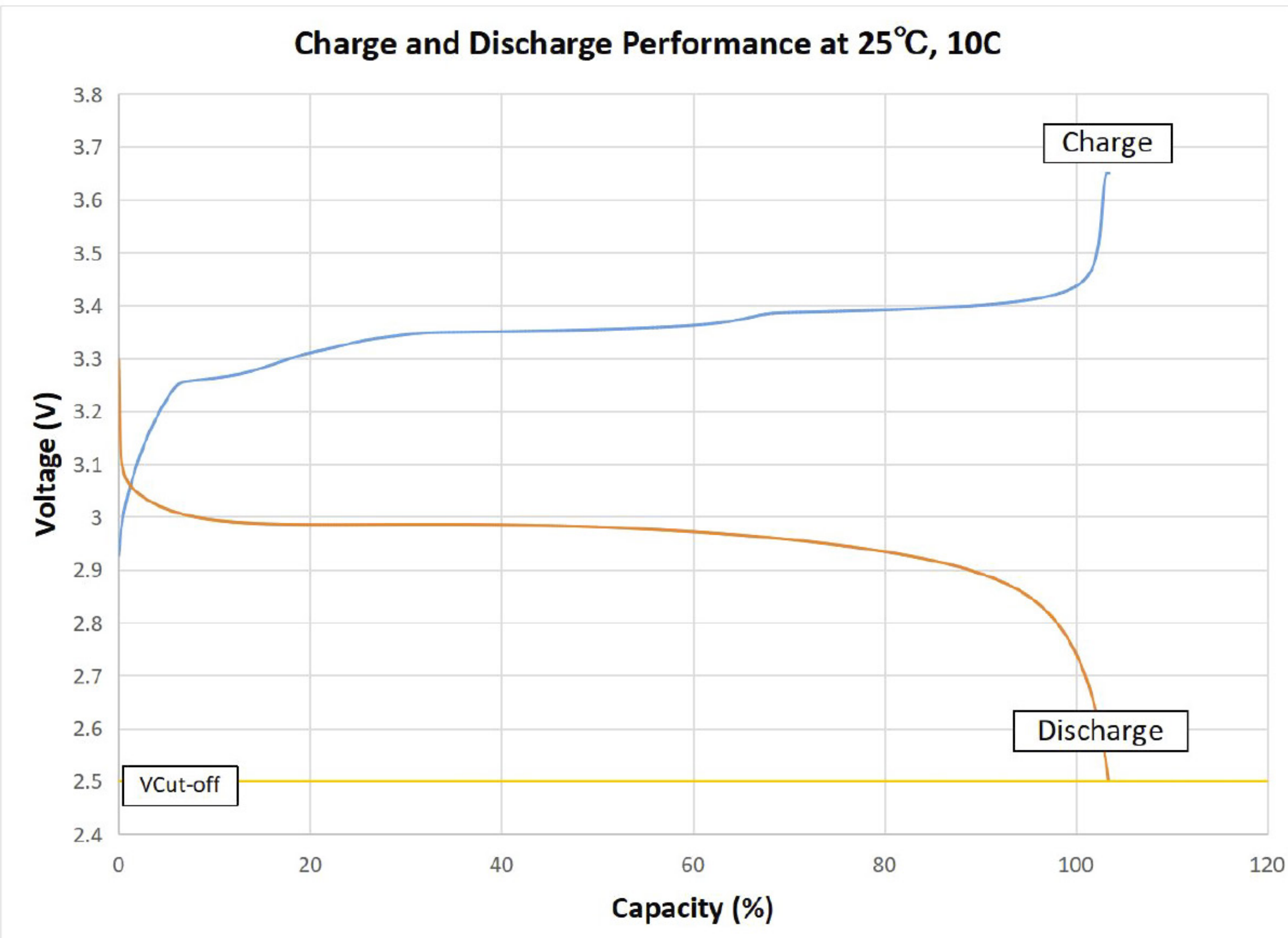



Figure 1: Charge and discharge voltage curves at 77°F (25°C) and 10C rate

## 5.2 Discharge performance at 77°F (25°C)

The discharge curves in figure 2 illustrate how cell voltage responds under different high-rate discharge conditions at a constant temperature of 77°F (25°C). As the discharge rate increases from 6C to 10C rate, the voltage declines more rapidly and the usable capacity slightly decreases, reflecting the increased internal resistance and polarization effects at higher loads. The cut-off voltage marks the lower operating limit, ensuring the cell is protected from over-discharge during high-power UPS events.

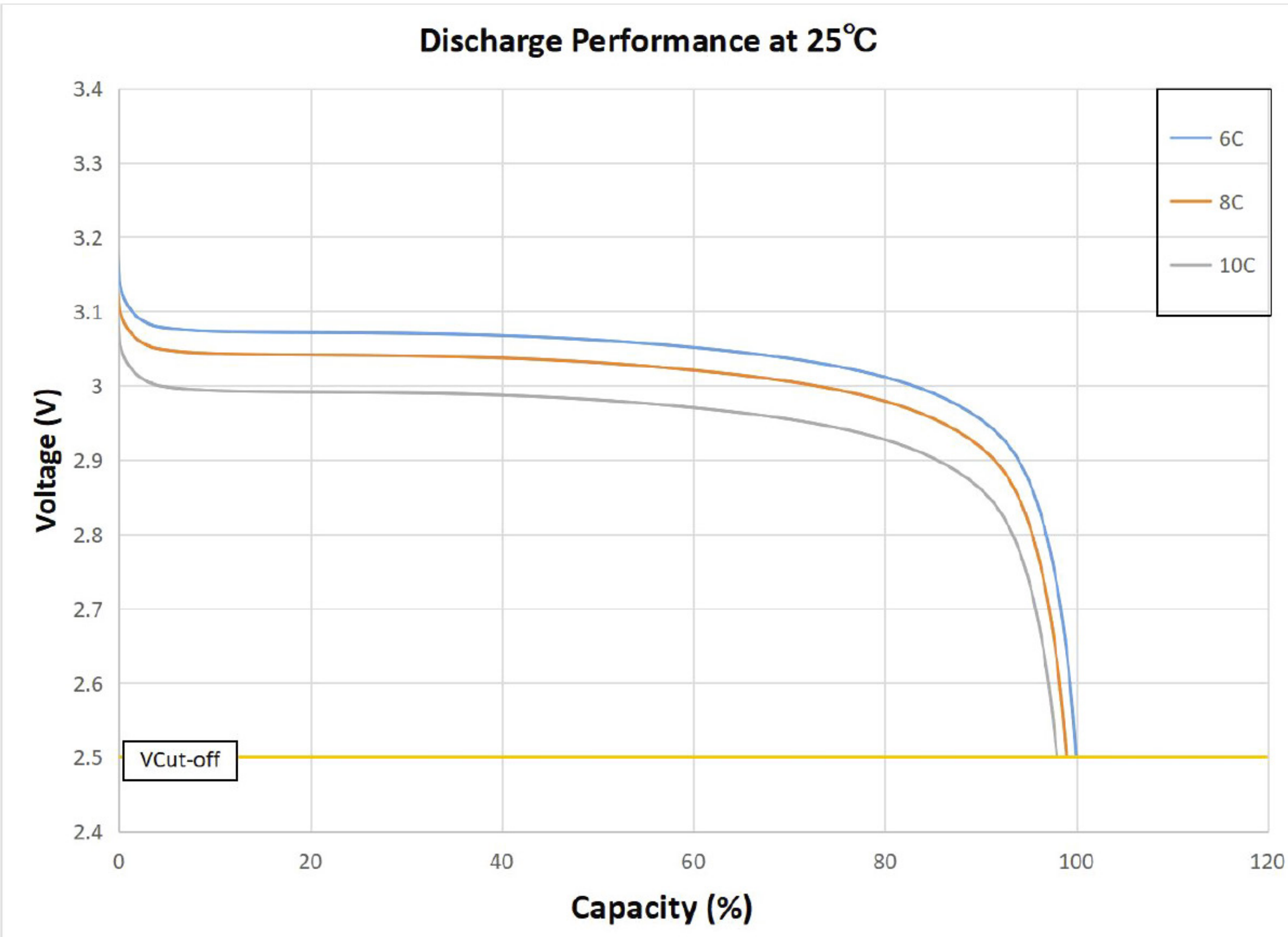



Figure 2: Discharge performance at 77°F (25°C)

## 5.3 Temperature effects on capacity

Figure 3 shows how available capacity varies with temperature when the cell is discharged at a 10C rate. Capacity increases steadily as temperature rises from sub-zero conditions, reaching its optimal range near 77°F (25°C), where electrochemical activity is most efficient. At lower temperatures, reduced ion mobility limits usable capacity, while higher temperatures provide marginal gains but may accelerate long-term aging. The curve highlights the importance of maintaining stable thermal conditions for predictable performance.

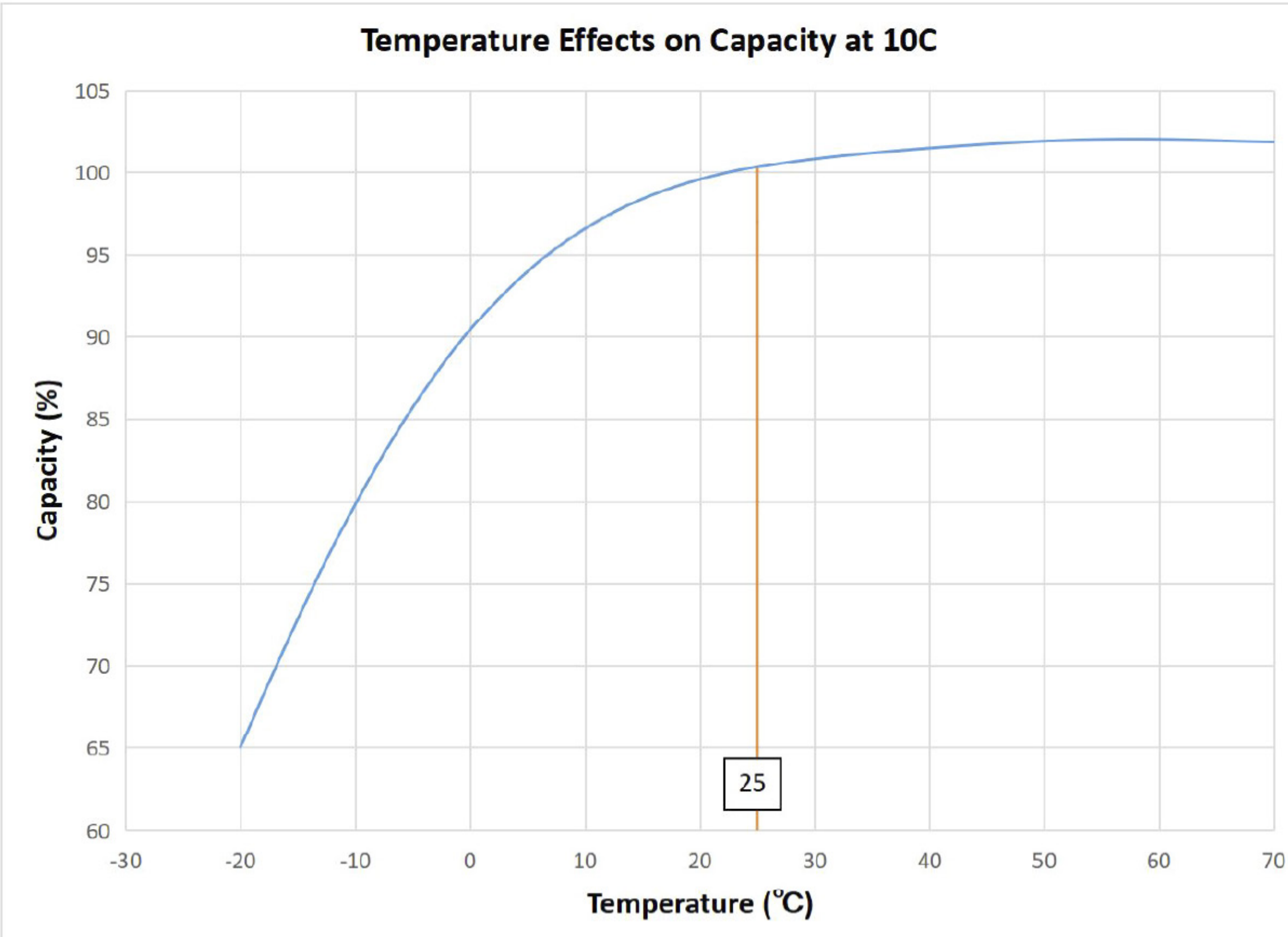



Figure 3: Temperature effects on capacity at 10C rate

## 5.4 Cycle life with depth of discharge

The cycle-life curves in figure 4 compare how different depths of discharge influence long-term capacity retention at 77°F (25°C). Shallower discharge cycles result in significantly slower capacity fade, while deeper cycles accelerate aging and reduce total cycle count. The relationship demonstrates the tradeoff between usable energy per cycle and overall service life, emphasizing the value of optimized discharge strategies in high-availability UPS applications.

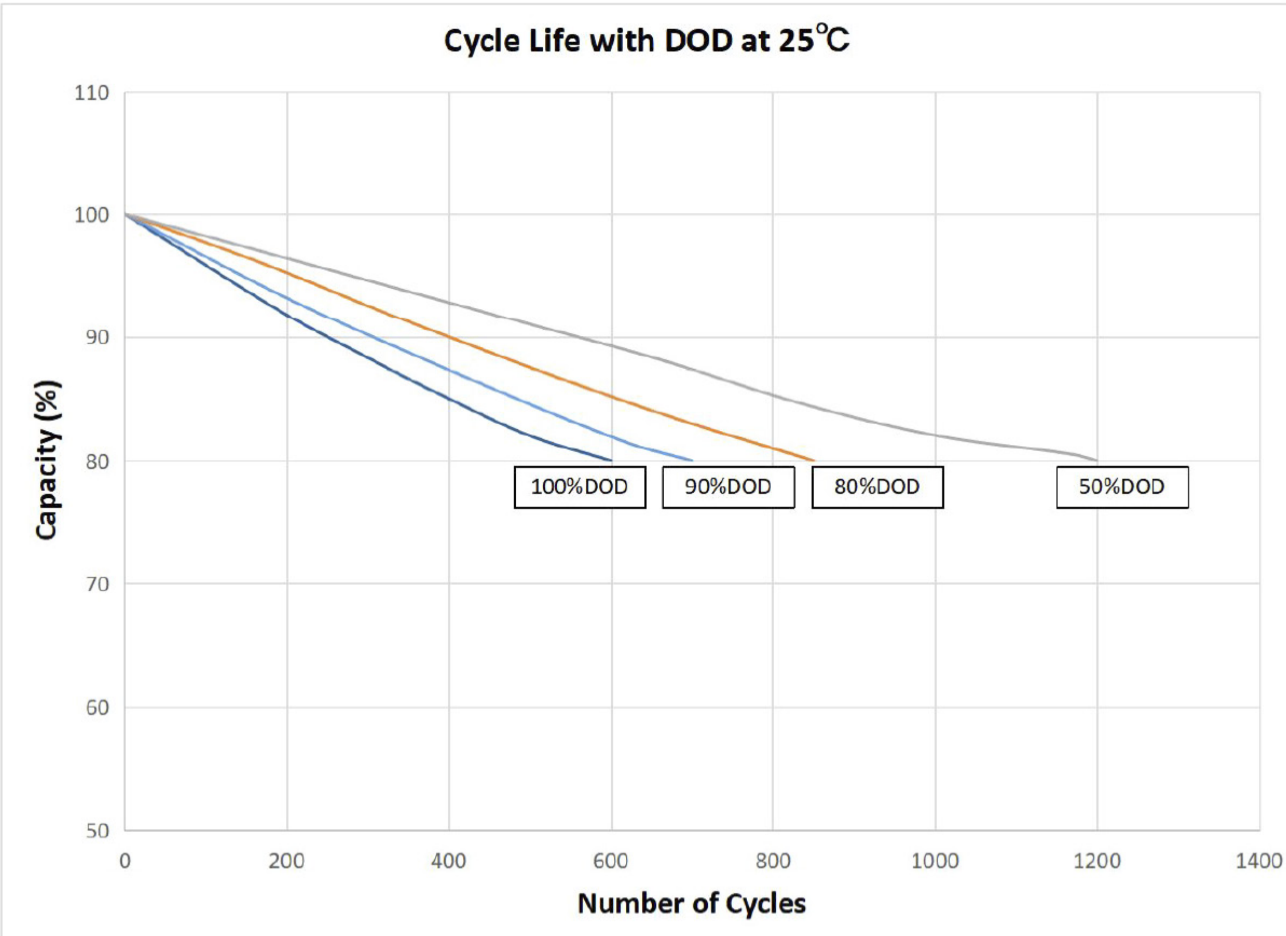



Figure 4: Cycle life at various depths of discharge.

# 6. Inspection

## 6.1 Packaging materials

The DataSafe Noir™ energy storage system and its associated modules are packaged to ensure safe transport and compliance with all applicable regulatory requirements for lithium-ion systems. EnerSys follows strict quality and environmental objectives from product development through final packaging, using materials that are recyclable or sourced from sustainable suppliers whenever possible. Energy storage systems are shipped on pallets in protective enclosures designed to prevent mechanical damage, moisture ingress, or terminal shorting during transport. All packaging conforms to the manufacturer's guidelines and relevant dangerous-goods handling standards.

## 6.2 Returns for service

The original shipping container and internal protective materials should be retained whenever possible. If the enclosure or any energy storage module must be returned for service, it should be repackaged in its original container to ensure safe transport and regulatory compliance. If the original packaging is unavailable, the product must be packed using certified lithium-ion transport materials with sufficient shock-absorbing protection to prevent damage during shipment. Refer to the Transportation section for additional requirements related to lithium-ion energy storage module handling and return logistics.

## 6.3 Checking for damage

Before unpacking, inspect the shipping container for signs of impact, puncture, moisture, or deformation. Note any visible damage and report it to the carrier immediately. After opening the container, inspect the enclosure and energy storage modules for dents, cracks, loose hardware, or other abnormalities. Continue the inspection for internal components once access panels are removed. If internal damage is suspected, notify the carrier and contact EnerSys for guidance before proceeding with installation.

## 6.4 Receipt of shipment

The contents of your shipment depend on the configuration and options ordered. All included items are listed on the packing slip and bill of materials, and the shipping labels identify the specific system configuration. Verify that the received equipment matches the documentation and that all components are present and undamaged.

## 6.5 Miscellaneous small parts

Review the bill of materials to confirm that all configuration kits, hardware sets, and accessory components are included. This may include communication harnesses, terminators, mounting hardware, and dry-contact connectors. If any discrepancies are found, contact EnerSys before beginning installation.

## 6.6 What's included

A typical shipment may include the following items, depending on configuration:

- DataSafe Noir™ energy storage system
- CAN communication cable
- CAN terminator plug
- Mounting hardware and fasteners
- Mating connectors for dry-contact interfaces
- Additional configuration kits as specified on the bill of materials.

# 7. Installation

## 7.1 Installation overview

Installing the DataSafe Noir™ energy storage system involves preparing the site, positioning and securing the system, completing all mechanical and electrical connections, and verifying system readiness before power-up. The work must be performed by qualified personnel familiar with high-voltage energy storage systems, UPS integration, and local electrical codes. The installation area must be a temperature-controlled indoor environment free of conductive dust, corrosive gases, moisture, or explosive atmospheres, with adequate floor loading capacity and the required front clearance for operation and maintenance.

The process begins with unpacking and inspection to confirm that the enclosure, modules, and accessories have not been damaged during transport. Once verified, the system is moved into position using a forklift and aligned with the pre-marked anchoring points. Expansion bolts are installed to secure the enclosure to the floor, and any protective shipping components—such as top covers, crossbeams, or internal bracing—are removed in the prescribed order.

After the system is mechanically secured, internal access panels are removed to allow installation of energy storage modules, copper busbars, grounding conductors, and communication harnesses. DC power cables, neutral conductors (if required by the UPS), and protective earth conductors are routed and terminated according to torque specifications. AC supply wiring for the BMS controllers is connected, followed by CAN, RS-485, and dry-contact communication lines. Parallel systems require DIP-switch addressing and coordinated system-to-system wiring.

Before closing the enclosure, all electrical connections must be inspected for correct polarity, proper torque, insulation integrity, and absence of foreign objects. Insulation resistance tests are performed on the system, modules, and output cables to confirm safe operating conditions. Once verified, all covers are reinstalled and the system is prepared for commissioning. Power-up begins with the first system in the address sequence, using the **DC Start** button or AC activation to initiate the self-check process. Each system is validated individually before enabling parallel operation and connecting to the UPS.

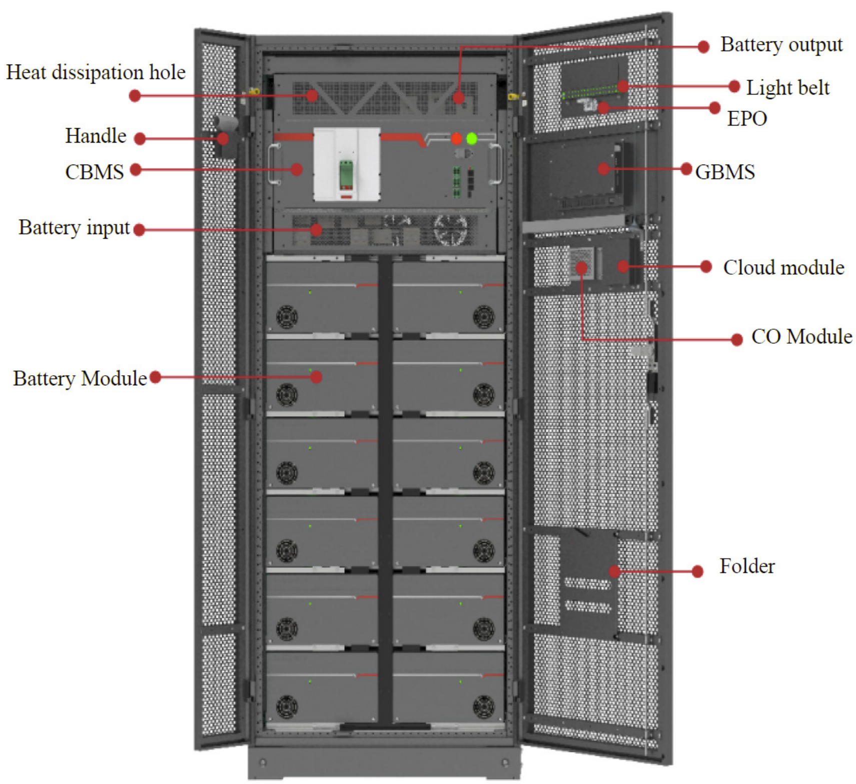



Figure 5: Energy storage system overview

## 7.2 Required tools and equipment

The following tools and equipment are required for installation, inspection, electrical work, and commissioning.

### Personal protective equipment

- Insulated gloves suitable for high-voltage work
- Safety goggles or face shield
- Insulated safety shoes
- ESD wrist strap
- Protective clothing appropriate for electrical environments

### Electrical test instruments

- Multimeter with DC voltage and continuity ranges
- Clamp meter
- Insulation resistance meter (megohmmeter)
- Laptop computer for BMS configuration and monitoring software

### Mechanical and installation tools

- Forklift or pallet jack for enclosure positioning
- Impact drill for floor anchoring
- Drill bits sized for expansion bolts
- Expansion bolts appropriate for the installation surface
- Socket spanners in required sizes
- Torque wrench capable of meeting all torque specifications (M4 through M16)
- Cross-head screwdriver
- Slot-type (flat) screwdriver
- Electric screwdriver
- Wire stripper
- Crimping tool for DT-style cable terminals
- Wrenches for M4, M5, M6, M8, M10, M12, and M16 fasteners
- Marking tools for layout and alignment
- Cleaning materials for copper busbar contact surfaces

### Cable and connection materials

- DT-style crimp terminals sized for the required cable gauges
- Heat-shrink tubing or insulation sleeves
- Cable ties for routing and bundling
- Labels for identifying DC, AC, communication, and grounding conductors

### Safety and site equipment

- Fire-fighting equipment (fire sand, $CO_2$ extinguisher)
- Lockout/Tagout devices
- Grounding straps and bonding conductors

- Flashlight or inspection light
- Dust covers for systems awaiting commissioning

## 7.3 Recommended DC and PE cable sizes

The following table provides the recommended conductor sizes for connecting the DataSafe Noir™ energy storage system to the UPS DC terminals. Cable sizing is based on system output power, allowable voltage drop, and UL-aligned installation requirements. Installers must also comply with NEC Article 310, local electrical codes, and the UPS manufacturer's terminal specifications.

Table E: Recommended DC and PE cable sizes

<table>
<tr><th>Cable</th><th>Connection method</th><th>300 kW<<br>P ≤ 400 kW</th><th>400 kW<<br>P ≤ 500 kW</th><th>500 kW<<br>P ≤ 600 kW</th><th>Bolt size</th><th>Torque</th></tr>
<tr><td>BAT+</td><td rowspan="4">Crimped DT terminal</td><td rowspan="3">2 × 350 kcmil (185 mm²)</td><td rowspan="3">2 × 500 kcmil (240 mm²)</td><td rowspan="3">2 × 500 kcmil (240 mm²)</td><td rowspan="3">M16 × 50</td><td rowspan="3">88.5 ft-lb (120 N·m)</td></tr>
<tr><td>N (if required)</td></tr>
<tr><td>BAT–</td></tr>
<tr><td>PE</td><td>300 kcmil (150 mm²)</td><td>350 kcmil (185 mm²)</td><td>500 kcmil (240 mm²)</td><td>M12 × 30</td><td>34.7 ft-lb (47 N·m)</td></tr>
<tr><td colspan="7">Notes:<br>• The neutral (N) conductor is required only for UPS models that use a DC-side neutral reference.<br>• Bolt sizes and torque values apply to the system terminals. Refer to the UPS installation manual for the correct hardware at the UPS end.<br>• Conductors must be copper, stranded, and rated for the installation environment (THHN/THWN-2 or XHHW-2 recommended).</td></tr>
</table>

### 7.3.1 North American conductor size reference

The following table provides a reference between common North American conductor sizes and their approximate cross-sectional area. Use this table for interpretation only. Cable sizing must follow the requirements in this guide, NEC Article 310, local electrical codes, and the UPS manufacturer's instructions.

Table F: AWG/kcmil to Cross-sectional area

| Conductor size | Cross-sectional area |
|---|---|
| 3/0 AWG | 85.0 mm² |
| 4/0 AWG | 107.2 mm² |
| 250 kcmil | 126.7 mm² |
| 300 kcmil | 152.0 mm² |
| 350 kcmil | 177.3 mm² |
| 400 kcmil | 202.7 mm² |
| 500 kcmil | 253.3 mm² |

**Notes:**

This table is for cross-sectional reference only. It does not define ampacity or suitability for a specific installation.

## 7.4 Pre-installation checks

1. **Verify site conditions.**

   Confirm the room is indoors, temperature-controlled, dry, free of conductive or corrosive dust, and suitable for high-voltage equipment. Check that floor loading capacity is adequate for the system weight.

   Also verify:

   - Relative humidity is between 5 and 95%, with no condensation.
   - The battery system has not been stored in a low-charge state; establish a replenishment plan if required.
   - The battery-room fire-protection system complies with local requirements.
   - Fire-suppression equipment (such as fire sand or $CO_2$ extinguishers) is available if required by local construction standards.

2. **Confirm clearances and layout.**

   Ensure the planned location provides the required front clearance for operation and maintenance and allows the enclosure to be anchored to a solid, non-combustible surface.

3. **Review documentation.**

   Read the safety instructions, installation section, and wiring diagrams before starting work. Confirm that all required tools, PPE, and materials are available.

4. **Inspect packaging.**

   Before opening, check the enclosure and module packaging for visible damage. If damage is found, stop and report it according to site procedures.

5. **Verify environmental readiness.**

   - Implement a dust-prevention plan if the system will not be powered immediately.
   - Keep the dust cover in place until the system is ready for operation.
   - Confirm anti-condensation controls are established if required by site conditions.

## 7.5 Unpacking and inspection

1. **Unpack the energy storage system.**

   Remove external packaging carefully. Do not damage the system surface, labels, or wiring.

2. **Inspect the enclosure exterior.**

   Check for dents, deformation, broken panels, or damaged paint that could indicate mechanical stress.

3. **Verify accessories.**

   Confirm that all accessories are present: bolts, panels, busbars, communication cables, covers, and documentation.

   Accessory kit list:

   | | |
   |---|---|
   | Battery module bracket | EPO device |
   | Battery module panel | EPO cable and communication terminal |
   | BMS sheet metal cover | GBMS light strip |
   | Copper bar No. 1 (10) | GBMS power cable |
   | Copper bar No. 2 (2) | GBMS network cable |
   | Copper bar No. 4 (1) | Light strip power cable |
   | CBMS power cable | Power cable |
   | Communication cable (11) | Positive and negative terminal insulation bracket |

4. Unpack energy storage modules (if shipped separately).

Inspect each module for damage, loose connectors, or visible defects. Do not install any damaged module.

## 7.6 Positioning and anchoring the enclosure

1. **Mark the installation position.**

   On the floor, mark the enclosure footprint and anchor hole locations according to the dimensional drawing.

   Confirm the marked position aligns with the approved layout and project drawings.

2. **Drill anchor holes.**

   Drill holes for the expansion bolts at the marked positions. Ensure hole depth and diameter match the anchor specifications.

   Ensure expansion-bolt holes are flush and do not protrude above the floor surface.

3. **Move the system into place.**

   Using a forklift or suitable lifting equipment, move the system from the pallet to the installation position. Align it with the anchor holes.

   Verify the floor surface is level, non-combustible, and capable of supporting the system weight.

4. **Install expansion bolts.**

   Insert and tighten the expansion bolts to secure the enclosure to the floor. Ensure the enclosure is level and stable.

   Confirm the enclosure cannot tilt under vibration or mechanical disturbance.

5. **Remove shipping protection.**

   Remove any temporary top covers, crossbeams, or internal transport braces as specified. Keep removed hardware for reference or reuse if required.

   Photograph cabinet alignment before electrical connections are installed.

6. **Parallel-cabinet alignment (if applicable).**

   When installing multiple enclosures, align adjacent cabinets and secure them using parallel-cabinet panels as required by the configuration.

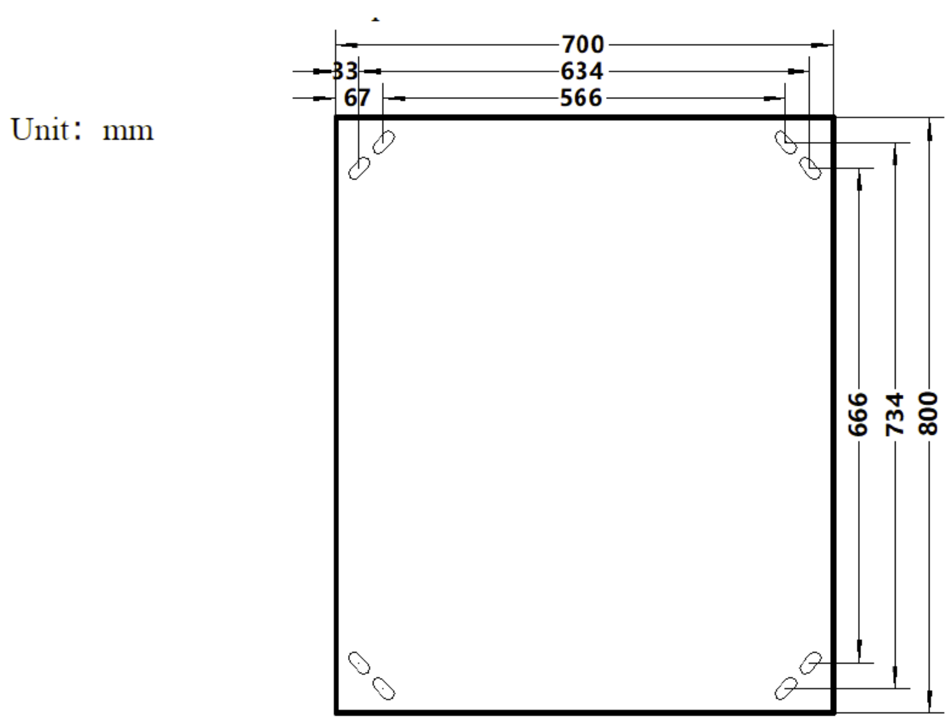



Figure 6: Positioning and anchoring the system

## 7.7 Internal preparation

1. **Open the enclosure doors and covers.**

   Unlock and open the front door. Remove internal covers for the CBMS, GBMS, and module compartments as needed.
2. **Verify internal components.**

   Confirm that the CBMS, GBMS, internal wiring harnesses, and mounting rails are present and undamaged.
3. **Prepare cable routes.**

   Identify and clear the intended paths for DC cables, optional AC supply, communication lines, and grounding conductors. Separate power and communication routes.

## 7.8 Cable connections

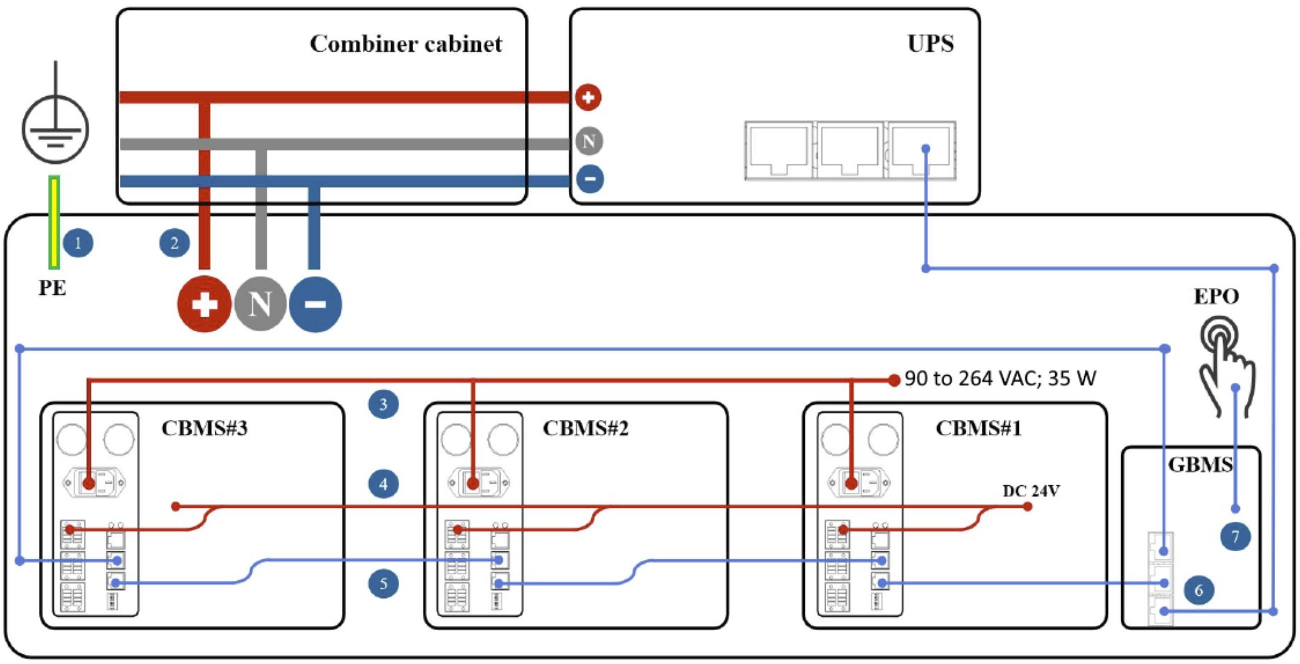



Figure 7: Cable connections

This section describes the required grounding, DC bus, communication, and auxiliary power connections for the DataSafe Noir™ system. All wiring must comply with local electrical codes and EnerSys installation requirements.

### 7.8.1 Cable routing best practices

To ensure safe and reliable operation, follow these cable-routing principles during installation:

- **Separate power and signal wiring:** Maintain physical separation between DC bus cables, AC supply wiring, and communication lines to reduce electrical noise and prevent interference.

  Communication cables must never be tied together with power cables.
- **Avoid crossing AC and DC paths:** Where crossing is unavoidable, cross at 90 degrees to minimize coupling.
- **Maintain proper bend radius:** Do not sharply bend or compress cables. Follow manufacturer bend-radius requirements for all conductors.
- **Protect cable insulation:** Ensure cables are not pinched under cover plates or routed across sharp edges. Inspect cable insulation for damage before routing; repair or replace damaged insulation before proceeding.

- **Support and secure cables:** Use cable ties or clamps to maintain neat routing and prevent strain on terminals.
- **Keep cable paths clear:** Do not route cables across ventilation openings, hinge paths, or service access areas.

These practices support long-term reliability and reduce the risk of communication faults, insulation wear, and installation-related failures.

## 7.8.2 Connection overview

The system uses:

- High-voltage DC bus connections
- Protective earth (PE)
- Isolated CAN and RS-485 communication buses
- Auxiliary AC and DC supplies

Before making any connections:

- Verify insulation resistance meets specification (greater than 2 megaohm to ground)
- Confirm polarity and torque values
- Ensure the UPS is isolated from all upstream sources
- Follow Lockout/Tagout procedures
- Verify the grounding conductor is installed first and removed last
- Confirm UPS documentation for N-conductor requirements before wiring.

Table G: Cable connections

| Cable type | Figure ID | Source component/port | Destination component/port | Description |
|---|---|---|---|---|
| **Protective grounding conductor** | **1** | Cabinet » PE | Facility grounding point » PE | Bonds the cabinet to the site grounding system for safety and fault-current protection. |
| **DC bus cables (BAT+, N, BAT–)** | **2** | CBMS » BAT+, N, BAT– | UPS or Combiner Cabinet » BAT+, N, BAT– | Main DC power path between the battery system and the UPS. Carries charge and discharge current. |
| **AC supply cable** | **3** | CBMS » AC | Customer AC source » AC | Provides auxiliary AC power to the CBMS control electronics. |
| **24VDC auxiliary power cable** | **4** | CBMS » V+/V– | GBMS » 24V/GND | Supplies low-voltage DC power from the CBMS to the GBMS controller and display. |
| **CBMS-to-GBMS communication cable** | **5** | CBMS » COM1 | GBMS » CBMS1 | Transfers module-level operating data and alarms from the CBMS to the GBMS. |
| **GBMS-to-UPS communication cable** | **6** | GBMS » COM2 | UPS » COM | Provides system-level communication between the GBMS and the UPS for alarms and operational coordination. |
| **GBMS internal signal cable** | **7** | GBMS » I1 | GBMS » I1 | Internal GBMS I/O signal used for system coordination. Not customer-accessible. |

### 7.8.3 Ground connection (PE)

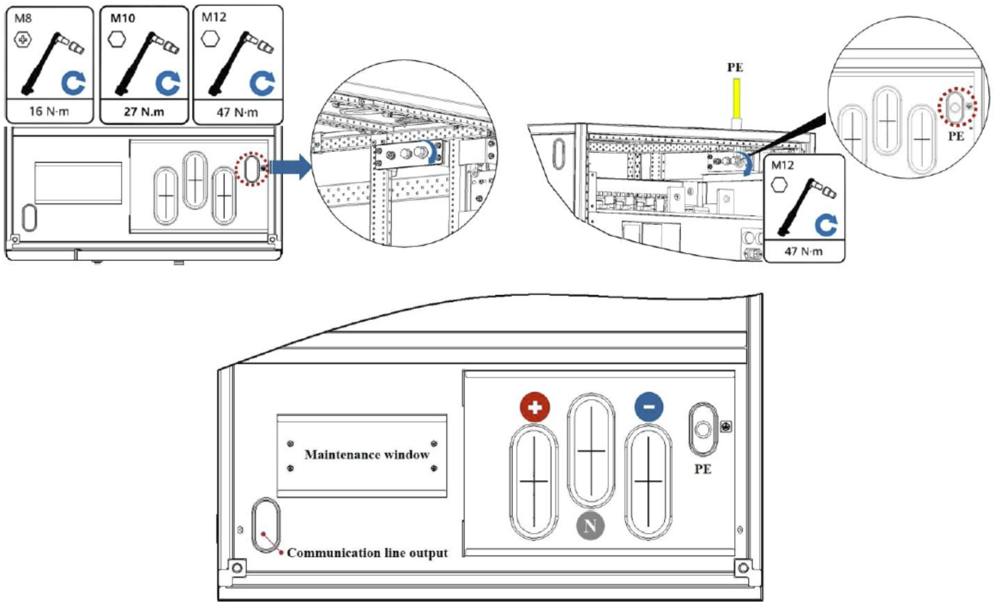



Figure 8: Protective earth (PE) connection

A verified protective earth connection must be established before any other wiring.

- **PE conductor size:** 500 kW to 600 kW: 500 kcmil (240 mm²)
- **Ground resistance requirement:** Less than 0.1 ohm
- **Terminal hardware:** M12 × 30 bolt
- **Torque:** 35 to 42 ft-lb (47 to 55 N·m)

The enclosure contains high leakage current. The PE conductor must be connected first and removed last.

### 7.8.4 DC bus connections (BAT+/BAT–/N)

The system DC bus connects the energy storage modules to the UPS.

**Recommended conductor size:** 300 to 500 kcmil (150 to 240 mm²)

**Terminal hardware:** M16 × 50 bolt

**Torque:** 89 to 96 ft-lb (120 to 130 N·m)

- Maintain correct polarity at all times
- DT terminals must be crimped using the correct tooling and oriented so the installation surface is parallel to the copper bar
- Do not route communication cables with power conductors
- Neutral (N) is required only if the UPS specifies a neutral reference.
- Verify N-conductor requirements directly from the UPS manual before installation.

### 7.8.5 Communication wiring (CAN/RS-485)

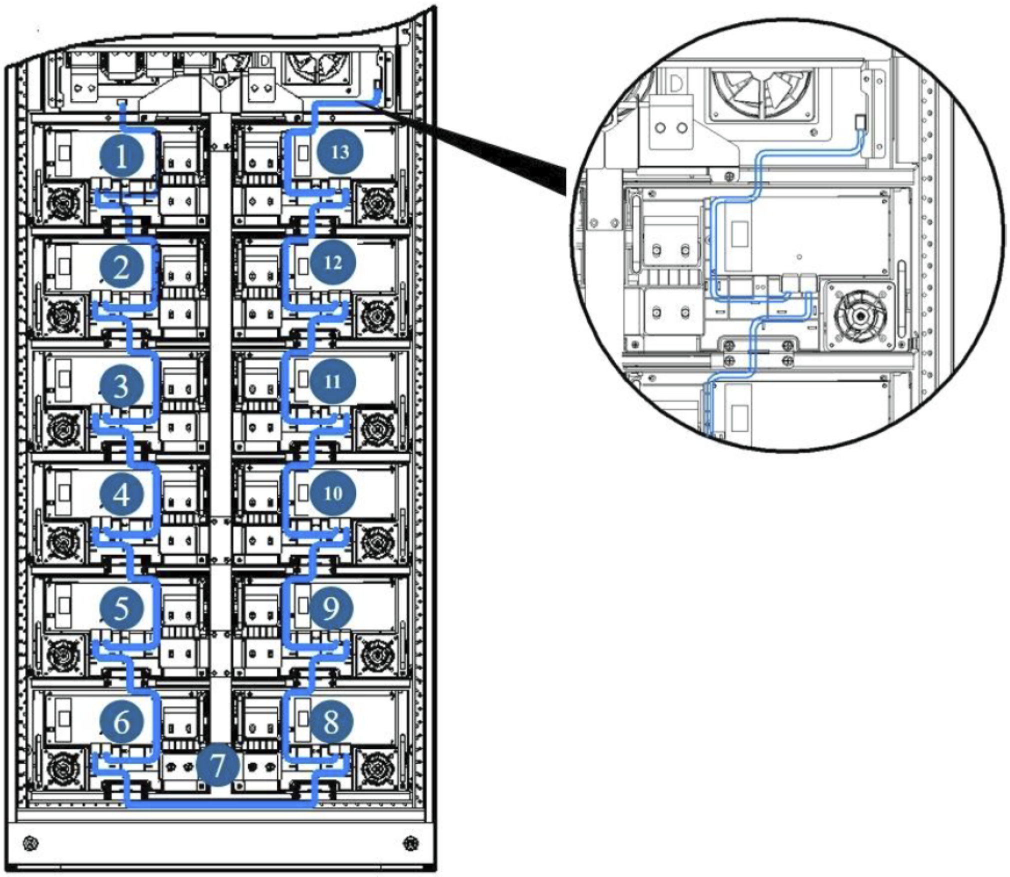



Figure 9: Module communication wiring

The system uses isolated communication buses for module-level and system-level control.

- **CAN bus:** Shielded twisted pair, 120 ohm termination at endpoints
- **RS-485:** Shielded twisted pair, daisy-chain topology
- Maintain separation from DC power cables
- Do not exceed manufacturer-specified cable lengths
- Ensure correct addressing for parallel systems
- Communication cables must not be bundled, tied, or routed in parallel with DC power conductors

### 7.8.6 Internal cabinet interconnections

Internal wiring includes:

- Module-to-module communication
- CBMS » GBMS communication
- 24 VDC auxiliary power distribution
- Dry-contact signaling (charge enable, discharge enable, alarm)

All internal wiring must follow the system addressing sequence and communication topology.
Remove the CMBS cover plate and battery module cover plate.

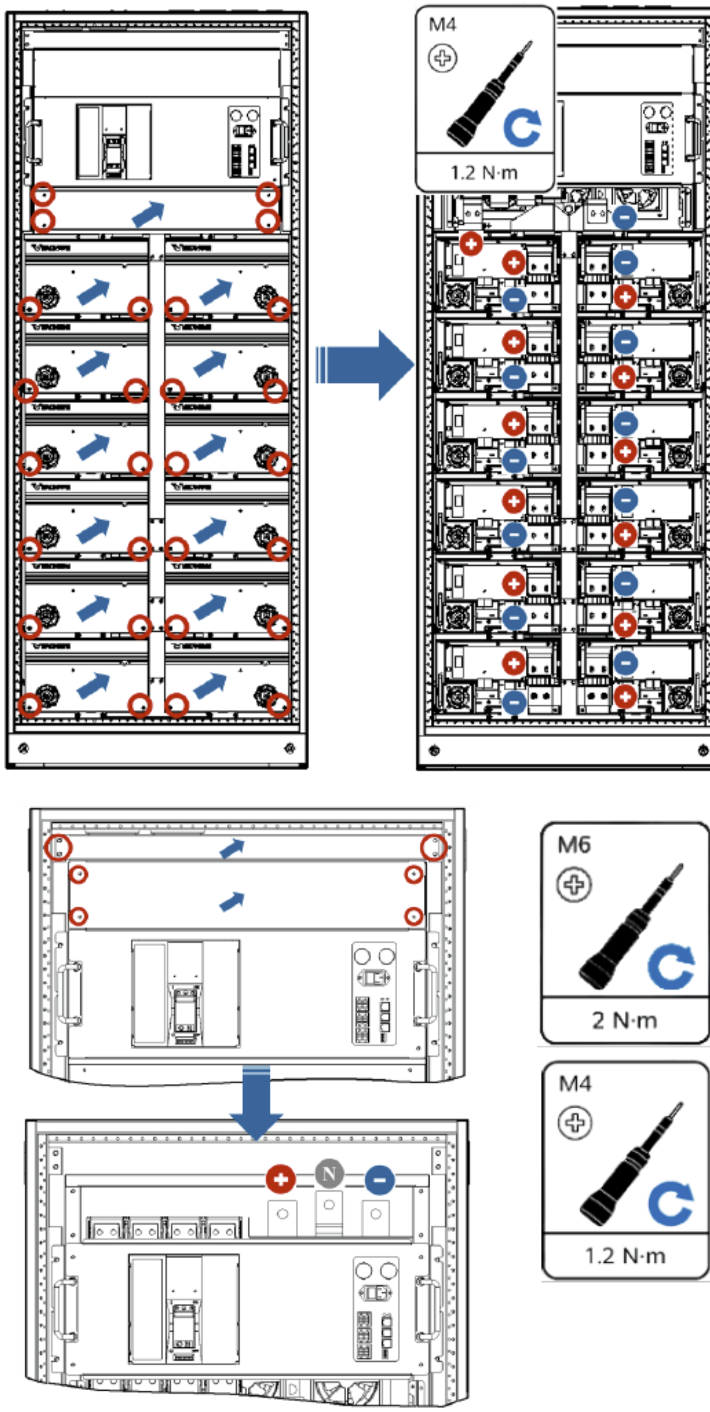



Figure 10: Internal module-to-module interconnection layout

### 7.8.7 Auxiliary power connections

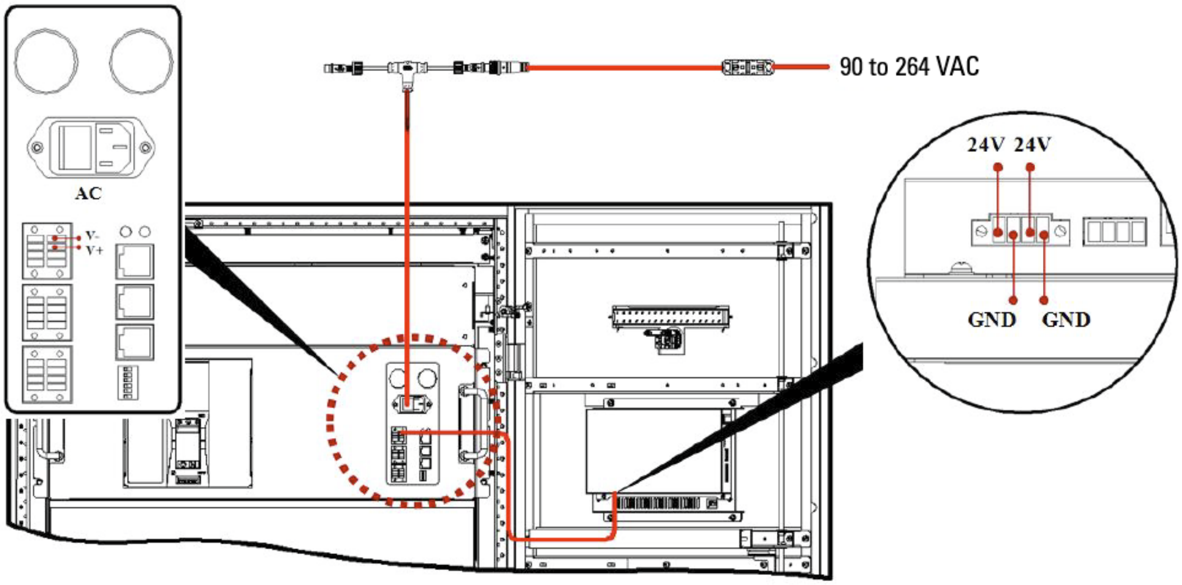



Figure 11: Auxiliary power connections (90 to 264 VAC and 24 VDC)

The BMS requires:

- **AC supply:** 90 to 264 V; 35 W; auxiliary AC supply connection is optional
- **24 VDC supply:** CBMS » GBMS

Verify correct voltage before energizing the system.

### 7.8.8 UPS integration

The system supports communication with the UPS through:

- CAN
- RS-485
- Dry contacts

UPS parameters must be configured to match:

- Charge voltage
- Charge current
- Protection thresholds
- Dry-contact enable logic

Refer to the UPS manufacturer's documentation for parameter mapping. See also Chapter Figure 7: Cable connections.

## 7.9 Energy storage module installation

1. **Install energy storage modules in sequence.**

   Slide each module into its designated position, typically from bottom to top, following the module numbering scheme. See Chapter Figure 9: Module communication wiring for more information.
2. **Secure modules mechanically.**

Fasten each module according to the specified torque values. Ensure modules are fully seated and cannot move under vibration.

3. **Connect module communication cables.**

   Connect the communication cables between modules in the prescribed order (usually top-to-bottom daisy chain) and from the module chain to the CBMS or GBMS.

## 7.10 DC busbar and grounding installation

1. **Install DC busbars.**

   Position and install the copper busbars between module terminals in the specified sequence. Avoid contact between busbars and the enclosure chassis.

2. **Torque DC connections.**

   Tighten all DC terminal and busbar bolts to the specified torque values. Use a torque wrench and follow the recommended sequence.

3. **Install grounding conductors.**

   Connect the enclosure protective earth terminal to the building grounding system. Verify that the connection is secure and accessible.

   Ground resistance between the enclosure PE point and the facility grounding system must be less than 0.1 ohm.

4. **Check for clearances and insulation.**

   Confirm that no busbar or cable insulation is damaged and that no conductive parts are touching the enclosure where they should not.

   Inspect all copper-bar insulation sleeves; repair or replace any damaged insulation before proceeding.

## 7.11 AC supply and auxiliary wiring

**Note: AC supply is not required for standard operation. When used, the AC output voltage must be selected and ordered correctly.**

1. **Connect AC supply to CBMS/GBMS.**

   Route and terminate the AC supply conductors to the designated terminals for the BMS power input, following local electrical codes.

2. **Connect 24VDC auxiliary power.**

   Wire the 24VDC supply from the CBMS to the GBMS as indicated in the wiring diagram.

3. **Secure all AC and auxiliary cables.**

   Bundle and tie cables neatly, maintaining separation between power and communication wiring.

## 7.12 Communication and UPS integration

1. **Install communication cables.**

   Route and connect CAN, RS-485, and Ethernet cables between the system, UPS, and any monitoring or EMS systems. Use shielded cable where specified.

   Verify the UPS communication port type (CAN, RS-485, or Ethernet) and confirm termination requirements before wiring.

   Confirm whether the UPS requires a neutral (N) reference for communication or control circuits and check this against the UPS documentation.

2. **Connect dry contacts.**

   Wire dry-contact signals (such as charge enable, discharge enable, and alarms) between the system and the UPS or monitoring system as required.

Verify dry-contact logic (NO/NC) and polarity according to the UPS manufacturer's specification.

Confirm Emergency Power Off (EPO) interface requirements if the UPS uses an external EPO circuit.

3. **Set system addresses (if parallel).**

   Configure DIP switches on CBMS/GBMS to assign unique addresses to each system in a parallel system.

   Verify addressing order matches the communication topology and that termination resistors are set correctly at endpoints.

4. **Label all connections.**

   Clearly label DC, AC, communication, and grounding cables at both ends for future maintenance and troubleshooting.

   Record the UPS model, rating, and DC input connection point as part of installation documentation.

### 7.12.1 Dry contact I/O functions

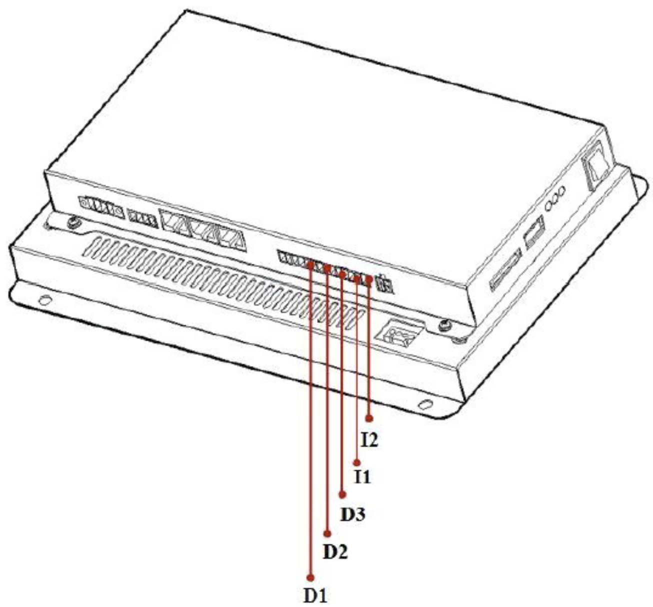



Figure 12: Dry contacts

| Table H: Dry contact I/O functions | | |
|---|---|---|
| **Dry contact** | **Definition** | **Description** |
| D1 | Charge inhibit/charger shutdown | Closes when the system requires charging to stop. This may occur when the system is fully charged, when cell voltage or temperature limits are reached, or when charging is otherwise restricted by the BMS. The UPS should stop charging when this contact closes. |
| D2 | Battery cabinet breaker (BCB) status | Closes when one or more battery cabinet breakers have opened or when available discharge capacity is reduced. Indicates that the system may not be able to support full UPS load. |
| D3 | BMS breaker (MCB) trip indication | Closes when the BMS-controlled breaker has tripped or been manually opened. Signals that the cabinet is electrically isolated and requires inspection before returning to service. |
| I1 | External EPO input | When closed by an external device (UPS, EPO circuit, or facility system), all cabinet breakers open and the system disconnects from the UPS. Used for emergency shutdown. |

| | | |
|---|---|---|
| I2 | Reserved | Reserved for future use. No function assigned. |
| **Dry contact wiring requirements:** Use 18 to 16 AWG (1.0 to 1.5 mm²) conductors for all dry-contact connections. | | |

## 7.12.2 DIP-switch addressing

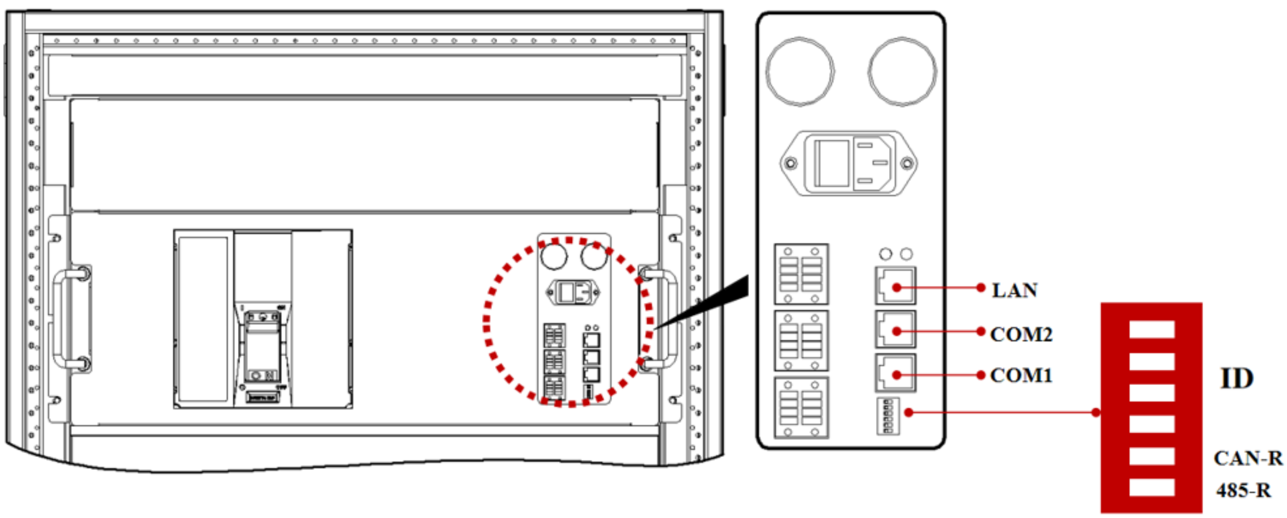



Figure 13: DIP-switch location

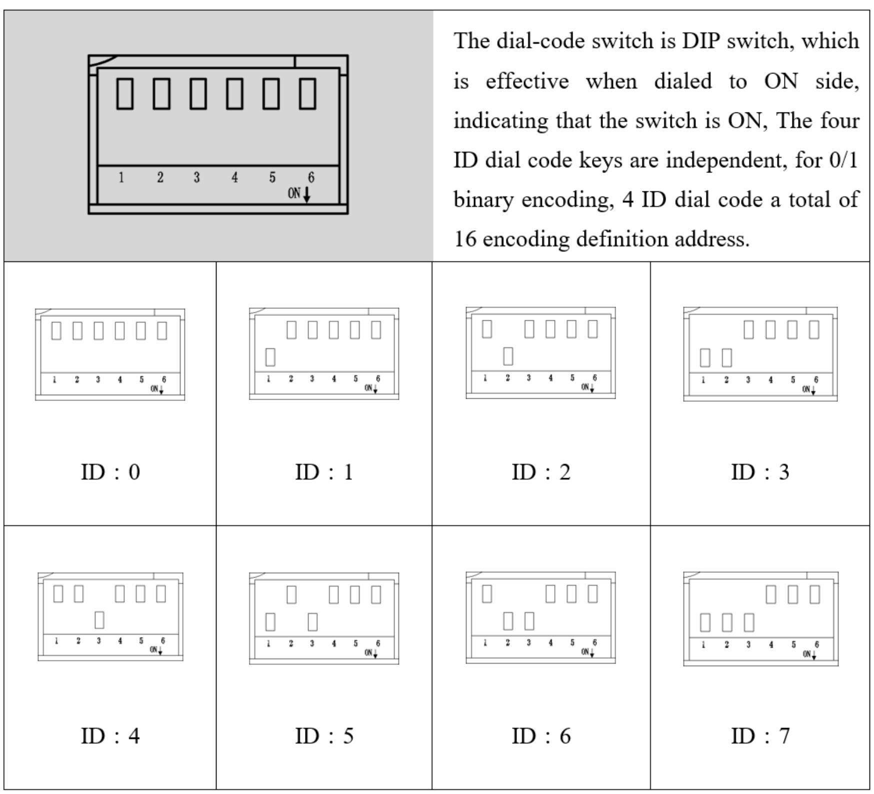



Figure 14: DIP-switch address settings (IDs 0 to 7)

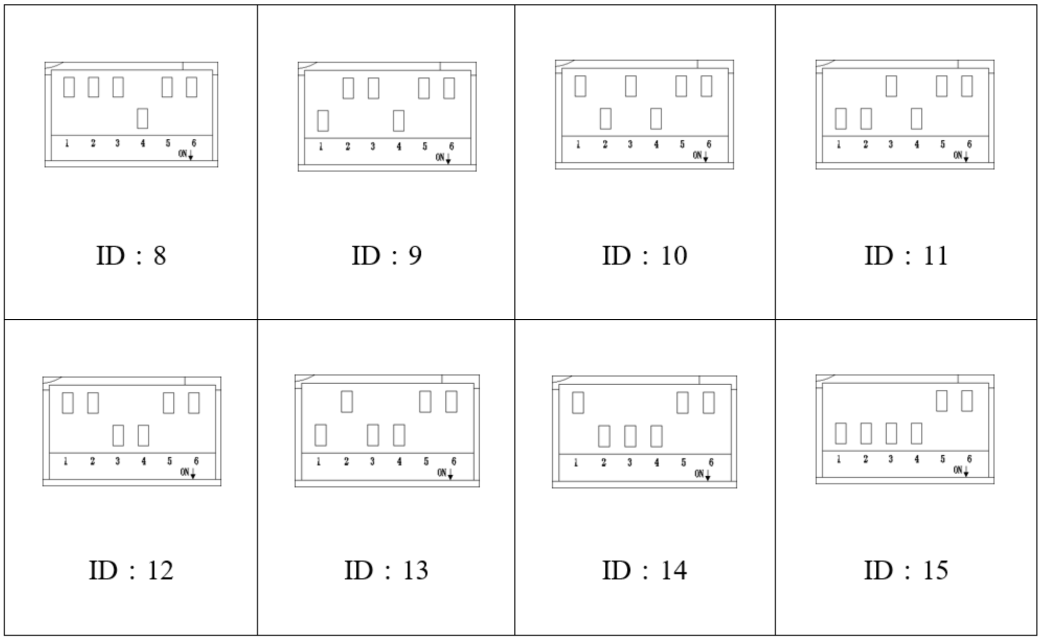



Figure 15: DIP-switch address settings (IDs 8 to 15)

## 7.13 CBMS and GBMS configuration

### DIP-switch addressing

Each cabinet must be assigned a unique address for correct system-level communication.

- Address 1 » First cabinet
- Address 2 » Second cabinet
- Continue sequentially for all cabinets in the system

DIP-switch positions follow binary encoding. Only one address may be active per cabinet.

### Communication mode

- CBMS and GBMS use isolated CAN for internal communication.
- GBMS uses RS-485 or CAN for UPS integration depending on UPS model.
- Ensure all communication cables are shielded and routed separately from power conductors.

### 24 VDC auxiliary power

The CBMS supplies 24 VDC to the GBMS. Verify correct polarity before energizing.

### 7.13.1 CBMS DIP-switch setting for a single cabinet

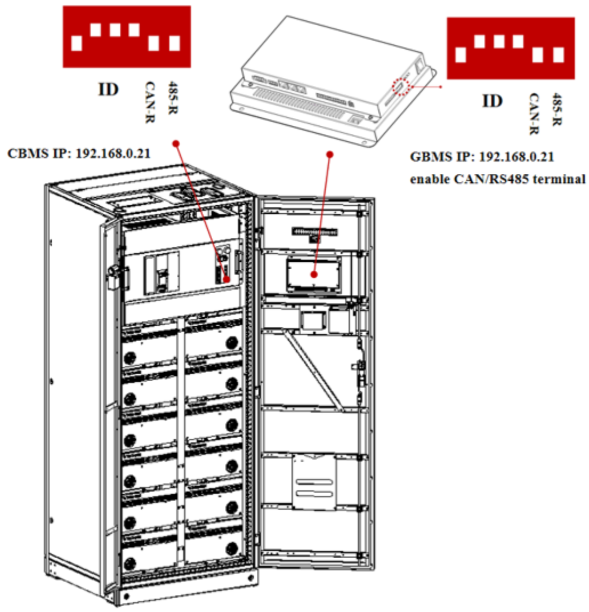



Figure 16: CBMS DIP-switch setting for single cabinets

### 7.13.2 CBMS DIP-switch setting for a multiple cabinet setup

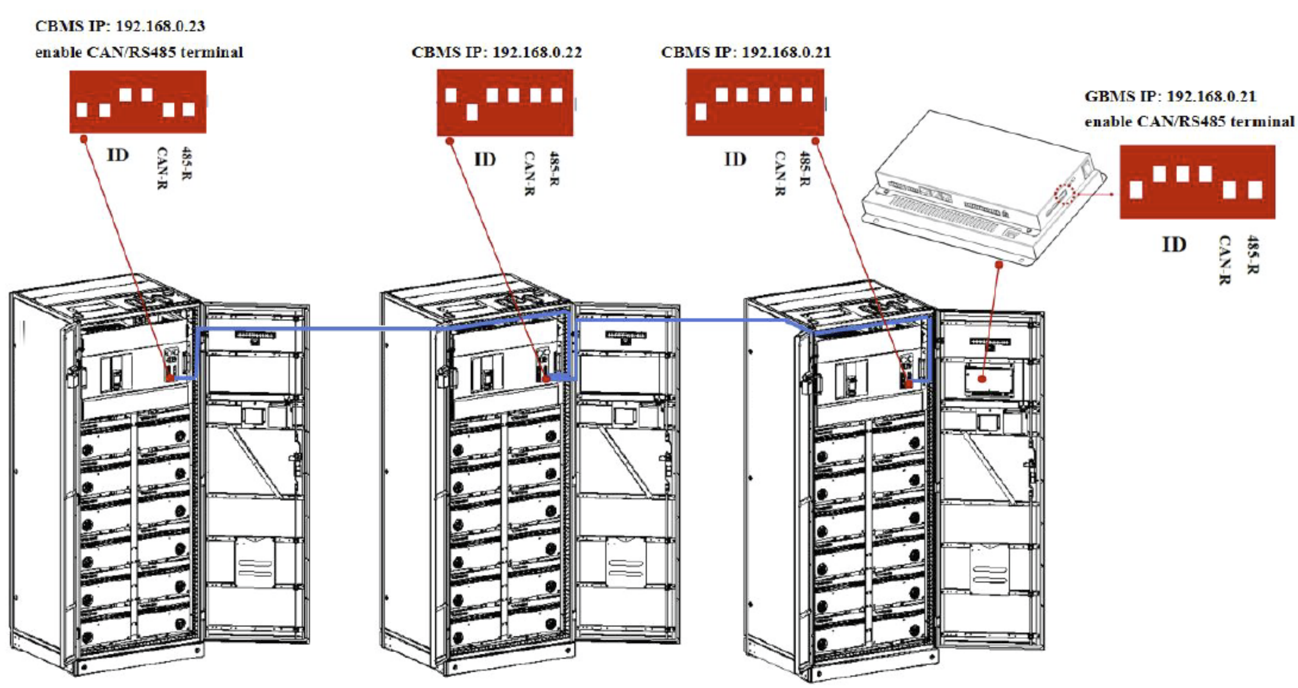



Figure 17: CBMS DIP-switch setting for multiple cabinets

## 7.14 Parallel cabinet wiring overview

For systems installed in parallel:

- Connect each cabinet's DC output (BAT+, BAT–, and N if required by the UPS) to the combiner cabinet using appropriately sized conductors. The wire lengths should be the same length for each cabinet.
- Connect the combiner cabinet output to the UPS DC input terminals.
- Neutral conductor (N) is only required for UPS models that specify a neutral connection.
- Ground each cabinet individually to the facility grounding system; do not daisy-chain protective earth conductors.
- **Addressing:** Set CBMS and GBMS DIP-switch addresses according to the system configuration to ensure proper communication sequencing.

## 7.15 Electrical verification and insulation checks

1. **Verify polarity and connections.**

   Using a multimeter, confirm correct polarity at module terminals, busbars, system DC output, and UPS connection points.
2. **Measure insulation resistance.**

   Use an insulation resistance meter to check insulation between DC conductors and ground, and between conductors where specified. Confirm values meet the minimum requirements.
3. **Check ground continuity.**

   Verify that the resistance between the enclosure ground and the building ground is within the specified limit.
4. **Inspect for foreign objects.**

   Ensure there are no loose tools, hardware, or debris inside the enclosure.

### 7.15.1 Insulation and polarity verification requirements

Before energizing the system, verify the following electrical conditions:

- **Module-to-cabinet insulation:** Measure the voltage between each module's positive and negative terminals and the unpainted cabinet frame. Readings must decay to within 1 VDC, indicating acceptable insulation.
- **Output-cable insulation resistance:** Measure insulation resistance between BAT+, BAT–, and N (if used) and the cabinet ground. Values must be greater than 2 megaohms.
- **Correct polarity:** Confirm that BAT+, BAT–, and N (if applicable) are correctly routed to the UPS or combiner cabinet.
- **No short circuits:** Verify that no conductive objects or damaged insulation create unintended continuity between conductors or between conductors and the chassis.

These checks ensure safe energization and compliance with high-voltage installation requirements.

## 7.16 Reassembly and pre-power checks

1. **Reinstall all covers and panels.**

   Replace internal covers, CBMS/GBMS covers, and any removed front or top panels. Tighten all fasteners to the specified torque.
2. **Confirm environmental readiness.**

   Verify that room temperature, humidity, and ventilation are within the specified operating range and that dust protection is adequate.
3. **Apply Lockout/Tagout where required.**

Ensure upstream disconnection devices are clearly identified and controlled according to site safety procedures.

## 7.17 Initial power-up and commissioning

Commissioning verifies that all electrical, communication, and protection functions operate correctly before the system is placed into service. Perform all steps in the order shown. Only qualified personnel may perform commissioning.

### 7.17.1 Pre-start verification

Before applying power, verify the following:

- All DC power cables, PE conductors, and communication cables are installed and torqued to specification.
- Cabinet-to-cabinet communication (CAN/RS-485) is correctly routed and shielded.
- CBMS and GBMS DIP-switch addresses are set according to the system layout.
- All module covers, busbars, and internal hardware are installed and secured.
- All internal and external covers, shields, and protective plates are reinstalled and secured. Do not energize the system with any cover removed.
- Insulation resistance tests have been completed and meet requirements.
- Polarity of BAT+, BAT–, and N (if used) has been verified at the cabinet and at the UPS/combiner.
- No tools, hardware, packaging, or debris remain inside or on the enclosure.
- All cabinet doors are closed and latched.

### 7.17.2 Cabinet-level startup

Start each cabinet individually:

1. Open the enclosure door and verify the main DC breaker is open.
2. Close the main DC breaker.
3. Press and hold the DC Start button for the required duration to energize the BMS.
4. Observe the cabinet self-check sequence on the LEDs and HMI.
5. Confirm successful self-check (green indicator, no alarms).
6. If the cabinet reports a fault, identify the condition (voltage, temperature, communication, or configuration) and correct it before proceeding.
7. Close the enclosure door and lock it.

Repeat for each cabinet in the system.

### 7.17.3 System-level startup (parallel systems)

Once all cabinets have passed individual self-checks:

1. Power up cabinets in address order (lowest to highest).
2. Verify that each cabinet appears on the GBMS and reports correct voltage, temperature, and status.
3. Confirm that cabinet parameters (voltage, SoC, firmware versions) are consistent across the system.
4. Verify communication integrity on all buses (CAN, RS-485).
5. Verify dry-contact behavior (charge inhibit, breaker status, EPO) using Section 8.12.1.
6. Close external DC switches or combiner breakers to place the system into parallel operation.
7. Confirm that system voltage at the combiner or UPS input is within the expected range.

### 7.17.4 UPS integration and verification

1. Configure UPS charge voltage, charge current, and discharge cut-off parameters according to Section 8.12.
2. Select the correct communication mode (CAN, RS-485, or dry contact).
3. Verify that the UPS recognizes the energy storage system and reports normal battery status.
4. Enable controlled charging and confirm that charge current and voltage follow expected behavior.
5. Verify that the system transitions from charging to standby when full.
6. Initiate a controlled discharge test (if permitted by site procedures) to confirm UPS interaction.

### 7.17.5 Functional tests

Perform the following functional checks:

- **State transitions:** Confirm transitions between standby, charging, and discharging occur without alarms.
- **Protection functions:** Trigger or simulate conditions (as permitted) to verify overvoltage, undervoltage, overtemperature, and communication protections.
- **Dry-contact signaling:** Confirm that D1, D2, D3, and I1 behave LED definition table.
- **Communication:** Verify stable communication with UPS, BMS, and monitoring systems.
- **Backup-time verification:** If required, perform a runtime test to confirm expected discharge performance.

### 7.17.6 Commissioning records

Record the following information for site documentation:

- Cabinet addresses and DIP-switch settings
- Firmware versions (CBMS, GBMS, HMI)
- System voltage, module voltages, and SoC at commissioning
- Insulation resistance measurements
- Communication mode and network parameters
- Dry-contact configuration and verification results
- UPS configuration parameters
- Any corrective actions taken during commissioning

Commissioning is complete when all cabinets pass self-check, all communication paths are verified, UPS integration is confirmed, and all functional tests meet specification.

# 8. Operation

## 8.1 Normal operating states

The DataSafe Noir™ energy-storage system operates in defined states that reflect its interaction with the UPS and facility power system.

- **Charging:** The system receives power from the UPS rectifier or AC source to replenish stored energy. The BMS regulates charging current and voltage to maintain safe operation and ensure balanced cell conditions.
- **Discharging:** The system supplies power to the UPS inverter during utility interruptions or transfer events, delivering high-rate output to support critical loads.
- **Standby:** The system remains connected, monitored, and ready to respond to UPS demands.
- **Fault or protection:** The BMS detects abnormal conditions such as temperature deviations, voltage imbalance, communication loss, or wiring issues. The system may restrict operation or disconnect to protect modules and connected equipment.

These operating states ensure predictable behavior and safe operation across all UPS scenarios.

## 8.2 System monitoring and HMI navigation

The front-mounted HMI provides real-time visibility into operating conditions, including:

- State of Charge
- Charge and discharge current
- System voltage
- Power flow
- Module-level data
- Active alarms and warnings

Operators can navigate pages showing system-level measurements, individual module readings, BMS status, and alarm history. Configuration menus provide access to communication settings, network parameters, and dry-contact behavior.

This monitoring capability allows operators to verify system readiness, confirm UPS integration, and respond promptly to operational issues.

## 8.3 Behavior during utility outages and UPS transitions

The system responds automatically to changes in utility power without operator intervention.

- During a utility outage, the UPS inverter draws power from the energy-storage system, placing the system into the discharging state.
- When utility power returns, the UPS resumes normal operation and the system transitions back to charging.
- During brief disturbances or transfer events, the system may momentarily support the UPS until stable input power is restored.

Throughout these transitions, the BMS monitors cell conditions, enforces protection limits, and communicates status to the UPS to ensure coordinated operation.

## 8.4 Communication, dry contacts, and timing functions

The system supports CAN, RS-485, Ethernet, and dry-contact interfaces for integration with UPS systems, building-management systems, and monitoring platforms.

Communication links provide real-time data exchange for operating status, alarms, and control signals.

Network-time synchronization (if enabled) ensures consistent timestamping of alarms, transitions, and operational data.

Dry-contact inputs and outputs support:

- Charge enable/disable
- Breaker status
- Emergency shutdown (EPO)

When a defined condition occurs—such as charge inhibit, breaker trip, or system EPO—the corresponding dry contact changes state and the event is recorded in the system log.

For terminal assignments and wiring details, see Section 8.

# 8.5 Operational considerations

Operators should periodically review system status through the HMI or remote monitoring interface to confirm that the system remains in standby with no active alarms. During routine operation, the system requires no manual intervention, and all transitions between charging, discharging, and standby occur automatically.

Any persistent warnings or faults should be investigated promptly to maintain system readiness. Stable environmental conditions, proper ventilation, and reliable communication links support long-term performance and predictable behavior during UPS events.

## 8.5.1 UPS compatibility considerations

The UPS must support the system's DC operating range, charge-voltage profile, charge-current limits, and communication requirements.

A UPS listed as lithium compatible may not support the specific high-voltage lithium profile used by this system.

Confirm:

- Nominal and working DC voltage range
- Recommended charge-voltage window
- Maximum charge-current limit
- CAN or RS-485 communication for battery alarms and protection states
- Breaker or shunt-trip logic
- Runtime/load ratings for high-rate discharge

For high-rate discharge applications, verify that the UPS's rated output power aligns with the system's maximum discharge capability and expected runtime. At full UPS load, runtime may be limited; evaluate load levels, UPS efficiency, temperature, and end-of-discharge reserve.

Before procurement, obtain written compatibility confirmation from both the UPS manufacturer and EnerSys.

# 8.6 Charging and discharging behavior

Charging and discharging are managed automatically through coordinated actions of the module-level, cabinet-level, and group-level BMS controllers.

### Charging

The system regulates current and voltage to restore capacity while maintaining cell balance and thermal stability. Charging typically occurs after utility restoration or whenever the UPS determines that replenishment is required.

### Discharging

The system supplies high-rate power to the UPS inverter to support critical loads. The BMS ensures discharge current remains within allowable limits and that cell voltages do not fall below the defined cut-off threshold.

Transitions between charging, discharging, and standby occur seamlessly.

## 8.7 User responsibilities during operation

Routine operation requires minimal user involvement. Operators must:

- Periodically check the HMI or remote interface to confirm standby state
- Investigate persistent warnings or faults promptly
- Maintain a clean, dry, temperature-controlled environment
- Keep airflow paths and enclosure access points unobstructed
- Maintain communication links with the UPS and monitoring systems
- Verify that charging resumes after utility events or UPS transitions.

## 8.8 Alarm response workflow

When an alarm or warning appears on the HMI, operators should follow a consistent response sequence:

- Identify the alarm category and review the associated description.
- Verify whether the system remains in standby, has restricted operation, or has entered a protection state.
- Review module voltages, temperatures, and communication status to identify abnormal values.
- Confirm that UPS communication remains active and that the UPS is operating normally.
- Determine whether the alarm is transient or persistent.
- If the alarm persists, refer to Chapter 12. Troubleshooting for detailed troubleshooting.
- If a protection state is active, follow the emergency shutdown procedure in Chapter 13. Emergency shutdown procedures before performing corrective action.

## 8.9 System performance expectations

During normal operation, the following behaviors are expected:

- Module balancing may occur during the final stage of charging or after extended standby.
  Minor variations in reported SoC may occur over time; periodic SoC calibration restores accuracy.
- Module temperatures rise during high-rate discharge and during charging but remain within specified limits.
- Brief communication polling delays may appear on the HMI as the GBMS cycles through cabinet queries.
- During utility disturbances, the system may briefly enter discharging and return to standby once the UPS stabilizes.
- Charge current tapers automatically as the system approaches full charge to maintain cell balance.

Understanding these behaviors helps operators distinguish normal operation from abnormal conditions.

## 8.10 System configuration workflow

Operators may need to verify or adjust configuration parameters during commissioning, maintenance, or integration changes:

- Confirm that CBMS and GBMS addressing matches the system layout.
- Verify that UPS communication mode (CAN, RS-485, or dry contact) matches the UPS configuration.

- Confirm that dry-contact behavior aligns with facility requirements.
- Review network settings, including IP address, subnet, gateway, and NTP configuration.
- Verify that all modules and cabinets are detected on the HMI.
- Perform SoC calibration after installation, module replacement, or extended storage.
- Confirm that alarm and protection functions operate as expected.

## 8.11 Post-event verification

After a utility outage, UPS transfer, or extended discharge event, operators should verify the following:

- The system has returned to standby and is no longer discharging.
- No active alarms remain on the HMI.
- Module temperatures have returned to normal operating range.
- Charging has resumed and SoC is increasing.
- Communication links with the UPS and monitoring systems remain active.
- Event logs show expected behavior during the outage or transition.

# 9. System monitoring and HMI/BMS navigation

The DataSafe Noir™ energy storage system includes an integrated HMI that provides real-time visibility into system status, operating conditions, alarms, and configuration parameters. The HMI is the primary interface for system monitoring and is intended for use by qualified personnel familiar with energy storage systems and UPS integration.

The HMI displays cabinet-level and module-level information, enabling rapid assessment of system health and operational readiness.

## 9.1 Access levels and sign in

The HMI includes multiple access levels to ensure safe operation of the DataSafe Noir™ energy storage system.

Access levels include:

- **User level:** View-only access to system status, alarms, and monitoring pages.
- **Installer level:** Access to network settings, NTP configuration, and system information.
- **EnerSys service level:** Restricted access for authorized EnerSys personnel.

A sign in prompt appears when accessing protected pages. Unauthorized users cannot modify system parameters.

## 9.2 Menu navigation

The HMI menu structure provides access to all monitoring and system-information pages.

The primary menu categories include:

- **Home:** High-level system summary
- **Monitoring:** Real-time system measurements
- **Cabinet:** CBMS-level data
- **Modules:** Module-level data
- **Alarms:** Active and historical alarms
- **Settings:** Network, NTP, dry-contact, and function-parameter information
- **System Info:** Firmware versions, hardware versions, and serial numbers
- **Parallel:** Multi-cabinet system information.

Navigation is performed using the on-screen menu buttons.

## 9.3 Settings overview

The **Settings** menu provides access to system configuration information.

Most settings are read-only and cannot be modified without authorized access.

Settings categories include:

- **Network settings:** IP address, subnet mask, gateway
- **Time synchronization (NTP):** Server address and synchronization status
- **Dry contact mapping:** Contact assignments and alarm associations
- **Parallel configuration:** Cabinet addressing and communication status
- **HMI settings:** Language, display preferences, brightness, screen-sleep timing, and interface options.
- **Function parameters:** Operating mode, charge/discharge limits, temperature thresholds, balancing parameters (read-only for most users)

These settings are configured during installation and should not be changed during normal operation.

## 9.4 HMI overview

The HMI provides:

- Real-time operating data
- System-level and cabinet-level status
- Module-level measurements
- Alarm and protection indicators
- Configuration parameters (read-only for most users)
- Network and communication settings
- Parallel-system information.

The HMI is designed for monitoring and verification. Configuration changes must be performed only by authorized personnel.

## 9.5 Home screen

The home screen provides a high-level summary of system status, including:

- System operating state
- DC bus voltage
- Charge or discharge current
- Number of active cabinets
- Number of active modules
- Alarm or protection indicators.

From the home screen, users can navigate to detailed monitoring pages.

## 9.6 Real-time monitoring

The real-time monitoring page displays continuously updated system measurements, including:

- System voltage and current
- Cabinet-level voltage and current
- Module temperatures
- Ambient temperature
- State of Charge (SoC)
- State of Health (SoH)
- Power-on duration
- Charge/discharge status.

Values update automatically while the system is operating.

## 9.7 Cabinet BMS (CBMS) data

The CBMS page provides cabinet-level information, including:

- Cabinet voltage
- Cabinet current
- Maximum and minimum module voltages

- Maximum and minimum module temperatures
- Communication status
- Protection states
- Dry contact states
- Internal CAN communication status

This page is used to verify cabinet-level operation and communication integrity.

## 9.8 Module data

The module data page provides detailed information for each energy storage module, including:

- Individual cell voltages
- Module voltage
- Module temperature
- Balancing status
- Charge/discharge MOSFET status
- Module address
- Module SoC and SoH
- Module alarm and protection states

This page is used for module-level diagnostics and performance verification.

## 9.9 Alarm and protection monitoring

The alarm/protection page displays:

- Active alarms
- Active protection states
- Historical alarm information
- Alarm categories (voltage, temperature, communication, current, system-level)

Alarms are color-coded by severity.

Protection states require immediate investigation.

## 9.10 System configuration (read-only)

The configuration page displays system parameters, including:

- System operating mode
- Charge and discharge limits
- Temperature thresholds
- Balancing parameters
- Module addressing
- Parallel-system configuration

Most parameters are read-only and cannot be modified without authorized access.

## 9.11 Network and communication settings

The HMI provides access to network configuration information, including:

- IP address
- Subnet mask
- Gateway
- Communication port settings
- Time synchronization (NTP)
- Controller communication status.

These settings are typically configured during installation and should not be modified without authorization.

## 9.12 Dry contact configuration (read-only)

The dry contact page displays:

- Contact assignments
- Contact states
- Alarm mapping
- UPS integration parameters.

Dry contact behavior is defined during commissioning and is not normally changed during operation.

## 9.13 Parallel-system information

For systems with multiple cabinets, the HMI displays:

- Number of cabinets online
- Cabinet addresses
- Cabinet communication status
- System-level SoC and SoH
- System-level alarms.

This page is used to verify proper operation of multi-cabinet deployments.

## 9.14 Equipment information

The equipment information page provides:

- Firmware versions (CBMS, GBMS, BMU)
- Hardware versions
- Serial numbers
- System configuration summary.

This information is required when contacting EnerSys service.

## 9.15 BMS tool (engineering interface)

The BMS tool provides engineering-level access to system data and is intended for qualified service personnel. It is used when deeper diagnostics are required beyond what the HMI provides.

The tool runs on Microsoft® Windows and communicates with the system through a USB-to-RS-485 cable.

## 9.16 BMS tool communication setup

To establish communication:

1. Disconnect any controller interface.
2. Connect the USB-to-RS-485 cable
3. Install the cable driver
4. Launch the BMS tool executable
5. Select the COM port
6. Select the baud rate (default 9600)
7. Connect to the system

## 9.17 BMS tool monitoring functions

The BMS tool provides:

- Cell voltages
- Module voltages
- Module temperatures
- SoC and SoH
- Charge/discharge current
- Alarm, protection, and fault states
- MOSFET status
- Dry contact states
- Module addressing
- Communication parameters.

Values update in real time.

## 9.18 Equipment-parameter configuration

The BMS tool includes a parameter-configuration page used by authorized personnel to adjust system-level settings. These parameters must not be modified without EnerSys approval.

## 9.19 Device-history viewing

The BMS tool includes a history-viewing page that displays historical operating data, alarms, and protection events.

## 9.20 Communication-log function

The BMS tool includes a communication-log page that records CAN/RS-485 communication events for diagnostic purposes.

## 9.21 Language and interface options

The BMS tool supports switching between multiple languages and interface skins.

## 9.22 Addressing and multi-module display

The BMS tool supports up to 64 addressable modules.

- Start address defines the first module displayed
- Number of modules defines the range
- Modules outside the range are not shown.

## 9.23 Data logging

The BMS tool supports optional data logging:

- Logs are saved to the file path shown in the tool
- Logging can be started or stopped manually
- Clearing data removes displayed values but not saved files.

## 9.24 Disconnecting

To disconnect safely:

1. Select **Disconnect**
2. Wait for data refresh to stop
3. Remove the USB-to-RS-485 cable
4. Restore controller connections if required

# 10. Maintenance

## 10.1 Routine inspection and monitoring

Routine maintenance ensures long-term reliability of the DataSafe Noir™ energy-storage system. Qualified personnel must perform periodic inspections at intervals defined by site policy or UPS maintenance schedules.

During each inspection:

- Verify that the HMI reports normal operating state with no active alarms.
- Review cabinet-level and module-level measurements under Monitoring > Cabinet and Monitoring > Modules.
- Confirm that module voltages, temperatures, SoC, and SoH remain within expected ranges.
- Check CBMS and GBMS indicators for normal status.
- Inspect the enclosure for signs of physical damage, corrosion, or moisture intrusion.
- Confirm that ventilation paths are unobstructed and ambient temperature remains within operating limits.
- Review the alarm log under Alarms > History for recurring or intermittent events.

Routine inspection does not require system shutdown.

## 10.2 Environmental and site conditions

Environmental conditions directly affect system performance and service life. During maintenance:

- Verify that ambient temperature remains within the specified operating range.
- Confirm that humidity levels do not exceed site requirements.
- Ensure that the enclosure is free of dust accumulation, debris, or conductive contaminants.
- Inspect for signs of water ingress, condensation, or chemical exposure.
- Confirm that airflow around the cabinet meets installation requirements.
- Check that seismic anchoring hardware remains secure.

If environmental deviations are detected, correct site conditions before continuing operation.

## 10.3 Electrical and communication integrity

Electrical and communication checks ensure stable operation and proper UPS integration.

Perform the following:

- Inspect DC busbar connections for tightness and signs of heating or discoloration.
- Verify that grounding conductors are secure and free of corrosion.
- Confirm that module connectors are fully seated and latched.
- Check communication cables (CAN, RS-485, Ethernet) for strain, damage, or loose terminations.
- Validate UPS communication status under Settings > Network and Settings > Communication.
- Review dry-contact states under Dry Contact Configuration to ensure correct UPS signaling.
- Confirm that parallel-system communication is stable and all cabinets report online.

If any electrical or communication irregularity is detected, follow Chapter 12 Troubleshooting.

## 10.4 Firmware and configuration management

Firmware and configuration maintenance ensures consistent system behavior across all cabinets and modules.

During scheduled maintenance:

- Verify CBMS, GBMS, and module firmware versions under System Info →Equipment Information.
- Confirm that all cabinets operate on the same approved firmware revision.
- Review configuration parameters under System Configuration for consistency across cabinets.
- Validate network settings (IP, subnet, gateway, NTP) for accuracy and alignment with site requirements.
- Confirm that parallel-system addressing remains correct after any cabinet replacement or reconfiguration.
- Ensure that no unauthorized parameter changes have been made.

Firmware updates must be performed only by EnerSys service personnel or authorized technicians.

## 10.5 Long-term reliability and service life

Long-term maintenance focuses on preserving system performance over the full service life of the energy-storage system.

Perform the following checks at extended intervals:

- Review SoH trends for all modules to identify early signs of degradation.
- Confirm that balancing activity remains within expected limits.
- Inspect the enclosure for structural integrity, including hinges, latches, and mounting hardware.
- Verify that cooling paths remain unobstructed and free of dust accumulation.
- Review historical logs for repeated alarms or protection events that may indicate emerging issues.
- Confirm that UPS charge and discharge parameters remain within recommended limits.

If module performance deviates significantly from expected values, escalate to EnerSys service.

## 10.6 Safety and preventive measures

Maintenance activities must follow all safety requirements outlined in Chapter 2 Safety and Chapter 8 Installation.

During maintenance:

- Ensure the cabinet is electrically safe before opening any access panels.
- Confirm that the UPS is isolated if maintenance requires access to DC busbars or internal wiring.
- Use appropriate PPE, including insulated gloves and eye protection.
- Avoid contact with energized components unless performing authorized measurements.
- Verify that tools and test equipment are rated for the system’s voltage.
- Ensure that no conductive materials are placed inside the enclosure.
- After maintenance, confirm that all access panels are closed and secured, and that the system returns to normal operating state.

If any unsafe condition is identified, stop work immediately and follow Chapter 13 Emergency Shutdown.

# 11. Troubleshooting

## 11.1 Energy storage system LED indicators

The system provides immediate visual feedback through two front-panel LEDs: DC Start and Status. These indicators allow operators to quickly assess whether the system is powered, charging, discharging, or experiencing a protective or fault condition. The following table summarizes the LED behaviors and their meanings.

Table I: Energy storage system LED states

| LED name | Color | State | Meaning |
|---|---|---|---|
| **DC Start** | **Red** | **Off** | Indicates the system is dormant or powered off. |
| | | **Solid** | Indicates the system is discharging or charging in protect mode. |
| | | **Flashing** | Not Used |
| **Status** | **Green** | **Off** | Indicates the system is dormant or powered off. |
| | | **Solid** | Indicates the system is in standby or charging normally |
| | | **Flashing** | Not Used |
| | **Red** | **Off** | Not Used |
| | | **Solid** | Indicates the system is discharging or charging in protect mode. |
| | | **Flashing** | Indicates breaker trip or system failure. |

**Notes:**

The Start button shares an indicator with the Breaker, so the red flashing state on the Status LED reflects breaker trip conditions.

Protect mode refers to conditions where the system is operating with protective limits engaged (for example, thermal, voltage, or current thresholds).

## 11.2 Alarm categories and their meaning

Alarms are grouped into categories that reflect the type of abnormal condition detected by the BMS. Understanding these categories helps operators quickly narrow down the source of a problem.

Electrical alarms: Overvoltage, undervoltage, overcurrent, short-circuit conditions, or abnormal DC output readings.

- **Thermal alarms:** Overtemperature, undertemperature, or temperature sensor faults.
- **Communication alarms:** CAN bus errors, RS-485 loss, Ethernet link failure, or module communication loss.
- **Module-level alarms:** Cell imbalance, module offline, internal module fault, or abnormal cell voltage spread.
- **System-level alarms:** Breaker trip, contactor failure, BMS internal error, or power-supply failure.

Each alarm type may trigger protective behavior, including current limiting, charge/discharge suspension, or system shutdown.

## 11.3 Common fault conditions

Certain issues occur more frequently in UPS environments. This section summarizes the most common conditions and what operators typically observe.

- **Breaker trip:** Red flashing status LED, UPS reporting energy storage module unavailable, DC output at zero.
- **Module communication loss:** Missing module data on HMI, SoC instability, communication alarms.
- **Overtemperature:** Elevated module temperatures, charging suspended, protect-mode LED behavior.
- **Undervoltage:** System unable to discharge, UPS alarms for low energy storage module voltage.
- **Overcurrent:** Protect-mode operation during high-load events or wiring issues.
- **UPS communication error:** SoC not reported, UPS unable to enter charge mode, CAN/RS-485 alarms.

These conditions often resolve once the underlying cause is corrected, but persistent faults require deeper diagnosis.

## 11.4 Diagnostic procedure

A structured diagnostic workflow helps operators isolate issues efficiently and safely.

1. Check LED indicators to determine whether the system is in standby, protect mode, or fault.
2. Review the HMI alarm list for active and historical alarms, noting timestamps and repeated patterns.
3. Verify communication links by checking CAN/RS-485 connectors, Ethernet cables, and DIP-switch addressing.
4. Inspect environmental conditions for temperature extremes, blocked airflow, or contamination.
5. Measure DC output voltage at the system terminals to confirm correct polarity and expected voltage.
6. Check module seating and busbar connections for loose hardware or signs of overheating.
7. Confirm grounding continuity and inspect for insulation damage.
8. Reset the breaker only after identifying and correcting the root cause.

This workflow ensures that faults are approached methodically and safely.

## 11.5 Communication and network faults

Communication issues can prevent the UPS from recognizing the energy storage module or receiving accurate SoC and alarm data. Typical symptoms include missing module information, UPS energy storage module alarms, or inconsistent readings.

Key diagnostic checks include:

- Ensuring CAN and RS-485 cables are fully seated and undamaged.
- Verifying correct termination resistors where required.
- Confirming unique system addresses in parallel systems.
- Checking Ethernet link status and network configuration.
- Reviewing HMI communication error codes for directionality (system-to-UPS or module-to-system).

Stable communication is essential for coordinated operation and accurate reporting.

## 11.6 Thermal and environmental faults

Temperature-related issues are among the most common in lithium-ion systems. The BMS will limit charging or discharging if temperatures exceed safe thresholds.

Troubleshooting steps include:

- Verifying room temperature is within specification.

- Checking for blocked ventilation paths or nearby heat sources.
- Confirming that temperature readings across modules are consistent.
- Inspecting for dust accumulation or restricted airflow.
- Reviewing HMI logs for repeated thermal warnings.

Maintaining a controlled environment significantly improves system reliability and cycle life.

## 11.7 Electrical fault isolation

Electrical faults may arise from wiring issues, improper torque, or abnormal load conditions.

Operators should:

- Measure DC voltage at the system output to confirm expected values.
- Verify polarity and ensure no reverse-connection conditions exist.
- Inspect busbars and terminals for discoloration, loose hardware, or mechanical stress.
- Perform insulation resistance tests if safe and appropriate.
- Confirm grounding integrity and bonding continuity.

Electrical faults must be corrected before re-energizing the system.

## 11.8 Breaker trip and recovery

A breaker trip is indicated by a flashing red Status LED. This condition typically results from overcurrent, short-circuit events, or wiring faults.

Recovery steps include:

- Identifying the cause of the trip through HMI logs and visual inspection.
- Verifying that no short circuits or reversed connections are present.
- Ensuring all modules and busbars are properly seated and torqued.
- Resetting the breaker only after confirming safe conditions.
- Monitoring the system after reset to ensure normal operation resumes.

Repeated trips indicate a deeper issue requiring escalation.

## 11.9 HMI alarm log interpretation

The HMI provides detailed alarm codes, timestamps, and module identifiers. Operators should review both active and historical alarms to identify patterns such as repeated communication losses, temperature excursions, or voltage anomalies. Clearing resolved alarms helps maintain a clean diagnostic history and simplifies future troubleshooting.

## 11.10 Parallel system troubleshooting

In multi-system architecture, a fault in one system can affect the entire array. Operators should:

- Identify which system raised the alarm using address labels and HMI data.
- Verify inter-system communication wiring and addressing.
- Isolate the affected system if necessary to maintain system availability.
- Confirm that the remaining systems operate normally before reintroducing the isolated unit.

Parallel systems require consistent configuration and communication to function correctly.

## 11.11 When to escalate to EnerSys service

Certain conditions require professional support, including:

- Repeated breaker trips with no identifiable cause.
- Persistent module offline alarms.
- Abnormal voltage differences between modules.
- Firmware corruption or failed updates.
- Internal BMS faults that do not clear after power cycling.
- Any condition that cannot be resolved through standard diagnostic steps.

Before contacting service, operators should collect alarm logs, firmware versions, environmental readings, and a description of recent events. Also include serial number, model, and commissioning date.

# 12. Emergency shutdown procedures

## 12.1 Purpose of emergency shutdown

Emergency shutdown procedures provide a controlled method for isolating the energy storage system during hazardous conditions such as electrical faults, thermal events, physical damage, or fire. These procedures ensure the safety of personnel, protect connected equipment, and prevent escalation of abnormal conditions. Shutdown actions must be performed only by qualified personnel familiar with high-voltage systems.

## 12.2 Conditions requiring immediate shutdown

Emergency shutdown is required when any of the following conditions are observed:

- Visible smoke, unusual odor, or signs of overheating.
- Physical damage to the enclosure, modules, or wiring.
- Repeated breaker trips or persistent fault indicators.
- Water ingress, flooding, or exposure to conductive contaminants.
- Fire in the room or adjacent equipment.
- Severe UPS malfunction affecting energy storage module operation.

These conditions indicate that continued operation may pose a safety risk.

## 12.3 Emergency shutdown procedure

1. Assess the environment and ensure it is safe to approach the enclosure.
2. Press the DC start/stop button to place the system into a dormant state if accessible and safe.
3. Open the upstream DC breaker or disconnect device feeding the system.
4. Open the AC supply breaker powering the BMS and auxiliary circuits.
5. Verify that all LEDs are off, indicating the system is fully de-energized.
6. Isolate the area and prevent unauthorized access.
7. Notify facility management and EnerSys service personnel for further evaluation.

If fire or smoke is present, do not attempt to access the enclosure; follow the fire-response guidance below.

## 12.4 Post-shutdown actions

After an emergency shutdown, the system must remain isolated until inspected by qualified personnel. No attempt should be made to restart the system until the root cause has been identified and corrected.

# 13. Decommissioning and disposal

## 13.1 Purpose of decommissioning

Decommissioning ensures that the energy storage system is safely removed from service at the end of its operational life, during facility upgrades, or when relocating equipment. Proper decommissioning protects personnel, prevents electrical hazards, and ensures compliance with environmental and regulatory requirements.

## 13.2 Preparation for decommissioning

- Review site safety procedures and Lockout/Tagout requirements.
- Confirm that the system is not supporting any active UPS load.
- Notify all affected personnel of the planned shutdown.
- Ensure appropriate PPE and insulated tools are available.

## 13.3 Decommissioning procedure

1. Perform a controlled shutdown using the standard shutdown procedure.
2. Open all upstream DC and AC disconnects and apply Lockout/Tagout devices.
3. Verify zero energy state by confirming no voltage is present at the system output.
4. Remove communication cables (CAN, RS-485, Ethernet, dry contacts).
5. Remove AC auxiliary wiring to the BMS controllers.
6. Remove DC output cables and grounding conductors.
7. Remove energy storage modules one at a time, following safe-handling procedures.
8. Remove internal busbars and hardware and store them in insulated containers.
9. Unbolt and remove the system from the installation site.

All components must be handled carefully to avoid short circuits or mechanical damage.

## 13.4 Energy storage module disposal

Lithium-ion energy storage modules must be disposed of in accordance with:

- Local and national environmental regulations.
- Transportation of Dangerous Goods (TDG) requirements.
- EnerSys recycling and return programs.

Modules must never be incinerated, compacted, or disposed of in general waste streams. Damaged or swollen modules require special handling and must be isolated in a fire-resistant container until collected by certified personnel.

### 13.4.1 End-of-life responsibility (EU/EMEA)

EnerSys is classified as the “producer” under EU Battery Regulation 2023/1542 for all lithium-ion energy storage modules placed on the EU market. EnerSys is responsible for:

- Registering as a producer in each EU Member State where products are sold.
- Financing the collection, transport, and recycling of end-of-life modules.
- Ensuring treatment at certified lithium-ion recycling facilities.
- Meeting EU-mandated material recovery targets.

### 13.4.2 Customer obligations

- End-users must not dispose of modules through municipal waste streams.
- End-users must return end-of-life modules through EnerSys-approved collection channels.
- Damaged or swollen modules must be isolated in a fire-resistant container and reported immediately to EnerSys service.

### 13.4.3 Collection and return

EnerSys will arrange collection and transport of end-of-life modules in accordance with:

- EU Battery Regulation 2023/1542.
- ADR transport requirements for Class 9 lithium-ion batteries.
- National waste-handling laws in the country of installation.

### 13.4.4 Prohibited actions

Modules must never be incinerated, compacted, landfilled, or shipped without proper ADR-compliant packaging and documentation.

## 13.5 Documentation and recordkeeping

Maintain records of:

- Serial numbers of removed modules.
- Disposal or recycling certificates.
- Final inspection reports.
- Environmental compliance documentation.

These records support regulatory compliance and traceability.

# 14. Transportation and fire-safety requirements

## 14.1 Transportation requirements

Lithium-ion energy storage systems are regulated under international and national transportation standards. The system and its modules must be transported in accordance with:

- UN 3480/UN 3481 (Lithium-ion batteries).
- UN Manual of Tests and Criteria, Part III, Sub-section 38.3.
- TDG (Canada), DOT (USA), and IATA/ICAO regulations.

Key requirements include:

- Transporting modules in their original certified packaging.
- Ensuring terminals are protected against short circuit.
- Securing modules to prevent movement during transport.
- Labeling packages with appropriate hazard markings.
- Using carriers certified to handle Class 9 dangerous goods.

Damaged or defective modules require special packaging and must not be shipped with normal goods.

## 14.2 Storage and handling during transport

- Store modules in a cool, dry environment away from ignition sources.
- Maintain SoC within the recommended transport range (typically 30 to 50 percent).
- Avoid stacking heavy objects on top of packaged modules.
- Inspect packaging for damage before loading.

These precautions reduce the risk of thermal or mechanical stress during transit.

## 14.3 Fire-safety requirements

Lithium-ion systems require specific fire-response measures. In the event of smoke, overheating, or fire:

- Use Class D extinguishing agents, dry chemical, or $CO_2$ extinguishers.
- Do not use water directly on energized equipment.
- If safe, isolate the system by disconnecting AC and DC sources.
- Evacuate the area if thermal runaway is suspected.
- Allow fire-affected modules to cool completely before handling.

Fire-safety equipment such as extinguishers, fire blankets, and sand buckets should be readily accessible in the installation area.

## 14.4 Post-incident handling

After any fire-related event:

- Do not move or open affected modules until inspected by qualified personnel.
- Store damaged modules in a fire-resistant container.
- Document the incident and notify EnerSys for further guidance.

# 15. Acronyms, abbreviations, and definitions

## 15.1 System and component terms

Table J: System and component terms

| Term | Definition |
|---|---|
| **Battery Management System (BMS)** | Electronic control system that monitors cell voltages, temperatures, current, and SoC, and enforces protection limits. |
| **Battery Monitoring Unit (BMU)** | Module-level controller responsible for monitoring individual energy storage modules and reporting data to the system BMS. |
| **Cell Monitoring Unit (CMU)** | Sub-module controller that measures individual cell voltages and temperatures. |
| **Energy Management System (EMS)** | Higher-level supervisory system that may coordinate multiple systems or integrate with facility controls. |
| **Energy Storage System (ESS)** | A complete system consisting of energy storage modules, BMS, system, wiring, and protective devices. |
| **Uninterruptible Power Supply (UPS)** | System that provides backup power to critical loads during utility outages or disturbances. |
| **State of Charge (SoC)** | Percentage of remaining usable energy storage module capacity relative to full charge. |
| **State of Health (SoH)** | Indicator of long-term energy storage module condition, typically based on capacity fade and internal resistance. |
| **Depth of Discharge (DoD)** | Percentage of capacity removed during discharge; deeper DoD reduces cycle life. |
| **VCut-off – Cut-off Voltage** | Minimum allowable discharge voltage enforced by the BMS to prevent cell damage. |
| **DC Bus – Direct Current Bus** | The high-voltage DC connection between the energy storage system and the UPS. |
| **Contactor** | Electrically controlled switch used to connect or disconnect the energy storage module from the DC bus. |
| **Breaker/DC Disconnect** | Protective device that interrupts current during faults or overloads. |
| **Human-Machine Interface (HMI)** | Display panel used to view system status, alarms, and configuration settings. |
| **Light-Emitting Diode (LED)** | Indicator lights on the system showing operating state or fault conditions. |
| **Site Operating Input (SOI)** | The steady-state load level the site normally draws during standard operation. |

## 15.2 Electrical and communication terms

Table K: Electrical and communication terms

| Term | Definition |
|---|---|
| **Alternating Current (AC)** | Electrical power supplied by the utility or UPS rectifier. |
| **Direct Current (DC)** | Electrical power supplied by the energy storage system. |
| **Controller Area Network (CAN)** | Communication protocol used between energy storage modules and the BMS. |
| **RS-485** | Serial communication standard used for UPS or external monitoring interfaces. |
| **Ethernet** | Network communication interface for remote monitoring or supervisory control. |
| **Electromagnetic Interference (EMI)** | Electrical noise that may affect communication or control circuits. |
| **Radio-Frequency Interference (RFI)** | High-frequency interference that may affect sensitive electronics. |
| **Protective Earth (PE)** | Grounding conductor used to prevent electric shock and ensure fault-current paths. |
| **Low-Voltage Disconnect (LVD)** | Protective function that disconnects the energy storage module when voltage falls below safe limits. |
| **Overvoltage protection/ Undervoltage protection (OVP/UVP)** | BMS functions that prevent cell damage from abnormal voltage conditions. |
| **Overcurrent protection (OCP)** | Protection against excessive charge or discharge current. |
| **Overtemperature protection/ Undertemperature protection (OTP/ UTP)** | Thermal protections that limit operation outside safe temperature ranges. |

## 15.3 Mechanical and installation terms

Table L: Mechanical and installation terms

| Term | Definition |
|---|---|
| **Lockout/Tagout (LOTO)** | Safety procedure used to ensure equipment is de-energized before servicing. |
| **Torque Specification** | Required tightening force for electrical and mechanical fasteners. |
| **Busbar** | Rigid conductor used to distribute high-current DC power within the system. |
| **Enclosure Rating (for example, NEMA, IP)** | Classification describing protection against dust, water, and environmental exposure. |

## 15.4 Energy storage module chemistry and performance terms

Table M: Energy storage module chemistry and performance terms

| Term | Definition |
|---|---|
| **Lithium Iron Phosphate (LFP)** | The lithium-ion chemistry used in the DataSafe Noir™ energy storage system, known for thermal stability and long cycle life. |
| **Cycle Life** | Number of charge/discharge cycles the energy storage module can deliver before reaching end-of-life criteria. |
| **C-Rate** | Charge or discharge rate expressed as a multiple of energy storage module capacity (for example, 10C). |
| **Internal Resistance (IR)** | Electrical resistance within the energy storage module that affects voltage drop and heat generation. |
| **Thermal Runaway** | Uncontrolled temperature rise that may lead to battery overheating. |

## 15.5 Operational and monitoring terms

Table N: Operational and monitoring terms

| Term | Definition |
|---|---|
| **Event Log** | Record of alarms, warnings, and operational transitions stored by the BMS. |
| **Standby Mode** | Normal ready state where the energy storage system is fully charged and available to support the UPS. |
| **Protect Mode** | BMS-limited operation triggered by abnormal temperature, voltage, or current conditions. |
| **Fault State** | Condition requiring shutdown or service intervention. |
| **Parallel Operation** | Configuration where multiple energy storage systems operate together to increase capacity or redundancy. |
| **Redundancy** | System design where additional systems or modules ensure continued operation during failures. |

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