

DOCKETED

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APPENDIX 2-B: BASIS OF DESIGN (REVISED) AND DC LINK SPECIFICATIONS

Appendix 2-B: Basis of Design (Revised) and DC LINK Specifications

- Basis of Design
- F2D4-5.1US-OP01_DC LINK Operation & Maintenance Manual_V8.1
- F2D4-5.1US-GN06_DC LINK Code and Standard_V1.0
- F2D4-5.1US-GN04_DC LINK Product Specification_V5.0
- F2X4-5.1US-GN03_Pack Product Specification_V5.0
- F2D4-5.1US-TH01_DC LINK Thermal Component Specification_V4.0
- F2XX-5.1US-GN02_Cell Product Specification_V4.0
- F2D4-5.1US-EL06_DC LINK Electrical Drawing_V3.0

Basis of Design

BCR-A-002

Corby Energy Storage, LLC

**Corby BESS
Project No. 163851**

**For Permitting Purposes Only
Issued for 30%**

**Revision A
12/17/2025**

Basis of Design

prepared for

**Corby Energy Storage, LLC
Corby BESS
Vacaville, CA**

Project No. 163851

**Revision A
12/17/2025**

prepared by

**Burns & McDonnell Western Enterprises, Inc.
Brea, CA**

INDEX AND CERTIFICATION

Corby Energy Storage, LLC Design Basis Project No. 163851

Report Index

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1.0	General Information	2
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Certification – Electrical & I&C

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Rev	Date	By	Checked	Revision Description
A	12/17/2025	A. Thanvi	J. Thomas	Issued for 30%

INDEX AND CERTIFICATION

Corby Energy Storage, LLC Design Basis Project No. 163851

Report Index

<u>Chapter Number</u>	<u>Chapter Title</u>	<u>Number of Pages</u>
5.0	Civil	1

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12/17/2025

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INDEX AND CERTIFICATION

Corby Energy Storage, LLC Design Basis Project No. 163851

Report Index

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Certification – Structural

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1.0 GENERAL INFORMATION

1.1 General

Basis of Design (BOD) is defined as the documentation of codes, standards, principles, assumptions, rationale, criteria, and considerations that each engineering discipline will be using to develop the engineering drawings, specifications, and studies to meet the design requirements of the agreement.

1.2 General Project Information

Design Criteria	Value(s)	Note(s)
Client	Corby Energy Storage, LLC	
Site Address	6865 Byrnes Rd, Vacaville, CA 95687	
Site Access via	Byrnes Rd	
POI Type	AC	
POI Voltage	230kV	
POI Location	Vaca-Dixon PG&E Substation	
Project Type	Li-Ion Battery Storage (LFP)	
Battery Installation	Containerized	
Project Rated Power	300MW	
Project Rated Capacity	1200MWh	
BESS System Voltage (Max)	1500VDC	

1.3 Site Conditions

Design Criteria	Value(s)	Note(s)
Ambient Design Air Temp (Max)	45.7 °C	*ASHRAE, Extreme DB, n=20 PCS nameplate rating of 4.2MVA @40°C used for design calculations.
Ambient Design Air Temp (Min)	-6.6 °C	*ASHRAE, Extreme DB, n=20
Site Elevation	77'	DK Engineering Survey
Known Utilities/Obstructions	PG&E owned transmission pipeline at southwest corner of site	
Site Contamination	None known	

*ASHRAE: [VACAVILLE NUT TREE, CA, USA \(WMO: 724828\)](#)

1.4 Sparing Philosophy

Design Criteria	Value(s)	Note(s)
34.5kV Breakers	N/A	
Inverters and Step-Up Transformers	N/A	
480V Distribution Breakers	See Section 1.5	
120VAC Breakers	N/A	
120VAC UPS Feeders	N/A	
125VDC Breakers	N/A	
Aux Switchboard Bus Capacity	TBD	At Beginning of Life
Aux Transformer Capacity	TBD	
UPS Battery Margin	N/A	
UPS Inverter Margin	N/A	
Duct Spares	N/A	
Tray Fill Margin	N/A	
Fiber Optic Cabling	Over 50% spare strands	

1.5 Future Expansion/Augmentation, Equipment Space

Design Criteria	Value(s)	Note(s)
34.5kV Breakers	N/A	Spare capacity on existing breakers planned for augmentation.
Inverters and Step-Up Transformers	AC Augmentation planned to meet facility nameplate rating for 20-year design life.	Space allocated for 13 future PCS skids.
480V Distribution Breakers	None planned.	
120VAC Breakers	N/A	
120VAC UPS Feeders	N/A	
125VDC Breakers	N/A	
Battery Augmentation Skids	AC Augmentation planned to meet facility nameplate rating for 20-year design life.	Space allocated for 38 future battery containers

1.6 Drawing Number Format

Design Criteria	Value(s)	Note(s)
Site Code	BCR	
Discipline	A - General C – Civil E – Electrical S – Structural T - Controls	
Sequence	XXX	
Drawing Number Format	Site Code-Discipline-Sequence	Ex. BCR-A-000

2.0 MAJOR EQUIPMENT

2.1 Battery Enclosures

Design Criteria	Value(s)	Note(s)
Quantity	(303) Three Hundred and Three battery enclosures	Beginning of Life Sizing and quantity provided by Owner
Manufacturer, Model	LG DC Link 5.1	Owner Supplied
Rated Power (BOL)	5112 kWh	
Discharge Duration	4 Hours	
Voltage Range	1134-1499.4VDC	
Nominal Voltage	1344 VDC	
Auxiliary Power Requirements	22.8 kVA, 480VAC, 3PH, 4W	
UPS Power Requirements	N/A	

2.2 Power Conversion System Enclosures

Design Criteria	Value(s)	Note(s)
Quantity	(101) One Hundred One	Beginning of Life Sizing and quantity provided by Owner
Manufacturer, Model	Power Electronics FP4200M	Owner Supplied
MV Transformer Rating	4207 kVA @ 40 °C	
MV Transformer Voltage	34.5 kV-660 V	
MV Transformer Configuration	Delta-Wye	
MV Transformer Impedance	8.%	Impedance at 4207 kVA

2.3 Auxiliary Power transformer

Design Criteria	Value(s)	Note(s)
Quantity	9	
Manufacturer	Hitachi/ABB	Owner Supplied
Auxiliary Transformer Rating	1500 kVA @ 40 °C	
Auxiliary Transformer Voltage	34.5 kV-480/277 V	
Auxiliary Transformer Configuration	Delta-Wye Grounded	HV-LV
Transformer Impedance	5.65 +/- 7.5%	

2.4 Auxiliary Power Distribution

Design Criteria	Value(s)	Note(s)
Quantity	9	
Manufacturer	Lakeshore Electric	Owner Supplied
Switchboard Main	3P, 2000AF/2000AT	
Switchboard Feeder	(64) 3P, 125AF/40AT, 4-Wire	

2.5 Equipment Clearances

Design Criteria	Value(s)	Note(s)
Battery Enclosures	Front – 14' Rear – 3' E-Panel Side – 10' Non- E-Panel Side – 3' Top – N/A Bottom – N/A	Rear clearance is for 2 containers back-to-back with reversed orientation.
PCS Skid Enclosures	Front – 10' Rear – 10' Left Side – 10' Right Side – 10' Top – N/A Bottom – N/A	

3.0 ELECTRICAL

3.1 Cable Requirements

3.1.1 General Requirements for all Cable

Design Criteria	Value(s)	Note(s)
Flame Tests	IEEE 1202/CSA FT-4 UL1685	
Other Compliance Standards/Listings	ICEA S-93-639 / NEMA WC 74 AIEC CS8 SUN RES UL44	
Other Requirements	Surface printing shall show manufacturer's name, insulation type, jacket	

3.1.2 35kV Power Cable Requirements

Design Criteria	Value(s)	Note(s)
Temperature Ratings	105 °C Continuous 140 °C Emergency 250°C Short Circuit	
NEC/BMCD Cable Type	MV105/TPWR-S-1.0	
Installation	Underground/Aboveground	
Conductor Material and Construction	Single Conductor Class B compact or compressed stranded, 1350 or 8000 series aluminum OR Copper – Stranded (ASTM B496 and B8)	
Conductor Shielding	Extruded layer of semiconducting thermoset	
Insulation/Jacket	TRXLPE/LLDPE	
Insulation Shield	Extruded layer of semiconducting thermoset	
Metallic Shield	Helically applied, annealed, solid bare copper wires, 1/3 rated neutral	

3.1.3 2000V Power Cable Requirements

Design Criteria	Value(s)	Note(s)
NEC/BMCD Cable Type	PV/PV-1.0	
Installation	Underground/Aboveground	
Conductor Material and Construction	Single Conductor Copper – Stranded/Annealed (ASTM B496 and B8) Or Class B or C stranded, 8000 series Aluminum	
Insulation/Jacket	XLPE or EPR	
Strand Shield	N/A	
Conductor Shielding	N/A	
Insulation Shield	N/A	
Metallic Shield	N/A	

3.1.4 600V Power Cable Requirements

Design Criteria	Value(s)	Note(s)
NEC/BMCD Cable Type	XHHW-2, RHH, RHW-2, TC-ER/SPWR-S-1.0	
Installation	Underground/Aboveground	
Conductor Material and Construction	4-Conductor with Ground Copper – Stranded/Annealed (ASTM B8)	
Insulation/Jacket	XLPE/CPE	
Strand Shield	N/A	
Conductor Shielding	N/A	
Insulation Shield	N/A	
Metallic Shield	N/A	

Design Criteria	Value(s)	Note(s)
NEC/BMCD Cable Type	XHHW-2, RHH, RHW-2, USE-2/SGND-1.0	
Installation	Underground/Aboveground	
Conductor Material and Construction	Multi-Conductor Copper – Solid (ASTM B8)	
Insulation/Jacket	XLPE	
Strand Shield	N/A	
Conductor Shielding	N/A	
Insulation Shield	N/A	
Metallic Shield	N/A	

3.2 Acceptable Conduit Construction

Design Criteria	Value(s)	Note(s)
PVC	Buried, Ducts, Embedded Concrete, Buried Road Crossings	Schedule 40
Fiberglass	Risers	
RGS	Exposed, Risers	
Aluminum	Exposed	
EMT	Finished Areas	

3.3 Grounding Requirements

Design Criteria	Value(s)	Note(s)
Design Requirement	Modeled, step/touch per IEEE 80 requirements	
Conductors	Sized per CEC, Copper, minimum 4/0 AWG	
Rods	Copper-clad steel, minimum 10 ft. length, minimum 5/8" diameter	
Grid Burial Depth	Minimum 18", determined by model	
Risers	Size per NEC. Minimum 4/0 AWG	
Rod Connections	Exothermic	
Conductor Connections	Exothermic	
Equipment Connections	Bolted	
Cable Tray Grounds	N/A	

4.0 INSTRUMENTATION & CONTROL

4.1 Preferred Manufacturer

Design Criteria	Value(s)	Note(s)
Managed Ethernet Switch	Cisco	
Unmanaged Ethernet Switch	RLH	
Fiber Patch Panel	Corning	
PLC	Modicon	
EMS	Orion	
Other controllers	None	

4.2 Communications Cables

Design Criteria	Value(s)	Note(s)
FIB1	Corning 006ESF-T4101D20	Fiber Optic – Loose Tube Indoor/Outdoor Nonconductive Riser Cable
FIB2	Corning 072EUF-T4101D20	Fiber Optic – Loose Tube Indoor/Outdoor Nonconductive Riser Cable
DAT60		Category 6 - Outside Plant-Rated Communications Cable

4.3 Networking Requirements

Design Criteria	Value(s)	Note(s)
Network Redundancy	Redundant corporate fiber cables	
Route Redundancy	Separate Ducts	
Quantity of Networks	2 - corporate, control	
Cybersecurity	Inverter and BMS in separate fiber bundles and cassettes	
Termination and Splicing	Home-run bulk cables are directly spliced to field cables	

5.0 CIVIL

5.1 Civil

5.1.1 Earthwork

Design Criteria	Value(s)	Note(s)
Cut/Fill Balance. Limit import material.	22,650/28,188 Cu. Yd. (Cut/Fill)	Includes 10% fill factor. Substation basin may be expanded to generate additional material.
Drainage Features designed for the 10yr-24hr storm.	Two (2) Retention Ponds – Retain the increase in runoff.	

5.1.2 Sitework Design Requirements

Description	Site Specific Depth (in)	Paved Width (ft)	Bottom Width (ft)	Minimum Drainage Slope %	Minimum Density %	Design Codes and Standards
Design Storm 10yr- 24hr	4.37"					NOAA Atlas 14/Solano County Road Improvement Standards Used for pond design
Design Storm 100yr- 24hr	6.67"					NOAA Atlas 14/Solano County Road Improvement Standards Used for ditch design
Soil Compaction @ Optimum Moisture Density					90 for general grading 95 for under roads and structures	Geotech Report/ASTM D1557
Crushed Rock Roads	6" AB over geotextile fabric over 12" properly prepared subgrade					Site Specific
Plant Road Width & Surfacing	6" AB over geotextile fabric over 12" properly prepared subgrade	30'				Site Specific
Crushed Rock Surfacing	6" over compacted subgrade					Site Specific
Grass Topsoil Surfacing	4"					Site Specific
Overland Flow Storm Runoff				0.5%		Site Specific
Open Channel Ditches			8'	0.5%		Site Specific

6.0 GEOTECHNICAL INFORMATION

6.1.1 Sources

- Draft Geotechnical Report, Corby BESS Project, Prepared by RRC. RRC Project No. GE23006031, January 19, 2024.

7.0 STRUCTURAL

7.1.1 Design Standards and Codes

- California Building Code, 2022
- ACI 318-19, Building Code Requirements for Structural Concrete, 2019
- American Welding Society Structural Welding Code – Steel (AWS D1.1)
- ANSI/AISC 341, Seismic Provisions for Structural Steel Buildings, 2016
- ANSI/AISC 360, Specification for Structural Steel Buildings, 2016
- ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, 2016
- AISC Steel Construction Manual, 15th Edition

Design Criteria	Value(s)	Note(s)
Design Life	30 Years	

7.1.2 Structural and Miscellaneous Steel

Design Criteria	Value(s)	Note(s)
Wide flange (WF) shapes and tees cut from WF	ASTM A992, Grade 50 or ASTM A572, Grade 50	
Channels, angles, structural plate and bars	ASTM A36 or ASTM A572 Grade 50	
Pipe for structural uses	ASTM A53, Type E or S, Grade B or ASTM A106, Grade B	
Square and rectangular HSS	ASTM A500, Grade C (Fy = 50 ksi)	
Round HSS	ASTM A500 Grade C (Fy = 46 ksi)	
Anchor bolts (cast-in-place)	ASTM F1554, Grade 36, UNO (hot-dipped galvanized)	
Anchor bolts (post-installed)	Epoxy or adhesive type w/ galvanized materials, UNO	Design in accordance with manufacturer's printed instructions
Connection bolts	5/8" diameter ASTM F3125 Grade A325, UNO	
Grating	Main and cross bars – ASTM A1011 Depth – 1 1/4", UNO Serrated Finish - Galvanized	



CREATE AMAZING.

Burns & McDonnell Western Enterprises, Inc.
145 S STATE COLLEGE BLVD.
SUITE 600 BREa, CA 92821
www.burnsmcd.com

Operation & Maintenance Manual

JF2 DC LINK 5.1



Document No :

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8.1

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Reference Documents

Document No.	Document Name
F2D4-5.1US-GN04	DC LINK Product Specification
F2D4-5.1US-EL04	DC LINK Arc Flash Analysis
F2D4-5.1US-CT01	BSC SW User Manual
F2X4-5.1US-FS01	AC&DC LINK Fire Safety Logic
F2X4-5.1US-FS02	AC&DC LINK Fire Safety Electrical & Communication Design
F2D4-5.1US-IC01	DC LINK Installation Manual
F2D4-5.1US-MC01	DC LINK Mechanical & Structural Drawings
F2D4-5.1US-EL02	DC LINK MAIN & AUX Single Line Drawing

Note: Only the latest version of reference documents is valid. Please check the version to LG Energy Solution before reading the reference documents.

Important Safety Information

Safety Notice

General definition of safety notices follows ANSI Z535.5: Safety Tags and Barricade Tape.



DANGER

A red DANGER notice contains information about a hazard that will cause severe personal injury, death, or substantial property damage.



WARNING

An orange WARNING notice contains information about a hazard that can cause serious personal injury, death, or property damage if you ignore the information.



CAUTION

A yellow and black CAUTION notice identifies conditions or practices that could result in injury or damage the equipment.



Note

Important installation information that does not involve safety hazards or equipment damage.

Electrical Hazards



DANGER

Dangerous electrical voltages are present on parts of the energy storage device. Disconnecting the PCS will not completely de-energize the system because the batteries remain a source of energy. Obey all safety warnings on the device and in the manual when working on or near the energy storage device.



DANGER

- *Risk of injury from electric voltages.*
- *Do not ground or short circuit batteries.*
- *Always wear the safety gear listed in recommended safety equipment.*



DANGER

There is an immediate and serious risk of electrocution when contacting live parts. Damage to cable insulation can result in death. Additionally, incorrect connections can cause the system to malfunction.

- *Electrical work and connections should only be carried out by qualified personnel, authorized by local authorities.*
- *If damage to cable insulation is detected, immediately de-energize and replace the damaged cables with identical new ones.*
- *Follow established procedures and regulations. Lock out the necessary devices before carrying out the work.*
- *Follow the five safety rules in accordance with EN 50110-1:2004, regardless of any additional notices or legal requirements:*
 - *Completely disconnect.*
 - *Secure against re-connection.*
 - *Verify that the installation is dead.*
 - *Carry out grounding and short-circuiting.*
 - *Provide protection against adjacent live parts.*
- *Never bypass fuses.*
- *Replace defective fuses only with identical fuses from the same manufacturer.*
- *Ensure that live parts are kept dry and free from moisture that can cause a short circuit.*

**WARNING**

Before starting the work:

- *Disconnect completely*
- *Protect against reconnection.*
- *Verify absence of operating voltage.*
- *Install temporary ground cable kit to relevant equipment, except to battery pack terminals.*
- *Install protection from adjacent parts that are energized to prevent injury due to electrocution or arc flash.*

**WARNING**

Risk of injury from hot components under operation. Allow sufficient time for equipment to cool before opening covers or doors.

**WARNING**


Risk of injury from moving parts. Follow safety warnings in this manual and on the equipment.

**CAUTION**

De-energize the device:

- *De-energize the Aux. power and main DC power supplies as described in the operation & maintenance manual.*
- *De-energize all power inverters and AC contactors to keep them open.*
- *De-energize all DC contactors to keep them open.*
- *De-energize both control cabinets.*

Recommended Safety Equipment



WARNING

KEEPS INSTALLERS SAFE

To protect installers at any LGES system, ensure that:

- *All workers need to select appropriate PPE in compliance with the local code and regulation*
- *All work complies with all local, national, and international code and regulations.*
- *Personal fall arrest equipment is used in accordance with the manufacturer's specifications and instructions.*

(1) Personal Protective Equipment (PPE)

(2) All personnel who enter the site must wear basic PPE. In addition, all personnel who work on JF2 DC-LINK equipment for electrical work shall follow Arc Flash PPE Requirements in [NFPA 70E Table 130.5\(G\)](#) and [F2D4-5.1US-EL04_DC LINK Arc Flash Analysis](#). Review Arc Flash Analysis and select appropriate PPE for personal safety. All personnel must comply with the local code and regulation for PPE to protect from Arc Flash. Please refer to the Arc Flash Protection Section for detailed information.








Basic PPE		Electrical Work	Working at Elevation
			
Safety Goggle	Safety Gloves	Insulation Gloves	Fall Arrest Gear
			
Safety Hat	Safety Shoes	FR Rated Clothing	

Figure 1: Personal Protective Equipment

(3) Fall Arrest Equipment

All LGES employees and contractors working on top of DC LINK enclosures or on any other elevated surface must use fall arrest anchoring equipment and personal fall arrest gear. Personnel should not stand on top of DC LINK enclosures. Instead, work from ladders, scaffolding, or lifts beside the enclosures. If working on top of an enclosure is absolutely necessary during installation or repair of equipment, fall arrest gear must be used. All personnel must comply with local codes and regulations with respect to working at elevation.

Arc Flash Protection

An arc flash analysis has been conducted, following the guidelines of Annex D of NFPA 70E, to protect personnel from the risk of injury due to arc flash or electric hazards. The analysis includes incident energy calculations. For more details, refer to *F2D4-5.1US-EL04_DC LINK Arc Flash Analysis*. Anyone who accesses and/or works on a battery system must wear appropriate PPE (Personal Protective Equipment) based on the incident energy level.

• Simulation Condition

DC LINK : E-Panel 1EA & M-LINK 3EA are in parallel



	<div style="background-color: red; color: white; padding: 10px; text-align: center;">  DANGER </div>		
	<div style="background-color: white; padding: 5px;"> ARC FLASH and Shock HAZARD. Follow requirements in NFPA70E for safe work practices and appropriate personal protective equipment. </div>		
	M-LINK 3EA parallel	M-LINK 2EA parallel	M-LINK 1EA
Battery System Voltage	1421.9 Vdc	1421.9 Vdc	1421.9 Vdc
Clearing Time	3 ms	3 ms	3 ms
Arc Flash Incident Energy	1.514 cal/cm ²	1.010 cal/cm ²	0.505 cal/cm ²
Working Distance	45.5cm (18 inch)	45.5cm (18 inch)	45.5cm (18 inch)
Arc Flash Boundary	51.1 cm (20.1 inch)	41.7 cm (16.4 inch)	29.5 cm (11.6 inch)
Limited Approach Boundary	1.5 m (4.92 ft)	1.5 m (4.92 ft)	1.5 m (4.92 ft)
Restricted Approach Boundary	0.5 m (1.64 ft)	0.5 m (1.64 ft)	0.5 m (1.64 ft)

Figure 2. Arc-Flash and Shock Protection Label

WARNING



- *When handling live electrical components, it is essential for workers to wear arc-rated clothing at all times to ensure protection against arc flash according to local codes and regulations.*
- *Arc flash rated clothing must ensure worker freedom of movement and visibility while covering all ignitable clothing.*
- *The worker must always wear: (i) the non-conductive safety helmet and (ii) non-conductive protective equipment for the face, neck, chin, and eyes to protect against injury from electric shock or burns due to contact with energized electrical conductors or debris from arc flash and arc blast.*
- *The worker shall wear hearing protection within the arc flash boundary.*
- *The worker must wear appropriately rated gloves to provide protection against arc flash. Rubber gloves providing protection against electric shock must include leather protectors.*
- *The worker shall wear heavy-duty leather footwear, dielectric footwear or both to provide a degree of arc flash protection.*
- *The worker shall inspect arc flash rated apparel before every use.*
- *Work clothing or arc flash suits that are contaminated or damaged to the extent that their protective qualities are impaired must not be used.*
- *Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.*
- *The garment manufacturer's instructions for the care and maintenance of arc-rated apparel shall be followed.*
- *Arc-rated apparel shall be stored in a manner that prevents physical damage, damage from moisture, dust, or other deteriorating agents or contamination from flammable or combustible materials.*

Exclusion of Liability

Warranty claims and liability for direct or indirect damages are excluded if they are caused by one or more of the following:

- 1) Damage during movement within the site or storage.
- 2) Incorrect installation.
- 3) Operation of product in an inappropriate environment.
- 4) Incorrect use or inappropriate operation.
- 5) Insufficient ventilation of the device.
- 6) Ignoring applicable safety warnings and instructions.
- 7) Any attempted repairs or product modifications by unauthorized personnel.
- 8) Force majeure events.

1. Introduction

1.1 About This Manual

This Operation & Maintenance manual for the JF2 DC LINK (hereinafter “DC LINK”) of LG Energy Solution (hereinafter “LGES”) provides operators with information on the product introduction, safety precautions, operation, commissioning, maintenance, and troubleshooting, required for LGES products. Prior to proceeding with the operation and maintenance explained in this document, the operators must fully understand and familiarize themselves with the contents of this document. LGES recommends that this documentation be kept on-site at all times during product life. Compliance with all specified safety guidelines is a prerequisite for safe operation and maintenance. Local regulations and general safety conditions for battery operation shall be applied for accident prevention as well. Where this document directly or indirectly refers to laws, regulations, guidelines or citations, the manufacturer assumes no responsibility for the accuracy, completeness or currency of the reference material. Always comply with local and national regulations, applicable standards, and laws for using the product. LGES is responsible for providing information and taking responsibility for DC LINK, but does not provide any information or take responsibility for other facilities (EMS, PCS, AC Utility Power and TR), which are out of scope of supply of LGES. Additionally, the operation, commissioning, maintenance, and troubleshooting provided in this manual must be performed by qualified personnel, and LGES is not responsible for any personal or material damages that may occur if this is not followed.

1.2 Safety

During the operation and maintenance, high-voltage products are handled, and only technicians qualified in accordance with local standards must carry out the work. If you encounter any problems during the operation and maintenance, please refer to the Emergency Response Plan ("ERP") for assistance.

1.3 Product Overview

As defined in Figure 3, the DC LINK system consists of one E-Panel unit and a maximum of three M-LINK units, depending on the specifications of PCS. DC LINK interfaces to the energy management system (EMS) and the power conversion system (PCS), with a maximum of three DC LINKs for each PCS, and only the first DC LINK is equipped with BSC in E-Panel, which allows communication with upper device only by the E-Panel#1. In other case, the client can also choose to purchase three DC LINKs that both include E-Panels, equipped with FACP and BSC. It will allow each DC LINK to communicate with upper control device directly. The aux power is branched from E-Panel to M-LINK separately. However, the main & auxiliary power and signal related to FACP are connected for all E-Panels, regardless of the E-Panel type.

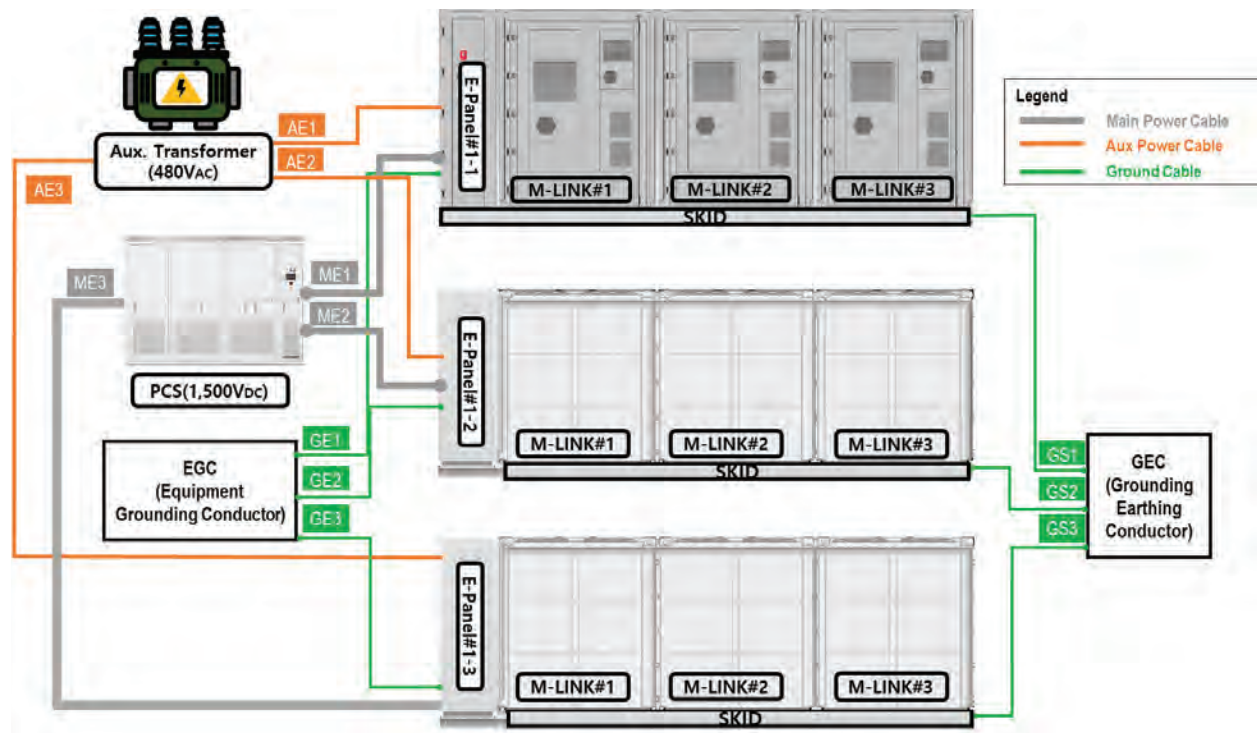


Figure 3: DC LINK System Electrical Configuration Diagram (3EA DC LINKs in a power block)

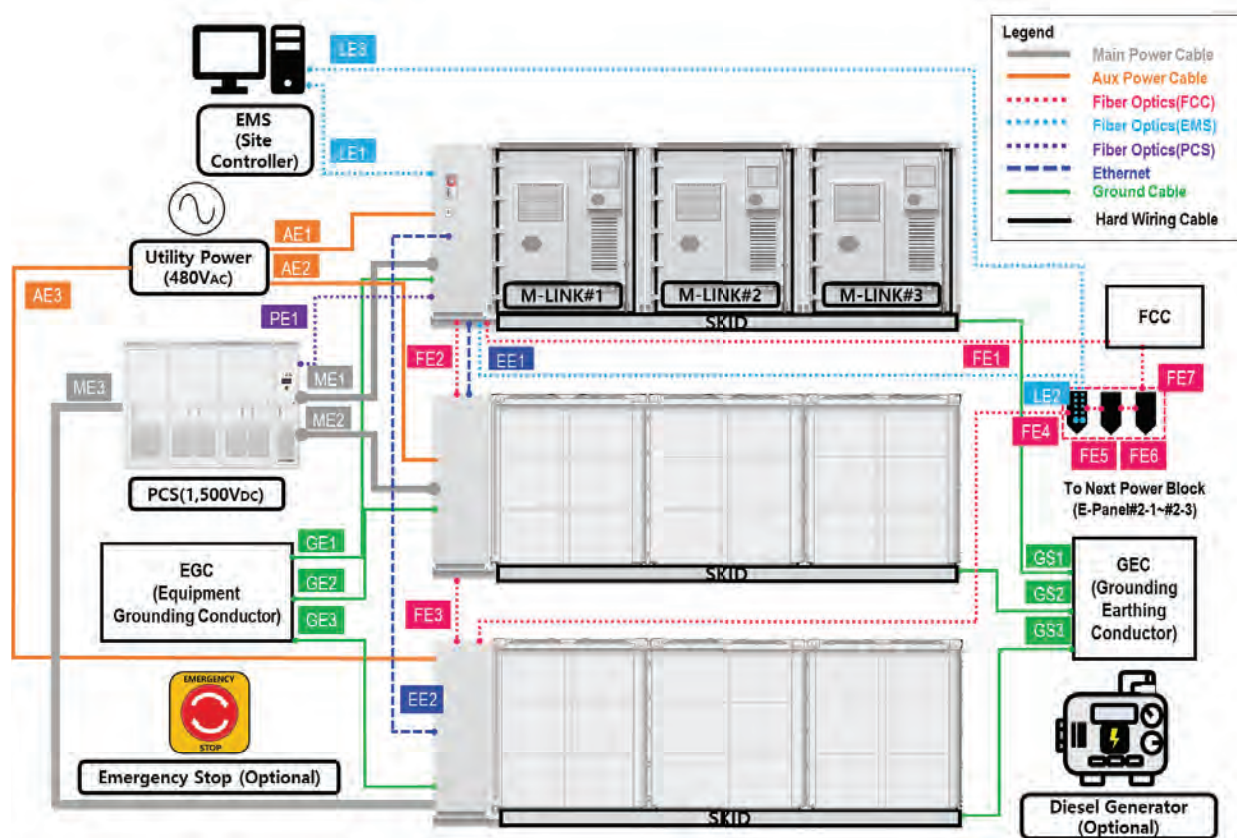


Figure 4: DC LINK System Communication Configuration Diagram (3EA DC LINKs in a power block)



Note

Above images are for reference purpose only. Actual image and connection may be different depending on the models and the system configuration.

As aforementioned, DC LINK includes M-LINK and E-Panel. The system's model name indicates DC LINK specifications. Refer to [F2D4-5.1US-IC01_DC LINK Installation Manual](#) for the configuration of component for E-Panel and M-LINK.

1.4 Technical Support

In case of technical difficulties with Operation & Maintenance, contact the LGES using below contact information.

E-Mail Support

lgesswarranty@lgensol-vt.com


To ensure efficient support, please provide the following information when contacting us.






- ✓ Project & Installation Site Name
- ✓ Contact information
- ✓ Support required (describe the problem, the symptoms of the problem, the time of the problem, etc.)



1.5 Operation & Maintenance Tools (by LGES)

For the operation & maintenance of the DC LINK, several maintenance tools are provided by LGES and are found in the right door of E-Panel. Please refer to the list below. The images are for reference purposes only, and the actual tools may differ.

Table 1: Installation Tool List (Reference Purpose Only)

Items	Image	Product Model	Quantity per DC LINK	Reference
Door Padlock		J55	1EA for E-Panel 3EA for M-LINK	For locking the doors

Items	Image	Product Model	Quantity per DC LINK	Reference
Door Padlock Key		-	4EA	For locking the doors
Drawing Documents		-	1EA	-
HASP		SHAH 11	1EA	2.2.8.1 LOTO Installation on DC Main Line in E- Panel
Safety Tag		SHLT02-ENG	5EA	2.2.8.1 LOTO Installation on DC Main Line in E- Panel
Locking Device (MCB)		06410096	4EA	2.2.8.2 LOTO installation on DC BPU control power in E-Panel

Items	Image	Product Model	Quantity per DC LINK	Reference
LOTO Padlock		SHP38S	5EA	<p>2.2.8.2 LOTO installation on DC BPU control power in E-Panel</p> <p>2.2.8.3 FACP MCB Locking Installation in E-Panel</p>
LOTO Padlock Key		SHNK	5EA	<p>2.2.8.2 LOTO installation on DC BPU control power in E-Panel</p> <p>2.2.8.3 FACP MCB Locking Installation in E-Panel</p>

2. Operation

DANGER

Before operating the DC LINK, please follow the precautions below:



- 1) Do not open the door of the DC LINK during high humidity (>85%), strong winds, or rainy weather. LGES is not responsible for any damages resulting from violation of this warning.***
- 2) Do not approach energized conductors with conductive materials.***
- 3) Verify if the power is disconnected before commencing work (meaning disconnection of M-LINK and E-Panel).***
- 4) Only authorized personnel are allowed to enter the operating area.***
- 5) Workers must wear personal protective equipment (PPE) at all times.***
- 6) The power supply unit must be kept in a locked state to ensure maximum security.***
- 7) Carefully read the safety precautions (Danger, Warning, and Caution) in this manual.***



Note

When powering on the DC LINK, it is essential to first activate the E-Panel before operating the M-LINK.

This chapter explains the operation method for powering on/off the DC LINK. It starts with a pre-checklist before powering on the DC LINK, followed by the power-on method for charging/discharging and the power-off method for de-energizing. It also introduces the emergency power-off method.

The owner, operator, and contractor representatives must adhere to the safety regulations described in this procedure. Before conducting any testing, commissioning, or operational activities, general conditions are to be followed. The operator must understand the following basic

safety rules.

- 1) The working area shall be clear and free from debris and leftover materials.
- 2) Access to all working areas and equipment shall be clear.
- 3) Fire safety system and all related equipment shall be ready to operate.
- 4) Danger/warning signs as applicable shall be posted.
- 5) Before conducting any tests on equipment, that equipment shall be properly grounded.

2.1 Inspection before Power-On



CAUTION

Please check the following items before supplying power. Failure to verify any of these items may result in abnormal operation and damage to the DC LINK.

Table 2: Check list before Power-on

No.	Product	Check list	Check (✓)	Remarks
1	PCS	Is the PCS DC side opened so that there is no risk of inrush current to the DC capacitors in PCS?		
2	E-Panel	Are the switches for AC aux power lines turned off?		
3		Is the Disconnect Switch of Main DC 1500V open?		
4		Are the cable connections between the E-Panel and PCS wired correctly?		
5		Are the communication lines properly connected to the PCS or other E-Panels within the same power block?		
6		Is the Ventilation Door closed?		
7		Is the Emergency Stop Switch in the release state?		
8		Is the grounding wire properly connected?		

For detailed information for connection of DC power lines, aux lines and communication lines, Please refer to *F2D4-5.1US-IC01_DC LINK Installation Manual*.

2.2 Power-On DC LINK



CAUTION

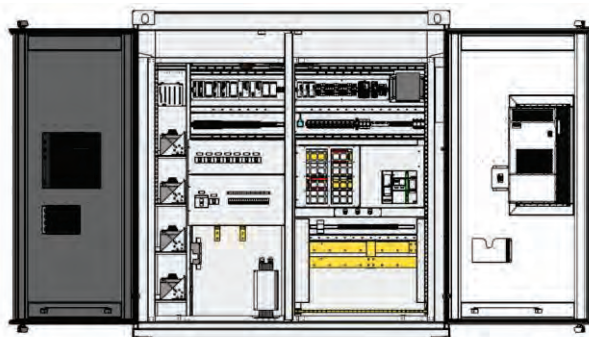
Please make sure to check the check list in “2.1 Inspection before Power-On” to prevent electrical accidents before powering on. If any warnings or faults occur during power on, please refer to “5. Troubleshooting”. For any alarms, warnings, or faults not mentioned in this manual, please contact LGES Technical Support



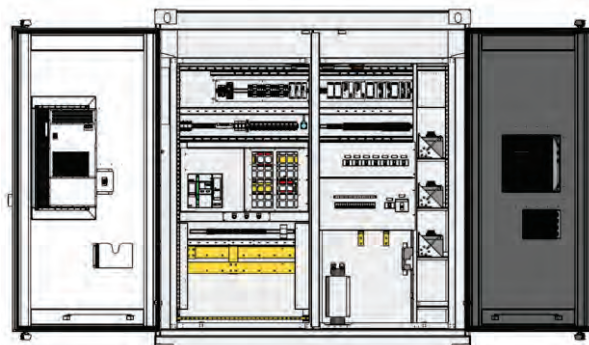
Note

There are three types of E-Panel, EPNL_1200A, EPNL_1200B, and EPNL_1200C that account for their mirrored internal layouts. The operation and maintenance procedures are the same for all panels, except for the opposite locations of components.

Type A: EPNL_1200A



Type B: EPNL_1200B



Type C: EPNL_1200C

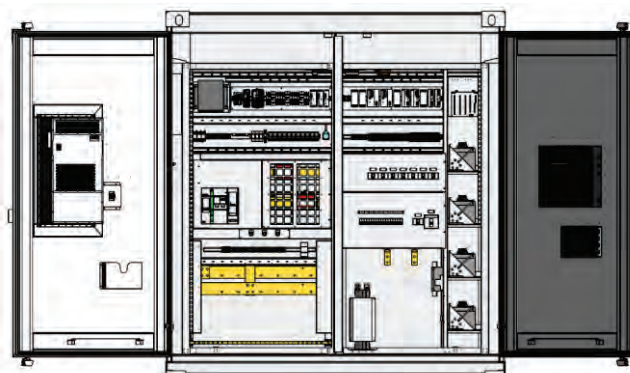


Figure 5: Comparison of E-Panel Types (EPNL_1200A & EPNL_1200B & EPNL_1200C)

The operation procedures described in this manual are primarily based on the E-Panel Type A (EPNL_1200A), unless the mirrored layout could potentially confuse the operator.

(1) Access to E-Panel

The E-Panel consists of two doors: The door for battery side connection and communication system (right) and the door for AC aux and FACP system (left). The main AC Aux, system includes the transformer, FACP panel, and DC for PCS side connection. Pull the handle located to open each door. To ensure safety, the disconnect switch (DS) in the E-Panel and the contactors in the M-LINKs are automatically opened when either door is opened.

Table 3: Diagnosis Condition by Opening the E-Panel doors

Category	Action	Diagnosis Level	Description
E-Panel Door For AC Aux & FACP (Left for Type A)	Open E-Panel Door	Fault	E-PLC: Report to BSC BSC: Report to Upper Controller BSC: Recalculate charge and discharge limit E-PLC: DS Open after 2s BSC: MC Open after 4s * All MCs in M-LINKs connected to E-Panel.
E-Panel Door For Battery side & Communication (Right for Type A)			

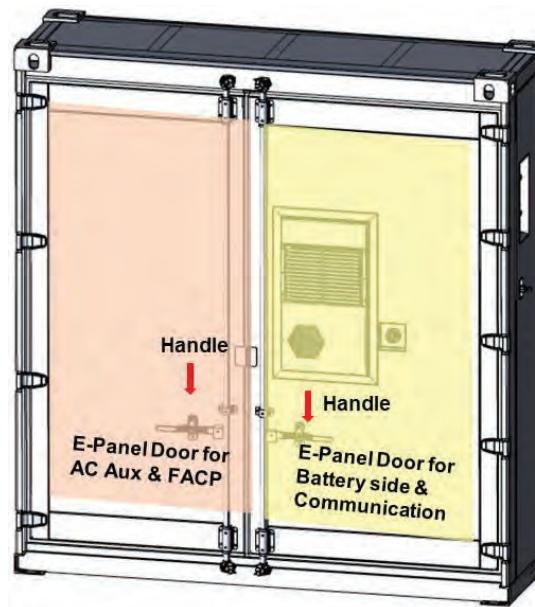


Figure 6: The location of E-Panel Doors and Handles

2.2.1 Turn On AC Aux Power



Note

Refer to *F2D4-5.1US-EL02_DC LINK Main & Aux Single Line Drawing* for detailed information about E-Panel electrical diagram.

AC Aux Power supplies the power to the loads in DC LINK. Aux loads are: M-LINK control power, FACP, UPS and Communication devices, HVAC and Chiller etc. Figure 7 illustrates the positions of the MCCB and Circuit Protector (CP) related to AC Aux Power. Table 4: Actions and results of AC Aux Power MCCBs/CP in E-Panel lists the names of each switch and the corresponding results based on their Turn ON status. Power to Aux loads can be switched on with No. 1 Main Aux Power. Power switch operation is shown in Figure 7. Turn on all AC Aux Power MCCB/CP switches sequentially as listed in Table 4.

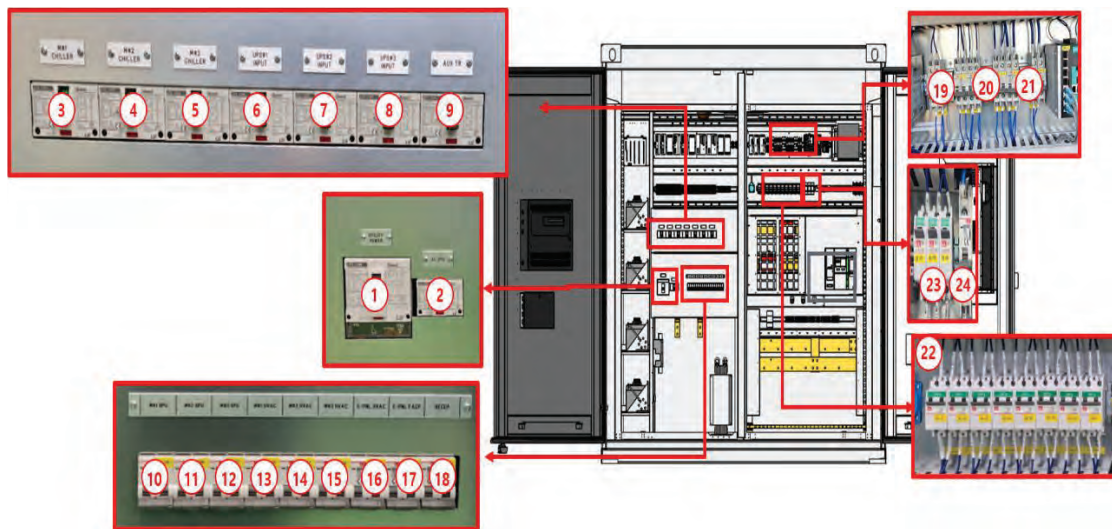


Figure 7: Layout of AC Aux Power MCCB and CP of E-Panel

Table 4: Actions and results of AC Aux Power MCCBs/CP in E-Panel

No.	Item	Action	Result
1	AC Utility Power(QE1)	Turn ON	Power is supplied to main aux line to all loads (3P 480Vac) (incl. SPD, M-LINK Chiller, M-LINK HVAC, FACP, Power Supply Unit for 24V _{DC} , Communication devices, etc.)
2	AC SPD	Turn ON	Connection SPD to the Power Line
3	M-LINK #1 Chiller	Turn ON	Power is supplied to M-LINK #1 Chiller (3P 480Vac)
4	M-LINK #2 Chiller	Turn ON	Power is supplied to M-LINK #2 Chiller (3P 480Vac)
5	M-LINK #3 Chiller	Turn ON	Power is supplied to M-LINK #3 Chiller (3P 480Vac)
6	AC Aux for UPS #1 Loads	Turn ON	AC Aux lines for UPS #1 Loads (3P 480Vac)
7	AC Aux for UPS #2 Loads	Turn ON	AC Aux lines for UPS #2 Loads (3P 480Vac)
8	AC Aux for UPS #3 Loads	Turn ON	AC Aux lines for UPS #3 Loads (3P 480Vac)
9	Aux TR	Turn ON	Step down TR for 280-120Vac Loads
10	M-LINK#1 BPU(QE35)	Turn ON	Power is supplied to M-LINK #1 24V control power
11	M-LINK#2 BPU(QE36)	Turn ON	Power is supplied to M-LINK #2 24V control power
12	M-LINK#3 BPU(QE37)	Turn ON	Power is supplied to M-LINK #3 24V control power
13	M-LINK #1 HVAC(QE16)	Turn ON	Power is supplied to M-LINK #1 HVAC
14	M-LINK #2 HVAC(QE17)	Turn ON	Power is supplied to M-LINK #2 HVAC
15	M-LINK #3 HVAC(QE18)	Turn ON	Power is supplied to M-LINK #3 HVAC
16	E-Panel HVAC(QE19)	Turn ON	Power is supplied to M-LINK #3 E-Panel HVAC
17	FACP Power(QE20)	Turn ON	Power is supplied to FACP
18	E-Panel receptacle(QE21)	Turn ON	Power is supplied to spare outlet
19	24Vdc for UPS #1 Loads	Turn ON	Power is supplied to M-LINK #1 UPS #1 Loads
20	24Vdc for UPS #2 Loads	Turn ON	Power is supplied to M-LINK #2 UPS #2 Loads
21	24Vdc for UPS #3 Loads	Turn ON	Power is supplied to M-LINK #3 UPS #3 Loads

No.	Item	Action	Result
22	Circuit Protectors for 24Vdc	Turn ON	24Vdc feeders of loads like communication devices, ventilation systems (8ea circuit protectors + 4ea circuit protectors for UPS/FACP Battery maintenance)

2.2.2 UPS & FACP Battery Switch Close



CAUTION

The circuit protector (QE104) for FACP battery should not be connected before FACP AC Power (QE20) is supplied.

To connect the UPS and FACP batteries, ensure that the circuit protectors and MCB switches are closed on site. It is important to close the circuit protector (QE104) only after the MCB (QE20) for FACP AC power is connected, in order to prevent damage to the FACP. Make sure to close the circuit protectors and MCB switches after AC power is connected.

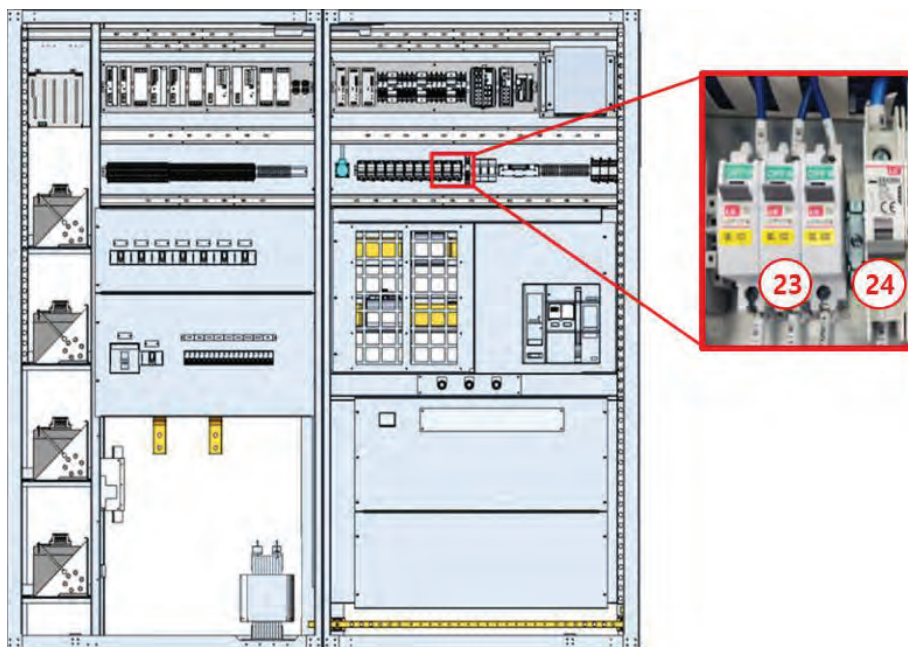


Figure 8: UPS & FACP Battery CP and MCB

Table 5: UPS & FACP Battery CP and MCB

Label	Device Type	Corresponding Equipment	Remark
QE101	CP	UPS#1	
QE102	CP	UPS#2	
QE103	MCB	UPS#3	
QE104	CP	FACP battery	Close only after the MCB (QE20) for FACP AC Power is closed

2.2.3 UPS buffer Time Setting Adjustment

To enable UPS operation, adjust the buffer time from 0.5 minutes to infinity (∞). Use a tool such as a flat screwdriver to adjust the setting. Each E-Panel contains three UPS units. Ensure that the settings are adjusted on-site for all three UPS units.



Figure 9: UPS Buffer Time Setting Adjustment

2.2.4 FACP Operation Check

As part of the start-up procedure, please ensure that the "System Normal" message is displayed on the control panel. In the absence of any alarms or troubles, the system operates in normal mode. During this mode, the control panel will display a "SYSTEM NORMAL" message. For detailed information on FACP event clearing and troubleshooting, please refer to "Chapter 3 Maintenance." This section provides comprehensive guidance to clear events and troubleshoot issues that may arise.

Refer to *F2X4-5.1US-FS01_AC&DC LINK Fire Safety Logic* and *F2X4-5.1US-FS01_AC&DC LINK Fire Safety Electrical & Communication Design* for detailed information about FACP.



Figure 10: FACP key pad

Typical Trouble message that appears on the LCD display:

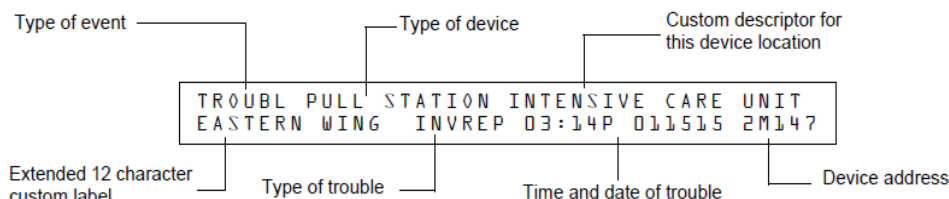


Figure 11: Message details of FACP window

Table 6: Descriptions and actions depending of FACP system trouble (Diagnosis Condition)

Category	Description	Diagnosis Level	Action
E-Panel FACP Trouble	FACP in E-Panel has a trouble.	Alarm	'EFACPTA' alarm on BSC window

2.2.5 DC Side Disconnect Switch Close in E-Panel



CAUTION

Beware that DS shows opposite behavior with connection between DC line and E-Panel. For example, If DS is opened, DC line is disconnected from E-Panel, and if DS is closed, DC line is connected to E-Panel.

(1) Unlock LOTO in E-Panel

Refer to 3.3.5 chapter for detailed information of LOTO process in E-Panel. The LOTO removal process should be followed in reverse for installation.

(2) Operation with AC Control Power

When the control power is supplied, the DS (Disconnect Switch) spring is automatically charged. This allows for the opening and closing operation of the DS by simply pushing the button on the DS. Figure 12 provides a visual representation of the operation of the DS, illustrating how it can be manipulated to open or close the circuit as needed. Press “I” button to close the DS. After confirming that DS is closed, apply the LOTO back to DS.

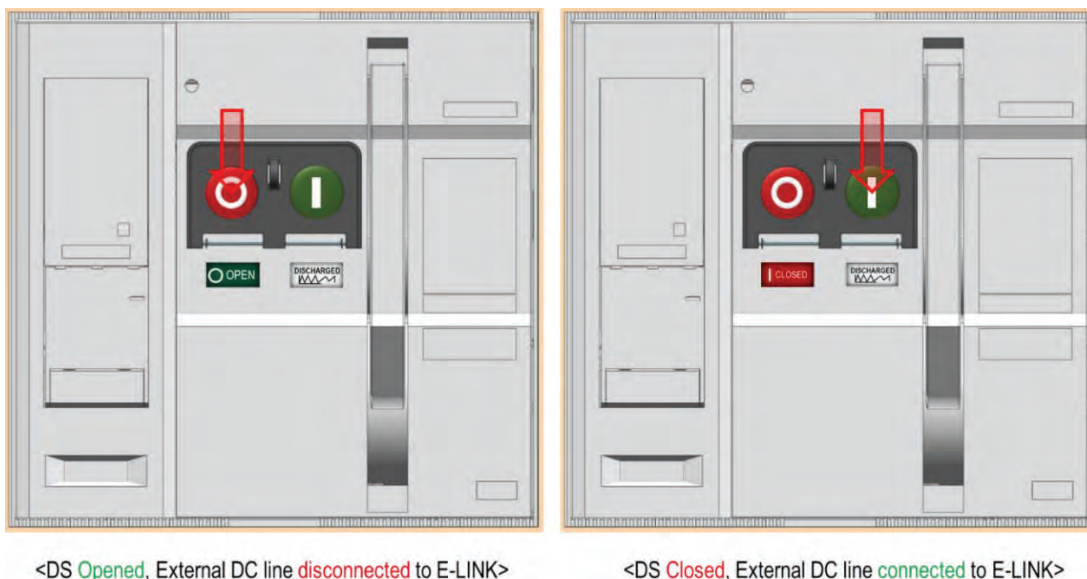


Figure 12: Operating disconnect switch (control power supplied)

Table 7. Description and Action of E-Panel DS Status (Diagnosis Condition)

Category	Action	Diagnosis Level	Result
E-Panel Disconnect Switch Status	E-Panel DS opens	Fault	E-PLC: Report to BSC BSC: Report to Upper Controller BSC: Recalculate charge and discharge limit BSC: MC Open after 4s

Table 8. Actions and results of E-Panel DS Status

Action	Result
Push red button(O)	DS is opened. The external DC Line is disconnected to E-Panel electrically. DS status indicator changes from '(I)CLOSE' to '(O)OPEN'
Push green button(I)	DS is closed. The external DC Line is connected to E-Panel electrically. DS status indicator changes from '(O)OPEN' to '(I)CLOSE'

(3) Manual Operating without AC Control Power

Note



In the absence of control power, the Disconnect Switch (DS) can only be operated by using the lever on the main body to manually charge the DS spring. It is necessary to manually charge the DS spring in order to resume the opening or closing operation of the DS without AC control power. This ensures that the DS can still be operated even in situations where control power is not available.

If the control power is not supplied, spring must be charged manually to operate DS. Follow these steps to charge the spring and confirm it is charged.

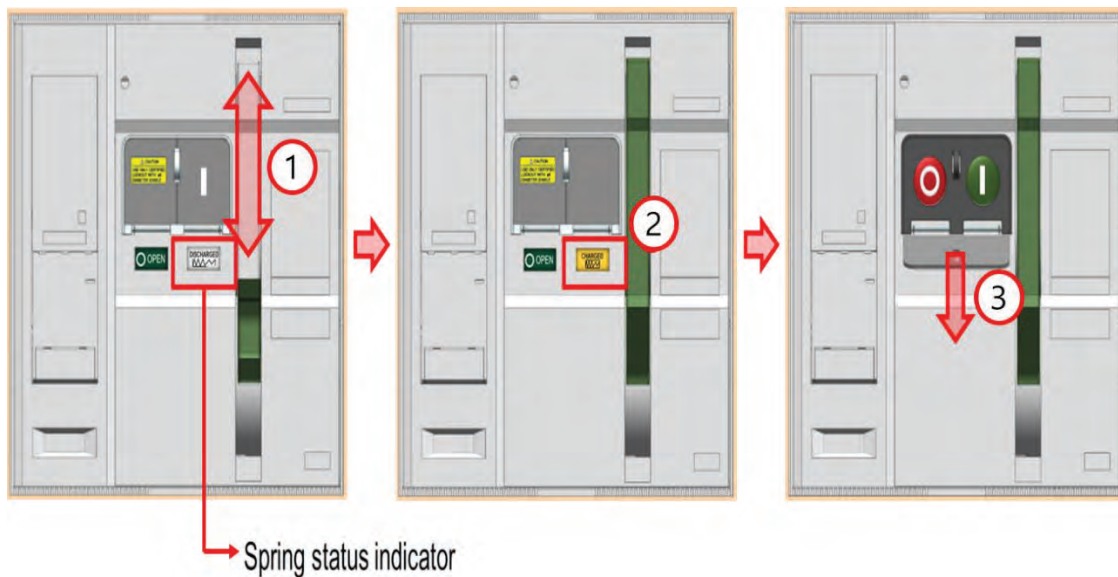


Figure 13: Spring charging and changes in spring status

1. Pull the lowering handle up and down. Repeat this action until spring status indicator changes color.
2. If the color of the spring status indicator changes to yellow, it indicates that the spring is charged and ready for operation.
3. Pull the cover and operate DS as described above.
4. Apply LOTO back to DS.

2.2.6 Turn on the 'BSC IPC' in E-Panel and Automatically run BSC SW.

The BSC IPC will be turned on when the Circuit Protectors for 24Vdc are closed(QE38 CP is the BSC switch).

When 'JF2Enc BSC Viewer' is executed in USER PC, it automatically attempts connection to the BMS. If Communication with BMS is normally connected, it transitions to 'Normal' state. If Communication with BMS is NOT normally connected in case of failure, it transitions to 'Not Initialized' state. Refer to *F2D4-5.1US-CT01_BSC SW User Manual* for checking the operating state.

2.2.7 Check Battery Normal state and Close Contactors

To verify the M-LINK racks are closed, check that the battery state is 'Normal' and confirm the visibility of the rack voltage on the BSC display.

When the battery state is normal, the system can be operated after closing the contactors on each rack. Below are the method for control of contactors for each rack.

Method 1) Send 'ContactorClose' signal through L1 Controller

Once the L1 controller is connected to the L2 controller of the E-Panel, the 'ContactorClose' command can be sent through Modbus communication. Please refer to the modbus map for the communication setup between the L1 controller and L2 controller

Method 2) Send 'ContactorClose' signal through BSC UI Interface

Once the authority is changed to 'Supervisor'(Only permission allowed LGES internal), the JF2Enc.Emulator can execute. Enter the IP address of the BSC system. Click 'Connect' to establish the connection, ensuring that both the PCS and DC LINK tabs are connected. Verify the connection status and navigate to the Command section. Click 'ContactorClose' to close the MC in the M-LINK rack. This action will initiate the closing of the contactor within the racks of the M-LINK system. Refer to *F2D4-5.1US-CT0_BSC SW User Manual* for JF2Enc.Emulator and IP address set-up. Check battery status information, including the number of online racks.



Note

Some racks may fail to close a contactor due to voltage or state of charge (SOC) differences between the racks or a system fault. Refer to JF2Enc BSC SW Supervisor Manual for Relay Control.

2.2.8 LOTO Process

2.2.8.1 LOTO Installation on DC Main Line in E-Panel



Note

E-Panels [EPNL_1200A and (EPNL_1200B & EPNL_1200C)] have mirrored internal layouts. The installation procedures are the same for all E-Panel types, except for the opposite locations of mirrored components.

LOTO must be applied prior to E-Panel maintenance work. Method of applying LOTO process is as follows.

- 1) Prepare LOTO components located in the E-Panel door.
- 2) Close both DS switch covers.
- 3) Insert HASP through both covers' holes and verify that hasp is securely fixed to the switch cover.
- 4) Insert the safety tag in the padlock.
- 5) Lock the padlock with the safety tag to ensure it is easily recognized.
- 6) Verify that E-Panel is securely locked out. Verify absence of voltage for each element that personnel can come into contact with such as DC SPD, DC Main busbar, and etc. Authorized personnel shall retain padlock key.

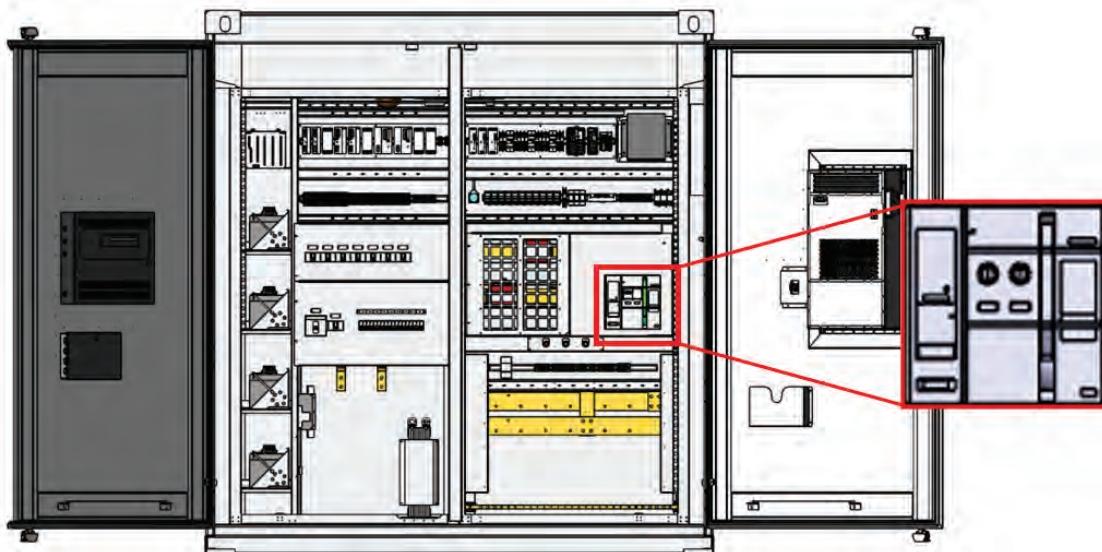


Figure 14: E-Panel LOTO location (DC Main Circuit)



1. In order to apply the LOTO system on E-Panel, prepare the enclosed Lockout hasp



2. Close both DS B1 Covers



3. Fasten the lockout hasp on both cover holes



4. Verify that the lockout hasp device is secured well on DS B1 cover



5. Fasten the enclosed lock with safety tag to the lockout hasp hole



6. Fasten the lock. Verify that the LOTO system is well secured to E-Panel. The authorized person keeps the lock key

Figure 15: Applying LOTO (DC Main Circuit)

2.2.8.2 LOTO installation on DC BPU control power in E-Panel



Note

Both E-Panels (EPNL_1200A & EPNL_1200B) have mirrored internal layouts. The installation procedures are the same for both panels, except for the opposite locations of mirrored components.

The LOTO process for the 24V DC control power follows the same procedure as the LOTO process for the DC Main Circuit. Locate the corresponding 24V circuit breakers in the diagram below.

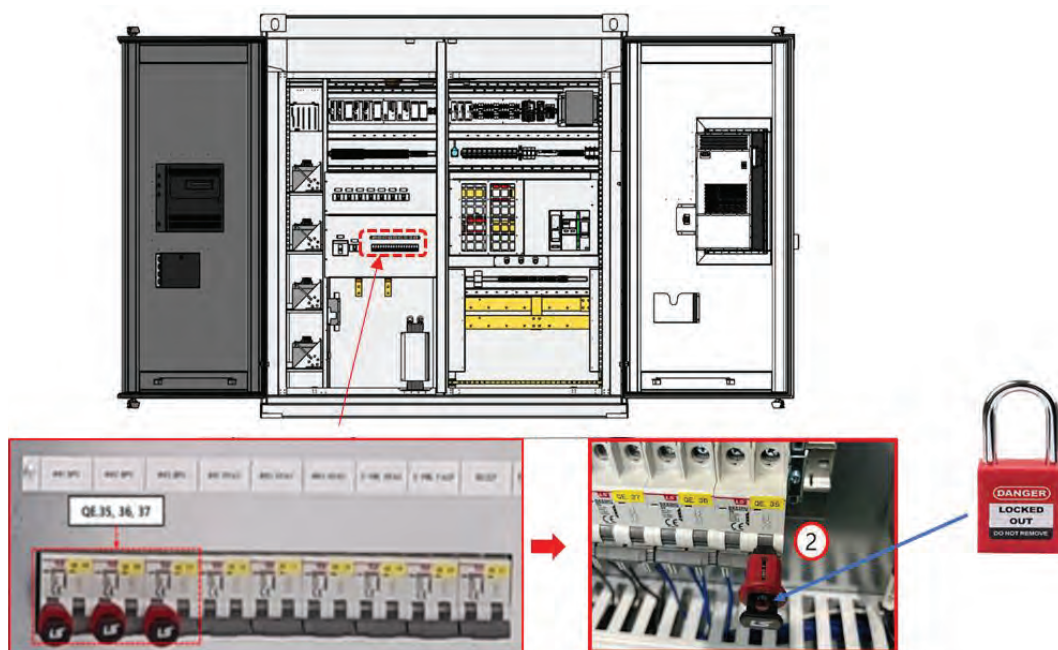


Figure 16: Applying LOTO to E-Panel MCB

- 1) Plug the MCB locking device into QE.35, QE.36, and QE 37.
- 2) Insert the padlock into the hole of the locking device and lock it.
- 3) The authorized person should keep the key to the lock.

2.2.8.3 FACP MCB Locking Installation in E-Panel



Note

E-Panels [EPNLTF_1200A and (EPNLTF_1200B & EPNLTF_1200C)] have mirrored internal layouts. The installation procedures are the same for all E-Panel types, except for the opposite locations of mirrored components.

To ensure the MCB remains in the closed state, the FACP MCB must be secured with a locking device and a padlock.

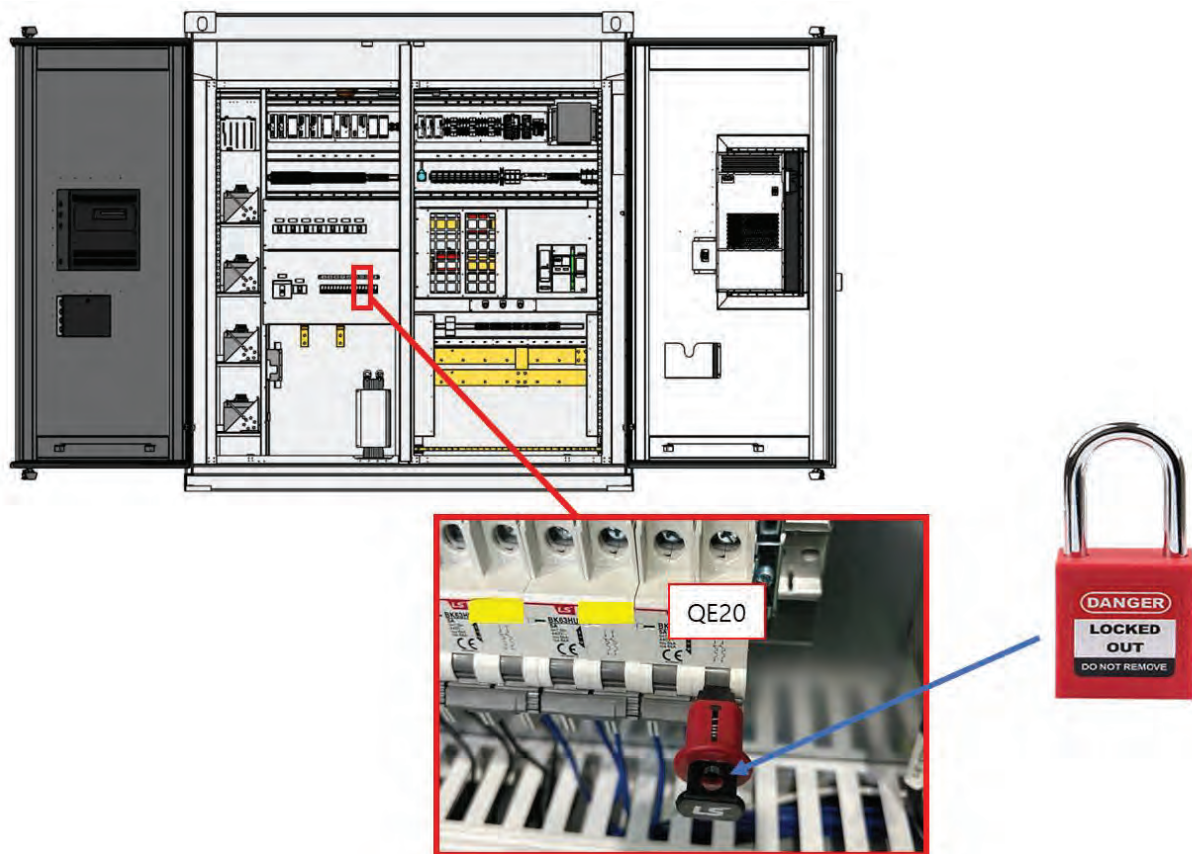


Figure 17: Applying LOTO to E-Panel MCB

- 1) Plug the MCB locking device into QE.20.
- 2) Insert the padlock into the hole of the locking device and lock it.
- 3) The authorized person should keep the key to the lock.

2.3 Power-Off DC LINK

When it is necessary to stop operation of the DC LINK for inspection or maintenance, proceed as follows.

2.3.1 Power-Off for 'Normal state'

Step 1 Verify that the system's Charge/Discharge function has stopped.

Step 2 Verify that the PCS system has been turned OFF.

Step 3 Send 'ContactorOpen' and 'Stop' signal through BSC.

Method 1) Send 'ContactorOpen' signal through L1 Controller

Please refer to the modbus map for the communication setup between the L1 controller and L2 controller

Method 2) Send 'ContactorOpen' signal through BSC UI Interface

Once the authority is changed to 'Supervisor', the JF2Enc.Emulator can execute. In the Command window, select 'ContactorOpen' to open the MCs in the racks. Ensure that all MCs in the rack are open and all racks are in an offline state.



CAUTION

Stop charging/discharging before disconnecting from the BMS. If this is not done, the stop command will be rejected during charging/discharging.

Step 4 Turn off the power of the BSC IPC to terminate BSC.

Open the Maintenance door in E-Panel. Press the power button of BSC IPC inside E-Panel to turn off the BSC IPC power.

Step 5 Press the ‘Open’ Button on the DS in E-Panel.

Refer to Step 4 in 2.2 Power-On DC LINK for DS operation in E-Panel.

Press “O” button to open the DS.

Step 6 Turn off the ‘FACP’.

Disconnect battery cable. (Recommended Torque: 2 ~ 2.9 N·m)

Protect terminals with battery caps to prevent short circuit.

Turn off the Main MCCB and FACP MCB.

Step 7 Turn off the ‘AC Aux Power’ by opening the MCCBs.

Refer to Step 3 in 2.2 Power-On DC LINK for BPU Power Switch.

Turn off all MCCBs in reverse order.

2.3.2 Power-Off for Emergency



WARNING

In the event of an arc flash or electrical hazard on the DC LINK system, it is crucial to prioritize safety. The Emergency Stop Switch (E-Stop) should be manually operated immediately to halt all operations and cut power to the system.

The Emergency Stop (E-Stop) switch is used during emergency situations involving electrical accidents. When the E-Stop switch is pressed, the contactors in M-LINK and DS (Disconnect Switch) in the E-Panel system open. The specific actions for each device are detailed in the following Table 9. Once the emergency situation is resolved and it is safe to do so, the E-Stop switch should be turned in the direction indicated by the arrow to release it. This action restores the normal operation of the system. It is important to follow proper safety procedures and guidelines when using the E-Stop switch and to only release it once the emergency situation has been resolved.

Table 9: Description and action of E-Stop (Diagnosis Condition)

Category	Action	Diagnosis Level	Result
E-Panel E-Stop	Press E-Stop in E-Panel manually.	Fault	E-PLC: Report to BSC

			BSC: Report to Upper Controller BSC: Recalculate charge and discharge limit E-PLC: DS Open after 2s BSC: MC Open after 4s
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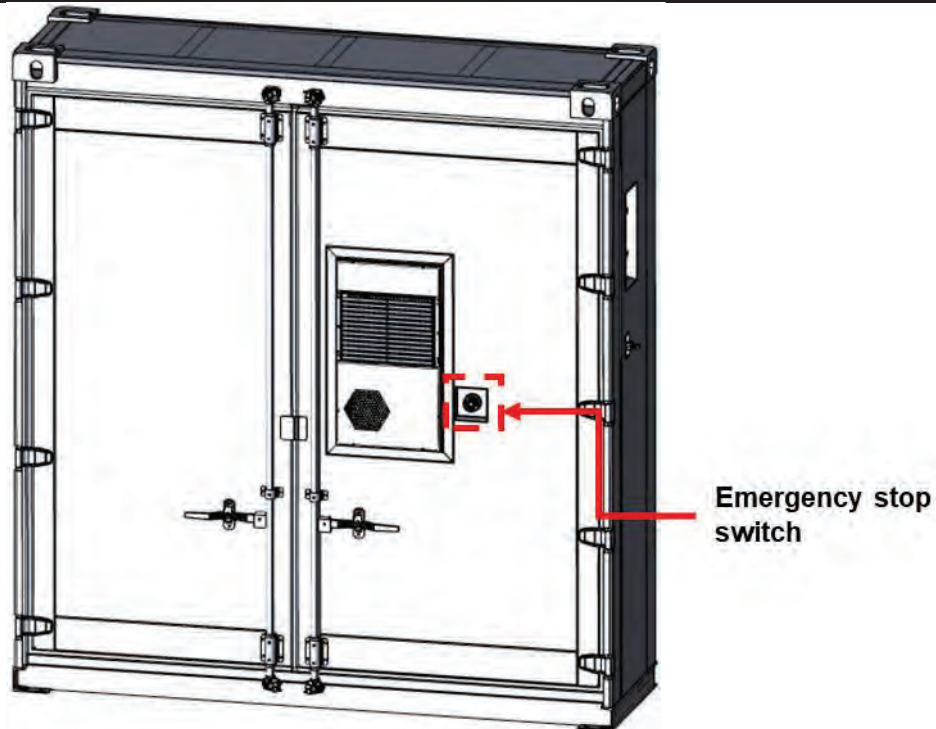


Figure 18: Emergency stop switch of E-Panel

2.4 Operational Permission

There are three types of accounts in BSC SW, each with different permissions. Two ('User' & 'Admin') accounts are available for the user to operate DC LINK.

2.4.1 Permission Change

Current permissions can be checked in the upper right corner of the main screen.



Figure 19: Changing Account

Click on the current permission, to open the password window as shown above. Enter the password for the desired authority and click 'Yes', the authority automatically changes.

2.4.2 Admin authority

The User account is used for regular operation, while the Admin account is used for maintenance.

- User : Only basic control necessary for operation is possible.
 - 1) Manipulate BSC: BMS communication connection and disconnection,
 - 2) BSC basic setting: user option setting (Logging Path & Port No.)
- Admin : The following functions can be used in addition to the functions available in user permissions.
 - 1) Simulator: Simulator for Matching Test with Upper Controller, JF2Enc.Emulator
 - 2) Setting Values Read / Write : Configurator, NV Read/Write
DC LINK PLC NV Read/Write(JF2 Enclosure)
 - 3) CER(Critical Event Record) Read / Write

For detailed functions for each permission, refer to *F2D4-5.1US-CT01_BSC SW User Manual*.



Note

Individual settings cannot be changed with admin authority. Only LGES-provided setting values can be written.

3. Maintenance



DANGER

Before maintenance of JF2 DC LINK, read following cautions carefully.

- 1) *Do not bring any conductive object closer to energized conductors.*
- 2) *Read all safety notices (Caution, Warning, Not and Danger) carefully.*
- 3) *Ensure DC LINK system is completely shut down.*
- 4) *Ensure only authorized persons can enter the operation area.*
- 5) *Ensure that all people on-site wear appropriate PPE.*
- 6) *Ensure maximum security for all energized zones shall be kept locked*



WARNING

Do not perform maintenance for JF2 DC LINK System during conditions of rain, wind, snow, or excessive humidity. LGES is not liable for any damage caused by violation of this warning.



CAUTION

When conducting any maintenance work, it is essential to strictly adhere to the regulations of the country where the installation is located. Restrictions imposed upon the equipment, where applicable, must be respected.



Note

*The O&M contractor is responsible for product maintenance.
LGES only provides guidance on product maintenance and replacement options.*

3.1 Maintenance Precautions

Maintenance work may only be performed by trained personnel familiar with the characteristics of the individual product, in accordance with all relevant safety regulations and those of other technical authorities, and with other overriding instructions that may apply.

The inspection and servicing intervals for some of the equipment/components (e.g. parts

subjects to wear) are determined by fixed criteria, such as switching frequency, length of service and number of short-circuit breaking operations. Maintenance intervals for certain equipment may depend upon the different modes of operation, the degree of loading, and environmental conditions (including pollution and dusty air).

- 1) Where necessary, the working area must be isolated and secured against reconnection in accordance with the safety regulations specified by appropriate national standards before inspection.
- 2) The proper condition of the panel should be verified by regular inspections.
- 3) Under abnormal operating conditions (including adverse climatic conditions) and/or special environmental stresses (including heavy pollution and dusty atmosphere), inspection may be necessary at shorter intervals.
- 4) Visual inspection primarily involves checking for grime, corrosion and moisture, such as:
 - A) Effects of high temperature on the main circuits.
 - B) Traces of partial discharge on the insulating material parts.
 - C) Traces of leakage current on the insulating material parts.
 - D) Surfaces of the contact systems.
- 5) To ensure that fire-related components operate effectively in environments with snow, rain, and wind, appropriate managing must be taken like preventing snow accumulation above the intake damper.

Inspection must also include correct mechanical/electrical operation of the following parts: switching devices, actuating, interlocking, protection and signaling devices.

3.2 Maintenance Item and Period

The following maintenance periods are recommended. The actual maintenance period should be reasonably adjusted considering the specific installation environment of the product. Factors such as the scale and location of the power plant, as well as the on-site environment, can affect the maintenance period of the product. In operating environments with severe sandstorms or dust, the maintenance period should be shortened, and the frequency of maintenance should be increased.

3.2.1 Classification of Periodic Inspection

Item	Description
Visual inspections & System status check	<p>Visual inspection involves visually evaluating the components and overall condition of the system, which can be done externally, whether or not the system is in operation. This includes checking for any damage or deformation of the container and internal devices.</p> <p>Additionally, it is important to verify if the system status is normal and if any nuisance trips or faults have occurred during operation.</p> <p>These inspections should be conducted periodically, regardless of the time frame.</p>
Every half a year inspections	<p>These inspections include system normality check and safety tests such as system shut down sequence and ventilation system.</p> <p>These involve visual inspections of DC LINK while the supply ac power is not interrupted.</p> <ol style="list-style-type: none"> 1) Check the status of the communications 2) Check for alarms generated by BSC 3) Check the shutdown sequence of BSC and ventilation system 4) Correct any observed abnormality in the normal.
Every year inspections	<p>These inspections include full operational checks and fire system safety system maintenance</p> <p>These involve visual inspections while opening doors of DC LINK while the supply ac power is not interrupted.</p> <ol style="list-style-type: none"> 1) Complete operational testing is performed ensuring all equipment fully and efficiently operates without abnormalities. 2) All equipment and components should be inspected according to manufacturer's specifications. 3) Check the fire safety system maintenance and calibration. 4) Where equipment must remain energized, caution should be exercised when inspecting. 5) If a full inspection is not possible as energization must be maintained, visual inspection should be performed, and a full operational inspection must be rescheduled in the near future.

3.2.2 Every half year inspections

Part	Object	Inspection Type	Criteria	Inspection Method
M-LINK	Enclosure	Appearance	1) No Corrosion or dent on the enclosure 2) Check the abnormality of door sealing	Refer to Chapter 3.4.1
		Grounding Cable	1) No visible damage, corrosion, or wear on the grounding cable? 2) No looseness of the grounding connection 3) Door Grounding cable is pointing downward?	Refer to Chapter 3.4.1.2
	HVAC	Appearance	1) The unit is clean and dust-free and free of dirt 2) There is no dust in the fan and no foreign matter blockage at the air inlet.	Refer to Chapter 3.4.3.4
		Terminals of wiring Panel		
		Operational Reliability of fan		
		Condensate drain		
		Condensate cleaning		
		Evaporator cleaning		
	Chiller	Appearance	1) The liquid cooling unit is clean and dust-free and free of dirt 2) There is no dust in the fan and no foreign matter blockage at the fan/condenser	Refer to Chapter 3.4.3.1
		Terminals of wiring panel		
		Circuit breaker check		
		Operational reliability of fan		
		Condenser cleaning		
	Cooling Pipe	Pipe Line Assembly Check	1) Check whether the connection points are loose and damaged 2) Check any other leakage occurred (The color of coolant is neon pink). 3) Inspect the I-torque mark for every M-LINK's coolant pipe 4) If the torque mark is not aligned, it should be fastened and mark again through the torque wrench.	Refer to Chapter 3.4.3.2
	Rack & Comm device	Cable Connections	Check whether pack-to-pack connection cables are securely locked	Refer to Chapter 3.4.2
		Communication Cables	No visible damage on pack-pack comm cables / Ethernet cables	Visual inspection
		BPU Fan	Check whether the fan is clean and free of dirt	Visual inspection
		BPU Cable Connections	1) Check whether there is no visible damage on BPU power cable 2) Check the power terminal block is securely installed.	Visual inspection

Part	Object	Inspection Type	Criteria	Inspection Method
	Fire Safety System	Smoke Sensor & Gas Sensor	Check the status of gas/smoke sensors → If the gas sensor LEL data over 1.0, calibrate the gas sensor of it	Refer to 3.5.1.5
		FACP	Check whether there is any alarm in FACP	
		Horn & Strobe	Clean and check the horn& Strobe	
		Ventilation Door Opening (3 Months recommended)	In BSC browser and entering manual mode of BSC, check whether roof exhaust vents and intake fan operates or not.	Refer to 3.5.1.4
E-Panel	Enclosure	Appearance	No Corrosion or dent on the enclosure	Refer to 3.3.1
	HVAC	Appearance	1) The unit is clean and dust-free and free of dirt 2) There is no dust in the fan and no foreign matter blockage at the air inlet.	Refer to Chapter 3.4.3.4
		Terminals of wiring Panel		
		Operational Reliability of fan		
		Condensate drain		
		Condensate cleaning		
		Evaporator cleaning		
	Electrical Component	DC Main Circuits	Check the loose terminals or any deformation, burned mark in DC main circuits	Refer to 3.3.2
		Aux Power Circuits	Check the loose terminals or any deformation, burned mark in Aux power circuits	Visual Inspection
		Protection Relay	Visual check overall protection relay (MCCB,MCB,CP) by referring to figure 8 Check the status of relay and any burned or deformation mark.	Visual Inspection
		Indicators & Lamp	Check the M-LINK and E-Panel lamp operates and Indicator for DS in E-Panel	Visual Inspection
		UPS & UPS battery	Check the UPS status lamp is green And battery status by checking UPS battery lamp	Refer to 3.3.3.2
		SPD	1) Check the DC SPD status by indicator 2) Check the AC SPD status by indicator	Refer to 3.3.3.5
		Aux TR	Check any signs of discoloration, cracks, or bulges on the insulation material	Visual Inspection

3.2.3 Every year inspections

Part	Object	Inspection Type		Criteria	Inspection Method
M-LINK	Enclosure	Abnormal Condition		Check the any abnormal noise and temperature or condensation	Refer to Chapter 3.4.1.1
		Locking Rod, Cam		Check M-LINK Door locking rod is well operated	Visual inspection
		Warning Label		Clean the warning labels	Visual inspection
		Flammable & Foreign object		Check whether flammable or foreign object around DC-LINK	Visual inspection
		Anchors and/or Welding Points		Check corrosion or crack in Anchoring bolt or welding status	Visual inspection
	HVAC	Check System Alarm		Check the HVAC alarm history	Visual inspection
	Chiller	Coolant maintenance		Measure the coolant PH by following 3.4.3.3 PH value less than 7.5	Refer to 3.4.3.3
		Check System Alarm		Check the Chiller alarm history	Visual inspection
	BPU	BPU Contactor function tests		Check the operating status of the DC contactor	Send the Start/Stop command at the power-off status
	Fire Safety System	Gas Sensor Calibration		Do the calibration of gas sensors	Refer to 3.5.1.5
		Linkage Test	Smoke Sensor & Gas Sensor	Follow the linkage test by following 3.5.1.1	Refer to 3.5.1.1
			FACP		
			Ventilation System		
			Horn & Strobe		
E-Panel	Electrical Component	DS operation		Check the operation of Disconnect Switch and check the status	-
		Insulation Check of DC Main Circuits		Insulation resistance over 30M Ω between DC main circuit to GND *Must remove DC SPD	-
		Insulation Check of AC Power Circuits		Insulation resistance over 30M Ω between 1) AC aux circuit(L1,L2,L3) to GND 2) Between each phase(L1-L2 / L2-L3 / L3-L1) *Must remove AC SPD or Turn off MCCB of it	
		UPS battery		Voltage over 24Vdc for UPS 1-3	
		FACP battery		Voltage over 10.8Vdc for each battery (2 battery installed in FACP)	

3.3 Maintenance: E-Panel

3.3.1 Enclosure

Inspect the enclosure of the E-Panel, including the door, handle, latch, and hinge and lock devices, etc. for any signs of rust or damage.

If necessary, perform a clean-up or re-paint to remove any corrosion or debris.

3.3.2 DC Main & AC Aux Circuit

3.3.2.1 Visual and Loose Parts Check

Check for loose terminals in DC Main Circuits and AC aux circuits. Check for deformation or abnormal odors at conductors on DC main & AC aux circuits.

Securely tighten any loose terminals and replace damaged parts.

3.3.2.2 Insulation Resistance Check of DC Main Circuits

Verify DC LINK system insulation resistance as follows :

- 1) Wear appropriate PPE before checking the voltage and insulation resistance
- 2) Verify PCS system has been turned OFF
- 3) Open the Main DC side disconnect switch in E-Panel
- 4) Close the all the contactors of M-LINK by commanding through BSC
- 5) Check the Main DC voltage of battery side by measuring terminal to the disconnect switch
in E-Panel (To conduct measurements within the E-Panel, the multimeter's voltage range should be at least 1500Vdc)
- 6) Check the insulation resistance between the DC voltage lines and GND
- 7) Open all the contactors of M-LINK after checking the resistance
- 8) Refer to 2.2 Power-On DC LINK for rebooting the system

Table 10: Insulation resistance requirement

Item	Requirement
DC LINK System	1000V, 60 sec, ≥ 30MΩ

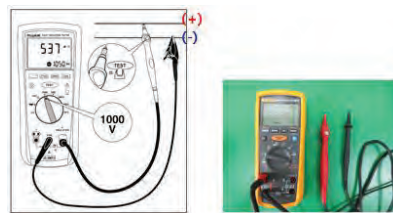


Figure 20: Insulation resistance check


CAUTION

LGES shall be notified if the insulation-resistance or measurement voltage displayed on the device drops suddenly when measuring the insulation-resistance.

3.3.2.3 Insulation Resistance Check of Aux power line

The insulation resistance check should be performed when the DC main and Aux power are off.

Item	Interval (1 time)	Inspection Method	Remarks
Insulation resistance	Annually	With insulation resistance meter. -. Low voltage circuit : 500V. Do after cleaning the insulator and insulation material with a dry cloth. * Must remove SPD and Turn off MCCB	 -. Between each phase. (L1-L2, L2-L3, L3-L1) -. Between parallel connection Points (L1, L2, L3) and ground. -. Criteria: Value $\geq 30 \text{ M}\Omega$

3.3.3 UPS, SPD and Transformer

Item	Interval (1 time)	Inspection Method	Remarks
UPS status check	6 Months	UPS status check	Check the LED indicator at the UPS
UPS battery Status check	6 Months	UPS battery status check	Check the LED indicator at the UPS battery
Voltage check of UPS	1 Year	UPS Battery terminal voltage check	Over 24V _{DC}
SPD Status	6 months	SPD status and installation check	Whether SPD all three modules installed and green status check
Transformer	6 Months	any signs of discoloration, cracks, or bulges on the insulation material?	Check the insulation of transformer and replace the transformer if needed

3.3.3.1 Voltage Check of UPS Battery

To do the voltage check of UPS battery, the process is as follows and refer to the below figure for the detail guidance.

- 1) Turn off AC aux power by turning off the all AC Utility MCCB.
- 2) Check the location of UPS by refer to the below figure
- 3) Check the UPS battery SOC by using multimeter.
- 4) Set the UPS as battery mode off by shorting remote-SGnd using the cable
- 5) Measure the voltage of UPS battery. If the voltage is below 24Vdc, please replace the UPS corresponding UPS battery
- 6) Set the UPS as battery mode off by shorting Bat-Start-SGnd using the cable

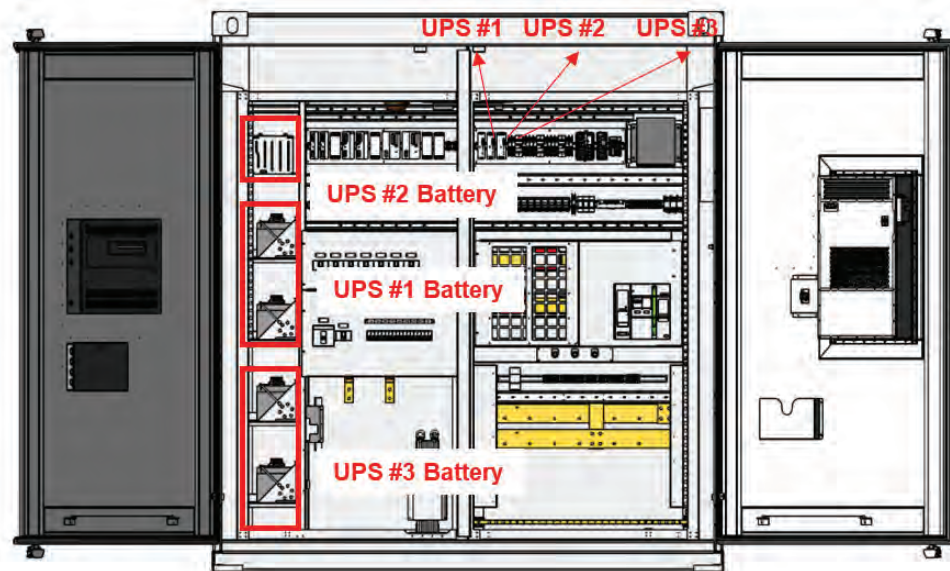


Figure 21: Location of UPS and Battery in E-Panel

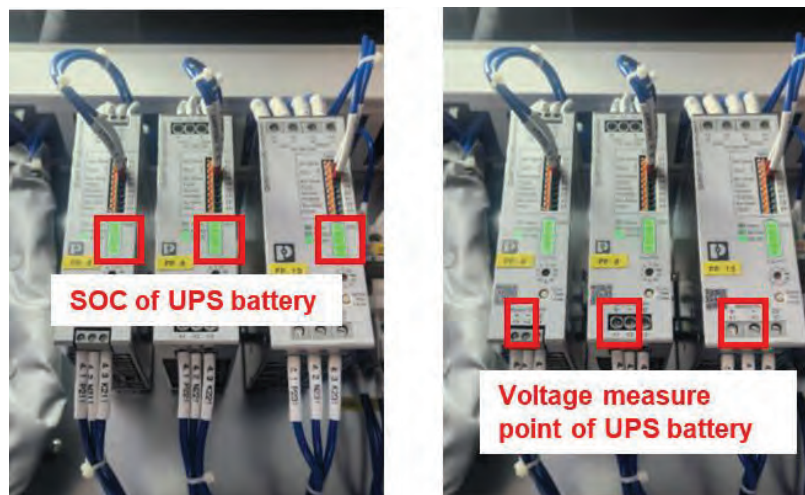


Figure 22: UPS battery SOC and voltage measuring point

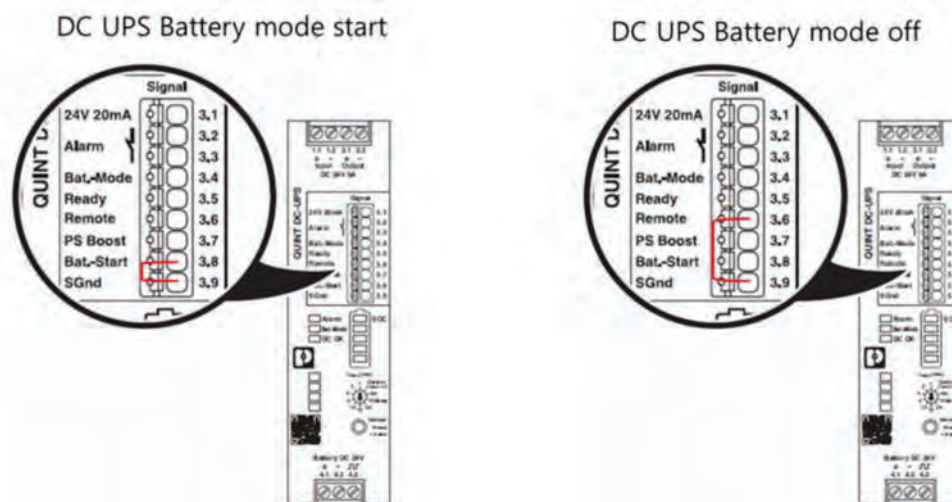


Figure 23: UPS battery start/off setting mode

3.3.3.2 UPS Status Check

The UPS has LED indicator at the front panel of it. Below figure is the LED status check table.

If the alarm LED is red or maintenance is needed, please replace the UPS or UPS battery.





























		Mains operation		Battery operation		Maintenance required		
	Element	Nature	Fully charged, No alarm	Charging, No alarm	Battery good	Battery almost discharged	Alarm (Replace battery)	Alarm (other)
LED	Alarm	red						
	Bat.-Mode	yellow						
	DC OK	green						
Signal	Alarm	active low	high	high	high	low	low	low
	Bat.-Mode	active high	low	low	high	high	low	low
	Ready	active high	high	low	low	low	both possible	
LED bar graph (SOC)	100-81%	green		depends on SOC status*	depends on SOC status*	depends on SOC status*		
	80-61%	green						
	60-41%	green						
	40-21%	green						
	20-0%	green / red		 flashing**		 20-11%  10-0%	 flashing	

Figure 24: UPS status table

3.3.3.3 UPS Battery Replacement

There is no official recommended replacement period, as battery replacement varies greatly depending on charge/discharge cycles and operating temperatures. However, we recommend that replace it within 3-4 years. After checking the UPS Battery voltage, please decide to replace it.

The process is as follows and refer to the below figure for the detail guidance.

- 1) After turning off the MCCB of Aux power, Remove the battery fuse
- 2) Unscrew the bolts on the battery case using screw driver
- 3) Remove the battery case
- 4) Replace the UPS battery and screw the bolts(18-19N·m) and reinstall the battery fuse
- 5) After install the battery, turn on the MCCB of Aux Power

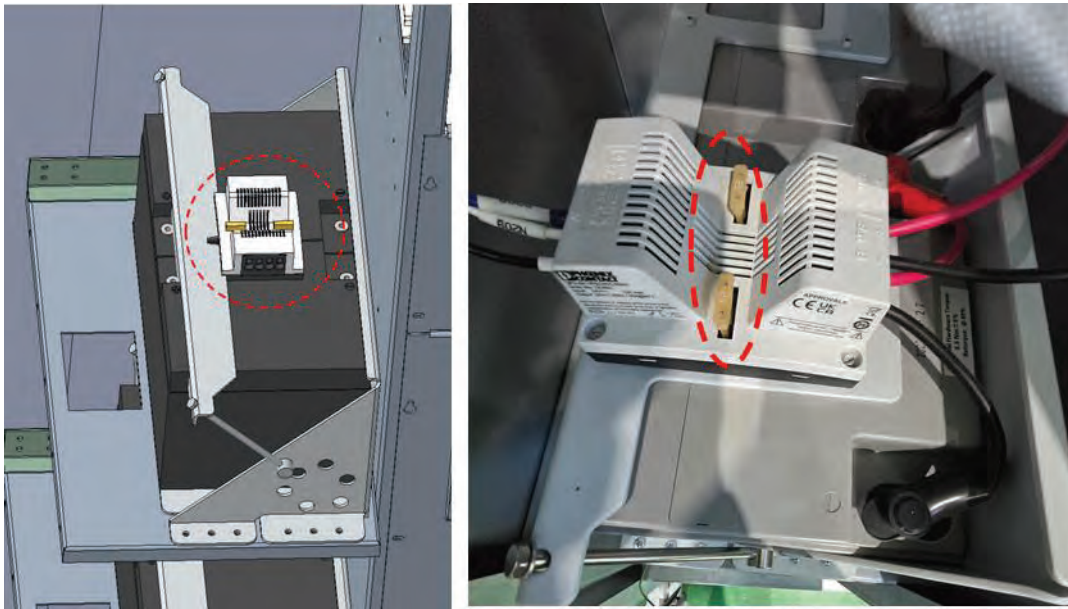


Figure 25: Location of UPS Battery Fuse

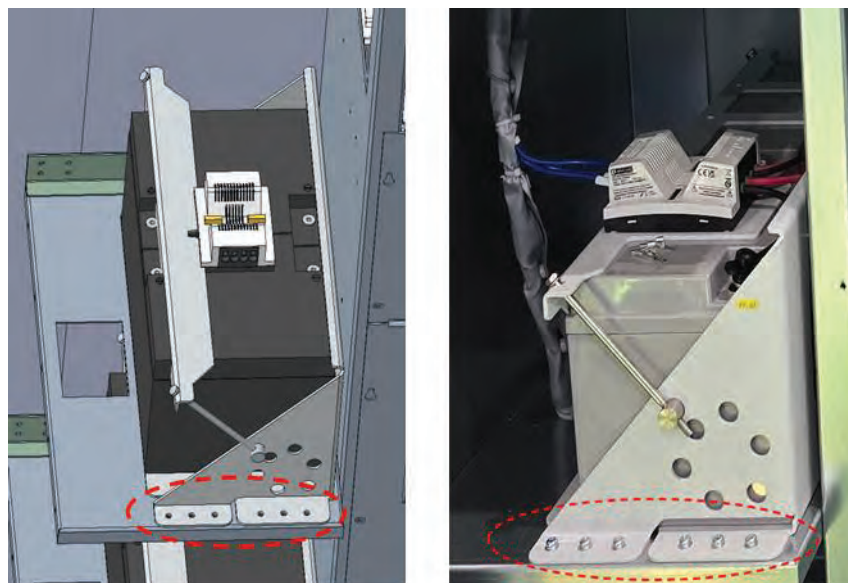


Figure 26: Location of UPS Battery screw

3.3.3.4 UPS By-Pass Mode

If the UPS is failed and there are no spare parts to replace, the customer can use UPS by-pass mode until the UPS is supplied.

After turning off the Main Aux MCCB, and turn off the MCB what you need to change UPS, then by changing the location of lock pad, you can switch to UPS MCB to bypass MCB.

Below are the figures of location of UPS MCB and bypass MCB, and the diagram of it.

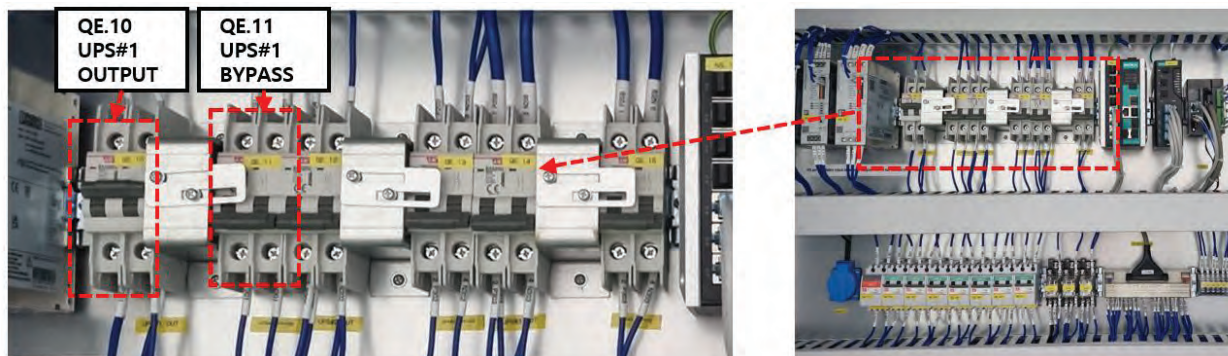


Figure 27: Location of UPS and Bypass MCB

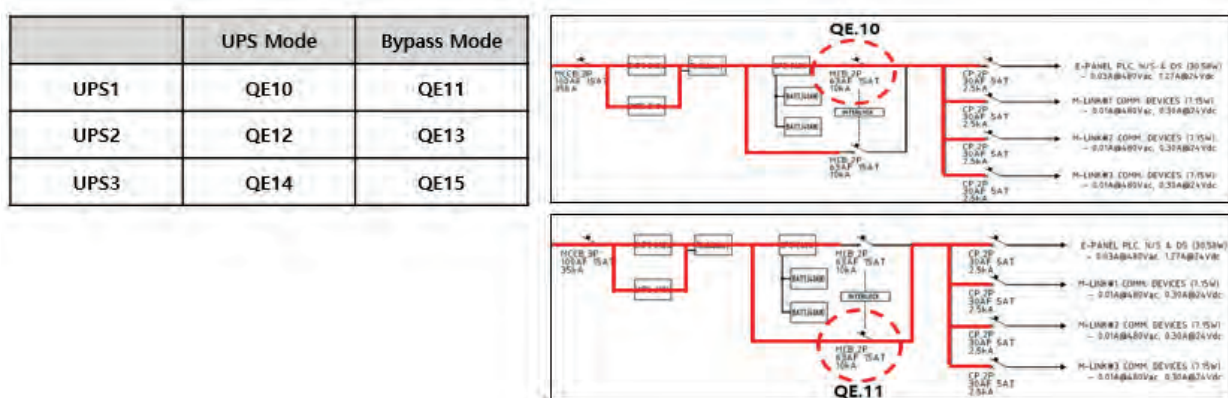


Figure 28: MCB QE number and diagram

3.3.3.5 SPD Installation and Status

There are two kinds of SPDs on E-Panel, Check the equipment status of SPDs on AC and DC. Check the SPD all three modules are installed each and check the indicator if SPD is green.

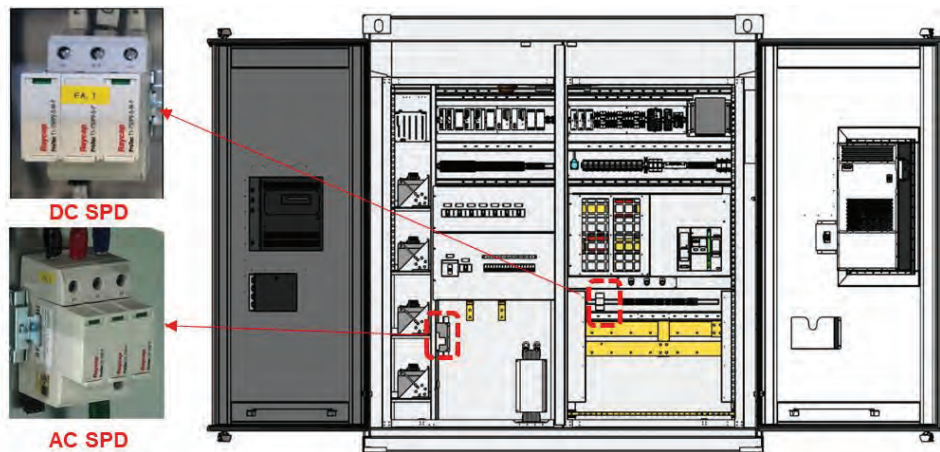


Figure 29: Location of AC&DC SPD

In case of DC Main circuit Hi-Pot test on site, please make sure to remove left and right DC SPD Plug. Do not remove middle SPD Plug.

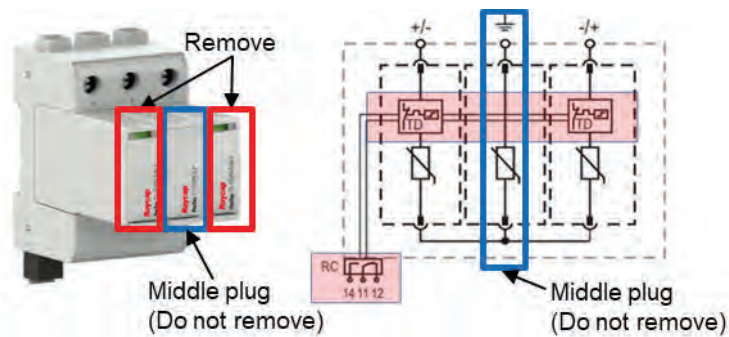


Figure 30: DC SPD Internal Configuration

In case of AC Aux circuit Hi-Pot test on site, please make sure to remove AC SPD Plug.

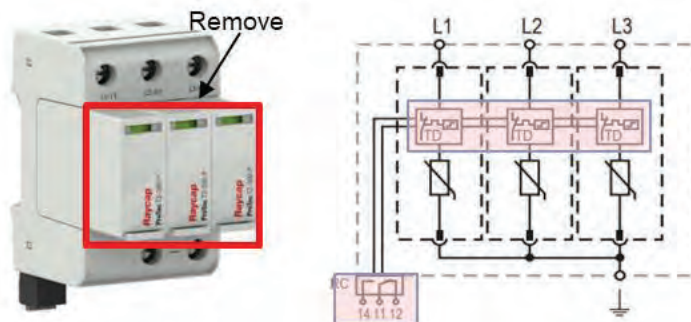


Figure 31: AC Aux SPD Internal Configuration

3.3.4 FACP (Fire Alarm Control Panel)



Note

This section specifically covers the FACP (Fire Alarm Control Panel) Mode programmed by LGES. It includes information about the Alarm, Supervisory, and Trouble modes as programmed by LGES. For detailed information about the modes that occur within the FACP itself, refer to the FACP manual provided by the manufacturer.

Item	Interval (1 time)	Inspection Method	Remarks
FACP Battery	Annually	In compliance to NFPA 72, Table 14.4.3.2	Over 10.8V _{DC} for each battery
FACP	Annually	Check whether there is any alarm in FACP	Inspection details described in M-LINK

3.3.4.1 Fire Alarm & Supervisory Mode on Fire Event



WARNING

When a fire alarm is triggered from the FACP (Fire Alarm Control Panel), it indicates that the corresponding DC LINK may be in a very dangerous condition. In such cases, it is crucial to prioritize safety and take appropriate measures to ensure the well-being of personnel and mitigate potential risks.

If the occurrence of a fire event is confirmed, it is important to avoid approaching the specific DC LINK and leave it alone for a sufficient amount of time to allow for the ventilation of any potentially explosive gases inside the DC LINK system. This is necessary to minimize the risk of ignition or further escalation of the fire hazard.

During this time, it is recommended to follow established emergency protocols, evacuate the area if necessary, and contact the appropriate authorities, such as the fire department, to report the incident and seek professional assistance in handling the situation. Safety should always be the top priority in such circumstances.

The FACP operation guide may be changed by changing the model of FACP.

When the M-LINK Fire Safety Logic is triggered, either by actuation of the combustible gas detector or smoke sensor, the control panel initiates a series of actions to respond to the fire event. These actions may include:

- 1) A buzzer sounding on the control panel.
- 2) Flashing FIRE ALARM LED and SUPERVISORY LED.
 - FIRE ALARM LED is on: An alarm signal is sent to designated center (FCC) to warn operators of fire.
 - SUPERVISORY LED is on: Ventilation doors open.



Figure 32: FACP Screen After Detection of H2 Sensor

Table 11: Descriptions And Actions Depending on FACP Fire Alarm (Diagnosis Condition)

Category	Description	Diagnosis Level	Result
Smoke Sensor Detected	Smoke Detector on the left side of M-LINK is detected.	Alarm	SMK1A alarm on BSC window
M-LINK Fire Alarm	M-LINK Fire Alarm Signal Activation Trigger (One of the following): 1) Smoke sensor 2) Combustible gas sensor	Fault	Open ventilation doors (3 EA) Shutdown HVACs (3 EA) on M-LINK. BFAF fault on BSC window.

	3) PLC DI Activated		
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Refer to *F2X4-5.1US-FS01_AC&DC LINK Fire Safety Logic* for detailed information of JF2 M-LINK Fire Alarm.

If it is confirmed that the detection of smoke or combustible gas sensor in the M-LINK system is due to gas or smoke generated outside the M-LINK, and there is no fire or smoke occurring inside the M-LINK system, follow the procedures to reset the FACP (Fire Alarm Control Panel) and return to System Normal Mode.

1. To silence the panel sounder and any programmed audible outputs that may be on, press the "SIGNAL SILENCE" key. The "FIRE ALARM" LED, "SUPERVISORY," and "SIGNALS SILENCED" LED lights will remain steady.



Figure 33: FACP screen after pressing SIGNAL SILENCE

2. Reset JF2 M-LINK fire alarms

Press the "SYSTEM RESET" key. The display will show "TROUBLE IN SYSTEM" for approximately 10 seconds while the fire safety system initializes. After the system initialization, the "SUPERVISORY" LED and "SIGNALS SILENCED" LED will turn on again, indicating that the ventilation doors are open.

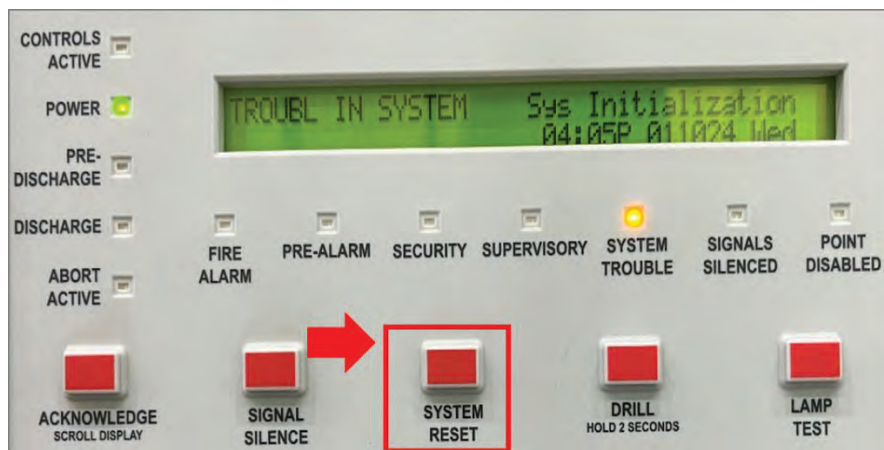


Figure 34: Fire alarm mode of FACP after pressing SYSTEM RESET

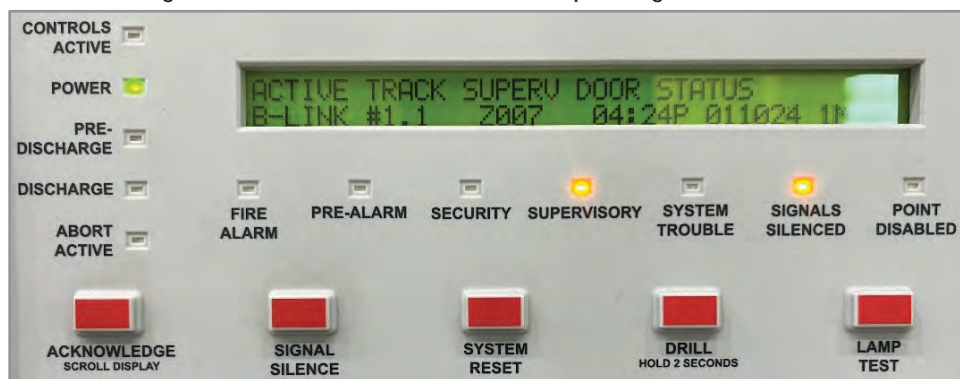


Figure 35: FACP screen after system initialization

3. Turn off SUPERVISORY SIGNAL.

Note



The Supervisory Signal is programmed to monitor the status of the ventilation doors to ensure they are completely closed. If any ventilation doors are open or if the electrical latches on the ventilation doors fail to send a 'closed status' signal to the FACP, the SUPERVISORY LED will be illuminated. This indicates that there is a supervisory condition due to the open ventilation doors or the failure of the latches to indicate the closed status. It is important to address and rectify the issue by closing the ventilation doors properly or resolving any latch-related issues to clear the supervisory condition.

To turn off the SUPERVISORY LED, ensure that all ventilation doors on the M-LINK are closed properly. The method for closing the ventilation doors is explained in Chapter 3.4.4.4 in this [manual](#).

manual. Please refer to that chapter for detailed instructions to close the ventilation doors correctly. Once all ventilation doors are closed as per the instructions, the SUPERVISORY LED turns off, indicating that the supervisory condition has been resolved.

Table 12: Descriptions and actions depending of FACP supervisory #1 (Diagnosis Condition)

Category	Description	Diagnosis Level	Action
Ventilation Door Status	Any Ventilation Door Opens	Alarm	VDSA alarm on BSC window

Refer to *F2X4-5.1US-FS01_AC&DC LINK Fire Safety Logic* for detailed information of M-LINK Supervisory Mode.

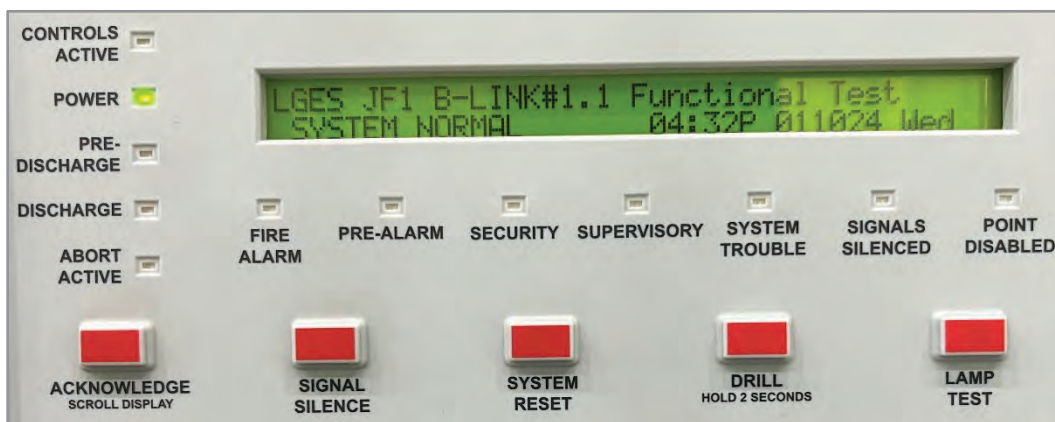


Figure 36: FACP Screen After Closing All Ventilation Doors

3.3.4.2 Trouble Mode



CAUTION

The subject of work to resolve electrical fault is determined by contract among LGES, contractor and EPC.

The system is in a trouble condition when the control panel detects an electrical fault as specified on Table 13 below. If fire alarms are not active, the control panel performs the following actions:



Figure 37: FACP screen for trouble mode

- 1) A buzzer sounds on the control panel.
- 2) The SYSTEM TROUBLE LED flashes.

Table 13: Descriptions and Result due to FACP system trouble (Diagnosis Condition)

Category	Description	Diagnosis Level	Result
E-Panel FACP Trouble	FACP in E-Panel experiences trouble.	Alarm	EFACPTA alarm on BSC window

Refer to *F2X4-5.1US-FS01_AC&DC LINK Fire Safety Logic* for detailed information of JF2 M-LINK Trouble Mode.

Table 14: Trouble Type and Procedure to Solve FACP System Trouble

Trouble Type	Description	Procedure to solve trouble
FACP AC FAIL (E-Panel)	FACP AC input power cut off	Check FACP&POWER UNIT MCCB on and AC input power lines
FACP BATTERY FAULT (E-Panel)	FACP battery lines disconnected.	Check FACP battery lines. *Detailed Information is in the next page
	FACP battery low (Less than 20V)	Charge FACP batteries. (Exceeding 20.5V)
	FACP battery high (More than 30V)	Discharge FACP batteries. (Less than 29.5V)
	FACP battery completely discharged	Replace FACP batteries.

LINE TROUBLE (DC LINK)	Wiring error (open, short) occurred related to the fire safety system	Check wiring related to the fire safety system
---------------------------	--	--

3.3.4.3 Voltage Check of FACP Battery

To do the voltage check of FACP battery, the process is as follows and refer to the below figure for the detail.

- 1) Turn off AC aux power by turning off the all AC Utility MCCB.
- 2) Open the FACP box
- 3) The backup battery voltage must be checked one by one. (a total of two backup batteries are connected parallel to the FACP) : Measure the voltage between the + and - terminals of the backup battery of the FACP using a voltmeter. (refer to the image below) Insert the safety tag in the padlock.
- 4) Replace the backup battery with a new one if the voltage is less than 10.8V since the battery life is reduced.
- 5) If the backup battery voltage of the FACP is 10.8V or higher, there is no problem with performance and quality even if used without replacement. (10.8V: Cut-Off Voltage of Discharge for a backup battery)

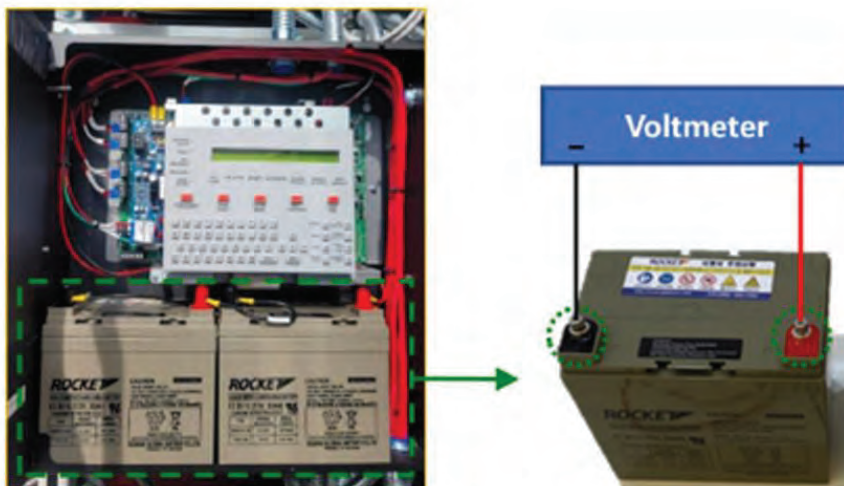


Figure 38: FACP battery and measuring point

3.3.4.4 Replacement of FACP Battery

The typical lifespan of a battery is 4-5 years. After checking the FACP Battery voltage, please decide to replace it.

The process is as follows and refer to the below figure for the detail guidance.

- 1) After turning off the Aux power, disconnect the cable.
- 2) Take out the FACP battery
- 3) Replace the FACP battery and screw the bolts (4-5 N·m)
- 4) Please note that the two FACP battery should be connected in series

3.3.5 HVAC

If HVAC maintenance is required, consult the HVAC manufacturer's manual written located in the box installed on the E-Panel door.

Refer to 'ESS Cabinet Cooler Instruction Manual' for detailed information.

3.4 Maintenance: M-LINK

3.4.1 Enclosure

Dirt on surface caused by water spots or dust can be polished. If the dirt on JF2 Enclosure cannot be removed by polishing, then re-touch with paint.

Limited changes or deformations of M-LINK appearance that occurs within a range that do not affect internal insulation and air circulation inside the M-LINK is permitted at the customer's discretion. If the door is completely closed through the action of the locking rod and cam, some scratches and dents on locking rod and cam can be tolerated.



Figure 39: Examples excluded from the appearance limit

3.4.1.1 Abnormal Conditions

Check for abnormal noises inside and for abnormally high or low interior temperature.

The noise level per M-LINK is as follows. ^{*1}

¹ This noise level is provided only for reference. Exceeding the value does not necessarily indicate an abnormal condition.

- 80 dBA (1m)

Temperature and humidity sensors are located in the return section of each HVAC unit. The permissible temperature range of M-LINK based on computational fluid dynamics (CFD) analysis is as follows. *2

- Winter: 15 ~ 30°C
- Summer: 20 ~ 35°C

3.4.1.2 Grounding Cable Damage

Door ground cables connecting the doors to the enclosure, may sustain damage during opening and closing. To prevent this, if the door grounding cables are pointing upward, re-orient them to point downward. Replace damage ground cables.



Figure 40: Grounding cable orientation

3.4.2 Cable Connection

3.4.2.1 Rack Cable Connection

Measure the voltage of DC LINK to ensure the system is completely deenergized prior to performing maintenance of the rack system.

When maintaining 'Cable Connection Status' and 'Pack and BPU Fixing Status', check the status of each component according to the procedures in *F2D4-5.1US-IC01_DC LINK Installation Manual*.

Ensure that the pack-to-pack connection cables are securely locked. The Safety lock should be located in the connector direction.

² This temperature range is provided only for reference. Exceeding the value does not necessarily indicate an abnormal condition. Follow system diagnosis conditions to check the warning and alarm for temperature



Figure 41: Pack to Pack cable connections

3.4.2.2 BPU Cable Connection

Ensure that the BPU power cables and terminal for control voltage are securely locked. Check the DC power cable, terminal cover and cable for control voltage.

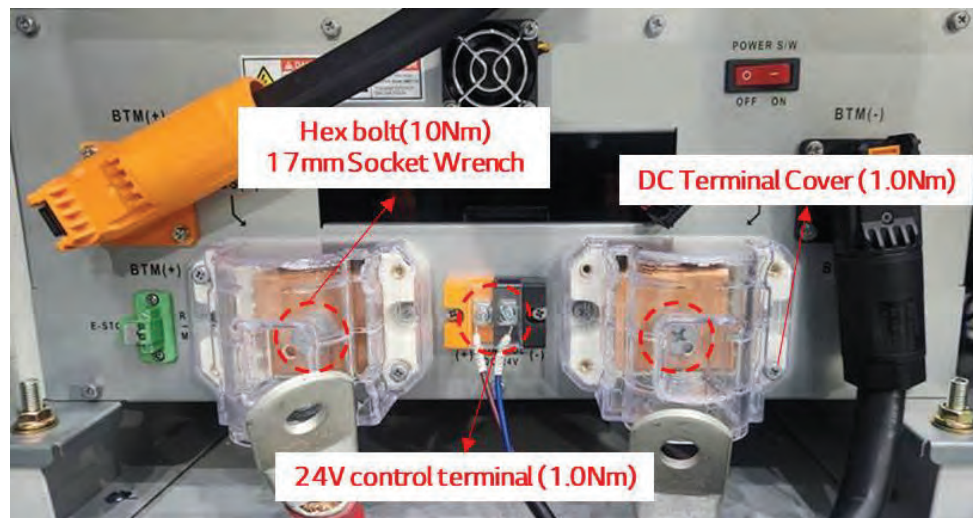


Figure 42: BPU cable connection

3.4.3 Liquid Cooling System and HVAC

Below are the liquid cooling system maintenance items and their methods. For more detailed maintenance is required, consult the Chiller/HVAC manufacturer's manual written located in the box installed on the E-Panel door.

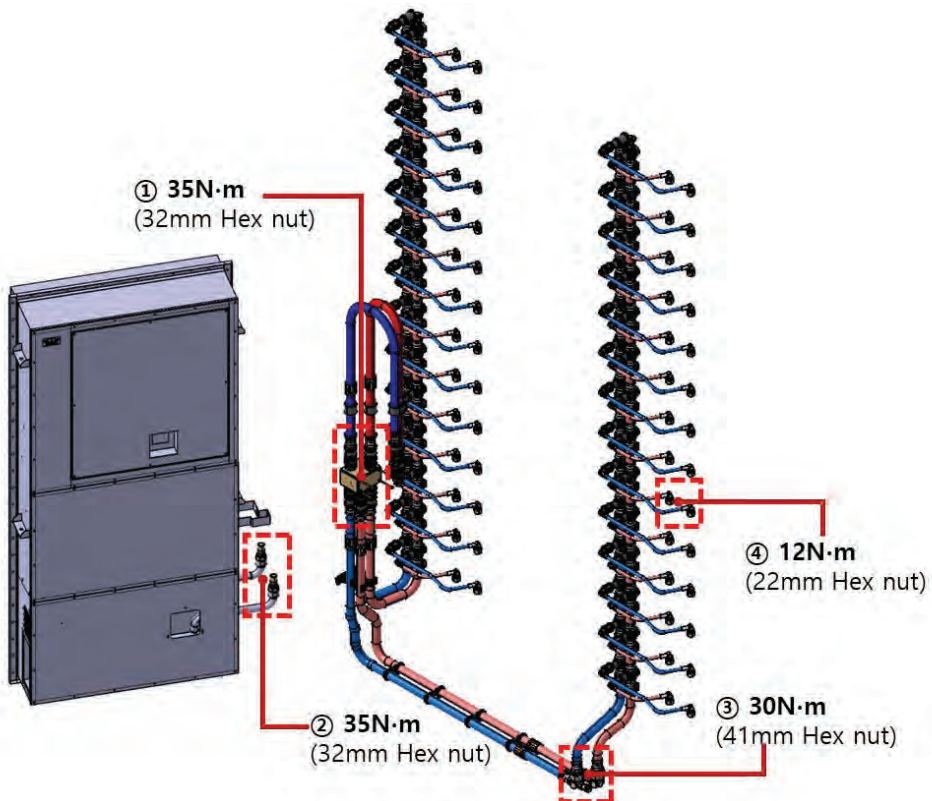
Refer to 'ESS Cabinet Cooler Instruction Manual' for detailed information.

3.4.3.1 Chiller

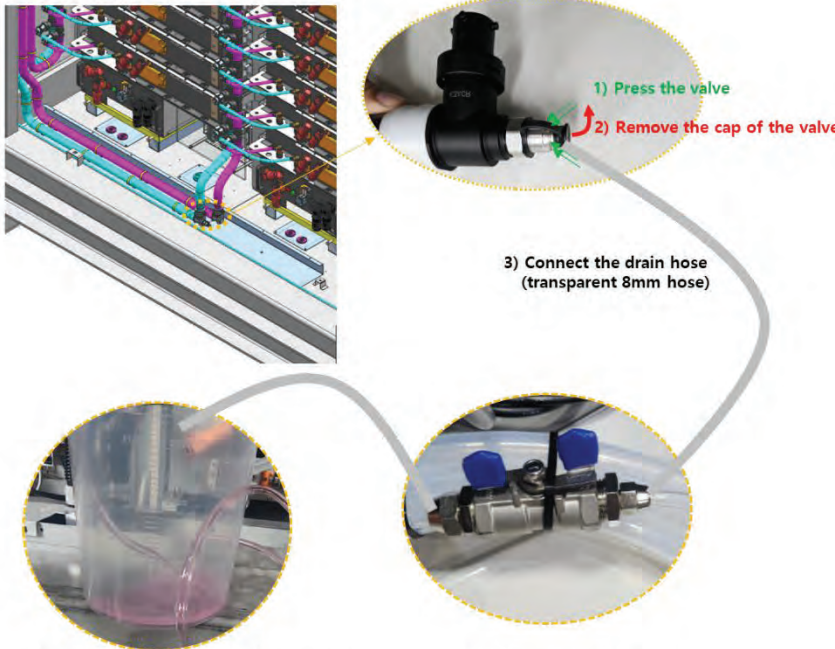
Item	Contents
------	----------

Appearance	The liquid cooling unit is clean and dust-free and free of dirt
Electrical Control System	<ol style="list-style-type: none"> 1. Check the power cable and signal cable of wiring panel for any signs of looseness, damage, abnormal heating, or dust accumulation. 2. Check circuit breaker turned off automatically when the circuit is abnormal (The circuit breaker is located in the electrical box)
Fan	Check the operational reliability of fan <ol style="list-style-type: none"> 1. There is no dust in the fan and no foreign matter blockage at air inlet. 2. The fan blades are not damaged and the fan rotates smoothly without abnormal noise.
Condenser	Do the condenser cleaning from dust and foreign matter blockage
Cooling System Alarm	The system has no abnormal alarm

3.4.3.2 Cooling Pipe

Item	Contents
Pipe Line Assembly Check	<ol style="list-style-type: none"> 1. Check whether the connection points are loose and damaged 2. Check any other leakage occurred (The color of coolant is neon pink). 3. Inspect the I-torque mark for every M-LINK's coolant pipe 4. If the torque mark is not aligned, it should be fastened and mark again through the torque wrench. <p>Recommended torques are as follows :</p>  <p>① 35N·m (32mm Hex nut)</p> <p>② 35N·m (32mm Hex nut)</p> <p>③ 30N·m (41mm Hex nut)</p> <p>④ 12N·m (22mm Hex nut)</p>

3.4.3.3 Coolant Maintenance

Maintenance periods	Sequence and criteria
Every year	<p>Drain the coolant sample and check the PH value and do the visual check whether there is obvious discoloration from pink to dark. The coolant PH value check procedure is as follows :</p> <ol style="list-style-type: none"> 1. Press the valve 2. Remove the cap of the coolant pipe valve 3. Connect the 8mm drain hose 4. Release the drain hose valve slightly 5. Drain the coolant sample during 1-3 sec (about 20ml) 6. Check the coolant PH using a PH meter 7. Replace if the coolant PH value less than 7.5 <p>After drain the coolant sample, be sure to remove the drain hose and lock the cap of the coolant pipe valve.</p>  <p>The diagram illustrates the coolant maintenance procedure in five steps: 1) Press the valve (indicated by a green arrow), 2) Remove the cap of the valve (indicated by a red arrow), 3) Connect the drain hose (transparent 8mm hose), 4) Release the drain hose valve, and 5) Drain coolant sample into a beaker or similar for 1-3 seconds (about 20ml).</p>

3.4.3.4 HVAC

Item	Contents
Appearance	The unit is clean and dust-free and free of dirt

Electrical Control System	The electrical control items by visual check. 1. The key operation of the controller is displayed normally (Visual Check) 2. No looseness of electrical cables and terminals 3. Contactor suction flexible, no blocking phenomenon, and visual contact suction burn mark 4. No dust at the wiring panel
Fan	Check the operational reliability of fan 1. There is no dust in the fan and no foreign matter blockage at air inlet. 2. The fan blades are not damaged and the fan rotates smoothly without abnormal noise.
Condenser	Do the condenser cleaning from dust and foreign matter blockage
Cooling System Alarm	The system has no abnormal alarm

3.5 Maintenance : Fire Safety System



CAUTION

Ensure that maintenance of fire safety system includes verifying sensor functionality, fire alarm check, ventilation system, system normalization after event. During the procedure, Fire alarm will be reported to upper device (ex, FCC)

In order to avoid miscommunication, inform personnel of the maintenance plan before conducting maintenance.

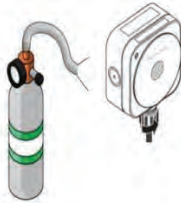
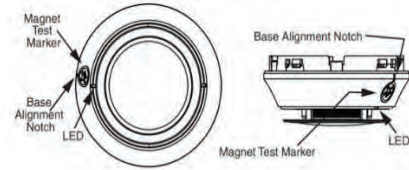
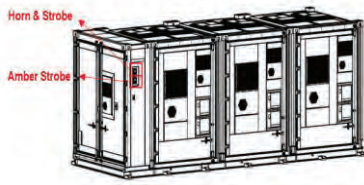
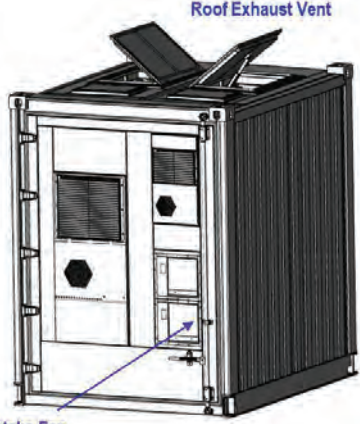
The status of the following components can be individually checked as follows;
 smoke sensors, combustible gas sensor, FACP, Horn & Strobe and roof exhaust vents and & door intake dampers.

Also, the linkage test is available for the maintenance of fire safety system.

- Fire detection (combustible gas sensor / smoke sensor)
- Fire alarm with horn & strobe,
- Ventilation system operation and system shutdown
- System normalization after event.

At least two personnel are required to perform the multiple, simultaneous actions for fire safety system maintenance.

3.5.1.1 Linkage Test Procedure for Fire Safety System Maintenance

Step 1. System Status Normal Check	Step 2. Combustible gas sensor / Smoke sensor Alarm Trigger	
<p>System Normal Check via BSC</p> <ul style="list-style-type: none"> - BSC normal - FACP normal - All gas sensors normal - All smoke detectors normal - Ventilation door all close - HVAC operation normal 	<p>Trigger the combustible gas sensor / smoke sensor by using the suitable tools.</p> <p>Detail Method for triggering, refer to chapter 3.5.1.2 for smoke sensor trigger and 3.5.1.3 for combustible gas sensor trigger.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Combustible gas sensor trigger by gas cylinder source</p> </div> <div style="text-align: center;">  <p>Smoke Sensor trigger By maget testor</p> </div> </div>	
Step 3. BSC/FACP Alarm Check	Step 4. Check Ventilation System And HVAC Shutdown	Step 5. System Normalization
<ul style="list-style-type: none"> - BSC displays the fire alarm corresponding M-LINK. - FACP displays the fire alarm. - Horn & Strobe in DC LINK flash and audible alarm sounds. <p>(Amber strobe flash and audible alarm sounds for combustible gas detector)</p> 	<ul style="list-style-type: none"> - Roof Exhaust Vents / Intake Doors are opened - HVAC will shutdown 	<ul style="list-style-type: none"> - Reset FACP (Refer to chapter 2.4.1) - BSC display indicates alarms have been cleared. - FACP and smoke sensor audible alarm cease. - Horn & Strobe visual and audible alarms cease. - Close ventilation doors issuing the appropriate BSC command - HVAC operates normally

3.5.1.2 Fire Detection: Smoke Sensors Tests

Table 15 below describes about trigger for the fire detection. For more detail information, please refer to the manufacturer's manual or instructions.

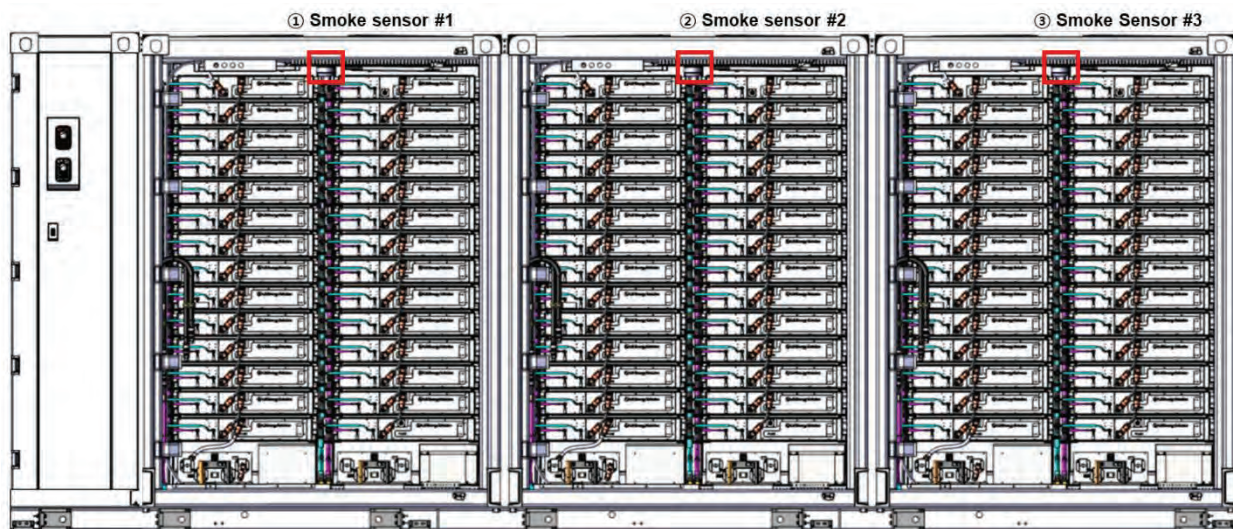
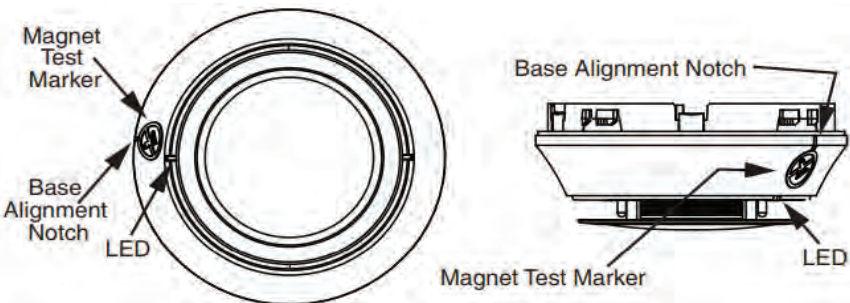


Figure 43: The location of smoke sensors

Table 15: Test Method of Smoke Sensor

Test Item	Sequence								
Magnet Test	<p>① Hold the test magnet in the magnet test area as shown in image.</p> <p>② The LEDs should latch on indicating alarm and annunciating the FACP</p> 								
Smoking can Test	<p>① Sensitivity readings are available through the FACP. Refer to the manufacturer's published instructions for proper use.</p> <p>② Additionally, canned aerosol simulated smoke (canned smoke agent) may be used for smoke entry testing of the smoke Sensor. Tested and approved aerosol smoke products are;</p> <table border="1" data-bbox="534 1648 1276 1829"> <thead> <tr> <th>Manufacturer</th><th>Model</th></tr> </thead> <tbody> <tr> <td>HSI Fire & Safety</td><td>25S, 30S (PURCHECK)</td></tr> <tr> <td>SDi</td><td>SMOKE CENTURIAN, SOLOA4, SMOKESABRE, TRUTEST</td></tr> <tr> <td>No Climb</td><td>TESTIFIRE 2000</td></tr> </tbody> </table> <p>When used properly, the canned smoke agent will cause the smoke sensor initiate an alarm. Refer to the manufacturer's published instructions for proper use of the canned smoke agent.</p>	Manufacturer	Model	HSI Fire & Safety	25S, 30S (PURCHECK)	SDi	SMOKE CENTURIAN, SOLOA4, SMOKESABRE, TRUTEST	No Climb	TESTIFIRE 2000
Manufacturer	Model								
HSI Fire & Safety	25S, 30S (PURCHECK)								
SDi	SMOKE CENTURIAN, SOLOA4, SMOKESABRE, TRUTEST								
No Climb	TESTIFIRE 2000								

- ③ Provide sufficient ventilation so that smoking does not remain in the smoking Sensor.

3.5.1.3 Fire Detection : Combustible Gas Sensors Test

Table 16 below describes about trigger for the fire detection. For more detail information, please refer to the manufacturer's manual or instructions.

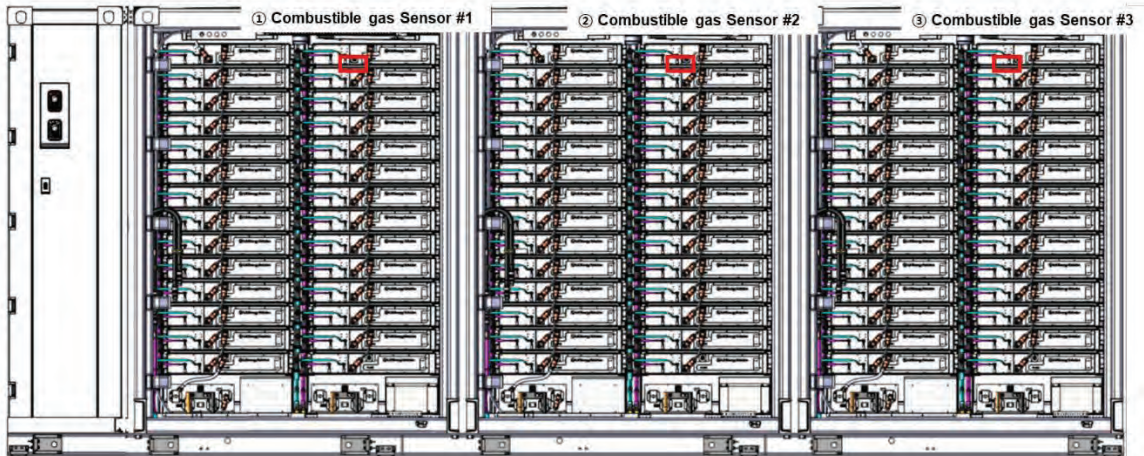




Figure 44: The location of gas sensors

Table 16: Test Method of Combustible Gas Sensor

Test Item	Sequence
H2 Gas Tank	<p>Discharge H2 gas to H2 gas sensor near the are as shown below.</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;">   </div> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <p><H2 Gas Tank></p> <p><H2 Gas Tank Attached to H2 Sensor></p> </div>

3.5.1.4 Ventilation Door Maintenance

The recommended maintenance interval for ventilation door opening is every 3 months

according to NFPA69 15.7.1.

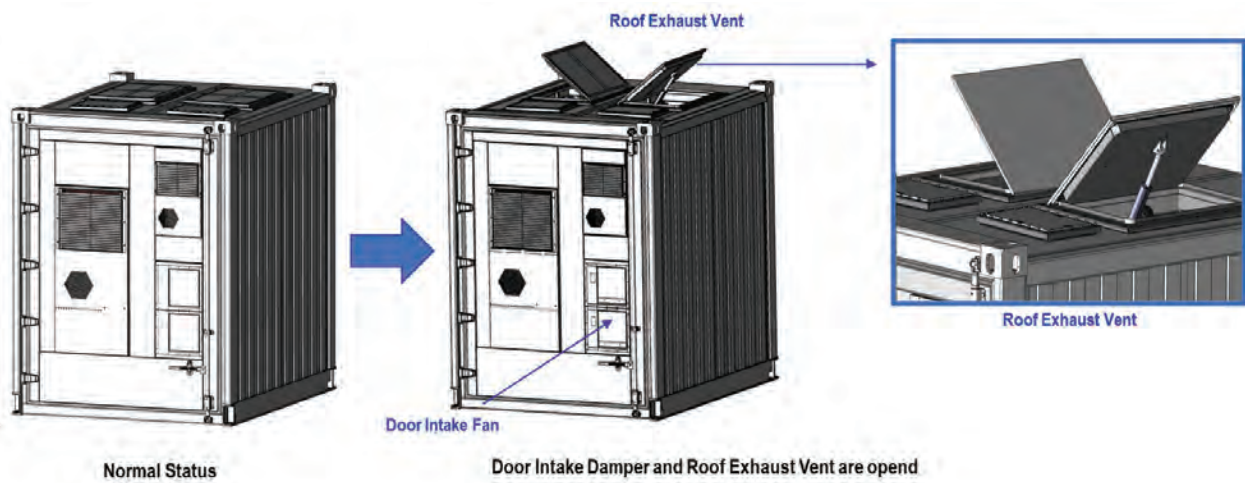


Figure 45: Process of opening vent door manually

Vent doors can be opened during the 3.4.4 Fire Safety System Linkage test

- 1) State 1 (Initial): vent doors are closed.
- 2) State 2: Command the ventilation door to open using the BSC.
- 3) State 3: Command the ventilation door to close using the BSC. Verify vent doors close.

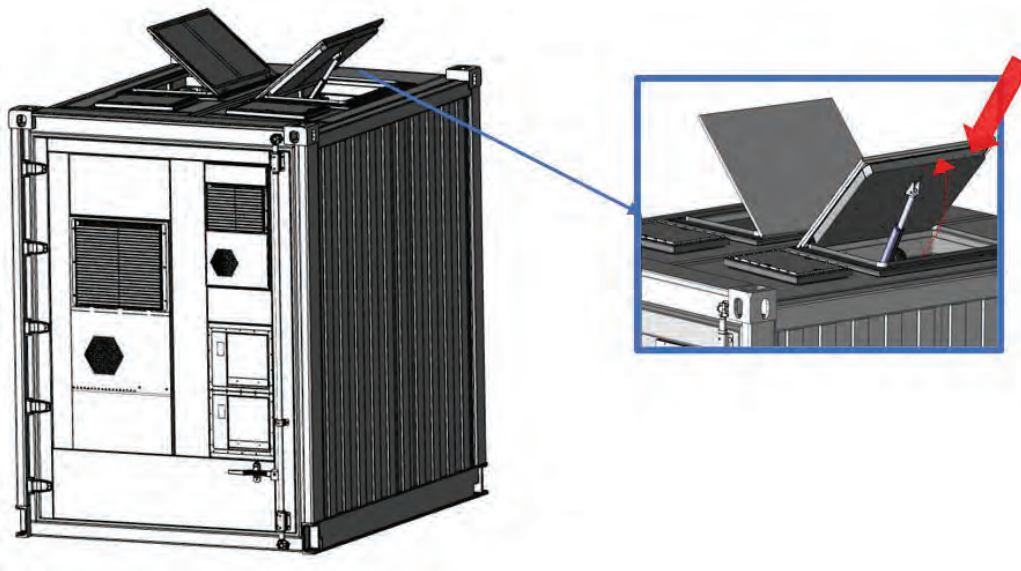


Figure 46: Method of closing ventilation door

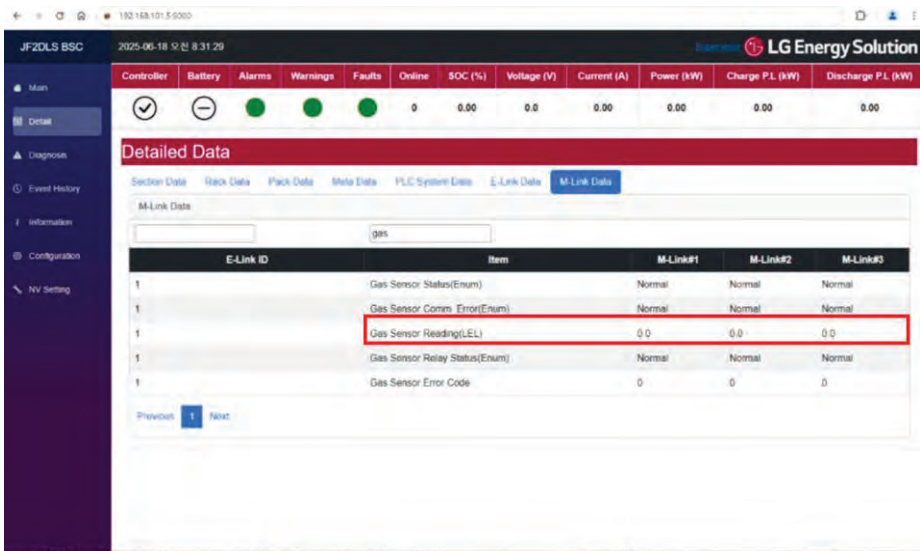
3.5.1.5 Gas Sensor LEL Reading Check

To read the LEL data of gas sensors of DC LINK, it is recommended to monitor the BSC by connecting the maintenance port of E-panel and the laptop ethernet cable.

(Recommend ethernet cable model : NBC-R4AC-R4RC-IE8A or CUC-V14-C1ZNI-S)

Detail position of maintenance port, refer to Figure 52: Location of LAN cable at the DC LINK.

Table 17: Gas sensor LEL monitoring procedure

Item	Description
BSC Access	<ol style="list-style-type: none"> 1. Connect the ethernet cable from the laptop to maintenance port of E-panel at the side 2. Access the https://192.168.101.5:5000 website
Gas Sensor LEL monitor	<ol style="list-style-type: none"> 3. Go to Detail >> M-LINK Data and find the gas sensor reading data 4. Check the gas sensor LEL data under 1% at the clean environment. 
Check the unit is defective or not	<ol style="list-style-type: none"> 5. If the LEL value is greater than 1%, The inspection method for identifying a defective unit is as follows: If any one of the following four conditions is met, the Gas sensor shall be considered defective and replace the gas sensor. <ol style="list-style-type: none"> 1) Fault lamp on the sensor exterior is activated (Fault: orange lamp is lit). 2) Fault signal is detected when checking communication data via the BSC. 3) When injecting gas with an actual LEL concentration of 50%, the Gas Sensor Leading (LEL) reading fails to reach 10% within 7 seconds. 4) The Gas Sensor Reading (LEL) value fluctuates continuously at 3-second intervals during a 30-second monitoring period, and the deviation exceeds 1%.

Calibrate the gas sensor	<p>6.If the gas sensor is not defective but fluctuates less than 1%, perform calibration and recheck the Gas Sensor Reading (LEL) value at 3-second intervals.</p> <p>If the fluctuate of Gas Sensor Reading persists after calibration, the Gas sensor need to be replaced.</p> <p>Gas Sensor calibration is required before proceeding.</p>
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3.5.1.6 Calibration of Combustible Gas Sensor

The maintenance interval for calibration of combustible gas sensor is recommended within every 12 months. Below describes the calibration method and interval setting. For more information, please refer to the manufacturer's manual.

The maintenance of Gas detector can be done by installing App on the mobile phone. The procedure is as follows.

Download Sense-point App and Connect Gas detector

- 1) Download the Sense-point App from the Google Store.
- 2) Create and resister a user account, and log on with the created account information.
- 3) To associate with one or more gas detector, scan the QR code on the sheet included in the box or enter its Activation Key and Device Serial Number.



Figure 47: Activation key of the combustible gas sensor



Note

LGES recommends customers to use activation key with serial numbers since the location of QR code is not easily accessible

- 1) Complete the installation of the detectors.
- 2) On the app's home screen, tap DETECTORS to scan for available detectors

- 3) Select a detector from the detector list to pair with.
- 4) Look for the detector whose Status Indicator is flashing blue.
- 5) Tap Confirm Detector to pair with that detector. Otherwise, tap Return to list to select one of the others.
- 6) To connect to detectors that are not added to your user account, you will need registration sheet containing the device QR code. This can also be found on a label on the rear of the electronics module

When a Bluetooth connection is established, the detector's reading is displayed on the app interface with the gas type. For details how to use the mobile app, refer to the Sense-point app manual.



Note

LGES recommends customers to calibrate Gas detector by Fresh air since it is easy and convenient. However, the accuracy of the calibration with fresh air can be decreased when the air inside M-LINK is not clean, customers can also use Zero & Span Gas calibration method.

Method 1 : Calibration by Fresh Air

- 1) Click 'Calibrate'
- 2) Click 'Zero' to start calibration with Fresh air

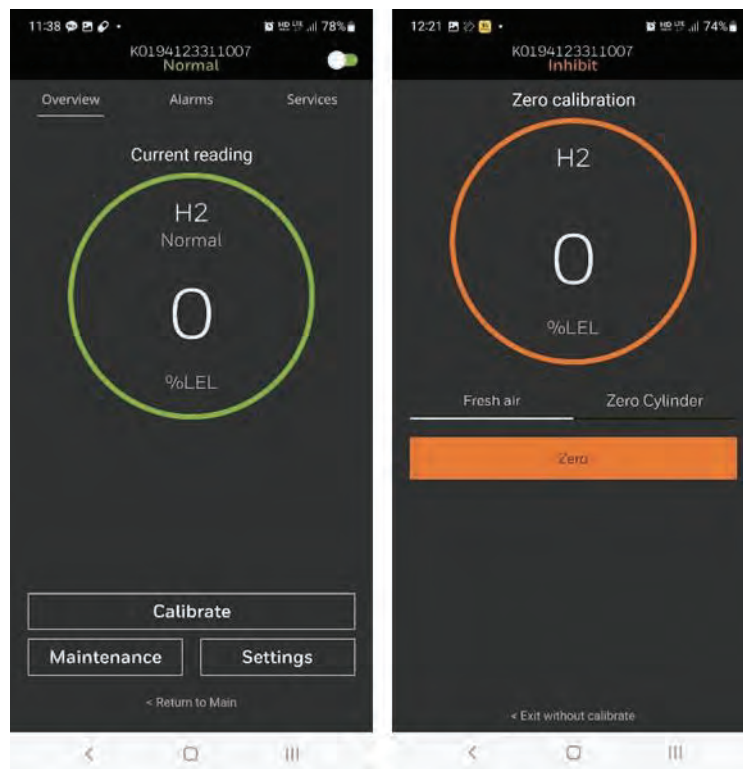


Figure 48: Procedure of calibration with fresh air

Method 2 : Zero and Span Gas Calibration

- 1) Click 'Calibrate'
- 2) Click 'Zero Cylinder' to enter Zero Cylinder Calibration Method.
Zero calibration require removing any trace of target gas or any other cross-sensitivity gases from the sensor, to provide the instrument with a baseline reading when no gas is present.
- 3) Set the calibration cap and N2 gas cylinder.

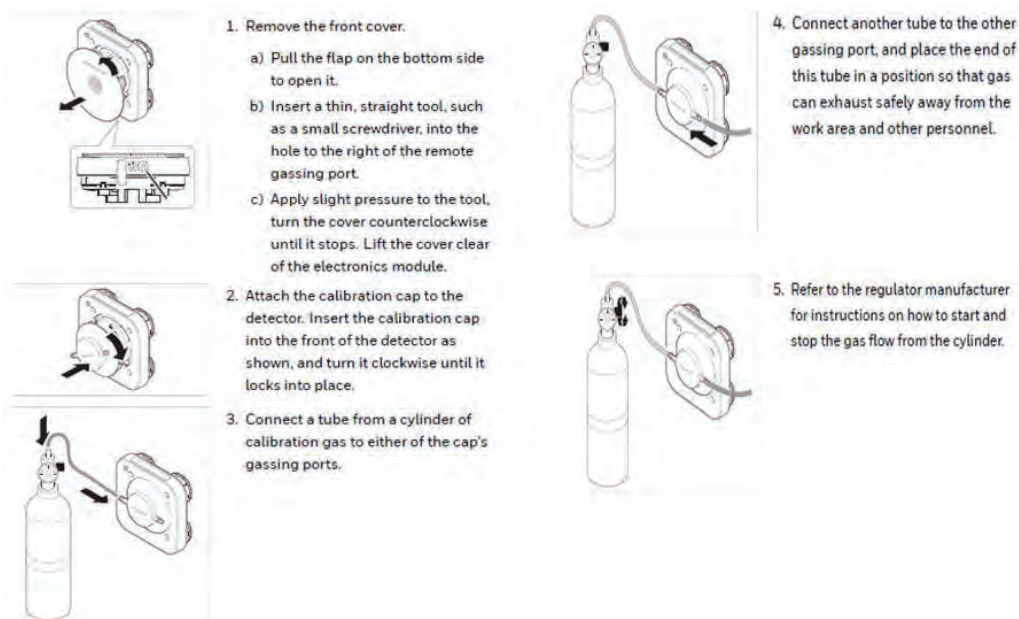


Figure 49: Procedure of setting

- 4) Open N₂ gas cylinder valve to insert N₂ gas into calibration cap.
- 5) Enter Serial number of N₂ gas cylinder (serial number written on N₂ gas cylinder) and Click 'Save & Zero'.
- 6) After finishing zero setting, close N₂ gas cylinder.
- 7) Remove N₂ gas cylinder and install H₂ gas cylinder on calibration cap for Span Calibration.
Span calibration requires applying a specific known concentration of the target gas (JF2 DC LINK: H₂ gas) to the sensor in order to provide an additional datapoint with which to chart the instrument's detection curve.
- 8) Open H₂ gas cylinder valve to insert H₂ gas into calibration cap.
- 9) Enter Serial number of H₂ gas cylinder (serial number written on N₂ gas cylinder) and Click 'Continue'.

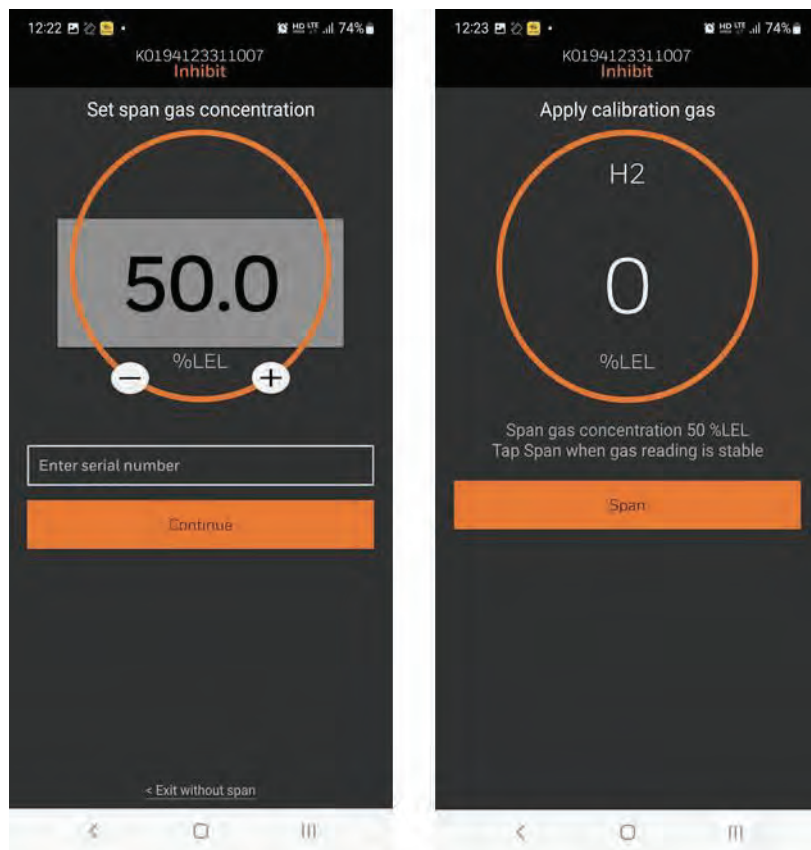


Figure 50: Procedure of calibration with zero cylinder

- 10) After finishing Span Calibration, closing H2 gas cylinder valve and removing calibration cap.
- 11) Click 'Exit'.

Below describes how to set the maintenance interval(cycle)

- 1) Click 'Setting'
- 2) Click 'Calibration & Alarm Settings'.
- 3) Change the Calibration Interval to 365 days. (Default setting: 180 days)

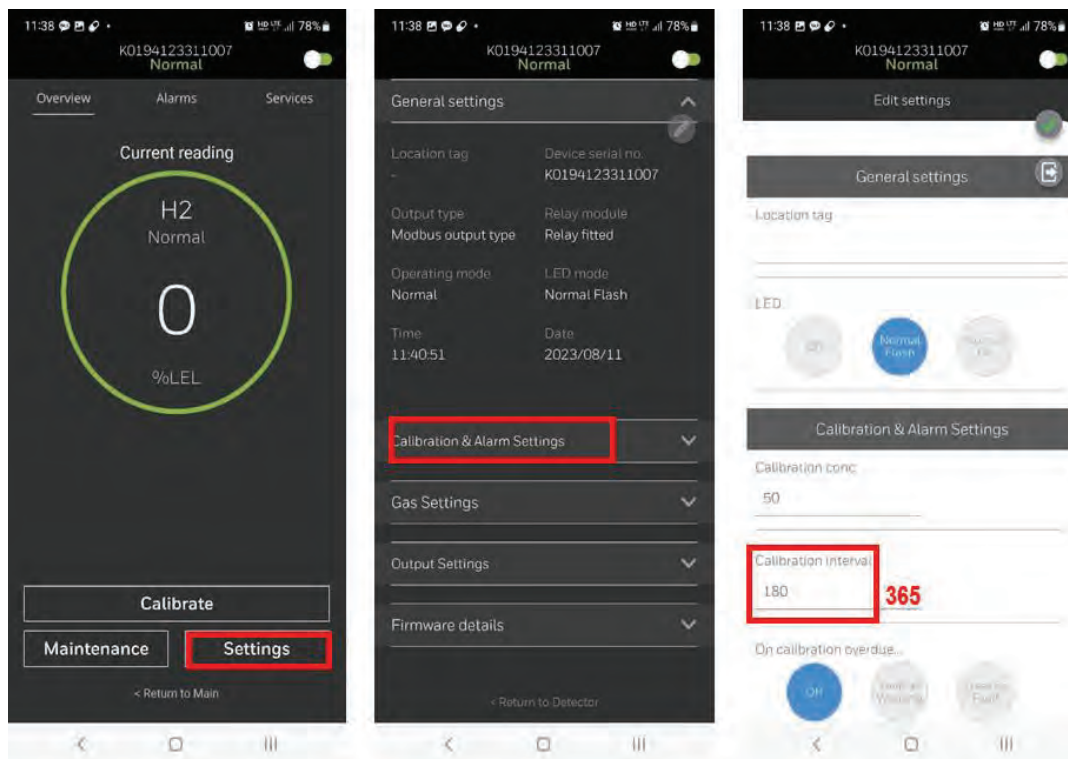


Figure 51: Setting the calibration interval



Note

If customers want to receive signal that the calibration period has passed, change the status from 'Off' to 'Treat as warning' or 'Treat as Fault' on calibration & Alarm Settings

3.6 Maintenance of battery system operation

Users can control the DC LINK directly or indirectly using the BSC, for maintenance purposes. DC LINK system is typically controlled by sending commands to BSC through the upper controller. The BSC can also be accessed using a UI PC with the same functionality includes maintenance tasks.

Users are granted the control authority of the DC LINK system based on their BSC Account. Users can only control the functions specified in the table below.

Account	Function	Detail	Remark
User & Admin	Normal Mode	- BSC Status for System Operation.	- Controlled by Upper Controller & BSC - refer to F2D4-5.1US-CT01_BSC SW User Manual
	Full Charge Mode	- BSC Status for SOC Recalibration	
	Emergency Mode	- When an emergency signal is received from the upper controller or an equivalent diagnosis	

		occurs. - Impossible to operate without Event Clear using CER Tool.	
	Manual Mode	- BSC Status for Maintenance - In Manual Mode, individual rack control (MC ON/OFF) is possible for maintenance. - Diagnostic conditions for safety do not work.	
	Contactor Open/Close	- Controlling the BPU Contactor on the Battery Rack - Can be controlled in general operating conditions including Normal Mode	
	User Option Setting	- Change the logging Path - Change the Port No.(BSC-Controller Comm.)	- Controlled by BSC - refer to F2D4-5.1US-CT01 _ BSC SW User Manual
Admin	Configurator	- Import / Export for System Unit Settings	- Controlled by BSC - Refer to F2D4-5.1US-CT01 _ BSC SW User Manual - Operation in accordance with LGES bylaws (prior discussion required)
	NV Read / Write	- Import / Export for BMS Unit Settings	
	CER (Critical Event Record)	- Critical error status check and Event Clear. (eg. Emergency, etc) - Refer 5.3 Critical Event Record	
	E-Panel DS	- E-Panel DS open remotely.(only available with BSC-BMS Disconnection status)	
	Ventilation Door	- Ventilation door open remotely.(only available with BSC-BMS Disconnection status)	

3.6.1 SOC Recalibration

To maintain the SOC accuracy of $\pm 3.5\%$ @ 15-35°C, The SOC recalibration is required. The SOC recalibration is conducted automatically in real time if the battery enters the SOC under 30% or over 98%. LGES recommend to enter this condition by full charge of the battery of this every 1 time for a monthly basis. Below table is the period and method of the SOC recalibration.

Recalibration	Criteria or conditions
Period	1 time /1 month [Full charge 1time]
Method	Full Charge : Charge until max cell voltage reaches 3.57V (The SOC Recalibration is conducted automatically in real time with the range of SOC $\leq 30\%$, SOC $\geq 98\%$)

3.6.2 Cell Balancing

There may be variations in the State of Charge (SOC) between cells during operation. To prevent these discrepancies, it is recommended to periodically meet the conditions by entering cell balancing.

Below are the entry conditions and logic for cell balancing, as well as the target conditions and execution time.

Cell Balancing	Criteria or conditions
Entry Condition	<p>■ Condition 1. (Upper Area) Avg. Cell V > 3.342V(Configurable) and Idle > 10 min (Lower Area) Max. OCVsoc < 35% and Idle > 60 min</p> <p>■ Condition 2. Pack min. temperature > 0 °C Pre-condition satisfaction : Go to target judgement if Condition 1 and Condition 2 are satisfied.</p>
Target Judgement Condition	<p>■ Upper area : ΔV (each Cell V – Min. Cell V) > 20 mV ※ Wait 10 minutes again for entry condition if there's no target.</p> <p>■ Lower area : ΔOCV_{soc}(each Cell OCVsoc – Min. Cell OCVsoc) > 5%</p>
Execution Logic	<ul style="list-style-type: none"> Continuing Idle state after target selection : Perform individual cell balancing until the target condition is satisfied regardless of maximum balancing time. (All Cell voltage deviation is under 18.5 mV) Charge or Discharge in performing cell balancing : Perform cell balancing until maximum balancing time. Terminate balancing and reselect target if entry condition is met again in performing balancing.
Other conditions	<ul style="list-style-type: none"> Calculation for Maximum Balancing Time (0.1% Capacity) : Pack Capacity * 0.1% * 3600 / (nominal balancing current * balancing duty%) = 159.2Ah * 4P * 0.001 * 3600 / (0.076 A * 0.98) * 2 = 61559.6s (17.1 hours)

3.6.3 BSC/Battery Status Check & Monitoring

If it is hard to monitor the BSC remotely, The system status can be checked by connecting LAN cable without opening the M-LINK or E-Panel

Lan cable terminal is located at the side of E-Panel under the Horn/Strobe. The figure shows the location of LAN Cable Terminal. (The recommended operating condition of LAN cable terminal is -10°C to 40°C)

To avoid damage when connecting the Ethernet cable and connector, it is recommended to use the following connector.

Model: NBC-R4AC-R4RC-IE8A or CUC-V14-C1ZNI-S

** Caution: Due to frequent damage to the IP cap, extra caution must be taken during removal. For disassembly, turn the IP cap counterclockwise to disassemble it following figure.



Figure 52: Location of LAN cable at the DC LINK



Figure 53: Image of ethernet cable

4. Replacement

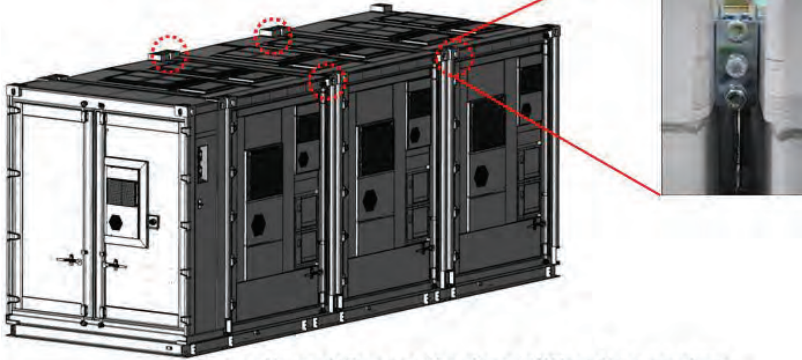
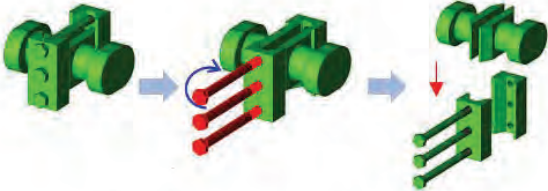
4.1 M-LINK Replacement

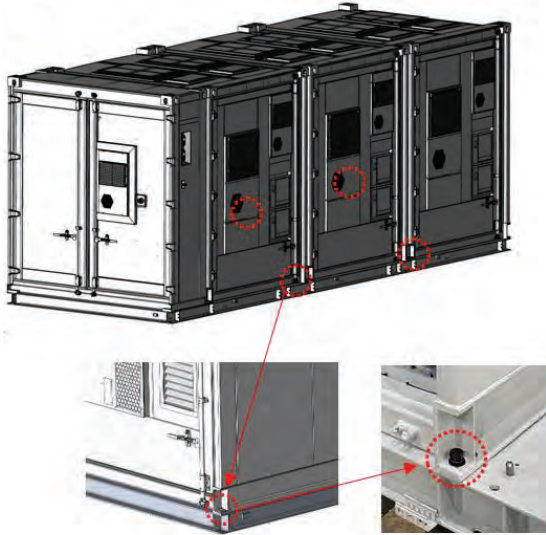
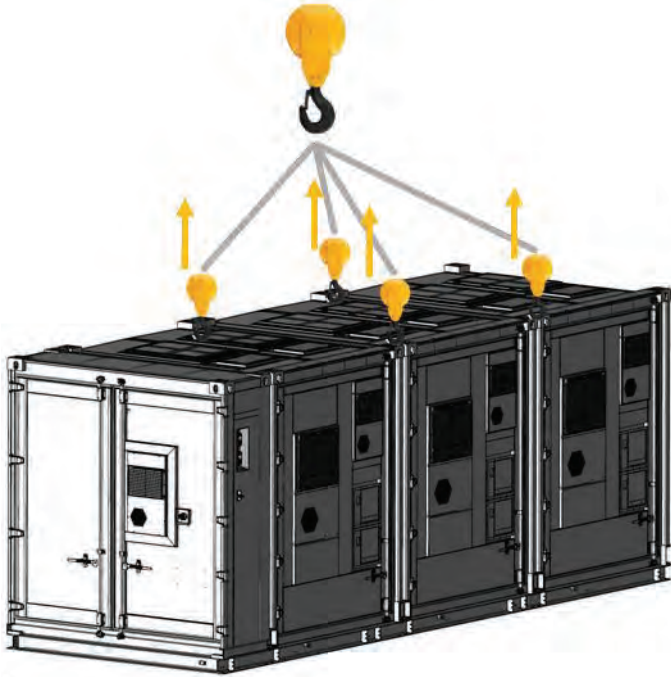
If the M-LINK replacement is necessary by severe damage of M-LINK, below table are the

process concept of M-LINK replacement. Please contact LGES for getting the detail guidance



Figure 54: Concept of M-LINK Replacement

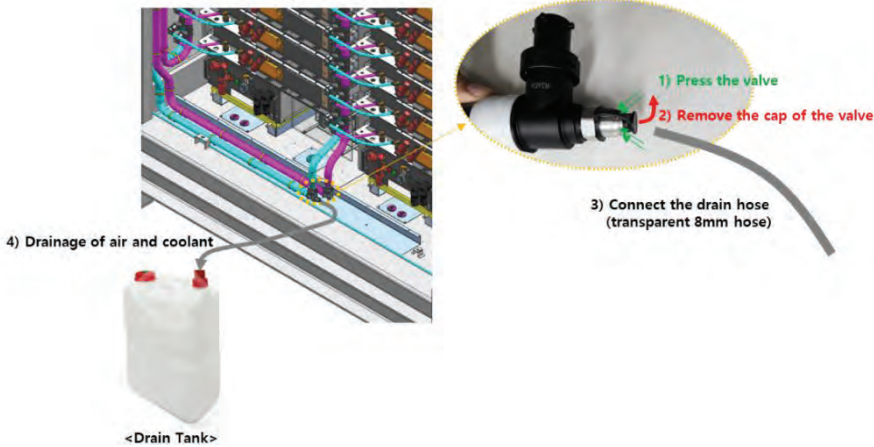
No	Contents	Image
1	Shut down the DC LINK system	Refer to 2.3 Power-Off DC LINK
2	Remove all cables connected to the M-LINK	Remove cables connected E-Panel to the M-LINK
3	Remove the corner casting connector	<p>Remove the corner casting fitting connectors of M-LINK to be replaced</p>  <p><Location of Corner Casting Fitting Connector></p>  <p><Disassembly Sequence></p>
4	Remove the anchoring parts	Remove the anchoring bolts and parts of M-LINK to be replaced

		
5	Lift the M-LINK	<p>Connect the lifting hooks to the corner castings at the top corners of the M-LINK to be replaced.</p> 

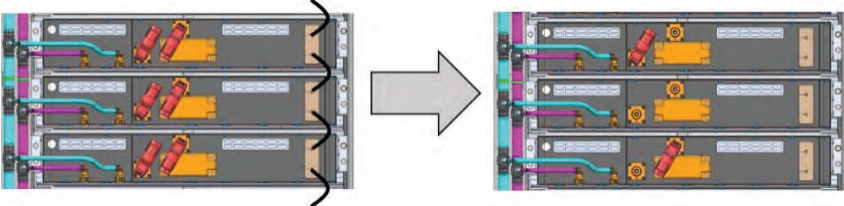
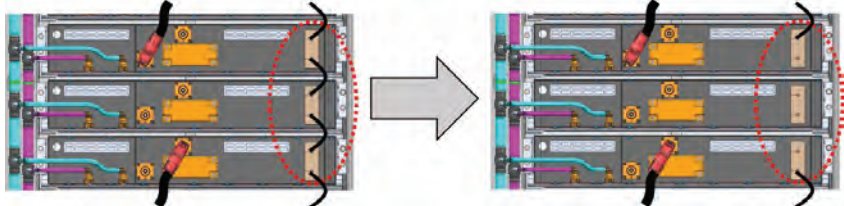
4.2 Battery Pack Replacement Process

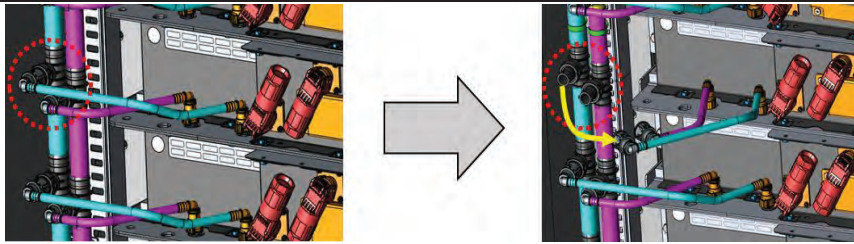
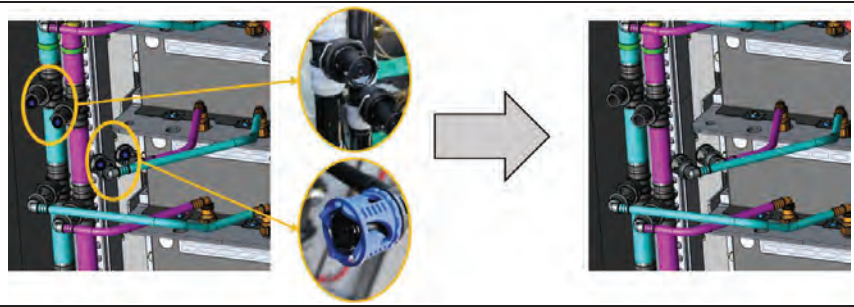
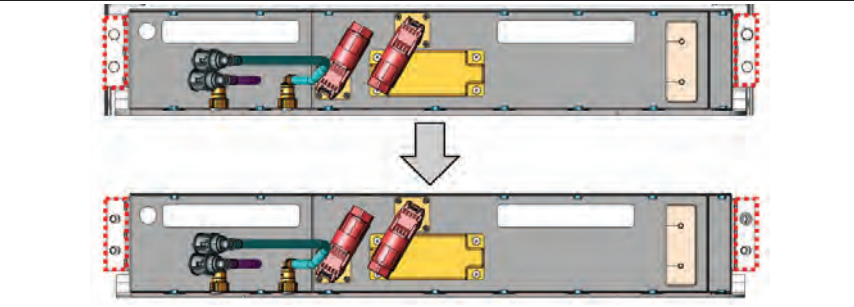
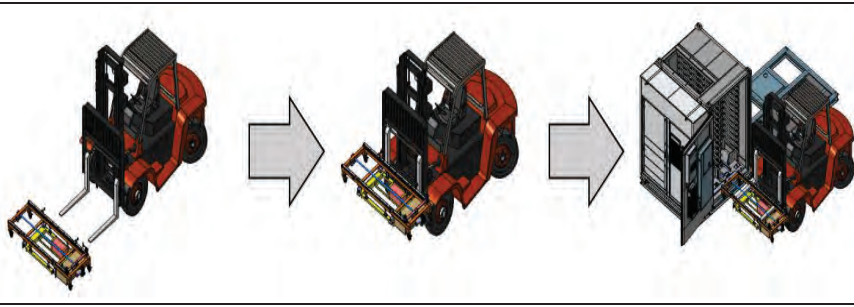
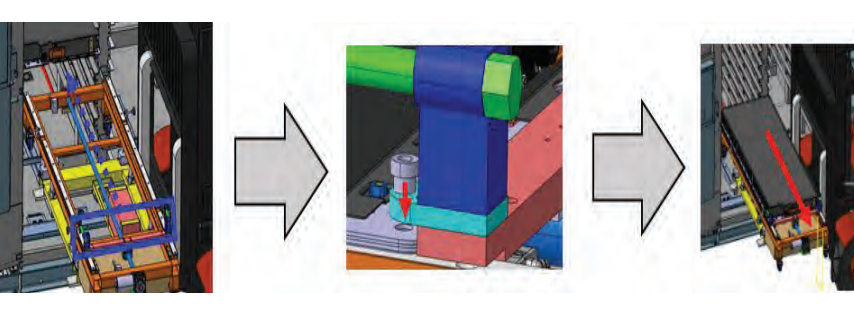
If the pack replacement is necessary for any reason, follow the procedures outlined below to replace the pack. Power OFF the DC LINK and interconnected PCS before starting the pack replacement process.

4.2.1 Release the coolant pressure

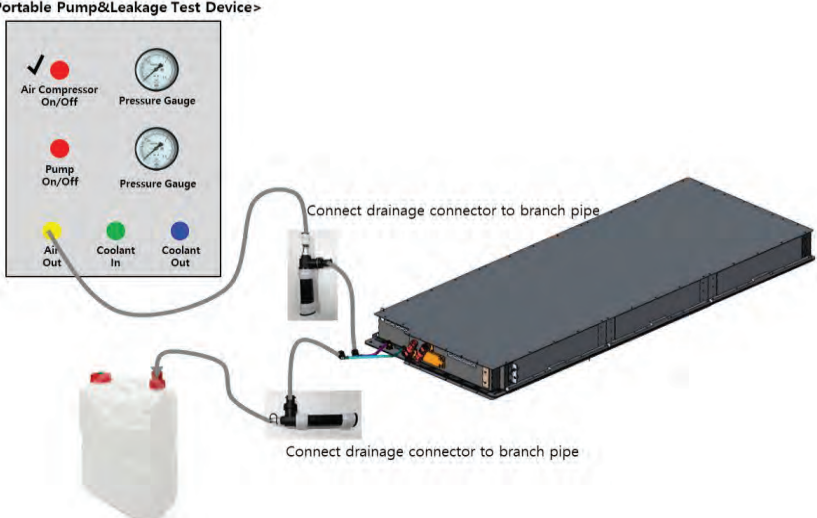
No	Contents	Image
1	Shut down the DC LINK system	Refer to 2.3 Power-Off DC LINK
2	Remove the cap of One Way Valve(Shut-Off) Connect the drain hose to One Way Valve Drain air and coolant into drain tank about 2L	

4.2.2 Remove the pack

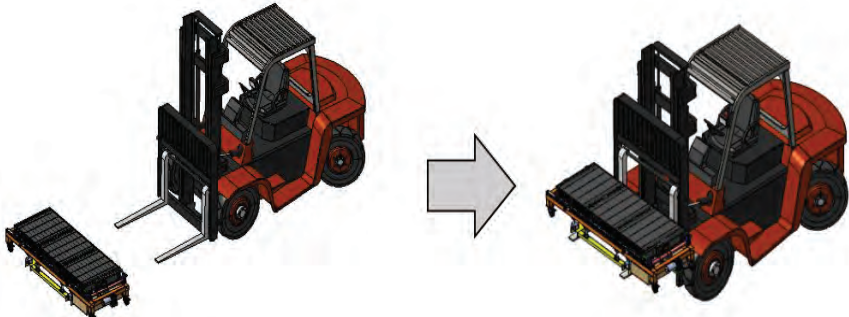
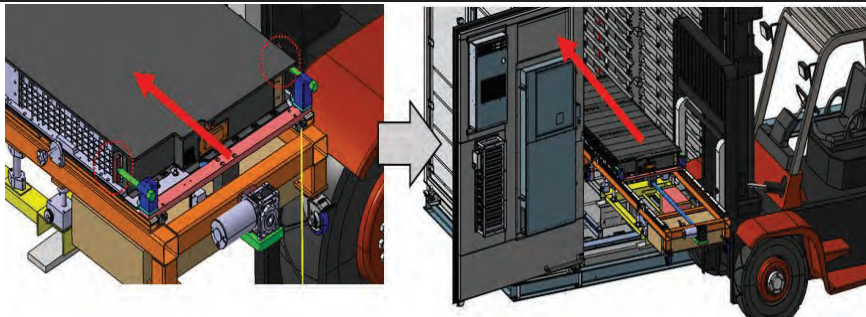
No	Contents	Image
1	Disconnect pack to pack power cable	
2	Disconnect pack to pack communication cable	

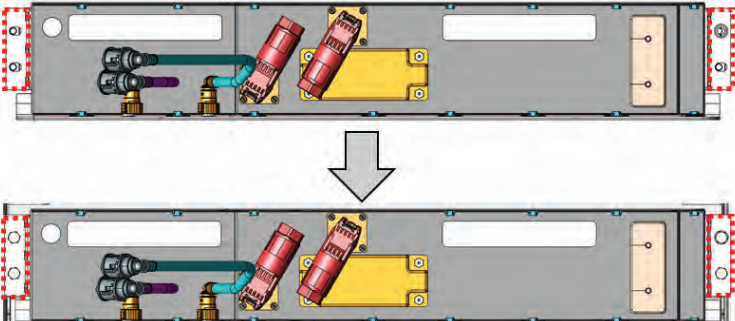

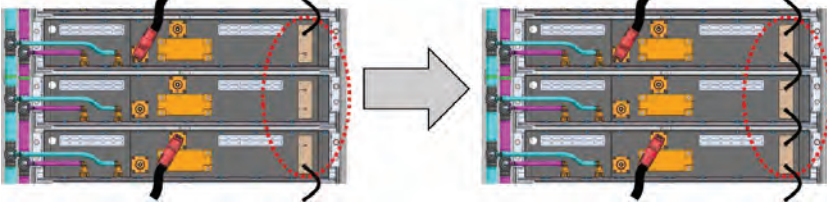
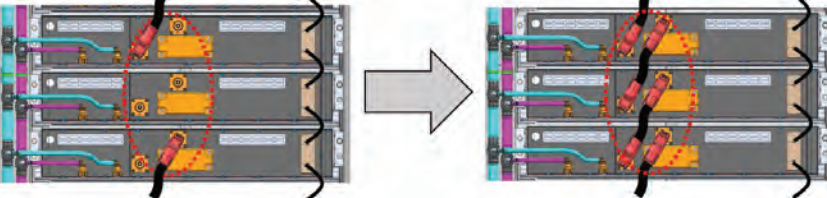
3	Disconnect the shut-off connector between manifold to branch pipe	
4	Wipe off the small amount of coolant generated after disconnecting connector	
5	Loosen rack mounting bolts(4ea)	
6	Using a forklift (or electric lift), install the Pack JIG by lifting it from the side.	
7	<p>Move the Mounting bracket of the JIG to the front of the Pack.</p> <p>Align the Mounting bracket hook of the JIG with the holes on the bottom of the Pack and secure it. Then, press the pull button to pull out the pack</p>	

4.2.3 Drain the coolant from the removed pack

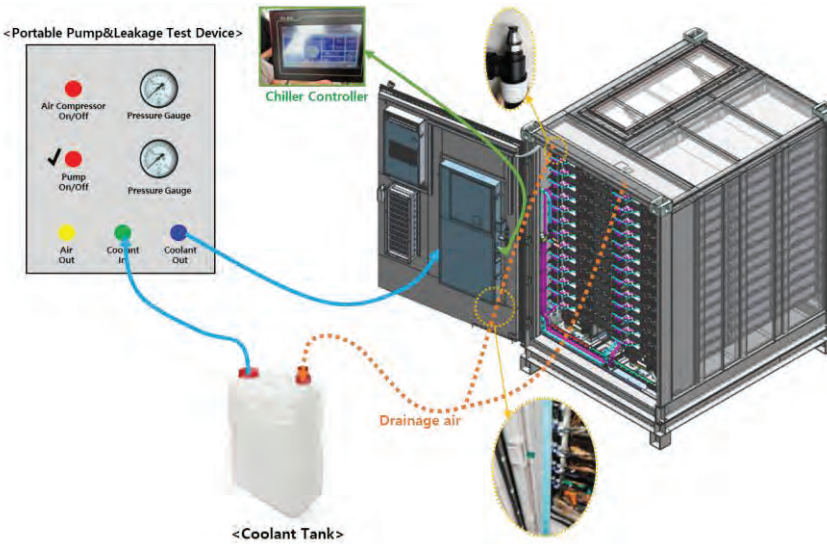
No	Contents	Image
1	<p>Place the removed pack on a flat surface.</p> <p>Connect the drainage connector and a hose to remove remaining coolants inside.</p> <p>Operate the air compressor at 2 bar pressure to remove coolant from the pack</p> <p>Remove the branch pipe from the pack</p>	<p><Portable Pump&Leakage Test Device></p> 

4.2.4 Inserting the new pack

No	Contents	Image
1	<p>Using a forklift (or electric lift), lift the Pack JIG and new Pack from the side for installation.</p> <p>Move the forklift to the designated Pack installation location inside the M-Link and position the JIG for access.</p>	
2	<p>After bringing the JIG's Mounting bracket into contact with the left/right mounting brackets of the Pack, push the Pack.</p>	

3	Fasten rack mounting bolts(4ea / $8.4 \pm 10\%$ Nm)	
4	Connect shut-off connector between manifold to branch pipe Connect branch pipe to the pack	
5	Connect pack to pack communication cable	
6	Connect pack to pack power cable	

4.2.5 Coolant filling

No	Contents	Image
1	<p>Connect the pipes in the section below to fill the coolant</p> <p>1) Portable Device ↔ Supply valve in Chiller</p> <p>2) Portable Device ↔ Coolant Tank</p> <p>3) One Way Valve(Shut-Off) at the top of Pipe 2ea ↔ Coolant Tank</p> <p>Connect the portable chiller controller to fill the coolant and remove air from the pipe assembly and heatsink.</p> <p>Operate the pump for 30 minutes in the portable device and chiller with the supply mode (pump speed 55%).</p> <p>: Check chiller returning pressure over 1Bar and visual inspection of pipe</p>	

4.3 BMS Replacement

4.3.1 RBMS Replacement

If the RBMS replacement is necessary for any reason, follow the procedure to replace the RBMS. Power OFF the DC LINK and interconnected PCS before starting the RBMS replacement process

- 1) Turn off the power switch of the BPU
- 2) Remove the DC power connectors and communication connectors connected BPU
- 3) Loosen 2EA screw bolts at the bottom front of BPU and pull out the RBMS case.
- 4) Remove the RBMS from the case
- 5) Replace the RBMS and connect the DC power cables of BPU
- 6) Turn on the power switch of the BPU and follow the Power-On DC LINK sequence

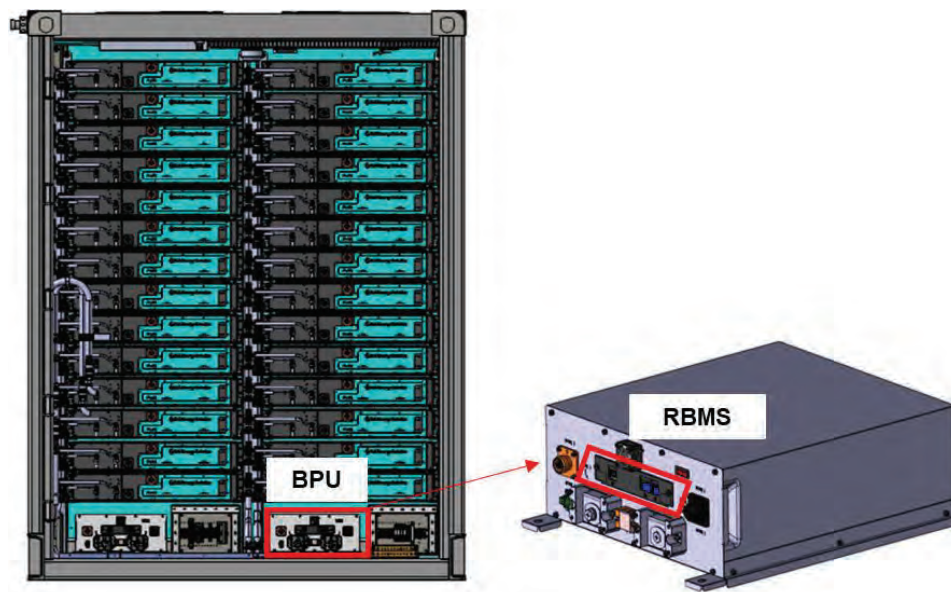


Figure 55: Location of RBMS

4.4 Coolant Replacement

4.4.1 Coolant drainage and refilling

Power off by referring to 2.3 Power-Off DC LINK.

Refer to 4.2.3 and 4.2.5 for the coolant drainage and refilling during replacement

4.5 Skid Cable Replacement

If the skid cable replacement is necessary for any reason, follow the procedure to replace the cable in skid.

- 1) Power Off the Main Power and AC Aux, after checking for defective cables and conduits, unplug the cable connections (E-Panel & M-Link both)

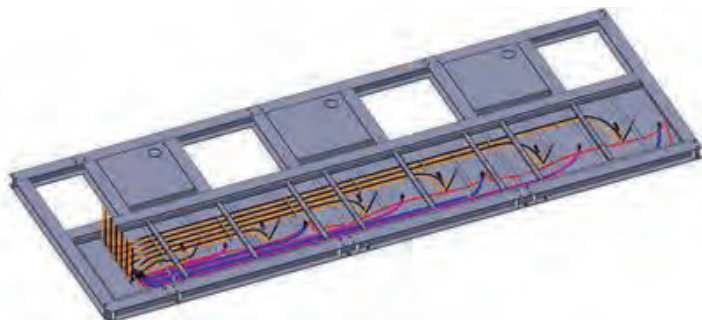


Figure 56: Image of Skid Cables

- 2) Cut the ferrule terminal (for multi-core cables, cut the cable to the outer jacket) and Pull out the cable from the conduit from the E-panel
- 3) Pass the fish tape (outlet line) from the E-Panel to the M-Link through the corresponding Conduit so that the yoke line head is completely raised from the M-Link Conduit.
- 4) Tighten the cable to be replaced firmly to the M-Link side fish tape head hook, then pull it through the E-Panel and pass it through completely.



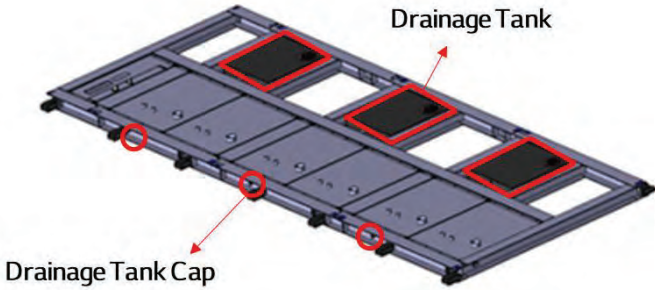
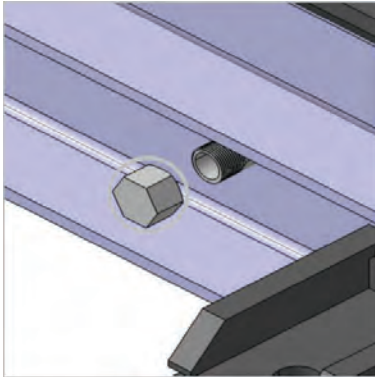
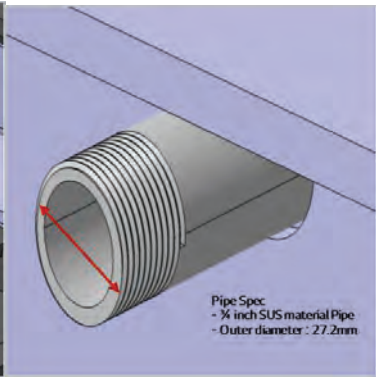
Figure 57: Image of fish tape

- 5) Complete terminal (ring terminal or ferrule terminal) and label work according to each TB type to be connected to E-Panel & M-Link.
- 6) Power on the AC aux line and check the voltage with a multimeter to see if the voltage corresponding to each TB is applied (in case of communication cables, check the communication)

4.6 Drainage Tank in SKID

Drainage tank is installed in the skid for each M-LINK to prevent chemicals generated during the replacement process or within the M-LINK product from leaking outside the unit. Below table are the process concept of drainage method. Please contact LGES for getting the detail guidance.

No	Contents	Image
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1	Shut down the DC LINK system	
2	Remove the drain cap	  <p>Pipe Spec: - 3/4 inch SUS material Pipe - Outer diameter : 27.2mm</p>
3	Drain the liquid in the tank	

Use the pump instrument to get rid of liquid inside the Drain Tank
 * Pipe Spec : 3/4inch SUS material pipe (Outer diameter 27.2mm)

5. Troubleshooting

As defined in this chapter, when an issue occurs during the operation of the DC LINK system, the status of the battery system is checked through the BSC and remedial measures to be taken immediately in the field are described.

The troubleshooting described in this section may have limitations in resolving the problem for each situation, and if an abnormal event occurs repeatedly, user should contact LG Energy Solution.

5.1 Extraction BSC Log



CAUTION

Attach BSC log files before contacting LG Energy Solution.

The operational information of the DC LINK System is stored in the BSC IPC. This data can be extracted through a User PC (not the BSC IPC).

Log files, as described below, are created and stored daily for a one-year duration.

- Data Log : /mnt/d/log/Gen3BSC/Section1/YYYYMMDD
- META Log : /mnt/d/log/Gen3BSC

Table 18: BSC Log save path and file list

Item	File name	Information
Data Log	JF2Enc_BSC_Section_YYYYMMDD.csv	The battery section's operating information
	JF2Enc_BSC_RackS1.R##_YYYYMMDD.csv	A battery rack's operating information (##: Rack No.)
	JF2Enc_BSC_PacksS1.R##_YYYYMMDD.csv	A battery pack's operating information of the Rack (##: Rack No.)
	JF2Enc_BSC_Event_YYYYMMDD.txt	Event History
	JF2Enc_BSC_DC LINK_YYYYMMDD.csv	Main PLC information
	JF2Enc_BSC_E-PanelS1.E#. _YYYYMMDD.csv	E-Panel information
	JF2Enc_BSC_M-LINKS1.E#. _YYYYMMDD.csv	M-LINK information
	JF2Enc_BSC_Controller_ YYYYMMDD.csv	Upper controller (PCS or EMS) information
META Log	JF2Enc_BSC_Nameplate_YYYYMMDD.txt	Rack nameplate data

Data Log files, as described below, are created and stored daily. META data received from BMS is saved in a file when BMS is connected.

Log data can be obtained by following the procedure below while the USER PC is connected to the DC LINK system.

- Method 1) Use software that supports SFTP
Install SFTP-related SW (e.g. filezilla) and extract log files.
(Basic log path: /mnt/d/log/Gen3BSC/Section1)
- Method 2) Use PowerShell on Windows
For extracting log data using PowerShell, refer to F2D4-5.1US-CT01 *_BSC SW User Manual*.

5.2 Loss of Communication (LOC)

Table 19: Loss of Communication

Trouble	Common Cause	Corrective action
PBMS – RBMS (LOC)	Communication error between PBMS and RBMS.	Check if the cable is connected properly between PBMS and BPU. Check if the cable is connected properly between PBMS and PBMS
RBMS – BSC (LOC)	Communication error between RBMS and BSC.	Check if the cable is connected properly between RBMS and BBMS. Check if the cable is connected properly between RBMS and BSC. Check if BPU is on.
BSC – Controller (LOC)	Communication error between BSC and Controller.	Check if the cable is connected properly between BSC and Controller Check if the firewall on the BSC computer is disabled.
BSC – E-Panel (LOC)	Communication error between BSC and E-Panel.	Check if the cable is connected properly between BSC and E-Panel PLC. Check the IP address and port settings of BSC and Main E-Panel PLC. (Port No.: 502)

5.3 Battery Warning & Fault

Table 20: Battery Warning, Fault Message

Battery Warning, Fault Message		
Trouble	Common Cause	Corrective action
Warning Alarms		<ol style="list-style-type: none"> 1) Confirm the position of the warning alarm. (i.e.: BSC#1 Rack#4) 2) Lower the PCS power following the BSC Power Limit (If not, BSC would diagnose power limit fault.)
OVF (Over Cell Voltage Fault)	When the maximum cell voltage is over the diagnostic value.	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Discharge the rack in manual mode until the cell voltage is lower than the diagnostic value. 4) Shut down and restart the BSC S/W. If OVF is not cleared, contact LG Energy Solution for technical support.
UVF (Under Cell Voltage Fault)	When the minimum cell voltage is under the diagnostic value.	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Charge the rack in the manual mode until the cell voltage is higher than the diagnostic value. 4) Shut down and restart the BSC S/W. If UVF is not cleared, contact LG Energy Solution for technical support.
RDVF (Rack Deviation Cell Voltage Fault)	When the voltage deviation of the cells in the rack exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Contact LG Energy Solution for technical support.
PDVF (Pack Deviation Cell Voltage Fault)	When the voltage deviation of the cells in the module exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Contact LG Energy Solution for technical support.
OTF (Over Module Temperature Fault)	When the maximum module temperature in the rack exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Measure ambient temperature and set the air

Battery Warning, Fault Message		
Trouble	Common Cause	Corrective action
		<p>conditioning system.</p> <p>4) Wait until the module temperature to be lower than the diagnostic value.</p> <p>5) Shut down and restart the BSC S/W. If OTF is not cleared, contact LG Energy Solution for technical support.</p>
UTF (Under Module Temperature Fault)	When the minimum module temperature in the rack exceeds the diagnostic value	<p>1) Stop charging or discharging. (Automatically action)</p> <p>2) Confirm the position of the rack where the fault happened.</p> <p>3) Measure ambient temperature and set the air conditioning system.</p> <p>4) Wait until the module temperature to be higher than the diagnostic value.</p> <p>5) Shut down and restart the BSC S/W. If UTF is not cleared, contact LG Energy Solution for technical support.</p>
DTF (Difference Module Temperature Fault)	When the module temperature deviation in the rack exceeds the diagnostic value	<p>1) Stop charging or discharging. (Automatically action)</p> <p>2) Confirm the position of the rack where the fault happened.</p> <p>3) Wait until the module temperature deviation to be within the diagnostic value.</p> <p>4) Shut down and restart the BSC S/W. If DTF is not cleared, contact LG Energy Solution for technical support.</p>
OCCF (Over Charge Current Fault) - Rack	When the charge current of the rack exceeds the diagnostic value	<p>1) Stop charging. (Automatically action)</p> <p>2) Confirm the position of the rack where the fault happened.</p> <p>3) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.</p>
ODCF (Over Discharge Current Fault) - Rack	When the discharge current of the rack exceeds the diagnostic value	<p>1) Stop discharging. (Automatically action)</p> <p>2) Confirm the position of the rack where the fault happened.</p> <p>3) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.</p>
OCPF (Over Charge Power Fault) - Rack	When the charge power of the rack exceeds the diagnostic value	<p>1) Stop charging. (Automatically action)</p> <p>2) Confirm the position of the rack where the fault happened.</p> <p>3) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.</p>

Battery Warning, Fault Message		
Trouble	Common Cause	Corrective action
ODPF (Over Discharge Power Fault) - Rack	When the discharge power of the rack exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop discharging. (Automatically action) 2) Confirm the position of the rack where the fault happened. 3) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.
OCCF (Over Charge Current Fault) - BSC	When the charge current of BSC exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging. (Automatically action) 2) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.
ODCF (Over Discharge Current Fault) - BSC	When the discharge current of BSC exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop discharging. (Automatically action) 2) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.
OCPF (Over Charge Power Fault) - BSC	When the charge power of BSC exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging. (Automatically action) 2) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.
ODPF (Over Discharge Power Fault) - BSC	When the discharge Power of BSC exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop discharging. (Automatically action) 2) Check PCS output power. If there is no problem in the PCS, contact LG Energy Solution for technical support.
CIF (Current Imbalance Fault) – BSC	When the current deviation between racks exceeds the diagnostic value	<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Contact LG Energy Solution for technical support.
SVDF&PSVDF (Sudden Voltage Fault) – Rack		<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Check insulation value and contact LG Energy Solution for technical support.
MFRD (Multiple Faults Rack Detection) – BSC		<ol style="list-style-type: none"> 1) Stop charging or discharging. (Automatically action) 2) Confirm the position of the Bank where the fault happened. 3) Contact LG Energy Solution for technical support.
USOHF (Under State of Health Fault) – Rack	When the current deviation between racks exceeds the diagnostic value	Contact LG Energy Solution for technical support.
CWEF (Cycle Warranty Expiration)	When the current deviation between racks exceeds the	Contact LG Energy Solution for technical support.

Battery Warning, Fault Message		
Trouble	Common Cause	Corrective action
Fault) – Rack	diagnostic value	

5.4 Non-Battery Alarm

Table 21: Non-Battery Warning, Alarm Message

Non-Battery Warning, Alarm Message		
Trouble	Common Cause	Corrective action
COF (Contractor Open Fault) - Rack	When main contactor of BPU is welded.	Contact LG Energy Solution for technical support.
RCF (Rack Connection Fault) - Rack	When current is not flowing due to BPU out of order.	Contact LG Energy Solution for technical support.
CSWE (Current sensing wire error) - Rack	When current sensor of BPU is out of order.	Contact LG Energy Solution for technical support.
DSE (Disconnect Switch error) - Rack	When DS (or CB) of BPU is out of order	Contact LG Energy Solution for technical support.
MCE (Main Contactor Error) - Rack	When main contactor of BPU is out of order.	Contact LG Energy Solution for technical support.
PBMSF (PBMS Fault) - Rack	When micro-controller in a pack is out of order.	Contact LG Energy Solution for technical support.
TSE (Temperature sensor Error) - Rack	When temperature sensor in a pack is out of order.	Contact LG Energy Solution for technical support.
SLFA (System Logging Failed Alarm) – BSC	When the storage of the BSC H/W is out of order.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack Vcore 1.25V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.

Non-Battery Warning, Alarm Message		
Trouble	Common Cause	Corrective action
RBMS H/W Diagnosis – Rack CT 13.3V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack CT 5V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack PC 24V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack SMPS 24V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack Vpre 6.5V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack Vcca 5V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack SBC 5V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack CB 24V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack MC2 24V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W Diagnosis – Rack MC1 24V Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.
RBMS H/W	When RBMS H/W	Contact LG Energy Solution for technical support.

Non-Battery Warning, Alarm Message		
Trouble	Common Cause	Corrective action
Diagnosis – Rack SBC Fail Safe EDC Error	diagnosis occurs.	
RBMS H/W Diagnosis – Rack SBC Fail Redundant Error	When RBMS H/W diagnosis occurs.	Contact LG Energy Solution for technical support.

5.5 Critical Event Record (CER)

Critical events are recorded when a fatal error occurs in which the battery cannot be operated (Emergency Mode, etc.). When this situation occurs, the battery cannot be operated, even if the BMS is re-started. During an actual critical event, the LG Energy Solution engineer can use this function to identify the affected rack and clear the critical event after checking the pack and taking corrective action.

Table 22: Critical Event Record

Trouble	Common Cause	Corrective action
Fatal Error -Emergency etc.	When the system is stopped due to fatal error.	Immediately contact the person in charge of LG Energy Solutions and act.

5.6 FACPS Point and System Trouble Lists

A variety of point (i.e. a specific device) or system-wide trouble types may appear in a trouble message. The tables below lists troubles and indicates their cause.

5.6.1 Supervisory Mode for Combustible Gas Detection Failure

If the gas sensor is not functioning or unable to detect H₂ gas, the SUPERVISORY LED will flash. In such cases, appropriate actions will be taken, depending upon the situation. Such actions could involve re-installing the gas sensor line to ensure proper connection and functionality, or replacing

the specific gas sensor if it is determined to be faulty. Follow the manufacturer's guidelines and procedures for re-installation or replacement to ensure the proper operation of the gas sensor and to clear the alarm condition indicated by the flashing SUPERVISORY LED.

Table 23: Descriptions and actions depending upon FACP supervisory #2 (Diagnosis Condition)

Category	Description	Diagnosis Level	Action
H2 Gas Detection System Failure	Any H2 Gas Detection System Failure	Alarm	H2DA alarm on BSC window

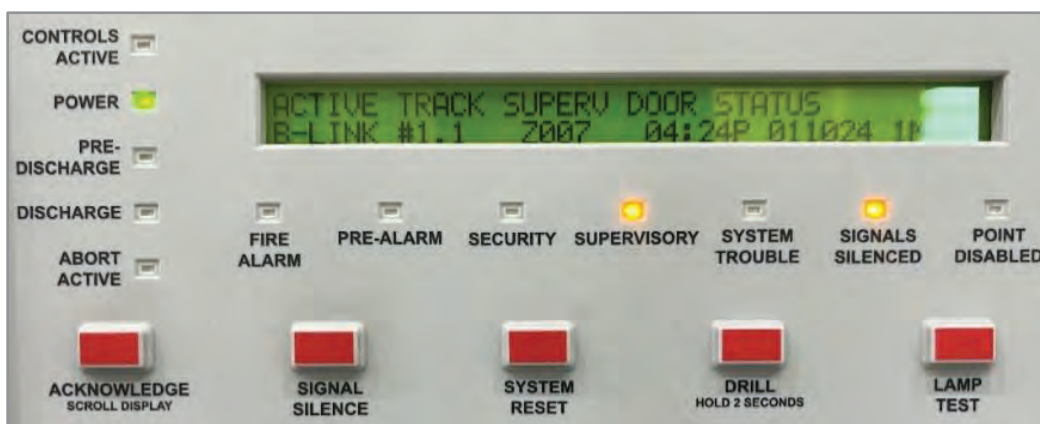


Figure 58: FACP Screen Supervisory Mode

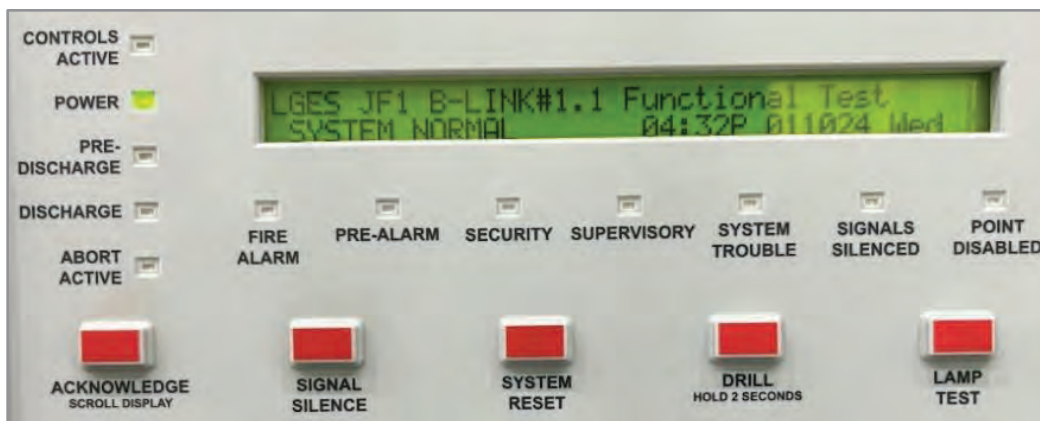


Figure 59: FACP Screen after fixing Combustible gas detection failure

5.6.2 FACP Point (Device) Troubles

When a point (device) trouble occurs, a message from the "Trouble Type" column in the table

below will appear in the upper right corner of the panel display. The operator can refer to this table to help determine the nature of the trouble.

POINT TROUBLES		
TRouble TYPE	TRouble DESCRIPTION	ACTION
AC FAILURE	The auxiliary power supply has lost AC power.	Determine whether there is an AC power loss or whether the power supply and wiring is correct.
ADRFLT	Detector and new sounder base address doesn't match. Or the ACPs address is incorrect.	Readdress the incorrect device.
ALIGN	A beam detector is in configuration mode.	No action is necessary, as the trouble will clear when the configuration is complete. However, the detector will not detect a fire while this trouble exists.
BLOCK	Something has come between the detector's beam and its reflector.	Investigate and clear the blockage.
CHGFLT*	The power supply's battery charger is not working properly.	Correct the fault.
CO 6MN	The CO (carbon monoxide) detection element on the detector has six months left to expiration. (This trouble generates in FlashScan mode only. CLIP mode will generate a LO VAL error.)	Replace the detector.
CO EXP	The CO (carbon monoxide) detection element on the detector has reached the expiration date. (This trouble generates in FlashScan mode only. CLIP mode will generate a LO VAL error.)	Replace the detector.
CO TBL	The CO element on the detector is not working properly. (This trouble generates in FlashScan mode only. CLIP mode will generate a LO VAL error.)	Replace the detector.
DIRTY 1	The detector is dirty and needs cleaning	Clean the detector.
DIRTY 2	The detector requires cleaning immediately. It is a false alarm risk.	Clean the detector immediately.
DISABL	The point has been disabled.	Service and re-enable the point.
DUAL ADDRESS	There is more than one device of a single type (detector or module) with the same SLC address. A detector and a module can share the same address on an SLC, but two detectors, or two modules, can not. Not that some addressable devices (e.g. certain power supplies and RFxs) may not appear to be detectors or modules, but are addressed on the SLC as such.	Readdress the incorrect device.
GNDFLT	There is a ground fault on the main or auxiliary power supply.	Correct the fault.
HI BAT	The auxiliary power supply's battery charge is too high.	Check the batteries for problems. Replace batteries if necessary.
INVREP	The device has returned a response to the panel that the panel did not expect.	Check the device for functionality, addressing and wiring.
IR TBL	The infrared element is not working properly on the detector. (This trouble generates in FlashScan mode only. CLIP mode will generate a LO VAL error.)	Replace the detector.
LO BAT	The auxiliary power supply's battery is low.	Check the batteries for problems. Replace batteries if necessary.
LO TEMP	The temperature read by a Heat+ or Accclimate™+ detector is too low.	Raise the heat in the area of the detector.
LO VAL	The detector chamber reading is too low; the detector is not operating properly. Or (CLIP Mode only) the thermistors, CO element, or infra-red element on the detector is not working properly, or they are experiencing a freeze warning.	The detector must be removed and replaced by an authorized service representative.
NO ANS	The device (module or detector) is not responding to the poll. Either the device is not working or it is not connected properly.	Determine whether the device is functional, and connected and addressed properly on the SLC.
NO SIG	The device (module or detector) is not responding to the poll. Either the device is not working or it is not connected properly.	Determine whether the device is functional, and connected and addressed properly on the SLC.
OPEN	The module device has an open circuit on its supervised wiring.	Check the connections from the module to the input or output device to which it is wired.
PRLOSS	The output module or new sounder base lost power.	Turn power back on.
PSFAIL	The power supply is not working properly.	Check the battery for problems. Replace battery if necessary.
SHORT	The module device has a short circuit on its supervised wiring.	Check the connections from the module to the input or output device to which it is wired.
TEST F	This detector has failed the FACP's periodic detector test for alarm capabilities.	The detector should be removed and replaced by an authorized service representative.
*This trouble may be fire panel or backup battery related. Test and replace backup batteries if necessary.		
THERM	The thermistors are not functioning properly on the detector. (This trouble generates in FlashScan mode only. CLIP mode will generate a LO VAL error.)	Replace the detector.
VER HI	This detector, which has been programmed to participate in alarm verification, has gone into and come out of verification its programmed limit without going into alarm. Either something is wrong with the detector or there is a condition nearby (such as someone smoking) that causes it to go into verification frequently.	Check the detector and the conditions nearby to determine the problem.

Figure 60: FACP Point(Device) Troubles

5.6.3 FACP System Troubles

When a system trouble occurs, a message from the "Trouble Type" column in the following table will appear in the upper right corner of the panel display. The operator can refer to this table to help determine the nature of the trouble.

SYSTEM TROUBLES		
TRouble MESSAGE TYPE	TRouble DESCRIPTION	ACTION
AC FAIL	The main power supply has lost AC power.	Determine whether there is an AC power loss or whether the power supply and wiring is correct.
ADV WALK TEST	There is an Advanced Walk Test in progress.	No action is required.
ANNUN <u>x</u> NO ANSWER	The annunciator at address <u>x</u> is not responding.	Determine whether the device is functional, and connected and addressed properly.
ANNUN <u>x</u> TROUBLE	The annunciator at address <u>x</u> is in trouble.	Determine if the ACS module is functional, correctly installed, and configured properly.
AUXILIARY TROUBLE	An auxiliary device connected to the NFS-320 at J6 is in trouble or the cable is missing.	Check the wiring and source.
BASIC WALK TEST	A Basic Walk Test is in progress.	No action is required.
BATTERY	The main power supply's battery charge is too high or too low.	Check batteries, replace if necessary.
BAT.BACKUP RAM	RAM battery backup is low.	Replace battery.
CHARGER FAIL *	The main power supply's battery charger is not working properly.	Correct the fault.
CORRUPT LOGIC EQUAT	The database that houses the panel's logic equations is corrupt. It must be re-downloaded, or all programming must be cleared and re-entered.	The database must be re-downloaded, or all programming must be cleared and re-entered.
DRILL ACTIVATED	Drill has been initiated.	No action is required.
EPROM ERROR	The application and/or boot code is corrupt.	Service is required.
EXCEEDED CONN. LIMIT	More than two panels have been connected to a high-speed network communications module.	Remove extra panel(s).
EXTERNAL RAM ERROR	The external RAM test failed.	Service is required.
GROUND FAULT	A ground fault has occurred within the panel.	Locate the ground fault and repair.
GROUND FAULT LOOP <u>x</u>	There is a ground fault on loop <u>x</u> .	Locate the ground fault and repair.
HS-NCM SNIFFER ACTIV	The HS-NCM is in a diagnostic mode.	No action is required.
INTERNAL RAM ERROR	The internal RAM test failed.	Service is required.
LCD80 SUPERVISORY	Communication has been lost with the LCD-80.	Check connections to the LCD-80 Annunciator.
LOADING.NO SERVICE	A program or database download is in progress. The panel is NOT providing fire protection during the download. P	Proper authorities should be notified while a download is in progress so that other means of fire protection can be supplied.
MASTER BOX TROUBLE	A TM-4 connected to a municipal box is in trouble.	Reset the master box.
MASTER BOX NO ANSWER	A TM-4 connected to a municipal box is not responding.	Determine whether the device is functional and connected properly.

Figure 61: FACP System Troubles

SYSTEM TROUBLES		
TROUBLE MESSAGE TYPE	TROUBLE DESCRIPTION	ACTION
*This trouble may be fire panel or backup battery related. Test and replace backup batteries if necessary.		
NCM COMM FAILURE	Communication is lost between the NFS-320 and the network communications module.	Check to see if the NUP cable is properly installed and the network communications module is functional.
NETWORK FAIL PORT x	Communication lost between NCM Port x and corresponding node.	Check wiring and verify the node is online.
NETWORK INCOMPATIBLE	The brand of this panel is incompatible with this network.	Verify all nodes are branded for the same OEM.
NFPA 24HR REMINDER	This message occurs every day at 11 am if any troubles exist.	Resolve any troubles on the system.
NO DEV. INST ON L1	No devices are installed on the system.	Install SLC and run autoprogram.
PANEL DOOR OPEN	The panel door is open.	Close door.
POWER SUPPLY COMM FAIL	There has been a communication failure with the power supply.	Service is required.
PROGRAM CORRUPTED	The database that houses the panel's programming is corrupt.	The database must be re-downloaded, or all programming must be cleared and re-entered. Service is required.
PROGRAM MODE ACTIVATED	A user is currently accessing the panel's programming menus.	No action is required / Exit the Programming mode.
RELEASE DEV. DISABLE	Releasing devices have been disabled.	Enable the devices.
SELF TEST FAILED	Diagnostic test failed.	Call Technical Services.
STYLE 6 POS. LOOP x	There is an open circuit on the positive side of loop x. Style 6 and Style 7 are supervised methods of communicating with addressable devices. If the control panel detects a trouble (open), it will drive both ends of the loop, maintaining communication in an unsupervised method. The latching trouble will display on the panel as a Style 6 trouble until you correct the condition and press RESET. Style 7 configuration of the SLC requires the use of ISO-X modules.	
STYLE 6 NEG. LOOP x	There is an open circuit on the negative side of loop x. Style 6 and Style 7 are supervised methods of communicating with addressable devices. If the control panel detects a trouble (open), it will drive both ends of the loop, maintaining communication in an unsupervised method. The latching trouble will display on the panel as a Style 6 trouble until you correct the condition and press RESET. Style 7 configuration of the SLC requires the use of ISO-X modules.	
STYLE 6 SHORT LOOP x	Style 6 and Style 7 are supervised methods of communicating with addressable devices. If the control panel detects a trouble (open or short), it will drive both ends of the loop, maintaining communication in an unsupervised method. The latching trouble will display on the panel as a Style 6 trouble until you correct the condition and press RESET. Style 7 configuration of the SLC requires the use of ISO-X modules.	
SYS INITIALIZATION	The devices are initializing.	No action is required, as the trouble will clear when initialization is completed. However, the devices will not report off-normal events while this trouble exists.
TERMINAL SUPERVISORY	There is a communication error with the CRT-2.	Check connections to the CRT-2 terminal.
UDACT NO ANSWER	The UDACT or UDACT-2 is not responding.	Determine whether the UDACT/UDACT-2 is functional, and connected and addressed properly.
UDACT TROUBLE	The UDACT or UDACT-2 is in trouble.	Determine if the UDACT/UDACT-2 is functional and wired correctly.

Figure 62: FACP System Troubles

5.7 HVAC & Chiller

5.7.1 Inspection and Measures to be taken when alarm occurs.

If the HVAC or chiller stop operation by fault alarms, please contact LG Energy Solution for assistance.

During the HVAC and Chiller malfunction, do not open the door of the M-LINK until the it has been repaired to prevent condensation of the pack.

If it is absolutely necessary to open the door, please install the temperature and humidity sensor inside the M-Link to record the temperature and humidity data during the time the door is open.

And make sure that the HVAC runs at least one day to dehumidify inside the M-LINK sufficiently before operating the system.

For more information, HVAC/Chiller manual written by HVAC/Chiller manufacturer is located in the box installed on the E-Panel door. Detailed procedures and actions are specified in the document.

APPENDIX A. Periodic Maintenance Check (Every half a year)

Every half a year Inspections				
Date :		Number/Serial number :		Inspector :
				Sign :
Part	Object	Item	Criteria	Result
M-LINK	Enclosure	Appearance	1) No Corrosion or dent on the enclosure 2) Check the abnormality of door sealing	
		Grounding Cable	1) No visible damage, corrosion, or wear on the grounding cable? 2) No looseness of the grounding connection 3) Door Grounding cable is pointing downward?	
	HVAC	Appearance	1) The unit is clean and dust-free and free of dirt 2) There is no dust in the fan and no foreign matter blockage at the air inlet.	
		Terminals of wiring Panel		
		Operational Reliability of fan		
		Condensate drain		
		Condensate cleaning		
		Evaporator cleaning		
	Chiller	Appearance	1) The liquid cooling unit is clean and dust-free and free of dirt 2) There is no dust in the fan and no foreign matter blockage at the fan/condenser	
		Terminals of wiring panel		
		Circuit breaker check		
		Operational reliability of fan		
		Condenser cleaning		
	Cooling Pipe	Pipe Line Assembly Check	1) Check whether the connection points are loose and damaged 2) Check any other leakage occurred (The color of coolant is neon pink). 3) Inspect the I-torque mark for every M-LINK's coolant pipe 4) If the torque mark is not aligned, it should be fastened and mark again through the torque wrench.	
	Rack & Comm device	Cable Connections	Check whether pack-to-pack connection cables are securely locked	
		Communication Cables	No visible damage on pack-pack comm cables / Ethernet cables	
		BPU Fan	Check whether the fan is clean and free of dirt	
		BPU Cable Connections	1) Check whether there is no visible damage on BPU power cable 2) Check the power terminal block is securely installed.	
	Fire Safety	Smoke Sensor & Gas Sensor	Check the status of gas/smoke sensors → If the gas sensor LEL data over 1.0, calibrate the gas sensor of it	

Every half a year Inspections					
Date :		Number/Serial number :		Inspector :	Sign :
	System	FACP	Check whether there is any alarm in FACP		
		Horn & Strobe	Clean and check the horn& Strobe		
		Ventilation Door Opening (3 Months recommended)	In BSC browser and entering manual mode of BSC, check whether roof exhaust vents and intake fand operates or not.		
E-Panel	Enclosure	Appearance	No Corrosion or dent on the enclosure		
	HVAC	Appearance	1) The unit is clean and dust-free and free of dirt		
		Terminals of wiring Panel			
		Operational Reliability of fan	2) There is no dust in the fan and no foreign matter blockage at the air inlet.		
		Condensate drain			
		Condensate cleaning			
	Electrical Component	DC Main Circuits	Check the loose terminals or any deformation, burned mark in DC main circuits		
		Aux Power Circuits	Check the loose terminals or any deformation, burned mark in Aux power circuits		
		Protection Relay	Visual check overall protection relay (MCCB,MCB,CP) by referring to figure 8 Check the status of relay and any burned or deformation mark.		
		Indicators & Lamp	Check the M-LINK and E-Panel lamp operates and Indicator for DS in E-Panel		
		UPS & UPS battery	Check the UPS status lamp is green And battery status by checking UPS battery lamp		
		SPD	1) Check the DC SPD status by indicator 2) Check the AC SPD status by indicator		
		Aux TR	Check any signs of discoloration, cracks, or bulges on the insulation material		

APPENDIX B. Periodic Maintenance Check (Every year)

Every year Inspections				
Date :		Number/Serial number :		Inspector :
				Sign :
Part	Object	Item		Criteria
M-LINK	Enclosure	Abnormal Condition		Check the any abnormal noise and temperature or condensation
		Locking Rod, Cam		Check M-LINK Door locking rod is well operated
		Warning Label		Clean the warning labels
		Flammable & Foreign object		Check whether flammable or foreign object around DC-LINK
		Anchors and/or Welding Points		Check corrosion or crack in Anchoring bolt or welding status
	HVAC	Check System Alarm		Check the HVAC alarm history
	Chiller	Coolant maintenance		Measure the coolant PH by following 3.4.3.3 PH value less than 7.5
		Check System Alarm		Check the Chiller alarm history
	Rack	BPU Contactor function tests		Check the main contactors of BPU working properly
	Fire Safety System	Gas Sensor Calibration		Check the main contactors of BPU working properly
		Linkage Test	Smoke Sensor & Gas Sensor	Follow the linkage test by following 3.4.1.1
			FACP	
			Ventilation System	
			Horn & Strobe	
E-Panel	Electrical Component	DS operation		Check the operation of Disconnect Switch and check the status
		Insulation Check of DC Main Circuits		Insulation resistance over 30MΩ between DC main circuit to GND *Must remove DC SPD
		Insulation Check of AC Power Circuits		Insulation resistance over 30MΩ between 1) AC aux circuit(L1,L2,L3) to GND 2) Between each phase(L1-L2 / L2-L3 / L3-L1) *Must remove AC SPD or Turn off MCCB of it
		UPS battery		Voltage over 24Vdc for UPS 1-3
		FACP battery		Voltage over 10.8Vdc for each battery (2 battery installed in FACP)

APPENDIX C. Acronym

Table 24: Acronyms and abbreviations

Acronyms and abbreviations	Description	Acronyms and abbreviations	Description
AUX	Auxiliary power	HVAC	Heating, Ventilation, & Air conditioning
M-LINK	Modular LINK	SMPS	Switching Mode Power Supply
BMS	Battery Management System	MCCB	Molded Case Circuit Breaker
BPU	Battery Protection Unit	PCS	Power Conversion System
BSC	Battery System Controller	PLC	Programmable Logic Controller
Comm.	Communication	PPE	Personal Protective Equipment
E-Panel	Electric Panel	TR	Transformer
CP	Circuit Protector	UPS	Uninterruptible Power Supply
DS	Disconnect Switch	EMS	Energy Management System
EOL	End of Life	E-Stop	Emergency Stop
E-PLC	PLC in E-Panel	FACP	Fire Alarm Control Panel

Revision History

Version	Date	Change Description
1.0	Jul.26.2024	Initial Release
2.0	Nov.04.2024	Update overall image by changing the design Update Appendix contents for periodic maintenance check lists Update Gas sensor / Cooling pipe / Coolant maintenance Update Fire system linkage test procedure
3.0	Jan.21.2025	Update the SOC Recalibration/Cell Balancing condition for the maintenance of the battery. Update the Skid Cable Replacement Update troubleshoot guidance of HVAC/Chiller
4.0	Jan.23.2025	Update the image of E-Panel Update the voltage check of UPS/FACP battery
5.0	Mar.05.2025	Update E-Panel Maintenance guide below <ul style="list-style-type: none"> - SPD Installation and Status - UPS/FACP Battery replacement guide - UPS Status check and maintenance - UPS By-Pass mode Update M-LINK Maintenance guide below <ul style="list-style-type: none"> - Drainage Tank in SKID
6.0	Apr.07.2025	Update the Image of M-LINK
7.0	Apr.29.2025	Update the 2.2.1 UPS & FACP Battery Circuit Protector and MCB Switch Close
8.0	Jun.23.2025	Update the Appendix A. Periodic maintenance check(Every half a year) criteria. Update the Appendix B. Periodic maintenance check(Every year) criteria. Update the 3.2.2 Every half year inspections and 3.2.3 Every year inspections Update the cooling pipe maintenance detail in 3.4.3.2 Cooling Pipe
8.1	Jul.11.2025	Add 1.5 Operation & Maintenance Tools (by LGES) Update the detail sequence of 2.2 Power-On DC LINK .

		Change the location of LOTO Process from 3.3.5 to 2.2.8 LOTO Process Add 2.2.8.3 FACP MCB Locking Installation in E-Panel
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Document ID	Document Name	Version
-	Codes and Standards List	V1.0
Author	Reviewer	Approver
Juno Sohn	Jinman Kim	Hoeguk Jung

JF2 DC-LINK 0.25CP

Codes and Standards List

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Revision History

[illegible]

<JF2 DC-LINK 0.25CP - Codes and Standards List>

Publisher	Code/Standard Number	Published Date	Code/Standard Title	Applicable Components
CA	California Fire Code (CFC)	2022	California Fire Code (CFC)	M-LINK, E-Panel
NFPA	NFPA 69	2024	Standard on Explosion Prevention Systems	M-LINK, E-Panel
NFPA	NFPA 72	2022	National Fire Alarm and Signaling Code	M-LINK, E-Panel
NFPA	NFPA 855	2023	Standard for the Installation of Stationary Energy Storage Systems	M-LINK, E-Panel
UL	UL 1973	2022	Standard for safety - Batteries for Use in Stationary and Motive Auxiliary Power Applications	Pack, Rack
UL	UL 9540A	2019	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	Unit (Rack)
UL	UL 9540	2023	Standard for safety - Energy Storage Systems and Equipment	M-LINK, E-Panel
UL	UL 1741	2021	Standard for safety - Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources	E-Panel
UN	UN 38.3	2023	Transportation Testing for Lithium Batteries and Cells	Cell, Pack
UN	UN 3480	-	Lithium-ion batteries	Pack
UN	UN 3536	-	LITHIUM BATTERIES INSTALLED IN CARGO TRANSPORT UNIT lithium ion batteries or lithium metal batteries	M-LINK

DC LINK Specification

JF2 DC LINK 5.1



Document No :	F2D4-5.1US-GN04
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1. System Description

This document is the product specification for JF2 DC LINK 5.1 (hereinafter “DC LINK”) of LG Energy Solution (hereinafter “LGES”). DC LINK is a BESS solution containing all the components of a BESS within a single product, including batteries, battery protection unit, liquid cooling, EMS, and more. Systems are conveniently designed to reduce construction costs and maximize uptime, energy density, and efficiency.

The DC LINK is designed with a modular enclosure tailored to the optimal size per project specifications. By preventing oversizing, this approach minimizes the number of enclosures, resulting in reduced CAPEX costs for customers.

Safety is key in each part of our system design. The DC LINK is designed for tomorrow’s rigorous safety codes and standards, streamlining permitting and approval processes. JF2 Solution’s modular design minimizes propagation between M-LINKs

1.1 Application

The DC LINK is an innovative solution applicable to a wide range of customer business areas, including peak shaving and frequency regulation. LG Energy Solution’s design engineers provide in-depth pattern analysis and customized project proposals to help customers achieve maximum revenue with optimized CAPEX.

1.2 Capacity Maintenance

For each DC LINK, E-Panel and M-LINKs are installed on a SKID structure. The DC LINK system provides the most optimized system sizing with its flexible number of M-LINKs per the SKID. The following figure illustrates the typical sizing and augmentation configurations available:



Figure 1: Augmentation Capability

1.3 Components

The DC LINK consists of three main components: M-LINK, SKID, and E-Panel.

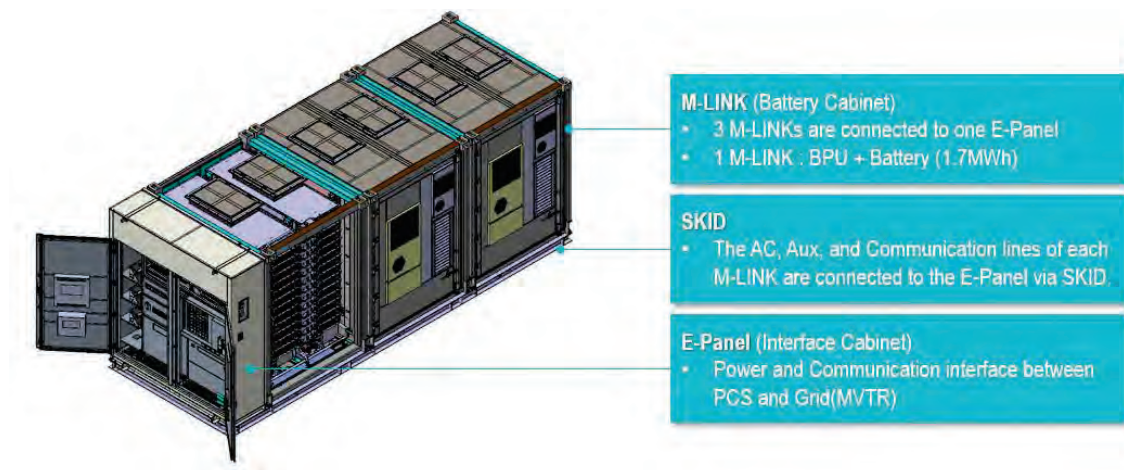


Figure 2: DC LINK Components

1.4 Definitions

Key Words	Description
JF2 DC LINK	Integrated System of M-LINK, SKID, and E-Panel offered by LG Energy Solution.
E-Panel	Distribution Panel between the PCS and M-LINK. It houses protective devices such as fuses and disconnect switches, as well as communication equipment that enables monitoring and control of the connected systems.
M-LINK	Containerized Structure that houses various components, including battery packs, BPU, chiller, and HVAC system.
SKID	Structure that supports E-Panel and M-LINKs. It also serves as a passage for power lines and communication cables, protecting them from the external environment.
JF2 DC LINK 3.4	System Configuration with two M-LINKs mounted on a skid.
JF2 DC LINK 5.1	System Configuration with three M-LINKs mounted on a skid.
Pack	A unit that combines battery cells for protection against physical shock from the external environment and enables specific functions. It is the product unit of a battery that includes cells, BMS, and electrical components.
BPU	Battery Protection Unit, Device that safeguards the battery from factors that could adversely affect its hardware, such as overcurrent or short circuits.
Thermal Management System	System that manages the internal temperature of M-LINK, including the chiller and HVAC.
CP-rate (Constant Power Rate)	Charging and discharging rate of a battery based on power. For instance, 0.25CP indicates that when 1MWh of battery system is installed, the maximum charge and discharge power is 0.25MW.
RTE	Round Trip Efficiency, the ratio of the amount of energy charged to a battery to the amount of energy discharged from the battery, expressed as a percentage.
Energy Consumption	The amount of energy required for ESS operation.
Ambient Temperature	The temperature of the air surrounding the JF2 DC LINK.
Usage Pattern	Information that describes how customers typically charge and discharge batteries in projects.
SOC	The remaining battery capacity relative to its full capacity, expressed as a percentage.

1.5 Codes and Standards

JF2 DC LINK complies with the following codes and standards.

Publisher	Code/Standard Number	Published Date	Applicable Components
ASCE	ASCE 7-22	2022	DC LINK
OSHA	29 CFR 1910.95	2024	M-LINK, E-Panel
CFR	47 CFR Part 15 Subpart B	2024	DC LINK
ICC	International Fire Code (IFC)	2024	DC LINK
CA	California Fire Code (CFC)	2022	DC LINK
Phoneix City	Phoenix Fire Code (PFC)	2018	DC LINK
NFPA	NFPA 69	2024	DC LINK
NFPA	NFPA 70	2023	DC LINK
NFPA	NFPA 70E	2024	DC LINK
NFPA	NFPA 72	2022	DC LINK
NFPA	NFPA 855	2023	DC LINK
UL	UL 268	2023	M-LINK, E-Panel
UL	UL 864	2020	M-LINK, E-Panel
UL	UL 2075	2023	M-LINK
UL	UL 1973	2022	Cell, Pack, Rack
UL	UL 9540A	2019	Cell, Pack, Unit (Rack)
UL	UL 9540	2023	DC LINK
UL	UL 1741	2021	E-Panel
UN	UN 38.3	2023	Cell, Pack
ISO	ISO 13849	2023	Rack
ISO	ISO 12944	-	M-LINK, E-Panel
IEC	IEC 60529	2013	M-LINK, E-Panel
IEC	IEC 61000-6-2	2016	Rack
IEC	IEC 61000-6-4	2018	Rack

2. Technical Specifications

2.1 Power and Energy

The following table shows the Power, Current, and Voltage values for different combinations of E-Panel and M-LINK quantities in a Power Block:

Table 1: Electrical Specification per DC LINK Configuration

Item	Value							
E-Panel Quantity	1 EA		2 EA			3 EA		
M-LINK Quantity	2 EA	3 EA	4 EA	5 EA	6 EA	7 EA	8 EA	9 EA
Max. CP-rate	0.25 CP							
Total Energy	3.4 MWh	5.1 MWh	6.8 MWh	8.5 MWh	10.2 MWh	11.9 MWh	13.6 MWh	15.3 MWh
Max. Power	0.85 MW	1.27 MW	1.7 MW	2.13 MW	2.55 MW	2.98 MW	3.4 MW	3.8 MW
Max. Current	751.3A	1,126.9 A	1,502.6 A	1,878.3 A	2,253.9 A	2,629.6 A	3,005.2 A	3,380.9 A
Operating Voltage	1,134~1,499.4 VDC							
Nominal Voltage	1,344 VDC							

2.2 Round Trip Efficiency

RTE (Round Trip Efficiency) varies depending on the battery life at the time of measurement. If necessary, LG Energy Solution engineers can help customers determine the appropriate RTE value for customer's project. The following Figure 3 shows the annual RTE values for different power that customers may use:

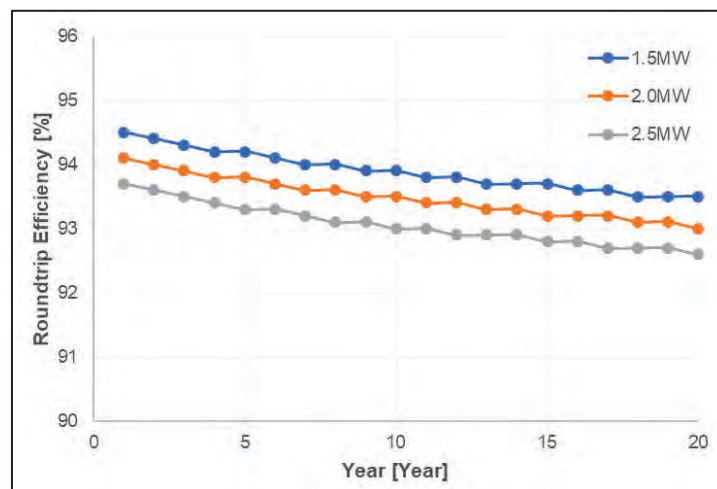


Figure 3: RTE Changes Over Time by Power (1.5MW, 2.0MW, 2.5MW /10.22MWh)

2.3 Energy Consumption

The full load power of the DC LINK is defined at the AC input terminals and includes the power consumption of the thermal management system, BMS, and other components. Losses between AC output terminals and the point of interconnection with utility vary depending on the site and are not included.

Table 2 shows the full load power. Customers can use this information for overall system design and power infrastructure planning. However, these figures are not always in use; they are based on the condition when all components are operating at maximum load.

Table 2: Full Load Power

Component	Full Load Power [kW]	Remark
M-LINK (3EA)	19.3	Chiller/HVAC BMS Others
E-Panel	2.2	HVAC FACP Controller Others
Total	21.5* (22.8kVA)	

* 480Vac input inlet power

Actual energy consumption varies depending on the specific charge and discharge patterns used. LG Energy Solution engineers work closely with customers to provide optimal system designs that reflect these patterns.

For customer usage patterns involving standby at 30% SOC followed by charging and discharging, the energy consumption is as follows:

Table 3: Energy Consumption at different outdoor temperature and operation

Outdoor Condition	Operation	Average Aux Power [kW]	Duration [hours]	Energy Consumption [kWh]	Daily Energy Consumption [kWh/day]
Winter -30°C	Charge	8.07	4.0	32.28	144.00
	Discharge	7.89	4.0	31.56	
	Standby*	5.01	16.0	80.16	
Moderate	Charge	9.44	4.0	37.77	174.19

25°C	Discharge	9.41	4.0	37.65	
	Standby	6.17	16.0	98.77	
Summer 50°C	Charge	13.47	4.0	53.88	249.24
	Discharge	15.36	4.0	61.44	
	Standby	8.37	16.0	133.92	

* standby : the state of a battery when it is not being charged or discharged.

- Outdoor Condition
 - Winter(-30°C): Climate information from Montreal, Canada, with an ambient temperature of at least -30°C, was incorporated into the simulation.
 - Moderate(25°C): An ambient temperature of 25°C was assumed for 24hours.
 - Summer(50°C): Climate information from Yuma, Arizona, with an ambient temperature of up to 50°C, was incorporated into the simulation.
- Usage Pattern

1 cycle/day, 0.25CP Charge/Discharge, 2hrs rest @ high SOC, 2hr rest @ low SOC

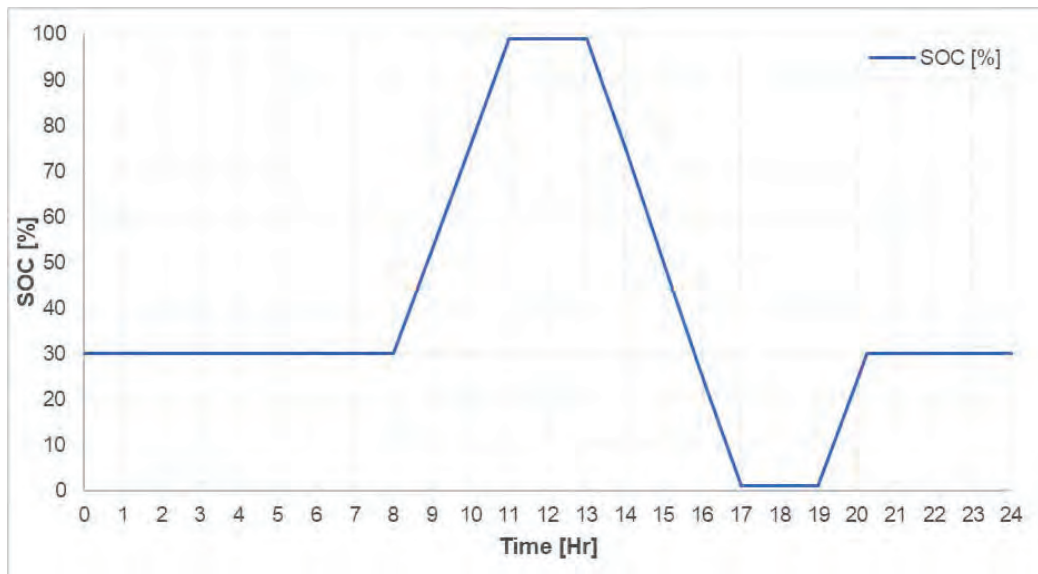


Figure 4: Assumed Usage Pattern

2.4 Charge and Discharge Limitations

The thermal management system of the DC LINK ensures that the battery can be charged and discharged stably within the rated temperature range.

If the battery has been stored for a long period in a place with inadequate temperature control, immediate charging or discharging can have a negative impact on battery performance. The thermal management system prevents this by pre-heating the temperature of the cells inside the M-LINK before starting charging and discharging.

Table 4: Energy Consumption at different starting temperature

Starting Temperature*	Time to Full Charge / Discharge Power Capability	Preheat Energy Consumption to Full Charge / Discharge Power Capability
10°C	4 hours	60 kWh
0°C	11 hours	150 kWh
-10°C	18 hours	250 kWh
-20°C	25 hours	350 kWh

* *Starting Temperature: the ambient temperature of the area where the DC LINK is placed. Assuming the worst-case scenario, the ambient temperature and battery cell temperature are considered to be equal.*

2.5 Environmental Specification

2.5.1 Ambient Temperature & Humidity

Due to the temperature control function of the thermal management system, the DC LINK can operate within the following ambient temperature and humidity range regardless of altitude:

- -30°C to 50°C
- 5 ~ 100 RH%

The storage temperature range* shall be:

- -20°C to 45°C (Before aux. power supply)
- -30°C to 50°C (After aux. power supply)

* *the period of storage environmental conditions is subject to the standard warranty provided by LG Energy Solution.*

2.5.2 Altitude

The DC LINK maintains its specified performance levels without degradation up to an altitude of 2,000 meters.

2.5.3 Seismic

The DC LINK is designed to meet the seismic performance requirements of Sds 1.2 (with 8 anchor brackets fixed), and Sds 1.5 (with 14 anchor brackets fixed) when subjected to Risk Category III criteria as defined in ASCE 7-22.

2.5.4 Wind

The DC LINK boasts specifications robust enough to withstand wind speeds of up to 200mph, far exceeding the intensity of even a Category 5 hurricane(157mph)

2.5.5 Snow

The DC LINK is able to withstand a snow load limit of no less than 144.5[lb./ft²] on its roof or other surface.

2.5.6 Shock and Vibration

The DC LINK maintains ample safety margins when subjected to Transportation Analysis, employing the Air cushion 18,000[lbs.] specified in ASTM-D4728-01 Standard Test Method Specification.

2.6 Mechanical Specification

2.6.1 Dimensions and Mass

The DC LINK is fully assembled into SKID units at LG Energy Solution factory and transported to the site. The dimensions and mass of three M-LINKs and E-Panel are as follows:

Table 5: DC LINK Dimensions and Mass (Weight)

Width	Depth	Height	Product Mass
7,170 mm (282.28 in)	2,570 mm (101.18 in)	2,896 mm (114.02 in)	< 48 ton (105,822 lbs.)

2.6.2 Transportation

The DC LINK is fully assembled on a SKID for transportation. Therefore, no disassembly is required for transportation. It can be simply installed after being positioned according to the site drawings.

2.6.3 Enclosure

2.6.3.1 Ingress Protection

The DC LINK, including its thermal management system, has an IP 55 rating.

2.6.3.2 Protection against Salt and Fog

The DC LINK has demonstrated its electrical insulation performance by passing a test based on the IEC 60068-2-52 standard, as defined in UL9540 3rd edition Section 41.3 (Outdoor installation in marine environments)

2.6.3.3 Corrosion Resistance and Paint

The paint of JF2 DC LINK is compliant with ISO 12944: C4H standards. The color code is RAL7035.

2.6.3.4 Audible Noise

When the thermal management system is operating at maximum performance, the DC LINK's noise level is less than 75dB at a distance of 1 meter in all directions.

3. Communication and Control

As illustrated in the accompanying figure, the DC LINK system comprises up to three M-LINKs per E-Panel. According to PCS specifications, each PCS can be configured with up to three E-Panels and nine M-LINKs.

The PCS is connected to each E-Panel through the main power cable, enabling it to control the charging and discharging of the battery. Auxiliary power is supplied from the utility to each E-Panel, and then separately branched to the M-LINK from the E-Panel.

The network switch installed in E-Panel#1-1 facilitates communication between EMS, PCS and other E-Panels by gathering information from them. BSC, installed only on the first E-Panel, functions to monitor and control the battery information of the entire JF2 DC LINK system.

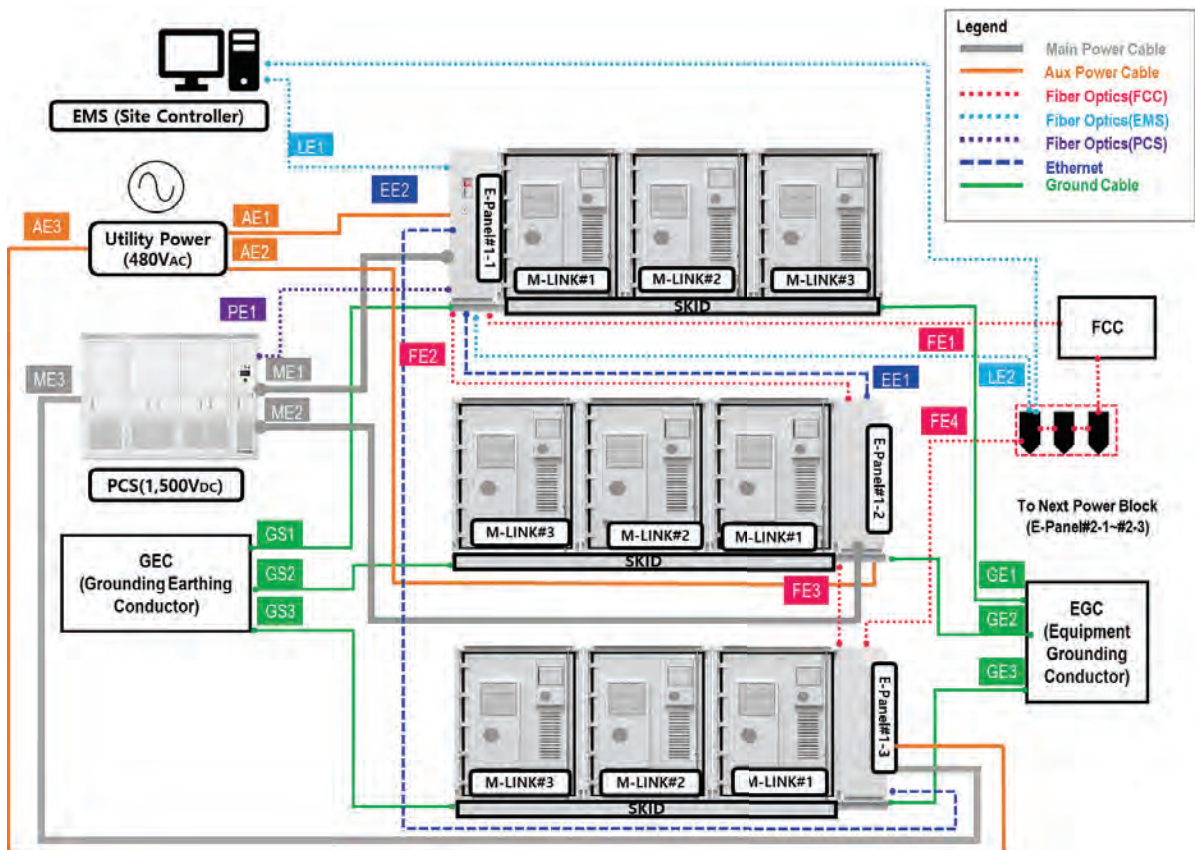


Figure 5: DC LINK System Network Diagram (Three DC LINKs in a Power Block)



Note

Above image is for reference purpose only. Actual image and connection may be different depending on the models and the system configuration. For detailed and precise connection information, please refer to F2D4-5.1US-SP08_DC LINK Cable Schedule

Revision History

Version	Date	Change Description
1.0	07/19/2024	Initial Release
2.0	10/30/2024	<p>Section 1.2 Capacity Maintenance : Figure 1 (Augmentation Capability) image updated</p> <p>Section 1.3 Components : Figure 2 (DC LINK Components) image updated</p> <p>Section 1.5 Codes and Standards updated</p> <p>Section 2.2 Round Trip Efficiency : Figure 3 (RTE Changes Over Time by Power) image updated</p> <p>Section 2.3 Energy Consumption : Table 2 (Full Load Power) newly added : Pattern applied to the calculation of values in Table 3 (Energy Consumption at different outdoor temperatures and operation) changed, and the updated values have been reflected.</p> <p>Section 2.5.3 Seismic : the Sds value for using 14 anchor brackets is additionally updated</p> <p>Section 2.5.5 Snow updated</p> <p>Section 2.6.1 Dimensions and Mass : Product mass in Table 4 (DC LINK Dimensions and Mass) updated</p> <p>Section 3. Communication and Control : Figure 5 (DC LINK System Network Diagram) image updated</p>
2.1	08/11/2024	<p>Section 2.2 Round Trip Efficiency : Figure 3 (RTE Changes Over Time by Power) image updated</p>
3.0	01/03/2025	<p>Section 1.5 Codes and Standards : Some codes and standards have been updated.</p>
4.0	01/15/2025	<p>Section 2.5.1 Ambient Temperature & Humidity : The storage temperature range has been revised.</p>
5.0	01/20/2025	<p>Section 2.6.3.4 Audible Noise : The noise level of the DC LINK has been updated.</p>

End of Document



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Approved	Description Energy module JF2 4P30S for long cycle (EP096636PFBA)		

Product Specification

Product name : Energy module JF2 4P30S for long cycle

Model name : EP096636PFBA (MI)

Revision history

[illegible]

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1. Summary

1.1 Application scope

This product specification sheet is prepared by LG Energy Solution and is for battery module for long cycle with peak shifting and renewable integration. The battery module is mounted on M-Link system and is installed in an area where air conditioning is worked.

1.2 Product name and Model name

1.1.1 Product name

JF2 4P30S for long cycle

1.1.2 Model name

EP096636PFBA (MI)

1.3 Cell specification

JF2		
Capacity	159.2 Ah	
Nominal Voltage	3.2 V	
Operating	2.5 ~ 3.65 V	
Energy	509.44 Wh	
Cycle Life	RT, 70%@6,000 Cycle	
Dimension	Thickness	17.8±0.3 mm
	Width	123.5±1.5 mm
	Length	600 (+1.0 / -1.5) mm
	Cell Lead	(+) : 45x33, 0.4t (-) : 45x33, 0.2t
Weight	2762±30g	
DCIR	0.708mΩ≤X≤1.208mΩ	

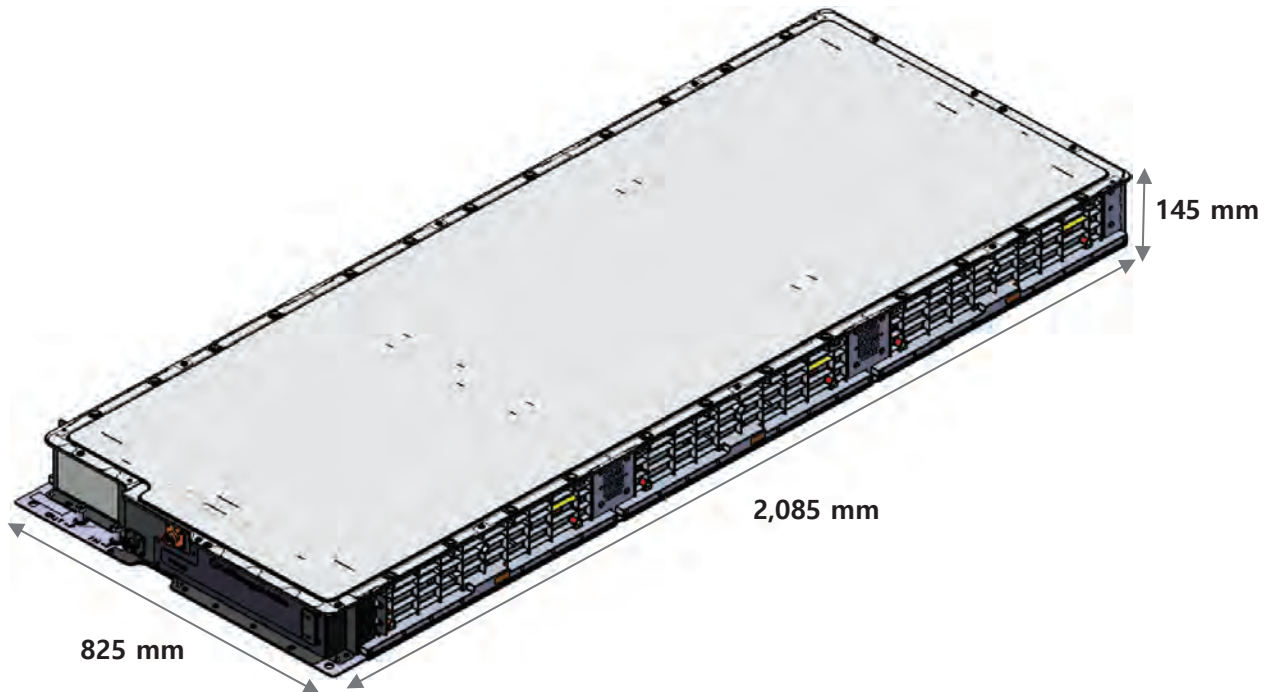
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1.4 Product appearance

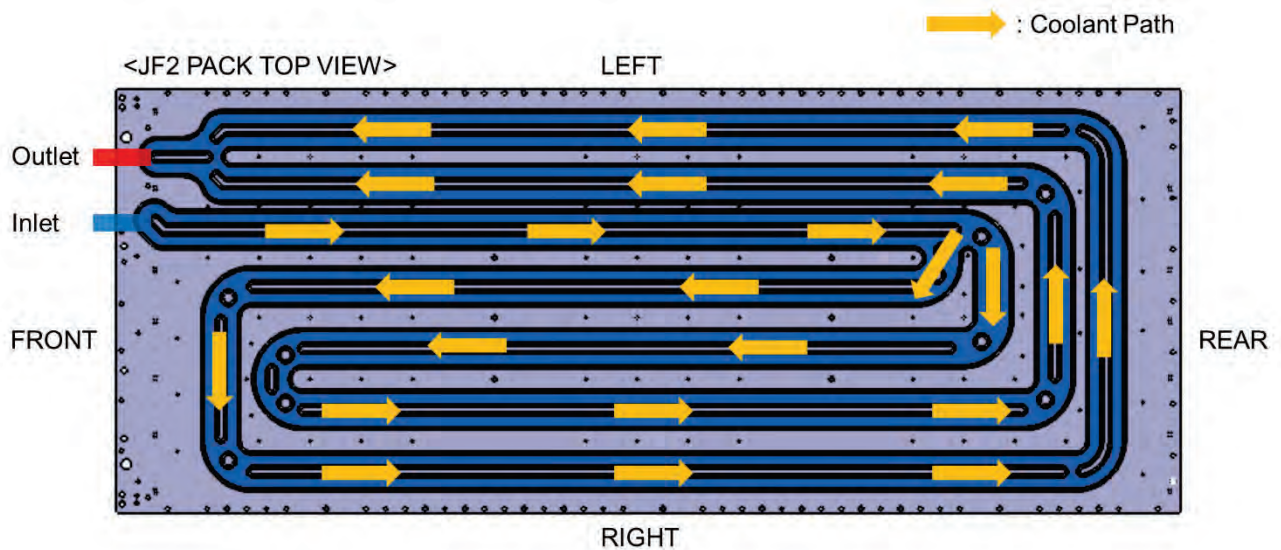
Depth : 2,085mm

Width : 825mm

Height : 145mm

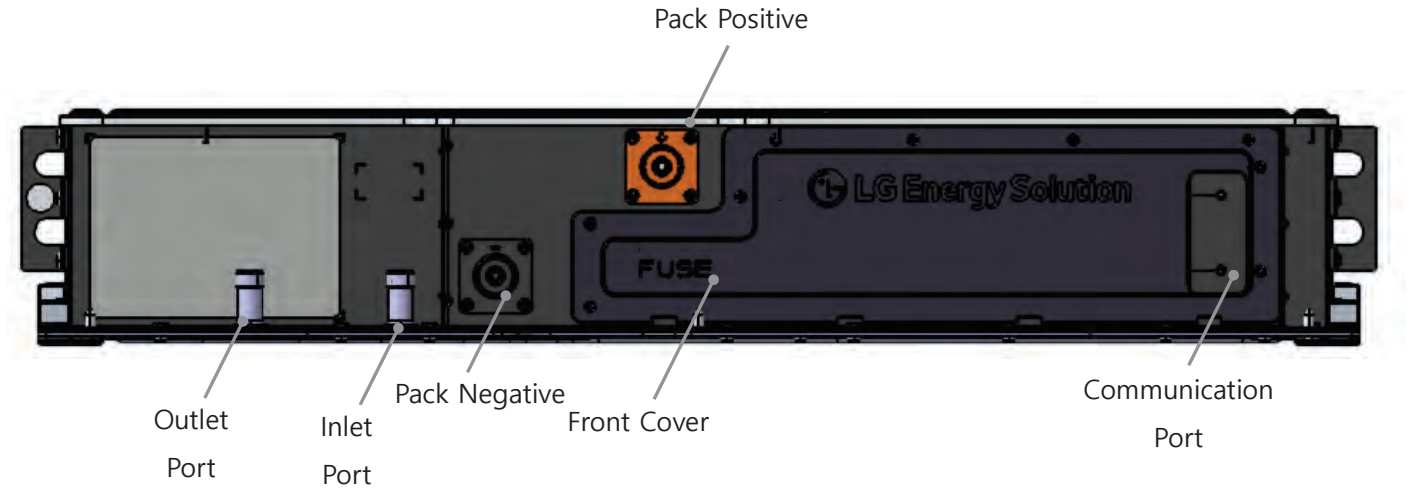


<Figure 1. Appearance dimension of module>



<Figure 2. Cooling path of module>

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	Power Connector P/N	제조사
(+)	1298082 (Orange)	PHOENIX CONTACT
(-)	1298081 (Black)	

<Figure 3. Module front view>

1.5 Label & Barcode

1.5.1 Attachment position



<Figure 4. Attachment position of Label>

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⚠ DANGER / HIGH VOLTAGE INSIDE
(DANGER / HAUTE TENSION INTÉRIEURE)

ESS Battery Pack

Model : EP096636PFBA
Battery type : Rechargeable Li-ion
Nominal voltage : 96 Vdc
Capacity : 636.8 Ah
Energy : 61130 Wh
Manufacturer : LG Energy Solution, LTD.
IP Rating : IP32
Made in USA
U - P - 1

cULus **FCC**

File No : MH49414

- * 인증된 정비 담당자 외에는 분해, 수리를 하지 마십시오.
- * 낙하, 충격, 날카로운 물체로 제품에 손상을 주지 마십시오. 파손 시 전해액 및 인화성 가스가 누출될 수 있습니다. 문제 발생시, LG 에너지솔루션으로 연락바랍니다.
- * 전해액이 눈 및 피부, 의류에 닿았을 경우 즉시 물로 씻어주십시오. 특히 눈의 경우 의사의 진료를 받으십시오.
- * 화기 및 인화 물질 가까이에서 사용하지 마십시오.
- * 낙수, 습기에 주의하십시오. 물기가 있을 경우 즉시 사용을 금해주십시오.
- * 고 출력 제품이므로 혼자서 작업하지 마십시오.
- * 어린이가 접촉하지 않도록 주의바랍니다.
- * 안전성을 위해 Rack System은 동일 색으로 구성되어야 합니다. 팩 전면의 QR바코드 색상이 같은 지 확인바랍니다.
- * 팩 전면의 브라켓으로 제품을 들지 마십시오.

- * Do not let unauthorized maintenance personnel repair or disassemble the product.
- * Do not damage the product with falls, shocks, or sharp objects. Failure to comply may result in electrolyte or flammable gas leaks. If damage occurs, please contact the LG Energy Solution.
- * If exposed to electrolyte, wash immediately with water. Seek medical attention, especially when contacted with eyes.
- * Keep away from fire and flammable materials.
- * Be cautious to water and moisture. Do not touch or use the product when it's wet.
- * Do not handle the product alone as it is a heavy product.
- * Keep the product out of reach of children.
- * For safety reasons, the Rack System must be configured with the same pack type. Please check if the QR barcode color on the front of the pack is the same.
- * Do not lift the product with a bracket on the front of the pack.


- * Ne pas démonter ou réparer à moins d'avoir du personnel d'entretien qualifié.
- * Ne pas endommager le produit par des chutes, des chocs ou des objets pointus ou tranchants. Le défaut de se conformer peut entraîner des fuites d'électrolytes et de gaz inflammables. En cas de problème, veuillez contacter de LG Energy Solution
- * Si l'électrolyte touche les yeux, la peau ou les vêtements, laver immédiatement avec de l'eau. Consultez un médecin.
- * Ne pas utiliser près du feu et des matériaux inflammables.
- * Attention aux chutes d'eau et d'humidité. S'il y a de l'humidité, n'utilisez pas de tentacules.
- * Ne pas travailler seul car il s'agit d'un produit lourd.
- * Faites attention de ne pas contacter votre enfant.
- * Pour des raisons de sécurité, le Rack System doit être configuré avec le même pack. Vérifiez si la couleur du code-barres QR sur le devant du pack est la même.
- * Ne pas soulever le produit avec un support de poignée sur le devant du pack.

<Figure5. Warning/Spec Label>

Item	PJT	Item	Production site	Subline	Year	Month	Day	Line	Serial number	Size
BMA	EP096636PFBA	B	S (MI) H (H2P) A (AZ, NB Cell) D (AZ, MI Cell)	A	YY	MM	DD	1	001	

<Figure 6. Pack QR Barcode system>

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Item	PJT	Item	Production site	Subline	Year	Month	Day	Serial number	Size
CMA	SM032636PFBA	C	S (MI) H (HZP) A (AZ, NB Cell) D (AZ, MI Cell)	A	YY	MM	DD	001	

<Figure 7. CMA QR Barcode system>

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1.5.2 Symbols



Caution, risk of electric shock.



Do not place nor install near flammable or explosive materials.



Wear eye protection and protective clothing when working with batteries.
Observe accident prevention regulations



Install the product out of reach of children



Read the instruction manual before starting installation and operation.



Electrolyte is highly corrosive.



Metal parts of the battery cell are always live. Never place foreign object or tools on the battery.



Heavy weight may cause serious injury to the back.



Do not dispose of the product with household wastes.



Recyclable.

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2. Product specification

2.1 Standard

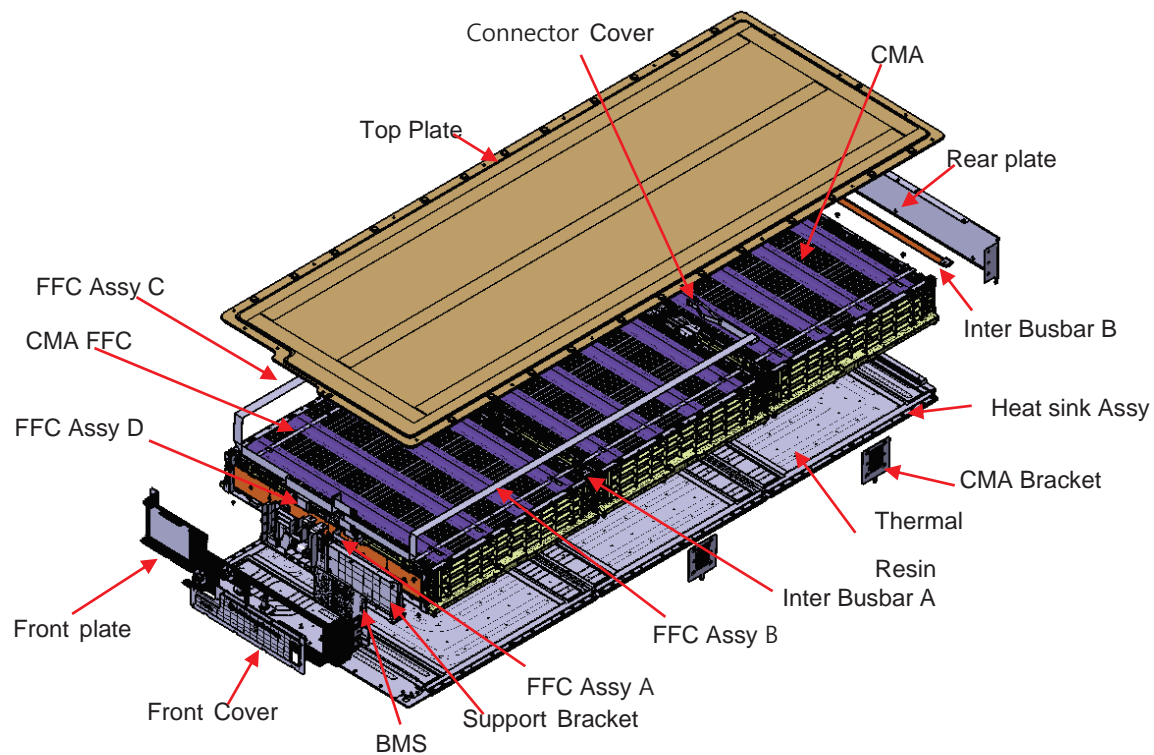
Electrical	
Cell / MBMS	JF2 / Gen3 PBMS
Configuration	4P30S
Capacity (Min)	636.8 Ah (Cell voltage 2.5~3.65V)
Voltage (Nominal)	96 V
Energy (Nominal)	61.13 kWh (0.25C)
Standard charge condition	CC, Charge : Charge current 159.2A (0.25C) End of charge voltage: 109.5 V or Any Cell > 3.65V
Standard discharge condition	CC, Discharge : Discharge current 159.2A (0.25C) End of discharge voltage : 75 V or Any Cell <2.5V
Max. Charge Power	15.283kWh (0.25CP) , Peak current 203.776A End of charge voltage : 109.5V or Any Cell > 3.65V
Max. Discharge Power	15.283kWh (0.25CP) , Peak current 203.776A End of discharge voltage : 75V or Any Cell <2.5V
Dielectric strength	4.15 kV
Pollution degree	3 (Basic)
Over voltage category	2 (Basic)
Environmental	
Operating temperature range	0 ~ 40 °C (Ambient temperature)
Operating humidity range	5 ~ 85 % RH (Non Condensing)
Recommended temperature range	Ordinary temperature (23±4 °C)
Storage temperature range (for shipping state)	~7days : - 30 ~ 60 °C
	~6month : -20 ~ 45 °C
Mechanical	
Ingress Protection level	32
Cooling Method	Liquid Cooling (Coolant EG50%) - Flow rate : 1.5LPM ↑ - Operating pressure : 3 bar ↓ - Coolant inlet temperature : 25 °C (Recommended)
Dimension	2085 x 825 x 145 mm (Depth x Width x Height)
Weight	400 ± 10 kg (Max. 410kg)
ETC.	
Certification	Transportation : UN38.3

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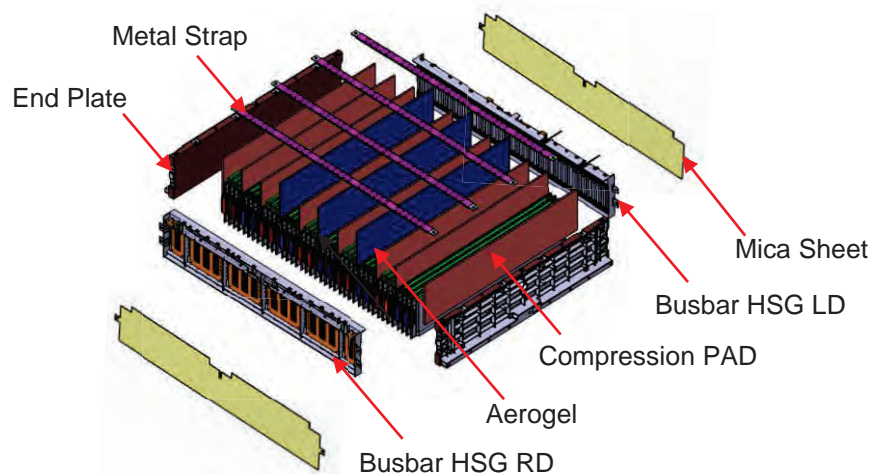
	System : UL9540A, UL9540, FCC, IEC62619, IEC61439, EMC&LVD Pack : UL 1973
Cycle Life	65% Retention, 7,300 Cycle @0.25C

2.2 Property

2.2.1 Structural property (Exploded view)



<Figure8. Module Exploded View>



<Figure9. 4P10S CMA Exploded View>

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2.3 Part list Information (BOM)

Part No.	Material		
	Cell Module Assy		
MPL02970AA	JF2 Cell		LFP, 159.2Ah
	8226 EV (HENKEL)		
	End plate Assy		ADC12
		End plate	Al (ALDC 12) , Diecasting
MPL02974AA		Insulation Plate	PC (Maker-LGChem , P/N - LUPOY EF1006F)
	Metal strap Assy		CR590
		Steel bar	CR590 (2t) + PFzn5-B (5um)
		Strap Mica	0.5t
MPD00268AA		Steel bar Insulation Tube	KKDK-A2-HF, 0.6t
		QR Barcode	
	Compression PAD		PU, 5T
	Aerogel		LGC NEXULA TB, 9T
MPD00250AA			
MHU00854AA	Busbar HSG Assy RD		
		Busbar HSG RD	PC (Maker-LGChem , P/N - LUPOY EF1006F), UL94 V0, MIN RTI 120°C
		Busbar Type 1	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 2	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 3	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 4	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		M5 Insert Bolt	SCM435 (M5 x 12 , 10.9T) , Coating (PFZn 8TC , 8um)
		M4 Pan Head Screw	SWCH22A (M4 x L8 , 4T) , Coating (PFZn 5-C)
		Busbar HSG RD QR	QR Barcode
		ICB RD_1	
		ICB RD_2	
	Busbar HSG Assy LD		
MHU00853AA		Busbar HSG LD	PC (Maker-LGChem , P/N - LUPOY EF1006F), UL94 V0, MIN RTI 120°C
		Busbar Type 6	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 7	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 4	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		Busbar Type 5	C1100 / 2t / Hardness 1/2 / Ni coating (3~8um)
		THERMISTOR_BRIDGE Assy	
		THERMISTOR_BRIDGE	PC (Maker-LGChem , P/N - LUPOY EF1006F), UL94 V0, MIN RTI 120°C

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MIS00305AA MBT00702AA PMARU71 PMARU72 MPL02975AA			wire	UL3633 , AWG22		
			HOUSING	2007HS-H04DR(BLACK)		
			TERMINAL	20071TS-D		
			THERMISTOR_Chip	LNFK103F028-20 (Maker : LATTRON)		
			THERMISTOR_PAD	PU, 1T		
			THERMISTOR_Tape	Tape, 0.1T		
		M5 Insert Bolt		SCM435 (M5 x 12 , 10.9T) , Coating (PFZn 8TC , 8um)		
		M4 Pan Head Screw		SWCH22A (M4 x L8 , 4T) , Coating (PFZn 5-C)		
		Busbar HSG LD QR		QR Barcode		
		ICB Type LD_1				
		ICB Type LD_2				
	CMA Mica Sheet			0.5t		
	Bolt			SCM435 (M6 x L18, 10.9T) , Coating (MFZn 3TC , 3um)		
	Enclosure					
	Thermal Resin (주제)			LGC TRU-7 (HS code : PMARU71)		
	Thermal Resin (경화제)			LGC TRU-7 (HS code : PMARU72)		
	Heat sink assy			Al30+40		
			Heatsink plate top A		Al3003mod+Al4045 (clad) 2t	
			Heatsink plate top B Assy			
				Heatsink Plate top B		Al3003mod, 1.5t
				Heatsink Port		Al6005-H112 , Port Hole 8Φ
				Weld washer		Al4045-Al3003-Al4045 , clad
				Heatsink plate bottom Assy		
				Heatsink plate bottom		Al3003mod+Al4045 (clad) 3t
				M4 Clinching Nut		M4
M6 Clinching Nut				M6		
Al Bar			Al 6063-T5			
Resin block pad type A			Silicon pad 2t, UL94 V0			
Resin block pad type B			Silicon pad 2t, UL94 V0			
Insulation sheet type A			PP Vacuum Forming, LUPOL GP1006FE, 0.2t , UL94 VTM-0			
Insulation sheet type B			PP Vacuum Forming, LUPOL GP1006FE, 0.2t , UL94 VTM-0			
Insulation sheet type C			PP Vacuum Forming, LUPOL GP1006FE, 0.2t , UL94 VTM-0			
water block pad A			Silicon pad 2t, UL94 V0			
water block pad B			Silicon pad 2t, UL94 V0			
water block pad C			Silicon pad 2t, UL94 V0			
Bolt			M6 x L8.2 (Low Head Screw , 10.9T) , Coating (MFZn 8TC , 8um)			
CMA Guide Pin		SUS304				

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		Supporting Bar	Al3003, 0.5t
		Base POM Block	POM (LUCEL FW715CS)
MBK01153AA	CMA Bracket Assy		
		CMA Bracket Plate	CR590 (2t) , Coating (MFZn 8TC , 5um)
		PIN	
		PAD	EPDM
		Double side tape	
MPL02973AA	Top Plate Assy		
		Top Plate	Al 5052-H32, 0.5T
		Insulation Sheet	PC Sheet 0.2t (UL94 V0 or VTM0)
		Double side tape 1	Bobaek C&S BK-2511-050C
		Double side tape 2	Bobaek C&S BK-2511-050C
		Mica Sheet	0.3t
MPL02973AA	Front Plate Assy		
		Front Plate	CR590 (1t) , Electro-Deposition Coating (Thickness 20 μ m)
		Mouting bracket	HR550 3t, Spot welding
		M4 Weld Nut	M4 Coating (PFZn5, 5um) 4T
		Front Cover	PC (Maker-LGChem , P/N - LUPOY EF1006F), UL94 V0, MIN RTI 80°C
		Power Connector (+)	1500Vdc / IP67 / PHOENIX CONTACT 社 350A Orange 1298082
		Power Connector (-)	1500Vdc / IP67 / PHOENIX CONTACT 社 350A Black 1298081
		M4L10 Pan Head Bolt	SWCH10A (M4 x 10 , 4.6T) , Coating (PFZn5, 5um)
	Sealing Grommet		EPDM , UL94 V0 , Shore Hardness A (40)
	Rear Plate Assy		
MRB00133AA		Rear Plate	Al 5052-H32 (1t)
		M4 Pop Nut	Steel
MPL02971AA	Support Bracket Assy		
		Power & Sensing HSG	PC (LGChem, LUPOY EF1006F) UL94 V0 + RTI 120°C
		M6 Bolt	SCM435 (M5 x L19 , 10.9T) , Coating (PFZn5, 5um)
		M10 Insert Bolt	SCM435 (M10 x L23 , 10.9T) , Coating (PFZn5, 5um)
		Insert Nut	M4 x 8 Coating (PFZn5, 5um)
		M10 Nut	SCM435 (M10) , Coating (PFZn5, 5um)
		Terminal Busbar Positive A	C1100(1/4H) / 3t
		Terminal Busbar Negative A	C1100(1/4H) / 3t
		Terminal Busbar Negative B	C1100(1/4H) / 3t
		Nut	M10, 8.8T, Coating (PFZn5, 5um)

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		Fuse	DC250V, 500A, Sinofuse (P/N : NH5KM-500)
		Mica Sheet	0.3T
	PBMS		
	FFC Assy A		
		12 Pin CNT HSG	Maker : HIROSE
		Retainer	Maker : HIROSE
		FFC_Insulation	Maker : SAMKEE
		FFC_Conductor	AU : Min0.05_m, Ni : Min 0.3_m
		Tape	TBD
		Tape (Poam)	TBD
		Label	TBD
	FFC Assy B		
		12 Pin CNT HSG	Maker : HIROSE
		Retainer	Maker : HIROSE
		22 Pin CNT HSG	Maker : HIROSE
		FFC_Insulation	Maker : SAMKEE
		FFC_Conductor	AU : Min0.05_m, Ni : Min 0.3_m
		Tape	TBD
		Tape (Poam)	TBD
		Label	TBD
	FFC Assy C		
		12 Pin CNT HSG	Maker : HIROSE
		Retainer	Maker : HIROSE
		22 Pin CNT HSG	Maker : HIROSE
		FFC_Insulation	Maker : SAMKEE
		FFC_Conductor	AU : Min0.05_m, Ni : Min 0.3_m
		Tape	TBD
		Tape (Poam)	TBD
		Label	
	FFC Assy D		
		12 Pin CNT HSG	Maker : HIROSE
		Retainer	Maker : HIROSE
		FFC_Insulation	Maker : SAMKEE
		FFC_Conductor	AU : Min0.05_m, Ni : Min 0.3_m

TBD

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ECW02119AA		Tape	TBD
		Tape (Poam)	TBD
		Label	TBD
	FFC Assy_CMA to CMA		
		FFC Connector	P/N : KBF10-10P-1F (Hirose) , Material : PA+Glass fiber , AWG31
		Retainer	P/N : KBF10-10RP-1 (Hirose) , Material : PA+Glass fiber
		FFC_Insulation	P/N : L-HMPP(25-50)N (sumitomo) , Material : PET , Thickness : 25um , White
		FFC_Conductor	P/N : 0.1x0.4(NPA 1um) (Misuzu seisen) , Material : Nicked plated copper
		Tape	P/N : NITTO TAPE #5000NS (Dongguan Sihui Cheng) , Material : Acrylic adhesive + Nonwoven fabric + release paper
		PI Tape	Material : PI
		Label	Material : PET + Polymer adhesive (SATO SHANGHAI)
		Fixing Folding Tape	Material : Acrylic adhesive + Nonwoven fabric + release paper
MCV01491AA	Connector Cover		P/N : LUMILOY FB2106F (LG Chem) , UL94 V0 , Color : Orange
EBB00896AA	Inter Busbar Type A		C1100 (1/4H) / 3t
EBB00895AA	Inter Busbar Type B		C1100 (1/4H) / 3t / Ni Coating / Busbar dipping
MBT00702AA	Bolt		SCM435 (M6 x L18, 10.9T) , dacromet
MBT00701AA	Bolt		SCM435 (M4 x L5 , 10.9T) , (MFZn 3TC , 3um)
MBT00700AA	Bolt		SCM435 (M4 x L9 , 10.9T) , dacromet
MBT00699AA	Bolt		SCM435 (M4 x L9 , 10.9T) , Head 10.4mm, dacromet
MNT00255AA	Nut		SWCH10A (M5 X L3.5, 10.9T) , Coating (MFZn 3TC , 3um) (Hexgon-Flange Nut)

Detail information refer to attachment BOM file



250123_JF2_Pack_
BOM_V02_구미+US

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3. PBMS

3.1. PBMS Usage

This specification is applied to the GRID JF2 PBMS 30S project that is applied to the packs of LG Energy Solution.

3.2. General Information

3.2.1 Model Name

- GRID JF2 PBMS 30S (EBA02266AA)

3.2.2 Functions

- Measure

Cell Voltage	30CH
Module Temperature	6CH
PCB Temperature	2CH

- Communication

PBMS – RBMS	isoSPI
PBMS – PBMS	isoSPI

3.2.3 Product composition

❖ Structure

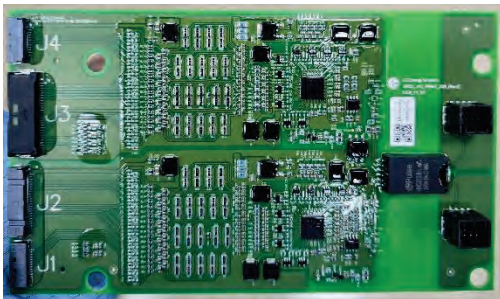
- PCB MATERIAL : FR-4

- PCB SIZE : 200 mm x 116 mm

- LAYER : 4 Layers : See PCB Layout

- SILK : See PCB Layout

❖ PCB Ass'y



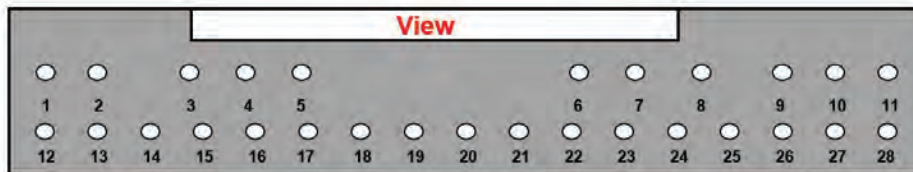
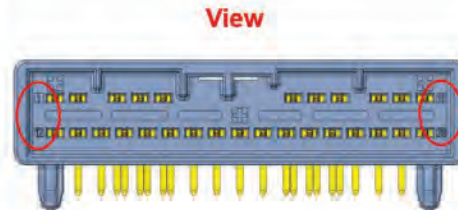
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ESS Pack Development Team 4	Confidential	2025-02-11	5.0
Approved	Description		
	Energy module JF2 4P30S for long cycle (EP096636PFBA)		

3.2.4 PBMS Connector Pinmap

J1 (210302-NA)

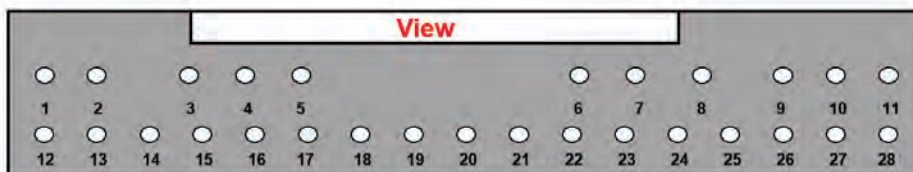
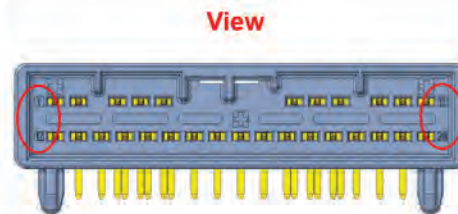
Item	Description	Remark
용도	셀 전압 측정, 온도 측정	Cell1 ~ Cell15, TH1~2
제조사	YURA	
PCB 커넥터	210302-NA	28pin, Natural Color
Wire 커넥터	220261-NA	
Terminal (Receptacle)	320151-11, 320152-11	
Thermistor	TBD	



1	2		3	4	5						6	7	8		9	10	11
V(+)_U1	Cell 13		Cell 11	Cell 10	Cell 8						Cell 2	Cell 0	NC		NC	TH2 +	TH1 +
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Cell 15	Cell 14	Cell 12	Cell 11N	Cell 9	Cell 7	Cell 6	Cell 6N	Cell 5	Cell 4	Cell 3	Cell 1	V(-)_U1	NC	NC	TH2 -	TH1 -	

J2 (210303-BK)

Item	Description	Remark
용도	셀 전압 측정, 셀 온도 측정	Cell16 ~ Cell30, TH3-6
제조사	YURA	
PCB 커넥터	210303-BK	28pin, Black Color
Wire 커넥터	220262-BK	
Terminal (Receptacle)	320151-11, 320152-11	
Thermistor	TBD	



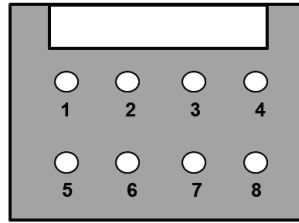
1	2											3	4	5											6	7	8											9	10	11
V ₁ +U ₂	Cell 25											Cell 26	Cell 25	Cell 23											Cell 17	Cell 18N	TH ₆ +											TH ₅ +	TH ₄ +	TH ₃ +
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28																								
Cell 30	Cell 29	Cell 27	Cell 26N	Cell 24	Cell 22	Cell 21	Cell 21N	Cell 20	Cell 19	Cell 18	Cell 15	V ₁ -U ₂	TH ₆ -	TH ₅ -	TH ₄ -	TH ₃ -																								

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J3, J4 (KW10-8DP-2.5V)

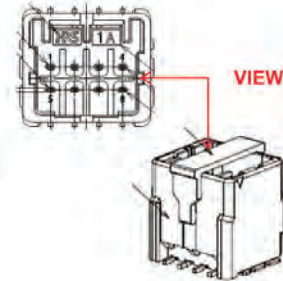
isoSPI 2wire 통신 커넥터

Item	Description	Remark
용도	isoSPI 2wire 통신	
제조사	HIROSE	
PCB 커넥터	KW10-8DP-2.5V	주석도금
Wire 커넥터	KW10-8DS-2.5C + KW10-8RS-2.5	Retainer * 2 결함
Terminal (Receptacle)	KW10-2022SCF	주석도금, AWG22

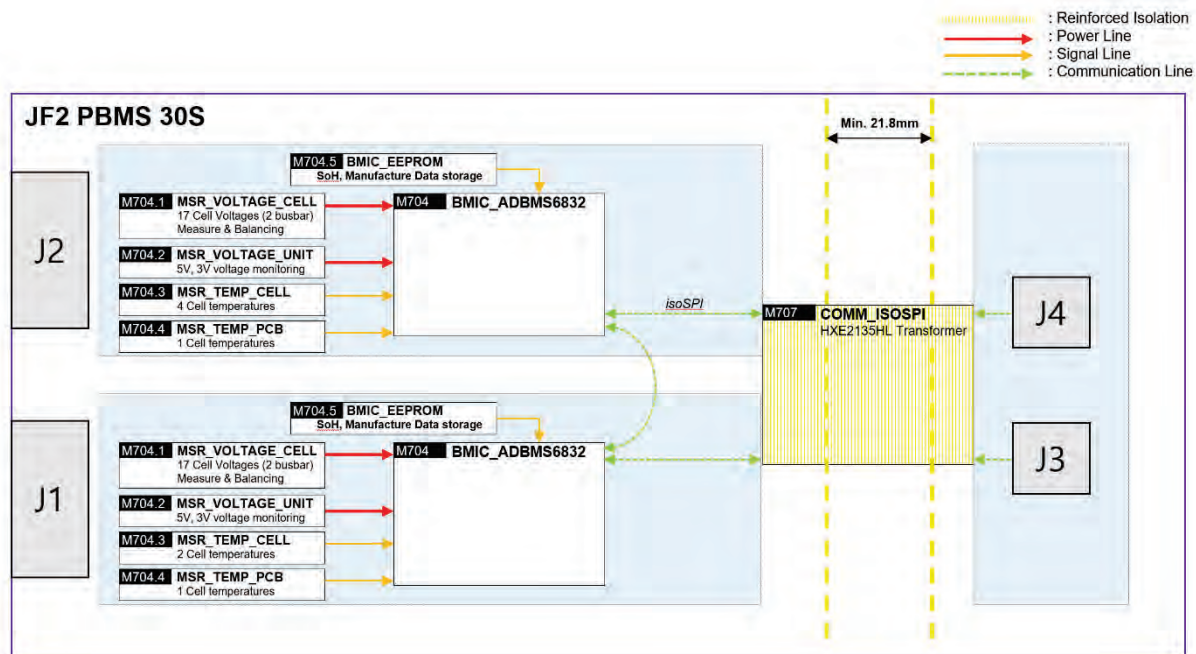


1	2	3	4
isoSPI_M		isoSPI_P	
5	6	7	8
(isoSPI_M)		(isoSPI_P)	

*Twisted 처리 필수
추천 wire color
#2,4,5,6,7,8 미 연결



3.2.5 Block Diagram



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3.2.6 Hardware

❖ Electrical

Item		MIN	TYP	MAX	Unit
Module Input Voltage (Cell@1.0~3.65V)		30		109.5	V
Cell Input Voltage		2.5	3.2	3.65	V
Withstand Voltage (HV↔LV)	1mA, 60sec			5000	V
Insulation Resistance (HV↔LV)	10 MΩ, 60sec			1000	V
isoSPI Communication				2	Mbps
Current Consumption			4		mA
Dark Current (HV)			6		μA
Operating Temperature		-25		85	°C
Operating Temperature (Recommend)		20	25	30	°C
Storage Temperature (Stand-alone)	Max. 6 month	-40		85	°C
Storage Humidity				85%	RH

❖ Accuracy

Item		Criteria	Remark
Cell Voltage	2.5~3.65V	±5mV	
Temperature	-25~85°C	±2°C	Excepting Thermistor Error

❖ Mechanical

Item		MIN	TYP	MAX	Unit
Weight(Before Coat)			121.6		g
Weight(After Coat)			127.2		g

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4. Product Inspection (EOL)

Test Item		Inspection Standard	선택 검사기 오차 범위	JF2 Pack spec
Cell	Cell Inspection	Voltage		OCV 3.228V ~ 3.248V
		Insulation Voltage		0.5V
		Insulation Resistance (DC 25V/1s , Al pouch and Ni lead)		Insulation Resistance $\geq 100M\Omega$
CMA	Cell Voltage	3.228V ~ 3.248V		3.228V ~ 3.248V
	Cell Voltage Deviation	$X \leq 25$ [mV]		25 [mV]
	CMA Voltage	Voltage measurement of each half CMA voltage		16.14 ~ 16.24V
	Gas Detection	Gas Concentration <2000ppm		<2000ppm
BMA (4P30S)	Insulation Resistance	Test condition : Max. 1000V Test Time : 10sec	UL1973	More than 1G Ω
	Withstanding Voltage of Pack	Test condition : max. DC 4150V Ramp time : 3sec Test Time : 60sec	Ramp 3 sec IEC60950	Less than 10mA
	Ground Bond	Test condition : max. 25A Test Time : 60sec	UL1973	Less than 0.1 Ω

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	Cell voltage check	* Read BMS DATA	BMS Measurement deviation : ±5mV/Cell	3.223V ~ 3.253V
	Cell Delta Voltage	* Read BMS DATA - Voltage Deviation = Max Cell - Min Cell Voltage		≤ 45mv
	BMA temperature check	* Read Thermister Voltage - Module Temperature #1~4		Each Thermistor Temp. , 19°C≤X≤27°C
	BMA temperature deviation			Each Thermistor Temp. Deviation, -2°C≤X≤2°C
	Pack Voltage (BMS)	* Read Voltage and Cell Sum	BMS Measurement deviation : 5mV x 30 (±150mV)	96.69 ~ 97.59V (96.84 ~ 97.44V ±150mV)
	Pack Voltage (DMM)	* Cell IQC voltage x 30 = Module Voltage	IQC Cell voltage x 30 (± 100mV)	96.74 ~ 97.54V (96.84 ~ 97.44V ± 100mV)
	DCIR	Cell DCIR BMA DCIR External DCIR		DV Standard Pack DCIR : 11.8575 ~ 21.8581 [mohm]
				DV Standard External DCIR : 0 ~ 10.1992 [mohm]

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	Heat sink leakage	Max 2 SCCM		Max 2 SCCM
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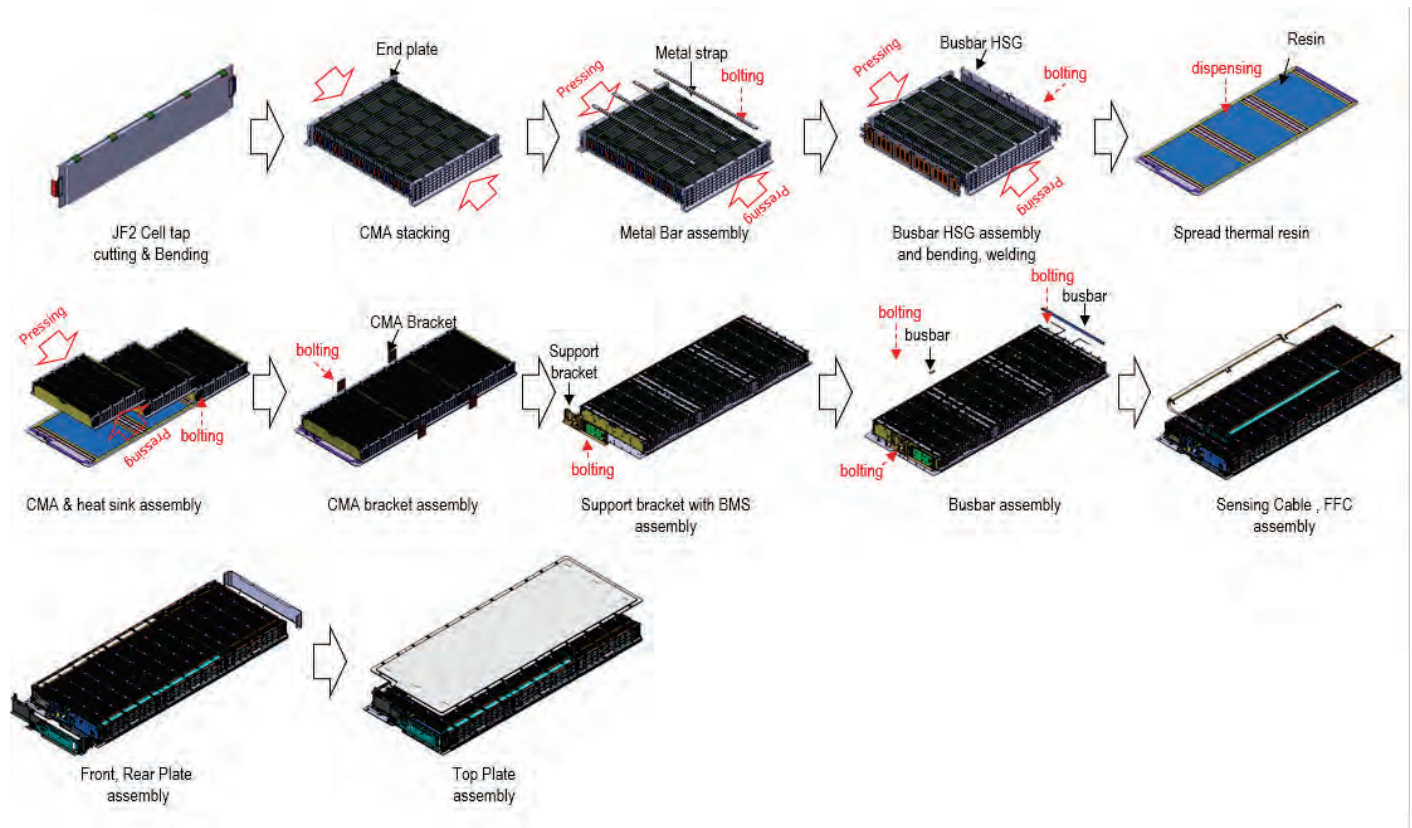
Detail information refer to attachment EOL file



241115_Grid_JF2_
Pack EOL_v1.2.xlsx

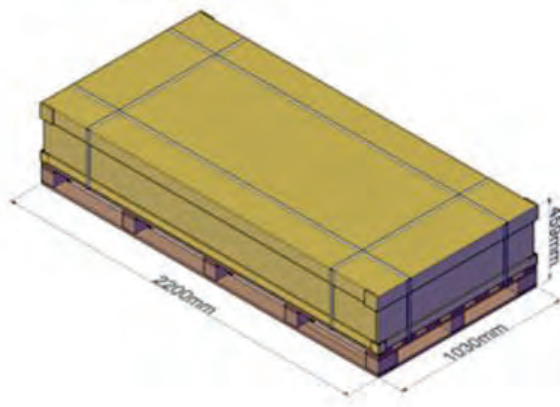
5. Manufacture process

5.1. Assembly process



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6. Packaging Specification



7. Cautions and Prohibitions in Handling

Warning for using the rechargeable lithium-ion battery Module - Mishandling of the battery may cause heat, fire and deterioration in performance. Be sure to observe the following.

7.1 Cautions for Use and Handling

- Battery module must be charged and discharged at operating temperature range.
- Battery module must be stored in a cool, dry place for long-term storage.
- Do not use battery cells in high static electricity environment where the protection device can be damaged.
- Battery module must be kept away from children or pets
- Be sure to request and confirm the most recent product specifications in advance.
- Do not disconnect, disassemble or repair the module except authorized engineers.
- There are some risks of fire, electric shock and injuries.
- Do not drop, deform, impact the module. And do not cut or spearing the module with a sharp object. It may cause electrolyte leakage or fire.
- If the module is damaged, It causes electrolyte leakage or flammable gas generation.
In such cases, please contact LG Energy solution ESS QA Team immediately.
- If electrolyte leaks out, do not touch it.
If you touch electrolyte, wash electrolyte with water and take medical care immediately.
- Do not place inflammable materials or fire near the module. And do not burn the module. It may lead to fire or explosion.
- Keep the module away from humid circumstances or liquid.
- If liquid spills on the module, do not touch and use it.
- Do not carry and lift the module alone. If not, it may cause injury.
- Use proper equipment or carry it with assistants.

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- For safety, Rack system must be composed of same type of battery modules which are sorted by QR barcode label and model name.
- Make sure that all modules have same model name labels which are attached on the front side of battery module.

7.2 Prohibitions

- Do not charge with constant power higher than maximum charge power.
- Do not attempt to disassemble or alter battery module.
- Do not throw or subject the battery to severe impacts.
- Do not puncture or otherwise damage a battery with sharp objects (e.g. nail, knife, pencil, drill)
- Do not expose the battery to high heat. (such as a fire)
- Do not microwave or put batteries under high pressure.
- Do not connect positive(+) and negative(-) terminals with conductive materials (such as metal, wire, etc.)
- Do not immerge or wet batteries with water or sea-water.

8. Exclusion of Liability

The warranty shall not cover defects caused by normal wear and tear, inadequate maintenance, handling, storage, faulty repair, modification to the battery or pack by a third party other than LG Chem or LG Chem's agent approved by LG Chem, failure to observe the product specification provided herein or improper use of installation, including but not limited to, the following:

- Damage during transport or storage
- Incorrect installation of module into rack or maintenance.
- Use of battery module in inappropriate environment
- Improper, inadequate, or incorrect charge / discharge, or production of circuits other than stipulated herein
- Incorrect use or inappropriate use
- Insufficient ventilation
- Ignoring applicable safety warnings and instructions
- Any attempt to alter or repair by unauthorized personnel
- In case of force majeure (Ex. Lightning, Storm, Flood, Fire, Earthquake, etc.)
-

There are no warranties – implied or express – other than those stipulated herein. LG chem. shall not be liable for any consequential or indirect damages arising out of or in connection with the product specification, battery module

Thermal Component Specification

JF2 DC LINK 5.1 (0.25CP)



Document No :

F2D4-5.1US-TH01

Revision :

4.0

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Technical Specification

Version V1.0

Description: Inverter Liquid Cooling Unit

Model: LCI-70CR-05C4SZ5-3487CU

SN: NY-XY-2024-00515

Compiled by Ruiyang Xu **Date** 2025-03-11

Approved by Jie Liu **Date** 2025-03-11

三河同飞制冷股份有限公司
Sanhe Tongfei Refrigeration Co., Ltd.

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1. Model description

LCI - 70 C R - 05 C4 S Z5 - 3487 - CU
(1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

- (1) LCI: Inverter Liquid Cooling Unit
- (2) 70: Rated cooling capacity=70*100=7kW
- (3) C: Closed-cycle system with water pump
- (4) R: With heating function
- (5) 05: Design code
- (6) C4 Anti-corrosion grade C4H
- (7) S: Painting RAL7035 Textured finish
- (8) Z5: Eco-friendly refrigerant R32
- (9) 3487: Power supply 3/PE AC 400V±10% 50Hz 3/PE 480V±10% 60Hz
- (10) CU: Meet CE/UL certification requirements

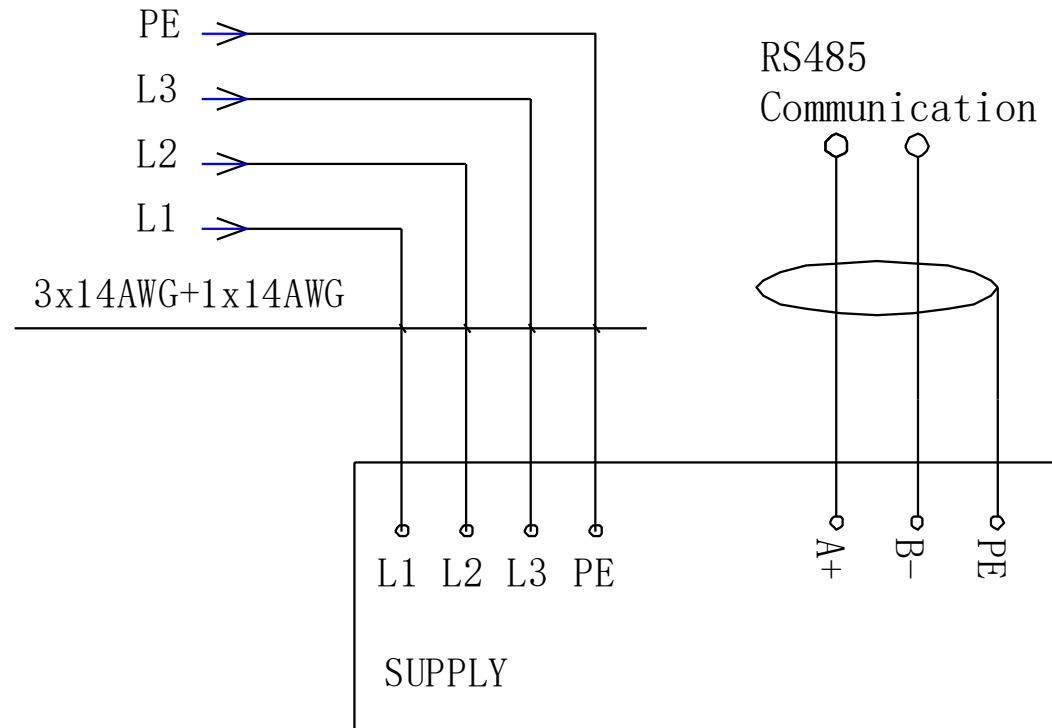
2. Technical data

NO	Items	Unit	Data	
1	Power supply	——	3/PE AC 400V±10% 50Hz	3/PE AC 480V±10% 60Hz
2	Max. power/current	kW/A	4.6/6.9	4.6/5.8
3	Cooling power/current	kW/A	3.5/5.1(L45℃/W20℃)	3.5/4.5(L45℃W20℃)
4	Heating capacity	kW	2	3
5	Heating power/current	kW/A	2.5/3.7	3.5/4.3
6	Standby power	W	50	
7	Self-circulation power	W	500	
8	Communication protocol	/	MODBUS RTU (RS485)	
9	Cooling capacity	kW	7kW (L45℃/W20℃)	
10	Working mode	Automatic control mode, cooling mode, heating mode, standby mode, self-circulation mode		
11	Liquid setting range	℃	10～50 (Liquid factory setting temperature 20℃)	
12	Refrigerant	/	R32	
13	Condensing air volume	m³/h	2000	
14	Noise	dB(A)	75	
15	Rated flow	L/min	50	
16	Rated differential pressure	kPa	200	
17	Max. Inlet/outlet differential pressure	kPa	300	
18	Liquid circuit system design pressure	MPa	0.6	
19	Inlet/outlet size	/	G3/4 pipe thread	
20	Drainage/refilling size	/	Self-sealing quick socket (G1/2' internal thread)	
21	Ambient temperature range	℃	-30℃～+55℃	
22	Anticorrosion grade	/	C4H	
23	Applicable altitude	m	≤2000: Cooling Capacity without de-rating ≤3000: Cooling Capacity 3% de-rating But, It depends on environment conditioin	
24	Protection degree	/	IP55	

25	Painting	/	RAL7035 Textured Finish
26	Dimension	mm	W×D×H: 700×285×1500 Without flange W×D×H: 880×285×1554 With flange
27	Weight	kg	≤140
28	Coolant	Concentration ≤50% glycol solution	
29	Remarks	1. Max. Outlet alarm temp 35°C 2. Min. outlet alarm temp 10°C 3. Ambient temp -40°C-55°C, The allowable storage time is 6 months. 4. EMS, EMI have met the UL 9540:2023 article 36 'Electromagnetic Immunity Test' and the FCC in enclosure system.	

3. Electrical control

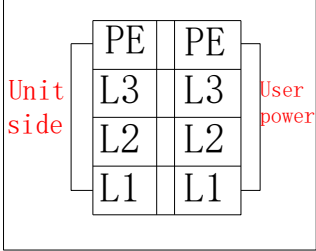
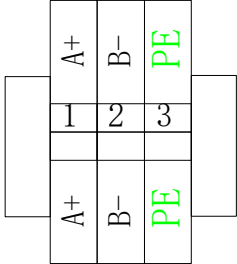
3.1 Wiring diagram



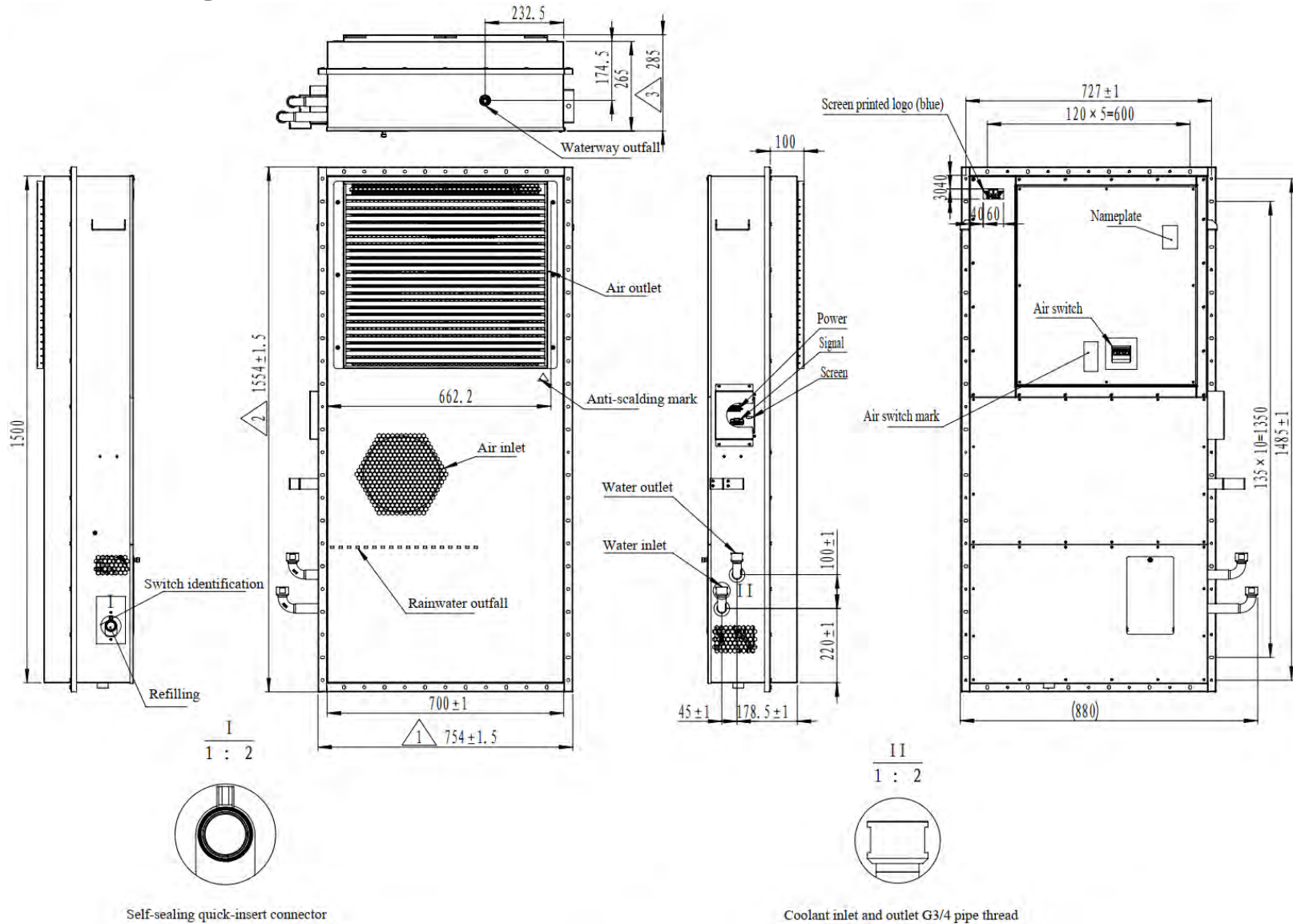
3.2 Power supply wiring

Rated load current (RLA)	6.9/4.3A
Maximum operating current (MCC)	9.6A
Recommended: 3×14AWG+1×14AWG American Standard copper cable	

3.3 Power supply and communication port configuration

Connector function name definition	Liquid cooling unit pin location	User side pin location	
Power supply	L1 L2 L3 PE	L1 L2 L3 PE	
BMS Communication	A+ B- PE	A+ B- PE	

4. Outline drawing



Overall Dimension

5. Technical change record

Version	Modified basis	Modified content	Page	Date	Modified by	Approved by



Technical Specification

Version V1.0

Model: ECA-20HR-06A1C4SZ6-1227CU

Description: Industrial Air Conditioner

Spec: NY-XY-2024-00196

Compiled by Yue Tian **Date** 2024-10-10

Approved by Xiaohao Liang **Date** 2024-10-10

三河同飞制冷股份有限公司
Sanhe Tongfei Refrigeration Co., Ltd.

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1. Model description

<u>ECA</u>	-	<u>20</u>		<u>H</u>		<u>R</u>	-	<u>06</u>		<u>A1</u>		<u>C4</u>		<u>S</u>		<u>Z6</u>	-	<u>1227</u>		<u>CU</u>
(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)

- (1) ECA: Industrial Air Conditioner
- (2) 20: Rated cooling capacity=20×100=2.0kW
- (3) H: Wall-mounted installation
- (4) R: With Heating function
- (5) 06: Design serial number
- (6) A1: Design code
- (7) C4: Anti-corrosion grade C4H
- (8) S: RAL7035 Textured finish
- (9) Z6: Eco-friendly refrigerant R513A
- (10) 1227: Power supply 1/PE AC 220V 50Hz/60Hz
- (11) CU: Meet CE/UL certification requirements

Remarks:

2. Technical data

2.1 Technical parameter list

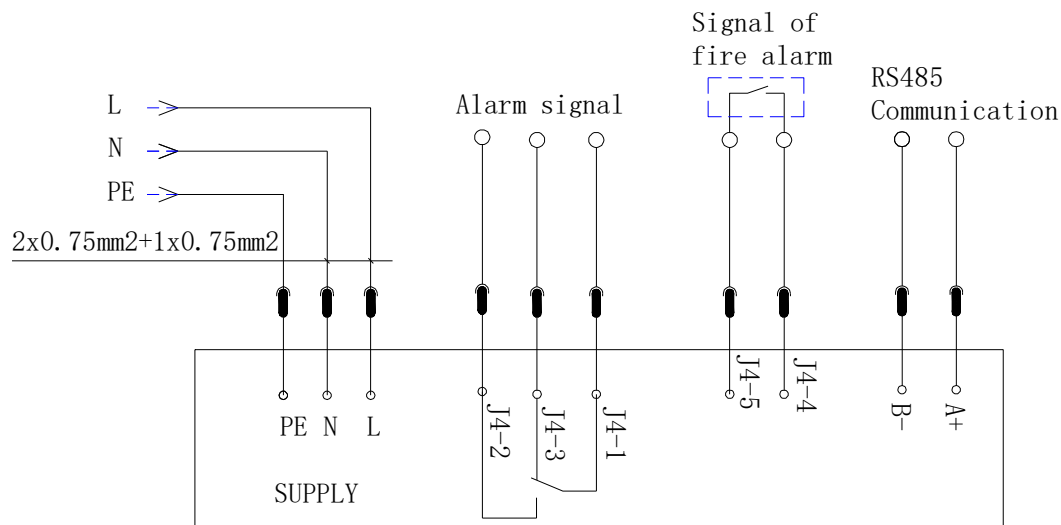
No.	Item	Unit	Data	
1	Power supply	—	1/PE AC 220V $\pm 10\%$ 50Hz ± 2 Hz	1/PE AC 220V $\pm 10\%$ 60Hz ± 2 Hz
2	Rated power (Cooling/heating)	kW	0.9/1.2	1.1/1.3
3	Rated current (Cooling/heating)	A	4.1/5.2	5.0/5.5
4	Rated cooling capacity ^①	kW	2.0	
5	Heating power	kW	1.0	
6	Max. running current	A	6.3 (Cooling mode)	
7	Maximum operating power	kW	1.4 (@50°C/50°C)	(Cooling mode)
8	Evaporator fan airflow	m ³ /h	600	
9	Condenser fan airflow	m ³ /h	1000	
10	Temp. control range	°C	20~50	
11	Humid. control		No	
12	Ambient temperature	°C	-30~55	
13	ROHS compliant		Yes	
14	Refrigerant		R513A	
15	Controller		Digital controller	
16	Painting		RAL7035 Textured finish	
17	Noise	dB(A)	70	
18	Power supply connection		Terminals	
19	Condensate water treatment		Condensate water is collected in the water pan and discharged through the drain.	
20	Installation method		Wall-mounted	
21	Protection level		Inside/outside IP55	
22	Dimension	mm	501×280×851 (With flange) 446×280×800 (Without flange)	
23	Weight	kg	39	

24	Special requirements:	1. Inside lower air inlet and upper air outlet 2. Use R513A refrigerant 3. Anticorrosion grade C4H 4. Comply with CE/UL certification 5. The ambient temperature is -30℃ -55℃, and the allowable storage time is 6 months 6. EMS, EMI have met the UL 9540:2023 article 36 'Electromagnetic Immunity Test' and the FCC in enclosure system. 7. None dehumidification mode 8: The allowable altitude is 2000m. ≤2000m: Cooling Capacity without de-rating ≤3000m: Cooling Capacity 3% de-rating But, It depends on environment condition
----	-----------------------	---

① Test conditions: Dry Bulb Temp. inside the cabinet is 35℃, and ambient Dry Bulb temp. is 35℃.

3. Electrical Control

3.1 Wiring diagram



3.2 Power supply wiring

Rated current (cooling/heating)	4.1/5.2A @50Hz	5.0/5.5A @60Hz
Maximum operating current (MCC)	6.3A @50Hz	6.3A @60Hz
Starting current (LRA)	16.3A @50Hz	16.3A @60Hz
Recommended: 2×0.75 mm²+1×0.75 mm² (cable meeting national-standard)		

3.3 Signals wiring

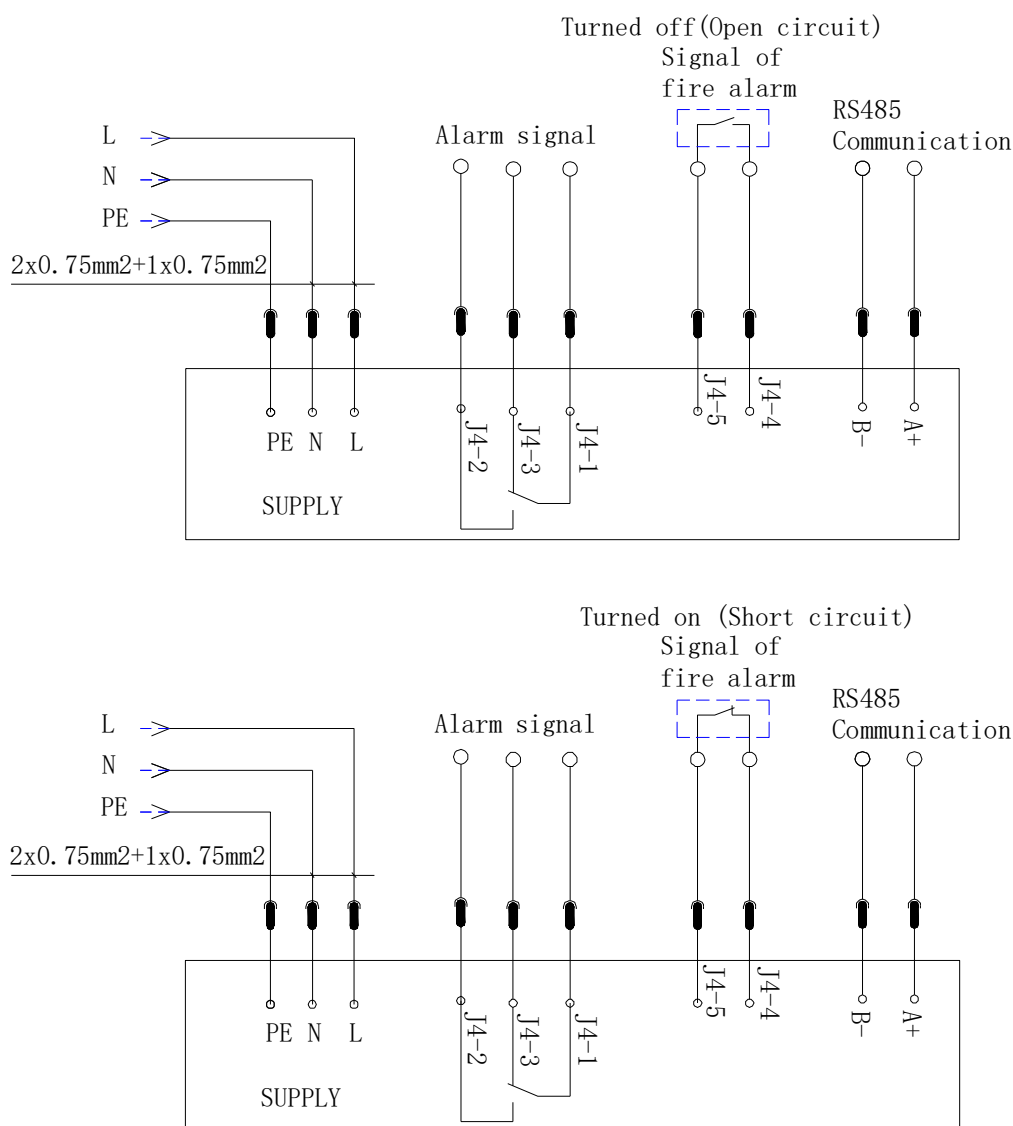
3.3.1 Alarm signals

Electrical control system on the chiller provides the host with passive alarm signals. In the event of breaking down for some reason, the chiller will stop. When the signal terminal of the unit enters the working state, J4-1 and J4-2 are disconnected, and J4-1 and J4-3 are connected; Stop and alarm state J4-1 and J4-2 are connected, and J4-1 and J4-3 are disconnected. Alarm terminals are fully independent contacts, with a maximum driving power of 220V/3A.

3.3.2 Signal of fire alarm

The refrigeration unit provides the host with a pair of fire alarm interlock protection signals J4-4/J4-5. When J4-4/J4-5 is turned on, the refrigeration unit is in standby mode. When J4-4/J4-5 is turned off, the refrigeration unit is allowed to start.

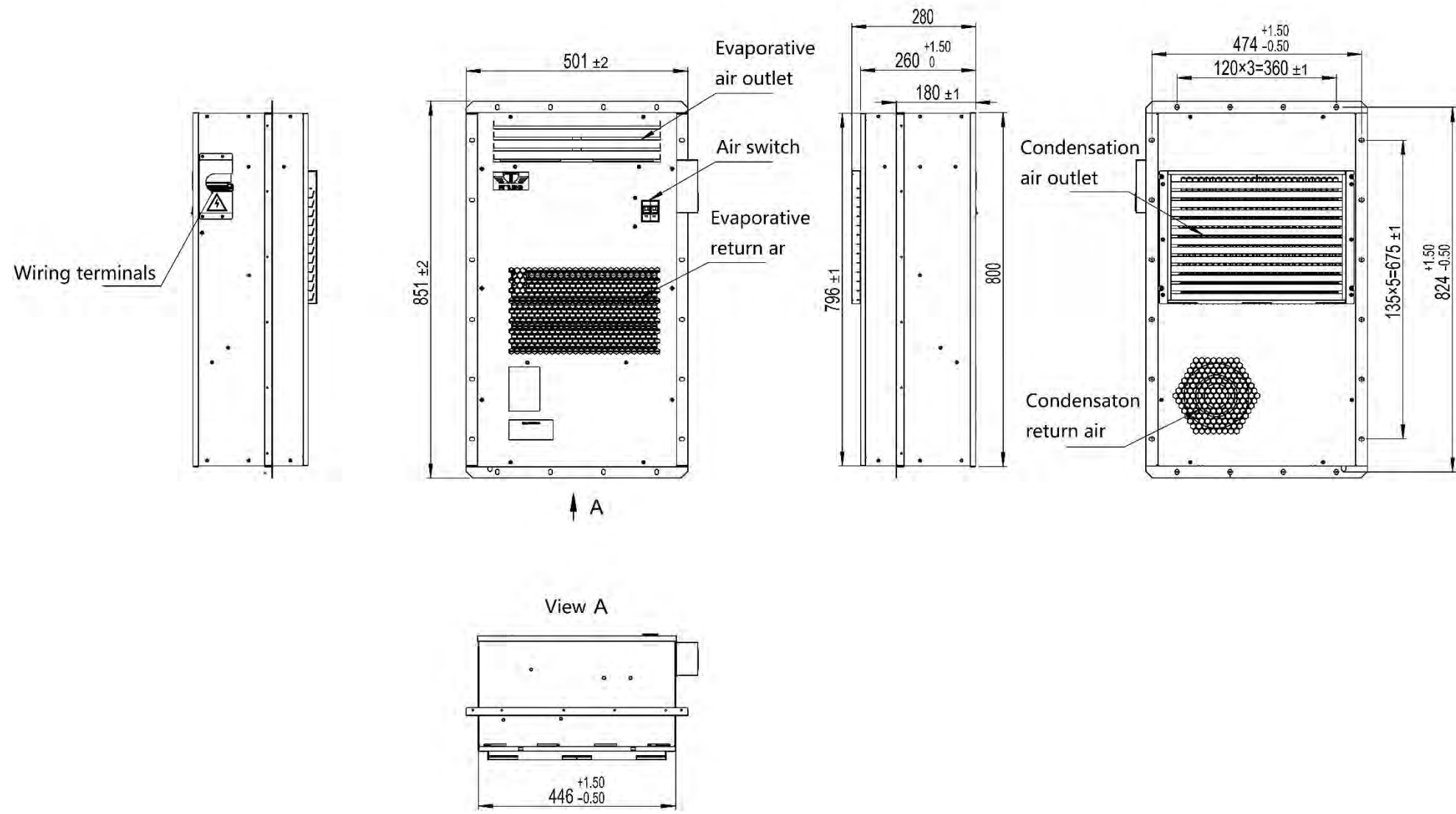
At this time, the upper computer needs to send a start signal or press the break button on the screen to start the refrigeration unit.



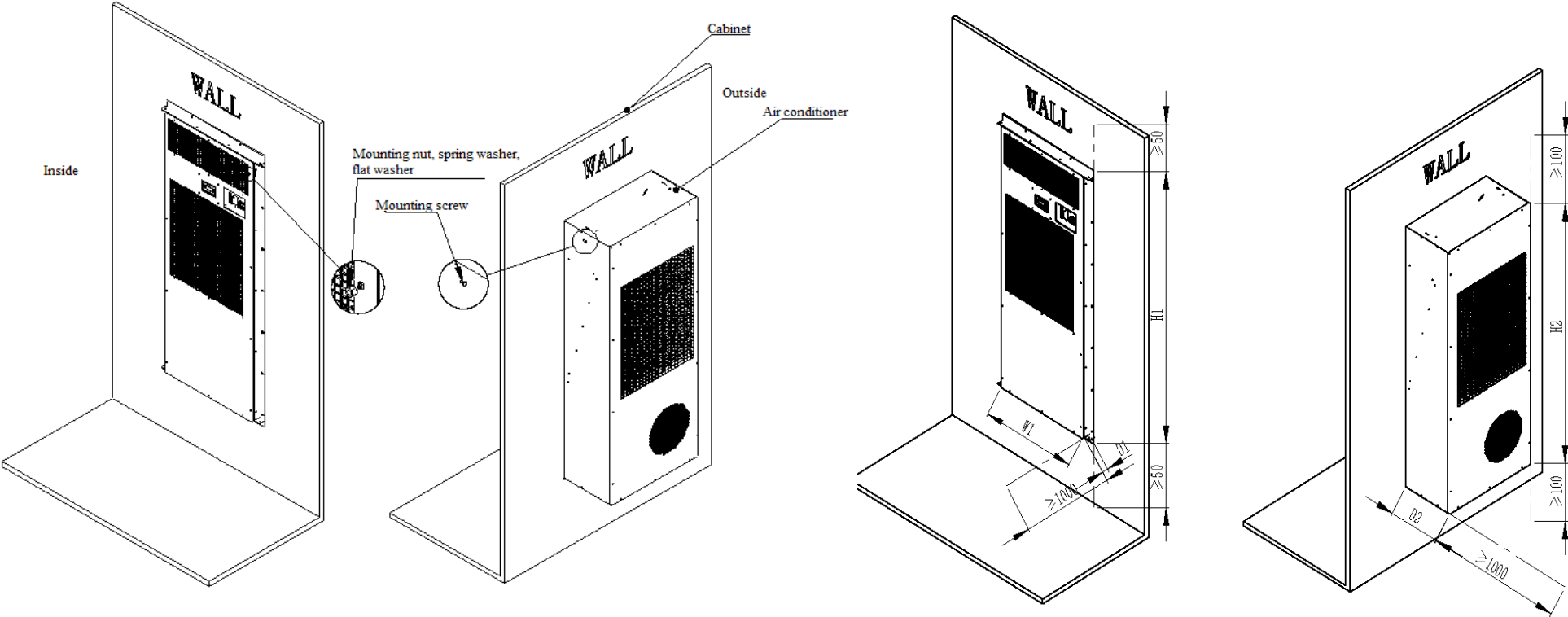
3.3.3 RS485 communication protocol

Controller adopt 485 communication protocol, communication protocol: MODBUS-RTU.

4. Outline drawing



5. Installation Diagram



6. Technical change record

Reason	Content	Page	Date	Modified by	Approved by



Technical Specification

Version V1.0

Model: ECA-20HR-06A2C4SZ6-1227CU

Description: Industrial Air Conditioner

Spec: NY-XY-2024-00448

Compiled by Yue Tian **Date** 2024-10-10

Approved by Xiaohao Liang **Date** 2024-10-10

三河同飞制冷股份有限公司
Sanhe Tongfei Refrigeration Co., Ltd.

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5. Installation Diagram.....	8
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1. Model description

<u>ECA</u>	-	<u>20</u>		<u>H</u>		<u>R</u>	-	<u>06</u>		<u>A2</u>		<u>C4</u>		<u>S</u>		<u>Z6</u>	-	<u>1227</u>		<u>CU</u>
(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)

- (1) ECA: Industrial Air Conditioner
- (2) 20: Rated cooling capacity=20×100=2.0kW
- (3) H: Wall-mounted installation
- (4) R: With Heating function
- (5) 06: Design serial number
- (6) A2: Design code
- (7) C4: Anti-corrosion grade C4H
- (8) S: RAL7035 Textured finish
- (9) Z6: Eco-friendly refrigerant R513A
- (10) 1227: Power supply 1/PE AC 220V 50Hz/60Hz
- (11) CU: Meet CE/UL certification requirements

Remarks:

2. Technical data

2.1 Technical parameter list

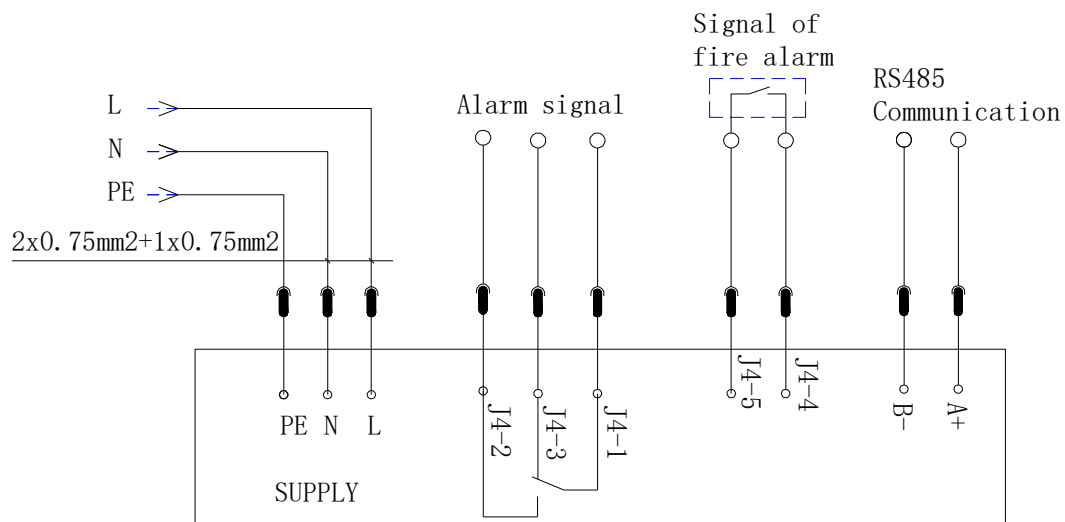
No.	Item	Unit	Data	
1	Power supply	——	1/PE AC 220V ±10% 50Hz	1/PE AC 220V ±10% 60Hz
2	Rated power (Cooling/heating)	kW	0.9/1.2	1.1/1.3
3	Rated current (Cooling/heating)	A	4.1/5.2	5.0/5.5
4	Rated cooling capacity ^①	kW	2.0	
5	Heating power	kW	1.0	
6	Max. running current	A	6.3 (Cooling mode)	
7	Maximum operating power	kW	1.4 (@50°C/50°C)	(Cooling mode)
8	Evaporator fan airflow	m ³ /h	600	
9	Condenser fan airflow	m ³ /h	1000	
10	Temp. control range	°C	20~50	
11	Humid. control		Yes	
12	Ambient temperature	°C	-30~55	
13	ROHS compliant		Yes	
14	Refrigerant		R513A	
15	Controller		Digital controller	
16	Painting		RAL7035 Textured finish	
17	Noise	dB(A)	70	
18	Power supply connection		Terminals	
19	Condensate water treatment		Condensate water is collected in the water pan and discharged through the drain.	
20	Installation method		Wall-mounted	
21	Protection level		Inside/outside IP55	
22	Dimension	mm	501×280×851 (With flange) 446×280×800 (Without flange)	
23	Weight	kg	39	

24	Special requirements:	<ol style="list-style-type: none"> 1. Inside lower air inlet and upper air outlet 2. Use R513A refrigerant 3. Anticorrosion grade C4H 4. Comply with CE/UL certification 5. The ambient temperature is -30℃-55℃, and the allowable storage time is 6 months 6. EMS, EMI have met the UL 9540:2023 article 36 'Electromagnetic Immunity Test' and the FCC in enclosure system. 7: The allowable altitude is 2000m. $\leq 2000\text{m}$: Cooling Capacity without de-rating $\leq 3000\text{m}$: Cooling Capacity 3% de-rating But, It depends on environment condition
----	-----------------------	---

① Test conditions: Dry Bulb Temp. inside the cabinet is 35℃, and ambient Dry Bulb temp. is 35℃.

3. Electrical Control

3.1 Wiring diagram



3.2 Power supply wiring

Rated current (cooling/heating)	4.1/5.2A @50Hz	5.0/6.0A @60Hz
Maximum operating current (MCC)	6.3A @50Hz	6.3A @60Hz
Starting current (LRA)	16.3A @50Hz	16.3A @60Hz
Recommended: 2×0.75 mm²+1×0.75 mm² (cable meeting national-standard)		

3.3 Signals wiring

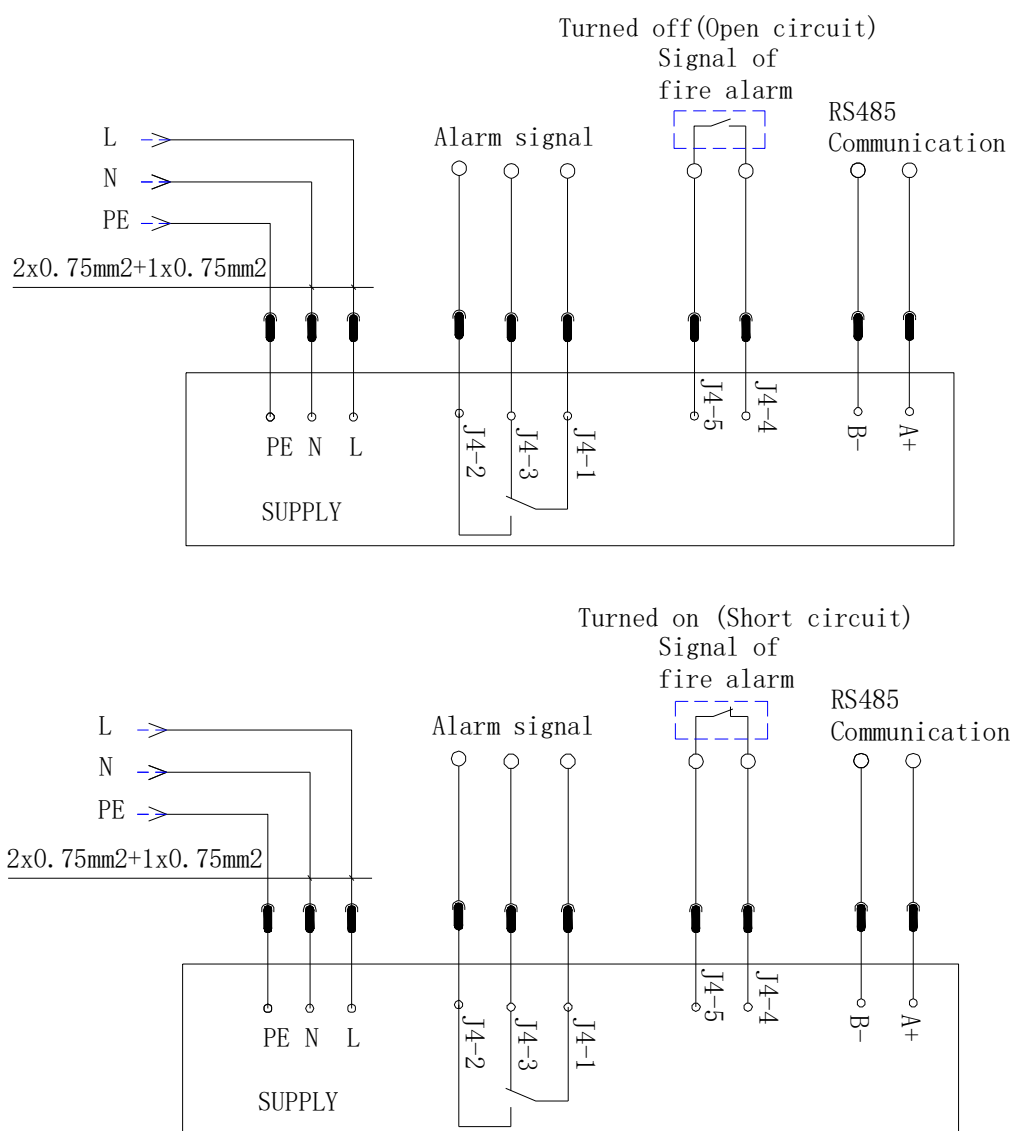
3.3.1 Alarm signals

Electrical control system on the chiller provides the host with passive alarm signals. In the event of breaking down for some reason, the chiller will stop. When the signal terminal of the unit enters the working state, J4-1 and J4-2 are disconnected, and J4-1 and J4-3 are connected; Stop and alarm state J4-1 and J4-2 are connected, and J4-1 and J4-3 are disconnected. Alarm terminals are fully independent contacts, with a maximum driving power of 220V/3A.

3.3.2 Signal of fire alarm

The refrigeration unit provides the host with a pair of fire alarm interlock protection signals J4-4/J4-5. When J4-4/J4-5 is turned on, the refrigeration unit is in standby mode. When J4-4/J4-5 is turned off, the refrigeration unit is allowed to start.

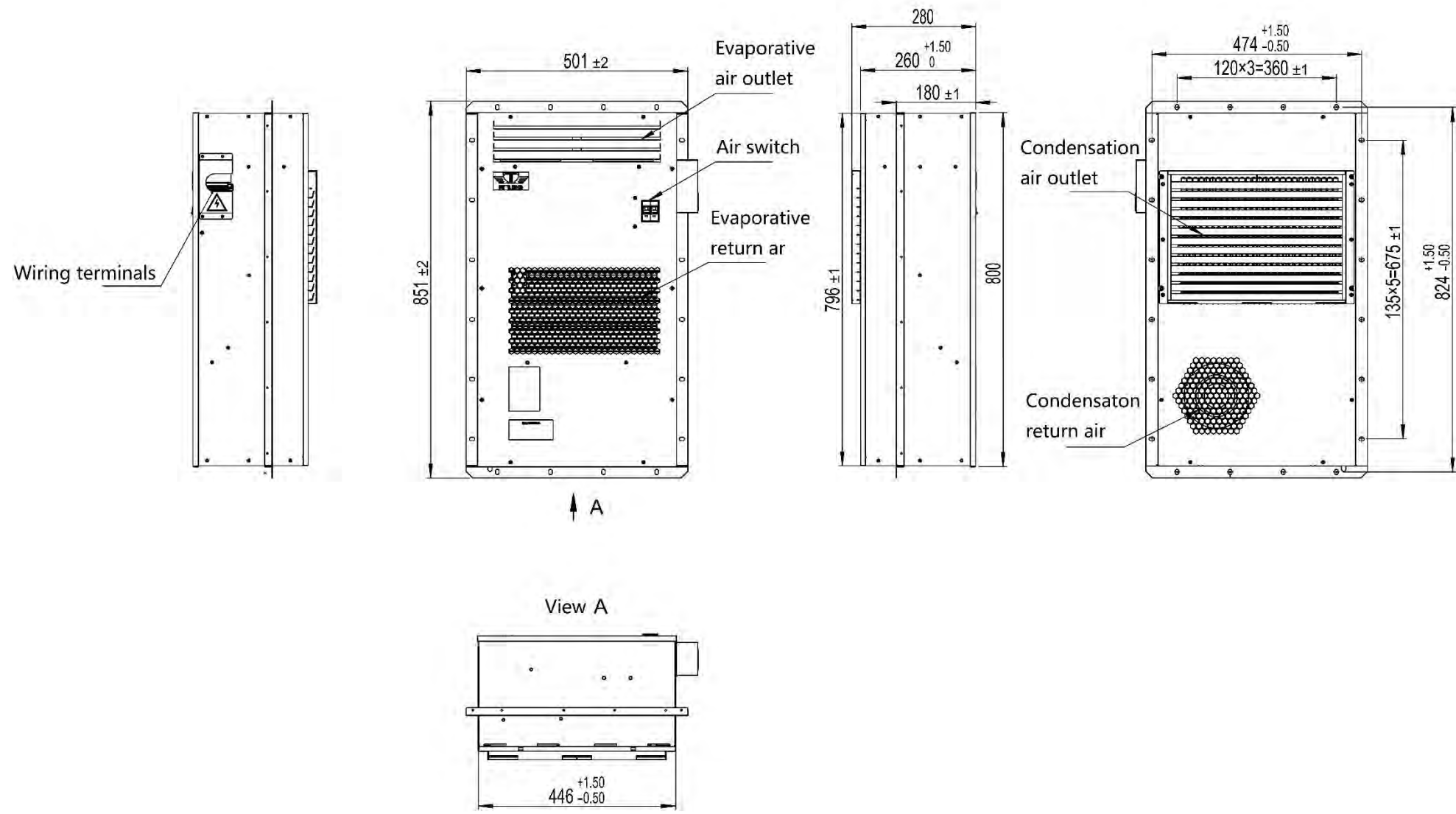
At this time, the upper computer needs to send a start signal or press the break button on the screen to start the refrigeration unit.



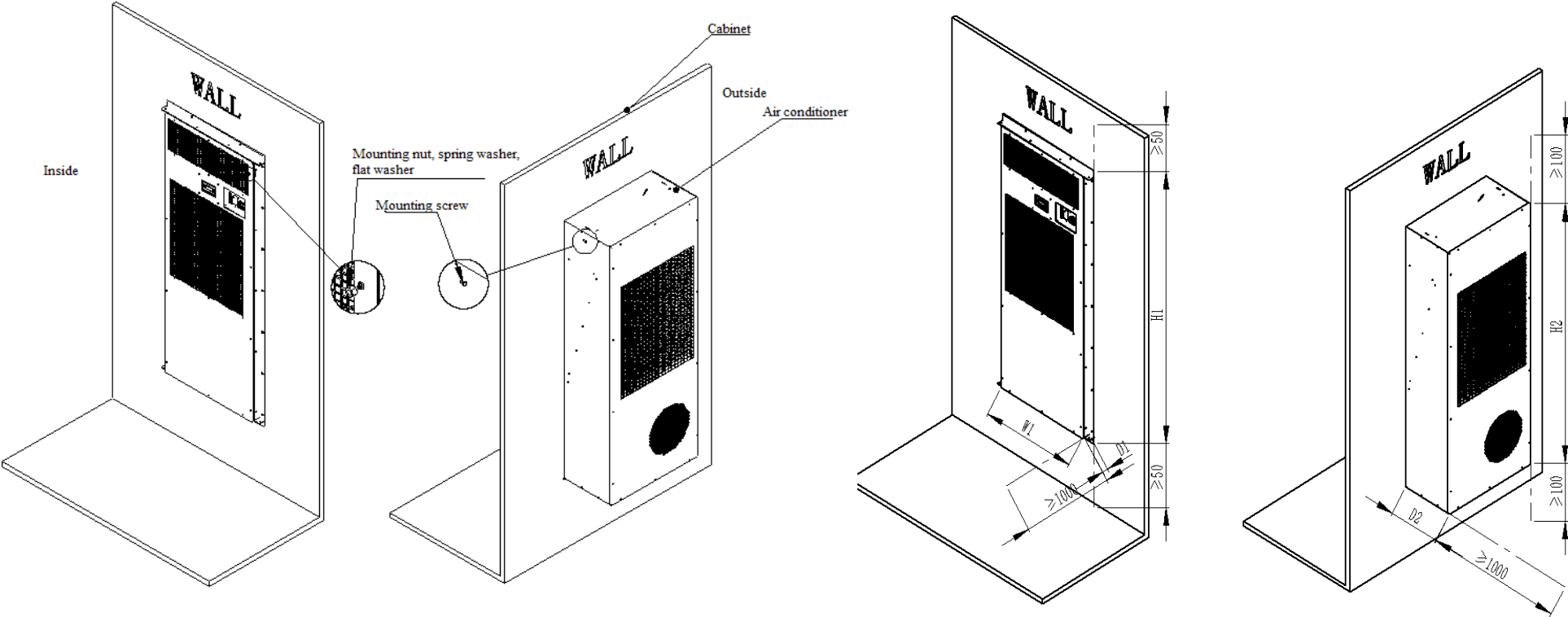
3.3.3 RS485 communication protocol

Controller adopt 485 communication protocol, communication protocol: MODBUS-RTU.

4. Outline drawing



5. Installation Diagram



6. Technical change record

Reason	Content	Page	Date	Modified by	Approved by

SEV1-R3A-35电池系统低电导率冷却液 SEV1-R3A-35 Battery system low conductivity coolant

■ 产品概述

Product Overview

电池系统低电导率冷却液配方采用自主开发的低电离常数、具有特殊分子结构的防锈剂，是一款具有防腐、防沸、抗低温、低电导率等性能的锂离子高压电池专用热交换液；并且对塑料、橡胶等非金属材料部件无化学和物理损害，且添加了独特的流体改性添加剂，具有独特的微流体性能，能有效提高冷却液在电池冷却系统中的流动低压阻的物理性能，可以提高冷却液在微通道长距离的散热铝材中的扩散和热传导性能；极低电导率特性可以有效降低因冷却液泄露导致的沉淀堵塞、电击短路、电器部件腐蚀等现象，适合于高功率磷酸铁锂、镍钴锰酸锂以及钴酸锂等锂离子动力电池系统，也适合于储能电站的冷却交换系统。

The formula of the low conductivity coolant for battery system is a self-developed rust inhibitor with low ionization constant and special molecular structure, which is a special heat exchange fluid for lithium ion high-voltage batteries with corrosion resistance, boiling resistance, low temperature resistance and low conductivity. And has no chemical and physical damage to nonmetallic material parts such as plastics, rubber and the like, and a unique fluid modification additive is added, thus having unique microfluidics performance, effectively improving the physical performance of low pressure resistance of cooling liquid flowing in a battery cooling system, and improving the diffusion and heat conduction performance of cooling liquid in microchannel long-distance radiating aluminum materials; The extremely low conductivity can effectively reduce precipitation blockage, electric shock short circuit and corrosion of electrical components caused by coolant leakage, and is suitable for high-power lithium ion power battery systems such as Ferrous lithium phosphate, lithium nickel cobalt manganate and lithium cobalt oxide, and also suitable for the cooling exchange system of energy storage power stations.

■ 化学成分

Chemical Composition

乙二醇、去离子水、腐蚀抑制剂

Ethylene glycol, deionized water, corrosion inhibitor

■ 主要特点:

Main Feature

●独特的低电离常数和独特的分子结构防锈剂，可在冷却系统内部形成保护膜，有效的抑制电化学腐蚀；

Unique low ionization constant and unique molecular structure antirust agent can form a protective film inside the cooling system, effectively inhibiting electrochemical corrosion;

●内含独特流体改性剂，可以大大提高冷却液在电池冷却液管中的输送能力和热传导能力，控制整个电池包的运行温度；

It contains a unique fluid modifier, which can greatly improve the conveying ability and heat conduction ability of coolant in the battery coolant pipe and control the operating temperature of the whole battery pack;

●不含禁用物质，降低冷却液更换时对环境的污染；

Does not contain prohibited substances, reducing the environmental pollution when the coolant is replaced;

●冷却液具有优异的金属腐蚀保护，适用于当前的电池系统（铝，不锈钢，钢，铁，黄铜，铜）；

Coolant has excellent metal corrosion protection and is suitable for current battery systems (aluminum, stainless steel, steel, iron, brass, copper);

●与传统内燃系统发动机冷却液相比，电池系统冷却液具有更高的电绝缘性。（通过电气绝缘测试）也通过了电池组火灾风险测试。

Compared with the traditional engine coolant of internal combustion system, the battery system coolant has higher electrical insulation. (passed the electrical insulation test) and also passed the battery pack fire risk test.

■ 适用范围

Scope of Application

适用于电动汽车冷却系统，储能系统，风电系统等冷却液系统。

Suitable for electric vehicle cooling system, energy storage system, wind power system and other coolant systems.

■ 注意事项:

Matters Need Attention

●储存条件应密封，阴凉，干燥；不建议更换产品包装，使用后应及时密封，防止杂质及气体混入导致污染而降低绝缘性；

Storage conditions should be sealed; cool and dry. It is not recommended to replace the product packaging, and it should be sealed in time after use to prevent impurities and gases from mixing and causing pollution and reducing insulation;

●加注时应使用PP、HDPE或304及以上不锈钢材质储存及加注设备，保证加注设备及管道密封无污染，防止杂质及气体混入导致污染而降低绝缘性；

When filling, storage and filling equipment made of PP, HDPE or 304 or above stainless steel should be used to ensure that the filling equipment and pipeline are sealed without pollution, and to prevent impurities and gas from mixing and causing pollution and reducing insulation;

●本产品仅用于电池电动汽车，不适用于内燃机车辆；

This product is only used for battery electric vehicles, not for internal combustion engine vehicles;

●请将产品存放在常温常湿（20±5℃，65±5%rh）无光或弱光照环境中，禁止在阳光下长期放置。

Please store the product in the dark or weak light environment at Normal temperature and humidity (20±5℃, 65±5%rh). Do not place the product under sunshine for a long time.

●当电池系统冷却液与其他发动机冷却液混合时，会降低电绝缘性，因此不要将该冷却液与卡舌水或其他冷却液混合。

When the battery system coolant is mixed with other engine coolants, it will reduce the electrical insulation, so don't mix this coolant with tongue water or other coolants.

■ 符合标准

Meet the Standards

● Q/320991SY 002-2024

■ 典型参数
Typical Specifications

检测项目 Test Items		指标要求 Requirements	典型数值 Typical Value	分析方法 Analytical Methods
乙二醇浓度/% Glycol concentration/%		≥50.0	50	—
外观 Appearance		无沉淀及悬浮物，清亮透明液体 No precipitation and suspended matter, clear and transparent liquid	无沉淀及悬浮物，清亮透明液体 No precipitation and suspended matter, clear and transparent liquid	目测 Visual Inspection
颜色 Colour		有醒目的颜色 It has striking colors	红色 RED	目测 Visual Inspection
气味 Odour		无刺激性异味 Non-irritating odor	无刺激性异味 Non-irritating odor	嗅觉 Smell
密度, kg/m³ Density, kg/m³	-30°C	—	1091	SH/T 0068
	-20°C		1086	
	-10°C		1085	
	-0°C		1081	
	20°C		167	
	40°C		1063	
	60°C		1052	
	80°C		1038	
冰点(°C) Freezing Point(°C)		≤-35.0	-38.2	SH/T 0090
沸点(°C) Boiling Point (°C)		≥107.5	110.5	SH/T 0089
pH		7.0-10.0	8.75	SH/T 0069
灰分 (质量分数) /% Ash (mass fraction) /%		≤1.5	0.01	SH/T 0067
氯含量(mg/kg) Chlorinity(mg/kg)		≤10	未检出 N.D.	JT/T 1230
硫酸盐含量 (以SO ₄ ²⁻ 计)/(mg/kg) Sulfate Content (as SO ₄ ²⁻)/(mg/kg)		≤10	未检出 N.D.	JT/T 1230
硼含量 (以 B 计) / (mg/kg) Boron content (as B) /(mg/kg)		≤10	未检出 N.D.	NB/SH/T 0802
储备碱度(ml) Reserve Alkalinity (ml)		报告值 Report Value	2.3	SH/T 0091
对汽车有机涂料的影响 The Influence of Organic Coating on Automobile		无影响 No Effect	无影响 No Effect	SH/T 0084
导热系数, W/ (m·K) Thermal Conductivity, W/(m·K)	-30°C	—	0.352	ASTM D7896
	-20°C		0.369	
	-10°C		0.378	
	-0°C		0.387	
	20°C		415	
	40°C		0.418	
	60°C		0.424	
	80°C		0.435	
比热容, J/ (kg·K) Specific heat capacity, J/ (kg·K)	-30°C	—	3133	SY/T 7517
	-20°C		3200	
	-10°C		3217	
	-0°C		3269	
	20°C		3298	
	40°C		3378	
	60°C		3437	
	80°C		3545	

运动粘度, mm ² /s Kinematic viscosity, mm ² /s		-30°C	—	39.89	GB/T 265
		-20°C		17.82	
		-10°C		11.65	
		-0°C		7.46	
		20°C		3.18	
		40°C		2.09	
		60°C		1.27	
		80°C		0.92	
电导率 (25°C) (μS/ cm) Conductivity (25°C) (μS/ cm)			≤100	68.4	GB29743.2 附录A GB29743.2 Annex A
泡沫倾向 Foaming	30±1°C	泡沫体积/ml Volume /ml	≤100	50	SH/T 0066
		泡沫消失时间/s Break Time /s	≤5.0	1.3	
	80±1°C	泡沫体积/ml Volume /ml	≤100	45	
		泡沫消失时间/s Break Time /s	≤5.0	1.2	
静态腐蚀 Static corrosion (80°C±2°C, 336h±2h)	质量变化, mg/试片 Weight change, mg/test piece	紫铜 Copper	±10	+ 0.2	GB29743.2 附录B GB29743.2 Annex B
		黄铜 Brass	±10	-0.4	
		钢 Steel	±10	+ 0.7	
		ZL101A 铸铝 ZL101A Cast Aluminium	±10	+ 0.3	
		3003 铝 3003 Aluminum	±10	-0.4	
		4043 铝 3003 Aluminum	±10	-0.5	
		6063 铝 3003 Aluminum	±10	-0.2	
循环台架腐蚀 Cyclic bench corrosion (80°C±2°C, 1064h±2h)	质量变化, mg/试片 Weight change, mg/test piece	紫铜 Copper	±10	+ 1.7	GB29743.2 附录C GB29743.2 Annex C
		黄铜 Brass	±10	+ 1.9	
		钢 Steel	±10	-0.8	
		ZL101A 铸铝 ZL101A Cast Aluminium	±10	-0.5	
		3003 铝 3003 Aluminum	±10	+ 1.0	
		4043 铝 3003 Aluminum	±10	-0.2	
		6063 铝 3003 Aluminum	±10	-0.4	
	试验后溶液性能 Post-test solution properties	pH	6.5~10.0	8.52	
		pH变化值 pH change value	±1.0	0.18	
		电导率 (25°C) (μS/ cm) □Conductivity (25°C) (μS/ cm)	≤300	143	
橡胶材料兼容性 Rubber material compatibility (80°C±2°C, 168h±2 h)	三元乙丙橡胶 EPDM	硬度变化(IRHD) Hardness change (IRHD)	±5	-2	GB29743.2 附录D GB29743.2 Annex D
		体积变化率, % Volume change, %	±5	0.1	
		断裂拉伸强度变化率, % Tensile strength change, %	±15	-7.8	
		拉伸伸长率变化率, % Elongation change rate at break, %	±30	3.7	
	硅橡胶 Silicon Rubber	硬度变化(IRHD) Hardness change (IRHD)	±5	-1	
		体积变化率, % Volume change, %	±5	0.4	
		断裂拉伸强度变化率, % Tensile strength change, %	±15	-2.1	
		拉伸伸长率变化率, % Elongation change rate at break, %	±30	-2.6	

高温稳定性 High Temperature Stability (135°C±1°C, 168h±2h)	重量变化, mg/cm² Weight change, mg/cm²	±1.0	-0.43	SH/T 0620
	试验后溶液沉淀量/mL Amount of solution precipitation after the test/mL	≤0.5	< 0.05	GB29743.1 附录D GB29743.1 Annex D
储存稳定性 (60°C±2°C, 336h±2h) Storage stability (60°C±2°C, 336h±2h)		颜色无明显变化, 无沉淀及悬浮物 No obvious change in color, no precipitation and suspended matter	颜色无明显变化, 无沉淀及悬浮物 No obvious change in color, no precipitation and suspended matter	GB29743.1 附录D GB29743.1 Annex D
耐硬水稳定性 (90°C±2°C, 336h±2h) Hard water resistance stability (90°C±2°C, 336h±2h) 沉淀物体积, mL precipitate volume, mL		≤0.5	<0.05	GB29743.1 附录D GB29743.1 Annex D
汽车禁用物质, mg/kg Prohibited substances in automobiles, mg/kg	铅 Pb	≤1000	未检出 N.D.	GB/T 30512
	镉 Cd	≤1000	未检出 N.D.	
	汞 Hg	≤1000	未检出 N.D.	
	六价铬 Cr	≤1000	未检出 N.D.	
	多溴联苯 PBBs	≤1000	未检出 N.D.	
	多溴联苯醚 PBDEs	≤1000	未检出 N.D.	

■ 质量控制

Quality control

所列数据为本数据表在出版时的平均值。这些数据只可作为指导数据, 但不可作为产品的特定数据。
The data listed is the average value of this data sheet at the time of publication. These data can only be used as guidance data, but not as specific.

■ 安全

Safety

使用该产品时, 需了解安全数据表中的所有信息和使用建议, 应注意处理化学品时必要的预防措施。
When using this product, you need to know all the information and usage suggestion in the MSDS, and pay attention to the necessary preventive measures when handling chemicals.

■ 免责声明

Disclaimers

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SEV1-R3A-35 Battery system low conductivity coolant

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version: 1.3	Revision Date: 2024-09-25	SDS Number: SY-TD-MSDS-042	Issue date: 2021-05-19

第1部分 化学品及企业标识
Section 1 Chemicals and corporate identification

产品名称 Product Name	: 电动汽车低电导率冷却液 Low conductivity coolant for electric vehicle
产品代码 Product Code	: SEV1-R3A-35
供应商/制造商 Supplier/Manufacturer	: 江苏三阳环保科技有限公司 Jiangsu Samyang Environmental Science Technology Co., Ltd.
地址 Address	: 江苏省盐城市经济技术开发区盐澳东路117号No.117 Yandu East Road, Yancheng Economic and Technological Development Zone, Jiangsu Province
电话 Telephone	: 0515-88256551
应急咨询电话 Emergency consultation telephone	: 0515-88256551
电子邮件 E-mail	: xinxinzheng@samyangind.com
推荐用途 Recommended uses	: 防冻剂、冷却剂 Antifreeze、Coolant

第2部分 危害识别
Section 2 Hazards identification

危险性类别
Classification

急性毒性 (经口) Acute Toxicity--Oral	: 类别 4 Category 4
特异性靶器官系统毒性(反复接触) Specific target organ toxicity--repeated exposure	: 类别 2 Category 2

标签要素
Label elements

象形图
Hazard Pictograms



信号词 Signal Word(S)	: 警告 Warning
危险性说明 Hazard Statement	: H302 吞咽有害。 H302 Harmful if swallowed. H373 长期或反复接触可能损害器官。 H373 Prolonged or repeated exposure may cause damage to organs.
防范说明 Precautionary statement	: P260 不要吸入烟雾或蒸气。 P260 Do not breathe dust/fume/gas/mist/vapours/spray. P264 作业后彻底清洗皮肤。 P264 Wash thoroughly after work. P270 使用本产品时不要进食、饮水或吸烟。 P270 Do not eat, drink or smoke when using this product. P301 + P312 如误吞咽: 如感觉不适, 呼叫急救中心/医生。 P301+P312 IF SWALLOWED: Call a poison center/doctor if you feel unwell. P330 漱口。 P330 Rinse mouth. P314 如感觉不适, 须求医/就诊。 P314 If you feel unwell, you must seek medical advice. P501 将内容物/容器送到批准的废物处理厂处理。 P501 Dispose of contents/container in accordance with local regulation.

物理和化学危险
Physical and chemical hazards

根据现有信息无需进行分类。
According to the existing information, classification is unnecessary.

健康危害
Health hazard

吞咽有害。 长期或反复接触可能损害器官。
Swallowing is harmful. Long-term or repeated contact may damage organs.

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环境危害

Environmental harm

根据现有信息无需进行分类。
According to the existing information, classification is unnecessary.

GHS 未包括的其他危害

Other hazards not covered by GHS

未见报道。
No report.

第3部分 成分/组成信息

Section 3 Composition/information on ingredients

纯品/混合物
Substance/Mixture

组分
Component

化学品名称 Chemical Name	化学文摘登记号 CAS No.	浓度或浓度范围 (% w/w) Proportion range (% w/w)
乙二醇 Ethylene glycol	107-21-1	50-55%
EDI去离子水 EDI deionized water	7732-18-5	45-50%
添加剂 Additives	N/A	1-5%

第4部分 急救措施

Section 4 First aid measures

急救措施描述

Description of first aid measures

吸入 In case of inhalation	如果有疑问，或症状持续，请就医。 In all cases of doubt, or when symptoms persist, seek medical attention.
皮肤接触 In case of skin contact	移到有新鲜空气的地方，保持呼吸道畅通。如果呼吸困难，给病人吸氧，并征求医生意见。 Move to fresh air. If breathing has stopped, give artificial respiration first aid. Seek medical attention.
眼睛接触 In case of eyes contact	脱掉被污染的衣服，用肥皂和水彻底冲洗皮肤。如果发生皮肤炎症或皮疹，请就医。 Take off contaminated clothing. Rinse the skin thoroughly with soap and water. Seek medical attention if skin inflammation or rash occurs.
食入 In case of ingestion	用大量水冲洗眼睛至少 15 分钟，就医。 Flush eyes with plenty of water for at least 15 minutes. Seek medical attention.

最重要的急性和迟发性症状和影响

Most important symptoms and effects, both acute and delayed

它会导致眼睛发炎，例如发红和视力模糊。食入和呕吐可能导致化学物质进入肺部，引起肺炎和肺损伤。据悉，过量摄入会导致肝肾损害。接触蒸汽或雾气会导致鼻子、喉咙和肺部发炎。出现头痛、恶心、嗜睡、意识不清和头晕等症状。短期接触皮肤会引起轻微的炎症。长期皮肤接触会引起更严重的炎症和不适，局部红肿。
It can cause inflammation of the eyes, such as redness and blurred vision. Ingestion and vomiting may cause chemicals to enter the lungs, causing pneumonia and lung damage. It is reported that excessive intake can cause liver and kidney damage. Exposure to steam or mist can cause inflammation of the nose, throat, and lungs. Symptoms such as headache, nausea, drowsiness, unconsciousness, and dizziness. Short-term contact with the skin can cause slight inflammation. Long-term skin contact can cause more severe inflammation and discomfort, local redness and swelling.

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需要立即就医和特别治疗的迹象

Indication of any immediate medical attention and special treatment needed

中毒的迹象有点类似于一般的醉酒，最初是兴奋，然后是昏迷和抽搐。症状包括手舞足蹈、困倦、呕吐、腹泻、口渴和抽搐。中毒的最后阶段包括因酸中毒引起的肾脏损害。静脉注射酒精可作为乙二醇/二甘醇的解毒剂。及时治疗可减少肾脏损害，必要时进行血液透析。如果吞食后自然发生呕吐，因吸入肺部而出现呼吸困难的患者应监测至 48 小时。
The signs of poisoning are somewhat similar to general drunkenness, with initial excitement followed by coma and convulsions. Symptoms include hand dancing, drowsiness, vomiting, diarrhea, thirst, and convulsions. The final stage of poisoning includes kidney damage due to acidosis. Intravenous alcohol injection can be used as an antidote to ethylene glycol/diethylene glycol. Timely treatment can reduce kidney damage, and hemodialysis if necessary. If vomiting has occurred naturally after ingestion, patients with dyspnea should be monitored until 48 hours due to inhalation of the lungs.

第5部分 消防措施

Section 5 Firefighting measures

灭火剂

Extinguishing media

适用的灭火剂

Suitable extinguishing media

泡沫、洒水或喷雾。化学干粉、二氧化碳、沙子或泥浆只能用于小规模火灾。

Foam,sprinkle water or spray.Dry chemical powder,carbon dioxide,sand or mud should only be used for small-scale fires.

不合适的灭火剂

Unsuitable extinguishing media

水射流和卤化物灭火剂。

Water jet.Halide fire extinguisher.

有害分解产物或副产物

Special hazards arising from the substance or mixture

有害燃烧物品可能包括：空气中固体和液体颗粒和气体（烟雾）的复杂混合物，一氧化碳，无法识别的有机和无机化合物。

Hazardous combustion items may include: A complex mixture of airborne solids and liquid particles and gases (smoke). Carbon monoxide, unrecognized organic and inorganic compounds.

消防建议

Advice for firefighters

如果发生火灾，请佩戴自给式呼吸器。使用个人防护装备，使用个人防护装备，用水喷雾冷却容器/罐。

In the event of fire,wear self-contained breathing apparatus.Use personal protective equipment.Wear chemical resistant oversuit.Cool containers/tanks with water spray.

第6部分 泄漏应急处理

Section 6 Accidental release measures

作业人员防护措施、防护设备和应急程序

Personal precautions, protective equipment and emergency procedures

非紧急工作人员

For non-emergency personnel

在确保安全的前提下，防止进一步泄漏或溢出。远离不安全的产品。

Prevent further leakage or spillage if safe to do so. Keep away from Incompatible products.

紧急救援人员

For emergency responders

将人员疏散到安全区域，让人们远离溢出/泄漏点和上风处，使该区域通风，并穿戴合适的防护服。

Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ventilate the area. Wear suitable protective clothing.

环境保护措施

Environmental Precautions

不应释放到环境中；不要冲入地表水或下水道系统。如果产品污染河流和湖泊或下水道，请通知有关当局。

Should not be released into the environment. Do not flush into surface water or sanitary sewer system. If the product contaminates rivers and lakes or drains inform respective authorities.

遏制和清理的方法和材料

Methods and material for Containment and Cleaning up

使用沙子、泥土或其他可用作屏障的材料来设置屏障以防止扩散；直接回收液体或储存在吸收剂中；用清洁剂、水和硬扫帚清洁污染区域，将收集的液体放入一次性容器中。

Use sand, mud or other materials that can be used as barriers to set up barriers to prevent diffusion. Recover liquid directly or store in absorbent. Clean the contaminated area with detergent, water and a hard broom. Put the collected liquid in a disposable container.

参考其他部分

Reference to other sections

有关安全处理的信息，请参阅第7节。

See Section 7 for information on safe handling.

有关个人防护设备的信息，请参阅第8节。

See Section 8 for information on personal protection equipment.

有关处置的信息见第13节。

See Section 13 for information on disposal.

第7部分 操作处置与储存

Section 7 Handling and storage

安全操作注意事项

Precautions for safe handling

防护措施

Protective measures

加强通风，操作人员必须经过专门培训，严格遵守操作规程。建议操作人员佩戴口罩、化学安全眼镜和橡胶手套。应急处理设备和合适的容器材料，以防止蒸汽泄漏。避免长时间或持续的皮肤接触。避免吸入蒸汽和/或烟雾。

To strengthen ventilation, operators must undergo special training and strictly abide by the operating regulations. It is recommended that operators wear face masks, chemical safety glasses, and rubber gloves. Emergency treatment equipment and suitable containment materials to prevent steam leakage. Avoid prolonged or continuous skin contact. Avoid inhaling vapors and/or fumes.

职业卫生建议

Advice on general occupational hygiene

不要在工作区域吃东西、喝水和吸烟。使用后洗手。在进入饮食区之前，脱掉受污染的衣服和防护设备。

Do not eat, drink and smoke in work areas. Wash hands after use. Remove contaminated clothing and protective equipment before entering eating areas.

安全存储条件，包括不相容的物质

Conditions for safe storage, including any incompatibilities

将容器密闭，置于阴凉通风处。使用贴有标签且可密封的容器。储存温度：长期储存（3个月以上）-15 ~ 50℃；短期储存 -20 ~ 60℃。容器或容器内衬应采用低碳钢或高密度聚乙烯。避免在容器或容器内层使用PVC。

Keep container tightly closed in a cool and well-ventilated place. Use properly labeled and sealable containers. Storage temperature: long-term storage (more than 3 months) -15 ~ 50 °C; short-term storage -20 ~ 60 °C. For the container or container lining, mild steel or high-density polyethylene should be used. Avoid using PVC in the container or the inner layer of the container.

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特殊用途
Specific end use(s) : 不适用。
Not available.

第8部分 接触控制和个体防护
Section 8 Exposure Controls/Personal Protection

危害组成及职业接触限值
Composition and occupational exposure limits

化学品名称 Chemical Name	化学文摘登记号 CAS No.	数值的类型 (接触形式) Type of numerical value (contact)	控制参数 / 容许浓度 Occupational Exposure Limit	依据 Basis
乙二醇 Ethylene Glycol	107-21-1	PC-TWA	20 mg/m³	CN OEL
		PC-STEL	40 mg/m³	CN OEL
		TWA(蒸气)	25 ppm	ACGIH
		TWA (steam)		
		STEL(蒸气)	50 ppm	ACGIH
		STEL (steam)		
		STEL(可吸入性粉尘, 仅气溶胶)	10 mg/m³	ACGIH
		STEL (respirable dust, aerosol only)		

工程控制
Engineering controls : 确保充分通风。采取技术措施以符合职业接触限值。
Ensure adequate ventilation. Apply technical measures to comply with the occupational exposure limits.

个人防护措施
Individual protection measures

眼睛/面部防护
Eye/face protection : 如果可能发生飞溅，请佩戴护目镜或全面罩。
If splashing may occur, wear safety goggles or a full face mask.

手部防护
Hand protection : 戴上防护手套。适用材料：PVC、氯丁橡胶或丁腈橡胶手套。
Wear protective gloves. Suitable material: PVC, Neoprene or nitrile rubber gloves.

身体防护
Body protection : 耐化学品实验服。PVC 实验服/靴子，氯丁橡胶以防灰尘。
Chemical resistant apron. Apron/boots of PVC, neoprene in case of dusts.

呼吸系统防护
Respiratory protection : 在正常使用条件下，一般不需要佩戴呼吸防护设备。如果工程控制设施不能将空气浓度维持在足以保护人员健康的水平，请选择适合使用条件并符合相关法律要求的呼吸防护设备。如果您需要佩戴安全过滤式口罩，请选择合适的口罩和过滤器组合，选择适合微粒/有机气体和蒸气混合物的过滤器（沸点 >65°C）。
Under normal conditions of use, it is generally not necessary to wear respiratory protection equipment. If the engineering control facility does not maintain the air concentration at a level sufficient to protect the health of personnel, choose respiratory protection equipment suitable for the conditions of use and in compliance with relevant legal requirements. If you need to wear a safety filter mask, please choose a suitable mask and filter combination. Choose a filter suitable for a mixture of particulate/organic gas and vapor [boiling point > 65°C (149 °F)].

热危害
Thermal hazards : 穿戴合适的防护服以防止受热。
Wear suitable protective clothing to prevent heat.

环境暴露控制
Environmental exposure controls : 避免排放到环境中。
Avoid discharge into the environment.
根据当地法规、联邦和官方法规。
According to local regulations, Federal and official regulations.

第9部分 理化特性
Section 9 Physical and chemical properties

外观与性状
Appearance : 无沉淀及悬浮物、明亮透明液体。
No sediment and suspended materials, bright and clear transparent solution.

颜色
Colour : 红色
Red

气味
Odour : 无刺激性异味
No pungent peculiar odour

气味阈值
Odour threshold : 不适用
Not available.

pH : 7.0-10.0

凝固点
Freezing point : ≤-35°C

沸点
Boiling point : ≥107.5°C

闪点
Flash point : 不适用
Not available.

蒸发速率
Evaporation rate : 不适用
Not available.

易燃性(固体, 气体)
Flammability (solid, gas) : 不适用
Not available.

易燃(液体)
Flammability limit : 不适用
Not available.

爆炸上限 / 可燃性上限
Upper explosive limits : 15.3 % (乙二醇)
15.3 % (ethylene glycol)

爆炸下限 / 可燃性下限
Lower explosive limits : 3.2 % (乙二醇)
3.2 % (ethylene glycol)

蒸气压
Vapour pressure : 不适用
Not available.

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SEV1-R3A-35 Battery system low conductivity coolant

蒸气密度	不适用
Vapour density	Not available.
密度/相对密度	≥1.060(20°C)
Relative Density	
电导率	≤100μS/cm
Conductivity	
水溶性	溶于冷水 (20°C)
Water solubility	Soluble in cold water (20°C)
正辛醇/水分配系数	不适用
n-Octanol/Water	Not available.
自燃温度	不适用
Auto-ignition temperature	Not available.
分解温度	不适用
Decomposition temperature	Not available.
运动黏度	不适用
Viscosity, dynamic	Not available.
爆炸特性	无爆炸性
Explosive properties	Nonexplosive
氧化性	此物质或混合物不被分类为氧化剂。
Oxidising properties	This substance or mixture is not classified as an oxidant.

第10部分 稳定性和反应性
Section 10 Stability and reactivity

反应性	该物质在正常储存和处理条件下是稳定的。
Reactivity	The substance is stable under normal storage and handling conditions.
稳定性	在正常储存和处理条件下，在密闭容器中室温下稳定。
Chemical stability	Stable at room temperature in closed containers under normal storage and handling conditions.
危险反应	没有已知的危险反应。
Possibility of hazardous reactions	No dangerous reactions known.
应避免的条件	不相容的材料。极端温度和阳光直射。
Conditions to avoid	Incompatible materials. Extreme temperature and direct sunlight.
禁配物	强氧化剂。
Incompatible materials	Strong oxidizing agents.
危险的分解产物	一氧化碳，无法识别的有机和无机化合物。
Hazardous decomposition products	Carbon monoxide, unrecognized organic and inorganic compounds.

第11部分 毒理学信息
Section 11 Toxicological information

接触途径	吸入
Contact route	In case of inhalation
	皮肤接触
	In case of skin contact
	食入
	In case of eyes contact
	眼睛接触
	In case of ingestion
急性毒性	吞咽有害。
Acute toxicity	Harmful to swallow.
产品	
Product	
急性经口毒性	急性毒性估计值： 1,191 mg/kg
Acute oral toxicity	Estimated acute toxicity: 1,191 mg/kg
	方法： 计算方法
	Methods: Calculation method.
组分	
Component	
乙二醇	
Ethylene glycol	
急性经口毒性	急性毒性估计值： 500mg/kg
Acute oral toxicity	Estimated acute toxicity: 500mg/kg
	方法： 专家意见
	Methods: Expert opinion.
急性吸入毒性	LC50 (大鼠): > 2.5 mg/l
Acute inhalation toxicity	LC50 (rat): > 2.5 mg/L
	暴露时间： 6 小时
	Exposure time: 6 hours
	测试环境： 粉尘/烟雾
	Test environment: dust/smoke
急性经皮毒性	LD50 (小鼠): > 3,500 mg/kg
Acute percutaneous toxicity	LD50 (mice): > 3,500 mg/kg
皮肤腐蚀/刺激	根据现有信息无需进行分类。
Skin corrosion/irritation	According to the existing information, classification is unnecessary.
组分	
Component	
乙二醇	
Ethylene glycol	

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SEV1-R3A-35 Battery system low conductivity coolant

种属	:	家兔
Species	:	Rabbit
结果	:	无皮肤刺激
Result	:	No skin irritation
严重眼睛损伤/眼刺激		
Serious eye injury/eye irritation		
组分		
Component		
乙二醇		
Ethylene glycol		
种属	:	家兔
Species	:	Rabbit
结果	:	无眼睛损伤/眼刺激
Result	:	No eye injury/eye irritation
呼吸或皮肤过敏		
Respiratory or skin allergy		
组分		
Component		
乙二醇		
Ethylene glycol		
测试类型	:	最大反应试验
Test type	:	Maximum response test
接触途径	:	皮肤接触
Contact route	:	Skin contact
种属	:	豚鼠
Species	:	Guinea pig
结果	:	阴性
Result	:	Negative
生殖细胞致突变性		
Germ cell mutagenicity		
组分		
Component		
乙二醇		
Ethylene glycol		
体外基因毒性	:	
In vitro genotoxicity	:	
测试类型	:	细菌回复突变试验 (AMES)
Test type	:	Bacterial reversion mutation test (AMES)
方法	:	OECD测试导则 471
Methods	:	OECD test guideline 471
结果	:	阴性
Result	:	Negative
致癌性		
Carcinogenicity		
组分		
Component		
乙二醇		
Ethylene glycol		
种属	:	小鼠
Species	:	Mouse
染毒途径	:	食入
Exposure route	:	Ingestion
暴露时间	:	2 年
Duration of exposure	:	2 years
结果	:	阴性
Result	:	Negative
生殖毒性		
Reproductive toxicity		
特异性靶器官系统毒性- 一次接触		
STOT- single exposure		
特异性靶器官系统毒性- 反复接触		
STOT-repeated exposure		
组分		
Component		
乙二醇		
Ethylene glycol		
接触途径	:	食入
Contact route	:	Ingestion
靶器官	:	肾
Target organ	:	Kidney
评估	:	在浓度10 -100 mg/kg体重时,在动物身上显示出产生了明显的健康影响。
Estimate	:	When the concentration is 10 -100 mg/kg body weight, it shows obvious health effects on animals.

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SEV1-R3A-35 Battery system low conductivity coolant

重复染毒性 Repeated toxicity	根据现有信息无需进行分类。 According to the existing information, classification is unnecessary.
组分 Component	
乙二醇 Ethylene glycol	
种属 Species	大鼠 Rat
NOAEL	150 mg/kg
染毒途径 Exposure route	食入 Ingestion
暴露时间 Duration of exposure	2 年 2 years
种属 Species	犬 Dog
NOAEL	2,200 - 4,400 mg/kg
染毒途径 Exposure route	皮肤接触 Skin contact
暴露时间 Duration of exposure	4 周 4 weeks
方法 Methods	OECD 测试导则 410 OECD test guideline 410
吸入危害 Aspiration hazard	根据现有信息无需进行分类。 According to the existing information, classification is unnecessary.

第12部分 生态学信息
Section 12 Ecological information

生态毒性 Toxicity	根据现有信息无需进行分类。 According to the existing information, classification is unnecessary.
组分 Component	
乙二醇 Ethylene glycol	
对鱼类的毒性 Toxicity to fish	
LC50(肥头鲈鱼) LC50(Pimephales promelas)	72,860 mg/l
暴露时间 Duration of exposure	96 小时 96 hours
对水蚤和其他水生无脊椎动物 For Daphnia and other aquatic invertebrates	
EC50 (水蚤) EC50 (Daphnia magna)	> 100 mg/l
暴露时间 Duration of exposure	48 小时 48 hours
方法 Methods	OECD 测试导则 202 OECD test guideline 202
对藻类/水生植物的毒性 Toxicity to algae/aquatic plants	
EC50(绿藻) EC50(Pseudokirchneriella subcapitata)	6,500 -13,000 mg/l
暴露时间 Duration of exposure	96 小时 96 hours
对鱼类的毒性 (慢性毒性) Toxicity to fish (chronic toxicity)	
NOEC (肥头鲈鱼) NOEC(Pimephales promelas)	15,380 mg/l
暴露时间 Duration of exposure	7天 7 days
对水蚤和其他水生无脊椎动物的毒性(慢性毒性) Toxicity to Daphnia and other aquatic invertebrates (chronic toxicity)	
NOEC (肥头鲈鱼) NOEC(Pimephales promelas)	8590 mg/l
暴露时间 Duration of exposure	7 天 7 days
持久性和降解性 Durability and degradability	
组分 Component	
乙二醇 Ethylene glycol	
生物降解性 Biodegradability	
结果 Result	快速生物降解的。 Rapidly biodegradable.

SEV1-R3A-35电池系统低电导率冷却液
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生物降解性	90 - 100 %
Biodegradability	
暴露时间	10 天
Duration of exposure	10 days
方法	OECD 测试导则 301A
Methods	OECD test guideline 301A

生物蓄积潜力
Biological accumulation potential

组分

Component

乙二醇

Ethylene glycol

生物蓄积

Biological accumulation

种属	高体雅罗鱼
Species	Leuciscus idus
生物富集系数(BCF)	10
Bioconcentration factors (BCF)	
正辛醇/水分配系数(Log Pow)	-1.93
N-Octanol/Water Partition Coefficient(Log Pow)	

土壤中的迁移性

Mobility in soil	会溶于水。如果本产品侵入土壤，由于其高流动性，可能会污染地下水。 Will dissolve in water. If this product invades the soil, it may pollute the groundwater because of its high mobility.
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其他环境有害作用

Other harmful effects on the environment	不适用 Not available.
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第13部分 废弃处置

Section 13 Disposal considerations

处置方法

Waste treatment methods

废弃处置前应参考国家和地方有关法规，采用回收/循环再造，否则建议采用焚化方法处理空容器可能含有有害残留物。不要在容器上或容器附近切割、穿刺或焊接。容器上的标签在清洗后才能取下。受污染的容器不能作为家庭废物处理。容器应以适当的方法清洁，或以填埋或焚化的方式处置。不要焚烧封闭容器。
Dispose of in accordance with all applicable local and national regulations. Use recovery/recycling where feasible, otherwise incineration is the recommended method of disposal. Empty containers may contain hazardous residues. Do not cut, puncture or weld on or near to the container. Labels should not be removed from containers until they have been cleaned. Contaminated containers must not be treated as household waste. Containers should be cleaned by appropriate methods and then re-used or

第14部分 运输信息

Section 14 Transport information

国际法规

International regulations

陆运(UNRTDG)

Land transport(UNRTDG)

联合国编号	不适用于供应的产品。
UN number	Not applicable to the supplied products.
联合国运输名称	不适用于供应的产品。
UN Proper shipping name	Not applicable to the supplied products.
运输风险类别	不适用于供应的产品。
Transport hazard Class(es)	Not applicable to the supplied products.
次要危险性	不适用于供应的产品。
Secondary danger	Not applicable to the supplied products.
包装类别	不适用于供应的产品。
Packing group	Not applicable to the supplied products.
标签	不适用于供应的产品。
Label	Not applicable to the supplied products.

空运(ATA-DGR)

Air transport(ATA-DGR)

联合国编号	不适用于供应的产品。
UN number	Not applicable to the supplied products.
联合国运输名称	不适用于供应的产品。
UN Proper shipping name	Not applicable to the supplied products.
运输风险类别	不适用于供应的产品。
Transport hazard Class(es)	Not applicable to the supplied products.
次要危险性	不适用于供应的产品。
Secondary danger	Not applicable to the supplied products.
包装类别	不适用于供应的产品。
Packing group	Not applicable to the supplied products.
标签	不适用于供应的产品。
Label	Not applicable to the supplied products.
包装说明(货运飞机)	不适用于供应的产品。
Package description (cargo plane)	Not applicable to the supplied products.
包装说明(客运飞机)	不适用于供应的产品。
Package description (passenger aircraft)	Not applicable to the supplied products.

海运(IMDG-Code)

Sea transport(IMDG-Code)

SEV1-R3A-35电池系统低电导率冷却液
SEV1-R3A-35 Battery system low conductivity coolant

联合国编号 UN number	:	不适用于供应的产品。 Not applicable to the supplied products.
联合国运输名称 UN Proper shipping name	:	不适用于供应的产品。 Not applicable to the supplied products.
运输风险类别 Transport hazard Class(es)	:	不适用于供应的产品。 Not applicable to the supplied products.
次要危险性 Secondary danger	:	不适用于供应的产品。 Not applicable to the supplied products.
包装类别 Packing group	:	不适用于供应的产品。 Not applicable to the supplied products.
标签 Label	:	不适用于供应的产品。 Not applicable to the supplied products.
EmS 表号 EmS meter number	:	不适用于供应的产品。 Not applicable to the supplied products.
海洋污染物(是/否) Marine pollutants (YES/NO)	:	不适用于供应的产品。 Not applicable to the supplied products.
按《MARPOL73/78 公约》附则 II 和 IBC 规则 Transport in bulk according to Annex II of Marpol and the IBC Code	:	不适用于供应的产品。 Not applicable to the supplied products.
国内法规 Domestic regulations	:	GB 6944/12268
联合国编号 UN number	:	不适用于供应的产品。 Not applicable to the supplied products.
联合国运输名称 UN Proper shipping name	:	不适用于供应的产品。 Not applicable to the supplied products.
运输风险类别 Transport hazard Class(es)	:	不适用于供应的产品。 Not applicable to the supplied products.
次要危险性 Secondary danger	:	不适用于供应的产品。 Not applicable to the supplied products.
包装类别 Packing group	:	不适用于供应的产品。 Not applicable to the supplied products.
标签 Label	:	不适用于供应的产品。 Not applicable to the supplied products.
特殊防范措施 Special precautions for user	:	不适用于供应的产品。 Not applicable to the supplied products.

第15部分 法规信息
Section 15 Regulatory information

适用法规 Applicable regulations	:	职业病防治法 Occupational disease prevention law
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第16部分 其他信息
Section 16 Other information

参考文献 Key literature references and sources for data	:	内部技术数据,数据来源于原料 SDS、OECD eChem 门户网站搜索结果,以及欧洲化学品管理局,http://echa.europa.eu/ Internal technical data, which comes from raw material SDS, search results of OECD eChem portal, and the European Chemicals Agency, http://echa.europa.eu/
日期格式 Date format	:	年-月-日 YYYY-MM-DD
缩略语和首字母缩写 Abbreviations and acronyms	:	美国政府工业卫生学家会议(ACGIH)之阈限值 (TLV) The threshold limit value (TLV) of ACGIH 工作场所所有有害因素职业接触限值 - 化学有害因素 Workplace hazardous factors occupational exposure limits-chemical hazardous factors 8 小时,时间加权平均值 8 hours, time-weighted average 短期暴露限制 Short-term exposure limit 时间加权平均容许浓度 Time-weighted average allowable concentration 短时间接触容许浓度 Permissible concentration short term exposure limit,pc stel

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SAFETY DATA SHEET

according to GB/T 16483 and GB/T 17519



HFC-32 Refrigerant

Version	Revision Date:	SDS Number:	Date of last issue: 2022/07/07
6.5	2023/04/14	1329112-00040	Date of first issue: 2017/02/27

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : HFC-32 Refrigerant

SDS-Identcode : 130000016047

Manufacturer or supplier's details

Company : The Chemours Chemical (Shanghai) Co., Ltd.

Address : 9F, SCG Parkside, 868 Yinghua Road, Pudong New District
201204, Shanghai, China

Telephone : 86 400 8056 528

Emergency telephone number : 86 532 8388 9090

E-mail address : SDS.ChinaPSR@chemours.com

Telefax : 86 21 2612 0862

Recommended use of the chemical and restrictions on use

Recommended use : Propellant
Refrigerant

Restrictions on use : For professional users only.

2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance	: Liquefied gas
Colour	: colourless
Odour	: slight, ether-like

Extremely flammable gas. Contains gas under pressure; may explode if heated.

GHS Classification

Flammable gases : Category 1

Gases under pressure : Liquefied gas

GHS label elements

Hazard pictograms :



Signal word : Danger

SAFETY DATA SHEET

according to GB/T 16483 and GB/T 17519



HFC-32 Refrigerant

Version	Revision Date:	SDS Number:	Date of last issue: 2022/07/07
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Hazard statements : H220 Extremely flammable gas.
H280 Contains gas under pressure; may explode if heated.

Precautionary statements : **Prevention:**
P210 Keep away from heat/ sparks/ open flames/ hot surfaces.
No smoking.

Response:
P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 Eliminate all ignition sources if safe to do so.

Storage:
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

Physical and chemical hazards

Extremely flammable gas. Contains gas under pressure; may explode if heated.

Health hazards

Not classified based on available information.

Environmental hazards

Not classified based on available information.

Other hazards which do not result in classification

Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects.

Rapid evaporation of the product may cause frostbite.

May displace oxygen and cause rapid suffocation.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Substance name : Difluoromethane

CAS-No. : 75-10-5

Components

Chemical name	CAS-No.	Concentration (% w/w)
Difluoromethane#	75-10-5	>= 99.9 -<= 100

Voluntarily-disclosed substance

4. FIRST AID MEASURES

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical

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	advice.
If inhaled	: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
In case of skin contact	: Thaw frosted parts with lukewarm water. Do not rub affected area. Get medical attention immediately.
In case of eye contact	: Get medical attention immediately.
If swallowed	: Ingestion is not considered a potential route of exposure.
Most important symptoms and effects, both acute and delayed	: May cause cardiac arrhythmia. Other symptoms potentially related to misuse or inhalation abuse are Cardiac sensitisation Anaesthetic effects Light-headedness Dizziness confusion Lack of coordination Drowsiness Unconsciousness Gas reduces oxygen available for breathing. Contact with liquid or refrigerated gas can cause cold burns and frostbite.
Protection of first-aiders	: No special precautions are necessary for first aid responders.
Notes to physician	: Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in situations of emergency life support should be used with special caution.

5. FIREFIGHTING MEASURES

Suitable extinguishing media	: Water spray Alcohol-resistant foam Carbon dioxide (CO ₂) Dry chemical
Unsuitable extinguishing media	: None known.
Specific hazards during fire-fighting	: Vapours may form flammable mixture with air Exposure to combustion products may be a hazard to health. If the temperature rises there is danger of the vessels bursting due to the high vapor pressure.
Hazardous combustion products	: Hydrogen fluoride carbonyl fluoride

SAFETY DATA SHEET

according to GB/T 16483 and GB/T 17519



HFC-32 Refrigerant

Version	Revision Date:	SDS Number:	Date of last issue: 2022/07/07
6.5	2023/04/14	1329112-00040	Date of first issue: 2017/02/27

Carbon oxides

Specific extinguishing methods : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Fight fire remotely due to the risk of explosion.
Use water spray to cool unopened containers.
Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
Remove undamaged containers from fire area if it is safe to do so.
Evacuate area.

Special protective equipment for firefighters : Wear self-contained breathing apparatus for firefighting if necessary.
Use personal protective equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures : Evacuate personnel to safe areas.
Only trained personnel should re-enter the area.
Remove all sources of ignition.
Avoid skin contact with leaking liquid (danger of frostbite).
Ventilate the area.
Follow safe handling advice (see section 7) and personal protective equipment recommendations (see section 8).

Environmental precautions : Avoid release to the environment.
Prevent further leakage or spillage if safe to do so.
Retain and dispose of contaminated wash water.

Methods and materials for containment and cleaning up : Ventilate the area.
Non-sparking tools should be used.
Suppress (knock down) gases/vapours/mists with a water spray jet.
Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable.
Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

7. HANDLING AND STORAGE

Handling

Technical measures : Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty.

Local/Total ventilation : If sufficient ventilation is unavailable, use with local exhaust ventilation.
If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventila-

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tion.

Advice on safe handling : Avoid breathing gas.
Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment
Keep container tightly closed.
Wear cold insulating gloves/ face shield/ eye protection.
Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point.
Prevent backflow into the gas tank.
Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.
Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems.
Close valve after each use and when empty. Do NOT change or force fit connections.
Prevent the intrusion of water into the gas tank.
Never attempt to lift cylinder by its cap.
Do not drag, slide or roll cylinders.
Use a suitable hand truck for cylinder movement.
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Take precautionary measures against static discharges.
Take care to prevent spills, waste and minimize release to the environment.

Avoidance of contact : Oxidizing agents

Storage

Conditions for safe storage : Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.
Separate full containers from empty containers.
Do not store near combustible materials.
Avoid area where salt or other corrosive materials are present.
Keep in properly labelled containers.
Keep tightly closed.
Keep in a cool, well-ventilated place.
Keep away from direct sunlight.
Store in accordance with the particular national regulations.
Keep away from heat and sources of ignition.

Materials to avoid : Do not store with the following product types:
Self-reactive substances and mixtures
Organic peroxides
Oxidizing agents
Flammable liquids
Pyrophoric liquids
Pyrophoric solids
Self-heating substances and mixtures
Explosives

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Recommended storage temperature	: < 52 °C
Storage period	: > 10 yr
Further information on storage stability	: The product has an indefinite shelf life when stored properly.
Packaging material	: Unsuitable material: None known.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures	: Minimize workplace exposure concentrations. If sufficient ventilation is unavailable, use with local exhaust ventilation. If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventilation.
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Personal protective equipment

Respiratory protection	: If adequate local exhaust ventilation is not available or exposure assessment demonstrates exposures outside the recommended guidelines, use respiratory protection.
Filter type	: Organic gas and low boiling vapour type
Eye/face protection	: Wear the following personal protective equipment: Chemical resistant goggles must be worn. Face-shield
Skin and body protection	: Wear the following personal protective equipment: If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.
Hand protection Material	: Heat resistant gloves
Remarks	: Choose gloves to protect hands against chemicals depending on the concentration and quantity of the hazardous substance and specific to place of work. For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!

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Protective measures	: Wear cold insulating gloves/ face shield/ eye protection.
Hygiene measures	: If exposure to chemical is likely during typical use, provide eye flushing systems and safety showers close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: Liquefied gas
Colour	: colourless
Odour	: slight, ether-like
Odour Threshold	: No data available
pH	: No data available
Melting point/freezing point	: -136 °C
Initial boiling point and boiling range	: -51.6 °C
Flash point	: Not applicable
Evaporation rate	: > 1 (CCL4=1.0)
Flammability (solid, gas)	: Flammable
Self-ignition	: The substance or mixture is not classified as pyrophoric.
Upper explosion limit / Upper flammability limit	: Upper flammability limit 31 %(V) Method: ASTM E681
Lower explosion limit / Lower flammability limit	: Lower flammability limit 14 %(V) Method: ASTM E681
Vapour pressure	: 17,010 hPa (25 °C)
Relative vapour density	: 1.82 (Air = 1.0)
Relative density	: 0.96 (25 °C)

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Density	:	0.961 g/cm ³ (25 °C) (as liquid)
Solubility(ies) Water solubility	:	4.4 g/l (25 °C)
Partition coefficient: n-octanol/water	:	log Pow: 0.21 (25 °C)
Auto-ignition temperature	:	530 °C
Decomposition temperature	:	No data available
Viscosity Viscosity, kinematic	:	Not applicable
Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Particle size	:	Not applicable

10. STABILITY AND REACTIVITY

Reactivity	:	Not classified as a reactivity hazard.
Chemical stability	:	Stable if used as directed. Follow precautionary advice and avoid incompatible materials and conditions.
Possibility of hazardous reactions	:	Vapours may form flammable mixture with air Can react with strong oxidizing agents. Flammable gas.
Conditions to avoid	:	Heat, flames and sparks.
Incompatible materials	:	Oxidizing agents
Hazardous decomposition products	:	No hazardous decomposition products are known.

11. TOXICOLOGICAL INFORMATION

Exposure routes	:	Inhalation Skin contact Eye contact
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Acute toxicity

Not classified based on available information.

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Components:

Difluoromethane:

Acute oral toxicity : Assessment: The substance or mixture has no acute oral toxicity

Acute inhalation toxicity : LC50 (Rat): > 520000 ppm
Exposure time: 4 h
Test atmosphere: gas
Method: OECD Test Guideline 403

No observed adverse effect concentration (Dog): 350000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitisation

Lowest observed adverse effect concentration (Dog): > 350000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitisation

Cardiac sensitisation threshold limit (Dog): > 735,000 mg/m³
Test atmosphere: gas
Remarks: Cardiac sensitisation

Acute dermal toxicity : Assessment: The substance or mixture has no acute dermal toxicity

Skin corrosion/irritation

Not classified based on available information.

Components:

Difluoromethane:

Result : No skin irritation

Serious eye damage/eye irritation

Not classified based on available information.

Components:

Difluoromethane:

Result : No eye irritation

Respiratory or skin sensitisation

Skin sensitisation

Not classified based on available information.

Respiratory sensitisation

Not classified based on available information.

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Components:

Difluoromethane:

Exposure routes : Skin contact
Result : negative

Germ cell mutagenicity

Not classified based on available information.

Components:

Difluoromethane:

Genotoxicity in vitro : Test Type: Bacterial reverse mutation assay (AMES)
Method: OECD Test Guideline 471
Result: negative

Test Type: Chromosome aberration test in vitro
Method: OECD Test Guideline 473
Result: negative

Genotoxicity in vivo : Test Type: Mammalian erythrocyte micronucleus test (in vivo cytogenetic assay)
Species: Mouse
Application Route: inhalation (gas)
Method: OECD Test Guideline 474
Result: negative

Germ cell mutagenicity - Assessment : Weight of evidence does not support classification as a germ cell mutagen.

Carcinogenicity

Not classified based on available information.

Reproductive toxicity

Not classified based on available information.

Components:

Difluoromethane:

Effects on fertility : Species: Mouse
Application Route: Inhalation
Result: negative
Remarks: Based on data from similar materials

Effects on foetal development : Test Type: Combined repeated dose toxicity study with the reproduction/developmental toxicity screening test
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 414
Result: negative

Test Type: Combined repeated dose toxicity study with the reproduction/developmental toxicity screening test
Species: Rabbit

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Application Route: inhalation (gas)
Method: OECD Test Guideline 414
Result: negative

Reproductive toxicity - Assessment : Weight of evidence does not support classification for reproductive toxicity

STOT - single exposure

Not classified based on available information.

Components:

Difluoromethane:

Exposure routes : inhalation (gas)
Assessment : No significant health effects observed in animals at concentrations of 20000 ppmV/4h or less

STOT - repeated exposure

Not classified based on available information.

Components:

Difluoromethane:

Exposure routes : inhalation (gas)
Assessment : No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

Repeated dose toxicity

Components:

Difluoromethane:

Species : Rat, male and female
NOAEL : 49100 ppm
LOAEL : > 49100 ppm
Application Route : inhalation (gas)
Exposure time : 13 Weeks
Method : OECD Test Guideline 413

Aspiration toxicity

Not classified based on available information.

Components:

Difluoromethane:

No aspiration toxicity classification

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12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

Difluoromethane:

Toxicity to fish	:	LC50 (Fish): 1,507 mg/l Exposure time: 96 h Method: ECOSAR (Ecological Structure Activity Relationships)
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia (water flea)): 652 mg/l Exposure time: 48 h Method: ECOSAR (Ecological Structure Activity Relationships)
Toxicity to algae/aquatic plants	:	EC50 (green algae): 142 mg/l Exposure time: 96 h Method: ECOSAR (Ecological Structure Activity Relationships)

Persistence and degradability

Components:

Difluoromethane:

Biodegradability	:	Result: Not readily biodegradable. Method: OECD Test Guideline 301D
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Bioaccumulative potential

Components:

Difluoromethane:

Partition coefficient: n-octanol/water	:	log Pow: 0.714
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Mobility in soil

No data available

Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	:	Dispose of in accordance with local regulations.
Contaminated packaging	:	Empty containers should be taken to an approved waste handling site for recycling or disposal. Empty pressure vessels should be returned to the supplier.

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Empty containers retain residue and can be dangerous.
Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury and/or death.
If not otherwise specified: Dispose of as unused product.

14. TRANSPORT INFORMATION

International Regulations

UNRTDG

UN number	: UN 3252
Proper shipping name	: REFRIGERANT GAS R 32
Class	: 2.1
Packing group	: Not assigned by regulation
Labels	: 2.1

IATA-DGR

UN/ID No.	: UN 3252
Proper shipping name	: Refrigerant gas R 32
Class	: 2.1
Packing group	: Not assigned by regulation
Labels	: Flammable Gas
Packing instruction (cargo aircraft)	: 200
Packing instruction (passenger aircraft)	: Not permitted for transport

IMDG-Code

UN number	: UN 3252
Proper shipping name	: REFRIGERANT GAS R 32
Class	: 2.1
Packing group	: Not assigned by regulation
Labels	: 2.1
EmS Code	: F-D, S-U
Marine pollutant	: no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

National Regulations

GB 6944/12268

UN number	: UN 3252
Proper shipping name	: REFRIGERANT GAS R 32
Class	: 2.1
Packing group	: Not assigned by regulation
Labels	: 2.1

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

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15. REGULATORY INFORMATION

National regulatory information

Regulations on Safety Management of Hazardous Chemicals

Catalogue of Hazardous Chemicals : Listed

Identification of Major Hazard Installations for Hazardous Chemicals (GB 18218)

No. / Code	Chemical name / Category	Threshold quantity
W2	Flammable gases	10 t

Montreal Protocol : Difluoromethane

Yangtze River Protection Law

This product does not contain any dangerous chemicals prohibited for inland river transport.

16. OTHER INFORMATION

Revision Date : 2023/04/14

Other information : Chemours™ and the Chemours Logo are trademarks of The Chemours Company.
Before use read Chemours safety information.
For further information contact the local Chemours office or nominated distributors.

Further information

Sources of key data used to compile the Safety Data Sheet : Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, <http://echa.europa.eu/>

Date format : yyyy/mm/dd

Full text of other abbreviations

AIIC - Australian Inventory of Industrial Chemicals; ANTT - National Agency for Transport by Land of Brazil; ASTM - American Society for the Testing of Materials; bw - Body weight; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median

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Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; n.o.s. - Not Otherwise Specified; Nch - Chilean Norm; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NOM - Official Mexican Norm; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; SADT - Self-Accelerating Decomposition Temperature; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TDG - Transportation of Dangerous Goods; TECI - Thailand Existing Chemicals Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative; WHMIS - Workplace Hazardous Materials Information System

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

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Opteon™ XP10 (R-513A) Refrigerant

Version	Revision Date:	SDS Number:	Date of last issue: 04/06/2023
6.14	09/25/2023	1336485-00048	Date of first issue: 02/27/2017

SECTION 1. IDENTIFICATION

Product name : Opteon™ XP10 (R-513A) Refrigerant

SDS-Identcode : 130000051352

Other means of identification : No data available

Manufacturer or supplier's details

Company name of supplier : The Chemours Canada Company

Address : 151 Bloor Street West - 12th Floor
Toronto, ON M5S 1S4 Canada

Telephone : 1-844-773-CHEM (2436)

Emergency telephone : 1-866-595-1473 (24 hours)

Recommended use of the chemical and restrictions on use

Recommended use : Refrigerant

Restrictions on use : Consumer use, For professional users only.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with the Hazardous Products Regulations

Gases under pressure : Liquefied gas

Simple Asphyxiant : Category 1

GHS label elements

Hazard pictograms :



Signal Word : Warning

Hazard Statements : H280 Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary Statements : **Storage:**
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

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Version 6.14 Revision Date: 09/25/2023 SDS Number: 1336485-00048 Date of last issue: 04/06/2023
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Other hazards

Vapors are heavier than air and can cause suffocation by reducing oxygen available for breathing. Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects.

Rapid evaporation of the product may cause frostbite.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Components

Chemical name	Common Name/Synonym	CAS-No.	Concentration (% w/w)
2,3,3,3-Tetrafluoropropene#	No data available	754-12-1	56
1,1,1,2-Tetrafluoroethane#	HFC-134a	811-97-2	44

Voluntarily-disclosed substance

SECTION 4. FIRST AID MEASURES

- General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.
- If inhaled : If inhaled, remove to fresh air.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
Get medical attention immediately.
- In case of skin contact : Thaw frosted parts with lukewarm water. Do not rub affected area.
Get medical attention immediately.
- In case of eye contact : Get medical attention immediately.
- If swallowed : Ingestion is not considered a potential route of exposure.
- Most important symptoms and effects, both acute and delayed : May cause cardiac arrhythmia.
Other symptoms potentially related to misuse or inhalation abuse are
Cardiac sensitization
Anaesthetic effects
Light-headedness
Dizziness
confusion
Lack of coordination
Drowsiness
Unconsciousness
Skin contact may provoke the following symptoms:
Irritation

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Swelling of tissue
Itching
Discomfort
Redness
Eye contact may provoke the following symptoms
tearing
Redness
Discomfort
May displace oxygen and cause rapid suffocation.
Gas reduces oxygen available for breathing.
Contact with liquid or refrigerated gas can cause cold burns
and frostbite.

Protection of first-aiders : No special precautions are necessary for first aid responders.

Notes to physician : Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in situations of emergency life support should be used with special caution.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : Not applicable
Will not burn

Unsuitable extinguishing media : Not applicable
Will not burn

Specific hazards during fire fighting : Exposure to combustion products may be a hazard to health.
If the temperature rises there is danger of the vessels bursting due to the high vapor pressure.

Hazardous combustion products : Hydrogen fluoride
Fluorine compounds
Carbon oxides
carbonyl fluoride

Specific extinguishing methods : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Fight fire remotely due to the risk of explosion.
Use water spray to cool unopened containers.
Remove undamaged containers from fire area if it is safe to do so.
Evacuate area.

Special protective equipment for fire-fighters : Wear self-contained breathing apparatus for firefighting if necessary.
Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency measures : Evacuate personnel to safe areas.
Avoid skin contact with leaking liquid (danger of frostbite).

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- | | |
|---|--|
| gency procedures | Ventilate the area.
Follow safe handling advice (see section 7) and personal protective equipment recommendations (see section 8). |
| Environmental precautions | : Avoid release to the environment.
Prevent further leakage or spillage if safe to do so.
Retain and dispose of contaminated wash water. |
| Methods and materials for containment and cleaning up | : Ventilate the area.
Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable.
Sections 13 and 15 of this SDS provide information regarding certain local or national requirements. |

SECTION 7. HANDLING AND STORAGE

- | | |
|-----------------------------|--|
| Technical measures | : Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty. |
| Local/Total ventilation | : Use only with adequate ventilation. |
| Advice on safe handling | : Avoid breathing gas.
Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment
Wear cold insulating gloves/ face shield/ eye protection.
Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point.
Prevent backflow into the gas tank.
Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.
Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems.
Close valve after each use and when empty. Do NOT change or force fit connections.
Prevent the intrusion of water into the gas tank.
Never attempt to lift cylinder by its cap.
Do not drag, slide or roll cylinders.
Use a suitable hand truck for cylinder movement.
Keep away from heat and sources of ignition.
Take precautionary measures against static discharges.
Take care to prevent spills, waste and minimize release to the environment. |
| Conditions for safe storage | : Cylinders should be stored upright and firmly secured to prevent falling or being knocked over.
Separate full containers from empty containers.
Do not store near combustible materials.
Avoid area where salt or other corrosive materials are present. |

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Keep in properly labeled containers.
Keep in a cool, well-ventilated place.
Keep away from direct sunlight.
Store in accordance with the particular national regulations.

Materials to avoid : Do not store with the following product types:
Self-reactive substances and mixtures
Organic peroxides
Oxidizing agents
Flammable liquids
Flammable solids
Pyrophoric liquids
Pyrophoric solids
Self-heating substances and mixtures
Substances and mixtures which in contact with water emit flammable gases
Explosives
Very acutely toxic substances and mixtures
Acutely toxic substances and mixtures
Substances and mixtures with chronic toxicity

Recommended storage temperature : < 52 °C

Storage period : > 10 y

Further information on storage stability : The product has an indefinite shelf life when stored properly.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures : Ensure adequate ventilation, especially in confined areas.
Minimize workplace exposure concentrations.

Personal protective equipment

Respiratory protection : If adequate local exhaust ventilation is not available or exposure assessment demonstrates exposures outside the recommended guidelines, use respiratory protection.

Filter type : Organic gas and low boiling vapor type

Hand protection
Material : Low temperature resistant gloves

Remarks : Choose gloves to protect hands against chemicals depending on the concentration specific to place of work. For special applications, we recommend clarifying the resistance to che-

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micals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!

Eye protection	: Wear the following personal protective equipment: Chemical resistant goggles must be worn. Face-shield
Skin and body protection	: Skin should be washed after contact.
Protective measures	: Wear cold insulating gloves/ face shield/ eye protection.
Hygiene measures	: If exposure to chemical is likely during typical use, provide eye flushing systems and safety showers close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: Liquefied gas
Color	: colorless
Odor	: slight, ether-like
Odor Threshold	: No data available
pH	: No data available
Melting point/freezing point	: No data available
Initial boiling point and boiling range	: -29.2 °C
Flash point	: Not applicable
Evaporation rate	: > 1 (CCL4=1.0)
Flammability (solid, gas)	: Will not burn
Burning rate	: 15 mm/s
Upper explosion limit / Upper flammability limit	: Upper flammability limit Method: ASTM E681 None.

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Lower explosion limit / Lower flammability limit	:	Lower flammability limit Method: ASTM E681 None.
Vapor pressure	:	7,063.6 hPa (25 °C)
Relative vapor density	:	3.83 (Air = 1.0)
Relative density	:	1.17 (25 °C)
Solubility(ies) Water solubility	:	No data available
Partition coefficient: n-octanol/water	:	Not applicable
Autoignition temperature	:	No data available
Decomposition temperature	:	No data available
Viscosity Viscosity, kinematic	:	Not applicable
Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Particle size	:	Not applicable

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Not classified as a reactivity hazard.
Chemical stability	:	Stable if used as directed. Follow precautionary advice and avoid incompatible materials and conditions.
Possibility of hazardous reactions	:	Can react with strong oxidizing agents.
Conditions to avoid	:	This substance is not flammable in air at temperatures up to 100 °C (212 °F) at atmospheric pressure. However, mixtures of this substance with high concentrations of air at elevated pressure and/or temperature can become combustible in the presence of an ignition source. This substance can also become combustible in an oxygen enriched environment (oxygen concentrations greater than that in air). Whether a mixture containing this substance and air, or this substance in an oxygen enriched atmosphere become combustible depends on the inter-relationship of 1) the temperature 2) the pressure,

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and 3) the proportion of oxygen in the mixture. In general, this substance should not be allowed to exist with air above atmospheric pressure or at high temperatures; or in an oxygen enriched environment. For example this substance should NOT be mixed with air under pressure for leak testing or other purposes.
Heat, flames and sparks.

Incompatible materials : Avoid impurities (e.g. rust, dust, ash), risk of decomposition.
Incompatible with acids and bases.
Incompatible with oxidizing agents.
Oxygen
Peroxides
peroxide compounds
Powdered metals

Hazardous decomposition products : No hazardous decomposition products are known.

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation
Skin contact
Eye contact

Acute toxicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Acute inhalation toxicity : LC50 (Rat): > 405800 ppm
Exposure time: 4 h
Test atmosphere: gas
Method: OECD Test Guideline 403

No observed adverse effect concentration (Dog): 120000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitization

Lowest observed adverse effect concentration (Dog): > 120000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitization

Cardiac sensitisation threshold limit (Dog): > 559,509 mg/m³
Test atmosphere: gas
Remarks: Cardiac sensitization

1,1,1,2-Tetrafluoroethane:

Acute oral toxicity : Assessment: The substance or mixture has no acute oral toxicity

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Acute inhalation toxicity : LC50 (Rat): > 567000 ppm
Exposure time: 4 h
Test atmosphere: gas
Method: OECD Test Guideline 403

No observed adverse effect concentration (Dog): 40000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitization

Lowest observed adverse effect concentration (Dog): 80000 ppm
Test atmosphere: gas
Symptoms: May cause cardiac arrhythmia.

Cardiac sensitisation threshold limit (Dog): 334,000 mg/m³
Test atmosphere: gas
Symptoms: May cause cardiac arrhythmia.

Acute dermal toxicity : Assessment: The substance or mixture has no acute dermal toxicity

Skin corrosion/irritation

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : No skin irritation

1,1,1,2-Tetrafluoroethane:

Result : No skin irritation

Serious eye damage/eye irritation

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : No eye irritation

1,1,1,2-Tetrafluoroethane:

Result : No eye irritation

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

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Components:

2,3,3,3-Tetrafluoropropene:

Routes of exposure : Skin contact
Result : negative

1,1,1,2-Tetrafluoroethane:

Routes of exposure : Skin contact
Result : negative

Routes of exposure : Inhalation
Species : Rat
Result : negative

Routes of exposure : Inhalation
Species : Humans
Result : negative

Germ cell mutagenicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Genotoxicity in vitro : Test Type: Bacterial reverse mutation assay (AMES)
Method: OECD Test Guideline 471
Result: positive

Test Type: Chromosome aberration test in vitro
Method: OECD Test Guideline 473
Result: negative

Genotoxicity in vivo : Test Type: Mammalian erythrocyte micronucleus test (in vivo cytogenetic assay)
Species: Mouse
Application Route: inhalation (gas)
Method: OECD Test Guideline 474
Result: negative

Test Type: In vivo mammalian alkaline comet assay
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 489
Result: negative

Test Type: Mammalian erythrocyte micronucleus test (in vivo cytogenetic assay)
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 474
Result: negative

Germ cell mutagenicity - : Weight of evidence does not support classification as a germ

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Assessment cell mutagen.

1,1,1,2-Tetrafluoroethane:

Genotoxicity in vitro : Test Type: Bacterial reverse mutation assay (AMES)
Method: OECD Test Guideline 471
Result: negative

Test Type: Chromosome aberration test in vitro
Method: OECD Test Guideline 473
Result: negative

Genotoxicity in vivo : Test Type: Mammalian erythrocyte micronucleus test (in vivo cytogenetic assay)
Species: Mouse
Application Route: inhalation (gas)
Method: OECD Test Guideline 474
Result: negative

Test Type: Unscheduled DNA synthesis (UDS) test with mammalian liver cells in vivo
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 486
Result: negative

Germ cell mutagenicity - Assessment : Weight of evidence does not support classification as a germ cell mutagen.

Carcinogenicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : negative

Carcinogenicity - Assessment : Weight of evidence does not support classification as a carcinogen

1,1,1,2-Tetrafluoroethane:

Species : Rat
Application Route : inhalation (gas)
Exposure time : 2 Years
Method : OECD Test Guideline 453
Result : negative

Carcinogenicity - Assessment : Weight of evidence does not support classification as a carcinogen

Reproductive toxicity

Not classified based on available information.

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Components:

2,3,3,3-Tetrafluoropropene:

- Effects on fertility : Test Type: Two-generation reproduction toxicity study
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 416
Result: negative
- Effects on fetal development : Test Type: Prenatal development toxicity study (teratogenicity)
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 414
Result: negative
- Reproductive toxicity - Assessment : Weight of evidence does not support classification for reproductive toxicity, No effects on or via lactation

1,1,1,2-Tetrafluoroethane:

- Effects on fertility : Species: Mouse
Application Route: Inhalation
Result: negative
- Effects on fetal development : Test Type: Combined repeated dose toxicity study with the reproduction/developmental toxicity screening test
Species: Rabbit
Application Route: inhalation (gas)
Method: OECD Test Guideline 414
Result: negative
- Reproductive toxicity - Assessment : Weight of evidence does not support classification for reproductive toxicity

STOT-single exposure

May displace oxygen and cause rapid suffocation.

Components:

2,3,3,3-Tetrafluoropropene:

- Routes of exposure : inhalation (gas)
Assessment : No significant health effects observed in animals at concentrations of 20000 ppmV/4h or less

1,1,1,2-Tetrafluoroethane:

- Routes of exposure : inhalation (gas)
Assessment : No significant health effects observed in animals at concentrations of 20000 ppmV/4h or less

STOT-repeated exposure

Not classified based on available information.

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Components:

2,3,3,3-Tetrafluoropropene:

Routes of exposure	: inhalation (gas)
Assessment	: No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

1,1,1,2-Tetrafluoroethane:

Routes of exposure	: inhalation (gas)
Assessment	: No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

Repeated dose toxicity

Components:

2,3,3,3-Tetrafluoropropene:

Species	: Rat, male and female
NOAEL	: 50000 ppm
LOAEL	: >50000 ppm
Application Route	: inhalation (gas)
Exposure time	: 13 Weeks
Method	: OECD Test Guideline 413

1,1,1,2-Tetrafluoroethane:

Species	: Rat, male and female
NOAEL	: 50000 ppm
LOAEL	: >50000 ppm
Application Route	: inhalation (gas)
Exposure time	: 2 y
Method	: OECD Test Guideline 453

Aspiration toxicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

No aspiration toxicity classification

1,1,1,2-Tetrafluoroethane:

No aspiration toxicity classification

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

2,3,3,3-Tetrafluoropropene:

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Toxicity to fish	: LC50 (Cyprinus carpio (Carp)): > 197 mg/l Exposure time: 96 h Method: OECD Test Guideline 203
Toxicity to daphnia and other aquatic invertebrates	: EC50 (Daphnia magna (Water flea)): > 100 mg/l Exposure time: 48 h Method: OECD Test Guideline 202
Toxicity to algae/aquatic plants	: EC50 (Selenastrum capricornutum (green algae)): > 100 mg/l Exposure time: 72 h Method: OECD Test Guideline 201
	: NOEC (Selenastrum capricornutum (green algae)): > 75 mg/l Exposure time: 3 d Method: OECD Test Guideline 201

1,1,1,2-Tetrafluoroethane:

Toxicity to fish	: LC50 (Oncorhynchus mykiss (rainbow trout)): 450 mg/l Exposure time: 96 h Method: Regulation (EC) No. 440/2008, Annex, C.1
Toxicity to daphnia and other aquatic invertebrates	: EC50 (Daphnia magna (Water flea)): 980 mg/l Exposure time: 48 h Method: Regulation (EC) No. 440/2008, Annex, C.2
Toxicity to algae/aquatic plants	: ErC50 (green algae): > 100 mg/l Exposure time: 96 h Remarks: Based on data from similar materials

Persistence and degradability

Components:

2,3,3,3-Tetrafluoropropene:

Biodegradability	: Result: Not readily biodegradable. Method: OECD Test Guideline 301F
------------------	--

1,1,1,2-Tetrafluoroethane:

Biodegradability	: Result: Not readily biodegradable. Method: OECD Test Guideline 301D
------------------	--

Bioaccumulative potential

Components:

2,3,3,3-Tetrafluoropropene:

Bioaccumulation	: Remarks: Bioaccumulation is unlikely.
-----------------	---

Partition coefficient: n-octanol/water	: log Pow: 2 (25 °C)
--	----------------------

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1,1,1,2-Tetrafluoroethane:

Bioaccumulation : Remarks: Bioaccumulation is unlikely.

Partition coefficient: n-octanol/water : log Pow: 1.06

Mobility in soil

No data available

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of in accordance with local regulations.

Contaminated packaging : Empty containers should be taken to an approved waste handling site for recycling or disposal.
Empty pressure vessels should be returned to the supplier.
If not otherwise specified: Dispose of as unused product.

SECTION 14. TRANSPORT INFORMATION

International Regulations

UNRTDG

UN number : UN 1078
Proper shipping name : REFRIGERANT GAS, N.O.S.
(2,3,3,3-Tetrafluoropropene, 1,1,1,2-Tetrafluoroethane)
Class : 2.2
Packing group : Not assigned by regulation
Labels : 2.2
Environmentally hazardous : no

IATA-DGR

UN/ID No. : UN 1078
Proper shipping name : Refrigerant gas, n.o.s.
(2,3,3,3-Tetrafluoropropene, 1,1,1,2-Tetrafluoroethane)
Class : 2.2
Packing group : Not assigned by regulation
Labels : Non-flammable, non-toxic Gas
Packing instruction (cargo aircraft) : 200
Packing instruction (passenger aircraft) : 200

IMDG-Code

UN number : UN 1078
Proper shipping name : REFRIGERANT GAS, N.O.S.
(2,3,3,3-Tetrafluoropropene, 1,1,1,2-Tetrafluoroethane)
Class : 2.2

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Packing group : Not assigned by regulation
Labels : 2.2
EmS Code : F-C, S-V
Marine pollutant : no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

TDG

UN number : UN 1078
Proper shipping name : REFRIGERANT GAS, N.O.S.
(2,3,3,3-Tetrafluoropropene, 1,1,1,2-Tetrafluoroethane)
Class : 2.2
Packing group : Not assigned by regulation
Labels : 2.2
ERG Code : 126
Marine pollutant : no

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SECTION 15. REGULATORY INFORMATION

International Regulations

Montreal Protocol : 1,1,1,2-Tetrafluoroethane

SECTION 16. OTHER INFORMATION

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Before use read Chemours safety information.

For further information contact the local Chemours office or nominated distributors.

Full text of other abbreviations

AIIC - Australian Inventory of Industrial Chemicals; ANTT - National Agency for Transport by Land of Brazil; ASTM - American Society for the Testing of Materials; bw - Body weight; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemi-

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cal Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; n.o.s. - Not Otherwise Specified; Nch - Chilean Norm; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NOM - Official Mexican Norm; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; SADT - Self-Accelerating Decomposition Temperature; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TDG - Transportation of Dangerous Goods; TECI - Thailand Existing Chemicals Inventory; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative; WHMIS - Workplace Hazardous Materials Information System

Sources of key data used to compile the Material Safety Data Sheet : Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, <http://echa.europa.eu/>

Revision Date : 09/25/2023
Date format : mm/dd/yyyy

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CA / Z8

Revision History

Version	Date	Change Description
1.0	07/24/2024	Initial Release
2.0	11/25/2024	Updated Document Format
3.0	01/14/2025	Updated HVAC, Chiller Specification Added HVAC, Chiller Refrigerent MSDS
4.0	03/25/2025	Updated HVAC, Chiller Specification (Mechanical Drawing)

End of Document



Product Specification

Rechargeable Lithium-ion Battery Cell

Model : JF2

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Revision History

Version	Date	Change Description
1.0	May.19. 2025	Initial Release

Author	Reviewer	Approval
JH. Jeon	SY. Ahn	KW. Kim

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1 General Information

1.1 Scope

This document describes the Product Specification of the rechargeable lithium-ion battery cells ('Cell' hereinafter) supplied by LG Energy Solution, Ltd. ('LGES' hereinafter)

1.2 Application

Energy Storage System

1.3 Product Classification

Rechargeable lithium-ion battery cell

1.4 Model Name

JF2

2 Product Appearance

2.1 Appearance

There shall be no such defects as deep scratch, crack, rust, discoloration or leakage, which may adversely affect the commercial value of the battery. Appearance standard shall follow the internal inspection specifications of LGES.

Width:	Max. 125.0 mm
Height:	Max. 601.0 mm (without lead tab)
Thickness ¹ :	Max. 18.1 mm (at shipping state)

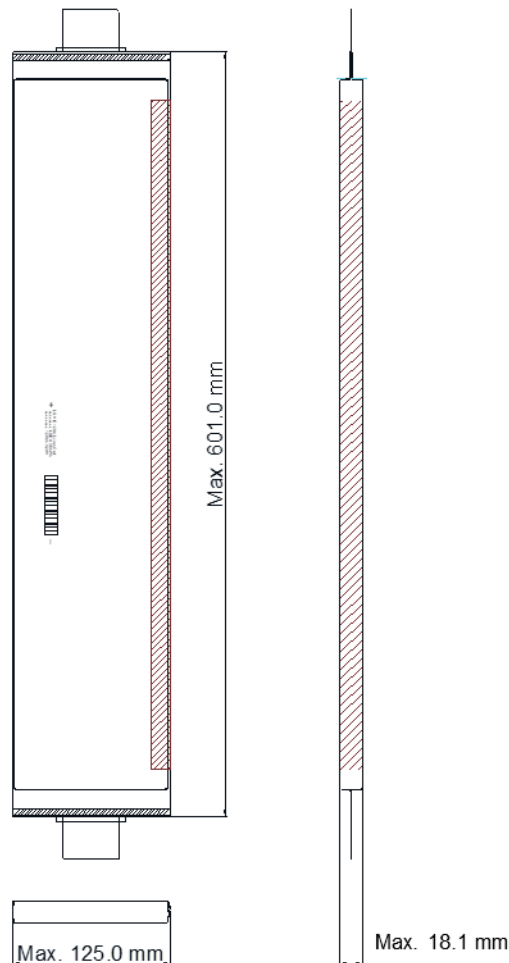


Figure 1. JF2 Cell appearance with dimension

¹ It shall be measured under 90 kgf for 2 sec

3 Cell Specification

3.1 Electrical Specification

Item	Specification
Capacity ²	Min. 159.2 Ah
Voltage (Nominal) ³	3.2 V
Energy ⁴	Min. 509.44 Wh
Operating Voltage Range ⁵	2.5 ~ 3.65 V (0.25CP)
Operating Voltage Range ⁵ (Continuous Cycle)	2.5 ~ 3.65 V (0.25CP)
Max. Charge Power ^{6, 7} (Continuous)	127.36 W (0.25CP)
Max. Charge Power ⁸ (Peak)	254.72 W (0.5CP)
Max. Discharge Power ⁷ (Continuous)	127.36 W (0.25CP)
Max. Discharge Power ⁸ (Peak)	254.72 W (0.5CP)

3.2 Mechanical Specification

Item	Specification
Dimension	Thickness: Max. 18.1 mm (at shipping state) Width: Max. 125.0 mm Height: Max. 601.0 mm (without lead tab)
Weight	Max. 2,792 g

² Charge/Discharge at 25 ± 2 °C (Refer to Appendix. 7.1.1)

³ Average for standard discharge

⁴ Capacity x Voltage (Nominal)

⁵ Cut-off Voltage, not Open Circuit Voltage (OCV)

⁶ It can be adjusted upon discussion with LGES because battery life span can be differentiated by user patterns and environment. (at 25 ± 2 °C)

⁷ Maximum "Continuous" power is the maximum CP-rate sustainable for full operating voltage range.

⁸ Maximum "Peak" power is the maximum CP-rate sustainable for 10 seconds.

3.3 Environmental Specification

Item	Specification	
Operating Temperature ⁹	Charge: 0 ~ 50 °C Discharge: 0 ~ 50 °C	
Storage Temperature (at shipping state ¹⁰)	Max. 7days	-30 ~ 60°C
	Max. 6months	-20 ~ 45°C
Recommended Operating Temperature ¹¹	Ordinary temperature 23 ± 4 °C with Uniformity 4 °C	
Altitude	≤ 4,000 m	

Cell must be operated below Max. Power of each operating temperature range. Also, Max. Power of Cell can be reduced or limited at the low SOC or high SOC.

Operating Temperature ⁹ Range											
Temp. (°C)	0 ≤ T < 5		5 ≤ T < 10		10 ≤ T < 15		15 ≤ T < 20		20 ≤ T < 25		25 ≤ T ≤ 50
SOC (%)	S < 80	S ≥ 80	S < 80	S ≥ 80	S < 80	S ≥ 80	S < 80	S ≥ 80	S < 90	S ≥ 90	Full range
Charge	0.2CP	0.1CP	0.25CP	0.2CP	0.33CP	0.25CP	0.5CP	0.33CP	0.5CP	0.33CP	0.5CP
Discharge	0.2CP		0.33CP		0.5CP						

3.4 Performance Specification

Specification can be differentiated if the cells are tested at the environment that is not specified in this document. Please refer to 4. Standard Test Condition and Appendix. 7.1 Test Method and Procedure in detail. We should have no responsibility with the inconsistency due to the different test method and environment.

Item	Condition / Note	Specification
DC Resistance ¹²	SOC 23 %, 80.0 A, 10 sec. (Refer to Appendix. 7.1.2)	≥ 0.708 mΩ ≤ 1.208 mΩ
AC Impedance ¹⁰	SOC 23 %, 1 kHz	≥ 0.45 mΩ ≤ 0.75 mΩ

⁹ Operating Temperature indicates cell surface temperature.

¹⁰ Shipping State: < SOC 23 %.

¹¹ Recommended Temperature indicates ambient temperature.

¹² It is determined using Beginning-of-Life (BOL) Cell. (within 90 days from the production date)

High Temperature Storage Characteristics ¹³	SOC 100 %, 4 weeks, 45 ± 2 °C (Refer to Appendix. 7.1.3)	≥ 90 % vs. Initial Capacity
Cycle Life#1 ^{11, 13}	2.5 ~ 3.65V, 254.72W charge / 254.72W discharge, 45 ± 2 °C (Refer to Appendix. 7.1.4)	≥ 93.6% @ 300 cycle
Cycle Life#2 ^{11, 13}	2.5 ~ 3.65V, 127.36W charge / 127.36W discharge, 25 ± 2 °C	≥ 70.0% @ 7300 cycle
Cycle Life#3 ^{11, 13} (EOW ¹⁴)	2.5 ~ 3.65V, 127.36W charge / 127.36W discharge, 25 ± 2 °C	≥ 89.5% @ 1825 cycle (5 years)
Self-Discharge ¹⁵	At shipping state, 25 ± 2 °C	< 6 % per year

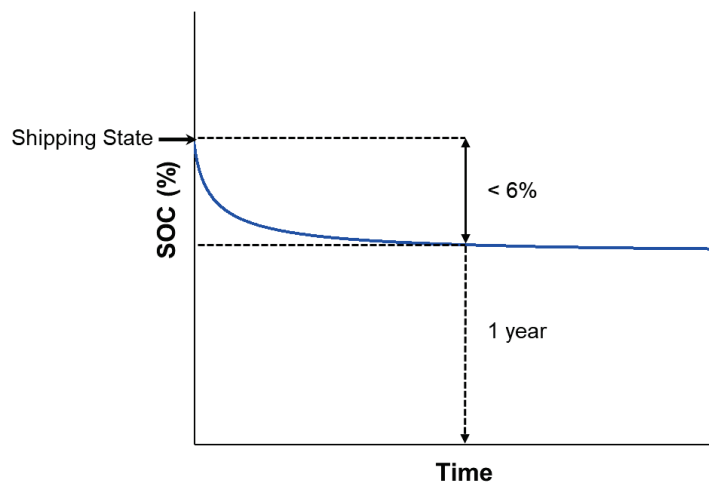


Figure 2. Self-Discharge at shipping state

¹³ Cells shall be pressurized with pressure jig that is consist of a pair of Al plate with 18 bolting with bolting torque of 150 kgf x cm.(Refer to “LGES Cell Jig application manual” document)

¹⁴ EOW will be updated by additional data.

¹⁵ Self-discharge rate gets smaller as time passes (refer to Figure 2)

4 Standard Test Condition

4.1 Environmental Condition

Unless otherwise specified, all tests stated in this specification are conducted at temperature 25 ± 2 °C.

4.2 Standard Charge

Unless otherwise specified, “Standard Charge” shall consist of charging at a constant current of 39.8 A to 3.65 V using a constant current-constant voltage (CC-CV) charging method. Charging is continued until the charge current is reduced to 7.96 A.

4.3 Standard Discharge

Unless otherwise specified, “Standard Discharge” shall consist of discharging at a constant current of 39.8 A to 2.50 V within 5 min after the standard charge.

5 International Certification

UN 38.3

UL1973 : 2022 Annex E11

IEC 62619

KC 62619

6 Proper Use and Handling

This document describes the requirements for the customer to properly use the Cell supplied by LGES including cautions, warnings, and prohibitions.

- 1) The customer is required to contact LGES in advance when to use the Cell for other applications or conditions than mentioned in this document to avoid possible damage to the Cell.
- 2) Mishandling of Cell may cause leakage, heat, fire and deterioration in performance.
- 3) LGES will take no responsibility for any accidents when the Cell is used under different conditions from those in this document without LGES's consent.
- 4) Be sure to request and confirm the most current product specifications in advance which explain the specifications in detail, before the final stage of your design, purchasing or use for any application.

6.1 Storage

- 1) Do not insulate the Cell not to make an electrical short.
- 2) Cell must be stored in a cool, dry place free from corrosive gas.
- 3) Cell must be stored at lower than shipping state throughout the period of storage.
(A higher temperature/voltage of the Cell during storage will accelerate the deterioration of the capacity.)
- 4) Keep the Cell away from fire.
- 5) Do not leave Cell in any places that are exposed direct sunlight or heat.
- 6) Keep the Cell away from objects or materials with static electric charge.
- 7) The Cell must be stored separately.

6.2 Operation

Use or test the Cell under proper operating condition LGES recommended. If the customer wants the Cell to operate under different conditions, the customer is required to contact LGES in advance.

When the Cell is frequently used out of recommendation ranges, it may be excessively swollen.

- 1) Do not use the Cell out of operating temperature. (Refer to 3.3)
- 2) Do not operate the Cell with higher power than maximum power of each operating temperature range.
- 3) Do not exceed the charging voltage of 4.0 V per Cell.
- 4) Do not charge the Cell whose voltage is less than 1.5 V.
- 5) Do not charge the Cell in the place where static electricity is generated.
- 6) Do not reverse-charge.
- 7) Do not short-circuit the Cell.

6.3 Others

- 1) Cell must be kept away from children or pets to avoid any accidents such as swallow.
- 2) If any smell, discoloration, or excessive heat is noticed, stop using the Cell.
- 3) If any cracks, deformation, or other damage is found on the Cell or container, or if any electrolyte leakage is found, stop using the Cell immediately.
- 4) If the electrolyte from the Cell comes in contact with your skin or clothes, wash immediately with soap and water. If the electrolyte comes in contact with your eyes, wash thoroughly with water and go to see a doctor immediately.
- 5) Do not wear metallic objects (e.g. ring, watch, accessory) while handling the Cell.
- 6) Do insulate the Cell before disposal.
- 7) Do not fold the Cell.
- 8) Do not apply excessive heat and force to the Cell.
- 9) Do not attempt to disassemble the Cell.
(The disassembling may generate internal short circuit in the Cell, which may cause burst, fire, or other problems.)
- 10) Do not attempt to replace the Cell.
(The battery replacement shall be done only by either Battery supplier or device supplier and never be done by the user.)
- 11) Do not throw or subject the Cell to severe impacts.
- 12) Do not puncture or otherwise damage Cell with sharp objects. (e.g. nail, needle, screw driver, knife, pencil, drill)
- 13) Do not put the Cell into fire.
- 14) Do not put the Cell into liquids such as water, seawater, and drinks such as soft drinks, juices, coffee or others.
- 15) Do not short circuit (+) and (-) terminals with metallic object intentionally.
- 16) Do not subject the Cell to abnormal vibration and impact.
- 17) Do not put the Cell into a microwave oven, dryer, or high pressure container.
- 18) Do not use the Cell in proximity of organic solvents.
- 19) Do not directly solder on the Cell.
- 20) Do not press the Cell with overload in manufacturing process, especially while undergoing ultrasonic welding.
- 21) Do not use old and new Cell together.
- 22) Do not connect positive (+) and negative (-) terminals with conductive materials. (such as metal, wire, etc.)
- 23) Do not bend or apply excessive force to the welded part of terminals.
- 24) Do not use seriously scared or deformed Cell.
- 25) The cells should be handled and used in Pack/System manufacturing companies only.

6.4 Pack Assembly and Operation

Rechargeable lithium-ion battery packs ('Pack' hereinafter) shall meet under conditions to obtain optimum performance and safety.

6.4.1 Installing the Cell into the Pack

- 1) The Cell should be inspected visually before Pack assembly.

- 2) The damaged Cell should not be used.
- 3) Do not use the Cell mixed with any other batteries.

6.4.2 Assembly of the Pack

- 1) The Pack must be designed to prevent external short circuit.
- 2) Check insulation of Cell not to make short-circuit during Pack assembly.
- 3) Positive (+) and negative (-) direction of Cell must be checked before Pack assembly.
- 4) The Cell should not be soldered directly.
- 5) Excessive force on the terminal should be avoided.
- 6) The design of the Pack and its structure should be reviewed physically, mechanically and electrically not to cause the Cell imbalance.
- 7) The Pack should be designed to monitor the voltage of each Cell.
- 8) The Pack should have sufficient strength and be protected from mechanical shock.
- 9) No sharp edge components should be inside the casing containing the Cell.

6.4.3 Operation

- 1) Operation of the Pack must be controlled by Battery Management System (BMS).
- 2) Charging should be operating under maximum charge voltage and power which is specified in product specification.
- 3) The battery should be charged under operating temperature specified in product specification.
- 4) Discharging should be operating under maximum discharge power which is specified in product specification.
- 5) Discharging should be done by cut off voltage which is specified in product specification.
- 6) The battery should be discharged under operating temperature specified in product specification.

6.4.4 Protection Circuit

- 1) The protection circuit should be installed in the Pack.
- 2) Pack should have voltage sensing system to control over charge or discharge.
- 3) Pack should have warning system for over temperature, over voltage and over current.
- 4) When the Pack for any applications is assembled with Cells, following functions must be designed into the Pack.
- 5) The detailed levels, values, conditions for each following functions should be referring to the contents specified in this Product Specification. If one or more than one function is/are to be omitted, the Packer Company (and/or System Integration Company) must be informing to LGES. Without informing to LGES, LGES will not be liable for any field quality

issues happened due to exclusion of following functions.

- (1) Over voltage protection circuit.
- (2) Under voltage protection circuit.
- (3) Over Charge current protection circuit.
- (4) Over Discharge current protection circuit.
- (5) Short circuit protection.
- (6) Over Temperature protection circuit.

- (7) 2nd over voltage protection.
- (8) Cell imbalance protection circuit. (Only for battery packs assembled with more than one cell)
- (9) Cell Voltage balancing function. (Only for battery packs assembled with more than one cell)

7 Exclusion of Liability

LGES should have no any responsibility with the contingency caused by inadequate maintenance, handling, storage, faulty repair, modification to the battery, including but not limited to, the following:

- 1) The customer to whom the product had been supplied directly by LGES re-sells the product in a cell format.
- 2) The problem is caused by a process which is not a cell process of LGES.
(Module/pack parts, BMS, BPU, cable, fuse, etc.)
- 3) Improper pack assembly or maintenance such as without BMS.
- 4) Improper transportation, storage, handling, installation or wiring by the purchaser.
- 5) Modification, remodelling, disassembly, repair or replacement carried out without the consent of LGES.
- 6) The official standard or the manual of LGES has not been followed.
(Charging/discharging conditions, pressurization jig, etc.)
- 7) Insufficient ventilation.
- 8) Ignoring proper use and handling guidelines specified in this document.
- 9) Battery damages caused by physical, electrical, thermal, or environmental impacts or stresses that are abnormal.
(Such as power surge, in-rush current, lightning, flood, fire, casual damage, etc.)
- 10) Misuse of the product, inexperienced use, or negligence.
- 11) Secondary defects caused by not reporting or repairing at a right timing after defects occur. (Swelling, leakage, safety level, etc.)
- 12) A damage or failure arising out of the purchaser's failure to comply with the national, state or local electric or safety codes such as National Electric Code (NEC) and Occupational Safety and Health Administration (OSHA).
- 13) A battery that is not LGES's product has been used, or different models of LGES's batteries have been used together.
- 14) Disassembly of the battery without a consent by LGES.
- 15) Any attempt to alter or repair by unauthorized personnel.
- 16) A force majeure event, including natural disaster, war, strike, riot, etc.

LGES shall not be liable for any consequential or indirect damages arising out of or in connection with the product specification.

Appendix

7.1 Test Method and Procedure

7.1.1 Capacity

Step	Action	Mode	Control parameter	Value
1	Rest	Soaking	Temperature ¹⁶	25 ± 2 °C
			Time	60 min
2	Discharge	Constant current	Current	15.92 A (0.1C)
			Voltage limit	2.50 V
3	Rest		Time	5 min
4	Charge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	3.65 V
		Constant voltage	Voltage	3.65 V
			Current limit	7.96 A (0.05C)
5	Rest		Time	5 min
6	Discharge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	2.50 V
7	Rest		Time	5 min
8	Repeat	Step 4~7	Cycle	2 times

7.1.2 DC Resistance

Step	Action	Mode	Control parameter	Value
1	Rest	Soaking	Temperature	25 ± 2 °C
			Time	60 min
2	Discharge	Constant current	Current	39.8 A (0.25C)

¹⁶ Temperatures in 7.1 Test Method and Procedure mean ambient temperature, unless otherwise noted.

			Voltage limit	2.50 V
3	Rest		Time	1 min
4	Charge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	3.272 V
		Constant voltage	Voltage	3.272 V (SOC23)
			Current limit	7.96 A (0.05C)
5	Rest		Time	1 min
6	Discharge	Constant current	Current	80.0 A
			Time	10 sec
			Voltage limit	2.50 V

7.1.3 High Temperature Storage Characteristics

Step	Action	Mode	Control parameter	Value
1	Rest	Soaking	Temperature	25 ± 2 °C
			Time	60 min
2	Discharge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	2.50 V
3	Rest		Time	30 min
4	Charge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	3.65 V
		Constant voltage	Voltage	3.65 V
			Current limit	7.96 A (0.05C)
5	Rest		Time	20 min
6	Discharge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	2.50 V
7	Rest		Time	20 min

8	Repeat	Step 4~7	Cycle	2 times ¹⁷
9	Charge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	3.65 V
		Constant voltage	Voltage	3.65 V
			Current limit	7.96 A (0.05C)
10	Rest		Time	20 min
11	Rest	Soaking	Temperature	45 ± 2 °C
			Time	4 weeks ¹⁸

7.1.4 Cycle Life

Step	Action	Mode	Control parameter	Value
1	Rest	Soaking	Temperature	45 ± 2 °C
			Time	4 hr
2	Discharge	Constant current	Current	39.8 A (0.25C)
			Voltage limit	2.50 V
3	Rest		Time	5 min
4	Charge	Constant Power	Power	254.72 W (0.5CP)
			Voltage limit	3.65 V
5	Rest		Time	20 min
6	Discharge	Constant Power	Power	254.72 W (0.5CP)
			Voltage limit	2.50 V
7	Rest		Time	60 min
8	Repeat	Step 4~7	Cycle	300 times

¹⁷ Initial (Reflects the 1st measured capacity), After 4 weeks (Reflects the 2nd measured capacity.)

¹⁸ After 4 weeks, cells shall be cycled per Step 1~8 to obtain capacity retention

JF2 DC LINK 5.1 (0.25CP) ELECTRICAL DRAWING

Customer

Supplier LG EnergySolution



Product Information

Product Model : LINK-FDF2JR13, LINK-FDF2JLL13
Product Description : JF2 DC LINK 5.1 (0.25 CP, US)
Document No. : F2D4-5.1US-EL02

Editing date : 17. APR. 2025

Supplier : LG EnergySolution

Total : 5

THE SPECIFICATION MAY BE SUBJECT TO CHANGE

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△3					
△2					
△1					
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		DIMENSION MM
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DWG NO. -	DWG SIZE A3	SHEET 01 / 05 SHEETS

JF2 DC LINK 5.1 (0.25CP) E-PANEL SINGLE LINE DIAGRAM REVISION HISTORY

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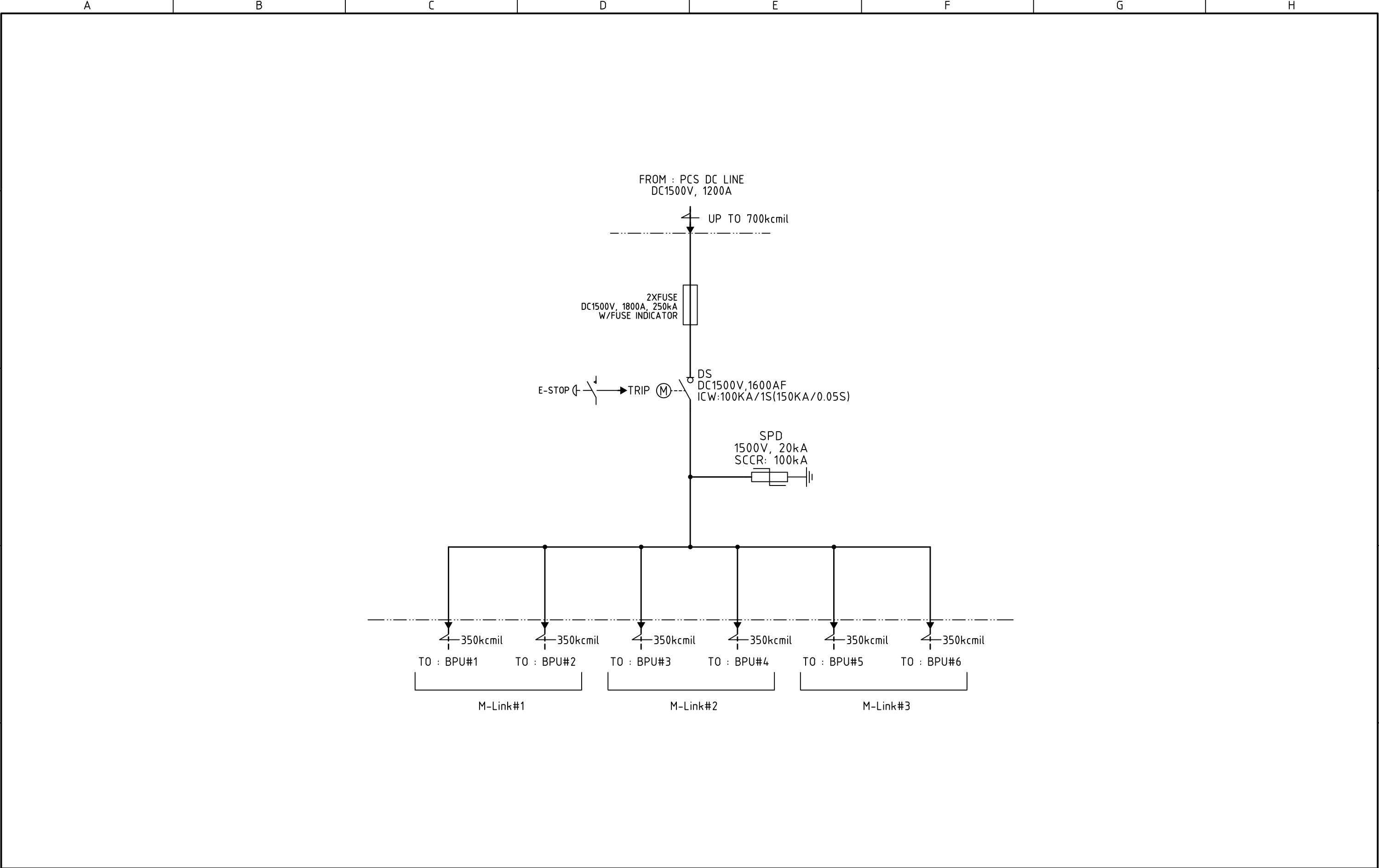
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REV	DESCRIPTION	DATE	DRWN	CHKD	APPD	DWG NO.	-	DWG SIZE	A3	SHEET	02	05

JF2 DC LINK E-PANEL ELECTRICAL DIAGRAM
(EPNLTF_1200A/C)

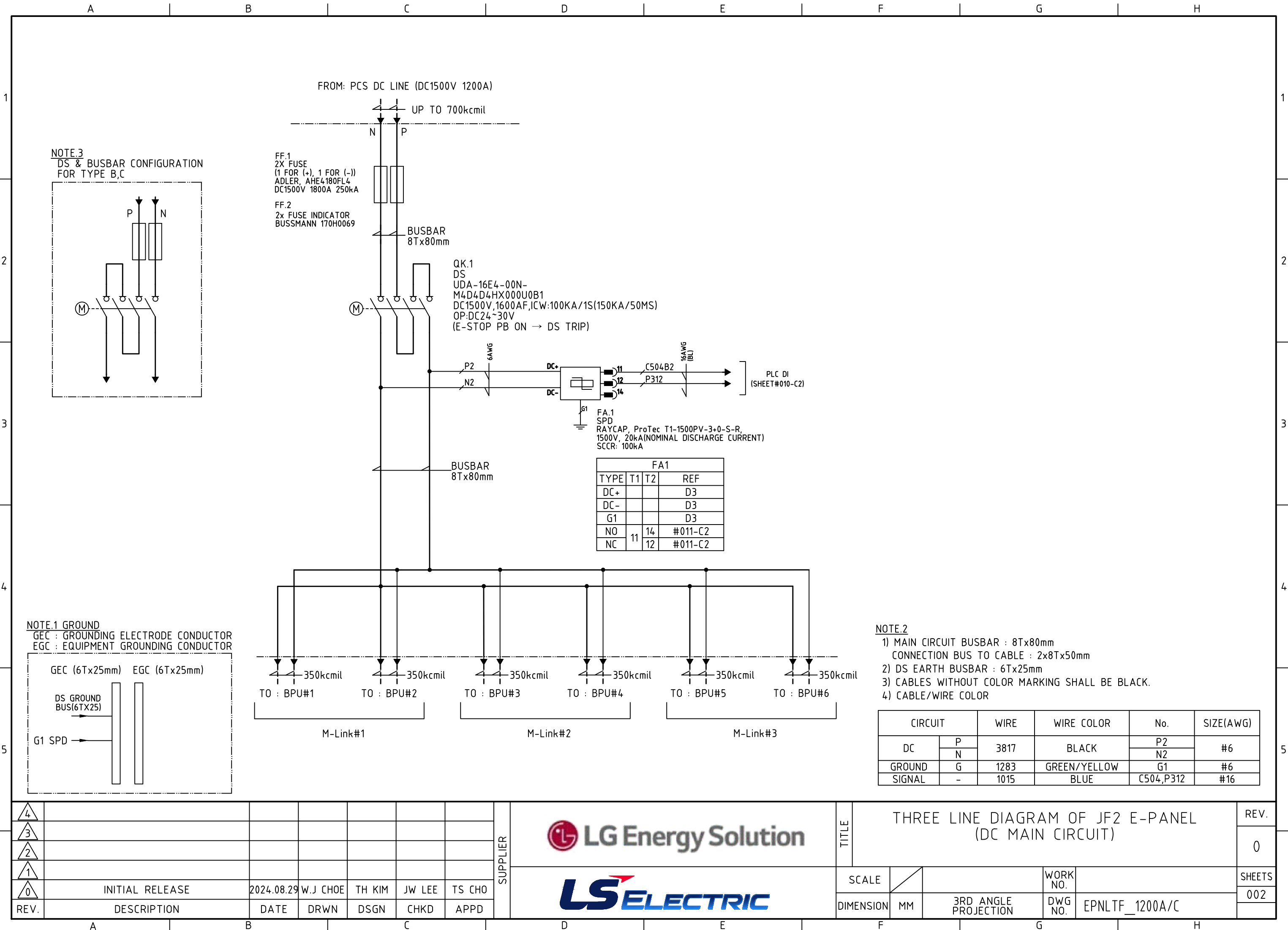
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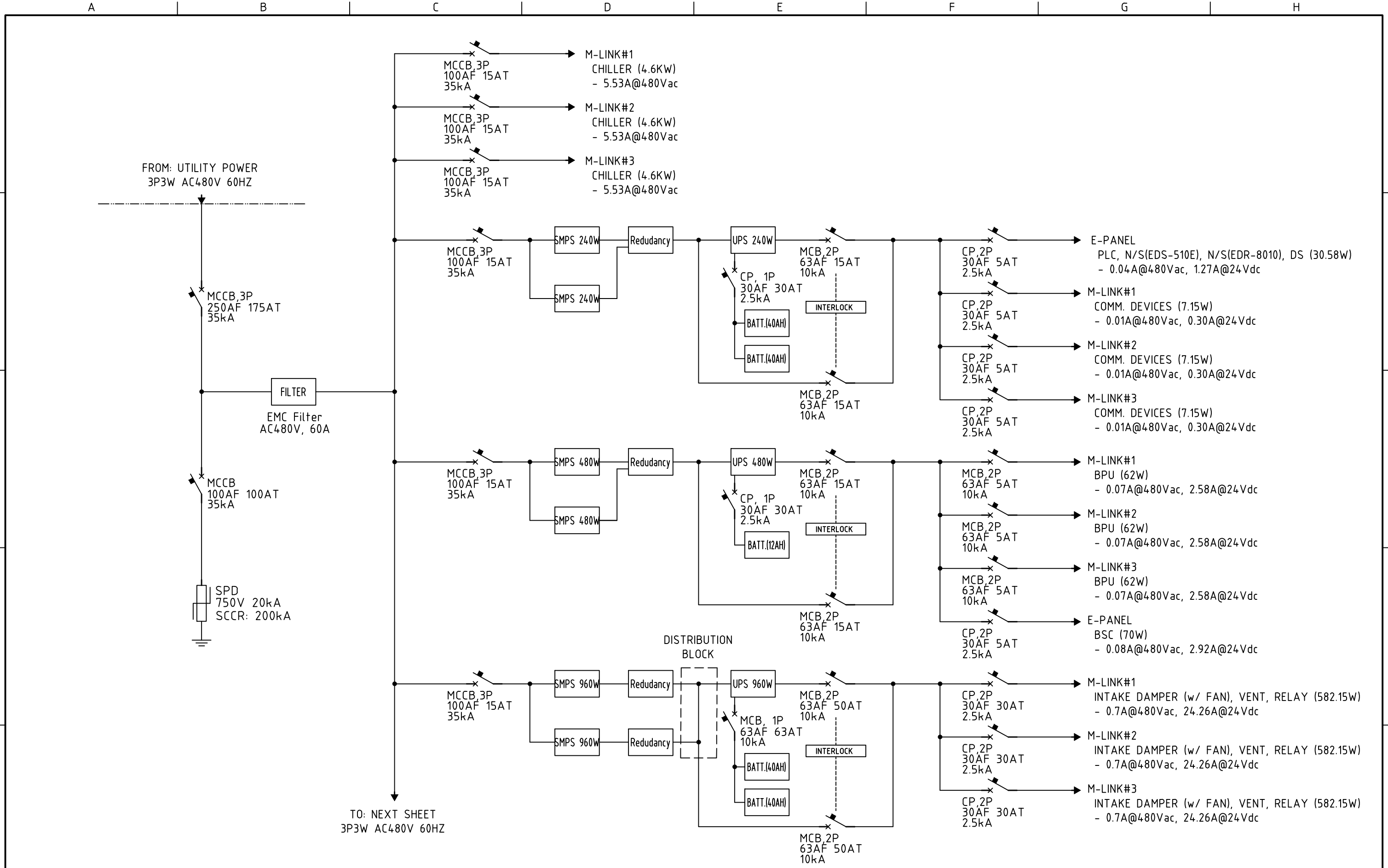
V3.5 (2025.04.23)

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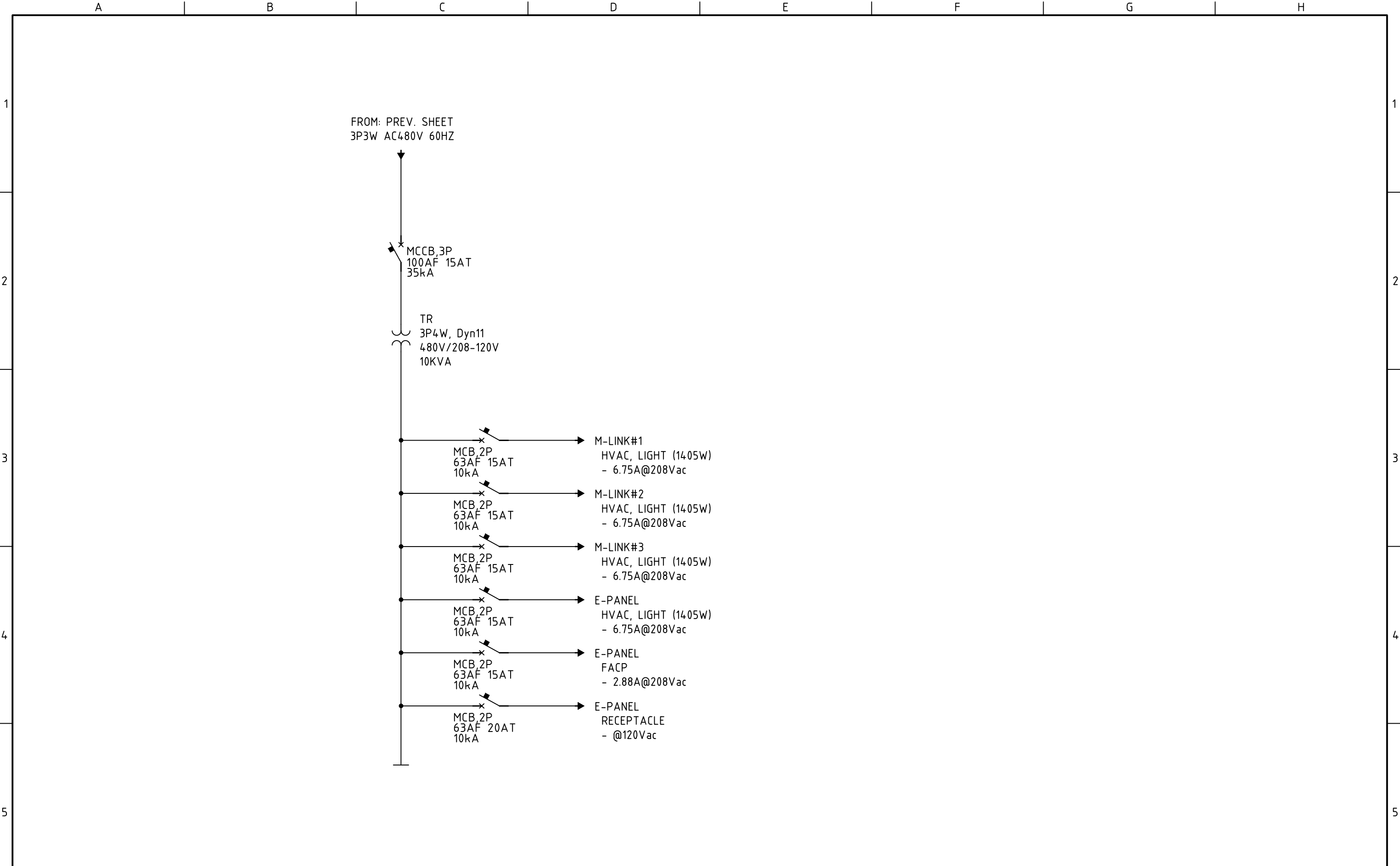


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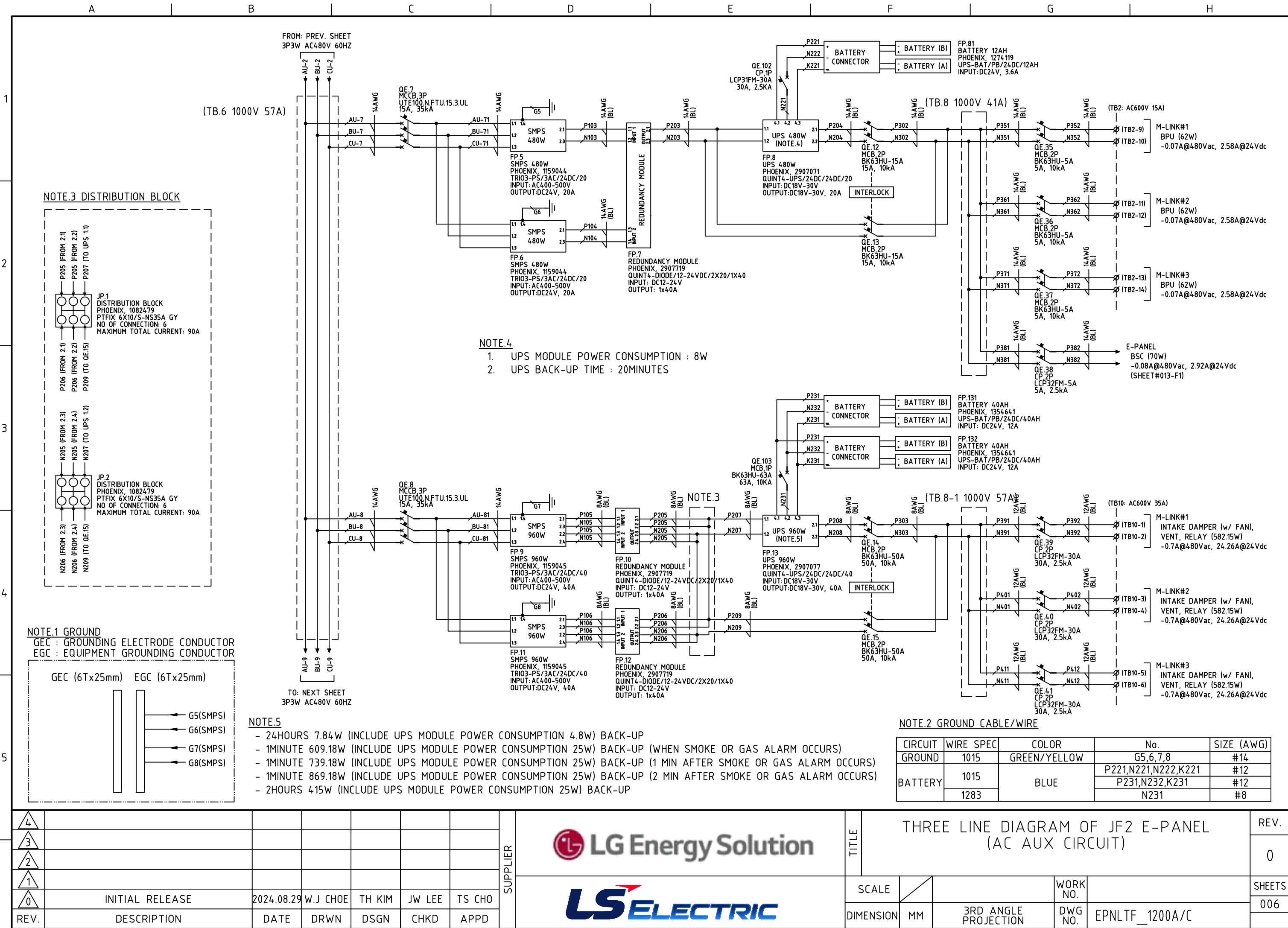


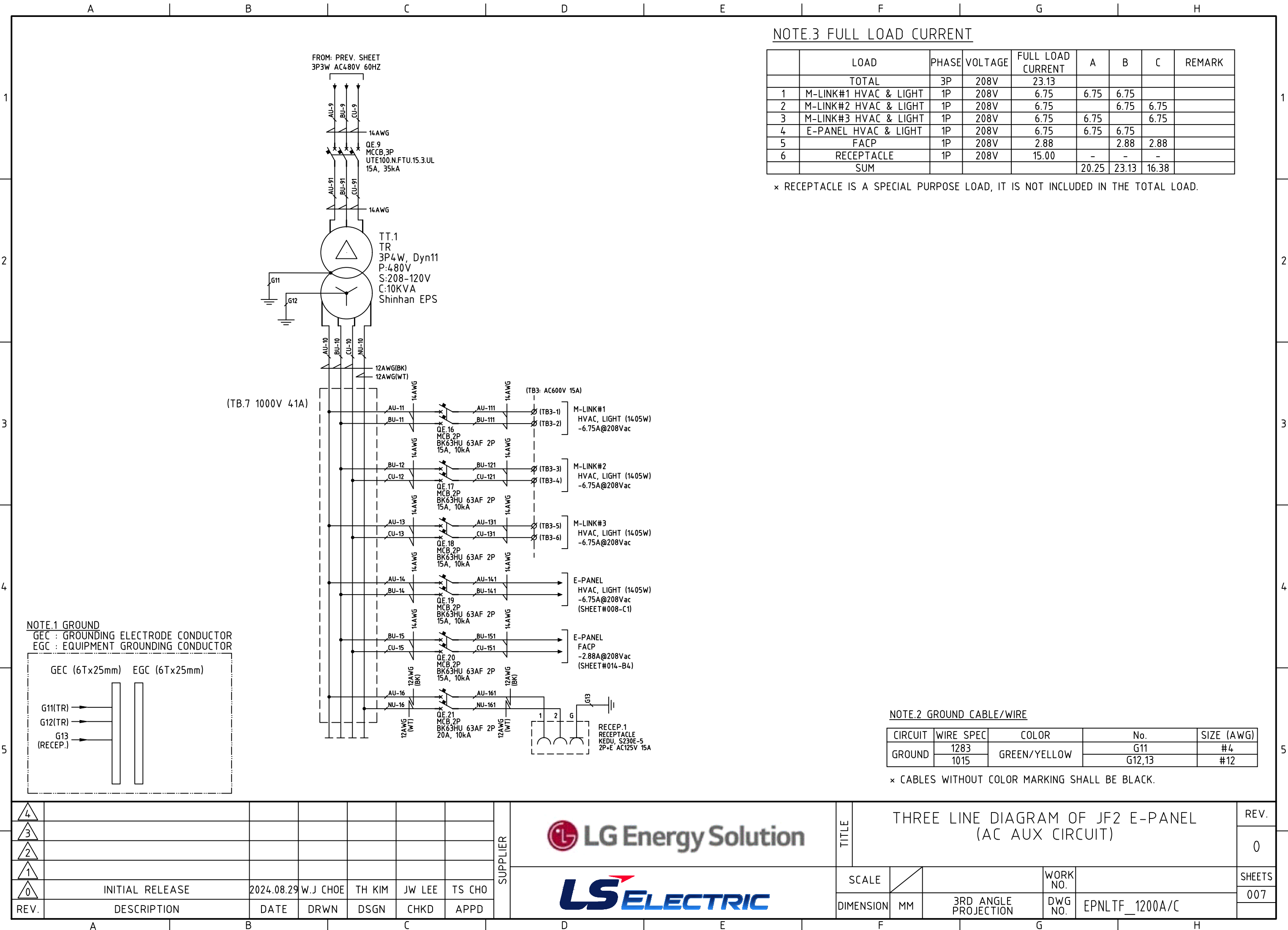


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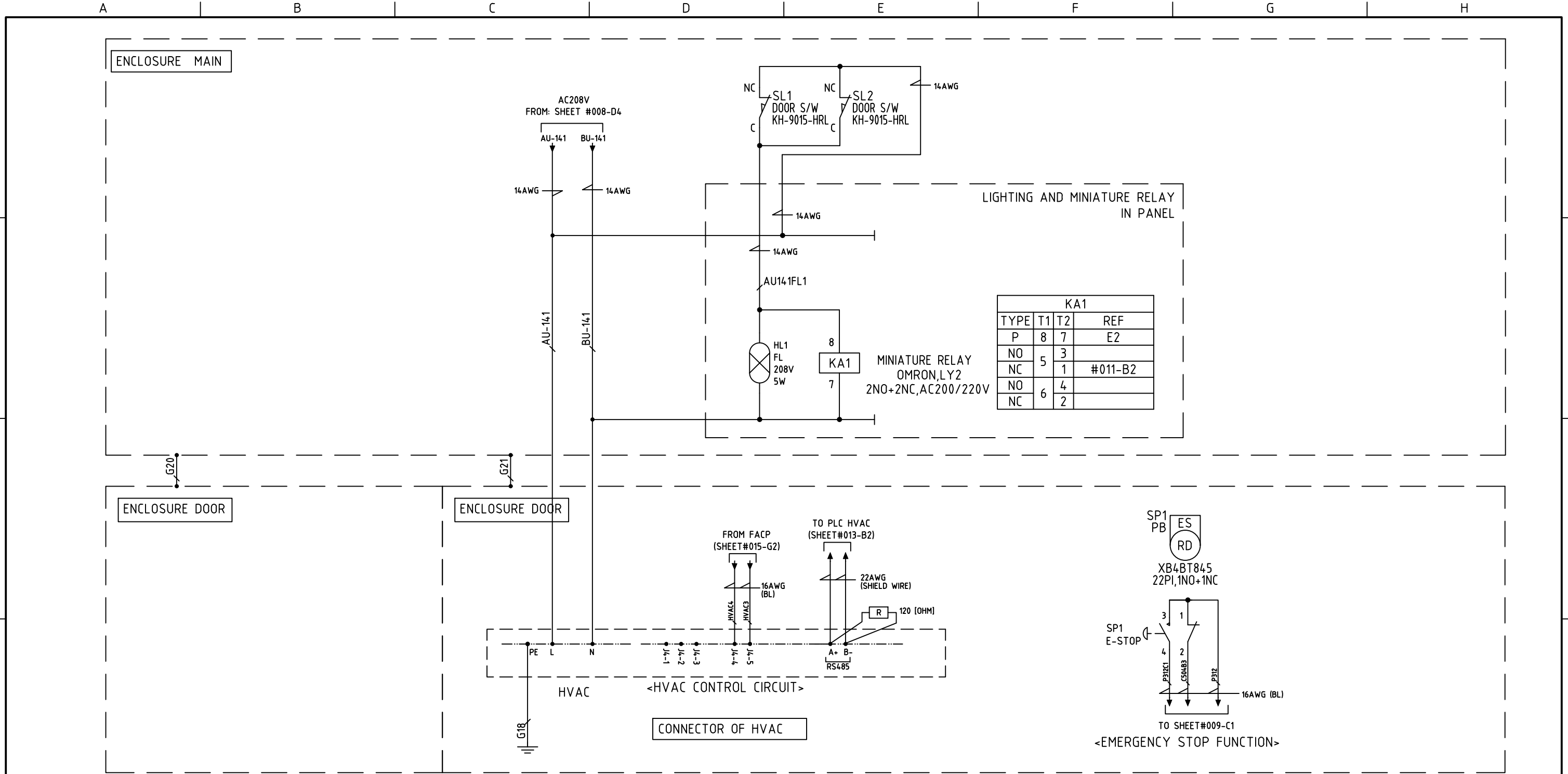




NOTE.3 FULL LOAD CURRENT

	LOAD	PHASE	VOLTAGE	FULL LOAD CURRENT	A	B	C	REMARK
	TOTAL	3P	208V	23.13				
1	M-LINK#1 HVAC & LIGHT	1P	208V	6.75	6.75	6.75		
2	M-LINK#2 HVAC & LIGHT	1P	208V	6.75		6.75	6.75	
3	M-LINK#3 HVAC & LIGHT	1P	208V	6.75	6.75		6.75	
4	E-PANEL HVAC & LIGHT	1P	208V	6.75	6.75	6.75		
5	FACP	1P	208V	2.88		2.88	2.88	
6	RECEPTACLE	1P	208V	15.00	-	-	-	
	SUM				20.25	23.13	16.38	

× RECEPTACLE IS A SPECIAL PURPOSE LOAD, IT IS NOT INCLUDED IN THE TOTAL LOAD.



NOTE.1 GROUND

NOTE.3 HVAC & E-STOP S/W LOCATION
A TYPE: RIGHT DOOR
B,C TYPE: LEFT DOOR

NOTE.2 GROUND CABLE/WIRE

CIRCUIT	WIRE SPEC	COLOR	No.	SIZE (AWG)
SIGNAL	-	1015	BLUE	HVAC3~4
				#16
AC	-	1015	BLACK	AU-141
				#14
GROUND	1015	GREEN/YELLOW	G20,21	#10
			G18	#14

4							SUPPLIER		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (SEQUENCE CIRCUIT)				REV.	
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2									SCALE	<div></div>		WORK NO.		SHEETS	
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REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD									
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INTERFACE TB FOR PLC
IOLINK, XTB-40H
(SHEET#015-B2)

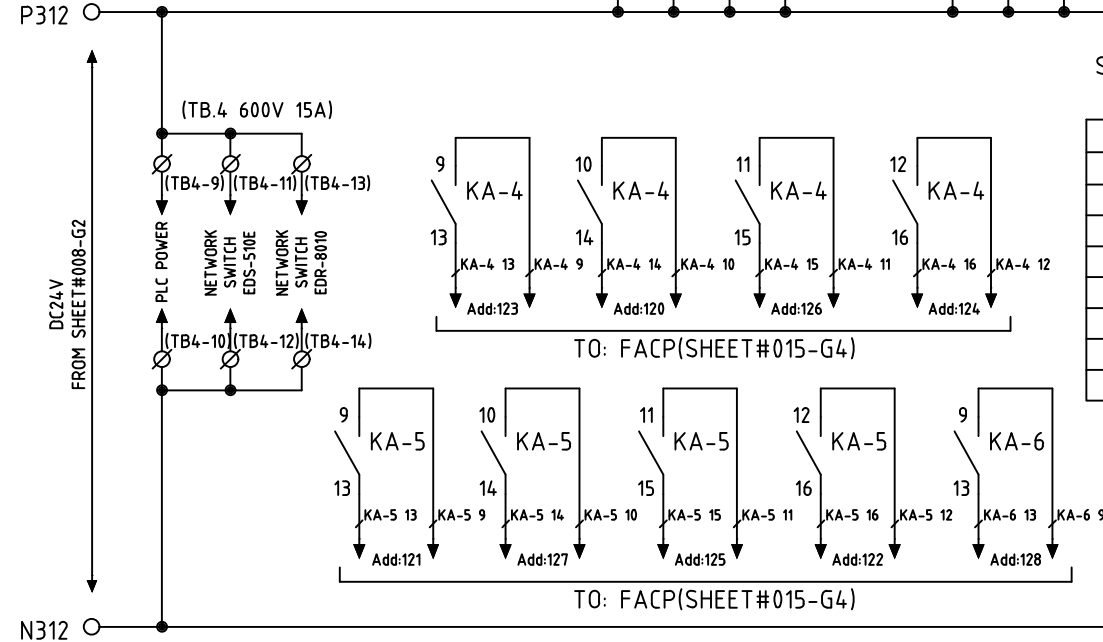
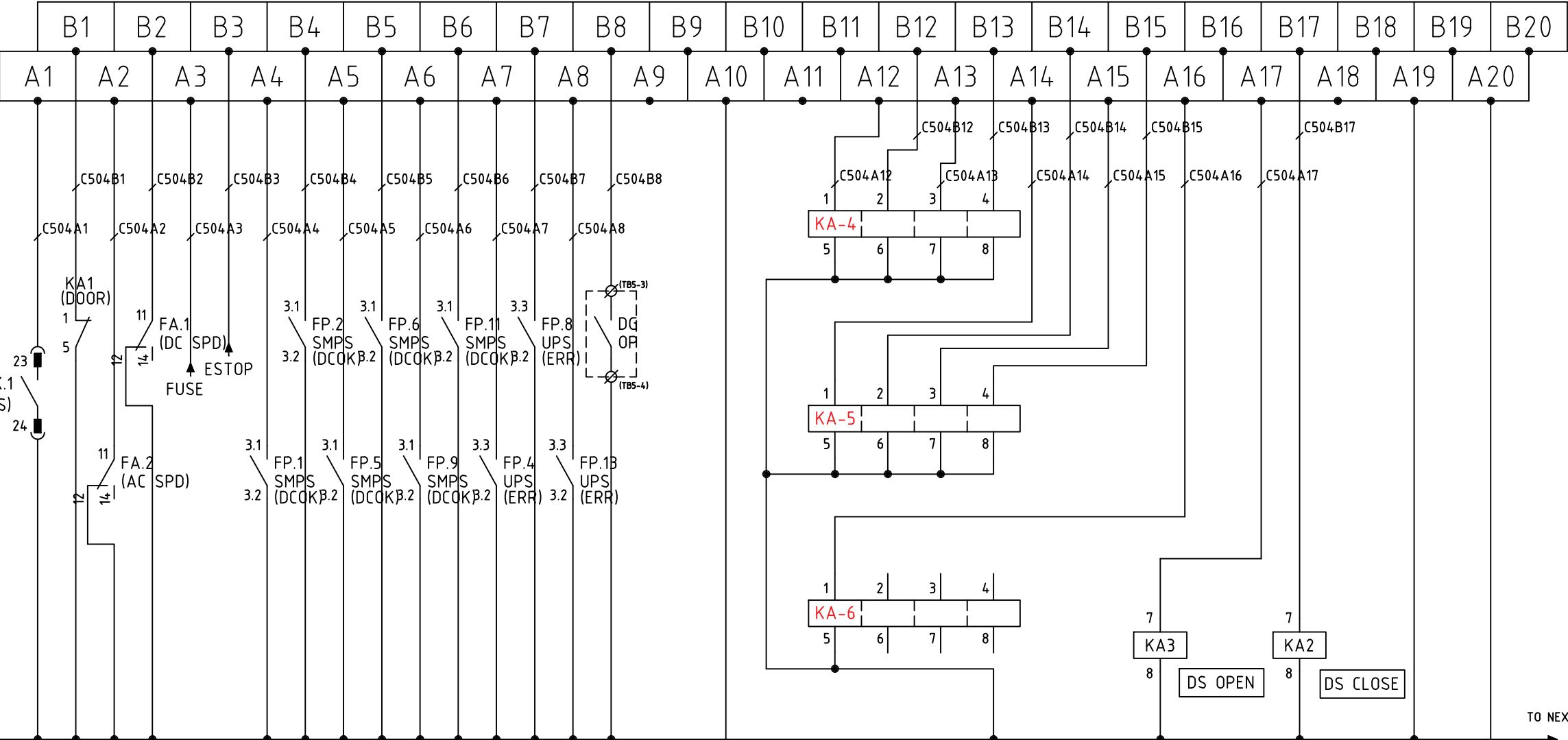
NOTE.2

[PLC INPUT]

A1	QK.1 (DS)	SHEET#011-C5
B1	KA1 (DOOR)	SHEET#010-C2
A2	FA.2 (AC SPD)	SHEET#002-E1
B2	FA.1 (DC SPD)	SHEET#006-A4A3
A3	FUSE	
B3	SP1 (ESTOP)	SHEET#011-C3
A4	FP.1 (SMPS DCOK)	SHEET#014-A2
B4	FP.2 (SMPS DCOK)	SHEET#014-B2
A5	FP.5 (SMPS DCOK)	SHEET#014-C2
B5	FP.6 (SMPS DCOK)	SHEET#014-D2
A6	FP.9 (SMPS DCOK)	SHEET#014-E2
B6	FP.11 (SMPS DCOK)	SHEET#014-F2
A7	FP.4 (UPS1 ERROR)	
B7	FP.8 (UPS2 ERROR)	
A8	FP.13 (UPS3 ERROR)	
B8	DIESEL GENERATOR OPERATION	

[PLC OUTPUT]

A12	M LINK#1 VENT STATE (#018-C2)
B12	M LINK#1 DAMPER STATE (#018-C2)
A13	M LINK#1 FAN STATE
B13	M LINK#2 VENT STATE (#018-C2)
A14	M LINK#2 DAMPER STATE (#018-C2)
B14	M LINK#2 FAN STATE
A15	M LINK#3 VENT STATE (#018-C2)
B15	M LINK#3 DAMPER STATE (#018-C2)
A16	M LINK#3 FAN STATE
A17	KA3 (DS OPEN) SHEET#011-B2
B17	KA2 (DS CLOSE) SHEET#011-B2



KA4			
P	5	1	E2
P	6	2	E2
P	7	3	F2
P	8	4	F2
NO	9	13	B4
NO	10	14	C4
NO	11	15	B5
NO	12	16	B5

KA5			
P	5	1	E3
P	6	2	E3
P	7	3	F3
P	8	4	F3
NO	9	13	B5
NO	10	14	C5
NO	11	15	C5
NO	12	16	D5

KA6			
P	5	1	E3
P	6	2	E3
P	7	3	F3
P	8	4	F3
NO	9	13	D5
NO	10	14	D5
NO	11	15	
NO	12	16	

KA3			
TYPE	T1	T2	REF
P	8	7	F3
NO	5	3	#011-B2
NC		1	
NO	6	4	
NC		2	

KA2			
TYPE	T1	T2	REF
P	8	7	G3
NO	5	3	#011-B2
NC		1	
NO	6	4	
NC		2	

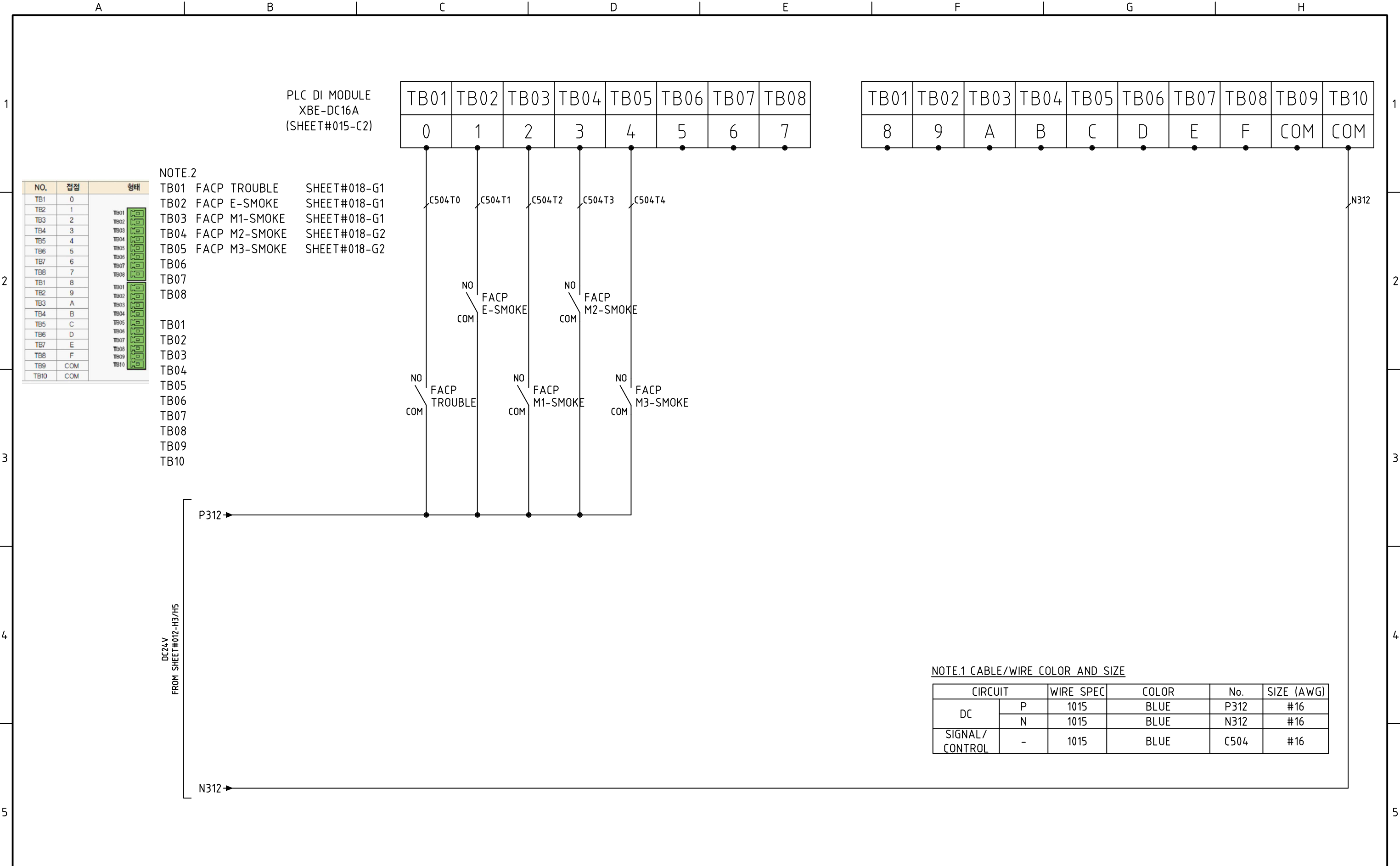
NOTE.1 CABLE/WIRE COLOR AND SIZE

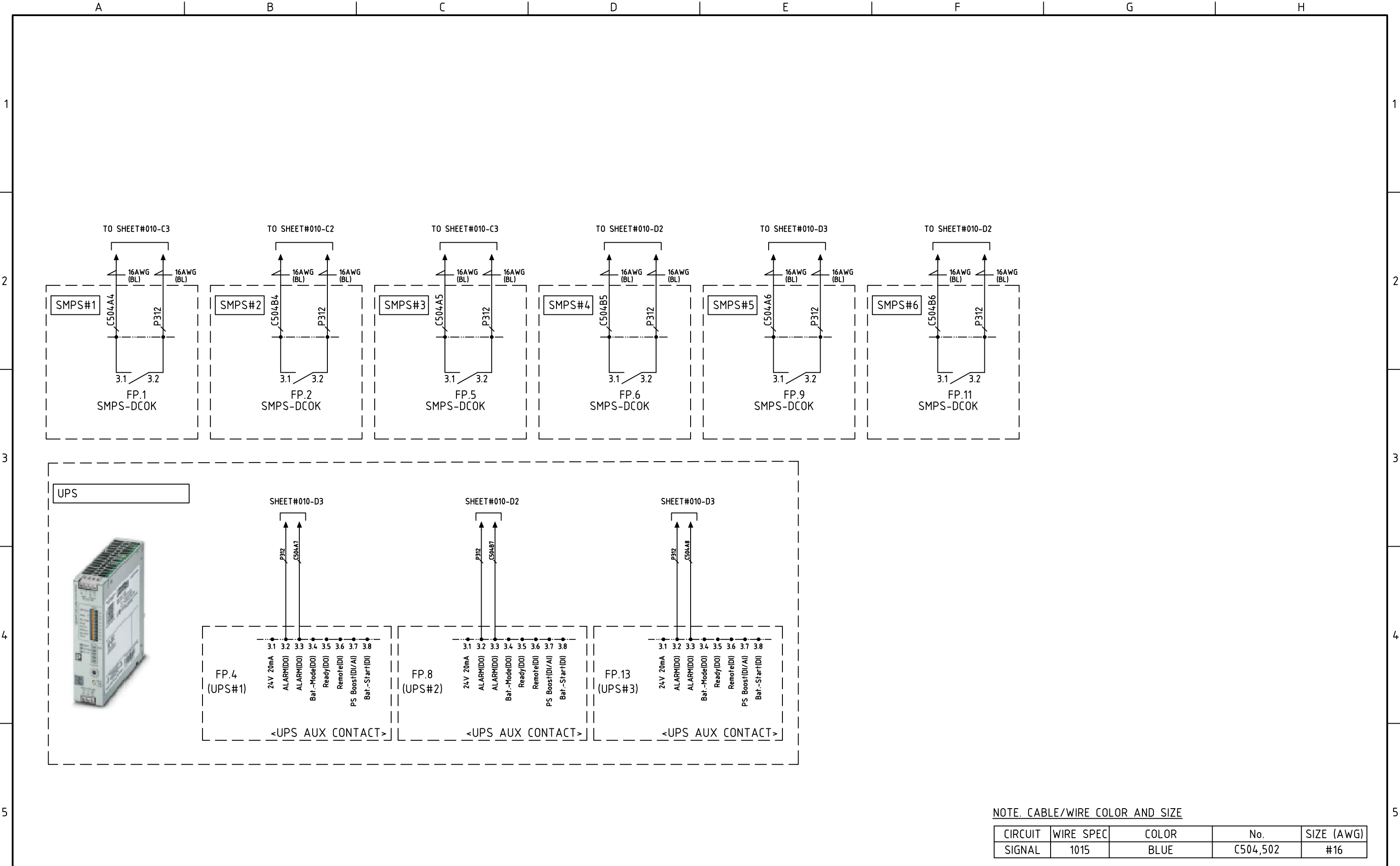
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	N			N312	
SIGNAL/CONTROL		1015	BLUE	C504	#16



TITLE				REV.
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DIMENSION	MM	DWG NO.	EPNLTF_1200A/C	010

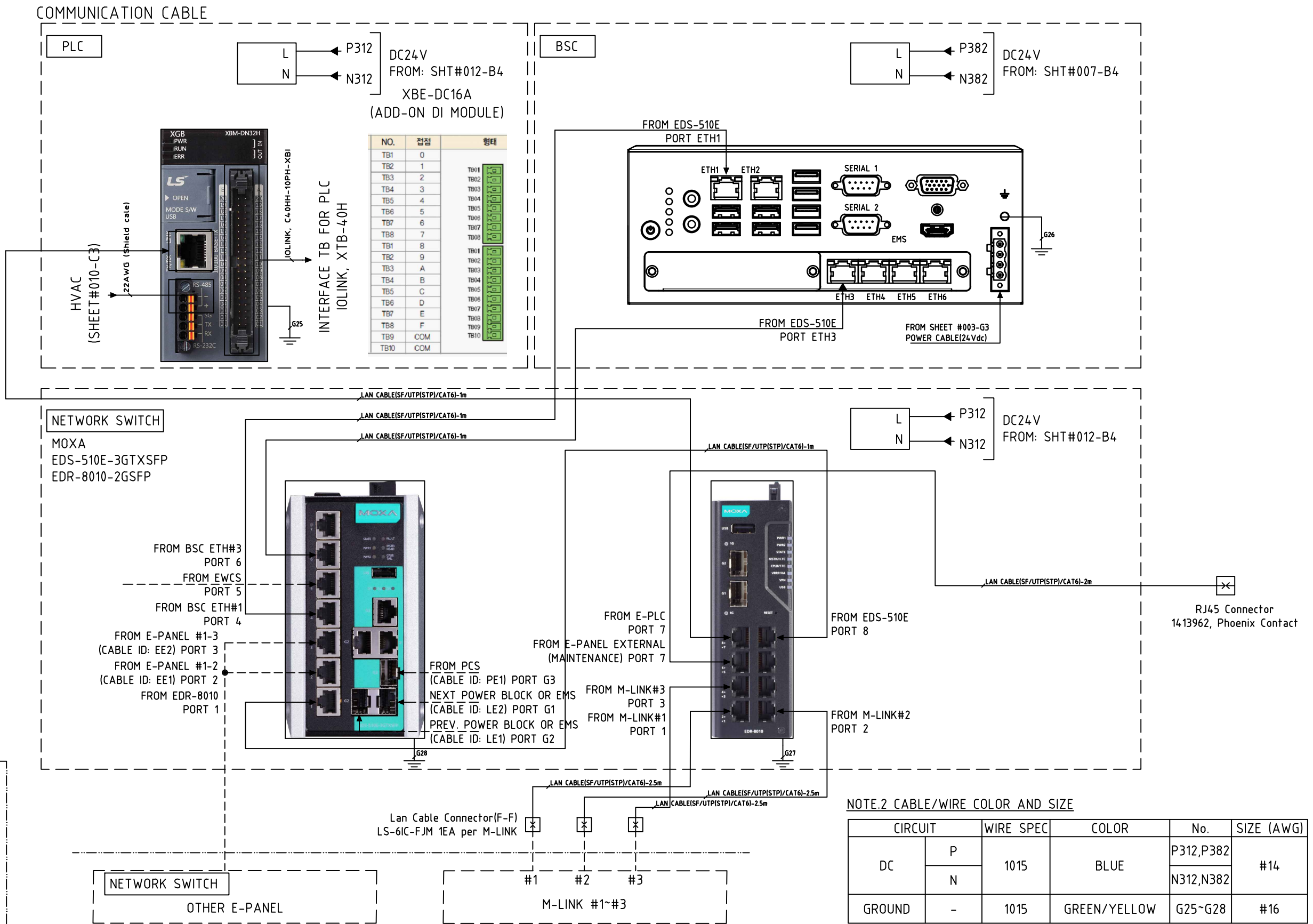
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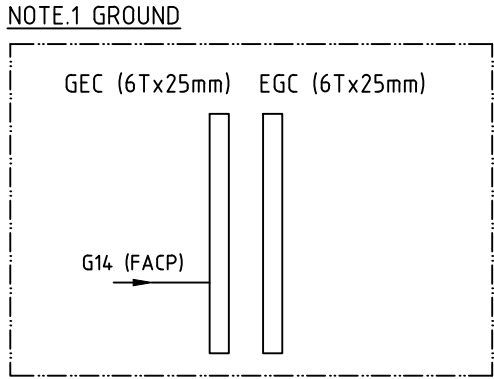
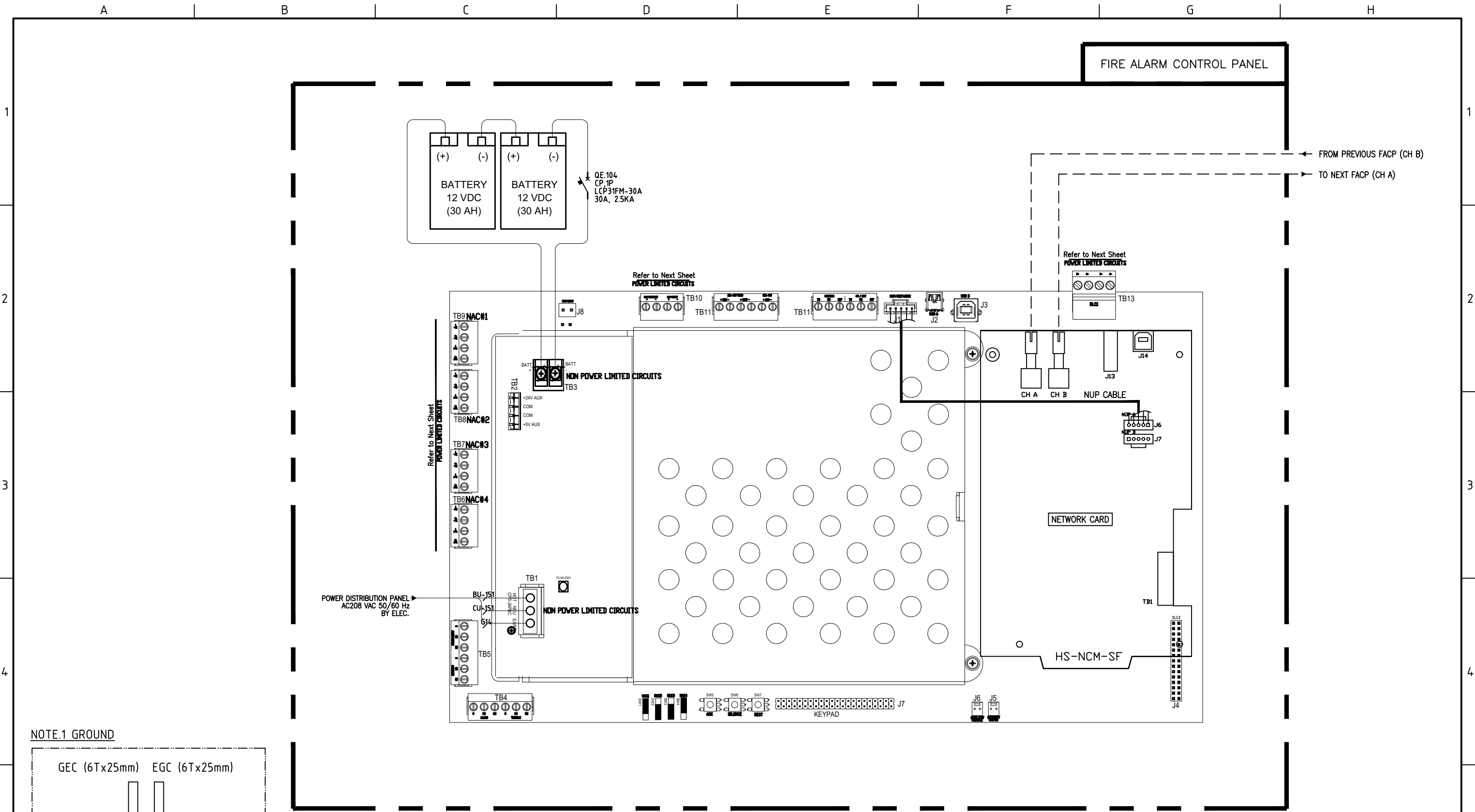


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2														
1														
0	FOR REVIEW	2024.01.15	J.S.LEE	W.J.CHOE	W.J.CHOE	R.YOO				SCALE			WORK NO.	
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD			DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200A/C	012
	A	B		C				D	E		F		G	H

With BSC (TYPE-A/C)



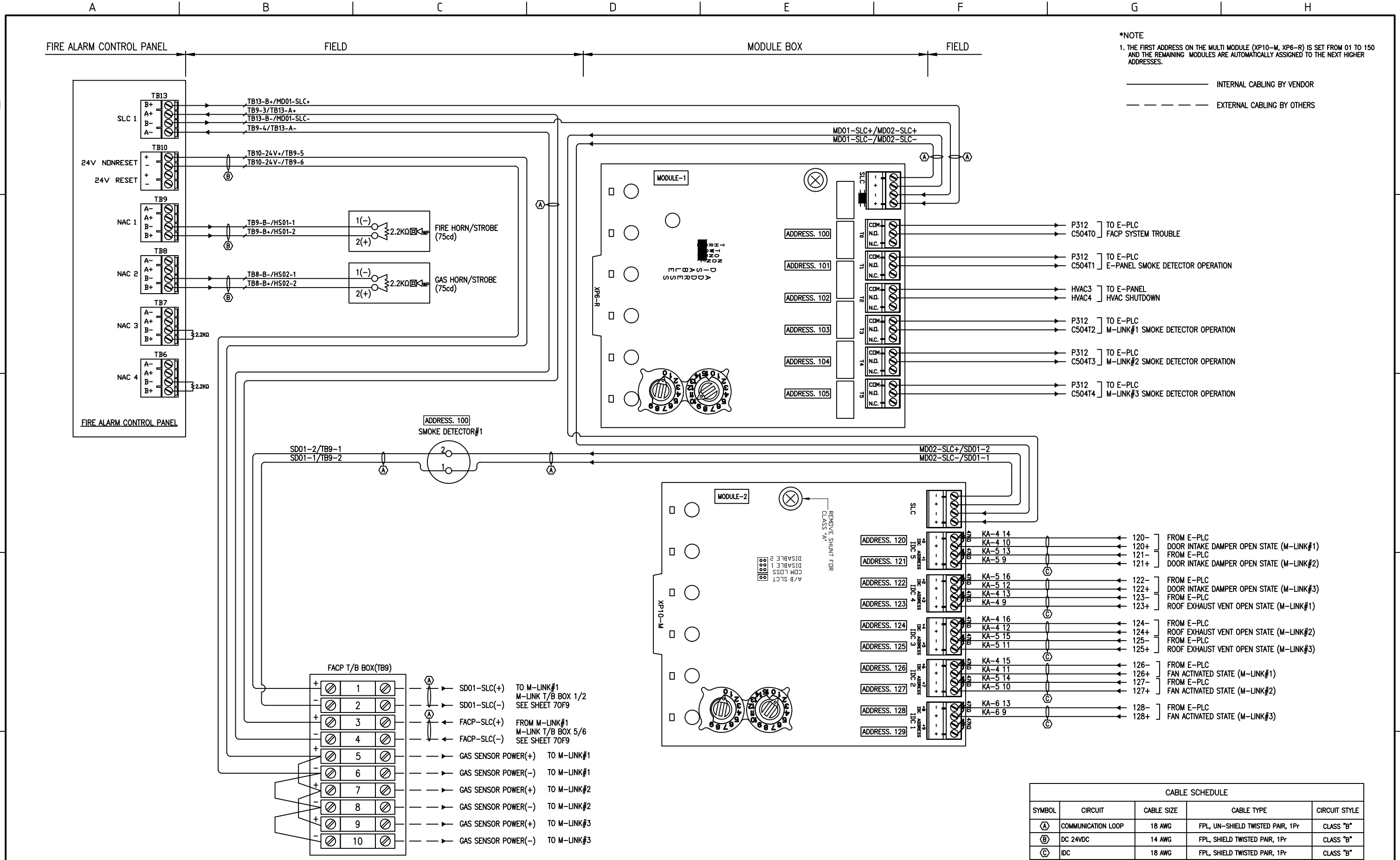
4							SUPPLIER		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (COMMUNICATION CABLE)					REV.
3										0					
2															
1															
0	FOR REVIEW	2024.01.15	J.S.LEE	W.J.CHOE	W.J.CHOE	R.YOO			SCALE			WORK NO.		SHEETS	
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD	DIMENSION		MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200A/C	013		



———— INTERNAL CABLING BY VENDOR
- - - - - EXTERNAL CABLING BY OTHERS

- NOTE.2
1. POWER-LIMITED AND NON POWER-LIMITED CIRCUIT WIRING MUST REMAIN SEPARATED.
 2. AC POWER WIRING SIZE : 14 AWG.
 3. BATTERY WIRING SIZE : 12 AWG.
 4. GAS SENSOR POWER WIRING SIZE : 14 AWG.

REV.	4						SUPPLIER	LG Energy Solution	TITLE	SCHEMATIC DIAGRAM OF E-PANEL (SEQUENCE CIRCUIT- FACP)				REV.
	3													0
	2													SHEETS
	1													
	0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO	LS ELECTRIC	SCALE	MM	3RD ANGLE PROJECTION	WORK NO.	EPNLT_F_1200A/C	014
		DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD		DIMENSION			DWG NO.		



4							SUPPLIER		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (SEQUENCE CIRCUIT-FACP)					REV.
3															0
2															
1															
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO									SHEETS
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD		SCALE			WORK NO.		015		
								DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200A/C			
A		B		C			D	E		F		G	H		

A		B		C		D		E		F		G		H			
TB.1 (600V 15A,9P)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 AU-31	M-LINK#1 CHILLER															
2	2 BU-31	M-LINK#1 CHILLER															
3	3 CU-31	M-LINK#1 CHILLER															
4	4 AU-41	M-LINK#2 CHILLER															
5	5 BU-41	M-LINK#2 CHILLER															
6	6 CU-41	M-LINK#2 CHILLER															
7	7 AU-51	M-LINK#3 CHILLER															
8	8 BU-51	M-LINK#3 CHILLER															
9	9 CU-51	M-LINK#3 CHILLER															
TB.2 (600V 15A,14P)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 P312	E-PANEL PLC, N/S, DS															
2	2 N312	E-PANEL PLC, N/S, DS															
3	3 P322	M-LINK#1 COMM. DEVICES															
4	4 N322	M-LINK#1 COMM. DEVICES															
5	5 P332	M-LINK#2 COMM. DEVICES															
6	6 N332	M-LINK#2 COMM. DEVICES															
7	7 P342	M-LINK#3 COMM. DEVICES															
8	8 N342	M-LINK#3 COMM. DEVICES															
9	9 P352	M-LINK#1 BPU															
10	10 N352	M-LINK#1 BPU															
11	11 P362	M-LINK#2 BPU															
12	12 N362	M-LINK#2 BPU															
13	13 P372	M-LINK#3 BPU															
14	14 N372	M-LINK#3 BPU															
TB.3 (600V 15A,6P)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 AU-111	M-LINK #1 HVAC & LIGHT															
2	2 BU-111	M-LINK #1 HVAC & LIGHT															
3	3 BU-121	M-LINK #2 HVAC & LIGHT															
4	4 CU-121	M-LINK #2 HVAC & LIGHT															
5	5 AU-131	M-LINK #3 HVAC & LIGHT															
6	6 CU-131	M-LINK #3 HVAC & LIGHT															
TB.4 (600V 15A,14P)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 C501a3	DS AUX "a"															
2	2 C501n3	DS AUX "a"															
3	3 C501a4	DS AUX "a"															
4	4 C501n4	DS AUX "a"															
5	5 C501b3	DS AUX "b"															
6	6 C501n5	DS AUX "b"															
7	7 C501b4	DS AUX "b"															
8	8 C501n6	DS AUX "b"															
9	9 P312	PLC POWER				9 P312											
10	10 N312	PLC POWER				10 N312											
11	11 P312	N/S EDS-510E				11 P312											
12	12 N312	N/S EDS-510E				12 N312											
13	13 P312	N/S EDR-8010				13 P312											
14	14 N312	N/S EDR-8010				14 N312											
TB.5 (600V 15A,4P)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 P312C1	EXTERNAL E-STOP															
2	2 P312	EXTERNAL E-STOP															
3	3 C504B8	DIESEL GENERATOR OPERATION															
4	4 P312	DIESEL GENERATOR OPERATION															
TB.6 (1000V 57A,21P - PHOENIX CONTACT, PT-10)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 AU-2	AC480V PHASE A				1 AU-3		●									
2						2 AU-4		●									
3						3 AU-5		●									
4						4 AU-6		●									
5						5 AU-7		●									
6						6 AU-8		●									
7						7 AU-9		●									
8	9 BU-2	AC480V PHASE B				8 BU-3		●									
9						9 BU-4		●									
10						10 BU-5		●									
11						11 BU-6		●									
12						12 BU-7		●									
13						13 BU-8		●									
14						14 BU-9		●									
15	17 CU-2	AC480V PHASE C				15 CU-3		●									
16						16 CU-4		●									
17						17 CU-5		●									
18						18 CU-6		●									
19						19 CU-7		●									
20						20 CU-8		●									
21						21 CU-9		●									
TB.7 (1000V 41A,12P - PHOENIX CONTACT, PT-6)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 AU-10	AC208V PHASE A				1 AU-11		●									
2						2 AU-13		●									
3						3 AU-14		●									
4						4 AU-16		●									
5	5 BU-10	AC208V PHASE B				5 BU-11		●									
6						6 BU-12		●									
7						7 BU-14		●									
8						8 BU-15		●									
9	9 CU-10	AC208V PHASE C				9 CU-12		●									
10						10 CU-13		●									
11						11 CU-15		●									
12	12 NU-10	AC120V PHASE N				12 NU-16		●									
TB.8 (1000V 41A,16P - PHOENIX CONTACT, PT-6)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 P301	DC24V PHASE P				1 P311		●									
2						2 P321		●									
3						3 P331		●									
4						4 P341		●									
5	5 N301	DC24V PHASE N				5 N311		●									
6						6 N321		●									
7						7 N331		●									
8						8 N341		●									
9	9 P302	DC24V PHASE P				9 P351		●									
10						10 P361		●									
11						11 P371		●									
12						12 P381		●									
13	13 N302	DC24V PHASE N				13 N351		●									
14						14 N361		●									
15						15 N371		●									
16						16 N381		●									
TB.8-1 (1000V 57A,6P - PHOENIX CONTACT, PT-10)																	
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.		CONNECTION									
1	1 P303	DC24V PHASE P				1 P391		●									
2						2 P401		●									
3						3 P411		●									
4	4 N303	DC24V PHASE N				4 N391		●									
5						5 N401		●									
6						6 N411		●									
△4									SCHEMATIC DIAGRAM OF E-PANEL (TERMINAL BLOCK LIST)				REV.				
△3													0				
△2																	
△1																	
△0	FOR REVIEW	2024.01.15	J.S.LEE	W.J.CHOE	W.J.CHOE	R.YOO			SCALE				WORK NO.		SHEETS		
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD							DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200A/C
<div>SUPPLIER</div> <div>LG Energy Solution</div> <div>LS ELECTRIC</div>								TITLE		SCALE		3RD ANGLE PROJECTION		WORK NO.		SHEETS	

A		B		C		D		E		F		G		H					
TB.9 (600V 15A,10P)																			
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION												
1		SD01-SLC(+)																	
2		SD01-SLC(-)																	
3		FACP-SLC(+)																	
4		FACP-SLC(-)																	
5		GAS SENSOR POW 1+																	
6		GAS SENSOR POW 1-																	
7		GAS SENSOR POW 2+																	
8		GAS SENSOR POW 2-																	
9		GAS SENSOR POW 3+																	
10		GAS SENSOR POW 3-																	
TB.10 (600V 35A,6P)																			
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION												
1	1 P392	M-LINK#1 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
2	2 N392	M-LINK#1 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
3	3 P402	M-LINK#2 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
4	4 N402	M-LINK#2 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
5	5 P412	M-LINK#3 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
6	6 N412	M-LINK#3 INTAKE DAMPER (w/ FAN), VENT, RELAY																	
TB.11 (600V 60A,3P)																			
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION												
1	1 AU-1	UTILITY POWER																	
2	2 BU-1	UTILITY POWER																	
3	3 CU-1	UTILITY POWER																	
COM. TB (600V 15A, 20P)																			
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION												
1	P312	DC SPD (12), AC SPD (12)				P312	●												
2	P312	DS MOTOR CHARGE, DS AUX (11)				P312	●												
3	P312	DS AUX (13,24)				P312	●												
4	P312	KA1 (5), FP.1 (3.2)				P312	●												
5	P312	FP.2 (3.2), FP.5 (3.2)				P312	●												
6	P312	FP.6(3.2), FP.9 (3.2)				P312	●												
7	P312	FP.11 (3.2), FP.4 (3.2)				P312	●												
8	P312	FP.8 (3.2), FP.13 (3.2)				P312	●												
9	P312	FUSE FF.2a, FACP				P312	●												
10	P312	FACP × 2				P312	●												
11	P312	FACP × 2				P312	●												
12	P312	SPARE				P312	●												
13	P312	SPARE				P312	●												
14	P312	SPARE				P312	●												
15	N312	DS MOTOR CHARGE, DS CLOSE COIL				N312	●												
16	N312	DS OPEN COIL, H3 L2				N312	●												
17	N312	PLC DI (COM), XTB (A10)				N312	●												
18	N312	SPARE				N312	●												
19	N312	SPARE				N312	●												
20	N312	SPARE				N312	●												
4						SUPPLIER		LG Energy Solution		TITLE		SCHEMATIC DIAGRAM OF E-PANEL (TERMINAL BLOCK LIST)				REV.			
3																0			
2																			
1																			
0		FOR REVIEW														2024.01.15		J.S.LEE	
REV.		DESCRIPTION				DATE		DRWN		DSGN		CHKD		APPD		017			
A		B				C		D		E		F		G				H	

JF2 DC LINK 5.1 (0.25CP) ELECTRICAL DRAWING

Customer

Supplier LG EnergySolution



Product Information

Product Model : LINK-FDF2KL13

Product Description : JF2 DC LINK 5.1 (0.25 CP, US)

Document No. : F2D4-5.1US-EL02

Editing date : 17. APR. 2025

Supplier : LG EnergySolution

Total : 5

△4					
△3					
△2					
△1					
△0	INITIAL RELEASE	2025.03.10	TH KIM	JW LEE	TS CHO
REV	DESCRIPTION	DATE	DRWN	CHKD	APPD

CUSTOMER		
CONTRACTOR		SCALE N/A
		DIMENSION MM
TITLE	JF2 AC LINK 5.1 (0.25CP) ELECTRICAL DRAWING	
DWG NO.	-	DWG SIZE A3
		SHEET 01
		05 SHEETS

JF2 DC LINK 5.1 (0.25CP) E-PANEL SINGLE LINE DIAGRAM REVISION HISTORY

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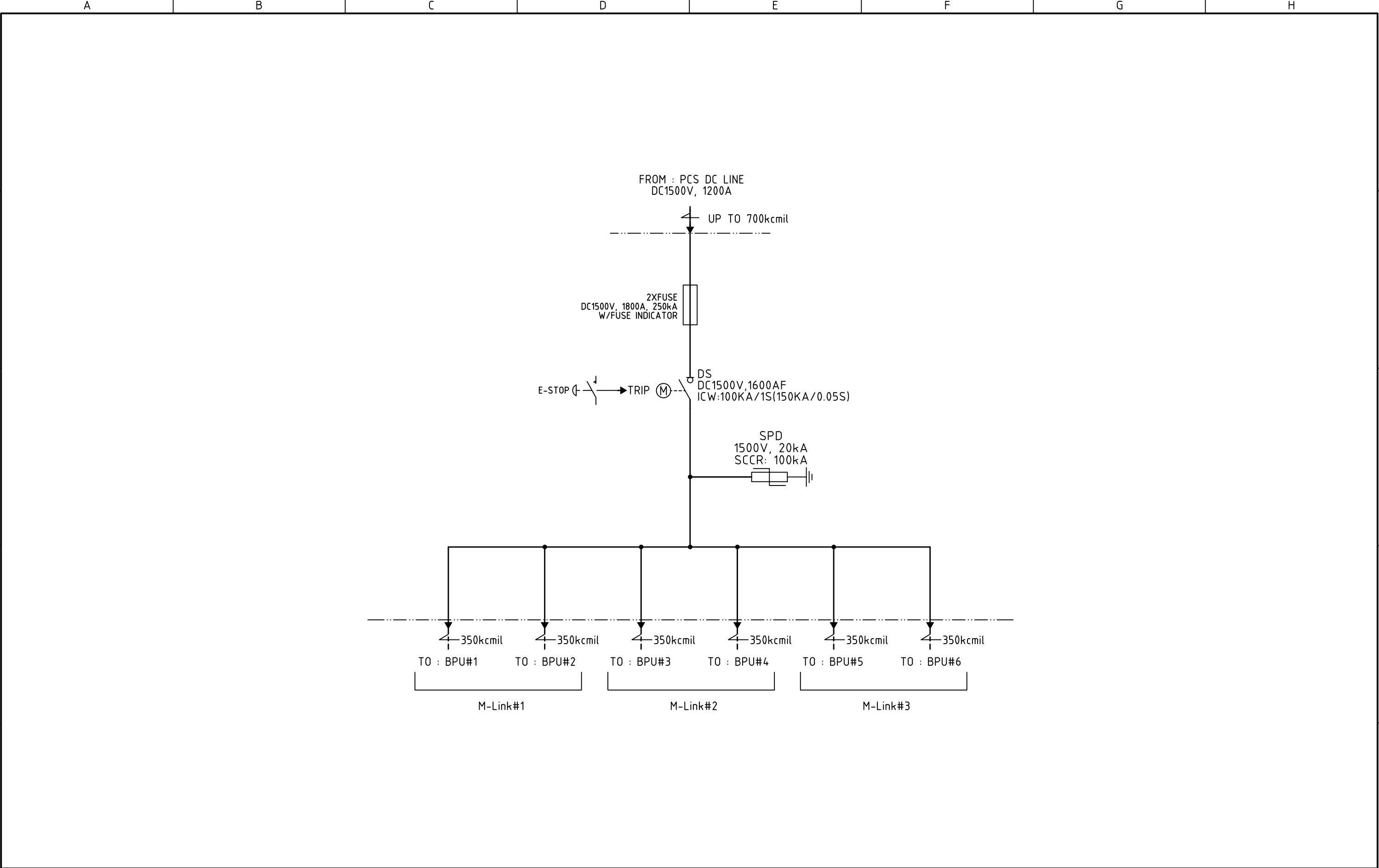
4						CONTRACTOR		SCALE N/A	
3									DIMENSION MM
2									
1									
0	INITIAL RELEASE	2025.03.10	TH KIM	JW LEE	TS CHO	TITLE JF2 DC LINK5.1 (0.25CP) E-PANEL SINGLE LINE DIAGRAM REVISION HISTORY			
REV	DESCRIPTION	DATE	DRWN	CHKD	APPD	DWG NO.	-	DWG SIZE A3	SHEET 02 05 SHEETS

JF2 DC LINK E-PANEL ELECTRICAL DIAGRAM
(EPNLTF_1200B)

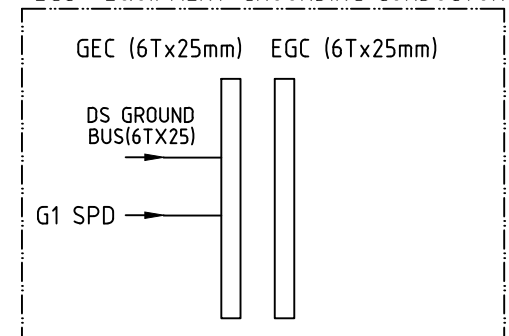
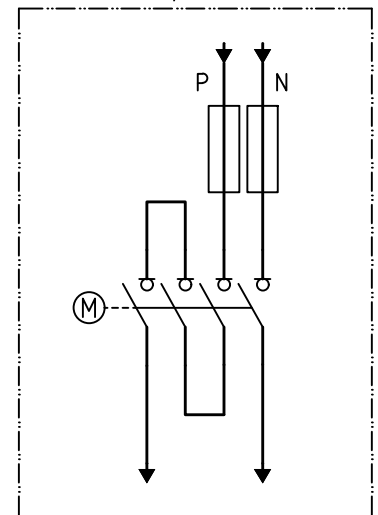
컨테이너형

V3.5 (2025.04.23)

4							SUPPLIER		TITLE	SHEET COVER				REV.
3														0
2									SCALE			WORK NO.		SHEETS
1									DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B	000
0	INITIAL RELEASE	2024.08.29	W.J.CHOE	TH KIM	JW LEE	TS CHO								
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD								



<div>4</div> <div>3</div> <div>2</div> <div>1</div> <div>0</div>							SUPPLIER	<div></div> <div></div>	TITLE	SINGLE LINE DIAGRAM OF JF2 E-PANEL (DC MAIN CIRCUIT)				REV.
														0
	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO			SCALE	<div></div>	WORK NO.			SHEETS
	REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD		DIMENSION					001
									MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B		



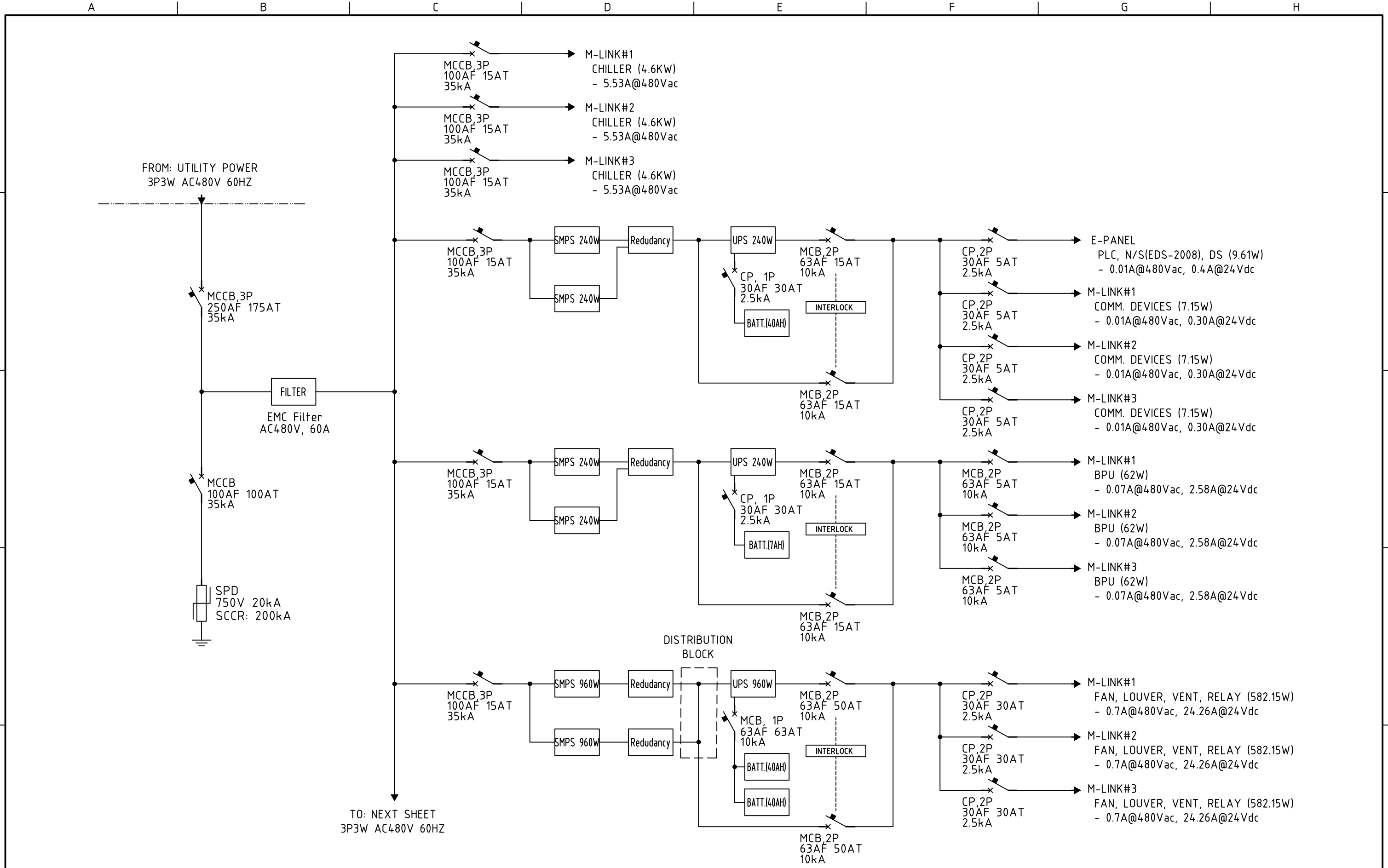
FA1			
TYPE	T1	T2	REF
DC+			D3
DC-			D3
G1			D3
NO	11	14	#011-C2
NC		12	#011-C2

NOTE 2

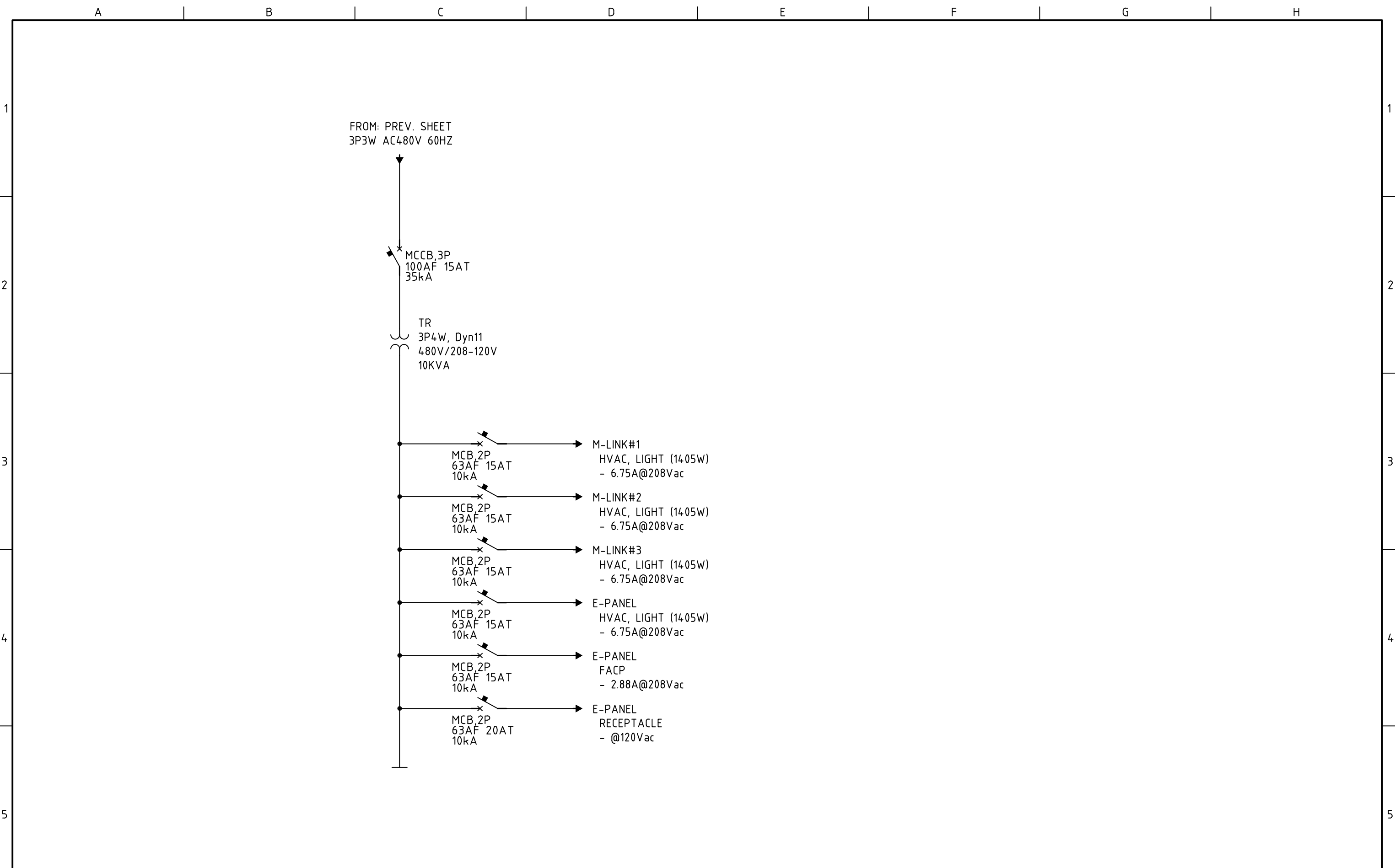
- 1) MAIN CIRCUIT BUSBAR : 8Tx80mm
CONNECTION BUS TO CABLE : 2x8Tx50mm
- 2) DS EARTH BUSBAR : 6Tx25mm
- 3) CABLES WITHOUT COLOR MARKING SHALL BE BLACK.
- 4) CABLE/WIRE COLOR

CIRCUIT		WIRE	WIRE COLOR	No.	SIZE(AWG)
DC	P	3817	BLACK	P2	#6
	N			N2	
GROUND	G	1283	GREEN/YELLOW	G1	#6
SIGNAL	-	1015	BLUE	C504.P312	#16

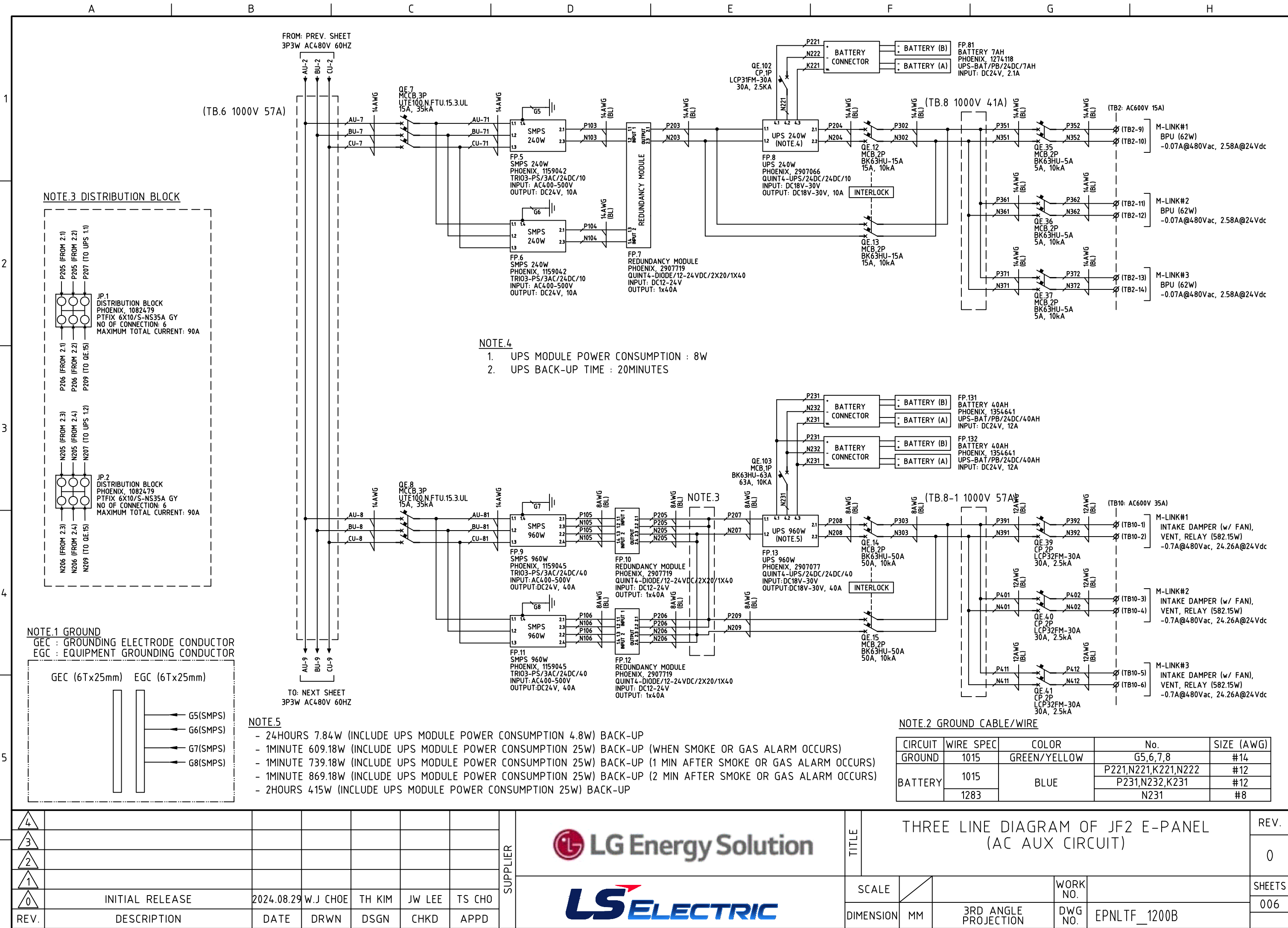
4							SUPPLIER	 LG Energy Solution	TITLE	THREE LINE DIAGRAM OF JF2 E-PANEL (DC MAIN CIRCUIT)				REV.
3										0				
2														
1														
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO								
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD		 LS ELECTRIC	SCALE			WORK NO.		SHEETS
									DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B	002

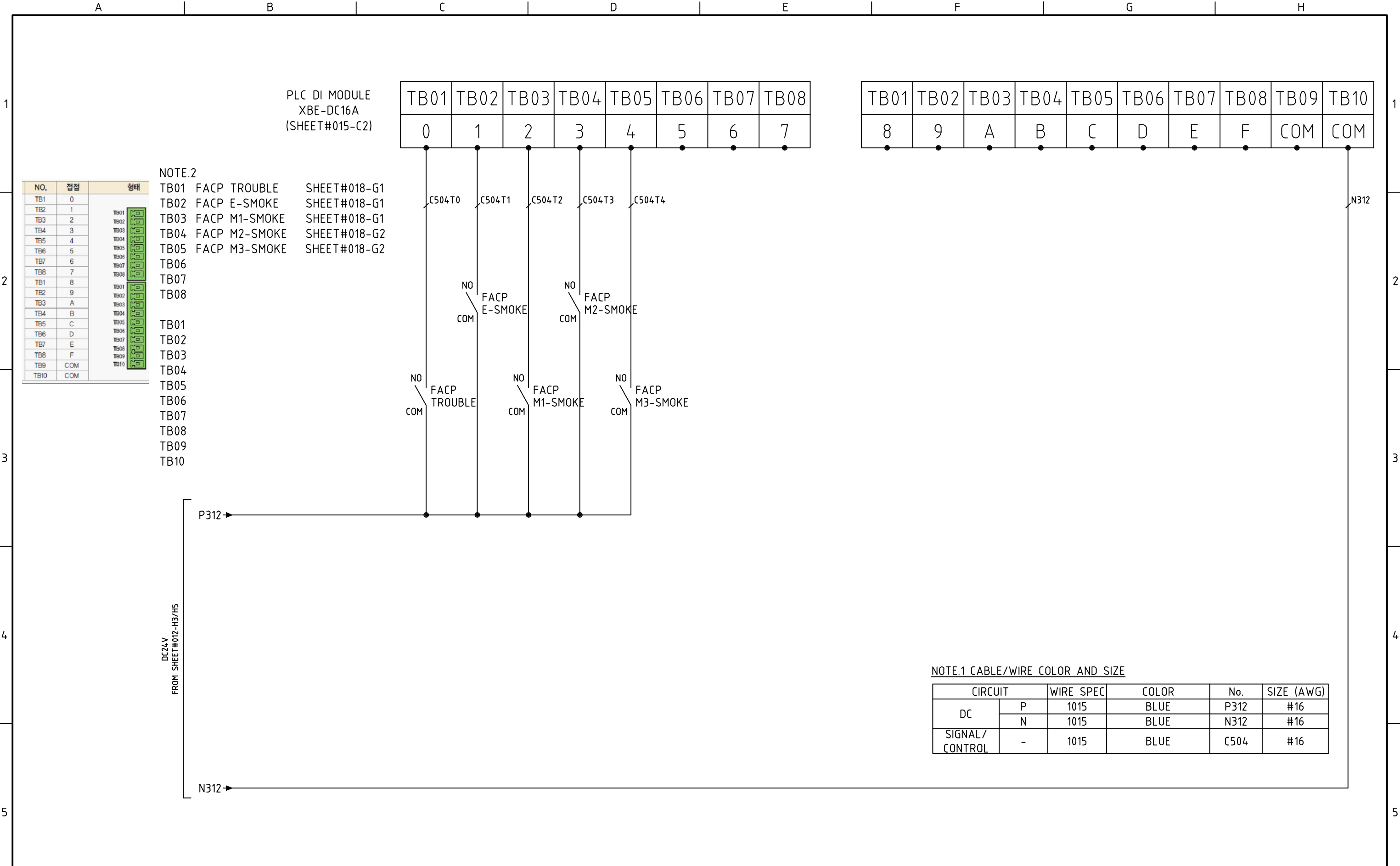


4							SUPPLIER		TITLE	THREE LINE DIAGRAM OF JF2 E-PANEL (AC AUX CIRCUIT)				REV.
3														0
2														
1														
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO								SHEETS
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD			SCALE			WORK NO.		003
									DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B	

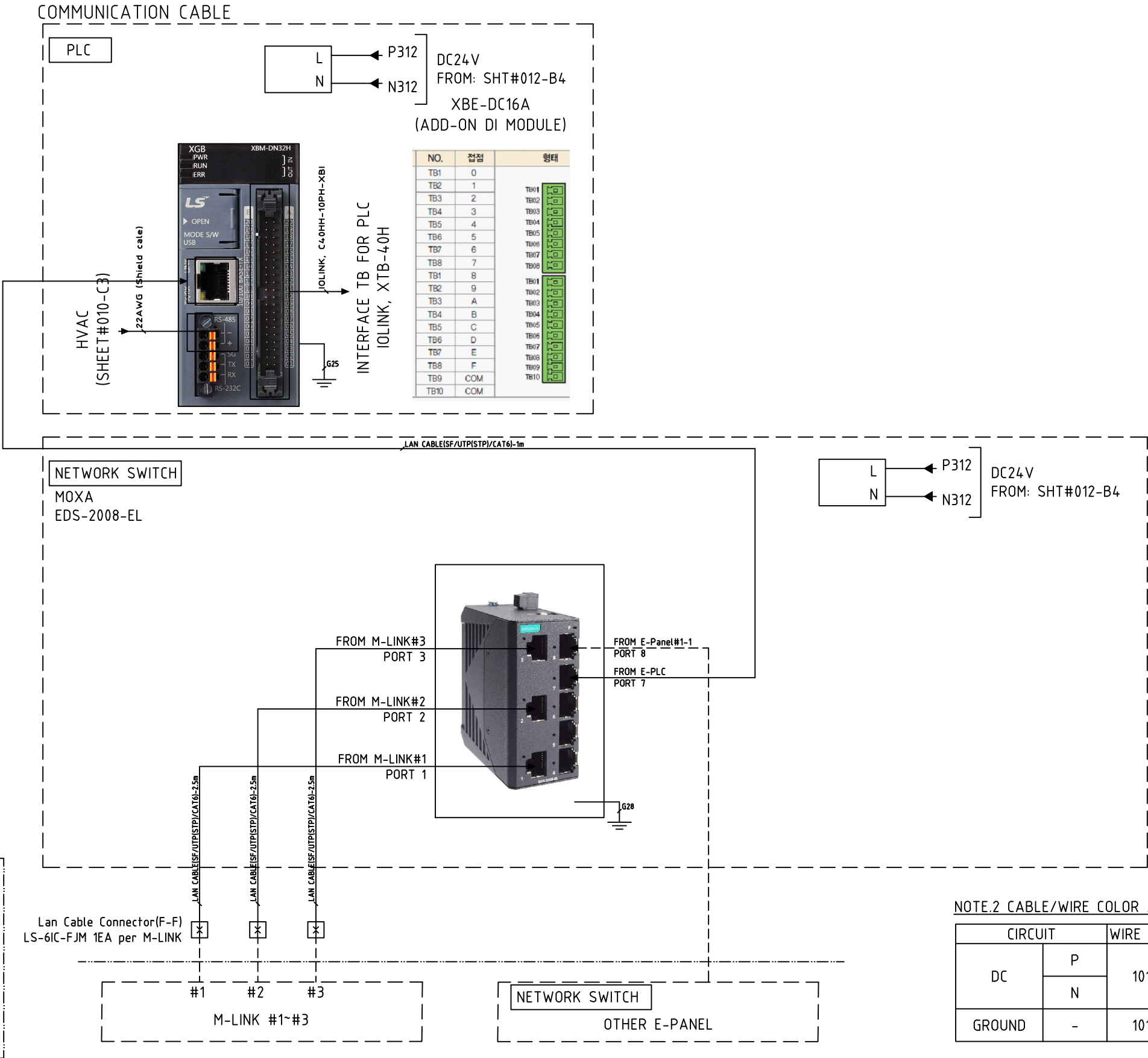


4							SUPPLIER		TITLE	THREE LINE DIAGRAM OF JF2 E-PANEL (AC AUX CIRCUIT)				REV.	
3														0	
2									SCALE			WORK NO.		SHEETS	
1									DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B	004	
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO									
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD									
A		B		C		D		E		F		G		H	







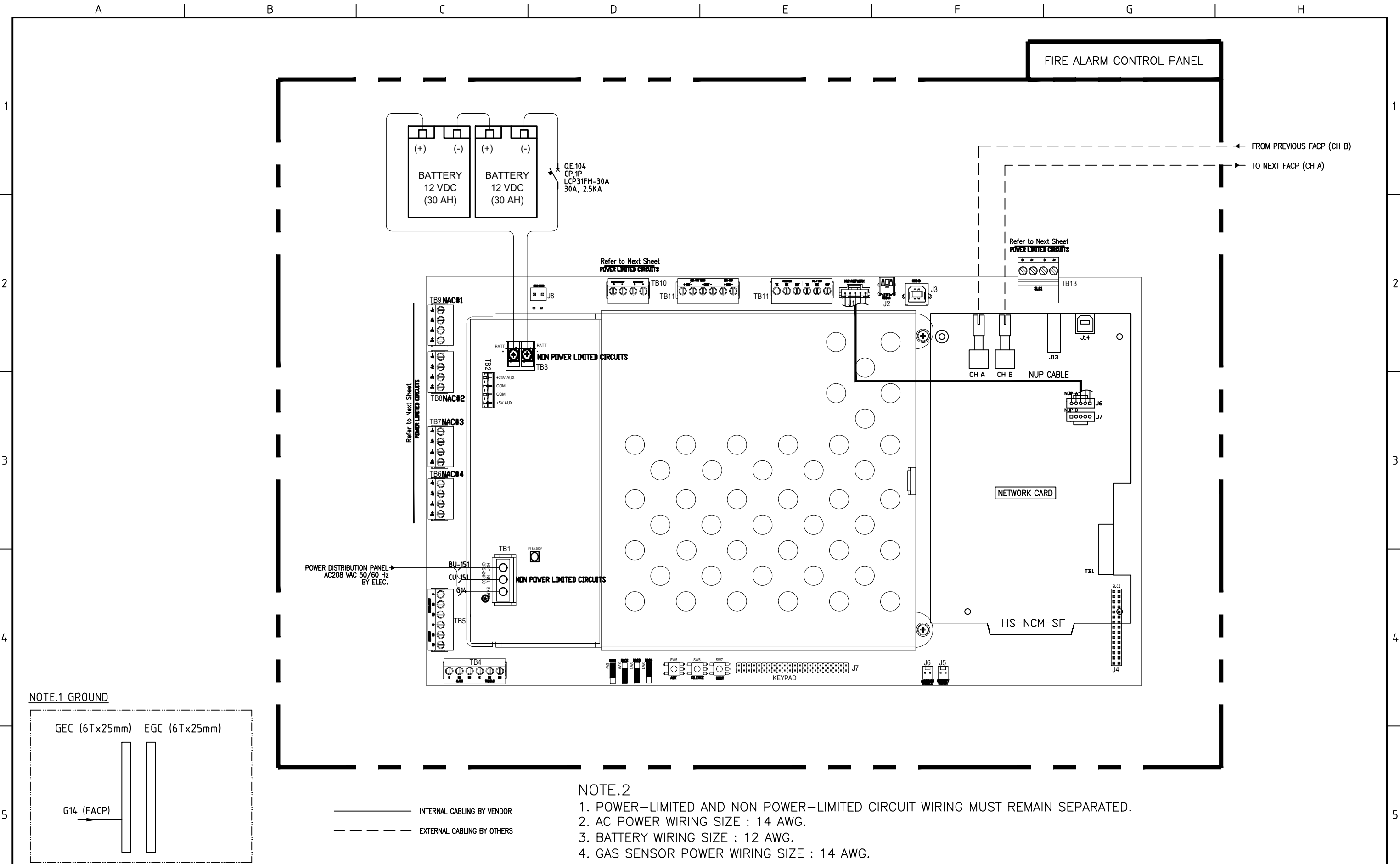
Without BSC (TYPE-B)



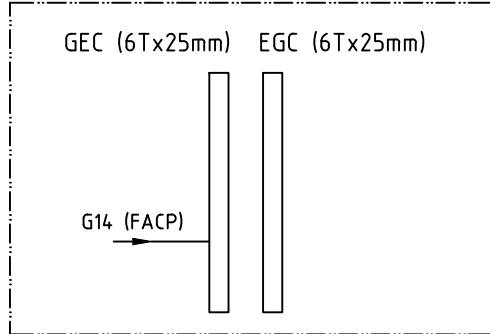
RJ45 Connector
1413962, Phoenix Contact
(SPARE)

4						
3						
2						
1						
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD

SUPPLIER	 LG Energy Solution		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (COMMUNICATION CABLE)					REV.
									0
			SCALE			WORK NO.		SHEETS	
			DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNL_1200B	013	



NOTE.1 GROUND



INTERNAL CABLING BY VENDOR
EXTERNAL CABLING BY OTHERS



NOTE.2

1. POWER-LIMITED AND NON POWER-LIMITED CIRCUIT WIRING MUST REMAIN SEPARATED.
2. AC POWER WIRING SIZE : 14 AWG.
3. BATTERY WIRING SIZE : 12 AWG.
4. GAS SENSOR POWER WIRING SIZE : 14 AWG.

4							SUPPLIER		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (SEQUENCE CIRCUIT- FACP)				REV.
3											0			
2														
1														
0	INITIAL RELEASE	2024.08.29	W.J CHOE	TH KIM	JW LEE	TS CHO			SCALE			WORK NO.		SHEETS
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD				DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLTF_1200B

	A	B	C	D	E	F	G	H
1	TB.1 (600V 15A,9P)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 AU-31	M-LINK#1 CHILLER					
	2	2 BU-31	M-LINK#1 CHILLER					
	3	3 CU-31	M-LINK#1 CHILLER					
	4	4 AU-41	M-LINK#2 CHILLER					
	5	5 BU-41	M-LINK#2 CHILLER					
	6	6 CU-41	M-LINK#2 CHILLER					
	7	7 AU-51	M-LINK#3 CHILLER					
	8	8 BU-51	M-LINK#3 CHILLER					
	9	9 CU-51	M-LINK#3 CHILLER					
2	TB.2 (600V 15A,14P)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 P312	E-PANEL PLC, N/S, DS					
	2	2 N312	E-PANEL PLC, N/S, DS					
	3	3 P322	M-LINK#1 COMM. DEVICES					
	4	4 N322	M-LINK#1 COMM. DEVICES					
	5	5 P332	M-LINK#2 COMM. DEVICES					
	6	6 N332	M-LINK#2 COMM. DEVICES					
	7	7 P342	M-LINK#3 COMM. DEVICES					
	8	8 N342	M-LINK#3 COMM. DEVICES					
3	TB.3 (600V 15A,6P)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 AU-111	M-LINK #1 HVAC & LIGHT					
	2	2 BU-111	M-LINK #1 HVAC & LIGHT					
	3	3 BU-121	M-LINK #2 HVAC & LIGHT					
	4	4 CU-121	M-LINK #2 HVAC & LIGHT					
	5	5 AU-131	M-LINK #3 HVAC & LIGHT					
	6	6 CU-131	M-LINK #3 HVAC & LIGHT					
4	TB.4 (600V 15A,14P)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 C501a3	DS AUX "a"					
	2	2 C501n3	DS AUX "a"					
	3	3 C501a4	DS AUX "a"					
	4	4 C501n4	DS AUX "a"					
	5	5 C501b3	DS AUX "b"					
	6	6 C501n5	DS AUX "b"					
	7	7 C501b4	DS AUX "b"					
	8	8 C501n6	DS AUX "b"					
5	TB.5 (600V 15A,4P)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 P312C1	EXTERNAL E-STOP					
	2	2 P312	EXTERNAL E-STOP					
	3	3 C504B8	DIESEL GENERATOR OPERATION					
	4	4 P312	DIESEL GENERATOR OPERATION					
6	TB.6 (1000V 57A,21P - PHOENIX CONTACT, PT-10)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 AU-2	AC480V PHASE A	1 AU-3	●			
	2			2 AU-4	●			
	3			3 AU-5	●			
	4			4 AU-6	●			
	5			5 AU-7	●			
	6			6 AU-8	●			
	7			7 AU-9	●			
	8	9 BU-2	AC480V PHASE B	8 BU-3	●			
7	TB.7 (1000V 41A,12P - PHOENIX CONTACT, PT-6)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 AU-10	AC208V PHASE A	1 AU-11	●			
	2			2 AU-13	●			
	3			3 AU-14	●			
	4			4 AU-16	●			
	5	5 BU-10	AC208V PHASE B	5 BU-11	●			
	6			6 BU-12	●			
	7			7 BU-14	●			
	8			8 BU-15	●			
8	TB.8 (1000V 41A,16P - PHOENIX CONTACT, PT-6)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 P301	DC24V PHASE P	1 P311	●			
	2			2 P321	●			
	3			3 P331	●			
	4			4 P341	●			
	5	5 N301	DC24V PHASE N	5 N311	●			
	6			6 N321	●			
	7			7 N331	●			
	8			8 N341	●			
9	TB.8-1 (1000V 57A,16P - PHOENIX CONTACT, PT-10)							
	NO.	INS. WIRING NO.	DESIGNATION	OUS. WIRING NO.	CONNECTION			
	1	1 P303	DC24V PHASE P	1 P391	●			
	2			2 P401	●			
	3			3 P411	●			
	4	4 N303	DC24V PHASE N	4 N391	●			
	5			5 N401	●			
	6			6 N411	●			
10	△4					TITLE	SCHEMATIC DIAGRAM OF E-PANEL (TERMINAL BLOCK LIST)	
	△3					SCALE	3RD ANGLE PROJECTION	
	△2					MM	EPNLT_F_1200B	
11	△1					WORK NO.		
	△0	FOR REVIEW	2024.01.15	J.S.LEE	W.J.CHOE	DWG NO.		
	REV.	DESCRIPTION	DATE	DRWN	DSGN			
12	SUPPLIER					LG Energy Solution		
	LS ELECTRIC							
	016							

A		B		C		D		E		F		G		H	
TB.9 (600V 15A,10P)															
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION								
1		SD01-SLC(+)													
2		SD01-SLC(-)													
3		FACP-SLC(+)													
4		FACP-SLC(-)													
5		GAS SENSOR POW 1+													
6		GAS SENSOR POW 1-													
7		GAS SENSOR POW 2+													
8		GAS SENSOR POW 2-													
9		GAS SENSOR POW 3+													
10		GAS SENSOR POW 3-													
TB.10 (600V 35A,6P)															
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION								
1	1 P392	M-LINK#1 INTAKE DAMPER (w/ FAN), VENT, RELAY													
2	2 N392	M-LINK#1 INTAKE DAMPER (w/ FAN), VENT, RELAY													
3	3 P402	M-LINK#2 INTAKE DAMPER (w/ FAN), VENT, RELAY													
4	4 N402	M-LINK#2 INTAKE DAMPER (w/ FAN), VENT, RELAY													
5	5 P412	M-LINK#3 INTAKE DAMPER (w/ FAN), VENT, RELAY													
6	6 N412	M-LINK#3 INTAKE DAMPER (w/ FAN), VENT, RELAY													
TB.11 (600V 60A,3P)															
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION								
1	1 AU-1	UTILITY POWER													
2	2 BU-1	UTILITY POWER													
3	3 CU-1	UTILITY POWER													
COM. TB (600V 15A, 20P)															
NO.	INS. WIRING NO.	DESIGNATION				OUS. WIRING NO.	CONNECTION								
1	P312	DC SPD (12), AC SPD (12)				P312	●								
2	P312	DS MOTOR CHARGE, DS AUX (11)				P312	●								
3	P312	DS AUX (13,24)				P312	●								
4	P312	KA1 (5), FP.1 (3.2)				P312	●								
5	P312	FP.2 (3.2), FP.5 (3.2)				P312	●								
6	P312	FP.6(3.2), FP.9 (3.2)				P312	●								
7	P312	FP.11 (3.2), FP.4 (3.2)				P312	●								
8	P312	FP.8 (3.2), FP.13 (3.2)				P312	●								
9	P312	FUSE FF.2a, FACP				P312	●								
10	P312	FACP × 2				P312	●								
11	P312	FACP × 2				P312	●								
12	P312	SPARE				P312	●								
13	P312	SPARE				P312	●								
14	P312	SPARE				P312	●								
15	N312	DS MOTOR CHARGE, DS CLOSE COIL				N312	●								
16	N312	DS OPEN COIL, H3 L2				N312	●								
17	N312	PLC DI (COM), XTB (A10)				N312	●								
18	N312	SPARE				N312	●								
19	N312	SPARE				N312	●								
20	N312	SPARE				N312	●								

4							SUPPLIER		TITLE	SCHEMATIC DIAGRAM OF E-PANEL (TERMINAL BLOCK LIST)				REV.			
3														0			
2									SCALE		WORK NO.	SHEETS					
1													DIMENSION	MM	3RD ANGLE PROJECTION	DWG NO.	EPNLT_F_1200B
0	FOR REVIEW	2024.01.15	J.S.LEE	W.J.CHOE	W.J.CHOE	R.YOO											
REV.	DESCRIPTION	DATE	DRWN	DSGN	CHKD	APPD											

A	B	C	D	E	F	G	H
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