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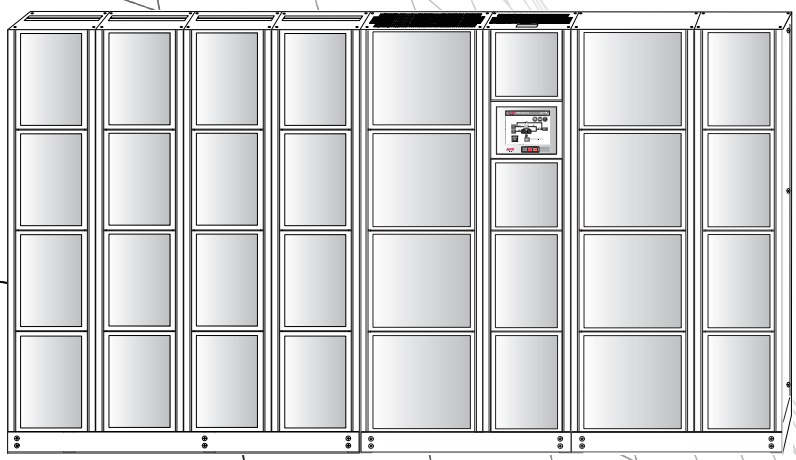
Installation

Symmetra® MW

800 kW
400 V



Contents

Safety

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS

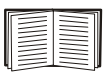
This guide contains important instructions for SYMF800KH that should be followed when handling the UPS, External Bypass Static Switch, Battery Enclosures, and Batteries.

Symbols used in this guide

WARNING!
Indicates an electrical hazard, which, if not avoided, could result in injury or death.

CAUTION!
Indicates a hazard, which, if not avoided, could result in injury or death.

Indicates important information.



Indicates that more information is available on this subject in a different section of this manual.

Indicates that more information is available on the same subject in a different manual.

Main Protective Earthing Terminal symbol.

Ground symbol.

Installation safety

EPO

Press the optional EPO (Emergency Power Off) button to switch off all AC and DC power supply to connected equipment in the room and to cut off the load supply. The EPO is typically located on a wall in the room in which the UPS is installed. See "Communication cable overview" section for information on how to wire the UPS to the EPO.

WARNING!
Before starting installation, check and test that all AC and DC power source breakers are in open position.

WARNING!
Only personnel trained in the construction and operation of the equipment, and the electrical and mechanical hazards involved, may install or remove system components.

CAUTION!
Do not use High Voltage Testing Equipment. This equipement will destroy the electronic circuits in the unit.

CAUTION!
The system is equipped with an optional auto-start function, enabling the system to start without any warning when power is applied.

CAUTION!
All wiring to be in accordance with applicable national and/or local electrical wiring rules.

This unit contains components that are sensitive to electrostatic discharge (ESD). Follow proper ESD procedures to avoid severe damage to electronic components.

System Overview

UPS Sections

Serial number

The serial number is stated on the type label behind the finishing panel above the display unit. Remove finishing panel to see serial number.

Inverter Section

The Inverter Section regulates the UPS output and operates from battery power in the event of utility input loss.

Control Section

The Control Section controls and monitors the UPS and the Mains Static Switch Module (incorporated in the Control Section).

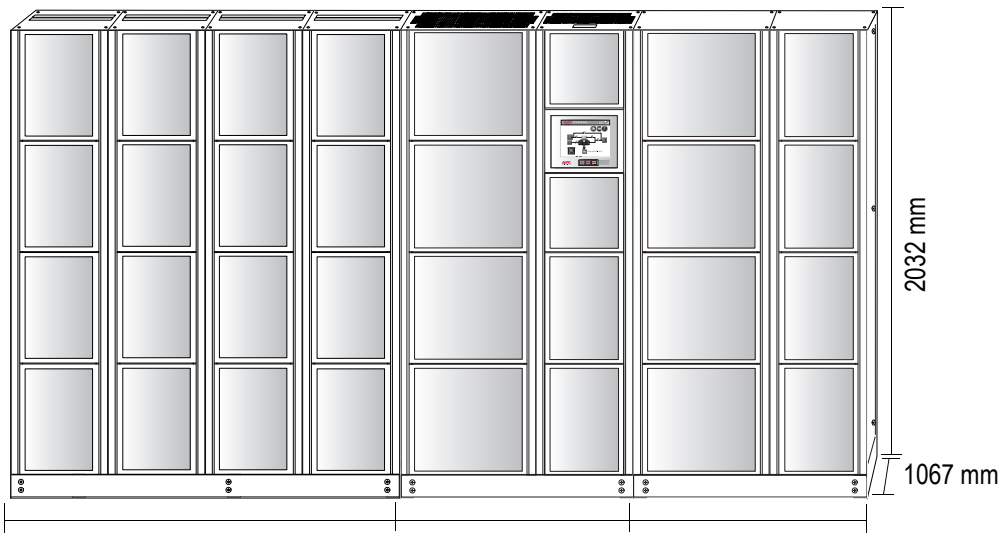
Input/Output Section

The Input/Output Section provides electrical connection of input and output.

Configurations

The UPS system can be configured in two ways. The Inverter Section can be placed either to the left or to the right of the Control Section. The two configurations are shown below.

Configuration 1 (Inverter Section placed to the left)



Inverter Section	Control Section	Input/Output Section
Width: 1690 mm	**Width:** 1012 mm	**Width:** 1014 mm

Total width of UPS sections:
3716 mm

Weight:
Without Power Modules: 3548 kg
With Power Modules: 4230 kg

Configuration 2 (Inverter Section placed to the right)

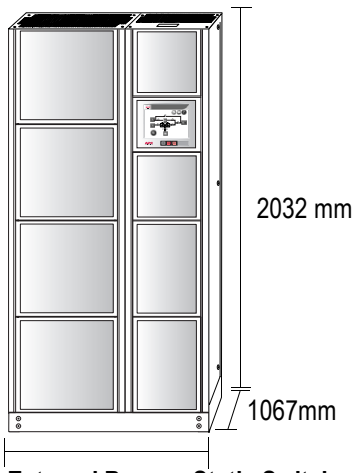
Input/Output Section	Control Section	Inverter Section
Width: 1014 mm	**Width:** 1012 mm	**Width:** 1690 mm

Total width of UPS sections:
3716 mm

Weight:
Without Power Modules: 3548 kg
With Power Modules: 4230 kg

External Bypass Static Switch

The External Bypass Static Switch (External Bypass SSW) transfers the load (manually or automatically) from the UPS to an alternate source without interrupting the supply to the load.



External Bypass Static Switch

Width:
1016 mm

Weight:
1 MW: 460 kg

Serial number

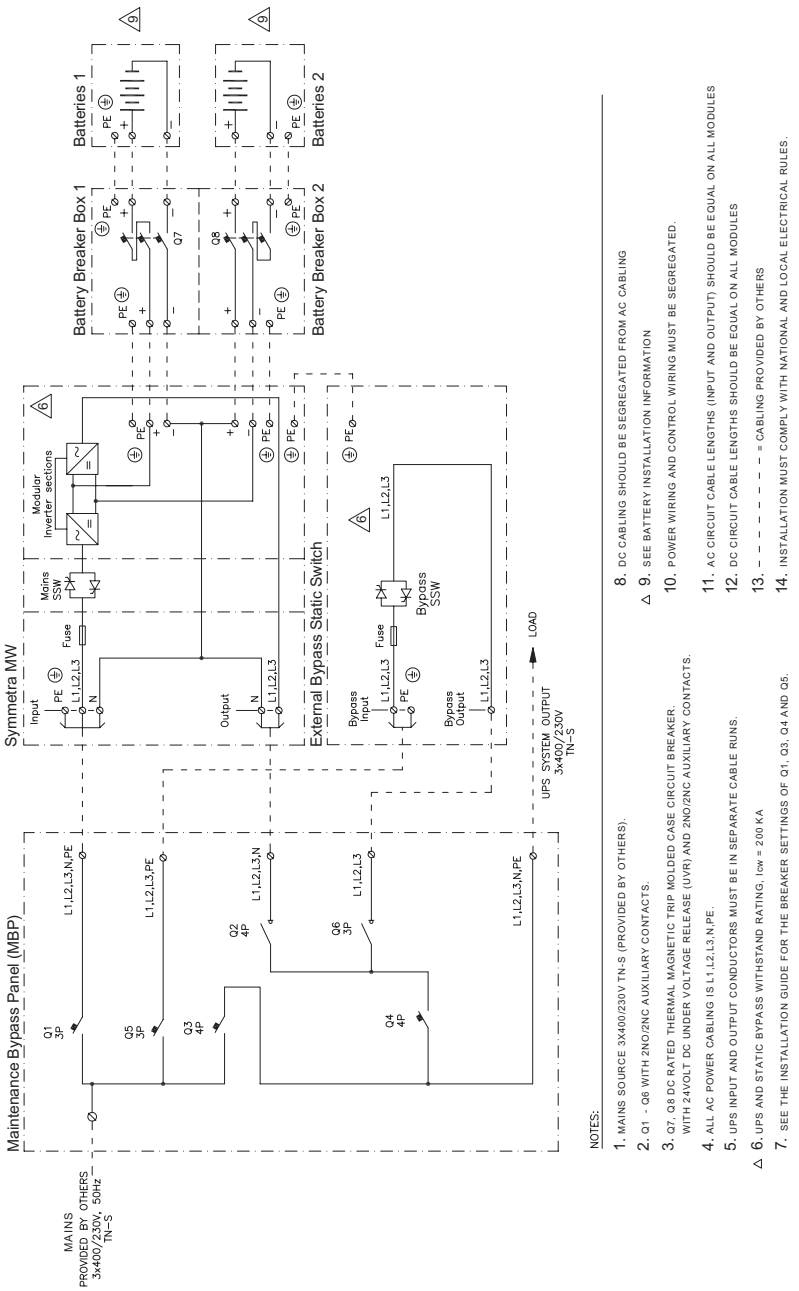
The serial number is stated on the type label behind the finishing panel above the display unit. Remove finishing panel to see serial number.

Electrical Installation

Electrical Wiring Principle

See also

See separate guide on parallel operation for wiring overview in parallel systems.



NOTES:

1. MAINS SOURCE 3X400/230V TN-S (PROVIDED BY OTHERS).
2. Q1 - Q6 WITH 2NO/2NC AUXILIARY CONTACTS.
3. Q7, Q8 DC RATED THERMAL MAGNETIC TRIP MOLDED CASE CIRCUIT BREAKER. WITH 24VOLT DC UNDER VOLTAGE RELEASE (UVR) AND 2NO/2NC AUXILIARY CONTACTS.
4. ALL AC POWER CABLING IS L1,L2,L3,N,PE.
5. UPS INPUT AND OUTPUT CONDUCTORS MUST BE IN SEPARATE CABLE RUNS.
△ 6. UPS AND STATIC BYPASS WITHSTAND RATING, Icw = 200 KA
7. SEE THE INSTALLATION GUIDE FOR THE BREAKER SETTINGS OF Q1, Q3, Q4 AND Q5.
8. DC CABLING SHOULD BE SEGREGATED FROM AC CABLING
△ 9. SEE BATTERY INSTALLATION INFORMATION
10. POWER WIRING AND CONTROL WIRING MUST BE SEGREGATED.
11. AC CIRCUIT CABLE LENGTHS (INPUT AND OUTPUT) SHOULD BE EQUAL ON ALL MODULES
12. DC CIRCUIT CABLE LENGTHS SHOULD BE EQUAL ON ALL MODULES
13. - - - - - - - - - = CABLING PROVIDED BY OTHERS
14. INSTALLATION MUST COMPLY WITH NATIONAL AND LOCAL ELECTRICAL RULES.

External disconnection switches

WARNING!
The UPS has no internal manual disconnect devices to switch off external AC (Q1 and Q5) and DC (Q7 and Q8) input power. Ensure that disconnection devices are available as separate components for this installation.

The installer must provide each external disconnection device for this UPS system with labels displaying the following text:
"Isolate the Uninterruptible Power Supply (UPS) as instructed in the Operation Manual before working on circuit."

Input/Output wiring precautions

WARNING!
Only personnel trained in the construction and operation of the equipment, and the electrical and mechanical hazards involved, may install or remove system components.

WARNING!
Before starting installation, check and test that all AC and DC power source breakers are in open position.

WARNING!
Supply the UPS from a 3 × 400/230 V, L1, L2, L3, N, PE source or a high-impedance grounded system.

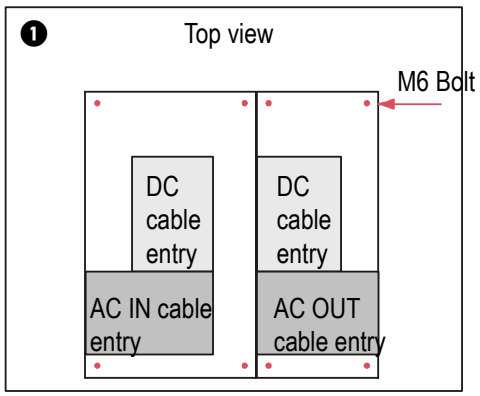
CAUTION!
All wiring to be in accordance with applicable national and/or local electrical wiring rules.

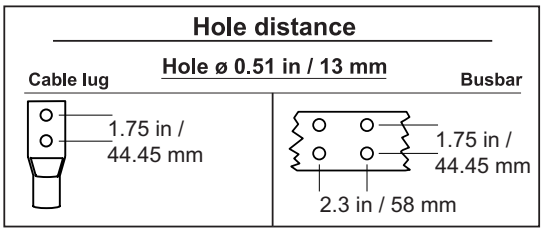
Use only copper conductors.

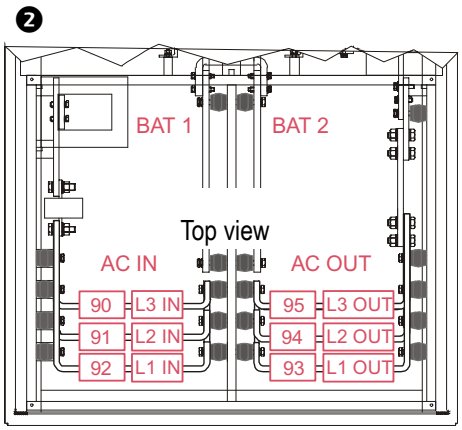
Top Cable Entry

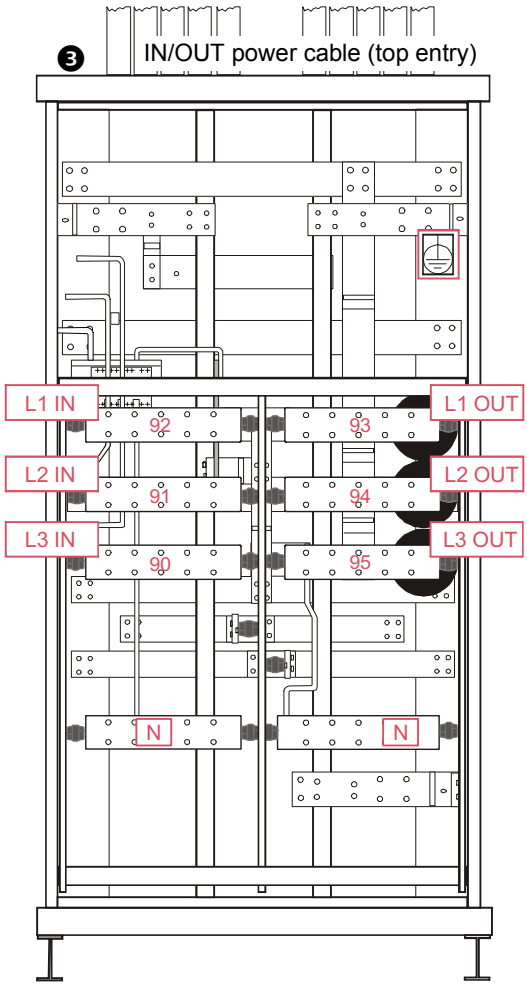
Preparing for top cable entry (Default)

Cable entry in Top Cover of Input/Output Section.









1. Loosen the 8 bolts in both cable entry covers (4 bolts in each cover). Drill holes for the grommets in areas shown. Install the grommets and re-fit the covers.
2. Install cable lugs on busbars. Use M12 bolts. Feed cables through the top grommets.
3. Connect L1, L2 and L3 to busbars where indicated.

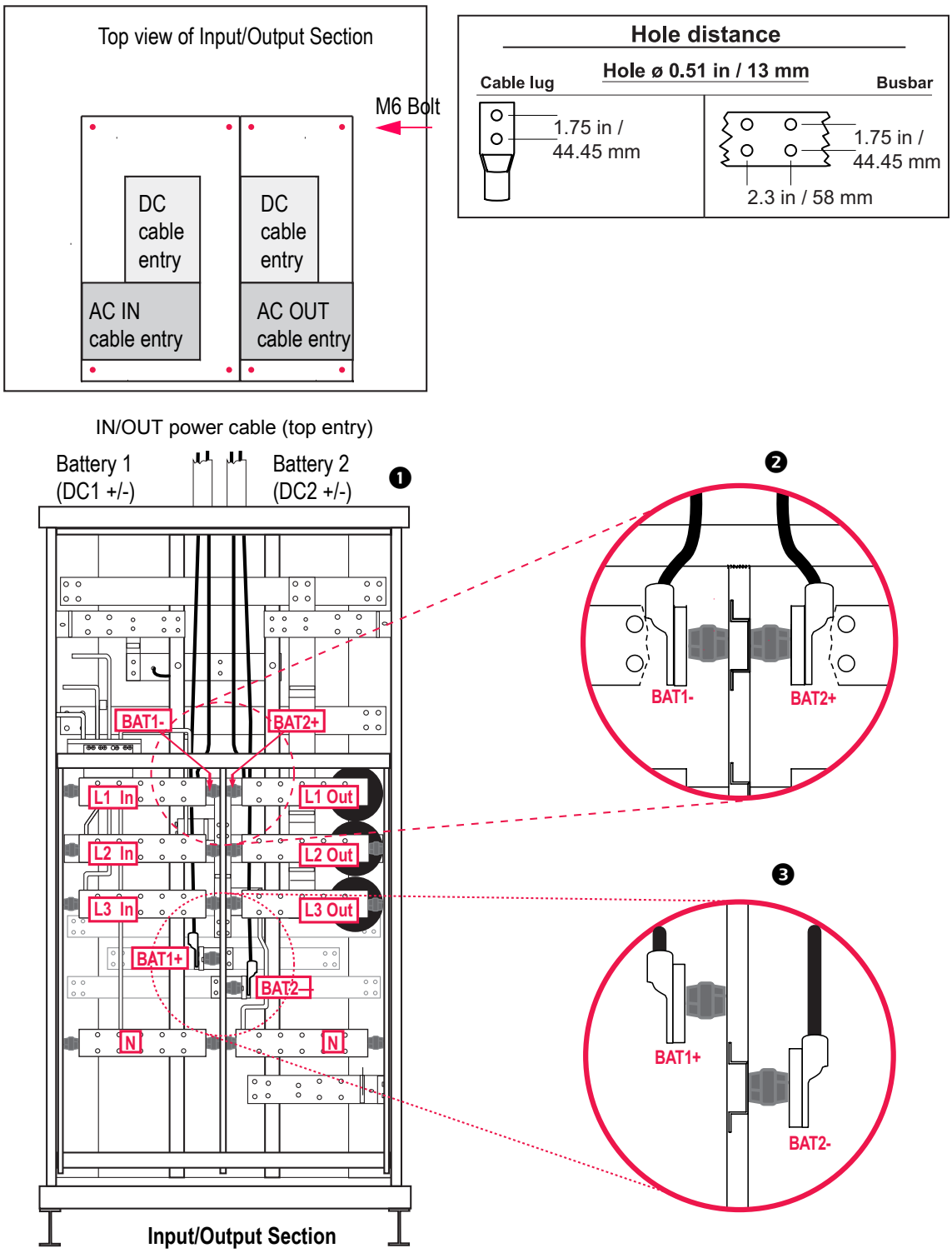
Battery cable connections (top cable entry)

WARNING!
Make sure that the battery breakers are open (OFF) prior to running the cables.

CAUTION!
Refer to the battery manufacturer's installation manual.

CAUTION!
The minimum DC voltage rating of the battery supply over-current protective device is 500 V.

Over-current protection for the battery circuit is required by national wiring rules.

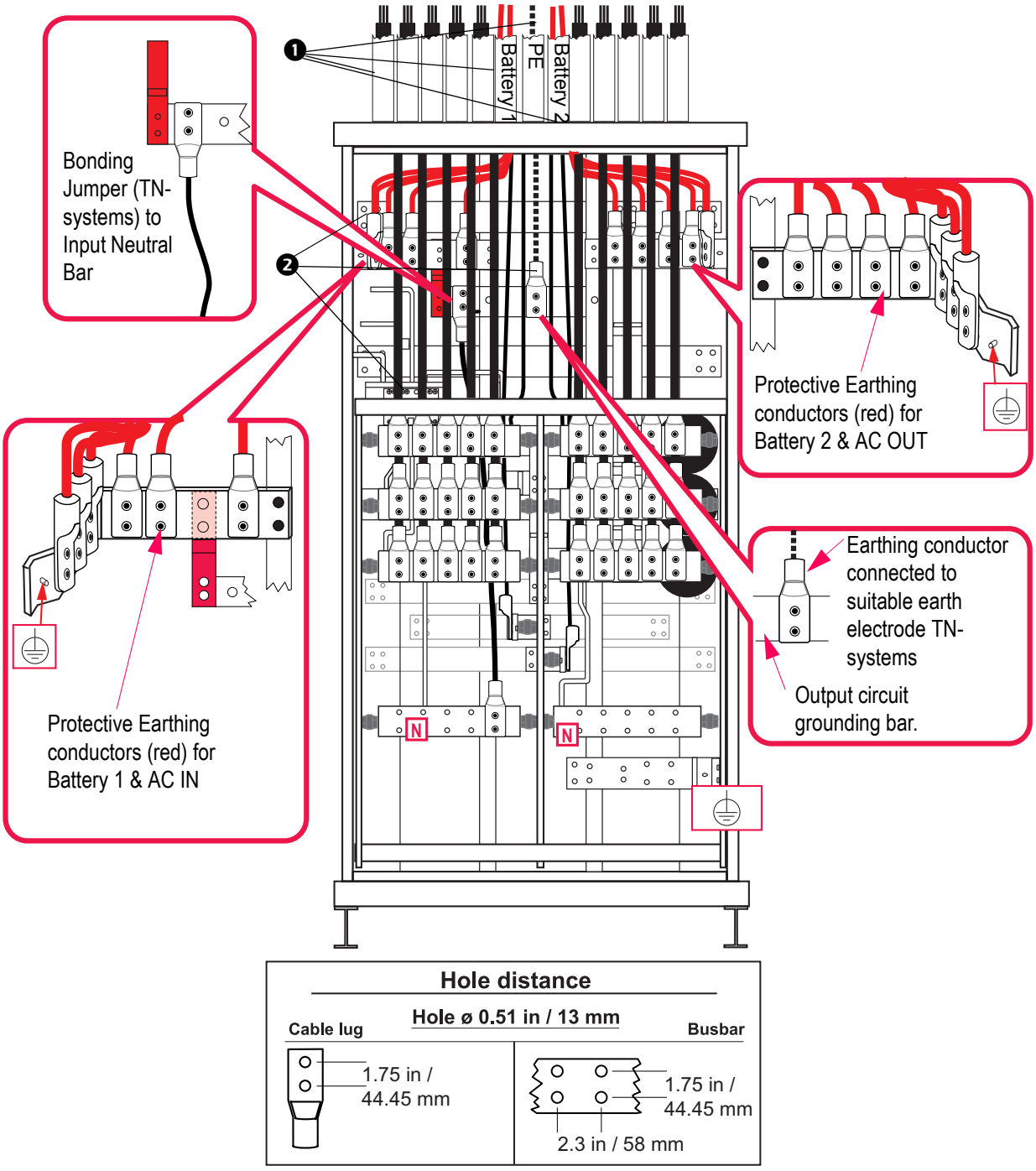


❶ Feed the battery cables through the grommets

❷ Connect cables from battery system.

❸ Connect cables from battery system.

PE and AC cable connections (top cable entry)



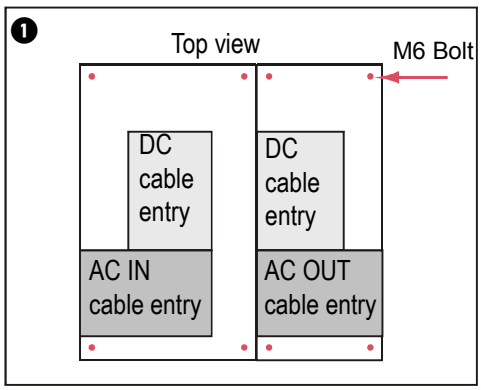
❶ Feed the AC and PE cables through the top of Input/Output Section.

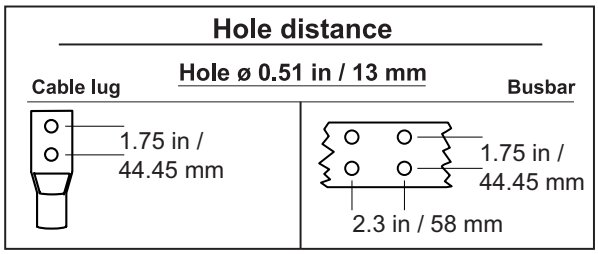
❷ Connect cables.

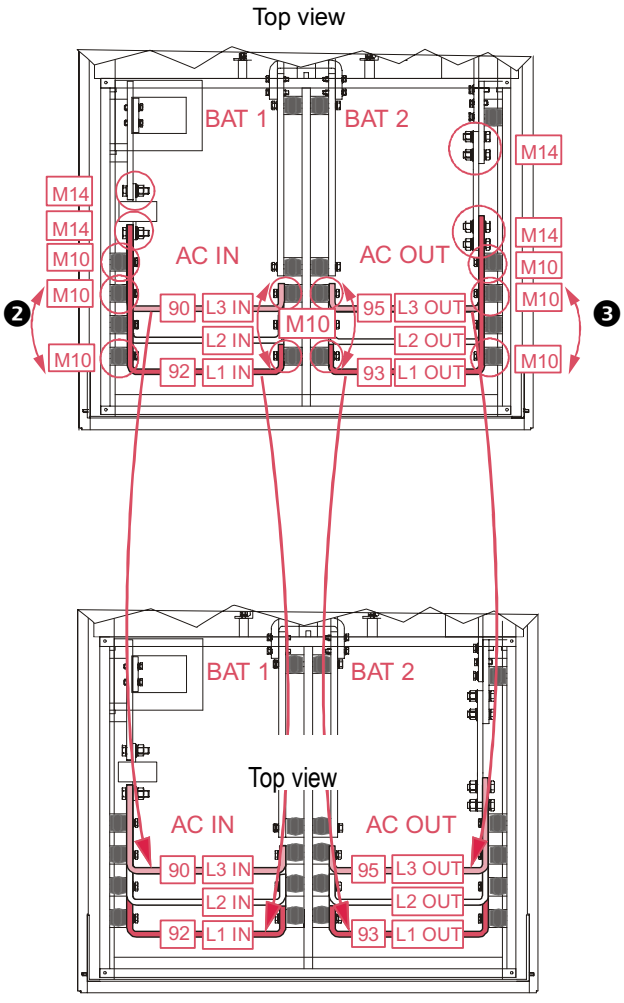
Bottom Cable Entry

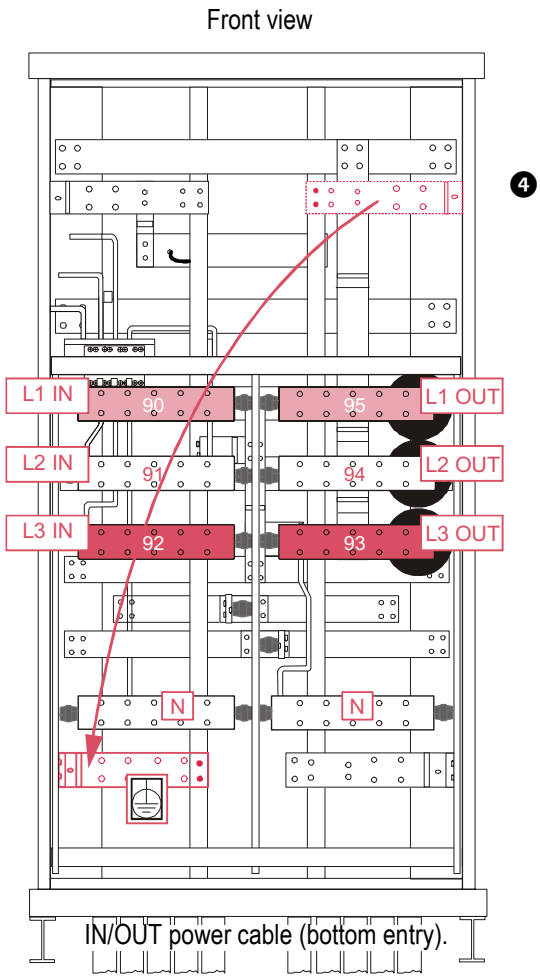
Preparing for bottom cable entry

Cable entry in bottom cover of Input/Output Section









❶ Preparation for bottom cable entry

a. Loosen bolts of both cable entry covers and remove.

b. Drill holes for grommets for AC, DC, and Output circuit grounding electrode cable in areas shown.

Note

No drilling or cutting should take place inside the UPS.

c. Install grommets.

d. Remount covers.

❷ Interchange of AC IN busbars for bottom entry

a. Remove nuts from M14 bolts at busbars 90 and 92.

b. Remove bolt, washer and fuse.

c. Remove bolts from M10 at busbars 90 and 92.

d. Remove busbars 90 and 92 at AC IN.

e. Move the two front isolators in the topmost busbar position two steps to the front.

f. Move the two front isolators in the lowest busbar position two steps to the rear.

g. Install busbar 90 in original position of busbar 92.

h. Install busbar 92 in original position of busbar 90.

i. Reattach M14 bolts at busbars 90 and 92.

j. Install cable lugs on busbars using M12 bolts.

❸ Interchange of AC OUT busbars for bottom entry

a. Remove nuts from M14 bolts at busbars 93 and 95.

b. Remove bolt, washer and fuse.

c. Remove bolts from M10 at busbars 93 and 95.

d. Remove busbars 93 and 95 at AC OUT.

e. Move the two front isolators in the topmost busbar position two steps to the front.

f. Move the two front isolators in the lowest busbar position two steps to the rear.

g. Install busbar 93 in original position of busbar 95.

h. Install busbar 95 in original position of busbar 93.

i. Reattach M14 bolts at busbars 93 and 95.

j. Install cable lugs on busbars using M12 bolts.

❹ Moving busbar for grounding

a. Move busbar for grounding from upper right corner to lower left corner as illustrated.

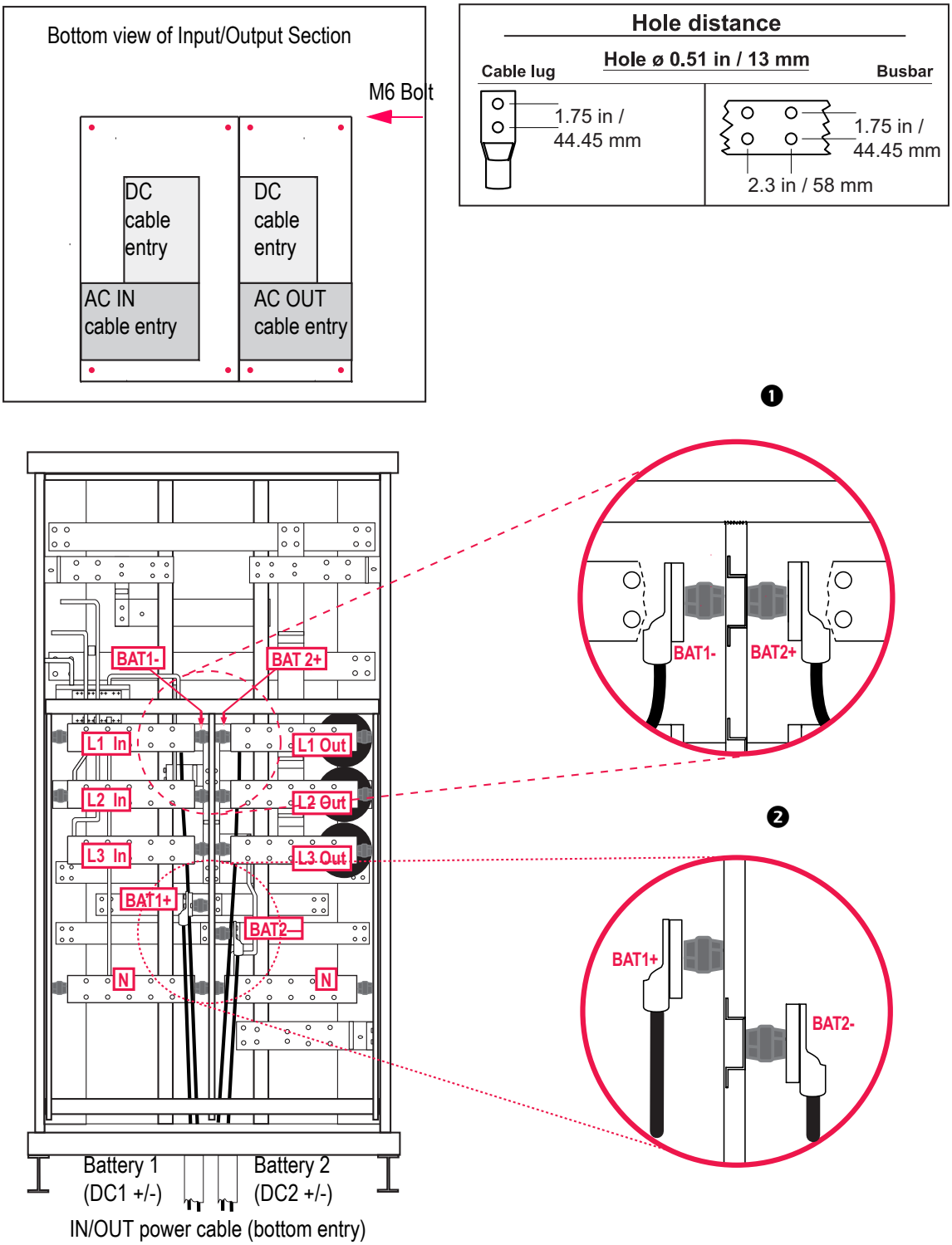
Battery cable connection (bottom cable entry)

WARNING!
Make sure that the battery breakers are open (OFF) prior to running the cables.

CAUTION!
Refer to the battery manufacturer's installation manual.

CAUTION!
The minimum DC voltage rating of the battery supply over-current protective device is 500 V.

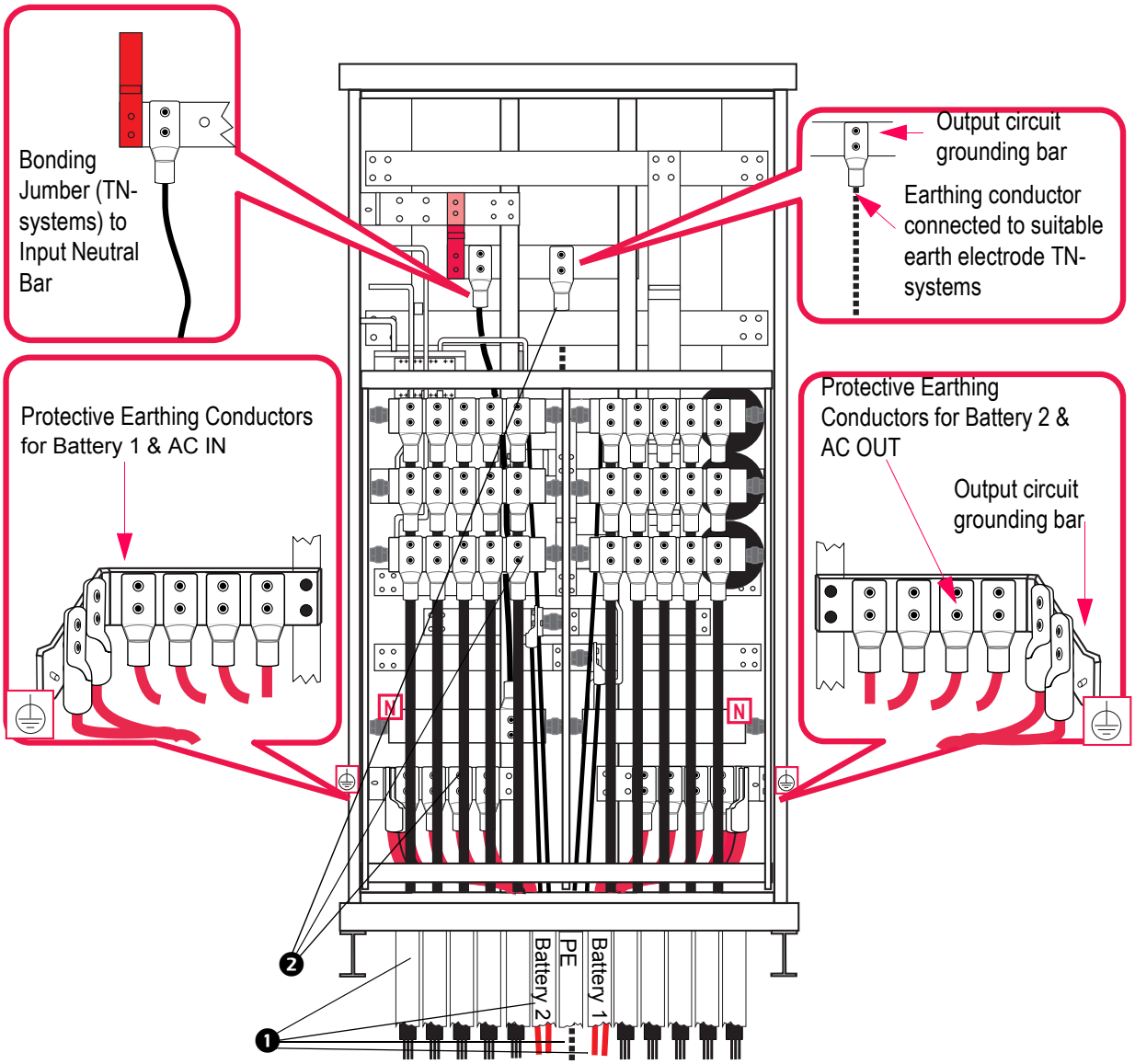
Over-current protection for the battery circuit is required by national wiring rules.

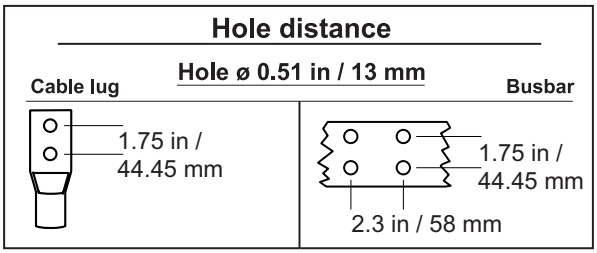


❶ Connect cables from battery system.

❷ Connect cables from battery system.

PE and AC cable connections (bottom cable entry)





1. Feed the AC and PE cables through the bottom of Input/Output Section.
2. Connect cables.

External Bypass Static Switch Wiring

WARNING!
Before starting installation, check and test that all AC and DC power source breakers are in open position.

WARNING!
Use only manual reset protection as input over-current protection.

WARNING!
Over-current protection required by national wiring rules.

WARNING!
The UPS has no internal manual disconnect devices to switch off external AC (Q1 and Q5) and DC (Q7 and Q8) input power. Ensure that disconnection devices are available as separate components for this installation.

CAUTION!
The External Bypass Static Switch is not provided with built-in backfeed protection. Use suitable breakers with a minimum of 0.8 in/20 mm air gap and trip function. The breaker is controlled from the External Bypass SSW and will be tripped in case of backfeed.

Note
The installer must provide each external disconnection device for this UPS system with labels displaying the following text:
“Isolate the Uninterruptible Power Supply (UPS) as instructed in the Operation Manual before working on circuit.”

Note
The installation of the External Bypass Static Switch must comply with local and national regulations.

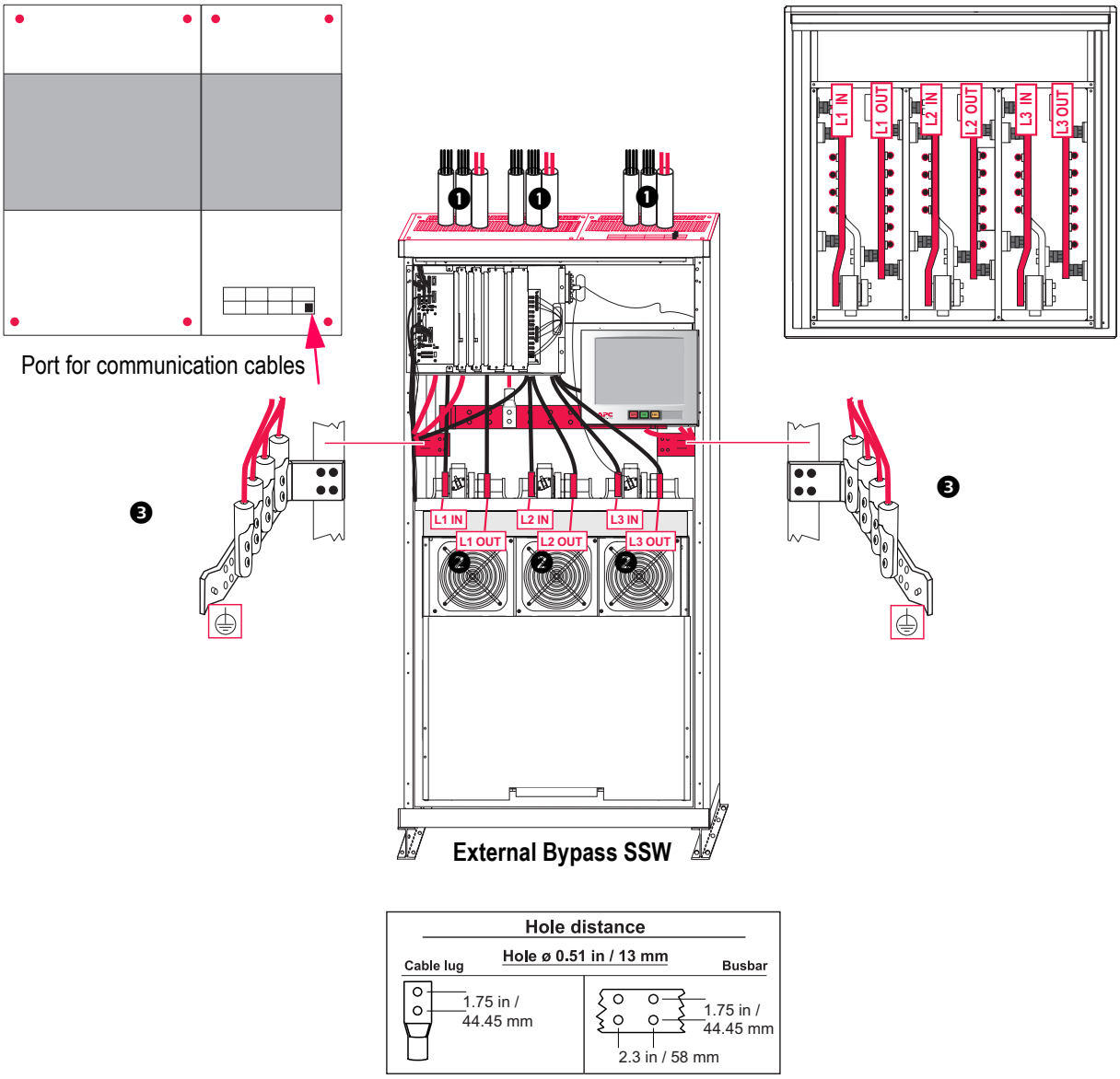
Note
Run matched set of phase cables in the same cable run(s).
Do not separate phases into different cable runs.

Note
Use only copper conductors.

Top cable entry

❶ Top view of top cable entry

❷ Top view of AC IN & OUT cable connections



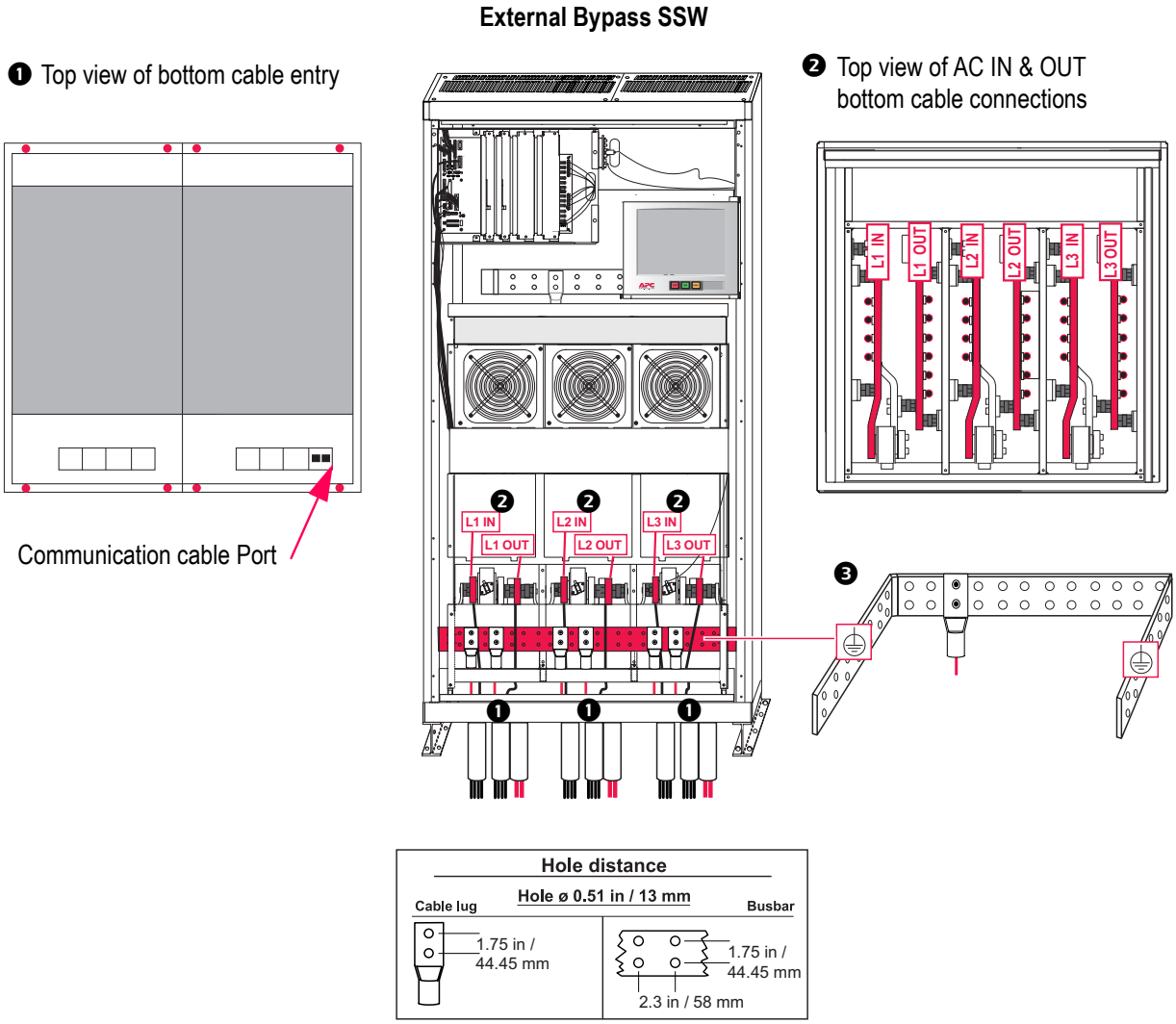
❶ Loosen the 8 screws to remove top covers. Drill holes for grommets. Re-fit the covers and install the grommets.

Note No drilling or cutting should take place over the top of the External Bypass SSW.

❷ Feed the cables through the grommets. Connect cables at cable connection points.

❸ Connect grounding electrode conductor to busbar locations.

Bottom cable entry



❶ Loosen the 8 screws to remove bottom covers. Drill holes for the grommets. Re-fit the covers and install the grommets.

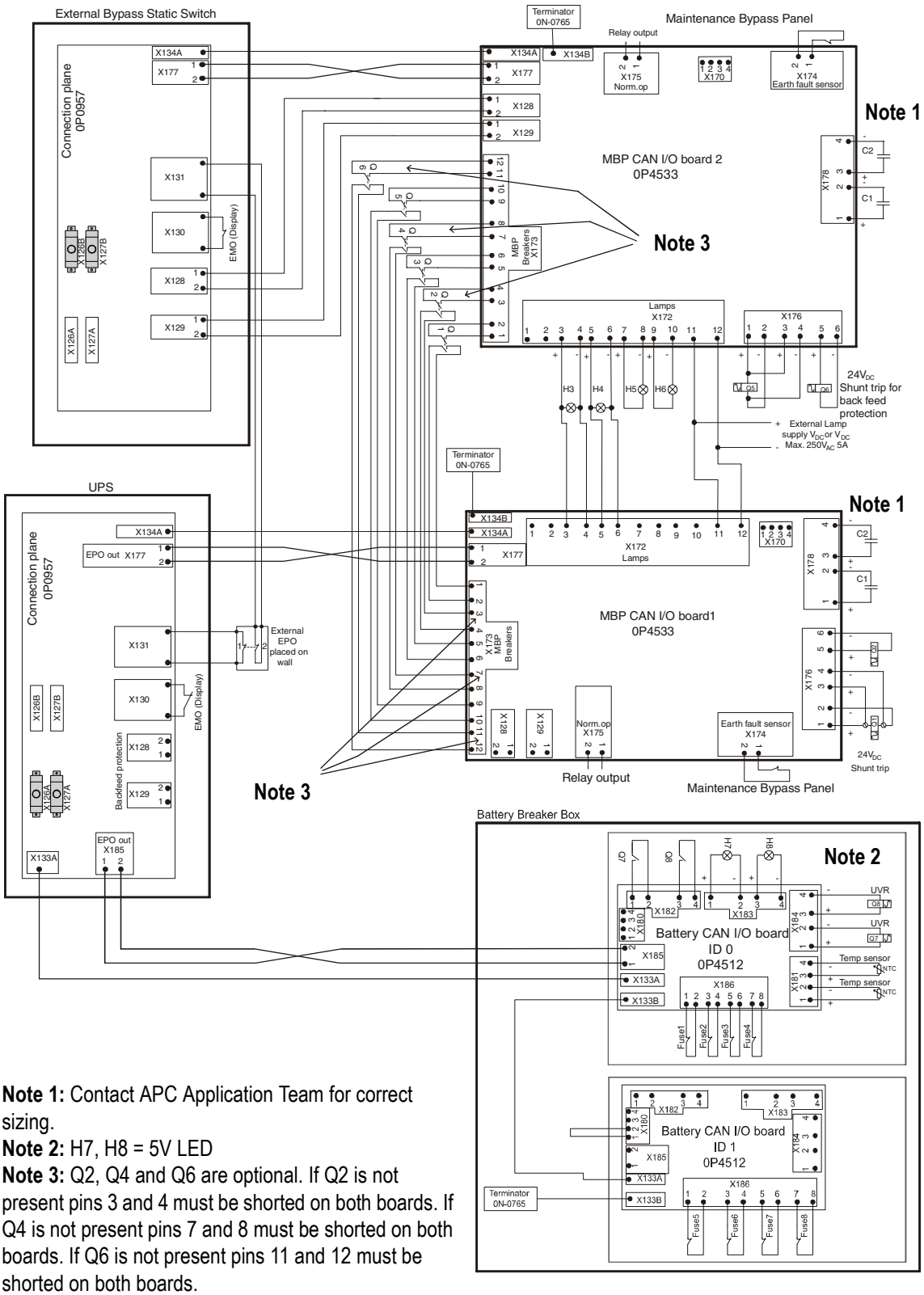
Note

No drilling or cutting should take place inside the External Bypass SSW.

❷ Feed the cables through the grommets. Connect cables at cable connection points.

❸ Connect grounding electrode conductor to busbar locations.

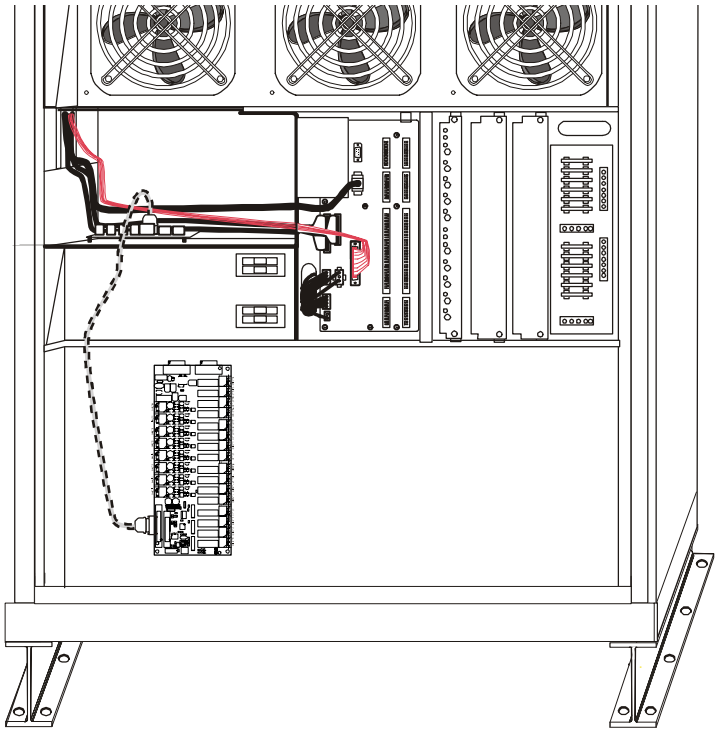
Communication cable overview



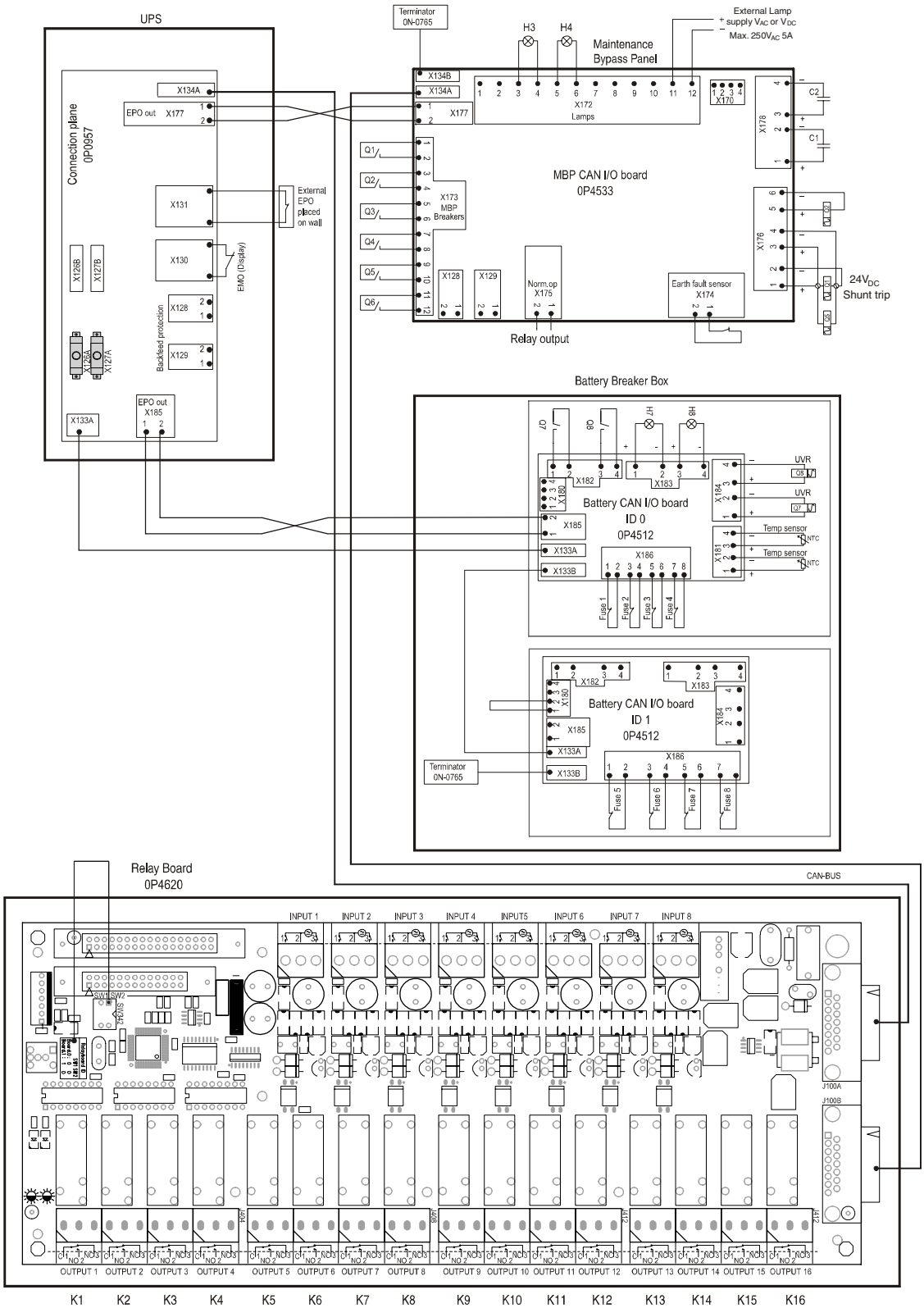
Note 1: Contact APC Application Team for correct sizing.
Note 2: H7, H8 = 5V LED
Note 3: Q2, Q4 and Q6 are optional. If Q2 is not present pins 3 and 4 must be shorted on both boards. If Q4 is not present pins 7 and 8 must be shorted on both boards. If Q6 is not present pins 11 and 12 must be shorted on both boards.

Relay Board (Optional)

Location of optional Relay Board



Communication cables with optional Relay Board



Relay Board functions

The Relay Board informs the user of the operation mode, status, and alarm conditionsand has 8 ports on the input side and 16 output terminals.


Note

Use Normally Closed (NC) contacts for Fail safe Mode and Normally Open (NO) for Active on.

Relay ID	Name	Events that will trigger the alarm	Mode	Comment
K1	Common Alarm	• Any of the functions below, except relays K8, K9, K10, K11; • Inverter section fault; • Main PSU fault; • System locked in operation mode; • Internal memory fault; • Internal communication fault.	Fail safe	Warning
K2	Battery voltage out of tolerance	• DC voltage is too high (shut down); • DC voltage is under warning level; • DC voltage is low (shut down).	Fail safe	Warning
K3	Mains out of tolerance	• Mains voltage RMS value is out of tolerance; • Mains waveform not accepted (fast detector); • Mains frequency is out of tolerance.	Fail safe	Warning
K4	Bypass out of tolerance	• Bypass voltage RMS value is out of tolerance; • Bypass waveform not accepted (fast detector); • Bypass frequency is out of tolerance.	Fail safe	Warning
K5	Battery condition fault	• Battery monitor has detected a weak battery; • Battery monitor has detected a defective battery.	Fail safe	Fault
K6	Battery disconnected	• Battery breaker tripped/open.	Fail safe	Fault
K7	System overload	• Output load exceeded 100%; • Delta Inverter current limiter is active; • Main Inverter current limiter is active.	Fail safe	Fault
K8	Output out of tolerance	• Output voltage RMS value is out of tolerance; • Output waveform not accepted (fast detector); • Output frequency is out of tolerance.	Fail safe	Fault
K9	Normal operation	• UPS is running in normal operation.	Active on	Opr. mode
K10	Battery operation	• UPS is running in battery operation.	Active on	Opr. mode

Relay ID	Name	Events that will trigger the alarm	Mode	Comment
K11	Bypass operation	• UPS is running in normal operation/ bypass operation according to AS400/ Novell.	Active on	Opr. mode
K12	Maintenance bypass ON	• The maintenance bypass switch is active.	Active on	Opr. mode
K13	Stand-by operation	• UPS is in stand-by operation.	Active on	Opr. mode
K14	Boost charge operation	• UPS is boost charging the batteries.	Active on	Opr. mode
K15	Fan fault	• Blocked or faulty fan.	Fail safe	Fault
K16	High equipment temperature or inverter fuse blown	• Static Switch temperature is high; • Main Inverter failure (high temperature or blown fuse); • Delta Inverter temperature is high; • Magnetics temperature is high; • Isolation Transformer temperature is high (optional); • Battery temperature is high.	Fail safe	Warning
IN1	Generator active	• System on generator		System is running on generator. Battery charging is derated.
IN2	Battery room ventilation fault	• Battery room ventilation		Ventilation fault in battery room. Battery charging is off.
IN3 - IN8	Reserved for future use			

Specifications

Low-Impedance/High-Impedance Earthing

The Symmetra® MW is easily integrated into either a solid grounded system, or a high-impedance grounded system.

In a solid grounded system, the neutral power source (mains, generator, or UPS) is solidly grounded. In the event of a down-stream ground fault, the fault current will have a path back to the source, and the over-current device feeding the faulted part of the installation will trip and isolate the fault.

In a high-impedance grounded system, the source is grounded with an impedance (grounding resistor). In the event of a down-stream fault, the fault current will be limited by the impedance of the grounding resistor. The value of a high-impedance system is its ability to maintain operation with a given system fault to ground, i.e. the over-current device will only trip at line-to-line faults or double ground faults. For a high-impedance system to provide enhanced power system reliability and availability, a ground-fault monitoring/alarm system is required.

Grounding electrode conductor to be supplied by the customer.

For more information refer to “Appendix” in Installation Guide.

Electrical Specifications

WARNING!
Supply the UPS from a dedicated, 3 × 400/230 V, L1, L2, L3, N, PE source or a high-impedance grounded system.

CAUTION!
Ensure clockwise phase rotation (L1, L2, L3) of input voltages.

CAUTION!
AC and DC disconnect switches and over-current protection must be included in the installation.

All wiring must comply with all applicable national and/or local electrical codes.

Max. prospective RMS short-circuit current on input terminals: 200 kA
Max. prospective RMS short-circuit current on DC terminals: 50 kA

AC Input

AC Input	
Input rating	800 kW/kVA
Power Factor	1
Input Voltage	**380 V**
Input Frequency	50 Hz
Nominal input current (note 1)	1132 A
Input Current Limitation (note 2)	1422 A
Input Voltage	**400 V**
Input Frequency	50 Hz
Nominal input current (note 1)	1203 A
Input Current Limitation (note 2)	1466 A
Input Voltage	**415 V**
Input Frequency	50 Hz
Nominal input current (note 1)	1159 A
Input Current Limitation (note 2)	1447 A

DC Input

DC Input

Nominal Voltage (note 3)	2 x 384 V
I_{Nom} Discharge (note 4)	1085 A
I_{Max} Discharge (note 5)	1276 A

CAUTION!
The minimum DC voltage rating of the battery supply over-current protective device is 500 V.

AC Output

AC Output

Voltage	**380 V**
- Current Nom (note 8)	1094 A
- Max (note 7)	1311 A
Voltage	**400 V**
- Current Nom	1155 A
- Max (note 7)	1444 A
Voltage	**415 V**
- Current Nom	1113 A
- Max (note 7)	1391 A

AC Input External Bypass SSW

The External Bypass SSW is designed to accommodate a continuous overload of 25%.

AC Input External Bypass SSW

External Bypass SSW Max Input Current (100% load)	
380 V	1094 A
400 V	1155 A
415 V	1113 A

Heat dissipation

24.74 kW / 84.4 kBTU/hr (note 6)

Notes

1. Nominal (Nom): Input current based on rated load, nominal input voltage and fully charged batteries.
2. Current limitation is maximum allowed via electronic current limiting and is based on full battery recharge + nominal load and -10% input voltage.
3. Nominal battery voltage assumed to be 2.0 volts/cell (lead technology).
4. Nominal Battery Discharge current based on rated load, and nominal Battery voltage.
5. Maximum Battery Discharge current based on rated load at end of Discharge.
6. Heat dissipation calculated at rated load capacity.
7. This current is at 125% of rated load and is electronically current-limited to a maximum of 10 minutes. This value is only provided so the engineer can ensure that the selected AC output circuit overcurrent device's time-current characteristic will support this condition.
8. At 380 V, nominal output is reduced from 200 kW to 180 kW in each section.

Torque specifications

Torque specifications	
Bolt Size M8	13.5 Nm
Bolt Size M10	30 Nm
Bolt Size M12	50 Nm
Bolt Size M14	75 Nm

Required Breaker Settings (400 V Systems)

Note

Contact APC Application Team for Required Breaker Settings in 380 V and 415 V systems.

The Symmetra® MW is a fault-tolerant system capable of handling and surviving overloads and internal/external faults. The overload performances and fault clearings are possible when the system meets specified minimum requirements for breaker settings. The settings are specified in the tables below, but some of them can also be found in the Electrical Specification section. The settings are all minimum settings and may not result in a drop-out.

See also

See separate guide on parallel operation for information on required breaker settings in parallel systems.

Input and upstream breakers — minimum settings

Q1, Q5, and any upstream breaker			
Duration [S]	**Current [A]**	**Total load [%]**	**Event/Operation**
≤ 0.005	22 kA	--	Internal fault clearing
∞	1466*	127	Overload on-line
∞	1195	100	On-line
∞	1315	110	On-line+ Max. Battery charge
*** Only applicable to Q1**			

Output and downstream breakers — minimum settings

Q2, Q4, Q6, and any downstream breaker			
Duration [S]	**Current [A]**	**Total load [%]**	**Event/Operation**
≤ 0.005	22 kA	--	Internal fault clearing.
60	2406*	200	Overload on-line
600	1504*	125	Overload on-line
∞	1155	100	On-line
*** Only applciable to Q2 and Q4**			

22 kA is the maximum peak let-through current (including safety factor) available during clearing of an internal fault in a 200 kW section or a Power Module. During or after a controlled fault clearing, none of the breakers are allowed to trip on the instantaneous trip setting below the specified value. This is also applicable to the upstream breakers, and a control of the instantaneous trip setting in this part of the installation is required. The maximum peak let through current is applicable to utility with prospective short-circuit currents up to 200 kA.

Note

The instantaneous trip setting must not be derated even though the UPS system is derated in system output power. The system size has no influence on the instantaneous trip setting.

Note

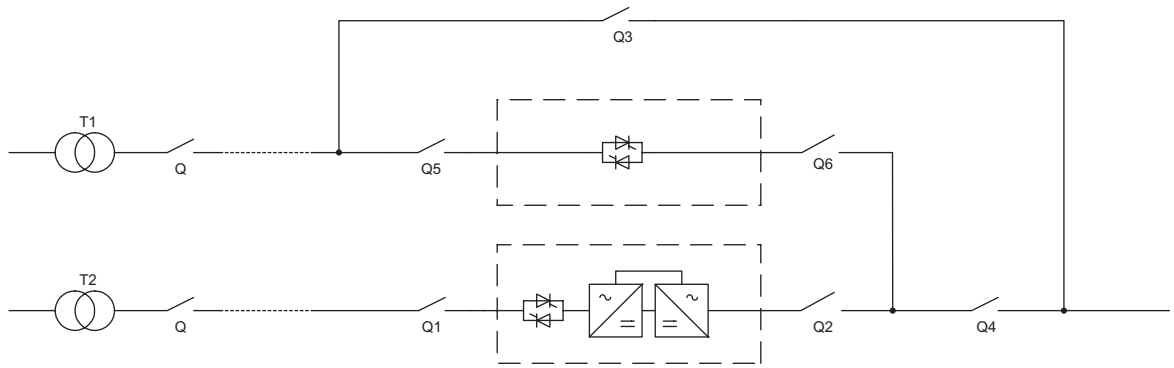
For derated or parallel systems, the APC Application Team provides the correct breaker settings and breaker frame sizes.

Note

For upstream breakers not mentioned in the table, the APC Application Team provides the correct breaker settings for on-line, overload, and trip currents.

The diagram shows a dual mains systems in which the upstream breakers are named Q. Correct settings of upstream breaker settings are mandatory. The systems can also be configured as single mains systems.

Dual Mains Single Installation



Appendix

System and Protective Earthing

The purpose of this appendix is to describe the system- and protective earthing principles of the Symmetra® MW.

CAUTION!
All wiring to be in accordance with applicable national and/or local electrical wiring rules.

TN Systems

Characteristics

TN systems have one point connected directly to ground. All exposed conductive parts must be connected to that point by protective conductors.

Depending on the way the neutral and protective conductors are fed, there are three types of TN systems:

- TN-S system: a separate protective conductor is used in the system
- TN-C-S system: the neutral and protective conductors are combined to one single conductor in a part of the system
- TN-C system: the neutral and protective conductors are combined to one single conductor in the whole system

Reference to IEC 60364-4-41 413.1.3

All exposed conductive parts of the installation must be connected to the earthed point of the power system by protective conductors which must be earthed at or near to each relevant transformer or generator.

Exposed conductive parts that are accessible at the same time must be connected to the same earthing system, either individually, in groups or collectively.

Normally the earthed point of the power system is the neutral point. If a neutral point is not available or accessible, a phase conductor must be earthed. The phase conductor must not serve as a PEN conductor.

In fixed installations a single conductor may serve both as a protective conductor and a neutral conductor (PEN conductor).

Reference to IEC 60364-5-54 546.2.3

If from any point in the installation the neutral and protective functions are provided by separate conductors, it is inadmissible to connect these conductors to each other from that point. At the point of separation, separate terminals or bars must be provided for the protective and neutral conductors. The PEN conductor must be connected to the terminal or bar intended for the protective conductor.

If there are other effective earth connections, the protective conductors must be connected to such points when it is possible. It may be necessary to earth at additional points to ensure that the potentials of protective conductors remain as close as possible to that of earth in case of a fault.

Additional requirements for generating sets (IEC 60364-5-55 551.4.2)

To be used when the generating set provides a switched alternative to the public supply.

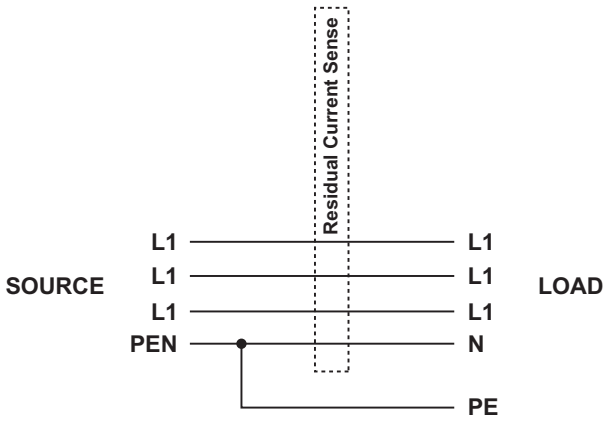
Protection by automatic disconnection of supply must not rely on the connection to the earthed points of the public supply system when the generator is operating as a switched alternative to a TN system. A suitable earth electrode must be provided.

Protective devices in TN systems

The following protective devices are recognized in TN systems:

- Overcurrent protective devices
- Residual current protective devices (not to be used in TN-C systems)

When a residual current protective device is used in a TN-C-S system, a PEN conductor must not be used on the load side. The connection of the protective conductor to the PEN conductor must be made on the source side of the residual current protective device (see below illustration):



The characteristics of protective devices and the circuit impedances shall be such that, if a fault of negligible impedance occurs anywhere in the installation between a phase conductor and a protective conductor or exposed conductive part, automatic disconnection of the supply will occur within 5 seconds (valid for distribution circuits), the following condition fulfilling this requirement:

$Z_s \times I_a \leq U_0$

In the condition:

Z_s is the impedance of the fault loop comprising the source, the live conductor up to the point of the fault, and the protective conductor between the point of the fault and the source

I_a is the current causing the automatic operation of the disconnecting protective device within a conventional time not exceeding five seconds

U_0 is the nominal AC RMS voltage to earth

If a fault occurs close to the UPS (before the power distribution) while the UPS system is in Battery Operation and Bypass is unavailable, the available power is unable to activate the protective device. In that situation the Inverter will shut down in five seconds (IEC 60364-4-41 413.1.3.5 norm). If a residual current protective device is used, this device will disconnect the supply.

The four diagrams show the Symmetra MW installed in four different TN systems:

- Earthing arrangements and protective conductors - Symmetra® MW in “TN-S installation”
- Earthing arrangements and protective conductors - Symmetra® MW in “TN-S installation” (Legal in DK - special cases)
- Earthing arrangements and protective conductors - Symmetra® MW in “TN-C-S installation”
- Earthing arrangements and protective conductors - Symmetra® MW in “TN-C installation”

TT Systems

Characteristics

TT systems have one point connected directly to ground and all exposed conductive parts of the installation must be connected to an earth electrode. This earth electrode is independent of the power system earthed point.

Reference to IEC 60364-4-41 413.1.4

All exposed conductive parts that are protected collectively by the same protective device must be connected to a common earth electrode together with the protective conductors. In installations where several protective devices are utilized in series, the requirement applies separately to all exposed conductive parts protected by each device.

The neutral point or, if a neutral point does not exist, a phase conductor of each generator station or transformer station must be earthed.

Protective devices in TT systems

The following protective devices are recognized in TT systems:

- Overcurrent protective devices
- Residual current protective devices

Overcurrent protective devices are only applicable for protection against indirect contact in TT systems where a low R_A value exists (see specification below).

The condition $R_A \times I_a \leq 50V$ must be fulfilled.

In the condition:

R_A is the sum of resistance of the earth electrode and the protective conductor for the exposed conductive parts

I_a is the current causing the automatic operation of the protective device.
When the protective device is a residual current protective device, I_a is the rated residual operating current $I_{\Delta n}$

For discrimination purposes, S-type residual current protective devices may be used in series with general type residual current protective devices. To provide discrimination with S-type residual current protective devices, an operating time not exceeding 1 second is permitted in distribution circuits.

When the protective device is an overcurrent protective device, it must be either:

- a device with inverse time characteristics and I_a must be the current causing automatic operation within 5 seconds, or
- a device with an instantaneous tripping characteristic and I_a must be the minimum current causing instantaneous tripping

The following diagram shows a Symmetra® MW installed in a TT system:

- Earthing arrangements and protective conductors - Symmetra® MW in “TT installation”

IT Systems

Characteristics

In IT systems the installation is insulated from earth or connected to earth through a sufficiently high impedance. Exposed conductive parts are earthed individually, in groups, or collectively.

Reference to IEC 60364-4-41 413.1.5

In IT systems the installation must be insulated from earth or connected to earth through a sufficiently high impedance. This connection must be made either at the neutral point of the system or at an artificial neutral point. The latter may be connected directly to earth if the resulting zero-sequence impedance is sufficiently high. In installations where no neutral point exists, a phase conductor can be connected to earth through an impedance. In case of a single fault to an exposed conductive part or to earth, the fault current will be low and disconnection will not be imperative.

Exposed conductive parts must be earthed individually, in groups or collectively and the condition $R_A \times I_d \leq 50V$ must be fulfilled.

In the condition:

R_A is the resistance of the earth electrode for exposed conductive parts

I_d is the fault current of the first fault of negligible impedance between a phase conductor and an exposed conductive part. The I_d value takes the leakage currents and the total earthing impedance of the electrical installation into account

In systems where an IT system is used for continuity of supply, an insulation monitoring device must be provided to indicate the occurrence of a first fault from a live part to the exposed conductive parts or to the earth. It is recommended to eliminate a first fault as soon as possible.

Depending on whether all exposed conductive parts are interconnected by a protective conductor (collectively earthed) or are earthed in groups or individually, after a first fault, the disconnection conditions of the supply for a second fault must be as follows:

a. In installations where the exposed conductive parts are earthed in groups or individually, the protection conditions for TT systems apply (see 413.1.4.1)

b. In installations where the exposed conductive parts interconnected by a protective conductor collectively earthed, the conditions for TN systems apply

In installations where the neutral is not distributed, the following conditions must be fulfilled:

$$Z_s \equiv \frac{\sqrt{3} \times U_0}{2 \times I_a}$$

In installations where the neutral is distributed, the following conditions must be fulfilled:

$$Z'_s \leq \frac{U_0}{2 \times I_a}$$

In the condition:

U_0	is the nominal AC RMS voltage between phase and neutral
Z_s	is the impedance of the fault loop comprising the phase conductor and the protective conductor of the circuit
Z'_s	is the impedance of the fault loop comprising the neutral conductor and the protective conductor of the circuit
I_a	is the operating current of the protective device. The disconnecting time is 5 seconds (distribution circuits)

Protective devices in IT systems

The following protective devices are recognized in IT systems:

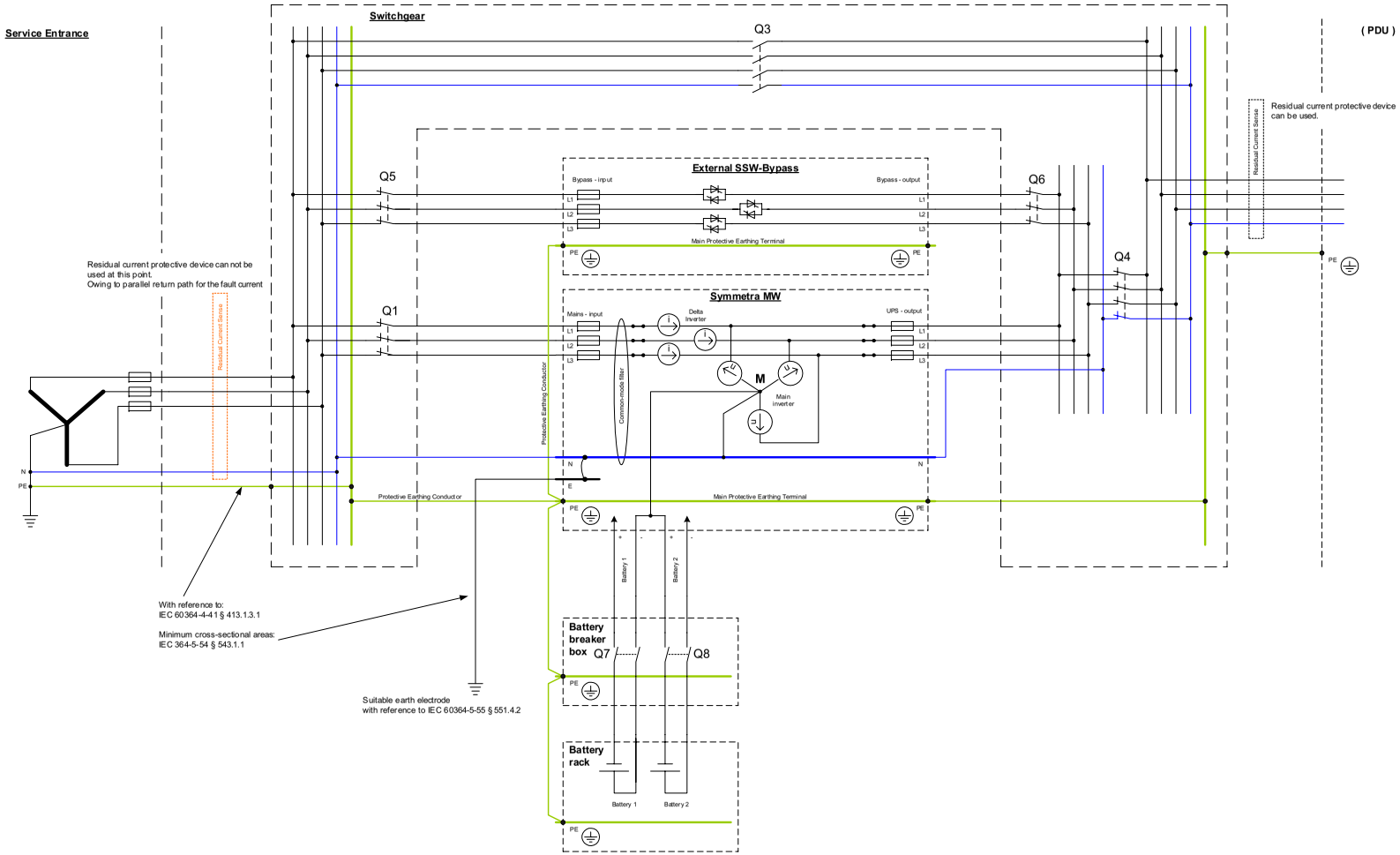
- Insulation monitoring devices
- Overcurrent protective devices
- Residual current protective devices

The following diagram shows a Symmetra® MW installed in a IT system:

- Earthing arrangements and protective conductors - Symmetra® MW in “IT installation”

Earthing arrangements and protective conductors - Symmetra MW in TN-S installation

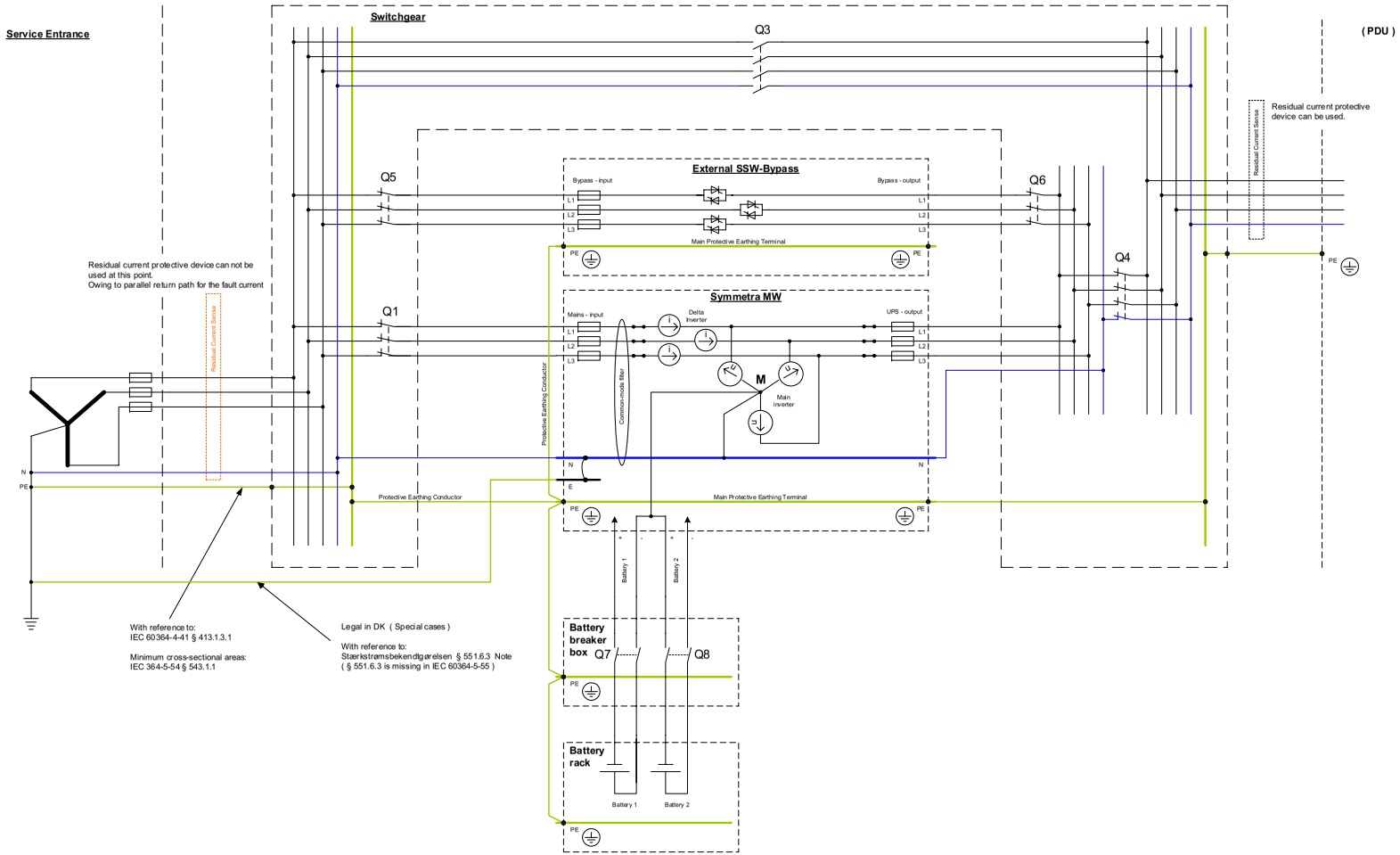
See: IEC 60364-4-41 § 413.1.3



Earthing arrangements and protective conductors - Symmetra MW in "TN-S installation"

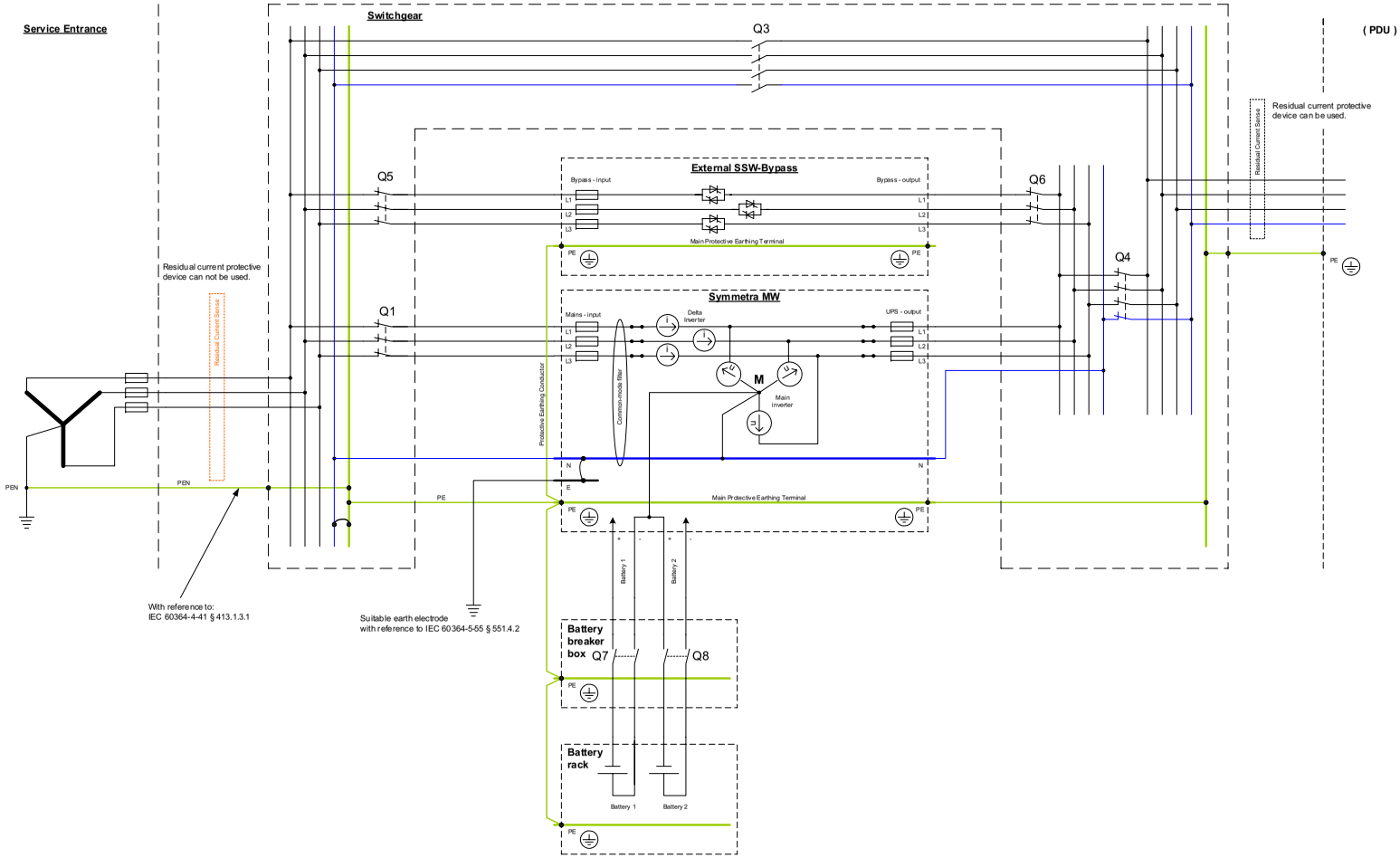
(Legal in DK - special cases)

See: IEC 60364-4-41 § 413.1.4 and "Stærkstrømsbekendtgørelsen" § 551.6.3, Note



Earthing arrangements and protective conductors - Symmetra MW in "TN-C-S installation"

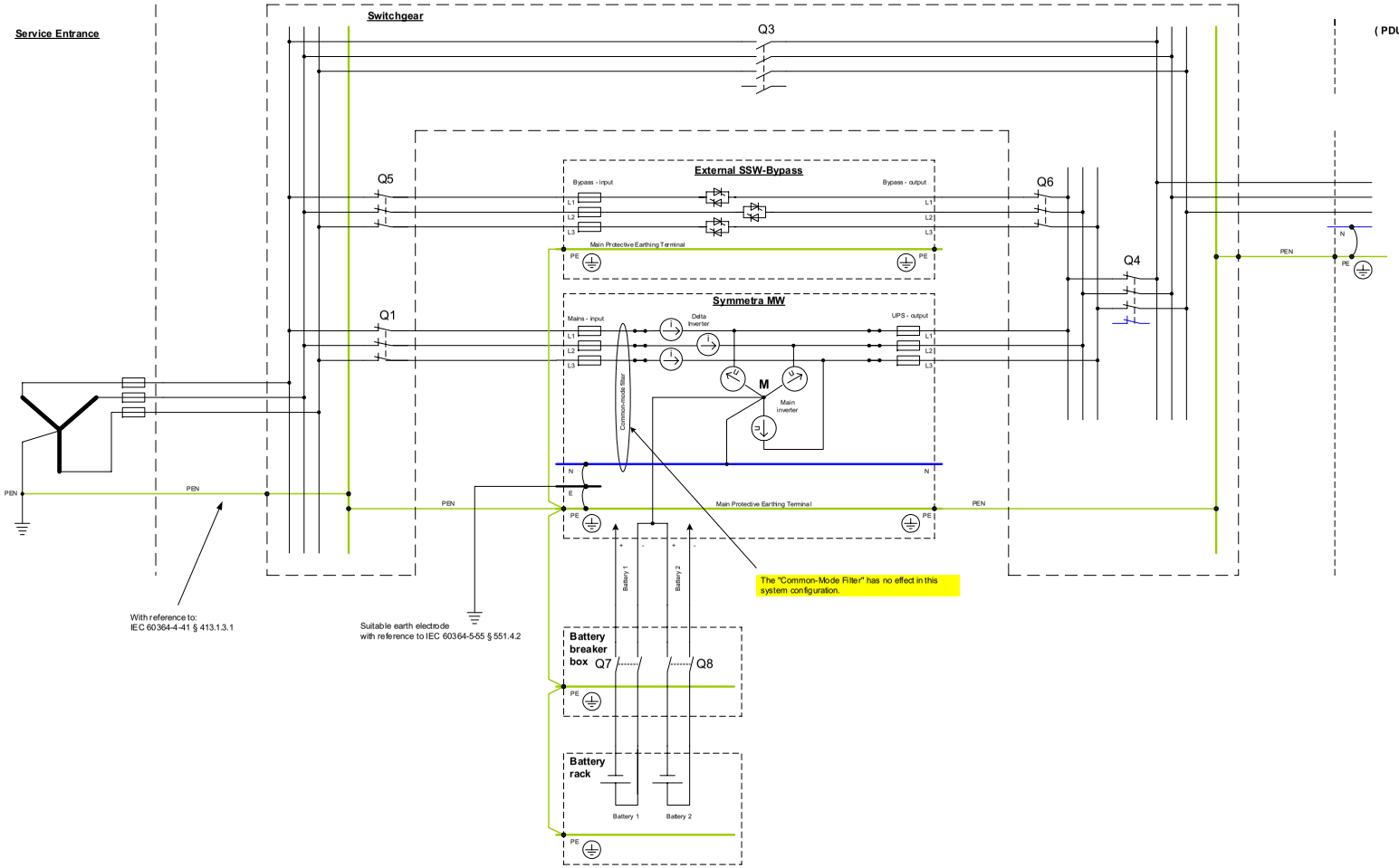
See: IEC 60364-4-41 § 413.1.3



Earthing arrangements and protective conductors - Symmetra MW in TN-C installation

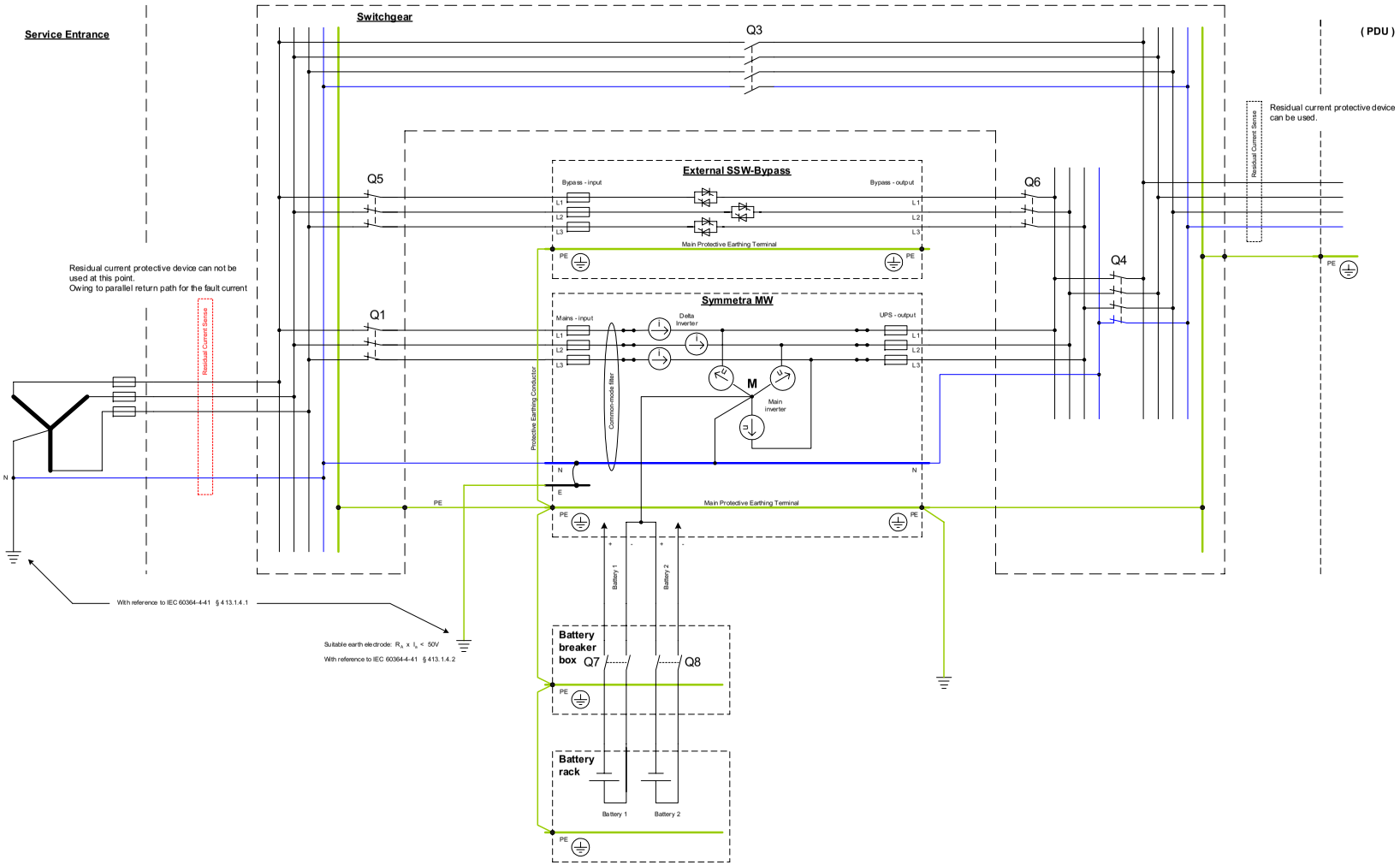
See: IEC 60364-4-41 § 413.1.3

This system configuration is not recommended



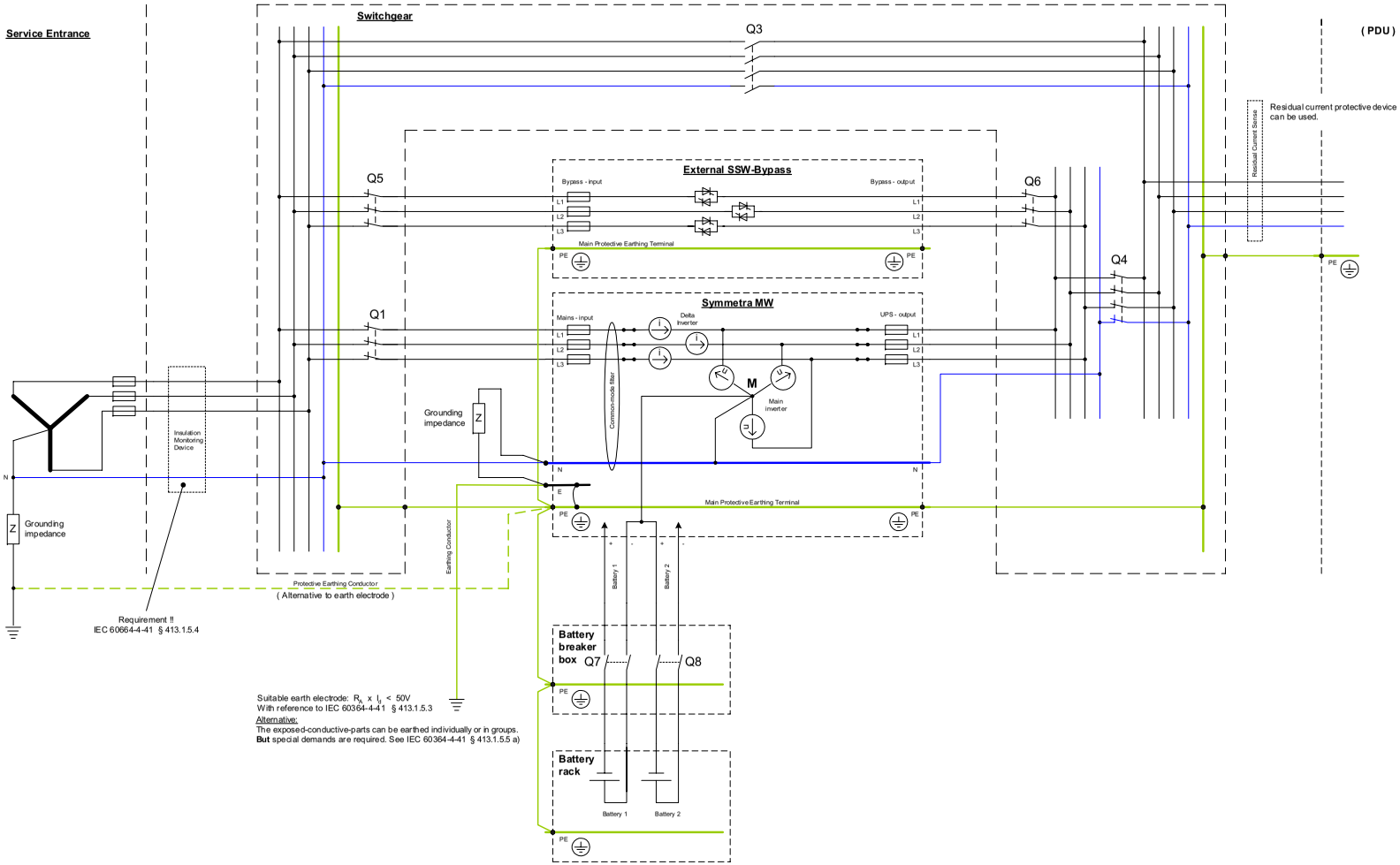
Earthing arrangements and protective conductors - Symmetra MW in TT installation

See: IEC 60364-4-41 § 413.1.4



Earthing arrangements and protective conductors - Symmetra MW in "IT - installation"

See: IEC 60364-4-41 § 413.1.5



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