APPLICATION GUIDE

Continuous Power for UPS networks' Selectivity in Data Centers

UL

Data Centers UPSs are crucial for the continuity of service and their power factor correction. Having them without a proper selectivity chain might lead to unwanted downtime together with financial and physical damage.

What is Continuous Power?
Continuous Power is everything in terms of products and functionalities inside installations tasked with supplying energy, protecting people and loads. Cutting-edge solutions achieve fast coordination between devices, thus avoiding stress and damage to the electrical distribution system by excluding only the minimum zone affected by the fault.

Why you need Continuous Power solutions
Data Centers are, in fact, coordinated, optimized facilities built as intelligent, highly efficient, and highly reliable systems. Selectivity is the key to establishing a good system in facilities that cannot tolerate power cuts in their Data Centers. This is because selective systems isolate faults within the shortest time, with the minimum damage and ensure that the least number of unrelated loads is affected by the fault. It is well known that outages in Data Centers may have a huge impact due to loss of data, corrupted files, ruined equipment, reputational damage, etc. When there are immeasurable losses, costs cannot be predicted precisely because they are strongly related to where the error occurred and how long it took to be eliminated. This application is explaining how to correctly design a selectivity having a UPS in the middle, so that it doesn't get excluded from the network when a fault occurs, but it safely keeps feeding paramount important loads.

Main benefits

Continuity of service
This tool aim is to provide everything needed to boost system reliability

Pre-engineered solutions
Leverage on ABB expertise for your installation selectivity

Introduction

After global awareness of the effects of the COVID-19 pandemic, the importance of digitalization became crystal clear. Modern society and businesses began relying on data centers as never before. Growing dependence on such facilities and the need to assure zero-downtime in data center operations means that each tiny detail of data center design becomes of the utmost importance and has to be carefully managed.

The reliability of electrical distribution infrastructure in data centers must be treated as one of the key design factors if high availability is to be assured. Owing to their sensitive nature, IT loads need clean and continuous power supplied through a UPS. This means that selectivity coordination of different protection devices (upstream and downstream of the UPS) during faults plays a vital role in increasing the availability of the electrical network. The purpose of this Application Note is to illustrate the way that ABB UPSes function together with what is called the “Site Planning Tool”: a collection of coordination tables and technical information to support customers in designing, setting and installing the chosen UPS and its protection devices. It also contains information about how to design the protection settings and correctly size and choose the general DC circuit-breaker of the UPS battery cabinets.

Double Conversion UPS topology

Depending on application requirements, different types of UPS systems are available on the market including standby, lineinteractive and double conversion UPSes.

The protection philosophy must be designed to suit the type of UPS and system configuration. This paper focuses on low voltage double conversion UPSes as they are the type most often used in data centers worldwide. Double conversion UPSes (as indicated by the name itself, this type of UPS converts twice – AC to DC and DC to AC) ensure complete isolation through the DC bus between the output of the UPS system connected to the loads and the input grid, which may be affected by power quality problems, such as voltage or frequency disturbances. Typically, double conversion UPSes meet VFI (Voltage Frequency Independent) performance classification requirements as laid down by UL 1778. It means that the load supply is independent of frequency and voltage variations in the supply network.

In this configuration, the UPS would be able to accept three different power sources:

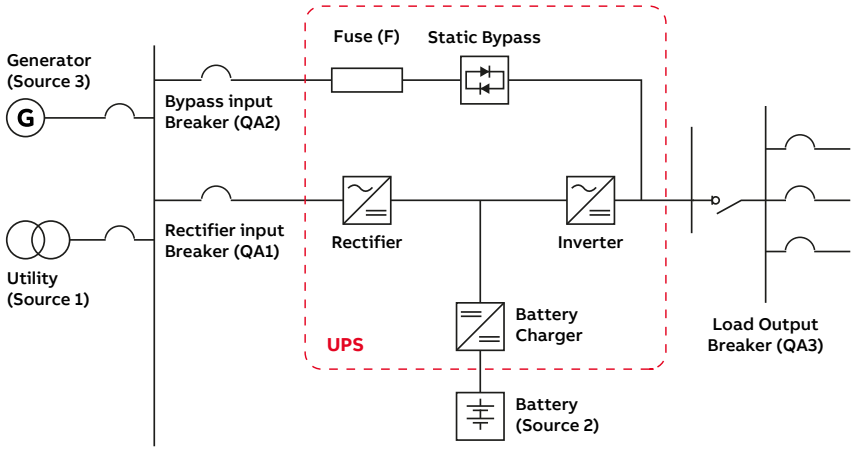
1. The First Source is the utility, which acts as a main power source and supplies power to the battery charging source as well as the load via the rectifier/ inverter combination.
2. The Second source is the battery itself, which provides power instantaneously during transient events at the input side and provides bridging time until the generator starts (usually within the range of minutes).
3. The Third source is a generator, which provides backup during outages (usually within in the range of hours).

Loads can be supplied through a static bypass if minimum possible losses are targeted, but in this operating mode the load is exposed to voltage and frequency variations in the supply source (VFD Voltage Frequency Dependent) . The other case in which a static bypass switch supplies power to the load is during abnormal conditions such as shortcircuits. Knowing the different power sources and UPS operating modes is imperative if the right protection layout is to be dimensioned and the correct protection devices selected. To provide a complete overview before examining the selectivity topic, another important aspect, i.e. the available input configuration, will be considered in the next section.

Dual or Single input feed configurations

ABB UPSes support configurations with dual or single input feeds. This means that the configuration can be as shown in figure 1 (Dual), where one protection device (QA1) is dedicated to protecting the cable from the switchgear to the UPS rectifier bridge while another (QA2) is dedicated to the static bypass.

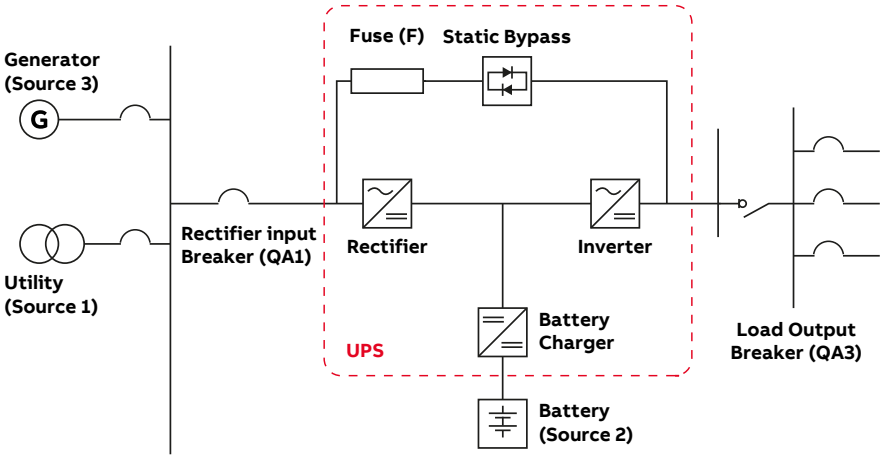
—
Fig.1
Double Conversion mode
UPS, Double input Feed



In the Single input feed configuration, a single protection device protects the same line, feeding both the rectifier and the static bypass. Note that this circuit-breaker (QA2) it shares the same name as the one in the Dual input feed architecture on the bypass.

The coordination tables in the Site Planning tool described further on have been created considering circuit-breaker QA2 for one of the two selectivity chains for modular UPSes, but this will be explained in detail the next sections.

—
Fig. 2
Double Conversion mode
UPS, single input Feed



UPS Modes of Operation

The UPS's main function is to provide clean and continuous power to the downstream loads. If the UPS cannot provide clean energy or an adequate voltage level, as per UL 1778 the UPS will transfer the load to the static bypass switch.
A UPS represents an additional power source in the electrical network that has its own behavior/ characteristics, which needs to be taken into consideration during system and protection design.
In a normal operation, the UPS supplies the load from either:

1. The utility (or Generator) through the rectifier in path 1 in Figure 3.
2. The utility (or Generator) through the static bypass switch to minimize losses (By-pass-mode), as shown in path 2 in Figure 3.
3. Through the battery in the case of a utility outage till the generator comes online, as shown in path 3 in Figure 3.

The UPS inverter capability on current delivery for downstream short circuits is typically limited to 2-3 times of its rated current value, while the static bypass switch is often dimensioned to carry at least 10 times of the UPS rated current for a period of 20-100 milliseconds.
During downstream load faults, the load circuit breaker is required to clear the fault as fast as possible to restore the voltage on the output bus and stay within the UL standards.

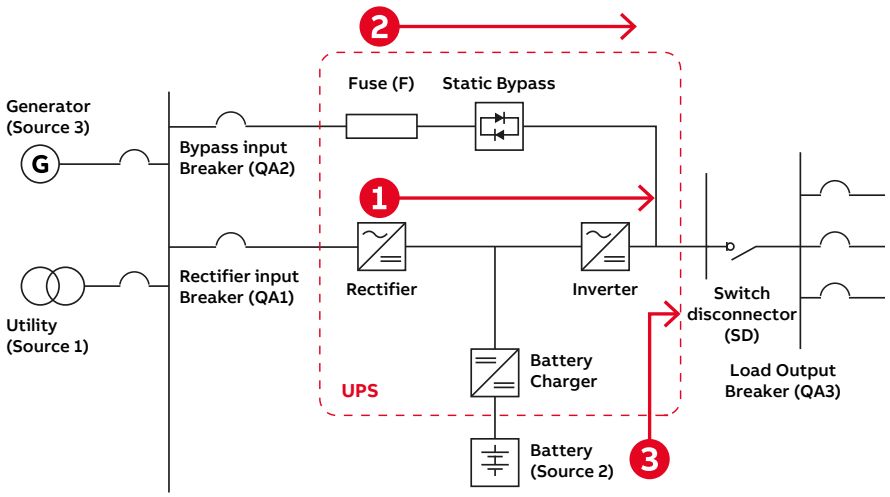


Fig. 3
Current paths during normal operation of Double Conversion UPS, Double Input Feed

Standalone or Modular UPS

ABB UPSs are available either as standalone or modular.

Standalone UPSs are built up as a unique, monolithic machine, therefore the selectivity chain is the one between the Downstream circuit breaker (QA3) and the bypass internal Fuse (F).
Modular UPSs, instead, are leveraging the Decentralized Parallel Architecture (DPA) which consists in several modules, up to the desired nominal power of the unit, completely independent between each other (each module has a rectifier–inverter branch and a static by-pass) so that, in case of an internal fault of one module and a redundant configuration, the UPS is still able to carry the current with the remaining ones.
In case of a Modular UPS then the selectivity chains to be considered are 2:

- Load circuit breaker QA3 with static bypass internal fuse F
- The fuses F of each module with the circuit breaker QA2 (as main input circuit breaker for single input feed UPSs or as bypass input circuit breaker for dual topology).

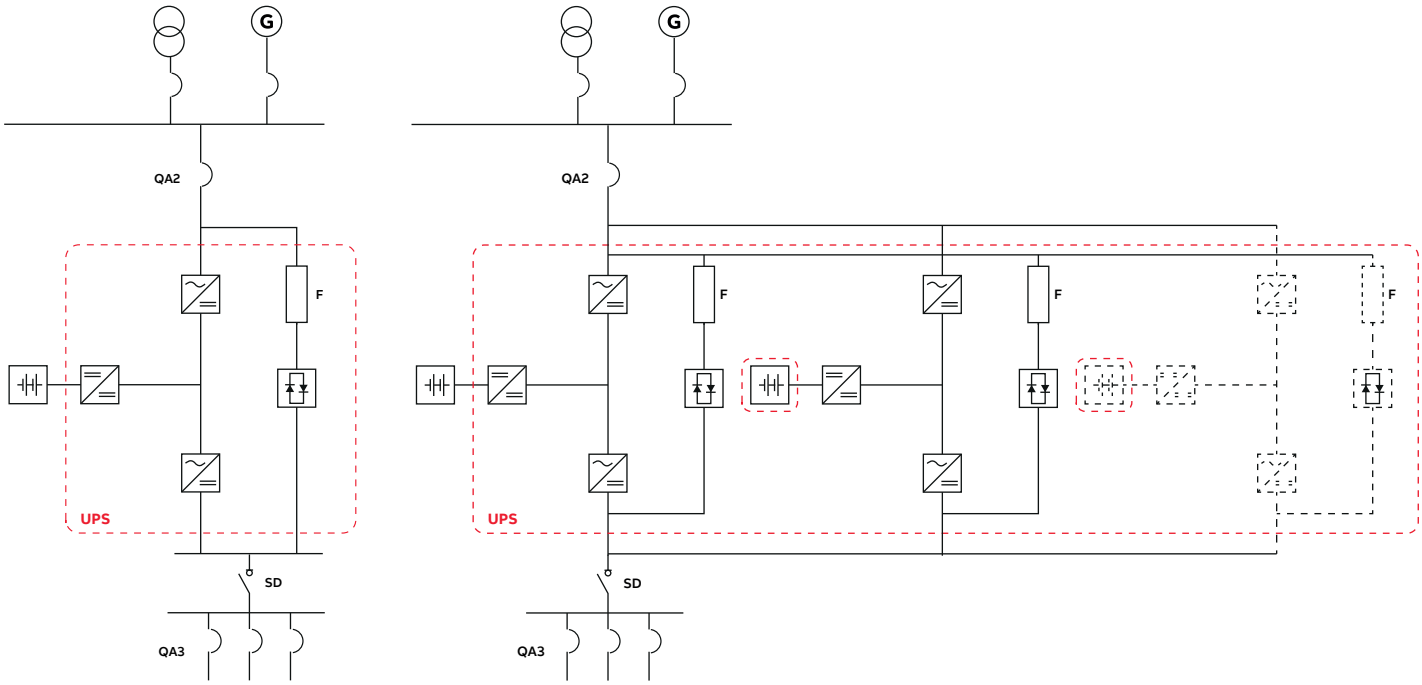


Fig 4
Two UPS schematics, one Standalone (left side) and one Modular (right side)

Protection Devices sizing considerations

The circuit breaker selection needs to take into consideration factors based on the location of the breaker in the circuit

Below are a few factors to support the UPS network design and component selection.
The UPS input breaker (QA1) shall consider:

- The UPS rated power and overload characteristics.
- The Battery charging current.
- Must interrupt the prospective short circuit from the power sources (utility transformer or generator and transformer in case of close transition).
- Must trip the prospective short circuit delivered by the least powerful of sources (typically the generator).

The static bypass switch input breaker (QA2) shall consider:

- The same rules for short circuit withstand for QA1 in relation to different power sources apply as well to QA2
- Shall withstand the simultaneous energizing of all loads.

Downstream Load breakers (QA3)

- The breakers shall be sized for the load needs for the prospective short circuit current at the installation point.

Site Planning Tool

Introduction and User Guide

Having considered the characteristics of ABB UPSes and the information about sizing the protection devices, the next step is to take a look at the pre-engineered tables created by ABB to facilitate installation design by providing clear and univocal indications.

Instructions about how to consult and use the Site Planning Tool are given below.

1. Find your way around different types of UPSs
Open the tool and scroll down to the main menu where different UPSes, in terms of technology and size, are listed.

STANDALONE UPSs	MODULAR UPSs
MegaFlex	DPA 60
TLE Series	DPA 120
TLE Scalable	DPA 300
	DPA 500

2. Find the best match to achieve selectivity
After clicking on the desired UPS, you will be taken to the related page where you can find a table like the one below.

Nominal Voltage [V]	Number of Modules	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	1	20	10	XT2N 125 Ekip LS/I 100	XT1N 125 TMF 100 + RC Sel	no solution	
480	2	40	10	XT4N 250 Ekip LS/I 150	XT3N 225 TMF 150 + RC Sel	S303-B25 + F204 A 25/0.03mA	Up to 1,8 kA
480	3	60	10	XT4N 250 Ekip LS/I 250	XT3N 225 TMF 225 + RC Sel	S303-B25 + F204 A 25/0.03mA	Up to 4,3 KA
480	4	80	10	XT5N 400 Ekip Dip LS/I 250	XT4N 250 Ekip LSIG 250	S303-B25 + F204 A 25/0.03mA	Up to 9,6 kA
480	5	100	10	XT5N 400 Ekip Dip LS/I 400	XT5N 400 Ekip Dip LSIG 400	S303-B63 + F204 A 63/0.03mA	Up to 7,8 kA
480	6	120	10	XT5N 400 Ekip Dip LSIG 400	XT5N 400 Ekip Dip LSIG 400	S303-B63 + F204 A 63/0.03mA	Total

Technical information about the UPS is given from left to right (**Nominal Voltage, Number of Modules, UPS Nominal Power** and **UPS Icw** columns).
The column **Rectifier Circuit-Breaker QA1** shows the recommended size (e.g., XT2N 125) and rated current (e.g., Ekip LS/I 100) of the circuit breaker which is placed in the Rectifier - Inverter Branch (If dual input feed UPS is chosen).
Bypass Circuit-Breaker QA2 stands for the recommended size and rated current to be chosen for the circuit breaker above the UPS static bypass in case of dual input feed configuration otherwise it will be considered as main and only circuit breaker for single input feed configuration.

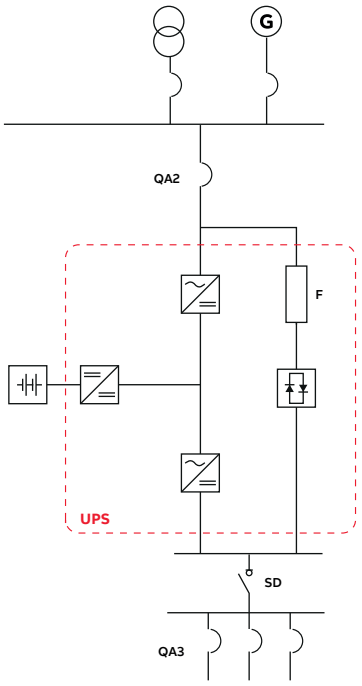
Load Circuit-Breaker QA3 is the column related to the load circuit breaker choice that grants the Selectivity level displayed in the column **Bypass Branch selectivity F – QA3**.

STANDALONE UPSs	MODULAR UPSs
MegaFlex	DPA 60
TLE Series	DPA 120
TLE Scalable	DPA 300
	DPA 500

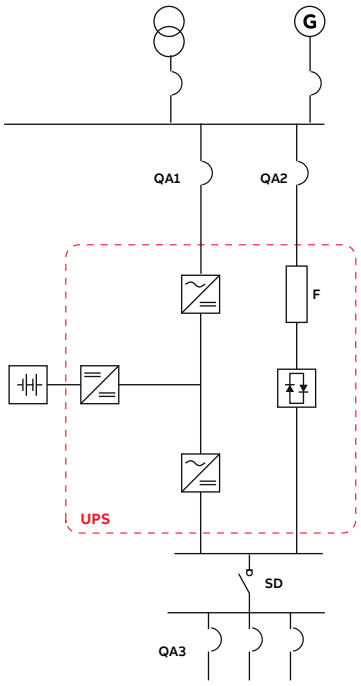
MegaFlex

Available Configurations

Single Input Feed



Dual Input Feed



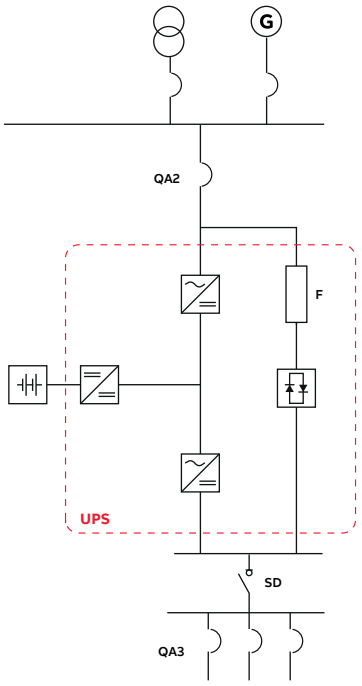
Nominal Voltage [V]	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)(5)	Bypass Circuit Breaker QA2 (2)(5)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	1000	100	E2.2V-A 1600 Ekip Hi-Touch LSI	E2.2V-A 1600 Ekip Hi-Touch LSI	XT6 H 800 Ekip LSIG 800	Up to 13.3kA
480	1100	100	E2.2V-A 1600 Ekip Hi-Touch LSI	E2.2V-A 1600 Ekip Hi-Touch LSI	XT6 H 800 Ekip LSIG 800	Up to 13.3kA
480	1200	100	E2.2V 2000 Ekip Hi-Touch LSI	E2.2V 2000 Ekip Hi-Touch LSI	XT6 H 800 Ekip LSIG 800	Up to 13.3kA
480	1500	100	E4.2V-A 2500 Ekip Hi-Touch LSI	E4.2V-A 2500 Ekip Hi-Touch LSI	XT6 H 800 Ekip LSIG 800	Up to 13.3kA
480	1600	100	E4.2V-A 2500 Ekip Hi-Touch LSI	E4.2V-A 2500 Ekip Hi-Touch LSI	XT6 H 800 Ekip LSIG 800	Up to 13.3kA

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point
(5) E2 Max should be ordered together with external toroid for residual current protection.

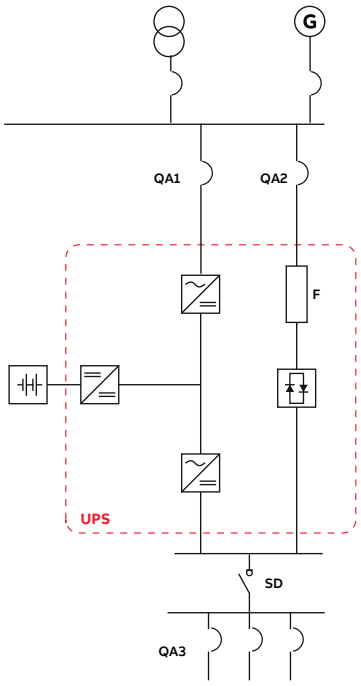
TLE Series

Available Configurations

Single Input Feed



Dual Input Feed



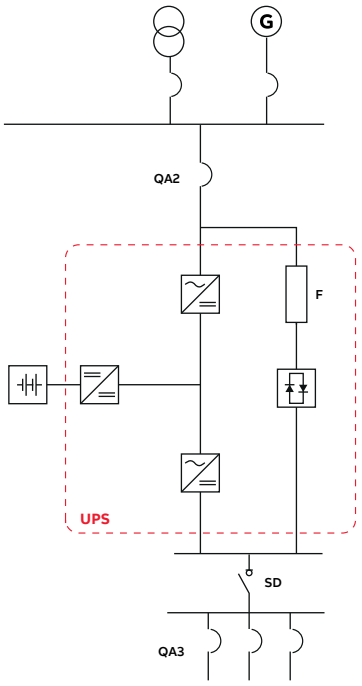
Nominal Voltage [V]	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)(5)(6)	Bypass Circuit Breaker QA2 (2)(5)(6)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	160	100	XT4L 250 Ekip LSIG 250	XT4L 250 Ekip LSIG 250	S303P-B63 + F204 A 63/0.03mA	up to 6,5 kA
480	200	100	XT5L 400 Ekip LSIG 300	XT5L 400 Ekip LSIG 300	S303P-B63 + F204 A 63/0.03mA	up to 6,5 kA
480	225	100	XT5L 400 Ekip LSIG 400	XT5L 400 Ekip LSIG 400	S303P-B63 + F204 A 63/0.03mA	up to 6,5 kA
480	250	100	XT5L 400 Ekip LSIG 400	XT5L 400 Ekip LSIG 400	S303P-B63 + F204 A 63/0.03mA	up to 6,5 kA
480	300	100	XT7L 800 Ekip Touch LSI 800	XT7L 800 Ekip Touch LSI 800	S303P-B63 + F204 A 63/0.03mA	Total
480	400	100	XT7L 800 Ekip Touch LSI 800	XT7L 800 Ekip Touch LSI 800	S303P-B63 + F204 A 63/0.03mA	Total
480	500	100	XT7L 800 Ekip Touch LSI 800	XT7L 800 Ekip Touch LSI 800	S303P-B63 + F204 A 63/0.03mA	Total
480	625	100	XT7L 1200 Ekip Touch LSI 1200	XT7L 1200 Ekip Touch LSI 1200	XT2L 125 Ekip LSIG 125	up to 69,5kA
480	750	100	XT7L 1200 Ekip Touch LSI 1200	XT7L 1200 Ekip Touch LSI 1200	XT2L 125 Ekip LSIG 125	Total
480	1000	100	E2.2V 1600 Ekip Hi-Touch LSI 1600	E2.2V 1600 Ekip Hi-Touch LSI 1600	XT2L 125 Ekip LSIG 125	Total

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point
(5) XT7 should be ordered together with Ekip Measuring with a dedicated rating plug with an external toroid for residual current protection.
(6) E2 Max should be ordered together with external toroid for residual current protection

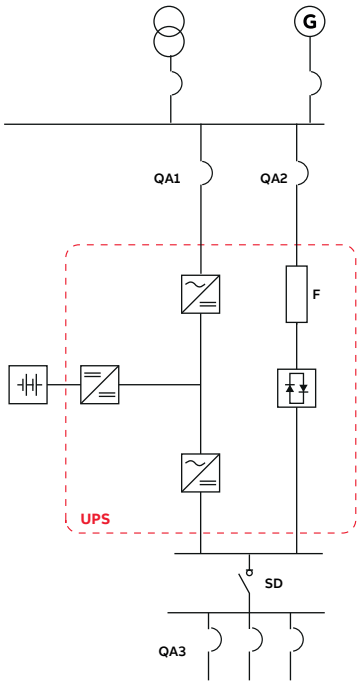
TLE Scalable

Available Configurations

Single Input Feed



Dual Input Feed



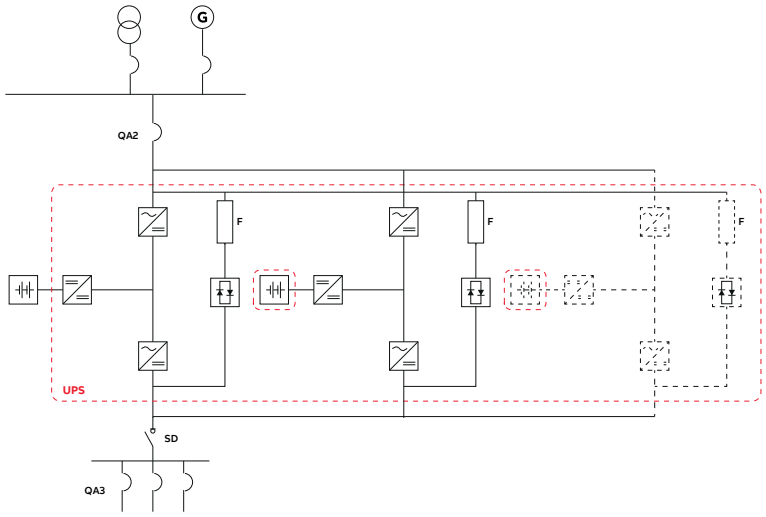
Nominal Voltage [V]	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	40	65	XT1H 125 TMF 100 + RCSel	XT1H 125 TMF 100 + RCSel	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA
480	50	65	XT2H 125 Ekip LSIG 125	XT2H 125 Ekip LSIG 125	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA
480	80	65	XT4H 250 Ekip LSIG 225	XT4H 250 Ekip LSIG 225	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA
480	100	65	XT5H 400 Ekip LSIG 250	XT5H 400 Ekip LSIG 250	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA
480	120	65	XT5H 400 Ekip LSIG 250	XT5H 400 Ekip LSIG 250	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA
480	150	65	XT5H 400 Ekip LSIG 250	XT5H 400 Ekip LSIG 250	S303P-B25 + F204 A 25/0,03mA	up to 1,1kA

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point

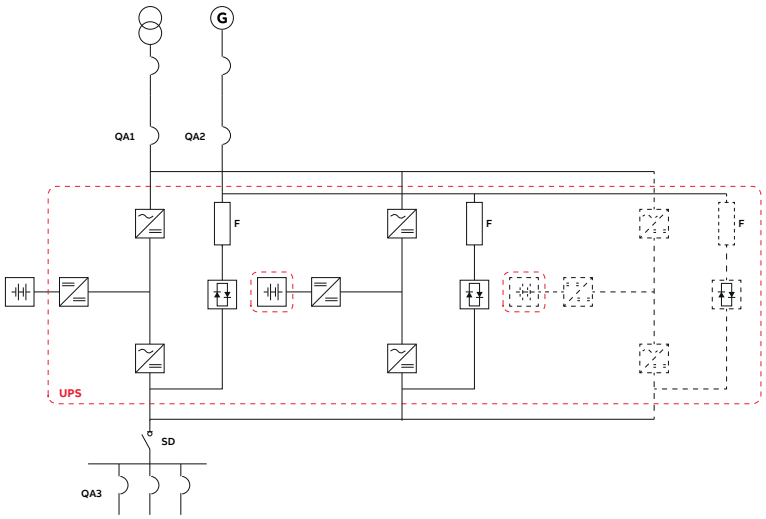
ConceptPower DPA 60

Available Configurations

Single Input Feed



Dual Input Feed



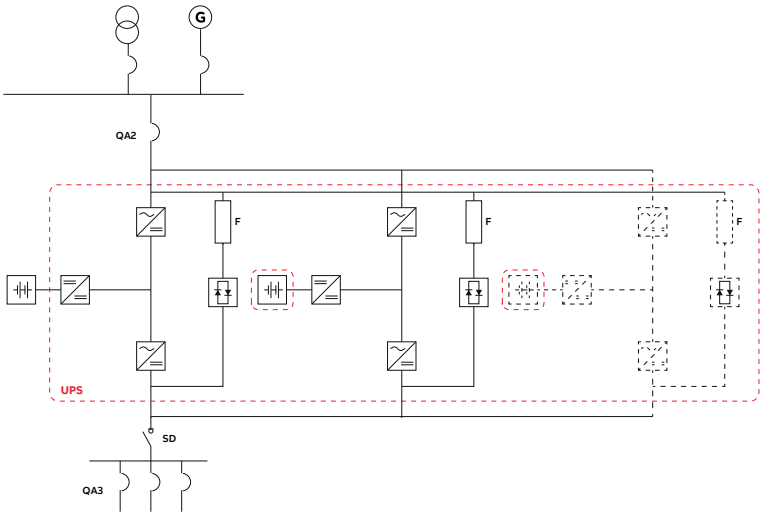
Nominal Voltage [V]	Number of Modules	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	1	20	5	XT1N 125 TMF 100 +RC Inst	XT2N 125 Ekip LSIG 100	S303-B25	Up to 2.4 kA
480	2	40	5	XT3N 225 TMF 150 +RC Inst	XT4N 250 Ekip LSIG 150	S303-B63	Up to 6 kA
480	3	60	5	XT3N 225 TMF 225 + RC Inst	XT4N 250 Ekip LSIG 250	S303-B63	Total

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning. Moreover, the reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity QA2-F”.
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point

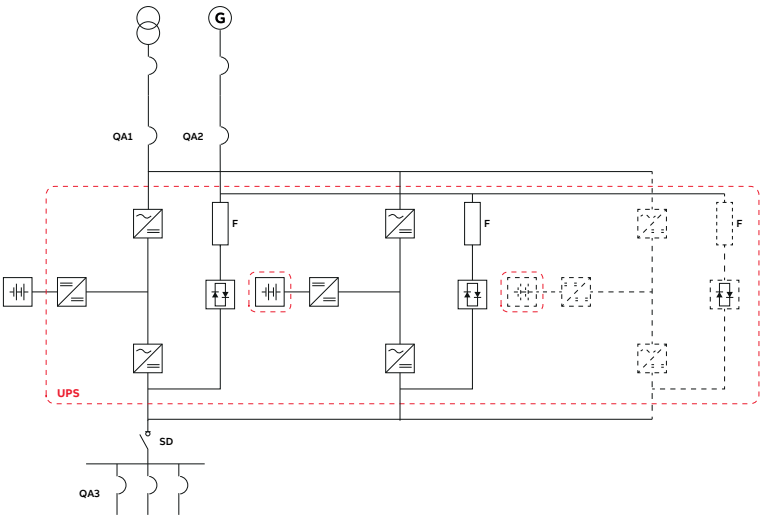
ConceptPower DPA 120

Available Configurations

Single Input Feed



Dual Input Feed



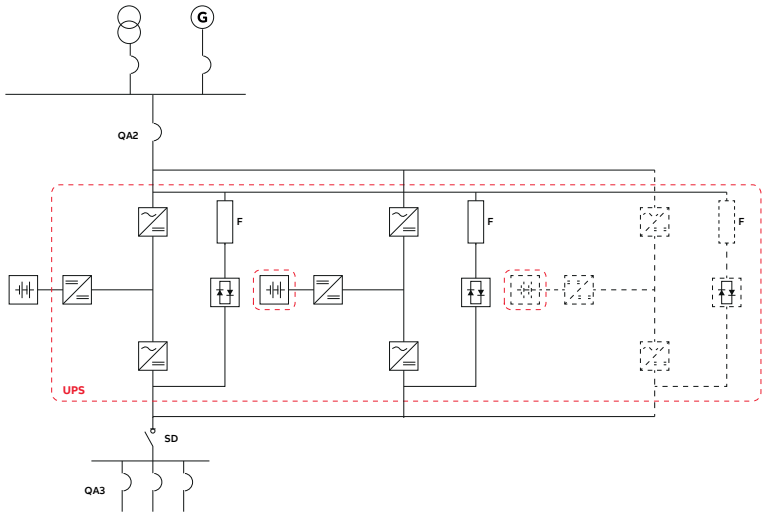
Nominal Voltage [V]	Number of Modules	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	1	20	10	XT1N 125 TMF 100 + RC Sel	XT2N 125 Ekip LS/I 100	no solution	
480	2	40	10	XT3N 225 TMF 150 + RC Sel	XT4N 250 Ekip LS/I 150	S303-B25 + F204 A 25/0.03mA	Up to 1,8 kA
480	3	60	10	XT3N 225 TMF 225 + RC Sel	XT4N 250 Ekip LS/I 250	S303-B25 + F204 A 25/0.03mA	Up to 4,3 KA
480	4	80	10	XT4N 250 Ekip LSIG 250	XT5N 400 Ekip Dip LS/I 250	S303-B25 + F204 A 25/0.03mA	Up to 9,6 kA
480	5	100	10	XT5N 400 Ekip Dip LSIG 400	XT5N 400 Ekip Dip LS/I 400	S303-B63 + F204 A 63/0.03mA	Up to 7,8 kA
480	6	120	10	XT5N 400 Ekip Dip LSIG 400	XT5N 400 Ekip Dip LSIG 400	S303-B63 + F204 A 63/0.03mA	Total

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning. Moreover, the reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity QA2-F”.
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point

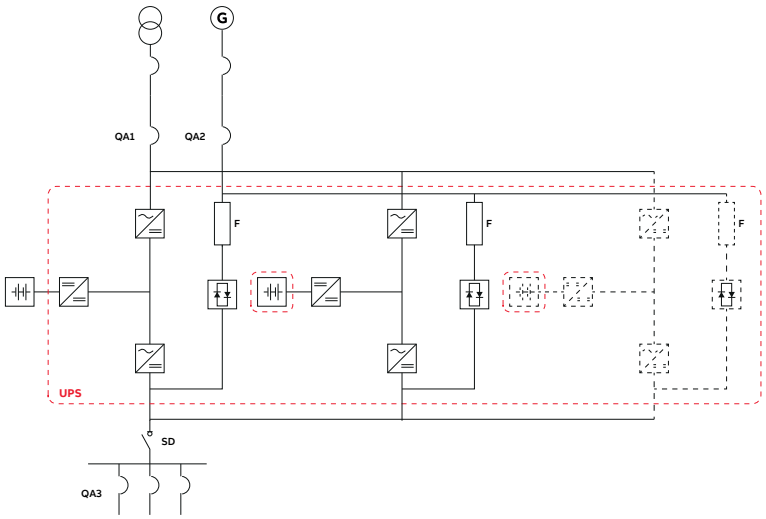
ConceptPower DPA 300

Available Configurations

Single Input Feed



Dual Input Feed



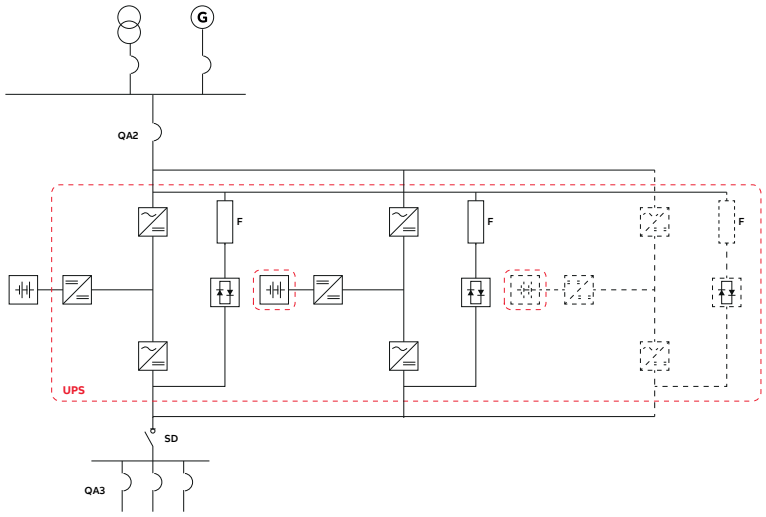
Nominal Voltage [V]	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	100	25	XT3N 225 TMF 225-2250 + RC Sel	XT4N 250 Ekip Dip LSIG 200	S303-B63 + F024 A 63/0.03mA	Up to 9,7 kA
480	200	25	XT5N 400 Ekip Dip LSIG 400	XT5N 400 Ekip Dip LSIG 400	XT2N 125 Ekip LSIG 125	up to 8,5 kA
480	300	25	XT5N 600 Ekip Dip LSIG 600	XT5N 600 Ekip Dip LSIG 600	XT4N 250 Ekip LSIG 250	Total

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning. Moreover, the reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity QA2-F”.
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point

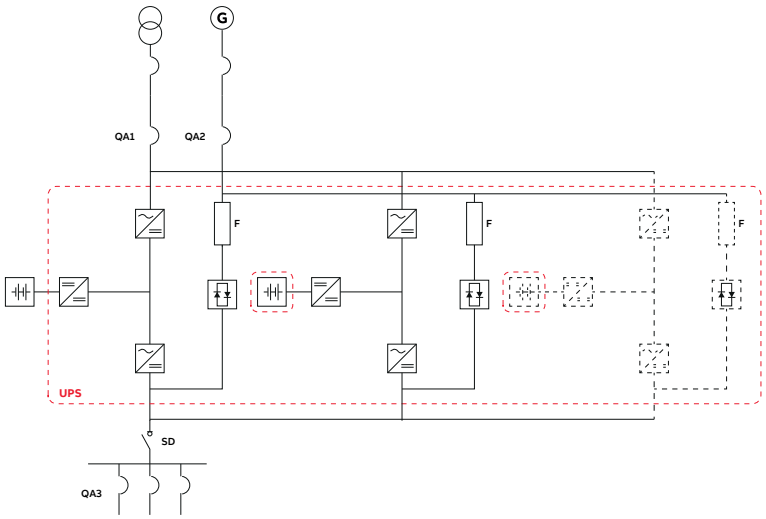
ConceptPower DPA 500

Available Configurations

Single Input Feed



Dual Input Feed



Nominal Voltage [V]	Nominal power UPS [kW]	UPS Icw [kA]	Rectifier Circuit Breaker QA1 (1)	Bypass Circuit Breaker QA2 (2)	Load Circuit Breaker QA3 (4)	Bypass Branch Selectivity F-QA3
480	100	25	XT3N 225 TMF 225-2250 + RC Sel	XT4N 250 Ekip Dip LSIG 200	S303P-B63 + F204 A 63/0.03mA	Up to 9,7 kA
480	200	25	XT5N 400 Ekip Dip LSIG 400	XT5N 400 Ekip Dip LSIG 400	XT2N 125 Ekip Dip LSIG 125	up to 8,5 kA
480	300	25	XT5N 600 Ekip Dip LSIG 600	XT5N 600 Ekip Dip LSIG 600	XT4N 250 Ekip Dip LSIG 250	Total
480	400	25	XT5N 600 Ekip Dip LSIG 600	XT5N 600 Ekip Dip LSIG 600	XT4N 250 Ekip Dip LSIG 250	Total
480	500	25	XT6N 800 Ekip Dip LSIG 800	XT6N 800 Ekip Dip LSIG 800	XT4N 250 Ekip Dip LSIG 250	Total

(1) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point.
(2) Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breakers must be chosen accordingly with the prospective short circuit current at the installation point. In case of single input feed configuration, this is the circuit breaker to be used for correct electrical dimensioning. Moreover, the reported circuit breakeris granting the selectivity level displayed in the column “Bypass Branch Selectivity QA2-F”.
(3) Optional device, suggested instead of a circuit breaker for selectivity purposes
(4) The reported circuit breaker is granting the selectivity level displayed in the column “Bypass Branch Selectivity F-QA3”. Rated ultimate short circuit breaking capacity (Icu) of the here reported circuit breaker must be chosen accordingly with the prospective short circuit current at the installation point

Note:

(1) Guarantee

The information contained in the coordination table document reflects the current state of our knowledge and aims to present our products for power continuity, their coordination, and possible applications, as defined with the applicable international standards. All devices contained in coordination tables shall be installed and used as per product data and instruction contained in products' installation manuals and user manuals.
This coordination table is made available "as is" and with no express warranty. ABB further disclaims all other statutory and implied warranties, including, but not limited to, any warranty of fitness for particular purpose or merchantability. The user and user's company agree that in no event will ABB be liable to the user or user's company for any claims, liabilities, or damages even if caused by the negligence of ABB, and under no circumstances will ABB be liable for any indirect, special, incidental or consequential damages.

(2) Liability

The devices in coordination tables do not endanger safety when they are selected, mounted, commissioned, used, maintained and disassembled with the applicable rules and standards and in accordance with the user manual. The devices shall be used by experts and well-trained people.
The selections contained in coordination table must be reviewed and approved by the user.

(3) Additional information

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars will take precedence. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

Bill of Materials

To further understand how to compose a bill of materials with the guidelines of Site Planning tool, here is an example.

Here it is considered a UPS MegaFlex, with the biggest available size (1600 kW) the bill of material for coordination purposes is the following

Quantity	US Ordering code	Global Ordering code	Product name
1	4NWP106511R0001		MegaFlex UL 1600KW
2	Z4VGULBB000A000000XX	1SDA078059R1	E4.2V-A 2500 Ekip Dip LSI 3p FHR
6	XT5LU340AFFF000XXX	1SDA102685R1	XT5L 400 BREAKING PART 3p F F UL/CSA
6	XT5LU440AFFF000XXX	1SDA102713R1	Ekip Dip LSI In=400 XT5 3p UL/CSA

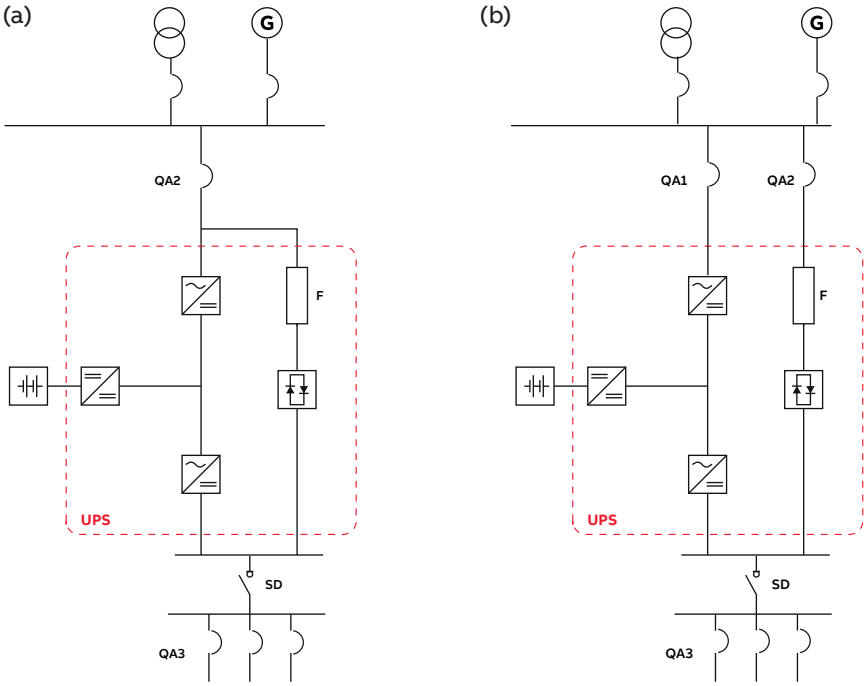
APPLICATION FINDER

We've made it simpler for you to set up your project!
Click here to find the reference architecture that best fits your needs and download the Bill of Materials.

The engineering study behind the Site Planning Tool

Selectivity with Standalone UPSs

Selectivity between the downstream circuit-breaker and the fuse in the static bypass is the one to be considered.



—
Simplified diagram of a Double Conversion UPS with one (a) or two (b) input feeds

To achieve this configuration, we have applied the following rules:

1. The let-through energy i2t of the downstream breaker shall be lower than the pre-arcing I2t of the upstream fuse.
2. Short circuit selectivity is ensured when the short circuit current is higher than the circuit breaker's instantaneous threshold.
3. Tripping time of circuit breakers for instantaneous trip threshold shall be lower than the pre-arcing time of the fuse.

In view of all the above considerations, the equations for verifying selectivity between the downstream circuit-breaker and upstream fuse are the following:

Rule 1

a) $I_{CB}{}^2t < \text{pre-arcing } I_F{}^2t * k_1$

Where:

$I_{CB}{}^2t$ = let-through energy of downstream circuit breakers, declared by the manufacturer

$\text{pre-arcing } I_F{}^2t$ = pre-arcing let-through energy of upstream fuses, declared by the manufacturer

k_1 = safety factor

Rule 3

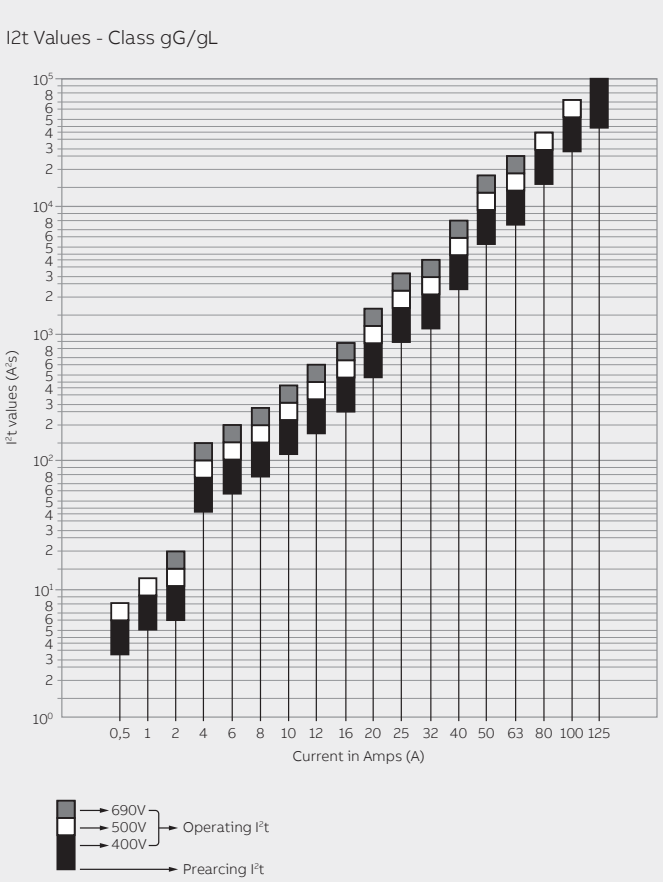
b) $t_{CB} < t_{F\ \text{pre-arc}}$

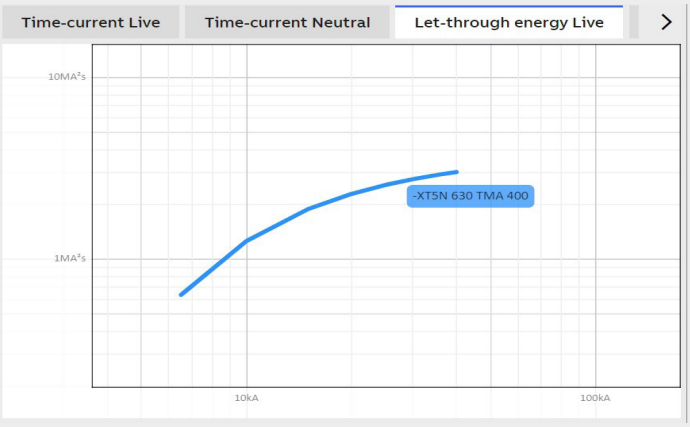
Where:

t_{CB} = tripping time of a circuit breaker for fault current equal to the circuit breaker's instantaneous trip threshold

$t_{F\ \text{pre-arc}}$ = pre-arcing time of the fuse, declared by the manufacturer

—
Fuse let-through energy diagram





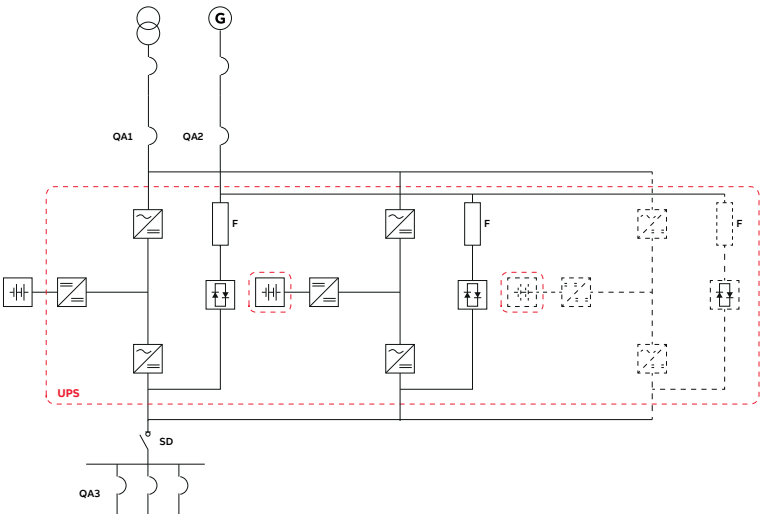
—
Circuit-Breaker let-through energy diagram

Selectivity with Modular UPSs

ABB Modular UPS is based on DPA (Decentralized Parallel Architecture) architecture. In DPA architecture, each UPS module contains all the hardware and software required for full UPS system operation.

The modules do not share any component and each module is a fully functional UPS. Thus the DPA system is able to increase system reliability and maximize uptime. The UPS modules are in parallel to provide redundancy or to increase the total capacity of the system.

—
DPA architecture (the modules are totally independent from each other)



Getting back to the subject of selectivity, because the fuse inside every UPS module is considered in parallel with the other, two different co-ordinations need to be verified:

- Selectivity between upstream fuses in parallel and downstream circuit breakers
- Selectivity between fuses in parallel and upstream circuit breakers, in case it is the only input or it is located at the bypass feeder.

The following rules have been considered for the purpose of verifying selectivity between upstream fuses in parallel and downstream breakers:

1. The let-through energy I2t of the downstream circuit breaker shall be lower than the pre-arcing I2t of the upstream fuse, multiplied by the square value of the number of fuses in parallel.
2. Short circuit selectivity is ensured when the short circuit current is higher than the circuit breaker's instantaneous threshold protection.
3. Tripping time of circuit breakers for instantaneous trip threshold shall be lower than pre-arcing time of the fuse

In view of all the above considerations, the equations to verify selectivity between up-stream fuses in parallel and downstream breakers are the following:

Rule 1

c) $I_{CB}{}^2t < pre\text{-}arcing\ I_F{}^2t * k_2 * N^2$

Where:

$I_{CB}{}^2t$ = let-through energy of downstream circuit-breakers, declared by the manufacturer

$pre\text{-}arcing\ I_F{}^2t$ = pre-arcing let-through energy of upstream fuses, declared by the manufacturer

N = number of fuses in parallel

k_2 = safety factor

Rule 3

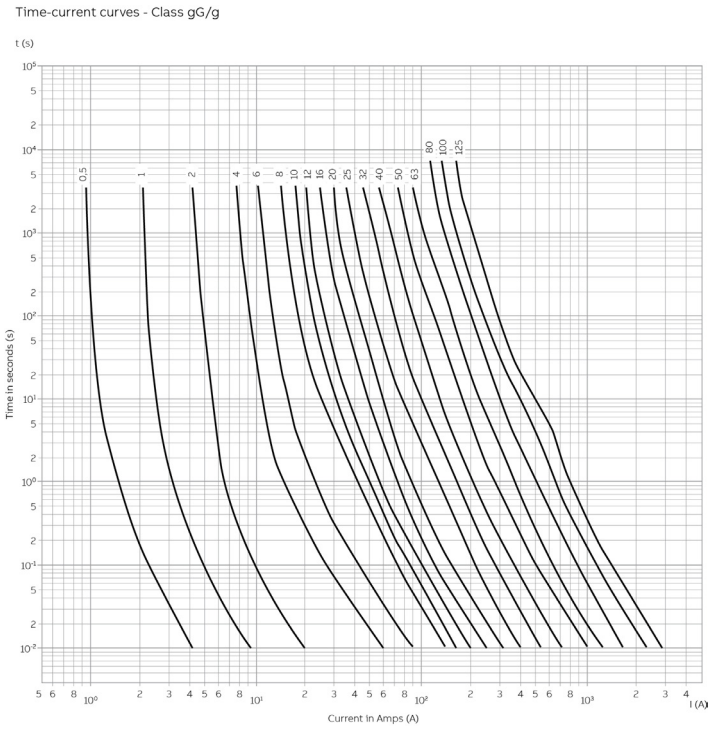
d) $t_{CB} < t_{F\ pre\text{-}arc}$

Where:

t_{CB} = tripping time of a circuit-breaker for fault current equal to the circuit breaker's instantaneous trip thresholdr

$t_{F\ pre\text{-}arc}$ = pre-arcing time of the fuse, as declared by the manufacturer

—
Fuse pre-arcing time



Selectivity between downstream fuses in parallel and the upstream circuit breaker

To verify selectivity between the upstream circuit breaker and downstream fuses in parallel, the following rule has been considered:

- the let-through energy I2t of the upstream circuit breaker shall be higher than the melting I2t of the downstream fuse, multiplied by the square value of the number of fuses in parallel.

In view of the above considerations, the equation for verifying selectivity between the up stream circuit-breaker and downstream fuses in parallel is the following:

e) $I_{CB}{}^2t < melting\ I_F{}^2t * N^2$

Where:

$I_{CB}{}^2t$ = let-through energy of downstream circuit-breakers, declared by the manufacturer

$melting\ I_F{}^2t$ = melting let-through energy of downstream fuses, declared by the manufacturer

N = number of fuses in parallel

Circuit Breakers protection settings

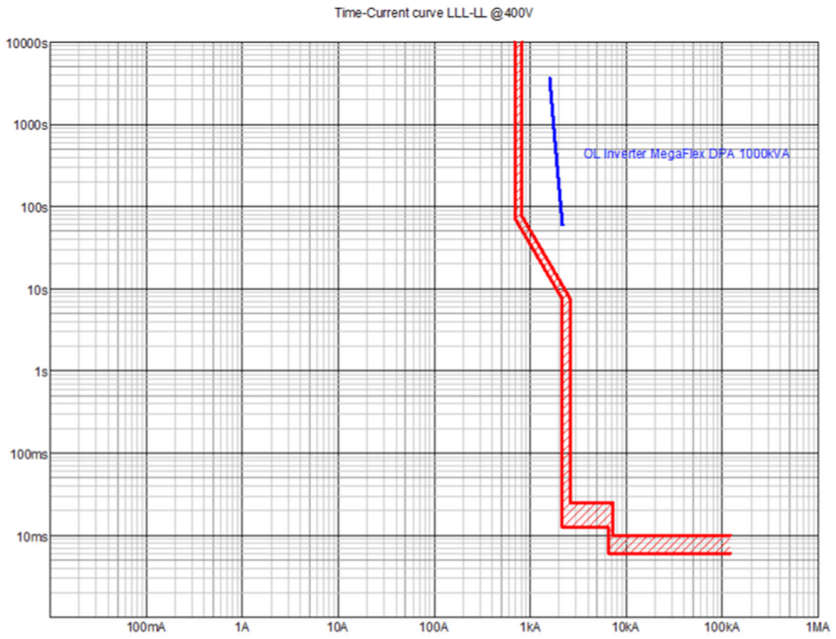
Having determined size and frame of the circuit breakers QA1, QA2 and QA3, the last step for ensuring selectivity is to choose the protection settings wisely .
The step can be divided into parts: Overload Zone and Short Circuit Zone.

Overload Zone

Overload zone is intended for current which are not higher of 8-10 times the rat-ed current of QA3.
As explained earlier, in case of a short circuit the UPS automatically switches from double conversion mode to static bypass, but for overload this is not the case, at least not for a certain period of time.
The actors of this selectivity are then:

- Circuit Breaker QA3 which has to intervene as first to protect the UPS;
- The inverter with its withstand capability;
- Circuit Breaker QA1 that should never open in this selectivity chain

In order to have the correct sequence, the settings should lead to have QA3 circuit breaker to act more rapidly than the inverter.
Figure X is showing exactly the expected coordination:



Short Circuit Zone

Short Circuit Zone Is intended as the one equal or above 10 times the nominal circuit breaker current.
Again, the actors of this type of selectivity remain the same, but with additional settings:

- QA3 should have the magnetic protection set at a value which is lower than the inverter's short circuit withstand capability
- QA1/QA2, if they are equipped with a Thermomagnetic trip unit, should the instantaneous protection setting to its maximum. If, instead, they are equipped with an electronic trip unit, then the Instantaneous protection I3 setting should be set to OFF.

To complete the information needed to correctly size the circuit Breakers pro-tecting the UPS, the last one to mention is the main circuit breaker on the DC side in the Battery Racks.

ABB is providing a complete solution (UPS + Batteries), but in case it is requested, other batteries from other manufacturers/suppliers can be used.
Nevertheless, guidelines are important to be followed for a correct coupling of these 2 components.

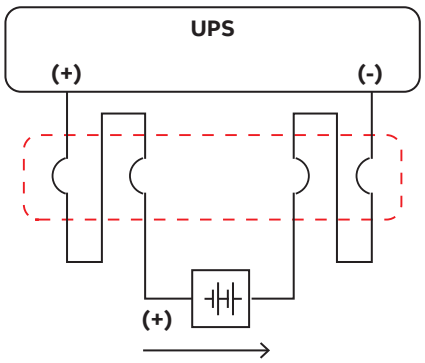
Guidelines are based on the following remarks:
1. DC side of the UPS isolated from the ground
2. Maximum breaking capacity to be selected according to the prospective short circuit current of each case
3. Circuit breaker size to be selected considering maximum voltage and maximum discharge current
4. To be able to consider the fault between batteries and circuit breakers negligible, they shall be installed very close to each other.
5. Ambient temperature not higher than +40°C.

The ABB circuit breaker which is easily answering needs in terms of fast and reactive protection are the Tmax XT range and Emax DC.

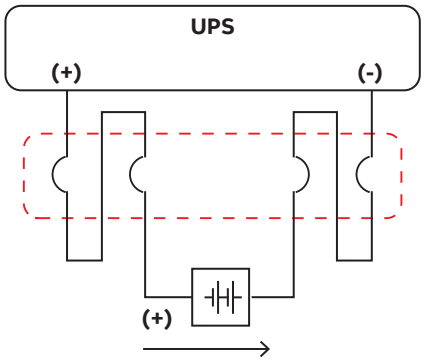
Examples of Tmax XT (left side) and Emax DC (right side)

Speaking now about the connection between batteries and the UPS bus, this is achievable in the configuration of 2 or 3 poles.
The guidelines, in terms of connections and desired achievable operational voltages, can then be summarized as follow::

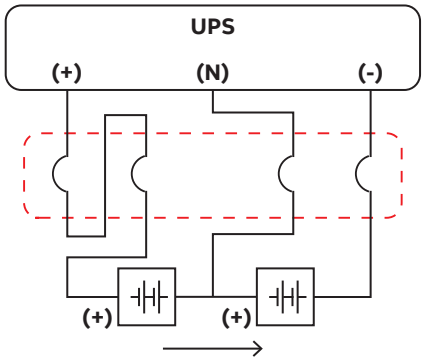
- For 2 poles UPS's Bus configuration (without mid-pint) T4, T5 and T6 4 – poles circuit breakers are recommended if, current permitting, the desired achievable voltage is up to 1000 V. It is also possible to use 4-pole T4N/PV-E up to a voltage of 1500Vdc.



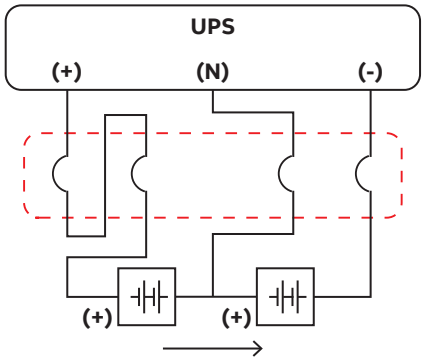
- If Emax DC range is required the connection, due to the integrated flapper, is the following:



- For 3 poles UPS's Bus configuration T4, T5 and T6 4 – poles circuit breakers are recommended if, current permitting, the desired achievable voltage is up to 750 V.



- If Emax DC range is required the connection, due to the integrated flapper, is the following up to 750 V:



To discover more

APPLICATION FINDER

Find the reference architecture tailored to your needs and speed up your project thanks to our new Application Finder Tool!

CONTACT US

Do you have a similar project and are you searching for the right Application configuration? Contact us and talk to our experts!

RATE US

Your opinion matters! Let us know if you found the document useful and how can we improve!

ABB S.p.A.
Electrification Business Area
Smart Power Division
5, Via Pescaria
I-24123 Bergamo - Italy
Phone: +39 035 395.111

new.abb.com/low-voltage

9AKK108467A8318 - 2023.03