TECHNICAL NOTE

Find your way around selectivity in Continuous Power

Site Planning Tool information

Keep your critical power installations running with reliable, clean and efficient uninterrupted power!

UPS is what you need to ensure the availability and continuity of power in your installation.
Switch to full protection to guarantee the functioning of your critical power installations and avoid compromising them in case of a fault downstream, with this guide through different types of selectivity.

Table of contents

What, why, how
Site Planning Tool

Find your way around different types of selectivity when adopting UPSs and circuit breakers **with our new Site Planning Tool:** a new datasheet where to find much useful information about selectivity, based on different types of UPSs and their working principles.

Achieve selectivity and keep your critical power installations running!

Are you searching for a way to protect the UPS's battery cabinet? The Site Planning tool will also guide you through the **selection of a DC breaker**, which is fundamental to protect the battery cabinet in case of a fault in between the cabinet and the inverter inside the UPS.

Read this guide **to easily navigate inside the Site Plannig tool** and discover the technicalities of the **engineering study** from which the data in the sheet were taken.

Site Planning Tool overview
Let's start from the beginning

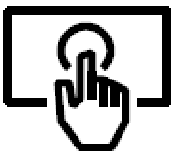
1

Find your way around different types of UPSs

Once you opened the tool, you can scroll down to the main menu on page 3, where different UPSs, in terms of technology and size, are listed.

Select the one that best reflects your needs from the list.

—
01
Site Planning tool choice interface



STANDALONE UPSs	MODULAR UPSs
PowerWave 33 S2	DPA 250 S4
PowerWave 33 S3	DPA 500
SG Series	PowerLine DPA
TLE Series	MegaFlex DPA
PowerScale	DPA UPScale ST/RI

DC PROTECTION

14 – 20 DC Protection selection

Note: UPSs are divided into **Standalone** and **Modular**. Scan the QR code to open the brochure of *Continuous Power in Data Centers - Selectivity in UPS networks,* to know more about Standalone and Modular UPSs.

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 in the picture below.

02
Example of table

UPS rated power [kVA]	Upstream CB Type QA1 (1)	Selectivity (2)	Downstream CB Type QA3 (3)	Selectivity with upstream bypass	Alternative downstream breaker QA3
1000	XT7 1600 Ekip 1600	Up to 120kA	XT5 630 Ekip 630	Total	
1250	E2.2 2500 Ekip 2500	Total	XT5 630 Ekip 630	Total	
1500	E4.2 3200 Ekip 3200	Total	XT7 1600 Ekip 1600	up to 29kA	XT5 630 Ekip 630 total selectivity

In the table, we've collected all the nominal characteristics of the selected UPS, together with all the relevant information about required circuit breakers to make it easier for you to match them together and achieve selectivity.

Highlight

Selectivity, what it is and why it is important

Overcurrent Selectivity means:
"Co-ordination of the operating characteristics of two or more over-current protective devices such that, on the inci-dence of over-currents within stated limits, the device in-tended to operate within these limits does so, while the oth-er(s) does (do) not". (IEC 60947-2 Paragraph 2.17).

Additionally, the achieved selectivity can either be:

- **Total** when "in the presence of two over-current protec-tive devices in series, the protective device on the load side affects the protection, without causing the other protective device to operate" (IEC 60947-2 Paragraph 2.17.2).
- **Partial** when "the protective device on the load side af-fects the protection up to a given level of overcurrent, without causing the other protective device to operate" (IEC 60947-2 Para-graph 2.17.3).

In **case of multiple loads fed by the UPS**, it is advisable to split the loads in different feeders, thus being protected by a smaller circuit breaker each instead of a bigger, general one. Doing so the selectivity level is extended to higher short circuit currents.

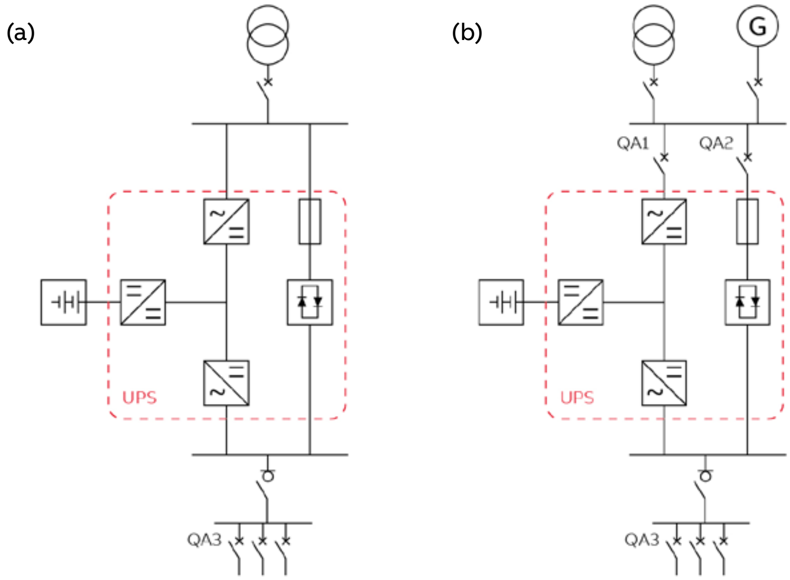
This type of electrical design explains why selectivity is usually required: having the loads split into different feed-ers increases the overall safety and continuity of operation of the whole installation. In fact, in case of a fault on a ge-neric load, only the involved circuit breaker will operate, sig-nificantly restricting the affected area.

In the Site Planning tool, under the columns "Selectivity" it is clearly stated the level of selectivity achieved and upon which value.

Site Planning Tool
The engineering study behind it

Selectivity with Standalone UPSs

The UPSs presented in the Site Planning tool are all designed with **Double Conversion mode**, whose typical scheme is shown in the below pictures.



03
Simplified diagram of a Double Conversion UPS with one (a) or two (b) input feeds

In **case of a fault condition at the load side downstream,** the UPS will rapidly **switch** from double conversion operating mode **to static bypass**, made of a thyristor bridge and a fuse or a thyristor bridge only, depending on the UPS model. The **selectivity** to be considered is the one **between the downstream circuit breaker and the fuse in the static bypass.**

In order 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.

For all the above considerations, the equations to verify selectivity between the downstream circuit breaker and the upstream fuse are the following:

Rule 1

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

Where:

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

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

k_1 = safety factor

Rule 3

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

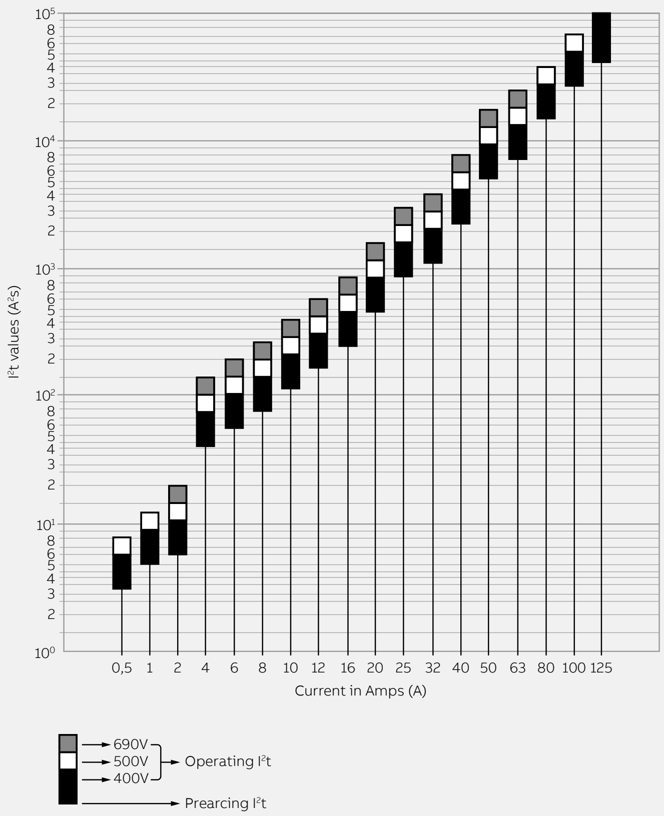
Where:

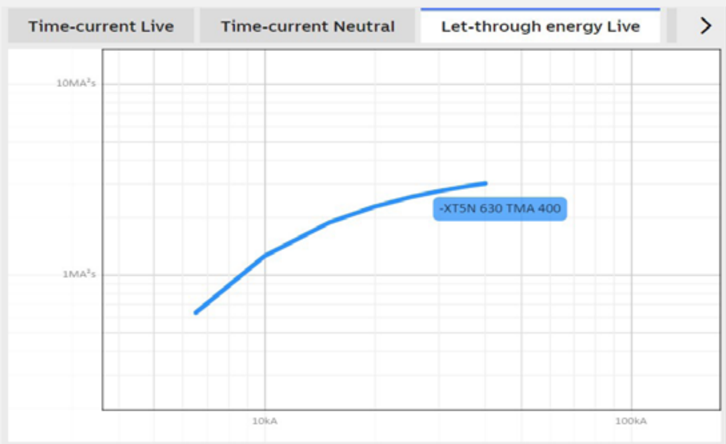
t_{CB} = tripping time of a circuit breaker for fault current equal to the circuit breaker's instantaneous trip threshold

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

04
Fuse let-through energy diagram

I2t Values - Class gG/gL





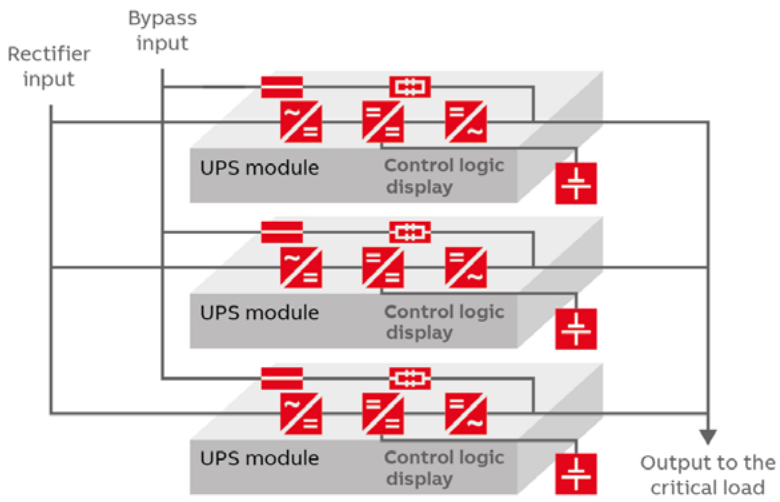
05
Circuit Breaker let-through energy diagram

Selectivity with Modular UPSs

ABB Modular UPSs are designed based on the **DPA** (**Decentralized Parallel Architecture) architecture**.

In the DPA architecture, each UPS module contains all the hardware and software required for **full UPS system operation**. Modules do not share any component and each module is a fully functional UPS. In this way, the DPA system is able to increase the system's reliability and maximize uptime. UPS modules are in parallel to provide redundancy or to increase the system's total capacity.

06
DPA architecture (the modules are totally inde-pendent from each other)



Coming back to 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

To verify selectivity between upstream fuses in parallel and downstream breakers, the following **rules** have been considered:

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.

For all the above considerations, the equations to verify selectivity between upstream fuses in parallel and downstream breakers are the following:

Rule 1

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

Where:

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

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

N = number of fuses in parallel

k_2 = safety factor

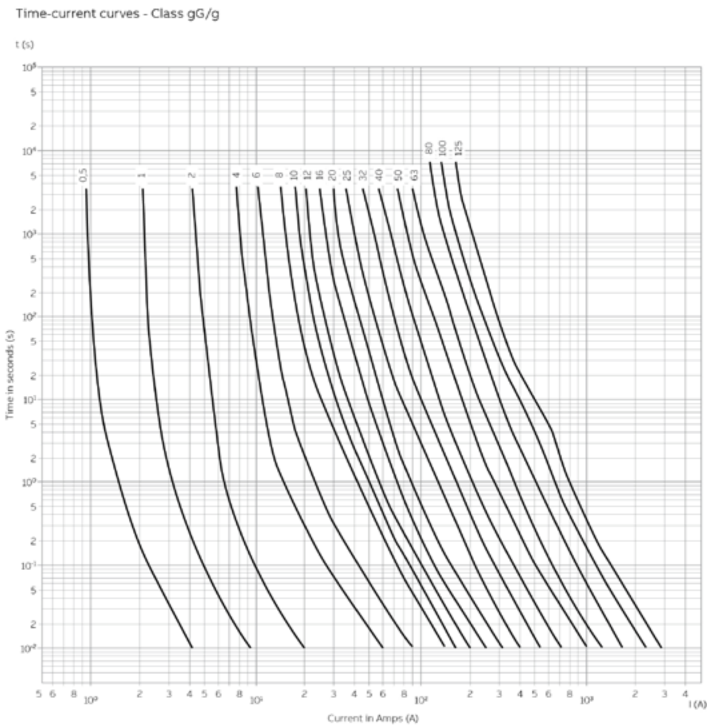
Rule 3

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

Where:

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

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



07
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 lower than the melting I2t of the downstream fuse, multiplied by the square value of the number of fuses in parallel.

For the above consideration, the equation to verify selectivity between the upstream 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

Example with DPA 250

The melting let-through energy of the 80A fuse used at the bypass circuit of the UPS module is 300000 A2s, as shown in Figure 06 and 07.

Let's now consider the UPS configuration with 6 modules in parallel, therefore the number of bypass fuses in parallel will be equal to 6.

To select an upstream coordinated device with downstream fuses in parallel, the equation (c) shall be verified with the following values:

$$melting\ I_F{}^2t = 300000\ \text{A}^2\text{s}$$

$$N = 6$$

Therefore:

$$I_{CB}{}^2t = 300000 * 6^2$$

$$I_{CB}{}^2t = 18000000$$

At this point, it is possible to verify the selectivity with an upstream moulded case circuit breaker, for example a XT6. From the catalog it is possible to check the let-through energy curve of the circuit breaker, working at 400V- 415V.
The same curve is available on the CurvesWEB software which you can find at this link. Alternatively, you can scan the below QR code.

Additional information

- Speaking about the Battery Mode of the UPS (in absence of a main power supply), commutation to Static Bypass is not possible. Each rectifier/ inverter module can sustain a short circuit current for a short while before getting damaged. In order to avoid this, the downstream breaker should trip for a short circuit within maximum inverter fault current and within the specified time.

- The coordination tables provided in the Site Planning tool were developed based on the engineering study, illustrated before. In this case, safety factors were implemented to guarantee that coordination (that you can find in the Site Planning tool) is working in total safety.

Circuit Breaker Selection for DC side Protection

Protect the battery cabinet of your UPS

Another function of the tool is to guide you through the **selection of a DC breaker**, for which you will find a dedicated section. Choosing the right DC breaker is fundamental if you want to protect the battery cabinet in case of a fault in between the cabinet and the inverter inside the UPS.

In the tool, you can find all the relevant information about the **number of poles required by each UPS**, as well as the **batteries' nominal characteristics** to observe, such as maximum DC voltage and maximum current output.

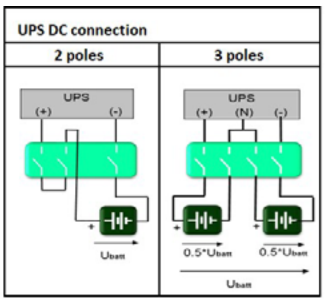
The study has been performed under the following **remarks**:

- DC side isolated from the ground
- Maximum breaking capacity to be selected according to prospective short circuit current of each case
- Circuit breaker size has been selected considering maximum voltage and maximum discharge current
- To be able to consider the fault between batteries and circuit breakers negligible, they shall be installed very close to each other.
- Ambient temperature not higher than +40°C
- Maximum discharge current refers to 1.7V/cell as battery cut off voltage
- Always refer to UPS TDS for details on the number of blocks vs autonomy and temperature

An example is shown in the figure below:

—
08
Example of DC table for PowerWavw 33 S3

UPS Series	UPS rated power [kW]	UPS number of poles	Circuit Breaker - 3P
PowerWave 33 S3	60	2	T4 250 TMA 160
PowerWave 33 S3	80	2	T4 250 TMA 200
PowerWave 33 S3	100	2	T4 250 TMA 250
PowerWave 33 S3	120	2	T5 400 TMA 320



—

ABB Ltd.
Affolternstrasse 44
CH-8050 Zurich
Switzerland

9AKK107992A9528 REV A 11.10.2021