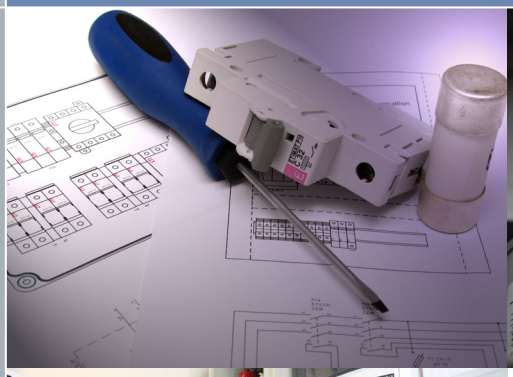
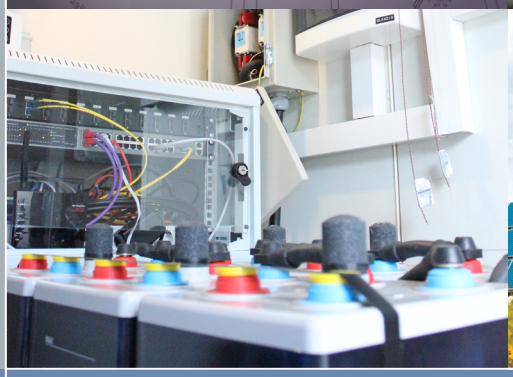
# SOLUTIONS



SOLUTIONS





ETI PROSTIK

PROSTIK

## What we do:

- We review your requirements,
- We provide a technical proposal,
- We offer technical assistance,
- We handle your order from start to finish,
- We sell our products.

We offer solutions for photovoltaic systems protection and battery storage system protection.

We provide drawings, layout and ready made distribution panels, distribution cabinets on customer's demand, solutions for reactive power compensation in industrial environments where the nature of the system load is very variable. We also offer overcurrent and overvoltage motor protection.

# Reactive Power Compensation

Let us help you reduce your energy costs

**Power factor correction is one of the best investments to reduce energy costs with a short payback. In a large number of cases, the design and dimensioning work has been made more difficult by the fact that, in a company´s internal low-voltage installation, and also in the medium-voltage supplying it, the proportion of network harmonics has grown increasingly over the last few years. Power converters, electronically controlled drives, static frequency converters, televisions and computers feed harmonic currents into the supply network. These harmonics might be amplified by the network impedances and capacitors installed. The freedom from harmonics also minimizes interference with other devices being powered from the same source.**

## Low voltage products for better power quality and improved network efficiency

**ETI Prostik power compensation equipment (enclosures) helps customers improve performance through energy savings and better power quality. With our products and solutions, customers save money and reduce the environmental impact of their operations.**

We offer a wide range of power compensation equipment for low voltage levels. We analyse your needs and engineer the right solutions for optimal efficiency and economy.

### Key Benefits

- Reduce harmonics
- Compact solutions
- Lower losses
- Improved Power Quality
- Money savings

**Visit our webpage to download Software for calculation and selection of appropriate reactive power compensation components.**

## Power factor

Power factor is a way of describing how efficiently electrical power is consumed.

Power factor correction shapes the input current of off-line power supplies to maximize the real power available from the mains. Ideally, the electrical appliance should present a load that emulates a pure resistor, in which case the reactive power drawn by the device is zero. Inherent in this scenario is the absence of input current harmonics - the current is a perfect replica of the input voltage (usually a sine wave) and is exactly in phase with it. In this case the current drawn from the mains is at a minimum for the real power required to perform the needed work, and this minimizes losses and costs associated not only with the distribution of the power, but also with the generation of the power and the capital equipment involved in the process.

Power factor correction is simply defined as the ratio of real power to apparent power, or:

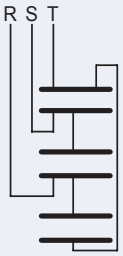
$$PF = \frac{\text{Real power (expressed in Watts)}}{\text{Apparent Power (expressed in VA)}}$$

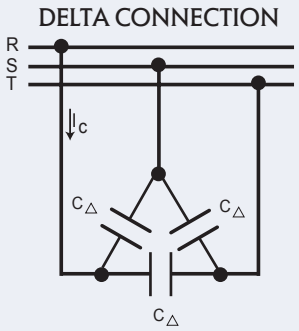
where the real power is the average, over a cycle, of the instantaneous product of current and voltage, and the apparent power is the product of the rms value of current times the rms value of voltage. If both current and voltage are sinusoidal and in phase, the power factor is 1.0. If both are sinusoidal but not in phase, the power factor is the cosine of the phase angle. In elementary courses in electricity this is sometimes taught as the definition of power factor, but it applies only in the special case, where both the current and voltage are pure sine waves. This occurs when the load is composed of resistive, capacitive and inductive elements and all are linear (invariant with current and voltage).

# MAIN COMPONENTS FOR REACTIVE POWER COMPENSATION

## Three phase low voltage power capacitors

DESCRIPTION
LPC capacitors are manufactured with low loss metallized self-healing polypropylene film. Dry type capacitors are filled with a nontoxic an ecological polyurethane resin, this resin provides an excellent heat dissipation properties. This capacitors are mounted in aluminium housing with overpressure disconnection system. Two types of connectors, faston connector for capacitors with rated power up to 5kVAr, for higher values above 5kVAr screw terminal type.




Advantages
- Self healing
- Overpressure disconnection system
- Discharge resistor

## Contactors for capacitor banks

DESCRIPTION
Contactors for capacitor switching were specially designed for power factor correction capacitor operation (utilization category AC-6b). They are pre-charged through resistors that reduce the peak current to the contactor when CEM_CN special contactors are switched on. After the pre-charge, the main contactors close allowing passage of rated current.

Advantages
- Mounting on DIN rails and on mounting plates
- Technical specification according to IEC 60947-4
- Built-in pre-charge resistors
- High reliability
- Reduced dimensions
- Standard control voltage 230V AC

Operating principle:
When capacitor bank being switched on, the capacitors are uncharged and the system sees them as a short circuit for a quick period of time. The in-rush current is the result of this little short circuit and usually lasts for a few milliseconds. It may reach 100 times the rated current, being one of the main reasons for the short life of a capacitor. The CEM CN contactor is assembled with damping resistors which limit the high in-rush current when the capacitors are switched on. They are assembled with an early-make contact block, which is switched on before the main contacts, thus, limiting the in-rush current.
However, the damping resistors don't influence the final load, since they are switched off after 5 milliseconds, leaving only the capacitors in parallel with your inductive load, providing the proper power factor correction. This process increases the lifetime of the capacitors and also prevents net distortions.

## Power factor controllers

DESCRIPTION
An essential way of electrical energy cost reduction is the compensation of the reactive power caused by various type of loads. The main part of central and group power factor correction in systems with a variable load is the power factor controller. A proper power factor controller and the correct design of PFC (Power factor correction) system are the key to the reduction of reactive energy costs. Nowadays, when four-quadrant energy meters are used, the right power factor controller is essential to achieve the highest efficiency of PFC system. Reliable, smart and advanced ETI controllers assure effective reduction of reactive energy and long working life of PFC systems.

Features
- monitoring of U, I, P, Q, S, cos , THDU, THDI, odd harmonics up to the 19th order, temperature

- three regulation methods (APFR default)
- small design 97 x 97 mm for pannel mounting, PFC 6 RS and PFC 8 RS
- automatic or manual configuration of measuring circuit connection
- automatic or manual detection of connected capacitor steps
- universal current transformer input ../1A and ../5A
- internal temperature sensor
- temperature levels for ventilator control and steps disconnection
- ready for applications with de-compensation reactor steps
- monitoring of switching operations and operation time
- setting of discharging and min. operation time for each step
- memory for min. and max. values
- discharging time and min. operation time setting for each step
- last step output programmable for alarm purposes
- second tariff activation by external input, PFC 12 RS only
- programmable alarms and independent alarm output at PFC 12 RS only


### Metal enclosures IP65

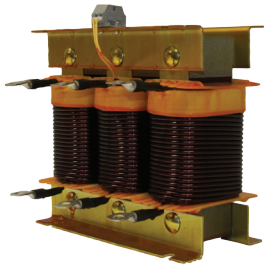
DESCRIPTION
GT-Type metal enclosures cover a wide range of applications both for industrial and civil buildings. Due to their design they provide high IP protection level, mechanical strength and functionality. They are used in places where electrical equipment is exposed to adverse effect of factors such as water, dust, mechanical impact.

Main advantages:
- Enclosures made of high quality sheet steel thicknesses from 1,2 mm to 2 mm, resistant to external mechanical factors - IK10.
- Specially profiled edges of the housing ensure stiffness and excellent protection against water. Poured polyurethane gasket on the door providing IP65 protection.
- Door opening in the contour of the outer casing, which allows direct linking of several enclosures in series - a special structure hinges. The door mounting on the left or right side.

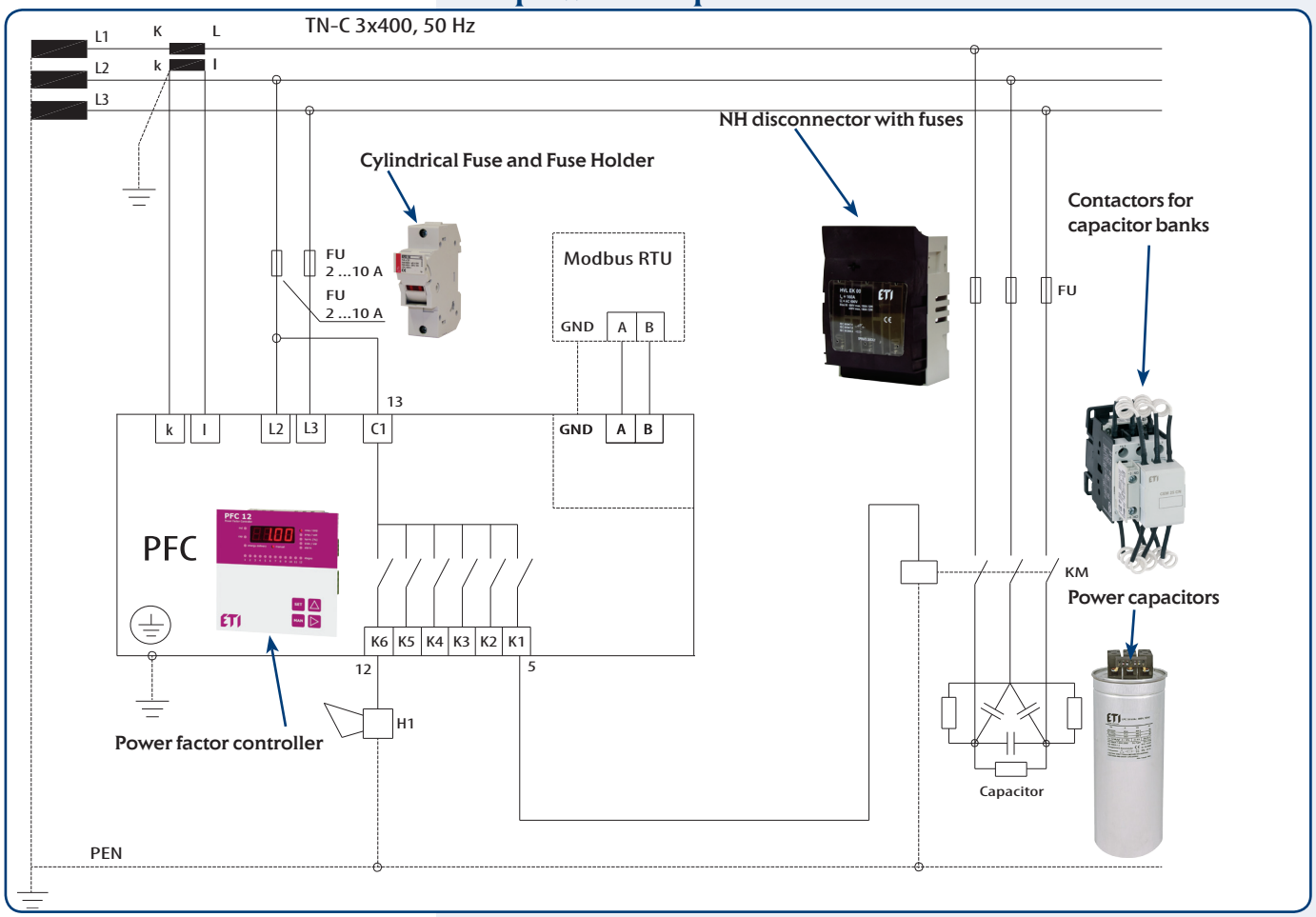
## Advanced Solutions

### Three-phase harmonic filters

Constructive Characteristics - Three phase harmonic filters are made of low losses magnetic plates, permanent regime class F (1550C) copper conductor and thermal protection relay.
With the purpose of increasing filters ventilation, windings are separated among them, improving thermal dissipation.
Available factor p is 7% and 14% with resonance frequency 189 Hz and 134 Hz for 50 Hz networks.
With this standard values in three phase networks and balanced loads, the 5th (250 Hz) harmonic and higher resonant phenomenons are eliminated avoiding resonance between inductive impedance and three phase capacitors for power factor correction and preventing network capacitors and capacitor banks for overloads, caused by harmonics.



## Inside a power compensation enclosure




## HOW TO DECIDE THE OPTIMUM LEVEL OF COMPENSATION?

### General method

Technical-economic optimization for an existing installation:
The optimum rating of compensation capacitors for an existing installation can be determined from the following principal considerations:

- Electricity bills prior to the installation of capacitors
- Future electricity bills anticipated following the installation of capacitors
- Costs of:
  - Purchase of capacitors and control equipment (contactors, relaying, cabinets, etc.)
  - Installation and maintenance costs
  - Cost of dielectric heating losses in the capacitors, versus reduced losses in cables, transformer, etc., following the installation of capacitors

### Simplified method

Method based on the calculation and the table as shown in the example below.

For any technical assistance, please contact our product manager:
e-mail: matjaz.bobnar@eti.si
tel: +386 (0)3 56 57 451

## EXAMPLE OF THE CALCULATION

We will look at an example automatic determination of compensation devices that can be used globally or just in a particular sector:

In the consumer with an installed power of 120 kW working with the current cos fi = 0,7. We want to improve on at 0,94.

If we do not have table 1 at hand the factor "k" is calculated as:

$k = tg\,\varphi_1 - tg\,\varphi_2 = 1{,}02 - 0{,}36 = 0{,}66$ (where $\varphi_1$ is obtained from the current cos$\varphi$, $\varphi_1$ is of desired).

Thus, we obtain the necessary reactive power compensation circuit (capacitor bank) $Q_{cb}$:

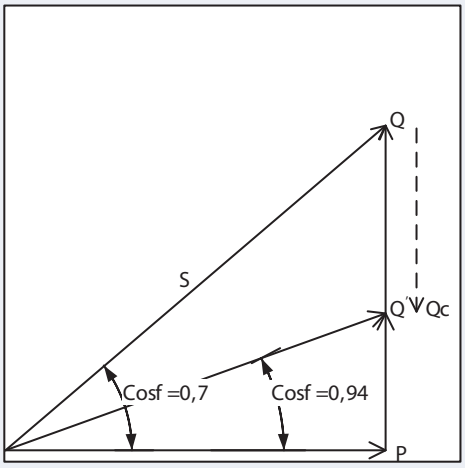
$Q_{cb} = P \cdot k = 120kW \cdot 0{,}66 = 79{,}2kVAr$

Using the table, the factor to be read at the intersection of the current and desired cos fi.

**Determination of the factor k**

| Existing power factor cos $\varphi_1$ | Desired power factor cos $\varphi_2$ | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0,7** | **0,75** | **0,8** | **0,82** | **0,84** | **0,86** | **0,88** | **0,9** | **0,92** | **0,94** | **0,95** | **0,96** | **0,98** | **1** |
| **0,2** | 3,88 | 4,02 | 4,15 | 4,20 | 4,25 | 4,31 | 4,36 | 4,41 | 4,47 | 4,54 | 4,58 | 4,61 | 4,70 | 4,90 |
| **0,25** | 2,85 | 2,99 | 3,12 | 3,17 | 3,23 | 3,28 | 3,33 | 3,39 | 3,45 | 3,51 | 3,54 | 3,58 | 3,67 | 3,87 |
| **0,3** | 2,16 | 2,30 | 2,43 | 2,48 | 2,53 | 2,59 | 2,64 | 2,70 | 2,75 | 2,82 | 2,85 | 2,89 | 2,98 | 3,18 |
| **0,35** | 1,66 | 1,79 | 1,93 | 1,98 | 2,03 | 2,08 | 2,14 | 2,19 | 2,25 | 2,31 | 2,34 | 2,38 | 2,47 | 2,68 |
| **0,4** | 1,27 | 1,41 | 1,54 | 1,59 | 1,65 | 1,70 | 1,75 | 1,81 | 1,87 | 1,93 | 1,96 | 2,00 | 2,09 | 2,29 |
| **0,45** | 0,96 | 1,10 | 1,23 | 1,29 | 1,34 | 1,39 | 1,44 | 1,50 | 1,56 | 1,62 | 1,65 | 1,69 | 1,78 | 1,98 |
| **0,5** | 0,71 | 0,85 | 0,98 | 1,03 | 1,09 | 1,14 | 1,19 | 1,25 | 1,31 | 1,37 | 1,40 | 1,44 | 1,53 | 1,73 |
| **0,52** | 0,62 | 0,76 | 0,89 | 0,94 | 1,00 | 1,05 | 1,10 | 1,16 | 1,22 | 1,28 | 1,31 | 1,35 | 1,44 | 1,64 |
| **0,54** | 0,54 | 0,68 | 0,81 | 0,86 | 0,91 | 0,97 | 1,02 | 1,07 | 1,13 | 1,20 | 1,23 | 1,27 | 1,36 | 1,56 |
| **0,56** | 0,46 | 0,60 | 0,73 | 0,78 | 0,83 | 0,89 | 0,94 | 1,00 | 1,05 | 1,12 | 1,15 | 1,19 | 1,28 | 1,48 |
| **0,58** | 0,38 | 0,52 | 0,65 | 0,71 | 0,76 | 0,81 | 0,86 | 0,92 | 0,98 | 1,04 | 1,07 | 1,11 | 1,20 | 1,40 |
| **0,6** | 0,31 | 0,45 | 0,58 | 0,64 | 0,69 | 0,74 | 0,79 | 0,85 | 0,91 | 0,97 | 1,00 | 1,04 | 1,13 | 1,33 |
| **0,62** | 0,25 | 0,38 | 0,52 | 0,57 | 0,62 | 0,67 | 0,73 | 0,78 | 0,84 | 0,90 | 0,93 | 0,97 | 1,06 | 1,27 |
| **0,64** | 0,18 | 0,32 | 0,45 | 0,50 | 0,55 | 0,61 | 0,66 | 0,72 | 0,77 | 0,84 | 0,87 | 0,91 | 1,00 | 1,20 |
| **0,66** | 0,12 | 0,26 | 0,39 | 0,44 | 0,49 | 0,54 | 0,60 | 0,65 | 0,71 | 0,78 | 0,81 | 0,85 | 0,94 | 1,14 |
| **0,68** | 0,06 | 0,20 | 0,33 | 0,38 | 0,43 | 0,48 | 0,54 | 0,59 | 0,65 | 0,72 | 0,75 | 0,79 | 0,88 | 1,08 |
| **0,7** | | 0,14 | 0,27 | 0,32 | 0,37 | 0,43 | 0,48 | 0,54 | 0,59 | 0,66 | 0,69 | 0,73 | 0,82 | 1,02 |
| **0,72** | | 0,08 | 0,21 | 0,27 | 0,32 | 0,37 | 0,42 | 0,48 | 0,54 | 0,60 | 0,63 | 0,67 | 0,76 | 0,96 |
| **0,74** | | 0,03 | 0,16 | 0,21 | 0,26 | 0,32 | 0,37 | 0,42 | 0,48 | 0,55 | 0,58 | 0,62 | 0,71 | 0,91 |
| **0,76** | | | 0,11 | 0,16 | 0,21 | 0,26 | 0,32 | 0,37 | 0,43 | 0,49 | 0,53 | 0,56 | 0,65 | 0,86 |
| **0,78** | | | 0,05 | 0,10 | 0,16 | 0,21 | 0,26 | 0,32 | 0,38 | 0,44 | 0,47 | 0,51 | 0,60 | 0,80 |
| **0,8** | | | | 0,05 | 0,10 | 0,16 | 0,21 | 0,27 | 0,32 | 0,39 | 0,42 | 0,46 | 0,55 | 0,75 |
| **0,82** | | | | | 0,05 | 0,10 | 0,16 | 0,21 | 0,27 | 0,34 | 0,36 | 0,41 | 0,49 | 0,70 |
| **0,84** | | | | | | 0,05 | 0,11 | 0,16 | 0,22 | 0,28 | 0,31 | 0,35 | 0,44 | 0,65 |
| **0,86** | | | | | | | 0,05 | 0,11 | 0,17 | 0,23 | 0,26 | 0,30 | 0,39 | 0,59 |
| **0,88** | | | | | | | | 0,06 | 0,11 | 0,18 | 0,21 | 0,25 | 0,34 | 0,54 |
| **0,9** | | | | | | | | | 0,06 | 0,12 | 0,15 | 0,19 | 0,28 | 0,48 |
| **0,92** | | | | | | | | | | 0,06 | 0,09 | 0,13 | 0,22 | 0,43 |
| **0,94** | | | | | | | | | | | 0,03 | 0,07 | 0,16 | 0,36 |

Graphical representation of the vectors of power before and after compensation:




Let's change is analytical, before correction:

$$Q = tg\,\varphi_1 \cdot P = 1{,}02 \cdot 120 = 122{,}42kVAr$$

Reactive power after compensation:

$$Q' = Q - Q_{cb} = 122{,}42kVAr - 79{,}2kVAr = 43{,}22kVAr$$

If you check cos fi after compensation:

$$\cos\varphi_1 = \frac{P}{S'} = \frac{P}{\sqrt{Q'^2 + P^2}} = \frac{120}{127{,}55} = 0{,}94$$

However, as reactive power varies (on and off devices), it is necessary to use automatic compensation device.



# Our Services

**Measuring:**
- Measuring Power Quality According to EN 50160,
- Energy Measurement

**Constructing:**
- low-voltage switching systems

**Manufacturing:**
- low-voltage compensation devices

**Setting up:**
- electrical power equipment, compensation devices

**Service of:**
- compensation devices

# Automatic Power Factor Correction Banks

| Technical data | |
|---|---|
| Power range | 20 - 700 kVAr |
| Rated voltage | 400 V, 50 Hz three-phase, other voltages on request |
| Capacity tolerance | 0 % to + 10 % |
| Overload capacity | 1,0 × Un permanent<br>1,1 × Un 8 hours per day<br>1,3 × In permanent |
| Temperature range | -25 °C to +50 °C |
| Dielectric losses | ≤ 0,2 W/kvar |
| Total losses of device | < 1,5 W/kvar |
| Level of mechanical protection | IP 20 |
| Colour | RAL 7032 |

**Type compensation**

| Power [kVar] | Program | Type | Composition | Connecting cable Cu [mm²] | Connecting fuses [A] | Sleeve |
|---|---|---|---|---|---|---|
| 20 | 1:3 | RPC 20kVAr_5+15 | 1x5+ 1x15 | 4 x 16 | 50 | PG21 |
| 30 | 1:2:3 | RPC 30kVAr_10+20 | 10+20 | 4 x 16 | 63 (80) | PG29 |
| 40 | 1:2.2 | RPC 40kVAr_2x10+20 | 2x10+20 | 3 x 25 | 100 | PG29 |
| 50 | 1:2:2 | RPC 50kVAr_10+2x20 | 10+2x20 | 3x35 | 125 | PG36 |
| 60 | 1:1:2:2 | RPC 60kVAr_2x10+2x20 | 2x10+2x20 | 3x50 | 125 | PG36 |
| 70 | 1:2:2:2 | RPC 70kVAr_10+3x20 | 10+3x20 | 3x70 | 160 | PG36 |
| 80 | 1:1:2:2:2 | RPC 80kVAr_2x10+3x20 | 2x10+3x20 | 3x70 | 160 | PG36 |
| 90 | 1:2:3:3 | RPC 90kVAr_10+20+2x30 | 10+20+2x30 | 3x95 | 200 | PG42 |
| 105 | 1:2:2:2 | RPC 105kVAr_15+3x30 | 15+3x30 | 2x3x50 | 250 | PG42 |

CUSTOM DESIGN: Other voltages (up to 1 MVAr) and ratings also available upon request.

Compensation from 10 to 50 kVAr -> Dimensions enclosures 800x400x250 (mm).
Compensation from 60 to 100 kVAr -> Dimensions enclosures 1000x800x300 (mm).

# Automatic Power Factor Correction Banks with Harmonic Filters

| Technical data | |
|---|---|
| Power range | 20 - 700 kVAr |
| Rated voltage | 460 V, 50 Hz three-phase, other voltages on request |
| Capacity tolerance | 0 % to + 10 % |
| Overload capacity | 1,0 × Un permanent<br>1,1 × Un 8 hours per day<br>1,3 × In permanent |
| Resonant frequency | 189 Hz (p= 7%) / 134 Hz (p=14%) / others on request |
| Temperature range | -25 °C to +50 °C |
| Dielectric losses | ≤ 5 W/kvar |
| Total losses of device | < 1,5 W/kvar |
| Level of mechanical protection | IP 20 |
| Colour | RAL 7032 |

**Type compensation available (examples)**

| Power [kVar] | Type | Composition | Connecting cable Cu [mm²] | Connecting fuses [A] | Sleeve |
|---|---|---|---|---|---|
| 20 | RPCF 20kVAr_5+15 | 1x5+ 1x15 | 4 x 16 | 50 | PG21 |
| 30 | RPCF 30kVAr_10+20 | 10+20 | 4 x 16 | 63 (80) | PG29 |
| 40 | RPCF 40kVAr_2x10+20 | 2x10+20 | 3 x 25 | 100 | PG29 |
| 50 | RPCF 50kVAr_10+2x20 | 10+2x20 | 3x35 | 125 | PG36 |
| 60 | RPCF 60kVAr_2x10+2x20 | 2x10+2x20 | 3x50 | 125 | PG36 |
| 70 | RPCF 70kVAr_10+3x20 | 10+3x20 | 3x70 | 160 | PG36 |
| 80 | RPCF 80kVAr_2x10+3x20 | 2x10+3x20 | 3x70 | 160 | PG36 |
| 90 | RPCF 90kVAr_10+20+2x30 | 10+20+2x30 | 3x95 | 200 | PG42 |
| 105 | RPCF 105kVAr_15+3x30 | 15+3x30 | 2x3x50 | 250 | PG42 |

CUSTOM DESIGN: Other voltages (up to 1 MVAr) and ratings also available upon request.

## REFERENCE



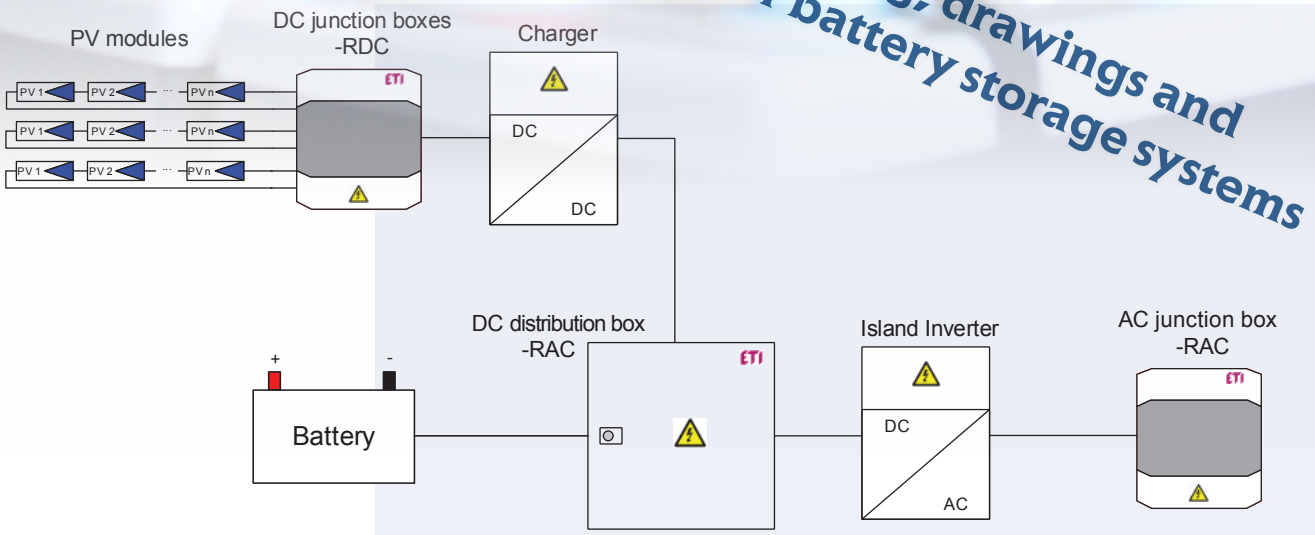




Our partners: AquafilSLO, EMO toolshop, OKK, Ultramarin, Energetika Maribor, Električar Split, Central waste water treatment plants Zagorje and Logatec

# Battery Storage Systems Protection

## Consulting, drawings and layout for battery storage systems




### Solutions for protection of

- battery storage systems
- UPS systems

### ETI solutions ensure your off-grid system safety

- Protection of battery connections to inverters by an external DC distributor
- Guaranteed all pole battery protection,
- Easy disconnection of battery bank from inverters.

### Customized to your needs

- Versions available for most inverters on the market,
- Up to six DC connections possible on the battery side,
- Connection of up to three inverters available
- for nominal voltages 12 / 24 / 48 V

### Our expertise, your safety

- All-pole battery protection,
- Cable protection,
- Very simple inverter disconnection

**Battery fuses protect the batteries and cables between batteries and inverters and allow easy isolation for installation or maintenance of the inverters.**

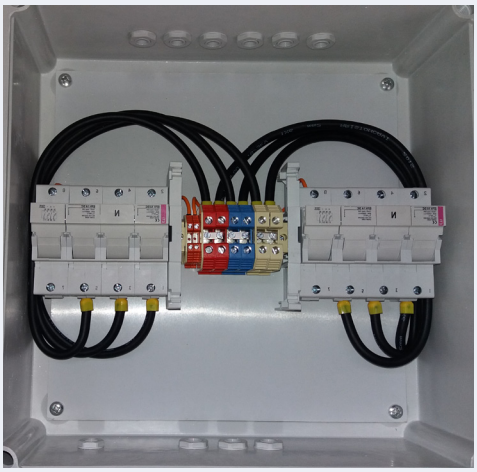
For smaller batteries cylindrical CH fuse links
and for larger batteries NH battery fuse links are used.


Versions for use with either one inverter or clusters of three.

## Battery Fuse/Breaker to Inverter

The wiring and fusing from the battery to an AC/DC inverter is of critical importance because this is where the most current will likely flow. Similar to the charge controller case, the recommended wire and fusing should be obtained from the inverter manual. It is very likely the invert already has a built in fuse/breaker on the input as well as the output (AC) side of the unit.

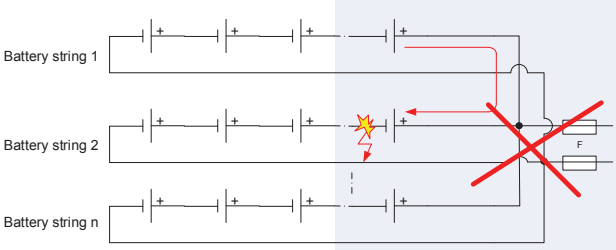
| Technical data | | | | | |
|---|---|---|---|---|---|
| **FUSE** | | | | | |
| **Type** | Cylindrical (CH) | | Knife-blade (NH) | | |
| **Bracket** | Fuse disconnector EFD 10 | Fuse disconnector EFD 14 | Fuse base PK 1 | Load disconnector switch HVL 1 | Load disconnector switch HVL 1 |
| **Number** | 2 | 2 | 6 | 2 | 6 |
| **ELECTRICAL DATA** | | | | | |
| **Nominal voltage** | 12 / 24 / 48 V | | | | |
| **Nominal current depending on the fuse plug** | 25 A | 40 / 50 / 63 / 80 / 100 / 125 / 160 / 200 / 224 / 250 A | | | |
| **CONNECTIONS FOR BATTERY** | | | | | |
| **Quantity per pole** | 2 | 2 | 4 | 3 | 6 |
| **Pipe cable lug** | M8 | | | | |
| **Max. Cross-section of the cable** | 2 x 70 mm$^2$ | | | | |
| **Outer diameter of the cable** | 14 – 21 mm | | | | |
| **MECHANICAL DATA** | | | | | |
| **Width x Height x Depth [mm]** | 270x180x170 | 360x360x170 | 540x360x170 | 360x360x170 | 540x360x170 |
| **AMBIENT CONDITIONS** | | | | | |
| **Ambient temperature** | -20° C... +60° C | | | | |
| **Humidity (no condensation)** | 100 % | | | | |
| **GENERAL DATA** | | | | | |
| **Protection rating** | IP 65 | | | | |
| **Mounting** | Wall mounting | | | | |

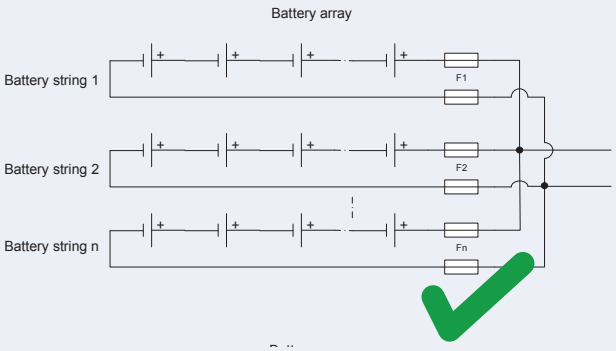


EFH 10 in EFH 14 DC Fuse holder have been developed to offer a compact, safety and economic protection solution in battery storage protection where due to the increase of the power and technologic evolution, no-load voltages above 800V DC can be achieved. Modular fuse holders for 10×38 & 14×51 battery fuses according IEC/EN 60269 standard.

4 pole fuse holder:
- first pole it's intended protecting the batteries + pole
- second pole (N) it contains a separator
- third pole it's intended protecting the batteries - pole
- fourth pole is for the signalization if the fuse holder open or closed.

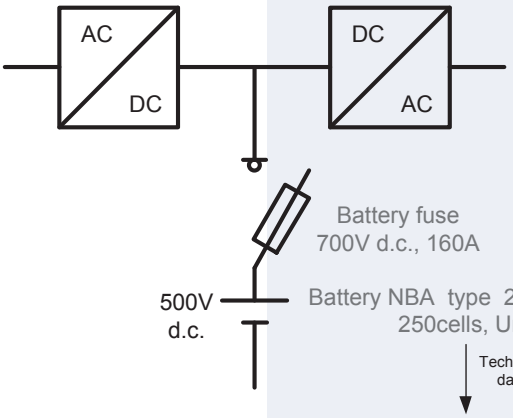
# The correct use of battery fuses




$P_W$=67,5kW

$t_E$= 20min (back-up time of storage system)

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1. Short circuit point ($I_k$):

**2. Types, capacities, dimensions, mass**

| Type | C10 | C5 | C3 | C1 | Ri 1) | Ik 2) | length | width | height max | mass 3) | mass 4) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ah | Ah | Ah | Ah | mΩ | kA | mm | mm | mm | kg | kg |
| Ue (V/cell) | 1,80 | 1,77 | 1,75 | 1,67 | | | | | | | |
| 2V 1 OPzS 50 | 50 | 45 | 36 | 24 | 3,96 | 0,58 | 103 | 206 | 426 | 4,5 | 7 |
| 2V 2 OPzS 100 | 100 | 85 | 69 | 48 | 1,98 | 1,16 | 103 | 206 | 426 | 7,5 | 6,5 |
| 2V 3 OPzS 150 | 150 | 125 | 102 | 72 | 1,27 | 1,74 | 103 | 206 | 426 | 10 | 6 |
| 2V 4 OPzS 200 | 200 | 170 | 138 | 96 | 1,01 | 2,06 | 103 | 206 | 426 | 12 | 6 |
| 2V 5 OPzS 250 | 250 | 210 | 171 | 120 | 0,81 | 2,57 | 124 | 206 | 426 | 14 | 7,5 |
| 2V 6 OPzS 300 | 300 | 250 | 204 | 144 | 0,69 | 3,14 | 145 | 206 | 426 | 16 | 9 |
| 6V 3 OPzS 150 | 150 | 125 | 107 | 75 | 3,71 | 1,62 | 233 | 224 | 426 | 23,5 | 13,5 |

1, 2) internal resistance and short - circuit - current according to IEC 896-1 3) dry-charged 4) filled and charged

$I_k$=580A

2. Operating point ($t_E$/$I_B$):

$t_E$ = 20min (1200s)

$U_E$= 250cells x 1,8V= 450V d.c.

$I_B = P_W/U_E$...67,5kW / 450V = 150A

3. DC rated fuse link:

Battery fuse 700V d.c., L/R=10ms

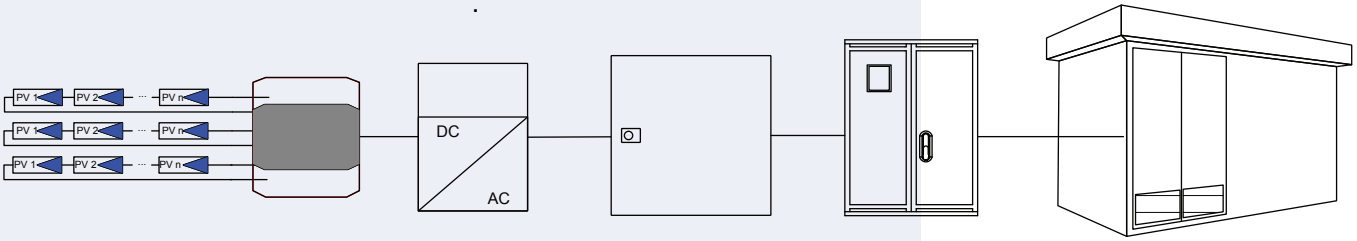
NH00 gG 160A 690V a.c.....problem DC rating at min. breaking capacity ~ 2xIn ???

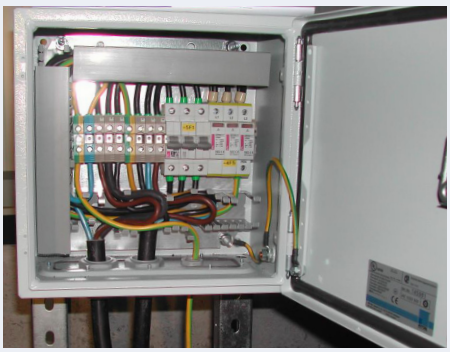
# Protection of Photovoltaic Systems

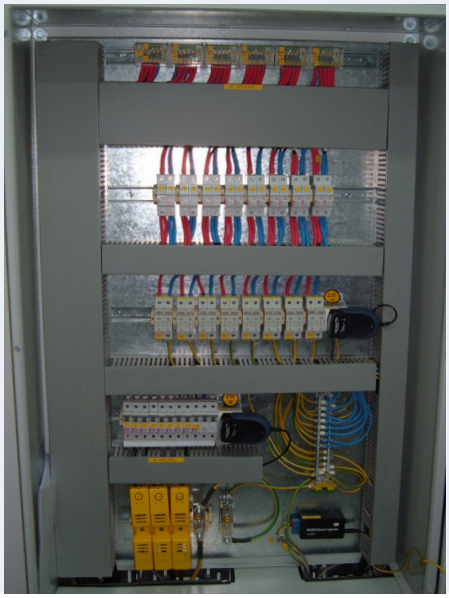
**ETI provides high-quality solutions for the complete overcurrent and overvoltage protection of applications in the field of photovoltaic and other renewable energy sources. We provide PV design, engineering and consulting services.**

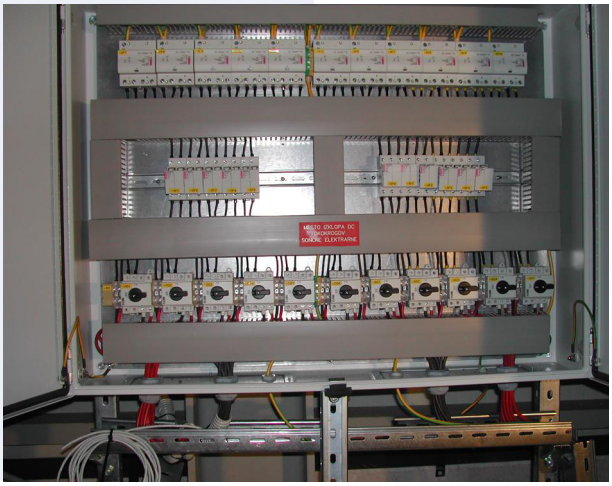
Our products are designed for complete protection of:
- DC circuits (overvoltage and reverse current protection)
- circuits inside DC/AC inverters (semiconductor protection)
- AC circuits between the inverter and the power grid (overvoltage, overcurrent and anti-islanding protection) and all protection for Meter distribution cabinet.

The products are internationally certified and carry several quality marks.

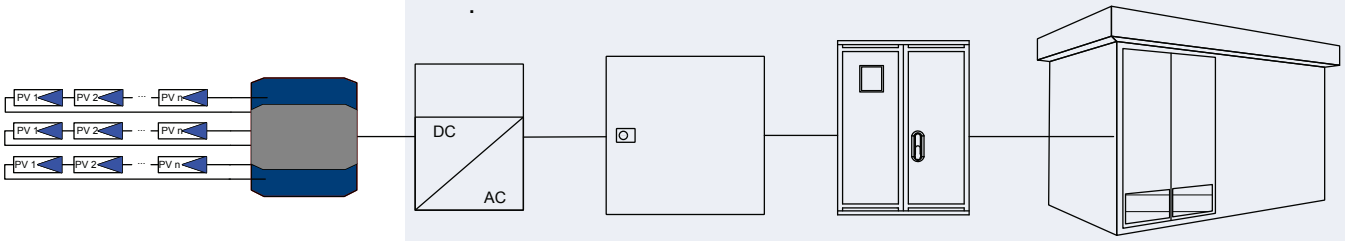






# DC - distribution and protection




## Protection on the DC side of a PV system

The direct current section of a typical photovoltaic system consists of a generator formed by the parallel of the strings of solar panels connected in series.

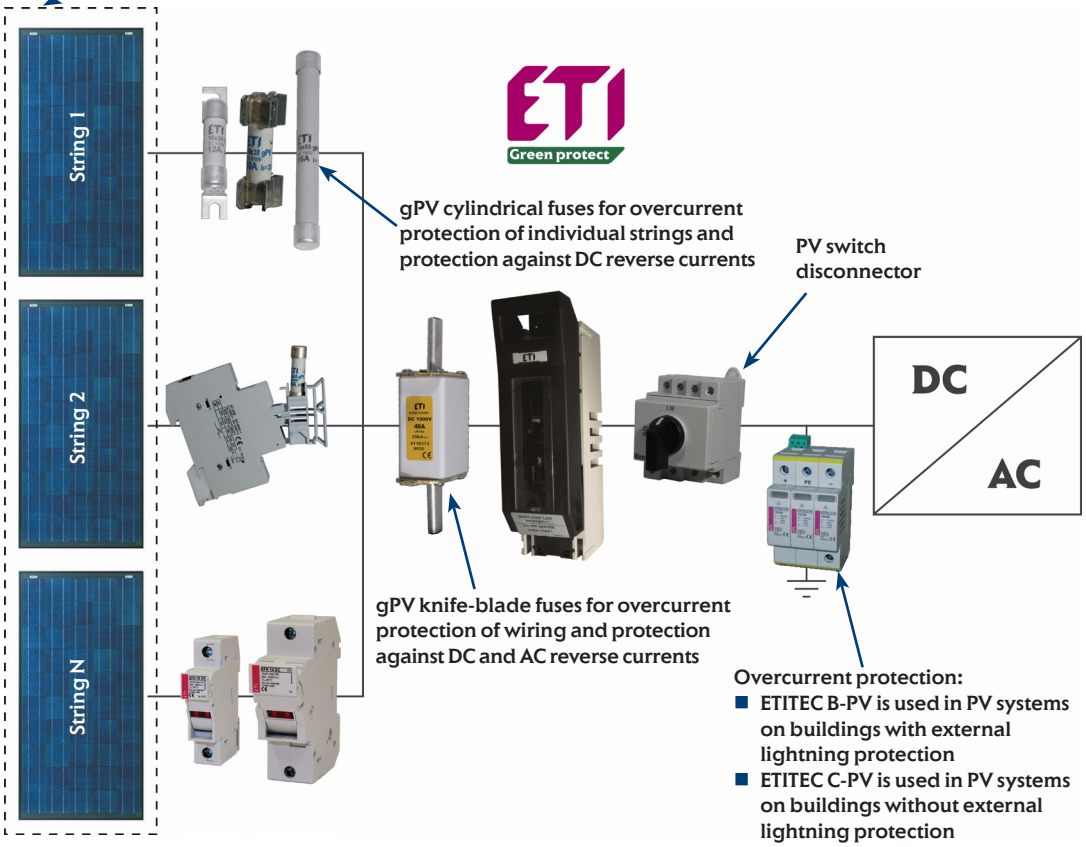
Along with the specific characteristic of the solar modules (inability to shut off the voltage other than by obscuring the solar panels and generation, by the strings, of short-circuit currents with values very near to those produced in normal conditions), the presence of voltage as high as 300-600 V d.c. and beyond requires a very careful assessment of the protection and isolating devices, which must be able to suppress direct fault currents under high voltages within a very short time.

## Features of ETI junction boxes

- Easy to install and operate,
- Short mounting times,
- Ample wiring space



## Inside a PV array junction box



## Overview of Array Protection

Depending on the desired capacity of the Photovoltaic (PV) system, there may be several PV sub-arrays (each subarray consists of multiple strings) connected in parallel to achieve higher currents and subsequently more power. A fuse link on each sub-array will protect the conductors from fault current and help minimise any safety hazards. It will also isolate the faulted sub-array so that the rest of the PV system can continue to generate electricity.

## Overview of String Protection

Depending on the desired capacity of the Photovoltaic (PV) system, there may be several PV strings connected in parallel to achieve higher currents and subsequently more power.
PV systems that have three or more strings connected in parallel need to have each string protected. Systems that have less than three strings will not generate enough fault current to damage the conductors, equipment or modules. Therefore they do not present a safety hazard, provided the conductor is sized correctly, based on local codes and installations requirements.
Where three or more strings are connected in parallel, a fuse link on each string will protect the conductors and modules from overcurrent faults and help minimise any safety hazards. It will also isolate the faulted string so that the rest of the PV system can continue to generate electricity. It should be remembered that PV module output changes with the module temperature as well as the amount of sun it is exposed to. The exposure is dependant on irradiance level, incline as well as shading effect from trees/buildings or clouds. In operation, fuse links, as thermal devices, are influenced by ambient temperature.

## String protection against reverse currents

When the installation layout includes centralized conversion with the use of a single inverter, the strings must be protected against reverse current. This could circulate after faults or temporary unbalances in the system due, for example, to certain of the solar modules being partially in the shade or covered by snow, leaves, etc.

## Fuses

ETI gPV fuses protect the installation against the inverse over-currents which could occur in photovoltaic installations.

| General characteristics | UL file: E347771 |
|---|---|
| Rated voltage | 1000V d.c. L/R=2ms |
| Breaking capacity | 10kA d.c. / 30kA d.c. |
| Standards | UL 2579, UL 248-1 |
| Application | For protection of PV modules. |

## Lightning and Surge Arresters

ETITEC B-PV series of overvoltage surge protective devices has been developed to protect against direct and indirect lightning discharges and is intended to protect photovoltaic systems. The circuit topology consist of two varistors stages each protected by a thermal disconnection device. ETITEC B-PV is used for photovoltaic systems on buildings with External Lightning Protection

ETITEC C-PV series of overvoltage surge protective devices has been developed to protect against indirect discharges and is intended to protect photovoltaic systems. The circuit topology consist of two (three) varistors stages each protected by a thermal disconnection device. ETITEC C-PV is used for photovoltaic system on buildings without External Lightning Protection or when the inverter is installed at a distance of more than 10 m cable length to the building's main power distribution.

| General characteristics | | |
|---|---|---|
| | ETITEC B-PV | ETITEC C-PV |
| Category IEC/EN/VDE | Class I, II/Type 1,2/B+C<br>High surge discharge ratings:<br>$I_{imp}$ = 12,5kA/per pole, $I_{max}$ = 40kA/per pole | Class II/Type 2/C<br>High surge discharge ratings:<br>$I_{in}$ = 20kA/per pole, $I_{max}$ = 40kA/per pole |
| Location of use: | Photovoltaic systems- PV module side<br>Internal protection and safety:<br>Separate thermal disconnector for each MOV block | Branch sub-distribution boards<br>Internal protection and safety:<br>Thermal disconnector for each MOV block |
| Protective element :<br>High Energy MOVs | Status indication:<br>Mechanical flag + remote signalization contacts (RC) | |

## PV switch disconnector

The construction of the switch ensures reliable switching up to 58A with 1000V in the category DC 21B.
The construction of the contacts and the material selection guarantee that no oxidation (small switching frequency develops, and is thus prevented inadmissible heating-up.
The switch disconnector has 2, 4 or 4+2 contacts, by serial / parallel wiring of the contacts the contact rating will be increased.

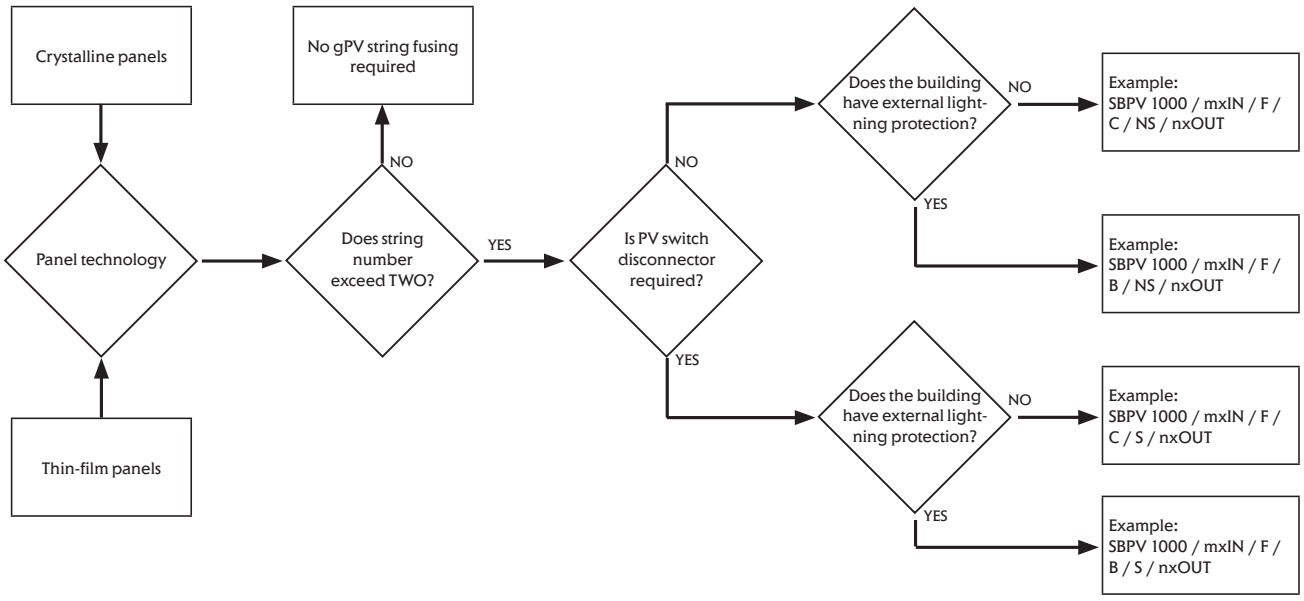
The switching speed at the manually operated handle does not have an effect on the switching attitude of the contacts.

## Enclosures

- Fibreglass reinforced polyester (GRP/SMC) rear back panel - Light grey colour RAL 7035
- Polycarbonate cover, 2 versions : transparent or opaque, UV stabilized
- High Insulation rating IP66 and impact resistance IK10
- Big range of accessories : viewing windows, mounting plates, cable entry flanges, hinges, screws, wall mounting brackets, depth extensions, ventilation devices, etc
- Most complete range of sizes in the market : 24 different sizes, each one of them available on 2 different versions, transparent or opaque cover
- Modularity: Used as an individual enclosure or connected together to build up complete Low-Voltage switchgear and control gear panels

| General characteristics | | |
|---|---|---|
| Description | Rating | Standard |
| Fibreglass reinforced polyester Enclosure (GRP) | RAL-7035 colour | IEC 62208 |
| Polycarbonate Cover | UV Stabilized | IEC 62208 |
| Double Insulation | Halogen Free | IEC 60439-1 |
| Mechanical (Impact) Resistance | IK10 | IEC-62262 |
| Protection against dust-water | IP-66 | IEC-60529 |
| Thermal Class | A | UNE-21305 |
| Self extinguishing material | 960ºC | IEC 60695-2 |
| Temperature Range | -30ºC +60ºC | IEC 60670 |
| Current Rating | 1,000A | IEC 60439-5 |
| Dielectric Strength | 5,000V | IEC 60439-5 |
| Insulation Rating | 5MΩ | IEC 60439-5 |

## How to choose correct protection for PV junction boxes

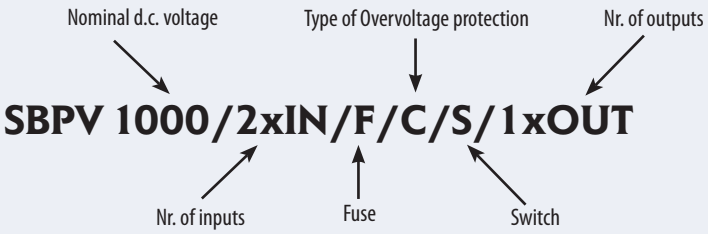


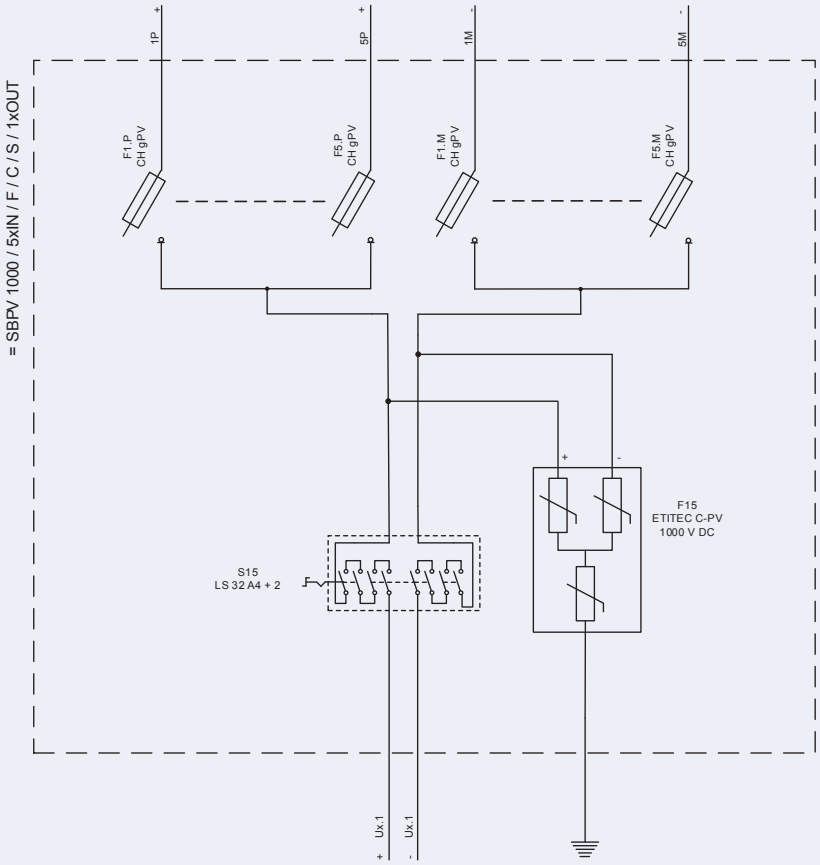
# Standard junction box 1 x OUTPUT

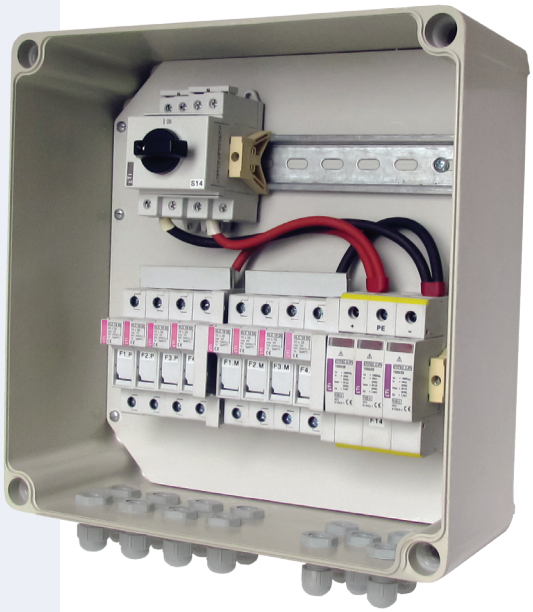
| 1 x OUTPUT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Max. U | Overvoltage protection | Inputs | Switch | Designation | Code No. | Max. I [A] | Dimensions WxHxD [mm] |
| 1000 V d.c. | B | 2 | × | SBPV 1000 / 2xIN / F / B / NS / 1xOUT | 001110000 | 25 | 270x180x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / B / S / 1xOUT | 001110001 | 25 | 270x180x170 |
| | | 3 | × | SBPV 1000 /3xIN / F / B / NS / 1xOUT | 001110004 | 25 | 270x180x170 |
| | | | ✓ | SBPV 1000 /3xIN / F / B / S / 1xOUT | 001110005 | 25 | 270x180x170 |
| | | 4 | × | SBPV 1000 /4xIN / F / B / NS / 1xOUT | 001110008 | 32 | 270x180x170 |
| | | | ✓ | SBPV 1000 /4xIN / F / B / S / 1xOUT | 001110009 | 32 | 360x360x170 |
| | | 5 | × | SBPV 1000 /5xIN / F / B / NS / 1xOUT | 001110012 | 58 | 360x360x170 |
| | | | ✓ | SBPV 1000 /5xIN / F / B / S / 1xOUT | 001110013 | 58 | 360x360x170 |
| | C | 2 | × | SBPV 1000 / 2xIN / F / C / NS / 1xOUT | 001110002 | 25 | 270x180x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / C / S / 1xOUT | 001110003 | 25 | 270x180x170 |
| | | 3 | × | SBPV 1000 /3xIN / F / C / NS / 1xOUT | 001110006 | 25 | 270x180x170 |
| | | | ✓ | SBPV 1000 /3xIN / F / C / S / 1xOUT | 001110007 | 25 | 270x180x170 |
| | | 4 | × | SBPV 1000 /4xIN / F / C / NS / 1xOUT | 001110010 | 32 | 270x180x170 |
| | | | ✓ | SBPV 1000 /4xIN / F / C / S / 1xOUT | 001110011 | 32 | 360x360x170 |
| | | 5 | × | SBPV 1000 /5xIN / F / C / NS / 1xOUT | 001110014 | 58 | 360x360x170 |
| | | | ✓ | SBPV 1000 /5xIN / F / C / S / 1xOUT | 001110015 | 58 | 360x360x170 |

- 2 - 5 x PV string inputs
- 1 x output
- 1 x DC type B or C surge arrester
- Suitable for outdoor installation, UV resistant
- Current per PV string: DC 9,5 A max.
- Maximum voltage DC 1000 V
- Equipped with cable glands
- Option for connection with plug-in connectors compatible to MC4,
- Rated connecting capacity PE: 1,5 - 16 mm²

## Type designation:



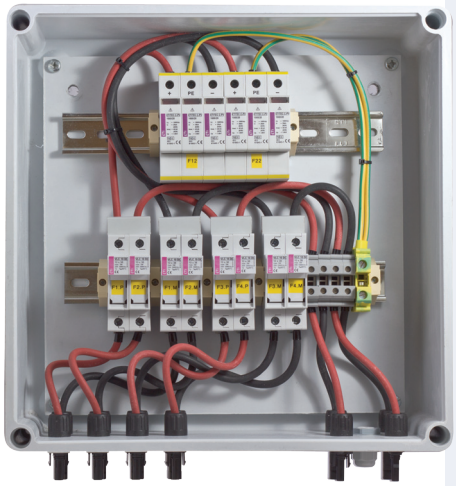



# Standard junction box 2 x OUTPUTS

- 1-5 x PV string inputs
- 2 x outputs
- 2 x DC type B or C surge arrester
- Suitable for outdoor installation, UV resistant
- Current per PV string: DC 9,5 A max.
- Maximum voltage DC 1000 V
- Equipped with cable glands
- Option for connection with plug-in connectors compatible to MC4,
- Rated connecting capacity PE: 1,5 - 16 mm²

| 2 x OUTPUTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Max. U | Overvoltage protection | Inputs | Switch | Designation | Code No. | Max. I [A] | Dimensions WxHxD [mm] |
| 1000 V d.c. | B | 2 | × | SBPV 1000 / 2xIN / F / B / NS / 2xOUT | 001110016 | 25 | 360x360x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / B / S / 2xOUT | 001110017 | 25 | 360x360x170 |
| | | 3 | × | SBPV 1000 / 3xIN / F / B / NS / 2xOUT | 001110020 | 25 | 360x360x170 |
| | | | ✓ | SBPV 1000 / 3xIN / F / B / S / 2xOUT | 001110021 | 25 | 540x360x170 |
| | | 4 | × | SBPV 1000 / 4xIN / F / B / NS / 2xOUT | 001110024 | 32 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 4xIN / F / B / S / 2xOUT | 001110025 | 32 | 540x360x170 |
| | | 5 | × | SBPV 1000 / 5xIN / F / B / NS / 2xOUT | 001110028 | 58 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 5xIN / F / B / S / 2xOUT | 001110029 | 58 | 540x360x170 |
| | C | 2 | × | SBPV 1000 / 2xIN / F / C / NS / 2xOUT | 001110018 | 25 | 360x360x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / C / S / 2xOUT | 001110019 | 25 | 360x360x170 |
| | | 3 | × | SBPV 1000 / 3xIN / F / C / NS / 2xOUT | 001110022 | 25 | 360x360x170 |
| | | | ✓ | SBPV 1000 / 3xIN / F / C / S / 2xOUT | 001110023 | 25 | 360x360x170 |
| | | 4 | × | SBPV 1000 / 4xIN / F / C / NS / 2xOUT | 001110026 | 32 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 4xIN / F / C / S / 2xOUT | 001110027 | 32 | 540x360x170 |
| | | 5 | × | SBPV 1000 / 5xIN / F / C / NS / 2xOUT | 001110030 | 58 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 5xIN / F / C / S / 2xOUT | 001110031 | 58 | 540x360x170 |

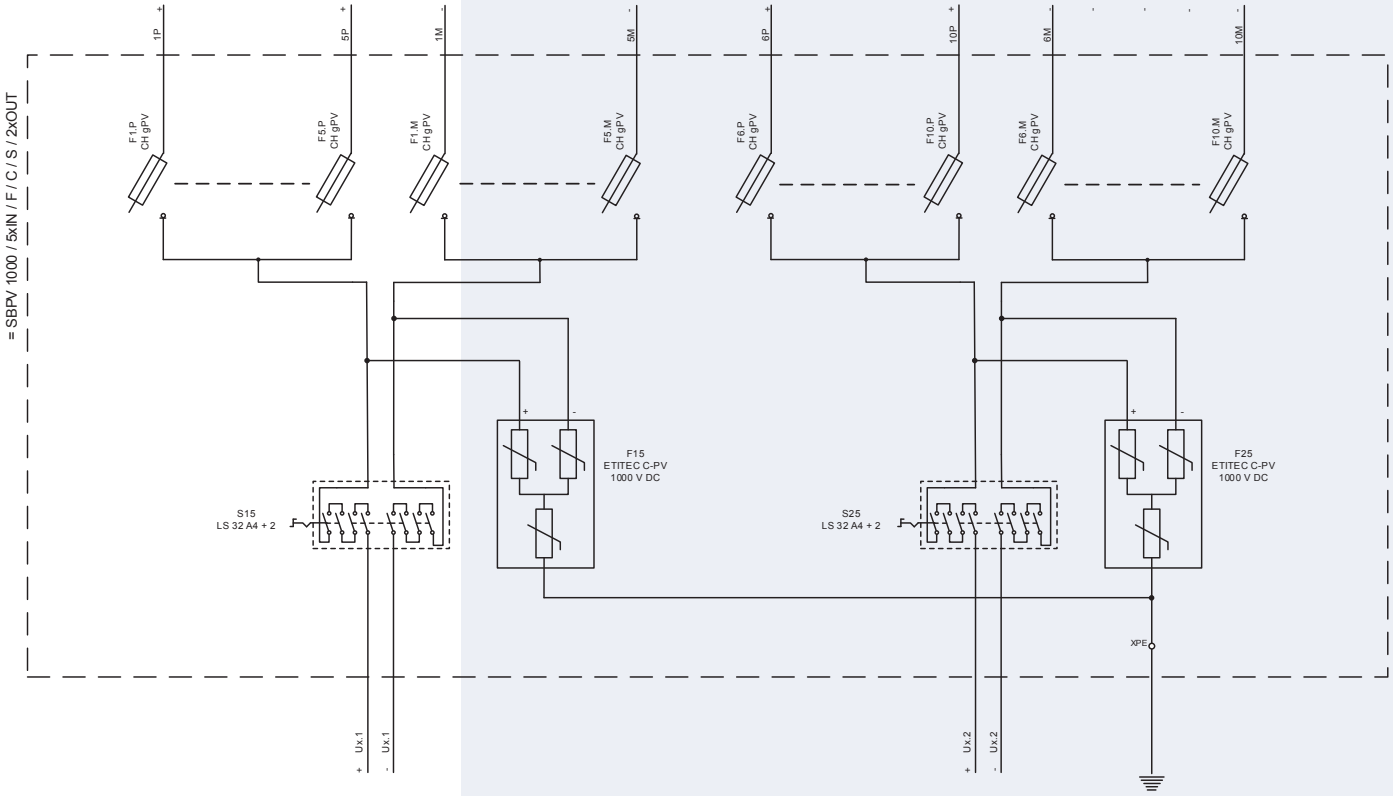


## Type designation:

Nominal d.c. voltage — Type of Overvoltage protection — Nr. of outputs

**SBPV 1000/2xIN/F/C/S/2xOUT**

Nr. of inputs per output — Fuse — Switch

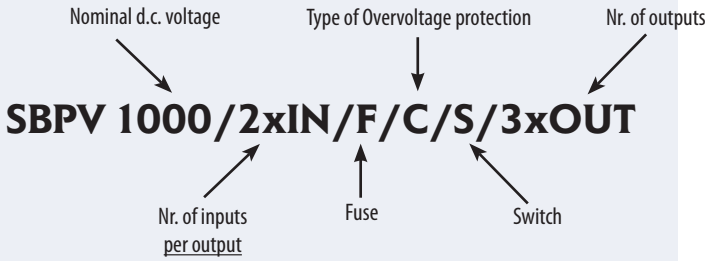


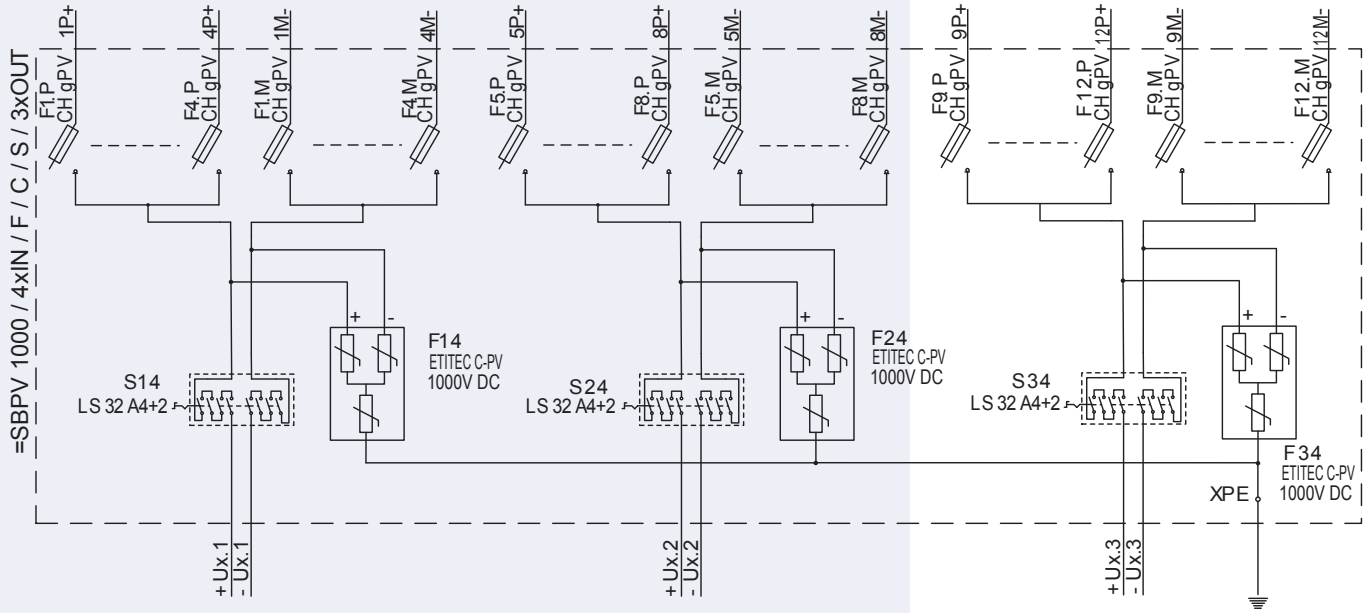
# Standard junction box 3 x OUTPUTS

| 3 x OUTPUTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Max. U | Overvoltage protection | Inputs | Switch | Designation | Code No. | Max. I [A] | Dimensions WxHxD [mm] |
| 1000 V d.c. | B | 2 | × | SBPV 1000 / 2xIN / F / B / NS / 3xOUT | 001110032 | 25 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / B / S / 3xOUT | 001110033 | 25 | 540x360x170 |
| | | 3 | × | SBPV 1000 / 3xIN / F / B / NS / 3xOUT | 001110036 | 25 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 3xIN / F / B / S / 3xOUT | 001110037 | 25 | 540x360x170 |
| | | 4 | × | SBPV 1000 / 4xIN / F / B / NS / 3xOUT | 001110040 | 32 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 4xIN / F / B / S / 3xOUT | 001110041 | 32 | 540x360x170 |
| | C | 2 | × | SBPV 1000 / 2xIN / F / C / NS / 3xOUT | 001110034 | 25 | 360x360x170 |
| | | | ✓ | SBPV 1000 / 2xIN / F / C / S / 3xOUT | 001110035 | 25 | 540x360x170 |
| | | 3 | × | SBPV 1000 / 3xIN / F / C / NS / 3xOUT | 001110038 | 25 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 3xIN / F / C / S / 3xOUT | 001110039 | 25 | 540x360x170 |
| | | 4 | × | SBPV 1000 / 4xIN / F / C / NS / 3xOUT | 001110042 | 32 | 540x360x170 |
| | | | ✓ | SBPV 1000 / 4xIN / F / C / S / 3xOUT | 001110043 | 32 | 540x360x170 |

- 1-4 x PV string inputs
- 3 x ouputs
- 3 x DC type B or C surge arrester
- Suitable for outdoor installation, UV resistant
- Current per PV string: DC 9,5 A max.
- Maximum voltage DC 1000 V
- Equipped with cable glands
- Option for connection with plug-in connectors compatible to MC4,
- Rated connecting capacity PE: 1,5 - 16 mm²

Type designation:



# Non - standard solutions (upon customer's request)

**In addition to our standard junction boxes we can also provide customized superior solutions, tailored to the needs of our customers.**

## DC junction boxes for large grid-connected photovoltaic power systems

We can prepare drawings, layout and ready made DC junction boxes for large PV plants, incorporating our groundbreaking knife-blade fuses.

**Advantages of ETI NH gPV fuses:**

- Breaking capacity up to 1500 VDC
- Product dedicated to PV installations
- Operating ranges adjusted for small over-currents specific to PV installations.
- High reliability
- Absolute protection over time guaranteed by the simplicity of manufacture and function (Joule effect).
- No downgrading of fuse characteristics over time.

## DC junction boxes with superior safety and durability

We can offer solutions adhering to the new standard EN50539-11 with increased safety when disconnecting DC current in case of thermal overload and prolonged durability.


**Advantages of ETITEC S Series:**

- Current limiting for long duration; overvoltage path through mov – no degradation, long life guaranteed
- Improved thermal disconnection mechanism - rotating barrier, secure arcing shutdown, no risk of fire

## DC junction boxes with additional protection of surge arresters

Varistors inside surge arresters may degrade over time due to repeated lightning strikes, overheating etc. which in turn may cause short-circuiting and explosion of the arrester. To prevent this, special cylindrical SRF fuses are used that provide overcurrent protection of the arrester.

**Features of ETI SRF fuses:**

- Rated voltage 600V a.c. (8/20 µs) or 400V a.c. (10/350 µs)
- Breaking capacity 200 kA (8/20 µs) or 50kA (10/350 µs)
- Available in Surge Ratings from 10 kA to 40 kA (8/20 µs) and 25 kA (10/350 µs)
- Designed to meet UL1449 Second Edition requirements,
- Comply with the applicable requirements in UL 248-1

## Fault and additional protection against smooth DC and high frequency AC residual currents

Smooth DC currents and high frequency AC currents frequently occur in small photovoltaic plants on the roofs of family houses, because inverters in these PV systems are usually without insulating transformers . The problem with fault and additional protection of such installations is that A-type RCCBs do not detect smooth DC residual currents and may even become "blinded" by them, causing them to fail completely. The solution, according to IEC/EN 62423 standard is the new universal RCCB B-type, which is an upgrade of A-type RCCB with an additional current transformer, sensitive to smooth DC residual currents and also high frequency AC currents.

**Features of EFI B and B+ type RCCB:**

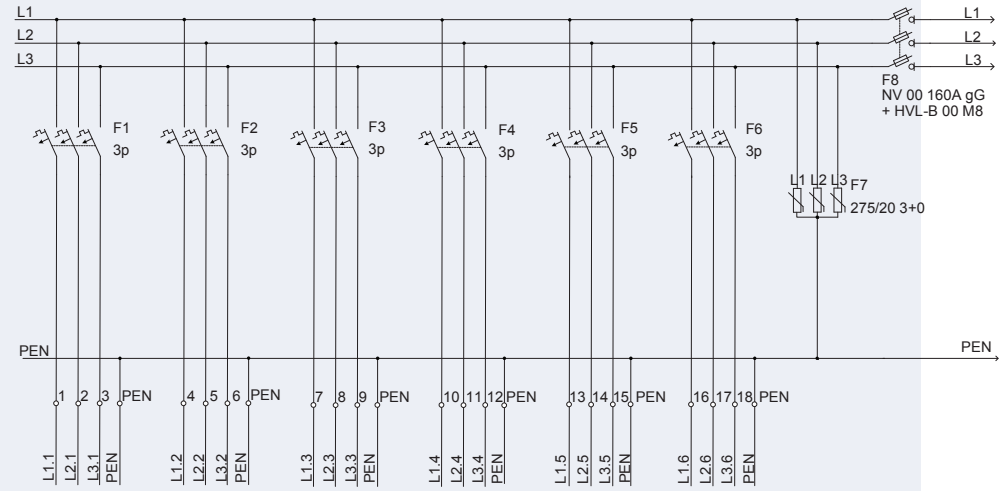
- Fault protection (protection against indirect contact of live parts) against smooth DC and high frequency AC residual currents
- Additional protection (protection in case of direct contact of live parts, $I_{\Delta n} \leq 30mA$) against smooth DC and high frequency AC residual currents
- Fire Protection (for locations exposed to fire hazard) against smooth DC and high frequency AC residual currents

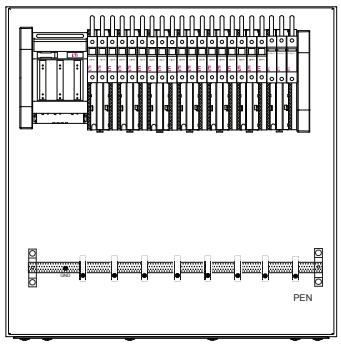
# AC - distribution and protection

## AC Photovoltaic installations require different protection than ordinary residential installations

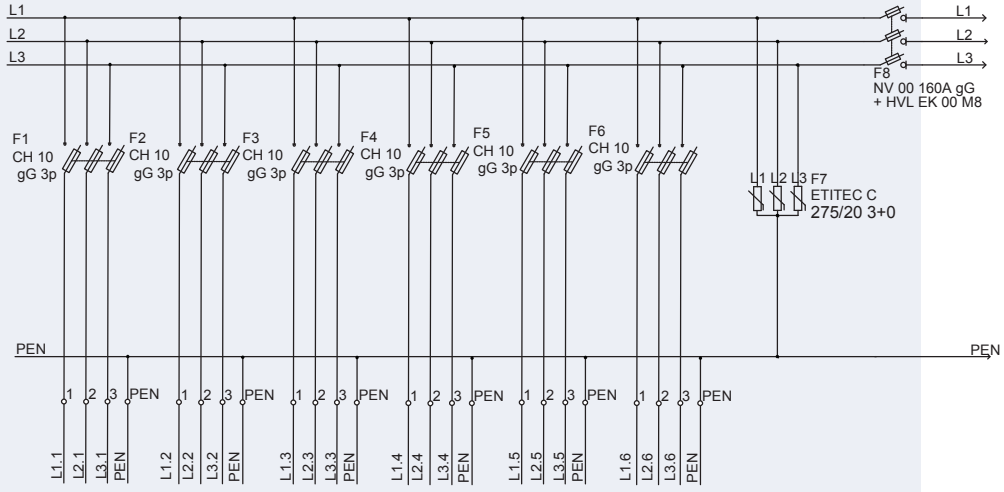
- Overcurrent protection must be determined according to the respective load of the solar inverter on the AC side
- Distribution boards in PV installations must not be dimensioned simply according to the number of consumers (as is the case with ordinary residential installations, where simultaneity factor is low), but you need to take into account wider cable cross-sections, higher rated currents etc.
- High power dissipation, as a result of constant high loads, is typical for PV installations and needs to be reduced below the maximum operating temperature of individual devices (larger enclosures, setting devices further apart to allow air circulation etc).

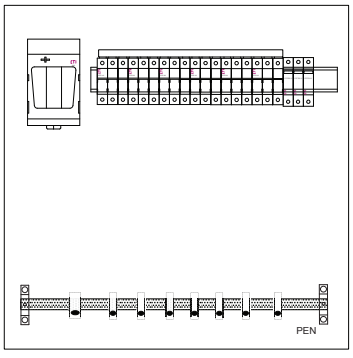
We provide design, engineering and consulting services and production of custom made AC PV junction boxes. You can choose between busbar system and mounting plate system.



Busbar system



Mounting plate system