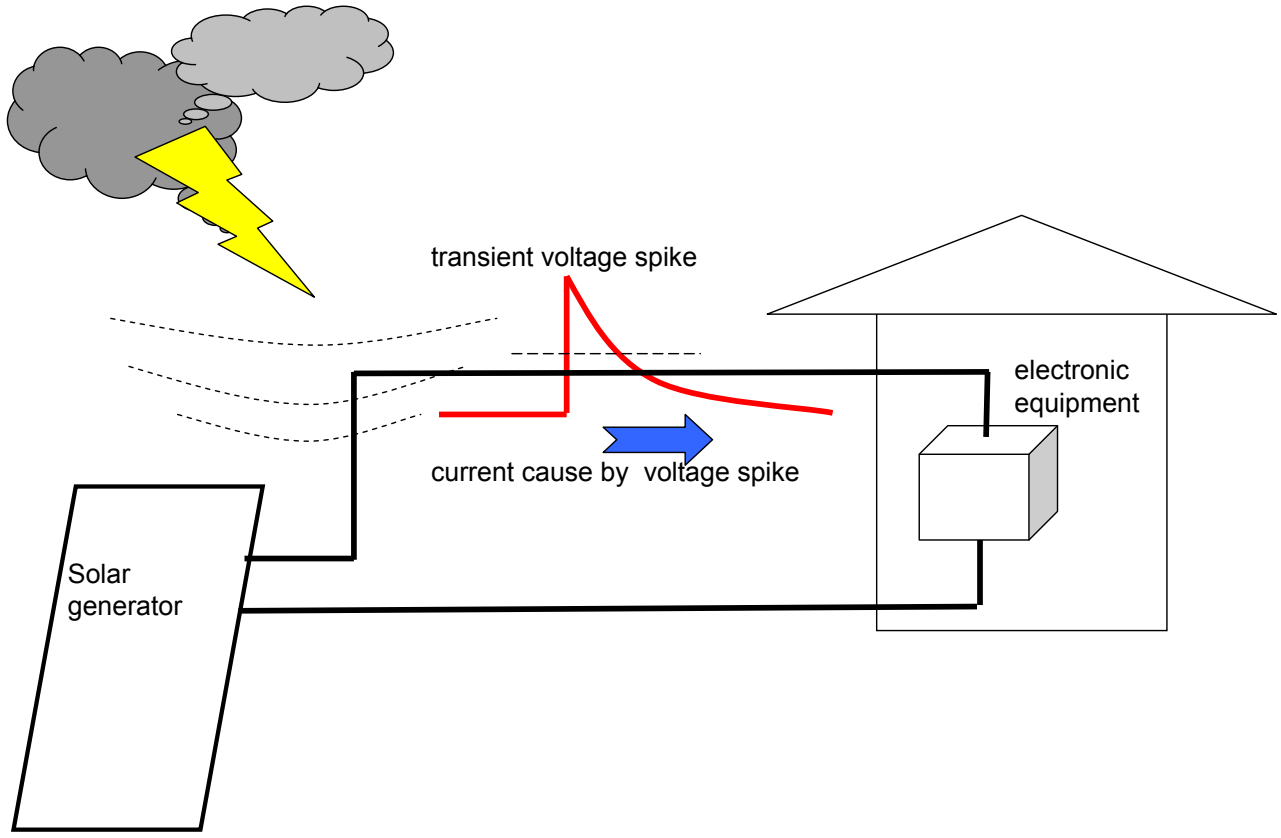
# Application note for lightning protection and parallel connection for Tarom and Power Tarom

## 1 Comprehensive explanation of possible failure mechanism

### 1.1 Influence of transient over voltage spikes

Transient voltage spikes can be caused by effects of lightning. It's not necessary that the system got a direct hit – in this case the energy is normally that high that the degree of destruction is obviously.

Even a discharge between clouds or a strike far away can induce energy pulses into the electrical conducting parts of the installation like wires, metal structure or electronic components.

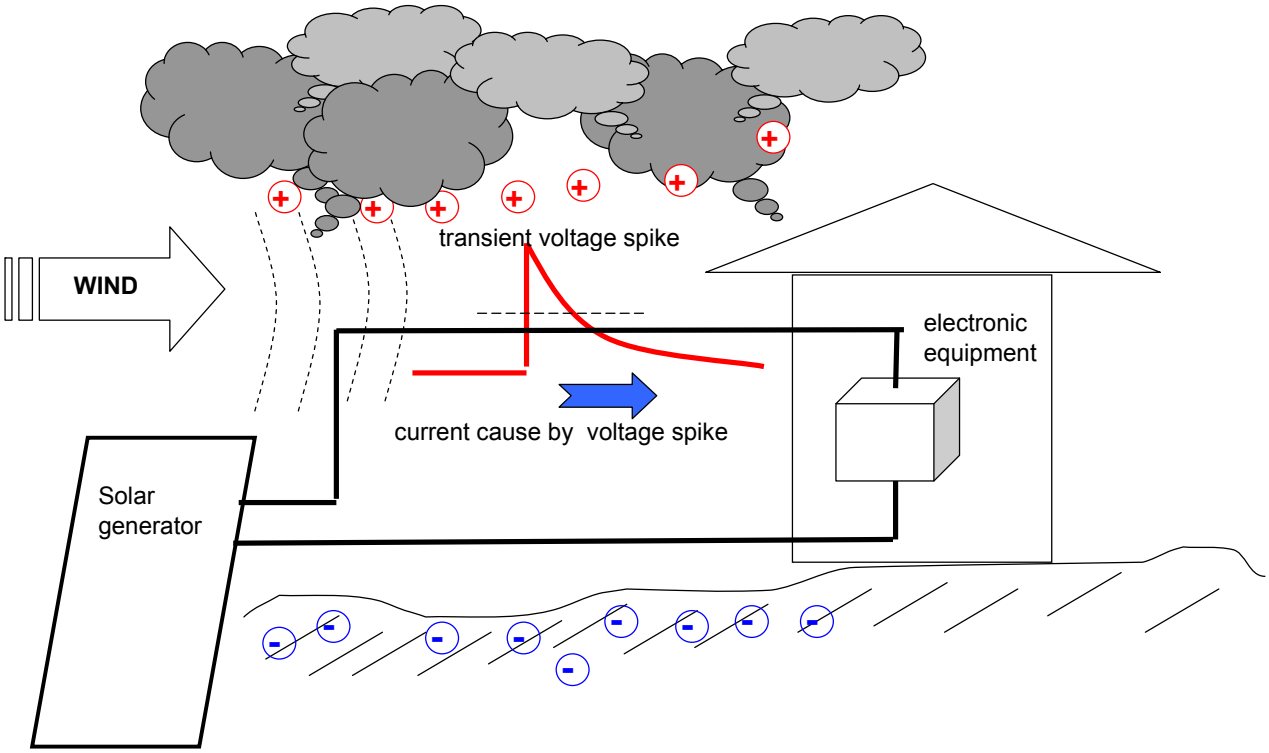



This overage of energy will cause a transient voltage spike

Not even a visible and/or audible lightning strike with thunder can cause a transient voltage spike. Also discharges of electrostatic charge may cause transient spikes of some 1000 V !

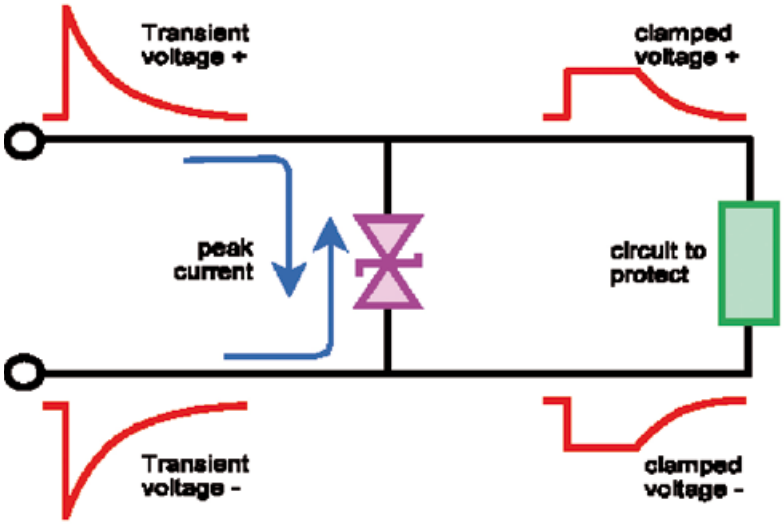
Well known examples of electrostatic discharge are the hit you feel sometimes getting out of your car or when you hear some crackling when putting off your wool pullover.

In nature electrostatic will appear when electrical charged parts are separated, for example by friction. On exposed sites his friction can be done by wind. Dry air reinforces the situation because it acts like an isolator. A discharge will happen when the isolation between the charged particles are no longer present. If the potential differences between the two poles are too high you can also get a disruptive discharge like a small lightning.



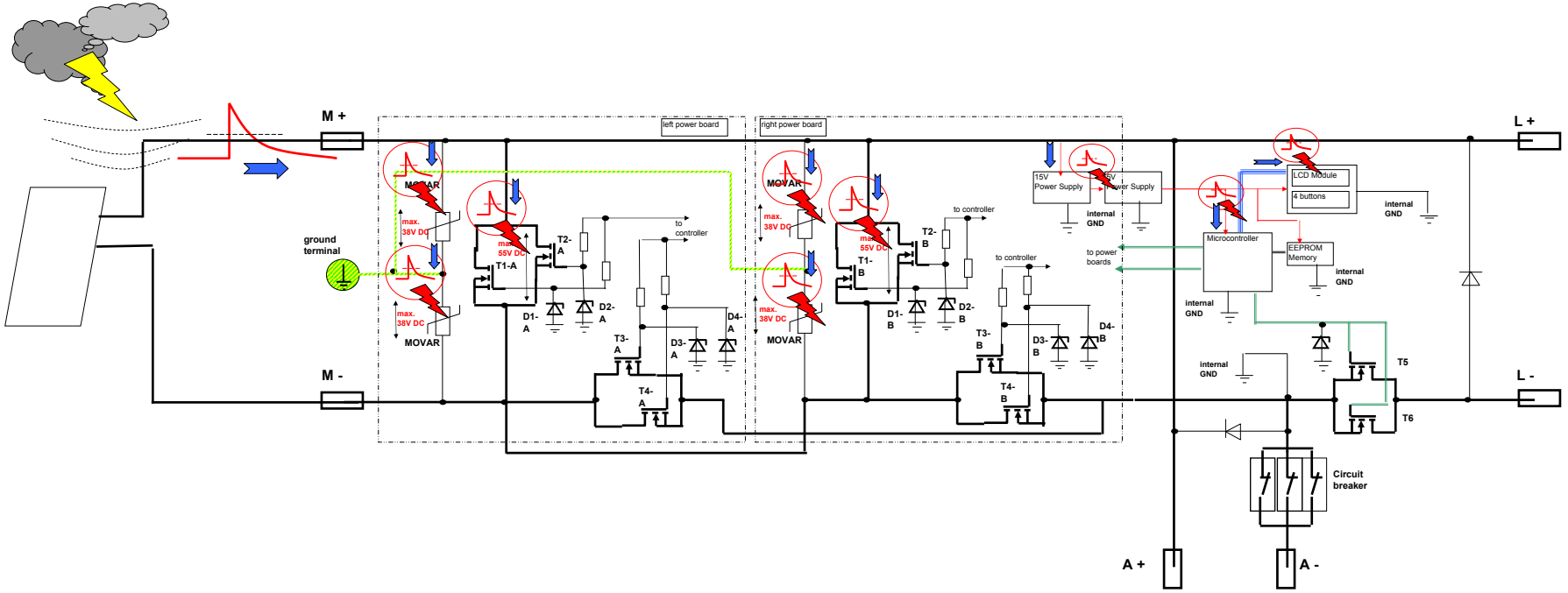

Such transient voltage spike can be a positive or a negative pulse related to the ground.

Electronic components like Varistors can limit the energy of such transient spike. These elements normal absorb some limited energy and convert them into heat. If the power = heat is too big even this element will be destroyed.

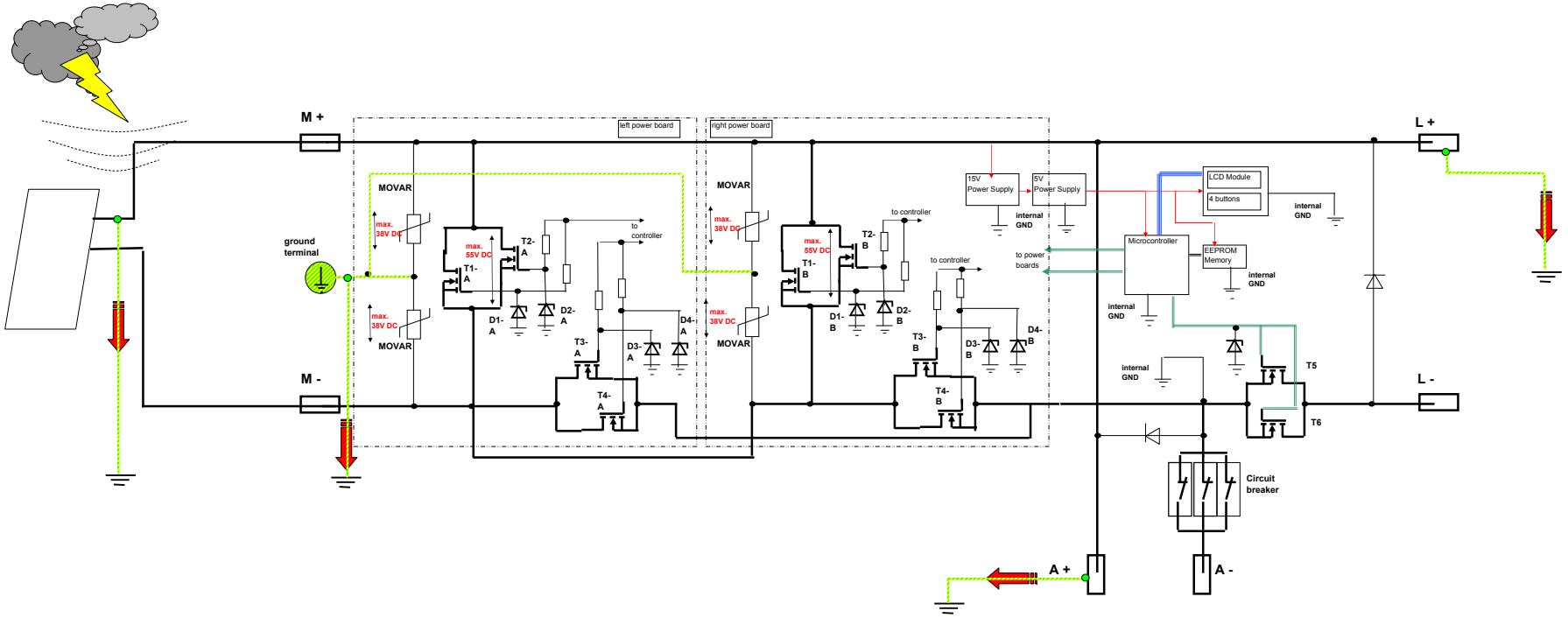


If the system is floating – not grounded or not equipotential bonding is present – the discharging of the energy will cause an current flow thru the electronic or voltage spikes at resistive parts. Depending on the sensitivity of these parts they may be destroyed immediately or lifetime will be reduced. Analyses of the defective controller demonstrate that mostly these parts have been damaged!

The schematic below shows some of the affected components.



Grounding the system can help to bypass some of the energy from the electronic components as shown in the following schematic.



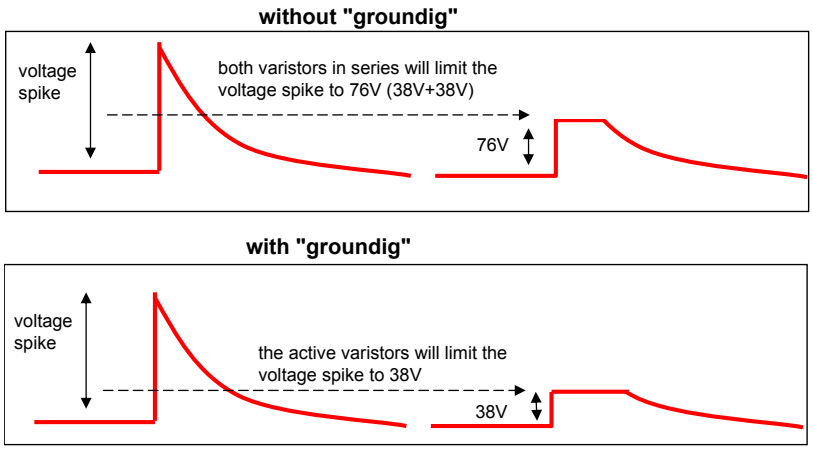

Only grounding will not solve all problems and effects on transient voltage spikes.
Because of the induced current still high voltage levels may appear on electronic parts.
Additional parts will be necessary to limit the voltage. These are zinc type varistors, spark gaps. transient voltage suppressors, etc.
The PowerTarom is equipped with Varistors limiting the voltage spikes. As mentioned before the energy capacity of the elements is limited.
Therefore it’s essential that additional, external components are added to improve robustness against overvoltage and lightning effects.

The following components are integrated into the PowerTarom:

| | max. DC operating voltage | AC operating voltage | max. Peek curren | max. Power |
|---|---|---|---|---|
| PowerTarom 2070, 2140 | 38 V dc | 30V rms | 2000A -8/20 $\mu$s | 0,2W; 36W/2ms |
| PowerTarom 4055, 4110 | 85 V dc | 60 V rms | 6500 A- 8/20 $\mu$s | 1W; 33W/2ms |

As shown on previous schematics there are two Varistors in series connection between the module minus and the module plus terminal. The serial connection point of these two elements is the ground terminal of the PowerTarom.

Grounding or not grounding has effects on the efficiency of the Varistors, see the next diagramm:




## 1.2 Malfunction and defects caused by Humidity

Humidity will cause a higher risk of corrosion at metal parts like copper wires, connectors, and screw terminals.

Some electronic components are hygroscopic, that means that they suck the moisture like a sponge. It's quite logical that a higher degree of moisture will influence the electrical characteristic of the parts.

It also became very dangerous when the moisture is condensing. The condense water drops may cause direct contacts between contact pins, wires or solder joints.

Such effects can cause unpredictable malfunctions of the electronic system.

The risk of condensate will be given at high humidity at high temperature differences at or inside the charge controller.

High temperature differences are naturally given because the shelter is exposed to the sun and will be heated up directly as well he will cool down during night time.

Also the electronic itself will be heated up during daytime due to the charging current coming from the solar modules as well as from the load connected to the output.

Because the conditions of temperature differences are given inside the electronic it is most important to focus on preventing intrusion of humidity into the charge controller case.

The IP65 enclosure of the PowerTarom is equipped with PG glands to inhibit the transportation of wet air into the charge controller case. But this will only work if the glands are use properly.

It's important that used cable fits to the gland diameter so that it seals up by tie up the gland.

Not used glands can be tighten by using pieces of cabel or a simple cork.

Condensation caused by high humidity and improper sealing of the glands will effect the function of the printed circuit board. The following effects could appear:

- wrong LCD reading
- wrong sensing of physical parameters like voltage, current and temperature
- wrong regulation of power components

This effect could be very serious especially if the regulation is effected. This could cause an irreversible damage to the power components.

If humidity influence the sensing the regulator is not able to control the system correctly. This can cause over voltage or deep discharge as long as water is condensing. After the condensate water is evaporated the system could operate correctly again.

The electronic of the Power Tarom is included into a IP65 rated enclosure. To keep the IP65 rating it is necessary to use the attached PG glands and to fix them correctly. If the glands are removed the IP protection is no longer present. Water, dust or insects can easily enter the electronic and cause server damage.

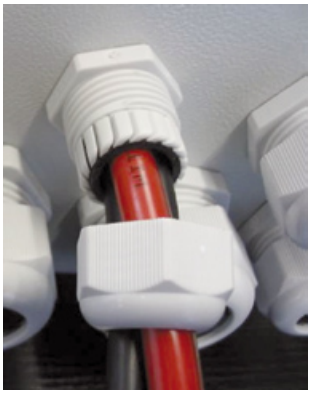
Sometimes it may be difficult to tighten the cable gland when the diameter of the used cable are smaller than the diameter of the gland.

In such a case, as a hint, you can use small pieces of wires to stuff the gland completely.

By filling the hole the gland can be completely closed and will prevent the diffusion of water and moisture into the charge controller.

See the following pictures as a example:

Open glands



The red power cable and 3 small pieces of wire are put thru the PG gland to stuff the opening.

### 1.3 Effects by erroneous installation.

Wrong installation process or improperly conditions can cause faulty conditions during installation which may cause direct damage to the charge controller.

To prevent such unwished situations it is highly recommended to read the manual before starting the installation.

### 1.4 Quick installation instructions for the PowerTarom

For the complete installation and the safety instructions please refer to the manual!
Please do all steps following the numbers below. Do not go ahead if any step failed.

1. Check system parameters and PowerTarom label : System voltage, max. module/load current

→ This is to prevent a too high input current and voltage to the used charge controller.

2. The solar modules have to be equipped with an extra switch or circuit breaker (CB). (Switches available from the producer, too)

→ a switch or circuit breaker is necessary to a installation without cables under voltage. This will prevent sparking when cables being assembled.

3. fix the PowerTarom vertically at the wall

→ This is will ensure natural air convection necessary for cooling the heat sink during operation.

4. Switch off battery, modules and load:
   a. switch off external battery fuse or CB and the main CB inside the PowerTarom
   b. switch off the modules at the external module CB
   c. switch off all loads

→ This is recommended to prevent short cuts while assembling the cables.

5. Cabling (not yet to be switched on)
   a. connect the battery poles to the A+ and A!(blue) terminals. Respect polarity!
   b. connect the modules to the M+ and M!(blue) terminals. Respect polarity!
   c. connect the load to the L+ and L!(blue) terminals. Respect polarity!

→ Short circuits or wrong polarity connection will not damage the controller immediately but it will but unnecessarily stress to the electronic components.

6. Switch on battery
   a. insert battery fuse and/or switch on battery CB (external and in the PowerTarom). Do not switch on the modules yet.
   b. watch the LC-display for proper indication of system parameters

→ Try not to operate the system if something behaves strange. Additional circuit breaker between battery and charge controller made a voltage free assembling much easier and safer.

7. Switch on the modules
   a. switch on the external module CB
   b. watch the LC-display for proper indication: during daylight you should see the module and charge current, “I mod“ and “I in“

→ If the solar modules are connected in wrong polarity the input current will still go thru the charge controller but it will not charge the battery. Imod and Iin reading will be “0“. Wrong polarity connection of the input will heat up the charge controller – so the wrong wiring should be cleared immediately.

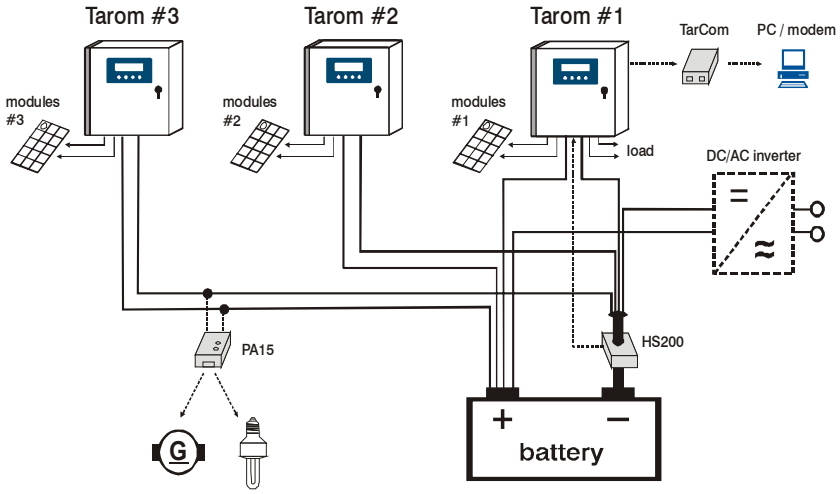
8. Switch on the load
   a. switch on the load and check whether the load is working
   b. watch the LC-display for proper indication of the load current (top-rightmost number).

→ Do not connect any input sources to the load output of the charhe controller. This may cause uncontrolled current flow.

9. Installation is completed, congratulations.

### 1.5 Hints for the usage of multiple PowerTaroms

In a photovoltaic system several PowerTarom regulators can charge a battery simultaneously.




Please note the following notes for an optimal installation:

1. battery: the battery terminals (A+ and A-) of all regulators are connected to the same battery
2. modules: each PowerTarom needs an individual, separate module group. No connection or grounding is allowed between the several M- terminals.
3. load: do not connect the L- terminals between several PowerTaroms.
4. grounding: only the + terminals of different PowerTaroms can be connected together or grounded. Never connect or ground the M- or L- to the battery minus!
5. Configuration of the PowerTaroms:
   a. Tarom 1
      i. set regulation to “voltage” (menu conf/regulation/voltage)
      ii. set electrolyte type corresponding to your battery (menu conf/electrolyte/fixed|liquid)
   b. Tarom 2, 3, ..
      i. set regulation to “voltage” (menu conf/regulation/voltage)
      ii. set all electrolyte types to fixed to disable the gasing phase(menu conf/electrolyte/fixed)
6. accessories:
   a. data logger TarCom: The TarCom logger can communicate to a single PowerTarom only.

   So the currents data of the other PowerTaroms are not registrated. You can use for each PowerTarom a several TarCom or you install instead a HS200 current sensor in the battery main line.

   b. current sensor HS200: If you attach a HS200 to the main battery cable, all currents going in and out the battery are calculated and displayed at this PowerTarom and his TarCom logger. You only need one HS200 for the whole system. Currents higher than the maximum of 200A will not be displayed but do not harm the sensor. If you use a HS200 sensor together with Tarom #1 you can reset its configuration menu/regulation to “SOC”.

   c. receiver PA15: only one PowerTarom may supply the radio signals for the PA15 receivers. Set the “option transmit” to “accu” at Tarom #1 and set “option transmit” to “off”at all other PowerTaroms in the system.

## 2 Attachment

Please find attached the Word-Document “Common practices for protection against the effects on lightning on stand – alone photovoltaic systems” from the International Energy Agency IEA PVPS

http://141.51.158.34/iea/Publications/Lightning.pdf

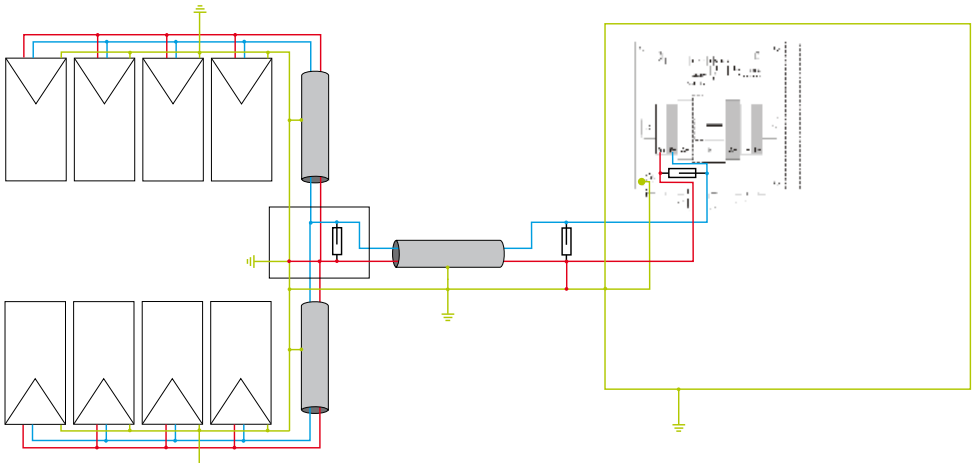
This report gathers general information about PV installation lightning protection measures and then describes lightning expert’s recommendations for different specific installations.

The recommendations made in this report are indicative.

Please find also attached a presentation from Dehn regarding lightning protection. This documents deals especially with grid connected systems but you can use the recommendation as well for stand alone systems with lower voltages. Therefore you had to choose lightning protectors specially designed for the system voltage.

http://www.dehn.de/www_DE/frameset_E.html

Recommendation for surge protection with a single regulator



Recommendation for surge protection with parallel regulators

Every regulator had to be connected to an isolated solar generator