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Peripheral racks and crates grounding implementation.

Proposal

The proposed grounding technique based on the following document:

CMS EMU CSC policy on Grounding, Shielding and Power Distribution.

N. Bondar, B. Bylsma, S. Lusin, A. Madorsky, P. Robl, V. Sedov.

CMS ME CSC HV system grounding.
The document prepared by Alex Madorsky

Evidently the grounding technique should comply with the CERN safety and electrical installation rules.

Contents

1. Grounding concept

Terminology

Documentation and implementation must clearly distinguish between three types of "grounds":

1. Safety ground (SG). Connection to earth.

   Symbol: 

2. Reference ground (RG). Zero volt reference for the system.

   Symbol: 

3. Signal return (SR). Path for returning a signal to its source. Connected to reference ground in a single point for each signal.

   Symbol: 

The main grounding idea

CMS EMU Chambers will sit on the surface of the huge metal disks (CMS return yoke). We suppose that these disks have very low resistance, and they will be very well connected to each other in each of the two End Caps. Due to the good conductivity of these disks, they can be used as part of RG for all electronics sitting on chambers and disks.

Resume:

All racks and crates should be directly connected to disks.

2. Initial schemes of grounding, shielding and power distribution

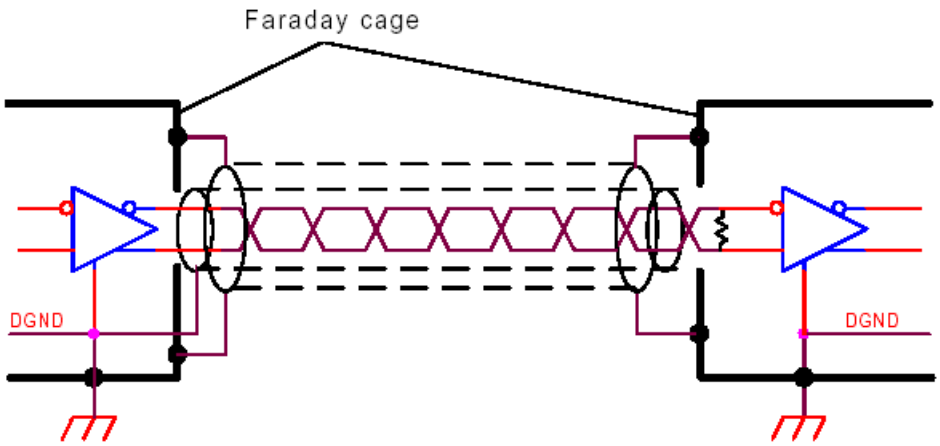


Figure 3. Digital signal transmission.

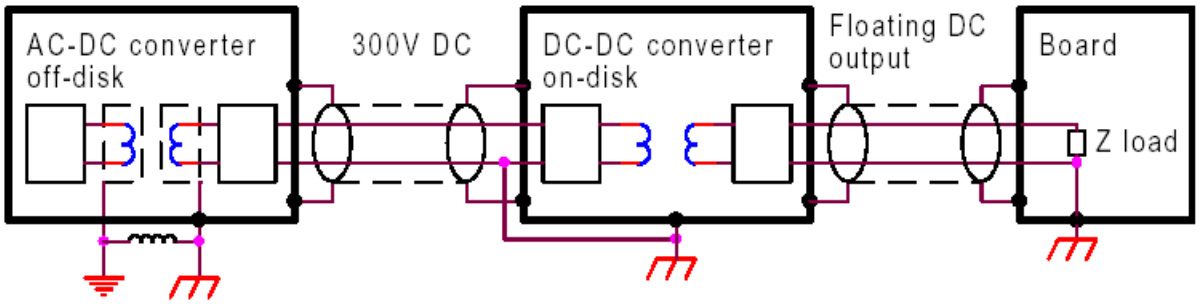


Figure 6. DC-DC converter shield and case connection.

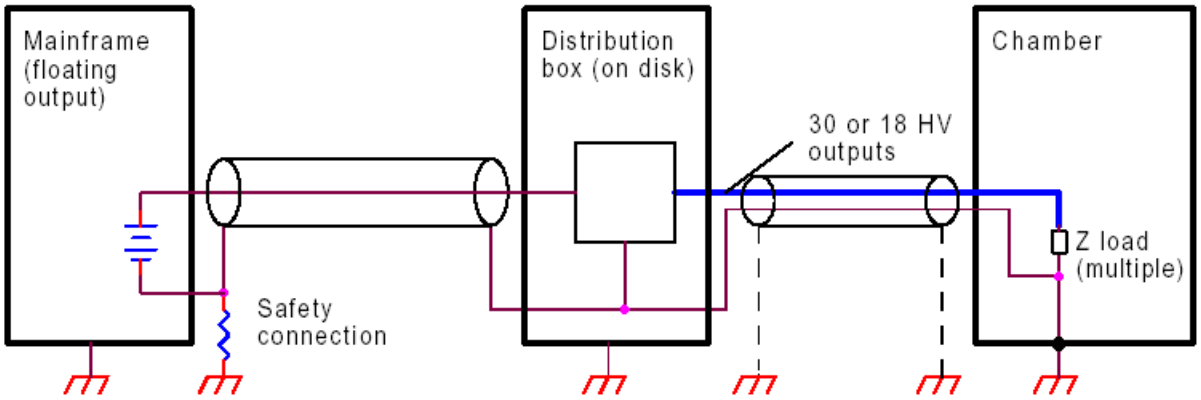
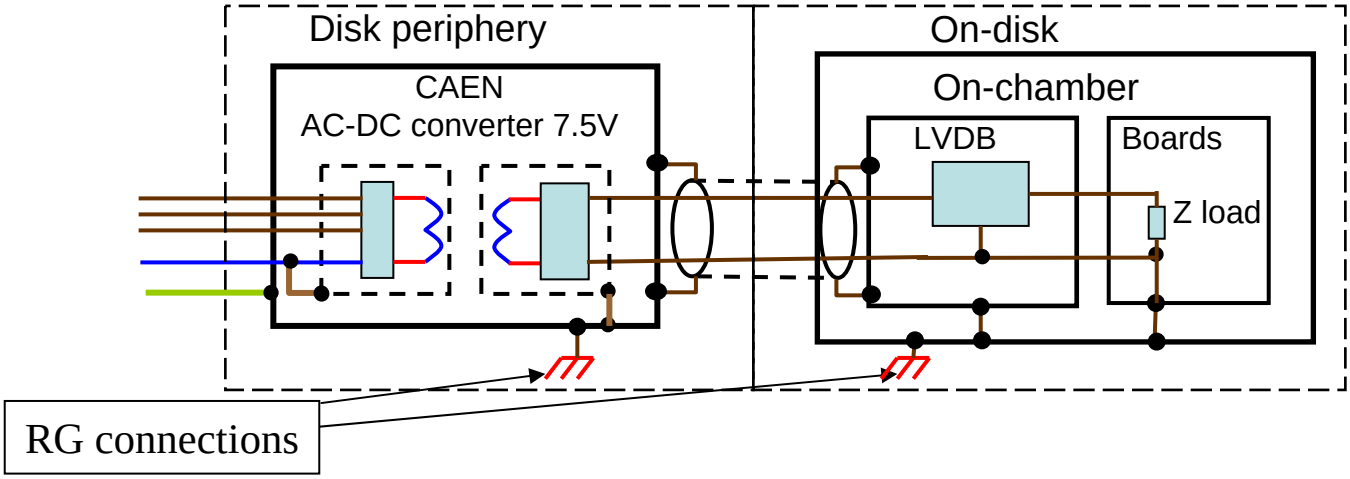


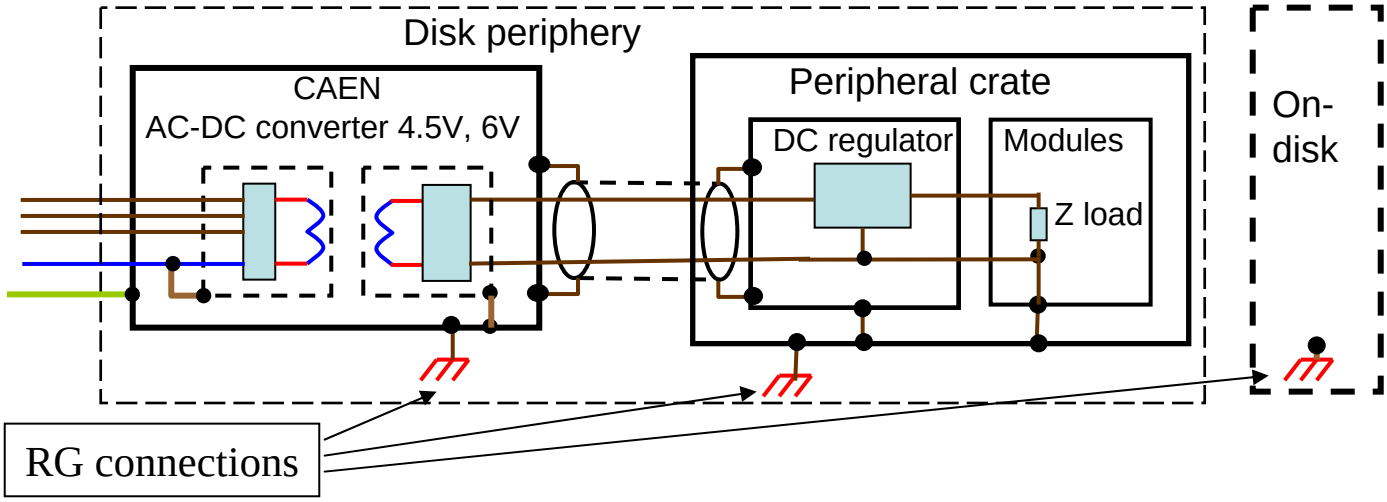
Figure 7. HV power distribution.

3. Updated schemes of grounding, shielding and power distribution

Chambers power supply shielding and grounding



Peripheral crates power supply shielding and grounding



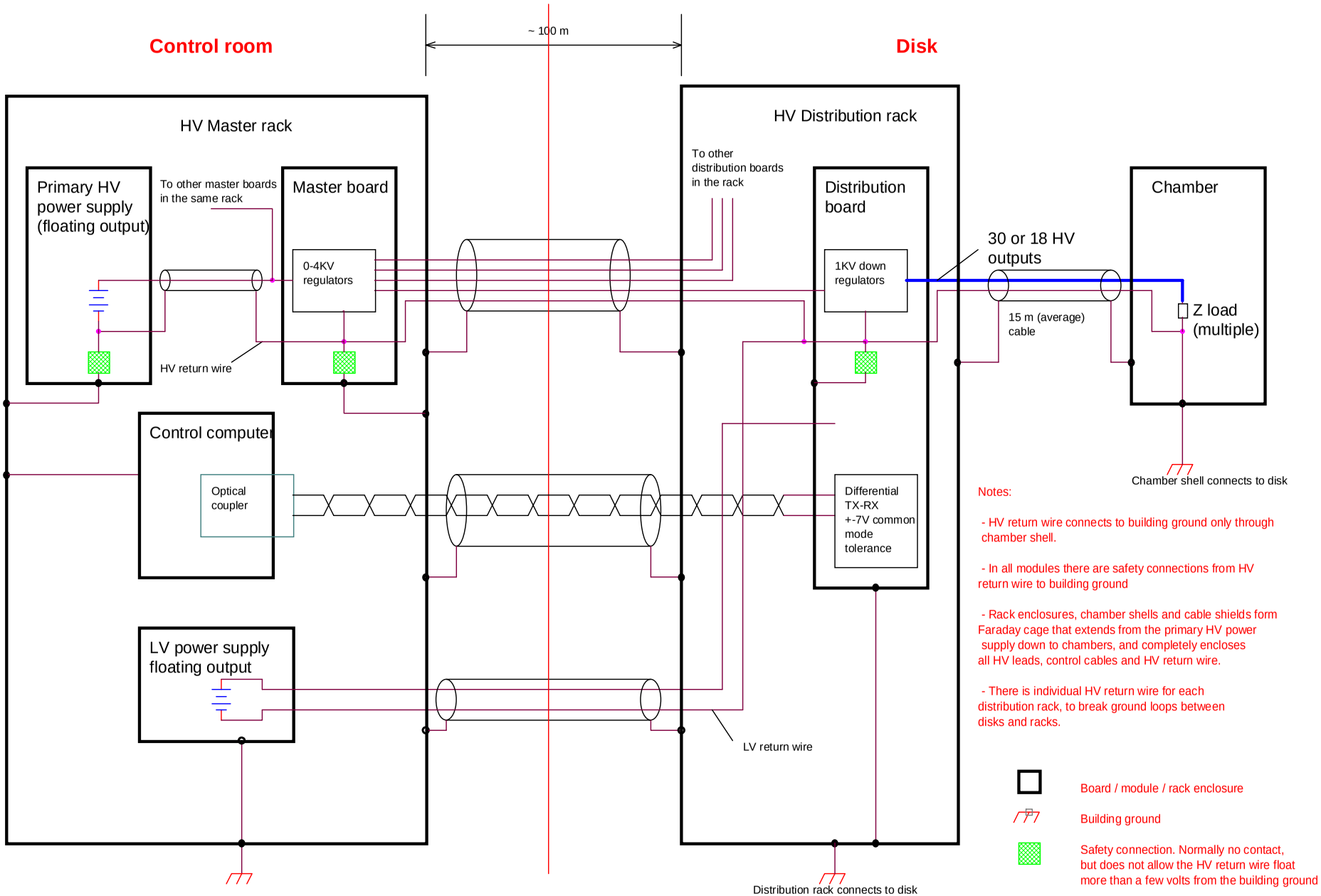
CAEN AC-DC converters are High Frequency (HF) devices. The grounding and shielding of these converters should be discussed in more details.

Topics for discussions :

- Double screen devices
- HF screens connection
- Common mode protection (value of common mode)
- LVDB and DC regulators Common mode Immunity factor?)
- Device efficiency
- Device cooling

CMS ME CSC HV system grounding

Prepared by Alex Madorsky



Notes:

- HV return wire connects to building ground only through chamber shell.

- In all modules there are safety connections from HV return wire to building ground

- Rack enclosures, chamber shells and cable shields form Faraday cage that extends from the primary HV power supply down to chambers, and completely encloses all HV leads, control cables and HV return wire.

- There is individual HV return wire for each distribution rack, to break ground loops between disks and racks.

Board / module / rack enclosure

Building ground

Safety connection. Normally no contact, but does not allow the HV return wire float more than a few volts from the building ground

RG – RG connection should be very low resistive and very low inductive. The question is: How RG – RG connection will be implemented on the disk periphery?

4. Peripheral electronics grounding requirements

1. Each rack must be connected to the disk with a proper wire. We can expect the maximum rack power consumption is not more than 4 kW. So we can estimate grounding wire (copper braid) cross section as 16 mm^2 .

2. Special Disk Ground Terminals (DGT) must be created directly on the disks to provide rack grounding. The DGT must be located to get a reasonable shortest wire length. One of the reasonable grounding point is a threaded hole on the chamber mounting post (orange color).

3. Each rack must have special Rack Ground Terminal (RGT) to accept the crate grounding wires and the rack grounding wire.

4. Each crate must be connected to the RGT with a proper wire.

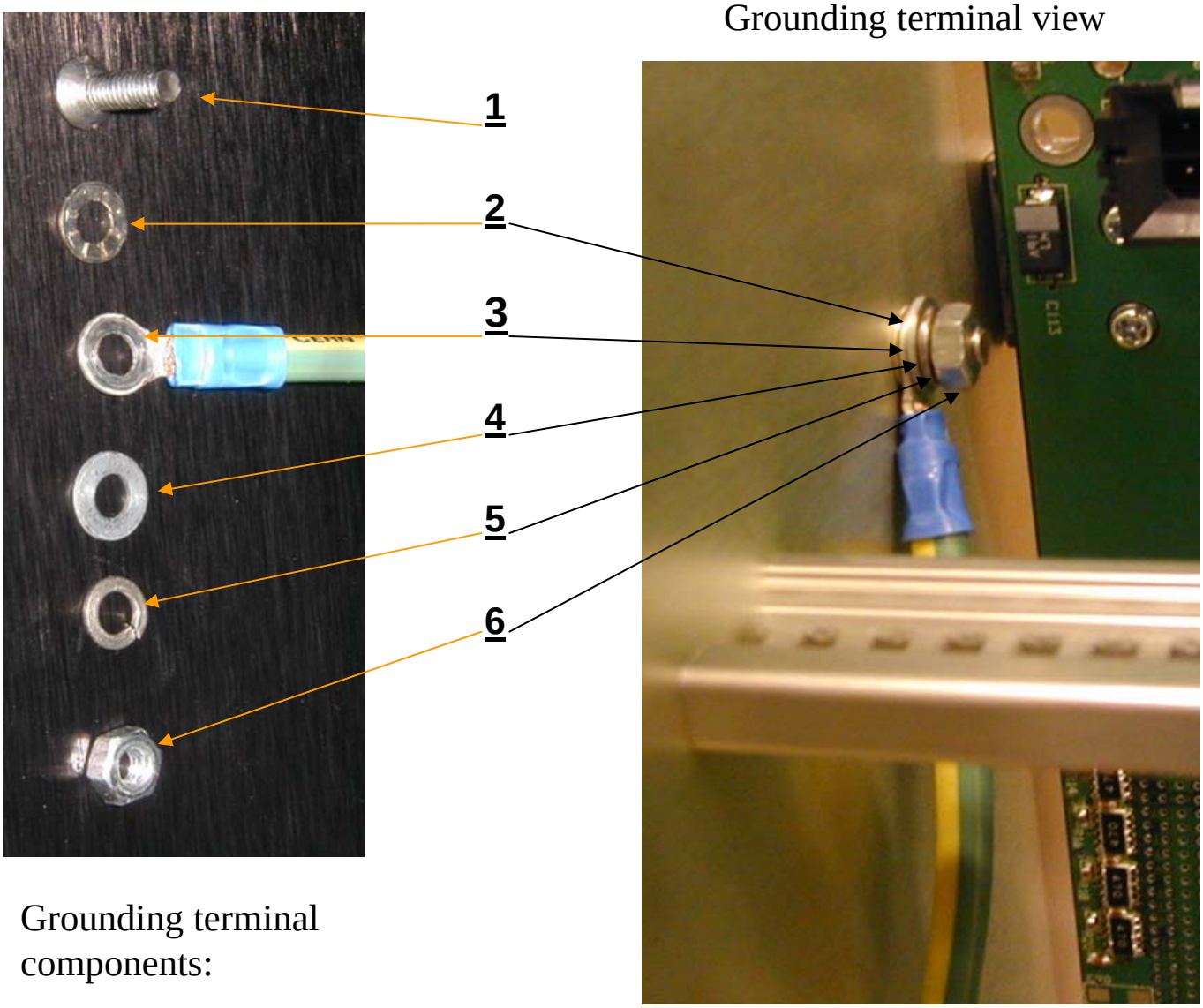
5. Each crate must have Crate Ground Terminal (CGT) at the back side of its chassis.

Implementation of this circuits are presented below.

5. Peripheral Crate Grounding Terminal (CGT)

Note: Currently M4 screw proposed as a grounding terminal at peripheral crates. This is sufficient if the crate power consumption is not more than 500W ant total current limited at 100A value. Otherwise the larger screw must be selected.

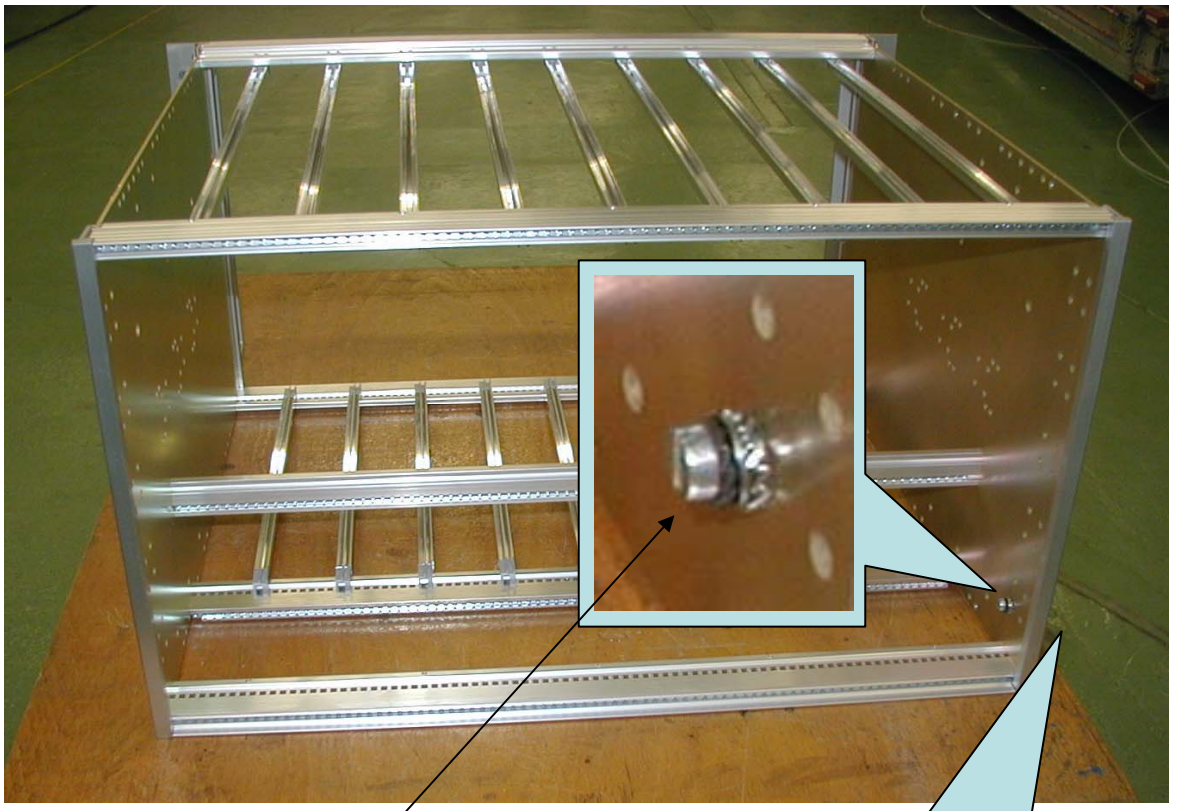
Grounding terminal view



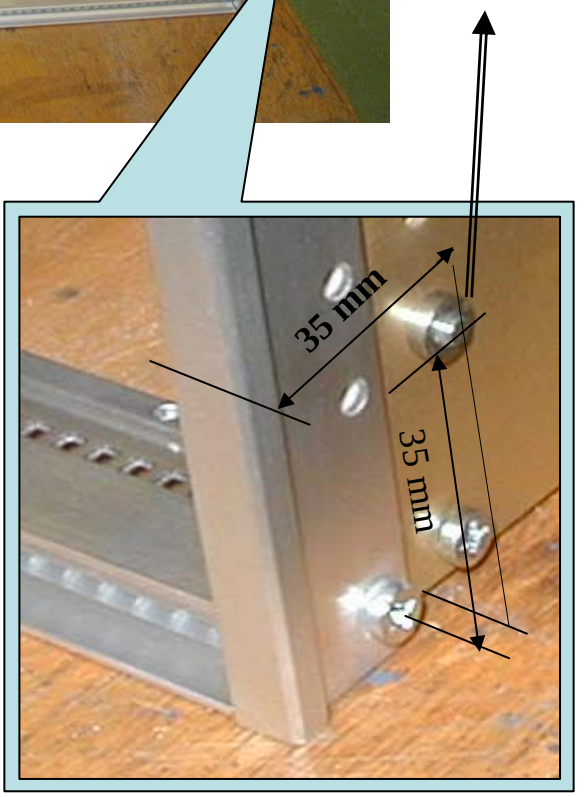
Grounding terminal components:

1- Screw M4, flat head L=10 stainless steel, 47.62.41.410.6
2- Contact washer M4, steel, zinc coated, 47.78.09.104.8
3- Green/Yellow wire 6mm^2 , 04.08.61.270.6
with ring terminals: Yellow, M4, 04.76.22.344.4 – crate side
and Yellow, M6, 04.76.22.346.2 - rack side
4- Flat washer M4, stainless steel, 47.78.09.004.1
5- Spring lock washer M4, stainless steel, 47.78.15.202.8
6- Nut M4, stainless steel, 47.43.77.040.1

6. HV Crate Grounding Terminal (CGT)



M4 insert

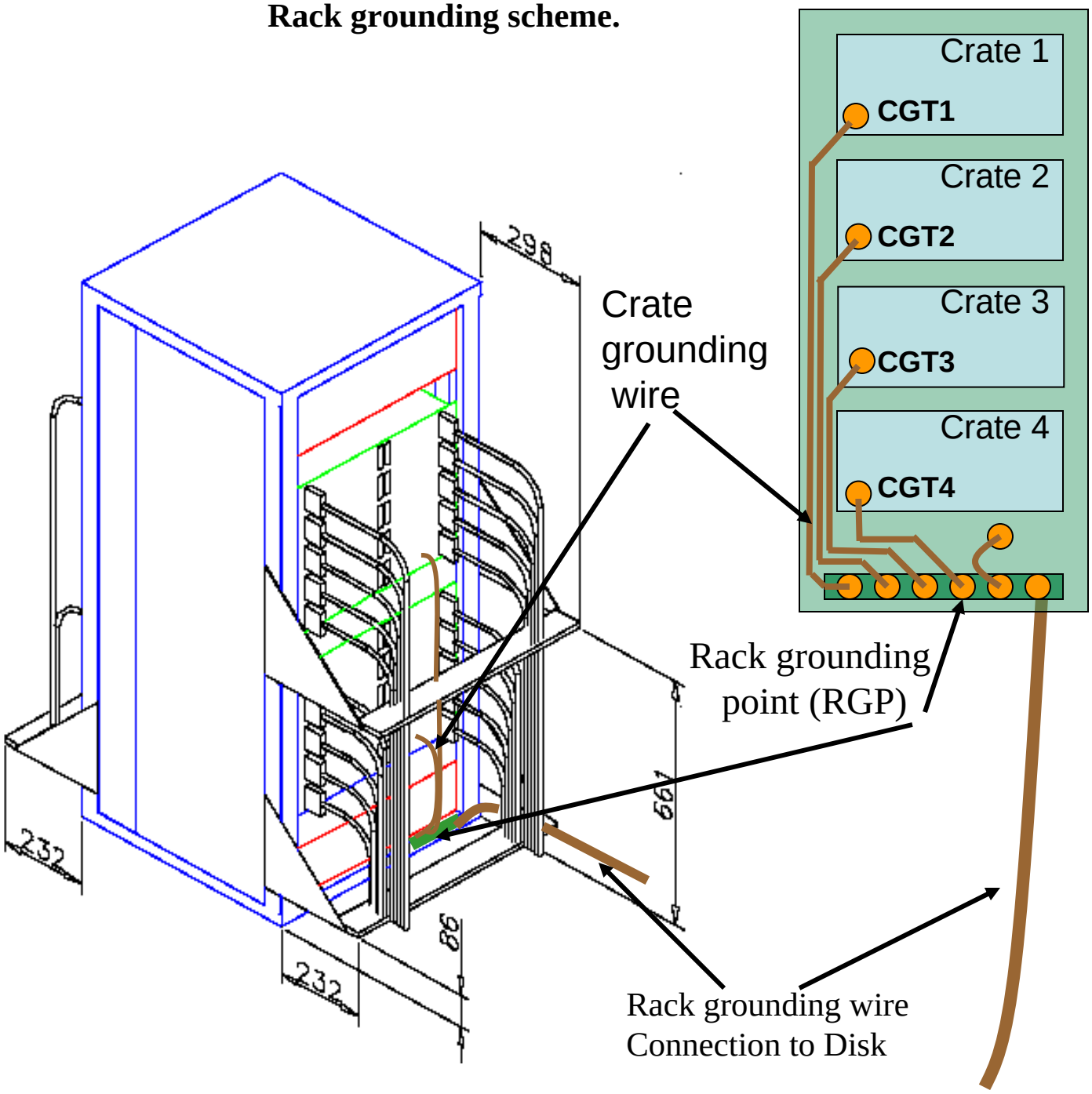


HV crate Grounding terminal:

1- M4 insert
2- Screw M4, hex socket head L=10 stainless steel, 47.62.71.154.8
3- Contact washer M4, steel, zinc coated, 47.78.09.104.8
4- Flat washer M4, stainless steel, 47.78.09.004.1
5- Spring lock washer M4, stainless steel, 47.78.15.202.8
6- Green/Yellow wire 6mm2 , 04.08.61.270.6
ring terminals: Yellow, M4, 04.76.22.344.4 – crate side
and Yellow, M6, 04.76.22.346.2 - rack side

7. Rack Grounding Terminal (RGT).

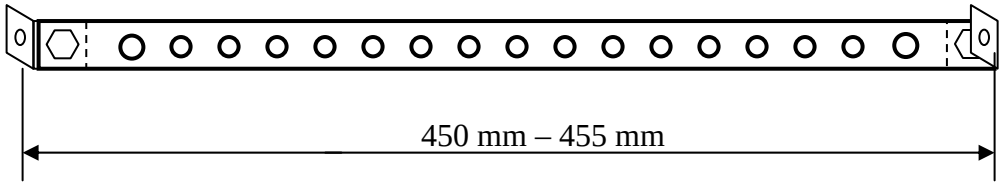
Rack grounding scheme.



Crate grounding wire :
Copper braid 10 mm^2 with O-ring terminals on both sides

Rack grounding point:
Brass bar size 15x5 mm^2. Length – to be determined;

Rack grounding bar (assembly)

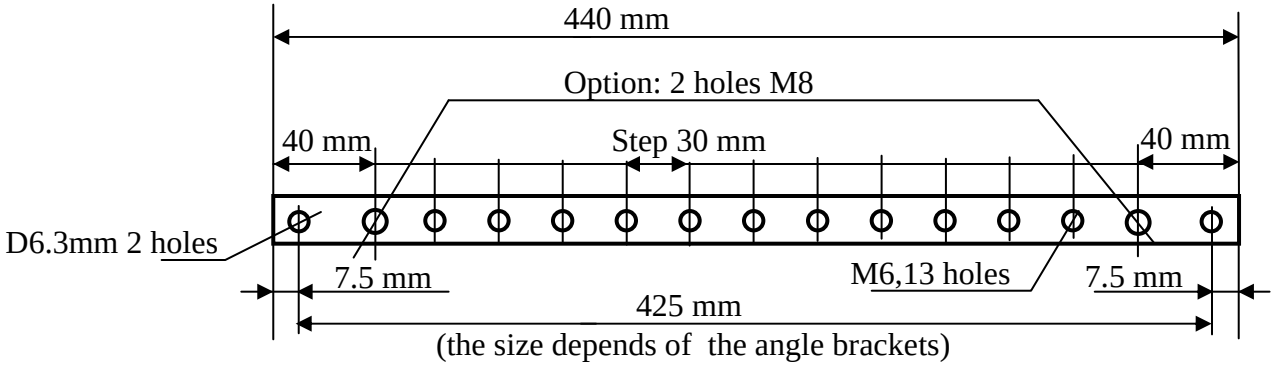


Note: Standard Rack width - 450 mm
Mini rack width - 455 mm

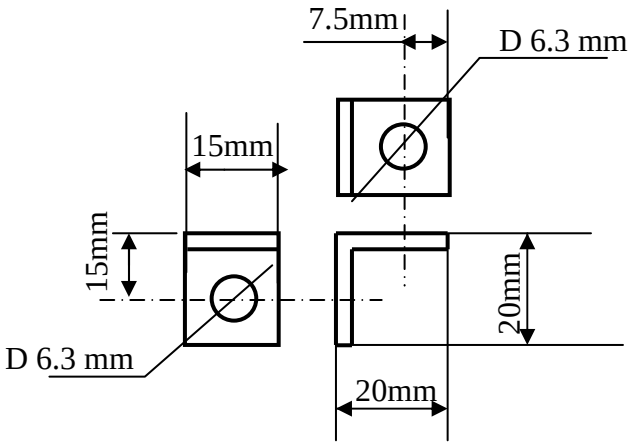
Copper bar

Bar profile 15x5 mm^2

Material:
Brass bar 15x5 mm^2
CERN Stores Catalog
44.09.02.076.0

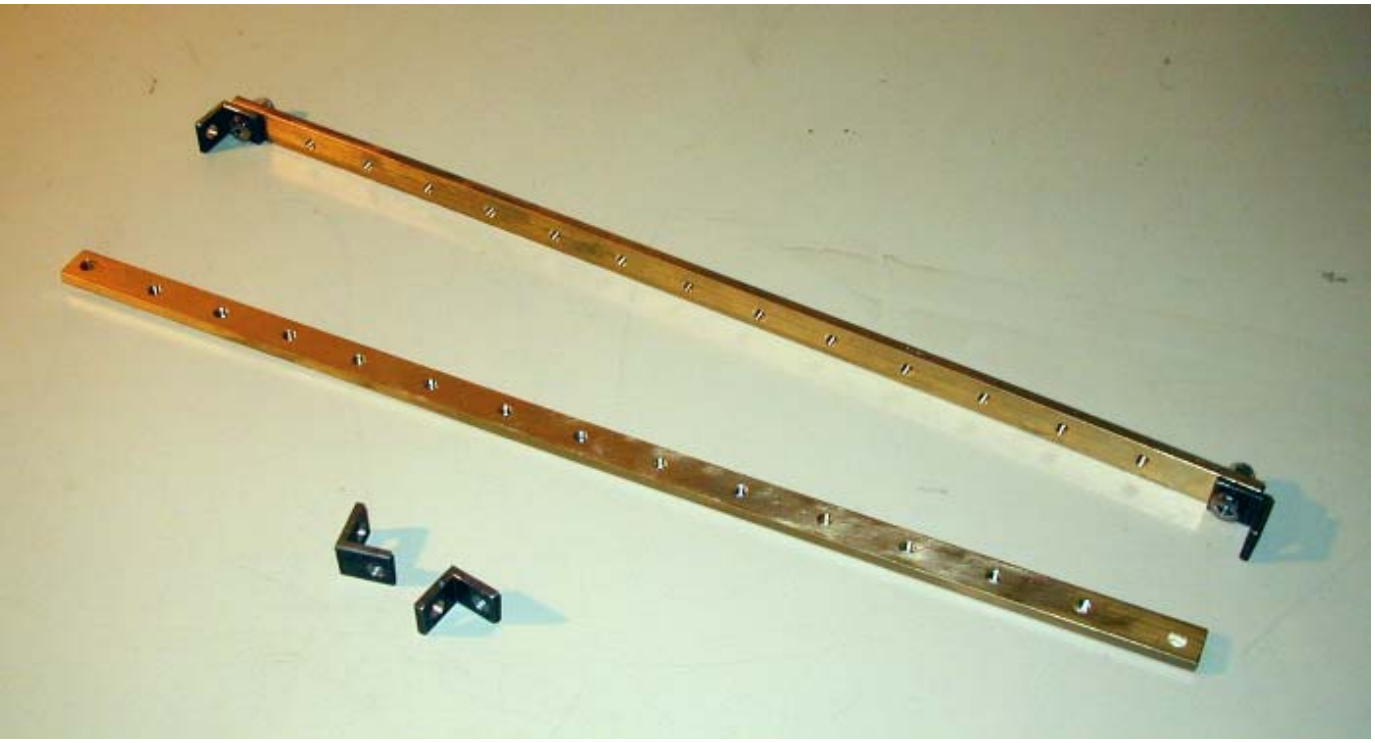


Angle bracket



Material:
steel angle 20X20 mm
CERN Stores Catalog
44.47.02.020.0

Rack grounding bar



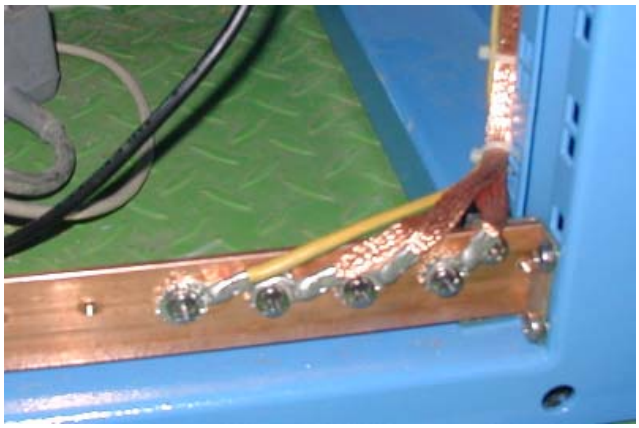
List of components:

1.	Copper bar		1 pc
2.	Angle bracket		2 pc
3.	Screw M6 x 16 mm	47.62.82.257.3	2 pc
4.	Screw M6 x 10mm	47.62.82.254.6	2 pc
5.	Nut M6 stainless steel	47.43.77.060.7	2 pc
6.	Washer lock M6, steel, zinc coated,	47.78.09.106.6	2 pc
7.	Unloose Nut M6 (Accessories for racks)	06.61.81.634.2	2 pc

Grounding technique implemented at the HV rack

LV power supply grounding (top)
HV primary power supply grounding (bottom)

HV crates grounding point

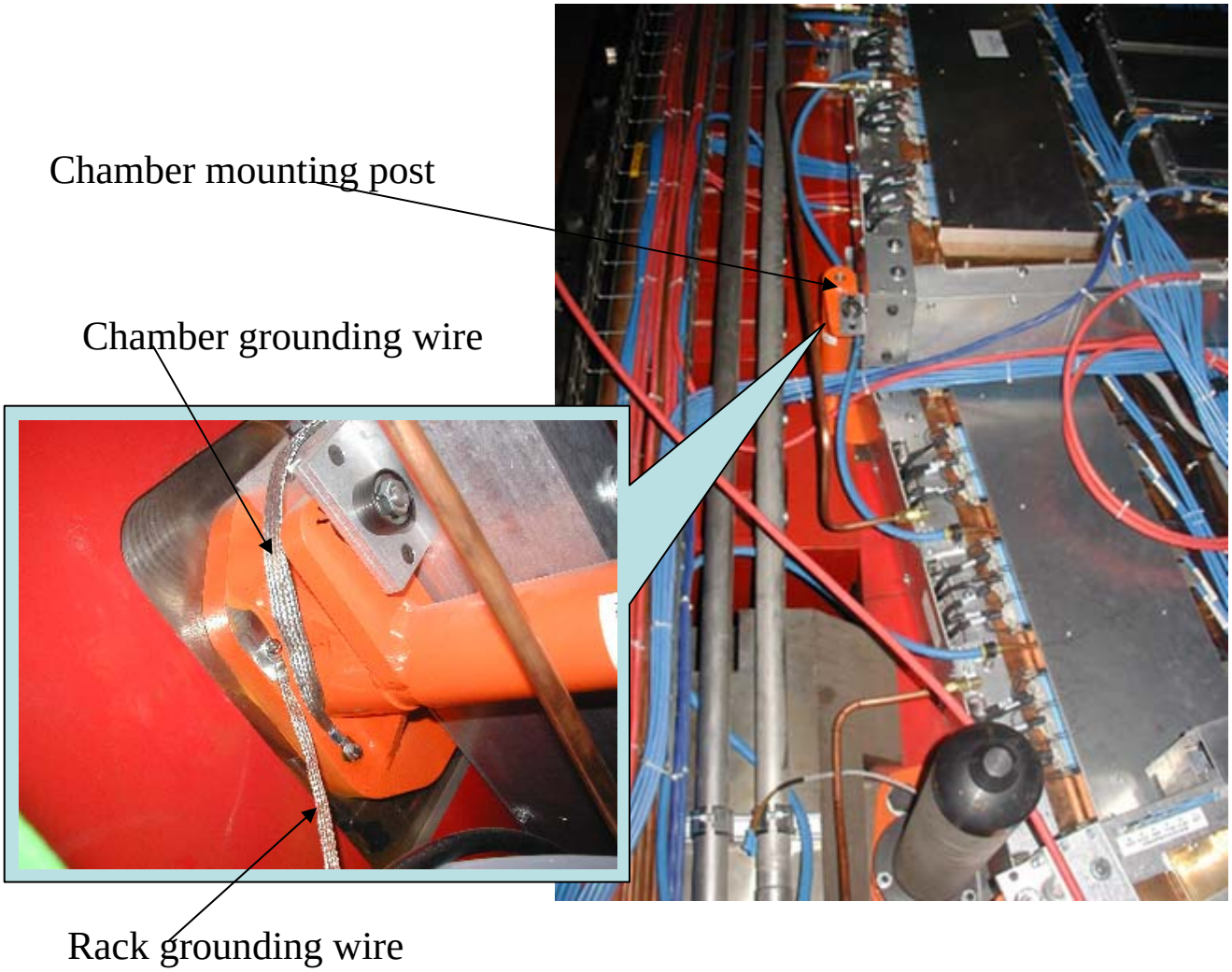


Left and right sides of the rack grounding point

8. **Disk Ground Terminals (DGT) and rack grounding.**

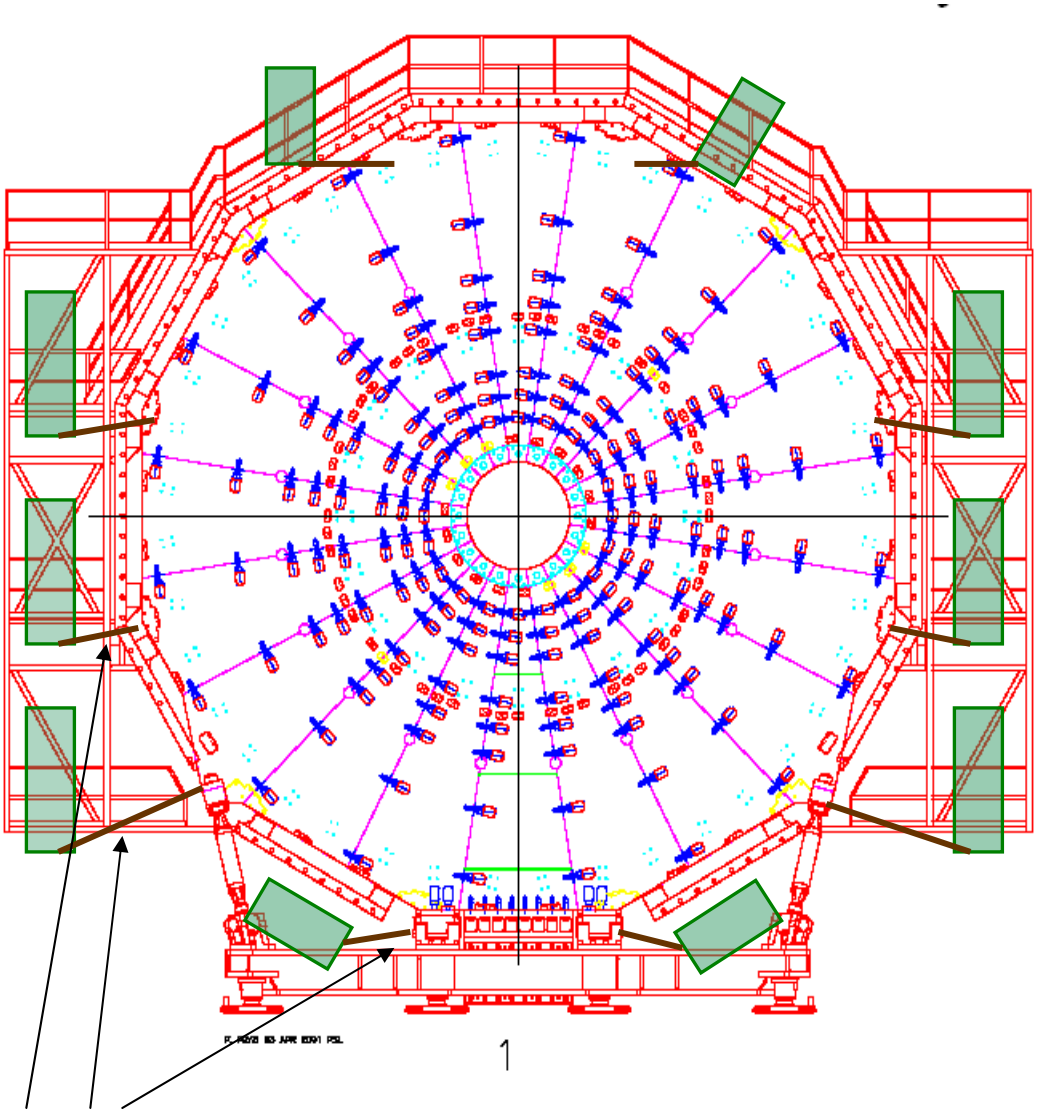
We assume that the rack power is not more than 5 KW, and we can use M6 threaded hole at the chamber mounting post. As shown at the picture. If any rack consumes more than 5 KW location and size of DGT needs more attention.

Warning: We may not use a construction bolt for grounding.



Peripheral Racks location and grounding scheme.

In spite of the disks peripheral structure bolted to the disk, this junction may not be assumed as a proper grounding circuit.



Grounding Wire connected to rack at one side
and to special point at the disk (DGT) at the other side.

Grounding wires

1. Crate grounding wires:

Option A

Copper braid 10 mm^2 . Size 10mm x 1,5mm. 04.01.31.010.1

Terminals:

Cable Lugs Crimped-Type 10, M6. 04.76.21.032.1

Option B

Flexible installation wire 6 mm^2 . Yellow/Green. 04.08.61.270.6

Terminals:

For crate connection - Cable Lugs Crimped-Type Yellow, M4, 04.76.22.344.4

For rack connection - Cable Lugs Crimped-Type Yellow, M6. 04.76.21.032.1

2. Rack grounding wires:

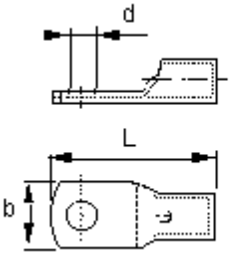
Copper braid 16 mm^2 . Size 15mm x 2mm. 04.01.31.016.5

Terminals:

For M6 screw - Cable Lugs Crimped-Type 16, M6. 04.76.21.038.5

For M8 screw - Cable Lugs Crimped-Type 16, M8. (optional) 04.76.21.040.1

Cable Lugs Crimped-Type



Copper braid

9. Conclusions

1. Crate Ground Terminal (CGT)

Peripheral DAQ crates have M4 grounding screw. The power of the crate is about 0.5 kW. This CTG is sufficient in case of limited current for each crate. The consuming current should be limited at the CAEN AC-DC converter side. Otherwise the M$ grounding screw must be replaced with M6 screw.

2. Rack Ground Point (RGP)

Proposed grounding technique is easy to make and sufficient for all racks. Width of standard rack – 450 mm, but mini rack width – 455 mm.
Length for each grounding wire should be selected during crate installation.

4. Rack-to-disk wire.

Gauge of the wire copper braid section /16 mm^2 .
The grounding wire route should be selected during wiring.

5. Disk Ground Terminals (DGT).

One option is to use M6 threaded hole at the chamber mounting post.
If any rack consumes more than 5 KW this DGT needs more attention.

Warning: We may not use a construction bolt for grounding.