CMS Preshower (ES) : Protective Earthing of the subdetector and of its Silicon bias supply system

Irrespective of the electronics’ grounding scheme finally selected, the following is known:

- The ES structure/enclosure, with plentyful use of aluminium alloys, is galvanically insulated from neighbouring subdetectors and from CMS support structures.
- Supplies’ terminals are insulated\(^1\), and the active parts will be earthed on the subdetector side, the "load" side.
- To this end, an explicit star point (per endcap) will be constructed, encompassing the active parts and all structural and enclosure parts.
- From that star point, one PE conductor (per endcap) will be routed through CMS, so that it is explicitly accessible with a closed CMS detector.

See Appendix 2.

The extra-low-voltage supplies to power the on-detector electronics (typically 5V, hard-limited to some 7V) can have insulated terminals.

The low-voltage supplies to bias the silicon sensors (up to 550V) will have insulated terminals as well, but a voltage limiter between return and PE shall be provided. The (multiconductor) bias cable comes with a shield, and thus shall a voltage limiter for that shield as well be installed, and the connector at the intermediate patch panel shall ensure the shield’s continuity. See Appendix 3.

In an attempt to define the PE-conductor’s cross-section, we take the following extreme fault scenario:

- earthing of minus terminals of all bias supplies\(^2\) in combination with a global insulation fault on the ES side.

The supplies’ current limit is quoted to be 10mA per channel. We have foreseen at most 192 supply channels per endcap. The maximum fault current is thus 1.92A.

From this, we would be tempted to conclude that a gauge of 2.5mm\(^2\) would be more than sufficient. This ES-specific PE conductor will be no longer than approx. 30m. After that, it will connect to the heavy-gauge CMS PE system.

An adequate earthing of each individual "motherboard" can also be achieved. At most 5 supply channels feed such board. The "indirect contact" voltage in case of a board insulation fault would be limited to 50mA*470Ω or approx. 25V, see Appendix 2.

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1. often referred to as "floating"
2. due to erroneous manipulation, or voltage limiter giving way
Lexicon

VFE hybrid: very-front-end board, containing among others, the PACE chipset: pre-amplifier, shaper, analogue memory, multiplexer

Ceramic support: common holder and heat sink for Si sensor and VFE hybrid

Tile: aluminium block holding the ceramic support

Micromodule: assembly of tile, ceramic support, Si sensor and VFE hybrid

Ladder: a grouping of 7 to 10 micromodules. Each ladder is covered by a motherboard.

Motherboard: ADCs to read the PACEs out (differential transmission)

K chips to organize/serialize data, and prepare for optical transmission to the ES outside

distribute power through voltage regulators

distribute bias

take part in control ring (CCU chip)

Control Ring: grouping of up to 13 ladders, to receive fast signals (clock, L1 trigger, reset) and to send/receive slow control

Communication between a ring and the counting room: optical.

Communication between members (motherboards) of a same ring: galvanic: Token Ring: LVDS, apart from the Reset which is single–ended.

NO FAST GALVANIC SIGNALS BETWEEN ES AND OUTER WORLD

PE: Protective Earthing

Blue name: electrical “node” of specific importance

electrical connection, wire, conductor

unshielded multiconductor cable

cable shield

voltage limiter: high “impedance” for voltages lower than 50V in magnitude

MB: motherboard

FT: galvanic feedthrough. The outer drum, supporting all FT, is, in a way, the subdetector’s local patch panel.

Standard FT: dedicated to MB: distribute power, bias, and lines for voltage regulator management

Special FT: dedicated to DCS and artificial vessel heating

MB_GND: local “star point” (materialized as a single ground plane) of a ladder. Departure point for power returns and for bias minus
Star point construction and Protective Earthing

(quantities are for 1 endcap)

- MB (252x)
- MB_GND
- Rs = 470 Ω
- Rs

(absorber)

- tile
- outer drum

- other absorber

- other vessel parts (windows, inner drum)

- equipotential star point block

- insulated PE conductor (1x) fed through and exported to YE1 exit for connection to CMS PE system

ES vessel (enclosure) INSULATED from surroundings – cooling included

(heating power supplies with insulated terminals)

standard FT (38x)

special FT (2x)

this wire is the added conductor of the motherboard’s bias cable bunch)

Rs = 470 Ω
Bias (HV) distribution outside ES

Evidently, the metallic enclosures of supplies and switchboard are tied to PE (not shown)

In absence of safety–relevant incidents:
* active parts of bias at supply side: insulated
* active parts of bias system at ES side: referred to PE through ES global star point
* cable shield only connected to ES outer drum (ref. to PE through ES star point)