User instructions for CMS EE HV Distribution Crates [DEG 547]

(including the associated control, input and output cards)

Draft Version 0.3 : 27 February 2009

1. Overview

The DEG547 distribution crate, together with its associated cards, is designed to form part of the CMS ECAL Endcap HV distribution system. The overall system is described in [Camanzi document].

The distribution crate uses three kinds of plug-in cards:

- One “control card”, which manages the operation of the crate and handles the control signals which pass between the crate and the rest of the distribution system.
- Up to three “input cards”, each of which takes one pair of high voltage supplies (i.e. one anode supply and one dynode supply) from the HV power supply, monitors it, and distributes it to the output cards.
- Up to seven “output cards”, each of which takes the high voltage supplies from the input cards and distributes them to a group of twelve supercrystals.

2. The crate

2.1. View of front and rear of crate

[With one input card and one output card]

2.2. Power supply connections

The distribution crate is powered by low voltage supplies from the DEG548 low voltage crate. The supply inlet is on the rear panel.

To ensure the crate is properly earthed, even when the power supply is disconnected, the crate should be grounded using the M6 grounding stud on the rear panel.

2.3. Cages

There is a hinged bar (the “front cage”) across the front of the crate, to prevent any input or output cards being inserted or removed except when the HV supplies are turned off and all HV lines are discharged.

Similarly there is a “rear cage” at the rear to prevent any of the cables to the detector being inserted or removed except under those conditions.

Both cages are secured by quarter-turn fasteners. If either cage is opened, the crate is disabled and all HV lines are clamped.

2.4. HV-enabled and HV-disabled states

2.4.1. General

At any time, the distribution crate is either in the HV-enabled state or the HV-disabled state.

The current state is indicated as follows:

1. The “HV on” LEDs are lit when in the HV-enabled state, and unlit otherwise. (There is an “HV on” LED on the front panel of the control card, and another on the rear panel of the distribution crate.)
2. The “Control Out” signal (from the front panel of the control card) is HIGH when in the HV-enabled state, and LOW otherwise.

2.4.2. HV-enabled state

The distribution crate is in the HV-enabled state when it is powered and there are no trip conditions indicated.

When the distribution crate is in this state, the HV supplies can be operated normally to bias the detector.

2.4.3. HV-disabled state

The distribution crate is in the HV-disabled state when it is not powered or when there are one or more trip conditions indicated.

When the crate is turned on, it enters the HV-disabled state and remains in that state until there is a reset. (As explained in 2.5.4, at least the “5V” trip condition is always indicated under these circumstances.)

When the distribution crate is in this state, each of the HV supply lines connected to the crate is clamped to ground through a 2.2 kΩ resistance. This ensures that the supply lines to the detector are discharged and held at a safe voltage, even if the HV supply is still turned on.

The voltage and current monitors on the input cards still operate normally (if the crate is powered!) and so can be used to confirm the voltage on each supply line.

2.5. Trip operation

2.5.1. General

The distribution crate recognises a number of trip conditions. These conditions are listed below.

When a trip condition is detected, the appropriate indicator LED is lit. The indicator remains lit until a reset operation is performed after the trip condition has been removed. Therefore, merely removing the trip condition does not remove the indication.

The distribution crate is in the HV-disabled state whenever, and for as long as, a trip condition is indicated.

2.5.2. Trip conditions

External trip

A trip will occur if the “Control In” signal is LOW or missing.

This condition is indicated by the “Ext” LED on the front panel of the control card.

Cage open

A trip will occur if the front cage and/or the rear cage is open.

This condition is indicated by the “Cage” LED on the front panel of the control card.

Overvoltage

A trip will occur if any HV supply exceeds a built-in limit (approx 1.4 kV).

This condition is indicated by the “Anode Volts” or “Dynode Volts” LED on the front panel of the appropriate input card (depending on which voltage exceeded the limit).

Overcurrent

A trip will occur if the current drawn from any HV supply exceeds a built-in limit (approx 450 uA).

This condition is indicated by the “Anode Current” or “Dynode Current” LED on the front panel of the appropriate input card (depending on which current exceeded the limit).

Note: The relevant current is the current drawn by the supercrystals, i.e. it does not include the current drawn from the HV supplies by the pull-down resistors on the input cards themselves.

Power failure

A trip will occur if any of the low voltage power supplies fails (i.e. if the voltage drops below an acceptable level).

This condition is indicated by the “5V” and “15V” LEDs on the front panel of the control card (according to which supply or supplies have failed).

Of course, no LED is lit if the 5V supply is turned off completely, or is too low to light the LEDs.

2.5.3. Resetting the crate

A reset operation cancels any trip conditions which have since been cleared. Trip conditions which still exist (for example, if a cage is still open) are not affected.

If, as a result, there are no outstanding trip conditions, the crate enters the HV-enabled state.

There are two ways to perform a reset:

1. Press one of the green “Reset” buttons (which are on the front panel of the control card and on the rear of the distribution crate).
2. Change the “Control In” signal from LOW to HIGH.

2.5.4. Initial state

When the distribution crate is turned on, it always enters the HV-disabled state. The “5V” trip indicator will be lit. Other trip conditions will also be indicated if the relevant conditions are present.

3. Control card

The control card manages the operation of the crate and handles the control signals which pass between the crate and the rest of the HV distribution system.

Each distribution crate requires a single control card, which is placed in the card slot marked “CONTROL”.

3.1. Panel views

Figure 3.1 shows the front panel of the control card.

Figure 3.1 : Front panel of control card.

The “HV on” led and “reset” button are duplicated on the rear panel of the distribution crate as shown in figure 3.2.

Figure 3.2 : Part of rear panel of distribution crate.

3.2. Trip conditions

The control card triggers a trip of the distribution system if any of the following conditions occur. The LEDs on the front panel indicate which of these conditions caused a trip.

“Cage” : The front and/or rear cage is open.

“Ext” : The “control in” signal is missing or in the off state.

“15V” : The 15V power supply has failed or is inadequate.

“5V” : The 5V power supply is inadequate, or the crate has just been powered.

The “HV on” leds are illuminated when the crate is in the HV-enabled state.

The “reset” buttons cause the crate to be reset.

For more details about trips and resets, see section 2.5.

3.3. Control signals

There are two control signals, “Control In” and “Control Out”, which are intended to be connected to the CAEN HV power supply via the DEG548 low voltage crate (see [lv crate manual]).

Control In

This input signal is a TTL logic signal. A LOW input puts the distribution crate in the HV-disabled state; a HIGH input puts it in the HV-enabled state (unless there is some internal trip condition). A LOW to HIGH transition causes a reset.

This input is intended to be driven from the GEN output of the CAEN supply, via the DEG548 low voltage crate.

Control Out

This output signal is a TTL logic signal. It is LOW when the distribution crate is in the HV-disabled state, and HIGH when it is in the HV-enabled state.

This output is intended to be connected to the INTERLOCK input of the CAEN supply, via the DEG548 low voltage crate.

4. Input cards

Each input card accepts one pair of anode/dynode supplies (via the connectors on the rear panel of the distribution crate). It distributes these supplies to the output cards, monitors the voltages and currents, and initiates a trip if either voltage or current exceeds built-in limits. When the crate is in the HV-disabled state, the input card clamps its HV lines to ground (through 2.2 kΩ resistors).

Each distribution crate can have up to three input cards, which are placed in the card slots marked “INPUT 1”, “INPUT 2” and “INPUT 3”.

4.1. Panel views

Figure 4.1 shows the front panel of an input card.

Figure 4.2 shows the corresponding high voltage inputs on the rear panel of the distribution crate. As shown by the markings, each anode/dynode pair of connectors supplies the input card directly behind it.

Figure 4.1 : Front panel of input card.

Figure 4.2 : High voltage input connectors on rear panel.

4.2. Resistance to ground

The input card provides a resistance to ground.

When the crate is in the HV-enabled state, the resistance is 22 MΩ. This provides a path to discharge the supply cables when the supplies are turned off, and

When the crate is in the HV-disabled state, the resistance is 2.2 kΩ. This ensures the supply cables to the detector are fully discharged and do not have voltages exceeding safe levels, even if the HV supply is still turned on.

4.3. Voltage and current monitors

The input card provides monitor signals, via the front panel, showing the voltage on each supply and the current drawn by the supercrystals from each supply (i.e. *excluding* the current drawn by the resistance to ground on the input cards themselves).

The monitor outputs are analog voltages scaled as follows:

Voltage monitor: 1V represents 1kV.

Current monitor: 1mV represents 100nA.

There is an offset on the current monitor which may be a few mV, and is thus significant when measuring very small currents. However, nA currents can be measured if this offset is taken into account. [Add note about drift??]

4.4. Trip conditions

Each input card triggers a trip of the distribution system if the voltage on either supply, or the current drawn by the supercrystals from either supply, exceeds a built-in limit.

The LEDs on the front panel indicate which of these conditions caused a trip.

The limits are fixed by on-board resistors, and are approximately 1.4kV and 450µA (for both supplies).

For more details about trips, see section 2.5.

5. Output card

Each “output card” distributes the high voltage from the input cards to a single REDEL connector (supplying twelve supercrystals).

Each distribution crate can have up to seven output cards, which are placed in the card slots marked “OUTPUT 1” to “OUTPUT 7”.

5.1. Installation of output cards

Once an output card is plugged into a slot, it can be more securely fixed using the screw at the top of its front panel, as well as using the screw fixing to its right on the rear panel (see figure 5.1). The latter screw fixing also provides a better grounding of the cable screen. Be careful not to uses excessive force when tightening this screw.

Figure 5.1 : Rear fixing of output card.

5.2. Configuration of output cards

The output cards allow each supercrystal to be supplied by any of the three anode/dynode voltage pairs provided by the input cards. This is configured by making the appropriate wire links as follows. Figure 5.2 shows the wiring on an output card.

The three supply voltage pairs are brought to the central pins (marked A1, D1 etc). Pins A1 and D1 provide the anode and dynode voltages from the input card in the “INPUT 1” slot. Similarly A2 and D2 provide the voltages from “INPUT 2”, and A3 and D3 provide the voltages from “INPUT 3”.

The connections to the supercrystal anodes are made from the row of pins marked “ANODES” and labelled “1”, “5”, “9” etc. Similarly, the connections to the supercrystal dynodes are made from the row of pins marked “DYNODES” and labelled “3”, “7”, “11” etc. The numbers correspond to the pin numbers on the REDEL connector. The pins are arranged so that the anode and dynode connections for a given supercrystal are aligned on opposite sides of the board.

During manufacture, each output card is configured so that all supercrystals are supplied from “INPUT 1”. To reconfigure the board, remake the wiring of the pins described in the paragraph above. Ensure there is sufficient separation between wires connected to different supplies to allow for the voltage differences that may occur. A separation of at least 10mm, or wire with a suitably rated insulation, is recommended.

Only the wiring from the central pins to the “ANODES” and “DYNODES” pins should be modified by users. The wiring between the on-board pins and the connectors should not be modified.

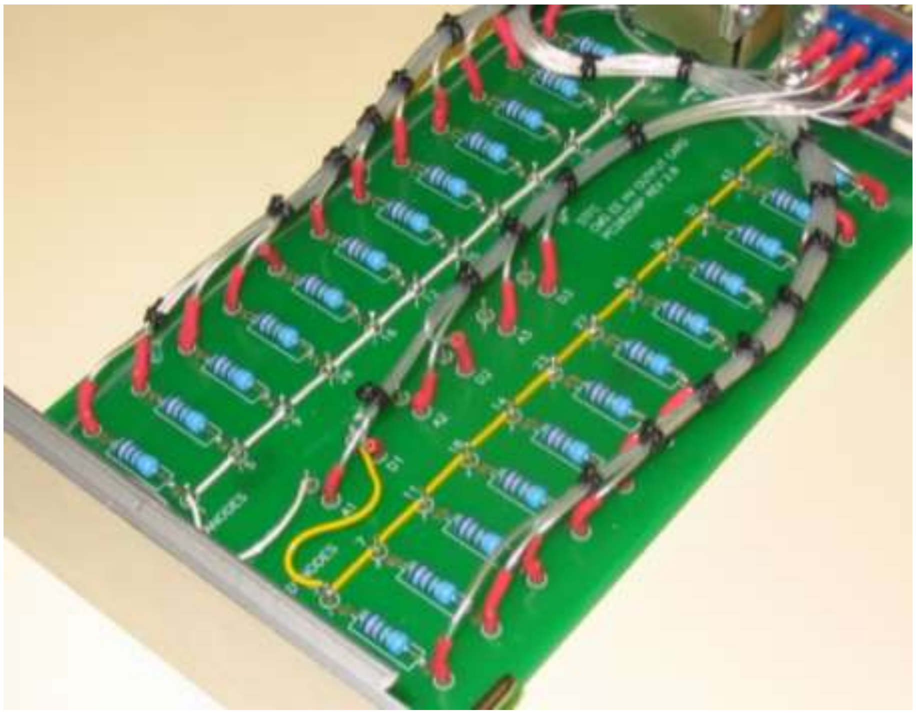

Figure 5.2 : Output card wiring.

6. General safety matters

This equipment has been designed to meet the requirements of safety standard EN 61010-1:2001 when used as part of the CMS EE HV distribution system or equivalent test rigs.

Safety may be impaired if the equipment is used otherwise than as described in this document. In particular, safety may be compromised if:

- Changes are made to the crate or cards (other than rewiring the output cards as described in section 5.2).
- The HV supplies are not limited to 1500V and 7mA (or less).
- The LV supplies are not limited to a maximum of 6A (or less).

7. Technical details

Power supply

Low voltage power requirements:

+5 V - 0.7 A
+15 V - 0.1 A
-15 V - 0.1 A

HV ratings.

Maximum voltage: 1500V.

Maximum supply current (for each input): 7mA.

Control signals.

The “Control In” and “Control Out” signals are standard TTL/CMOS logic levels.

Control In: LOW or Not Connected = Use HV-disabled state.
HIGH = Use HV-enabled state (if no other trip conditions).
LOW->HIGH transition = Reset.

Control Out: LOW = In HV-disabled state.
HIGH = In HV-enabled state.

Monitor signals.

Voltage monitors: 1 V represents 1 kV.

Current monitors: 1 mV represents 100 nA.

Connector types

Control and monitor signal connectors: LEMO 00.

Power connector: 4-pole LEMO 2B.

HV input connectors: SHV.

HV output connectors: REDEL SLG H51.

Earth point: M4 stud.

For the pin-outs of multi-pin connectors, see the relevant circuit diagrams.