## EPCT Board

The EPCT contains isolation transformers for critical generator voltage and current measurements. Two three-phase generator PT voltage inputs are input to EPCT. Two generator CT current inputs, with current levels of 1 A or 5 A, are input. In addition, one analog input, which can be either 0 - 10 V or 4 - 20 mA, is brought into EPCT. All the signals are interfaced to the EMIO board. For more information, refer to *Chapter 4* and *GEI-100459*.

**Note** EPCT receives and conditions generator PT and CT feedbacks.

## Exciter Customer Terminal Board (ECTB)

The ECTB supports excitation contact inputs and contact outputs. There are two versions: the ECTBG1 for redundant and the ECTBG2 for simplex applications. Each version contains two trip contact outputs for driving a customer lockout device (86G), and four general-purpose form-C relay contact outputs. Six auxiliary contact inputs are powered (wetted) with 70 V dc by ECTB. Also, the board processes 52G and 86G contact inputs.

## EXHS Board

The EXHS board supports pilot relay contact outputs, contact inputs, and signal conditioning circuits. EXHS cables to the EMIO board through the EBKP backplane.

**Note** EXHS handles field flashing and protection functions.

Pilot relays for the breaker/contactor close 41, and flashing contactors 53A, and 53B are located on the board, plus pilot relays for the trip relay 41T and the de-excitation relay KDEP. Crowbar status signals and de-excitation status signals from the EDEX board are conditioned on EXHS and sent to EMIO. Three contact inputs from 41, 53A, and 53B are powered (wetted) by 70 V dc on EXHS. Power for the contacts is from the M1 and M2 power supplies (redundantly), and the resulting status signals are sent to EMIO in the control rack. Different groups of EXHS are available for controlling either a field breaker or a contactor in the field circuit. These groups are defined in *EXHS Board Groups*. For more information, refer to *GEI-100475*.

*EXHS Board Groups*

| Type of Redundancy | Board | Control Mode | Trip Relay 41T used | Close Relay 41 used |
|---|---|---|---|---|
| Redundant control | EXHS G1 | Contactor Mode | No | Yes |
| Redundant control | EXHS G3 | Breaker Mode | Yes | Yes |
| Simplex control | EXHS G2 | Contactor Mode | No | Yes |
| Simplex control | EXHS G4 | Breaker Mode | Yes | Yes |

# De-excitation

During shutdown of the generator, the stored energy of the generator field inductance must be dissipated. In the EX2100 exciter, this is the function of the EDEX de-excitation module and field discharge resistor or inductor (when supplied).

Standard de-excitation is provided by a thyristor (33, 53, or 77 mm cell size) mounted in an assembly with attached snubber network and control board EDEX.

**Note** In the 42 mm optional non-inverting topology, de-excitation is provided through the free-wheeling diode located on the thyristor bridge heatsink.

The EDEX board contains Hall effect conduction sensors. The sensors are mounted in the air gap of a circular steel core attached to the board. They sense the magnetic field produced by the field discharge current flowing through the thyristor. Two independent sensor circuits are used. The EDEX fires the SCR when either of two control inputs is true or when the anode to cathode voltage of the SCR exceeds a certain value. The two firing control circuits on the board are powered from separate power supplies and use separate conduction sensors making them mutually independent.

The actual control logic inputs used are dependent on the application. When the exciter shuts down, a P24 V firing control signal is sent to both de excitation module firing control circuits. Both firing control circuits send gate pulses to fire the de-excitation SCR. At this point, the main field polarity reversal has occurred making the SCR anode positive with respect to the cathode. Therefore the SCR conducts and dissipates the stored energy of the generator field through the field discharge device.

Feedback from either conduction sensor verifies that the discharge circuit has operated successfully. If both independent firing control circuits fail to fire, the SCR is fired by the anode firing circuit when the anode to cathode voltage has exceeded the selected level.

For large exciters, it is possible to connect multiple de-excitation modules together with one EDEX board configured to be the *Master* and the other boards configured to be *Slaves.* In this case, a firing control signal sent to the master is relayed to the slave modules, firing all modules simultaneously.

EXHS controls the main breaker or contactor in the field circuit. When this opens, the auxiliary contacts cause an immediate de-excitation commanded by EDEX. De-excitation controlled by EXHS in both the contactor and breaker mode is shown in the figures *Dc Contactor Control and Wiring to De-Excitation Board*, and *Ac or Dc Breaker Control and Wiring to De-Excitation Board.*

Location of the 41A dc contactor in the field circuit is shown in the figure *Dc Field Circuit Contactor and Control Board*. Contactor 41B is optional. Both contactors are located in the power conversion cabinet (Dc exit case for 100 mm), and are driven from the 41 Close pilot on the EXHS board. Several auxiliary contacts are used to provide status feedback to the control, and firing commands to the de-excitation board, EDEX.

An alternative to 41A and 41B contactor is to use a breaker in the excitation ac supply or dc output field circuit. Normally, the breaker would be a dc field breaker that could break the output while inserting a discharge resistor with the normally open contact. But, an ac breaker with the SCR based de-excitation module could also be applied. The breaker has two coils, 41 Close and 41 Trip, and auxiliary contacts for de-excitation. Figure *Ac or Dc Breaker Control and Wiring to De-Excitation Board* shows an example breaker interface with the EXHS control board and EDEX.

# Crowbar

The optional crowbar subsystem limits high negative voltages that can be induced into the PCM during a pole slip (loss of synchronization) event. Like the de-excitation module, the crowbar will self-fire based on selective field voltage limits. It includes a discharge resistor, which may be shared with the de-excitation function when the two are supplied together. This is typically provided only on generators with salient poles (hydro applications). For the connections to the field, refer to the figure *Shaft Voltage Suppressor, Thyrite, and Crowbar.* The crowbar and de-excitation functions may be provided as a combined module in some EX2100 systems.

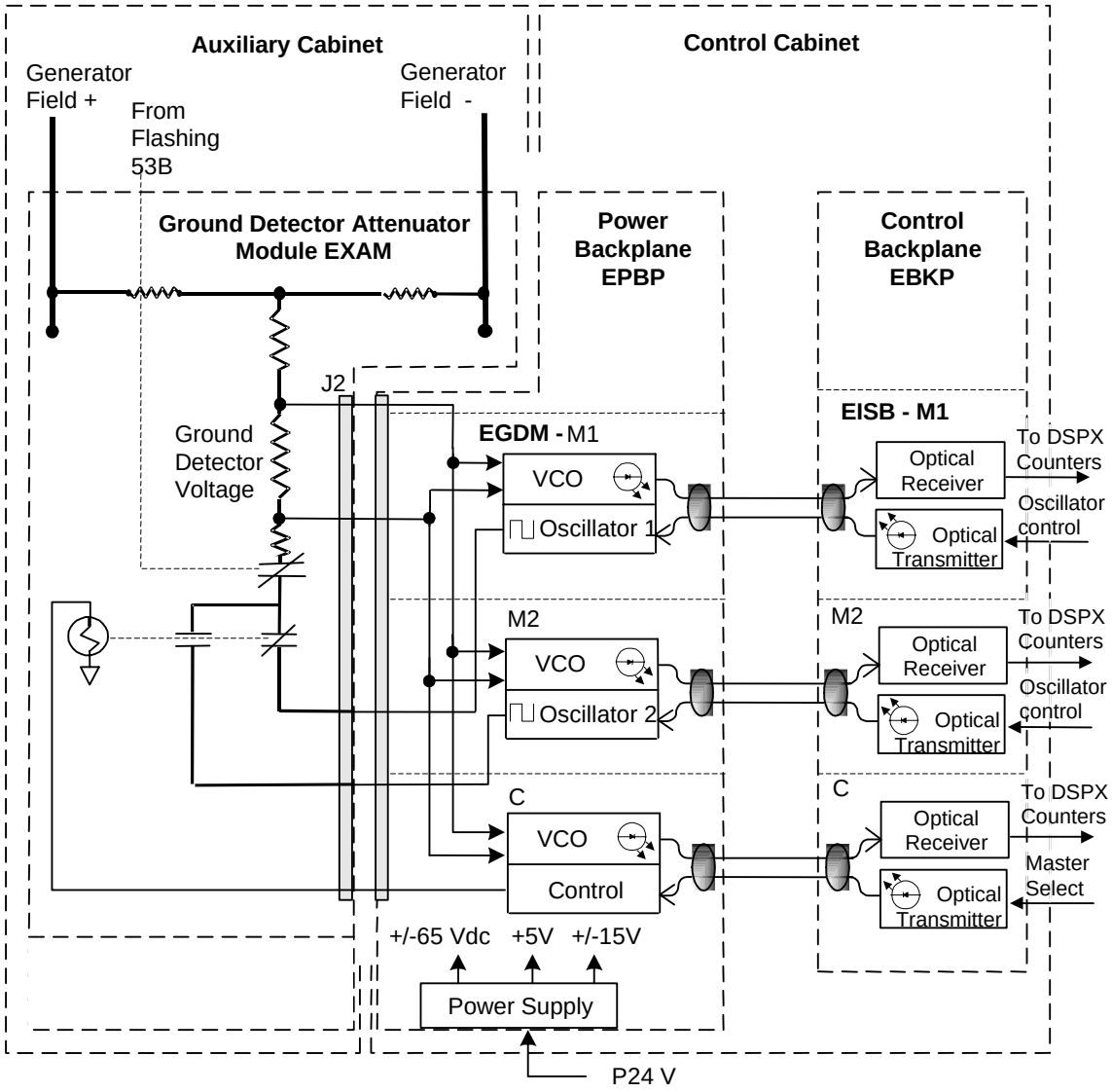
# Field Ground Detector

The generator field is an ungrounded system. The field ground detector (EGDM) detects field leakage resistance between any point in the field circuit of the generator and ground. The active detection system shown in the figure *Field Ground Detector* applies a low frequency square wave voltage with respect to ground, and monitors for current flow through a high impedance ground resistor. The square wave is ± 50 V dc at 0.2 Hz frequency. If PRV resistors are present, grounds anywhere in the system can be detected even while the exciter is not gating cells, from the PPT secondary to any point in the generator field.

**Note** The EGDM is an active system that applies a voltage to the field circuit.

The ground detector feedback voltage is sent over a fiber-optic link to the DSPX where it is monitored and alarmed. The DSPX controls the oscillator voltage over an adjacent fiber-optic link. In the case of redundant control, if the M1 controller fails, the oscillator in the M2 channel takes over, as commanded by controller C.

One or three EGDMs are mounted next to the power supplies in the power backplane. On simplex control applications, the ground detector function is provided by the EROC board.




*Field Ground Detector*

# *Field Flashing*

Field flashing relays 53A and 53B are controlled from drivers on the EMIO board, through pilot relays on EXHS. In redundant control, the three driver signals actuate pilot relays on EXHS that are contact voted to output a single voltage. These outputs actuate the 53A and 53B relays in the auxiliary cabinet. The 53A and 53B contacts put dc voltage from the station battery across the generator field, as shown in the figure *Field Flashing Control from EMIO and EXHS.* The field flashing module supplies approximately 15 to 20% of AFNL to the generator field during the startup sequence.

**Note** The station battery is used to initiate the field current. An auxiliary ac source can also be used.

For ac field flashing, the ac voltage is rectified by a diode bridge and filtered. The startup sequences and logic are the same.

## Dc Field Flashing Settings

Field flashing cabinets are used to supply a wide range of flashing currents. Configuring a maximum and minimum allowable value in the control module sets the flashing current magnitude required for a generator.

The current values are preset in the factory based on information supplied. These values define the envelope in which the hysteretic flashing control holds the field current during the flashing sequence.

## Flashing Control Sequence

A start request is issued by the operator. The optional field contactor(s) closes, followed by contactor 53B, then 53A. When the field current reaches the maximum allowable field flash value (typically 15 - 20% of AFNL), contactor 53A opens and the field current decays through the freewheeling diodes. If the control has not taken over before the current decays to the minimum field flash current setting, typically 10% AFNL, the sequence is repeated. If the current magnitude exceeds approximately 25% AFNL, or the control has not taken over after a fixed time delay, the startup is stopped and a diagnostic alarm is issued.

**Note** Flashing current flow is monitored by the control through the field shunt.

## Boost Operation

In brushless applications, the field flashing module may be used to support the boost function, whether flashing is required or not. Boost is used to power the field from the stationary battery when the PPT voltage has collapsed due to a terminal fault condition. A boost module may be present to limit the current applied. If so, both flashing current and boost current pass through the boost resistor module. Boost is typically applied for a maximum of 10 seconds should the PPT voltage fall below 75% of rated. Control software is included to protect the boost resistor from overload.