Application Note

## Configuring the PT/CT Module and SEF Option

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Introduction:

The PCD incorporates a separate module for direct interface and pre-signal conditioning of the external PT voltage and CT current secondary inputs. The PT/CT Module provides both signal isolation and signal scaling for the three phase voltage signals (V_a, V_c and V_c) and four phase current inputs (I_a, I_b, I_c and I_n). When configured for the SEF option, it provides the necessary low-level secondary signal scaling.

Description:

The PT/CT Module accepts four voltage inputs and four current inputs as shown in Figure 1: PT/CT Module. The PT/CT Module only installs in Slot F in the PCD case (see Figure 6: PCD Rear Module View).

Figure 1: PT/CT Module
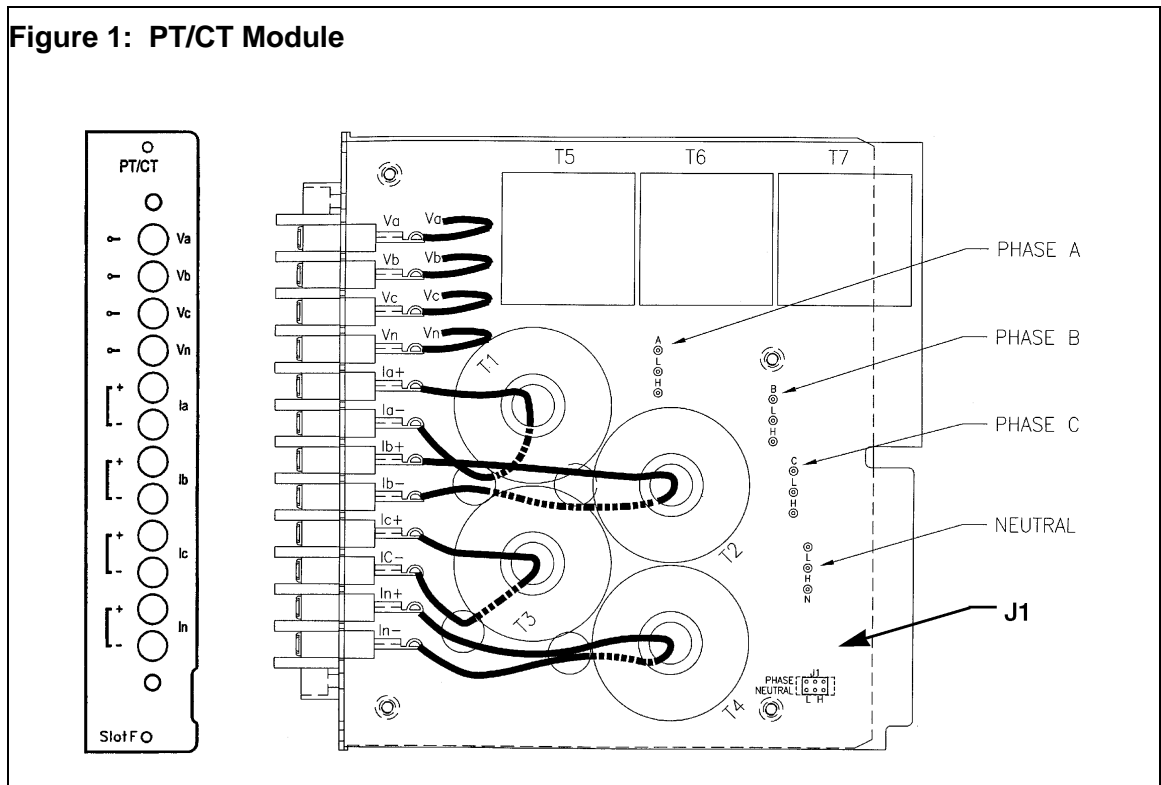
The PT/CT Module is comprised of six different types to accommodate varies CT tap and setting ranges. Each of the six Types is further divided into 3 basic CT Ratio groups which include; 1) Multi-Ratio Feeder CT, 2) 600:1 CT Ratio and 3) 1000:1 CT Ratio. Within each group the user can select with or without (w/o) Sensitive Earth Fault (SEF). Moving the

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NEUTRAL jumper will have no effect on the SEF range, which is always fixed (see *Sensitive Earth Fault (SEF) Option:*).

PT/CT Module Types are:

- **Type 1**: 600:1 Current Sensor w/o SEF (Discontinued – Reduced Range)
- **Type 2**: 600:1 Current Sensor w/SEF (Discontinued – Reduced Range)
- **Type 3**: 1000:1 Current Sensor w/o SEF (Discontinued – Reduced Range)
- **Type 4**: 1000:1 Current Sensor w/SEF (Discontinued – Reduced Range)
- **Type 5**: Multi-Ratio CT input (Current Input 1-16A or 0.2-3.2A) w/o SEF
- **Type 6**: Multi-Ratio CT input (Current Input 1-16A or 0.2-3.2A) w/SEF
- **Type 7**: 600:1 Current Sensor w/o SEF
- **Type 8**: 600:1 Current Sensor w/SEF
- **Type 9**: 1000:1 Current Sensor w/o SEF
- **Type A**: 1000:1 Current Sensor w/SEF

The PT/CT Module has two tap settings: HIGH tap and LOW tap. (Refer to Figure 2: PT/CT Module Tap Settings for Phase and Neutral) for the range and tap settings).

Figure 2: PT/CT Module Tap Settings for Phase and Neutral

| CT Module Group	Tap Setting	Range for Phase	Range for Neutral	Range for SEF (50N-2 setting for **Type 6** only)
Multi-Ratio CT: (Types 5 and 6) (Secondary current) *Feeder CT retrofit	Low	0.2 to 3.2 A (.02A steps)	0.2 to 3.2 A	5.0 to 200 mA (0.5 mA steps)
	High	1.0 to 16.0 A (0.1 A steps)	1.0 to 16.0 A	5.0 to 200 mA (0.5 mA steps)
CT Module Group	Tap Setting	Range for Phase	Range for Neutral	Range for SEF (50N-2 setting for **Type 8** only)
600:1 CT: (Types 7 and 8) (Primary current) *OVR and VR	Low	20 to 320 A (2A steps)	10 to 160 A (1A steps)	3.0 to 200 A (5A steps)
	High	100 to 1600A (10 A steps)	50 to 800 A (5A steps)	3.0 to 200 A (5A steps)
CT Module Group	Tap Setting	Range for Phase	Range for Neutral	Range for SEF (50N-2 setting for **Type A** only)
1000:1 CT: (Types 9 and A) (Primary current) *Cooper Retrofit	Low	20 to 320 A (2A steps)	10 to 160 A (1A steps)	5.0 to 200 A (5A steps)
	High	100 to 1600 A (10A steps)	50 to 800 A (5 A steps)	5.0 to 200 A (5A steps)

* Typical application of this module.

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CT Tap Setting Jumper Locations:

Figure 3: PT/CT Module Jumper Locations shows the locations of the referenced CT Tap Setting jumpers for Phase A, B, C and NEUTRAL.

Figure 3: PT/CT Module Jumper Locations
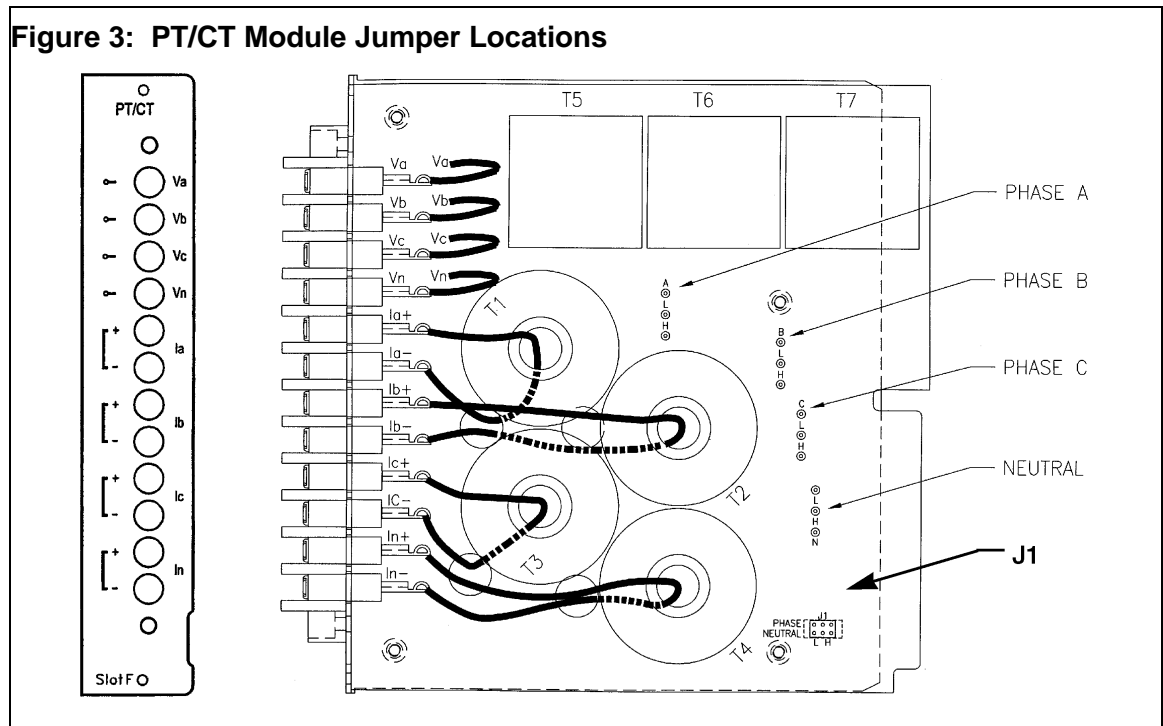
Setting the CT Tap Ranges:

1. Remove the PT/CT module from the PCD housing and identify the four red jumpers as shown in *Figure 3: PT/CT Module Jumper Locations* each phase and neutral, notice an "L" for LOW tap and an "H" for HIGH tap. Insert the jumper across the "H" to configure each phase for HIGH tap and across the "L" for LOW tap.

2. For correct operation, each phase CT (T1, T2 and T3) must have the same tap setting. However, the neutral (T4) tap setting can be different from the phase tap setting.

3. When the range settings for each CT is finished, locate the jumper labeled J1 to establish proper identification and operation of the PCD.

4. Insert the black J1 jumper with "H" to configure the PCD for HIGH range or across "L" for LOW range.

PHASE and **NEUTRAL** jumpers should match the respective "J1" Phase and Neutral CT configuration. The CPU reads the J1 jumper connection to identify the selected HIGH or LOW taps.

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Sensitive Earth Fault (SEF) Option:

SEF is applicable only to systems where all loads are connected line-to-line and there is no neutral or earth current flow unless an earth fault occurs. This option is not recommended for use on four-wire multi-grounded systems. All CT/PT modules have a separate I_N connection. In order to use the SEF function, place the I_N input in series with three external CTs, one on each phase, or connect one large window CT placed around all phase conductors. See *Figure 4: SEF Element Settings* below for applicable SEF settings. The SEF element also has a user-defined definite time characteristic.

The SEF pickup current is always set in secondary amperes (milliamps), regardless of whether the other protective settings are in primary or secondary amperes. To determine the desired pickup level for the SEF element, divide the desired minimum trip current (primary amperes) by the CT ratio of the selected CT. The value must fall within the range given in *Figure 2: PT/CT Module Tap Settings for Phase and Neutral*. Enter this value in the Pickup Amps field for the 50N-2 element. The accuracy of this feature is dependent on the accuracy of the CT at the fault level.

Note: The SEF element can be Enabled or Disabled in the Primary, Alternate 1 and Alternate 2 setting groups. The default is disabled. The SEF element is available as an option with the PCD and is set using the 50N-2 element. If the PCD was ordered without the SEF option, the SEF Blocked target LED on the front panel will be lit at all times, except on the enhanced front panel (the enhanced front panel has a "3" as the third digit in the PCD catalog. In the case of the enhanced front panel, the SEF function can be controlled through programmable logic and an external toggle switch, or via SCADA. Note that the SEF function is also controlled by the Ground Block operation. The SEF Disable control operation, however, does not control the Ground block status.

Figure 4: SEF Element Settings	
SEF Setting	Description
SE CT Ratio	Specification in Configuration Settings indicating the neutral CT ratio. The setting range is 1 to 2000. Note: This is only for the CT connected to the I_N terminals.
50N-2 Curve	Sets the type of ground fault protection to be used. Selections are: Disable, Enable (uses regular definite time curve), SEF and Directional SEF.
SEF Pickup	Pickup threshold setting in amperes (secondary current). The setting range is 3 to 200 mA, increment 0.5 mA.
50N-2 Time Delay	Delays tripping. The setting range is 0.5 to 180 sec, increment 0.1 sec.

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Figure 4: SEF Element Settings

SEF Setting	Description
50N-2 Torque Angle	Applies only when Directional SEF element is used. Torque angle is the normal angle at which I_0 lags/leads V_0. The unit will be set to trip in the opposite hemisphere. See the section on 67N for more details. The setting range is 0° to 355° in 5° steps. Requires three voltage transformers.
N Cold Ld Time	This setting is a separate Neutral Cold Load Timer that applies only to the SEF element.

The analog and digital filtering provide a rejection ratio of third harmonic greater than 50:1 to prevent incorrect operation due to the effects of distribution transformer excitation currents. For closed loop schemes or ungrounded systems, a directional SEF model is available. The directional unit is polarized by a separate zero sequence voltage input (V_0). The potential transformers should be connected wye-grounded. The minimum polarization voltage is 2 volts and the torque angle can be set from 0° to 355° in 5° steps with a sector width of 180°. The SEF tripping can be enabled or disabled in each step of the reclose sequence. It can also be supervised torque controlled by mapping the SEF logical input to a physical input for external supervision or logical output and feedback for internal supervision.

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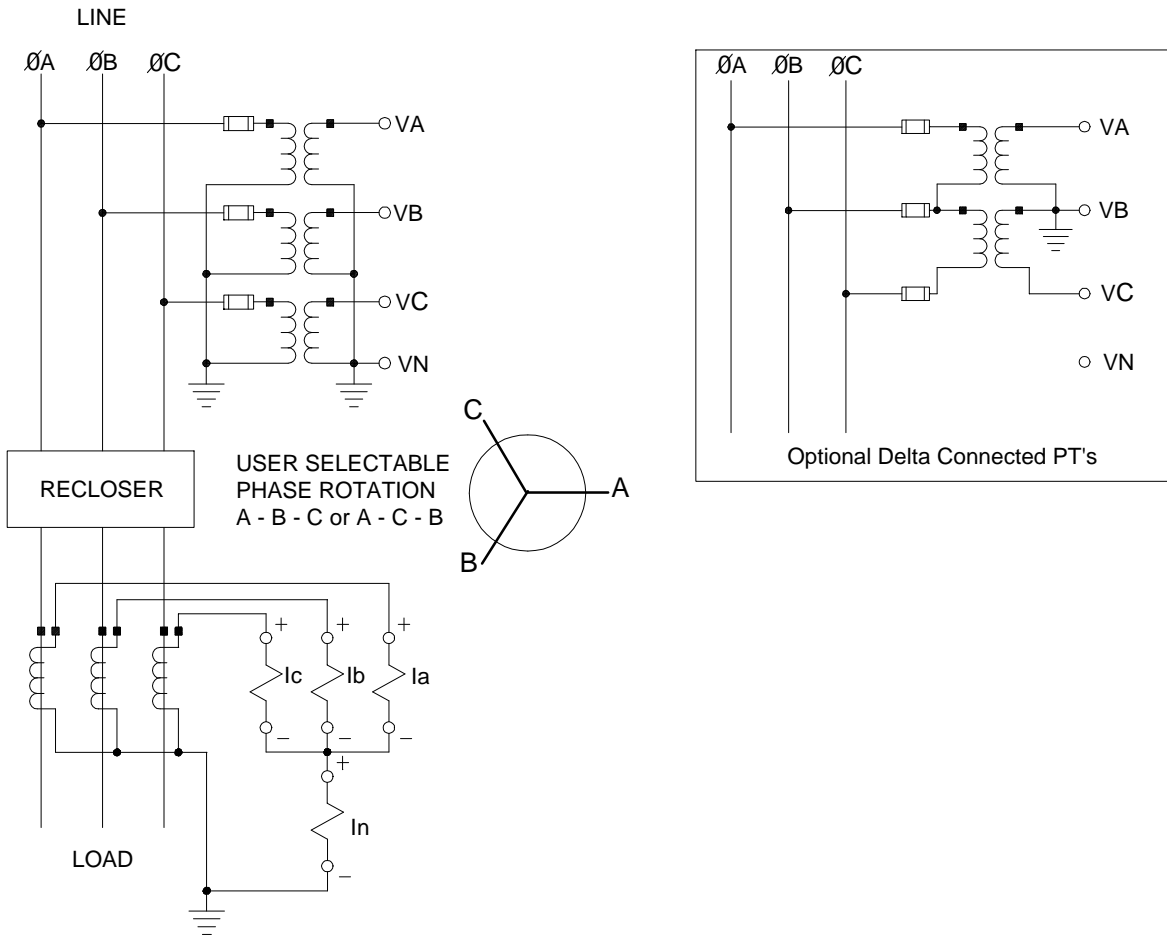**Figure 5: Typical External Connections**

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PCD Rear Module View:

The following figure shows the rear module view of the PCD. The PCD uses a six-slot card case with the **Slots** defined as follows:

- Slot A: **PS** or **UPS Type 1,2,3 or 4** (Power supply card)
- Slot B: **DIO Type 2** or **DIO Type 1** (Magnetic Actuator FET card or Binary Input/Output card)
- Slot C: **DIO Type 1** – (Binary Input/Output card *if installed*)
- Slot D: **CPU Type 1 or 2** (Central Processing Unit card)
- Slot E: **COM Type 2, 3, 4 or Type** 5 (Communication card *if installed*)
- Slot F: **PT/CT Type 5, 6, 7, 8, 9 or A** (Analog voltage and current card)

As can be seen in the photo, the modules are lettered **Slot A** (far left - UPS) through **Slot F** (far right – PT/CT). The **Slot** designator is located on the bottom of the module silkscreen panels. It is important to note that the module types are fixed to specific **Slot** positions. You can **NOT** mix modules and slots.
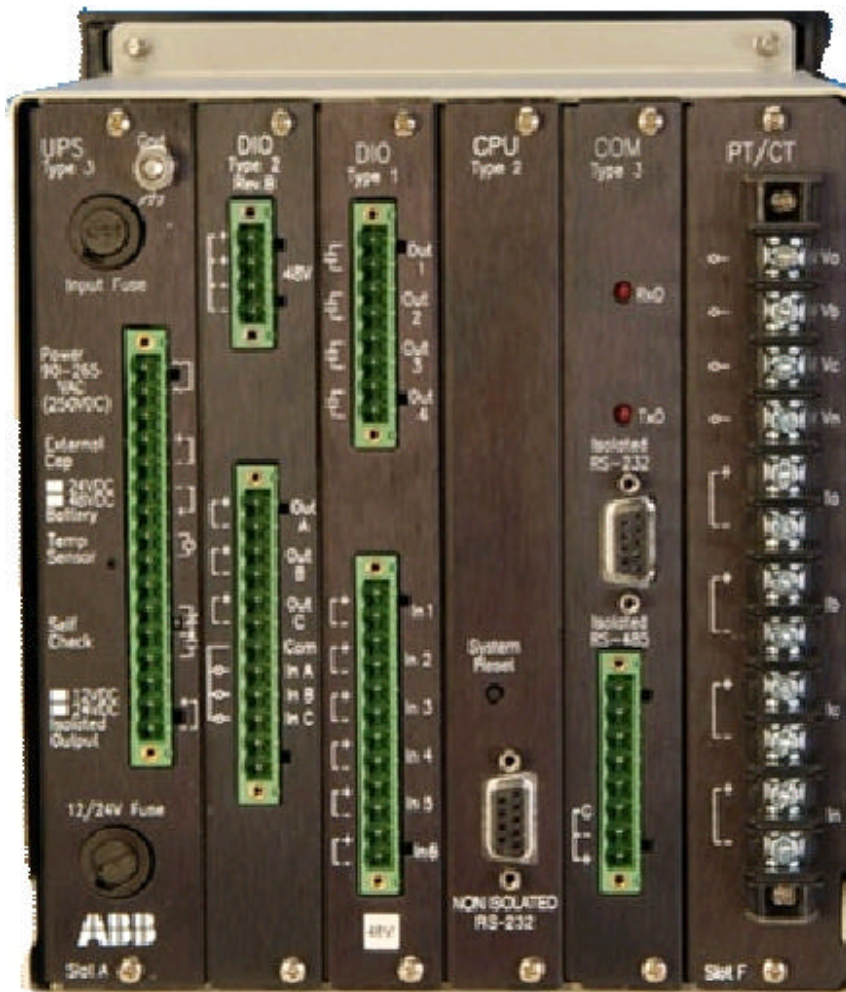

Figure 6: PCD Rear Module View

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