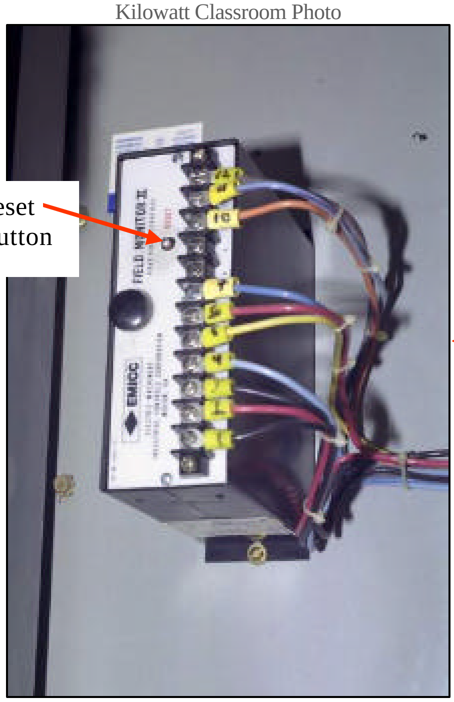
Field Monitor Relay

Purpose

Pictured below is the Dresser Rand (EEMIC) Field Monitor II relay used to provide pull-out protection for large synchronous motors (IEEE Standard Device Designation 78) . The Field Monitor Relay measures the power factor of the motor and trips the motor stator and DC exciter field if synchronism is not achieved within a specific length of time or if the motor pulls out-of-step while running. Connection of the field monitor relay in the synchronous motor control scheme is shown in simplified form on Sheet 5 and a detailed connection diagram of the current and potential inputs is provided on Sheet 8. **Note: This article provides general installation and operation information only. If troubleshooting or installing a similar system, be sure to use the exact relay connection diagram and system prints for the specific switchgear.**

Field Monitor Relay
Detail

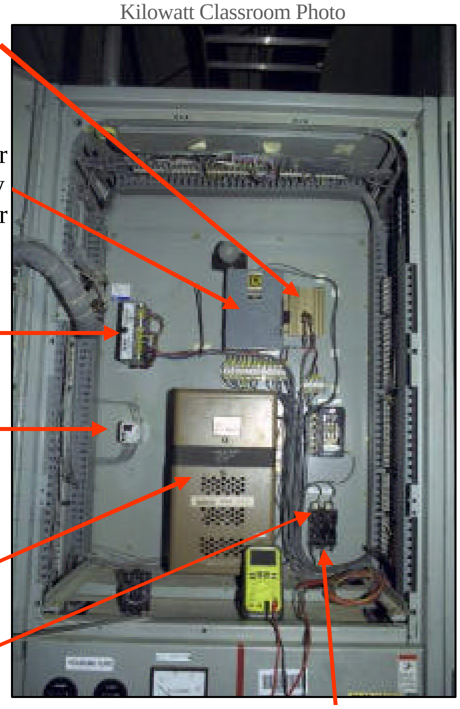
Kilowatt Classroom Photo



See connection diagram on Sheet 8.

Sync Motor Field Excitation Cubicle
Component Arrangement

Kilowatt Classroom Photo



DC leads to exciter stationary field.
See diagram on Sheet 4.

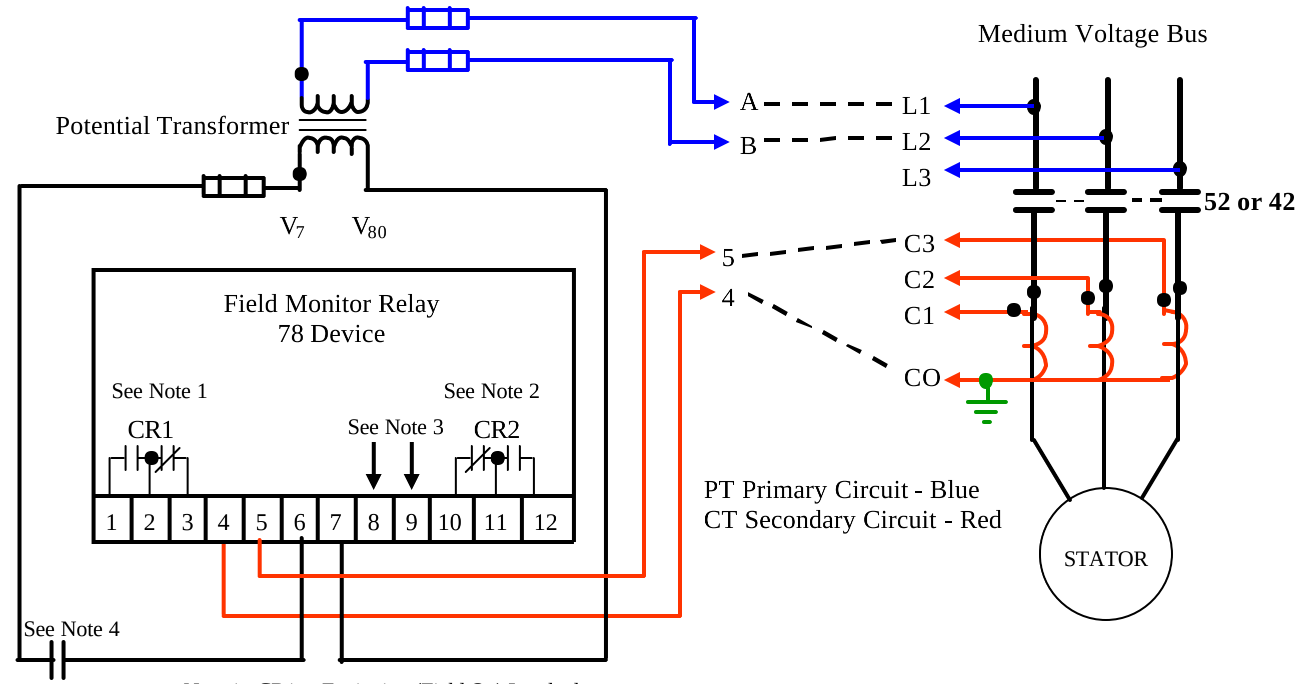
Relay Connections

For correct connection of the relay, the rotation of the system must be known and a single-phase voltage and current of the correct phase relationship and polarity must be supplied. To assist the user in this regard, the manufacturer provides the Connection Table shown on the following page. The basic field monitor connection criteria are as follows:

- The voltage connection is line-to-line and the required matching current in derived from the other phase.
- For the correct connection, the applied field monitor current will *lead* the applied voltage by 90^{o} when the synchronous motor is running at unity power factor.
- If the polarity of the voltage is reversed, the correct connection can be maintained by reversing the polarity of the corresponding current.
- To verify correct connection of the current and potential, the analog output terminals 8 (-) and 9 (+) of the Field Monitor II Relay can measured. This voltage will be about 4 VDC with the system at unity power factor. The DC analog output voltage will *increase* toward a maximum of 8 VDC as the system goes *leading* and will *decrease* below 4 VDC as the motor runs *lagging*.

Field Monitor Relay
Connections

Connection Diagram
Dashed lines show example connection.



Note 1: CR1 - Excitation (Field On) Interlock.
Note 2: CR2 - Cage Winding Protection Interlock. To 52 circuit breaker trip or 42 contactor hold coil.
Note 3: Analog Output - 0 to 8 VDC proportional to motor power factor.
Note 4: When motor starts, auxiliary contact applies voltage to field monitor relay to initiate timer .

Field Monitor Connection Table
(Highlighted areas show connection example.)

If A & B Voltage is connected as shown	And the phase sequence is: 1- 2 - 3						And the phase sequence is: 3 - 2 - 1					
A	L1	L3	L2	L1	L3	L2	L1	L2	L2	L3	L3	L1
B	L3	L1	L1	L2	L2	L3	L2	L1	L3	L2	L1	L3
Connect 4 & 5 Current as shown												
4	C2	CO	C3	CO	C1	CO	C3	CO	C1	CO	C2	CO
5	CO	C2	CO	C3	CO	C1	CO	C3	CO	C1	CO	C2

Determination of PT and CT Connections

Assume when measuring the system phase rotation at the bus potential transformer secondary fuses (see photo on Sheet 9) it is determined that the system rotation is L1, L2, L3. Assume also the Field Monitor voltage input is connected with L1 to Terminal 6 (follow Line 1 through the transformer to V_7), and L2 to Terminal 7 (follow Line 2 through the transformer to V_{80}), For these conditions, the current transformer input must be connected with Terminal 4 to CO and Terminal 5 to C3. The correct phase relationship can verified by measuring the analog output of the Field Monitor as described on the preceding page.

Field Monitor Relay
Verifying System Phasing & Rotation

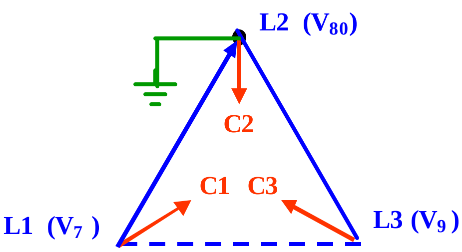
System Phasor Diagram

In this example, assume two Bus Potential Transformers (PT's) are used and they are connected in an open-delta configuration. The 120 volt secondary phase designations are V_7, V_{80}, V_9, with B-Phase (Line 2) being grounded. This ground is indicated by the V_{80} labeling where the suffix "0" indicates a grounded connection. (If Line 2 were not grounded, it would be referred to a V_8).

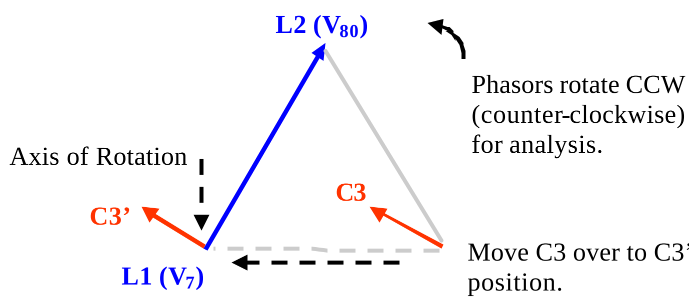
Assume also that the system rotation was shown to be L1, L2, L3 using the phase rotation indicator. The delta would be labeled as shown in the diagram below left. Because phasors are always rotated counter-clockwise for analysis, a reversed system rotation would be shown by re-labeling the delta as L1, L3, L2, or L3, L2, L1. (On a three-phase system, reversing any two leads changes the rotation.)

The phasor diagram shown below right has been constructed to illustrate the 90 degree phase relationship between the current phasor C3 and the L1-L2 voltage phasor and shows the current leading the voltage by 90^{o} as required for proper operation of the Field Monitor II Relay. Using a similar process the other voltage and current combinations in the Connection Table can be analyzed.

To construct the phasor diagram shown on the right, keep L1-L2 phasor in its original orientation and move the tail of the C3 phasor over to tail of L1-L2 phasor without changing the angular relationship of C3. The tail of the C3 phasor is CO.



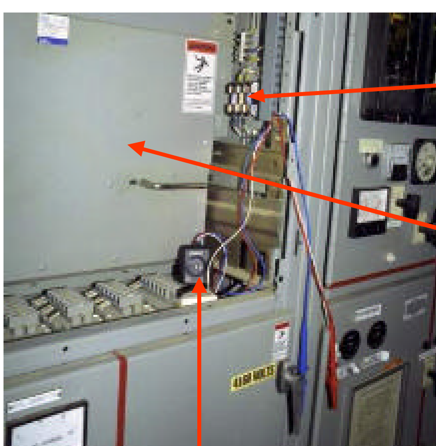
PT & CT Secondary Phasors



Relationship of L1-L2 Phasor to C3 Phasor
Showing C3 leading L1-L2 by 90 degrees.

Phase Rotation Measurement Example

Switchgear Bus PT Cubicle

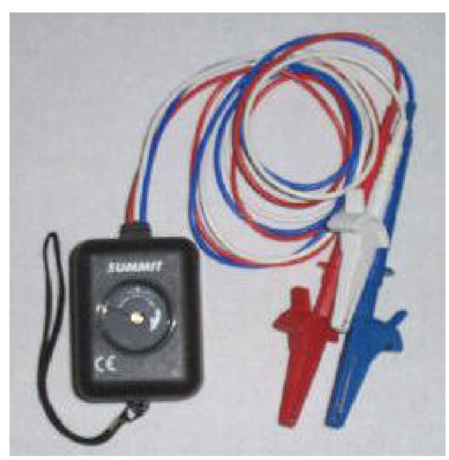


PT Secondary Fuse Block
Phase rotation check was made at this location.

Potential Transformers (PT's) and high voltage fuses located behind swing-out panel.

Phase Sequence Indicator
Used to establish system rotation as required for correct Field Monitor II connection. See table on Sheet 8.

TPI Phase Sequence Indicator



The sequence indicator leads are connected:
Red - Line 1, White - Line 2, Blue - Line 3.
The disk turns clockwise for a L1, L2, L3 system rotation, and runs counter-clockwise if the rotation is reversed.