CEH

Loss of Exitation Relay

For high speed detection of loss of excitation for generators.

Features and Benefits

- High speed tripping
- Drawout case

Applications

- Generators (all types)

Protection and Control

- Loss of excitation
- Impedance unit
- Second z unit with a timer available

Application

The CEH relays are used for the detection of the loss of excitation of synchronous generators, and to automatically remove the generator from service. Loss of excitation can be damaging to the machine, and/or detrimental to the operation of the system. It is recommended that loss-of-excitation protection be considered for all synchronous generators.

Fig. 1 illustrates a unit generator connected to a power system with an offset Mho distance relay at its terminals set as indicated on the R-X diagram. The relay is set with an offset equal to one half the direct axis transient reactance, and a diameter equal to the direct axis synchronous reactance of the generator. Typical impedance loci, as seen by the relay when the excitation is lost as a result of a short circuit across the field windings, are also shown in Fig. 1. Curve A represents loss of excitation from full load conditions. This locus terminates in a region near the negative X axis at a point located approximately at the average of the direct and quadrature axis sub-transient impedances of the generator. In the case of no load, or very light load prior to the loss of excitation, the impedance seen by the relay terminates in an area near the negative X axis as shown by point C. The impedance seen in this case is approximately equal to the average of the direct and quadrature synchronous impedances of the generator. Curve B applies for some moderate condition between full and no load. Thus, the characteristic of Fig. 1 will suffice to detect a loss of excitation from any initial loading. Since a characteristic with settings as illustrated in Fig. 1 is required to detect loss of excitation, it should be ascertained that such an application is secure against undesired operation on stable system swings resulting from system disturbances.

Fig. 2 illustrates typical impedance loci as viewed by two offset Mho relays located at the generator terminals for different system conditions after a nearby fault is cleared. Two Mho characteristics are shown; the larger one with settings as shown in Fig. 1, and the Loss of Exitation Relay one set with a diameter equal to the impedance of 1.0 per unit on the machine base. Referring to Fig. 1, a loss of excitation will be detected by the Mho unit set with the larger characteristic regardless of the load on the generator, whereas the Mho unit set with the Loss of Exitation Relay characteristic will only detect the loss if the generator is operating with a moderate to heavy load.

The dash curve A in Fig. 2 represents the case for conditions of a three-phase short circuit at F, the high side of the unit transformer, occurring when the machine is running at full load and unity power factor La. The fault was cleared at the critical switching time, that is, the maximum switching time for which the machine is just stable. When the fault is cleared in nominal relay plus breaker times with the voltage regulator in service, the impedance jumps to point Sa and follows the path of the dash lines back to the region around La. This is a stable swing, and the impedance path does not enter either characteristic.

Fig. 1 Typical impedance loci on loss of field excitation

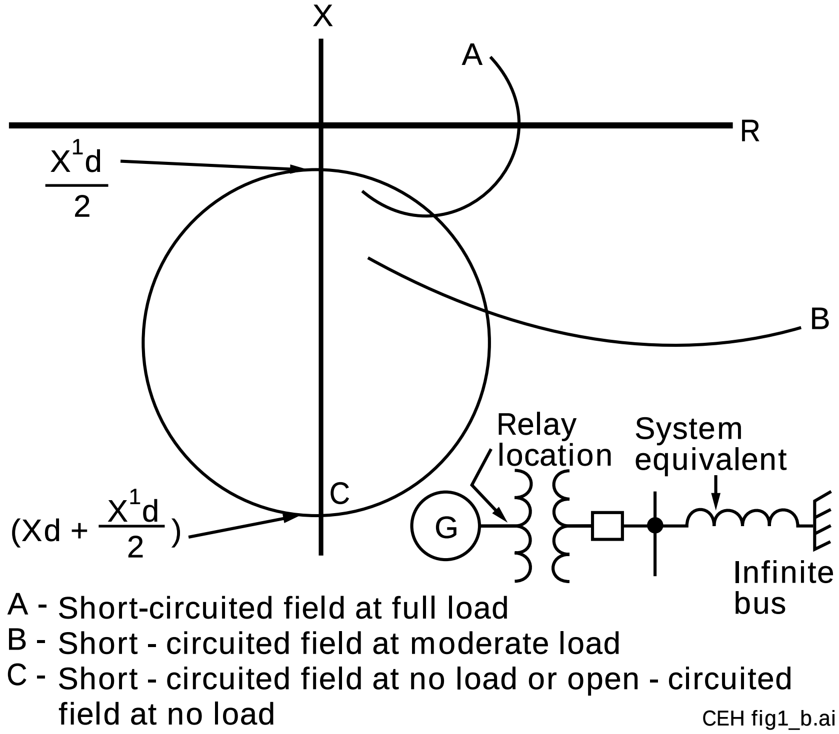
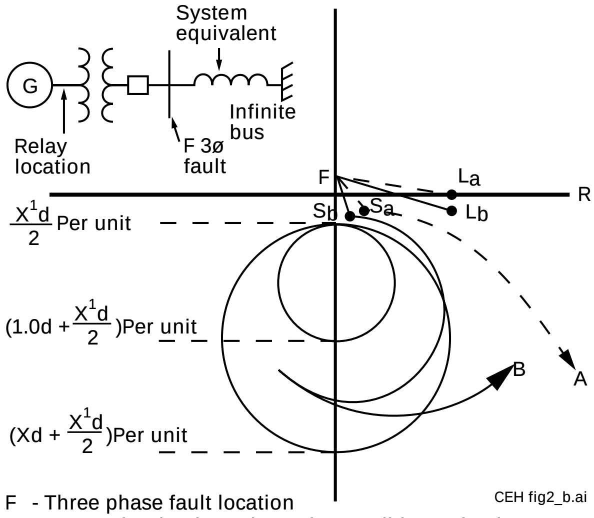


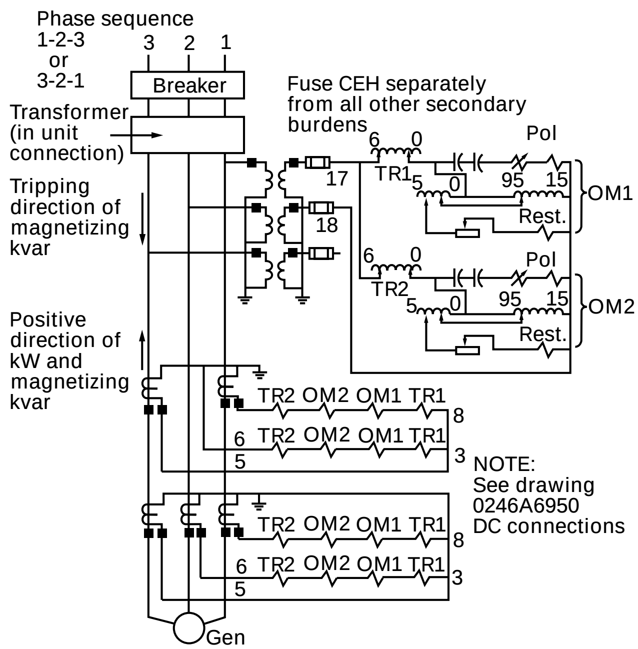
Fig. 2. Typical impedance loci for swings resulting from system disturbances



F - Three phase fault location
A - Locus of swing impedance for conditions of unity power factor load, and/or fast fault clearing, and/or voltage regulator in service (dashed lines)
L_a - Unity power factor 1.0 per unit load impedance.
S_a - Impedance immediately after fault is cleared.
B - Locus of swing impedance for conditions of leading 0.95 power factor load, and fault clearing at critical switching time, and voltage regulator out of service. (solid lines)
L_b - 0.95 Leading power factor unit load impedance.
S_b - Impedance immediately after fault is cleared.

Connection Diagram

Fig. 3. External AC connections for CEH52A relay using wye connected PT's



The solid curve B illustrates an extreme case of a similar set of circumstances. In this case:

a. The machine was running under-excited prior to the fault L_b.

b. The fault was not cleared until the critical switching time for the machine in question.

c. Low system impedance.

d. The voltage regulator was out of service.

While the resultant swing was stable and would eventually settle back to the area around Lb, the impedance locus entered the larger relay characteristic. Studies indicate that the duration of its stay in the characteristic is in the order of 0.2 to 0.4 sec. Thus, if the larger relay characteristic is employed with a time delay set for about 0.5 to 0.6 sec, undesired tripping will not take place.

Thus, a Mho relay set as in Fig. 1 can detect a loss of excitation for all machine loadings, but it is susceptible to tripping during a stable swing if the conditions of Fig. 2 exist. If two Mho functions are used, and set with the diameters shown in Fig. 2, time delay can be incorporated with the larger set function, and incorrect tripping can be avoided. The Loss of Exitation Relay set function will provide high-speed tripping for a loss of excitation when the machine is carrying moderate to heavy loads. It should be recognized that a bonafide loss of excitation, when the machine is lightly loaded, may be detected only by the Mho function set with the larger characteristic. This will result in a delayed trip which may have an adverse effect on the system. This contingency should be evaluated by the user.

Two models of the CEH relay are available for use in loss of excitation detection schemes.

The first model, designated the CEH51A, contains a single Mho function. It is designed primarily for use in those applications where the impedance loci will enter the characteristics due only to a loss of excitation; for example, for the conditions shown in Fig. 2.

The second model, designated the CEH52A, Fig. 3, is designed specifically for use in those applications where the impedance loci can enter the required characteristic for other system conditions as well as a bonafide loss of excitation; for example, for the conditions depicted in Fig. 2. This relay contains two independent Mho functions and a built-in timer that operates in conjunction with one of the Mho functions. The Mho function without the timer can be set short, as shown in Fig. 2, to provide high-speed tripping for a loss of excitation when the machine is carrying moderate to heavy loads. The second Mho function can be set larger as shown in Fig. 2, and through the built-in timer provide a delay in tripping so that the machine will ride through any stable swings that may occur. External connections for the CEH52A relay are shown in Fig. 3.

Selection Guide

Rating			Auxiliary Unit Voltage	Characteristic Circle Diameter (Ω)[1]		Offset (Ω)		T. & S.I. Rat. (A)	Time Delay (Sec)	Model Number	Case Size	Approx. Wt. in lbs. (kg)	
Volt	Frequency (Hz)	Current (A)		Min	Max	Min	Max					Net	Ship
SINGLE PHASE — 1 MHO UNIT													
115	60	5	24/48 48/125 125/250	5	50	0	4	0.2/2.0		CEH51A6A A4A A1A	M1	24 (10.9)	35 (15.9)
115	50	5	110/220 125/250	″	″	″	″	″		CEH51A5A A3A	″	″	″
SINGLE PHASE — 2 MHO UNITS, 1 STATIC TIMER													
120	60	5	125/250	10	100	0	6	0.2/2.0 0.6/2.0	0.05-3.0	CEH52A2D A1D	L2D	34 (15.4)	45 (20.4)
120	50	5	110/220	10	100	0	6	0.6/2.0	0.05-3.0	A3D	L2D	34 (15.4)	45 (20.4)

[1]Phase to neutral secondary basis.

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