



# Overcurrent Elements for Feeder Protection in the F60

**GE Publication No. GET-8394**

Copyright © 2002 GE Power Management

---

## Introduction

---

### **F60 FEATURES**

The GE Power Management F60 Feeder Protection Relay is intended for feeder protection and includes numerous features required to provide complete feeder protection against all types of faults in different system conditions. The relay includes several overcurrent elements for protection against phase-to-phase and phase-to-ground faults in solidly grounded, impedance grounded or ungrounded systems.

For protection against high impedance phase-to-ground faults (associated or not with a down conductor) in a solidly grounded system, a high impedance (Hi-Z) element is provided. *The element requires a special DSP that must be ordered if this feature is desired.*

The relay also includes various under and overvoltage elements, under and overfrequency elements, breaker failure protection, autorecloser and synchrocheck schemes, and additional specific functions such as Breaker Arcing Current, Cold Load Pickup, and VT Fuse Failure.

This document is a guide for setting the F60 overcurrent elements for feeder protection.

### **OVERCURRENT ELEMENTS OVERVIEW**

A number of instantaneous and inverse time delay overcurrent elements (phase, neutral, ground/sensitive ground, and negative sequence) are available in F60. Ideally, overcurrent settings must be sensitive to short circuit/overload currents, coordinate with upstream and downstream devices, and be set above maximum load (or maximum unbalance current).

The phase TOC elements include voltage restraint capability for situations where the fault to load ratio is low. For detecting unbalanced faults and for more sensitive protection against phase-to-phase faults, instantaneous and time delay negative sequence overcurrent elements are available. All instantaneous overcurrent elements can be used as instantaneous elements with no intentional time delay or as definite time elements (when necessary for coordination purposes).

All overcurrent elements can be assigned up to 8 different settings according to the setting group designation 1 to 8. Multiple setting groups provide the capability to automatically change settings for different system conditions (cold load pickup, changing settings between autorecloser shots, etc.).

To establish overcurrent elements settings, the following data are necessary:

- a single line diagram including equipment significant characteristics: lines, cables, generators, motors, transformers, circuit breakers, CTs, VTs, relays, fuses, normal and emergency operating conditions
- a short circuit study for the system
- maximum expected load on feeders and transformers
- maximum expected unbalance current
- existing settings on adjacent equipment

---

## Phase Overcurrent Elements

---

### PHASE INSTANTANEOUS OVERCURRENT (50P)

Two instantaneous overcurrent elements are available in the F60. Typical applications for these elements includes:

- A high set instantaneous overcurrent intended to operate for close faults with high short circuit current. In some applications this element can be used to block the autorecloser. The setting applied is usually higher than the maximum short circuit current beyond the closest downstream device (breaker or fuse) and above the feeder inrush current. This setting should prevent the high-set overcurrent from unselectively tripping the feeder breaker for faults on taps, which will normally be cleared by the tap fuse (unless a fuse-saving scheme is preferred).
- A low-set instantaneous element is used for further coordination with the downstream devices, for enhanced equipment protection against the damaging effect of the fault currents and used in fuse-saving schemes.

### PHASE INVERSE TIME OVERCURRENT (51P)

Two inverse time overcurrent elements are available in F60. The settings of these elements must be coordinated with the downstream and upstream devices, be above the feeder maximum load current, and be sensitive to the end feeder short circuit current. To satisfy these conditions, the appropriate pickup, time delay, reset characteristic (fast or induction disc emulation), and curve type settings should be selected. When coordination with electromechanical relays is required, the induction disc reset must be considered.

---

## Neutral/Ground Overcurrent Elements

---

### DESCRIPTION

Several neutral and ground overcurrent elements are provided for protection against phase to ground faults. The neutral overcurrent elements respond to the calculated neutral (residual or unbalance) current, as the sum of the phase currents:  $I_n = I_a + I_b + I_c$ .

The ground elements respond to the current connected to the relay ground current terminals ( $I_G$ ), typically from a ground current source (core-balance CT or a CT installed on the ground connection of the system neutral).

On three-phase, four-wire systems it is not always possible to balance perfectly the single phase loads among the three phases and a significant residual current may occur in normal operation condition. The setting of the neutral overcurrent protections must be above this residual current.

**NEUTRAL INSTANTANEOUS  
OVERCURRENT (50N)**

There are two Neutral Instantaneous Overcurrent elements available. The setting of neutral instantaneous elements must be higher than maximum phase to ground short circuit current beyond the closest downstream device and also must be higher than the maximum unbalanced load current on the line. In some applications this element can be used to block the autorecloser.

The second element may be applied as a low-set function in autoreclose applications. In this case, the element trips instantaneously for any feeder ground fault. The block function would be used to inhibit operation on the first reclose attempt to allow coordinated clearing of permanent faults.

**NEUTRAL INVERSE TIME  
OVERCURRENT (51N)**

The setting of these elements must be coordinated with the downstream and upstream devices, must be above the feeder maximum residual current, and must be sensitive to ground faults at the end of the main feeder. To satisfy these conditions, the appropriate pickup, time delay, curve type and reset characteristic (fast or induction disc emulation) settings should be selected. When coordination with electromechanical relays is required, the induction disc reset must be considered.

**GROUND/SENSITIVE  
GROUND INSTANTANEOUS  
& INVERSE TIME  
OVERCURRENT (50G/51G)**

These settings should be selected similar to the neutral elements. When increased sensitivity for ground protection is required, a sensitive ground input is available. This input is 10 times more sensitive than the standard ground input. Increased sensitivity may be applied in three-phase, four-wire systems, where ground overcurrent protection setting does not consider the unbalance current.

---

## Negative-Sequence Overcurrent Elements

---

**DESCRIPTION**

Negative-sequence instantaneous and time delay overcurrent elements can be used to detect and clear unbalance conditions in the system and as protection against phase-to-phase faults. This protection is more sensitive than phase overcurrent protection, since the negative sequence elements do not respond to balanced loads.

**NEGATIVE SEQUENCE  
INSTANTANEOUS  
OVERCURRENT (50I\_2)**

The setting of negative sequence instantaneous elements must be higher than maximum unbalanced fault current beyond the closest downstream device and must coordinate with downstream phase and ground overcurrent devices.

**NEGATIVE SEQUENCE TIME  
OVERCURRENT (51I\_2)**

The setting of these elements must be coordinated with the downstream phase and ground overcurrent devices, must be above the feeder maximum unbalanced current, and ideally must be sensitive to unbalanced faults at the end of the main feeder. To sat-

isfy these conditions, the appropriate pickup, time delay, curve type and reset characteristic (fast or induction disc emulation) settings should be selected.

## Directional Elements

---

### **PHASE DIRECTIONAL**

Phase Directional elements monitor the direction of the phase current flow for steady state and fault conditions and can be used to control the operation of the phase overcurrent elements for situations when the feeder is interconnected within the system or is part of a interconnection involving co-generation.

### **NEUTRAL DIRECTIONAL**

Neutral Directional Overcurrent elements monitor the direction of the neutral current for ground fault conditions and can be used as an independent protection or to control the operation of the neutral overcurrent elements for conditions when the feeder may operate interconnected.