

Mitigation Methods I

- Motor - generator set
- Ferroresonance transformer

2.4.1 Motor Generator Set

Motor-generator (M-G) sets come in a wide variety of sizes and configurations. This is a mature technology that is still useful for isolating critical loads from sags and interruptions on the power system. The concept is very simple, as illustrated in Fig. 2.8

Motor Generator Sets are a combination of an electrical generator and an engine mounted together to form a single piece of equipment. Motor generator set is also referred to as a genset, or more commonly, a generator. Motor generator sets are used throughout industry to provide electrical power on demand.

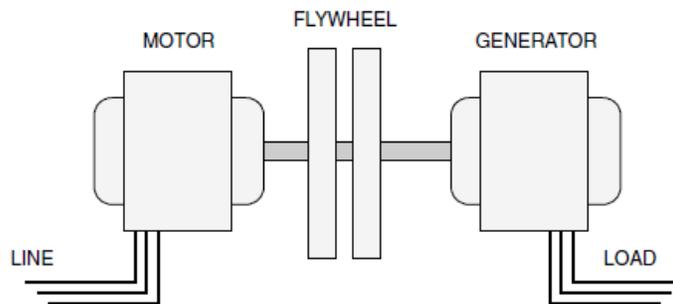


Figure 2.8 Block diagram of typical M-G set with flywheel

A motor powered by the line drives a generator that powers the load. Flywheels on the same shaft provide greater inertia to increase ride-through time. When the line suffers a disturbance, the inertia of the machines and the flywheels maintains the power supply for several seconds. This arrangement may also be used to separate sensitive loads from other classes of disturbances such as *harmonic distortion* and *switching transients*. While simple in concept, M-G sets have disadvantages for some types of loads:

- There are losses associated with the machines, although they are not necessarily larger than those in other technologies described here.
- Noise and maintenance may be issues with some installations.
- The frequency and voltage drop during interruptions as the machine slows. This may not work well with some loads.

Another type of M-G set uses a special synchronous generator called a written-pole motor that can produce a constant 60-Hz frequency as the machine slows. It is able to supply a constant output by continually changing the polarity of the rotor's field poles. Thus, each revolution can have a different number of poles than the last one. Constant output is maintained as long as the rotor is spinning at speeds between 3150 and 3600 revolutions per minute (rpm). Flywheel inertia allows the generator rotor to keep rotating at speeds above 3150 rpm once power shuts off. The rotor weight typically generates enough inertia to keep it spinning fast enough to produce 60 Hz for 15 s under full load. Another means of compensating for the frequency and voltage drop while energy is being extracted is to rectify the output of the generator and feed it back into an inverter. This allows more energy to be extracted, but also introduces losses and cost.

Ferro resonance Transformer

Ferro resonant transformers, also called constant-voltage transformers (CVTs), can handle most voltage sag conditions. (See Fig. 2.9) CVTs are especially attractive for constant, low-power loads. Variable loads, especially with high inrush currents, present more of a problem for CVTs because of the tuned circuit on the output. Ferro resonant transformers are basically 1:1 transformers which are excited high on their saturation curves, thereby providing an output voltage which is not significantly affected by input voltage variations. A typical Ferro resonant transformer schematic circuit diagram is shown in Fig.2.9

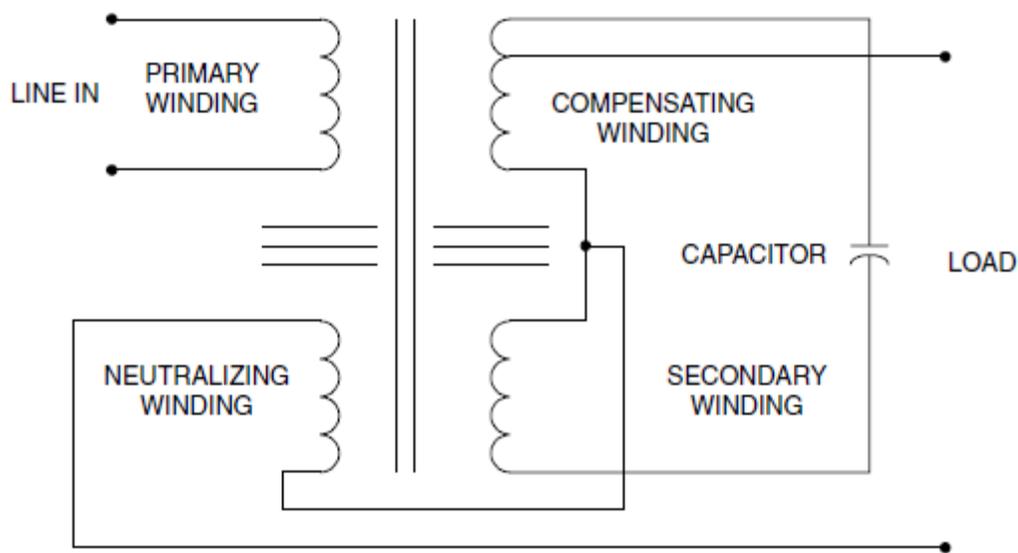


Figure 2.9 Schematic of ferroresonant constant-voltage transformer

Ferroresonance in electromagnetic voltage transformers, fed through circuit breaker grading capacitance, is studied using nonlinear dynamics methods. The magnetising characteristic of a typical 100 VA voltage transformer is represented by a single-valued two-term polynomial of the order seven. The system exhibits three types of ferroresonance: fundamental frequency ferroresonance, subharmonic ferroresonance and chaotic ferroresonance, similar to high capacity power transformers fed through capacitive coupling from neighbouring lines or phases.