Technical Note

ABB VFD Utilization on High Resistive Ground or Floating Networks

Source:

Technical Note: ABB VFD used on high resistive ground or floating network
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Summary:

Ground Fault Protection of the ABB VFD

Applies to: ABB ACS800 and ACS550 motor and motor cables. Mains supply on ACS800 regen models.

The ground fault protection of the VFD is triggered by current imbalance in the output phases (mains as well on the ACS800 regen). A differential of over 10% typically is required to trigger the ground fault protection.

High Resistance Ground

Ground Fault

Ground fault may not be triggered as the High Resistance Ground (HRG) limits the fault current to less than 10% of the threshold imbalance. System will run with Ground Fault present without any indication other than at the Neutral Grounding Resistor (NGR).

Vendors exist that provide products to detect this. Startco, Bender, etc. ABB has not endorsed a particular product to this point.

EMC Filters

Is the case of a ground fault, capacitors that form part of the EMC filter and are usually dealing with Phase-Ground voltages experience Phase-Phase voltage as the ground fault effectively has one phase shorted to ground. Damage to the EMC filter can result.

It is possible to disconnect the EMC filter on the VFD. It is typically not required in the North American market and most VFDs ordered into our market come with the EMC disconnected by default.

Common Mode

Common mode voltages produced by any brand of VFD can induce current through the cable and motor circuit capacitance and through the NGR.

This may trigger false Ground Faults at the NGR.

Floating Networks

Ground Fault

Ground fault may not be triggered as there is no path to ground that will elevate output current imbalance above 10%. System will run with Ground Fault present without any indication other than at the Neutral Grounding Resistor (NGR).

Vendors exist that provide products to detect this. Startco, Bender, etc. ABB has used the Bender IRDH275 for years to detect this. It is an option on ABB cabinet drives.

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GROUND FAULT PROTECTION INCORPORATED IN ABB VFD

Technical note applies to the following ABB VFDs that incorporate earth fault protection for Solidly Grounded Networks.

ACS800 followed by 01/U1/02/U2/04/04M/07/U7/11/31/17/37
ACS550 followed by 01/02/U1/U2/CC/PD/PC
ACH550 followed by 01/02/U1/U2/PDR/PCR/VDR/VCR/BDR/BCR

The internal earth fault protective function protects the drive against earth faults in the motor and motor cable. In the case of the ACS800-17/37/this protection also extends to an earth fault on the mains supply cable. (This is not a personal safety or a fire protection feature.) Earth fault protective functions can be disabled. The drive detects the ground fault based on phase to phase current measurements with default (adjustable) detection levels being over 10% (current imbalance on most drives).For large drives, this may equal several hundred amperes.

HIGH RESISTANCE GROUND

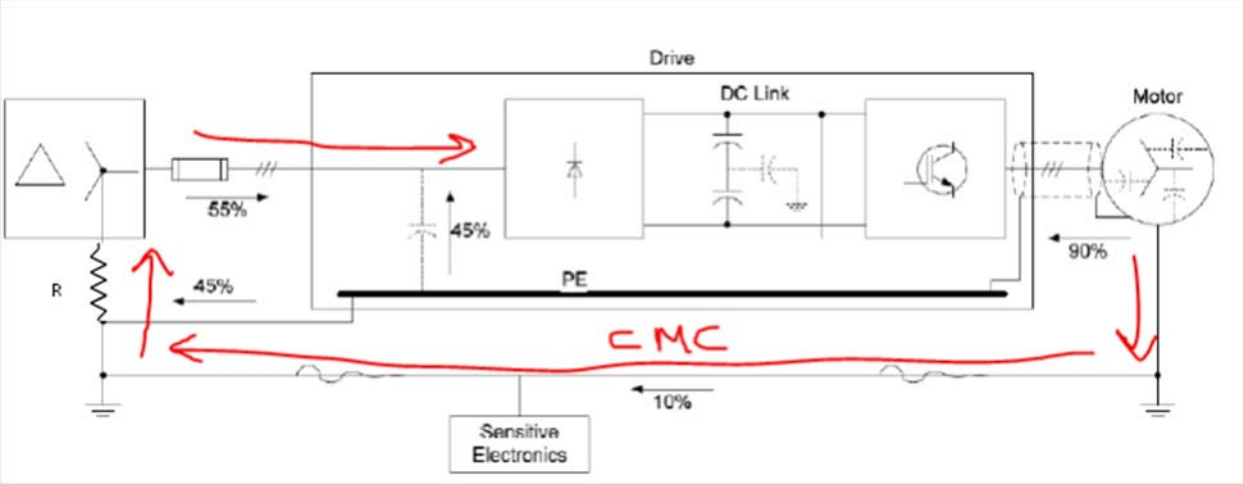
High Resistance Grounding (HRG) systems limit the fault current to below 25A when one phase of the system shorts or arcs to ground. In the event that a ground fault condition exists, the HRG typically limits the current to 5-10A.
The reasons for using a HRG are;

- To essentially eliminate arcing currents and ARC flash hazards associated with phase-to-ground arcing current conditions only.
- Prevents operation of overcurrent devices and allows equipment to function until the fault can be located (when only one phase faults to ground).
- Will eliminate the mechanical damage and may limit thermal damage to shorted transformer and rotating machinery windings.

HRG's are continuous current rated, ground fault current flowing through a HRG is usually not of significant magnitude to result in the operation of an overcurrent device, that is to say that that fuses or breakers will not trip. Since the ground fault current is not interrupted, a ground fault detection system should be installed that monitors current through the resistor.

CONSIDERATIONS USING VFD ON HRG NETWORK

- As the HRG will limit fault current to 5A to 10A, on larger drives, the current limiting devices at VFD input (fuses and breaker) will not trip.
- As mentioned above, the VFD may not detect phase to ground fault in motor or motor cable (or supply cable in the case of ACS800-17/37) as current is limited by HRG and phase to phase current imbalance trip levels in VFD are typically much higher than HRG limits for larger drives.
- The drive may be equipped with optional EMC filters in the form of phase to ground capacitors that attenuate high frequency noise. The filters are rated for line-to-neutral voltage, with the assumption that the power system will be solidly ground. A shorted phase to ground in a floating or HRG network will cause the phase to ground voltage on the two remaining phases to rise by 73%. If phase to ground EMC filters are left connected, the voltage rise will damage the filters and the VFD.
- The VFD will drive high frequency 'Common Mode' Current (CMC) through the cable and motor circuit capacitance and through the grounding resistor (see image below). The common mode current may be well above 5-10A rms on larger drives and may cause nuisance tripping of HRG ground fault detection devices.

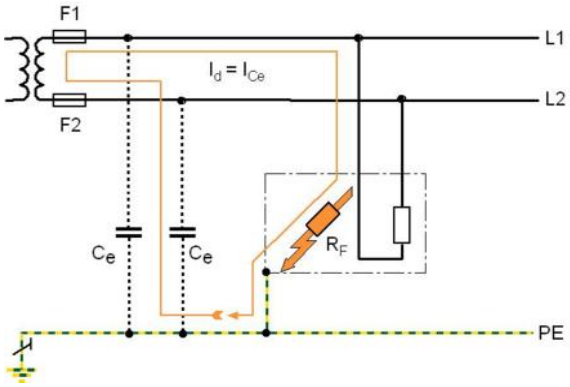


A ground fault detector for HRG networks that can differentiate the common mode current from true earth fault current should be used. Information for such devices are available by manufacturers like 'Bender' / (www.bender.org) or equivalent.

UNGROUNDED (FLOATING NETWORKS)

Ungrounded sources are often called Floating, because they float with reference to earth ground. System and wiring capacitance determines the voltage on any system point with reference to ground.
The reasons for using an ungrounded network are;

- Ground fault current from (one) phase to ground fault is limited by the system capacitance. Typically the ground fault current will be less than 1% of three phase current.
- To limit arcing currents and ARC flash hazards associated with phase-to-ground arcing current conditions only.
- Prevents operation of overcurrent devices and allows equipment to function until the fault can be located (when only one phase faults to ground).



CONSIDERATIONS USING VFD ON UNGROUNDED NETWORK

- If one of the system conductors phases faults to ground, current flow through that capacitance to ground will cease, since no potential difference across it now exists. The voltage across the remaining two distributed capacitors to ground will, however, increase from line to neutral to line to line. The drive may be equipped with optional EMC filters in the form of phase to ground capacitors that attenuate high frequency noise. The filters are rated for line-to-neutral voltage, with the assumption that the power system will be solidly ground. If phase to ground EMC filters are left connected, the voltage rise will damage the filters and the VFD.
- The VFD may not detect phase to ground fault in motor or motor cable (or supply cable in the case of ACS800-17/37) as fault current is limited by system capacitance and phase to phase current imbalance trip levels in larger VFDs may be higher than fault current.
- Although the floating network has no wired reference to ground, the network is grounded through the system capacitance. The VFD will drive high frequency 'Common Mode' Current (CMC) through the cable and motor circuit capacitance .The common mode current may cause nuisance tripping of external ground fault detection devices.

A ground fault detector for ungrounded networks that can differentiate the common mode current from true earth fault current should be used. Information for such devices are available by manufacturers like 'Bender' / (www.bender.org) or equivalent. The principal of operation is to test phase to ground isolation strength as shown in image below.