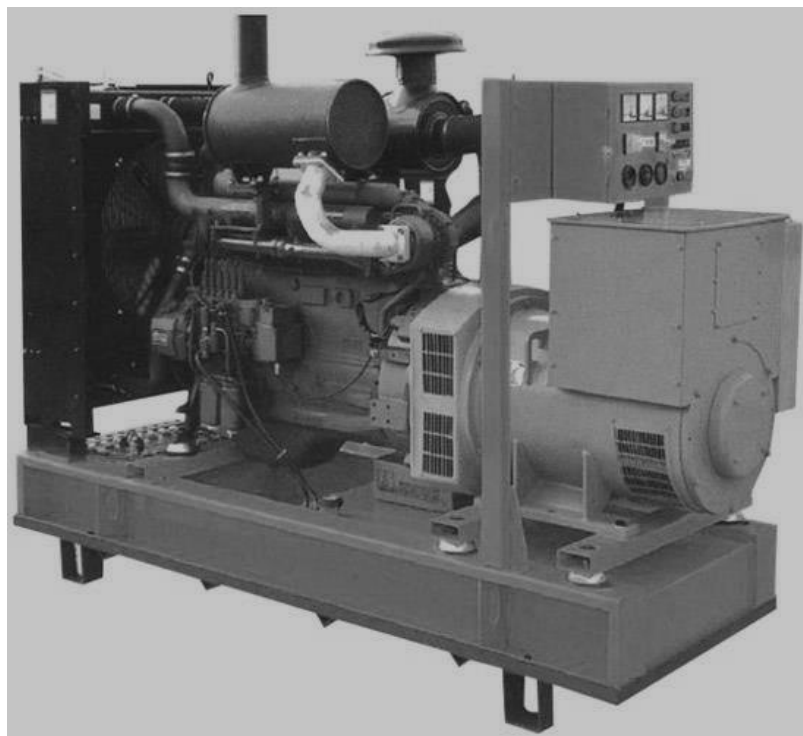


PowerXL™

Connecting drives to generator supplies
Technical aspects for a reliable operation



Level 3	<ul style="list-style-type: none">1 – Fundamental – No previous experience necessary2 – Basic – Basic knowledge recommended3 – Advanced – Reasonable knowledge required4 – Expert – Good experience recommended
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1 Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automatic control functions.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specification, otherwise this may cause malfunction and/or dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching of the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been properly installed and with the housing closed.
- Wherever faults may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.).
- Frequency inverters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may destroy the device and may lead to serious injury or damage.
- The applicable national safety regulations and accident prevention recommendations must be applied to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant electrical regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the frequency inverter (increased motor speed or sudden standstill of motor). These measures include:
 - Other independent devices for monitoring safety related variables (speed, travel, end positions etc.).
 - Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
 - Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be alive after disconnection. Consider appropriate warning signs.

2 Disclaimer

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3 General

With the correct consideration of some of the issues related to running AC drives from a generator supply it is possible to successfully use the Eaton Drives within this type of application.

Generator rating, drive ratings, loading, and operating conditions vary in each application and as such it is difficult to give precise recommendations, however the purpose of this guide is to highlight some of the issues involved and to help ensure the correct choices are made.

4 Applications:

Generators can be used to provide a back-up supply (also termed stand-by supply) in the event that the mains power supply is lost. Alternatively the generator may provide a dedicated supply for drives in areas where a mains supply is typically unavailable. In either application due consideration must be given to all frequency drives units that may be called upon to run from the generator supply.

Generators are typically used on motors and lighting circuitry that are not adversely effected by minor variations of supply and that in themselves do not cause unbalanced loading or distortion of the generator supply. AC drives present what is termed a non-linear load to the generator which can have an adverse effect on the generator supply and can affect drive operation.

5 Background Information:

Eaton Drives, as per most variable speed drives, have an input rectifier on the input power side of the drive that converts the AC supply into DC and that is then maintained by the DC bus capacitors on the DC-bus. This input rectifier usually takes the form of a diode bridge on smaller units (less than 50 Amps) and input thyristors on the larger drives sizes. Because the rectifier devices in the input bridge only conduct when the incoming phase voltage is greater than the DC bus voltage, the current is drawn from the supply in pulses and is no longer in the shape of a sine wave. The current pulses drawn from the supply by the drive input bridge are of short duration and higher amplitude than the normal sine wave, placing additional load on the generator at their peaks.

Generators generally have high source impedance (far higher than the typical mains supply transformer) and thus are affected significantly more by loading than the normal mains supply. As maximum load is drawn from the generator the peak voltage from the generator can sag (although RMS voltage can remain the same). The effect is compounded by the high amplitude pulses of current caused by the drive input stage and can result in significant distortion of the generator output waveform.

The real issue presented to the drive by a loaded generator and reduced peak voltage is that the peak input voltage directly affects the drive DC bus level, thus giving the potential for a significantly reduced operating DC bus when the generator is loaded. Even if the generator has a voltage regulator fitted then this device typically works on rms voltage measurement so may do nothing to fix the reduced peak voltage.

Additional problems can be caused if the drive / motor are shock loaded, causing a sudden high current demand from the drive supply. This might cause the generator supply to dip for sufficient period and the drive DC bus to drop to a trip or none operational level. When the drive trips or powers off

the load on the generator drops off and the supply returns to normal levels. If the drive is set to automatic restart or automatic trip reset and restarts into the same load it can be seen that oscillation might occur between the generator supply voltage levels and drive power (or trip) cycles. The power oscillation may eventually correct itself but a larger capacity generator or better load sharing would generally be required to prevent repeat at next start up.

Start-up of a generator will involve a set time period where in output voltage and frequency are increased and then stabilized at the desired values. For traditional generator operated equipment this is unlikely to present an issue but could cause issues for the drive input power stage and pre-charge circuits. Control modules can be employed on the generator to ensure generator output is within the specifications of the drive before the load is connected to the generator output.

One of the advantages of using a variable speed drive (with a generator supply) to start a motor is that start-up current of the motor is controlled and reduced compared to direct on line motors, actually resulting in less current draw from the generator on motor start up (provided application is suitable for AC drive control).

6 Applying a Drive to a Generator:

The following advice should be followed to ensure satisfactory operation of the drive on a generator supply. It is always advisable to contact the generator supplier to check suitability of the load for their particular generator. Manufacturers will often have software that enables the correct choice of generator for any given load combination.

6.1 Generator power rating

Never match the generator 'rated' output power with the input power rating of the connected drive or drives as generator manufacturers rarely consider non-linear loads when specifying ratings. The generator will need to be significantly over-sized in relation to the load presented by the drive(s). Some of the advice commonly given is that the combination of drive and other non-linear loads of the system do not equate to more than 20% of the stated generator capacity, however a generator of two to three times the rated power compared to the load will normally suffice. When using drives with a lower dc bus capacity (like DE1), the higher value is preferable.

Always check that the output voltage from the generator remains within the tolerance range of the drive under all load conditions. This is best achieved by monitoring the drive DC bus (available as a reference parameter in the drive) against the nominal bus voltage (operating level) given in the following table.

Drive Rated Supply Voltage	DC Bus Voltage Level (Volts DC)				
	Nominal Bus Voltage	Under Voltage Trip	Minimum Bus	Operating	Over Voltage Trip
200 – 240 Volts AC	280 - 340	160	239		418
380 – 480 Volts AC	540 – 680	320	478		835
480 – 525 Volts AC	680 – 740	360	540		930
500 – 600 Volts AC	710 - 850	400	598		1020

6.2 Generator Configuration

If the generator permits some adjustment of the output voltage level then adjust this level to the highest value permissible by the drive (specified in the user manual data tables). Higher voltage levels have the effect of reducing the current level drawn by the drive on the generator supply.

Ideally the generator should be fitted with timer or interlock circuits to ensure that, on startup of the generator, the output voltage and frequency are stable prior to switching the generator output onto the load. Generators with ungoverned outputs should generally be avoided.

6.3 Generator Loading

When more than one generator is available then drives (and other non-linear loads) should be shared as equally as possible between the generators to minimize their loading effects. If single phase input drives are connected to a three phase generator then share load as equally as possible between each phase.

For multiple drive installations, try to power up and start drives individually and in a sequence starting with the largest rated drives. Avoid single power switches that connect a bank of drives simultaneously to the generator output.

6.4 Drive Configuration

Do not place a line reactor on the incoming supply to the drive. This will only add more impedance and result in higher line voltage drops.


Where there is more than one drive connected to a single generator try to avoid enabling the drive auto-start on power up as this will cause simultaneous start-up of several drives / motors.

Try to avoid enabling of the trip auto-reset function or brown out ride through on mains loss. Ensure control circuit cabling for the Drive is as short as possible and is adequately screened.

6.5 Application Consideration

Try to avoid applications that involve shock or sudden loading of the motor, particularly on drives with thyristor input bridges (typically larger frame size drives). Applications that do not require fast acceleration times are equally preferable. If applications do require dynamic acceleration or fast load change response then an increase in generator size may be required.

On drives supplied by generators the DC bus voltage can vary to a far greater extent than when connected to the utility mains supply. This may cause slight variation in the drive output to the motor and applications that require very precise output regulation should be avoided. For the majority of applications some very slight variation in motor performance is permissible and will usually go unnoticed.

	<p>Variable torque loads, such as fan or pump applications are well suited to being controlled by drives with generator supply connection as they require very little start-up torque and present a smooth increase in load to the generator as speed is increased. Acceleration times are usually not critical for fans or pumps (can be extended if necessary) and slight variation in fan or pump performance has negligible effect.</p>
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