

Variable Speed Drives

On Single Phase Supplies



Note: This article is intended as a guide only. It is the responsibility of the installer to define and accommodate all environmental & site factors influencing the drive selection & ensure compliance with all local rules & regulations.

Reference: IM10114

Dated: February 2009

Section 1.0 – Introduction

This document is intended to be a general guide only for the installation of Variable Speed Drives on single phase supplies. The two supply voltages discussed will include 240V (220v) and 480V Single Wire Earth Return (SWER) systems. For further information regarding SWER line installation please read the Technical Note 3 'Variable Speed Drives & Single Wire Earth Supplies, also available on our website: www.zener.com.au

A Variable Speed Drive (VSD) provides many benefits including:

- Soft starting of the motor & load reducing mechanical stresses & reduced water hammer with pumps.

- Significantly reduce the starting current, from 600-800% down to <110-150% of the motors rated FLC.

- Automation & process control using the built-in electronics to provide constant pressure / flow systems for irrigation or other pumping applications.

- Ability to control the speed of the motor.

- Energy Savings: Substantial energy savings may be achievable for Fan & Pump loads.

Section 2.0 –The Supply, Motor and VSD

2.1 The Supply, Motor & VSD Combination

The Variable Speed Drive required will be dependant upon both the motor and the supply available. The general rule to remember is that a variable speed drive can convert single phase into three phase but, it cannot provide a higher voltage out than what you put in. Therefore if you only have a 240V 1 phase supply, you cannot get 415V out. It will only provide 240V 3 phase out. If you have a 480V supply you can output 415V – a lower voltage.

There are basically 4 situations you may have;

Supply:	Motor:	Comments:
240V 1 Phase	240V Delta / 415V Star	240V VSD; connect motor for 240V Delta (ZENER MSC-3L series or equivalent)
240V 1 Phase	415V Delta	Motor suitable for 415V only, will need step-up transformer to increase input voltage to >415V and a 415V VSD with DC bus choke. (ZENER MSC-3R series with a DC bus choke)
480V 1 Phase SWER	415V Delta	480V VSD with DC bus choke; connect motor for 415V Delta
480V 1 Phase SWER	240V Delta / 415V Star	480V VSD with DC bus choke; connect motor for 415V Star

If you have any questions at this stage please contact Zener or your nearest Zener Distributor to discuss your application.

2.1 The Drive

The standard ZENER Variable Speed Drive is designed to operate from both a single phase & three phase supply making it ideal for SWER Line or single phase supply systems.

1. The standard MSC-3R series drive can operate from a 480VAC single phase supply (SWER) and provide a controlled 415V 3 phase output to the motor.

2. The standard MSC-3L series drive (or equivalent) can operate from a 240VAC single phase supply and provide a controlled 240V 3 phase output to the motor.

When selecting the drive it is important to determine the motors full load current at the voltage in which it will operate. To do this, it is useful to know the relationship between star and line voltages & currents.

Section 2.0 –The Supply, Motor and VSD

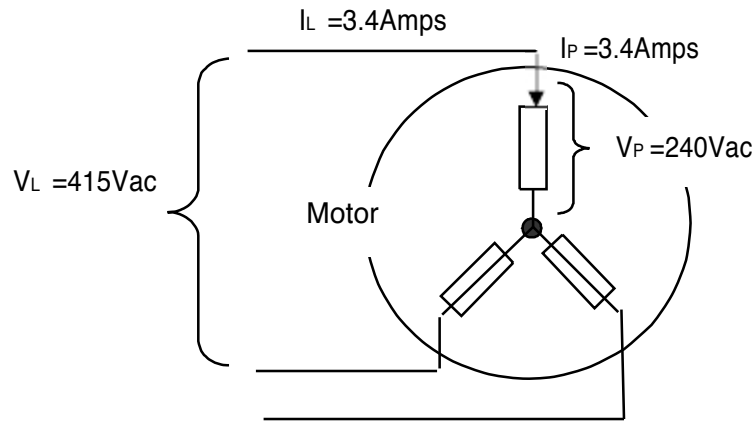
This is especially important when a 415V star / 240V Delta motor is being used on a 240V supply system.

Eg. 1.5kW ; 3.4Amps 415V star

Star Connected:

$$I_L = I_P$$

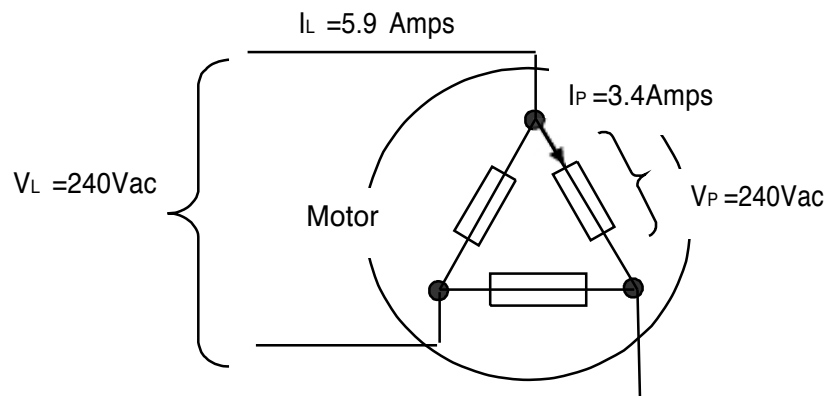
$$V_L = 3\sqrt{3} \times V_P$$



When Delta Connected:

$$V_L = V_P$$

$$I_L = 3\sqrt{3} \times I_P$$



Therefore, the Line current or Full Load Current of the motor when connected in 240V Delta is **5.9Amps**.

A Variable Speed Drive capable of a continuous output of 5.9 Amps is required.

Section 2.0 Issues using VSD's on Single Phase Supplies

2.2 Issues when using VSD's on Single Phase Supplies

The operation of a ZENER drive on a single phase supply is simple, but you do need be aware of some of the issues and how they may be addressed.

1. EMC Compliance:

All Zener VSD's satisfy the requirements of the Australian standard AS61000.3 and carry the Australian C-tick label. To achieve these standards it is necessary to install the equipment as per the manufacturers instructions. This may require screened motor cables from the VSD to the motor. Additional measures may be required for installations which may be sensitive to RFI. Additional measures & alternatives to screened motor cables are available such as ZENER's High Performance Output Filter.

2. Harmonics

All VSD's produce some form of harmonics on the supply, which is significantly increased when operating on a single phase supply and particularly so, on SWER or rural environments where the loading on smaller supplies may be relatively high. A DC bus choke is mandatory for VSD's operating on a SWER supply. The sizing of the transformer and the VSD/motor loading on the supply needs to be taken into consideration when concerned about harmonics. The effect of excessive harmonics may cause overheating of electrical components such as transformers and cables. For the smaller motors operating from a 240V 1Phase supply, harmonics are some what lower and a DC bus choke may not be required.

3. Temperature rating

Because SWER line systems only occur in rural areas, where higher ambient temperatures may be experienced, the ambient temperature must be considered. Zener offer a Drive with a continuous rating of 50degC ambient. An IP66 enclosed Drive is also available so the equipment can be direct wall mounting without further enclosing. This promotes better cooling and lower internal operating temperatures.

4. DC Bus Choke

A DC Bus choke is mandatory for operation on a 480V SWER supply and on some 240V installations depending on the motor size. There are numerous benefits provided by a DC bus choke which include:

- Reduction of Power Line Harmonics
- Improved Power Factor
- Transient Filter
- Reduce peak inrush currents

5. Supply Current Capacity

Since the ZENER VSD acts as an inverter and produces a 3 Phase supply from a 2 Phase supply, the current is expected to be higher on the input then the output. It is therefore important to determine what level of supply current is required for the intended motor. As a guide the RMS AC line current to be allowed for, is 1.84 times the motor phase current.

Section 2.0 Issues using VSD's on Single Phase Supplies

6. Drive Rating

When a drive is operating from a single phase SWER supply, the standard drive must be rated accordingly. Other considerations when selecting the most suitable drive is the ambient temperature and the type of load. Your nearest ZENER Distributor can assist with selecting the correct Drive for your applicaton.

The drive should be selected based on the full load current in the manner which the motor is connected. Refer to calculation in section 2.1.

7. Motor Suitability

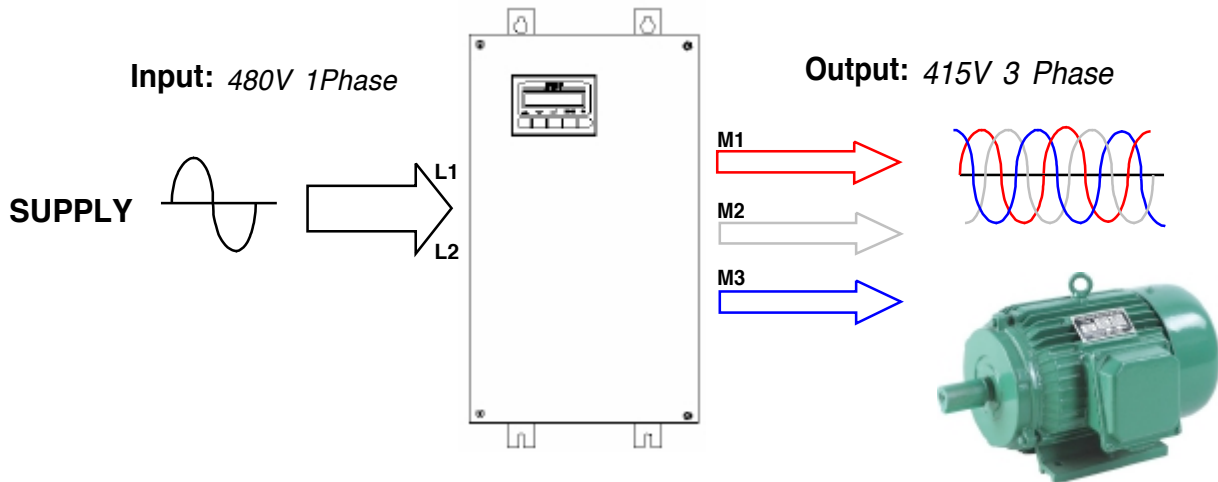
The motor should be suitable for operation on a Variable Speed Drive and comply with the Australian standard AS60034 Part 17.

Section 3 – The ZENER Drive

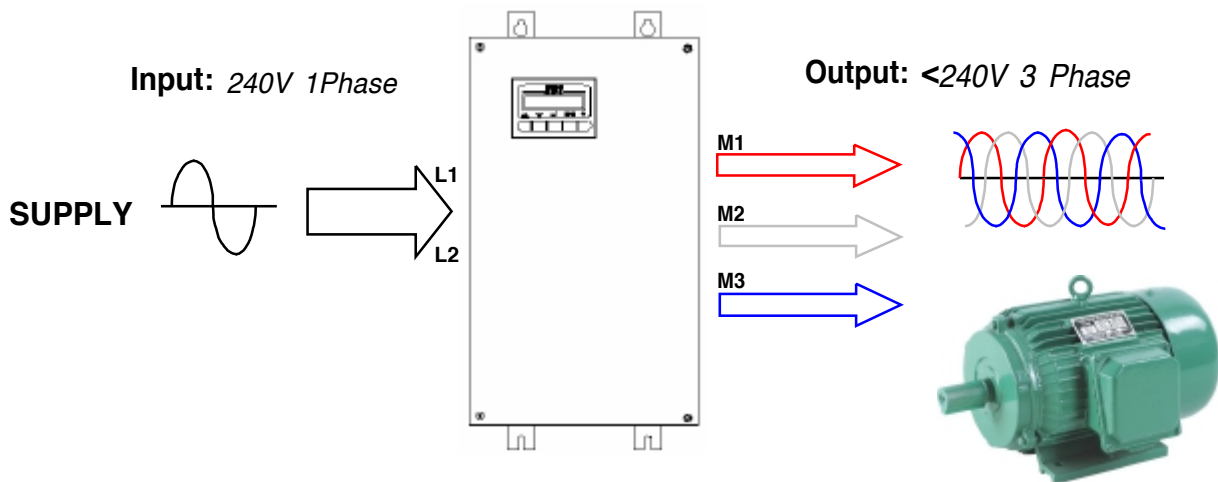
3.1 The ZENER Variable Speed Drive

The Variable Speed Drive operates from the single phase supply connected to L1 and L2.

1. 480V SWER Supply: The ZENER VSD takes the 480V single phase AC Supply and converts it to a 3 Phase output suitable for a standard 3 phase 415V motor.



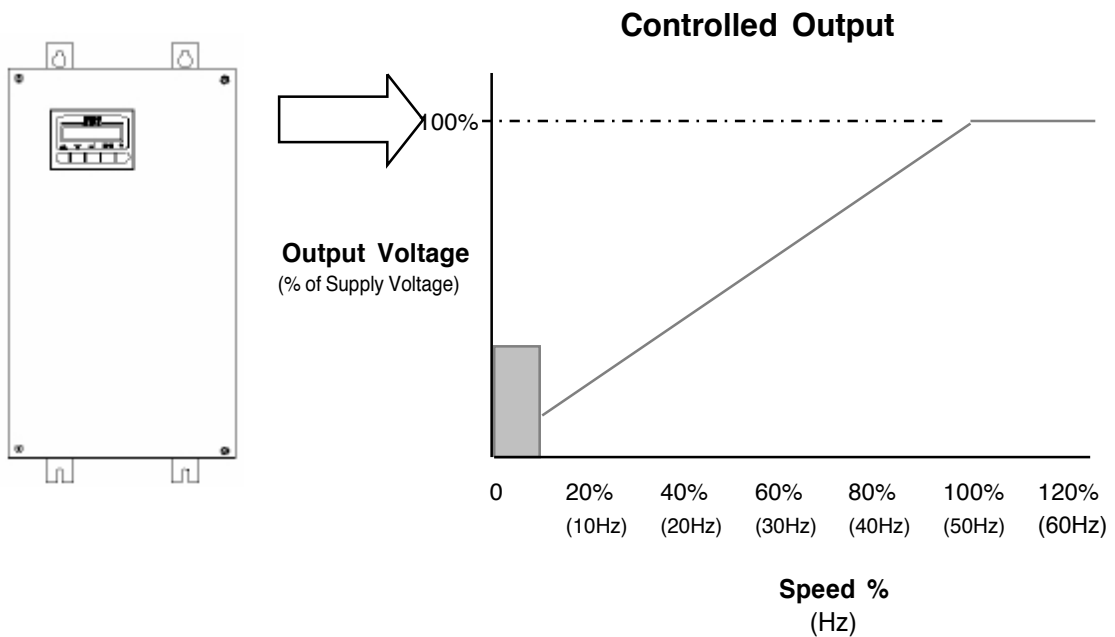
1. 240V 1Phase Supply: The ZENER VSD (or equivalent) takes the 240V single phase AC Supply and converts it to a 3 Phase output suitable for a standard 3 phase 240V motor.



Section 3 – The ZENER Drive

3.2 The MSC-3 Series

The ZENER Drive actually does more than just convert from a single to 3 phase supply. The VSD controls the output waveform to allow the speed to be controlled by changing the frequency to the motor from 0-200Hz. The normal supply frequency is 50Hz, so the drive actually allows you to over speed the motor if desired. With full control of the motor speed, you have direct control of the load, enabling manual or automatic control of a process, such as water pressure or flow. The ZENER drive also has total control over the rate which a motor accelerates and decelerates, providing a smooth controlled soft start and soft stop.



The ZENER MSC-3 is designed in Australia for the Australian climate, offering a robust IP66 enclosure and a 50°C rating.

- Allows direct mounting close to the motor (protection from sunlight required)
- Protection against the ingress of dust & moisture
- More efficient cooling and reduces internal operating temperatures
- Increased life expectancy of electronic components
- No air filters to clean, eliminating nuisance over temperature trips from poor ventilation.
- Robust metal enclosure

Other enclosure types are also available including; IP30 & Stainless Steel IP66.

The ZENER MSC-3 has the technology built-in to provide automated control systems and to interface with external control systems.

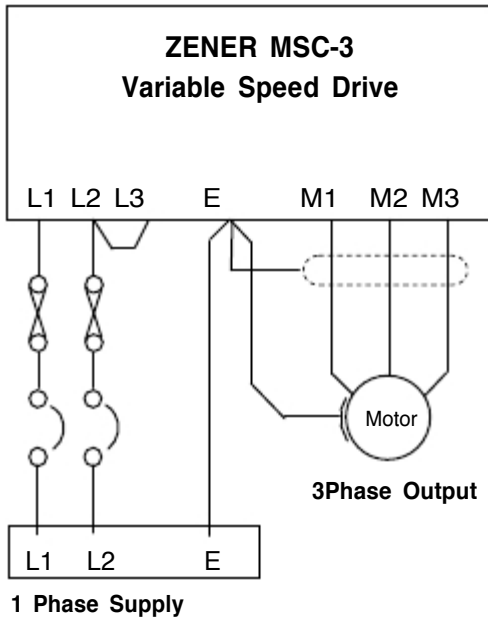
Including:

- Digital & Analogue I/O for remote controls and interfacing with control systems.
- PID control for automated process controls such as constant pressure system.
- 'Hibernation' mode to automatically switch the output on and off with demand.

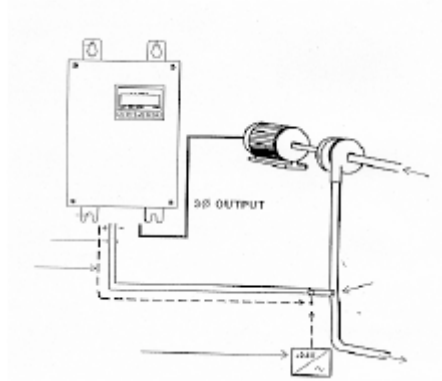
Section 3 – The ZENER Drive

3.3 Installation

The installation of a ZENER VSD is simple as shown.



Speed control can be manually using the controls provided or remote speed potentiometer. A Pressure control system can be easily achieved using the drives internal PID control and an external pressure transducer.



Refer to the instruction manual for comprehensive details on installation, in particular using screened motor cables.

3.4 Drive Selection & Supply Requirements

For assistance in the selection of a suitable Variable Speed Drive please contact your nearest authorized ZENER Distributor.

Factors that need to be considered are:

1. Motor Nameplate Full Load Current (FLC) and voltage.
2. Type of load.
3. The environment:
 - 3.1 Enclosure IP rating.
 - 3.2 Ambient Temperature.
 - 3.3 Protection from Sunlight & other heat sources.
4. Actual Supply Voltage.
5. Appropriate de-rating for Single Phase operation.
6. Adequate Supply Capacity Available.
7. VSD Options required.
8. Special requirements from motor or pump manufacturer.