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# VARIABLE SPEED DRIVES (VSDs) FOR INSTRUMENTATION AND CONTROL SYSTEMS



## **YOU WILL LEARN HOW TO:**

- Demonstrate a sound understanding of how AC Variable Speed Drives (VSDs) work
- Install VSDs properly
- Select the right VSD for a given application
- Troubleshoot VSDs competently
- Competently explain how flux-vector control works for drive applications
- Understand squirrel cage induction motors
- Identify the protection and control system requirements for VSDs
- Interface VSDs with PLCs
- Understand the causes of motor burnout
- Deal effectively with VSD harmonics and EMC/EMI problems

## **WHO SHOULD ATTEND:**

Anyone associated with the use of Variable Speed Drive techniques in the industrial or automation environment. The workshop will also benefit those working in system design as well as site commissioning, maintenance and troubleshooting. Typical personnel who would benefit are:

- Plant engineers
- Instrument technicians
- Operations personnel
- Electrical maintenance technicians and supervisors
- Instrument and control engineers
- Process control engineers
- Mechanical engineers
- Service technicians
- Maintenance personnel

## The Workshop

It is estimated that electrical drives and other rotating equipment consume about 50% of the total electrical energy generated in the world today. Other estimates are that pumps, fans, blowers and compressors consume as much as 65% of this total, a large proportion of these applications are powered by fixed or constant speed drivers whose load demands often fluctuate. This poor match of speed and demand results in considerable wasted energy and significantly increased wear of system components.

Variable speed drive technology is a cost effective method to match driver speed to load demands and is an excellent opportunity to reduce operating costs and improve overall efficiencies in your application.

This course gives you a fundamental understanding of the installation, operation and troubleshooting of variable speed drives. Typical practical applications of VSDs in process control and materials handling, such as those for pumping, ventilation, conveyers, compressors and hoists are covered in detail. You will learn the basic setup of parameters, control wiring and safety precautions in installing a VSD. The various drive features such as operating modes, braking types, automatic restart and many others will be discussed in detail. You will learn the four basic requirements for a VSD to function properly with emphasis on typical controller faults, their causes and how they can be repaired.

The concluding section of the course gives you the fundamental tools in troubleshooting VSDs confidently and effectively.

Even though the focus of the course is on the direct application of this technology, you will also gain a thorough understanding of the problems that can be introduced by VSDs such as harmonics, electrostatic discharge and EMC/EMI problems.

### Pre-requisites

A fundamental knowledge of basic electrical concepts would be useful.

## The Program

### INTRODUCTION TO VARIABLE SPEED DRIVES

- The need for variable speed drives
- Fundamental principles of speed control
- Efficiency, torque, inertia, horsepower/ power factor
- Torque-speed curves
- How the motor produces torque
- Types of variable speed drives

### 3 – PHASE AC INDUCTION MOTORS

- Basic construction and physical configuration
- Principles of operation and performance
- Equivalent circuit and fundamental equations
- Starting, acceleration, running and stopping
- Power, torque and thermal rating

### POWER ELECTRONIC CONVERTERS

- Definitions and basic principles
- Power diodes and thyristors
- Principles of communication
- Power electronic rectifiers
- Power electronic inverters
- Gate commutated converters
- Gate controlled devices – GTO, FCT, GTR, FET, IGBT

### ELECTROMAGNETIC COMPATIBILITY (EMC)

- Sources of electromagnetic interference
- Harmonics on the power supply side of AC converters
- The effect of harmonic distortion on other connected equipment
- Methods of reducing the effect of supply side harmonics
- Electric motor protection
- Thermal overload protection – current sensing
- Thermal overload protection – direct temperature sensing

### PROTECTION OF MOTORS AND CONVERTERS

- AC frequency converter protection
- Fault diagnostics
- Electric motor protection
- Thermal overload protection – current sensors
- Thermal overload protection – direct temperature

### CONTROL SYSTEM FOR AC VARIABLE SPEED DRIVES

- The overall control system
- Power supply to the control system
- DC bus charging system
- VSD control loops
- Vector control and its applications
- Current feedback in AC VSDs
- Speed feedback from the motor

### THE SELECTION OF AC CONVERTERS FOR VARIABLE SPEED DRIVE APPLICATIONS

- The basic selection procedure
- Loadability of converter fed induction motors
- Operation in the constant power region
- The nature of the machine load
- Starting and stopping VSDs
- How to calculate acceleration torques and times
- How to select the correct motor and converter for pump and fan loads
- How to select the correct motor and converter for constant torque loads
- Summary of the selection procedure

### INSTALLATION AND FAULT FINDING TECHNIQUES

- General installation and environmental requirements
- Power supply connections and earthing
- Where to install the contactors in the power circuit
- Installing AC converters into metal enclosures

### SPECIAL TOPICS

- PWM rectifier for AC converters
- Soft switching
- The matrix converter

### SUMMARY, OPEN FORUM AND CLOSING