Vector Drive Trainers

Educational Training Equipment for the 21st Century

Bulletin 257-120B

H-ACVD-100

AC Vector Drive Trainer System

Purpose

The Hampden **Model H-ACVD-100** AC Vector Drive Trainer System provides students with hands-on experience with advanced motor controls.

Description

The Hampden **Model H-ACVD-100** AC Vector Drive Trainer System is available in two configurations; as a stand-alone trainer and as an adjunct trainer to the Hampden Series 100 Rotating Machine System. Either system is designed for bench top mounting or may be used with the optional **Model HMT-4** Mobile Table.

The Hampden AC Vector Drive Trainer System is state-of-the-art in that it incorporates features which surpasses the inverter drive for many applications. The basic difference is the on-board high-speed processing computer with its associated three channel encoded motor. This system basically eliminates the “slip factor” of the motor by using a closed-loop feedback.

This system has many applications such as handling very high torque at low or even no speed which is desirable in a pick and place stacker crane or elevator. It also has precise speed regulation, hence can be used in applications where precise timing is required between interconnecting drives. Other applications include accurate positioning utilizing motion control cards for servo performance, braking, regeneration, high performance dynamometer, and precise metering pumps.

Control Panel

The control panel is 18" high (45.7 cm), 16" wide (40.64 cm), by 11" deep (27.9 cm). The case is made of code gauge steel and the panel of clear Lexan® polycarbonate. Graphics and nomenclature are silkscreened to the panel in a contrasting color. Mounted within the case are the Vector Drive, main input circuit breaker with pilot light, motor interface connector, encoder connector, and 8 ft. 5/c power cord. Mounted on the panel is the 12-key keypad, four character LED display, two 20 segment bar graph indicators, remote speed control. Provided is an assortment of fault switches for instructor insertion.

This system includes the following system diagnostic indications:

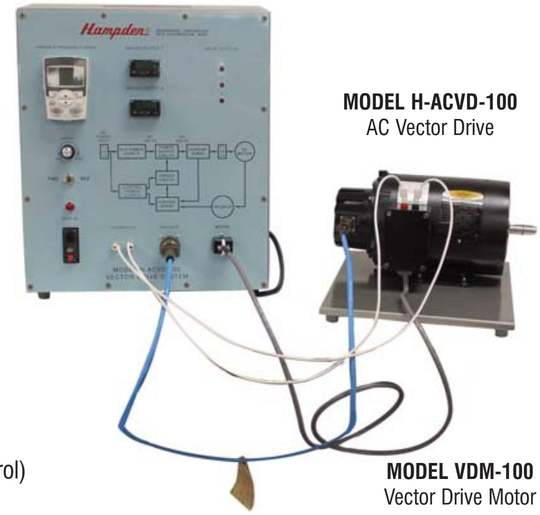
- Current Sense Fault
- Over temperature (motor or control)
- Following Error
- Over voltage
- Ground fault
- Parameter Loss
- Instantaneous over current
- Power Base ID fault
- Ready
- Microprocessor failure
- Regeneration Overload (dynamic braking)
- Over Speed
- Soft Start Fault
- Overload
- Torque Proving Fault
- Under voltage

Vector Drive Motor

The **Model VDM-100** Vector Drive motor is a 1/3 HP squirrel cage induction motor with built-in multi-channel encoder.

When ordering this system for a stand-alone configuration, the following components are necessary:

H-ACVD-100	AC Vector Drive
VDM-100	Vector Drive Motor
MGB-100DG	Base



MODEL H-ACVD-100
AC Vector Drive

MODEL VDM-100
Vector Drive Motor

When ordering this system for use with the Series 100 Rotating Machines, order:

H-ACVD-100	AC Vector Drive
VDM-100	Vector Drive Motor

Manuals

Operating Instruction & Experiment Manual

Input

120V/208VAC, 3-phase, 50/60 Hz

Option

Hampden **Model HMT-4** Mobile Table

All Hampden units are available for operation at any voltage or frequency

Hampden® ENGINEERING CORPORATION

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Flux Vector Theory

The “Flux Vector” is an algorithm for running an AC induction motor. The induction motor has 3-phase wye or delta connected stator. Instead of permanent magnets, the rotor has a group of shorted bars commonly referred to as a squirrel cage. This makes the induction motor very rugged requiring low maintenance. The goal of the control scheme is to achieve the same high performance of the more costly, less robust permanent magnet motors.

A standard induction motor control has been the voltage source invertor which allows the induction motor to operate at variable speeds by controlling the voltage and frequency to the motor. This type of control yields very poor performance at low speeds and under dynamic conditions.

The modern approach to this problem is the “Vector” control. This control scheme regulates the flux and torque producing components (or vectors) of current. There are several methods of achieving this but one approach is to use the known electrical frequency of the motor to strip off the rotating portion of the sensed motor currents, leaving magnitude and phase information. This magnitude and phase is then used to produce a direct component (flux) and a quadrature component (torque) of current which are DC values. (These currents are in fact analogous to the field and armature currents in a permanent magnet DC motor.) The direct and quadrature components are then compared to the commanded components and used to create two compensating DC voltage components which in turn yield a voltage magnitude and phase.

Once again, using the known electrical frequency of the motor, a three-phase AC voltage pattern is created and sent to the motor.

In addition to the motor current the electrical frequency must be calculated. The electrical frequency is equal to the sum of the rotating frequency and the slip frequency. The slip frequency is calculated by dividing the torque producing current by the flux current times an appropriate scale factor. This means that when the torque producing current is zero, the slip frequency is zero and the electrical frequency equals the rotating frequency. When the torque producing current is positive the electrical frequency is slightly higher than the rotating frequency. Up until this point, the position feedback version is identical to the sensorless version.

The motor control system has a constant torque (below base speed) and a constant power (extended speed) region. The flux producing current is the main contributor in setting the motor voltage. With the flux current held constant the motor voltage will increase proportionally with speed. When the motor voltage equals the line voltage, the flux current must be reduced as the speed increases. This is known as field weakening. Because the torque constant (that is, the amount of torque per torque producing amp) of the motor is proportion to flux, the region where the flux is held constant is known as the constant torque region.

Since power is torque times speed, the region where the flux (or torque) is reduced as the speed increases is known as the constant power region.

By using a shaft position transducer (resolver, optical or magnetic encoder) the rotating frequency is measured directly. This term plus the calculated slip frequency give the electrical frequency. The position transducer is also used to provide speed regulation and/or positioning depending upon the operating mode. By supplying the controller with a marker input, positioning to an index is also possible.

All Hampden units are available for operation at any voltage or frequency

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