H-REM-120-CM-MP

Universal Laboratory Machine

Introduction

The Hampden **MODEL H-REM-120CM-MP** Universal Laboratory Machine, which can operate in a variety of AC and DC modes, is available to meet these needs and serve as an experimental platform of a wide variety of electrical machine studies, including computer analysis and control.

In recent years the pattern of experimental work on electrical machines in Technical Schools and Institutes, College and University laboratories has changed. More emphasis is now placed upon the common electromagnetic principles of machines, upon their dynamic performance and their use as elements in control systems. There is also a growing tendency to introduce in the later stages of courses a more generalized approach to the analysis of electrical machines.

On attempting to change laboratory courses to suit this new approach, it is soon found that the conventional laboratory machines offer too few experimental facilities. Furthermore, as the numbers of students in laboratory classes increase, the need for multiplication of a given experiment arises and it then becomes costly, financially and in terms of space, to equip laboratories with many machines of conventional type.

Unit shown is 120/208 V.AC 60Hz

MODEL H-REM-120-CM-MP

Description

The Universal Laboratory Machine set shown here consists of a 2 kVA uniform gap universal Machine coupled to a trunnion mounted DC dynamometer. The dynamometer torque can be measured under both motoring and generating conditions by means of a spring balance calibrated directly in pounds-feet and newton-meters.
A 36 position locking device is fitted in the dynamometer to allow stalled torque measurements on the Universal Machine. There is also a DC tachometer on the dynamometer.

The Universal Machine is basically a two-pole induction motor with all of the stator coil ends brought out. Its rotor has a commutator winding with 2ø and 3ø tappings. All of these windings, including a rotor and stator search coil, as well as a full-pitch search coil on the dynamometer armature, are brought out to the terminal panel.

The stator coils can be connected to form a variety of 1ø, 2ø, and 3ø windings with different phase spreads for the AC modes of operation and also to form the main field, compounding and compensating windings that are required for the DC modes of operation. These windings are also to form the main field, compounding -and compensating windings that are required for the DC modes of operation. These windings are also terminated at a 24-pin socket so that, if desired, the coil to coil interconnections for a particular winding can be made by simply inserting an appropriate pre-wired plug, a variety of which are included with the machine.

A three-position brush lifting mechanism is fitted on the Universal Machine so that the brushes can be lifted off the commutator when they are not required, thus preventing spurious effects from shout-circuited coils.

A rotor-angle indicator permits measurement of machine load angle, winding inductances as a function of angular position, and, in conjunction with the dynamometer locking device static torque/angle characteristics.

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

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The nominal ratings of the Universal Machine are 1.5-2 kVA 208/120V, 3ø, 60 Hz, 3400-3600 RPM in its AC modes of operation, and 1 kW 115V, 1800-2400 RPM in its DC modes of operation.

The dynamometer has a rating of 3 kW 115V, 2400/3600 RPM as a separately excited DC generator and it can also be operated as a 115V DC shunt motor over the same speed range using field control.

Primary Input

208/120V, 3ø, 4-wire, 20A

Modes of Operation

By appropriate connection of the stator and rotor windings, the Universal Machine can operate in a wide variety of modes.

- As a 3ø, 208/120V induction motor with 2ø, 3ø, 6ø or 12ø secondary connections.
- As a 2ø, 120V/ø, induction motor with the above secondary connections. In this mode it can run as a 2ø servo motor and can be used to demonstrate the principle of the drag-cup tachometer.
- As a 1ø, 120V, capacitor motor and as a simple 1ø induction motor.

In these modes the power output ranges from 1-2 HP.

The Universal Machine can also be operated as follows:

- As a 3ø 120V, synchronous machine with distributed field and damper windings, each of 90° spread, or of 120° and 60° spreads respectively. For synchronous motor operation, the machine can be started as an induction motor and synchronized on the line by feeding DC to the field winding. The synchronous reactance is approximately 2 p.u.
- As a 3ø 78V AC 115V DC rotary convertor.

Unit shown is
220/308 V.AC 50Hz

The Universal Machine can operate in a variety of DC modes. In some of these it is necessary to compensate the armature m.m.f. because of the small, and uniform, air-gap length, which is of course desirable for the induction modes. Speeds for 115V DC operation are in the range 1800-2400 RPM. The machine can then run as follows:

- As a 1 HP DC shunt or series motor.
- As a 1 kW DC generator with separate or shunt main-field excitation and a choice of two degrees of series compounding.
- As an amplidyne or metadyne generator.
- As a metadyne transformer, which has certain dynamic properties which are of interest form the viewpoint of generalized machine analysis.

It is also possible to run the machine as:

- An AC series motor.

These many different modes of operation of one machine demonstrate the unity and common principles of electrical machines. The field conditions within all of these machines can be examined by means of the search coils and the results can be used to explain why a salient pole form of construction is preferable for certain types of machines: the field distribution within the DC dynamometer being used as an example.

If a number of these Universal Machines are installed in a laboratory, it is possible for several groups of students to do the same experiment simultaneously and thus a greater degree of coordination can be achieved between lecture work and laboratory work than is usually possible in a machines laboratory.

If several machines are available, they can be used for experimental work on interconnected machines such as Ward-Leonard drives, Selsyn systems and interconnected synchronous machines. The power rating of the Universal Machine is also convenient for control system experiments and many experiments on speed, position and voltage

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control of both AC and DC machines can be devised using control devices such as saturable reactors, variable frequency drives and SCR drives.

Versatile machines of this type are invaluable for student project work.

Tutorial Applications

On of the most important applications of the Universal Machine is that of demonstrating to students some of the basic features of electrical machine theory, such as:

- The relationship between the spatial distribution of current in a winding and the resultant m.m.f. and flux density distributions.
- The relationship between winding spread and the space harmonics of m.m.f.
- The nature of the voltages induced in commutator and phase windings by stationary, pulsating and traveling flux density distributions.
- The torque developed by the interaction of winding m.m.f.s.
- The field distributions within particular machines.

Experimental work and demonstrations of this kind can present machine theory in a novel and stimulating way and can provide a sound basis for a unified treatment of machines.

Comprehensive instruction manus are provided with each machine.

Terminal/Meter Panel

The terminal panel is equipped with binding posts for all field leads, armature leads, slip ring leads, search coil leads, and metering for all motor functions. Winding for armature, etc., is diagrammatically shown on the panel.

The terminal panel is equipped with necessary jumper cords for connecting up any type of experiment within the capabilities of the unit.

The terminal panel has the following meters terminating to HB-3M binding posts:

- 1 DC voltmeter, 0-150/300V
- 1 DC ammeter, 0-10A
- 1 AC ammeter, 0-10/20A
- 1 DC ammeter, 0-15A
- 2 Wattmeters, 0-1.5/3kW
- 1 DC ammeter, 0-20A
- 1 AC voltmeters, 0-150/300V
- 1 Tachometer, 0-2000/4000

Optionally, all meters can be supplied as digital displays.

The meter panel also provides three sets of ammeter receptacles, each terminating in two HB-3M binding posts.

Accessories

A nylon facilon cover is available for the Hampden H-REM-120-CMMP. It is zippered to permit a custom tailored fit and protects the Universal Machine while not in use. Specify H-REM-120-C Cover.

Control Console

The control console has various controls for the following equipment:

1. Main AC circuit breaker with pilot light.
2. 0 to 208/120V, 3ø, 4-wire power source. Variable autotransformer, circuit breaker and pilot light.
3. 120V, 2ø, 3-wire, 15A power source. Circuit breaker with pilot light.
4. 115V DC, 30A power source from full wave 3ø bridge rectifier. Circuit breaker with pilot light.
5. Induction Start/Sync. Run switch for operating Univ. Machine as a 3ø synchronous motor.
6. Set of two switches for capacitor starting and capacitor running the Universal Machine as a 1ø motor.
7. Three-pole full-voltage AC starter. Start and Stop pushbuttons.
8. Automatic two-step DC starter with overload and field failure protection. Start and Stop pushbuttons.
9. Dynamometer shunt field control with auxiliary resistor. Rheostat knob and toggle switch.
10. Universal Machine shunt field control with swamp resistor. Rheostat knob.
11. Speed control of Universal Machine when operated as wound rotor motor. Rheostat knob and three-pole circuit breaker.

The right-hand end of the console has all jack receptacles form the power supplies, load banks, starter controls, etc., as well as ten 3-pole switches to provide steps of 1ø and 3ø loads up to 3KW from the load bank mounted within the console. All controls, terminal jacks, etc., are labeled to describe their function.

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Computer Data Logging

In order to demonstrate closed loop control, the **H-REM-120CM-MP-CDLC** Universal Laboratory Machine with Computer Data Logging and Control provides a console fully computerized for control and data acquisition. Through the use of relays and digital instrumentation, the student can control all aspects of the Universal Machine in any mode of operation available.

Hampden provides the **H-REM-120CM-MP-CDLC** as a fully configured turnkey, computerized machine learning center. The Hampden **H-REM-LTCS** Laptop Computer System provides the laptop computer, cables, software and courseware as a seamless package to make the curriculum development process painless for the instructor.

CDL Specifications

All meters are supplied as digital devices with integral 0-5V DC outputs. The **Model H-REM-120CM-MP-CDLC** contains solid-state relays, motor-driven rheostats, and a motor-driven variable autotransformer, allowing remote machine operation, via industry-standard Opto-22 relays, as well as from the console.

All signals are brought out to internal terminal strips, easy accessible for ribbon cable connection.

Unit shown is 220/308 V.AC 50Hz

MODEL H-REM-120-CM-MP

Technical Data

Universal Machine

Ratings:
1.5-2 KVA, 208/120V, 3ø, 60 Hz, 3400-3600 RPM in AC modes 1 kW, 115V, 1800-2400 RPM in DC modes.

Stator:
24 slots wound with a 12 coil single-layer winding, coil pitch 1-12. Four auxiliary commutating windings are fitted on the d and q axes.

Rotor:
36 slots, skewed one slot-pitch wound with a full-pitch commutator winding having 12 coils, tapped for 2ø and 3ø outputs. Full-pitch search coils are fitted on stator and rotor.

Dynamometer

Rating:
3kW, 115V, 4-pole, 2400-3600 RPM as a separately excited DC generator. Operates as a 115V shunt motor with field control over same speed range.

Full-pitch search coil on dynamometer armature. 36-position locking device for stalled torque measurements.

Torque measurements by spring balance calibrated in pounds-feed and newton-meters. Optionally, the **H-REM-LC-D** Digital Load Cell can be provided, which has computer-level output for closed-loop control.

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