

Large Scale Motor Test System Design Brings Full Regulation Output Ratings of up to 10 MVA into Reach

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June, 2001

Introduction

New developments in High Power Motor Test System design mean that fully regulated AC motor test systems are now available with output power ratings up to 10 MVA. In most cases, this will provide sufficient power to test motors rated up to 10,000 HP under full load conditions, and motors up to 50,000 HP under no load conditions.

To date, the largest fully regulated AC power supplies utilizing variable transformer regulation have been limited to approximately 2.5 MVA. *The new large scale motor test system design will be offered by Phenix Technologies in power ratings beginning at 2.5 MVA, and increasing up to 10 MVA.*

The secret behind this dramatic increase in fully regulated power capacity is in the switching and boosting circuit developed for the motor testing application by Phenix Technologies. Utilizing this technology, the same number of variable transformer windings that were previously required to regulate 2.0 MVA can be used to regulate 10 MVA! Across the entire 2.5 to 10 MVA range, a 4 to 5 fold increase in output capacity can be realized, per variable transformer winding, as compared with present designs.

Flexible Input Voltage

One benefit inherent to the new design is that it is easily adapted to operate from any input voltage up to 15 kV. Since Phenix designs and manufactures the transformers used in its test systems, it is no problem to produce a system with any custom input voltage. Only the primary winding of the main AC supply transformer changes. The rest of the system, including all necessary regulating transformer windings and switches, are unaffected by supply voltage changes.

Full Regulation, With No Voltage Interruption

The regulating options available with the new large scale motor test system design are essentially unlimited.

Perhaps the most intriguing feature of the new design is the ability to raise the output voltage from zero to maximum rated output voltage without ever shutting

the power off to change taps. This capability allows for very large motors to be started with ease, without danger of tripping circuit breakers, blowing line fuses, or even causing a local power outage due to operation of utility company protective relays that are programmed to trip on overcurrent.

It should be mentioned that when testing very large synchronous motors, the new Phenix large scale motor test system design will permit synchronization of the motor at reduced voltage. Since there is never a need to remove voltage from the AC windings during startup, it is no problem to synchronize the motor as soon as it reaches synchronous speed. This lowers the no load running current of the synchronous motor dramatically, as the motor can be fully synchronized and running at minimum AC line current before full voltage is ever applied. This is an especially important operating feature when starting synchronous motors in excess of 20,000 HP.

This all adds up an outstanding capability to start and run very large motors, with no unexpected and expensive surprises.

Power on Tap Switching

The new Phenix Technologies large scale motor test systems utilize a sophisticated network of boosting windings and high voltage switches operated through PLC controlled switching algorithms, that seamlessly step through a tap switching sequence with the power on! The regulating transformer is sized just large enough to provide enough power on a given tap to regulate to the next tap.

The output voltage of the test set on a given transformer tap is actively monitored by the control system, and is continuously compared to the voltage on the next tap up. When the operator instructs the test set to "tap up", the control system automatically and independently adjusts the test set output voltage on each phase to match the voltage already present on the next tap of the main transformer, prior to closing the switch onto the next tap. This method eliminates switching transients that could be dangerous to the motor under test. Additionally, the practical elimination of switching transients reduces wear on the switch contacts, extending their life dramatically.

Automatic Phase Balance

The fundamental design and operation of the new large scale motor test systems from Phenix require independent phase voltage control. This independent phase control is managed behind the scenes by the control system, with no input required from the operator. What this means for the test operator is that the test set will automatically provide output voltages balanced within 1% at full load, even for phase voltage imbalances of up to 10% seen on the incoming supply. Under light load conditions, even larger imbalances may be corrected.

CTVT Regulation

As always, the Phenix Technologies Column Type Variable Transformer (or CTVT) is used exclusively as the regulating transformer in the high power Phenix Technologies Motor Test System line. The CTVT has the proven track record of a workhorse in the motor testing industry. At present, hundreds of Phenix CTVT's are in operation, each running for many years without the need for significant maintenance. The new large scale motor test system design continues to utilize the CTVT as the regulating transformer, based on its simplicity, durability, and proven effectiveness.

No SCR's or Diodes Used In Regulation

The Phenix CTVT design uses no SCR's or Diodes which may generate large harmonic voltages. This is good both for the motor under test, as well as for other users of power running from the same distribution circuit.

Additionally, the absence of any semiconducting devices used in the AC regulation scheme translates into increased reliability and an overall very rugged system.

Across - The - Line Start

An additional feature that comes as standard equipment on all large scale motor test systems is the capability to perform "Across - The - Line" starts on large motors, at as high a voltage as the input service will permit.

Although it is possible (and recommended) to raise the voltage from zero when starting a repaired motor for the first time, once the integrity of the motor windings has been established, it is recommended to start the motors across the line, at reduced voltage. This will bring the motor up to speed more quickly, as well as simulate actual starting conditions more realistically.

As standard procedure, once the motor has been tested for winding integrity, Phenix recommends that

the motor be started across the line at approximately 30% of rated line to line voltage, when testing using the new large scale motor test set design. After the motor is up to speed, the voltage can be raised to rated voltage either manually, or under the automated control of the internal PLC.

In fact, a motor can be started across the line at as high a voltage as the input service to the test set will permit. 30% is generally recognized to be a good compromise between excessively long startup currents, and excessively high startup currents.

Overload Capability

As with all Phenix Technologies high power motor test systems, the standard AC overload duty ratings are included on all models. These overload duty ratings permit the test set to supply 250% of rated output current for one minute, and 110% of rated output current for one hour.

Low Impedance

All Phenix Technologies new large scale motor test systems feature a low series impedance, resulting in less internal voltage drop in the test set while under load. Low internal voltage drop means increased efficiency, and the ability to get full voltage out - at full load.

Software and Automation Features

All Phenix software and automation features that our customers have come to know and expect are included as standard equipment on the new large scale motor test system designs.

All large scale motor test systems utilize the Allen Bradley Panelview controller, and all systems are provided with the most up to date version of the Phenix WINMTS testing software. This allows the operator to take advantage of exclusive Phenix Technologies motor testing control features, such as:

- Automatic Voltage Control
- Programmable Overloads
- Programmable Alarms and Lockout Features
- Programmable Current Limiting Features

Example Output Ratings

As an example of available AC and DC output ratings, the following specification provides the input and output electrical data for a 5 MVA motor test system, designed and manufactured using the techniques discussed in this paper:

Sample Ratings - 5 MVA Motor Test System:

Input Voltage: 4,160 VAC, 3 - Φ , 60 Hz
Input Current: 765 AAC

AC Output Taps:	480 V	1,200 A
	960 V	1,200 A
	1,440 V	1,200 A
	1,920 V	1,200 A
	2,400 V	1,200 A
	3,000 V	962 A
	3,750 V	770 A
	4,688 V	616 A
	5,859 V	493 A
	7,324 V	394 A
	9,155 V	315 A
	11,444 V	252 A
	14,305 V	202 A

DC Output Taps: 750 VDC 1,500 ADC

AC Duty Cycle: Continuous at 100%
1 Minute at 250%
1 Hour at 110%

DC Duty Cycle: Continuous at 100%

Conclusion:

At 5 MVA, the output ratings presented above fall approximately in the middle of the practical range of available output power ratings using this new approach to voltage regulation. Standard designs will be produced in output power ratings as follows:

2.5 MVA
3.75 MVA
5 MVA
6.25 MVA
7.5 MVA
8.75 MVA
10 MVA

The unique features provided by the new large scale motor test system design, particularly with regard to the uninterrupted voltage control, make the new large scale motor test systems especially well suited to running very large motors, up to 50,000 HP under no load conditions.

Technical questions regarding this newly upgraded product line can be addressed to the Phenix Technologies Engineering Department:

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Contacts and questions are also invited by Telephone or FAX at:

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