MARATHON ELECTRIC'S LIMA®MAC GENERATOR
# DESCRIPTION OF OPERATION

The Lima®MAC (Motor Application Characteristics) generator is a brushless, synchronous, self excited, self voltage regulated 60 Hertz AC generator with superior motor starting and operating capabilities. The Lima®MAC generator will start three phase induction motor loads equivalent to one horse power (0.746 kW$_m$), NEMA Starting Code G (6.3 SkVA/HP) per kW of 80° C temperature rise rated output power while maintaining a maximum transient voltage dip of 35% or less. This means that the MAC generator can accept motor starting inrush currents in excess of 500% of rated full load current, and maintain its output voltage within 65% or higher of nameplate value during this transient condition.

The heart of this unique generator is its patented excitation system. The exciter stator (stationary winding) and the exciter rotor (rotating winding) are three phase armature type windings, and in essence, are the primary and secondary windings of a rotating current transformer frequency converter. The exciter stator is comprised of two separate windings: a shunt winding, and a series winding. Each of the six major coil groups of the generator's main stator (stationary winding) have a shunt tap on a portion of the winding which is interconnected with the shunt portion of the exciter stator to provide no load excitation. The series portion of the exciter stator winding is connected across the complete stator winding, and carries all of the load current to provide a load compounding characteristic. (Figure 1)

**Figure 1   CIRCUIT DIAGRAM OF Lima®MAC GENERATOR**
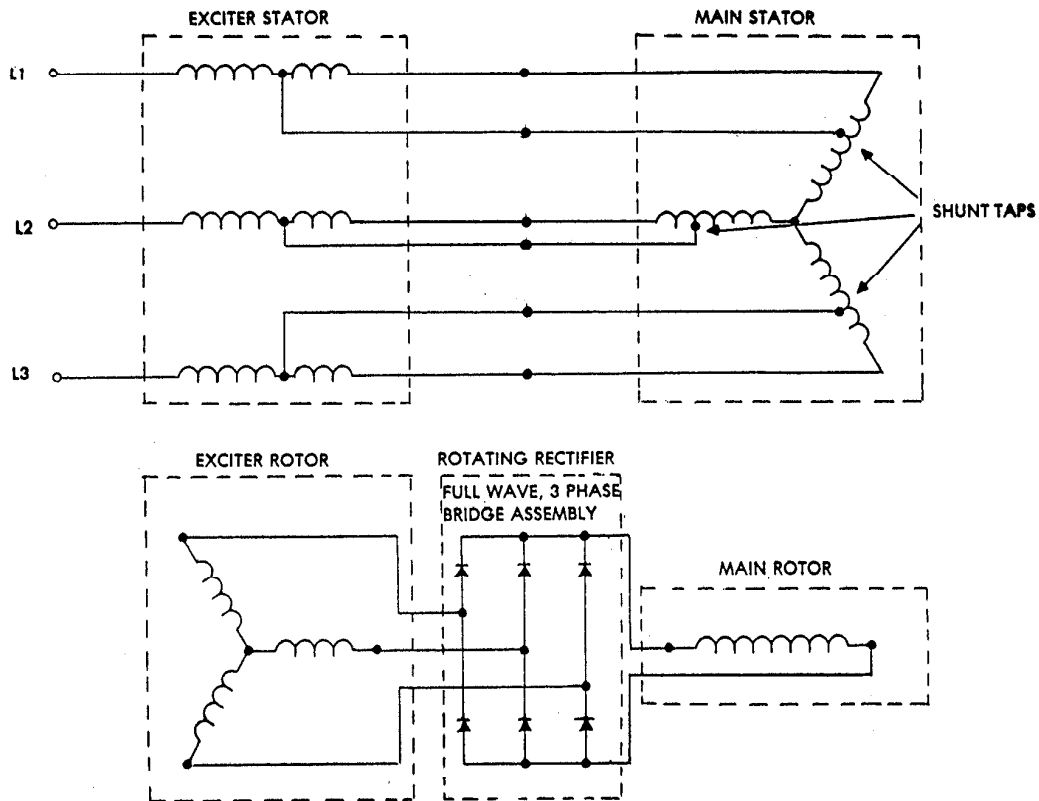
The three phase exciter rotor, acting as the secondary of this integral rotating current transformer, will have a current induced into it in proportion to the sum of the currents flowing in both the shunt and series windings of the exciter stator. This current induced in the exciter rotor is rectified to DC current by a three phase, full wave rotating rectifier assembly, and fed directly into the main rotating field windings as excitation current.

Since the exciter windings are AC windings, there is no residual magnetism in the exciter stator core iron to provide the magnetic flux required for initial voltage buildup as seen in conventional brushless externally voltage regulated units. Instead, small permanent magnets are embedded in each of the four poles of the main rotor to provide the required residual magnetic flux across the air gap for initial voltage buildup.

Figure 2 below is a graphic illustration of main stator and exciter stator interconnections along with a typical cross sectional view showing the individual major components of the Lima®MAC generator.

Figure 2   **Lima®MAC GENERATOR**
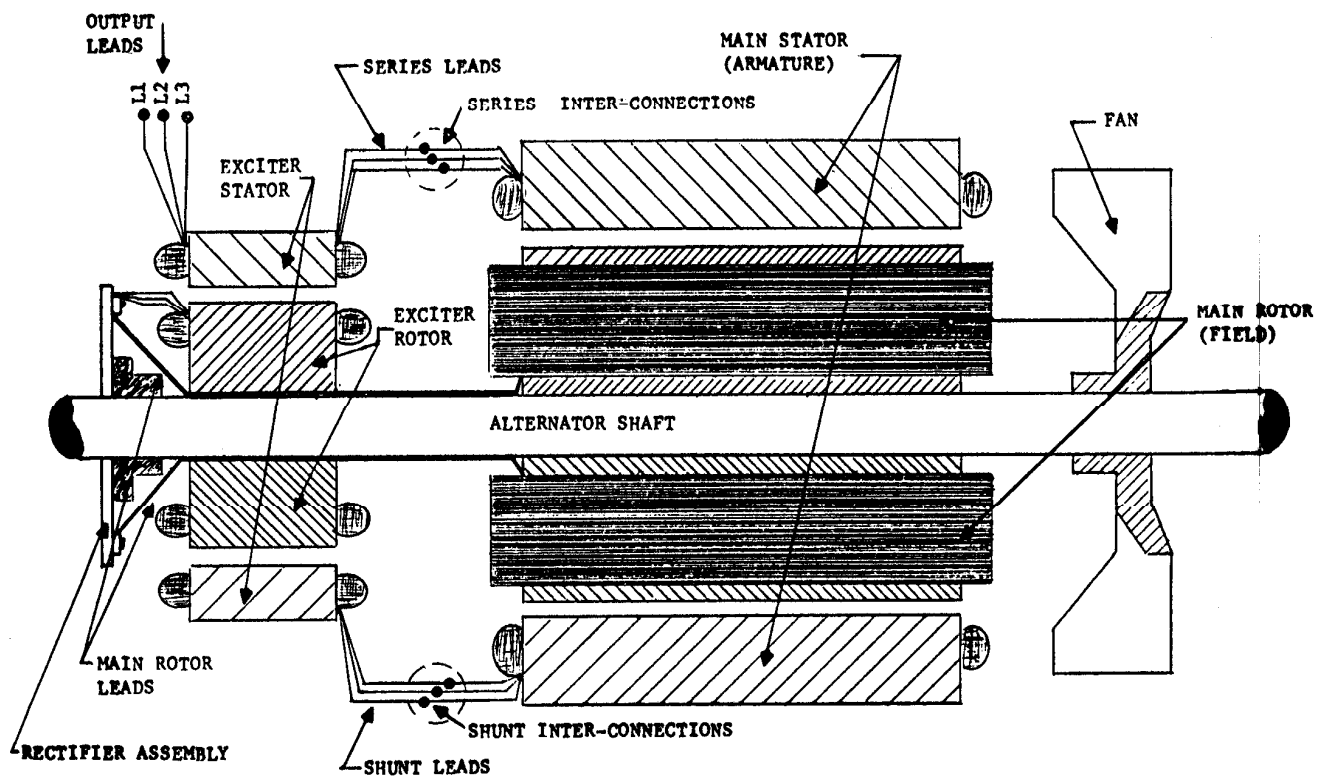
The advantages of this type of AC generator to power induction motor loads are as follows:

1. This generator is completely self voltage regulated, and does not employ an external automatic voltage regulator. Thus, the need to maintain or stock a spare regulator is eliminated.
2. The brushless design of the Lima®MAC eliminates the need for brush and collector ring

maintenance, a requirement of a statically excited generator.

3. The ability to support motor starting inrush current in excess of 500% of the generator's full load running current is approximately twice that of conventional externally voltage regulated brushless generators.

4. This same inrush current sustaining capability, 500% of full load current, also enables the Lima®MAC generator to sustain fault currents of the same magnitude to assist in fault clearance, without the need for an external excitation support system such as a Current Boost, Series Boost, or PMG as is required by a conventional brushless generator.

5. By the nature of its design (no external automatic voltage regulator sensing and correcting output voltage) the Lima®MAC generator will produce a Volts-Per-Hertz voltage characteristic with variations in shaft rotative speed. This Volts-Per-Hertz characteristic will allow on line motors to track the generator speed without injury when the generator is subjected to variations in shaft speed. This capability of the MAC is often used to control the speed of motors by varying the speed of the generator's prime mover. Figure 3 below is a typical Voltage vs Speed curve.

Figure 3.   **Lima®MAC 10 LEAD GENERATOR**
TYPICAL VOLTAGE vs RPM CURVES

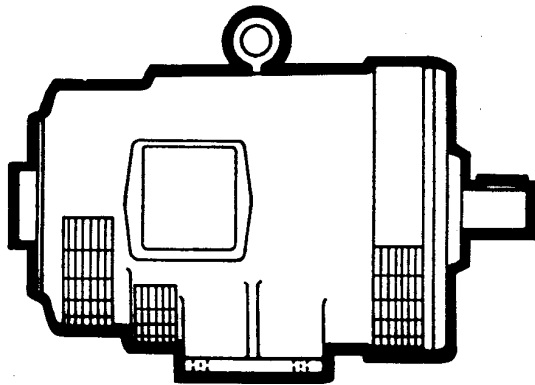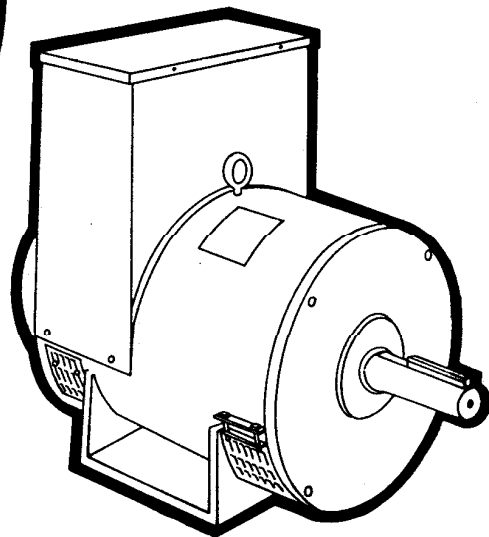—— **No-load volts**   —+— **Full-load volts**
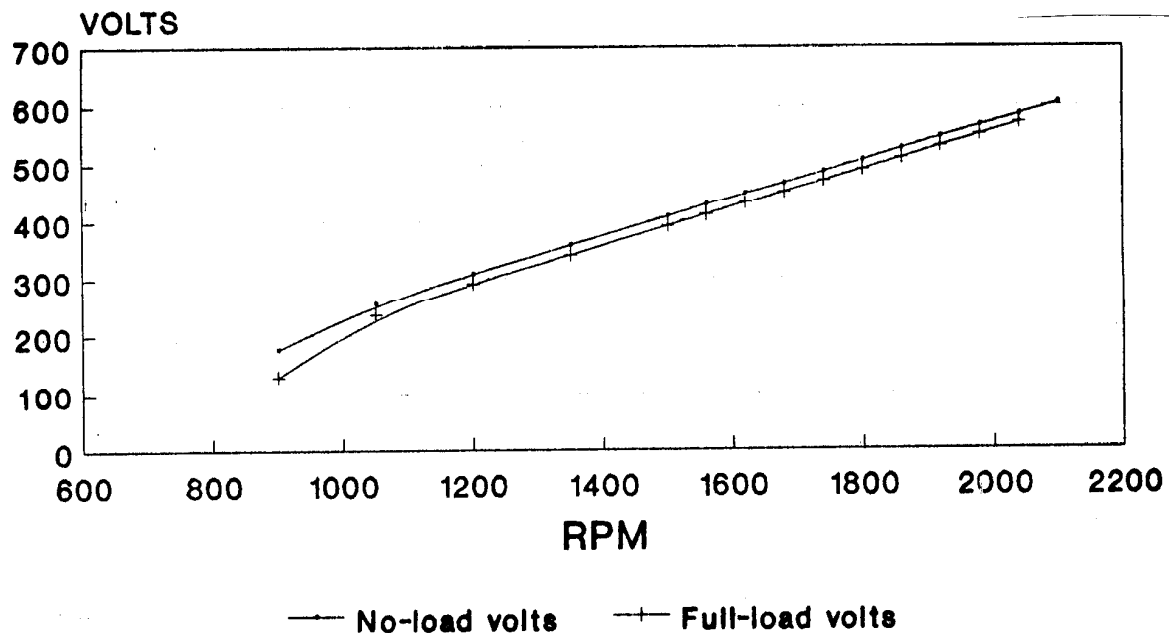
6. An important consequence of brushless design and the self voltage regulating features given in paragraphs 1 and 2 above is that, as a brushless unit with no brushes, and no arcing contactors, the Dripproof Lima®MAC generator is suitable for operation in Class I, Group D, Division 2, Temperature Code T3 hazardous locations per the National Electric Code NFPA 70-1996. Externally voltage regulated employing voltage adjust rheostats, build-up relays, field flashing circuits, and fuse or circuit breaker protected voltage regulator power circuitry would require

these devices be installed in explosion proof enclosures.

7. The Lima®MAC line of generators have relatively low sub-transient reactances (X''_d). The actual values of X''_d will differ among the various models, but will range in the area of 9.5% (.095 PU) to 6% (.06 PU). These low values of reactance, coupled with the lack of an automatic voltage regulator, result in MAC generators being good to excellent power sources for most non-linear thyristor loads such as Soft Start Starters, Variable Frequency Drives (VFDs), and other switching power supplies. The reason for this good performance is that the voltage regulation is based upon line current, and not upon generator terminal voltage as seen in the sensing circuit of an automatic voltage regulator. The result of this system of generator excitation/regulation is that generator's output voltage will remain very stable even under rather severe load induced voltage spikes, and notches on the wave form resulting in false zero crossings.
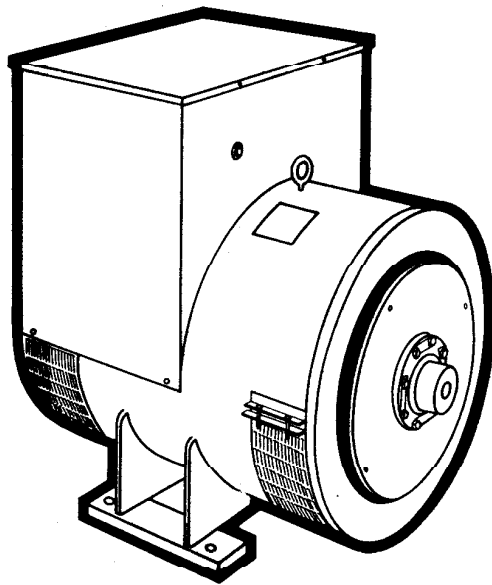
**360 Frame and Larger
1 and 2 Bearing Generators**

**280 Frame
Two Bearing**