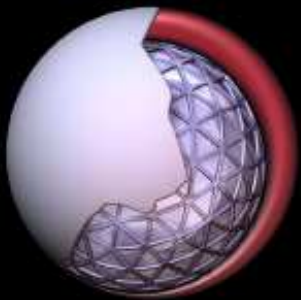


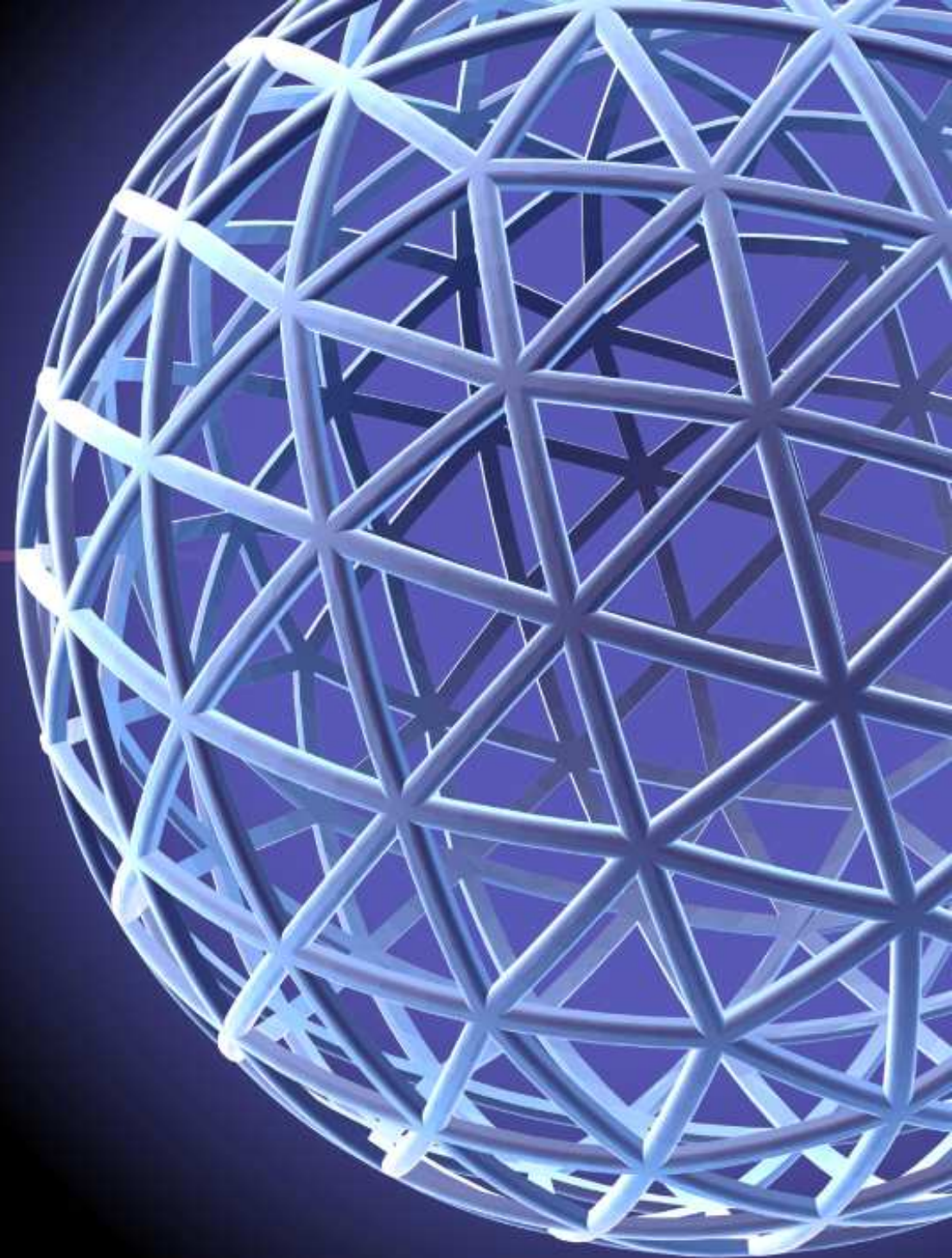
# SEMA Features & Benefits

Revised February 10, 2009

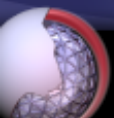
Prepared for Lynx Motion Technology  
By Kinetic Art & Technology



**Kinetic Art & Technology**  
CORPORATION



- Purpose of this document
  - Provide additional information regarding the tremendous features, benefits and potential of SEMA Motor and Generator Technologies
  - To provide greater technical detail regarding the features and benefits of the SEMA Motor and Generator Technologies than is given elsewhere





# Over 98% Efficiency Demonstrated

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- Highest motor/generator efficiencies
  - Whether direct-drive or geared
  - Achieved without superconductor materials
  - This benefit can be used:
    - To lower fuel costs in motor/generator applications
    - To increase battery life for a given charge and increase battery lifetime (due to fewer overall charge cycles)
    - To decrease the battery size and weight of the system.
- SEMAs have been independently tested **over 98% efficient** without the use of magnetic-levitation or air bearings.
- SEMA motors and generators tend to demonstrate high efficiencies over a broad range of torque and speed

# Low Mutual Inductance & Bearing Loads

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- **Low mutual inductance between coils and stators**
  - This allows the SEMA phases to be divided into multiple groups and easily driven by multiple inverter stages for a fault tolerant system.
  - This low “cross-talk” allows multi-stator designs to have each stator driven by an independent inverter for another level of fault tolerance.
- **No magnetically induced bearing loads**
  - All forces are transferred through the shaft, not through the bearings
  - Benefits
    - Increased bearing life
    - Lowers bearing cost
    - Improved overall efficiency
  - Allows very large diameter motors/generators to be produced that rotate freely with the lowest drag.

# Peak Torque/Current & Low Electrical Time Constant

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- **Highest peak torques as a motor and highest peak currents as a generator**
  - This allows the motor to respond to transients and/or accelerate quickly.
- **Low electrical time constant**
  - Allows the motor's current to change direction and/or magnitude quickly, thereby allowing the motor to respond to torque/force disturbances quickly.
  - As a generator it allows the generator to source current quickly to respond to transient loads.
- **Full peak torque available across entire speed range**
  - From 0 rpm to top end speed
  - The torque is only limited by the available bus voltage.



# No Cogging Torque, Low Torque Ripple & Linear $K_T$

- **No cogging torque**
  - Allows better control
  - Easier on bearings
  - Motor/generator is acoustically quiet - it doesn't transmit vibrations to mounting structure or the load
  - Allows very large diameter motors/generators to be produced
  - Along with other factors, allows for extremely precise servo motor control
- **Low torque ripple with as little as three phases**
  - Smooth torque/force with off the shelf 3-phase controllers
  - Custom controls and/or more than three phases will meet the most demanding low torque ripple applications.
- **Linear torque constant**
  - Torque is predictable and linearly proportional to current thereby making control easier.

# Fantastic Manufacturing Advantages

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- **Tolerance stack up has little affect on performance**
  - Easily manufactured, worn tooling replaced less often, lowers manufacturing costs.
  - Example: In a typical SEMA, the “true” air gap is from flux return to flux return and can be on the order of 25 mm where the clearance gap is typically 1 mm. Therefore if our stack up error were 0.25 mm it would represent approximately only a 1% change with the SEMA technology. However, with competing motor technologies, their clearance gap needs to be very small to maximize performance (thus inherently requiring low tolerances to be specified in their machining processes and driving cost up and tooling maintenance up) and a stackup error of anywhere near 0.25 mm would severely reduce performance. In addition, as their tooling wears, their performance suffers a greater penalty.
- **Fewer and simpler parts**
  - Easily manufactured, lower initial investment for production line.

# Brushless, COTS Controls & Near Unity Power Factor

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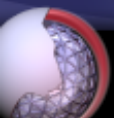
- **Brushless**
  - No arcing ignition source, low EMI/RFI, no maintenance, cleaner because no dust is created.
- **Can easily be driven by shaft-sensorless controls and Off-The-Shelf controls**
- **Natural pumping action of dual axial air gaps provides an excellent “built in” passive cooling approach**
  - Increases duty cycle performance
  - May lower cost.
- **Near unity power factor**
  - As a generator, voltage and current are closely in phase and therefore more ideal.



# Single and Multi-Stator Designs

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- Available in single stator or multi-stator designs
  - This provides for shape factors ranging from “pancake style” (large diameter, short cylinder) to “traditional” (small diameter, long/tall cylinder) to accommodate a wide range of packaging requirements.
  - Multi-stator designs can be used to standardize on fewer numbers of stator/rotor sizes thereby reducing inventory across a wide range of applications, if desired.



# Through-Hole Application & Highly Scalable

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- **Available with large, central through-hole**
  - This allows the motor to “wrap” around an existing component, or allow for cabling/etc. to pass through the center of the motor.
  - This through hole can easily be >80% of outside diameter. This allows for unique integration options and a greater number of applications can be accommodated.
- **Highly Scalable**
  - Produced from 1.2hp@20,200rpm measuring 3” OD up to 175hp@2,500rpm (215hp for one hour) measuring 32” OD
  - The SEMA technology can cover a wide range of applications successfully with efficiencies often over 98%.

# Conclusion

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- The SEMA Technology has many advantages over competing motor technologies

- Contact Kinetic Art & Technology to learn more:

<http://www.katech.com>  
(812) 923-7474

- Or Contact Lynx Motion Technology

<http://www.lynxmotiontechnology.com/>  
(812) 923-6700

