

## SYNCHRO-SYM versus EMRAX 348

[SYNCHRO-SYM Designed To Meet EMRAX Maximum Load RPM With the same Continuous Torque and Power]

	SYNCHRO-SYM	EMRAX 348
<p>The green design compares SYNCHRO-SYM, which is designed with BEM-CAD and manufactured with MOTORPRINTER, to the EMRAX 348, which is designed and manufactured by EMRAX in accordance to EMRAX348 specification. The green design clearly shows SYNCHRO-SYM is up to half the cost, half the size, and half the loss as EMRAX for a given unit of power rating while providing up to 8x peak torque, which is necessary to eliminate the compounding loss, cost, and size of the electric vehicle gearbox. Unlike EMRAX, which does not include the compounding loss, cost and size of the necessary electronic controller, SYNCHRO-SYM specification always includes the tightly integrated BRTEC. With active winding sets on rotor and stator, respectively, SYNCHRO-SYM provides continuous failsafe operation during catastrophic failure of the either the rotor or stator winding set. Also, SYNCHRO-SYM has no delicate permanent magnets, back EMF safety, or Cogging issues.</p> <p><i>NOTE: The EMRAX348 Continuous Power Specification comparison, such as volume, does not meet the half size per unit of power rating as expected of SYNCHRO-SYM (see yellow design comparison comparison) but in response, EMRAX 348 does not include the electronic controller in its specification nor does it include the frame robustness of SYNCHRO-SYM, which is designed to meet the 4x peak torque capability. Also, it is obvious EMRAX is using highly optimized material, winding, and packaging techniques, which are not clearly indicated in its specification for an equitable comparison but if immediately programmed into BEM-CAD and MOTORPRINTER, instead of by painstaking discovery through multiple design iterations, SYNCHRO-SYM would provide better results.</i></p>		
	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[DOES NOT INCLUDE Electronic Control - <b>MOTOR ONLY</b> ]
Continuous Power	<p><b>110 KW / 147.5 HP</b>  <b>@ 2800 RPM, 800V</b>  <b>@ 375.34 Nm Torque</b>                      @ 95.5% Motor Efficiency                      @ 94.1% System Efficiency #                      @ 1.25T Airgap Flux Density                      @ 0.5 mm Air-gap                      @ <b>10 pole-pairs</b></p> <p><b>No RE-PM</b></p>	<p><b>110 KW / 147.5 HP *</b>  <b>@ 2800 MAX Load RPM, 800V</b>  <b>@ 375.34 Nm Torque</b>                      @ 96% Motor Efficiency                      @ Est. 92% System Efficiency with                      96% Efficient Electronic Control #                      @ ? Airgap Flux Density                      @ ? Air-gap                      @ <b>10 pole-pairs</b></p> <p>RE-PM Amount: ? Kg @ ?T</p>
Diameter	351.7 mm #####	348 mm ##
Length	85 mm #####	107 mm ##
Weight	32.2 Kg #####	42 Kg ##
Volume	8,253 cm <sup>3</sup> (W BRTEC & 110KW)	10,172 cm <sup>3</sup> ## (WO electronic control & 110KW)
Continuous Power Density	13.3 KW/L (W BRTEC & 220KW)	11 KW/L (WO electronic control & 110KW)
Peak Power (2x)	<b>220 KW / 294.8 HP ###</b>	<b>300 KW / 402.3 HP *</b>

	<b>@ 2800 RPM, 800V</b> <b>@ 750.68 Nm Torque ###</b>  <b>@ 89.4% System Efficiency #</b>	<b>@ 2800 MAX Load RPM, 800V</b> <b>@ 1023 Nm Torque</b> <b>@ 86-90% Motor Efficiency</b> <b>@ Est. 83-86% System Efficiency with 96% Efficient Electronic Control #</b>
Power Density (2x)	26.7 KW/L (2x) (W BRTEC & 110KW)	30 KW/L (3x) (WO electronic control & 300KW)
Peak Power (4x)	<b>440 KW / 589 HP ###</b> <b>@ 2800 RPM, 800V</b> <b>@1501 Nm Torque ###</b> <b>@ 79.9% System Efficiency #</b>	N.A.
Power Density (4x)	53.3 KW/L (W BRTEC & 110KW)	N.A.
Peak Power (8x)	<b>Available w rated BRTEC &amp; Robust Frame Assembly</b>	N.A.

The yellow design compares SYNCHRO-SYM to the EMRAX 348, both of which are BEM-CAD designed and MOTORPRINTER manufactured to the same optimizing material, winding, and packaging (including frame) techniques, which clearly shows SYNCHRO-SYM is up to half the cost, half the size, and half the loss for a given unit of power rating while providing up to 8x peak torque, which is necessary to eliminate the compounding loss, cost, and size of the electric vehicle gearbox. Both designs include their respective electronic controller tightly integrated into the frame assembly. Also, SYNCHRO-SYM has no delicate permanent magnets, back EMF safety, or Cogging issues.

	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[INCLUDES Electronic Control]
Continuous Power	<b>110 KW / 147.5 HP</b> <b>@ 2800 RPM, 800V</b> <b>@ 375.34 Nm Torque</b> <b>@ 95.5% Motor Efficiency</b> <b>@ 94.1% System Efficiency #</b> <b>@ 1.25T Airgap Flux Density</b> <b>@ 0.5 mm Air-gap</b> <b>@ 10 pole-pairs</b>  <b>No RE-PM</b>	<b>55 KW / 147.5 HP *</b> <b>@ 1400 MAX Load RPM, 800V</b> <b>@ 375.34 Nm Torque</b> <b>@ 95.5% Motor Efficiency</b> <b>@ 92% System Efficiency #</b> <b>@ 1.25 Airgap Flux Density</b> <b>@ 0.5 mm Air-gap</b> <b>@ 10 pole-pairs</b>  RE-PM Amount: 5.5 Kg @ 1.25T
Diameter	351.7 mm	351.7 mm
Length	85 mm	167.5 mm
Weight	32.2 Kg	33.8 Kg
Volume	8,253 cm <sup>3</sup> (W BRTEC & 110KW)	16,268 cm <sup>3</sup> (W electronic control & 110KW)
Continuous Power Density	13.3 KW/L (W BRTEC & 110KW)	3.4 KW/L (W electronic control & 110KW)

Note: SYNCHRO-SYM is non-optimized design: Only 10 design iterations.

Note: SYNCHRO-SYM is the only brushless, symmetric multiphase wound-rotor "synchronous" doubly-fed electric machine system, as only provided by Brushless Real Time Emulation Control (BRTEC).

Note: SYNCHRO-SYM requires the additional size cost and weight of a much more robust axle and frame assembly to meet the ultrahigh peak torque! Also, SYNCHRO-SYM electronic control (BRTEC) rating is designed to meet the indicated peak torque!

**\* To avoid deciphering the EMRAX specification minutia, 110KW was taken from EMRAX 348 graphs, which clearly show 110KW “continuous power” at 2800 “maximum rated load RPM” and 96% efficiency.**

# System efficiency is the compounded product of electric motor and electronic controller efficiency.

### The symmetrical or dual ported transformer circuit topology of SYNCHRO\_SYM provides eight times the torque potential as the asymmetric transformer circuit topology. Electronic rating designed for indicated peak torque.

#### The size and weight of the axle and frame size and weight must meet the high peak torque demand