

SYNCHRO-SYM versus EMRAX 348

[Analysis: Retrofit EMRAX "Passive Rotor" with an "Active Rotor"
as only provided by the circuit and control architecture of SYNCHRO-SYM]

	SYNCHRO-SYM	EMRAX 348
	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[DOES NOT INCLUDE Electronic Control - MOTOR ONLY]
Continuous Power	220 KW / 295 HP @ 5600 RPM, 800V @ 375.34 Nm Torque @ 96.5% Motor Efficiency @ 95.2% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No Rare earth permanent magnets (No RE-PM)	110 KW / 147.5 HP * @ 2800 MAX Load RPM, 800V @ 375.34 Nm Torque @ 96% Motor Efficiency @ Est. 92% System Efficiency with 96% Efficient Electronic Control # @ ? Airgap Flux Density @ 10 pole-pairs RE-PM Amount: ? Kg @ ?T
Diameter	375.5 mm	348 mm ##
Length	74 mm	107 mm ##
Weight	27.5 Kg	42 Kg ##
Volume	8,202 cm ³ (W BRTEC & 220KW)	10,172 cm ³ ## (WO electronic control & 110KW)
Power Density	26.8 KW/L (W BRTEC & 220KW)	11 KW/L (WO electronic control & 110KW)
Peak Power 2x	440 KW / 590 HP ### @ 5600 RPM, 800V @ 750.68 Nm Torque ### @ 91.5% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs	300 KW / 147.5 HP * @ 2800 MAX Load RPM, 800V @ 1023 Nm Torque @ 86-90% Motor Efficiency @ Est. 83-86% System Efficiency with 96% Efficient Electronic Control # @ ? Airgap Flux Density @ 10 pole-pairs
Peak Power 4x	880 KW / 1179.2 HP ### @ 5800 RPM, 800V @ 1501.36 Nm Torque ### @ 84% System Efficiency # @ 1.25T Airgap Flux Density & 7 pole- pairs	N.A.
Peak Power 8x	Available w rated BRTEC & Robust Frame Assembly	N.A.

The green design compares SYNCHRO-SYM, which is designed with BEM-CAD and manufactured with MOTORPRINTER, to the EMRAX 348 specifications, such as 10 pole-pairs, voltage at max load RPM, and continuous power rating at highest efficiency, which were painstakingly leveraged from the specification minutia. **For instance, the EMRAX 348 graphs clearly show the EMRAX 348 provides 110KW of “continuous power” at the 2800 “maximum rated load RPM” and 96% efficiency. Unlike the contestant, SYNCHRO-SYM specification includes the loss, cost, and size of the tightly integrated BRTEC but EMRAX specification does not include electronic control. The green design 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 the peak torque, which is necessary for gearless electric vehicles. Also, with active winding sets on rotor and stator, SYNCHRO-SYM has no delicate permanent magnets with back EMF safety or cogging issues and more importantly, provides failsafe continuous operation with catastrophic failure of the either the rotor or stator winding set.**

	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[INCLUDES Electronic Control]
Continuous Power	220 KW / 295 HP @ 5600 RPM, 800V @ 375.34 Nm Torque @ 96.5% Motor Efficiency @ 95.2% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No RE-PM	110 KW / 147.5 HP * @ 2800 MAX Load RPM, 800V @ 375.34 Nm Torque @ 96.5% Motor Efficiency @ 93% System Efficiency # @ 1.25 Airgap Flux Density @ 10 pole-pairs RE-PM Amount: 5.5 Kg @ 1.25T
Diameter	375.5 mm	375.4 mm
Length	74 mm	156.7 mm
Weight	27.5 Kg	30.5 Kg
Volume	8,202 cm ³ (W BRTEC & 220KW)	17,332 cm ³ (W electronic control & 110KW)
Power Density	26.8 KW/L (W BRTEC & 220KW)	6.4 KW/L (W electronic control & 110KW)

The yellow design compares SYNCHRO-SYM (with BRTEC) to EMRAX 348 with integrated electronic control, both of which are designed with BEM-CAD and manufactured with MOTORPRINTER to the same optimizing material, winding, and packaging (including frame) techniques, which clearly show SYNCHRO-SYM is up to half cost, half size, and half loss for a given unit of power rating. Optimization was limited to less than 10 design iterations. **The results would be even better, if the obviously highly optimized material, winding, and packaging techniques utilized by EMRAX were immediately programmed into BEM-CAD and MOTORPRINTER instead of discovered by multiple design iterations.**

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.

A lower flux density (< 1T) will decrease the amount of RE-PM material from 0.1Kg/KW at 1.25T but with larger size and lower 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!

SYNCHRO-SYM versus EMRAX 348

[SYNCHRO-SYM Designed To Meet or Exceed EMRAX Speed-Performance]

	SYNCHRO-SYM	EMRAX 348
	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[DOES NOT INCLUDE Electronic Control - MOTOR ONLY]
Continuous Power	220 KW / 294.8 HP @ 2800 RPM, 800V @ 750.68 Nm Torque @ 92.6% Motor Efficiency @ 91.3% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No RE-PM	110 KW / 147.5 HP * @ 2800 MAX Load RPM, 800V @ 375.34 Nm Torque @ 96% Motor Efficiency @ Est. 92% System Efficiency with 96% Efficient Electronic Control # @ ? Airgap Flux Density @ 10 pole-pairs RE-PM Amount: ? Kg @ ?T
Diameter	375.1 mm ####	348 mm ##
Length	89.2 mm ####	107 mm ##
Weight	36.3 Kg ####	41 Kg ##
Volume	9,870 cm ³ #### (W BRTEC & 220KW)	10,172 cm ³ ## (WO electronic control & 110KW)
Power Density	22.3 KW/L (W BRTEC & 220KW)	11 KW/L (WO electronic control & 110KW)
Half Peak Power 2x	440 KW / 589 HP ### @ 2800 RPM, 800V @ 1501.4 Nm Torque ### @ 83.7% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs	300 KW / 402.3 HP * @ 2800 MAX Load RPM, 800V @ 1023 Nm Torque @ 86-90% Motor Efficiency @ Est. 83-86% System Efficiency with 96% Efficient Electronic Control # @ ? Airgap Flux Density @ 10 pole-pairs
Peak Power 4x	880 KW / 1179 HP ### @ 2800 RPM, 800V @ 3002 Nm Torque ### @ 68.4% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs	N.A.

Peak Power 8x	Available w rated BRTEC & Robust Frame Assembly	N.A.
<p>The green design compares BEM-CAD designed SYNCHRO-SYM to the specifications of EMRAX 348, which clearly show SYNCHRO-SYM is up to half cost, half size, and half loss advantage but <i>unlike the contestant, SYNCHRO-SYM specification includes the loss, cost, and size of the tightly integrated BRTEC.</i> With active winding sets on rotor and stator, SYNCHRO-SYM provides failsafe operation with continuous operation with catastrophic failure of the either the rotor or stator winding set. SYNCHRO-SYM has no delicate permanent magnets, back EMF safety, or Cogging issues.</p>		
	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[INCLUDES Electronic Control]
Continuous Power	220 KW / 294.8 HP @ 2800 RPM, 800V @ 750.7 Nm Torque @ 92.6% Motor Efficiency @ 91.3% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No RE-PM	110 KW / 147.5 HP @ 1400 MAX Load RPM, 800V @ 750.7 Nm Torque @ 92.6% Motor Efficiency @ 89.1% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs RE-PM Amount: 5.5 Kg @ 1.25T
Diameter	375.1 mm #####	375.1 mm
Length	89.2 mm #####	171.8 mm
Weight	36.3 Kg #####	36.8 Kg
Volume	9,870 cm ³ ##### (W BRTEC & 220KW)	18,995 cm ³ (W electronic control & 110KW)
Power Density	22.3 KW/L (W BRTEC & 220KW)	5.79 KW/L (W electronic control & 110KW)
<p>The yellow design used the limited set of specifications for comparison but with the same optimizing material, winding, and packaging techniques under BEM-CAD and MOTORPRINTER, which clearly show SYNCHRO-SYM is up to half cost, half size, and half loss for a given unit of power rating. <i>Optimization was limited to less than 10 design iterations. The results would be even better, if the obviously highly optimized material, winding, and packaging techniques utilized by EMRAX were immediately programmed into BEM-CAD and MOTORPRINTER instead of discovered by multiple design iterations.</i></p>		
<p>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</p>		

SYNCHRO-SYM versus EMRAX 348

[SYNCHRO-SYM Designed To Meet or Exceed EMRAX Power-Performance]

	SYNCHRO-SYM	EMRAX 348
	[INCLUDES BRTEC & Up to 8x PEAK TORQUE]	[DOES NOT INCLUDE Electronic Control - MOTOR ONLY]
Continuous Power	110 KW / 147.5 HP @ 2800 RPM, 800V @ 375.34 Nm Torque @ 95.5% Motor Efficiency @ 94.1% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No RE-PM	110 KW / 147.5 HP * @ 2800 MAX Load RPM, 800V @ 375.34 Nm Torque @ 96% Motor Efficiency @ Est. 92% System Efficiency with 96% Efficient Electronic Control # @ ? Airgap Flux Density @ 10 pole-pairs RE-PM Amount: ? Kg @ ?T
Diameter	351.7 mm #####	348 mm ##
Length	85 mm #####	107 mm ##
Weight	32.2 Kg #####	42 Kg ##
Volume	8,253 cm ³ ##### (W BRTEC & 110KW)	10,172 cm ³ ## (WO electronic control & 110KW)
Power Density	13.3 KW/L (W BRTEC & 220KW)	11 KW/L (WO electronic control & 110KW)
Half Peak Power 2x	220 KW / 294.8 HP ### @ 2800 RPM, 800V @ 750.68 Nm Torque ### @ 89.4% System Efficiency #	300 KW / 402.3 HP * @ 2800 MAX Load RPM, 800V @ 1023 Nm Torque @ 86-90% Motor Efficiency @ Est. 83-86% System Efficiency with 96% Efficient Electronic Control #
Peak Power 4x	440 KW / 589 HP ### @ 2800 RPM, 800V @ 1501 Nm Torque ### @ 79.9% System Efficiency #	N.A.
Peak Power 8x	Available w rated BRTEC & Robust Frame Assembly	N.A.
Power Density	13.3 KW/L (W BRTEC & 110KW)	11 KW/L (WO electronic control & 110KW)

The green design compares BEM-CAD designed SYNCHRO-SYM to the specifications of EMRAX 348, which clearly show SYNCHRO-SYM is up to half cost, half size, and half loss advantage but *unlike the contestant, SYNCHRO-SYM specification includes the loss, cost, and size of the tightly integrated BRTEC*. With active winding sets on rotor and stator, SYNCHRO-SYM provides failsafe operation with continuous operation with catastrophic failure of the either the rotor or stator winding set. 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	110 KW / 147.5 HP @ 2800 RPM, 800V @ 375.34 Nm Torque @ 95.5% Motor Efficiency @ 94.1% System Efficiency # @ 1.25T Airgap Flux Density @ 10 pole-pairs No RE-PM	55 KW / 147.5 HP * @ 1400 MAX Load RPM, 800V @ 375.34 Nm Torque @ 95.5% Motor Efficiency @ 92% System Efficiency # @ 1.25 Airgap Flux Density @ 10 pole-pairs 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 ³ ##### (W BRTEC & 110KW)	16,268 cm ³ (W electronic control & 110KW)
Power Density	13.3 KW/L (W BRTEC & 220KW)	3.4 KW/L (W electronic control & 110KW)
<p><i>The yellow design compares SYNCHRO-SYM (with BRTEC) to EMRAX 348 with integrated electronic control, both of which are designed with BEM-CAD and manufactured with MOTORPRINTER to the same optimizing material, winding, and packaging (including frame) techniques, which clearly show SYNCHRO-SYM is up to half cost, half size, and half loss for a given unit of power rating. Optimization was limited to less than 10 design iterations.</i></p>		
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