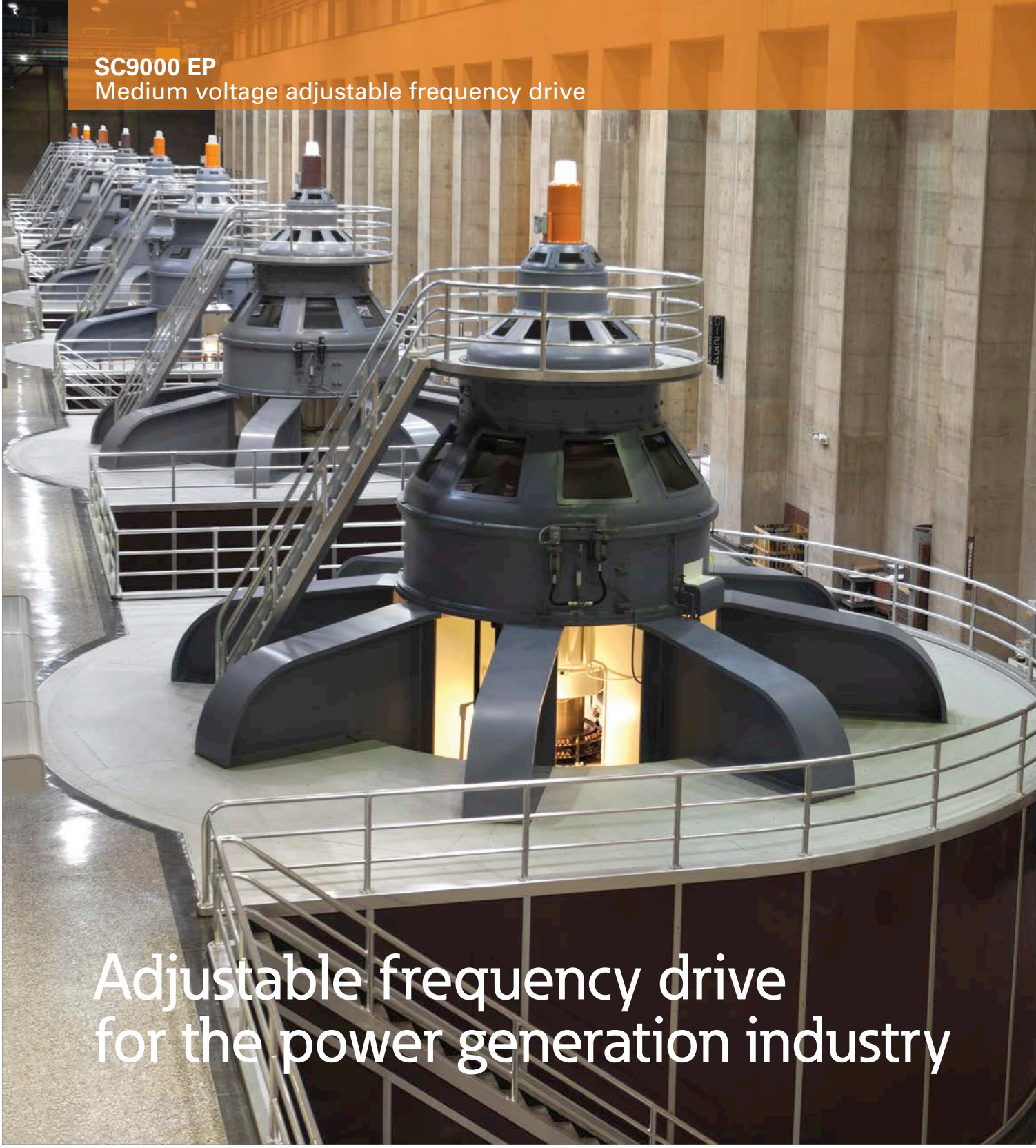
SC9000 EP
Medium voltage adjustable frequency drive



Adjustable frequency drive for the power generation industry

Powering Business Worldwide

Eaton SC9000 EP medium voltage adjustable frequency drive—"game-changing technology"

Eaton's second generation of medium voltage adjustable frequency drives, SC9000™ with encapsulated powerpole, is a state-of-the-art medium voltage AC drive that delivers features required by today's most demanding power-generating facility applications. Designed for use with induction or synchronous motors at 2400, 3300 and 4160 V, 50/60 Hz, up to 6000 hp, the SC9000 EP is highly innovative, with superior technology that yields maximum benefits in performance, reliability and harsh environment applications that require a design not previously found in the power-generation industry. Through extensive testing and hours of operation in the toughest of applications, the SC9000 EP has earned the right to be a member of the Eaton family of medium voltage control products.

Why **SC9000 EP** is different

SC9000 EP Frame C+
Up to 3000 hp at 4160 V, 137 inches W x 50 inches D x 92 inches H

Harsh environment duty

- Encapsulated powerpole inverter with heat pipe technology helps to increase power density, reduce overall equipment size and protect sensitive electronic components in harsh environments

Built for reliability and tested to prove it

- The SC9000 EP drive incorporates three-level neutral point clamped (NPC) inverter topology, which reduces the number of components and improves reliability. With the count of 46 active components in the topology, the inverter has MTTF (Mean Time To Failure) of 12.7 years
- All SC9000 EP electronic components are being stocked and assembled in a climate-controlled clean room to ensure no performance degradation from surface contaminations
- State-of-the-art test facilities for full load testing with ambient temperature control for up to 50 °C

Minimize upfront costs

- Totally integrated medium voltage control eliminates cables and reduces costs
- Eaton integrated control gear, all types of motor starters, load-break switches and main breakers can be integrated into a single lineup
- The high voltage input option (up to 15 kV) eliminates the need of a separate distribution transformer, reduces overall footprint and simplifies overall installation
- Industry-leading drive technology enables synchronous transfer, which allows customers to use a single drive to control multiple motors and reduce equipment costs. Eaton is the first to provide an integrated, double bus design, eliminating the need (and cost) for cabling to support synchronous transfer
- Innovative heatpipe technology and high-density packaging allows for compact footprint

Safety is our priority

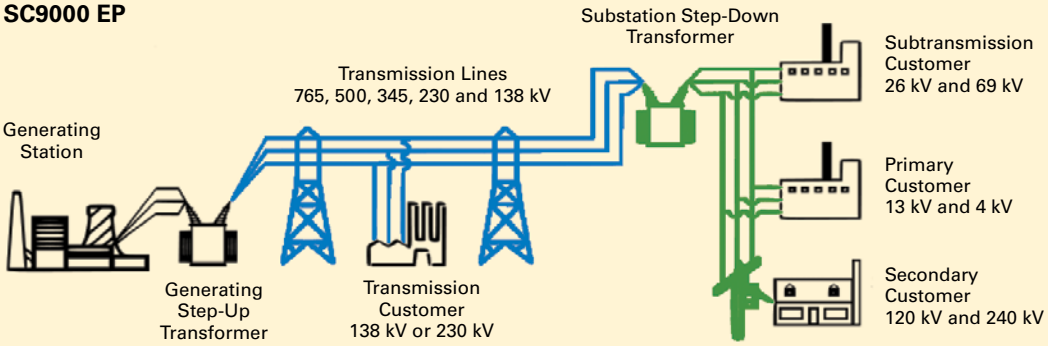
- Integrated isolation switch, fuses and main contactor ensure that incoming service voltage is disconnected and isolated before service is performed
- Key interlocks prevent access to energized compartments
- Standard grounding stick to ensure DC bus is fully discharged
- Provisions for optional remote operator for isolation switch. Remote operator allows opening of isolation switch while personnel remain outside the arc flash boundary

300–2500 hp VT at 2400 V
300–4000 hp VT at 3300 V
300–6000 hp VT at 4160 V
Sync transfer control
Sync motor control
High voltage primary

World-class service and support

- After order support—frequent communication with job status update and on-board approvals
- Local service—more than 100 Eaton field service engineers with drives training are strategically located in the U.S. and Canada
- "Test Drive" program—the Eaton field service engineer responsible for order-specific drive commissioning will participate in factory testing to ensure familiarity with their customer's drive
- Factory support—dedicated Customer Solution Center with in-house experts. Applications, commissioning, warranty and aftermarket solutions experts are available with extended hours of availability
- Dedicated service engineer will be located in the factory, ready to support field service engineers when needed

SC9000 EP



Color Key
Generation **Transmission** **Distribution**

SC9000 EP double-bus design for synchronous transfer control was first to market. Do not be misled by "cable copycats"

SC9000 EP double-bus design

With the SC9000 EP AFD double-bus, a second 1000 A AFD bus is located above the main bus, adding only 8 inches of additional height to the system.

The SC9000 EP double-bus enables close-coupling of a drive output contactor and multiple motor bypass and motor select contactors under a common bus alignment.

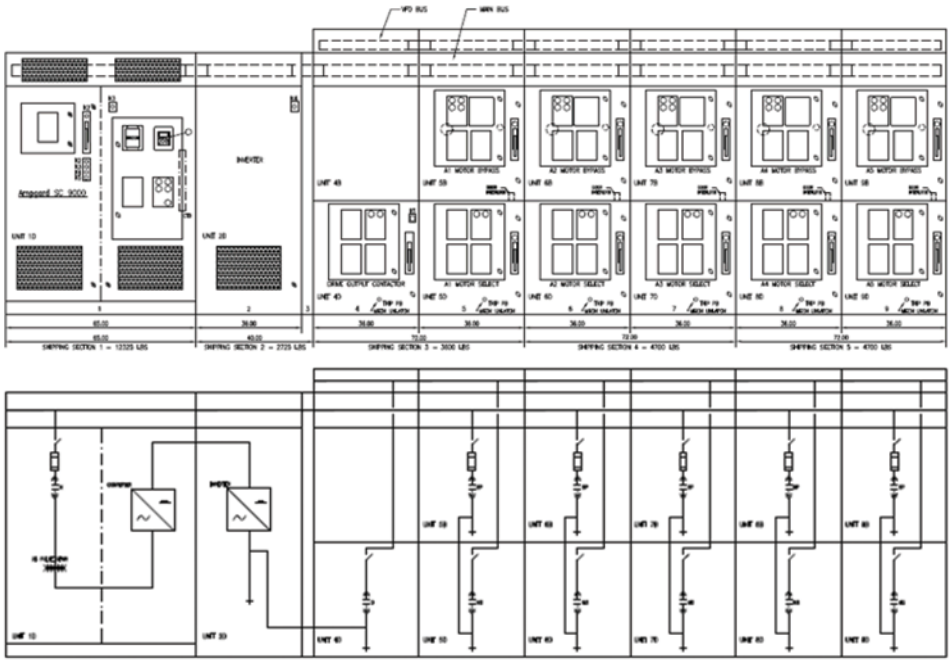
SC9000 EP integrated control gear synchronous transfer control design gives Eaton's customers the benefit of a compact and reliable system:

- Close-coupling of SC9000 EP and motor select contactors eliminates the many cable connections required for typical synchronous transfer systems—an ideal solution for electrical houses and smaller control rooms
- Double-bus configuration with paired motor bypass starter and motor select contactor provides a single location for landing motor leads, optimizing system configuration and connections

The SC9000 EP double-bus is integrated with a 36-inch-wide drive output contactor (optional) and 36-inch-wide motor bypass starters and motor select contactors structure that can be equipped with a 400 A or 800 A contactor, as required.

A 400 A motor bypass starter and a 400 A motor select contactor can be double-stacked in a single, 36-inch-wide cabinet for motor systems up to 3000 hp.

800 A motor bypass starter and motor select contactor assemblies require two 36-inch-wide structures for a total width of 72 inches per motor.



SC9000 EP Synchronous Transfer Contactor Assemblies

Drive Output Contactor

400 A Motor Bypass Starter and Motor Select Contactor Assembly

Contactor Rating	Maximum Motor hp	Cabinet Dimensions for Motor Bypass and Motor Select Contactor Assembly (Inches)	Short-Circuit Rating
400 A	3000	36 W x 92 H x 30 D	8500 A
800 A	6000	72 W x 92 H x 30 D	12,500 A

Medium voltage integrated control gear adjustable frequency drive double-bus design

Frame A 65-Inch W 250–1150 hp

Transition Reactor

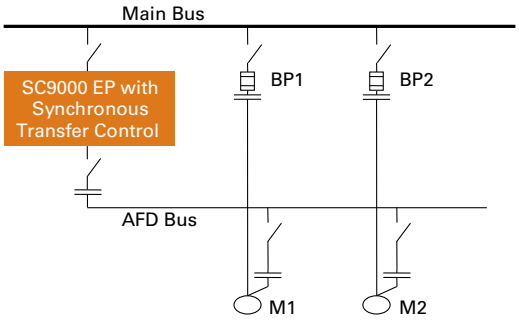
AFD Bus Output Contactor

Bypass Starters/Motor Select Contactors

Synchronous transfer systems help power generating facilities maximize the capital efficiency of their systems by controlling multiple motors with one adjustable frequency drive.

Most manufacturers synchronous transfer control system have multiple drive output and motor select contactors that are interconnected typically via cables to allow the AFD to manage multiple motors.

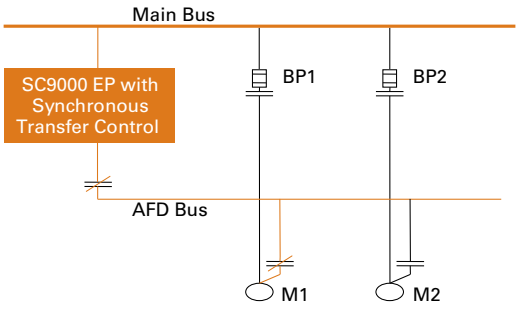
With the SC9000 EP and Eaton's medium voltage control gear AFD double-bus design, the drive output and motor select contactors are close-coupled under a common power bus (no cables), giving our customers the compact design and superior performance they expect.



The basic principle of synchronous transfer control is to adjust the SC9000 EP output voltage, frequency and phase to match the utility.

By matching these parameters, the drive system can transfer a motor from the SC9000 EP output to the utility in a "bumpless" manner.

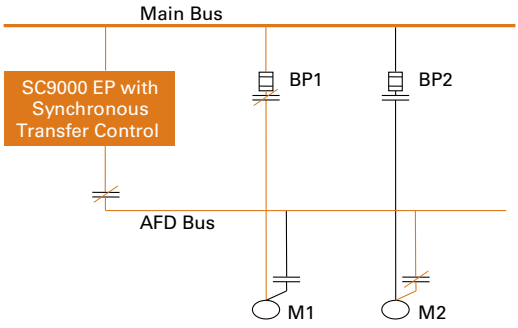
The SC9000 EP and control systems are programmed to start or stop a single motor, as well as sync up or down to other motors as needed.



Upon system startup, the SC9000 EP and AFD bus are energized.

The control closes the drive output contactor and the designated motor select contactor and starts the SC9000 EP, allowing power to be directed to the desired motor (M1 above) for operation.

The designated motor can now be operated at adjustable speed as needed.



When an additional motor is required, the PLC will send the sync up command to the SC9000 EP.

The SC9000 EP adjusts its output to match the line voltage, frequency and phase angle. Once the drive output and line are synchronized, the system will transfer the motor from the drive output to the utility by opening the motor select contactor (M1) and closing the motor bypass contactor (B1).

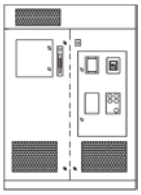
Once synchronization is locked, the adjacent motor select contactor (M2) is closed, and the SC9000 EP can now operate the additional motor at variable speed as needed.

SC9000 EP—a small package with a lot of power

Power Specifications

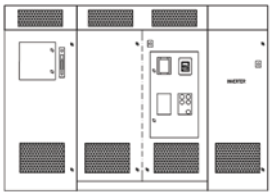
Voltage Class	**4160**												
Drive rating (A)	38	44	51	57	63	76	89	101	114	124	132	155	
4160 drive output (kVA)	274	317	367	411	454	548	641	728	821	893	954	1117	
Nominal hp 4160 V	300	350	400	450	500	600	700	800	900	1000	1150 ❶	1250	
Frame size	Frame A											Frame B	
Voltage Class	**4160**												
Drive rating (A)	186	217	248	279	310	372	455	493	558	620	682	713	744
4160 drive output (kVA)	1340	1564	1787	2010	2234	2680	3286 ❹	3552	4021	4467	4914	5137	5361
Nominal hp 4160 V	1500	1750	2000	2250	2500	3000 ❷	3700	4000	4500	5000	5500	5750	6000
Frame size	Frame B			Frame C			Frame D			Frame E			
Voltage Class	**3300 ❸**												
Drive rating (A)	48	56	64	72	80	96	112	128	144	160	200	240	
3300 drive output (kVA)	274	320	366	412	457	549	640	732	823	915	1143	1372	
Nominal hp 3300 V	300	350	400	450	500	600	700	800	900	1000	1250	1500	
Frame size	Frame A							Frame B					
Voltage Class	**3300 ❸**												
Drive rating (A)	280	320	360	400	440	480	520	560	600	640			
3300 drive output (kVA)	1600	1829	2058	2286	2515	2744	2972	3201	3429	3658			
Nominal hp 3300 V	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000			
Frame size	Frame C		Frame D				Frame E						
Voltage Class	**2400**												
Drive rating (A)	69	80	91	103	114	134	156	178	201	223			
2400 drive output (kVA)	287	333	378	428	474	557	648	740	836	927			
Nominal hp 2400 V	300	350	400	450	500	600	700	800	900	1000			
Frame size	Frame A					Frame B							
Voltage Class	**2400**												
Drive rating (A)	279	335	390	448	504	561							
2400 drive output (kVA)	1160	1393	1621	1862	2095	2332							
Nominal hp 2400 V	1250	1500	1750	2000	2250	2500							
Frame size	Frame C			Frame D									

Note: Typical for a 4-pole motor.

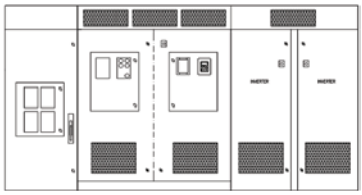


Frame A

Frame B



Frame C



Frame D & E

Frame A

Output Voltage	Motor		Cabinet Size (Inches)			Redundant Blower
	FLA	hp	Width	Height	Depth	Height
2400	67–112	300–500	65	92	50	18.5
3300 ❸	48–112	300–700	65	92	50	18.5
4160	37–132	300–1150[1]	65	92	50	18.5

Frame B

Output Voltage	Motor		Cabinet Size (Inches)			Redundant Blower
	FLA	hp	Width	Height	Depth	Height
2400	134–223	600–1000	95	92	50	20.1
3300 ❸	128–240	800–1500	95	92	50	20.1
4160	124–248	1000–2000	95	92	50	20.1

Frame C

Output Voltage	Motor		Cabinet Size (Inches)			Redundant Blower
	FLA	hp	Width	Height	Depth	Height
2400	279–390	1250–1750	131	92	50	12.1
3300 ❸	280–320	1750–2000	131	92	50	12.1
4160	279–372	2250–3000	131 ❷	92	50	12.1

Frame D & E

Output Voltage	Motor		Cabinet Size (Inches)			Redundant Blower
	FLA	hp	Width	Height	Depth	Height
2400	446–558	2000–2500	198	92	50	12.1
3300 ❸	360–480	2250–3000	198	92	50	12.1
3300 ❸	520–640	3250–4000	222	92	50	12.1
4160 ❹	403–558	3250–4500	198	92	50	12.1
4160	620–744	5000–6000	222	92	50	12.1

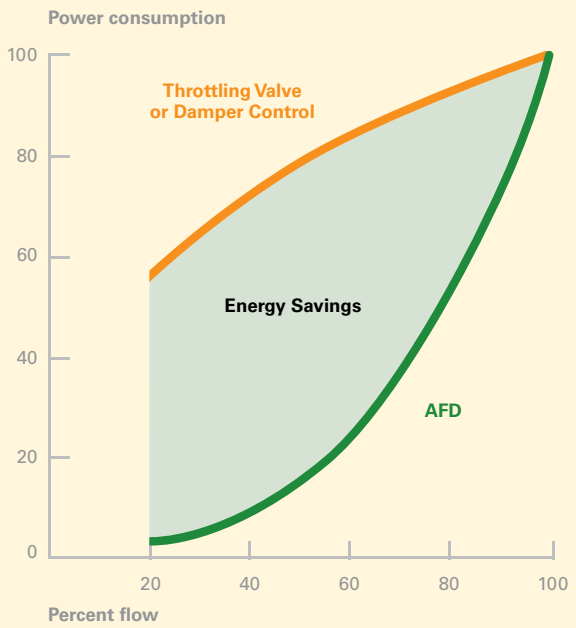
❶ 1000 hp and higher in Frame 'A' require second blower. Redundant cooling option is not available at these higher hp ratings.

❷ 4160 V, 2750 hp and 3000 hp require 137-inch width and additional blowers. Redundant cooling option is not available at these higher hp ratings.

❸ 3300 V, 50 Hz.

❹ Frame DS with single inverter.

SC9000 EP frequency drive efficiency, power factor and harmonics typical data



SC9000 EP Affinity laws for pumps and fans

- Flow rate varies directly with the ratio of speeds
- Pressure varies with the square of the ratio of the speeds
- Horsepower varies with the cube of the ratio of the speeds
  - With an AFD running a motor at 50%, speed requires only 12.5% power

Speed: 50%	Load (%)		
	50	75	100
Input PF (1)	0.96	0.98	0.98
Input THD (V)	3.13	3.64	3.43
Input THD (I)	7.59	6.40	6.73
Efficiency (%)	0.94	0.96	0.96

Speed: 75%	Load (%)		
	50	75	100
Input PF (1)	0.98	0.99	0.99
Input THD (V)	1.34	2.32	3.15
Input THD (I)	6.76	4.44	3.85
Efficiency (%)	0.97	0.97	0.97

Speed: 100%	Load (%)		
	50	75	100
Input PF (1)	0.98	0.99	0.99
Input THD (V)	2.16	2.20	2.30
Input THD (I)	5.95	4.38	3.13
Efficiency (%)	0.97	0.97	0.97

Reduce your parasitic loads by reducing process-related energy cost

Energy savings estimator—pump and fan applications

Pump and Fan Total Annual Hours of Operation:	8,736 Hours

Pump and Fan Operation / Motor / AC Drive Data	
Cost per kWh	$0.06
Motor power	2000 hp
Motor efficiency	95%
Drive efficiency	97%
Utility incentive	0.0$/hp
Variable speed drive cost	$300,000

Pump and Fan Duty Cycles

% Flow	Time (Hrs)	Time (%)
100%	87.4	1%
90%	174.7	2%
80%	786.2	9%
70%	1,485.1	17%
60%	2,096.6	24%
50%	1,485.1	17%
40%	1,135.7	13%
30%	961.0	11%
20%	524.2	6%
10%	0.0	0%

Annual Energy Cost per Control Method	
Adjustable frequency drive (pump and fan)	$181,908
Throttling valve control (pump)	$600,306
Inlet vane control (fan)	$449,420
Outlet damper control (fan)	$600,306
No speed control (pump and fan)	$825,137

Annual Energy Savings with Adjustable Frequency Drive	
Versus no speed control (pump and fan)	$643,229
Versus throttling valve control (pump)	$418,399
Versus outlet damper control (fan)	$418,399
Versus inlet vane control (fan)	$267,513

Payback Time of Adjustable Frequency Drive	
Versus no speed control (pump and fan)	0.466 year
Versus throttling valve control (pump)	0.717 year
Versus outlet damper control (fan)	0.717 year
Versus inlet vane control (fan)	1.121 year

Note: Includes utility incentive.

By reducing process-related energy cost, you create more product to sell to your customers.

Solutions that deliver

Substantial energy savings • Speed control • Extend equipment life • Full starting torque

Eaton Low Voltage Adjustable Frequency Drives

SC9000 EP Frame C+
Up to 3000 hp at 4160 V

Superior service

While Eaton offers products and solutions to meet your most critical electrical power management challenges, we also have one of the largest and most experienced team of power system engineers in the industry. Eaton's Electrical Engineering Services and Systems focuses on understanding your business requirements and optimizing your power system. We not only offer startup, acceptance testing and commissioning services, but our engineers and consultants can help diagnose problems, identify ways to improve performance or transform concepts into flexible, practical solutions that can improve productivity and use of capital. We can help keep your power system safe, efficient, reliable and up to date.

For more information on
Eaton adjustable frequency drives:

Eaton.com/LVDrives

Eaton.com/SC9000

1-877-ETN-CARE, option 2, then option 7

Powering Business Worldwide

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1000 Eaton Boulevard
Cleveland, OH 44122
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Printed in USA
Publication No. BR0204008EN / Z15342
June 2014