

Motortronics

AFE Drives / Regenerative Drives

Low Harmonic Type Inverter

Air cooled & Liquid cooled "Slim-LC"
55-4000 kW | 380-690V

Technical catalogue



MOTORTRONICS
Solid State AC Motor Control

Low harmonics with high efficiency



General information overview for Motortronics FDUL/VFXR/AFR 2.1

Motortronics Active Front End is a robust and flexible set of IGBT based supply rectifier drives for any network.

The Motortronics AFE product family consists of FDUL (low harmonic), VFXR (regenerative low harmonic) and AFR (DC supply unit with regenerative and low harmonic performance).

FDU 2.1/VFX 2.1	FDUL/VFXR/AFR Air cooled	FDUL/VFXR/AFR Liquid cooled
Power range	55 - 2200 kW	132 - 4000 kW
Voltage range	3 ph, 230 - 690 V	3 ph, 230 - 690 V
IP class, cabinet	IP23/54	IP54
Control mode	VFX : Direct torque control or V/Hz, FDU: V/Hz	
LCL line filter	Standard	Standard
EMC filter	C3 is standard, C2 is optional	
Communication	RS-485 (Modbus RTU) is standard	
Coated boards	Optional	Optional
Detachable control panel - multilanguage	Standard	Standard
Options	Encoder PTC/PT100 Extended IO Safe Torque Off (STO) CRIO (only VFXR) Wireless communication, (WiFi or Bluetooth)	
Serial communication option	RS-232/485 (Modbus RTU)	
Communication options	DeviceNet, Modbus/TCP, Profibus Profinet IO, EtherNet IP EtherCAT, CANopen	
Liquid cooling		Standard (heat exchanger optional)

CE certification		All sizes	
Marine certification			DNV



Motortronics AFE 2.1 Top end efficiency and flexibility to suit any application

The Motortronics AFE 2.1 with top rated efficiency and low harmonic distortion is available in a large power range. It is non-sensitive to voltage dips or harmonics, provides a unity power factor and has a wide power margin. Every aspect of its construction is made to secure a reliable operation at all times.

The AFE2.1 is made up of compact PEBB (Power Electronic Building Block) modules with a variety of cooling options. To avoid downtime, the modules are self-monitored and interchangeable. Communication options are plenty and extensive service options include remote access.

MAIN FEATURE

- Top end efficiency - FDUL/VFXR at 97% and AFR at 98%
- Low harmonic distortion to supply, THDi < 5%
- Power range up to 4MW, 380-690V supply
- IP54 cabinet solution
- 100% interchangeable and uniquely self-monitored PEBB power modules
- Regenerative DC-bus supply unit (AFR) for common DC-bus application
- Project specific adaptation possible
- FDU/VFX options including WiFi and Bluetooth wireless communication
- Very compact liquid cooled version (in-built)
- State of the art liquid cooling
- Liquid cooling options include water-to-water and water-to-air heat exchanger
- DNV Marine approval (liquid cooled)

Cost-efficient and trouble-free operation with Motortronics AFE

Motortronics Active Front End drives will save costs and improve reliability in your process. They are available in two versions: Low harmonic drives and Regenerative drives. Both are based on standard Motortronics AC drives, providing the same benefits in reliability, easy handling and advanced functionality, as well a wide range of options. Motortronics AFE units are delivered as complete solutions in IP54 classified cabinets. Setup is easy thanks to plug-and-play functionality to the mains supply.

Trouble-free operation

State-of-the-art technology makes Motortronics AFE drives produce extremely low harmonic distortions, thereby reducing power losses in supply equipment. They provide genuine unity power factor, which allows for optimized sizing of the distribution transformer and can lower the electricity transfer tariff. They also offer the possibility of reactive power compensation. The Motortronics AFE drives are nonsensitive to voltage dips or harmonics from other equipment, which could cause it to trip or break down. Voltage boosting assures full motor power in case of mains voltage fluctuations.

Complete certified solutions

Motortronics AFE drives are delivered as complete solutions, including a robust IP54 classified cabinet, IGBT power modules, LCL filter, circuit breaker, main contactor, charging circuit, EMC filter and output choke.

The full series of Motortronics's liquid cooled AFE have marine DNV approval.

The Motortronics PEBB modular system

A flexible modular PEBB (power electronic building block) construction forms the basis of the Motortronics AFE. Each PEBB is a line or motor inverter in itself with only the control board missing. Multiple PEBBs are connected to a common control board and function as a single unit.

The PEBB construction is excellent for redundancy, scalability and ease of service. The electrical and mechanically robust construction of the Motortronics AFE is very easy to install and use.

The mechanically robust construction of the Motortronics AFE is very easy to install and use.



Complete 1.1MW cabinet with water-to-water cooling. Cabinet sections from left to right : 1) Cooling 2) Main switch 3) and 4) LCL filter 5) AFR with 4 PEBBs 6) VSI with 5 PEBBs 7) Aux section.

Compact liquid cooled drives for optimal power density

A state of the art cooling system and the flexible modular PEBBs (power electronic building blocks) form the basis of a more compact AFE drive. In the Motortronics liquid cooled AFE, the PEBB is mounted without frames directly into the cabinet, making the construction both space and cost efficient.

For example, with the unique PEBB structure and state of the art cooling, a 2MW liquid cooled drive fits in a 2,4m wide cabinet.

Hassle-free cooling

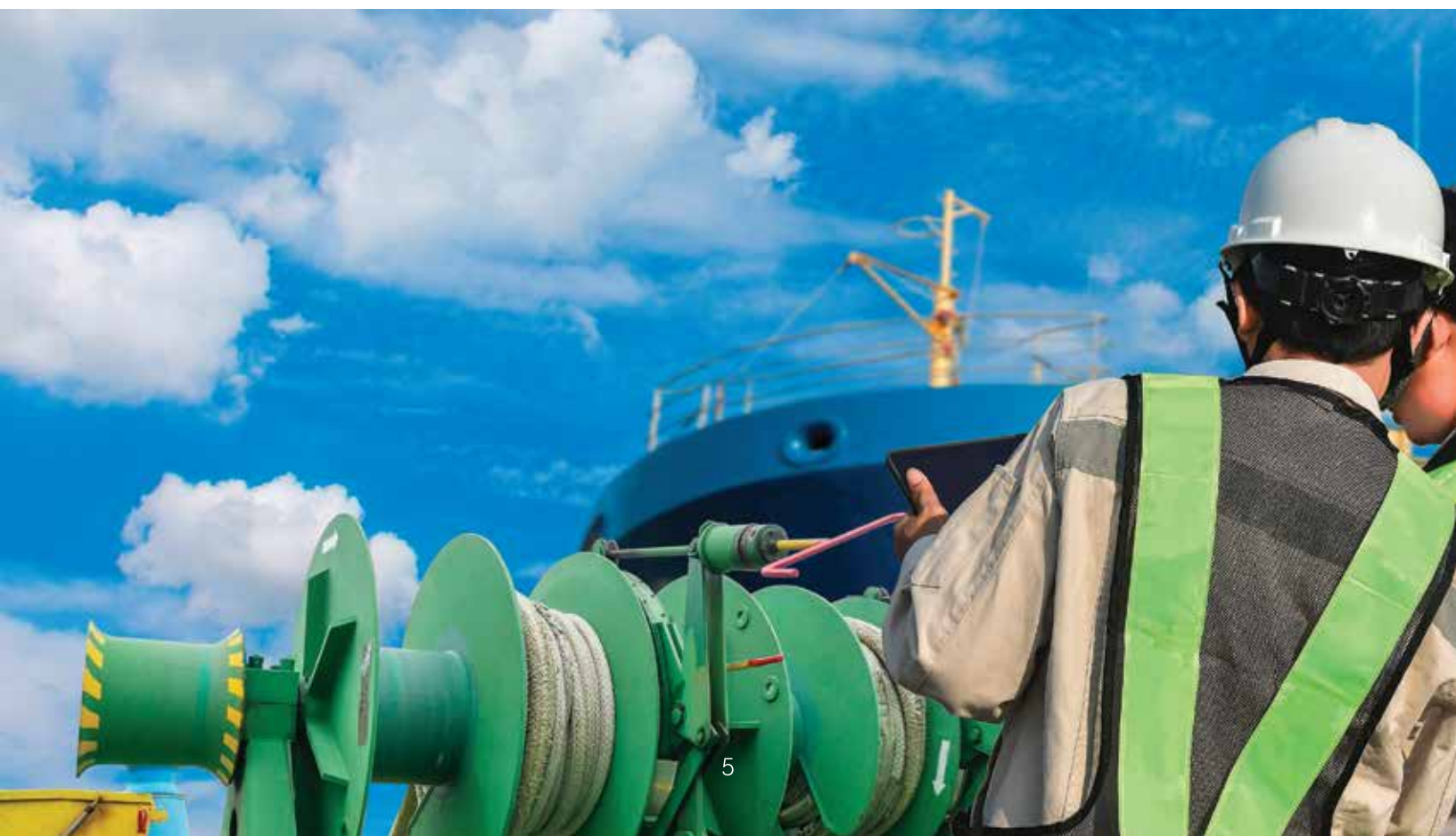
The new cooling system is easy to feed with industrial water from your own water cooling system or through an optional water to water heat exchanger section delivered as part of your complete drive solution cabinet. The water to water heat exchanger is also available in a seawater variant option.

The Motortronics AFE has very low requirements on your water pressure, flow and temperature – the cooling water is allowed to have a maximum temperature of 35°C. With the optional water/water heat exchanger and pump system, the water-cooling is fed directly from an adjacent part of the cabinet to the bottom of the AC drive for maximum electrical protection.

The cooling section is also available as a water to air heat exchanger type.

No need for air conditioning

With liquid cooling there is no need for expensive and high maintenance air-conditioning units in the electrical room. The water cooling system is cooling both the drive modules and the LCL-filters, eliminating the need for e-room air-conditioner. Without the need for additional fans and air conditioning, noise level is also reduced. Mechanically robust construction of the Motortronics AFE it very easy to install and use.



Network friendly low harmonic drives

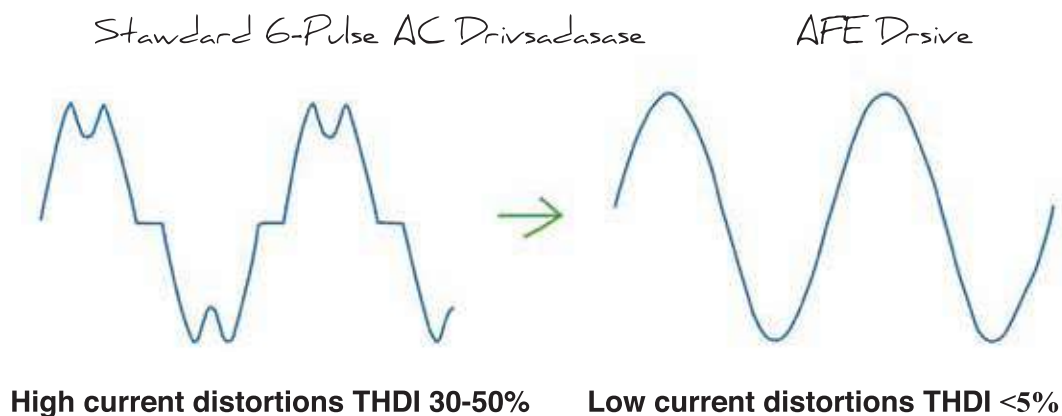
The demand for network friendly electronic equipment is continuously increasing. Low harmonic drives are the answer to this challenge, improving reliability and reducing investment costs in applications such as pumps and fans in the mining, marine and process industries.

Extremely low harmonic distortions

Motortronics Low harmonic drives produce typically less than THDI 5% compared to 30-50% in conventional drives, thereby fulfilling the IEEE-519 standard. Reduced power losses eliminate the need to overdimension cables and transformers. Lower distortions also cause fewer malfunctions in other electronic equipment.

Reactive power compensation

The AC drive is rated for 100% power in both directions. It provides genuine unity power factor, which allows for optimized sizing of the distribution transformer and can lower the electricity transfer tariff. It also provides the possibility of reactive power compensation.



Low harmonic drives are the answer for applications demanding extremely low harmonic distortions. The results are improved reliability and reduced investment costs.



Energy saving regenerative drives

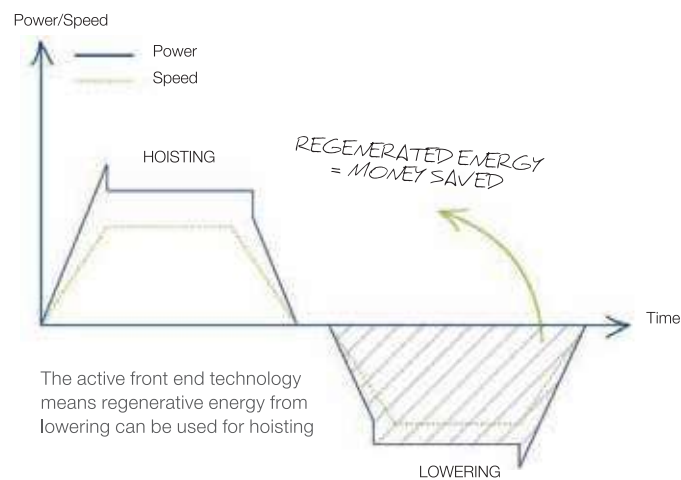
Motortronics Regenerative drives, in addition to low harmonics, offer energy savings in applications with frequent braking, such as cranes, centrifuges, test benches, winders and ski lifts. They provide robust yet fast and smooth control, and allow uninterrupted power flow to and from the mains supply. Regenerative units can also be supplied as DC-bus feeder units.

Regenerative braking

Motortronic Regenerative drives offer the option of feeding braking energy back to the mains instead of dissipating it via brake resistors. This will save considerable energy costs as well as the cost of investing in brake resistors, equipment that has limited lifetime and require cooling or external installation. The regenerative drives are rated for four quadrant operation with 100% power in both directions, ensuring continuous full braking power.

Trouble-free operation

The regenerative drive is nonsensitive to voltage drops or harmonics from other equipment which otherwise could cause it to trip or break down. Voltage boosting also assures full motor power in case of mains voltage fluctuations.



Regenerative drives save energy in, for example, crane operation, by feeding the braking energy back to the mains instead of dissipating it via brake resistors.



Technical data

Slim-LC – Liquid cooled version

Motortronics VFXR - Regenerative drives

Motortronics FDUL - Low harmonic drives

Typical motor power at mains voltage 400V

Model	*Max output current (A)	Normal duty 120% 1min/10min		Heavy duty 150% 1min/10min		Frame	Width (mm) IP54 Cabinet without/with heat exchanger section (water/water)
		Rated current (A)	Power @400V (kW)	Rated current (A)	Power @400V (kW)		
FDUL/VFXR46-250-CL	300	250	132	200	110	F+F	600/1000
FDUL/VFXR46-295-CL	354	295	160	236	132	F+G1	600/1000
FDUL/VFXR46-365-CL	438	365	200	292	160	H1+H1	800/1200
FDUL/VFXR46-590-CL	708	590	315	472	250	H+G2	1400/1800
FDUL/VFXR46-730-CL	876	730	400	584	315	H2+H2	1600/2000
FDUL/VFXR46-810-CL	972	810	450	648	355	H2+G3	1800/2200
FDUL/VFXR46-1010-CL	1212	1010	560	808	450	G3+H3	1800/2200
FDUL/VFXR46-1100-CL	1320	1100	630	880	500	H3+H3	2000/2400
FDUL/VFXR46-1250-CL	1500	1250	710	1000	560	G4+H4	2000/2400
FDUL/VFXR46-1460-CL	1752	1460	800	1168	630	H4+H4	3000/3600
FDUL/VFXR46-1710-CL	2052	1710	900	1368	710	H4+H5	3200/3800
FDUL/VFXR46-2200-CL	2640	2200	1250	1760	1000	H6+H6	3600/4200
FDUL/VFXR46-2500-CL	3000	2500	1350	2000	1120	H6+H7	3600/4200

Typical motor power at mains voltage 690V

Model	*Max output current (A)	Normal duty 120% 1min/10min		Heavy duty 150% 1min/10min		Frame	Width (mm) IP54 Cabinet without/with heat exchanger section (water/ water)
		Rated current (A)	Power @690V (kW)	Rated current (A)	Power @690V (kW)		
FDUL/VFXR69-200-CL	240	200	200	160	160	E69+F69	600/1000
FDUL/VFXR69-250-CL	300	250	250	200	200	F69+F69	600/1000
FDUL/VFXR69-500-CL	600	500	500	400	400	H69+H69	800/1200
FDUL/VFXR69-750-CL	900	750	710	600	600	I69+I69	1400/1800
FDUL/VFXR69-1000-CL	1200	1000	1000	800	800	J69+J69	1600/2000
FDUL/VFXR69-1250-CL	1500	1250	1250	1000	1000	K69+KA69	1800/2200
FDUL/VFXR69-1500-CL	1800	1500	1500	1200	1200	K69+K69	1800/2200
FDUL/VFXR69-2000-CL	2400	2000	2000	1600	1600	M69+M69	2000/2400
FDUL/VFXR69-3000-CL	3600	3000	3000	2400	2400	Q69+Q69	2000/2400
FDUL/VFXR69-4000-CL	4800	4000	4000	3200	3200	U69+U69	3000/3600

Cabinets complete with incoming breaker/contactors, LCL-filter, EMC-filter, inverters & output chokes.
Cabinet H=2200mm / D=600mm

*Available for a limited time and as long as drive temperature permits.

Slim-LC - Liquid cooled AFR Regenerative DC-bus supply unit

Motortronics AFR output power at mains voltage 400V

Model	*Max output current (A)	Normal duty 120% 1min/10min		Heavy duty 150% 1min/10min		Frame	Width (mm) IP54 Cabinet without/ with heat exchanger section (water/ water)
		Rated input current (A)	Output DC power @400VAC (kW)	Rated input current (A)	Output DC power @400VA (kW)		
AFR46-250-CL	300	250	170	200	136	F	600/1000
AFR46-365-CL	438	365	248	292	198	H1	600/1000
AFR46-500-CL	600	500	340	400	272	H	1000/1400
AFR46-700-CL	840	700	475	560	380	H2	1200/1600
AFR46-885-CL	1062	885	600	708	480	G3	1200/1600
AFR46-1050-CL	1260	1050	713	840	570	H3	1400/1800
AFR46-1400-CL	1680	1400	950	1120	760	H4	2400/2800
AFR46-1770-CL	2124	1770	1200	1416	960	G6	2400/3000
AFR46-2100-CL	2520	2100	1425	1680	1140	H6	2400/3000

Motortronics AFR output power at mains voltage

Model	*Max output current (A)	Normal duty 120% 1min/10min		Heavy duty 150% 1min/10min		Frame	Width (mm) IP54 Cabinet without/with heat exchanger section (water/water)
		Rated input current (A)	Output DC power @690VAC (kW)	Rated input current (A)	Output DC power @690VA (kW)		
AFR69-175-CL	210	175	205	140	164	E69	600/1000
AFR69-233-CL	280	233	275	186	220	F69	800/1200
AFR69-466-CL	559	466	545	373	436	H69	1000/1400
AFR69-700-CL	840	700	820	560	656	I69	1200/1600
AFR69-900-CL	1080	900	1050	720	840	J69	1200/1600
AFR69-1400-CL	1680	1400	1640	1120	1312	K69	2200/2600
AFR69-1800-CL	2160	1800	2100	1440	1680	M69	2400/2800
AFR69-2100-CL	2520	2100	2460	1680	1968	N69	3400/4000
AFR69-2700-CL	3240	2700	3150	2160	2520	Q69	3400/4000
AFR69-3600-CL	4320	3600	4200	2880	3360	U69	4800/5600

Cabinets complete with incoming breaker/contactator, LCL-filter, EMC-filter, inverters and output chokes.
Cabinet H=2200mm / D=600mm

*Available for a limited time and as long as drive temperature permits.

Cooling sections for Slim-LC AFE Drives

Slim-LC – Liquid cooled version

Option Water/ Water- cooling section incl IP54 cabinet

Cooling section	Max power losses in kW (to water)	Water flow in l/min	Cabinet dimensions HxWxD (mm)	Cab. dim with redundant pumps HxWxD (mm)
Cooling section 12kW	12	20	2200x400x600	2200x400x600
Cooling section 24kW	24	50	2200x400x600	2200x600x600
Cooling section 30kW	30	50	2200x400x600	2200x600x600
Cooling section 48kW	48	80	2200x600x600	2200x600x600
Cooling section 55kW	55	100	2200x800x600	2200x1000x600
Cooling section 70kW	70	120	2200x800x600	2200x1000x600

Cooling section includes: Heat exchanger, pump, pump inverter, expansion tank, valves & cabinet

Max water pressure in - 4 bar

Max water inlet temperature - 35°C

Pipe couplings for in- and out-water - G1"



Cooling section water to water with redundant pumps.

Air-cooled version

Motortronics VFXR - Regenerative drives

Motortronics FDUL - Low harmonic drives

Typical motor power at mains voltage 400 V

VFXR/ FDUL model	Max output current I _{max} [A] *	Normal duty 120%, 1 min every 10 min		Heavy duty 150%, 1 min every 10 min		Frame	Dimensions Height = 2,250 mm Depth = 600 mm Width [mm]	Weight [kg]
		Rated current I _{nom} [A]	Power @400 V [kW]	Rated current I _{nom} [A]	Power @400 V [kW]			
46-109	131	109	55	87	45	E46+E=G	800	380
46-146	175	146	75	117	55	E46+E=G	800	400
46-175	210	175	90	140	75	E46+E=G	900	480
46-210	252	210	110	168	90	F46+F=H	900	500
46-250	300	250	132	200	110	F46+F=H	900	500
46-300	360	300	160	240	132	F46+H=I	1,300	700
46-375	450	375	200	300	160	G46+G	1,500	750
46-430	516	430	220	344	200	G46+H	1,500	830
46-500	600	500	250	400	220	H46+H	1,500	880
46-600	720	600	315	480	250	H46+I	1,900	1,040
46-650	780	650	355	520	315	I46+I	2,200	1,210
46-750	900	750	400	600	355	I46+I	2,200	1,210
46-860	1,032	860	450	688	400	I46+J	2,500	1,370
46-1K0	1,200	1,000	560	800	450	J46+J	3,000	1,600
46-1K2	1,440	1,200	630	960	500	J46+KA	3,300	1,700
46-1K5	1,800	1,500	800	1,200	630	K46+K	4,500	2,250
46-1K75	2,100	1,750	900	1,400	800	K46+L	On request	
46-2K4	2,880	2,400	1,350	1,920	1,100	N46+O	On request	
46-3K25	3,900	3,250	1,850	2,600	1500	Q46+R	On request	

Motortronics VFXR/FDUL typical motor power at mains voltage

VFXR/ FDUL model	Max output current I _{max} [A] *	Normal duty 120%, 1 min every 10 min		Heavy duty 150%, 1 min every 10 min		Frame	Dimensions Height = 2,250 mm Depth = 600 mm Width [mm]	Weight [kg]
		Rated current I _{nom} [A]	Power @690 V [kW]	Rated current I _{nom} [A]	Power @690 V [kW]			
69-109	131	109	110	87	90	F69+F69=H69	800	410
69-146	175	146	132	117	110	F69+F69=H69	800	430
69-185	222	185	160	148	132	F69+F69=H69	900	540
69-250	300	250	250	200	200	H69+H69	1,800	870
69-300	360	300	315	240	250	H69+H69	1,800	870
69-375	450	375	355	300	315	H69+H69	1,800	910
69-430	516	430	450	344	355	I69+I69	2,800	1,350
69-560	672	560	560	448	450	I69+I69	2,800	1,390
69-749	900	750	710	600	600	J69+J69	On request	
69-995	1,200	1,000	1,000	800	800	K69+KA69	On request	
69-1K12	1,344	1,120	1,100	896	900	K69+K69	On request	
69-1K68	2,016	1,680	1,650	1,344	1,300	N69+N69	On request	
69-2K24	2,688	2,240	2,200	1,792	1,750	Q69+Q69	On request	

* Available for a limited time and as long as drive temperature permits.

Motortronics AFR - Regenerative DC-bus supply unit

Motortronics AFR46 output DC power at mains voltage 400 V

Model	Max Input current I _{max} [A] *	Normal duty 120%, 1 min every 10 min		Frame	Dimensions Height = 2,250 mm Depth = 600 mm Width [mm]	Weight [kg]
		Rated Input current I _{nom} [A]	Output DC power @400 V AC [kW]			
AFR46-175	210	175	115	E46	600	290
AFR46-250	300	250	165	F46	800	400
AFR46-375	450	375	250	G46	1,000	560
AFR46-500	600	500	330	H46	1,200	660
AFR46-750	900	750	500	I46	1,500	830
AFR46-1K0	1,200	1,000	660	J46	1,800	1,100
AFR46-1K5	1,800	1,500	1,000	K46	2,700	1,600
AFR46-2K25	2,700	2,250	1,500	N46 (9)	On request	
AFR46-3K0	3,600	3,000	2,000	Q46 (12)	On request	

Motortronics AFR69 output DC power at mains voltage

Model	Max Input current I _{max} [A] *	Normal duty 120%, 1 min every 10 min		Frame	Dimensions Height = 2,250 mm Depth = 600 mm Width [mm]	Weight [kg]
		Rated Input current I _{nom} [A]	Output DC power @690 V AC [kW]			
AFR69-175	210	175	200	F69	800	320
AFR69-350	420	350	400	H69	1,200	590
AFR69-525	630	525	600	I69	1,700	860
AFR69-700	840	700	800	J69	On request	
AFR69-1K05	1,260	1,050	1,200	K69	On request	
AFR69-1K57	1,890	1,570	1,800	N69 (9)	On request	
AFR69-2K1	2,520	2,100	2,400	Q69 (12)	On request	

* Available for a limited time and as long as drive temperature permits.

General electrical specifications

(valid for both Liquid cooled and Air cooled versions)

General		
Mains voltage:	AFR46/VFXR46/FDUL46 AFR69/VFXR69/FDUL69	380 - 460V +10%/-15% 480 - 690V +6%/-15%
Mains frequency:		48 to 52Hz and 58 to 62Hz
Input total power factor:		1.0
Output DC voltage:	AFR46/AFR69	$(1.0 - 1.2) * \sqrt{2} * \text{Mains supply voltage}$
Output AC voltage:	VFXR/FDUL46/69	$(0 - 1.2) * \text{Mains supply voltage}$
Output frequency:	VFXR/FDUL46/69	0-599 Hz
Switching frequency:	AFR46/AFR69	3 kHz (adjustable 3-6 kHz)
	VFXR/FDUL46/69	3 kHz (adjustable 1.5 - 6 kHz (max=8 kHz @ Fnmot > 400 Hz), FDUL only)
Efficiency at nominal load:	AFR46/AFR69	98%
	VFXR/FDUL46/69	97%
Harmonics to supply, THDI		< 5%

All units assembled in an IP54 cabinet including main switch + main contactor or motorized circuit breaker, LCL filter, charging unit, and output chokes.

Environmental conditions

Operation

Parameter	Normal operation
Nominal ambient temperature	0 deg C – 40 deg C (Air cooled) / 0 deg C – 45 deg C (Liquid cooled) For operation at higher temperatures, see below.
Atmospheric pressure	86-106 kPa
Relative humidity, non-condensing	5-95%
Contamination, according to IEC 60721-3-3	No electrically conductive dust allowed. Cooling air must be clean and free from corrosive materials. Chemical gases, class 3C2 (Coated boards 3C3). Solid particles, class 3S2.
Vibrations	According to IEC 60068-2-6, Sinusoidal vibrations: 10<f<57 Hz, 0.075 mm 57<f<150 Hz, 1g
Altitude	0-1,000 m, 460 V AFE units, with derating 1%/100m of rated current up to 4,000 m. Coated boards recommended > 2,000m 690 V AFE units, with derating 1%/100m of rated current up to 2,000 m.

Storage

Parameter	Storage
Temperature	-20 to +60 °C
Atmoapheric pressure	86-106 kPa
Relative humidity, non-condensing	0-90%

Operation at higher temperatures

All Motortronics AFE units are made for operation at maximum of 40/45 deg C ambient temperature. However it is possible to use the AFE units at higher temperatures with some loss in performance, using derating. Derating Liquid cooled AFE: -1% per degree Celsius. Maximum is +10 deg C (55 deg C)
Derating Air cooled AFE: -2.5% per degree Celsius. Maximum is +5 deg C (45 deg C)

Basic I/O Data

Control signal inputs - Analogue (differential), 4 channels	
Analogue Voltage/current:	0-±10 V/0-20 mA via switch
Max. input voltage:	+30 V/30 mA
Input impedance:	20 kΩ (voltage) / 250 Ω (current)
Resolution:	11 bits + sign
Hardware accuracy:	1% type + 1 ½ LSB (Least Significant Bit) fsd (full scale deflection)
Non-linearity:	1½ LSB
Control signal inputs - Digital, 8 channels	
Input voltage:	High: >9 VDC, Low: <4 VDC
Max. input voltage:	+30 VDC
Input impedance:	<3.3 VDC: 4.7 kΩ / ≥3.3 VDC: 3.6 kΩ
Signal delay:	≤8 ms
Control signal outputs - Analogue, 2 channels	
Output voltage/current:	0-10 V/0-20 mA via parameter setting
Max. output voltage:	+15 V @5 mA cont.
Short-circuit current (∞):	+15 mA (voltage), +140 mA (current)
Output impedance:	10 Ω (voltage)
Resolution:	10 bit
Maximum load impedance for current	500 Ω
Hardware accuracy:	1.9% of full scale deflection (voltage), 2.4% of full scale deflection (current)
Offset:	3 LSB
Non-linearity:	2 LSB
Control signal outputs - Digital, 2 channels	
Output voltage:	High: >20 VDC @50 mA, >23 VDC open
Shortcircuit current(∞):	Low: <1 VDC @50 mA 100 mA max (together with +24 VDC)
Relays, 3 pcs	
Contacts	0.1 – 2 A/U _{max} 250 VAC or 42 VDC
Reference voltages	
+10VDC	+10 VDC @10 mA Short-circuit current +30 mA max
-10VDC	- 10 VDC @10 mA
+24VDC	+24 VDC Short-circuit current +100 mA max (together with Digital Outputs)

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MOTORTRONICS
Solid State AC Motor Control

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