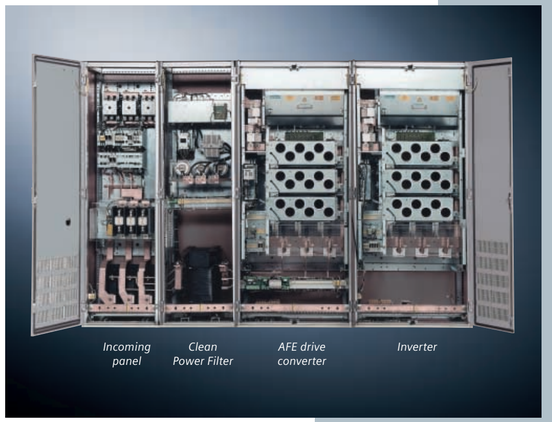
SIMOVERT MASTERDRIVES –
AFE drive converter cabinet unit 400 kW



Subject to change without prior notice | Order No. E20001-A120-P510-X-7600 | Dispotarife 21503 | 2106264 | MK.MC.3D.MAS7.52.2.03 WS1013. | Printed in Germany

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ACTIVE FRONT END
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ACTIVE FRONT END – SIMOVERT MASTERDRIVES
with the intelligent rectifier-regenerative feedback unit

The SIMOVERT® MASTERDRIVES drive system consists of modular, high-performance components which can be combined for individual applications.

Two MASTERDRIVES components are available for regenerative feedback (four-quadrant operation):

1. The line-commutated rectifier-regenerative feedback unit comprising two anti-parallel 6-pulse thyristor bridges. The regenerative thyristor bridge is connected through an autotransformer (Fig. 1).

2. ACTIVE FRONT END (AFE) – A self-commutated, pulsed rectifier-regenerative feedback unit comprising an inverter with IGBT modules and Clean Power Filter. The inverter operates as an intelligent converter (Fig. 2).

For SIMOVERT MASTERDRIVES, the AFE converter comprises a standard inverter. This offers advantages when it comes to the interfaces, operator control interface (HMI) and spare parts. And the full performance of the MASTERDRIVES can be utilized. The standard output range is between 37 kW and 1200 kW. For customized solutions, outputs of up to 6000 kW can be implemented (Fig. 3).

ACTIVE FRONT END guarantees low stressing of the line supply, i.e. extremely low harmonics are fed back into the line supply, independent of the operating status. The power drawn from the line supply or fed back into the line supply is in the form of sinusoidal current (Fig. 2).

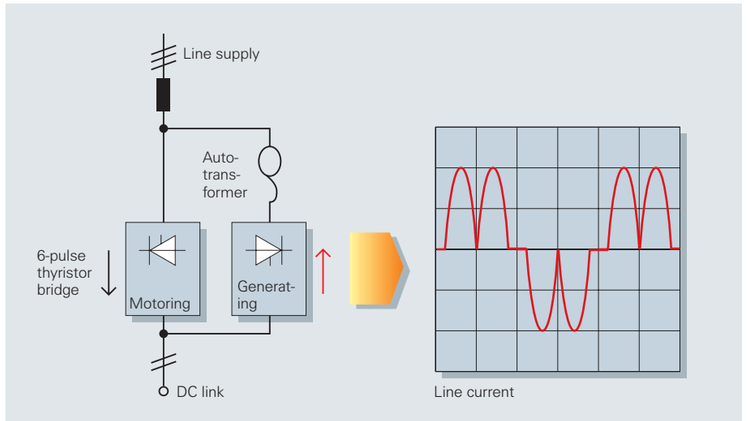


Fig. 1: Line-commutated rectifier-regenerative feedback unit

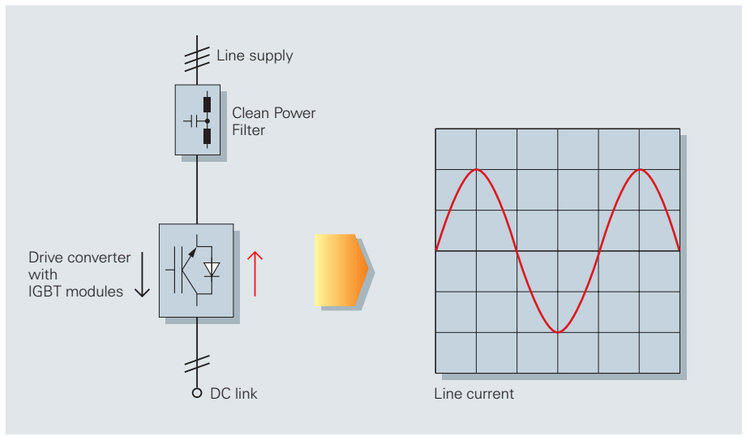


Fig. 2: ACTIVE FRONT END (AFE) – self-commutated, pulsed rectifier-regenerative feedback unit

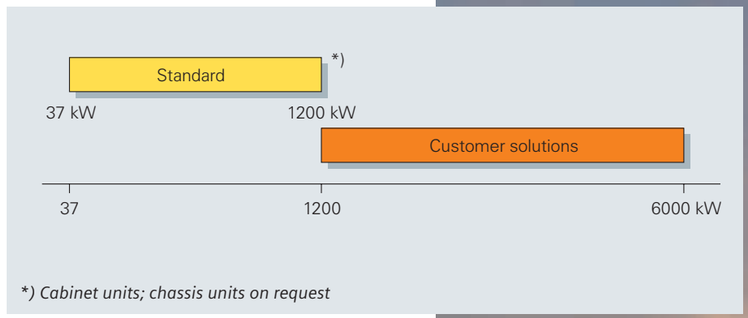


Fig. 3: Output range of AFE SIMOVERT MASTERDRIVES

For drives with AFE, practically no harmonics are generated. This eliminates complex, costly compensation equipment on the line side. This means that the AFE is an ideal solution for power utility companies and power users who have to fulfill tough specifications regarding the line supply. AFE reduces the power loss and harmonics in the line supply. The capital investment costs for the AFE are offset by lower costs for cables, filter, compensation equipment and transformers. Operating costs are simultaneously reduced due to the lower reactive power and losses.

Typical applications:

- Wind-driven generator systems
- Test stands
- Pumping plants
- Paper and rolling mill systems
- Sheet-cutters and shears
- Elevator and crane systems
- Sugar centrifuges
- Marine drives

ACTIVE FRONT END –
Interesting features for every application

Sinusoidal line currents – low harmonics

For conventional diode- and thyristor supplies, the harmonics fed back into the line supply can only be significantly reduced by using higher-pulse circuit configurations. For example, for higher output, three-winding transformers are used to configure 12-pulse supplies; the low-frequency 5th and 7th order harmonics are compensated (Fig. 4).

The typical mains harmonics, which are generated for conventional circuit configurations, are eliminated with ACTIVE FRONT END. Almost pure sinusoidal line currents and voltages are generated as a result of the intelligent rectification and conversion (IGBTs are quickly and precisely switched) and a special filter (Clean Power Filter) – and this really does mean clean power.

No commutation faults when the power fails in regenerative operation

The AFE is admirably suited for regenerating back into the line supply, especially for weak networks. As a result of the active shutdown, even in regenerative operation commutation faults with the associated fuse failure do not occur! The self-commutated drive converter, clocked with 3 kHz, switches the current, independent of the line supply. Operation is even maintained during brief supply interruptions in the millisecond range.

Compensating line voltage fluctuations

AFE converters operate as step-up controller with a DC link voltage which lies above the peak line supply voltage. For line supplies with significant voltage fluctuations, the DC link voltage level, which can be parameterized, can be kept constant.
Voltage fluctuations down to 65% of the line supply voltage can be compensated. If the voltage falls below the limit, the AFE is shutdown in a controlled fashion. For special applications, if appropriately engineered, even higher voltage fluctuations can be tolerated.

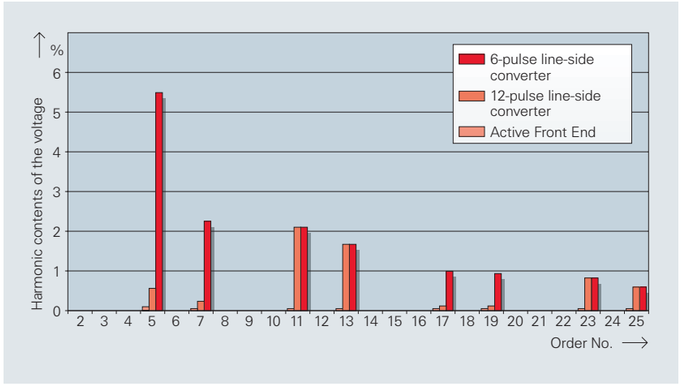


Fig. 4: Comparison of the harmonic contents of the line voltage for conventional 6- and 12-pulse supplies for a typical application example.

Extremely high drive dynamic performance

Drives are often subject to extreme torque changes or must often cope with frequent changing between driving and braking operation. For conventional drive converters, the dynamic performance of the drive can be diminished by long delay times. In many cases, this means that the drive is shutdown and, in turn, the plant. For AFE, the DC link voltage always remains constant as a result of the active, fast IGBT switching. This closed-loop control is realized with a dynamic performance corresponding to the pulse frequency. When the load changes from –100% to +100% torque (or vice versa), for AFE, only extremely short delay times occur. The delay time at the drive shaft is exclusively defined by the inverter, which is connected to the DC link.

AFE features

- Regenerative feedback into the line supply (four-quadrant operation)
- Sinusoidal line currents – low harmonics are fed back into the line supply
- No commutation faults when the power fails in regenerative operation
- Line supply voltage fluctuations are compensated
- Extremely high drive dynamic performance
- Selectable power factor

Selectable power factor

The AFE power factor cos φ can be selected depending on the particular application. The setting can either be directly parameterized or dynamically set via a fieldbus system.

• Constant power factor

The power factor cos φ, i.e. the phase position between the line current and voltage, can be selected in a range between 1.0 and 0.8 (capacitive or inductive). The power factor is then automatically controlled to the selected value (Fig. 5).

• Constant reactive power

In this mode, the reactive component of the line current is capacitively or inductively used. This means that the reactive power can be controlled to a set value, and the reactive current is independent of the motor output.

If the line current exceeds the 100% value of the AFE, then a special closed-loop line current control is used in the overload range – the so-called line current management. In the **line current management**, the DC link current, i.e. essentially the motor output, is maintained by appropriately reducing the line reactive current.

This feature is admirably suited to optimize operation of loads connected to the line supply: The reactive power demand of other three-phase loads is compensated. Compensation equipment, which is required for conventional supplies, is not necessary (Fig. 6).

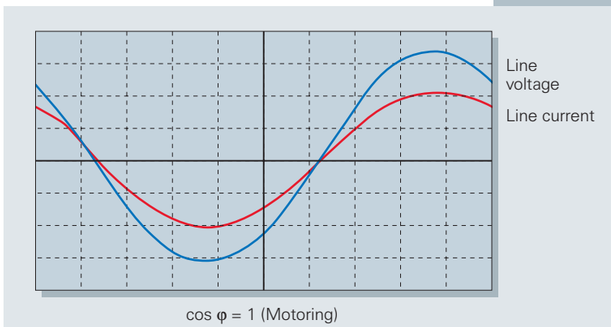


Fig. 5: Constant power factor cos φ set differently

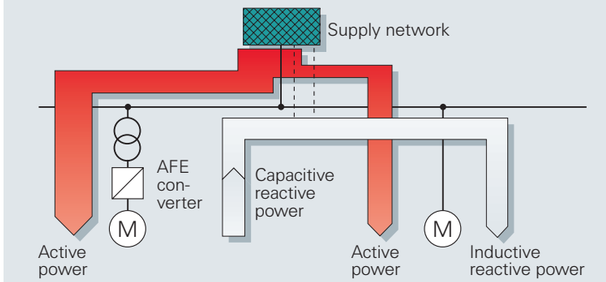
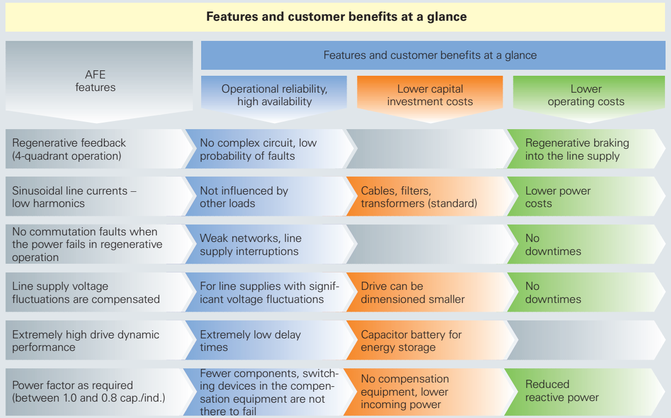


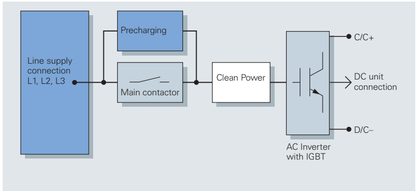
Fig. 6: Reactive power compensation of other loads

ACTIVE FRONT END –
Features and customer benefits at a glance



Design and principle of operation

The ACTIVE FRONT END essentially comprises modules from the SIMOVERT MASTERDRIVES drive series. As AFE is fully integrated into this family of drives, all of the advantages relating to interfaces, operator control inter-faces (HMI) and spare parts can be fully utilized.



AFE structure

- IGBT drive converter with gating unit
- Clean Power Filter
- Pre-charging and main contactor

After the AFE is powered-up, the DC link is charged-up close to the peak value of the line supply voltage via the charging circuit. The main contactor then closes and the drive converter starts to clock and increases the DC link voltage 10% above the peak line supply voltage. The AFE converter then practically operates as step-up controller, as the DC link is always just above the peak value of the line supply voltage.

The **Clean Power Filter**, which has been especially designed for AFE, decouples the two voltage systems and smooths the line current, with a pulse frequency of 3 kHz, resulting in an extremely low harmonic content.

Technical data, selection- and ordering data

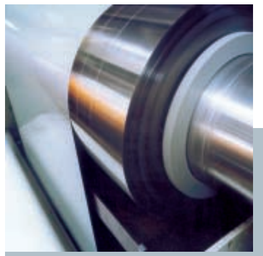
SIMOVERT MASTERDRIVES converter with AFE rectifier-regenerative feed-back units are standard cabinet units which are available with different types of protection: The output range is from 37 kW to 1200 kW, customer-specific outputs up to 6000 kW.

With the intelligent rectifier-regen-erative feedback unit ACTIVE FRONT END, Siemens has created a state-of-the-art solution for drive technology which reduces the stress on the supply side and is therefore energy-saving.

For AFE, the harmonics generated are a fraction of those harmonics defined for low-voltage networks in accordance with Standard E6100 Part 2-2. Thus, drives with AFE do not generate any harmonics and disturbances which are fed back into the line supply.

As a result of the unified modularity of the SIMOVERT MASTERDRIVES drive series, the complete AFE spec-trum is also available on request in a water-cooled version with high degrees of protection for applica-tions in tough environments or where low noise levels are required.

Nominal data			
Rated voltage Line supply voltage	3-ph. 380 V AC –15% up to 460 V AC + 5%	3-ph. 480 V AC –15% up to 575 V AC + 5%	3-ph. 600 V AC – 12% up to 690 V AC + 5%
Rated frequency Line supply frequency	50/60 Hz (±10%)	50/60 Hz (±10%)	50/60 Hz (±10%)
Load class II acc. to EN 60 146-1-1 Base load current	Also refer Catalog DA 65.10 0.91 x rated input current		
Short-time current	1.36 x rated input current for 60 s		
Cycle time	300 s		
Overload duration	60 s (20% of the cycle time)		
Line power factor • Basic fundamental • Total	 Parameterized (factory setting = 1) 0.8 ind. ≤ cos φ ≤ 0.8 cap.		
Efficiency	0.97 to 0.98		



SIMOVERT MASTERDRIVES –
AFE drive converter cabinet units 37 kW to 1200 kW air-cooled

Type output kW	Rated output current A	Base load current A	short-time current A	Rated input current *) A	AFE-Converter Order-No.	Power loss (3 kHz) kW	Cabinet dimensions W x H x D mm	Weight approx. kg
Line supply voltage, 3-ph. 380 V to 460 V AC								
400 V								
45	92	84	126	92	6SE7131-0EC61-5BA0	2,8	900 x 2000 x 600	400
55	124	113	169	124	6SE7131-2EE61-5BA0	3,5	1500 x 2000 x 600	600
75	146	133	199	146	6SE7131-5EE61-5BA0	4,1	1500 x 2000 x 600	600
90	186	169	254	186	6SE7131-8EE61-5BA0	4,4	1500 x 2000 x 600	620
110	210	191	287	210	6SE7132-1EF61-5BA0	5,7	1800 x 2000 x 600	900
132	260	237	355	260	6SE7132-6EF61-5BA0	7,1	1800 x 2000 x 600	920
160	315	287	430	315	6SE7133-2EF61-5BA0	8,7	1800 x 2000 x 600	940
200	370	337	503	370	6SE7133-7EF61-5BA0	10,3	1800 x 2000 x 600	950
250	510	464	694	510	6SE7135-1EH62-5BA0	14,3	2400 x 2000 x 600	1500
315	590	537	802	560	6SE7136-0EK62-5BA0	16,0	3000 x 2000 x 600	1600
400	690	628	938	655	6SE7137-0EK62-5BA0	20,0	3000 x 2000 x 600	1700
500	860	782	1170	817	6SE7138-6EK62-5BA0	28,4	3000 x 2000 x 600	2300
630	1100	1000	1496	1045	6SE7141-1EL62-5BA0	31,7	3300 x 2000 x 600	2400
710	1300	1183	1768	1235	6SE7141-3EM62-5BA0	34,5	3600 x 2000 x 600	3300
Line supply voltage, 3-ph. 480 V to 575 V AC								
500 V								
37	61	55	83	61	6SE7126-1FC61-5BA0	1,9	900 x 2000 x 600	380
45	66	60	90	66	6SE7126-6FC61-5BA0	2,2	900 x 2000 x 600	390
55	79	72	108	79	6SE7128-0FE61-5BA0	2,6	1500 x 2000 x 600	580
75	108	98	147	108	6SE7131-1FE61-5BA0	3,7	1500 x 2000 x 600	590
90	128	117	174	128	6SE7131-3FF61-5BA0	4,4	1800 x 2000 x 600	900
110	156	142	213	156	6SE7131-6FF61-5BA0	5,4	1800 x 2000 x 600	910
132	192	174	262	192	6SE7132-0FF61-5BA0	6,8	1800 x 2000 x 600	910
160	225	205	307	225	6SE7132-3FF61-5BA0	8,2	1800 x 2000 x 600	920
200	297	270	404	297	6SE7133-0FH62-5BA0	11,9	2400 x 2000 x 600	1300
250	354	322	481	354	6SE7133-5FK62-5BA0	13,3	3000 x 2000 x 600	1450
315	452	411	615	429	6SE7134-5FK62-5BA0	16,5	3000 x 2000 x 600	1500
400	570	519	775	541	6SE7135-7FK62-5BA0	21,0	3000 x 2000 x 600	2150
450	650	592	884	617	6SE7136-5FK62-5BA0	23,6	3000 x 2000 x 600	2200
630	860	783	1170	817	6SE7138-6FK62-5BA0	27,5	3000 x 2000 x 600	2300
800	1080	983	1469	1026	6SE7141-1FM62-5BA0	33,3	3600 x 2000 x 600	3300
900	1230	1119	1673	1168	6SE7141-2FM62-5BA0	39,1	3600 x 2000 x 600	3350
Line supply voltage, 3-ph. 600 V to 690 V AC								
690 V								
55	60	55	82	60	6SE7126-0HE61-5BA0	2,3	1500 x 2000 x 600	380
75	82	75	112	82	6SE7128-2HE61-5BA0	3,1	1500 x 2000 x 600	380
90	97	88	132	97	6SE7131-0HF61-5BA0	4,1	1800 x 2000 x 600	800
110	118	107	161	118	6SE7131-2HF61-5BA0	4,9	1800 x 2000 x 600	810
132	145	132	198	145	6SE7131-5HF61-5BA0	5,9	1800 x 2000 x 600	880
160	171	156	233	171	6SE7131-7HF61-5BA0	7,3	1800 x 2000 x 600	900
200	208	189	284	208	6SE7132-1HF61-5BA0	8,9	1800 x 2000 x 600	1200
250	297	270	404	267	6SE7133-0HH62-5BA0	14,1	2400 x 2000 x 600	1250
315	354	322	481	319	6SE7133-5HK62-5BA0	15,3	3000 x 2000 x 600	1450
400	452	411	615	407	6SE7134-5HK62-5BA0	18,8	3000 x 2000 x 600	1600
500	570	519	775	513	6SE7135-7HK62-5BA0	22,9	3000 x 2000 x 600	2300
630	650	592	884	585	6SE7136-5HK62-5BA0	26,4	3000 x 2000 x 600	2400
800	860	783	1170	774	6SE7138-6HK62-5BA0	32,8	3000 x 2000 x 600	2450
1000	1080	983	1469	972	6SE7141-1HM62-5BA0	40,4	3600 x 2000 x 600	3400
1200	1230	1119	1673	1107	6SE7141-2HM62-5BA0	52,5	3600 x 2000 x 600	3450