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Data Sheet 8.73/11

Control and Feeding Converter for Variable Output Voltage and Frequency, Type CFI

Application

The control and feeding converters, type CFI, are used as an AC power supply with a variable output of both voltage and frequency. They are mainly designed as a universal power supply for testing of distribution transformer, power transformers and shunt reactors on-site as well as in test laboratories. Other applications are the replacement of motor-generator-sets in test systems with output frequencies different from the mains frequency. The converter can operate with two or three active output phases.

Principle

The heart of the CFI series is a three-phase converter with a LC filter at the output side (Fig. 1).

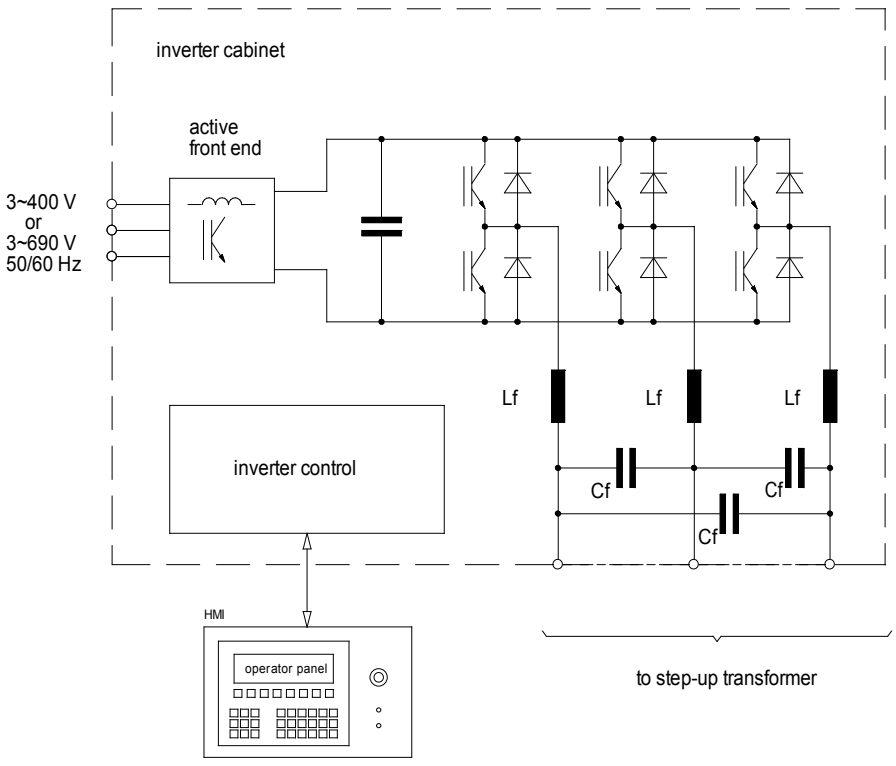


Fig. 1: Principle structure of the converter

The three-phase line voltage is rectified and boosted up by an active front-end line converter. Thus, an active line current with the lowest harmonic contents will be drawn from the power grid.
The direct voltage is buffered by a capacitor bank. The connected converter generates sinusoidal modulated voltage pulses of adjustable frequency and amplitude. A power sine-wave filter connected to the converter output is used to filter the fundamental wave. Due to this filter, the available output power of the converter depends on the output frequency and the power factor of the load (Fig. 2 to 19). The converter consists of power transistors (IGBT's) and is driven by a microcontroller.

Control and Measurement

The test sequence and the supervision of the complete test system are controlled by a programmable logic controller (PLC), type SIMATIC. An operator device, type BG, is used for the data input and the display of preselected and measured parameters or other information. The PLC communicates with other measuring instruments of the entire test system (e.g. peak voltmeters MU 18). The control system is completed by an external PC (e.g. a notebook computer), which is connected to the PLC of the converter via a network connection (Ethernet). This enables the remote control, the test parameter recording and evaluation (voltage, frequency, current, etc.) as well as the printing of a test report, communication within a local network (LAN) or internet including connections to the HIGHVOLT Service Center (Catalog Sheet 1.52).

Design

All components of the CFI series are built in one converter cabinet with several front doors (dependent on converter type). The cabinet is equipped with a single emergency-off switch. The separate operator device, type BG , contains the operator panel, a second emergency-off switch and a key-operated switch to turn the control voltage on and off. Most of the connections can be plugged; for power connections busbars are installed.

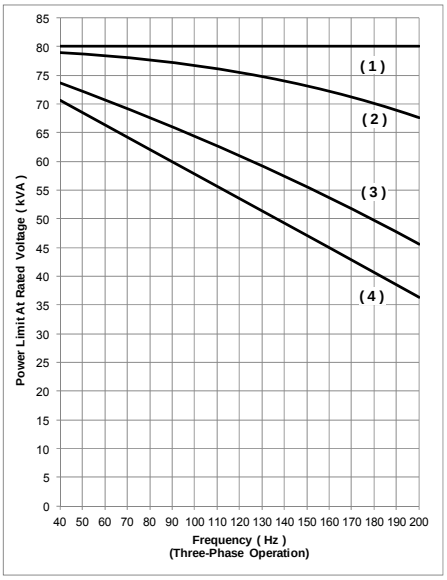
Operation

The manual mode offers the possibility to vary output voltage and frequency using fixed function keys. In the automatic mode given voltage-time-sequences can be performed automatically at a pre-given output frequency. The automatic test procedure can be interrupted at any time to change the preselected values, e.g. test voltage or frequency or to enter the manual mode.
Test object and test system are protected against fault conditions, feeding voltage changes, overload, breakdown of the test object and further events by safety measures such as voltage or current limiters.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

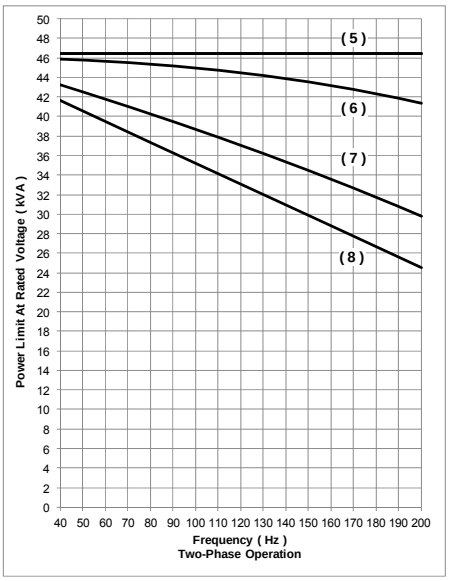
Table 1: Main parameters for CFI 80-80

Rated parameters			
Output power	80 kVA		
Output active power	80 kW		
Voltage range (r.m.s)	3~ /2~ 40 … 400 V		
Rated current (r.m.s)	115 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 2 and 3		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	157 mΩ	315 mΩ
	x_3	460 mΩ	921 mΩ
	x_5	864 mΩ	1728 mΩ
	x_7	1533 mΩ	3067 mΩ
	x_9	3231 mΩ	6462 mΩ
THD of output voltage	<5 % *1)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	125 kVA *2)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	66 dB (A) at 4 m		
Dimensions, Environment			
Dimensions (WxHxD)	2200 mm x 2202 mm x 2000 mm		
Weight	3000 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) ≤ 0.97 (inductive load);
(2) cos(φ) = 1 (ohmic load);
(3) cos(φ) = - 0.8 (capacitive load);
(4) cos(φ) = - 0.2 (capacitive load)

Fig. 2: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 80-80



(5) cos(φ) ≤ 0.97 (inductive load);
(6) cos(φ) = 1 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) = - 0.2 (capacitive load)

Fig. 3: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 80-80

*1) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9}(I_k X_k)^2}}{U_1}$$

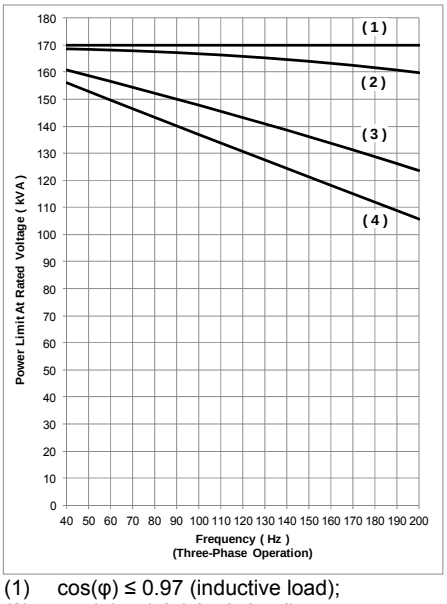
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*2) –short-circuit impedance of grid distribution transformer ≤ 4 % / sub-transient impedance of generator ≤ 0.052 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

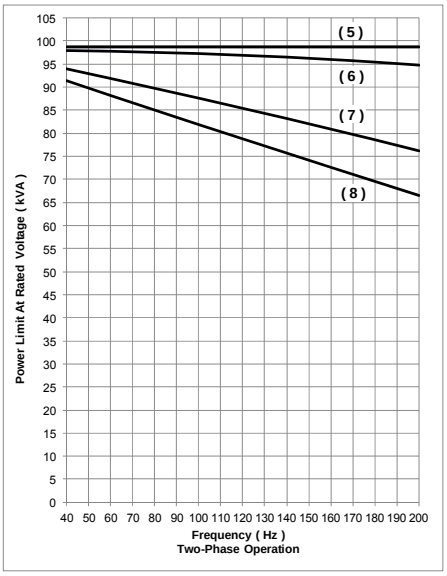
Table 2: Main parameters for CFI 170-170

Rated parameters			
Output power	170 kVA		
Output active power	170 kW		
Voltage range (r.m.s)	3~ /2~ 40 … 400 V		
Rated current (r.m.s)	245 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 4 and 5		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	82 mΩ	164 mΩ
	x_3	248 mΩ	496 mΩ
	x_5	452 mΩ	904 mΩ
	x_7	746 mΩ	1493 mΩ
	x_9	1298 mΩ	2596 mΩ
THD of output voltage	<5 % *3)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	250 kVA *4)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	66 dB (A) at 4 m		
Dimensions, Environment			
Dimensions (WxHxD)	2200 mm x 2202 mm x 2000 mm		
Weight	3500 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) ≤ 0.97 (inductive load);
(2) cos(φ) = 1.0 (ohmic load);
(3) cos(φ) = - 0.8 (capacitive load);
(4) cos(φ) = - 0.2 (capacitive load)

Fig. 4: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 170-170



(5) cos(φ) = 0.42 - 0.97 (inductive load);
(6) cos(φ) = 1.0 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) =- 0.2 (capacitive load)

Fig. 5: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 170-170

*3) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9}(I_k X_k)^2}}{U_1}$$

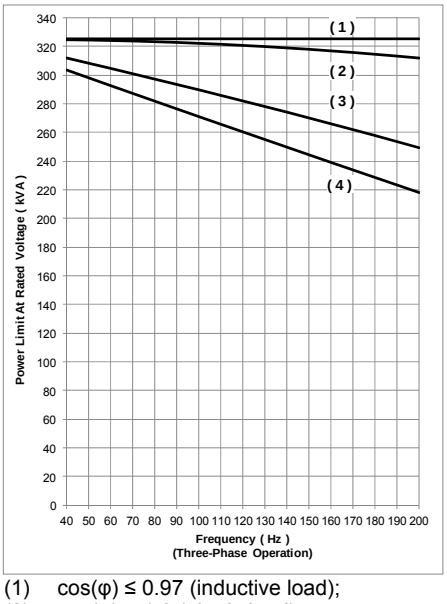
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*4) –short-circuit impedance of grid distribution transformer ≤ 4 % / sub-transient impedance of generator ≤ 0.026 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

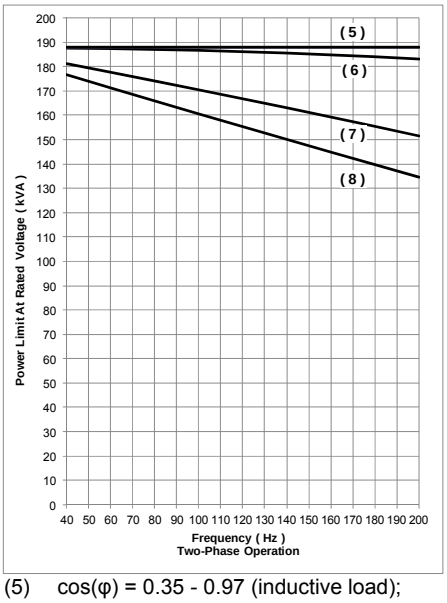
Table 3: Main parameters for CFI 325-325

Rated parameters			
Output power	325 kVA		
Output active power	325 kW		
Voltage range (r.m.s)	3~ /2~ 40 … 400 V		
Rated current (r.m.s)	470 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 6 and 7		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	43 mΩ	85 mΩ
	x_3	119 mΩ	239 mΩ
	x_5	213 mΩ	425 mΩ
	x_7	338 mΩ	676 mΩ
	x_9	539 mΩ	1078 mΩ
THD of output voltage	<5 % *5)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	400 kVA *6)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	86 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	4230 mm x 2600 mm x 2000 mm		
Weight	4500 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) ≤ 0.97 (inductive load);
(2) cos(φ) = 1.0 (ohmic load);
(3) cos(φ) = - 0.8 (capacitive load);
(4) cos(φ) = - 0.2 (capacitive load)

Fig. 6: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 325-325



(5) cos(φ) = 0.35 - 0.97 (inductive load);
(6) cos(φ) = 1.0 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) = - 0.2 (capacitive load)

Fig. 7: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 325-325

*5) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

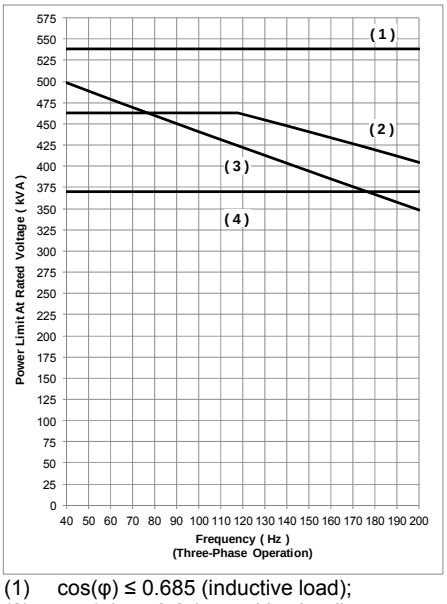
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*6) –short-circuit impedance of grid distribution transformer ≤ 4 % / sub-transient impedance of generator ≤ 0.017 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

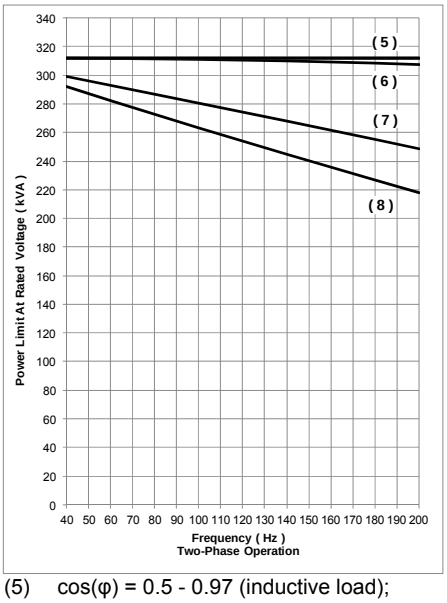
Table 4: Main parameters for CFI 370-540

Rated parameters			
Output power	540 kVA		
Output active power	370 kW		
Voltage range (r.m.s)	3~ /2~ 40 … 400 V		
Rated current (r.m.s)	780 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 8 and 9		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	26 mΩ	51 mΩ
	x_3	73 mΩ	147 mΩ
	x_5	129 mΩ	258 mΩ
	x_7	199 mΩ	398 mΩ
	x_9	301 mΩ	602 mΩ
THD of output voltage	<5 % *7)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	500 kVA *8)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	86 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	4830 mm x 2600 mm x 2000 mm		
Weight	5350 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) ≤ 0.685 (inductive load);
(2) cos(φ) = - 0.8 (capacitive load);
(3) cos(φ) = - 0.2 (capacitive load);
(4) cos(φ) = 1.0 (ohmic load)

Fig. 8: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 370-540



(5) cos(φ) = 0.5 - 0.97 (inductive load);
(6) cos(φ) = 1.0 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) = - 0.2 (capacitive load)

Fig. 9: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 370-540

*7) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

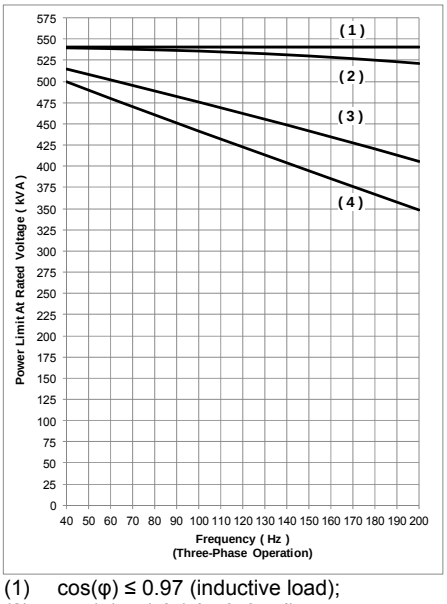
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*8) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.02 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

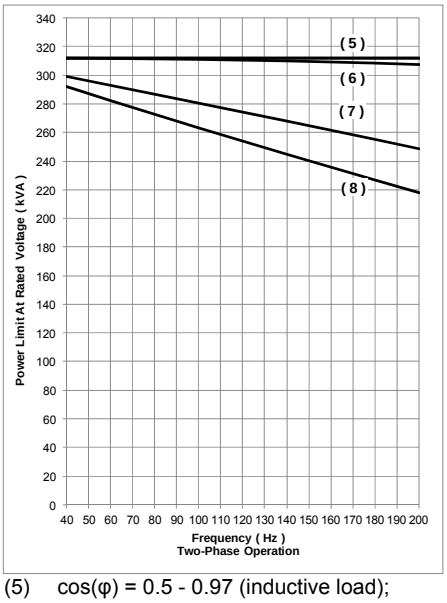
Table 5: Main parameters for CFI 540-540

Rated parameters			
Output power	540 kVA		
Output active power	540 kW		
Voltage range (r.m.s)	3~ /2~ 40 … 400 V		
Rated current (r.m.s)	780 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 10 and 11		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	26 mΩ	51 mΩ
	x_3	73 mΩ	147 mΩ
	x_5	129 mΩ	258 mΩ
	x_7	199 mΩ	398 mΩ
	x_9	301 mΩ	602 mΩ
THD of output voltage	<5 % *9)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	630 kVA *10)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	86 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	5630 mm x 2600 mm x 2000 mm		
Weight	5800 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) ≤ 0.97 (inductive load);
(2) cos(φ) = 1.0 (ohmic load);
(3) cos(φ) = - 0.8 (capacitive load);
(4) cos(φ) = - 0.2 (capacitive load)

Fig. 10: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 540-540



(5) cos(φ) = 0.5 - 0.97 (inductive load);
(6) cos(φ) = 1.0 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) = - 0.2 (capacitive load)

Fig. 11: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 540-540

*9) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

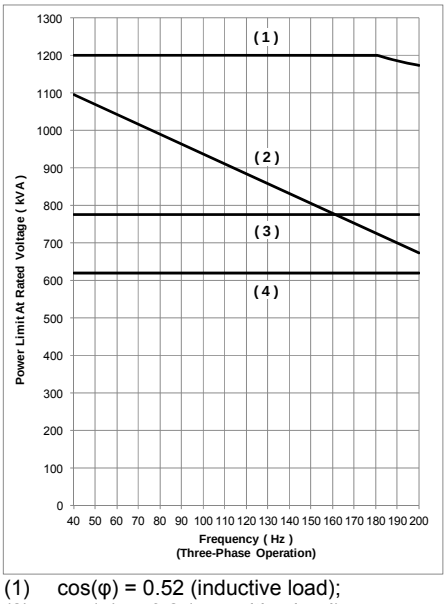
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*10) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.016 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

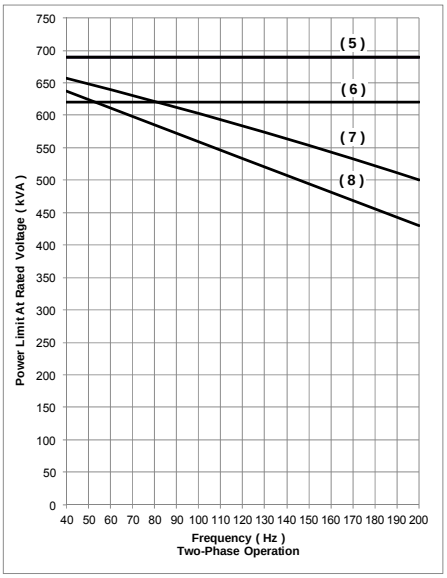
Table 6: Main parameters for CFI 620-1200

Rated parameters			
Output power	1200 kVA		
Output active power	620 kW		
Voltage range (r.m.s)	3~ /2~ 70 … 690 V		
Rated current (r.m.s)	1000 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 12 and 13		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	11 mΩ	22 mΩ
	x_3	34 mΩ	67 mΩ
	x_5	58 mΩ	116 mΩ
	x_7	85 mΩ	170 mΩ
	x_9	118 mΩ	235 mΩ
THD of output voltage	<5 % *11)		
Power supply			
Voltage, three-phase	400 V ± 10 %, 50/60 Hz		
Power	1000 kVA *12)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 V AC		
Contact for warning lamps			
Voltage / Current	230 V AC / max. 5A		
Cooling			
Method of cooling	forced-air cooling		
Sound pressure level	86 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	5630 mm x 2600 mm x 1600 mm		
Weight	6600 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) = 0.52 (inductive load);
(2) cos(φ) = -0.2 (capacitive load);
(3) cos(φ) = ± 0.8 (inductive and capacitive load);
(4) cos(φ) = 1.0 (ohmic load)

Fig. 12: Three-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 620-1200



(5) cos(φ) = 0.68 - 0.9 (inductive load);
(6) cos(φ) = 1.0 (ohmic load);
(7) cos(φ) = - 0.8 (capacitive load);
(8) cos(φ) = - 0.2 (capacitive load)

Fig. 13: Two-phase output power as a function of test frequency at rated output voltage (parameter: power factor) for type CFI 620-1200

*11) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

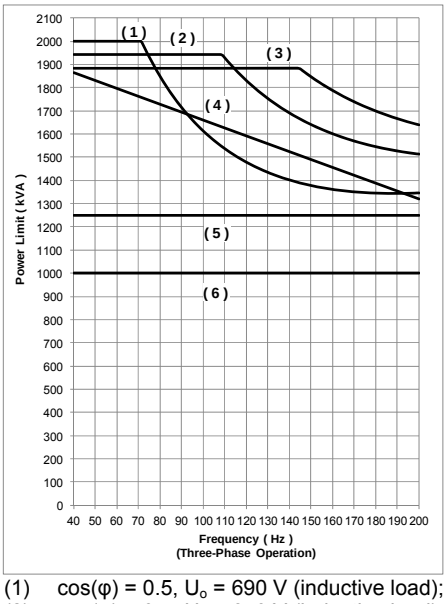
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k);

*12) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.01 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

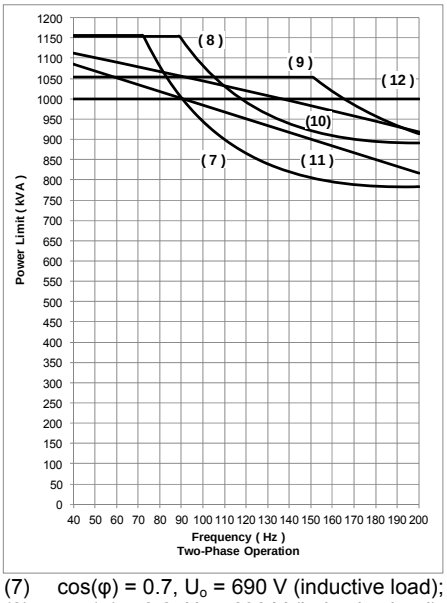
Table 7: Main parameters for CFI 1000-2000

Rated parameters			
Output power	2000 kVA		
Output active power	1000 kW		
Voltage range (r.m.s)	3~ /2~ 70 … 690 V		
Rated current (r.m.s)	1680 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 14 and 15		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	13 mΩ	25 mΩ
	x_3	39 mΩ	78 mΩ
	x_5	69 mΩ	139 mΩ
	x_7	108 mΩ	217 mΩ
	x_9	165 mΩ	330 mΩ
THD of output voltage	<5 % *13)		
Power supply			
Voltage, three-phase	690 V ± 10 %, 50/60 Hz		
Power	1250 kVA *14)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 / 400 V AC		
Contact for warning lamps			
Voltage / Current	230 / 400 V AC / max. 220 A		
Cooling			
Method of cooling	water cooling		
Sound pressure level	78 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	12200 mm x 5850 mm x 2450 mm		
Weight	27000 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) = 0.5, U_o = 690 V (inductive load);
(2) cos(φ) = 0.4, U_o = 670 V (inductive load);
(3) cos(φ) = 0.2, U_o = 650 V (inductive load);
(4) cos(φ) = - 0.2, U_o = 690 V (capacitive load);
(5) cos(φ) = ± 0.8, U_o = 690 V (ind. and cap. load);
(6) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 14: Three-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 1000-2000



(7) cos(φ) = 0.7, U_o = 690 V (inductive load);
(8) cos(φ) = 0.8, U_o = 690 V (inductive load);
(9) cos(φ) = 0.2, U_o = 630 V (inductive load);
(10) cos(φ) =-0.8, U_o = 690 V (capacitive load);
(11) cos(φ) = -0.2, U_o = 690 V (capacitive load);
(12) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 15: Two-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 1000-2000

*13) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

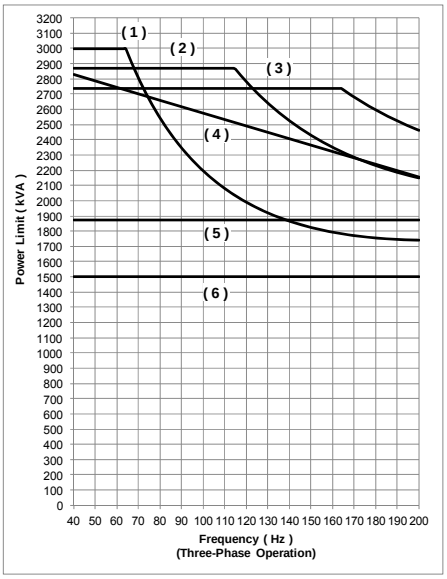
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k).

*14) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.023 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

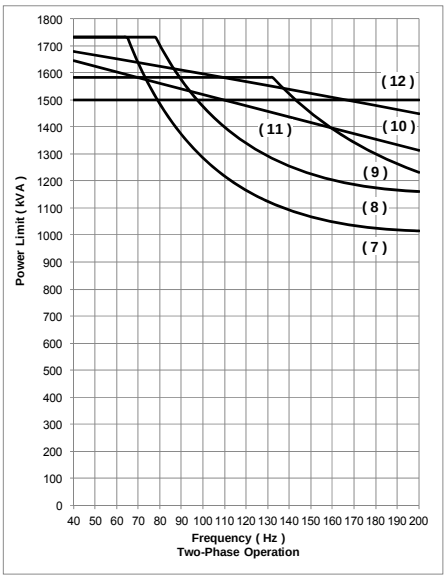
Table 8: Main parameters for CFI 1500-3000

Rated parameters			
Output power	3000 kVA		
Output active power	1500 kW		
Voltage range (r.m.s)	3~ /2~ 70 … 690 V		
Rated current (r.m.s)	2510 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 16 and 17		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	9 mΩ	18 mΩ
	x_3	27 mΩ	55 mΩ
	x_5	48 mΩ	96 mΩ
	x_7	73 mΩ	146 mΩ
	x_9	107 mΩ	213 mΩ
THD of output voltage	<5 % *15)		
Power supply			
Voltage, three-phase	690 V ± 10 %, 50/60 Hz		
Power	2000 kVA *16)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 / 400 V AC		
Contact for warning lamps			
Voltage / Current	230 / 400 V AC / max. 220 A		
Cooling			
Method of cooling	water cooling		
Sound pressure level	78 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	12200 mm x 5850 mm x 2450 mm		
Weight	29000 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) = 0.5, U_o = 690 V (inductive load);
(2) cos(φ) = 0.4, U_o = 660 V (inductive load);
(3) cos(φ) = 0.2, U_o = 630 V (inductive load);
(4) cos(φ) = -0.2, U_o = 690 V (capacitive load);
(5) cos(φ) = ± 0.8, U_o = 690 V (ind. and cap. load);
(6) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 16: Three-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 1500-3000



(7) cos(φ) = 0.7, U_o = 690 V (inductive load);
(8) cos(φ) = 0.8, U_o = 690 V (inductive load);
(9) cos(φ) = 0.2, U_o = 630 V (inductive load);
(10) cos(φ) =- 0.8, U_o = 690 V (capacitive load);
(11) cos(φ) = - 0.2, U_o = 690 V (capacitive load);
(12) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 17: Two-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 1500-3000

*15) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

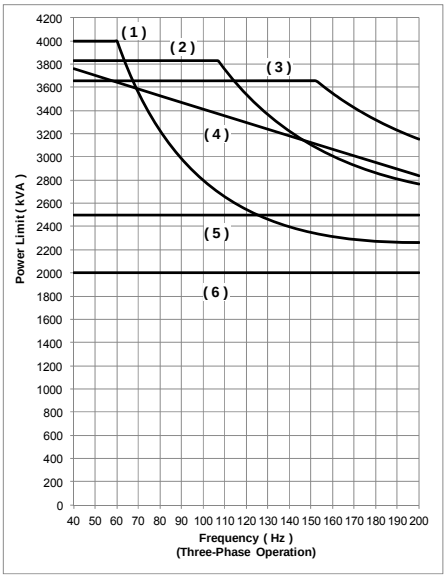
At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k).

*16) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.015 Ω.

Type designation: CFI a-b (a ─ active output power, b ─ apparent output power)

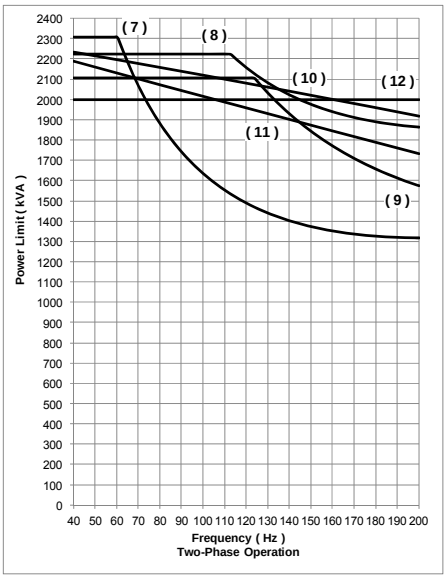
Table 9: Main parameters for CFI 2000-4000

Rated parameters			
Output power	4000 kVA		
Output active power	2000 kW		
Voltage range (r.m.s)	3~ /2~ 70 … 690 V		
Rated current (r.m.s)	3350 A		
Rated frequency	50 / 60 Hz		
Output parameters			
Power factor range	$0.2_{cap}…1…0.2_{ind}$		
Frequency range	40…200 Hz		
Power limit curve	See figure 18 and 19		
Output impedance: X_1, X_3, X_5, X_7, X_9 at 50 – 150 – 250 - 350 – 450 Hz respectively		3~	2~
	x_1	7 mΩ	14 mΩ
	x_3	22 mΩ	44 mΩ
	x_5	38 mΩ	77 mΩ
	x_7	58 mΩ	117 mΩ
	x_9	85 mΩ	171 mΩ
THD of output voltage	<5 % *17)		
Power supply			
Voltage, three-phase	690 V ± 10 %, 50/60 Hz		
Power	2500 kVA *18)		
Interfaces for control			
Emergency-off & safety loop			
Operation voltage	230 / 400 V AC		
Contact for warning lamps			
Voltage / Current	230 /400 V AC / max. 220 A		
Cooling			
Method of cooling	water cooling		
Sound pressure level	78 dB (A) at 1 m		
Dimensions, Environment			
Dimensions (WxHxD)	12200 mm x 5850 mm x 2450 mm		
Weight	30000 kg		
Pollution degree acc. to IEC 60664-1, clause 4.5	2		
Environmental conditions acc. to IEC 60721-3-3, clause 5	3K3/3B1/3C2/3S1/3M3		



(1) cos(φ) = 0.5, U_o = 690 V (inductive load);
(2) cos(φ) = 0.4, U_o = 660 V (inductive load);
(3) cos(φ) = 0.2, U_o = 630 V (inductive load);
(4) cos(φ) = - 0.2, U_o = 690 V (capacitive load);
(5) cos(φ) = ± 0.8, U_o = 690 V (ind. and cap. load);
(6) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 18: Three-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 2000-4000



(7) cos(φ) = 0.7, U_o = 690 V (inductive load);
(8) cos(φ) = 0.9, U_o = 690 V (inductive load);
(9) cos(φ) = 0.2, U_o = 630 V (inductive load);
(10) cos(φ) = - 0.8, U_o = 690 V (capacitive load);
(11) cos(φ) = - 0.2, U_o = 690 V (capacitive load);
(12) cos(φ) = 1.0, U_o = 690 V (ohmic load)

Fig. 19: Two-phase output power as a function of test frequency (parameter: output voltage and power factor) for type CFI 2000-4000

*17) – at rated output voltage of the CFI; The THD of output voltage is defined in following equation:

$$THD = \frac{\sqrt{\sum_{k=2}^{9} (I_k X_k)^2}}{U_1}$$

At a specified fundamental output voltage (U_1), the THD of output voltage depends on the harmonic load current of the converter (I_k) and its output impedances (X_k).

*18) –short-circuit impedance of grid distribution transformer ≤ 6 % / sub-transient impedance of generator ≤ 0.012 Ω.