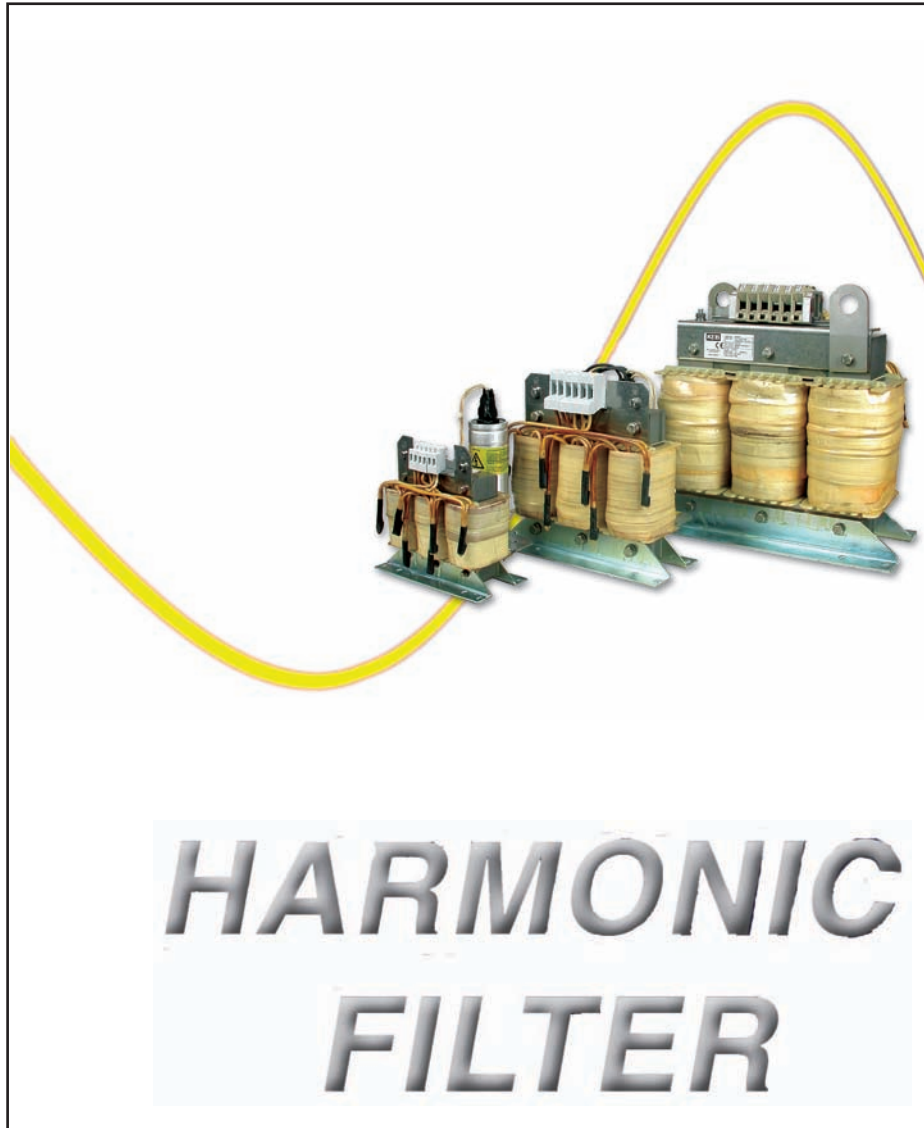


# COMBILINE



GB INSTRUCTION MANUAL

KEB COMBILINE

Mat.No.	Rev.
00U0HE0-K310	1E

**KEB**



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**1. Safety Instructions**

The directions in this chapter must be absolutely observed for the following reasons:


- **Safety for people and machines**
- **Function and susceptibility to faults**
- **Technical inspectorate acceptance and certification**
- **Guarantee and warranties**

**1.1 General instructions**

	<b>Only Qualified Electro-Personnel</b>	All work from the transport, to installation and start-up as well as maintenance may only be done by qualified personnel (IEC 364 and/or CENELEC HD 384 and IEC-Report 664 and note national safety regulations). According to this manual qualified staff means those who are able to recognise and judge the possible dangers based on their technical training and experience and those with knowledge of the relevant standards and who are familiar with the field of power transmission (VDE 0100, EN 50178, EN 60204 as well as the appropriate regulations for your area).
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**1.2 Intended use**

Frequency inverters / servo drives are drive components which are intended for installation into electrical systems or machines. They serve exclusively for stepless speed regulation / control of three-phase asynchronous / permanent magnet motors. Use for other purpose is not recommended and may lead to equipment damage.

	<b>Observe Discharge Time</b>	<p>The KEB harmonic filter will be used for reduction of harmonic current distortion on the main supply network. The filter is a pass through filter connected in the supply line comparable to a standard AC choke with a laminated iron core. An almost sinusoidal current is drawn from the line side of the filter and optimum conditions are created towards the inverter or other electrical equipment with B6 rectifier as front end.</p> <p>The harmonic filter must not be started until it is determined that the installation complies with 2006/42/EC (machine directive) as well as the EMC-directive (2004/108/EC)(note EN60204).</p> <p>Changes to the harmonic filter are not allowed. The guarantee expires if the product is changed or disassembled or operated in contradiction to our instructions.</p> <p>Operation of the harmonic filter is exclusively permissible at VDE-conform networks of public electrical power companies! Not observance can lead to reduction of the filter effect and to destruction of the filter module.</p> <p>In accordance with the corresponding standards and guidelines operation is not allowed, also at short-time, with overcompensated networks and/or reactive-power compensation equipment without chokes. For this, the occurring overvoltages can damage all connected consumers through oscillation procedures.</p>
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**1.3 Electrical connection**

Before any installation and connection work, the system must be switched off and secured.

# Safety Instructions

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## 1.4 Personal protection



### **Protect Against Accidental Contact**

Dangerous voltage can be available at the mains connections after switching off the network.  
The supplied frequency inverter and the harmonic filter form a technical unit and for this they may not be separated from the mains independently. An exception is when several frequency inverters are used i.e. several KEB COMBIVERT are supplied from one common harmonic filter. If a separate switching off is necessary for this type of application, use a discharge choke or a power contactor with discharging resistor.  
Otherwise the complete system must be switched off and the following rules are valid.



### **Note Capa- citor Discharge Time**

Before any installation and connection work, the system must be switched off and secured.  
After clearing the frequency inverter / servo drive the intermediate circuit capacitors are still charged with high voltage for a short period of time. The unit can be worked on again, after it has been switched off for 5 minutes.



### **Cyclic acti- vation and deactivation**

With applications requiring the frequency inverter / servo drive to be switched on and off cyclically, maintain an off-time of at least 5 min. If you require shorter cycle times please contact KEB.

## 2. Unit Description

### 2.1 Technical data of the 400V class and environmental conditions

Voltage class	400V
Rated voltage <sup>2)</sup>	400V
Permissible range of the rated voltage	360V to 440V
Mains frequency <sup>2)</sup>	50Hz/ 60Hz
Overload capacity EN 60146-1-1/duty class III	150% for 60 sec. all 10 min.
Efficiency @ <sup>1) 3)</sup>	> 99%
THDI @ <sup>1)</sup>	<= 15%
cos phi <sup>1)</sup>	ca. 0.99
Storage temperature	-25...70 °C (-13...158 °F)
Operation temperature	-10...45 °C (14...113 °F)
Type of protection (EN 60529)	IP20
Environment (IEC 664-1):	Pollution degree 2
Climatic category (EN 60721-3-3)	3K3
1) Rated operation	
2) At rated voltage $\geq 460V$ and 60Hz multiply the rated current with factor 0.86. Through the preset switching level by COMBIVERT for braking chopper and overvoltage protection the filter can only be operated at a „real“480V mains, if the mains voltage does not exceed 500V. The no-load voltage increase of the filter is 50 Hz = 5...6% (60Hz = 8...9%).	
3) At power supply capacity $\geq 30kW$ motor rating power at the frequency inverter	

### 2.2 Input rated current for series THD = 8%

Part number	I <sub>rating</sub> [A]	P <sub>rating</sub> [kW]	P <sub>loss</sub> [W]	Weight [kg]	Connection [mm <sup>2</sup> ]	PE-connection
09.Z1.C04-1000	4.3	1.5	60	5.8	4	M4
12.Z1.C04-1000	10	4	110	11.5	4	M6
13.Z1.C04-1000	12.6	5.5	130	13.4	4	M6
14.Z1.C04-1000	17.3	7.5	180	18.3	16	M6
15.Z1.C04-1000	25.2	11	190	25.5	16	M6
16.Z1.C04-1000	34.7	15	260	38.5	16	M8
17.Z1.C04-1000	44.1	18.5	270	47.1	16	M8
18.Z1.C04-1000	52.5	22	285	54.6	35	M8
19.Z1.C04-1000	63	30	420	63.0	35	M8
20.Z1.C04-1000	79	37	430	72.6	35	M8
21.Z1.C04-1000	95	45	520	96.0	50	M10
22.Z1.C04-1000	121	55	590	107.7	50	M10
23.Z1.C04-1000	158	75	785	162.0	95	M10
24.Z1.C04-1000	189	90	950	182.5	95	M10
25.Z1.C04-1000	221	110	1145	244.0	150	M10
26.Z1.C04-1000	263	132	1360	241.5	150	M10
27.Z1.C04-1000	315	160	1480	294.0	240	M10
28.Z1.C04-1000	390	200	1650	353.0	2*150	M12
29.Z1.C04-1000	485	250	1800	513.0	2*240	M12

## Unit Description

### 2.3 Input rated current for series THD = 15%

Part number	$I_{\text{rating}}$ [A]	$P_{\text{rating}}$ [kW]	$P_{\text{loss}}$ [W]	Weight [kg]	Connection [mm <sup>2</sup> ]	PE-connection
07.Z1.C04-1001	2.4	0.75	40	2.6	4	M4
10.Z1.C04-1001	6.1	2.2	65	4.8	4	M4
12.Z1.C04-1001	10	4	90	6.8	4	M4
13.Z1.C04-1001	12.6	5.5	105	8.7	4	M6
14.Z1.C04-1001	17.3	7.5	135	11.5	4	M6
15.Z1.C04-1001	25.2	11	165	16.3	16	M6
16.Z1.C04-1001	34.7	15	210	22.6	16	M8
17.Z1.C04-1001	44.1	18.5	255	27.0	16	M8
18.Z1.C04-1001	52.5	22	295	33.0	35	M8
19.Z1.C04-1001	63	30	360	38.7	35	M8

### 2.4 Options

- Thermal contact (NC contact)
- Option HF-Filter integrated
- 3ph/ 230 VAC/ 500 VAC/ 690 VAC
- Housing type, mechanical structure IP23

### 2.5 Dimensions

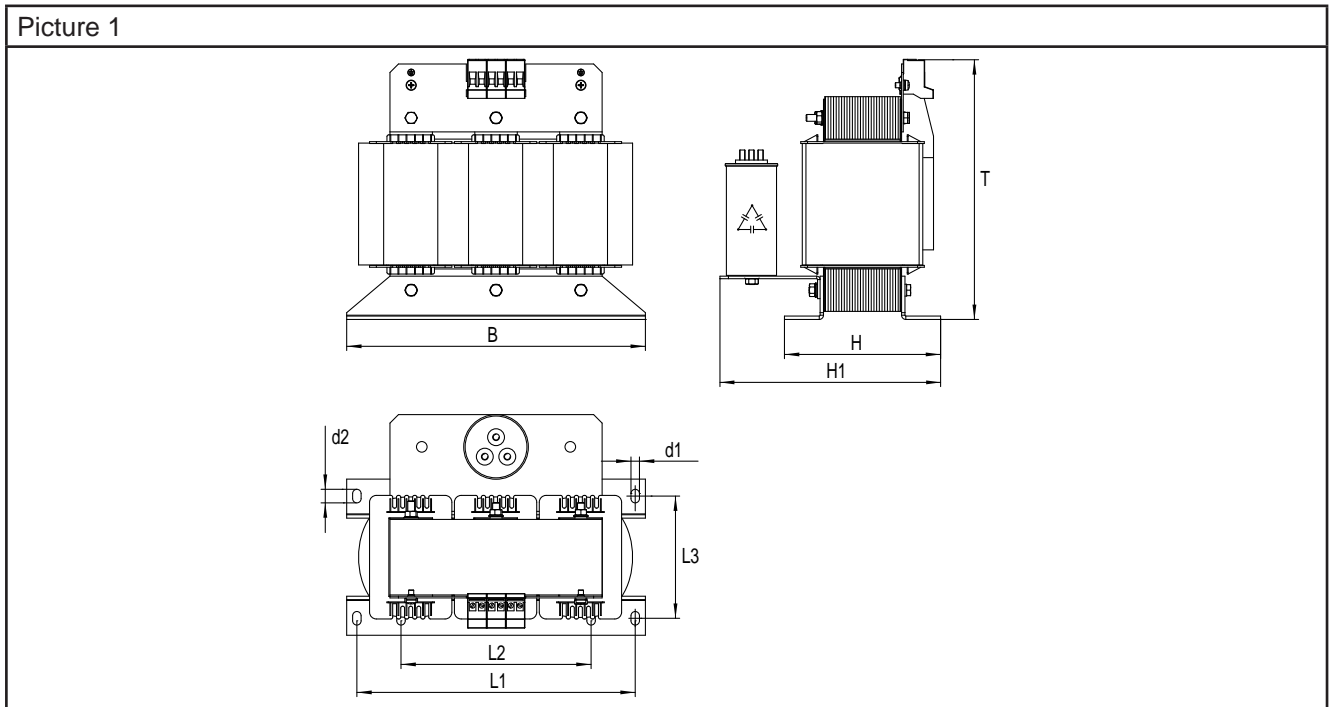
Dimensions [mm]											
Part number	Pic- ture	B	H	H1	T	L1	L2	L3	L4	d1	d2
07.Z1.C04-1001	1	148	69	134	163	136	90	51	---	4.8	8.0
09.Z1.C04-1000	1	178	90	142	170	166	113	71	---	4.8	8.0
10.Z1.C04-1001	1	178	75	128	168	166	113	56	---	4.8	8.0
12.Z1.C04-1000	1	219	121	170	233	201	136	91	---	7	12
12.Z1.C04-1001	1	175	90	145	220	168	113	75	---	4.8	10
13.Z1.C04-1000	1	243	115	195	230	225	144	86	---	7	12
13.Z1.C04-1001	1	219	102	155	233	202	136	73	---	7	12
14.Z1.C04-1000	1	291	118	192	256	273	185	86	---	10	18
14.Z1.C04-1001	1	243	105	185	260	225	145	75	---	7	12
15.Z1.C04-1000	1	291	140	214	257	273	185	106	---	10	18
15.Z1.C04-1001	1	267	109	174	280	249	176	78	---	7	12
16.Z1.C04-1000	2	352	145	240	324	328	224	106	---	10	16
16.Z1.C04-1001	2	291	130	205	275	275	185	97	---	10	18
17.Z1.C04-1000	2	352	170	261	324	328	224	131	---	10	16
17.Z1.C04-1001	2	291	140	215	280	275	185	110	---	10	18
18.Z1.C04-1000	2	352	185	260	337	328	224	147	---	10	16
18.Z1.C04-1001	2	316	152	256	300	292	200	112	---	10	16
19.Z1.C04-1000	2	352	193	355	326	328	224	155	---	10	16
19.Z1.C04-1001	2	316	163	260	297	292	200	124	---	10	16
20.Z1.C04-1000	2	388	183	296	360	364	248	144	---	10	16
21.Z1.C04-1000	2	412	193	320	405	388	264	153	---	10	16
22.Z1.C04-1000	2	412	214	378	404	388	264	175	---	10	16
23.Z1.C04-1000	2	480	245	416	475	450	316	193	---	12	20

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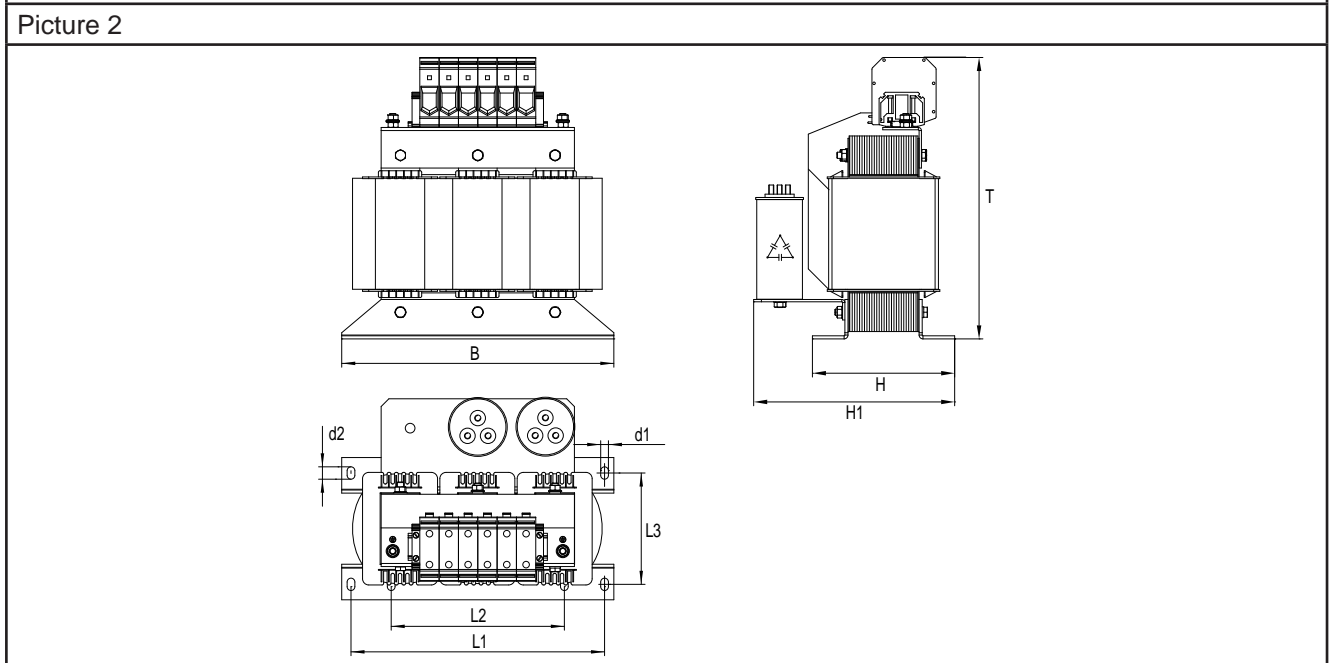


Dimensions [mm]											
Part number	Picture	B	H	H1	T	L1	L2	L3	L4	d1	d2
24.Z1.C04-1000	2	552	241	515	522	516	356	184	---	14.5	24
25.Z1.C04-1000	2	552	275	550	520	525	360	215	---	14.5	24
26.Z1.C04-1000	2	552	294	567	545	516	356	236	---	14.5	24
27.Z1.C04-1000	2	552	315	635	550	515	355	255	---	14.5	24
28.Z1.C04-1000	3	651	264	530	629	611	454	214	461	14.5	24
29.Z1.C04-1000	3	660	350	633	620	620	460	288	535	14.5	24

Picture 1

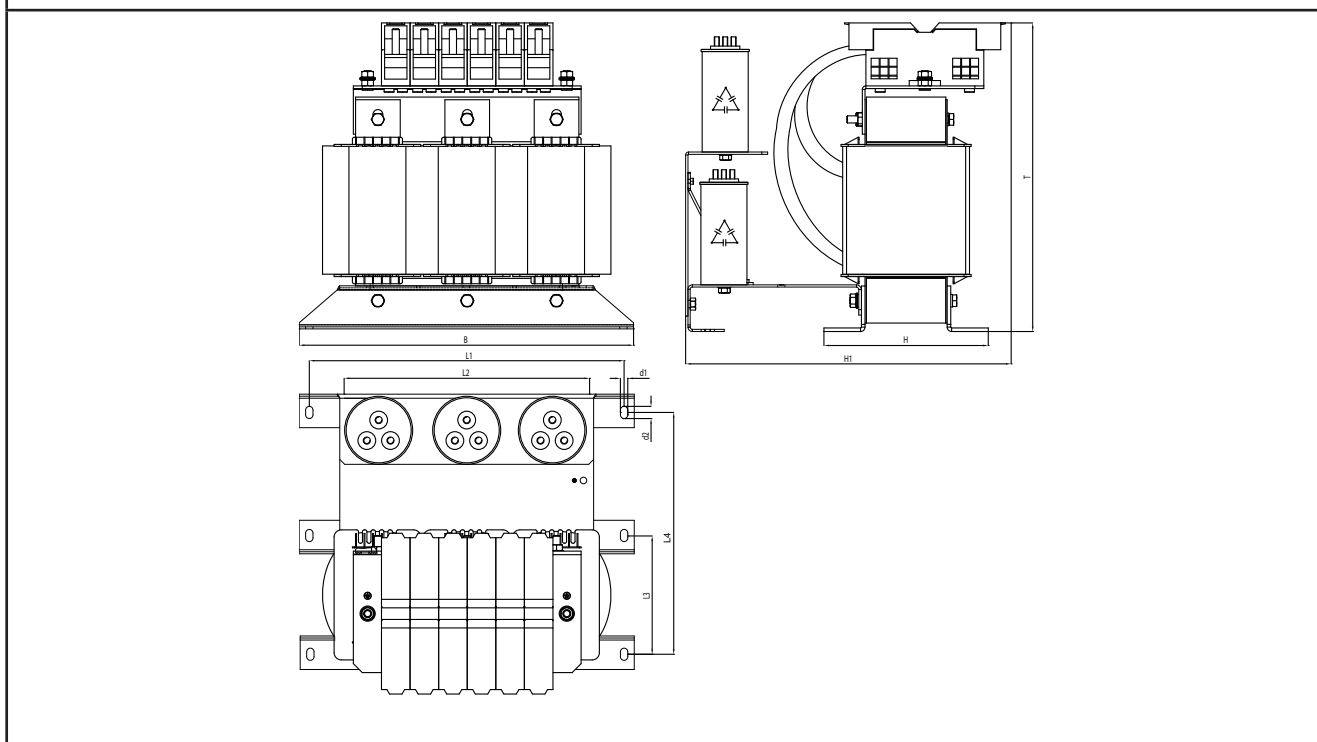


Picture 2



## Unit Description

Picture 3



### 2.6 Description

#### 2.6.1 International standards

The KEB harmonic filter is a new innovative solution, which can be already assigned in the planning phase into the electrical system. The harmonic filter enables the compliance of growing international standards to reduced harmonic components.

The following belongs to this standards:

- IEEE 519-1992 (USA)
- G5/4 Engineering Recommendation (GB)
- EN 61000-3-2 (to 16A)
- EN 61000-3-12 (16-75A)
- EN 61000-3-4
- EN 12015 (European lift norm)
- AS 2279 (Australian)
- COP, supply rules (Hongkong)
- Quality of Electric Energy Supply, Harmonics in Public Supply Networks (China)

### 2.6.2 Advantages

The following advantages are given by means of the special structure of the harmonic filter:

- optimum filter effect
- compact structure, small space requirements for installation
- installation solution ready-to-connect
- significant reduction of the capacitive current during no-load operation
- no tendency to oscillation during load change
- significant smaller voltage drop compared to mains choke
- increase inverter lifetime by means of the trapezoidal output voltage and the resulting square-wave current
- reduction of THDI to < 8% PWHD to < 15% (Version Standard)
- optional THDI < 15%; PWHD < 39% (version according to EN 12015)
- optional THDI < 5% (extreme requirements on request)
- large power range because parallel connection of filter modules is possible
- very high efficiency

### 2.6.3 Applications

The reduction of the THDI to the indicated value of < 8% supposes a VDE conform public supply system with a max.predistortion of THDU = 2% and a minimum ratio of short-circuit power to connected power  $RSCE = 66$  min.

Applications:

- Observance of the standards
- Smaller voltage drop compared to mains choke
- Reduction of effective input current (supply via generators)
- Protection of frequency inverter in case of bad mains (voltage overshoots)
- Protection of "weak supply systems"
- Increasing DC bus capacitor lifetime (several KEB COMBIVERT can be operated at one filter.)

### 2.6.4 Reactive-power compensation equipment without choke and resonance danger

Reactive-power compensation equipment are used in the power supply of companies. Disturbances or damages at these units can have effects to the power supply of the company and they can cause losses of production.

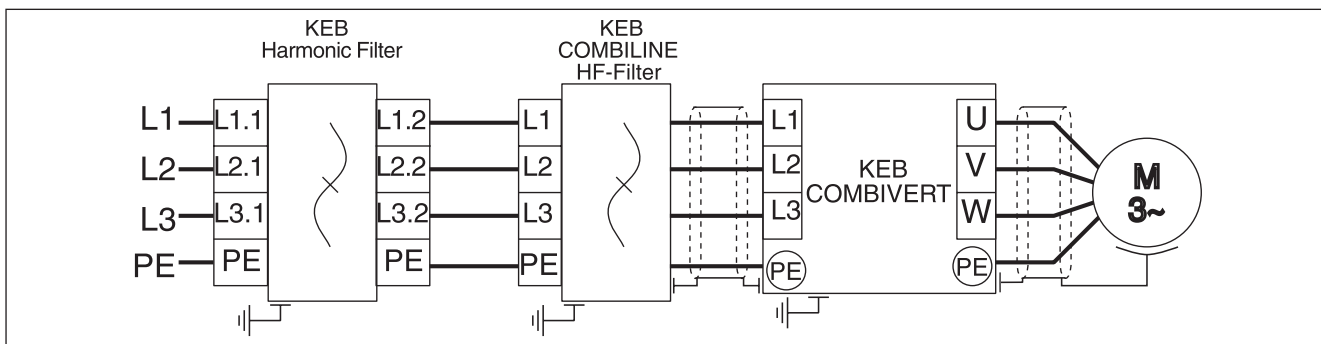
In practice many reactive-power compensation equipments without choke are still used. Various problems can occur in this connection:

- direct resonance
- resonance danger
- switching transient
- interference of ripple control transmissions

For the case that resonances occur it is not essential whether a company causes itself disturbance of main supply network. The compensation power at the transformer is decisive for the risk that resonances occur. The higher the power the higher the resonance risk. An important factor for this is the harmonic preloading in the MV range. The harmonic preloading is transferred by the transformer and affects the LV level.

## 3. Installation

### 3.1 Connection

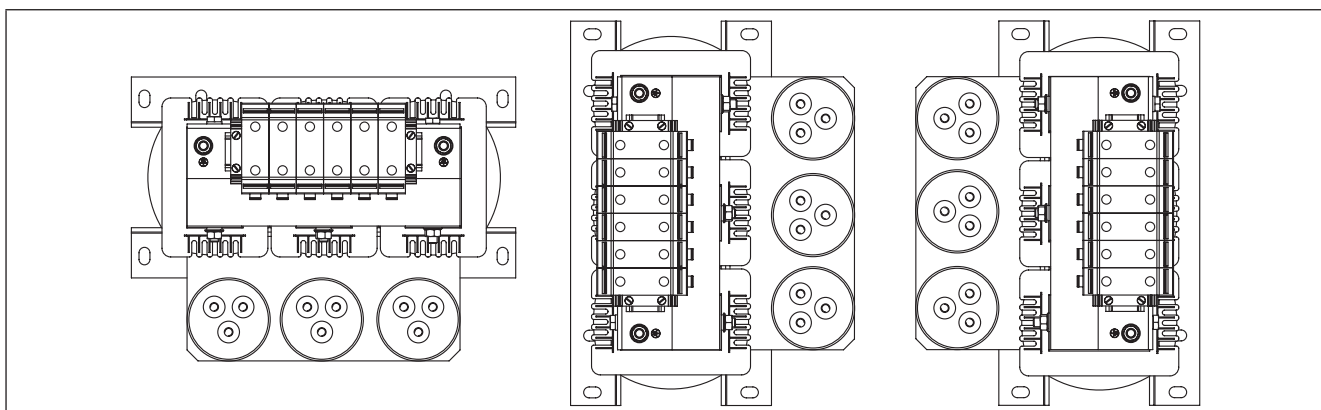


### 3.2 Installation Instructions

The KEB harmonic filter is to be used only as built-in unit. During installation pay attention to the following:

- The distance to adjacent modules may not fall below 150 mm.
- A distance of 150 mm must be observed above and below the filter.
- Sufficient countermeasures must be taken against impurities of any kind.
- The permissible ambient temperatures may not be exceeded.

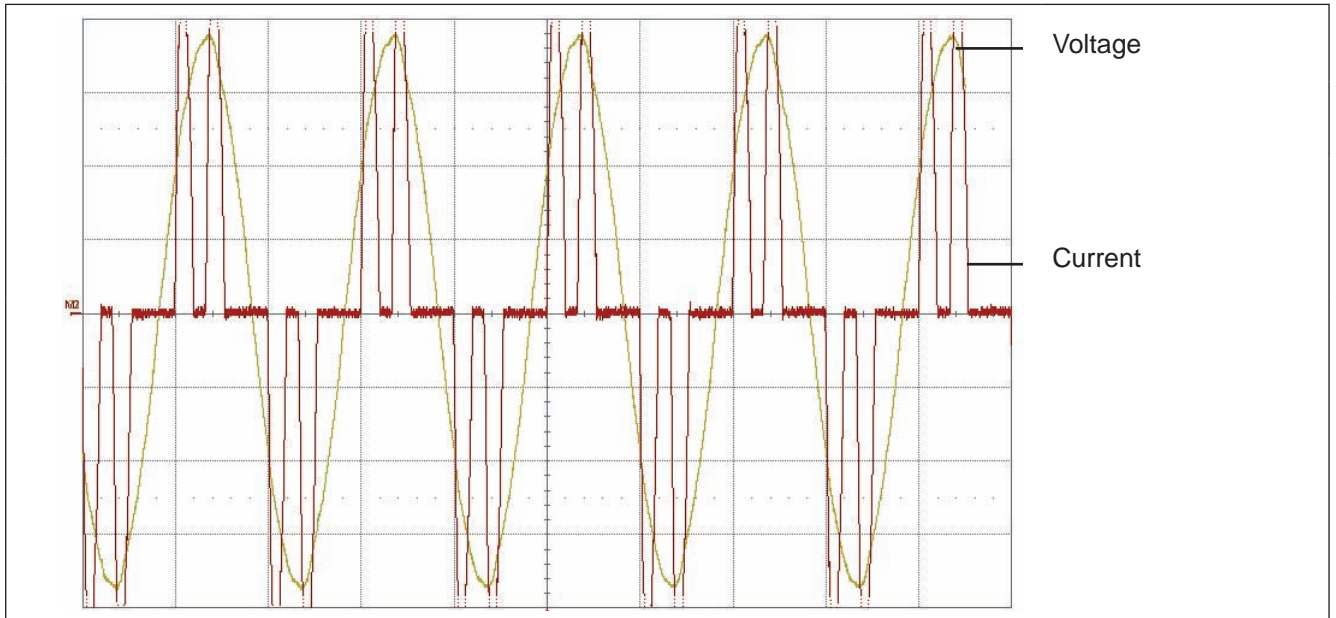
The installation of the filter can be made in standing or lying position. The arrangement of the capacitors is below or beside the choke (see mapping). In order to avoid damage or destruction of the capacitors by overheat the capacitors may not be arranged above the choke!



## 4. Oscillograms

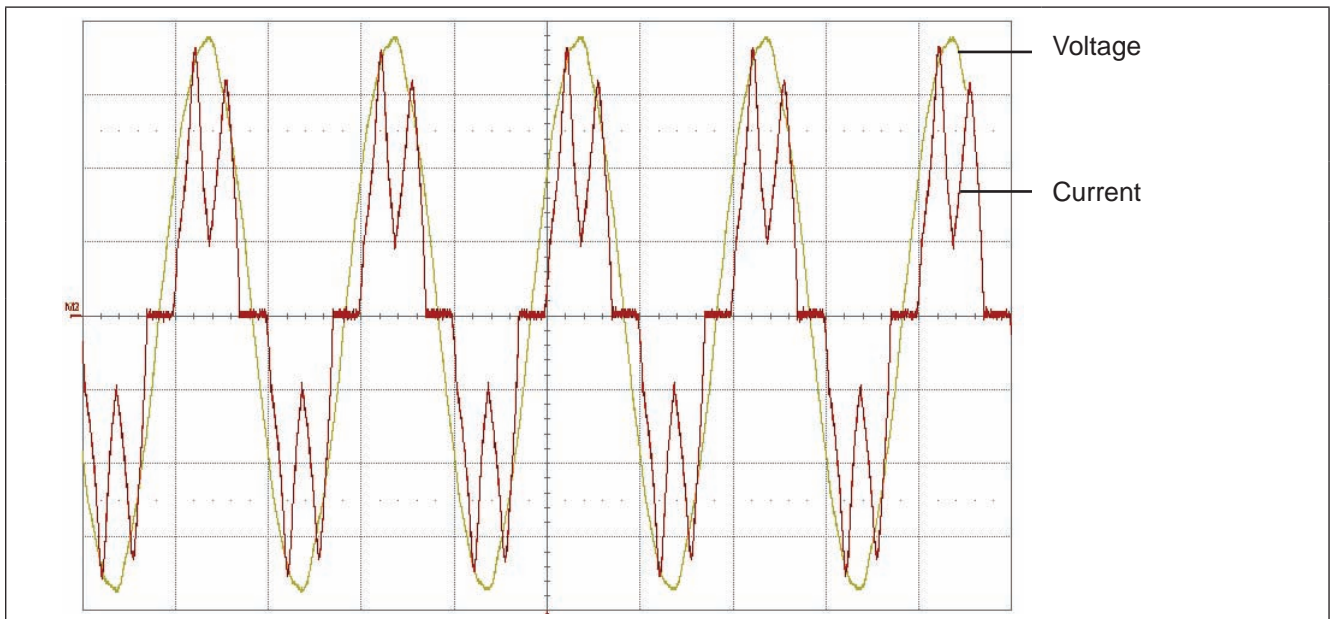
### 4.1 Voltage and current at the mains

Without smoothing reactor high current peaks occur by no-limit loading of the DC link capacitors. Thus the increased disturbances of the DC link voltage continue to the motor by manner of torque fluctuations.



### 4.2 Voltage and current with mains choke $u_k = 4\%$

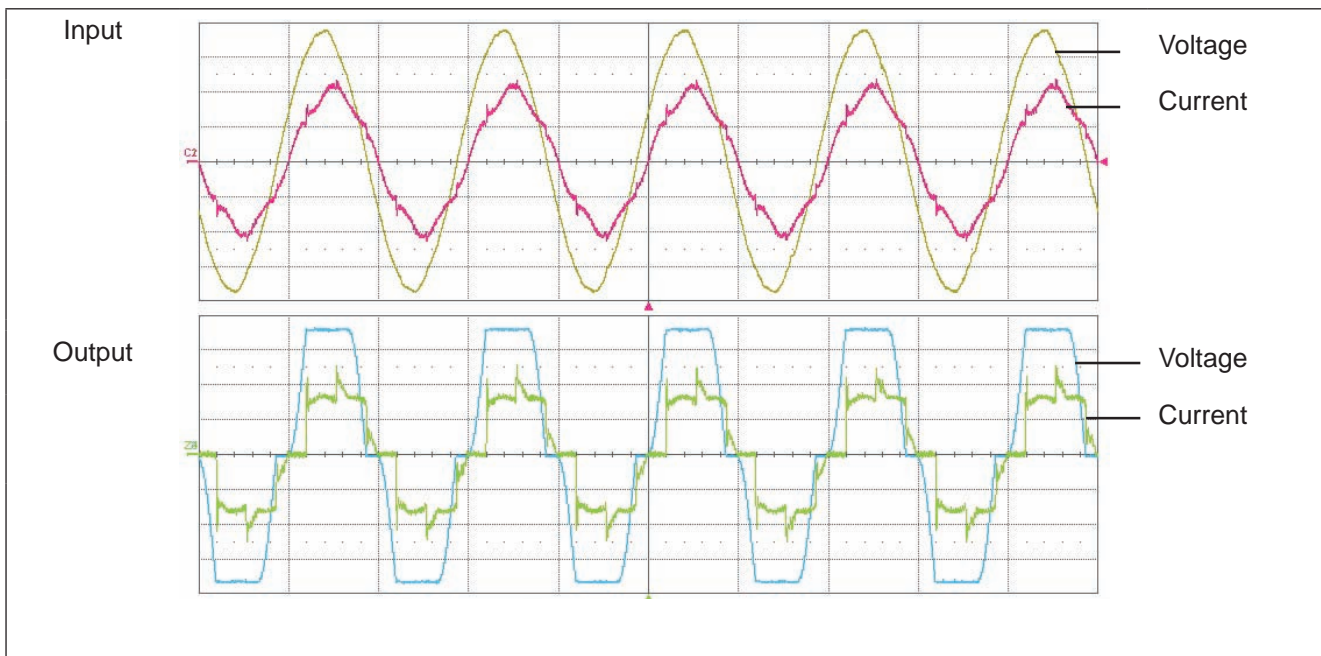
With inductance (mains choke) the amplitudes of the currents are reduced due to the smoothing. The DC link voltage is smoother and thus the lifetime of the capacitors is extended.



## Oscillograms

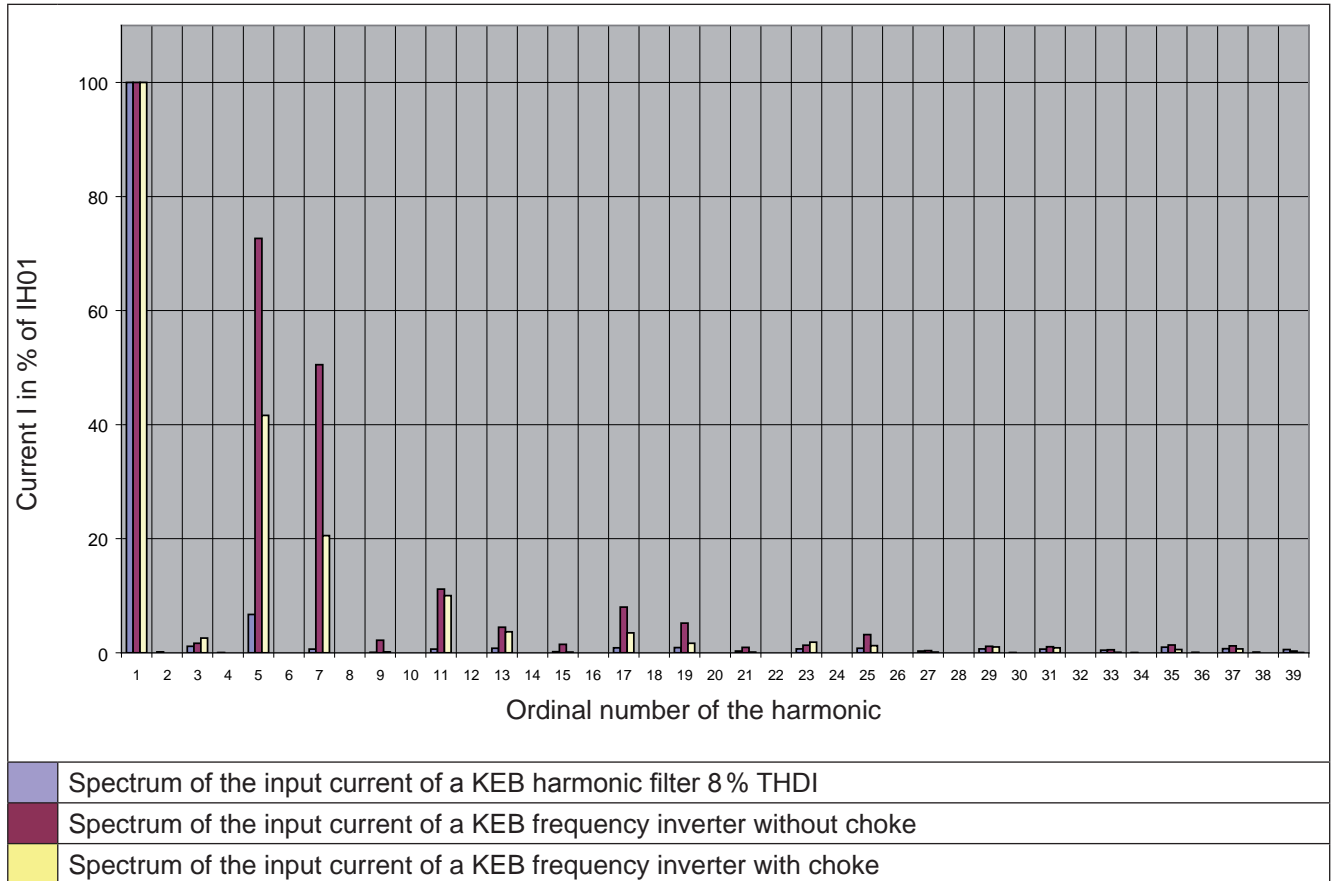
### 4.3 Voltage and current with the harmonic filter THD < 8%

With the harmonic filter and the line-side sinusoidal current the amplitudes of the currents are reduced again compared to the choke. The output variables are nearly rectangular and they cause so a very smooth voltage in the DC link and an increased lifetime of the capacitors.



## 5. Annex

### 5.1 Fourier Analysis / Spectrum



### 5.2 Formula and Abbreviations

THD (Total Harmonic Distortion) 
$$THD = \sqrt{\sum_{n=2}^{40} \left(\frac{I_N}{I_1}\right)^2}$$

THDU (Total Harmonic Distortion Voltage)

THDI (Total Harmonic Distortion Current)

PWHD (Partial Weighted Harmonic Distortion) 
$$PWHD = \sqrt{\sum_{n=14}^{40} n \left(\frac{I_N}{I_1}\right)^2}$$

$S_{equ}$  (Rated Apparent Power of the Equipment) 
$$S_{equ} = \sqrt{3} * U_i * I_{equ}$$

$R_{sce}$  (Short-circuit Ratio) 
$$R_{sce} = \frac{S_{sc}}{S_{equ}}$$



**Karl E. Brinkmann GmbH**

Försterweg 36-38 • D-32683 Barntrup  
fon: +49 5263 401-0 • fax: +49 5263 401-116  
net: [www.keb.de](http://www.keb.de) • mail: [info@keb.de](mailto:info@keb.de)

**KEB worldwide...**

**KEB Antriebstechnik Austria GmbH**

Ritzstraße 8 • A-4614 Marchtrenk  
fon: +43 7243 53586-0 • fax: +43 7243 53586-21  
net: [www.keb.at](http://www.keb.at) • mail: [info@keb.at](mailto:info@keb.at)

**KEB Antriebstechnik**

Herenveld 2 • B-9500 Geraardsbergen  
fon: +32 5443 7860 • fax: +32 5443 7898  
mail: [vb.belgien@keb.de](mailto:vb.belgien@keb.de)

**KEB Power Transmission Technology (Shanghai) Co.,Ltd.**

No. 435 QianPu Road, Songjiang East Industrial Zone,  
CHN-201611 Shanghai, P.R. China  
fon: +86 21 37746688 • fax: +86 21 37746600  
net: [www.keb.cn](http://www.keb.cn) • mail: [info@keb.cn](mailto:info@keb.cn)

**KEB Antriebstechnik Austria GmbH**

Organizační složka  
K. Weise 1675/5 • CZ-370 04 České Budějovice  
fon: +420 387 699 111 • fax: +420 387 699 119  
net: [www.keb.cz](http://www.keb.cz) • mail: [info.keb@seznam.cz](mailto:info.keb@seznam.cz)

**KEB Antriebstechnik GmbH**

Wildbacher Str. 5 • D-08289 Schneeberg  
fon: +49 3772 67-0 • fax: +49 3772 67-281  
mail: [info@keb-combidrive.de](mailto:info@keb-combidrive.de)

**KEB España**

C/ Mitjer, Nave 8 - Pol. Ind. LA MASIA  
E-08798 Sant Cugat Sesgarrigues (Barcelona)  
fon: +34 93 897 0268 • fax: +34 93 899 2035  
mail: [vb.espana@keb.de](mailto:vb.espana@keb.de)

**Société Française KEB**

Z.I. de la Croix St. Nicolas • 14, rue Gustave Eiffel  
F-94510 LA QUEUE EN BRIE  
fon: +33 1 49620101 • fax: +33 1 45767495  
net: [www.keb.fr](http://www.keb.fr) • mail: [info@keb.fr](mailto:info@keb.fr)

**KEB (UK) Ltd.**

6 Chieftain Buisness Park, Morris Close  
Park Farm, Wellingborough GB-Northants, NN8 6 XF  
fon: +44 1933 402220 • fax: +44 1933 400724  
net: [www.keb-uk.co.uk](http://www.keb-uk.co.uk) • mail: [info@keb-uk.co.uk](mailto:info@keb-uk.co.uk)

**KEB Italia S.r.l.**

Via Newton, 2 • I-20019 Settimo Milanese (Milano)  
fon: +39 02 33535311 • fax: +39 02 33500790  
net: [www.keb.it](http://www.keb.it) • mail: [kebitalia@keb.it](mailto:kebitalia@keb.it)

**KEB Japan Ltd.**

15-16, 2-Chome, Takanawa Minato-ku  
J-Tokyo 108-0074  
fon: +81 33 445-8515 • fax: +81 33 445-8215  
mail: [info@keb.jp](mailto:info@keb.jp)

**KEB Korea Seoul**

Room 1709, 415 Missy 2000  
725 Su Seo Dong, Gang Nam Gu  
ROK-135-757 Seoul/South Korea  
fon: +82 2 6253 6771 • fax: +82 2 6253 6770  
mail: [vb.korea@keb.de](mailto:vb.korea@keb.de)

**KEB RUS Ltd.**

Lesnaya Str. House 30, Dzerzhinsky (MO)  
RUS-140091 Moscow region  
fon: +7 495 632 0217 • fax: +7 495 632 0217  
net: [www.keb.ru](http://www.keb.ru) • mail: [info@keb.ru](mailto:info@keb.ru)

**KEB Sverige**

Box 265 (Bergavägen 19)  
S-43093 Hälsö  
fon: +46 31 961520 • fax: +46 31 961124  
mail: [vb.schweden@keb.de](mailto:vb.schweden@keb.de)

**KEB America, Inc.**

5100 Valley Industrial Blvd. South  
USA-Shakopee, MN 55379  
fon: +1 952 224-1400 • fax: +1 952 224-1499  
net: [www.kebamerica.com](http://www.kebamerica.com) • mail: [info@kebamerica.com](mailto:info@kebamerica.com)

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