

COMBIVERT



GB Before starting

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1. Introduction

Before you start with the installation of the frequency inverter / servo drive, please read this manual carefully and pay special attention to the notes and suggestions.



This manual contains

- **safety and warning instructions**
- **installation instructions that conform with EMC**
- **explanation of the EG directive / CE mark**
- **sticker to fasten onto the inverter / servo controller**

This manual must be made available to every user. Before working with the unit the user must become familiar with it. This especially applies to the knowledge and observance of the following safety and warning indications.

1.1 About this Manual

The pictograms used here have the following meaning:



	Danger Warning Caution	Is used when the life or health of the user is in danger or considerable damage to property can occur.
	Attention observe at all costs	Is used when a measure is necessary for safe and disturbance free operation.

2. Safety and Application 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**
- **Guarantees**

2.1 General instructions


	Danger to Life	Inverters / servo drives contain dangerous voltages which can cause death or serious injury. During the operation and depending on the type of protection, they can have live, bright, possibly also mobile parts as well as hot surfaces. Care should be taken to ensure correct and safe operation to minimise risk to personnel and equipment.
	Only Qualified Electro-Personnel	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).

2.2 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.

	<p>Observe standards</p>	<p>The inverter / servo drive 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). The frequency inverters / servo drives meet the requirements of the Low-Voltage Directive 2006/95/EC. The harmonized standards of the series EN61800-5-1 in connection with EN60439-1 and EN60146 were used. This is a product of limited availability in accordance with IEC 61800-3. This product may cause radio interference in residential areas. In this case the operator may need to take corresponding measures.</p>
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2.3 Transport, storage and installation






	<p>Protect Against Accidental Contact</p>	<p>Inverters / servo drives must be protected against physical damage during transport, installation and use. Especially, no components may be bent or isolating distances altered in the course of transportation or handling. The units contain electrostatically endangered components which can be destroyed by inappropriate handling. For that reason the contact of electronic components and contacts is to be avoided. The equipment must not be switched on if it is damaged as it may no longer comply with mandatory standards. Make sure that during installation there is enough minimum clearance and enough cooling. Climatic conditions must be observed in accordance with EN 61800-2 .</p>
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2.4 Installation instructions


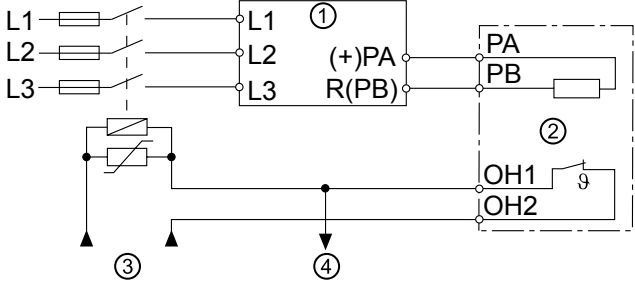
- Stationarily install and earth frequency inverters / servo drives.
- Maintain minimum spaces to surrounding elements when setting up.
- Rack devices are designed for vertical installation and can be placed one next to the other. Maintain a minimum space of 50 mm to previous elements. Ensure sufficient cooling.
- In regulated systems use original KEB cables as motor and transmitter cables only.
- The device must not be permeated by mist or water.
- Avoid dust permeating the device. Allow for sufficient heat dissipation if installed in a dust-proof housing.
- Do not operate the frequency inverter / servo drive in explosive spaces!
Install the frequency inverter / servo drive in an appropriate housing in accordance with the local regulations when operating it in explosive spaces.
- Protect the frequency inverter / servo drive against conductive and aggressive gases and liquids.


2.5 Electrical connection

	<p>Note Capacitors Discharge Time</p>	<p>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.</p>
	<p>Secure isolation</p>	<p>The terminals of the control terminal strip and the transmitter inputs are securely isolated in accordance with EN 50178. With existing or newly wired circuits the person installing the units or machines must ensure the EN requirements are met.</p>
	<p>Control lines</p>	<p>With frequency inverters / servo drives that are not isolated from the supply circuit (EN 50178) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).</p>
	<p>Voltage With Respect To Ground</p>	<p>Connection of the frequency inverter / servo drive is only permissible on symmetrical networks with a maximum line voltage (L1, L2, L3) with respect to earth (N/PE) of 300V. An isolating transformer must be used for supply networks which exceed this value! The units may be damaged if this is not observed.</p>

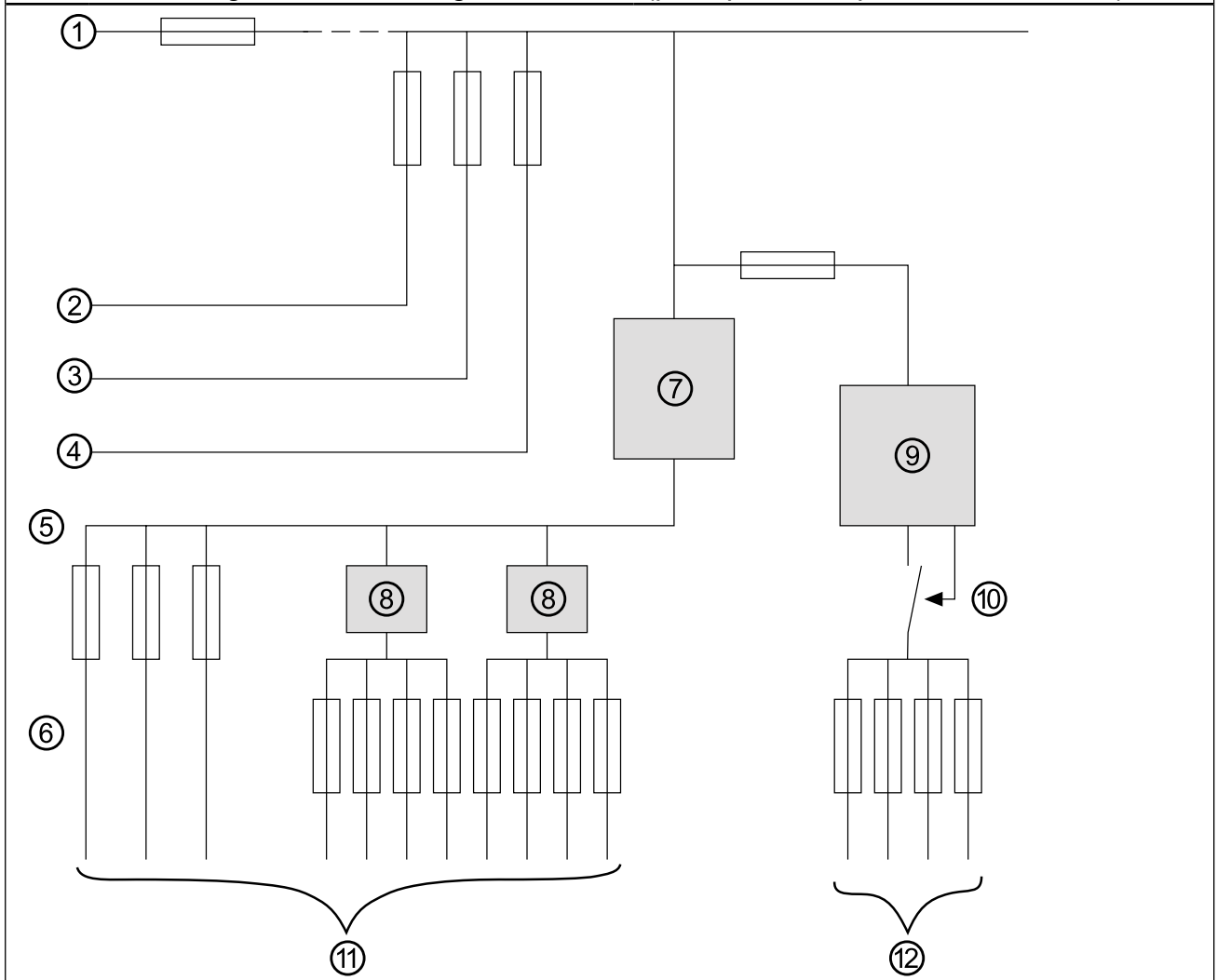
	<p>Earthed external conductor</p>	<p>The frequency inverter/ servo drive can be connected to power systems with earthed external conductors (e.g. delta power systems) if the following exceptions apply:</p> <ul style="list-style-type: none"> • The control is not longer considered as "safe separate circuit", therefore further protective measures must be met. (see "Connection of the Control Lines") • with this type of power system, the max.voltage phase / earth must not exceed 500 V absolute
	<p>Only fixed connection</p>	<p>The frequency inverter/ servo drives are designed for fixed connection only as discharge currents of > 3.5mA may occur especially when using EMI filters. It is therefore necessary to lay a protective conductor with a section of at least 10mm² (copper) or a second protective conductor in compliance with EN 50178. Ground point-to-point with the shortest connection possible to mains earth (avoid earth loops).</p>
	<p>Voltage Peaks</p>	<p>When using IGBT inverters, high voltage peaks may arise in the motor due to the switching action of the inverter output devices, that may damage the insulation of the motor winding. These must be taken into account when using motor cables longer than 15m or high frequency motors. In this case, the motor can be protected with a motor choke, dv/dt filter or sine filter.</p>
	<p>Insulation Measurement</p>	<p>When doing an insulation measurement in accordance with VDE 0100 / Part 620, the power semiconductor of the unit and existing radio interference filters must be disconnected because of the danger of destruction. This is permissible in compliance with the standard, since all inverters are given a high voltage test in the end control at KEB in accordance with EN 50178.</p>
	<p>Different Earth Potentials</p>	<p>When using components without isolated inputs / outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. through the equalizer). Disregard can cause destruction of the components by the equalizing currents.</p>

	Prevent Disturbances	<p>A trouble-free and safe operation of the frequency inverter / servo drive is only guaranteed when the connection instructions below are strictly followed. Incorrect operation or damage may result from incorrect installation.</p>
		<ul style="list-style-type: none"> • Note mains voltage and rated motor voltage.
		<ul style="list-style-type: none"> • Do not swap around mains and motor lines.
		<ul style="list-style-type: none"> • Install power cables and control cables separately (>15 cm separation).
		<ul style="list-style-type: none"> • Use shielded / twisted control lines. Connect shield to PE at inverter only!
		<ul style="list-style-type: none"> • Only use suitable circuit elements to control the logic and analog inputs, whose contacts are rated for extra-low voltages.
		<ul style="list-style-type: none"> • Make sure inverter and motor housing are well grounded. The screen of the power cable must be directly and securely attached to both the inverter PE terminal and the motor ground terminal. Remove paint finish where necessary.
		<ul style="list-style-type: none"> • Connect the braking module / braking resistor with shielded / twisted cables (install shield on one side of the inverter) • Ground the cabinet or the system earth star point with the shortest connection to mains earth (avoid earth loops)

	Fire hazard	<p>It is absolutely necessary to monitor the braking resistance temperature switch to avoid a braking resistance overload. To do so, connect the sensor to T1 (OH) and T2 (OH) as described in Part 2 of the instructions. If the braking transistor is defective, however, this measure will not suffice to prevent an extreme overload and acute danger of fire. This type of danger can only be averted by disconnecting the mains voltage (see diagram). Overloads may be caused by:</p> <ul style="list-style-type: none"> • the ramps are too short or the operating time is too long • incorrect dimensioning of the braking resistance • the input voltage being too high • defect of the braking transistor in the inverter or braking module 	
			
		1	Frequency inverter / servo
		2	Braking resistance with temperature switch
3	230 or 24 V AC/DC drive		
4	at 24 V AC/DC check tripping		




	<p>RCD (FI-Protective Switch)</p>	<p>If personnel protection is required during installation of the system the frequency inverters must be protected according to EN 50178:</p> <ul style="list-style-type: none"> • 1-phase inverters by RCD type A (pulse-current sensitive FI's) or type B (all-current sensitive FI's) • 3-phase inverters (with B6 bridge-connected rectifier) by RCMA's with separation (used privileged) or RCD's type B (all-current sensitive FI's) <p>The tripping current should be 300mA or more, in order to avoid a premature triggering of the inverter by discharge currents (about 200mA).</p> <p>Dependent on the load, the length of the motor cable and the use of a radio interference filter, substantially higher leakage current can occur.</p> <p>The connection instructions from the manufacturer and the valid local requirements must be observed.</p> <p>Dependent on the available mains form (TN, IT, TT) further protective measures are necessary in accordance with VDE Part 410 (Part 4; Chapter 41).</p> <p>For example, with TN-mains this protection is made with overcurrent protective devices, with IT-mains it is insulation monitoring with a pulse-code measuring method. A protective separation can be used with all mains forms as long as the required power and cable lengths permit this.</p> <p>The person setting up the unit must present proof of compatibility before installing the inverter!</p>
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Circuit diagram of low voltage distribution (principle of the protective elements)



1	Mains	
2	to further sub-distributions	Outlet 1
3		Outlet 2
4		Outlet 3
5	Level 1	
6	Level 2	
7	Type A	
8	RCD Type A sel. T	
9	RCMA/ RCD Type B	
10	Isolator according to EN 60947-2	
11	To further consumers that do not prevent the tripping of the FI.	
12	To the consumers not compatible with FI.	

2.6 Operating Instructions

	<p>Damage to property and injury to persons</p>	<p>Before putting the unit into operation, check terminals and screw connections for tight fit and put back all pertaining covers. Observe the following instructions to avoid damage to the frequency inverter / servo drive as well as subsequent damage and injury to persons:</p> <ul style="list-style-type: none"> • Install circuit breaker between power supply and frequency inverter / servo drive so that it is possible to switch the device off independently. • In the case of separate drives, switching between motor and frequency inverter / servo drive is prohibited during operation as this may trigger the protection gear of the device. If you cannot avoid switching, consult KEB regarding protective measures. Connecting and disconnecting is permissible with multiple motor drives if at least 1 motor is running during the switch-over process. Dimension the frequency inverter / servo drive to match the occurring starting currents. • If the motor is still running during a frequency inverter / servo drive restart (mains on) -e.g. due to large gyrating masses - the RPM search or DC braking function must be activated. • When switching between motor and frequency inverter / servo drive, the RPM search function must be activated. The function may only be triggered after closing the motor contactor. • Modified programming of the frequency inverter / servo drive (variation of works setting), should be checked again before putting the device into operation. !Misadjustments may cause unintentional drive performance! • Should malfunctions or defects regarding the frequency inverter / servo drive occur despite observance of the instructions concerning connection and operation, these may cause undefined operating statuses. Activation of software-supported protective functions such as limit switch function, correct switching of a brake or correct reactions to set value specifications is no longer guaranteed. • Securing a unit solely with software-supported functions does not suffice. It is imperative to install external protective measures that are independent of the frequency inverter / servo drive.
	<p>Automatic Restart</p>	<p>Inverters/ servo drives may be set, dependent on type, to restart automatically following a fault stoppage (e.g. Undervoltage Error), when the fault conditions clear. System design must take this into account, if appropriate, and additional monitoring or protective features added where necessary.</p>
	<p>Cyclic activation and deactivation</p>	<p>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.</p>



Conditionally short-circuit proof

The frequency inverters / servo drives are conditionally short-circuit proof (EN 50178/VDE 0160). After resetting the internal protection devices, the function as directed is guaranteed.

Exceptions:

- If an earth-leakage fault or short-circuit often occurs at the output, this can lead to a defect in the unit.
- If a short-circuit occurs during regenerative operation (2nd or 4th quadrant, feedback into the intermediate circuit), this can lead to a defect in the unit.

3. EMC Fundamentals

3.1 General

Frequency inverters / servo drives represent electrical equipment designed for use in industrial and commercial units. In accordance with the EMC directive 2004/108/EC, it is not obligatory to mark these devices as they represent components to be further processed by the respective machine and unit manufacturer and are not operable independently according to the EMC directive. The person installing / operating the machine / unit is obliged to prove the protective measures demanded by the EMC directive are complied with. The prescribed ratings can usually be complied with when using the radio interference voltage filters specified by KEB, and when observing the following measures and installation guidelines.

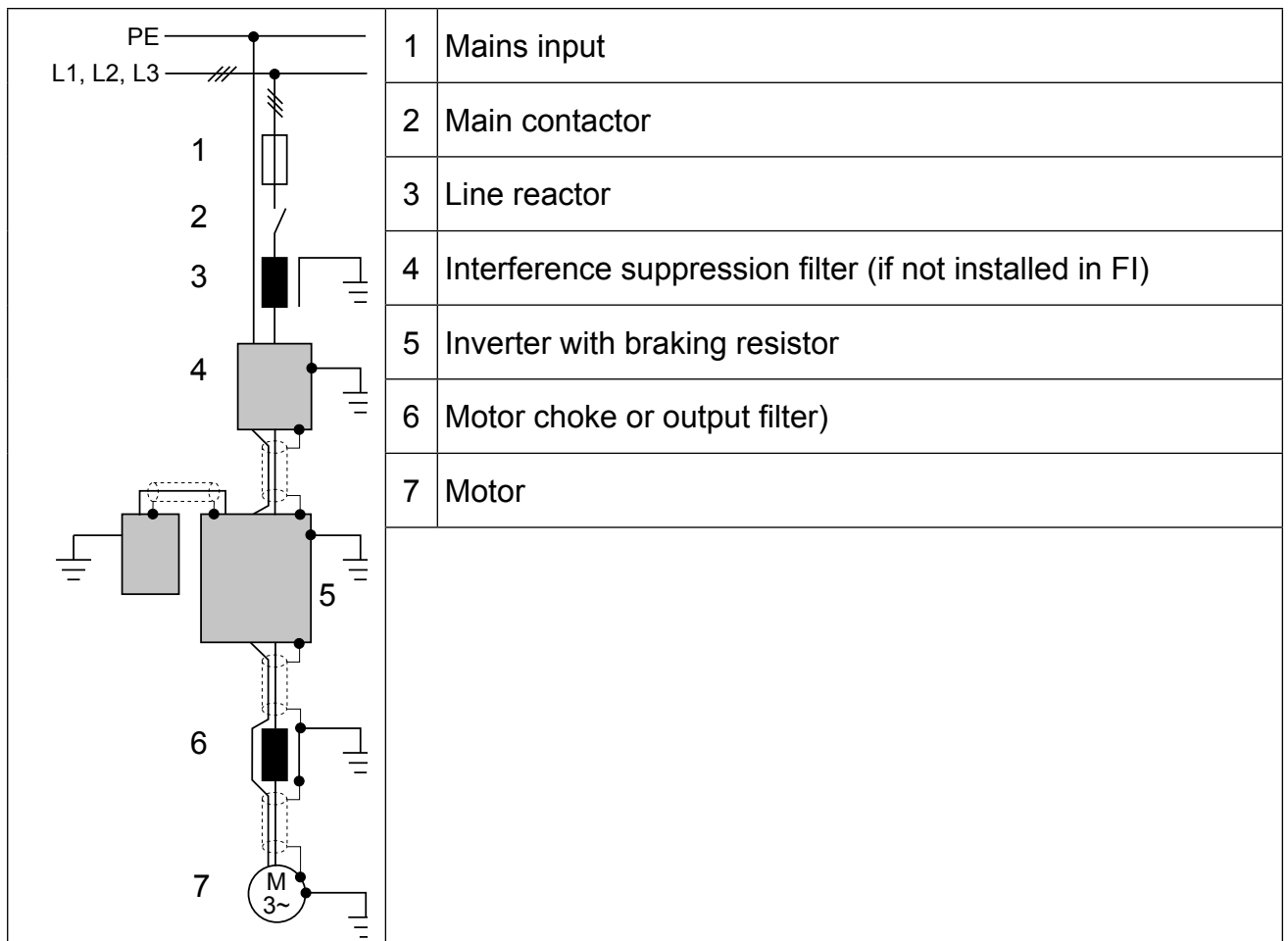
The KEB frequency inverter / servo drive is designed to be used in the second environment as defined in EN 61800-3 (unit with its own supply transformer). Take additional measures when using it in the first environment (residential and commercial area connected to public low-voltage mains)!

3.2 Installation

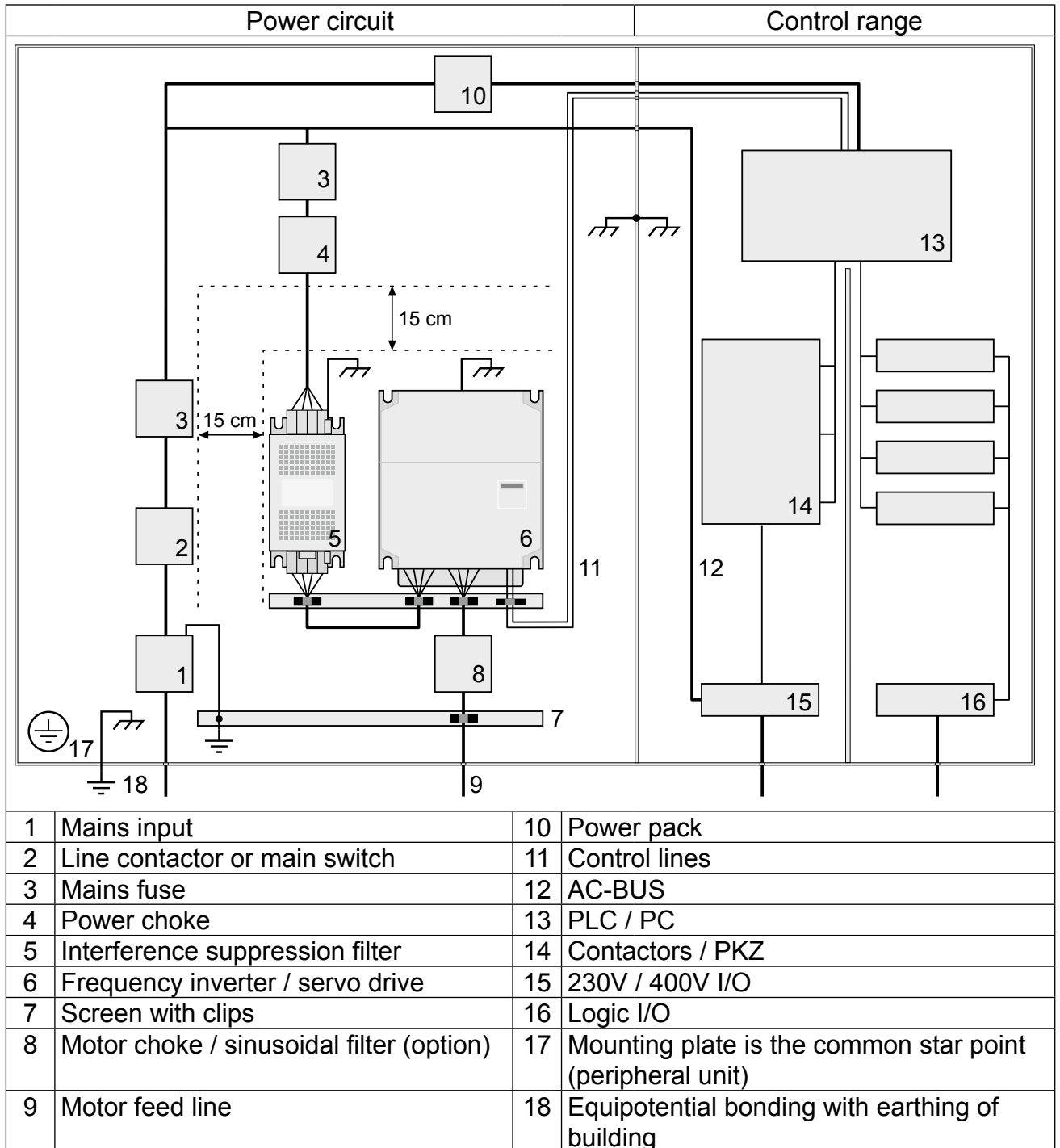
- Install the cabinet or system correctly.
- To avoid coupled-in noise, separate
 - mains / supply lines
 - motor lines from inverters / servo actuator
 - control and data lines (low-voltage level < 48V)

and leave a space of at least 15 cm between them when installing.

- In order to maintain low-resistance high frequency connections, earthing and shielding, as well as other metallic connections (e.g. mounting plate, installed units) must be in metal-to-metal contact with the mounting plate, over as large an area as possible. Use earthing and equipotential lines with a section as large as possible (min. 10mm²) or use thick earthing strips.
- Only use shielded cable with copper or tin-plated braid, since steel braid is not suitable for high frequency ranges. The screen must always be installed on the compensating rail and fastened with clips or guided through the wall of the housing with metal screw connections. Do not elongate the screen end (pigtailed) with individual conductors!
- If external interference suppression filters are used, then these must be installed as close as possible to (<30cm from) the interference source and in metal-to-metal contact with the mounting plate, over as large an area as possible.
- Always equip inductive control elements (contactors, relays etc.) with suppressors such as varistors, RC-elements or damping diodes.
- All connections must be kept as short as possible and as close as possible to the earth, as free floating lines work as active and passive aerials.
- Keep connection cables straight (do not bundle). Install a non-assigned wire on both sides of the protective conductor.
- The flow and return circuit must be twisted when the lines are not shielded, in order to dampen common-mode noise.



3.3 Installation of an EMC Conform Cabinet



3.4 Explanations

- A system should be broadly separated into power section and control section. It doesn't matter whether the system is mounted in a single control cabinet or comprises several control cabinets. It is recommended that a screen wall is installed between the two sections because of the radiated noise from the power section. This screen must be in good metal-to-metal contact with the mounting plate (remove galvanized or lacquer finish), over as large an area as possible.
- The installed inverter and a superposed interference suppression filter must form a unit, i.e. they must, for example, be connected to each other without an insulating layer of lacquer and cover the mounting plate evenly.
- The connecting line between interference suppression filter and inverter should be a shielded line installed on both sides and usually be no longer than 30 cm.
- The mounting plate of the inverter must be seen as the neutral point for the entire earthing and shield connection in the machine or system. If the motor or other system parts lead to disturbances, then the HF-connection of these elements is bad. In this case equipotential bonding must be done.
- A good connection of the shield onto the motor terminal box is only given, when the terminal box is made out of metal, and a metal cable gland is used to connect the screen. When using a plastic box, provide the shield without elongation with a cable lug and connect directly with the earthing point.
- The leakage currents in the circuit increase when interference suppression filters are used. Since these lie above the 3.5mA threshold, one of the following conditions must be met:
 - Protective conductor section at least 10 mm² copper
 - Monitoring of the protective conductor by a device that switches independently in case of error
 - Install a second conductor electrically parallel to the protective conductor via separate terminals. This conductor must also fulfill the requirements for protective conductors itself alone..
- Place consumers generating electric or magnetic fields or affecting the voltage supply as far away as possible and take measures to suppress the interference.
- The service life of the frequency converter/ servo drive with intermediate voltage circuit depends on the current load of the electrolytic capacitors in the intermediate circuit. The use of mains chokes can increase the service life of the condensators to a considerable extent, especially when connecting to „hard“ power systems or when under permanent drive load (continuous duty).

For continuous duty (S1) drives with a medium duty of >60% , KEB recommends the use of mains chokes with a terminal voltage (U_k) of 4%.

The term “hard” mains can be defined as follows:

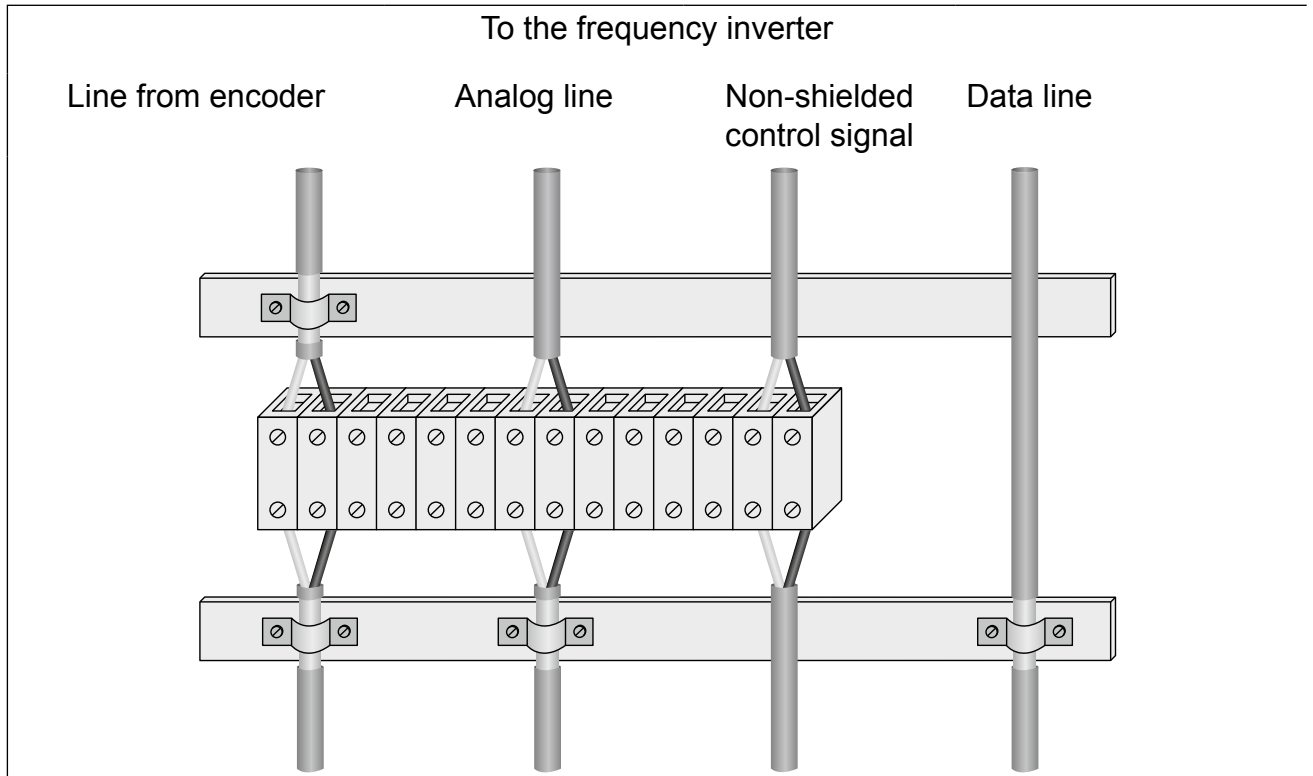
$$k = \frac{S_{\text{mains}}}{S_n} \gg 200$$

The inverter's nominal power (S_n) is very low compared to the nodal point power (S_{mains}). Example:

$$k = \frac{S_{\text{mains}}}{S_{\text{m}}} = \frac{2 \text{ MVA (supply transformer)}}{6.6 \text{ kVA (12.F5)}} = 330 \rightarrow \text{Choke required}$$

- When using a mains choke, it should usually be mounted on the mains side of the interference suppression filter.

3.5 Connection of the Control Lines



Notes:

- Connect the screen schiene with the stripped mounting plate covering as much space as possible and do not use as strain relief.
- The shield from the digital signal lines, which is not connected via terminals, must be clamped to the screen bus, both at the cabinet entrance and near the inverter, in order to decrease the screen impedance.
- If digital signal lines are connected via terminals, the screen must be clamped to the screen bus before and after the terminals.
- If a screen bus is used near the inverter (max 20 cm distance), then the screen no longer needs to be connected to the inverter.
- If the shield is earthed with a single charger, then the interference derivation deteriorates by 70%.
- Metal copper pipe clips are suitable as a shield connection.
- When using non-shielded signal lines, they should always be installed as a twisted pair with a forward and return circuit.

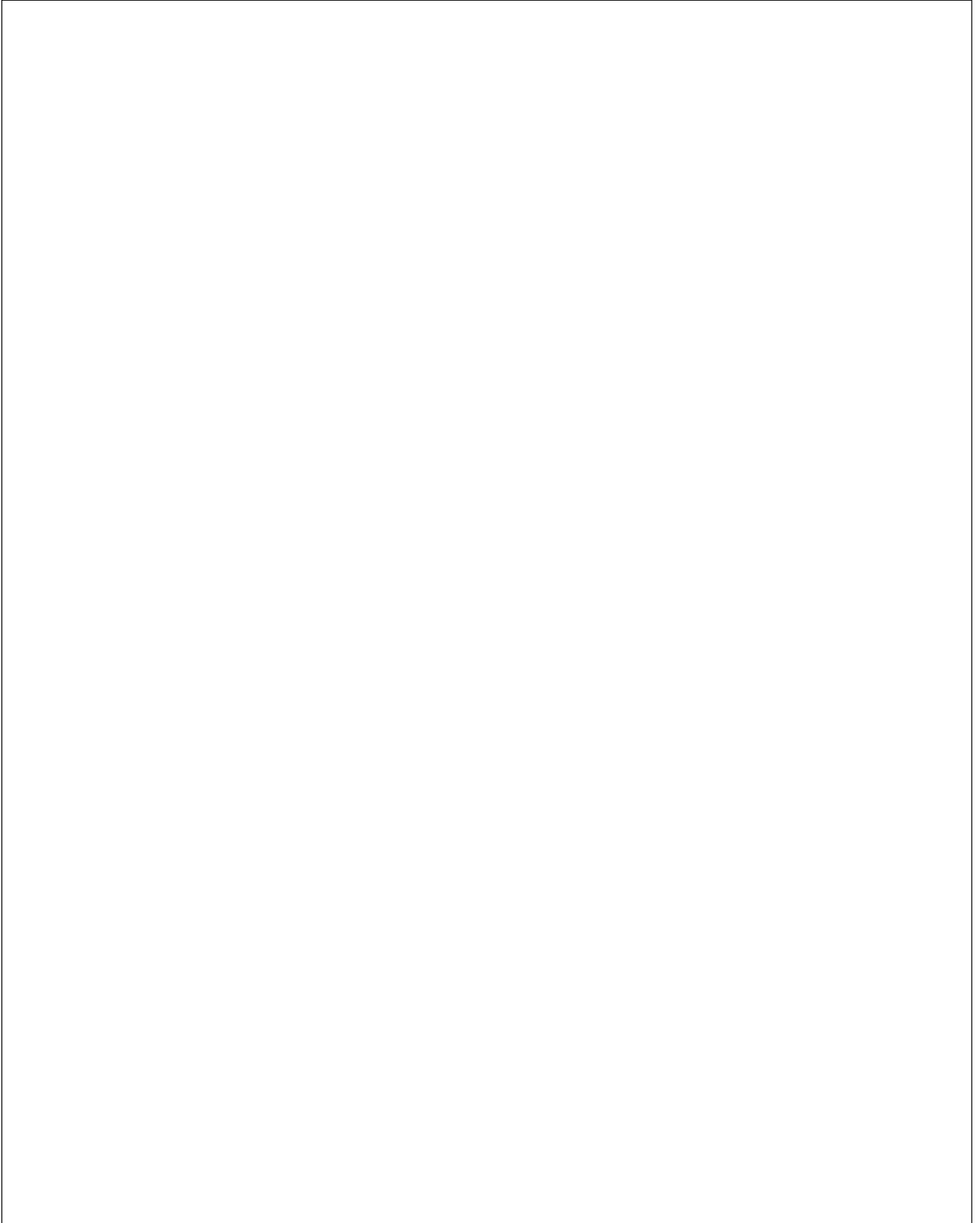
4. Certification

4.1 CE-Marking

CE marked frequency inverter and servo drives were developed and manufactured to comply with the regulations of the Low-Voltage Directive 2006/95/EEC. The applied standards are listed in the technical documentation part 2.

4.2 Manufacturer's Declaration

A manufacturer declaration in accordance with 2006/42/EEC can be provided by KEB if needed.





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