COMBIVERT

F4

1 to 400 hp

c UL us LISTED

CE

INSTRUCTION MANUAL **POWER STAGE**

Important Note: The user should read this manual completely prior to operating the inverter

0L.F4.0EB-K002

KEBCO

POWER TRANSMISSION

08/00

This instruction manual must be made available to all users. Before working with this unit the user must be familiar with it. This is especially true for the attention, safety and warning guides. The meaning of the icons used in this manual are:

Danger
Warning
Caution

Attention, observe at all costs

Information
Help
Tip

KEBCO POWER TRANSMISSION

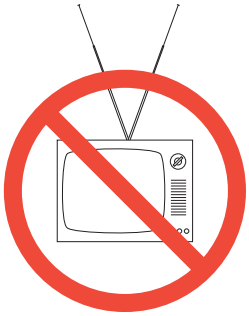
Table of Contents

1. General

1.1 Product description

In selecting the COMBIVERT F4 series inverter, you have chosen a frequency inverter with the highest quality and dynamic performance.

It is exclusively designed for smooth speed regulation of a three-phase motor.



The operation of other electrical loads is forbidden and can lead to destruction of the unit.

This manual describes the frequency inverter **COMBIVERT F4.**

- 1 hp...15 hp / 230V class
- 1 hp...300hp / 460V class

The COMBIVERT F4 inverter has the following features:

- small mounting footprint
- IGBT power circuit gives low switching losses
- low motor noise with high carrier frequency
- extensive protection for over- current, voltage and temperature
- voltage and current monitoring in static and dynamic operation
- short circuit proof and ground-fault proof
- noise immunity in accordance with IEC1000
- hardware current regulation
- integrated cooling fan
- uniform mounting pattern
- can be mounted side by side with zero clearance
- CE compliant and UL listed

1.2 Model number information

Part Number

15.F4.C1G-3440

Options	0	= Standard
	1	= Interbus S Card
Max. carrier freq.	1	= 2 kHz
	2	= 4 kHz
	4	= 8 kHz
	6	= 12 kHz
	8	= 16 kHz
Supply voltage	2	= 230 V
	4	= 460 V
Input identification	1	= 1-phase
	2	= DC
	3	= 3-phase
	4	= Special-/Customer version[1)]
	5	= Special-/Customer version[1)]
	A	= Special-/Customer version[1)]
	B	= Special-/Customer version[1)]
Housing type	D, E, G, H, R, U, P Chassis [2)]	
Accessories	0	= None
	1	= Braking transistor
	2	= Filter
	3	= Filter and braking transistor
	4	= Braking transistor and resistor
	5	= Braking transistor, resistor and filter
	6	= Braking transistor jumpered out (D-sized housing only)
Control stage	C	= Custom
	S	= Simple
	F	= Field orientated control (flux vector)
Unit Type	F4	
Unit size	07...29 size corresponds to hp 07 = 1hp 09 = 2 hp etc. see technical data on pages 12-19 for hp ratings	

1) On special- or customer versions the last positions are unique.
2) NEMA 1 Kits are available for certain housing sizes. Contact KEBCO for more information.

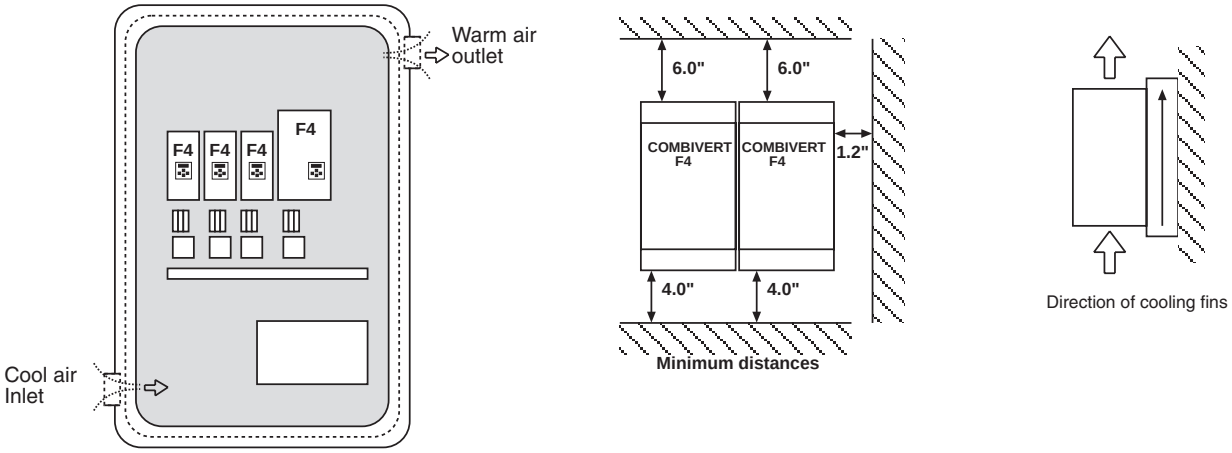
1.3 Mounting instructions

1.3.1 Classification

- ❑ **The chassis models are classified as an "Open Type" inverter with an IP20 rating and must be mounted inside of a control cabinet.**

1.3.2 Physical Mounting

- ❑ Install the inverter in a stationary location offering a firm mounting point with low vibration.
- ❑ Installation of the inverter on moving system may require special earth ground connections to the inverter. Please consult KEBCO.
- ❑ For best high frequency grounding, install the inverter on a bare metal sub-panel, i.e. zinc plated steel or galvanized steel.
- ❑ Take into consideration the minimum clearance distances when positioning the inverter (see drawing below). The F4 series inverters are designed for vertical installation and can be aligned next to each other. Maintain a distance of at least 2 inches in front of the unit. Make sure cooling is sufficient.



1.3.3 Harsh Environments

- ❑ For extended life, prevent dust from getting into the inverter.
- ❑ When installing the unit inside a sealed enclosure, make sure the enclosure is sized correctly for proper heat dissipation or that a cooling system has been installed in the panel.
- ❑ **Protect the inverter against conductive and corrosive gases and liquids. Water or mist should not be allowed into the inverter.**
- ❑ **The COMBIVERT F4 inverter must be installed in an explosion-proof enclosure when operating in an explosion-proof environment.**

1.3.4 Ambient Conditions

- **The operating temperature range of the unit is -10°C to + 45°C. Operation outside of this temperature range can lead to shut down of the inverter.**
- The unit can be stored (power off) in the temperature range -25°C to 70°C. After prolonged storage, one half year or more, apply voltage to the inverter for 2 hours before operating the motor. This will allow the electrolytic bus capacitors to stabilize before use and result in longer lifetime of the unit.
- The power rating of the inverter must be derated for operation above 3,300 ft (1000 m). Reduce the rated power 1% for each additional 330 ft (100 m). The maximum elevation for operation is 6,560 ft (2000 m)
- The relative humidity should be limited to 95% without condensation.

1.4 Electrical connections

1.4.1 Safety First

- **RISK OF ELECTRIC SHOCK! Always disconnect supply voltage before servicing the COMBIVERT F4.**
- **After disconnecting the supply voltage, always wait 5 minutes before attempting to change the wiring. The internal DC BUS capacitors must discharge.**

1.4.2 Voltage Supply

- The F4 series inverters are suitable for use on a circuit capable of delivering not more than 5kA rms symmetrical amperes, at the inverter's rated maximum voltage.
- Pay attention to the supply voltage and be sure the supply voltage matches that of the inverter. A 230V unit can be supplied with voltage in the range 180 to 260VAC +/-0%, for a 460V unit the range is 305 to 500VAC +/- 0%, 48Hz to 62 Hz.

- **Connection of the F4 series inverters to voltage systems configured as a corner grounded delta, center tap grounded delta, open delta, or un-grounded delta, may defeat the internal noise suppression of the inverter. Increased high frequency disturbance in the machine and on the line may be experienced. A balanced, center grounded wye connection is always recommended. The three phase voltage imbalance must be less than 2% phase to phase. Greater imbalance can lead to damage of the inverter's power circuit.**

1.4.3 Disconnect switch

- ❑ A disconnect switch or contactor should be provided as a means of turning off the supply voltage when the unit is not in use or when it must be serviced.
- ❑ Repetitive cycling on and off of the input supply voltage more than once every two minutes can lead to damage of the inverter.

1.4.4 Fusing

- ❑ **A circuit breaker or a disconnect switch with fuses must be provided in accordance with the National Electric Code (NEC) and all local codes.**
- ❑ **The F4 is to be connected to the supply voltage using fast acting fuses (BUSSMANN type KTS-R or equivilant) or using a magnetic trip circuit breaker with ratings as specified per unit size in the tables on pages 12-19.**
- ❑ The minimum voltage rating for protection devices used with 230V inverters shall be 250VAC. The minimum votlage rating for protection devices used with 460V inverters shall be 600VAC.
- ❑ Fuses should not be installed between the inverter and the motor.

1.4.5 Line Chokes

- ❑ **A line choke with minimum 3% impedance is required for all inverters 100hp (size 23) and greater.**
- ❑ A line choke can be used to generally reduce conducted high frequency noise. See section 3.2.1 on pages 34 and 35 for more information.

1.4.6 Motor Thermal Protection

- ❑ The F4 series inverters provide motor overload protection at 130% of the inverter's rated current.
- ❑ If the inverter is oversized in comparison the to the motor, an independent thermal protection device should be used. A motor winding sensor, either a normally closed contact (rating: 15V / 6mA) or a PTC (positive temperature coeificient) resistor can be connected to the OH terminals on the inverter. The thermal device should be connected as indicated on page 25.
- ❑ Overload protection base on current sensing can also be used. The normally closed contact from the sensing device can be connected to the OH terminals on the inverter. See page 26 for wiring.

- ❑ **In general, overload protection through current sensing does not provide protection against overheating at low speeds; reduced fan cooling. Therefore it is recommended that a motor winding sensor be used in applications requiring prolonged operation at low motor speeds.**

1.4.8 High Voltage Connections

- ❑ Always note inverter voltage, select appropriate over current protection devices, select disconnect device, and select proper wire size before beginning the wiring process. Wire the inverter according to NEC Class 1 requirements.
- ❑ The correct wire gauge for each size inverter can be selected from the charts on pages 12-19. The terminal tightening torque can be found for each unit in the same charts.
- ❑ Always use UL listed and CSA approved wire. The wire gauge is based on the maximum fuse rating for the inverter and a minimum of 75°C insulation rating. Use copper wire only. Use 300V rated wire with 230V systems and 600V rated wire with 460V systems.
- ❑ To prevent coupling high frequency noise, the following wires must be spatially separated from each other a minimum distance of 8 inches (20 cm)when they are laid parallel to each other :
  - AC supply power and motor lines not connected to inverters
  - motor lines connected to inverters
  - control and data lines (low-voltage level < 48 V)
- ❑ When using KEBCO EMI filters, use only the wire provided with the filter to connect the filter to the inverter. Do not add additional wire between the filter and the inverter as this will have a negative effect on the operation of the filter.

1.4.9 Ground Connections

- ❑ When working with high frequencies (> 1kHz) and power semiconductors it is recommended to make all ground connections with large exposed metal surfaces in order to minimize the ground resistance.
- ❑ The metal sub-plate the inverter is mounted on is regarded as the central ground point for the machine or the equipment. For best results use an unpainted, galvanized or plated sub-panel.
- ❑ An additional high frequency ground wire should be connected between the inverter and the sub-panel. Use a wire (10 gauge) or a thick ground strap. This is in addition to the ground wire required by NEC.
- ❑ All ground connections should be kept as short as possible and as close as possible to the ground system, sub-panels.
- ❑ If other components in the system exhibit problems due to high frequency disturbances, connect an additional high frequency ground wire between them and the sub-panel.
- ❑ The KEBCO EMI filter should be mounted to the inverter or as close as possible to the inverter and on the same sub-panel as the inverter. Good metallic surface contact to the sub-panel is required to provide adequate high frequency grounding of the filter.

1.4.10 High Frequency Shielding

❑ Use of shielded cable is recommended when high frequency emissions or easily disturbed signals are present. Examples are as follows:

- motor wires connected to inverters: connect shield to ground at both the inverter and motor, NOTE the shield should never be used as the protective ground conductor required by NEC. Always use a separate conductor for this.

- digital control wires: connect shield to ground at both ends.

- analog control wires: connect shield to ground only at the inverter.

❑ The connection of meshed shields to the ground connection should not be done through a single strand of the shield, but with metallic clamps to provide 360° contact around the surface of the shield to the ground point. Connection with a single wire bundle from the braided shield reduces the effectiveness of the shield 70%. Metal conduit clamps work well for this. Be sure the fit is tight.

❑ Ridged metal conduit can be used as the shield of the motor wires. Always observe the following points :

- remove all paint from the control cabinet and motor housing where the conduit is fastened

- securely fasten all conduit fittings

- run only the motor wires through the conduit, all other wires, high voltage AC and low voltage signal, should be pulled through a separate conduit.

- connect the control panel to the Sub-panel with a heavy ground strap.

❑ If KEBCO CE filters are used, they should be mounted to the inverter or as close as possible to the inverter and on the same sub-panel as the inverter. Good metallic surface contact to the sub-panel is required to provide adequate high frequency grounding of the filter. Always use the shielding plate provided with the filter when connecting the filter to the inverter.

❑ Shielding of control wires:

If digital signal wires are terminated on a terminal block in the control panel, the shields should be firmly connected to the sub-panel on both sides of the terminal block.

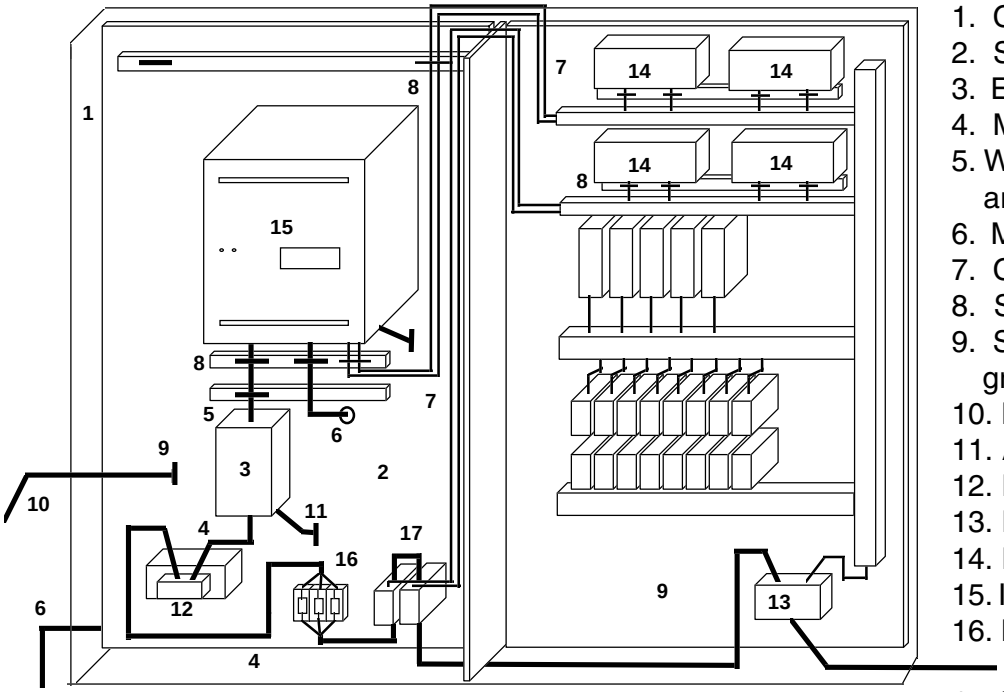
The shields of digital signal wires originating outside the control cabinet which are not terminated on a terminal block, must be connected to the sub-panel at the point where the cable enters the control panel and at the inverter.

If the shield is terminated to the sub-panel with in 8 inches (20cm) of the inverter, then the shield no longer needs to be connected to the inverter.

When using un-shielded signal wires, they should always be installed as a twisted pair (signal and common).

Low voltage signal wires should cross high voltage wires at right angles.

1.4.11 Example Control Cabinet Layout



1. Cabinet
2. Sub-panel
3. EMI filter
4. Main voltage supply
5. Wires between EMI filter and voltage supply
6. Motor wires
7. Control wires
8. Shield with clamps
9. Sub-panel is central ground point
10. Main ground connection
11. Additional HF ground wire
12. Line choke
13. Low voltage power supply
14. PLCs or PCs
15. Inverter
16. Main supply fuse
17. Main supply contactor

1.4.12 DC supply connections

When connecting the F4 series inverter from a DC supply or when connecting several F4 series inverters to a common DC bus the follow points should be observed.

- ❑ Each inverter must be fused on both the + and - conductors. BUSSMANN DC fuse type FWP are recommended. The DC input current of the inverter can be calculated using the equations below.
- ❑ Connect the positive wire to the ++ terminal and the negative wire to the -- terminal. Terminals marked PA, PB, or - are not suited for DC voltage input. See page 26 for wiring example. All previously stated wiring conditions are still valid.
- ❑ The peak DC supply current can be calculated with the following formulas:

230V Supply

$$\frac{2.6 \times \text{rated motor voltage} \times \text{rated motor current} \times \text{motor PF}}{310V}$$

460V Supply

$$\frac{2.6 \times \text{rated motor voltage} \times \text{rated motor current} \times \text{motor PF}}{620V}$$

If the motor power factor (PF) is not known, use the value 0.78 as a default.

For additional information about DC supply of the inverter contact KEBCO Inc.

2. Technical Data

2.1 Summary of technical data 230V class

Inverter Size	O7	O9	10	12	13	
Recommended Motor Power [HP]	**1**	**2**	**3**	**5**	**7.5**	
Output Ratings						
Rated motor power [kW]	0.75	1.5	2.2	4.0	5.5	
Rated power [kVA]	1.6	2.8	4.0	6.6	8.3	
Rated output current [A]	3.6	6.8	9.6	15.2	22	
Peak current (30 seconds) [A]	7.2	12.6	18	36.0	36	
Overcurrent fault (E.OC) level) [A]	8.8	15	22	43	43	
Output voltage [V]	3 phase 0 to V supply					
Output frequency [Hz]	0 to 1600Hz max.					
Maximum carrier frequency [kHz][1)]	16	8	16	8	4	16
Maximum braking current [A] [2)]	7	7	14	21	21	29
Typ. braking resistor impedance [Ohm] [2)]	100	100	68	56	56	22
Min. braking resistor impedance [Ohm] [2)]	56	56	28	39	39	16
Input Ratings						
Supply voltage [VAC]	180...260 +/-0 (rated at 230V)					
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 250...360 VDC)					
Supply voltage phases	1 ǀ 3	1 ǀ 3	1 ǀ 3	1	3	
Rated input current [A]	7.0 ǀ 3.9	12 ǀ 6.6	18 ǀ 9.9	29	24	
Max. allowable input fuse [A]	15 ǀ 10	20 ǀ 10	25 ǀ 20	40	35	
Recommended wire gauge [awg] [3)]	14 ǀ 16	12 ǀ 16	10 ǀ 12	8	8	
Tightening torque for power terminals[in lb]	4					11
Wiring diagram (see P.24/25)	**1 or 2**					**4**
Environmental						
Housing size code	**D**	**D**	**D**	**E**	**E**	**G**
Power dissipation [W][4)]	65	70	135	165	165	220
Storage temperature [°C/°F]	-25...70 °C / -13...158°F					
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F					
Relative humidity	max. 95% without condensation					
Approvals						
Housing design	Chassis / IP20					
Tested in accordance with...	EN 61800-3 / UL508C					
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6					
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A					

1) This is the maximum carrier frequency the power stage can support. The actual operating carrier frequency is adjusted and limited by the control card. F4F control cards require a power stage which can support at least 8kHz.

2) This data pertains only to units with the braking circuit installed. All inverters in the D,E,G,H housing are supplied with the braking circuit as standard. It is optional in the R and U housings and not available in the P housing.

3) The wire gauge is based on the maximum fuse rating, copper wire with a 75°C insulation rating, THHW or equivalent. If circuit protection is selected based on the rated input current, the wire size could be reduced.

4) This is the power dissipation at the maximum carrier frequency, rated voltage and rated load. Operation at reduced carrier frequencies or reduced load will decrease this value.

Inverter Size	**14**	**15**	**16**	**17**	**18**	**19**
Recommended Motor Power [HP]	**10**	**15**	**20**	**25**	**30**	**40**
Output Ratings						
Recommended motor rating [kW]	7.5	11	15	18.5	22	30
Output nominal power [kVA]	11	17	23	29	35	42
Rated output current [A]	28	42	54	68	80	104
Peak current (30 seconds) [A]	49.5	72	99	126	150	172
Overcurrent fault (E.OC) level) [A]	59	88	119	135	162	207
Output voltage [V]	3 phase 0 to V supply					
Output frequency [Hz]	0 to 1600Hz max.					
Maximum carrier frequency [kHz][1)]	16	16	16	16	16	16
Maximum braking current [A] [2)]	29	70	70	88	88	88
Typ. braking resistor impedance [Ohm] [2)]	16	13	9	13	11	9
Min. braking resistor impedance [Ohm] [2)]	13	5.6	5.6	9	9	9
Input Ratings						
Supply voltage [VAC]	180...260 +/-0 (rated at 230V)					
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 250...360 VDC)					
Supply voltage phases		3				
Rated input current [A]	31	46	60	83	100	127
Max. allowable input fuse [A]	50	80	80	100	160	160
Recommended wire gauge [awg] [3)]	8	4	4	3	2/O	2/O
Tightening torque for power terminals[in lb]	11	22				
Wiring diagram (see P.24/25)	**4**			**3**		
Environmental						
Housing size code	**G**	**H**	**H**	**R**	**R**	**R**
Power dissipation [W][4)]	280	430	550	900	1100	1200
Storage temperature [°C/°F]	-25...70 °C / -13...158°F					
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F					
Relative humidity	max. 95% without condensation					
Approvals						
Housing design	Chassis / IP20					
Tested in accordance with...	EN 61800-3 / UL508C					
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6					
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A					

The recommended motor rating is for 2/4 pole standard motors. When using motors with different numbers of poles, the inverter must be dimensioned based on the motor rated current. Contact KEBCO for special or medium frequency motors.

The power rating of the inverter must be derated for operation above 3,300 ft (1000 m). Reduce the rated power 1% for each additional 330 ft (100 m). The maximum elevation for operation is 6,560 ft (2000 m)

2.2 Summary of Technical Data 460V Class (Size O7 to 15)

Inverter Size	O7	O9	10		12	
Recommended Motor Power [HP]	**1**	**2**	**3**		**5**	
Output Ratings						
Rated motor power [kW]	0.75	1.5	2.2		4.0	
Rated power [kVA]	1.6	2.8	4.0		6.6	
Rated output current @ 460V [A]	1.8	3.4	4.8		7.6	
Rated output current @ 400V [A]	2.6	4.1	5.8		9.5	
Peak current (30 seconds) [A]	4.6	7.4	10.4		17.1	
Overcurrent fault (E.OC) level [A]	5.7	9.0	12.7		20.9	
Output voltage [V]	3 phase 0 to V supply					
Output frequency [Hz]	0 to 1600Hz max.					
Maximum carrier frequency [kHz][1)]	4	4	4	12	4	16
Maximum braking current [A] [2)]	5	5	5	5	10	15
Typ. braking resistor impedance [Ohm] [2)]	390	390	270	270	150	150
Min. braking resistor impedance [Ohm] [2)]	160	160	160	160	82	50
Input Ratings						
Supply voltage [VAC]	305...500 +/-0V					
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)					
Supply voltage phases	3					
Rated input current @ 460V [A]	1.9	3.8	5.3		8.4	
Rated input current @ 400V [A]	2.6	4.5	6.4		10.5	
Max. allowable input fuse [A]	10	10	10		20	
Recommended wire gauge [awg] [3)]	14	14	14		12	
Tightening torque for power terminals[in lb]	4					
Wiring diagram (see P.24/25)	**2**					**3**
Environmental						
Housing size code	**D**	**D**	**D**	**D**	**D**	**E**
Power dissipation [W][4)]	45	60	80	130	1150	180
Storage temperature [°C/°F]	-25...70 °C / -13...158°F					
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F					
Relative humidity	max. 95% without condensation					
Approvals						
Housing design	Chassis / IP20					
Tested in accordance with...	EN 61800-3 / UL508C					
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6					
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A					

1) This is the maximum carrier frequency the power stage can support. The actual operating carrier frequency is adjusted and limited by the control card. F4F control cards require a power stage which can support at least 8kHz.

2) This data pertains only to units with the braking circuit installed. All inverters in the D,E,G,H housing are supplied with the braking circuit as standard. It is optional in the R and U housings and not available in the P housing.

3) The wire gauge is based on the maximum fuse rating, copper wire with a 75°C insulation rating, THHW or equivalent. If circuit protection is selected based on the rated input current, the wire size could be reduced.

4) This is the power dissipation at the maximum carrier frequency, rated voltage and rated load. Operation at reduced carrier frequencies or reduced load will decrease this value.

Inverter Size	13			14		15		
Recommended motor Power [HP]	**7.5**			**10**		**15**		
Output Ratings								
Recommended motor rating [kW]	5.5			7.5		11		
Output nominal power [kVA]	8.3			11		17		
Rated output current @ 460V [A]	11			14		21		
Rated output current @ 400V [A]	12			16.5		24		
Peak current (30 seconds) [A]	21.6		18	29.7	24.8	36		
Overcurrent fault (E.OC) level [A]	26.4		21.6	36.3	29.7	43.2		
Output voltage [V]	3 phase 0 to V supply							
Output frequency [Hz]	0 to 1600Hz max.							
Maximum carrier frequency [kHz][1)]	2	16	16	8	16	4	8	16
Maximum braking current [A] [2)]	10	15	21	15	21	21	21	37
Typ. braking resistor impedance [Ohm] [2)]	100	100	100	82	82	56	56	56
Min. braking resistor impedance [Ohm] [2)]	82	50	39	50	39	39	39	22
Input Ratings								
Supply voltage [VAC]	305...500 +/-0V							
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)							
Supply voltage phases	3							
Rated input current @ 460V [A]	12.1			15.4		23.1		
Rated input current @ 400V [A]	13.2			18.1		26.5		
Max. allowable input fuse [A]	20			25		35		
Recommended wire gauge [awg] [3)]	12			10		8		
Tightening torque for power terminals[in lb]	4				11	4	11	22
Wiring diagram (see P.24/25)	**2**		**4**	**2**	**4**	**2**	**4**	
Environmental								
Housing size code	**D**	**E**	**G**	**E**	**G**	**E**	**G**	**H**
Power dissipation [W][4)]	135	240	200	240	260	260	290	360
Storage temperature [°C/°F]	-25...70 °C / -13...158°F							
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F							
Relative humidity	max. 95% without condensation							
Approvals								
Housing design	Chassis / IP20							
Tested in accordance with...	EN 61800-3 / UL508C							
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6							
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A							

The recommended motor rating is for 2/4 pole standard motors. When using motors with different numbers of poles, the inverter must be dimensioned based on the motor rated current. Contact KEBCO for special or medium frequency motors.

The power rating of the inverter must be derated for operation above 3,300 ft (1000 m). Reduce the rated power 1% for each additional 330 ft (100 m). The maximum elevation for operation is 6,560 ft (2000 m)

2.3 Summary of technical data 460V class (size 16 to 22)

Inverter Size	16		17			18	
Recommended motor Power [HP]	**20**		**25**			**30**	
Output Ratings							
Recommended motor rating [kW]	15		18.5			22	
Output nominal power [kVA]	23		29			35	
Rated output current @ 460V [A]	27		34			40	
Rated output current @ 400V [A]	33		42			50	
Peak current (30 seconds) [A]	49.5		63			75	
Overcurrent fault (E.OC) level [A]	59.4		75.6			90	
Output voltage [V]	3 phase 0 to V supply						
Output frequency [Hz]	0 to 1600Hz max.						
Maximum carrier frequency [kHz] [1]	8	16	4	8	16	8	16
Maximum braking current [A] [2]	30	37	30	37	88	63	88
Typ. braking resistor impedance [Ohm] [2]	39		28			22	
Min. braking resistor impedance [Ohm] [2]	25	22	25	22	9	13	9
Input Ratings							
Supply voltage [VAC]	305...500 +/-0V						
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)						
Supply voltage phases	3						
Rated input current @ 460V [A]	29.7		37.4			44	
Rated input current @ 400V [A]	36.5		46			55	
Max. allowable input fuse [A]	50		63			80	
Recommended wire gauge [awg] [3]	8		6			4	
Tightening torque for power terminals[in lb]	11	22	11	22		22	
Wiring diagram (see P.24/25)	**4**				**3**	**4**	**3**
Environmental							
Housing size code	**G**	**H**	**G**	**H**	**R**	**H**	**R**
Power dissipation [W] [4]	310	490	360	470	700	610	850
Storage temperature [°C/°F]	-25...70 °C / -13...158°F						
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F						
Relative humidity	max. 95% without condensation						
Approvals							
Housing design	Chassis / IP20						
Tested in accordance with...	EN 61800-3 / UL508C						
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6						
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A						

1) This is the maximum carrier frequency the power stage can support. The actual operating carrier frequency is adjusted and limited by the control card. F4F control cards require a power stage which can support at least 8kHz.

2) This data pertains only to units with the braking circuit installed. All inverters in the D,E,G,H housing are supplied with the braking circuit as standard. It is optional in the R and U housings and not available in the P housing.

3) The wire gauge is based on the maximum fuse rating, copper wire with a 75°C insulation rating, THHW or equivalent. If circuit protection is selected based on the rated input current, the wire size could be reduced.

4) This is the power dissipation at the maximum carrier frequency, rated voltage and rated load. Operation at reduced carrier frequencies or reduced load will decrease this value.

Inverter Size	19		20		21		22	
Recommended motor Power [HP]	**40**		**50**		**50**		**75**	
Output Ratings								
Recommended motor rating [kW]	30		37		45		55	
Output nominal power [kVA]	42		52		62		80	
Rated output current @ 460V [A]	52		65		77		96	
Rated output current @ 400V [A]	60		70		90		115	
Peak current (30 seconds) [A]	90		112		135		173	
Overcurrent fault (E.OC) level [A]	108		135		162		207	
Output voltage [V]	3 phase 0 to V supply							
Output frequency [Hz]	0 to 1600Hz max.							
Maximum carrier frequency [kHz][1)]	4	8	8	16	8	16	4	16
Maximum braking current [A] [2)]	63	88	88	160	88	160	88	160
Typ. braking resistor impedance [Ohm] [2)]	16		13		11		9	
Min. braking resistor impedance [Ohm] [2)]	13	9	9	6	9	6	9	6
Input Ratings								
Supply voltage [VAC]	305...500 +/-0V							
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)							
Supply voltage phases	3							
Rated input current @ 460V [A]	57		72		85		106	
Rated input current @ 400V [A]	66		83		100		127	
Max. allowable input fuse [A]	80		100		160		160	
Recommended wire gauge [awg] [3)]	4		3		2/O		2/O	
Tightening torque for power terminals[in lb]	22							
Wiring diagram (see P.24/25)	**4**		**3**					
Environmental								
Housing size code	**H**	**R**	**R**	**U**	**R**	**U**	**R**	**U**
Power dissipation [W][4)]	540	750	900	1350	1100	1650	1200	2400
Storage temperature [°C/°F]	-25...70 °C / -13...158°F							
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F							
Relative humidity	max. 95% without condensation							
Approvals								
Housing design	Chassis / IP20							
Tested in accordance with...	EN 61800-3 / UL508C							
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6							
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A							

The recommended motor rating is for 2/4 pole standard motors. When using motors with different numbers of poles, the inverter must be dimensioned based on the motor rated current. Contact KEBCO for special or medium frequency motors.

The power rating of the inverter must be derated for operation above 3,300 ft (1000 m). Reduce the rated power 1% for each additional 330 ft (100 m). The maximum elevation for operation is 6,560 ft (2000 m)

2.4 Summary of technical data 460V class (size 23 to 30)

Inverter Size	23		24		25	26
Recommended motor Power [HP]	**100**		**125**		**150**	**175**
Output Ratings						
Recommended motor rating [kW]	75		90		110	132
Output nominal power [kVA]	104		125		145	173
Rated output current @ 460V [A]	124		156		180	210
Rated output current @ 400V [A]	150		180		210	250
Peak current (30 seconds) [A]	225		225		263	313
Overcurrent fault (E.OC) level [A]	270		270		315	375
Output voltage [V]	3 phase 0 to V supply					
Output frequency [Hz]	0 to 1600Hz max.					
Maximum carrier frequency [kHz][1)]	2	8	4	8	4	4
Maximum braking current [A] [2)]	133	160	200	200	200	200
Typ. braking resistor impedance [Ohm] [2)]	6		6		4	4
Min. braking resistor impedance [Ohm] [2)]	6		4		4	4
Input Ratings						
Supply voltage [VAC]	305...500 +/-0V					
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)					
Supply voltage phases	3					
Rated input current @ 460V [A]	136		172		198	231
Rated input current @ 400V [A]	165		198		231	275
Max. allowable input fuse [A]	200		315		315	400
Recommended wire gauge [awg/kcmil] [3)]	3/O		400		400	600
Tightening torque for power terminals[in lb]	22					
Wiring diagram (see P.24/25)	**3**					
Environmental						
Housing size code	**R**	**U**	**U**	**U**	**U**	**U**
Power dissipation [W][4)]	1300	1900	2000	2400	2300	2800
Storage temperature [°C/°F]	-25...70 °C / -13...158°F					
Operating temperature chassis [°C/°F]	-10...45 °C / 14...113°F					
Relative humidity	max. 95% without condensation					
Approvals						
Housing design	Chassis / IP20					
Tested in accordance with...	EN 61800-3 / UL508C					
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6					
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A					

1) This is the maximum carrier frequency the power stage can support. The actual operating carrier frequency is adjusted and limited by the control card. F4F control cards require a power stage which can support at least 8kHz.

2) This data pertains only to units with the braking circuit installed. All inverters in the D,E,G,H housing are supplied with the braking circuit as standard. It is optional in the R and U housings and not available in the P housing.

3) The wire gauge is based on the maximum fuse rating, copper wire with a 75°C insulation rating, THHW or equivalent. If circuit protection is selected based on the rated input current, the wire size could be reduced.

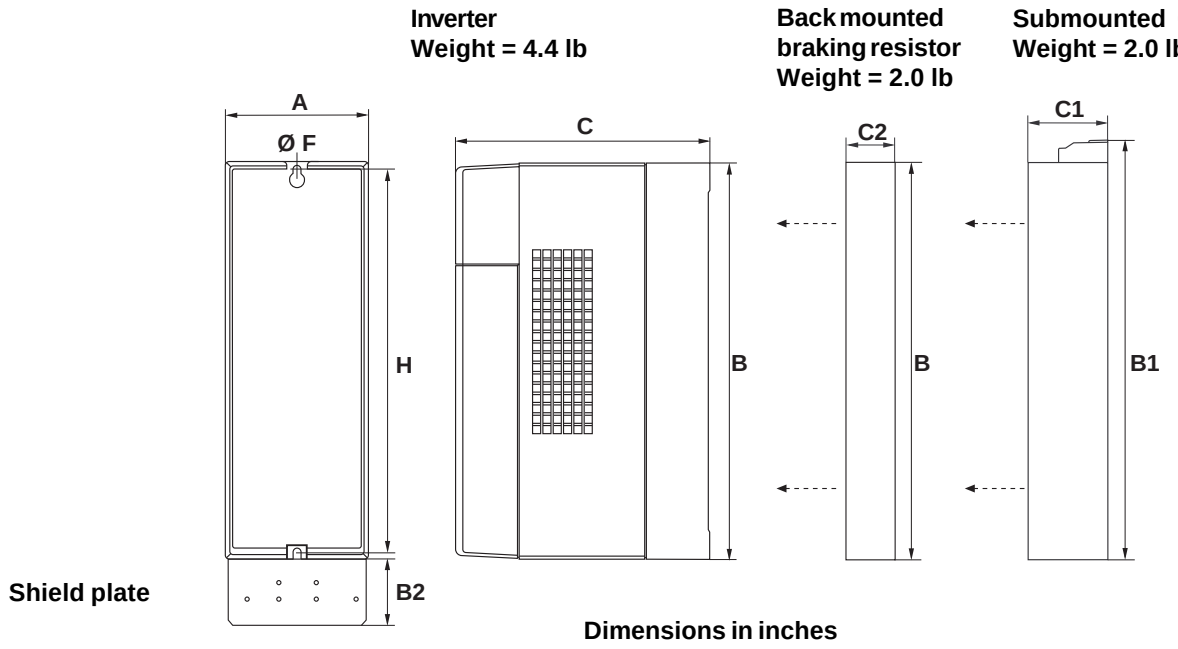
4) This is the power dissipation at the maximum carrier frequency, rated voltage and rated load. Operation at reduced carrier frequencies or reduced load will decrease this value.

Inverter Size	27	28	29	30
Recommended motor Power [HP]	**200**	**250**	**300**	**400**
Output Ratings				
Recommended motor rating [kW]	160	200	250	315
Output nominal power [kVA]	208	256	319	402
Rated output current @ 460V [A]	240	302	361	477
Rated output current @ 400V [A]	300	370	460	580
Peak current (30 seconds) [A]	375	463	575	725
Overcurrent fault (E.OC) level [A]	450	555	690	870
Output voltage [V]	3 phase 0 to V supply			
Output frequency [Hz]	0 to 200Hz max.			
Maximum carrier frequency [kHz][1)]	2	2	1	1
Maximum braking current [A] [2)]	200	N/A	N/A	N/A
Typ. braking resistor impedance [Ohm] [2)]	4	N/A	N/A	N/A
Min. braking resistor impedance [Ohm] [2)]	4	N/A	N/A	N/A
Input Ratings				
Supply voltage [VAC]	305...500 +/-0V			
Supply voltage frequency [Hz]	50 / 60 +/- 2 (option 430...707 VDC)			
Supply voltage phases	3			
Rated input current @ 460V [A]	264	332	401	530
Rated input current @ 400V [A]	330	410	510	645
Max. allowable input fuse [A]	450	550	700	900
Recommended wire gauge [kcmil] [3)]	700	1250	2 x 600	2 x 700
Tightening torque for power terminals[in lb]	22			
Wiring diagram (see P.24/25)	**3**	**5**		
Environmental				
Housing size code	**U**	**P**	**P**	**P**
Power dissipation [W][4)]	3100	3500	4200	6500
Storage temperature [°C]	-25...70 °C			
Operating temperature chassis [°C]	-10...45 °C	..40°C	..35°C	..35°C
Relative humidity	max. 95% without condensation			
Approvals				
Housing design	Chassis / IP20			
Tested in accordance with...	EN 61800-3 / UL508C			
Standards for noise immunity	IEC 1000-4-2 / -3 / -4 / -5 / -6			
Standards for emitted interference	EN 55011 Class B / EN 55022 Class A			

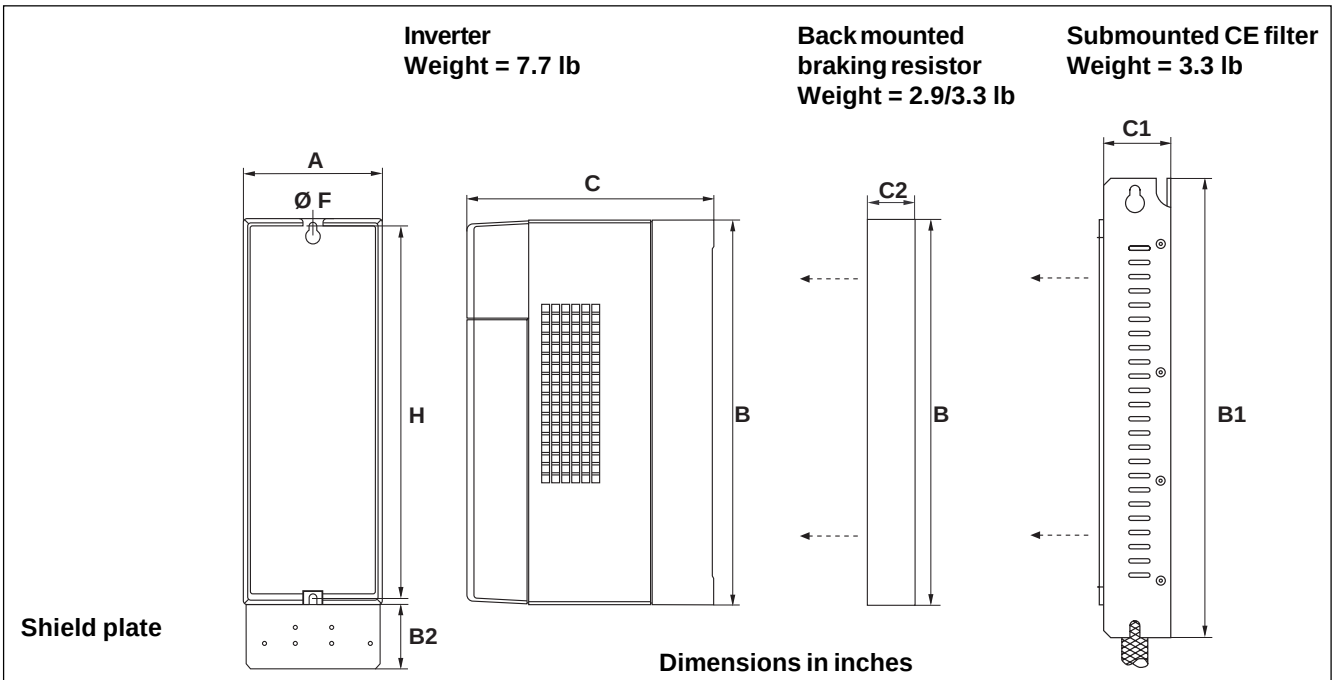
The recommended motor rating is for 2/4 pole standard motors. When using motors with different numbers of poles, the inverter must be dimensioned based on the motor rated current. Contact KEBCO for special or medium frequency motors.

The power rating of the inverter must be derated for operation above 3,300 ft (1000 m). Reduce the rated power 1% for each additional 330 ft (100 m). The maximum elevation for operation is 6,560 ft (2000 m)

2.5 Dimensions and weight



Housing	A	B	B1	B2	C	C1	C2	F	H
D	3.5	9.8	10.4	1.5	6.3	2.0	1.2	0.20	9.4

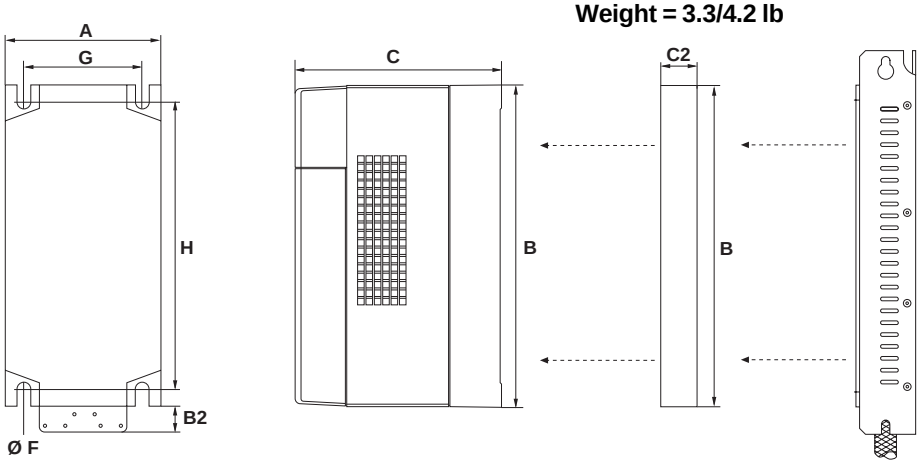


Housing	A	B	B1	B2	C	C1	C2	F	H
E	5.1	11.4	13.9	1.5	7.9	2.0	1.2	0.28	10.8

Inverter

Back mounted braking resistor Weight = 3.3/4.2 lb

Submounted CE filter



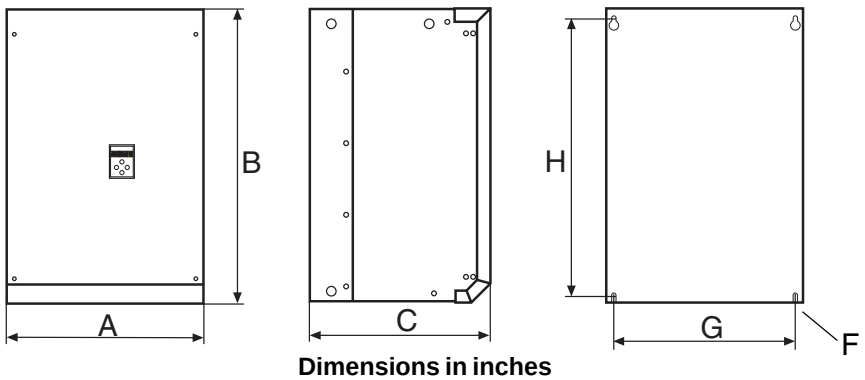
Shield plate

Dimensions in inches

Housing	A	B	B2	C	C2	F	G	H	Weight [lb]
G	6.7	13.4	1.3	10.0	1.2	0.28	5.9	13.0	22
H	11.7	13.4	2.0	10.0	-	0.28	9.8	13.0	31
R *	13.5	20.5	2.7	14.2	-	0.43	11.8	19.5	55-64
U	13.5	31.5	-	14.0	-	0.43	11.8	30.5	-

Dimensions and weights of the CE-filters: see pages 38-39

*) For the R-Housing CE filters can be installed into the housing resulting in no change to the overall dimension of the unit. (Weight = 15.5 lb)



Dimensions in inches

Housing	A	B	C	F	G	H	Weight [lb]
P	20.1	32.4	16.1	0.32	18.2	30.8	243

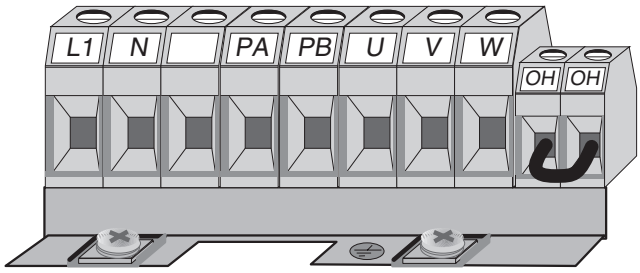
Dimensions and weights of the CE - side mounted filter: see page 39

2.6 Summary of the power circuit terminals

Housing size D

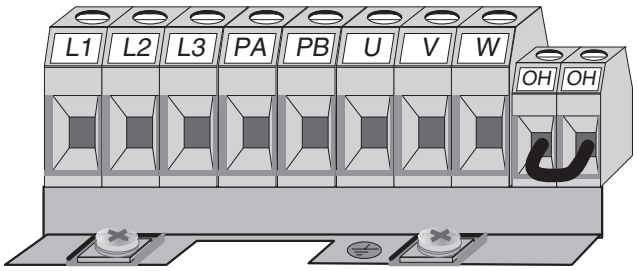
Note always verify input voltage with name plate for proper connection 230V or 460V

1 phase



L1, N	1 phase supply connection
L1, L2, L3	3 phase supply connection
PA, PB	Connection for braking resistor

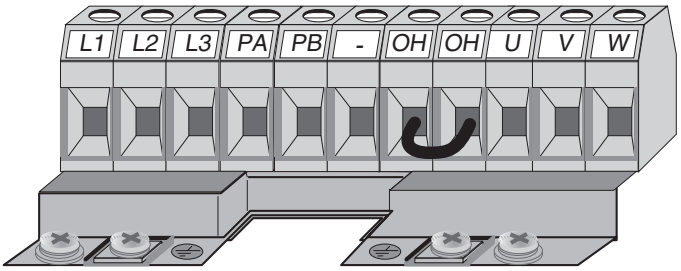
3 phase



U, V, W	Motor connection
OH, OH	Connection for temperature sensor
⏚	Connection for earth ground

Housing size E

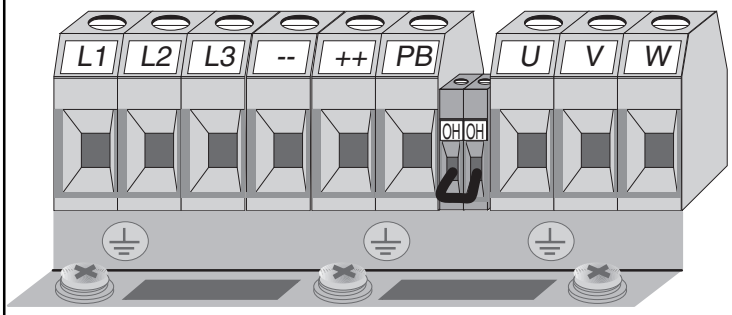
Note always verify input voltage with name plate for proper connection 230V or 460V



L1, L2, L3	3 phase supply voltage
PA, PB	Connection for braking resistor
PA, -	Connection for braking module or regen unit
OH, OH	Connection for temperature sensor
U, V, W	Motor connection
⏚	Connection for earth ground

Housing size G

Note always verify input voltage with name plate for proper connection 230V or 460V



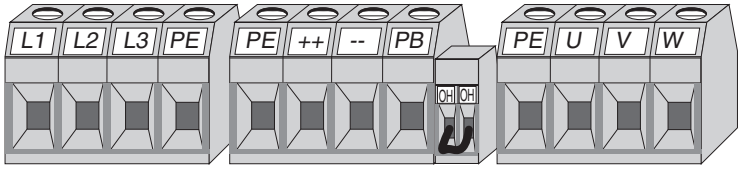
L1, L2, L3	3 phase supply voltage
++, PB	Connection for braking resistor
++, --	Connection for braking module, regen unit or DC input
OH, OH	Connection for temperature sensor
U, V, W	Motor connection
⏚	Connection for earth ground

Inverters without DC input

+PA, PB	Connection for braking resistor
+PA, -	Connection for braking module and regen unit

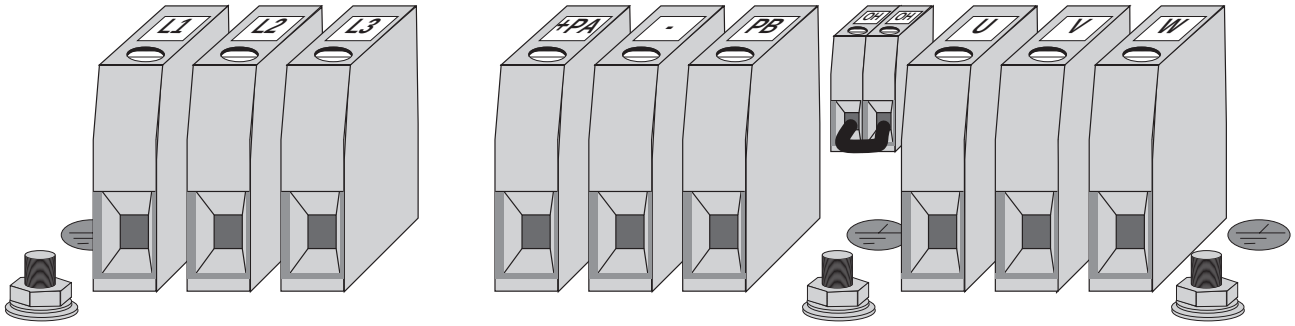
Housing size H

Note always verify input voltage with name plate for proper connection 230V or 460V



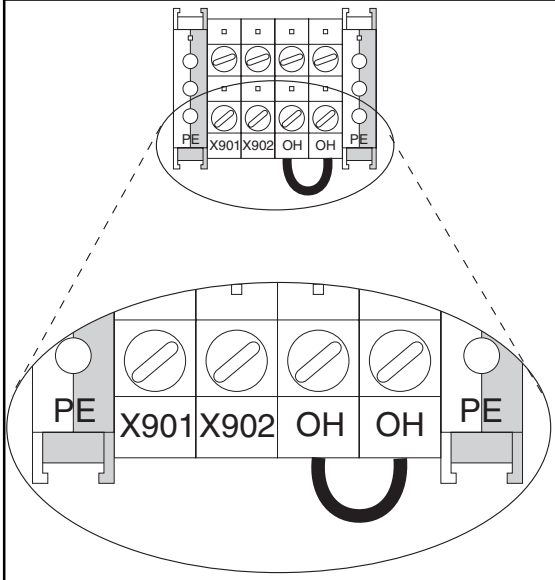
L1, L2, L3	3 phase supply voltage
++, PB	Connection for braking resistor
++, --	Connection for braking module, regen unit or DC input
OH, OH	Connection for temperature sensor
U, V, W	Motor connection
PE	Connection for earth ground

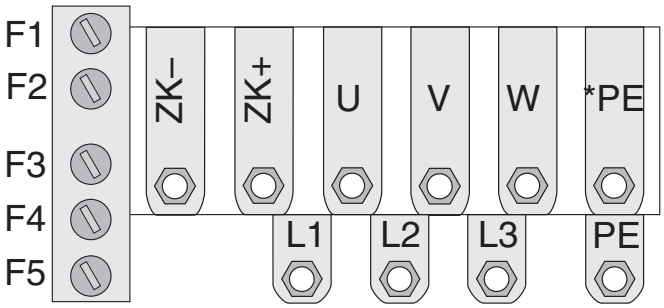
Housing size R and U ⚠ Note always verify input voltage with name plate for proper connection



L1, L2, L3	3 phase supply voltage
+PA, PB	Connection for braking resistor
+PA, -	Connection for braking module and regen unit
OH, OH	Connection for temperature sensor
U, V, W	Motor connection
⏚	Connection for earth ground

Housing size P





F1...F5	Fuses for supply lines (10A / 500V medium time-lag)
-ZK, +ZK	Connection for braking module
U, V, W	Motor connection
PE, PE	Connection for earth ground
L1, L2, L3	3 phase supply voltage
OH, OH	Connection for temperature sensor
PE	Connection for shields
X901/X902	Reserved, Attention DC bus potential!

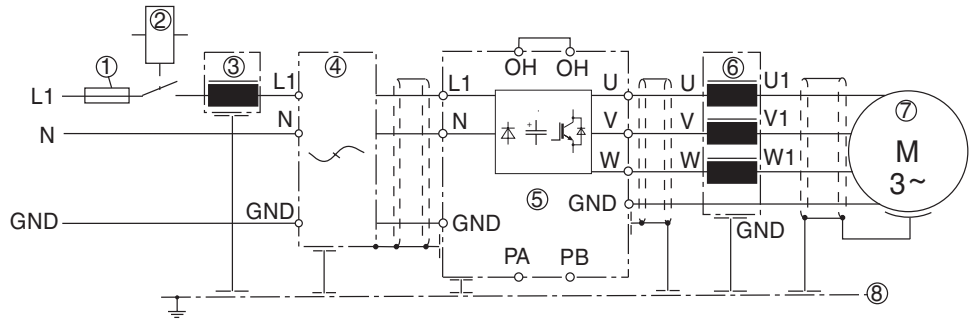
2.7 Connection of the power circuit

See technical data on pages 12-19 to match the wiring diagram to inverter size and housing type.

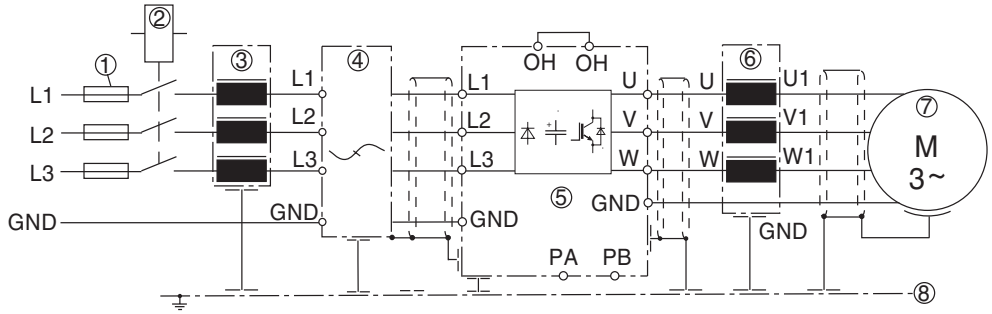
If the supply voltage is connected to the motor terminals, the unit will be destroyed!

Pay attention to the supply voltage 230/460V and the correct polarity of the motor!

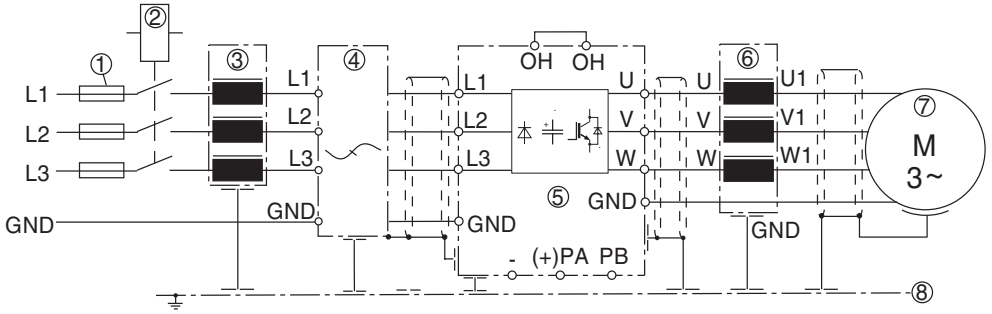
Wiring diagram 1



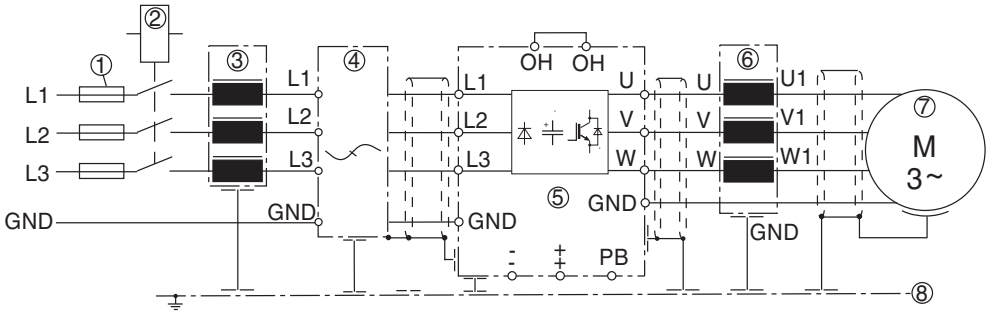
Wiring diagram 2



Wiring diagram 3

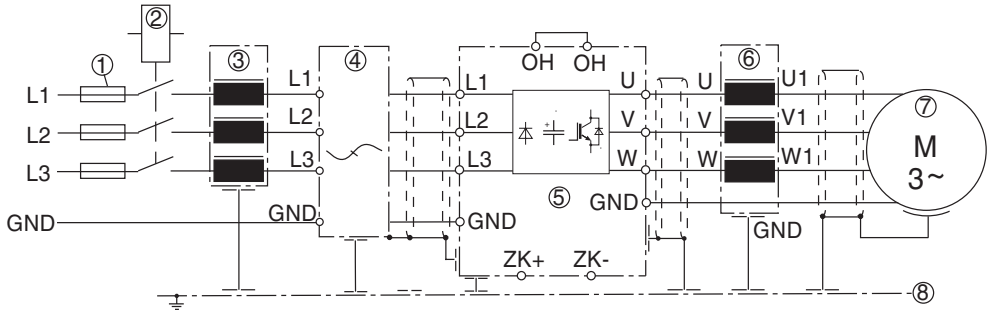


Wiring diagram 4



1. **Supply fuse**
2. **Disconnect switch or contactor**
3. **Line choke**
4. **Interference suppression filter**
5. **COMBIVERT F4**
6. **Motor choke or output filter**
7. **Motor**
8. **Sub panel in control cabinet**

Wiring diagram 5

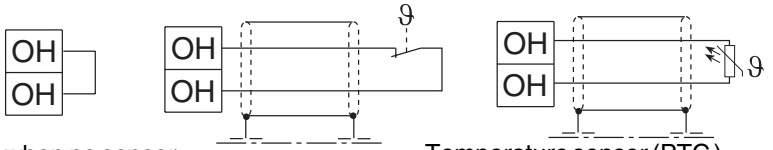


External motor temperature sensor

(for all units)

Don't install sensor wires with control wires.

Must use double shield when running these wires with motor wires



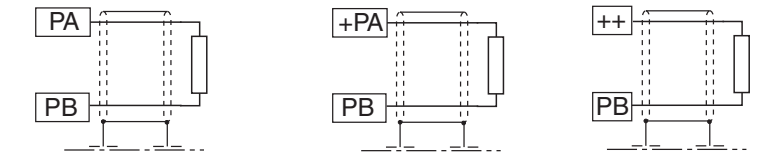
Jumper, when no sensor is connected

Thermal switch (NC-contact)

Temperature sensor (PTC)
1650Ω...4kΩ tripping resistance
750Ω...1650Ω reset resistance

Connection of braking resistor

(Braking circuit installed as standard in housing sizes D,E,G,H, optional in housings R and U.)

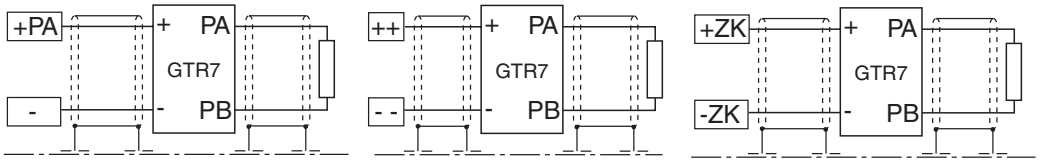


use with wiring diagram 1 and 2

use with wiring diagram 3

use with wiring diagram 4

Connection of a braking module



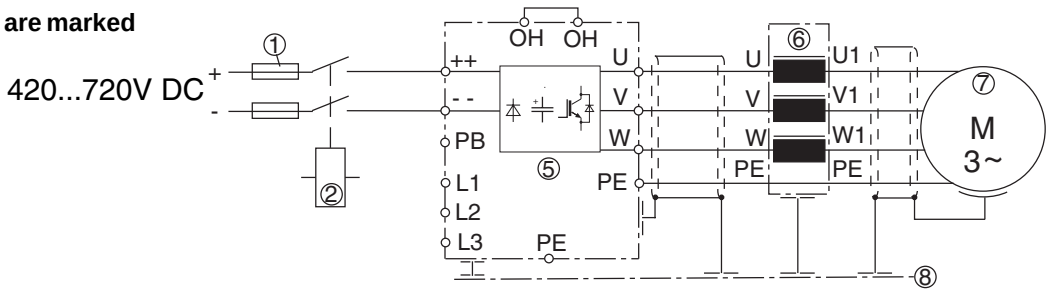
use with wiring diagram 3

use with wiring diagram 4

use with wiring diagram 5

DC supply input

(only when terminals are marked ++ and - -)



1. **Supply fuse**
2. **Disconnect switch or contactor**
3. **Line choke**
4. **Interference suppression filter**
5. **COMBIVERT F4**
6. **Motor choke or output filter**
7. **Motor**
8. **Sub panel in control cabinet**

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3. Accessories

3.1 Braking resistor

The COMBIVERT F4 inverter can be equipped with an external braking resistor or an external braking module for limited 4 quadrant operation. The energy the motor regens into the inverter during deceleration is dissipated through the braking transistor to the braking resistor.

The braking resistor heats up during braking. If it is installed inside a control cabinet, sufficient interior cooling must be provided. The resistor should be mounted above and a minimum of 9 inches away from the inverter or in a separate enclosure.

3.1.1 Selection of the braking resistor

Different braking resistors are available from KEBCO. They are selected according to their application requirements. The selection formulas and technical data of the resistors are listed on the following pages. The procedure for selecting a braking resistor is outlined below.

1. Establish desired braking time.
2. Calculate braking time without braking resistor (t_{Bmin}).
3. If the desired braking time is shorter than the calculated braking time, it will be necessary to use a braking resistor. ($t_B < t_{Bmin}$)
4. Calculate braking torque (T_B) taking the load torque (T_L) into account. T_L is a positive value for friction and windage and negative for overhauling loads.
5. Calculate peak braking power (P_B). This must always be calculated for the "worst case" (n_{max} to standstill).
6. Selection of the braking resistors:
   a) The resistor should be selected so that $P_R > P_B$.
   b) P_N is to be selected according to the duty cycle factor (d.c.f.).
   The braking resistors may only be used for the specified value. The maximum ON period of the braking resistor may not be exceeded.
   6 % d.c.f. = maximum braking time 8 s
   25 % d.c.f. = maximum braking time 30 s
   40 % d.c.f. = maximum braking time 48 s
   Longer ON periods require specially-designed braking resistors. Take into account the current through the braking transistor.
7. Check whether the desired braking time is attained with the selected braking resistor (t_{Bmin}).

Note: Consider the capacity of the braking resistor and motor. The braking torque may not exceed the rated torque of the motor by more than 1.5 times. To realize maximum possible braking torque, the frequency inverter must be sized for the increased motor current.

Braking time

The braking time is adjusted in the frequency inverter through the deceleration parameters. If the selected deceleration time is too short, either the peak inverter current level or the maximum DC bus voltage will be exceeded. The error message ***E.OC*** or ***E.OP*** will result. The following formulas can be used to determine an allowable braking time.

Formulas

1. Braking time without braking resistor

$$t_{Bmin} = \frac{(J_M + J_L) \bullet (n_1 - n_2)}{307 \bullet (K \bullet T_N + T_L)}$$

Valid range: $n_1 > n_N$

(field weakening)

2. Braking torque (required)

$$T_B = \frac{(J_M + J_L) \bullet (n_1 - n_2)}{307 \bullet t_B} - T_L$$

Conditions: $T_B - 1.5 \bullet T_N$

f - 1.4 x rated frequency of motor

3. Peak braking power

$$P_B = \frac{T_B \bullet n_1}{7.04}$$

Conditions: $P_B - P_R$

4. Braking time with braking resistor

$$t_{Bmin} = \frac{(J_M + J_L) \bullet (n_1 - n_2)}{307 \bullet \left(K \bullet T_N + T_L + \frac{P_R \bullet 7.04}{(n_1 - n_2)} \right)}$$

Valid range: $n_1 > n_N$

Conditions: $\frac{P_R \bullet 9.55}{(n_1 - n_2)} - T_N \bullet (1.5 - K)$

f - 1.4 x rated frequency of motor

$P_B - P_R$

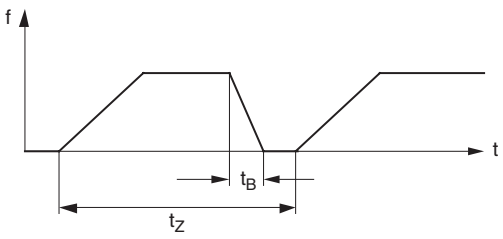
On period d.c.f.

ON period d.c.f for cycle time t_Z - 120 s

$$d.c.f = \frac{t_B}{t_Z} \bullet 100\ \%$$

ON period d.c.f for cycle time t_Z > 120 s

$$d.c.f = \frac{t_B}{120\ s} \bullet 100\ \%$$



Definitions

K =	0.25 for motors	up to 2 hp
	0.20 for motors	3 to 5 hp
	0.15 for motors	7.5 to15 hp
	0.08 for motors	20 to 60 hp
	0.05 for motors	75 to 300 hp

J_M	=	Moment of inertia of the motor	[lb ft²]	T_B	=	Braking torque (required)	[ft lbs]
J_L	=	Moment of inertia of the load	[lb ft²]	T_L	=	Load torque	[ft lbs]
n_1	=	Motor speed before deceleration	[rpm]	t_B	=	Braking time (required)	[s]
n_2	=	Motor speed after deceleration (Stand still = 0 rpm)	[rpm]	t_{Bmin}	=	Minimum braking time	[s]
				t_Z	=	Cycle time	[s]
n_N	=	Motor rated speed	[rpm]	P_B	=	Peak braking power	[W]
T_N	=	Motor rated torque	[ft lbs]	P_R	=	Peak power dissipation of the resistor	[W]

3.1.2 Panel Mount Brake Resistors

Structure of the part number

xx.56.080-xxx8

- 00 = 6 % d.c.f 01 = 25 % d.c.f 02 = 40 % d.c.f
- Voltage class: 2 = 230V 4 = 460V
- Braking resistor
- Size

Technical data braking resistor

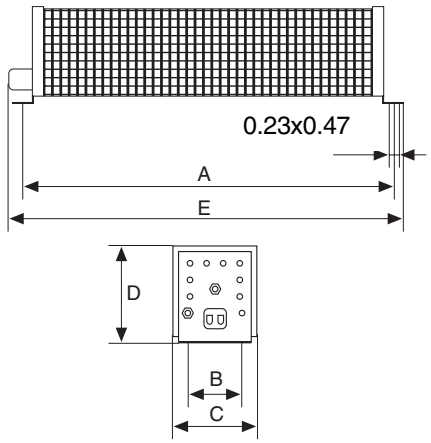
Part number	R_B [OHM]	P_R [2] [kW]	COMBIVERT	P_N Nominal power[1] [W] 6 %	25 %	40 %
07.53.080-2008	100	1,4	07/09	150		
10.56.080-2xx8	68	2,1	07/10	285	800	1000
11.56.080-2xx8	47	3,0	10/13 (E)	300	1000	1200
13.56.080-2xx8	27	5,2	13 (G)	600	1700	2700
14.56.080-2xx8	18,4		14	1000	3500	4000
15.56.080-2xx8	13,5		15	1520	4500	5500
16.56.080-2xx8	9		16	2000	5500	7000
09.56.080-4xx8	390	1,5	07/09	150	430	800
10.56.080-4xx8	270	2,1	07/09/10	285	600	1000
11.56.080-4xx8	180	3,2	07/09/10/12	300	1000	1200
12.56.080-4xx8	150	3,9	12	430	1200	1700
13.56.080-4xx8	100	5,8	12/13	600	1700	2700
14.56.080-4xx8	82	7,0	12/13/14	800	2700	3700
15.56.080-4xx8	56	10,3	12 (E)/13 (E,G)/14/15	1200	3700	5500
16.56.080-4xx8	39/40	14,8/14,4	13 (G)/14 (G)/15 (G,H)/16	1700	5000	7500
17.56.080-4xx8	27/28	21,4/20,6	15 (H)/16/17	3000	7500	11500
18.56.080-4xx8	22	26,3	15 (H)/16 (H,R)/17 (H,R)/18	4000	9000	13500
19.56.080-4xx8	16	36,1	17 (R)/18/19	5500	12000	17000
20.56.080-4xx8	13	44,4	17 (R)/18/19/20	6500	16500	20000
21.56.080-4xx8	11	52,5	18 (R)/19 (R)/20/21	8000	20500	25000
22.56.080-4xx8	8,9/9,0	64,9/64,2	21 (L)/22 (L)	9500	25000	30000
23.56.080-4xx8	6,1/6,2	94,7/93,2	22 (L)/23 (R,L,U)	14000	31000	45500

[1] The nominal power (P_N) of the resistor to be selected is dependent on the peak braking power P_B and the duty cycle factor d.c.f [%].

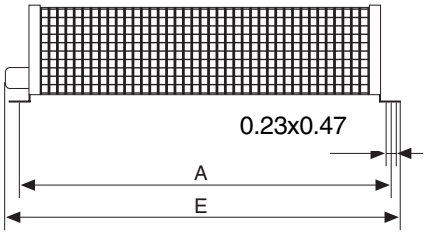
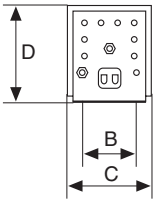
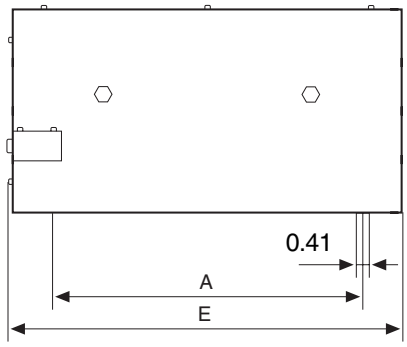
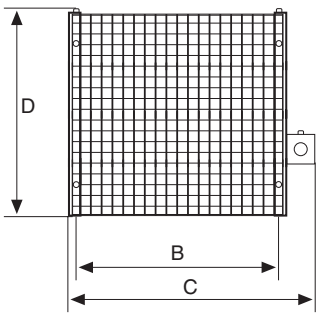
[2] Peak power dissipation of the resistor P_R.

For more information about braking moduls and resistors for COMBIVERT size 24...29 please contact KEBCO.

Dimensions 230V



Part number	RB [Ohm]	PN [W]	A	B	C	D	E
			[inches]				
07.53.080-2008	100	150	5.9	7.2	1.9	3.0	3.4
10.56.080-2008	68	285	11.2	12.7	1.9	3.0	3.4
10.56.080-2018	68	600	23.6	16.8	2.5	3.6	4.7
10.56.080-2028	68	1000	39.4	24.6	2.5	3.6	4.7
11.56.080-2008	47	300	11.8	12.8	1.9	3.0	3.4
11.56.080-2018	47	1000	39.4	24.6	2.5	3.6	4.7
11.56.080-2028	47	1200	47.2	16.8	5.9	7.3	4.7
12.56.080-2008	33	430	16.9	12.8	2.5	3.6	4.7
12.56.080-2018	33	1200	47.2	16.8	5.9	7.3	4.7
12.56.080-2028	33	1700	66.9	16.9	7.5	9.1	5.7
13.56.080-2008	27	600	23.6	16.8	2.5	3.6	4.7
13.56.080-2018	27	1700	66.9	16.9	7.5	9.1	5.7
13.56.080-2028	27	2700	106.3	24.8	7.5	9.1	5.7
14.56.080-2008	18.4	1000	39.4	11.8	5.9	7.3	4.7
15.56.080-2008	13.6	1520	59.8	11.8	5.9	7.3	4.7
16.56.080-2008	9	2000	78.7	10.6	15.0	19.3	10.2

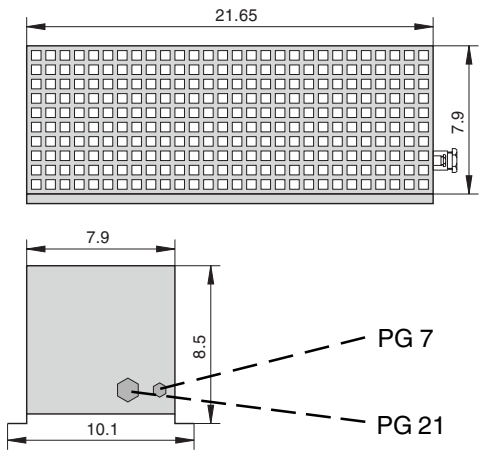
Dimensions 460V	Part number	RB [Ohm]	PN [W]	A	B	C [inches]	D	E
 	09.56.080-4008	390	150	7.2	1.9	3.0	3.4	8.9
	09.56.080-4018	390	430	12.8	2.5	3.6	4.7	14.4
	09.56.080-4028	390	800	20.7	2.5	3.6	4.7	22.3
	10.56.080-4008	270	285	12.7	1.9	3.0	3.4	14.4
	10.56.080-4018	270	600	16.8	2.5	3.6	4.7	18.3
	10.56.080-4028	270	1000	24.6	2.5	3.6	4.7	26.2
	11.56.080-4008	180	300	12.8	1.9	3.0	3.4	13.8
	11.56.080-4018	180	1000	24.6	2.5	3.6	4.7	25.6
	11.56.080-4028	180	1200	16.8	5.9	7.3	4.7	17.7
	12.56.080-4008	150	430	12.8	2.5	3.6	4.7	13.8
	12.56.080-4018	150	1200	16.8	5.9	7.3	4.7	17.7
	12.56.080-4028	150	1700	16.9	7.5	9.1	5.7	17.7
	13.56.080-4008	100	600	16.8	2.5	3.6	4.7	17.7
	13.56.080-4018	100	1700	16.9	7.5	9.1	5.7	17.7
	13.56.080-4028	100	2700	24.8	7.5	9.1	5.7	25.6
	14.56.080-4008	82	800	20.7	2.5	3.6	4.7	21.7
	14.56.080-4018	82	2700	24.8	7.5	9.1	5.7	25.6
	14.56.080-4028	82	3700	32.7	7.5	9.1	5.7	33.5
	15.56.080-4008	56	1200	16.8	5.9	7.3	4.7	17.7
	15.56.080-4018	56	3700	32.7	7.5	9.1	5.7	33.5
	15.56.080-4028	56	5500	32.7	11.8	13.4	5.7	33.5
	16.56.080-4008	39	1700	16.9	7.5	9.1	5.7	17.7
 	16.56.080-4018	39	5000	15.0	14.6	16.9	10.2	19.3
	16.56.080-4028	40	7500	15.0	22.4	24.8	10.2	19.3
	17.56.080-4008	28	3000	15.0	10.6	13.0	10.2	19.3
	17.56.080-4018	27	7500	15.0	22.4	24.8	10.2	19.3
	17.56.080-4028	28	11500	15.0	30.3	32.7	10.2	19.3
	18.56.080-4008	22	4000	15.0	14.6	16.9	10.2	19.3
	18.56.080-4018	22	9000	15.0	22.4	24.8	10.2	19.3
	18.56.080-4028	22	13500	15.0	30.3	32.7	10.2	19.3
	19.56.080-4008	16	5500	15.0	14.6	16.9	10.2	19.3
	19.56.080-4018	16	12000	15.0	30.3	32.7	10.2	19.3
	19.56.080-4028	16	17000	15.0	38.2	40.6	10.2	19.3
	20.56.080-4008	13	6500	15.0	22.4	24.8	10.2	19.3
	20.56.080-4018	13	16500	15.0	38.2	39.2	10.2	19.3
	20.56.080-4028	13	20000	15.0	38.2	39.2	10.2	19.3
	21.56.080-4008	11	8000	15.0	22.4	24.8	10.2	19.3
	21.56.080-4018	11	20500	15.0	38.2	39.2	10.2	19.3
	21.56.080-4028	11	25000	15.0	30.3	31.3	28.0	19.3
	22.56.080-4008	8.9	9500	15.0	22.4	24.8	10.2	19.3
	22.56.080-4018	9.0	25000	15.0	30.3	31.3	28.0	19.3
	22.56.080-4028	9.0	30000	15.0	30.3	31.3	28.0	19.3
	23.56.080-4008	6.1	14000	15.0	30.3	31.3	10.2	19.3
	23.56.080-4018	6.2	31000	15.0	30.3	31.3	28.0	19.3
	23.56.080-4028	6.3	45500	15.0	30.3	31.3	37.8	19.3

3.1.3 Tubular braking resistor

The tubular braking resistors have the following characteristics in comparison to the conventional wire-wound resistors:

– low audible noise generation
– better EMC-properties

They are recommended for environments which require a low noise level. (i.e. passenger elevators, theater applications)

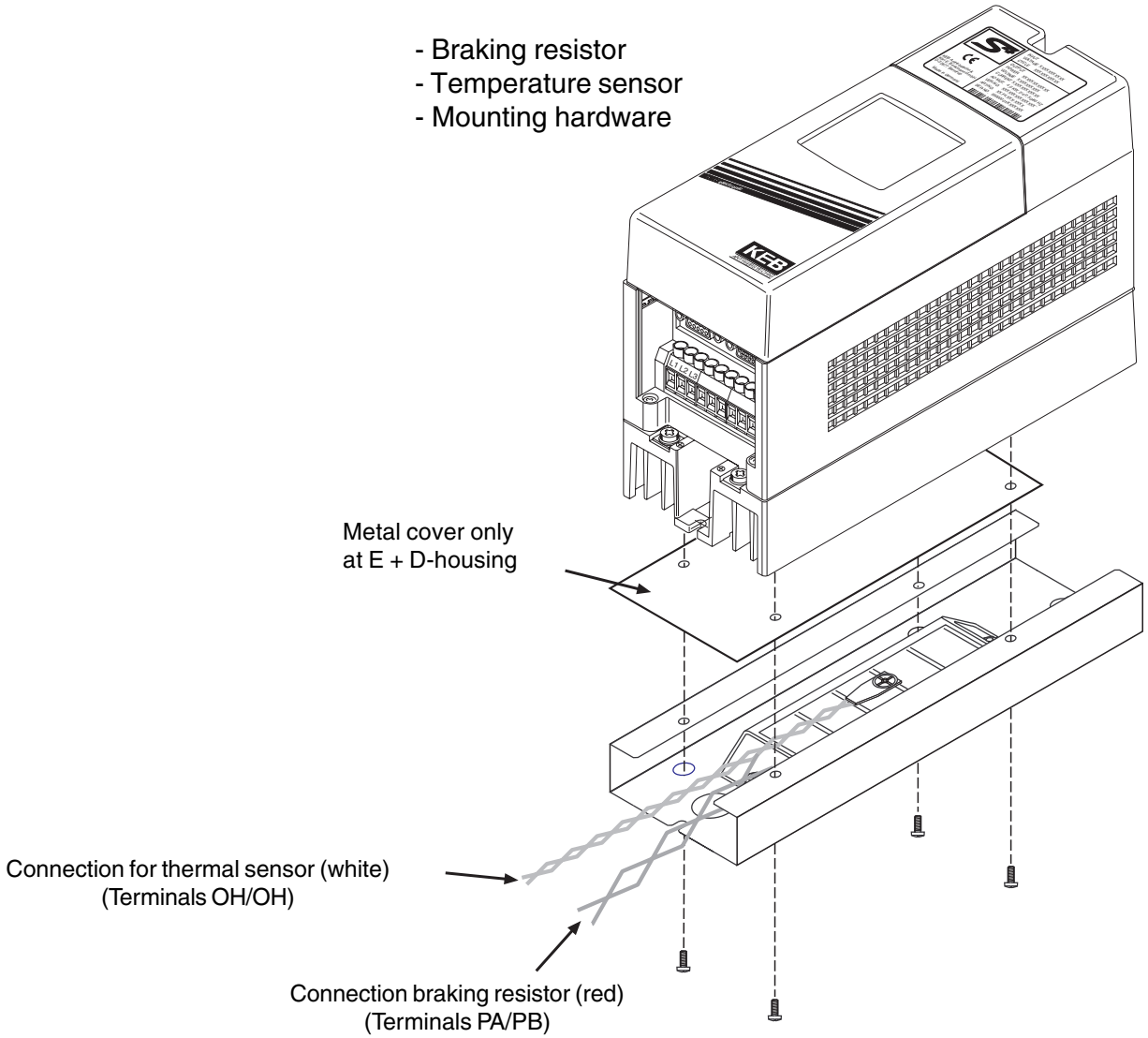
Dimensions 460V [inches]	Part number	R_B [OHM]	P_R 1) [kW]	COMBIVERT	P_N [W] 6 %
	14.56.B80-4008	80	7.2	12 (E)/13 (E,G)/14	850
	15.56.B80-4008	56	10.3	12 (E)/13 (E,G)/14 (G)/15	1200
	16.56.B80-4008	40	14.4	13 (G)/14(G)/15	1700
	17.56.B80-4008	28	20.6	15 (H)/16/17	2400
	18.56.B80-4008	22	26.3	15 (H)/16 (H,R)/17 (H,R)/18	3600
	19.56.B80-4008	16.5	35.0	17 (R)/18/19	4800
	20.56.B80-4008	13.2	43.8	17 (R)/18/19/20	6000
	21.56.B80-4008	11	42,5	17 (R)/18 (R)/19 (R)/20/21	7200

1) Peak power P_R for < 2 seconds

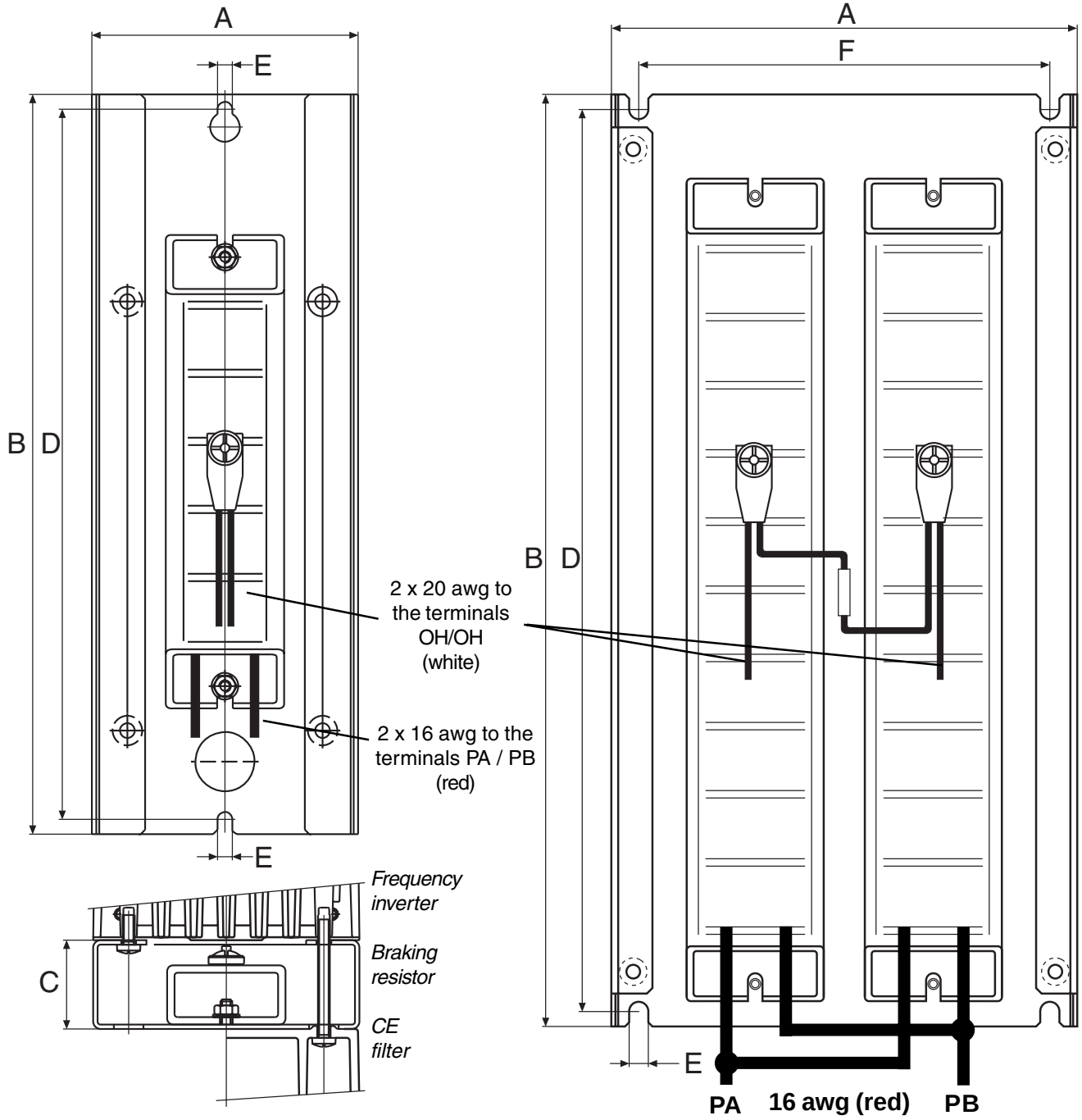
3.1.4 Back mount braking resistor

The inverter mounted braking resistor is designed with space savings in mind. The resistor is mounted directly under the heatsink of the inverter. The heat generated flows vertically out the top of the unit. It should be used only in applications where the braking time is kept to a minimum. The resistor kit consists of:

- Braking resistor
- Temperature sensor
- Mounting hardware



Use with 230V inverters size		**07,09**	**10**	**13**	**-**	**-**	**14**
Use with 460V inverters size		**07,09,10**	**12**	**12,13,14**	**15**	**13,14,15**	**16**
Housing		D	D	E	E	G	G
Braking resistor	[Ω]	160	82	60	30	50	25
Continuous power dissapation	[W]	35	35	60	2 x 60	80	2 x 80
One time peak power (max. 3s)	[W]	3600	7800	9600	19000	11500	23000
Power at 5% d.c.f.	[W]	700	700	1200	2400	1600	3200
Power at 10% d.c.f.	[W]	350	350	600	1200	800	1600
Power at 20% d.c.f.	[W]	175	175	300	600	400	800
Power at 40% d.c.f.	[W]	90	90	150	300	200	400
Weight	lb	2	2	3	3.3	3.3	4.2
Partnumber of the kit		10.F4.D50-4200	12.F4.D50-4200	14.F4.E50-4200	15.F4.E50-4200	15.F4.G50-4200	16.F4.G50-4200



Dimensions
Back mount braking resistors

Housing	D	E	G
A [in]	3.5	5.1	6.69
B [in]	9.8	11.4	13.4
C [in]	1.2	1.2	0.98
D [in]	9.5	10.8	13.0
E [in]	0.20	0.28	0.28
F [in]	-	-	5.9

3.2 Input filters

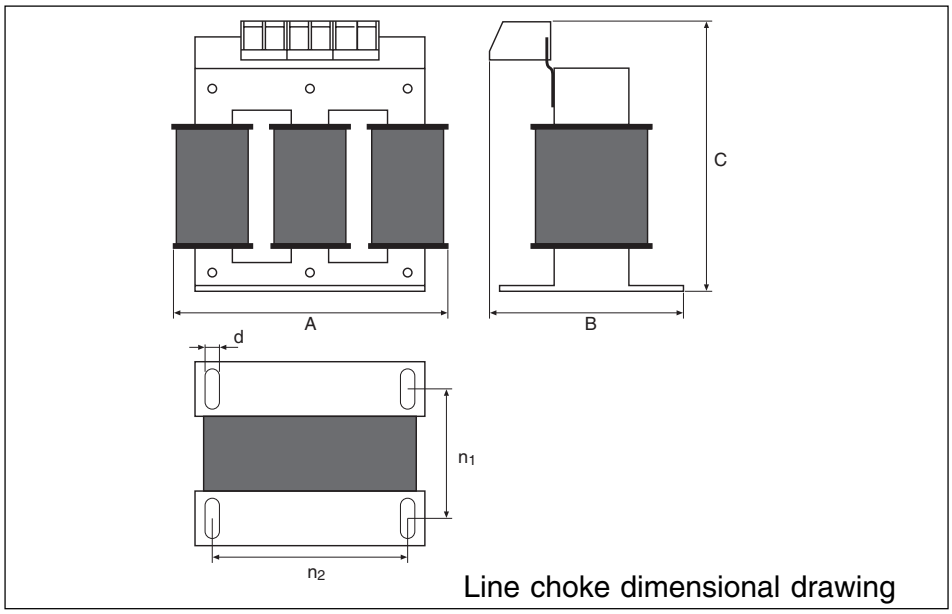
3.2.1 Line choke

The KEBCO line choke reduces the harmonics of the input current and the power factor of the inverter improves from 0.5... 0.6 to approximately 0.8... 0.9.

Conducted high frequency interference is reduced up to 30 db in the frequency range from 10 kHz to approximately 300 kHz.

In addition, the noise immunity of the system is improved and the lifetime of the DC-bus capacitors increases.

See page 36 for more information.

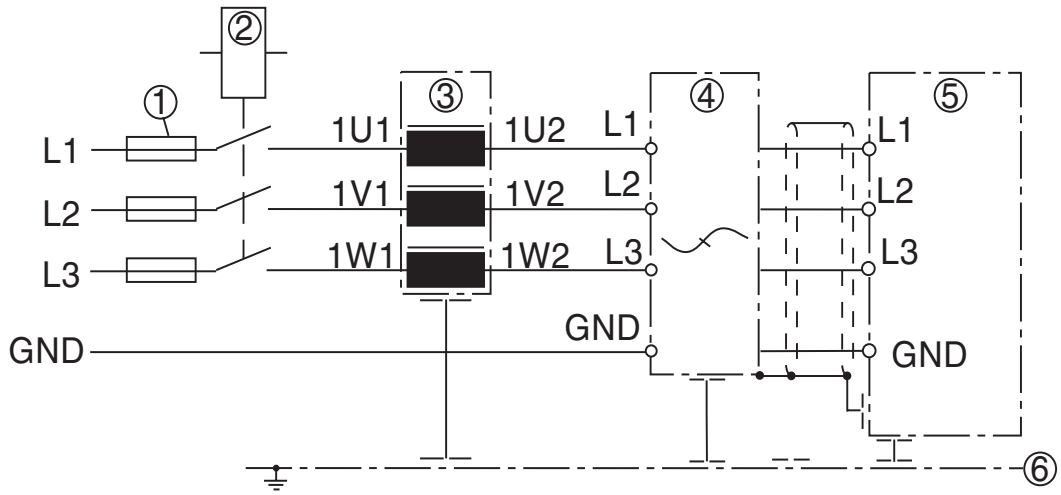


Line choke dimensional drawing

230V-Class														
For hp	Phases	I_N [A]	P_{loss} [W]	Imp. [%]	Part number	Dimensions [inches]						Wire awg	Weight [lb]
						A	B	C	n_1	n_2	d		
			14.5	3	**U0.90.290-0401**								
1	3	4	20	5	**U0.90.290-0402**	4.4	2.75	4.1	1.98	1.44	0.31 x 0.56	22-14	4
			19.5	3	**U0.90.290-0801**								7
2	3	8	29	5	**U0.90.290-0802**	6	3	4.75	2.1	2	0.31 x 0.62	22-14	8
			26	3	**U0.90.290-1201**								9
3	3	12	31	5	**U0.90.290.1202**	6	3.25	5	2.1	2	0.31 x 0.62	22-5	10
			36	3	**U0.90.290-1801**		3.25		2.1				9
5	3	18	43	5	**U0.90.290-1802**	6	3.5	5.25	2.48	2	0.31 x 0.62	22-5	12
7.5	3	25	52	5	**U0.90.290-2502**	7.25	3.43	6	2.35	3	0.38 x 0.75	22-5	14
10	3	35	54	5	**U0.90.290-3502**	7.25	4	5.75	2.75	3	0.38 x 0.75	22-5	16
15	3	45	62	5	**U0.90.290-4502**	9	4.75	7.35	3.16	3	0.38 x 0.75	18-4	28
20	3	55	67	5	**U0.90.290-5502**	9	4.55	7.35	3.15	3	0.38 x 0.75	18-4	27

460V-Class														
For hp	Phases	I_N [A]	P_{loss} [W]	Imp. %	Part number	Dimensions A	B	C	n1	n2	d	Wire [awg]	Weight [lb]
			7.5	3	**U0.90.290-0201**								4
1	3	2	11.3	5	**U0.90.290-0202**	4.4	2.75	4.1	1.98	1.44	0.31 x 0.56	22..14	4
			20	3	**U0.90.290-0402**		4.75		1.98				4
2	3	4	25	5	**U0.90.290-0403**	4.4	3.12	4.1	2.35	1.44	0.31 x 0.56	22..14	4
			20	3	**U0.90.290-0402**		4.75		1.98				4
3	3	4	25	5	**U0.90.290-0403**	4.4	3.12	4.1	2.35	1.44	0.31 x 0.56	22..14	4
			29	3	**U0.90.290-0802**		3		2.1				8
5	3	8	25.3	5	**U0.90.290-0803**	6	3.37	4.75	2.48	2	0.31 x 0.62	22..14	11
			31	3	**U0.90.290-1202**		3.25		2.1				10
7.5	3	12	41	5	**U0.90.290-1203**	6	3.87	5	2.75	2	0.31 x 0.62	22...5	18
			43	3	**U0.90.290-1802**	6	3.5	5.25	2.48				12
10	3	18	43	5	**U0.90.290-1803**	8	4	6	2.6	2	0.31 x 0.62	22...5	16
			52	3	**U0.90.290-2502**		3.43		2.35				14
15	3	25	61	5	**U0.90.290-2503**	7.25	4.25	6	3.1	3	0.38 x 0.75	22...5	20
			54	3	**U0.90.290-3502**	7.25	4	5.75	2.75			22...5	16
20	3	35	54	5	**U0.90.290-3503**	9	4.75	7.5	3.16	3	0.38 x 0.75	18...4	30
			54	3	**U0.90.290-3502**	7.25	4	5.75	2.75			22...5	16
25	3	35	54	5	**U0.90.290-3503**	9	4.75	7.5	3.16	3	0.38 x 0.75	18...4	30
			62	3	**U0.90.290-4502**		4.75	7.35	3.16				28
30	3	45	65	5	**U0.90.290-4503**	9	5.3	7.25	3.66	3	0.38 x 0.75	18...4	39
			67	3	**U0.90.290-5502**		4.66	7.35	3.16				27
40	3	55	71	5	**U0.90.290-5503**	9	5.41	7.5	3.91	3	0.38 x 0.75	18...4	41
			86	3	**U0.90.290-8002**		5.62		3.47			12...1	51
50	3	80	96	5	**U0.90.290-8003**	10.8	6.75	8.5	4.16	3.63	0.38 x 0.75	6...0	61
			86	3	**U0.90.290-8002**		5.62		3.47			12...1	51
60	3	80	96	5	**U0.90.290-8003**	10.8	6.75	8.5	4.16	3.63	0.38 x 0.75	6...0	61
			84	3	**U0.90.291-0002**		6.63		3.66				51
75	3	100	108	5	**U0.90.291-0003**	11	7.62	8.5	4.16	3.63	0.375 x 0.75	6...0	74
			180	3	**U0.90.291-3002**		6.63		3.66				62
100	3	130	128	5	**U0.90.291-3003**	11.25	8.5	8.5	4.18	3.63	0.38 x 0.75	2...4/0	64
			149	3	**U0.90.291-6002**	11	7		3.47				51
125	3	160	138	5	**U0.90.291-6003**	11.25	8	8.5	4.66	3.63	0.38 x 0.75	2...4/0	72
			168	3	**U0.90.292-0002**		8.25		4.41				67
150	3	200	146	5	**U0.90.292-0003**	11.5	10	8.5	5.91	3.63	0.38 x 0.75	2...4/0	100
			231	3	**U0.90.292-5002**	15	10.3		5.16				106
175	3	250	219	5	**U0.90.292-5003**	14.5	11.3	11.3	5.82	4.6	0.56	2/0..500	143
			231	3	**U0.90.292-5002**	15	10.3		5.16				106
200	3	250	219	5	**U0.90.292-5003**	14.5	11.3	11.3	5.82	4.6	0.56	2/0..500	143
			264	3	**U0.90.293-2002**	14.75	11		5.88				125
250	3	320	351	5	**U0.90.293-2003**	15	12	11.3	7.13	4.6	0.56	2/0..500	190
			335	3	**U0.90.294-0002**		12.1		6.75				155
300	3	400	293	5	**U0.90.294-0003**	15.5	14.5	11.3	7.25	4.6	0.56	2/0..500	200
			340	3	**U0.90.295-0002**		12.5		6.76			-	180
400	3	500	422	5	**U0.90.295-0003**	15.5	14.8	11.3	9.76	4.6	0.56	-	290

Connection of the line choke



1. **Supply fuse**
2. **Disconnect switch or contactor**
3. **Line choke**
4. **Interference suppression filter**
5. **KEB COMBIVERT F4**
6. **Sub panel in control cabinet**

Line Chokes - Additional Information

Interference and or voltage spikes on the supply voltage are created when large loads such as heaters, motors, arc-welders etc. are turned on and off. In some instances, switching in and out large power factor correction capacitors either in the factory or on the utility grid can also lead to large voltage spikes appearing at the inverter. These spikes are typically short in time duration but high enough in voltage to create nuisance tripping of the inverter i.e. E.OP. The voltage spike enters the inverter and raises the DC bus voltage level above the predefined limit, 400V in 230V units and 800V in 460V units. The protection circuits in the inverter activate leading to an interruption in the operation of the unit. The choke prevents these spikes from reaching the inverter eliminating the problem.

When installing larger inverters (100 hp and greater), harmonic distortion in the line current can become a problem. This distortion is caused by the diode bridge rectifier which serves as the input to all inverters. This distortion can create large fluctuations in the line voltage within a facility leading to problems with other equipment. The choke reduces the distortion of the current, there by eliminating the associated problems.

3.2.2 EMI (CE) - Filter

The KEBCO COMBIVERT frequency inverters are optionally available with EMI filters. Depending on the housing size they are available from the factory already mounted to the inverter or as filter kits for installation by the user. These filters allow the KEBCO COMBIVERT to meet the CE EMC directive 89/339. All filters are dimensioned for the inverter's rated current and are designed to meet the conducted emission limit as defined by EN55011/B.

The filter kits contain all required hardware for installation. Filters for sizes up to 100 hp include the shielded supply wires which connect the filter to the inverter. Depending on the available space and filter type, the filter can either be installed under the frequency inverter (sub-mounted), or beside the frequency inverter (side mounted).

EMI (CE) -Filter 230V-Class			
Phases	Filter Kit incl. shield plate	Filter (alone)	mounts with inverter housing
1	07.U4.00D-B600	07.F4.T60-0009	D
3	09.U4.00D-B600	09.F4.T60-0009	D
1	10.U4.00D-B600	10.F4.T60-0009	D
3	13.U4.00E-BA00	15.F4.T60-1008	E
1	14.U4.00G-BA00	16.F4.T60-1009	G
3	15.U4.00H-BA00	18.F4.T60-1009	H
3	16.U4.00H-BA00	19.F4.T60-1009	H

EMI (CE) - Filter 460V-Class			
Phases	Kit incl. Filter	Filter	mounts with inverter housing
3	10.U4.00D-BM00	09.F4.T60-1009	D
3	12.U4.00D-BM00	12.F4.T60-1009	D
3	13.U4.00D-BM00	13.F4.T60-1009	D
3	14.U4.00E-BM00	14.F4.T60-1008	E
3	15.U4.00E-BM00	15.F4.T60-1008	E
3	14.U4.00G-BM00	14.F4.T60-1008	-
3	16.U4.00G-BM00	16.F4.T60-1009	G
3	16.U4.00H-BM00	16.F4.T60-1009	-
3	18.U4.00H-BM00	18.F4.T60-1009	H
3	19.U4.00H-BM00	19.F4.T60-1009	H
3	20.U4.00R-BM00	20.F4.T60-1029	R
3	22.U4.00R-BM00	22.F4.T60-1029	R
3	23.U4.00U-BM00	23.F4.T60-1008	-
3	25.U4.00U-BM00	25.F4.T60-1008	-
3	27.U4.00U-BM00	27.F4.T60-1008	-
3	28.U4.00P-BM00	28.F4.T60-1008	-
3	29.U4.00P-BM00	29.F4.T60-1008	-
3	30.U4.00P-BM00	30.F4.T60-1008	-

Fig. 1

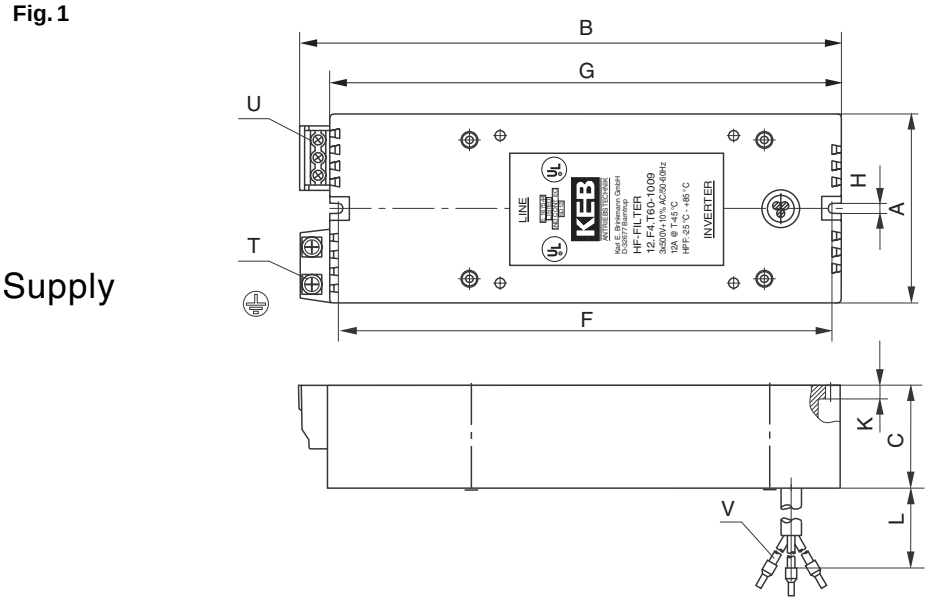
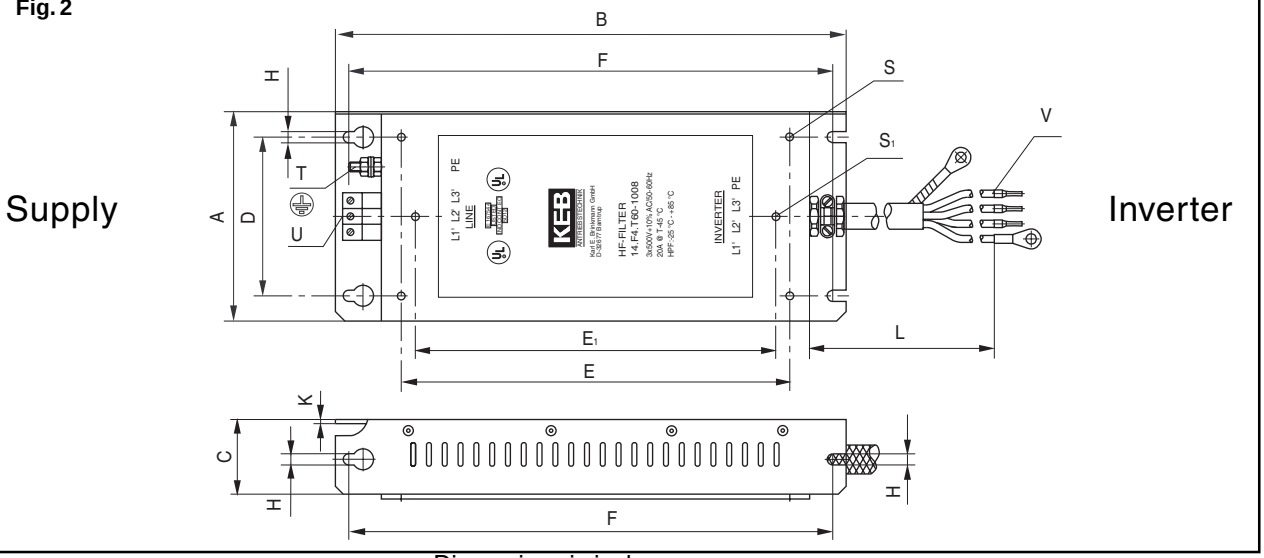
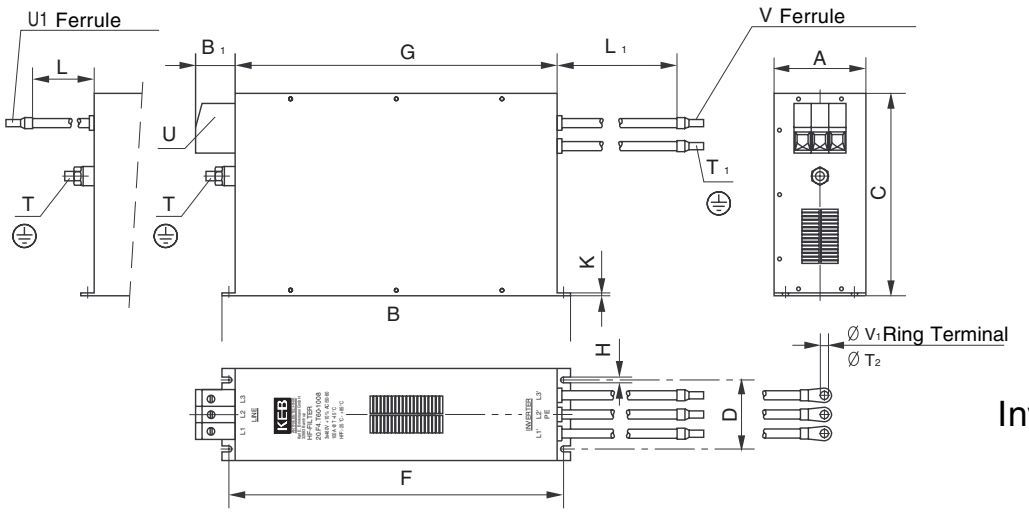


Fig. 2



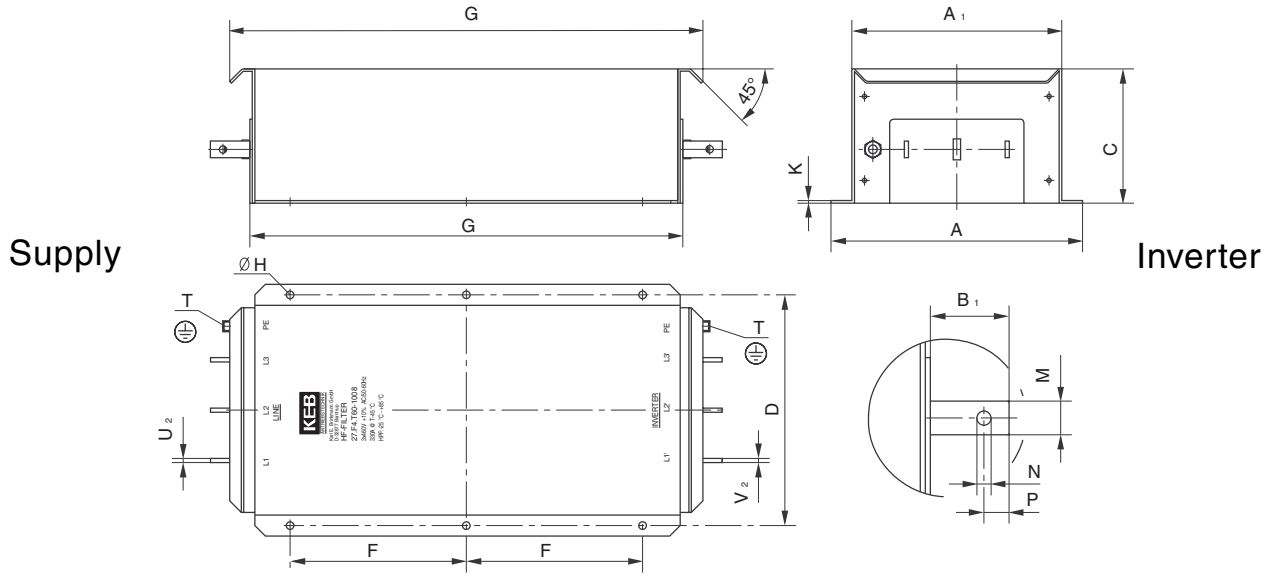
Dimensions in inches

Ratet current			Fig.	A	B	C	D	E	E1	F	G	H	K	S	S1	T	LINE	INVERTER	L	Weight
Voltage	V max.																U	V		
KEB Art.No.:	[V]	[A]															Terminal strip	Shielded wire		[lb]
07.F4.T60-0009	1x250	12	1	3.5	10	2	-	-	-	9.4	9.8	0.2	0.2	-	-	M4	2x AWG 10	2x AWG 14	4.3	2
09.F4.T60-0009		20																		
10.F4.T60-0009		30																2x AWG 10		
09.F4.T60-1009	3x500	8															3x AWG 10	3x AWG 14		2.9
12.F4.T60-1009		12																		
13.F4.T60-1009		16																		
14.F4.T60-1008	3x500	20	2	5.2	14	2	3.9	-	11	13	-	0.3	0.1	-	M6	M6		4x AWG 12	15.7	3.3
15.F4.T60-1008		30																4x AWG 10	15.7	3.3
16.F4.T60-1009		50		7.1	16	2.2	5.9	13	-	16	-	0.3	0.1	M6	-	M6	3x AWG 6	4x AWG 8	15.7	7.1
18.F4.T60-1009		70		12	18	2.6	9.8	13	-	17	-	0.3	0.2	M6	-	M6		4x AWG 6	13.8	11.2
19.F4.T60-1009		90															3x AWG 2	4x AWG 4	13.8	13.4



Dimensions in inches

Ratet current														LINE			INVERTER					Weight
Voltage / KEB Art.No.:	V max. [V]	[A]	A	B	B1	C	D	F	G	H	K	L	L1	T	U Terminal [awg]	U1 Cable [awg²]	T1 [mm²]	T2	V [mm²]	V1	[lb]
20.F4.T60-1008	3x 500	100	3.5	14.9	1.7	8.7	2.6	14.3	13.8	0.3	0.1	-	15.7	M10	3x50	-	1x25	-	3x25	-	14.3
21.F4.T60-1008		130	4.3	17.2	1.7	9.4	3.1	16.3	15.7	0.3	0.2	-	15.7	M10	3x50	-	1x35	-	3x35	-	18.7
23.F4.T60-1008		180	4.3	17.2	2.0	9.4	3.1	16.3	15.7	0.3	0.2	-	15.7	M10	3x95	-	1x50	-	3x50	-	28.7
25.F4.T60-1008		250	4.3	18.8	-	9.4	3.1	17.9	17.3	0.3	0.2	39.4	19.7	M10	-	3x70	-	1xØ0.35	-	3xØ0.35	35.3

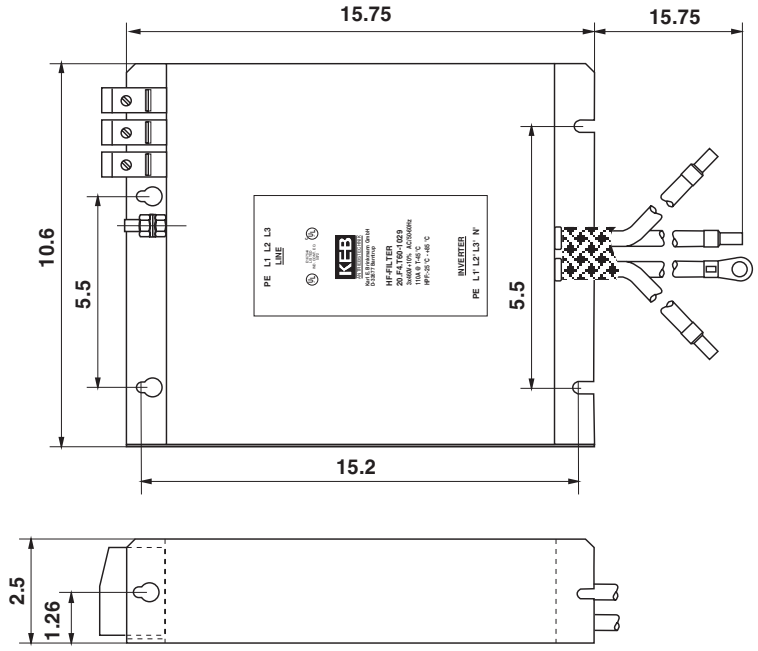


Dimensions in inches

Ratet current																LINE		INVERTER		
Voltage / KEB Art.No.:	V max. [V]	[A]	A	A1	B	B1	C	D	F	G	H	K	M	N	P	T	U2	T1 [mm²]	V2	Weight [lb]
27.F4.T60-1008	3x 500	330	11.8	9.8	22.2	1.9	6.3	10.8	8.3	20.3	0.35	0.12	0.79	0.33	0.6	M12	0.2	M12	0.2	35.3
28.F4.T60-1008		400											0.98	0.41	0.71		0.24		0.24	40.8
29.F4.T60-1008		500											0.98	0.41	0.71		0.32		0.32	41.9

20.F4.T60-1029 / 22.F4.T60-1029

Supply



Inverter

Dimensions in inches

3.3 Output filter

3.3.1 Motor choke

There are three primary reasons to install a choke between the inverter and the motor. These reasons depend on four variables, operating voltage, inverter size, motor type, and motor cable length. The conditions around the usage of the chokes are described below.

Generally chokes are only required when the operating voltage is 400V to 480V. Systems operating on 230V typically do not have the same problems since the voltages are half that of the 460V systems.

If the inverter is rated for 1, 2 and 3 hp it may be necessary to use a motor choke when the motor cables reach 25 feet in length. Capacitive current flows between the motor cables and adds to the motor current. The resulting current typically exceeds the rated current of the inverter resulting in nuisance over load or over current faults. This does not effect the larger hp units since the capacitive current is proportional to the cable length and is roughly the same for all sizes of inverters.

When the motor cables are 50 to 150 feet in length, voltage peaks several times greater than the rated voltage of the motor can begin to appear at the motor. By using motors which have a high insulation breakdown rating, usually listed in volts (1600V or higher), the choke can be eliminated. However, if standard motors with normal insulation ratings are used, the choke is highly recommended.

Finally, when the motor cables exceed 150 feet, it is possible for voltage peaks to appear at the motor and the inverter's terminal strip. In this case the motor windings may have a high insulation rating protecting the motor, but the inverter has only a 1200V rating on the power IGBTs. As a result a motor choke is always recommended when the cables are 150 feet or longer.

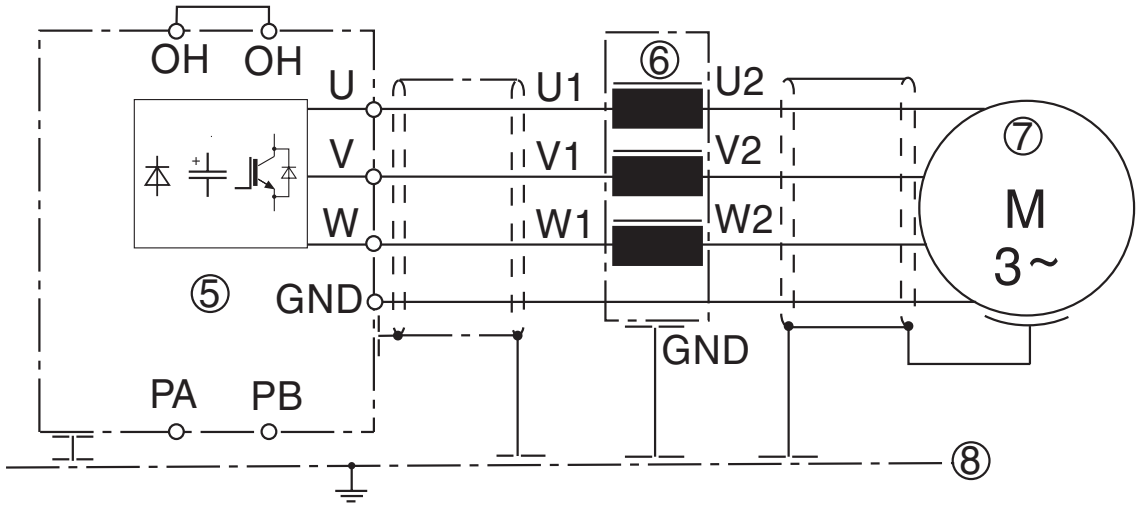
By installing a motor choke the applied voltage to the motor drops three to five percent. In most applications, the results are negligible.

Choke sizing-motor chokes should be selected such that the rated current of the choke is equal to or greater than the rated current of the inverter. Three percent chokes are recommended for cable lengths up to 150ft. Greater than 150 feet five percent chokes should be used.

230V-Class														
For hp	Phases	I_N [A]	P_{loss} [W]	Imp. [%]	**Part number**	Dimensions [inches] A	B	C	n_1	n_2	d	Wire awg	Weight [lb]
			14.5	3	**U0.90.290-0401**								
1	3	4	20	5	**U0.90.290-0402**	4.4	2.75	4.1	1.98	1.44	0.31 x 0.56	22-14	4
			19.5	3	**U0.90.290-0801**								7
2	3	8	29	5	**U0.90.290-0802**	6	3	4.75	2.1	2	0.31 x 0.62	22-14	8
			26	3	**U0.90.290-1201**								9
3	3	12	31	5	**U0.90.290.1202**	6	3.25	5	2.1	2	0.31 x 0.62	22-5	10
			36	3	**U0.90.290-1801**		3.25		2.1				9
5	3	18	43	5	**U0.90.290-1802**	6	3.5	5.25	2.48	2	0.31 x 0.62	22-5	12
7.5	3	25	52	5	**U0.90.290-2502**	7.25	3.43	6	2.35	3	0.38 x 0.75	22-5	14
10	3	35	54	5	**U0.90.290-3502**	7.25	4	5.75	2.75	3	0.38 x 0.75	22-5	16
15	3	45	62	5	**U0.90.290-4502**	9	4.75	7.35	3.16	3	0.38 x 0.75	18-4	28
20	3	55	67	5	**U0.90.290-5502**	9	4.55	7.35	3.15	3	0.38 x 0.75	18-4	27

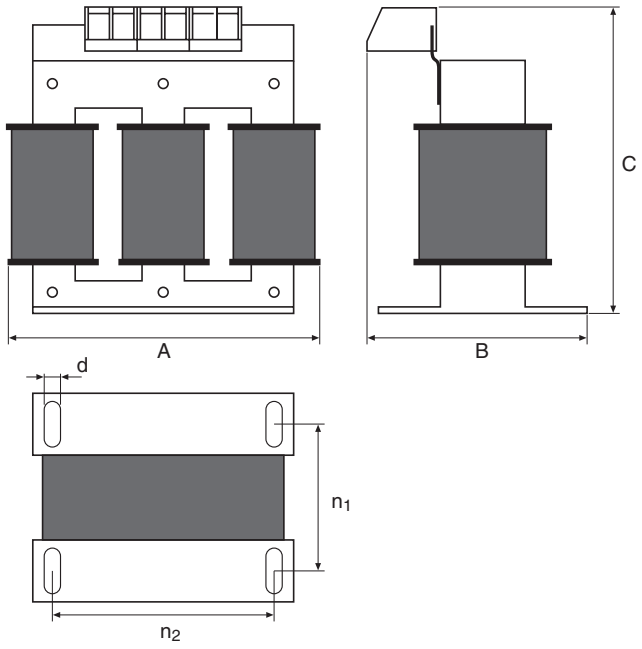
460V-Class														
For hp	Phases	I_N [A]	P_{loss} [W]	Imp. %	Part number	Dimensions						Wire [awg]	Weight [lb]
						A	B	C	n1	n2	d		
			7.5	3	**U0.90.290-0201**								4
1	3	2	11.3	5	**U0.90.290-0202**	4.4	2.75	4.1	1.98	1.44	0.31 x 0.56	22..14	4
			20	3	**U0.90.290-0402**		4.75		1.98				4
2	3	4	25	5	**U0.90.290-0403**	4.4	3.12	4.1	2.35	1.44	0.31 x 0.56	22..14	4
			20	3	**U0.90.290-0402**		4.75		1.98				4
3	3	4	25	5	**U0.90.290-0403**	4.4	3.12	4.1	2.35	1.44	0.31 x 0.56	22..14	4
			29	3	**U0.90.290-0802**		3		2.1				8
5	3	8	25.3	5	**U0.90.290-0803**	6	3.37	4.75	2.48	2	0.31 x 0.62	22..14	11
			31	3	**U0.90.290-1202**		3.25		2.1				10
7.5	3	12	41	5	**U0.90.290-1203**	6	3.87	5	2.75	2	0.31 x 0.62	22...5	18
			43	3	**U0.90.290-1802**	6	3.5	5.25	2.48				12
10	3	18	43	5	**U0.90.290-1803**	8	4	6	2.6	2	0.31 x 0.62	22...5	16
			52	3	**U0.90.290-2502**		3.43		2.35				14
15	3	25	61	5	**U0.90.290-2503**	7.25	4.25	6	3.1	3	0.38 x 0.75	22...5	20
			54	3	**U0.90.290-3502**	7.25	4	5.75	2.75			22...5	16
20	3	35	54	5	**U0.90.290-3503**	9	4.75	7.5	3.16	3	0.38 x 0.75	18...4	30
			54	3	**U0.90.290-3502**	7.25	4	5.75	2.75			22...5	16
25	3	35	54	5	**U0.90.290-3503**	9	4.75	7.5	3.16	3	0.38 x 0.75	18...4	30
			62	3	**U0.90.290-4502**		4.75	7.35	3.16				28
30	3	45	65	5	**U0.90.290-4503**	9	5.3	7.25	3.66	3	0.38 x 0.75	18...4	39
			67	3	**U0.90.290-5502**		4.66	7.35	3.16				27
40	3	55	71	5	**U0.90.290-5503**	9	5.41	7.5	3.91	3	0.38 x 0.75	18...4	41
			86	3	**U0.90.290-8002**		5.62		3.47			12...1	51
50	3	80	96	5	**U0.90.290-8003**	10.8	6.75	8.5	4.16	3.63	0.38 x 0.75	6…0	61
			86	3	**U0.90.290-8002**		5.62		3.47			12...1	51
60	3	80	96	5	**U0.90.290-8003**	10.8	6.75	8.5	4.16	3.63	0.38 x 0.75	6…0	61
			84	3	**U0.90.291-0002**		6.63		3.66				51
75	3	100	108	5	**U0.90.291-0003**	11	7.62	8.5	4.16	3.63	0.375 x 0.75	6…0	74
			180	3	**U0.90.291-3002**		6.63		3.66				62
100	3	130	128	5	**U0.90.291-3003**	11.25	8.5	8.5	4.18	3.63	0.38 x 0.75	2…4/0	64
			149	3	**U0.90.291-6002**	11	7		3.47				51
125	3	160	138	5	**U0.90.291-6003**	11.25	8	8.5	4.66	3.63	0.38 x 0.75	2…4/0	72
			168	3	**U0.90.292-0002**		8.25		4.41				67
150	3	200	146	5	**U0.90.292-0003**	11.5	10	8.5	5.91	3.63	0.38 x 0.75	2…4/0	100
			231	3	**U0.90.292-5002**	15	10.3		5.16				106
175	3	250	219	5	**U0.90.292-5003**	14.5	11.3	11.3	5.82	4.6	0.56	2/0..500	143
			231	3	**U0.90.292-5002**	15	10.3		5.16				106
200	3	250	219	5	**U0.90.292-5003**	14.5	11.3	11.3	5.82	4.6	0.56	2/0..500	143
			264	3	**U0.90.293-2002**	14.75	11		5.88				125
250	3	320	351	5	**U0.90.293-2003**	15	12	11.3	7.13	4.6	0.56	2/0..500	190
			335	3	**U0.90.294-0002**		12.1		6.75				155
300	3	400	293	5	**U0.90.294-0003**	15.5	14.5	11.3	7.25	4.6	0.56	2/0..500	200
			340	3	**U0.90.295-0002**		12.5		6.76			-	180
400	3	500	422	5	**U0.90.295-0003**	15.5	14.8	11.3	9.76	4.6	0.56	-	290

Connection of the motor choke



⑤ **KEB COMBIVERT**
⑥ **Motor choke**
⑦ **Motor**
⑧ **Sub panel in control cabinet**

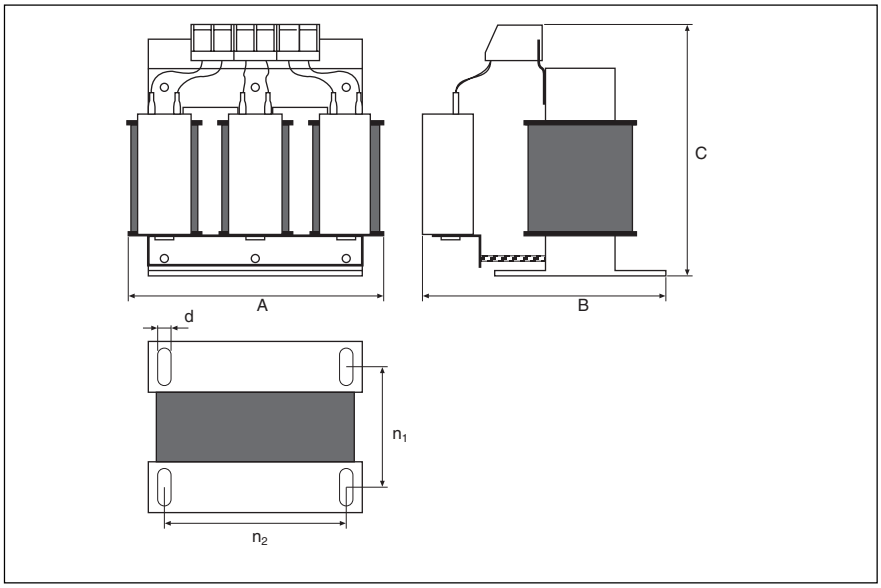
Motor choke dimensional drawing



3.3.2 PWM to Sine filter

When controlling the motor with pulse width modulation (PWM), the motor can be subject to very rapid voltage rise times, dv/dt of 5…10kV/ms. This rapid turn on can create many side effects with long cable runs greater than 150 feet, the primary problem being voltage peaks either at the motor or at the inverter. If a motor with suitable winding insulation is used then the inverter becomes the limiting factor since the output transistors are only rated for 1200V.

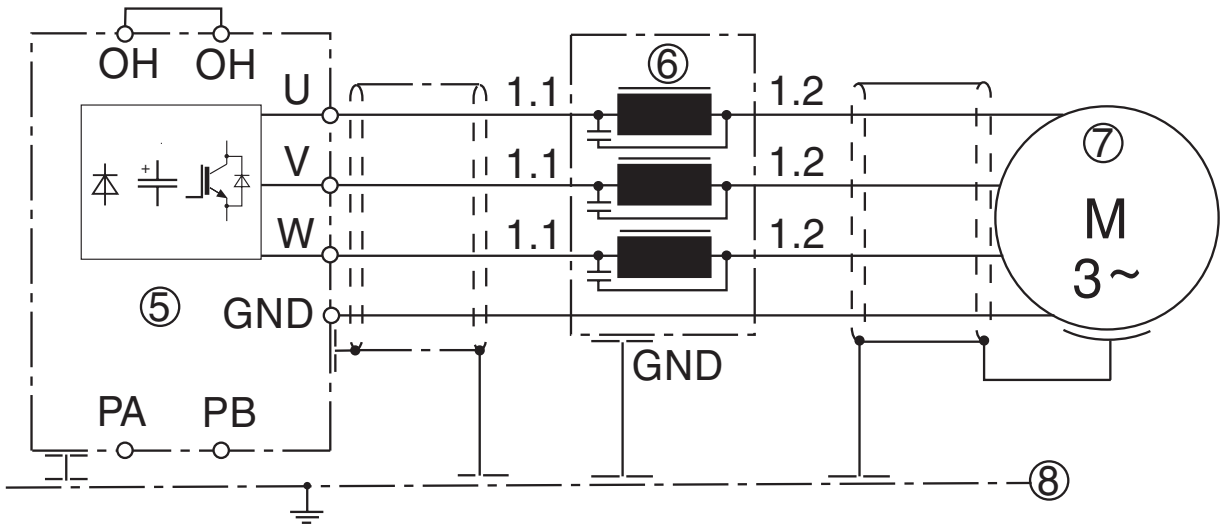
Installing a PWM to sine filter converts the PWM voltage to standard AC sine wave voltage phase to phase. As a result all of the problems associated with long cable runs, high dv/dt, and high voltage peaks are eliminated. The phase to ground voltage still contains some PWM voltage therefore shielded motor cable s are still recommended. The standard-PWM to sine filters are designed for a maximum output frequency of 120 Hz.



230V-Class, up to f_{out} max. 120Hz, for 4kHz switching frequency, IP00, VBG4, T 40/F										
For COMBIVERT Size	Part number	I_N	Mounting Dimensions [inches]						Terminal wire size	Weight
		[A]	A	B	C	n1	n2	d	[Awg]	[lb]
07	00.90.428-5099	4.1	4.9	4.3	7.1	2.2	3.9	0.31	12	7
09	00.90.428-5129	9.5	6.1	5.1	8.3	2.8	5.1	0.31	12	15
10	00.90.428-5139	12.0	7.5	5.5	8.7	2.3	6.7	0.31	8	18
12	00.90.428-5149	16.5	7.5	5.9	8.7	2.7	6.7	0.31	8	26
13	00.90.428-5159	24.0	8.3	6.5	9.4	3.2	7.1	0.31	8	26
14	00.90.428-5169	33.0	9.4	7.7	11.0	4.2	7.5	0.43	5	44
15	00.90.428-5189	50.0	9.4	8.7	11.6	5.0	7.5	0.43	2	66
16	00.90.428-5199	60.0	11.8	14.0	14.0	4.8	9.4	0.43	2	84

460V-Class, f_{out} max. 120Hz, IP00, VBG4, T 40/F											
For	Minimum	Part number	I_N	Mounting Dimensions						Terminal	Weight
COMBIVERT	Switching			[inches]						wire size	
Size	Frequency		[A]	A	B	C	n1	n2	d	[Awg]	[lb]
07 /09	4 kHz	00.90.428-5099	4.1	4.92	4.33	7.09	2.2	3.94	0.31	12	7
10/12	4 kHz	00.90.428-5129	9.5	6.1	5.12	8.27	2.8	5.12	0.31	12	15
13	4 kHz	00.90.428-5139	12	7.48	5.51	8.66	2.3	6.69	0.31	8	18
14	4 kHz	00.90.428-5149	16.5	7.48	5.91	8.66	2.7	6.69	0.31	8	26
15	4 kHz	00.90.428-5159	24	8.27	6.5	9.45	3.2	7.09	0.31	8	26
16	4 kHz	00.90.428-5169	33	9.45	7.68	11.0	4.2	7.48	0.43	6	44
17	4 kHz	00.90.428-5179	42	9.45	8.66	11.6	5.0	7.48	0.31	2	66
18	4 kHz	00.90.428-5189	50	9.45	8.66	11.6	5.0	7.48	0.43	2	66
19	4 kHz	00.90.428-5199	60	11.8	14.0	14.0	4.8	9.45	0.43	2	84
20	4 kHz	00-90.428-5209	75	11.8	9.45	14.0	5.3	9.45	0.43	2	93
21	4 kHz	00-90.428-5219	90	11.8	10.0	14.2	5.7	9.45	0.43	1/O	110
22	4 kHz	00-90.428-5229	115	14.2	10.2	15.9	5.0	12.2	0.43	2/O	132
23	4 kHz	00-90.428-5239	152	14.2	11.0	16.5	5.6	12.2	0.43	3/O	154
24	4 kHz	00-90.428-5249	180	14.2	12.0	17.3	6.1	12.2	0.43	300	187
25	4 kHz	00-90.428-5259	210	16.5	11.4	19.5	6.0	14.6	0.43	300	243
26	4 kHz	00-90.428-5269	250	16.5	12.6	19.5	7.2	14.6	0.43	300	287
27	2 kHz	00-90.428-5279	300	16.5	16.5	19.5	8.3	14.6	0.43	300	353
28	2 kHz	00-90.428-5289	370	18.9	17.7	22.0	9.4	16.9	0.43	500	551
29	2 kHz	00-90.428-5299	450	18.9	17.7	22.0	9.4	16.9	0.43	500	551

Connection of the sine filter

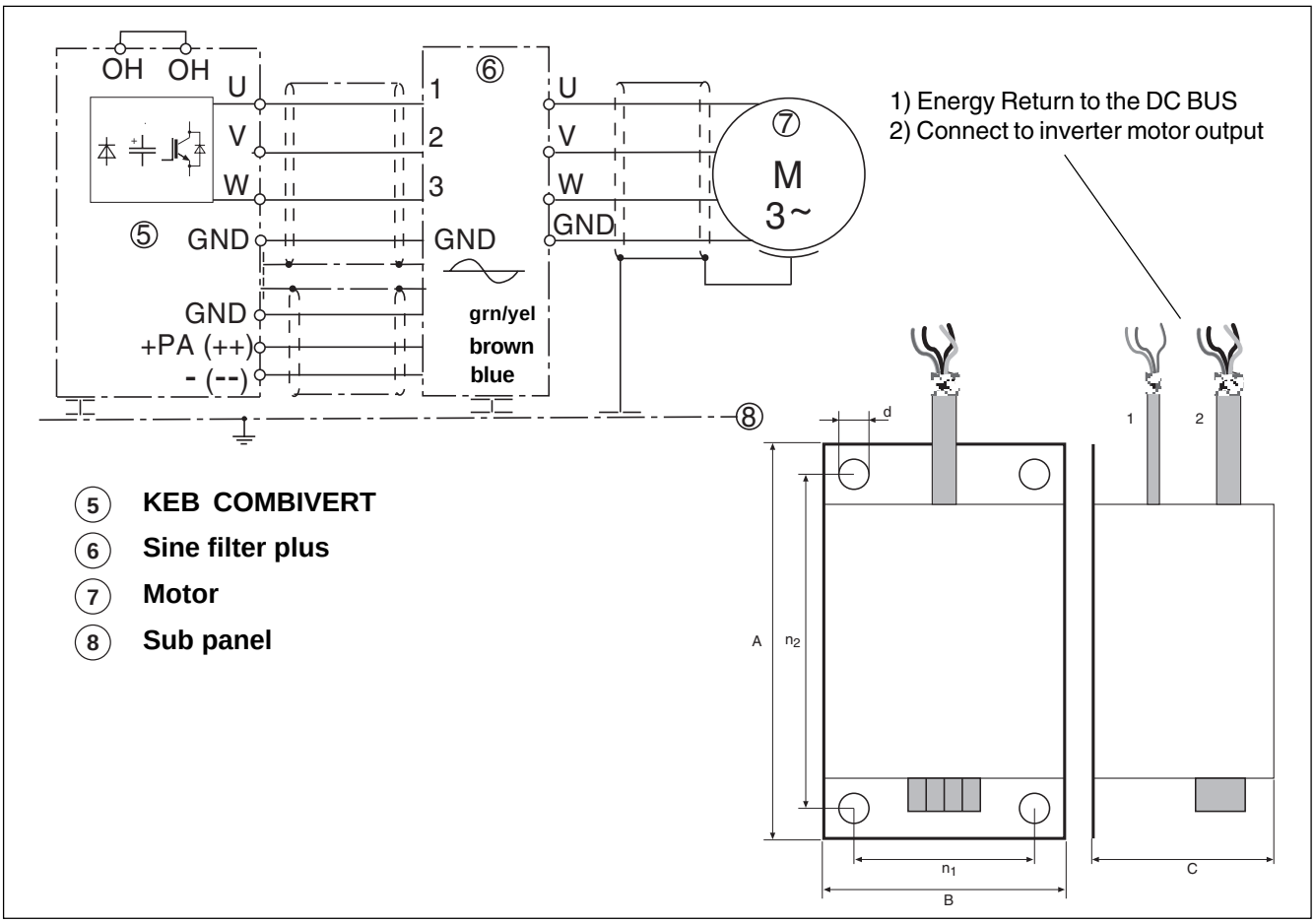


⑤ **KEB COMBIVERT**
⑥ **Sinus filter**
⑦ **Motor**
⑧ **Mounting plate**

3.3.3 PWM to sine filter plus

The KEBCO PWM to sine filter plus creates sinusoidal voltages phase to phase and phase to ground. All problems with long motor leads are eliminated and it is no longer necessary to use shielded motor cable. This filter is recommended for extremely long motor cables, >300ft. Additionally, these filters can be used when retrofitting older installations with inverters. The filter allows the use of the existing motor cables instead of requiring a new shielded cable to be installed.

With loads >150% inverter-rated current (I_N) the next higher filter must be used. Min. 8 kHz (better 16 kHz) carrier frequency are required. The filter is dimensioned for a maximum output frequency of 100 Hz.



⑤ **KEB COMBIVERT**
⑥ **Sine filter plus**
⑦ **Motor**
⑧ **Sub panel**

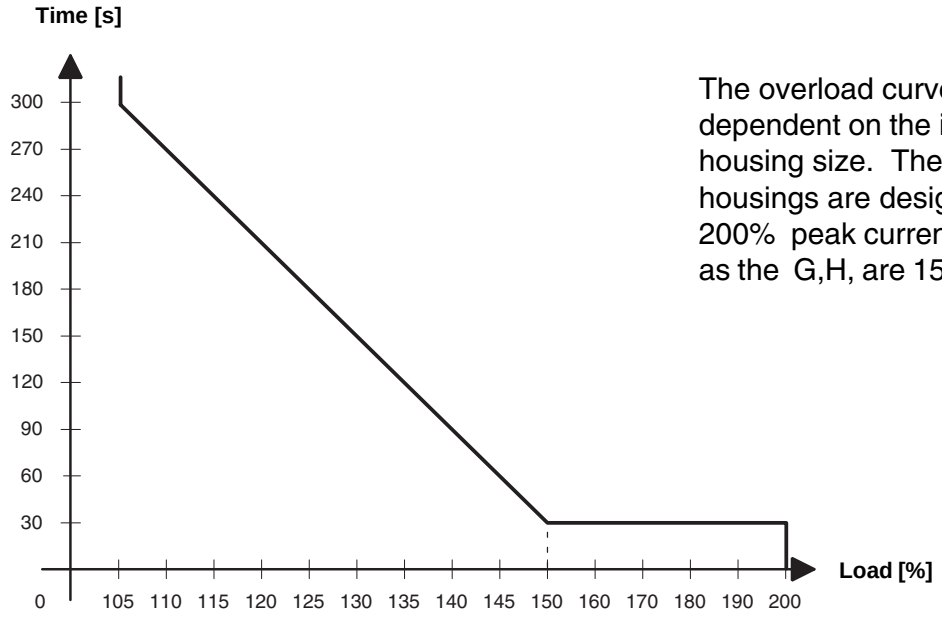
460V-Class, f_{out} max. 100Hz, for min. 8kHz switching frequency										
For COMBIVERT Size	Part Number	I_N	Mounting Dimensions [inches]						Terminal Wire size	Weight
		[A]	A	B	C	n1	n2	d	[Awg]	[lb]
07/09	00.90.426-5099	4	15.4	3.5	5.9	1.7	14.7	0.26	12	25
10	00.90.426-5119	8	15.4	3.5	7.1	1.7	14.6	0.34	12	33
12/13	00.90.426-5139	12	15.4	3.5	8.5	1.7	14.6	0.34	8	41
14	00.90.426-5149	16	13.8	5.5	9.1	3.7	13.0	0.34	8	51
15	00.90.426-5159	25	15.4	6.5	9.1	5.3	14.6	0.34	8	55

4. Annex

4.1 Time dependent overload curve

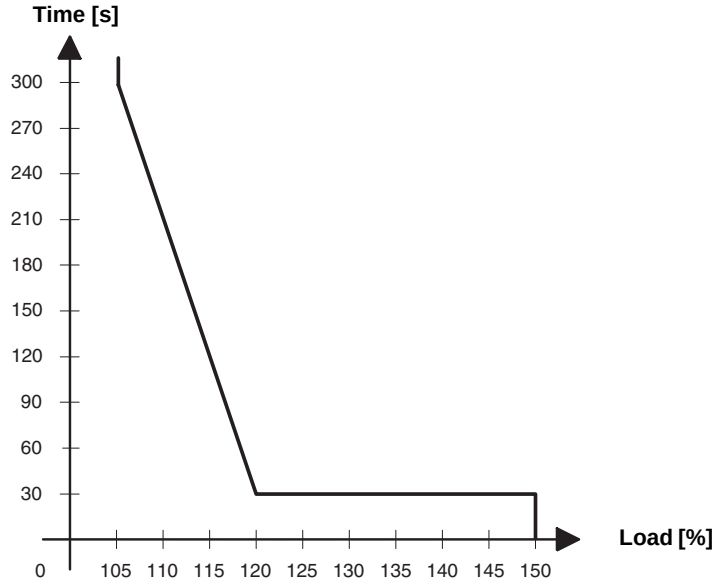
If the load current exceeds the rated current but is below the over current level, an overload timer begins counting. The rate at which the timer increments is a function of load current. The higher the current the faster the increments. When the counter reaches the limit the fault E.OL is triggered and the output to the motor is shut off. At this point the inverter begins a cool down period where the inverter is allowed to cool before the fault can be reset.

❶ Housing size D,E,G,H

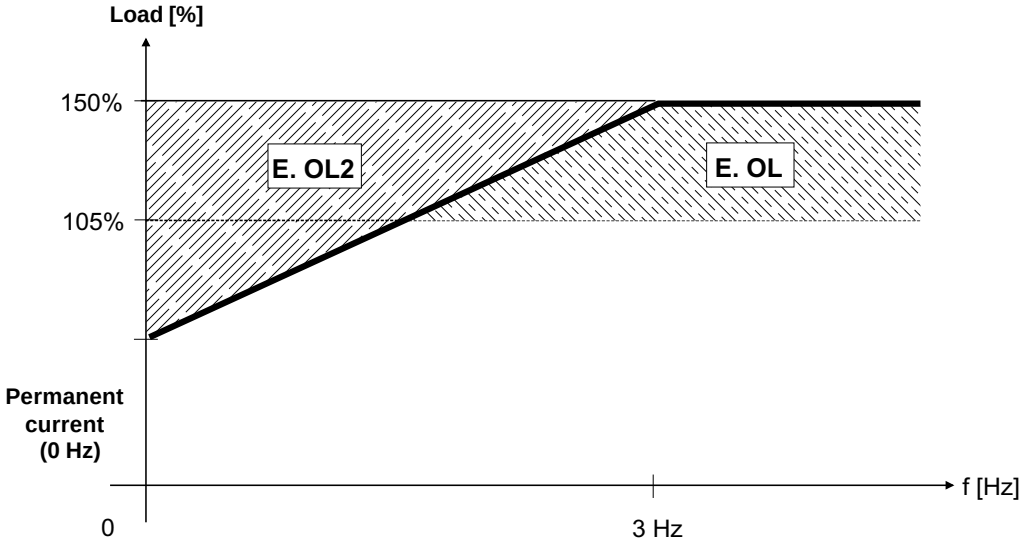


The overload curves are dependent on the inverter housing size. The D and E housings are designed for 200% peak current where as the G,H, are 150%.

❷ Housing size R,U,P



4.2 Stall overload for F4F



At low speeds (below 3 Hz) the rms current flowing through the power transistors is higher, reaching 1.4 times the rated 60Hz rms value. This is caused by the low frequency sine wave created by the PWM. As a result, the continuous output current must be limited at low speeds to prevent the power transistors from overheating. Take these current values into consideration when the motor must hold the load at zero speed.

230V F4F maximum stall current (amps at 0Hz)

Inverter Housing	Carrier Frequency	Inverter Size O7	10	12	13	14	15	16	17	18	19
D	8 kHz	4	10								
	16 kHz	4	10								
E	8 kHz			16.5	24						
	16 kHz			16.5	24						
G	8 kHz				19	33					
	16 kHz				8.6	33					
H	8 kHz						48	66			
	16 kHz						48	66			
R	8 kHz								75	90	115
	16 kHz								75	90	115

460V F4F maximum stall current (amps at 0Hz)

Inverter Housing	Carrier Frequency	Inverter Size 10	12	13	14	15	16	17	18	19	20	21	22	23	24
D	8 kHz	6.4													
	16 kHz	-													
E	8 kHz		9.5	12	16.5										
	16 kHz		9.5	12	-										
G	8 kHz			19	19	19	21.5								
	16 kHz			12	12	8.5	9.7								
H	8 kHz					25	33	30	45						
	16 kHz					15	20	13.5	20						
R	8 kHz							42	50	60	75	90			
	16 kHz							30	40	27	33.7	40.5			
U	8 kHz													150	180
	16 kHz													-	-

Notes

Special Notice to Customer

Prior to delivery all products pass several quality and performance inspections in order to guarantee the product is free from defects in manufacturing. When used in accordance with the operating instructions, failure of the unit is not likely. However, if you have reason for concern please contact KEBCO at 800-899-3226 and ask for inverter technical support. From this point our technical support engineers can help you determine the cause of the problems and also the proper solution.

Listed values in this manual are standard values only and do not pertain to special units. We reserve the right to make technical changes without notification.

KEBCO Limited Warranty

KEBCO will repair or replace, at KEBCO's discretion, any inverter which shows signs of defect in material, workmanship or fails to meet factory specifications with in one year from original date of shipment from KEBCO in St. Paul. The serial number will be used to track the shipping date. Operation of the inverter outside the rated specifications printed in the instruction manuals will void the warranty.

KEBCO does not assume any liability (cost of removal, cost of installation, down time, production delays, or damage to other items associated with the inverter) for failures which occur during or after the warranty period.

To make a warranty claim contact the Electronic repair department at the number listed above, and request a Return Goods Authorization (RGA) number. The inverter is to be shipped prepaid to the address listed below. Suitable packaging must be provided to prevent the inverter from incurring damages during shipping as damages of this nature will void the warranty.

KEBCO will inspect the inverter to determine the cause of the problems in the inverter and will repair or replace the inverter at its discretion.

KEBCO Inc.
Attn. ELECTRONIC REPAIR (RGA#)
1335 Mendota Heights Road
St. Paul, MN 55120

Argentina	SILGE ELECTRONICA · Av. Mitre 950	RA-1602 Florida-Prov. BS.AS.	Tel.: (54) 1/7610675	FAX: (54) 1/7604950
Belgium	S.A. Vermeire Belting N.V. · Rue de la Filature, 41 ·	B - 4800 Ensival (Verviers)	Tel.: (32) 87/322360	FAX : (32) 87/315071
Denmark	REGAL-Maskin Elektro A.S. · Industrievej 4 ·	DK - 4000 Roskilde	Tel.: (45) 46755544	FAX : (45) 46757620
Finnland	Advancetec Oy · Malminkaari 10 B · PL 149 ·	FIN 00701 Helsinki	Tel.: (358) 9/70029270	FAX : (358) 9/70029279
Israel	OMEGA ENGINEERING Ltd. · P.O. Box 1092	IL - 44110 Kfar- Saba	Tel.: (972) 9/7673240	FAX: (972) 9/7673398
Netherlands	Marsman Elektronica · En Aandrijvingen BV · Zeearend 16	NL - 7609 PT Almelo	Tel.: (31) 546/812121	FAX : (31) 546/810655
Sweden	REVA-drivteknik AB · Slussgatan 13 ·	S - 211 30 Malmö	Tel.: (46) 40/771 10	FAX : (46) 40/79994
Switzerland	Stamm Industrieprodukte AG · Hofstraße 106 ·	CH - 8620 Wetzikon	Tel.: (41) 1/9325980	FAX : (41) 1/9325986
Spain	ELION, S.A · Farell 9 ·	E - 08014 Barcelona	Tel.: (34) 3/2982030	FAX: (34) 3/2965632
New Zealnd	Pneumatic Elec. Contr. Syst. (PTY) Ltd. · P.O. Box 47396	ZA - Durban / Greyville 4023	Tel.: (27) 31/23-2353	FAX : (27) 31/23-7421
Tunesia	H 2 M · 13, Rue El Moutanabi	TN - 1004, El Menzah	Tel.: (216) 1/238518	FAX : (216) 1/752599
India	Amtech Electronics PVT. LTD. · E-6, Gidc Electronics Zone	IND - Gandhinagar - 382044	Tel.: (91) 2712/25324	FAX : (91) 2712/24611

KEB-Antriebstechnik Ges.m.b.H.
Ritzstraße 8 • A - 4614 Marchtrenk • Austria
Tel.: 0043 / 7243 / 53586 - 0
FAX: 0043 / 7243 / 53586-21

Via Newton, 2 • I - 20019 SETTIMO MILANESE (Milano), Italy
Tel.: 0039 / 2 / 33500782
FAX: 0039 / 2 / 33500790

KEB (UK) Ltd.
6 Chieftain Buisiness Park, Morris Close
Park Farm, Wellingborough
Great Britain - Northants, NN8 6 XF
Tel.: 0044 / 1933 / 402220
FAX: 0044 / 1933 / 400724

Z.I. de la Croix St Nicolas
14, rue Gustave Eiffel
France - 94510 LA QUEUE EN BRIE
Tél.: 0033 / 1 / 49620101
FAX: 0033 / 1 / 45767495

KEB - YAMAKYU Ltd.
711 Fukudayama, Fukuda
Japan - Shinjo City, Yamagata (996)
Tel.: 0081 / 233 / 29 / 2800
FAX: 0081 / 233 / 29 / 2802

Karl E. Brinkmann GmbH
Postfach 11 09
D - 32677 Barntrup, Germany
Tel.: 05263 / 401 - 0
FAX 05263 / 401 - 116

KEBCO
POWER TRANSMISSION

KEBCO Inc. • USA Headquarters
1335 Mendota Heights Road
St. Paul, MN 55120
PH:800-899-3226 / 651-454-6162
FAX:651-454-6198
WEB:www.kebco.com

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