GEORGII KOBOLD

AUGUST HEINE GmbH & Co

Digital
Frequency converter
for the rotational speed control
of 3-phase asynchronous motors
0.25 kw to 0.75 kw

unit description 221077E, 01/00

This operating instruction apply for:

- KFU .. / 230 - A - DF3

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The relevant regulations regarding safely engineering and radio interference suppression must be observed in the use of the unit.

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1. General

1.1. Technical features

The rotation speed of three-phase induction motors can smoothly be adjusted using the KFU .. / 230 digitalized frequency converters. The converter works according to the principle of sine-weighted pulse width modulation. Pulse width modulation is controlled by a dual processor system. Communication is performed via a conventional plug-in terminal block. Control connections 1-19 of the frequency converter are floating.

At all devices, a protection of the power module in case of undervoltage, inadmissible converter temperature or short-circuit on the converter output is guaranteed.

1.2. Special features

The practical design offers the following advantages:

- ☞ four different installation positions optimize the installation and minimize the space requirement in the switching cabinet
- ☞ no additional expenses for direct mounting on machines due to pre-wired power line and motor cables as well as built-in potentiometer and power switch according to customer requirements.
- ☞ built-in braking chopper (optional)

Plug-in type operator interface for different installation positions offers the following advantages:

- ☞ 3-line LC-display
- ☞ plain text display
- ☞ memory for four files
- ☞ 5 operator languages
- ☞ on-line parameterization

Easy parameterization via comfortable PC user interface:

- ☞ RS-232 interface as standard
- ☞ 4 programmable parameter sets each with 3 freely selectable set values for positioning tasks or multi-axis drives.
- ☞ programmable input/output terminals

High operational safety due to:

- ☞ aluminum cases and standard input/output filters provide high noise immunity and only slight noise emissions
- ☞ short-circuit protection
- ☞ the new CCDS-SYSTEM (current-control dynamic scan) prevents the converter from switching-off at excess current flow

☞ potential isolated set value input

1.3. Delivery and packaging

The converters are delivered packed in carton boxes.

☞ Please check for transportation damages.

Please notify immediately the shipping company and let them confirm the damage if you find any outside traces of damages.

Then, inform the supplier of the damage.

1.4. Commissioning notes

The setup location should be selected to allow for sufficient clean and dry airflow for cooling the enclosure. The devices are designed for indoor use. A larger concentration of dust, chemical active substances, fungoid growth, or the penetration of pest can cause a failure of the device.

For thermal reasons, the device has to be mounted vertically.

Special attention has to be paid to sufficiently cool the device when mounting it in a control cabinet.

1.5. Maintenance

Fundamentally, the converters are maintenance-free.

Depending on dust in atmosphere, the air filters of cabinet devices must be regularly controlled and be cleaned if required. With increased pollution, check the isolating gaps and heat sinks more frequently and clean where appropriate.

Cleaning of the devices is only permissible with halogen-free agents!

2. Connection and operating conditions

The perfect function of a frequency converter is only then guaranteed if the mains voltage is applied and it does not exceed or fall short of the defined tolerance zones. The tolerance zones of the frequency converter correspond to the guidelines defined in VDE 0160.

All conducting connections still carry voltage after shutdown of the supply voltage until the intermediate circuit condenser has been unloaded (approx. 90 sec). Only in terms of this time, the converter can be considered to be voltage-free.

Cabling work on the terminal block may only be carried out with a voltage-free converter.

After taking out of service, the devices are to be disposed as requested by applicable laws or regulations.

2.1. VDE regulations

☞ The VDE regulations for installing and operating electric equipment are absolute to be considered.

2.2. Motor cables

With this converter principle, the motor insulation is burdened in addition by the switching edges in the voltage. Long motor cables can cause voltage increases which are not admissible in some applications.

Therefore, the maximum admissible motor cable length totals approx. 100 m. Using an external "output choke" option, the length can be further increased. The actual maximum motor cable length depends essentially on the wiring of the cables (e.g.: underground, cable routing, etc.). To guarantee an EMC (electromagnetic compatibility) conforming operation, shielded cables (e.g.: LIYCY; cable cross section 1,5 mm²) **must** be used. The screen is to be connected to the therefore anticipated boltusing an area as large as possible.

In no case, a connector must be wired between motor and converter.

2.3. Analog and digital control line

Shielded cables are to be used for all analog and digital control lines. Control lines and power lines must be routed separately.

3. Parameterizing using the operating interface

3.1. Connection and operation of the plain text display

The operator interface with a 3-line backlit display is one possibility of setting the parameters of the KFU. The connection of the operator interface to the converter is shown in Figure 1

The parameterization is performed quickly and simply on the basis of the clear menu structure (refer to Figure 1) and the parameters displayed in plain text. The PRG key must be pressed to change a selected parameter The cursor starts to flash. The value can be chaged using the UP, DOWN, PRG, or SH keys. Finally, the changes must be svaed by simultaneously pressing the PRG and SH keys.

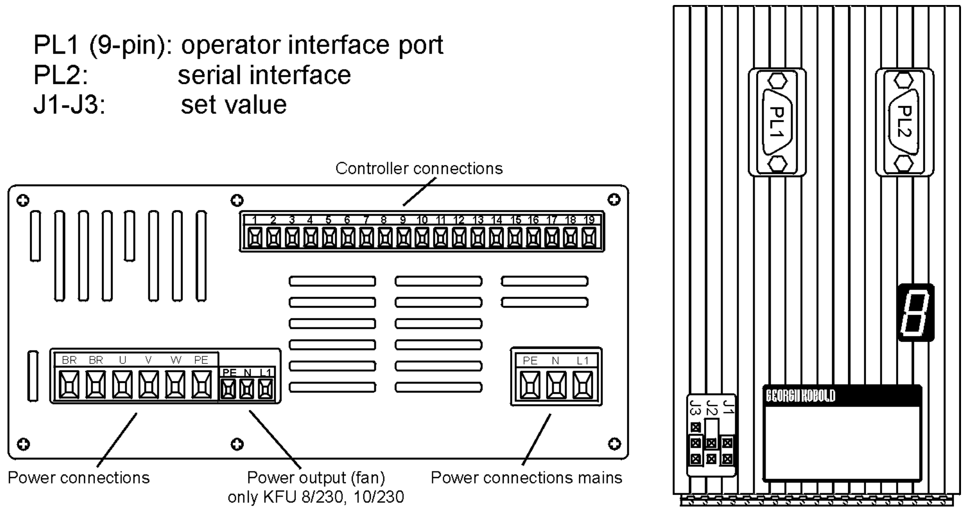

Figure 1: Connector arrangement

Only connect the user interface with the voltage switched-off!

3.2. Operating values

The "Operating values" menu item enables an operation status request with regard to the following visible messages:

preset value / Hz	current preset value of the rotary field frequency
actual value / Hz	actual value of the rotary field frequency
TC active current / Amp	current temporary circuit- active current
parameters	current active parameter set
conv. temp. / °C	current converter temperature
version no.	version number of the device software

3.3. Error messages

☞ Voltage too high

Admissible intermediate circuit voltage exceeded.
Possible cause:
1. Running-down to fast.

☞ Vltg. too low

Dropped below the admissible intermediate circuit voltage.
Possible cause:
1. Mains voltage to low.

☞ Conv. temp. to high (stage 1: only as user information)

Critical operating temperature of the converter.
Possible cause:
1. Environment temperature too high.
2. Air circulation to low.

☞ Conv. temp. inadm. (stage 2: converter switches off)

Operating temperature of the converter is inadmissible (results in switching off of the converter)
Possible cause:
1. Environment temperature too high.
2. Air circulation to low.

☞ Short circuit

Short circuit or inadmissible high output current
Possible causes:
1. Set corner frequency to low
2. Static and (or) dynamic BOOST set to high
3. DC brake set to high
4. Running-up time to short
5. Running-down time to short
6. External short circuit on the outputs

☞ Motor temperature to high

1. corner frequency set too low.
2. static boost set too high during longer lasting operation of the motor with low rotary field frequencies
3. Clock operation with short running-up times

☞ I^2t error

Programmed current integral error exceeded overdue

4. The menu structure

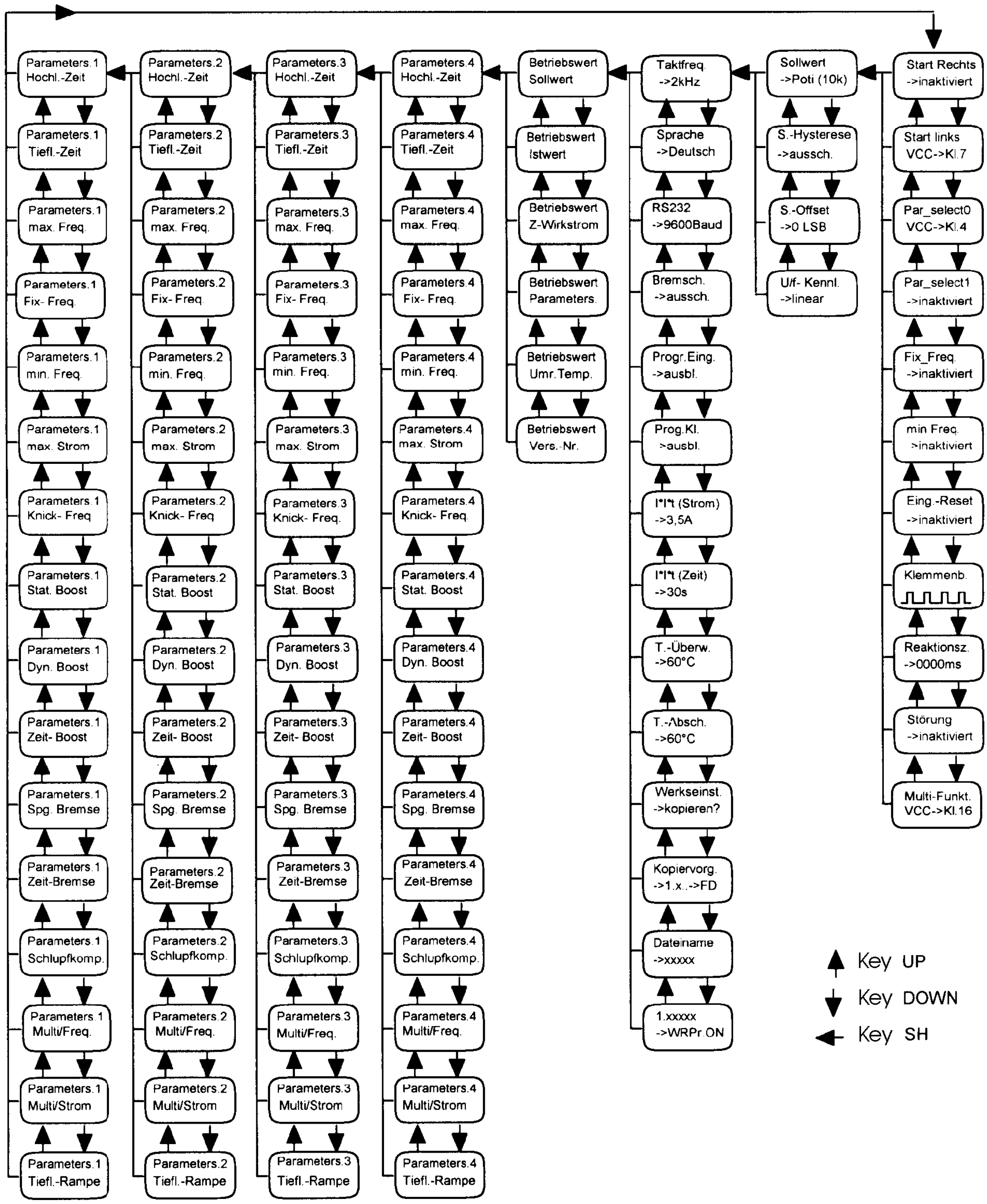

Figure 2: The menu strucutre

5. Parameter list

The values of all parameters stored in the KFU are shown in tables Table 1 and Table 2. These values become active after enabling the factory setting (cf., section 9.9). Tables Table 3 and Table 4 offer the possibility of entering individual parameters. Parameter set 2 is active if no further wiring is carried out (refer to 9. and 11.).

Parameter set-depending variables				
Parameter set	**1**	**2**	**3**	**4**
Run.-up time	2.0 sec.	6.0 sec.	6.0 sec.	6.0 sec.
Run.-down time	2.0 sec.	6.0 sec.	6.0 sec.	6.0 sec.
Max. frequency	120 Hz	120 Hz	120 Hz	120 Hz
Fix frequency	40 Hz	40 Hz	40 Hz	40 Hz
Min. frequency	0 Hz	0 Hz	0 Hz	0 Hz
Max. current	3.0 A	3.0 A	3.0 A	3.0 A
Corner freq.	50 Hz	50 Hz	50 Hz	50 Hz
stat. boost	4 %	4 %	8 %	8 %
dyn. boost	0 %	0 %	0 %	0 %
Time boost	0.0 s	0.0 s	0.0 s	0.0 s
Brake voltage	0 %	0 %	0 %	0 %
Brake time	0.0 s	0.0 s	0.0 s	0.0 s
Slip compens.	0.0 %	0.0 %	0.0 %	0.0 %
Multi freq.	100 Hz	100 Hz	100 Hz	100 Hz
Multi current	0.0 A	0.0 A	0.0 A	0.0 A
Ramp	1 (ON)	1 (ON)	1 (ON)	1 (ON)

Table 1: Factory-set parameters

Parameter set-independent variable				
General			**Progr. terminals**	
Clock freq	. 2 kHz		Inputs	
Language	English		Start cw	cl. 8
RS 232	9600 baud		Start	ccw cl. 7
Brake chopper	deactive		Par selec. 0	cl. 6
Progr.	cl. fade out		Par selec. 1	deactivated
Display P.	P.-set 1-2		Fix frequency	deactivated
I*I*t (current)	∞		Min. frequen.	cl. 5
I*I*t (time)	∞		Input reset	deactivated
Over temp.	60ºC		Terminal ass.	
Deact. temp.	65ºC		Reaction time	0000ms
Pass word	FDxxxxxx			
Preset value			**Outputs**	
Preset value	Potentiom. (10k)		General fault	VCC --> 15
Thres. preset	activate		Multi-function	VCC --> 16
Offset preset	0 LSB			
V/f character.	linear			
Fade-out freq1	deactiveated			
Fade-out freq2	deactiveated			

Table 2: Factory-set parameters

Where have the paramerters been saved and under whitch file name ?					
Data memory	KFU	Operat. instr 1st file	Operat. instr 2nd file	Operat. instr 3rd file	Operat. instr 4th file
File name					

Parameter set-depending variables				
Parameter set	**1**	**2**	**3**	**4**
Run.-up time	sec.	sec.	sec.	sec.
Run.-down time	sec.	sec.	sec.	sec.
Max. frequency	Hz	Hz	Hz	Hz
Fix frequency	Hz	Hz	Hz	Hz
Min. frequency	Hz	Hz	Hz	Hz
Max. current	A	A	A	A
Corner freq.	Hz	Hz	Hz	Hz
stat. boost	%	%	%	%
dyn. boost	%	%	%	%
Time boost	s	s	s	s
Brake voltage	%	%	%	%
Brake time	s	s	s	s
Slip compens.	%	%	%	%
Multi freq.	Hz	Hz	Hz	Hz
Multi current	A	A	A	A
Ramp				

Table 3: Individually set parameters

Parameter set-independent variable				
General			**Progr. terminals**	
Clock freq			Inputs	
Language			Start cw	
RS 232			Start	
Brake chopper			Par selec. 0	
Progr.			Par selec. 1	
Display P.			Fix frequency	
I*I*t (current)			Min. frequen.	
I*I*t (time)			Input reset	
Over temp.			Terminal ass.	
Deact. temp.			Reaction time	
Pass word				
Preset value			**Outputs**	
Preset value			General fault	
Thres. preset			Multi-function	
Offset preset				
V/f character.				
Fade-out freq1				
Fade-out freq2				

Table 4: Individually set parameters

6. Parameterizing using the PC

6.1. The serial interface

Theserial RS-232C interface of the KFU .. / 230 is used for communication with a supervisory station. In this so-called master/slave operation, the KFU is operated as a slave that is controlled or parameterized by means of a PC, a programmable controller, a microcontroller or other facilities with an UART interface.

Figure shows the connections of the serial interface. Potential separation provides for an undisturbed data transfer.

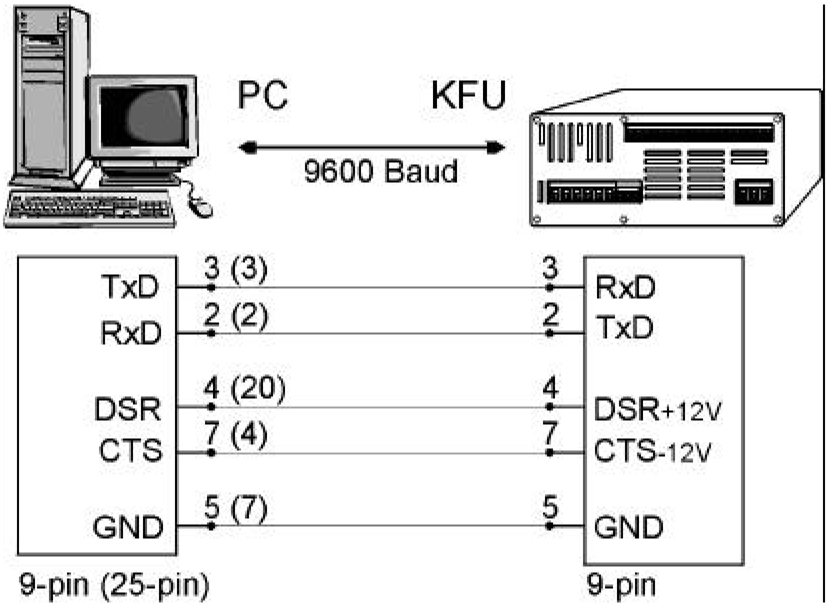

Figure 3: RS232 pin assignment

7. Outputs of the seven-segment display

Depending on operating mode of the converter (stop, cw start , ccw start, fault), important information are output for the operator via the seven-segment display.

7.1. Output at the stop

If a stop is preset for the converter then the preset value is displayed on the seven-segment display.

Example: if the set preset value is 11 Hz, then -, 0, 1,1 is shown in this sequence. These values are constantly displayed until other preset values are set or the converter is switched into another operating mode.

7.2. Output at cw or ccw start

If a cw or ccw start is preset for the converter then a line circling in the determined direction is shown on the display.

7.3. Output in case of a fault, a reset and communications with the PC

The current status of the converter is output via the seven-segment display.

1st digit	short circuit (see 3.3)
2n digit	undervoltage (see 3.3)
3rd digit	overvoltage (see 3.3)
4th digit	converter temperature too high (see 3.3)
4th digit	(flashing) converter temperature inadmissibly (refer to 3.3)
5th digit	motor temperature too high (refer to 3.3)
6th digit	not used
7th digit	I 2 x t (the integral of the current across the time was exceeded refer to 3.3)
8th digit	not used
9th digit	not used
letter C	communications with the PC (refer to 6.1.)
letter F	reset active (refer to 11)

8. Four programmable parameter sets

8.1. Running-up time

Time in which the motor will reach the previously set maximum frequency starting at 0 Hz using a ramp set value. (Value range: 0,0 to 120,0 sec. provided that the 0,1 Hz /sec. to 1000 Hz /sec. limit values of the ramp slope are observed.) With 0,0 sec., the actual value follows directly the set value without ramp!

The running-up time always relates to the adjusted maximum frequency. The quotient: maximum frequency/running-up time yields the so-called ramp. This designates the rotating field frequency change per time unit. One ´steep' ramp is equivalent to a short running-up time. One' flat' ramp is equivalent to a long running-up time. Deficiently entered running-up times, i.e. running-up times not lieing within the limit values stated above are automatically corrected by the controller of the converter. With a maximum frequency of 5 Hz and a running-up time of 100 seconds (corresponding to a ramp slope of 0,05 Hz/ second) the controller will adjust the running-up time to 50 seconds. The adjusted running-up times must always be application-specific, taking the physical realities resulting out of this into account. Especially short running-up times can influence the motor stability or cause a switch-off of the converter due to excess current. A sensible feeling is also required when determining sufficient long running-up times for large centrifugal masses. If very high currents appear during a fast running-up, the set running-up ramp is dynamically flattened by the converter resulting in an unexpected long running-up time.

8.2. Running-down time

Time in which the motor will reach 0 Hz starting at the previously set maximum frequency using a ramp set value of 0 V. (Value range: 0,0 to 120,0 sec. provided that the 0,1 Hz /sec. to 1000 Hz /sec. limit values of the ramp slope are observed.) With 0,0 sec., the actual value follows directly the set value without ramp!

As for the running up time, the running-down time always relates to the set maximum frequency. Essentially the explanations given in the section "Running-up times" also apply here. When selecting inappropriate short running-down ramps (especially with large centrifugal masses) overvoltages in the intermediate circuit can cause a switch-off of the converter. Since in this operating state the rotating field frequency applied to the motor is slightly less than the frequency of the motor shaft, energy will be fed back (generator operation) resulting in an inadmissible increase of the intermediate circuit voltage in the converter.

Use a braking chopper the excessive intermediate circuit voltage is reduced If the special application does not admit longer running-down times. The braking chopper will convert the energy produced in the generator operation into heat losses.

8.3. Maximum rotating field frequency

The maximum rotating field frequency to be set in advance that the converter should never exceed even if the utmost set value (valid range: 0 V to 10 V) is applied to the analog input.

(Value range: fixed rotating field frequency - 250 Hz)

8.4. Fixed rotating field frequency

Fixed frequency, the converter assumes regardless of the default analog set value.

(Value ranges:minimum rotating field frequency - maximum rotating field frequency)

Note: For activating this function, an input must be re-programmed since only a limited number of inputs are available (refer to section 11.1).

8.5. Minimum rotating field frequency

The minimum rotating field frequency to be set in advance that the converter should not drop below even if the lowest set value is applied to the analog input.

(Value range: 0 - fixed rotating field frequency)

This means that the specified value may not exceed the fixed rotating filed frequency value defined in section 8.5.

Note: Only for pre-setting: a min. frequency of 1 Hz will result in a frequency of 0 Hz with an applied set value of 0 volt. With a set frequency exceeding 1 Hz, a frequency of 0 Hz can only be obtained via a STOP or a RESET. The turning direction defined with the minimum frequency depends on the polarity of the applied set value voltage.

8.6. Current limiting

Current to be set in advance that the converter tries to limit itself to by holding the rotating field frequency or by lowering this frequency.

(Value range: 0.4 -10.0 amps)

8.7. Corner frequency

Rotating field frequency, the motor is operated with when the converter is supplying the maximum voltage. (Value range: 30 -250 Hz)

With an increased/decreased the stator frequency, the number of rotor rotations is also increased/ decreased. With an increasing number of rotor rotations, the induction voltage also increases. To preserve a constant torque at different number of rotations, the magnetic flow must however be kept steady. This results in the consequence that the proportionality must be guaranteed between rotating field frequency and voltage, e. g. the output voltage increases linearly with the rotating field frequency. This relation is guaranteed up to the corner frequency. Above the corner frequency, the converter cannot increase the voltage anymore. But with an increased frequency, the magnetic flow cannot be held steady any longer. The motor is now operated in the so-called field weakening range. With an increased frequency the motor torque is now reduced conversely proportionally to the rotating field frequency. As a consequence the motor should usually be operated only up to the corner frequency. At a high number of rotations the frictional losses are unproportionally high increased (e. g.: by the fan). If the torque to be achieved becomes too large, the motor 'tips' , i.e. the torque submitted by the motor suddenly falls and the number of shaft rotations quickly drops to low values. A restart is only possible by drastically reducing the rotating field frequency or by a new start.

With the corner frequency set to low for the respective motor a destruction of the motor can be caused by thermal overload. The converter might also be switched off by excess current.

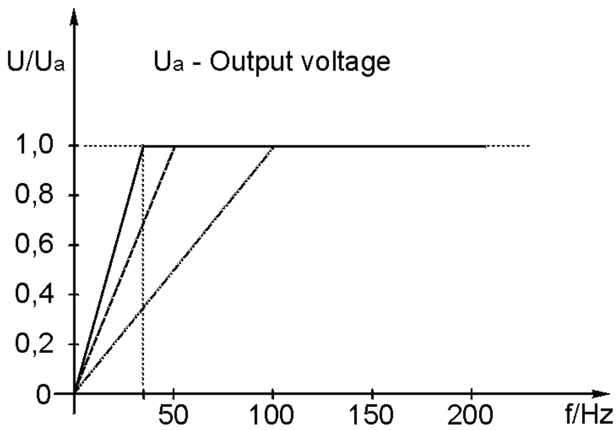

Figure 4: Standadized output voltage as function of the corner frequency (linear V/f characteristics)

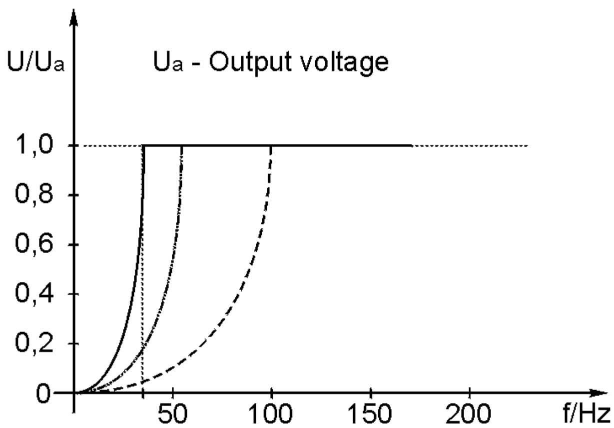

Figure 5: Standadized output voltage as function of the corner frequency (square V/f characteristics)

8.8. Static boost

Deviating from the linear V/f characteristics, this voltage increase is specified in percent of the nominal voltage for increasing the starting torque at low rotating field frequencies.

(Value ranges: 0 - 30%)

With low rotations, the copper resistance of the stator winding strongly influences the operating characteristics of the motor. Without voltage correction, the breakdown torque is significantly reduced towards low rotating field frequencies. During slow starts it could happen that the motor does not start due a too high breakaway torque to be obtained. By using a voltage increase - the so-called BOOST - the starting torque is increased. The amount of the BOOST is specified in percentage of the nominal voltage at 0 Hz. With an increasing frequency, the voltage is continually raised starting at this value and approaches thereby the normal (linear) V/f characteristics: V/f = const. A constantly available voltage increase is called ´static BOOST´. The range of the voltage increase extends to about up to a frequency of 2/3 of the corner frequency. To prevent a torque step during transition of the BOOST to the V/f=constant characteristics, all characteristics of the static BOOST end at the V/f characteristics.

Good starting torques are achieved with a BOOST setting of 8%. Exaggerated high values result in an increased motor temperature which can result in the destruction of the motor by overheating, particularly if no forced cooling is used. A high BOOST value can cause an excessive current resulting also in the switch-off the converter.

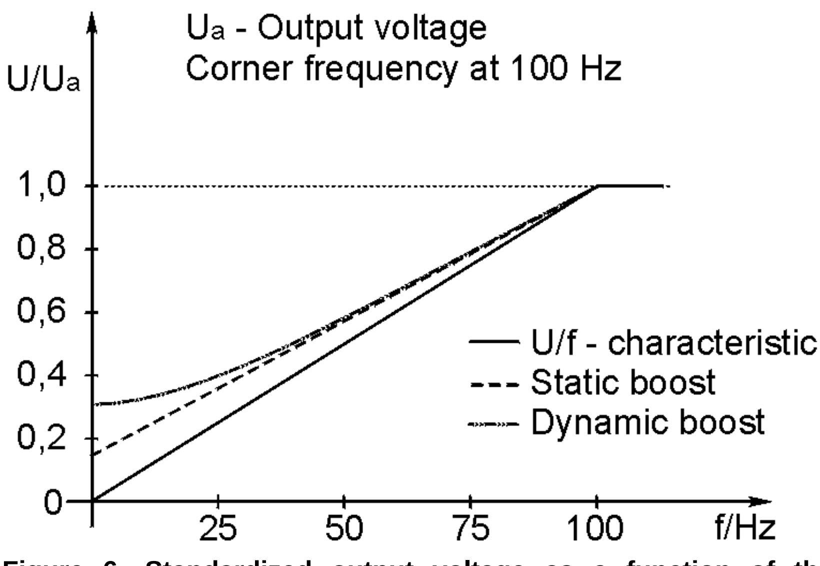

Figure 6: Standardized output voltage as a function of the frequency and boost

8.9. Dynamic boost

Deviating from the linear V/f characteristics, this "timely limited" voltage increase is specified in percent of the nominal voltage for increasing the starting torque at low rotating field frequencies.

(Value ranges: 0 - 30%)

By using the dynamic BOOST the motor is exposed to a thermal limited minimal burden. The dynamic BOOST is added to a possibly present static BOOST. The same explanations apply as for the static BOOST.

8.10. Temporally limited boost

During the running-up the dynamic boost is activated for the set duration when exceeding 1Hz.

(Value range: 0.1 - 25.0 sec)

8.11. DC brake

Value specified in percentage of the nominal voltage which determines the stopping torque (torque at standstill) of the motor ("DC brake").

(Value range: 0 - 20%)

Note: Despite a high torque generated by the motor at a rotating field frequency of 0 Hz, the motor shaft can slowly be rotated by an externally applied torque since this is not a regulated system.

8.12. Duration of the DC braking

Temporal duration of the effectiveness of the DC brake.

(Value range: 0.1 - 25.0 sec.)

To prevent a thermal overload of the motor, the DC brake is limited to a maximum of 25 seconds and it is activated when reaching 0 Hz. DC braking can either be activated by applying a set value of 0 V or by a STOP command. DC braking remains active for the entire preset time if the set value is not increased again during braking or a START command is issued. During reversing, DC braking is not activated.

8.13. Slip compensation

Compensation of the difference of the rotating field frequency and rotor frequency.

(Value range: 0.1 - 25%)

8.14. Multi-function output (frequency)

For setting the rotating field frequency at which the multi-function relay should be activated. This relay function is activated by specifying a default value greater than ZERO.

(Value range: 2 - 250 Hz)

8.15. Multi-function output (current)

For setting the amount of current at which the multi-function relay should be activated. To activate this function, the value entered for the “Multi-function output/frequency” parameter must be ZERO.

(Value range: 0.1 - 20.0 amps)

8.16. Running-down ramp 1 = ON, 0 = OFF

With no signal applied to the Start/Stop input and 1 (ONE) was specified for this parameter, the converter reduces the rotating field frequency corresponding the set running-down ramp. Otherwise, the converter releases the motor shaft immediately.

9. Parameter set-independent presettings

9.1. Clock frequency

Frequency, the inverter of the power circuit is clocked with.

The following values are admissable: 1, 2, 4, 8, and 16 kHz.

Note: With the exception of 16 kHz, the clock frequency will be noticed as more or less loud noise. The lower the clock frequency, the lower the switching power loss in the power circuit and thus the warming-up of the converter. The best motor characteristics are achieved using 2 kHz and up. The clock frequency of 16 kHz should only be used in exceptional cases due to the increased heating of the converter. A sufficient ventilation of the converter is to be guaranteed if it is selected. Possibly, the power must be reduced.

9.2. Language

Language used for the operator prompts.

The following languages can be selected: German, English, French, Italian, and Spanish.

9.3. Braking chopper (optional)

This option must be activated at devices with intergrated braking chopper and an externally connected braking resistor. Using a resistor the energy produced in the generator operation in the temporary circuit will be converted into heat losses (refer to section 15.1).

9.4. Display/hide the menu for the programmable input terminals

Using this function the display of the programmable inputs can be suppressed (if no programming of these are not required).

9.5. Show parameter sets

The number of parameter sets to display.

9.6. I^2t current / I^2t time

The I^2t function is used to avoid a thermal overloading of the motor and/or to avoid a motor operation over an extended period in a spurious operation (e.g. shaft blocking). The current value above the normal operating state is entered for this aim. An accordingly long time must be enetred to avoid a shutdown of the converter with short current peaks.

9.7. Temperature monitoring

The integrated temperature monitoring enables the output of a warning signal while exceeding the set temperature. The warning is shown on the operating interface in the form of a flashing "converter temperature too high" message.

Furthermore, there is the possibility to output the warning signal to the programmable digital outputs (refer to 11.2)

9.8. Temperature switching-off

While exceeding the set temperature, the switching-off of the frequency converter is performed paralled by outputting the "converter temperature inadmissible" message and the signalling of the digit 4 on the seven-segment display.

9.9. Factory settings

The factory settings is activated by selecting " → copy? Y "and causes the overwriting of every parameter with the preset factory values (cf., section 5).

9.10. Copy process

The operating interface contains a memory that enables the storing of four files. A file contains all parameters available in the frequency converter (refer to figure Figure 7). Furthermore, the possibility exists to assign a file an individual file name consisting of eight freely selectable charcters. This file name is read on-line without initiating a copy operation. Eight question marks shown instead of a file name signal a missing memory (memory area).

The following examples should clarify the structure and the program execution of the possible copy operations.

1. Band1 --> FD copies the 1st file of the operating interface with the Band1 file name into the

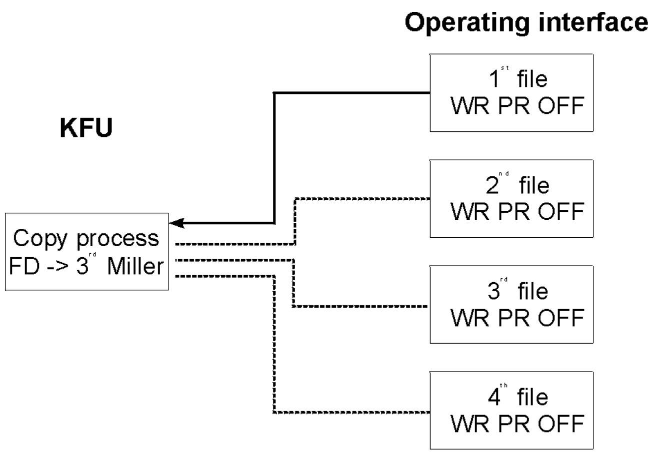

Figure 7: 1st example of a copy process

FD -> 3. Milling machine	copies all parameters of the FD to the 3rd file of the operating interfaces with the **Miller** file name (precondition: write protection is inactive)

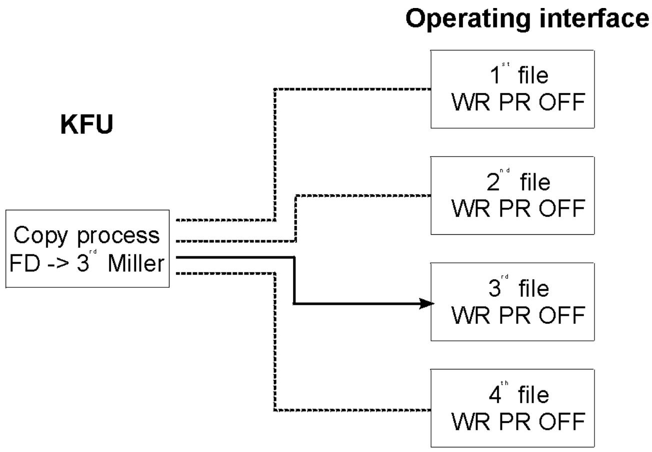

Figure 8: 2nd example of a copy process

9.11. File name

A file name with eight freely selectable characters can be entered for the designation of the parameters stored in the FD. While copying all parameters of the FD into the memory of the operating interface, the file name offers a designation possibility of the four files (refer to 9.11).

9.12. Write protection

The write protection refers exclusively to the four files of the operating interface. It is used as a safety measure concerning operating errors with regard to unintentional overwriting of files. With active write protection, a file can only be read by the frequency converter. The attempt to overwrite a protected file is prompted by an error message.

10. Set value assignment

10.1. Set value

The set value presetting can alternatively be made by specifying

1. a master reference voltage (preset value input, refer to section 10)
2. an impressed current (preset value input, refer to section 10)
3. a frequency (preset value input, refer to section 10)
4. by using the push-buttons (UP and DOWN push-button of the operating interface) or
5. by means of a PC via the RS-232c interface (refer to section 6.1)

Corresponding to this specification, jumpers must be setthat are located in the device directly behind the terminal strip of inputs 1 - 2:

Jumper settings for the different types of set value specifications

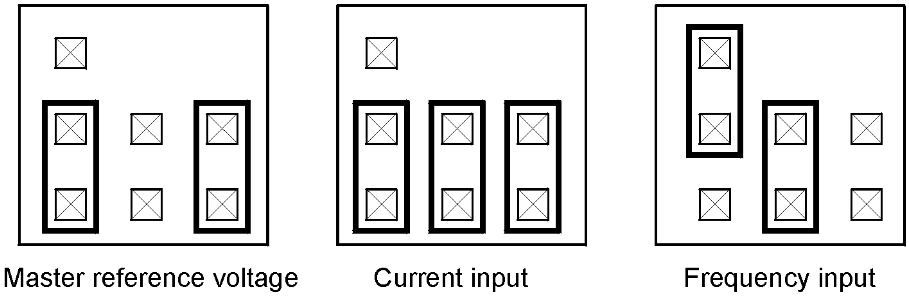

Figure 9: Jumper settings

After a RESET, the rotary field frequency stored as fixed preset value is enabled during activation of the preset value assignment via push-button. In the push-button mode, the fixed preset value is stored by setting the desired rotary field frequency using the UP/DOWN keys and the subsequent acknowledgement using the PRG, SH keys (press simultaneously).

The push-button mode is deactivated by pressing the PRG key for more than 5 seconds and by selecting any other preset value.

Indipendently of what preset value specification is selected, the preset value input of the converter must be wired!

If for example, no master voltage and no potentiometer is used then the simplest possibility of wiring is a jumper between terminal 2 and terminal 3 (fmin) or a jumper between terminal 1 and terminal 2 (fmax).

10.2. Set value - Hysteresis

Stabilization of the pre-defined rotating field frequency.

10.3. Set value - Offset

Specification of an offset (e. g. to compensate for noise).

In figure Figure 10 it is shown how the original characteristic is affected by a positive or negative offset.

1 LSB corresponds to an input voltage of approx. 10 mV or an input current of 20 µA!

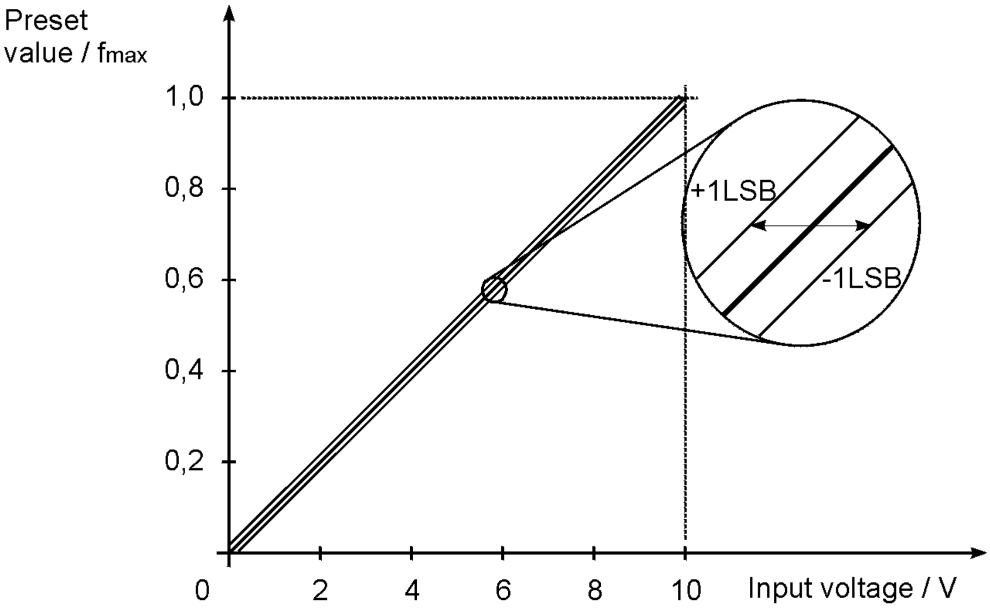

Figure 10: Preset value offset with 0 .. 10 V, 0 .. 20 mA preset assignment

10.4. V/f characteristics

A selection can be made between the linear V/f characteristics (with the output voltage being proportional to the rotating field frequency) and the square characteristics (“fan characteristics” with a squared output voltage increase in relation to the rotating field frequency) whereby the reference point is the corner frequency.

10.5. Fade out frequency1, fade out frequency2

In case of resonance effects in drive systems, two frequency ranges can be defined disabling any stationary operation. The definition of a frequency range is made by means of programming a fading frequency ±2 Hz. A reference value specification within this range causes an offset of the actual value (refer to figure Figure 11) above or below the limiting frequencies.

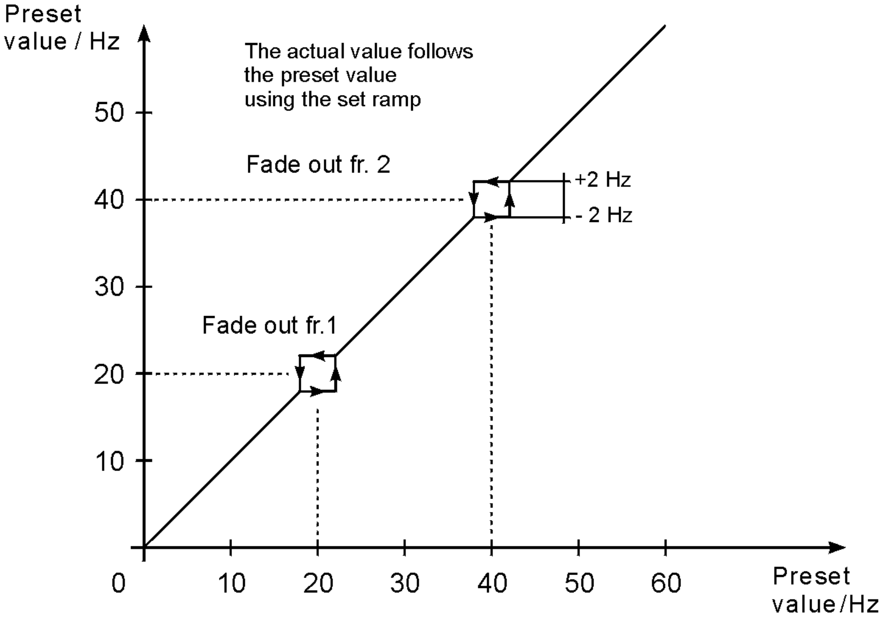

Figure 11: Rotating fieled frequency using the fade out frequencies

11. Programming of the digital inputs/outputs

The digital inputs and outputs of the KFU are programmable. They can be assigned to the converter functions mentioned in sections 9.

A special feature of the digital inputs is the programmability of a multifunctional terminal and four logical linking possibilities. Furthermore, the evaluation of the input signals at terminals 5, 6, 7, and 8 can be programmed independently of the function parameters (refer to figure Figure 12) by means of the "terminal assignment" parameter. A definable "reaction time" is used for the suppression of noise signals or bouncing times of switch contacts.

As described in section 9.4, it is required to display the menu for the parameterization of inputs/outputs.

11.1. Parameterization of the control inputs

The following functions can be applied to terminals 5, 6, 7, and 8. The assignment of several functions to one input is possible (refer to section 11.1).

(1) cw start

(2) ccw start

(3) parameter set changeover 0

(4) parameter set changeover 1

(5) f min

(6) f fix

(7) input reset

The logical linking and inversion of input terminals is defined as follows:

☞ Kl. 5 ---> non-inverted input (high active)

☞ INV 5 ---> inverted input (low active)

☞ OR 5+6 ---> logical OR non-inverted inputs

☞ INV 5+6 ---> logical OR inverted inputs

☞ AND 5&6 ---> logical AND non-inverted inputs

☞ INV 5&6 ---> logical AND inverted inputs

The following symbols are determined for terminal assignment:

☞ level-controlled input (high active)

☞ level-controlled input (low active)

☞ edge-controlled input (positive edge-triggering)

☞ edge-controlled input (negative edge-triggering)

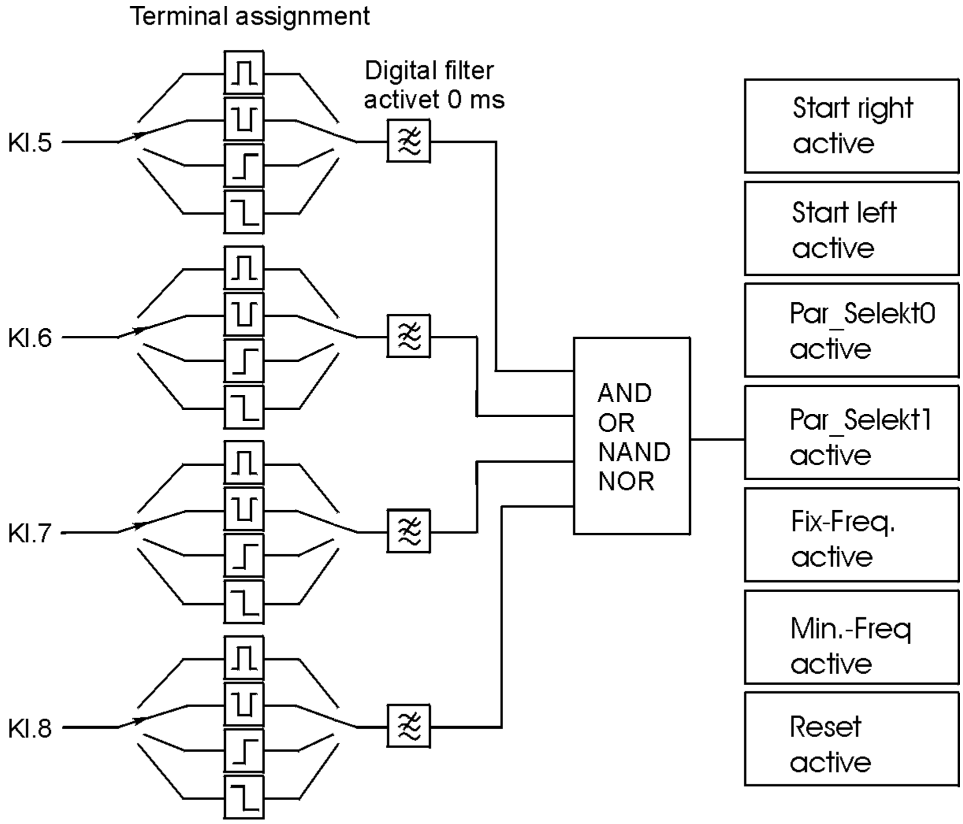

Figure 12: Configuration of the control inputs

11.2. Parameterization of the control outputs

Terminals 15 and 16 (the relay output switches together with the open collector output of terminal 6). The following functions can be assigned:

(1) multi-function	(8) excess temperature 2
(2) PTC motor temperature	(9) general fault message
(3) undervoltage	(10) zero monitoring
(4) overvoltage 1	(11) DC braking
(5) overvoltage 2	(12) ready
(6) short-circuit	(13) I²t error
(7) excess temperature 1	(14) digital output (only to terminal 15)

Furthermore, there is the possibility of inverting the outputs!

11.3. Explanations to the control inputs and outputs

Minimum rotating field frequency

With a wired input, the minimum rotating field frequency is kept independently of the set value.

Parameter set switching

The current parameter set is displayed in the ”Operating values” menu. A parameter set desired by wiring the corresponding inputs is taken over online.

	Parameter set changeover 0	Parameter set changeover 1
Parameter set 1	active	active
Parameter set 2	inactive	active
Parameter set 3	active	inactive
Parameter set 4	inactive	inactive

Table 5: Parameter set changeover

Note: For parameter sets can be activated ba re-programming the inputs and using the parameter set changeover 1 function (Par1)

Clockwise rotation start (cw start)

If this input is wired and a positive set value is simultaneously applied the motor runs up to speed withthe running-up time specified in the selected parameter set until the set value is reached and in the specified direction.

If the input is opened running-down is initiated using the set ramp of the selected parameter set up to the standstill. If the ramp of the corresponding parameter set is deactivated the shaft is immediately released.

Ccounter-clockwise rotation start (ccw start)

Refer to ´Clockwise rotation start´ with the opposite rotating direction. If ´Clockwise rotation start´ is activated in addition, it has precedence (a reversing procedure is made).

Fixed frequency

Immediate running-up/running-down to this preset value of the corresponding parameter set, independent of the currently applied set value.

Note: The fixed frequency can be activated by re-programming the inputs and using the f fix function.

Input reset

An active "input reset" function de-activates all input latches (refer to figureFigure 12) and therefore all programmable functions exclusively linked to edge-controlled inputs.

Reset

Activating this input initializes the controller and the power circuit of the converter. After this, the device is a ready to operate state.

If the input is opened the converter immediately releases the motor shaft.

PTC input

Motor protection or thermal protection as a switch

Analog output

Analog signal (0 -10V) corresponding to the current rotating field frequency.

at f max <= 127 Hz ® 127 Hz = 10 V

at f max <= 250 Hz ® 250 Hz = 10 V

Digital output (programmable function, refer to section 11.2)

Digital signal corresponding to the current rotary field frequency (0-250Hz).

Programmable digital outputs

Refer to section 11.2

12. Connection diagram

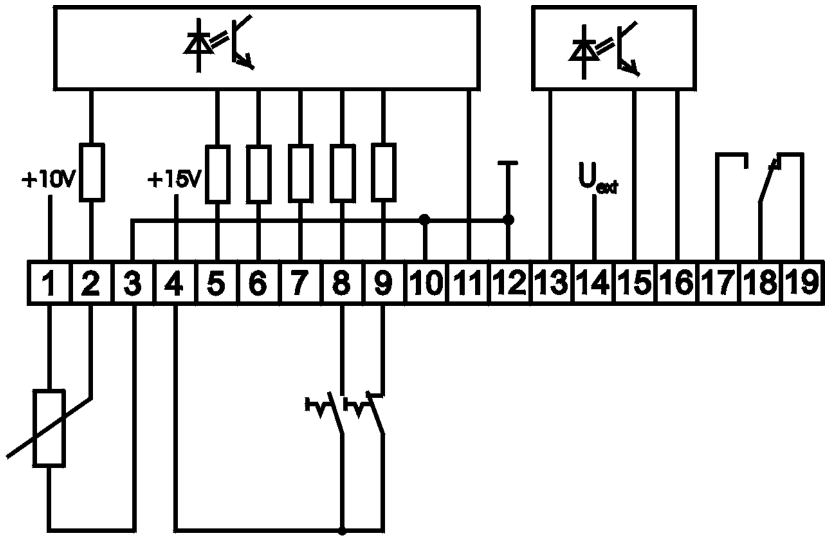

Table 6: Terminals, control stage, minimal required assignment

Pin	Description	Value
1	Reference voltage	+ 10 V-DC
2	Preset value input, analog/digital	0 .. 10 V-DC, 2 .. 10 V-DC 0 .. 20 mA, 4 .. 20 mA 0 .. 100 kHz
3	GND	Ground
4	Reference voltage	+ 15 V-DC
5	Digital input *[*]	min. rotating field frequency
6	Digital input *	parameter set changeover 0
7	Digital input *	ccw start
8	Digital input *	cw start
9	Digital input	Reset
10	GND	Ground
11	Analog input	PTC motor temp. monitoring
12	GND	Ground
13	Analog output	0 .. 10 V-DC

[*] factory settings of the 4 programmable inputs

14	External voltage input	12 .. 30 V-DC
15	Digital output 2	Programmable
16	Digital output 1	Programmable
17	Relais output	NO-contact
18	Relais output	common contact
19	Relais output	NC-contact

Table 7: Terminal assignment, control stage

Note: The digital inputs (terminals 5, 6, 7, 8, 9) are designed for a control voltage range of 12 V up to 30 V!
The open collector outputs (terminals 15,16) can be loaded 30V/40mA max.!
The relay can be loaded 250V-AC/7A max. or 30 V-DC/7 A max.!

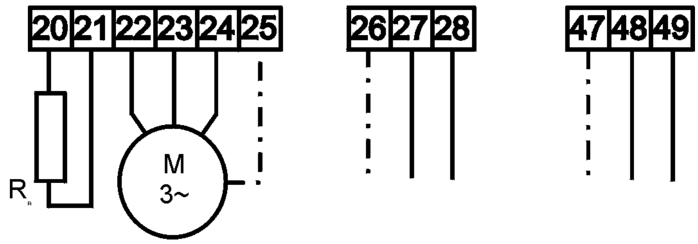

Figure 13: Terminal assignment, power stage

Pin	Description	Value
20	Input	external braking resistor
21	Input	external braking resistor
22	U	U_{mot} 3 x 0 .. 230 V-AC
23	V	
24	W	
25	PE	
26	PE	
27	N	
28	L1	
Pin 47-49, KFU 8/230, KFU 10/230 only! Voltage output for fan.		
47	PE	
48	N	
49	L1	

Table 8: Terminal assignment, power stage

13. Dimensions

	KFU 2-230 DF3 KFU 4-230 DF3	KFU 8-230 DF3 KFU 10-230 DF3
a	65 mm	130 mm
b	220 mm	296 mm
c	230 mm	310 mm
d	70 mm	80 mm
e	112 mm	180 mm
f	50 mm	40 mm
g	204 mm	270 mm
s	5,5 mm	6 mm

Table 9: Dimensions

Casing with terminal compartment, prog. unit cable lockings.

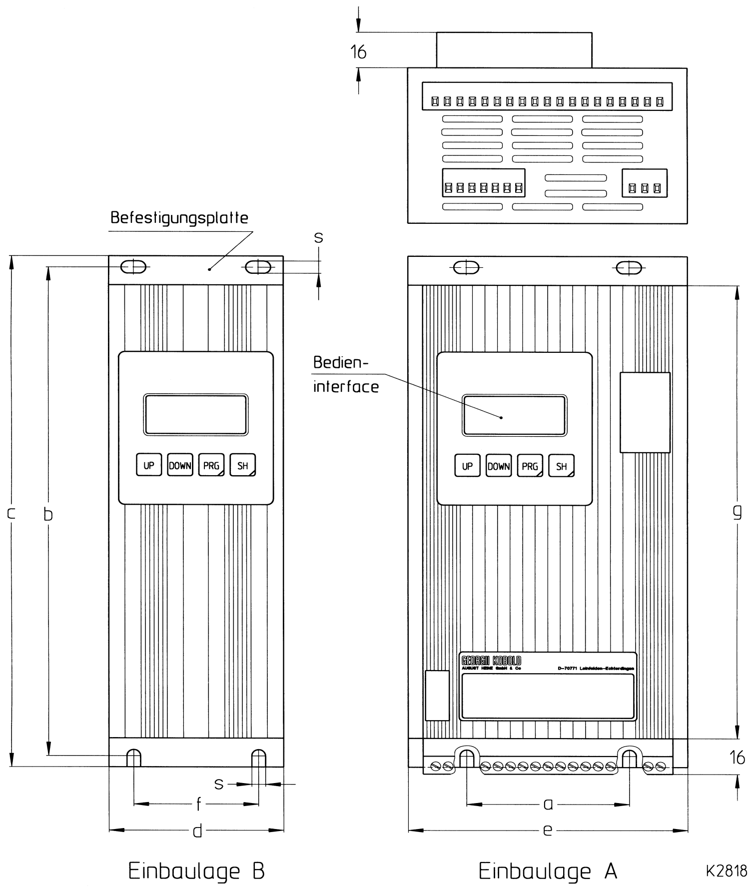

Figure 14: Dimensions

14. Technical data

Typ	KFU .../230-A-DF3	**2**	**4**	**8**	**10**
Output motor side	Device output power	0,88 kVA	1,6 kVA	3,2 kVA	3,9 kVA
	Max. motor power	0,37 kW	0,75 kW	1,5 kW	2,2 kW
	Rated output current	2,0 A	4,0 A	8,0 A	10,0 A
	Max. rated output voltage	3 x 0 .. 230 V, PWM, sinusoidal			
	Max. rated output frequency	0 .. 250 Hz + 25%			
	Output choke	internal			
Input main side	Rated voltage	400 V ±10%			
	Mains filter	internal			
	Mains frequency	50 /60 Hz ±10%			
General data	Protection class	IP 20			
	Resolution analog input	2^{12} Bit at 0 .. 10 V, 2^{6} Bit			
	Max. voltage rising time	4 kV/µs			
	Mean operating hours	~100 000 h			
	Max. surface temperature	55 °C			
	Environmental temerapure	0 - 50 °C			
	Environmentaly humidity	20 - 90% rel.			
	Weight	1,8 kg			

Table 10: Technical Data

15. Application notes

15.1. Dynamic braking using a braking chopper

The built-in braking chopper with external braking resistor enables dynamic braking of large masses without initiating a switch-off of the converter.

When braking centrifugal masses with a relatively short running-down time (brake time), the mass inertia of the entire drive works as generatoric torque.

This braking operating is equivalent to an energy feedback of the drive resulting in a temporary circuit voltage increase up to the point where the excessive voltage switch-off is initiated. By routing this braking energy into a resistor, the switching off can be prevented. The braking chopper compares the temporary circuit voltage with a reference voltage which has a voltage level below the over-voltage tripping level. When the reference voltage is exceeded a power transistor connects the braking resistor to the temporary circuit voltage. The resistor then converts the power generated by the motor in heat loss.

The braking power can be calculated with reference to the activation time (ED) of the braking resistors. Thus the breaking chopper can be individually adapted to the drive.

Recommendations for the selection of brake resistors:

The used resistors must be suited for the current and peak power. The electrical strength of the resistors must be 1000 V.

The necessary mean brake power is calculated from the peak power and the on-time of the chopper.

$$\text{Nom. power(W)} = \frac{\text{on} - \text{time duration ED(s)}}{\text{cycle time(s)}} * \text{peak power(W)}$$

In practice it showed that for most applications resistors with a nominal continuous power loss of 60 Watts are sufficient.

KFU .. / 230	Resistor	Peak power	I max
2	100 Ohm	1 kW	2.5 A
4	100 Ohm	1 kW	2.5 A
8	100 Ohm	1.5 kW	3.7 A
10	100 Ohm	1.5 kW	3.7 A

Table 11: Spezification of braking resistors

15.2. Motor protection

Despite using high-grade sine modulation when powering standard 3-phase asynchronous motors additional losses occur in the motor. Even at nominal revolutions these losses incur a power reduction whose extent depends essentially on the exploitation of the temperature ranges of the motor.

For drives with a square counter-torque (e.g.fans) and 50 Hz as maximum rotating field frequency the imposed power reduction is usually around 0 - 10%.

For drives with a constant counter-torque (compressors, conveyer belts, etc.), the power reduction has to be selected correspondingly larger depending on the range of the adjustment.

For the adjustment range,the stationary load torque must lie below the continuous operating characteristics of the motor to guarantee a safe operation of a motor. During operation and starting of the drive, it able to momentarily submit torques corresponding to the current limiting of the converter. The setting of the voltage increase (static Boost). essentially determines the maximum torque below 10 Hz. During a continuous operation an excessive high boost setting for the lower rotating field frequency range (up to 15 Hz) can cause an overheating of the motor.

An all-including thermal protection of the self-cooling motor can be achieved by means of a temperature sensor (e.g. PTC thermistor or thermal time-delay switch) built into the motor. For revolutions above 120% of the nominal revolutions, the performance of the motor has to be examined.

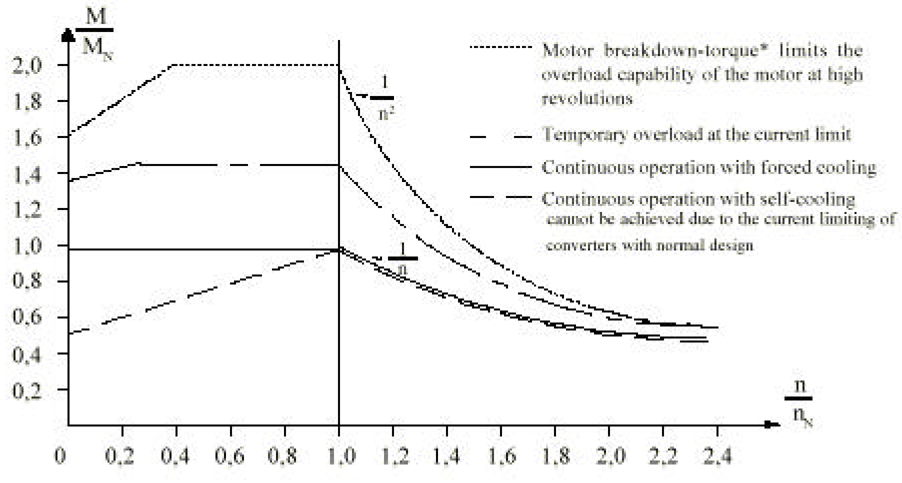

Figure 15: Operating characteristics of a frequency-controlled asynchronous machine

15.3. Cabinet mounting

Design notes:

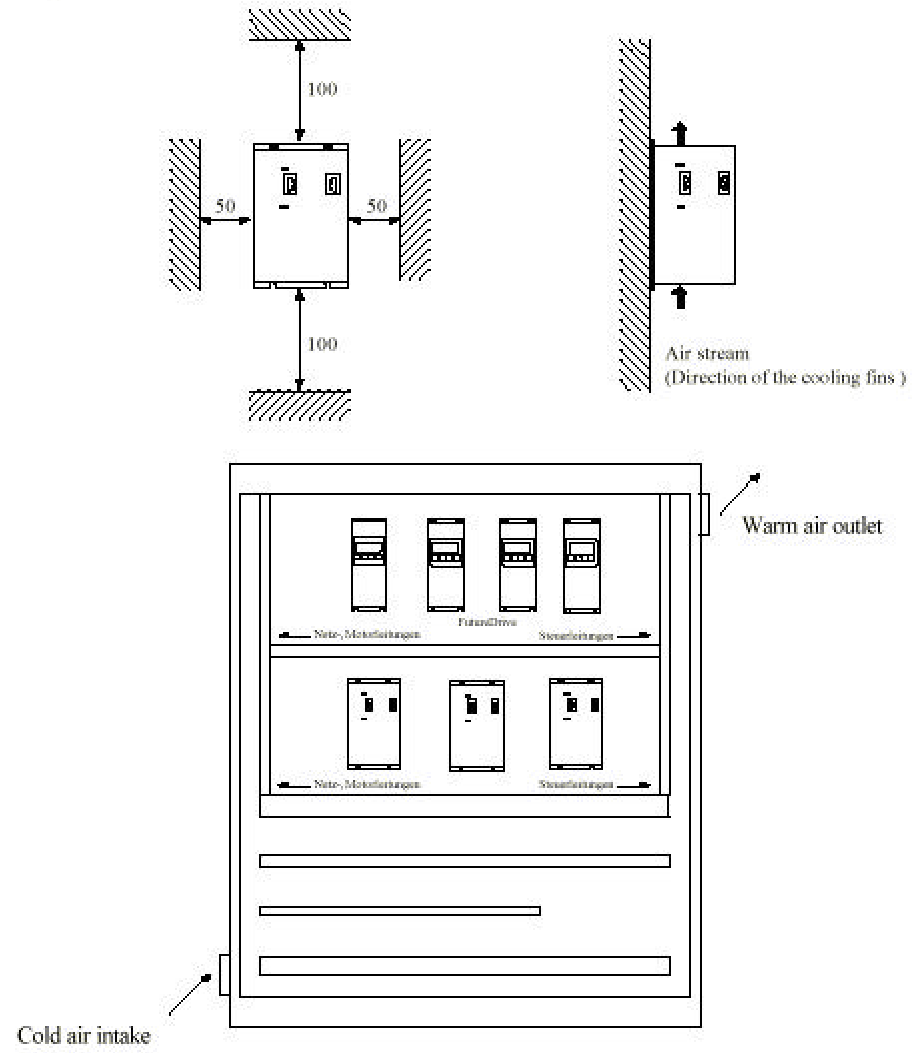

Figure 16: Cabinet mounting

15.4. Measures for securing the EMC

Subsequently measures for guaranteeing the electromagnetic compatibility are presented which are to be regarded as an imperative necessity in the area of the converter technology.

Grounding, earthing, potential compensation

The correct, professional grounding or earthing guarantees the personnel protection against dangerous touch voltages (input, output and intermediate circuit voltage). Spill current diverting and low-impedance potential compensation are important measures for reducing electromagnetic influences.

Filtering

Filters are inserted into the lead-bound transfer way between interference source and interference susceptible equipment. Their task is to reduce lead-bound transmissions as well as to increase the noise immunity. Therefore, the KFU mainsfilter and output chokes have been built-in.

Screening

Screening is used for decoupling fields of two spatial areas, i.e. it also used to decrease the emission of electromagnetic radiation and to increase the noise immunity. The consistent use of metal cases (KFU) shows one of the most important standard measures for guaranteeing the EMC.

Coupling into motor cables

Using twisted core cables can essentially reduce couplings into a circuit. Capacitive, inductive and electromagnetic interferences are reduced by using cable screens. Note that for reducing low frequency capacitive interference, generally a one-sided connection of the screening may be sufficient. Inductive and high frequency electromagnetic interference can be prevented only by connecting both sides of the cable screening.

The screening must not be used as protection earthing!!!

15.5. Warnings

According to the newest state of the technology, electronical power controllers are operating-safe electrical equipment for use in all heat engineering equipment.

!! Please take special note of safety remarks!!

Caution:

Perform work on the controllers, e.g. assembly, connection, maintenance only if

☞ the electric equipment is voltage-free

☞ protected against powering up, and

☞ all drives are standing still

Danger:

In the power-up state, electrical equipment and machines have voltage-leading and non-isolated conductors or rotating parts. After removing the operation covers and mandatory protection facilities, those wires and rotating parts can cause personnel insuries and property damages when treated and maintained wrongly and/or at non-intended use.

There is an additional danger connected with power electronical devices since it is not necessarily known by every skilled worker that the equipment might still be under voltage even after switching off of the supply voltage (capacitor chargement!). In addition for the awaiting of the discharge time (approx. 90 sec.), the residual voltage must be checked before starting the work.

Attention:

Only skilled workers who master the respectively valid safety regulations and assembly instructions are allowed to

☞ transport,

☞ set up,

☞ connect,

☞ commission,

☞ maintain, and

☞ operate

electric equipment and machines.

The safety-legal responsible of the equipment must authorize the skilled workers for the necessary activities.

Skilled workers are persons that

☞ are educated and experienced.

☞ master the respective valid standards, regulations, determinations and accident prevention instructions.

☞ have been introduced to the method of functioning and operating conditions of electric motion systems.

☞ can recognize and avoid dangers.

For the regulation concerning skilled workers

refer to VDE 0105 or IEC 364.

The use of non-qualified personnel is forbidden.

The controller and interlocks as well as the monitoring and protection functions (rotational speed monitoring, excess current a.s.o.) may not be overridden or made functionless also not during the test operation.

Equipment may only be assembled and operated in the documented order. Intended use! Each other usage is not admissible!

Storage regulations:

The instructions for the storing of electric equipment are to be observed. Please request more information if required and/or take these from the specifications!

Prevent noise and thereby avoid personnel and property damages.

The responsible for the equipment must ensure that safety notes and operating instructions are at hand and are observed,

☞ operating conditions and specifications according to the order are observed,

- ☞ protection facilities are used,
- ☞ prescribed maintenance work is performed,
- ☞ the maintenance personnel are immediately notified or the electric equipment is immediately stopped if higher temperatures, noise, oscillations etc. appear in contrast to the rated operation.

Information are contained in the operating instruction which are required by skilled workers for using the electrical equipment in industrial equipment. Additional information and notes for non-qualified personnel, for using the equipment in non-industrial equipment, and about possible drive variants are not contained in this operating manual.

A guarantee of the manufacturer is only maintained when observing and maintaining the respectively valid operating instructions