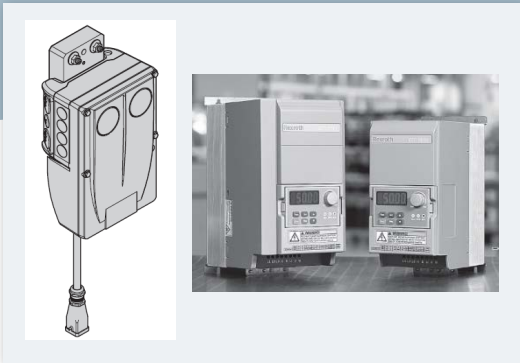


# Technical Information

## VFD Selection Guideline

Assembly Technology | TS & VF Conveyors | VFD's



**Guideline for selecting frequency converters (VFD's) for use with TS and VF conveyor systems. Including a summary of all Rexroth decentralized and centralized VFD's.**

All Rexroth TS & VarioFlow conveyor modules are powered with IE3 high efficiency, invert-duty rated motors or gearmotors. The use of frequency converters (VFD's) with pulse width modulation (PWM) technology together with any Rexroth conveyor motor requires careful attention to the selection of the VFD, as well as the overall length of the cables from the motor to the VFD. Please note the following Rexroth guidelines when selecting a VFD:

- Rexroth conveyor motors are designed to operate at a range between 16Hz and 60Hz.
- The permissible output parameters of the VFD (measured on motor terminals – including supply cable between motor and frequency converter) are:  $U_{peak} \leq 1,35kV$ ;  $t_r \geq 0,8\mu s$
- Incoming power and cable lengths should be no longer than **3M**. Consider the use of shielded cabling and DV/DT filters for longer length cables.
- Always follow the VFD manufacturer's recommendations.
- Failure to follow Rexroth guidelines and manufacturer's recommendations may result in premature failure of motors/gearmotors and voiding of warranty.

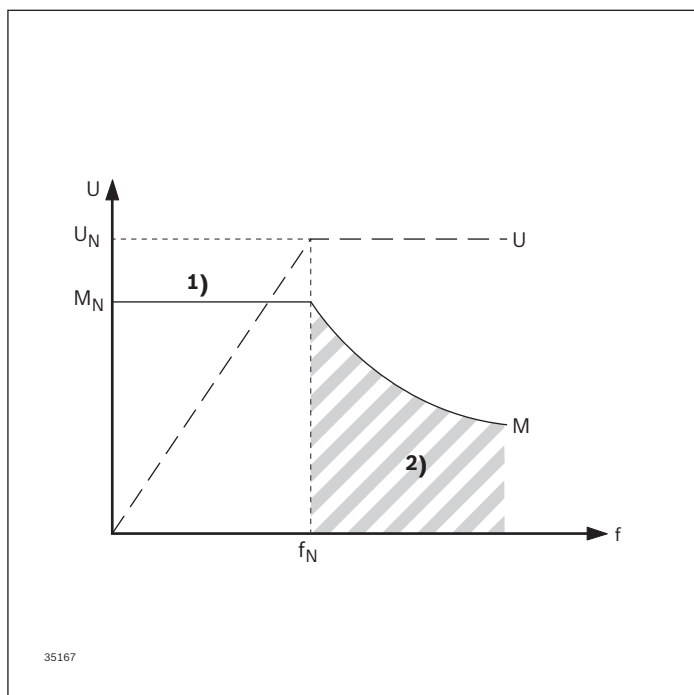
To support conveyor applications requiring variable speeds, Rexroth offers both decentralized (line mounted) and centralized (panel mounted) VFD's and accessories (including mounting hardware, communication modules, potentiometers, and connection cables). See the following TS2plus catalog pages for the complete Rexroth VFD offering.

### Documentation

- PDF Catalog Pages – attached
- Online Catalog (Decentralized VFD's): <https://www.boschrexroth.com/en/us/products/product-groups/assembly-technology/transfer-systems/ts-2plus-transfer-system/transportation-control/frequency-converter-fu>
- Online Catalog (Centralized VFD's): <https://www.boschrexroth.com/en/us/products/product-groups/electric-drives-and-controls/frequency-converters>

# FU frequency converter

## U/f mode



A frequency converter is a power converter that adjusts the frequency and amplitude of AC voltage in order to directly power three-phase motors.

- ▶ VFCplus: U/f open loop, linear and quadratic
- ▶ SLVC: Sensorless vector control (torque/speed)
- ▶ VFC eco (energy-saving function)

1 M = const.  
 2 Field weakening mode  
 f = frequency  
 f<sub>N</sub> = nominal frequency

M = torque  
 M<sub>N</sub> = nominal torque  
 U = voltage  
 U<sub>N</sub> = nominal voltage

## Operating modes

### U/f mode, U/f characteristic curve

The converter regulates motor voltage and keeps the frequency constant. Frequency and voltage are proportional to each other. Due to the inductive nature of the motor, this results in a constant torque over an extensive range without overloading the motor.

In U/f mode, the speed of the connected motor varies depending on the load.

For this reason, U/f mode is only adequate when speed does not need to be constant at all times and there is no heavy starting.

### Field-oriented controller

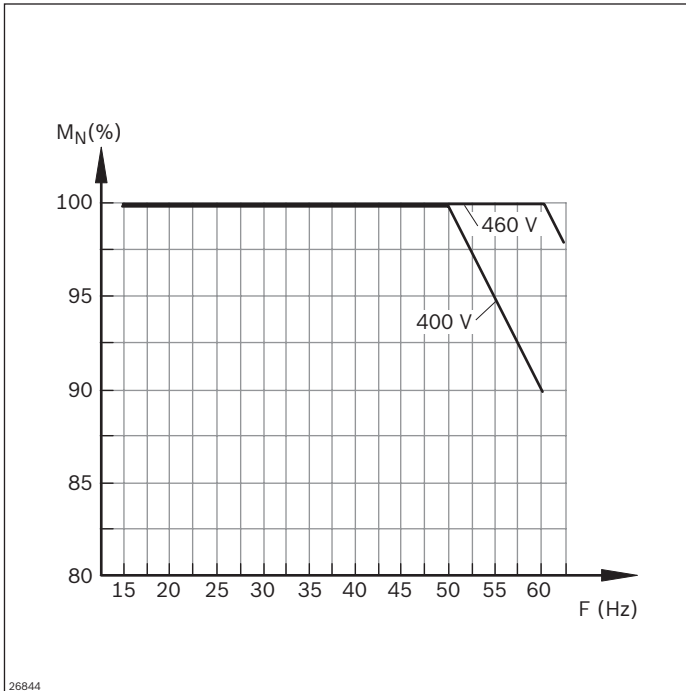
The vector controller, also called the field-oriented controller, is a speed regulator that is based on an underlying current regulator.

The instantaneous active and reactive current components are regulated. In an electronic motor model saved in the converter, the motor parameters can be saved or, if necessary, automatically detected and adapted. The instantaneous current is the only returned value used for control.

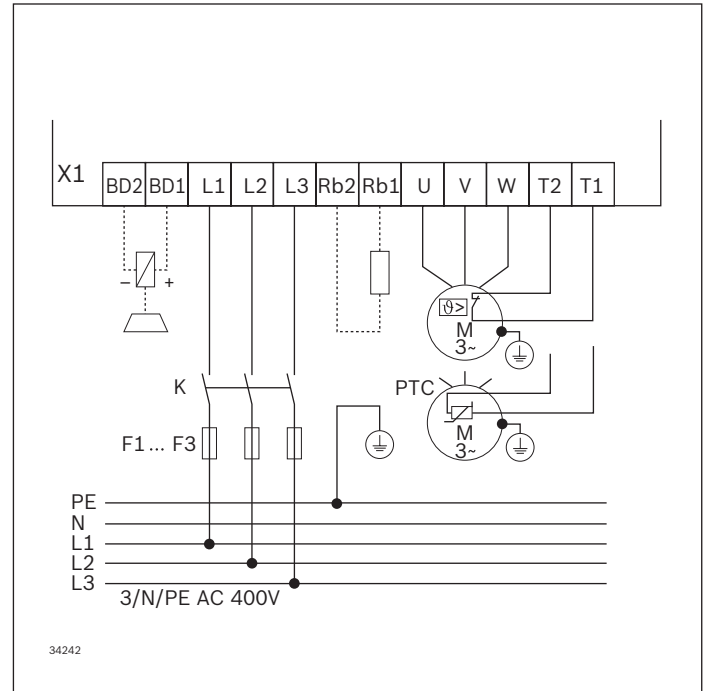
This value and voltage phasing is used to determine all necessary motor states (speed, slip, torque and thermal dissipation loss).

This makes very high speed and torque calibration ranges possible.

**Drive range of motors with frequency converters (FU)**



**Principle circuit diagram**



Circuit diagram for moltec 8400

- 1 Minimum wiring required for operation
- (\*)--- 2 Additional wiring to change direction of rotation

**Technical information:**

At rotating field frequencies of  $\geq 15$  Hz, the motor can be operated under normal operating conditions without an external fan. The motor's thermal conditions should be considered at rotating field frequencies of  $\leq 20$  Hz. In the range 20 ... 50 Hz, the full torque is available.

In order to operate a drive with a frequency converter (FU), the user needs to work out the minimum wiring required for the internal and external voltage supply (see terminal assignment plan).

**Technical data**

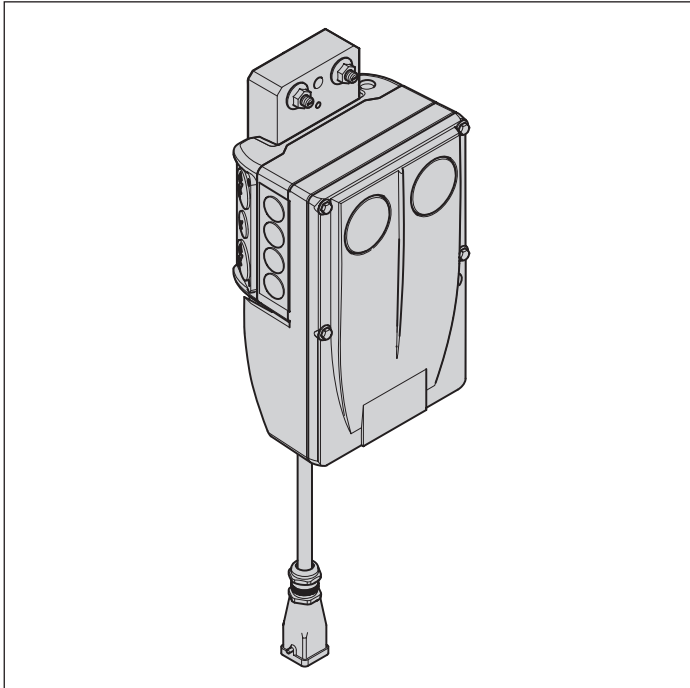
**Note:** The speed range of the frequency converter is based on the base speed of the motor.

(By accepting a resulting loss of power, a higher bandwidth can be covered.)

Base speed of motor at 50 Hz (m/min)	Min. (m/min)	Max. (m/min)	Max. at max. 80% (m/min)
4	2*	4.5	6
6	2*	6	8
9	3.5	10	13
12	4	13	17
15	5	15	20
18	6	18.5	25

\* Additional measures may be necessary

## Frequency converter selection guide



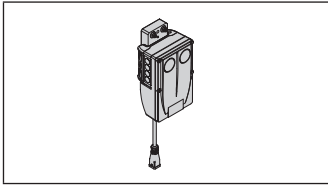
### **FU/motec 8400 frequency converter**

- ▶ Decentralized frequency converter for motor wall mounting
- ▶ U/f controller motor control, sensorless vector control
- ▶ Communication via field buses: ASInterface, CANopen, EtherCAT, PROFIBUS, PROFINET, Ethernet I/P
- ▶ Built-in brake chopper
- ▶ IP 65 rating
- ▶ Output: 0.55 kW



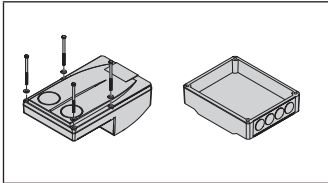
### **EFC 3610 and EFC 5610 frequency converters**

- ▶ Frequency converters for control cabinet installation
- ▶ U/f controller and SVC motor control (only possible with EFC 5610)
- ▶ Multi-Ethernet interface (sercos III, EtherCAT, Ethernet I/P, PROFINET, Modbus TCP, CAN, PROFIBUS)
- ▶ Built-in brake chopper (max. 22 kW)
- ▶ Removable control panel for quick and easy start-up
- ▶ I/Os: Analog voltage/current input/output switching
- ▶ IP 20 rating
- ▶ Output: 0.44 kW; 0.75 kW



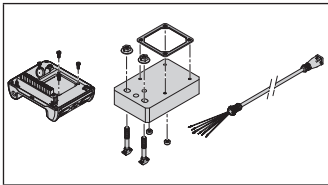
**FU/motec 8400 frequency converter**

**8-120**



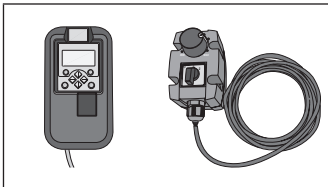
**FU frequency converter: power unit  
Communication module**

**8-121**



**Connection unit  
Attachment kit  
Connection cable**

**8-122**



**Hand-held control panel, Switching/potentiometer unit**

**8-123**



**EFC 3610, EFC 5610 frequency converters**

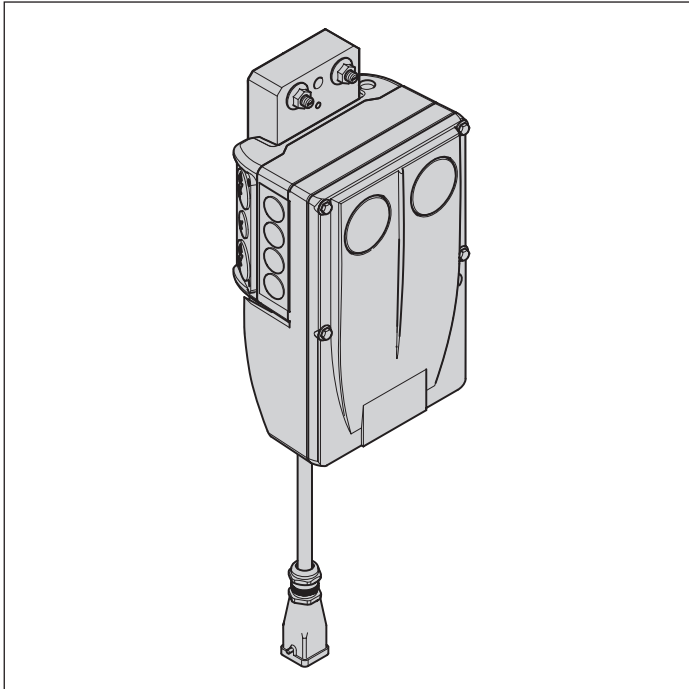
**8-126**



**Option cards**

**8-127**

## FU/motec 8400 frequency converter



In order to operate a gear motor with adjustable speed, the motor needs to be retrofitted with a frequency converter (FU). The frequency converter has a modular design so that it can be easily mounted on a leg set and connected to the motor by cable.

- ▶ Connected load: 0.55 kW
- ▶ (Connected voltage: 400 V  $\pm$  10% ... 460 V/480 V  $\pm$  10%)
- ▶ Speed ( $v_N$ ) depends on the base speed of the gear motor used

Complete frequency converter (FU) consisting of the following modules:

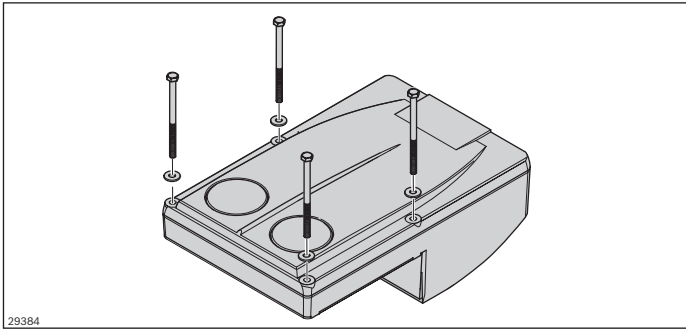
- Frequency converter power unit
- Communication module
- Connection unit
- Attachment kit
- Optional: Connection cable for the plug-in connection to the gear motor (AT = S)

The individual modules can be ordered separately and are easy to connect with the screws supplied with the scope of delivery. For the internal and external voltage supply, the modules must be wired by the user.

### Required accessories

- ▶ Manual control unit, see p. 8-123
- ▶ Switching/potentiometer unit, see p. 8-123

## FU frequency converter: power unit

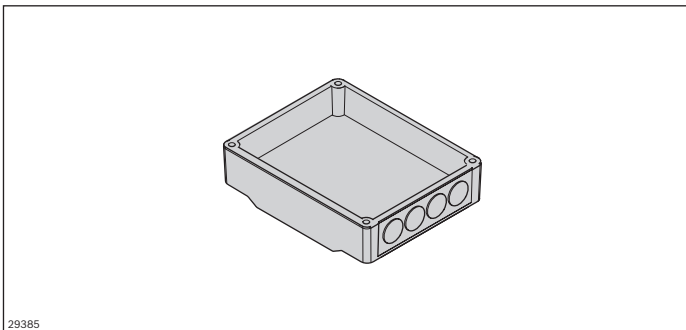


- ▶ Power unit: 0.55 kW  
(400 V ± 10% ... 460 V/480 V ± 10%)
- ▶ Easy start-up via hand-held control panel
- ▶ Easy-to-replace memory module
- ▶ Large LED status indicator

### Ordering information

Product designation	Material number
Frequency converter: 0.55 kW power unit	3842553447

## Communication module



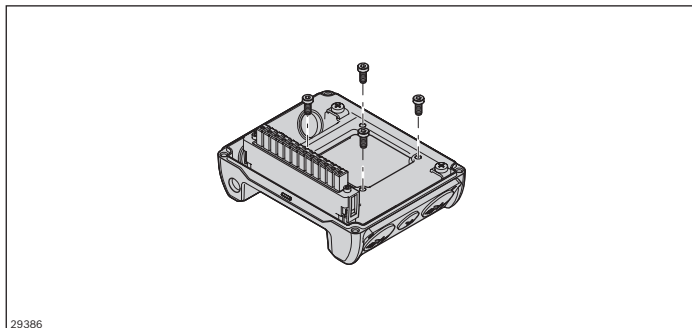
- ▶ Used to control the frequency converter
- ▶ Cable connection options

### Ordering information

Product designation	Material number
Standard I/O communication module	3842553449
AS-I communication module	3842553453
CANopen communication module	3842553454
EtherNet/IP communication module	3842553451
EtherCAT communication module	3842553459
PROFIBUS communication module	3842553452
PROFINET communication module	3842553450

Depending on their function, the individual communication modules are provided with the corresponding connections.

## Connection unit

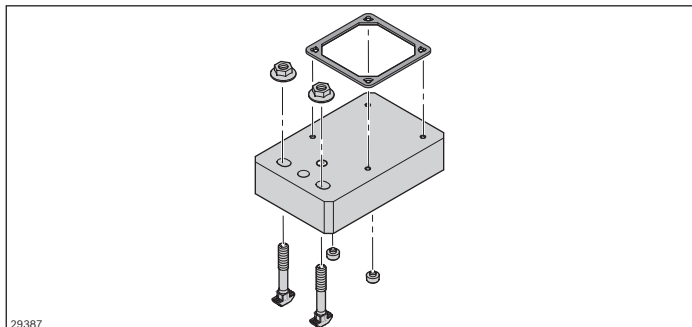


- ▶ Power grid connection options

### Ordering information

Product designation	Material number
Connection unit	3842553445

## Attachment kit

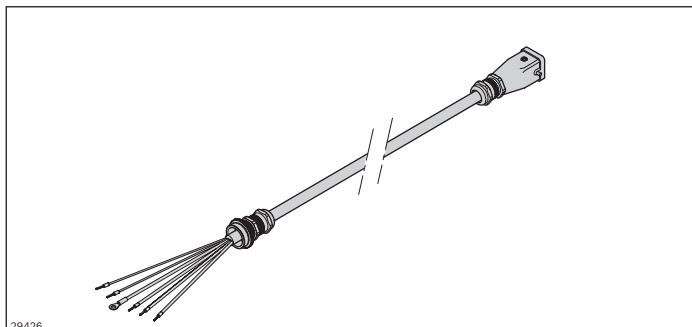


- ▶ For the simple attachment of the frequency converter to the AL leg set (grooves of a 60 mm or 80 mm strut profile)

### Ordering information

Product designation	Material number
Attachment kit	3842553457

## Connection cable



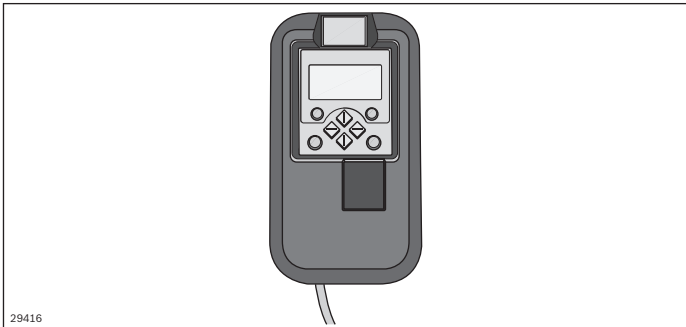
- ▶ For connecting the gear motor to the frequency converter (length: 1 m)

### Ordering information

Product designation	Material number
Connection cable	3842553512



## Hand-held control panel



- ▶ For the parameterization of drives with frequency converters
- ▶ For controlling (e.g., block and release)
- ▶ For displaying operating data
- ▶ For infinitely variable control of the transport speed on drives
- ▶ For transferring parameter sets to other base units

### Delivery notes

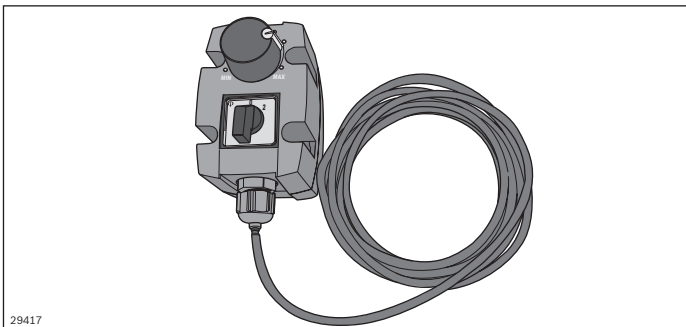
#### Scope of delivery

- ▶ Incl. 2.5 m connection cable

### Ordering information

Product designation	Material number
Hand-held control panel	3842552821

## Switching/potentiometer unit



The switching/potentiometer unit is used to fine tune the transport speed within a range that has been preset with the manual control unit. The switching/potentiometer unit is connected to the frequency converter by a cable. The drive can be started or stopped with the rotary switch.

**Note:** It is imperative that the direction in which the chain conveyor is running is checked prior to start-up.

### Delivery notes

#### Scope of delivery

- ▶ Incl. 2.5 m connection cable

### Ordering information

Product designation	Material number
Switching/potentiometer unit	3842553184

**Technical data**

<b>Connection conditions</b>			
<b>Motor connection</b>			
4-pin ASM motor cable	$P_{aN}$	kW	0.55
No. phases			3
Motor cable length	m		< 20 (system cable, shielded)
<b>Control</b>			
Control method			VFCplus: U/f control (linear or quadratic), SLVC: sensorless vector control (torque/speed); VFCplus eco: energy-efficient U/f control
Switching frequency	kHz		4; 8; 16
<b>Torque response</b>			
Max. torque when rated motor output = rated controller output			1.5 x $M_N$ for 60 s; 2.0 x $M_N$ for 3 s
<b>Sensorless vector control (speed)</b>			
Min. output frequency	Hz		0.5 (0 ... $M_N$ )
Accuracy in 3 ... 50 Hz speed range	%		±0.5
Concentricity in 3 ... 50 Hz speed range	Hz		±0.1
<b>Output frequency</b>			
Range	Hz		-300 ... +300
Absolute resolution	Hz		0.2
Standardized resolution	%		Parameter data: 0.01; Process data: 0.006 (= 2 <sup>14</sup> )
<b>Grid</b>			
Grid			3 PE/AC
Line voltage	$U_{LN}$	V	320 -0% ... 528 +0%
Line frequency range	f	Hz	45 -0% ... 65 +0%
Output voltage	$U_{LN}$		0 ... line voltage
Output frequency	f	Hz	0 ... 300
Line current at $I_{aN}$	$I_{aN}$	A	1.8

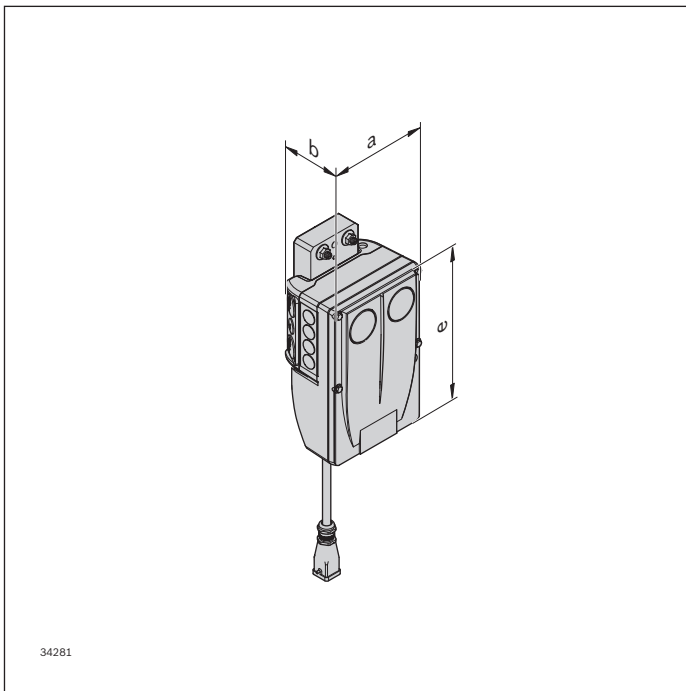
**Note:**

The max. output voltage possible is approx. 88% of the line voltage.

<b>Safety technology</b>		
STO		SIL 3, PLe Cat.4
Drive unit IP rating		IP 65
Certifications		CE, UL, CSA, EAC
<b>Climate conditions</b>		
In operation	°C	-30 ... +55
Derating	%/K	2.5

	<b>Digital inputs</b>	<b>Digital outputs</b>	<b>Relay outputs</b>	<b>Analog inputs</b>
	No.	No.	No.	No.
<b>I/O modules</b>				
Basic I/O	2	–	1	–
Standard I/O	5	1	1	1
Extended I/O	8	1	1	2

## Dimensions



<b>Dimension</b>	<b>Dimension</b>	<b>Dimension</b>	<b>Mass</b>
<b>a</b>	<b>b</b>	<b>e</b>	<b>m</b>
<b>(mm)</b>	<b>(mm)</b>	<b>(mm)</b>	<b>(kg)<sup>1</sup></b>
161	109	241	2.6

<sup>1</sup> For the Basic I/O version without cable gland

## EFC 3610, EFC 5610 frequency converters

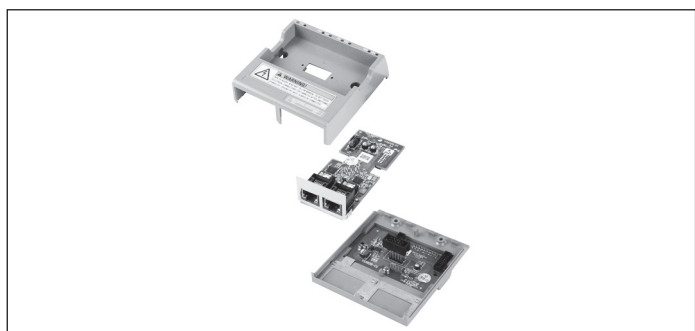


FU for control cabinet installation

- ▶ No control panel (-NN-)
- ▶ 7-segment display (7 digits) (-7P-)
- ▶ LCD display (extra option)
- ▶ Languages: DE, EN, FR, ES, IT, PT, KR, RU, ZH

### Optional module with two slots:

Multi-Ethernet interface (sercos III, EtherCAT, Ethernet I/P, PROFINET, Modbus TCP, CAN, PROFIBUS)



### I/O extension

- ▶ Relay module (250 V AC, 3 A/30 V DC, 3 A)
- ▶ Standard I/O extension:
  - 4 digital inputs (24 V DC, 8 mA/12 V DC, 4 mA)
  - 1 digital output (24 V DC/50 mA)
  - 1 relay output (250 V AC, 3 A/30 V DC, 3 A)
  - 1 analog input (-10 ... 10 V/0[2] ... 10 V/0[4] ... 20 mA)
  - 1 analog output (0[2] ... 10 V/0[4] ... 20 mA)
- ▶ U/f controller and SVC motor control (only possible with EFC 5610)
- ▶ Output: 0.44 kW; 0.75 kW



You can find more detailed information on both frequency converters in the "EFC 3610/EFC 5610 frequency converter" catalog.

	Material number
DE	R999000429
EN	R999000430
PL	R999001226
TW	EFC/VFC x610

## EFC 3610, EFC 5610 frequency converters



- ▶ FU for control cabinet installation
- ▶ U/f controller and SVC motor control (only possible with EFC 5610)
- ▶ Loadable, application-specific firmware (ASF)
- ▶ Integrated line filter
- ▶ Built-in brake chopper (max. 22 kW)
- ▶ Removable control panel for quick and easy start-up
- ▶ I/Os: Analog voltage/current input/output switching
- ▶ EFC 5610: STO, Cat. 4 SIL3 PLe safety function
- ▶ IP 20 rating

### Ordering information

Product designation	Material number
EFC 3610 0.4 kW, 3 AC 380 ... 480 V, 50/60 Hz, 1.3 A, LED display	R912005717
EFC 3610 0.75kW, 3 AC 380 ... 480 V, 50/60 Hz, 2.3A, LED display	R912005718
EFC 5610 0.4kW, 3 AC 380 ... 480 V, 50/60 Hz, 1.3A, LED display	R912007272
EFC 5610 0.75kW, 3 AC 380 ... 480 V, 50/60 Hz, 2.3A, LED display	R912007273

## Option cards

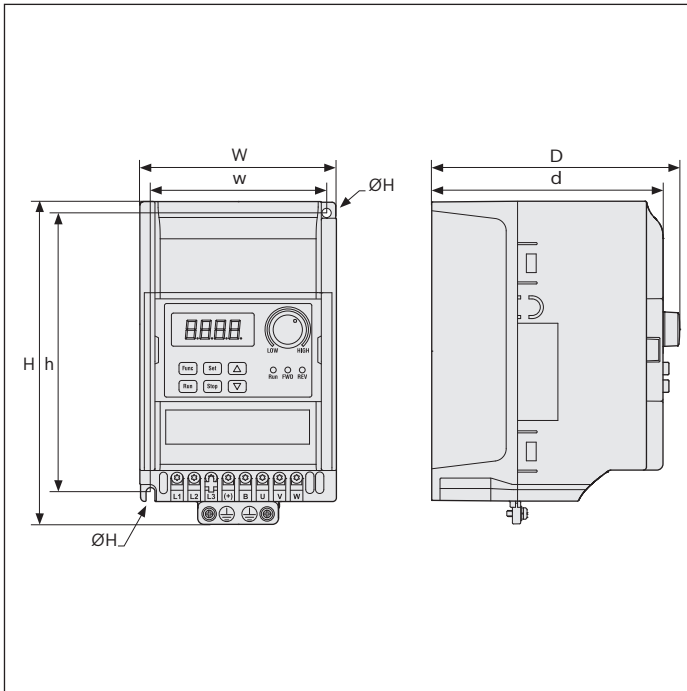


Description	Material number
Option terminal base	R912006052
Relay card	R912006051
I/O card	R912006050
I/O plus extension	R912007257
CANopen interface	R912006133
PROFIBUS interface	R912006132
Multi-Ethernet interface	R912006134

**Technical data**

			<b>EFC 3610</b>		<b>EFC 5610</b>	
<b>(3P 380 ... 480 V AC -15%/+10%)</b>			Max. rated current (A)	Rated motor output (kW)	Max. rated current (A)	Rated motor output (kW)
EFC3610-0K40-3P4-.../EFC5610-0K40-3P4-...			1.3	0.4	1.3	0.4
EFC3610-0K75-3P4-.../EFC5610-0K75-3P4-...			2.3	0.75	2.3	0.75
<b>Type</b>						
Line voltage	V		3 AC 380 ... 480 (-15%/+10%)			
Line frequency	Hz		50 ... 60 (±5%)			
Rated motor voltage	V		3-phase, 0 ... line voltage			
Output voltage	V		0 ... line voltage			
Output frequency	Hz		0 ... 400			
Overload capacity, heavy-duty mode			150% for 60 s, 200% for 1 s			
<b>Functions</b>						
Control technology			U/f	U/f or SVC (sensorless vector control)		
Pulse width modulation (PWM)			1 ... 15 kHz, adjustable in 1 kHz increments			
Speed control range			1:50			
Starting torque	U/f	100% at 1,5 Hz; 150% at 3 Hz				
	SVC	Not available		200% at 0.5 Hz		
Frequency resolution	Analog	1/1000 of output frequency				
	Digital	Hz	0.01			
Frequency setting accuracy	Analog	%	0.1			
	Digital	%	0.01			
U/f characteristic curve			Linear, quadratic, openly definable			
Acceleration and brake ramps			Linear, S-curve			
DC brake	Starting frequency	Hz	0 ... 50			
	Brake time	s	0 ... 10			
Integrated controller			Integrated stepping mechanism			
Controller			PID			
Bus systems			On-board: Modbus/Ext. Options: PROFIBUS, CANopen, multi-Ethernet			
No. digital 24 V DC inputs			5 (with 1x 50 kHz pulse train)			
No. digital 24 V DC/50 mA outputs			1 (32 kHz pulse train)			
No. 230 V AC/30 V DC/3 A relay outputs			1			
No. analog 0 ... 10 V or 0 ... 20 mA inputs			2			
No. analog 0 ... 10 V or 0 ... 20 mA outputs			1			
Display			Dust cover with 5 diagnostic LEDs; 5-point LED (optional); LCD (optional)			
Status LED			Direction of rotation and operating state			
<b>Brake</b>						
Brake chopper			Internal up to 22 kW			
Brake resistor			External			
<b>Motor cable length</b>						
Internal C3 filter	0.4 kW ... 4 kW	m	15			
External C3 filter	0.4 kW ... 4 kW	m	30			
<b>Ambient conditions</b>						
Ambient temperature (during operation)			-10 ... 45 °C (derating 1.5% of output per 1° from 45 ... 55 °C)			
Relative humidity	%		< 90 (no condensation)			
IP rating			IP20			
Certifications			CE, UL, cUL, EAC, RCM			

**Dimensions**



Type	Dimen-	Dimen-	Dimen-	Dimen-	Dimen-	Dimen-	Dimen-	Mass
	sion	sion	sion	sion	sion	sion	sion	
	W	w	H	h	D	d	dH	
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg)
EFC3610-0K40-3P4-.../EFC5610-0K40-3P4-...	95	66	166	156	167	159	4.5	1.5
EFC3610-0K75-3P4-.../EFC5610-0K75-3P4-...	95	66	166	156	167	159	4.5	1.5

Circuit diagram

