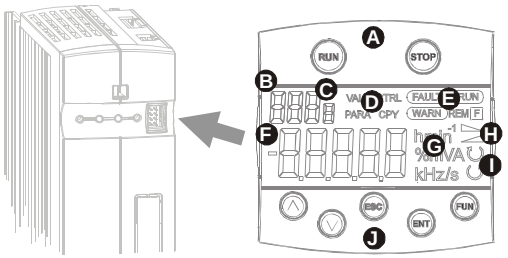
6 Operating unit KP500

The parameterization, parameter display and control of the frequency inverter can be done via the optional operating unit KP500.
The operating unit is not absolutely necessary for the operation of the frequency inverter and can added on if necessary.

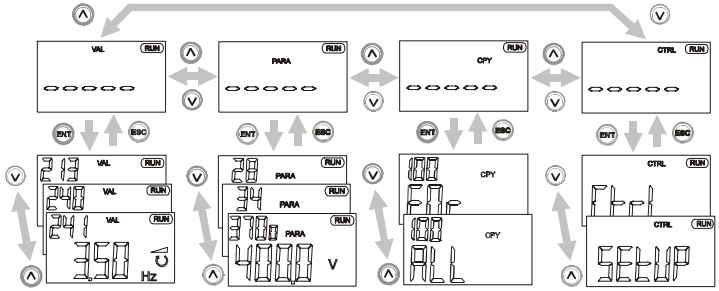


		Keys
A	RUN	Start of the drive mechanism and change to the CTRL menu. Pressing the RUN key branches to the motor potentiometer function.
	STOP	Change to the CTRL menu and stop of the drive mechanism. Acknowledge fault.
J	▲ ▼	Navigation in the menu structure and selection of parameters. Enlarge or reduce parameter values.
	ENT	Call parameters or change within the menu structure. Confirmation of the selection function or the parameter.
	ESC	Quitting parameters or return within the menu structure. cancellation of the function or reset of the parameter value.
	FUN	Switch-over of the key function and access to special functions.

		Display
B	Three-digit 7-segment display to show the parameter number	
C	Single-digit 7-segment display for the active data set, direction of rotation etc.	
D	Display of the selected menu branch:	
	VAL	Display actual values
	PARA	Parameter selection and editing of the parameter values
	CTRL	Selection of functions which can be used via the operating unit: SEtUP Guided commissioning CtrL Motorpoti and jog function
	CPY	Copy function of the parameters via the operating unit: ALL All the parameter values are copied FOr Memory in the operating unit is formatted or deleted
E	Status and operating messages:	
	WARN	Warning about a critical operating behavior
	FAULT	Fault switch-off with the matching message
	RUN	Flashing signalizes readiness for operation Lighting signalizes operation and release of the power part
	REM	Active remote control via interface connection
	F	Function switch-over with the FUN key
F	Five-digit 7-segment display for parameter value and sign	
G	Phys. unit for the parameter value displayed	
H	Active acceleration or deceleration ramp	
I	Current direction of rotation of the drive mechanism	

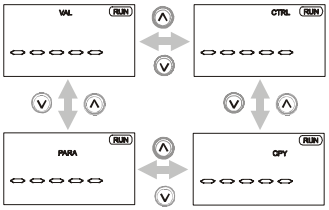
6.1 Menu structure

The menu structure is arranged via the operating unit according to the graphic overview. The PC program structures the functions and parameters functionally on various levels. The complete information is stored in the software and enables flexible use of the options for parameterization and control of the frequency inverters.



6.2 Main menu (MENU)

The various parameters and information of the frequency inverters can be displayed with the help of the operating unit. The menu structure thematically groups the various functions and parameters in four menu branches. Within the menu structure, you change to the main menu by pressing the ESC key for a long time or pressing it repeatedly.



Menu branch VAL
Display of actual values

Menu branch PARA
Display and change of parameters

Menu branch CPY
Copy function of the parameters

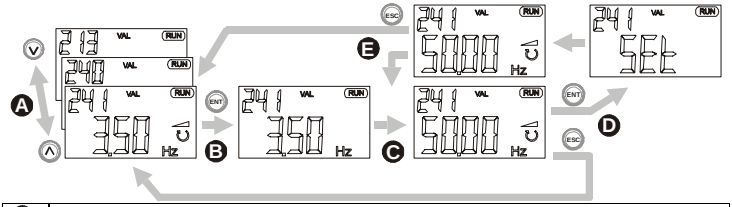
Menu branch CTRL
Selection of control and test functions

You select the required menu branch with the arrow keys. The selected menu branch is shown flashing on the display.
Select the menu branch by pressing the ENT key. The display changes to the first parameter of the first function in the selected menu branch.
Pressing the ESC key leads back to the main menu of the operating unit.

Keys	
▲ + ▼	Navigation in the menu structure and selection of a menu branch
ENT	Transition into the selected menu branch
ESC	Quitting the menu branch and return to the main menu.

6.3 Actual value menu (VAL)

In the VAL menu branch, the operating unit displays a variety of actual values as a function of the configuration selected and the options installed. The operating instructions document the parameters and the basic functions of the software connected with the actual value in question.



A	With the help of the arrow keys, select the required number from the actual values displayed in numerical order. Actual value parameters capable of a data set switch are displayed in the current data set with the matching data set number. The seven-segment display shows data set 0 if the actual values in the four data sets are identical.

Keys	
▲ + ▼	Change to actual value parameter on switch-on
FUN , ▲	Display of last actual value parameters (highest number)
FUN , ▼	Display of first actual value parameters (lowest number)

B	By pressing the ENT key, you select the actual value that is displayed with the current parameter value, unit and active data set.

C	In the course of the commissioning, operating and error analysis, it is possible to monitor each actual value parameter. Some of the actual value parameters have been arranged in the four available data sets. If the parameter values in the four data sets are identical, the actual value is displayed in data set 0. Differing actual values in the four data sets are marked in data set 0 by the display dIFF.

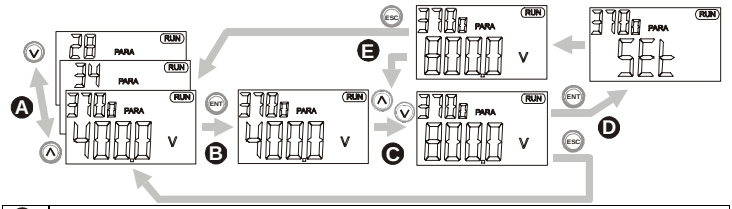
Keys	
▲ , ▼	Change of the data set with adjustable actual values
FUN , ▲	Maximum actual value is continuously determined and displayed
FUN , ▼	Minimum actual value is continuously determined and displayed
FUN , ENT	Mean value of the actual value dimension in the period of monitoring

D	The selected actual value is stored as a parameter at switch-on by pressing the ENT key. The message SEt with the parameter number appears for a short time. When the frequency inverter is switched on, this actual value is automatically displayed in future.

E	After the parameter has been stored, you can monitor and display the value again. By pressing the ESC key, you change into the parameter selection of the VAL menu branch.

6.4 Parameter menu (PARA)

The parameters inquired within the guided commissioning have been selected from known applications and can be supplemented as required by further settings in the PARA menu branch. The operating instructions document the parameters and the basic functions of the software connected with the actual value in question.



A With the help of the arrow keys, select the required number from the parameters displayed in numerical order.
Actual value parameters capable of a data set switch are displayed in the current data set with the matching data set number. The seven-segment display shows data set 0 if the actual values in the four data sets are identical.

Keys	
▲ + ▼	Change to the last parameter altered
FUN , ▲	Display of last parameters (highest number)
FUN , ▼	Display of first parameters (lowest number)

B By pressing the ENT key, you select the actual value that is displayed with the current parameter value, unit and active data set. Settings in data set 0 change the parameter values in the four data sets.

C The arrow keys enable adaptation of the parameter value. The value can be changed or an operating mode selected as a function of the parameter.
Pressing the arrow keys for a long time increases the value of the change. The change speed is reduced to a tenth of the value difference previously reached after an interruption. If the parameter starts to flash, the increment has been returned to the starting value.

Keys	
▲ + ▼	Parameter is set to the factory setting
FUN , ▲	Parameter is set to the highest setting
FUN , ▼	Parameter is set to the smallest setting
FUN , ENT	Change of the data set with adjustable parameters

D The parameter value is stored by pressing the ENT key. For a short time, the message SEt with the parameter number and the data set is displayed. If you would like to quit the parameter without an alteration, press the ESC key.

Messages	
Err1: EEPrO	Parameter has not been stored
Err2: StOP	Parameter can only be read in operation
Err3: Error	Other kind of error

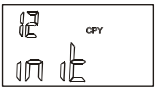
E After the parameter has been stored, you can change the value again or change to the parameter selection by pressing the ESC key.

6.5 Copy menu (CPY)

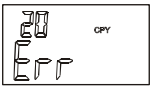
The copy function of the operating unit enables a copying of parameter values from the frequency inverter into a non-volatile memory (upload) in the operating unit and storing the values back (download) into a frequency inverter.
The parameterization of recurring applications is facilitated by the copy function. The function archives all the parameters, regardless of the access control and the value range. The memory space available in the operating unit for four files is dynamically scaled to match the scope of the data.

6.5.1 Reading the stored information

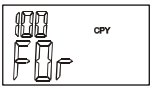
If the CPY menu branch is called, information about the data stored in the operating unit must be read out. This process takes a few seconds. For this duration, **init** and a progress display are shown. After the initialization, the function can be selected in the copy menu.



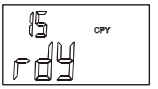
If the existing memory information in the operating unit is not valid, the initialization is stopped with an error message.
In this case, the memory in the operating unit must be formatted. Please take the following steps:



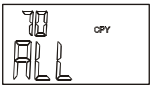
1. Confirm the fault message with the ENT key.
2. With the help of the arrow keys, select the Format function of the memory **FOr** and confirm the selection with the ENT key.



3. For the duration of the formatting, the display shows the sign **FCOPY** and a progress display.
4. The process if complete after a few seconds. The display shows **rdY**.
   Confirm the display with the ENT key.



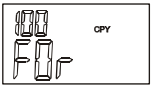
5. Now, you can continue with the selection of the copy function.



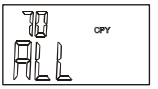
6.5.2 Menu structure

The copy menu CPY is structured in two principal part functions. With the help of the arrow keys, a selection can be made between the memory functionality and deletion of the stored data. The source and the target are to be selected for the process. The three-digit seven-segment display gives information about the free memory space in the non-volatile memory of the operating unit.

Function – FOr
The FOr function provides the functionality for formatting and deleting the memory in the operating unit. This can be necessary in the first use of a new operating unit.



Function – ALL
All the read and write-capable parameter values are transferred. For a normal copying process, confirm this selection with the ENT key and continue with the selection of the source.



6.5.3 Selection of the source

The ALL part function in the CPY menu branch is to be parameterized specific to the application. With the help of the arrow keys, select the origin of the data for the copy process from the sources available (upload). The seven-segment display shows the free memory space in the operating unit.

Display	Description
Src. 0	The data of the four data sets of the frequency inverter are copied
Src. 1	The data from data set 1 are copied
Src. 2	The data from data set 2 are copied
Src. 3	The data from data set 3 are copied
Src. 4	The data from data set 4 are copied
Src. E	An empty data set for deletion of a file in the operating unit
Src. F1	File 1 is transferred from the memory
Src. F2	File 2 is transferred from the memory
Src. F3	File 3 is transferred from the memory
Src. F4	File 4 is transferred from the memory

6.5.4 Selection of the target

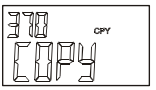
The target for the copy process is likewise to be parameterized specific to the application. The data source is transferred to the selected target (download). The targets available correspond to the logical allocation of the data source selected.

Display	Description
dSt. 0	The four data sets of the frequency inverter are overwritten
dSt. 1	The data are copied into data set 1
dSt. 2	The data are copied into data set 2
dSt. 3	The data are copied into data set 3
dSt. 4	The data are copied into data set 4
dSt. F1	The data are transferred into file 1
dSt. F2	The data are transferred into file 2
dSt. F3	The data are transferred into file 3
dSt. F4	The data are transferred into file 4

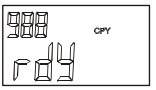
6.5.5 Copy process

Warning: Transmission of the parameter setting to the frequency inverter demands examination of the individual parameter values.
The value range and the parameter setting can differ according to the power range of the frequency inverter. Transmission of parameter values outside the value range leads to an error message.

The display shows **COPY** during the copy process and, as a process display, the number of the parameter currently being copied. Parameters that have no importance for the selected configuration are also copied.

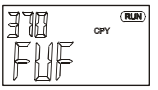


The copy process is complete after about 100 seconds and the display shows **rdY**.
By pressing the ENT key, you change the display to the copy menu and with the help of the ESC key to the selection of the target.

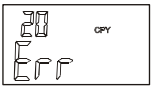


If the ESC key is pressed during the copy process, the copy process is stopped and the data transmitted incomplete. The display shows **Abr** and the number of the last parameter which was copied.
The ENT key leads back to the selection in the copy menu and the ESC key to the selection of the target.

6.5.6 Error messages



The copy function archives all the parameters regardless of the access control and the value range. Some of the parameters are only write-capable if the frequency inverter is not in operation. The controller release (S1IND) may not be activated during the copy process and leads to a stoppage of the data transmission. The display shows **FUF** and the number of the last parameter which was copied. If the controller release is deactivated again, the interrupted copy process is continued.



The data transmission from the selected source to the target is continuously monitored by the copy function. If an error occurs, the copy process is stopped and the message **Err** is displayed with an error key.

Error messages

Key		Meaning
0	1	Writing error in the memory of the operating unit; repeat the copy function or format the memory in the case of a multiple error.
	2	Reading error in the memory of the operating unit; repeat the copy function or format the memory in the case of a multiple error.
	3	The memory size of the operating unit has been established wrongly; if this error occurs repeatedly, replace the operating unit.
	4	Insufficient memory space, the data are incomplete; delete the incomplete file and data no longer required from the operating unit.
	5	The communication has been disturbed or interrupted; repeat the copy function, delete the incomplete file if necessary.
1	0	Invalid identification of a file in the operating unit; delete faulty file and format memory if necessary.
	2	The memory space of the selected target file is occupied; delete file or use different target file in the operating unit.
	3	The source file to be read in the operating unit is empty; only select files containing sensible data as a source.
	4	Faulty file in the operating unit; delete faulty file and format memory if necessary.
2	0	The memory in the operating unit is not formatted; implement the part function for formatting in the copy menu.
3	0	Reading error of a parameter from the frequency inverter; check connection and repeat reading process.
	1	Writing error of a parameter from the frequency inverter; check connection and repeat reading process.
	2	Unknown parameter type; delete faulty file and format memory if necessary.
4	0	The communication has been disturbed or interrupted; repeat the copy function, delete the incomplete file if necessary.

6.6 Control menu (CTRL)

The control of the frequency inverters can be done with the help of the operating unit. In the CTRL menu branch, various functions facilitating a commissioning and enabling control via the operating unit can be selected.
The control of the frequency inverters via an optional communication module can be parameterized with the help of the parameter *Local/Remote* **412**. With the help of the parameter, the possibilities of control that can be available can be selected or limited. The control menu is only partly available as a function of the operating mode selected.

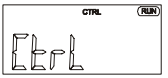
Operating mode	Function
0 - Control via contacts	The Start and Stop command as well as the statement of the direction of rotation are via digital signals.
1 - Control via State machine	The Start and Stop command as well as the statement of the direction of rotation are via the DRIVECOM State machine of the communication interface.
2 - Control via remote contacts	The Start and Stop command as well as the statement of the direction of rotation are via logic signals by the communication protocol.
3 - Cont. Keypad, Dir. rot. contacts	The Start and Stop command comes from the operating unit and the statement of the direction of rotation via digital signals.
4 - Cont. KP or Cont., Dir. rot. Cont.	The Start and Stop command comes from the operating unit or via digital signals. The statement of the direction of rotation only with the help of the digital signals.
13 - Control. Keypad, Dir. rot. Keypad	The Start and Stop command as well as the statement of the direction of rotation are via the operating unit.
14 - St. KP + contact, Dir. rot. Keypad	The Start and Stop command comes from the operating unit or via digital signals. The statement of the direction of rotation only with the help of the operating unit.
20 - Control contacts, only clockwise	The Start and Stop command is via digital signals. The statement of the direction of rotation is fixed, only clockwise.
23 - Control Keypad, only clockwise	The Start and Stop command is via the operating unit. The statement of the direction of rotation is fixed, only clockwise.
24 - Control. contacts + KP, only clockwise	The Start and Stop command comes from the operating unit or via digital signals. The statement of the direction of rotation is fixed, only clockwise.
30 to 34	Operating mode 20 to 24, direction of rotation only anticlockwise.
43 - Control KP, Dir. rot. contact + KP	The Start and Stop command is via the operating unit. The statement of the direction of rotation comes from the operating unit or via digital signals.
44 - Control contact + KP, Dir. rot. contact + KP	The Start and Stop command and the statement of the direction of rotation come from the operating unit or via digital signals.

Warning: Control of the drive mechanism via the operating unit demands the release of the power component via the digital input controller release S1IND. To avoid serious physical injuries or considerable damage to property, only qualified persons may work on the devices. Qualified means people who are acquainted with the erection, assembly, commissioning and operation and have corresponding qualifications for their activity. The documentation is to be read carefully beforehand and the safety instructions are to be obeyed.

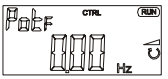
6.7 Control motor via the operating unit

The operating unit enables control of the connected motor in accordance with the selected operating mode of the parameter *Local/Remote* **412**.

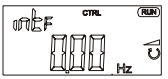
Warning: Control of the drive mechanism via the operating unit demands the release of the power component via the digital input controller release S1IND. To avoid serious physical injuries or considerable damage to property, only qualified persons may work on the devices. Qualified means people who are acquainted with the erection, assembly, commissioning and operation and have corresponding qualifications for their activity. The documentation is to be read carefully beforehand and the safety instructions are to be obeyed.



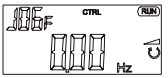
The CTRL menu branch can be reached via the navigation within the menu structure. The CtrL function contains sub-functions which can be displayed according to the operating point of the frequency inverter.
Pressing the RUN key leads to a direct change from anywhere within the menu structure to the motorpoti function **Pot** or the internal reference value **int**.



Motorpoti function **Pot**
With the help of the arrow keys, the output frequency of the frequency inverter can be set from the *minimum frequency* **418** to the *maximum frequency* **419**. The acceleration corresponds to the factory setting (2 Hz/s) for the parameter *Ramp Keypad-Motorpoti* **473**. The parameters *Acceleration (clockwise)* **420** and *Deceleration (clockwise)* **421** are taken into account with lower acceleration values.



Internal reference value **int**
The drive mechanism is in operation and the current actual value is being displayed. By pressing the arrow keys, you change into the motorpoti function **Pot**, with the current value of the frequency being taken over.



JOG frequency **JOG**
By pressing the FUN key, you change from the internal reference value **int** or the motorpoti function **Pot** to the *JOG frequency* **489**. The frequency can be set with the help of the arrow keys. If the FUN key is released, the drive mechanism stops and the display changes to the output function **Pot** or **int**. The last frequency value is stored in the parameter *JOG frequency* **489**.

Key functions	
ENT	Adjustment of the direction of rotation independent of the control signal on the terminals clockwise S2IND or anticlockwise S3IND.
ESC	Quit function and change back into the menu structure.
FUN	Pressing the key changes to the JOG frequency and drive mechanism starts. Releasing the key changes to the sub-function and stops the drive mechanism.
RUN	Start drive mechanism; alternative to control signal S2IND or S3IND
STOP	Stop drive mechanism; alternative to control signal S2IND or S3IND

Attention: The ENT key results in a **change of direction of rotation** independent of the signal on the terminals clockwise S2IND or anticlockwise S3IND.
If the *minimum frequency* **418** has been set to 0.00 Hz, there is a **change of direction of rotation** of the motor with a change of sign of the reference frequency value.

7 Commissioning of the frequency inverter

7.1 Switching mains voltage on

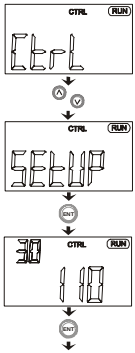
After the installation work has been completed, all the control and power connections should be checked again before the mains voltage is switched on. If all the electrical connections are correct, please make sure that the release of the frequency inverter has been switched off (control output S1IND open). After the mains voltage has been switched on, the frequency inverter carries out a self-test and the relay output (X10) reports "Fault".
The frequency inverter concludes the self-test after a few seconds, the relay reacts and reports "No fault ".
In the state on delivery and after adjustment of the factory setting, the guided commissioning is automatically called. The operating unit shows the menu point “SEtUP“ from the CTRL menu branch.

7.2 Set-up with the operating unit

The guided commissioning of the frequency inverter finds all the parameter settings relevant for the desired application. The selection of the available parameters has been derived from the known standard applications of drive technique. This facilitates the selection of the important parameters. After a successful completion of the SETUP routine, the actual value *Actual frequency* **241** from the VAL menu branch is displayed in the operating unit. After this, the user should check whether further parameters are relevant for the application.

Attention: The guided commissioning contains the function for parameter identification. With a measurement, the parameters are determined and set accordingly. Before the start of the measurement, the motor should not yet have been operated, as a part of the machine data depends upon the operating temperature.

The guided commissioning appears automatically in the state upon delivery. Following a successful commissioning, you can select the CTRL sub-menu in the main menu and call the function once more.

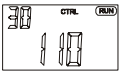


By pressing the ENT key, you change to the CTRL sub-menu. In this sub-menu, you use the arrow keys to select the menu point “SEtUP“ and confirm it with the ENT key.

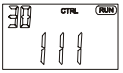
As a function of the selected *Control level* **28** the configurations available are automatically displayed to you. The operating instructions document the configurations described in the following chapter. With the help of the arrow keys, select the number of the required configuration and confirm the input with the ENT key.
If the configuration has been altered, the hardware and software functionality are configured. After the initialization, please confirm the selected configuration once more and continue the guided commissioning.

7.2.1 Configuration

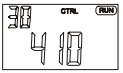
The *Configuration* **30** determines the occupancy and basic function of the control inputs and outputs and the software functions. The software of the frequency inverter provides a number of configurations for selection. The configurations essentially differ in the way in which the drive mechanism is controlled. The analog and digital inputs are to be combined within the configuration and supplemented by optional communication protocols. The operating instructions describe the following configurations and matching parameters on the **third** *Control level* **28**.



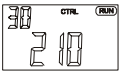
Configuration 110, sensor-less control
Configuration 110 contains the functions for variable-speed controls of a 3-phase machine in a large number of standard applications. The motor speed is set according to the V/f characteristic in accordance with the ratio of voltage and frequency.



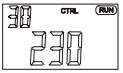
Configuration 111, sensor-less control with technology controller
Configuration 111 extends the sensor-less control by software functions that facilitate customer-specific adaptation in various applications. The technology controller, the volume flow control and the V-belt monitoring are to be used relative to the application.



Configuration 410, sensor-less field-oriented control
Configuration 410 contains the functions for sensor-less, field-oriented control of a 3-phase machine. The current motor speed is determined from the present currents and voltages in combination with the machine parameters. Parallel switching of 3-phase motors is only restrictedly possible in this configuration.

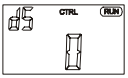


Configuration 210, field-oriented control
Configuration 210 contains the functions for speed-controlled, field-oriented control of a 3-phase machine with speed sensor feedback. The separate control of torque and flux-forming current enables high drive dynamism with a high moment of load. The necessary speed sensor feedback leads to a precise speed and torque behavior.



Configuration 230, field-oriented control with torque control
Configuration 230 extends configuration 210 by functions for torque-dependent field-oriented control. The reference torque is represented as a percentage and transmitted to a corresponding operating behavior of the application. The switch-over between variable-speed control and torque-dependent control is done via a digital control input.

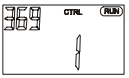
7.2.2 Data set



The parameter *Data set* enables a selection between four data sets for storing parameter settings.
In data set 0, data sets 1 to 4 are stored with the same parameter values. The standard application of the frequency inverter, without use of the data set switch-over, uses data set 1.

Setting	
Parameter dS	**Function**
0	All data sets (DS0)
1	Data set 1 (DS1)
2	Data set 2 (DS2)
3	Data set 3 (DS3)
4	Data set 4 (DS4)

7.2.3 Motor type



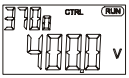
The properties of the control functions and methods to be set vary with the motor connected. The parameter *Motor type* **369** provides a selection of motor variants with the matching table values. The check of the rated values input and the guided commissioning take the parameterized motor type into account. The selection of motor types varies according to the applications of the various control functions and methods. The operating instructions describe the functionality and the operating behavior for the 3-phase motor.

Operation mode	Function
0 - Unknown	The motor is not one of the standard types
1 - Asynchronous	Three-phase asynchronous motor, squirrel cage
2 - Synchronous	Three-phase synchronous motor
3 - Reluctance	Three-phase reluctance motor
10 - Transformer	Transformer with three primary windings

Note: The setting of the motor type leads to differing results in the inquiry and pre-setting of the relevant parameters. A faulty input can lead to damage to the drive mechanism.

After this, you enter the machine data appearing in a tabular order, which are described in the following chapters. Confirm the input of the parameters and the selection by pressing the ENT key. Navigate between the parameters and change the necessary value with the help of the cursors. After input of the machine data, the calculation or examination of the parameters is automatically started. The display briefly changes to CALC, in order to continue the guided commissioning with the parameter identification if the check of the machine data is successful.

7.2.4 Machine data



The machine data to be input in the following sequence of the guided commissioning can be seen on the rating plate or the data sheet of the motor. The factory settings of the machine parameters are relative to the reference data of the frequency inverter and to the applicable four-poled three-phase motor. The machine data necessary for the control functions and methods are calculated in the course of the commissioning from the settings that have been checked for plausibility. The rated values for the three-phase motor stated by the factory are to be checked by the user.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
370	Rated voltage	$0.17 \cdot U_{FIN}$	$2 \cdot U_{FIN}$	U_{FIN}
371	Rated current	$0.01 \cdot I_{FIN}$	$10 \cdot o \cdot I_{FIN}$	I_{FIN}
372	Rated speed	96 min^{-1}	60,000 min^{-1}	n_N
374	Rated cosine Phi	0.01	1.00	$cos(\varphi)_N$
375	Rated frequency	10.00 Hz	1000.00 Hz	50.00
376	Rated mechanical power	$0.01 \cdot P_{FIN}$	$10 \cdot P_{FIN}$	P_{FIN}

Attention: The guided commissioning takes the increase of the rated speed with constant torque into account by switching over the motor winding from star to delta connection. The rated data are to be parameterized according to the rating plate of the motor for the switching of the motor winding. The increased rated current of the connected three-phase motor is to be taken into account.

7.2.5 Speed sensor data

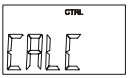
Configurations 210 and 230 of the field-oriented control demand the connection of an incremental speed sensor. The track signals of the speed sensor are to be connected to digital inputs S5IND (track A) and S4IND (track B).
The *Operation mode speed sensor 1* **490** defines the form of measurement.

Operation mode	Function
0 - off	Speed measurement is not active; the digital inputs are available for further functions.
1 - Single Evaluation	Two-channel speed sensor with recognition of direction of rotation via track signals A and B; one signal edge is evaluated per division mark.
4 - Quadruple Evaluation	Two-channel speed sensor with recognition of direction of rotation via track signals A and B; four signal edges are evaluated per division mark.
11 - Single Evaluation unsigned	One-channel speed sensor via track signal A. The actual speed value is positive. One signal edge is evaluated per division mark. The digital input S4IND is available for further functions.
12 - Double Evaluation unsigned	One-channel speed sensor via track signal A. The actual speed value is positive. Two signal edges are evaluated per division mark. The digital input S4IND is available for further functions.
101 - Single Evaluation inverted	Like operation mode 1. The actual speed value is inverted. (Alternative to exchanging the track signals)
104 - Quadruple Evaluation inverted	Like operation mode 4. The actual speed value is inverted. (Alternative to exchanging the track signals)
111 - Single Evaluation negative	Like operation mode 11. The actual speed value is negative.
112 - Double Evaluation negative	Like operation mode 12. The actual speed value is negative.

The number of increments of the speed sensor is to be parameterized via the parameter *Division marks, speed sensor 1* **491**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
491	Division marks, speed sensor 1	1	8192	1024

7.2.6 Plausibility check



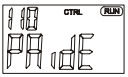
Checking the machine data should only be omitted by an expert user. The configurations contain complex control systems that are essentially dependent on the correct input of the machine parameters. The warning and error reports shown in the test sequence must therefore be obeyed. If a critical condition is recognized in the sequence of the guided commissioning, it is displayed on the operating unit. A warning or error message matching the deviation from the expected parameter value is displayed.
The warning message can be acknowledged with the ENT key and the guided commissioning is continued. A correction of the input parameter values can be done by a subsequent pressing of the ESC key.

Warning messages	
Code	**Measures / Remedy**
SA000	No warning message exists. This message can be read out via an optional communication card.
SA001	The *Rated voltage* **370** is outside the inverter nominal voltage range. The maximum reference voltage is stated on the rating plate of the frequency inverter.
SA002	The *Rated current* **371**, the *Rated power* **376** and the *Rated voltage* **370** are to be checked. The calculated efficiency is in the threshold area for a three-phased motor.
SA003	The *Rated cosine phi* **374** is outside the standard range (0.6 to 0.95).
SA004	The *Rated speed* **372** and the *Rated frequency* **375** are to be checked. The slip is in the threshold area for a three-phase motor.

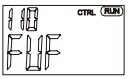
If an error message appears, the parameterized rated data are to be checked and input again. The guided commissioning is repeated until error-free input of the rated values. Premature ending of the guided commissioning with the help of the ESC key should only be done by expert users, as a part of the rated data is not correct.

Error messages	
Code	**Measures / Remedy**
SF000	No error message exists
SF001	The input *Rated current* **371** is too low.
SF002	The *Rated current* **371** is too high relative to the *Rated power* **376** and the *Rated voltage* **370**.
SF003	The *Rated cosine phi* **374** is faulty (larger than 1 or smaller than 0.3).
SF004	The slip frequency calculated from the reference values is negative. The *Rated speed* **372** and the *Rated frequency* **375** are to be checked.
SF005	The input *Rated speed* **372** and the *Rated frequency* **375** are to be checked as the calculated slip frequency is too large.
SF006	The overall output of the drive mechanism calculated from the reference data is lower than the rated power input.
SF007	The set configuration is not supported by the guided commissioning.

7.2.7 Parameter identification

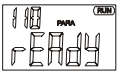


As a supplement to the parameterized rated data, the selected configuration demands knowledge of further machine data not stated on the rating plate of the three-phase machine. As a supplement to the manufacturer's data sheet or as an alternative, the guided commissioning can measure the necessary machine data. The variables measured with the drive mechanism at a standstill are input directly or following a calculation for the parameter. The sequence and the duration of the parameter identification varies according to the machine connection and the device output. The PAidE display is to be confirmed by pressing the ENT key. The load connected is measured in the following sequence of the parameter identification with the displayed signals.



After checking the input machine data, the guided commissioning changes to the functions of the parameter identification. The security functions of the frequency inverter prevent the release of the power component without switching on digital input S1IND. If a signal has been applied at the start of the guided commissioning, the FUF message is not displayed.

Warning: The parameter identification of the frequency inverter demands the release of the power component. To avoid serious physical injury or considerable damage to property, only qualified people may work on the devices. Qualified means people who are acquainted with erection, assembly, commissioning and operation of frequency inverters or who have qualifications corresponding to their activity. The necessary documentation must therefore be read carefully and the safety information obeyed.



The final message rEAdY is to be confirmed with the ENT key. Cancellation by pressing the ESC key or withholding the release S1IND leads to an incomplete take-over of values.

7.2.8 Application data

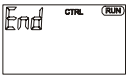
The varied drive applications with the parameter settings resulting from them demand the check of further parameters. The parameters inquired within the guided commissioning have been selected from known applications and are to be supplemented by further settings in the PARA menu branch after completion of the commissioning.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
420	Acceleration (clockwise)	0.00 Hz/s	999.99 Hz/s	5.00 Hz/s
421	Deceleration (clockwise)	0.00 Hz/s	999.99 Hz/s	5.00 Hz/s

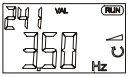
Attention: The deceleration of the drive mechanism is monitored in the parameter setting *Voltage controller operation mode* **670** from the factory settings. The deceleration ramp can be extended with an increase in the DC link voltage in generator operation or in the braking process.

The multifunctional input MFI1 is to be parameterized in *Operation mode* **452** according to the reference value signal. Operation mode 3 should only be selected by expert users who would like to use a drive mechanism control via *Fixed frequency 1* **480** and *Fixed frequency 2* **481**.

Operation mode	Function
1 - Voltage input	Voltage signal (MFI1A), 0V to 10V
2 - Current input	Current signal (MFI1A), 0mA to 20mA
3 - Digital input	Digital signal (MFI1D), 0V to 24V



The operating unit shows the message End, which you confirm with the ENT key. The guided commissioning of the frequency inverter is ended with a reset and the initialization of the frequency inverter. Relay output X10 reports a fault in the initialization.



Following the faulty initialization of the frequency inverter, the parameter *Actual frequency* **241** defined in the factory settings is displayed. If there is a signal on digital input 1 and on digital input 2 or digital input 3, the drive mechanism is accelerated to the set *Minimum frequency* **418** (factory setting: 3.50 Hz)

The guided commissioning facilitates selection of the important parameters for you and finds further rated data of the motor. If the settings of the parameters have been done via the optional operating software or in the PARA menu branch of the operating unit, the display of the selected actual value is to be activated manually. When the frequency inverter is switched on, the set-up function appears, which you quit with the ESC key. Change to the VAL menu branch and select the required actual value that is to be displayed in future. By pressing the ENT key, the value of the parameter is displayed and selected as the actual value in a new start by repeated pressing of the ENT key.

7.3 Check direction of rotation

The interconnection of reference value and actual direction of rotation of the drive mechanism is to be checked. A check should be done as follows. State a reference value of about 10% and briefly switch on the release of the frequency inverter (control inputs FUF (S1IND) and STR (S2IND) for clockwise or FUF (S1IND) and STL (S3IND) for anticlockwise). In the acceleration of the drive mechanism, check whether the motor shaft turns in the right direction. In addition to a check of the drive mechanism, corresponding actual values and operating messages can be read out with the help of the operating unit. If for example, a wrong direction of rotation is established, two motor phases, e.g. U and V, are to be exchanged on the terminals of the frequency inverter. The mains side connection of the frequency inverter has no effects on the direction of rotation of the drive mechanism.
Within the field-oriented control with incremental speed sensor, the actual value is compared with the nominal value via the *Speed Sensor monitoring* **760**. The faulty registered direction of rotation demands not only a check of the motor connection, but also a check of the digital inputs S5IND (track A) and S4IND (track B).

Note: The commissioning of the frequency inverter has been completed and can now be supplemented by further settings in the PARA menu. The set parameters have been selected in such a way that they are sufficient for a commissioning in most cases of application. The checking of the further settings relevant for the application is to be done on the basis of the operating instructions.

7.4 Set-up via the communication interface

The parameterization and commissioning of the frequency inverter via one of the optional communication interfaces contains the functions of the plausibility check and the parameter identification. Before starting, the documentation is to be read carefully and the safety information to be obeyed, as the relevant parameter settings are to be parameterized independently by the expert user. The parameter selection within the guided commissioning contains the underlying parameters of known standard applications of the configuration in question and can be used as a guideline.
The parameter *SETUP Select* **796** defines the function that is directly implemented. The operation modes share the steps automatically following one another in the course of the guided commissioning.

Operation mode	Function
0 - Clear Status	The auto set-up does not implement a function
1 - Continue	The warning message is acknowledged and the auto set-up continued.
2 - Abort	The auto set-up is stopped and a RESET of the frequency inverter implemented.
10 - Complete Setup, DS0	The auto set-up is implemented in data set 0 and the parameter values are stored identically in all four data sets.
11 - Complete Setup, DS1	The parameter values of the auto set-up are stored in data set 1.
12 - Complete Setup, DS2	The parameter values of the auto set-up are stored in data set 2.
13 - Complete Setup, DS3	The parameter values of the auto set-up are stored in data set 3.
14 - Complete Setup, DS4	The parameter values of the auto set-up are stored in data set 4.
20 - Plaus.-Check Machine Data, DS0	The auto set-up checks the rated motor parameters in the four data sets.
21 - Plaus.-Check Machine Data, DS1	The rated motor parameters are checked for plausibility in data set 1.
22 - Plaus.-Check Machine Data, DS2	The rated motor parameters are checked for plausibility in data set 2.
23 - Plaus.-Check Machine Data, DS3	The rated motor parameters are checked for plausibility in data set 3.
24 - Plaus.-Check Machine Data, DS4	The rated motor parameters are checked for plausibility in data set 4.
30 - Calculation and Para-Ident., DS0	The auto set-up determines extended motor data via the parameter identification, calculates dependent parameters and stores the parameter values identically in all four data sets.
31 - Calculation and Para-Ident., DS1	Extended motor data are measured, dependent parameters calculated and the parameter values stored in data set 1
32 - Calculation and Para-Ident., DS2	Extended motor data are measured, dependent parameters calculated and the parameter values stored in data set 2
33 - Calculation and Para-Ident., DS3	Extended motor data are measured, dependent parameters calculated and the parameter values stored in data set 3
34 - Calculation and Para-Ident., DS4	Extended motor data are measured, dependent parameters calculated and the parameter values stored in data set 4

The monitoring and checking of the individual steps in the course of the auto set-up can be done via the parameter *SETUP Status* **797**. The setup via the communication interface continuously updates the status parameter, which can be read out via the interface.

Status	Meaning
0 - Ok	Auto set-up has been carried out.
1 - PC Phase 1	The plausibility check of the motor data is active.
2 - PC Phase 2	The calculation of dependent parameters is active.
3 - FUF	The parameter identification demands the controller release at digital input S1IND.
4 - Parameter Identification	The rated motor values are being checked by the parameter identification.
10 - Setup already active	Setup via the operating unit is being carried out.
11 - SF0001 Rated Current Too Low	The registered *Rated current* **371** is too low.
12 - SF0002 Rated Current Too High	The *Rated current* **371** is too high relative to the *Rated output* **376** and the *Rated voltage* **370**.
13 - SF0003 Rated Cos-Phi	The *Rated Cos phi* **374** is faulty (larger than 1 or smaller than 0.3).
14 - SF0004 Negative Slip Frequency	The slip frequency calculated from the rated values is negative. The *Rated speed* **372** and the *Rated frequency* **375** are to be checked.
15 - SF0005 Slip Frequency Too High	The input *Rated speed* **372** and the *Rated frequency* **375** are to be checked as the calculated slip frequency is too large.
16 - SF0006 Power Balance	The overall output of the drive mechanism calculated from the rated values is lower than the input rated power.
17 - SF0007 Unsupported Configuration	The set configuration is not supported by the auto set-up.
21 - SA0001 Rated Voltage	The *Rated voltage* **370** is outside the reference voltage range of the inverter. The maximum reference voltage is stated on the rating plate of the frequency inverter.
22 - SA0002 Efficiency	The *Rated current* **371**, the *Rated output* **376** and the *Rated voltage* **370** are to be checked. The calculated efficient is in the threshold area for a three-phase motor.
23 - SA0003 Rated Cos-Phi	The *Rated Cos phi* **374** is outside the standard area (0.6 to 0.95).
24 - SA0004 Slip Frequency	The *Rated speed* **372** and the *Rated frequency* **375** are to be checked. The slip is in the threshold area for a three-phase motor.
30 - No Release	The parameter identification demands the controller release on digital input S1IND
31 - Error	An error has occurred in the course of the auto set-up
32 - Warning Phase Asymmetry	The parameter identification has established an unbalance in the measurements in the three motor phases.

8 Inverter data

The series ACT frequency inverters are suited for a wide range of applications. The modular hardware and software structure enables customer-specific adaptation. The available hardware functionality of the frequency inverter is displayed and can be modified by setting the software parameters specific to the application.

8.1 Serial number

The *Serial number* **0** is entered when the frequency inverter is manufactured. Information on the type of device and the production data with an 8-digit number are displayed. In addition, the serial number is printed on the rating plate.

Serial number **0** : **ACT 400 – 003 ; 02102013**
Rating plate: **Type: ACT 400 – 003 ; Serial No.: 02102013**

8.2 Optional modules

Modular extension of the hardware is possible via the plug-in sections. The *Optional modules* **1** recognized by the frequency inverter are displayed with the matching abbreviations after initialization.

CM-232 ; EM-SYS

8.3 Inverter software version

The firmware stored in the frequency inverter defines an available parameter and function structure of the software. The *Inverter software version* **12** is displayed. In addition to the version, the 6-digit software key is printed on the rating plate of the frequency inverter.

Inverter software version **12** : **4.0.2**
Rating plate: **Version: 4.0.2 ; Software: 140001**

8.4 Set password

As a protection against unauthorized access, the parameter *Set password* **27** can be set in such a way that this password in inquired when a parameter is changed. A change of parameter is only possible if the password in entered correctly. If the *Set password* **27** parameter is set with the value zero, there is no password inquiry in access to the parameters. The previous password is deleted.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact sett.**
27	Set password	0	999	0

8.5 Control level

The *Control level* **28** defines the scope of the functions to be parameterized. The operating instructions describe the parameters on the third control level, which should only be set by qualified users. Before starting work, please read the documentation and comply with the safety instructions. For the purposes of the instructions, a "qualified person" means a person acquainted with the erection, assembly, commissioning and operation of the frequency inverters and in possession of a qualification matching the work.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact sett.**
28	Control level	1	3	1

8.6 User name

The *User name* **29** can be entered via the optional operating software VPlus. The display of the plant or machine designation is only possible in a limited way via the operating unit.

32 alphanumeric characters

8.7 Configuration

The *Configuration* **30** determines the occupancy and basic function of the control inputs and outputs and the software functions. The software of the frequency inverters offers a number of configurations for selection. The configurations essentially differ in the way in which the drive mechanism is controlled. The analog and digital inputs are to be combined within the configuration and supplemented by optional communication protocols. The operating instructions describe the following configurations and matching parameters on the **third** *Control level* **28**.

Configuration 110, sensor-less control
Configuration 110 contains the functions for variable-speed controls of a 3-phase machine in a large number of standard applications. The motor speed is set according to the V/f characteristic in accordance with the ratio of voltage and frequency.

Configuration 111, sensor-less control with technology controller
Configuration 111 extends the sensor-less control by software functions that facilitate customer-specific adaptation in various applications. The technology controller, the volume flow control and the V-belt monitoring are to be used relative to the application.

Configuration 410, sensor-less field-oriented control
Configuration 410 contains the functions for sensor-less, field-oriented control of a 3-phase machine. The current motor speed is determined from the present currents and voltages in combination with the machine parameters. Parallel switching of 3-phase motors is only restrictedly possible in this configuration.

Configuration 210, field-oriented control
Configuration 210 contains the functions for speed-controlled, field-oriented control of a 3-phase machine with speed sensor feedback. The separate control of torque and flux-forming current enables a high drive dynamism with a high moment of load. The necessary speed sensor feedback leads to a precise speed and torque behavior.

Configuration 230, field-oriented control with torque control
Configuration 230 extends configuration 210 by functions for torque-dependent field-oriented control. The reference torque is represented as a percentage and transmitted to a corresponding operating behavior of the application. The switch-over between variable-speed control and torque-dependent control is done via a digital control input.

8.8 Language

The parameters are stored in the frequency inverter in various languages. The parameter description is displayed, for example by the PC program VPlus, in the selected *Language* **33**.

Operation mode	Function
1 - Deutsch	Parameter description in the German language
2 - English	Parameter description in the English language
3 - Italiano	Parameter description in the Italian language

8.9 Programming

The parameter *Program* **34** permits acknowledgment of a fault message and resetting of the factory setting. The display of the operating unit shows the message "dEFLt" or "rESEt", and the light diodes additionally signalize the status of the frequency inverter.

Setting	Function
123	The current error report can be acknowledged via digital input S1IND and the software parameter. The display of the operating unit shows the message "rESEt".
4444	The setting of the parameters within the selected configuration is overwritten with the factory settings. The display of the operating unit shows the message "dEFLt".

9 Machine data

The input of the machine data is the foundation for the functionality of the control functions and methods. In the course of the guided commissioning, the necessary parameters are inquired according to the selected *Configuration* **30**.

9.1 Rated motor parameters

The rated parameters of the three-phase asynchronous machine are to be parameterized according to the rating plate or the data sheet of the motor. The factory settings of the machine parameters are relative to the reference data of the frequency inverter and the matching four-poled 3-phase machine. The machine data necessary for the control functions and methods are calculated in the course of the commissioning from the settings, which have been checked for plausibility.
The factory settings of the rated parameters are to be checked by the user.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
370	Rated voltage	$0.17 \cdot U_{FIN}$	$2 \cdot U_{FIN}$	U_{FIN}
371	Rated current	$0.01 \cdot I_{FIN}$	$10 \cdot o \cdot I_{FIN}$	I_{FIN}
372	Rated speed	96 min^{-1}	60.000 min^{-1}	n_N
373	No. of pole pairs	1	24	2
374	Rated cosine (φ)	0.01	1.00	$cos(\varphi)_N$
375	Rated frequency	10.00 Hz	1000.00 Hz	50.00
376	Rated mechanical power	$0.01 \cdot P_{FIN}$	$10 \cdot P_{FIN}$	P_{FIN}

The increase of the rated speed at constant torque can be implemented in 3-speed machines if the motor winding can be changed over from star to delta circuit. The change-over leads to a modification of the dependent rated values by a square root of three.
The admissible rated voltage and rated speed must be observed!

9.2 Further motor parameters

The selected control functions and methods demand determination of further data which cannot be read off the rating plate of the 3-phase machine, in particular with field-oriented controlling, for the precise calculation of the machine model. In the course of the guided commissioning, the parameter identification has been done to measure the further motor parameters.

9.2.1 Stator resistance

The resistance of the stator winding has been measured in the course of the guided commissioning. The parameter is parameterized as a phase value and is a factor of 3 smaller than the winding resistance in the delta circuit.
In the factory, the alternative stator resistance of a standard motor has been input to match the reference output of the frequency inverter.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
377	Stator resistance	0 mΩ	65535 mΩ	R_{SN}

The stator resistance can be optimized in the open circuit of the machine. At the stationary operating point, the torque-forming current *Isq* **216** or the selected *Active current* **214** should be zero. The adjustment should be done at a winding temperature also reached in normal operation of the motor, as the stator resistance is temperature-dependent.

9.2.2 Leakage coefficient

The leakage coefficient of the machine defines the ratio of the leakage inductivity to the main inductivity. The torque and flux-forming current components are thus coupled via the leakage coefficient. Optimization of the leakage coefficient within the field-oriented control systems demands movement to various operating points of the drive mechanism. The flux-forming current *Isd* **215** should be independent of the load moment to a large extent, unlike the torque-forming current *Isq* **216**. The flux-forming current component behaves inversely proportional to the leakage coefficient. If the leakage coefficient is increased, the torque-forming current increases and the flux-forming component drops. The adjustment should result in a relatively constant actual current value *Isd* **215**, matching the set *Rated magnetizing current* **716**, regardless of the load on the drive mechanism.
The sensor-less controlling uses the parameter *Leakage coefficient* **378** for optimization of the synchronization to one drive.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
378	Leakage coefficient	1.0 %	20.0 %	7.0 %

9.2.3 Magnetizing current

The *Rated magnetizing current* **716** is a measure of the flux in the motor and thus of the voltage set on the machine in an open circuit, regardless of the speed. The guided commissioning determines this value at about 30% of the *Rated current* **371**. This current is comparable with the field current of an externally excited direct current machine.
As optimization for the sensor-less field-oriented controls, the machine must be operated in an open circuit at a rotary frequency below the *Rated frequency* **375**. The precision of the optimization rises with the set *Switching frequency* **400** and the open circuit of the drive to be implemented. The flux-forming actual current value *Isd* **215** to be read off should roughly match the set *Rated magnetizing current* **716**.
The field-oriented control with speed sensor feedback uses the parameterized *Rated magnetizing current* **716** for the flux in the motor.
The dependence of the magnetizing on the frequency and voltage at the operating point in question is taken into account by a magnetizing characteristic. The characteristic is calculated via three points, in particular in the field weakening area above the rated frequency. The parameter identification has determined the magnetizing characteristic and set the parameters *Magnetizing current 50%* **713**, *Magnetizing current 80%* **713** and *Magnetizing current 110%* **713**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
713	Magnetizing current 50%	1.00 %	50.00 %	31.00 %
714	Magnetizing current 80%	1.00 %	80.00 %	65.00 %
715	Magnetizing current 110%	110.00 %	197.00 %	145.00 %
716	Rated magnetizing current	$0.01 \cdot I_{FIN}$	$o \cdot I_{FIN}$	$0{,}3 \cdot I_{FIN}$

9.2.4 Rated slip correction factor

The rotor time constant results from the inductivity of the rotor circuit and the rotor resistance. Due to the temperature-dependence of the rotor resistance and the saturation effects of the iron, the rotor time constant is also dependent on temperature and current. The load behavior and thus the rated slip are a function of the rotor time constant. The guided commissioning has determined the machine data in the parameter identification and set the parameter *Rated slip correction factor* **718** accordingly. For the fine adjustment or a control of the rotor time constant, the following mode of procedure can be used: the machine is loaded at half the *Rated frequency* **375**. Then, about half the *Rated voltage* **370** must result with a deviation of max. 5 %. If this is not the case, the corresponding correction factor must be modified. The larger the correction factor is set, the stronger the drop in the voltage upon load. The value of the rotor time constant calculated by the software can be read out via the actual value *Current rotor time constant* **227**. The adjustment should be done at a winding temperature also reached in normal operation of the motor.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
718	Rated slip correction factor	0.01 %	300.00 %	100.00 %

9.3 Speed sensor 1

The frequency inverters are to be adapted according to the requirements in the application. Some of the available *Configurations* **30** demand continuous measurement of the actual speed value for the control functions and methods. The necessary connection of an incremental speed sensor is done on the digital control terminals S5IND (track A) and S4IND (track B) of the frequency inverter.

9.3.1 Operation mode speed sensor 1

Operation mode speed sensor 1 **490** is to be selected according to the connected incremental speed sensor. A unipolar speed sensor is to be connected to the standard control terminals.

Operation mode	Speed sensor 1 490
0 - off	Speed measurement is not active; the digital inputs are available for further functions.
1 – Single Evaluation	Two-channel speed sensor with recognition of direction of rotation via track signals A and B; one signal edge is evaluated per mark.
4 – Quadruple Evaluation	Two-channel speed sensor with recognition of direction of rotation via track signals A and B; four signal edges are evaluated per mark.
11 – Single Evaluation unsigned	One-channel speed sensor via track signal A. The actual speed value is positive. One signal edge is evaluated per mark. The digital input S4IND is available for further functions.
12 – Double Evaluation unsigned	One-channel speed sensor via track signal A. The actual speed value is positive. Two signal edges are evaluated per mark. The digital input S4IND is available for further functions.
101 – Single Evaluation inverted	As operation mode 1. The actual speed value is inverted. (Alternative to exchanging the track signals)
104 – Quadruple Evaluation inverted	As operation mode 4. The actual speed value is inverted. (Alternative to exchanging the track signals)
111 – Single Evaluation negative	As operation mode 11. The actual speed value is negative.
112 – Double Evaluation negative	As operation mode 12. actual speed value is negative.

9.3.2 Division marks speed sensor 1

The number of increments of the connected speed sensor is to be parameterized via the parameter *Division marks speed sensor 1* **491**. The division marks of the speed sensor are to be selected according to the speed range of the application.
The maximum number of division marks S_{max} is defined by the frequency limit of f_{max} = 150 kHz of the digital inputs S5IND (track A) and S4IND (track B).

$$S_{\max} = 150000Hz \cdot \frac{60s/\min}{n_{\max}}$$

n_{max} = Max. speed of the motor in RPM

In order to guarantee a good true running of the drive, a sensor signal must be evaluated at least every 2 ms (signal frequency f = 500 Hz). From this demand, the minimum number of division marks S_{min} of the incremental speed sensor can be calculated for the required minimum speed n_{min}.

$$S_{\min} = 500Hz \cdot \frac{60s/\min}{A \cdot n_{\min}}$$

n_{min} = Min. speed of the motor in RPM
A = Evaluation (1,2,4)

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
491	Division marks, speed sensor 1	1	8192	1024

10 System data

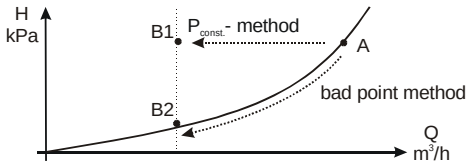
The various control functions and methods according to the selected *Configuration* **30** are supplemented by control and special functions. A calculation of process values from the electrical control values to monitor the application specific to the application in question in helpful.

10.1 Volume flow and pressure

The parameterization of the factors *Nominal volumetric flow* **397** and *Nominal pressure* **398** is necessary if the matching actual values *Volumetric flow* **285** and *Pressure* **286** are used to monitor the drive mechanism. The conversion of the electrical control value is done by the bad point method. In the bad point method, the working point is displaced by modification of the speed on the characteristic.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
397	Nominal volumetric flow	1 m^3/h	99999 m^3/h	10 m^3/h
398	Nominal pressure	0.1 kPa	999.9 kPa	100.0 kPa

Pipe network or channel characteristic:



Point A in the figure describes the rating point of a pump. The transition into part-load operation can be done with constant pressure (modification of conveying flow, pressure remains constant) or by the bad point method (modification of pressure and conveying flow). Both methods can be realized with the integrated technology controller. The actual values displayed are calculated by the bad point method independently of the operation mode of the technology controller selected.

11 Operational behavior

The operational behavior of the frequency inverter is to be parameterized relative to the application. In particular, the starting and stopping behavior is to be configured freely according to the selected *Configuration* **30**. In addition, functions such as the auto-start, synchronization and positioning facilitate integration into the application.

11.1 Starting behavior

The start of the 3-phase machine is to be parameterized in accordance with the control functions and methods. The field-oriented control systems are based on a complex controller structure and only demand definition of the maximum *Flux-formation time* **780** and *Current during flux-formation* **781** limit values, unlike sensor-less controlling, which is supplemented by the selected *Operation mode* **620** of the starting behavior.

11.1.1 Starting behavior of sensor-less controlling

The parameter *Operation mode starting behavior* **620** is available in the configuration 110 and the configuration 111. Depending on the operation mode selected, the machine is firstly magnetized or a starting current is impressed. The loss of voltage on the stator resistance, which reduces the torque in the lower frequency range, can be compensated by the IxR compensation.

Operation mode	Starting behavior
0 - off	At the start, the voltage set with the parameter *Starting voltage* **600** is output with an output frequency of 0 Hz. After this, the output voltage and the output frequency are altered according to the control functions and methods. The break-away torque or the current at the start is determined by the starting voltage set. The starting behavior must possibly be optimized with the parameter *Starting voltage* **600**.
1 - Magnetisation	In this operation mode, the *Current during flux-formation* **781** for magnetization is impressed into the motor after release. The output frequency is kept to the value of zero Hz for the *Maximum flux-formation time* **780**. After this time has expired, there is continuation with the set V/f characteristic. (see operation mode 0)
2 - Magnetisation + Current Impr.	Operation mode 2 contains operation mode 1. After the expiry of the *Maximum flux-formation time* **780**, the output frequency is increased according to the set acceleration. If the output frequency reaches the value set with the parameter *Limit frequency* **624**, the *Starting current* **623** is withdrawn. There is a smooth transition to 1.4 times the limit frequency to the set V/f characteristic. The output current is dependent on the load from this operating point on.
3 - Magnetisation + IxR-Comp.	Operation mode 3 contains operation mode 1 of the start function. If the output frequency reaches the value set with parameter *Limit frequency* **624**, the increase of the output voltage by the IxR compensation becomes effective. The V/f characteristic is displaced by the share of voltage dependent on the stator resistance.

Operation mode	Starting behavior (continuation)
4 - Magnet. + Curr.Imp. + IxR-Comp.	In this operation mode, the current set with the parameter *Current during flux-formation* **781** is impressed into the motor for magnetization after release. The output frequency is kept to the value of zero Hz for the *Maximum flux-formation time* **780**. After expiry of the time, the output frequency is increased according to the set acceleration. If the output frequency reaches the value set with the parameter *Limit frequency* **624**, the *Starting current* **623** is withdrawn. There is a smooth transition to the V/f characteristic and an output current dependent on the load is set. At the same time, the increase of the output voltage by the IxR compensation becomes effective from this output frequency onwards. The V/f characteristic is displaced by the share of voltage dependent on the stator resistance.
12 - Magn. + Curr.Imp. w. Ramp Stop	Operation mode 12 contains an additional function to guarantee a starting behavior under difficult conditions. The magnetization and starting current impress are done according to operation mode 2. The ramp stop takes the current consumption of the motor at the operating point in question into account and controls the frequency and voltage alteration by stopping the ramp. The *Controller status* **275** reports the contact of the controller with the message "**RSTP**".
14 - Magn. + Current Imp. w RS. + IxR-Comp.	In this operation mode, the functions of operation mode 12 are extended by the compensation of the loss of voltage on the stator resistance. If the output frequency reaches the value set with the parameter *Limit frequency* **624**, the increase of the output voltage by the IxR compensation becomes effective. The V/f characteristic is displaced by the share of voltage dependent on the stator resistance.

Unlike the field-oriented control systems, sensor-less controls are extended by a current controller for the starting behavior. The compensated proportional regulator controls the current impress of the parameterized *Starting current* **623**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. set.**
621	Amplification	0.01	10.00	1.00
622	Integral time	1 ms	30000 ms	50 ms

11.1.1.1 Starting current

The configurations 110, 111 and 410 for sensor-less control of a 3-phase machine use the starting current impress in operation modes 2, 4, 12 and 14. The *Starting current* **623** guarantees, in particular for high start torque, sufficient torque to reach *Limit frequency* **624**.
Applications in which high current is permanently needed at a low speed are to be implemented with forced-ventilated motors for thermal reasons.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. set.**
623	Starting current	0.0 A	$o \cdot I_{FIN}$	I_{FIN}

11.1.1.2 Limit frequency

The *Starting current* **624** is impressed in configurations 110, 111 and 410 for sensorless control of a 3-phase machine until the *Limit frequency* **624** is reached. Permanent operating points below the limit frequency are only admissible if forced-ventilated motors are used. Above the limit frequency, there is the transition to the control functions and methods of the selected *configuration* **30**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
624	Limit frequency	0.00 Hz	100.00 Hz	2.60 Hz

11.1.2 Flux-formation

Field-oriented control in the configurations 210, 230 and the configuration 410 are based on separate regulation of the flux-forming and torque-forming current components. At the start of the machine, there is firstly excitation or impressing of a current. With the parameter *Current during flux formation* **781** the magnetization current I_{sd} is set, with the parameter *Maximum flux-formation time* **780** setting the maximum time for the current impress.
The current impress is done until the reference value of the rated magnetizing current is reached or the *Maximum flux-formation time* **780** has been exceeded.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
780	Maximum flux-formation time	1 ms	10000 ms	1000 ms
781	Current during flux formation	$0.1 \cdot I_{FIN}$	$o \cdot I_{FIN}$	I_{FIN}

11.2 Stopping behavior

The stop function of the 3-phase machine is to be defined in stopping behavior via *Operation mode* **630** and is activated via the digital logic signals *Start clockwise* **68** and *Start anticlockwise* **69**. The following operation modes can be selected by combination of the logic signals that are assigned to the digital inputs as follows in the factory setting.

Stopping behavior									
		Start clockwise = 0 and Start anticlockwise = 0							
Operation mode *Stop function* **630**		Stopping behavior 0	Stopping behavior 1	Stopping behavior 2	Stopping behavior 3	Stopping behavior 4	Stopping behavior 5	Stopping behavior 6	Stopping behavior 7
Start clockwise = 1 and Start anticlockwise = 1	Stopping behavior 0	0	1	2	3	4	5	6	7
	Stopping behavior 1	10	11	12	13	14	15	16	17
	Stopping behavior 2	20	21	22	23	24	25	26	27
	Stopping behavior 3	30	31	32	33	34	35	36	37
	Stopping behavior 4	40	41	42	43	44	45	46	47
	Stopping behavior 5	50	51	52	53	54	55	56	57
	Stopping behavior 6	60	61	62	63	64	65	66	67
	Stopping behavior 7	70	71	72	73	74	75	76	77

Operation mode **630** of the stopping behavior is to be parameterized according to the matrix. The selection of the operation modes can vary according to the control functions and methods and the control inputs available.

Stopping behavior	
Stopping behavior 0 **Free stopping**	The converter is inhibited immediately. The drive mechanism is free of voltage immediately and stops freely.
Stopping behavior 1 **Stop + Switch off**	The drive mechanism is taken to a standstill with the set deceleration. When standstill has been reached, the converter is inhibited after a holding time. The holding time can be set with the parameter *Holding time* **638**. Depending on the setting of the parameter *Starting function* **620**, there is impressing for the duration of the holding time of the starting current, or the starting voltage is applied.
Stopping behavior 2 **Stop + Hold**	The drive mechanism is taken to a standstill with the set deceleration and remains permanently supplied with current. Depending on the setting of the parameter *Starting function* **620** there is impressing from the standstill of the *Starting current* **623**, or the starting voltage is applied.
Stopping behavior 3 **Stop + brake**	The drive mechanism is taken to a standstill with the set deceleration. From the standstill, the DC set with the parameter *Braking current* **631** is impressed for the *Braking time* **632**. Stopping behaviors 3, 6 and 7 are only available in the configurations for sensor-less control.
Stopping behavior 4 **Emergency stop + switch off**	The drive mechanism is guided to a standstill with the emergency stop deceleration. When a standstill has been reached, the converter is inhibited after a holding time. The holding time can be set with the parameter *Holding time* **638**. Depending on the setting of the parameter *Starting function* **620** the starting current is impressed or the starting voltage applied from standstill.
Stopping behavior 5 **Emergency stop + Hold**	The drive mechanism is taken to a standstill with the emergency stop deceleration and remains permanently supplied with current. Depending on the setting of the parameter *Starting function* **620, the** *Starting current* **623** is impressed or the starting voltage applied from standstill.
Stopping behavior 6 **Emergency stop + Brake**	The drive mechanism is guided until a standstill with the set emergency stop deceleration. From standstill, the DC set for the *Braking time* **632** with the parameter *Braking current* **631** is impressed. Stopping behaviors 3, 6 and 7 are only available in the configurations for sensor-less control.
Stopping behavior 7 **Direct current brake**	Direct current braking is activated immediately. The direct current set with the parameter *Braking current* **631** is impressed for the die *Braking time* **632**. Stopping behaviors 3, 6 and 7 are only available in the configurations for sensor-less control.

11.2.1 Switch-off threshold

The *Switch-off threshold stop function* **637** defines the frequency from which a standstill of the drive mechanism is recognized. The percentage parameter value is relative to the set *Maximum frequency* **419**.
The switch-off threshold is to be parameterized according to the load behavior of the drive mechanism and the device output, as the drive mechanism must be controlled to a speed below the switch-off threshold.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
637	Switch-off threshold stop function	0.0 %	100.0 %	1.0 %

11.2.2 Holding time

The *Holding time stop function* **638** is considered in stopping behavior 1, 3, 4 and stopping behavior 6. Controlling to speed zero leads to a heating of the motor and should only be done for a short period in internally ventilated motors.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
638	Holding time stop function	0.0 s	200.0 s	1.0 s

11.3 Direct current brake

Stopping behaviors 3, 6, 7 and the search run function contain the direct current brake. Depending on the setting of the stop function, a direct current is impressed into the motor either directly or in standstill after the demagnetization time. The impression of the *Braking current* **631** leads to a heating of the motor and should only be done for a short period in internally ventilated motors.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
631	Braking current	0.00 A	$\sqrt{2}\cdot I_{FIN}$	$\sqrt{2}\cdot I_{FIN}$

The setting of the parameter *Braking time* **632** defines the stopping behavior controlled by time. The contact-controlled operation mode of the direct current brake is to be activated by the value zero for the *Braking time* **632**.

Time controlled:
The direct current brake is activated with the controller release and the Start clockwise and Start anticlockwise signals. The current set by the parameter *Braking current* **631** flows until the time set by the parameter *Braking time* **632** has expired or a control signal logically becomes 0.

Contact-controlled:
If the parameter *Braking time* **632** is set to the value 0.0 s, the direct current brake is only controlled by the Start clockwise and Start anticlockwise signals. The time monitoring and limit by the *Braking time* **632** are deactivated.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
632	Braking time	0.0 s	200.0 s	10.0 s

To avoid current surges, which can possibly lead to a fault switch-off of the frequency inverter, a direct current may only be impressed into the motor after the latter has been demagnetized. As the demagnetization time depends on the motor used, it can be set with the parameter *Demagnetizing time* **633**.
The demagnetization time should be parameterized in the range of three times the rotor time constant.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
633	Demagnetization time	0.1 s	30.0 s	5.0 s

The selected configuration is extended by a current controller to control the direct current brake. The compensated proportional regulator controls the current impression of the parameterized *Braking current* **631**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
634	Amplification	0.00	10.00	1.00
635	Integral time	0 ms	1000 ms	50 ms

11.4 Auto-start

The Auto-start function is suitable for applications that permit a start at mains voltage by their function. By activation of the auto-start function with the parameter *Auto-start* **651** the frequency inverter accelerates the drive mechanism after application of the mains voltage. The controller release control signal and the start command are necessary according to the regulations.
The motor is accelerated when switched on according to the parameterization and the reference value signal.

Operation mode	Function
0 - Off	The drive mechanism is accelerated if the controller release and the start command are switched after application of the mains voltage.
1 - Switched on	By application of the mains voltage, the drive mechanism is accelerated by the frequency inverter.

Danger: At the point, we expressly refer to VDE provision 0100 part 227 and provision 0113, in particular Sections 5.4, protection against independent restarting after a power failure and resumption of voltage, and Section 5.5, undervoltage protection.
A risk to man, machines and production goods is to be ruled out if one of these cases occurs.
Further, particular national directives and those applicable for the case of application in question are to be obeyed.

11.5 Search run

The synchronization to a rotating drive mechanism is necessary in applications which drive the motor by their behavior or if the drive mechanism is still rotating after a fault switch-off. With the help of *Operation mode search run* **645** there is synchronization to the current motor speed without an "Overcurrent" fault message. After this, the motor is guided to the reference speed with the set acceleration.
The synchronization function determines the current rotary frequency of the drive mechanism via a search run in operation modes 1 to 5.
The synchronization in operation modes 10 to 15 is accelerated by short test impulses. Rotary frequencies of up to 250 Hz are determined within 100 ms to 300 ms. For higher frequencies, a wrong frequency is determined and the synchronization fails. The search run cannot determine whether an attempt at synchronization has failed in the operation modes "Quick synchronization".

Operation mode	Function
0 - off	The synchronization to a rotating drive mechanism is deactivated.
1 - Search Dir. acc. to Preset Val.	The search direction is stated by the sign in front of the reference value. If a positive reference value (clockwise rotating field) is stated, the search is in a positive direction (clockwise rotating field), with a negative reference value, the search is in a negative direction (anticlockwise rotating field).
2 - First Clockw., Then Anticl., DCB	The first attempt is to synchronize to the drive mechanism in a positive direction (clockwise rotating field). If this attempt fails, the attempt is to synchronize to the drive mechanism in a negative direction (anticlockwise rotating field).
3 - First Anticl., Then Clockw., DCB	The first attempt is to synchronize to the drive mechanism in a negative direction (anticlockwise field of rotation). If this attempt fails, the attempt is to synchronize to the drive mechanism in a positive direction (clockwise rotating field).
4 - Clockwise Only, DC-Brake	Synchronization to the drive mechanism is only done in a positive direction (clockwise rotating field).
5 - Anti-clockwise Only, DC-Brake	Synchronization to the drive mechanism is only done in a negative direction (anticlockwise rotating field).
10 - Quick Synchronisation	An attempt is made to synchronize to the drive mechanism in a positive direction (clockwise rotating field) and negative (anticlockwise rotating field).
11 - Quick Synch. acc. to Preset Value	The search direction is determined by the sign in front of the reference value. If a positive reference value (clockwise rotating field) is stated, the search direction is in a positive direction (clockwise rotating field), with a negative reference value, the search is in a negative direction (anticlockwise rotating field).
14 - Quick Sync., Clockwise Only	Synchronization to the drive mechanism is only done in a positive direction (clockwise rotating field).
15 - Quick Sync., Anti-clockwise Only	Synchronization to the drive mechanism is only done in a negative direction (anticlockwise rotating field).

The operation modes 1, 4 and 5 state a direction of rotation for the search run and avoid a deviating direction. The search run can accelerate drive mechanisms by checking the rotary frequency if the mechanism possesses a low moment of inertia or a small load moment.
In operation modes 10 to 15, determination of a wrong direction of rotation cannot be ruled out in quick synchronization. For example, a frequency not equal to zero can be determined although the drive mechanism is stationary. If there is no overcurrent, the drive mechanism is accelerated accordingly. The statement of a direction of rotation takes place in operation modes 11, 14 and 15.

Synchronization changes the parameterized starting behavior of the selected configuration. To start with, the start command activates the search run in order to determine the rotary frequency of the drive mechanism. In operation modes 1 to 5, the *Current / Rated motor current* **647** is used as a percentage of the *Rated current* **371** for synchronization.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
647	Current / rated motor current	1.00 %	100.00 %	70.00 %

The sensor-less control is extended for the search run by a compensated proportional regulator, which regulates the parameterized *Current / Rated motor current* **647**.
If the *Operation mode Synchronization* **645** parameter has been set to operation mode 1 to 5 (search run), there is firstly a wait for the *Demagnetization time* **633** before the search run is started.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
648	Amplification	0.00	10.00	1.00
649	Integral time	0 ms	1000 ms	20 ms

If synchronization to the drive mechanism is not possible, the *Braking current* **631** is impressed into the motor in operation modes 1 to 5 for the duration of the *Braking time after search run* **646**. The impress of the direct current set in the parameters of the direct current brake leads to a heating of the motor and should only be done for a short period in internally ventilated motors.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
646	Brake time after search run	0.0 s	200.0 s	10.0 s

11.6 Positioning

Controlled positioning uses a digital reference signal for speed-independent positioning of the drive mechanism. The feedback of the current position relates to the revolutions of the motors relative to the time of the reference signal. The precision of the positioning for the application to be realized is dependent on the current *Actual frequency* **241**, the *deceleration (clockwise)* **421**, the *No. of pole pairs* **373**, the selected *Positioning distance* **460** and the parameterized control functions and methods.
The parameter *Positioning* **458** activates the function "Positioning from reference point" in operation mode 1.

Operation mode	Function
0 - Off	Positioning has been switched off.
1 - Pos. from reference point	Positioning from reference point, the reference point is registered via a *Signal source* **459**

The digital signal for registration of the reference point and the logical assignment are to be chosen from a selection of *signal sources* **459**. The assignment of the digital inputs S2IND, S3IND and S6IND with further functions is to be checked according to the selected *Configuration* **030**.

Operation mode	Function
2 - S2IND, falling edge	The positioning starts with the logical signal change from 1 (HIGH) to 0 (LOW) at the reference point.
3 - S3IND, falling edge	
6 - S6IND, falling edge	
1x - SxIND, rising edge	The positioning starts with the logical signal change from 0 (LOW) to 1 (HIGH)
2x - SxIND, rising/falling edge	The positioning begins with the logical signal change

The distance between the reference point and the required position is to be stated in revolutions. The calculation of the distance covered is done with the selected *Positioning distance* **460** according to the application.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
460	Positioning distance	0.000 U	1000000.000 U	0.000 U

The actual value parameter *Revolutions* **470** facilitates the setting and optimization of the function. The revolutions of the motor displayed should correspond to the *Positioning distance* **460** at the required position.

The registration of the reference position via a digital signal can be influenced by a variable dead time in reading in and processing the control command. The signal running time is compensated by a positive value for the *Signal correction* **461**. The setting of a negative signal correction decelerates the processing of the digital signal.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
461	Signal correction	-327.68 ms	+327.67 ms	0.00 ms

The influences on the positioning dependent on the operating point are to be corrected empirically via the *Load correction* **462** parameter. If the required position is not reached, the deceleration duration is increased by a positive value for the load correction. The distance between the reference point and the required position is lengthened. Negative values accelerate the braking process and shorten the distance of positioning. The limit of the negative signal correction results from the application and the *Positioning distance* **460**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
462	Load correction	-32768	+32767	0

The behavior of the positioning after the required position of the drive mechanism has been reached can be defined via the *Activity after positioning* **463** parameter.

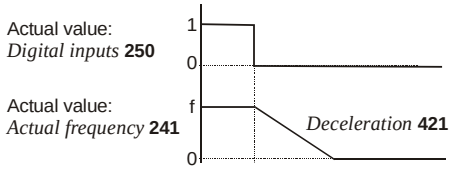
Operation mode	Function
0 - End positioning	The drive mechanism is stopped with the stopping behavior of the *Operation mode stop function* **630**.
1 - Waiting for positioning signal	The drive mechanism is held until the next signal edge; with a new edge of the position signal, there is acceleration in the previous direction of rotation.
2 - Reversal by new edge	The drive mechanism is held until the next signal edge; with a new edge of the position signal, there is acceleration in the opposite direction of rotation.
3 - Positioning ; off	The drive mechanism is stopped and the power part of the inverter switched off.
4 - Start by time control	The drive mechanism is held for the *Time to wait* **464**; after the waiting time, there is acceleration in the previous direction of rotation.
5 - Reversal by time control	The drive mechanism is held for the *Time to wait* **464**; after the waiting time, there is acceleration in the opposite direction of rotation.

The position reached can be maintained for the *Waiting time* **464** before the drive mechanism is accelerated according to operation mode 4 or 5.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. Set.**
464	Waiting time	0 ms	3600000 ms	0 ms

Examples of positioning from reference point as a function of the parameter settings selected in the works.

Positioning 458 = 1



- The reference point is registered according to the *Signal sources* **459** parameter in operation mode 2–S2IND, neg. edge by a signal on digital input 2.
- The *Positioning distance* **460** with the parameter value 0.000 U defines a direct stoppage of the drive mechanism according to the defined *Operation mode stop function* **630**
- The *Signal correction* **461** of the signal running time from the measurement point to the frequency inverter is not used by the 0 ms.
- The *Load correction* **462** can compensate a faulty positioning by the load behavior. Ex works, the compensation with the value 0 is deactivated.
- The *Action after positioning* **463** is defined by operation mode 0–End of positioning.
- The *Waiting time* **464** is not considered by the *Activity after positioning* **463** parameter in the above setting.
- The actual value *Rotations* **470** enables a direct comparison with the required *Positioning distance* **460**.

12 Error and warning behavior

Operation of the frequency inverter and the connected load is continuously monitored. The monitoring functions are to be parameterized with the matching limit values specific to the application. If the limits have been set below the switch-off limit of the frequency inverter, the fault switch-off can be prevented by suitable measures in the event of a warning message.
The warning message is displayed with the LED's and can be read out with the operating unit via the parameter *Warnings* **269** or issued via one of the digital control outputs.

12.1 Overload Ixt

The admissible load behavior depends on various technical data of the frequency inverters and the ambient conditions.
The selected *Switching frequency* **400** determines the reference current and the available overload for one second and for sixty seconds. The *Warning limit short-term Ixt* **405** and *Warning limit long-term Ixt* **406** are to be parameterized accordingly.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
405	Warning limit short-term Ixt	6 %	100 %	80 %
406	Warning limit long-term Ixt	6 %	100 %	80 %

12.2 Temperature

The ambient conditions and the current operating point lead to a heating of the application. In order to avoid a fault switch-off of the frequency inverter, the *Warning limit Tc* **407** for the heat sink temperature limit and the *Warning limit Ti* **408** as a temperature limit in the inside are to be parameterized. The temperature value calculated from the type-independent limit value less the warning limit set is to be determined from the application data.
The switch-off limit of the frequency inverter is at 60°C – 70°C inside temperature and 80°C – 90°C heat sink temperature.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
407	Warning limit Tc	-25 °C	0 °C	-5 °C
408	Warning limit Ti	-25 °C	0 °C	-5 °C

12.3 Controller status

The selected control functions and methods and the matching monitoring functions prevent a switch-off of the frequency inverter. The intervention of the function amends the operating behavior of the application and can be displayed by the status messages with the parameter *Controller status* **275**. The limit values and incidents leading to intervention by the controller in question are described in the chapters in question. The behavior in intervention of a controller is configured with the parameter *Controller status message* **409**.

Operation mode	Function
0 - No Message	Controllers influencing the operating behavior are displayed in the *Controller status* **275** parameter.
1 – Warning Status	The limitation by a controller is displayed as a warning by the operating unit.
4 – Warning Status and LED	The limitation by a controller is displayed as a warning by the operating unit and the LED's.

12.4 IDC compensation limit

A DC voltage component can occur in the output current at the output of the frequency inverter due to unbalances. This DC voltage component can be compensated by the frequency inverter. The maximum output voltage of the compensation is set with the parameter *IDC compensation limit* **415**. If a higher voltage than the set limit is needed for the compensation of a DC voltage component, the error "F1301 IDC COMPENSATION" is triggered.
If this fault occurs, there should be a check whether the load is possibly defective. The voltage limit may possibly have to be increased.
If the parameter *IDC compensation limit* **415** is reduced to zero, the DC compensation is deactivated.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
415	IDC compensation limit	0.0 V	1.5 V	0.0 V

12.5 Frequency switch-off limit

The maximum allowed output frequency of the frequency inverter is to be set with the parameter *Frequency switch-off limit* **417**. If this frequency limit is exceeded by the *Stator frequency* **210** or *Actual frequency* **241**, the frequency inverter switches off with fault message "F1100".

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
417	Frequency switch-off limit	0.00 Hz	999.99 Hz	999.99 Hz

12.6 Motor temperature

The configuration of the control terminals contains the monitoring of the motor temperature. The monitoring function can be parameterized specific to the application via the parameter *Motor-PTC operation mode* **570**. The integration into the application is improved by an operating mode with a switch-off with a delay.

Operation mode	Function
0 - off	Monitoring of the motor temperature
1 - Warning only	The critical operating point is displayed by the operating unit and the parameter *Warnings* **269**.
2 - Error Switch-Off	The fault switch-off is displayed by message F0400. The fault switch-off can be acknowledged via the operating unit or the digital input.
3 - Err. Switch-Off 1 min delayed	The fault switch-off according to operation mode 2 is delayed by one minute.
4 - Err. Switch-Off 5 min delayed	The fault switch-off according to operation mode 2 is delayed by five minutes.
5 - Err. Switch-Off 10 min delayed	The fault switch-off according to operation mode 2 is delayed by ten minutes.

12.7 Phase failure

If a failure of one of the three phases both on the motor and also on the mains side is not noticed, it can lead to damage on the frequency inverter, the motor and on the mechanical drive components. The behavior in a phase failure can be set with the parameter *Phase supervision* **576**.

Operation mode	Function
10 - Mains: Error Switch-Off	The fault switch-off in a phase failure takes place after one minute with fault F0703. Within the delay, the warning message A0100 is displayed.
11 - Mains & Motor: Error Switch-Off	The phase monitoring switches the frequency inverter off after one minute with the fault message F0403 for a motor phase failure and F0703 for a mains phase failure.
20 - Mains: Shutdown	In a mains phase failure, the drive mechanism is shutdown with the fault F0703 after one minute
21 - Mains & Motor: Shutdown	In a mains phase failure, the function shuts the drive mechanism down directly, in a mains phase failure after one minute.

12.8 Automatic error acknowledgment

The automatic error acknowledgment enables acknowledgment of the faults Overcurrent F0500, Overcurrent F0507 and Overvoltage F0700 without interference of a superior control or the user. If one of the aforementioned errors occurs, the frequency inverter switches the power semi-conductors off and waits for the time stated with the parameter *Restart delay* **579**. If the error must be acknowledged, the speed of the machine is determined with the quick catching function and synchronized to the rotating machine. The automatic error acknowledgment makes use of the quick catching operation mode regardless of the setting of the parameter *Search run operation mode* **645**. The information of the search run function must be observed. With the parameter *Allowed no. of auto-acknowl.* **578**, the number of errors which can be acknowledged within ten minutes is set. The aforementioned faults have a separate counter, by which repeat acknowledgment above the allowed number within 10 minutes leads to a direct switch-off of the frequency inverter.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
578	Allowed number of auto-acknowl.	0	20	5
579	Restart delay	0 ms	1000 ms	20 ms

13 Reference values

The ACT series frequency inverters are to be configured specific to the application and enable customer-specific adaptation of the module hardware and software structure.

13.1 Frequency limits

The speed setting range and thus the output frequency of the frequency inverter is defined by the parameters *Minimum frequency* **418 a**nd *Maximum frequency* **419**. The control functions and methods in question use the two limit values for scaling and calculating the frequency.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
418	Minimum frequency	0.00 Hz	999.99 Hz	3.50 Hz
419	Maximum frequency	0.00 Hz	999.99 Hz	50.00 Hz

The torque-forming current component and thus the slip frequency of the 3-phase machine is a function of the required torque. The field-oriented control system also contains the parameter *Slip frequency* **719** to limit the torque in the calculation of the machine model. The rated slip calculated from the rated motor parameters is limited in accordance with the percentage parameterized *Slip frequency* **719**.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
719	Slip frequency	0 %	10000 %	250 %

13.2 Percentage value limits

The setting range of the percentages is defined by the parameters *Minimum reference percentage* **518 a**nd *Maximum reference percentage* **519**. The control functions and methods in question use the two limit values for scaling and calculating the frequency.

Parameter		Setting		
No.	**Description**	**Min.**	**Max.**	**Fact. sett.**
518	Minimum reference percentage	0.00 %	300.00 %	0.00 %
519	Maximum reference percentage	0.00 %	300.00 %	100.00 %

13.3 Frequency reference value channel

The varied functions for the statement of the reference frequency are connected by the frequency reference value channel in the speed-controlled configurations. The *Reference frequency source* **475** determines the additive assignment of the available reference value sources as a function of the hardware installed.

Operation mode	Function
1 - Abs. Analog Value MFI1A	Reference value source is the multifunctional input 1 in *Operation mode* **452** - Analog signal.
10 - Abs. Val. Fixed Frequency (FF)	The fixed frequency according to the *Fixed frequency change-over 1* **66** and the current data set
11 - Abs. Value MFI1A + FF	Combination of the operation modes 10 and 1
20 - Abs. Val. Motorpoti (MP)	Reference is the function *Frequency Motorpoti Up* **62** and *Frequency Motorpoti Down* **63**
21 - Abs. Value MFI1A + MP	Combination of the operation modes 20 and 1
30 - Abs.Val. Speed Sensor 1 (F1)	The frequency signals in the *Operation mode Speed Sensor 1* **490** are evaluated as reference.
31 - Abs. Value MFI1A + F1	Combination of the operation modes 30 and 1
32 - Abs. Val. Rep. Freq. Inp. (F3)	The frequency signal on the digital input according to *Operation mode repetition frequency* 496
33 - Abs. Value MFI1A + F3	Combination of the operation modes 32 and 1
90 - Abs. Value MFI1A + FF + MP + F3	Combination of the operation modes 1, 10, 20 and 32
91 - Abs. Value MFI1A+FF+MP+F1+F3	Combination of the operation modes 1, 10, 20, 30 and 32
101 to 191	Operation modes with sign (+/-)

13.3.1 Circuit diagram

The following table describes the software switches shown in the circuit diagram as a function of the selected *Frequency reference value source* **475**.

Switch position on circuit diagram						
Operation mode	**MFI1A**	**FF**	**MP**	**F1**	**F3**	**Sign**
1	1					Abs. value
10		1				Abs. value
11	1	1				Abs. value
20			1			Abs. value
21	1		1			Abs. value
30				1		Abs. value
31	1			1		Abs. value
32					1	Abs. value
33	1				1	Abs. value
90	1	1	1		1	Abs. value
91	1	1	1	1	1	Abs. value
101	1					+/-
110		1				+/-
111	1	1				+/-
120			1			+/-
121	1		1			+/-
130				1		+/-
131	1			1		+/-
132					1	+/-
133	1				1	+/-
190	1	1	1		1	+/-
191	1	1	1	1	1	+/-

Circuit diagram of frequency reference value channel