SLOVAKIA

VONSCH spol. s r.o.,
Budovateľská 13,
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VQfrem 500

Vector frequency converter for motors supplied with 3 x 500 V and power ranging:

315 ÷ 1400 kW

Version : v.6.07

User guide

Contents: ***page:***

SLOVAKIA

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CERTIFICATE OF WARRANTY

a, Converter testing:

The producer performed comprehensive testing of the product prior to its expedition. Product features conform to the technical documentation, if the product is installed and used in compliance with instructions and recommendations specified in technical documentation and operating manual.

b, Warranty period:

Warranty period for the frequency converter VQFREM 400 is 25 months from its expedition.

c, Warranty terms:

The warranty applies only for defects and faults that result from production failures or used materials.

Within the warranty period, the producer will perform a warranty repair free of charge. A precondition for complaint application is a duly completed and approved certificate of warranty. Warranty period will be extended by a period the frequency converter is under repair.

Faults resulting from the following actions are excluded from the warranty:

1, Customer/user failure caused by mechanical damages (e.g. within transportation, accident), product use in conflict with technical documentation, incorrect connection and an unauthorized intervention into the product.

2, A damage of the equipment caused by external effects (dusting of converter internal parts) and natural events (high overvoltage after lightning; fire; water immersion - flood).

3, Improper storage, connection in conflict with recommended wiring, improper electrical installation (electrical values of non-permissible size).

Type of frequency converter:	**VQFREM 500 630**
Production number:	
Date of production:	
Date of expedition:	
Date of start - up:	

Producer signature and stamp:

Producer notes:

Producer notes:

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Budovateľská 13,
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COMPLIANCE CERTIFICATE

Producer : VONSCH spol. s. r.o. (Ltd.)

Location : Budovatelska 13, 977 03 BREZNO, Slovakia

Business Identification No. : 31567835

Product name : Static frequency converter of a type
VQFREM 500 315, VQFREM 500 400,
VQFREM 500 500, VQFREM 500 630,
VQFREM 500 710, VQFREM 500 800,
VQFREM 500 1000, VQFREM 500 1200,
VQFREM 500 1400

The above mentioned product was audited in terms of CODE No. 264/1999 C.c. and **is compliant** with technical requirements of the following Government Regulations and Legislations:

No: 308/2004
Title: Government Regulation on technical requirements and conformity assessment of electrical equipment designed for defined voltage range.
No: 245/2004
Title: Government Regulation on technical requirements of products with electromagnetic compatibility requirement.

The following technical norms were prevailing during product conformity auditing:

STN EN 60146-1-1 +A1: 2001
STN EN 61800-3
STN EN 61000-2-4
STN EN 501-708

VONSCH responsible :
Name : Ing. Pavol Šperka
Post : CEO
Address : Budovatelska 13, 977 03 BREZNO, Slovakia
Date : June 30, 2008
Signature :

SAFETY INSTRUCTIONS

A T T E N T I O N !

The following material must be studied before attempting any work on, or with the unit!

Following safety instructions must be followed when installing, operating and servicing frequency converters! If neglected, physical injury and death may follow, or damage may occur to the frequency converter, the motor and driven equipment!

If safety norms and regulations currently in force are violated, the producer is relieved from liability for damages and injuries!

Electrical installation, mounting and maintenance work on frequency converters may be carried out exclusively by skilled electricians qualified minimally according to § 21 - 24 Regulation No. 718/2002 Collection of Laws.

W A R N I N G !

- Before operating frequency converter study this material carefully and make yourself acquainted with the warnings laid down in this operating instruction and converter functions.
- Take care that nobody without sufficient knowledge manipulates with the frequency converter!
- Qualified electricians who are familiar with the equipment, its operating requirements and instructions mentioned in this user guide should carry out all electrical installation and maintenance work on frequency converter. Presence of children and unauthorized persons is prohibited!
- Frequency converter can be used only for the purposes recommended by the manufacturer!
- This equipment contains hazardous voltages and controls hazardous rotating mechanical parts. All work on the equipment and its installation must be carried out in accordance with this operating instruction to reduce risk of injury or death, or damage to the converter.
- The successful and safe operation of frequency converter is dependent upon its proper transportation, handling, installation, operation, and maintenance and upon the setting of various parameter values!
- Dc-link circuit capacitors remain charged to dangerous voltages for some time after the incoming power has been switched off. It is not allowed to touch frequency converter for up to five minutes after it was disconnected.
- When the motor is not running, dangerous voltages are still present on power terminals.
- Under certain operating conditions, the converter can restart automatically after an input power failure. Ensure that no one is close to the machinery controlled by the converter when such conditions prevail.

MOUNTING AND INSTALLATION OF FREQUENCY CONVERTER :

- To guarantee safe operation of the equipment it must be installed and commissioned properly by qualified personnel in compliance with the directions and warnings listed in this operating instruction.
- Take particular note of general and regional installation safety regulations regarding work on heavy-current equipment, as well as the relevant regulations regarding the correct use of tools and personal protective gear.
- If these instructions are not followed, physical injury or death may follow, or damage may occur to the equipment.
- Take care to mount the converter on dry places, away from potential water hazards. Do not install the converter beneath pipes that are subject to condensation!
- Ensure that a free space is left both above and below the converter. Make sure that there is adequate airflow through the cabinet – see drawings at the end of this user guide.
- Ensure that the converter's air vents are not obstructed.
- In a case that frequency converters are assembled one above another, ensure that there is sufficient free space left between them and that there is adequate cooling.
- After installation and operational test, assure that air temperature is below permissible value.
- Do not install the converter in an area where it is likely to be exposed to constant vibration and any impacts.

- The printed circuit boards contain highly sensitive semiconductor MOS parts. Do not touch MOS parts with hands or with any metallic objects because they are particularly sensitive on static.
- Use insulated screwdrivers for making or changing any connections to the unit (for connecting control and power conductors).
- Any changes or any use of replacement parts, which are not recommended by the manufacturer, can cause input power failure, fire or serious physical injury.

I M P O R T A N T :

In a case that frequency converters are operating near switching components (contactors, relays and so on), or are operating on the same network, it is recommended to realize the following in order to ensure interference elimination of switching components:

- use RC protectors or diodes on coils of contactors, on coils of relays and other switching components.
- use shielded conductors for external control circuits, external regulating and measuring accuracy circuits.
- the distance between control conductors and conductors that are sources of current noise (e.g. power cables and control cables) should be at least 30 cm.

Overvoltage protection:

Exclusively semiconductor fuses of a type gR, aR should be used to ensure current protection of frequency converter!

Frequency converter should not be used in operations where short-term power supply failures occur. (e.g. improper overhead conductor circuit).

In a case of power supply failure, frequency converter can stop automatically. Later it restarts automatically, when supply network is in normal condition. If higher frequencies are used, power supply failure causes undervoltage, therefore the converter may cycle.

In a case of short-term power supply failure, not allowed current spikes may occur, that may cause damage to the converter. If current spikes of non-permissible intensity exist, accessory equipment must be added to the converter. Overvoltage filter is an example of accessory equipment that eliminates overcurrent spikes. It is essential to connect overvoltage filter in front of the converter.

Cable lengths over 50 m or 25 m:

Cable capacity (the longer the cable, the greater its capacity) causes that the frequency converter has to deliver extra current at every commutation. Extra current is needed to charge the capacity of a cable between motor and converter. The mentioned current together with motor current can be too high and can exceed the maximal accepted converter current. In such a case, the converter switches off. The switch off is caused by the fault „CNV *Overcurrent* “ or „ *Out.short circ*. “.

Total cable length is the sum of the cables connected to each motor.

The total length of the motor cable should not exceed 50 m. For applications where longer cables are required, inductors or sine filters *must be fitted to reduce capacitive currents.*
Cable lengths above 50 m are possible, if additional motor choke is used every 100 m.

When using cables of longer lengths, it is suitable to use sine filter (connect the sine filter directly to converter output), which reduces capacitive currents and ensures EMC, as well. If arbitrary cable lengths are used (also arbitrary shielded cable lengths), it is sufficient to fit a single sine filter.

If a shielded motor cable is used, the maximum length should not exceed 25 m. If the length of a shielded motor cable is more than 25 m, it is necessary to use additional motor choke every 50 m. In order to reduce capacitive currents and to satisfy the requirements of EMC product standard, it is desirable to use sine filter. Sine filter ensures that the motor is supplied with practically sinusoidal voltage waveforms.

TECHNICAL DESCRIPTION

FREQUENCY CONVERTER **VONSCH -** type serie **VQFREM 500**

VQFREM 500 frequency converters are modern vector control frequency converters, which are specially designed for the most difficult technical drives applications. These drives applications with asynchronous motors are supplied with voltage 3 x 500 V. VQFREM 500 frequency converters are characterized by a very high level of system dynamism and overloading. They are available for open and closed systems. VQFREM 500 frequency converters are characterised by high quality of software control, which enables energetic power optimalization, adherence of reference speed, torque control of motors.

Modern type SkiiP, SkiiM, IPM – IGBT semiconductors, that provide complex protection of converters and their controlling, are applied in the VQFREM 500 converters. The communication is provided by two 32-bit digital signal processors (DSP).

The converters are pre-programmed for some specific applications (applications macros). Frequency converters have an Auto Tuning function that makes parameter setting significantly easier. Auto tuning helps the converter to measure important motor parameters, causes that the converter is adapted to motor automatically taking the parameters of the motor into account.

Examples of application:
- **chemical industries**: *speed controlling of pumps and fans*
- **paper industries**: *torque controlling of reeling machines and controlling of paper lines drives*
- **waterworks and sewage tanks**: *controlling of pumps and compressors*
- control drives of various machines
- every application, where it is necessary to control the speed and torque of technological equipment

Features of VQFREM:

- **high reliability –** it was achieved by careful selection of component suppliers, reducing the number of components has contributed to high reliability of the products, as well
- **testing** – every complete frequency converter and every single part of it are 100 % tested
- **power units** – the most modern type with low losses and high integration
- **control circuit** – two 32-bit DSP
- **protection against –** overcurrent, overvoltage and undervoltage, against short-circuits, converter overtemperature, motor overtemperature and overload protection
- **fault self-indication** – in the event of a failure, frequency converter displays relevant fault code
- **fault history** – frequency converter remembers the latest 10 faults
- **energetic power optimalization** of converter-motor system
- **high electromagnetic immunity** - commutating input reactor is integrated into the converter
- **emission suppression** – steel enclosure of the converter contributes to emission suppression
- **built-in control panel** (9-buttons keypad) with 4-lines alphanumeric display
- **user friendly actuating of the converter** (block programming)
- **auto tuning** - frequency converter is automatically adapted to asynchronous motor
- **low motor noisiness** – switching frequency up to 15 kHz
- **software options** – PID regulator, energetic optimalization, autotunning, two sets of parameters, programmable relay, position and torque controlling, flying start, cranes and reeling functions

BASIC OPTIONS

- **built-in control panel „BCP“:** the panel contains alphanumeric 4 x 20 characters display, operating instructions are supplied in Slovak language and English, parameters can be changed and set using 9-buttons keypad
- **RFI suppression filter** class A1 integrated into the converter(according to STN EN 55011)
- **commutating reactor „CR“** (commutating choke) integrated into the frequency converter circuit, it reduces the harmonics of the converter and voltages in the power supply system of a converter according to STN 33 34 30. It lengthens the operating life of power capacitors of a converter.
- **inputs:** 3 analogue inputs, 6 programmable binary inputs
- **outputs :** 2 analogue current outputs: 0 ÷ 20 mA (4 ÷ 20 mA) used for output frequency (current) indication
- 3 programmable **output relays 230 V / 3 A** (e.g. READY…)
- **two sets of** adjustable **parameters**
- **setting of reference value**: binary 8 speeds, reverse, reset, analogue signal 0 ÷ 10 V, 2 ÷ 10 V, or 0 ÷ 20 mA, 4 ÷ 20 mA, potentiometer, external motor - potentiometer …
- **adjustable acceleration time**: the time for the motor to accelerate from standstill to the maximum frequency
- **adjustable deceleration time**: the time for the motor to decelerate from maximum frequency to standstill
- **PID process regulator** (normal and inverse function)
- **automatic “parking” (sleep function)** of a converter at sufficient input analogue signal and during the regulation using PID of process regulator
- energetic **power optimalization** of the system
- **fault history** (the converter restores the latest 10 faults)
- **U/f** for constant and variable torque of the motor
- **braking unit** - can be connected in parallel in order to increase braking power. Each braking unit needs its own external braking resistor.
- deceleration with controlled frequency decrease , **DC braking**
- **measurement of**: f_{OUT}, RPM, U_{OUT}, U_{IN}, I_{OUT}, analogue inputs…
- modern type **SkiiP, SkiiM, IPM – semiconductors**, that have low losses, are applied in the converter

SUPPLEMENTARY OPTIONS

- **External wall control panel „EWCP“:** it uses RS 422 system to communicate with the converter, it can be mounted up to 100m from the converter, it should be wall mounted (the doors of instrument panel), the panel contains 4-lines alphanumeric display and 9-buttons keypad, operating instructions are supplied in Slovak language and English. See d.no. EWCP1.
- **External door control panel „EDCP“:** it should be mounted on the doors of instrument panel. The rest is the same as EWCP. See d.no. EDCP1.
- **External manual control panel “EMCP”:** it is designed for manual control of converters. Parameters can be indicated, set, copied from one converter to another using this panel. The rest is the same as EWCP. See d.no. EMCP1.
- **Output reactor (motor choke) „OR1“** (filter du/dt)**:** it eliminates cable capacity on frequency converter. Output reactor should be connected to the output terminals U, V, W.
- **Sine filter „SF1“ -** the use of sine filter ensures that the motors are supplied with practically sinusoidal voltage and current waveforms. If there is minimum radio interference emission demand (theatres), shielded interconnecting cables do not have to be used. Sine filter can be connected directly to the output terminals of frequency converter. It completely eliminates overvoltage spikes on output (motor) terminals. If the presently available sine filters are used, it is necessary to set sampling frequency (parameter 9.1.1) rating from **4 ÷ 10 kHz**!
  When using sine filter, frequency converter cannot operate in vector control mode.
- **Braking resistor „BR1“** - it should be connected to output terminals „+“ and „BR“ of a converter. It is necessary when masses of inertia of a drive slow down. You should request an advice from frequency converter producer about the type of the resistor in a case of bigger inertial drives. Release thermo – contact is included in braking resistor.
- **Higher degree of protection** - e.g. IP 55, IP 66 (frequency converter is built-in instrument panel cabinet)

TECHNICAL DATA

of frequency converters VONSCH VQFREM 500

Power and current:

Converter's losses: temperature losses of frequency converter at sampling frequency 1,5 kHz
Nom. output current: nominal and maximum permanent output current of the converter
Motor power: recommended maximum power of a motor connectable to converter's output
(holds for 4 - pole motors)

Typ meniča	Motor output rating Pnom [kW]	Converter's losses at 2.5 kHz (kW)	Nominal output current of the converter In [A]
VQFREM 500 315	315	7,7	484
VQFREM 500 400	400	9,3	622
VQFREM 500 500	500	12,7	773
VQFREM 500 630	630	15,1	897
VQFREM 500 710	710	16,6	1035
VQFREM 500 800	800	18,6	1187
VQFREM 500 900	900	21,2	1353
VQFREM 500 1000	1000	23,4	1491
VQFREM 500 1200	1200	30	1698
VQFREM 500 1400	1400	34	2029

Dimensions of VQFREM 500

Converter type	height [mm]	width [mm]	depth [mm]	weight [kg]
VQFREM 500 315 ÷ 800	2200	1800	600	400
VQFREM 500 1000 ÷ 1400	2200	1800	600	800

General technical data

Input voltage range:	500 V ± 10%
Input frequency:	47 - 63 Hz
Power factor:	Cos $\Phi_{1N} \geq 0{,}98$
Converters efficiency:	$\geq 0{,}975$
Output frequency range:	0 Hz - 300 Hz
Control system:	2 × 32 bit. µP DSP - PWM - HDDiS
Analogue inputs:	0 ÷ 20 mA (165 Ω), 4 - 20 mA (165 Ω), 0 - 10 V, 2 - 10 V, potentiometer, motor potentiometer; output voltage + 10 V (short circuit protection) max. 10 mA. Potentiometer 1 kΩ to 10 kΩ
Control inputs and interface:	6 binary inputs for multi-level speed selection, or for remote motor potentiometer, reverse, reset, voltage + 24 V (short circuit protection), max. 100 mA
Analogue outputs:	0 ÷ 20 mA, 4 ÷ 20 mA max. 750 Ω
Input for IRC	power supply for IRC: +5V or +24V, can be selected by a jumper max. frequency on inputs A+, B+ : 500kHz – in terms of the converter, the type of IRC output (open collector NPN, TTL, HTL) used signals: A+, B+, ZP+ maximal cable length (power supply +24V) 20m – output of a type open collector,NPN,producer LARM 50m – output of a type HTL, producer LARM 100m – output of a type HTL, producer KÜBLER, SIEMENS
Starting motor torque:	to 200 % of M_n (according to the type of motor)
Electronic protection against:	overcurrent, overvoltage, undervoltage, short circuit protection, ground fault protection, converter overtemperature, motor overtemperature
Ventilation:	fan cooling
Installation height above sea level:	≤ 1000 m above sea level, each 100 m above 1000 m above sea level causes decrease in converter's power by 1 %
Humidity:	≤ 80 % non-condensing (in accordance with EN 60146-1-1)
Operating temperature:	+ 1 ^{o} C to + 40 ^{o} C (in accordance with EN 60146-1-1)
Degree of pollution:	**The converter cannot operate in the environment that contains conducting dust.** Air used for converter cooling must be clean, without corrosive materials and electrically conducting dust.
Positioning:	The converter must be installed so that it is not exposed to vibration or free fall downs.
Degree of protection:	IP 32 - IP54 – swith board

ELECTRICAL INSTALLATION

VQFREM 500 frequency converters have controlled charging of power capacitors; therefore input currents do not exceed nominal values while converters are being connected to the network. VQFREM 500 frequency converters can be connected to the network 5 times in a minute.

If the frequency converter had not been connected to the network more than one year, it is necessary to connect the frequency converter on special forming equipment. It is essential to order this service or this special forming equipment from the manufacturer.

The operating life of power capacitors is also affected by charging currents at converter's common operation. ***In order to lengthen the operating life, commutating reactor is recommended to be used.***

Connection of power conductors and the size of semiconductor-protection fuses (gR, aR):

There are recommended cross-section of input and output cables and cross-section of single input and single output conductors in the table below.

It is as well desirable to think about cables length, distance from the transformer and other at dimensioning.

Semiconductor fuses of a type gR, aR should be used to ensure the protection of frequency converter input !

CONVERTER TYPE	Cross-section of input cables (type CYKY 4B), into the instrument panel of a converter: Cu [mm2]	Cross-section of input conductors (type CYA), into the converter in an instrument panel: Cu [mm^2]	Cross-section of output conductors (type CYA), from the converter in an instrument panel: Cu [mm^2]	Cross-section of output cables (type CYKY 4B), from the instrument panel of a converter: Cu [mm^2]	Recommend-ed fuses (type gR,aR): [A]
VQFREM 500 315	2 x 95	2 x 95	2 x 95	2 x 95	350
VQFREM 500 400	2 x 120	2 x 120	2 x 120	2 x 120	500
VQFREM 500 500	2 x 185	2 x 185	2 x 185	2 x 185	630
VQFREM 500 630	2 x 240	2 x 240	2 x 240	2 x 240	2 x 400
VQFREM 500 710	3 x 185	3 x 185	3 x 185	3 x 185	2 x 500
VQFREM 500 800	3 x 185	3 x 185	3 x 185	3 x 185	2 x 630
VQFREM 500 900	4 x 185	4 x 185	4 x 185	4 x 185	3 x 500
VQFREM 500 1000	4 x 185	4 x 185	4 x 185	4 x 185	3 x 500
VQFREM 500 1250	4 x 240	4 x 240	4 x 240	4 x 240	3 x 500
VQFREM 500 1400	4 x 300	4 x 300	4 x 300	4 x 300	4 x 500

FILTERS AND CHOKES

Interference suppression filter provides interference suppression of input power network (according to EN 618 00-3), class A.

Commutating reactor „CR“ reduces current harmonics in power supply (according to STN 333430). It lengthens the operating life of capacitors in unidirectional circuit.

When interference suppression filter and commutating reactor are integrated into the frequency converter, VQFREM 500 complies with the EMC product standard.

Output reactor (motor choke) „OR1“ can be connected to converter's output terminals, providing that total length of motor cables exceeds 50 m or special types of motors are used (e.g. immersion pumps, reeling and older motors). The total cable length is the sum of the cables connected to each motor. The distance between frequency converter and motor can be up to 100 m when output reactor is used. If the length of motor cable is more than 50 m, it is necessary to use additional motor choke every 100 m. In a case, that shielded motor cable is used; the total length should not exceed 25m, or 50m when output reactor is used. If the length of a shielded motor cable is more than 25 m, it is necessary to use additional output reactor every 50 m.
Motor choke eliminates capacitive currents, limits overvoltage spikes on output motor terminals. It minimizes interference from output motor cable.
Connect the OR1 directly to the output terminals „U“, „V“, and “W“ of the frequency converter.
Dimensions: see appendix “D” - d.no.: VQ OR1
Ordering: example for 500 kW: „OR1- 690 500“

Sine filter „SF1“ can be connected to converter's output terminals. It supplies almost sinusoidal output voltages to the motor. The use of sine filter is always recommended when the motor supply cables are extremely long. If there is minimum radio interference emission demand, shielded output cables do not have to be used. Sine filter completely eliminates overvoltage spikes on output motor terminals. If the presently available sine filters are used, it is necessary to set sampling frequency (parameter 9.1.1) rating from 4 to 10 kHz!

When using sine filter, frequency converter cannot operate in vector control mode!
Sine filter is 3-phase filter. Connect the sine filter directly to the output terminals „U“, „V“, „W“ of frequency converter.
Dimensions: see appendix “D” - d.no.: VQ SF1
Ordering: example for 500 kW: „SF1 - 690 500“

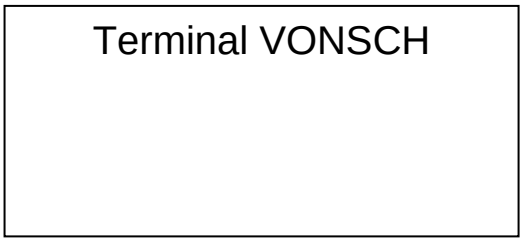
ACRONYMS AND ABBREVIATIONS

RFC - regulator of flux component of current
RTC - regulator of torque component of curr.
TR - torque regulator
SR - speed regulator
PR - process regulator
STR - starting torque regulator
MCR - maximal current regulator
FSR - field suppression regulator
CNV - converter (converter's)
MT - motor (motor's)
AINx - x = 1, 2, 3 analogue input
AOUTx - x = 1, 2 analogue output
BINx - x = 1 ÷ 6 binary input
EXT. - external
SW - software (that relates to software)
U_{DC} - voltage of converter's unidirectional bus
DC - relates to unidirectional converter's bus
SSS - speed synchronous system
TSW - terminal switch
Dyn.RD - dynamic ramp down (deceleration)
val. - value
clos. - closed
KB - kinetic backup
REF - reference (value)
ref. - reference (required)
PSSS - position-speed synchronous system
CRC - check sum -cyclic redundancy code
SETX - the name of communication protocol
CP - control panel
EWCP - external wall control panel
EMCP - external manual control panel
EDCP - external door control panel
RT - rotor (that relates to rotor)
ST - stator (that relates to stator)
MS - master (superior control processor)
SL - slave (subordinate control processor)
EEPROM - parameters memory
BU - braking unit (module)
SF1 - sine filter
AM - asynchronous motor
SMPM - synchronous motor with permanent magnets
IRC - incremental rotary counter
TSW2 - terminal switch of a type 2
ZP - zero pulse
attr. - attribute/attributes
var. - variable
RD - ramp down (deceleration)
HS - heat sink
AM-ARC1 - extension module ARC1
rev. - revolutions

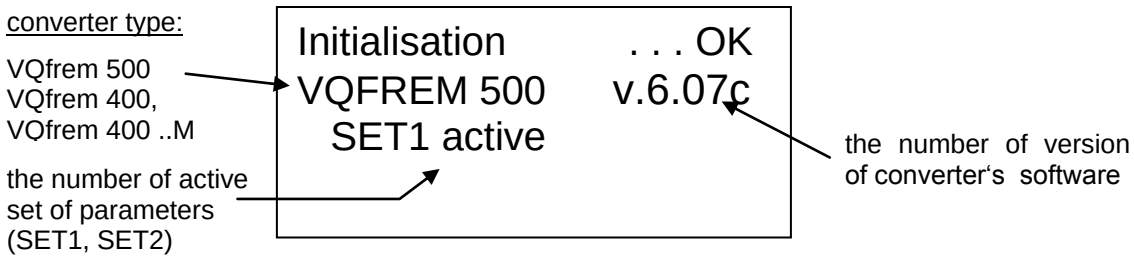
CONVERTER'S OPERATION AFTER BEING SWITCHED ON

If the input conductors are connected to motor terminals (L1, L2, L3, PE) correctly, the display of control panel lights up and displays ***initialisation window of the converter***. This window informs operating personnel about converter's initialisation, about eventual faults, that the converter's control unit can identify on individual components during starting diagnostic.

If initialisation of control panel was accomplished correctly, initialisation window displays the message below after approximately 1s.

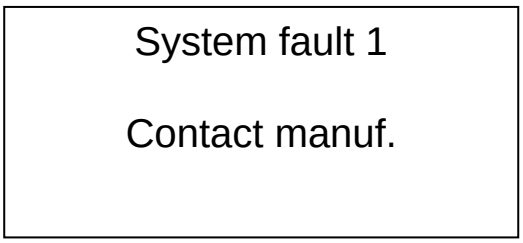


Then, the frequency converter continues to control hardware and software. In a case, that any fault was detected during initialisation, initialisation phase finishes by displaying "OK" message.

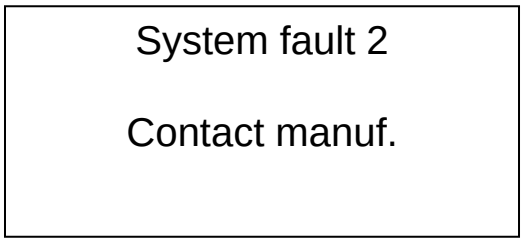


There is the number of version of converter's control software displayed at the end of second line in a window during initialisation.

If the converter's control unit detects some fault, ***fault window*** or ***significant hardware fault window*** appears on the display. In a case of **significant hardware fault,** it is necessary to contact the manufacturer. When ordering warranty or after warranty service, it is needed to mention the number of system fault (1 or 2), the type and production number of frequency converter. It will be useful at fault detection and elimination during the repair.



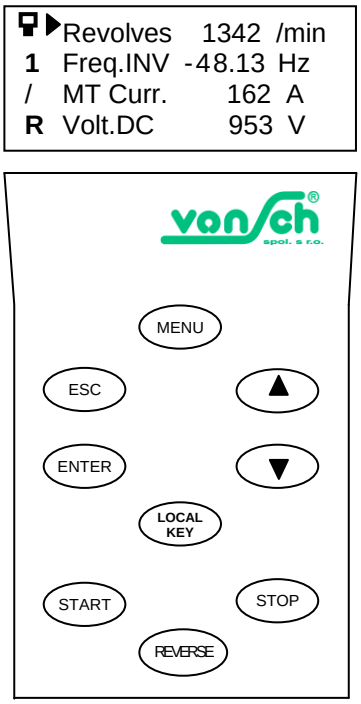
or



DISPLAY AND KEYPAD DESCRIPTION

CONVERTER'S KEYPAD

User membranous keypad consists of nine buttons. Their meaning changes in dependence on user window, which is already displayed on the display. The buttons have following main meanings:



- MENU — ENTRY into main user MENU
- ▲ — UP / INCREASE, acceleration, increase of value
- ▼ — DOWN / DECREASE, deceleration, decrease of value
- ENTER — CONFIRMATION
- ESC — ESCAPE (EXIT)
- LOCAL KEY — displaying of parameter number in Parameter Window, radix point and other ...
- START — RUN button
- STOP — STOP button
- REVERSE — reversion of motor rotating direction (polarity change of requested variable)

CONVERTER'S DISPLAY

The converter is equipped with 4-lines alphanumeric display that displays operating states of the converter, converter's states, fault messages, parameters description and more.

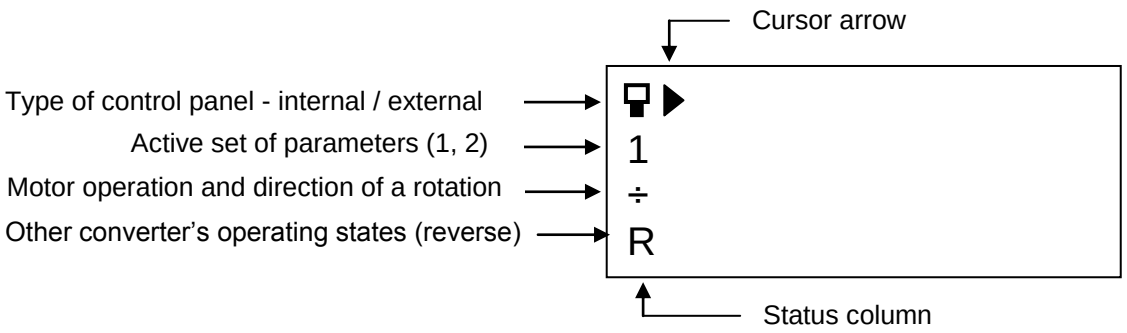
Cursor arrow

Cursor arrow is displayed only when there is some offer displayed on the display. It can move up or down, depending on pressing following buttons ▼ . ▲

In a case, that selection contains more than four items and cursor arrow is in a marginal upper or lower position, pressing one of these buttons evokes scrolling of selective menu. The cursor arrow is not displayed in every window (when any selection is expected).

Status column

It consists of four symbols. Every symbol supports some information. The status column is sometimes not being displayed. For example, when the converter is being initialised after switching on, when it is being parameterised after a change of parameter setting.



Indication of a type of control panel – internal / external

Internal (built-in) control panel (CP).

External control panel – wall or manual (EWCP, EMCP).

If external control panel is active, built in control panel CP shows the same texts as external control panel but its keypad is not active.

By disconnecting the external control panel from the converter, it is possible to actuate the converter only by built-in panel. The converter displays the warning „W17 external panel“. External actuating will again be automatically possible when external panel is reconnected to the converter.

Operating personnel can choose in parameter 2.4.1, which control panel they want to be active.

Indication of active set of parameters.

The number in the second line of status column shows, which set of parameters is already active. The setting of the set of parameters influences overall converter's operation, the function of binary and analogue inputs and outputs. The changes of parameters apply to the set, in which they were executed.

***Note**: The set of parameters can be changed only if the converter is in STOP. This change can be realized by chosen binary input. (parameters 3.X.1)*

IMPORTANT !!! : IF THE USER CHANGES THE SET OF PARAMETERS, THAT IS NOT ACTIVE, THE CHANGES DO NOT OVERALL INFLUENCE CONVERTER'S OPERATION.

Indication of motor operation and direction of motor rotation

The state of power outputs of the converter is indicated in the third line of status column.

Motor is in standstill; converter's power switches are closed.

If this arrow is rotating clockwise (in a direction of hour hands), the motor is rotating in a positive direction (positive required frequency) and converter's power switches generate 3-phase voltages of corresponding polarity.

If this arrow is rotating counter-clockwise, the motor is rotating in a negative direction (negative required frequency) and converter's power switches generate 3-phase voltages of corresponding polarity.

Other converter's operating states

The information about converter's operating states is displayed in the fourth line of status column.

R Symbol **R** is displayed, when control command REVERSE is active. If the motor is in REVERSE, it decelerates from default frequency to standstill and starts to rotate at requested frequency in a counter direction. Symbol **R** will disappear, if control command REVERSE is inactive. If the motor is not in REVERSE, the motor slows down, comes to a controlled stop and starts to rotate at requested revolution in a positive direction, after default time period.

***Note**: It is possible to choose the command REVERSE from active control panel by pressing (REVERSE) button or by chosen binary input (parameters 3.X.1).*

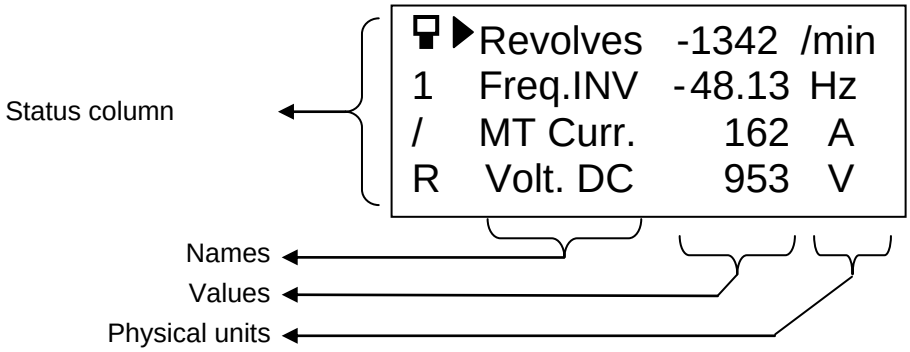
THE MAIN USER WINDOW - MONITOR

The window MONITOR displays chosen physical variables, states, faults or warnings of the converter.

In this window, it is possible to start or stop the motor by (START) (STOP) buttons, to reverse the direction of the rotation by (REVERSE) button (if there is "control panel" adjusted in parameter 2.1.1).

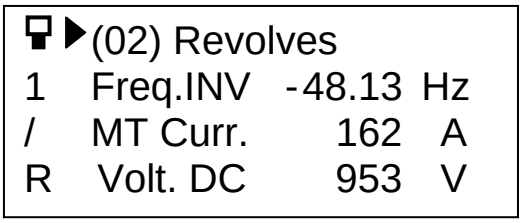
It is possible to decrease or increase desired physical variable by (▼) (▲) buttons (if there is "control panel" adjusted in parameter 2.3.1.).

Displayed variables:



Change of displayed variable

If you want to change required variable, you have to set the cursor arrow by (▼) (▲) buttons to the line that contains the variable. By pressing (ENTER) button, the text in a given line changes:



If the name of required displayed variable is highlighted, press (ENTER) button to change the list of displayed variables. By pressing (ESC) button, original displayed variable remains shown.

The list of displayed variables:

Display	Dimens.	Note
(01) Freq. INV	Hz	*the frequency of voltage on converter's output (stator frequency)*
(02) Revolves	/min	*output revolutions of the motor*
(03) Revol / i	/min	*revolutions behind gear/transmission (motor rev. divided by gear ratio1.7.1)*
(04) Freq. RT	Hz	*rotor frequency (evaluated from speed encoder – IRC)*
(05) Freq. RF	Hz	*required converter frequency*
(06) MT Curr.	A	*converter output current = effective current value into the motor*
(07) R.torque	Nm	*required mechanical motor torque*
(08) Torque	Nm	*mechanical motor torque*
(09) Mag. flux	Wb	*rotor magnetic flux*
(10) Volt. MT	%	*momentary motor supply voltage (100.0% responds to 500 V)*
(11) Volt. DC	V	*real voltage of converter's unidirectional DC bus*
(12) Inp.pow.	kW	*momentary input power into the motor*
(13) MT power	kW	*motor power*
(14) kW hours	kWh	*motor energy consumption in kWh*
(15) MW hours	MWh	*motor energy consumption in MWh*
(16) Temp.COOL	°C	*temperature of converter's heat sink (cooler)*
(17) Temp.INV.	°C	*air temperature in the converter*
(18) PR ref.	%	*required value of process regulator*

The list of displayed variables: (continued)

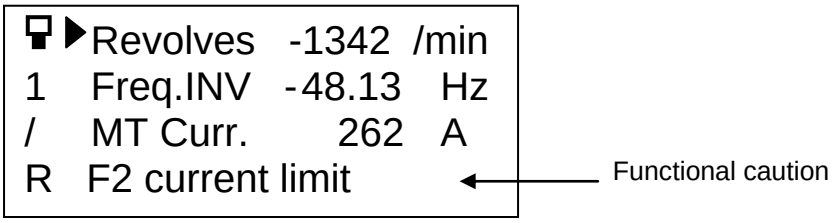
Display	Dimens.	Note
(19) PR real	%	*feedback of process regulator (real value)*
(20) Inp. AIN1	%	*the value of analogue input AIN1 in % range*
(21) Inp. AIN2	%	*the value of analogue input AIN2 in % range*
(22) Inp. AIN3	%	*the value of analogue input AIN3 in % range*
(23) BIN 1-6	XXX XXX	*status of binary inputs BIN 1 ÷ BIN 6 (X=N/A not active/active)*
(24) RELAY 1-3,4	XXX,X	*status of relay inputs RELAY 1 ÷ RELAY 4 (X=N/A --- | | ---)*
(25) Hours INV	h	*converter operating time counter*
(26) Hours MT	h	*motor operating time counter*
(27) Pos.ref.	cm	*required position in a case of „position" variable (11.2.1)*
(28) Position	cm	*real position*
(29) Pos. TSW2	cm	*the trajectory for running down when Terminal switch TSW2 is on*
(30) ARC zero	d	*zero position error at ARC (position encoder) calibration*
(31) Date / Time		*actual date and time, e.g.: 23.09.2003 / 14:07*
(32) cos(fi)		*momentary value of motor power factor*
(33) Overload	%	*momentary value of overload, see option "OFF,overload", par.5.1.1*
(34) Service SL	d	*service displayed variable*
(35) Service MS	d	*service displayed variable*

Warning and functional cautions

In the fourth line of monitor window, there are some warning and functional cautions displayed, as well as chosen displayed variables.

Warnings – inform operating personnel about various marginal operating states of the converter that may worsen the quality of regulation. The warning is flashing regularly. If more than one warning exists, they are displayed one after the other.

Functional cautions – inform operating personnel about various functional modes and operating states of the converter.



The list of warning cautions:

Display	Note
W1 field weakening	*The converter reduces motor magnetic flux in order to achieve over-synchronous revolutions. The value of field suppression is being set in par. 13.5.2 by amplification.*
W2 minimal Flux	*Magn.flux has decreased to the minimal value at field suppression (par. 9.12.1).*
W3 saturated R-flx	*Regulator of magnetic flux is saturated (only in vector mode).*
W4 saturated R-trq	*Regulator of motor torque is saturated (only in vector mode).*
W5 saturated R-spd	*Speed regulator is saturated (only in vector mode).*
W6 temp.of cooler	*Heat sink's (cooler's) elevated temperature (more than 98 °C)*
W7 IRC/ARC failure	*If this failure occurs, the converter switches itself into scalar mode. (see par. 10.2.1)*
W8 direct. IRC/ARC	*This warning caution signalises reverse direction of IRC. (for IRC, it is tested only if reference frequency is higher than 1.50 Hz, see par. 10.2.1).*
W9 input phase	*Converter input phase was interrupted (testing can be forbidden by par. 10.2.2).*
W11 new parameters	*Parameters in EEPROM were replaced by converter's basic parameters.*

The list of warning cautions: (continued)

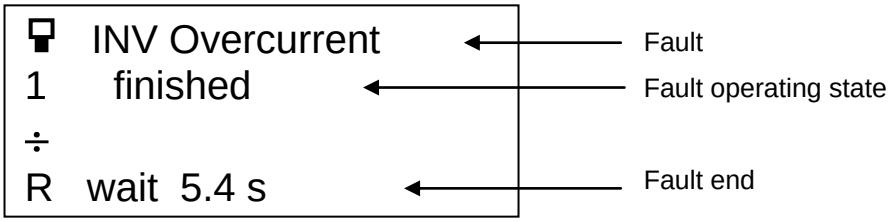
Display	Note
W12 saturated PR	*Process regulator is saturated. Converter frequency has reached its maximum value.*
W14 added param.	*If the converter during initialisation phase recognized a new parameter, which is not in EEPROM memory. (Only if later software version had been recorded into the converter).*
W15 corrected par.	*If EEPROM parameters memory during initialisation phase contained the value of some parameter outside permissible interval. Parameter value was replaced by the value that was preset by manufacturer.* **If operating personnel does not check converter parameters, it will be impossible to start the converter !**
W16 motor temp.	*Sensored motor temperature has achieved nonpermissible value. See par. 10.2.4.*
W17 external panel	*If EWCP,(M),(I) panel is active (2.4.1)and the connection with the converter has failed.*
W18 communication	*Serial communication error has occurred. See par. 10.2.6.*
W23 disconnect. MT	*The converter recognized no load at output terminals U,V,W at START command.*
W20 AIN 1 interrupted	*Input value falled under 1 V and input range is 2 ÷ 10 V, (param. 4.4.1).*
W21 AIN 2 interrupted	*Input value falled under 2 mA and input range is 4 ÷ 20 mA, (param. 4.5.1).*
W22 AIN 3 inerrupted	*Input value falled under 2 mA and input range is 4 ÷ 20 mA, (param. 4.6.1).*
W24 back-up supply!	*Loss of converter's input phase has occurred and the converter is supplied from back-up power supply (battery or UPS).* *The converter can operate until the value of voltage in unidirectional circuit is 158V_{DC}.*
W25 temp. in INV	*Air temperature in the converter is more than 70 °C.*
W26 stop SLAVE *adr.*	*Converter with the corresponding address is not ready to start and it inhibits other converters.* *See „Status register" in appendix „C".*
END OF OPERATION	*If trial period of operation expired and the converter generated STOP command.*

The list of functional cautions:

Display	Note
F1 inverters reset	*PWM converter outputs are blocked.* *Reset is the result of switching on the binary input with RESET function, or receiving the command via serial link, or serial communication error.*
F2 current limit	*Maximal current regulator (par.13.3.1) is active. It limits the current to the value of parameter 9.10.1.*
F3 kinetic backup	*The converter is in kinetic backup mode after input power failure. (par. 13.4.X)*
F4 flying start	*The converter is processing frequency for spinning motor. (parameters 14.1.X, 10.3.3)*
F5 parking PR	*Sleep function of process regulator. (par. 12.5.X)*
F6 brak.un. active	*Braking unit is active. (par. 8.2.1)*
F7 time PWM off/on	*The time needed for motor field suppression has not expired yet (before subsequent start). (par. 1.10.1)*
F8 dynam.rump down	*Dynamic deceleration was activated as a result of sharp decrease in speed. (par. 8.1.X)*
F9 position preset	*Position calibration initiated by 9.4.3 command, or calibration of IRC encoder on synchronous motor (see par. 3.7.2).*
F10 search ZP-IRC	*IRC zero pulse is being searched on synchronous motor, after the converter was connected to the power network and START command was selected.*
F11 SW term.switch	*The speed decreased to the zero by activating a software terminal switch. (par. 14.5.1).*
F12 term. switch	*Terminal switch 1 or terminal switch 2 is switched on.(par. 3.X.1)*
F13 flux braking	*The function „flux braking" (8.3.1) increases motor excitation proportionally to* U_{DC}-U_{DCnom}.
F14 autotuning	*OFF-LINE identification of some motor parameter. (par. 1.12.8)*
F16 relay-overload	*It signalize, that relay with function „shut-down, overload" did currently release*

FAULT WINDOW

If some fault has occurred during converter's operation, fault window will appear on the display. Fault window contains fault name, fault operating states (lasting, finished...) and the way to bring the fault to the end (confirmation, restarting, waiting...). The way of bringing the fault to the end can be adjusted in parameters 10.3.X.



The list of fault messages:

Display	Note
INV Overcurrent	*Short-term converter overcurrent. You can find current values and times for various converter types in the chapter "TECHNICAL DATA". The converter always waits 15s after the fault.*
INV Overload	*The converter has worked above permissible current limit for time longer than permissible overload time. You can find current values and times in the chapter "TECHNICAL DATA". The converter always waits 600s after the fault.*
INV Undervoltage	*DC Voltage of the converter has decreased under 75% of nominal value.* *If kinetic backup is active (par. 13.4.1), the limit is 61%.* *If back-up power supply is active (par. 14.7.1), the limit is 28%.* *Undervoltage is caused by the loss of converter's input phase or by supply failure, by low supply voltage.*
INV Overvoltage	*Voltage in unidirectional circuit has exceeded 130% of nominal value. Reasons of the fault can be **1.)** the motor generates electric energy with braking unit disconnected, **2.)** network overvoltage, or **3.)** it was short deceleration time set in parameters 7.2.3, 7.2.4.*
MT Overheat	*Motor thermal integral has exceeded the maximal permissible value: more than 1,05 of I_{MOT} for the time longer than in parameter 10.2.5. If the temperature was sensorially scanned directly in motor winding, it has reached dangerous value. (Test can be enabled in parameter 10.2.4).*
Temp.of cooler	*Temperature of converter's heat sink (cooler) has exceeded maximal allowed value (more than 109 °C).*
Temp. in INV	*Air temperature in the converter is more than 75 °C.*
Converter temperature	Converter temperature exceeded
Rectifier temperature	Rectifier temperature exceeded
Incorrect par. of currents	*The setting of parameter "motor current" 1.2.1 is lower than 1/7 of In (nominal output current) of the converter, in vector mode. As a consequence, accuracy of current measurement is decreased and the quality of regulation declines.*
Incorrect par. of MT const.	*The setting of parameters of motor constants 1.X.X is incorrect (it does not correspond to real motor).*
Incorrect par. of speed	*The setting of parameters of motor frequency 1.4.1, setting of number of IRC pulses 3.7.1 or number of motor pole pairs 1.6.1 do not correspond to the reality.*
Regulation err.	*One of the regulators has generated incorrect value of control variable.*
Autotunning err.	*Identification of motor parameters has been interrupted. See par. 1.12.8 and 9.6.3.*
Out.short circ.	*Short circuit between output phases or bad earth.*
IRC failure	*It signalises incorrect IRC encoder connection or IRC failure. For IRC encoder, the test is active only if reference frequency is more than 1.50 Hz.It can be deactivated in par.10.2.1*
RM-ARC failure	*Extension module of absolute position encoder does not transmit the sensored position into the converter.*
Inp. phase loss	*Input phase loss occurred. It was caused by adverse conditions for further operation, which had arisen (it can be deactivated in par. 10.2.2).*

The list of fault messages: (continued)

Out. phase loss	*Output phase loss between the converter and motor occurred.(it can be deactivated in par. 10.2.3).*
External failure	*The converter is being blocked as a consequence of external hardware fault. This fault message is displayed only if the function "external failure" exists in one of 3.X.1 parameters and BINx is connected to voltages 0 V/ 24 V.*
Communic. error	*Serial link communication error occurred. See par.10.2.6.*
MultiSLAVE err. *adr.*	*At MASTER–SLAVE communication, the converter with corresponding address has generated some failure or converter's reset occurred from binary input.*
SLAVE overload *adr.*	*At MASTER–SLAVE communication, the converter with corresponding address has generated critical warning, allowed in 10.2.7 and 10.2.8 parameters.*
Err.position SL	*A converter of a type MASTER had sent the calibration command to other SLAVE converters via serial link and one of them did not accept it. This error occurs after certain number of attempts: (par.2.10.4 + 1)*
System fault x	*Significant hardware fault of a control board*(x=1 - 8)CONTACT THE MANUFACTURER!

Every time some fault occurs, the converter immediately switches off power outputs and causes motor and braking resistor disconnection. It continuously comes to a stop. If START, STOP and REVERSE commands are being set by binary inputs and corresponding binary input is switched on, the command is recovered after the fault ends.

Required values of torque, position or process variable are reseted at a fault and remain at zero after a fault end. They must be re-set by personnel. If required values are being set by binary or analogue inputs, the required value is not zero after fault end, it remains the same as it was before a fault.

If it is incorrect parameters setting or inadequate state on converter's outputs (AINx, RS232/485) a reason of a **long-lasting fault**, the operating personnel can go into MENU window and PARAMETERS window by pressing

(MENU) button and change parameters that has caused a fault.

Operating states of converter's faults:

Display	Note
lasting	*The fault is still active.*
finished	*The fault has finished.*
MT field suppr.	*In a case, that it is "phasing after undervoltage" set in parameter 10.3.3 and undervoltage time has taken shorter than the time of motor field suppression, this message signalises that the converter is waiting for motor field suppression.*

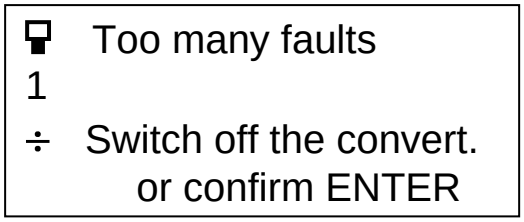
The way of bringing the fault to the end: (according to parameters 10.3.1 and 10.3.3)

Display	Note
Wait for 10.3 s	*Operating personnel has to wait for a default period, which was adjusted in parameter 10.3.2.*
Confirm ENTER	*The converter is waiting for fault confirmation (by pressing ENTER button; by giving the command from serial link or by switching on binary input, which function was set to „fault confirmat."). (par. 3.X.1).*
Contact manuf.	*Fault window is permanently displayed.* ***CONTACT THE MANUFACTURER !***
Switch off the convert. or confirm ENTER	*The converter is waiting for fault confirmation. See Confirm ENTER in this table.*

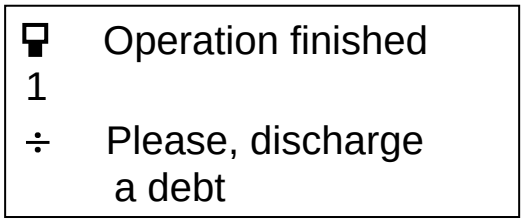
Note:

After fault confirmation, the converter in MASTER mode will transmit the comand of fault confirmation to other converters.

In a case, that more than 5 faults have occurred, the following message is displayed:



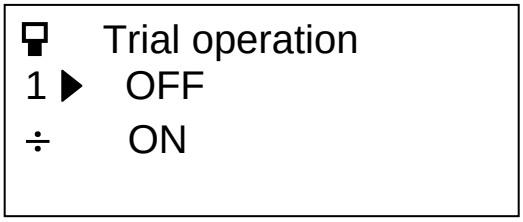
The **window of trial period expiration** is the special fault window. It is activated only in a case, that the customer uses the frequency converter for trial period. When converter's trial period, which was set at converter's production, expires, the converter becomes disabled. It does not respond to the commands and shows the following window after choosing START command.



<u>Note:</u> Subcontractors can obtain the information about activation of trial period operation by phone or e-mail. Call or e-mail to VONSCH Ltd. customer service centre.

Unblocking of converter's trial operation:

- Enter the password notified by the supplier in the „Security code" window.
- The parameter „Trial operation" displays. After choosing OFF option, trial operation is unblocked. Confirm the password by button (ENTER) and press (ESC) button to let the converter's parameterization start.

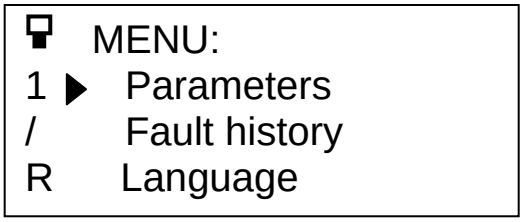


MENU WINDOW

User menu displays after pressing (MENU) button in a window „MONITOR“ or during a fault.

In MENU window, it is possible to choose from offers: parameter setting, fault diagnostic and other converter's functions configuration.

Operating personnel can monitor the main converter operating states in state column all at once with choosing from menu window.

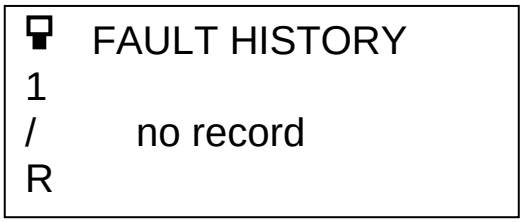


It is possible to return from „MENU“ window to „MONITOR“ window by pressing (ESC) button.

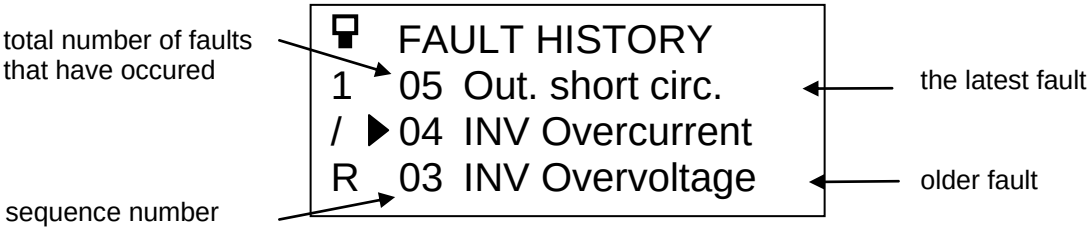
FAULT HISTORY WINDOW

Fault history window is the main diagnostic window of the converter. Thus the user can find out, which fault has occurred and its sequence number. There can be 10 faults remembered in fault history.

If any fault has occurred during converter's operation, there is no record in fault history. It displays as following:



In a case, that some fault has occurred, sequence number and fault name displays.



State column is displayed in this window, as well as in window MONITOR.

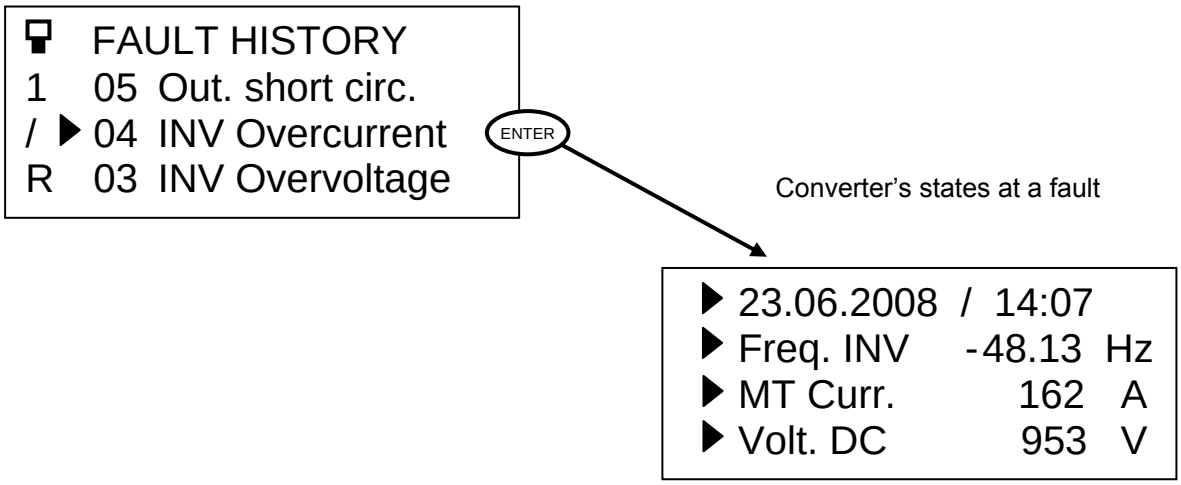
If more than ten faults occurred, the oldest fault would disappear from fault history. Then, every fault is given lower sequence number and the most recent fault (11^{th}) is given sequence number 10.

After pressing (ESC) button it is possible to return from “FAULT HISTORY” window to „MENU“ window.

After pressing (ENTER) button there are converter's states, which were actual when the fault had occurred, displayed (converter's operating time counter (hours), frequency, current, DC voltage).

***Note**.: Fault history can be reseted by authorized user at any time by the command „Fault history reset“ in parameter 10.1.1.*

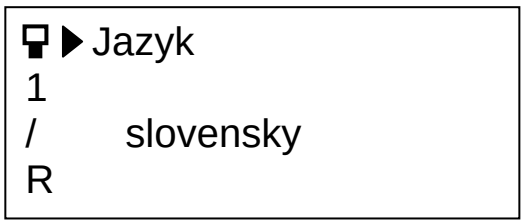
Displaying converter's states at a fault:



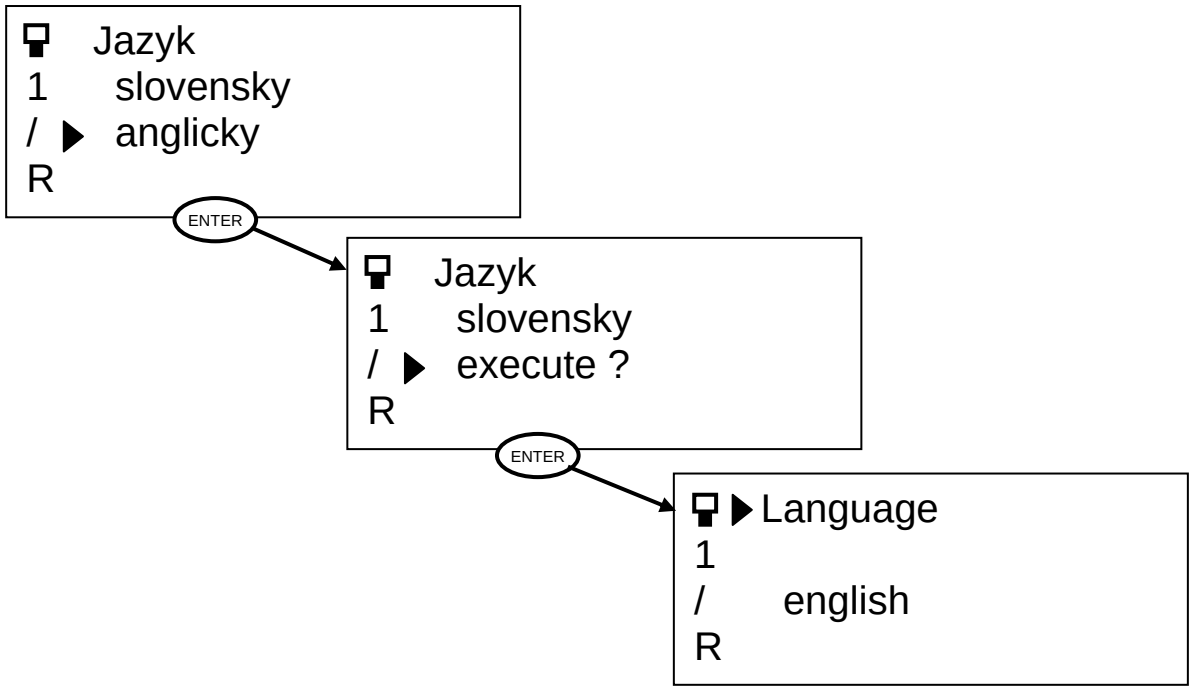
It is possible to return from the display shown above (from the display of converter's states at a fault) by pressing one of the following buttons: ESC, ENTER, LOCAL KEY or MENU. Otherwise, the return is made automatically after 10 seconds.

LANGUAGE WINDOW

If you want “Language” window to be displayed on the display, set cursor arrow to the offer „Language“ in MENU window and press ENTER button. At first, „Security code“ window will display. This window ensures converter’s security against unauthorized changes to its language interface. If the Security code is correct, “Language” window, which allows changing the language of user text interface, will show on the display. The name of actual language is shown in the third line.

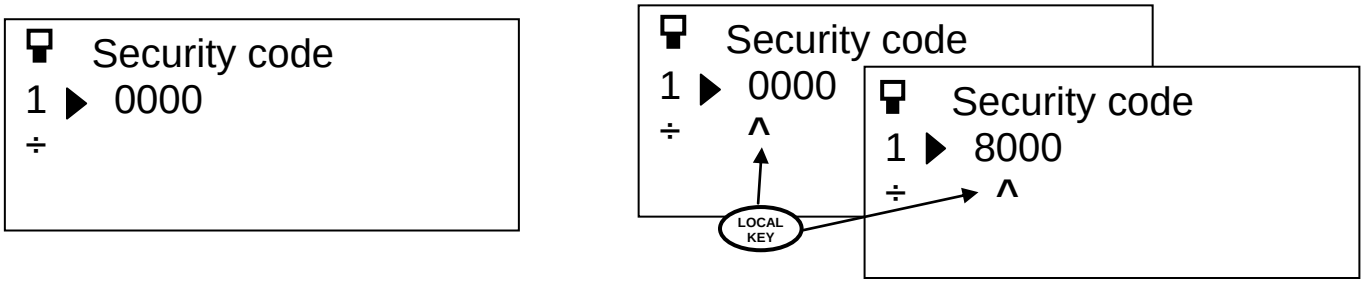


Presently, the operating personnel have the possibility to choose between two languages, Slovak and English. After pressing ENTER button the cursor arrow moves downward and all the possible optional languages will display. Operating personnel can choose a language and confirm by double pressing ENTER button. As a consequence, all the texts shown on the display will change to its equivalents in chosen language.



PASSWORD AND SET SETTING WINDOW

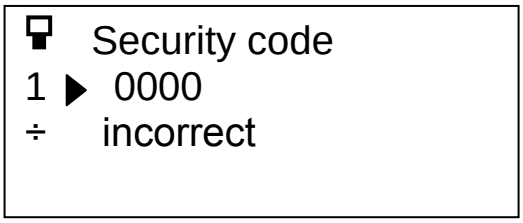
After you set cursor arrow to the offer „Parameters“ in MENU window and press (ENTER) button, the window “Security code” will display on the display. This window ensures protection against unauthorized changes in converter’s parameters, which could result into incorrect converter operation.



There is the possibility to adjust numeric protection password that was before set in parameter 2.5.1. It can be adjusted by (▼) (▲) buttons by authorized users. Default protection password is 0000.

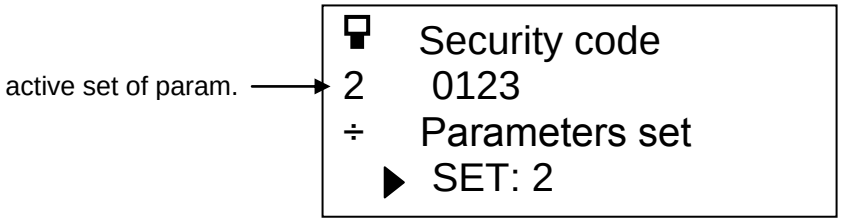
If button (LOCAL KEY) is pressed at adjusting numeric protection password, the setting is switched to the mode of place value of digit. The cursor ´^´ will be displayed under the digit with the highest place value (under thousand firstly, hundred secondly, ten thirdly and unit lastly). This digit can be changed by arrows. If (LOCAL KEY) button is pressed again, the cursor moves under the digit with lower place value (cursor moves from thousand to hundred, from hundred to ten, from ten to unit) and finally disappears.

If the password is correct, it will be accepted after pressing (ENTER) button . If the password is incorrect, the converter will display the message “incorrect” in the third line and will reset the number.



Note: *User security code is the same for both parameters sets 1 and 2. It can be adjusted in SET 1 in parameter 2.5.1. Adjusting of parameter 2.5.1 in SET 2 is not helpful.*

If the protection password is accepted, it is possible to choose one of two parameters sets. Choose the parameters set, in which you want to make changes or look through its content.



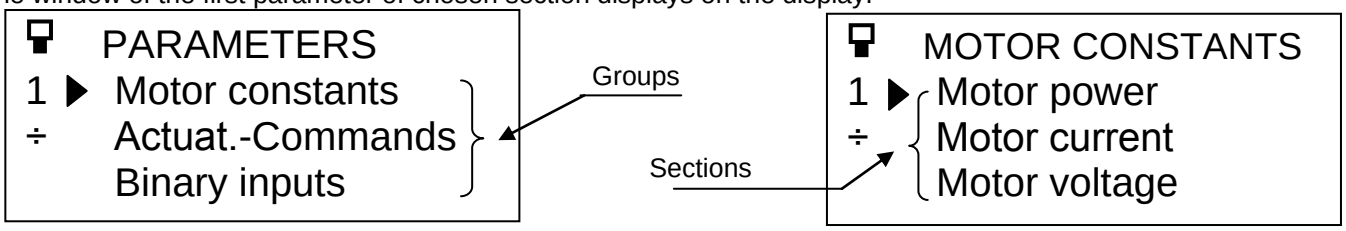
The number in the second line, in state column, signalises which set of parameters is active (SET1 or SET2), which values are being looked through and in which changes will be made. If you chose a set of parameters and press (ENTER) button, “Parameters ” window will display. If you want to return to a window on a higher level, press (ESC) button.

Note*: The set of parameters that was chosen is valid only during parameters adjustment. The active set of parameters (the set used during converter’s operation) is the set which is given by the function of binary input „Parameters SET“ (par. 3.X.1).*
If this function is not chosen, SET2 will never be active during converter’s operation.
If it is not needed to switch between parameters sets, the setting „SET: 1“ should remain in this window. Otherwise, the converter would not work properly.

WINDOW - PARAMETERS

If the protection password was accepted and the set of parameters was chosen, the following window will appear on the display. Parameters are lined up into 3 levels: GROUPS – SECTIONS - PARAMETERS and are organized according to their meaning.

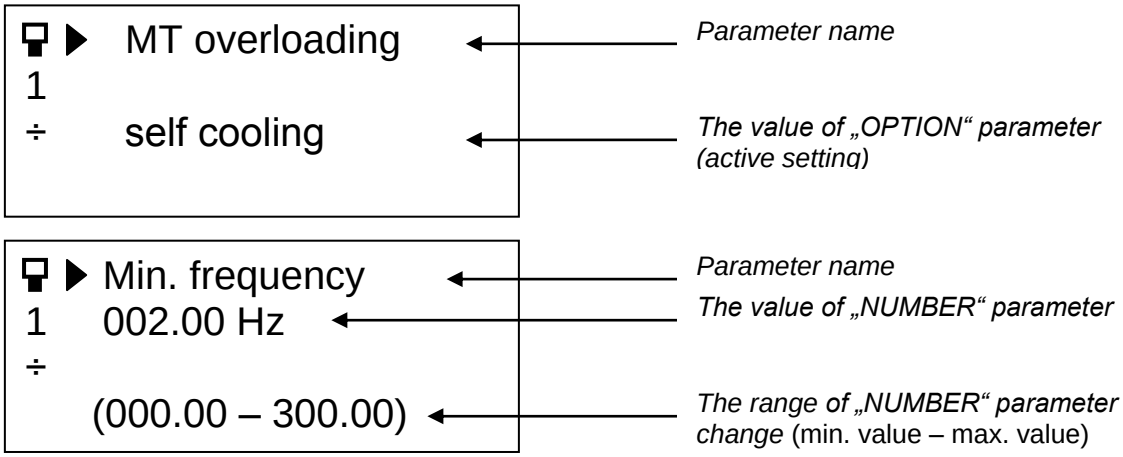
In a "Parameters" window, you can choose parameter's groups according to their meaning. If you chose concrete section of parameters, set the cursor on that section by ▼ ▲ buttons and press ENTER button. Then, the window of the first parameter of chosen section displays on the display.



If operating personnel changed the value of some parameter, pressing ESC button will activate parameterization phase. Otherwise, the operating personnel will be returned to „Menu" window. After parameterization phase is finished, MONITOR window displays.

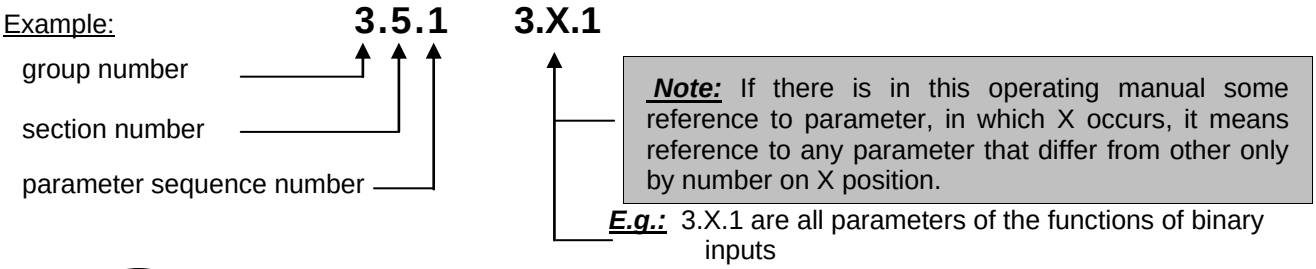
Looking through the values of parameters

You can look through parameters of corresponding section by ▼ ▲ buttons. Then, information about chosen parameter is being displayed.



If you want to finish looking through the parameters of corresponding section, press ESC button. It will return you one level upwards, where you can choose another section of parameters or return to the window MENU.

Parameters numbering



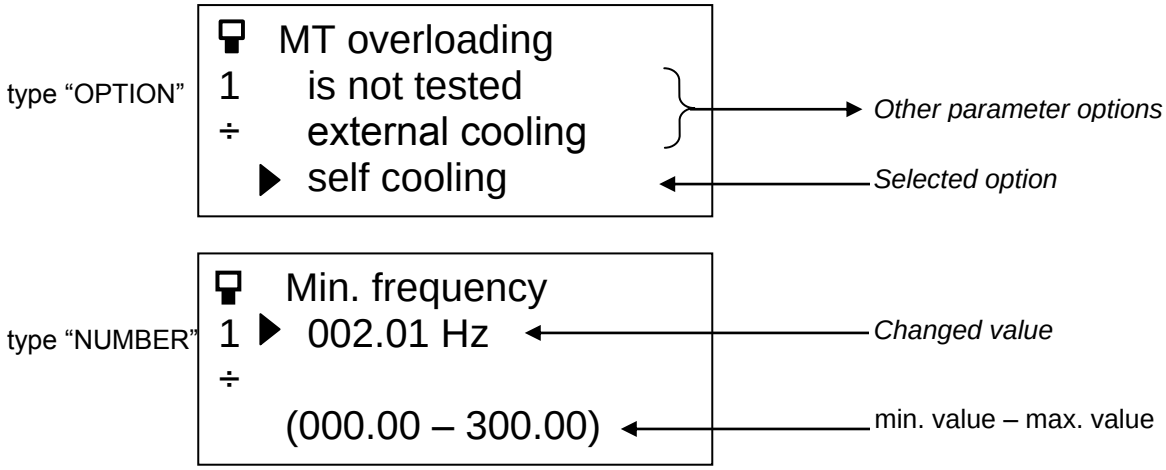
By pressing LOCAL KEY button during the time of looking through parameters, the number of group, section or parameter displays for approximately 2 seconds.

Example: 03.xx.xx represents 3rd group: „Binary inputs" (during looking through groups)
03.05.xx represents 5th section: „BIN5" (during looking through sections in a concrete group)
03.05.02 represents 2nd parameter: „Polarity BIN5" (during looking through parameters in a sec.)

Parameter value change

Warning: *It is possible to change parameter's value only if the converter is in STOP (motor is in standstill) while setting the password. If the motor was in standstill while setting the password, it won't be possible to run the motor until „Parameters" window is left.*

If you want to change parameter's value, set the cursor to the parameter, which value you want to change. Press (ENTER) button and the cursor arrow shifts from parameter name to parameter value. In a case, that it is „OPTION" parameter, the options are listed as below.



You can use (▼) (▲) buttons to choose between various parameter options or to change parameter values.

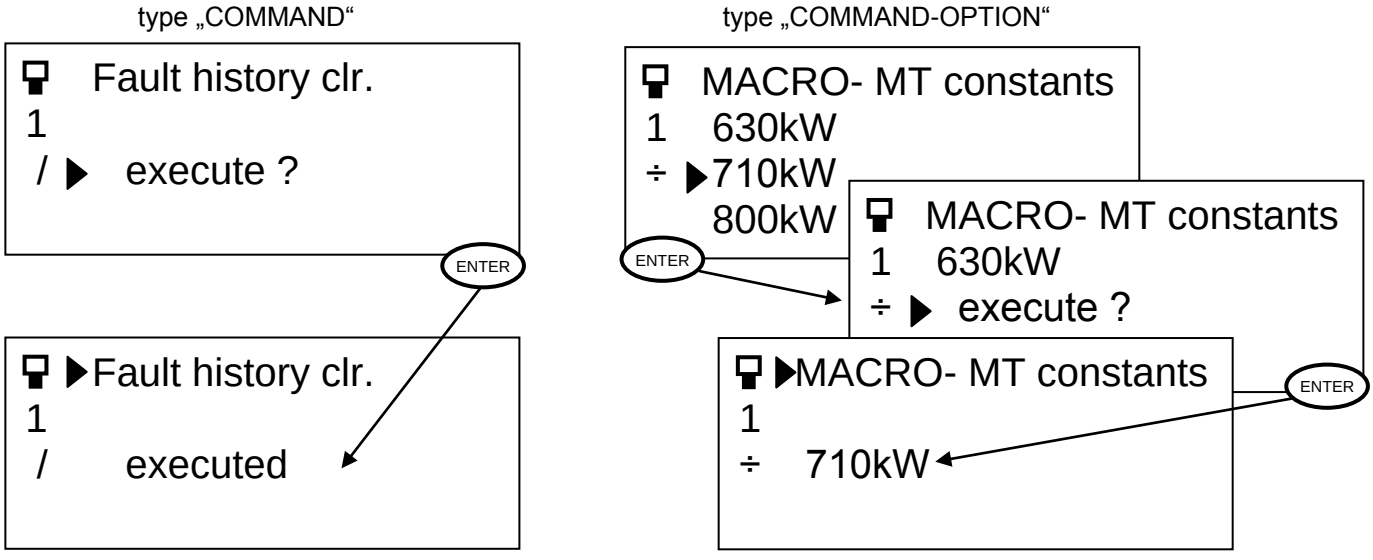
Press (ESC) button, if you want to finish parameter changing. Then the changes are not accepted and the parameter setting will remain unchanged. Cursor arrow returns to a parameter name and you can choose another parameter.

Press (ENTER) button, if you want new parameter setting to be accepted. Then, the cursor arrow returns to a parameter name and the original value will be replaced by a new value or option. The operating personnel can choose another parameter.

„COMMAND" and „COMMAND-OPTION" parameters

These parameters are instrumental for immediate execution of chosen operation. The question „**execute** ?" protects the converter against unwanted execution of a command. After command was executed, the message „**execute** ?" will be replaced by „**executed**" and the operating personnel can choose another parameter. After pressing (ESC) button, the command won't execute.

In a case of „COMMAND-OPTION" parameter, the command can be chosen from various options. After chosen command was executed, only the name of executed command will be displayed. The operating personnel can choose another parameter.



THE LIST OF ALL PARAMETERS

(ver. 6.07 / 24.06.2008)

GROUPS		SECTIONS		PARAMETERS	atr.	options
MOTOR CONSTANTS (**1**.x.x)	1	Motor power	1	Motor power	S,V	
	2	Motor current	1	Motor current	S,V	
	3	Motor voltage	1	Motor voltage	S,V	
	4	Motor frequency	1	Motor frequency	S,V	
	5	Motor revolutions	1	Motor revolutions	S,V	
	6	Number of poles	1	Number of poles	S,V	
	7	Gear ratio	1	Gear ratio	S,V	
	9	Motor efficiency	1	Motor efficiency	S,V	
	10	PWM off/on time	1	PWM off/on time	S,V	
	11	Motor therm. cons.	1	Motor therm. cons.	S,V, R	
	12	Special	1	Stator resist.Rs	V,R	
			2	Stator inductance	V,R	
			3	Mutual inductance	V,R	
			4	Rotor time const.	S,V,R	
			5	Autotunning MT	S,V	Stator resist. RS; Magnetic flux; Inductances Ls, Lm
ACTUAT. – COMMANDS (**2**.x.x)	1	StartStopReverse	1	StartStopReverse	S,V	control panel; binary inputs; serial link
			2	Start/Stop/Rev. (2)	S,V	control panel; binary inputs; serial link
	2	REVERSE	1	REVERSE	S,V	enabled; permanently off; permanently on
	3	Source-req.value	1	Source-req.value	S,V	fixed value; control panel; analogue input; binary speeds; bin. combinations; BIN motor-potent.; BIN memor.potent.; AIN+bin.speeds; serial link; automatic
			2	Required value (2)	S,V	fixed value; control panel; analogue input; binary speeds; bin. combinations; BIN motor-potent.; BIN memor.potent.; AIN+bin.speeds; serial link; automatic
	4	Contr. panel type	1	Contr. panel type	S,V,R	internal; external
	5	Security code	1	Security code	S,V	
	6	Motor run time	1	Motor run time	S,V,R	reset; set
			2	MT run time x1	S,V,R	
			3	MT run time x1000	S,V,R	
	7	Consumption reset	1	Consumption reset	S,V	0→kWh; 0→MWh
	8	Factory macros	1	Default settings	S,V	
			2	MACRO – MT constants	S,V	2.2kW….250kW
	9	Parameter copying	1	Backup → Act. Set	S,V	
			2	Act.Set → backup	S,V,R	
			3	Set1 → Set2	S,V	
			4	Set2 → Set1	S,V	
			5	EXT.pan.→ Set1,2	S,V	
			6	Set1,2 → Ext.pan.	S,V,R	
	10	Communication	1	Link interface	S,V	RS-485; RS-232
			2	Converter address	S,V	
			3	Communic. mode	S,V	SLAVE-subordinate; MASTER-speed; MASTER-IRC speed; MASTER-position
			4	Number of SLAVEs	S,V	
			6	Speed from MASTER	S,V,R	
			7	Position for SLAVE	S,V,R	
			9	Communic. timeout	S,V,R	
			12	Baudrate	S,V	

GROUPS	SECTIONS		PARAMETERS		atr.	Options
BINARY INPUTS, IRC (**3**.x.x)	1	BIN1	1	Function BIN1	S,V	Start/Stop; StartReverse/Stop; BIT0; BIT1; BIT2; reverse; acceleration; deceleration; terminal switch; fault acknowl.; inverters reset; SET of parame.; external fault; position preset; REM/LOC control; quick STOP; terminal sw.+; terminal sw.–
			2	Polarity BIN1	S,V	switch. ON- 24 V; switch. ON- 0 V
	2	BIN2	1	Function BIN2	S,V	see „Function BIN1“
			2	Polarity BIN2	S,V	see „Polarity BIN1“
	3	BIN3	1	Function BIN3	S,V	see „Function BIN1“
			2	Polarity BIN3	S,V	see „Polarity BIN1“
	4	BIN4	1	Function BIN4	S,V	see „Function BIN1“
			2	Polarity BIN4	S,V	see „Polarity BIN1“
	5	BIN5	1	Function BIN5	S,V	see „Function BIN1“
			2	Polarity BIN5	S,V	see „Polarity BIN1“
	6	BIN6	1	Function BIN6	S,V	see „Function BIN1“
			2	Polarity BIN6	S,V	see „Polarity BIN1“
	7	IRC / ARC	1	IRC pulses/revol.	S,V	
			2	SMPM pos.calibrat.	V	
			3	0 pos. of encoder	S,V,R	
			4	SMPM pole centre	V,R	
ANALOGUE INPUTS (**4**.x.x)	1	Requir.val. INV/PR	1	Requir.val. INV/PR	S,V	AIN1; AIN2; AIN3; AIN2-AIN3; max(AIN2,AIN3); AIN2+AIN3
	2	Range of AIN	1	AIN1-min	S,V	
			2	AIN1-max	S,V	
			3	AIN2-min	S,V	
			4	AIN2-max	S,V	
			5	AIN3-min	S,V	
			6	AIN3-max	S,V	
	3	PR feedback	1	PR feedback	S,V	see „ Requir.val. INV/PR "
	4	AIN1	1	Type AIN1	S,V	0÷10 V; 2÷10
			2	Filter AIN1	S,V,R	
	5	AIN2	1	Type AIN2	S,V	0÷20mA; 4÷20mA
			2	Filter AIN2	S,V,R	
	6	AIN3	1	Type AIN3	S,V	0÷20mA; 4÷20mA
			2	Filter AIN3	S,V,R	
RELAY OUTPUTS (**5**.x.x)	1	RELAY1	1	Function RELAY1	S,V	ON,motor running; ON,invert.READY; ON-fault; OFF-fault; ON-warning; ON from AIN1; ON from AIN2; ON from AIN3; ON from frequency; ON from req.value; brake,ON/OFF; cascade 1; cascade 2; cascade 3; ON,Finv=Fref; ON from PROFIBUS; ON,overload; pump rotate
			2	Value RELAY1	S,V,R	
			3	Hyst. RELAY1	S,V,R	
	2	RELAY2	1	Function RELAY2	S,V	see „Function RELAY1”
			2	Value RELAY2	S,V,R	
			3	Hyst. RELAY2	S,V,R	
			4	RE2-ON,delay	S,V,R	
			5	RE2-OFF,delay	S,V,R	
	3	RELAY3	1	Function RELAY3	S,V	see „Function RELAY1”
			2	Value RELAY3	S,V,R	
			3	Hyst. RELAY3	S,V,R	
	4	Brake	1	Brake delay	S,V,R	
			2	Brake advance	S,V,R	
			3	Brake frequency	S,V	
			4	Br. response time	S,V	

GROUPS		SECTIONS		PARAMETERS	atr.	options
RELAY OUTPUTS (**5**.x.x)	5	Delay in cascade	1	RELAY ON at Fmax	S,V,R	
			2	RELAY OFF at Fmin	S,V,R	
	6	Warnings choice	1	RELAY – warnings 1	S,V,R	
			2	RELAY – warnings 2	S,V,R	
	7	Overload	1	Static overload	S,V,R	
			2	Total overload	S,V,R	
			3	Toler. START	S,V	
			4	Static overload time	S,V	
			5	Total overload time	S,V	
			6	Cancel overload	S,V	
ANALOGUE OUTPUTS (**6**.x.x)	1	AOUT1	1	Function AOUT1	S,V,R	INV frequency; INV current; Motor torque; Motor power; sensor PT100; AOUT-RELAY4; Service. var.SL; service.var.MS
			2	Type AOUT1	S,V,R	0÷20mA,0÷MAX.; 4÷20mA,0÷MAX.; 0÷20mA,-MAX÷MAX.; 4÷20mA,-MAX÷MAX
			3	AOUT1 min.	S,V,R	
			4	AOUT1 max.	S,V,R	
	2	AOUT2	1	Function AOUT2	S,V,R	see „Function AOUT1”
			2	Type AOUT2	S,V,R	see „Type AOUT1”
			3	AOUT2 min.	S,V,R	
			4	AOUT2 max.	S,V,R	
	3	AOUT – RELAY4	1	Function RELAY4	S,V	see „Function RELAY1”
			2	Value RELAY4	S,V,R	
			3	Hyst RELAY4	S,V,R	
ACCEL. – DECEL. (**7**.x.x)	1	Style	1	Rump up, Rump down	S,V	dynamic, time ramps, „S“ ramps
			2	Profile „S“ curve	S,V,R	
	2	Times	1	Acceler. ramp 1	S,V	
			2	Acceler. ramp 2	S,V	
			3	Deceler. ramp 1	S,V	
			4	Deceler. ramp 2	S,V	
			5	REVERSE rump down	S,V,R	
			6	Quick decel.	S,V	
	3	Break points	1	Acceler.br. point	S,V	
			2	Deceler.br. point	S,V	
BRAKING (**8**.x.x)	1	Dynamic rump down	1	Dynamic rump down	S,V,R	OFF, ON
			2	Dyn.RD DC-voltage	S,V,R	
	2	Braking unit	1	Braking unit (BU)	S,V,R	OFF, ON
	3	Flux braking	1	Flux braking	S,V,R	OFF, ON
			2	Flux braking gain	S,V,R	

Constraints (**9**.x.x)	1	Sampling frequen.	1	Sampling frequen.	S,V	
	2	Bin. frequencies	1	1.binary freq.	S,V,R	
			2	2.binary freq.	S,V,R	
			3	3.binary freq.	S,V,R	
			4	4.binary freq.	S,V,R	
			5	5.binary freq.	S,V,R	
			6	6.binary freq.	S,V,R	
			7	7.binary freq.	S,V,R	
			8	8.binary freq.	S,V,R	
	3	Min./max. freq.	1	Min. frequency	S,V	
			2	Max. frequency	S,V	
	4	Terminal switches	1	Terminal sw.freq.	S,V,R	
			2	Terminal path +	S,V	
			3	Terminal path –	S,V	
			4	Preset value	S,V,R	0→position; +MAX→position; -MAX→position
			5	Position preset	S,V	by serial link; after SET's init.; at once; cancel
	5	Boost zones	1	Shift frequen U/F.	S	
			2	Shift frequen STR	S	
	6	Initial/ end volt.	1	Initial voltage	S	
			2	End voltage	S,V	
			3	Autotunning Vin	S	
	7	Curve exponent	1	Curve index	S	
	8	Starting torque	1	Starting torque	S,R	
	9	Maximal torque	1	Maximal torque	V,R	
			2	Ratio Mmot/Mgen	V,R	
	10	Maximal current	1	Maximal current	S,V,R	
	12	Min./max. mag.flux	1	Min. magn. flux	V,R	
			2	Max. magn. flux	V,R	
	13	Max. position	1	Max. position	S,V,R	
			2	Position constraint	S, V	OFF; ON
	14	Position scale	1	Position scale	S,V	

FAULTS (**10**.x.x)	1	Faults reset	1	Faults reset.	S,V,R	
	2	Selective faults	1	IRC/ARC dropout	S,V,R	motor OFF; scalar mode; not tested
			2	Inp. phases testing	S,V,R	OFF; ON
			3	Out. phases testing	S,V,R	OFF; ON
			4	MT overloading	S,V,R	not tested; external cooling; self cooling; 1x sensor PT100; 2x sensor PT100; 3x sensor PT100
			6	Test. communic.err.	S,V,R	not tested; warning; stop INV; reset INV; error INV
			7	Dangerous warning	S,V,R	not tested; enabled
			8	Danger.warn.filter	S,V,R	
	3	Failure routine	1	Operat. after fault	S,V	don't wait.; wait choice time; confirmation
			2	Time after fault	S,V	
			3	Operat. undervolt.	S,V	don't wait.; wait choice time; flying start; confirmation

GROUPS		SECTIONS		PARAMETERS	atr.	options
CONTROL MODE (**11**.x.x)	1	Contr. strategy	1	Contr. strategy	S,V	scalar,open; scalar,closed; vector IM,clos.; vector IM,open; vector SMPM,clos.
	2	Control variable	1	Control variable	V	torque; speed; position
PROCESS REGULATOR (**12**.x.x)	1	Option- Function	1	Process reg. (PR)	S,V	OFF; direct; inverse
			2	PR dead zone	S,V,R	
	2	Constants PID	1	P – compon. of PR	S,V,R	
			2	I – compon. of PR	S,V,R	
			3	D – compon. of PR	S,V,R	
	3	Fixed req.var. PR	1	Fixed req.var. PR	S,V,R	
	4	Req.var. constr.	1	Min.req.var.of PR	S,V,R	
			2	Max.req.var.of PR	S,V,R	
	5	Parking	1	Parking of PR	S,V,R	OFF; ON
			2	ParkOFF hysteresis	S,V,R	
			3	Park ON time	S,V,R	
REGUL.-PROPERTIES (**13**.x.x)	1	Speed	1	Spd. regul. mode	V	normal; adapting from f
			2	P – compon. of SR	V, R	
			3	I – compon of SR	V, R	
			4	D – compon of SR	V, R	
			5	Sampling of Reg.	V	
			6	Speed filter type	V, R	
	2	Starting torque	1	Start.torq.regul.	S, R	OFF; ON
			2	P – compon. of STR	S, R	
			3	I – compon. of STR	S, R	
	3	Maximal current	1	Max current reg.	S, R	OFF; ON; up to Fmin; generator; genrator,Fmin
			2	P – compon. of MCR	S, R	
			3	I – compon. of MCR	S, R	
	4	Kinetic backup	1	Kinetic backup	S,V,R	OFF; ON
			2	Max.time of KB	S,V,R	
			3	P– compon. of KBR	S,V,R	
			4	I – compon. of KBR	S,V,R	
			5	D – compon. of KBR	S,V,R	
			6	UDC refer for KBR	S,V,R	
	5	Field suppress.	1	P – compon. of FSR	V, R	
			2	I – compon. of FSR	V, R	
			3	P–comp.of FSR/Imax	V, R	
	6	Positioning	2	Sampling of Reg.	V	
			3	P -com. of pos.reg.	V,R	
	7	Control dynamics	1	Dyamics curr.reg.	V	
			2	Dyamics torq.reg.	V	
			3	Dyamics flux.reg.	V	
	8	Adapting SR	1	Fa	V,R	
			2	P0	V,R	
			3	I0	V,R	
			4	D0	V,R	
			5	Pa	V,R	
			6	Ia	V,R	
			7	Da	V,R	

GROUPS	SECTIONS		PARAMETERS		atr.	options
AUXILIARY MODES (**14**.x.x)	1	Flying start	2	Detect. time	S,V	
			3	Criterial limit	S,V,R	
			4	Detect. current	S,V,R	
	2	MT volt.correct.	1	MT volt.correct.	S,V,R	OFF; ON
			2	Resonance damping	S,V,R	
			3	Reserved.	S,V,R	
	5	SW term. switch	1	SW term. switch	S,V,R	OFF; type STOP; type REVERSE
			2	Posit. for deceler.	S,V,R	
	6	Extension modules	1	Extension modules	S,V	none; RM-ARC1, RM-DIRC
			2	RM-xxx MODE	S,V	
	7	Backup bat. (UPS)	1	Backup bat. (UPS)	S,V	OFF; ON; ON,auto-reverse
			2	Stabilization time	S,V	
			3	Rump UP/DOWN,ups	S,V	
			4	Brake frequency	S,V	
	8	Service DVA var.	1	DVA service SL	S,V,R	
			2	Type DVA service SL	S,V,R	
			3	DVA service MS	S,V,R	
			4	Type DVA service MS	S,V,R	
	9	Service AOUT var.	1	AOUT service SL	S,V,R	
			2	SL for 100% AOUT	S,V,R	
			3	AOUT service MS	S,V,R	
			4	MS for 100% AOUT	S,V,R	

DETAILED PARAMETERS DESCRIPTION

EXPLANATORY NOTES

Parameter names, names of parameters groups and sections, as well as options texts are being displayed as they appear on the converter display.

Table heading:

Parameter number **Parameter name** **atr = attributes**

G R O U P – S e c t i o n default setting: Factory setting

Attributes:

S *– parameter has its meaning in scalar control mode; if the control mode is „scalar, opened.“ (11.1.1)*

V *– parameter has its meaning in vector control mode; if the control mode is not „scalar, opened.“ (11.1.1)*

R *– parameter can be changed while the motor is running (in START), (e.g.: 2.6.1, 10.1.1).*

ATTENTION !
Unexpected shut off of some regulator during motor operation can cause the fault „overcurrent“ or „overvoltage“.
This relates to parameters: 9.10.1, 13.2.1, 13.3.1, 13.4.1, 14.1.X

MOTOR CONSTANTS

1.1.1 Motor power

atr = S+V

MOTOR CONSTANTS – Motor power default setting: **see Appendix B**

The value of nominal motor power from motor label.

rozsah: (1.0 kW ÷ 2000.0 kW)

The value is necessary particularly for correct calculations of momentary input power, motor power and consumption.

1.2.1 Motor current

atr = S+V

MOTOR CONSTANTS – Motor current default setting: **see Appendix B**

The value of nominal motor current from motor label.

rozsah: (1 A ÷ 2000 A)

This parameter is essential for correct operation of motor protections against overtemperature, which can be the result of overcurrent. ***If less than 1/7 of nominal converter current is set in vector mode, accuracy of current sensing decreases, and the converter displays the fault „Incorrect par. of currents“***

1.3.1 Motor voltage

atr = S+V

MOTOR CONSTANTS – Motor voltage default setting: **Un = 500 V**

The value of nominal motor voltage from motor label.

range: (1 V ÷ 999 V)

This parameter is necessary for correct calculations made by frequency converter VQfrem

1.4.1 Motor frequency

atr = S+V

MOTOR CONSTANTS – Frequency default setting: **Fn = 50.0 Hz**

The value of nominal motor frequency from motor label.

range: (10.0 Hz ÷ 300.0 Hz)

This parameter represents the frequency, at witch U/f curve reaches the value of output voltage according parameter (9.6.2) (standard in Europe is 50 Hz, standard in the USA is 60 Hz).

1.5.1 Motor revolutions

atr = S+V

MOTOR CONSTANTS – Motor revolutions default setting: **nn = 1450 /min**

The value of nominal motor revolutions from motor label.

range: (1 /min ÷ 20 000 /min)

It is essential for correct depiction of revolutions and for calculations of nom. motor torque.

1.6.1 Number of poles

atr = S+V

MOTOR CONSTANTS – Number of poles default setting: **p = 4**

Number of pole pairs defines electrical speed to mechanical speed ratio of rotor rotation.

range: (2 ÷ 60)

*The parameter can be computed as follows: p = 2 * 3000 divided by nominal motor revolutions. The result is rounded down on integer number. E.g.: for n_n = 1450 rev./min the parameter equals to p = 4.*

1.7.1 Gear ratio

atr = S+V

MOTOR CONSTANTS – Gear ratio default setting: **i = 1.0**

The ratio of revolutions ahead and behind gear.

range: (0.1 ÷ 3000.0) [i]

The parameter is necessary for correct displaying of revolutions, for correct operation of „terminal switch+/-“ (3.X.1) and „SW term.switch“(13.8.X) functions, and at position controlling (11.2.1, 13.7.X).

1.9.1 Motor efficiency

atr = S+V

MOTOR CONSTANTS – Motor efficiency default setting: **0.82**

The value of motor efficiency from motor label or catalogue.

range: (0.50 ÷ 0.99)

Motor efficiency is essential for correct displaying of momentary motor power.

1.10.1 PWM-off/on time

atr = S+V

MOTOR CONSTANTS – PWM-off/on time default setting: **viď. Príloha B**

The value of this parameter represents the time between the last interruption of converter's power output (result of any reason - fault, converter's reset, Stop command) and converter's Start permission. Parameter does not continually delay converter's Start, it delay its Start only after last power outputs interruption.

range: (0.0 ÷ 60.0)

The parameter should be used, if it is required to restrict converter's Start until specified time expires after the last converter's power outputs interruption.

1.11.1 Motor therm. cons.

atr = S+V+R

MOTOR CONSTANTS – Motor therm. cons. default setting: **see Appendix B**

Motor thermal constant is a time constant, which consider warming and cooling time of motor winding. It defines time period during which thermal integral is computed. After this time period expires integral is computed again from zero value.

The converter indicates an error, if thermal integral value during time period exceeds maximal value set in parameter 10.2.4. The error terminates, when default time period expires, i.e. when new one computing starts.

range: (1 min ÷ 300 min)

Parameter value depends on motor size. See the following table:

The converter automatically sets mentioned parameters values depending on motor power after choosing the command „MAKRO – MT constants".

Motor	Constant	Motor	Constant
132 kW	55 min	630 kW	65 min
160 kW	55 min	710 kW	70 min
200 kW	60 min	800 kW	70 min
250 kW	60 min	900 kW	70 min
315 kW	65 min	1000 kW	70 min
400 kW	65 min		
500 kW	65 min		

1.12.1 Stator resist. Rs

atr = V+R

MOTOR CONSTANTS – Special default setting: **see Appendix B**

The value of stator resistance at wye connection. The value of this parameter can be the result of tuning process or identification.

rozsah: (0.1 mΩ ÷ 3200.0 mΩ)

Rs is the sum of effective resistance of winding of 1st motor phase and resistance of leading-in (input) cables.

1.12.2 Stator inductance

atr = V+R

MOTOR CONSTANTS – Special default setting: **see Appendix B**

The value of stator inductance at wye connection. The value of this parameter can be the result of tuning process or identification.

rozsah: (0.01 mH ÷ 320.00 mH)

Ls is an inductance of a single motor phase.

1.12.3 Mutual inductance

atr = V+R

MOTOR CONSTANTS – Special default setting: **see Appendix B**

The value of stator mutual inductance at wye connection. The value of this parameter can be the result of tuning process or identification.

rozsah: (0.01 mH ÷ 320.00 mH)

Lm defines the relationship between current and magnetic flux. Incorrect setting can cause insufficient or excess excitation of a motor. It ranges mostly from 70 to 95% of Ls (1.12.3), while it must always be less than Ls. In a case of control (11.1.1) "vector SMPM, clos.", this parameter does not have its meaning.

1.12.4 Rotor time const.

atr = S+V+R

MOTOR CONSTANTS – Special default setting: **see Appendix B**

The value of rotor time constant. The value of this parameter can be the result of tuning process or identification.

range: (0.1 ms ÷ 3000.0 ms)

(Tr = Lr / Rr) – directly affects the dynamics of motor excitation, as well as the quality of calculations of mathematical model of a motor in vector control mode.

In a scalar mode, this constant affects a slope of increase (decrease) of motor voltage at excitation, at phasing and at other special modes. Double value of this parameter defines time period, during which START is disabled in order motor to reach field suppression (rotor magnetic field to terminate). START is always disabled during motor field suppression, when the motor is disconnected from voltage and repeatedly put into the operation, e.g. when RESET is selected or after the fault.

In a case of control (11.1.1) "vector SMPM, clos.", this parameter has the meaning of electrical time constant of SMPM.

1.12.5 Autotunning MT

atr = V

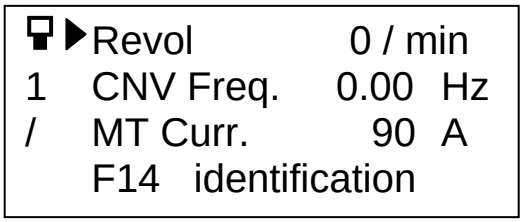
MOTOR CONSTANTS – Special

COMMANDS

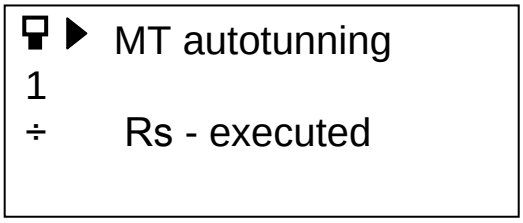
Activation of this command makes one-shot motor constants identification to start (parameters 1.12.1 to 1.12.3). It is required before first activating of vector control (11.1.1). **Keep the following sequence of steps: Stator resistance Rs – Magnetic flux – Ls, Lm inductance**

Stator resist. Rs

- During Rs identification motor remains in standstill. **Relay–brake remains switched off (motor is braked)**. Rs identification lasts approximately 4s.
- After command activation, functional caution "F14 identification" will be shown on converter display. The converter gradually connects unidirectional voltage to motor with 3 different sampling frequencies.



- The converter writes a new value of parameter Rs into the parameters (1.12.1). Than, it returns to parameters window.

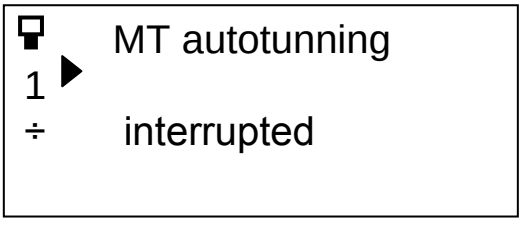


- ***Common reasons of identification error ("Identification err.") of Rs and Ls,Lm (Magn.flux):***

#98 - frequency converter is in back-up power supply mode („W24 back-up supply!“)
#99 - motor voltage correction is not activated (14.2.1), it can result in inaccuracy of voltage measurements

- ***Common reasons of identification error ("Identification err.") of Rs:***

#2 - the result of resistance computing represents unreal value, probably it is due to incorrect motor parameters or starting torque regulator oscillation which causes that current can not be stabilized.
#3 - during Rs identification warning „W23 MT disconnected“ has occurred – motor is not connected to the converter correctly or motor is too small to the converter.
#0, 4 – the process of identification has been interrupted by command RESET or by some of converter's faults.
In a case of a fault, the value of the parameter 1.12.1 does not change and the display signalises identification interruption.



Magnetic flux

The command is being applied for correct identification of parameters “Min. magn. flux” and “Max. magn. flux” (9.12.1-2). Different values of magnetic flux are applicable for different motor voltages (230V, 400V, 690V). ***ATTENTION !*** At “vector SMPM” control, this identification is enabled only if motor is un-loaded. The converter lets the motor to rotate at half of the nominal revolutions (nominal speed).

Inductances Ls,Lm

Is ignored for synchronous motors.

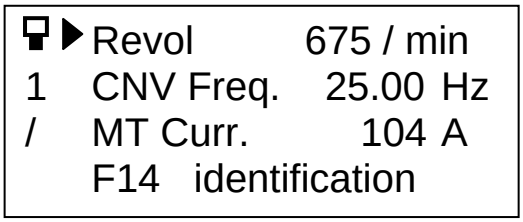
ATTENTION !!!

The motor should be un-loaded (disconnected from any load) at Ls, Lm identification. Unless the mentioned condition is accomplished, the values of identified parameters will be incorrect or the process of identification may result in a fault.

The converter makes the motor rotate at half the nominal revolutions (stator freq. = 25Hz). Operating personnel should ensure that all the blockages of converter’s controlling (RESET, control system signals etc.) are deactivated. No access to rotor shaft should be allowed.

Ls, Lm identification should be done exclusively after Rs and magnetic flux identification.

- After command activation, functional caution "F14 identification" will be shown on converter display.
- The converter starts to rotate the motor at half the nominal revolutions (stator freq. = 25Hz). The motor stops after approximately 5 s.



- The converter writes new values into parameters (1.12.2)-Ls and (1.12.3)-Lm. Than, it returns to parameters window.
- ***Common reasons of identification error ("Identification err.") of Ls,Lm:***

#11,13 - the converter has registered a fault during identification (short circuit, undervoltage, overcurrent, etc.).
#12,14 - the process of identification has been interrupted by command RESET.
#15 - exciting current I_0 equals to zero – motor is not connected to the converter correctly or motor is too small to the converter.
#16 - exciting current I_0 is more than 1,5 times nominal motor current – the motor is loaded, incorrectly connected or has incorrect motor label parameters.
#17,18 - incorrect result during Ls, Lm computing – motor is not connected to the converter correctly or incorrect motor label parameters or absence of Rs identification prior to Ls, Lm identification.

It is necessary to repeat identification after fault elimination. In a case of a fault, the value of parameter 1.12.1 and 1.12.3 does not change and the display signalises identification interruption.

ACTUATING-COMMANDS

2.1.1 StartStop-Reverse

atr = S+V

ACTUAT.-COMMANDS – StartStopReverse default setting: **binary inputs**

OPTIONS Selection of the source of entering of control commands - Start, Stop, Reverse.

control panel	the sources of entering are the buttons of control panel (keypad).
binary inputs	the source of entering are binary inputs, that have assigned functions „Start/Stop“, „reverse“, „startReverse /stop“ in parameters 3.X.1.
serial link	the source of entering is superior computer (via RS 232 or RS 485).

2.1.2 Start/Stop/Rev.(2)

atr = S+V

ACTUAT.-COMMANDS – StartStopReverse default setting: **control panel**

The meaning of this parameter is identical with the previous one. Parameter becomes of use, if binary input “REM/LOC control” (par.3.1.1) is active. The function of Start / Stop / Rev.(2) is another source of entering Start – Stop – Reverse.

2.2.1 REVERSE-options

atr = S+V

ACTUAT.-COMMANDS – REVERSE-options default setting: **enabled**

OPTIONS Selection of the type of REVERSE function actuating.

yes	motor rotates in a direction that depends on REVERSE function.
permanent. off	motor rotates in a positive direction not depending on REVERSE function.
permanent. on	motor rotates in a negative direction not depending on REVERSE function.

The parameter is used, if the user wants to block (to prevent from the use)REVERSE function permanently. At the same time it is also used for electronic change of the sequence of phases on motor outputs, if the actual direction of motor rotation doesn’t correspond to the requested.

2.3.1 Source-requir.val. *atr = S+V*

ACTUAT.-COMMANDS – Source-requir.val. default setting: **analogue input**

Selection of the source of entering of converter's required value – frequency, torque (according to parameter 11.2.1), process variable (according to parameter 12.1.1).

– *Required value is the value, which regulation can be set in parameter 11.2.1.*
– *Functions of binary inputs are being set in parameters 3.X.1.*
– *At torque, position and process variable setting a slope of increase and decrease is stable - 10s / range of a change.*

OPTIONS

fixed value

the source of entering of required value of process variable is parameter 12.3.1.
the source of entering of required frequency is parameter 9.2.1.

control panel

the source of entering are arrow buttons of active control panel (2.4.1).

analogue input

the source of entering is analogue input, which has assigned function "CNV/PR req.value" in parameters 4.1.1 according to ranges predetermined in par. 4.2.X.

If AIN =100%, it standardly (without using process regulator) refers to maximal value of controlled variable - frequency, torque, postion.

As far as the input has negative delimination (see par. 4.2.X), its absolute value is valid.
To change the direction from negative value AIN, choose „+/- AIN" in this parameter.

binary speeds

the source of entering are binary inputs in the function „BIT0", „BIT1", „BIT2" (3.X.1). This option does not have its meaning in a case of „torque" (11.2.1) required variable.

Frequency values for binary speeds:

BIN „BIT2"	BIN „BIT1"	BIN „BIT0"	BIN „Start/Stop" „StartReverse/Stop	required frequency
switched off	switched off	switched off	**switched on**	1. binary freq. (9.2.1)
switched off	switched off	**switched on**	**switched on**	2. binary freq. (9.2.2)
switched off	**switched on**	switched on/off	**switched on**	3. binary freq. (9.2.3)
switched on	switched on/off	switched on/off	**switched on**	4. binary freq. (9.2.4)

bin.combinations

the source of entering is the combination of binary inputs in the function „BIT0", „BIT1", „BIT2" (3.X.1). This option does not have its meaning in a case of „torque" (11.2.1) required variable.

Frequency values for binary combinations:

BIN „BIT2"	BIN „BIT1"	BIN „BIT0"	BIN „Start/Stop" „StartReverse/Stop	required frequency
switched off	switched off	switched off	**switched on**	1. binary freq. (9.2.1)
switched off	switched off	**switched on**	**switched on**	2. binary freq. (9.2.2)
switched off	**switched on**	switched off	**switched on**	3. binary freq. (9.2.3)
switched off	**switched on**	**switched on**	**switched on**	4. binary freq. (9.2.4)
switched on	switched off	switched off	**switched on**	5. binary freq. (9.2.5)
switched on	switched off	**switched on**	**switched on**	6. binary freq. (9.2.6)
switched on	**switched on**	switched off	**switched on**	7. binary freq. (9.2.7)
switched on	**switched on**	**switched on**	**switched on**	8. binary freq. (9.2.8)

AIN+bin. speeds

the source of entering are binary inputs in the function „BIT0", „BIT1", „BIT2" (3.X.1) and analogue input with a given function "CNV/PR req. value" in parameters 4.1.1, 4.2.1, 4.3.1. Binary inputs are superior to analogue inputs.
This option does not have it's meaning in a case of „torque" (11.2.1) required variable and at process regulator (12.1.1 = „ON").

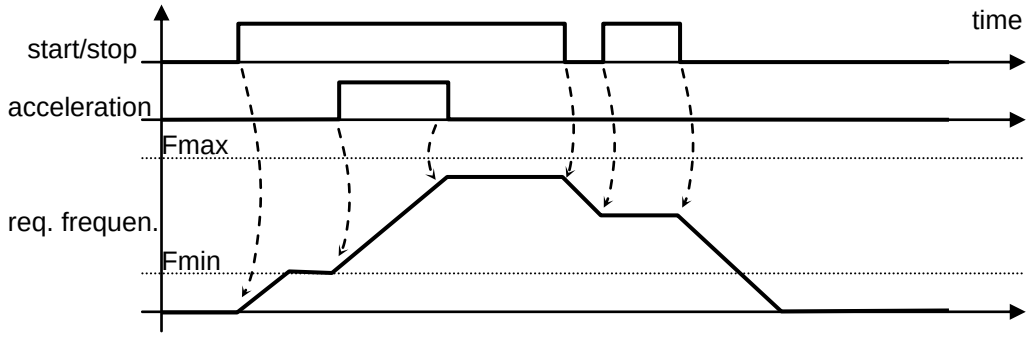
Frequency values for AIN and binary speeds:

BIN „BIT2"	BIN „BIT1"	BIN „BIT0"	BIN „Start/Stop" „StartReverse/Stop	required frequency
switched off	switched off	switched off	**switched on**	according to AINx
switched off	switched off	**switched on**	**switched on**	2. binary freq. (9.2.2)
switched off	**switched on**	switched on/off	**switched on**	3. binary freq. (9.2.3)
switched on	switched on/ off	switched on/off	**switched on**	4. binary freq. (9.2.4)

2.3.1 (continued) Source-requir.val. *atr = S+V*

ACTUAT.-COMMANDS – Source-requir.val. default setting: **analogue input**

OPTIONS

BIN motor-potent.	the source of entering are binary inputs with "acceleration" and "deceleration" functions (see parameters 3.X.1). Parameter 2.1.1 must be „binary inputs“. A slope of increase and decrease is constrained by time ramps (7.2.X).
BIN memor.potent.	the source of entering are binary inputs with "Start/Stop" and "acceleration" or "startReverse /stop" and "acceleration" functions (see parameters 3.X.1). Parameter 2.1.1 must be „binary inputs“. A slope of increase and decrease is constrained by time ramps (7.2.X). 
serial link	the source of entering of required value is superior computer or MASTER converter (via RS 232 or RS 485).
+/- AIN	Instrument to put data is analogue input, which has a function „desired value MN/PR“ in parameters 4.1.1 according to ranges predetermined in par. 4.2.X. Unlike option „analoque input“ it can change slewing direction, when it is in parameter 4.2.X a negative value predetermined.
automatic	the source of entering of required value is an automatic unit inside the converter, which uses parameters 9.2.1. - 9.2.4 instead of the values of required frequencies and parameters 9.2.5.- 9.2.8. instead of time periods of being on these frequencies (XX.XX sec. format). The automatic unit changes the frequencies according to following sequence of steps: - After START command activation, the direction of the rotation is set according to the direction at last STOP. - 1. binary freq. (9.2.1) for the period according to par. (9.2.5) in XX.XX sec. format, - 2. binary freq. (9.2.2) for the period according to par. (9.2.6) in XX.XX sec. format, - 3. binary freq. (9.2.3) for the period according to par. (9.2.7) in XX.XX sec. format, - 4. binary freq. (9.2.4) for the period according to par. (9.2.8) in XX.XX sec. format, - the direction of the rotation is changed (if REVERSE is set „enabled“ in parameter 2.2.1) and the cycle starts to repeat from 1. binary frequency.

2.3.2 Required value (2) *atr = S+V*

ACTUAT.-COMMANDS – Source-req.value default setting: **control panel**

The meaning of this parameter is identical with the previous one. Parameter becomes of use, if binary input “REM/LOC control” (par.3.1.1) is active. The function of Start / Stop / Rev.(2) is another source of entering Start – Stop – Reverse.

2.4.1 Contr. panel type

atr = S+V+R

ACTUAT.-COMMANDS – Contr. panel type default setting: **external**

Selection of active control panel. Active control panel is the panel, by which keypad the converter can be controlled and configured.

OPTIONS

internal	built in – internal control panel is active.
external	detachable – external control is active.

The symbol on the display signalises, which control panel is active.

2.5.1 Security code

atr = S+V

ACTUAT.-COMMANDS – Security code default setting: **0**

The setting and modification of converter's security code (password). The code set in SET1 is valid for both sets, SET1 and SET2. The value of this parameter in SET2 does not have its meaning.

range: (0 ÷ 9999)

Security code inhibits unauthorized person to change converter's parameters. If incorrect code is written before parameter adjustment, it is not allowed to get into adjusting mode. Default security code is 0000. The user can freely change default security code!

IF SECURITY CODE IS FORGOTTEN, IT IS NECESSARY TO CONTACT THE MANUFACTURER - VONSCH Ltd. !!!.

2.6.1 Motor run time

atr = S+V+R

ACTUAT.-COMMANDS – Motor run time

COMMANDS

If this command is activated, motor running time counter is set to zero or to defined value.

reset	Motor running time counter is set to zero (reseted).
set	Motor running time counter is set to the value that is given in parameters 2.6.2 and 2.6.3.

Motor running time counter measures the time the motor is running under certain voltage. At activation of a command „set", motor running time counter is set to the value **1000x(2.6.3)+(2.6.2)**.

2.6.2 MT run time x1

atr = S+V+R

ACTUAT.-COMMANDS – Motor run time default setting: **0**

The value of motor run time that is used for the setting of the counter in parameter 2.6.1.

range: (0 h ÷ 999 h)

2.6.3 MT run time x1000

atr = S+V+R

ACTUAT.-COMMANDS – Motor run time default setting: **0**

The value of motor run time times 1000 that is used for the setting of the counter in parameter 2.6.1.

range: (0 h ÷ 99) [x1000h]

2.7.1 Consumption reset atr = S+V

ACTUAT.-COMMANDS – Consumption reset

COMMANDS — Activation of these commands causes motor consumption reset.

0→kWh	If this command is activated, motor kWh counter is set to zero (reseted).
0→MWh	If this command is activated, motor MWh counter is set to zero (reseted).

Motor consumption is recorded while the motor is running. It is only informative value. If MWh have exceeded the value 65536, the converter starts to count motor consumption from zero.

2.8.1 Company settings atr = S+V

ACTUAT.-COMMANDS – Company macros

COMMAND — If this parameter is activated, default values are recorded into actual set of parameters.

After this command was applied, „MACRO-MT constants" (2.8.2) should be activated for corresponding motor power.

2.8.2 MACRO-MT constants atr = S+V

ACTUAT.-COMMANDS – Company macros default setting: **750W**

COMMANDS-OPTIONS — The converter transcribes chosen parameters in active set of parameters according to chosen motor power. A list and values are listed in APPENDIX „B".

132kW	default parameters of 132kW motor will be recorded into the active set of parameters.
160kW	default parameters of 160kW motor will be recorded into the active set of parameters.
...	...
1MW	default parameters of 1MW motor will be recorded into the active set of parameters.

Macros make converter's setting significantly easier. If you want to recover the original parameter setting after unwanted macro execution, you can use „Backup ->Act.Set" (2.9.1) command. This is possible only if the original parameter setting was before saved to the corresponding BACKUP using „Act.Set ->backup" (2.9.2) command.

2.9.1 Backup -> Act. Set atr = S+V

ACTUAT.-COMMANDS – Parameter copying

COMMAND — Selection of this command causes recovery of the last setting of active set from backup.

If parameter value is changed when pressing ENTER button; previous parameter value is always recorded into the backup.

2.9.2 Act. Set -> backup atr = S+V+R

ACTUAT.-COMMANDS – Parameter copying

COMMAND — Selection of this command causes that the actual setting of active set is copied into the backup.

2.9.3 Set1 -> Set2 atr = S+V

ACTUAT.-COMMANDS – Parameter copying

COMMAND — It causes copying of SET2 into the backup and consecutive copying of SET1 into SET2.

2.9.4 Set2 -> Set1 atr = S+V

ACTUAT.-COMMANDS – Parameter copying

COMMAND — It causes copying of SET1 into the backup and consecutive copying of SET2 into SET1.

2.9.5 EXT.pan. -> Set1,2 atr = S+V

ACTUAT.-COMMANDS – Parameter copying

COMMAND — It causes copying of SET1 and SET2 into the backup and consecutive download of SET1 and SET2 from External control panel.

It is needed to choose „Contr. panel type“ = „external“.

If the communication with external control panel was interrupted, parameter recording will stop. The converter displays „reading interrupted“ and recovers SET1 and SET2 from backup.

2.9.6 Set1,2 -> EXT.pan. atr = S+V+R

ACTUAT.-COMMANDS – Parameter copying

COMMAND — It causes download of SET1 and SET2 into External control panel.
It is needed to choose „Contr. panel type“ = „external“.

If the communication with external control panel was interrupted, parameter exporting will stop. The converter displays „writing interrupted“. The content of parameter memory in external control panel is incomplete. If it is tried to read the parameters from ECP to the converter, the converter displays „Incomplete ext. param.“.

2.10.1 COM interface atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **RS-232**

OPTIONS — A type of serial link interface serving for communication with a superior control system.

RS-485	Serial link interface is of a type RS485, used for long distance connections.
RS-232	Serial link interface is of a type RS232, used for short distance connections.

RS232 interface is intended to be used in laboratory environment and is helpful for connecting the converter VQfrem with PC. RS485 is intended to be used in industrial environment.

2.10.2 Converter address atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **1**

Converter's address is important for recognizing of commands transmitted to a particular converter. It is important especially in a case of serial communication with control system using SETX communication protocol.

range: (1 ÷ 99)

In MASTER–SLAVE applications, addresses of SLAVE converters start from the value 01.

2.10.3 Communic. mode atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **SLAVE, subordinate**

OPTIONS Communication mode defines MASTER –SLAVE station type on communication bus.

SLAVE, subordinate	the converter receives messages, executes them and responds to superior system.
MASTER - speed	the converter is in a function of superior system. It communicates only with converters, that are in SLAVE mode and **transmits its own required speed**, as required variable for SLAVE converters.
MASTER - IRC speed	the converter is in a function of superior system. It communicates only with converters, that are in SLAVE mode and **transmits its real speed from IRC**, as required variable for SLAVE converters.
MASTER - position	the converter is in a function of superior system. It communicates only **with one converter** that is in **SLAVE** mode and transmits its real position, as required variable for SLAVE converter.

You can find more detailed description of drives operation in modes listed above at the end of Appendix „C“.

2.10.4 Number of SLAVEs atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **1**

The number of subordinate SLAVE converters, which are connected to MASTER (superior converter). It is recommended for edgers and production lines with more on-line drives.

range: (1 ÷ 10)

This parameter is helpful only for converters in MASTER mode. MASTER communicates by serial link with subordinate converters, starting with the address 01. It generates control commands and required value of frequency for them. ***If it is in parameter 2.10.3 set “MASTER, position”, it is PRSS method and the number of SLAVEs (2.10.4) must be set to 1.***

2.10.6 Speed from MASTER atr = S+V+R

ACTUAT.-COMMANDS – Communication default setting: **1.000**

A constant that is used for re-counting of required frequency (a frequency, which SLAVE receives from a superior system or from a MASTER).

range: (0.001 ÷ 15.999)

This constant is intended only for a converter in SLAVE (2.10.3) communication mode, which source of entering required frequency (2.3.1) is serial link. The converter in SLAVE mode multiplies received required frequency by the value of this parameter (2.10.6) and generates the final value to the motor. It is very well used at multi-motor systems, where individual drives have different gear ratios. It is also useful when it is needed to re-count SLAVE’s speed linearly according to MASTER’s speed (different number of poles).

2.10.7 Position for SLAVE

atr = S+V+R

ACTUAT.-COMMANDS – Communication default setting: **1.50**

Correction amplification of required position, that MASTER transmits to a SLAVE.

range: (0.10 ÷ 100.00)

The converter in "MASTER-position" (2.10.3) mode adds a correction to transmitted position (2.10.4). The correction is calculated from momentary motor speed and from the time between the position is transmitted and received.

2.10.9 Communic. timeout

atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **1000 ms**

Time needed for communication error recognition and recognition of serial link disconnection. It is the time between the last character (ETX) transmission and whole valid telegram receiving.

range: (10 ms ÷ 30 000 ms)

Recommended timeout for connection with VQFREM Monitor program is about 2000ms.
*For MASTER–SLAVE**1** mode, minimal timeout for each converter is: **25ms * (par2.10.12)**.*
*For MASTER–SLAVE**1**–SLAVE**2**–...–SLAVE**n** mode, minimal timeout is:*
*– for MASTER: **25ms * (par2.10.12)***
–** for each SLAVE: **[2 * n * 25ms * (par2.10.12)]
It exists so called „response time" in MASTER mode, which is firmly set to 10ms. It means that if SLAVE converter does not respond until this time expires, MASTER transmits another telegram. It enables faster response in comparison with timeout.

2.10.12 Baudrate

atr = S+V

ACTUAT.-COMMANDS – Communication default setting: **2**

The parameter is necessary for the setting of communication speed.

range: (1 ÷ 8) [*19.2kBd/x*]

There are following communication speeds for individual parameter settings:

BAUD = 1	*19 200 Bd (Bps)*	*BAUD = 5*	*3 840 Bd (Bps)*
BAUD = 2	*9 600 Bd (Bps)*	*BAUD = 6*	*3 200 Bd (Bps)*
BAUD = 3	*6 400 Bd (Bps)*	*BAUD = 7*	*2 743 Bd (Bps)*
BAUD = 4	*4 800 Bd (Bps)*	*BAUD = 8*	*2 400 Bd (Bps)*

BINARY INPUTS, IRC

3.1.1 Function BIN1

atr = S+V

BINARY INPUTS,IRC – BIN1 default setting: **Start/Stop**

Function selection of binary input 1.

If various binary inputs have the same function, the function is active, if either of these inputs is switched on (EITHER-OR operation). Binary input is activated, if 24V or 0V is supplied (according to chosen input polarity).

OPTIONS

The state of input BINx is considered to be valid, if the signal (0V, 24V) takes longer than 50 ms.

Start/Stop	If binary actuating is active (2.1.1), switching on binary input causes converter's START.
StartReverse/Stop	If binary actuating is active (2.1.1), switching on binary input causes converter's START and reverse. **This function is superior to „Start/Stop" function.**
BIT0	The meaning is according to the parameter 2.3.1 – binary speeds or binary combinations.
BIT1	The meaning is according to the parameter 2.3.1 – binary speeds or binary combinations.
BIT2	The meaning is according to the parameter 2.3.1 – binary speeds or binary combinations.
reverse	If binary input is switched on, it causes the change of the direction of motor rotation (if binary actuating is active (2.1.1)) and REVERSE function is enabled (parameter 2.2.1)).
acceleration	If binary input is switched on, it causes arising of motor revolutions (if it is chosen „BIN motor-potent." in parameter 2.3.1.).
deceleration	If binary input is switched on, it causes decreasing of motor revolutions (if it is chosen „BIN motor-potent." in parameter 2.3.1). **This function is superior to „acceleration" function.**
terminal switch	the function of terminal switch, common to both directions of movement. It requires Start-Stop-Reverse actuating from binary inputs. (2.1.1) If BINx with this function is switched on, the converter decreases required speed to the value of parameter „Term. switch freq." (9.4.1). Computing the trajectory of running down: - the trajectory of running down is being set separately for positive and negative direction of motion in parameters "Term.switch path+" (9.4.2) and " Term.switch path-" (9.4.3) - the converter computes running down trajectory only if value of parameters (9.4.2) or (9.4.3) is not equal zero **- at zero running down trajectory the converter slows down to set frequency** - it is also necessary to set parameter „Position scale" (9.14.1) appropriately - the converter displays actual trajectory on its display in window MONITOR under "Running down" The following holds: - if the change of direction of rotation occurs, the converter makes the motor rotate at original value of revolutions - if supply failure and failure recovery occurs, the converter remembers the direction of terminal switch and the trajectory of running down, separately for each parameter set Automatic STOP: - if realized trajectory reaches the value set in parameter 9.4.2 or 9.4.3, the converter generates STOP - command STOP is being reset after direction change, the converter makes the motor rotate at original value of revolutions
fault acknowl.	If binary input is switched on, it causes fault confirmation providing that the converter is set to "confirm the fault" (parameter 10.3.1) after the fault.
inverters reset	If binary input is activated, it causes converter's RESET (motor voltage cut off). It is used as electronic emergency stop and it reacts within 52 ms.
SET of paramet.	If the converter is not in START mode, switching on binary input causes that the other set of parameters (SET2) is activated.
external fault	If binary input is switched on, it causes that converter's start is not enabled and „External fault" occurs.
position preset	If binary input is switched on, it causes that the value of real position is set according to parameter 9.4.3. If the converter is in MASTER mode, it transmits calibration command via serial link until the SLAVE confirms command receiving. It is recommended to use calibration at zero motion speed. *This command is being used at PRSS control or at active SW terminal switch.*

3.1.1 Function BIN1 atr = S+V

BINARY INPUTS,IRC – BIN1 default setting: **Start/Stop**

continue

REM/LOC control	This function enables to switch between various converter's actuating modes: input switched on – local actuating according to 2.1.2 and 2.3.2 parameters input switched off – remote actuating according to 2.1.1 and 2.3.1 parameters. It is possible to switch between actuating modes during converter's operation. Frequency changes smoothly in compliance with chosen ramp. Every time operating personnel switches between actuating modes, command Start from control panel (if it is switched on) terminates and required frequency is being set to minimal value.
quick STOP	Quick – emergency stop of the motor. The motor stops within shortened ramp down (deceleration) time period, which is being calculated by multiplying deceleration time (7.2.3 - 7.2.4) by parameter „Quick decel." (7.2.6). Activating of this command terminates command START from control panel or serial link.
terminal sw. +	the function of terminal switch exclusively for positive direction of motion. For details see option "**terminal switch**".
terminal sw. –	the function of terminal switch exclusively for negative direction of motion. For details see option "**terminal switch**".

3.1.2 Polarity BIN1 atr = S+V

BINARY INPUTS,IRC – BIN1 default setting: **switches ON- 24 V**

Logical polarity of binary input BIN1.

switches ON- 24 V	Binary input is switched on, if it is connected to the voltage +24 V.
switches ON- 0 V	Binary input is switched on, if it is connected to zero voltage or is disconnected.

3.2.1 Function BIN2 atr = S+V

BINARY INPUTS,IRC – BIN2 default setting: **acceleration**

3.2.2 Polarity BIN2 atr = S+V

BINARY INPUTS,IRC – BIN2 default setting: **switches ON- 24 V**

3.3.1 Function BIN3 atr = S+V

BINARY INPUTS,IRC – BIN3 default setting: **deceleration**

3.3.2 Polarity BIN3 atr = S+V

BINARY INPUTS,IRC – BIN3 default setting: **switches ON- 24 V**

3.4.1 Function BIN4 atr = S+V

BINARY INPUTS,IRC – BIN4 default setting: **converter's reset**

3.4.2 Polarity BIN4 atr = S+V

BINARY INPUTS,IRC – BIN4 default setting: **switches ON- 24 V**

3.5.1 Function BIN5 atr = S+V

BINARY INPUTS,IRC – BIN5 default setting: **fault confirmat.**

3.5.2 Polarity BIN5 atr = S+V

BINARY INPUTS,IRC – BIN5 default setting: **switches ON- 24 V**

3.6.1 Function BIN6 atr = S+V

BINARY INPUTS,IRC – BIN6 default setting: **reverse**

3.6.2 Polarity BIN6 atr = S+V

BINARY INPUTS,IRC – BIN6 default setting: **switches ON- 24 V**

3.7.1 IRC pulses/revol. atr = S+V

BINARY INPUTS,IRC – IRC/ARC default setting: **1024**

Recognition ability of speed encoder (in pulses per revolution). It depends on accuracy requirements.

range: (100 ÷ 65 000)

The following must hold for the number of pulses of IRC: $8*N_{IRC}*F_{MAX}*T_{VZ}/p < 32\ 768$

Quantisation error at speed regulation in [Hz]: $\Delta F = 1 / (4*N_{IRC} * T_{VZ})$

Relative error out of speed range in [%]: $p * \Delta F / (2*F_{MAX}) * 100$

N_{IRC} – the number of IRC pulses
F_{MAX} – max. frequency in Hz (par.9.3.2)
p – the number of poles (par. 1.6.1)

T_{VZ} = (13.1.5) * $200*10^{-6}$
speed regulator sampling

3.7.2 SMPM pos.calibrat. atr = V

BINARY INPUTS,IRC – IRC

COMMAND

This command activates IRC encoder calibration for synchronous motor with permanent magnets.

Motor's rotor must be unbraked and without any load during calibration !

Calibration procedure of IRC encoder consists of two stages:

1. stage - After command activation, the converter generates START. Motor is energized with DC current and so rotor is moved to pole centre.
2. stage – if incremental position encoder (IRC) is used, 14.6.1 = „none" :
   Motor is energized with current with low frequency (14.1.5). By rotor rotation, the converter is waiting for zero pulse (ZP) location from IRC encoder. The calibration procedure is finished after zero pulse location is found. Result of calibration is written into parameter 3.7.4.

We recommend to study an additional material for synchronous motor control.

3.7.3 0 pos. of encoder atr = S+V+R

BINARY INPUTS,IRC – IRC default setting: **0**

This parameter is useful at position calibration (9.4.4) when either IRC encoder is used. It reflects the difference between various positions within 1 revolution. It reflects the difference between calibrated position and IRC zero pulse.
Parameter range 0 ÷ 65535 corresponds to 0° ÷ 360°.

range: (0 ÷ 65535)

This parameter is automatically set by the execution of the command - „pos. calibration" in parameter 9.4.4. It is also set using binary input with the function "pos. calibration".

3.7.4 SMPM pole centre atr = S+V+R

BINARY INPUTS,IRC – IRC default setting: **0**

This parameter is useful at controlling synchronous motors. It enables simple calibration of IRC position encoder to the centre of motor magnetic pole.

range: (0 ÷ 65535)

This parameter is automatically set by the execution of a command in parameter 3.7.2.

ANALOGUE INPUTS

4.1.1 Requir.val. INV/PR atr = S+V

ANALOGUE INPUTS – Requir val. INV/PR default setting: **AIN1**

This parameter defines, which AIN input is the source of required value of a converter or a process regulator.
This option comes to practice, only if parameter 2.3.1 is equal to „analogue input“, „+/- AIN“, „AIN+bin.speed“.
Without process regulator means input AIN = 100% maximal value of regulated parameter – frequency, moment, position.

OPTIONS	
AIN1	the source of required value is input AIN1
AIN2	the source of required value is input AIN2
AIN3	the source of required value is input AIN3
AIN2-AIN3	the source of required value is the difference between inputs AIN2 – AIN3
max(AIN2,AIN3)	the source of required value is the higher value of inputs AIN2 and AIN3
AIN2+AIN3	the source of required value is the sum of inputs AIN2 and AIN3

4.2.1 AIN1 min. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **0.0 %**

This parameter defines the final value of input AIN1 in [%], if input signal is 0V (2V). For more information about calculating this parameter see folowing picture and table.

range: (-500.0 % ÷ 500.0 %)

4.2.2 AIN1 max. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **100.0 %**

This parameter defines the final value of input AIN1 in [%], if input signal is 10V. For more information about calculating this parameter see folowing picture and table.

range: (-500.0 % ÷ 500.0 %)

4.2.3 AIN2 min. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **0.0 %**

This parameter defines the final value of input AIN1 in [%], if input signal is 0mA (4mA). For more information about calculating this parameter see folowing picture and table.

range: (-500.0 % ÷ 500.0 %)

4.2.4 AIN2 max. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **100.0 %**

This parameter defines the final value of input AIN1 in [%], if input signal is 20mA. For more information about calculating this parameter see folowing picture and table.

range: (-500.0 % ÷ 500.0 %)

4.2.5 AIN3 min. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **0.0 %**

Parameter description is identical with 5.1.1 parameter description.

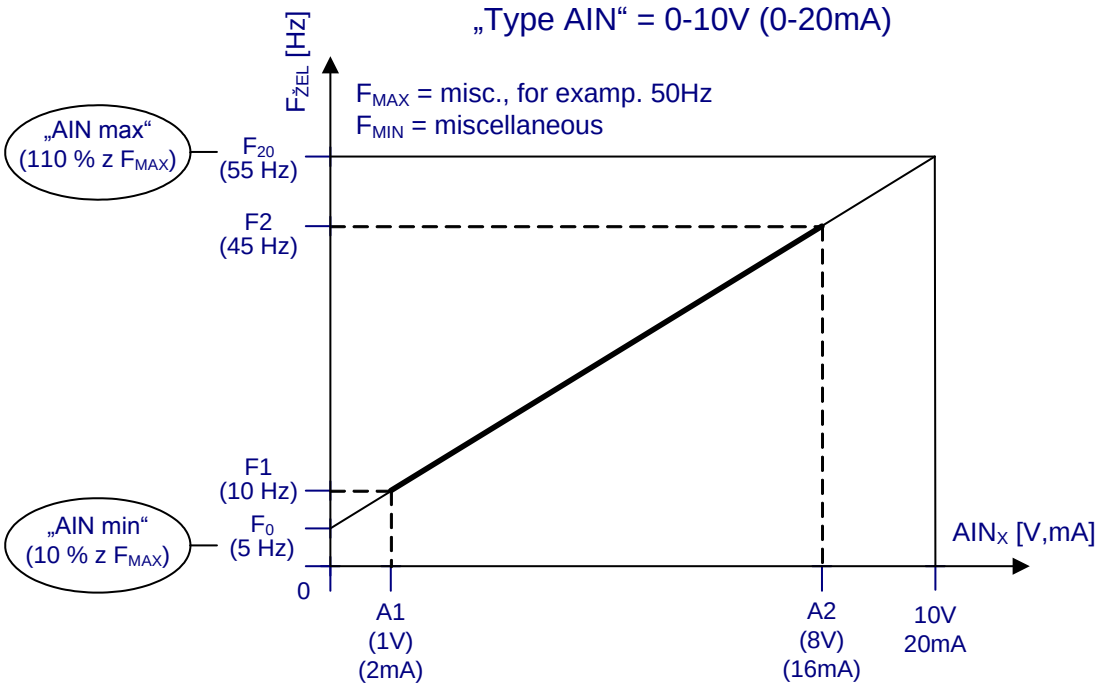
range: (-500.0 % ÷ 500.0 %)

4.2.6 AIN3 max. atr = S+V+R

ANALOGUE INPUTS – Range of AIN default setting: **100.0 %**

Parameter description is identical with 5.1.1 parameter description.

range: (-500.0 % ÷ 500.0 %)



Examples:

By A1 = 2mA should F1 = $F_{ŽEL}$ = 10Hz
By A2 = 16mA should F2 = $F_{ŽEL}$ = 45Hz
F_{MIN} = miscellaneous, F_{MAX} = misc., for examp. 50Hz

Result:
„AINmin“ = 10,0%, „AINmax“ = 110,0%

„Type AIN“ = 0÷10V (0÷20mA) ..... 0V (0mA) means AIN = 0,0%

Examples of measures $F_{ŽEL}$	„AIN min“ [%]	„AIN max“ [%]	Note
by A1 = 0mA should be F1 = $F_{ŽEL}$ = 0Hz by A2 = 20mA should be F2 = $F_{ŽEL}$ = Fmax	0,0 %	100,0 %	0 till Fmax
by A1 = 0mA should be F1 = $F_{ŽEL}$ = Fmin by A2 = 20mA should be F2 = $F_{ŽEL}$ = Fmax	Fmin / Fmax * 100 %	100,0 %	Fmin till Fmax
by A1 = 20mA should be F1 = $F_{ŽEL}$ = Fmax by A2 = 0mA should be F2 = $F_{ŽEL}$ = Fmin	100,0 %	Fmin / Fmax * 100 %	Fmax till Fmin, (inverse char.)
by A1 = 0mA should be F1 = $F_{ŽEL}$ = – ¾ Fmax by A2 =20mA should be F2 = $F_{ŽEL}$ = + ¾ Fmax	– ¾ * 100 %	+ ¾ * 100 %	par. 2.3.1 = „+/– AIN“
by A1(mA) should be F1(Hz) = $F_{ŽEL}$ by A2(mA) should be F2(Hz) = $F_{ŽEL}$	F_0 / Fmax * 100 % F_0 = F1 – A1 * K_{AIN}	F_{20} / Fmax * 100 % F_{20} = F1+(20–A1)*K_{AIN}	K_{AIN} = (F2–F1)/(A2–A1)

„Type AIN“ = 2÷0V (4÷0mA) ..... 2V (4mA) means AIN = 0,0%

Examples of measures $F_{ŽEL}$	„AIN min“ [%]	„AIN max“ [%]	Note
by A1 = 4mA should be F1 = $F_{ŽEL}$ = 0Hz by A2 = 20mA should be F2 = $F_{ŽEL}$ = Fmax	0,0 %	100,0 %	0 till Fmax
by A1 = 4mA should be F1 = $F_{ŽEL}$ = Fmin by A2 = 20mA should be F2 = $F_{ŽEL}$ = Fmax	Fmin / Fmax * 100 %	100,0 %	Fmin till Fmax
by A1(mA) should be F1(Hz) = $F_{ŽEL}$ by A2(mA) should be F2(Hz) = $F_{ŽEL}$	F_0 / Fmax * 100 % F_0 = F1+(4–A1)*K_{AIN}	F_{20} / Fmax * 100 % F_{20} = F1+(20–A1)*K_{AIN}	K_{AIN} = (F2–F1)/(A2–A1)

4.3.1 Feedback PR

atr = S+V

ANALOGUE INPUTS – Feedback PR default setting: **AIN2**

It defines the source of signal for process regulator's feedback. It means, which AIN input will scan the real value of process variable.

OPTIONS	
AIN1	process variable is scanned by input AIN1
AIN2	process variable is scanned by input AIN2
AIN3	process variable is scanned by input AIN3
AIN2-AIN3	process variable is a difference between inputs AIN2 – AIN3
max(AIN2,AIN3)	process variable is the higher value of inputs AIN2 and AIN3
AIN2+AIN3	process variable is the sum of inputs AIN2 and AIN3

4.4.1 Type AIN1

atr = S+V

ANALOGUE INPUTS – AIN1 default setting: **0÷10 V**

Type selection of analogue input 1.

OPTIONS	
0÷10V	voltage input ranging from 0 ÷ 10 V. Value 0V represents AIN = 0%.
2÷10V	voltage input ranging from 2 ÷ 10 V. Value 2V represents AIN = 0%. *If voltage decreases under 1V, fault "AIN 1 disconn." is activated.* *The fault does not occur, if signal decreases for the period shorter than the period according to the parameter „Filter AIN1".*

4.4.2 Filter AIN1

atr = S+V+R

ANALOGUE INPUTS – AIN1 default setting: **0.10 s**

Defines the filter time constant for analogue input AIN1.

range: (0.01 s ÷ 10.00 s)

It is used for noise reducing and reducing of disturbing peaks, which come from the environment to analogue input 1.

4.5.1 Type AIN2

atr = S+V

ANALOGUE INPUTS – AIN2 default setting: **0÷20mA**

Type selection of analogue input 2.

OPTIONS	
0÷20mA	voltage input ranging from 0 ÷ 20 mA. Value 0mA represents AIN = 0%
4÷20mA	voltage input ranging from 4 ÷ 20 mA. Value 4mA represents AIN = 0% *If current decreases under 2 mA, fault "AIN 2 disconn." is activated. The fault does not occur, if signal decreases for the period shorter than the period according to the parameter „Filter AIN2".*

4.5.2 Filter AIN2

atr = S+V+R

ANALOGUE INPUTS – AIN2 default setting: **0.10 s**

Defines the filter time constant for analogue input AIN2.

The range of values is the same as for parameter „Filter AIN1" 4.4.2.

4.6.1 Type AIN3

atr = S+V

ANALOGUE INPUTS – AIN3 default setting: **0÷20mA**

Type selection of analogue input 3.

Options and their meanings are the same as options of parameter „Type AIN2" 4.5.1 .

4.6.2 Filter AIN3

atr = S+V+R

ANALOGUE INPUTS – AIN3 default setting: **0.10 s**

Defines the filter time constant for analogue input AIN3.

The range of values is the same as for parameter „Filter AIN1" 4.4.2 .

RELAY OUTPUTS

5.1.1 Function RELAY1 atr = S+V

RELAY OUTPUTS – RELAY1 default setting: **ON, motor running**

OPTIONS Condition selection for actuation of RELAY1-binary output.

ON, motor running	relay is switched on, if motor is running.
ON, invert. READY	relay is switched on, if the converter is ready to execute START command. Relay remains switched off, if: - Initialization is in progress after converter being connected to the power supply - converter Parameterization is being active (after switching between sets of parameters, after parameters change) - operating personnel works in window PARAMETERS or in Language window - the converter experienced an error and waits for error confirmation - Trial period of converter operation has terminated - converter's RESET is active (from BIN input, from serial link command, at communication error) - internal converter's Stop is active, e.g. earning „W18 communication" is displayed at communication error - internal converter's Start is active, e.g. after activating motor identification
ON - fault	relay is switched on, if some converter's fault has occurred.
OFF - fault	relay is switched off, if some converter's fault has occurred.
ON - warning	relay is switched on, if some of the warnings from parameters 5.6.1 and 5.6.2 occurred.
ON from AIN1	relay is switched on, if the value of AIN1 exceeds the limit according to par.5.1.2.
ON from AIN2	relay is switched on, if the value of AIN1 exceeds the limit according to par.5.1.2.
ON from frequency	relay is switched on, if converter's frequency exceeds the limit according to par.5.1.2 from Fmax (par.9.3.2)
ON from req.value	relay is switched on, if converter's required value in [%] exceeds the limit according to par. 5.1.2
brake, ON/OFF	relay controls motor brake. Relay is switched on after converter's start, after the converter reaches the frequency **Fbr** (5.4.3), after the time **Tbd** (5.4.1). If converter's frequency reaches **Fbr** at the stop, relay is switched off but the voltage will remain in the motor until the time **Tba** (5.4.2) expires. During the time **Tba** (5.4.2), the converter keeps the frequency at **Fbr** (5.4.3). See the picture no. 1. *This solution prevents falling of a load at lifting drives with electro-hydraulic brake.*
cascade 1	relay of cascades 1, 2 and 3 is switched on, if motor's frequency levels off at maximal value (par. 9.3.2) for a period longer than period in par. 5.5.1. Relay of cascades 1, 2 and 3 is switched off, if motor's frequency levels off at minimal value (par. 9.3.1) for a period longer than period in par. 5.5.2. *<u>At the same time, the following holds:</u>* - relay with function cascade 1 switches off, if cascade 2 is already switched off. - relay with function cascade 2 switches on, if cascade 1 is already switched on. - relay with function cascade 2 switches off, if cascade 3 is already switched off. - relay with function cascade 3 switches on, if cascade 2 is already switched on. *In a case that only two cascades are chosen, e.g. 2 and 3, the remaining does not have influence on their operation (cascade 2 does not wait for non existing cascade 1). At converter's stop, failure and reset each cascade is switched off. Converter's sleep function is activated, providing cascades are switched off.*
cascade 2	
cascade 3	
ON, Finv=Fref	relay is switched on, if converter's frequency reaches required (reference) value. It means, if the frequency stabilizes.
ON from PROFIBUS	relay is switched on, if 11th bit is set to level „1" in PROFIBUS control word.

5.1.1 Function RELAY1 atr = S+V

RELAY OUTPUTS – RELAY1 default setting: **ON, motor running**

OPTIONS Continue

OFF, overload	Electronic overloading switch for lifting drives. See parameters 5.7.1 and 5.7.6. 1) The limit value of overload is being set in parameter (5.7.1) "Static overload" and (5.7.2) "Total overload" in [%]. Values is proportional to motor moment. 2) Momentary value of overload is displayed at converter's display in [%], and helps setting the limit value. 3) After motor start the converter tolerates overload during preset time according to par.5.7.3 "Toler. START". If RELAY Brake is set, the converter tolerates overload from the moment of switching on RELAY Brake. 4) If operating personnel set STOP during the time described above, the converter remembers this operation. After repeating this operation 4 times, the converter switches off the RELAY into "overload" status. 5) During upward lifting operation the converter tolerates overload during the time set in parameter (5.7.4) " Time,Static overl." and (5.7.5) " Time,total overl.". 6) If overload exceeds the set value in [%] during preset time, the converter switches off RELAY "overload". The converter expects this RELAY to switch off Start at upward direction and to terminate load lifting. The converter by itself does not give the command Stop if overload occurs. 7) Simultaneously, the converter computes estimated trajectory, during which the lifting drive has operated in overload till motor switched off. The lifting drive must realize downward operation with the load by this trajectory in order to reset overload. During load launching by active overload, the speed is limited on a value of Terminal switch frequency (9.4.1). Attention, the value can be not set on 0 ! 8) Data relating to overload states, trajectory during overload and number of quick Start/Stop are being recorded into the EEPROM memory during Undervoltage or Parameterization. If function 'Overload' is not set, data in EEPROM resets after Initialisation / Parameterization. 9) The overload status can be aborted by the command in parameter "Abort overload".
pump rotate	Relay changes its status at every motor shutdown applied from STOP command. It changes its status also when a fault occurs, command converter's reset is chosen or at process regulator parking. If there are more pumps, motors of individual pumps alternates between themselves at each change of relay status. The use of this function (motor alternation) results in balanced pumps wear and tear. Relay with this function represents auxiliary relay intended for another contactors connection.

5.1.2 Value RELAY1 atr = S+V+R

RELAY OUTPUTS – RELAY 1 default setting: **20.0 %**

The limit value for actuation of RELAY 1. The value represents variable set in parameter "Function RELAY 1". The variable can be the value of AIN1, AIN2, AIN3, required value or converter frequency. There are two options at variable frequency.

If there is control without feedback (scalar opened, vector AM opened), it represents stator frequency.
If there is control with feedback, it represents rotor frequency (values from the sensor).

RELAY switches on, if the value of variable reaches preset percentage of its maximal value.

range: (0.0 % ÷ 100.0 %)

Example:

Let switch on the relay depending on frequency. Fmax = 50.00 Hz. Relay should switch on at 45.00 Hz. Thereafter "Value RELAY1" = 90,0 %.

5.1.3 Hyst. RELAY1

atr = S+V+R

RELAY OUTPUTS – RELAY 1

default setting: **5.0 %**

The value of this parameter represents hysteresis out of the scale of selected variable in percentage. RELAY 1 switches off, if the variable representing the value of parameter 5.1.2 decreases by value of "Hyst. RELAY1".

If the hysteresis is greater than "Value RELAY", the Relay remains constantly switched on.

range: (0.0 % ÷ 100.0 %)

Example:

Let switch on the relay depending on frequency. Fmax = 50.00 Hz. Relay should switch off at 42.50 Hz. Thereafter "Hyst. RELAY1" = 5,0 %.

5.2.1 Function RELAY2

atr = S+V

RELAY OUTPUTS – RELAY2

default setting: **ON - fault**

Parameter description is identical with 5.1.1 parameter description.

5.2.2 Value RELAY2

atr = S+V+R

RELAY OUTPUTS – RELAY2

default setting: **50.0 %**

Parameter description is identical with 5.1.2 parameter description.

range: (0.0 % ÷ 100.0 %)

5.2.3 Hyst. RELAY2

atr = S+V+R

RELAY OUTPUTS – RELAY2

default setting: **5.00 %**

Parameter description is identical with 5.1.3 parameter description.

range: (0.0 % ÷ 100.0 %)

5.2.4 RE2-ON,delay

atr = S+V+R

RELAY OUTPUTS – RELAY 2

default setting: **0.0 s**

Delay time of RELAY 2 switching on from all its functions. It substitutes time relay.

range: (0.0 s ÷ 60.0 s)

5.2.5 RE2-OFF,delay

atr = S+V+R

RELAY OUTPUTS – RELAY 2

default setting: **0.0 s**

Delay time of RELAY 2 switching off from all its functions. It substitutes time relay.

range: (0.0 s ÷ 60.0 s)

5.3.1 Function RELAY3

atr = S+V

RELAY OUTPUTS – RELAY3

default setting: **ON, converter READY**

Parameter description is identical with 5.1.1 parameter description.

5.3.2 Value RELAY3

atr = S+V+R

RELAY OUTPUTS – RELAY3

default setting: **70.0 %**

Parameter description is identical with 5.1.2 parameter description.

5.3.3 Hyst. RELAY3

atr = S+V+R

RELAY OUTPUTS – RELAY3

default setting: **5.00 %**

Parameter description is identical with 5.1.3 parameter description.

5.4.1 Brake delay

atr = S+V+R

RELAY OUTPUTS – Brake default setting: **1.0 s**

Delay time of motor brake deactivation.

range: (0.1 s ÷ 300.0 s)

Delay time is the time of brake later deactivation at drive's start. It can be better understood from the picture in par. 5.4.3. For more information see the option „brake ON/OFF. " in parameter 5.1.1.

5.4.2 Brake advance

atr = S+V+R

RELAY OUTPUTS – Brake default setting: **1.0 s**

Advance time of brake activation.

range: (0.1 s ÷ 300.0 s)

Brake advance is the time of brake earlier activation, before the converter disconnects the voltage from motor at drive's stop. It can be better understood from the picture in par. 5.4.3. For more information see the option „brake ON/OFF." in parameter 5.1.1.

5.4.3 Brake frequency

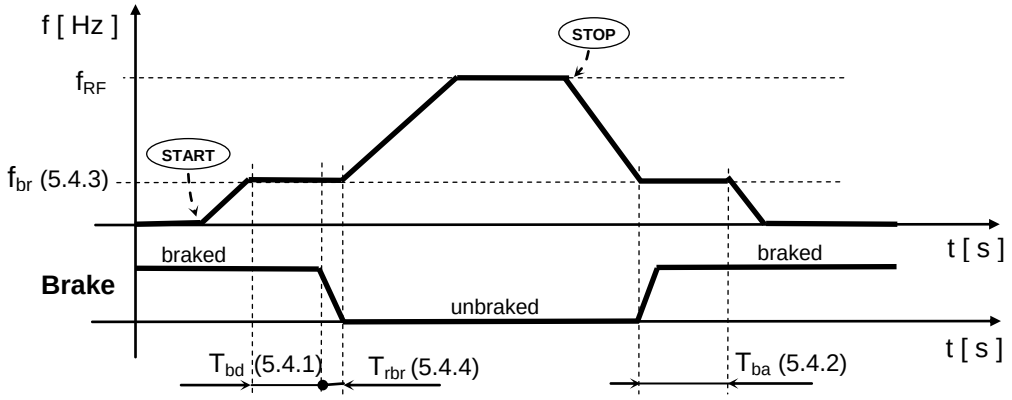
atr = S+V

RELAY OUTPUTS – Brake default setting: **3.00 Hz**

Frequency (Fbr), at which the electromagnetic motor brake is switched on and off.

range: (0.00 Hz ÷ 10.00 Hz)

Fbr should be set in the range from 1 Hz to 10 Hz at scalar control mode and around the value 0Hz at vector speed and position control mode with the feedback.



The function of electro-hydraulic motor brake that is controlled by a RELAY.

5.4.4 Break react. time

atr = S+V

RELAY OUTPUTS – Brake default setting: **T_{rbr} = 0.2 s**

The parameter reflects the real time of brake release after switching on RELAY „brake".

range: (0.0 s ÷ 5.0 s)

Parameter eliminates disturbing amplitude of required torque of speed regulator. This amplitude is caused by the delay of real motor unbraking from RELAY switching on. It can be better understood from the picture in par. 5.4.3.

5.5.1 Relay ON af Fmax

atr = S+V+R

RELAY OUTPUTS – Delay in cascade default setting: **60.0 s**

Time between the first occurrence of RELAY frequency condition – "cascade X" and the real relay switching on.

You can find detailed description of cascade control in parameter „Function RELAY1".

range: (0.1 s ÷ 999.9 s)

5.5.2 Relay OFF at Fmin

atr = S+V+R

RELAY OUTPUTS – Delay in cascade default setting: **60.0 s**

Time between the expiration of RELAY frequency condition – "cascade X" and the real relay switching off.

range: (0.1 s ÷ 999.9 s)

5.6.1 Relay – warnings 1

atr = S+V+R

RELAY OUTPUTS – Warning choice default setting: **0**

Logic mask of warnings. These warnings affect switching on of RELAY with „ON, warning" function.

range: (0 ÷ 65 535)

Parameter's value = the sum of individual values of warning masks according this table :

Warning / Functional cautions	Mask	Warning / Functional cautions	Mask
some warnings W1, W2, W3, W4, W5	**1**	F8 dynam.rump down	**256**
W6 temp. of cooler	**2**	W16 motor temp.	**512**
W7 IRC/ARC failure	**4**	W17 external panel	**1024**
W8 direct. IRC/ARC	**8**	F2 current limit	**2048**
F7 time PWM off/on	**16**	F3 kinetic backup	**4096**
W12 saturated PR	**32**	F4 flying start	**8192**
F9 position preset F10 search ZP-IRC	**64**	F5 parking PR	**16 384**
F11 SW terminal switch	**128**	F6 braking unit is active	**32 768**

5.6.2 Relay – warnings 2

atr = S+V+R

RELAY OUTPUTS – Warning choice default setting: **0**

Logic mask of warnings. These warnings affect switching on of RELAY with „ON, warning" function.

range: (0 ÷ 65 535)

Parameter's value = the sum of individual values of warning masks according this table :

Warning / Functional cautions	Mask	Warning / Functional cautions	Mask
W23 disconnect.MT	**1**	F14 autotuning	**32**
F12 termin. switch	**2**	W25 temp. in INV	**64**
F13 flux braking	**4**	reserved	**128**
W9 input phase	**8**	W18 communication RS232(485)	**256**
reserved [(1)]	**16**	F16 relay-overload	**512**

[(1)] it has the same meaning as „ AIN disconnected" VQFREM 500 converters

5.7.1 Static overload

atr = S+V+R

RELAY OUTPUTS – Overload default setting: **100.0 %**

Overload limit value by **stabilized lifting speed** in positive direction (up). In order to set this parameter correctly, it is useful to check variable "(33) Overload" on converter's display. The value reflects momently overload value, which is proportional to motor moment.

range: (0.0 % ÷ 500.0 %)

5.7.2 Total overload

atr = S+V+R

RELAY OUTPUTS – Overload default setting: **150.0 %**

Overload limit value by **run up and run down** in positive direction (up). In order to set this parameter correctly, it is useful to check variable "(33) Overload" on converter's display. The value reflects momently overload value, which is proportional to motor moment..

range: (0.0 % ÷ 500.0 %)

5.7.3 Toler. START

atr = S+V

RELAY OUTPUTS – Overload default setting: **500 ms**

Time during which the converter tolerates overload exceeding preset value. Time begins to expire from the moment of motor unbraking by function RELAY Brake. If this function is not set, time begins to expire from the moment of voltage connection to motor.

range: (0 ms ÷ 10 000 ms)

It is necessary to use this parameter because there is short time torque impact during load unbraking.

5.7.4 Time, Static overl.

atr = S+V

RELAY OUTPUTS – Overload default setting: **1.00 s**

Time during which the converter tolerates overload exceeding preset value according to par. „Static overload". This time should be calculated just by **stabilized speed** during load lifting from the moment when overload exceeds preset limit (At any time after "Toler.START" expires). Time is reset, if overload decreases under preset limit. Overload status occurs if overload prevails longer than time according to this parameter.

range: (0.00 s ÷ 50.00 s)

5.7.5 Time, Total overl.

atr = S+V

RELAY OUTPUTS – Overload default setting: **1.00 s**

Period, when converter alows overload over predetermined limit accordint to par. „Total overload". This period should be caldulated just by **run up and run down** during lifting the load, when overload rise over predetermined limit. (After expiration of time „Toler.START") Time period are accumulative, even though overload sink below predetermined limit. Overload occures, when sum of periods overreach value according to this parameter. By this, the lift is protected from high load tripping.

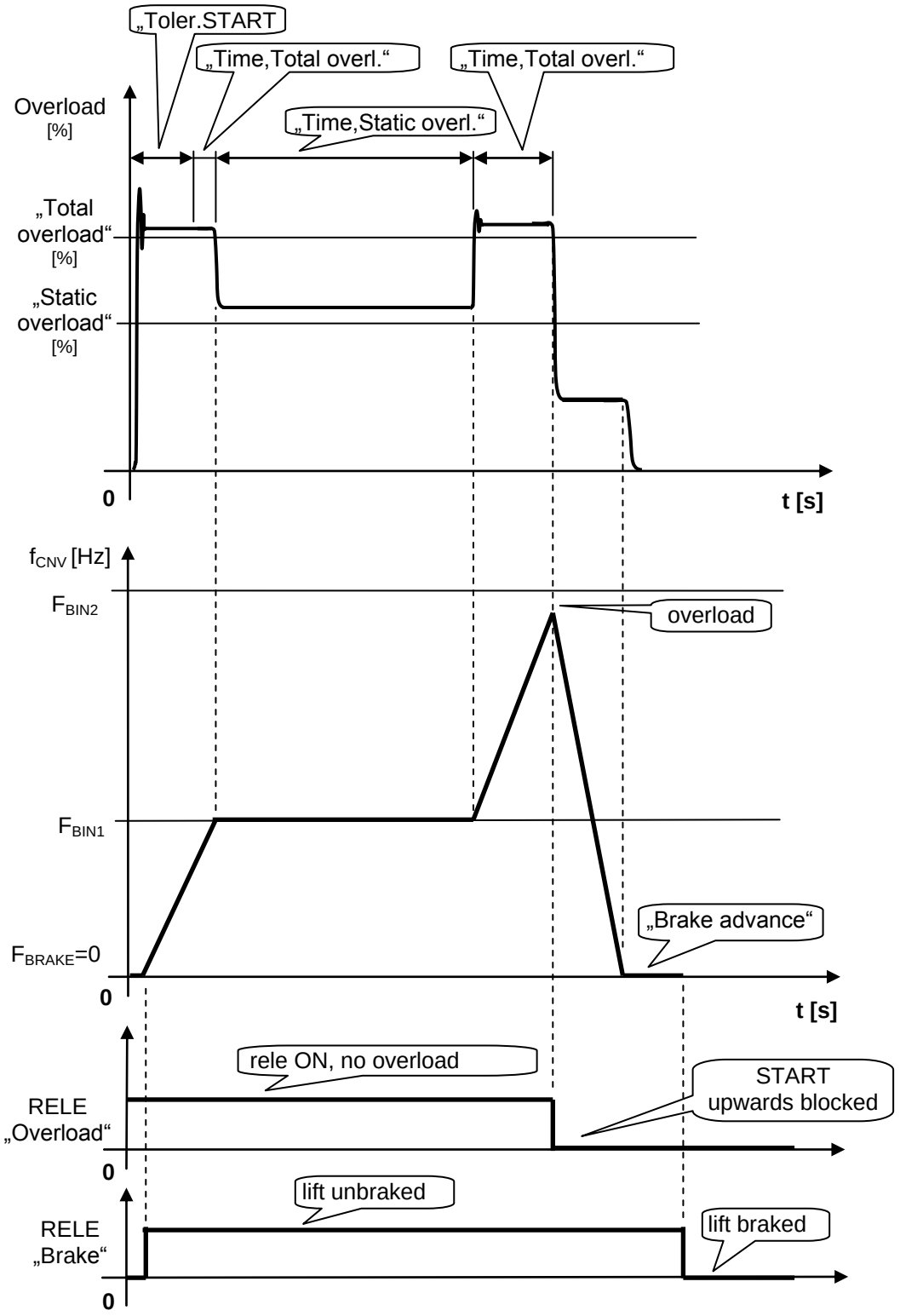
range: (0.00 s ÷ 50.00 s)

5.7.6 Cancel overload

atr = S+V

RELAY OUTPUTS – Overload

COMMAND This command aborts overload status. Simultaneously, it deletes overload data in converter's EEPROM.



Example: Overload behaviour during load lifting

ANALOGUE OUTPUTS

6.1.1 Function AOUT1

atr = S+V+R

ANALOGUE OUTPUTS – AOUT1 default setting: **CNV frequency**

OPTIONS Selection of the variable, which value is transmitted on AOUT1.

INV frequency	is equivalent to momental converter's frequency in proportion to max. frequency (see. par. 9.3.2) in range according parameters 6.1.3 and 6.1.4.
INV current	output is equivalent to momental converters current in proportion to double nomin. Output current of current for constant (linear) load - I_{nL} (see „TECHNICAL DATA"), in range according to par. 6.1.3. and 6.1.4.)
motor torque	output is equivalent to momental motor moment in proportion to max. moment (see par. 9.9.1), in range according to par. 6.1.2 and 6.1.4
motor power	is equivalent to momental motor power in proportion to nominal motor power (see par.1.1.1) in range according to par. 6.1.3 and 6.1.4.)
sensor PT100	constant value of 10 mA output which represents current source for PT100 sensor serving for motor thermal protection, see par. (10.2.4)
AOUT – RELAY4	RELAY, which is connected between I_{OUT1} and GND2 (I_{OUT2} and GND2) terminals is being switched on by current of 20mA
service var. SL	it is used for service purposes – for variables monitoring of SLAVE processor
service var. MS	it is used for service purposes – for variables monitoring of MASTER processor

Options of „service. var. SL" and „service. var. MS" are used for variables testing.

6.1.2 Type AOUT1

atr = S+V+R

ANALOGUE OUTPUTS – AOUT1 default setting: **0÷20mA, 0÷MAX**

OPTIONS The type of converter's analogue output AOUT1.

0÷20mA, 0÷MAX	output 0÷20mA is equivalent to aboslute value of parameter (chosen according to par. 6.1.1.) Value of parameter necesary for AOUT=0mA and 20mA are defined by parameters 6.1.3. a 6.1.4.
4÷20mA, 0÷MAX	output 4÷20mA is equivalent to aboslute value of parameter (chosen according to par. 6.1.1.) Value of parameter necesary for AOUT=4mA and 20mA are defined by parameters 6.1.3. a 6.1.4.
0÷20mA, -MAX÷MAX	output 0÷20mA is equivalent to negative and positive value of parameter (chosen according to par. 6.1.1.) Value of parameter necesary for AOUT=0mA and 20mA defines parameter 6.1.4. Value of parameter necesary for AOUT=10mA defines parameter 6.1.3.
4÷20mA, -MAX÷MAX	output 4÷20mA is equivalent to negative and positive value of parameter (chosen according to par. 6.1.1.) Value of parameter necesary for AOUT=4mA and 20mA defines parameter 6.1.4. Value of parameter necesary for AOUT=12mA defines parameter 6.1.3.

6.1.3 AOUT1 min.

atr = S+V+R

ANALOGUE OUTPUTS – AOUT1

prednastavene: **0.0 %**

Output is AOUT1=0mA (4mA) exactly by ***Relative value*** equal to value in this parameter. For more information about calculating this parameter see following tables and picture.

range: (0.0 % ÷ 200.0 %)

6.1.4 AOUT1 max.

atr = S+V+R

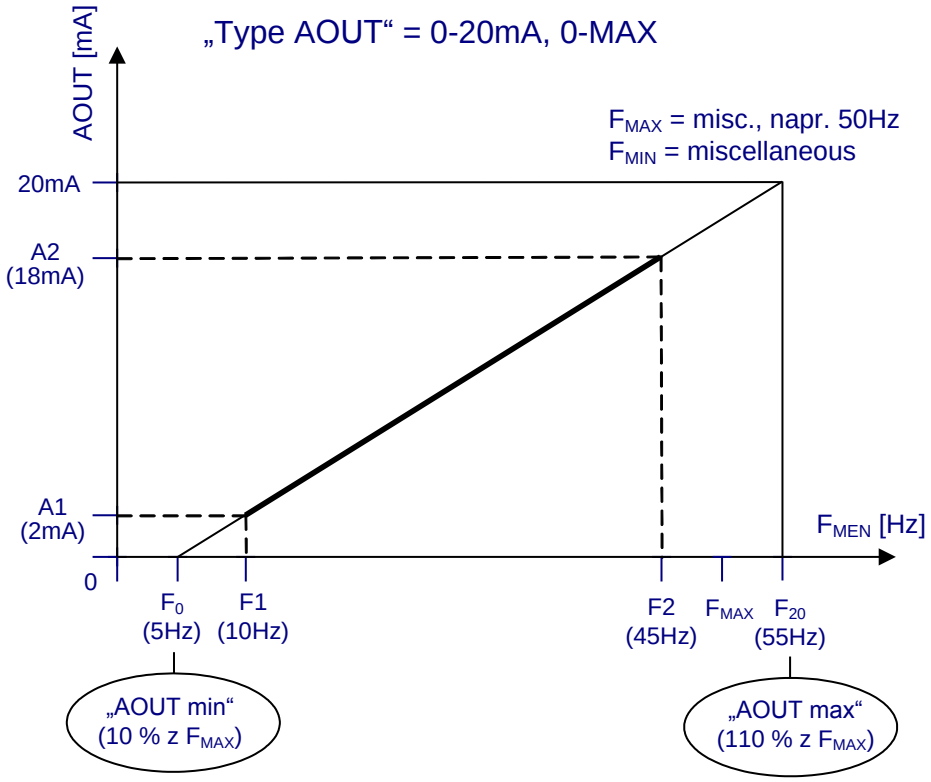
ANALOGUE OUTPUTS – AOUT1

prednastavene: **100.0 %**

Output is AOUT1=20mA exactly by ***Relative value*** equal to value in this parameter. For more information about calculating this parameter see following tables and picture.

range: (0.0 % ÷ 200.0 %)

„Function AOUT1“ (par. 6.1.1.)		**Relative value**	
„freq. Converter“	freq. converters / Max.freq.	* 100 %	(Max. freq. = par. 9.3.2)
„converters current“	converters current / $2xI_{NL}$	* 100 %	(I_{NL} = see „TECHNICAL DATA“)
„motor moment“	motor moment / Max.moment	* 100 %	(Max.moment = par. 9.9.1)
„motor power“	motor power / Nominal power	* 100 %	(Nominal power = par. 1.1.1)



Example:

by F_{MEN} = F1 = 10Hz should A1 = 2mA
by F_{MEN} = F2 = 45Hz should A2 = 16mA
F_{MIN} = miscellaneous, F_{MAX} = 50Hz

Result:
„AOUT min“ = 10,0%, „AOUT max“ = 110,0%

„Type AOUT“ = 0÷20mA, 0÷MAX

Examples of measures F_{MEN}	„AOUT min“ [%]	„AOUT max“ [%]	Note
by F1(Hz) = 0Hz should be A1 = 0mA by F2(Hz) = Fmax should be A2 = 20mA	0,0 %	100,0 %	0 till Fmax
by F1(Hz) = Fmin should be A1 = 0mA by F2(Hz) = Fmax should be A2 = 20mA	Fmin / Fmax * 100 %	100,0 %	Fmin till Fmax
by F1(Hz) = Fmax should be A1 = 20mA by F2(Hz) = Fmin should be A2 = 0mA	100,0 %	Fmin / Fmax * 100 %	Fmax till Fmin, (inverse char.)
by F_{MEN} = F1(Hz) should be A1 (mA) by F_{MEN} = F2(Hz) should be A2 (mA)	F_0 / Fmax * 100 % F_0 = F1 – A1 * K_{AO}	F_{20} / Fmax * 100 % F_{20} = F1+(20–A1)*K_{AO}	K_{AO} = (F2–F1)/(A2–A1)

„Type AOUT“ = 4÷20mA, 0÷MAX

Examples of measures F_{MEN}	„AOUT min“ [%]	„AOUT max“ [%]	Note
by F1(Hz) = 0Hz should be A1 = 4mA by F2(Hz) = Fmax should be A2 = 20mA	0,0 %	100,0 %	0 till Fmax
by F1(Hz) = Fmin should be A1 = 4mA by F2(Hz) = Fmax should be A2 = 20mA	Fmin / Fmax * 100 %	100,0 %	Fmin till Fmax
by F_{MEN} = F1(Hz) should be A1 (mA) by F_{MEN} = F2(Hz) should be A2 (mA)	F_0 / Fmax * 100 % F_0 = F1+(4–A1)*K_{AO}	F_{20} / Fmax * 100 % F_{20} = F1+(20–A1)*K_{AO}	K_{AO} = (F2–F1)/(A2–A1)

„Type AOUT“ = 0÷20mA, –MAX÷MAX

Examples of measures F_{MEN}	„AOUT min“ [%]	„AOUT max“ [%]	Note
by –F2(Hz) = –Fmax should be A2 = 0mA by F1(Hz) = 0Hz should be A1 = 10mA by +F2(Hz) = +Fmax should be A2 = 20mA	0,0 %	100,0 %	– Fmax till Fmax
by –F2(Hz) = –Fmax should be A2 = 0mA by F1(Hz) = +/–Fmin should be A1 = 10mA by +F2(Hz) = +Fmax should be A2 = 20mA	Fmin / Fmax * 100 %	100,0 %	–Fmax ÷ –Fmin +Fmin ÷ +Fmax
by –F2(Hz) should be A2 (≥0mA) by –F1(Hz) should be A1 (≤10mA) by +F1(Hz) should be A1 (≥10mA) by +F2(Hz) should be A2 (≤20mA)	F_0 / Fmax * 100 % F_0 =| F1|+(10–A1)*K_{AO}	F_{20} / Fmax * 100 % F_{20} = | F1|+(20–A1)*K_{AO}	K_{AO} = (|F2|–|F1|) / / (A2–A1)

6.2.1 Function AOUT2

atr = S+V+R

ANALOGUE OUTPUTS – AOUT2 default setting: **CNV current**

OPTIONS Selection of the variable, which value is transmitted on AOUT2.

Options and their meanings are identical with the options of „Function AOUT1“ parameter (6.1.1).

6.2.2 Type AOUT2

atr = S+V+R

ANALOGUE OUTPUTS – AOUT2 default setting: **0÷20mA, 0÷max.**

OPTIONS The type of converter's analogue output AOUT2.

Options and their meanings are identical with the options of „Type AOUT1“ parameter (6.1.2).

6.2.3 AOUT2 min.

atr = S+V+R

ANALOGUE OUTPUTS – AOUT2 prednastavene: **0.0 %**

Output is AOUT2=0mA (4mA) exactly by ***Relative value*** equal to value in this parameter. For more information about calculating this parameter see previous tables and picture.

range: (0.0 % ÷ 200.0 %)

6.2.4 AOUT2 max.

atr = S+V+R

ANALOGUE OUTPUTS – AOUT2 prednastavene: **100.0 %**

Output is AOUT2=20mA exactly by ***Relative value*** equal to value in this parameter. For more information about calculating this parameter see previous tables and picture.

range: (0.0 % ÷ 200.0 %)

6.3.1 Function RELAY4

atr = S+V

ANALOGUE OUTPUTS – AOUT-RELAY4 default setting: **ON, Finv = Fref**

Parameter description is identical with 5.1.1 parameter description.

6.3.2 Value RELAY4

atr = S+V+R

ANALOGUE OUTPUTS – AOUT-RELAY4 default setting: **50.0 %**

Parameter description is identical with 5.1.2 parameter description.

range: (0.0 % ÷ 100.0 %)

6.3.3 Hyst RELAY4

atr = S+V+R

ANALOGUE OUTPUTS – AOUT-RELAY4 default setting: **5.0 %**

Parameter description is identical with 5.1.3 parameter description.

range: (0.0 % ÷ 100.0 %)

RAMP UP, RAMP DOWN

7.1.1 Ramp up, Ramp down

atr = S+V

RAMP UP, RAMP DOWN – Style default setting: **time ramps**

OPTIONS Selection of a mode of acceleration and deceleration.

dynamic	the converter regulates the frequency with maximal dynamics **(only in a case of vector mode 11.1.1)**, which is given by torque (9.9.2) limit and current (9.10.1) limit.
time ramps	acceleration/start and deceleration/running down of frequency at linear time ramps (see parameters 7.2.1 – 7.2.4).
„S“ curve	acceleration/start and deceleration/running down of frequency smoothly by „S“ curve. Maximal steepness in the middle of “S” curve is 2 times higher than the steepness of linear ramps (see parameters 7.2.1 – 7.2.4)

Warning: if you choose dynamic acceleration/deceleration, acceleration time and deceleration time is given only by moment of inertia and maximal motor torque.

7.1.2 Profile „S“ curve

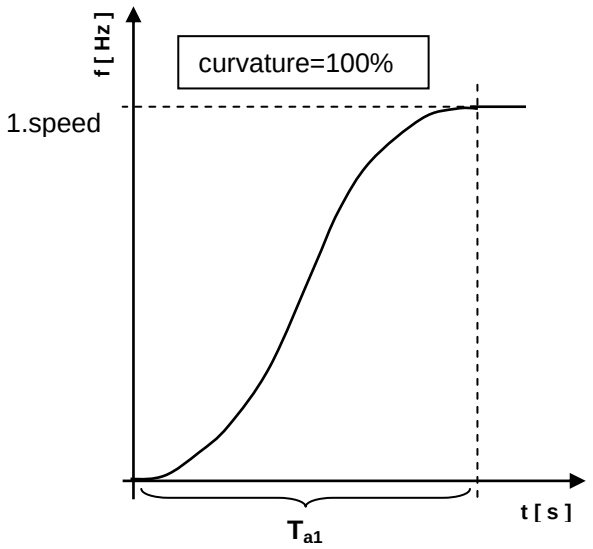
atr = S+V+R

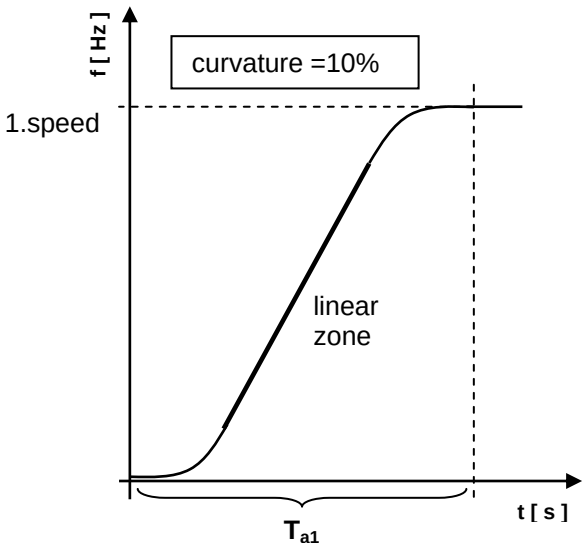
RAMP UP, RAMP DOWN – Style default setting: **100 %**

The parameter affects the length of linear zone of “S” ramp. It can be better understood from the following picture.

range: (10 % ÷ 100 %)

The value of “S” curve curvature affects *„smoothness“ at drive‘s acceleration and deceleration.*





7.2.1 Acceler. ramp 1

atr = S+V

RUMP UP, RUMP DOWN – Times default setting: **Ta1 = 10.0 s**

The time of the first section of motor acceleration.

range: (0.1 s ÷ 999.9 s)

The meaning of the parameter can be better understood from the following picture.

7.2.2 Acceler. ramp 2

atr = S+V

RUMP UP, RUMP DOWN – Times default setting: **Ta2 = 10.0 s**

The time of the second section of motor acceleration.

range: (0.1 s ÷ 999.9 s)

The meaning of the parameter can be better understood from the following picture.

7.2.3 Deceler. ramp 1

atr = S+V

RUMP UP, RUMP DOWN – Times default setting: **Td1 = 10.0 s**

The time of the first section of motor deceleration.

range: (0.1 s ÷ 999.9 s)

The meaning of the parameter can be better understood from the following picture.

7.2.4 Deceler. ramp 2

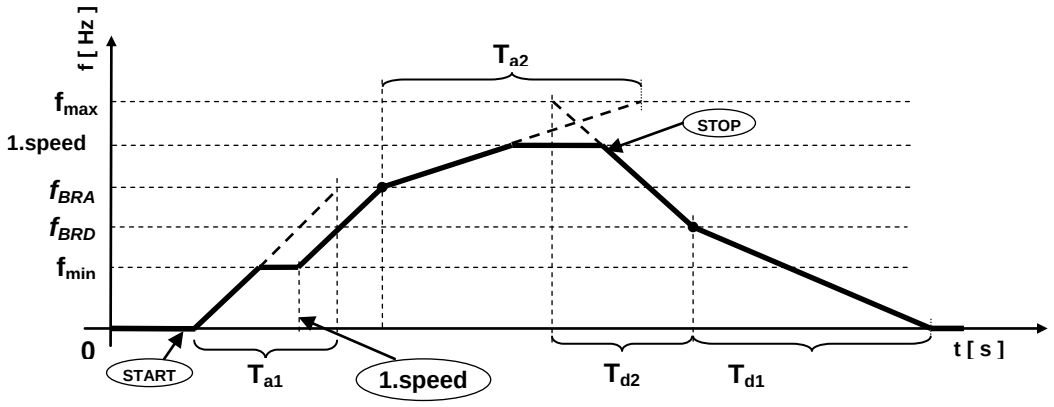
atr = S+V

RUMP UP, RUMP DOWN – Times default setting: **Td2 = 10.0 s**

The time of the second section of motor deceleration.

range: (0.1 s ÷ 999.9 s)

The meaning of the parameter can be better understood from the following picture.



The meaning of break points (Fmin,Fmax), acceleration/ deceleration times.

7.2.5 REVERSE ramp down

atr = S+V+R

RUMP UP, RUMP DOWN – Times default setting: **1.00 decelerate**

The constant for reduction of running down time at the change of direction of motor rotation.

range: (0.10 ÷ 1.00) [decelerate]

If the direction of motor rotation is changed with REVERSE command, the time of running down to zero frequency is reduced to the value of original running down time (as at stop) multiplied by this constant. It is for example used at crane travel controlling. If control lever moves to neutral position STOP during forward motion, the crane decelerates according to deceleration 7.2.3, 7.2.4. If control lever moves into the position of reverse motion, deceleration becomes shorter according to parameter 7.2.5. Reverse direction acceleration is according to normal time ramps 7.2.1, 7.2.2.

7.2.6 Quick decel.

atr = S+V

RUMP UP, RUMP DOWN – Times default setting: **0.20 decelerate**

The constant for reduction of running down time at quick STOP (function BINx).

range: (0.13 ÷ 1.00) [decelerate]

In order to achieve correct functionality of quick (emergency) stop and prevent from occurring overvoltage or overcurrent error, it is necessary the converter to be capable to stop within shortened shutdown time. If drives with high inertia are controlled, it is needed to use braking mode with braking unit (8.2.1) possible enforced by „flux braking" (8.3.1) function. Maximal possible quick STOP time is defined by the following formula: (number values in brackets represent numbers of parameters)

quick deceleration = (par. 7.2.6) * [(par. 7.2.3) + (par. 7.2.4)]

7.3.1 Acceler.br. point

atr = S+V

RUMP UP, RUMP DOWN – Break points default setting: f_{BRA} **= 50.00 Hz**

The value of frequency up to which the first section of acceleration holds and from which the second section of acceleration begins to hold.

range: (0.00 Hz ÷ 300.00 Hz)

The meaning of the parameter can be better understood from the picture in par. 7.2.4.

7.3.2 Deceler.br. point

atr = S+V

RUMP UP, RUMP DOWN – Break points default setting: f_{BRD} **= 50.00 Hz**

The value of frequency up to which the first section of deceleration holds and from which the second section of deceleration begins to hold.

range: (0.00 Hz ÷ 300.00 Hz)

The meaning of the parameter can be better understood from the picture in par. 7.2.4.

BRAKING

8.1.1 Dynamic rump down

atr = S+V+R

BRAKING – Dynamic Rump Down default setting: **OFF**

OPTIONS

Dynamic deceleration function enables drive deceleration by maximal steepness, by which the voltage limit of unidirectional circuit (8.1.2) is not exceeded. It is not allowed to switch on this function if „Control mode = vector AM, opened“ (11.1.1) is active.

OFF	dynamic deceleration switched off
ON	dynamic deceleration switched on

Dynamic deceleration is used when it is necessary to stop the drive in a minimal time period, and any braking mode is set. Deceleration (7.2.3 – 7.2.4) must not be too long, otherwise the dynamic deceleration will not apply. The function is performed by the regulator, constants of which are set in parameters (13.4.3 – 5).

8.1.2 Dyn.RD DC-voltage

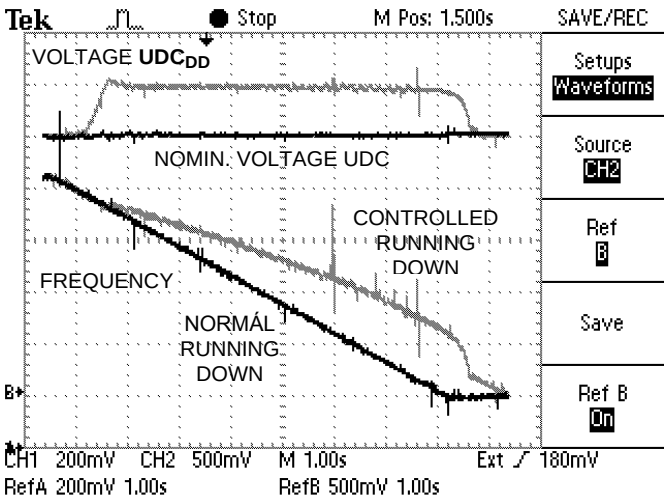
atr = S+V+R

BRAKING – Dynamic Rump Down default setting: **Udc_dd = 110.0 %**

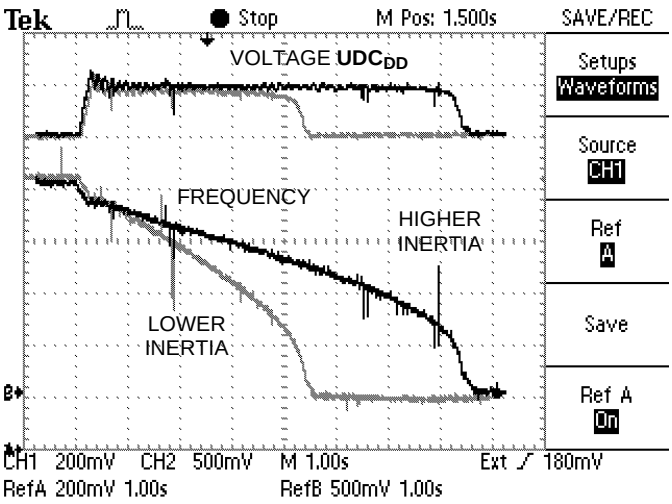
The value of voltage in unidirectional (DC) circuit, which is kept by dynamic deceleration regulator during controlled frequency deceleration.

range: (105.0 % ÷ 130.0 %)

If this value is lowered, it causes that running down takes longer. If this value is higher, it causes that running down takes shorter. See the next picture.



Dynamic running down activation



Different running down times at different inertia

8.2.1 Braking unit

atr = S+V

BRAKING – Braking unit default setting: **OFF**

OPTIONS — Operation of braking unit enabled (forbidden).

OFF	braking unit is inactive.
ON	braking unit is active. If braking unit BU is operating, the converter generates functional warning „F6 brak.u. active“.

If braking unit is inactive, quick motor revolutions reduction (especially when the drives with higher moment of inertia are used) can cause converter's failure – „CNV overvoltage“.

8.3.1 Flux braking

atr = S+V + R

BRAKING – Flux braking default setting: **OFF**

OPTIONS — The function of flux braking is enabled (forbidden). Flux braking enables to shorten the time of deceleration at halting masses of inertia.This function does not have its meaning, if braking from higher frequency than the motor frequency (1.4.1).

OFF	flux braking is switched off.
ON	flux braking is switched on.

This braking mode will ensure that the portion of kinetic energy is transformed into heat losses in stator and rotor winding. There is a higher current consumption in motor and it is being more warmed up. If flux braking is switched on and fault overvoltage or overcurrent occurs, it is necessary to set longer time of deceleration (7.2.3-4) or switch on the function dynamic deceleration (8.1.1). Flux braking controls motor current at deceleration and reduces the intensity of influence on rotor magnetic flux (on voltage - in scalar mode), if this current is exceeded.

8.3.2 Flux braking gain

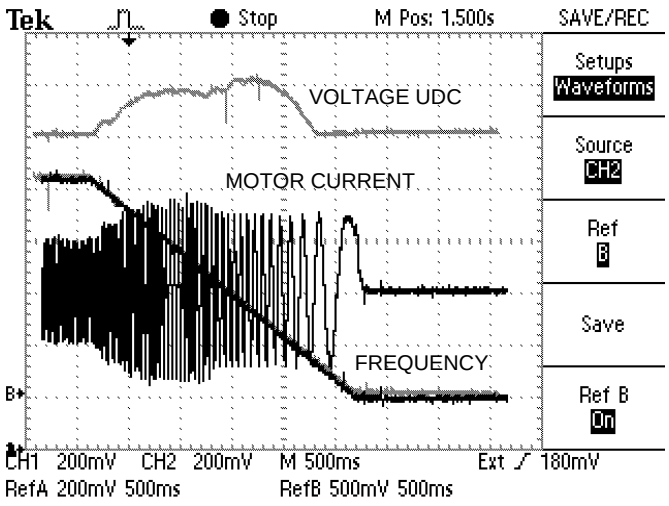
atr = S+V + R

BRAKING – Flux braking default setting: **3.00**

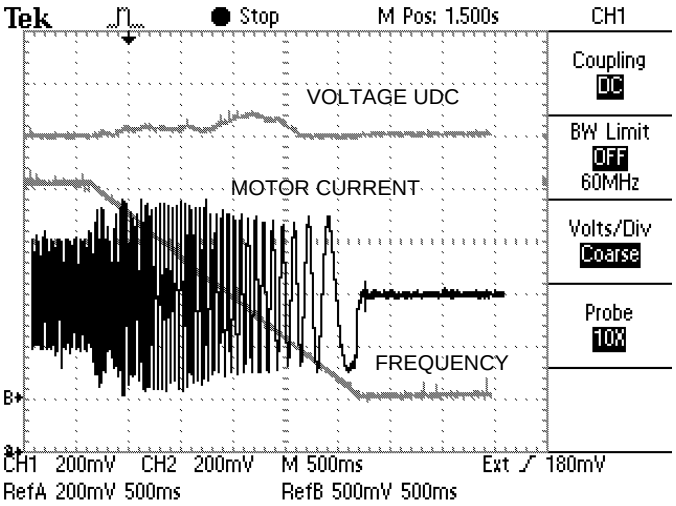
The setting of influence intensity of „Flux braking" function.

range: (0.00 ÷ 10.00)

If overvoltage occurs at chosen deceleration type and the converter still has current reserve, the increase in this parameter causes UDC voltage decrease at deceleration and motor current increase. If this parameter is too high, overcurrent may occur at deceleration. There exists optimal value of this parameter. In such a case, motor current and UDC voltage values are optimal (within allowed interval) and the time of deceleration is minimal.



Example of flux braking at low gain 8.3.2.



Example of flux braking at high gain 8.3.2.

CONSTRAINTS

9.1.1 Sampling freq.

atr = S+V

CONSTRAINTS – Sampling freq. default setting: **1.5 kHz**

Modulation frequency (switch frequency) for actuating of converter's power transistors.

range: (1.0 kHz ÷ 10.0 kHz)

If low value is set, converter and motor switching losses are lower, motor noisiness is higher. If 16 kHz is set, the motor is running noiselessly but constant motor power is lowered because of it's overheating (higher iron losses). It is set different optimal value for each individual power by manufacturer. ***IT IS NECESSARY TO SET SAMPLING FREQUENCY HIGHER THAN 4.0 kHz WHEN USING SF1!***

9.2.1 1.bin/const. freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **5.00 Hz**

First value of required frequency. In a case, that the source of required value (2.3.1) is „fixed value", it is fixed value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value depends on parameter 2.3.1- on the option "fixed value", „binary speeds", „bin.combinations", „AIN+bin.speeds" or „automatic".

9.2.2 2.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **10.00 Hz**

Second value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value has its meaning, if „Source-req.value“ (2.3.1) = „binary speeds“, „bin.combinations“, „AIN+bin.speeds“ or „automatic".

9.2.3 3.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **15.00 Hz**

Third value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value has its meaning, if „Source-req.value“ (2.3.1) = „binary speeds“, „bin.combinations“, „AIN+bin.speeds“ or „automatic".

9.2.4 4.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **20.00 Hz**

Fourth value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value has its meaning, if „Source-req.value“ (2.3.1) = „binary speeds“, „bin.combinations“, „AIN+bin.speeds“ or „automatic".

9.2.5 5.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **25.00 Hz**

Fifth value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value depends on parameter 2.3.1- on the option „bin.combinations“. If „automatic“ is chosen as an option of parameter 2.3.1, it represents the time of duration of the 1. binary frequency in XXX.XX sec. format.

9.2.6 6.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **30.00 Hz**

Sixth value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value depends on parameter 2.3.1- on the option „bin.combinations“. If „automatic“ is chosen as an option of parameter 2.3.1, it represents the time of duration of the 2. binary frequency in XXX.XX sec. format.

9.2.7 7.binary freq.

atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **35.00 Hz**

Seventh value of required frequency

range: (0.00 Hz ÷ 300.00 Hz)

The use of this value depends on parameter 2.3.1- on the option „bin.combinations“. If „automatic“ is chosen as an option of parameter 2.3.1, it represents the time of duration of the 3. binary frequency in XXX.XX sec. format.

9.2.8 8.bin/max. freq. atr = S+V+R

CONSTRAINTS – Binary frequencies default setting: **40.00 Hz**

Eighth value of required frequency.

range: (0.00 Hz ÷ 300.00 Hz)

This parameter can be used for speed constraining at postion control. Speed constraint equals to the minimum of parameters 9.3.2 and 9.2.8. This parameter is useful for positioning speed change via serial link while motor is operating.

The use of this parameter depends on parameter 2.3.1. If „automatic" is chosen as an option in parameter 2.3.1, it represents the time of duration of the 4. binary frequency in XXX.XX sec. format.

9.3.1 Min. frequency atr = S+V

CONSTRAINTS – Min./max. freq. default setting: **fmin = 0.00 Hz**

This parameter represents minimal permanent operating frequency. Output frequency decreases under this value only in a case of acceleration and deceleration and in a case that current limit under 'fmin' is active (see 13.3.1 = "ON").

range: (0.00 Hz ÷ 300.00 Hz)

Example of setting: - The blower cannot operate permanently under certain critical revolutions (e.g. 43 Hz). By setting fmin=43Hz, permanent blower operation under certain revolutions is not allowed. The blower operates under these revolutions only for a short period of time during acceleration and deceleration.

9.3.2 Max. frequency atr = S+V

CONSTRAINTS – Min./max. freq. default setting: **fmax = 50.00 Hz**

This parameter represents maximal output operating frequency. Ranges of input voltages (10 V), currents (20 mA) of analogue inputs refer to this value.

range: (0.00 Hz ÷ 300.00 Hz)

It is standardly set to 50 Hz. Lower value is set when it is needed to constraint maximal motor revolutions (maximal drive's speed). The value over 50 Hz must be allowed by mechanical facilities of the whole set of machines and by power facilities of a motor.

9.4.1 Terminal sw. freq. atr = S+V+R

CONSTRAINTS – Terminal switch default setting: **5.00 Hz**

The value of frequency, when the function „terminal switch" or „terminal switch +/–" is activated.

range: (0.00 Hz ÷ 300.00 Hz)

If binary input with the function (3.X.1) is switched on, the converter decelerates to „Term. switch freq." 9.4.1. If the direction of motor rotation is changed and terminal switch is switched on, the frequency stops to be constrained (returns to the original value).

9.4.2 Terminal path + atr = S+V

CONSTRAINTS – Terminal switch default setting: **0 cm**

The parameter represents the trajectory of running down **at positive frequency**. The converter enables the trajectory after activating the function „terminal switch" or „terminal switch+". Simultaneously, it is necessary to set parameter „Position scale" (9.14.1) and „Gear ratio" (1.7.1) appropriately.

If terminal switch is intended to be used for deceleration (not stop), the trajectory value should be set to zero.

range: (0 cm ÷ 10 000 cm)

Detailed description of terminal switch operation is stated in binary input function "terminal switch".

9.4.3 Terminal path – atr = S+V

CONSTRAINTS – Terminal switch default setting: **0 cm**

The parameter represents the trajectory of running down **at negative frequency**. The converter enables the trajectory after activating the function „terminal switch“ or „terminal switch–“. Simultaneously, it is necessary to set parameter „Position scale“ (9.14.1) and „Gear ratio“ (1.7.1) appropriately.

If terminal switch is intended to be used for deceleration (not stop), the trajectory value should be set to zero.

range: (0 cm ÷ 10 000 cm)

Detailed description of terminal switch operation is stated in binary input function "terminal switch".

9.4.4 Preset value atr = V+R

CONSTRAINTS – Terminal switch default setting: **0→position**

OPTIONS

The option specifies the value of real position at position calibration in dependence on binary input or control panel. It also determines which command of calibration MASTER converter will transmit.

0→position	it sets the actual position to zero
+MAX→position	actual position = positive value of parameter 9.13.1.
- MAX→position	actual position = negative value of parameter 9.13.1.

9.4.5 Position preset atr = V

CONSTRAINTS – Terminal switch

COMMANDS-OPTIONS

Real position is set to the value, which is given by the option in parameter 9.4.3.
If the converter is in MASTER mode and calibration has started, the MASTER sends the corresponding calibration command to SLAVE by serial link, until SLAVE confirms command receiving.
Independently from this parameter, calibration activated by binary input (function „Pos. calibration“) is possible at any time.

by serial link	it enables calibration activation using commands via serial link. (commands: 0, +max., -max. position)
after init.	calibration is done automatically after converter’s initialisation or parameterization
immediately	position calibration is done immediately after this command confirmation
finish	this command stops calibration that is actually in progress. The converter executes parameterization as soon as operating personnel escapes parameters menu.

*The command is used at MASTER - SLAVE control (PRSS type), at SW terminal switch or position control. After calibration, the converter will show functional warning „**F9 IRC calibrat.**“. The motor starts to rotate and the converter is waiting for zero pulse from IRC. After the zero pulse has arrived, the position is calibrated and parameter 3.7.3 reaches a new value.*

9.5.1 Shift frequen. U/F

atr = S

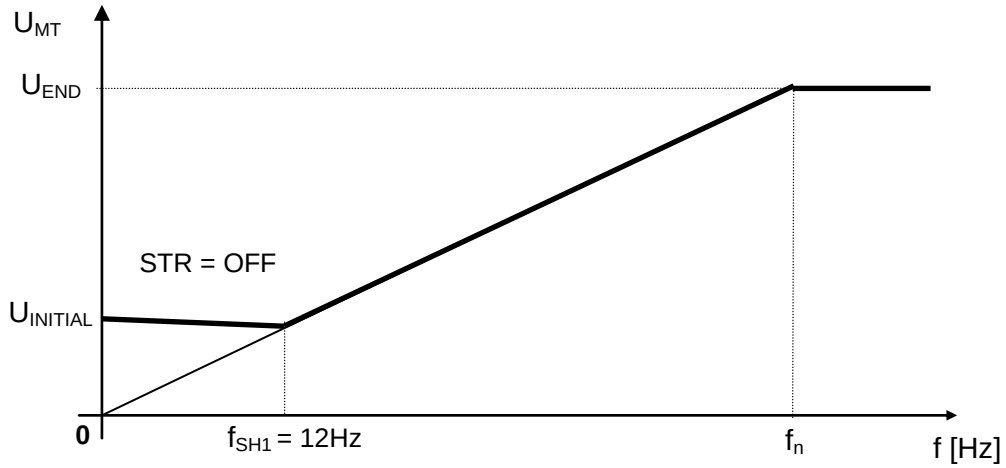
CONSTRAINTS – Boost zones

default setting: f_{SH} **1 = 10.00 Hz**

The value of frequency that bounds the area of elevated voltage in scalar mode.

The meaning of this parameter is shown in the following picture.

range: (0.00 Hz ÷ 300.00 Hz)



Voltage – frequency characteristic used in scalar control mode where voltage is increased at low frequencies ($f < f_{SH}1$).

9.5.2 Shift frequen. STR

atr = S

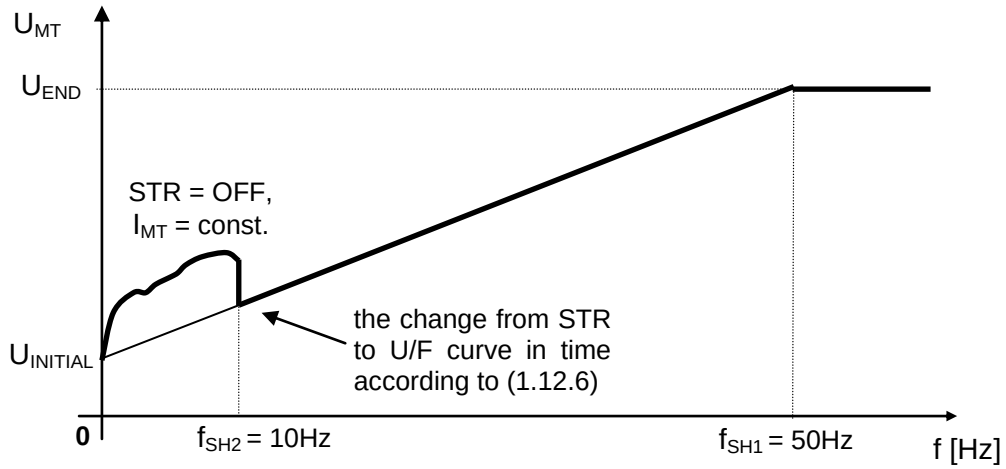
CONSTRAINTS – Boost zones

default setting: f_{SH} **2 = 10.00 Hz**

If the starting torque regulator (STR) is active, this frequency defines frequency area within which STR operates. The meaning of this parameter is shown in the following picture. For more information see also parameter 13.2.1. The value of starting torque is being set in parameter 9.8.1.

range: (0.00 Hz ÷ 300.00 Hz)

The following picture depicts the settings for elevation drive. By setting „U/F shift freq. " to nominal motor frequency, the „rise" of voltage curve is achieved. At the same time, starting torque regulator forces constant current until the frequency „STR shift freq." is achieved.



Voltage – frequency characteristic used in scalar control mode with current regulation area ($f < f_{SH}2$).

9.6.1 Initial voltage

atr = S

CONSTRAINTS – Initial/ end volt. default setting: **see Appendix B**

Initial – starting voltage is output voltage of the converter at starting – zero output frequency, if starting torque regulator is not chosen / inactive (13.2.1).

range: (0.1 % ÷ 25.0 %)

Motor voltage, by increasing the frequency, moves linearly up to the value of ideal voltage characteristic of f_{SH1} *frequency (9.5.1). When frequency converter is used for driving the mechanism with quadratic torque (pump, fan), it is appropriate to decrease this parameter by 10 - 15 % from the value* U_{INIT}*. See the picture in parameter 9.7.1.*

9.6.2 End voltage

atr = S+V

CONSTRAINTS – Initial/ end volt. default setting: U_{END} **= 100.0 %**

End voltage is the voltage on the break point of the voltage curve (e.g. the voltage by nominal motor frequency). This voltage is constant at higher frequency.

range: (5.0 % ÷ 107.5 %)

It is set nominal value at 100 %. The decrease in value of this parameter is possible only when overdimensioned motors are used – as temperature losses in the converter and motor are minimized.

The manufacturer does not recommend adjusting of the parameter without having corresponding technical skills. See the picture in parameter 9.7.1.

If voltage values exceed 100.0%, the motor is supplied with disharmonic voltage and 3.harmonic of voltage and current increases.

9.6.3 Autotunning Vin

atr = S

CONSTRAINTS – Initial/ end volt.

COMMAND Activation of this command makes the identification of motor initial voltage (9.6.1) start.

Identified voltage value corresponds to current value, which is dependant on the setting of parameter „Starting torque“ (9.8.1). Identification is finished within 3 – 5 seconds from command activation, according to motor type.
If the motor is connected to the converter incorrectly, the converter will display fault message “Identification err.” and original value of parameter 9.6.1 will stay unchanged.
Relay – brake should be switched off during U_{INIT} **autotunning.**

9.7.1 Curve index

atr = S

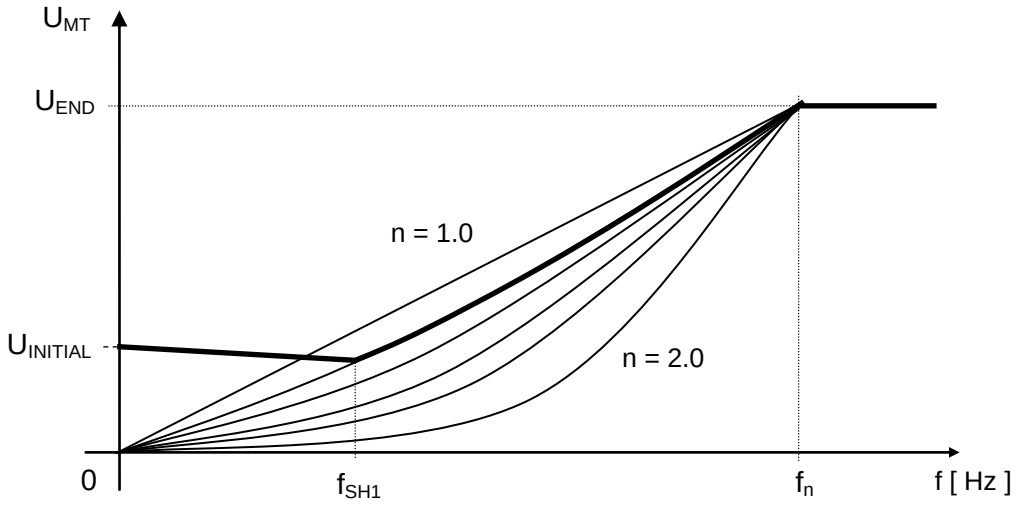
CONSTRAINTS – Curve index default setting: **n = 1.0**

Selection of the U/f characteristic type – curve exponent.

For drives with constant load torque n = 1.0 .

For drives with exponential behavior of load torque in dependence on revolutions (fans, pumps) n = 1.7.

range: (1.0 ÷ 2.0)



Pic. 7 Voltage – frequency characteristics used in scalar control mode are depicted for various load types.

9.8.1 Starting torque

atr = S+R

CONSTRAINTS – Starting torque default setting: **35.0 %**

The value of starting torque in % of the nominal of motor torque. If the starting torque regulator is active (13.2.1) and converter's frequency is less than „STR shift freq." (9.5.2), STR keeps this default value of starting torque.

range: (1.0 % ÷ 200.0 %)

STR – starting torque regulator

9.9.1 Maximal torque

atr = V+R

CONSTRAINTS – Min./max. torque default setting: **see Appendix B**

Maximal torque value at speed regulation (13.1.X) or motor torque regulation.

range: (0.0 Nm ÷ 32500 Nm)

At speed regulation in vector mode, the output of speed regulator is constrained to the value of this parameter. The limitation is used for constraining dynamic impacts in mechanic system.

9.9.2 Ratio Mmot/Mgen

atr = V+R

CONSTRAINTS – Min./max. torque default setting: **1.000**

Relation of maximal moment value between motor-operated and generator-operated mode.

range: (0.100 ÷ 7.000)

To limit braking power for electrodynamical braking of traction vehicles chose value lower than 1. F. e..: If (9.9.1) = 567Nm and (9.9.2) = 0.700, than maximal braking moment is 396 Nm.

9.10.1 Maximal current

atr = S+V+R

CONSTRAINTS – Max. current default setting: **see Appendix B**

The value of current limit. If the maximal current regulator (MCR) (13.3.1) is active, it does not allow the motor to be permanently supplied with a current greater than this set value.

rozsah: (1 A ÷ 2000 A)

In vector mode, this parameter defines converter's current limit. Either in a case that MCR is not allowed in parameter 13.3.1.

9.12.1 Min. magn. flux

atr = V+R

CONSTRAINTS – Min./max. mag.flux default setting: **0.800 Wb**

Minimal magnetic flux for speed regulator operation. At the same time, it is the value of minimal excitation at economical mode (14.3.1).

range: (0.010 Wb ÷ 5.000 Wb)

Magnetic flux decreases under this value only at converter's start and stop.

9.12.2 Max. magn. flux

atr = V+R

CONSTRAINTS – Min./max. mag.flux default setting: **2200 Wb**

Operating value of magnetic flux. (The value of magn.flux at operation.)

range: (0.010 Wb ÷ 5.000 Wb)

The level of operating magnetic flux determines the level of motor excitation and temperature losses in the motor. It affects the dynamics of speed and torque control. There can be magnetic flux higher than this value in the motor but only for a short period, if the function "flux braking" (8.3.1)is active.
In a case of SMPM control, this parameter represents magnetic flux of permanent magnets and can be measured by activating the command „MT autotunning" with „Ls,Lm" option (see parameter 1.12.5).

9.13.1 Max. position

atr = S+V+R

CONSTRAINTS – Max. position default setting: **3000.0 cm**

It defines maximal position at position, speed and torque control. When software terminal switch (14.5.1) is active, it constraints the position both in speed and torque mode.

range: (0.0 cm ÷ 3200.0 cm)

*The following must hold: Max.position ≤ 32768 * (par.9.14.1) / (par.1.7.1)*

9.13.2 Position constraint

atr = S+V+R

CONSTRAINTS – Max. position default setting: **ON**

OPTIONS It defines position restriction mode.

OFF	position constraint is switched off; so called electronic shaft with „unlimited position“
ON	position constraint is switched on; position control restricted by an interval +/- of max. position

9.14.1 Position scale

atr = S+V

CONSTRAINTS – Position scale default setting: **25.00 cm/rev.**

Parameter represents the circumference of a wheel behind gear. Position scale enables the converter to display the variable „Position“ on its display. It is necessary to set the parameter „Gear ratio“ (1.7.1) appropriately.

range: (0.01 cm/rev. ÷ 300.00 cm/rev.)

FAULTS

10.1.1 Faults reset

atr = S+V+R

FAULTS – Faults reset

COMMAND Reset of the list of faults in fault history.

10.2.1 IRC / ARC dropout

atr = S+V+R

FAULTS – Selective faults default setting: **not tested**

OPTIONS This parameter enables to choose from various ways of speed regulator' fault testing and converter's operation during this fault testing.

motor OFF	In a case of speed regulator fault, the converter generates the warning "IRC failure" and switches off the motor.
scalar mode	In a case of speed regulator fault, the converter generates the warning "W7 IRC dropout" and switches the converter into scalar mode.
not tested	The fault of speed regulator is not tested.

If IRC test is active in „scalar, opened“ mode , the test of correct connection of A+,B+ (IRC signals) to the converter executes. In a case of incorrect connection, the converter shows the warning "W8 bad dir.of IRC ". It is used before converter's start in closed control mode.

10.2.2 Inp. phases testing

atr = S+V+R

FAULTS – Selective faults default setting: **OFF**

OPTIONS Selection of converter's input phase dropout testing.

OFF	The test of input phase dropout is not enabled.
ON	The test of input phase dropout is enabled. In a case of small dropout (U_{dc} ripple **under 13% U_n**), the converter generates the warning "W9 input phase". In a case of higher ripple(**above 20% U_n**), the converter generates the warning „Input phase”

10.2.3 Out. phases testing

atr = S+V+R

FAULTS – Selective faults default setting: **OFF**

OPTIONS Selection of converter's output phase dropout testing.

OFF	The test of output phase dropout is not enabled.
ON	The test of output phase dropout is enabled. In a case of dropout, the converter generates the fault "Output phase" The test is active, if $\mathbf{F_{CNV} > 0.1*F_{MT}}$ (1.4.1) and $\mathbf{I_{CNV} > 0.1*I_{MT}}$ (1.2.1).

10.2.4 MT overloading

atr = S+V+R

FAULTS – Selective faults default setting: **self cooling**

OPTIONS Selection of motor temperature checking. If thermal integral is exceeded or dangerous motor temperature occurs, the failure "MT overheat" is generated.

not tested	checking is inactive.
external cooling	for motors with external cooling, not depending on motor revolutions. The limit for integral excess test is: (par.10.2.5) x I^2_{MOT} x 1.05^2 .
self cooling	for motors with self cooling, depending on motor revolutions. The limit for integral excess test is: (par.10.2.5) x I^2_{MOT} x 1.05^2 x K_{SPEED} , K_{SPEED} > 1 at F_{CNV} from 0 Hz to F_{MOT}, K_{SPEED} = 1 over F_{MOT}.
sensor PTC	1÷3 x PTC sensors in motor winding, connected in-line. Sensor's output terminals are being connected to X15 – X16 terminals of control terminal board. The converter generates the warning „W16 motor temp ", if increased motor temperature occurs.
1x sensor PT100	1 x PT100 sensor, motor with a single sensor. It is needed to set AOUT function as following: (6.X.1) = „sensor PT100". The sensor is supplied with constant current from analogue output AOUT1 (2). Voltage decrease is sensed by analogue input AIN1.
2x sensor PT100	2 x PT100 sensor, motor with two sensors which are connected in-line. It is needed to set AOUT function as following: (6.X.1) = „sensor PT100". The sensors are supplied with constant current from analogue output AOUT1 (2). Voltage decrease is sensed by analogue input AIN1.
3x sensor PT100	3 x PT100 sensor, motor with three sensors which are connected in-line. It is needed to set AOUT function as following: (6.X.1) = „sensor PT100". The sensors are supplied with constant current from analogue output AOUT1 (2). Voltage decrease is sensed by analogue input AIN1.

Checking of motor temperature overloading inhibits motor overheating and motor damage during insufficient cooling. The second and the third option do not fully substitute PTC temperature sensors that are directly built in the motor.

Thermal characteristic of temperature sensor in motor winding (3x PTC in-line):

temperature up to 135 °C - $R_{PTC} \leq 3.6\ k\Omega$ — normal motor temperature,
temperature above 135 °C - $R_{PTC} > 3.6\ k\Omega$ — increased motor temperature (warning),
temperature above 150 °C - $R_{PTC} > 4\ k\Omega$ — dangerous motor temperature (failure),
temperature under 135 °C - $R_{PTC} < 3.6\ k\Omega$ — temp. when failure and warning is finished.

Thermal characteristic of a single sensor (1x PT100):

temperature up to 135 °C - $R_{PT100} < 152\ \Omega$ — normal motor temperature,
temperature above 135 °C - RPT100 $\geq 152\ \Omega$ — resulting in failure,
temperature under 121 °C - RPT100 $< 137\ \Omega$ — resulting in failure turn off.

10.2.6 Test communic. err. atr = S+V+R

FAULTS – Selective faults default setting: **disabled**

OPTIONS It defines corrective action at communication error using serial link.

not tested	The failure is ignored on serial link.
warning	If a failure occurs, the warning "W18 communication" is shown.
stop INV	If a failure occurs, the converter decreases its frequency (in compliance with acceleration – deceleration style) and automatically generates STOP command (not depending on the source of entering). It displays the warning "W18 communication". After failure termination „automatic“ STOP ends up and the converter starts the operation according to the source of entering. In SLAVE mode, STOP occurs only when the source of entering of START/STOP is serial link.
reset INV	If a failure occurs, the converter immediately disconnects the motor from the voltage („F1 converter’s reset“) and displays the warning "W18 communication". In SLAVE mode, STOP occurs only when the source of entering of START/STOP is serial link.
error INV	The fault "Communic. error" is generated. The converter cannot operate until the communication is recovered. In SLAVE mode, the fault occurs only if Start/Stop can be set exclusively by serial link.

The reasons of communication error may be as following:

- insufficient field suppression of a link (if the problem has occurred only during the start)
- link disconnection, or incorrect setting of RS485 link end resistors
- incorrect parameters setting 2.10.X (address, timeout, speed, CRC type, ...)

10.2.7 Dangerous warning atr = S+V+R

FAULTS – Selective faults default setting: **not tested**

If the converter is in SLAVE communication mode, this parameter allows the SLAVE to choose between setting and not setting critical warning bit in its status word. Critical warnings are the following:
– one of the regulators (current, magnetic flux, torque or speed regulator) has been saturated at vector control mode
– current limit has been activated at scalar control mode
OPTIONS – IRC encoder does not give correct speed information

not tested	Critical warnings are not tested.
enabled	Critical warnings are tested. It is the occurrence of critical warning tested and the time of critical warning tolerance counted.

10.2.8 Danger. warn.filter atr = S+V+R

FAULTS – Selective faults default setting: **5 s**

If critical warnings occurs (par.10.2.7) and default time period expires, the converter in SLAVE mode sets the corresponding bit in its status word. It will result in an immediate reaction in MASTER converter, which generates „SLAVE overload“ fault.

range: (1 s ÷ 120 s)

10.3.1 Operat. after fault

atr = S+V

FAULTS – Failure routine default setting: **waiting**

OPTIONS It defines converter's operation after the fault termination.

don't wait	The converter immediately reopens the window MONITOR after fault termination and responds to every command.
wait choice time	The converter is waiting certain time period according to parameter 10.3.2. After this time period elapses, the converter reopens the window MONITOR and responds to every command.
confirmation	The converter is waiting for failure confirmation using binary input with the function "fault confirmat.", or by pressing ENTER button of active control panel, or by command via serial link. After fault confirmation, the converter reopens the window MONITOR and responds to every command.

10.3.2 Time after fault

atr = S+V

FAULTS – Failure routine default setting: **2.5 s**

Time the converter counts down after fault termination (providing that parameter 10.3.1 = "waiting").

range: (0.1 s ÷ 60.0 s)

10.3.3 Operat. undervolt.

atr = S+V

FAULTS – Failure routine default setting: **not waiting**

OPTIONS It defines converter's operation after the undervoltage termination (after the recovery of voltage in unidirectional circuit).

don't wait	The converter immediately reopens the window MONITOR after fault termination and responds to every command.
wait choice time	The converter is waiting certain time period according to parameter 10.3.2. After this time period elapses, the converter reopens the window MONITOR and responds to every command. If the power supply is recharged, the converter generates „CNV Undervoltage" and counts down time after the fault.
flying start	After START command, the converter finds rotor frequency using detecting current (14.1.4), executes flying start (starts to rotate at the same revolutions as the motor that has already been rotating) and infinitely starts to rotate according to required revolutions (see par. 14.1.X) *If this option is chosen, the function RELAY "brake" (see 5.X.1) cannot be enabled. Flying start function can not be applied at opened vector control mode.*
confirmation	The converter is waiting for failure confirmation using binary input with the function "fault confirmat.", or by pressing ENTER button of active control panel, or by command via serial link. After fault confirmation, the converter reopens the window MONITOR and responds to every command. If the power supply is recharged, the converter generates „CNV Undervoltage" and waits for a fault confirmation.

CONTROL SETTINGS

11.1.1 Contr. strategy

atr = S+V

CONTROL SETTING – Contr. strategy default setting: **scalar, open**

OPTIONS	Selection of the way of motor controlling according to control algorithms. Motor parameters (1.12.X) have a great influence on the control at vector control.
scalar, open	It is not necessary to have revolutions encoder on motor shaft. By increasing the frequency, the converter directly proportionally increases its output voltage. The converter starts from „Initial voltage“ (9.6.1) at zero frequency and reaches „End voltage“ at „Motor frequency“ (1.4.1). If the frequency is higher than nominal frequency, the voltage no more increases. – This control mode is used, if there are not high demands on the observance of motor revolutions and motor torque . – It is possible to connect more motors parallelly on converter’s output. Motors’ currents are being summed up. – It is allowed to use sine filter SF1 between the converter and the motor. – Within scalar mode, only parameters with "S" attribute affect converter’s operation. – It is not possible to use both position and torque control. (11.2.1)
scalar, closed	It is necessary to have revolutions encoder of a type IRC on motor shaft. The control mode is the same as „scalar, opened“. Moreover, it is speed regulator (13.1.X) activated in the converter. Speed regulator compensates the error (slip) made by an encoder so as rotor speed equals to the required speed. – Approx. values of the regulator: – P-reg = 0.05–0.10; I-reg = 1000–2000 ms; D-reg = 0; sampling = 5; filter = 1 – Maximal difference between stator and rotor speed is 4x nominal motor slip. – In a case of reverse polarity of IRC or reverse sequence of motor phases, the motor may oscillate.
vector IM, clos.	It is necessary to have revolutions encoder of a type IRC on motor shaft. The converter supplies the motor with specific value of voltage, so as magnetic flux in rotor is always the same. (it applies for the range of frequencies from zero to „Motor frequency“ (1.4.1)). – This control mode is used, if there are high demands on the observance of motor revolutions and motor torque in wider frequency range. – It is not allowed to connect more motors parallelly on converter’s output unless their shafts are connected through load. It is allowed to use sine filter SF1 only in special cases. – Within vector mode, only parameters with "V" attribute affect converter’s operation. – It is possible to use both position and torque control. (11.2.1) – In a case of incorrect IRC connection or incorrect motor phases sequence, the motor may oscillate and high current may occur.
vector IM, open	It is not necessary to have revolutions encoder on motor shaft. The control mode is the same as „vector AM,closed“ but the converter itself finds out rotor speed from the shape of motor voltage and motor current. – This control mode is used, if there are medium demands on the observance of motor revolutions and motor torque in the frequency range, starting from approx. 2Hz. – The error of regulated speed equals maximally to 2% of regulated frequency range when converter operation is stable. – It is allowed to connect more motors parallelly on converter’s output and to use sine filter SF1 only under exceptional circumstances. – It is not possible to use both position and torque control. (11.2.1)
vector SMPM, clos.	It is necessary to have motor revolutions encoder. The control mode is the same as „vector AM,closed“ but there exists the modification for synchronous motors with permanent magnets (SMPM). – This control mode is used, if there are high demands on the observance of motor revolutions and motor torque in wider frequency range. – It is not allowed to control more motors parallelly on converter’s output and to use sine filter SF1. – In a case of incorrect ARC connection or incorrect motor phases sequence, the motor may oscillate and high current may occur.

11.2.1 Control variable

atr = V

CONTROL SETTING – Control variable default setting: **speed**

OPTIONS Selection of main converter's variable that is being regulated (controlled) and chosen.

torque	It is motor torque controlled. If you have chosen this option, „vector AM, closed" or „vector SMPM, clos." control mode type is needed.
speed	It is stator frequency or rotor speed controlled.
position	It is rotor position or position of a shaft behind gear controlled. If you have chosen this option, „vector AM, closed" or „vector SMPM, clos." control mode type is needed.

PROCESS REGULATOR

12.1.1 Process reg. (PR) atr = S+V

PROCESS REGULATOR – Option-Funct. default setting: **OFF**

Process regulator is suitable for regulating various variables (pressure, overflow, the level of liquid surface, etc.) in dependence on motor revolutions. Regulated variable is input analogue signal from process sensor according to par.4.3.1. "PR feedback".

The required value may be as following:
– fixed; par.2.3.1 = „fixed value" and par.12.3.1 = concrete required value
– depending on AIN; par.2.3.1 = „analogue input" and par.4.1.1 = concrete AINx
– depending on the buttons of control panel; par.2.3.1 = „control panel"

The period of process regulator sampling is 10ms.

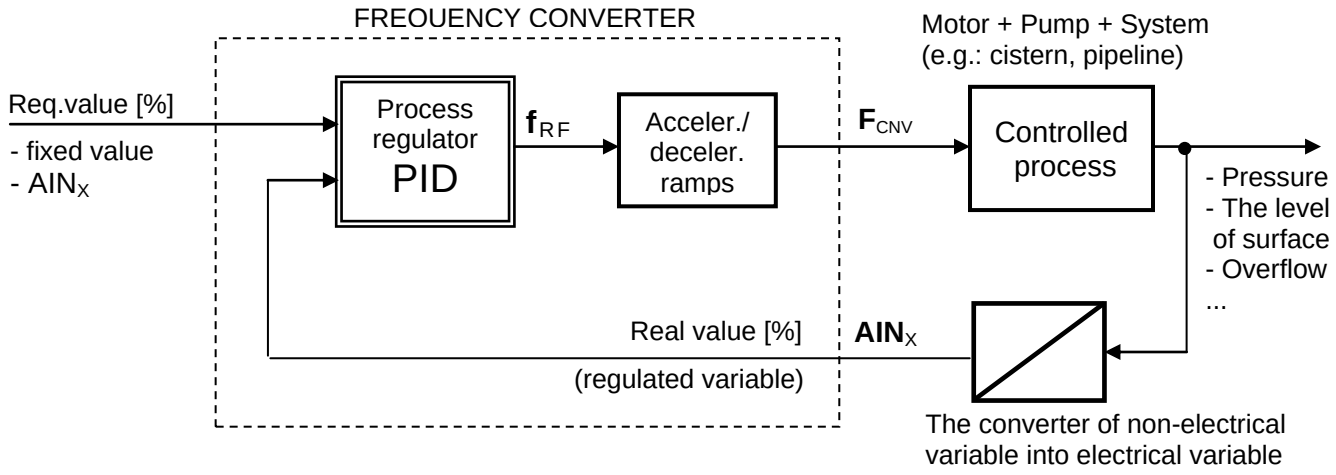
Polarity of AIN inputs in case of negative parameters 4.2.X is as following:

Desired value (PR des.) = absolute value from AINx, x = 1,2,3
OPTIONS Real value (PR real) = 0 ÷ AINx max. , x = 1,2,3

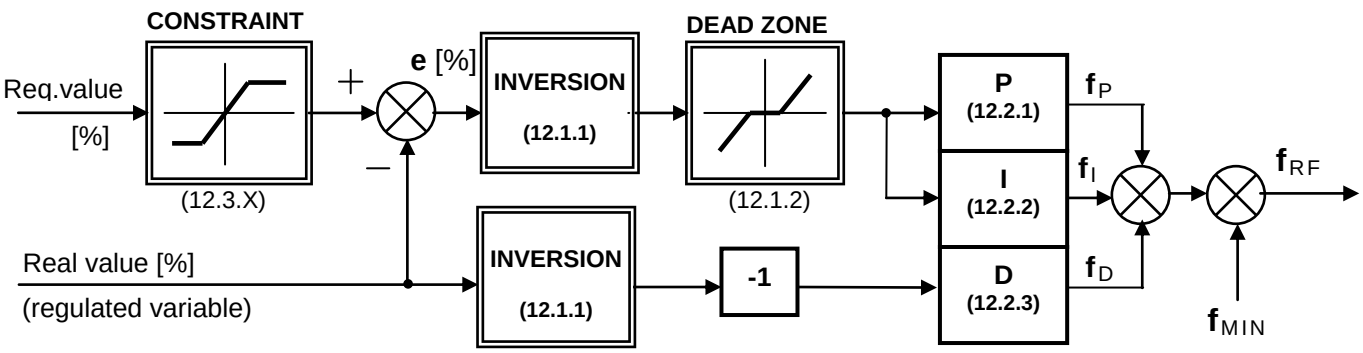
OFF	Regulator is inactive.
normal	Regulator is active, **regulating deviation = required value – actual value**.
inverse	Regulator is active, **regulating deviation = – (required value – actual value)**.

The example of regulation (constant level of liquid surface): In a case that liquid is charged into the cistern by a pump, it is **normal function of the regulator**, (the level of surface increases by overflow). In a case that liquid is taken away by pump, it is **inverse function of the regulator**, (the level of surface decreases by overflow).

ATTENTION ! If the motor should rotate only in a single direction (pump), reverse function must be forbidden in par. 2.2.1.



Pic. 8 : The use of process regulator



Regulator structure – speed controlling

12.1.2 PR dead zone

atr = S+V+R

PROCESS REGULATOR – Option-Funct. default setting: **0.0 %**

Process regulator' s dead zone. Here, it is ignoring small changes of process variable.

range: (0.0 % ÷ 10.0 %)

It is set, if the signal of regulated variable contains disturbing components (with lower amplitude than set dead zone), on which the process regulator should not react.

12.2.1 P-const. of PR

atr = S+V+R

PROCESS REGULATOR – Constants PID default setting: **K_P = 1.00**

Proportional amplification of K_P of process regulator. This parameter can be changed during converter's start. Amplification is proportional to motor frequency.

range: (0.00 ÷ 30.00)

The influence of P-component on output frequency (depending on the change of regulating deviation):

K_P = 0,10 to 0,50 – very small
K_P = 0,50 to 2,50 – small
K_P = 2,50 to 7,50 – large
K_P = 7,50 to 15,00 – very large

12.2.2 I-const. of PR

atr = S+V+R

PROCESS REGULATOR – Constants PID default setting: **T_i = 10.00 s**

Time constant T_i of process regulator's integrating (I) component. Integrating component is switched off, if T_i=600,1s. This parameter can be changed during converter's start. Amplification is proportional to motor frequency.

range: (0.01 s ÷ 600.01 s)

In order to ensure regulation stability, it is necessary to set acceleration (deceleration) time period shorter than the constant T_i , or to set T_i constant longer than acceleration (deceleration).

The change of output frequency depending on the change of regulating deviation:

T_i = 600,00s to 120,00s – very slow
T_i = 120,00s to 15,00s – slow
T_i = 15,00s to 2,00s – fast
T_i = 2,00s to 0,30s – very fast

12.2.3 D-const. of PR

atr = S+V+R

PROCESS REGULATOR – Constants PID default setting: **T_D = 0**

Time constant T_D of process regulator's derivation (D) component. Deviation component is switched off, if T_D =0. This parameter can be changed during converter's start. Amplification is proportional to motor frequency.

range: (0 ÷ 100)

– Derivating component has its meaning only if acceleration (deceleration) takes less than 3 s.
– The decrease of regulated variable at AIN input results in frequency increase, and vice versa.
– Required value of the regulator does not enter into D-component (only feedback, i.e. regulated variable).

The influence of D-component on output frequency (depending on the change of regulating deviation):

T_D = 0,10s to 0,30s – very small influence
T_D = 0,30s to 0,50s – small influence
T_D = 0,50s to 0,70s – big influence
T_D = 0,70s to 1,00s – very big influence

12.3.1 Fixed req.var. PR

atr = S+V+R

PROCESS REGULATOR – Fixed req.var. default setting: **50.0 %**

Fixed value of regulator's required variable.

range: (0.0 % ÷ 500.0 %)

This parameter is applied as required value of PR, if there is in parameter 2.3.1 set the option „fixed value".

12.4.1 Min.req.var.of PR

atr = S+V+R

PROCESS REGULATOR – Req.var.constr. default setting: **0.0 %**

Minimal value of required process variable.

range: (0.0 % ÷ 500.0 %)

12.4.2 Max.req.var.of PR

atr = S+V+R

PROCESS REGULATOR – Req.var.constr. default setting: **100.0 %**

Maximal value of required process variable.

range: (0.0 % ÷ 500.0 %)

12.5.1 Parking of PR

atr = S+V+R

PROCESS REGULATOR – Sleep function default setting: **OFF**

This parameter has its meaning only if process regulator is active. Sleep function represents automatic voltage outage on the motor when the command START is active. The following conditions must be met:

1. output frequency is equal to minimal frequency **Fmin** (9.3.1)
2. the first condition takes longer than the time, during which sleep function is finished (12.5.3)

OPTIONS Sleep function termination is described in parameter (12.5.2).

OFF	Sleep function is forbidden.
ON	Sleep function is enabled.

Sleep function enables energy savings. It is appropriate in those cases, when motor operation at minimal frequency has the same effect as motor operation in stop.

When sleep function finished, it is indicated by functional message „F5 PR sleep function".

ATTENTION! If you choose the command STOP, sleep f. is terminated and the drive starts after the command START, not depending on sleep f. termination conditions!

12.5.2 ParkOFF hysteresis

atr = S+V+R

PROCESS REGULATOR – Sleep function default setting: **5.0 %**

The setting of analogue input limit for converter's sleep function.

range: (0.0 % ÷ 99.9 %)

This parameter does not affect converter's operation, until sleep function (12.5.1) is switched on. The meaning of this parameter depends on inversion of process regulator(12.1.1). If the converter is not being in excitation (sleep function finished), then:

- *at* **12.1.1 = normal***; if feedback signal* **decreases** *under required value* **by** *the value 12.5.2, the converter deactivates sleep function and motor starts to rotate at minimal frequency (1.4.1).*
- *at* **12.1.1 = inverse***, if feedback signal* **increases** *over required value* **by** *the value 12.5.2, the converter immediately deactivates sleep function and motor starts to rotate at minimal frequency (1.4.1).*

12.5.3 Park ON time

atr = S+V+R

PROCESS REGULATOR – Sleep function default setting: **60.0 s**

The time within which the converter disconnects the motor from voltage (only if sleep function conditions are met 12.5.1).

range: (0.1 s ÷ 3200.0 s)

REGULATORS - OPTIONS

13.1.1 Spdeed reg. mode

atr = V

REGUL.-PROPERTIES – Speed default setting: **normal**

OPTIONS — Selection of the mode of hardness/dynamics of speed control/regulation.

normal	smooth (soft) frequency regulation – regulator with no supplementary non-linearity
adapting from f	adaptive setting of P, I and D constants of speed regulator depending on required frequency

The setting of SpeedReg. adaptivity can be changed via parameters (13.8.x).

ATTENTION! Adapting option is designed exclusively for closed vector control mode. It's use in open vector conrtrol may lead to incorrect operation of all regulators!

13.1.2 P-compon. of SR

atr = V+R

REGUL.-PROPERTIES – Speed default setting: **10.00**

The value of amplification of speed regulator's proportional component.

range: (0.01 ÷ 100.00)

The value of speed regulator's P - component is used for influencing frequency oscillation reduction . It is set higher value (5.0 ÷ 20.0) for higher inertial mass, lower value (0.1 ÷ 5.0) for lower inertial mass.

13.1.3 I-compon. of SR

atr = V+R

REGUL.-PROPERTIES – Speed default setting: **3.0 ms**

The value of amplification of speed regulator's integration component.

range: (0.2 ms ÷ 3000.0 ms)

I – component of speed regulator affects the reaction of speed to a change of load and regulation time. The higher inertia is connected to motor shaft, the higher integrating time constant is needed to be set (it is needed to slow down the regulator). If the preceding assumption is not met, the operation of SR will be restricted to on-off control (torque of current limitation), what can result in permanent oscillations of regulated system.

13.1.4 D-compon. of SR

atr = V+R

REGUL.-PROPERTIES – Speed default setting: **0.000**

The value of amplification of speed regulator's derivation component.

range: (0.000 ÷ 7.999)

D – component of speed regulator is derived from acceleration (= a derivation of real speed). It helps to make the regulation response on load jumps quicker. We recommend to consult the setting of this parameter with the manufacturer (VONSCH Ltd.) because it can cause arising of permanent oscillations in the regulation.

13.1.5 Sampling of reg.

atr = V

REGUL.-PROPERTIES – Speed default setting: **2 x 200us**

A period of speed regulator sampling in vector control mode with IRC encoder.

It is longer period used in a case of IRC encoder with a smaller number of pulses (e.g. 1024) and if there is a need of low motor revolutions control (e.g. up to 5Hz). It prolongs regulation time.

range: (1 ÷ 10) [x 200us]

Quantisation error at speed regulation in [Hz]: $\Delta F = 1 / (4*N_{IRC} * T_{VZ})$

Relative error out of speed range in [%]: $p * \Delta F / (2*F_{MAX}) * 100$

N_{IRC} – the number of IRC pulses

F_{MAX} – max. frequency in Hz (par.9.3.2)

p – the number of poles (par. 1.6.1)

$T_{VZ} = (13.1.5) * 200*10^{-6}$ speed regulator sampling

13.1.6 Speed filter type

atr = V + R

REGUL.-PROPERTIES – Speed default setting: **0**

Speed filter smoothes undesirable jumps of measured speed that arise during the real speed evaluation from IRC encoder.
If the value equals to 0, the filter is switched off.

range: (0 ÷ 5)

The use of this filter results in noisiness reduction at vector control mode. The noisiness arises from quantization error ΔF*.*

13.2.1 Start torq. regul.

atr = S+R

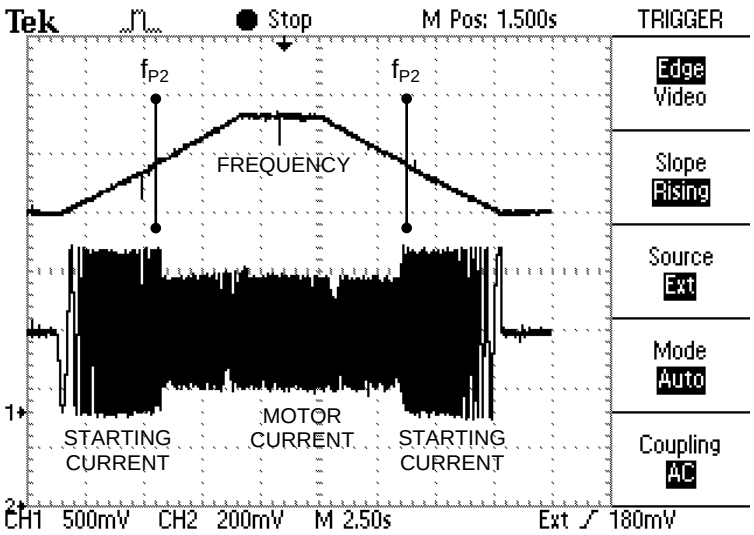
REGUL.-PROPERTIES – Starting torque default setting: **STR = ON**

The selection of starting torque regulator operation. STR is used at drive starts in scalar mode in order to overcome dry friction or a big load at low speed (revolutions) and keeps up / sustains required starting torque in the frequency range 0 ÷ fSH The value of starting torque can be set in parameter 9.8.1.

OPTIONS

OFF	Starting torque regulator is inactive.
ON	Starting torque regulator is active.
hard load	This option is helpful when big load is applied. In order to enable motor operation within stable torque characteristic during heavy operation, the converter enables starting torque increase.

It is used to remove unwanted current oscillations in the area of changing frequencies in no-load motor. ***ATTENTION ! External motor cooling is essentially needed, when STR is permanently operating in the frequency range 0÷f_{SH}!***



Motor current behaviour when STR is used

13.2.2 P-component of STR

atr = S+R

REGUL.-PROPERTIES – Starting torque default setting: **0.50**

The value of amplification of starting torque regulator's proportional component.

range: (0.00 ÷ 30.00)

Optimal setting of P – constant of STR depends on motor power, on the length of input motor cables and the use of sine filter (SF1).). In a case of strong current oscillating, which may cause the faults „CNV overcurrent" or „CNV overvoltage", ***CONTACT THE MANUFACTURER!***

13.2.3 I-component of STR

atr = S+R

REGUL.-PROPERTIES – Starting torque default setting: **120 ms**

The value of integral time constant of starting torque regulator.

range: (1 ms ÷ 4097 ms)

I – constant does not apply, when the value is equal to 4097. The optimal setting of STR's I – constant depends on motor power, on the length of input motor cables, on the use of sine filter (SF1). In a case of strong current oscillating, which may cause the faults „CNV overcurrent" or „CNV overvoltage" ***, CONTACT THE MANUFACTURER!***

13.3.1 Max. current reg.

atr = S+R

REGUL.-PROPERTIES – Maximal current default setting: **MCR = OFF**

The selection of maximal current regulator operation. MCR is used in order to limit the motor current to required value. This value is being set in parameter 9.10.1. **It operates only in scalar mode.** In vector mode, motor current limitation is always activated to 9.10.1 value – not depending on the setting of parameter 13.3.1.

OPTIONS

OFF	regulator is inactive
ON	maximal current regulator is active. It can reduce motor frequency up to 0 Hz, if it is needed because of current limit. It is appropriate to use this option in cases where it is not dangerous when frequency decreases under Fmin. Current is not limited at motor generatoric operation (cosφ<0).
up to Fmin	maximal current regulator is active. It can reduce motor frequency only up to Fmin. If motor current is higher at Fmin than Imax (9.10.1), MCR does not work. This can lead to overtemperature or to activation of motor and converter current protection, if load increasing continues. It is appropriate to use this option in cases where frequency decreases under Fmin are not permitted (blowers). Current is not limited at motor generatoric operation (cosφ<0).
generator	At motoring operation the regulator operates identically with option „ON". At generatoric operation this option restricts current by frequency increasing up to Fmax. Combining this option with braking by braking unit (8.2.1) and resistor results in regulation fully substituting dynamic deceleration (8.1.1). **WARNING ! If generatoric load has enough energy it could result in permanent motor operation at Fmax. This option is suitable for load with high moment of inertia. It is dangerous to use this option for lifts and drives without other braking equipment!**
generator, Fmin	It holds the same as for the previous option. The difference is that the regulator does not apply until frequency reaches Fmin.

Maximal current regulator is helpful, when the converter is connected to a smaller motor – it protects the motor by current limitation or e.g. for pumps, where existing converter output is adequate for normal operation but under special conditions (replenishment of empty pipeline after a failure) the converter and motor used to be overloaded. Current limit allows to set a limitation of output current of a converter to an acceptable value using automatic reduction of maximum pump revolutions within the period of empty tank replenishment to a satisfactory level. Without a limit setting, the converter would be overloaded and electronic protection of converter and motor would disable the converter.

13.3.2 P-compon. of MCR

atr = S+R

REGUL.-PROPERTIES – Maximal current default setting: **0.10**

The value of amplification of proportional constant of maximal current regulator.

range: (0.00 ÷ 30.00)

13.3.3 I-compon. of MCR

atr = S+R

REGUL.-PROPERTIES – Maximal current default setting: **100 ms**

The value of integral time constant of maximal current regulator.

range: (1 ms ÷ 4097 ms)

I – component does not apply, if the value is equal to 4097.

13.4.1 Kinetic backup

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: **OFF**

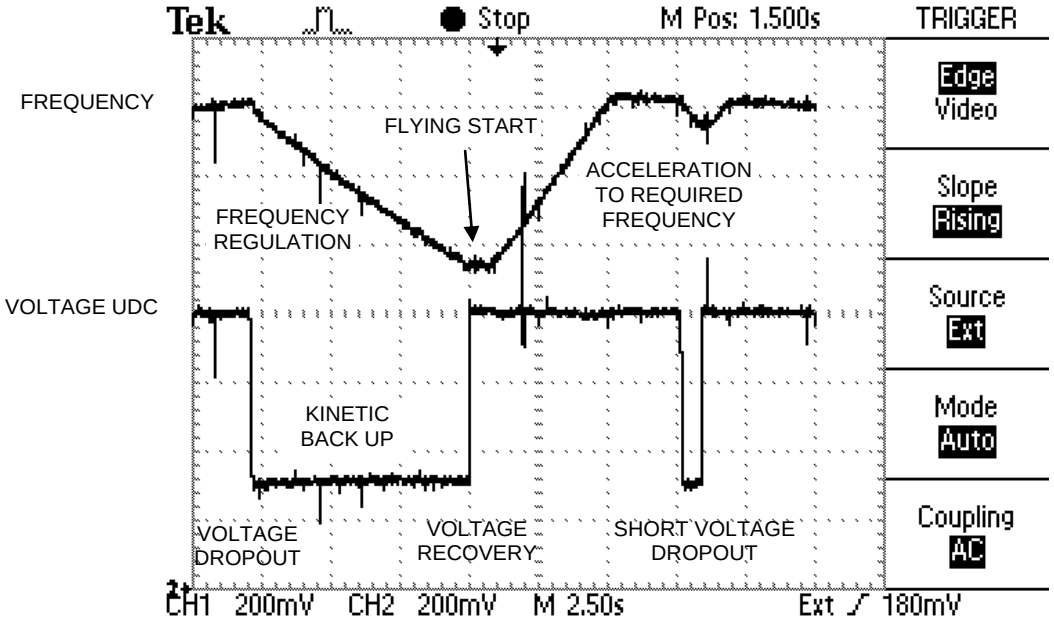
OPTIONS

The selection of kinetic backup regulator KBR operation. KBR is used to bypass short-term power failures of drives with higher moments of inertia.

OFF	Kinetic backup regulator is switched off.
ON	Kinetic backup regulator is switched on.

Kinetic energy is being transformed to electric energy and the motor remains in operation at controlled speed reduction. We recommend to consult the use of kinetic backup and it's setting with the manufacturer.

At kinetic backup, excitation is reduced automatically in order to minimize energy losses in motor winding.



Coverter's kinetic backup along with an input voltage failure.
It reduces the frequency in order to Udc=Udcref.

13.4.2 Max.time of KB

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: **7.0 s**

The maximal time period of the activity of KBR. If kinetic backup takes longer than this time period and converter STOP has been generated, the motor stops after defined/set time ramps.

range: (0.0 s ÷ 60.0 s)

If the decrease of network voltage lasts longer than this time, kinetic backup is disabled and the converter generates fault "CNV undervoltage".

13.4.3 P-compon. of KBR

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: **1.50**

The value of amplification of proportional constant of kinetic backup regulator.

range: (0.00 ÷ 30.00)

Incorrect setting of P-constant of kinetic backup regulator may result, along with a voltage failure, in disabling of this function or in a fault "CNV overvoltage". Setting of this parameter affects the activity of converter's dynamic running down, see parameter (8.1.1).

13.4.4 I-compon. of KBR

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: **80 ms**

The value of integral time constant of kinetic backup regulator.

range: (1 ms ÷ 4097 ms)

Incorrect setting of I-constant of kinetic backup regulator may result, along with a voltage failure, in disabling of this function or in a fault "CNV overvoltage". Setting of this parameter affects the activity of converter's dynamic running down, see parameter (8.1.1).

13.4.5 D-compon. of KBR

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: **17.000**

The value of amplification of derivation constant of kinetic backup regulator.

range: (0.00 ÷ 100.00)

Incorrect setting of D- constant of kinetic backup regulator may result, along with a voltage failure, in disabling of this function or in a fault "CNV overvoltage". Setting of this parameter affects the activity of converter's dynamic running down, see parameter (8.1.1).

13.4.6 UDC refer. for KBR

atr = S+V+R

REGUL.-PROPERTIES – Kinetic backup default setting: $\boldsymbol{Udc_{REF}}$ **= 76.0 %**

The value of unidirectional circuit voltage, which is sustained by the regulator of kinetic backup during input power failure.

range: (75.0 % ÷ 98.0 %)

In order to avoid kinetic backup start at small DC voltage decreases, the user can change this value. See the picture no. 10.

13.5.1 P-component of FSR

atr = V+R

REGUL.-PROPERTIES – Field suppress. default setting: **2.00**

The value of amplification of P-constant of field suppression regulator of motor magnetic flux. Parameter is helpful during vector control regulating over-synchronous revolutions.

range: (0.00 ÷ 70.00)

If minimal flux (9.12.1) is less than maximal (9.12.2) at vector control and voltage reaches Uend (9.6.2) – 5% value, FSR is activated.

13.5.2 I- component of FSR

atr = V+R

REGUL.-PROPERTIES – Field suppress. default setting: **50 ms**

The value of amplification of I-constant of field suppression regulator of motor magnetic flux. Parameter is helpful during vector control regulating over-synchronous revolutions.

range: (1 ms ÷ 4097 ms)

13.5.3 P- comp. of FSR/Imax

atr = V+R

REGUL.-PROPERTIES – Field suppress. default setting: **100 Hz**

This parameter represents frequency limit, over which the converter reduces maximal motor current indirectly proportional to revolutions. Parameter is helpful during vector control regulating over-synchronous revolutions.

range: (10.0 Hz ÷ 300.0 Hz)

13.6.2 Sampling of Reg. atr = V+R

REGUL.-PROPERTIES – Positioning default setting: **10 x 200us**

A period of position regulator's calculations sampling.

range: (0.00 ÷ 30.00)

It should be shorter period of sampling used in a case of quick changes monitoring of required position or liner position increasing monitoring (electronic shaft – PRSS control). If it is extremely short period used, greater inaccuracy of feed forward acceleration feedback can be a result. It can consequently cause noise or rotor vibrations.

13.6.3 P-com.of pos.reg. atr = V+R

REGUL.-PROPERTIES – Positioning default setting: **0.50**

The value of amplification of P-constant of position regulator.

range: (0.00 ÷ 30.00)

13.7.1 Dynamics curr.reg. atr = V

REGUL.-PROPERTIES – Control dynamics default setting: **1.0 ms**

The parameter represents current regulator dynamics. This parameter influences dynamic features of vector control (load jump, fast change of required revolutions). Current regulation directly influences the quality of torque and speed regulation.

range: (0.1 ÷ 5.0)

Recommended value for SMPM motors is 0.8 ms.

13.7.2 Dynamics torq.reg. atr = V

REGUL.-PROPERTIES – Control dynamics default setting: **2.0 ms**

The parameter represents torque regulator dynamics. This parameter influences dynamic features of vector control (load jump, fast change of required revolutions). Torque regulation directly influences the quality of speed regulation.

range: (0.2 ÷ 20.0)

Recommended value for SMPM motors is 1.6 ms.

13.7.3 Dynamics flux.reg. atr = V

REGUL.-PROPERTIES – Control dynamics default setting: **0.50**

The parameter represents magnetic flux regulation dynamics. It defines the speed and the quality of flux regulation and the quality of over-synchronous revolutions control.

range: (0.10 ÷ 5.00)

It represents the multiple of rotor time constant Tr (1.12.4).

13.8.1 Fa atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **0.00 Hz**

It represents the frequency of SR's (speed regulator's) adaptivity break point. The parameter has its meaning, only if par. 13.1.1 equals to „adaptivity from f".

range: (0.00 Hz ÷ 300.00 Hz)

See the picture in par.13.8.7.

13.8.2 P0 atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original P-constant of position regulator at zero frequency. See the picture in par.13.8.7.

range: (0.000 ÷ 30.000)

At opened vector control *parameters 13.8.1-2 have different meaning.* ***Fa*** *(13.8.1) bounds adaptivity area of stator resistance Rs (1.12.1) at low speed. The adaptivity solves the problem of acceleration of high power motors during which non stable regulation is the result of drifts and non-linearities. Thus in mathematical model resistance is adjusted as following Rs****P0*** *(if F=0Hz).* ***Fa*** *values comes to Rs values as frequency increases. Generally,* ***Fa*** *is being set from 2 to 5 Hz and* ***P0*** *from 0.3 to 0.6 .*

13.8.3 I0

atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original I-constant of position regulator at zero frequency.

range: (0.000 ÷ 30.000)

See the picture in par. 13.8.7.

13.8.4 D0

atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original D-constant of position regulator at zero frequency.

range: (0.000 ÷ 30.000)

See the picture in par. 13.8.7.

13.8.5 Pa

atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original P-constant of position regulator at adaptivity break point at frequency **Fa** (par.13.8.1).

range: (0.000 ÷ 30.000)

See the picture in par. 13.8.7.

13.8.6 Ia

atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original I-constant of position regulator at adaptivity break point at frequency **Fa** (par.13.8.1).

range: (0.000 ÷ 30.000)

See the picture in par. 13.8.7.

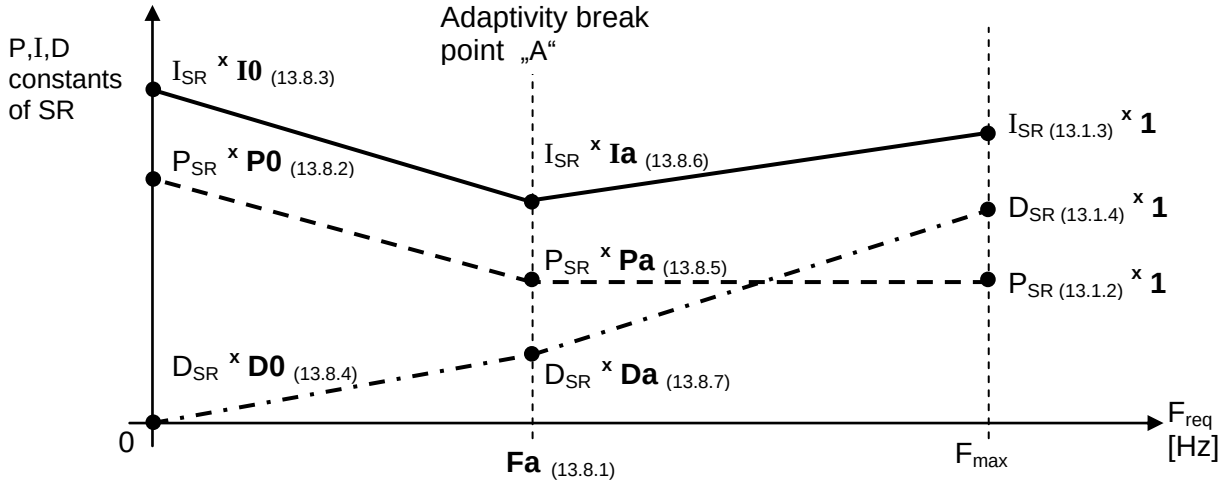
13.8.7 Da

atr = V+R

REGUL.-PROPERTIES – Adapting SR default setting: **1.000**

It is the multiple of original D-constant of position regulator at adaptivity break point at frequency **Fa** (par.13.8.1).

range: (0.00 Hz ÷ 300.00 Hz)



Speed regulator adaptivity.

AUXILIARY MODES

14.1.2 Detect. time

atr = S+V

AUXILIARY MODES – Flying start default setting: **1.5 s**

If function "flying start" (par.10.3.3) is set, this parameter represents maximal time period during which the converter detects revolutions of freely running down motor, separately for each direction.

range: (0.1 s ÷ 15.0 s)

Flying start works also without IRC revolution encoder. Detection period should be proportional to revolutions decrease – thus to total inertia. When IRC encoder is used frequency detection period is not necessary.

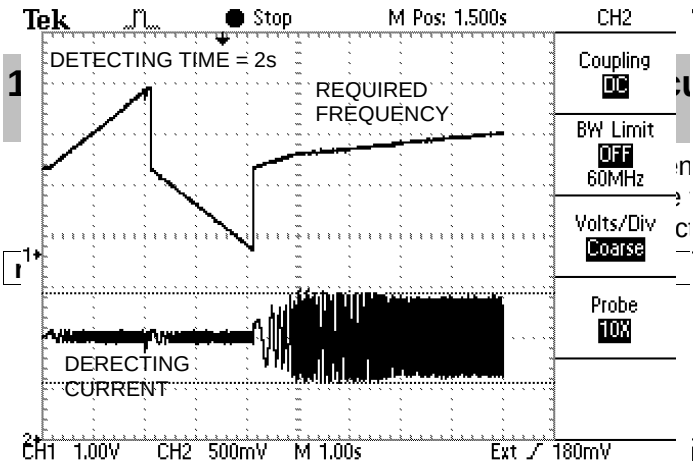
14.1.3 Criterial limit

atr = S+V+R

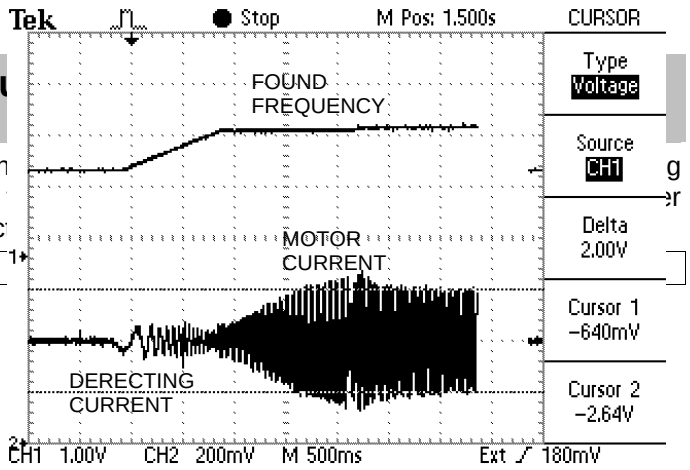
AUXILIARY MODES – Flying start default setting: **63.0 %**

100 % represents maximal accuracy at motor revolutions detection. The accuracy depends on detecting time and detecting current. The shorter the detecting time is the better flying start accuracy is required. The lower the detecting current is the better flying start accuracy is required.

range: (0.0% ÷ 100.0%)



Converter's flying start on steady motor.



Converter's flying start on spinning motor.

14.2.1 MT volt.correct. atr = S+V

AUXILIARY MODES – MT volt.correct. default setting: **ON**

OPTIONS

This parameter compensates motor voltage (the width of PWM pulses), if the change of unidirectional voltage on DC bus occurs.

OFF	Voltage correction is inactive.
ON	Voltage correction is active.

It can be switched off only after consultation with service personnel !

14.2.2 Resonance damping atr = S+V+R

AUXILIARY MODES – MT volt.correct. default setting: **0.00**

Amplification of motor resonance damping regulator. Motor resonance oscillations arise from motor operation using DC bus voltage and motor current. (resonance damping = making the resonance less strong). Resonance damping regulator is inactive, if the value is equal to 0.00.

range: (0.00 ÷ 1.00)

14.5.1 SW term. switch atr = S+V+R

REGUL.-PROPERTIES – SW term. switch default setting: **OFF**

OPTIONS

Software terminal switch can be enabled or forbidden at torque or speed control. IRC revolutions encoder provides the information about position.

OFF	Speed and torque regulation is not affected, if maximal position is exceeded.
type STOP	If actual position comes closer to maximal position (9.13.1), for the distance shorter than deceleration limit (14.5.2), either in positive or negative direction, output frequency becomes constrained so as the drive does not allow motor frequency to increase over 0 Hz at maximal position. Speed (torque) is not constrained within polarity change of required frequency.
type REVERSE	If actual position reaches maximal position (9.13.1) either in positive or negative direction, converter changes the direction of motor rotation. In a case of this option, the converter does not accept REVERSE commands from control panel or binary inputs. **ATTENTION! The trajectory, which the motor can pass over position limit/constraint, is dependant on the dynamics of acceleration and deceleration, on torque and current limitation. It is proportional to the drive's speed, at which it passes the maximal position.**

Although SW terminal switch does not substitute protection terminal switch of position systems, it does substitute operational terminal switch at correct drive's operation.

14.5.2 Posit. for decel. atr = S+V+R

REGUL.-PROPERTIES – SW term. switch default setting: **150.0 cm**

The distance from maximal positive or maximal negative position(9.13.1). If „SW terminal switch " (14.5.1) "type STOP" is selected, the drive starts to slow down at maximal position.

range: (0.1 cm ÷ 3200.0 cm)

In a case of low decreasing limit and high maximal frequency of a drive (9.3.2), drive using SW terminal switch may exceed maximal position.

14.6.1 Extension modules

atr = S+V

EXTENSION MODULES – Extension modules default setting: **none**

OPTIONS Selection of supplementary extension module of a converter.

none	Any supplementary module is connected to the converter.
AM-ARC1	AM-ARC1 is a supplementary module used for absolute position sensing. (producers - Heidenhain, Kübler) The use of this module is appropriate for synchronous motors (SMPM) controlling. If you choose this option, the meaning of parameters 3.7.X changes and the converter does not evaluate the signals coming into entries of control terminal board X1-20 to X1-24. ARC is being connected to the converter via 15 - pin CANNON connector. It is connecting cable of requested length included in extension module. **Exclusively VONSCH Ltd. employees should carry out the installation of AM-ARC1.** **It can be exclusively used in the converters of a type VQFREM 400 or 500.**
RM-DIRC	Extension module use for evaluation of two IRC senssors with tha same resolution. **Exclusively VONSCH Ltd. employees should carry out the installation of AM-ARC1.** **It can be exclusively used in the converters of a type VQFREM 400 or 500.**

Extension modules (as extra hardware) are instrumental for various supplementary frequency converters functions, which can be utilized only with a few applications. It is necessary to order any type of extension module additionally, if needed. Exclusively VONSCH Ltd. employees should carry out the installation of some of the modules (as stated above). Extension modules can be installed on control board of FC. Control board must be equipped with extension conector.

14.6.2 RM-xxx MODE

atr = S+V

EXTENSION MODULES – Extension modules default setting:: **3**

Extension module mode chosen in parameter 14.6.1.

range: (1 ÷ 64)

Serves for parametrisation of extension modules. Its relevance depends from chosen Extension module type.

RM-ARC1 –no relevance

RM-DIRC:

- *1 – RM-DIRC evaluates real speed only from IRC1 –* $F_{RT} = F_{IRC1}$
- *2 – RM-DIRC evaluates real speed only from IRC2 –* $F_{RT} = F_{IRC2}$
- *3 – RM-DIRC evaluates real speed as minimum of speeds from both conected sensors.* $F_{RT} = \min(F_{IRC1}, F_{IRC2})$ ***Serves for elimination traction vehicle axle rearrange*** *and for better control by unequal load.*
- *4 – RM-DIRC evaluates real speed as average of both speeds of both connected sensors.* $F_{RT} = (F_{IRC1} + F_{IRC2}) * 0.5$.

At mode 3 and 4 extension module tests,if both sensors turn at the same direction and if not, periodically each 1s it sends place of real speedi 0Hz. These allerts operating staff at oposite polarity motor phase or outputs in IRC.

14.7.1 Backup bat. (UPS) atr = S+V

AUXILIARY MODES – Backup bat. (UPS) default setting: **OFF**

OPTIONS Activation of the function of automatic switch into back-up power supply mode.

OFF	The mode is switched off. The converter does not operate, if voltage on unidirectional bus decreases under 423 V.
ON	The mode is switched on. If voltage on unidirectional bus decreases under 390 V, the converter terminates undervoltage error and switches itself into back-up power supply mode. Chosen brake parameters become changed when operating in this mode (see other parameters in this section).
ON,auto-reverse	The mode is switched on together with automatic location of the direction of rotation depending on load action. After motor unbraking at start, the converter automatically selects the direction of equipment operation so as the motor rotates in the direction of lower load. It results in longer back-up operation. Detection process and detection time of the direction of operation depends on drive load type, setting of this section parameters and acceleration ramp. Direction of rotation (e.g. entered from binary input) is ignored in back-up mode. Automatic detection of the direction of rotation is active only if vector control mode is chosen with regulated variable – frequency. Chosen brake parameters become changed when operating in this mode (see other parameters in this section). This parameter is mostly used at lift applications, where load type level depends on the number of passengers.

If power supply failure occurs, the converter is capable to continue in its operation because it starts to be charged from back-up power supply (batteries or UPS). Back-up power supply should be connected to converter's unidirectional circuit using special module.

If power supply failure occurs, the converter behaves as following:

- *the converter generates the fault „CNV Undervoltage" .*
- *if U_{DC} decreases under 390V, the fault terminates after default time period. The converter tolerates lower power supply from back-up supply and it displays warning caution „W24 back-up supply!".*
- *after consecutive START command, the converter starts to rotate the motor at minimal frequency (9.3.1).*
- *it is possible to escape back-up mode only if power supply is recovered in STOP.*

If the voltage equals to 158 Vdc or less, the converter generates the fault „CNV Undervoltage" although it is supplied form back-up power supply. It is 423 Vdc when supplied from the power network.

14.7.2 Stabilization time

atr = S+V

AUXILIARY MODES – Backup bat. (UPS) default setting: **0.2 s**

Time required for torque stabilization at direction detection in auxiliary mode 14.7.1 = „ON, auto-reverse“.

range: (0.0 s ÷ 5.0 s)

The parameter is useful at back-up power supply. After the command START at back-up power supply, reaching brake frequency (14.7.4) and unbraking of drive's mechanical brake the converter waits „Stabil. time“ and measures motor torque (its direction and intensity). If the motor operates in generatoric mode, the converter sets positive direction and continues its operation at this direction. Otherwise, it repeats detection test at other direction. If motoric mode is active at both directions of operation, the converter sets the direction of motor rotation with lower load.

14.7.3 Ramp UP/DOWN,UPS

atr = S+V+R

AUXILIARY MODES – Backup bat. (UPS) default setting: **1.0 of U/D time**

The parameter represents prolongation of acceleration and deceleration ramp at back-up power supplying from UPS (see 5.4.3).

range: (1.00 ÷ 10.00) [of U/D time]

Acceleration and deceleration current peak at lift applications is usually 2 - 2.5 multiple of steady current. It is necessary to slow down acceleration and deceleration using this parameter to reduce current peaks (resulting from acceleration dynamics and from overcoming of mass of inertia) at back-up power supplying. If parameter setting equals to 1.00, acceleration and deceleration time do not change. If parameter setting equals to 10.00, acceleration and deceleration last 10 times longer.

14.7.4 Brake frequency

atr = S+V

AUXILIARY MODES – Backup bat. (UPS) default setting: **3.00 Hz**

Brake frequency at back-up power supplying from UPS (see 5.4.3).

range: (0.00 Hz ÷ 10.00 Hz)

It is needed to set nonzero brake frequency at back-up power supplying from UPS, when drives with excessive dry friction are used. The main reason is to make load direction detection possible.

14.8.1 DVA service SL

atr = S+V+R

AUXILIARY MODES – Service DVA var. default setting: **2048**

Internal data address of SLAVE CPU operating personnel wants to be displayed on control panel. The option „Service SL“ should be chosen in control panel.

range: (512 ÷ 4095)

The parameter is applicable for special applications, when it is needed to display some variable outside default variables list.

14.8.2 Type DVA service SL

atr = S+V+R

AUXILIARY MODES – Service DVA var. default setting: **signed**

OPTIONS Display mode of „Service SL“ variable defined in parameter 14.8.1.

signed	display mode: - 32 767 ÷ 32 767
unsigned	display mode: 0 ÷ 65 535

14.8.3 DVA service MS

atr = S+V+R

AUXILIARY MODES – Service DVA var. default setting: **640**

Internal data address of MASTER CPU operating personnel wants to be displayed on control panel. The option „Service MS“ should be chosen in control panel.

range: (512 ÷ 4095)

The parameter is applicable for special applications, when it is needed to display some variable outside default variables list.

14.8.3 Type DVA service MS

atr = S+V+R

AUXILIARY MODES – Service DVA var. default setting: **signed**

OPTIONS Display mode of „Service MS“ variable defined in parameter 14.8.3.

signed	display mode: - 32 767 ÷ 32 767
unsigned	display mode: 0 ÷ 65 535

14.9.1 AOUT service SL

atr = S+V+R

AUXILIARY MODES – Service AOUT var. default setting: **551**

Internal data address of SLAVE CPU operating personnel wants to be displayed on arbitrary analogue output. The option „Service var. SL“ should be chosen in par. 6.1.1 (6.2.1).

range: (512 ÷ 4095)

14.9.2 SL for 100% AOUT

atr = S+V+R

AUXILIARY MODES – Service AOUT var. default setting: **4096**

Represents the value of internal processor variable at which analogue output AOUT = 20mA.

range: (0 ÷ 32767)

14.9.3 AOUT service MS

atr = S+V+R

AUXILIARY MODES – Service AOUT var. default setting: **640**

Internal data address of MASTER CPU operating personnel wants to be displayed on arbitrary analogue output. The option „Service var. MS“ should be chosen in par. 6.1.1 (6.2.1).

range: (512 ÷ 4095)

14.9.4 MS for 100% AOUT

atr = S+V+R

AUXILIARY MODES – Service AOUT var. default setting: **4096**

Represents the value of internal processor variable at which analogue output AOUT = 20mA.

range: (0 ÷ 32767)

APPENDIX "A" - COMPANY SETTINGS (ver.6.07 / 24.06.2008)

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3
MOTOR CONSTANTS							
1.1.1	Motor power	1.0	2000.0	see Appendix B			
1.2.1	Motor current	1	2000	see Appendix B			
1.3.1	Motor voltage	1	999	500 V			
1.4.1	Motor frequency	10.0	300.0	50.0 Hz			
1.5.1	Motor revolutions	1	20000	1450/min			
1.6.1	Number of poles	2	60	4			
1.7.1	Gear ratio	0.1	3000.0	1.0			
1.9.1	Motor efficiency	0.50	0.99	0.82			
1.10.1	PWM off/on time	0.0	60.0	see Appendix B			
1.11.1	Motor therm. cons.	1	300	see Appendix B			
1.12.1	Stator resistance	0.1	3200.0	see Appendix B			
1.12.2	Stator inductance	0.01	320.0	see Appendix B			
1.12.3	Mutual inductance	0.01	320.0	see Appendix B			
1.12.4	Rotor time const.	0.1	3000.0	see Appendix B			
1.12.5	Autotunning MT	0	2				
ACTUATING – COMMANDS							
2.1.1	StartStopReverse	0	2	bin.inputs			
2.1.2	Start/Stop/Rev. (2)	0	2	control panel			
2.2.1	REVERSE	0	2	enabled			
2.3.1	Source-req.value	0	9	analogue input			
2.3.2	Required value (2)	0	9	control panel			
2.4.1	Contr. panel type	0	2	external			
2.5.1	Security code	0	9999	0			
2.6.1	Motor run time	0	1				
2.6.2	MT run time x1	0	999	0 h			
2.6.3	MT run time x1000	0	99	0 x1000h			
2.7.1	Consumption reset	0	1				
2.8.1	Default settings	0	0				
2.8.2	MACRO-MT constants	0	11	500kW			
2.9.1	Backup -> Act. Set	0	0				
2.9.2	Act. Set -> backup	0	0				
2.9.3	Set1 -> Set2	0	0				
2.9.4	Set2 -> Set1	0	0				
2.9.5	EXT.pan. -> Set1,2	0	0				
2.9.6	Set1,2 -> EXT.pan.	0	0				
2.10.1	COM interface	0	1	RS-232			
2.10.2	Converter address	1	99	1			
2.10.3	Communic. mode	0	3	SLAVE,subordinate			
2.10.4	Number of SLAVEs	1	10	1			
2.10.6	Speed from MASTER	0.001	15.999	1.000 (correction)			
2.10.7	Position for SLAVE	0.10	100.00	1.50 (correction)			
2.10.9	Communic. timeout	10	30000	1000 ms			
2.10.12	Baudrate	1	8	2 (19.2kBd/x)			

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3
BINARY INPUTS, IRC							
3.1.1	Function BIN1	0	18	Start/Stop			
3.1.2	Polarity BIN1	0	1	switchesON-24V			
3.2.1	Function BIN2	0	18	acceleration			
3.2.2	Polarity BIN2	0	1	switchesON-24V			
3.3.1	Function BIN3	0	18	deceleration			
3.3.2	Polarity BIN3	0	1	switchesON-24V			
3.4.1	Function BIN4	0	18	inverters reset			
3.4.2	Polarity BIN4	0	1	switchesON-24V			
3.5.1	Function BIN5	0	18	fault acknowl.			
3.5.2	Polarity BIN5	0	1	switchesON-24V			
3.6.1	Function BIN6	0	18	reverse			
3.6.2	Polarity BIN6	0	1	switchesON-24V			
3.7.1	IRC pulses/revol.	100	65 000	1024			
3.7.2	SMPM pos.calibrat.	0	0				
3.7.3	0 pos. of encoder	0	65 535	0			
3.7.4	SMPM pole centre	0	65 535	0			
ANALOGUE INPUTS							
4.1.1	Requir.val. INV/PR	0	4	AIN1			
4.2.1	AIN1 min.	-500.0	500.0	0.0 %			
4.2.2	AIN1 max.	-500.0	500.0	100.0 %			
4.2.3	AIN2 min.	-500.0	500.0	0.0 %			
4.2.4	AIN2 max.	-500.0	500.0	100.0 %			
4.2.5	AIN3 min.	-500.0	500.0	0.0 %			
4.2.6	AIN3 max.	-500.0	500.0	100.0 %			
4.3.1	Feedback PR	0	4	AIN2			
4.4.1	Type AIN1	0	1	0÷10V			
4.4.2	Filter AIN1	0.01	10.00	0.10 s			
4.5.1	Type AIN2	0	1	0÷20mA			
4.5.2	Filter AIN2	0.01	10.00	0.10 s			
4.6.1	Type AIN3	0	1	0÷20mA			
4.6.2	Filter AIN3	0.01	10.00	0.10 s			
RELAY OUTPUTS							
5.1.1	Function RELAY1	0	17	ON,motor running			
5.1.2	Value RELAY1	0.0	100.0	20.0 %			
5.1.3	Hyst. RELAY1	0.0	100.0	5.0 %			
5.2.1	Function RELAY2	0	17	ON - fault			
5.2.2	Value RELAY 2	0.0	100.0	50.0 %			
5.2.3	Hyst. RELAY2	0.0	100.0	5.0 %			
5.2.4	RE2-ON,delay	0.0	60.0	0.0 s			
5.2.5	RE2-OFF,delay	0.0	60.0	0.0 s			
5.3.1	Function RELAY3	0	17	ON,converterReady			
5.3.2	Value RELAY 3	0.0	100.0	70.0 %			
5.3.3	Hyst. RELAY3	0.0	100.0	5.0 %			
5.4.1	Brake delay	0.1	300.0	1.0 s			
5.4.2	Brake advance	0.1	300.0	1.0 s			
5.4.3	Brake frequency	0.00	10.00	3.00 Hz			
5.4.4	Br. response time	0.0	5.0	0.2 s			
5.5.1	RELAY ON at Fmax	0.1	999.9	60.0 s			
5.5.2	RELAY OFF at Fmin	0.1	999.9	60.0 s			
5.6.1	RELAY – warnings 1	0	65 535	0			

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3
5.6.2	RELAY – warnings 2	0	65 535	0			
5.7.1	Static overload	0.0	500.0	100.0 %			
5.7.2	Total overload	0.0	500.0	150.0 %			
5.7.3	Toler. START	0	10 000	500 ms			
5.7.4	Time,Static.overl.	0.00	50.00	1.00 s			
5.7.5	Time,Total.overl..	0.00	50.00	1.00 s			
5.7.6	Cancel overload			(povel)			

ANALOGUE OUTPUTS

6.1.1	Function AOUT1	0	8	INV frequency			
6.1.2	Type AOUT1	0	3	0÷20mA, 0÷max.			
6.1.3	AOUT1 min.	0.0	200.0	0.0 %			
6.1.4	AOUT1 max.	0.0	200.0	100.0 %			
6.2.1	Function AOUT2	0	8	INV current			
6.2.2	Type AOUT2	0	3	0÷20mA, 0÷max.			
6.2.3	AOUT2 min.	0.0	200.0	0.0 %			
6.2.4	AOUT2 max.	0.0	200.0	100.0 %			
6.3.1	Function RELAY4	0	15	ON, Finv = Fref			
6.3.2	Value RELAY4	0.0	100.0	70.0 %			
6.3.4	Hyst. RELAY4	0.0	100.0	5.0 %			

ACCELERATION - DECELERATION

7.1.1	Rump up, Rump down.	0	1	time ramps			
7.1.2	Profile „S“ curve	10	100	100 %			
7.2.1	Acceler. ramp 1	0.1	999.9	10.0 s			
7.2.2	Acceler. ramp 2	0.1	999.9	10.0 s			
7.2.3	Deceler. ramp 1	0.1	999.9	10.0 s			
7.2.4	Deceler. ramp 2	0.1	999.9	10.0 s			
7.2.5	REVERSE rump down	0.10	1.00	1.00 decelerate			
7.2.6	Quick decel.	0.13	1.00	0.20			
7.3.1	Acceler.br point	0.00	300.00	50.00 Hz			
7.3.2	Deceler.br point	0.00	300.00	50.00 Hz			

BRAKING

8.1.1	Dynamic rump down	0	1	OFF			
8.1.2	Dyn.RD DC-voltage	100.0	130.0	110.0 %			
8.2.1	Braking unit	0	1	OFF			
8.3.1	Flux braking	0	1	OFF			
8.3.2	Flux braking gain	00.00	10.00	3.0			

CONSTRAINTS

9.1.1	Sampling frequen.	1.0	10.0	1.5 kHz			
9.2.1	1.bin/const freq.	0.00	300.00	5.00 Hz			
9.2.2	2.binary freq.	0.00	300.00	10.00 Hz			
9.2.3	3.binary freq.	0.00	300.00	15.00 Hz			
9.2.4	4.binary freq.	0.00	300.00	20.00 Hz			
9.2.5	5.binary freq.	0.00	300.00	25.00 Hz			
9.2.6	6.binary freq.	0.00	300.00	30.00 Hz			
9.2.7	7.binary freq.	0.00	300.00	35.00 Hz			
9.2.8	8.bin/max freq.	0.00	300.00	40.00 Hz			
9.3.1	Min. frequency	0.00	300.00	0.00 Hz			
9.3.2	Max. frequency	0.00	300.00	50.00 Hz			

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3
9.4.1	Terminal sw. freq.	0.00	300.00	5.00 Hz			
9.4.2	Terminal path +	0	10 000	100 cm			
9.4.3	Terminal path –	0	10 000	100 cm			
9.4.4	Preset value	0	2	0→position			
9.4.4	Position preset	0	3	immediately			
9.5.1	Shift frequen. U/F	0.10	300.00	10.0 Hz			
9.5.2	Shift frequen. STR	0.10	300.00	10.0 Hz			
9.6.1	Initial voltage	0.1	25.0	see Appendix B			
9.6.2	End voltage	5.0	107.5	100.0 %			
9.6.3	Autotuning Vin	0	0				
9.7.1	Curve index	1.0	2.0	1.0			
9.8.1	Starting torque	1.0	200.0	35.0 %			
9.9.1	Maximal torque	0.0	32500	see Appendix B			
9.9.2	Ratio Mmot/Mgen	0.100	7.000	1.000			
9.10.1	Maximal current	1	2000	see Appendix B			
9.12.1	Min. magn. flux	0.010	5.000	0.800 Wb			
9.12.2	Max. magn. flux	0.010	5.000	2.200 Wb			
9.13.1	Max. position	0.0	3200.0	3000.0 cm			
9.13.2	Position constraint	0	1	ON			
9.14.1	Position scale	0.01	300.00	25.00 cm/rev.			

FAULTS

10.1.1	Faults reset	0	0				
10.2.1	IRC (ARC) dropout	0	2	not tested			
10.2.2	Inp. phases testing	0	1	OFF			
10.2.3	Out. phases testing	0	1	OFF			
10.2.4	MT overloading	0	3	self cooling			
10.2.6	Test communic.err.	0	3	disabled			
10.2.7	Dangerous warning	0	1	not tested			
10.2.8	Danger.warn.filter	1	120	5 s			
10.3.1	Operat. after fault	0	2	waiting			
10.3.2	Time after fault	0.1	60.0	2.5 s			
10.3.3	Operat. undervolt.	0	3	not waiting			

CONTROL MODE

11.1.1	Contr. strategy	0	4	scalar, opened			
11.2.1	Control variable	0	2	speed			

PROCESS REGULATOR

12.1.1	Process reg. (PR)	0	2	OFF			
12.1.3	PR dead zone	0.0	10.0	0.0 %			
12.2.1	P – compon. of PR	0.00	30.00	1.00			
12.2.2	I – compon. of PR	0.01	600.01	10.00 s			
12.2.3	D – compon. of PR	0.00	1.00	0.00 s			
12.3.1	Fixed req.var. PR	0.0	500.0	50.0 %			
12.4.1	Min.req.var.of PR	0.0	500.0	0.0 %			
12.4.2	Max.req.var.of PR	0.0	500.0	100.0 %			
12.5.1	Parking of PR	0	1	OFF			
12.5.2	ParkiOFF hysteresis	0.0	99.9	5.0 %			
12.5.3	Park ON time	0.1	3200.0	60.0 s			

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3

REGULATORS – PROPERTIES

13.1.1	Speed. reg. mode	0	3	normal			
13.1.2	P –compon. of SR	0.01	100.0	10.00			
13.1.3	I –compon. of SR	0.2	3000.0	3.0 ms			
13.1.4	D -compon. of SR	0.000	7.000	0.000			
13.1.5	Sampling of Reg.	1	10	1 x 200us			
13.1.6	Speed filter type	0	5	0			
13.2.1	Start torq. regul.	0	1	ON			
13.2.2	P –compon. of STR	0.00	30.00	0.50			
13.2.3	I –compon. of STR	1	4097	120 ms			
13.3.1	Max current reg.	0	1	OFF			
13.3.2	P -compon. of MCR	0.00	30.00	0.10			
13.3.3	I - compon. of MCR	1	4097	100 ms			
13.4.1	Kinetic backup	0	1	OFF			
13.4.2	Max.time of KB	0.0	60.0	7.0 s			
13.4.3	P –compon. of KBR	0.00	30.00	1.50			
13.4.4	I –compon. of KBR	1	4097	80 ms			
13.4.5	D –compon. of KBR	0.00	100.00	17.00			
13.4.6	UDC refer. for KBR	75.0	98.0	76.0 %			
13.5.1	P –component of FSR	0.00	70.00	2.00			
13.5.2	I –component of FSR	1	4097	50 ms			
13.5.3	P –comp.of FSR/Imax	10.0	300.0	100.0 Hz			
13.6.2	Sampling of Reg.	1	50	10 x 200us			
13.6.3	P-com.of pos.reg.	0.00	30.00	0.50			
13.7.1	Dynamics curr.reg.	0.1	5.0	1ms			
13.7.2	Dynamics torq.reg.	0.2	20.0	2ms			
13.7.3	Dynamics flux.reg.	0.10	5.00	0.50			
13.8.1	Fa	0.00	300.00	0.00 Hz			
13.8.2	P0	0.000	30.000	1.000			
13.8.3	I0	0.000	30.000	1.000			
13.8.4	D0	0.000	30.000	1.000			
13.8.5	Pa	0.000	30.000	1.000			
13.8.6	Ia	0.000	30.000	1.000			
13.8.7	Da	0.000	30.000	1.000			

NO.	PARAMETER	MIN.	MAX.	FACTORY SETTING	USER SETTING 1	USER SETTING 2	USER SETTING 3
AUXILIARY MODES							
14.1.2	Detect. time	0.1	15.0	1.5 s			
14.1.3	Criterial limit	0.0	100.0	94.0 %			
14.1.4	Detect. current	5.0	70.0	20.0 %			
14.2.1	MT volt.correct.	0	1	ON			
14.2.2	Resonance damping	0.00	1.00	0.00			
14.5.1	SW term. switch	0	2	OFF			
14.5.2	Posit. for decel.	0.1	3200.0	150.0 cm			
14.7.1	Backup bat. (UPS)	0	2	OFF			
14.7.2	Stabilization time	0.0	5.0	0.2 s			
14.7.3	Rump UP/DOWN, UPS	1.00	10.00	1.00 of U/D time			
14.7.4	Brake frequency	0.00	10.00	3.00 Hz			
14.8.1	DVA service SL	512	4095	2048 d			
14.8.2	Type DVA service SL	0	1	signed			
14.8.3	DVA service MS	512	4095	640 d			
14.8.4	Type DVA service MS	0	1	signed			
14.9.1	AOUT service SL	512	4095	551 d			
14.9.2	SL for 100% AOUT	0	32 767	4096 d			
14.9.3	AOUT service MS	512	4095	640 d			
14.9.4	MS for 100% AOUT	0	32 767	4096 d			

APPENDIX "B" - MACRO MOTOR CONSTANTS

Notes:

1) There are default factory settings of some motor constants listed in the following table. They are divided according to motor power. Default settings are being written into the converter via parameter „MACRO-motor constants“ in section „Actuating-Commands“.
2) The values of resistance and inductance in the following tables relate to motor wye connection, 500V. These values are only informative. Practically, they are being identified during identification „Autotunning MT“ in section „Motor constants“.

VQFREM 500

PARAMETER	MACRO- MT constants											
	132kW	160kW	200kW	250kW	315kW	400kW	500kW	630kW	710kW	800kW	900kW	1000kW
Motor power [kW]	132.0	160.0	200.0	250.0	315.0	400.0	500.0	630.0	710.0	800.0	900.0	1000.0
Motor current [A]	133	159	199	245	312	398	490	612	690	780	880	970
Maximal current [A]	266	318	345	345	345	480	600	756	852	960	1080	1200
Maximal torque [Nm]	1698	2060	2214	2256	2242	3110	3948	4957	5584	6298	7085	7936
Initial voltage [%]	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.2	1.1
Stator resistance [Ω]	15.0	11.0	8.0	7.5	5.4	3.9	2.6	2.1	1.5	1.5	1.2	1.0
Stator inductance [mH]	8.70	8.97	6.74	5.80	5.12	4.15	3.50	3.15	2.80	2.80	2.20	1.80
Mutual inductance [mH]	8.30	8.75	6.59	5.76	5.10	4.13	3.42	3.13	2.76	2.76	2.14	1.76
Rotor time const. [ms]	966.0	1130.0	1359.2	1400.0	1500.0	1600.0	1775.6	1902.0	2000.0	2000.0	2100.0	2200.0
PWM-off/on time [s]	2.0	2.3	2.7	2.9	3.2	3.5	3.7	4.0	4.2	4.5	4.5	4.6
Motor therm. cons. [min]	55	55	60	60	65	65	65	65	70	70	70	70

APPENDIX "C" - COMMUNICATION PROTOCOL SETX (Rev.: 12.10.2006)

Description of serial interface of VQFREM frequency converter

Serial interface is used for reading motor operating variables, for reading and writing access to parameters in individual sets and for controlling converter‘s functions (e.g. requested frequency, command start/ stop). Interface is based on communication protocol SETX.

Communication protocol SETX is **asynchronous, serial, character oriented communication protocol**. Its framework consists of 8-bit characters (bytes), which have accurately defined meaning. It is always MASTER - SLAVE communication in VONSCH applications! MASTER is a superior system (or control frequency converter) and SLAVE is a subordinate system (one or more frequency converters).

The mode of asynchronous serial port is: 1 start bit, 8 data bits, parity none, 1 stop bit.

Communication speed is adjustable in parameter (2.10.12).

COMMUNICATION FRAMEWORK

STX	STX	STX	DATA_n	CRC_hi	CRC_lo	ETX
1byte	1byte	1byte	n bytes	2 bytes		1byte

STX (02 hex) = character determining telegram header
DATA_n = data field = [ADRMEN, ADRDAT, DATA, STAT]
ADRMEN (hi,lo) = converter address (higher, lower byte)
ADRDAT (hi,lo) = data address (higher, lower byte), according pre-defined data addresses
DATA (hi,lo) = data (higher, lower byte)
STAT (hi,lo) = status register of a converter (higher, lower byte)
CRC (hi,lo) **=** check sum (higher, lower byte)
ETX (03 hex) = end character
DLE (10 hex) = prefix character

Prefix characters

If characters **STX**, **ETX**, **DLE** will be in data meaning in **DATA_n** and **CRC** section, prefix character **DLE** (e.g.: DLE DLE, DLE STX, DLE ETX) must be at the position in front of them.

If the character **DLE** will be in **DATA_n** and **CRC** section, but any of these characters **DLE**, **STX**, **ETX** are in a position behind it, the message is considered to be mistaken / false.

DESCRIPTION OF DATA FIELD.

Data reading access or command executing:

DATA_n =	+ADRMEN_hi	+ADRMEN_lo	ADRDAT_hi	ADRDAT_lo

ADRMEN (hi,lo) = Converter address (parameter 2.10.2) Example: 0005h

ADRDAT (hi,lo) = Data address Example: 00A1h, (converter's start)

If converter address equals ADRMEN (hi,lo) = 7FFFh, every converter responds to it not depending on its own address. The converter does not transmit any respond to received telegram. This converter reaction is necessary at controlling simultaneously more drives.

This "*Global address*" is not useful within data reading telegrams (e.g. reading telegrams of displayed variables).

Data writing access:

DATA_n =	– ADRMEN_hi	– ADRMEN_lo	ADRDAT_hi	ADRDAT_lo	DATA_hi	DATA_lo

ADRMEN (hi,lo) = (-1) x (Converter address) Example: 0FFFBh (–0005h)

If converter address equals ADRMEN (hi,lo) = 8001h, every converter responds to it not depending on its own address. The converter does not transmit any respond to received telegram. This converter reaction is necessary at writing access of required frequency for more drives.

"*Global address*" is not recommended to be used for converter's parameters writing.

Converter's respond to command, writing or reading access:

DATA_n =	+ ADRMEN_hi	+ ADRMEN_lo	ADRDAT_hi	ADRDAT_lo	DATA_hi	DATA_lo	**STAT**_hi	**STAT**_lo

The converter always responds with its own address, data address and data.
– In a respond to writing access telegram, DATA (hi,lo) are being filled with momentary real value of frequency and position.
– Data do not have meaning in a respond to command telegram.

The converter always adds its status register at the end of data field in order to enable the superior system to recognize operating states of a converter.

Status register of a converter:

Bit	Meaning	Log. 0	Log.1
0	**Motor voltage**	disconn.	connected
1	**Converter is ready for START via serial link** - converter cannot start because of some internal event: (operating personnel works with parameters during stop, Start/Stop is not from serial link, motor field suppression is not finished yet, motor identification is not finished yet, converter's trial period has expired)	not ready	ready
2	**Converter's reset via serial link** - the converter has executed Reset command from serial link	OFF	ON
3	**Reverse** - required frequency or position is negative	OFF	ON
4	**Motor ready** - motor is excited and brake is unbraked (if it is used)	not ready	ready
5	**Active set**	SET1	SET2
6	**Converter's reset** - caused by chosen binary input or internal reset at communication error	OFF	ON
7	**Terminal switch 2** - if it is binary input with function „terminal switch2" switched on	inactive	active
8	**Fault** - some bit has different value than zero in the fault registry (0046h)	didn't occur	occurred
9	**Warning** - some bit has different value than zero in the warning registry (0044h, 45h)	didn't occur	occurred
10	**Start / Stop**	in stop	in start
11	**End of trial operation**	OFF	ON
12	**Critical warning** (see parameters 10.2.6 and 10.2.7) - one of the regulators (current, magnetic flux, torque or speed regulator) has been saturated at vector control mode - current limit has been activated at scalar control mode - IRC encoder does not give correct speed information	didn't occur	occurred
13	**Frequency change at the output of ramp generator** (see the picture no. 2) - if the freq. is constant, the change finished and the logical value is equal to 1	not finished	finished
14	**Position calibration command** - the converter received position calibration telegram	not received	received
15	**Password authorization** - enables the change of parameters via serial link	not valid	valid

PRE – DEFINED DATA ADDRESSES

Commands addresses

Address	*Name*	*Meaning*	*Telegram*
00A0h	Reset + Stop	initiates converter's reset and stop at the same time, (if reset terminates, it does not activate start again)	Read access
00A1h	Start	initiates converter's start, (only if par. 2.1.1 = „serial link“)	Read access
00A2h	Stop	initiates converter's stop, (only if par. 2.1.1 = „serial link“)	Read access
00A3h	Reset – ON	activates converter‘s reset, (immediate voltage disconnection from motor)	Read access
00A4h	Reset – OFF	cancels converter‘s reset and activates start, (if start is from binary input or serial link)	Read access
00A5h	Position calibration	Real position = 0 , (only if par. 9.4.4 = „by serial link“)	Read access
00A6h	Position calibration	Real position = + max., (only if par. 9.4.4 = „by serial link“)	Read access
00A7h	Position calibration	Real position = – max., (only if par. 9.4.4 = „by serial link“)	Read access
00A8h	Fault confirmation	confirms the fault, if the converter is waiting for fault confirmat.	Read access
00A9h	Parameterization	Initiates parameterization, if the converter is in stop. It is necessary after parameters change via serial link. The command executes only if password authorization is correct	Read access
0080h	Password authorization	DATA = security code (par. 2.5.1). It is is needed for parameters change authorization via serial link. It is valid until communication timeout does nit expire. For timeout value see par. 2.10.9.	**Write access**

Note:

If some command cannot be executed, the converter sends a telegram with error specification. You can find the description of error specifications at the page 100 under the heading „**Special responds**“.

Addresses of required variables

Required variable is accepted, if the source of required value is "serial link" (parameter 2.3.1).
Write access of frequency or position is accepted in dependence on regulated variable (parameter 11.2.1).

Address	*Name*	*Meaning*	*Telegram*
0020h	Required frequency	Data format is: +/- XXX,XX Hz	Write access
0021h	Required position – behind gear	Data format is: +/- XXXX,X cm	Write access
FFDFh (-0021h)	Required position – on rotor	Data format is: +/- [XXXX YYYY]hex XXXX is 16bit as complete revolution YYYY is 16bit as an angle within revolution (8000h represents 180°)	32bit Write access
0022h	Required mechanical torque on rotor	Data format is: +/- XXX,X % out of MAX. torque (9.9.1)	Write access

Note:

32bit. position is used at synchronous speed – position control of two motors, MASTER - SLAVE communication. Data are being transmitted in 32bit telegram.

Addresses of displayed variables

Address	*Name*	*Meaning*	*Telegram*
0001h	Software version	0x607 for ver.6.07	Read access
0004h	Voltage range	0x190 for 400V, 0x191 for 400 ...M 0x2b2 for 500V	Read access
0025h	Freq.INV	+/- XX.XX Hz	Read access
0026h	Revolves	+/- XXXX rev/min	Read access
0027h	Revol/i	+/- XXXX.X rev/min	Read access
0028h	Freq.RT	+/- XX.XX Hz	Read access
0029h	Freq.RF	+/- XX.XX Hz	Read access
002Ah	MT curr.	XXXX A	Read access
002Bh	R.torque	+/- XXXX Nm	Read access
002Ch	Torque	+/- XXXX Nm	Read access
002Dh	Magn. flux	X.XXX Wb	Read access
002Eh	Volt. MT	XXX.X %	Read access
002Fh	Volt. DC	XXX V	Read access
0030h	Inp.pow.	XXXX kW	Read access
0031h	MT power	XXXX kW	Read access
0032h	kW hours	XXXX kWh	Read access
0033h	MW hours	XXXX MWh	Read access
0034h	Temp. in cooler	XX.X °C	Read access
0035h	Temp. in INV	XX.X °C	Read access
0036h	PR req.	XX.X %	Read access
0037h	PR real	XX.X %	Read access
0038h	Inp. AIN1	XX.X %	Read access
0039h	Inp. AIN2	XX.X %	Read access
003Ah	Inp. AIN2	XX.X %	Read access
003Bh	BIN 1- 6	see **BIN / RELAY register**	Read access
003Ch	RELAY 1- 3,4	see **BIN / RELAY register**	Read access
003Dh	Hours INV	XXXX h	Read access
003Eh	Hours MT	XXXX h	Read access
003Fh	Pos. ref.	+/- XXXX.X cm	Read access
0040h	Position	+/- XXXX.X cm	Read access
0041h	Pos. TSW2	+/- XXXX cm	Read access
0042h	ARC zero	XXXX d	Read access
0043h	cos(fi)	+/- X.XX	Read access
0044h	Warnings 2	see **Warnings register 2**	Read access
0045h	Warnings 1	see **Warnings register 1**	Read access
0046h	Faults	see **Faults register**	Read access
0048h	Overload	XXX.X %	Read access

Addresses of displayed variables (continued)

Address	*Name*	*Meaning*	*Telegram*
0049h	Service SL	XXXX d	Read access
004Ah	Service MS	XXXX d	Read access

Faults and warnings registers

DATA_hi								DATA_lo							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Faults register*: :* If arbitrary bit is set to log.1, the corresponding fault/failure has arisen in the converter.

Bit	Meaning	Bit	Meaning
0	CNV Overcurrent	8	Identification err.
1	CNV Overload	9	Out. short circ.
2	CNV Undervoltage	10	IRC failure
3	CNV Overvoltage	11	Input or Output phase loss
4	MT Overheat	12	External failure
5	Heatsink Temp.	13	Temperature in INV
6	Incorrect par. of currents, MT const. or speed	14	AIN1, AIN2 disconn.
7	Regulation err.	15	*reserved*

Warnings register 1*:* If arbitrary bit is set to log.1, the converter generates corresponding warning.

Bit	Meaning	Bit	Meaning
0	some warnings W1, W2, W3, W4, W5	8	F8 dynam.rump down
1	W6 temp. of cooler	9	W16 motor temp.
2	W7 IRC/ARC failure	10	W17 external panel
3	W8 direct. IRC/ARC	11	F2 current limit
4	F7 time PWM off/on	12	F3 kinetic backup
5	W12 saturated PR	13	F4 flying start
6	F9 position preset F10 search ZP-IRC	14	F5 parking PR
7	F11 SW terminal switch	15	F6 braking unit is active

Warnings register 2:

Bit	Meaning	Bit	Meaning
0	W23 disconnect.MT	8	W18 communication RS232(485)
1	F12 termin. switch	9	F16 relay-overload
2	F13 flux braking	10	reserved
3	W9 input phase	11	reserved
4	reserved	12	reserved
5	F14 autotuning	13	reserved
6	W25 temp. in INV	14	reserved
7	reserved	15	reserved

BIN/RELAY register: If arbitrary bit is set to log.1, than corresponding input (RELAY) is switched on.

Bit	Meaning	Bit	Meaning
0	state of input BIN1	8	state of RELAY1
1	state of input BIN2	9	state of RELAY2
2	state of input BIN3	10	state of RELAY3
3	state of input BIN4	11	*reserved*
4	state of input BIN5	12	*reserved*
5	state of input BIN6	13	*reserved*
6-7	*idle - not used*	14-15	*idle*

Parameters addresses

The values of parameters can be changed via serial link, providing that password authorization is valid.

Address	*Name*	*Meaning*	*Telegram*
0421h | 1FFFh	Parameters of SET 1	Parameter address is calculated according the following formula: 200h*X + 20h*Y + Z	Read access / Write access
2421h | 3FFFh	Parameters of SET 2	Parameter address is calculated according the following formula: **2000h** + 200h***X** + 20h***Y** + **Z**	Read access / Write access

X = [group number + 1], (X = 2 to 15)
Y = section number, (Y = 1 to 15)
Z = parameter number, (Z = 1 to 31)

Special responds

If the converter sent out one of the following addresses on the position ADRDAT (hi,lo) in his respond, the corresponding event has occurred. The value DATA (hi,lo) received in such a telegram is not useful.

Address	*Meaning*	*Telegram*
0011h	Parameters writing / reading from EEPROM error.	Respond
0012h	The address is not defined.	Respond
0013h	The command could not be executed.	Respond
0014h	The variable is not regulated variable (see parameter 11.2.1).	Respond
0015h	Incorrect number, the parameter does not exist.	Respond
0016h	Parameter access forbidden, password authorization not valid.	Respond
0017h	Parameter access not allowed, parameters are being changed via CP.	Respond
0018h	The value of parameter is out of permissible interval, write access forbidden.	Respond

COMPUTATION OF CRC

CRC is computed only from the characters of data field DATA_n.
When computing CRC, prefix characters DLE are not considered, except the case they have data meaning.

Writing access in C language:

```
unsigned short ComputeCrc16(unsigned int n, unsigned char *buf)
{     unsigned char *s;
      unsigned short val = 0, length;
      length = n;
      for (s = buf; n; n--)
              val += (*s++) ^ (length-n);
      return( ~val );
}
```

Writing access in Pascal language:

```
type
 TBuffer=array[byte]of byte;
 PBuffer=^TBuffer;

function Crc16(n:integer;Buf:PBuffer):word;
var i:byte;Val:word;
begin
 Val:=0;
 for i:=0 to n-1 do
   inc(Val,Buf^[i] xor i); {n je pocet bytov, ak n by bol index posledneho, tak cyklus je "to
n". inc(Val,...) sa da zapisat aj ako Val:=Val+...}
 Crc16:=not Val;
end;
```

CRC CALCULATION EXAMPLES

Commands : (Converter address = 5)

All of the numeric values are in hexadecimal system!

CRC type	**STX**	**STX**	**STX**	**DATA_n**	**CRC**	**ETX**
Start	02	02	02	00 05 00 A1	FF 57	03
Stop	02	02	02	00 05 00 A2	FF 58	03
Parameterization	02	02	02	00 05 00 A9	FF 4F	03

Reading : (Converter address = 5)

All of the numeric values are in hexadecimal system!

Telegram	**STX**	**STX**	**STX**	**DATA_n**	**CRC**	**ETX**
the variable "Volt.DC"	02	02	02	00 05 00 2F	FF CD	03
the variable "Temp. INV"	02	02	02	00 05 00 35	FF C3	03

Writing : (Converter address = 5)

All of the numeric values are in hexadecimal system!

Telegram	**STX**	**STX**	**STX**	**DATA_n**	**CRC**	**ETX**
Freq.ref. = 23,00 Hz	02	02	02	FF FB 00 20 08 FC	FC DC	03
Freq.ref. = 6,40 Hz	02	02	02	FF FB 00 20 ***10*** 02 80	FD 56	03
Authorization password = 0000	02	02	02	FF FB 00 80 00 00	FD 78	03

EXAMPLES OF MASTER–SLAVE COMMUNICATION

1. Synchronnous control of two motors (PRSS):

PRSS is Position-Speed Synchronous System for controlling a pair of converters. The first of the pair is in the function of MASTER – controlled by speed and the second is in the function of SLAVE – controlled by position. This method is used e.g. for synchronous controlling of elevations on cranes.

PRSS principle

The converter - MASTER transmits its real position and the converter - SLAVE accepts it as requested. In order to eliminate position delay during position transmission via serial link, it is the position in MASTER adjusted by a correction. The correction is calculated from momentary motor speed and parameter „Position for SLAVE“ (2.10.7).

PRSS operation

START – if Master start is activated (e.g. from binary input), Master transmits start command to the Slave.

BRAKE – after start, both drives are braked. Master and Slave count down the time „Brake delay“ (5.4.1) individually. Then, drives become unbraked. At stop, as soon as drives reach zero speed they become braked. Motors continue to be excited. Both converters start to count down the time „Brake advance“ (5.4.2). Then, motors finish being excited and become disconnected from the voltage.

MOTION – after start (e.g. from AIN), Master applies required value after the time „Br. response time“ (5.4.4) expires.
This time considers mechanic delay during unbraking. Then, Master drive moves according to deceleration time and required value, its real position is transmitted to Slave drive.

STOP – if stop is activated, both drives come to zero speed according to deceleration time. Than, Master transmits stop command to Slave.

PRSS security

POSITION DETUNING – to prevent position detuning, it is needed to calibrate both drives on the same position according to par.9.4.3. Calibration can be executed using binary input (3.X.1) or always after converter's switching on (by serial link 9.4.4).

POSITION CONSTRAINT – drive's motion can be constrained using two methods.

a) using program, so called „SW term. switch“ (par. 14.5.1), in both Master and Slave converters.

b) using tangible terminal switches individually for each drive. They should be connected into binary input with the function „terminal switch 2“ (par. 3.X.1), in both Master and Slave converters. Information about activated terminal switch is transmitted via serial link to the Master.

READY FOR START – if Slave converter is not ready for start (for reasons - see “Status register“ in appendix „B“), Master converter displays the warning „W26 stop SLAVE 1“ and start is forbidden.

READY TO MOVE – if Slave converter is not ready to move (for reasons - see “Status register“ in appendix „B“), Master and Slave converters are in start but they do not move, sustains zero speed.

SLAVE OVERLOADING – if Slave converter displays some critical warning (see 10.2.7, 10.2.8), Master converter immediately turns off both drives by activating the command „Converter's reset“ and generates the fault „SLAVE overload 1“.

SLAVE FAILURE– if Slave converter's failure occurs, Master immediately stops its operation and displays the fault „SLAVE error1“

2. Synchronnous control of more motors (RSS):

RSS is Speed Synchronous System for controlling several converters. One of the converters is in MASTER mode and the others are in SLAVE mode. Each of the converters is controlled by speed. MASTER converter can control the maximum 10 SLAVE converters.

This method is used in production lines, where it is necessary to control the speed of whole system of drives (e.g. transporter lines).

RSS principle

The converter - MASTER transmits its required (or real) speed simultaneously to all SLAVE converters. SLAVE converters gradually accept it as requested, after multiplying it by correction "Speed from MASTER"(2.10.6).

RSS operation, RSS security

The security and operation of RSS method is equivalent with the security and operation of PRSS, (see PRSS operation, PRSS security).

WARNING!
Please, consult parameters settings for applications of PRSS or RSS method with converter manufacturer !

PARAMETERS SETTING FOR MASTER–SLAVE COMMUNICATION MODE

PRSS:

No.	Parameter	MASTER	SLAVE
2.1.1	StartStopReverse	binary inputs	serial link
2.3.1	Source-req.value	*as required*	serial link
2.10.1	COM interface	RS-485	RS-485
2.10.2	Converter address	---	1
2.10.3	Communic. mode	MASTER-position	SLAVE-subordinate
2.10.4	Number of SLAVEs	1	---
2.10.7	Position for SLAVE	2.50 to 5.00	---
2.10.9	Communic. timeout	25 ms	25 ms
2.10.12	Baudrate	1 (19200 Bd)	1 (19200 Bd)
3.1.1	Function BIN1	Start/Stop	---
3.2.1	Function BIN2	terminal switch	terminal switch
3.3.1	Function BIN3	pos. calibration	---
5.1.1	Function RELAY1	brake,ON/OFF	brake,ON/OFF
5.4.1	Brake delay	0.2 s	0.2s
5.4.2	Brake advance	3.5 s	3.5 s
5.4.3	Brake frequency	0 Hz	0 Hz
5.4.4	Br. response time	0.2 s	---
7.1.1	Rump up,Rump down	time ramps	dynamic
7.2.1	Accel. ramp 1	*as required*	0.9 x MASTER
7.2.3	Decel. ramp 1	*as required*	0.9 x MASTER
9.4.1	Term. switch freq.	0 Hz	0 Hz
9.4.2	Terminal path +	0 cm	0 cm
9.4.3	Terminal path -	0 cm	0 cm
9.4.4	Preset value	0 –> position	0 –> position
9.4.5	Position preset	after init.	by serial link
9.13.1	Max. position	*as required*	*as required*
10.2.6	Communic.err.test	*as required*	*as required*
10.2.7	Dangerous warning	---	tested
10.2.8	Danger.warn.filter	---	3 s
11.1.1	Contr. strategy	vector AM,closed	vector AM,closed
11.2.1	Control variable	speed	position
14.5.1	SW term. switch	*as required*	*as required*
14.5.2	Posit. for deceler.	*as required*	*as required*

RSS:

No.	Parameter	MASTER	SLAVE-n
2.1.1	StartStopReverse	binary inputs	serial link
2.3.1	Source-req.value	*as required*	serial link
2.10.1	COM interface	RS-485	RS-485
2.10.2	Converter address	---	1, 2, 3, ..., n
2.10.3	Communic. mode	MASTER-speed	SLAVE-subordinate
2.10.4	Number of SLAVEs	n , max.10	---
2.10.7	Speed from MASTER	---	1.00, *as required*
2.10.9	Communic. timeout	25 ms	2 x n x 25 ms
2.10.12	Baudrate	1 (19200 Bd)	1 (19200 Bd)
7.1.1	Rump up,Rump down	linear ramps	linear ramps
7.2.1	Accel. ramp 1	*as required*	0.9 x MASTER
7.2.3	Decel. ramp 1	*as required*	0.9 x MASTER
10.2.6	Communic.err.test	*as required*	*as required*
10.2.7	Dangerous warning	---	tested
10.2.8	Danger.warn.filter	---	3 s
11.1.1	Contr. strategy	vector AM,closed	vector AM,closed
11.2.1	Control variable	speed	speed

APPENDIX "D" - TECHNICAL DRAWINGS