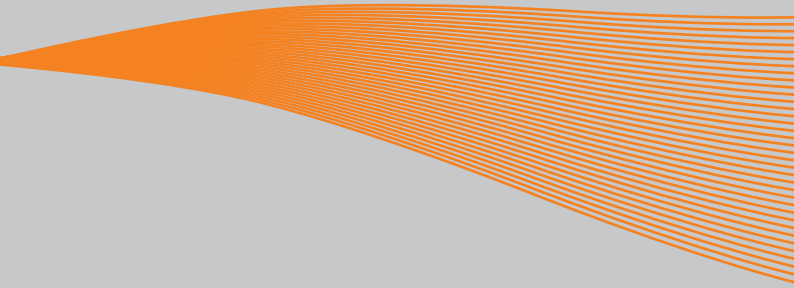
VACON® 10
AC DRIVES

VACON 10 PFC USER MANUAL



VACON®
DRIVEN BY DRIVES

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1.SAFETY

ONLY A COMPETENT ELECTRICIAN IS ALLOWED TO CARRY OUT THE ELECTRICAL INSTALLATION!

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully:

	=Dangerous voltage Risk of death or severe injury
	=General warning Risk of damage to the product or connected appliances

1.1 Warnings

The components of the power unit of the frequency converter are live when Vacon 10 is connected to the mains. Coming into contact with this voltage is extremely dangerous and may cause death or severe injury. The control unit is isolated from the mains.

The motor terminals U, V, W (T1, T2, T3) and the possible brake resistor terminals -/+ are live when Vacon 10 is connected to the mains, even if the motor is not running.

The control unit I/O-terminals are isolated from the mains. However, the relay output terminals may have a dangerous control voltage present even when Vacon 10 is disconnected from the mains.

Ground leakage current of Vacon 10 frequency converters exceeds 3.5mA AC. According to standard EN61800-5-1, a reinforced protective ground connection must be ensured.

If the frequency converter is used as a part of a machine, the machine manufacturer is responsible for providing the machine with a main switch (EN 60204-1).

If Vacon 10 is disconnected from the mains while running the motor, it remains live if the motor is energized by the process. In this case the motor functions as a generator feeding energy to the frequency converter.

After disconnecting the frequency converter from the mains, wait until the fan stops and the indicators on the display disappear. Wait 5 more minutes before doing any work on Vacon 10 connections.

The motor can start automatically after a fault if the automatic restart function has been enabled.

1.2 Safety instructions

The Vacon 10 frequency converter has been designed for fixed installations only.

Do not perform any measurements when the frequency converter is connected to the mains.

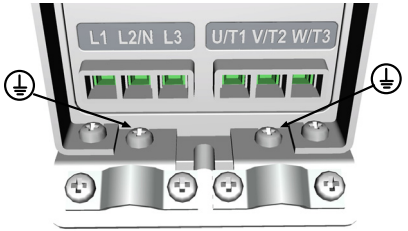
Do not perform any insulation tests on any part of Vacon 10.
Product safety has undergone full factory testing.

Prior to measuring the motor or the motor cable, disconnect the motor cable from the frequency converter.

Do not open the cover of Vacon 10. Static voltage discharge from your fingers may damage the components. Opening the cover may also damage the device. If the cover of Vacon 10 is opened, warranty becomes void.

1.3 Earthing and earth fault protection

The Vacon 10 frequency converter **must always** be grounded with a ground conductor connected to the grounding terminal. See figure below:



- The earth fault protection inside the frequency converter protects only the converter itself against ground faults.
- If ground fault current protective switches are used, they must be tested on the drive with ground fault currents that may arise in fault situations.

1.4 Before running the motor

Checklist:

Before running the motor, check it is correctly installed and make sure that the machine it is connected to allows the motor to be started.

Set the maximum motor speed (frequency) according to the motor and the machine connected to it.

Before reversing the motor shaft rotation direction make sure that this can be done safely.

Make sure that no power correction capacitors are connected to the motor cable.

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from www.vacon.com/downloads.

REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site www.vacon.com/downloads.

2. RECEIPT OF DELIVERY

After unpacking the product, check there are no signs of transport damages to the product and that the delivery is complete (compare the type designation of the product to the code below).

If the drive is damaged during shipping, please contact the shipper's insurance company or the carrier.

If the delivery does not correspond to your order, contact the supplier immediately.

2.1 Type designation code

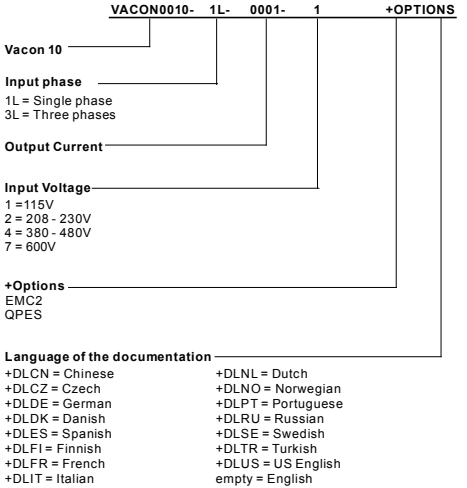


Figure 2.1: Vacon 10 type designation code

2.2 Storage

If the frequency converter is to be kept in store before use make sure that the ambient conditions are acceptable:

Storing temperature -40...+70°C

Relative humidity < 95%, no condensation

2.3 Maintenance

In normal operating conditions, Vacon 10 frequency converters are maintenance-free.

2.4 Warranty

Only manufacturing defects are covered by the warranty. The manufacturer assumes no responsibility for damages caused during or resulting from transport, receipt of the delivery, installation, commissioning or use.

The manufacturer shall in no event and under no circumstances be held responsible

for damages and failures resulting from misuse, wrong installation, unacceptable ambient temperature, dust, corrosive substances or operation outside the rated specifications. Neither can the manufacturer be held responsible for consequential damages.

The Manufacturer's time of warranty is 18 months from the delivery or 12 months from commissioning, whichever expires first (General Conditions NL92/Orgalime S92).

The local distributor may grant a warranty time different from the above. This warranty time shall be specified in the distributor's sales and warranty terms. Vacon assumes no responsibility for any other warranties than that granted by Vacon itself.

In all matters concerning the warranty, please contact your distributor.

3. INSTALLATION

3.1 Mechanical installation

There are two possible ways to mount Vacon 10 in the wall. For MI1-MI3, either screw or DIN-rail mounting. The mounting dimensions are given on the back of the drive and on the following page.

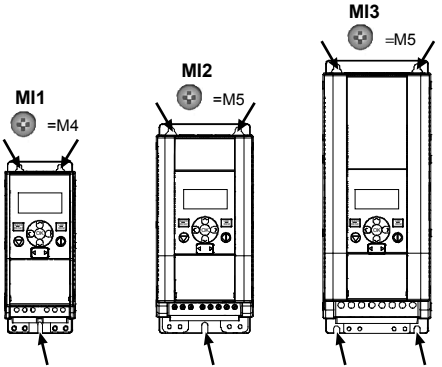


Figure 3.1: Screw mounting, MI1 - MI3

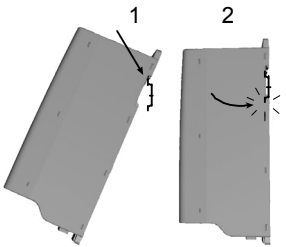


Figure 3.2: DIN-rail mounting, MI1 - MI3

3.1.1 Vacon 10 dimensions

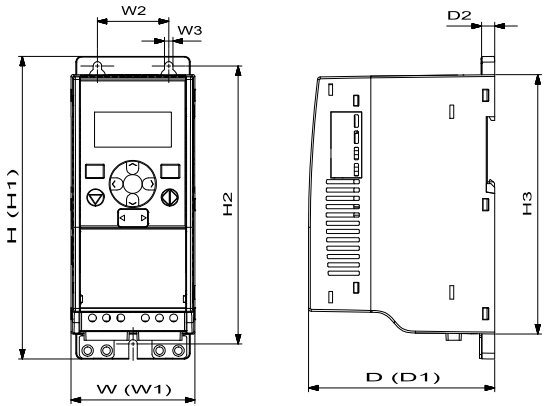


Figure 3.3: Vacon 10 dimensions, MI1 - MI3

Frame	H1	H2	H3	W1	W2	W3	D1	D2
MI1	160.1	147	137.3	65.5	37.8	4.5	98.5	7
MI2	195	183	170	90	62.5	5.5	101.5	7
MI3	254.3	244	229.3	100	75	5.5	108.5	7

Table 3.1: Vacon 10 dimensions in millimetres

Frame	Dimensions(mm)		Weight*	
	W	H	D	(kg.)
MI1	66	160	98	0.5
MI2	90	195	102	0.7
MI3	100	254.3	109	1
				*without shipping package

Table 3.2: Vacon 10 frame dimensions (mm) and weights (kg)

Frame	Dimensions(Inches)		Weight*	
	W	H	D	(lbs.)
MI1	2.6	6.2	3.9	1.2
MI2	3.5	9.9	4	1.5
MI3	3.9	10.3	4.3	2.2
				*without shipping package

Table 3.3: Vacon 10 frame dimensions (Inch) and weights (Ibs)

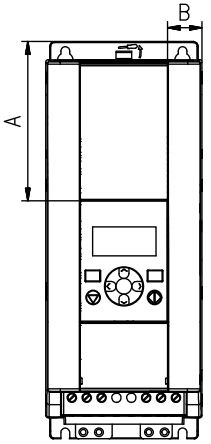


Figure 3.4: Vacon10 dimensions, MI2 - 3 Display Location

Dimensions(mm)	Frame	
	MI2	MI3
A	17	22.3
B	44	102

Table 3.4: Vacon 10 frame dimensions (mm)

3.1.2 Cooling

Enough free space shall be left above and below the frequency converter to ensure sufficient air circulation and cooling. You will find the required dimensions for free space in the table below.

If several units are mounted above each other the required free space equals C + D (see Installation space). Moreover, the outlet air used for cooling by the lower unit must be directed away from the air intake of the upper unit.

The amount of cooling air required is indicated below. Also make sure that the temperature of the cooling air does not exceed the maximum ambient temperature of the converter.

Min clearance (mm)				
Frame	**A***	**B***	**C**	**D**
MI1	20	20	100	50
MI2	20	20	100	50
MI3	20	20	100	50

Table 3.5: Min. clearances around AC drive

*. Min clearance A and B for drives for MI1 ~ MI3 can be 0 mm if the ambient temperature is below 40 degrees.

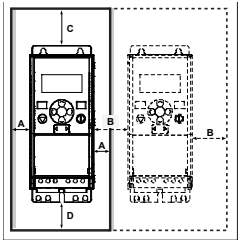


Figure 3.5: Installation space

A = clearance around the freq. converter (see also B)

B = distance from one frequency converter to another or distance to cabinet wall

C = free space above the frequency converter

D = free space underneath the frequency converter

NOTE! See the mounting dimensions on the back of the drive.

Leave **free space** for cooling above **(100 mm)**, below **(50 mm)**, and on the sides **(20 mm)** of Vacon 10! For MI1 - MI3, side-to-side installation allowed only if the ambient temperature is below 40 °C

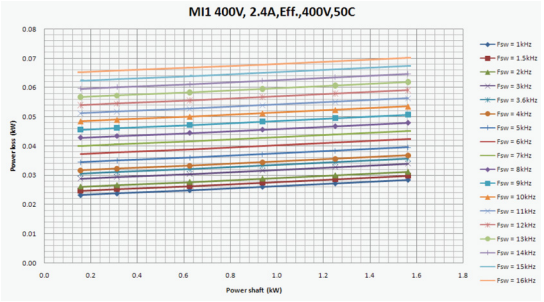
Frame	Cooling air required (m³/h)
MI1	10
MI2	10
MI3	30

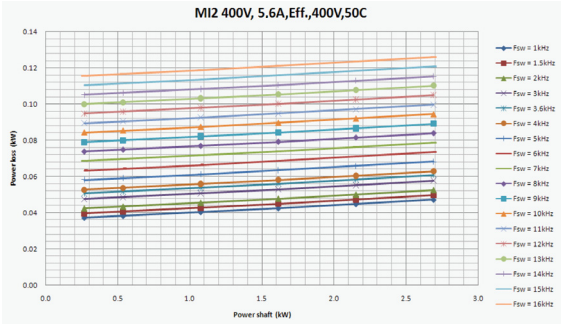
Table 3.6: Required cooling air

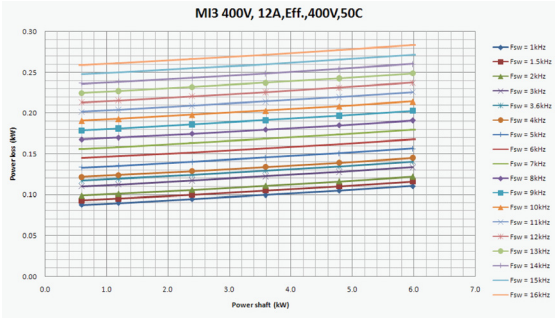
3.1.3 Power losses

If the operator wants to raise the switching frequency of the drive for some reason (typically e.g. in order to reduce the motor noise), this inevitably affects the power losses and cooling requirements, for different motor shaft power, operator can select the switching frequency according to the graphs below.

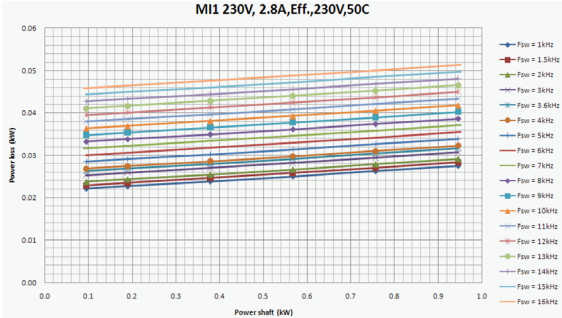
MI1 - MI3 3P 400 V POWER LOSS

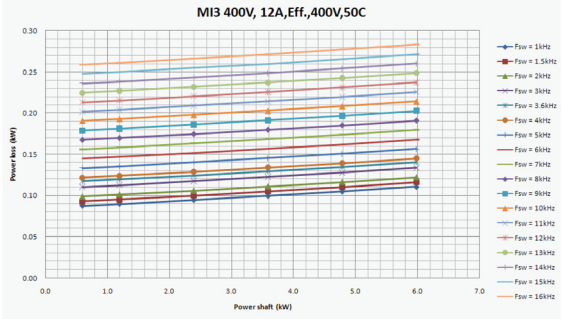


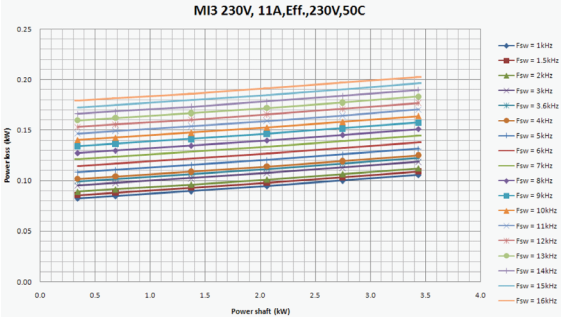




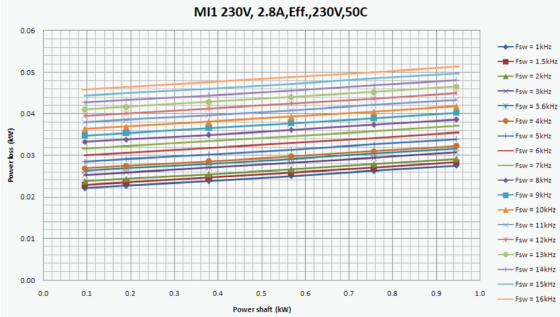
MI1 - MI3 3P 230 V POWER LOSS

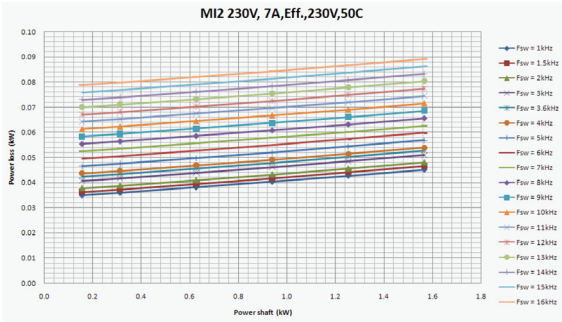


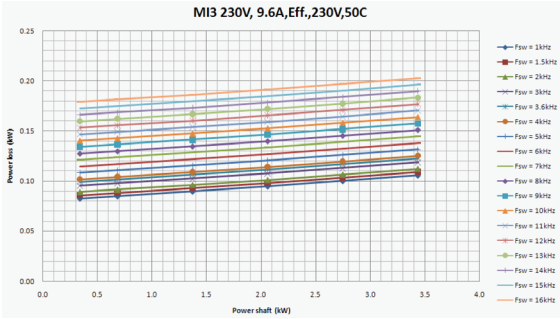

MI3 400V, 12A,Eff.,400V,50C
Power loss (kW)
Power shaft (kW)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Fsw = 1kHz
Fsw = 1.5kHz
Fsw = 2kHz
Fsw = 3kHz
Fsw = 3.6kHz
Fsw = 4kHz
Fsw = 5kHz
Fsw = 6kHz
Fsw = 7kHz
Fsw = 8kHz
Fsw = 9kHz
Fsw = 10kHz
Fsw = 11kHz
Fsw = 12kHz
Fsw = 13kHz
Fsw = 14kHz
Fsw = 15kHz
Fsw = 16kHz

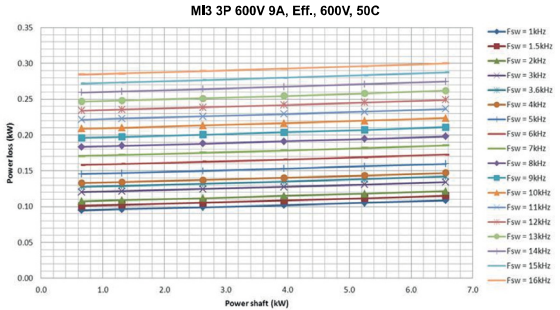

MI3 230V, 11A,Eff.,230V,50C
Power loss (kW)
Power shaft (kW)
0.00
0.05
0.10
0.15
0.20
0.25
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Fsw = 1kHz
Fsw = 1.5kHz
Fsw = 2kHz
Fsw = 3kHz
Fsw = 3.6kHz
Fsw = 4kHz
Fsw = 5kHz
Fsw = 6kHz
Fsw = 7kHz
Fsw = 8kHz
Fsw = 9kHz
Fsw = 10kHz
Fsw = 11kHz
Fsw = 12kHz
Fsw = 13kHz
Fsw = 14kHz
Fsw = 15kHz
Fsw = 16kHz

MI1 - MI3 1P 230 V POWER LOSS






MI3 230V, 9.6A,Eff.,230V,50C
Power loss (kW)
Power shaft (kW)
Fsw = 1kHz
Fsw = 1.5kHz
Fsw = 2kHz
Fsw = 3kHz
Fsw = 3.6kHz
Fsw = 4kHz
Fsw = 5kHz
Fsw = 6kHz
Fsw = 7kHz
Fsw = 8kHz
Fsw = 9kHz
Fsw = 10kHz
Fsw = 11kHz
Fsw = 12kHz
Fsw = 13kHz
Fsw = 14kHz
Fsw = 15kHz
Fsw = 16kHz


MI3 3P 600V 9A, Eff., 600V, 50C
Power loss (kW)
Power shaft (kW)
Fsw = 1kHz
Fsw = 1.5kHz
Fsw = 2kHz
Fsw = 3kHz
Fsw = 3.6kHz
Fsw = 4kHz
Fsw = 5kHz
Fsw = 6kHz
Fsw = 7kHz
Fsw = 8kHz
Fsw = 9kHz
Fsw = 10kHz
Fsw = 11kHz
Fsw = 12kHz
Fsw = 13kHz
Fsw = 14kHz
Fsw = 15kHz
Fsw = 16kHz

3.1.4 EMC levels

EN61800-3 defines the division of frequency converters into four classes according to the level of electromagnetic disturbances emitted, the requirements of a power system network and the installation environment (see below). The EMC class of each product is defined in the type designation code.

Category C1: Frequency converters of this class comply with the requirements of category C1 of the product standard EN 61800-3 (2004). Category C1 ensures the best EMC characteristics and it includes converters the rated voltage of which is less than 1000 V and which are intended for use in the 1st environment.

NOTE: The requirements of class C are fulfilled only as far as the conducted emissions are concerned.

Category C2: Frequency converters of this class comply with the requirements of category C2 of the product standard EN 61800-3 (2004). Category C2 includes converters in fixed installations and the rated voltage of which is less than 1000 V. The class C2 frequency converters can be used both in the 1st and the 2nd environment.

Category C4: The drives of this class do not provide EMC emission protection. These kinds of drives are mounted in enclosures.

Environments in product standard EN 61800-3 (2004)

First environment: Environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.

NOTE: houses, apartments, commercial premises or offices in a residential building are examples of first environment locations.

Second environment: Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.

NOTE: industrial areas, technical areas of any building fed from a dedicated transformer are examples of second environment locations.

3.1.5 Changing the EMC protection class from C2 to C4

The EMC protection class of MI1-3 frequency converters can be changed from class C2 to class C4 (except 115V and 600V drives) by **removing the EMC-capacitor disconnecting screw**, see figure below.

Note! Do not attempt to change the EMC level back to class C2. Even if the procedure above is reversed, the frequency converter will no longer fulfil the EMC requirements of class C2!

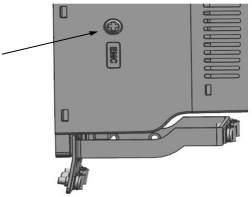


Figure 3.6: EMC protection class, MI1 - MI3

3.2 Cabling and connections

3.2.1 Power cabling

Note! Tightening torque for power cables is 0.5 - 0.6 Nm

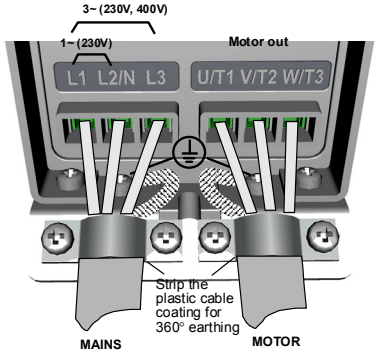


Figure 3.7: Vacon 10 power connections, MI1

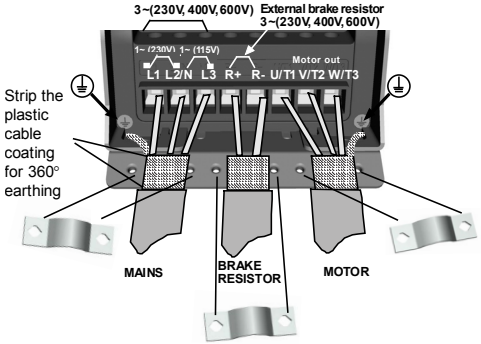


Figure 3.8: Vacon 10 power connections, MI2 - MI3

3.2.2 Control cabling

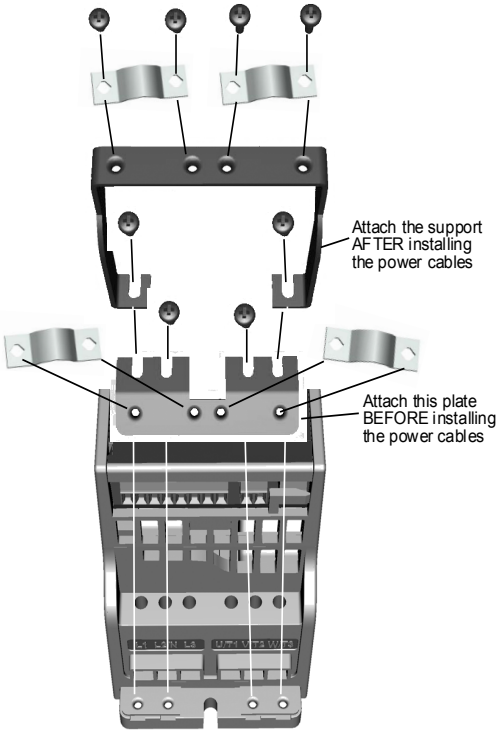


Figure 3.9: Mount the PE-plate and API cable support, MI1 - MI3

Figure 3.10: Open the lid, MI1 - MI3

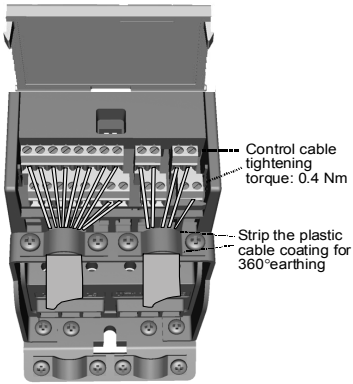


Figure 3.11: Install the control cables. MI1 - MI3. See Chapter 6.1

3.2.3 Screw of cables

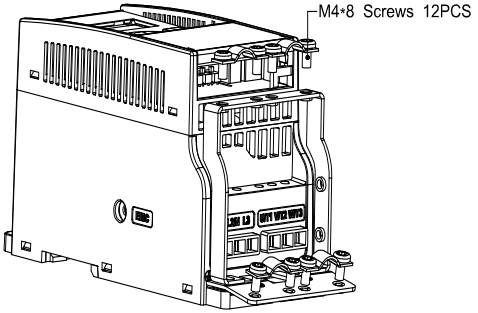


Figure 3.12: MI1 screws

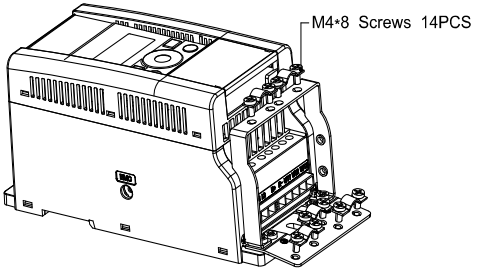


Figure 3.13: MI2 screws

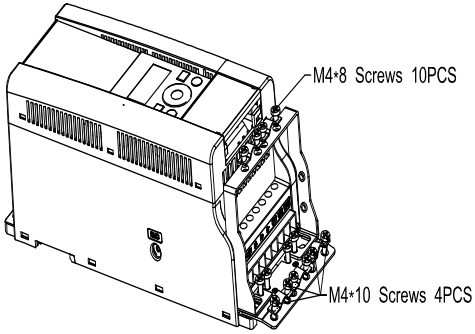


Figure 3.14: MI3 screws

3.2.4 Cable and fuse specifications

Use cables with heat resistance of at least +70°C. The cables and the fuses must be dimensioned according to the tables below. Installation of cables according to UL regulations is presented in Chapter 3.2.7.

The fuses function also as cable overload protection.

These instructions apply only to cases with one motor and one cable connection from the frequency converter to the motor. In any other case, ask the factory for more information

EMC category	cat. C2	cat. C4
Mains cable types	1	1
Motor cable types	3	1
Control cable types	4	4

Table 3.7: Cable types required to meet standards. EMC categories are described in Chapter 3.1.4

Cable type	Description
1	Power cable intended for fixed installation and the specific mains voltage. Shielded cable not required. (NKCABLES / MCMK or similar recommended)
2	Power cable equipped with concentric protection wire and intended for the specific mains voltage. (NKCABLES / MCMK or similar recommended).
3	Power cable equipped with compact low-impedance shield and intended for the specific mains voltage. (NKCABLES / MCCMK, SAB / ÖZCUY-J or similar recommended). *360º earthing of both motor and FC connection required to meet the standard
4	Screened cable equipped with compact low-impedance shield (NKCABLES /Jamak, SAB / ÖZCuY-O or similar).

Table 3.8: Cable type descriptions

Frame	Type	Fuse [A]	Mains cable Cu [mm²]	Motor cable Cu [mm²]	Terminal cable size (min/max)			
					Main terminal [mm²]	Earth terminal [mm²]	Control terminal [mm²]	Relay terminal [mm²]
MI2	0001-0004	20	2*2.5+2.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0005	32	2*6+6	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5

Table 3.9: Cable and fuse sizes for Vacon 10, 115 V, 1~

Frame	Type	Fuse [A]	Mains cable Cu [mm²]	Motor cable Cu [mm²]	Terminal cable size (min/max)			
					Main terminal [mm²]	Earth terminal [mm²]	Control terminal [mm²]	Relay terminal [mm²]
MI1	0001-0003	10	2*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI2	0004-0007	20	2*2.5+2.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0009	32	2*6+6	3*1.5+1.5	1.5-6	1.5-6	0.5-1.5	0.5-1.5

Table 3.10: Cable and fuse sizes for Vacon 10, 208 - 240 V, 1~

Frame	Type	Fuse [A]	Mains cable Cu [mm²]	Motor cable Cu [mm²]	Terminal cable size (min/max)			
					Main terminal [mm²]	Earth terminal [mm²]	Control terminal [mm²]	Relay terminal [mm²]
MI1	0001-0003	6	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI2	0004-0007	10	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0011	20	3*2.5+2.5	3*2.5+2.5	1.5-6	1.5-6	0.5-1.5	0.5-1.5

Table 3.11: Cable and fuse sizes for Vacon 10, 208 - 240 V, 3~

Frame	Type	Fuse [A]	Mains cable Cu [mm²]	Motor cable Cu [mm²]	Terminal cable size (min/max)			
					Main terminal [mm²]	Earth terminal [mm²]	Control terminal [mm²]	Relay terminal [mm²]
MI1	0001-0003	6	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI2	0004-0006	10	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0008-0012	20	3*2.5+2.5	3*2.5+2.5	1.5-6	1.5-6	0.5-1.5	0.5-1.5

Table 3.12: Cable and fuse sizes for Vacon 10, 380 - 480 V, 3~

Frame	Type	Fuse [A]	Mains cable Cu [mm^2]	Motor cable Cu [mm^2]	Terminal cable size (min/max)			
					Main terminal [mm^2]	Earth terminal [mm^2]	Control terminal [mm^2]	Relay terminal [mm^2]
MI3	0002-0004	6	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0005-0006	10	3*1.5+1.5	3*1.5+1.5	1.5-4	1.5-4	0.5-1.5	0.5-1.5
MI3	0009	20	3*2.5+2.5	3*2.5+2.5	1.5-6	1.5-6	0.5-1.5	0.5-1.5

Table 3.13: Cable and fuse sizes for Vacon 10, 600 V,3~

Note! To fulfil standard EN61800-5-1, the protective conductor should be at **least 10 mm2 Cu or 16 mm2 Al**. Another possibility is to use an additional protective conductor of at least the same size as the original one.

3.2.5 General cabling rules

1	Before starting the installation, check that none of the components of the frequency converter is live.
2	Place the motor cables sufficiently far from other cables: • **Avoid** placing the motor cables in long **parallel lines** with other cables. • If the motor cable runs in parallel with other cables, the **minimum distance** between the motor cable and other cables is **0.3 m**. • The given distance also applies between the motor cables and signal cables of other systems. • The **maximum length** of the motor cables for MI1-3 is **30 m**. If use longer cable, current accuracy will be decreased. • The **motor cables** should cross other cables at an angle of **90 degrees**.
3	If cable insulation checks are needed, see Chapter 3.2.8
4	Connecting the cables: • Strip the motor and mains cables as advised in Figure 3.15. • Connect the mains, motor and control cables into their respective terminals, see Figures 3.7 - 3.8. • Note the tightening torques of chapter3.2.1 and chapter 3.2.2 . • For information on cable installation according to UL regulations see Chapter 3.2.7. • Make sure that the control cable wires do not come in contact with the electronic components of the unit. • If an **external brake resistor** (option) is used, connect its cable to the appropriate terminal. • **Check the connection** of the earth cable to the motor and the frequency converter terminals marked with.  • Connect the **separate shield of the motor cable to the earth plate** of the frequency converter, motor and the supply centre.

3.2.6 Stripping lengths of motor and mains cables

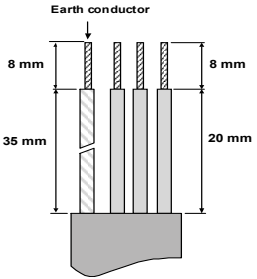


Figure 3.15: Stripping of cables

Note! Strip also the plastic cover of the cables for 360 degree earthing. See Figures 3.7- 3.8 and 3.11.

3.2.7 Cable installation and the UL standards

To meet the UL (Underwriters Laboratories) regulations, a UL-approved copper cable with a minimum heat-resistance of +60 / 75°C must be used.

Use Class 1 wire only.

The units are suitable for use on a circuit capable of delivering not more than 50,000 rms symmetrical amperes, 600V maximum, when protected by T and J Class fuses.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electric Code and any additional local codes. Branch circuit protection provided by fuses only.

Motor overload protection provided at 110% of full load current.

3.2.8 Cable and motor insulation checks

These checks can be performed as follows if motor or cable insulations are suspected to be faulty.

1. Motor cable insulation checks

Disconnect the motor cable from terminals U / T1, V / T2 and W / T3 of the frequency converter and from the motor. Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor.

The insulation resistance must be >1 MOhm.

2. Mains cable insulation checks

Disconnect the mains cable from terminals L1, L2 / N and L3 of the frequency converter and from the mains. Measure the insulation resistance of the mains cable between each phase conductor as well as between each phase conductor and the protective ground conductor. The insulation resistance must be >1 MOhm.

3. Motor insulation checks

Disconnect the motor cable from the motor and open the bridging connections in the motor connection box. Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1000 V. The insulation resistance must be >1 MOhm.

4. COMMISSIONING

Before commissioning, read the warnings and instructions listed in Chapter 1!

4.1 Commissioning steps of Vacon 10

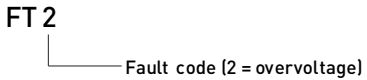
1	Read carefully the safety instructions in Chapter 1 and follow them.
2	After the installation, make sure that: • both the frequency converter and the motor are grounded. • the mains and motor cables comply with the requirements given in Chapter 3.2.4. • the control cables are located as far as possible from the power. cables (see Chapter 3.2.5, step 2) and the shields of the shielded cables are connected to protective ground. 
3	Check the quality and quantity of cooling air (Chapter 3.1.2).
4	Check that all Start / Stop switches connected to the I / O terminals are in **Stop**-position.
5	Connect the frequency converter to mains.
Note: The following steps are valid if you have an API Full or API Limited Application Interface in your Vacon 10.	
6	Set the parameters of group 1 according to the requirements of your application. At least the following parameters should be set: • motor nominal voltage (par. 1.1) • motor nominal frequency (par. 1.2) • motor nominal speed (par. 1.3) • motor nominal current (par. 1.4) You will find the values needed for the parameters on the motor specification plate.
7	Perform test run **without motor**. Perform either Test A : **A)** Control from the I / O terminals: • Activate digital inputs DI1 (8) and D13 (10). • Change the frequency reference (potentiometer) • Check in the Monitoring Menu that output frequency changes according to the change in frequency reference. • Turn the Start/Stop switch, DI1, to OFF position.

8	Run the no-load tests without the motor being connected to the process, if possible. If this is not possible, ensure the safety of each test prior to running it. Inform your co-workers of the tests. • Switch off the supply voltage and wait until the drive has stopped. • Connect the motor cable to the motor and to the motor cable terminals of the frequency converter. • Make sure that all Start/Stop switches are in Stop positions. • Switch the mains ON • Repeat test 7A.
9	Connect the motor to the process (if the no-load test was run without the motor being connected). • Before running the tests, make sure that this can be done safely. • Inform your co-workers of the tests. • Repeat test 7A.

5. FAULT TRACING

Note: The fault codes listed in this chapter are visible if the Application Interface has a display, like e.g. in API FULL or API LIMITED or if a personal computer has been connected to the drive.

When a fault is detected by the frequency converter control electronics, the drive is stopped and the symbol F together with the ordinal number of the fault and the fault code appear on the display in the following format, e.g:



The fault can be reset by pressing the stop button on the control keypad. The faults with time labels are stored in the Fault history menu which can be browsed. The different fault codes, their causes and correcting actions are presented in the table below.

Fault code	Fault name	Possible cause	Correcting actions
1	Overcurrent	Frequency converter has detected too high a current (>4*I_N) in the motor cable: • sudden heavy load increase • short circuit in motor cables • unsuitable motor	Check loading. Check motor size. Check cables.
2	Overvoltage	The DC-link voltage has exceeded the internal safety limit: • deceleration time is too short • high overvoltage spikes in mains	Increase the deceleration time (P.4.3)
3	Earth fault	Current measurement has detected extra leakage current at start: • insulation failure in cables or motor	Check motor cables and motor
8	System fault	• component failure • faulty operation	Reset the fault and restart. If the fault re-occurs, contact the distributor near to you.

Table 5.1: Fault codes

Fault code	Fault name	Possible cause	Correcting actions
9	Undervoltage	The DC-link voltage has gone below the internal safety limit: • most probable cause: supply voltage is too low • frequency converter internal fault • Power outages	In case of temporary supply voltage break reset the fault and restart the frequency converter. Check the supply voltage. If it is adequate, an internal failure has occurred. Contact the distributor near to you.
11	Output phase fault	Current measurement has detected that there is no current in one motor phase.	Check motor cable and motor.
13	Frequency converter low temperature	IGBT switch temperature is below -10 °C	Check the ambient temperature.
14	Frequency converter overheating	IGBT switch temperature is above 120 °C. Overheating warning is issued when IGBT switch temperature exceeds 110 °C.	Check that the cooling air flow is not blocked. Check ambient temperature. Make sure that the switching frequency is not too high in relation to ambient temperature and motor load.
15	Motor stalled	Motor stall protection has been activated.	Check motor
16	Motor overheating	Motor overheating has been detected by frequency converter motor temperature model. Motor is overloaded.	Decrease the motor load. If no motor overload exists, check the temperature model parameters.
17	Underload	The motor is underloaded. Eg. lack of input water.	Check the load and parameters related to underload detection (P6.5 - P6.8)
22	EEPROM fault	Parameter save fault • faulty operation • component failure	Contact the nearest distributor.
25	Microcontroller watchdog fault	• faulty operation • component failure	Reset the fault and restart. If the fault recurs, contact the nearest distributor.

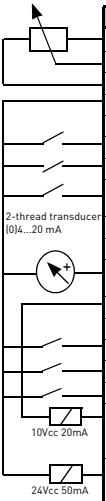
Table 5.1: Fault codes

Fault code	Fault name	Possible cause	Correcting actions
27	Back EMF protection	Drive has detected that the magnetized motor is running in start situation. • A rotating PM-motor	Make sure that there is no rotating PM-motor when the start command is given.
34	Internal bus communication	Ambient interference or defective hardware	If the fault recurs, contact your nearest distributor.
35	System fault	System does not work	Contact the nearest distributor.
41	IGBT Overtemperature	Overtemperature alarm is issued when the IGBT switch temperature exceeds 110 °C.	Check loading. Check motor size. Make identification run.
50	Analog input Iin < 4 mA (selected signal range 4 to 20 mA)	Current at the analog input is < 4mA • control cable is broken or loose. • signal source has failed.	Check the sensor and sensor cable.
51	External fault	Digital input fault. Digital input has been programmed as external fault input and this input is active.	Check the programming and the device indicated by the external fault information. Also the cabling of this device.
53	Fieldbus fault	The data connection between the fieldbus Master and the fieldbus of the drive has broken.	Check installation. If installation is correct contact the nearest Vacon distributor.
80	Interlock alarm	An autochange with interlocks (P1.7) has been selected and the controller fails to detect them.	Use the monitoring menu (M1.14) to check the state of digital inputs D14, D15 and D16 and also check their cabling.
81	System identification fault	Pressure unit discharge has not been closed properly.	Check that the pressure unit discharge opens and closes correctly.
82	Output frequency < Reference frequency	The pump is unable to rotate at system-desired speed due to high consumption or to the mains power supply being too low.	Check the controller power supply and that the pump is not blocked or the discharge piping dirty.

Table 5.1: Fault codes

6. PFC SYSTEM INTERFACE

6.1 I/O Control



Terminal		Signal	Factory preset	Description
1	+10Vref	Ref. voltage out		Maximum load 10 mA
2	AI1	Frequency Reference		0 - 10 V Ri = 200 kΩ (min)
3	GND	I/O signal ground		
6	24Vcc			±20%, max. load 50 mA
7	GND	I/O signal ground		
8	DI1	Digital input 1	Run	0 - +30 V Ri = 12 kΩ (min)
9	DI2	Digital input 2	PI 2 Reference	
10	DI3	Digital input 3	Disable PI (Frequency ref. from AI1)	
A	A			
B	B			
4	AI2	Analog signal	Pressure input 4-20mA	0(4) - 20 mA, Ri = 200Ω
5	GND	I/O signal ground		
13	GND	I/O signal ground		
14	DI4	Digital input 4	Interlock 1	0 - +30 V Ri = 12 kΩ (min)
15	DI5	Digital input 5	Interlock 2	
16	DI6	Digital input 6	Interlock 3	
18	AO	Analog Output Programmable in P5.3	Fault Inverted	0 - 10V, 0 - 20 mA, Ri = 500Ω
20	DO	Digital signal out Programmable in P5.2	Pump 3 Control	Discharge open, max. load 48 Vcc/50 mA
22	RO 13	Relay output 1	Pump 1 Control	Max. switching load: 250Vac/2A or 250Vdc/0,4A
23	RO 14			
24	RO 22	Relay output Programmable in P5.1	Pump 2 Control	Max. switching load: 250Vac/2A or 250Vdc/0,4A
25	RO 21			
26	RO 24			

Table 6.1: PFC System preset I/O connections and settings for Vacon 10

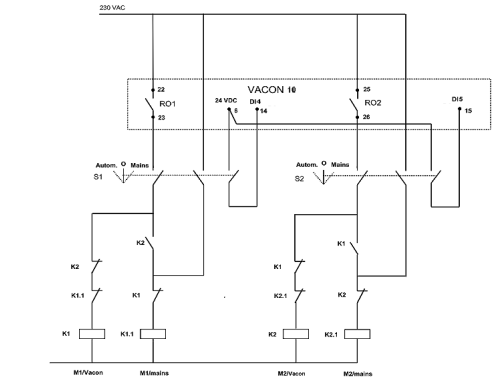


Figure 6.1: 2-pump autochange systems, sample control diagram

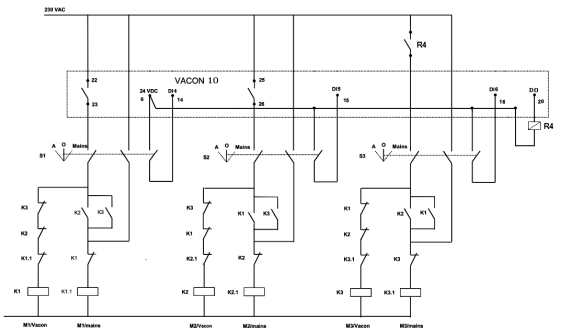


Figure 6.2: 3-pump autochange system, sample control diagram

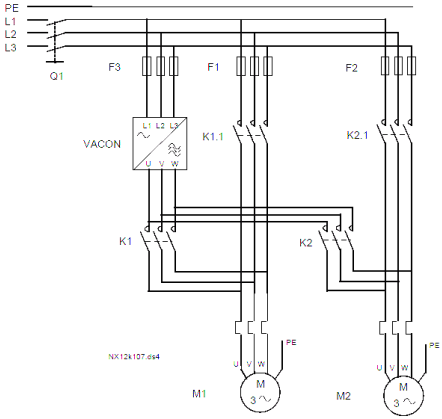


Figure 6.3: Example of 2-pump autochange, power diagram

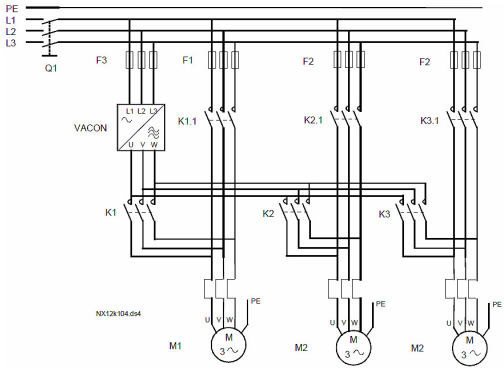


Figure 6.4: Example of 3-pump autochange, power diagram

7. CONTROL PANEL

7.1 General

The panel is an irremovable part of the drive consisting of corresponding control board; The overlay with display status on the cover and the button are in clarifications in the user language.

The User Panel consists of an alphanumeric LCD display with backlight and a keypad with the 9 push buttons (see Figure 7.1).

7.2 Display

The display includes 14-segment and 7-segment blocks, arrowheads and clear text unit symbols. The arrowheads, when visible, indicate some information about the drive, which is printed in clear text in user language on the overlay (numbers 1...14 in the figure below). The arrowheads are grouped in 3 groups with the following meanings and English overlay texts (see Figure 7.1):

Group 1 - 5; Drive status

1 = Drive is ready to start(READY)
2 = Drive is running(RUN)
3 = Drive has stopped(STOP)
4 = Alarm condition is active(ALARM)
5 = Drive has stopped due to a fault(FAULT)

Group 6 - 10; Control selections

6 = Motor is rotating forward(FWD)
7 = Motor is rotating reverse(REV)
8 = I/O terminal block is the selected control place(I / O)
9 = Keypad is the selected control place(KEYPAD)
10 = Fieldbus is the selected control place(BUS)

Group 11 - 14; Navigation main menu

11 = Reference main menu(REF)
12 = Monitoring main menu(MON)
13 = Parameter main menu(PAR)
14 = System main menu(SYS)

Figure 7.1: Vacon 10 Control panel

7.3 Keypad

The keypad section of the control panel consists of 9 buttons (see Figure 7.1). The buttons and their functions are described as Table 7.1.

The drive stops by pressing the keypad STOP button.

The drive starts by pressing the keypad START button when the selected control place is KEYPAD.

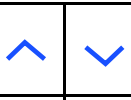
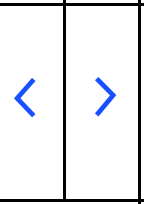
Symbol	Button Name	Function Description
	Start	Motor START from the panel
	STOP	Motor STOP from the panel
	OK	Used for confirmation. Enter edit mode for parameter Alternate in display between the parameter value and parameter code. Reference frequency value adjusting no need to press OK-button to confirm
	Back / Reset	Cancels edited parameter Move backwards in menu levels Reset fault indication
	Up and Down	Select root parameter number on root-parameter list, Up decrease / Down increase parameter number, Up increase / Down decrease parameter value change
	Left and Right	Available in REF,PAR and SYS menu parameter digit setting when changing value MON,PAR and SYS can also use left and right button to navigate the parameter group, like in MON menu use right button from V1.x to V2.x to V3.x Can be used to change direction in REF menu in local mode: - Right arrow would mean reverse (REV) - Left arrow would mean forward (FWD)
	Loc / Rem	Change control place

Table 7.1: Keypad Function

NOTE! The status of all the 9 buttons are available for application program!

7.4 Navigation on the Vacon 10 control panel

This chapter provides you with information on navigating the menus on Vacon 10 and editing the values of the parameters.

7.4.1 Main menu

The menu structure of Vacon 10 control software consists of a main menu and several submenus. Navigation in the main menu is shown below:

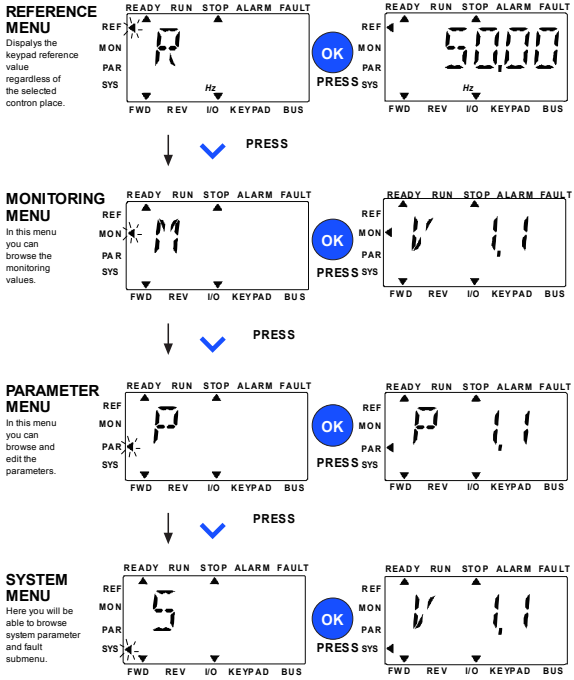


Figure 7.2: The main menu of Vacon 10

7.4.2 Reference menu

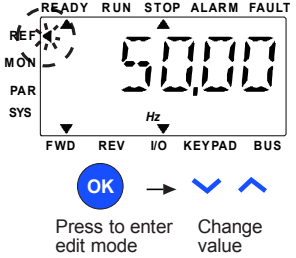


Figure 7.3: Reference menu display

Move to the reference menu with the UP / DOWN button (see Figure 7.2).
The reference value can be changed with UP / DOWN button as shown in Figure 7.3.

If the value has big change, first press Left and Right buttons to select the digit which has to be changed, then press Up button to increase and Down button to decreases the value in the selected digit. When the drive is in run mode, the reference value changed by Up/Down/Left/Right button will take effective no need to press OK button.

NOTE: LEFT and RIGHT buttons can be used to change the direction in Ref menu in local control mode.

7.4.3 Monitoring menu

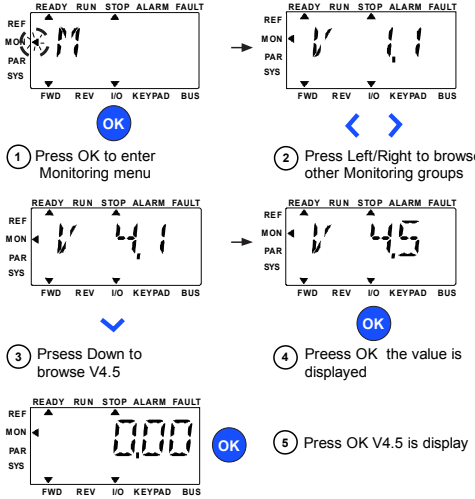


Figure 7.4: Monitoring menu display

Monitoring values are actual values of measured signals as well as status of some control settings. It is visible in Vacon 10 display, but it can not be edited. The monitoring values are listed in Table 7.2.

Pressing Left/Right button to change the actual parameter to the first parameter of the next group, to browse monitor menu from V1.x to V2.1 to V4.1. After entering the desired group, the monitoring values can be browsed by pressing UP /DOWN button, as shown in Figure 7.4.

In MON menu the selected signal and its value are alternating in the display by pressing OK button.

NOTE! Turn on drive power, arrowhead of main menu is at MON, V x.x or monitor parameter value of Vx.x is displayed in Panel.

NOTE! Display Vx.x or monitor parameter value of Vx.x is determined by the last show status before power shut down. E.g., it was V4.5, and it is also V4.5 when restart.

NOTE! Vacon 10 PFC only have one monitor group!

Code	Monitoring signal	Unit	ID	Description
V1.1	Output frequency	Hz	1	Output frequency to motor
V1.2	Frequency reference	Hz	25	
V1.3	Motor speed	rpm	2	Rated motor speed
V1.4	Motor current	A	3	Measured motor current
V1.5	Motor torque	%	4	Rated torque (nominal/real)
V1.6	Motor Power	%	5	Calculated power (nominal/real)
V1.7	Motor voltage	V	6	Motor voltage
V1.8	DC-link voltage	V	7	Measured DC-link voltage
V1.9	Unit temperature	°C	8	Measured temperature
V1.10	Analog input 1	V	13	Value of AI1 in V
V1.11	Analog input 2	mA	14	Value of AI2 in mA
V1.12	DI1, DI2, DI3		15	Run / Ref PI2 / Undo PI
V1.13	I4, DI5, DI6		16	Interlock 1 / Interlock 2 / Interlock 3
V1.14	RO1, RO2, DO		17	Output statuses
V1.15	Digital output (AO)		26	
V1.16	PI Reference	%	20	% of max. process reference
V1.17	Current pressure value	%	21	% of max. current value
V1.18	PI error	%	22	% of max. error value
V1.19	PI Output	%	23	% of max. output value
V1.20	Current pressure value	Kg	1616	Current pressure in Kg

Table 7.2: Vacon 10 monitoring signals

7.4.4 Parameter menu

Parameter menu only shows the Quick setup parameter list by default. By giving the right value to parameter 8.1, it is possible to access the other advanced parameter groups. Parameter lists and descriptions can be found in chapters 9 and 10.

The following figure shows the parameter menu display:

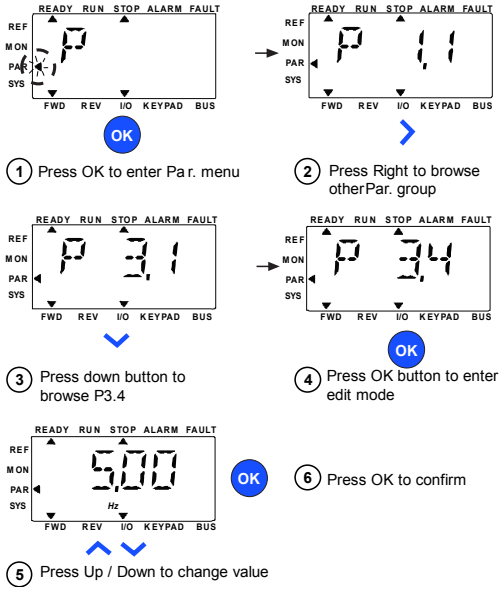


Figure 7.5: Parameter menu

The parameter can be changed as the Figure 7.5.

Left / Right button is available inside Parameter menu. Pressing Left / Right button to change the actual parameter to the first parameter of the next group (Example: any parameter of P1... is displayed -> RIGHT button -> P2.1 is displayed -> RIGHT button -> P3.1 is displayed ...). After entering the desired group, pressing UP / DOWN button to select root parameter number, and then press OK button to display the value of the parameter and also enter edit mode.

In edit mode, Left and Right buttons are used to select the digit which has to be changed, and Up increases / Down decreases parameter value.

In edit mode, the value of Px.x is displayed blinkingly in the panel. After about 10 s, Px.x is displayed in the panel again if you don't press any button.

NOTE! In edit mode, if you edit the value and don't press OK button, the value isn't changed successfully.

NOTE! In edit mode, if you don't edit the value, you can press Reset /Back button to display Px.x again.

7.4.5 System menu

SYS menu including fault submenu and system parameter submenu, and the display and operation of the system parameter submenu is similar to PAR menu or MON menu.In system parameter submenu, there are some editable parameter (P) and some uneditable parameter (V).

The Fault submenu of SYS menu includes active fault submenu and fault history submenu.

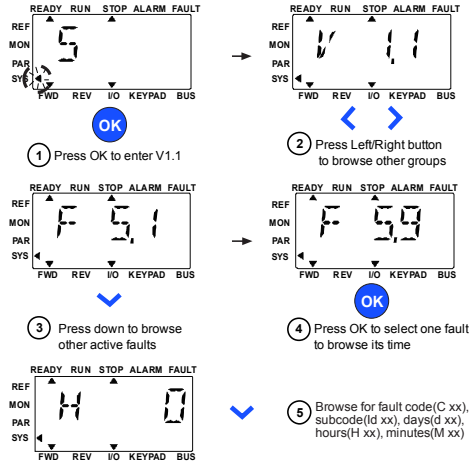


Figure 7.6: Fault menu

In active fault situation, FAULT arrow is blinking and the display is blinking active fault menu item with fault code. If there are several active faults, you can check it by entering the active fault submenu F5.x. F5.1 is always the latest active fault code. The active faults can be reset by pressing BACK / RESET button with long time (>2 s), when the API is in active fault submenu level (F5.x). If the fault cannot be reset, the blinking continues. It is possible to select other display menus during active fault, but

in this case the display returns automatically to the fault menu if no button is pressed in 10 seconds. The fault code, subcode and the operating day, hour and minute values at the fault instant are shown in the value menu (operating hours = displayed reading).

NOTE! Fault History can be reset by long pressing the BACK / RESET button for 5 second time,when the API is in fault history submenu level (F6.x), it will also clear all active faults.

See Chapter5 for fault descriptions

8. START-UP

8.1 Quick start-up wizard

Note! You should only use the wizard when starting up the controller, since parameters are reset to their factory default values every time it is used. If you need to change a particular value, you are recommended to go to the specific parameter (see page 54).

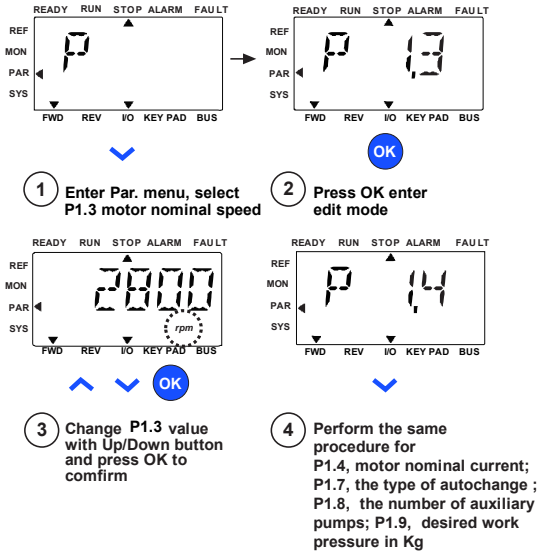


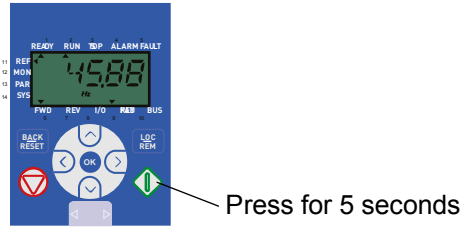
Figure 8.1: Startup wizard

8.2 System identifcation function

In order to identify the pump, we must follow the steps listed below:

1. Completely close the pressure unit discharge to prevent water intake. Pressure must be 0 bars.

2. Press the green (START) button for 5 seconds to start the pump and begin to carry out identification Identification takes around 60s. approximately).



3. Once the pump has stopped working, you can reopen the pressure unit intake and the equipment is ready to function.

9. SYSTEM PARAMETERS

On the next pages you can find the lists of parameters within the respective parameter groups. The parameter descriptions are given in Chapter 10.

NOTE: Parameters can only be changed when drive is in stop mode!

Explanations:

Code:	Location indication on the keypad; Shows the operator the present Monitoring value number or Parameter number
Parameter:	Name of monitoring value or parameter
Min:	Minimum value of parameter
Max:	Maximum value of parameter
Unit:	Unit of parameter value; given if available
Default:	Factory preset value
ID:	ID number of the parameter (used with fieldbus control)
	More information on this parameter available in chapter 10: 'Parameter descriptions' click on the parameter name.

9.1 Quick setup parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.1	Nominal voltage of the motor	180	500	V	230 400	110	Check specification plate on the motor
P1.2	Nominal frequency of the motor	30	320	Hz	50,00	111	Check specification plate on the motor
P1.3	Nominal speed of the motor	300	20000	rpm	2800	112	Default applies for a 4-pole motor.
P1.4	Nominal current of the motor	0,2 x I_{Nunit}	1,5 x I_{Nunit}	A	I_{Nunit}	113	Check specification plate on the motor
P1.5	Motor φ connection	0,30	1,00		0,85	120	Check specification plate on the motor
P1.6	Min frequency	0	P3.1	HZ	30,00	101	Minimum frequency of pumps
P1.7	Autochange Mode	0	4		4	1603	0 = No Autochange 1 = Aux. autochange without interlocks 2 = Autochange all without interlocks 3 = Aux. autochange with interlocks 4 = Autochange all with interlocks
P1.8	Number of Auxiliary Pumps	0	3		1	1600	Auxiliary pumps in the system
P1.9	Desired work pressure	0	P2.20	kg	4,0	167	Desired work pressure in Kg

Table 9.1: Quick setup parameters

9.2 Advanced PFC settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P2.1	Work pressure 2	P1.9	P2.20	kg	5,0	1617	Second pressure reference. Activated using DI2
P2.2	Acceleration	0,1	3000,0	S	3,0	103	Acceleration time from 0 Hz to maximum frequency
P2.3	Deceleration	0,1	3000,0	S	3,0	104	Deceleration time from maximum frequency to 0 Hz
P2.4	PI Gain	0,0	1000,0	%	125,0	118	

Table 9.2: Advanced PFC settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P2.5	I Time, PI	0,00	320,00	S	1,00	119	
P2.6	PI Inversion Error	0	1		0	340	0 = Not inverted 1 = Inverted
P2.7	Autochange interval	0	3000,0	H	48,0	1604	0,0 = Test 40 s. Autochange time elapsed
P2.8	Autochange: Maximum number of auxiliaries	0	3		0	1605	Autochange level for auxiliary pump connection
P2.9	Autochange: frequency limit	0,00	P3.1	HZ	0,00	1606	Controller output frequency level for autochange
P2.10	Auxiliary pump start frequency	P1.6	320,00	HZ	51,00	1607	
P2.11	Auxiliary connection delay	0,0	200,0	S	4,0	1601	
P2.12	Auxiliary stop frequency	P1.6	P3.1	HZ	31,00	1608	
P2.13	Auxiliary stop delay	0,0	200,0	S	2,0	1602	
P2.14	Snooze frequency	0,00	P3.1	HZ	31,0	1609	
P2.15	Snooze delay	0	3600	S	15	1610	
P2.16	Wake-up level	0,00	100,0	%	92,00	1611	
P2.17	Wake-up function	0	3		2	1612	0 = Wake-up below level (P2.16) 1 = Wake-up above level (P2.16) 2 = Wake-up below level(P1.9) 3 = Wake-up above level(P1.9)
P2.18	PI hysteresis	0,0	50,0	%	2,0	1613	
P2.19	Increase Ref. PI to run	0,00	325,50	S	5,00	1614	
P2.20	Pressure Transducer Scale	0,0	100,0	KG	10,0	1615	
P2.21	Overpressure when snooze activated	0,0	10,0	KG	0,0	1617	

Table 9.2: Advanced PFC settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P2.22	Frequency Selection (disable PI) (DI3)	0	1		1	1618	0 = Navigation wheel 1 = AI1
P2.23	Pressure Selection	0	1		0	1619	0 = Panel (P1.9) 1 = AI1
P2.24	Interlock updating	0	1		1	1619	0 = Always 1 = Only in Stop mode

Table 9.2: Advanced PFC settings

9.3 Motor control

Code	Parameter	Min	Max	Unit	Default	ID	Note
P3.1	Maximum frequency	P1.6	320,00	HZ	50,00	102	
P3.2	Start Mode	0	1		0	505	0 = Ramp 1 = Flying
P3.3	Stop mode	0	1		1	506	0 = Coasting 1 = Ramp
P3.4	Current threshold	0,2 x in	2 x in	A	1,5 x in	107	
P3.5	Monitor control	0	1		0	600	0 = U/f 1 = Ctrl. Vector
P3.6	U/F ratio	0	1		1	108	0 = Linear 1 = Squared
P3.7	Field warkening point	30,00	320,00	HZ	50,00	602	
P3.8	Voltage at field weakening point	10,00	200,00	%	100,00	603	
P3.9	U/F Optimization	0	1		0	109	0 = Not used 1 = Automatic torque boost
P3.10	Switching frequency	1.5	16,0	KHZ	6,0	601	

Table 9.3: Motor control

9.4 Analog inputs

Code	Parameter	Min	Max	Unit	Default	ID	Note
P4.1	AI1 Hysteresis	0,000	9,000	V	0,100	1620	AI1 Sensitivity
P4.2	AI2 Signal Range	2	3		3	390	2 = 0 - 20mA 3 = 4 - 20mA
P4.3	AI2 filter time	0,0	10,0	S	0,1	389	0 = not filtered
P4.4	AI2 Customer Min.	-100,0	100,0	%	0,0	391	0.0 = Not scaled
P4.5	AI2 Customer Max.	-100,0	100,0	%	100,0	392	100.0 = Not scaled
P4.6	Minimum scaling Current Value	0,0	100,0	%	0,0	336	0 = Not scaled
P4.7	Maximum scaling Current Value	0,0	100,0	%	100,0	337	100.0 = Not scaled

Table 9.4: Analog inputs

9.5 Output signals

Code	Parameter	Min	Max	Unit	Default	ID	Note
P5.1	Relay 2 (RO2)	0	3		0	314	0 = Ctrl. Pump 2 1 = Ready 2 = Run 3 = Fault
P5.2	Digital Output (DO)	0	3		0	315	0 = Ctrl. Pump 3 1 = Ready 2 = Run 3 = Fault
P5.3	Digital Output (AO)	0	3		0	315	0 = Ready 1 = Run 2 = Fault 3 = Fault inverted

Table 9.5: Output signals

9.6 Protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P6.1	Response to fault 4mA	0	2		2	700	0 = No response 1 = Warning 2 = Fault, stop as in P3.3
P6.2	Response undervoltage fault	0	2		2	727	
P6.3	Ground fault protection	0	2		2	703	
P6.4	Low frequency protection	0,00	99,99	S	10,00	1621	
P6.5	Underload protection	0	2		2	713	As in P6.1
P6.6	Torque curve at zero frequency	0	150,0	%	10,0	715	
P6.7	Torque curve a nominal frequency	0	150,0	%	50,0	714	
P6.8	Underload protection time limit	2,00	320,00	S	20.0	716	
P6.9	Motor thermal protection	0	2		0	704	As in P6.1
P6.10	Motor ambient temperature	-20	100	C	40	705	
P6.11	Motor cooling factor at zero speed	0,0	150,00	%	40,0	706	
P6.12	Motor thermal time constant	1	200	min	45	707	
P6.13	Motor stall current	0,2 x I_{Nunit}	1,5 x I_{Nunit}	A	0	1622	Current threshold for block fault activation

Table 9.6: Protection

9.7 Automatic restarts

Code	Parameter	Min	Max	Unit	Default	ID	Note
P7.1	Wait time	0,10	10,00	S	0.50	717	Delay before automatic restart after a fault disappears
P7.2	Trial time	0,00	320,00	S	90,00	718	Defines the time before the frequency converter attempts to automatically restart the motor after a fault has disappeared
P7.3	Start mode	0	2		0	719	0 = Ramp 1 = Flying start 2 = As in P3.2
P7.4	Automatic Restart, Code	0	32500		0	731	0 = Disabled

Table 9.7: Automatic restarts

9.8 Hide parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P8.1	Hide parameters	0	1		1	115	0 = Parameters visible 1 = Parameters hidden

Table 9.8: Hide parameters

9.9 System parameters

Code	Parameter	Min	Max	Default	ID	Note
Software information (MENU PAR -> S1)						
S1.1	Software package				833	
S1.2	Power SW version				834	
S1.3	API SW version				835	
S1.4	API Firmware interface				836	
S1.5	Application ID				837	
S1.6	Application revision				838	
S1.7	System load				839	
RS485 information (MENU PAR -> S2)						
S2.1	Communication status				808	Format: xx.yyy xx = 0-64 (Number of error messages) yyy = 0 - 999 (Number of correct messages)
S2.2	Fieldbus protocol	0	1	0	809	0 = FB disabled 1= Modbus
S2.3	Slave address	1	255	1	810	
S2.4	Baud rate	0	5	5	811	0=300, 1=600, 2=1200, 3=2400, 4=4800, 5=9600,
S2.5	Number of stop bits	0	1	1	812	0=1, 1=2
S2.6	Parity type	0	0	0	813	0= None (locked)
S2.7	Communication time-out	0	255	10	814	0= Not used, 1= 1 second, 2= 2 seconds, etc.
S2.8	Reset communication status				815	1= Resets par. S2.1
Total counters (MENU PAR -> S3)						
S3.1	MWh counter				827	
S3.2	Power on days				828	
S3.3	Power on hours				829	
User settings (MENU PAR -> S4)						
S4.1	Display contrast	0	15	7	830	Adjusts the display contrast
S4.2	Restore factory defaults	0	1	0	831	1= Restores factory defaults for all parameters

Table 9.9: System parameters

NOTE! Parameters in bold are hidden, see P8.1.

10. PARAMETER DESCRIPTIONS

On the next pages you can find the descriptions of certain parameters. The descriptions have been arranged according to parameter group and number.

GROUP 1. Quick setup parameters

1.7 AUTOCHANGE MODE

This parameter allows the user to select the autochange mode for the system. Autochange is used to make pump wear more uniform.

0 = No autochange. Connection/disconnection order of pumps will always remain the same and the controller will regulate the speed of the first pump.

1 = Auxiliary autochange without interlocks. Controller regulates the speed of the first pump and auxiliary pumps alternate (connecting and disconnecting).

2 = Total autochange without interlocks. Controller alternates the regulation of all pump speeds in the system.

3 = Auxilliary autochange with interlocks. Controller regulates the speed of the first pump and auxiliary pumps alternate (connecting and disconnecting). Interlocks are required to connect pumps.

5 = Total autochange with interlocks. Controller alternates regulation of the speed of all the pumps in the system. Interlocks are required to connect pumps.

1.8 NUMBER OF AUXILIARY PUMPS

Auxiliary pumps assist the main pump.

For example, a pressure unit with a total of 3 pumps has 2 auxiliary pumps. Number of Auxiliary Pumps = No of pumps - 1.

GROUP 2. Advanced PFC settings

2.1 WORK PRESSURE 2

By enabling digital input DI2, you can work with the pressure inserted in this parameter.

2.2 ACCELERATION

Acceleration time from 0Hz to maximum frequency.

2.3 DECELERATION

Deceleration time from maximum frequency to 0Hz.

2.4 PI CONTROLLER GAIN

This parameter defines the gain of the PI controller. If this parameter is set to 100%, a 10% change in the error value results in a 10% change in controller output.

2.5 PI CONTROLLER I - TIME

This parameter defines the integration time of the PI controller. If this parameter is set to 1.00 second, controller output changes by a value corresponding to the output caused by the gain every second. (Gain/Error)/s.

2.6 PID ERROR VALUE INVERSION

This parameter enables users to invert the PID controller error value (and therefore PID controller operations).

0 = Not inverted

1 = Inverted

2.7 AUTOCHANGE INTERVAL

After the time set by this parameter has elapsed, autochange takes place if the load used is less than the level set in parameters P2.9 (autochange interval limit) and 2.8 (Maximum number of auxiliary pumps). If the load exceeds the value in parameter 2.9, autochange will not occur until the load is below this limit.

- Timing is enabled only if Start/Stop request is activated.
- Timing is reset after autochange takes place or when the Start request is removed.

2.9 AUTOCHANGE: INTERVAL LIMIT

These parameters set the maximum load for autochange to take place. This level is defined as follows:

- Autochange can take place if the number of auxiliary pumps running is lower than the value in parameter 2.89, autochange may take place.

- Autochange can take place if the number of auxiliary pumps running is equivalent to the value in parameter 2.8 and controlled drive frequency is lower than the value in parameter 2.9.
- If the value in parameter 2.9 is 0.0 Hz, autochange can only take place when on standby (Stop and Snooze) regardless of the value in parameter 2.8.

2.10 AUXILIARY PUMP START FREQUENCY

When the pump controlled at this output frequency, or higher, and the time set in P2.11 has elapsed, an auxiliary pump will be connected.

2.11 AUXILIARY PUMP START DELAY

The time that must elapse before an auxiliary pump is connected when the main pump is at its maximum level of output, if required by the system.

2.12 AUXILIARY PUMP FREQUENCY

When the controlled pump runs at this output frequency, or a lower value, and the time set in P2.13 has elapsed, an auxiliary pump will be disconnected.

2.13 AUXILIARY PUMP STOP DELAY

Time that must elapse before an auxiliary pump is disconnected, when the controlled pump is at its minimum level of output.

2.14 SNOOZE FREQUENCY

Frequency converter cuts out automatically if running frequency drops below the snooze level, set by this parameter, for a longer period of time than established in parameter 2.15. While Stopped, the PI controller changes the frequency converter to Start mode when the current value drops below or exceeds (see parameter 2.17) the wake-up Level set in parameter 2.16.

2.15 SNOOZE DELAY

The minimum amount of time that frequency should remain below the snooze Level before the frequency converter cuts out.

2.16 WAKE-UP LEVEL

The wake-up level defines the level that the current value must drop below or exceed before the Start mode of the frequency converter is restored.

2.17 WAKE-UP FUNCTION

This parameter defines whether Start mode is restored when the signal of the current value drops below or exceeds wake-up Level (parameter 2.16).

2.18 PI HYSTERESIS

In installations where the level of noise produced by the transducer may not allow the system to ever go into snooze mode, this parameter can help offset this effect.

2.19 REFERENCE INCREASE START PI

Delay time before the pressure reference reaches 100%.

2.20 PRESSURE TRANSDUCER SCALE

Maximum pressure permitted by pressure transducer.

2.21 OVERPRESSURE IN SNOOZE MODE

Overpressure that takes place in the installation when the system goes into snooze mode.

2.22 REFERENCE FREQUENCY SELECTION (PI DISABLED) (D13)

Parameter that allows the user to select the source of the reference frequency, when PI has been disabled using DI3.

0 = Panel

1 = AI1

2.23 REFERENCY PRESSURE SELECTION

Parameter that allows the user to select the source of work pressure.

0 = Panel (P1.9/P2.1)

1 = AI1

GROUP 3. Motor Control

3.2 START MODE

The user can select two start modes for Vacon 10 with this parameter:

0 = Ramp start:

The frequency converter starts from 0 Hz and accelerates to the set frequency reference within the set acceleration time (P4.2). (Load inertia or initial friction may lengthen acceleration times).

1 = Flying start:

The frequency converter is also able to start running a motor by applying a small torque to it and searching for the frequency that matches the speed the motor is running at. Searching starts at maximum frequency and works downwards until the correct frequency is detected. Therefore, output frequency will be increased/decreased to the set reference value according to the set acceleration/deceleration parameters. Use this mode if the motor is rotating when the start command is given. A flying start makes it possible to ride through short interruptions in mains voltage

3.3 STOP MODE

Two stop modes can be selected in this application.

0 = Coasting:

The motor coasts to a halt without control from the frequency converter after the Stop command.

1 = Ramp stop:

After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters.

If regenerated energy is high, it may be necessary to use an external braking resistor to decelerate the motor in acceptable time.

3.5 MOTOR CONTROL

With this parameter the user can select the motor control mode. The options are:

0 = Frequency Control:

I/O terminal references are frequency references and the frequency converter controls output frequency (output frequency resolution = 0.01 Hz)

1 = Speed Control:

I/O terminal references are speed references and the frequency converter controls motor speed.

3.6 U/F RATIO

The options for this parameter are:

0 = Linear:

Motor voltage changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point where nominal voltage is supplied to the motor.

Linear U/f ratio should be used in constant torque applications. See Figure 9.17.

This default setting should be used if no other adjustment is necessary.

1 = Squared:

Motor voltage changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point where nominal voltage is also supplied to the motor. The motor runs magnetised below the field weakening point and produces less torque, power losses and electromechanical noise.

The U/f ratio can be used in applications in which load torque is proportional to squared speed.

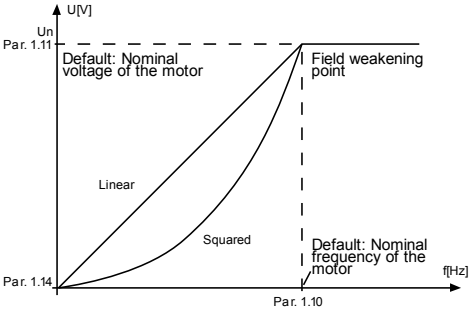


Figure 10.1: Linear and motor voltage change

2 = Programmable U/f curve:

The U/f curve can be programmed with three different points.

Programmable U/f curve can be used if the other settings do not satisfy the needs of the application

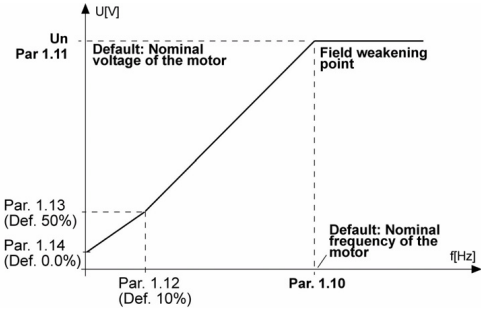


Figure 10.2: Programmable U/f curve

3.7 FIELD WARKENING POINT

The field weakening point is the output frequency at which the output voltage reaches the value set with parameter 3.8.

3.8 VOLTAGE AT FIELD WEAKENING POINT

The field weakening point is the output frequency at which the output voltage reaches the value set with this parameter. Below the frequency at field weakening point, the output voltage depends on the setting of the U/f curve parameters.

When parameters 1.1 and 1.2 (nominal voltage and nominal frequency of the motor) are set, parameters 3.7 and 3.8 are given the corresponding values automatically. If you need different values for the field weakening point and voltage, change these parameters after setting parameters 1.1 and 1.2.

3.9 U/F OPTIMIZATION

0 = Not used

1 = Automatic Torque Boost

The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The increase in voltage depends on motor type and power. Automatic torque boost can be used in applications with high start torque due to friction, e.g. in conveyor belts.

3.10 SWITCHING FREQUENCY

Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the frequency converter unit.

Switching frequency for Vacon 10: 1.5...16 Hz.

GROUP 4. Analog Inputs

4.1 AI1 HYSTERESIS

Analog Input Sensitivity

4.2 AI2 SIGNAL RANGE

2 = 0 - 20 mA

3 = 4 - 20 mA

4.3 AI2 FILTER TIME

This parameter, given a value greater than 0, activates the function that filters out disturbances from the incoming analog signal.

4.4 CUSTOMER MIN.

4.5 CUSTOMER MAX.

These parameters make it possible to scale input current from 0 to 20 mA.

4.6 MINIMUM SCALING

4.7 MAXIMUM SCALING

Set maximum/minimum scaling to current Value.

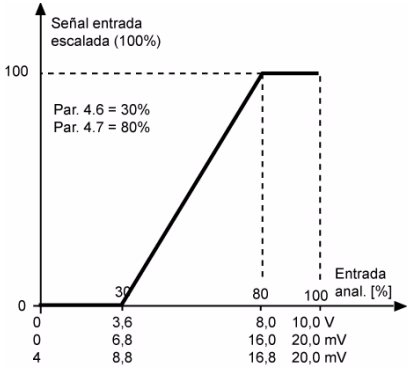


Figure 10.3: Example of signal scaling

GROUP 5. Output Signals

5.1 RELAY 2 (RO2)

0 = Pump 2 Control
1 = Ready
2 = Run
3 = Fault

5.2 DIGITAL OUTPUT (DO)

0 = Pump 3 Control
1 = Ready
2 = Run
3 = Fault

5.3 DIGITAL OUTPUT (AO)

0 = Ready
1 = Run
2 = Fault
3 = Fault Inverted

GROUP 6. Protection

6.5 UNDERLOAD PROTECTION

0 = No response

1 = Warning

2 = Fault, stop mode after fault as in parameter 3.3

Pump is underloaded. Check: that pump suction is not obstructed or blocked, that the pump has enough water.

If the pumping is working properly, you should set parameters P6.6 and P6.7. Underload protection, field weakening area load

Torque limit can be set between 0.0-150.0 % x TnMotor.

This parameter provides the minimum torque value permitted when output frequency is above the field weakening point. See Figure 1-22.

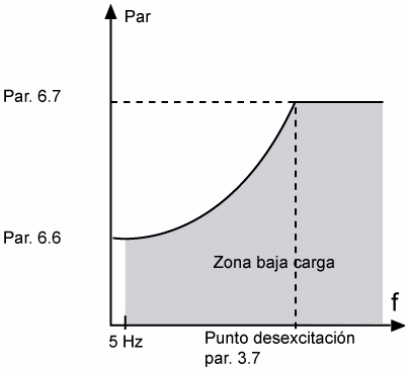


Figure 10.4: Setting Minimum Load

6.6 TORQUE CURVE AT ZERO FREQUENCY

Torque limit can be set between 0.0-150.0 % x TnMotor. This paramter provides the minimum torque value permitted at zero frequency. See Figure 1-22.

If the value of parameter 1.4 is changed (nominal motor current), this parameter automatically resets to the default value.

6.8 UNDERLOAD PROTECTION TIME LIMIT

This time can be set between 2.0 and 320.00 s.

This is the maximum amount of time permitted in underload status. An internal timer measures the time accumulated in underload status. If the underload timer exceeds this limit, the protection will cause a fault as in parameter 6.5. If the pump stops, the underload timer resets to zero. See Figure 1-23.

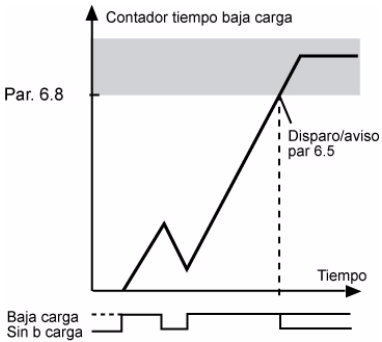


Figure 10.5: Underload Timer Function

MOTOR THERMAL PROTECTION (PARAMETERS 6.9 - 6.11)

Motor thermal protection is to protect the motor from overheating. The Vacon drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will thermally overheat. This is particularly the case at low frequencies. At low frequencies the cooling effect of the motor is reduced as well as its capacity. If the motor is equipped with an external fan the load reduction at low speeds is small.

Motor thermal protection is based on a calibrated model and uses the output current of the drive to determine the load on the motor.

Motor thermal protection can be adjusted with parameters. The thermal current IT specifies the load current above which the motor will be overloaded. This current threshold is a function of the output frequency.

CAUTION! The calibrated model does not protect the motor if the air intake grill is blocked and reduces the airflow to the motor.

6.9 THERMAL PROTECTION OF THE MOTOR

0 = No response

1 = Warning

2 = Fault, stop mode after an error as in parameter 3.3

If tripping is selected, the drive will stop and activate the fault phase. AI

Disable protection (that is, by setting the parameter to 0), the thermal model of the motor is reset to 0%.

6.10 MOTOR AMBIENT TEMPERATURE

When motor ambient temperature should be taken into account, the user should change this parameter. Values can range from -20 to 100 degrees Celsius.

6.11 MOTOR COOLING FACTOR AT ZERO SPEED

Cooling power can be set between 0-150.0% x cooling power at nominal frequency. See Figure 10.6.

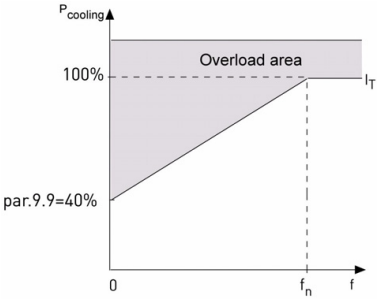


Figure 10.6: Motor cooling power

6.12 MOTOR THERMAL TIME CONSTANT

This time can be set between 1 and 200 minutes.

This is the thermal time constant of the motor. The larger the motor, the longer the time constant. The time constant is the time within which the calibrated thermal model has reached 63% of its final value.

Motor thermal time is specific to motor design and varies from one motor manufacturer to another.

If the motor t6-time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer), it can be used as a basis for setting the time constant parameter. As a rule of thumb, the motor thermal time constant in minutes is equal to 2xt6. If the drive is in stop mode, the time constant is internally increased to three times the set parameter value. See also Figure 10.7.

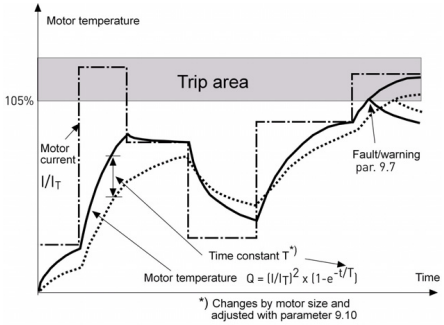


Figure 10.7: Motor temperature calculation

GROUP 7. Automatic Restarts

7.2 AUTOMATIC RESTART, TRIAL TIME

The automatic restart function restarts the frequency converter when the faults have disappeared and waiting time has elapsed.

The time count starts from the first autorestart. If more than three faults occur during trial time, the fault mode is activated. Otherwise, the fault is cleared after the trial time has elapsed and the next fault starts the trial time count again. See Figure 10.8.

If one single fault remains during the trial time, fault mode is true.

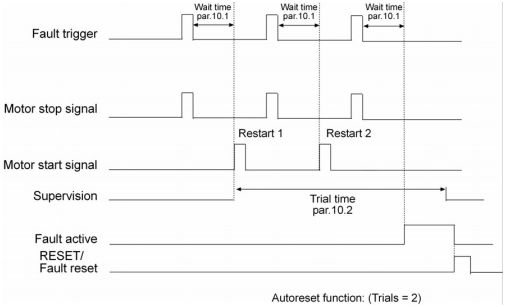


Figure 10.8: Automatic restart

7.4 AUTOMATIC RESTART, CODE

A binary code is inserted in this parameter to enable or disable automatic restarts for some faults.

Example:

Bit 0 = Undervoltage

Bit 1 = Overvoltage

Bit 2 = Overcurrent

Bit 3 = Motor Overheating

Bit 4 = Underload

Bit 5 = User Error

Examples:

1. If we only want to restart the controller when Undervoltage and Overvoltage faults appear, we should set P7.4 to 3.

2. If we only want to restart the controller when Undervoltage and Overcurrent faults appear, we should set P7.4 to 5.

3. If we only want to restart the controller when Overcurrent faults apper, we should set P7.4 to 4.

11. TECHNICAL DATA

11.1 Vacon 10 technical data

Mains connection	Input voltage U_{in}	115 V, -15%...+10% 1~ 208...240 V, -15%...+10% 1~ 208...240 V, -15%...+10% 3~ 380 - 480 V, -15%...+10% 3~ 600 V, -15%...+10% 3~
	Input frequency	45...66 Hz
	Connection to mains	Once per minute or less (normal case)
Supply network	Networks	Vacon 10 (400 V) cannot be used with networks that have a phase to ground
	Short circuit current	Maximum short circuit current has to be < 50 kA.
Motor connection	Output voltage	0 - U_{in}
	Output current	Continuous rated current I_N at ambient temperature max. +50 °C (depends on the unit size), overload 1.5 x I_N max. 1 min / 10 min
	Starting current / torque	Current 2 x I_N for 2 sec in every 20 sec period. Torque depends on motor
	Output frequency	0...320 Hz
	Frequency resolution	0,01 Hz
Control characteristics	Control method	Frequency Control U / f Open Loop Sensorless Vector Control
	Switching frequency	1...16 kHz; Factory default 4 kHz
	Frequency reference	Resolution 0.01 Hz
	Field weakening point	30...320 Hz
	Acceleration time	0.1...3000 sec
	Deceleration time	0.1...3000 sec
	Braking torque	100%*T_N with brake option (only for 400 V > 1.5 kW) 30%*T_N without brake option

Table 11.1: Vacon 10 technical data

Ambient conditions	Ambient operating temperature	-10 °C (no frost)...+40 / 50°C (depends on the unit size): rated loadability IN Side by side installation for MI1-3 it is always 40°C; For IP21/Nema1 option in MI1-3 the maximum temparture is also 40 °C.
	Storage temperature	-40°C...+70°C
	Relative humidity	0...95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - chemical vapours - mech. particles	IEC 721-3-3, unit in operation, class 3C2 IEC 721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m. 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration: EN60068-2-6	3...150 Hz Shift range 1(spike) mm at 3...15.8 Hz Max. range of acceleration 1 G at 15.8...150 Hz
	Shock IEC 68-2-27	UPS Drop Test (for applicable UPS weights) Storage and shipping: max 15 G, 11 ms (in package)
	Enclosure class	IP20 / IP21 / Nema1 for MI1-3
	Pollution degree	PD2
EMC	Immunity	Complies with EN50082-1, -2, EN61800-3
	Emissions	230V: Complies with EMC category C2; (level H Vacon); With an internal RFI filter 400V: Complies with EMC category C2; (level H Vacon): With an internal RFI filter Both: No EMC emission protection (Vacon level N): Without RFI filter
Standards		For EMC: EN61800-3 For safety: UL508C, EN61800-5
Certificates and manufacturer's declarations of conformity		For safety: CB, CE, UL, cUL, For EMC: CE, CB, c-tick (see drive nameplate for more detailed information)

Table 11.1: Vacon 10 technical data

11.2 Power ratings

11.2.1 Vacon 10 - Mains voltage 115 V

Mains voltage 115 V, 50/60 Hz, 1~ series						
Freq. converter type	Rated loadability		Motor shaft power	Nominal input current	Mechanical size	Weight (kg)
	100% contin. current I_N [A]	150% over-load current [A]	P [KW]	[A]		
0001	1.7	2.6	0.25	9.2	MI2	0.70
0002	2.4	3.6	0.37	11.6	MI2	0.70
0003	2.8	4.2	0.55	12.4	MI2	0.70
0004	3.7	5.6	0.75	15	MI2	0.70
0005	4.8	7.2	1.1	16.5	MI3	0.99

Table 11.2: Vacon 10 rated loadability, 115 V

11.2.2 Vacon 10 – Mains voltage 208-240 V

Mains voltage 208 - 240 V, 50/60 Hz, 1~ series						
Freq. converter type	Rated loadability		Motor shaft power	Nominal input current	Mechanical size	Weight (kg)
	100% contin. current I_N [A]	150% over-load current [A]	P [KW]	[A]		
0001	1.7	2.6	0.25	4.2	MI1	0.55
0002	2.4	3.6	0.37	5.7	MI1	0.55
0003	2.8	4.2	0.55	6.6	MI1	0.55
0004	3.7	5.6	0.75	8.3	MI2	0.7
0005	4.8	7.2	1.1	11.2	MI2	0.7
0007	7.0	10.5	1.5	14.1	MI2	0.7
009*	9.6	14.4	2.2	22.1	MI3	0.99

Table 11.3: Vacon 10 power ratings, 208-240 V, 1~

* The maximum ambient operating temperature of these drives is +40 °C.

11.2.3 Vacon 10 – Mains voltage 208-240 V

Mains voltage 208 - 240 V, 50/60 Hz, 3~ series						
Freq. converter type	Rated loadability		Motor shaft power	Nominal input current	Mechanical size	Weight (kg)
	100% contin. current I_N [A]	150% overload current [A]	P [KW]	[A]		
0001	1.7	2.6	0.25	2.7	MI1	0.55
0002	2.4	3.6	0.37	3.5	MI1	0.55
0003	2.8	4.2	0.55	3.8	MI1	0.55
0004	3.7	5.6	0.75	4.3	MI2	0.7
0005	4.8	7.2	1.1	6.8	MI2	0.7
0007*	7.0	10.5	1.5	8.4	MI2	0.7
0011*	11	16.5	2.2	13.4	MI3	0.99

Table 11.4: Vacon 10 power ratings, 208-240 V, 3~

* The maximum ambient operating temperature of these drives is +40 °C.

11.2.4 Vacon 10 – Mains voltage 380-480 V

Mains voltage 380 - 480 V, 50/60 Hz, 3~ series						
Freq. converter type	Rated loadability		Motor shaft power	Nominal input current	Mechanical size	Weight (kg)
	100% contin. current I_N [A]	150% overload current [A]	P [KW]	[A]		
0001	1.3	2.0	0.37	2.2	MI1	0.55
0002	1.9	2.9	0.55	2.8	MI1	0.55
0003	2.4	3.6	0.75	3.2	MI1	0.55
0004	3.3	5.0	1.1	4.0	MI2	0.7
0005	4.3	6.5	1.5	5.6	MI2	0.7
0006	5.6	8.4	2.2	7.3	MI2	0.7
0008	7.6	11.4	3.0	9.6	MI3	0.99
0009	9.0	13.5	4.0	11.5	MI2	0.99
0012	12.0	18.0	5.5	14.9	MI3	0.99

Table 11.5: Vacon 10 power ratings, 208-240 V, 3~

11.2.5 Vacon 10 – Mains voltage 600 V

Mains voltage 600 V, 50/60 Hz, 3~ series						
Freq. converter type	Rated loadability		Motor shaft power	Nominal input current	Mechanical size	Weight (kg)
	100% contin. current I_N [A]	150% over-load current [A]	P [KW]	[A]		
0002	1,7	2,6	0.75	2	MI3	0,99
0003	2,7	4,2	1,5	3,6	MI3	0,99
0004	3,9	5,9	2,2	5	MI3	0,99
0006	6,1	9,2	3,7	7,6	MI3	0,99
0009	9	13,5	5,5	10,4	MI3	0,99

Table 11.6: Vacon 10 power ratings, 600 V

Note 1: The input currents are calculated values with 100 kVA line transformer supply.

Note 2: The mechanical dimensions of the units are given in Chapter 3.1.1.

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