AK06

VARIABLE SPEED DRIVE

TRIOL

ELEGANT AND FUNDAMENTAL
INDUSTRIAL SOLUTIONS

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Quickstart Manual

Dear customer

Thank you for purchasing Triol Variable Speed Drive (VSD), the key to your successful artificial lift strategy.

We are sure that our variable speed drive technologies allow you to improve operations and maximize your production.

VSD is complete with the following manuals:

- Design Manual;
- Operation Manual;
- Quickstart Manual;
- Programming Manual;
- Troubleshooting Manual;
- Approvals/Standards.

<u>IMPORTANT</u>: The list may be extended with the additional documents (The Factory Acceptance Testing (FAT) and others) depending on the VSD line.

<u>NOTE</u>: Quickstart manual includes only the necessary basic steps to start VSD with an induction motor and permanent magnet motor at a well site during pre-commissioning: set-up VSD to motor and transformer, no-load test and test a VSD with step-up transformer. During commissioning must be set-up protections, operation and starting modes in accordance to a field standards or well design. Explanation of VSD controller settings are given in the Programming manual. Procedures of starting/stop, recommendations for settings, connection of external equipment (such as downhole sensors, analog/digital, input/outputs sensors are given in the Operation manual. In case of any problems or failures please use Troubleshooting manual. Design manual includes technical specifications, a set of dimensional drawings and electrical diagrams for Variable Speed Drives Triol AK06. The list of all kinds of user manuals is discussed at the placing an order stage. E-documents version for the product is available on the official Triol Corporation website.

https://triolcorp.us/documents/

Quickstart Manual AT.654252.409 ver. 1.2.

The manual applies to the commercially available Variable Speed Drives Triol AK06 UD, CP and RD lines with UMKA07 controller for ESP application.

Contents

Safety requirements and personnel qualification

All the activities on installation, mounting, dismantling, operation and maintenance of a Variable Speed Drive must be carried out in conformity with effective local and electrical codes and regulations. Improper installation and operation of the drive may result in personal injury or equipment damage. There is a deadly level of voltage in drive's cabinet. When working on installation, maintenance, repair, it is vital to monitor the absence of voltage at the input and output terminals of VSD.

Before start working with VSD the staff must:

- be specially trained and examined in labor protection issues;
- attend a preliminary medical examination (when hired for work) and periodic health examinations (during the entire labor activity);
- have electrical safety qualification.

At conducting connection to the power supply line there a special attention must be paid to ensuring of reliable grounding of VSD casing. Grounding resistance must meet the local and national requirements.

UD/CP line

RD line

At executing any work inside Variable Speed Drive the following safety measures must be performed:

- circuit breaker ON/OFF must be placed to «OFF» position;
- leading-in cables must be de-energized;
- warning tags must be put «ON»;
- make sure that leading-in cables are de-energized and ground them.

* – circuit breaker handle may change place in different VSD's types.

ATTENTION! Filter power capacitors conserve the charge hazardous to life within 5 minutes after de-energization! Prior to execution of work inside the cabinet make sure that capacitors are de-energized. Filter power capacitors conserve the charge hazardous to life within 5 minutes after de-energization!

ATTENTION! It is prohibited to disconnect and connect detachable joints if supply voltage is available. Electronic control units of Variable Speed Drives contain components made on the basis of metal-oxide-semiconductor (MOS) technology excluding the action of static electricity. If you need to touch some MOS component, ground your body and the tools to be used.

Safety Recommendation

The drive must be installed, adjusted and serviced by qualified electrical maintenance personnel. Improper installation or operation of the drive may cause injury to personnel or damage to equipment. The drive must be installed and grounded in accordance with local and national electrical codes. There is a deadly level of voltage in drive's cabinet. Extreme care must be taken to ensure all power sources are disconnected before starting installation, maintenance and repair jobs. Whenever a drive containing a SCADA or telemetry connection is to be repaired or serviced, the service man must disconnect any communication devices attached to the drive to prevent unexpected start commands from the remote control system. Service men must be aware that there could be more than one remote telemetry connection and that all of them must be disabled or disconnected for the duration of the repair period. Once repairs are completed, the telemetry connections must be reestablished.

Personal Protective Equipment (PPE)

The basic personal protection equipment (PPE) required for field service includes, but is not limited to, steel toe shoes, safety glasses and a hard hat. If electrical configuration or maintenance is performed on potentially energized circuits, personal protective equipment is required to minimize the danger or electrical shock, arc flash and/or arc blast. The level of PPE required can vary based upon the available electrical energy available at the installation site. If any doubt exists, consult and employ the recommendations published in the National Fire Protection Code, NFPA-70E.

Safety Procedures

Work inside the cabinets must be performed with the power off. Isolate energy source(s) and use proper Lock Out/Tag Out (LOTO) procedures and Personal Protective Equipment (PPE) to ensure personnel safety. The drive also contains stored sources of energy in the form of capacitors. Allow sufficient time after power is removed for those capacitors to discharge to a safe level below 50 V DC. The bleed resistors attached to the capacitors reduce the voltage to safe levels

within five minutes of power down. Confirm removal of energy source using a proven voltage indicator device.

Variable Speed Drive description

The VSD design provides possibility for replacement of all the basic modules, functional units and circuit board in the field. All couplings and connections between units and circuit boards are detachable and demountable; there is no need to perform soldering when replacing any failed unit inside the VSD.

If agreed with Customer, AK06 Variable Speed Drive may be completed with Ethernet (TCP/IP protocol) support module that enables to receive and process commands through the upper-level supervisory control and data acquisition (SCADA) channel over Ethernet in all operating modes of the Variable Speed Drive. To connect the Ethernet cable, use the 8P8C socket located in the compartment where a terminal block for external connections is placed.

At the same time AK06 can be connected to SCADA only via Ethernet or RS 485.

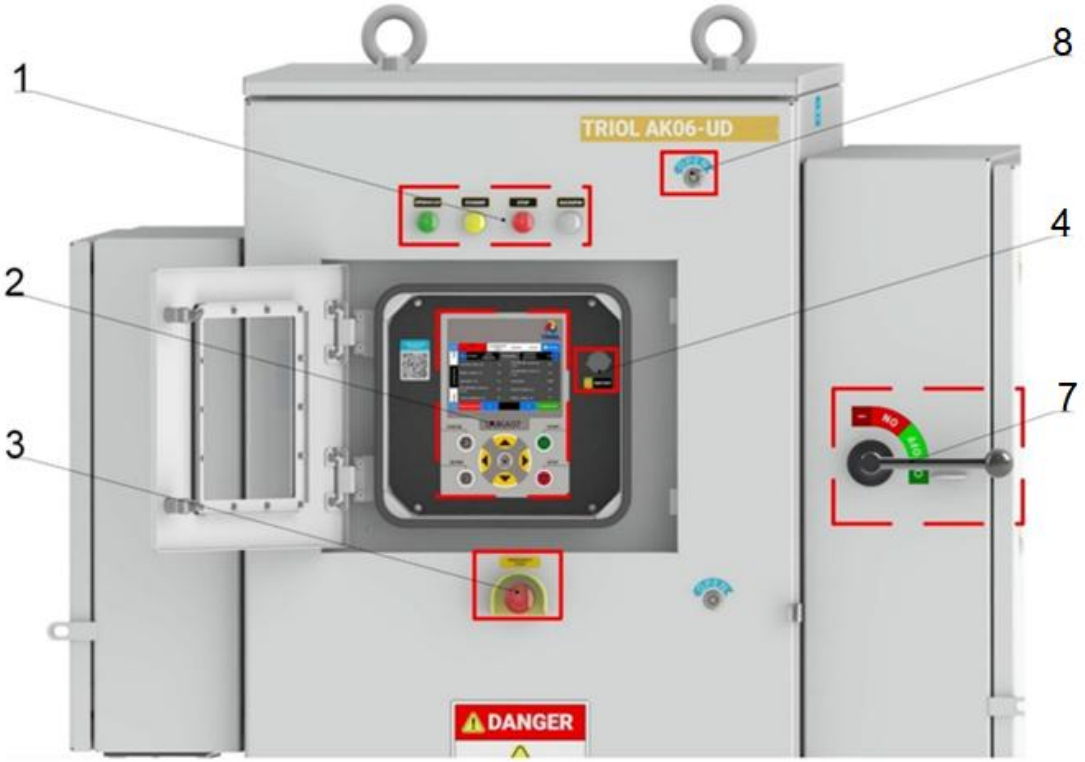
All VSD parameters and operation data are displayed by UMKA07 controller via its large 7 / 800 x 480 dots liquid-crystal touch screen located in the upper part of the controller front panel. All messages about the VSD current state, actuation of protections, values of operating parameters, etc. are offered as texts without any numerical codes or symbols to simplify reading. Liquid-crystal display is backlit for greater viewing experience under insufficient light conditions. The display is designed to operate within a wide range of ambient temperatures.

The controller's event log memory capacity is 16 Mb. This allows to store over 1 million of records and to ensure the information is saved with 1 sec recording step over the period of 10 days.

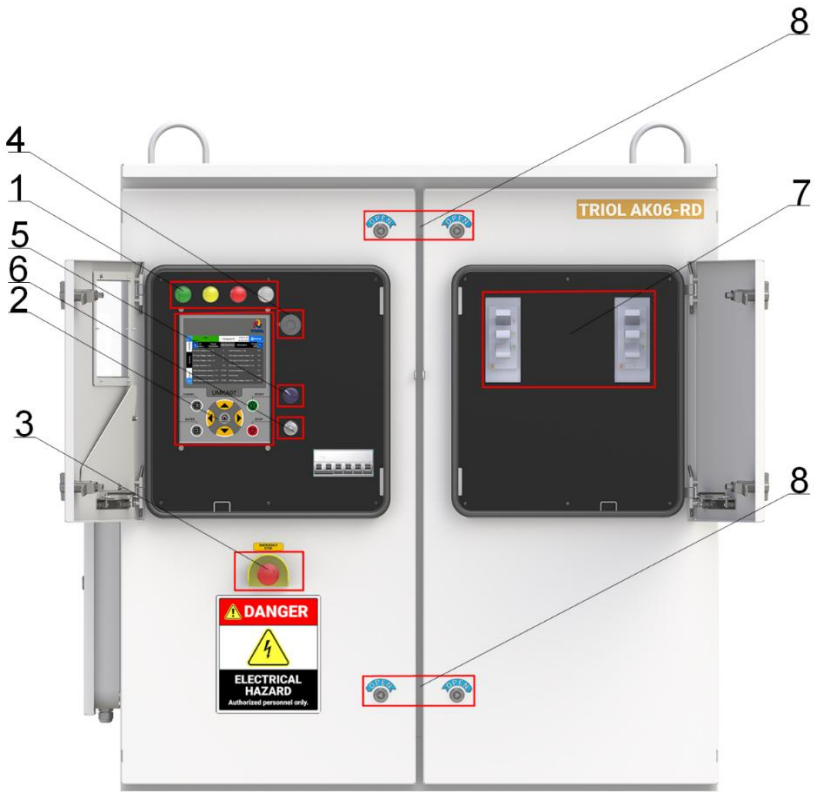
Two physical hot keys located on the right and underneath the UMKA07 display screen are for VSD's immediate START (green) and STOP (red).

***NOTE:** there are two versions of UMKA07 controller displays available: with or without touch-screen capability. In touch screen version, the following physical keys are disabled: «CANCEL», «ENTER», «STATUS», «LEFT», «RIGHT», «UP», «DOWN».*

VSD AK06-UD and CP lines internal design



VSD AK06-RD line internal design



Triol AK06 VSD can be provided with varied input and output parts, as well as with different enclosure types for indoor and outdoor installation.

1. External light indicator

Green indicator HL1 (OPERATION) is intended for indicating the VSD ON state. Indicator blinking means that some parameter has exceeded a threshold value and a countdown to protective shutdown has begun. If the parameter value becomes normal the VSD keep running, if not, VSD shuts down;

Yellow indicator HL2 (STANDBY) indicates the VSD OFF state with a capability of automatic restart. It shows a continuous glow if some parameter has reached a threshold value. Indicator blinking improves operator's awareness of the VSD status and goes to show that there are no reasons, which may prevent motor from starting up, and a countdown to automatic restart begins;

Red indicator HL3 (STOP) indicates the VSD OFF state without any capability of automatic restart;

White indicator HL4 (BACKSPIN) indicates dangerous voltage in VSD outputs terminals or the presence of motor backspin rotation voltage at the output terminals. If backspin voltage becomes less than 60 V AC, HL4 stops lightning;

2. UMKA07 controller with touchscreen display. If UMKA07 complete with touchscreen only  «START» and  «STOP» buttons are active;
3. Emergency button - press this button to stop VSD;
4. The USB port is intended for connecting devices for reading data log to USB Flash memory, writing manufacturer settings from USB Flash memory;
5. Frequency potentiometer – allows to set VSD output frequency;
6. Manual/Auto switch – intended to change VSD mode of operation «Manual» or «Auto»;
7. Input power circuit breakers handle;
8. Door locks.

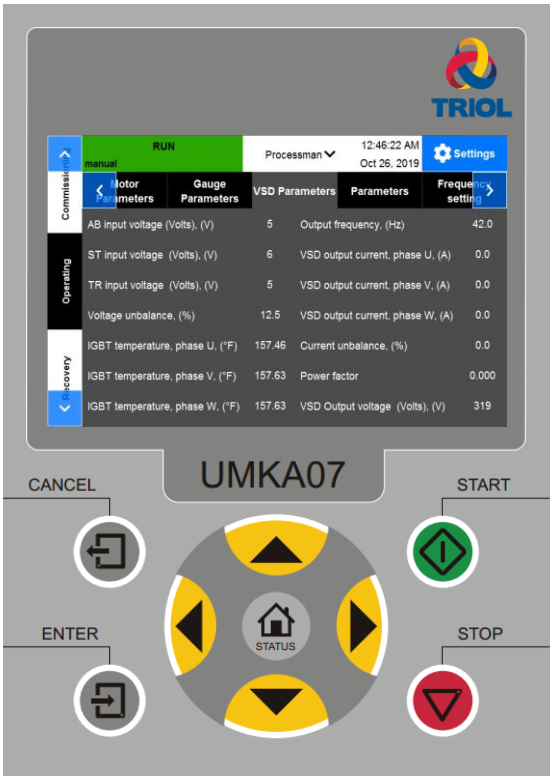


Figure 1 – UMKA07 view

Levels «Processman» and «User» give accesses to different menus:

Menu	Processman	User
Testing	V	X
Commissioning	V	X
Operating	V	V
Recovery	V	V

Access to menu levels is protected by a password. To change the status of a particular access level («V» – permitted, «X» – restricted) tap on the current access level on the display.

Each menu describes VSD lifecycles and gives access to configuration of VSD for each lifecycle. This logic helps quicker commissioning and step-by-step VSD configuration.

Overview of UMKA07 menu structure

- «**Settings**» - basic HMI settings VSD information

Display	Language	Date and time	Units	VSDC information	VSD information	USB Operation	VSD temperature

- «**Testing**» - pre-commissioning VSD test procedure

Parameters	Installation parameters	U/F	Gauge	Inputs/ Outputs	Alarm setting	Modes of operation	Modes of start	SCADA
	Motor	Frequency settings	Gauge select	Digital inputs	Overload	Setting modes		
	SUT	U/F curve	Intake pressure	Digital outputs	Underload	Power ON-start		
	Line parameters		Discharge pressure	Analog inputs	Current unbalance	Shaking		
	PMM vector*		Ambient temperature	Analog outputs	Insulation	Gas bag removal mode		
	PMM cos*		Discharge temperature		Backspin	PID control mode		
	Pump		Motor winding temperature		Input voltage	Current synchronization		
	Well data		Vibration X		Low frequency			
	VSD		Vibration Y		DC-link voltage			
			Vibration Z		Power switches overheat			
			Vibration XY		Overcurrent			
			Flow		Power switches			
			Leakage current		Door			
			Axial vibration speed		Phasing			
			Radial vibration speed		Cabinet overheat			
					Connection			
					Emergency stop			
					UMKA temperature			
					Overtorque*			
					Overshoot*			
					Mains frequency			
					Automatic restart counters			

- «**Operating**» - actual parameters of ESP operation and speed adjustment

Parameters	Frequency settings	Motor Parameters	Gauge Parameters	VSD Parameters	Current calibration

- «**Recovery**» - analysis of ESP operation

Actual fault	Fault log	Event log	Log settings	Starting graph	Diagnostics
			Log manage		
			Evens by time		
			Events by change		
			User trend		

General overview of UMKA07 interface is shown on the picture below:

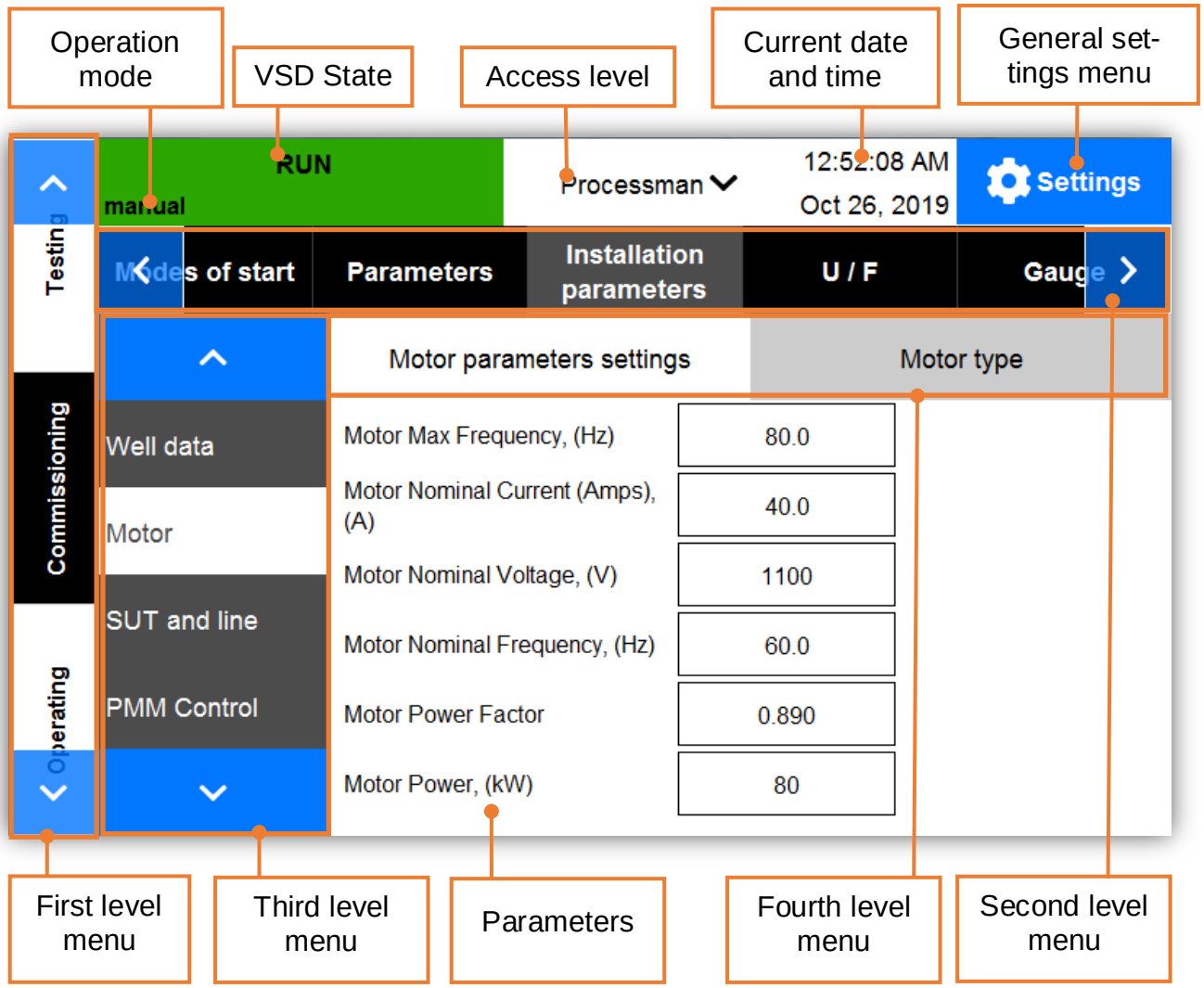
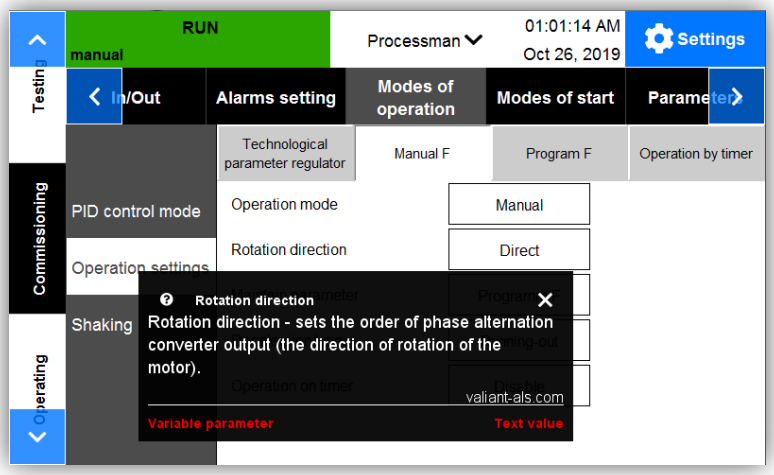
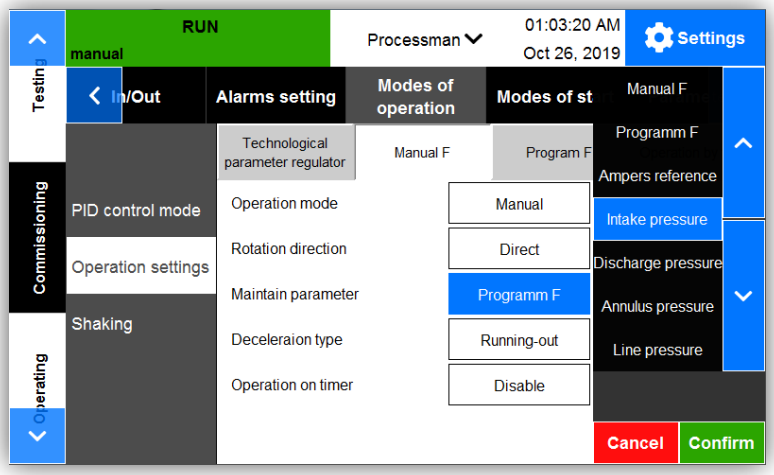


Figure 2 – UMKA07 interface overview

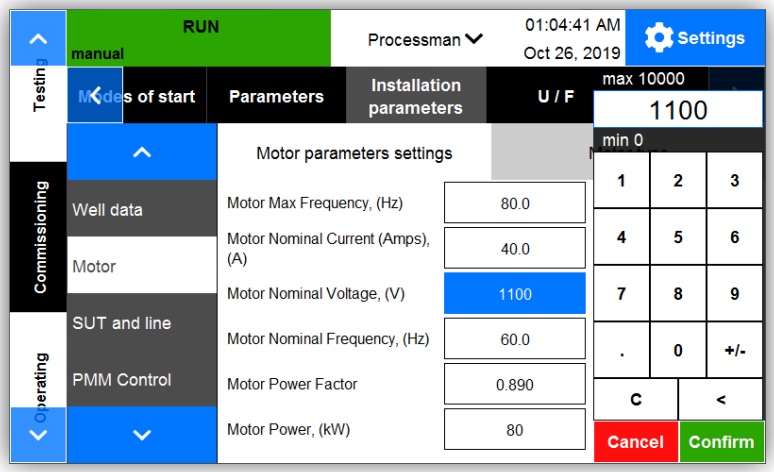
All menu navigation and setpoint adjustment of selected parameter are made by tapping on the corresponding area of touch screen display.



To view reference information about the UMKA07 parameter, just tap on a parameter name: the pop-up window appears with helpful information about the chosen parameter.



Settings of a parameter that can have a defined value are made by selecting a desired value from the list of possible values. The parameter is highlighted while being edited. Tap on «Confirm» button to store the new value of a parameter.



Numeric parameters are entered via display's pop-up numeric keyboard. To store the new value tap on the «Confirm» button. Numeric keyboard shows possible minimum and maximum values of the editable parameter.

Variable Speed Drive starting procedure

Follow the steps given below to start the VSD:

1. Check the environmental conditions, supply voltage, check if the connected equipment corresponds with the VSD nameplate.
2. Check the mounting, power connections and grounding reference with the operation manual recommendation.
3. Make no-load test.
4. Startup with step-up transformer.
5. Startup with the load.
6. Startup with PMM.
7. Additional settings:
   - Gauge;
   - SCADA;
   - Inputs/outputs.

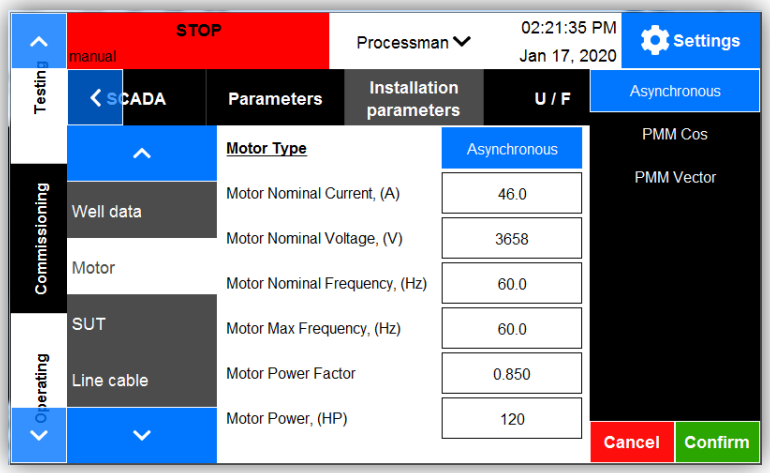
VSD function testing

<u>ATTENTION!</u> All personnel must use the product properly and safely to prevent any injury or any kind of damage.

Motor settings:

To set-up motor parameters in to VSD controller, go to the UMKA controller menu:

1. «Commissioning» → «Installation parameters» → «Motor» → «Motor type».

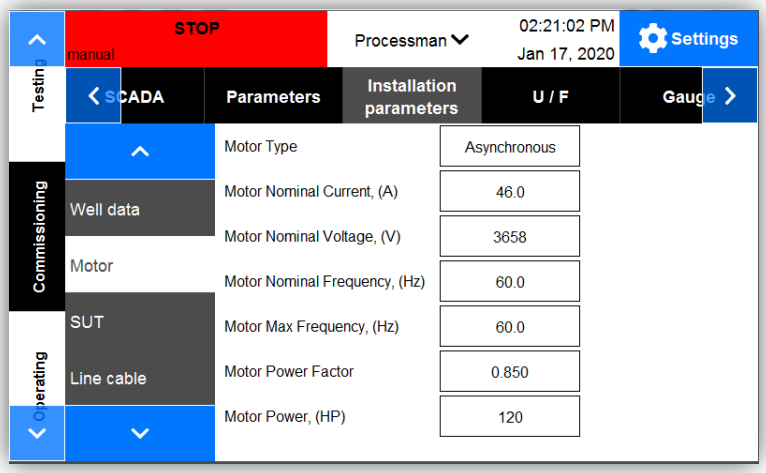


Set-up type of motor «Asynchronous»;

Press «Confirm».

<u>Note:</u> to make the no-load test set the Asynchronous type of motor only.

2. «Commissioning» → «Installation parameters» → «Motor».



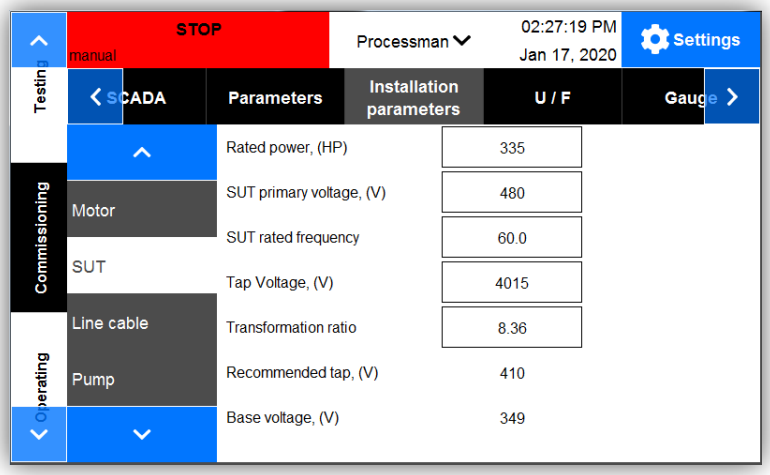
Set-up the rated motor parameters according to the motor nameplate:

- «Motor Max Frequency», Hz;
- «Motor Nominal Current», A;
- «Motor Nominal Voltage», V;
- «Motor Nominal Frequency», Hz;
- «Motor Power Factor»;
- «Motor Power», kW or HP.

Step-up transformer and cable line settings

To set-up step-up transformer (SUT) and cable line parameters into the VSD controller, go to the UMKA controller menu:

1. «Commissioning» → «Installation parameters» → «SUT».



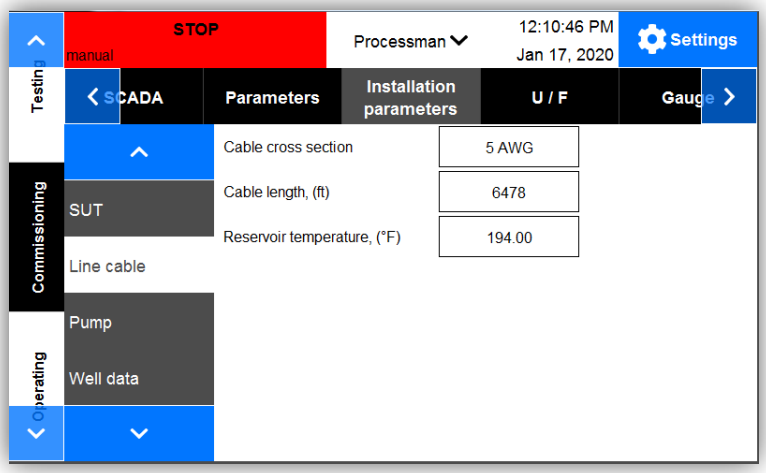
Set-up the rated step-up transformer parameters according to the transformer nameplate:

- «Rated power», HP;
- «SUT primary voltage», V;
- «SUT rated frequency», Hz.

Set-up the «SUT tap Voltage». The «SUT tap Voltage» set point must be selected according to the real connected tap and must be not less than the «Recom. tap voltage» (parameter below in same menu). After entering «SUT tap Voltage» «Transformation ratio» and U/F the parameter be recounted.

« Recom. tap voltage », V – the calculated value of the needed tap of SUT.

2. «Commissioning» → «Installation parameters» → «Line cable».



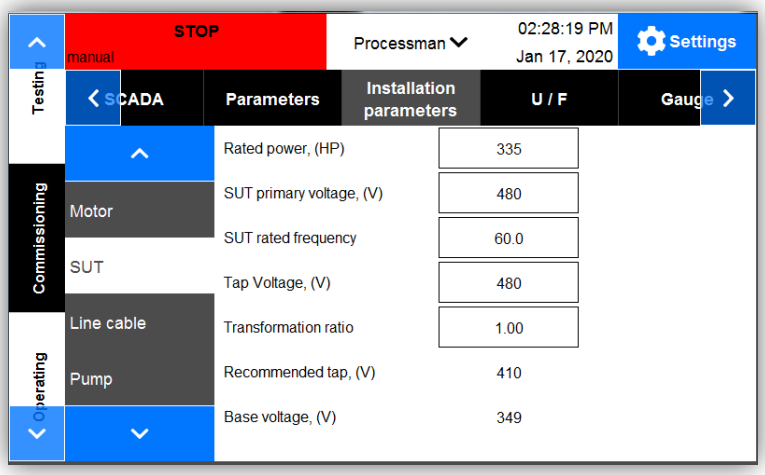
Set-up the cable parameters and operation conditions:

- «Cable cross-section», AWG;
- «Reservoir temperature», °F;
- «Setting depth» (cable length), ft.

No Load Test

Disconnect all load from the VSD!

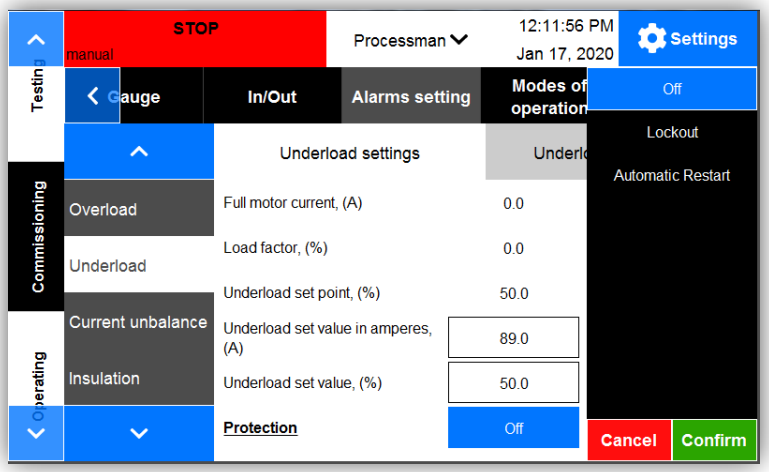
The following test is performed in the absence of a connected load to the VSD output terminals.



If the «Tap Voltage» parameter in «Commissioning» → «Installation parameters» → «SUT».

«Step-Up Transformer tap» differs from supply voltage, than the parameter must be set according to the supply voltage value.

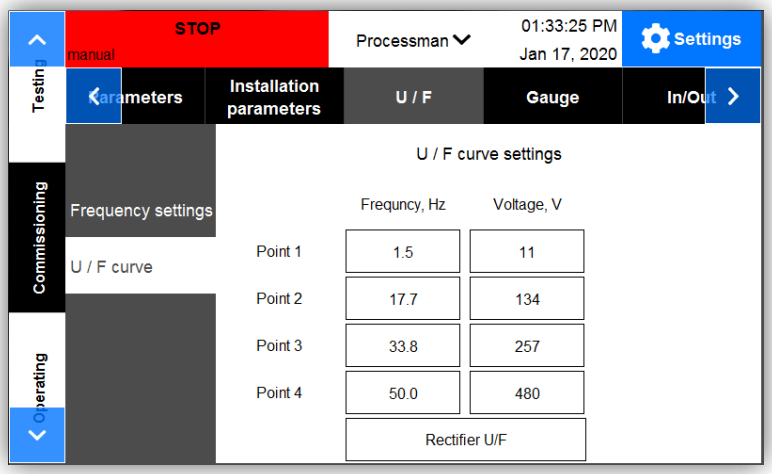
1. Go to Menu → «Commissioning» → «Installation parameters» → «Alarms settings».



Turn off «Underload» alarm:

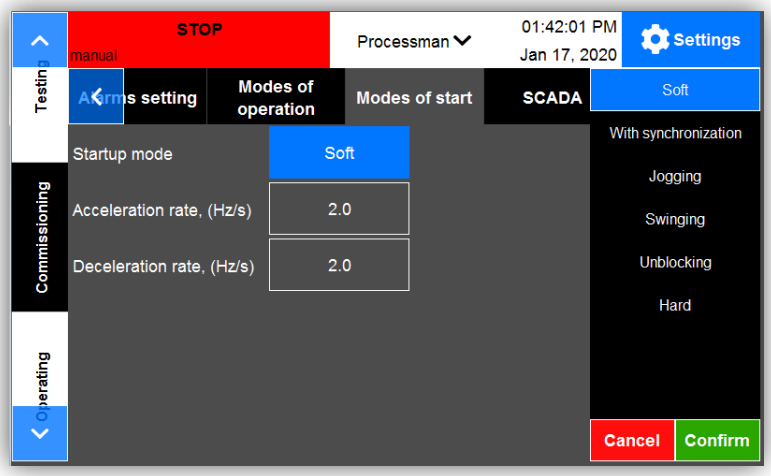
- set «Protection» parameter to «Off».
- Press «Confirm».
- Turn off «Current unbalance» alarm:
- set «Protection» parameter to «Off».
- Press «Confirm».

2. Go to → «Commissioning» → «U/F» → «U/F curve».



- set-up voltage and frequency points 4 as the maximum motor operation voltage and frequency. Voltage here is the VSD output. Voltage can be set equal to supply voltage;
- then press parameter «Straight U/F», the controller automatically transforms the curve in line.

3. Go to «Commissioning» – «Modes of start» and make sure that there is installed startup mode «Soft».



Now the VSD is ready for no-load test.

TO START A MOTOR PRESS

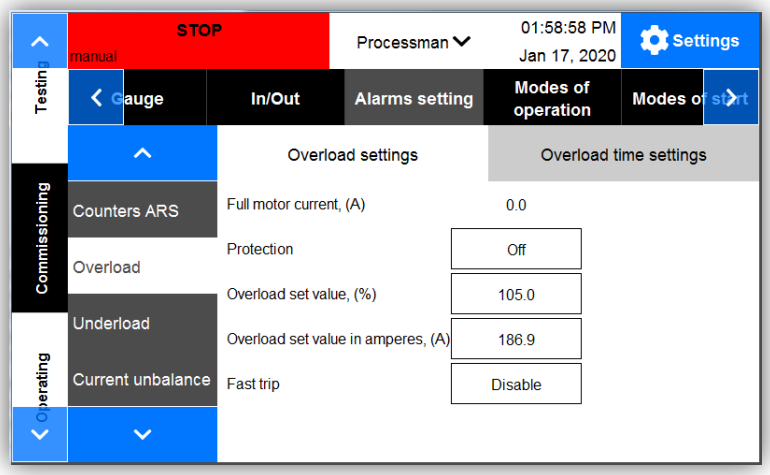
TO STOP A MOTOR PRESS

Asynchronous motor start

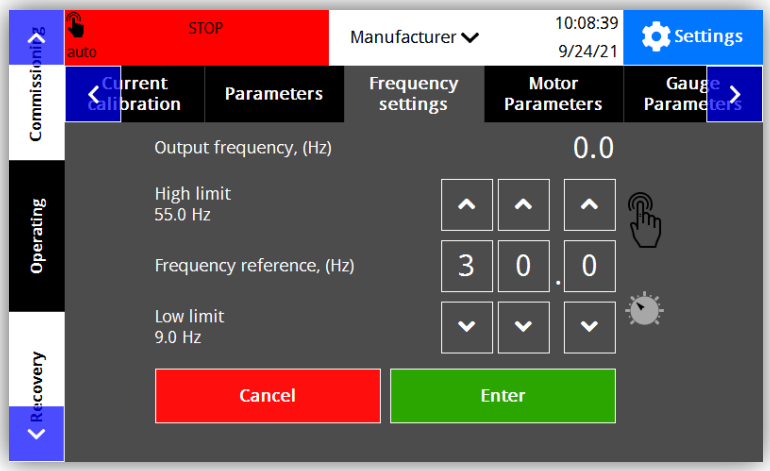
Before starting the VSD check if all the steps of «VSD function testing» are performed properly.

Adjusting the protections of the VSD and downhole equipment.

1. Go to «Commissioning» → «Alarms settings».



Set the alarms settings according to the installed equipment type, operation conditions and technology compliance.



To set-up frequency for a motor, go to «Operating», set the required frequency in the parameter «Frequency setting».

Motor frequency can be changed during operation by changing the value of «Frequency setting» parameter.

TO START A MOTOR PRESS

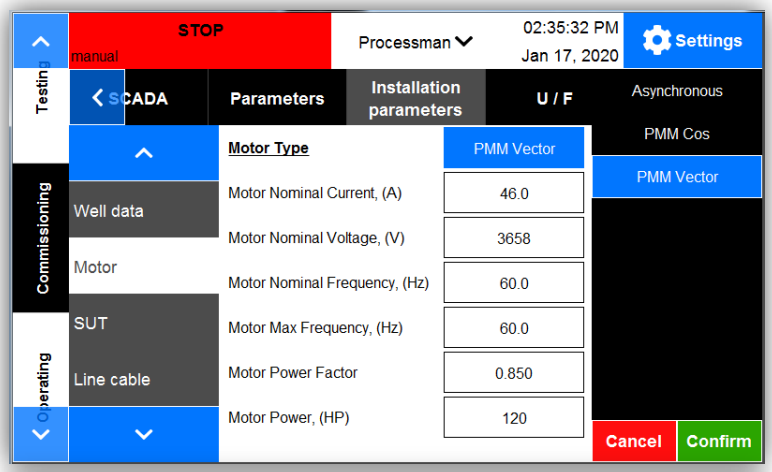
Measure transformer output currents and compare them with values shown by the VSD controller. The difference between controller data and real measured values must be not more than 2 %.

Permanent magnet motor start

Auto set up procedure.

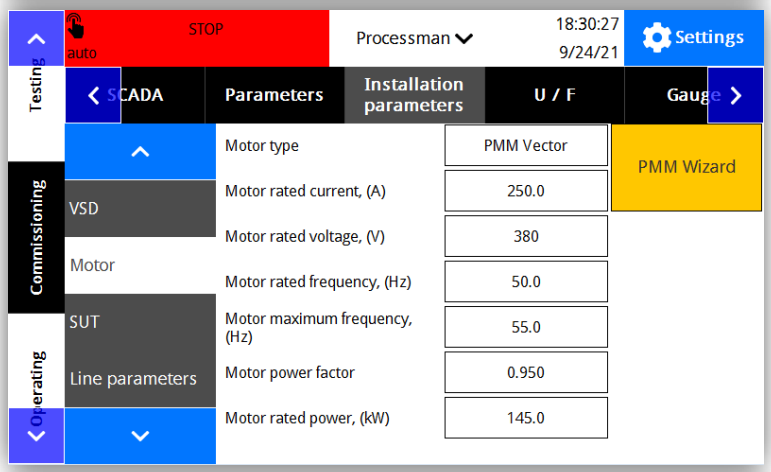
1. To start AK06 in vector control mode with permanent magnet motor change drive type to «PMM Vector»:

Go to «Commissioning» → «Installation parameters» → «Motor» → «Motor type».

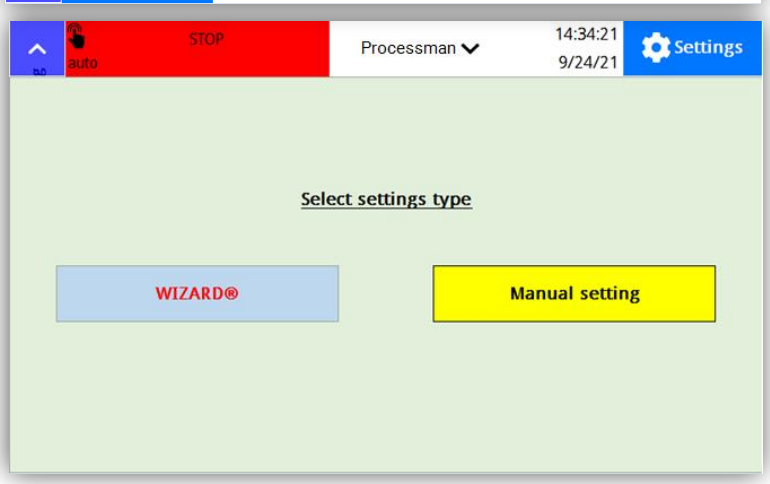


- set-up the type of the drive to «PMM Vector».

After set-up motor type PMM vector controller menu will be updating for activate «PMM Wizard»

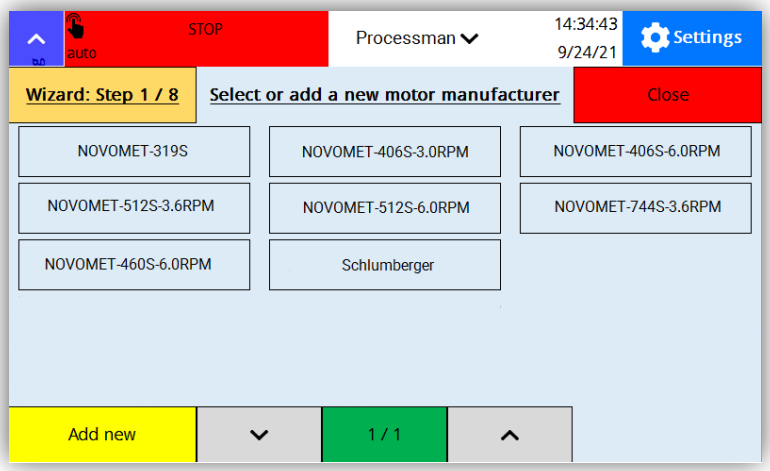


Go to PMM Wizard



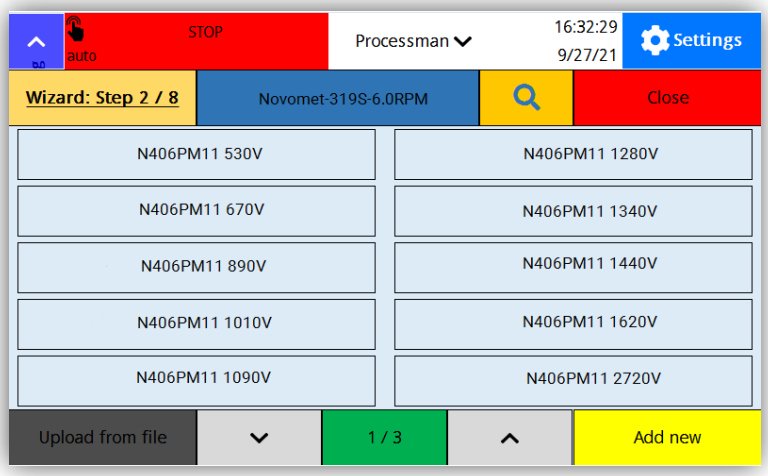
Select settings type «WIZARD®»

Wizard – assistant which in eight steps help start running ESP with PMM motor



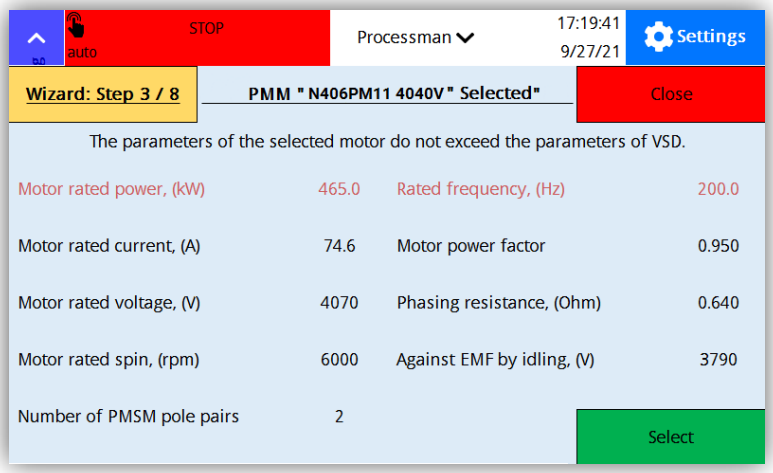
Step 1 – Select the motor manufacture and motor series

Add new motor if in list absent motor. For add new motor press «Add new».
Add a motor using the help



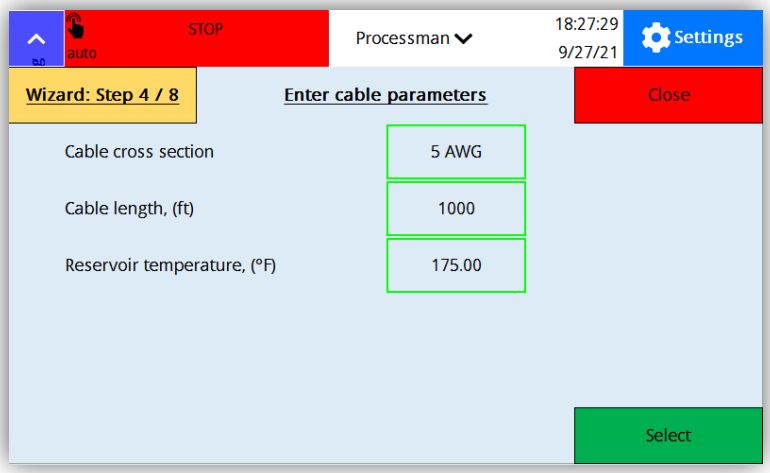
Step 2 – Select the motor type

Add new motor if in list absent motor. For add new motor press «Add new».
Add a motor using the help

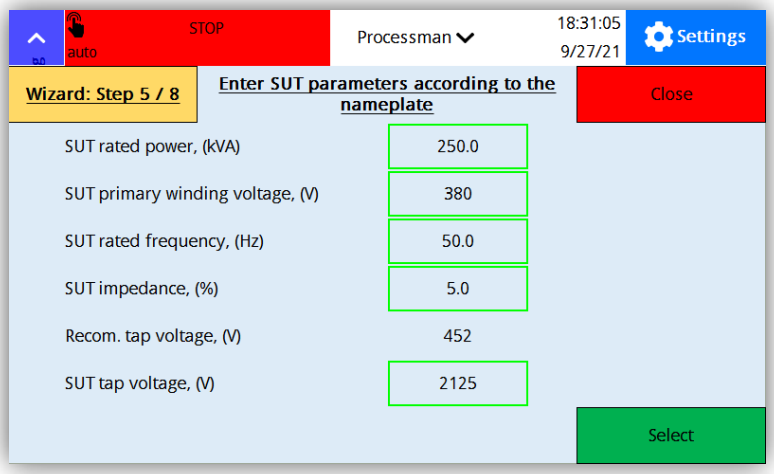


Step 3 – Check main motor parameters

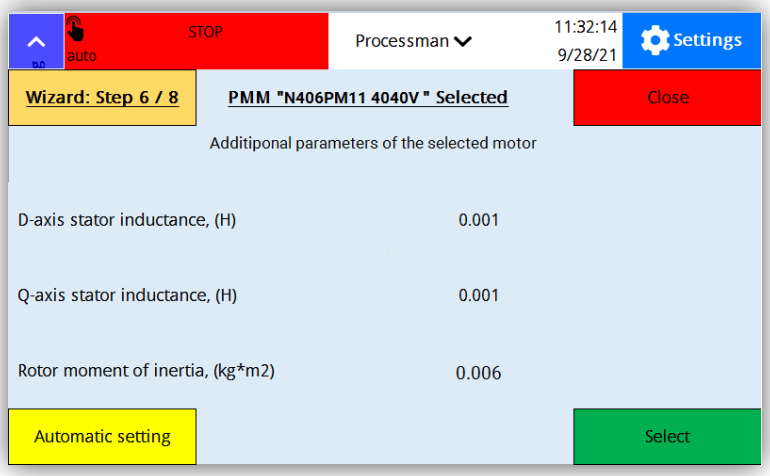
Set up parameters if add new motor. Motor parameters provide motor manufacturer in technical documents



Step 4 – Set up cable parameters and operation conditions

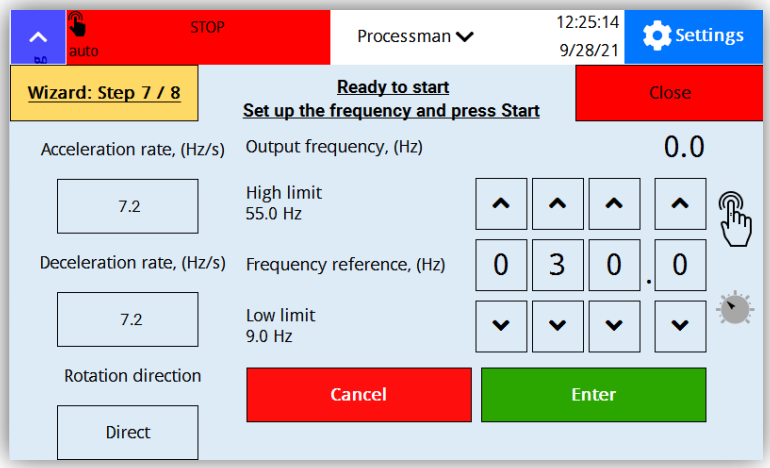


Step 5 – Enter SUT parameters according to the nameplate



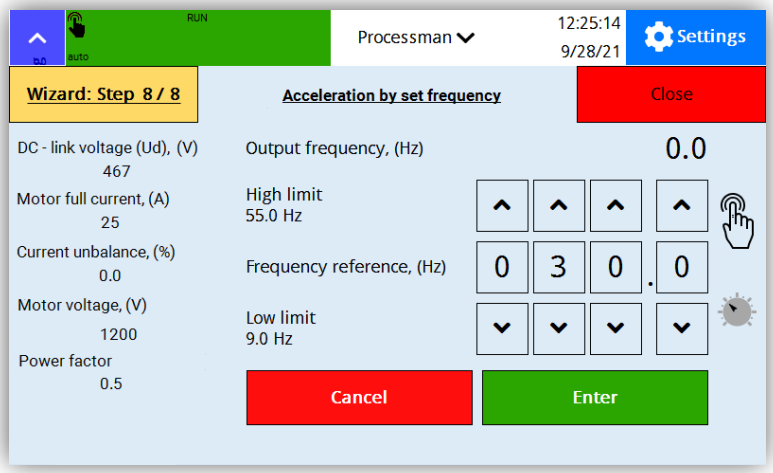
Step 6 – Check additional parameter of the select motor

Set up parameter if add new motor. Motor parameters provide motor manufacturer in technical documents

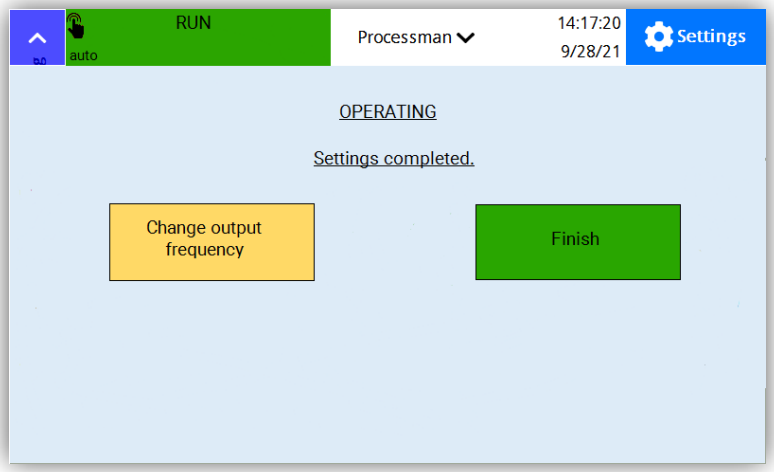


Step 7 – Set up operating frequency, acceleration rate and deceleration rate.

TO START A MOTOR PRESS



Step 8 – VSD automatic acceleration motor to the set frequency



After motor acceleration to the set frequency, on controller screen opened window. Select «Finish» for close Wizard.

External connections

Gauge

UD/CP line

RD line

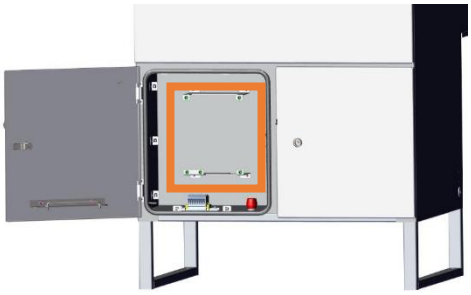
Follow the steps described below for successful downhole equipment connection:

- de-energize the VSD by turning the circuit breakers to «OFF»;
- wait 5 minutes for the DC link capacitors to discharge, the ––UMKA07 screen and the Backspin light fade;

Install downhole measurement unit at highlighted area;

VSD Line UD/CP 100…675 A

VSD's 800…1K6 A



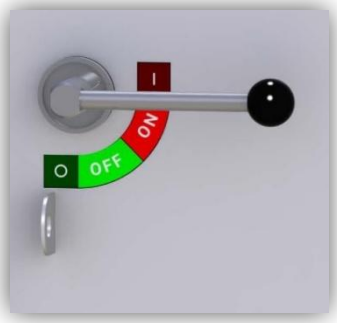
VSD Line RD

User terminal

ACS1_RS485A	27	SCADA RS485
ACS1_RS485B	28	
NC	29	
Net		
ACS1_RXD	30	SCADA RS232
ACS1_TXD	31	
ACS1_0V_U2	32	
Net		
DME_RS485A	33	Gauge RS485
DME_RS485B	34	
Net		
DME_RXD	35	Gauge RS232
DME_TXD	36	
DME_0V_U1	37	
Net		
~220_Sensor	38	Sensor power supply (max power 230 VA)
~220_Sensor	39	
NC	40	
~110_Sensor	41	
~110_Sensor	42	
Net		
+24V_USER	43	Power supply +24V DC (max power 100 W)
-24V_USER	44	

- connect the downhole equipment power supplies to the external terminals: 110 V or 220 V according to the Downhole Measuring equipment datasheet;
- connect the RS-485 or RS-232 interface circuit to the external terminal;

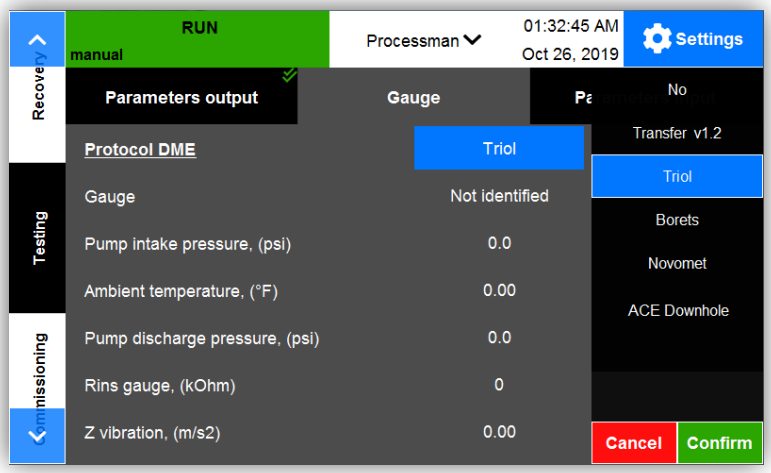
- connect the surface unit high-voltage cable of the Downhole Measuring equipment and the step-up transformer cable (or choke) to «WYE-point» (highlight area), located in this compartment;



UD/CP line

RD line

- energize the VSD by turning the circuit breakers «ON»;

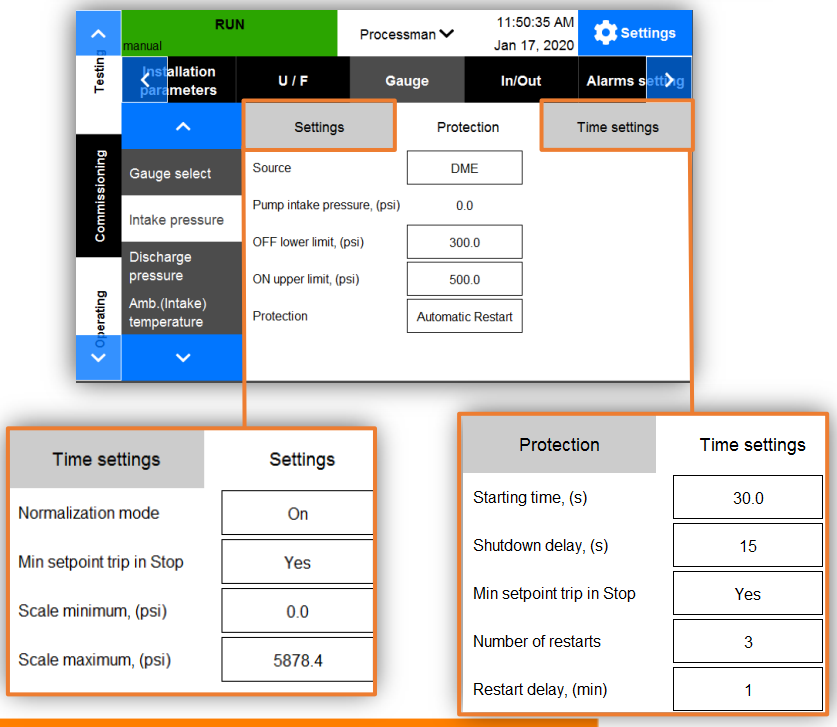


- go to «Commissioning» → «Gauge», select «Protocol DME» according to the downhole equipment type. Press «Confirm»;

Parameter «Gauge» must be set as «Identified»;

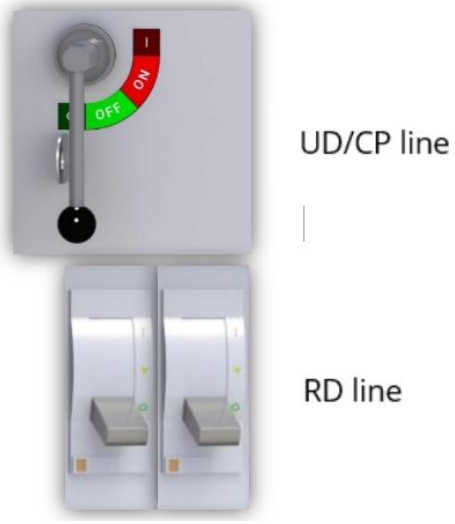
- turn «Auto-setup» on («Yes»). Downhole data must be displayed on the screen;

set up the protection parameters according to the data from downhole equipment. Find more details on setting up in «Programming manual» section «Commissioning» menu → «Gauge»».

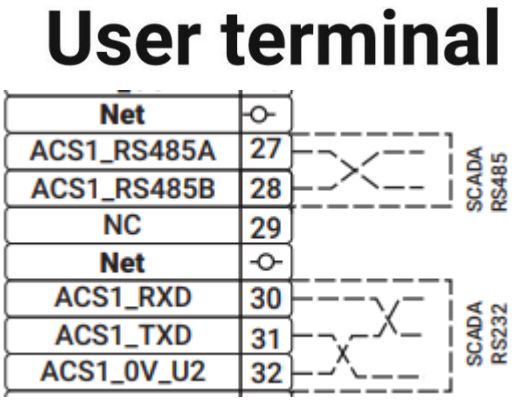


SCADA connection

Follow the steps described below for successful SCADA connection to the VSD:

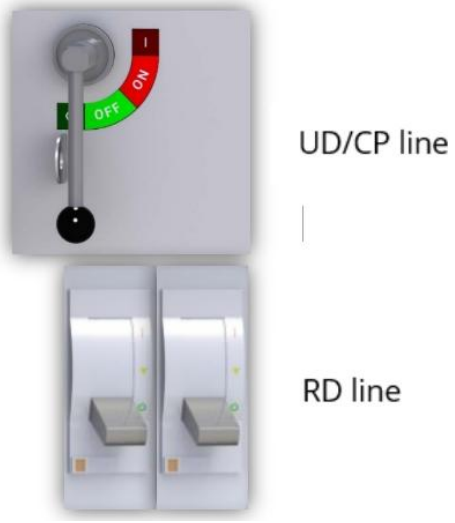


- de-energize the VSD by turning the circuit breakers «OFF»;
- wait 5 minutes for the DC link capacitors to discharge, the UMKA07 screen and the Back-spin light fade;

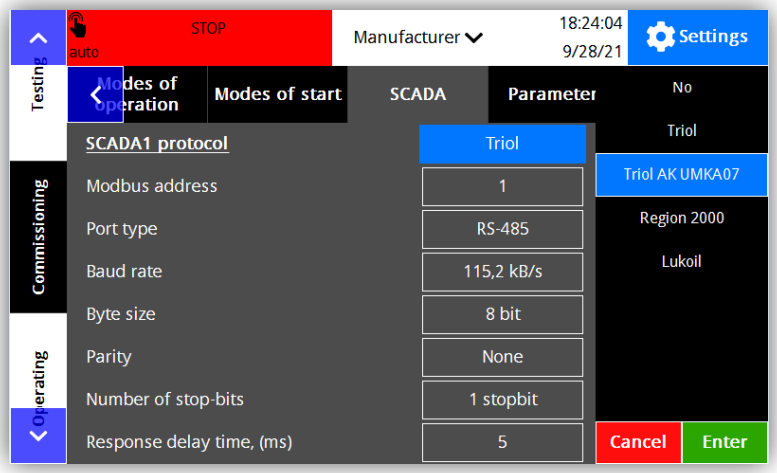


- connect SCADA the RS485 or RS232 to the terminal according to the figure on the left;

  RS232 – available depending on VSD configuration.



- energize the VSD by turning the circuit breakers «ON»;



Go to «Commissioning» → «SCADA» → «Protocol ACS» → «SCADA file setting»

- select the exchange protocol «Triol AK UMKA07», then press «Confirm».
- «Triol AK UMKA07» Modbus Map is given at Triol Corporation website:

https://triolcorp.us/documents/

- Switch the VSD to «Remote» mode. If it is acceptable, start the VSD by SCADA;
- Remotely adjust the VSD frequency and make sure that all required VSD and motor parameters are set and observed from a control room. Remotely stop the VSD.

Analog and Digital inputs/outputs

Description of different extension units

Extension units	USP	MUSP	Din8Dout4	AUSP
Numbers of digital inputs	6	4	8	0
Numbers of digital outputs	2	2	4	0
Numbers of analog inputs	6	4	0	8
Numbers of analog outputs	0	2	0	4

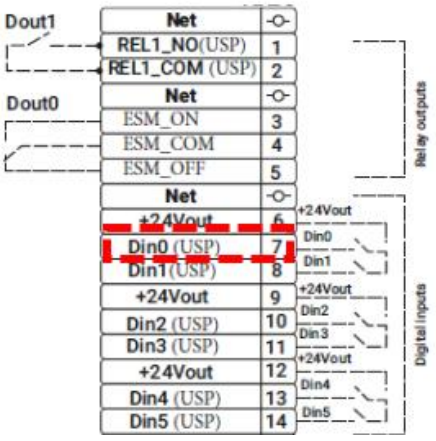
Example of extension connection

Configuration	Numbers of inputs/out-puts			
	Din	Dout	Ain	Aout
USP	6	2	6	0
USP+AUSP+ Din8Dout4	14	6	14	4
USP+AUSP+ AUSP	6	2	24	8
USP+ Din8Dout4+ Din8Dout4	24	10	6	0
MUSP	4	2	4	2
MUSP+AUSP+ Din8Dout4	12	6	12	6
MUSP+AUSP+ AUSP	4	2	22	8
MUSP+ Din8Dout4+ Din8Dout4	20	10	4	2

Note!

Expansion units are configured based on the required number of analog and digital inputs / outputs specified in the order.

The configuration of the terminal block of external connections can be changed based on the applied configuration of the expansion units



The terminal block for external connections contains the name of the input and the name of the extension unit to which it belongs.

«Din0» – Name of the input
«(USP)» - Name of extension unit to which input belong

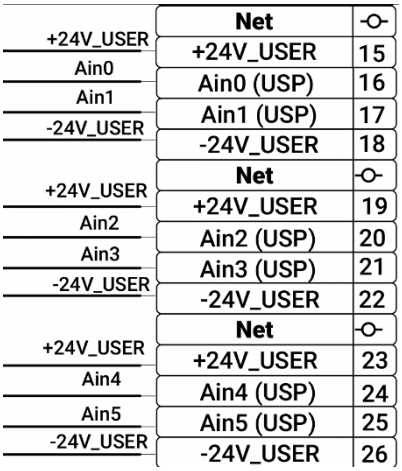
Analog inputs

Follow the steps described below for successful analog inputs connection:

UD/CP line

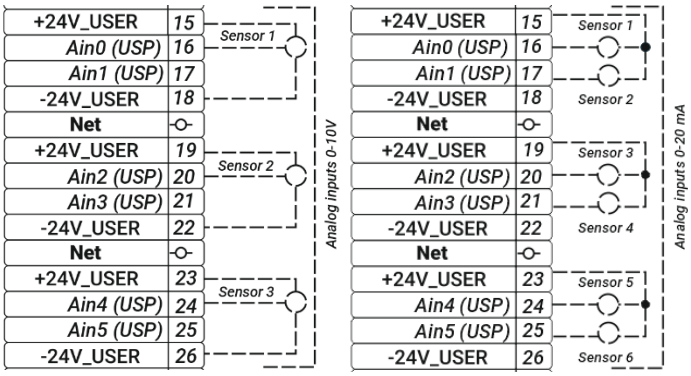
RD line

- de-energize the VSD by turning the circuit breakers «OFF»;
- wait 5 minutes for the DC link capacitors to discharge, the UMKA07 screen and the backspin light fade;



- there are 5 analog inputs on USP in the connection compartment;

Numbers of analog inputs depend of VSD configuration



- according to the scheme on external connections connect the analog inputs.

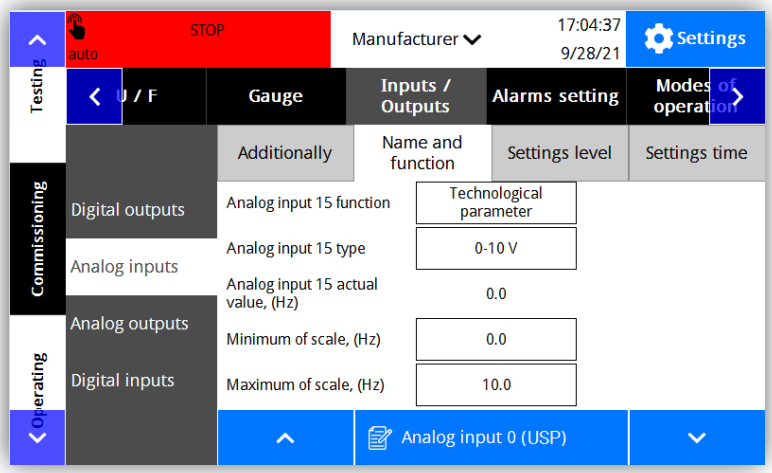
If sensor connected 0-10V in same extension unit can connect only voltage sensor

For example, to connect a signal to the analog input number 0 of the USP it is necessary to connect the supplies wires to the 15th terminal(+24V) and 18th terminal(-24V). Signal wire of the sensor connect to the 16th «Ain0 (USP)».

UD/CP line

RD line

energize the VSD by turning the circuit breakers «ON».



- go to «Commissioning» →«Inputs / Outputs» → «Analog inputs»;
- switching between the setup menu of each analog input is performed using the buttons located at the bottom of the screen;

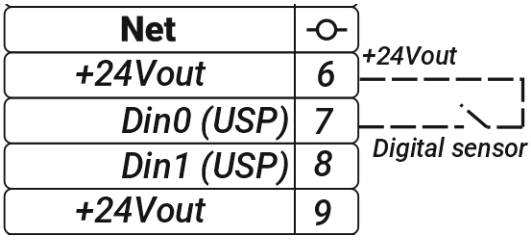

;

- select «Analog input 0 (USP)»;
- set up the logic of the VSD operation when the signal at the analog input 0.

Digital inputs

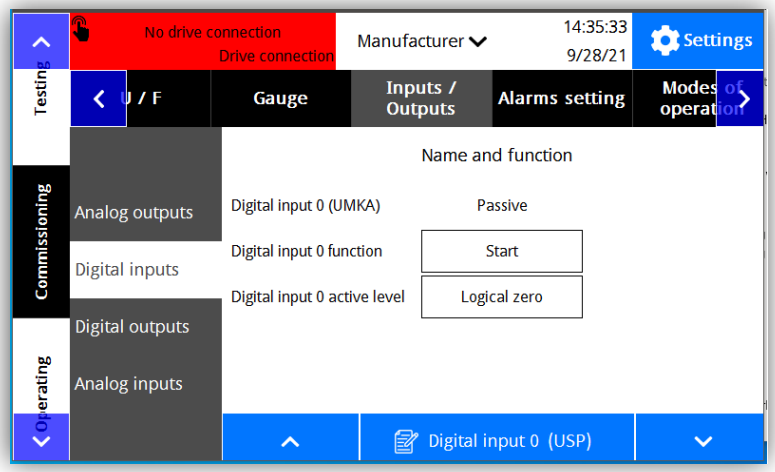
Follow the steps described below for successful digital inputs connection:

- de-energize the VSD by turning the circuit breakers «OFF»;
- wait 5 minutes for the DC link capacitors to discharge, the UMKA07 screen and the Back-spin light fade;



- there are 5 digital inputs on USP in the connection compartment;
- according to the scheme oncon-nect the digital inputs;
- For example, to connect a sig-nal to the 0th didgital input of it is necessary to connect the «general» conductor of the did-gital sensor to the 6th terminal of «Terminal block of external connections», and connect the signal circuit from the sensor to the 7th output of the «Terminal block of external connections».;

- energize the VSD by turning the circuit breakers «ON»;



- go to «Commissioning» → «Input / Outputs» → «Digital inputs»;
- switching between the setup menu of each digital input is performed using the buttons located at the bottom of the screen;


;

- select «Digital input»
- set up the logic of the VSD operation when the signal at the digital input 0th of «Terminal block of external connections» is received.

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