

# AK06

## VARIABLE SPEED DRIVE



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# Troubleshooting Manual



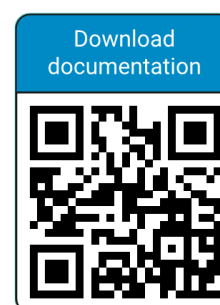
## Dear customer

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.



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

***NOTE: 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/>

### Troubleshooting Manual AT.654254.050 ver. 1.0.

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

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## 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.

### 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 of 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.



## General description

The Troubleshooting manual contains comprehensive step-by-step instruction with description all possible alarms, faults and actions for their diagnostic and repair.

Variable Speed Drive cabinet has five separate sections: power section with control system, section of power winding, input / output cabinet, gauge connection cabinet, extension units connection cabinet.

Inputs and outputs terminals in VSD, located in same cabinet on the backside of the cabinet.

# List and description of alarms and faults

Troubleshooting of VSD at start motor, fault finding charts are given in Table below:

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
1	The screen of the controller UMKA 07 does not light up and the control lamps of the VSD status do not light	Perhaps the mains power is not supplied to the control system	Supply power to the control system
		It is possible that power breakers and auxiliaries are turned off	Turn on auxiliaries located in the VSD and turn on the main input circuit breaker.
		Malfunction of power unit	Change circuit board
		Malfunction of UMKA07 controller	Change the controller UMKA07
2	Alarm «Drive connection failure» is displayed	There is no connection between the controller UMKA07 and the drive	Restore electrical connection between the UMKA07 controller and the electronics panel
			Insert the connectors according to the VSD diagram
		The software between the UMKA07 controller and the drive is not compatible	Update the UMKA07 Controller software to a version compatible with the firmware of the drive, if the necessary firmware is recorded in the drive
			Change the software of the drive to a version compatible with the firmware of the UMKA07 Controller, if the necessary firmware is recorded in the UMKA07 Controller
3	Alarm «Incompatibility soft drive» is displayed	The software between the UMKA07 controller and the drive is not compatible	Update the UMKA07 Controller software to a version compatible with the firmware of the drive, if the necessary firmware is recorded in the drive
			Change the software of the drive to a version compatible with the firmware of the UMKA07 Controller, if the necessary firmware is recorded in the UMKA07 Controller
4	Alarm «Emergency stop» is displayed	The emergency stop signal comes	Press the emergency stop button
		Electronics malfunction	Check the integrity of the circuits from the emergency stop button and restore their circuits
5	Alarm «R insulation» is displayed	«Low insulation of submersible equipment» signal comes	Replace equipment that has low resistance (transformer, long line, submersible unit of telemetry)
			Replace a faulty insulation measurement unit (surface telemetry unit or electronics panel if the equipment does not have telemetry)

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
		Malfunction of the controller UMKA07	Replace the controller
6	Alarm «Door» is displayed	«Open door» signal comes	Close all VSD doors with a loose closure; adjust the locks for a snug fit of the doors to the VSD itself
			Replace the faulty door open sensor, restore the door open control circuit
		Malfunction of the UMKA07 controller	Replace the controller with a working one
7	Alarm «Press gauge» is displayed	«contact pressure gauge» signal comes	Ensure the absence of a signal from the contact pressure gauge; check the integrity of the wires from the sensor to the control system
			Correctly connect the contact pressure gauge to the control system; correctly configure the «Press gauge»
		Malfunction of the UMKA07 controller	Replace the controller with a working one
8	Alarm «U,V,W phase power switch» is displayed	The inverter module or driver in this phase is defective in the corresponding phase	Diagnosis occurs by alternating phase loops. If the field of loop alternations did not pass the error, then the control system is faulty, if it does, the problem may be in the module driver or in the module. Replace driver and module together. If the module fails, it most likely damaged the driver
		Defective Electronics panel	Diagnosis occurs by alternating phase loops. If, after the loop alternations, the error did not transfer, then the control system is faulty. If the switch has passed, there may be a problem in the module driver or in the module. Replace the electronics panel assembly
		Faulty cable connecting the electronics panel and the driver	Replace with a working cable
9	Alarm «Overcurrent p.U,V,W» is displayed	Faulty current sensor or MDN or MDS3	Diagnosis occurs by alternating phase loops. If, after the loop alternations, the error did not switch, then the control system is faulty, if the problem has passed in the current sensor or in the MDN or 3MDS blocks, replace the current sensor if it is one, or all of them in this phase. If the alarm does not go away replace the MDN or 3MDS blocks
		Defective Electronics panel	Diagnosis occurs by alternating phase loops. If, after the loop alternations, the error did not transfer, then the control system is faulty. If the switch has

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
			passed, there may be a problem in the module driver or in the module. Replace the electronics panel assembly
		The adjusted numbers and rated current of the VSD are entered incorrectly	Restore factory default rates and verify their correspondence to the set rated power of the VSD (you may need to contact a Triol service for assistance)
10	Alarm «T° power switch U,V,W» is displayed	Defective temperature sensor, driver board, or electronics panel	Diagnosis occurs by alternating phase loops. If after loop alternations error did not pass, then the control system is faulty, if the switch has passed, there may be a problem in the temperature sensor or in the MDN or 3MDS units. Replace temperature sensor and MDN or 3MDS units or electronics panel
		Overheating protection activation setpoint «T ° power switch U, V, W» set incorrectly	Restore factory default rates and verify their correspondence to the set rated power of the VSD (you may need to contact a Triol service for assistance)
		Cooling fan defective	Check the operation of the fan, if not working, replace it with a working one
11	Alarm «T° digital sensor» is displayed	Faulty temperature sensor, electronics panel	Diagnosis of the sensor is carried out using a tester. If, at a radiator temperature below 70 degrees Celsius and the sensor is in the open state, the sensor is faulty. Replace sensor. If the sensor is faulty and an alarm is issued, replace the electronics panel
		The cooling fan is defective or the radiator is clogged	Check the operation of the fan, replace it if faulty. Clean the VSD radiators from dust and dirt
12	Alarm «Phase failure 1,2,3,4 grid» is displayed	There is no power on one of the networks or one of the power switches is turned off	Supply power to all networks. Check that all power circuit breakers are fully turned on and there is power on all phases
		There is no contact in the connectors of the rectifier unit, or on the electronics panel	Restore the connection of the connectors according to the electrical diagram, check their reliable fixation
13	Alarm «Time-out charge DC» is displayed	Defective charge unit or power unit	When a signal is applied to the charge of a link, there is no charge, the voltage across the capacitors does not increase. Replace charge circuits consisting of charging resistors and starter or BVN unit
		Defective electronic panel	When charging, the voltage rises but the controller does not measure this voltage.

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
			Replace the electronics panel with a working one
		The adjusted number for the measured voltage in the link is entered incorrectly	Restore the correct settings for measuring voltage in the link
14	Alarm «Fail AutoSet» is displayed. On the controller, it is displayed only during autotest in vector mode	When conducting auto determination of motor parameters, it was not possible to get the correct data	Connection of motor to the drive is incorrect, or there is a transformer in the scheme
			Incorrectly entered parameters of the measured equipment (rated current, voltage, PMM RPM speed)
15	Alarm «Phasing labc» is displayed	Incorrectly connected current sensors behind the sine filter	Restore the connection as indicated in the electrical diagram. Reconnect the connectors to verify the reliability of the contacts
		One of the transformers/current sensors behind the sine filter is defective	Check transformers for serviceability by dialing using a tester with a connected and disconnected load current resistor; if a malfunction is detected, replace it with a working one
16	Alarm «Charge DC bus» is displayed	Defective charge unit or power unit	When a signal is applied to the charge of a link, there is no charge, the voltage across the capacitors does not increase. Replace charge circuits consisting of charging resistors and starter or BVN unit
		Defective electronic panel	When charging, the voltage rises but the controller does not measure this voltage. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
17	Alarm «Short circuit DC bus»	Faulty power unit	When a signal is applied to the charge of a link, there is no charge, the voltage across the capacitors does not increase. Replace BVN
		Defective electronic panel	When charging, the voltage rises but the controller does not measure this voltage. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
18	Alarm «DC bus Min» is displayed	Low supply voltage	During operation, the supply voltage draws down and as a result, the «DC bus Min» is triggered to provide a stable voltage source with the required power

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
		Defective electronic panel	The readings of the voltage measurement in Ud do not coincide in a smaller direction with the actually measured ones. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
19	Alarm «DC bus Max» is displayed	High supply voltage	During operation, the supply voltage is overvalued, as a result of which the «DC bus Max» is triggered to ensure a connection with a stable voltage source
		Defective electronic panel	The readings of the voltage measurement in Ud do not coincide upwards with the actually measured ones. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
20	Alarm «Grid Min» is displayed	Low supply voltage	During operation, the supply voltage sags; as a result, the «Grid Min» network is activated to provide a connection with a stable voltage source of the required power
		Defective electronic panel	The readings of the voltage measurement in Ud do not coincide in a smaller direction with the actually measured ones. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
21	Alarm «Grid Max» is displayed	High supply voltage	During operation, the supply voltage is overestimated, as a result of which the «Grid Max» is activated to provide a connection with a stable voltage source
		Defective electronic panel	The readings of the voltage measurement in Ud do not coincide upwards with the actually measured ones. Replace the electronics panel with a working one
		Incorrectly entered adjusted number of measured voltage in the link	Restore the correct settings for measuring voltage in the link
22	Alarm «Unbalance U» is displayed	The supply voltage has a phase imbalance	During operation, there is a voltage imbalance in different phases; as a result, «Unbalance U» is triggered to provide a connection to a stable voltage source

№	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
		Defective electronic panel	The readings of the voltage measurement in the network do not coincide with the actually measured Replace the electronics panel with a working one
23	Alarm «Phasing CBA» is displayed	The supply voltage has an incorrect phase sequence	Change the sequence of incoming supply phases
24	Alarm «Backspin» is displayed	There is a backspin motor rotation	Wait until backspin rotation falls below the setpoint
		A tip on a long line running parallel to other live lines	Run shielded cable, or increase distance from other live conductors
25	Alarm «SCADA conn. error» is displayed	Incorrect exchange protocol, speed and address for communication with ACS selected	Set the correct exchange protocol, speed and address between VSD and the upper level controller; check what comes from the controller
		Incorrect connection made	Check the connection and make the connection according to the connection diagram.
		Defective UMKA07 Controller	Replace the controller with a working one
26	Alarm «USP conn. error» is displayed	Block USP not configured	Set speed and address in USP settings
		Block USP out of order	Replace USP
		Defective UMKA07 controller	Replace the controller with a working one
27	Alarm «A-USP conn. error» is displayed	Block A-USP not configured	Set speed and address in A-USP settings
		Block A-USP out of order	Replace A-USP
		Defective UMKA07 controller	Replace the controller with a working one
28	Alarm «Din8Dout4 conn. error» is displayed	Block Din8Dout4 not configured	Set speed and address in Din8Dout4 settings
		Block Din8Dout4 out of order	Replace Din8Dout4.
		Defective UMKA07 controller	Replace the controller with a working one
29	Alarm «STM conn. error» is displayed	Defective UMKA07 controller	Replace the controller with a working one
30	Alarm «T° UMKA» is displayed	Defective UMKA07 controller	Replace the controller with a working one
		Protection enable setting low	Set settings according to factory values
		The ambient temperature of the place where the controller is installed is too high	Ensure a decrease of ambient temperature in the compartment where the controller or VSD is installed
31	Alarm «Overtorch» is displayed	The program determined that during operation in PMM the vectors of speed and moment do not coincide	Check the correctness of the entered motor parameters and VSD settings and restart. If it is not possible to eliminate, please contact Triol service having with you the VSD operation log
32	Alarm «Overshoot» is displayed	The program determined that in the process of operation in PMM	Check the correctness of the entered motor parameters and VSD settings and restart.

Nº	Potential problem/Message on the controller display	Probable causes of message displaying	Remedies
		mode, vectors have fluctuations in loading above the specified	If it is not possible to eliminate, please contact Triol service having with you the VSD operation log



## Replacement of the RMPS + UDP unit.

RMPS + UDP replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the RMPS + UDP unit:

- crosshead screwdriver — 1 pc;

In case if it is necessary to dismantle RMPS + UDP unit:

1. Take photo or mark all connectors locations.
2. Unplug signal connectors (yellow) from a terminal blocks which is shown at figure 1 and disconnect the blade clamps shown in red circles.

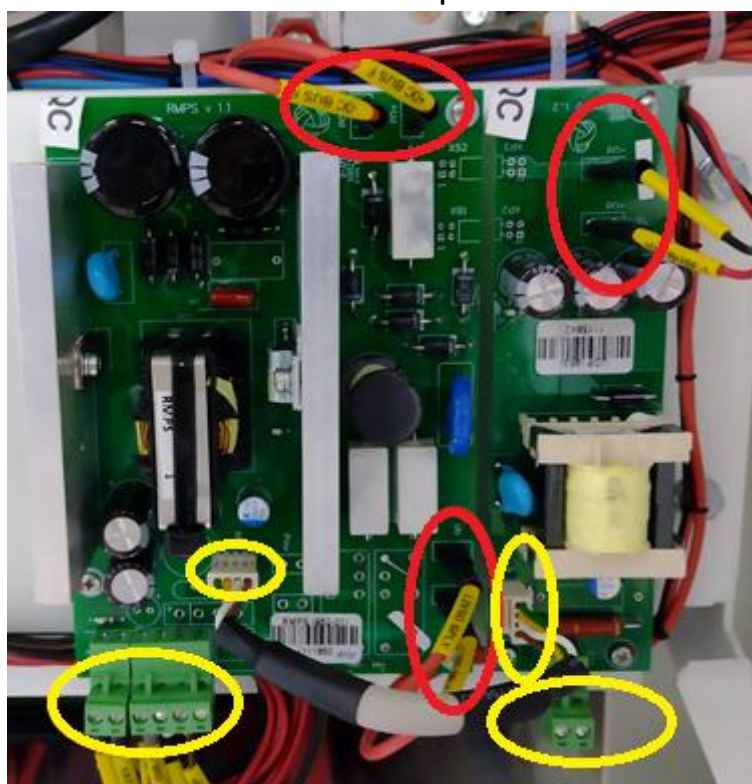


Figure 1 – Unplug and unscrew connectors of a RMPS + UDP unit

3. Unscrew the screws which fixing RMPS + UDP units as shown at the figure 2 using crosshead screwdriver.

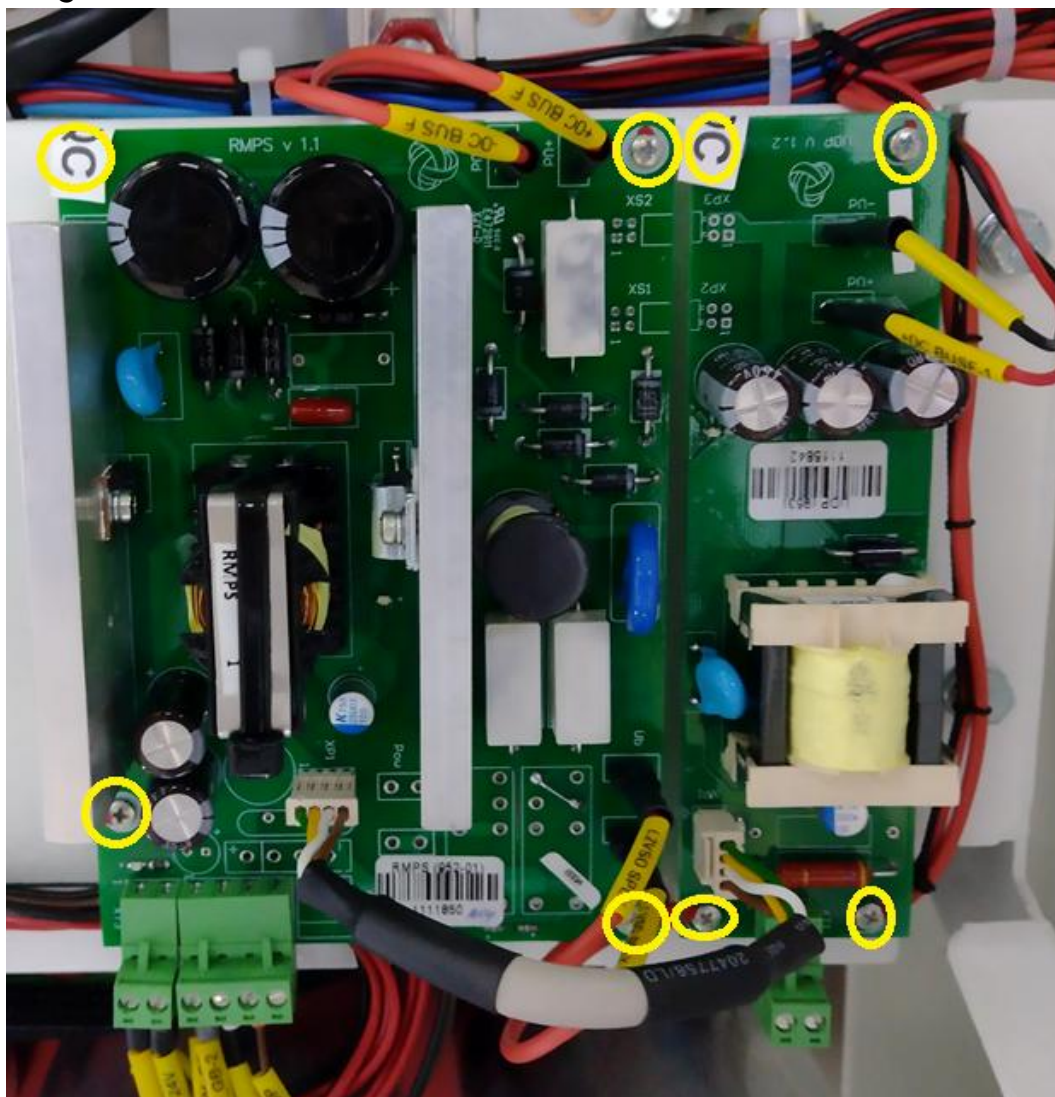


Figure 2 – RMPS + UDP unit final dismantle step

4. Installation of a new RMPS + UDP unit must be done in reversal sequence. Connection of the RMPS + UDP unit must be carried out according to the electric circuit and marks.

## Replacement of the GB unit.

GB replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the GB unit:

- crosshead screwdriver – 1 pc.

In case if it is necessary to dismantle GB unit:

1. Take photo and mark all connectors locations. Special attention must be paid to the chains not highlighted in red. After installing a new GB unit you must strictly follow the sequence of connected loops according to the previously taken photo and tags.
2. Unplug signal connectors (yellow, red) from a terminal blocks which is shown at figure 3.

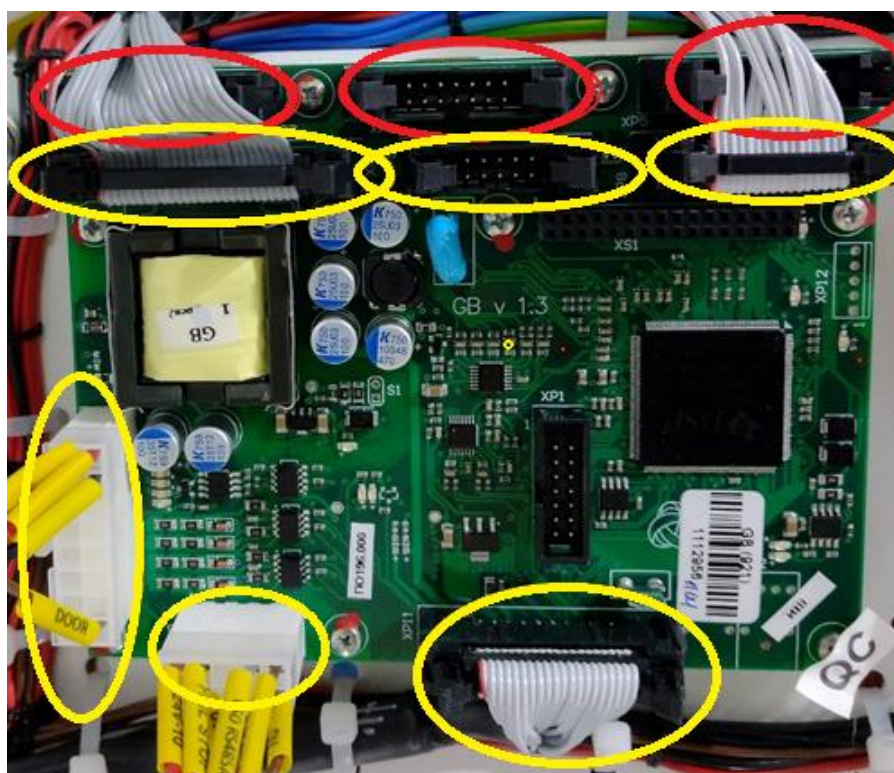


Figure 3 – Unplug connectors of a GB unit



3. Unscrew the screws which fixing GB unit from fastening (yellow) as shown at figure 4 using crosshead screw driver.

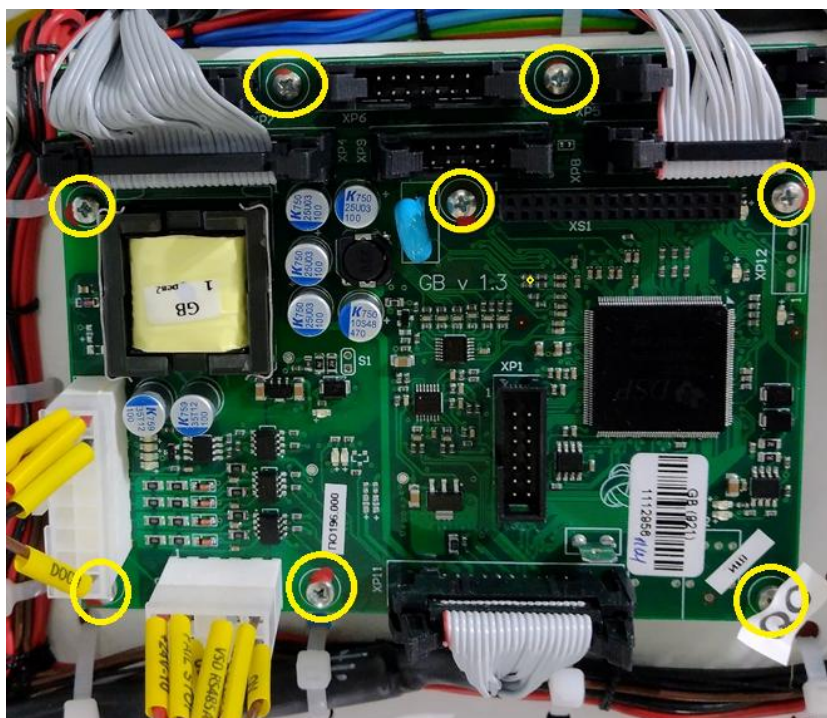


Figure 4 – Unscrew the screws which fixing GB unit

4. Remove the GB units from a VSD.
5. Installation of a new GB unit must be done in reversal sequence. Connection of the GB unit must be carried out according to the electric circuit and marks.

## Replacement of the BVN unit.

BVN replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the BVN unit:

- crosshead screwdriver – 1 pc;
- flat screwdriver – 1 pc.

In case if it is necessary to dismantle BVN unit:

1. Take photo or mark all connectors locations.
2. Unplug signal connectors (yellow) from a terminal blocks which is shown at figure 5 and disconnect the blade clamps shown in red circles.



Figure 5 – Unplug and unscrew connectors of a BVN unit

3. Unscrew the BVN unit from fastening which is shown at figure 6 using cross-head screw driver.

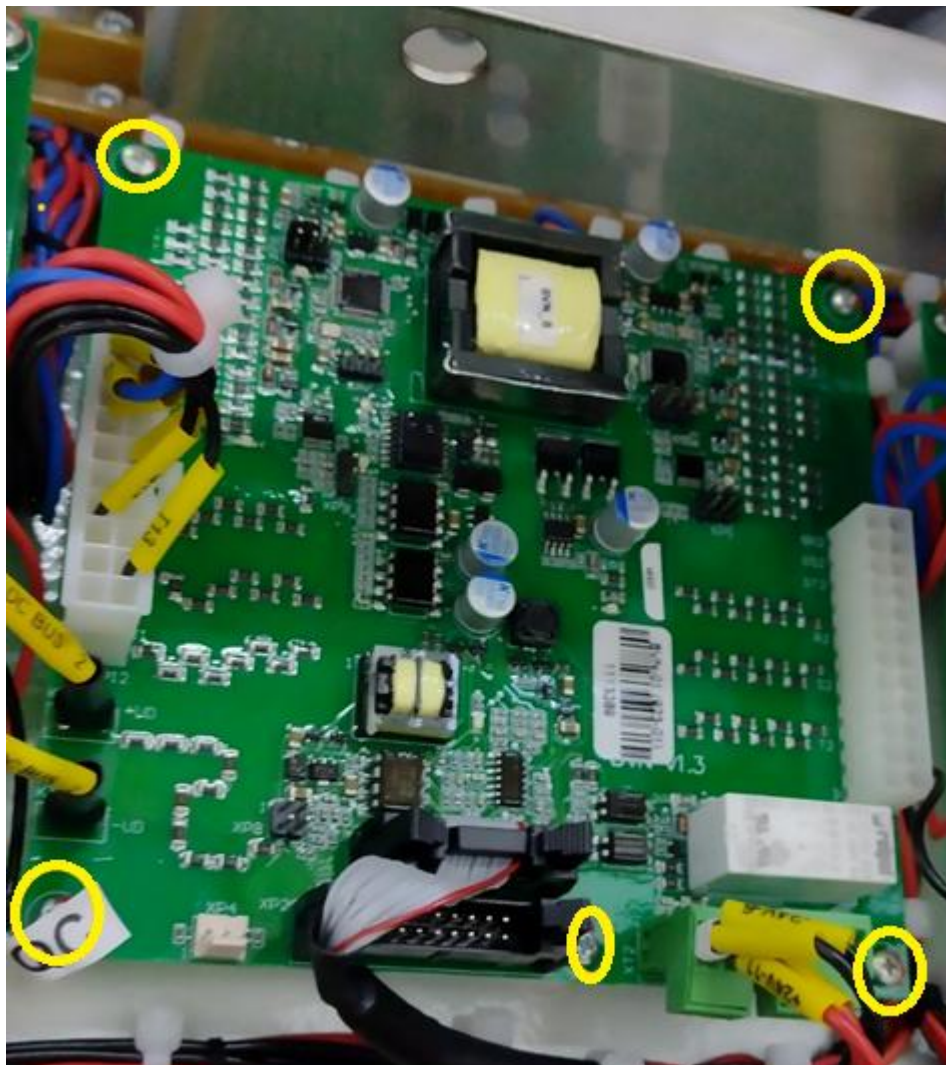


Figure 6 – BVN unit dismantling step

4. Installation of a new BVN unit must be done in reversal sequence. Connection of the BVN unit must be carried out according to the electric circuit and marks.



## Replacement of the 3MDS unit.

3MDS replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the 3MDS unit:

- crosshead screw driver – 1 pc;

In case if it is necessary to dismantle 3MDS unit:

1. Take photo and mark all connectors locations. Special attention must be paid to the chains not highlighted in red. After installing a new 3MDS unit you must strictly follow the sequence of connected loops according to the previously taken photo and tags.
2. Unplug signal connectors (yellow, red) from a terminal blocks which is shown at figure 7.

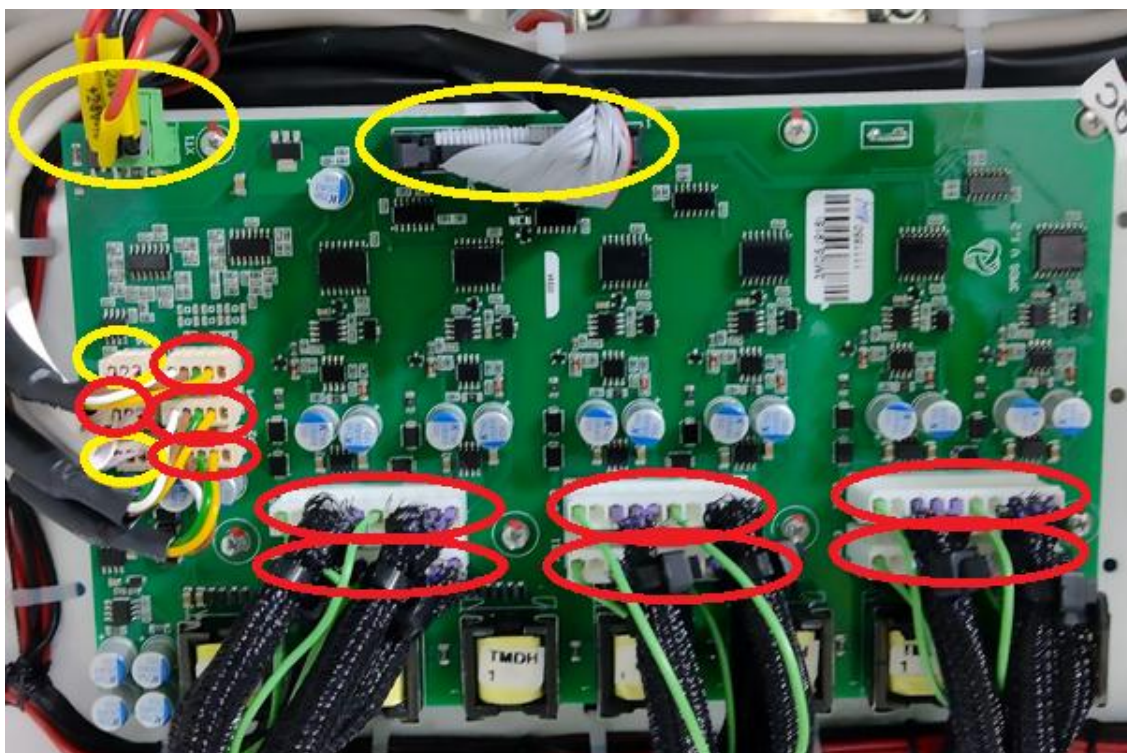


Figure 7 – Unplug and unscrew connectors of a 3MDS unit

3. Unscrew the 3MDS unit from fastening which is shown at figure 8 using crosshead screw driver.



Figure 8 – 3MDS unit dismantling step

4. Installation of a new 3MDS unit must be done in reversal sequence. Connection of the 3MDS unit must be carried out according to the electric circuit and marks.



## Replacement of the MDN unit.

MDN replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the MDN unit:

- Lineman's pliers – 1 pc;

In case if it is necessary to dismantle MDN unit:

1. Take photo and mark all connectors locations.
2. Unplug signal connectors (yellow) from a terminal blocks which is shown at figure 9 and unscrew circuits from a terminal blocks (yellow) using flat screw driver.

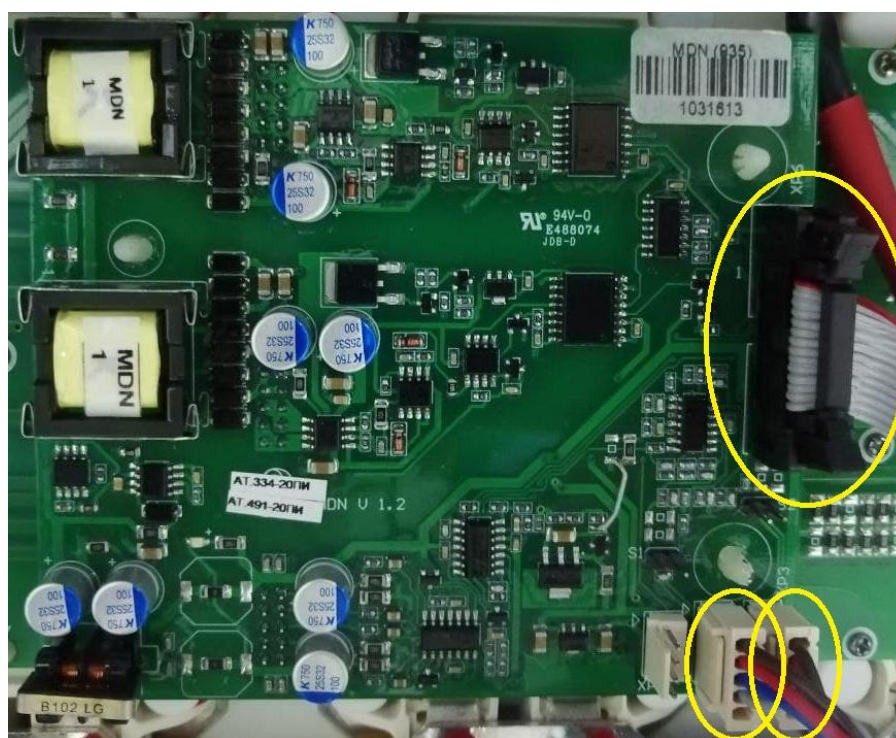


Figure 9 – Unplug connectors of a MDN unit

3. Compress the tendrils of the plastic clips and remove the block, which is shown at figure 10 using lineman's pliers.

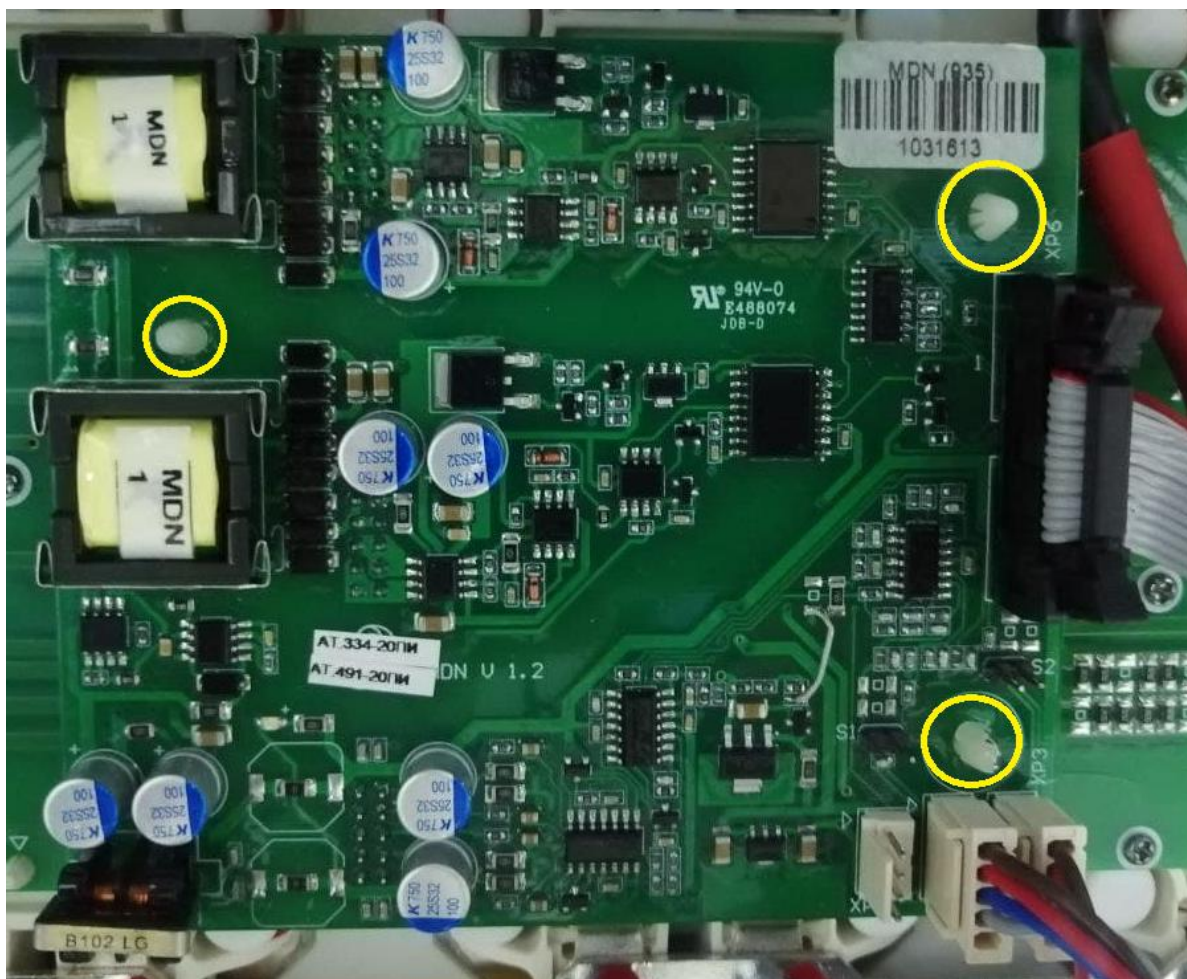


Figure 10 –MDN unit dismantling step

4. Installation of a new MDN unit must be done in reversal sequence. Connection of the MDN unit must be carried out according to the electric circuit and marks.

## Replacement of the UMKA07 controller.

UMKA07 controller replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the UMKA07 controller:

- crosshead screwdriver — 1 pc;
- wrench size 10 mm (3/8") — 1 pc.

In case if it is necessary to dismantle UMKA07 controller:

1. Disconnect all signal connectors from a terminal blocks which is shown at figure 11.

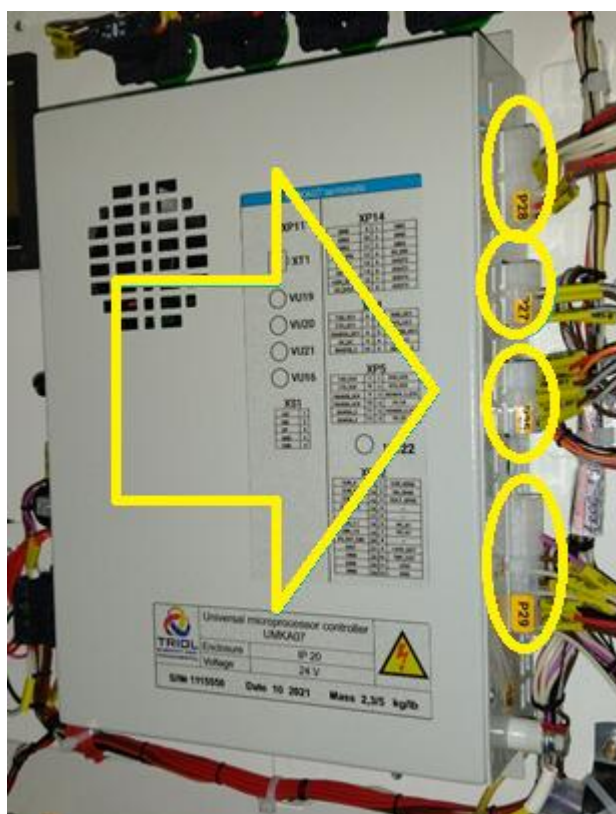


Figure 11 – Places of the connectors of an UMKA07 controller



2. Disconnect the rest inputs shown on figure 12.



Figure 12 – Places of the connectors of an UMKA07 controller

3. Disconnect the UMKA07 controller from fastening using crosshead screwdriver and wrench 10 mm (3/8"). The location of fastening is shown on figure 13.



Figure 13 – Location of UMKA07 controller fastening

4. Installation of the UMKA controller is carried out in reversed order. Connection of the controller must be carried out according to the electric circuit.

All bolted connectors must be screwed in according to:

M5 – 8 ± 1,5 N•m
------------------

## Replacement of the RisS unit.

RisS replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the RisS unit:

- crosshead screwdriver — 1 pc;

In case if it is necessary to dismantle RisS unit:

1. Take photo or mark all connectors locations.
2. Unplug signal connectors (yellow) from a terminal blocks which is shown at figure 14 and disconnect the blade clamps shown in red circles.



Figure 14 – Unplug and unscrew connectors of a RisS unit

3. Unscrew the RisS unit from fastening which is shown at figure 15 using crosshead screw driver.



Figure 15 – RisS unit final dismantle step

4. Installation of a new RisS unit must be done in reversal sequence. Connection of the RisS unit must be carried out according to the electric circuit and marks.



## Replacement of the OutM unit.

OutM replacement procedure is the same for each VSD.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the OutM unit:

- crosshead screwdriver – 1 pc;

In case if it is necessary to dismantle OutM unit:

1. Take photo or mark all connectors locations.
2. Unplug signal connectors (yellow) from a terminal blocks which is shown at figure 16 and disconnect the blade clamps shown in red circles.



Figure 16 – Unplug and unscrew connectors of a OutM unit



3. Unscrew the OutM unit from fastening which is shown at figure 17 using crosshead screwdriver.



Figure 17 – OutM unit final dismantle step

4. Installation of a new OutM unit must be done in reversal sequence. Connection of the OutM unit must be carried out according to the electric circuit and marks.

## Replacement of the extension unit.

Extension unit replacement procedure is the same for each VSD, different only in numbers of extension units. VSD can be completed of one, two or three extension units.

Preparations:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

Use the following tools for dismantling the extension unit:

- crosshead screwdriver – 1 pc;
- side cutter – 1 pc;
- flat screwdriver – 1 pc;
- lineman's pliers – 1 pc.

### Replacement one extension unit

In case if it is necessary to dismantle Extension unit:

1. Remove safety plate, unscrewing 6 screws, as shown at the figure 18, using crosshead screwdriver.

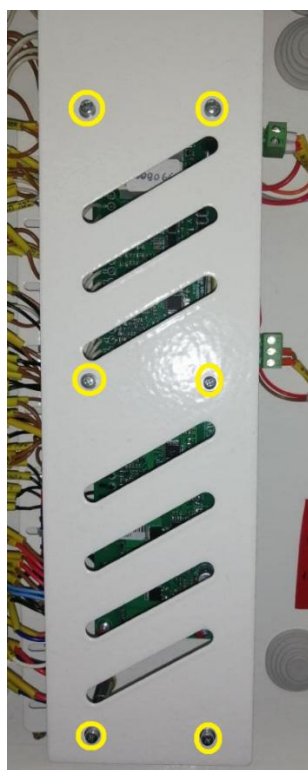


Figure 18 – Remove extension unit safety plate

2. Unplug connectors (red) as shown at figure 19 and cut wires(yellow) from extension unit to the terminal block.



**For modernized block extension units wires unplug same as signal and power cable(red)**

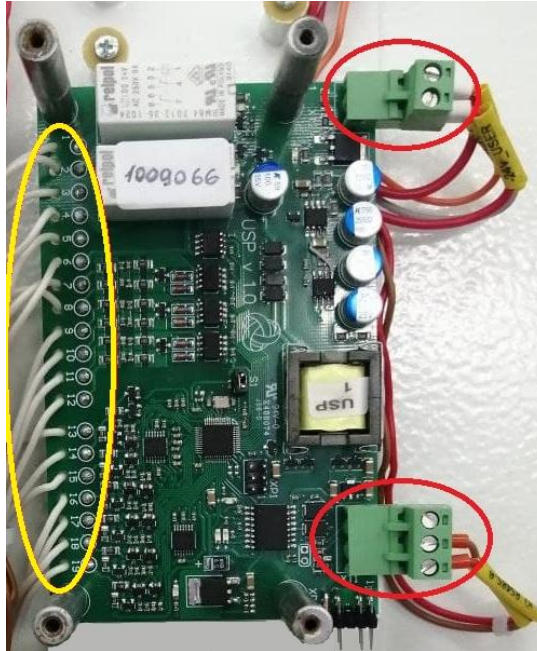


Figure 19 – Unplug connectors and cut wire of extension unit.

3. Connect cut wires to the terminal block which is included in kit with replacement extension unit.



**Only for extension unit same as at figure 19**



Figure 20. Example of terminal block

4. Unscrew bolts which fixed external unit, which shown at the figure 21, using lineman's pliers

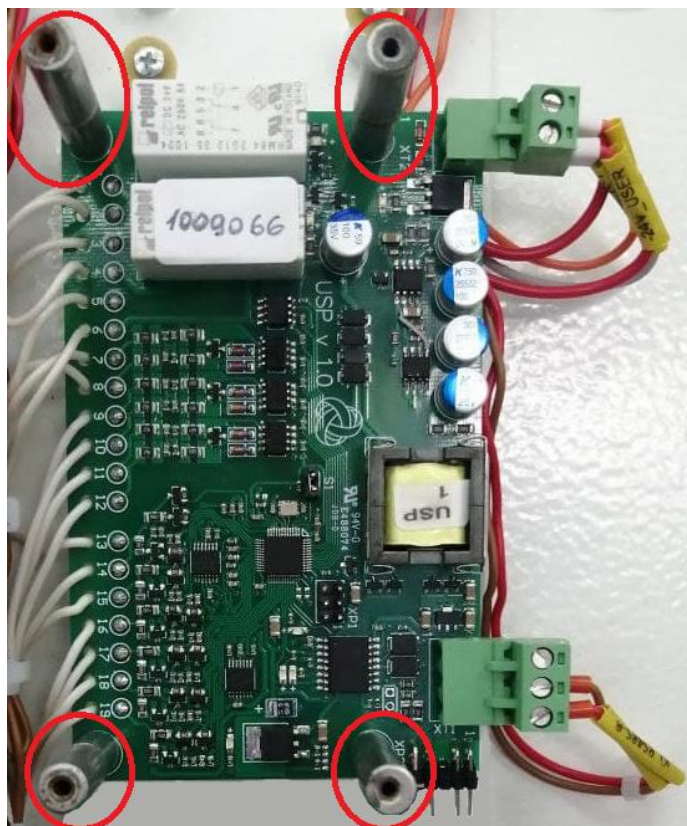


Figure 21 - Unscrew bolts which fixed external unit

5. Installation of a new external unit must be done in reversal sequence. Connection of the external unit must be carried out according to the electric circuit and marks.



**Wire witch was cut, figure 20, plug-in in terminal block, as explain in step 3**



## Replacement two and more external units

For VSD with two and more external units replacement same as describe above, only, first unscrew and remove second or third unit that below main unit (main unit it is unit witch connect signal an power cable), descript on figure 22.

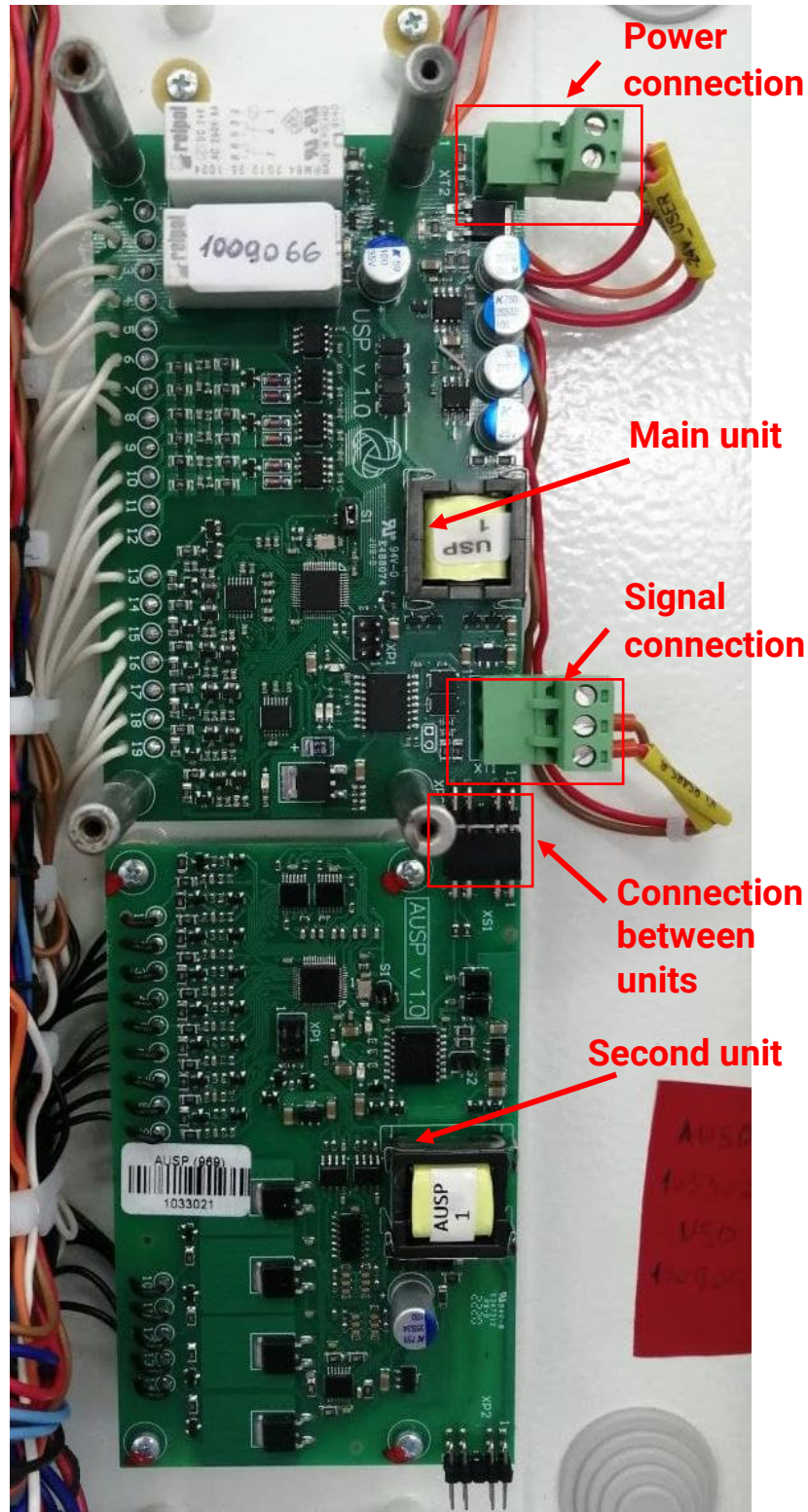


Figure 22 – VSD with two external units

1. Unscrew screw fixed second unit, which shown at figure 23, using crosshead screwdriver.



Figure 23 - Unscrew screw fixed second unit

2. Disconnect second unit from main, for that pull second unit in the opposite direction main unit, as shown at the figure 24.

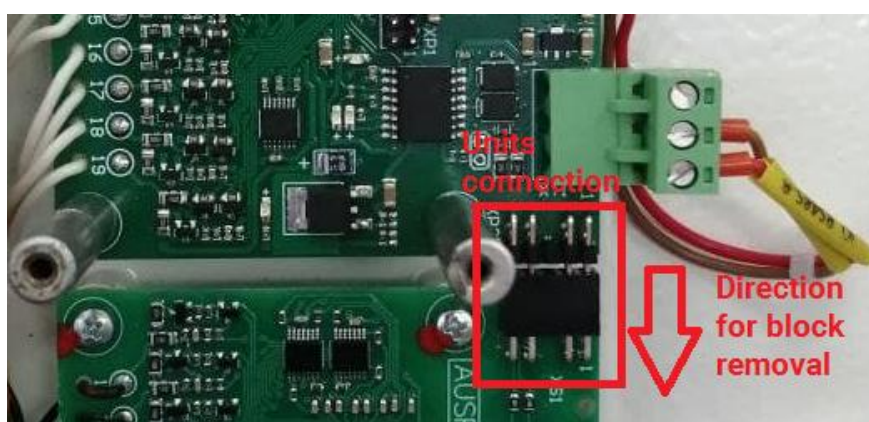


Figure 24 - Disconnect second unit from main

# Instruction for updating software UMKA and GB



**Turning off power of VSD is prohibited during updating.**

STOP	automatic		User ▼	14:59:16 3/3/20	Settings
	VS Parameters	Current calibration	Parameters	Frequency setting	Motor Parameters
Operating	VSD output current, phase U, (A)	0.0	Phase W, (A)	0.0	
	VSD output current, phase V, (A)	0.0	Full motor current, (A)	0.0	
	VSD output current, phase W, (A)	0.0	Power factor	0.000	
	Phase U, (A)	0.0	Motor load factor, (%)	0.0	
	Phase V, (A)	0.0	Current unbalance, (%)	0.0	
Recovery					
Delete parameter		^	Fullscreen	▼	Add parameter

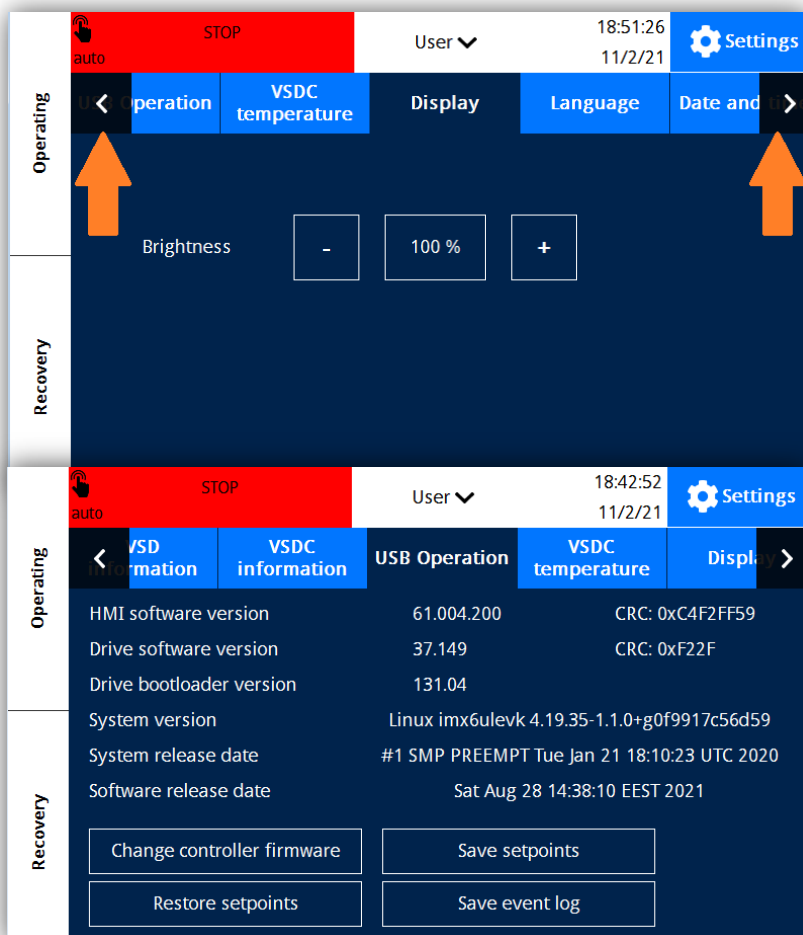
Other parameters can be set in any sequence.

Energize the VSD, wait until the controller displays the information about the interface loading. The loading takes up to 2 minutes. The screen display field as shown below. Then follow the steps from point 1.

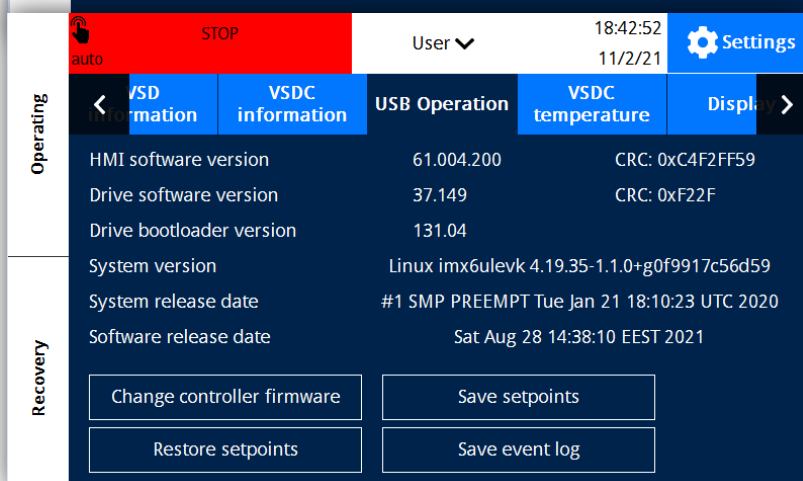
1. Insert the flash drive with the latest UMKA07 controller version into the USB output and perform the actions shown in the figures below

STOP	automatic		Manufacturer ▼	18:18:33 3/3/20	Settings
	VS Parameters	Current calibration	Parameters	Frequency setting	Motor Parameters
Operating	VSD output current, phase U, (A)	0.0	Phase W, (A)	0.0	
	VSD output current, phase V, (A)	0.0	Full motor current, (A)	0.0	
	VSD output current, phase W, (A)	0.0	Power factor	0.000	
	Phase U, (A)	0.0	Motor load factor, (%)	0.0	
	Phase V, (A)	0.0	Current unbalance, (%)	0.0	
Recovery					
Delete parameter		^	Fullscreen	▼	Add parameter

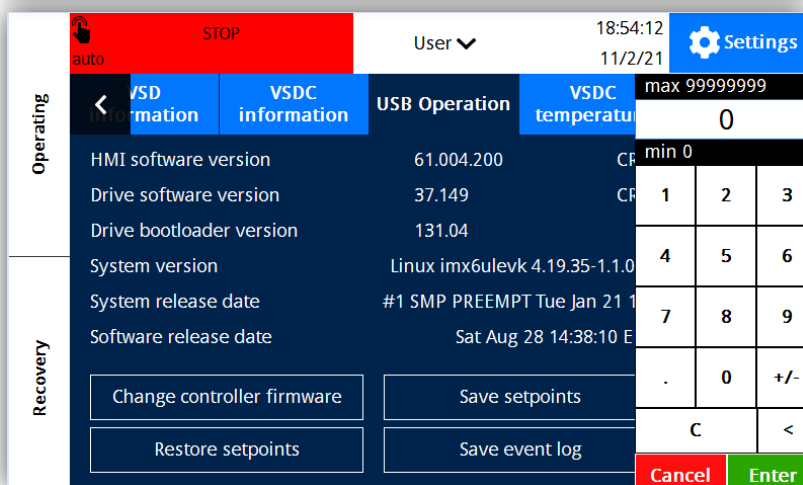
Enter the «Settings».



Go to the USB operation menu using the navigation buttons.



Press «Change controller firmware»

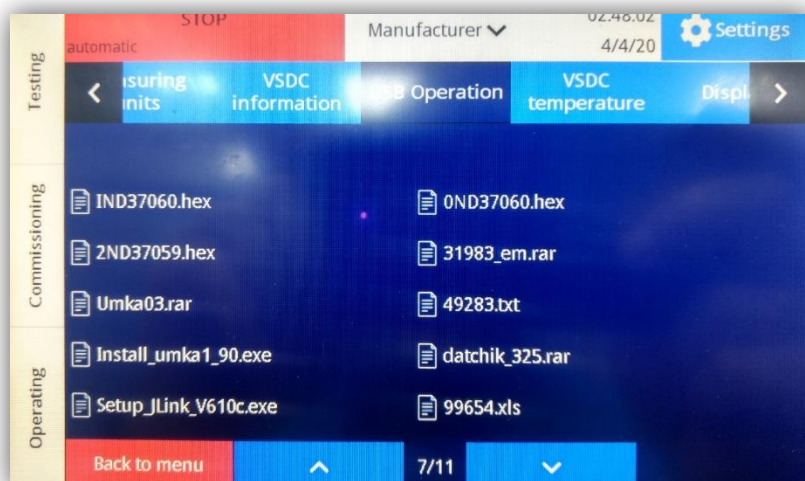


Enter the password and press the «Confirm» button.



In case if you don't know the password, please contact Triol Service.





Select the file with the latest software version, press the «Select» button and update process begins.

Updating process completed.

It is necessary to check values of parameters in the following order:

- Installation parameters;
- Calculation of step-up transf. tap voltage;
- PMM COS or PMM Vector mode (only if you work with pmm motor);

U/f characteristic, min and max frequency limits.

# Drive static check

Check the following connections

- current breakers;
- rectifier;
- diode-thyristor modules;
- DC bus filter;
- inductance;
- DC bus capacitors;
- inverter;
- diode - transistor module;
- output filter;
- inductance;
- sine filter capacitors;
- sine filter contactor.

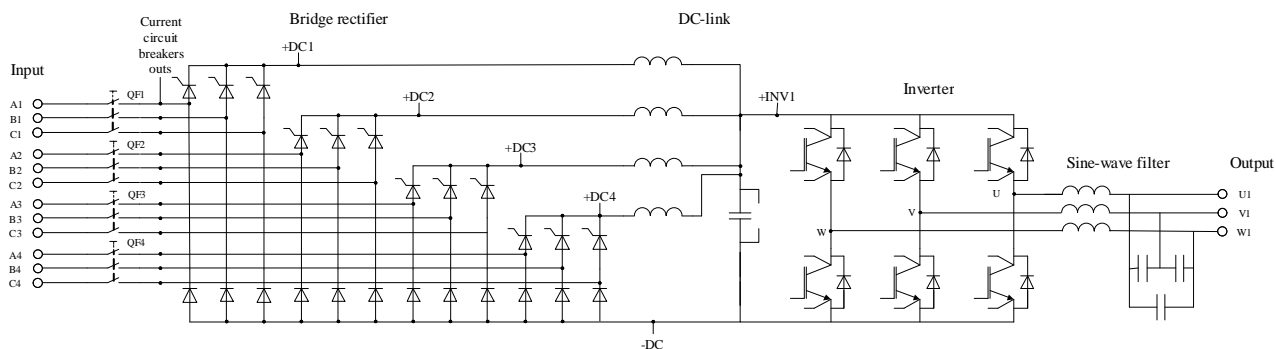


Figure 25 - Example of VSD drawing

Measure with a multimeter in diode mode (input circuit breakers must be ON).

## Input

Variable speed drive input continuation			
Positive probe	Negative probe	Value in diode mode	Comments
A1	Circuit breakers outs	Conductivity	For all VSDs
B1		Conductivity	For all VSDs
C1		Conductivity	For all VSDs
A2		Conductivity	For 12-24 pulse VSDs
B2		Conductivity	For 12-24 pulse VSDs
C2		Conductivity	For 12-24 pulse VSDs
A3		Conductivity	For 18, 24 pulse VSDs
B3		Conductivity	For 18, 24 pulse VSDs
C3		Conductivity	For 18, 24 pulse VSDs
A4		Conductivity	For 24 pulse VSDs
B4		Conductivity	For 24 pulse VSDs
C4		Conductivity	For 24 pulse VSDs
+DC1	A1	1. (no conductivity/charging)	For all VSDs
+DC1	B1	1. (no conductivity/charging)	For all VSDs
+DC1	C1	1. (no conductivity/charging)	For all VSDs
+DC2	A2	1. (no conductivity/charging)	For 12-24 pulse VSDs
+DC2	B2	1. (no conductivity/charging)	For 12-24 pulse VSDs
+DC2	C2	1. (no conductivity/charging)	For 12-24 pulse VSDs
+DC3	A3	1. (no conductivity/charging)	For 18, 24 pulse VSDs
+DC3	B3	1. (no conductivity/charging)	For 18, 24 pulse VSDs
+DC3	C3	1. (no conductivity/charging)	For 18, 24 pulse VSDs
+DC4	A4	1. (no conductivity/charging)	For 24 pulse VSDs
+DC4	B4	1. (no conductivity/charging)	For 24 pulse VSDs
+DC4	C4	1. (no conductivity/charging)	For 24 pulse VSDs
-DC1	A1	0.400+/- 20%	For all VSDs

Variable speed drive input continuation			
Positive probe	Negative probe	Value in diode mode	Comments
-DC1	B1	0.400+/- 20%	For all VSDs
-DC1	C1	0.400+/- 20%	For all VSDs
-DC1	A2	0.400+/- 20%	For 12-24 pulse VSDs
-DC1	B2	0.400+/- 20%	For 12-24 pulse VSDs
-DC1	C2	0.400+/- 20%	For 12-24 pulse VSDs
-DC1	A3	0.400+/- 20%	For 18, 24 pulse VSDs
-DC1	B3	0.400+/- 20%	For 18, 24 pulse VSDs
-DC1	C3	0.400+/- 20%	For 18, 24 pulse VSDs
-DC1	A4	0.400+/- 20%	For 24 pulse VSDs
-DC1	B4	0.400+/- 20%	For 24 pulse VSDs
-DC1	C4	0.400+/- 20%	For 24 pulse VSDs

## Output

Positive probe	Negative probe	Value in diode mode
+INV1	U	Capacitors charging
+INV1	V	Capacitors charging
+INV1	W	Capacitors charging
-DC1	U	0.350+/- 20%
-DC1	V	0.350+/- 20%
-DC1	W	0.350+/- 20%
U	+INV1	0.350+/- 20%
V	+INV1	0.350+/- 20%
W	+INV1	0.350+/- 20%
U	-DC1	Capacitors charging
V	-DC1	Capacitors charging
W	-DC1	Capacitors charging

# 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.

STOP		Processman	02:28:19 PM Jan 17, 2020	Settings
Testing	< SCADA	Parameters	Installation parameters	U / F Gauge >
Commissioning	Rated power, (HP)	335		
	SUT primary voltage, (V)	480		
	SUT rated frequency	60.0		
	Tap Voltage, (V)	480		
Operating	Transformation ratio	1.00		
	Recommended tap, (V)	410		
	Base voltage, (V)	349		

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».

STOP		Processman	12:11:56 PM Jan 17, 2020	Settings
Testing	< Gauge	In/Out	Alarms setting	Modes of operation
Commissioning	Underload settings	Underload		Off
	Overload	Full motor current, (A)	0.0	Lockout
	Underload	Load factor, (%)	0.0	Automatic Restart
	Current unbalance	Underload set point, (%)	50.0	
Operating	Insulation	Underload set value in amperes, (A)	89.0	
		Underload set value, (%)	50.0	
	Protection	Off	Cancel	Confirm

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».

U / F curve settings		
	Frequency, Hz	Voltage, V
Point 1	1.5	11
Point 2	17.7	134
Point 3	33.8	257
Point 4	50.0	480
Rectifier U/F		

- 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».

Modes of start	
Startup mode	Soft
Acceleration rate, (Hz/s)	2.0
Deceleration rate, (Hz/s)	2.0

With synchronization

- Jogging
- Swinging
- Unblocking
- Hard

Cancel Confirm

Now the VSD is ready for no-load test.

TO START A MOTOR PRESS



TO STOP A MOTOR PRESS



## Short circuit full load test procedure

1. Install jumpers on the output of VSD between three output phases. Diameter of cables must be suitable for full VSD current level.

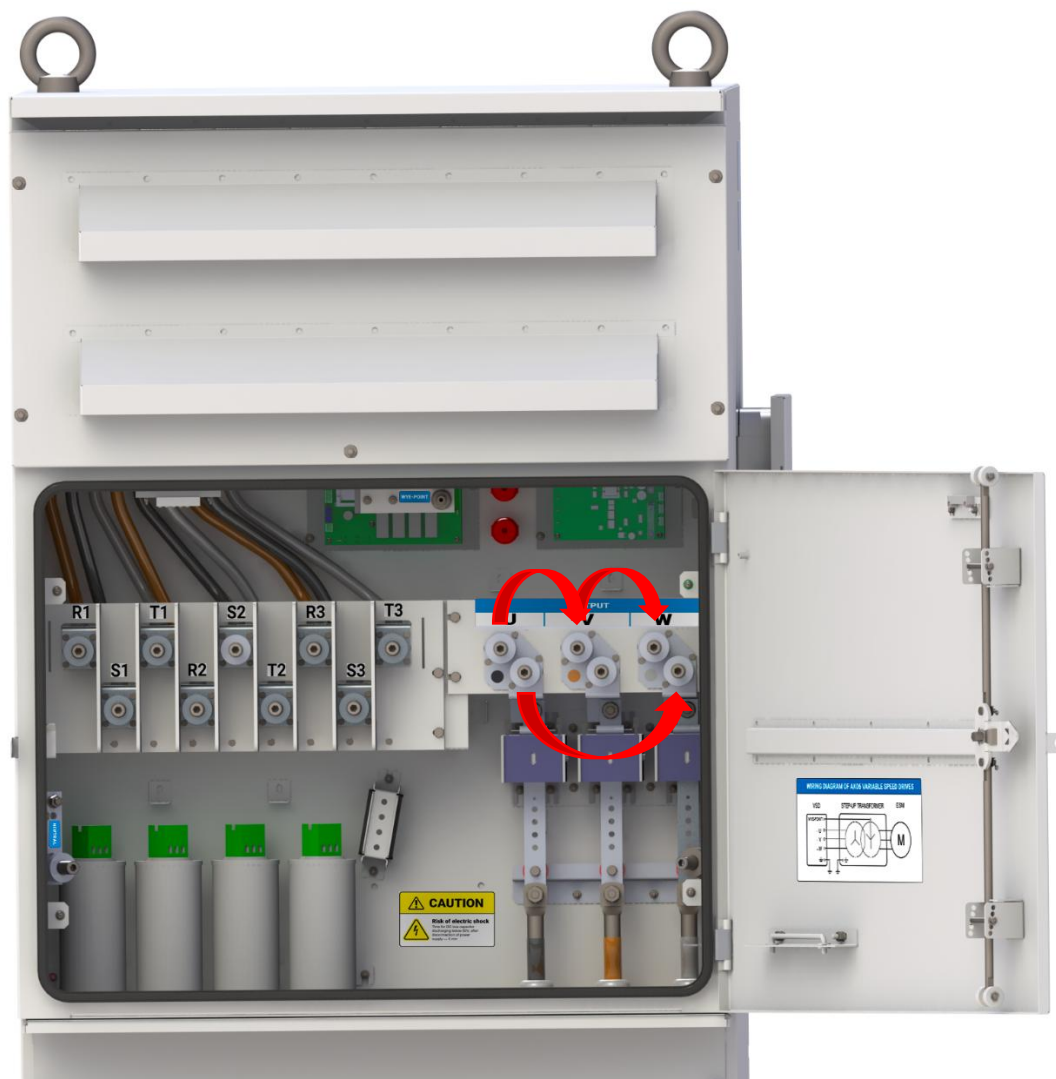
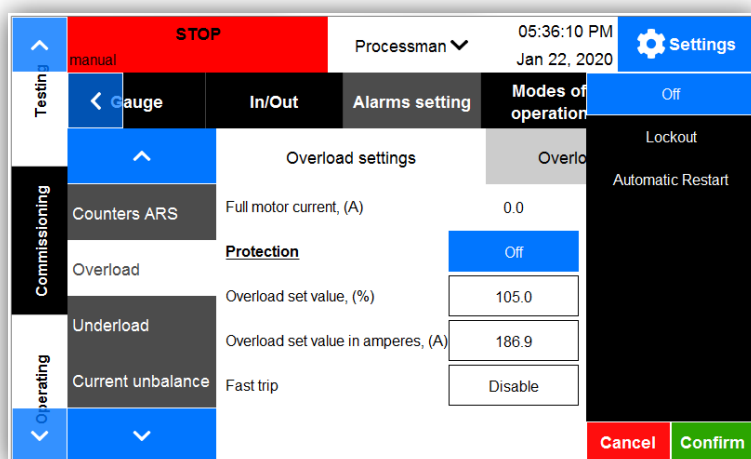
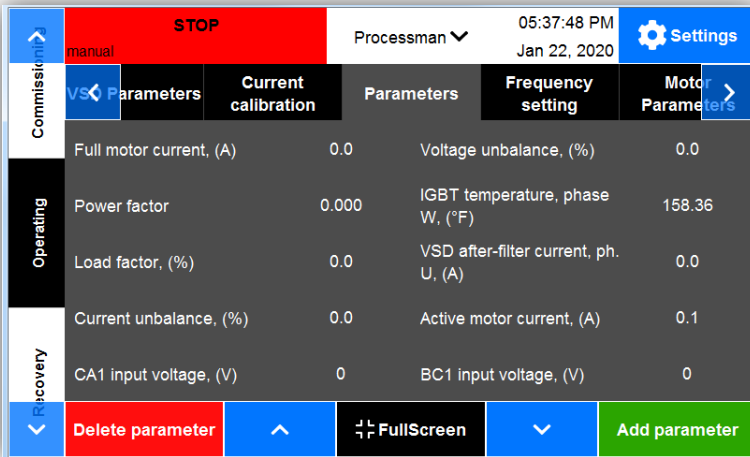


Figure 26 – Scheme of jumper installation for full load test

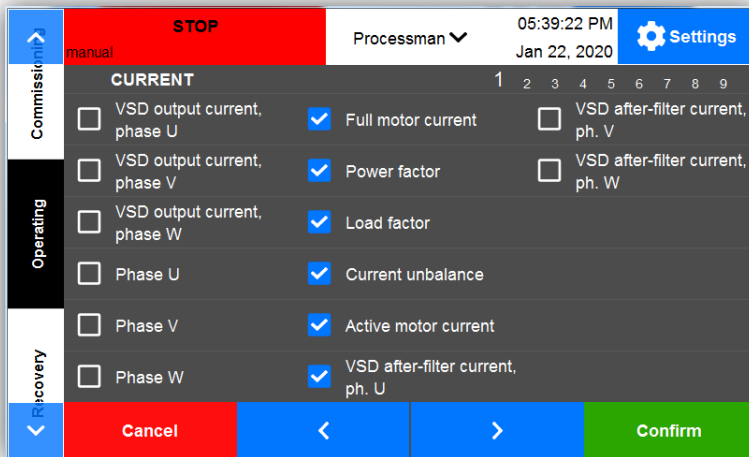
VSD rated current	Output (3 phase)	
	Terminals per phase, pcs	Recommended cable cross section, AWG/kcmil (mm <sup>2</sup> )
100	2	AWG 1 (50)
160		AWG 1 (50)
250		AWG 2/0 (70)
300	2	AWG 2/0 (70)
360		AWG 3/0 (95)
400		AWG 3/0 (95)
420		AWG 3/0 (95)
515	4	MCM 300 (150)
590		MCM 400 (185)
630		MCM 400 (185)
675		MCM 400 (185)
800	6	MCM 400 (185)
900	4	MCM 500 (240)
1000		MCM 500 (240)
1200		MCM 750 (300)
1400		MCM 750 (300)
1600		MCM 800 (400)



2. Turn off «Overload», «Underload», «Current unbalance» alarms.

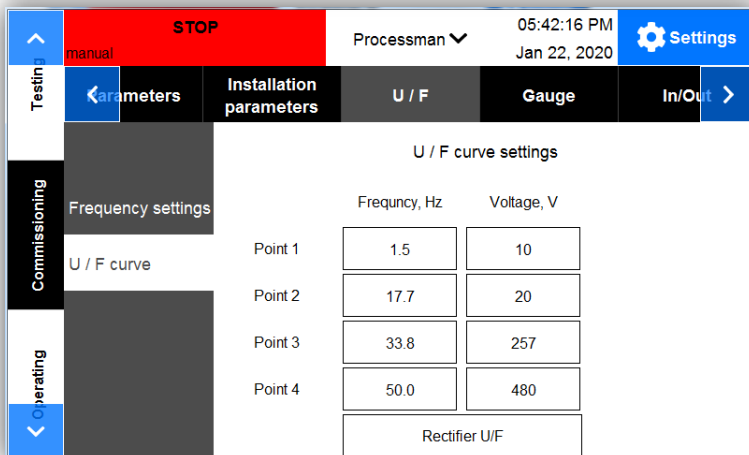


3. To the status display select displaying of three VSD currents.



4. Adjust U/f characteristic by the following steps:

- Install Point 1 voltage – 10V;
- Install Point 2 Voltage – 20V;
- Install Point 3 Voltage – 30V;
- Install Point 4 Voltage – 40V.



5. Set «Startup mode» – «Soft». «Acceleration Rate» – 1Hz/s.

6. Set «Frequency setting» – 10Hz.

7. Press start button, monitor VSD output currents values. If current level

less than necessary, then slowly increase «Frequency setting» for 1-2Hz, monitor level of VSD currents. Increase setpoint until get required current level.

If on 50Hz output current level not enough than VSD required current, then change «Point 4 Voltage» to 50V. Then set «Rectify U/f» to «Yes». Start VSD again.

## Periodic maintenance of VSD Triol

The period through which it is necessary to conduct periodic maintenance of the drive is once every six months if VSD operated, once a year if it was not in use. Also, the maintenance is required before start after long idle time.

You need following tools and materials for periodic maintenance:

- socket wrench set with metric standard from 8 to 19 mm inclusive;
- set of flat spanners with metric standard from 8 to 19 mm;
- set of hex keys with metric standard from 2 to 10 mm;
- compressor with air nozzle to remove dust;
- screwdriver set with bits RN1 – PH3 and SL1-SL3;
- torque wrench for sockets;
- rags to remove any impurities;
- conductive grease;
- aerosol cleaner for connectors;
- aluminum grease;
- multimeter capable to measure resistance, DC and AC voltage, and variable current with a maximum measurement range of current equal to the nominal value of VSD at which the work is conducted;
- portable grounding device – 3 sets;
- the key to VSD;
- silicone grease.

- 1. Before carrying out the maintenance of the VSD ensure the absence of voltage at the input terminals of the drive with the help of a tester established on measurement of AC voltage.**

Install portable grounding device on the input supply terminals of the VSD.

Wait until the backspin lamp turns off. If there is a backspin of the PMM it take long time.

To check the absence of voltage on the output terminals of the VSD and install portable grounding on VSD output terminals.

- 2. Check of torque of input power terminals, circuit breakers, overvoltage protective circuits.**

To monitor the presence of contamination at the input terminals, at presence clean with aerosol cleaner, connectors and rags.

To inspect torque of bolted connections of terminal connections, and conductors leading from the terminals to the power units, and the conductors coming from the power units to the power rectifier unit.



The bolts must be tightened with the specified torque for each thread.

- M10 30 N•m;
- M8 20 N•m;
- M6 10 N•m.

Surge arresters must not have visible damage.

Leads from surge arresters are connected each to its phase. The ground wire are connected to the VSD enclosure.

### 3. Check of electrical connection of rectifier unit



**Before checking the torque of UD connection to check the voltage at connections with the help of the tester in the mode of the DC voltage measurement.**

To conduct monitoring of the torque of terminal connection block rectifier – screw connections with thread M8 tighten to 20 N•m.

Visually check the condition of screw connections located on the block of the rectifier.

Reconnect the connectors going to the electronics unit and the rectifier unit to control the contamination and oxides.

At presence of contaminants or oxides to remove using the cleaner and rags.

To set the connectors in a regular place following the keys for installation of connectors. To fix the connectors by standard clamps.

### 4. Check of electrical connections of the inverter unit.



**Before checking the torque of UD connection to check the voltage at connections with the help of the tester in the mode of the DC voltage measurement.**

To conduct monitoring of the torque of terminal connection block rectifier – screw connections with thread M8 tighten to 20 N•m.

Visually check the condition of screw connections located on the block of the rectifier.

Reconnect the connectors going to the electronics unit and the rectifier unit to control the contamination and oxides.

At presence of contaminants or oxides to remove using the cleaner and rags.

To set the connectors in a regular place following the keys for installation of connectors. To fix the connectors by standard clamps.

Using the compressor to remove the dust if any on the Ud connections.

## **5. Check of electrical connections of electronic units.**

Visually check the condition of the electronics modules – there are no traces of soot. If dust is present, remove it with compressed air.

Reconnect the connectors going to the GB, RMPS, OutM, RisS units and control contamination and oxides.

In the presence of contaminants or oxides to remove them with cleaner and rags.

To set the connectors in a regular places following the keys for installation of connectors. To fix connectors with the standard clamps.

## **6. Check of the cooling fans and ventilation.**

Open back VSD's door and check that the fan rotates freely.

Upon detection of foreign objects or contamination in the compartment of the fan to remove them with a rag, solvent and compressed air.

If any binding in the rotation of the fan is revealed replace the fan with serviceable one.

To monitor the integrity of rubber seals of the upper ventilation compartment.

Upon detection of cracking of rubber to replace the rubber seal partially or completely.

Ensure that there is no sand and dust in large quantity in this compartment. Remove foreign objects from this compartment is compartment (dust, sand).

## **7. Check the sealing and locking system of the Cabinet.**

To check the condition of rubber seals on all compartments, upon detection of cracking of rubber seals to replace them. Upon detection of hardening of rubber seals apply silicone grease to the seals.

To ensure all the locks are fit and close smoothly without binding when closing, tightly draw the door.

Upon detection of jamming of the lock to lubricate with aluminum grease.

## **8. VSD low-voltage conductors check.**

Visually assure that the wiring is not damaged, the insulation of the conductors is not cracked and not melted.

Upon detection of insignificant cracking of the insulation of the conductors of the harness eliminate the damaged insulation with the help of electrical tape, upon significant damage replace the harness.

To check the performance of auxiliary circuit breakers of telemetry and ventilators.

Machines must be turned on and off. Using the tester to check that is the breakers conduct when enabled and do not conduct when turned off. Upon detection of the faulty machine to replace by working one.

Check the fuse holders and fuses themselves for correct operation. Upon detection of a faulty fuse, replace with serviceable one.

To hold the wire terminals for external connections.

## APPENDIX A

### AK06-RD-300...420 with output frequency 200 Hz



**WARNING!** Do not connect and disconnect live connections. Electronic control units of variable speed drives contain components made on the basis of metal-oxide semiconductor (MOS) technology that is not tolerant to static electricity. If you need to touch some MOS component, ground your body and the tools to be used. When working with these units, place them on current-conducting pads.

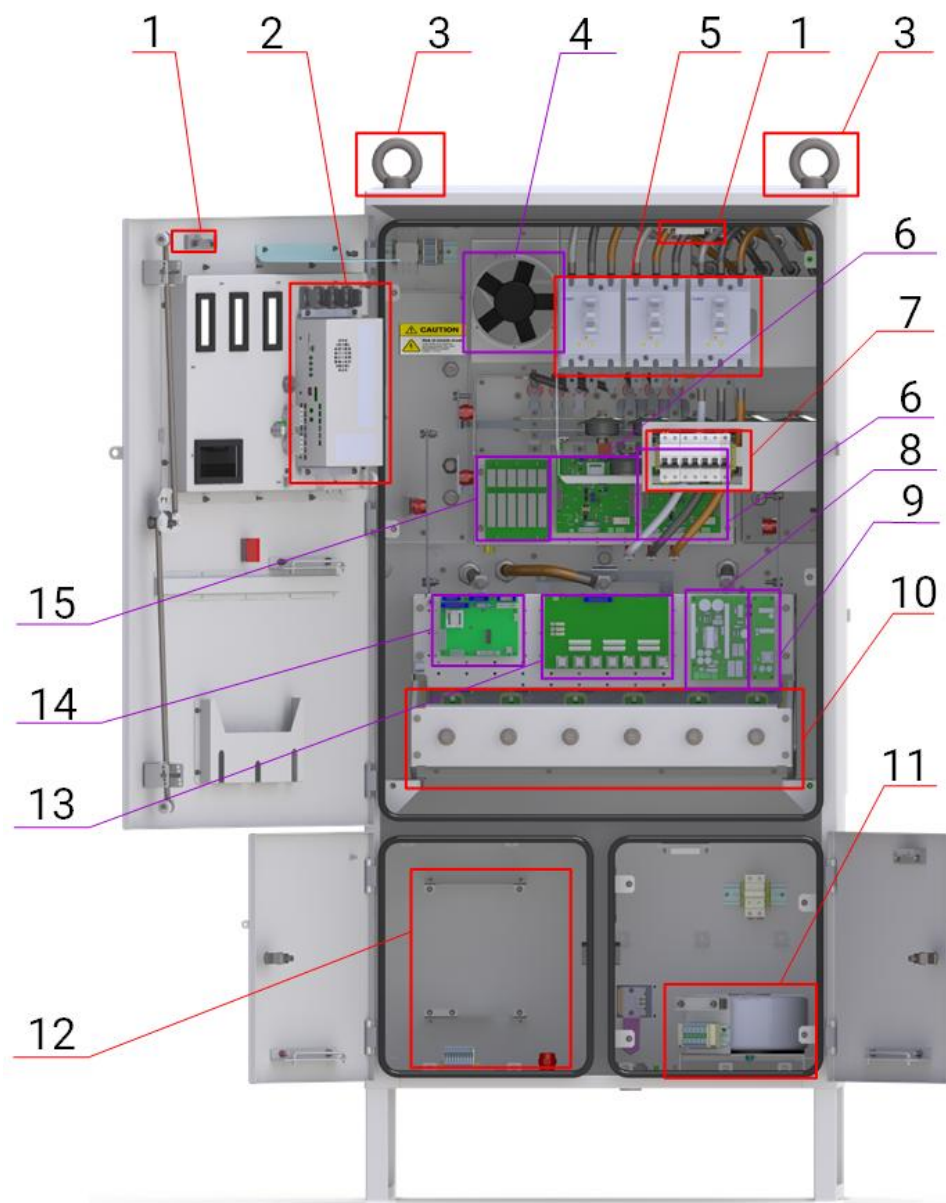


**WARNING!** Within 5 min after switching off the mains power, DC-link capacitors retain the dangerous charge. Before working inside the cabinet, make sure that the capacitors are free of voltage. Default of the above-listed requirements can lead to failures and premature failing of the VSD.

## AK06-RD-300...420 with output frequency 200 Hz overview

### Electronic compartment

Reference marks in VSD AK06-RD 300....420 Amps with output frequency up to 200 Hz.



VSD AK06-RD 300....420 Amps with output frequency up to 200 Hz

1. Cabinet doors control
2. UMKA07 controller
3. Sliding ears
4. Auxiliary fan
5. Power supply Automatic circuit breakers
6. BVN – controller of rectifier unite



7. Automatic circuit breakers:

- power supply of control system;
- fan and lighting power supply;
- transformer supply.

8. RMPS – power supply unit

9. UDP – signal light power supply

10. Capacitors block of inverter

11. Transformer power supply.

12. Cabinet of installation and connection sensor

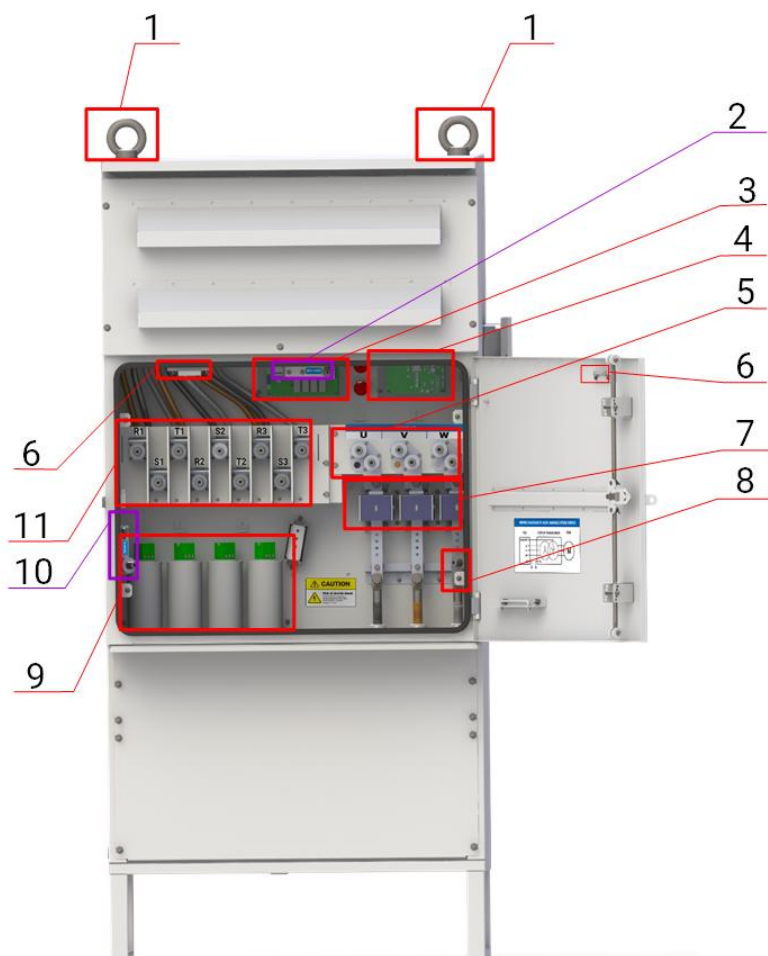
13. 3MDS – inverter driver

14. GB – VSD controller

15. CRC2 – Overvoltage protection of controller of rectifier unit.

## Power input/output compartment

Reference marks in VSD AK06-RD 300....420 Amps with output frequency up to 200 Hz.

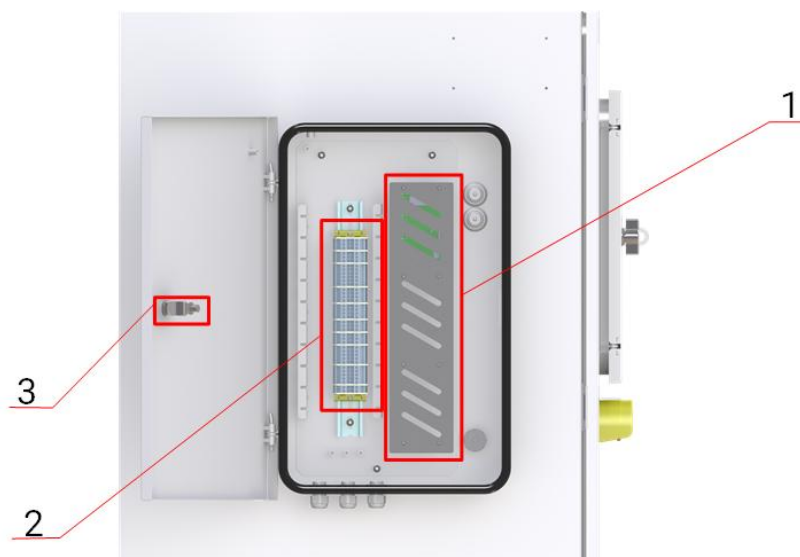


VSD AK06-RD 300....420 Amps with output frequency up to 200 Hz

1. Slinging ears.
2. WYE - point connection terminal
3. RisS – measuring of motor winding resistance
4. OutM – measuring VSD output parameters
5. Output power connections
6. Cabinet doors control
7. Current transformers
8. Grounded «Neutral» connection terminal
9. Sinwave filter capacitors
10. Grounded «Insulated neutral» connection terminal
11. Input power connections

## External connection section

Reference marks in VSD AK06-RD 300....420 Amps with output frequency up to 200 Hz.

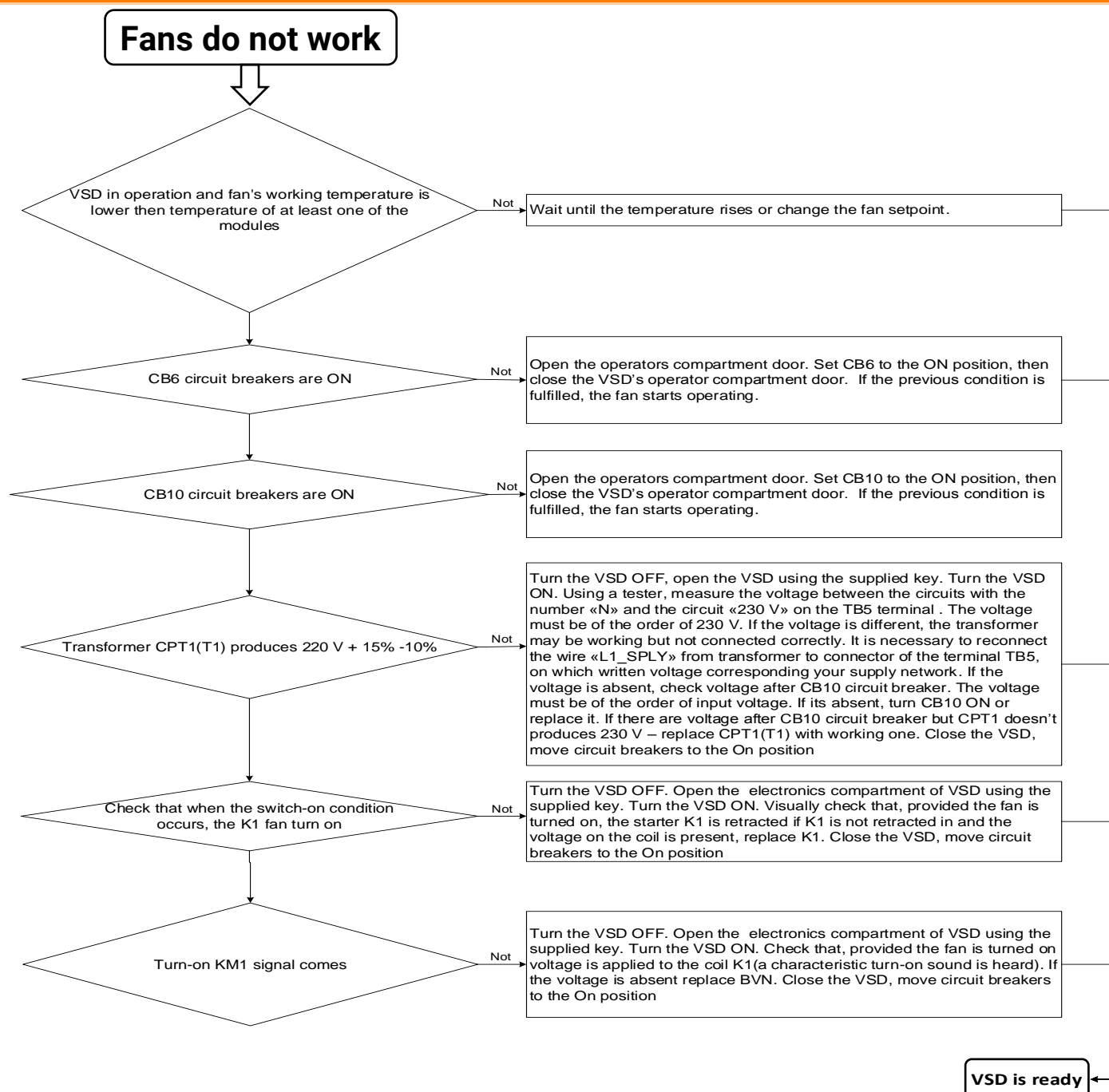


- 1. Expansion units.
- 2. Terminal block of external connections.
- 3. Door lock.

## **AK06-RD-300...420 with output frequency 200 Hz diagnostics flow charts**

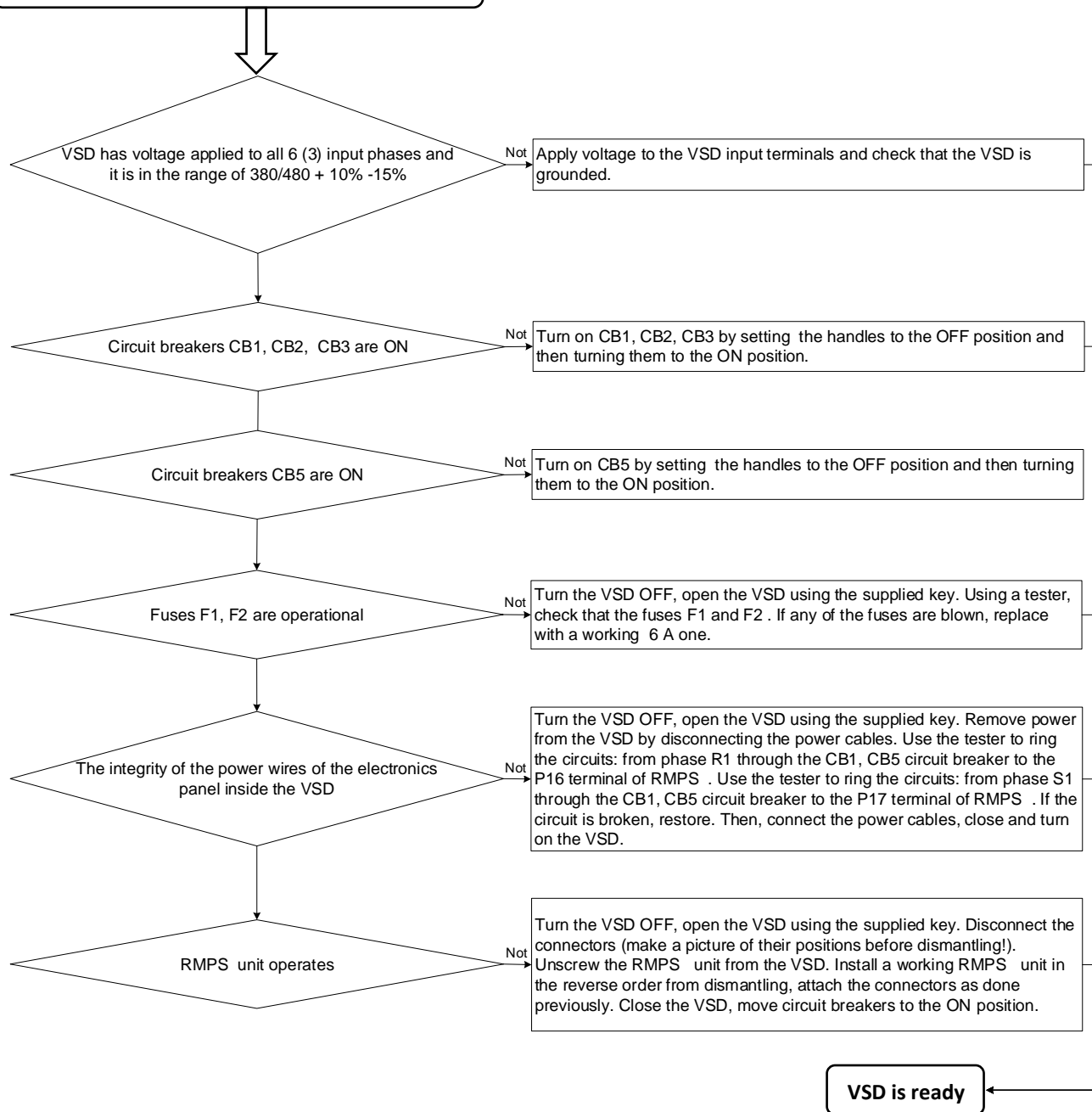
In this section described the following VSD failure diagnostics:

1. Fans do not work.
2. VSD indicators are not active.
3. No input voltage indication(or it does not match).
4. DC bus voltage cannot be measured or measurements are incorrect.
5. Failures of measuring voltage DC in operation, DC overvoltage, DC undervoltage.
6. Supply network currents 1 differs from network 2 by more than 20%.
7. No connection with Downhole Measuring System(Sensors).
8. No data on ACS.
9. Digital inputs do not work.
10. Analog Inputs do not work.
11. No supply voltage on the surface unit.
12. Constant emergency stop is displayed.
13. Constant «Discr T» failure is displayed.
14. Diagnostics of phase failure.
15. The VSD overheating alarm.
16. Output current are not measured or measurement are incorrect.
17. The VSD diagnostics during Power Switch failure (stopped).

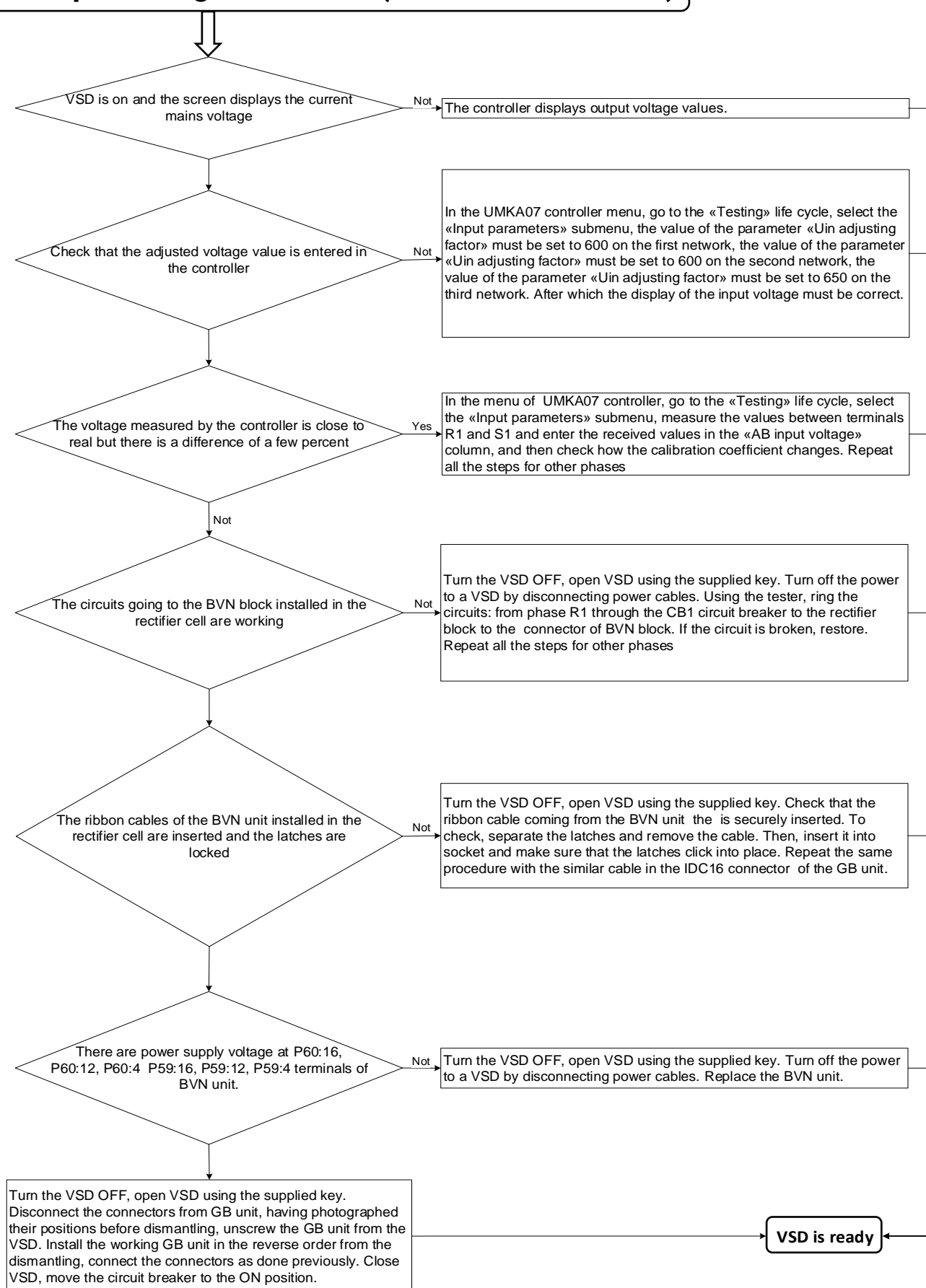




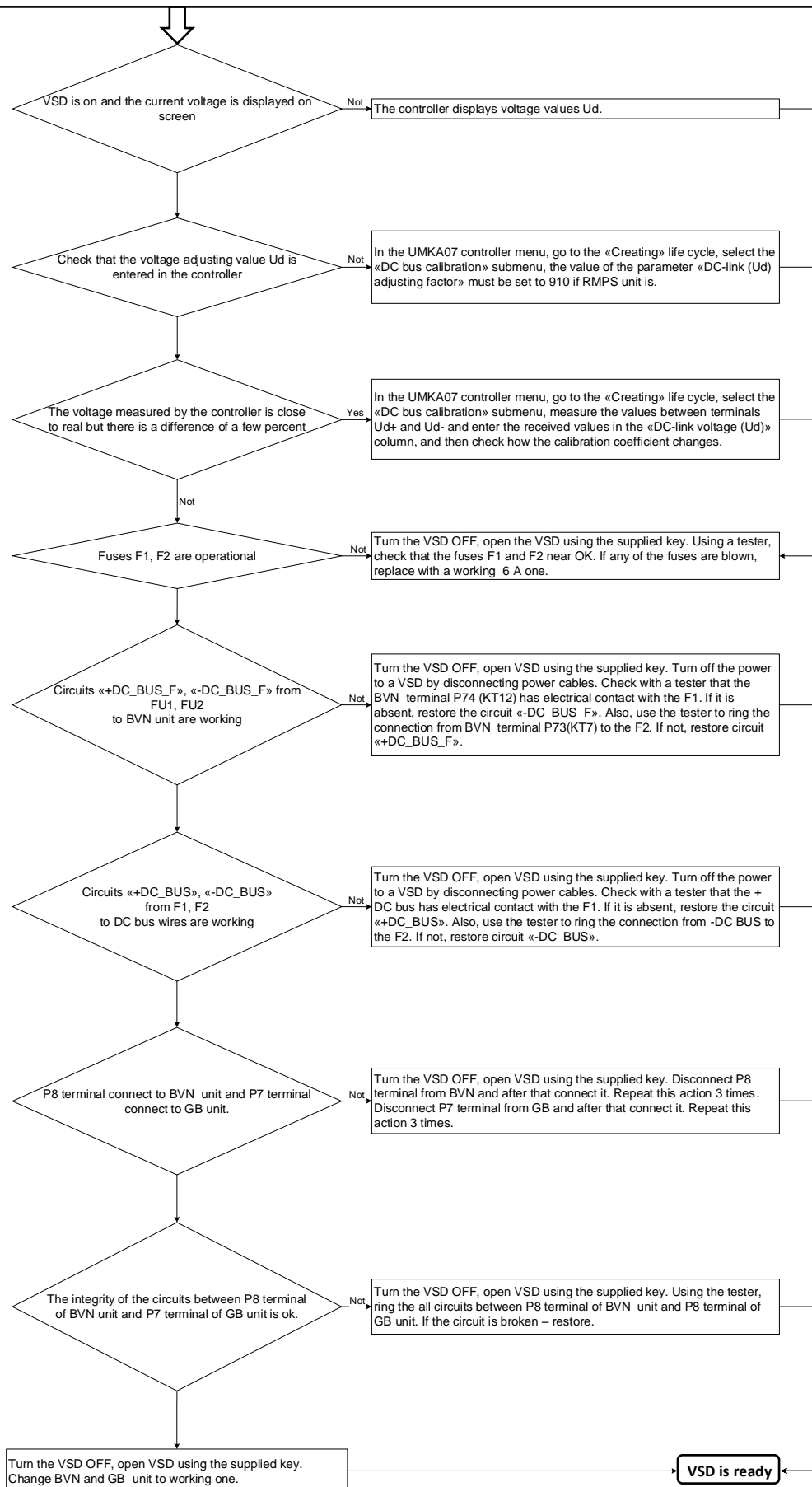
# VSD indicators are not active



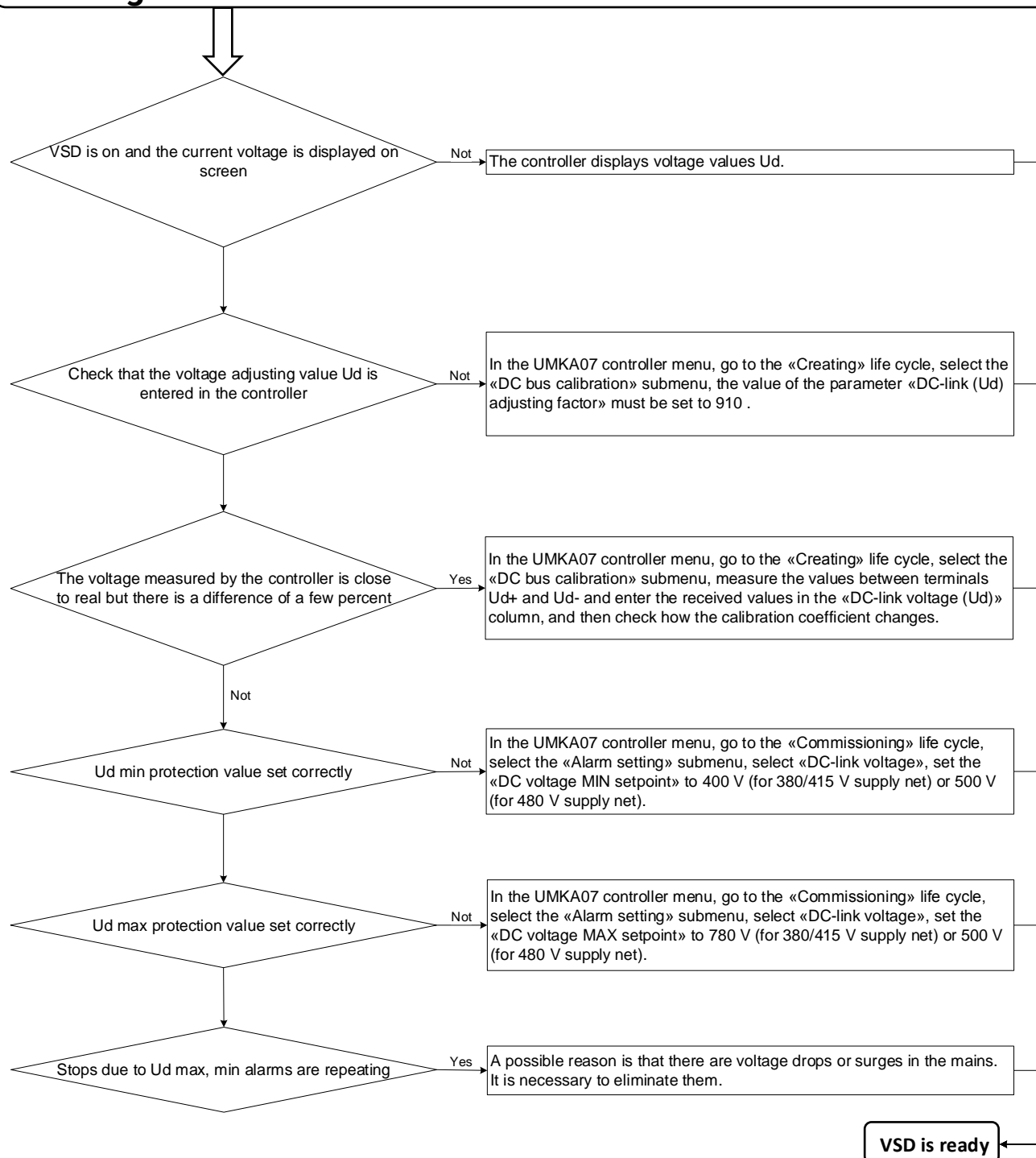
## No input voltage indication (or it does not match)



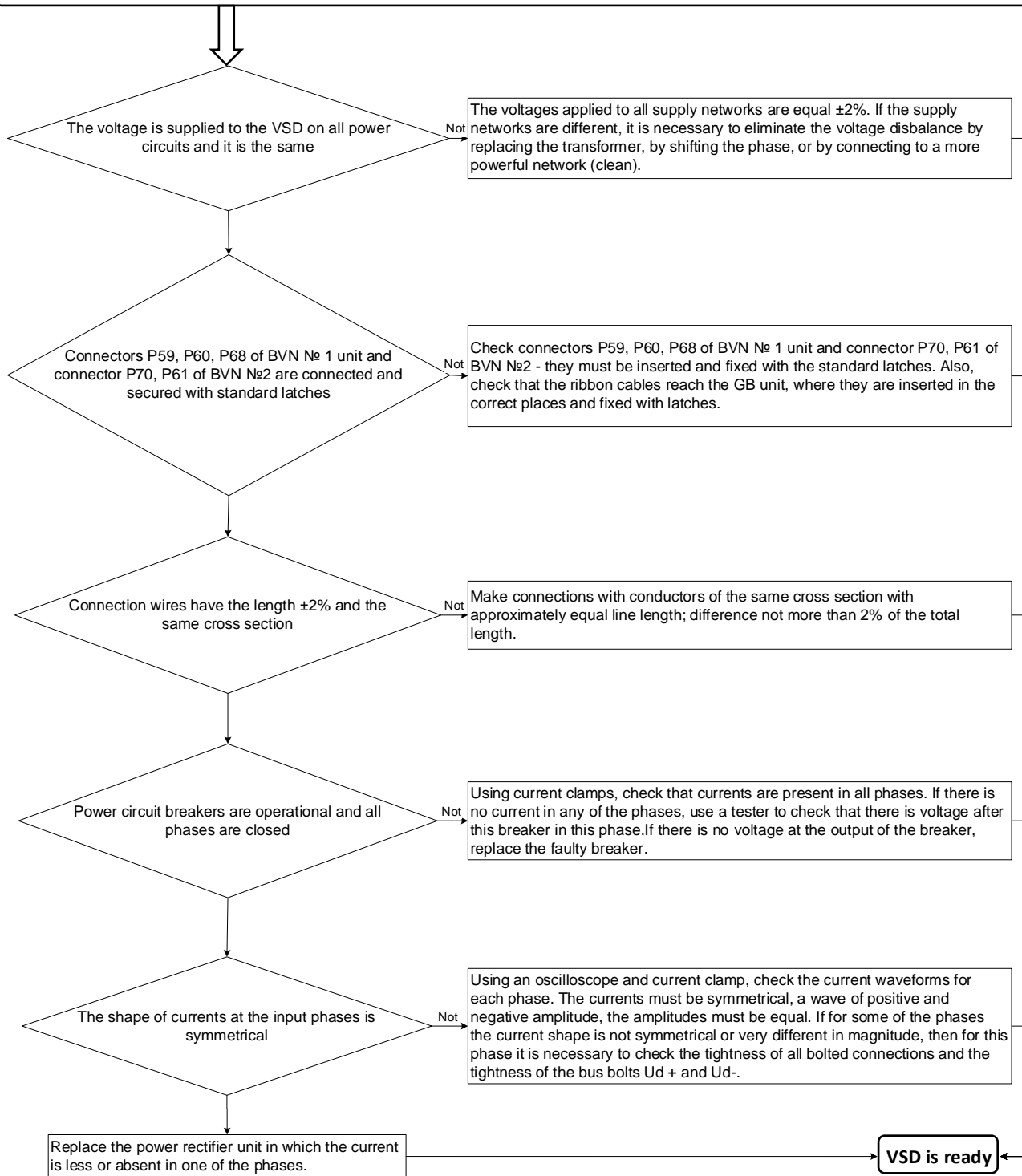
# DC bus voltage cannot be measured or measurements are incorrect



# Failures of measuring voltage DC in operation, DC overvoltage, DC undervoltage

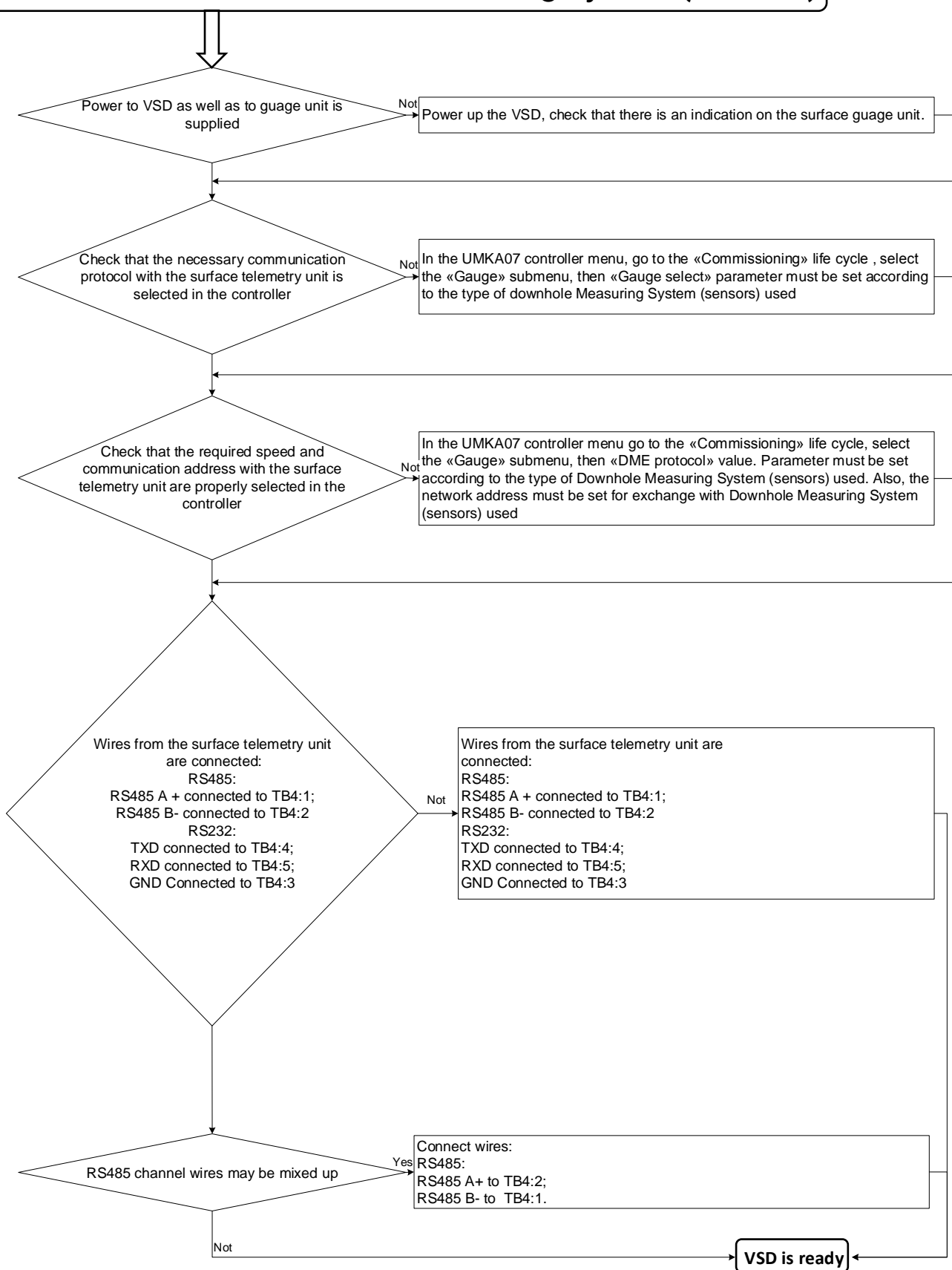


# Supply network currents 1 differs from network 2 by more than 20%

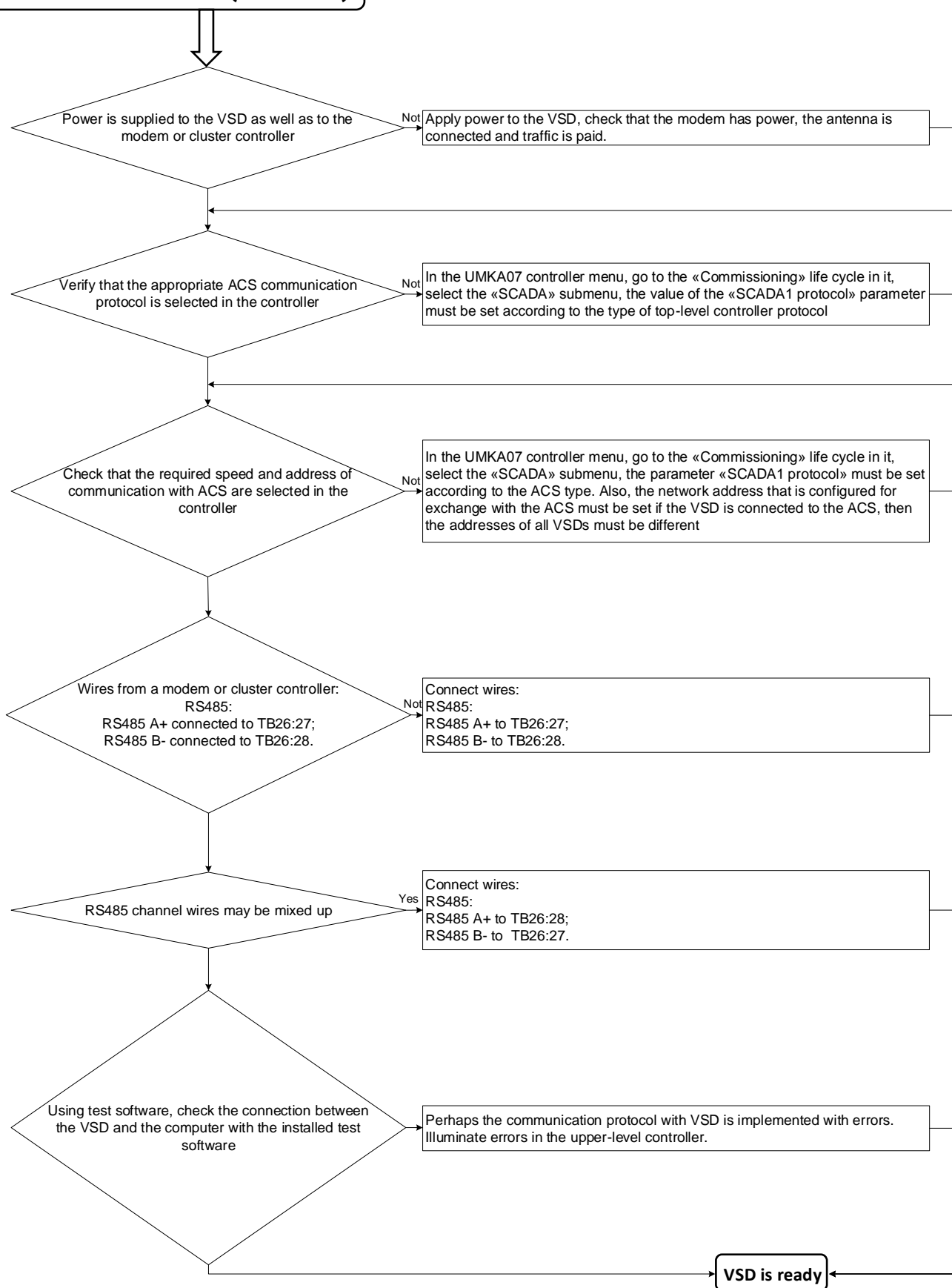




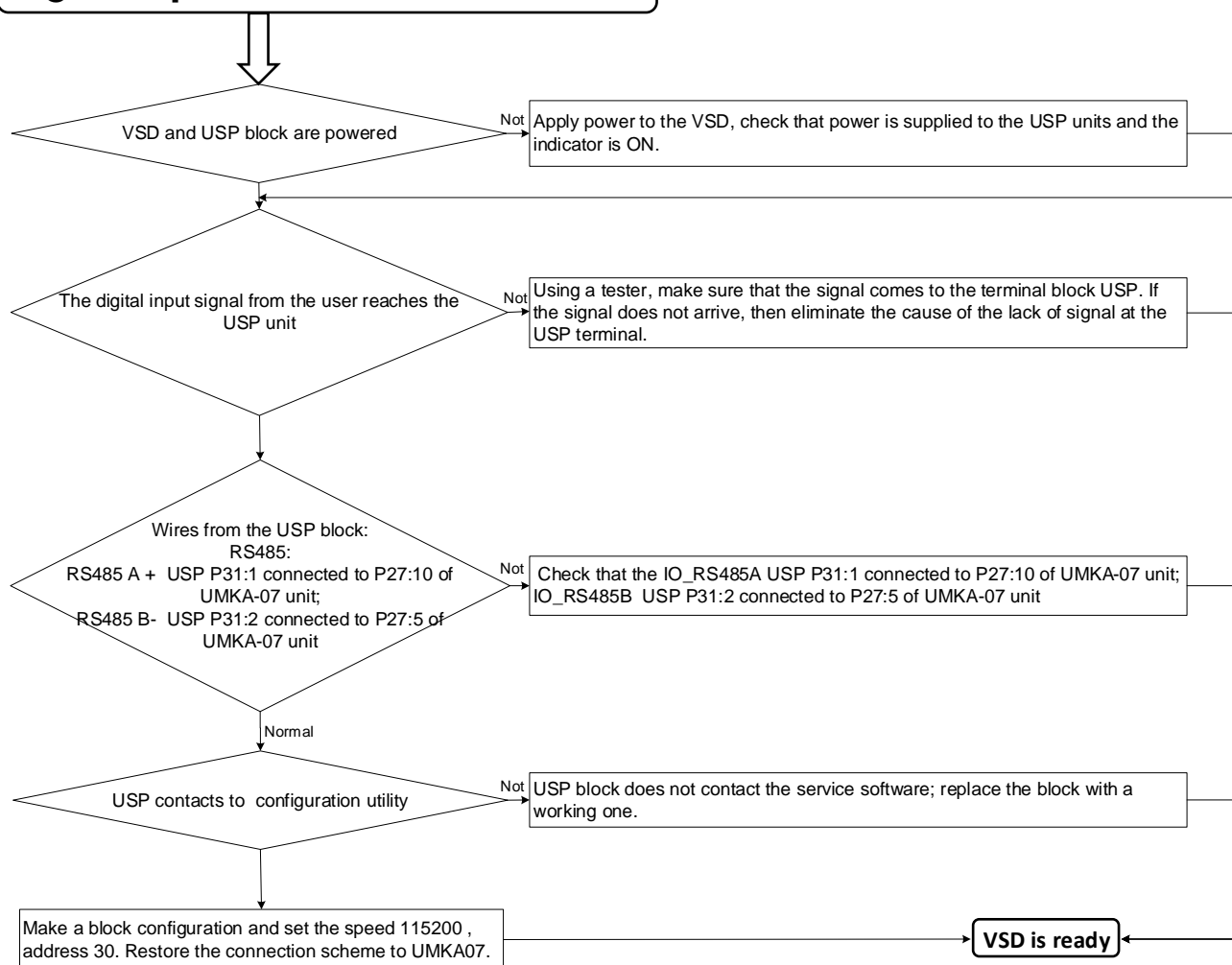
# No connection with Downhole Measuring System (Sensors)



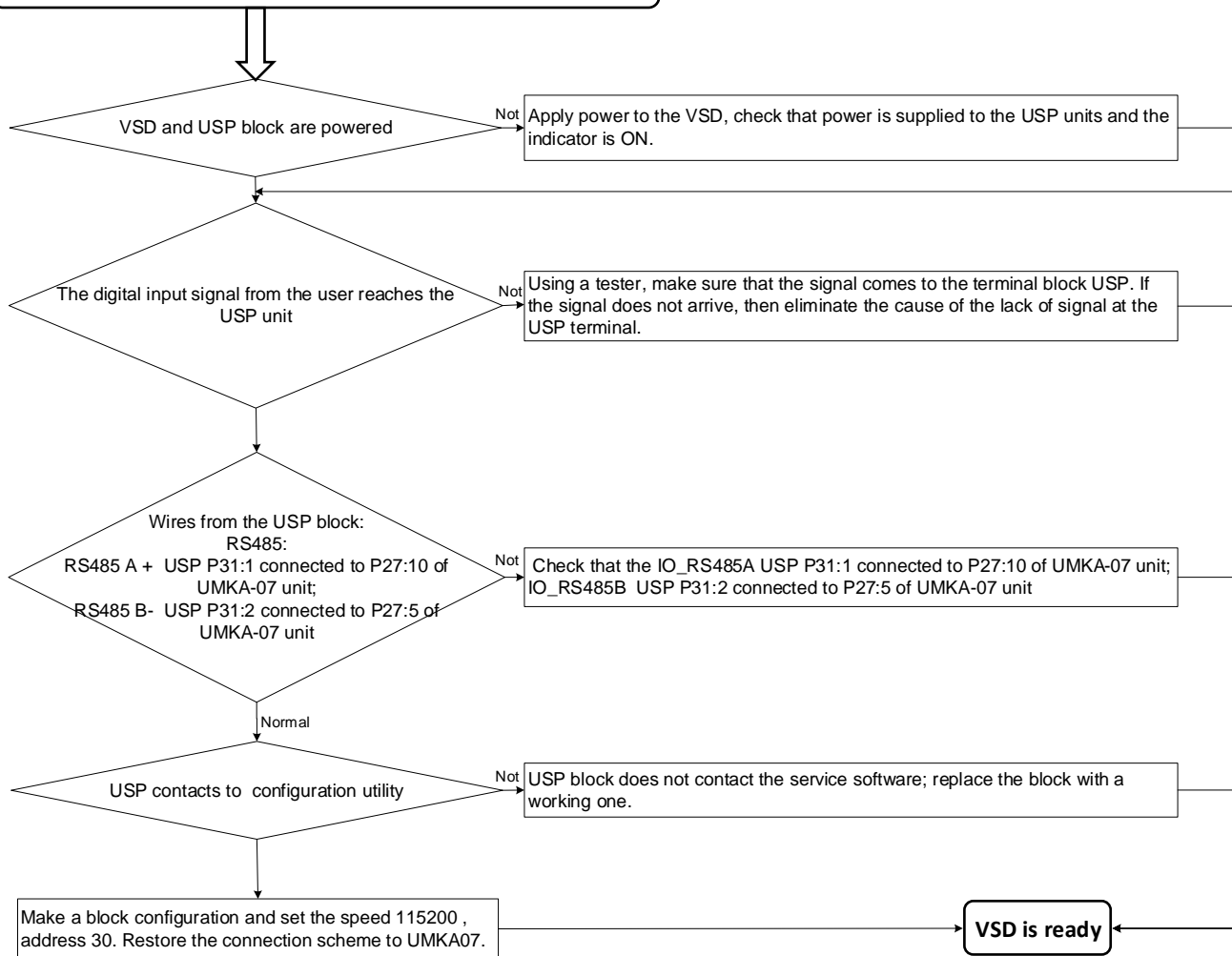
# No data on ACS (SCADA)



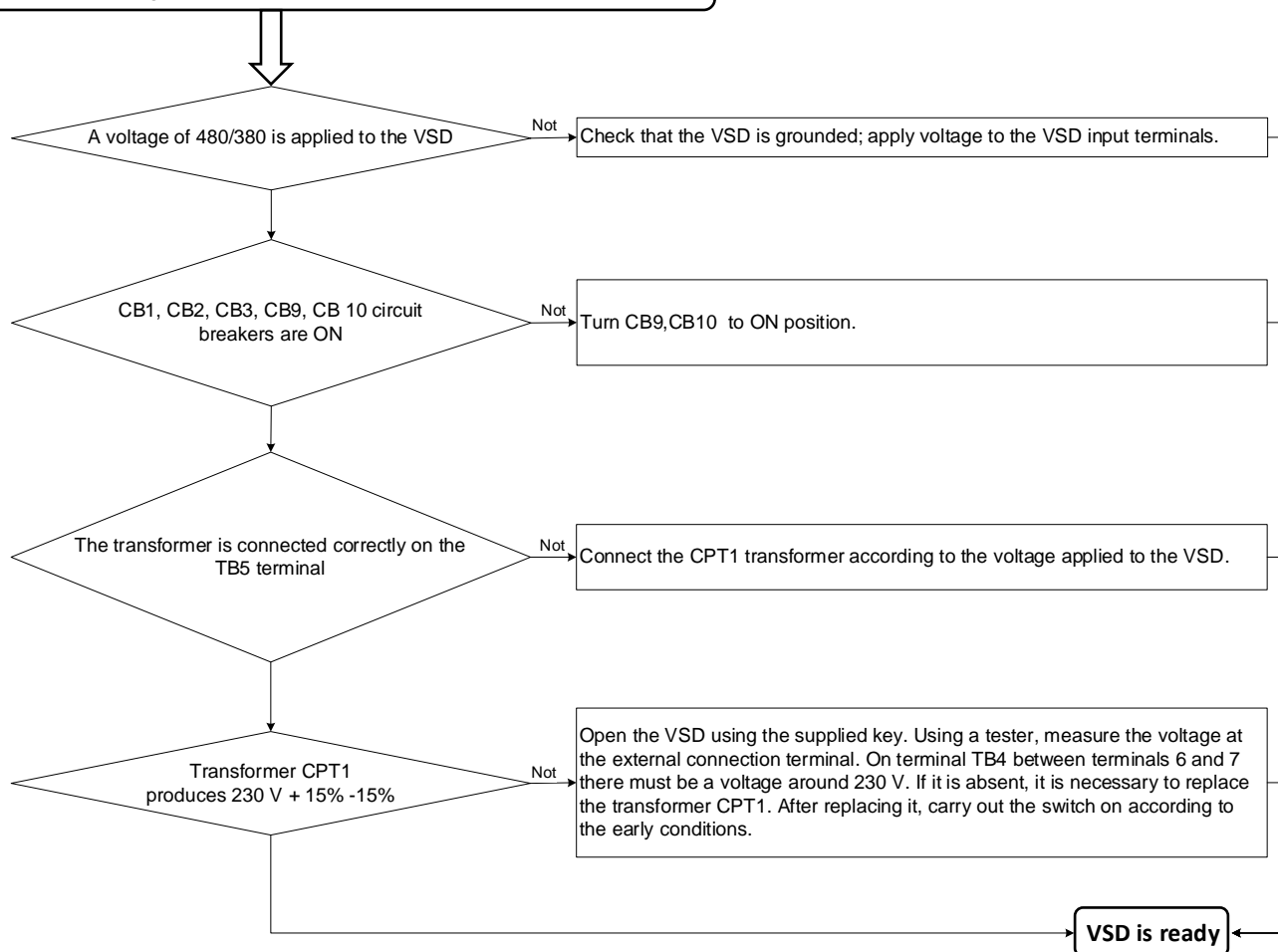
# Digital inputs do not work



## Analog Inputs do not work

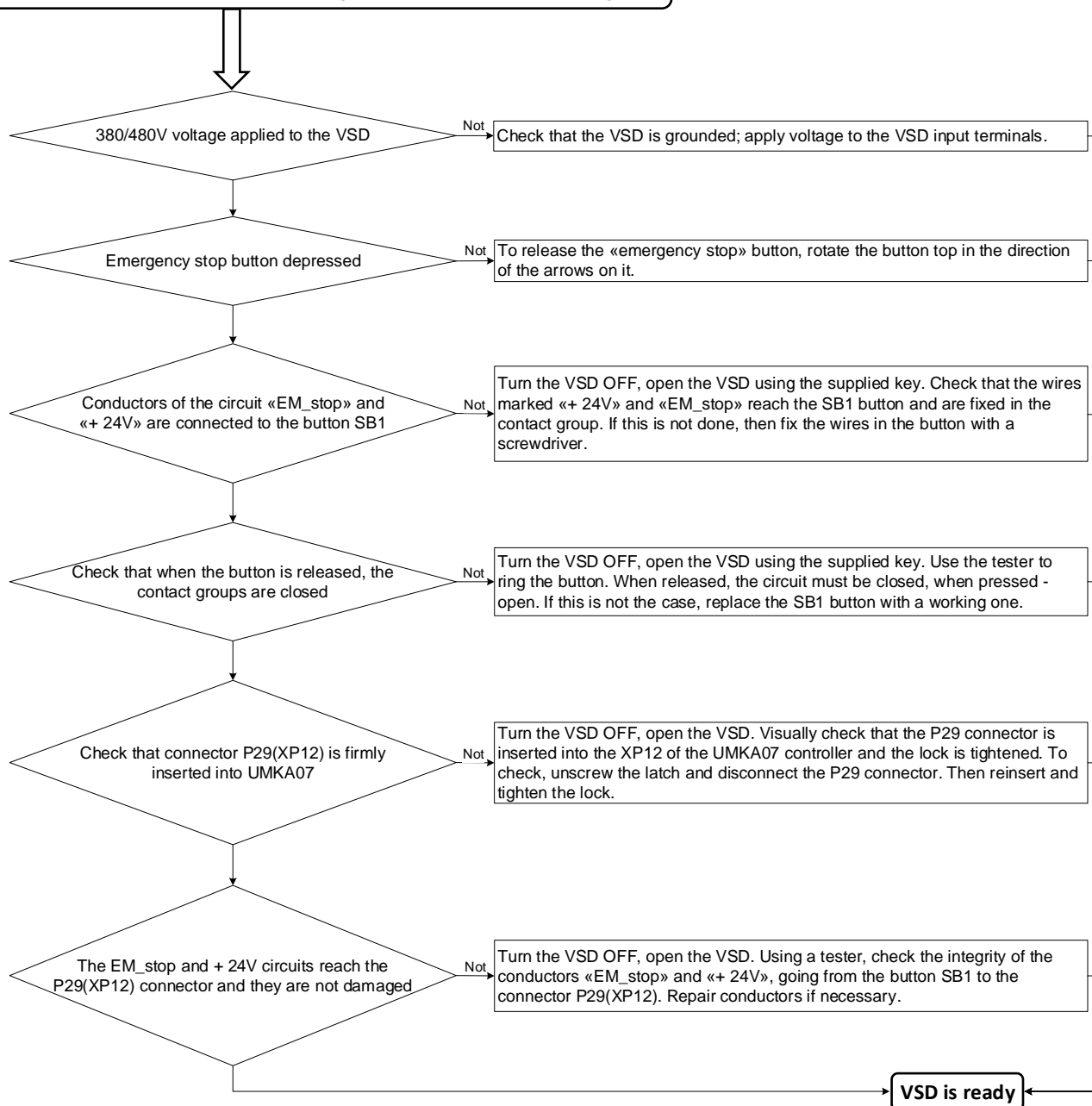


# No supply voltage on the surface unit

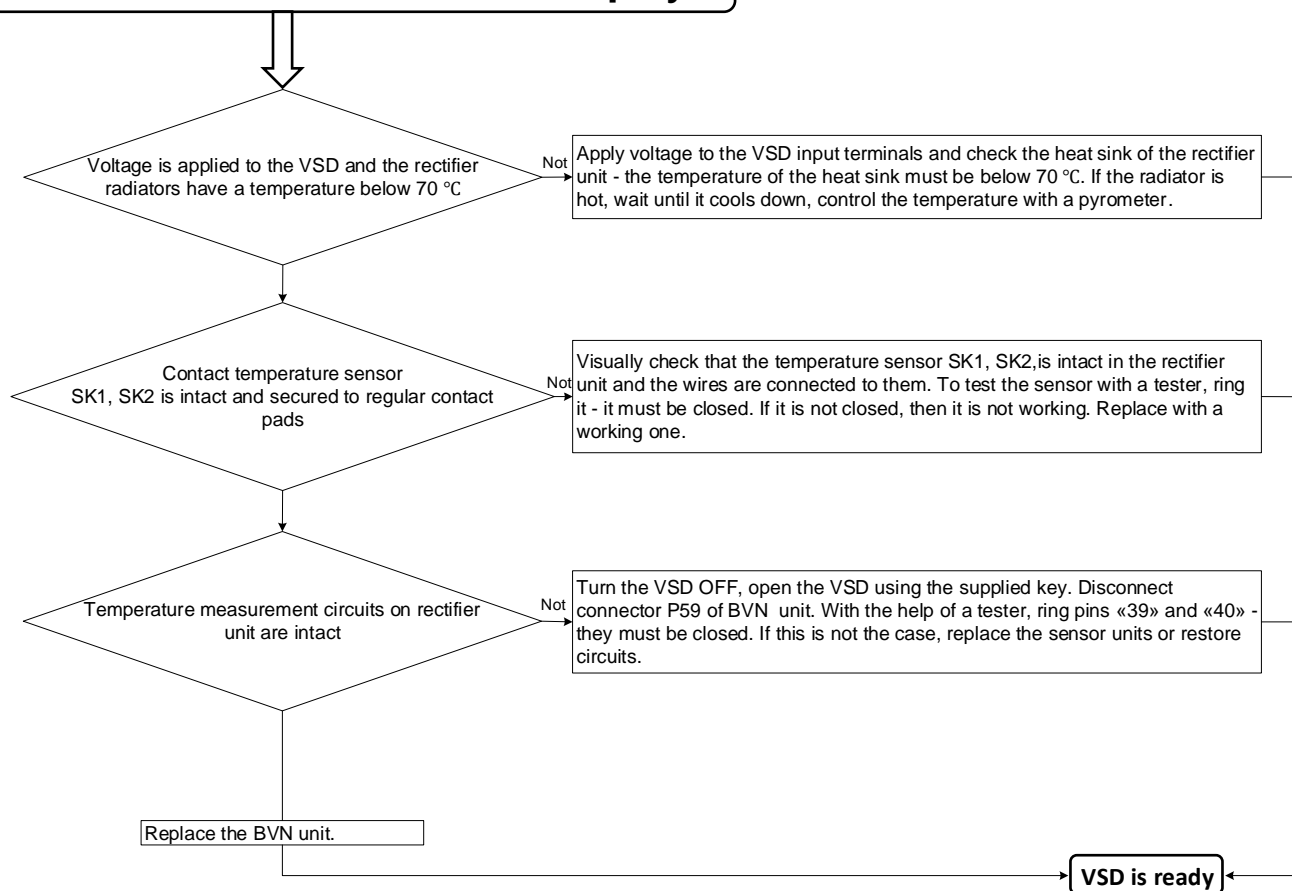




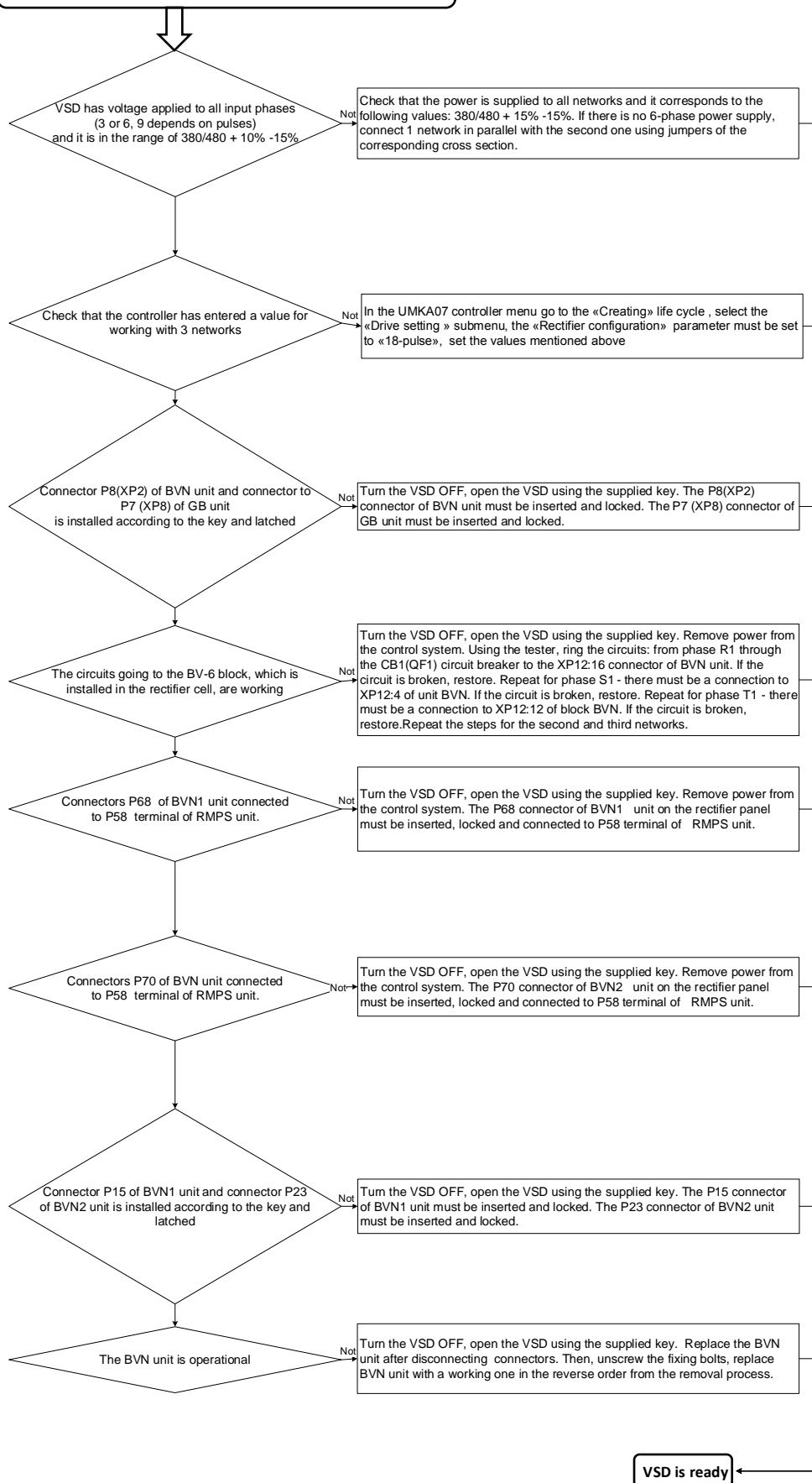
## Constant «Emergency stop» is displayed



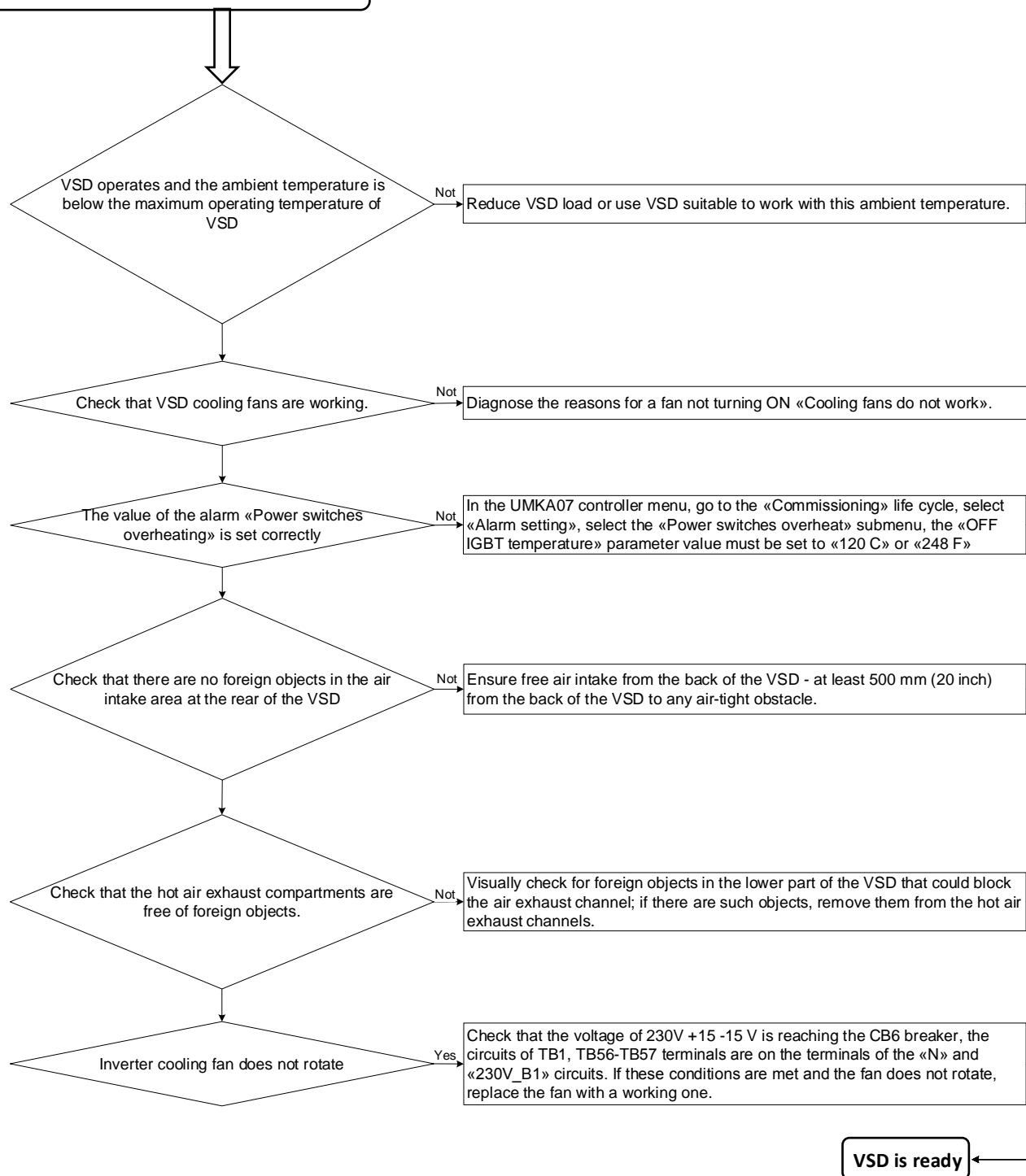
## Constant «Discr T» failure is displayed



## Diagnostics of phase failure



# VSD overheating alarm

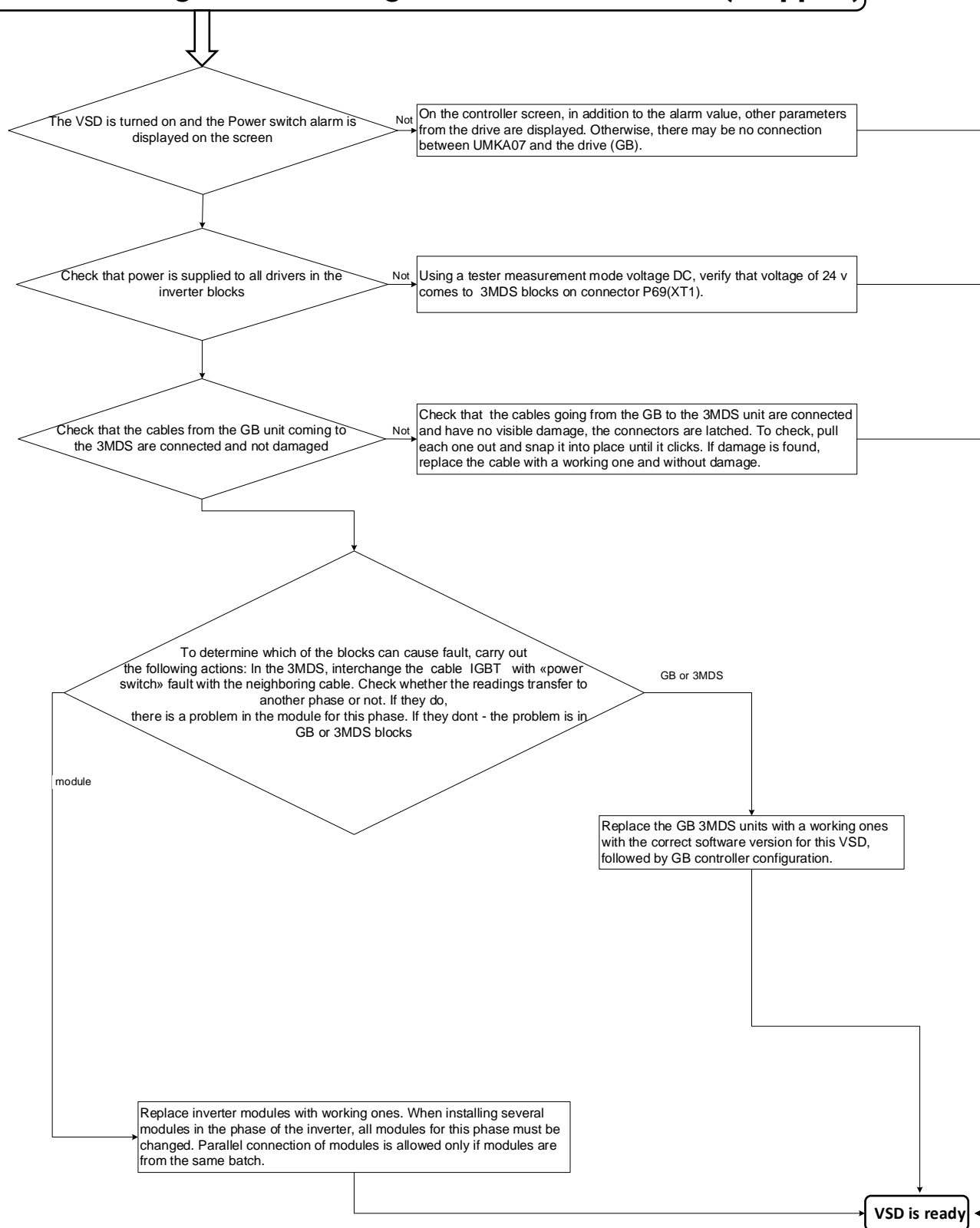


# Output current are not measured or measurement are incorrect





## The VSD diagnostics during Power Switch failure (stopped)



## Replacing of an inverter current sensors.

A VSD must be de-energized and disconnected from a power supply.



Using a multimeter, make sure that there is no dangerous voltage on a DC-link.

For unit disassembly you need next tool:

- wrench size 10 mm (13/32") – 1 pc;
- wrench size 17 mm (11/16") – 2 pc;
- flat screwdriver size 1.2 mm (3/64") – 1 pc;
- side cutter – 1 pc;
- cable tie – not less than 10 pcs.

In case if it is necessary to dismantle inverter current sensors:

### Step 1. Remove electronic units panel

Remove electronic units panel shown on the figure 27:

1. Disconnect all signal connectors from electronic units
2. Uncrew four bolt shown on the figure 29. Use wrench size 10 mm (13/32").

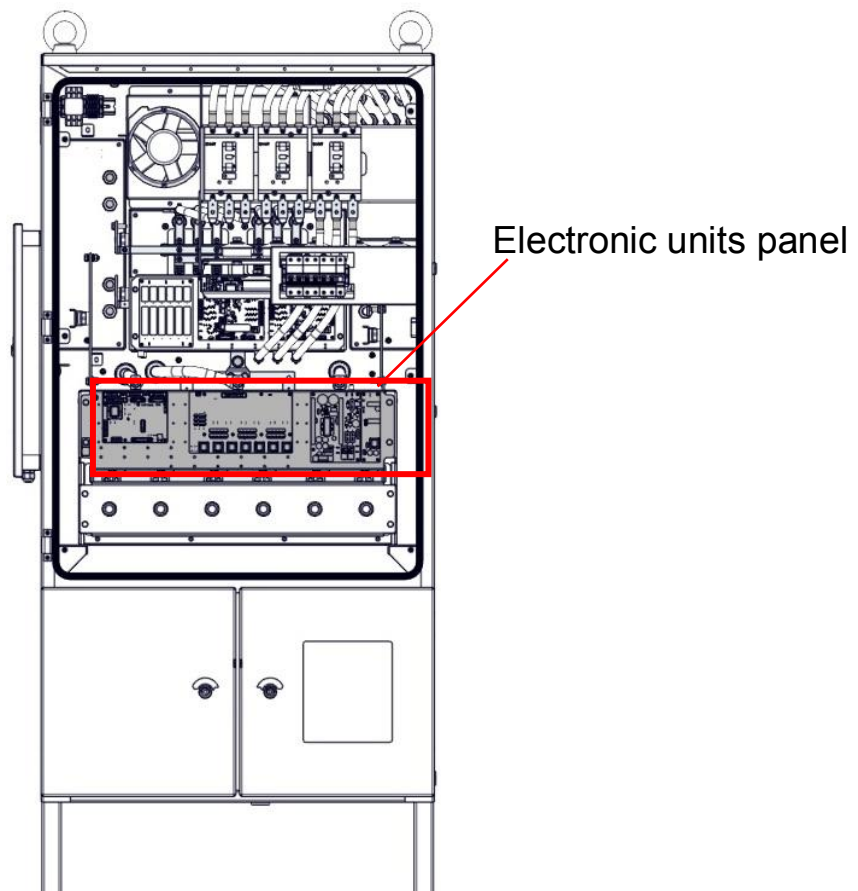


Figure 27 – Electronic units pantel

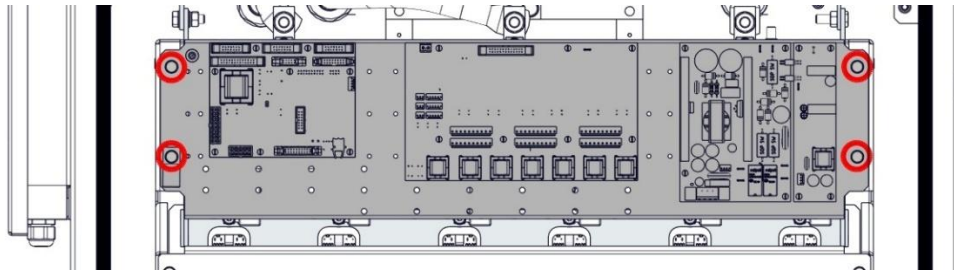


Figure 28 – Electronic units panel fixing bolts

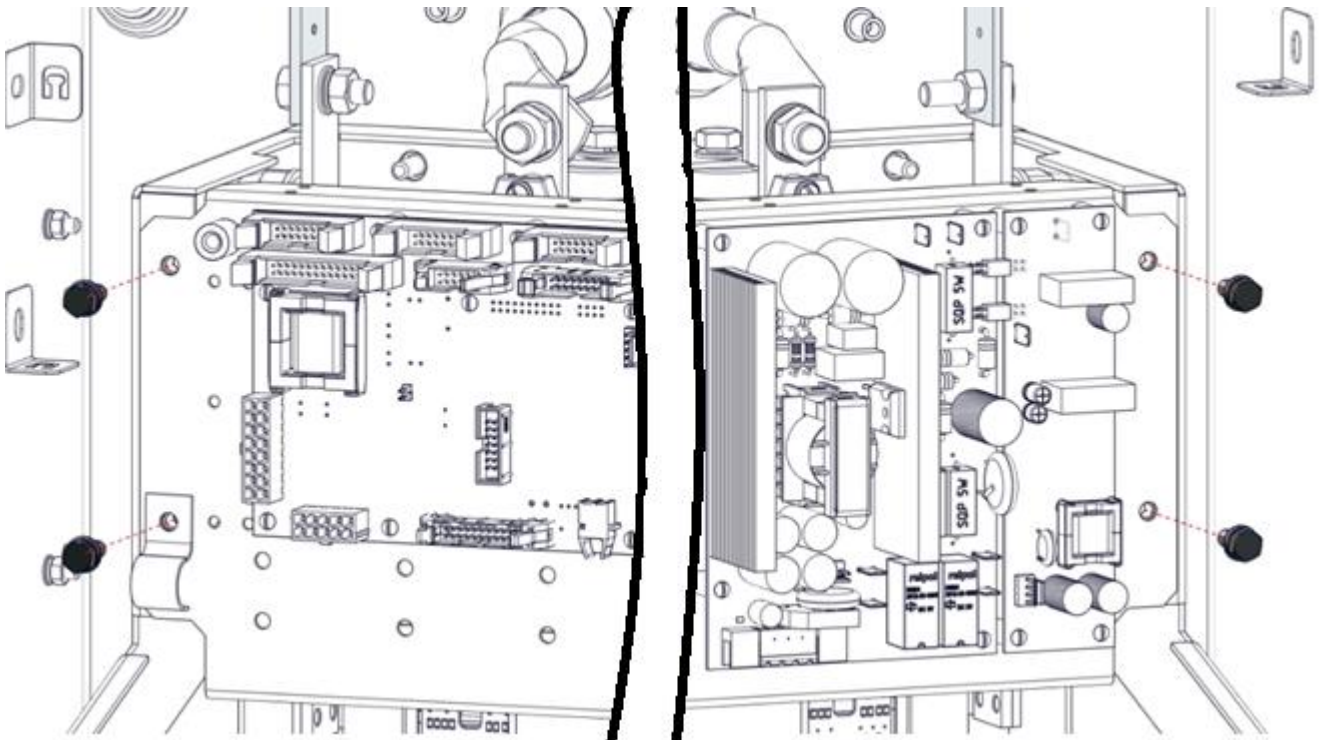


Figure 29 – Unscrewing fixing bolts

3. Remove panel as shown on the figure 30, if necessary bite through (use side cutter) cable ties which fixing cables on panel.

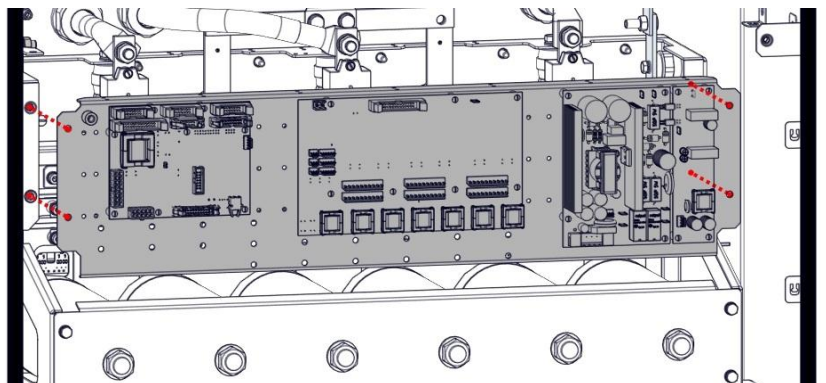


Figure 30 – Remove electronic units panel

## Step 2. Uninstall current sensors

Uninstall current sensor as shown on the figure 31

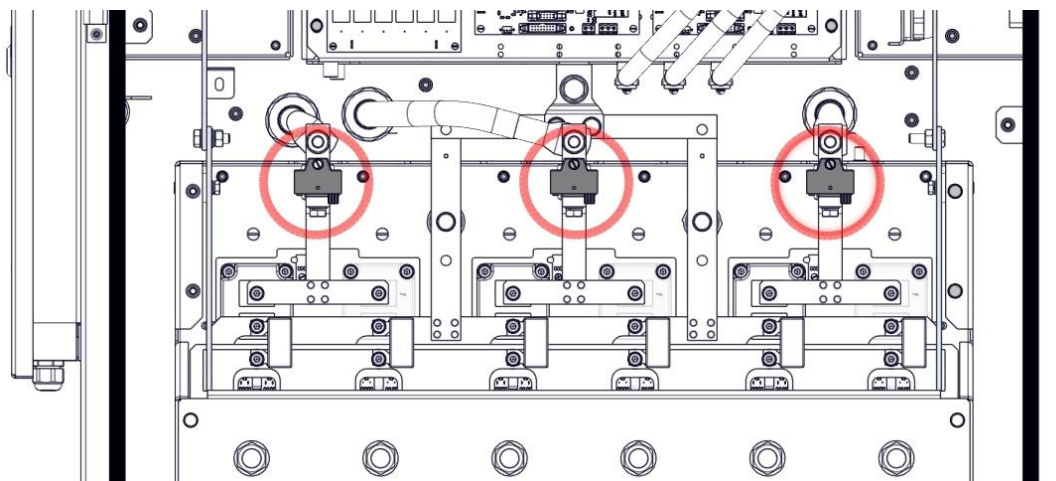


Figure 31 – Current sensors

1. Unscrew three bolts fixing cables on the buses, using wrenches size 17 mm (11/16"), as shown on the figure 32.
2. Unscrew three screws fixing current sensors, using flat screwdriver size 1.2 mm (3/64"), as shown on the figure 32

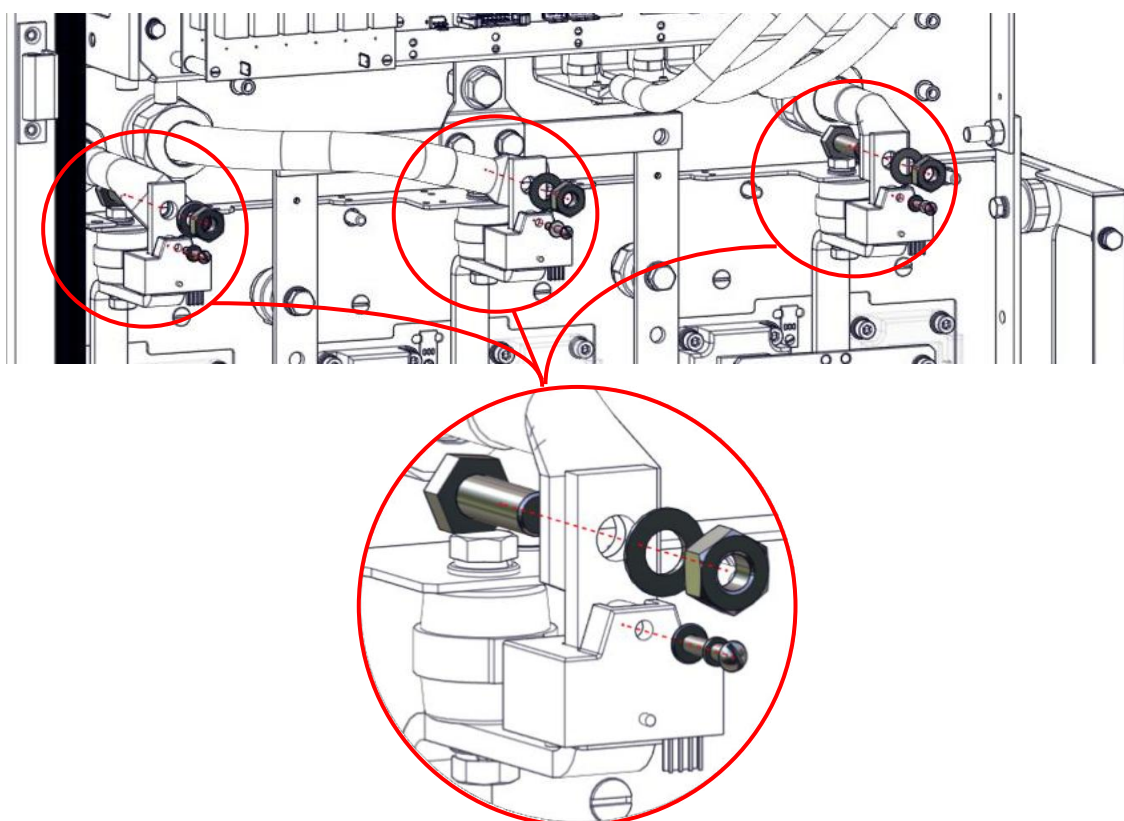


Figure 32 – Unfixing current sensors

3. Uninstall current sensors. For that move cables aside from buses, after that take off current sensors from buses, as shown on the figure 33.

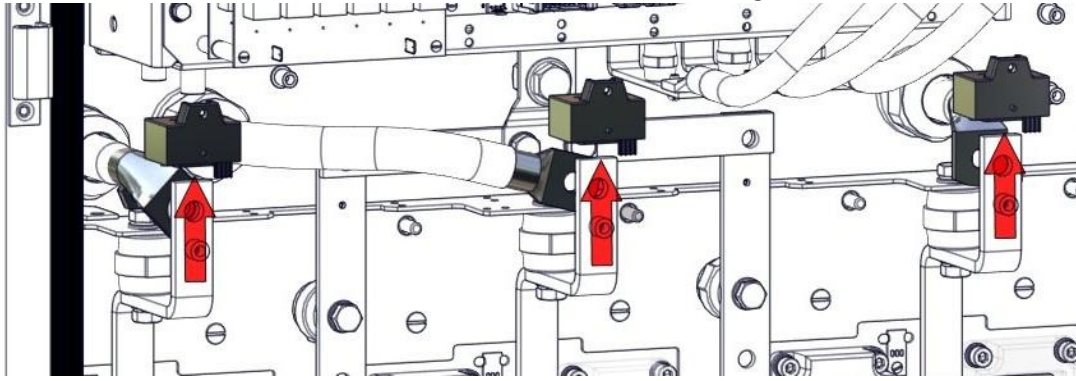


Figure 33 – Uninstall current sensors

### Step 3. Installation new current sensors

1. Installation of a new current sensors must be done in reversal sequence. Bolts must be tightened with a torque:

M10 – $30 \pm 1,5 \text{ N}\cdot\text{m}$	M8 – $22 \pm 1,5 \text{ N}\cdot\text{m}$
---	--



**All signal connectors must be installed to their positions and tightened with their original screws and connected to case via cable ties.**



## Main fan unit replacing

Preparation:



**A VSD must be de-energized and disconnected from a power supply.**

**Using a multimeter, make sure that there is no dangerous voltage on a DC-link.**

For fan dismantling you need next tool:

- wrench size 10 mm (13/32") - 1 pc;
- flat screwdriver size 0,8 mm (1/32") – 1 pc.

### Step 1. Disconnect fan signal and power cables.

1. Unscrew the cable gland, shown on the figure 34
2. Disconnect fan signal and power cables from terminal box, shown on the figure 34.

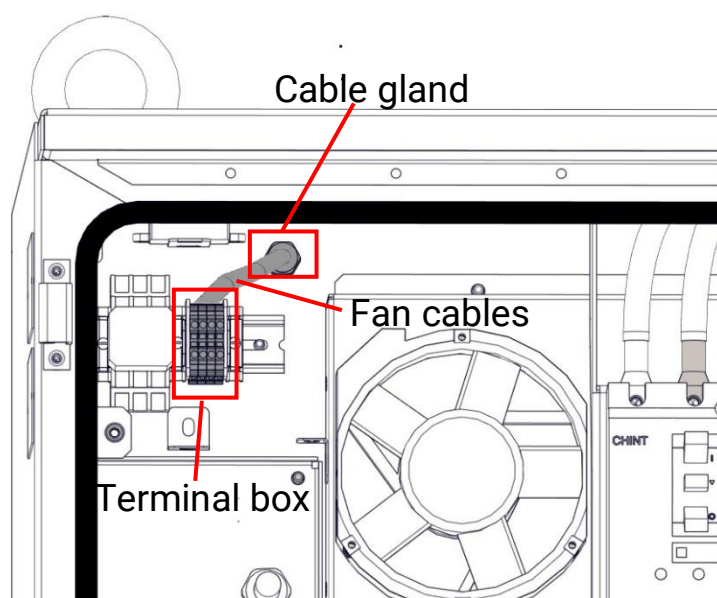


Figure 34 - Disconnect main fan signal and power cables

### Step 2. Uninstall fan.

1. Unscrew four bolts shown on the figure 36. Use wrench size 10 mm (13/32").



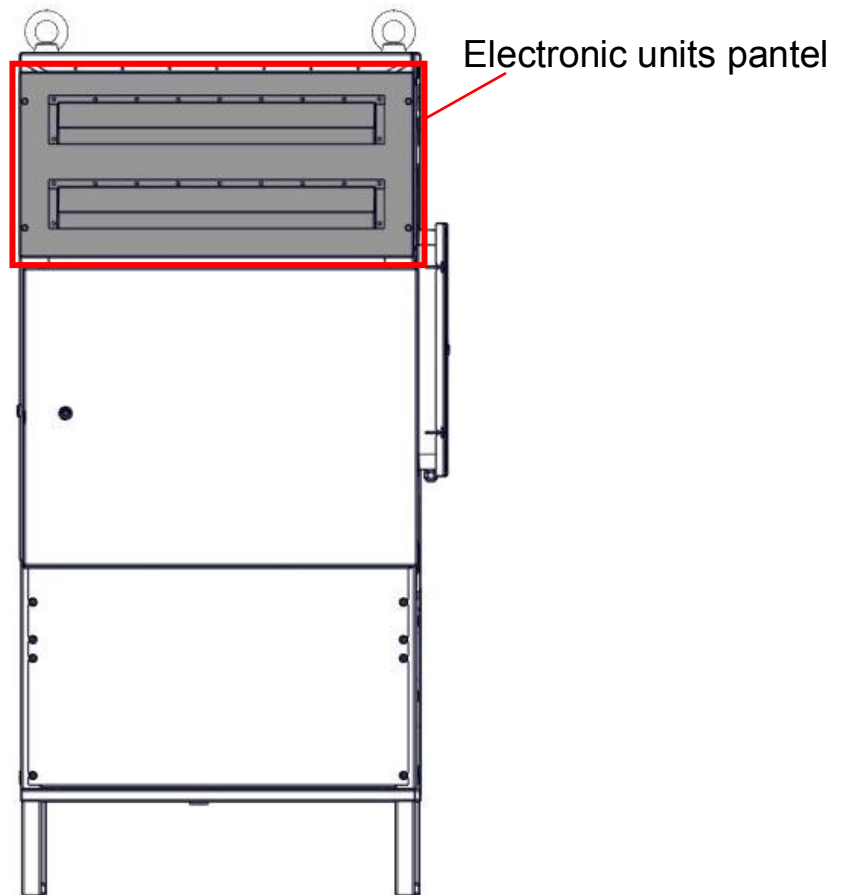


Figure 35 – Fan compartment

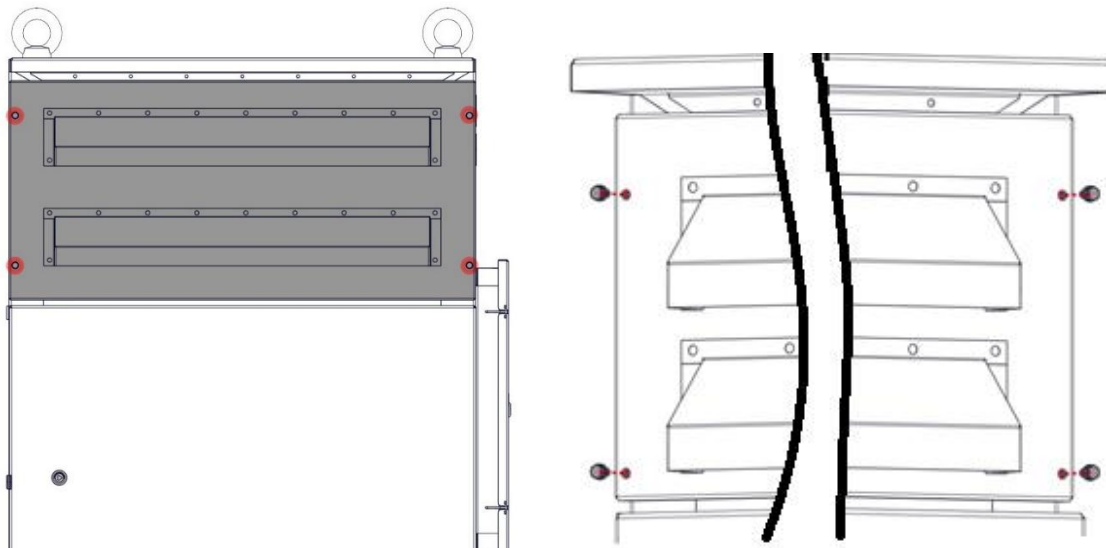


Figure 36 – Remove cover of fan compartment

2. Unscrew fan fixed nuts, as show in the figure 38.

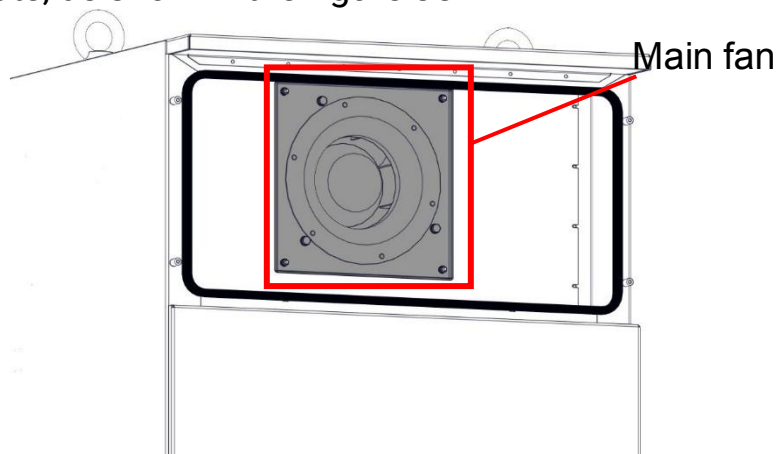


Figure 37 – Main fan.

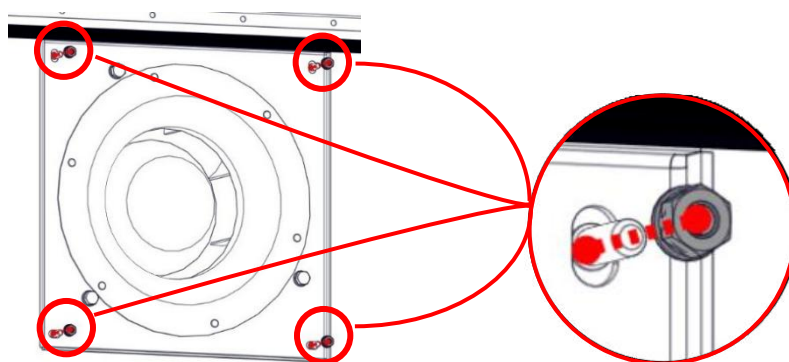


Figure 38 – Unscrew fan fixed nuts.

3. Uninstall main fan, as shown on the figure 39.

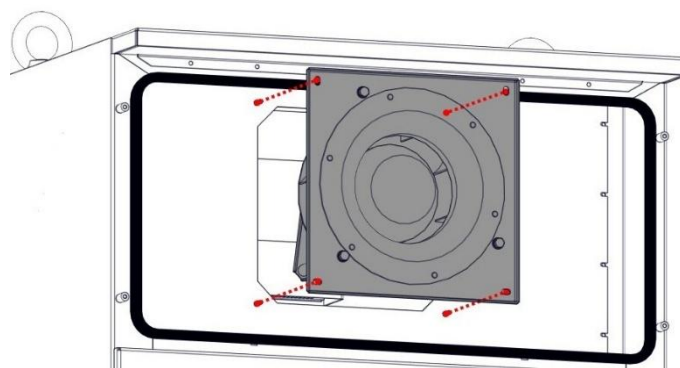


Figure 39 – Uninstall main fan.

### Step 3. Installation new main fan

Installation of a new main fan must be done in reversal sequence. Bolts and nuts must be tightened with a torque  $M8 - 30 \pm 1,5 \text{ N}\cdot\text{m}$ .

**All signal connectors must be installed to their positions and tightened with their original screws.**



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