IRZ 500

VARIABLE SPEED DRIVE

«QUICK START»

INSTALLATION MANUAL

2019

Contents

1 GENERAL PROVISIONS FOR WORK WITH THE PRODUCT

1.1 Safety measures

1.1.1 All dismounting, installation, start and adjustment works shall be performed according to the applicable “Safety Standards for Users of Electrical Installations” and “Maintenance Rules for Users of Electrical Installations” and applicable departmental regulations.

1.1.2 Grounding and safety measures shall be performed according to requirements of applicable “Rules for Electrical Equipment Installation”.

1.1.3 When installed in the place, the drive shall be grounded by a steel grounding conductor with cross section not less than 75 mm^2. The grounding conductor shall be connected to the drive’s terminal for external protective conductor; the connection shall be a bolted or welded joint. The joint shall be protected against corrosion.

ATTENTION! WHEN INSTALLING THE DRIVE, CHECK THAT THE 480V, 50 Hz 3-PHASE SUPPLY LINE AND LOAD LINE ARE CORRECTLY CONNECTED TO THE DRIVE INPUT AND OUTPUT TERMINALS.

1.1.4 Before starting the drive, check and if necessary tighten the fastening of components, conductors and contact connections of the main circuit.

ATTENTION! WHEN THE Q1 SWITCH IS IN OFF STATE, VOLTAGE REMAINS ACROSS THE XT1, XT2, AND XT3 TERMINALS, AS WELL AS ACROSS TERMINALS OF THE Q1, SF1, AND SF2 SWITCHES, RU1…RU3 OUTPUTS AND ELECTRICAL ENERGY METER (WHEN INCLUDED)

1.1.4 Before to perform any works inside the drive:

- shut down power, and disconnect and ground the external leading-in cables.
- put up warning posters

1.2 Installation of VSD

1.2.1 The environment shall be inexplosive, free from current-conducting dust and have type II atmosphere as per GOST 15150.

1.2.2 The unit shall be positioned vertically; the slant from the vertical shall not exceed 5 degrees.

1.2.3 It is not allowed to install the drive under an overhead power transmission line.

1.2.4 The drive must not be operated without proper grounding.

1.2.5 The drive shall be installed on a foundation or pedestal that prevents from flooding or snowdrift. The drive shall be fixed to the foundation or pedestal with bolts using holes in the mounting frame.

1.2.6 Before the start of operation, be sure to familiarize yourself with the operating manual for the IRZ-500 drive.

1.3 Technical characteristics

1.3.1 Characteristics of the various versions of the drive are given in table 1.1.

Table 1.1

Name	Main circuit rated current, A	Total output power (at rated input voltage of 480 V and frequency of 50/60 Hz), kV·A	Recommended rated power of the connected motor (at rated input voltage of 480 V and frequency of 50/60 Hz), kW	Motor type
IRZ-510-xx-100	100	80	35	Induction
IRZ-510-xx-160	160	120	60	
IRZ-511-xx-250	250	190	90	
IRZ-512-xx-400	400	300	150	
IRZ-513-xx-630	630	480	210	
IRZ-514-xx-800	800	600	270	
IRZ-515-xx-1000	1000	800	360	
IRZ-516-xx-1200	1200	900	480	
IRZ-517-xx-1400	1400	1100	540	
IRZ -518-xx-1600	1600	1200	600	
IRZ -540-xx-100	100	80	35	Induction or permanent magnet
IRZ -540-xx-160	160	120	60	
IRZ -541-xx-250	250	190	90	
IRZ -542-xx-400	400	300	150	
IRZ -543-xx-630	630	480	210	
IRZ -544-xx-800	800	600	270	
IRZ -545-xx-1000	1000	800	360	
IRZ -551-xx-160	160	120	60	Permanent magnet
IRZ -551-xx-250	250	190	90	
IRZ -552-xx-400	400	300	150	
IRZ -553-xx-630	630	480	210	
IRZ -554-xx-800	800	600	270	
IRZ -555-xx-1000	1000	800	360	

1.4 Description of VSD design

1.4.1 The drive constitutes a metallic cabinet that can be accessed on two sides.
Functionally the drive consists of a power section and control system.
1.4.2 The connection of the drive to the power supply network and to the load is made inside the main circuit I/O compartments located on the rear side of the cabinet.
1.4.3 On the rear side of the cabinet, there are also compartments for connection to a telemechanics system and to the step-up transformer Y-point, and a compartment of the frequency inverter.
1.4.4 The operator's panel is located inside a separate lockable compartment on the front side of the cabinet.

1.4.5 Design and operation of the control system

1.4.5.1 The control system consists of control units and IRZ-500 drive controller (hereinafter referred to as "controller").
1.4.5.2 The operator's panel includes the following controls and indicators:
- Incoming power circuit breaker;
- controller with a USB connector for connection of USB-flash devices;
- three-position switch of operation modes (see table 1.2);
- "~220 V, 50 Hz" receptacle for geophysical instruments;
- circuit breakers: Light, Receptacle, Controller, Heating, Venting, DHS (see figure 1.1);
- electrical energy meter (optional)

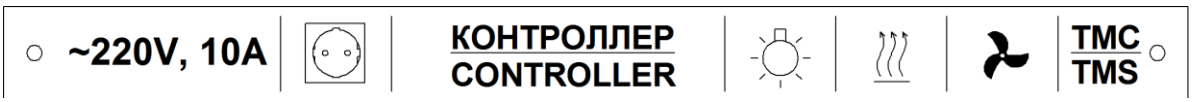
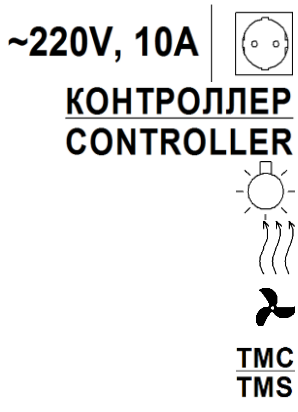


Figure 1.1 – Plate of automatic circuit breakers on the operator's panel

Table 1.2

Position of operation mode switch	VSD operation mode	Motor start/ shut-down via START/STOP buttons	Motor remote start via RS485 interface	Motor auto-restart
AUTO	Automatic control mode	+	+	+ *
MANUAL	Manual control mode	+	+ **	-
NO	Motor start blocking mode	-	-	-
* - when there is no auto-restart blocking ** - when the relevant setting in the "Additional settings" menu is selected				

1.4.5.3 The plate (fig. 1.1) on the operator's panel of the IRZ-500 drive is for understanding the purpose of the automatic circuit breakers:



"220V, 10A" receptacle

To switch on the drive controller

To switch on the drive lighting circuit

To switch on the heating circuit

To switch on the fan circuit

To switch on the downhole sensor system power circuit

1.5 VSD operation at environment temperature variations

1.5.1 A temperature control system is used to ensure operability of the drive within the given operating temperatures range. This system ensures operating temperature inside the drive cabinet. Depending on the heatsink temperature, the drive can be in several states in accordance with table 1.3.

Table 1.3

Drive temperature	Drive condition
below minus 20 °C	Heating of the drive and controller is turned on, the inverter and controller are deactivated. Start is impossible.
from minus 20 °C to minus 5 °C	Heating of the drive and controller is turned on. The controller and inverter are activated. Start is possible.
from minus 5 °C to 45 °C	Heating and ventilation of the drive are turned off.
above 45 °C	Instrument compartment ventilation is turned on.
above 50 °C	Turning on the ventilation of the inverter compartment and sine filter compartment
above 80 °C	Drive shutdown due to inverter overheating
above 150 °C (in sine filter compartment)	Drive shutdown due to sine filter overheating

2. INTENDED USE

2.1 Operations with the drive controller

Description of the main menu is given in Table 2.1.

Table 2.1

Menu item	Menu description
MAIN REAL-TIME PARAMETERS	Real-time condition of the drive, inverter and DHS
INPUT VOLTAGE PARAMETERS	View and edit of input voltage settings
MOTOR CONTROL POINTS AND PROTECTION FUNCTIONS	View and edit of drive protection main settings and parameters
DHS CONTROL POINTS AND PROTECTION FUNCTIONS	View and edit of DHS settings and motor protections
INVERTER SETTINGS	View and edit of inverter operation settings (frequency, acceleration and deceleration rates, motor start mode)
TECHNOLOGICAL SETTINGS	Settings for automatic intermittent mode of motor operation, as well as the characteristics of additional modes of drive operation
SETTINGS OF ADDITIONAL ANALOG INPUTS	Settings to measure the input signal from each of the two analog inputs
SETTINGS OF ADDITIONAL DIGITAL INPUTS	Settings for operation with additional digital inputs of the drive
NOTEBOOK	Characteristics of the field, pad, and well. Technical parameters of the motor, ESP, step-up transformer, drive and controller. Statistics of operation, number of motor starts and shutdowns
POWER ENERGY	Indications of active, reactive and total electrical energy consumed by the motor and drive
ADDITIONAL SETTINGS	Adjusting parameters of information exchange of the drive in the network and parameters of record in the history of operation. Clearing the event archive of the drive Parameters for calculating step-up transformer secondary voltage
PASSWORD SETTING	View and change of security profiles, passwords change
DATE AND TIME	Setting the current date and time
EVENT ARCHIVE	History of motor operation
DIAGNOSTICS	Condition of various modules
SERVICE MENU	Setup and reprogramming of individual drive modules

2.1.2 "▲" and "▼" buttons are used to navigate between menu items and drive parameters, and to adjust control points values ("▲" – increase, "▼" - decrease).
2.1.3 "ENTER" button is intended to select certain menu item and to approve correctness of the value entered.
2.1.4 “ESC” button is intended to exit current menu item and cancel new control point value
2.1.5 It is also possible to access the PASSWORD SETTING menu from any section of the drive menu by pressing the F3 button.
2.1.6 It is possible to view real-time parameters of the drive from any menu section by pressing F2.
2.1.7 F1 button is used to return to the previous menu item from the real-time parameters window.
2.1.8 As indicated in Table 2.2, the controller of the drive can be operated and configured on four access levels.
2.1.9 The real-time parameters page displays the real-time status of the drive, inverter, and downhole unit (DHS). Designations of possible states and their descriptions are given in Tables 2.3 - 2.6.

Table 2.2 – List of security profiles with allowed actions

Allowed actions	Access level			
	OPERATOR	ELECTRICIAN	WORKS FOREMAN	ADMINISTRATOR
Profile access password	No password	159	410	*
Control points (settings) review**	+	+	+	+
Control points change**	-	+	+	+
SERVICE MENU contents review	-	-	+	+
Full access to SERVICE MENU	-	-	-	+
Reset of history and statistics counters	-	-	+	+
Change of password for the ELECTRICIAN profile	-	+	+	+
Change of password for the WORKS FOREMAN profile	-	-	+	+
Change of password for the ASMINISTRATOR profile	-	-	-	+

***** - only servicing specialists have password to the profile access

****** - except for the SERVICE MENU section

Table 2.3 – Real-time parameters of the downhole sensor system

Message on the drive's display	Description	Message on the drive's display	Description
DHS status	Codes of downhole sensor actual status	No. of instrument counted from the wellhead, 1-6	No. of the instrument
ESP intake pressure	ESP intake pressure	Ser. No.	Serial number
Motor oil temperature	Motor oil temperature	Type	Instrument type
Motor winding temperature	Motor winding temperature	Pin	Intake pressure
ESP intake temperature	Fluid temperature at the ESP intake	Tin	Intake temperature
Vibration - X/Y/Z	Vibration along X/Y/Z axis	Flowrate1	Flow rate
Frame	Counter of downhole sensor system responses	Flowrate2	Flow rate
Frame type	Frame type	Humidity	Humidity value

Table 2.4 – Drive and frequency inverter actual status codes

Message on the drive's display	Status description
RUNNING	The motor has been started and is now operating; the rotor catch mode may be active
PUSH	The motor is running, the PUSH mode is active
ROCKING	The motor is running, the ROCKING mode is active
SYNCHRONIZATION	The motor is running, the frequency synchronization mode is active
PID	The motor is running, the PID-regulation mode is active
JOGGLE	The motor is running, the JOGGLE deposits removal mode is active
F SMOOTH CHANGE	The motor is running, the mode of frequency change by software is active
Un SEARCH	The motor is running, the voltage optimization mode is active
I LIMIT	The motor is running, the current limiting mode is active
T LIMIT	The motor is running, the temperature limiting mode is active
STOP	The motor has been stopped
WAIT	The motor has been stopped and time is being counted till the start (at operation with the timer in automatic mode or when time till automatic restart after tripping is counted) or time is counted to the start after power supply
START IS BLOCKED	The motor has been stopped, start is blocked either according to a setting or after a remote stop command
MANY AUTORESTARTS BLOCKING	The motor has been stopped, start is blocked due to achieving the limit number of automatic restarts

Table 2.5 – List of messages on causes of drive starts and stops

Status designation	Event type
STOP	The motor has been stopped
Rinsul STOP	The motor has been stopped due to decrease of insulation resistance below the control point or failure of the Rinsul control circuit
Uab<NORM	The motor has been stopped due to decrease of Uab below the normal value set by the control point
Ubc<NORM	The motor has been stopped due to decrease of Ubc below the normal value set by the control point
Uca< NORM	The motor has been stopped due to decrease of Uca below the normal value set by the control point
Uab>NORM	The motor has been stopped due to increase of Uab above the normal value set by the control point
Ubc> NORM	The motor has been stopped due to increase of Ubc above the normal value set by the control point
Uca> NORM	The motor has been stopped due to increase of Uca above the normal value set by the control point

Status designation	Event type
Uab-Ubc IMBALANCE	The motor has been stopped due to imbalance of Uab-Ubc voltage
Uab-Uca IMBALANCE	The motor has been stopped due to imbalance of Uab-Uca voltage
Ubc-Uca IMBALANCE	The motor has been stopped due to imbalance of Ubc-Uca voltage
UNDERLOAD	The motor has been stopped due to low current load
OVERLOAD	The motor has been stopped due to high current
Ia-Ib IMBALANCE	The motor has been stopped due to imbalance of Ia-Ib current
Ia-Ic IMBALANCE	The motor has been stopped due to imbalance of Ia-Ic current
Ib-Ic IMBALANCE	The motor has been stopped due to imbalance of Ib-Ic current
LOAD FACTOR	The motor has been stopped due to decrease of motor load factor below the control point value
BACKSPIN	The motor has been stopped due to backspin of motor rotor at a frequency above the control point value
DOOR IS OPEN	The motor has been stopped because the cabinet door was open (I/O compartments, telemechanics compartment or transformer Y-point compartment)
PHASE SEQUENCE	The motor has been stopped due to wrong phase sequence on the input terminals of the drive
FLOW LINE PRESSURE TRANSDUCER	The motor has been stopped due to actuation of the high/low pressure flow line transducer
STOP BUTTON	Manual stop of the motor by pressing the STOP button
START BUTTON	Manual start of the motor by pressing the START button
REMOTE STOP	Remote stop of the motor (by a command of the SCADA-system)
REMOTE START	Remote start of the motor (by a command of the SCADA-system)
OFF	Manual stop of the motor by putting the mode switch into the OFF position
NO START CONFIRMATION	Confirmation of motor start is missing
NO STOP CONFIRMATION	Confirmation of motor stop is missing
START IS BLOCKED	Motor start was blocked when the predetermined number of restarts was reached or when the predetermined number of manual starts was reached
AUTOSTART	The motor has been automatically started by a time program
AUTOSTOP	The motor has been automatically stopped by a time program
AUTORESTART	Automatic restart of the motor after tripping
MOTOR WINDING TEMPEERATURE	Motor winding temperature is higher than allowed
MOTOR OIL TEMPERATURE	Motor oil temperature is higher than allowed
MOTOR X VIBRATION	X-vibration in the place of motor installation is higher than allowed
MOTOR Y VIBRATION	Y-vibration in the place of motor installation is higher than allowed
INTAKE PRESSURE	ESP intake pressure is lower than allowed
MOTOR OIL PRESSURE	Motor oil pressure is lower than allowed

Status designation	Event type
MISSING COMMUNICATION WITH INVERTER	Motor cannot start because communication with the inverter processor board via RS485 is missing
INVERTER POWER LOSS	Motor cannot start due to loss of supply voltage in the inverter processor board
INVERTER HEATING	Motor start is blocked while the drive is heating
CATCH PROBLEM	Motor cannot start in the catch mode
AN.INPUT1>NORM	Signal at the analog input 1 is higher than the tolerance set by the control point
AN.INPUT1<NORM	Signal at the analog input 1 is lower than the tolerance set by the control point
AN.INPUT2>NORM	Signal at the analog input 2 is higher than the tolerance set by the control point
AN.INPUT2<NORM	Signal at the analog input 2 is lower than the tolerance set by the control point
NO ACCESS	The actual access level does not allow viewing / editing the selected parameter / control point
HIGH INVERTER RADIATOR TEMPERATURE	Inverter radiator temperature exceeds the allowed value
SC TO GROUND	Sum of motor currents is not zero
HIGH Udc	Inverter DC circuit voltage exceeds the allowed value
LOW Udc	Inverter DC circuit voltage is lower than the allowed value
Udc CIRCUIT FAILURE	Inverter DC circuit fault
UNSTABLE Udc	Inverter DC circuit voltage fluctuations are higher than allowed
INVERTER OUTPUT SC	Short circuit at the Inverter output or failure of the Inverter power module
INVERTER OVERLOAD	Inverter output current exceeds the allowed value
INVERTER UNDERLOAD	Inverter load is much less than the nominal load (not related to underload control points)
MISSING TEMPERATURE SENSOR	Fault of the inverter's internal temperature sensor
TEMPERATURE SENSOR SC	Short circuit at the inverter's temperature sensor output
LOW INVERTER RADIATOR TEMPERATURE	Inverter's radiator temperature is lower than the allowed value (-10°C)
INVERTER CURRENTS IMBALANCE	Asymmetrical load of the inverter
INVERTER EXTERNAL ALARM	A signal of inverter external alarm is present
HIGH INVERTER TORQUE	The motor has been stopped due to too high load
INVERTER RS485 TIMEOUT	Time till inverter response to a RS485 signal has elapsed
Fout>Fmax	Inverter output frequency exceeds the maximum value set by the control point

Table 2.6 – Downhole sensor system actual state codes

Message on the drive's display	State description
NORM	All signals coming from DHS are normally received by the drive
MISSING COMMUNICATION WITH I/F UNIT	Communication with the downhole sensor surface unit is missing
MISSING COMMUNICATION WITH DH SENSOR	Communication between the downhole sensor and surface unit of the downhole sensor system is missing

3 PROCEDURE OF DRIVE OPERATION

3.1 Preparation of the drive

3.1.1 After installation, mounting (clause 1.2.5) and drive grounding (cl. 1.1.3), perform connection of the drive according to the scheme in Annex B.

3.1.2 If it is necessary to install or replace a DHS surface readout unit inside the drive, the installation should be performed according to the procedure specified in the VSD Operation manual.

3.1.3 At the first start of the drive, it is recommended to set the factory settings. Then enter or correct the required list of settings in accordance with Table 3.1.

Table 3.1

Group of settings	Control point name	Recommendations
"MOTOR CONTROL POINTS AND PROTECTION FUNCTIONS"	Motor nominal current	As in the motor tech. certificate (datasheet)
	Motor nominal power factor	As in the motor tech. certificate (datasheet)
	Step-up transformer secondary voltage	Equal to the transformer secondary winding voltage
	Step-up transformer primary voltage	As in step-up transformer technical certificate (datasheet)
	Insulation resistance setting	30 – 50 kOhm
	Backspin rotation protection	On
	Motor underload setting	After reaching the set frequency, wait for 10-15 mins and set the value equal to 0.8 from the current loading value.
"NOTEBOOK"	Field ID number Pad ID number Well ID number Motor nominal power Motor nominal supply voltage ESP capacity ESP head Running depth Formation fluid density Step-up transformer nominal power	Acc. to equipment data
"INPUT VOLTAGE PARAMETERS"	Nominal voltage	460 V

Group of settings	Control point name	Recommendations
“INVERTER SETTINGS”	Nominal frequency of motor	Max operating frequency of ESP unit. The value should correspond to the frequency for which the Step-up transformer secondary voltage is calculated.
	Nominal voltage of inverter	460 V
	Set frequency	Required motor frequency in Hz
	Motor type	Asynchronous, permanent magnet (synch., 6 pulse)
	Number of pole pairs of PMM	Only for PMM
“DHS CONTROL POINTS AND PROTECTION FUNCTIONS”	DHS Model	Acc. to the DHS used

3.1.4 Check operation capability of surface equipment in idle mode (check the real-time parameters and protections).
3.1.5 Perform a test run of the drive in the manual control mode and monitor on the controller display that frequency is increased to 5 Hz.
3.1.6 While monitoring the value of motor current on the drive's display, increase the frequency with the step of 5 Hz.
3.1.7 If at a frequency of 10 Hz the overload protection or protection at inverter output short circuit activates, perform the following actions:
- check that the step-up transformer and motor are connected properly;
- if the connection is correct, disconnect the cables in the drive output compartment and press the START button, set the output frequency to 50 Hz;
- if the overload protection or protection at inverter output short circuit is not activated with the disconnected cable in the drive output compartment, then the step-up transformer, Motor or Cable may be damaged;
- if the step-up transformer, cable and motor are in good condition, contact the manufacturer's service department.
3.1.8 If the overload protection or protection at inverter output short circuit activates at 15-35 Hz frequency, then the ESP is probably jammed. It is necessary to enable push or rocking start mode and repeat the start attempt. Recommended setting values are given in table 3.2.
3.1.9 If the attempt to start the jammed ESP makes no effect, it is necessary to flush the well.
3.1.10 After reaching the required frequency and after 20-30 minutes of operation at a constant frequency, it is recommended to perform automatic voltage optimization with respect to current. To do so, set the control point "AUTO.OPTIMIZATION Un" to "ON".
3.1.11 When selecting the PSI pressure units of measurement, select "PSI" in the "Pressure measurement" item of the "DHS control points and protections" / "DHS settings" menu, and set "0,1" in the "multiplier" item.

Table 3.2 – Drive settings at jammed ESP

Push start mode		**Rocking start mode**	
"Motor start mode"	PUSH	"Motor start mode"	ROCKING
"Push frequency"	12 - 18 Hz	"Rocking frequency"	7 – 15 Hz
"Number of pushes"	3 - 5	"Rocking torque boost"	10 – 20 %
"Push voltage"	150 %	"Rocking duration"	3 – 5 s
"Push duration"	1 – 2 s	"Rocking acceleration rate"	25 Hz/s
		"Rocking deceleration rate"	25 Hz/s
		"Number of cycles"	3 - 5

3.2 Emergency actions

The procedure of work at emergency ESP stops and abnormal modes of operation is as follows:
3.2.1 In case of a tripping caused by the insulation resistance protection function:

Check the insulation resistance control protection function for normal operation.
If a downhole sensor system surface unit is not used, the DHS TYPE control point shall have the “NO” value; in the TRANSFORMER Y compartment of the drive, the XS12 connector shall be connected to VR210.
If a downhole sensor system surface unit is used (no matter if the downhole sensor itself is used or not), make sure that the downhole sensor system surface unit is not damaged and the settings of communication with the downhole sensor system are correct; in the TRANSFORMER Y compartment, the XS12 connector shall be disconnected from the VR210 unit.
Disconnect the ends of the cable of the downhole ESP unit from step-up transformer output terminals, measure the insulation resistance with a megohmmeter and make sure that motor windings have the same insulation value, visually check condition of the cable coming from step-up transformer terminals to the well mouth (for reflow or mechanical damage).

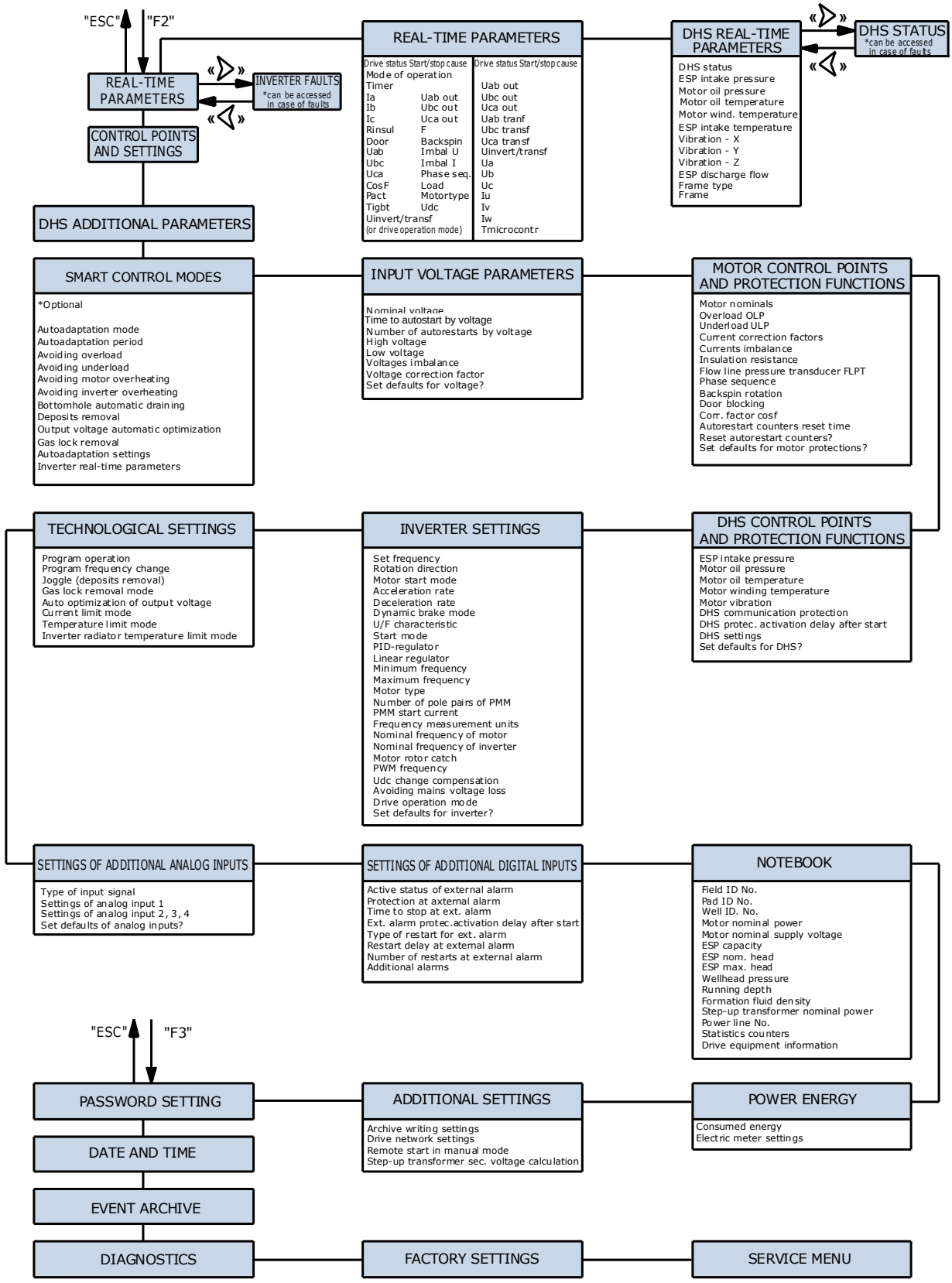
3.2.2 In case of tripping caused by frequency inverter or sine filter overheating protection function:

Check the status of the SF4 “VENTILLATION” circuit breaker – it shall be in “On” position.
Check the status of venting holes and filters, clean when necessary.
Reduce PWM frequency, but it should not be lower than 4 kHz.

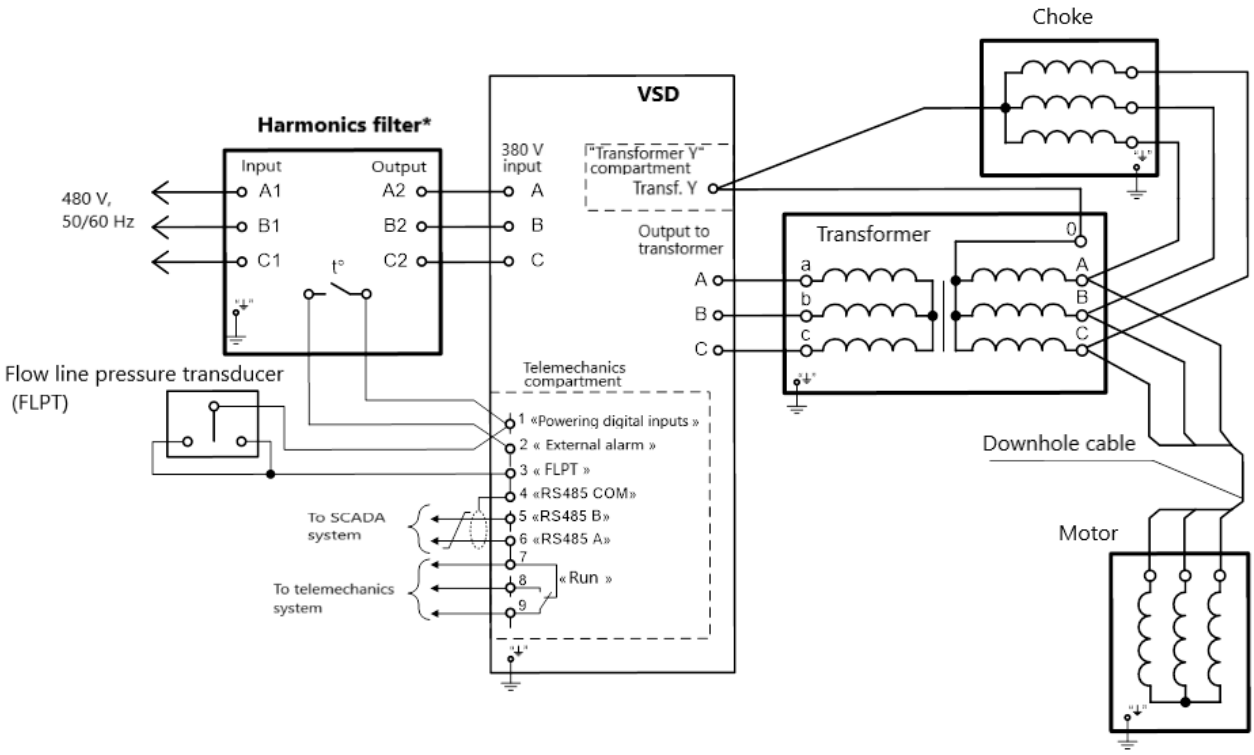
3.2.3 In case of tripping caused by the overload protection (OLP) function:

Check the drive OLP function for correct operation.
Check supply voltage in the phases at the low and high sides of the step-up transformer.
Using a 1000 V megohmmeter: check insulation resistance in the “TRANSFORMER - MOTOR” system and make sure that motor windings have the same insulation value. If insulation resistance is not less than 0.5 MΩ, start the ESP unit. Measure currents in the phases using a clamp meter at the high and low sides of the step-up transformer. Phases distortion in terms of voltage and current shall not exceed 5%.
Check the ESP system for normal operation. The delivery parameters and dynamic level may change and water cut may increase.
If load current exceeds its nominal value, stop the ESP system. Increase or decrease step-up transformer voltage (by switching tapping in one or two steps).
After load current decreases till its nominal value, set optimized value of step-up transformer voltage, adjust OLP, ULP and load level.
If load current fails to decrease till its nominal value, start the unit in the “push” or “rocking” mode.
If the ESP unit fails to start, perform additional maintenance operations (rinsing and others) or pull out the ESP system.
If it is decided to pull out the ESP system, shut down the unit, disconnect the cable from terminal contacts of the step-up transformer.

ANNEX A - IRZ-500 MENU STRUCTURE



ANNEX B - RECOMMENDED IRZ-500 DRIVE CONNECTION DIAGRAM



* Optional

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