ACE

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Variable Speed Drive For Electrical Submersible Pump

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VSD for Electrical Submersible Pump

VARIABLE SPEED DRIVE FOR ELECTRICAL SUBMERSIBLE PUMP

The Drive ALVD-SWD variable speed drives (VSD's) includes many standard features to protect and control ESP's for variable-speed applications.

The Drive ALVD-SWD series VSD's can be configured with an integral output sine wave filter (SWD), typically used with ESP's. The sine wave filter is low pass frequency filter, which convert the rectangular PWM output signal of motor drives into a smooth sine wave voltage with low residual ripple. Sine wave filter is mainly used in combination with VSD to protect the motor against excessive voltage spikes and overheating. The filter also decreases acoustic switching noise levels and enable longer power cable layouts. Consequently, insulations stress and losses in AC motors are reduced, and therefore prolonging the motor lifetime. (OPTIONAL)

The Drive ALVD-SWD series VSD's can come in 6,12 pulse configurations. The 12 pulse configuration will require the use of an external phase shifting transformer. Compared to the multi-pulse configuration solution with shifting transformer, the filtered 6 pulse solution (5% passive harmonic filter matched with 6 pulse VSD) is more economical, saves more installation space and cost. This solution increases the reliability and service life of electric installation, help utilize electric system capacity better. Passive Harmonic Filter reshapes distorted current back to the desired sinusoidal waveform.

The use of a VSD allows a pumping system to perform across a wider operating range than is possible using a Fixed-Speed Drive (FSD) because of the VSD's ability to vary the speed of the motor. Optimum producing conditions can be preset and maintained by automatically adjusting the speed to preset drawdown pressure or load. Making this adjustment decreases the need to resize a pump as operating conditions change. It thus reduces downtime and operating cost.

IP30 indoor type VSD

APPLICATIONS

- ESP operations
- Surface pumping with long power cable

BENEFITS

- Prolongs electrical system life
- Reduces operating and installation costs
- Minimized downtime

FEATURES

- Fuji Electric mature variable speed drive technology
- Designed lifetime of main components is 10 years
- Speed control to maintain constant load or pressure
- Soft start function
- Ability to start an ESP while motor is spinning
- Hard start (torque promote), Rocking start, Shaking mode, used to start wells with stuck pumps
- Backspin observer function
- Slow acceleration function
- Sleep and wakeup function, optimize energy use
- Surge Protective Device for protection against lightning strikes and voltage surges
- Load-side, phase-to-phase, short-circuit protection
- Output sine wave filter (SWD)
- 12 pulse VSD solution and filtered 6 pulse solution
- Friendly operating interface and 10 language selected
- Remote monitor and control

ENHANCED OPERATION AND PROTECTION

Standard features enhance downhole and surface operations. The hard start function gives motor a voltage boost at low speed for a set amount of time sufficient to develop starting torque. The rocking start function makes motors run forward and reverse for the defined number of cycles as the programmable sequence to remove the solids stuck to impeller blades. The shaking mode makes motors run in two defined speed reference for the defined number of cycles as the programmable sequence to remove the solids stuck to impeller blades. The current-pressure mode allows pumps to be set to a target load or pressure and their speed to be adjusted as operating conditions change. This flexibility in speed helps stabilize operations in gassy and viscous environments, and it maximizes uptime.

The Drive ALVD-SWD series VSDs use the View Controller as the single user interface for all wellsite control and data acquisition requirements. The Controller's expandable functionality optimizes data gathering, remote monitoring, and controls related to downhole and surface pumping operations.

The customizable controller provides:

- Main interface to display the data of the surface and downhole units e.g., VSD's and motors Ampere, Voltage, Power and the 3 phase input data.
- Normal setting interface is used to set the motor parameters, Step-Up Transformer ratio (defined as the secondary side voltage of SUT divided by the primary side voltage) etc.
- There are 9 general protections and 8 protections related to the downhole sensor parameters in the protect setting area.
- A single point for all wellsite data gathering, including data from the different brands downhole monitoring system e.g., Phoenix and Zenith.
- Setting the different starting modes when the pump stuck.

Enclosure solution:

The Drive ALVD-SWD series VSDs are provided in IP23 (large HP VSD, indoor type), IP30 (indoor type) and IP55 (outdoor type) enclosures solution. The cooling method of the VSD is air-forced cooling.

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STANDARD CONFIGURATION

- Electric modular frequency converter unit including diode rectifier and inverter
- Main breaker with fuses
- Input reactor
- Output sine wave filter matched with frequency converter module (SWD)
- Surge Protective Device (SPD)
- Temperature and humidity controller
- Cabinet heater
- Emergency stop
- View Controller including programmable logic control unit and touched screen panel which is embed on the front door of VSD
- Indicator lights. Red-Stop, Green-Run, Yellow-Standby, White-Backspin
- Enclosure cooling fans
- Control transformer supplies 220V and 110V power
- 24V power module
- 2×RS485 bus and 1×Ethernet communication
- Intelligent power meter for measure input power supply data

OPTIONS

- Input passive harmonic filter
- Input active filter
- 12 pulse solution
- Electronic chart recorder
- Junction box for power cable inlet and outlet

MAIN CONTROL FUNCTIONS

- Local control and remote control
- Power interrupt ride through
- Spinning-load capacity
- Auto-restart capacity
- Start-up ramp and slow acceleration function
- Backspin observer
- Restart delay function
- Hard start, rocking start and Shaking mode
- Sleep and wake-up function

MAIN PROTECTION FUNCTIONS

- Load (overload and underload) protection
- Short circuit protection
- Over current and under current protection
- DC bus over voltage and under voltage protection
- 3 phase unbalance protection
- Loss phase protection
- Heatsink and enclosure overtemperature protection
- Frequency converter module overtemperature protection
- Downhole sensor protection

The Drive ALVD-SWD series VSD's provide state-of-the-art motor control, incorporating advanced digital pulse-width modulation (PWM) flux-vector control that ensures constant speed and torque. VSD's also provide higher torque per amp, which results in minimal motor heating and reduced torque pulsation, both of which can prolong the life of the electrical system. Electrical stresses during startup are detrimental to the electrical system, but the capability of reducing the in-rush current to as low as 1.5 times the operating current helps prolong insulation life for all electrical components downstream of the VSD, including connectors, splices, cables, and motor insulation.

INPUT HARMONIC REDUCTION

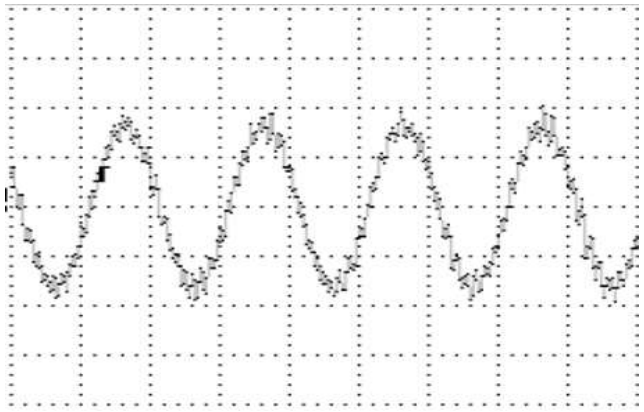
The 12 pulse VSD matched phase shifting transformer is a solution for input harmonic reduction. Compare to 12 pulse solution with external phase shifting transformer, the filtered 6-pulse solution is more economical and saves more installation space. The input filters include Passive Harmonic Filter and Active Filter. 5% input passive harmonic filter represent an economical solution to the challenge of load-applied harmonics mitigation in three-phase power system. With a plug-and-play approach and more compact dimensions than comparable products, they can be quickly installed and easily commissioned. They increase the reliability and service life of electric installations, help utilize electric system capacity better. The input passive harmonic filter reshapes the distorted current back to the desired sinusoidal waveform.

The active filters are connected in parallel to the load and do steadily monitor all 3-phase line currents. Harmonic currents and reactive power components are reliably detected and processed in an ultra-fast digital control structure. By generating and actively imposing currents in the opposite phase shift, unwanted harmonic and reactive currents are reliably mitigated. By using the latest generation of 3-level IGBT technology ultra-fast (real time) feeling is possible.

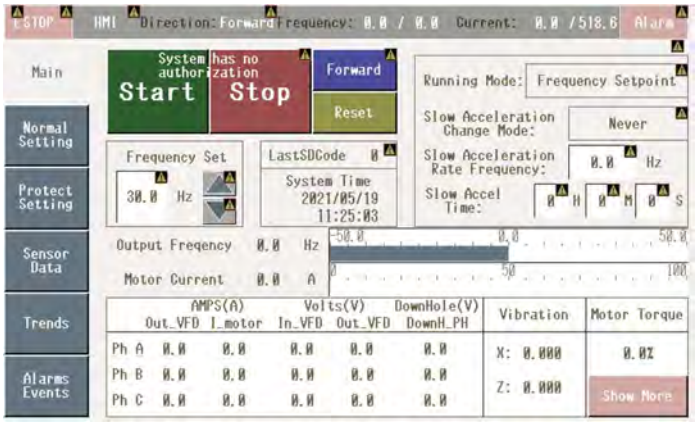
OUTPUT HARMONIC REDUCTION

Output sine wave filter is standard configuration and integrated in the same enclosure with the frequency converter module for output low harmonic. The total harmonic current distortion of Drive ALVD-SWD series VSD is less than 5%

Sine wave drive output voltage



FUNCTIONS AND INTERFACE DESCRIPTIONS

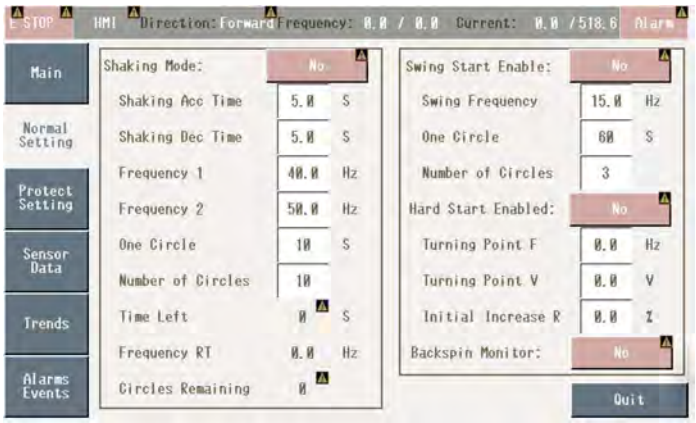


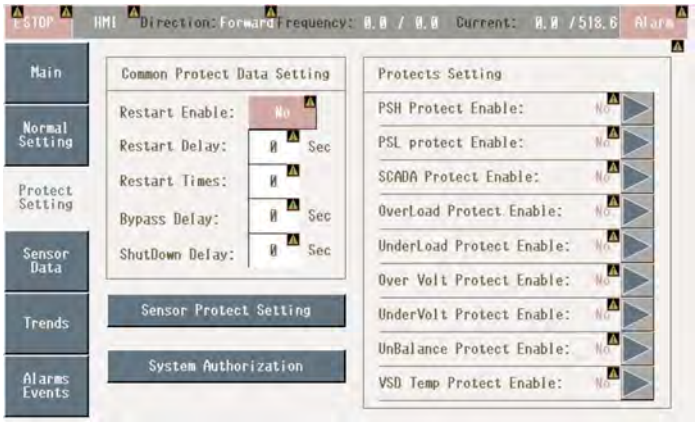
Main interface

- Information bar shows the equipment state e.g., RUN/STOP, motor direction, VSD output current value, motor current value, motor set frequency value and real frequency value.
- Start/Stop, Reverse/Reset the VSD, VSD speed (frequency) can be set and the last shut down code and system time can be displayed.
- Slow Acceleration Mode setting
- Display running parameters including output current of VSD, motor current, input voltage of VSD, output voltage of VSD, downhole phase-to-phase voltage, output torque of motor (shown as percentage), parameters of downhole sensor etc.

Normal setting interface

- Setting the motor parameters, but instead of directly input the motor nameplate data, the data converted from the medium voltage motor parameters to the low voltage will be filled.
- Setting the VSD parameters including acceleration time, deceleration time, start speed, maximum speed and current limitation.
- Setting the Step-Up Transformer ratio (defined as the secondary side voltage of the transformer divided by the primary side voltage) and display the converted downhole rated voltage.
- Setting Shaking Mode, Rocking Start, Hard Start parameters
- Enable backspin monitor function or not





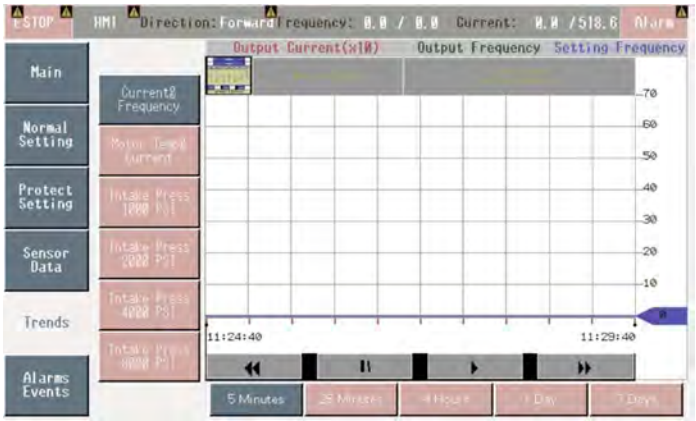
Protect setting interface

- There are 5 common protect data setting on the left area.
- The right area is used to define 9 protection parameters and display whether the protection is enabled or not.
- If the users want to set 8 protections related to downhole sensor parameters, click the “Sensor Protect Setting”.
- In order to protect intellectual property rights and prevent unauthorized replication, the control system needs to be authorized before it can be used normally. The system can’t work without authorization.

FUNCTIONS AND INTERFACE DESCRIPTIONS

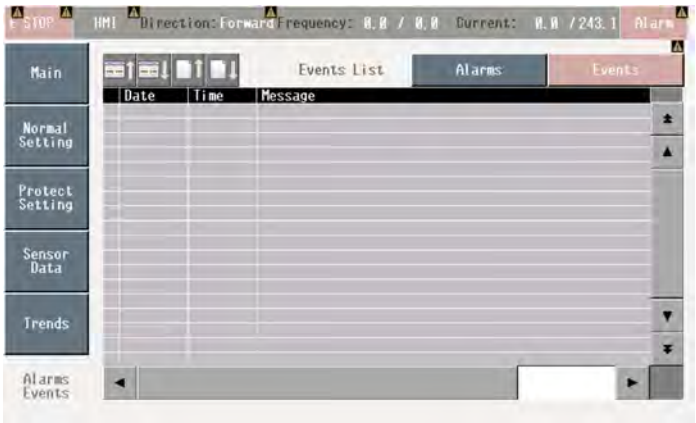
Sensor data interface

- Choose sensor type e.g., zenith, phoenix, etc. The VSD can customized to connect different brands of downhole sensors.
- Display the parameters from the downhole sensor.
- Three types of data will be saved on a USB disk that plugs into the bottom of the back of the touched screen which is embed on the front door. One type is running data record file, with 13 parameters stored on USB disk at one-minute intervals, the other type is event record file, and the file will be saved for every 300 actions records, the third type is fault record file and be saved for every 300 actions.



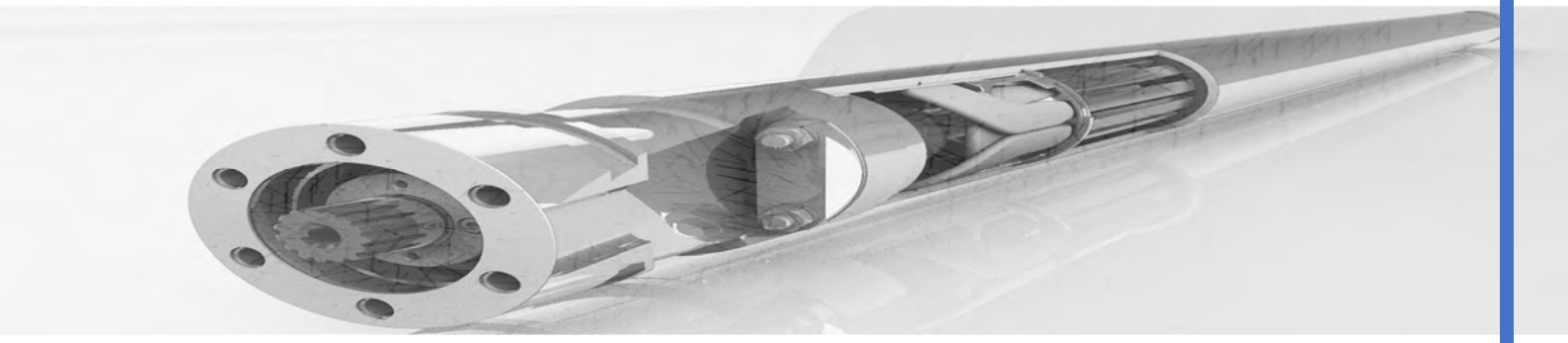
Trends interface

- The interface includes six different trend charts, showing the trend chart of 6 parameters. The operator can switch different trend charts by clicking the button on the left side of the interface.
- Each trend chart can switch the length of the time axis by clicking the time button at the bottom of the interface.



Alarm events interface

- This interface is used to display the current and historical system alarms.
- When the VSD shut down by the alarms occurs, the data, time and content of the alarm will be shown in the record of alarm interface. The fault record scrolls down, and the latest fault record is always on the top.
- In the event recording interface, the “start”, “stop” and “speed change” actions of triggering records in the event recording file according to the sequence of events, as well as the actions of user-defined protection parameters will be modified.



Drive ALVD-SWD VSD SPECIFICATIONS

Enclosure rating	IP23: indoor type, for large HP pump units	Motor control	V/F control PWM output
	IP30: indoor type	Input voltage	3 phase 380V to 480V +10%/-15%
	IP55: outdoor type	Input frequency	50Hz/60Hz ±5%
Cooling method	Air-forced cooling	Output voltage	Same as power supply
Altitude	0 to 1000m without derating, 1000m to 4000m with derating 1%/100m	Output frequency	10Hz to 90Hz
		Frequency setting	Digital or analog setting
Operating temperature	0°C to 40°C (indoor type VSD)	Starting frequency	0.1Hz to 60Hz
	-30°C to 50°C (outdoor type VSD)	Overload capacity	120% for 60s
Storage temperature	-40°C to 70°C	Frequency resolution	Analog setting: 0.05% for max. frequency
Relative humidity	5% to 95%, noncondensing		Digital setting: 0.01Hz
Enclosure material	Carbon steel and the thickness is 2mm	Speed accuracy	Analog setting: ±0.2% of max. frequency
Paint color	RAL9010		Digital setting: ±0.01% of max. frequency
Cable inlet and outlet	Through VSD junction box	Input configuration	6 pulse diode, 12 pulse is option
Installation	Anchor bolts for bottom installation	VSD efficiency	98% at rated load
Input harmonic reduction	5% input passive harmonic filter	Power factor	0.98 at rated load
	Input active filter	AI/AO	3×AI / 2×AO and expandable
	12 pulse VSD with phase shifting transformer	DI/DO	21×DI / 14×DO and expandable
		Communication	2×RS485 and 1×Ethernet communication
		USB	1×USB port

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Drive ALVD-SWD VSD DATA SHEET

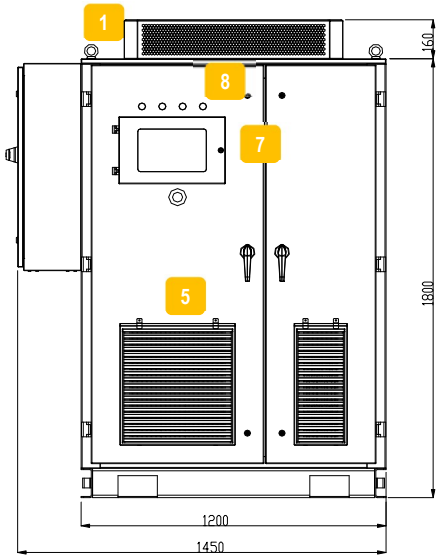
Output rating				IP23		IP30		IP55	
Output current	VSD power rating		Drive module power	Dimension	Weight	Dimension	Weight	Dimension	Weight
A	kVA@380V	kVA@480V	kW	H×W×D [mm]	Kg	H×W×D [mm]	Kg	H×W×D [mm]	Kg
168	105	134	90	/	/	1960×1250×700	364	1800×1250×700	388
203	127	162	110	/	/	1960×1250×700	372	1800×1250×700	397
240	150	191	132	/	/	1960×1450×800	482	2000×1450×800	515
290	181	231	160	/	/	1960×1450×800	496	2000×1450×800	529
361	225	288	200	/	/	1960×1450×800	698	2000×1450×800	736
415	259	331	220	/	/	1960×1450×800	699	2000×1450×800	737
520	324	414	280	/	/	2160×1450×1000	858	2200×1550×1000	905
590	368	470	315	/	/	2160×1450×1000	1088	2200×1550×1000	1148
*740	461	590	400	2050×2000×800	1350	/	/	/	/
*840	524	669	450	2050×2000×800	1356	/	/	/	/
*1040	648	829	560	2250×2000×800	1440	/	/	/	/
*1170	730	932	630	2250×2000×800	1465	/	/	/	/
*1386	864	1104	710	2500×2200×850	1720	/	/	/	/
*1480	923	1179	800	2500×2200×850	1740	/	/	/	/

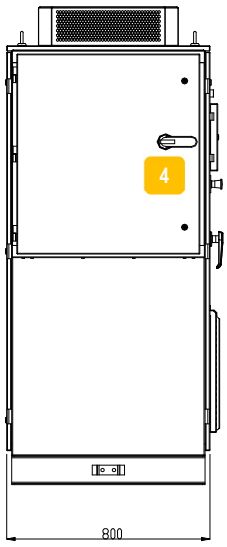
* Large Horsepower ESP VSD is indoor type and the outdoor type VSD can be customized

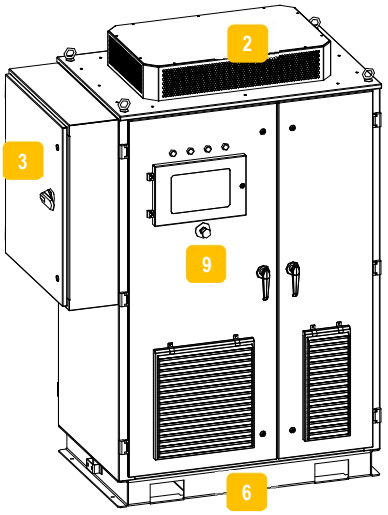
VSD for Electrical Submersible Pump

Drive ALVD-SWD VSD DESCRIPTION

Enclosure rating	IP30, conforming IEC60529
Input voltage	Low voltage: 3 phase 380V to 480V
Power rating range	From 134kVA to 470kVA
Integration solution	Skidded container solution
Work site environment	High temperature and dusty environment





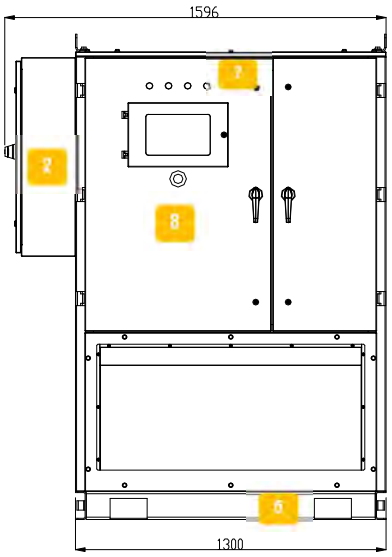


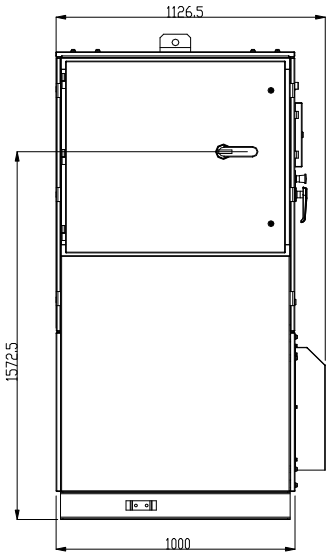
1	Lifting lugs on the top of VSD enclosure
2	Top air outlet
3	VSD junction box
4	Main breaker and extend handle
5	Air inlet with filter screen
6	VSD base with forklift hole
7	7” touched screen panel with protective cover
8	Indicator lights. Red-Stop, Green-Run, Yellow-Standby, White-Backspin
9	Emergency stop

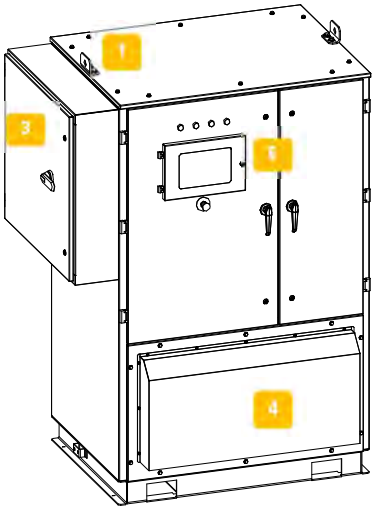
VSD for Electrical Submersible Pump

Drive ALVD-SWD VSD DESCRIPTION

Enclosure rating	IP55, conforming IEC60529
Input voltage	Low voltage: 3 phase 380V to 480V
Power rating range	From 134kVA to 470kVA
Integration solution	Outdoor skid
Work site environment	Tropical rainforest climate





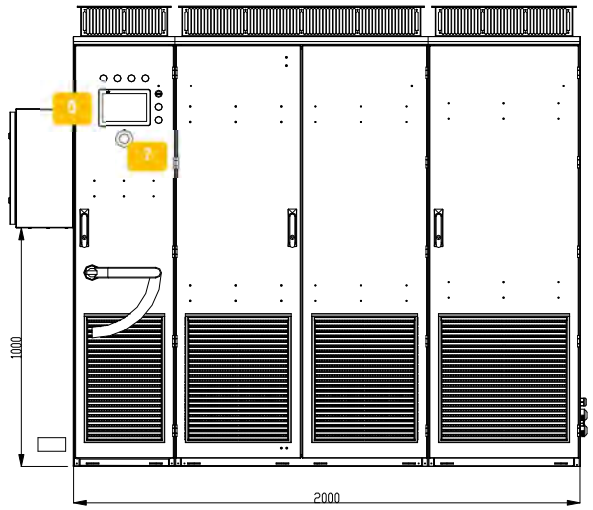


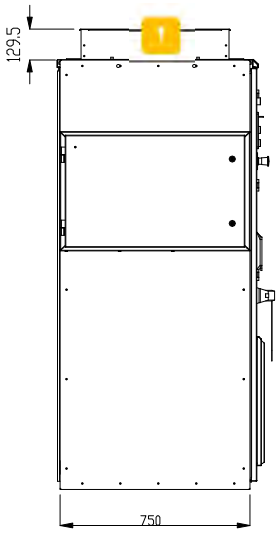
1	Lifting lugs on the top of VSD enclosure
2	VSD junction box
3	Main breaker and extend handle
4	Air inlet with filter screen and cover
5	VSD base with forklift hole
6	7” touched screen panel with protective cover
7	Indicator lights. Red-Stop, Green-Run, Yellow-Standby, White-Backspin
8	Emergency stop

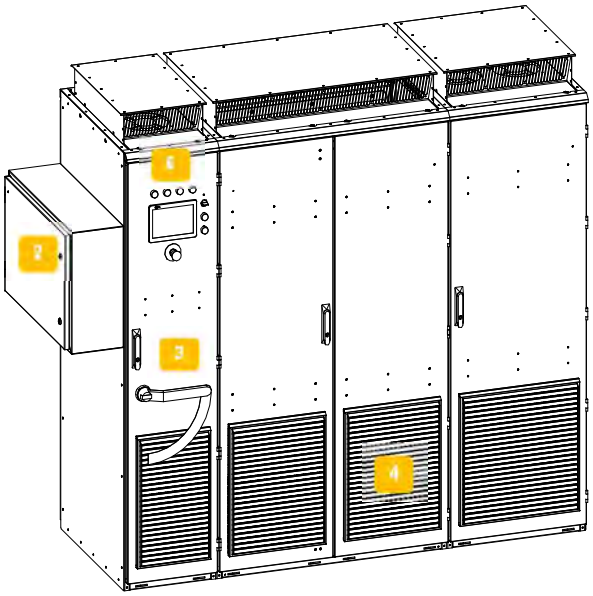
VSD for Electrical Submersible Pump

Drive ALVD-SWD VSD DESCRIPTION

Enclosure rating	IP23, conforming IEC60529
Input voltage	Low voltage: 3 phase 380V to 480V
Power rating range	From 590kVA to 1179kVA for large HP pump units
Integration solution	Skidded container solution
Work site environment	High temperature and dusty environment, tropical rainforest climate







1	Top air outlet
2	VSD junction box
3	Main switch (or breaker) and extend handle
4	Air inlet with filter screen
5	7” touched screen panel
6	Indicator lights. Red-Stop, Green-Run, Yellow-Standby, White-Backspin
7	Emergency stop