

Clean Power VFD User Guide

SDB-1-2185

SDB-1-2185-A

SSB-2-2220-A



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1. Introduction

(For simplicity SmartD Technologies Inc. is referred to as SmartD throughout the document, and the SmartD Clean Power Variable Frequency Drive is referred to as Clean Power VFD)

SDB series Clean Power VFDs have been designed for the specific requirements of fan and pump applications, however, their flexible design incorporating V/F control can be used in other applications requiring accurate speed control and fast torque response.

Their innovative clean power design saves space, cost, and time.

This user manual supplies detailed instructions for the series Clean Power VFD including product features, parameters settings, operation and commissioning, and inspection and maintenance.

Be sure to carefully read and follow all the safety instructions prior to use, to ensure the safety of personnel and property.

Qualified personnel

This user manual is intended for qualified personnel.

You must be able to program and operate Variable Frequency Drives.

In addition, you must understand the parameter settings and functions.

Important notes:

For instructional purposes, this guide contains pictures showing the product with the casing or safety cover removed.

When using this product, ensure that the casing and safety cover are in place and operate the unit according to the instructions in this documentation.

SmartD is committed to the continuous improvement of our products. Product features will continue to evolve, therefore the information in this manual is subject to change.

Please refer to our website for the most up-to-date product document.

Warning:

The Clean Power VFD can be used only to control the variable speed of 3-phase induction motors.

They are NOT suitable for 1-phase motors or other purposes.

About Registered Trademarks

All marks referenced herein with the ® or TM symbol are registered trademarks or trademarks of SmartD Technologies Inc. or its subsidiaries.

All rights reserved.

All other marks are trademarks of their respective owners.

Using the product safely

Read and follow all safety instructions in the User Guide precisely to avoid unsafe operating conditions, property damage, personal injury, or even death.

1.1. Safety labels

The following **safety symbols** are used in this user guide. Please take time to learn their meaning.



Danger indicates an imminently hazardous situation that, if not avoided, will result in severe injury or even death.



Warning indicates a potentially hazardous situation that, if not avoided, could result in injury or even death.



Caution indicates a potentially hazardous situation that, if not avoided, could result in minor injury or property damage.

1.2. Warranty and liability - summary

This summary is provided as a courtesy to our users. It does not replace the terms and conditions regarding the Warranty Information, Limitation of Liability, and Intellectual property that can be found at the end of this document and should be read in full before deploying the Clean Power VFD.

This SmartD quality product is warranted to operate as described in this User Guide and to be free from manufacturing defects in material and workmanship for a period of eighteen (18) months from the date of shipment to the person or organization to which the equipment was initially sold.

In no event and under no circumstances shall the manufacturer be liable for damages and failures due to misuse, abuse, improper installation, abnormal temperature conditions, dust, or corrosion, or failures due to operation outside the published ratings. The manufacturer is not liable for consequential and incidental damages.

1.3. Copyright

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All rights reserved, also regarding any disposal, exploitation, reproduction, editing, distribution, as well as in the event of applications for industrial property rights, without permission in writing from SmartD Technologies Inc.

2. How to select a VFD?

Selection of motor and Clean Power VFD should be performed by skilled and experienced personnel.

This guide is a supplement, not a replacement for such expertise.

2.1. Clean Power VFD selection

Knowing the application

Before selecting a Clean Power VFD and a motor, it is necessary to know the operating environment and the work to be performed.

First, the user must select the proper motor according to the load's driving force and the movement cycles.

The basic movement cycle is: start > acceleration > constant speed > deceleration > stop.

Second, the user must select the Clean Power VFD according to its capacity to drive the motor previously selected.

Start

The motor torque must be larger than the load starting torque.

Acceleration ↴

The motor torque must be larger than the load torque required for acceleration:

Motor torque > Load torque + Acceleration torque.

Acceleration torque = (total inertia of the system * (target speed - starting speed)) / (9.55 * acceleration time)

Deceleration

During deceleration, a motor acts as a generator and the energy flows back into the Clean Power VFD.

The deceleration capability is determined by the Clean Power VFD's capability to consume or regenerate this energy.

If the energy regenerated by the motor is higher than the Clean Power VFD's ability to handle it, then some alarms may be triggered, and the Clean Power VFD may turn into a "self-protective" lock state.

The user must ensure that the deceleration time is correctly set.

Constant speed

Check the motor temperature rise specification is compatible with both the movement cycles and the operating environment.

During acceleration or constant speed operation, the Clean Power VFD's capacity is limited by the peak current it can deliver to the motor.

The user must ensure that the rated current output and overload capacity are the correct size for the application.

Clean Power VFD current ratings:> ⚓

Clean Power VFD current ratings are given for Normal duty operation and Heavy-duty operation. They are RMS values.

In variable torque applications, a normal-duty drive is well-suited. For these applications in which the torque drops along with speed, a high overload tolerance is not required.

In constant torque applications, the Clean Power VFD must be chosen according to its heavy-duty capacity. These applications require a high overload tolerance with constant load torque,

- In normal-duty operation, the overload capacity is 110% of the VFD nominal output current during 60 s every 10 min @ 40 °C.

- In heavy-duty operation, the overload capacity is 150% of the VFD nominal output current during 60 s every 10 min @ 40 °C.

Example:

for a VFD rated 34 A in normal-duty operation and 25 A in heavy-duty operation,

- The overload capacity in normal-duty operation is $34 \times 1.1 = 37.4$ A during 60 s every 10 min @ 40 °C.
- The overload capacity in heavy-duty operation is $25 \times 1.5 = 37.5$ A during 60 s every 10 min @ 40 °C.

Driving several motors ⚓

While it is possible to drive multiple motors with a single Clean Power VFD, some additional precautions are required.

First, select a Clean Power VFD with a rated output current greater than the combined total of the individual motor currents.

Please note: Depending on the specifics of the application, driving multiple motors may not be the most economically efficient solution because the capacity of the Clean Power VFD may become very large.

V/F control must be selected to drive multiple motors with one Clean Power VFD.

Define the Clean Power VFD current rating on the number of driven motors:

- One motor is driven with one Clean Power VFD. Then, the rated output current of Clean Power VFD > the motor's rated current.

- Multiple motors are driven with one Clean Power VFD. Then, the rated output current of Clean Power VFD > total rated motor current

- If several motors are sequentially started with one Clean Power VFD. Then, the rated output current of Clean Power VFD > Total rated current of the started motors + Starting current for the largest capacity motor

Please note: When multiple motors are operated in parallel, the motors cannot be protected by the built-in electronic thermal relay function.

The user must add a thermal relay for each motor on the Clean Power VFD output side.

For a continuous drive at low speed, install a temperature detection device on the motors since the motors cannot be protected by the Clean Power VFD thermal function.

Acceleration and deceleration time of the application. ↕

When the acceleration or deceleration time is restricted, the selection of the VFD cannot be fully made only by matching the VFD current capacity with the motor capacity rated current.

The system's capacity (VFD+motor) must be selected so that the predetermined acceleration/deceleration time can be satisfied.

The Clean Power VFD capacity may be increased for the operation which repeats acceleration/deceleration in a short time (such as a vertical lift operation).

Make sure to fully consider the Clean Power VFD capacity in advance.

2.2. Motor nameplate

A motor nameplate is the ID card of a motor. It displays several pieces of information.

These information are useful for the motor selection itself, useful for the Clean Power VFD selection, and they are used to set the Clean Power VFD parameters.

Horsepower output (kW / hp). ↕

Usually given as hp or kW, this is a measure of the motor's mechanical power.

Time rating (DUTY). ↕

This designation specifies the length of time that the motor can carry its nameplate rating safely.

Usually, this is "continuous" (Cont), which NEMA defines as indefinite.

The duty for motors used intermittently (e.g., on cranes, hoists, and valve actuators) is usually expressed in minutes.

Maximum ambient temperature. ↕

This is the maximum allowable temperature of the surrounding air to ensure that the motor's operating temperature won't exceed the insulation system limit.

Insulation system designation (CLASS, INS. CLS., INSUL CLASS). ↕

This indicates the motor winding's thermal endurance using industry standard letter designations such as A, B, F or H.

Number of poles ↕

The pole count of a motor is the number of magnetic poles, north, and south, on the rotor. There is always the same number of north and south poles on the rotor. For example, in a 12-pole motor, there are 6 north poles and 6 south poles. This motor would also be considered a 6-pole-pair motor.

The synchronous speed of the motor depends on the number of poles (2p) of the motor and on the line frequency (f) in Hertz (Hz).

AC Motor Speed Formula: Synchronous Speed (RPM) = $120 \times \text{Frequency} / \text{Number of Poles}$

For example, the speed of a 4-Pole Motor operating at 60 Hz would be:

$$120 \times 60 / 4 = 7200 / 4 = 1800 \text{ RPM}$$

The speed at rated load (RPM). ↕

This is the speed at which rated horsepower output is delivered to the load (full-load speed).

This will be less than synchronous rpm, the speed of the stator's revolving magnetic field. The difference between the two is the "slip speed" or "slip rpm."

Frequency (HZ). ↕

Rated frequency of the AC power to be applied to the motor. The standard frequency is 60 Hz in North America and usually 50 Hz elsewhere.

The number of phases (PH). ↕

Single or three phases of the AC power lines supplying the motor.

Rated load current (AMPS). ↕

Rated load current in amps, at nameplate horsepower (hp) with nameplate voltage and frequency.

Voltage (VOLTS). ↕

Rated voltage of the AC power to be applied to the motor.

Code letter for locked rotor kVA (CODE). ↕

NEMA MG 1 defines locked rotor kVA per hp with a series of code letters (A to V). Generally, the farther the code letter is from A, the higher the inrush current per hp.

Design letter (DES, NEMA DESIGN, DESIGN). ↕

NEMA MG 1 defines four motor designs (A, B, C and D) in terms of torque and current characteristics.

Nominal efficiency ↕

Efficiency is defined as output power divided by input power, expressed as a percentage:

$$(\text{Output}/\text{Input}) \times 100$$

Service factor (SF) ↕

At nameplate voltage and frequency, the allowable overload for a motor with a nameplate service factor equals the rated load multiplied by that service factor.

The service factor is only required on a nameplate if it is higher than 1.0.

Power factor (PF or P.F. or $\cos\Phi$) ⚓

The power factor is the ratio of active power (watts) to apparent power (volt-amperes) for the motor at full load.

3. Installing the VFD

This section explains how to unbox, mount and wire the Clean Power VFD.

Before proceeding, please carefully read the safety messages.

3.1. Installing the Clean Power VFD: Safety message.



This drive should only be installed by qualified personnel as defined in the user's jurisdiction.

Failure to do so may result in property damage, electric shock, serious injury, or death.

3.2. Installation: overall procedure

The following steps list the sequence to be followed during installation.

Install the product following this sequence and check the operational status.

For more information on each step, refer to the sections below.

1. Product identification.
 - Check that the [product part number](#) is understood and the features match the application.
2. Unbox your Clean Power VFD.
 - Stock, carry, and unpack the Clean Power VFD with caution.
3. Select the installation location.
 - Check that the [environmental conditions](#) are within specifications.
4. Follow the [instruction to mount](#) your Clean Power VFD onto its support.
5. Follow the [instructions to wire](#) properly and safely the power cables on both the input and output sides.
6. Follow the [recommendation](#) for an efficient grounding
7. Follow the [instructions](#) to wire properly and safely the control signals
8. Before powering up, follow the [verification checklist](#).
9. Switch on power to the Clean Power VFD.
10. Follow the [instructions](#) to set up the Clean Power VFD.
11. Before the operation, perform a [test sequence](#).

3.3. Installation regulations and rules

The user must consider local regulations.

- European countries: In accordance with European EN standards.
- United States of America (USA):
 - National Electrical Code (NEC).
 - National Electrical Manufacturers Association (NEMA), as well as local engineering regulations.
 - Regulations of the National Fire Protection Association (NFPA).
- Canada: Canadian Standards Association (CSA).
- Other countries:
 - International Organization for Standardization (ISO).
 - International Electro-technical Commission (IEC).

3.4. Unboxing

3.4.1. Unboxing: Safety message

DANGER

- Do not install the product if the package shows signs of excessive damage, water ingress or if a component is missing or broken.
- Do not install the product if the label on the product is not identical to that on the packaging.
- If the Clean Power VFD appears to be damaged upon receipt, do not install it and contact the carrier immediately.

CAUTION

- Exercise care when carrying or transporting the device in order to minimize the risk of damage.
- If the Clean Power VFD has been stored or transported under a temperature out of the specifications, call SmartD technical support before attempting to use it.

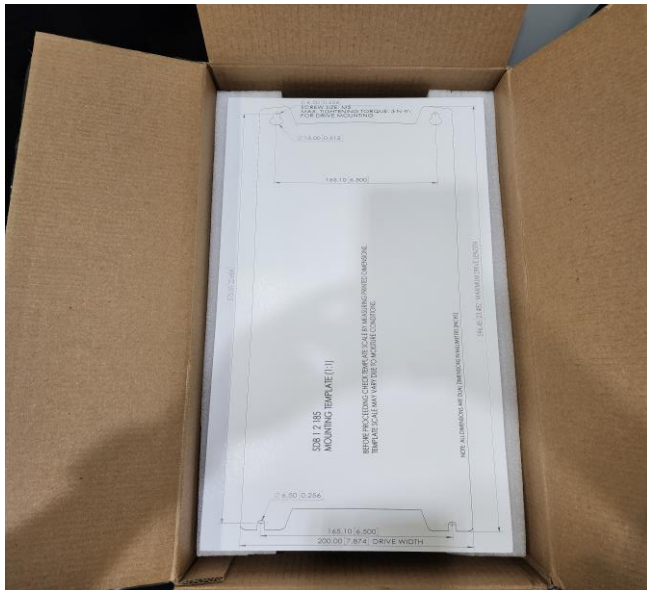
3.4.2. How to handle and unbox your Clean Power VFD

The shipping box is clearly marked for which way is up.

STEP 1

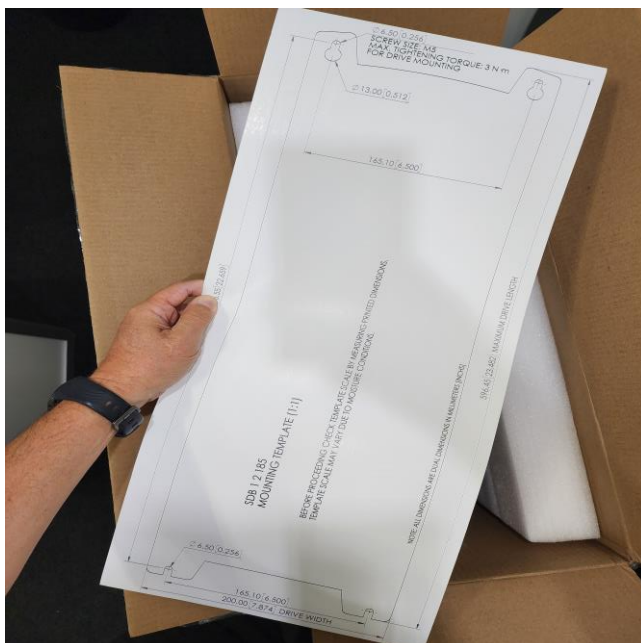
Place the box on a suitable flat surface and cut the tape on either end. Then cut along the tape to release the two lid halves. DO NOT use a knife.

Open the box to reveal the included mounting template.



STEP 2

Remove and keep the mounting template for later use.



STEP 3

You have now access to the Quick Start guide. Remove it and **READ it**.

**STEP 4**

To remove the side protections, just gently pull them.

**STEP 5**

The Clean Power VFD can now be pulled out its packaging.

The Clean Power VFD is a heavy device. SmartD recommends 2 people to proceed to the next action:

Place your hands under the VFD and lift it.

Then place the VFD on a suitable surface (not the floor) while you prepare for mounting and wiring.



- !** During unpacking, this is an opportunity to check for damage due to shipping.
If there is damage stop unpacking, take photos and contact SmartD.

3.4.3. Clean Power VFD description

Description SDB-1-2-185



1 Detachable HMI

User Interface. Can be detached and mounted remotely.

2 Control terminals blocks

Control wires have to be wired into this terminal block.

Refer to the [wiring section](#) of this document for details.

3 Power terminals

Power wires, input and output, and grounding

have to be wired into this terminal block.

Refer to the [wiring section](#) of this document for details.

4 Replaceable battery

The battery, used to save the real-time clock, can be changed easily.

Refer to the [maintenance section](#) of this document for details.

5 USB port

The USB port can be used to upload a drive configuration or [update the SmartDrive firmware](#).

6 unused RJ45

Do not plug anything in. This is for future features.

7 HMI port

The cable from the HMI must be plugged in here.

8 Ethernet ports

The Clean Power VFD provides users with 2 Ethernet ports.

Description SDB-1-2-185-A and SDB-2-2-220-A



1 Detachable HMI

User Interface. Can be detached and mounted remotely.

2 Control terminals blocks

Control wires have to be wired into this terminal block.

Refer to the wiring section of this document for details.

3 Power terminals

Power wires, input and output, and grounding have to be wired into this terminal block.

Refer to the wiring section of this document for details.

4 Replaceable battery

The battery, used to save the real-time clock, can be changed easily.

Refer to the maintenance section of this document for details.

5 USB port

The USB port can be used to upload a drive configuration or update the SmartDrive firmware.

6 unused RJ45

Do not plug anything in. This is for future features.

7 HMI port

The cable from the HMI must be plugged in here.

8 Ethernet ports

The Clean Power VFD provides users with 2 Ethernet ports.

9 cables ties holder

Tie the cables on this holder.

10 Glands for cable In and Out

Insert the power and control cables through the glands to keep them in a safe position.

11 Safety Protection cover

The Safety protection cover is screwed onto the Clean Power VFD housing.

Do not remove it when the power is on as the live parts may be accessible.

3.4.4. Understand the Clean Power VFD part number.

The Clean Power VFD part number can be found on the identification label on the right side of the Clean Power VFD.

Please check that the model is suitable for the installation.

		SD B - 1 - 2185 - A				
Product Family	SD					
	standalone, open type	B				
Input Voltage						
	3 phases 400 to 480 V	1				
	3 phases 600 V	2				
Motor Power						
	25HP / 18.5 kW		2	185		
	30HP / 22 kW		2	220		
	40HP / 30 kW		2	300		
	50HP / 37 kW		2	370		
	60HP / 45 kW		2	450		
	75HP / 55 kW		2	550		
	100HP / 75 kW		2	750		
	125HP / 90 kW		2	900		
	Standard 6 puses					-
	Embedded AFE					A

Nameplate Check SDB12185

SmartD Technologies Inc.
Clean Power Variable Frequency Drive

1 SDB-1-2-185 **2**
18.5 kW - 25 HP

Input	
U_{in} (VAC)	3~ 400...480
I_{in} (Arms)	36 w/o input choke 27 w 1mH input choke
F (Hz)	50 / 60

Output	
U_{out} (VAC)	3~ 380...480
I_{out} (Arms)	33
F (Hz)	0 to 120

Motor overload protection class 10 **4**
SCCR rating and protection: refer to user guide

75°C Cu - AWG 8 / 10mm²
2.71 Nm 24 Lb-In **IP20**

5





S/N 1234567890 **7** date yy/ww **8**

Eth1 MAC - 70:B3:XX:XX:XX:XX **6**
Eth2 MAC - 70:B3:XX:XX:XX:XX
BTh MAC - 70:B3:XX:XX:XX:XX

Made in CountryName **9**

1. Product part number
2. Suitable Motor power
 - o The motor power values are indicative. They vary with the motor type, technology, and manufacturer.
 - o The Clean Power VFD must not be selected from the motor power rating.
 - o The Clean Power VFD must be selected by skilled and experienced personnel.
 - o The Clean Power VFD must be selected according to motor Full Load Amps (FLA), the load's driving force, the movement cycle, and the operating environment.
3. Power input and power output rated values.
4. Technical features.
5. Certifications and compliances.
6. Mac Addresses
7. Product serial number.
8. Manufacturing date code.
9. Location of the main manufacturing process.

Nameplate check VFD AFE

SmartD Technologies Inc. Clean Power Variable Frequency Drive	
Input U_{in} (VAC) 3~400...480 I_{in} (Arms) 36 F (Hz) 50 / 60	SDB-1-2185-A 18.5 kW - 25 HP Variable frequency drive with integrated Active Front End
Output U_{out} (VAC) 3~380...480 I_{out} (Arms) 33 F (Hz) 0 to 120	 
Motor overload protection class 10 SCCR rating and protection: refer to user guide  75°C Cu - AWG 8 / 10mm ² 2.71 Nm 24 Lb-In IP20	
Eth1 MAC - 70:B3:XX:XX:XX:XX Eth2 MAC - 70:B3:XX:XX:XX:XX	
SmartD Technologies Inc. www.Smartd.tech	 S/N 1234567890 date yy/ww Made in Canada

1. Product part number
2. Suitable Motor power
 - The motor power values are indicative. They vary with the motor type, technology, and manufacturer.
 - The Clean Power VFD must not be selected from the motor power rating.
 - The Clean Power VFD must be selected by skilled and experienced personnel.
 - The Clean Power VFD must be selected according to motor Full Load Amps (FLA), the load's driving force, the movement cycle, and the operating environment.
3. Power input and power output rated values.
4. Technical features.
5. Certifications and compliances.
6. Mac Addresses
7. Product serial number.
8. Manufacturing date code.
9. Location of the main manufacturing process.
10. Local representative contact.
11. QR code - SmartD internal usage.

3.5. Mechanical installation

3.5.1. Mechanical installation: Safety messages

DANGER

- The installation base shall be metal or other non-flammable material.

Risk of fire.

- Do not install the Clean Power VFD in an environment containing explosive gases.

Risk of explosion.

- Do not unscrew the fixing bolts.

The Clean Power VFD may fall, risk damaging it and other surrounding products as well as risk of losing the cable connections with subsequent risk of short-circuits

CAUTION

- Do not leave cable strips or screws in the Clean Power VFD.

Risk of Clean Power VFD damage.

- Make sure that foreign materials such as metal shavings or wire fragments cannot fall into the VFD during installation.

Place temporarily a cover over the VFD during installation but remove it before use to ensure proper ventilation and avoid overheating the VFD.

Risk of damage to the VFD.

- Ensure the ambient temperature will never exceed the allowable range while operating the drive.

Risk of damage to VFD.

- Install the product in a location with minimal vibration and out of direct sunlight.

Risk of damage to VFD.

- If two or more Clean Power VFDs are installed in the same enclosure, ensure that there is sufficient ventilation to ensure proper cooling of all the devices.

Risk of damage to the VFD.

- Failure to respect the minimum mounting clearances may cause the Clean Power VFD to overheat, potentially reducing the operational lifespan of the VFD and/or voiding the warranty.
- Do not install the Clean Power VFD on the floor or mount it sideways against a wall.
- The VFD must be installed vertically on a wall or inside a panel, with its rear flat on the mounting surface.

3.5.2. Mounting instructions

Mount the Clean Power VFD inside a panel, on a pre-slotted plate, following the procedures provided hereafter.

Before installation, ensure that there is sufficient space to meet the clearance specifications and that there are no obstacles impeding the cooling airflow.

Select a wall or panel suitable to support the installation.

Refer to the [dimensions](#) section in this document and check the Clean Power VFD's mounting bracket dimensions.

1. Prepare to mount with corresponding threaded holes

Use a level to draw a horizontal line on the mounting surface, and then carefully mark the fixing points.

Apply the mounting template (delivered with the Clean Power VFD) on the mounting surface to ensure the right position of the fixing points.

Distances are given in the mounting [dimensions](#) section of this document.



2. Drill and prepare fixtures.

Drill the mounting bolt holes and then install the mounting bolts.

Fit screws and washers.

Do not fully tighten the bolts at this time.

3. Mount the Clean Power VFD

Mount the Clean Power VFD on the prepared mounting area via the keyhole suspensions.

Fully tighten the upper mounting bolts, then install two lower mounting bolts and tighten them fully to mount the VFD.

Ensure that the VFD is placed flat on the mounting surface and that the installation surface can securely support the weight of the VFD.

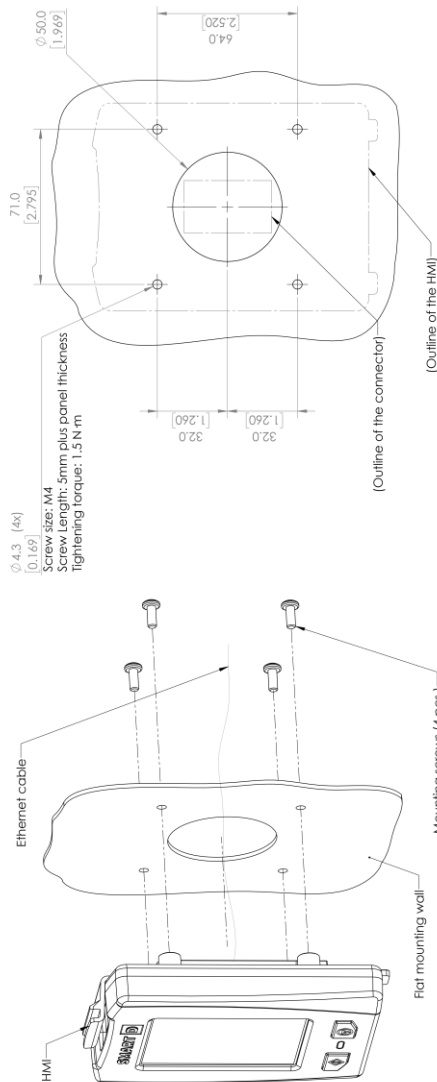
Do not exceed the recommended tightening torque:

Tightening torque	N.m	in-lbs
Screw M5	5	26.55

3.5.3. Mounting the HMI remotely

The embedded HMI can be unplugged from the Clean Power VFD front and mounted remotely.

A mounting template is delivered in the packaging:



3.5.4. Application environment

The Clean Power VFDs are manufactured with precision electronic components.

Therefore, the installation environment can impact the lifespan and reliability of the product.

The information below describes the recommended operation and installation conditions for the Clean Power VFD.

The user must comply with the environmental conditions listed below in order to ensure that the Clean Power VFD operates safely and correctly.

Failure to adhere to these environmental conditions may shorten the lifespan of the device, lead to malfunctioning and device failure, and void the warranty.

Environment	Conditions
Installation area	The Clean Power VFD must be mounted in a well-ventilated electrical cabinet respecting the clearance distances described in this document.
Ambient temperature	The normal operating range of the Clean Power VFD is -15 to 50°C (without derating) if not specified otherwise. The reliability of the Clean Power VFD increases in environments where temperature fluctuations are limited. When using an enclosure, install a cooling fan or air conditioner in the area to ensure the air temperature inside the housing does not exceed the specified levels. Do not allow ice to form on the frequency converter.
Relative humidity	Below 95% non-condensing.
Surrounding environment pollution degree	2, conforming to IEC61800-5-1
Storage temperature	-40...70 °C / -40...158 °F
Surrounding area	Mount in an area free of -oil mist and dust-metal shavings, oil, water or other foreign materials -radioactive materials -combustible materials -toxic or corrosive gases and liquids -excessive vibration -chlorides -direct sunlight -EMI source and other electronic devices that are sensitive to EMI
Altitude	Lower than 2000 m/6600 ft. Contact SmartD Technologies Inc. if you intend to use the Clean Power VFD at higher altitude.
Vibrations	Mount in a location where vibrations are less than an amplitude of 1.5 mm peak to peak (f= 2...13 Hz) and acceleration lower than 1 gn (f= 13...200 Hz).

Best practices:

To prevent high surrounding air temperature, users should design their electrical panel following the listed best practices:

- No heat stagnation in the panel.
- Sufficient heat dissipation of the panel (Size not too small, proper ventilation).
- Ventilation slits of the Clean Power VFD are not blocked by any object such as cable or cable trays.
- Avoid the proximity of any exothermic device.
- Ensure the mounting orientation of the Clean Power VFD allows an optimized airflow.
- Respect the clearance distances.

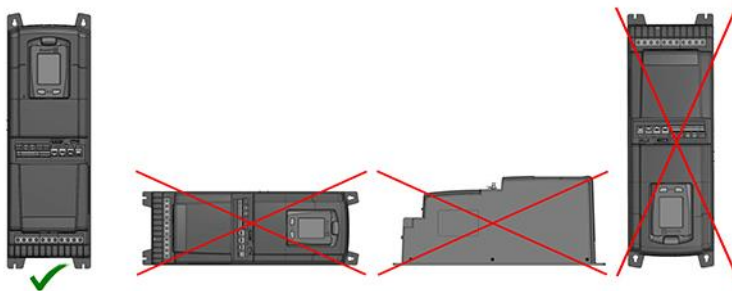
3.5.5. Installation position and distance

When selecting the installation location of the drive, check the following points:

- The Clean Power VFD must be installed on a surface that can support the weight of the device and is free from vibration exceeding the specified tolerances.
- The surface must be fire-resistant or flame-retardant and compliant with local electrical regulations.
- There must be sufficient clearance around the Clean Power VFD to allow air to circulate freely.

If the Clean Power VFD is installed inside an electrical panel, ensure that the cooling fan of the Clean Power VFD is properly located within the enclosure to ensure the proper evacuation of heat from both the Clean Power VFD and the enclosure.

Mounting orientation

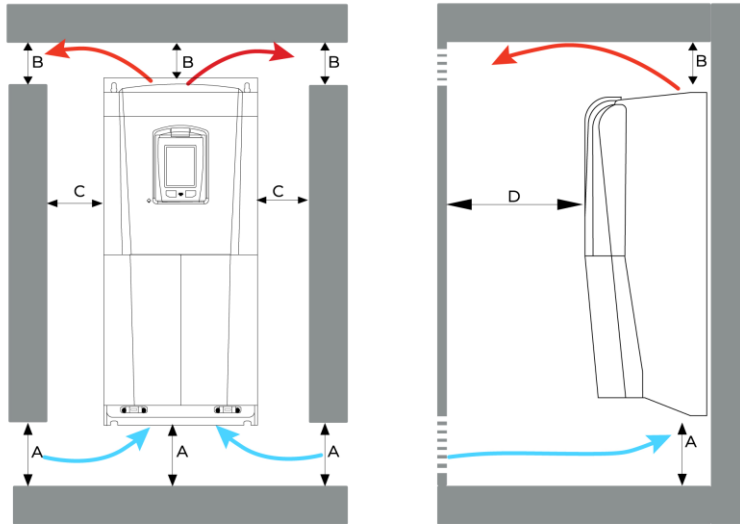


For correct heat dissipation, the Clean Power VFD must be mounted vertically. But do not install it upside down.

Do not mount it on its side or on its back.

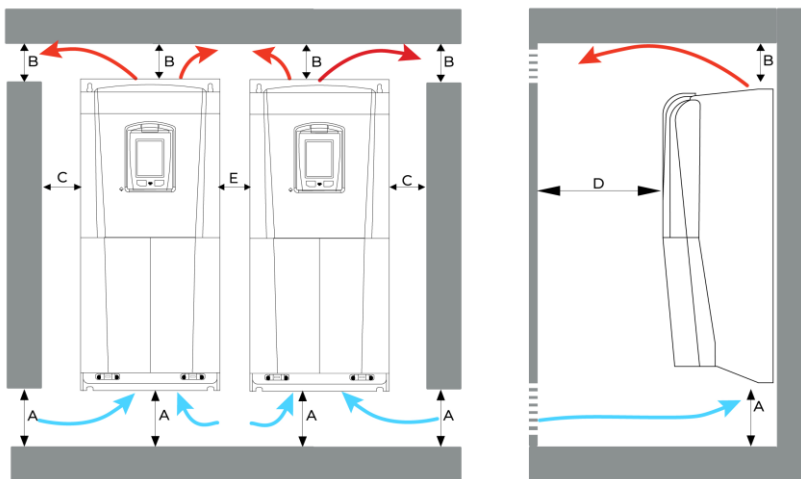
3.5.5.1. Mounting clearance distances SDB-1-2-185-A and SDB-2-2-220-A

Minimum mounting clearance distances - single drive installation



Clean Power VFD model	A mm / inch	B mm / inch	C mm / inch	D mm / inch
SDB-1-2-185-A and SDB-2-2-220-A	300 / 11.81	200 / 7.87	50 / 1.97	10 / 0.39

Minimum mounting clearance distances - side-by-side drives installation



VFD model	A mm / inch	B mm / inch	C mm / inch	D mm / inch	E mm / inch
SDB-1-2-185-A and SDB-2-2-220-A					

If a VFD is mounted above another it is important to ensure that the air temperature around the upper unit is not heated beyond the specified maximum operating temperature by the exhaust from the lower unit.

An air guide between the VFDs is recommended to prevent the rising hot exhaust air from being drawn into the upper unit.

Heat dissipation

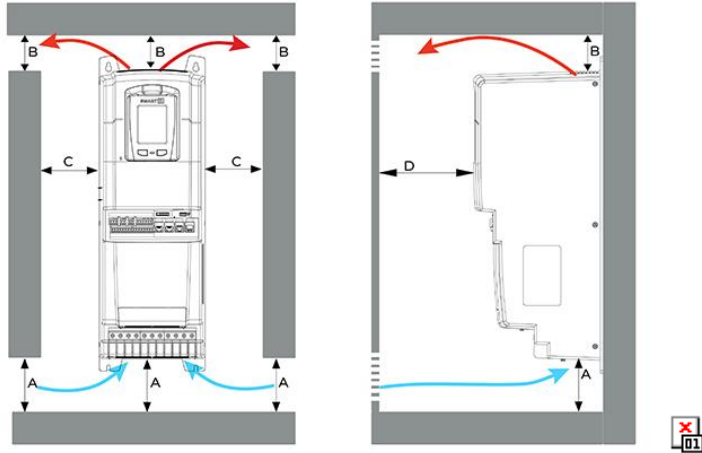
VFD model	W	BTU / h
SDB-1-2-185-A and SDB-2-2-220-A		

Airflow of fans

VFD model	Fans	airflow	
SDB-1-2-185-A and SDB-2-2-220-A	2 fans located bottom of the VFD behind a metal screen	212.6 CFM	6.02 m ³ /min

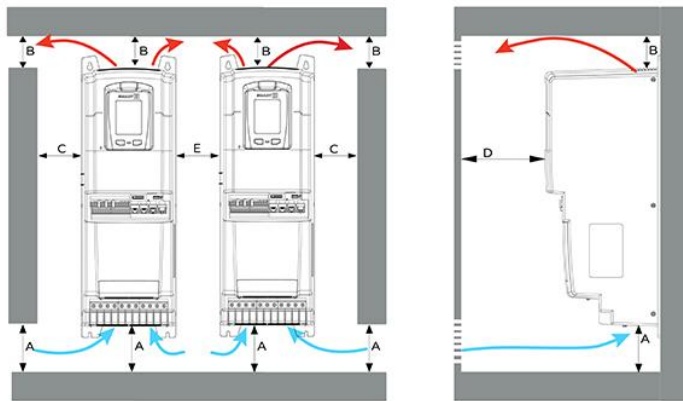
3.5.5.2. Mounting clearance distances SDB-1-2185

Minimum mounting clearance distances - single drive installation



Clean Power VFD model	A mm / inch	B mm / inch	C mm / inch	D mm / inch
SDB 12 185	300 / 11.81	200 / 7.87	50 / 1.97	10 / 0.39

Minimum mounting clearance distances - side-by-side drives installation



VFD model	A mm / inch	B mm / inch	C mm / inch	D mm / inch	E mm / inch
SDB 12 185	300 / 11.81	200 / 7.87	50 / 1.97	10 / 0.39	50 / 1.97

If a VFD is mounted above another it is important to ensure that the air temperature around the upper unit is not heated beyond the specified maximum operating temperature by the exhaust from the lower unit. An air guide between the VFDs is recommended to prevent the rising hot exhaust air from being drawn into the upper unit.

Heat dissipation

VFD model	W	BTU / h
SDB 12 185	387	1320.4

Airflow of fans

VFD model	70X70X25mm Fan		50X50X10mm Fan	
SDB 1 2 185	13.91 CFM	0.39 m ³ /min	12.7 CFM	0.36 m ³ /min

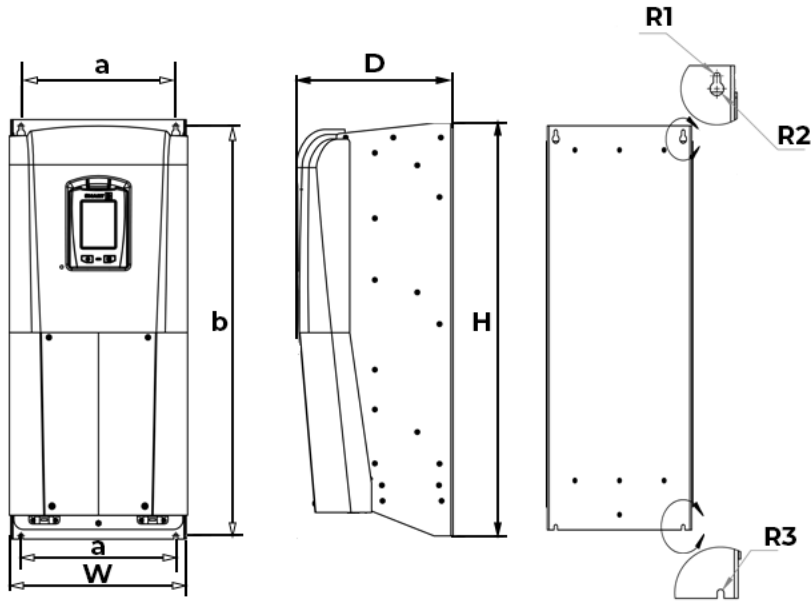
3.5.6. Enclosure types

The Clean Power VFD must always be mounted into an enclosure to meet the requirement of the surrounding environment.

Users must refer to local regulations in order to select the proper enclosure that meets the surrounding environmental conditions.

3.5.7. Dimensions

3.5.7.1. Dimensions SDB-1-2185-A and SDB-2-2220-A



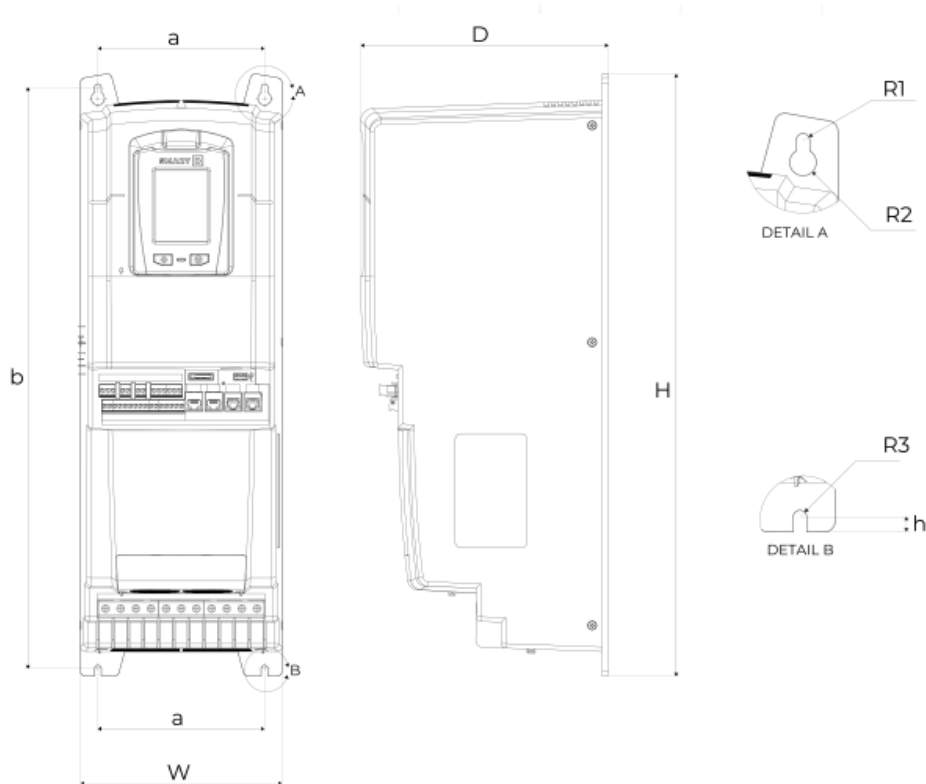
Overall Dimensions

SDB-1-2185-A and SDB-2-32220-A	Metric	Imperial
W	301 mm	11.85 in.
H	650 mm	25.59 in.
D	251 mm	9.88 in.
Weight	30 kg	66 lb

Mounting dimensions

SDB-1-2185-A and SDB-2-32220-A	Metric	Imperial
a	165.10 mm	6.50 in.
b	575.55 mm	22.659 in.
R1	3.47 mm	0.137 in.
R2	6.72 mm	0.265 in.
R3	3.47 mm	0.137 in.
h	7.28 mm	0.287 in.
Screw size	M5	10

3.5.7.2. Dimensions SDB-1-2-185



SDB-1-2-185 Dimensions

SDB-1-2-185	Metric	Imperial
W	199.56 mm	7.857 in.
H	596.45 mm	23.482 in.
D	245.32 mm	9.658 in.
Weight	15 kg	33.07 lb

SDB-1-2-185 Mounting dimensions

SDB-1-2-185	Metric	Imperial
a	165.10 mm	6.50 in.
b	575.55 mm	22.659 in.
R1	3.47 mm	0.137 in.
R2	6.72 mm	0.265 in.
R3	3.47 mm	0.137 in.
h	7.28 mm	0.287 in.
Screw size	M5	10

3.6. Electrical Installation

3.6.1. Electrical installation: Safety messages

DANGER

- Apply rated torques to the terminal screws.

Under-torqued screws may allow connections to come loose while over-torqued screws may damage the terminals.

Risk of short circuit. Risk of drive malfunction.

- Wiring must be performed by authorized, qualified personnel.

Risk of personal injury or death. Risk of damage to equipment.

- A circuit breaker must be installed between the Clean Power VFD and the mains.

Risk of personal injury or death. Risk of fire. Risk of damage to equipment

- Make sure the input power supply has been completely disconnected before wiring.

Risk of personal injury or death. Risk of damage to equipment

- Since the overall leakage current of this equipment may be up to 45 mA, ensure that the Clean Power VFD and its associated motor have a proper ground connection compliant with local regulations.

Risk of personal injury or death.

- Ensure that grounding wires meet the technical standards for electrical equipment. Impedance must conform to national and local regulations, safety regulations, and/or electrical codes.
- Furthermore, ensure that the length of grounding wires is minimized.
- connections should be periodically checked.
- Improper grounding of equipment may lead to dangerous electrical potentials on the equipment chassis.

Risk of serious injury or death.

- Drive not provided with integral motor overtemperature protection.

 **WARNING**

- For power terminal wiring use only 600V 75°C rated copper wire with the cable dimension specified in this document.

Risk of overheating or fire.

- Never connect the input line power cables to the output terminals (U/T1, V/T2, W/T3) of the AC drive.

Pay attention to the marks of the wiring terminals and ensure correct wiring.

Risk of damage to equipment.

- Ensure that the input phase wiring sequence (R/L1, S/L2, T/L3) is identical to the output phase sequence (U/T1, V/T2, W/T3).

Failure to do so may cause the motor to rotate in the opposite direction.

Risk of damage to equipment.

- The grounding impedance must conform to the requirements of local safety regulations.
- The Clean Power VFD must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply.
- The ground connections must be inspected and tested at appropriate intervals.
- Do not connect power to the Clean Power VFD until the installation has been fully completed and the Clean Power VFD is ready to be operated.

Failure to do so may cause an electrical shock and result in personal injury or even death.

- Integral solid-state short circuit protection does not provide branch circuit protection.

Branch circuit protection must be provided in accordance with the National Electrical Code (in North America) and any additional local codes.

Failure to install properly rated fuses may result in fire.

- The AC supply to the Clean Power VFD must be installed with fuses to provide protection against overloads and short-circuits.

Nominal fuse ratings are shown in this user guide.

Failure to install properly rated fuses may result in fire.

 **CAUTION**

- Lock out and tag out all potential energy sources before working on the Clean Power VFD.
- Do not share the ground wire with other devices, such as welding machines or electrical equipment using a high current.

Improper equipment grounding may cause the VFD to malfunction due to electrical interference.

Risk of equipment malfunction.

- When using multiple Clean Power VFDs, ground each drive according to instructions.

Do not share a common ground between devices.

Improper grounding of equipment could result in abnormal operation of the drive.

Risk of equipment malfunction.

- Ensure that input and output power cables are kept remote from the control cables in order to avoid interference with the latter.

If this is not possible, ensure that all crossovers occur at a right angle in order to minimize signal noise interference.

Risk of equipment malfunction.

- Do not start or stop the Clean Power VFD with a magnetic contactor.

Risk of damage to equipment.

- High levels of current drawn during power-on can affect the system.

Ensure that correctly rated circuit breakers are installed to operate safely during power-on.

Risk of nuisance breaker trip.

- High impulse voltages, like lightning, may cause damage to the VFD.

While SmartD VFDs have built-in surge protection, they do not have sufficient protection to mitigate a lightning strike or similar high-energy event.

SmartD recommends the use of specialized surge protectors in areas prone to frequent lightning strikes.

- Always mount the VFD before carrying out wiring connections.

Moving or mounting the VFD when wires are already connected may damage the wires and/or terminals, loosen the terminal connections or cause complete cable disconnection.

- When wiring the power, do not connect more than one wire to a terminal position.
- The power supply must be connected to the R/L1, S/L2, and T/L3 terminals.

Connecting them to the U/T1, V/T2, and W/T3 terminals will damage the Clean Power VFD.

- Shielded cables must be used for control terminal wiring.

Failure to do so may cause malfunction due to interference.

- When grounding is needed, use shielded twisted pair cables.

3.6.2. Power cables and fuses specifications for USA and Canada

The data listed in the table below are only used to select fuse and cable dimensions for USA / Canada.

For power terminal wiring use only 600 V 75°C rated copper wire with the cable dimension specified in this document.

In accordance with UL61800-5-1:

The fuses are required for branch circuit protection per the National Electrical Code (NEC) (One fuse per phase)

Fuses are not included in the purchased drive and must be provided by others.

Fuses with higher current ratings than the specified ones must not be used.

When installing a drive always follow installation instructions and NEC requirements.

Refer to local codes and regulations.

Clean Power VFD model	Recommended fuse	Cable for Power Connections	Cable for grounding connections
SDB-1-2-185	Class J or class T, 50A -600V	AWG 8	AWG 8
SDB-1-2-185-A and SDB-2-2-220-A	Class J or class T, 50A -600V	AWG 8	AWG 8

Instead of a fuse, a circuit breaker can be used for branch circuit protection.

SmartD recommends the device(s) that have been tested with the given Clean Power VFD model.

Clean Power VFD model	Suitable circuit breaker
SDB-1-2-185	HJL360700
SDB-1-2-185-A and SDB-2-2-220-A	HJL360700

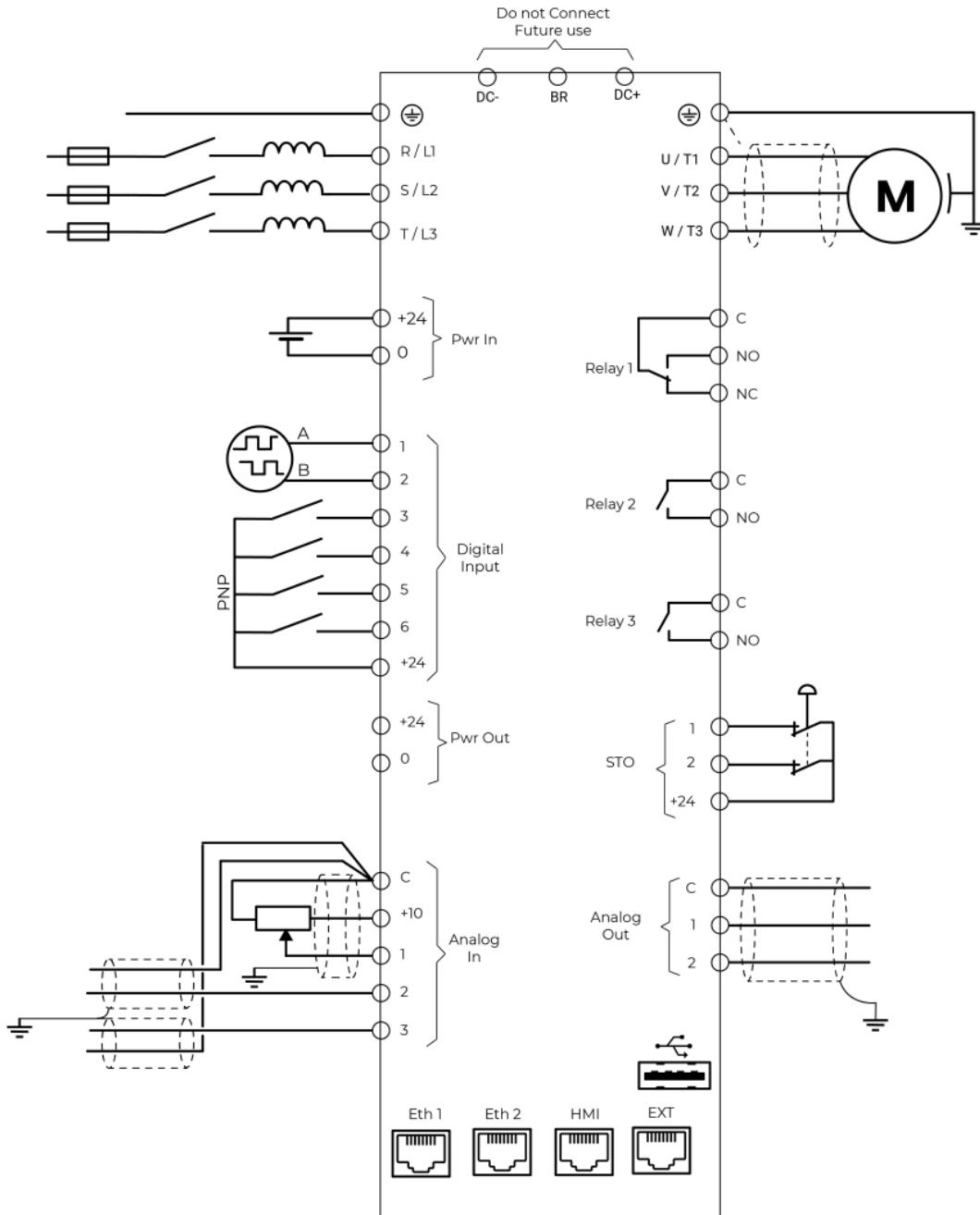
Note that the VFD SDB-1-2-185 is suitable for use on a circuit capable of delivering not more than 5,000 rms Symmetrical Amperes, 480 Vac maximum, when protected by a circuit breaker, having an interrupting rating not less than 5,000 rms symmetrical amperes, 480 Vac, with a maximum rating of 70 A, 480 Vac.

SmartD recommends adding a 1 mH line reactor (input choke) between the fuses and the input power line of the Clean Power VFD. This line reactor creates a magnetic field when current flows through it, increasing the impedance of the line and reducing the total harmonic injected from the VFD onto the power electrical system.

3.6.3. Standard connection diagram

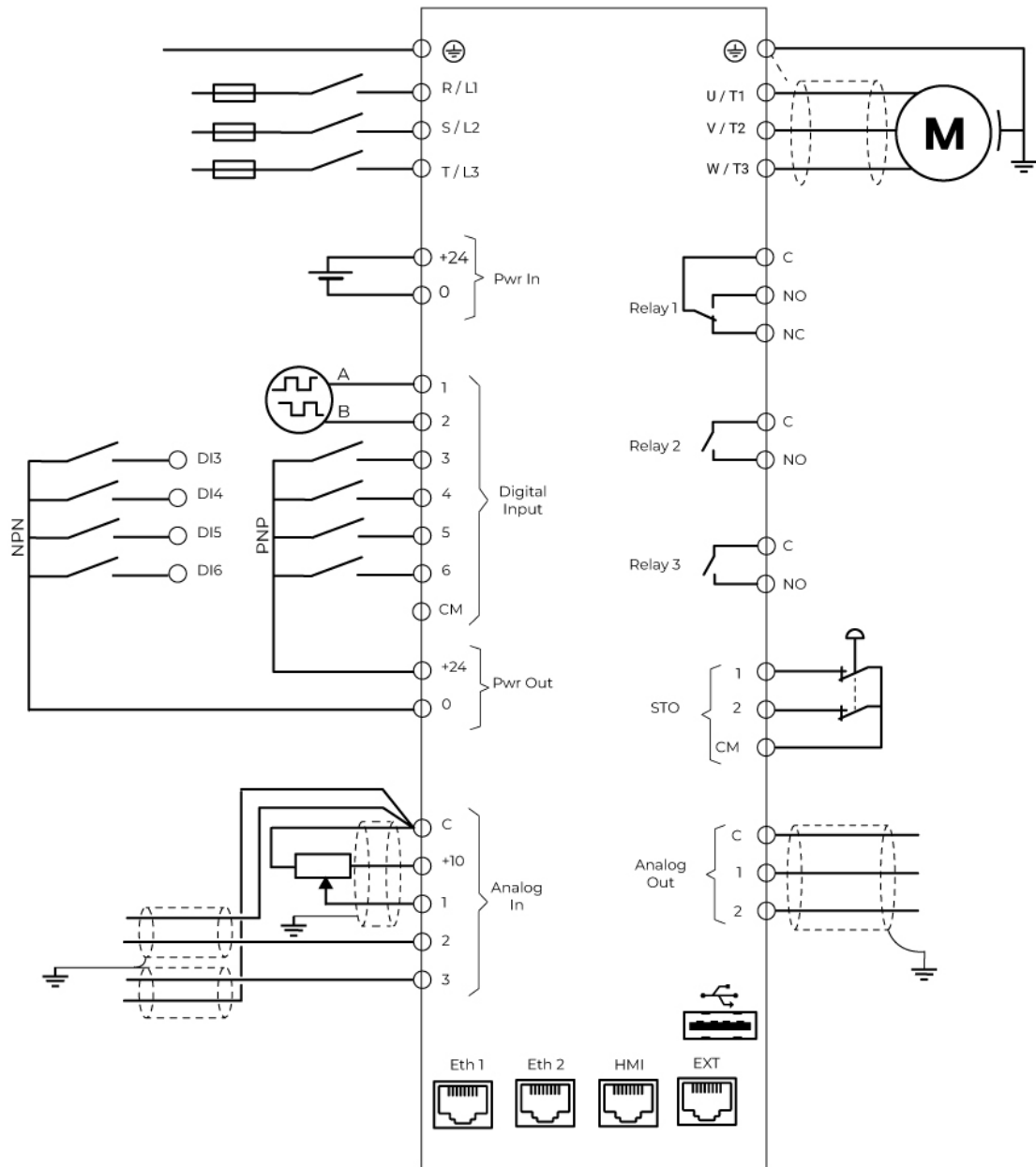
Standard Connection Diagram SDB-1-2-185

This diagram illustrates the typical connections of the Clean Power VFD.



Standard Connection Diagram SDB-x-y-zzz-A

This diagram illustrates the typical connections of the Clean Power VFD, part numbers that embed an active front end (AFE)

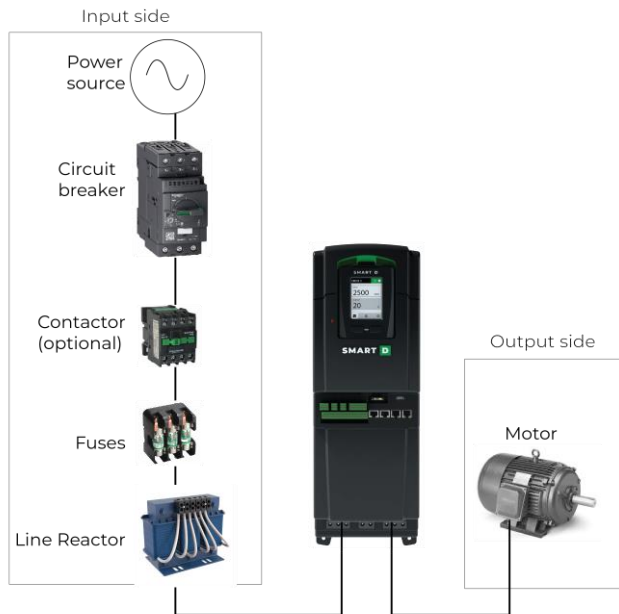


3.6.4. Basic configuration

The diagram below shows the basic system configuration. Refer to this diagram when connecting the Clean Power VFD within the overall system.

Also, ensure that each component in the system has the appropriate rating for the application and that the complete installation complies with local electrical codes.

Basic configuration SDB 12 185



Basic configuration SDB x yyyy A (AFE)



3.6.5. Basic wiring rules

SmartD recommends following those essential wiring rules:

- Install the ground connection as specified in the [wiring power connections](#) section.
- When you wire power and control cables in the terminal blocks, only use cables that meet the required specification for the safe and reliable operation of the product. They are described [here for North America](#) and [here for Europe and IEC word](#).
- Read the following information carefully before doing the wiring connections to the Clean Power VFD.
- Keep at least 150mm between high-voltage and low-voltage wires. Running in different trays inside the panel.


3.6.6. Main electrical lines and motor connections

This section describes the functions, specifications, and procedures required to safely connect the Clean Power VFD to the electrical mains and to the motor.

When you install power and signal cables in the terminal blocks, only use cables that meet the required specification for the safe and reliable operation of the product.

Refer to the following information to assist you with cable selection.

Configuration power terminals block

Marking	Name	Function
R / L1	Mainline input terminals	Connect the main supply to the Clean Power VFD power input.
S / L2		
T / L3		
	Grounding	Connect to earth (Impedance of the connection must conform with local regulations).
U / T1	Power output terminals	Connect the motor to the Clean Power VFD power output.
V / T2		
W / T3		

SDB-1-2185 Power terminals specifications

Wiring specifications

Clean Power VFD model	Terminal	Screw	Tightening torque	Conductor stripping length	Solid conductor cross section
SDB-1-2-185	Ground	M5, Combo head .25/6.25 blade, #2 pozidrive	2.7 N.m 24 in-lbs	12 mm 0.5 in.	10 mm ² AWG 8
	R/L1, S/L2, T/L3	M5, Combo head .25/6.25 blade, #2 pozidrive	2.7 N.m 24 in-lbs	12 mm 0.5 in.	10 mm ² AWG 8
	U/T1, V/T2, W/T3	M5, Combo head .25/6.25 blade, #2 pozidrive	2.7 N.m 24 in-lbs	12 mm 0.5 in.	10 mm ² AWG 8

SDB...A Power terminals specifications

Wiring specifications

Clean Power VFD model	Terminal	Screw	Tightening torque	Conductor stripping length	Solid conductor cross section
SDB-1-2-185-A SDB-2-2-220-A	Ground	- Thread: M5, - Slotted screwdriver size (Blade thickness x Width) (mm): 1.0x5.5 - Philips screwdriver size: PH2	-Rated: 3.8 N.m / 33.6 in-lbs -Recommended min: 3.73 N.m / 33.01 in-lbs -Recommended max: 4.5 N.m / 39.8 in-lbs	18 to 19 mm 0.71 to 0.75 in.	max 35 mm ² max AWG 2
	R/L1, S/L2, T/L3	- Thread: M5, - Slotted screwdriver size (Blade thickness x Width) (mm): 1.0x5.5 - Philips screwdriver size: PH2	-Rated: 3.8 N.m / 33.6 in-lbs -Recommended min: 3.73 N.m / 33.01 in-lbs -Recommended max: 4.5 N.m / 39.8 in-lbs	18 to 19 mm 0.71 to 0.75 in.	max 35 mm ² max AWG 2
	U/T1, V/T2, W/T3	- Thread: M5, - Slotted screwdriver size (Blade thickness x Width) (mm): 1.0x5.5 - Philips screwdriver size: PH2	-Rated: 3.8 N.m / 33.6 in-lbs -Recommended min: 3.73 N.m / 33.01 in-lbs -Recommended max: 4.5 N.m / 39.8 in-lbs	18 to 19 mm 0.71 to 0.75 in.	max 35 mm ² max AWG 2

Motor cable length and voltage drop:

The maximum length for the cable between the motor and the Clean Power VFD is 300 m (1000 ft).

Ensure that voltage drop is correctly accounted for in wire size selection.

If the calculated voltage drop is >2% of the rated motor voltage, then increase the gauge of the wire.

Ensure that the selected gauge is compatible with the terminal blocks of the Clean Power VFD.

Voltage drop may be calculated using the following formula:

Line loss voltage (V) = $\sqrt{3}$ x wire resistance (Ω /m) x wire length (m) x current (A)

Grounding:

The Clean Power VFD must be connected to the earth ground of the AC supply.

Ensure that grounding wires meet the technical standards for electrical equipment.

Impedance must conform to national and local regulations, safety regulations, and/or electrical codes.

Furthermore, ensure that the length of grounding wires is minimized.

The Clean Power VFD SDB-x-y-zzz-(A) has 2 earth (ground) terminals that must be securely connected to the earth ground before use.

The Clean Power VFD enclosure has been designed with materials that ensure electrical isolation. Despite this, there is the possibility that small leakage currents may still be present.

In order to mitigate the risks posed by these leakage currents, the Clean Power VFD must be connected to low-impedance earth ground.

Proper grounding eliminates the risk of electric shock due to leakage current when touching the Clean Power VFD case.

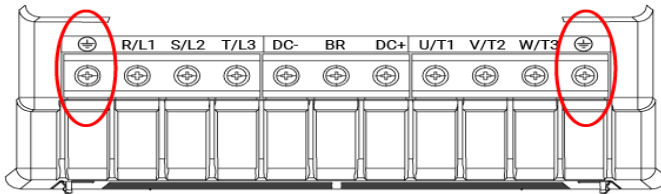
In addition to the mitigation of leakage current, a good low-impedance ground is important for the correct functioning of EMI-sensitive equipment, it reduces the impact of electrical noise in the installed environment.

3.6.7. Wiring power connections

1. Wire your Clean Power VFD as per the [connection diagram](#).
2. **Select the appropriate cable** following the recommendation given in the section "Power cables and fuses specifications."

and connect the cable to one of the ground terminals of the Clean Power VFD.

For basic VFD part number SDB-1-2-185 A:



For AFE VFD part number SDB-x-y-zzz-A :

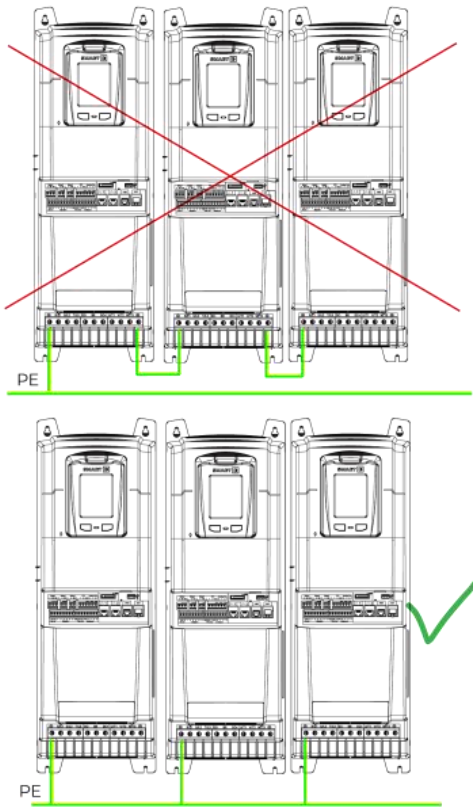


2. Carefully tighten the screw at the recommended torque. Torque values are listed [here](#).
3. **Connect the other end of the ground cables** to the supply earth ground terminal.

Use a dedicated ground wire for input power, motor power, and control wiring.

Each Clean Power VFD must have its own low-impedance ground connection, ensuring that ground wires are as short as possible.

Do not daisy-chain ground connections between multiple Clean Power VFDs as shown in the diagram.



4. Locate the Clean Power VFD input and output terminals on the power terminal block.

Refer to the detailed descriptions to understand the function and location of each terminal before making wiring connections.

5. Connect the motor to the U/T1, V/T2, W/T3 terminals.

Run motor cable separately from other signals.

Follow the wiring requirements specified by the motor manufacturer.

6. Connect the AC input power cables to R/L1, S/L2, T/L3 terminals.

3.6.8. Output circuit and motor protection

Clean Power VFD protection against short circuits. [↕](#)

In case of short-circuit on the outputs, the Clean Power VFD will immediately shut down its output and generate an alarm.

This protection is not configurable by the user.

No additional short-circuit protection devices are required.

Motor protection against overload. [↕](#)

The Clean Power VFD provides overload protection for the motor and its cable.

If the current drawn by the motor exceeds a threshold for a defined time, the Clean Power VFD will shut down its outputs and generate an alarm.

For more details, refer to the section Alarms and Protections

If the Clean Power VFD controls more than one motor, it is recommended that each motor be connected to the Clean Power VFD through a protection relay since the Clean Power VFD cannot protect each motor individually.

3.6.9. Parallel connection of several motors to One Clean Power VFD

The Clean Power VFDs allow parallel operation of several motors operating in V/F mode.

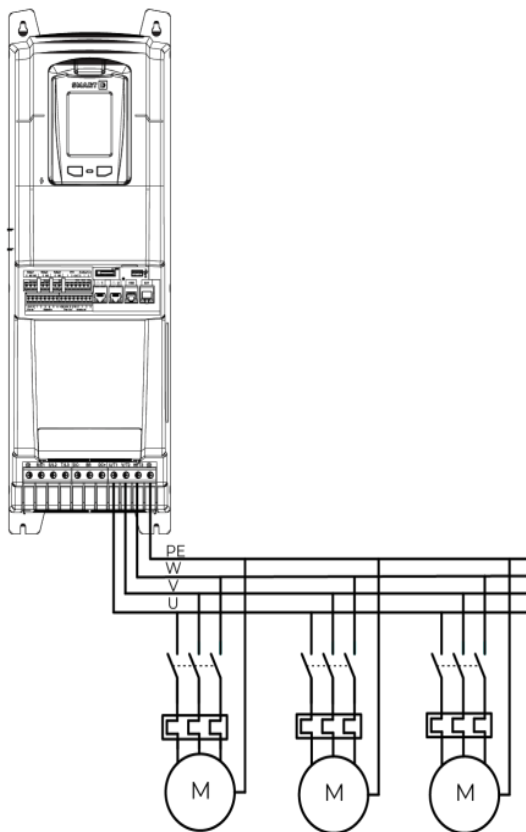
The sum of all motor currents must be less than the Clean Power VFD's rated current.

If you are connecting multiple motors on one Clean Power VFD you must select and install contactors for each motor according to utilization category AC3.

Each motor contactor must be sized according to the rated current of the corresponding motor.

The embedded protection functions of Clean Power VFD will not operate correctly in a parallel motor configuration and should not be used.

Each motor must be protected with external thermistors and/or overload relays.

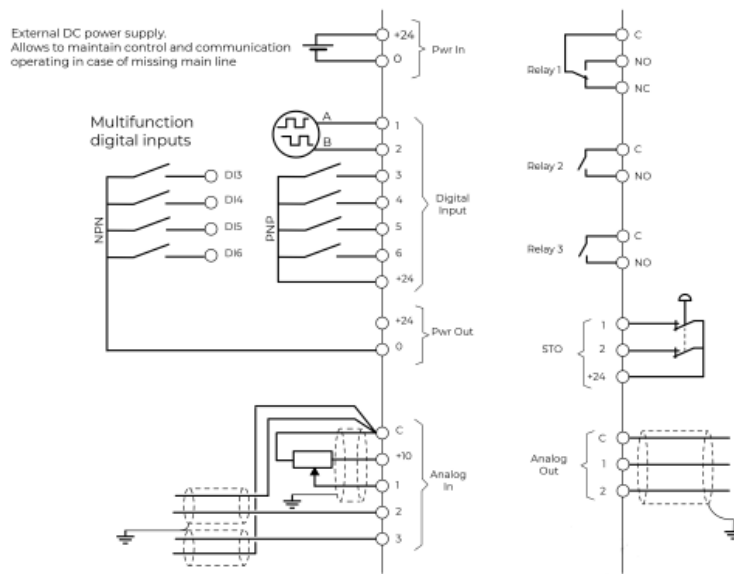


3.6.10. Control Circuit description

Control Circuit Connection Diagram and functions

The illustration below shows the detailed layout of control wiring terminals.

Ensure that the selected cables meet or exceed the [specifications](#).



24VDC power in

A 24VDC external power supply can be connected to the terminals Pwr In (terminals +24V and 0).

The 24VDC auxiliary supply will power the Clean Power VFD control board in the absence of line power, allowing both communications and the HMI to continue to operate.

If a 24VDC is used while commissioning the Clean Power VFD and line power is absent, the Clean Power VFD will be in the under-voltage alarm state.

Ensure to use a DC power supply that meets the following specifications:

- Nominal operating voltage: 24 VDC
- Minimum continuous operating voltage: 19.2 VDC
- Maximum continuous operating voltage: 28.8 VDC
- Maximum power supply requirement at 24V: 50 W
- Recommended protection fuse: 4A - 50 VDC

24VDC power out

Clean Power VFD provides the user with a 24VDC power out on the terminals Pwr Out (terminals +24VC and 0 onto SDB-1-2185, terminals CM and 0 onto SDB-x-zyyy-A).

This power is used to energize the digital inputs or to energize some sensors.

Ensure that the maximum current level, as defined in the following specifications, is respected.

- Nominal operating voltage: 24 VDC
- Minimum continuous operating voltage: 19.2 VDC
- Maximum continuous operating voltage: 28.8 VDC
- Maximum output current at 24V: 100mA
- Recommended protection fuse: 4A - 50 VDC

Digital input terminals

Marking	Name	Default Operation
1	Digital input 1	User settable, can be used for an encoder, phase A. Default setting: unused
2	Digital input 2	User settable, can be used for an encoder, phase B. Default setting: unused
3	Digital input 3	Run forward
4	Digital input 4	Run Reverse
5	Digital input 5	Stop
6	Digital input 6	Select reference speed between preset 1 and analog input 1
+24	Common terminal for digital inputs	

The digital inputs can be assigned by the user to various functions:

- Rotation direction,
- Stop,
- Selection of the speed setpoint source
- Selection of the local/remote control mode

Their logic operation is also user settable; the choices are between:

- rising or falling edge
- level high or low

last, a debounce delay is also user settable to avoid false input triggering.

Analog Input terminals

Marking	Name	Default Operation
1	Analog input 1	Speed reference (Hz) - preset to be used as potentiometer input
2	Analog input 2	un-assigned
3	Analog input 3	un-assigned
+10V	Reference power supply	10VDC - 10 mA max
C	Common terminal for Analog inputs	

Analog inputs from AI1 to AI3 can be assigned by the user to various functions and various electrical signals.

Available choices for the functions are

- Speed (frequency - Hz) setpoint
- Velocity (RPM) setpoint
- PTC motor thermal sensor
- Unused.

The signal that can be wired to Analog input can be either

- 0..10VDC,
- 0..20mA,
- 4..20mA,
- PTC.

Relays output terminals

Relay 1: SPDT

Marking	Name	Default Operation
C	Common of the contacts	Relay 1 (SPDT) is assigned by default to be the alarm relay. The relay is energized when there is no alarm present (C and NO connected). The relay is de-energized when there is an alarm or a loss of power supply (C and NC connected)
NO	Normally opened contact	
NC	Normally closed contact	

Relays 2 and 3: NO

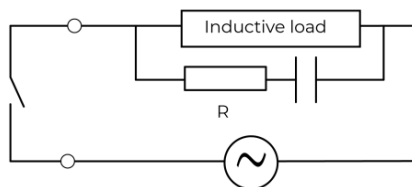
Marking	Name	Default Operation
C	Common of the contact	Relay 2 (NO) is the factory default settings to be closed when the drive is in the state "ready to run" Relay 3 (NO) is the factory default settings to be closed when the drive is in the state of "running"
NO	Normally opened contact	

The operation of the 3 independent relay outputs of the Clean Power VFD can be set by the user.

The settings are described in the section [Functions and Parameters](#).

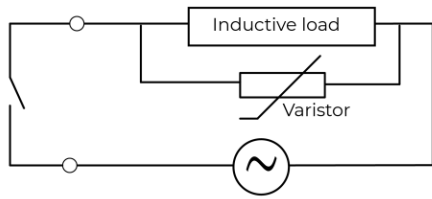
Relays protection

Always protect relay outputs from inductive load damage, using an appropriate external protective circuit or device.

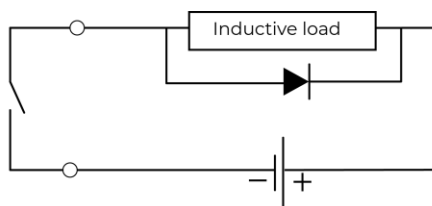


C: capacitor from 0.1 to 1 μ F.

R: resistor of approximately the same resistance value as the load.



In applications where the inductive load is switched on and off frequently and/or rapidly, ensure that the continuous energy rating (J) of the varistor exceeds the peak load energy by 20 % or more.



Use a diode with the following ratings:

Reverse withstand voltage: power voltage of the load circuit x 10.

Forward current: more than the load current.

Analog Output terminals

Marking	Name	Default Operation
1	Analog output 1	Analog Output 1 is factory preset to be assigned to the motor frequency. The preset signal is 0..10VDC
2	Analog output 2	Analog Out 2 is factory preset to be assigned to the motor current I _{rms} total. The preset signal is 0..10VDC
C	Common terminal for Analog outputs	

Analog outputs 1 and 2 can be assigned by the user to various functions and various electrical signals.

Available choices for the functions are

- Motor Current
- Motor Frequency
- Motor Torque
- Motor Power
- Drive thermal state.
- Unused.

The signal that is delivered by Analog output can be either

- 0..10VDC

- 0..20mA
- 4..20mA.

Selection and scaling are made by the mobile App.

STO terminals

The Safe Torque Off (STO) enabling terminals are positive logic input only.

The user is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

If the Safe Torque Off function is not required, the terminals STO1 and STO2 must remain connected to +24VDC.

Mark	Name	Default settings
STO1	Safe torque off - input 1	<p>Open: STO is enabled, and the Clean Power VFD output is de-energized.</p> <p>Closed: STO is disabled, and the Clean Power VFD is in normal operation</p> <p>Note: Remove the jumper between STO1 and +24V during the use of the safety deactivation input.</p> <p>The length of the wire should not exceed 30 m (98.4 ft).</p>
STO2	Safe torque off - input 2	<p>Open: STO is enabled, and the Clean Power VFD output is de-energized.</p> <p>Closed: STO is disabled, and the Clean Power VFD is in normal operation</p> <p>Note: Remove the jumper between STO2 and +24V during the use of the safety deactivation input.</p> <p>The length of the wire should not exceed 30 m (98.4 ft).</p>
+24 / CM	Safe torque off supply connection	<p>Delivers +24V for the STO inputs when the VFD is configured in Source logic mode.</p> <p>Refer to digital input logic connection section to wire correctly the STO terminals</p>

3.6.11. Control terminals blocks features.

Screw type	M3
Tightening torque	0,5 Nm ... 0,6 Nm 4.42 in-lbs ...5.31 in-lbs
Conductor stripping length	7 mm 0.28 in
Solid conductor cross-section	0,2 mm ² ... 2,5 mm ² AWG 24 ... 14
Flexible conductor cross-section with Ferrule	0,25 mm ² ... 2,5 mm ² AWG 23 ... 14
2 Solid conductors with the same cross-section	0,2 mm ² ... 1 mm ² AWG 27 ... 14
2 Flexible conductors with the same cross-section	0,2 mm ² ... 1,5 mm ² AWG 27 ... 15

3.6.12. Digital input Logic Connection

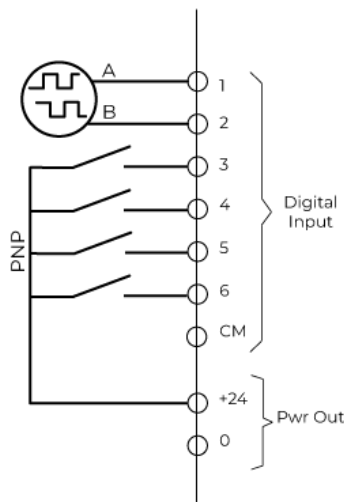
Sourcing / Sinking

Digital inputs DI1 to DI6 can be wired either in Source (PNP) or Sink (NPN) mode.

Selection is made by settings in the software. By default, the digital inputs are set to be wired in Source (PNP) mode.

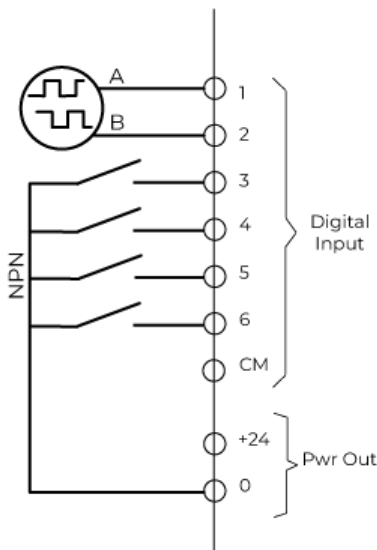
Note, you cannot mix source and sink wiring modes, all inputs from DI1 to DI6 must be wired in the same mode.

Wiring in Source mode

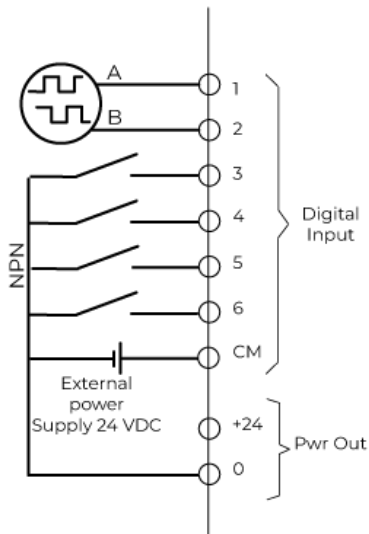


i The terminal CM, within the Digital Input group, is named +24 on former generation of Clean Power VFD.

Wiring in Sink mode - use of the internal power supply

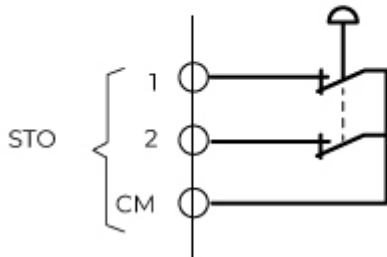


Wiring in Sink mode - use of an external power supply



STO wiring

VFD set in Source or Sink logic mode:



Terminals 1 and 2 must always be energized by +24VDC.

If you don't use the STO function, do not remove the short-circuit already wired on the delivered VFD.

If you used the STO function, the safety chain contacts output must be wired as the above example.

3.6.13. 2-wires, 3-wires, preset control modes

There are 2 wiring presets with their configuration selectable by the user, via the mobile application

The default preset is the 3-wires configuration.

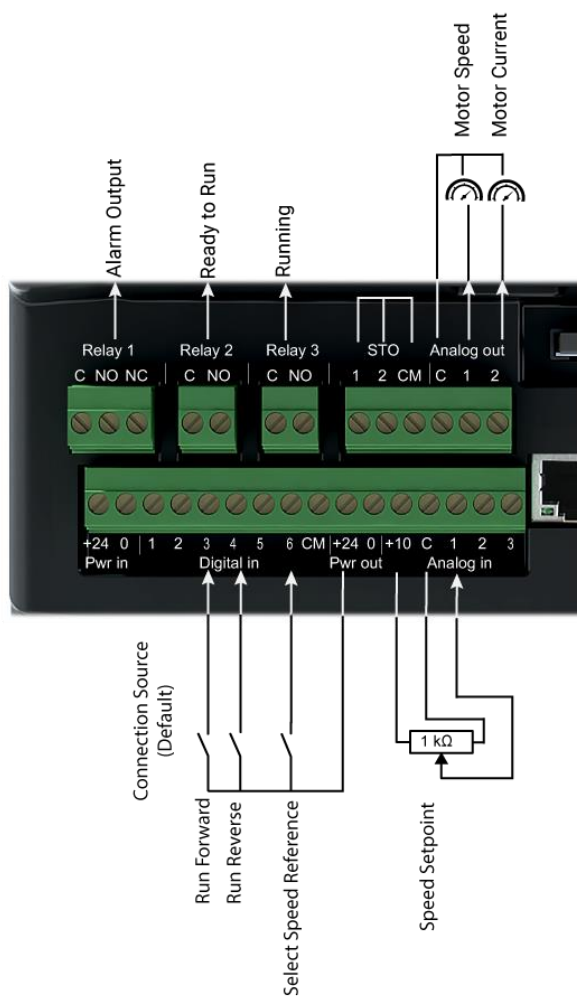
The following drawings show the I/O's that are used in the default presets with their function assignment. Those drawings are not wiring diagrams.

Check the [standard connection diagram](#) section for the wiring,

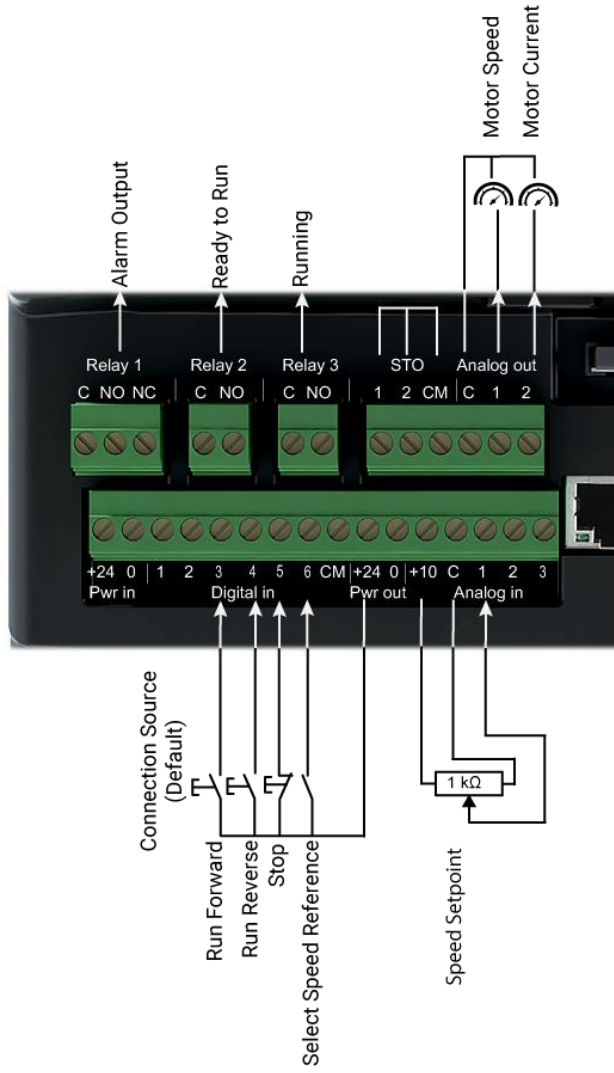
check the [control circuit description](#) section for the attributes and values of the control terminals,

check the [digital input logic connection](#) section for the details of Source and Sink logic connection modes.

2-wires connection



3-wires connection



3.6.14. Essential requirements for CE compliance

It is recommended to apply EMC best practices to

1. Assure personnel's safety
2. Protect installations against power system faults and lightning (Earthing),
3. Allow a low impedance path to divert the power faults current and high-frequency currents without passing through other equipment and to ensure equipotential (Bonding),
4. Ensure the equipment's performance and reliable operation,
5. To comply with EMC regulations.

The Clean Power VFD is open-type, it must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) for compliance with the Low Voltage Directive (LVD)

The motor cable should be kept as short as possible in order to avoid electromagnetic emissions as well as capacitive currents.

Note that conformity of a VFD with CE EMC requirements does not guarantee an entire machine/installation complies with CE EMC requirements.

Installation compliance is governed by the specific characteristics of a given installation.

Grounding must be done as described in the section [Wiring power connections](#).

Output power, control (I/O), and network wiring must be braided.

Use a shielded cable with a coverage of at least 75%.

Ground a large surface area of the shield at both ends.

4. Starting procedures

4.1. Operating the Clean Power VFD : Safety messages

DANGER

- Do not open the Clean Power VFD when powered.

Risk of electrical shock.

- Do not touch any of the terminals of the Clean Power VFD when powered.

Risk of electrical shock

WARNING

- The STOP function does not remove dangerous voltages from the Clean Power VFD or the motor.

Risk of electrical shock when touching live parts.

- The Safe Torque Off function does not remove dangerous voltages from the Clean Power VFD or the motor.

Risk of electrical shock when touching live parts.

- The Clean Power VFD becomes hot during operation.

Avoid touching the Clean Power VFD until it has cooled .

Risk of injury - burn.

CAUTION

- Ensure that the Clean Power VFD is free from foreign objects during installation and operation.

Risk of device damage.

- Do not control the start/stop of the Clean Power VFD by switching a contactor ON and OFF.

Risk of device damage.

- If the motor rating does not match that of the Clean Power VFD, especially when the rated power of the Clean Power VFD is higher than that of the motor, adjust motor protection parameters in the Clean Power VFD or install a thermal relay to protect the motor.

Risk of damage to the motor and/or Clean Power VFD.

- If the Clean Power VFD is required to operate above the motor nominal frequency (50.00Hz or 60Hz depending on your location), please take the endurance of mechanical devices into consideration.

4.2. Powering the Clean Power VFD : Safety messages

WARNING

- When the Clean Power VFD is powered-on, if there is an active command on the control inputs, the Clean Power VFD will run immediately.
- When using the 2-wires control method, ensure that the inputs are turned off prior to powering up the Clean Power VFD.

Risk of serious injury.

CAUTION

- Resolve all faults before powering on the Clean Power VFD.

If a fault is still present when the Clean Power VFD is powered on, it will not exit the lockout state.

To remove the lockout state, follow the instruction from the [system reset](#) chapter of this document.

- When the Clean Power VFD is powered on, a large inrush current flows for charging the DC bus capacitor.

A current-limiting resistor in the device limits the peak value of the inrush current. Once the DC bus is fully charged, an internal relay removes the resistor from the circuit.

Do not switch the variable frequency drive (VFD) on and off too frequently (more than 5 times per day) with a magnetic contactor. Repeated exposure to peak inrush current will shorten the lifetime of the rectifier and inrush-limiting circuits.

- Verify that
 - the input voltage is identical to the rated voltage of the product;
 - the correct wiring of input terminals R, S, and T;
 - the correct wiring of output terminals U, V, and W.

Risk of Clean Power VFD damage.

- A fault trip may be triggered if the Clean Power VFD starts operation while a motor's load (fan-type load) is in a free-run state.

4.3. Get the mobile App

Get the smartphone App to configure your Clean Power VFD.

Phone requirements:

- Android phone with firmware version 9 or higher,
- iOS phone with firmware version 13.0 or higher.

The SmartDrive Manager app can be downloaded with any of the methods below:

- Scan the QR code displayed on the Clean Power VFD's HMI screen, this will bring you to the google play store or Apple store for App downloading.
- or scan the following QR code with your cell phone:

Apple store:



Google Play:



4.4. First Time Authentication

Once the app is installed, the user can log in with username "admin", and password as the serial number of the CleanPower VFD

The serial number of the Clean Power VFD must be written with a hyphen, in this format:
xxxx-xxxxxxxx-xxxxxx

The serial number of the Clean Power VFD is written on the device side label that is described in the section [VFD nameplate description](#)

4.4.1. Pairing with the Ethernet connection

1. Connect the Clean Power VFD to your local network

The Clean Power VFD provides users with 2 Ethernet ports.

Before powering up, connect one of the Ethernet ports to your local network

See the product [description](#)

2. Connect your SmartPhone with App to the same local network

Use your smartphone setting menu to select and connect to the correct WiFi network.

3. Power up

Power up the Clean Power VFD and wait until the end of the booting process.

4. Access to the setup menu

When booting is complete, the HMI displays the Clean Power VFD dashboard.

Tap the hamburger menu button to enter the set up menu.



5. Select Setup Mobile App .



6. Scan to pair

With your phone, open the SmartDrive App

6.1. If your VFD settings have already been made offline

Select the Clean Power VFDs you want to download to the drive, tap on "Connect" and follow the instruction to power the VFD (if not yet done) and scan the QR code displayed on the VFDs HMI.

6.2 If Your VFD settings have not been made

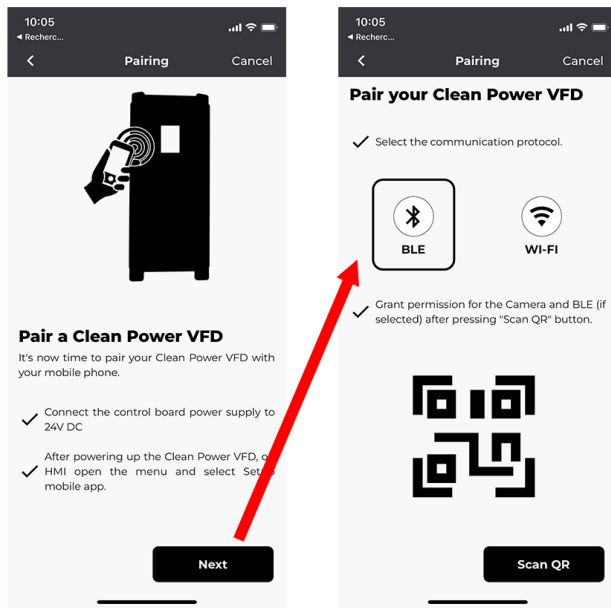
Select "Add a VFD" in the pop-up window, select "Set-up online" and follow the instruction to power the VFD (if not yet done) and scan the QR code displayed on the VFD HMI.

6.3 Wait a few seconds until you see the Clean Power VFD and your SmartPhone paired

4.4.2. Pairing with BlueTooth

To connect and pair your SmartDrive Manager App using the BlueTooth connection, follow the steps:

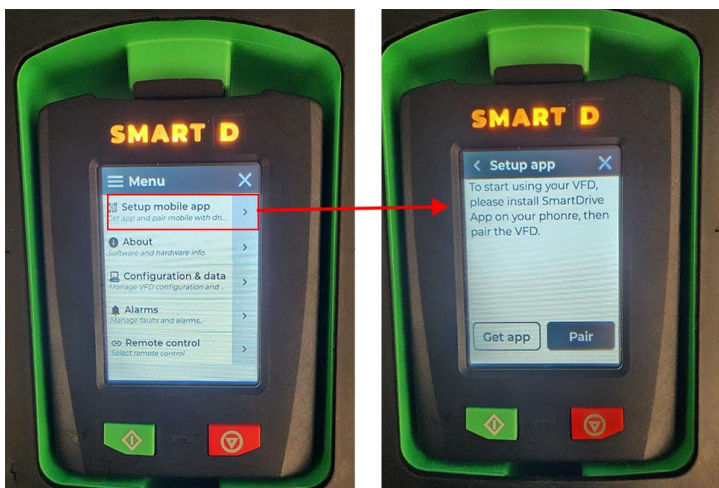
- 1- **ensure that the BlueTooth is activated** on your phone
- 2- **start the SmartDrive Manager App**
- 3- Tap "**Add a VFD**" and select "**Setup online**"
- 4- Follow the sequence displayed on your screen, moving step by step and tapping the button "next" to go to the **pairing** task
- 5- Once the pairing page is displayed, **select "Bluetooth (BLE)"** and click on "**scan QR**"



6- On the **Clean Power VFD HMI**, tap the hamburger button to display the menu.



7- select "**set up mobile App**" to pair the Clean Power VFD with your SmartDrive manager App.



Then tap on the button "Pair"

12- The screen is displaying the button "**Scan**".

Tap on the button "scan" to display the pairing QR code.

Then **scan the QR code with your SmartDrive App** to execute the pairing.



When the Clean Power VFD is advertising its Bluetooth connection, you have one (1) minutes to scan the displayed QR code.

During this time, the HMI LEDs are blinking in blue.

Past this time, you must close the HMI menu and restart from step 6.

4.5. Check list: Before starting the Clean Power VFD

The following list intends to help the user go through a stepwise check before powering up the Clean Power VFD.

Model number.

Check the model number of the Clean Power VFD to make sure you have received the correct model.

Environment.

Check that the area and environment around the Clean Power VFD comply with the specifications.

Power supply voltage.

Check that the power supply voltage is within the range of the input voltage specifications of the Clean Power VFD.

Motor voltage

Check that the nominal motor voltage corresponds to the output specifications of the Clean Power VFD.

Short-circuit protection

Check that a short-circuit protection is properly installed, complying with international and local regulations.

Power supply connections

Check that the main line power supply is correctly wired to the terminals R / L1, S / L2, and T / L3 of the Clean Power VFD.

Connection to the motor

Check that the Clean Power VFD is connected properly to the motor.

The motor cables must correspond to the output terminals U / T1, V / T2, and W / T3 of the Clean Power VFD to respect the order of the phases.

If the phase sequence is incorrect, the motor will rotate in the reverse direction.

Cross-section of the wires

Check that the cross-section of the wires complies with the recommendation of this document.

Voltage drop on the cable

Check that the voltage drop on the cable between the Clean Power VFD and the motor is less than 2% of the motor's nominal voltage.

Grounding

Check that the Clean Power VFD is properly connected to the ground.

Power terminal screws tightening torque.

Check that the power connectors' screws are tightened as specified in this document.

Power cables end connections

Check that the cables are not loosened from the terminals and not stripped too long, to avoid risks of short circuits.

Multiple motors protection

When using multiple motors on a single Clean Power VFD, ensure that each motor is installed with overload protection.

Cables for control

Check that all control wiring to the Clean Power VFD control circuit uses twisted pair cables.

Shielding

Check that all the shielding on all shielded cables is connected to the protective earth terminal.

Wiring preset

Check that the wiring preset (3-wires or 2-wires) complies with the schematic in this document.

STO1 and STO2 terminals

Check that the STO1 and STO2 terminals are correctly wired to a safety device. If STO is not used in your application, check that STO1 and STO2 terminals are connected to the +24 terminal.

Control terminal screws tightening torque.

Check that the screws on the control terminal blocks are tightened as specified in this document.

Control cables end connections

Check that the cables are not loosened from the control terminal blocks and not stripped too long, to avoid risks of short circuits.

Clean connection

Check that no cable copper strands touch other terminals or connections on the terminal block.

Foreign objects

Pick up any small pieces of cables or copper that may remain on or around the Clean Power VFD from your stripping and wiring operations.

Separation of power and control

Check that control circuit wires and main circuit wires (power supply and motor) are correctly separated.

Analog signals cables

Check that the cable for the analog signal is shorter than 30 m (98.4 ft).

STO cables

Check that the cable length for the STO signal, from operating contacts to the Clean Power

4.6. Test run

Prerequisite

After the wiring checklist has been completed, follow the instructions below to test the Clean Power VFD.

This test procedure uses the digital and analog inputs of the Clean Power VFD to control it.

Test run steps

1. **Unloaded motor**

Check that the motor is separated from its mechanical load.

2. **Turn on the power supply**

Turn on the power supply to the Clean Power VFD. Ensure that the HMI and LEDs are ON.

Switch on the breaker upstream of the Clean Power VFD.

If you power the control board via its 24VDC, switch it on to check its operation.

3. **Setting**

Use the mobile App to set the motor and Clean Power VFD's parameters.

4. **Motor parameter**

Follow the wizard to set the motor parameter accordingly to its nameplate.

5. **I/O's configuration**

Select the I/O's preset configuration complying with your wiring.

6. **Frequency reference**

Select the frequency reference as external from Analog input 1

7. **Acceleration and deceleration**

Set acceleration and deceleration times taking into account that this test runs an unloaded motor.

8. **Download**

Follow the App instructions to download the settings into the Clean Power VFD

9. **Press the run button:** Start the motor and check the motor rotates in the correct direction.

If the forward command is on, the motor should rotate counterclockwise when viewed from the load side of the motor.

If the motor rotates in the reverse direction, stop the motor immediately.

You can change the default rotation direction via the setting parameter "[Phase Inversion](#)" without changing the wiring of the motor.

But if you prefer to exchange two phases on the output:

Then turn off the power supply to the Clean Power VFD.

Wait 5 minutes for the capacitors to fully discharge.

Finally, switch the cables at the U and V terminals.

Restart this test run from step 1.

10. **Change the speed**

Increase the analog input value slowly, then decrease it gradually.

The motor accelerates and decelerates accordingly to reach the speed set via the analog input

The set speed is displayed in the HMI

11. **Acceleration and deceleration**

Ensure that the motor accelerates and decelerates according to the set times and that the motor speed reaches the frequency reference.

Adjust acceleration and deceleration times.

Adjust torque boost parameters as described in the "[Starting torque boost](#)" section.

and download your new settings if any.

12. **If you use the STO function**, test its operation:

Open STO1 / STO2 when the motor is running.

The motor should stop because the Clean Power VFD deactivates its output.

Try to start the motor while STO1 or STO2 is not activated. The motor should not start.

If they are still not operating as expected, call SmartD technical support for assistance.

5. Mobile App

The SmartDrive Manager Mobile App is built to guide the user step by step.

A startup wizard asks the users for essential information needed by the Clean Power VFD so that it can control the driven system.

5.1. Configuration application

Get the smartphone App to configure your Clean Power VFD.

Phone requirements:

- Android phone with firmware version 9 or higher,
- iOS phone with firmware version 13.0 or higher.

The SmartDrive Manager app can be downloaded with any of the methods below:

- Scan the QR code displayed on the Clean Power VFD's HMI screen, this will bring you to the google play store or Apple store for App downloading.
- or scan the following QR code with your cell phone:

Apple store:



Google Play:



5.1.1. Intuitiveness

The smartphone application has been designed to ease the user's life.

It is speaking the user's natural language, meaning that each parameter and information is delivered in full text.

The settings of the Clean Power VFD are organized by logical steps and groups, they can follow the step-by-step approach to write and store their application parameters.

No programming guide is needed to complete this task.

When moving from one step to the next, the summary of the last setting is displayed, allowing the user to check and modify it if needed.

If a modified parameter must be rewritten to its default value, an icon allows the user to activate the default value in one single click.

5.2. Authentication

Once the app is installed, the user can log in with username "admin", and password as the serial number of the CleanPower VFD

The serial number of the Clean Power VFD must be written with a hyphen, in this format:
XXXX-XXXXXXXX-XXXXXX

The serial number of the Clean Power VFD is written on the device side label that is described in the section [VFD nameplate description](#)

5.3. Organization of the configurations

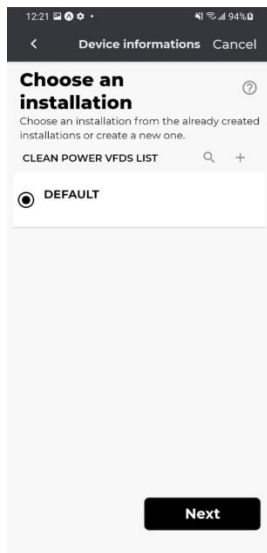
Each of the created configurations is defined by a unique name given by the user.

The configurations are organized in groups named "Installation".

Each Installation can be user-named for fast and easy management of the various Clean Power VFD configurations.

The installations are created when the user adds a Clean Power VFD configuration.

At this stage, the user can select a previously created installation or create a new one.



5.4 Configuration Notes

The configuration App provides the user with the possibility to write some notes to a VFD configuration file for several reasons.

It's good practice to make notes clear, concise, and directly relevant to the configuration settings they describe.

The notes area can be used to:

Documentation:

Just like any piece of software or hardware, good documentation is critical to its efficient use. Notes can provide insight into why certain parameters are set the way they are, which can be useful for troubleshooting or future modifications.

Clarification:

Particularly for complex systems, notes can help to clarify the purpose or function of specific parameters. This can help to reduce confusion and potential errors when the system is being adjusted or modified.

Collaboration:

If multiple people are working with the same VFD system, notes can aid in collaboration. They can inform others about changes that have been made, or need to be made, and can be used to communicate insights or suggestions.

Problem-solving and Debugging:

If there have been issues with the VFD in the past, notes can be used to record these and to detail how they were resolved. This can be a valuable resource if similar issues arise in the future.

Version Tracking:

If the configuration file undergoes regular changes, notes can be used to document these changes over time, effectively creating a log or history of alterations made.

6. Smart HMI

This section describes the HMI layout, functions, and operation method.

Ensure that you are familiar with the basic operation of the Clean Power VFD before deploying more complex features and settings or changing the Clean Power VFD frequency or rotation direction.

This Smart HMI is a graphic touchscreen.

It can be plugged into the Clean Power VFD front face or mounted remotely.

The Clean Power VFD can be controlled via its digital and analog I/Os, or via the Ethernet Ports, therefore the Smart HMI can be disconnected from the Clean Power VFD.

However, **do not disconnect or reconnect the Smart HMI while the Clean Power VFD is powered.**

Power-off the Clean Power VFD before disconnecting or connecting the Smart HMI.

6.1. Illuminated logo

The SmartD logo is illuminated in different colors and patterns, depending the Clean Power VFD status.

BLUE: Blinking blue during the pairing process window (maximum duration 5 minutes).

RED: Blinking red, the system has at least one unresolved CRITICAL alarm that is not **acknowledged** by the user.

Solid red, the system has at least one unresolved CRITICAL alarm, but this alarm has been acknowledged by the user.

Single blinking red (after booting the VFD or connecting the HMI), the HMI firmware has failed to start.

ORANGE: Blinking Orange, the system has no CRITICAL alarm but, at least one unresolved MAJOR alarm that is not acknowledged by the user.

Solid orange, the system has no CRITICAL alarm but, at least one unresolved MAJOR alarm that has been acknowledged by the user.

YELLOW: Blinking yellow, the system has no CRITICAL nor MAJOR alarms but, at least one unresolved MEDIUM alarm that is not acknowledged by the user.

Solid yellow, the system has no CRITICAL nor MAJOR alarms but, at least one unresolved MEDIUM alarm that has been acknowledged by the user.

GREEN: Blinking green, the system has no CRITICAL nor MAJOR nor MEDIUM alarms but, at least one unresolved MINOR alarm (minor alarm does need to be acknowledged)

Solid green, The system has no Alarm and is either in ready to run or running state.

WHITE: Blinking white, the HMI firmware is updating.

6.2. Functions of the HMI

The HMI is the local interface for user operations.

It gives access to several functions that are:

- Display the status of the Power Drive System (VFD + motor)
- Control the connected motor: start, stop, speed, and direction.
- Display the alarms, their status, and their statistics.
- Acknowledge and reset the alarm status.
- Access to the troubleshooting guide for the alarms
- Display the electrical values, powers, voltages, currents, and DC bus
- Display VFD cooling status.
- Export the audit file to a USB drive.
- Access to the online user guide.
- Access to the installation of the mobile App for your smartphone
- Reset to factory settings.
- Set the brightness of the display from 10 to 100%
- Set the date and time of the VFD. manually.

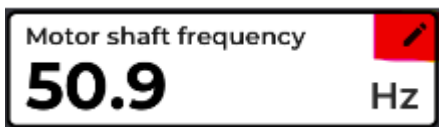
6.3. Control the Clean Power VFD from the Smart HMI

When the Clean Power VFD status permits user action (see Clean Power VFD status section), the following actions can be performed:

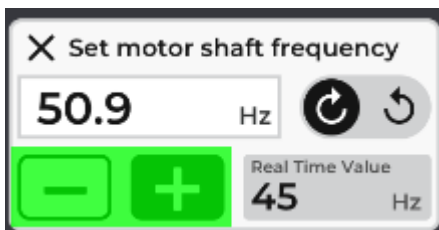
- start the motor: press the button start.
- stop the motor: press the button stop.
- Modify the speed reference and/or the rotation direction

Modify the speed reference and/or the rotation direction

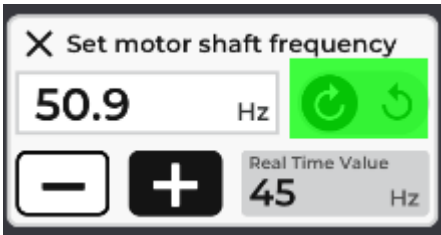
1. Click on the edit icon



2. increase or decrease the speed reference using the buttons + and -



3. change the motor direction by clicking (or sliding?) on the direction button:



note:

prior to changing the motor rotation direction, the VFD will stop the motor (following the preset ramp down).

The HMI will prompt for confirmation or cancellation of the action.

6.4. Display and set the motor speed.

The speed of the application can either be set and displayed in Hertz or in RPM, depending on the user's settings.

If the set parameter is speed, then the engineering unit is Hertz (Hz).

If the set parameter is velocity, then the engineering unit is revolution per minute (RPM).

Slip compensation and engineering units.

If the [slip compensation is enabled](#), then the HMI displays the velocity in RPM (no decimal)

If the slip compensation is disabled, then the HMI displays the speed in Hz.

Edit mode - change the setpoint:

The user can select between:

- Set velocity in RPM
Increment: +/- 1 RPM
- Set Preset Velocity (if preset velocities are configured on the drive)

Min and max velocities

If the user defines the application speed setpoint in RPM, the setpoint value must remain between the min and the max velocities configured on the Clean Power VFD.

The settings ask the user to define the [min and max frequencies of the motor](#) in Hz. To convert those values in RPM:

$$\text{min_velocity} = \text{min_frequency} * (\text{nominal_velocity} / \text{nominal_frequency})$$

$$\text{max_velocity} = \text{max_frequency} * (\text{nominal_velocity} / \text{nominal_frequency})$$

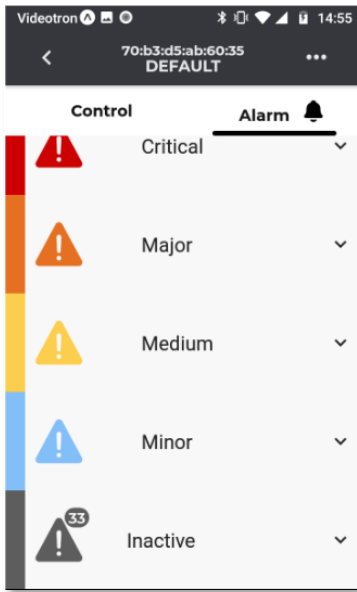
6.5. Access and manage the alarms.

Alarms can be accessed and managed either from your paired Smartphone or from the Clean Power VFD HMI.

Alarms using the paired Smartphone.

From the dashboard, click on ALARM in the upper right corner of the screen.

This opens the page that displays a general overview of the alarms, grouped by criticality.



The number and status of the alarm are summarized by the background color and by the acknowledgment radio button:

- besides the warning sign, the number of active alarms is displayed with a background related to the criticality, and the total number of alarms (active and past) with a dark grey background
- if the alarm is active, the background is colored according to its criticality.
- the radio button is filled if the alarm has been acknowledged, empty if not.



Acknowledge [↕](#)

Clicking on the radio button changes the alarm status to "acknowledge".

The radio button becomes filled.

Last event [↕](#)

Clicking on the i (information) radio button displays the last events of the alarm and the number of occurrences.

The last event gives the user the date and time of

- the alarm is detected,
- the alarm is acknowledged,
- the alarm is resolved.

7. Alarms and Protections

To protect your investment, the Clean Power VFD provides two categories of protection:

- protection from overheating damage to the motor, and
- protection against the Clean Power VFD malfunction.

In both cases, when protection is triggered, the related alarm notifies the user, and the event is logged.

7.1. If the Clean Power VFD is not configured

If the Clean Power VFD is not configured (no settings have been downloaded), the alarms coming from the motor control are not reported.

But some alarms are independent of that state. e.g. if a service failed to start during boot, it will be reported right away instead of waiting for a configuration (which might never get accepted if it's the wrong service that failed).

The monitoring function during boot can generate the following alarms if they happen:

- [Booted from backup software copy and restored factory settings.](#)
- [Booted from backup software,](#)
- [System degraded,](#)
- [Unknown boot state.](#)

7.2. How alarms are triggered

An alarm is raised, when its monitored value crosses a threshold for a sufficiently long period.

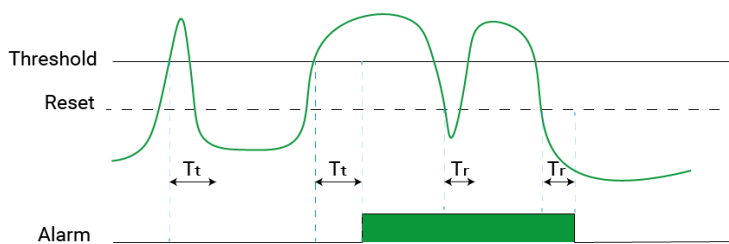
If the value exceeding the threshold lasts less than the trigger delay (T_t), then the alarm doesn't trigger.

The trigger delay acts as a filter for transient short-duration faults.

The alarm resets when the monitored value crosses the reset threshold for a sufficiently long period.

If the value lowering the reset lasts less than the reset delay (T_r), then the alarm doesn't reset.

The reset delay acts as a filter for transient short-duration corrected signals.



7.3. Types of Alarms

The Clean Power VFD manages its alarms on 4 levels of severity.

To catch the user's attention, the alarm displays different colors depending on the severity level.

Severity	Purpose	Behavior
Minor	A transitory fault with little impact on the drive and the process (such as a transient voltage drop).	<p>The motor does not stop.</p> <p>The fault is reset automatically when the cause disappears and does not need any acknowledgment.</p>
Medium	<p>The fault can be generated by the application or from a non-destructive electrical fault (such as a missing phase).</p> <p>These are faults that may disappear without the need for human intervention.</p>	<p>The motor stops when the fault occurs and lasts longer than the filter timer if one is configured.</p> <p>Restart behavior is configured by the user during setup:</p> <ul style="list-style-type: none"> - Automatic re-start, or - Manual Re-Start with acknowledgment. <p>Automatic Re-Start:</p> <p>The Clean Power VFD will attempt 4 times to detect whether the fault has been cleared, with each attempt separated by a time delay. If the fault is still present, the drive elevates the event to a critical failure. If not, the drive restarts.</p> <p>Manual Re-Start with Acknowledge:</p> <p>The drive will restart only with a reset (acknowledgment) of the fault. To use this mode, the user must have configured the way to trigger the acknowledgment. If the fault has been cleared, the drive restarts.</p> <p>If the fault is still present, the drive goes to the standby position.</p>
Major	<p>This can be a fault from the drive or an external fault (such as a loss of an STO channel).</p> <p>The generated fault could be destructive and/or</p>	<p>Example: one STO channel is missing (mostly coming from a disconnected wire)</p> <p>The fault can not be reset automatically, the user must analyze and fix the issue.</p>

	<p>dangerous to human beings.</p> <p>This is an abnormal situation state with imminent danger risk</p>	<p>The drive restarts if the fault is fixed and after a full reset from the user (power off / power on cycle is the default reset operation for a major fault).</p>
Critical	<p>This can be a fault from the drive or an external fault (such as a short circuit).</p> <p>The generated fault can be immediately destructive.</p> <p>This is a hazardous condition.</p>	<p>The fault cannot be reset automatically.</p> <p>The user must identify and fix the issue.</p> <p>The drive restarts if the fault is cleared and after a full reset from the user (power off / power on cycle is the default reset operation for a critical fault).</p>

7.4. Alarms actions

When an alarm is raised, the Clean Power VFD changes the state of both the motor control and the relay outputs.

When a fault is cleared and its related alarm removed, the Clean Power VFD will operate in accordance with the description in the section [types of alarms](#).

Some of the actions are configured by the user, while some are fixed and may not be changed.

The 3 actions are:

- Stop/Start the motor,
- Change motor speed,
- and Lockout.

The Clean Power VFD changes the state of its output relays in response to an alarm.

While creating the VFD's configuration, the user can choose which relay will receive the alarm and whether the relay will be energized or de-energized in response to an alarm.

By default, relay 1 is assigned to alarms and de-energizes in response to an alarm.

When the “de-energize on fault” setting is selected, this output relay also de-energizes if the control board is not powered. This allows the Clean Power VFD to issue an alarm if the control board is not operating due to a power issue.

Stop/ start the motor. ⚓

The motor stops as soon as an alarm is raised.

The user may configure whether the stop is coasting or with a deceleration ramp. (The default setting is deceleration ramp.)

If the Clean Power VFD is not in a lockout state and the alarms have been cleared, the motor will restart after the delay-restart time has elapsed.

Delay-restart is configurable and the default is set to 60s.

Change motor speed.

The user can choose to reduce motor speed to a user-defined speed setpoint when an alarm is triggered.

When the alarm disappears the Clean Power VFD resumes normal operating speed.

Lockout

If a critical alarm occurs, the Clean Power VFD goes into a lockout state.

The motor can only be restarted once the fault is cleared, and the user performs a complete [system reset](#).

7.5. System reset

Prior to executing a system reset, please carefully read the [safety messages related to powering the Clean Power VFD](#).

Note: if there are active alarms of severity major or critical when you execute the reset, the VFD will go back into the lock-out state at the end of the reset action.

Prior to executing a reset, check and fix all faults that have generated alarms.

How to reset a locked-out Clean Power VFD?

There are two ways to reset a locked-out Clean Power VFD.

- by sending the reset command to the Clean Power VFD.
- by executing a complete power cycle.

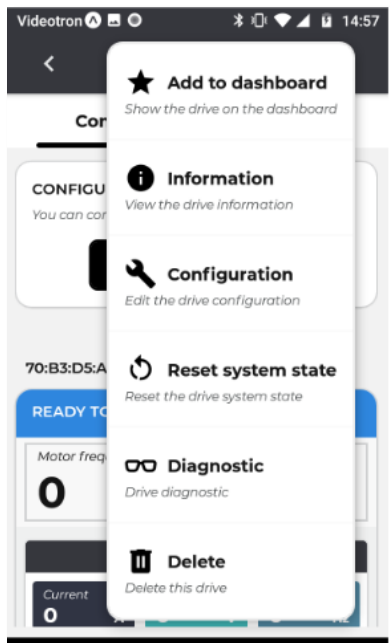
Reset by sending the reset command from the mobile App

The reset can be executed through a paired smartphone:

From the connected Clean Power VFD dashboard screen, select Menu.

in the displayed action lists, select Reset system state.

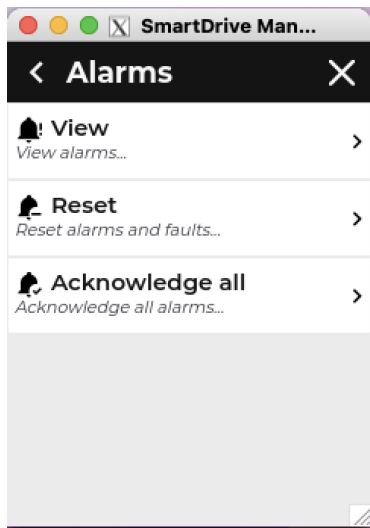
Follow the instructions displayed on the screen.



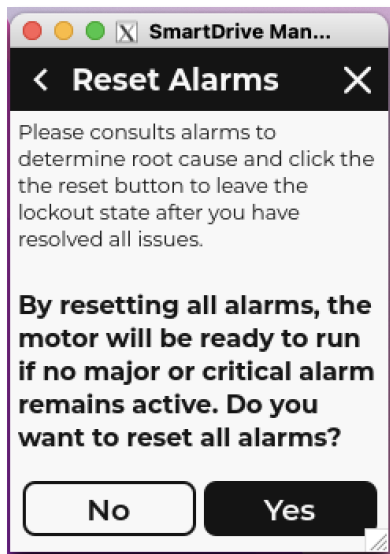
Reset by sending the reset command using the VFD's HMI.

From the alarms page, go into the menu.

Then select reset.



and confirm that you want to reset all the alarms.



Reset by sending the reset command using the Modbus TCP register SYSR [↕](#)

The reset can be executed remotely by sending the system reset command from a connected Ethernet network, using the appropriate Modbus command.

A description of the Modbus system reset can be found in this document, section Networks, and communication>[Modbus TCP](#)

Reset with Power cycle. [↕](#)

To execute a reset system of your Clean Power VFD, you must do a complete off/on power cycle of the Clean Power VFD.

If your Clean Power VFD is connected to an external 24VDC power supply, you must power off this power supply prior to powering off the main supply power to the Clean Power VFD.

Power off the main input AC power and wait for 5 minutes to ensure all capacitors are discharged.

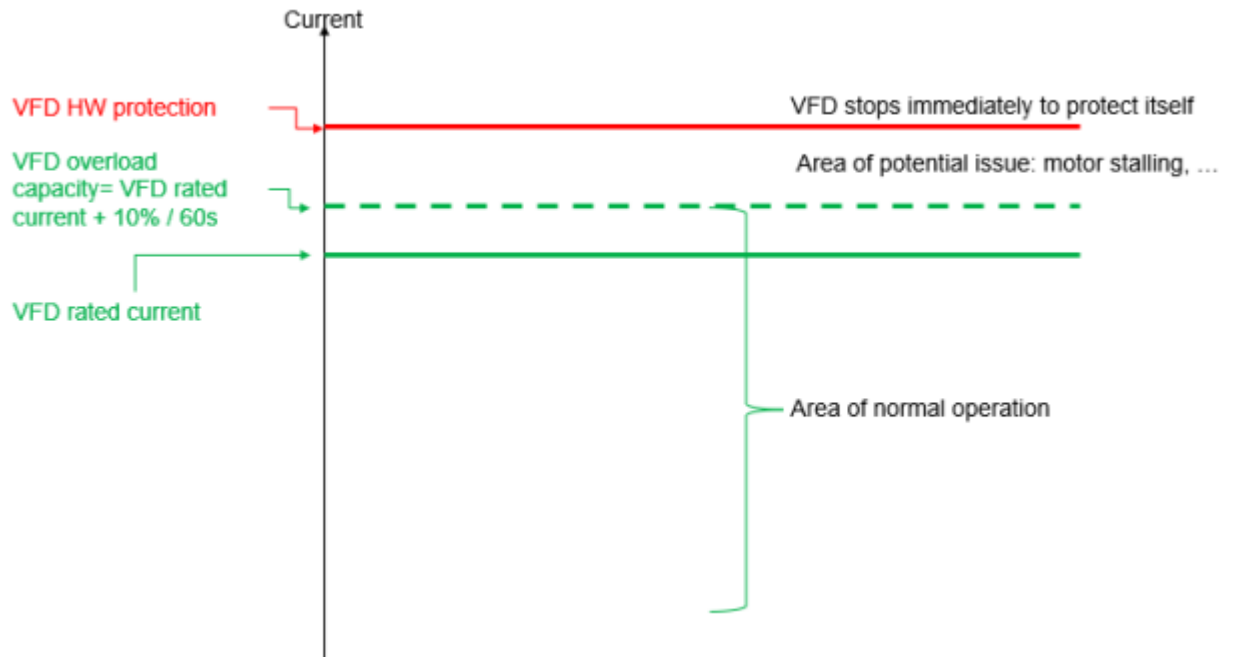
Power on the main input AC power and the external 24VDC power supply if any. Your Clean Power VFD will reboot and then will go into ready-to-run status.

7.6. Clean Power VFD protection against short-circuits.

The Clean Power VFD integrates its own protection against short circuits.

This protection is set at manufacturing and can not be modified by the user.

If the output current exceeds this protection value, the Clean Power VFD stops immediately. (reaction time is about one micro-second)



8. List of alarms by severity

The following list shows the types of alarms that can occur while using the Clean Power VFD.

Severity	Default action	Category	Alarm
Minor	None	Input power line	Line Voltage Swell
			Line Voltage Sag
			AFE Low Voltage Ride Through
		VFD System	Software update failed
			Booted from backup software
		VFD Hardware	Defective cooling fan
			HMI comm. loss
			Ethernet port 1 disconnected
			Ethernet port 2 disconnected
		Motor	Motor overcurrent stall prevention
Medium	Start / Stop	Input power line	Input power line phase loss
			Input power line unexpected frequency
			Input power line unexpected voltage
		Control	Loss of analog input
			Simultaneous reverse and forward commands
		VFD Hardware	DC unexpected voltage
			DC OverVoltage stall prevention
			DC bus single phase
			High ambient temperature
			Faulty cooling fan #(1,2,3,4)
		VFD System	Internal error
			Abnormal memory usage
			watchdog reset
		Motor	Motor Application underload
			Motor currents unbalanced
			Motor over temperature
Motor phase loss			

Major	lockout	input power line	Input power line current unbalanced
			AFE fault
		VFD Hardware	DC bus overvoltage
			Cooling fan capacity
			VFD high temperature
		VFD System	Unknown boot state
			DC unbalanced
			Abnormal CPU usage
			System degraded
		Motor	DC unexpected voltage
			Motor currents unbalanced
			Motor over current (short circuit on VFD output)
Critical	lockout	Input power line	Input power line over current
			Cooling fan capacity
		VFD Hardware	VFD internal over temperature
			Internal communication errors
		VFD System	Booted from backup software copy and restored factory settings.
			Safe torque off
		Control	Motor/Application overload
			Motor ground fault

9. Details of alarms and protections

The details of alarms and protections are organized in alphabetical order.

9.1. Abnormal CPU usage

This alarm is raised when the CPU usage is abnormally high (> 300%)

9.2. Abnormal memory usage

This alarm is triggered when the used memory reaches about 25MB.

Monit will attempt a cleanup by removing everything in `/var/data/iot-update-service/packages`.

Monit is a utility for managing and monitoring processes, programs, files, directories, and filesystems on the clean power VFD Unix system.

Monit conducts automatic maintenance and repair and can execute meaningful causal actions in error situations.

9.3. Application overload prevention

The Clean Power VFD is monitoring the motor current to detect an application overload.

If the current drawn by the motor exceeds the threshold value, which lasts longer than the inhibition delay, then the fault is triggered.

When a fault is triggered, the action can be selected between:

- ramp down to stop
- coast to stop (default setting)

The value of the overload threshold can be set by the user between 75% and 200% of the motor FLA (Full load Amp).

The default setting is 110%.

A settable inhibition delay prevents false fault triggering. This delay can be set by the user from 0s to 600s, its default value is 60 s.

Fault reset and motor restart:

When the current drawn by the motor falls below 10% of the overload threshold value, a fault reset time is started.

When this timer has elapsed, the motor can be restarted.

Fault reset time is settable between 0 to 600 s - default value: 60s

Recommended settings:

For normal duty light loads: set the threshold between 110% and 120% of motor FLA with a 60s delay.

For heavy-duty loads: set the threshold between 150% and 160% of motor FLA with a 60s delay.

9.4. Booted from backup software.

Booted on the backup version which is compatible with the current configuration of the VFD.

This alarm gets resolved after a reboot.

9.5. Booted from backup software copy and restored factory settings.

Booted on a backup version which is incompatible with the current configuration of the VFD.

This causes a factory reset. This alarm gets resolved after a reboot.

9.6. DC Bus single phased.

The DC single-phased alarm is triggered with both the 2 following conditions are true:

- ripple on DC bus is > 10%
- line unbalance is detected (ex: loss of one phase)

Most likely caused by the combination of 2 factors:

- one line-to-neutral phase from the grid was lost.
-
- The load is powerful enough to create a ripple on the DC bus.

The alarm is cleared only when both conditions are resolved.

9.7. DC Overvoltage

The DC bus voltage is way above the line-nominal-voltage side and the DC overvoltage stall prevention function did not succeed in limiting the rise of the DC bus voltage.

The overvoltage value is checked on both +DC and -DC.

The threshold value is not settable by the user.

This alarm is most likely caused by the motor and its load.

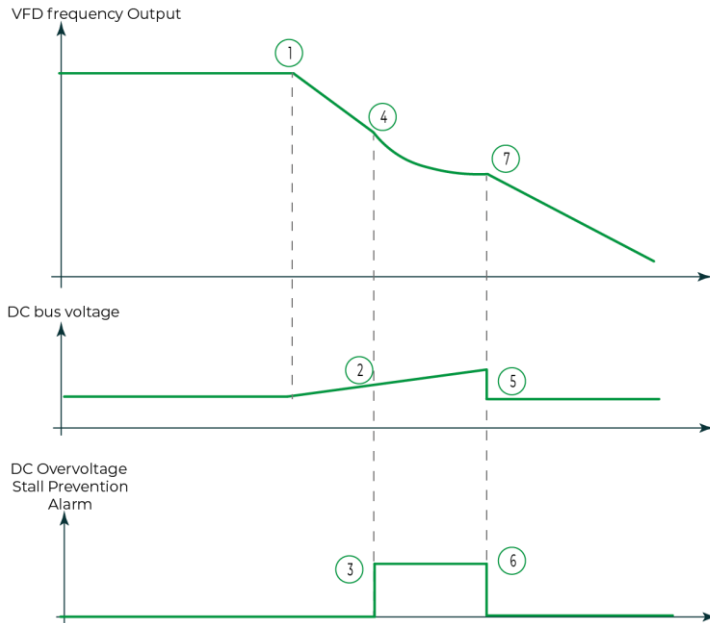
9.8. DC Overvoltage stall prevention

When the motor is decelerating and the voltage on the DC bus is too high the alarm "DC Overvoltage stall prevention" is raised and an automatic action is executed to prevent the VFD from going into a DC overvoltage alarm.

This alarm is automatically reset when the voltage of the DC bus falls back to normal value

Automatic limitation of deceleration:

The rate of deceleration is limited when the DC bus voltage is 10% greater than the expected value reading.



- 1- The VFD frequency Output decreases to make the motor decelerate.
- 2- In the deceleration phase, the motor acts as a generator. The regenerated voltage increases the DC bus voltage.
- 3- If the DC bus voltage reaches a value higher than normal the alarm "DC Overvoltage Stall prevention" rises.
- 4- At the same time, the Clean Power VFD automatically limits the rate of deceleration to prevent going into a DC overvoltage alarm.
- 5- The DC bus voltage value falls back to a normal value.
- 6- The alarm is automatically reset.
- 7- The preset deceleration resumes.

Note that this function increases the ramp-down duration to avoid falling into alarm conditions and lock the variable frequency drive. It is recommended to modify the ramp-down duration setting to avoid this condition.

9.9. DC unbalanced

Indicates the DC bus voltage on one side of the drive's floating neutral point is too high compared to the other.

This fault may be caused by:

- Motor control is unstable, for example, at low-speed. Try decreasing start/stop ramp durations, try decreasing torque boost percentage.
- DC bus voltage is not measured correctly.
- A Hardware issue.

9.10. DC unexpected voltage

This could happen when the line configuration does not match the line values.

The alarm may happen when the motor is not running. It prevents enabling the internal bypass relay during the startup sequence and informs the user it is unsafe to start the motor.

This alarm triggers when the DC bus voltage is too low compared to the input line voltage.

To resolve this alarm the user may have to push a new line configuration or check the grid.

9.11. Internal error

This alarm is raised by the firmware or the FPGA watchdog to indicate an issue with the Interrupt Service Routine (ISR).

The ISR is a process invoked by an interrupt request from some hardware sub-system of the VFD.

9.12. Line unexpected frequency

This could happen when the line configuration does not match the actual line values.

The alarm may happen when the motor is not running.

It prevents enabling the internal bypass relay during the startup sequence and informs the user it is unsafe to start the motor.

This alarm triggers as soon as the measured line frequency is not within 10% of what is user-defined in the configuration.

To resolve this alarm the user may have to push a new line configuration or check the grid.

9.13. Line unexpected voltage

This could happen when the line configuration does not match the actual line values.

The alarm may happen when the motor is not running.

It prevents enabling the internal bypass relay during the startup sequence and informs the user it is unsafe to start the motor.

This alarm triggers as soon as the measured line RMS voltage is not within 15% of what is user-defined in the configuration.

To resolve this alarm the user may have to push a new line configuration or check the grid.

9.14. Motor phase loss

If an accidental disconnection of one phase between the drive and the motor happens, then the motor is single phasing.

Current in remaining connected windings increases, motor internal temperature increases, and the motor may even stall due to a lack of torque.

The Clean Power VFD is permanently monitoring the motor current in each phase.

As soon as the loss of phase fault is detected, the Clean Power VFD stops the motor according to the user-defined stop scenario.

9.15. Motor Overcurrent stall prevention

In the acceleration phase or in the constant speed phase:

When the motor current exceeds 150% (of the inverter's permissible load amount), the output frequency is reduced to prevent an overcurrent trip from occurring.

During constant speed operation:

The inverter returns the output frequency to the original value when a motor current becomes smaller than 150%.

9.16. Overload motor protection-Motor overcurrent

Motor current draw is above motor nominal current and is also beyond motor ratings (see motor Plate).

An embedded electronic thermal relay protects the motor against overcurrent and short circuits.

The motor overload protection is factory set a 1.1 x FLA

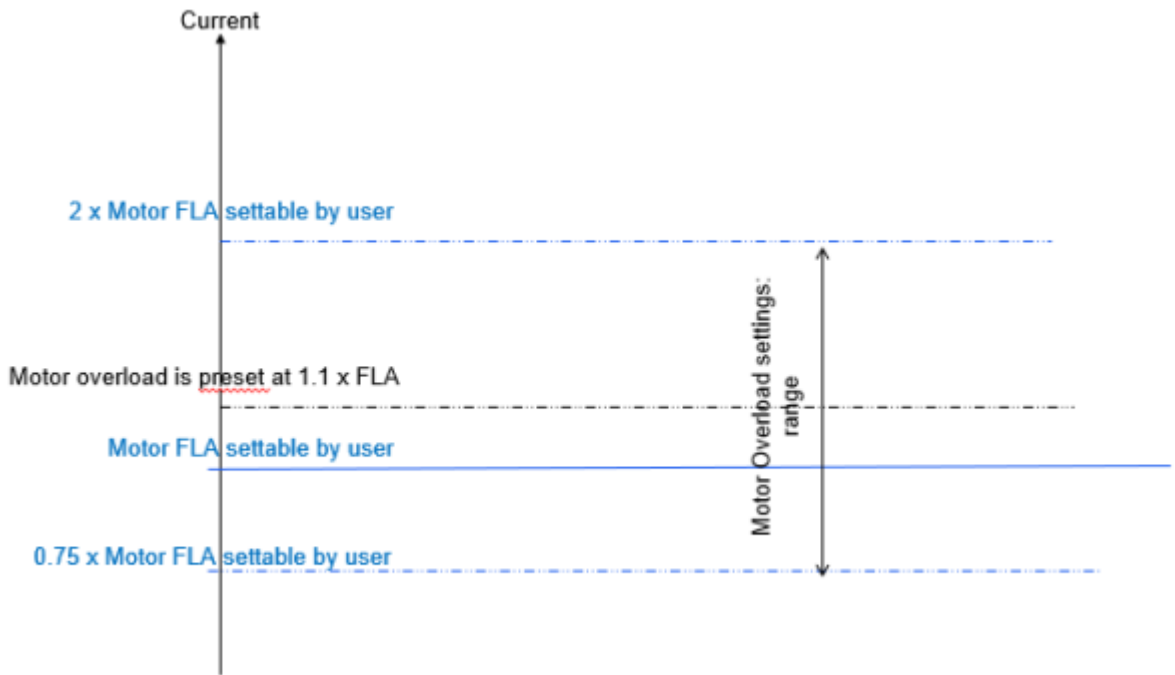
Depending on the motor application, the user can change this setting between 0.75 to 2 x FLA

The delay for this protection is factory set at 60 s. This delay can set it between 0 to 3600 s.

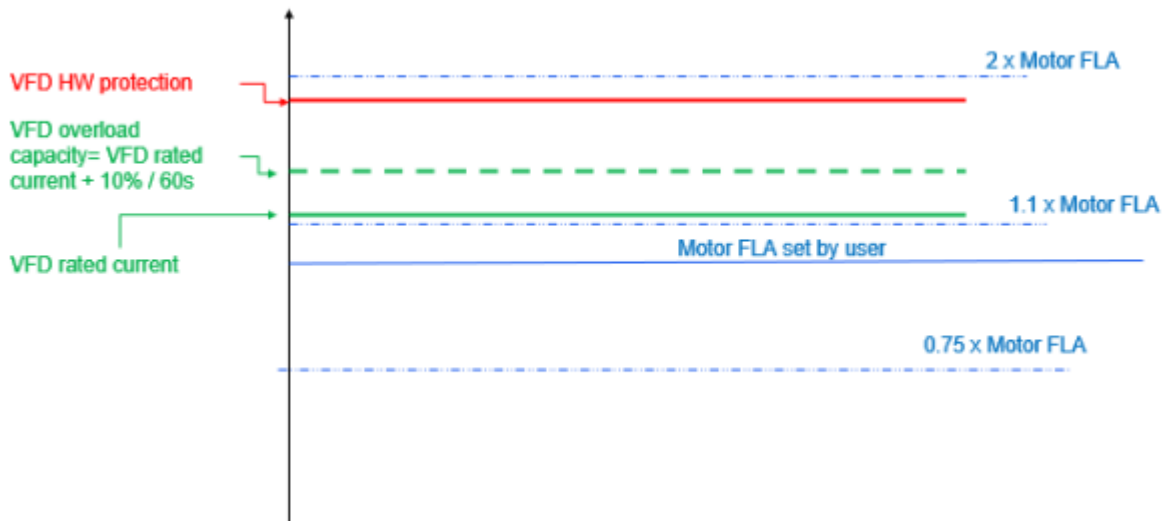
Users must properly set the motor parameters to ensure that its protection will work properly.

Among the list of motor parameters, the full load Amp (FLA) is of paramount importance for motor protection.

The FLA of the motor must be set as per the motor nameplate.



If the user modifies the motor overload protection threshold higher than the drive self-protection, then the drive self-protection will trigger before the overload.



9.17. System degraded.

One or more services repeatedly failed during booting.

The Clean Power VFD must be powered off and powered on to reboot.

If the issue happens again, call the technical support of SmartD.

9.18. Undervoltage

If the Clean Power VFD detects a voltage drop or power loss on the input phases, sufficient to cause the DC bus voltage to drop too low for the VFD to be able to operate.

The Clean Power VFD stops to deliver energy to the motor, then stops in freewheeling mode.

9.19. Unknown boot state

This alarm raises if something goes wrong during boot, a reboot is required. This alarm gets resolved after a reboot.

9.20. VFD high temperature

The temperature inside the Clean Power VFD is monitored through internal sensors.

When the Clean Power VFD internal temperature rises above 75 C, the output is blocked due to the activation of overheat protection.

This alarm allows for the protection of the Clean Power VFD before the internal temperature rises to a level that could be destructive.

The VFD will also raise a minor alarm if it detects that one of the cooling fans is defective.

9.21. VFD overheating protection.

The temperature inside the Clean Power VFD is monitored through internal sensors.

When the Clean Power VFD internal temperature rises above a certain level, the output is blocked due to the activation of overheat protection.

10. Troubleshooting

To help the user in solving issues he may encounter when using the Clean Power VFD, this section explains how to troubleshoot a problem when a protective function, alarm, or warning message occurs.

If the Clean Power VFD does not work normally after following the suggested troubleshooting steps, please contact the SmartD customer service center.

When the Clean Power VFD detects a fault, it sends a warning to the HMI and the SmartDrive app (if a smartphone with the SmartDrive app is connected to the drive).

The drive may also modify or stop its operation, depending on the criticality of the fault.

10.1. Versioning

If you need to connect with the customer support of SmartD, you will be requested to tell them about the version of your product.

Here is the method to find the version of your product:

Clean Power VFD software version

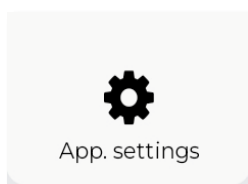
From the HMI display, open the menu by tapping on the hamburger icon

Then tap on "About", and then "Software".



SmartDrive Mobile Application version

Run the application on your smartphone, then tap on the button App. setting.



Then tap on "App. info" to display the application version.

10.2. Audit logs

What is the function Audit Log?

For traceability, technical support troubleshooting, and legal reasons the SmartDrive keeps a persistent log of auditable events on the systems.

An admin or SmartD qualified personal can consult these logs to diagnose problems that can arise in the field.

What are the logged events?

The logged events are the following:

- Start-up and shutdown of the system
- Start-up and shutdown of a service
- Network connection changes or failures
- Configuration change
See the new configuration and previous configuration.
- Set point changes
See new setpoint and previous setpoints.
- Alarm transitions
- Changes to, or attempts to change, system security settings and controls
Make sure firewall service start/stop is logged
Detecting firewall rules modification
Enabling/Disabling remote SSH access
Enabling/Disabling remote gRPC access.
- Create/Delete users.
- Log-on attempts (successful or unsuccessful) and logoff
SSH
Console
gRPC session start/end (including authentication failure)
- Software Update progress events
Start/end/reboot/power interrupts
Accept new version
Revert to the backup version.
- Errors (Persistent storage)
- Boot for backup software
- Backup configuration events
- Reset metrics
Examples: fans, start motor counter...

What is the content of a logged event? [↕](#)

The event contains the following information:

- Date/Time (UTC time)
- Type of Event(see logged events list above)
- Severity:

Use standard Syslog severities (limits to INFO, WARNING, ERROR, EMERGENCY)

- Short Message describing the request and response to the request.
- Origin:

gRPC API, Mobile, WEB, HMI, I/O module, MODBUS, BLE ...

Example of a logged event [↕](#)

```
{
  "time": "2022-05-09T19:08:18.000Z",
  "event": "EVENT_ALARM",
  "severity": "PRIORITY_INFO",
  "message": "Alarm Cooling fan 2 fault has been acknowledged by user 1.",
  "origin": "ORIGIN_SYSTEM"
},
{
  "time": "2022-05-09T19:08:18.000Z",
  "event": "EVENT_SETPOINTS_CHANGE",
  "severity": "PRIORITY_INFO",
  "message": "Alarm service responded to Set Setpoints request with status RESPONSE_STATUS_OK",
  "origin": "ORIGIN_GRPC_API"
},
```

Logged events capacity [↕](#)

The audit log is kept in persistent storage on the SmartDrive and the drive can store up to 250,000 events (or 300MB of data).

The audit log is not affected by the restore factory settings.

The SmartDrive brownout ensures that no audit log events are lost and stored on persistent before the end of the brownout period.

Audit Log Export

Users can export the audit log in JSON format compressed and encrypted via the smartphone app.

The exported file is available and shared via the mobile app.

Go to the Clean Power VFD main menu (click on the ellipsis in the upper right corner of the Smart App screen)

select audit log

select your filter

start the download

A JSON file is created in the app (phone)

Select share (with your usual sharing interface and function from your Ios or Android device)

Select your preferred app to share the file

and send/share

when exiting the share step, the generated file is deleted from the phone.

issue when sharing the file.

If you have trouble exporting the file, make sure you are properly authenticated to the service you want to use to share the file.

e.g: check that you are correctly identified in the e-mail application of your smartphone to ensure that you can share the file by e-mail.

10.3. Alarms and troubleshooting suggestions.

When an alarm occurs, refer to the following tables for possible causes and suggested remedies.

Alarm	Possible Cause	Suggested remedy
DC Over Voltage	Deceleration time is too short compared to load inertia.	Increase deceleration time
	The input voltage is too high.	Check if the input voltage is above the Clean Power VFD specifications.
DC Under Voltage	The input voltage is too low.	Check if the input voltage is below the Clean Power VFD specifications.
	If there's a contactor upstream of the Clean Power VFD, it may be defective.	Check the operation and connection of the upstream contactor. If defective, replace it.
Drive Over temperature	There is a problem with the Clean Power VFD cooling.	Check if a foreign object is obstructing the air inlet or outlet.
	A cooling fan is defective.	Replace the fan.
	The ambient temperature is too high.	Keep the ambient temperature below the specified max. operating temperature of the Clean Power VFD.
Faulty cooling fan	A foreign object is obstructing the fan's air vent.	Remove the foreign object from the air inlet or outlet.
	The cooling fan needs to be replaced.	Replace the fan.
Motor overcurrent	Short-circuit detected on the motor.	Check if there are any short circuits and grounding between the U, V, W, and motor.
	Acceleration/deceleration time is too short compared to load inertia.	Increase acceleration/deceleration time.
	The Clean Power VFD load (motor + mechanical load) is greater than the Clean Power VFD capacity.	Replace the Clean Power VFD with a model that fits the connected load.
	Torque compensation is too large.	Reduce torque compensation.
	The motor insulation is damaged.	Replace the motor.
Application overload	The load is greater than the motor capacity.	Replace both motor and Clean Power VFD to fit the application load constraints.
	The set value for the overload alarm is too low.	Increase the set value for the overload alarm.
	The torque boost value is too high.	Decrease the torque boost value.

Motor current unbalanced	Increase of current to at least one winding raising that winding temperature.	Potential single-phase load connected on one of the Clean Power VFD outputs. Check and fix the wiring.
Motor phase loss	The output wiring is faulty.	Check output wiring on Clean Power VFD side and motor side.
	If you use a contactor between the Clean Power VFD and the motor, it may be defective.	Check the contactor wiring. Replace the contactor.
Motor overtemperature	The motor has overheated.	Reduce the load or operating frequency.
	The PTC sensors are defective.	Disconnect the sensors from the Clean Power VFD and check their resistance. If defective, replace them.
Motor ground fault	A ground fault has occurred on the output wiring.	Check output wiring on the Clean Power VFD side and motor side.
	The motor insulation is damaged.	Replace the motor.
Power input Line overcurrent	The Clean Power VFD has been protected from overload and resulting overheating.	Check that the motor with its load does not exceed the overcurrent and duration limits as specified. Change the Clean Power VFD for a higher capacity Clean Power VFD.
Power input Line phase loss	The input wiring is faulty.	Check input wiring.
	If there's a contactor upstream of the Clean Power VFD, it may be defective.	Check the operation and connection of the upstream contactor. If defective, replace it.

10.4. Operation issues

Issue	Possible Cause	Suggested remedy
Can not modify the settings	The Clean Power VFD is in RUN mode.	Stop the Clean Power VFD to download the changed parameters from the SmartD app on your smartphone.
	The access parameters are incorrect.	Check your ID and password.

Issue	Possible Cause	Suggested remedy
The motor does not run	The frequency setpoint is not set correctly.	Check the selection of the frequency setpoint.
	The frequency selected setpoint is too low.	Check that the values of the selected frequency setpoint is above the minimum frequency.
	The RUN/STOP I/O's are not wired accordingly to their preset functions.	Check the I/O's wiring and their preset functions.
	Power is not supplied to R/L1, S/L2, T/L3	Check the terminal connections R/L1, S/L2, T/L3 and U/T1, V/T2, and W/T3.
	The power supply is not correct	Check for decreased input voltage, input phase loss, and proper wiring.
	The motor is not connected properly	Check the wiring between the Clean Power VFD and the motor.
	Two-wire or three-wire type connection is wrong.	Check the connection.
	The I/O's defined as the RUN command is off.	Turn on the RUN I/O.
	Both the forward and reverse rotation start signals are activated simultaneously.	Turn ON either the forward or reverse rotation start signal.
	The motor is mechanically locked.	Unlock the motor or lower the load.
	The emergency STO1 or STO2 is activated	Check the STO1 and STO2 wiring. Fix the Emergency signal that may have activated STO1 or STO2. Check the +24V on STO1 and STO2.
	The source/Sink (PNP/NPN) selection is not consistent with the wiring of the I/Os.	Check the wiring mode selection setting.

Issue	Possible Cause	Suggested remedy
The motor rotates in the opposite direction of the command.	The wiring for the motor output cable is incorrect.	Check if the cable on the output is wired with the correct sequence to the phase (U/V/W) of the motor.
	The signal connection between the control circuit terminal (forward/reverse rotation) of the Clean Power VFD and the forward/reverse rotation signal on the control panel side is incorrect.	Check the forward/reverse rotation wiring.

Issue	Possible Cause	Suggested remedy
The motor rotates in one direction only.	The single rotation direction has been selected in the Clean Power VFD settings.	Change to 2 directions rotation in the settings. Upload the new setting in the Clean Power VFD.
	The reverse and/or forward input is not wired consistently with the I/O's setting.	Check the forward/reverse rotation wiring.

Issue	Possible Cause	Suggested remedy
The motor is overheating	The load is too high.	Reduce the load.
		Increase acceleration/deceleration time.
		Check the motor parameters and set the correct values.
	Replace the motor and the Clean Power VFD with models with appropriate capacity for the load.	
	The ambient temperature of the motor is too high.	Lower the environment temperature of the motor to operate within the motor manufacturer's specifications.
The motor fan has stopped or a foreign object obstructs the fan.	Check the motor fan and remove any foreign objects.	

Issue	Possible Cause	Suggested remedy
The motor does not accelerate or stop during acceleration	The load is too high.	Reduce the load.
		Replace the motor and the Clean Power VFD with models with appropriate capacity for the load.
		Increase the acceleration time.
	The frequency setpoint is too low.	Set an appropriate value.
	The acceleration time is too long.	Decrease the acceleration time.
	Starting torque is too low.	Increase the starting boost torque value.

Issue	Possible Cause	Suggested remedy
Motor speed varies during operation.	There is a high variance in load	Replace the motor and the Clean Power VFD with models with appropriate capacity for the load.
	The input voltage varies.	Check your input power lines.

Issue	Possible Cause	Suggested remedy
The motor vibrates and does not rotate normally.	The voltage between phases is not balanced.	Check the input and output voltage balance.
		Check the motor's insulation.

11. Functions and parameters

This section provides a complete list and description of the functions and parameters of the Clean Power VFD.

11.1. Auto-tuning

Auto-tuning is an intelligent function of the Clean Power VFD that allows the refinement of the motor parameters and maximizes the performance of the whole power drive system.

Several motor features are measured during the auto-tuning process. However, this early version just measures the stator resistance. Moreover, this version executes static auto-tuning: it does not spin the motor.

The stator resistance value is used to compensate for the motor slip and the voltage loss in the stator.

Pre-requisite

Auto-tuning can be run when:

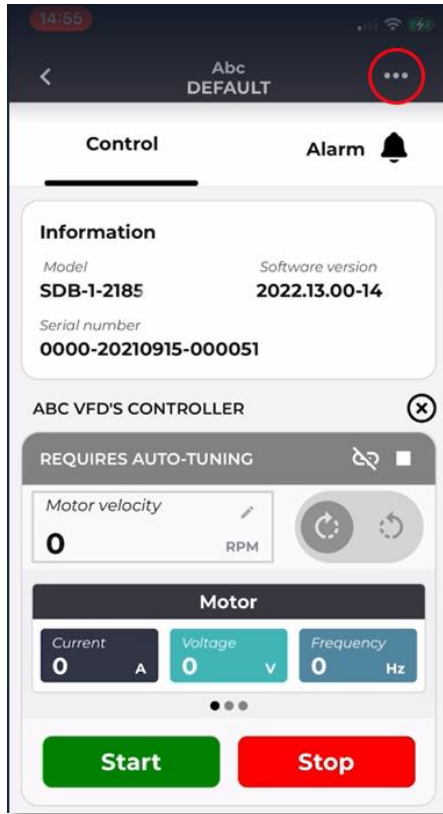
1. The variable frequency drive is in the “ready to run “ state.
2. The motor is at a standstill.
3. The motor is at ambient temperature.
4. Motors parameters are set correctly at motor nameplate values and downloaded in the VFD.
5. the mobile app is connected to the Clean Power VFD.

If the VFD is not in the “ ready to run state”, or if the back emf from the motor shows that the motor is spinning, then the user can not start the auto-tuning function.

Procedure

The user can initiate the motor auto-tuning process via the mobile App:

From the dashboard, tap on the ellipsis in the upper right corner of the screen to open the menu.



Then select "configuration", and "Motor Auto-Tuning."

When the auto-tuning wizard screen is displayed, tap on the button "start".

The auto-tuning is starting, and the step of the procedure is shown by its radio button.

After 5 seconds, the auto-tuning is complete, and the following step "review the parameters" is accessible.

In case of an error, the application shows an error modal when pressing on the icon !

When the user leaves the error modal, the application goes to the done state and the user can start a new auto-tuning sequence by tapping the button "retry".

When done with success, the user can save and apply the motor values by tapping on the button "Apply"

11.2. Motor frequency limits

Minimum frequency

This is the lower limit of the frequency setpoint

The value of this limit can be set through the SmartDrive app.

The range is between 0.1Hz and 120Hz. The default value is 0Hz.

Maximum frequency

This is the upper limit of the frequency setpoint, the value can be set through the SmartDrive app.

The range is between 0.1Hz and 120Hz. The default value is 60Hz.

The maximum frequency must always be greater than the minimum frequency.

The SmartDrive app generates a warning and prevents the configuration from being uploaded if this is not respected.

11.3. Motor frequency setpoint

SmartDrive provides several ways to set up and modify the frequency setpoint.

The embedded HMI, the SmartDrive App, the analog inputs, the preset speeds, and the remote control from the Ethernet connection.

Set the frequency setpoint from the Clean Power VFD analog input.

Analog inputs from AI1 to AI3 can be assigned to be the frequency setpoint input. By default, the analog input AI1 is assigned to the frequency setpoint.

Analog signals can be set by software to be either a potentiometer input, a 4 to 20 mA input, or a 0 to 10 VDC input. By default, the analog input AI1 is set as a potentiometer input.

A +10V voltage output on the control terminal is used as the reference value.

From the SmartDrive app, the user can define the conversion scale from the analog signal to the frequency by defining the minimum and maximum frequencies.

Any value change on this input will be read instantaneously by the Clean Power VFD and becomes the reference setpoint.

The Frequency output will vary immediately from the actual speed to the new speed defined by the setpoint.

A change of the setpoint value from the analog input is displayed on the Clean Power VFD's HMI.

i If the motor speed does not reach the set value

Check the most common following causes:

- The magnitude of the analog input differs from the Clean Power VFD input scale. Check the voltage across the analog input terminals.
- The scale of the analog input is not set according to the user's application. Check the minimum and maximum frequencies assigned to the minimum and maximum analog input values.

11.4. Motor velocity setpoint

SmartDrive provides several ways to set up and modify the velocity setpoint.

The embedded HMI, the SmartDrive App, the analog inputs, the preset speeds, and the remote control from the Ethernet connection.

Set the velocity setpoint from the Clean Power VFD analog input.

Analog inputs from AI1 to AI3 can be assigned to be the velocity setpoint input. By default, the analog input AI1 is the speed setpoint.

Analog signals can be set by software to be either a potentiometer input, a 4 to 20 mA input, or a 0 to 10 VDC input. By default, the analog input AI1 is set as a potentiometer input.

A +10V voltage output on the control terminal is used as the reference value.

From the SmartDrive app, the user can define the conversion scale from the analog signal to the velocity by defining the minimum and maximum velocities.

Any value change on this input will be read instantaneously by the Clean Power VFD and becomes the reference setpoint.

The frequency output will vary immediately from the actual speed to the new speed defined by the setpoint.

A change of the setpoint value from the analog input is displayed on the Clean Power VFD's HMI.

i If the motor speed does not reach the set value

Check the most common following causes:

- The magnitude of the analog input differs from the Clean Power VFD input scale. Check the voltage across the analog input terminals.
- The scale of the analog input is not set according to the user's application. Check the minimum and maximum velocities assigned to the minimum and maximum analog input values.

11.5. Preset frequencies / preset velocities.

Motor speed can be defined by the frequency in Hertz (Hz) of the sine wave applied to the stator, or by the shaft velocity in revolution per minute (RPM)

The users can define up to **8 preset** frequencies/velocities.

The values of the preset frequencies/velocities are fixed set points saved in the Clean Power VFD.

Velocities are set in Revolution Per Minute (RPM), and frequencies are set in Hertz (Hz). These engineering units are not mixed.

11.6. Acceleration and deceleration

Acceleration time

Acceleration time, also called ramp-up time, controls the time between when the motor starts and when it reaches its required speed.

The default value is 20 s. This timing may not be suitable for your application. The acceleration time can be adjusted up to 3600 s. If the acceleration time is too short, it will produce an overcurrent condition.

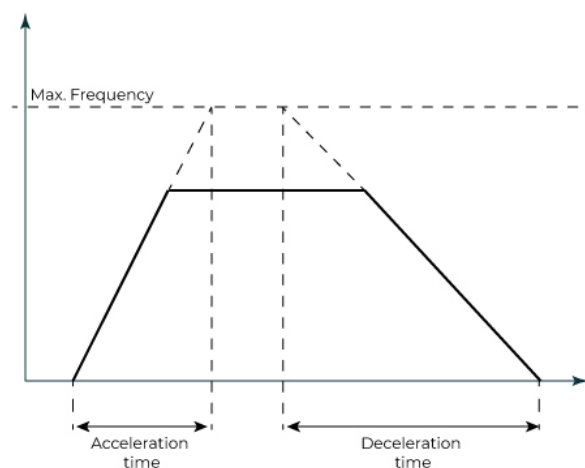
Deceleration time

Deceleration time, also called ramp-down time, controls the time that is taken to slow the motor down, normally to a standstill.

The default value is 20 s. This timing may not be suitable for your particular application. The deceleration time can be adjusted up to 3600 s.

During deceleration, the motor speed is faster than the synchronous speed, which is equivalent to the Clean Power VFD output frequency. In this condition, the motor functions as a generator and returns the energy to the Clean Power VFD. This is why DC voltage increases. This operation is called regeneration.

i if the deceleration time is too short it will produce an overvoltage condition



11.7. Torque boost

11.7.1. Torque boost: Safety messages



Be careful not to increase the torque boost rate too much because it could cause an overcurrent trip at startup.

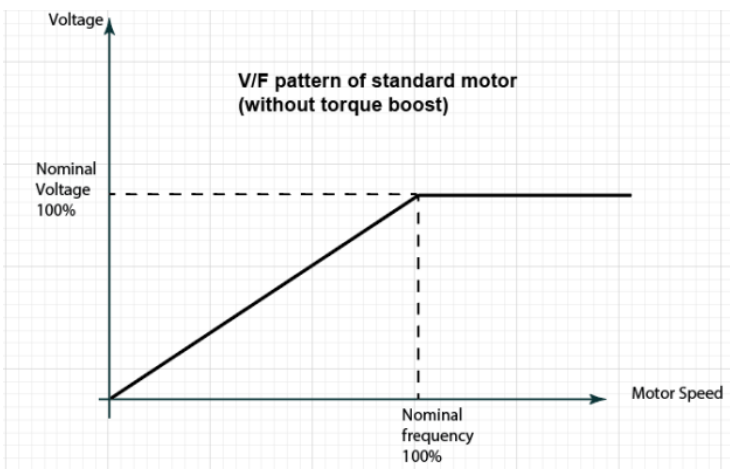
Moreover, before the over-current protection trips, the motor may overheat.

To avoid such a situation, adjust the torque boost to an appropriate level.

11.7.2. Low Speed Torque Compensation

With conventional V/F operating mode, when F (frequency) is changed, V (output voltage) is changed in the constant ratio (V/F) as shown in the figure below.

For this reason, this system is called V/F control.



The voltage value that is valid decreases due to a voltage drop in the wiring or the primary coil of a motor and enough torque cannot be output.

The load inertia may also require greater torque to start moving.

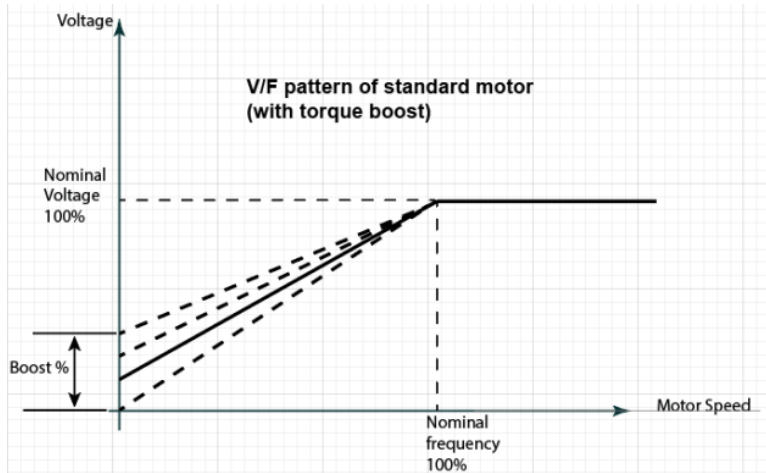
The slower the speed is, the more prevalent this phenomenon is.

Boosting the voltage inversely proportional to the speed during ramp-up ensures good torque at low speed and helps the motor start difficult loads more reliably.

Users can set higher voltage (torque boost) as indicated with the solid line in the figure below to cover the shortage of torque at low speed.

Setting the torque boost value must be done with caution and tested in small increments.

If torque boost is increased too much or applied for too long a time, some excessive current may be drawn triggering overcurrent protection.



Setting the starting torque boost

To adapt the starting torque boost to the application, the user can define its amount and its duration.

Amount of starting boost

Parameter amount of starting boost

Settable from 0% to 30% of nominal operating voltage.

Increments: 0.1%

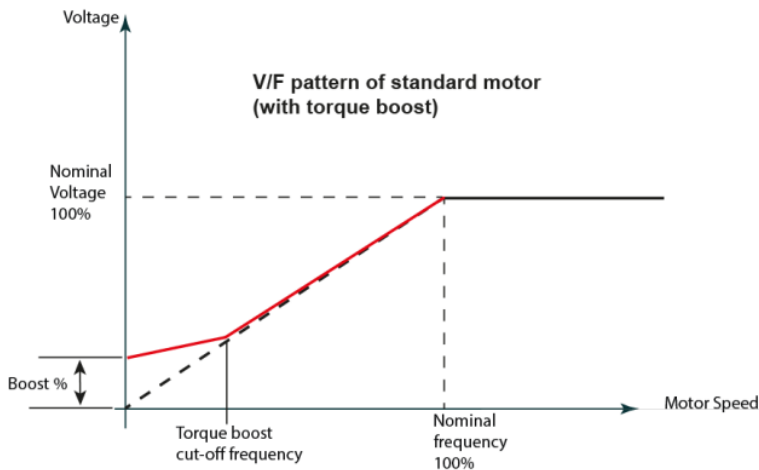
Default value: 0%

Starting torque boost cut-off frequency

Parameter starting torque boost cut-off frequency.

Settable from 20 to 80% of nominal speed.

Default value: 25% (boost stops when the speed reaches this value)



11.8. Slip Compensation

Slip compensation can be added to reduce the effect of motor slip.

A "slip compensation" function "compensates" for the reduction in shaft RPM by increasing the voltage and frequency applied to the motor.

In other words, V/f slip compensation can compensate for asynchronous motor speed deviation, in this way, motor rotary speed could be maintained in a stable state during load change.

Slip compensation is a function only available in V/f control mode for an asynchronous motor. Synchronous motors do not slip.

Clean Power VFD provides users with automatic slip compensation. The parameter "**Slip Compensation**" can be enabled/disabled by the user.

11.9. Acceleration overcurrent prevention

To prevent the Clean Power VFD from going in overcurrent alarm during acceleration, at starting phase, or speed change phase, the acceleration is automatically paused if the output current reaches a trigger threshold.

11.10. Phase Reversal

The Clean Power VFD allows the user to change the direction of rotation without modifying the wiring of the motor.

If the motor does not turn in the expected direction, clockwise instead of counter-clockwise or vice-versa, a standard solution is to exchange two wires on the power output connectors, the sequence UVW becomes UWV for example.

However, the Clean Power VFD makes this operation easier:

Just change the parameter Phase Reversal, this will invert the forward and reverse spin directions without modifying the drive wiring.

11.11. Reverse Rotation Prevention

If the motor must be run in only one direction, the reverse rotation can be disabled.

The parameter allows the user to enable/disable the rotation in the reverse direction.

11.12. Over modulation

When the required output voltage of the Clean Power VFD is higher than 85 % of the input voltage (typically when running over-synchronously). The output voltage is increased by over-modulation.

Some applications may face vibrations if the harmonics generated by the over-modulation are close to the resonance frequency of the driven system.

Users have the possibility to minimize the vibrations by disabling the over-modulation function.

To Disable the Overmodulation:

There is one parameter named Overmodulation.

Its value can be ON or OFF

Its default value is: ON (Over-modulation is active)

11.13. 2-wires and 3-wires control modes

Depending on the selected control preset, the controls have different actions, and the digital inputs have different assignments.

3-wires control mode

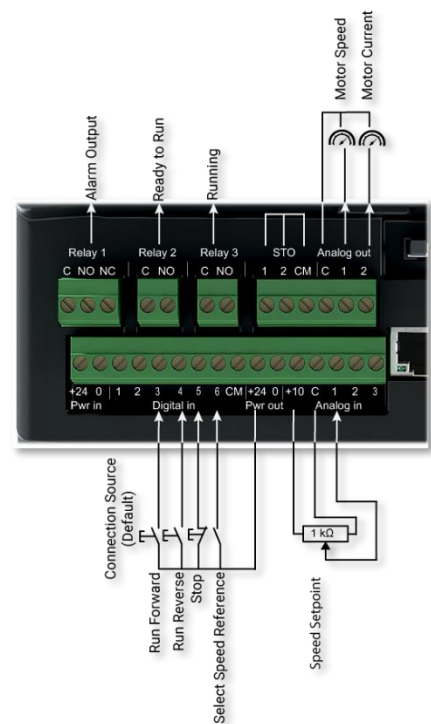
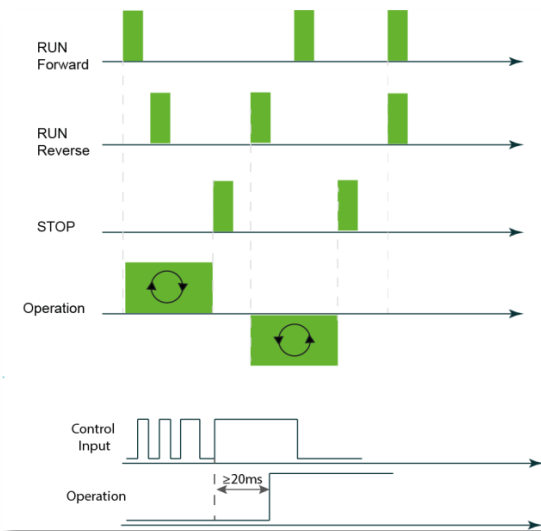
In 3-wires mode, the basic controls are:

- run forward,
- run reverse,
- stop.

The control inputs are managed as pulses of a minimum duration of 20ms.

Simultaneous activation of run forward and run reverse does not change the Clean Power VFD's status.

To change the motor rotor direction, a full stop is compulsory.



The 3-wires mode can be configured to operate only in the forward direction.

When the single direction is enabled, the preset I/O "Run Reverse" (digital input number 4) is available to be associated with another function such as selecting a preset speed.

Please read the section on reverse Rotation Prevention to enable/disable the single-direction operation.

2-wires control mode

In 2 wires mode, the basic controls are run forward and run reverse.

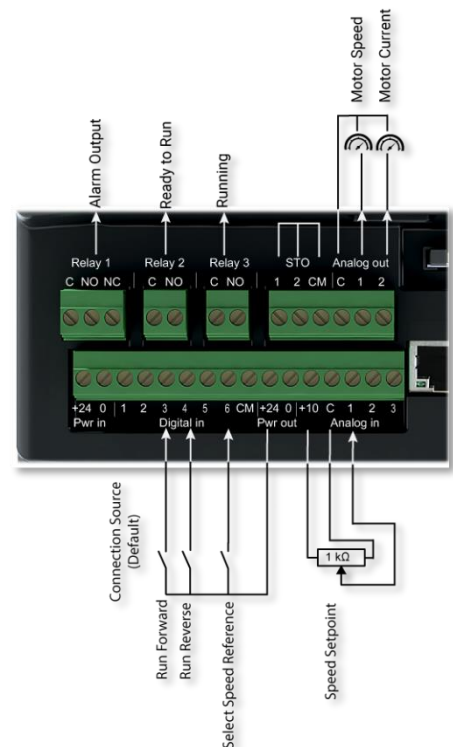
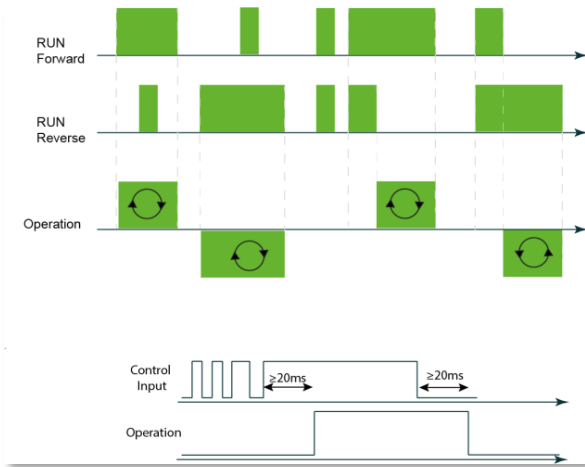
If none of those inputs is active, the Clean Power VFD stops the motor.

Simultaneous activation of run forward and run reverse does not change the Clean Power VFD's status.

To change the motor rotor direction, a full stop is compulsory.

A digital input is managed as active upon its steady state.

A filter (acting as a delay) of fixed 20ms is enabled on the digital inputs to prevent false triggering of the control.



11.14. Safe torque off (STO)

The "Safe Torque Off" function (STO) is used to prevent the Clean Power VFD from generating torque to the motor and preventing the motor from restarting as long as the STO function is activated.

This prevents the Clean Power VFD/motor system from operating while STO is engaged.

This STO safety function corresponds to **stop category 0** according to IEC 60204-1: the stopping is executed by immediate removal of power to the machine actuators.

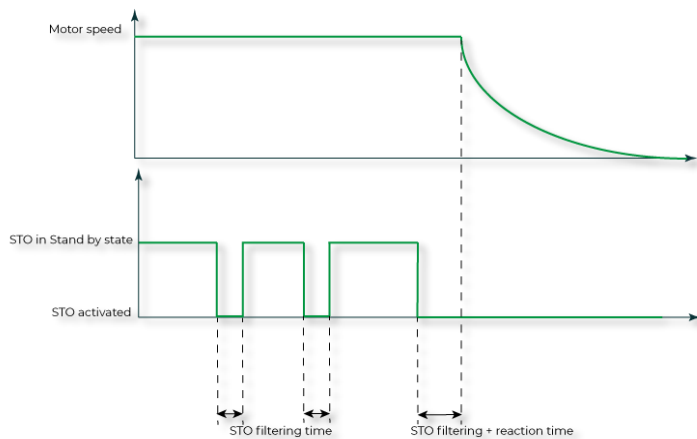
Note for users, other stop categories are:

- *Stop Category 1: A controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved.*
- *Stop Category 2: A controlled stop with power left available to the machine actuators*

When the Clean Power VFD is operating normally it is in a "normal" state and the STO function is in a "standby" state.

If one or both STO channels are de-energized the STO function is activated and the Clean Power VFD transitions to the "safe" state.

In a "safe" state the Clean Power VFD shuts off power to the semiconductors and disables the startup.



Filtering time refers to the width of the low-level pulse onto STO input. When the input pulse width is less than or equal to the STO filtering time, there is no influence on the operation.

Reaction time is the time interval from the power-off time of any STO input to the stop time of power output components.

Before using the STO function, a complete risk analysis of the system must be done. Depending on this analysis, additional measures may be necessary to prevent any hazard (e.g., mechanical brake with vertical load).

Acceptance test

The correct operation of the STO function must be checked at least once a year and during the validation (initial start-up) of the equipment's safety functions.

The goal of this procedure is to verify that all subsystems of the safety function are operational.

After any maintenance work related to the safety function, or after any modification related to the safety function (wiring, settings, etc) the acceptance test must also be executed.

The checking must be executed by an operator aware of potential risks due to the wrong operation of the safety system. This operator must master safety in general and functional safety specifically. He must report and sign the acceptance test in a dedicated document.

The initial acceptance test report and subsequent test reports must be stored in a logbook.

11.15. Remote/ Local control source

The Clean Power VFD speed setpoint, as well as the stop/start/direction controls, can come from various different sources.

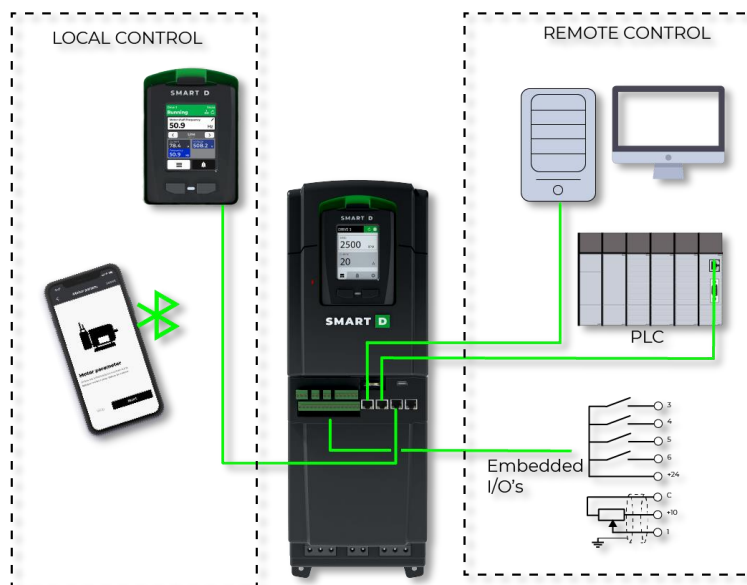
Remote / Local

When the VFD needs to be controlled remotely (away) (for example: from a control room using digital input and/or analog inputs, or from a remote system/device (PLC, DCS, network...) this is the remote-control mode.

In other words, the commands are coming from a system or a human being not close to the VFD.

When the VFD needs to be controlled from its front face HMI or locally with a connected SmartD App (commissioning, maintenance, test, ...) the user does not want any remote action to interfere and starts a dangerous operation while working locally on the VFD. This is the local control mode.

In other words, there's a human being close to the VFD, who controls the VFD.



The switch between the local and remote control modes can be made either from the HMI screen or from the SmartD mobile App or by using a digital input.

In the screen header, the HMI and the mobile APP (when connected) display if the VFD is

in remote control mode: 

or in local control mode: 

In Local mode

RUN/STOP, rotation direction and speed are controlled by the HMI and/or the connected App.

In this mode, the last command is applied wherever it comes from the HMI or from the App.

In this mode, the commands coming from the embedded I/Os or the Ethernet Comm ports are ignored.

In Remote mode

Control sources are determined by the settings for the parameter [Control_source].

Remote source selection

From the HMI:

Open Menu/Remote Control to enable/disable remote control and select the current active source.

Select the Menu/Configuration/Remote Control to edit the configuration of the remote source 1 and source 2.

2 remote sources can be defined but only one at once can be active.

The user must define the value of the variables "remote control sources" [source 1] and [source 2] when doing the product configuration.

The values of the variables [source_n] can be:

- I/Os: those are the wired_Inputs (then the control is done accordingly to the selection between 2-wires, 3-wires, or user-defined)
- Modbus TCP on CommPort (Start, stop, speed, and direction are controlled from the communication port)
- unused

Default values:

[source_1] = I/Os

[source_2] = unused

12. Clean Power VFD operation

This section explains how the Clean Power VFD is operating.

The explanations aim to give more information to variable frequency drive experts.

12.1. VFD IoT Health Monitor

The Health Monitor is responsible for system state management and transitions coordination, as well as for handling system state transitions based on faults, alarms, and defined system service behavior.

As such, it forms a central component in the Clean Power VFD operation and can be seen as the control center for all of the other modules and the central point of coordination between the IoT subsystem and the OS and related system processes at the lower level.

IoT services start-up sequence

The IoT services follow this order when they get started:

- IoT-health-monitor: this gives the health monitor time to verify the status of the banks and to get ready to receive messages from other services.
- IoT-alarm-service: this makes the alarm service ready before the other services, allowing it to catch alarms and report them to the already-started health monitor.
- All the other services can then boot, with some dependencies for some of them (e.g. the `iot-vfd-service` comes after the `iot-firmware-proxy`)

Bootting

The health monitor starts with several checks when booting.

It first verifies the status of the banks. If the VFD unexpectedly booted from the backup bank an alarm is raised. Another one is raised if the VFD was forced to restore the factory settings due to the backup bank being incompatible with the data present in the database.

Then, it checks if all the services seem to boot properly, it verifies that the allowed boot time is not exceeded and raises an alarm if the system is degraded (one or more service cannot start properly).

Normal operation

Once the system has exited the booting state, the health monitor keeps monitoring the system state (see the section on system states)

It also keeps track of the status of the services:

Each service is responsible for pinging the health monitor at regular intervals, showing it is responsive and running normally. If no new ping is received after 60 seconds, the service is considered unresponsive.

13. Networks and communication

The Clean Power VFD has a dual port Ethernet that can be used in Modbus TCP communication protocol.

13.1. Modbus TCP

While setting the Clean Power VFD with the mobile App, the Modbus communication can be disabled by the user (or enabled if previously disabled)

Note: If Modbus is disabled, remote control from Modbus is impossible, thus protecting workers that may work locally on the power drive system from an unexpected operation.

However, for a flexible choice of remote and local control, the Clean Power VFD provides users with settings for the [control source](#).

The communication speed selection is Automatic.

The Mac Address is written on the [product label](#).

The Modbus application layer is standard.

Mode: DHCP only.

The profile can be selected by the user between CIA402 and SmartD.

Parameters, Addresses, and Format

The Clean Power VFD is seen by other clients/servers as a table of parameters.

This table can be downloaded as an Excel file, from SmartD website, in the page resources, section products. <https://smartd.tech/technology/resources>

Registers MCx - Motor Control

The registers MCx are dedicated to Motor Control

The command register MCC can be used to change the Clean Power VFD status from "Ready to run" to running.

The command register MCD can be used to run the motor in the forward or reverse direction.

The command register MCS can be used to read the motor status.

Register SYSx - System State

The registers SYSx are dedicated to the System State

The command register SYS can be used to read the system state.

The command register SYSR can be used to reset the system after a [lockout](#).

Registers ALxy - Alarms

The registers ALxy are dedicated to alarms.

Supported functions

Code	Function
03	Read holding registers.
06	Write a single register.
16	Write multiple registers
23	Read/Write multiple registers.
43	Read Device Identification

14. Maintenance

This section explains how to perform regular inspections as well as how to safely execute prescribed maintenance.

A Clean Power VFD is vulnerable to environmental conditions, and faults may also occur due to component wear and tear.

To prevent breakdowns, please follow the maintenance recommendations in this section.

After each maintenance operation, an STO acceptance test must be executed by an operator skilled, trained, and knowledgeable about functional safety.

14.1. Maintenance: Safety messages



- Maintenance and inspection can only be performed by skilled professionals.

Risk of personal injury.

- Maintain and inspect devices after power is off.

Risk of electric hazard.

- Repair or maintain the AC drive after a minimum of 5 minutes have passed since it is powered off.

This allows for the residual voltage in the capacitors to discharge to a safe value.

Failure to comply will result in personal injury.

- If you replace the Clean Power VFD with a new one, set and check the parameters again after the AC drive is replaced.

Failure to comply will result in personal injury.



- The VFD becomes hot during operation.

Avoid touching the VFD until it has cooled to avoid burns.

 **CAUTION**

- Lock out and tag out all potential energy sources before working on the Clean Power VFD.
- Before you inspect the product, read all safety instructions contained in this manual.
- Before you clean the product, ensure that the power is off.
- Clean the Clean Power VFD with a dry cloth. Cleaning with wet cloths, water, solvents, or detergents may result in electric shock or damage to the product.
- When a motor is used for the first time or when a motor is reused after being kept unused for a long time, or when a periodical inspection is performed, an insulation inspection shall be conducted, so as to avoid damaging the Clean Power VFD because of the insulation failure of the motor windings.
- The motor wires must be disconnected from the Clean Power VFD during the insulation inspection.
- It is recommended to use a 500V mega meter, and the insulating resistance measured shall be 5MΩ.

14.2. Capacitors reforming

Caution

If you don't have the skills and knowledge, or the correct tools, to execute the reforming procedure as described hereafter, call SmartD Technologies Inc. to receive ad hoc technical support.

Why do capacitors need reforming?

If the Clean Power VFD has been non-operational for more than one year, the electrolytic DC capacitors of the DC bus need to be reformed.

The reforming time is a function of the time that the unit has been non-operational.

Without reforming, the capacitors can get damaged when the Clean Power VFD starts to operate.

Reforming time

Based on the unit production date code, check the Clean Power VFD age.

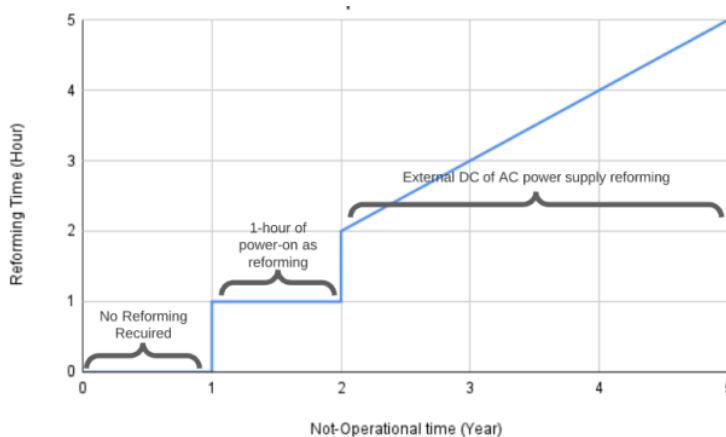
The production date information is indicated on the Clean Power VFD's side label. More detail in this [Chapter "Unboxing"- section "VFD nameplate description"](#)

1. If the Clean Power VFD has been stocked (non-operational) for 1 year or less, no reforming is required.
2. If the Clean Power VFD has been stocked (non-operational) for 1 year to 2 years:

Switch the power on the Clean Power VFD for one hour.

Do not load the Clean Power VFD until finish this process.

1. If the Clean Power VFD has been stocked (non-operational) for more than 2 years, refer to the following diagram to select the reforming time:



Reforming instruction

Note:

Note: Make sure that the converter is clean and dry (Without condensation) before starting the reforming.

Disconnect all the possible input/output power connections.

Ensure that the Clean Power VFD is not energized:

Using a high-voltage voltmeter, check the voltage of input lines L1, L2, and L3 to the earth connection. It must be less than 10V RMS, Otherwise, wait till it discharges to this value or lower.

Check the DC voltage of the drive DC+ and DC- and their voltages to the earth connection. It must be less than 10V RMS, Otherwise, wait till it discharges to this value or lower.

Connect a DC power supply to the DC+ and DC- of the Clean Power VFD.

Ensure that the current of the DC power supply is limited to 500mA.

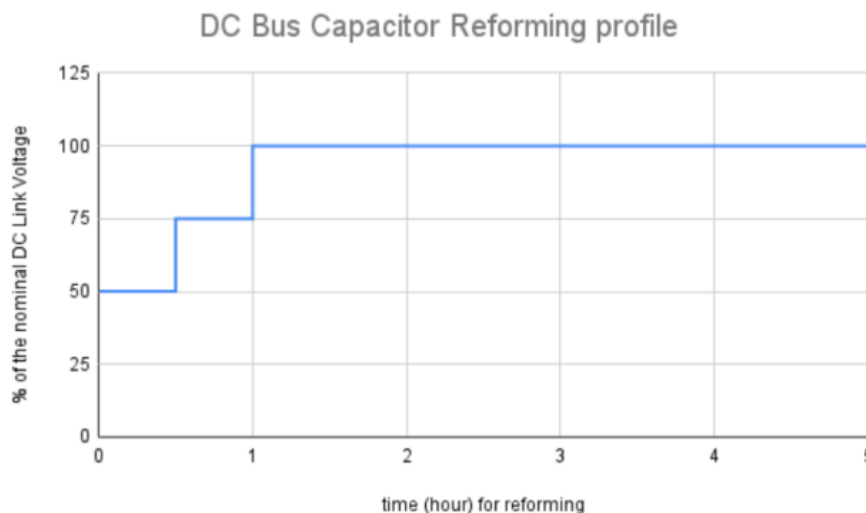
If the power Supply cannot limit the output current, use an external resistor to limit its current.

DC bus voltage

Clean Power VFD AC input voltage	DC Bus voltage
400/480V	680V

Procedure

1. ramp-up the voltage to 50% of the DC bus voltage for 30 minutes.
2. ramp-up the voltage to 75% of the DC bus voltage for 30 minutes.
3. ramp-up the voltage to 100% of the DC bus voltage for the rest of the reforming time.



14.3. Routine inspections

Regular checks of the following should be carried out to ensure the Clean Power VFD and installation reliability is maximized.

Item	Inspection	Methods and tools	Expected results
Environment	Is the ambient temperature and humidity within the specifications range, and is there any dust, dirt, corrosive gas, oil mist, or foreign objects present?	Visual, Thermometer, Hygrometer, Recorder	There must be no danger of freezing with an ambient temperature of -10 to 55 °C and no condensation with ambient humidity of less than 95%.
Enclosure door filters and fans	Check the airflow in the enclosure.	Visual Replace or clean the filters if needed. Replace the fans if needed.	Airflow from the enclosure door (in and out) is not obstructed.
Clean Power VFD overview	Is there any abnormal vibration or noise?	Visual and acoustic	No abnormality.
Power voltage	Are the input voltages within the specifications range?	Measure voltages between R/ S/ T (phase to phase)	Values are within the specifications range.
Cooling fan	Is there any abnormal vibration or noise?	Manual validation Turn off the system and check the operation by rotating the fan manually.	The fan rotates smoothly.
HMI	Is the display value normal?	Visual Check the displayed values and compare them with readings from external meters (voltmeter, ammeter, etc)	If there are variations, it should not be more than xx%
Motor mechanical health	Is there any abnormal vibration or noise?	Visual and acoustic	No abnormality.

14.4. Annual inspection

Item	Inspection	Methods and tools	Expected results
Input/output circuitry insulation	Insulation between input/output terminals and earth terminals	<ul style="list-style-type: none"> Measure Disconnect the Clean Power VFD and short R/S/T/U/V/W terminals, and then measure from each terminal to the ground terminal. Use a DC 500V insulation meter. 	Must be above 5 MΩ
Input/output terminals	Tightening torque of all screw terminals.	Manual validation Is there anything loose in the device?	All screws are tightened at the specified torque.
Connections and cables	<ul style="list-style-type: none"> Are there any corroded cables? Is there any damage to the cable insulation? Check cable for breakage and deterioration (crack, discoloration, etc.). 	Visual	No abnormality
Terminal blocks	Check for damage.	Visual	No abnormality
Motor	Insulation resistance	<ul style="list-style-type: none"> Measure Disconnect the cables for terminals U/V/W and test the wiring. Measure the insulation between U/V/W and the earth terminals with a DC 500V insulation meter. 	Must be above 5 MΩ
Safety function STO (to be done for STO1 and STO2)	Check the power output	<ul style="list-style-type: none"> Turn off the main power supply of the Clean Power VFD and then on again. 	STO alarm is displayed, and no voltage between U/V/W terminals.

		<ul style="list-style-type: none">• Activate the STO function and the RUN function..• Connected test: While the motor is running, activate the STO function.	
--	--	---	--

14.5. RTC Battery replacement

The Clean Power VFD includes a supercapacitor to keep the time of the real-time clock (RTC) for 24h.

If 24h is enough for the application, then there's no need to add a CR2032 battery.

Otherwise, please check the following instructions.

Clean Power VFDs have a real-time clock (RTC) feature.

A battery, type CR2032, ensures the clock works when the drive is powered down.

The battery is not sold with the Clean Power VFD.

The battery has a long lifetime but if the battery needs to be replaced or removed, follow the instructions below.

instruction:

To remove the battery push smoothly on it until the spring pushes it slightly outside its slot.

Check the polarity + and - of the battery.

Replace the battery by inserting a new one in its slot and push smoothly until the spring locks it inside its slot.

14.6. Update the Clean Power VFD software.

SmartD can update the Clean Power VFD software. This will add new options and functions to the drive.

The software version in your drive can be read through the embedded HMI or using the SmartDrive App.

Information about the version is accessible from the changelog database.

Before performing a software update, ensure that the date and time in the VFD are valid. You can set the proper date and time via one of the 3 following methods:

- Connect your drive to an Ethernet network having access to the Internet
- or connect the mobile application with the drive via BLE
- or edit the date/time using the HMI

Software version

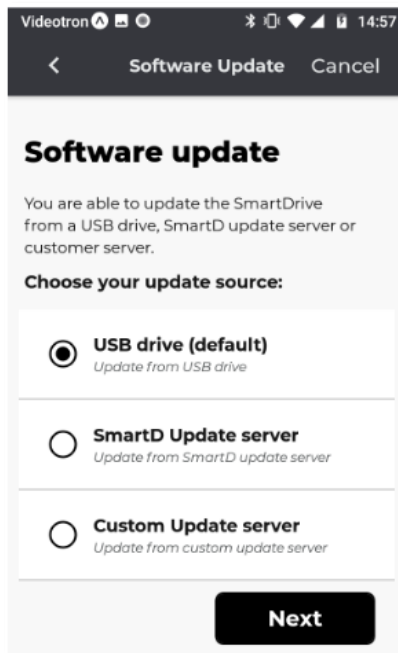
Go to the software Information from the Smartphone App menu:

(Accessible by clicking on the ellipsis in the upper right corner)

Select Update

Select from "SmartD Update server"

Note: you need your Smartphone connected to the internet to perform this operation.



It is displaying either that your version is OK or it will tell you that a new version is available.

The step-by-step operation to update/upgrade the Clean Power VFD software.

The software update is performed by pulling all the files from a distant server or a USB drive and installing them on the backup bank of the Clean Power VFD.

This means that the user does not need to stop the motor or any other process currently running on the boot bank.

Once the installation is complete, the user needs to reboot the Clean Power VFD for the update to be effective.

How to set up a USB drive for the software update?

USB drive system format:

The Clean Power VFD supports the following file system formats for the USB key: FAT, FAT32, ext3, ext4, and ExFAT.

Software update package:

The software update package must be located in the root folder of the USB drive and must have the following name:

smartd-vfd-linux-software-update.tar.xz

Plug the USB drive into your Clean Power VFD.



The software update process should then proceed by fetching the packages and will be ready to start after a few minutes.

Note:

If the configuration is already set to UPDATE_SOURCE_USB and the USB key is correctly formatted and plugged in but the software update does not seem to progress, you can send a Fetch request to force the software update to check for new packages.

It is possible to place the software update package in a directory on the USB drive but this requires modifying the configuration.

E.g. if the package is set in smartd/update/smartd-vfd-linux-software-update.tar.xz on the USB drive, the software update configuration should be set as:

```
{
"configuration": {
"selected_source": "UPDATE_SOURCE_USB",
"usb_path": "smartd/update"
}
}
```


14.7. STO acceptance test

Follow each step of the following procedure.

1- Stop the Clean Power VFD if it is running.

Give a stop command.

Switch off the power input line.

Isolate the Clean Power VFD from the main line by a disconnecter.

RESULT: Motor is stopped, and the motor system is safely disconnected from power.

2- Wait 5 minutes for the Clean Power VFD capacitors to be discharged.

Check that the remaining voltage is lower than **50 VDC**

3- Check that the STO circuit is correctly wired against the wiring diagram.

4- Check that proper cables are used and terminals are tightened with the recommended torque.

5- When previous steps have been checked and passed the verification, then switch on the disconnecter to power up the Clean Power VFD.

6- Check the prevention to start

Open the STO circuit.

Give a start command to verify that the STO function blocks the Clean Power VFD's operation.

RESULT: the drive displays a warning. The motor should not start.

7- Reset and restart.

Close the STO circuit.

Reset the Clean Power VFD status.

Give a start command.

RESULT: Check that the motor runs normally.

8- Test during running.

While the motor is running normally,

open one of the STO inputs.

RESULT: The motor should stop

Give a start command.

RESULT: The motor must remain standstill.

9- Reset and restart.

Close the STO circuit.

Reset the Clean Power VFD status.

Give a start command.

RESULT: The motor runs

10- Test STO channel lost.

Open one of the STO inputs.

RESULT: The motor stops and the alarm of the lost STO channel is raised

11- Reset and restart

Close the STO input.

Reset the Clean Power VFD status.

Give a start command.

RESULT: The motor runs normally.

12- Test STO second channel lost.

Open the other STO input.

RESULT: The motor stops and the alarm of the lost STO channel is raised

13- Reset and restart.

Close the STO input

Reset the Clean Power VFD status.

Give a start command.

RESULT: The motor runs normally.

14.8. Reset to factory settings.

To delete the user's setting from the Clean Power VFD, it's possible to reset it to factory settings.

Reset to the factory default configuration is possible via the Mobile or the Clean Power VFD, or the communication network API when your role allows it.

Note that resetting the configuration will reboot the Clean Power VFD.

Prior to executing a reset to factory settings, please read carefully the safety messages.

15.8.1. Reset to factory settings- Safety messages



- After a reset to factory default settings, the Clean Power VFD starts with settings that may not fit your application.
- If any input is active and a motor is connected, your system may run in an unpredictable or dangerous manner that may result in property damage, electric shock, serious injury, or death.



- Prior to initiating a reset, it is highly recommended that the user download the current configuration to the SmartDrive app and store it under a meaningful name.
- Prior to running a factory reset it is highly recommended that the motor be disconnected from the Clean Power VFD.
- When you execute a reset to factory default settings, the Clean Power VFD will stop all ongoing actions.
-

15.8.2. Reset to factory settings from the mobile App.

Prerequisite.

Make sure that you are running the latest software version on your smartphone.

Make sure that your Clean Power VFD is also running the latest software version.

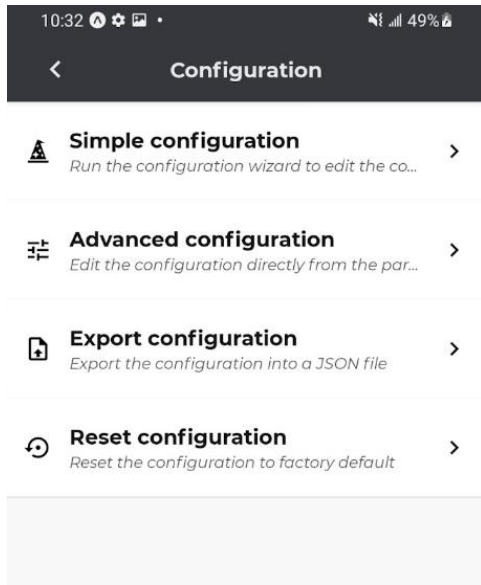
Your mobile App must be paired and connected to the Clean Power VFD via the same network.

Access the Reset function.

From the overall menu of the mobile App, select "Configuration."

Select the Reset function.

Select "Reset configuration".



Start the reset.

Tap on the button reset, and confirm your action by tapping the button Yes inside the popped-up confirmation window.



Result: The reset function is running, and the Clean Power VFD is rebooted when the operation is complete.

15. Disposal

If pollutant materials are disposed of improperly, they may cause lasting damage to human health and the environment.

Electrical and electronic equipment must be collected separately from unsorted waste so that it may be recycled or disposed of properly.

The packaging must be disposed of separately. Paper, cardboard, and plastics must be recycled.

15.1. WEEE - Waste Electrical and Electronic Equipment.

This Clean Power VFD is an electrical and electronic device.

Used electrical and electronic devices must not be disposed with domestic waste.

This Clean Power VFD contains valuable raw materials which can be recycled.

It must be disposed according to the legislation of the country, in the EU user must dispose of the device at the appropriate collecting depot (EU directive 2012/19/EU).



15.2. Disposal instructions

Some components such as electrolytic capacitors on the power circuit and PCBA may explode when they are burnt.

Emission of toxic gas may be generated when the plastic parts are burnt.

Please dispose of the Clean Power VFD as industrial waste.

16. Technical Specifications

16.1. Power Input SDB-1-2-185

Attributes		SDB-1-2-185
Input Power Voltage		3x400 VAC -15% / +10% 3x480 VAC -15% / +10%
Input Power Frequency		50 and 60Hz +/- 5%
Input Line Current		29 A
Apparent Power	at 480 V	24 kVA
Prospective Line Isc (SCCR)		5 KA

17.2. Power Input SDB-1-2-185-A

Attributes		SDB-1-2-185-A
Input Power Voltage		3 x 400 VAC -15% / +10% 3 x 480 VAC -15% / +10%
Input Power Frequency		50 and 60Hz +/- 5%
Input Line Current		36 A
Apparent Power	at 480 V	30 kVA
Prospective Line Isc (SCCR)		100 KA

16.3. Power Input SDB-2-2-220-A

Attributes		SDB-2-2-220-A
Input Power Voltage		3 x 600 VAC -15% / +10%
Input Power Frequency		50 and 60Hz +/- 5%
Input Line Current		36 A
Apparent Power	at 600 V	38 kVA
Prospective Line Isc (SCCR)		100 KA

16.4. Power Output SDB-1-2-185

Attributes		SDB-1-2-185
Rated Voltage Output	Voltage input max.	400 V or 480 V, depending input voltage
Rated output current	Normal operation (continuously available without overload)	33 A
	Heavy duty operation	24 A
Maximum Transient Output current	Normal operation	110% of rated output current during 60 s every 10 min at 40 °C (104 °F)
	Heavy duty operation	150% of rated output current during 60 s every 10 min at 40 °C (104 °F)
Permissible temporary current boost	Motor starting	1.8 x rated output current during 2 s
Rated Power Output capacity	@ 400V : @ 480V :	22.8 kVA 27.4 kVA

Motor power

Motor power values are indicative. They vary with the motor type, technology, and manufacturer.

The Clean Power VFD must not be selected from the motor power rating.

The Clean Power VFD must be selected by skilled and experienced personnel.

The Clean Power VFD must be selected according to motor FLA, the load's driving force and the movement cycle, and the operating environment.

Indicative motors power

Duty cycles		SDB-1-2-185
Motor Power	Normal duty	3 x 380 .. 460 VAC , 50/60Hz
	Heavy duty	
		18.5 kW / 25 HP
		15 kW / 20 HP

Frequencies

Output Frequency range of the VFD	0.001 to 0.5 kHz
Speed drive output Frequency	0.1 to 120 Hz
Nominal switching frequency	105 kHz
Effective switching frequency	210 kHz

16.5. Power output SDB-1-2-185-A

Attributes		SDB-1-2-185
Rated Voltage Output	Voltage input max.	400 V or 480 V, depending on input voltage
Rated output current	Normal operation (continuously available without overload)	33 A
	Heavy duty operation	24 A
Maximum Transient Output current	Normal operation	110% of rated output current during 60 s every 10 min at 40 °C (104 °F)
	Heavy duty operation	150% of rated output current during 60 s every 10 min at 40 °C (104 °F)
Permissible temporary current boost	Motor starting	1.8 x rated output current during 2 s
Rated Power Output capacity		@ 400V : 22.8 kVA @ 480V : 27.4 kVA

Motor power

Motor power values are indicative. They vary with the motor type, technology, and manufacturer.

The Clean Power VFD must not be selected from the motor power rating.

The Clean Power VFD must be selected by skilled and experienced personnel.

The Clean Power VFD must be selected according to motor FLA, the load's driving force and the movement cycle, and the operating environment.

Indicative motors power

Duty cycles		SDB-1-2-185
Motor Power	Normal duty	3 x 380 .. 460 VAC , 50/60Hz
	Heavy duty	
		18.5 kW / 25 HP
		15 kW / 20 HP

Frequencies

Output Frequency range of the VFD	0.001 to 0.5 kHz
Speed drive output Frequency	0.1 to 120 Hz
Nominal switching frequency	105 kHz
Effective switching frequency	210 kHz

16.6. Power Output SDB-2-2-220-A

Attributes		SDB-2-2-220-A
Rated voltage output	Voltage input max.	600 V
Rated output current	Normal operation (continuously available without overload)	34 A
	Heavy duty operation	25 A
Maximum Transient Output current	Normal operation	10% of rated output current during 60 s every 10 min at 40 °C (104 °F)
	Heavy duty operation	150% during 60s every 10 min at 40 °C (104 °F)
Permissible temporary current boost	Motor starting	1.8 x rated output current during 2 s
Rated Power Output capacity	@ 600 V	28 kVA

Motor power

Motor power values are indicative. They vary with the motor type, technology, and manufacturer.

The Clean Power VFD must not be selected from the motor power rating.

The Clean Power VFD must be selected by skilled and experienced personnel.

The Clean Power VFD must be selected according to motor FLA, the load's driving force and the movement cycle, and the operating environment.

Indicative motors power

Duty cycles		SDB-2-2-220-A	
Motor Power	Normal duty	3 x 575 VAC , 50/60Hz	22 kW / 30 HP
	Heavy duty		15 kW / 20 HP

Frequencies

Output Frequency range of the drive	0.001 to 0.5 kHz
Speed drive output Frequency	0.1 to 120 Hz
Nominal switching frequency	105 kHz
Effective switching frequency	210 kHz

16.7. Deratings SDB-1-2-185

Current ratings of the Clean Power VFD must be derated according to the environmental conditions when specified

Ambient temperature derating 

Temperature range	SDB-1-2-185
40 °C	UL tested value
-15...50 °C	without derating

Altitude derating

At altitudes up to 2000 m (6600 ft) above sea level, there isn't any derating to apply to the maximum output current.

For use at altitudes over 2000 m (6600 ft) above sea level, please contact SmartD Technologies Inc.

16.8. Deratings SDB-x-x-xxx-A

Current ratings of the Clean Power VFD must be derated according to the environmental conditions.

Ambient temperature derating 

Temperature range	SDB-x-x-xxx-A
40 °C	UL tested value
-15...60 °C	without derating

Altitude derating

At altitudes up to 2000 m (6600 ft) above sea level, there isn't any derating to apply to the maximum output current.

For use in altitudes over 2000 m (6600 ft) above sea level, please contact SmartD Technologies Inc.

16.9. Control I/Os

16.9.1. Auxiliary Power Input

The Smart Drive is equipped with auxiliary DC power input.

While this input is powered properly, the control functions of the Clean Power VFD operate even if the main power line is disconnected.

This auxiliary power input is protected against reverse polarity and overvoltage.

Voltage:	24 VDC
Limits:	20.4 VDC to 28.8 VDC

16.9.2. Digital inputs

Digital inputs follow IEC 61131-2 type 1

Quantity		6 digital inputs named from DI1 to DI6. Assignment settable by user. DI1 and DI2 can be assigned as encoder inputs.
Input logic		Wire-able as sink or source logic, configurable by software. Default: source.
Voltage levels in source mode	ON	18 .. 24 V
	OFF	0 .. 5V
Voltage levels in sink mode	ON	0 .. 5V
	OFF	18 .. 24 V
Current consumption		6 mA

Output power for digital inputs	+24VDC (20% .. +20%) / 100 mA
---------------------------------	-------------------------------

This auxiliary output power is protected against short-circuits.

16.9.3. STO inputs

Safe torque off (STO) inputs follow IEC 61131-2 type 1

Quantity		2
SIL capacity level	conformed to IEC61800-5-2	SIL 3
Stop category		Category 0
STO input reaction time		20 ms
STO input filtering time		5 ms
Nominal voltage of STO enabling input		24 V
Maximum input voltage		28.8 V
Logic threshold		10V (+/- 5V)
Low state maximum voltage for disabling to SIL3		5 V

16.9.4. Digital outputs

Quantity		3
Type		Relay
Relay 1	Contact arrangement	SPDT (Form C)
	NO contact features	Resistive load; AC:5A @ 250V; DC: 3A @ 30V
	NC contact features	Resistive load; AC: 3A @ 250V; DC: 3A @ 30V
Relay 2	Contact arrangement	SPST NO (Form A)
	NO contact features	Resistive load; AC: 3A @ 250V; DC: 3A @ 30V
Relay 3	Contact arrangement	SPST NO (Form A)
	NO contact features	Resistive load; AC: 3A @ 250V; DC: 3A @ 30V

16.9.5. Analog inputs

Quantity		3 analog inputs. Programmable
Input types		0..10VDC 0..20mA / 4..20mA 0..24VDC Impedance to read PTC temperature sensor Default settings: 0..10VDC
Input impedances	0..10VDC 0..20mA & 4..20mA 0..24VDC	> 3.5 k Ohms 165 Ohms 25 k Ohms
Resolution		12 bits
Time response		50 ms
Accuracy		± 1% at 25 °C (77 °F) / ± 2% for a temperature variation of 60 °C (108 °F)
Reference power supply for analog inputs		+10 VDC Tolerance ± 2% for the temperature range of 20 °C to 30 °C. Current: maximum 10 mA, short circuit protected.

16.9.6. Analog outputs

Quantity		2 analog outputs. Programmable
Output types		0..10VDC (20 mA max.) 0..20mA / 4..20mA
Output impedances	0..10VDC 0..20mA / 4..20mA	500 ohms minimum 75 ohms maximum
Resolution		12 bits
Response time		50 ms (worst case from 0 to max output)
Accuracy		± 1% at 25 °C (77 °F) / ± 2% for a temperature variation of 60 °C (108 °F)

16.10. Operating environment

The Clean Power VFDs are manufactured with precision electronic components.

Therefore, the installation environment can impact the lifespan and reliability of the product.

The information below describes the recommended operation and installation conditions for the Clean Power VFD.

The user must comply with the environmental conditions listed below in order to ensure that the Clean Power VFD operates safely and correctly.

Failure to adhere to these environmental conditions may shorten the lifespan of the device, lead to malfunctioning and device failure, and void the warranty.

Environment	Conditions
Installation area	The Clean Power VFD must be mounted in a well-ventilated electrical cabinet respecting the clearance distances described in this document.
Ambient temperature	The normal operating range of the Clean Power VFD is -15 to 50°C (without derating) if not specified otherwise. The reliability of the Clean Power VFD increases in environments where temperature fluctuations are limited. When using an enclosure, install a cooling fan or air conditioner in the area to ensure the air temperature inside the housing does not exceed the specified levels. Do not allow ice to form on the frequency converter.
Relative humidity	Below 95% non-condensing.
Surrounding environment pollution degree	2, conforming to IEC61800-5-1
Storage temperature	-40...70 °C / -40...158 °F
Surrounding area	Mount in an area free of -oil mist and dust-metal shavings, oil, water or other foreign materials -radioactive materials -combustible materials -toxic or corrosive gases and liquids -excessive vibration -chlorides -direct sunlight -EMI source and other electronic devices that are sensitive to EMI
Altitude	Lower than 2000 m/6600 ft. Contact SmartD Technologies Inc. if you intend to use the Clean Power VFD at higher altitude.
Vibrations	Mount in a location where vibrations are less than an amplitude of 1.5 mm peak to peak (f= 2...13 Hz) and acceleration lower than 1 gn (f= 13...200 Hz).

Best practices:

To prevent high surrounding air temperature, users should design their electrical panel following the listed best practices:

- No heat stagnation in the panel.
- Sufficient heat dissipation of the panel (Size not too small, proper ventilation).

- Ventilation slits of the Clean Power VFD are not blocked by any object such as cable or cable trays.
- Avoid the proximity of any exothermic device.
- Ensure the mounting orientation of the Clean Power VFD allows an optimized airflow.
- Respect the clearance distances.

17. Warranty, Software License and Legal Provisions

Limited Equipment Warranty

This quality product (“Equipment”) is warranted to operate in all material respects as described in this User Guide (the “Guide”) and it is free from manufacturing defects in material and workmanship for a period of eighteen (18) months from the date of shipment to the Purchaser, provided that the Equipment is used under normal operating conditions as described in the Guide. This warranty is available only to the person or organization (“Purchaser”) to which the Equipment was originally sold by SmartD Technologies Inc. (SmartD) or by an Authorized distributor of SmartD, and is non-transferable.

Exclusive Remedy

For any breach of warranties contained in the Limited Equipment Warranty Purchaser's sole and exclusive remedy and SmartD's sole and exclusive obligation shall be: At SmartD's option, to (i) repair or replace Equipment, at its sole and absolute discretion, in order for the Equipment to perform as warranted or correct any defect in material or workmanship; or (ii) reimburse Purchaser the full purchase price paid by Purchaser for the defective Equipment; provided in both cases that (i) Purchaser provides SmartD with sufficient details to enable SmartD to recreate and diagnose the failure of the Equipment to function as warranted; and (ii) the breach of the warranty is reported to SmartD within the Equipment Warranty Period.

Additional Terms of Warranty

Parts, accessories or components that are new or reconditioned to perform as new, shall be furnished by SmartD on an exchange basis, and, upon the completion of such exchange, the exchanged part shall become SmartD's property. Plastic components (e.g. plastic cover) are warranted for thirty (30) days from date of shipment to Purchaser, with no extensions provided. The Warranty Period shall not be extended due to suspension of the use of Equipment because of repair, replacement, examination, or any other reasons. Purchaser shall bear all costs associated with transportation of returned Equipment, parts, accessories and components, and will bear all risk of loss or damage while in transit. In the event no breach of the Limited Equipment Warranty is discovered by SmartD but the returned Equipment nonetheless requires repair or replacement, SmartD shall, upon approval by Purchaser, repair or replace the Equipment, and return same to Purchaser at Purchaser's expense and risk.

Restrictions

No warranty or insurance herein contained or set out shall apply when damage or repair is caused by any of the following:

1. Damage in transit or when moving or installing the Equipment;
2. Improper installation, such as defective wiring or inadequate protection;
3. Abnormal conditions of temperature, dust, corrosion or any operating conditions outside ranges specified in this Guide;
4. Accident, alteration, abuse or misuse of the Equipment or abnormal operating conditions;
5. Fire, water damage, theft, war, riot, hostility, acts of God such as hurricanes, floods, etc.;
6. Service calls resulting in customer education,
7. Other acts which are not attributable to SmartD.

Exclusions and Limitations of Liability

Save as herein provided, there are no other warranties, conditions, representations or guarantees, express or implied, made or intended by SmartD or its authorized distributors and all other warranties, conditions, representations or guarantees, including any warranties, conditions, representations or guarantees under any Sale of Goods Act or like legislation or statute are hereby expressly excluded where permitted by law. Nothing in this agreement shall be interpreted as a warranty that the Equipment or the services performed hereunder shall satisfy the needs of the Purchaser or be suited to a specific application. In particular but without restriction, the Equipment is not designed for any activity requiring fail-safe performance in which the failure of the Product could lead to death, serious personal injury or severe physical or environmental damage, including but not limited to medical applications, control of critical industrial processes, emergency response systems, air traffic control systems and weapons systems. Save as herein provided, SmartD, shall not be responsible for any damage to persons or property, including the Equipment itself, howsoever caused or any consequential damages arising from the malfunction of the Equipment and by the purchase of the Equipment. Purchaser agrees to indemnify and save harmless SmartD from any claim for damages to persons or property caused by the Equipment. In no event shall SmartD be responsible for installation, dismantling or re-installation costs or charges. Unless specifically authorized in a separate writing by SmartD, no warranty is made with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than an authorized SmartD technician. Modification or replacement of the embedded software provided with the Equipment shall void this warranty, with the exception of any user-defined scripts added or modified following the instructions and limitations outlined in this User Guide. The total liability of SmartD to Purchaser arising out of or in connection with this Equipment, whatever the cause of action, shall not, in the aggregate, be in excess of the purchase price having actually been paid by Purchaser for the Equipment. Purchaser releases SmartD from all obligations, liability, claims or demands in excess of this limitation. The existence of claims against more than one Equipment and/or service shall not enlarge or extend the limit.

Service

For service and support, Purchasers must contact the authorized SmartD reseller who sold you this Product, or SmartD if purchased directly. End users must contact the original Purchaser. If service is performed on the Equipment by anyone other than a technician authorized by SmartD then all obligations of SmartD under this warranty shall end.

Acceptance of Warranty

Purchaser and all users are deemed to have accepted this Limited Warranty, its exclusions and limitation of liability, which contains the complete and exclusive limited warranty for this product. This Limited Warranty may not be amended, modified or its terms waived, except in writing and signed by an Officer of SmartD.

Intellectual Property Rights and Software License

Nothing in these Terms and Conditions shall be construed as conferring upon Purchaser any right whatsoever in and to SmartD's intellectual property, patents, trademarks, trade names, software, designs, know how or trade secrets, title to which shall remain with SmartD. Purchaser shall not reverse engineer the Products or any part thereof. SmartD grants the purchaser of this product and any tiers end-user a non-exclusive, royalty-free license to use the embedded software and any associated documentation ("Software") solely in conjunction with the use of the product. Any other use of the Software is strictly forbidden, including, but not limited to, copying, renting, or selling. SmartD retains all other rights to the Software.

Export Controls

Purchaser shall comply with all applicable regulations and laws in effect now and hereinafter, including compliance with all export controls on the distribution or dissemination of this Equipment, embedded software and documentation related to this Equipment.

General Provisions

SmartD shall not be responsible for delays or failures in performance resulting from acts beyond its reasonable control. If any part or provision of this section shall be found to be illegal or unenforceable therein, the remaining provisions of this Section shall remain in full force and effect and such part or provision shall be deemed stricken. The terms of this Section shall be governed by and construed in accordance with the laws of the province of Quebec, CANADA, applied without giving effect to any conflicts of law principles. The parties agree that all disputes relating to, or arising out of, this Section shall be subject to the exclusive jurisdiction and venue of the courts of the judicial district of Montreal (Quebec).

18. Registered trademarks

Modbus is a registered trademark of Schneider Electric.

IOS is a registered trademark of Cisco in the U.S. and other countries.

App Store and related logos and badges are registered trademarks of Apple Inc.

Android is a trademark of Google LLC.

Google Play and Google Play's badge are trademarks of Google LLC.

The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. The Auracast™ word mark and logos are trademarks owned by Bluetooth SIG, Inc.