Astraada DRV-260 Series Low-voltage VFD Quick Start Guide

Astraada DRV-260 low-voltage general VFD is a product with optimized design based on the existing products of DRV-260, with the addition of the Safe Torque Off (STO) (SIL3) function. This guide briefly introduces the STO-related information, including safety standards, function descriptions, and faults and countermeasures. For other information, see DRV-260 product manual of full version.

Scan the QR code to view the full version of corresponding product e-manual.

Note: The DRV-260 STO function design comply with SIL3 Ple standards. ASTOR is applying for a certificate from TUV Nord.

Visit www.astor.com.pl for more information and source download.

⚠ Warning

This guide only provides the basic installation and commissioning information. Failure to comply with the safety instructions and installation and commissioning instructions in the relevant documentation may result in accidents such as equipment damage, personal injury, or even death.
Only trained and qualified professionals are allowed to carry out related operations.

⚠ Danger

Do not perform any operations including wiring, inspection, or component replacement when power supply is applied. Before performing these operations, ensure all the input power supplies have been disconnected, and wait for at least the time designated on the VFD or until the DC bus voltage is less than 36V.

Minimum waiting time	VFD model
5 minutes	3PH 380V 1.5–110kW
15 minutes	3PH 380V 132–315kW
20 minutes	3PH 380V >355kW

1 Safety standards

The product has been integrated with the STO function and complies with the following safety standards.

IEC 61000-6-7	Electromagnetic compatibility (EMC)—Part 7: General standards—Immunity requirements for equipment used in industrial sites to perform safety related functions (functional safety)
IEC 61326-3-1	EMC requirements for measurement, control, and laboratory electrical equipment—Part 31: Immunity requirements for safety related systems and equipment intended to perform safety related functions (functional safety)—General industrial applications
IEC 61508-1	Functional safety of electrical/electronic/programmable electronic safety related systems—Part 1: General requirements
IEC 61508-2	Functional safety of electrical/electronic/programmable electronic safety related systems—Part 2: Requirements for electrical/electronic/programmable electronic safety related systems
IEC/EN 61800-5-2	Adjustable speed electrical power drive systems Part 5-2: Safety requirements—Function
IEC/EN 62061	Safety of machinery—Safety-related functional safety of electrical, electronic, and programmable electronic control systems
EN/ISO 13849-1	Safety of machinery—Safety related parts of control systems—Part 1: General principles for design
EN/ISO 13849-2	Safety of machinery—Safety related parts of control systems—Part 2: Verification

Safety standard related data is as follows.

Code	Definition	Standard	Characteristics
SIL	Safety integrity level	IEC 61508 IEC 62061	SIL3
PFH	Probability of failure per hour	IEC 61508	$2.87x10^{-10}$
HFT	Hardware fault tolerance	IEC 61508	1
SFF	Safe failure fraction	IEC 61508	97.59%
DC	Diagnosis coverage	ISO 13849-1	Greater than 90%
Cat.	Category	ISO 13849-1	3

2 Safety function description

■ STO function principle description

STO (Safe Torque Off) function turns off the drive output by shutting down the drive signal, cutting off the electrical power supply to the motor and thus stopping the outward torque output (see Figure 4-3). When STO is activated, this function prevents the motor from accidentally starting if the motor is in static state. If the motor is rotating, it will continue to rotate by inertia until it comes to rest. If the motor has a brake, the brake closes immediately.

Note:

- In normal working mode, you are not recommended to use the STO function to stop the VFD running. The STO function cannot effectively prevent sabotage or misuse. If the STO function is used to stop a running VFD, the VFD will disconnect the power supply to the motor, and the motor will coast to stop. If the consequences caused by this action are unacceptable, related stop modes should be used to stop the VFD and mechanical equipment.
- When using a permanent magnet, reluctance, or nonsalient pole induction motor, even if the STO function is activated, there is still a possible failure mode (although the possibility is very low) that prevents the two power devices of the VFD from conducting. The drive system can output a uniform torque, which can rotate the permanent magnet motor shaft by a maximum electrical angle of 180°, or the nonsalient pole induction motor or reluctance motor shaft by an electrical angle of 90°. This possible failure mode must be allowed during the design of the machine system. Maximum motor shaft rotation angle = Electrical angle of 360°/Number of motor pole pairs.
- The STO function cannot replace the emergency stop function. When no other measures are taken, the power supply of the VFD cannot be cut off in an emergency.
- The STO function has priority over all other functions of the VFD.
- Although the STO function can reduce known hazardous conditions, it does not eliminate all potential hazards.
- Designing safety related systems requires professional safety knowledge. To ensure the safety of a complete control system, design the system according to the required safety principles. A single subsystem with the STO function, although intentionally designed for safety related applications, it cannot guarantee the safety of the entire system.

■ Emergency stop function description

When the emergency stop function is used in equipment, it mainly allows operators to take timely actions to prevent accidents in unexpected conditions. Its design may not necessarily be complex or intelligent, but it may use simple electromechanical devices to initiate a controlled rapid stop by cutting off the power supply or other means (such as dynamic or regenerative braking).

3 Risk assessment

1. Before using the STO function, a risk assessment needs to be conducted on the drive system to ensure compliance with the required safety standards.
2. There may also be some other risks when the device is operating with safety functions. Therefore, safety must always be considered when conducting risk assessments.
3. If an external force (such as vertical axis gravity) is applied while the safety function is in operation, the motor will rotate. A separate mechanical brake must be provided to secure the motor.
4. If the drive fails, the motor can operate within the range of 180 degrees, ensuring safety even in dangerous situations.
5. The rotation number and moving distance of each type of motor are as follows:
   - Rotating motor: can rotate up to 1/6 (of the motor shaft rotation angle).
   - Drive motor: can rotate up to 1/20 (of the motor shaft rotation angle).
   - Linear servo motor: can move up to 30mm.

4 STO wiring

In the factory, the STO function terminals +24V, H1, and H2 have been shorted.

The wiring requirements are as follows:

1. When using the STO function of the VFD, remove the jumpers between +24V and H1 and between +24V and H2.
2. When the VFD is in normal operation, close K (the switches or relays).

Figure 4-1 STO function terminal diagram for 1.5–7.5kW models (SLOT1 position)

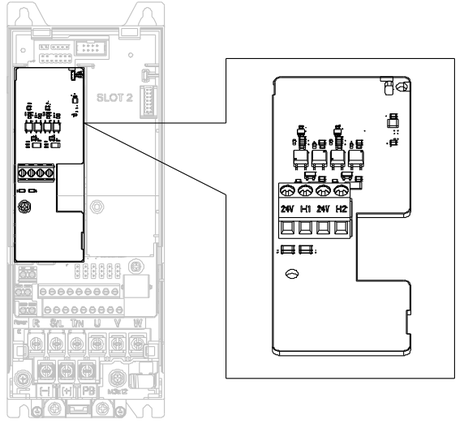


Figure 4-2 STO function terminal diagram for 11–500kW models (SLOT3 position)

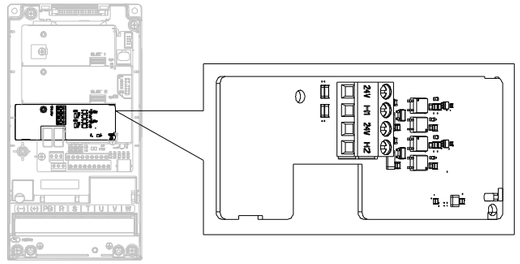
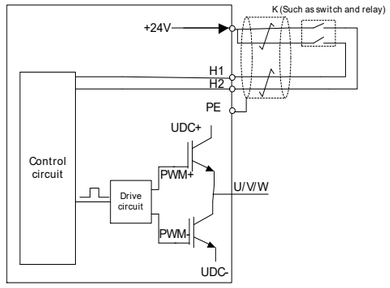


Figure 4-3 STO function circuit wiring



Note:

- The symbol K in the preceding figure can represent components such as manual operation switch, emergency stop switch, safety relay, and safety PLC contact.
- The opening or closing of safety switch contact must be within 200.
- The maximum length of the double-shielded twisted pair cable between the VFD and safety switch is 25m.
- The cable shield layer should be connected to the PE terminal of the VFD.
- When the STO function is enabled, the switch or relay is opened. If the VFD stops output, the keypad displays "STO".

5 STO function terminal description

STO function terminals are listed in the following table.

Terminal symbol	Function description
+24V	Voltage range: 24V±15% To disable the STO function, short +24V to H1 and to H2.
H1	Voltage in STO action mode: 0V < H1 and H2 < 5V Voltage in STO cut-off mode: 13V < H1 and H2 < 30V Input current: 5mA STO function channel signal input
H2	

Note: For the 1.5–7.5kW models, the extended interface SLOT1 will be occupied due to the H1/H2 terminals, that is, 1.5–7.5kW models only support extended interface SLOT2.

6 STO function logic table

The function logics of H1 and H2 and keypad display are listed in the following table.

H1	H2	VFD status	Keypad display	Fault description
H1 closed	H2 closed	Normal running	No exception displayed	-
H1 opened	H2 opened	Torque output off	STO	Safe torque off (STO)
H1 opened	H2 closed	Torque output off	STL1	H1 is abnormal.
H1 closed	H2 opened	Torque output off	STL2	H2 is abnormal.

Note: STL3 indicates both H1 and H2 are abnormal.

7 STO channel delay description

The following table describes the trigger and indication delay of the STO channels.

Table 7-1 STO channel trigger and indication delay

STO mode	STO trigger delay[1] and indication delay[2]
STO fault: STL1	Trigger delay < 10ms Indication delay < 280ms
STO fault: STL2	Trigger delay < 10ms
	Indication delay < 280ms
STO fault: STL3	Trigger delay < 10ms Indication delay < 280ms
STO fault: STO	Trigger delay < 10ms Indication delay < 100ms

1: STO trigger delay: time interval between trigger the STO function and switching off the drive output

2: STO instruction delay: Time interval between trigger the STO function and STO output state indication

8 Acceptance test

Alarm	
⚠	• Technical personnel, operators, maintenance and repair personnel must receive relevant training to understand the requirements and principles of safety system design and debugging. • Do not carry out maintenance on the VFD or motor before the power is cut off; otherwise, there may be a risk of electric shock or other electricity generated hazards. • The safety function acceptance test must be carried out by personnel with professional safety function knowledge, and must be recorded and signed by test engineers.

The acceptance test must be carried for the device in the following stages:

1. First starting of safety functions
2. After any safety function related change (including PCB, wiring, component, or setup)
3. After any safety function related maintenance work

The signed acceptance test report must be kept in machine logs. The report should include the documents of startup activities and test results, fault report references and fault solutions. Any new acceptance test conducted due to changes or maintenance should be recorded in the logs.

■ Acceptance test checklist

Step	Test	Result
1	Ensure that the VFD can run or stop randomly during commissioning.	
2	Stop the VFD (if it is running), disconnect the input power supply, and isolate the drive from the power cable through the isolation switch.	
3	Check the STO function circuit connection according to the circuit diagram.	
4	Close the isolation switch to connect to the power. Test the STO function as follows when the motor stops: If the VFD is running, send a stop command to it and wait until the motor shaft stops rotating. Disconnect the STO circuit. Then the VFD should enter the safe torque off mode and stop outputting voltage, and the keypad displays "STO". Send a VFD startup command, but the motor does not start. Close the STO circuit. Remove the fault, start the VFD, and ensure that the motor can run properly. Test the STO function as follows when the motor is running: Start the VFD and ensure that the motor runs. Disconnect the STO circuit. Then the VFD should enter the safe torque off mode and stop outputting voltage, and the keypad displays "STO". The motor should stop. Remove the fault, start the VFD, and ensure that the motor keeps the static state. Close the STO circuit. Remove the fault, start the VFD, and ensure that the motor can run properly.	
5	Test and detect the VFD fault. At this time, the motor can be in running or stopped state. Start the VFD and ensure that the motor runs properly. Disconnect H1 and keep H2 closed. If the motor is running, it should coast to stop, and the keypad displays "STL1". Send a VFD startup command, but the motor does not start. Close the STO circuit. At this time, the fault cannot be removed. Power off and restart the VFD, and ensure that the motor can run properly. Disconnect H2 and keep H1 closed. If the motor is running, it should coast to stop, and the keypad displays "STL2". Send a VFD startup command, but the motor does not start. Close the STO circuit. At this time, the fault cannot be removed. Power off and restart the VFD, and ensure that the motor can run properly.	
6	Record and sign the acceptance test report, which indicates the	

Step	Test	Result
	STO function is safe and can be put into service.	

Note:

- If the steps in the acceptance test checklist can be carried out normally without other exceptions, it indicates that the STO functional circuit is normal. If the situations are different from the expected results of the preceding steps or if "E43" is displayed, it indicates that the STO function circuit is abnormal. For details about fault handling, see chapter 10 STO-related faults and countermeasures.
- Fault "STO" can also be manually or automatically reset by setting P08.52.

VFD fault	Fault code displayed	Response time	Reset method
Normal running	No exception displayed	-	-
Torque output off	STO	≤20ms	Press STOP/RST.
Torque output off	STL1	≤20ms	Entire machine re-powered on
Torque output off	STL2	≤20ms	Entire machine re-powered on

9 STO-related parameter settings

The following briefly describes only some common function parameters and typical values.

"○" indicates that the value of the parameter can be modified when the VFD is in stopped or running state.

"◎" indicates that the value of the parameter cannot be modified when the VFD is in running state.

"●" indicates that the value of the parameter is detected and recorded, and cannot be modified.

(The VFD automatically checks and constrains the modification of parameters, which helps prevent incorrect modifications.)

Function code	Name	Description	Default	Modify
P08.52	STO lock selection	0–1 0: Lock upon STO alarm 1: No lock on STO alarm **Note:** "Lock upon STO alarm" indicates resetting is required after state restoration if STO alarm occurs. "No lock on STO alarm" indicates STO alarm disappears automatically after state restoration.	0	○
P07.27	Present fault type	0: No fault 1: Inverter unit U-phase protection (OUt1) 2: Inverter unit V-phase protection (OUt2) 3: Inverter unit W-phase protection (OUt3) 4: Overcurrent during acceleration (OC1) 5: Overcurrent during deceleration (OC2) 6: Overcurrent during constant speed running (OC3) 7: Overvoltage during acceleration (OV1) 8: Overvoltage during deceleration (OV2) 9: Overvoltage during constant speed running (OV3) 10: Bus undervoltage fault (UV) 11: Motor overload (OL1) 12: VFD overload (OL2) 13: Phase loss on input side (SPI) 14: Phase loss on output side (SPO) 15: Rectifier module overheat (OH1) 16: Inverter module overheat (OH2) 17: External fault (EF) 18: RS485 communication fault (CE) 19: Current detection fault (ItE) 20: Motor autotuning fault (tE) 21: EEPROM operation fault (EEP) 22: PID feedback offline fault (PIDE) 23: Braking unit fault (bCE) 24: Running time reached (END) 25: Electronic overload (OL3) 26: Keypad communication error (PCE) 27: Parameter upload error (UPE) 28: Parameter download error (DNE) 29: PROFIBUS communication fault (E-DP) 30: Ethernet communication fault (E-NET) 31: CANopen communication fault (E-CAN)	0	●
P07.28	Last fault type		0	●
P07.29	2nd-last fault type		0	●
P07.30	3rd-last fault type		0	●
P07.31	4th-last fault type		0	●
P07.32	5th-last fault type		0	●

Function code	Name	Description	Default	Modify
		32: To-ground short-circuit fault 1 (ETH1) 33: To-ground short-circuit fault 2 (ETH2) 34: Speed deviation fault (dEu) 35: Mal-adjustment fault (STo) 36: Underload fault (LL) 37–39: Reserved 40: Safe torque off (STO) 41: Exception to safety circuit of channel 1 (STL1) 42: Exception to safety circuit of channel 2 (STL2) 43: Exception to both channels 1 and 2 (STL3) 44–54: Reserved 55: Duplicate expansion card type (E-Err) 56: Reserved 57: PROFINET communication fault (E_PN) 58: CAN communication timeout (ESCAN) 59: Motor overtemperature fault (OT) 60: Failure to identify the card at slot 1 (F1-Er) 61: Failure to identify the card at slot 2 (F2-Er) 62: Reserved 63: Communication timeout of the card at slot 1 (C1-Er) 64: Communication timeout of the card at slot 2 (C2-Er) 65: Reserved 66: EtherCAT communication timeout fault (E-CAT) 67: BACnet communication fault (E-BAC) 68: DeviceNet communication timeout fault (E-DEV) 69: CAN slave fault in master/slave synchronization (S-Err) 70–72: Reserved 73: Freezing fault 74: Stalling fault 75: Dry pumping fault 76–79: Reserved		
P06.01	Y1 output	0: Invalid 1: Running 2: Running forward 3: Running reversely 4: Jogging 5: VFD in fault 6: Frequency level detection FDT1 7: Frequency level detection FDT2 8: Frequency reached 9: Running in zero speed 10: Frequency upper limit reached 11: Frequency lower limit reached 12: Ready for running 13: Pre-exciting 14: Overload pre-alarm 15: Underload pre-alarm 16: Simple PLC stage completed 17: Simple PLC cycle completed 18: Set counting value reached 19: Designated counting value reached 20: External fault is valid 21: Reserved 22: Running time reached 23: Modbus communication virtual terminal output 24: PROFIBUS/CANopen communication virtual terminal output 25: Ethernet communication virtual terminal output 26: DC bus voltage established 27: Z pulse output 28: Superposing pulses 29: STO action 30: Positioning completed 31: Spindle zeroing completed 32: Spindle scale division completed 33: In speed limit 34: PROFINET communication virtual terminal output 35: Reserved 36: Speed/position control switchover completed	0	○
P06.03	RO1 output		0	○
P06.04	RO2 output		0	○
P26.02	Y2 output		0	○
P26.04	RO3 output		0	○
P26.05	RO4 output		0	○
P26.06	RO5 output		0	○
P26.07	RO6 output		0	○
P26.08	RO7 output		0	○
P26.09	RO8 output		0	○
P26.10	RO9 output		0	○
P26.11	RO10 output		0	○

Function code	Name	Description	Default	Modify
		37: Any frequency reached 38–47: Reserved 48: Fire mode activated 49: Pre-alarm of PID1 feedback too low 50: Pre-alarm of PID1 feedback too high 51: PID1 in sleep 52: PID2 in startup 53: PID2 stopped 54: Indication of run with backup pressure 55: Water shortage indication of inlet pool 56: Pre-alarm output 57: Control variable-frequency circulation motor A 58: Control variable-frequency circulation motor B 59: Control variable-frequency circulation motor C 60: Control variable-frequency circulation motor D 61: Control variable-frequency circulation motor E 62: Control variable-frequency circulation motor F 63: Control variable-frequency circulation motor G 64: Control variable-frequency circulation motor H		

10 STO-related faults and countermeasures

Note: Our fault code scheme is being upgraded. Some products use the old scheme and the others use the new one, which are listed in "Fault code display".

Fault code display	Fault type	Possible cause	Solution
STO	Safe torque off	Safe torque off function is enabled by external forces.	-
STL1	Exception occurred to safety circuit of channel 1	The wiring of STO is improper; Fault occurred to external switch of STO; Hardware fault occurred to safety circuit of channel.	Check whether terminal wiring of STO is proper and firm enough; Check whether the external switch of STO can work properly; Replace the control board. **Note:** Re-power on is required to remove the fault.
STL2	Exception occurred to safety circuit of channel 2		
STL3	Exception occurred to channel 1 and channel 2	Hardware fault occurred to STO circuit.	Replace the control board.

Appendix A Energy efficiency data

Table A-1 Power loss and IE class

Model	Relative loss (%)								Standby loss (W)	IE class
	(0;25)	(0;50)	(0;100)	(50;25)	(50;50)	(50;100)	(90;50)	(90;100)		
AS260DRV41C5	0.78	0.95	1.03	0.86	1.17	1.23	1.35	2.02	13	IE2
AS260DRV42C2	0.82	0.76	0.55	1.09	1.11	1.07	1.59	1.76	17	IE2
AS260DRV44C0	0.74	1.20	1.55	1.15	1.28	1.89	1.45	2.29	16	IE2
AS260DRV45C5	0.71	0.97	1.32	1.02	1.21	1.83	1.34	2.18	17	IE2
AS260DRV47C5	0.68	0.78	1.75	0.76	1.03	1.79	1.22	2.06	20	IE2
AS260DRV4011	0.65	0.89	1.62	0.66	1.37	1.43	1.38	2.28	27	IE2
AS260DRV4015	0.96	1.30	2.26	0.74	0.90	1.43	0.87	1.49	27	IE2
AS260DRV4018	0.72	0.95	1.57	1.20	1.46	2.17	1.47	2.26	30	IE2
AS260DRV4022	0.67	0.87	1.44	1.07	1.29	1.92	1.27	2.04	30	IE2
AS260DRV4030	0.71	0.98	1.76	1.22	1.89	2.42	2.17	2.83	30	IE2
AS260DRV4037	0.67	0.85	1.60	1.09	1.75	2.37	1.91	2.73	30	IE2
AS260DRV4045	0.47	0.62	1.14	1.09	1.27	1.90	1.52	2.02	30	IE2
AS260DRV4055	0.42	0.69	1.04	0.98	1.19	1.72	1.45	1.88	31	IE2
AS260DRV4075	0.52	0.80	1.35	1.06	1.42	2.10	1.67	2.23	32	IE2
AS260DRV4090	0.40	0.72	1.29	0.93	1.31	1.98	1.58	2.11	31	IE2
AS260DRV4110	0.42	0.69	1.20	0.84	0.98	1.67	1.27	1.72	33	IE2
AS260DRV4132	0.50	0.65	1.28	0.97	1.12	1.74	1.22	1.85	35	IE2
AS260DRV4160	0.61	1.01	1.52	1.37	1.32	2.02	1.42	2.14	37	IE2
AS260DRV4185	0.56	0.95	1.45	1.13	1.19	1.88	1.37	2.07	37	IE2
AS260DRV4200	0.48	0.81	1.33	0.99	1.08	1.78	1.28	1.99	38	IE2
AS260DRV4220	0.59	0.85	1.76	1.24	1.58	2.61	1.68	2.65	40	IE2

Model	Relative loss (%)								Standby loss (W)	IE class
	(0;25)	(0;50)	(0;100)	(50;25)	(50;50)	(50;100)	(90;50)	(90;100)		
AS260DRV4250	0.65	0.91	1.86	1.33	1.72	2.79	1.73	2.85	42	IE2
AS260DRV4280	0.68	0.98	1.92	1.27	1.61	2.54	1.62	2.69	48	IE2
AS260DRV4315	0.66	0.94	1.88	1.19	1.49	2.45	1.56	2.54	50	IE2
AS260DRV4355	0.72	1.01	1.87	1.11	1.37	2.30	1.47	2.47	52	IE2
AS260DRV4400	0.78	0.82	1.64	1.14	1.38	2.25	1.43	2.31	55	IE2
AS260DRV4450	0.75	0.89	1.52	1.08	1.27	2.16	1.37	2.23	58	IE2
AS260DRV4500	0.73	0.78	1.40	0.90	1.10	1.90	1.25	2.16	60	IE2

Table A-2 Rated specifications

Model	Apparent power (kVA)	Rating output power (kW)	Rated output current (A)	Max. working temperature (°C)	Rated power frequency (Hz)	Rated power voltage (V)
AS260DRV41C5	2.44	1.5	3.7	50°C Derate by 1% for every increase of 1°C when the temperature exceeds 40°C.	50Hz/60Hz Allowed range: 47–63Hz	3PH 380V–480V
AS260DRV42C2	3.98	2.2	5			
AS260DRV44C0	6.2	4	9.5			
AS260DRV45C5	8.6	5.5	13			
AS260DRV47C5	12.2	7.5	17			
AS260DRV4011	16.5	11	25			
AS260DRV4015	21	15	32			
AS260DRV4018	24	18.5	38			
AS260DRV4022	30	22	45			
AS260DRV4030	39.5	30	60			
AS260DRV4037	49	37	75			
AS260DRV4045	60	45	92			
AS260DRV4055	75.7	55	115			
AS260DRV4075	98.7	75	150			
AS260DRV4090	120	90	180			
AS260DRV4110	142	110	215			
AS260DRV4132	172	132	250			
AS260DRV4160	200	160	305			
AS260DRV4185	217	185	330			
AS260DRV4200	250	200	380			
AS260DRV4220	280	220	425			
AS260DRV4250	316	250	460			
AS260DRV4280	349	280	530			
AS260DRV4315	395	315	600			
AS260DRV4355	425	355	650			
AS260DRV4400	474	400	720			
AS260DRV4450	540	450	820			
AS260DRV4500	566	500	860			