

Danfoss CDS203 Drive

Installation & Operating Instructions



Please read the IMPORTANT SAFETY INFORMATION below, and all Warning and Caution information elsewhere.



Danger: Indicates a risk of electric shock, which, if not avoided, could result in damage to the equipment and possible injury or death.

This variable speed drive product (CDS 203) is intended for professional incorporation into complete equipment or systems as part of a fixed installation. If installed incorrectly it may present a safety hazard. The CDS 203 uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction. Only qualified electricians are allowed to install and maintain this product.

System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must carefully read this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the CDS 203, including the specified environmental limitations.

Do not perform any flash test or voltage withstand test on the CDS 203. Any electrical measurements required should be carried out with the CDS 203 disconnected. Internal surge arrestors are fitted, intended to protect against damage due to mains borne spikes, which will result in the product failing the flash test.

Electric shock hazard! Disconnect and ISOLATE the CDS 203 before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply. Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.

Where supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.

Ensure correct earthing connections and cable selection as per defined by local legislation or codes. The drive may have a leakage current of greater than 3.5mA; furthermore the earth cable must be sufficient to carry the maximum supply fault current which normally will be limited by the fuses or MCB. Suitably rated fuses or MCB should be fitted in the mains supply to the drive, according to any local legislation or codes.

Do not carry out any work on the drive control cables whilst power is applied to the drive or to the external control circuits.



Danger: Indicates a potentially hazardous situation other than electrical, which if not avoided, could result in damage to property.

Within the European Union, all machinery in which this product is used must comply with Directive 98/37/EC, Safety of Machinery. In particular, the machine manufacturer is responsible for providing a main switch and ensuring the electrical equipment complies with EN60204-1.

The level of integrity offered by the CDS 203 control input functions – for example stop/start, forward/reverse and maximum speed, is not sufficient for use in safety-critical applications without independent channels of protection. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment and further protection provided where needed.

The driven motor can start at power up if the enable input signal is present.

The STOP function does not remove potentially lethal high voltages. ISOLATE the drive and wait 10 minutes before starting any work on it. Never carry out any work on the Drive, Motor or Motor cable whilst the input power is still applied.

The CDS 203 can be programmed to operate the driven motor at speeds above or below the speed achieved when connecting the motor directly to the mains supply. Obtain confirmation from the manufacturers of the motor and the driven machine about suitability for operation over the intended speed range prior to machine start up.

Do not activate the automatic fault reset function on any systems whereby this may cause a potentially dangerous situation.

CDS 203 are intended for indoor use only.

When mounting the drive, ensure that sufficient cooling is provided. Do not carry out drilling operations with the drive in place, dust and swarf from drilling may lead to damage.

The entry of conductive or flammable foreign bodies should be prevented. Flammable material should not be placed close to the drive.

Relative humidity must be less than 95% (non-condensing). Ensure that the supply voltage, frequency and no. of phases (1 or 3 phase) correspond to the rating of the CDS 203 as delivered. Never connect the mains power supply to the Output terminals U, V, W.

Do not install any type of automatic switchgear between the drive and the motor. This may cause the drive protection to activate, resulting in a trip and loss of operation.

Wherever control cabling is close to power cabling, maintain a minimum separation of 100 mm and arrange crossings at 90 degrees.

Ensure that all terminals are tightened to the appropriate torque setting.

Do not attempt to carry out any repair of the CDS 203. In the case of suspected fault or malfunction, contact your local Danfoss Compressor Sales Partner for further assistance.

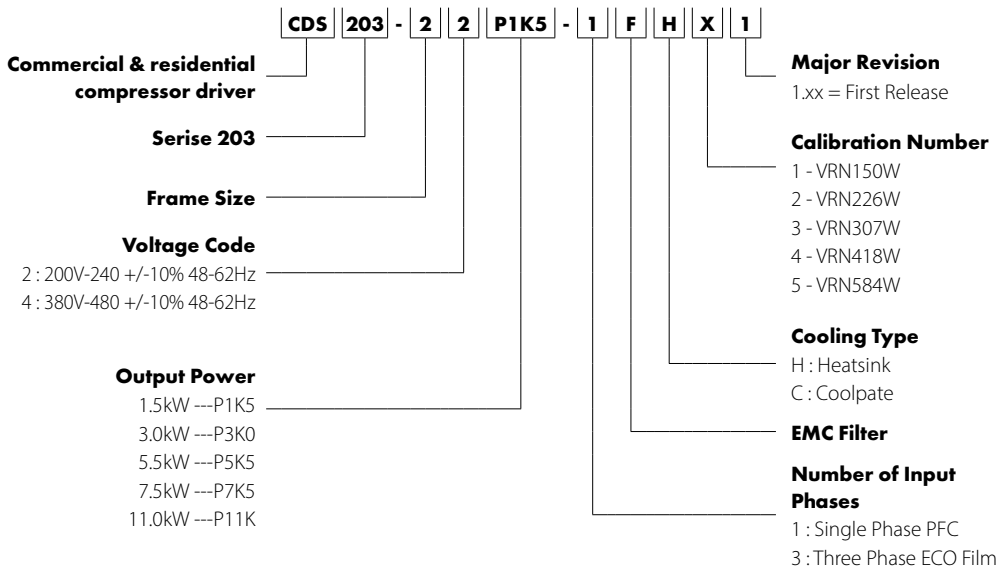
2. Product Introduction



The product range has been specifically designed for OEM and machine-builders alike with through panel mounting and cold-plate technology options available. The drive has no direct keypad/display but shows drive status with two status indicating LEDs on the front.

2.1. Identifying the Drive by Model Number

Each drive can be identified by its model number, shown below. The model number is on the shipping label, the drive rating label on the upper surface of the drive and on the front surface on the product identifier. The model number includes the drive and factory fitted options.



2.1.1. Model Variants

200 – 240V +/-10% Single Phase Input				
Model Code	Frame	kW	HP	Amps
CDS203-22P1K5-1FH11	2	1.5	2	7.0
CDS203-22P3K0-1FH21	2	3	3	12.0
CDS203-22P3K0-1FH31	2	3	3	12.0
CDS203-22P4K0-1FH41	2	4	5.5	16.0
380 – 480V +/-10% Three Phase Input				
Model Code	Frame	kW	HP	Amps
CDS203-24P5K5-3FH31	2	5.5	7.5	14
CDS203-24P5K5-1FH41	2	5.5	7.5	14
CDS203-24P11K-3FH51	2	11	15	24
CDS203-24P11K-3FH61	2	11	15	24

Replace 'H' with 'C' for coldplate version.

3.1. Mechanical Installation

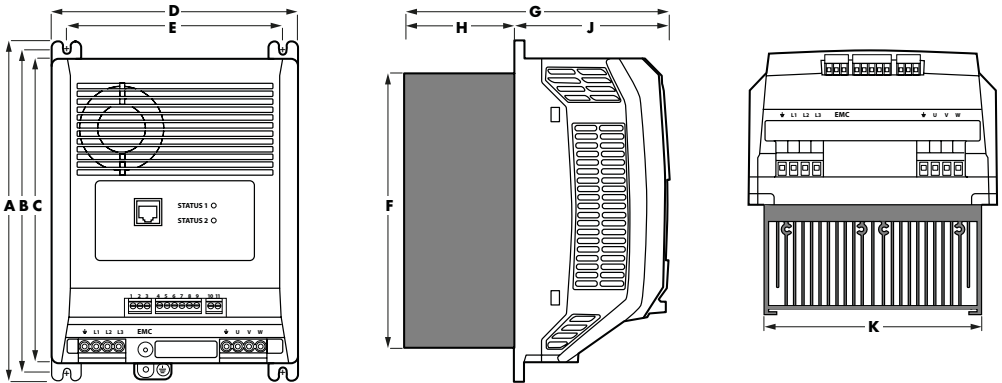
3.1.1. General

- The Danfoss CDS 203 has been designed to be installed in a suitable enclosure. The drive can be through panel mounted or mounted directly onto the back of a panel using the appropriate mounting kit.
- Using the drive as a template, or the dimensions shown below, mark the locations for drilling.
 - Ensure that when mounting locations are drilled, the dust from drilling does not enter the drive.
 - Mount the drive to the cabinet backplate using suitable mounting screws.
 - Position the drive, and tighten the mounting screws securely.
- The front of the drive is IP20 and must be installed in a pollution degree 1 or 2 environment only.
- In any environments where the conditions require it, the enclosure must be designed to protect the drive against ingress of airborne dust, corrosive gases or liquids, conductive contaminants (such as condensation, carbon dust, and metallic particles) and sprays or splashing water from all directions.
- Enclosures should be made from a thermally conductive material.
- Do not mount flammable material close to the CDS 203.
- Ensure that the minimum cooling air gaps, as detailed in section Ventilation and clearance.

3.1.2. Before Installation

- Carefully Unpack the CDS 203 and check for any signs of damage. Notify the shipper immediately if any exist.
- Check the drive rating label to ensure it is of the correct type and power requirements for the application.
- To prevent accidental damage always store the CDS 203 in its original box until required. Storage should be clean and dry and within the temperature range -40°C to $+70^{\circ}\text{C}$.

3.1.3. Drive Dimensions



A		B		C		D		E		F		G		H		J		K	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
226.3	8.9	215.2	8.5	201.4	7.9	165.3	6.5	144.8	5.7	182	7.2	177	6.96	71.7	2.82	104.4	4.11	145	5.7

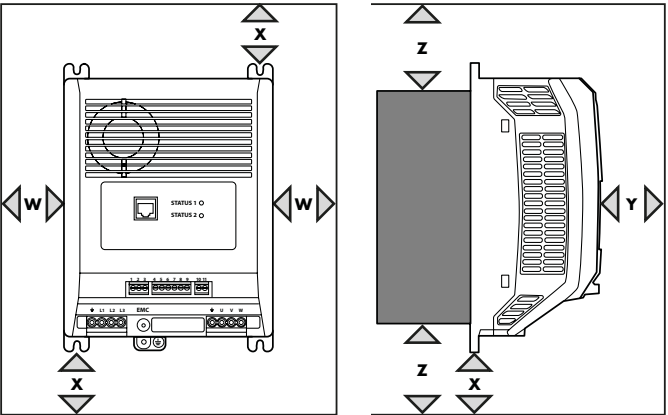
Tightening Torques		
	Required Torque	
Control Terminals	0.5 Nm	4.5 lb-in
Power Terminals	1 Nm	9 lb-in

Weights	
All 400V drives with Heatsink	3.05kg
230V PFC Heatsink (7/12A)	3.4kg
230V PFC Heatsink (16/20A)	3.74kg

3.1.4. Ventilation and Clearance

In order for the drive to maintain it's temperature, a minimum clearance is required around the drive as shown in the diagram below:

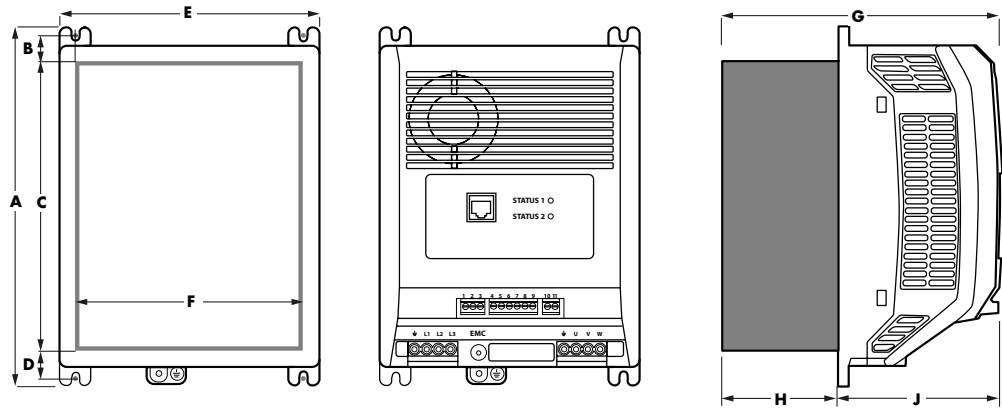
NOTE Value 'Z' is not applicable to the coldplate variant. These dimensions are the absolute minimum recommended clearances to allow sufficient air flow. The enclosure itself must be significantly wider or taller than the values given above in at least one direction.



W		X		Y		Z*	
mm	in	mm	in	mm	in	mm	in
20	0.787	78	3.07	10	0.394	100	3.94

3.1.5. Through panel mounting

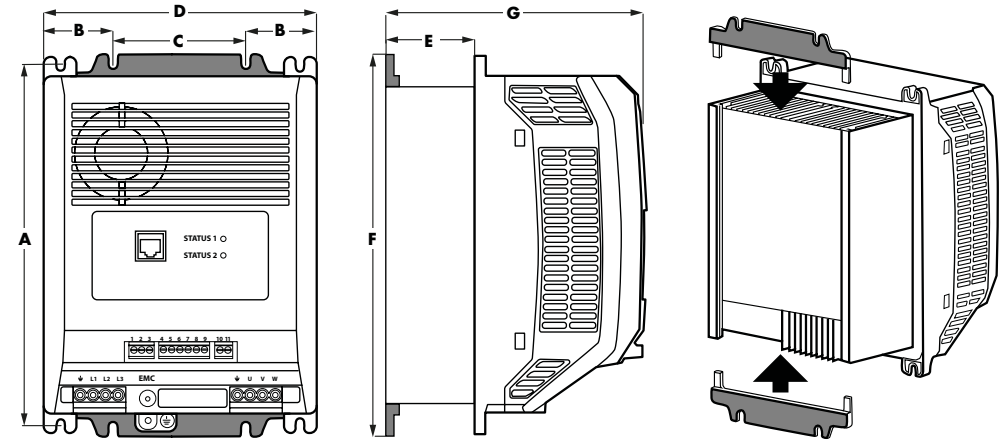
Through panel mounting is the most efficient installation in terms of both panel space and thermal management. With the heatsink protruding through the back of the electrical panel, the heat generated by the drive will be exhausted outside of the electrical panel.



A		B		C		D		E		F		G		H		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
226.3	8.9	15.6	0.61	184	7.24	15.6	0.61	165.3	6.5	147	5.78	177	6.96	71.7	2.82	104.4	4.11

3.1.6. Panel mounting (with the panel mounting kit)

If the installation does not lend itself to through panel mounting, the drive can be mounted to a back-plate of a panel using the optional panel mounting kit.



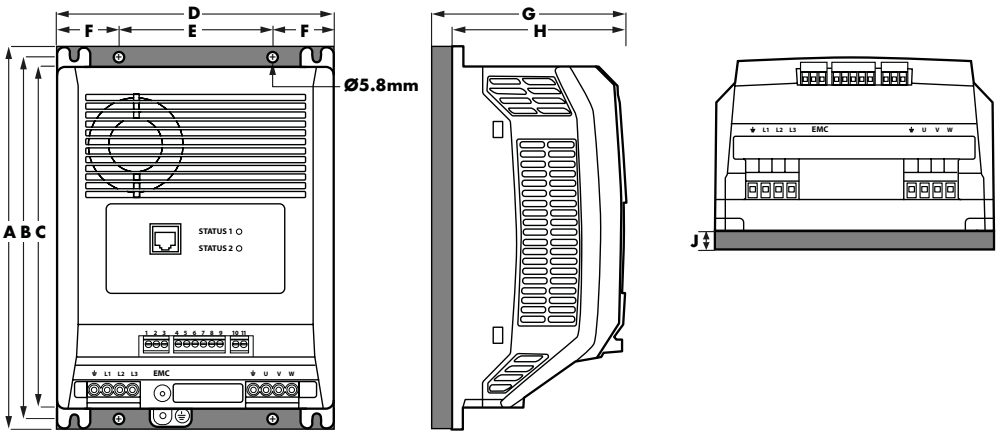
A		B		C		D		E		F		G	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
215.2	8.47	42.7	1.68	80	3.15	165.3	6.5	73.7	2.9	228	8.98	179	7.04

3. Installation



3.1.7. Panel mounting the cold-plate variant

The CDS 2003 is also available without a heatsink but with a coldplate that needs to be mounted onto a heat transfer surface, removing the drive losses and maintaining the coldplate temperature.



A		B		C		D		E		F		G		H		J	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
226.3	8.9	215.2	8.5	201.4	7.9	165.3	6.5	90	3.5	37.7	1.48	113.9	4.48	104.4	4.11	9.5	0.37

Tightening Torques			
		Required Torque	
Control Terminals		0.5 Nm	4.5 lb-in
Power Terminals		1 Nm	9 lb-in

Weights	
All 400V Coldplate Drive	2.03kg
230V PFC Coldplate Drives (7A & 12A)	2.4kg
230V PFC Coldplate Drives (16A & 20A)	2.74kg

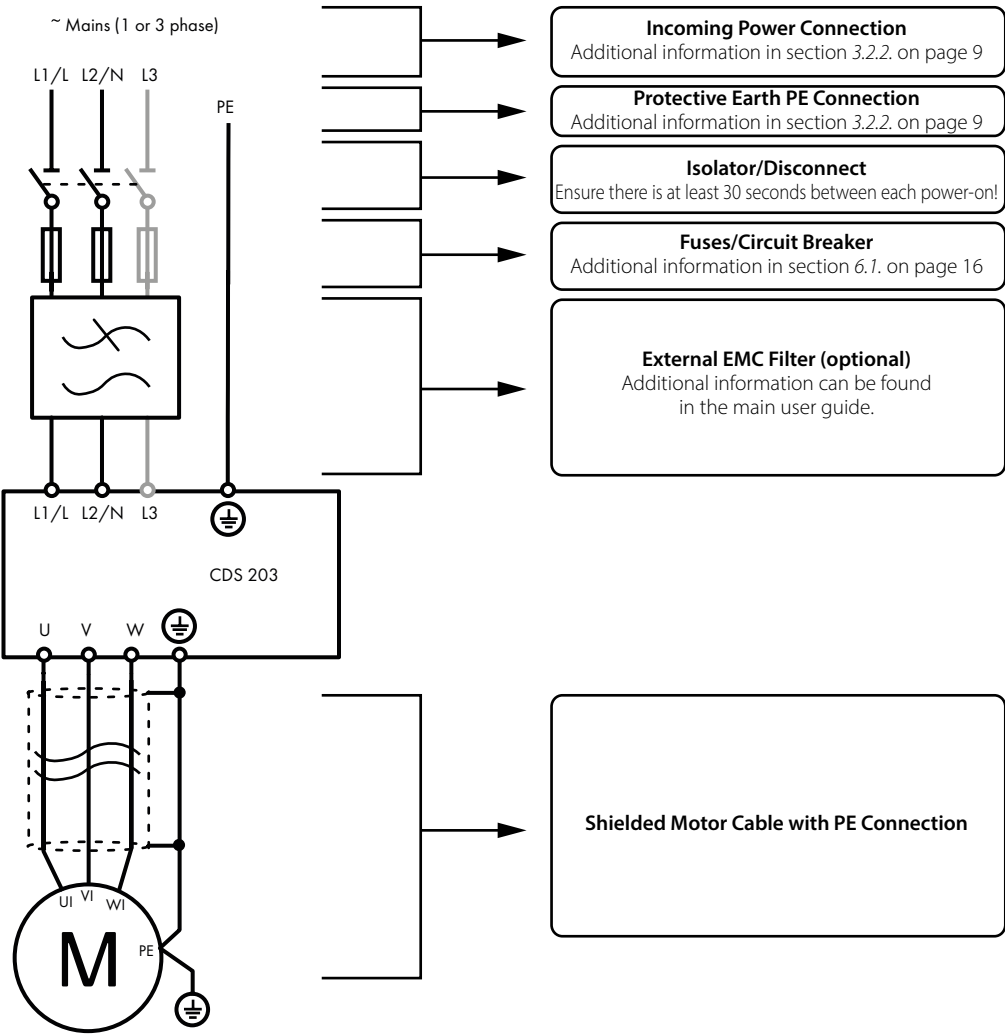
3. Installation



3.2. Connection Diagram

All power terminal locations are marked directly on the product with AC power input and motor connections located at the bottom of the unit.

3.2.1. Electrical Power Connections



3.2.2. Incoming Power Connection

Cable Selection

- For 1 phase supply, the mains power cables should be connected to L1/L, L2/N.
- For 3 phase supplies, the mains power cables should be connected to L1, L2, and L3. Phase sequence is not important.
- The cables should be dimensioned according to any local codes or regulations. Maximum dimensions are given in section 6.1. *Detailed Product Rating Tables on page 16.*

Protective Earth Conductor

- The cross-sectional area of the PE Conductor must be at least equal to that of the incoming supply conductor and connected to the drives main earth terminal.

Fuse / Circuit Breaker Selection

- Suitable fuses to provide wiring protection of the input power cable should be installed in the incoming supply line, according to the data in section 6.1. *Detailed Product Rating Tables on page 16.* The fuses must comply with any local codes or regulations in place. In general, type gG (IEC 60269) or UL type J fuses are suitable; however in some cases type aR fuses may be required. The operating time of the fuses must be below 0.5 seconds.
- Where allowed by local regulations, suitably dimensioned type B MCB circuit breakers of equivalent rating may be utilised in place of fuses, providing that the clearing capacity is sufficient for the installation.
- The maximum permissible short circuit current at the CDS 203 Power terminals as defined in IEC60439-1 is 100kA.

Motor Connection

- The motor should be connected to the CDS 203 U, V, and W terminals using a suitable 3 or 4 core cable. Where a 3 core cable is utilised, with the shield operating as an earth conductor, the shield must have a cross sectional area at least equal to the phase conductors when they are made from the same material. Where a 4 core cable is utilised, the earth conductor must be of at least equal cross sectional area and manufactured from the same material as the phase conductors.
- The motor earth must be connected to one of the CDS 203 earth terminals.
- Maximum permitted motor cable length for all models:
10 metres shielded, 20 metres unshielded.

Power Connections

230V Single Phase Variants

Power Earth / Ground	L1 (200VAC)	Neutral
E	L	N
Power Earth / Ground	Motor U Phase	Motor V Phase
E	U	V
		Motor W Phase
		W

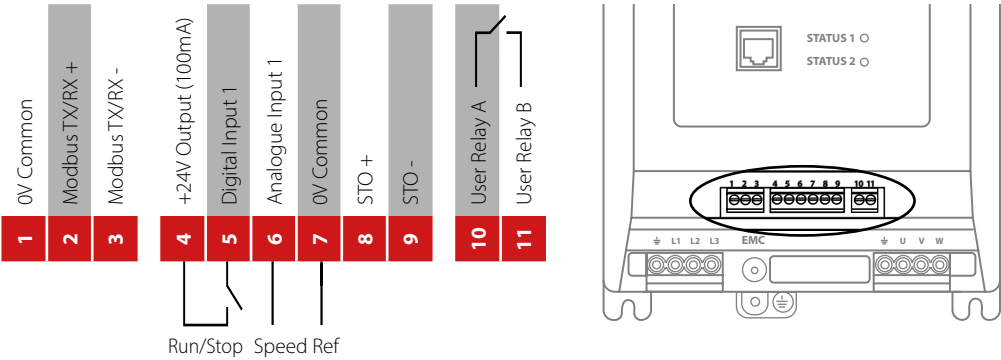
400V 3-Phase Variants

Power Earth / Ground	Supply L1	Supply L2	Supply L3
E	L1	L2	L3
Power Earth / Ground	Motor U Phase	Motor V Phase	Motor W Phase
E	U	V	W

3.3. Control Wiring

The CDS 203 has pluggable control terminals to support easy installation. There are three pluggable control terminal blocks split into:

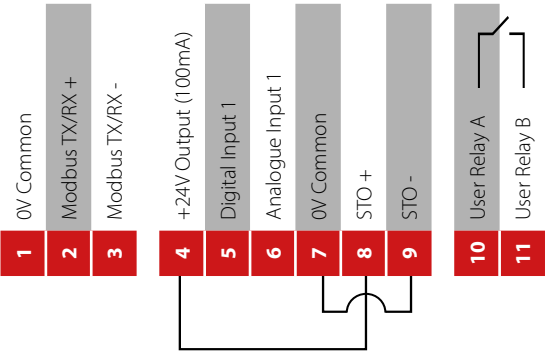
- Serial Communications (T1-T3)
- Inputs (T5 – T9)
- Output Relay (T10 – T11)



3.3.1. Safe Torque Off

For information covering the STO function refer to section 3.3.4 in the main user guide.

The STO input is a hardware enable for the drive. If your application does not require the Safe Torque Off function, it will be necessary to link terminal 4 to terminal 8 and separately terminal 7 to terminal 9 as per the diagram below:



4. Set-up and Operation



4.1. Basic Checks Before Commissioning

Please check that the drive and compressor are matching by checking both drive and compressors label – the compressor model is indeed mentioned on the drive label for an easy check

4.1.1. Access to Parameters

The drive parameters can be accessed via one of the following methods:

- 1. ModBus Communications
- 2. CDS203 LCP
- 3. CoolSetting - Drive Setup Software

4.1.2. Operating Limits and Ramp Rates

Par.	Modbus Address	Description	Def	Min	Max	Unit	R/W
1-01	101	Maximum Motor Speed	60	P1-02	500	Rps	R/W
1-02	102	Minimum Motor Speed	20	0	P1-01	Rps	R/W
1-03	103	Acceleration Ramp Time from 0rps to Rated Speed	5.0	0	6000	s	R/W
1-04	104	Deceleration Ramp Time from Rated Speed to 0rps	5.0	0	6000	s	R/W
5-06	506	Motor Switching Frequency (24 x max frequency)	DD	DD	DD	kHz	R/W
5-07	507	Maximum Torque / Current Limit	110	20	130	%	R/W
5-18	518	Maximum Peak Output Current	Drive rating dependant			Apk	R/W

4. Set-up and Operation



4.1.3. Start-up Sequence

Par.	Modbus Address	Description	Def	Min	Max	Unit	R/W
2-01	201	Start Speed 1	37	P1-02		Rps	R/W
2-02	202	Start Speed 1 Time	60	0	600	s	R/W
2-03	203	Start Speed 1 Acceleration Ramp Rate 0rps to Start Speed 1	30	0	6000	s	R/W
2-04	204	Start Speed 2	0	P1-02		Rps	R/W
2-05	205	Start Speed 2 Time	0	0	600	s	R/W
2-06	206	Start Speed 2 Acceleration Ramp Rate 0rps to Start Speed 2	0	0	6000	s	R/W
2-07	207	Start Speed 3	0	P1-02		Rps	R/W
2-08	208	Start Speed 3 Time	0	0	600	s	R/W
2-09	209	Start Speed 3 Acceleration Ramp Rate 0rps to Start Speed 3	0	0	6000	s	R/W

If the start-up sequencing (or part of the start-up sequencing) is not required, set that Start Speed Time to 0s to disable that function. e.g. if you want to have one part of the start up sequence, set Start Speed 1 (P2-01) to the desired speed in rps, set the time for the motor to sit at speed 1 in P2-02 and set the desired ramp rate in P2-03 – then ensure that P2-05 and P2-08 are both set to 0s. On start-up in this example, the drive will ramp the speed set in P2-01 using the ramp rate set in P2-03 for a duration set in P2-02 before then following the chosen speed reference.

NOTE The ramp rates here are entered in seconds per rated speed of the motor (e.g. 5.0s to go from 0rps to 60rps) where 60rps is the compressor rated speed..

4.1.4. Re-start Blocking

Par.	Modbus Address	Description	Def	Min	Max	Unit	R/W
2-10	210	Minimum Off Time	180	0	6000	s	R/W
2-11	211	Minimum On Time	180	0	6000	s	R/W
2-12	212	Re-start Delay (Start-to-start Delay)	600	0	6000	s	R/W
2-13	213	Re-start Function	10	0	Auto-10	-	R/W

NOTE Setting the minimum on time can mean that the drive will continue to run when the stop command is given. Removal of the STO signal will override any other command.

4.1.5. Control Mode

Par.	Modbus Address	Description	Def	Min	Max	Unit	R/W
1-11	111	Command Source	1- Terminal	0	3	-	R/W
		0: Modbus Mode					
		1: Terminal Control					
		2: Terminal Control (AI1 Start)					
		3: User PID Mode					
1-05	105	Stop Mode	1	0	3	-	R/W
		0: Ramp to Stop					
		1: Coast to Stop					
		2: AC Flux Braking (IM Motor only)					
		3: Ramp to Minimum Speed then Coast to Stop					

The primary command source setting in P1-11 makes a significant difference to how the drive is operated or controlled. The following table provides an overview of how the control commands vary for each setting.

P1-11	Drive Enable	Run/Stop	Speed Ref.	Ramps	Fault reset	Crankcase Heating
0 – Modbus	Safety (STO)	Modbus	Modbus	Parameters	DI1 / Modbus	Modbus
1 – Terminal	Safety (STO)	DI1	AI1	Parameters	DI1	STO / Modbus
2 – Terminal AI Start	Safety (STO)	AI1>10% / AI1<5%	AI1	Parameters	DI1	DI1 / Modbus
3 – User PI	Safety (STO)	DI1	PI Output	Parameters	DI1	STO / Modbus

5.1. Trips

Fault Code	No.	Description	Suggested Remedy
no-FLt	00	No Fault or No Trip	No fault in trip log – no problem with the drive
O-I	03	Instantaneous over current	High current from either – short-circuit on the drive output / acceleration ramps too short / incorrect motor data. NOTE Setting the maximum peak motor current too low in P5-18 could also lead to this trip.
I-Lt-EP	04	Motor Thermal Overload (I2t)	Drive has been delivering more than the configured motor rated current for a period of time – check the operating point of the compressor
P5-EP	05	Power stage trip	Hardware fault, contact the supplier of the drive
O-Volt	06	Over voltage on DC bus	DC Bus Overvoltage from either - the supply voltage is too high, a spike in the supply voltage, motor instability, try setting P1-05 = 3
U-Volt	07	Under voltage on DC bus	Usually caused by the supply voltage dropping too low – check connections and voltage at the drive terminals
O-T	08	Heatsink over temperature	Check the ambient temperature, check that the ventilation is not restricted, check the cooling system for the coldplate version
U-T	09	Under temperature	Drive heatsink temperature is too low
P-dEF	10	Factory Default parameters have been loaded	Warning to advise that the drive has been returned to factory defaults
E-EP	11	Safety circuit momentarily opened during drive running	Check the wiring of the STO circuit and any switches or devices within that circuit. Ensure that any intermediate devices are not activating momentarily during drive operation.
SC-ObS	12	Optibus comms loss	Loss of communications between drive and remote keypad or PC tools
FLt-dc	13	DC bus ripple too high	Check for supply phase imbalance or phase loss
P-L0SS	14	Input phase loss trip	Input phase loss trip – similar to FLt.dc above
h O-I	15	Instantaneous over current on drive output	Hardware overcurrent on drive output – similar to O-I trip above
th-FLt	16	Faulty thermistor on heatsink	If the drive heatsink temperature is within limits, contact the supplier of the drive
dRAr-F	17	Internal memory fault (IO)	If not coinciding with a firmware upgrade procedure, contact the supplier of the drive
4-20 F	18	4-20mA Signal Lost	Analogue input configured for 4-20mA but less than 3mA detected on drive terminals
dRAr-E	19	Internal memory fault (DSP)	If not coinciding with a firmware upgrade procedure, contact the supplier of the drive
U-dEF	20	User Default Parameters Loaded	User Default Parameters Loaded
F-Ptc	21	Motor PTC thermistor trip	Drive configured to monitor motor temperature through the PTC and resistance increases above 2.5k
FRn-F	22	Cooling Fan Fault	Drive cooling fan not running at demanded speed – check for any blockages in the cooling fan
O-hEArE	23	Environmental temperature too high	Check ambient temperature and ventilation system

Fault Code	No.	Description	Suggested Remedy
<i>OUt-F</i>	26	Drive output fault	Check for wiring faults, loose connections or badly terminated cables between the drive and the motor
<i>Sto-F</i>	29	Safety circuit momentarily opened during drive running	Check the wiring of the STO circuit and any switches or devices within that circuit. Ensure that any intermediate devices are not activating momentarily during drive operation.
		Slow rising edge on 24V supply	Can happen if an external 24V supply is used and the voltage ramps up slowly on power-up. Could also happen if the drive 24V rail is overloaded and collapses momentarily, check the loading of the 24V rail and all control connections.
		Safety input circuit error	Contact the supplier of the drive for further advice
<i>LoCHed rotor</i>	31	Locked Rotor	A speed error has been detected (Locked Rotor)
<i>REt-O 1</i>	40	Measured motor stator resistance varies between phases	Check the motor wiring, disconnect the drive and measure the phase to phase resistance from the motor cable
<i>REt-O2</i>	41	Measured motor stator resistance is too large	Check the motor wiring, disconnect the drive and measure the phase to phase resistance from the motor cable and refer to motor datasheet
<i>REt-O3</i>	42	Measured motor inductance is too low	Check the motor wiring
<i>REt-O4</i>	43	Measured motor inductance is too large	Check the motor wiring
<i>REt-O5</i>	44	Measured motor parameters are not convergent	Check the motor wiring
<i>OUt-Ph</i>	49	Motor output phase loss	Check the motor wiring
<i>SC-FD 1</i>	50	Modbus comms loss fault	Check the Modbus wiring, ensure that the 0V common is used, ensure that the communication wiring is kept away from any power wiring

5.2. Status LED Indication

Two LEDs are used to indicate the drive status as follows:

Drive Status	LED 1 Status		LED 2 Status
	Green	Red	Yellow
Stop	Slow flashing	Off	Off
Inhibit	Slow Flashing	Off	Slow Flashing alternate
Running	Constant On	Off	Slow flashing if in overload
Standby	Constant On	Off	Blink every 3s
Trip / Fault	Off	Constant On	Off
Internal Comms Loss	Off	Blink every 3s	Off
Oil Return Active	Constant On	Off	Fast Flashing Yellow
DSP Firmware Upgrade	All three LEDs lights up in order (Green->Yellow->Red->Yellow...)		
IO Firmware Upgrade	All LEDs on with weak light		

6.1. Detailed Product Rating Tables

Part Number	Power Rating		Input Current	Fuse or MCB (Type B)		Max Input Cable Size		Continuous Output Current	Overload Output Current	Maximum Output Cable Size		Maximum Motor Cable Length	
	kW	HP		Non UL	UL	mm²	awg			mm²	awg	m	ft
CDS203-22P1K5-1FH11	1.5	2.0	8.9	16	15	16	6	7	9.1	6	10	10	33
CDS203-22P3K0-1FH21	3.0	3.0	15.8	25	20	16	6	12	13.2	6	10	10	33
CDS203-22P3K0-1FH31													
CDS203-22P4K0-1FH41	4.0	5.5	21.3	25	25	16	6	16	20.8	6	10	10	33
CDS203-22P1K5-1FC11	1.5	2.0	8.9	16	15	16	6	7	9.1	6	10	10	33
CDS203-22P3K0-1FC21	3.0	3.0	15.8	25	20	16	6	12	13.2	6	10	10	33
CDS203-22P3K0-1FC31													
CDS203-22P4K0-1FC41	4.0	5.5	21.3	25	25	16	6	16	20.8	6	10	10	33
CDS203-24P5K5-3FH31	5.5	7.5	12.0	16	35*	6	10	14	18.2	6	10	10	33
CDS203-24P5K5-3FH41													
CDS203-24P11K-3FH51	11.0	15.0	22.0	25	35*	6	10	24	28.0	6	10	10	33
CDS203-24P11K-3FH61													
CDS203-24P5K5-3FC31	5.5	7.5	12.0	16	35*	6	10	14	18.2	6	10	10	33
CDS203-24P5K5-3FC41													
CDS203-24P11K-3FC51	11.0	15.0	22.0	25	35*	6	10	24	28.0	6	10	10	33
CDS203-24P11K-3FC61													

NOTE Maximum permissible motor cable without the use of output filters is 10m with shielded cable and 20m with unshielded cable – for all ratings.

6.2. Input Power Supply Requirements

Supply Voltage	200 – 240 RMS Volts for 230 Volt rated units, + /- 10% variation allowed.
	380 – 480 Volts for 400 Volt rated units, + / - 10% variation allowed.
Imbalance	Maximum 3% voltage variation between phase – phase voltages allowed.
	All CDS 203 units have phase imbalance monitoring.
	A phase imbalance of > 3% will result in the drive tripping.
Frequency	50 – 60Hz + / - 5% Variation.