Design Guide

MCD 200

MCD 201

MCD 202

MCD 203

Contents

Contents

■ Warnings

■ High Voltage Warning

MCD 200 soft starters contain dangerous voltages when connected to mains voltage. Only a competent electrician should carry out the electrical installation. Improper installation of the motor or the soft starter may cause equipment failure, serious injury or death. Follow this manual and local electrical safety codes.

■ Safety Regulations

Disconnect the soft starter from mains voltage before carrying out repair work.

Stopping the soft starter does not disconnect the equipment from mains voltage and leaves one phase connected to the motor. The soft starter should **not** be used as a safety switch.

It is the responsibility of the user or the person installing the MCD 200 to provide proper grounding and branch circuit protection according to the National Electrical Code (NEC ©) and local safety codes.

■ Warning Against Unintended Start

The motor can be stopped by means of digital or bus commands while the soft starter is connected to the mains.

1. If personal safety considerations make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient.
2. A motor that has been stopped may start if faults occur in the electronics of the soft starter, or a temporary fault in the supply mains or the motor connection ceases.

■ Symbols Used in this Manual

When reading this manual you will come across different symbols that require special attention. The symbols used are the following:

Indicates something to be noted by the reader.

Indicates a general warning.

Indicates a high voltage warning

■ Avoiding Soft Starter Damage

Please read and follow all instructions in this manual. Additionally, take special note of the following:

1. Do not connect power factor correction capacitors to the output of MCD 200 soft starters. If static power factor correction is employed, it must be connected to the supply side of the soft starter.
2. Do not apply incorrect voltages to the control input terminals.

Many electronic components are sensitive to static electricity. Voltages so low that they cannot be felt, seen or heard, can reduce the life, affect performance, or completely destroy sensitive components. When performing service, proper ESD equipment should be used to prevent possible damage from occuring.

The examples and diagrams in this manual are included solely for illustrative purposes. The information contained in this manual is subject to change at any time and without prior notice. In no event will responsibility or liability be accepted for direct, indirect or consequential damages resulting from the use or application of this equipment.

■ Disposal Instructions

Equipment containing electrical components may not be disposed of together with domestic waste.

It must be collected separately as electrical and electronic waste according to local and currently valid legislation.

■ MCD 200 Overview

■ Description

The MCD 200 of soft starters comprises two separate ranges, MCD 201 and MCD 202. These ranges share common power and mechanical designs but offer different feature sets.

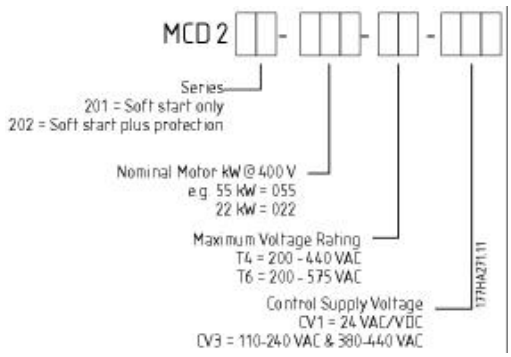
MCD 201 soft starters provide TVR (timed voltage ramp) starting and stopping control and are designed for use with an external motor protection device.

MCD 202 soft starters provide current limit starting control, TVR soft stop and include a range of motor protection features.

N.B.!:
This manual makes reference to MCD 200, MCD 201 and MCD 202. The MCD 200 designation is used when referring to characteristics common to MCD 201 and MCD 202. In all other cases the text refers to the specific range.

All MCD 200 starters include an internal bypass relay that bypasses the soft starter SCRs during run. This allows the MCD 200 to be installed in a non-ventilated enclosure without an external bypass contactor.

■ Ordering Type Code



■ Ratings

MCD 200 Model	Continuous Ratings (Internally Bypassed) @ 40 °C Ambient Temperature, <1000 metres ★	
	Normal	Heavy
007	18 A: AC53b 4-6:354	17 A: AC53b 4-20:340
015	34 A: AC53b 4-6:354	30 A: AC53b 4-20:340
018	42 A: AC53b 4-6:354	36 A: AC53b 4-20:340
022	48 A: AC53b 4-6:354	40 A: AC53b 4-20:340
030	60 A: AC53b 4-6:354	49 A: AC53b 4-20:340
037	75 A: AC53b 4-6:594	65 A: AC53b 4-20:580
045	85 A: AC53b 4-6:594	73 A: AC53b 4-20:580
055	100 A: AC53b 4-6:594	96 A: AC53b 4-20:580
075	140 A: AC53b 4-6:594	120 A: AC53b 4-20:580
090	170 A: AC53b 4-6:594	142 A: AC53b 4-20:580
110	200 A: AC53b 4-6:594	165 A: AC53b 4-20:580
MCD 200 Model	**Continuous Ratings (Internally Bypassed) @ 50 °C Ambient Temperature, <1000 metres ★**	
	Normal	**Heavy**
007	17 A: AC53b 4-6:354	15 A: AC53b 4-20:340
015	32 A: AC53b 4-6:354	28 A: AC53b 4-20:340
018	40 A: AC53b 4-6:354	33 A: AC53b 4-20:340
022	44 A: AC53b 4-6:354	36 A: AC53b 4-20:340
030	55 A: AC53b 4-6:354	45 A: AC53b 4-20:340
037	68 A: AC53b 4-6:594	59 A: AC53b 4-20:580
045	78 A: AC53b 4-6:594	67 A: AC53b 4-20:580
055	100 A: AC53b 4-6:594	86 A: AC53b 4-20:580
075	133 A: AC53b 4-6:594	110 A: AC53b 4-20:580
090	157 A: AC53b 4-6:594	130 A: AC53b 4-20:580
110	186 A: AC53b 4-6:594	152 A: AC53b 4-20:580

★ Contact Danfoss for other ratings.

Example

For 22 kW model: 48 A: AC53b 4-6:354

48 A: Starter current rating.
AC53b: Load category for soft starters with SCRs bypassed during run.
4-6: 400% start current for 6 seconds.
354: 354 seconds between the end of one start and the beginning of the next start (i.e. 10 starts per hour).

■ Frequently Asked Questions

■ MCD 200

- *How do I select an MCD 200 soft starter for duty cycles different from those listed in the standard ratings table?*

  Use WinStart to select soft starters for different duty cycles.

- *Which MCD 200 models carry the UL mark?*

  All T6 models carry the UL mark.

- *What are the MCD 200 operational ratings before maintenance may be required?*

  The operational ratings are:

  Models 007~055: 1,000,000 operations
  Models 075~110: 100,000 operations

- *What is the current consumption of the MCD 200 control supply?*

  The steady state consumption of the control supply is 100 mA maximum, for both CV3 and CV1 models.

  However, the short time inrush current at control supply switch-on can be as high as 10 A for CV3 models, and 2 A for CV1 models.

- *What is the impedance of the control inputs? Are any special precautions necessary during installation?*

  The impedance on terminals N1, N2 is approximately 150 kΩ @ 300 VAC and 5.6 kΩ @ 24 VAC/VDC.

  For long cable runs, all control wiring should be either twisted pair or shielded cable with the screen earthed at one end. Control wiring should be separated from power cables by at least 300 mm. If long cable runs cannot be avoided, install an interposing relay in close proximity to the soft starter to minimise noise interference.

- *Why is it necessary to apply control voltage before mains voltage at first power-up?*

  The soft starter may arrive at site with the internal bypass relays closed. When control voltage is applied, the bypass relays are commanded to open. If mains voltage is applied without control voltage, this step is missed and the motor may start direct on-line without warning.

- *What are the under- and over-frequency trip points for MCD 200 soft starters?*

The soft starter will trip on supply frequency if the frequency rises above 72 Hz or falls below 40 Hz for more than five seconds while the soft starter is running. These trip points are not adjustable.

In pre-start, starting and stopping modes the high and low frequency limits both apply with no time delay.

A supply frequency trip will also occur if:

- all three input phases are lost while the soft starter is running
- all three input phases fall below 120 VAC at start or while the soft starter is running
- the line contactor opens while running

- *Why is the starting current higher on the middle phase than on the other two phases?*

  During a soft start, the MCD 200 controls the two outside phases (L1-T1 and L3-T3), but the middle phase (L2-T2) is uncontrolled. The current on the uncontrolled phase is higher than on the other two phases (usually by 20%-25%), but is still lower than for an uncontrolled start.

■ MCD 201

- *Will the motor start DOL if the start ramp of an MCD 201 open loop soft starter is set to full voltage?*

  No, the MCD 201 will still provide a limited soft start. The voltage is ramped up from 0 to 100% in approximately 0.25 seconds.

- *What is the minimum size of motor that can be controlled using an MCD 201 open loop soft starter?*

  There is no minimum motor size when using an MCD 201 open loop soft starter.

■ MCD 202

- *What is the minimum size of motor that can be controlled using an MCD 202 closed loop soft starter?*

  Motors connected to an MCD 202 soft starter must have a full load current rating ≥ 50% of the MCD 202 nameplate rating. All the motor protections are based on this setting.

  It is possible to operate an MCD 202 with a small kW motor, for testing purposes. In this case, the motor will effectively start direct on-line, and the

MCD 202 will not protect the motor. The starter will not trip, because there is no undercurrent protection on the MCD 202.

- *What type of motor protection does the MCD 202 have?*

  The MCD 202 has built-in motor overload protection of the electronic thermal model type. The soft starter continuously monitors motor current and calculates the motor temperature from this information.

  The rate of rise of the calculated motor temperature is determined by the Motor Trip Class setting. The lower this setting, the faster the rate of rise of calculated motor temperature. A Motor Overload trip will occur when the calculated temperature reaches 105%. This protection is similar to a motor trip class setting on a standard thermal overload relay.

  An external motor protection device is not required when using an MCD 202 soft starter. MCD 202 is certified to conform to the IEC 60947-4-2 standard for electronic soft starters. The reliability of the motor protection feature is part of this standard.

- *How can the MCD 202 programmable output relay be used?*

  The programmable output relay (terminals 23, 24) can be used to signal either trip or run status. This relay is normally open.

  Trip:
  When set to trip, the relay closes when the MCD 202 trips. The relay can be used to operate the shunt-trip mechanism of an upstream circuit breaker (in order to isolate the motor branch circuit), or to signal the trip to an automation system or externally. The relay will open when the trip is reset.

  Run:
  When set to run, the relay operates when the soft start is complete, the bypass relays are closed and full voltage is being applied tot he motor. The relay can be used to operate a contactor for power factor correction capacitors, or to signal soft starter run status to an automation system.

- *Is the MCD 202 suitable for flying start application?*

  Yes. There is a built-in two second delay between the end of one stop and the beginning of the next start. This allows the motor flux to decay, preventing the soft starter tripping on Power Circuit fault due to detection of motor back EMF when the start signal is applied. The major effect of a flying start is on the actual time the MCD 202 current limits. The ramp-up time will be reduced and depends on the motor's speed when the start signal is re-applied.

■ General Questions

- *When should I use a line contactor?*

  Local regulations may require you to install a line contactor or circuit breaker, to completely disconnect the soft starter from mains voltage in the event of a trip.

- *When would I use semiconductor fuses?*

  Either when specified for an installation, or when Type 2 coordination is required.

  The MCD 200 is internally bypassed, so the SCRs are in use only during starting and soft stopping.

- *How do I size the fuses of the motor branch circuit when using an MCD 200 soft starter?*

  For current limit settings ≤ 350% and start times ≤ 15 seconds, the nominal rating of standard line supply fuses should be 1.75 x Motor FLC. If motor rated fuses are being used, their nominal rating should be 1.5 x Motor FLC.

  For current limit settings > 350% and start times > 15 seconds, the nominal rating of standard line supply fuses should be 2 x Motor FLC. If motor rated fuses are being used, their nominal rating should be 1.75 x Motor FLC.

■ General Technical Data

Mains Supply (L1, L2, L3)	
MCD 200-xxx-T4-xxx	3 x 200 VAC ~ 440 VAC (+ 10% / - 15%)
MCD 200-xxx-T6-xxx	3 x 200 VAC ~ 575 VAC (+ 10% / - 15%)
Supply frequency (at start)	45 Hz to 66 Hz
Control Voltage (A1, A2, A3)	
MCD 200-xxx-xx-CV3	110-240 VAC (+ 10% / - 15%)
	or 380-440 VAC (+ 10% / - 15%)
MCD 200-xxx-xx-CV1	24 VAC/VDC (± 20%)
Current consumption (during run)	< 100 mA
Current consumption (inrush)	
MCD 200-xxx-xx-CV1	2 A
MCD 200-xxx-xx-CV3	10 A
Inputs	
Start (terminal N1)	Normally Open, 300 VAC max
Stop (terminal N2)	Normally Closed, 300 VAC max
Outputs	
Main contactor (terminals 13, 14)	Normally Open
	6 A, 30 VDC / 6 A, 250 VAC, resistive
Programmable relay (terminals 23, 24)	Normally Open
	6 A, 30 VDC / 6 A, 250 VAC, resistive
Environmental	
Degree of protection MCD 200-007 to MCD 200-055	IP20
Degree of protection MCD 200-075 to MCD 200-110	IP00
Operating temperatures	- 10 °C to + 60 °C
Storage temperature	-25 °C to + 60 °C (to +70 °C for less than 24 hours)
Humidity	5% to 95% Relative Humidity
Pollution degree	Pollution Degree 3
Vibration	IEC 60068 Test Fc Sinusoidal
	4 Hz to 13.2 Hz: ± 1 mm displacement
	13.2 Hz to 200 Hz: ± 0.7 g
EMC Emission	
Equipment class (EMC)	Class B
Conducted radio frequency emission	0.15 MHz to 0.5 MHz: < 56-46 dB (µV)
	0.5 MHz to 5 MHz: < 46 dB (µV)
	5 MHz to 30 MHz: < 50 dB (µV)
Radiated radio frequency emission	30 MHz to 230 MHz: < 30 dB (µV/m)
	230 MHz to 1000 MHz: < 37 dB (µV/m)

This product has been designed as Class B equipment. Use of this product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.

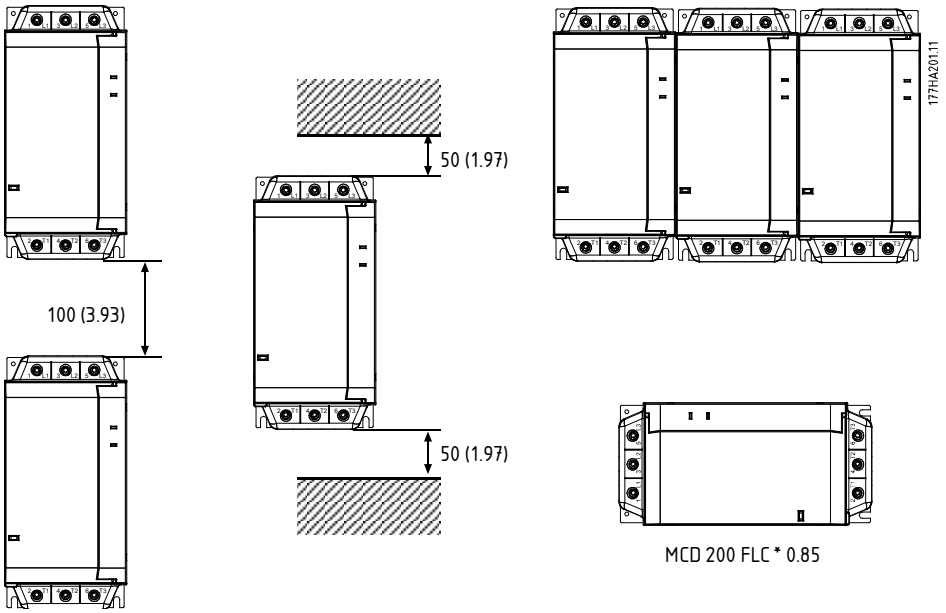
EMC Immunity	
Electrostatic Discharge	4 kV contact discharge, 8 kV air discharge
Radio frequency electromagnetic field	0.15 MHz to 1000 MHz: 140 dB (µV)
Rated impulse withstand voltage (Fast transients 5/50 ns)	2 kV line to earth, 1 kV line to line
Voltage dip and short time interruption	100 ms (at 40% nominal voltage)
Short Circuit	
Rated short-circuit current MCD 200-007 to MCD 200-037	5 kA[1]
Rated short-circuit current MCD 200-045 to MCD 200-110	10 kA[1]

[1] These short circuit ratings are with fuses used as given in the table under *Semiconductor Fuses* on page 12.

Heat Dissipation	
During Start	3 watts / ampere
During Run	10 watts typical
Approvals	
RCM	IEC 60947-4-2
UL / C-UL	UL 508
CE	IEC 60947-4-2
CCC	GB 14048.6
Marine	Lloyds Marine No 1 Specification

■ Installation

■ Mechanical Installation

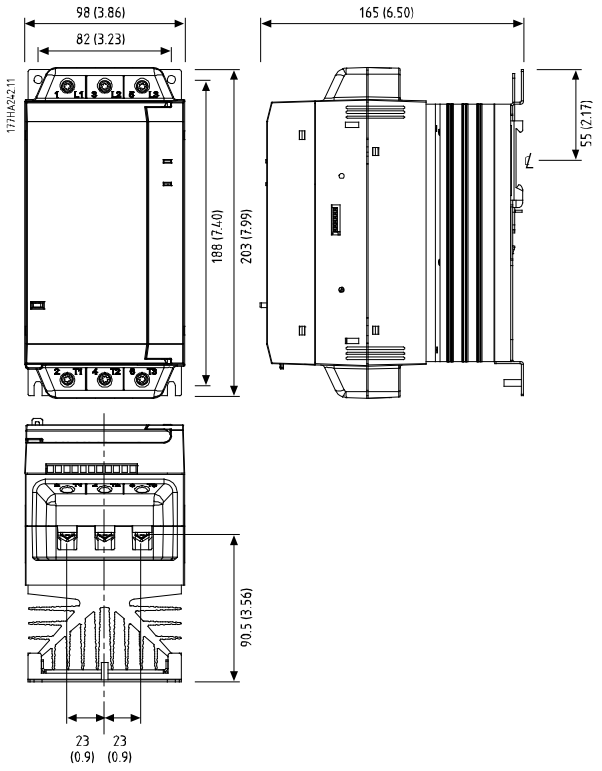


mm (inch)

MCD 200	Din Rail	Foot Mounting
MCD 200-007 ~ MCD 200-030	30 mm	Yes
MCD 200-037 ~ MCD 200-110	Not available	Yes

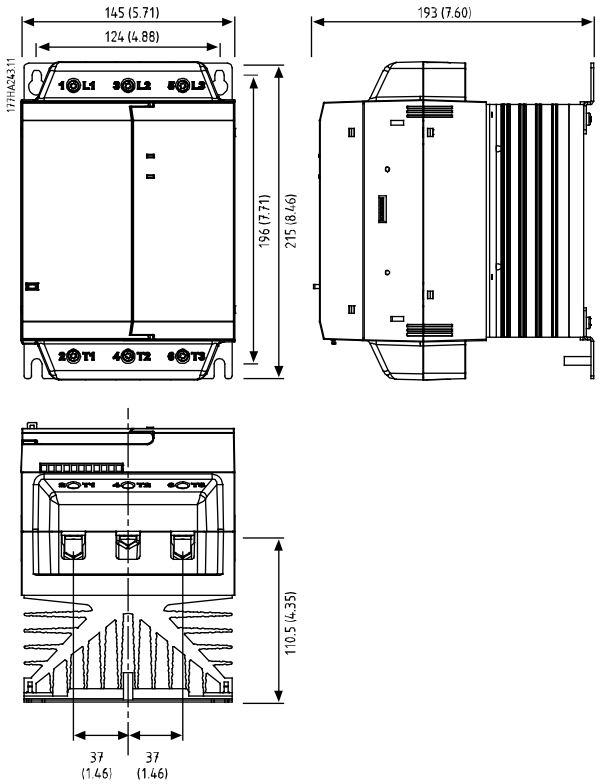
■ Dimensions and Weights

MCD 201-007 ~ MCD 201-030 (2.2 kg / 4.85 lb)
MCD 202-007 ~ MCD 202-030 (2.4 kg / 5.29 lb)



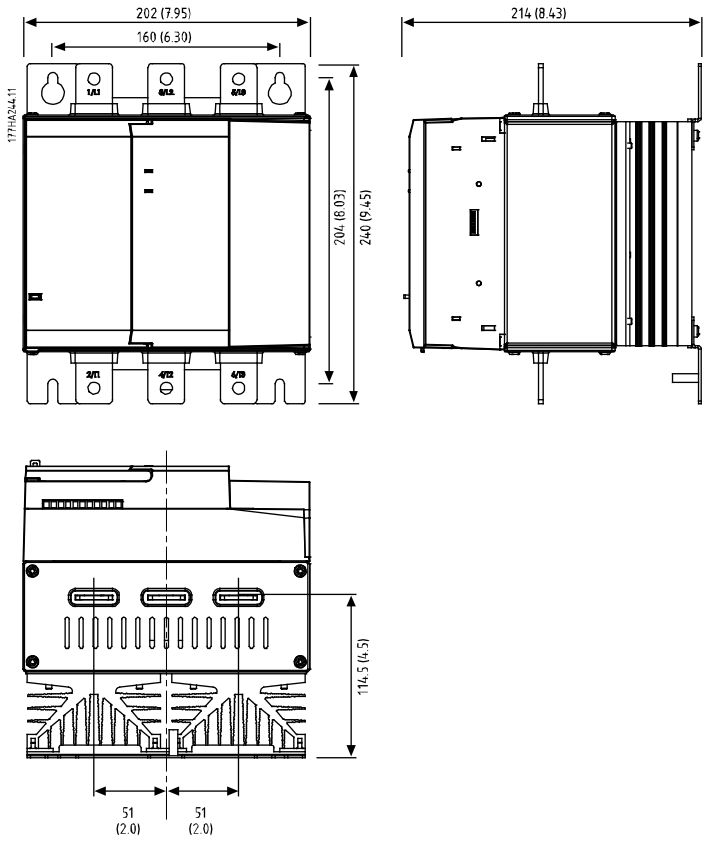
mm (inch)

MCD 201-037 ~ MCD 201-055 (4.0 kg / 8.82 lb)
MCD 202-037 ~ MCD 202-055 (4.3 kg / 9.48 lb)



mm (inch)

MCD 201-075 ~ MCD 201-110 (6.1 kg / 13.45 lb)
MCD 202-075 ~ MCD 202-110 (6.8 kg / 14.99 lb)



mm (inch)

■ Cable Size

	mm² (AWG)						mm² (AWG)	
	MCD 200-007 ~ MCD 200-030		MCD 200-037 ~ MCD 200-055		MCD 200-075 ~ MCD 200-110		MCD 200-007 ~ MCD 200-110	
	10 - 35 (8 - 2)	14 (0.55) mm (inch)	25 - 50 (4 - 1/0)	14 (0.55) mm (inch)	N.A.	11 (0.43), 26 (1.02), 8.5 (0.33) mm (inch)	0.14 - 1.5 (26 - 16)	6 (0.24) mm (inch)
	10 - 35 (8 - 2)		25 - 50 (4 - 1/0)		N.A.		0.14 - 1.5 (26 - 16)	
	Torx (T20) 3 Nm 2.2 ft-lb		Torx (T20) 4 Nm 2.9 ft-lb		N.A.		N.A.	
	7 mm 3 Nm 2.2 ft-lb		7 mm 4 Nm 2.9 ft-lb		N.A.		3.5 mm 0.5 Nm max 4.4 lb-in max	

177HA245.12

75° C Wire. Use copper conductors only.

■ Semiconductor Fuses

Semiconductor fuses can be used with MCD 200 soft starters to reduce the potential for damage to SCRs from transient overload currents and for Type 2 coordination. MCD 200 soft starters have been tested to achieve Type 2 coordination with semiconductor fuses. Suitable Bussman and Ferraz semiconductor fuses are detailed below.

If selecting alternate brands, ensure the selected fuse has a lower total clearing I^2T rating than the SCR, and can carry start current for the full starting duration.

MCD 200 Model	SCR I^2T (A^2S)	Ferraz Fuse European/IEC Style (North American Style)	Bussmann Fuse Square Body (170M)	Bussmann Fuse British Style (BS88)
007	1150	6.6URD30xxxA0063 (A070URD30xxx0063)	170M-1314	63 FE
015	8000	6.6URD30xxxA0125 (A070URD30xxx0125)	170M-1317	160 FEE
018	10500	6.6URD30xxxA0160 (A070URD30xxx0160)	170M-1318	160 FEE
022	15000	6.6URD30xxxA0160 (A070URD30xxx0160)	170M-1318	180 FM
030	18000	6.6URD30xxxA0160 (A070URD30xxx0160)	170M-1319	180 FM
037	51200	6.6URD30xxxA0250 (A070URD30xxx0250)	170M-1321	250 FM
045	80000	6.6URD30xxxA0315 (A070URD30xxx0315)	170M-1321	250 FM
055	97000	6.6URD30xxxA0315 (A070URD30xxx0315)	170M-1321	250 FM
075	168000	6.6URD31xxxA0450 (A070URD31xxx0450)	170M-1322	500 FMM
090	245000	6.6URD31xxxA0450 (A070URD31xxx0450)	170M-3022	500 FMM
110	320000	6.6URD31xxxA0450 (A070URD31xxx0450)	170M-3022	500 FMM

xxx = Blade Type. Contact Ferraz for options.

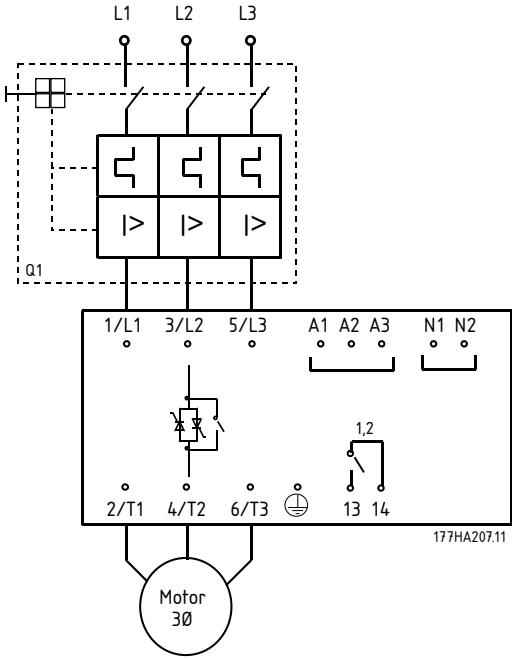
■ MCD 201

■ Overview

MCD 201 soft starters provide timed voltage ramp soft start and soft stop control. They are designed to be used with an external motor protection device.

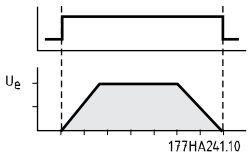
■ Electrical Schematics

Example 1. MCD 201 soft starter installed with a motor protection circuit breaker.

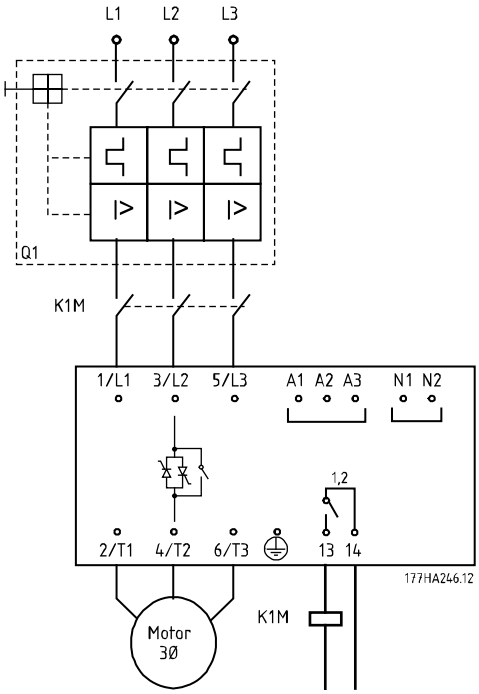


[1] 6 A @ 30 VDC resistive / 2 A 400 VAC AC11

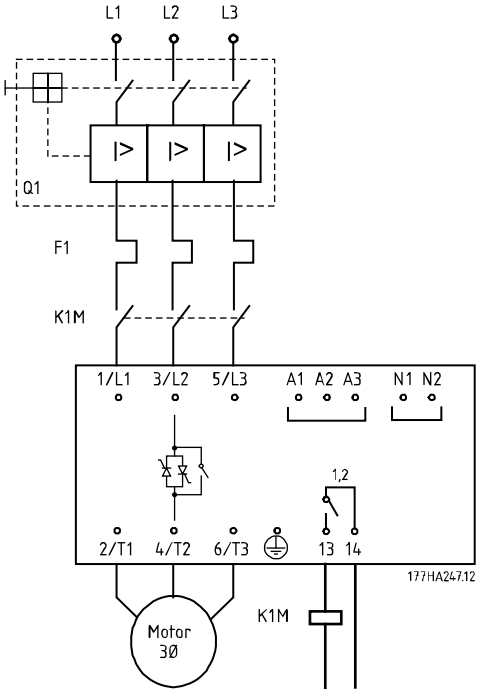
[2] Main contactor



Example 2. MCD 201 soft starter installed with a motor protection circuit breaker and line contactor.

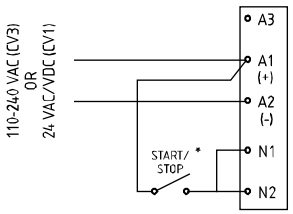


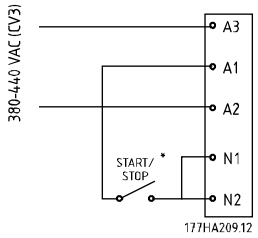
Example 3. MCD 201 soft starter installed with a system protection circuit breaker and line contactor.



■ Control Circuits

Two-wire control

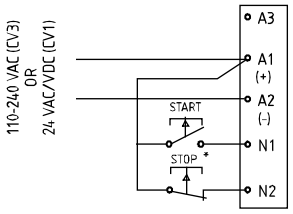


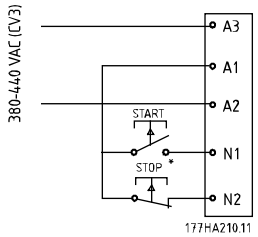


Two-wire control requires a maintained contact. A start command requires a permanently closed contact and a stop command requires a permanently open contact.

☐ To reset a trip, close then open N2.

Three-wire control

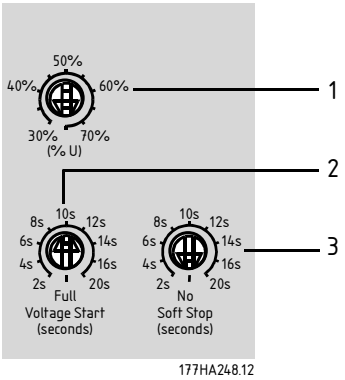




Three-wire control requires a momentary signal. A start command requires momentary operation of terminal N1 and a stop command required momentary operation of terminal N2. Only one command can be active at one time.

☐ To reset a trip, close then open N2.

■ User Adjustments



1 Initial Torque

Value:

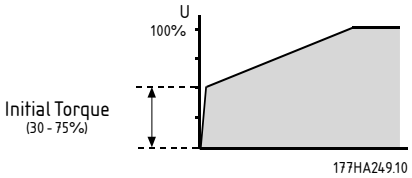
30% - 75% Initial Torque ★ 75%

Function:

Determines the start torque generated by the motor when the start command is first applied.

Description of choice:

Set so that the motor begins to rotate as soon as the start command is given.



Initial Torque

Application	Suggested Initial Torque
Centrifugal Pump	50%
Submersible Pump	60%
Screw Compressor	
Conveyor	70%
Crusher	
Fan	
Other applications	

2 Ramp Up

Value:

2 - 20 seconds, Full Voltage ★ 10 seconds

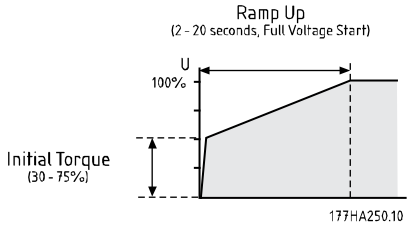
Function:

Determines the time taken for voltage to be ramped up to line voltage.

Description of choice:

Set to optimise motor acceleration and/or start current. Short ramp times result in quicker

acceleration and higher start currents. Long ramp times result in slower acceleration and lower start current.



Ramp Up time

1. Set the Ramp Up time to 20 seconds.
2. Set the Initial Torque as required for the application.
3. Attach a current monitoring device to output T1.
4. Start the motor under normal load conditions. Record the time required for the measured current to fall to (or below) the motor's rated full load current (t_1) then stop the motor.
5. Set Ramp Up time = t1.

3 Ramp Down

Value:

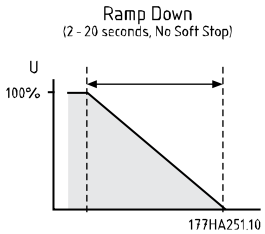
2 - 20 seconds, No Soft Stop ★ No Soft Stop

Function:

Sets the time of the soft stop voltage ramp. The soft stop function extends motor deceleration time by ramping down voltage supplied to the motor when a stop is initiated.

Description of choice:

Set the ramp time to optimise stopping characteristics for the load.

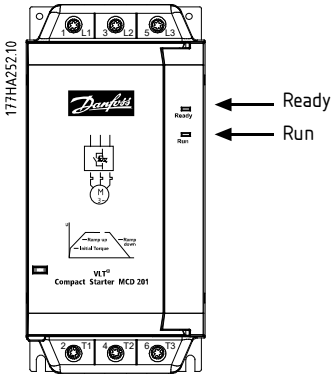


■ Main Contactor Output

The Main Contactor output (terminals 13, 14) closes as soon as the soft starter receives a start command and remains closed while the soft starter is controlling the motor (until the motor starts a coast to stop, or until the end of a soft stop). The Main Contactor output will also open if the soft starter trips.

The Main Contactor output can be used to directly control a main contactor coil.

■ Indication



LED	OFF	ON	FLASH
Ready	No control power	Ready	Starter tripped
Run	Motor not running	Motor running at full speed	Motor starting or stopping

■ Fault Finding

Ready LED	Description
x 1	Power Circuit: Check mains supply (L1, L2, L3), motor circuit (T1, T2, T3), soft starter SCRs and bypass relays.
x 6	Supply Frequency: Check mains voltage is available and supply frequency is in range.
x 8	Network Communication Failure (between module and network): Check network connections, settings and configuration.
x 9	Starter Communication Failure (between starter and module): Remove and refit accessory module.

■ Reset

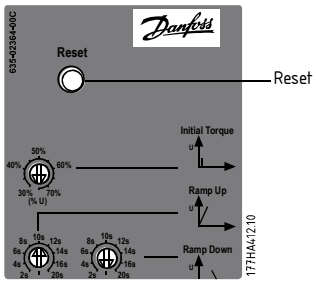
Trips can be cleared by pressing the Reset button on the soft starter, sending a Reset command from the serial communications network, or by switching the control inputs.

To clear a trip via the control inputs, the soft starter requires a closed to open transition on the stop input (N2).

– In three-wire control, use the external stop pushbutton to momentarily open the stop input (open A1-N2).

– In two-wire control, if the soft starter tripped with a start signal present, remove the start signal (open A1 to N1, N2).

The Reset button is located on the front of the unit, above the adjustment switches.



■ MCD 202

■ Overview

MCD 202 soft starters provide current limit soft start, timed voltage ramp soft stop and a range of motor and starter protection functions.

■ Protections

The MCD 202 includes the following types of protection for the motor and starter:

■ Motor Overload Protection

The MCD 202 will trip on motor overload if it calculates that the motor has been running above its operating range for longer than the time selected in the Motor Trip Class setting. Motor Trip Class should be set to match the motor's locked rotor time. If this information is not available from the motor datasheet, use the default setting (Motor Trip Class = 10). Using a higher setting can damage the motor.

N.B.!:
Motor overload protection does not protect the soft starter.

■ Excess Start Time Protection

The MCD 202 will trip on excess start time if the motor does not successfully start within the time selected in the Excess Start Time setting. This may indicate that the load has stalled.

If the soft starter frequently trips on excess start time:

– check that the Current Limit setting is high enough for the application
– check that the Excess Start Time setting is long enough for the application

■ Phase Imbalance Protection

The MCD 202 will trip on phase imbalance if the highest and lowest currents on the three phases vary by an average of 30% for more than 3 seconds. Current imbalance protection is not adjustable, and is only active when the average motor current is 50% or more of the programmed motor FLC.

If the soft starter frequently trips on phase imbalance:

– check that there is no imbalance on the mains voltage (on the input side of the soft starter)
– insulation test the motor
– move all input cables over one position (move L1 cable to L2, move L2 cable to L3, move L3 cable to L1) to rule out a cabling fault

■ Bypass Overload Protection

Bypass overload protection protects the soft starter from severe operating overloads while running. The protection is not adjustable and has two components:

- The soft starter will trip if it detects overcurrent at 600% of the programmed motor full load current.
- The soft starter models the temperature of the internal bypass relays and will trip if the temperature exceeds the safe operating level.

If the trip occurs frequently, this indicates that the soft starter has not been selected correctly for the application.

■ Supply Frequency Protection

The soft starter will trip on supply frequency if the frequency rises above 72 Hz or falls below 40 Hz for more than five seconds while the soft starter is running. These trip points are not adjustable.

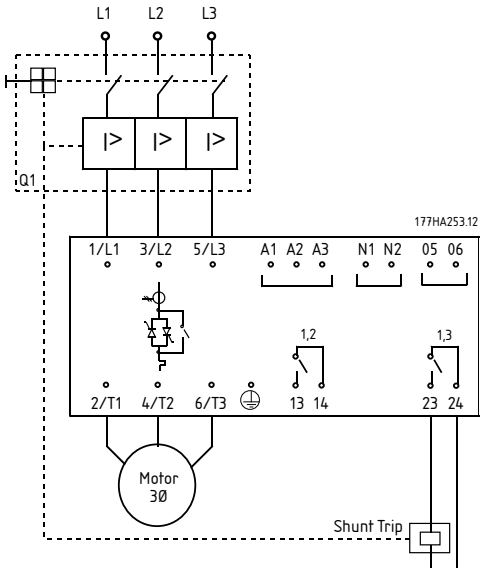
In pre-start, starting and stopping modes the high and low frequency limits both apply with no time delay.

A supply frequency trip will also occur if:

- all three input phases are lost while the soft starter is running
- all three input phases fall below 120 VAC at start or while the soft starter is running
- the line contactor opens while running

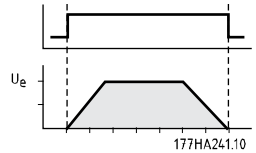
■ Electrical Schematics

Example 1. MCD 202 soft starter installed with a system protection circuit breaker complete with a shunt trip device.



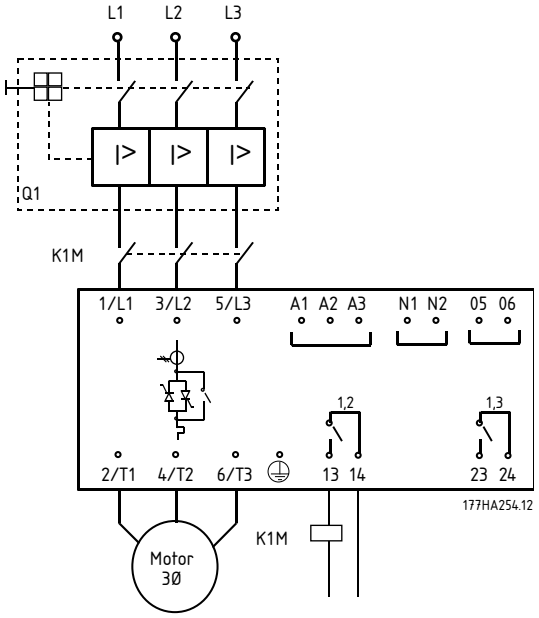
[1] 6 A @ 30 VDC resistive / 2 A 400 VAC AC11.

[2] Main contactor.



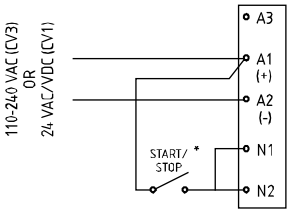
[3] Auxiliary relay (function = Trip).

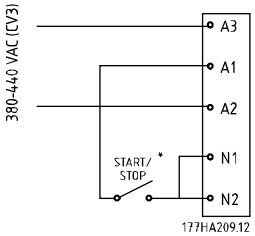
Example 2. MCD 202 soft starter installed with a system protection circuit breaker and line contactor.



■ Control Circuits

Two-wire control

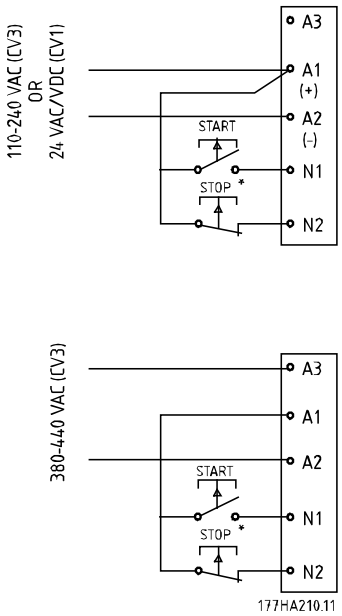




Two-wire control requires a maintained contact. A start command requires a permanently closed contact and a stop command requires a permanently open contact.

* To reset a trip, close then open N2.

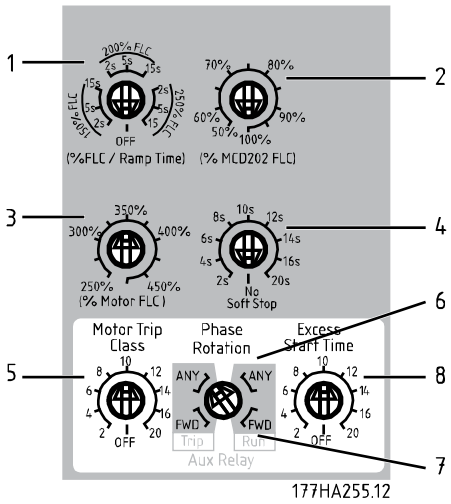
Three-wire control



Three-wire control requires a momentary signal. A start command requires momentary operation of terminal N1 and a stop command required momentary operation of terminal N2. Only one command can be active at one time.

★ To reset a trip, close then open N2.

■ User Adjustments



1 Current Ramp (% FLC / Ramp Time)

Value:

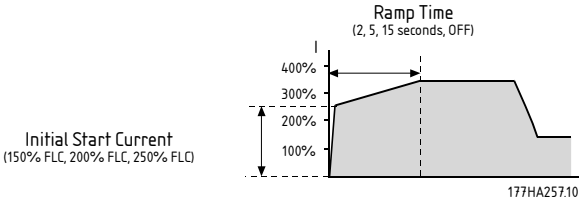
150% Motor FLC (2, 5 or 15 seconds) ★ Off
200% Motor FLC (2, 5 or 15 seconds)
250% Motor FLC (2, 5 or 15 seconds)
Off

Function:

Sets the initial start current and ramp time for the current ramp start mode.

Description of choice:

Current ramp provides an extended soft start by gradually increasing the start current from an initial level to the selected current limit. The initial start current and ramp duration are both selectable.



Current ramp start mode is commonly used in two circumstances.

1. For applications where start conditions vary between starts, current ramp provides an optimum soft start irrespective of motor loading (e.g. a conveyor that may start loaded or unloaded).
   In this case, use the following settings:
   – Set *Current Limit (% Motor FLC)* so that the motor can accelerate to full speed when fully loaded.
   – Set *Current Ramp (% FLC / Ramp Time)* so that:
     - the initial start current allows the motor to accelerate when unloaded
     - the ramp time provides the desired starting performance
2. On generator set supplies where a gradual increase in current is required to allow greater time for the generator set to respond to the increased loading.
   In this case, use the following settings:
   – Set *Current Limit (% Motor FLC)* as desired.
   – Set *Current Ramp (% FLC / Ramp Time)* so that:
     - the initial start current is lower than the setting for *Current Limit (% Motor FLC)*
     - the ramp time achieves the desired gradual draw of start current

2 Motor FLC (% MCD 202 FLC)

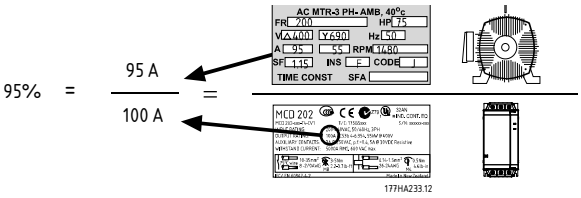
Value:

50% - 100% MCD 202 FLC ★ 100%

Function:

Calibrates the MCD 202 for the full load current of the motor.

Description of choice:



3 Current Limit (% Motor FLC)

Value:

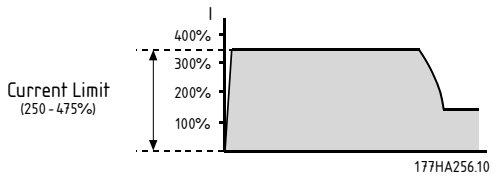
250% - 475% Motor FLC ★ 350%

Function:

Sets the desired starting current limit.

Description of choice:

The current limit should be set so that the motor accelerates easily to full speed.



N.B.!:
Start current must be great enough to allow the motor to produce sufficient torque to accelerate the connected load. The minimum current required to do this depends on motor design and load torque requirements.

4 Soft Stop Ramp Time

Value:

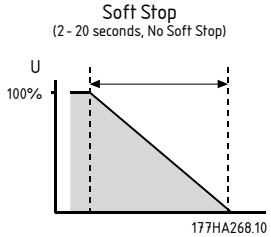
2 - 20 seconds, No Soft Stop ★ No Soft Stop

Function:

Sets the time of the soft stop voltage ramp. The soft stop function extends motor deceleration time by ramping down voltage to the motor when a stop is initiated.

Description of choice:

Set the ramp time to optimise stopping characteristics for the load.



5 Motor Trip Class

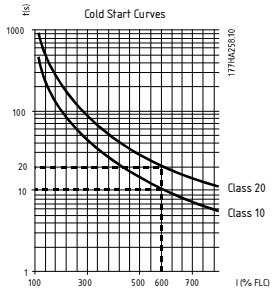
Value:

2 - 20, Off ★ 10

Function:

Calibrates the MCD 202 motor thermal model according to the desired motor trip class.

Description of choice:



6 Phase Rotation

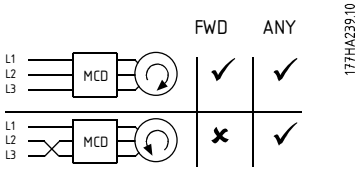
Value:

ANY, FWD ★ ANY
ANY = Forward and Reverse rotation permitted
FWD = Forward rotation only

Function:

Sets the allowable phase rotation of the incoming supply.

Description of choice:



The MCD 202 is phase rotation insensitive. This function allows motor rotation to be limited to one direction only, for applications where reverse rotation may damage the load.

N.B.!:
Phase Rotation and Auxiliary Relay Function are configured using a shared switch.

1. Set the Phase Rotation by turning the switch up (Any Rotation) or down (Forward Only).
2. Then set the Auxiliary Relay functionality by turning the switch to the left (Trip) or right (Run).

7 Auxiliary Relay

Value:

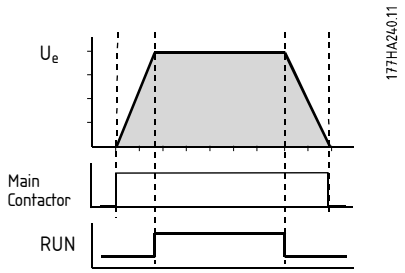
Trip, Run ★ Trip

Function:

Sets the functionality of the Auxiliary Relay (terminals 23, 24).

Description of choice:

Set as required, using the combined Phase Rotation/Auxiliary Relay adjustment.



8 Excess Start Time

Value:

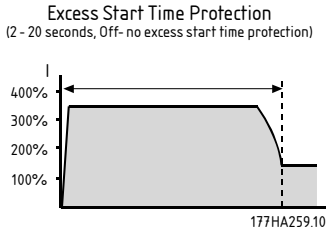
2 - 20 seconds, Off ★ 10 seconds

Function:

Sets the maximum allowable start time.

Description of choice:

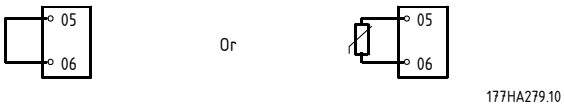
Set for a period slightly longer than the normal motor starting time. The MCD 202 will then trip if the start time exceeds normal.



This provides early indication that the application conditions have changed or that the motor has stalled. It can also prevent the soft starter being operated outside its rated capability.

N.B.!:
Ensure the Excess Start Time protection setting is within the MCD 202 rated capability.

■ Motor Thermistor



Motor thermistor cut out value = 2.8 kΩ.

■ Outputs

■ Main Contactor Output

The Main Contactor output (terminals 13, 14) closes as soon as the soft starter receives a start command and remains closed while the soft starter is controlling the motor (until the motor starts a coast to stop, or until the end of a soft stop). The Main Contactor output will also open if the soft starter trips.

The Main Contactor output can be used to directly control a main contactor coil.

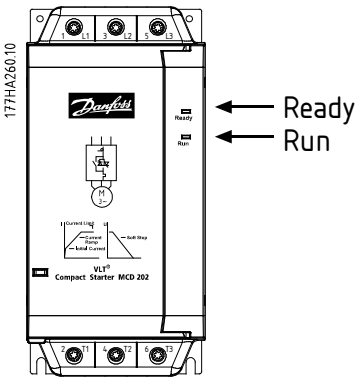
■ Programmable Output

The programmable output relay (terminals 23, 24) can be used to signal either trip or run status. This relay is normally open.

Trip:
When set to trip, the relay closes when the MCD 202 trips. The relay can be used to operate the shunt-trip mechanism of an upstream circuit breaker (in order to isolate the motor branch circuit), or to signal the trip to an automation system or externally. The relay will open when the trip is reset.

Run:
When set to run, the relay operates when the soft start is complete, the bypass relays are closed and full voltage is being applied tot he motor. The relay can be used to operate a contactor for power factor correction capacitors, or to signal soft starter run status to an automation system.

■ Indication



LED	OFF	ON	FLASH
Ready	No control power	Ready	Starter tripped
Run	Motor not running	Motor running at full speed	Motor starting or stopping

■ Fault Finding

Ready LED	Description
x 1	Power Circuit: Check mains supply (L1, L2, L3), motor circuit (T1, T2, T3), soft starter SCRs and bypass relays.
x 2	Excess Start Time: Check load, increase Current Limit or adjust Excess Start Time setting.
x 3	Motor Overload: Allow motor to cool, reset soft starter and restart. The soft starter cannot be reset until the motor has cooled.
x 4	Motor Thermistor: Check motor ventilation and thermistor connection 05, 06. Allow motor to cool.
x 5	Phase Imbalance: Check for mains supply or line current imbalance (L1, L2, L3).
x 6	Supply Frequency: Check mains voltage is available and supply frequency is in range.
x 7	Phase Rotation: Check for correct phase rotation.
x 8	Network Communication Failure (between module and network): Check network connections, settings and configuration.
x 9	Starter Communication Failure (between starter and module): Remove and refit accessory module.
x 10	Bypass Overload: Starter rating may be too low for the application.

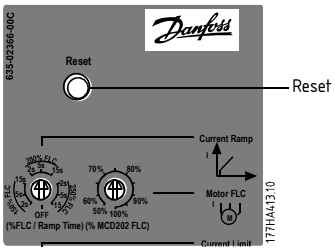
■ Reset

Trips can be cleared by pressing the Reset button on the soft starter, sending a Reset command from the serial communications network, or by switching the control inputs.

To clear a trip via the control inputs, the soft starter requires a closed to open transition on the stop input (N2).

- In three-wire control, use the external stop pushbutton to momentarily open the stop input (open A1-N2).
- In two-wire control, if the soft starter tripped with a start signal present, remove the start signal (open A1 to N1, N2).

The Reset button is located on the front of the unit, above the adjustment switches.



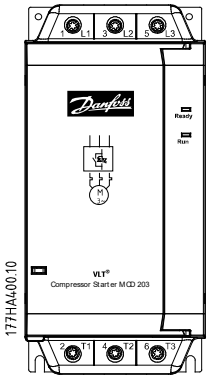
■ MCD 203

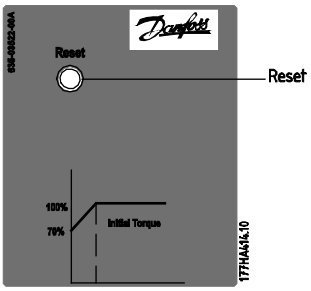
■ Overview

The MCD 203 is a compressor starter, optimised for use on specific compressors. The MCD 203 is based on the MCD 201 and is designed to be used in conjunction with external motor protection devices, on applications not requiring soft stop.

The MCD 203 is pre-configured to suit its target compressor and has no user adjustments.

Contact Danfoss for further information.





■ Accessories

■ Modbus Module

Order Code: 175G9000

The Modbus Module enables control and monitoring via a Modbus RTU network.

See the Modbus Module Instructions for further details.

■ Profibus Module

Order Code: 175G9001

The Profibus Module enables control and monitoring via a Profibus network.

See the Profibus Module Instructions for further details.

■ DeviceNet Module

Order Code: 175G9002

The DeviceNet Module enables control and monitoring via a DeviceNet network.

See the DeviceNet Module Instructions for further details.

■ Remote Operator

Order Code: 175G9004

The Remote Operator can control and monitor the soft starter's performance. Functionality includes:

- Operational control (Start, Stop, Quick Stop and Reset)
- Status monitoring (Start, Run and Trip)
- Performance monitoring (Motor Current and Motor Temperature) ★
- Trip code display
- 4-20 mA analogue output (Motor Current) ★

★ = MCD 202 models only.

See the Remote Operator Manual for details.

■ Pump Application Module

Order Code: PIM-PA-01

The Pump Application Module expands the soft starter's input and output functionality for applications where greater control and feedback are required.

See the Pump Application Module Instructions for further details.

■ PC Software

MCD PC Software can be used with Danfoss soft starters to provide the following functionality for networks of up to 99 soft starters:

Feature	MCD 201	MCD 202	MCD 3000
Operational control (Start, Stop, Reset, Quick Stop)		●	●
Starter status monitoring (Ready, Starting, Running, Stopping, Tripped)	●	●	●
Performance monitoring (motor current, motor temperature)		●	●
Upload parameter settings			●
Download parameter settings			●

To use MCD PC Software with the MCD 200, the soft starter must be fitted with a Modbus Module (175G9000) or a Remote Operator (175G9004).

See the MCD PC Software User Manual for further details.

■ Finger Guard Kit

Order Code: 175G007

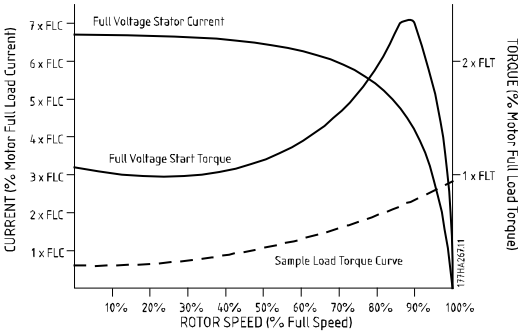
Finger guards may be specified for personnel safety and can be used on MCD 200 soft starter models 075~110. Finger guards fit over the soft starter terminals to prevent accidental contact with live terminals. Finger guards provide IP20 protection when used with cable of diameter 22 mm or greater.

Soft Start Application Guide

This section provides data useful in the selection and application of soft starters.

Reduced Voltage Starting

When started under full voltage conditions, an AC induction motor will initially draw locked rotor current (LRC) and produce locked rotor torque (LRT). As the motor accelerates the current falls, and the torque increases to breakdown torque before falling to full speed levels. Motor design determines the magnitude and shape of both the current and torque curves.



Motors with similar full speed characteristics can have very different starting capabilities. Locked rotor currents can range from 500% to more than 900% of motor full load current. Similarly, locked rotor torques can range from 70% to 230% of motor full load torque. These performance characteristics are determined by the design of the motor and set the limits of what can be achieved by the application of a reduced voltage starter.

For applications where it is essential to minimise start current or maximise start torque, it is important to ensure that a motor with low locked rotor current and high locked rotor torque is used.

When a reduced voltage starter is used, motor start torque is reduced by the square of the current reduction as shown in the formula below.

$$T_{ST} = LRT \times \left(\frac{I_{ST}}{LRC} \right)^2$$

T_{ST} = Start torque
I_{ST} = Start current
LRC = Motor locked rotor current
LRT = Motor locked rotor torque

17TH438510

Start current can be reduced only to the point where the resulting start torque still exceeds the torque required by the load. If the torque output from the motor falls below the torque required by the load at any point during motor starting, acceleration will cease and the motor/load will not reach full speed.

The most common reduced voltage starters are:

- Star/delta starters
- Auto-transformer starters
- Primary resistance starters
- Soft starters

Soft Starters

Soft starters are the most advanced form of reduced voltage starting. They offer superior control over starting current and torque as well as incorporating advanced motor protection and interface functions.

The main starting and stopping advantages of soft starters include:

- simple and flexible control over starting current and torque
- smooth control over voltage and current, without steps or transitions
- capable of frequent starting without performance variations
- optimum start performance for every start, even in applications where the load varies between starts
- soft stop control to extend motor deceleration times
- braking control to reduce motor deceleration times

Not all features are available in all starters.

Types of Soft Start Control

The term 'soft start' is applied to a range of technologies. These technologies all relate to motor starting but there are significant differences in the methods used and the benefits available.

Some of the key differences are described below.

Control philosophy: Soft starters can generally be divided into two groups.

- Timed Voltage Ramp (TVR) systems
- Current controlled systems

TVR starters control voltage applied to the motor in a preset manner and receive no feedback on motor starting current. The user controls start performance through settings such as Initial Voltage and Ramp up time. Soft stop is also commonly available and provides the ability to extend motor stopping times.

Current controlled soft starters monitor motor current and use this feedback to adjust voltage so that user specified starting current is maintained. Most current controlled soft starter also provide soft stop and a range of motor protection functions.

Power assemblies: Soft starters can control one, two or all three phases.

Single-phase controllers remove the torque shock associated with motor starting but provide no significant current reduction. They must be used with a line contactor and motor overload. They are suitable for very small motors and should only be applied to light applications with low to medium start frequency.

Two-phase controllers control two phases while the third phase is uncontrolled. These controllers provide soft start and current reduction. Care should be taken to ensure that the control algorithms of two-phase controllers balance the output waveform in order to provide a symmetrical waveform. Basic two-phase controllers subject the motor to an asymmetrical output waveform which creates a DC field in the motor. This stationary DC field increases the required start current and increases motor heating. Such unbalanced controllers should not be applied to high inertia loads or in situations with high start frequencies.

Three-phase controllers control all phases and are best suited for very large motors.

External or internal bypass connection: The SCRs in a soft starter can be bypassed once the motor has reached full speed. This reduces heat generation and prevents damage to the SCR from overcurrent or overvoltage events that occur while the motor is running. Some soft starters include built-in bypass contactors while others provide terminals for connection of an external bypass contactor.

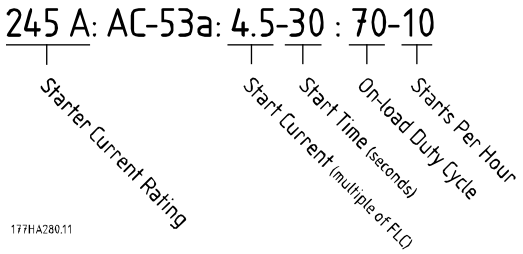
■ Understanding Soft Starter Ratings

The maximum rating of a soft starter is calculated so the junction temperature of the power modules (SCRs) does not exceed 125 oC. Five operating parameters affect the SCR junction temperature: Motor Current, Start Current, Start Duration, Number of Starts per Hour, Off Time. The full rating of a particular soft start model must account for all these parameters. A current rating on its own is not sufficient to describe the capability of a soft starter.

IEC 60947-4-2 details the AC53 utilisation categories for describing a soft starter's ratings. There are two AC53 codes:

1. AC53a: for soft starters used without bypass contactors.

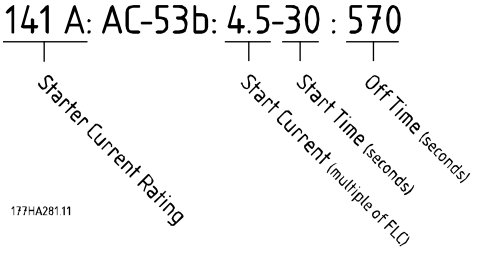
   For example, the following AC53a code describes a soft starter capable of supplying a 256 A run current and a start current of 4.5 x FLC for 30 seconds 10 times per hour where the motor runs for 70% of each operating cycle (operating cycle = 60 minutes / starts per hour).



   – Starter Current Rating: Maximum FLC rating of the motor to be connected to the soft starter given the operating parameters specified by the remaining items in the AC53a code.
   – Start Current: The maximum start current that will be drawn during start.
   – Start Time: The time taken for the motor to accelerate.
   – On-load Duty Cycle: The percentage of each operating cycle that the soft starter will run.
   – Starts Per Hour: The number of operating cycles per hour.

2. AC53b: for soft starters used with bypass contactors.

   For example, the following AC53b code describes a soft starter which, when bypassed, is capable of supplying 145 A run current and a start current of 4.5 x FLC for 30 seconds with a minimum of 570 seconds between the end of one start and the commencement of the next.



In summary, a soft starter has many current ratings. These current ratings depend on the start current and operational performance required by the application.

To compare the current rating of different soft starters it is important to ensure that operating parameters are identical.

■ Model Selection

N.B.!:
The start current requirements suggested in the table below are typical and appropriate in most circumstances. However, start torque requirements and performance of motors and machines do vary. Please contact Danfoss if your application involves extremes of operation (such as frequent starting, regular stalls, jams or overloads, high altitude or temperature extremes). Danfoss is always happy to discuss the most appropriate solution for your situation.

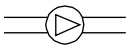
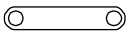
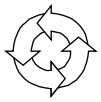
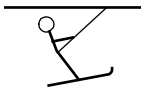
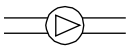
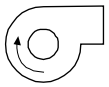
To select the correct MCD 200 model:

1. Determine whether the application requires a normal duty or heavy duty rating. The table below can be used as a guide.
2. Select an MCD 200 model with full load current greater than that of the motor at the appropriate duty.

Application	Duty
General and Water	
Centrifugal pump	Normal
Compressor (screw, unloaded)	Normal
Compressor (reciprocating)	Heavy
Conveyor	Normal
Fan (damped)	Normal
Fan (undamped)	Heavy
Mixer	Heavy
Positive displacement pump	Normal
Submersible pump	Normal
Metals and Mining	
Belt conveyor	Heavy
Dust collector	Normal
Grinder	Normal
Hammer mill	Heavy
Rock crusher	Normal
Roller conveyor	Normal
Roller mill	Heavy
Tumbler	Normal
Wire draw machine	Heavy
Food Processing	
Bottle washer	Normal
Centrifuge	Normal
Dryer	Heavy
Mill	Heavy
Palletiser	Heavy
Separator	Heavy
Slicer	Normal
Pulp and Paper	
Dryer	Heavy
Re-pulper	Heavy
Shredder	Heavy
Petrochemical	
Ball mill	Heavy
Centrifuge	Normal
Extruder	Heavy
Screw conveyor	Normal
Transport and Machine Tool	
Ball mill	Heavy
Grinder	Normal
Material conveyor	Normal
Palletiser	Heavy
Press	Normal
Roller mill	Heavy
Rotary table	Normal
Lumber and Wood products	
Bandsaw	Heavy
Chipper	Heavy
Circular saw	Normal
Debarker	Normal
Edger	Normal
Hydraulic power pack	Normal
Planer	Normal
Sander	Normal

■ Typical Applications

MCD 200 soft starters can offer benefits for almost all motor starting applications. Typical advantages are highlighted in the table below.

Application	Benefits
Pumps 	• Minimised hydraulic shock in pipelines during start and stop. • Reduced starting current. • Minimised mechanical stress on motor shaft. • Phase rotation protection prevents damage from reverse pump rotations.
Conveyor Belts 	• Controlled soft start without mechanical shocks, e.g. bottles on a belt do not fall over during starting, minimised belt stretch, reduced counterbalance stress. • Controlled stop without mechanical shock (soft stop). • Optimum start performance even with varying starting loads (e.g. coal conveyors start loaded or unloaded). • Extended mechanical lifetime. • Maintenance-free.
Centrifuges 	• Smooth application of torque prevents mechanical stress. • Reduced starting times over star/delta starting.
Ski Lifts 	• Jerk-free acceleration increases skier comfort and prevents swinging T-bars etc. • Reduced starting current allows starting of large motors on a weak power supply. • Smooth and gradual acceleration whether the ski lift is lightly or heavily loaded. • Phase rotation protection prevents operation in reverse direction.
Compressors 	• Reduced mechanical shock extends the life of the compressor, couplings and motor. • Limited start current enables large compressors to be started when maximum power capacity is limited. • Phase rotation protection prevents operation in reverse direction.
Fans 	• Extended coupling life though reduced mechanical shock. • Reduced start current enables large fans to be started when maximum power capacity is limited. • Phase rotation protection prevents operation in reverse direction.
Mixers 	• Gentle rotation during start-up reduces mechanical stress. • Reduced starting current.

■ Power Factor Correction

If a soft starter is used with static power factor correction, it must be connected to the supply side of the starter.

Connecting power factor correction capacitors to the output of the soft starter will result in damage to the soft starter.

www.danfoss.com/drives

AJ361178586196en-000201

175R0978

MG17C402

Rev. 2025-02

175R0978