



Power Installation Guide

Freestanding Drives

DFS Series High Power Drive Cubicles

Part Number: 0478-0573-05
Issue: 5

Compliance Information

Manufacturer: Nidec Control Techniques Limited ("we", "our")

Registered office: The Gro, Newtown, Powys, SY16 3BE United Kingdom

Registered in: England and Wales, company registration number 01236886

Manufacturer's EU Authorised Representative: Nidec Netherlands B.V., Kubus 155, 3364 DG Sliedrecht, the Netherlands, registered at the Dutch Trade Register under number 33213151; Tel. +31 (0)184 420 555, info.nl@mail.nidec.com

Original instructions

With reference to the UK Supply of Machinery (Safety) Regulations 2008 and the EU Machinery Directive 2006/42/EC, the English version of this Manual constitutes the original instructions. Manuals published in other languages are translations of the original instructions and the English language version of this Manual prevails over any other language version in the event of inconsistency.

Documentation and user software tools

Manuals, datasheets and software that we make available to users of our products can be downloaded from:

<http://www.drive-setup.com>

MARSHAL (Mobile App): This application is available for download from the Google Play Store and the Apple App Store.

Warranty and liability

The contents of this Manual are presented for information purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs, specifications or performance of our products at any time without notice. For full details of the warranty terms applicable to the product, contact the supplier of the product.

In no event and under no circumstances shall we be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings for the product, nor shall we be liable for consequential and incidental damages of any kind.

Environmental management

We operate an Environmental Management System which complies with the requirements of ISO 14001:2015. Further information on our Environmental Statement can be found at:

<http://www.drive-setup.com/environment>.

Restriction and control of hazardous substances

The products covered by this Manual comply with the following legislation and regulations on the restriction and control of hazardous substances:

UK Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

UK REACH etc. (Amendment etc.) (EU Exit) Regulations 2020, European Union REACH Regulation EC 1907/2006

EU restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) - Directive 2011/65/EU

EC Regulation 1907/2006 on the Registration, Evaluation, authorisation, and restriction of Chemicals (REACH)

Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products 2016/07/01

U.S. Environmental Protection Agency ("EPA") regulations under the Toxic Substances Control Act ("TSCA")

MEPC 68/21 / Add.1, Annex 17, Resolution MEPC.269(68) 2015 Guidelines for the development of the inventory of hazardous materials

The products covered by this Manual do not contain asbestos.

Further information on REACH and RoHS can be found at:

<http://www.drive-setup.com/environment>.

Conflict minerals

With reference to the Conflict Minerals (Compliance) (Northern Ireland) (EU Exit) Regulations 2020, the U.S. Dodd-Frank Wall Street Reform and Consumer Protection Act and Regulation (EU) 2017/821 of the European Parliament and of the European Council:

We have implemented due diligence measures for responsible sourcing, we conduct conflict minerals surveys of relevant suppliers, we continually review due diligence information received from suppliers against company expectations and our review process includes corrective action management. We are not required to file an annual conflict minerals disclosure. Nidec Control Techniques Limited is not an issuer as defined by the U.S. SEC.

Disposal and recycling (WEEE)



The products covered by this Manual fall within the scope of the UK Waste Electrical and Electronic Equipment Regulations 2013, EU Directive 2012/19/EU amended by EU Directive 2018/849 (EU) on Waste Electrical and Electronic Equipment (WEEE).

When electronic products reach the end of their useful life, they must not be disposed of along with domestic waste but should be recycled by a specialist recycler of electronic equipment. Our products are designed to be easily dismantled into their major component parts for efficient recycling. Most materials used in our products are suitable for recycling.

Our product packaging is of good quality and can be re-used. Smaller products are packaged in strong cardboard cartons which have a high recycled fibre content. Cartons can be re-used and recycled. Polythene, used in protective film and bags for the ground screws, can be recycled. When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

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UKCA Declaration of Conformity

1. Product range

Drive Free Standing (DFS).

2. Name and address of the manufacturer

Nidec Netherlands B.V.
Kubus 155
3364 DG Sliedrecht
Postbus 300
3360 AH Sliedrecht
Netherlands

3. Responsibility

This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

Model No.	Interpretation	Nomenclature aaaa - DFS b c d e f g h i
aaaa	Drive module range	Industrial drive = M700, M701, M702. Process drive = F300, F600
DFS	Format	DFS = Drive Free Standing
b	Number of drives	1, 2
c	Current rating step	Any alphanumeric character: 1 – 9, A – Z
d	Voltage rating	4 = 400 V, 6 = 690 V
e	World Region	E = Europe, A = Americas
f	Input circuit	N = Rectifier - Single 6 pulse
g	Input switch	S = Load Switch (Standard)
h	Enclosure rating	A = IP23 – Air Cooled, C = IP54 – Air Cooled
i	Options	The model number may be followed by any combination of 10 digits denoting customer options. The options do not affect the ratings.

5. Declaration

The object of the declaration is in conformity with the relevant UK statutory requirements.

UK Regulations

Electrical Equipment (Safety) Regulations 2016

Electromagnetic Compatibility Regulations 2016

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

The Ecodesign for Energy-Related Products Regulations 2010 / 2617

6. References to the relevant harmonised standards used

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonised standards:

Designated BS standards	
BS 61800-5-1: 2007 + A1: 2017	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
BS 61800-3: 2018	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
BS 61000-6-2: 2019	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments

7. Responsible person



Jon Holman-White
Vice President of Research and Development
Nidec Control Techniques Ltd
Date: 20th May 2019
Newtown, Powys, UK.

These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. The assembler is responsible for ensuring that the product or system complies with all the relevant laws in the country where it is to be used.

EU Declaration of Conformity

1. Product range

Drive Free Standing (DFS).

2. Name and address of the manufacturer

Manufacturer	Authorised representative:
Nidec Control Techniques Ltd The Gro Newtown Powys SY16 3BE UK Registered in England and Wales. Company Reg. No. 01236886	Nidec Netherlands B.V. Kubus 155 3364 DG Sliedrecht Netherlands.

3. Responsibility

This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

Model No.	Interpretation	Nomenclature aaaa - DFS b c d e f g h i
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f	Input circuit	N = Rectifier - Single 6 pulse
g	Input switch	S = Load Switch (Standard)
h	Enclosure rating	A = IP23 – Air Cooled, C = IP54 – Air Cooled
i	Options	The model number may be followed by any combination of 10 digits denoting customer options. The options do not affect the ratings.

5. Declaration

The object of the declaration is in conformity with the relevant European Union harmonisation legislation.

Low Voltage Directive (2014/35/EU)

Electromagnetic Compatibility Directive (2014/30/EU)

Restriction of Hazardous Substances Directive (2011/65/EU), as last amended in 4th June 2015, published as Directive (EU) 2015/863.

Regulation 2019/1781 of directive 2009/125/EC (Energy related products)

6. References to the relevant harmonised standards used

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonised standards:

EN 61800-5-1:2007+A1:2017	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-3: 2018	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN 61000-6-2: 2019	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments

7. Responsible person



Jon Holman-White
Vice President of Research and Development
Nidec Control Techniques Ltd
Date: 20th May 2019
Newtown, Powys, UK.

IMPORTANT NOTE

These products are Complete Drive Modules, intended to be used with motors, electrical protection components and other equipment to form Power Drive Systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Safety information and Installation instructions supplied with the drive. The installer is responsible for ensuring that the Power Drive System complies with all applicable laws in the country where it is to be used.

EU Declaration of Conformity (Machinery Directive)

1. Product model

Unidrive-M and derivative products incorporating a Safe Torque Off (STO) function when used as a safety component of a machine.

2. Name and address of the manufacturer

Nidec Control Techniques Ltd, The Gro, Newtown, Powys, SY16 3BE, UK

Registered in England and Wales, Company Reg. No. 0126885

Telephone: 00 44 1686 612300

E-mail: marketing.controltechniques@mail.nidec.com

Web: www.controltechniques.com

3. This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

Model No.	Interpretation	Nomenclature aaaa - bbc ddddde
aaaa	Basic series	M600, M700, M701, M702, M708, M709, M750, M751, M753, M754, F300, F600, H300, E200, E300, HS70, HS71, HS72, M000, RECT
bb	Frame Size	03, 04, 05, 06, 07, 08, 09, 10, 11, 12
c	Voltage Rating	1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V
dddd	Current Rating	Example 01000 = 100 A
e	Drive Format	A = 6P Rectifier + Inverter with internal choke, D = Inverter, E = 6P Rectifier + Inverter, T = 12P Rectifier + Inverter (external choke)

The model number may be followed by additional characters that do not affect the ratings.

5. The object of the declaration is in conformity with the relevant European Union harmonisation legislation.

Machine Directive (2006/42/EC)

Electromagnetic Compatibility Directive (2014/30/EU)

EC type examination has been carried out by the following notified body:

TUV Rheinland Industries Service GmbH
AM Grauen Stein
D-51105 Köln
Germany

EC type-examination certificate numbers:
01/205/5270.02/17 dated 2017-08-28

Notified body identification number: 0035

Only the Safe Torque Off function may be used for a safety function of a machine. None of the other functions of the drive may be used to carry out a safety function. The object of the declaration is in conformity with the relevant European Union harmonisation legislation.

6. References to the relevant harmonised standards used

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonized standards:

EN 61800-5-2:2016	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
EN 61800-5-1:2016 (in extracts)	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-3: 2004+A1:2012	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN ISO 13849-1:2015	Safety of Machinery, Safety-related parts of control systems, General principles for design
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of Machinery, Functional safety of safety related electrical, electronic and programmable electronic control systems
IEC 61508 Parts 1 - 7:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems

7. Signed for and behalf of:

Person authorised to complete the technical file: P. Knight
Conformity Engineer
DoC authorised by: **Jon Holman-White**
**Vice President of Research
and Development**
Date: **19th November 2018**
Place: **Newtown, Powys, UK**



1 Safety information

1.1 Warnings, Cautions and Notes



A Warning contains information which is essential for avoiding a safety hazard.



A Caution contains information which is necessary for avoiding a risk of damage to the product or other equipment.

NOTE

A **Note** contains information, which helps to ensure correct operation of the product.

1.2 General information

This guide applies to products which control electric motors either directly (drives) or indirectly (controllers, option modules and other auxiliary equipment and accessories). In all cases the hazards associated with powerful electrical drives are present, and all safety information relating to drives and associated equipment must be observed.

Specific warnings are given at the relevant places in this guide.

Drives and controllers are intended as components for professional incorporation into complete systems. If installed incorrectly they may present a safety hazard. The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning/start-up and maintenance must be carried out by personnel who have the necessary training and competence. They must read this safety information and this guide carefully.

1.3 Responsibility

It is the responsibility of the installer to ensure that the equipment is installed correctly with regard to all instructions given in this guide. They must give due consideration to the safety of the complete system, so as to avoid the risk of injury both in normal operation and in the event of a fault or of reasonably foreseeable misuse.

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation of the equipment.

1.4 Compliance with regulations

The installer is responsible for complying with all relevant regulations, such as national wiring regulations, accident prevention regulations and electromagnetic compatibility (EMC) regulations. Particular attention must be given to the cross-sectional areas of conductors, the selection of fuses or other protection, and protective ground (earth) connections.

This guide contains instructions for achieving compliance with specific EMC standards.

All machinery to be supplied within the European Union in which this product is used must comply with the following directives:

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive. Hazardous voltage may be present in any of the following locations:

- AC and DC supply cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

The STOP and Safe Torque Off functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit.

The drive must be installed in accordance with the instructions given in this guide. Failure to observe the instructions could result in a fire hazard.

1.6 Stored electrical charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

1.7 Mechanical hazards

Careful consideration must be given to the functions of the drive or controller which might result in a hazard, either through their intended behaviour or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

With the sole exception of the Safe Torque Off function, none of the drive functions must be used to ensure safety of personnel, i.e. they must not be used for safety-related functions.

The Safe Torque Off function may be used in a safety-related application. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

The design of safety-related control systems must only be done by personnel with the required training and experience. The Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application.

1.8 Access to equipment

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

1.9 Environmental limits

Instructions in this guide regarding transport, storage, installation and use of the equipment must be complied with, including the specified environmental limits. This includes temperature, humidity, contamination, shock and vibration. Drives must not be subjected to excessive physical force.

1.10 Hazardous environments

The equipment must not be installed in a hazardous environment (i.e. a potentially explosive environment).

1.11 Motor

The safety of the motor under variable speed conditions must be ensured.

To avoid the risk of physical injury, do not exceed the maximum specified speed of the motor.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective, causing a fire hazard. The motor should be installed with a protection thermistor. If necessary, an electric forced vent fan should be used.

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive must not be relied upon. It is essential that the correct value is entered in the Motor Rated Current parameter.

1.12 Mechanical brake control

Any brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in a risk of injury. In any application where the incorrect operation of the brake release mechanism could result in injury, independent protection devices of proven integrity must also be incorporated.

1.13 Adjusting parameters

Some parameters have a profound effect on the operation of the drive. They must not be altered without careful consideration of the impact on the controlled system. Measures must be taken to prevent unwanted changes due to error or tampering.

1.14 Electromagnetic compatibility (EMC)

Installation instructions for a range of EMC environments are provided in the relevant Power Installation Guide. If the installation is poorly designed or other equipment does not comply with suitable standards for EMC, the product might cause or suffer from disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation in the place of use.

1.15 Safe Torque Off

The Unidrive M700 / M701 has a single channel Safe Torque Off, whereas the Unidrive M702 has a dual channel STO. The Safe Torque Off function provides a means for preventing the drive from generating torque in the motor, with a very high level of integrity. It is suitable for incorporation into a safety system for a machine. It is also suitable for use as a conventional drive enable input.

Machinery Applications

The Safe Torque Off function has been independently assessed by Notified Body, TÜV Rheinland for use as a safety component of a machine:

Prevention of unintended motor operation: The safety function "Safe Torque Off" can be used in applications up to Cat 4, PL e according to EN ISO 13849-1, SIL 3 according to EN 61800-5-2/ EN 62061/ IEC 61508 and in lift applications according to EN 81-1 and EN 81-2.

TÜV certificate No. 01.205/5270.02/17

Date: 28-08-2017

For further details consult the M700, M701 M702 Control User Guide, CT part No. 0478-0353.

2 Product information

2.1 Introduction

This guide provides the information necessary to install the following cubicle models:

DFS 1

DFS 2

This guide focuses on the cubicle power section, for example: electrical installation of the supply / motor cables and mechanical installation of the cubicle.

The drives are housed in a compact IP23 or IP54 enclosure. A water-cooled option is available. A wide range of options are available including EMC filters and kWh meters.

This guide focuses on the drive power section, for example: electrical installation of the supply / motor cables and mechanical installation of the drive.

For information about the cubicle control section, for example: parameter set up information, control and encoder connections please refer to the M700, M701 M702 Control User Guide CT part No. 0478-0353.

2.2 Model number

The model number for the *DFS* product range is formed as illustrated below:

Figure 2-1 Model numbers

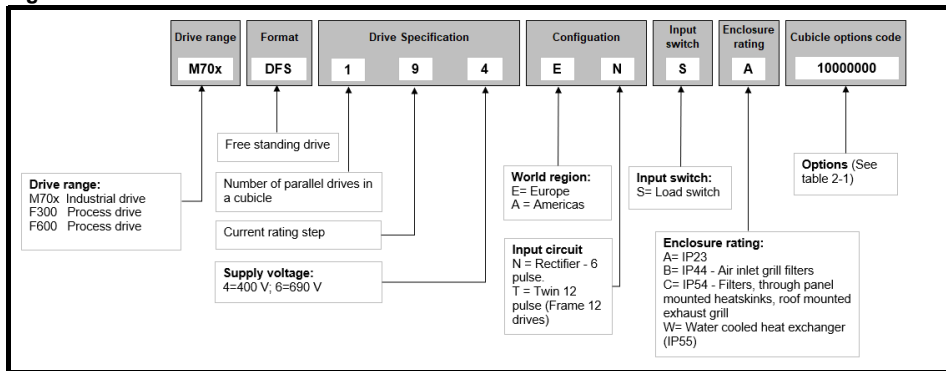


Table 2-1 Options

Option	Description	Selection Rule
IP23	A = IP23 (Standard)	Choose A, B or W
IP54	B = IP54	
IP55 - Water Cooled	W = Water cooled heat exchanger	
EMC Filter		N/A
Remove internal EMC filter	Remove internal EMC filter	N/A
Remove MOV protection	Remove MOV protection	N/A
Speed-controlled roof fan	Cabinet temperature controlled roof fan	N/A
Plinth 200 mm	Standard plinth is 100 mm	N/A
180° door hinges	Alternative hinge for improved access	N/A

Option	Description	Selection Rule
Cylinder lock with key	Extra cubicle security	N/A
A - Undervoltage release coil 230 VAC	Main switch with 230 VAC (MN)	If release coil needed, choose A, B, C or D
B - Undervoltage release coil 24 VAC	Main switch with 24 VAC (MN)	
C - Shunt trip voltage release coil 230 VAC	Main switch with 230 VAC (MX)	
D - Shunt trip voltage release coil 24 VAC	Main switch with 24 VAC (MX)	
A - kWh meter Conventional (IP54)	with CTs (non MID)	If kWh meter needed, choose A, B, C or D
B - kWh meter Modbus RTU	with CTs (non MID)	
C - kWh meter Profibus (Not available with 690 V)	with CTs (non MID)	
D - kWh meter Ethernet	with CTs (non MID)	
kWh meter pulse contacts	In combination with A, B, C or D kWh meters	See description
24 V back-up supply wiring	Provision for external 24 V backup power supply	N/A
Auxiliary contacts main switch	Supply and wiring of two auxiliary contacts on main switch	N/A
Rittal integrated empty incomer 400 mm	Includes plinth 100 mm both cable plates mounted to DFS	N/A
Back plate empty incomer		N/A
Emergency stop push button	Red push button on door	N/A
Air Freight Additional Packaging for DFS1 and 1	Pallet, Straps, Carton and Labour	N/A

When ordering a DFS drive, options can be selected using an on-line configurator tool. Alternatively, contact the local Control Techniques drives sales office for further information. The standard options are summarised in Table 2-1.

NOTE

Cubicle options code is generated by an on-line configurator.

2.3 Nameplate description

Figure 2-2 Typical drive rating label






DFS model number	M700 - DFS 194ENSA 0000000000	250/ 280 kW	Normal/heavy duty power rating
Serial number	S/N: 2018.031.003		
Unidrive M model number	Drive Module Base Model No. 1140 4640		
Input Voltage/frequency/current	Input: 380 - 480 Vac 50 / 60 Hz 3 ph 462/ 504 A (HD/ ND) 320/ 349 kVA (HD/ ND)	Output: 0 - 400 Vac 0 - 550 Hz 464/ 507 A (2 kHz) (HD/ ND)	Output Voltage/frequency/current
	Cooling method: Forced air Operating temperature range: 5 - 35°C Degree of protection: IP23 Altitude: 1000 m max	Nominal dissipation: 5850 W Weight: 300 kg Year of manufacture: 2018	
	Designed and manufactured in The Netherlands Patents: www.ctpatents.info	 	
	Kubus 155, 3364 Sliedrecht (NL) Postbus 300 3360 AH Sliedrecht (NL) Tel: +31(0)184-420555. Internet: www.nidecindustrialautomation.nl		

Figure 2-3 Auxiliary supply rating label


	Kubus 155, 3364 DG, Sliedrecht (NL) Postbus 300, 3360 AH, Sliedrecht (NL) Tel: +31(0)184-420555 Internet: www.nidecindustrialautomation.nl
Supply: Terminal Voeding: -X2:1,2	Supply: Terminal Voeding: Terminal
Max.cont input current: max 3A	Max.cont input current: Max.continu stroom:
Power supply: 230Vac/50Hz Voedingsspanning:	Power supply: Voedingsspanning:
Fault level: 50kA Kortsluitvastheid:	Fault level: Kortsluitvastheid:
Upstream fuse: 6A gG or Voorbeveiliging: mccb 6A B/C/D if fault level <10kA	Upstream fuse: Voorbeveiliging:

Figure 2-4 Upstream protection warning label


UPSTREAM PROTECTION

The AC supply to the DFS must be installed with suitable protection against overload and short-circuits.
Recommended protection ratings for: **DFS2-5-400-M700**

Fuse IEC class gG: 1250A, short-circuit strength 50kA
MCCB breaker: 1250A, short-circuit strength 30kA

To increase the short-circuit strength to 100kA. The following protection must be added in serie with above recommended protection in the AC supply to DFS:

1500A aR IEC class fuse

 Kubus 155, 3364 DG, Sliedrecht (NL)
Postbus 300, 3360 AH, Sliedrecht (NL)
Tel: +31(0)184-420555, Internet: www.nidecindustrialautomation.nl

2.4 Ratings

Table 2-2 400 V and 690 V ratings

Model	Volts	ND/HD kW	Frame size
xxxx-DFS1G4EN	400	75/55	8-11
xxxx-DFS1H4EN	400	90/75	
xxxx-DFS1J4EN	400	110/90	
xxxx-DFS1K4EN	400	132/110	
xxxx-DFS1L4EN	400	160/132	
xxxx-DFS1M4EN	400	200/160	
xxxx-DFS1N4EN	400	225/185	
xxxx-DFS1P4EN	400	250/200	
xxxx-DFS1Q4EN	400	280/250	
xxxx-DFS1R4EN	400	315/250	
xxxx-DFS1S4EN	400	355/315	
xxxx-DFS1T4EN	400	400/355	
xxxx-DFS1U4EN	400	500/400	
xxxx-DFS2Q4EN	400	560/500	8-11
xxxx-DFS166EN	690	75/55	
xxxx-DFS176EN	690	90/75	
xxxx-DFS186EN	690	110/90	
xxxx-DFS196EN	690	132/110	
xxxx-DFS1A6EN	690	160/132	
xxxx-DFS1B6EN	690	185/160	
xxxx-DFS1C6EN	690	200/185	
xxxx-DFS1D6EN	690	250/200	
xxxx-DFS1E6EN	690	280/250	
xxxx-DFS1F6EN	690	355/280	
xxxx-DFS1G6EN	690	400/355	
xxxx-DFS1H6EN	690	450/400	
xxxx-DFS1J6EN	690	500/450	8-11
xxxx-DFS2E6EN	690	560/500	

NOTE

DFS1 contains Frame size 8 to 11 or Frame size 12 drives. DFS2 contains Frame size 8 to 11 drives.

NOTE

xxxx denotes F300, F600, M700, M701 or M702.

NOTE

Output current and power ratings are shown as Normal Duty/ Heavy Duty For an explanation of Normal and Heavy-Duty ratings, refer to the M700, M701, M702 Control User Guide (CT part number: 0478-0353).

NOTE

M70x data based on Heavy Duty ratings. F300/F600 data based on Normal Duty ratings.

NOTE

M70x data based on Heavy Duty ratings. F300/F600 data based on Normal Duty ratings.

Table 2-3 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
> 35 mm ²	Half of the cross-sectional area of the input phase conductor

Typical short-term overload limits

The maximum percentage overload limit changes depending on the selected motor. Variations in motor rated current, motor power factor and motor leakage inductance all result in changes in the maximum possible overload. Typical values are shown in the table below:

Table 2-4 Typical overload limits (Frame size 8 to 11)

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 165 s	110 % for 9 s	110 % for 165 s	110 % for 9 s
Heavy Duty overload with motor rated current = drive rated current	175 % for 42 s	175 % for 5 s	150 % for 60 s	150 % for 7 s

Generally, the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting.

The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

NOTE

The maximum overload level which can be attained is independent of the speed.

Table 2-5 Typical overload limits (Frame size 12)

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 180s	110 % for 10 s*	110 % for 180 s	110 % for 10 s
Heavy Duty overload with motor rated current = drive rated current	140 % for 60 s	140 % for 10 s	140 % for 60 s	140 % for 10 s

* 1240720T rating provides 110 % for 3 s from rated normal duty current. 110 % is available for 10 s when limited to 850 A continuous.

120406600T and 12405660T support 110 % for 10 s.

NOTE

The maximum overload level which can be attained is independent of the speed.

Output current

The continuous output current ratings given on the rating label are for maximum 35 °C (95 °F), 1000 m altitude and 2 kHz switching frequency. Derating is required for higher switching frequencies, ambient temperatures > 40 °C (104 °F). For further information, refer to Chapter 5.1 *Drive technical data* on page 57.

Input current

The input current is affected by the supply voltage and impedance. The input current given on the rating label is the typical input current and is stated for a balanced supply.

2.5 Cubicle features

Figure 2-5 Features of the DFS1 cubicle (Frame size 8 to 11)

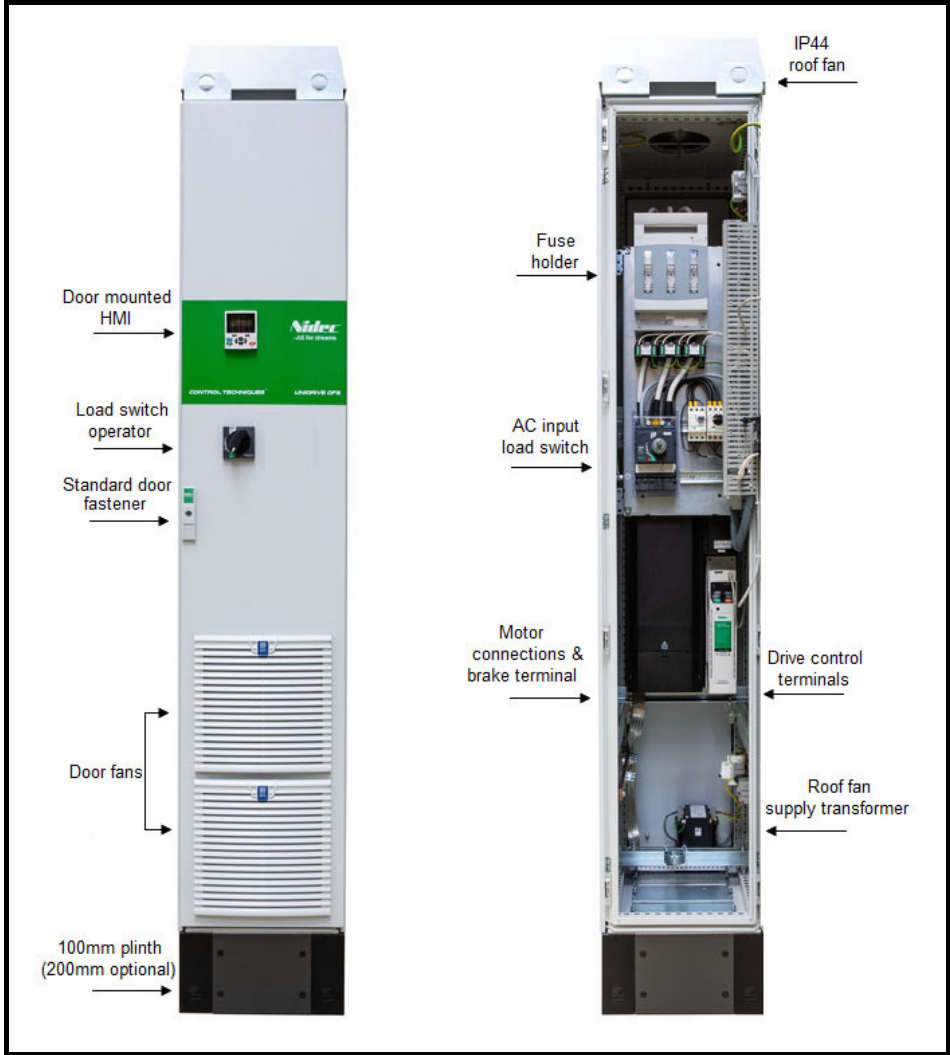


Figure 2-6 Features of the DFS1 cubicle (Frame size 12)

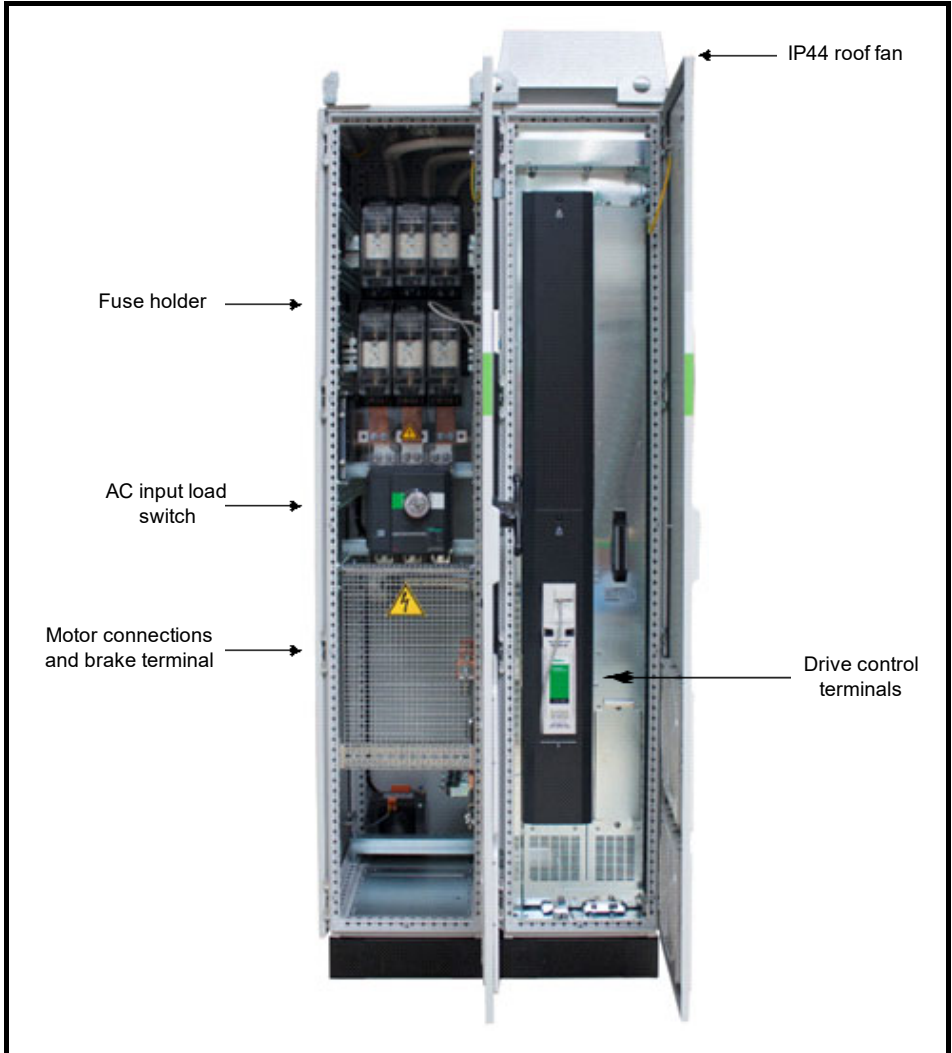


Figure 2-7 Features of the DFS2 cubicle



NOTE

E-plan drawings, which contain parts lists and electrical schematic diagrams for all the DFS frame sizes are available on Support Suite.

3 Mechanical installation

3.1 Safety information

**WARNING**

Follow the instructions

The mechanical and electrical installation instructions must be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the drive and any external option unit, and the way in which they are operated and maintained, comply with the requirements of the Health and Safety at Work Act in the United Kingdom or applicable legislation and regulations and codes of practice in the country in which the equipment is used.

**WARNING**

Stored charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge, or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Nidec Industrial Automation or their authorized distributor.

**WARNING**

Competence of the installer

The drive must be installed by professional assemblers who are familiar with the requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

**WARNING**

Enclosure

The drive is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination. It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

**WARNING**

Hazardous areas

The drive must not be installed in a classified hazardous area unless it is installed in an approved enclosure and the installation is certified.

**CAUTION**

Protection of equipment prior to installation


If the equipment is not to be installed immediately, it must be protected from moisture and dust.

The equipment is delivered wrapped in plastic to protect it from mechanical damage. It is recommended that wrapping is left in place until installation.

3.1.1 Lifting and Handling

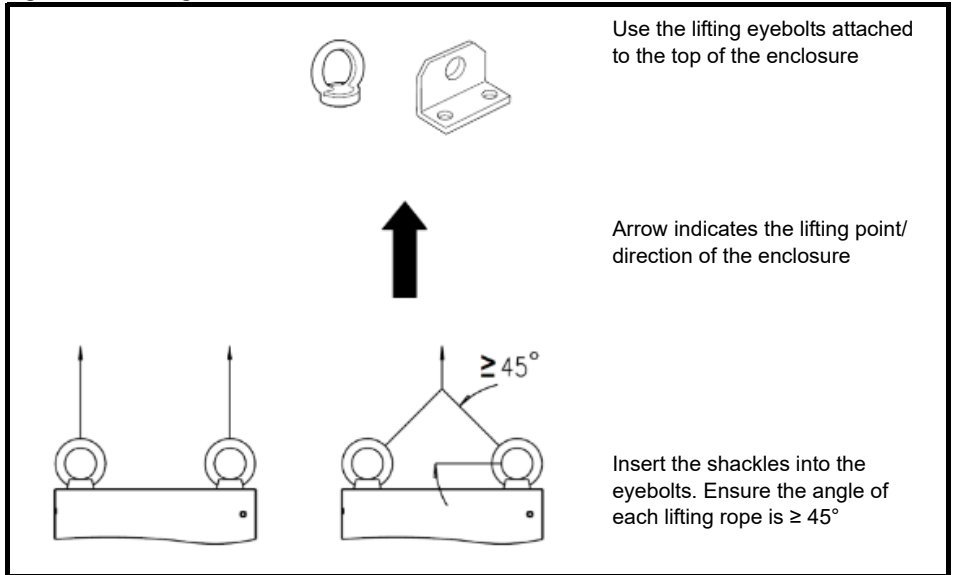
NOTE


The information in this section is also provided on a laminated sheet fixed to the outside of the enclosure. It is intended to be read by the personnel responsible for lifting, handling and transporting the drive.



Lifting and handling
 Always lift the drive by the lifting lugs.
 The drives are not supplied with lifting lugs. These must be fitted to the top of the enclosure by the installer.
 Insert shackles into the eye bolts. Ensure that the angle of each lifting rope is greater than 45°, as shown in Figure 3-1.

Figure 3-1 Lifting the cubicle



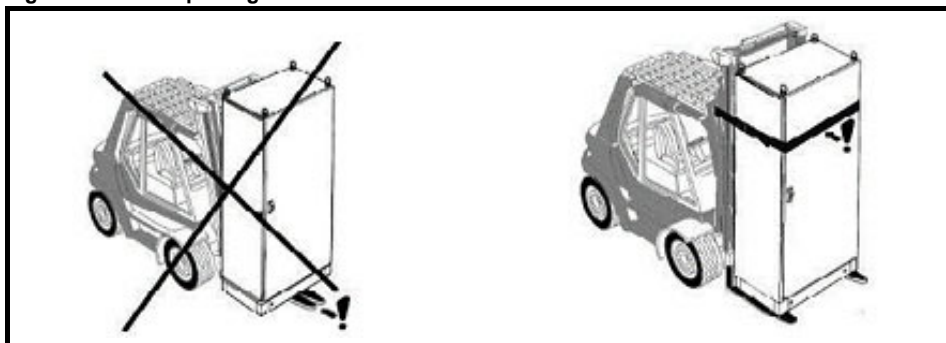


The cubicle is disproportionately heavy at the top and must be properly secured to prevent it from overbalancing and falling during installation.
 When transporting the equipment by fork lift truck, place the cubicle on a rigid pallet and secure it in place.
 Multiple bayed enclosures cannot be transported this way.

The maximum weight of the cubicles are shown in Table 3-1.

Table 3-1 Maximum cubicle weight

Size	Model	kg	lb
DFS1 (Frame size 8 to 11)	All variants	300	661
DFS1 (Frame size 12)	All variants	400	881
DFS2	All Variants	720	1587

Figure 3-2 Transporting the cubicle

3.2 Planning the installation

The following considerations must be made when planning the installation:

3.2.1 Access

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

3.2.2 Environmental protection

The DFS drives are offered with a choice of two Ingress Protection (IP) ratings:

IP23: Protection against fingers or similar objects larger than 12.5 mm. Protection from water falling as a spray at any angle up to 60° from the vertical.

IP54: Protection against ingress of dust is not entirely prevented but must not enter in quantities that may interfere with operation of the equipment. Protection from water splashing against the enclosure from any direction.

The drive enclosure protects the internal components from:

- Moisture, including dripping water or spraying water and condensation. An anti-condensation heater may be required, which must be switched off when the drive is running.
- Contamination with electrically conductive material
- Contamination with any form of dust which may restrict the fan, or impair airflow over various components
- Temperature beyond the specified operating and storage ranges
- Corrosive gasses

NOTE

During installation it is recommended that the vents on the drive are covered to prevent debris (e.g. wire off-cuts) from entering the cubicle.

3.2.3 Cooling

The heat produced by the internal components must be removed without its specified operating temperature being exceeded. Note that a sealed enclosure gives much reduced cooling compared with a ventilated one and may need to be larger and/or use internal air circulating fans.

3.2.4 Fire protection

The enclosure is classified as a Fire Enclosure within the meaning of IEC 62109-1. It surrounds the internal parts and is intended to minimize the spread of fire or flaming materials from within.

3.2.5 Electromagnetic compatibility

Variable speed drives are powerful electronic circuits which can cause electromagnetic interference if not installed correctly with careful attention to the layout of the wiring.

Some simple routine precautions can prevent disturbance to typical industrial control equipment.

If it is necessary to meet strict emission limits, or if it is known that electromagnetically sensitive equipment is located nearby, then full precautions must be observed. In-built into the drive, is an internal EMC filter, which reduces emissions under certain conditions. If these conditions are exceeded, then the use of an external EMC filter may be required at the drive inputs, which must be located very close to the drives. Space must be made available for the filters and allowance made for carefully segregated wiring. For further details relating to EMC, refer to the EMC data sheet, CT part number 0478-0575.

3.2.6 Electrical safety

The installation must be safe under normal and fault conditions. Electrical installation instructions are given in Chapter 4 *Electrical installation on page 33*.



WARNING

Hot surfaces

Care must be taken when opening the cubicle door as some components may be very hot to touch even after the 10 minutes discharge time.



CAUTION

Component IP ratings

The internal cubicle components are rated to IP20. This must be taken into consideration when the doors are opened.

3.3 Control terminal cover removal

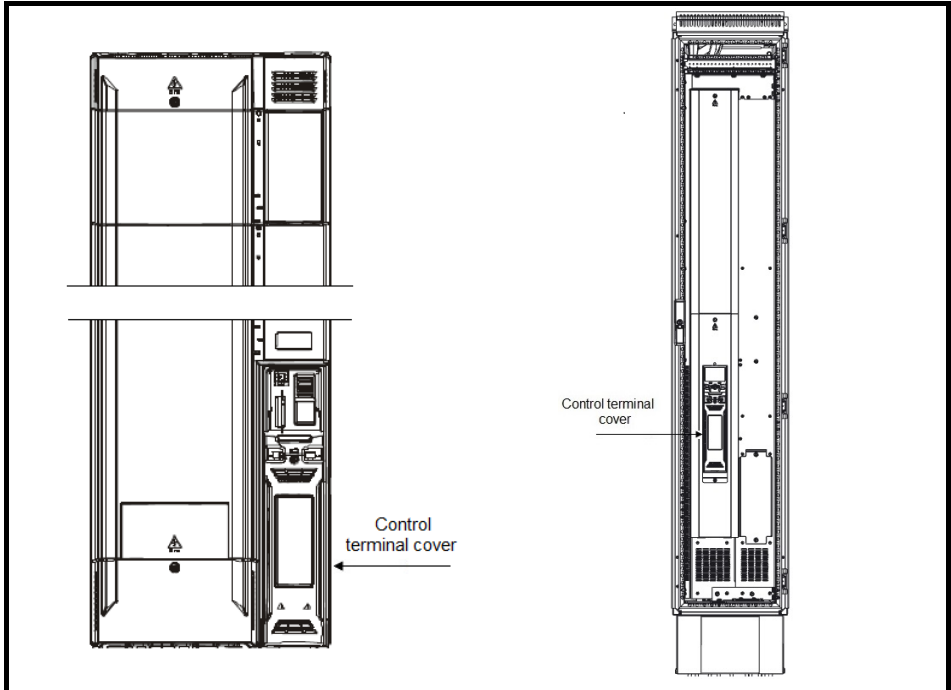
3.3.1 Removing the drive control terminal cover

The Unidrive M drive control terminals are fitted with a terminal cover. The terminal cover must be removed to gain access to the control terminals.

NOTE

Refer to the relevant control user guide for details on the control terminal layout, functionality and option modules.

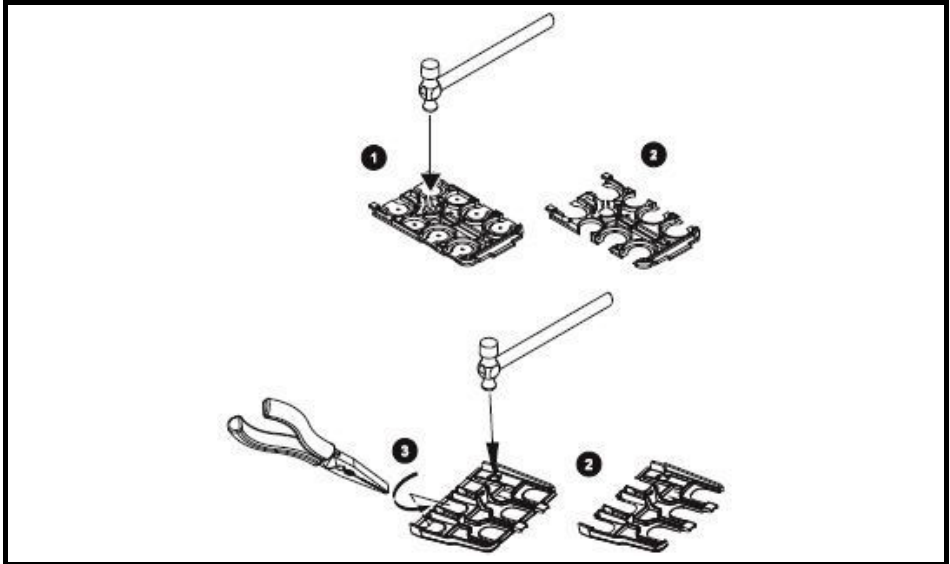
Figure 3-3 Location and identification of terminal cover



3.3.2 Removal of finger-guard breakouts

To remove the finger-guards place the finger-guard on a flat solid surface and knock out the finger guards using a hammer. The breakout can be removed by grasping it with pliers and twisting it off. Once all break-outs have been removed, remove any flash/sharp edges. See Figure 3-4.



Figure 3-4 Removing the finger-guard breakouts



Grommets

Grommets should be installed in the power terminal apertures to help restrict the spread of fire in the event of a major internal failure.

Table 3-2 Grommet kits (Frame size 8 to 11)

Drive module size	Part number	Image
Frame size 8 - kit of 8 single entry grommets	3470-0089	
Frame size 8- kit of 8 double entry grommets	3470-0090	
Frame size 9, 10 and 11 – kit of 8 double entry grommets	3470-0107	

3.4 Cubicle Dimensions

Figure 3-5 Dimensions of the DFS1 cubicle

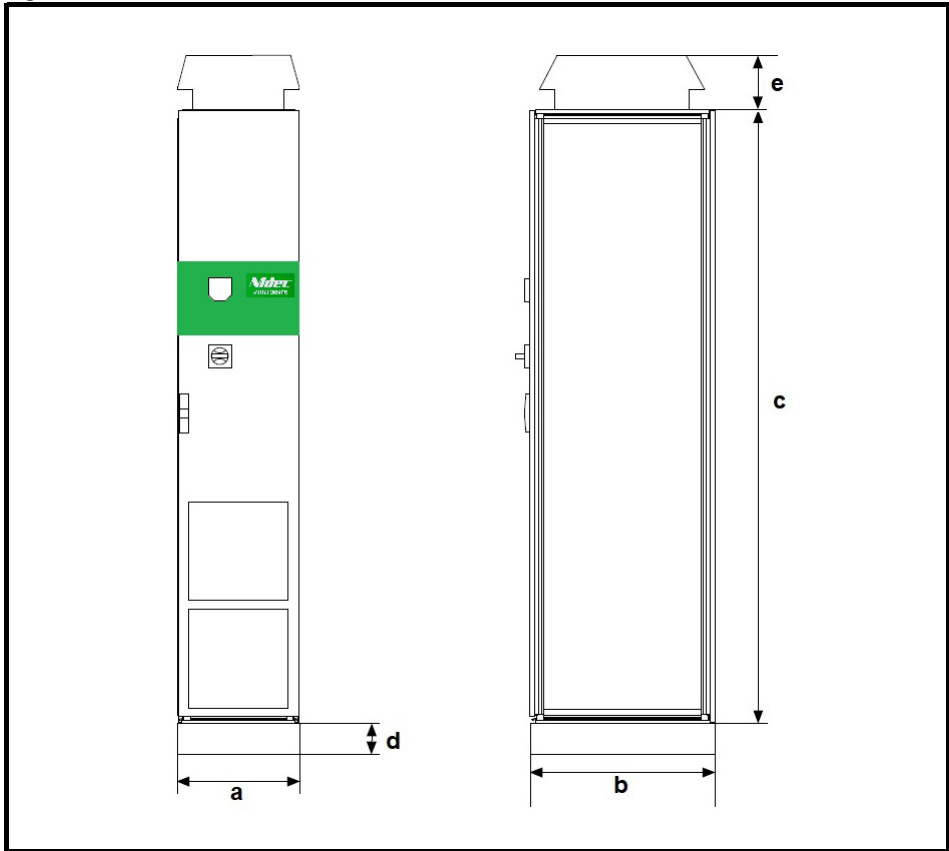


Table 3-3 DFS1 cubicle dimensions

Cubicle type	Width	Depth		Height	Plinth height	Roof fan height	
	a	b		c	d	e	
		IP23	IP54	IP23		IP23	IP54
DFS1	400	600	725	2000	100 or 200	180	65

3.4.1 Cubicle dimensions

Figure 3-6 Dimensions of the DFS2 cubicle

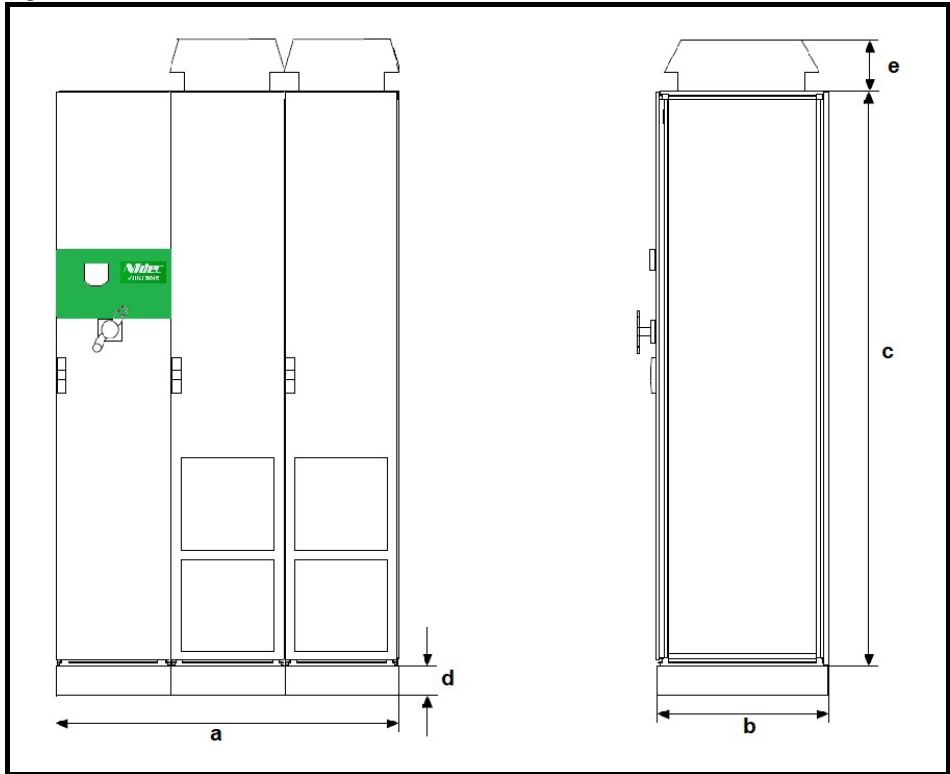


Table 3-4 DFS2 cubicle dimensions

Cubicle type	Width	Depth		Height	Plinth height	Roof fan height	
	a	b		c	d	e	
		IP23	IP54			IP23	IP54
DFS2	1200	600	725	2000	100 or 200	180	65

3.5 Terminal size and torque settings

Table 3-5 Drive power and control terminal data (Frame size 8 to 11)

Terminal	Connection size	Torque setting
AC supply	M10 lug	15 Nm (132.8 lb in)
Drive module Motor output terminals	1 x M10 x 17 AF Nut	15 Nm (132.8 lb in)
Earth (Ground) terminals	1 x M10 x 17 AF Nut	15 Nm (132.8 lb in)
Output sharing choke bus bar connections	1 x 11 mm hole	10 Nm (88.5 lb in)
Mains isolation switch	3 x M10 x 27.5 AF Nut	20 Nm (177 lb in)
Control terminals	Plug-in terminal block	0.2 Nm (1.77 lb in)
Status relay terminals	Plug-in terminal block	0.5 Nm (4.4 lb in)

Table 3-6 Drive power and control terminal data (Frame size 12)

Terminal	Connection size	Torque setting
Control and user relay	Plug-in terminal block	0.5 Nm (4.4 lb in)
Motor output	3 x M10 x 17 AF nut	30 Nm (265.5 lb in)
Brake	2 x M10 x 17 AF nut	30 Nm (265.5 lb in)
Earth (ground)	1 x M8 x 13 AF nut	12 Nm (106.2 lb in)
AC Supply and DC bus	8 x M10 x 17 AF nut	30 Nm (265.5 lb in)

**Stored charge**

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge, or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Nidec Industrial Automation or their authorized distributor.

3.6 Routine maintenance

The cubicle should be installed in a cool, clean, well ventilated location. Contact of moisture and dust with the drive should be prevented.

Regular checks of the following should be carried out to ensure drive / installation reliability are maximized:

Environment	
Ambient temperature	Ensure the enclosure temperature remains at or below maximum specified.
Dust	Check that the drive module heatsinks and cooling fans are not gathering dust. This includes the roof fans and the filters in the door. The lifetime of the fan is reduced in dusty environments.
Moisture	Ensure the cubicle shows no signs of condensation.
Enclosure	
Enclosure door filters	Ensure filters are not blocked and that air is free to flow.
Electrical	
Screw connections	Ensure all screw terminals remain tight.
Crimp terminals	Ensure all crimp terminals remains tight – check for any discoloration which could indicate overheating.
Cables	Check all cables for signs of damage.

3.7 Cooling fan replacement

Refer to the drive module Power Installation guides and Unidrive M Frame 12 Service Guide for details of how to replace the drive module cooling fans in the event of failure.

3.8 Storage

The storage conditions are as follows:

Storage temperature: 5 °C to 55 °C

Maximum humidity: 95 % non-condensing at 35 °C.

Maximum storage time: 2 years.



Storage time

Electrolytic capacitors in any electronic product have a finite storage period after which they require reforming or replacing.

The drive modules have a maximum storage time of 2 years, after which the equipment should be powered up for a minimum of 1 hour to reform the capacitors. The equipment can then be stored for a further 2 years.

4 Electrical installation

**WARNING**

Electric shock risk

The voltages present in the following locations can cause severe electric shock and may be lethal:

AC supply cables and connections

DC and brake cables, and connections

Output cables and connections

Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

**WARNING**

Isolation device

The AC and / or DC power supply must be disconnected from the drive using an approved isolation device before any cover is removed from the drive or before any servicing work is performed.

**WARNING**

STOP function

The STOP function does not remove dangerous voltages from the drive, the motor or any external option units.

**WARNING**

Safe Torque Off function

The Safe Torque Off function does not remove dangerous voltages from the drive, the motor or any external option units.

**WARNING**

Stored charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC and / or DC power supply has been disconnected. If the drive has been energized, the AC and / or DC power supply must be isolated at least ten minutes before work may continue. Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Nidec Industrial Automation or their authorized distributor.

**WARNING**

Permanent magnet motors

Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals. If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

4.1 Power connections

Figure 4-1 DFS1 Power connections (Frame size 8 to 11)

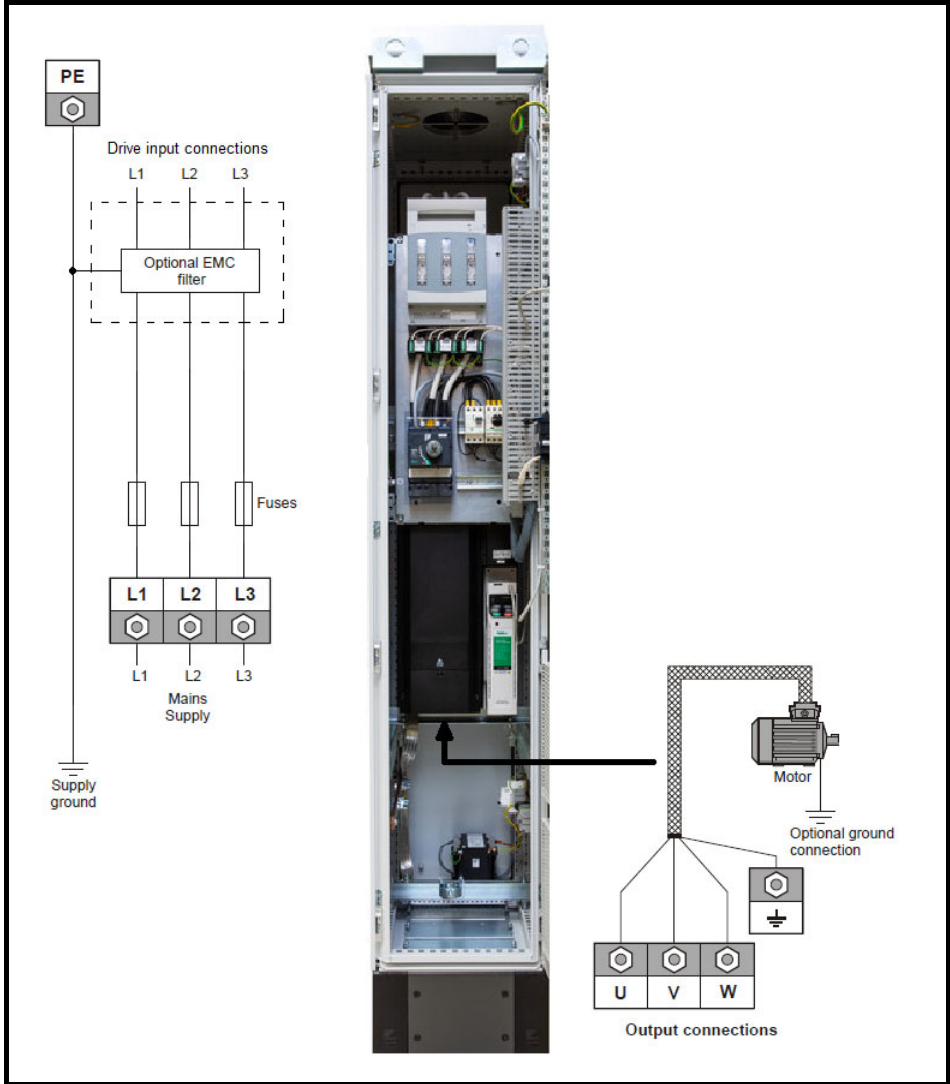


Figure 4-2 DFS1 Power connections (Frame size 12)

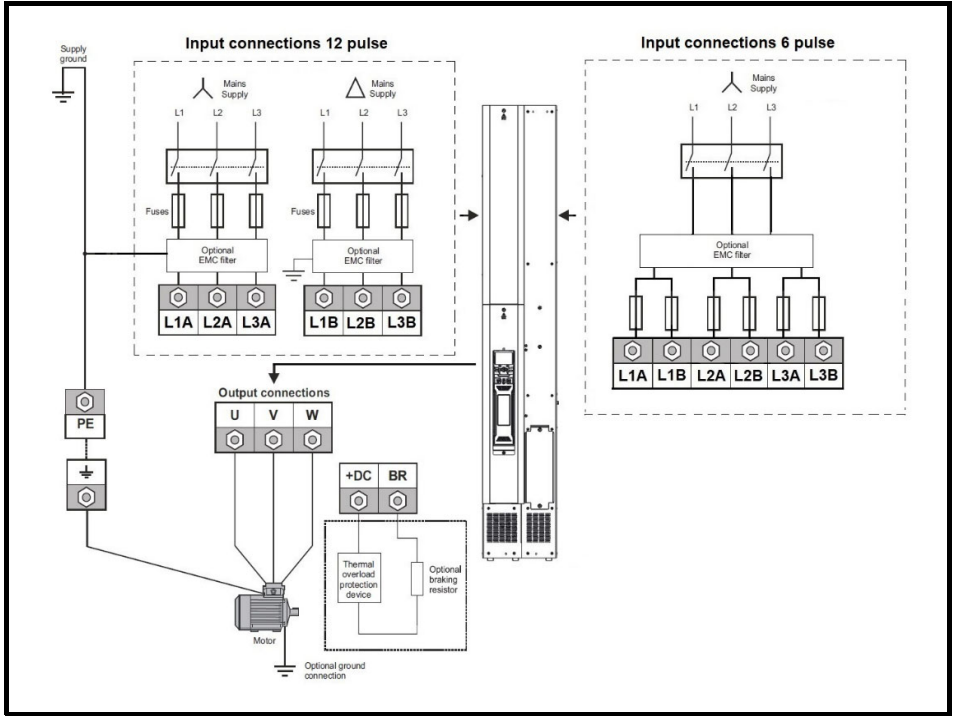
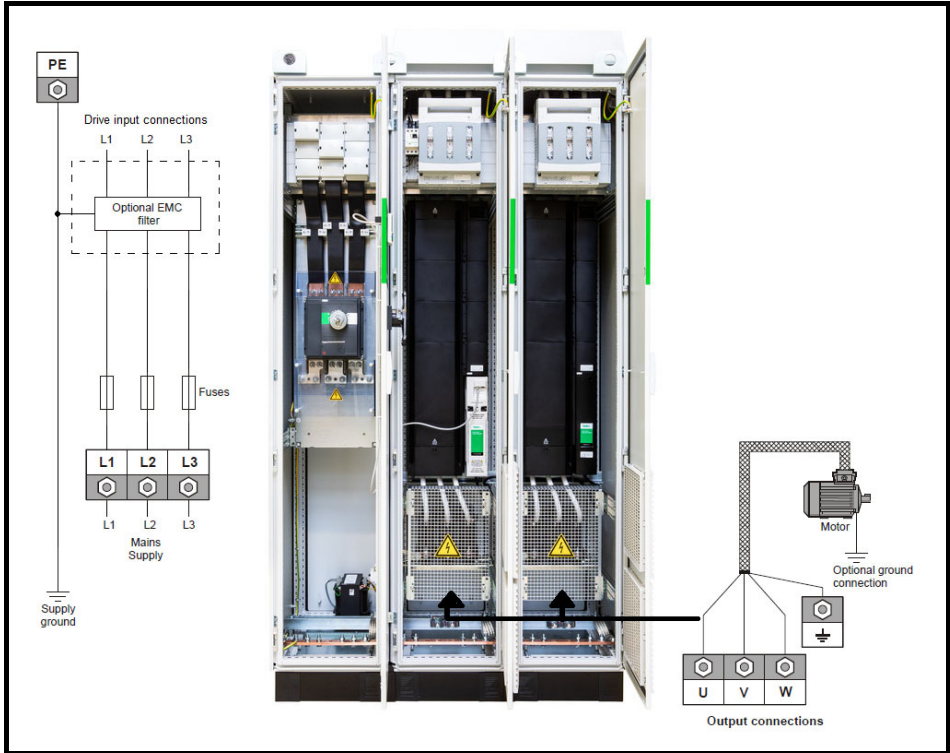


Figure 4-3 DFS2 power connections



4.2 Ground connections



The ground loop impedance must conform to the requirements of local safety regulations. The drive must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply. The ground connections must be inspected and tested at appropriate intervals.

The cubicle must be connected to the system ground of the AC supply. The ground wiring must conform to local regulations and codes of practice.

The supply and motor ground connections are made using the ground busbar shown in Figure 4-4 and Figure 4-6.

Figure 4-4 DFS1 ground connections (Frame size 8 to 11)

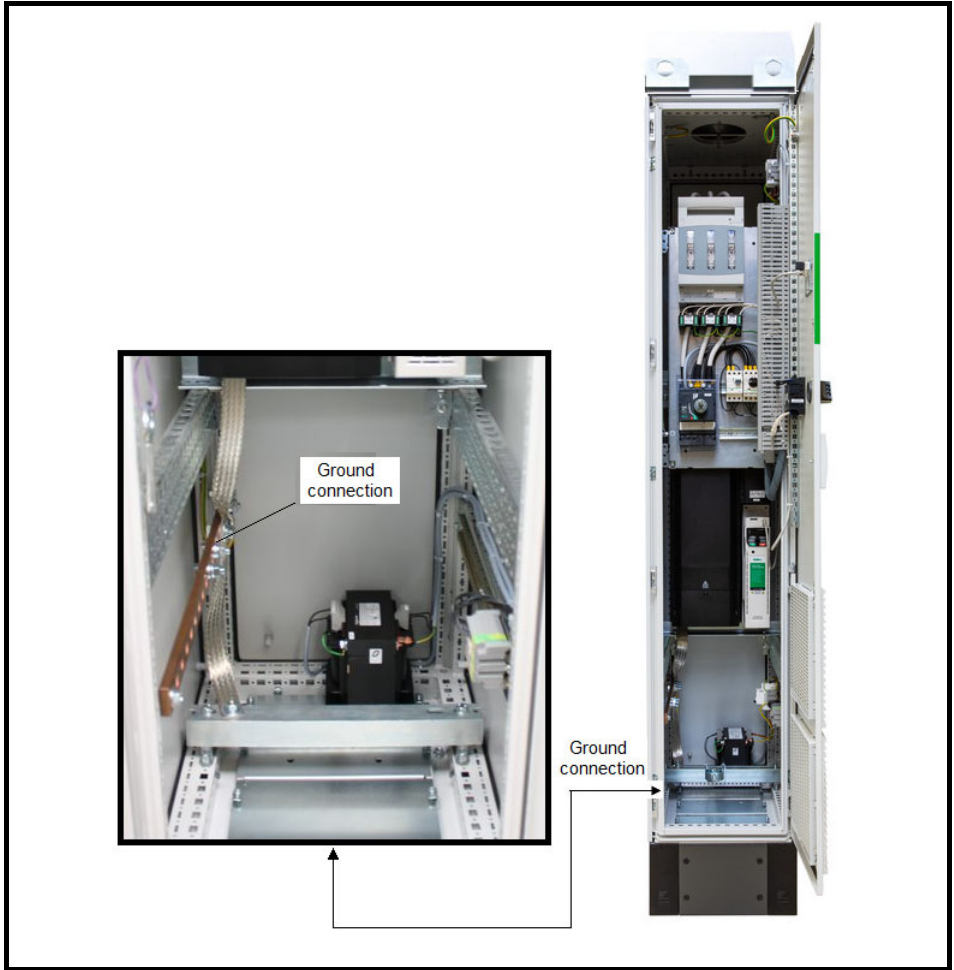


Figure 4-5 DFS1 ground connections (Frame size 12)

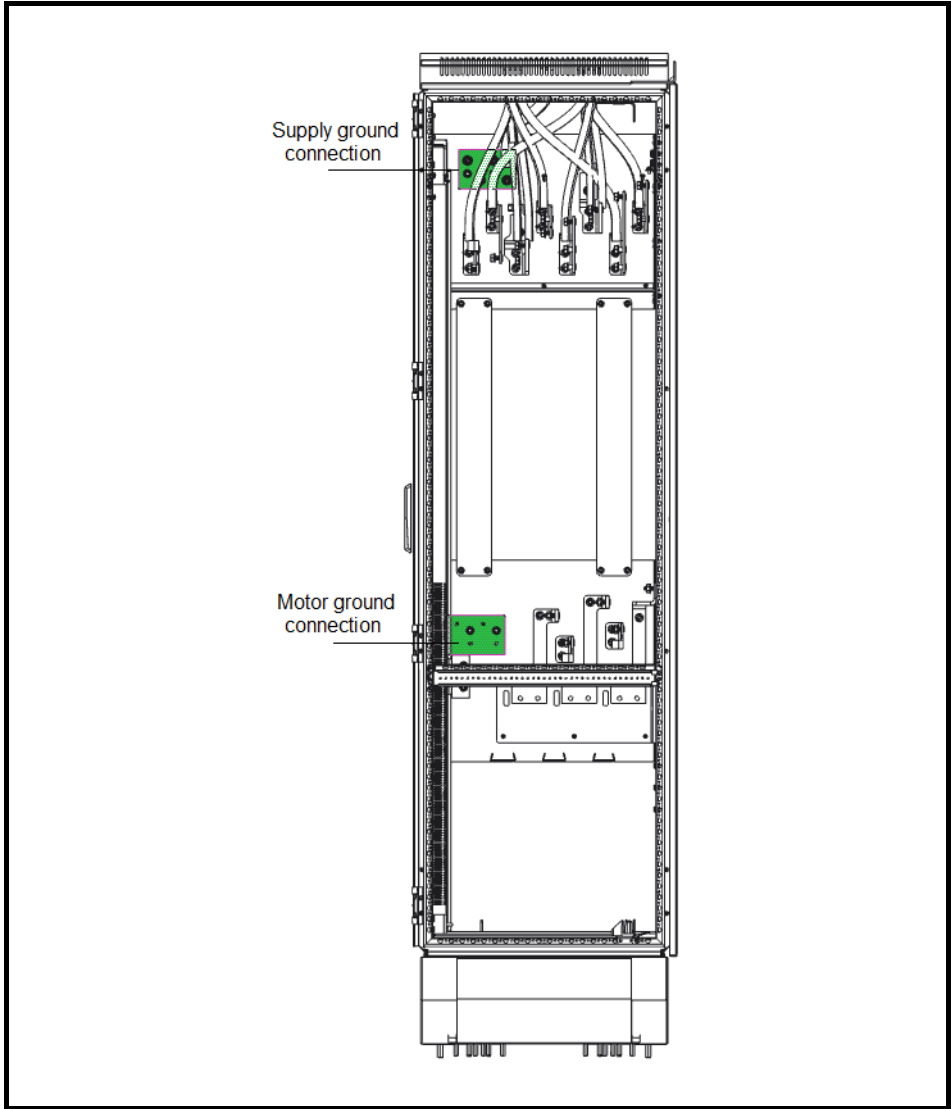


Figure 4-6 DFS2 ground connections



4.3 AC Supply requirements

The DFS drives are suitable for use on any supply type: TN-S, TN-C-S, TT and IT. The AC supply should comply with the limits shown in Table 4-1.

Table 4-1 AC supply specification

Parameter	Rating	
Voltage	380 V to 480 V ± 10 %	500 V to 690 V ± 10 %
No of phases	3	
Supply frequency	45 to 66 Hz	
Supply type	TN-S, TN-C-S, TT, IT	
Overvoltage category	OVC III (according to IEC 60664-1) ¹	
Impulse voltage rating	4 kV for 400 V, 6 kV for 690 V drives	
Maximum supply imbalance	2 % negative phase sequence (equivalent to 3 % voltage imbalance between phases).	

1. For installations where the equipment is installed at the origin of the supply, additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce the overvoltage category from OVC IV to OVC III.



Auxiliary transformer tap setting

Before powering up the drive, it is important to check that the auxiliary transformer tapping has been set correctly. Wrong selection could result in damage to transformer and the roof fans.

4.4 Operation on IT (ungrounded) supplies



Operation on IT (ungrounded) supplies

Unusual hazards can occur on IT (ungrounded supplies).

A ground (earth) fault in the incoming supply has no effect. The drive will continue to run. However, the phase to phase voltage will appear between two of the supply terminals and ground (Earth). On a 690 V supply, this will stress the insulation.

A ground (earth) fault in the motor circuit may not cause the drive to trip. If the motor is required to continue to run with a ground fault in its circuit, then an input isolating transformer must be provided. If an EMC filter is required, it must be located on the primary side of the isolating transformer.

The following measures must be taken:

Additional, independent motor ground fault protection must be provided.

EMC filters must not be used

The internal EMC filter inside the drive module must be disconnected¹.

1. Disconnection of the internal EMC filter on frame size 11E is only possible at the factory. This must be specified when ordering.

4.5 Ground connections



WARNING

Ground connections

The equipment must be grounded (earthed). The wiring must conform to local regulations and codes of practice. This is the responsibility of the installer.

The ground loop impedance must conform to the requirements of local safety regulations. The grounded connection must be capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply.

The cross-sectional area of the Ground (Earth) conductor must be not less than half the cross-sectional area of the input phase conductors.

The ground connections must be inspected and tested at appropriate intervals.



WARNING

Electrochemical corrosion of grounding terminals

Ensure that grounding terminals are protected against corrosion, for example caused by condensation.

4.6 Upstream protection



WARNING

It is necessary to install upstream fuses to protect the supply cables from overload and fire. The recommended fuse types and current ratings are marked on the Upstream Protection label fixed to the outside of the drive enclosure (See Figure 4-7).

Upstream fuse ratings for all DFS drives are shown in Table 4-2. The fuse voltage rating must be suitable for the drive supply voltage.

Figure 4-7 Upstream protection label

UPSTREAM PROTECTION

The AC supply to the DFS must be installed with suitable protection against overload and short-circuits.
Recommended protection ratings for: **DFS2-5-400-M700**

Fuse IEC class gG: 1250A, short-circuit strength 50kA
MCCB breaker: 1250A, short-circuit strength 30kA

To increase the short-circuit strength to 100kA. The following protection must be added in serie with above recommended protection in the AC supply to DFS:

1500A aR IEC class fuse

Nidec Kubus 155, 3364 DG, Sliedrecht (NL)
-All for dreams Postbus 300, 3360 AH, Sliedrecht (NL)
Tel: +31(0)184-420555, Internet: www.nidecindustrialautomation.nl

Table 4-2 Upstream fuse ratings

Model	No. of drive modules fitted	Input current A	Upstream fuse rating A	Fuse type	Short circuit current rating
xxxx-DFS1G4EN	1	155	160	gG	100
xxxx-DFS1H4EN	1	177	200	gG	100
xxxx-DFS1J4EN	1	232	250	gG	100
xxxx-DFS1K4EN	1	267	314	gG	100
xxxx-DFS1L4EN	1	332	400	gG	100
xxxx-DFS1M4EN	1	397	500	gG	100
xxxx-DFS1N4EN	1	449	500	gG	100
xxxx-DFS1P4EN	1	492	630	gG	100
xxxx-DFS1Q4EN	1	539	630	gG	100
xxxx-DFS1R4EN	1	720	400	gS	100
xxxx-DFS1S4EN	1	777	450	gS	100
xxxx-DFS1T4EN	1	845	500	gS	100
xxxx-DFS1U4EN	1	995	800	aR	70
xxxx-DFS2Q4EN	2	1024	1250	gG	40
xxxx-DFS166EN	1	83	100	gG	80
xxxx-DFS176EN	1	104	125	gG	80
xxxx-DFS186EN	1	149	160	gG	80
xxxx-DFS196EN	1	171	200	gG	80
xxxx-DFS1A6EN	1	202	250	gG	80
xxxx-DFS1B6EN	1	225	250	gG	80
xxxx-DFS1C6EN	1	256	315	gG	80
xxxx-DFS1D6EN	1	302	315	gG	80
xxxx-DFS1E6EN	1	329	400	gG	100
xxxx-DFS1F6EN	1	555	450	gS	100
xxxx-DFS1G6EN	1	625	450	gS	100
xxxx-DFS1H6EN	1	703	450	gS	100
xxxx-DFS1J6EN	1	781	450	gS	85
xxxx-DFS2E6EN	2	625	800	gG	100

4.7 Supply cable sizes



Cables sizes must comply with local wiring regulations and are the responsibility of the installer. The cable sizes shown in Table 4-3 and Table 4-4 are for guidance only. The current-carrying capacity of cables is affected by the mounting method and grouping. A larger cable size may be required to avoid excessive temperature or voltage drop.

NOTE

The cable sizes in Table 4-3 and Table 4-4 are calculated using IEC60364-5-52:2009, table B.52.5, for XLPE or EPR insulation. The cables are assumed to be arranged in a single layer on a perforated horizontal or vertical cable tray system.

A maximum operating ambient temperature of 35 °C is assumed at a maximum altitude of 1000 m and 2 kHz switching frequency. Derating is required for higher switching frequencies, ambient temperatures and altitudes.

Table 4-3 Incoming supply cable sizes and connections

Model	Input current A	Cable size (mm ²)	Incomer switch MCCB type (Schneider)	Connection	Connectable cable sizes			
xxxx-DFS1G4EN	155	1 x 50	NSX250	Bar, with 1 x 9 mm hole	1 or 2 cables up to 150 mm ² , with M8 lug			
xxxx-DFS1H4EN	177	1 x 70						
xxxx-DFS1J4EN	232	1 x 95	NSX400	Bar, with 1 x 11 mm hole	1 or 2 cables up to 240 mm ² , with M10 lug			
xxxx-DFS1K4EN	267	1 x 95						
xxxx-DFS1L4EN	332	1 x 150	NSX630	Bar, with 1 x 11 mm hole	1 or 2 cables up to 240 mm ² , with M10 lug			
xxxx-DFS1M4EN	397	1 x 185						
xxxx-DFS1N4EN	449	1 x 240						
xxxx-DFS1P4EN	492	2 x 95						
xxxx-DFS1Q4EN	539	2 x 120						
xxxx-DFS1R4EN	720	4 x 120 (6P) 2 x 120 (12P)						
xxxx-DFS1S4EN	777	4 x 150 (6P)	NS1250	Aluminium connections - terminals	1 to 4 cables 95 to 240 mm ² for AL or Cu conductors			
		2 x 150 (12P)						
xxxx-DFS1T4EN	845	4 x 150 (6P)						
		2 x 150 (12P)						
xxxx-DFS1U4EN	995	4 x 185 (6P)						
		2 x 185 (12P)						
xxxx-DFS2Q4EN	1024	3 x 150						
xxxx-DFS166EN	83	1 x 16				NSX160	Bar, with 1 x 9 mm hole	1 or 2 cable up to 150 mm ² , with M8 lug
xxxx-DFS176EN	104	1 x 25						
xxxx-DFS186EN	149	1 x 50				NSX250	Bar, with 1 x 9 mm hole	1 or 2 cable up to 150 mm ² , with M8 lug
xxxx-DFS196EN	171	1 x 50						
xxxx-DFS1A6EN	202	1 x 70						
xxxx-DFS1B6EN	225	1 x 95						
xxxx-DFS1C6EN	256	1 x 95						
xxxx-DFS1D6EN	302	1 x 120	NSX400	Bar, with 1 x 11 mm hole	1 or 2 cable up to 240 mm ² , with M10 lug			
xxxx-DFS1E6EN	329	1 x 150						
xxxx-DFS1F6EN	555	2 x 150 (6P)	NS1000	Aluminium connections - terminals	1 to 4 cables 95 to 240 mm ² for AL or Cu conductors			
		1 x 150 (12P)						
xxxx-DFS1G6EN	625	3 x 150 (6P)						
		1 x 240 (12P)						
xxxx-DFS1H6EN	703	2 x 185 (6P)						
		2 x 120 (12P)						
xxxx-DFS1J6EN	781	2 x 240 (6P)						
		2 x 150 (12P)						
xxxx-DFS2E6EN	625	2 x 150			NS800	Aluminium connection block required for supply voltage > 500 V	1 to 4 cables up to 240 mm ² , bare cables	

4.8 Motor cable sizes

The nominal output cable sizes assume that the motor maximum current matches that of the drive. Where a motor of reduced rating is used the cable rating may be chosen to match that of the motor. To ensure that the motor and cable are protected against over-load, the drive must be programmed with the correct motor rated current.

The number of cables is always 1 or 2 per installed power module

Table 4-4 Motor output cable sizes and connections

Model	Output current A	Motor cable size (mm ²)	Terminals	Connection	Connectable cable sizes	
xxxx-DFS1G4EN	150	1 x 50	Drive motor terminals	M10 x 17 AF nut	Maximum crimp size 2 x 150 mm ²	
xxxx-DFS1H4EN	184	1 x 70				
xxxx-DFS1J4EN	221	1 x 95				
xxxx-DFS1K4EN	266	1 x 95				
xxxx-DFS1L4EN	320	1 x 150				
xxxx-DFS1M4EN	361	1 x 185				
xxxx-DFS1N4EN	437	1 x 240				
xxxx-DFS1P4EN	487	2 x 95				
xxxx-DFS1Q4EN	507	2 x 95				
xxxx-DFS1R4EN	608	3 x 150				Output wiring kit
xxxx-DFS1S4EN	660	4 x 120				
xxxx-DFS1T4EN	755	3 x 185				
xxxx-DFS1U4EN	865	4 x 185				
xxxx-DFS2Q4EN	1014	3 x 120	Drive motor terminals	M10 x 17 AF nut	Maximum crimp size 2 x 150 mm ²	
xxxx-DFS166EN	86	1 x 16	Drive module motor terminals			
xxxx-DFS176EN	108	1 x 25				
xxxx-DFS186EN	125	1 x 35				
xxxx-DFS196EN	155	1 x 50				
xxxx-DFS1A6EN	172	1 x 50				
xxxx-DFS1B6EN	197	1 x 70				
xxxx-DFS1C6EN	225	1 x 95				
xxxx-DFS1D6EN	275	1 x 120				
xxxx-DFS1E6EN	305	1 x 120				
xxxx-DFS1F6EN	360	1 x 185				Output wiring kit
xxxx-DFS1G6EN	410	1 x 240				
xxxx-DFS1H6EN	460	2 x 120				
xxxx-DFS1J6EN	510	2 x 150				
xxxx-DFS2E6EN	610	2 x 120	Output sharing choke terminals	1 x 11 mm hole	1 or 2 cables, up to 240 mm ² , with M10 lug	

4.9 Motor requirements

No. of phases: 3

Maximum voltage:

400 V drive: 480 V

690 V drive: 690 V

4.10 Output short circuit protection

The drive modules are provided with fast-acting electronic short-circuit protection which limits the fault current to typically no more than five times the rated output current and interrupts the current in approximately 20 μ s. No additional short-circuit protection devices are required. Refer to the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

4.11 Motor overload protection

The drive modules are provided with overload protection for the motor and the motor cable.

For this to be effective, the drive overload protection parameter '*Rated Current (00.046)*' must be set to the rated motor current as marked on the motor rating plate. For details of how to adjust the drive parameters, refer to the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.



Parameter **Pr 00.046 'Motor Rated Current'** must be set correctly to avoid a risk of fire in the event of motor overload.

The maximum percentage overload limit depends on the motor and the operating mode. Typical values are shown in Table 2-4 and Table 2-5.

There is also provision for the use of a motor thermistor to prevent over-heating of the motor, e.g. due to loss of cooling.

Table 4-5 Typical motor overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 165 s	110 % for 9 s	110 % for 165 s	110 % for 9 s
Heavy Duty overload with motor rated current = drive rated current	175 % for 42 s	175 % for 5 s	150 % for 60 s	150 % for 7 s

4.12 Motor cable lengths

Capacitance in the motor cable causes loading on the output of the drive. The loading increases with switching frequency. The maximum recommended motor cable lengths for a range of switching frequencies are shown in Table 4-6.

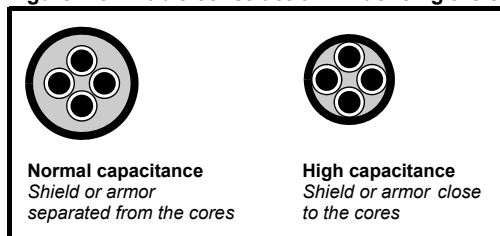
Table 4-6 Maximum motor cable lengths

Model	Maximum permissible motor cable length for each of the following switching frequencies						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
400 V							
xxxx-DFS1G4EN	250 m (820 ft)	187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)	
xxxx-DFS1H4EN							
xxxx-DFS1J4EN							
xxxx-DFS1K4EN							
xxxx-DFS1L4EN							
xxxx-DFS1M4EN							
xxxx-DFS1N4EN							
xxxx-DFS1P4EN							
xxxx-DFS1Q4EN							
xxxx-DFS1R4EN							
xxxx-DFS1S4EN							
xxxx-DFS1T4EN							
xxxx-DFS1U4EN							
xxxx-DFS2Q4EN							
690 V							
xxxx-DFS166EN	250 m (820 ft)	187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)	
xxxx-DFS176EN							
xxxx-DFS186EN							
xxxx-DFS196EN							
xxxx-DFS1A6EN							
xxxx-DFS1B6EN							
xxxx-DFS1C6EN							
xxxx-DFS1D6EN							
xxxx-DFS1E6EN							
xxxx-DFS1F6EN							
xxxx-DFS1G6EN							
xxxx-DFS1H6EN							
xxxx-DFS1J6EN							
xxxx-DFS2E6EN							
xxxx-DFS166EN					125 m (410 ft)	93 m (305 ft)	62 m (203 ft)
xxxx-DFS176EN							
xxxx-DFS186EN							
xxxx-DFS196EN							
xxxx-DFS1A6EN							
xxxx-DFS1B6EN							
xxxx-DFS1C6EN							
xxxx-DFS1D6EN							
xxxx-DFS1E6EN							
xxxx-DFS1F6EN							
xxxx-DFS1G6EN							
xxxx-DFS1H6EN							
xxxx-DFS1J6EN							
xxxx-DFS2E6EN							


4.13 High-capacitance / reduced diameter cables

The recommended motor cable has an insulating jacket between the cores and the armour or shield. These cables have low capacitance between each conductor and all other conductors, including the shield (typically 130 pF/m). Cables that do not have an insulating jacket tend to have high capacitance. If a high-capacitance/ reduced diameter cable is used, then the maximum recommended cable length is half that quoted in Table 4-6. (Figure 4-8 shows how to identify the two types of cable).

Figure 4-8 Cable construction influencing the capacitance



4.14 Output contactor



Output contactor

If the cable between the drive and the motor is to be interrupted by a contactor or circuit breaker, ensure that the drive is disabled before the contactor or circuit breaker is opened or closed. Severe arcing may occur if this circuit is interrupted with the motor running at high current and low speed.

A contactor is sometimes required to be installed between the drive and motor for safety purposes.

The recommended motor contactor is the AC3 type.

Switching of an output contactor should only occur when the output of the drive is disabled.

Opening or closing of the contactor with the drive enabled will lead to:

1. OI ac trips (which cannot be reset for 10 seconds)
2. High levels of radio frequency noise emission
3. Increased contactor wear and tear


The Drive Enable terminal (terminal 31 on *Unidrive M700 / M701* and terminal 29 on *Powerdrive F300 / Pump Drive F600*) when opened provides a Safe Torque Off function. This can in many cases replace output contactors.

For further information see the *Control User Guide*.

4.15 Safe Torque Off

The drives are provided with a Safe Torque Off function. In many cases this can replace output contactors.

For further information see the *Unidrive M700, M701, M702 Control User Guide*. CT Part Number: 0478-0353.



Safe Torque Off does not provide isolation

The Safe Torque Off function does not remove dangerous voltages from the drive and does not isolate the motor output terminals.

4.16 Braking



Braking

The current range of DFS drives are not provided with Braking resistors, cabling or a brake overload protection circuit that disconnects the drive from the supply in the event of an overload or fault.

Contact the supplier of the drive if braking is required.

4.17 Ground leakage



Ground leakage

The ground leakage current is > 3.5 mA AC (10 mA DC).

A permanent fixed ground connection must be provided, or other suitable measures taken to prevent a safety hazard occurring if the connection is lost.

NOTE

Suitable measures include either a fixed ground connection or automatic disconnection of the supply in case of discontinuity of the protective earthing conductor.

4.18 Use of a residual current device (RCD)

There are three common types of ELCB / RCD:

- AC - detects AC fault currents
- A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
- B - detects AC, pulsating DC and smooth DC fault currents

Type AC should not be used with variable speed drives.

Type A can only be used with single phase drives

Type B is the only type suitable for use with three phase, variable speed drives



RCD types

Only type B ELCB / RCD are suitable for use with 3 phase inverter drives.

NOTE

If an external EMC filter is used, a delay of at least 50 ms should be incorporated to prevent spurious tripping. The leakage current is likely to exceed the trip level if all phases are not energized simultaneously.

4.19 Starts per hour

The number of starts per hour under electronic control is unlimited.

The number of starts per hour caused by interrupting the AC supply is limited to 20 per hour equally spaced (A minimum interval of 3 minutes between successive starts).

4.20 Start-up time

The time from the instant that power is applied to the drive being ready to run the motor is a maximum of 5 seconds

4.21 Motor winding voltage

The drive output voltage can adversely affect the inter-turn insulation in the motor. This is because of the high rate of change of voltage, in conjunction with the impedance of the motor cable and the distributed nature of the motor winding.

For normal operation with AC supplies up to 500 Vac and a standard motor with a good quality insulation system, there is no need for any special precautions. In case of doubt, the motor supplier should be consulted.

Special precautions are recommended if drive is operated with a motor cable length > 10 m under either of the following conditions:

690 Vac supply voltage

400 Vac operation with continuous or very frequent sustained braking and motor cable length > 10 m.

Under these conditions, it is recommended that an inverter-rated motor be used. Inverter-rated motors use a reinforced insulation system intended by the manufacturer for repetitive fast-rising pulsed voltage operation.

If it is not practical to use an inverter-rated motor, an output choke (inductor) should be used.

The recommended type is a simple iron-cored component with a reactance of about 2 %. The exact value is not critical. This operates in conjunction with the capacitance of the motor cable to increase the rise-time of the motor terminal voltage and prevent excessive electrical stress.

4.22 Star / Delta motor operation

The voltage rating for Star and Delta connections to the motor should always be checked before attempting to run the motor.

The default setting of the motor rated voltage parameter is the same as the drive rated voltage, i.e. 400 V drive 400 V rated voltage.

A typical 3 phase motor would be connected in Star for 400 V operation and in Delta for 230 V operation. However, variations on this principle are common e.g. 690 V Star and 400 V Delta.

Incorrect connection of the windings will cause severe under or over fluxing of the motor.

Under-fluxing results in very poor output torque. Over-fluxing leads to motor saturation and overheating.

4.23 External 24 V DC Supplies

4.23.1 Control supply

An external 24 Vdc supply can be connected to control terminals to provide the following functions:

- To supplement the internal 24 V supply when multiple option modules are being used and the current drawn by the modules is greater than the drive can supply.
- As a back-up power supply to keep the control circuits powered up when the AC power supply is removed. This allows any fieldbus modules, application modules, encoders or serial communications to continue to operate.
- To set up the drive using the keypad when the AC power supply is not available. However, the drive will be in the Under-voltage state unless either line power supply or low voltage DC operation is enabled, therefore diagnostics may not be possible. (Power down save parameters are not saved when using the 24 V back-up power supply input).

For further information see the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

4.23.2 Backup supply

The power 24 Vdc supply (terminals 51, 52) can be connected to allow the 24 Vdc supply to be used as a backup supply.

If the 24 Vdc backup supply is not connected the message "Waiting For Power System" will be displayed on the keypad and no drive operations are possible.

For further information see the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

4.23.3 Heatsink fan supply

When the drive is operated in low voltage mode, a 24 V supply needs to be provided for the heatsink fan. This should be connected to terminals 61 and 62.

For further information see the Unidrive M700, M701, M702 Control User Guide. CT Part Number: 0478-0353.

4.23.4 Low voltage operation

With the addition of a 24 Vdc power supply to supply the control circuits, the drive can operate from a low voltage DC supply with a range from 24 Vdc up to the maximum DC volts. It is possible for the drive to go from operating on a normal line power supply voltage to operating on a much lower supply voltage without interruption. Going from low voltage operation to normal mains operation requires the inrush current to be controlled. This may be provided externally. If not, the drive supply can be interrupted to utilise the normal soft starting method in the drive.

To fully exploit the low voltage mode of operation, the under-voltage level is user programmable.

For more information on how to use this feature, contact the supplier of the drive.

4.24 Electromagnetic compatibility

4.24.1 General requirements for EMC

Variable speed drives are powerful electronic circuits which can cause electromagnetic interference if not installed correctly with careful attention to the layout of the wiring.

It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation.

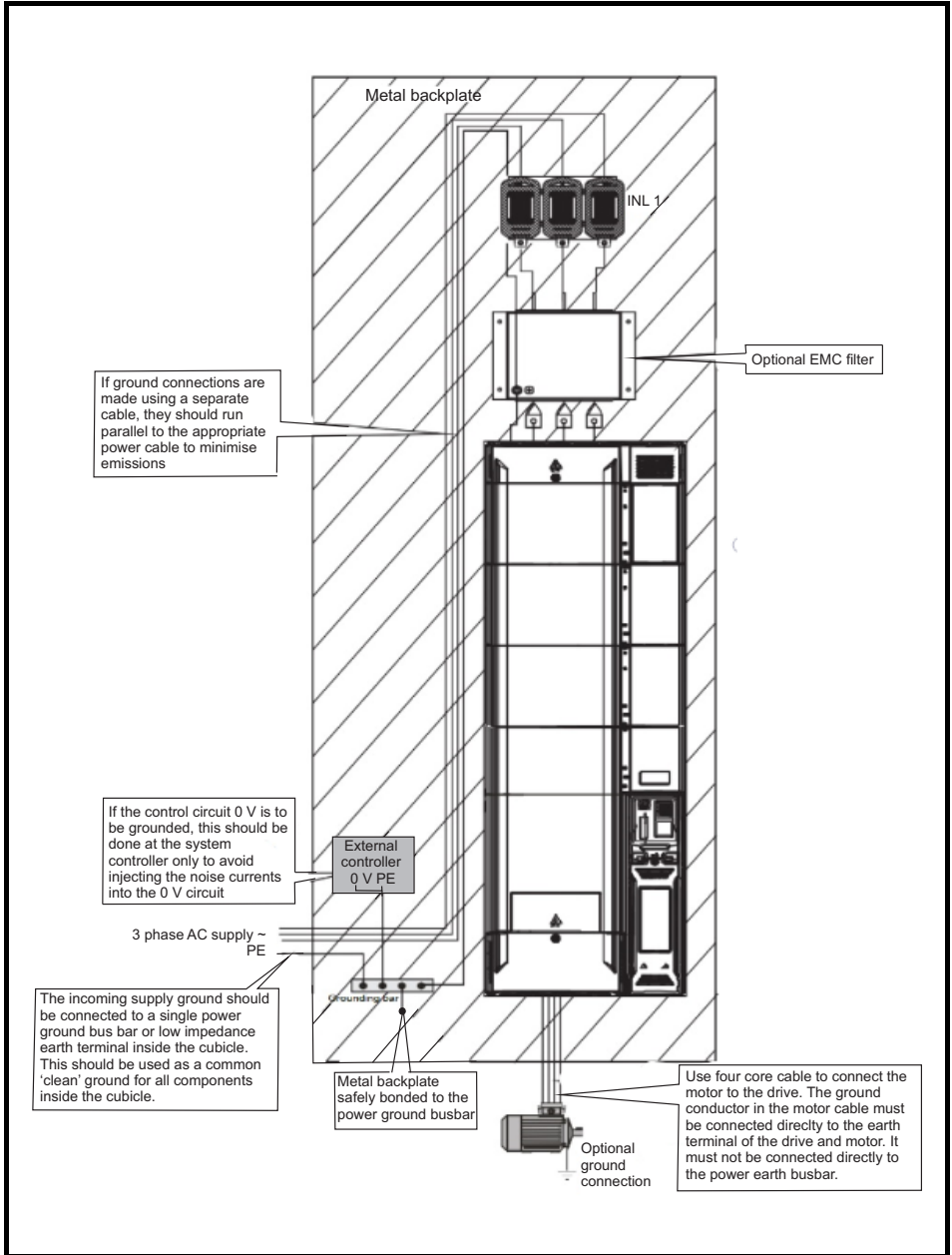


If used on a low-voltage public network which supplies domestic premises, then radio frequency interference is to be expected.

Detailed information on EMC compliance is given in the DFS drive EMC Data Sheet, available from the supplier of the drive, CT part number 0478-0575.

In the DFS drives, the drive module is mounted on a metal backplate which is safety bonded to the power ground busbar in the enclosure. See Figure 4-9.

Figure 4-9 General EMC enclosure layout showing ground connections

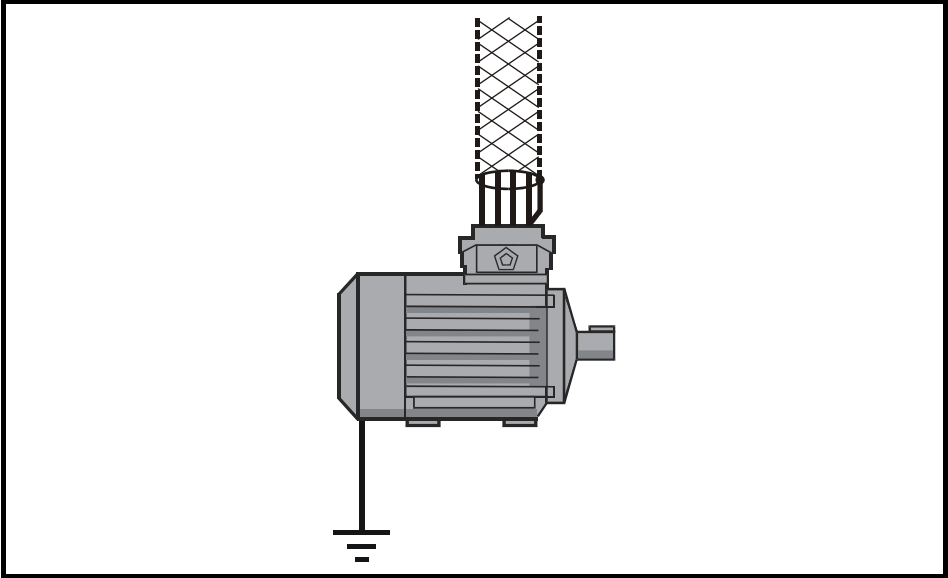


4.24.2 Motor cable

Use four core cable to connect the motor to the drive. Connect the ground core of the motor cable to the ground terminal of the motor. See Figure 4-10.

A shielded cable may also be used. The shield of the motor cable should be connected to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long. A full 360° termination of the shield to the terminal housing of the motor is beneficial.

Figure 4-10 Grounding the motor cable shield



4.24.3 Control cables

If the control circuit 0 V must be connected to Ground, this should be done at the system controller to avoid injecting noise into the 0 V circuit.

NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor, motor brake) will pick up large pulse currents via the cable capacitance. The shield of these signal cables must be connected to ground close to the motor cable, to avoid this noise current spreading through the control system.

4.24.4 Feedback device cable shielding

Shielding considerations are important for PWM drive installations due to the high voltages and currents present in the output (motor) circuit with a very wide frequency spectrum, typically from 0 to 20 MHz.

To ensure correct transfer of data, observe the following:

Resolver connections:

- Use a cable with an overall shield and twisted pairs.
- Connect the cable shield to the drive 0 V connection by the shortest possible link.
- It is preferable not to connect the cable shield to the resolver. However, in cases where there is an exceptional level of common-mode noise voltage present on the resolver body, it may be helpful to connect the shield at this point. The ground connections at both ends should be as short as possible. If possible, the cable shield should be clamped directly to the resolver body and to the drive grounding bracket.
- The cable should not be interrupted. If interruptions are unavoidable, ensure that the ground connections are as short as possible.

Encoder connections:

- Use a cable with the correct impedance.
- Use a cable with an overall shield and twisted pairs.
- Connect the cable shields to 0 V at both the drive and the encoder, using the shortest possible links.
- The cable should preferably not be interrupted. If interruptions are unavoidable, ensure that the ground connections are as short as possible. If possible, use a connection method which uses metallic clamps for the cable shield terminations.

The above recommendations apply where the encoder body is isolated from the motor and the encoder circuit is isolated from the encoder body. Where there is no isolation between the encoder circuits and the motor body, the following additional requirement must be observed to give the best possible noise immunity:

- The shields must be directly clamped to the encoder body and to the drive grounding bracket.

This may be achieved by clamping the individual shields or by providing an additional overall shield which is clamped.

NOTE

The recommendations of the encoder manufacturer must also be followed.

NOTE

In order to guarantee maximum noise immunity, double shielded cable should be used.

In some cases, single shielding of each pair of differential signals cables, or a single overall shield with individual shield on the thermistor connections is enough. In these cases, all the shields should be connected to ground and 0 V at both ends.

If the 0 V is required to be left floating, a cable with individual shields and an overall shield must be used.

Figures 4-11 and 4-12 show the preferred construction of cable and the method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or feedback device, with the ground connections made to a ground plate or similar metallic ground surface.

Figure 4-11 Feedback cable – twisted pair

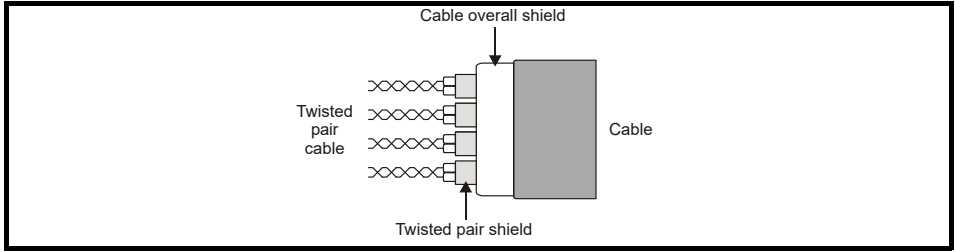
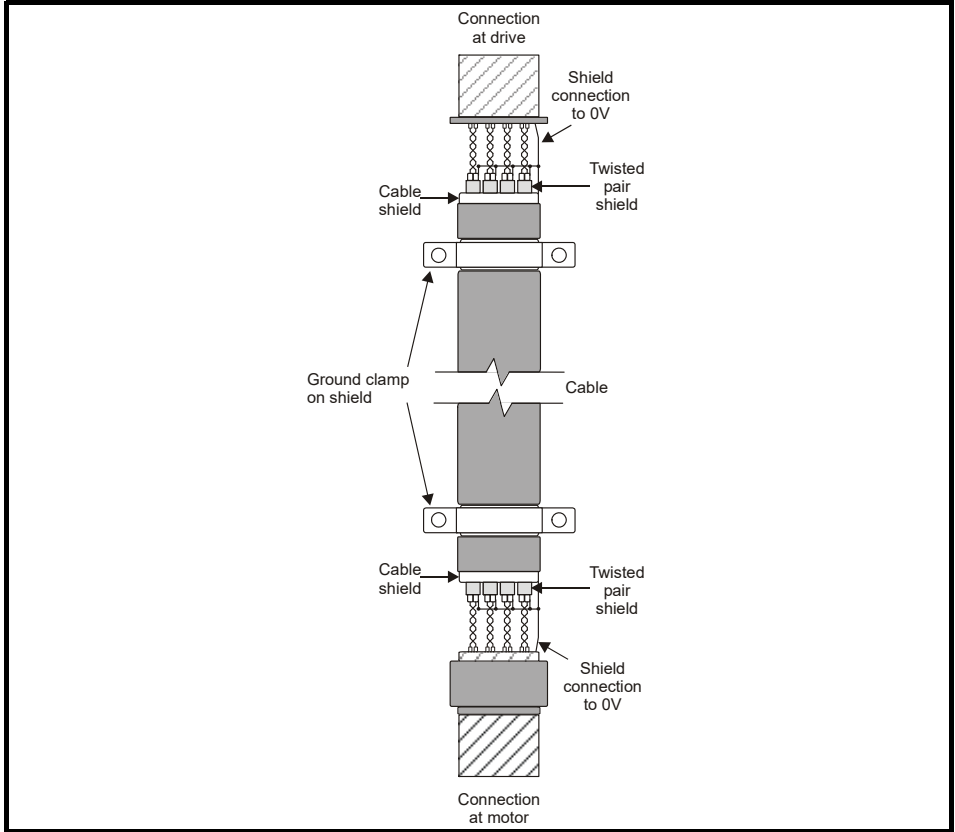


Figure 4-12 Feedback cable connections



4.24.5 Interruptions to the motor cable

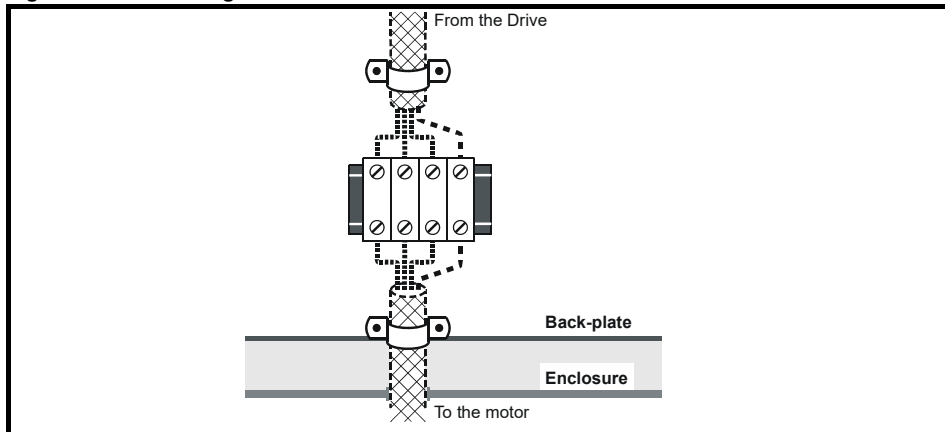
The motor cable should ideally be a single length of shielded or armoured cable having no interruptions. In some installations it may be necessary to interrupt the cable, as in the following examples:

- Connecting the motor cable to a terminal block in the drive enclosure
- Installing a motor isolator/disconnect switch for safety when work is being done on the motor

Terminal block in the enclosure

The motor cable shields should be bonded to a back-plate using uninsulated metal cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3 m (12 in) away from the terminal block.

Figure 4-13 Installing a terminal block in the motor cable



Using a motor isolator/disconnect-switch

The motor cable shields should be connected by a very short conductor having a low inductance.

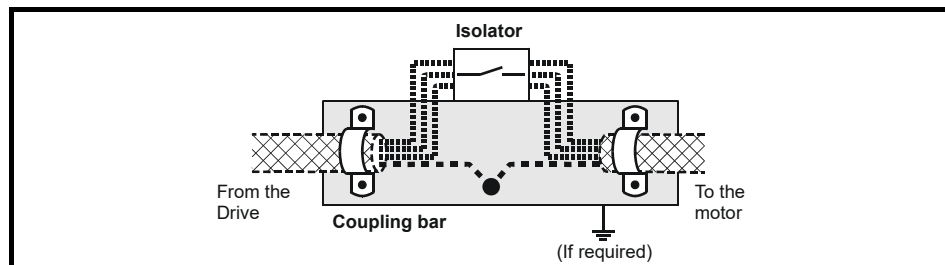
The use of a flat metal coupling-bar is recommended; conventional wire is not suitable.

The shields should be bonded directly to the coupling-bar using uninsulated metal cable-clamps.

Keep the length of the exposed power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3 m (12 in) away.

The coupling-bar may be grounded to a known low-impedance ground nearby, for example a large metallic structure which is connected closely to the drive ground.

Figure 4-14 Connecting the motor cable to an isolator/disconnect switch



4.24.6 Surge immunity of control circuits

The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.

These circuits meet the requirements of EN 61000-6-2:2005 (1 kV surge) provided the 0 V connection is not grounded.

In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. There is an increased risk when circuits extend outside a building.

In general, if the circuits are to pass outside the building where the drive is located, or if cable runs within a building exceed 30 m, some additional precautions are advisable. One of the following techniques should be used:

1. Galvanic isolation, i.e. do not connect the control 0 V terminal to ground. Avoid loops in the control wiring. Ensure that every control wire has its own return (0 V) wire.
2. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10 mm², or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression - for the analogue and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-15 and Figure 4-16.

If a digital port experiences a severe surge its protective trip may operate (O.L 1 trip code 26). For continued operation after such an event, the trip can be reset automatically by setting parameter Pr 10.034 to 5.

Figure 4-15 Surge suppression for digital and unipolar inputs and outputs

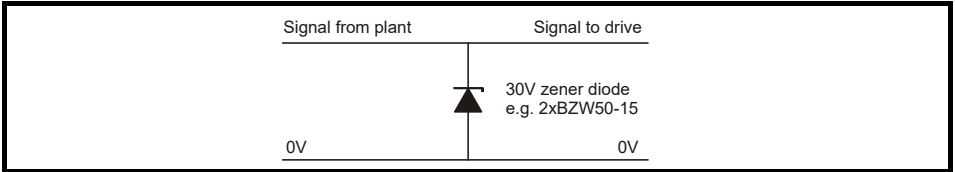
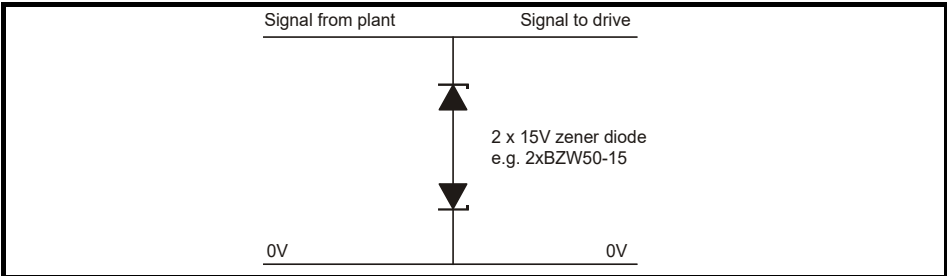


Figure 4-16 Surge suppression for analog and bipolar inputs and outputs



Surge suppression devices are available as rail-mounting modules, e.g. from Phoenix Contact:

Unipolar TT-UKK5-D/24 DC

Bipolar TT-UKK5-D/24 AC

These devices are not suitable for encoder signals or fast digital data networks because the capacitance of the diodes adversely affects the signal. Most encoders have galvanic isolation of the signal circuit from the motor frame, in which case no precautions are required. For data networks, follow the specific recommendations for the network.

5 Technical data

5.1 Drive technical data

5.1.1 Power and current ratings (Derating for switching frequency and temperature)

For a full explanation of 'Normal Duty' and 'Heavy Duty' refer to the *Control User Guide*.

Table 5-1 Maximum permissible continuous output current @ 40 °C (104 °F) ambient, drive temperature at 45 °C (113 °F)

Model	No overload					Normal duty								Heavy duty							
	Nominal Rating					Maximum permissible continuous output current (A) for the following switching frequencies															
	kHz					kHz								kHz							
	2	3	4	6	8	2	3	4	6	8	12	16	2	3	4	6	8	12	16		
400 V																					
xxxx-DFS1G4EN					155	155	155	151	128	96	73	134	134	125	104	88	71	56			
xxxx-DFS1H4EN					184	184	182	158	133	101	73	157	152	138	116	99	77	62			
xxxx-DFS1J4EN					221	221	217	184	152	103	73	200	180	177	150	125	88	62			
xxxx-DFS1K4EN					221	221	217	184	152	103	73	200	180	177	150	125	88	62			
xxxx-DFS1L4EN					320	320	310	272	228	164	118	270	270	265	226	191	139	103			
xxxx-DFS1M4EN					352	341	320	273	228	164	119	314	295	271	226	192	139	104			
xxxx-DFS1N4EN					437	426	395	317	256			377	377	358	285	234					
xxxx-DFS1P4EN					475	438	395	317	256			416	398	359	285	234					
xxxx-DFS1Q4EN					485	438	395	317	256			441	398	358	285	234					
xxxx-DFS1R4EN	635	629	571	464	369	608	608	608	556	447		480	480	480	470	387					
xxxx-DFS1S4EN	689	689	641	509	406	660	660	658	556	447		660	566	560	476	387					
xxxx-DFS1T4EN	788	780	701	552	441	755	739	679	556	447		660	629	574	476	387					
xxxx-DFS1U4EN	903	822	740	578	460	832	746	679	556	447		696	629	574	476	387					
xxxx-DFS2Q4EN						921	831	750	602	486		838	755	679	542	445					
690 V																					
xxxx-DFS166EN						86	86	86	82	69	47	35	63	63	63	62	51	35	27		
xxxx-DFS176EN						106	103	99	84	69	47	35	86	86	84	64	51	36	27		
xxxx-DFS186EN						125	125	125	120	95	67	51	104	104	104	101	84	58	45		
xxxx-DFS196EN						155	155	154	120	95	67	51	131	131	129	101	81	59	45		
xxxx-DFS1A6EN						172	172	161	120	95	67	52	150	150	133	101	82	59	45		
xxxx-DFS1B6EN						197	197	196	144	107	71	52	178	178	175	131	100	66	48		
xxxx-DFS1C6EN						215	215	209					201	205	175						
xxxx-DFS1D6EN						263	253	209					238	211	175						
xxxx-DFS1E6EN						301	253	209					254	211	175						
xxxx-DFS1F6EN	376	376	338	250	211	360	360	314	232	196		315	315	277	201	162					
xxxx-DFS1G6EN	428	428	381	281	235	410	410	351	257	215		360	360	307	225	178					
xxxx-DFS1H6EN	480	480	419	307	259	460	460	387	282	237		410	410	337	248	195					
xxxx-DFS1J6EN	532	532	455	331	277	510	510	470	303	255		460	453	370	268	214					
xxxx-DFS2E6EN						571	481	397				483	400	333							

5.1.2 Power dissipation

Table 5-2 Losses @ 35°C (95°F) ambient, drive temperature at 40 °C (104 °F)

Model	No overload					Normal duty								Heavy duty							
	Drive losses (W) including any current derating for the given conditions																				
	kHz					kHz								kHz							
	2	3	4	6	8	2	3	4	6	8	12	16	2	3	4	6	8	12	16		
400 V																					
xxxx-DFS1G4EN						1482	1652	1817	2154	2121	2142	2164	1224	1374	1509	1521	1510	1525	1540		
xxxx-DFS1H4EN						1798	2004	2191	2333	2279	2302	2325	1373	1541	1670	1674	1673	1690	1707		
xxxx-DFS1J4EN						2431	2710	2989	3075	2992	2842	2833	2132	2136	2370	2492	2475	2501	2538		
xxxx-DFS1K4EN						3015	3191	3143	3063	3000	2856	2828	2424	2532	2511	2489	2474	2498	2537		
xxxx-DFS1L4EN						3210	3582	3954	4148	4034	3939	3843	2604	2923	3242	3401	3391	3438	3469		
xxxx-DFS1M4EN						3703	4121	4226	4154	4038	3947	3874	3166	3376	3393	3398	3419	3442	3485		
xxxx-DFS1N4EN						4182	4576	4708	4444	4246			3553	3905	4200	3960	3907				
xxxx-DFS1P4EN						4734	4843	4708	4444	4246			3968	4325	4200	3960	3907				
xxxx-DFS1Q4EN						4962	4843	4708	4444	4246			4477	4325	4200	3960	3907				
xxxx-DFS1R4EN	6011	6411	6162	5663	5167	5696	6095	5881	5426	4974			4305	4691	4812	4580	4284				
xxxx-DFS1S4EN	6661	7167	7051	6239	5652	6308	6811	6716	5981	5440			5231	5666	5425	5046	4657				
xxxx-DFS1T4EN	7924	8390	7861	6819	6134	7493	7943	7472	6513	5891			6322	6399	6138	5563	5102				
xxxx-DFS1U4EN	9886	9052	9471	7234	6451	9335	8562	8041	6908	6190			7126	6898	6558	5867	5395				
xxxx-DFS2Q4EN						9924	9686	9416	8888	8492			8954	8650	8400	7920	7814				
690 V																					
xxxx-DFS166EN						1579	1861	2180	2814	2945	2974	3004	1132	1345	1585	2136	2284	2307	2330		
xxxx-DFS176EN						2015	2374	2753	2947	2935	2964	2994	1526	1813	2174	2212	2218	2240	2263		
xxxx-DFS186EN						1878	2213	2548	3218	3155	3266	3465	1513	1798	2083	2653	2714	2910	3161		
xxxx-DFS196EN						2384	2797	3211	3232	3155	3267	3474	1931	2281	2631	2677	2711	2917	3174		
xxxx-DFS1A6EN						2420	2882	3270	3083	3052	3192	3472	2042	2441	2604	2571	2648	2876	3128		
xxxx-DFS1B6EN						2614	3132	3649	3667	3495	3633	3993	2305	2774	3242	3265	3237	3442	3839		
xxxx-DFS1C6EN						3225	3893	4497					3034	3670	3814						
xxxx-DFS1D6EN						4023	4640	4497					6470	3865	3814						
xxxx-DFS1E6EN						4576	4684	4540					3869	3865	3814						
xxxx-DFS1F6EN	5348	6524	7002	7265	7966	5125	6275	6757	6166	6104			4511	5551	6083	6297	6808				
xxxx-DFS1G6EN	6088	7405	7821	7890	8546	5829	7102	7519	7617	8275			5125	6275	6646	6807	7257				
xxxx-DFS1H6EN	7345	8493	8733	8654	9360	7032	8143	8384	8353	9057			5999	7272	7418	7492	7876				
xxxx-DFS1J6EN	8173	9419	9441	9215	9858	7820	9024	9066	8887	9525			6733	8130	8063	7994	8417				
xxxx-DFS2E6EN						9152	9368	9080					7738	7730	7628						

NOTE

M70x data based on Heavy Duty ratings. F300/F600 data based on Normal Duty ratings.

5.1.3 Temperature, humidity and cooling method

Ambient temperature operating range:

5 °C to 35 °C, 40 °C with derate (41 °F to 95 °F).

Output current derating must be applied at ambient temperatures > 40 °C (104 °F).

Cooling method: Forced convection

Maximum humidity: 95 % non-condensing at 40 °C (104 °F)

The cubicle is intended to be installed internally and not outside)

5.1.4 Supply requirements

AC supply voltage:

400 V drive: 380 V to 480 V ± 10 %

690 V drive: 500 V to 690 V ± 10 %

Number of phases: 3

Maximum supply imbalance: 2 % negative phase sequence (equivalent to 3 % voltage imbalance between phases).

Frequency range: 45 to 66 Hz

5.1.5 Motor requirements

No. of phases: 3

Maximum voltage:

400 V drive: 480 V

690 V drive: 690 V

5.1.6 Storage

-40 °C (-40 °F) to +55 °C (131 °F) for long term storage, or to +70 °C (158 °F) for short term storage.

Storage time is 2 years.

Electrolytic capacitors in any electronic product have a storage period after which they require reforming or replacing.

The DC bus capacitors have a storage period of 10 years.

The low voltage capacitors on the control supplies typically have a storage period of 2 years and are thus the limiting factor.

Low voltage capacitors cannot be reformed due to their location in the circuit and thus may require replacing if the drive is stored for a period of 2 years or greater without power being applied.

It is therefore recommended that drives are powered up for a minimum of 1 hour after every 2 years of storage. This process allows the drive to be stored for a further 2 years.

5.1.7 Altitude

Altitude range: 0 to 1,000 m (3,281 ft).

5.1.8 IP / Rating

The cubicle has three IP ratings, IP23, IP54 and IP55.

The IP rating of a product is a measure of protection against ingress and contact to foreign bodies and water. It is stated as IP XX, where the two digits (XX) indicate the degree of protection provided as shown in Table 5-3.

Table 5-3 IP Rating degrees of protection

First digit		Second digit	
Protection against foreign bodies and access to hazardous parts		Protection against ingress of water	
0	Non-protected	0	Non-protected
1	Protected against solid foreign objects of 50 mm \varnothing and greater (back of a hand)	1	Protected against vertically falling water drops
2	Protected against solid foreign objects of 12.5 mm \varnothing and greater (finger)	2	Protected against vertically falling water drops when enclosure tilted up to 15°
3	Protected against solid foreign objects of 2.5 mm \varnothing and greater (tool)	3	Protected against spraying water
4	Protected against solid foreign objects of 1.0 mm \varnothing and greater (wire)	4	Protected against splashing water
5	Dust-protected (wire)	5	Protected against water jets
6	Dust-tight (wire)	6	Protected against powerful water jets
7	-	7	Protected against the effects of temporary immersion in water
8	-	8	Protected against the effects of continuous immersion in water

5.1.9 Corrosive gasses

Concentrations of corrosive gases must not exceed the levels given in:

- Table A2 of EN 50178:1998
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighborhood of industrial sources with chemical emissions.

5.1.10 Start up time

This is the time taken from the moment of applying power to the drive, to the drive being ready to run the motor:

5 seconds

5.1.11 Output frequency / speed range

Unidrive Mxxx models:

In open loop mode, the maximum output frequency is limited to 599 Hz. In RFC-A and RFC-S it is limited to 550 Hz.

In RFC-S mode the speed is also limited by the voltage constant (K_e) of the motor unless field weakening operation is enabled. K_e is a specific constant for the servo motor being used. It can normally be found on the motor data sheet in V/k rpm (volts per 1,000 rpm).

It is recommended that a minimum ratio of 12:1 is maintained between the switching frequency and the maximum output frequency to maintain the quality of the output waveform. If this minimum ratio is exceeded, extra motor losses will result due to the increased harmonic content of the output waveform.

5.1.12 Accuracy and resolution

Speed:

The absolute frequency and speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100 ppm, and so the absolute frequency/speed accuracy is 100 ppm (0.01 %) of the reference, when a preset speed is used. If an analog input is used the absolute accuracy is further limited by the absolute accuracy of the analog input.

The following data applies to the drive only; it does not include the performance of the source of the control signals.

Open loop resolution:

Preset frequency reference: 0.1 Hz

Precision frequency reference: 0.001 Hz

Closed loop resolution:

Preset speed reference: 0.1 rpm

Precision speed reference: 0.001 rpm

Analog input 1: 11 bit plus sign

Analog input 2: 11 bit plus sign

Current:

The resolution of the current feedback is 10 bit plus sign.

Accuracy: typical 2 %

worst case 5 %

5.1.13 Acoustic noise

The acoustic noise levels are as follows:

Minimum speed: 65 dBA

Maximum speed: 86 dBA.

Most of the noise is generated by the roof fan.

5.1.14 Weights

Table 5-4 Overall drive weights

Size	Model	kg	lb
DFS1 (Frame size 8 to 11)	All variants	300	661
DFS1 (Frame size 12)	All variants	400	882
DFS2	All variants	720	1587

5.1.15 Input current, fuse and cable size ratings

The input current is affected by the supply voltage and impedance.

Typical input current

The values of typical input current are given to aid calculations for power flow and power loss. The values of typical input current are stated for a balanced supply.

Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worst case condition with the unusual combination of stiff supply with bad balance. The value stated for the maximum continuous input current would only be seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the maximum supply fault current given in Table 5-5.



Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 5-5 shows the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 5-5 AC Input current and fuse ratings (400 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating		
				IEC		
	A	A	A	Nominal A	Maximum A	Class
xxxx-DFS1G4EN	137	155	267	250	250	gS
xxxx-DFS1H4EN	164	177	303			
xxxx-DFS1J4EN	211	232	306	315	315	
xxxx-DFS1K4EN	245	267	359			
xxxx-DFS1L4EN	306	332	445	400	400	
xxxx-DFS1M4EN	370	397	523	450	450	
xxxx-DFS1N4EN	424	449	579	500	500	
xxxx-DFS1P4EN	455	492	613			
xxxx-DFS1Q4EN	502	539	752	550	550	
xxxx-DFS1R4EN	476	720	748	550	550	
xxxx-DFS1S4EN	537	777	943			
xxxx-DFS1T4EN	605	845	1063			
xxxx-DFS1U4EN	756	995	1197			
xxxx-DFS2Q4EN	954	1024	1429	550	550	gS

Table 5-6 AC Input current and fuse ratings (690 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating			
				IEC			
	A	A	A	Nominal A	Maximum A	Class	
xxxx-DFS166EN	74	83	121	160	160	gS	
xxxx-DFS176EN	92	104	165	160	160		
xxxx-DFS186EN	124	149	194	200	200	aR	
xxxx-DFS196EN	145	171	226	200	200	gS	
xxxx-DFS1A6EN	180	202	268	250	250		
xxxx-DFS1B6EN	202	225	313	350	350	aR	
xxxx-DFS1C6EN	225	256	379	500	500		
xxxx-DFS1D6EN	271	302	425				
xxxx-DFS1E6EN	298	329	465				
xxxx-DFS1F6EN	311	440	486	400	400		
xxxx-DFS1G6EN	351	496	616				
xxxx-DFS1H6EN	394	558	694				
xxxx-DFS1J6EN	438	620	781				
xxxx-DFS2E6EN	566	625	884	500	500		aR

5.1.16 Electromagnetic compatibility (EMC)

This is a summary of the EMC performance of the drive. For full details, refer to the EMC Data Sheet which can be obtained from the supplier of the drive, CT part number 0478-0575.

Table 5-7 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC61000-4-2 EN61000-4-2:2009	Electrostatic discharge	6 kV contact discharge 8 kV air discharge	Module enclosure	Level 3 (industrial)
IEC61000-4-3 EN61000-4-3:2006+A2:2010	Radio frequency radiated field	10 V/m prior to modulation 80 - 1000 MHz 80 % AM (1 kHz) modulation	Module enclosure	Level 3 (industrial)
IEC61000-4-4 EN61000-4-4:2010	Fast transient burst	5/50 ns 2 kV transient at 5 kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50 ns 2 kV transient at 5 kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC61000-4-5 EN61000-4-5:2014	Surges	Common mode 4 kV 1.2/50 μ s waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2 kV 1.2/50 μ s waveshape	AC supply lines: line to line	Level 3
		Lines to ground	Signal ports to ground ¹	Level 2
IEC61000-4-6 EN61000-4-6:2014	Conducted radio frequency	10 V prior to modulation 0.15 - 80 MHz 80 % AM (1 kHz) modulation	Control and power lines	Level 3 (industrial)
IEC61000-4-11 EN61000-4-11:2004	Voltage dips and interruptions	-30 % 10 ms +60 % 100 ms -60 % 1 s <-95 % 5 s	AC power ports	
IEC61000-6-1 EN61000-6-1:2007	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
IEC61000-6-2 EN61000-6-2:2005	Generic immunity standard for the industrial environment			Complies
IEC61800-3 EN61800-3:2004+A1:2012	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

1. See section section 4.24.6 *Surge immunity of control circuits* on page 55 for control ports for possible requirements regarding grounding and external surge protection.

Emission

The drive contains an in-built filter for basic emission control. An additional optional external filter provides further reduction of emission. The requirements of the following standards are met, depending on the motor cable length and switching frequency.



0478-0573-05