MANUAL

DV GEN II

670199 02/26 (JVN)

A DRIVES PROGRAM DEDICATED TO VENTILATION SOLUTIONS

Content

Please note
that the language used in the original documentation is English. Other language versions are a translation of the original documentation. The manufacturer cannot be held liable for any errors in the documentation. The manufacturer reserves the right to make alterations without prior notice. Content may vary due to alternative software and/or configurations.

1. Symbols/definitions

Warning

- This symbol is used where there is a risk of severe or fatal injury.

Caution

- This symbol is used where potentially dangerous situations may result in minor or moderate injury. The symbol is also used to warn against unsafe and hazardous conditions.

Note

- This symbol is used to indicate important information in situations that may result in serious damage to equipment and property.

1.1 Warnings regarding electrical installations

Warning

Safety and protections for doing electrical installation

- The DV must only be installed and commissioned by trained/qualified personnel.
- Check that the data specified on the motor's rating plate matches the data specified on the DV rating plate.
- Incorrect electrical installation may lead to a risk of severe or fatal injury.

Warning

Dangerous induced voltage (windmilling)

- If drafts are allowed into the duct system, it can cause the fan to rotate without an operating/start signal. This is called windmilling. If windmilling occurs, there is a risk of inducing voltage on the DV motor terminals, which makes them dangerous to touch.

Note

Short-circuit protection: mains supply

- Short-circuit protection of the DV's mains supply is not provided with the product.
- Short-circuit protection on the DV's power supply input side must always be provided in accordance with local and international regulations.
- Short-circuit protection equipment must at a minimum have a tripping curve “C” that conforms with IEC 60898-1.
- Short-circuit protection is supplied by the installer.

Warning

Personal protection - use of RCDs (TT system), risk of electrocution.

- In the event of failure or wrongful installation, this product can result in a current running through the ground protection conductor .
- The 3 mains phases suppling to the DV must be switched on at the same time in order to avoid generating a current in the earth/ground conductor.

Warning

Please take the following precautions:

- If a residual current device (RCD) is used for extra personal protection, then only use a Type B RCD on this product's mains supply side.
- Type B RCDs must comply with all provisions of IEC 61008/9.
- Protective earthing of the DV in combination with the use of RCDs must always be performed in accordance with the relevant local and international requirements, laws and regulations.
- Failure to follow these precautions can lead to severe or fatal injuries to persons and animals.

Warning

Current hazard due to ground hazard (PE) leakage

- Follow national and local regulations regarding the protective earthing of equipment with a leakage current exceeding 3.5 mA.
- The DV technology causes switching at a high frequency. This will generate a leakage current in the earth/ground/PE connection.
- This ground leakage current is dependent upon the different configurations, including RFI filtering, shielded motor cables, and the motor type.
- Due to the possibility of there being a leakage current exceeding 3.5mA in the DV, the Power Drive System Product Standard EN/IEC61800-5-1 requires special attention .
  For further information, see EN60364-5-54 paragraph 543.7
  (*reinforced protective conductors for protective conductor currents exceeding 10 mA*).
- The earth/ground connection must be made in one of the following 3 ways:
  - Using one PE conductor: When connecting 1 PE conductor, the minimum cross-section should be at least 10 mm^2/ AWG 7
  - Using two separate conductors: When connecting 2 separate ground conductors, both should comply with the dimensioning rules, and they must be connected to individual earth/ground connectors in the DV.
  - Using an external ground connection: If the machine housing is approved as a ground connector, then the DV can be grounded to the machine.
- Ground connectors and connections must always be set up / made in accordance with applicable local and international standards and directives, as well as national electrical regulations for the DV's earth/ground . Always insure that the DV has the proper ground connection.
- Due to the possibility of leakage current, always establish protective ground for the DV.
- A dedicated ground conductor is required for input power, motor power and control wiring.
- Always use the clamps and connectors on the DV for ground connections.
- Do not loop the ground connection between 2 or more DVs.
- Keep the ground conductor connections as short as possible.
- In order to reduce EMC/EMI levels, always use shielded cables between the DV and motor .
- Follow the motor manufacturer's wiring requirements.

Warning

Potential equalization

- There is a risk of electrical interference if the ground potential between the DV, air handling unit, duct or construct differ from each other.
- An equalization conductor must always be fitted to prevent potential differences between system components.
- Recommended cable cross section: 10 mm^2/ AWG 7
- Lugs should be used, and the equalization conductor should be attached to the DV enclosure via one of the screws used to mechanically install the unit.

Caution

EMC/EMI-compliant installation

- Always use shielded cables as motor cables.
- Cable shields must always be electrically connected to the earthed product enclosure.
- Shielded cable is not necessary for I/O signal cables and RS-485 interface cables.
- Use the internal, factory-fitted cable clamps to ensure proper shield connection.
- Never send mains voltage, motor connections and control signals via the same cable.
- The +24 VDC from the DV is not intended to be used as power supply for third party products. If the +24 is used to supply power to third party products, the product might not fulfill the EMC/EMI regulations.

2. Safety information

2.1 Ensuring safety before installation

- The DV must only be installed by qualified personnel or people who have received the appropriate training for becoming qualified.
- Qualified personnel are knowledgeable about the installation practices and can perform installation in accordance with relevant local and international requirements, laws and regulations.
- Qualified personnel are familiar with the instructions and safety precautions described in this manual.
- The DV is charged with high voltage when connected to mains, and therefore mains voltage must always be disconnected before any installation, service or maintenance tasks are performed on the product.
- When the DV is connected to the mains, there is a risk that the motor could start unintentionally, which could potentially lead to dangerous situations and personal injuries.
- An unintentional start during programming, service or maintenance may result in serious injury or damage to equipment and property.
- The motor/fan can be started via an external input signal, RS-485 interface, or a connected control panel.
- Before connecting mains voltage, all the DV, motor and fan components must be properly fitted.
- Before supplying mains voltage to the DV, all covers and cable glands must be properly fitted and closed. Unused cable glands must be replaced with blind glands.
- The DV contains capacitors that are charged during operation. These capacitors can remain charged even after the power supply has been cut off. There is a risk of severe personal injury if the connection terminals or wire ends are touched before these capacitors have been completely discharged. The discharge time is about 3 minutes under normal conditions

2.2 Prohibition on use

- The DV must not be operated until the machine or product that it is incorporated into has been declared to be in full conformity with all relevant national and international regulations.
- The product must not be energized until the entire installation complies with ALL relevant directives.
- The product carries a manufacturer’s warranty if it is installed in accordance with these instructions and all applicable installation regulations.
- If the product has been damaged in any way, e.g. during transport, it must be inspected and repaired by authorized personnel before being connected to the power supply.
- If the DV is built into machinery with rotating parts, e.g. a ventilation system, transport system, etc. The entire system must comply with the Machinery Directive.

3. Introduction and product presentation

- The DVs are a range of drives suitable for regulating the speed of an electric motor in a wide variety of applications.
- The DV is highly versatile, as it can control various motor types, including:
  - ACIM: asynchronous induction motors
  - PMSM: permanent magnet synchronous motors
  - PMsynRM: Permanent Magnet Assisted Synchronous Reluctance Motor
- The DV’s can be used in combination with an external controller, or in standalone applications.
- Read this manual thoroughly before using the DV.
- This manual contains important information and should be used when installing, connecting and commissioning the DV, as well as during maintenance, service and troubleshooting.
- If the instructions contained in this manual are not followed, the liability of the supplier and the warranty shall be voided.
- Technical descriptions, drawings and figures must not be wholly or partly copied or disclosed to third parties without the permission of the manufacturer.
- All rights are reserved if the product is included in patent rights or in another form of registration.

4. Approvals and certifications

4.1 CE marking

- It is hereby declared that the product complies with the following directives issued by the European Parliament:
- LVD – Low voltage: 2014/35/E
- EMC/EMI – Electromagnetic compatibility: 2014/30/EU
- RoHS – Hazardous substances: 2011/65/EU and amendment annex II: EU/2015/863
- ECO – Ecodesign energy-related products: 2009/125/EC (implementation of motor and variable speed drives: 2019/1781/EU)
- EEA – Machinery Directive 2006/42/EC

Table 4 - IPxx/NEMA ratings					
Classification		**3 – IP65 / NEMA 3**	**5 – IP54**	**6 – IP65**	**7 – IP65 / NEMA 4X**
EC Declaration of Conformity	CE	√	√	√	√
UL Recognized	c UL us	√	-	-	√

Note

IPxx/Nema ratings only apply when the drive is installed according to the instructions.

4.2 Ignition Protected Components.

The DV incorporates ignition protected components in accordance with IEC/UL 60335-2-40, clauses 22.116 and 22.117, and UL 121201, Class I, Division 2.

4.3 UL Recognized

The DV product series is cULus-recognized. Additional evaluation is required before the combined drive and motor can be operated. The system in which the product is installed must also be UL-listed by the appropriate party. The drive complies with UL 61800-5-1 thermal memory retention requirements. The DV complies with the US National Electric Code NFPA 79 and the Canadian Electric Code CSA C22.1. No. 274

4.4 Product standard

- In accordance with EN/BS61800-2, which pertains to adjustable speed electrical power drive systems. Part 2. General requirements.

4.5 Safety requirements

- In accordance with EN/BS61800-5-1, which pertains to adjustable speed electrical power drive systems. Part 5. Safety requirements – electrical, thermal and energy.

4.6 RoHS-compatible

- Contains no hazardous substances according to the RoHS Directive.

4.7 EMC/EMI certifications

- All DVs have a built-in EMC/EMI filter.
  For CE/UKCA-marked DVs, EMC/EMI filters are constructed in accordance with EN/BS 61800-3, which pertains to adjustable speed electrical power drive systems. Part 3. EMC/EMI requirements and specific test methods.
  For UL-marked DV's, the EMC/EMI filters comply with FCC §47 part 15 B. and ICES-003.
- With up to 5 meters/16.4 ft of shielded motor cables, the DV product line fulfills the "residential level" for emissions as per EN/BS-61000-6-3 and the "industrial level" for immunity as per EN/BS-61000-6-2. *- 15kW drives are limited to 4 meters. Table 4.7 seen below shows an overview of drive size and allowed motor cable length.*
- Deviating from the allowed cable lengths is permissible, as long as the industrial level for both immunity and emissions is fulfilled. Fulfilling the requirements when using longer cables depends on the cable and motor capacity.

- By reducing the motor cable length, it is possible to install up to 6 DVs in the same unit while still fulfilling EN/BS-61800-3 C1 & C2.
- Conducted emissions: 8 to 150KHz complies with IEC TS 61578

Table 4.7 - CE/UKCA					
DV size	Motor cable length	Intended use	PDS of category EN/ BS-61800-3	Immunity	Emission
0.55 kW / 0.7 hp - 1.3 kW / 1.7 hp	<5.0 m /16 ft	First environment	C1 & C2	EN/BS-61000-6-2	EN/BS-61000-6-3 / IEC TS 61578
1.5 kW / 2 hp - 3 kW / 4 hp					
4 kW / 5.4 hp - 7.5 kW / 10 hp					
11 kW / 14.75 hp					
15 kW / 20 hp	<4.0 m / 13 ft				
11 kW / 15 hp - 15 kW / 20 hp	>4.0 m / 13 ft	Second environment	C3		EN-61000-6-4

4.8 Energy efficiency class

All DV drives are classified in the highest IE2 efficiency class, indicating low energy losses and high operational efficiency. IE2 is the top class for drives according to EN 61800-9-2 and complies with the EU EcoDesign requirements.

4.9 Harmonic distortion

- The DV 1-phase variants comply with IEC 61000-3-2 class A.
  The DV 3-phase variants comply with IEC 61000-3-12, provided that the short-circuit power Ssc is greater than or equal to what is specified at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the equipment to ensure, in consultation with the distribution network operator (if necessary), that the equipment is only connected to a supply with a short-circuit power Ssc that is greater or equal to that specified.
  The DV 3-phase variants comply with IEC 61000-3-12 for asynchronous motors and PM motors with sinusoidal back-EMF. Supply short-circuit power: Ensure that the supply Ssc's short circuit power is greater than or equal to: Ssc = $\sqrt{3}$ × Rsce × Umains × I equipment, at the interface point between the user's supply and the public system (Rsce).

4.10 Area of use

Table 4.9: areas of use	
Installation	CDM
DVC	C
Pollution degree	2
AMSL	< 2000m
Supply earthing system	TN / TT / IT
OVC	III

Specified in accordance with IEC/EN 60664.

4.11 Built-in protection

- If the temperature inside the DV exceeds 95°C/203°F, the DV will attempt to reduce its internal heat generation by its reducing motor speed (rpm).
- The DV has built-in current limitation for the protection of motor and cables and cannot supply more current than it is set to supply.
- In the event of a missing phase on the supply input, the DV will reduce its speed and report a warning.
- The DV motor output terminals are short-circuit-protected against phase-to-phase short circuiting.

5. Product use

- The DV is a drive that controls an electronic motor and is primarily used to regulate fan speed. The DV can be used to control AC asynchronous motors and PM motors.
- Depending on what is needed, the DV is suitable for stand-alone applications or as part of larger systems/applications.
- The product can be used under various environmental conditions. (See Section 16. Technical specifications.)
- The DV is primarily used in ventilation applications.
- If the DV is used in applications where it cannot be positioned directly in front of an air flow, which means that an alternative cooling source must be considered to avoid overheating. Overheating can be countered by creating additional ventilation around the product or by reducing performance requirements. For frame sizes H4 and H5, an external cooling fan can be fitted to the heat sink. - See Section technical specifications.
- To save space, the DV can be fitted directly to the fan motor frame.
- Motor operation can be regulated via an external source or sensor inputs.
- The DV has built-in motor protection.
- The DV can be used in domestic and industrial environments, and has a built-in EMC/EMI filter.
- The DV was developed for use in industry and is defined as professional equipment. It is not intended for sales to the general public.

6. Product range

- The DV is available in different frame sizes. These depend on the rated power.
- The product range contains 13 power sizes ranging from 0.55 kW/0.7HP to 15.0 kW/20HP
- Frame sizes are designated "H1"-"H5," where "H1" is the smallest and "H5" is the largest.
- All enclosures are made of die-cast aluminum.
- The DV products are designed for areas with a supply ranging from 208V to 600 V.
- The DV 600V is UL-recognized and abides by UL 61800-5-1 CSA C22.2 no. 274 / FCC §47 part 15 B. ICES-003.
- The DV has a general immunity toward unstable grid conditions.
- The enhanced DV offers an even higher immunity level with respect to unstable grid conditions.
- All 3 phased DVs have a very low leakage current, which allows for multiple drives on the same RCD.

Table 6: Full Product Range

Product name	Frame size	Power	Supply voltage	Dimensions (w, h, d)	Standard variant available	Enhanced variant available
DV-1005	H1	0.55 kW / 0.7 hp	1 x 208 V - 240 V	185 x 230.5 x 90 mm / 7 9/32 x 9 5/64 x 3 35/64 in.	Available	Not available
DV-1007		0.75 kW / 1.0 hp				
DV-1011		1.1 kW / 1.5 hp				
DV-1013	H1x	1.3 kW / 1.7 hp		185 x 265 x 125 mm / 7 9/32 x 10 7/16 x 4 59/64 in.		
DV-3015	H3	1.6 kW / 2.0 hp	3 x 208 V - 240 V 3 x 380 V - 480 V	185 x 265 x 100 mm / 7 9/32 x 10 7/16 x 3 15/16 in.		
DV-3024		2.4 kW / 3.2 hp				
DV-3030		3.0 kW / 4.0 hp				
DV-3040	H4	4.0 kW / 5.4 hp		220 x 294 x 107 mm / 8 21/32 x 11 37/64 x 4 7/32 in.		Available
DV-3055		5.5 kW / 7.4 hp				
DV-3065		6.5 kW / 8.7 hp				
DV-3075		7.5 kW / 10.0 hp				
DV-3110	H5	11.0 kW / 14.8 hp		244 x 399 x 144 mm / 9 39/64 X 15 45/64 x 5 43/64 in.		
DV-3150		15.0 kW/ 20.0 hp				
DV-6024	H4	2.4 kW / 3.2 hp	3 x 460 - 600 V	220 x 294 x 107 mm / 8 21/32 x 11 37/64 x 4 7/32 in.		Not available
DV-6030		3.0 kW / 4.0 hp				
DV-6040		4.0 kW / 5.4 hp				
DV-6055		5.5 kW / 7.4 hp				
DV-6065		6.5 kW / 8.7 hp				
DV-6075		7.5 kW / 10.0 hp				
DV-6110	H5	11 kW /15 hp		244 x 399 x 144 mm / 9 39/64 x 15 45/64 x 5 43/64 in.		
DV-6150		15 kW / 20 hp				

All 3x380-480V versions can also be supplied by 3x230V. Supplying at 3x230V will limit the possible output power to a maximum of 58% - (1/√3) of the rated power output at 3x380-480V.

**The DV can also be supplied using DC voltage.*

**Always ensure that the motor being used has the correct voltage rating, which aligns the mains voltage and motor rating.*

7. Product label, -ID and -code

7.1 The product label

- The DV is equipped with a silver-colored rating plate.
- Fig. 7 shows an example of a product label and table 7.1 explains numbers and symbols in connection with labels.
- Before use, check that the information specified on the rating plate is as expected.

Fig. 7

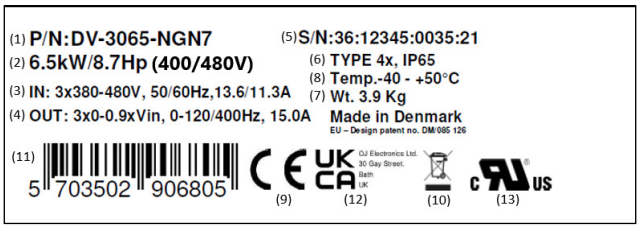


Table 7.1	
1	Product ID = see figure 7.3
2	Shaft power at nominal voltage
3	Max. input voltage, Hz/A
4	Max. output voltage/Hz/A
5	Product code = see table 7.2
6	Enclosure rating
7	Weight
8	Temperature range, operating
9	CE-approved, logo
10	Disposal, logo
11	Bar code
12	UKCA-approved, logo
13	ULrecognized, logo

7.2 The product code.

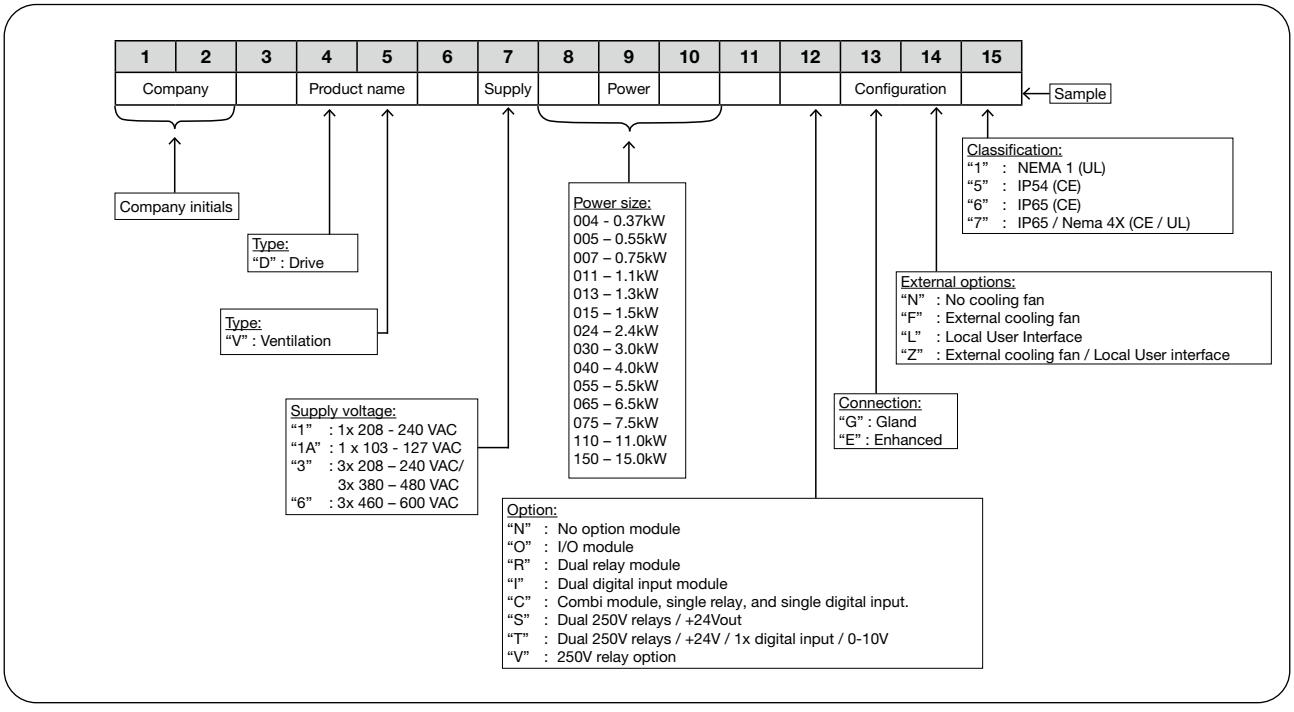
- Every DV is manufactured with its own product code.
  The product code provides precise information on the specific DV.
  The product code contains information as described in table 7.2.

Table 7.2			
Week number	Batch	Serial no.	Year
W W	**B B B B B**	**S S S S S**	**Y Y**
Week of production	Manufacturer's order number	Unit number	Year of manufacture

7.3 The product ID

- The product ID consists of a combination of 14 numbers and letters, each of which provides information about the specific product. See fig. 7.3.

Fig. 7.3



8. Mechanical drawing: dimensions

Fig 8.1

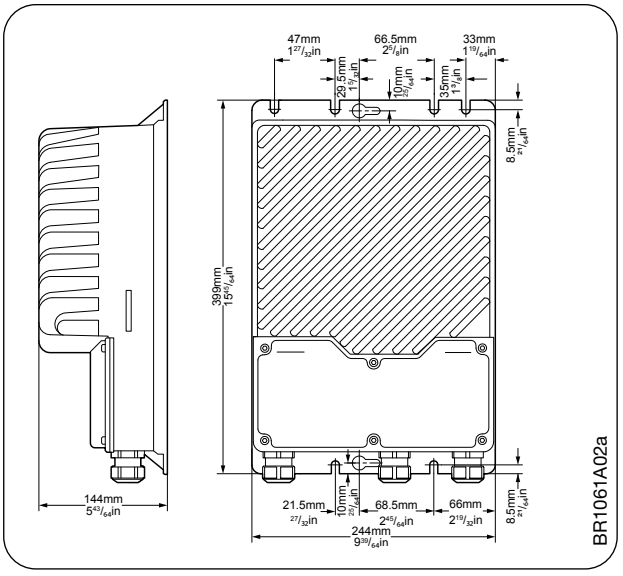


Fig 8.2

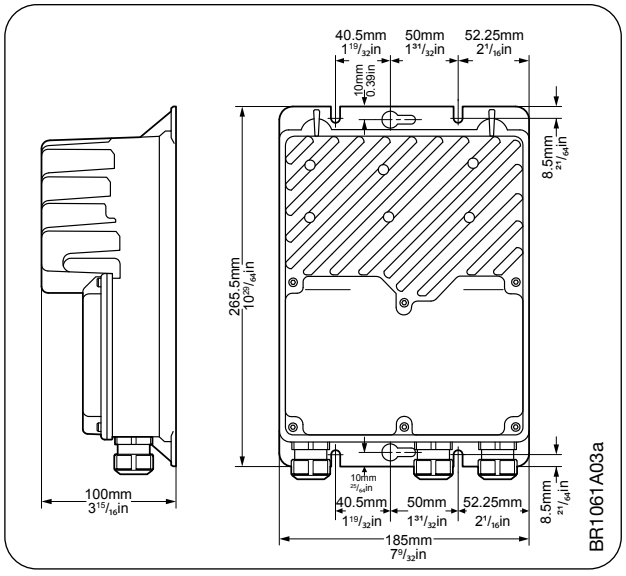


Fig 8.3

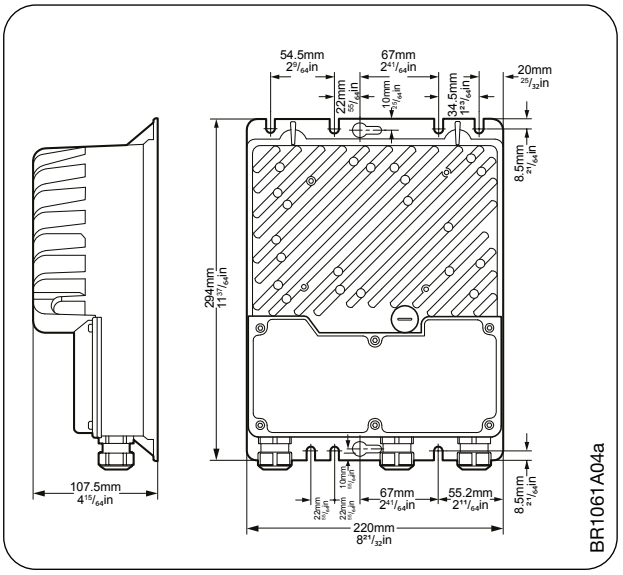


Fig 8.4

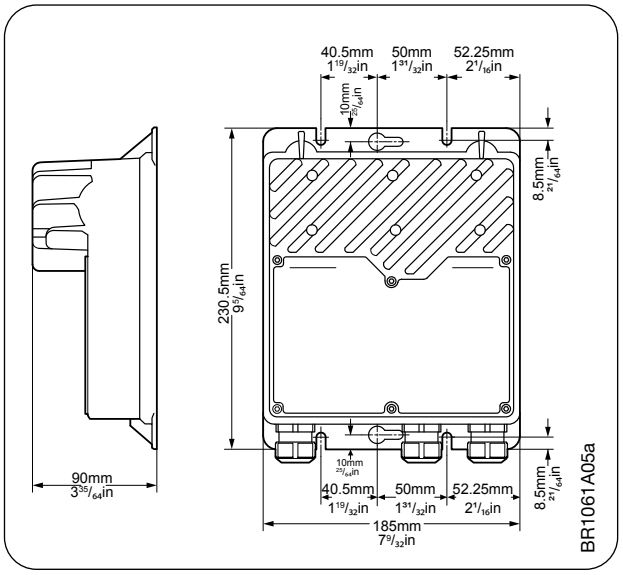
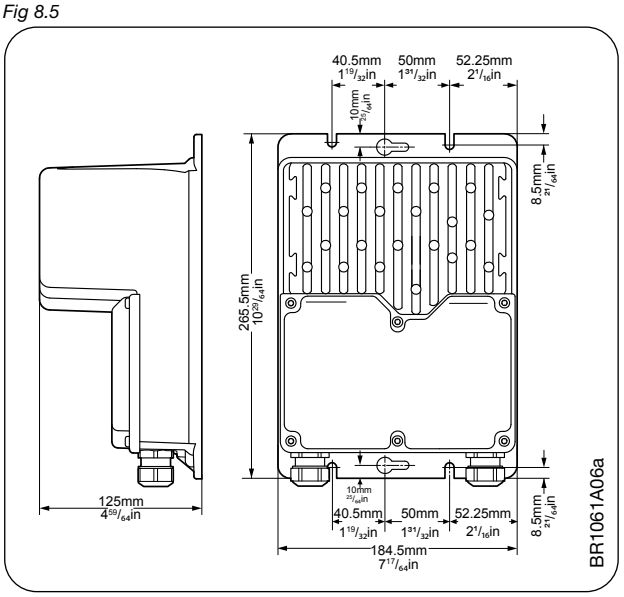


Fig 8.5



9. Mechanical installation

Incorrect mechanical installation may cause overheating and impaired performance.

- The DV must only be installed by trained/experienced personnel.
- To ensure proper cooling of the DV, it must be placed where it is exposed to adequate air flow.
  - *more than 3 m/s (6.7 mph) turbulent air speed or 6.5 m/s (14.5 mph) laminar air speed*
- If the DV is installed in a reduced air flow, or mounted outside of a direct airstream, the output power will be reduced. To mitigate this, an external cooling fan can be mounted on the drive.
- Only DV-1013 can be installed without considering the above requirements for sufficient air flow.
- The DV-1013 is supplied with extra-large cooling fins and can be mounted in still air, in an ambient temperature of max 40°C. (104°F) - *See Technical specifications.*
- To facilitate future service and maintenance tasks, ensure that there is sufficient space around the unit after it has been installed.
- To ensure the enclosure rating, the drive must NOT be mounted with cable glands facing upwards. - See fig. 9.1 for correct mounting.
- Incorrect mounting of the drive can lead to unintended moisture seeping in. Water must be prevented from accumulating around the cable and cable gland. - See fig. 9.2 for correct mounting.
- Check that the surface to which the DV is attached can support the entire weight of the unit.
- The DV can be mounted vertically, horizontally or at an incline. - See fig. 9.1
- The DV must be mounted on a flat, non flamable surface, with a spacer in between—such as a washer. The mounting surface can also be a perforated plate, as long as it is capable of supporting the weight of the drive.
- Drives can withstand forces of 1G and are tested in accordance with EN 61800-5-1, §5.2.6 regarding vibrations.
- To avoid unnecessarily long motor cables, the DV should be installed as close to the motor as possible.
- Use only the pre-cut installation holes / screw holes to secure the DV in place.
- Failure to follow guidelines for installation may result in a voided warranty.
- IPxx/Nema ratings only apply when the drive is installed according to the instructions.

Fig. 9.1

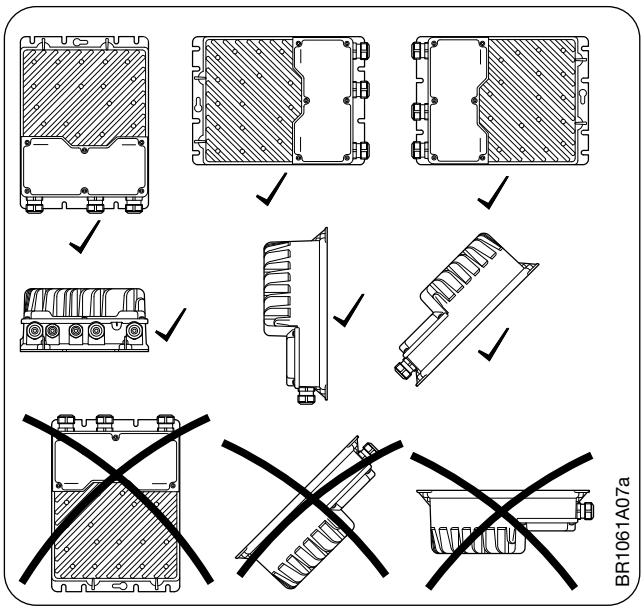
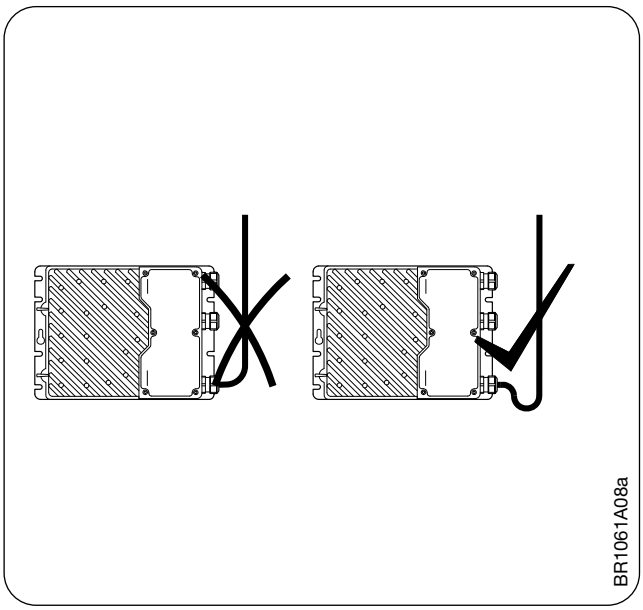


Fig. 9.2



9.1 Opening and closing the DV

- Check that the voltage supply to the DV has been disconnected.
- Wait approx 3 minutes after disconnecting mains voltage before removing the cover.
- The DV is opened by loosening the six screws holding the plastic cover in place – screw size Torx 20.
- Carefully remove the loosened cover.
- When all electrical connections have been correctly mounted, the DV can be closed again.
- Be careful not to trap wires when installing the plastic cover.
- Fasten the plastic cover with the associated 6 TX20 screws,
  which must be tightened to 2 Nm to ensure the sealing grade. To prevent the cover from deforming, do not tighten with torque above 2 Nm.

10. Electrical installation

Warning

10.0.1 Safety and protection measures for electrical installation

- The DV must only be installed and commissioned by trained/qualified personnel.
- Check that the data specified on the motor's rating plate matches the data specified on the DV rating plate.
- Incorrect electrical installation may lead to a risk of severe or fatal injury.

Warning

10.0.2 Dangerous induced voltage (windmilling)

- If drafts are allowed into the duct system, it can cause the fan to rotate without an operating/start signal. This is called windmilling. If windmilling occurs, there is a risk of inducing voltage on the DV motor terminals, which makes them dangerous to touch.

Note

10.0.3 Short-circuit protection: mains supply

- Short-circuit protection of the DV's mains supply is not provided with the product.
- Short-circuit protection on the DV's power supply input side must always be provided in accordance with local and international regulations.
- Short-circuit protection equipment must at a minimum have a tripping curve “C” that conforms with IEC 60898-1.
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Warning

10.0.4 Personal protection:use of RCDs (TT system), risk of electrocution.

- In the event of failure or wrongful installation, this product can result in a current running through the ground protection conductor .
- The 3 mains phases suppling to the DV must be switched on at the same time in order to avoid generating a current in the earth/ground conductor.

Warning

10.0.5 Please note the following precautions:

- If a residual current device (RCD) is used for extra personal protection, then only use a Type B RCD on this product's mains supply side.
- Type B RCDs must comply with all provisions of IEC 61008/9.
- Protective earthing of the DV in combination with the use of RCDs must always be performed in accordance with the relevant local and international requirements, laws and regulations.
- Failure to follow these precautions can lead to severe or fatal injuries to persons and animals.

Warning

10.0.6 Current hazard due to ground (PE) leakage

- Follow national and local regulations regarding the protective earthing of equipment with a leakage current exceeding 3.5 mA.
- The DV technology causes switching at a high frequency. This will generate a leakage current in the earth/ground/PE connection.
- This ground leakage current is dependent upon the different configurations, including RFI filtering, shielded motor cables, and the motor type.
- Due to the possibility of there being a leakage current exceeding 3.5mA in the DV, the Power Drive System Product Standard EN/IEC61800-5-1 requires special attention.
  For further information, see EN60364-5-54 paragraph 543.7
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  - Using one PE conductor: When connecting 1 PE conductor, the minimum cross-section should be at least 10 mm2 / 7 AWG
  - Using two separate conductors: When connecting 2 separate ground conductors, both should comply with the dimensioning rules, and they must be connected to individual earth/ground connectors in the DV.
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- A dedicated ground conductor is required for input power, motor power and control wiring.
- Always use the clamps and connectors on the DV for ground connections.
- Do not loop the ground connection between 2 or more DVs.
- Keep the ground conductor connections as short as possible.
- In order to reduce EMC/EMI levels, always use shielded cables between the DV and motor .
- Follow the motor manufacturer's wiring requirements.

Warning

10.0.7 Potential equalization

- There is a risk of electrical interference if the ground potential between the DV, air handling unit, duct or construct differ from each other.
- An equalization conductor must always be fitted to prevent potential differences between system components.
- Recommended cable cross section: 10 mm2 / 7 AWG.
- Lugs should be used, and the equalization conductor should be attached to the DV enclosure via one of the screws used to mechanically install the unit.

Caution

10.1 EMC/EMI-compliant installation

- Always use shielded cables as motor cables.
- Cable shields must always be electrically connected to the earthed product enclosure.
- Shielded cable is not necessary for I/O signal cables and RS-485 interface cables.
- Use the internal, factory-fitted cable clamps to ensure proper shield connection.
- Never send mains voltage, motor connections and control signals via the same cable.
- The +24 VDC from the DV is not intended to be used as power supply for third party products. If the +24 is used to supply power to third party products, the product might not fulfill the EMC/EMI regulations.

10.2 Terminal and connector overview

10.2.1 Mechanical overview:

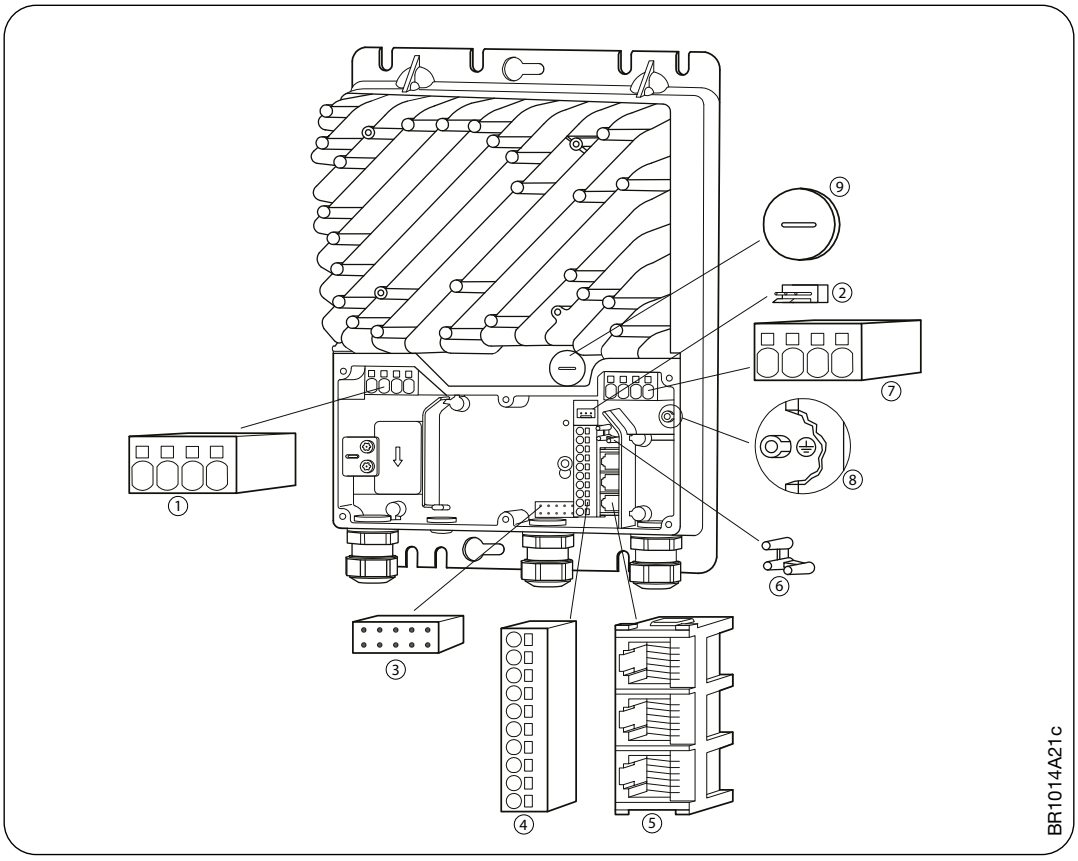
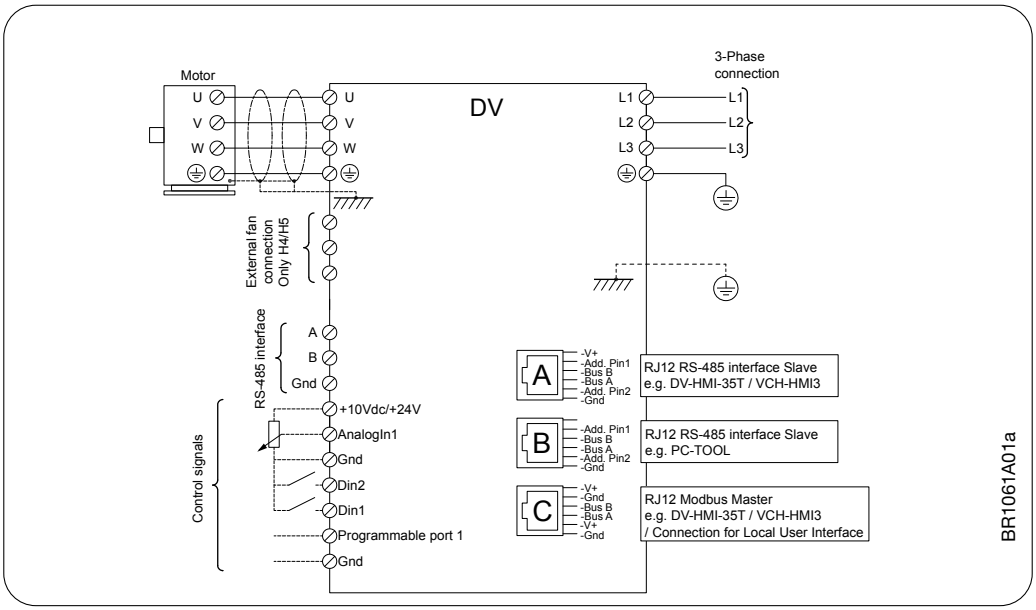


Table 10.2			
No.	Description	No.	Description
1	Motor connection terminals	6	3-point stain relief for RS-485 ribbon cable
2	External fan connection	7	Power terminals (H1=L, N, PE); (H3, H4, H5=L1, L2, L3, PE)
3	Connector for optional modules	8	Connector for the earth (PE) protective conductor
4	Terminal strip for RS-485 interface and A/D control signals	9	For external fan wire routing
5	RJ12 RS-485 interface connector (2 x slave & 1 x master)		

10.2.2 Electrical overview:



10.3 Terminals, cable entries and connections

10.3.1 Cable entries, cable glands, and strain relief

- The factory-fitted cable glands should be used when inserting power, motor and control cables into the DV.
- Tighten the cable glands to ensure ingress protection and strain relief. See Table 10.3.1 for recommended torque values.
- The RS-485 interface ribbon cable entry features 3-point strain relief, which must be used.
- If an additional cable gland is installed in the drive, the thread on the cable gland that enters the drive must not be longer than 8 mm.

Table 10.3.1

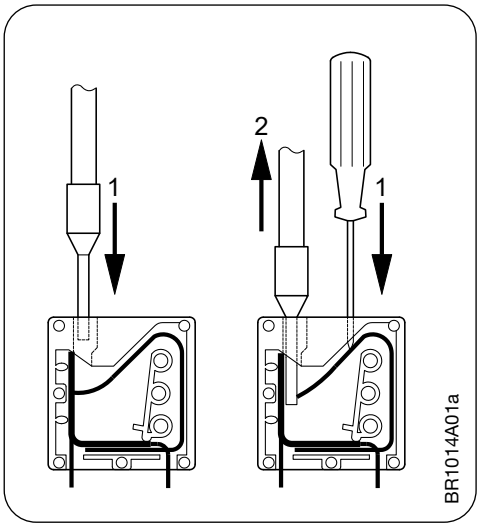
Gland type	Recommended gland fastening torque	Recommended cable tightening torque
M16	3.5Nm	3.5Nm
M20	3.5Nm	3.5Nm
M25	4.0Nm	4.0Nm
M16 blind plug	1.2Nm	1.2Nm
M20 blind plug	1.2Nm	1.2Nm

10.3.2 Spring terminals

- If multi-core cables/leads are used, core sleeves / end sleeves must always be used.
- The connection terminals are spring-loaded, and the wire can be easily inserted into the terminal by carefully pushing the wire in. No tool is needed.
- Alternatively, the terminal spring can be loosened by pressing it lightly with a screwdriver or similar implement. See fig. 10.3.2.
- Solid and multi-core cables/leads can be used.
- Stripped wire ends or end sleeves must be between 8 / $^{5}/_{16}$ in. and 15 mm / $^{19}/_{32}$ in.

Wires can be removed by carefully loosening the terminal spring by pressing lightly with a screwdriver or similar implement. See fig. 10.3.2.

Fig.10.3.2



10.3.3 Motor connection

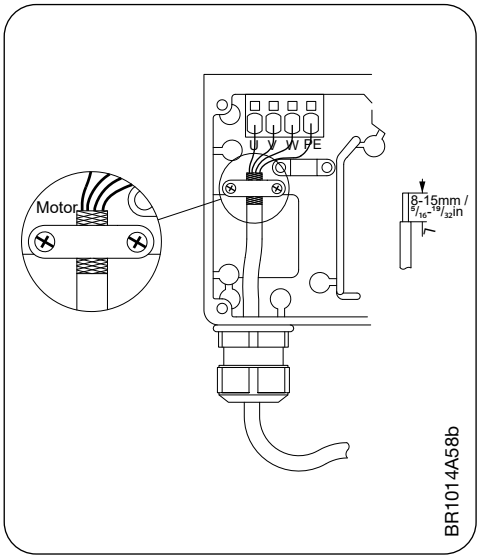
The motor cable must be connected to the terminals marked ”U,” ”V,” ”W” and ”PE.”

- When the stripped wire is inserted into the terminal (see section 10.3.2), the terminal tensions automatically with the correct torque.
- IMPORTANT! The motor cable must always be a shielded cable and the shield must be ended in the clamp intended for that purpose. See fig. 10.3.3.

Each drive frame size is designed to accommodate a range of power classes, which in turn requires the use of motor cables with varying diameters. This variability impacts the grounding method for the motor cable shield.

- The shielding bracket is designed to ensure correct clamping force for both thinner cables (used in lower-power variants) and thicker cables (used in higher-power variants).
- Brackets are tailored for each frame size but are universally adjustable by flipping them:
  - **For thinner cables**: The bow (or elevation) should face downwards.
  - **For thicker cables**: The bow should face upwards.

Fig.10.3.3



- The shielding bracket serves to ground the motor cable for proper EMC/EMI performance. It is not intended to act as a strain relief.

Pull the shield back over the outer cable sheath to ensure proper contact with the shield bracket and to relieve tension on the inner conductors.

The correct tightening torque for the bracket screws is 0.8 Nm.

- Tighten the cable glands to ensure ingress protection and strain relief.
- Contactors between the DV and motor are NOT allowed. If used it can cause drive failure.
- A filter between the drive and motor is NOT allowed. If used it can cause drive failure.

10.3.4 Mains connection

- For 3-phase units, connect the power cable to the terminals marked ”L1,” ”L2,” ”L3” and ”PE.” - See fig. 10.3.4.1. For 1-phase units, connect the power cable to the terminals marked ”L,” ”N” and ”PE.” - See fig. 10.3.4.2.
- Pay special attention to section 10.1.5:
- Ensure that earth/ground connections have been made correctly and follow all the applicable standards and directives.
- It is recommended that the PE wire be 20 mm / $^{25}/_{32}$ in longer than the other wires in the cable.
  This is recommended as a general safety rule. It ensures the continued functionality of safety circuits in the event that wires are pulled out accidentally.
- When the stripped wire is properly inserted into the terminal (see section 12.10), the terminal tensions automatically with the correct torque.
- Remember to tighten the cable glands in order to ensure ingress protection and strain relief.

Fig.10.3.4.1

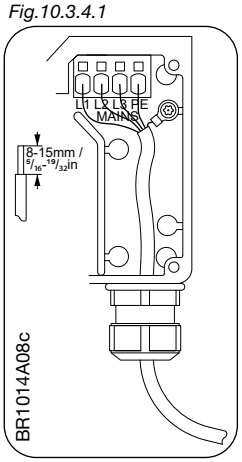
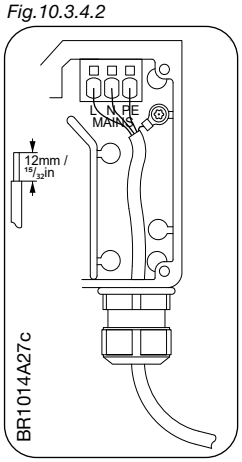


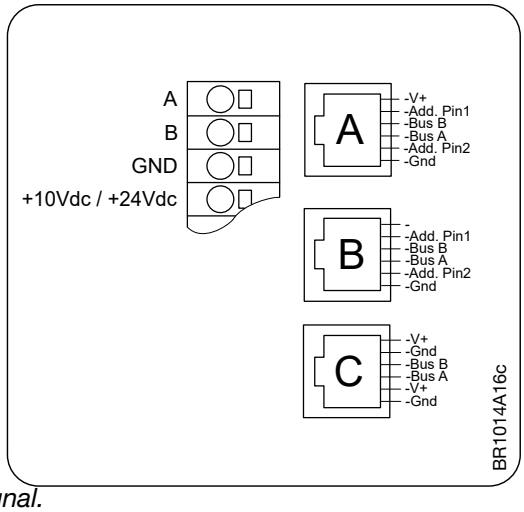
Fig.10.3.4.2



10.3.5 RS-485 interface connection

- The DV uses two types of RS-485 interface controls: Modbus and BACnet MS/TP. *See the Modbus and BACnet MS/TP protocols for more information.*
- The DV is equipped with four connectors, three RS-485 connections, two RJ12 connectors and designated spring terminals, and one Modbus connection.
- On the block terminal for control signals (A/D I/O), the terminals for the RS-485 interface are marked ”A,” ”B” and ”GND.” - *See fig. 10.3.5.1.*
  - *“GND” must be used in order to ensure a proper signal.*

Fig.10.3.5.1



- The block terminals for the RS485 interface are internally connected with the RJ12 connectors “A” and “B.”
- The three RJ12 connectors are marked ”A,” ”B” and ”C.”
  ”A”: RS-485 interface connection, slave, +24 V voltage in connector.
  ”B”: RS-485 interface connection, slave, no +24 V voltage in connector.
  ”C”: RS-485 interface connection, master, external equipment, e.g. DV-HMI-35T / VCHHMI3 / Local User Interface.
- A 6-core, unshielded, 0.066 mm^2/30 AWG telecommunications cable or similar type of ribbon cable can also be used for RS-485 interface communication.
- Attach RJ12 connectors to both ends using a special-purpose tool.
- The DV is ready to be installed in either a daisy chain or star Modbus network. Every DV has a pre-installed Modbus termination resistor of size 1 kΩ, which would be sufficient in most applications. When installing drives in a network in order to communicate with the individual DV, each one needs to have its Modbus ID configured. Since the RS485 interface pin from block connector “A/B” and connectors “A” and “B” are connected internally, they can be used for daisy chaining drives.

- Extra Modbus termination resistors are only to be used in installations where the Modbus exceeds >100m in a daisy chain Modbus connection.
- If the Modbus exceeds >100 m / 109 yards, it might be necessary to install an extra Modbus termination resistor with a size of 180Ω. This resistor is only to be installed in the last DV in the chain.
- In Modbus star connection installations, a Modbus termination resistor is generally not to be used.
- IBACnet MS/TP can only be installed in a daisy-chain connection.

Note

IMPORTANT! RJ12 connectors must be fitted to the ends in such a way that both connectors have the same color sequence as the cable. See fig. 10.3.5.2.

10.3.6 A/D control signal connections

- Connect A/D control signals to the terminal block, see fig. 10.3.6.1
- For further information on using the spring terminals, see section 10.3.2.
- The functionality of the A/D in- and outputs can be set using Modbus.
- *For further information on the Modbus protocol, see the website at myvfd.info*

Table 10.3.6: Block terminal connections overview

Pin	Designations	Function and recommendation
1	A	RS-485 interface
2	B	
3	GND	
4	+ 10Vdc / + 24Vdc	Pin 4 in the terminal block can be set as +10Vdc supply with a current rating of 20mA, or a +24Vdc with a current rating of 100mA.
		Terminal is short-circuit proof
		Tolerance ± 3%
5	AnalogIn1	0-10V signal for speed control (default)
		Other speed control possibilities include:
		PWM control signal (0-10V)
		0-20mA / 4-20mA control signal
		Internal input impedance: 60 kΩ
		Potentiometer: min. 500 Ω, recommended 4.7 kΩ
		Potentiometer, electrical connection, see fig. 10.3.6.2
		External controller, electrical connection, see fig. 10.3.6.3
6	GND	Ground (-)
7	Din2	Internally pulled up to +24V DC
		Digital input 2 (factory default - alarm reset)
		Thermistor input (motor overheat)
		Internal input impedance: 60 kΩ
		Electrical connection, see fig. 10.3.6.4

Fig.10.3.5.2

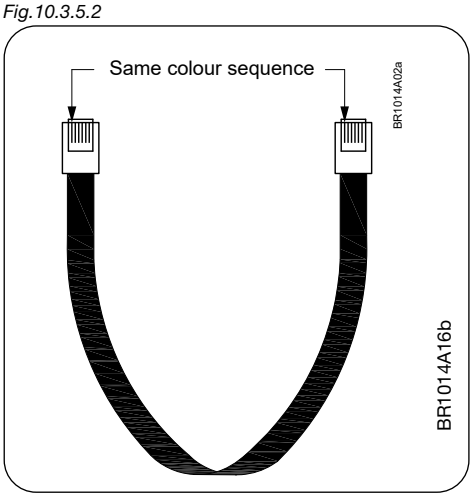


Fig.10.3.6.1

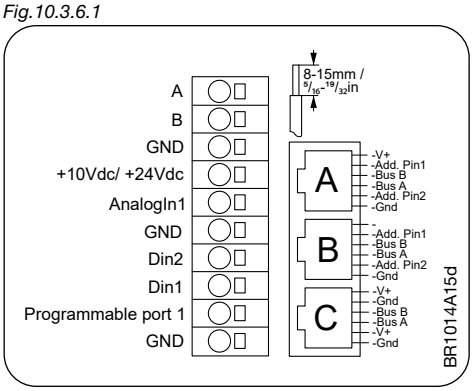


Fig.10.3.6.2

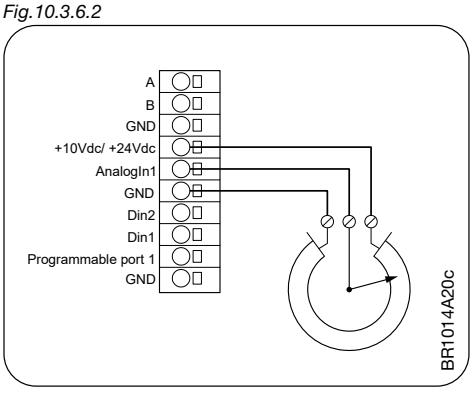


Fig.10.3.6.3

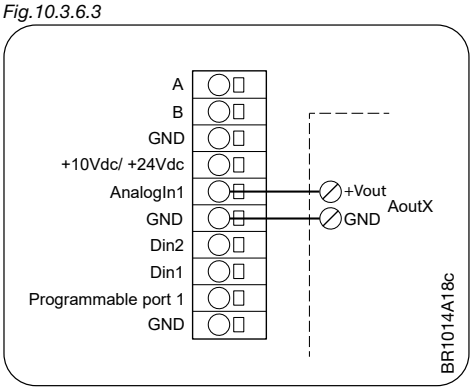


Table 10.3.6: Block terminal connections overview		
Pin	**Designations**	**Function and recommendation**
8	Din1	Internally pulled up to +24V DC
		Digital input 1 (factory default - Start/Stop)
		Internal input impedance: 60 kΩ
		Electrical connection, see fig. 10.3.6.4
		Thermistor input (motor overheat)
9	Programmable port 1	Digital output 1 (factory default - Tacho Out, open collector)
		Tacho
		Alarm/Running
		DigIn5
		See "DV Modbus protocol" for all options.
		Logical low for high stability after 1 ms
		"If EMC/EMI sensitive equipment is to be connected, then an external RC filter must be mounted with a time constant of 1 µs."
		Programmable port 1 has the option of being set as an open collector or of being pulled up internally to either +10Vdc / +24Vdc
		Electrical connection, see fig. 10.3.6.5
		0-10V signal for speed control
10	GND	Ground (-)

Fig.10.3.6.4

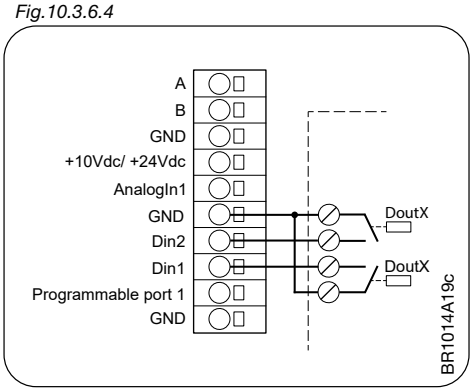
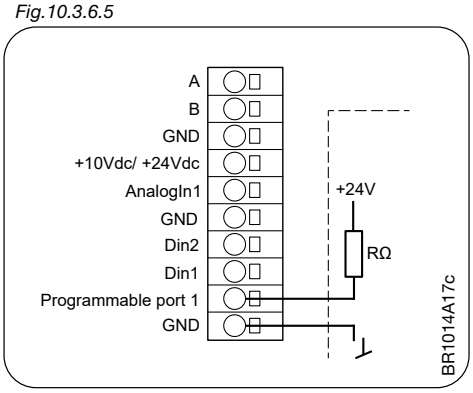


Fig.10.3.6.5



Note

Analog, digital inputs and the programmable port can be set for a range of uses. To learn more about the different options, please see the Modbus-Protocol instruction found on our webpage, www.myvfd.info

Note

Circuits are designed for 10V / 24V use, applying voltages that are higher than this can cause damage to circuits and drive.

11. Checklist for mechanical and electrical installation

- Before the DV is energized for the first time, its installation and connection must be checked.
- Use the table below as a checklist.

Item to be checked	Description of check	√
Completion	Check that the entire installation is ready to be commissioned, both electrically and mechanically, before energizing the installation.	☐
	Check that no people or animals are in the vicinity of moving parts.	☐
Product conformity	Check that the mains voltage on the supply terminals corresponds to the DV's rated input voltage.	☐
	Check the motor and DV rating plates to ensure that the units have been sized correctly.	☐
Mechanical installation	Check that the DV is correctly and securely attached to a flat surface. See Section 12 in this manual.	☐
	Check that there is a free, unobstructed passage of air to the cooling fins. See Section 12 in this manual.	☐
	Check that the blue plastic cover on the DV is correctly mounted and that all screws are sufficiently tightened before switching on power to the product. The tightening torque on the screws is 2 Nm.	☐
	Check that all unused cable glands and other unused openings are appropriately blanked off in accordance with the applicable enclosure rating.	☐
Ambient conditions	Check that requirements for the surrounding environment have been met. Check that temperature and other environmental specifications are being observed. *See Section 25 in this manual for the technical specifications.*	☐
Cabling	Check that all cabling has been fitted correctly and that motor and control cables are kept apart in separate cable conduits.	☐
	Check that the motor cable is a shielded cable and that its length is no longer than 5 meters.	☐
	Check that all cables are securely attached and relieved of tension and torsion.	☐
Electrical installation	Check that all cables have been correctly inserted into the DV and that the cable glands have been correctly tightened.	☐
	Check that the DV voltage supply terminals have been connected to the correct mains voltage level.	☐
	Check that all cables are correctly ended and securely attached.	☐
	Check that all cables are free of visible damage throughout their length.	☐
	Check whether there are any loose connections, which may cause overheating and serious damage to the product and property.	☐
Mains voltage	Check that the mains voltage wires have been correctly fitted to the supply terminals: one-phase on terminals ”L,” ”N” and ”PE” and three-phase on terminals ”L1,” ”L2,” ”L3” and ”PE.”	☐
	Check that there is the correct voltage on the terminals by measuring the voltage.	☐
	Check short-circuit protection and supplementary protection.	☐
Motor connection	Check that motor cables are correctly connected to ”U,” ”V,” ”W” and ”PE” – and check that the tightening torque is correct on the motor's spring terminals.	☐
Control and signal wires	Check that the control cables are ended correctly and securely attached.	☐
	Check that both ends of the RS-485 interface cable have been attached to the correct connectors.	☐
Shield	Check that the motor cable shield is ended correctly and use continuity measurement to check that the shield is connected to an active earth connection at both ends.	☐
Fuses and circuit breakers	Check that active short-circuit protection has been correctly fitted and sized.	☐
	Check that all safety equipment is operative and set correctly.	☐
Earthing	Check that all earth connections in the motor and the DV are correctly connected and free of oxidation.	☐
	Using continuity measurements, check that the earth connection is active and that the contact resistance complies with applicable local and international directives and regulations.	☐

12. Functions

12.1 Quick function overview

Functions name	Function use and description	Function connection/setup
Analog control	The analog input is used for controlling the speed. Both voltage 0-10V and current 4-20mA are possible as are PWM control setups.	Using 0-10V control, connect to pins as described under paragraph 10.3.6 A/D control signal connections and configuration using DV PC Tool or HMI.
		Using 4-20mA control, connect to pins as described under paragraph 10.5.6 A/D control signal connections and configuration using DV PC Tool or HMI
		When using PWM control, connect to pin 5.
Digital control input	Digital inputs can be set up for different functions, start/stop, alarm reset, fire mode and so on. Please see Modbus/BACnet protocol for specifics.	Using digital inputs, connect between pin(x) and pin(x) and the configuration using DV PC Tool or HMI.
Digital control output	Digital output can be used for outgoing signals and can be set for different functions. Please see Modbus/BACnet protocol for specifics.	Using digital output, connect between pin(x) and pin(x) and the configuration using DV PC Tool or HMI.
RS-485 interface control	The DV can be controlled using Modbus or BACnet protocols (BACnet supports a limited set of parameters).	Master interface connection C, slave interface connection B
Vibration detection	The vibration sensor can detect the resonance fields within the application's speed range. These can then be used in speed bypass to avoid areas of unwanted vibration.	Vibration sweep should be started using DV PC Tool or HMI.
Speed bypass	Speed bypass is used to ”jump” over specified speed ranges in order to avoid resonance and vibrations	Setting up Jumping frequency is done using DV PC Tool or HMI
Switching frequency	Switching frequency is set to control the amount of audible acoustic noise that is emitted. High switching frequency reduces noise, but at the cost of efficiency.	Switching frequency can be set by user or set to auto, which lets the drive define the frequency.
Fire mode	Fire mode is designed for emergency situations. Fire mode has 3 different modes available: Normal fire mode, Max fire mode and Analog fire mode	The fire mode setting should be done using DV PC Tool or HMI, after reading the section on this topic.
Dual speed setting	If only 2 fixed speeds are needed, high and low, then dual speed can be used.	Dual speed is controlled using a digital input and can be set up using the DV PC Tool or HMI
Holding torque	Holding torque can be used to lock the fan in position. Holding torque has 2 modes available: active holding and passive holding	The holding torque needs to be set up and activated using the DV PC Tool or HMI.
Time stamp	Real time clock function, gets reset with power cycle	Time stamp needs to be set over Modbus communication using DV-PC-Tool or other equipment having the function "real time clock". See Modbus protocol for further information.

**Due to differences in drive types, not all functions may be available.*

12.2 Analog/digital control

- The DV can be controlled using A/D inputs or the RS-485 interface.
- The DV is factory set for using A/D inputs as the control method. See section 10.3.6.

- AnalogIn1 is by default set to 0-10V speed control, which allows for a 0-10V signal to control the motor speed. The +10Vdc can be used as supply – see section 10.5.6.

- Controlling the motor speed using 4-20mA or PWM is also possible, but requires that changes be made to the setup.
  (*Note: a daisy chain of a 4-20mA signal is not supported.*)

- Default setting of digital in- and outputs:
  - Din1 = Start/Stop (1 = Start)
  - Din2 = Alarm reset (1 = Alarm reset)
  - Programmable port 1 = Tacho Out (1 pulse per motor revolution)

Note

The digital inputs and outputs can be given alternative functions via Modbus.
The relationship between the 0-10V control signal and motor speed depends on the settings for min./max. speed and ramp times. See figs 12.3.1 and 12.3.2.
While using A/D control, it is still possible to monitor drive status using RS-485.

Fig.12.3.1

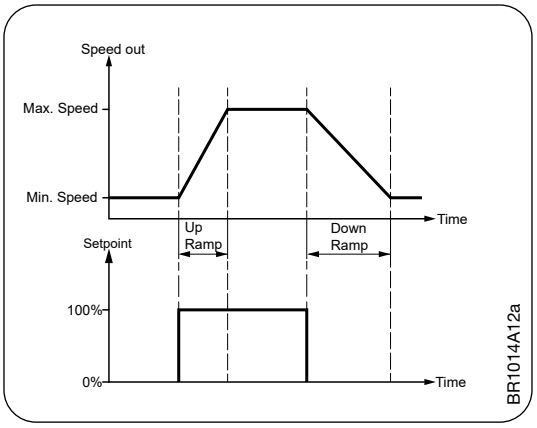
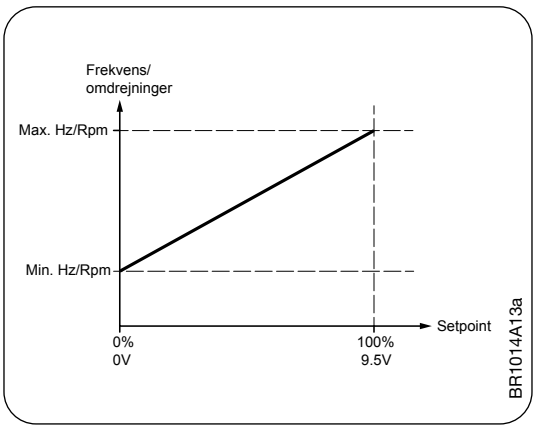


Fig.12.3.2



12.3 RS-485 interface control

- According to the Modbus and BACnet MS/TP protocols, the DV can be controlled via Modbus or BACnet MS/TP commands.
- (Note: BACnet MS/TP does not have the full range of commands as Modbus).
- BACnet MS/TP needs to be selected via Modbus or DV PC Tool.
- Motor speed control is set to “Autodetect” by default, and starts up as 0-10V control. If RS-485 communication is detected, the DV will automatically change to “speed control” by protocol. The power cycle returns the DV to 0-10V control.
- If the DV is to be controlled via RS-485 interface, Coil Stat Bit register 8 must be set to “0” = ”Protocol control.”
- Other functions, such as alarm read-out and acknowledgment, are still possible via RS-485 interface even though “Protocol control” is not activated.

12.4 Vibration detection

- The vibration sensor in the drive can detect the ranges in which the application would benefit from the use of the Speed bypass function,thus reducing resonance-based vibration from the motor and fan.

12.5 Switching frequency

- Switching frequency is crucial in determining the amount of audible acoustic noise emitted by the DV. The higher the switching frequency, the less audible noise will be emitted by the DV. At the same time, however, internal losses will be increased, which reduces efficiency.
- The DV can be set to operate constantly with a switching frequency of 8 kHz, 16 kHz or 20kHz, or it can be set to change switching frequency automatically depending on the motor speed (AUTO setting).
- Switching frequency (switching mode) is set via Modbus:

Table 12.5.1		
Switching frequency setting		
8 kHz	=	Constant 8kHz switching frequency
16 kHz	=	Constant 16kHz switching frequency
20kHz	=	Constant 20kHz switching frequency
Auto	=	Switching frequency is changed automatically

Auto function
With a default setting of ”Auto”:

- At motor speeds higher than 60% of rated speed, the switching frequency is changed to 8 kHz.
- At motor speeds lower than 50% of the rated speed, the switching frequency is changed to 16 kHz.
- The “high” set point can be changed using the DV PC Tool.
- The lower set point is automatically set 10% lower then the high set point.
- It is possible to set the switching frequency to extra high, thus enabling a max of 20kHz when using the DV PC Tool

Note

The switch frequency affects the drive and operations as shown in table 12.5.2

Table 12.5.2		
Effect of switching freq. setting		
Switching freq.	**Low**	**High**
	↓	↓
Motor noise	High	Low
Waveform of output	Rough	Smooth
Motor temp.	High	Low
Drive temp.	Low	High
Leakage current	Low	High
Interference	Low	High

12.6 Fire mode

Fire mode designates a function in which the DV is kept in operation by an emergency program that disables the alarm monitor. Among other things, the function can be used for extracting smoke from a burning property. When fire mode is activated, an extraction fan will continue to remove smoke from the property for as long as possible. The fire mode function can be activated via RS-485 interface or digital input. In fire mode, the DV is able to maintain operation for at least an hour, even when the DV and the fan motor are overheated (max. 70°C / 158°f). There are three different fire modes to choose from: normal-, max-, and analog fire mode.

- **Normal fire mode**
  All warnings and alarms in the DV will be ignored and the DV output to the motor remains the same value as it was just before the fire mode condition was activated. If the DV is controlled via RS-485 interface and there is a communication failure when in normal fire mode, then the output signal to the motor will have the same value as just before the RS-485 interface communication was disconnected. The DV will continue to deliver voltage and current to the motor for as long as possible, until the DV is powered off and the digital input goes back to the normal position. If the motor is not operating when normal fire mode is activated, then the motor will remain turned off.
- **Max fire mode**
  All warnings and alarms in the DV will be ignored and the DV will go to the max output frequency (for AC motor) or max RPM (for PM motor).
  The motor will continue to work this way for as long as possible, until the DV is powered off and the digital input returns to the normal position. Even if the motor is not operating when fire mode is activated, the motor's output accelerates to the maximum defined rotation speed.
- **Analog fire mode**
  If the 0-10V analog input detects 9V or higher, fire mode is activated even if the analog input is again reduced below 9V. All warnings and alarms in the DV will be ignored and the motor will run at max speed for as long as possible, or until the DV is powered off and the analog input is again below 9V.

12.7 Motors

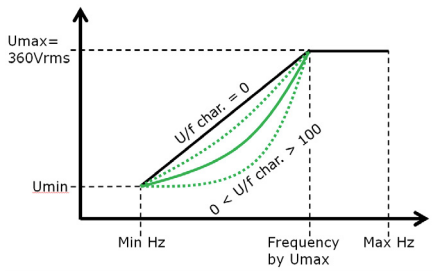
12.7.1 Frequency converter mode for asynchronous motors

- The DV is factory-set to frequency converter mode for standard asynchronous induction motors (AC-IM), and the control mode is 0-10VDC input.
- This can be changed using the DV PC Tool or DV-HMI-35T.
- If you use the DV in frequency converter mode, you must connect a standard 3-phase AC-IM motor.
- Pay special attention to the information that you will find on the motor's nameplate.
- The maximum output voltage from the DV is approx. 90% of input voltage.
- If the supply voltage is higher than the rated voltage of the single windings in the connected motor, then the motor will be damaged.
- Pay special attention if the motor is connected in “star” or “delta” connections. On a standard AC-IM motor, the “star”/“delta” connection can often be changed by rearranging the jumpers on the motor terminal.
- The DV supports multi-motor solutions. Two or more asynchronous can be driven by a DV.

Note

It is the installer’s responsibility to enter the correct control and motor parameters for the DV.

Pay special attention to the following parameters:

Table 12.7.1	
Minimum frequency	Even if the control signal is e.g. 0% or 0.0V and the DV has an activated start signal, the motor will not run slower than the value in this parameter.
Maximum frequency	Even if the control signal is e.g. 100% or 10.0V and the DV has an activated start signal, the motor will not run faster than the value in this parameter.
Ramp-up time	Along with the calibration and align time, Ramp-up time is the time (in seconds) from when the DV gets the start signal until the speed has been reached according to the set maximum speed. The ramp-up time is used to avoid overload and damage to the drive and motor. The ramp-up time is also used in upward jumps between speed set points. If this ramp-up is too short, the DV could possibly indicate a current limit warning.
Ramp-down time	Ramp-down time is the time (in seconds) from maximum speed to minimum speed and is used when a request for lower speed is given. If a “Stop” signal is given, ramp down time is not used. The ramp-down time is used to avoid overload and damage to the drive and motor. Ramp-down time is also used in connection with downward jumps between speed set points. If this ramp down is too short, the DV can experience raised voltage levels on the DC link, to the point that triggers the voltage high alarm.
Switch frequency	Switch frequency is a parameter that influences efficiency and the audible noise being emitted from the connected motor and/or the DV. In the DV, it is possible to select “Auto,” “8 kHz” or “16 kHz.” Activating the “Extra high” Modbus parameter makes it possible to select “Auto,” “8 kHz” or “20 kHz.” The higher the switch frequency, the lower the audible noise from the DV system. However, the consequence of lower audible noise is that it decreases the DV system's efficiency. In “Auto,” the DV will automatically switch between “8 kHz” and “16/20 kHz.” During start-up from 0 – 60% speed, the switch frequency will be “16/20 kHz”. This will result in less audible noise being emitted from the connected motor and/or the DV. When the speed has increased and passes 60%, the switch frequency will then switch to “8 kHz.” The noise from the fan and airflow will now drown out the audible noise being emitted from the DV system. In the speed-down sequence, the DV will switch to “16/20 kHz” when the speed of the motor passes 50% going downward. It is also possible to select a fixed switch frequency of “8 kHz” or “16/20 kHz.”
U-min Hz	This parameter sets the voltage to the motor at minimum frequency.
Freq U-max	This parameter sets the frequency to the motor at maximum voltage.
U/f characteristic	The U/f characteristic parameter makes it possible to change the ratio between voltage (U) and frequency (f) for the motor. As shown, the ratio is linear when set to zero, and parabolic when set to 100. A motor with poor efficiency may require a higher U/f characteristic (a number lower than 75) 

For further information about parameters in the DV, see the Modbus and BACnet MS/TP protocols.

12.7.2 Electronically-commutated mode (EC mode) – for PM

- The DV is factory-set to “frequency converter mode” for standard asynchronous induction motors (AC IM) and the control mode is set for 0-10 VDC input.
- This can be changed using the DV PC Tool or DV-HMI-35T (Hand terminal).
- The difference between an AC-IM motor and a PM-SM is the build of the motor, and each type requires a specific control method.
- The PM-SM motor is controlled using the Back EMF. This requires the drive to be setup correctly. If left in ”frequency converter mode,” this can cause failure.
- Before operating, select and load the correct fan and motor parameter files using the DV-HMI- 35T or DV PC Tool. It is the installer’s responsibility to enter the correct control and motor parameters.

Pay special attention to the following parameters:

Table 12.7.2	
Minimum rpm	Even if the control signal is e.g. 0% or 0.0V and the DV has an activated start signal, the motor will not run slower than the value in this parameter.
Maximum rpm	Even if the control signal is e.g. 100% or 10.0V and the DV has an activated start signal, the motor will not run faster than the value in this parameter.
Ramp-up time	Ramp-up time is the time (in seconds) between when the DV gets the start signal and when the speed has been reached according to the set point. The ramp-up time is used to avoid overload and damage to the drive and motor. The ramp-up time is also used in upwards jumps between speed set points. If this ramp up is too short, the DV might indicate a current limit warning.
Ramp-down time	Along with the calibration and align time, ramp-down time is the time (in seconds) from when the DV receives a stop signal until the motor reaches 0%. The ramp-down time is used to avoid overload and damage to the drive and motor. Ramp-down time is also used in connection with downward jumps between speed set points. If this ramp down is too short, the DV will use power to stop or slow down the motor. This could possibly trigger a high voltage alarm (Vhi) from the DV.
Switch frequency	Switch frequency is a parameter that influences efficiency and audible noise being emitted by the connected motor and/or the DV. In the DV it is possible to select “Auto,” “8 kHz” and “16 kHz.” The higher the switch frequency, the lower the audible noise emitted by the DV system. However, the lower audible noise results in decreased efficiency for the DV system. In “Auto,” the DV will automatically switch between “8 kHz” and “16 kHz.” During start-up from 0 - 60% speed, the switch frequency will be “16kHz,” which will result in less audible noise being emitted by the connected motor and/or the DV. When the speed has increased and passes 60%, the switch frequency will then switch to “8 kHz.” The noise from the fan and airflow will now drown out the audible noise being emitted by the DV system. In the speed-down sequence, the DV will switch to “16 kHz” when the motor speed passes 50% going downward. It is also possible to select a fixed switch frequency of “8 kHz” or “16 kHz.” In the speed-down sequence, the DV will switch to “16/20 kHz” when the motor speed passes 50% going downward. It is also possible to select a fixed switch frequency of “8 kHz” or “16/20 kHz.”

For further information about parameters in the DV, see the Modbus and BACnet MS/TP protocols.

12.8 Speed bypass

- With regard to applications suffering from resonance-related issues, it is possible to avoid frequencies that trigger resonance by programming the DV to jump frequencies.
  It is possible to avoid three different frequency bands.
  1. Low1 rpm/Hz – High1 rpm/Hz: the rpm/Hz between Low1 and High1 will be avoided.
  2. Low2 rpm/Hz – High2 rpm/Hz: the rpm/Hz between Low2 and High2 will be avoided.
  3. Low3 rpm/Hz – High3 rpm/Hz: the rpm/Hz between Low3 and High3 will be avoided.

  These three low and high rpm/Hz frequency bands must be configured via PC Tool, UDF or Modbus.

Example:
Use of the application generates resonance at 250 rpm. The Program Low1 is 245 rpm, the High1 is 255 rpm, and the DV will not let the motor run at a rpm between 245 and 255 rpm.

Tip:
If there are problems with resonance at a specific rpm, there may also be problems at double that rpm. If so, use the second frequency band to avoid that as well.
Alternatively, use the “vibration sensor” function to find the points of resonance.

12.9 Dual speed using digital input

- If only two speeds are needed, then dual speed can be controlled via digital input. When the chosen digital input is open, the low speed is selected, while the high speed is selected when the input is closed. High and low speeds must be configured through the UDF or PC tool.

12.10 Holding torque

- Active holding torque
  Used for holding the fan in a locked position. Can hold fan using up to 50% of maximum motor current.
- Passive holding torque
  Holding torque controlled by drive while monitoring drive temperatures and currents to ensure drive functionality.

12.11 Auto tune

The Auto Tune feature in the ConfigGenerator tab of the DV-PC-Tool allows you to easily generate configuration files for motors and fans using just a few parameters. This function is supported by firmware versions AOC 4.10, MOC 4.10, and DVPC-Tool 2.26 onward.
Find more information in the instructions for the DV-PC-Tool.

13. Communication: installation and setup

13.1 Modbus

13.1.1. Modbus addressing

Modbus addressing of the DV controls can be accomplished in three different ways.

- Via the addressing pins of connector ”A” or ”B” (Add. Pin 1 + Add. Pin 2) - see fig 13.1 for pin location. The addressing pins can be used to assign the DV control address range: 0x36 (dec.54), 0x37 (dec.55), 0x38 (dec.56) and 0x39 (dec.57), see table 13.2.
  1. Via Air2 FanIO through connector ”B” (see instructions for Air2 FanIO).
  2. Via the DV-HMI-35T menu (see instructions for DV-HMI-35T).
  3. Via the DV-PC-Tool by writing to Modbus Holding Register 4x0017 (see instructions for DV-PC-Tool)

Fig. 13.1

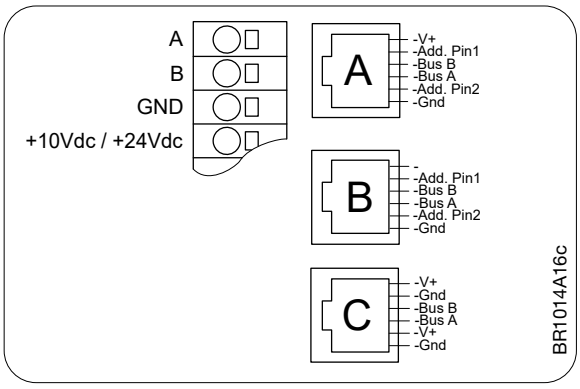


Table 13.1

Add. Pin. no.	0X36 (54 dec)	0X37 (55 dec)	0X38 (56 dec)	0X39 (57 dec)
Add.Pin1	⏚	⏚	⏚	⏚
Add.Pin2	⏚	⏚	⏚	⏚

13.1.2 Modbus communication

The DV is supplied with the factory setting (see table 13.2):

Table 13.2			
	Setting range	**Unit**	**Factory settings**
Address	1-247	n/a	54 dec
Baud rate	9.6, 19.2, 38.4, 57.6, 115.2	kbs	38.4 kbs
Parity	None, Odd, Even	n/a	None
Stop bit(s)	One, Two	n/a	One
Communication timeout	0-240	Sec.	10

The DV supports the following commands listed in table 13.3.:

Table 13.3	
Function code	**Description**
1	Read Coil Status
2	Read Input Status
3	Read Holding Registers
4	Read Input Registers
5	Force Single Coil
6	Preset Single Registers
8	Diagnostics. Sub-function 00 Only – Return Query Data (loop back)
15	Force Multiple Coils
16	Preset Multiple Registers

Values that are written to the DV via Modbus are rounded off to the nearest valid value.

13.1.3 Detection of active Modbus

- The DV automatically detects valid Modbus communication on the Modbus inputs (RJ12 connector or “A” & “B” terminals on the terminal strip).
- The DV will first use the following communication parameters to detect this: ID 54, 38.4 – None-One
- Alternative communication parameters can be set using the Modbus register.
- After 10 seconds without receiving a valid Modbus request with the default parameters, the DV will try to detect a Modbus request with the alternative parameters.
- *The Modbus protocol for the DV can be found on www.myvfd.info.*

Note

For more information regarding Modbus communication, please see the "Modbus-protocol" document found on our webpage, Link : http://www.myVFD.info

13.2 BACnet

13.2.1 BACnet MS/TP

- BACnet MS/TP can only be used for the operation of the DV. When the application-specific configurations (digital inputs etc.) need to be set in the DV, only the Modbus interface or DV PC Tool can be used.

13.2.5 BACnet communication parameters

- BACnet communications parameters can be set using the DV PC Tool or Modbus.
- The DV can be configured to automatically detect valid BACnet MS/TP communication on the RS-485 interface RJ12 connectors “A” & “B” or sprint terminals 1(A), 2(B) and 3(GND).
- After 10 seconds without detecting an active BACnet MS/TP network, the DV will try to detect a different communication protocol.
- The BACnet MS/TP protocol for the DV can be found on the DV's web page.

Table 22

	Setting range	Unit	Factory settings
Baud rate	9.6, 19.2, 38.4, 57.6, 115.2	kbs	115.2 kbs
BACnet MAC	0-127	1	0
BACnet MaxMaster	1 - 127	1	1
Device Object ID	0 - 4194302	1	0

Note

For more information regarding BACnet communication, please see the "BACnet-protocol" document found on our webpage, Link : http://www.myVFD.info

14. Accessories – connection and function

14.1 Optional modules

- Various optional modules can be connected to DV. These provide extra versatility where the unit is to be built into systems and applications that require additional inputs and outputs.

14.2 DV-HMI-35T: connection and functions

- The HMI-35T hand terminal can be connected to the DV via RS-485 interface RJ12 connector “A” and “C.”
- If an HMI-35T is connected to terminal “A,” it will act as a master for the DV.
- Only one master at a time can be connected to the RJ12 connectors marked ”A” and ”B.” It is thus not possible to connect both a hand terminal to connector “A” and an active Modbus communication cable to connector ”B” at the same time.
- When connected to terminal “C,” the DVHMI-35T will be passive to the DV, and acts as a display for the latter. If the Modbus communication is lost between the BMS controller and DV, or if the DV-HMI-35T is set to “Manual override,” the DV-HMI-35T will be able to take over control of the DV until communication is re-established between the controller and the DV, or the “manual override” has been deselected.

14.3 DV Local User Interface.

- The DV Local User Interface is a touch interface that is built into the lid of the drive. From here it provides access for monitoring operations, yet provides limited access to setup changes.

14.4 DV Remote User Interface

- The Remote User Interface is built and functions like the DV Local User Interface, but has the option of being mounted outside of the application using a cable connection.

15. DV PC Tool: connection and functions

- The DV range can be configured using the DV PC Tool, which must be connected to the RS-485 interface RJ12 ”B” or the spring terminals A, B and GND.

The DV PC -Tool allows the motor and drive parameters to be viewed and set, including:

- Status: Control and operating parameters for connected DV
- Setup: Setting application parameters
- Alarm: Readout of alarm log for connected DV
- Modbus: Changing Modbus settings for BACnet SM/TP control for the DV, while also initiating the control
- About: Readout of software version no. and type for connected DV
- Config: Configuration of motor, input and output settings
- Log data: Readout of log files
- Firmware: Updating firmware and motor/fan/user configuration
- Motor: Configuring motor parameters
- Fan: Configuring fan parameters

The DV PC Tool is solely used by fan and system manufacturers.

Note

DV configuration and updates using the DV PC Tool.
Updating configuration files and firmware can be done via a power up using 230v on all drives, independent of the voltage levels.
It is possible to update the application-oriented control part of the firmware as well as the motor-, fan- and user configuration files by connection the PC through the RJ12 port “A” or port "B", the circuits needed for this will be powered by the USB supply, no other supply is needed doing this updating process.
This enables users to setup or change active configuration files without applying high voltage to the drive, thus ensuring a more secure work environment and that the task is handled, while also reducing the required skills and/or education level.

USB wire connection	
USB pin no.	**DV connection**
2	5.0 VDC
3	B
4	A
6	GND

**It is recommended to add a Series Schottky Diode to the 5VDC for protection.*

16. Technical specifications

16.1 Drive specifications

	Type	DV-1005	DV-1007	DV-1011	DV-2011	DV-1013
Frame size		H1				H1x
Power size	kW	0.5	0.75	1.1	1.1	1.3
Horsepower	Hp	0.7	1.0	1.5	1.5	1.7
Efficiency	%	> 94%				
Power supply						
Voltage	VAC	1 x 208-240 VAC 50/60 Hz +/-10%			1 x 208-277 VAC 50/60 Hz+/-10%	1 x 240 VAC 50/60 Hz +/-10%
Supply current at max. load at nominal supply voltage (400V/480V)	A	3.6 / 3.1	5.4 / 4.7	7.9 / 6.8	7.9 / 5.9	9.3 / 8.1
Power factor (cos-phi) at max. load		> 0.99 (Active PFC)				
Motor output						
Nominal motor power (on shaft) *1	kW	0.5	0.8	1.15	1.15	1.3
Frequency	Hz	AC motor: 0-120 | PM motor: 0-595				
Max. output voltage	V_{rms}	3 x 0 - 250 VAC				
Max. output current	A_{rms}	2	3.2	4.5	4.5	5.2
Protection						
Max. fuse	A	16				
Short-circuit capacity	A	5000	5000	5000	5000	5000
Motor output		Short-circuit protected between phases				
Motor		Protected by current limit				
Max overvoltage		480V - prolonged exposure to max. overvoltage point can potentially lead to failure.				
Overload protection		Current and temperature overload protection				
Environment						
Operating temperature	°C/°F	-40°C to +50°C / -40°F to +122°F				
Starting temperature	°C/°F	-40°C to +50°C / -40°F to +122°F				
Storage temperature	°C/°F	-40°C to +70°C / -40°F to +158°F				
Protection rating		IP 54 & 65 / NEMA 4x				
Enclosure material		Aluminum				
Front cover		Plastic				
Weight	kg/lbs	2.0 kg /4.4 lbs				3.6 kg / 7.94 lbs
Humidity	% rh	10-95% rh, non-condensing				
Surface		Corrosion resistant according to EN/ISO 9223 Class 4				
Air flow / cooling		Turbulent air speed of min. 3 m/s or 9.84ft/s to achieve max. output power at max. ambient temperature. Turbulent air speed below 3m/s or 9.84ft/s and higher ambient temperature might lead to reduced output power. (3m/s or 9.84ft/s turbulent air speed is equivalent to 6.5m/s or 21.32ft/s laminar air speed)				
Interfaces						
Field bus		Modbus RTU, BACnet MS/TP				
Analogue Inputs		1 input / 0-10 VDC / 4-20mA / PWM				
Analogue Output		1 output / +10 VDC or +24 VDC				
Digital Inputs		2 inputs / Internal pull-up to +24VDC				
Digital Output		1 output / Open collector, Internal pull-up to +10 VDC or +24 VDC				
Status LED		Green/yellow/red				
Features						
Technology		Sinusoidal back-EMF signal controlled via FOC (Field Oriented Control)				
Software updating		Yes, via serial interface				
Motor parameters		Preprogrammed or on-site configuration				
Short-circuit protection		Yes				
Integrated EMC/EMI filters		Yes				
Approvals						
EMC/EMI		EN/BS 61800-3 (C1 & C2)				
LVD		EN/BS 61800-5-1 / UL 61800-5-1				
Product standard		EN/BS 61800 Part 2				
North America		UL -61800-5-1 / CS22.2.274				
Ignition-protected components		IEC/UL60335-2-40, cl.22.116 & cl.22.117 / UL 121201 Class1, Div2				
Overvoltage category		III				
Pollution degree		2				
Altitude		2000m / 6500ft "Without derating"				
Supply earthing system		TN / TT / IT				
RoHS Directive		Yes				
Product approvals		CE / cULus				

Note: Data are valid at: nominal supply voltage, +25°C, and sufficient air flow
*1 Motor Power Factor = 0.8 and efficiency = 90%

	Type	DV-3015	DV-3024	DV-3030	DV-3040	DV-3055	DV-3065	DV-3075	DV-3110	DV-3150
Frame size		H3			H4				H5	
Power size	kW	1.5	2.4	3.0	4.0	5.5	6.5	7.5	11	15
Horsepower	Hp	2.0	3.2	4.0	5.5	7.5	8.7	10.0	15	20
Efficiency	%	> 96.5%			> 96.5%				> 97.5%	
Power supply										
Voltage	VAC	3 x 208 - 240 VAC 50/60 Hz +/-10% *1 3 x 380 - 480 VAC 50/60 Hz +/-10%								
Supply current at max. load at nominal supply voltage (380V/480V)	A	3.2/2.6	5.0/4.2	6.3/5.2	8.4/7.0	11.5/9.6	13.6/11.3	15.7/13.1	23.0/19.1	30/26.1
Power factor (cos-phi) at max. load		> 0.9								
Motor output										
Nominal motor power (on shaft) *2	kW	1.5	2.4	3.0	4.0	5.5	6.5	7.5	11	15
Frequency	Hz	AC motor: 0-120 | PM motor: 0-595								
Max. output voltage	V_{rms}	3 x 0 - 0.9 x V_{in}								
Max. output current	A_{rms}	4.0	5.6	7.2	9.5	12.0	14.5	16.4	24.0	32.5 *3
Protection										
Max. fuse	A	16							32	
Short-circuit capacity	A	5000	5000	5000	5000	5000	5000	5000	5000	5000
Motor output		Short-circuit protected between phases								
Motor		Protected by current limit								
Max. overvoltage		< 565 V								
Overload protection		Current and temperature overload protection								
Environment										
Operating temperature	°C/°F	-40°C to +50°C / -40°F to +122°F								
Starting temperature	°C/°F	-40°C to +50°C / -40°F to +122°F								
Storage temperature	°C/°F	-40°C to +70°C / -40°F to +158°F								
Protection rating		IP 54 & 65 / NEMA 4x								
Enclosure material		Aluminum								
Front cover		Plastic								
Weight	kg/lbs	3.0 kg /6.6 lbs			3.9 kg / 8.6 lbs				9.5 kg / 20.9 lbs	
Humidity	% rh	10-95% rh, non-condensing								
Surface		Corrosion resistant according to EN/ISO 9223 Class 4								
Air flow / cooling		Turbulent air speed of min. 3 m/s or 9.84ft/s to achieve max. output power at max. ambient temperature. Turbulent air speed below 3m/s or 9.84ft/s and higher ambient temperature might lead to reduced output power. (3m/s or 9.84ft/s turbulent air speed is equivalent to 6.5m/s or 21.32ft/s laminar air speed)								
Interfaces										
Field bus		Modbus RTU, BACnet MS/TP								
Analogue Inputs		1 input / 0-10 VDC / 4-20mA / PWM								
Analogue Output		1 output / +10 VDC or +24 VDC								
Digital Inputs		2 inputs / Internal pull-up to +24VDC								
Digital Output		1 output / Open collector, Internal pull-up to +10 VDC or +24 VDC								
Status LED		Green/yellow/red								
Features										
Technology		Sinusoidal back-EMF signal controlled via FOC (Field Oriented Control)								
Software updating		Yes, via serial interface								
Motor parameters		Preprogrammed or on-site configuration								
Short-circuit protection		Yes								
Integrated EMC/EMI filters		Yes								
Approvals										
EMC/EMI		EN/BS 61800-3 (C1 & C2)								
LVD		EN/BS 61800-5-1 / UL 61800-5-1								
Product standard		EN/BS 61800 Part 2								
North America		UL -61800-5-1 / CS22.2.274								
Ignition-protected components		IEC/UL60335-2-40, cl.22.116 & cl.22.117 / UL 121201 Class1, Div2								
Overvoltage category		III								
Pollution degree		2								
Altitude		2000m / 6500ft "Without derating"								
Supply earthing system		TN / TT / IT								
RoHS Directive		Yes								
Product approvals		CE / cULus								

Note: Data are valid at: nominal supply voltage, +25°C, and sufficient air flow
* 1: At 3 x 230V supply the output power is derated to 58% / * 2: Motor Power Factor = 0.8 and efficiency = 90% / * 3: H5 OGF variant is limited to 32A

	Type	DV-6024	DV-6030	DV-6040	DV-6055	DV-6075	DV-6110	DV-6150
Frame size		H4					H5	
Power size	kW	2.4	3.0	4.0	5.5	7.5	11	15
Horsepower	Hp	3.2	4.0	5.5	7.5	10.0	15.0	20.0
Efficiency	%	> 96.5%					> 97.5%	
Power supply								
Voltage	VAC	3 x 460 - 600 VAC 50/60 Hz +/-10%						
Supply current at max. load at nominal supply voltage (460V/600V)	A	3.9/3.0	4.6/3.5	6.2/4.7	8.4/6.5	11.5/8.5	Max 23	Max 27
Power factor (cos-phi) at max. load		> 0.9						
Motor output								
Nominal motor power (on shaft) *1	kW	2.4	3.0	4.0	5.5	7.5	11	15
Frequency	Hz	AC motor: 0-120 | PM motor: 0-595						
Max. output voltage	V_{rms}	3 x 0 - 0.9 x V_{in}						
Max. output current	A_{rms}	4.9	5.8	7.7	10.5	18.3	23.5	28 *2
Protection								
Max. fuse	A	16					32	
Short-circuit capacity	A	5000	5000	5000	5000	5000	5000	5000
Motor output		Short-circuit protected between phases						
Motor		Protected by current limit						
Max. overvoltage		< 700V						
Overload protection		Current and temperature overload protection						
Environment								
Operating temperature	°C/°F	-40°C to +50°C / -40°F to +122°F						
Starting temperature	°C/°F	-40°C to +50°C / -40°F to +122°F						
Storage temperature	°C/°F	-40°C to +70°C / -40°F to +158°F						
Protection rating		IP 54 & 65 / NEMA 4x						
Enclosure material		Aluminum						
Front cover		Plastic						
Weight	kg/lbs	3.0 kg /6.6 lbs			3.9 kg / 8.6 lbs		9.5 kg / 20.9 lbs	
Humidity	% rh	10-95% rh, non-condensing						
Surface		Corrosion resistant according to EN/ISO 9223 Class 4						
Air flow / cooling		Turbulent air speed of min. 3 m/s or 9.84ft/s to achieve max. output power at max. ambient temperature. Turbulent air speed below 3m/s or 9.84ft/s and higher ambient temperature might lead to reduced output power. (3m/s turbulent air speed is equivalent to 6.5m/s laminar air speed)						
Interfaces								
Field bus		Modbus RTU, BACnet MS/TP						
Analogue Inputs		1 input / 0-10 VDC / 4-20mA / PWM						
Analogue Output		1 output / +10 VDC or +24 VDC						
Digital Inputs		2 inputs / Internal pull-up to +24VDC						
Digital Output		1 output / Open collector, Internal pull-up to +10 VDC or +24 VDC						
Status LED		Green/yellow/red						
Features								
Technology		Sinusoidal back-EMF signal controlled via FOC (Field Oriented Control)						
Software updating		Yes, via serial interface						
Motor parameters		Preprogrammed or on-site configuration						
Short-circuit protection		Yes						
Integrated EMC/EMI filters		Yes						
Approvals								
EMC/EMI		EN/BS 61800-3 (C1 & C2)						
LVD		EN/BS 61800-5-1 / UL 61800-5-1						
Product standard		EN/BS 61800 Part 2						
North America		UL -61800-5-1 / CS22.2.274						
Ignition-protected components		IEC/UL60335-2-40, cl.22.116 & cl.22.117 / UL 121201 Class1, Div2						
Overvoltage category		III						
Pollution degree		2						
Altitude		2000m / 6500ft "Without derating"						
Supply earthing system		TN / TT / IT						
RoHS Directive		Yes						
Product approvals		CE / cULus						

Note: Data are valid at: nominal supply voltage, +25°C, and sufficient air flow
* 1: Motor Power Factor = 0.8 and efficiency = 90% / * 2: H5 OGF variant is limited to 32A

16.2 Cable requirements

- All cables and conductors used in connection with the DV must comply with local and national rules and regulations.
- The DV product line fulfills the “residential level” for emissions as per EN/BS-61000-6-3.
- The DV product line fulfills the “industrial level” for immunity as per EN/BS-61000-6-2.
- Up to 5 meters shielded motor cables for drive up to 15kW/20hp.
- 15kW/20hp drives are limited to a maximum length of 4-meter motor cables.
- If longer motor cables are used, it is the installer’s responsibility to ensure that the standards in EN/BS-61000-6-2 are fulfilled and that they comply with the industrial level for both immunity and emissions, depending on cable and motor capacity.
- A 6-core, unshielded, 0.066 mm²/ 30 AWG telecommunications cable can be used as a RS-485 interface cable.
- It is recommended that cable types with copper conductors be used.
- For recommended cable dimensions, see table 16.2.

Table 16.2

Power cable *1					
	Cable gland	Cable diameter	Cable size, min.	Cable size, max.	Core sleeve/stripped min.
H1/H1x	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 1.5 mm² / 3 x 16 AWG	3 x 2.5 mm² / 3 x 14 AWG	10 mm / $^{25}/_{64}$ in.
H3	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	4 x 1.5 mm² / 4 x 16 AWG	4 x 4 mm² / 4 x 12 AWG	10 mm / $^{25}/_{64}$ in.
H4	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	4 x 1.5 mm² / 4 x 16 AWG	4 x 4 mm² / 4 x 12 AWG	10-15 mm / $^{25}/_{64}$ - $^{19}/_{32}$ in.
H5	M25	11-18 mm / $^{7}/_{16}$ - $^{45}/_{64}$ in.	4 x 2.5 mm² / 4 x 14 AWG	4 x 10 mm² / 4 x 8 AWG	10-18 mm / $^{25}/_{64}$ - $^{45}/_{64}$ in.
Motor cable *1					
	Cable gland	Cable diameter	Cable size, min.	Cable size, max.	Core sleeve/stripped min.
H1/H1x	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 1.5 mm² / 3 x 16 AWG	3x2.5 mm² / 3x14 AWG	10 mm / $^{25}/_{64}$ in.
H3	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	4 x 1.5 mm² / 4 x 16 AWG	4x4 mm² / 4x12 AWG	10 mm / $^{25}/_{64}$ in.
H4	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	4 x 1.5 mm² / 4 x 16 AWG	4x4 mm² / 4x12 AWG	10-15 mm / $^{25}/_{64}$ - $^{19}/_{32}$ in.
H5	M25	11-18 mm / $^{7}/_{16}$ - $^{45}/_{64}$ in.	4 x 2.5 mm² / 4 x 14 AWG	4x10 mm² / 4 x8 AWG	10-18 mm / $^{25}/_{64}$ - $^{45}/_{64}$ in.
A/D control cable					
	Cable gland	Cable diameter	Cable size, min.	Cable size, max.	Core sleeve/stripped min.
H1/H1x	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	2 x 2 x 0.7 mm² / 2 x 2 x 19 AWG	10 x 2 x 0.7 mm² / 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H3	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	2 x 2 x 0.7 mm² / 2 x 2 x 19 AWG	10 x 2 x 0.7 mm² / 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H4	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	2 x 2 x 0.7 mm² / 2 x 2 x 19 AWG	10 x 2 x 0.7 mm² / 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H5	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	2 x 2 x 0.7 mm² / 2 x 2 x 19 AWG	10 x 2 x 0.7 mm² / 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
RS-485 interface round cable					
	Cable gland	Cable diameter	Cable size, min.	Cable size, max.	Core sleeve/stripped min.
H1/H1x	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 2 x 0.7 mm² / 3 x 2 x 19 AWG	10 x 2 x 0.7 mm²/ 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H3	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 2 x 0.7 mm² / 3 x 2 x 19 AWG	10 x 2 x 0.7 mm²/ 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H4	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 2 x 0.7 mm² / 3 x 2 x 19 AWG	10 x 2 x 0.7 mm²/ 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
H5	M20	7-13 mm / $^{15}/_{64}$ - $^{15}/_{32}$ in.	3 x 2 x 0.7 mm² / 3 x 2 x 19 AWG	10 x 2 x 0.7 mm²/ 10 x 2 x 19 AWG	10 mm / $^{25}/_{64}$ in.
RS-485 interface ribbon cable					
H1 ... H5: Telecommunication cable/ribbon cable, 6-core, unshielded, 0.066 mm²/ 30 AWG					

Note 1: Power and motor cables for OGF variants must be rated for 90˚C
Note 2: All cable dimensions are based on copper wires.

16.3 Fuse and circuit breaker specifications

16.3.1 Overcurrent protection

- Provide overload protection in order to avoid cable overheating in the installation. Overcurrent protection must always be implemented and maintained according to local and national regulations. Suitable for use on a circuit capable of delivering no more than 5,000 rms symmetrical amperes and 480volt maximum. Circuit breakers must be designed for protection in a circuit capable of supplying a maximum of 10,000 Arms (symmetrical), 480 V maximum; or the value rated on the individual circuit breaker.

16.3.2 Circuit breaker and fuse rating

- To ensure compliance with UL or IEC 61800-5-1, use the breakers or fuses listed below in table 25.1t. Circuit breakers must be designed for protection in a circuit capable of supplying a maximum of 10,000 Arms (symmetrical), 480 V. In the event of malfunction, failure to follow the recommended protection measures may result in damage to the drive / frequency converter.
  Circuit breaker must comply with UL 489.

Table 16.3.2

Enclosure	Nominal power rating	Circuit breaker		Fuses	
		Rec. UL	Max. UL	Rec. UL	Max. non-UL
				Type	
				RK5, RK1,J, T,CC	gG
H1	0.55	4	15	6	16
	0.75	6	20	6	16
	1.1	8	30	15	16
H1x	1.3	10	35	15	16
H3	1.5	4	15	6	16
	2.4	6	20	6	16
	3.0	8	25	15	16
H4	4.0	10	35	15	16
	5.5	15	50	20	16
	6.5	15	60	25	16
	7.5	20	70	25	16
H5	11.0	30	100	35	32
	15.0	35	125	40	40

17. Maintenance, Storage and Disposal

17.1 Maintenance

- The DV is maintenance-free under normal operating conditions and load profiles.
- The cooling fins must be kept free of dust, dirt and other foreign matter so that air can pass over them unobstructed. Deposits of dust, dirt or other foreign matter on and between the cooling fins will prevent the DV from cooling and impair performance.
- The cooling fins may become very hot (max. 95°C / 203°F under normal operating conditions).
- The DV cannot be repaired on site.

***Never** attempt to repair a defective unit! Contact your supplier to obtain a replacement.*

17.2 Storage

- The DV should be stored indoors, preferably in the original packing.
  Recommended: a dry room with temperatures between -40°C / -40°F and +50°C /122°F, and a relative humidity below 70%. When the DV is stored as recommended, the drive can be stored for years from the date of manufacture. The DV can also be stored in a vacuum seal in a maximum of 300mBar / 225 torr.

17.3 Disposal

- The DV contains electronic components and must not be disposed of with household waste.
- The DV must be disposed of in accordance with applicable local rules and regulations.
- The DV meets the requirements with regard to the marking of electronic waste as stated in the European WEEE Directive 2012/19/EU.

18. Troubleshooting

18.1 Alarms and overview

- The DV has a built-in warning and alarm monitor that monitors optimal fault-free operation and triggers a warning or alarm if operational or performance issues are observed.
  Warnings are “non-critical” alarms that reduce motor performance, whereas alarms are “critical” and will stop the DV. Once the alarm situation passes, the alarm will automatically reset and the DV will restart.
  If the maximum number of restarts (factory setting: 5 times / 60 min.) is exceeded, the alarm must be reset manually. The alarm can be reset by means of a RS-485 interface command, via an DVHMI-35T, or it will automatically reset if the power is disconnected for longer than 60 seconds. Warnings and alarms can be read via the DV-HMI-35T or RS-485 interface.

Alarm/warning overview	Motor operation/response	Trigger	Possible solutions
V LO Alarm → Supply voltage low - Alarm	Drive will report Supply voltage low and Alarm stop. - Motor is not allowed to run.	✓ Supply voltage to the DV is too low.	1. Check supply voltage. 2. Check cables /wiring for damage and/or poor connections - if damaged replace.
V HI Alarm → Supply voltage too high - Alarm	Drive will report Supply voltage high and Alarm stop. - Motor is not allowed to run.	✓ Supply voltage to DV is too high.	1. Check input supply, if high reduce voltage. 2. Configuration for braking set wrong, allowing for DC link voltage to be pumped up through the motor - Check if fan config file is correct - reconfigure setup if needed. 3. Instability in load when supplied with max. voltage - secure load or reduce supply voltage
I HI alarm → Output current high - Alarm	Drive will report Output current high and Alarm stop. - Motor is not allowed to run.	✓ Short circuit in motor cable. ✓ Short circuit in one or more motor windings. ✓ IGBT failure	1. Check motor for shorts - if motor failed, exchange. 2. Check motor cables for damaged and shorts - if damaged, exchange. 3. Disconnect mains from drive and check motor connections for shorts - if shorted, exchange drive.
Temperature High → Temperature of drive too high (>95 °C) - Warning	Reduced drive performance	✓ Cooling of the DV enclosure too low. ✓ Insufficient air circulation around the DV. ✓ Air temperature around the DV is too high.	1. Check for and enable proper airflow. 2. Check cooling fins - clean if needed. 3. If external fan mounted - check if external fan spins, replace if damaged / not working.
Input phase Error → Main’s phase missing (L1, L2, L3) - Warning	Reduced drive performance	✓ Missing phase in supply voltage to the DV ✓ Large imbalance in supply voltage.	Check input supply, wiring and fuses.
Rotor blocked → Rotor/ Fan unable to rotate - Warning/Alarm	If occurs, the set numbers of retries (5), within 60 minutes, blocked rotor alarm and Alarm stop is given - Motor is not allowed to run.	✓ Configuration not matching application ✓ The rotor is unable to rotate due to a mechanical blockage of the rotor or fan.	1. Check configuration - if wrong, change configuration 2. Check if fan is blocked/unable to rotate - remove obstacles for fan to be able to spin. 3. If rotor is locked, exchange motor.
Current limit → Motor has reached it’s current limit - Warning	Reduced drive performance	✓ The DV has reached the limit for maximum output power. ✓ The connected motor is larger than allowed for the chosen DV. ✓ The load is too big for the connected motor. ✓ The drive is ramping up the fan too fast.	1. Increase ramp time. 2. Check configuration. 3. Increase maximum motor current to match motors nameplate.
V Limit → Voltage limit - Warning	Reduced drive performance	Displayed in case of derating due to insufficient motor voltage (e.g. insufficient supply voltage to run the motor at the requested speed).	1. Check if Mains supply matches motor voltage - output voltage for motor is approx. Mains voltage x 0.9. 2. Enable field weakening - allows for conversion of excess current to voltage to a limited degree.
Rotor direction → Rotating in the wrong direction - Alarm	Motor operation stops after windmilling timeout.	✓ Windmilling in the opposite direction during the startup process. ✓ Displayed if windmilling situation lasts for more than the specified time	1. Check for draft in duct or forced wind from other source
EEPROM Error → Fault in internal EEPROM circuit - Warning	Drive will not operate with requested configuration file	✓ Incorrectly chosen configuration file - tried to download a configuration file which is not contained in the DV. ✓ The DV is defective.	1. If error occurred whilst update was attempted, power cycle drive and retry update attempt. - Check that the correct configuration / firmware files are being used. 2. Replace drive.
Internal Stop → Alarm stop - Alarm	Motor stops	Displayed when an alarm/warning/ error has exceeded its maximum number of retries attempts	1. Reset alarm via Modbus or digital input 2. Power cycle drive

Alarm/warning overview	Motor operation/response	Trigger	Possible solutions
Earth fault (Only frame size H5) - Alarm	If occurs, the set numbers of retries (5), within 60 minutes alarm is given and motor stops	✓ Earth fault on motor cables or motor windings.	1. Check earth connections on drive and motor - if connection is loose or missing, mount cables correctly. 2. Check motor cables for damage - if damaged, replace cables. 3. Check motor windings - if fault is detected, replace motor. 4. Remove power and motor from drive and measure for shortage between motor output and earth.
Motor phase error (U, V, W) - Alarm	Drive will report Motor phase error and Alarm stop. - Motor is not allowed to run.	✓ One or more cables between drive and motor are disconnected. ✓ One or more motor windings are disconnected.	1. Check wires in motor phase terminals on drive. 2. Check motor wires for damaged - if damaged, exchange. 3. Check motor windings - if fault is detected, replace motor.
Communication error MOC → Internal communication fault - Alarm	Drive will not operate	✓ During the process of updating the MOC configuration file, communication was inadvertently disconnected. ✓ If the alarm goes off during normal operation, it indicates a defective DV.	1. MOC failure – Attempt to reinstall MOC software. 2. Replace drive.
V Ripple → Ripple voltage too high - warning	Reduced drive performance	✓ Imbalance on voltage supply. ✓ Load imbalance causing adaptive control difficulties	1. Check input supply. 2. Check load for defects.
Ext. 24VDC supply overload - Warning	Drive will switch off external +24V supply - Motor is still allowed to run.	✓ Overloading or short circuit on +24V voltage supply	1. Check ext. 24v output for external shortage causing overload. 2. If overload has been removed from +24VDC output and alarm can not be reset, drive might have suffered damage
MOC in bootloader - Alarm	Drive will not operate	✓ Displayed in case firmware update of MOC has failed	1. Attempt download of MOC software.
Communication error IOM - Warning	Displayed as a warning, I/O module function not usable	✓ Displayed in case communication to I/O Module is not detected	1. Check I/O module for correct installation – If I/O module is not needed it can be disabled in the UDF
Motor overheat (IOM) → Motor is overheating - Warning	If occurs, the set numbers of retries (5), within 60 minutes alarm is given along with Alarm stop. - Motor is not allowed to run.	✓ Displayed in case the motor has overheated.	1. Check wiring, motor and thermistor. 2. Check configuration - pay attention to max current setting, it most not exceed motor max. current.
Windmilling – Warning	If occurs Motor is spinning in the wrong direction.	✓ Displayed in case motor is spinning in the other direction compared to specified in setup	1. Check possibilities for drafts or winds causing backwards rotation, and remove possibilities. 2. Enable passive or active holding torque to keep fan from rotating backwards.
IO Config mismatch	Displayed as a warning, I/O function not usable.	✓ Displayed in case the same function has been assigned to several in- or outputs	Check configuration of in- and outputs and correct the assigned functions.
I_in_limit - Warning	If occurs, the set numbers of retries (5), within 60 minutes, alarm is given along with Alarm stop. - Motor is not allowed to run.	✓ If the input current is at the limit, set for DC bus current, Warning will be reported	1. Check configuration, correct if wrong config is used. 2. Check and correct current limit. 3. Hardware of drive might be damaged, check and replace drive if damage is found.
LowSpeed - Warning	If occurs, the set numbers of retries (5), within 60 minutes, alarm is given along with Alarm stop. - Motor is not allowed to run.	✓ If the low speed function is active and speed is lower than specified in configuration, a warning will be reported.	1. Check speed reference and control type set. 2. Check configuration, correct if wrong config is used. 3. Hardware of drive might be damaged, check and replace drive if damage is found.
Undervoltage17V - Alarm	Drive will not operate - Undervoltage17V is reported along with Alarm stop.	✓ Displayed in case of detection of an undervoltage of the 17V supply	1. Check for hardware of drive damage of drive. 2. Replace drive.
Cooling fan missing - Warning	Drive will derate when high temperature has been reached and will therefor not be able to deliver the desired effect.	✓ Displayed in case there is no feedback signal from the cooling fan.	1. Check connection between drive and external cooling fan. 2. Replace fan.
Fan vibration high - Warning	If the drive is subjecte to high vibration levels continuously, it will derate, until the vibration level has reached an acceptable level.	✓ Displayed if the vibration level of the drive is higher than the limits set in the FCF	1. Check for correct configuration, correct if needed. 2. Check for imbalance of fan. 3. Check for other sources of vibration, remove or stabilize to reduce vibration level
Drive vibration critical - Warning	If occurs, the set numbers of retries (5), within 60 minutes, alarm is given along with Alarm stop. - Motor is not allowed to run.	✓ Displayed if the vibration level of the drive is higher than the limit set in the CCF	1. Check for imbalance of fan. 2. Check for other sources of vibration, remove or stabilize to reduce vibration level

18.2 LED indication

- The DV is equipped with a two-color LED that indicates operating status.
- The LED is located on the underside of the DV, beside the entry point for the mains cable. See fig. 18.2.
- Lights are constantly green when mains voltage is connected.
- Flashes green when RS-485 interface communication is active.
- Lights are constantly red when at least one critical alarm is active.
- The LED can be set (Show alarm on LED) by Modbus or DV PC Tool to flash in a sequence in order to indicate where the error has arisen.
  1 Flash = Supply issue
  3 Flashes = Motor issue
  5 Flashes = Internal DV issue
- Flashes red when at least one warning is active

Figure 18.2