INVERTEK DRIVES
www.invertek.co.uk

User Guide

OPTIDRIVE™ HVAC

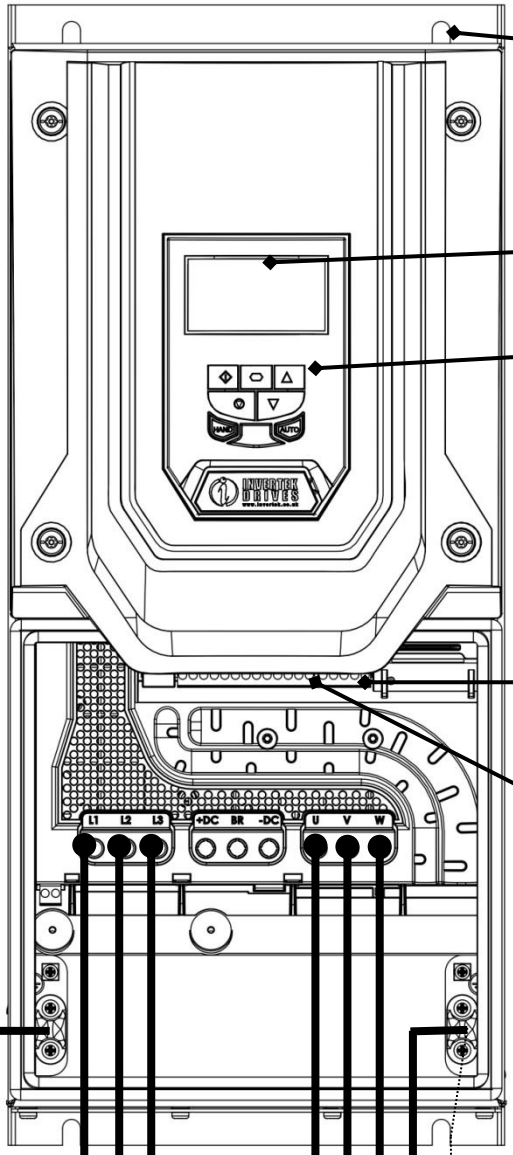
AC Variable Speed Drives
0.75 - 250kW / 1HP - 350HP
200-480V Single and 3 Phase Input

IP20
IP66 / NEMA 4X
IP55 / NEMA 12
IP40

Installation and Operating Instructions

Optidrive HVAC Start Up Guide

OPTIDRIVE HVAC (IP55 Enclosure).



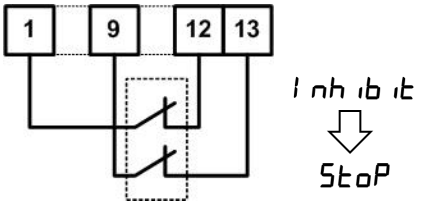
Mechanical Mounting

Information can be found in section 3.7 on page 16

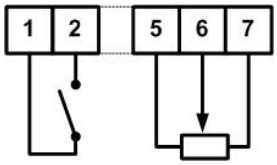
HVAC Display
(Status, Diagnostics, and Programming)

Keypad Operation can be found in section 5.5 on page 29

Hardware Enable Circuit
Link the terminals as shown, optionally through contacts to enable drive operation.



Control Terminal
Configuration based on factory settings



Close the switch to run (enable)
Open the switch to stop

Motor Cable
For correct cable size, see Technical Data on page 66
Observe the maximum permissible motor cable length.
For Motor cable lengths > 50 metres, an output filter is recommended.
Use a screened (shielded cable). The shield should be bonded to earth at both ends.

Fuses or MCB
Check Drive Rating info in section 13.4

PE L1 L2 L3

AC Supply Connection
200 – 240 Volts + / - 10%
380 – 380 Volts + / - 10%
Check Drive Input Voltage Ranges on page 66

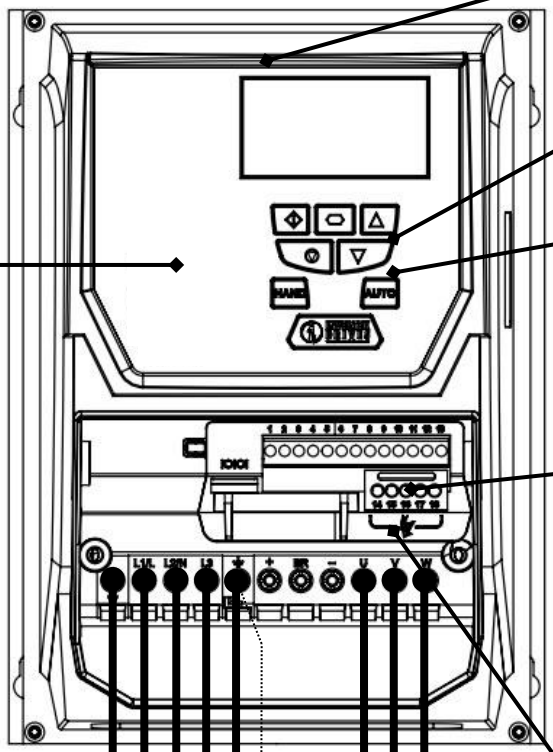
Motor Connection

Check for Star or Delta connection according to the motor voltage rating in section 4.5.

Motor Nameplate Details
Motor Rated Voltage: P1-07
Motor Rated Current: P1-08
Motor Rated Frequency: P1-09
Motor Rated Speed (Optional): P1-10

Optidrive HVAC Start Up Guide

OPTIDRIVE HVAC (IP66 Enclosure).

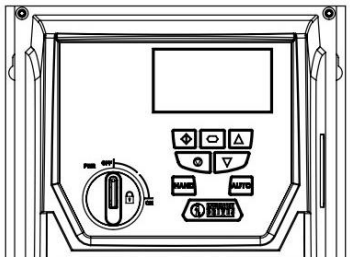


Mechanical Mounting
Information can be found in section on page 16

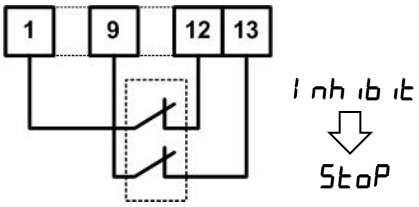
HVAC Display
(Status, Diagnostics, and Programming)

Keypad Operation can be found in section 5.5 on page 29

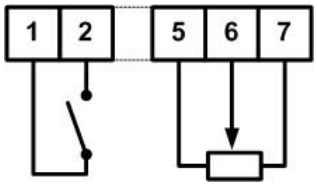
Applies to Switched version only
In-built Isolator:
Mains Power On / Off



Hardware Enable Circuit
Link the terminals as shown, optionally through switch contacts to enable drive operation.



Control Terminal
Configuration based on factory settings



Run / Stop **10K Pot**
Close the switch to run (enable)
Open the switch to stop

Fuses or MCB
Check Drive Rating info in section 13.4.

Motor Cable Sizes
Check the rating information in section 13.3 on page 66

PE L1 L2 L3

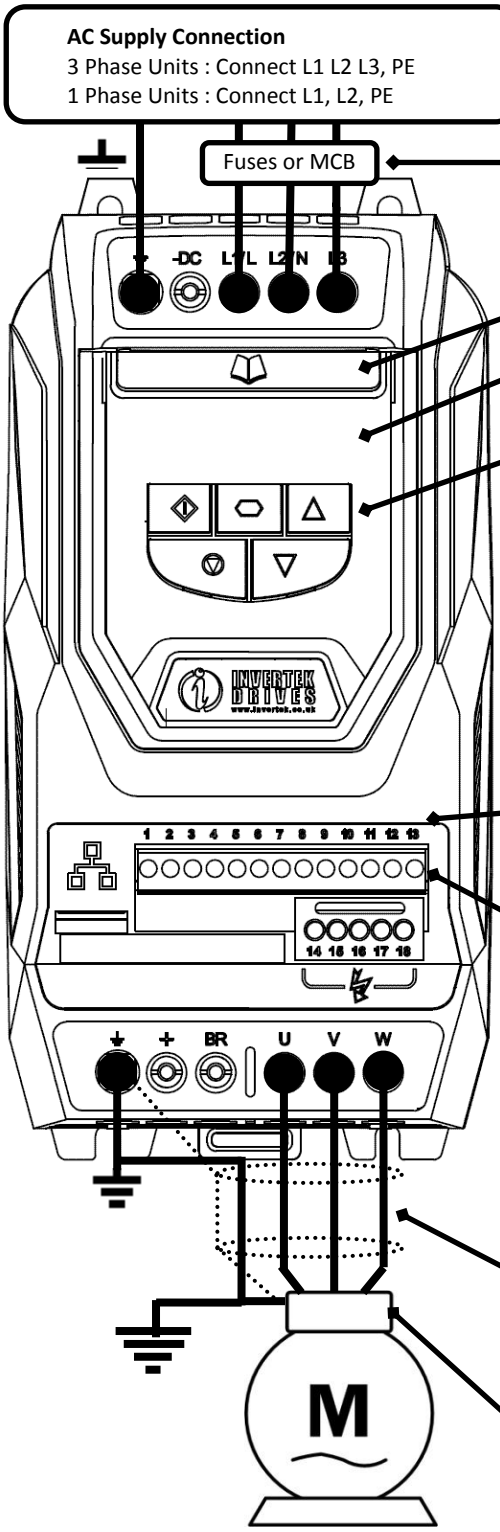
AC Supply Connection
200 – 240 Volts + / - 10%: 1 / 3 Phase
380 – 380 Volts + / - 10%: 3 Phase
Check Drive Input Voltage Ranges on page 66

Motor Connections
Check for Star or Delta connection according to the motor voltage rating – se section 4.5 on page 25

Motor Nameplate Details
Motor Rated Voltage: P1-07
Motor Rated Current: P1-08
Motor Rated Frequency: P1-09
Motor Rated Speed (Optional): P1-10

Optidrive HVAC Start Up Guide

OPTIDRIVE HVAC (IP20 Enclosure).



AC Supply Connection
3 Phase Units : Connect L1 L2 L3, PE
1 Phase Units : Connect L1, L2, PE

Supply Voltage
200 – 240 Volts + / - 10%
380 – 380 Volts + / - 10%

Fuses or MCB
- Check the Technical Data in section 13 on page 66

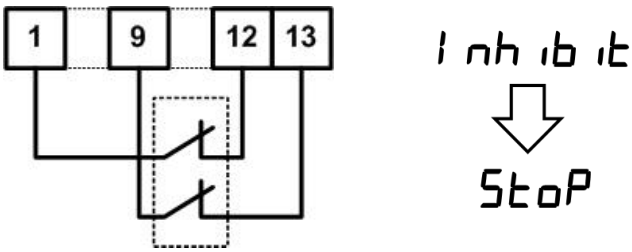
Help Card

Display Information can be found in section 5.4 on page 28

Keypad Operation can be found in section 5.2 on page 27

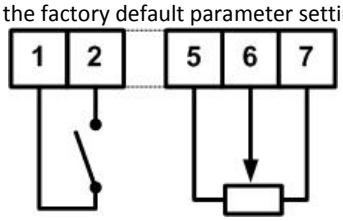
IMPORTANT!

Hardware Enable Circuit



Link the terminals as shown, optionally through contacts to enable drive operation

Control Terminals
Based on the factory default parameter settings



Run – Stop **10K Speed Pot**

Close the switch to run (enable), open to stop

Motor Cable
- For correct cable size see Technical Data on page 66
- Observe the maximum permissible motor cable length
- For Motor cable lengths > 50 metres, an output filter is recommended
- Use a screened (shielded cable)

Motor Connection
- Check for Star or Delta connection according to the motor voltage rating - see section 4.5 on page 25

- **Motor Nameplate Details**
- Motor Rated Voltage : P1-07
- Motor Rated Current : P1-08
- Motor Rated Frequency : P1-09
- Motor Rated Speed (Optional) : P1-10

Declaration of Conformity:

Invertek Drives Ltd hereby states that the Optidrive ODV-2 product range conforms to the relevant safety provisions of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC and has been designed and manufactured in accordance with the following harmonised European standards:

EN 61800-5-1: 2003	Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
EN 61800-3 2nd Ed: 2004	Adjustable speed electrical power drive systems. EMC requirements and specific test methods
EN 55011: 2007	Limits and Methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment (EMC)
EN60529 : 1992	Specifications for degrees of protection provided by enclosures

Electromagnetic Compatibility

All Optidrives are designed with high standards of EMC in mind. All versions suitable for operation on Single Phase 230 volt and Three Phase 400 volt supplies and intended for use within the European Union are fitted with an internal EMC filter. This EMC filter is designed to reduce the conducted emissions back into the supply via the power cables for compliance with harmonised European standards.
It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with the EMC Directive 2004/108/EC. When using an Optidrive with an internal or optional external filter, compliance with the following EMC Categories, as defined by EN61800-3:2004 can be achieved:

<table>
<tr><th rowspan="2">Drive Type / Rating</th><th colspan="3">EMC Category</th></tr>
<tr><th>Cat C1</th><th>Cat C2</th><th>Cat C3</th></tr>
<tr><td>1 Phase, 230 Volt Input
ODV-2-x2xxx-1xFxx-xx</td><td colspan="3">No additional filtering required
Use shielded motor cable</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="2">3 Phase, 400 Volt Input
IP20 & IP66 Models
ODV-2-x4xxx-3xFxx-xx</td><td>Use Additional External Filter</td><td colspan="2">No additional filtering required</td></tr>
<tr><td colspan="3">Use screened motor cable</td></tr>
<tr><td rowspan="2">3 Phase, 400 Volt Input
IP55 Models
ODV-2-x4xxx-3xFxN-xx</td><td colspan="2">Use Additional External Filter</td><td>No Additional Filtering Required</td></tr>
<tr><td colspan="3">Use screened motor cable</td></tr>
<tr><td>Note</td><td colspan="3">For motor cable lengths greater than 100m, an output dv / dt filter must be used, please refer to the Invertek Stock Drives Catalogue for further details</td></tr>
</table>

All Invertek Optidrive HVAC units carry a 2 year warranty against manufacturing defects from the date of manufacture. The manufacturer accepts no liability for any damage caused during or resulting from transport, receipt of delivery, installation or commissioning. The manufacturer also accepts no liability for damage or consequences resulting from inappropriate, negligent or incorrect installation, incorrect adjustment of the operating parameters of the drive, incorrect matching of the drive to the motor, incorrect installation, unacceptable dust, moisture, corrosive substances, excessive vibration or ambient temperatures outside of the design specification.

The local distributor may offer different terms and conditions at their discretion, and in all cases concerning warranty, the local distributor should be contacted first.

This user guide is the "original instructions" document. All non-English versions are translations of the "original instructions".

Contents of this User Guide are believed to be correct at the time of printing. In the interest of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.

The contents of this User Guide are believed to be correct at the time of printing. In the interest of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.

This User Guide is for use with version 1.20 Firmware.

User Guide 1.20

Invertek Drives Ltd adopts a policy of continuous improvement and whilst every effort has been made to provide accurate and up to date information, the information contained in this User Guide should be used for guidance purposes only and does not form the part of any contract.

1. Introduction

1.1. Important safety information

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

	**Danger : Indicates a risk of electric shock, which, if not avoided, could result in damage to the equipment and possible injury or death.**
	**Danger : Indicates a potentially hazardous situation other than electrical, which if not avoided, could result in damage to property.**
	This variable speed drive product (Optidrive) is intended for professional incorporation into complete equipment or systems as part of a fixed installation. If installed incorrectly it may present a safety hazard. The Optidrive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction. Only qualified electricians are allowed to install and maintain this product.
	System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must carefully read this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the Optidrive, including the specified environmental limitations.
	Do not perform any flash test or voltage withstand test on the Optidrive. Any electrical measurements required should be carried out with the Optidrive disconnected.
	Electric shock hazard! Disconnect and ISOLATE the Optidrive before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply. Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.
	Where supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.
	Ensure correct earthing connections and cable selection as per defined by local legislation or codes. The drive may have a leakage current of greater than 3.5mA; furthermore the earth cable must be sufficient to carry the maximum supply fault current which normally will be limited by the fuses or MCB. Suitably rated fuses or MCB should be fitted in the mains supply to the drive, according to any local legislation or codes.
	Do not carry out any work on the drive control cables whilst power is applied to the drive or to the external control circuits.
	Within the European Union, all machinery in which this product is used must comply with Directive 98/37/EC, Safety of Machinery. In particular, the machine manufacturer is responsible for providing a main switch and ensuring the electrical equipment complies with EN60204-1.
	The level of integrity offered by the Optidrive control input functions – for example stop/start, forward/reverse and maximum speed, is not sufficient for use in safety-critical applications without independent channels of protection. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment and further protection provided where needed.
	The driven motor can start at power up if the enable input signal is present.
	The STOP function does not remove potentially lethal high voltages. ISOLATE the drive and wait 10 minutes before starting any work on it. Never carry out any work on the Drive, Motor or Motor cable whilst the input power is still applied.
	The Optidrive can be programmed to operate the driven motor at speeds above or below the speed achieved when connecting the motor directly to the mains supply. Obtain confirmation from the manufacturers of the motor and the driven machine about suitability for operation over the intended speed range prior to machine start up.
	Do not activate the automatic fault reset function on any systems whereby this may cause a potentially dangerous situation.
	IP55 and IP66 drives provide their own pollution degree 2 environments. IP20 drives must be installed in a pollution degree 2 environment, mounted in a cabinet with IP54 or better.
	Optidrives are intended for indoor use only
	When mounting the drive, ensure that sufficient cooling is provided. Do not carry out drilling operations with the drive in place, dust and swarf from drilling may lead to damage.
	The entry of conductive or flammable foreign bodies should be prevented. Flammable material should not be placed close to the drive
	Relative humidity must be less than 95% (non-condensing).
	Ensure that the supply voltage, frequency and no. of phases (1 or 3 phase) correspond to the rating of the Optidrive as delivered.
	Never connect the mains power supply to the Output terminals U, V, W.
	Do not install any type of automatic switchgear between the drive and the motor
	Wherever control cabling is close to power cabling, maintain a minimum separation of 100 mm and arrange crossings at 90 degrees Ensure that all terminals are tightened to the appropriate torque setting
	Do not attempt to carry out any repair of the Optidrive. In the case of suspected fault or malfunction, contact your local Invertek Drives Sales Partner for further assistance.

2. General Information and Ratings

2.1. Drive model numbers

2.1.1. IP20 Enclosed Units

200-240V ±10% - 1 Phase Input					
kW Model	**kW**	**HP Model**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-22075-1KF12-SN[1)]	0.75	ODV-2-22010-1HF12-SN[1)]	1	4.3	2
ODV-2-22150-1KF12-SN[1)]	1.5	ODV-2-22020-1HF12-SN[1)]	2	7	2
ODV-2-22220-1KF12-SN[1)]	2.2	ODV-2-22030-1HF12-SN[1)]	3	10.5	2
200-240V ±10% - 3 Phase Input					
kW Model	**kW**	**HP Model**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-22075-3KF12-SN[1)]	0.75	ODV-2-22010-3HF12-SN[1)]	1	4.3	2
ODV-2-22150-3KF12-SN[1)]	1.5	ODV-2-22020-3HF12-SN[1)]	2	7	2
ODV-2-22220-3KF12-SN[1)]	2.2	ODV-2-22030-3HF12-SN[1)]	3	10.5	2
ODV-2-32040-3KF12-SN1[)]	4	ODV-2-32050-3HF12-SN[1)]	5	18	3
ODV-2-32055-3KF12-SN[1)]	5.5	ODV-2-32075-3HF12-SN[1)]	7.5	24	3
380-480V ±10% - 3 Phase Input					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-24075-3KF12-SN[1)]	0.75	ODV-2-24010-3HF12-SN[1)]	1	2.2	2
ODV-2-24150-3KF12-SN[1)]	1.5	ODV-2-24020-3HF12-SN[1)]	2	4.1	2
ODV-2-24220-3KF12-SN[1)]	2.2	ODV-2-24030-3HF12-SN[1)]	3	5.8	2
ODV-2-24400-3KF12-SN[1)]	4	ODV-2-24050-3HF12-SN[1)]	5	9.5	2
ODV-2-34055-3KF12-SN[1)]	5.5	ODV-2-34075-3HF12-SN[1)]	7.5	14	3
ODV-2-34075-3KF12-SN[1)]	7.5	ODV-2-34100-3HF12-SN[1)]	10	18	3
ODV-2-34110-3KF12-SN[1)]	11	ODV-2-34150-3HF12-SN[1)]	15	24	3

1) Note : The final two characters of the model number relate to available factory build options as follows

-SN Standard Seven Segment LED Display, standard PCB coating

-SC Standard Seven Segment LED Display, additional PCB conformal coating

2.1.2. IP66 Enclosed Units

200-240V ±10% - 1 Phase Input							
kW Model		**kW**	**HP Model**		**HP**	**Output**	**Frame**
Non Switched	**Switched**		**Non Switched**	**Switched**		**Current (A)**	**Size**
ODV-2-22075-1KF1X-TN[1)]	ODV-2-22075-1KF1D-TN[1)]	0.75	ODV-2-22010-1HF1X-TN[1)]	ODV-2-22010-1HF1D-TN[1)]	1	4.3	2
ODV-2-22150-1KF1X-TN[1)]	ODV-2-22150-1KF1D-TN[1)]	1.5	ODV-2-22020-1HF1X-TN[1)]	ODV-2-22020-1HF1D-TN[1)]	2	7	2
ODV-2-22220-1KF1X-TN[1)]	ODV-2-22220-1KF1D-TN[1)]	2.2	ODV-2-22030-1HF1X-TN[1)]	ODV-2-22030-1HF1D-TN[1)]	3	10.5	2
200-240V ±10% - 3 Phase Input							
kW Model Number		**kW**	**HP Model Number**		**HP**	**Output**	**Frame**
Non Switched	**Switched**		**Non Switched**	**Switched**		**Current (A)**	**Size**
ODV-2-22075-3KF1X-TN[1)]	ODV-2-22075-3KF1D-TN[1)]	0.75	ODV-2-22010-3HF1X-TN[1)]	ODV-2-22010-3HF1D-TN[1)]	1	4.3	2
ODV-2-22150-3KF1X-TN[1)]	ODV-2-22150-3KF1D-TN[1)]	1.5	ODV-2-22020-3HF1X-TN[1)]	ODV-2-22020-3HF1D-TN[1)]	2	7	2
ODV-2-22220-3KF1X-TN[1)]	ODV-2-22220-3KF1D-TN[1)]	2.2	ODV-2-22030-3HF1X-TN[1)]	ODV-2-22030-3HF1D-TN[1)]	3	10.5	2
ODV-2-32040-3KF1X-TN[1)]	ODV-2-32040-3KF1D-TN[1)]	4	ODV-2-32050-3HF1X-TN[1)]	ODV-2-32050-3HF1D-TN[1)]	5	18	3
380-480V ±10% - 3 Phase Input							
kW Model Number		**kW**	**HP Model Number**		**HP**	**Output**	**Frame**
Non Switched	**Switched**		**Non Switched**	**Switched**		**Current (A)**	**Size**
ODV-2-24075-3KF1X-TN[1)]	ODV-2-24075-3KF1D-TN[1)]	0.75	ODV-2-24010-3HF1X-TN[1)]	ODV-2-24010-3HF1D-TN[1)]	1	2.2	2
ODV-2-24150-3KF1X-TN[1)]	ODV-2-24150-3KF1D-TN[1)]	1.5	ODV-2-24020-3HF1X-TN[1)]	ODV-2-24020-3HF1D-TN[1)]	2	4.1	2
ODV-2-24220-3KF1X-TN[1)]	ODV-2-24220-3KF1D-TN[1)]	2.2	ODV-2-24030-3HF1X-TN[1)]	ODV-2-24030-3HF1D-TN[1)]	3	5.8	2
ODV-2-24400-3KF1X-TN[1)]	ODV-2-24400-3KF1D-TN[1)]	4	ODV-2-24050-3HF1X-TN[1)]	ODV-2-24050-3HF1D-TN[1)]	5	9.5	2
ODV-2-34055-3KF1X-TN[1)]	ODV-2-34055-3KF1D-TN[1)]	5.5	ODV-2-34075-3HF1X-TN[1)]	ODV-2-34075-3HF1D-TN[1)]	7.5	14	3
ODV-2-34075-3KF1X-TN[1)]	ODV-2-34075-3KF1D-TN[1)]	7.5	ODV-2-34100-3HF1X-TN[1)]	ODV-2-34100-3HF1D-TN[1)]	10	18	3

1) Note : The final two characters of the model number relate to available factory build options as follows

-TN OLED Text Display, standard PCB coating

-SC OLED Text Display, additional PCB conformal coating

2.1.3. IP55 Enclosed Units

200-240V ±10% - 3 Phase Input					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-42055-3KF1N-TN[1)]	5.5	ODV-2-42075-3HF1N-TN[1)]	7.5	24	4
ODV-2-42075-3KF1N-TN[1)]	7.5	ODV-2-42100-3HF1N-TN[1)]	10	30	4
ODV-2-42110-3KF1N-TN[1)]	11	ODV-2-42150-3HF1N-TN[1)]	15	46	4
ODV-2-52150-3KF1N-TN[1)]	15	ODV-2-52020-3HF1N-TN[1)]	20	61	5
ODV-2-52185-3KF1N-TN[1)]	18.5	ODV-2-52025-3HF1N-TN[1)]	25	72	5
ODV-2-52022-3KF1N-TN[1)]	22	ODV-2-52030-3HF1N-TN[1)]	30	90	5
ODV-2-62030-3KF1N-TN[1)]	30	ODV-2-62040-3HF1N-TN[1)]	40	110	6
ODV-2-62037-3KF1N-TN[1)]	37	ODV-2-62050-3HF1N-TN[1)]	50	150	6
ODV-2-62045-3KF1N-TN[1)]	45	ODV-2-62060-3HF1N-TN[1)]	60	180	6
ODV-2-62055-3KF1N-TN[1)]	55	ODV-2-62075-3HF1N-TN[1)]	75	202	6
ODV-2-72075-3KF1N-TN[1)]	75	ODV-2-72100-3HF1N-TN[1)]	100	248	7

380-480V ±10% - 3 Phase Input					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-44110-3KF1N-TN[1)]	11	ODV-2-44150-3HF1N-TN[1)]	15	24	4
ODV-2-44150-3KF1N-TN[1)]	15	ODV-2-44200-3HF1N-TN[1)]	20	30	4
ODV-2-44185-3KF1N-TN[1)]	18.5	ODV-2-44250-3HF1N-TN[1)]	25	39	4
ODV-2-44220-3KF1N-TN[1)]	22	ODV-2-44300-3HF1N-TN[1)]	30	46	4
ODV-2-54300-3KF1N-TN[1)]	30	ODV-2-54040-3HF1N-TN[1)]	40	61	5
ODV-2-54370-3KF1N-TN[1)]	37	ODV-2-54050-3HF1N-TN[1)]	50	72	5
ODV-2-54045-3KF1N-TN[1)]	45	ODV-2-54060-3HF1N-TN[1)]	60	90	6
ODV-2-64055-3KF1N-TN[1)]	55	ODV-2-64075-3HF1N-TN[1)]	75	110	6
ODV-2-64075-3KF1N-TN[1)]	75	ODV-2-64120-3HF1N-TN[1)]	120	150	6
ODV-2-64090-3KF1N-TN[1)]	90	ODV-2-64150-3HF1N-TN[1)]	150	180	6
ODV-2-64110-3KF1N-TN[1)]	110	ODV-2-64175-3HF1N-TN[1)]	175	202	7
ODV-2-74132-3KF1N-TN[1)]	132	ODV-2-74200-3HF1N-TN[1)]	200	240	7
ODV-2-74160-3KF1N-TN[1)]	160	ODV-2-74250-3HF1N-TN[1)]	250	302	7

1) Note : The final two characters of the model number relate to available factory build options as follows

-TN OLED Text Display, standard PCB coating

-TC OLED Text Display, additional PCB conformal coating

2.1.4. IP40 Enclosed Units

380-480V ±10% - 3 Phase Input					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
ODV-2-84200-3KF14-TN[1)]	200	ODV-2-84300-3HF14-TN[1)]	300	370	8
ODV-2-84250-3KF14-TN[1)]	250	ODV-2-84350-3HF14-TN[1)]	350	450	8

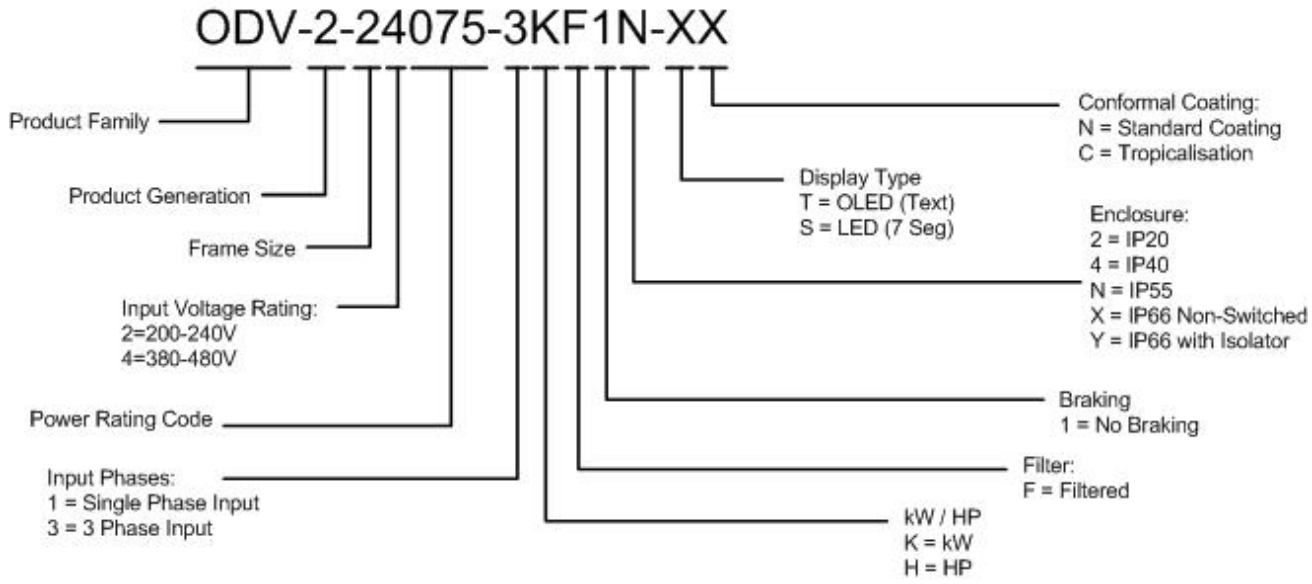
1) Note : The final two characters of the model number relate to available factory build options as follows

-TN OLED Text Display, standard PCB coating

-SC OLED Text Display, additional PCB conformal coating

2.2. Identifying the Drive by Model Number

Each drive can be identified by its model number, shown below. The model number is on the shipping label and the drive nameplate. The model number includes the drive and factory fitted options.



3. Mechanical Installation

3.1. General

- The Optidrive should be mounted in a vertical position only, on a flat, flame resistant, vibration free mounting using the integral mounting holes or DIN Rail clip (Frame Size 2 only).
- The Optidrive must be installed in a pollution degree 1 or 2 environment only.
- Do not mount flammable material close to the Optidrive
- Ensure that the minimum cooling air gaps, as detailed in sections 3.6, 3.7 and are left clear
- Ensure that the ambient temperature range does not exceed the permissible limits for the Optidrive given in section 13.1
- Provide suitable clean, moisture and contaminant free cooling air sufficient to fulfil the cooling requirements of the Optidrive

3.2. Before Installation

- Carefully Unpack the Optidrive and check for any signs of damage. Notify the shipper immediately if any exist.
- Check the drive rating label to ensure it is of the correct type and power requirements for the application.
- To prevent accidental damage always store the Optidrive in its original box until required. Storage should be clean and dry and within the temperature range –40°C to +60°C

3.3. UL Compliant Installation

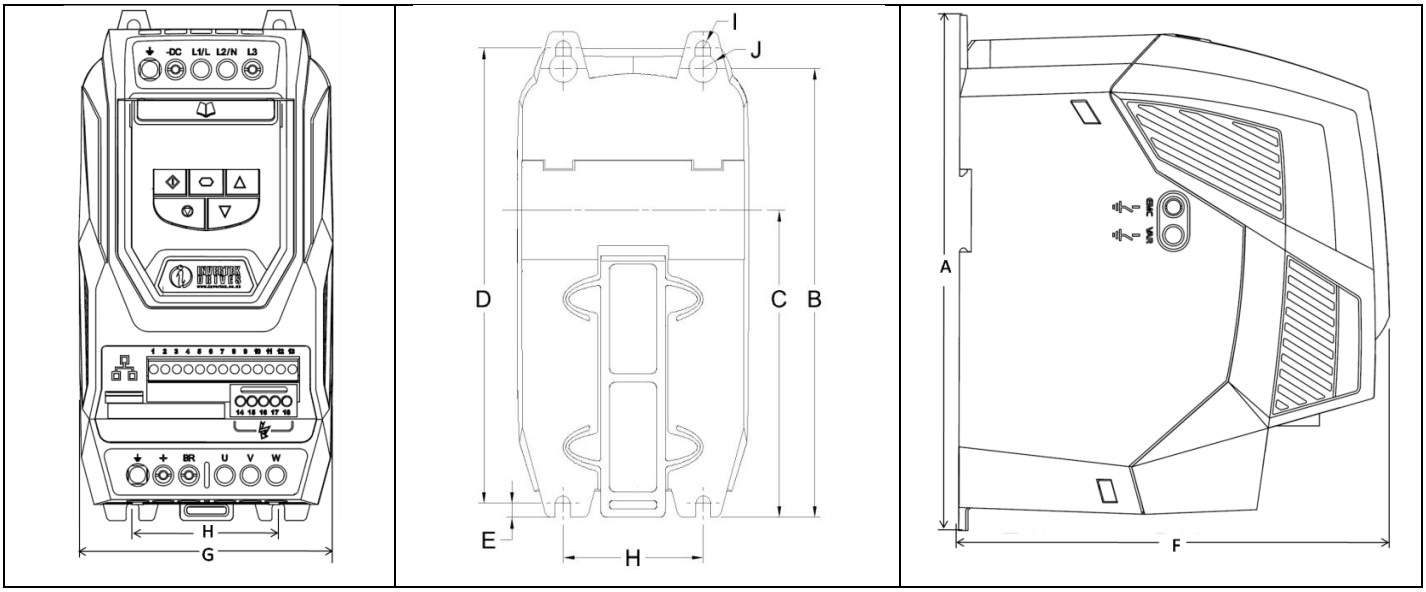
Note the following for UL-compliant installation:

- For an up to date list of UL compliant products, please refer to UL listing NMMS.E226333
- The drive can be operated within an ambient temperature range as stated in section 13.1
- For IP20 & IP40 units, installation is required in a pollution degree 1 environment
- For IP55 & IP66 units, installation in a pollution degree 2 environment is permissible
- UL Listed ring terminals / lugs must be used for all bus bar and grounding connections

Refer to section 13.4 on page 68 for Additional Information for UL Approved Installations

3.4. Mechanical dimensions and Weights

3.4.1. IP20 Units



Drive Size	A		B		C		D		E		F		G		H		I		J		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	Kg	lb
2	221	8.70	207	8.15	137	5.39	209	8.23	5.3	0.21	185	7.28	112	4.41	63	2.48	5.5	0.22	10	0.39	1.8	4
3	261	10.28	246	9.69	-	-	247	9.72	6	0.24	205	8.07	131	5.16	80	3.15	5.5	0.22	10	0.39	3.5	7.7

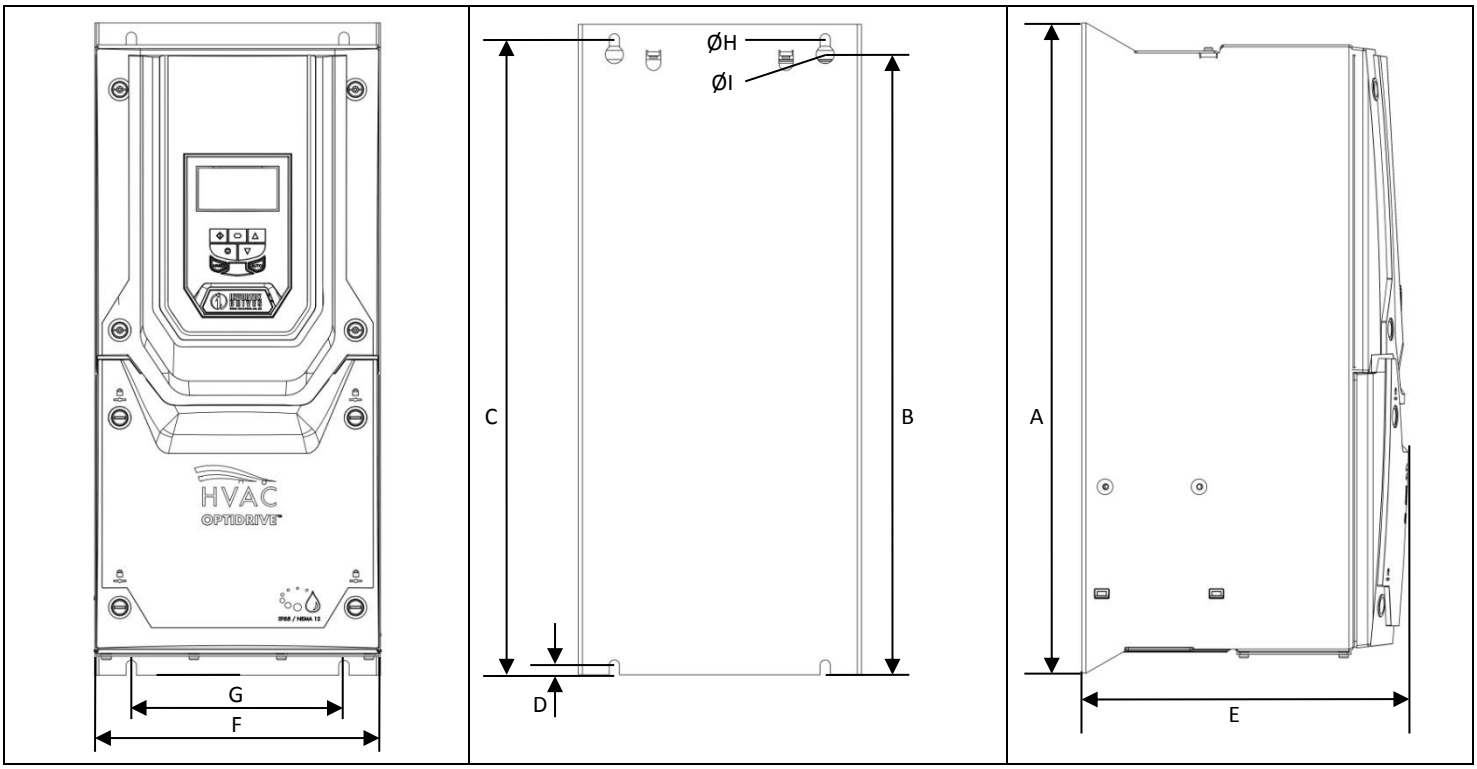
Mounting Bolts

All Frame Sizes : 4 x M5 (#10)

Tightening Torques

Control Terminal Torque Settings : All Sizes : 0.8 Nm (7 lb-in)
Power Terminal Torque Settings : All Sizes : 1 Nm (8.85 lb-in)

3.4.2. IP55 Units



Drive Size	A		B		C		D		E		F		G		H		I		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	Kg	lb
4	450	17.32	428	16.46	433	16.65	8	0.31	240	9.45	171	6.73	110	4.33	4.25	0.17	7.5	0.30	11.5	25.4
5	540	21.26	515	20.28	520	20.47	8	0.31	270	10.63	235	9.25	175	6.89	4.25	0.17	7.5	0.30	22.5	49.6
6	865	34.06	830	32.68	840	33.07	10	0.39	330	12.99	330	12.99	200	7.87	5.5	0.22	11	0.43	50	110.2
7	1280	50.39	1245	49.02	1255	49.41	10	0.39	360	14.17	330	12.99	200	7.87	5.5	0.22	11	0.43	80	176.4

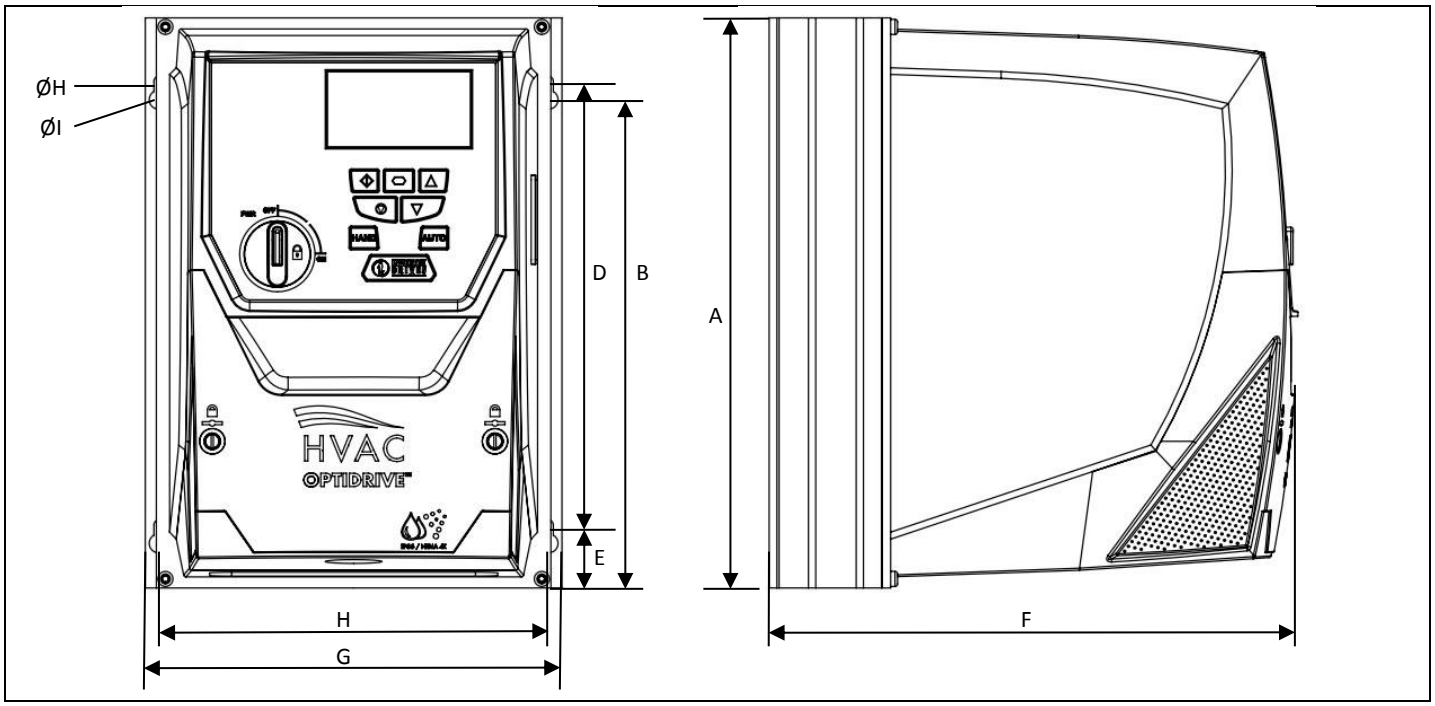
Mounting Bolts

Frame Size 4 : M8 (5/16 UNF)
Frame Size 5 : M8 (5/16 UNF)
Frame Size 6 : M10 (3/8 UNF)
Frame Size 7 : M10 (3/8 UNF)

Tightening Torques

Control Terminal Torque Settings : All Sizes : 0.8 Nm (7 lb-in)
Power Terminal Torque Settings : Frame Size 4 : 4 Nm (3 lb-ft)
Frame Size 5 : 15 Nm (11.1 lb-ft)
Frame Size 6 : 20 Nm (15 lb-ft)
Frame Size 7 : 20 Nm (15 lb-ft)

3.4.3. IP66 Units



Drive Size	A		B		D		F		G		H		I		J		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	Kg	lb
2	257	10.12	220	8.66	200	7.87	239	9.41	188	7.40	176	6.93	4.2	0.17	8.5	0.33	4.8	10.6
3	310	12.20	277	10.89	252	9.90	251	9.88	211	8.29	198	7.78	4.2	0.17	8.5	0.33	7.3	16.1

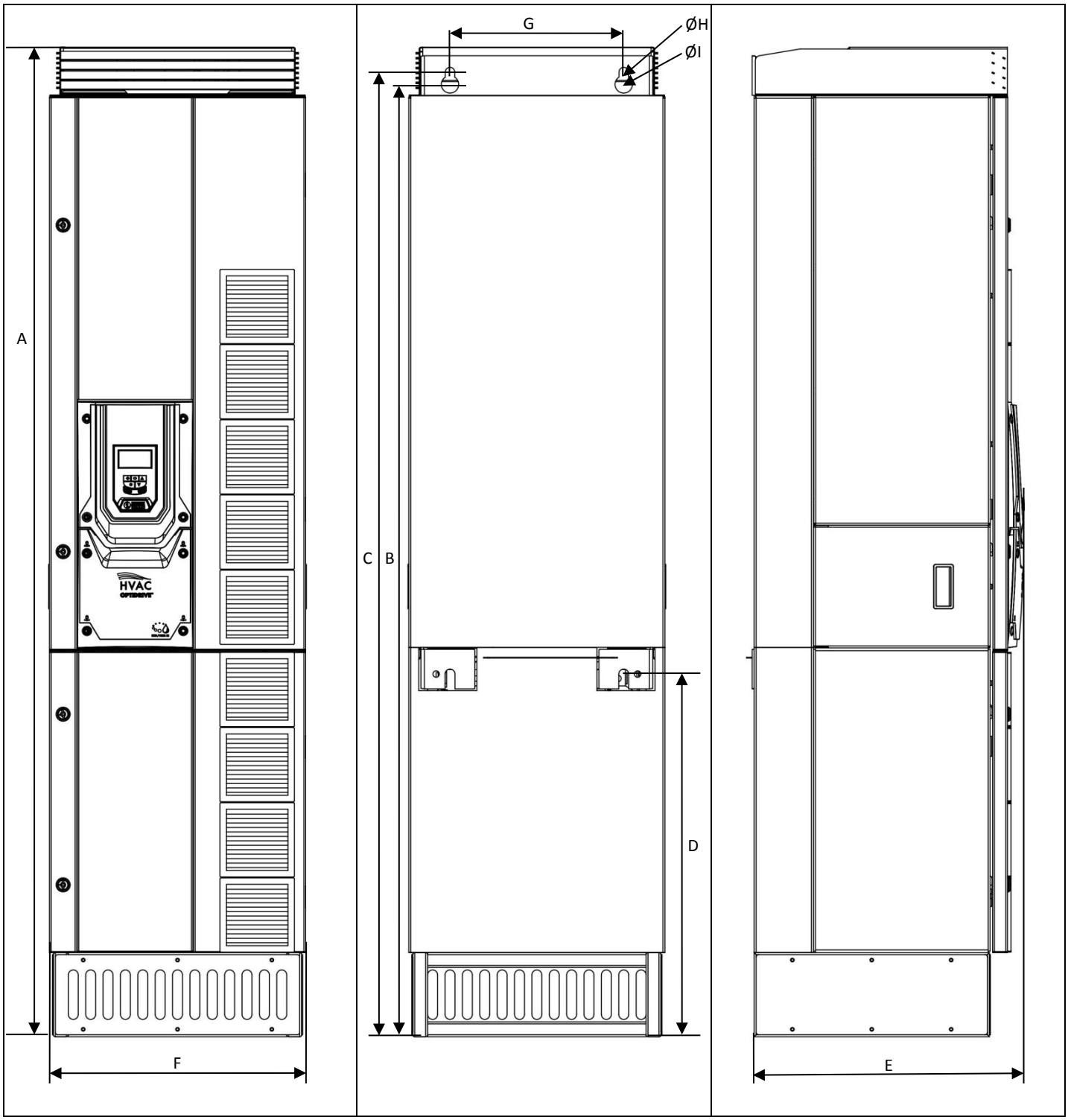
Mounting Bolt Sizes

All Frame Sizes 4 x M4 (#8)

Tightening Torques

Control Terminal Torque Settings : All Sizes : 0.8 Nm (7 lb-in)
Power Terminal Torque Settings : Frame Size 2 : 1.2 – 1.5 Nm (10 – 15 lb-in)

3.4.4. IP40 Units



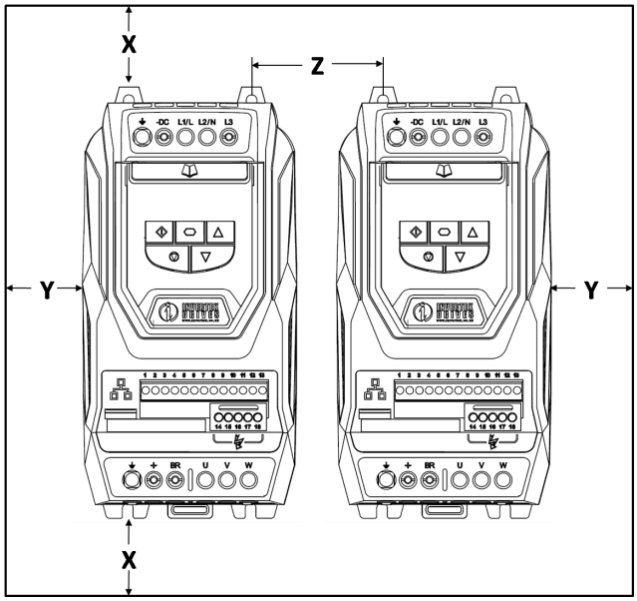
Drive Size	A		B		C		D		E		F		G		H		I		J		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	Kg	lb
8	2000	78.74	1925	75.79	1950	76.77	733	28.86	516	20.31	500	19.69	350	13.78	406	15.98	35	1.38	19	0.75	270	595.2

Control Terminal Torque Settings: All Sizes: 0.8Nm (7lb-in)
Power Terminal Torque Settings: All Sizes: 50Nm (37 lb-ft)

3.5. Guidelines for Enclosure mounting (IP20 Units)

- IP20 drives are suitable for use in pollution degree 1 environments, according to IEC-664-1. For pollution degree 2 or higher environments, drives should be mounted in a suitable control cabinet with sufficient ingress protection to maintain a pollution degree 1 environment around the drive.
- Enclosures should be made from a thermally conductive material.
- Ensure the minimum air gap clearances around the drive as shown below are observed when mounting the drive.
- Where ventilated enclosures are used, there should be venting above the drive and below the drive to ensure good air circulation. Air should be drawn in below the drive and expelled above the drive.
- In any environments where the conditions require it, the enclosure must be designed to protect the Optidrive against ingress of airborne dust, corrosive gases or liquids, conductive contaminants (such as condensation, carbon dust, and metallic particles) and sprays or splashing water from all directions.
- High moisture, salt or chemical content environments should use a suitably sealed (non-vented) enclosure.

The enclosure design and layout should ensure that the adequate ventilation paths and clearances are left to allow air to circulate through the drive heatsink. Invertek Drives recommend the following minimum sizes for drives mounted in non-ventilated metallic enclosures:-



Drive Size	X Above & Below		Y Either Side		Z Between		Recommended airflow
	mm	in	mm	in	mm	in	CFM (ft^3/min)
2	75	2.95	50	1.97	46	1.81	11
3	100	3.94	50	1.97	52	2.05	26

Note :

Dimension Z assumes that the drives are mounted side-by-side with no clearance.

Typical drive heat losses are 3% of operating load conditions.

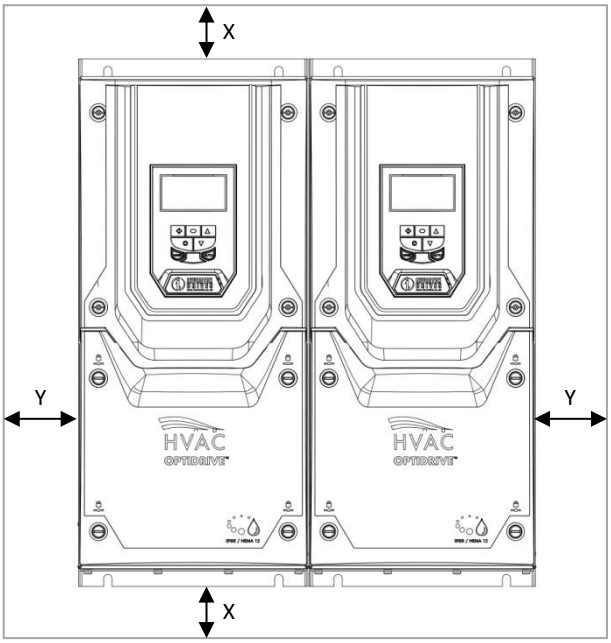
Above are guidelines only and the operating ambient temperature of the drive MUST be maintained at all times.

3.6. Mounting the Drive – IP20 Units

- IP20 Units are intended for installation within a control cabinet.
- When mounting with screws
  - Using the drive as a template, or the dimensions shown above, mark the locations for drilling
  - Ensure that when mounting locations are drilled, the dust from drilling does not enter the drive
  - Mount the drive to the cabinet backplate using suitable M5 mounting screws
  - Position the drive, and tighten the mounting screws securely
- When Din Rail Mounting (Frame Size 2 Only)
  - Locate the DIN rail mounting slot on the rear of the drive onto the top of the DIN rail first
  - Press the bottom of the drive onto the DIN rail until the lower clip attaches to the DIN rail
  - If necessary, use a suitable flat blade screw driver to pull the DIN rail clip down to allow the drive to mount securely on the rail
  - To remove the drive from the DIN rail, use a suitable flat blade screwdriver to pull the release tab downwards, and lift the bottom of the drive away from the rail first

3.7. Guidelines for mounting IP55 Units

- Before mounting the drive, ensure that the chosen location meets the environmental condition requirements for the drive shown in section 13.1
- The drive must be mounted vertically, on a suitable flat surface
- The minimum mounting clearances as shown in the table below must be observed
- The mounting site and chosen mountings should be sufficient to support the weight of the drives
- IP55 units do not require mounting inside an electrical control cabinet; however they may be if desired.



Drive Size	X Above & Below		Y Either Side	
	mm	in	mm	in
2 (IP66)	150	5.9	10	0.394
3 (IP66)	150	5.9	10	0.394
4 (IP55)	200	7.9	10	0.394
5 (IP55)	200	7.9	10	0.394
6 (IP55)	200	7.9	10	0.394
7 (IP55)	200	7.9	10	0.394

Note :

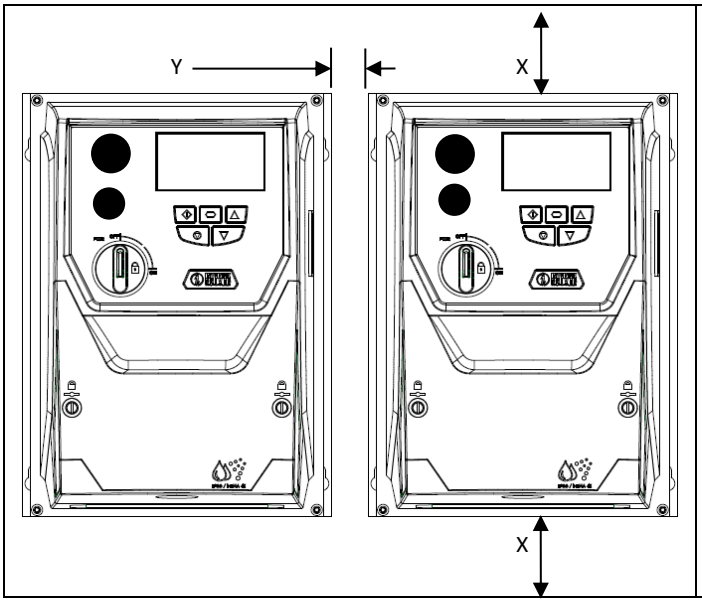
Typical drive heat losses are 3% of operating load conditions.

Above are guidelines only and the operating ambient temperature of the drive MUST be maintained at all times.

- Using the drive as a template, or the dimensions shown above, mark the locations required for drilling
- Suitable cable glands to maintain the IP protection of the drive are required. Gland sizes should be selected based on the number and size of the required connection cables. Drives are supplied with a plain, undrilled gland plate to allow the correct hole sizes to be cut as required. Remove the gland plate from the drive prior to drilling.

3.8. Guidelines for mounting (IP66 Units)

- Before mounting the drive, ensure that the chosen location meets the environmental condition requirements for the drive shown in section 13.1
- The drive must be mounted vertically, on a suitable flat surface
- The minimum mounting clearances as shown in the table below must be observed
- The mounting site and chosen mountings should be sufficient to support the weight of the drives



Drive Size	X Above & Below		Y Either Side	
	mm	in	mm	in
2	200	7.87	10	0.39
3	200	7.87	10	0.39

Note :

Typical drive heat losses are approximately 3% of operating load conditions.

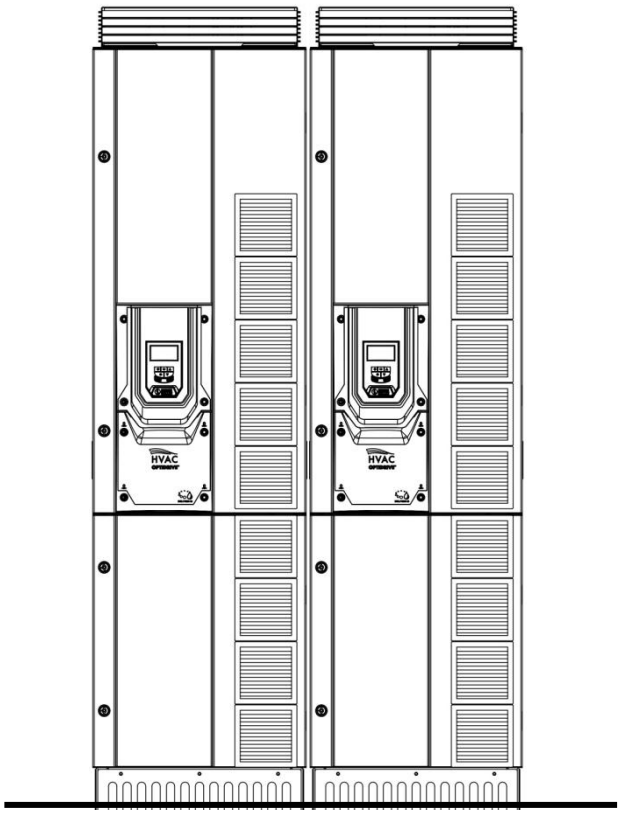
Above are guidelines only and the operating ambient temperature of the drive MUST be maintained at all times.

Cable Gland Sizes			
Frame	**Power Cable**	**Motor Cable**	**Control Cables**
2	**M25 (PG21)**	**M25 (PG21)**	**M20 (PG13.5)**
3	**M25 (PG21)**	**M25 (PG21)**	**M20 (PG13.5)**

- Using the drive as a template, or the dimensions shown above, mark the locations required for drilling
- Suitable cable glands to maintain the ingress protection of the drive are required. Gland holes for power and motor cables are pre-moulded into the drive enclosure, recommended gland sizes are shown above. Gland holes for control cables may be cut as required.

3.9. Guidelines for mounting IP40 Units

- Before mounting the drive, ensure that the chosen location meets the environmental condition requirements for the drive shown in section 13.1
- The drive must be floor standing, placed on a Horizontal and suitably flat surface
- The Enclosure must be anchored to an adjacent wall using the mounting points provided
- All Enclosure vents must remain clear with airflow unobstructed
- The mounting site and chosen mountings should be sufficient to support the weight of the drives



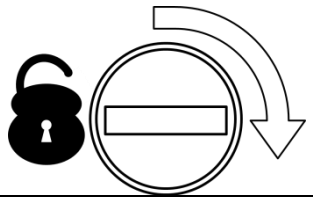
Level Ground

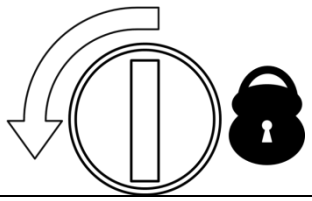
Note :

Typical drive heat losses are 3% of operating load conditions.

Above are guidelines only and the operating ambient temperature of the drive MUST be maintained at all times.

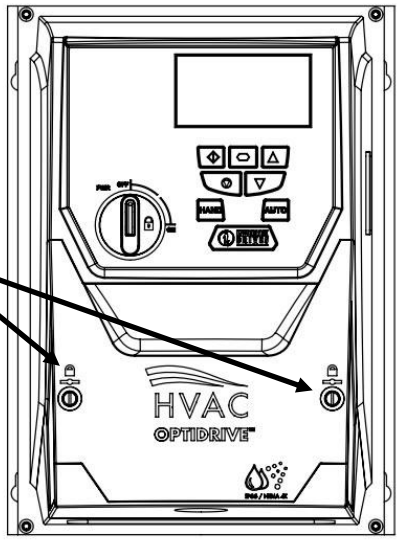
3.10. Removing the Terminal Cover





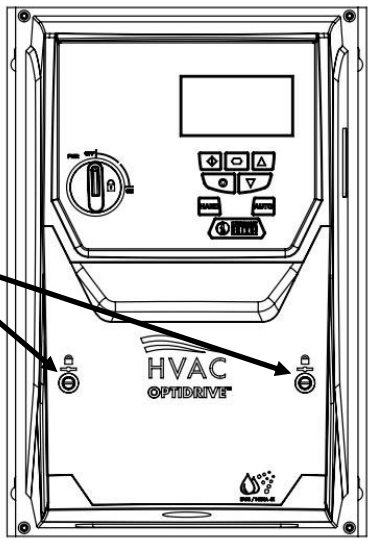
3.10.1. Frame Size 2

Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical



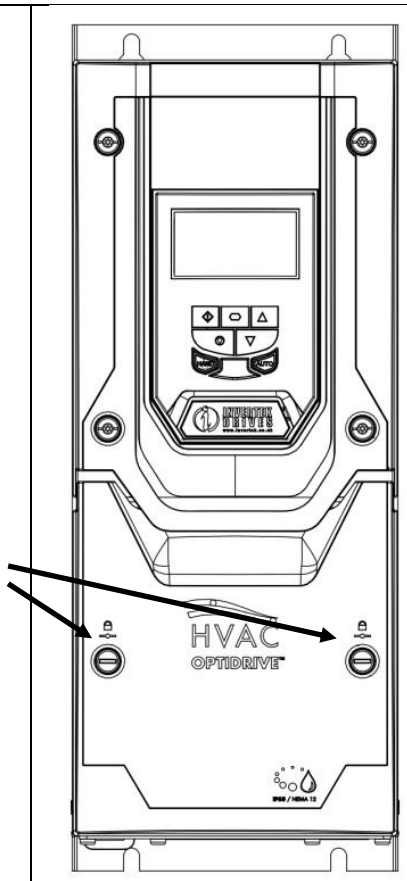
3.10.2. Frame Size 3

Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical



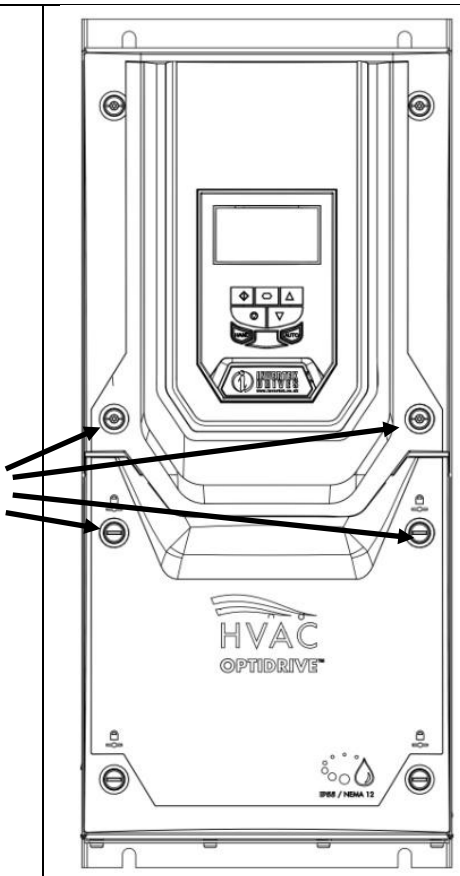
3.10.3. Frame Size 4

Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical.



3.10.4. Frame Size 5

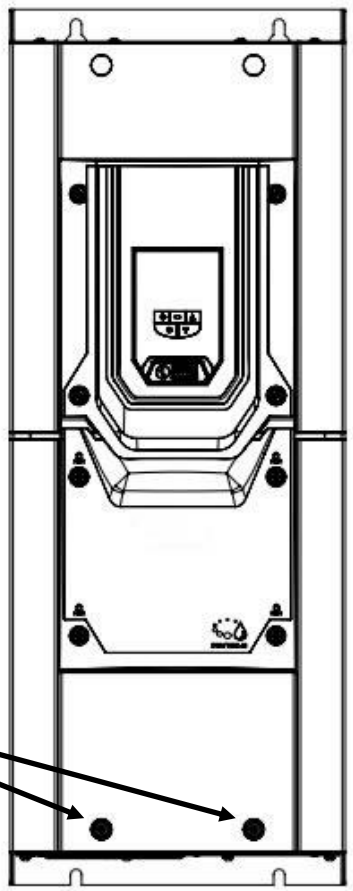
Using a suitable flat blade screwdriver, rotate the four retaining screws indicated until the screw slot is vertical.

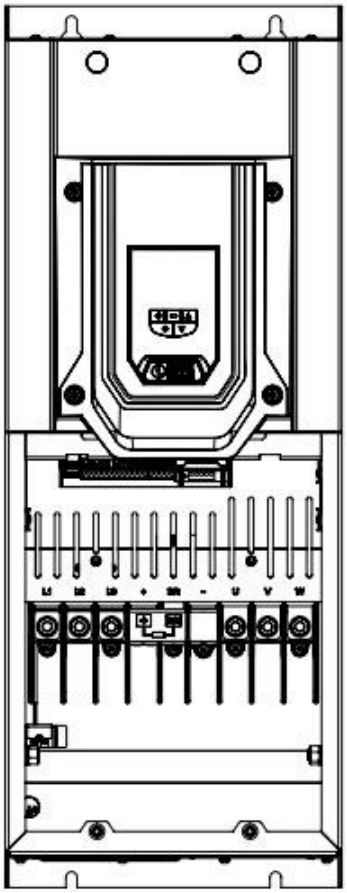


Terminal Cover Release Screws

3.10.5. Frame Size 6

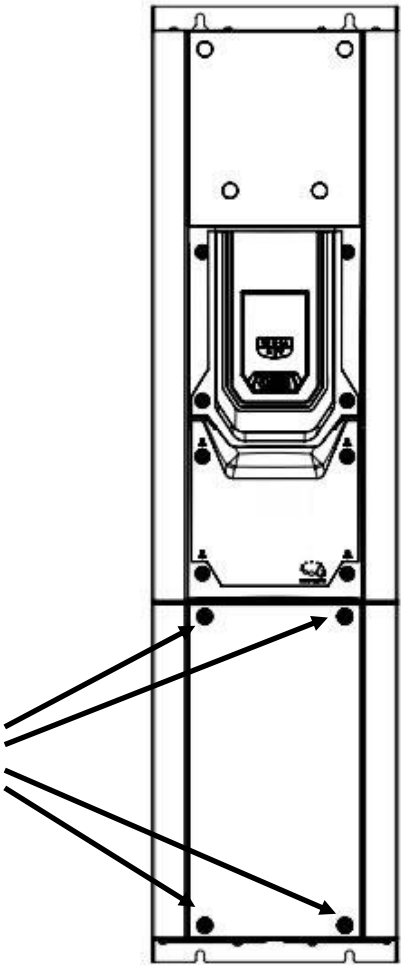
Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical

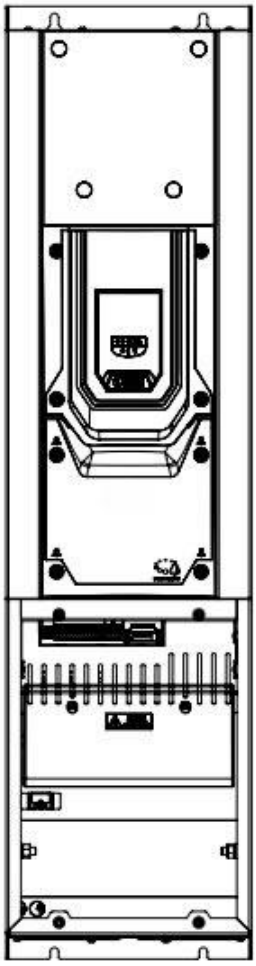




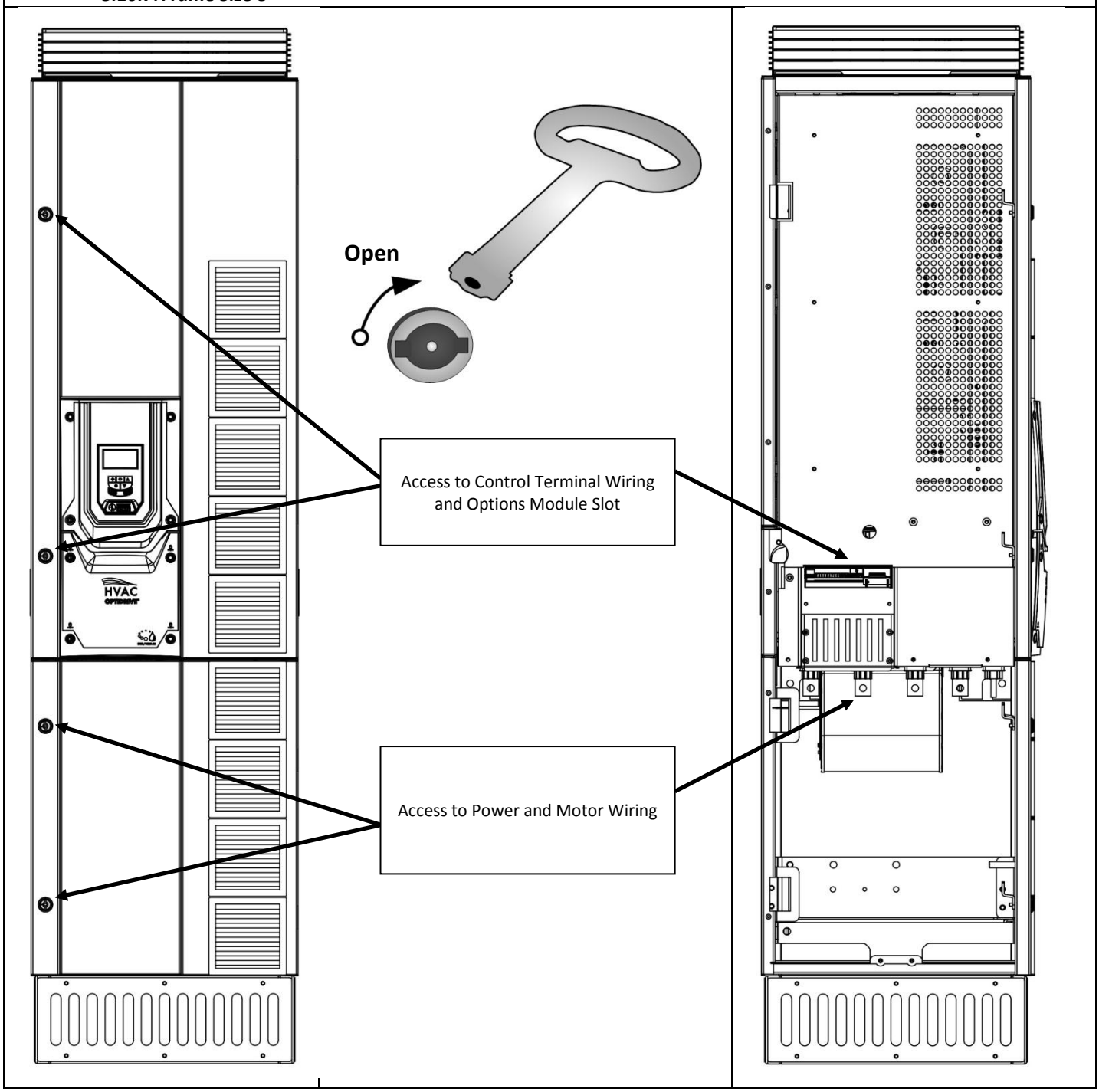
3.10.6. Frame Size 7

Using a suitable flat blade screwdriver, rotate the four retaining screws indicated until the screw slot is vertical





3.10.7. Frame Size 8



3.11. Routine Maintenance

The drive should be included within the scheduled maintenance program so that the installation maintains a suitable operating environment, this should include:

- Ambient temperature is at or below that set out in the “Environment” section.
- Heat sink fans freely rotating and dust free.
- The Enclosure in which the drive is installed should be free from dust and condensation; furthermore ventilation fans and air filters should be checked for correct air flow.

Checks should also be made on all electrical connections, ensuring screw terminals are correctly torqued; and that power cables have no signs of heat damage.

3.12. Gland Plate and Lock Off

The use of a suitable gland system is required to maintain the appropriate IP / Nema rating. Cable entry holes will need to be drilled to suit this system. Some guidelines sizes are defined below:
Please take care when drilling to avoid leaving any particles within the product.

Cable Gland recommended Hole Sizes & types:

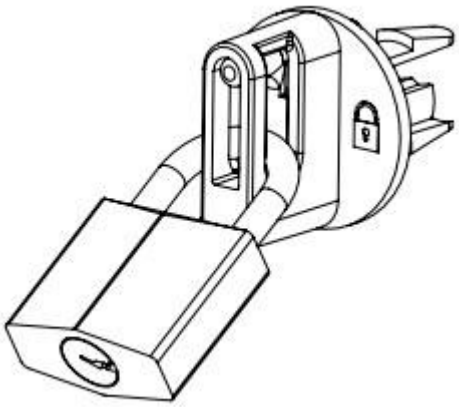
	Min Gland Rating	Hole Size	Imperial	Metric
Size 2	IP66	3 x 22mm	3 PG13.5	3 x M20
Size 3	IP66	1 x 22mm and 2 x 28mm	1 PG13.5 and 2 PG16	1 x M20 and 2 x M25

- UL rated ingress protection ("Type ") is only met when cables are installed using a UL recognized bushing or fitting for a flexible-conduit system which meets the required level of protection ("Type")
- For conduit installations the conduit entry holes require standard opening to the required sizes specified per the NEC
- Not intended for rigid conduit system

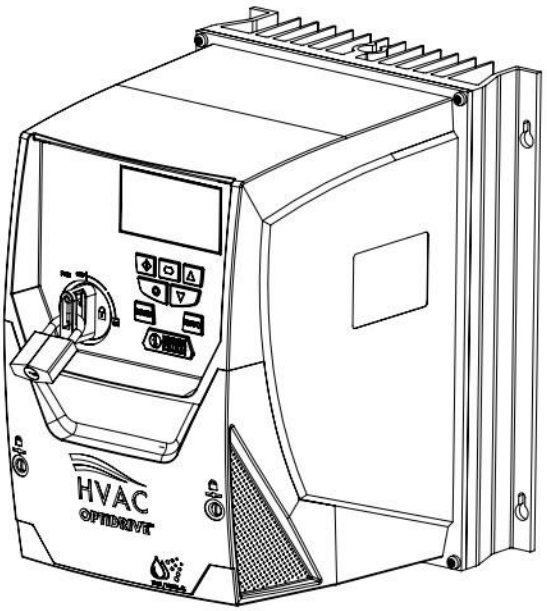
Power Isolator Lock Off – IP66 with Built in Isolator Option

On the switched models the main power isolator switch can be locked in the 'Off' position using a 20mm standard shackle padlock (not supplied).

IP66 / Nema 12 Unit Lock Off



IP66 / Nema 4X Unit Lock Off

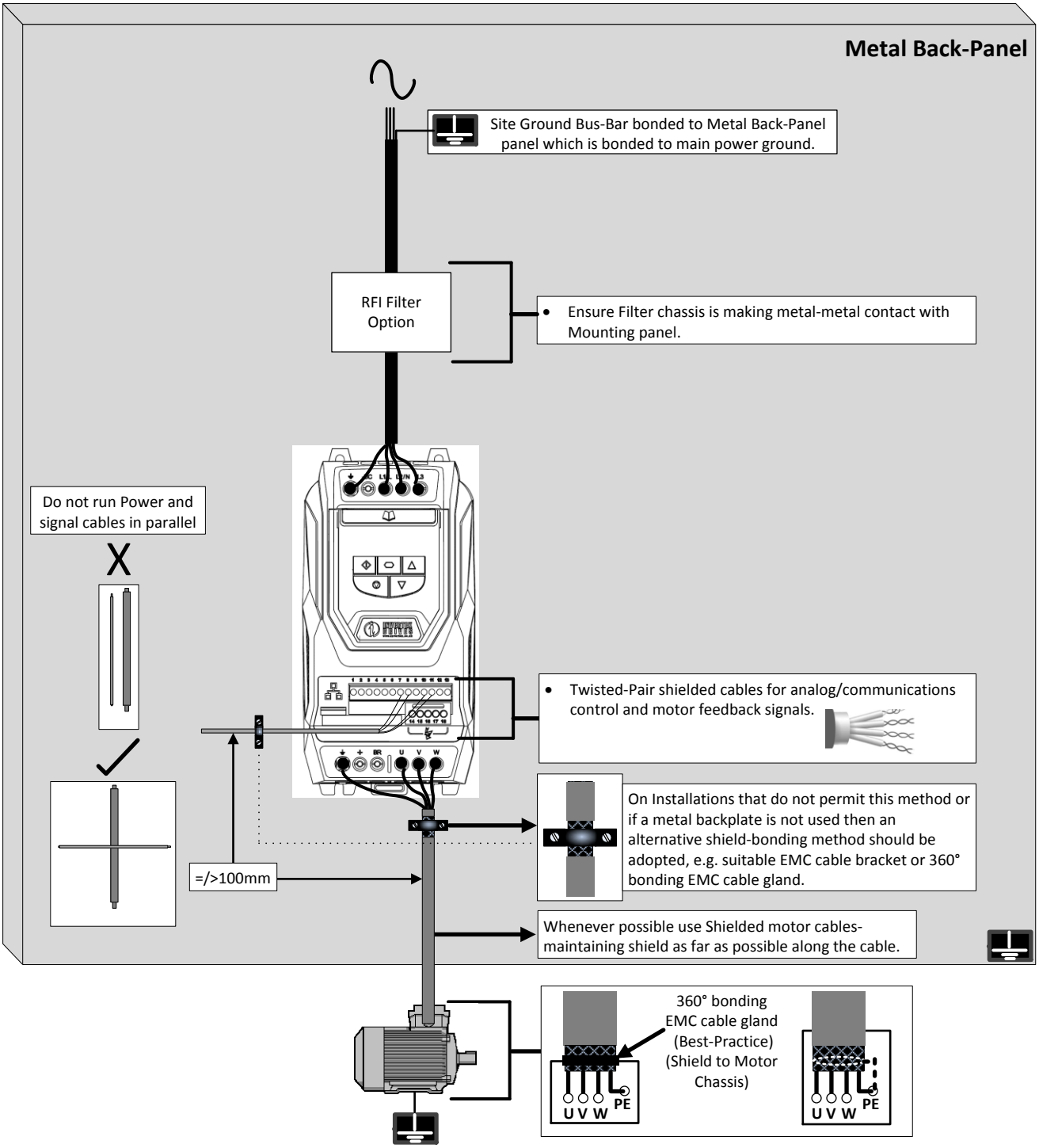


4. Electrical Installation

4.1. Grounding the Drive

	This manual is intended as a guide for proper installation. Invertek Drives Ltd cannot assume responsibility for the compliance or the non-compliance to any code, national, local or otherwise, for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.
	This Optidrive contains high voltage capacitors that take time to discharge after removal of the main supply. Before working on the drive, ensure isolation of the main supply from line inputs. Wait ten (10) minutes for the capacitors to discharge to safe voltage levels. Failure to observe this precaution could result in severe bodily injury or loss of life.
	Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

4.1.1. Recommended installation for EMC compliance.



4.1.2. Grounding Guidelines

The ground terminal of each Optidrive should be individually connected DIRECTLY to the site ground bus bar (through the filter if installed). Optidrive ground connections should not loop from one drive to another, or to, or from any other equipment. Ground loop impedance must confirm to local industrial safety regulations. To meet UL regulations, UL approved ring crimp terminals should be used for all ground wiring connections.
The drive Safety Ground must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be checked periodically.

4.1.3. Protective Earth Conductor

The Cross sectional area of the PE Conductor must be at least equal to that of the incoming supply conductor.

4.1.4. Safety Ground ⏚

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod, or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

4.1.5. Motor Ground

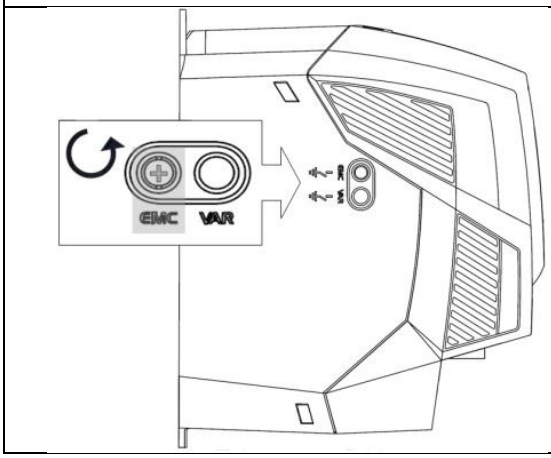
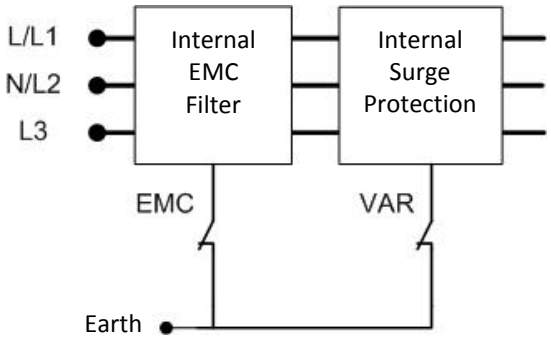
The motor ground must be connected to one of the ground terminals on the drive.

4.1.6. Ground Fault Monitoring

As with all inverters, a leakage current to earth can exist. The Optidrive is designed to produce the minimum possible leakage current whilst complying with worldwide standards. The level of current is affected by motor cable length and type, the effective switching frequency, the earth connections used and the type of RFI filter installed. If an ELCB (Earth Leakage Circuit Breaker) is to be used, the following conditions apply: -

- A Type B Device must be used
- The device must be suitable for protecting equipment with a DC component in the leakage current
- Individual ELCBs should be used for each Optidrive

Drives with an EMC filter have an inherently higher leakage current to Ground (Earth). For applications where tripping occurs the EMC filter can be disconnected (on IP20 units only) by removing the EMC screw on the side of the product.

Remove the screws as indicated below	
	

The Optidrive product range has input supply voltage surge suppression components fitted to protect the drive from line voltage transients, typically originating from lightning strikes or switching of high power equipment on the same supply.

4.1.7. Shield Termination (Cable Screen)

The safety ground terminal provides a grounding point for the motor cable shield. The motor cable shield connected to this terminal (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal.

4.2. Wiring Precautions

Connect the Optidrive according to section 4.3 and 4.4, ensuring that motor terminal box connections are correct. There are two connections in general: Star and Delta. It is essential to ensure that the motor is connected in accordance with the voltage at which it will be operated. For more information, refer to section 4.5 Motor Terminal Box Connection.

It is recommended that the power cabling should be 4-core PVC-insulated screened cable, laid in accordance with local industrial regulations and codes of practice.

4.3. Incoming Power Connection

- For a single phase supply, power should be connected to L1/L, L2/N.
- For 3 phase supplies power should be connected to L1, L2, and L3. Phase sequence is not important.
- For compliance with CE and C Tick EMC requirements, a symmetrical shielded cable is recommended.
- A fixed installation is required according to IEC61800-5-1 with a suitable disconnecting device installed between the Optidrive and the AC Power Source. The disconnecting device must conform to the local safety code / regulations (e.g. within Europe, EN60204-1, Safety of machinery).
- The cables should be dimensions according to any local codes or regulations. Guideline dimensions are given in section13.4.
- Suitable fuses to provide wiring protection of the input power cable should be installed in the incoming supply line, according to the data in section 13.4. The fuses must comply with any local codes or regulations in place. In general, type gG (IEC 60269) or UL type T fuses are suitable; however in some cases type aR fuses may be required. The operating time of the fuses must be below 0.5 seconds.
- Where allowed by local regulations, suitably dimensioned type B MCB circuit breakers of equivalent rating may be utilised in place of fuses, providing that the clearing capacity is sufficient for the installation.
- When the power supply is removed from the drive, a minimum of 30 seconds should be allowed before re-applying the power. A minimum of 10 minutes should be allowed before removing the terminal covers or connection.
- The maximum permissible short circuit current at the Optidrive Power terminals as defined in IEC60439-1 is 100kA.
- An optional Input Choke is recommended to be installed in the supply line for drives where any of the following conditions occur:-
    - The incoming supply impedance is low or the fault level / short circuit current is high
    - The supply is prone to dips or brown outs
    - An imbalance exists on the supply (3 phase drives)
    - The power supply to the drive is via a bus-bar and brush gear system (typically overhead Cranes).
- In all other installations, an input choke is recommended to ensure protection of the drive against power supply faults. Refer to your local Invertek sales partner for available options
- Optidrive HVAC models in frame sizes 4 to 8 are factory fitted with an Input choke as standard.

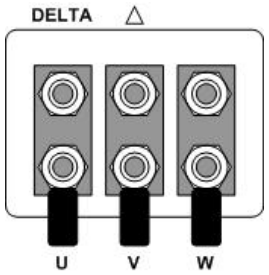
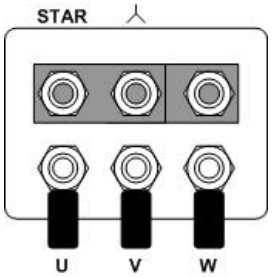
4.4. Drive and Motor Connection

- The drive inherently produces fast switching of the output voltage (PWM) to the motor compared to the mains supply, for motors which have been wound for operation with a variable speed drive then there is no preventative measures required, however if the quality of insulation is unknown then the motor manufacturer should be consulted and preventative measures may be required.
- The motor should be connected to the Optidrive U, V, and W terminals using a suitable 3 or 4 core cable. Where a 3 core cable is utilised, with the shield operating as an earth conductor, the shield must have a cross sectional area at least equal to the phase conductors when they are made from the same material. Where a 4 core cable is utilised, the earth conductor must be of at least equal cross sectional area and manufactured from the same material as the phase conductors.
- The motor earth must be connected to one of the Optidrive earth terminals.
- For compliance with the European EMC directive, a suitable screened (shielded) cable should be used. Braided or twisted type screened cable where the screen covers at least 85% of the cable surface area, designed with low impedance to HF signals are recommended as a minimum. Installation within a suitable steel or copper tube is generally also acceptable.
- The cable screen should be terminated at the motor end using an EMC type gland allowing connection to the motor body through the largest possible surface area
- Where drives are mounted in a steel control panel enclosure, the cable screen may be terminated directly to the control panel using a suitable EMC clamp or gland, as close to the drive as possible.
- For IP55 drives, connect the motor cable screen to the internal ground clamp

4.5. Motor Terminal Box Connections

Most general purpose motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor

This operational voltage is normally selected when installing the motor by selecting either STAR or DELTA connection. STAR always gives the higher of the two voltage ratings.

Incoming Supply Voltage	Motor Nameplate Voltages		Connection
230	230 / 400	Delta	
400	400 / 690		
400	230 / 400	Star	

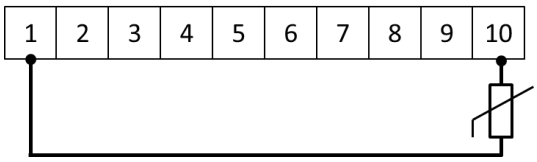
4.6. Motor Thermal overload Protection.

4.6.1. Internal Thermal overload protection.

The drive has an in-built motor thermal overload function; this is in the form of an "I.t-trP" trip after delivering >100% of the value set in **P**1-08 for a sustained period of time (e.g. 110% for 60 seconds).

4.6.2. Motor Thermistor Connection

Where a motor thermistor is to be used, it should be connected as follows :-



Additional Information

- Compatible Thermistor : PTC Type, 2.5kΩ trip level
- Use a setting of P1-13 that have Input 5 function as External Trip, e.g. P1-13 = 6. Refer to section 10.1 for further details.

4.7. Control Terminal Wiring

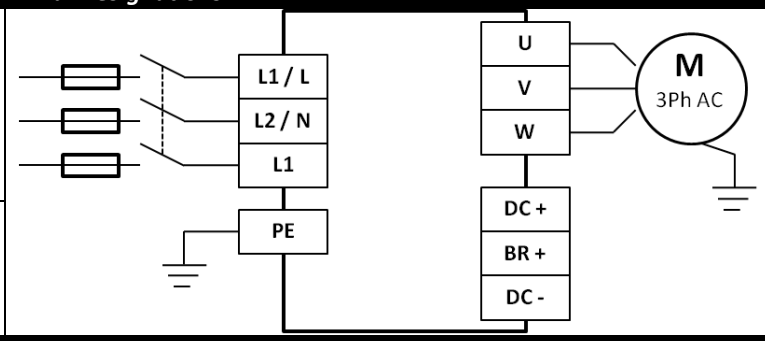
- All analog signal cables should be suitably shielded. Twisted pair cables are recommended.
- Power and Control Signal cables should be routed separately where possible, and must not be routed parallel to each other
- Signal levels of different voltages e.g. 24 Volt DC and 110 Volt AC, should not be routed in the same cable.
- Maximum control terminal tightening torque is 0.5Nm
- Control Cable entry conductor size: 0.05 – 2.5mm^2 / 30 – 12 AWG.

4.8. Connection Diagram

4.8.1. Power Terminal Designations

Incoming Mains Power Supply
For 1 Phase Supply, connect to L1/L and L2/N terminals.
For 3 Phase Supply, connect to L1, L2 & L3 terminals.
Phase sequence is not important.

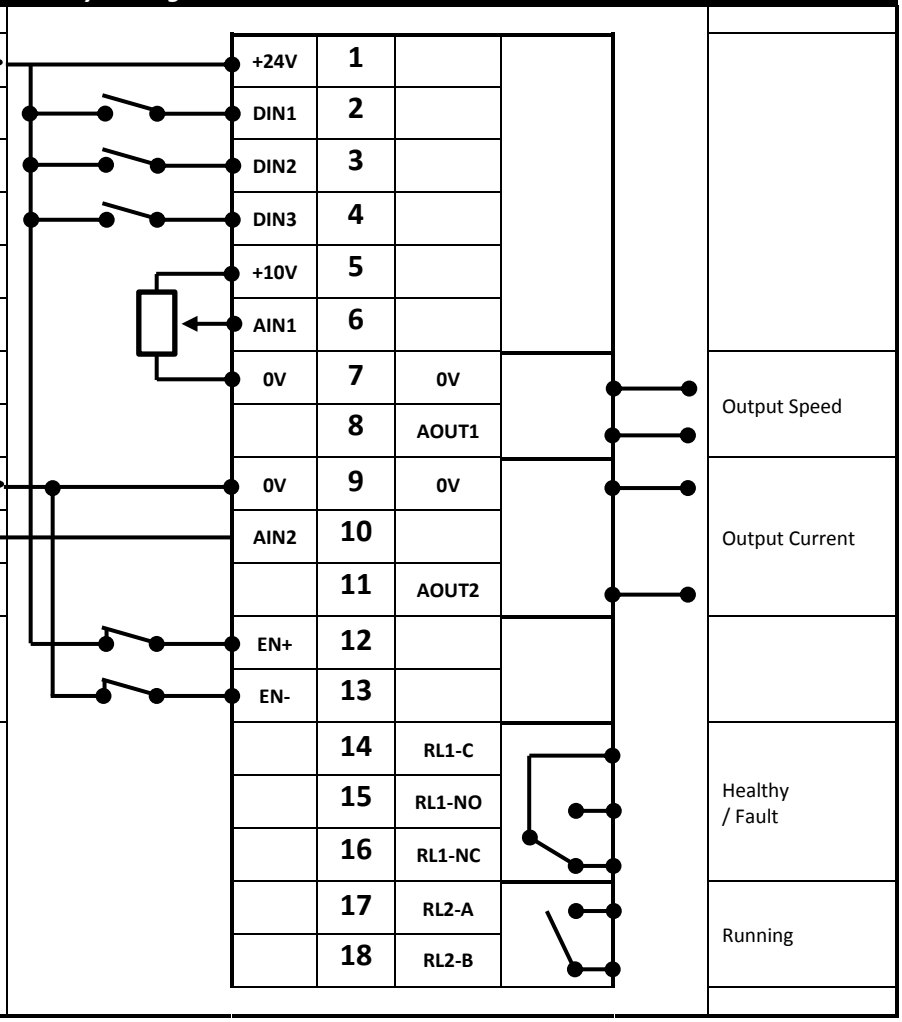
Protective Earth / Ground connection.
The drive must be Earthed / Grounded



Motor Connections
Connect the motor to the U, V & W terminals.
The motor earth must be connected to the drive

4.8.2. Control Terminal Connections & Factory Settings

	Open	Closed
+24V Supply (100mA) / External Input		
Digital Input 1	Run (Enable)	Stop
Digital Input 2	Analog Input Ref	Preset Speed 1
Digital Input 3	Analog Input 1 Ref	Analog Input 2 Ref
Digital Inputs : 8 – 30 Volt DC + 10 Volt, 10mA Output		
Analog Input 1		
Analog Output : 0 – 10 Volt / 4-20mA, 20mA Max		
0 Volt Supply / External Input		
Analog Input 2		
Analog Output : 0 – 10 Volt / 4-20mA, 20mA Max		
External Hardware Enable Circuit		
Relay Contacts 250VAC / 30VDC 5A Maximum		



5. Managing the Keypad

The drive is configured and its operation monitored via the built in keypad and display.

IP20 Drives:

IP20 rated drives are supplied with a 7 Segment LED display and a five button keypad (Start, Stop, Navigate, Up, Down)

IP55 and IP66 Drives:

IP55 and IP66 rated drives are supplied with an OLED multi-line text display and a seven button keypad (Start, Stop, Navigate, Up, Down, Hand, Auto)

Commissioning and operation of the drive with the two different Keypads and displays is detailed below.

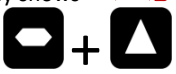
5.1. Keypad Layout and Function – Standard LED Keypad (IP20 Drives)

	NAVIGATE	Used to display real-time information, to access and exit parameter edit mode and to store parameter changes
	UP	Used to increase speed in real-time mode or to increase parameter values in parameter edit mode
	DOWN	Used to decrease speed in real-time mode or to decrease parameter values in parameter edit mode
	RESET / STOP	Used to reset a tripped drive. When in Keypad mode is used to Stop a running drive.
	START	When in keypad mode, used to Start a stopped drive or to reverse the direction of rotation if bi-directional keypad mode is enabled

5.2. Changing Parameters – Standard LED Keypad (IP20 Drives)

Procedure	Display shows...
Power on Drive	StoP
Press and hold the for >2 seconds	P1-01
Press the Key	P1-02
The and can be used to select the desired parameter	P1-03 etc..
Select the required parameter, e.g. P1-02	P1-02
Press the button	0.0
Use the and keys to adjust the value, e.g. set to 10	10.0
Press the key	P1-02
The parameter value is now adjusted and automatically stored. Press the key for >2 seconds to return to operating mode	StoP

5.3. Advanced Keypad Operation Short Cuts – Standard LED Keypad (IP20 Drives)

Function	When Display shows...	Press...	Result	Example
Fast Selection of Parameter Groups Note : Parameter Group Access must be enabled P1-14 = 101	Px- xx		The next highest Parameter group is selected	Display shows P1- 10 Press  Display shows P2-01
	Px- xx		The next lowest Parameter group is selected	Display shows P2-26 Press  Display shows P1-01
Select lowest Group Parameter	Px- xx		The first parameter of a group is selected	Display shows P1- 10 Press  Display shows P1-01
Set Parameter to minimum value	Any numerical value (Whilst editing a parameter value)		The parameter is set to the minimum value	When editing P1-01 Display shows 50.0 Press  Display shows 0.0
Adjusting individual digits within a parameter value	Any numerical value (Whilst editing a parameter value)		Individual parameter digits can be adjusted	When editing P1-10 Display shows 0 Press  Display shows _0 Press  Display shows 10 Press  Display shows _ 10 Press  Display shows 110 Etc...

5.4. Drive Operating Displays – Standard LED Keypad (IP20 Drives)

Display	Status	
StoP	Drive mains power applied, but no Enable or Run signal applied	
AUto-t	Motor Autotune in progress.	
H x.x	Drive running, display shows output frequency (Hz)	Whilst the drive is running, the following displays can be selected by briefly pressing the  button on the drive. Each press of the button will cycle the display through to the next selection.
A x.x	Drive running, display shows motor current (Amps)	
P x.x	Drive Running, display shows motor power (kW)	
C x.x	Drive Running, display shows customer selected units, see parameters P2-21 and P2-22	
Etc-24	Drive mains power not present, external 24 Volt control power supply present only	
Inh	Output power hardware enable circuit open. External links are required to the STO inputs (terminals 12 and 13) as shown in section 4.8 Connection Diagram	
P-dEF	Parameters reset to factory default settings	
U-dEF	Parameters reset to User default settings	
For drive fault code displays, refer to section 14.1		

5.5. Keypad Layout and Function – Standard OLED Keypad (IP55 and IP66 Drives)

OLED Display

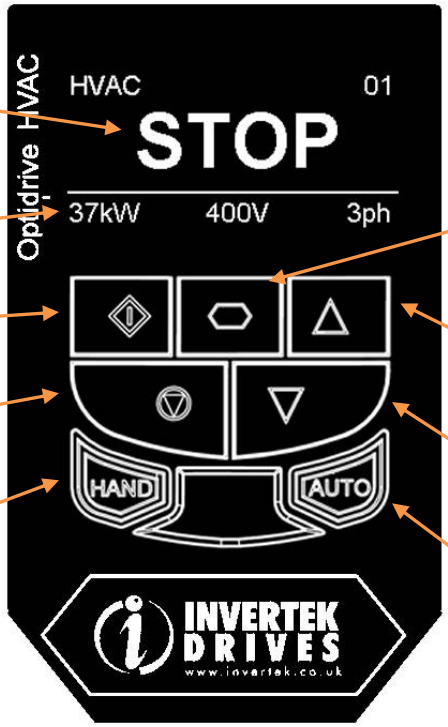
Main Displayed Parameter
Shows which of the selectable parameters is currently being shown on the main display, e.g. Motor Speed, Motor Current etc.

Operating Information
Provides a real time display of key operating information, e.g. output current and power

Start Button
When in Hand mode, used to Start the drive.

Stop / Reset Button
Used to reset a tripped drive.
When in Hand mode, used to Stop the drive.

Hand Button
Used to place drive in Hand (keypad) mode.



Control Keypad
Provides access to the drive parameters, and also allows control of the drive when Hand operation is selected.

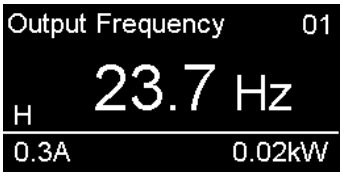
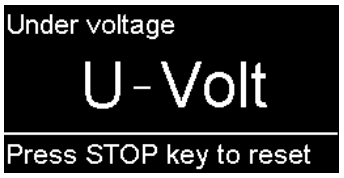
Navigate Button
Used to display real-time information, to access and exit parameter edit mode and to store parameter changes

Up Button
Used to increase speed in real-time mode or to increase parameter values in parameter edit mode

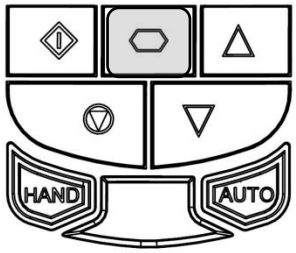
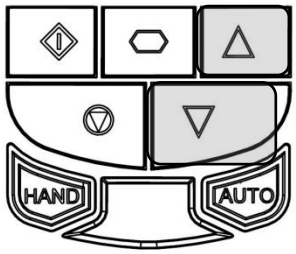
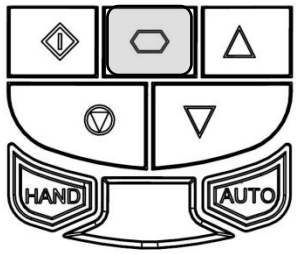
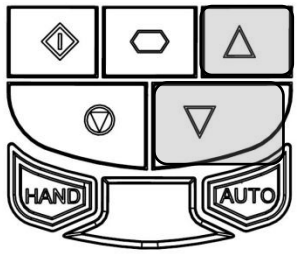
Down Button
Used to decrease speed in real-time mode or to decrease parameter values in parameter edit mode

Auto Button
Used to place drive in Auto (Remote) mode.

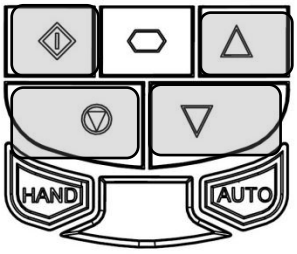
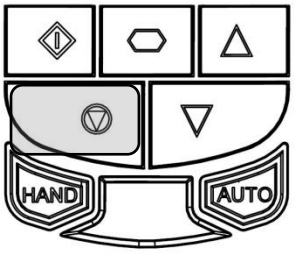
5.6. Drive Operating Displays – Standard OLED Keypad (IP55 and IP66 Drives)

			
Displayed when the hardware enable circuit is open	Displayed when the drive power is applied, motor stopped	Drive operating, display showing output information	Drive trip display showing trip condition

5.7. Accessing and Changing Parameter Values – Standard OLED Keypad (IP55 and IP66 Drives)

			
			
Hold navigate button in for >1 sec	Use up and down keys to scroll to required parameter.	Presss / release navigate button when required parameter shown	Use up and down keys to edit parameter value.

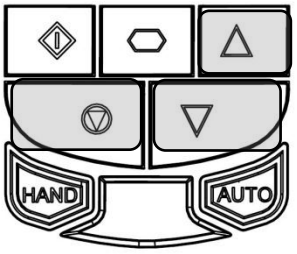
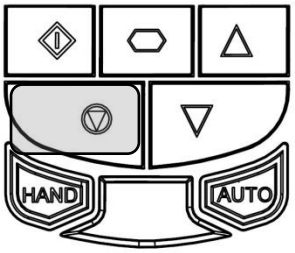
5.8. Resetting Parameters to Factory Default Settings – Standard OLED Keypad (IP55 and IP66 Drives)

	
	
Hold down the Up, Down, Start and Stop keys for >2s	The display shows P-Def. Drive is returned to factory settings. Press the Stop key

Note: Parameters cannot be defaulted whilst P2-39=1 (parameter set locked).

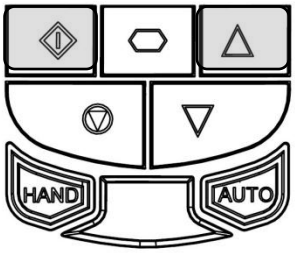
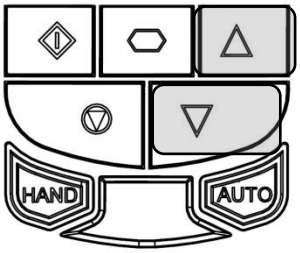
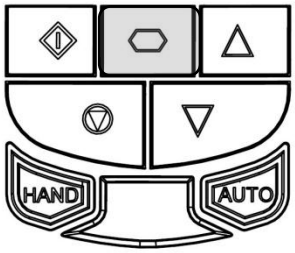
5.9. Resetting Parameters to User Default Settings – Standard OLED Keypad (IP55 and IP66 Drives)

The current parameter settings of the drive can be stored internally within the drive as the standard default settings. This does not affect the procedure for returning the drive to factory default settings as described above.
P6-29 (Save user parameters as default) can be enabled (set to 1) to invoke a parameter save of the current parameter values as the standard defaults for the drive. Parameter menu group 6 can only be accessed with advanced security level access (Default P1-14=201).

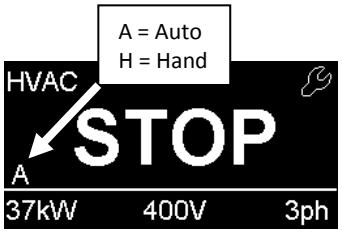
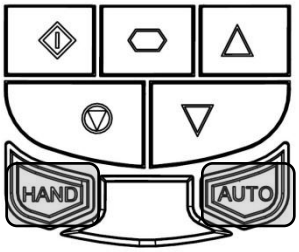
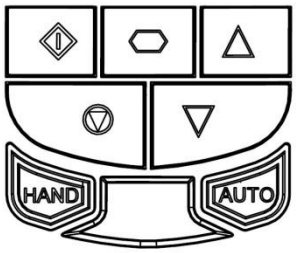
	
	
Hold down the Up, Down, and Stop keys for >2s	The display shows P-Def. Drive is returned to User Standard settings. Press the Stop key

Note: Parameters cannot be defaulted whilst P2-39=1 (parameter set locked).

5.10. Changing the Language on the OLED Display – Standard OLED Keypad (IP55 and IP66 Drives)

		
		
Hold down the Start, Navigate, and Up keys for >1s	Use the Up and Down arrows to select a language.	Press the Navigate button to select Language.

5.11. Selecting between Hand and Auto Control – Standard OLED Keypad (IP55 and IP66 Drives)

	
	
The active control source is shown on the OLED display. Use the Hand and Auto buttons on the keypad to switch between control sources	Hand mode permits drive control directly from the drive keypad. Auto mode control source is configured with Parameter P1-12 (Control Mode)

6. Commissioning

6.1. General

The following guidelines apply to all applications

6.1.1. Entering the motor nameplate information

Optidrive HVAC uses the information from the motor nameplate to

- Operate the motor with the best possible efficiency level
- Protect the motor against possible damage due to operation in overload condition

In order to achieve this, the Optidrive requires that the following information from the motor nameplate is entered into the parameters :-
P1-07 Motor Rated Voltage. This is the operating voltage for the motor in its present wiring configuration (Star or Delta). The maximum output voltage from the Optidrive can never exceed the incoming supply voltage.
P1-08 Motor Rated Current. This is the full load current of the motor from the nameplate
P1-09 Motor Rated Frequency. This is the standard operating frequency of the motor, generally 50 or 60Hz
P1-10 Motor Rated Speed. This parameter can optionally be set to the RPM shown on the motor nameplate. When this parameter is entered, all speed related parameters in the drive are displayed in RPM. When the parameter is set to zero, all speed related parameters are displayed in Hz.

6.1.2. Minimum and Maximum Frequencies / Speeds

Optidrive HVAC units are factory set to operate the motor from zero up to base speed (50 or 60Hz output). In general, this operating range is suitable for a wide range of requirements, however in some cases it may be desired to adjust these limits, e.g. where the maximum speed of a fan or pump may provide excessive flow, or where operation below a certain speed is never required. In this case, the following parameters can be adjusted to suit the application :-
P1-01 Maximum Frequency. In general this should match the motor rated frequency. If operation above this frequency is desired, confirmation from the motor manufacturer, and the manufacturer of any connected fan or pump should be sought that this is permissible, and will not cause damage to the equipment.

P1-02 Minimum Frequency. A suitable minimum can be set to prevent the motor operating at low speed, which may cause the motor to overheat. In some applications, such as a pump circulating water through a boiler, it may be necessary to set a speed to ensure the boiler does not run dry during operation.

6.1.3. Acceleration and Deceleration Ramp Times

Optidrive HVAC units are factory set with acceleration and deceleration ramp rates set to 30 seconds. The default value is suitable for the majority of HVAC applications but can be altered by changing the values in parameters P1-03 and P1-04. Care must be taken to ensure the driven load is capable of performing the specified ramps and that nuisance trips due to excessively short ramp times are not produced.
The ramp times entered in the parameter set always specify the time taken to ramp between 0Hz and motor rated speed P1-09.
*For example; If ramp rate = 30 seconds and P1-09 (motor vase speed) = 50Hz, and assuming the motor is currently running at 25Hz and the drive is commanded to accelerate to 50Hz. The time taken to reach 50Hz would be 30 seconds(P1-03) / 50 (P1-09) * 25 (required change in speed) = 15(s)*
P1-03 Acceleration Ramp Rate: Time taken for the drive to accelerate the motor from 0Hz to Motor base speed, P1-09 in seconds.

P1-04 Deceleration Ramp Rate: Time taken for the drive to decelerate the motor from Motor base speed, P1-09 to 0Hz in seconds.

6.1.4. Stop Mode Selection

Optidrive HVAC units can be programmed to either apply a fixed deceleration to the motor during stopping, or to release control of the motor and allow it to coast or free-wheel to a stop. The default selection is for the drive is ramp to stop and behaviour is programmed using parameter P1-05.
P1-05 Stop Mode Select: Defines how the motor will be stopped in the event of the enable input being removed from the drive. Ramp to stop (P1-05 = 0) will ramp the drive to stop using the value for deceleration entered in P1-04. Coast to stop (P1-05 = 1) will allow the motor to coast to stop (uncontrolled).

6.1.5. Energy Optimiser

The Energy Optimiser attempts to reduce the overall energy consumed by the drive and motor when operating at constant speeds and light loads. The Energy Optimiser is intended for applications where the drive may operate for some periods of time with constant speed and light motor load.
P1-06 Energy Optimiser: 0 = Disabled, 1 = Enabled.

6.1.6. Voltage Boost

Voltage boost is used to increase the applied motor voltage at low output frequencies, in order to improve low speed and starting torque. Excessive voltage boost levels may result in increased motor current and temperature, and force ventilation of the motor may be required. The default value for Voltage boost is set between 0.5 and 2.5%, depending on drive size, and is typically ok for the majority of HVAC applications.
P1-11 Voltage Boost: Set as a percentage of motor rated voltage P1-07

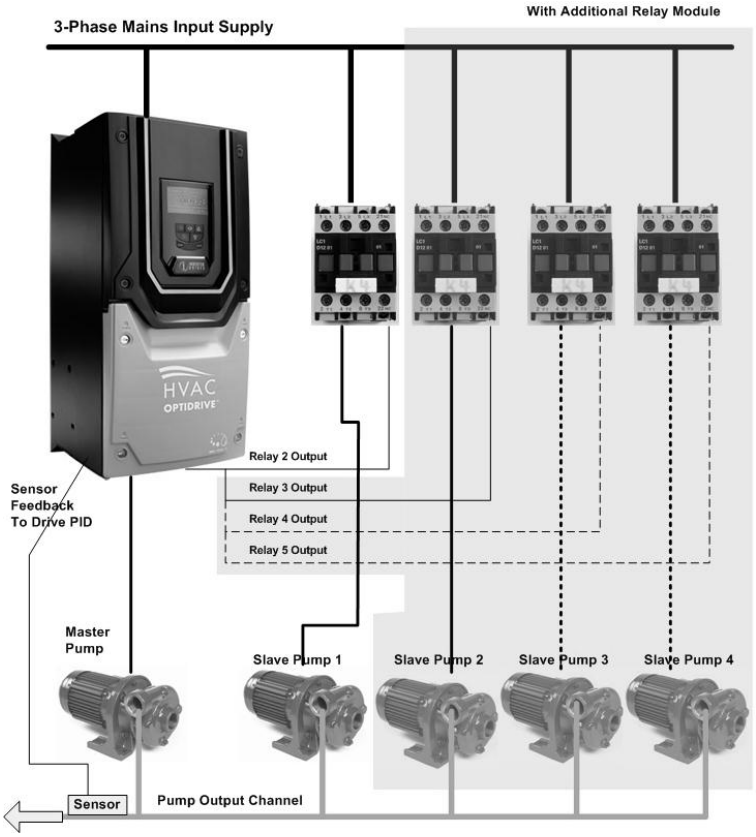
7. HVAC Specific Feature Setup (Menu 8)

The Optidrive HVAC has several features inbuilt into the drive standard operating software that are specific to HVAC applications. The majority of parameters used in enabling and configuring these functions are contained within menu 8 (See section 11.7). This section is an explanation of the purpose and operation of each of these functions and guidelines on how each one can be configured.

7.1. Pump Staging – DOL Cascade

Summary:

The below illustration shows the use of an Optidrive HVAC unit as the controller in a DOL pump staging system. The Master pump in this configuration is controlled from the output of the Optidrive HVAC in variable speed mode with direct relay control of up to four DOL slave pumps as shown below.



Relay 1 on the standard I/O terminals of the Drive (T14 & T15) cannot be used as part of the DOL control but is freely programmable to other functions through parameter P2-15. Relay 2 on the standard I/O terminals of the Drive (T17 & T18) can be used as the DOL control for the first slave pump. Relay 2 is set to DOL control by setting parameter P2-18 = 8, or can be used for an alternative function by setting a value other than 8.

For staging configurations with more than one slave pump an optional extended I/O option module will be required. Options modules are available allowing up to 3 further slave DOL pumps (giving a maximum of 4 DOL slave pumps) to be connected. Intermittent switching relays may be required if the contactor voltage or current requirement is outside of the specification of the drive relays (see section 4.7, Control Terminal Connections).

The system output sensor is connected to the Optidrive HVAC analog input 1 or 2 (T6 or T10) and is selected as the feedback to the drive PID controller. See parameter menu 3 for PID configuration parameters and feedback selection.

Operational Overview:

The pump staging with DOL cascade function is enabled by setting parameter P8-14=1 (Pump staging function select). In addition, the value of P8-15, 'Pump staging DOL pump availability' must be set with the number of Slave DOL pumps available (to a value other than 0).

The Optidrive HVAC Drive runs the master pump in variable speed control. The number of Slave DOL pumps available in the system is configured by parameter P8-15. At a predefined level the slave DOL pumps are brought on-line in sequence to assist the Master variable speed pump. Switch on sequence is defined by the pump run time clocks (monitored and maintained by the Optidrive HVAC) with the least run time pump switched in first. A pre-defined settle time (Set in P8-19) is observed before any further pumps are switched in or out of the system. This allows the system to reach a steady operating state before additional pump requirements are assessed. Pump switch off is done at a predefined level in the sequence of least run time.

The maximum difference in run time between DOL slave pumps can be limited by setting the 'Pump Staging Duty Switch Over Time' parameter (P8-16). When a value is entered into P8-16 the Optidrive HVAC will automatically switch off the DOL slave pump with the longest run time and switch in the pump with the shortest run time once the difference in run times set in P8-16 is exceeded. When P8-16 is set to 0 pump switch-over based on run time is disabled and switch over is determined only by the threshold limits (demand based).

Duty run time clocks are available to view in P0-19. Clocks are reset by setting parameter P8-20 'Pump Staging Master Clock Reset' to 1 (reset).

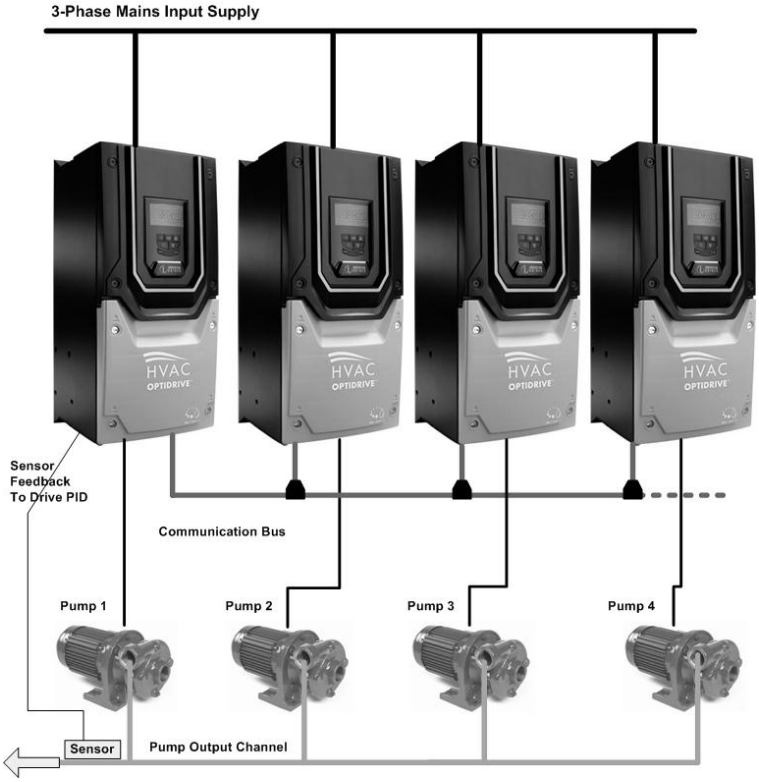
Quick Setup Overview:

- Set Basic parameters P1-01 to P1-10. Energy Optimiser P1-06 must remain disabled.
- Set Parameter P1-14= 101 to allow access to extended parameters
- In Menu 3, Configure parameters for the PID Control
- If drive relay 2 is used as part of the slave DOL cascade then set P2-18 = 8
- Set parameter P8-14=1 to enable the Pump staging – DOL cascade function
- Set the number of DOL slave pumps available in the system (not including Master VFD pump) in P8-15
- Set Optidrive HVAC operating speed limits used to activate / deactivate DOL slave pumps as follows:
    - P8-17: Pump Staging DOL Switch In Speed – Threshold to bring in DOL Slave pump
    - P8-18: Pump Staging DOL Switch Out Speed – Threshold to switch out DOL Slave pump
- Set a pump staging settle time (minimum 10 seconds) in P8-19. The time entered in P8-19 must be sufficient for the PID feedback signal from the system output sensor to settle to a steady level.
- If the duty run times between DOL slave pumps are to be balanced then the maximum permissible difference in hours should be entered in P8-16.

7.2. Pump Staging – Multiple Drive Cascade

Summary:

The below illustration shows the use of an Optidrive HVAC units as the controllers in a variable speed pump staging system. All pumps in this configuration are controlled the Optidrive HVAC units in variable speed mode with co-ordination and communication carried out over the built in RS485 communications link as shown below.



Drives can be connected using the RJ45 data cables and the RS485 Data Cable Splitter as shown above up to a maximum of 5 drives. Part numbers are as follows:

Product Code	Description
OPT-RJ45SP	RJ45 Splitter Box 1 – 2 Way
OPT-J4505	RJ45 to RJ45 RS485 Data Cable, 0.5m
OPT-J4510	RJ45 to RJ45 RS485 Data Cable, 1m
OPT-J4530	RJ45 to RJ45 RS485 Data Cable, 3m

Each motor / pump in this configuration is controlled by a dedicated HVAC drive (one drive per pump). All drives run in variable speed mode with the speed reference passed across the communications network.

One drive in the system is denoted the 'Network Master'. The Network Master has the Feedback sensor input connected to it along with the input set-point control, and uses its PID function to generate the operating speed for the system. The 'Network Master' provides an enable status and speed reference to the other drives on the network.

Operational Overview:

The pump staging with multiple drive cascade function is enabled by setting parameter P8-14=2 (Pump staging function select) **on the network master drive only**. All drives other than the network master drive must be set to communications slaves by setting parameter P1-12= 5 'slave mode).

In addition, the value of P8-15 on the network master, 'Pump staging DOL pump availability' must be set with the number of additional drives available in the system (slave drives), excluding the master (set to a value other than 0). The master drive must be set to drive address 1 (default), with the addresses of the slave drives set in sequence to subsequent addresses (2. 3. 4. 5...). Addresses are set within P5-01.

When the system is enabled the master drive will check the run time clocks for all drives in the network which are stored and maintained within menu 0 of the master drive. The first available drive with the lowest run time is automatically run first. At a predefined level additional drives / pumps are brought on-line in sequence to assist the running pumps. Switch on sequence is always defined by the pump run time clocks of the available drives (monitored and maintained by the master drive) with the least run time pump switched in first. A pre-defined settle time (Set in P8-19) is observed before any further pumps are switched in or out of the system. This allows the system to reach a steady operating state before additional pump requirements are assessed. Pump switch off is done at a predefined level in the sequence of least run time.

Maximum and minimum speed and Ramp times for each drive in the network are determined by the individual setting on each drive (P1-01 to P1-04).

The maximum difference in run time between drives / pumps can be limited by setting the 'Pump Staging Duty Switch Over Time' parameter (P8-16). When a value is entered into P8-16 the network master drive will automatically switch off the drive / pump with the longest run time and switch in the drive / pump with the shortest run time once the difference in run times set in P8-16 is exceeded. When P8-16 is set to 0 pump switch-over based on run time is disabled and switch over is determined only by the threshold limits (demand based).

Duty run time clocks are available to view in P0-19 of the network master drive. Clocks are reset by setting parameter P8-20 'Pump Staging Master Clock Reset' to 1 (reset) on the network master drive.

The Network Master will assume that any drive not responding to network messaging is currently unavailable (powered off / RS485 disconnected). The Network master will continue to poll drives that are offline but will not attempt to run the drive until communication is re-established.

When any drive, including the network master, enters into a trip condition it will be temporarily suspended from operation and the system will maintain operation with the remaining available drives. When a drive is reset from a trip condition it will automatically become available for selection by the network master.

The enable input (T1 – T2) to the network master is deemed to be the enable for the complete system and causes system operation to start or stop. Individual enable inputs (T1 – T2) on the network slave drives provide an inhibit input that prevent operation of that particular drive.

Quick Setup Overview:

On all HVAC Drives

- Set Basic parameters P1-01 to P1-10 on all drives in the system. Energy Optimiser P1-06 must remain disabled.
- Set Parameter P1-14= 101 to allow access to extended parameters

On the Network Master

- In Menu 3, Configure parameters for the PID Control
- Ensure the network serial address in P5-01 is left as default (1)
- Set parameter P8-14=2 to enable the Pump staging – Multiple Drive Cascade function
- Set the number of network slave pumps available in the system (not including Network Master VFD) in P8-15
- Set Optidrive HVAC operating speed limits used to activate / deactivate network slave pumps as follows:
  - P8-17: Pump Staging Assist Switch In Speed – Threshold to bring in assist pump
  - P8-18: Pump Staging Assist Switch Out Speed – Threshold to switch out assist pump
- Set a pump staging settle time (minimum 10 seconds) in P8-19. The time entered in P8-19 must be sufficient for the PID feedback signal from the system output sensor to settle to a steady level.
- If the duty run times between all available drives / pumps are to be balanced then the maximum permissible difference in hours should be entered in P8-16.

On the Network Slaves

- Set the drives to network slaves by setting P1-12 = 5
- Set the network serial address in P5-01 to unique addresses is sequence, starting at address 2 (2, 3, 4, 5...)

7.3. Maintenance Interval Set-up and Reset

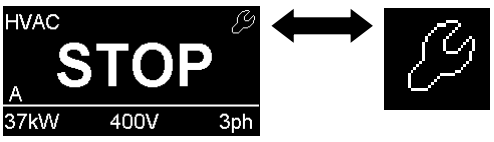
The Optidrive HVAC has a maintenance interval timer function with visible display indication and configurable output points to allow the programmer to set-up routine maintenance schedules / intervals for the machine / system and to indicate maintenance due to the machine operator. The maintenance interval is calculated from the 'Drive hours run clock' and is hence an indication of the operational use of the drive system rather than a basic calendar based timer function.

Operational Overview:

The maintenance interval is enabled and configured by parameter P6-24, Service Interval Timer. When P6-24 is set to 0 the maintenance interval timer is disabled. The maintenance interval (P6-24) is set in hours between 1 and 60000 (default 5000 hours). Access to parameter menu 6 is permitted only when the advanced security level password is entered into P1-14 (default password 201). The maintenance interval timer is initiated when a valid value is entered into P6-24. The time remaining until maintenance becomes due is stored and displayed in parameter P0-22 (Time Left to Next service).

When the maintenance interval expires (P0-22 reaches 0) the Optidrive HVAC can indicate maintenance due on the machine in the following ways:

- The maintenance symbol is automatically displayed on the OLED display (alternating with drive communications address in top right corner.
- One of the drive relay outputs can be configured for indication of maintenance due,



- A warning bit in the drive communications status words is set (see associated communications guide).

The following parameters are used to configure the relay drive outputs to represent Service Due.

Parameter Number	Parameter Description	Terminal	Value set
P2-15	Relay output 1 function select	14 / 15	10
P2-18	Relay output 2 function select	16 / 17 / 18	10

When the maintenance interval has expired and the scheduled service has been completed the service interval timer is reset by setting P6-25 = 1, Reset Service Indicator. The timer for the next service interval starts from the point at which the previous indication was reset. Advanced security access is required (default P1-14 = 201) in order to access the Reset Service Indicator parameter.

Quick Setup Overview:

Maintenance Interval Set-up

- Set Parameter P1-14 = 201 to allow access to advanced parameters in menu 6
- Set the number of hours between services in parameter P6-24, Service Timer Interval (Default 5000).
- If a drive output is required to indicate that maintenance is due then configure the output based on the table above (P2-15 or P2-18 = 10).

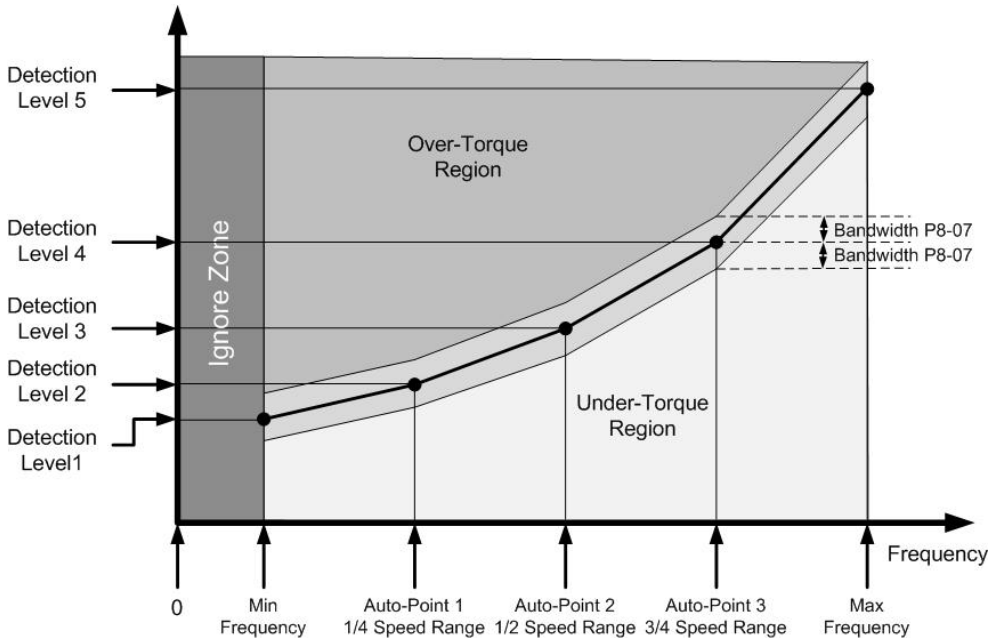
Maintenance Interval Reset

- Set Parameter P1-14 = 201 to allow access to advanced parameters in menu 6
- Set parameter P6-25 = 1, Reset Service Indicator to reset the Maintenance Timer Interval.

7.4. Load Profile Monitoring Function

The Load Profile Monitoring Function provides under and over torque protection to the driven load. Practical applications for the function might include Belt Snap detection, Motor Stall detection, Pump Blockage, or Pump Dry Run protection.
The Load Profile Monitoring Function uses a standard operating torque profile stored in memory and the drive current is continuously compared to the standard profile during operation. Should operating current / torque deviate outside of the standard profile for a specified period of time then a trip will be generated within the drive. The Optidrive HVAC uses 5 measured points on the frequency versus current operating curve in order to model normal operation.

A graphical representation of the Load Profile Monitoring Function is shown below:



Operational Overview:

In order to use the Load Profile Monitoring Function the standard (normal) operating profile of the drive current versus speed must be established. Set-up of the Load Profile Monitoring Function and the standard operating profile is normally performed as the final step in commissioning the system.
The standard operating profile is established within the drive using an automatic measurement sequence. The automatic measurement sequence is activated when the Load Profile Monitoring Function is enabled (P8-06 changed from 0). When the drive is first run, following enable of the Load Profile Monitoring Function, the drive output will be ramped to the maximum frequency setting (P1-01) with 5 evenly spaced current measurements recorded. The drive will then return to the normal set-point operating speed. In order to repeat the automatic measurement sequence the Load Profile Monitoring Function must be disabled (P8-06 = 0) and re-enabled (P8-06 <> 0).

Caution: The automatic measurement sequence over-rides the normal drive set-point speed and the drive will run the motor up to maximum frequency (P1-01). Ensure that the system is in a suitable condition to operate through the programmed speed range.

Maximum Frequency / Speed parameter (P1-01) and Minimum Frequency / Speed parameter (P1-02) can be adjusted following execution of the automatic measurement sequence without affecting the results obtained during the automatic measurement sequence. When operating outside of the maximum and minimum speed range the function is disabled.
When setting parameter P8-06 to activate the Load Profile Monitoring Function a value is set that instructions the Optidrive HVAC unit to trip on detection of under-current (P8-06=1), over-current (P8-06=2), or combination of both under-current or over-current (P8-06=3).
A detection tolerance for the Load Profile Monitoring Function is set within parameter P8-07. Parameter P8-07 (Load Profile Monitoring Function Bandwidth) is set as a current (amps) value and is then applied to the standard operating profile stored within the drive to allow for acceptable variations in the motor current measurement. The value entered is applied symmetrically to the nominal current value so totally bandwidth is 2 x P8-07. The Current values measured during the auto-tune are recorded to parameter P0-58 for reference.
In addition to a bandwidth of tolerance being applied to the standard operating profile (P8-07) a trip delay or time limit can also be specified for operation on the drive within the over torque or under torque regions. This time is set within parameter P8-08 (Load Profile Monitoring Function Trip Delay). This parameter can be set to avoid nuisance tripping whilst the load is in a temporary or transitional state.

The Optidrive HVAC will trip immediately on detecting an under / over torque condition for a time period greater than that set in P8-08 and will disable output to the motor with coast to stop. The trip will be displayed on the OLED display and can be reset by pressing the Keypad STOP key.

The Optidrive HVAC can be set to run an automatic pump cleaning function once the Load Profile Monitoring Function has detected an over-torque condition. See section 7.5, Pump Clean Function for more information.

Trip Codes: O_tor9 : Over-Torque Level Detected resulting in drive trip (Fault code 24)
U_tor9 : Under-Torque Level Detected resulting in drive trip (Fault code 25)

Quick Setup Overview:

- **Read Caution note associated with this function (above)**
- Set the maximum and minimum speed limits for the drive (P1-01 & P1-02).
- Set Basic parameters P1-03 to P1-10. Energy Optimiser P1-06 must remain disabled.
- Set Parameter P1-14 = 101 to allow access to advanced parameters in menu 8
- Enable the Load Profile Monitoring Function by setting P8-06
  - 0: Disabled
  - 1: Low Load Detection Enabled (Belt Failure / Dry Pump / Broken Impeller)
  - 2: High Load Detection Enabled (Pump Blockage)
  - 3: Low and High Current Detection
- Set an acceptable tolerance bandwidth in P8-07. Set a high bandwidth initially and monitor current during normal operation to determine tighter levels if required.
- Enable the drive and allow the automatic measurement sequence to run.
- Should some nuisance tripping occur, increase the Load Profile Monitoring Function Trip Delay in P8-08. If tripping still occurs then repeat the automatic measurement sequence.

7.5. Pump Clean Function

The Pump cleaning function is used to remove blockages from a pump. The pump clean function can be manually triggered by a digital input or can be triggered automatically on start-up, or when the drive detects an over-torque condition (due to blockage forming).
When the Pump cleaning cycle is activated the Optidrive HVAC will perform a predefined motion profile (cleaning cycle) in order to attempt to remove the blockage.

Operational Overview:
The pump cleaning function is enabled or disabled and its automatic triggering defined by parameter P8-03 Pump Cleaning Function Configuration. Options included for parameter P8-03 include:

0. Disabled
1. Pump cleaning function activated on drive start up
2. Pump cleaning function activated on drive start up or over-torque detection
3. Pump cleaning function activated on over-torque detection

If either option 1 or option 2 is selected for P8-03 then the drive will run the pump cleaning cycle immediately on drive enable (enable command given of digital input 1, drive terminal 2). Once the pump cleaning cycle is complete the drive will return to normal set-point control.

If either option 2 or option 3 is selected for P8-03 then the Load Profile Monitoring function must be set-up in order to detect an over-torque condition. Set up the Load Profile Monitoring function as per the instructions in this guide. **Please see section 7.4 – Load Profile Monitoring Function.** When the Pump cleaning function is triggered from an over-torque condition then the drive does not go into an over-torque trip following an over torque condition but instead automatically runs the pump clean function. On exiting the pump clean function the drive will return to its normal operating set-point. If any further over-torque events occur within 60 seconds of a pump clean function finishing then this will then cause an over-torque trip.
Further attempts to clean the pump (up to a maximum of 5 attempts) can be programmed through the Automatic Trip Reset function (see P2-36 – Start Mode Select). When auto-restarting from an over-torque trip the drive will automatically run the pump clean function provided the pump clean function is enabled.

If a digital input is assigned to this function then it will activate the pump clean sequence regardless of the setting of parameter P8-03 (Pump Cleaning Function Configuration). When the Pump Clean Function is initiated via an input to the drive, the drive will ramp immediately from its current operation speed to the first speed defined by the pump clean cycle using applicable ramp rates.
The digital input assignment for the pump cleaning function is defined through P9-42 – Clean trigger input edge. Menu 9 can only be accessed using the advanced level security access (default P1-14 – 201). Set P9-42 with the value associated with the digital input to be used.

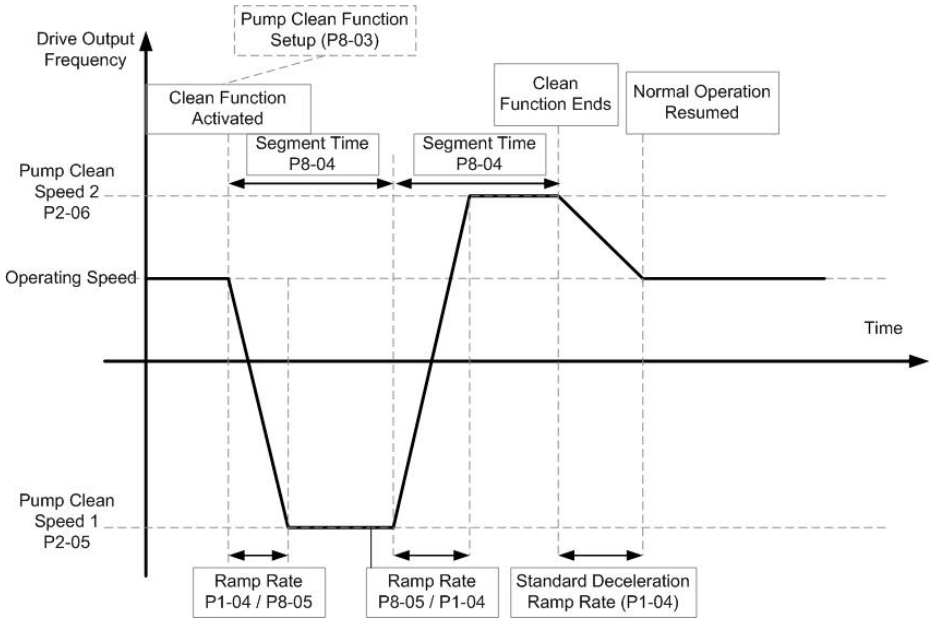
The Pump Cleaning cycle is defined by setting two segment speeds, a ramp time (used for acceleration and deceleration), and a segment time in the following parameters:

Parameter Number	Description
P2-05	Clean Speed 1
P2-06	Clean Speed 2
P8-04	Pump Cleaning Function Time Interval
P8-05	Pump Cleaning Function Ramp Time

If either of the two Pump Cleaning Speeds are set to zero then that segment of the cleaning cycle is disabled. Pump cleaning speeds can be set with positive or negative values to allow forward or reverse motion to be performed and two stage or bidirectional profiles to be created. The Acceleration ramp for the pump clean function is determined by setting P8-05. The deceleration ramp rate is determined by the standard deceleration ramp parameter P1-04.

Caution: Always ensure that the pump is suitable for reverse operation before applying a negative speed reference to either Clean Speed 1 or Clean Speed 2 (P2-05 & P2-06).

An example of the Pump cleaning profile is shown below.



When the Pump Cleaning function is completed the drive returns immediately to the current set-point speed. Return to normal operating speed is done using the standard ramp settings (P1-03 / P1-04). Segment execution time (set in P8-04) encompasses the time taken to accelerate the motor to the cleaning speed but does not include the ramped return to normal operating speed.

Quick Setup Overview:

- If the Pump Cleaning function is to be triggered by an over-torque condition then **section 7.4, Load Profile Monitoring Function must be commissioned prior to set-up of the Pump Clean function.**
- Set Basic parameters P1-01 to P1-10. Energy Optimiser P1-06 must remain disabled.
- Set Parameter P1-14 = 101 to allow access to advanced parameters in menu 8
- Set the segment speed for each cleaning segment in parameters P2-05 and P2-06
- Enable the Pump Clean function by setting P8-03. Setting of P8-03 is not necessary if the Pump Clean function is activated only by a digital input.
    - 0: Disabled
    - 1: Activated on enable (Pump start up)
    - 2: Activated on enable (Pump start up), or operation in Over-torque region
    - 3: Activated by operation in Over-torque region
- Set the segment time for the cleaning cycle in parameter P8-04. This is the time to run each cleaning segment, including acceleration.
- Set a ramp time for the Pump Clean function is P8-05. This is the ramp rate to use in accelerating to Pump Clean Speed 1 and Pump Clean Speed 2.

7.6. Pump Stir Function

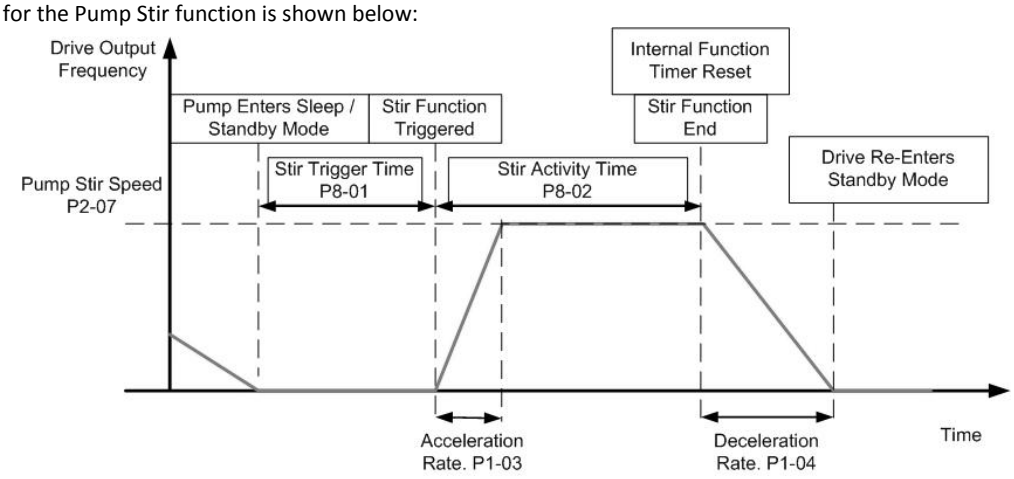
The Pump Stir function is used to trigger the pump to run following a period of inactivity. When the motor has remained inoperable for a pre-defined time a user defined motion profile is carried out on the pump. The function is active when the drive is in PID mode and the timer activated by the drive entering into 'standby'. The function is used to prevent pump blockage or pump degradation caused by sustained periods of pump inactivity. The function might also be used for fan applications to prevent degradation of bearing lubricants.

Operational Overview:

The time period to trigger the pump Stir function is entered into parameter P8-01 (Stir Function Integral Timer). When the drive enters into standby mode (see PID control, section 8) an internal timer is started. When the timer exceeds the user defined time limit set in P8-01 a preset motion profile is activated. When function execution is completed the drive returns immediately to standby mode. The internal function timer is reset by the drive exiting standby mode or on completion of the pump Stir function.

The motion profile is set within two parameters. Parameter P8-02 (Stir Activity Timer) sets the time that the pump is to be operated and P2-07 (Preset Speed 7 – Pump Stir Speed) sets the speed that the pump will be accelerated to and operate at during the stir cycle. The stir activity time includes the time take to accelerate to speed but not the time to decelerate back to stop.

The motion profile for the Pump Stir function is shown below:



Setting either the Stir Function Interval Time (P8-01) or the Stir Activity Timer (P8-02) to 0 disables the Pump Stir function. This function is disabled at default.

Quick Setup Overview:

- Set Basic parameters P1-01 to P1-10.
- Set Parameter P1-14 = 101 to allow access to advanced parameters in menu 8
- Set the PID control menu 3 parameters (see section 8)
- Set the Pump Stir Speed required in parameter P2-07
- Set the Time to elapse in standby before the Pump Stir Function is triggered in parameter P8-01.
- Set the time to run the Pump Stir Function in parameter P8-02

7.7. Bypass Control Function

The Bypass Control function allows the motor to be operated either from the Optidrive HVAC (variable speed control) or direct on line on the incoming supply (fixed speed). Bypass control requires external components and connection in creating the bypass system that are not provided as part of the Optidrive HVAC and are the responsibility of the system designer.

Caution: Circuit examples provided in this manual are for guidance only. System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. The system must be installed only by qualified electrical persons and in accordance with local and national regulations and codes of practice.

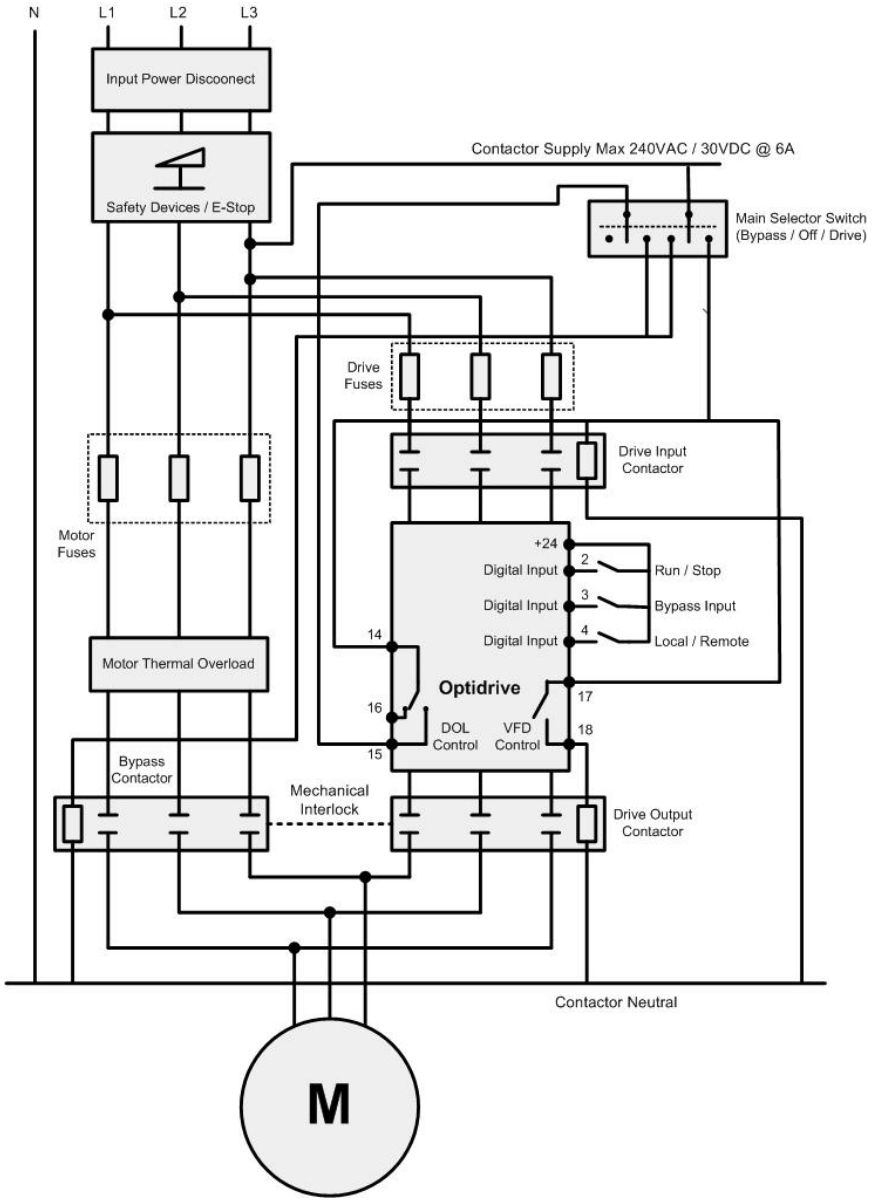
The bypass control function with the Optidrive HVAC allows the drive to switch in the bypass circuit automatically should the drive trip on a fault condition, should Fire Mode be activated (see section 7.8 - Fire Mode function) or manually via an input to the drive.

Invertek Drives Ltd recommended the use of a three contactor bypass arrangement in implementing a bypass circuit. Mechanical as well as electrical inter-locking is recommended to guard against contactor failure and to prevent damage to the system in such events.

Operational Overview:

The basic configuration for a three contactor bypass circuit is shown below.
Mechanical Interlocking is shown between the Bypass contactor and the Drive Output contactor. Electrical Interlocking is also recommended between the Bypass and Drive Output contacts using auxiliary contacts on each device.

Caution: The supply voltage for the coil of the contactors must not exceed the rating for the drive control relays contacts (250V AC / 30V DC @ 5A)



The main selector switch selects between the following modes.

- System Off : Drive is powered off; Bypass contactor is off
- Bypass Control : Drive is powered off; Bypass contactor is on, motor running from bypass supply
- Drive Control : Drive is powered on; Bypass or Drive Output contactor selection is controlled by the drive

When the Main Selector Switch is set to Drive Control, the drive input contactor is switched in such that the drive will power up. Selection of the two motor output contactors is controlled by the drive dependent on the settings provided to the drive by the user. When Optidrive HVAC control is selected the drive can co-ordinate bypass or drive control based on the settings and running conditions of the drive.

The two drive control relays (relay 1 and relay 2) are automatically configured when Bypass Mode is enabled. Relay 1 is configured for bypass control and is connected directly to the Bypass contactor. Relay 2 is configured for drive control and is connected directly to the Drive Output Contactor. Under normal operation the drive will close relay 2, bringing in the Drive Output contactor, and operation of the motor will be as per the logic and speed reference configuration of the drive.
The drive will switch off the Drive Output contactor (relay 2) and switch in the Bypass contactor (relay 1) if one of the bypass control functions is enabled and the logic to trigger that function becomes true. Bypass control functions include:

• Bypass on Fault	Drive will switch to bypass if a trip condition prevents the drive from operating the motor
• Bypass on Fire Mode	Drive will switch to bypass if the Fire Mode function is assigned to a digital input and that input becomes true (can be open active or close active)
• Bypass on Input	Drive will switch to bypass if a digital input is assigned to bypass control (through menu 9) and that input becomes true.

Note: A combination of bypass conditions is permitted.

Bypass on Fault.

Bypass Mode on Fault is enabled by setting parameter P8-11=1 (enabled). Once enabled the drive will switch to bypass mode in the event of a trip or fault occurring on the drive. When a trip occurs the drive will immediately open the drive output contactor (drive output already disabled due to trip), wait a time (defined by P8-13) and then close the bypass contactor. The motor will remain under Bypass control until the enable/run input is removed from the drive (drive control terminal 2) at which point the Bypass contactor will be opened. When the run/enable input is closed again the drive will attempt to run under drive control (drive output contactor closed).
It is required that Spin Start (P2-26) be enabled for this function.

Bypass on Fire Mode.
Bypass on Fire Mode is enabled by setting parameter P8-12=1 (enabled). Once enabled, the drive will switch to bypass mode in the event of the fire mode input becoming active (true). Fire Mode should be configured (see section 7.8. Fire Mode Function) and an input assigned either through parameter P1-13 or through menu 9 (P9-32) prior to enabling Bypass on Fire Mode.
When the Fire Mode input becomes true the drive will immediately disable its output and open the drive output contactor, wait a time (defined by P8-13) and then close the bypass contactor. The motor will remain under bypass control until the fire mode input is deactivated. When the Fire Mode input is deactivated the bypass contactor will be opened, there will be a short delay (defined by P8-13) and the Drive Output contactor will close. Provided the enable input is still present then the drive will take over operation of the motor.
It is required that Spin Start (P2-26) be enabled for this function.

Bypass on Input
Bypass mode on Input is enabled by assigning a bypass trigger input in menu 9. Set parameter P9-13 (Bypass Trigger Input) to one of the available digital inputs. Once an input is assigned the drive will switch to bypass mode in the event of that input becoming active (true).
When the bypass trigger input becomes true the drive will immediately disable its output and open the drive output contactor, wait a time (defined by P8-13) and then close the bypass contactor. The motor will remain under bypass control until the bypass trigger input is deactivated. When the bypass trigger input is deactivated the bypass contactor will be opened, there will be a short delay (defined by P8-13), the Drive Output contactor will close and the drive will take over operation of the motor.
If the enable input is removed from the drive then the drive will switch off whichever of the two output contactors is currently on. When the drive is re-enabled the drive will look at the status of the bypass input to determine which of the output contactors to operate.
It is required that Spin Start (P2-26) be enabled for this function.

In all modes of operation the time period between one of the output contactors switching off and the other switching on is defined by parameter P8-13 (Bypass Contactor Changeover Time). This parameter should be set with a value that ensures the first contactor has time to clear prior to an attempt being made to switch in the second contactor. Additional mechanical or electrical inter-locking should also be provided.

The Drive OLED display will show the following indication whenever bypass mode is activated by the Optidrive HVAC control.

Quick Setup Overview:

- Set Basic parameters P1-01 to P1-10.
- Set Parameter P1-14 = 201 to allow access to advanced parameters in menu 8 & 9
- Set time delay between switch over of output contactors to safe limit in parameter P8-13 (default 2S).
  If Bypass required on Fault:
- Set bypass mode of fault P8-11 to 1 (Enabled)
  If Bypass required on Fire:
- Go through Fire mode set up procedure (section 7.8) prior to enabling Fire Mode Bypass Function.
- Set bypass mode of fault P8-12 to 1 (Enabled)
  If Bypass required on Input:
- Set bypass trigger input parameter P9-43 to an available digital input
  Note: To set menu 9 parameters P1-13 must be set to 0 and input functions programmed manually.

7.8. Fire Mode Function

The Fire Mode function is designed to ensure continuous operation of the Optidrive HVAC until either the Fire Mode input is removed or the drive is no longer capable of sustaining operation. It is used in applications where an input is provided to the drive from a fire control system in the event of a fire in the building and drive operation is required to be maintained for the longest possible period in order to clear smoke or maintain air quality within that building.

Operational Overview:
The Fire Mode function is a dedicated digital input function within the Optidrive HVAC control software. An input can be assigned to activate the drive Fire Mode function in one of the following ways:

- P1-13: Fire Mode can automatically be configured on digital input 2 by selecting values 4, 8, or 13 in parameter P1-13. (See section 10.1 – Digital input configuration parameter.
- P9-32: Fire Mode input source can be set via P9-32 to an available digital input. Advanced level security (default P1-14 = 201) is required to access menu 9 parameters

The fire mode function is enabled once an input is assigned to activate fire mode.
The logic selection for the fire mode input is configured through parameter P8-09 – Fire Mode Logic Select. It can be set to open active (0) or close active (1). The default setting is open active such that the loss of the input signal to the digital input will cause the fire mode function to activate.
The speed of operation of the Optidrive HVAC whilst in fire mode is defined by parameter P8-10 – Fire Mode Speed. This can be set to any value up to maximum speed (P1-01) in either the forward or reverse direction.

When an input is configured to trigger Fire Mode and that input is activated all other inputs to the drive are ignored. Other inputs to the drive only become active again once the Fire Mode input is removed.

Caution: Digital input functions (including the Run / Stop and Forward / Reverse input functions) are disabled whilst fire mode is active. The drive can only be stopped by removal of the fire mode input or by disconnection of the mains power to the drive.

The following display is used to show when the drive is operating in Fire Mode:

Trips ignored whilst drive is in Fire Mode:

Display	Trip
O-t	Heat-sink Over-Temperature
U-t	Drive Under Temperature
Th-FLt	Faulty Thermistor on Heat-sink
E-trip	External Trip
4-20 F	4-20mA fault
Ph-Ib	Phase Imbalance
P-Loss	Input Phase Loss Trip
SC-trp	Communications Loss Trip
I_t-trp	Accumulated overload Trip

Trips not ignored whilst drive is in Fire Mode:

Display	Trip
O-Volt	Over Voltage on DC Bus
U-Volt	Under Voltage on DC Bus
h O-I	Fast Over-current Trip
O-I	Instantaneous over current on drive output
Out-F	Drive output fault, Output stage trip

In order to automatically reset the drive from one of the trips that is not ignored by Fire Mode, P2-36 (Start mode select / automatic restart) must be set to Auto-1, Auto-2, Auto-3, Auto-4, or Auto-5 depending on the number of automatic resets the user wishes to perform. Note that there is a time delay of 20 seconds between each reset attempt.

Fire Mode operation is recorded in menu 0 for reference. Fire Mode start time is recorded to parameter P0-51 – Fire Mode Start Time. This value is referenced to the drive life time hour's clock so it can be seen how recent the Fire Mode operation occurred.
The period of time that the drive has operated in Fire Mode is recorded in parameter P0-52 – Fire Mode Active Minutes.

Caution: Operation in Fire Mode may affect the warranty period offered on the Optidrive HVAC, or in some cases void the warranty provided. Please contact your authorised Invertek distributor for more information.

One of the drive relay outputs can be set to indicate when the drive is running on fire mode. To set relay 1 to indicate fire mode operation set parameter P2-15 = 9. To set relay 2 to indicate fire mode operation set parameter P2-18 = 9.

Quick Setup Overview:

- Set Basic parameters P1-01 to P1-10.
- Set Parameter P1-14 = 201 to allow access to advanced parameters in menu 8 & 9
- Set the logic required for the Fire Mode Trigger input in P8-09: 0 = Open Active, 1 = Close Active.
- Set the required speed for the drive to operate at whilst in Fire Mode in parameter P8-10
  Either
- Set parameter P1-13 to a value that activates Fire Mode selection on digital input 2 (4, 8, or 13).
  Or
- Set parameter P9-32 to an available digital input value. Note : P1-13 must be set to 0. Any other digital inputs required must also be configured through menu 9.
- If required, set either P2-15 or P2-18 = 9 to configure output relay 1 or output relay 2 to indicate fire mode active.

7.9. Motor Pre-Heat Function and DC Injection

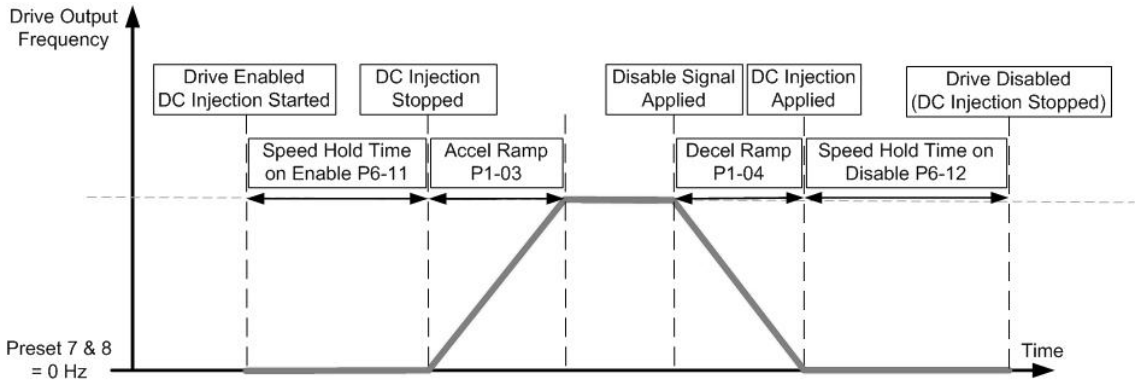
The Optidrive HVAC can be set to inject DC voltage into the motor on a start or stop condition, or can be set to maintain magnetising voltage across the motor whilst the speed reference to the drive is set to zero. Applying voltage to the motor creates a circulating current in the motor windings which in turn heats the motor and prevent moisture forming on the surface of the motor. Formation of moisture on the motor might be due to the motor operating in humid conditions or in low ambient temperature, or motor temperature change (specifically cool down) causing condensation to form.

Operational Overview: Setting up DC Injection braking on Start or Stop

The function uses the DC Injection parameters on either starting or stopping the motor in order to create a current and maintain an appropriate temperature within the motor prior to starting or post stopping. Parameters for configuring the DC Injection are contained in menu 6. Access to level 6 requires advanced level security access (Default P1-14=201). The level of DC Injection Voltage applied to the motor is set in parameter P6-18 (DC Injection Braking Voltage). The current can be monitored by changing the OLED display to show Amps (cycle the display to show Amps by pressing the Navigate button).

Caution: Always confirm the maximum acceptable current level that can be applied to the stationary motor prior to configuring the DC Injection function. It may be necessary to contact the motor manufacturer to confirm acceptable levels for operation. Check operation of the drive to ensure current levels are within the specified limited.

The time to apply DC Injection Voltage on motor starting is set by parameter P6-11 (Speed Hold Time on Enable). The time to apply DC Injection Voltage on motor stopping is set by parameter P6-12 (Speed Hold Time on Disable). The value set in either P6-11 or P6-12 represents the time in seconds that DC Injection Braking will be applied (maximum of 250 secs). The function is then activated by the Enable / Disable input (generally configured as digital input 1 – control terminal 2) going to an enable (start) or disable (stop) condition.
The speed for the Speed Hold Time on Enable is set in Preset Speed 7 (P2-07) and the speed for the Speed Hold Time on Disable is set in Preset Speed 8 (P2-08). These parameters must be set to 0 for the DC Injection function.
Note: Preset Speed 7 (P2-07) and Preset Speed 8 (P2-08) are also used as Boost Speeds within the PID function (see section 8) and hence DC Injection cannot be used when the PID controller is enable (P1-12=3).
Ramp to Stop should be enabled (P1-05=0) and appropriate ramp rates set in P1-03 and P1-04. The timing diagram for the DC Injection function is shown below.



Danger: The output from the drive to the motor will remain active whilst DC Injection braking is applied. Always disconnect power to the drive and wait 10 minutes before work is carried out to the drive or motor.

Quick Setup Overview: Setting up DC Injection Braking on Start or Stop

- Set Basic parameters P1-01 to P1-10.
- Ensure P1-05 is set to 0, Ramp to Stop. Ensure appropriate ramp rates are set in P1-03 and P1-04.
- Set Parameter P1-14 = 201 to allow access to advanced parameters in menu 6
- Set Preset Speed 7 and 8 (P2-07 & P2-08) to 0 Hz
- Set the DC Injection Braking Time required on Start in parameter P6-11.
- Set the DC Injection Braking Time required on Stop in parameter P6-12.
- Set the DC Injection Braking Voltage to apply in P6-18.
- Monitor current levels on the drive display and motor temperature to ensure they remain within the motor manufacturers specified limits.

Operational Overview: Setting up DC Injection Braking on zero speed reference

The function uses the Boost Voltage on the drive reaching zero speed in order to create a current and maintain an appropriate temperature within the motor. The drive Standby Mode must be disabled so that the drive output is not automatically put into Standby following a period of operation with zero speed reference.

The level of DC Injection Voltage applied to the motor is set in parameter P1-11 (V/F Boost Voltage). The current can be monitored by changing the OLED display to show Amps (cycle the display to show Amps by pressing the Navigate button).

Caution: Always confirm the maximum acceptable current level that can be applied to the stationary motor prior to configuring the voltage Boost function. It may be necessary to contact the motor manufacturer to confirm acceptable levels for operation. Check operation of the drive to ensure current levels are within the specified limited.

The time set in the Standby Mode parameter (P2-27) must be 0. This will disable Standby Mode and ensure Boost Voltage is applied whilst the drive is enabled with zero speed reference.
Ramp to Stop should be enabled (P1-05=0) and appropriate ramp rates set in P1-03 and P1-04.
If an input is required to activate motor stop with voltage boost then a digital input can be set to Preset Speed 1 (see section 10.1) and the Preset Speed 1 value (P2-01) set to 0Hz.

Quick Setup Overview: Setting up DC Injection braking on zero speed reference

- Set Basic parameters P1-01 to P1-10.
- Ensure P1-05 is set to 0, Ramp to Stop. Ensure appropriate ramp rates are set in P1-03 and P1-04.
- Set Parameter P1-14 = 101 to allow access to advanced parameters in menu 2
- Set parameter P2-27 = 0 to disable drive Standby Mode (default)
- If a digital input is required to activate motor stop with V/F Boost Voltage then ensure P1-13 is set to 1 (default). Digital input 2 (control terminal 3) is now configured for this function. Ensure P2-01 = 0.
- Set the Boost Voltage to apply in P1-11.
- Monitor current levels on the drive display and motor temperature to ensure they remain within the motor manufacturers specified limits.

8. PID Control Applications

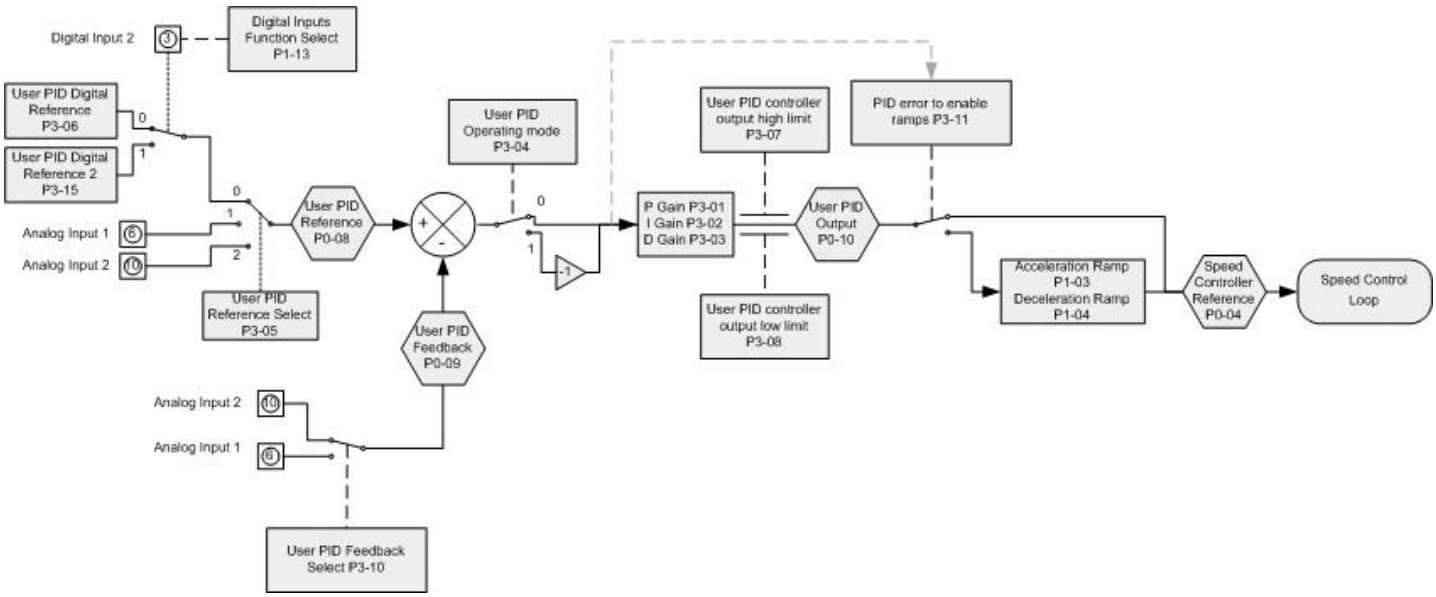
8.1. Overview

The PID Controller is a mathematical function designed to automate adjustments within a system and to eliminate the need for the machine operator to continuously pay attention to machine operation and to make manual adjustments. For a drive this generally means adjusting the motor speed automatically to try and maintain a specific measured value from a measurement sensor in the system, with the set-point being provided directly to the drive. For example, when the Optidrive HVAC is controlling a pump it might be required to maintain a pressure which is proportional to the speed the drive runs the motor. The required pressure (known as the set-point) is provided to the drive. The measurement sensor is connected to the drive analog input and provides a measurement (known as the feedback) of the current system pressure. The PID function in the drive compares the set-point and feedback and changes motor speed in order to increase or decrease the feedback to match the set-point. Should the set-point change then the drive will react by again changing motor speed is order to match the feedback signal to the new set-point value.

The difference between the set-point and feedback signals in real time is known as the PID error. PID represents P -Proportional, I - Integral, D – Derivative and describes the three basic mathematical functions applied to the error signal, using the calculated sum as the reference for controlling the motor speed. By adjusting values associated with the P, I, and D functions the programmer can configure how dynamically the drive responds to the PID error and how stable the system output (motor speed) is able to be maintained. Achieving best possible dynamic response and maintaining system stability by adjusting the values used by the P, I, and D functions is known as 'tuning the PID control'.

Caution: Adjusting values for the PID controller can result in dynamic response from the motor or introduce instability into the motor speed control. Tuning of the PID controller should only be attempted by experienced engineers.

The Optidrive HVAC has a full 3 term PID controller function for control of motor speed. The PID Set-point can be a digital or analog reference provided to the drive. Feedback is via one of the two analog inputs contained with the drive standard control terminals. All values are treated as % internally by the drive to assist in simple set up. PID control is enabled when P1-12 = 3. A block diagram of the Drive internal PID control function is shown below.



8.2. PID Function Set-up

8.2.1. PID Set-point (Reference) Selection

The set-point for the PID controller can be a fixed digital or a variable analog signal. Set-point selection is set by parameter P3-05 (PID Reference Source Select). Either analog input 1 (control terminal 6) or input 2 (terminal 10) can be configured to provide the set-point. The format for the analog reference can be configured within the drive with all standard formats included. P2-30 configures the signal format for analog input 1 and P2-33 configures the signal format for analog input 2.

A digital reference can also be provided in parameter P3-06 (PID digital reference) and P3-05 set to reference this value (P3-05=0). A second digital reference is provided by P3-15 (PID digital reference 2) and a digital input configured to switch between the two digital references (see P1-13 and section 10.1 – digital input functions). When no digital selection is configured then the PID digital reference is always provided by P3-06. The reference value for the PID controller can be viewed in the read only parameter P0-08 – User PID reference.

The digital references for the PID function (P3-06 and P3-15) can provided fixed set-points to the PID function or could be manipulated through serial communication or via the drive PLC functions.

8.2.2. PID Feedback Selection

The feedback for the PID controller can be configured to either variable analog input signal. Clearly, if an analog reference is used to provide the PID Set-point then it can't be used for feedback. Selection for PID feedback is set by parameter P3-10 (PID Feedback Signal Source Select). Either analog input 1 (control terminal 6) or input 2 (terminal 10) can be configured to provide the Feedback. The format for the analog feedback can be configured within the drive to match the feedback sensor with all standard formats included. P2-30 configures the signal format for analog input 1 and P2-33 configures the signal format for analog input 2.

8.2.3. PID Operating Mode Selection

For default operation the drive response to an increase in feedback signal is to decrease motor speed and vice versa to adjust the feedback signal back to the set-point. This is referred to as 'Direct Mode' PID control. For example when pressure increases in a pumping system and the feedback signal increases then the drive response is to slow the pump to reduce the pressure. This mode of operation is the default drive behaviour and can be selected by setting P3-04=0 (User PID operating mode = Direct Mode).
The alternative operating mode is when an increase in feedback signal requires an increase in motor speed. This is referred to as 'Inverse mode' PID control. For example on a condenser fan control where the feedback signal increases with the load on the condenser increases and the fan is reduced to operate at a higher speed. This mode of operation can be selected by setting P3-04=1 (User PID operating mode = Inverse mode).
PID operating mode selection is summarised in the following table.

Parameter P3-04 Setting	Mode Selected	Feedback Behaviour	Motor Behaviour
0	Direct Mode	Signal Increases	Speed decreases
		Signal decreases	Speed increases
1	Inverse Mode	Signal Increases	Speed increases
		Signal decreases	Speed decreases

8.2.4. PID Controller Output Limits

The output from the PID controller can be limited by settings within the drive other than the maximum and minimum speed limits set in parameters P1-01 and P1-02. This means that different maximum and minimum values can be applied when the drive switches from PID control to a preset speed (via digital input) or variable limits can be applied. Parameter P3-09 – PID Output Limit Control sets the method used for determining the PID output limits. The following options are available.

Parameter P3-09	Description
0	Digital preset limit value (P3-07 and P3-08) will be used to limit PID controller output
1	Analog input 1 (terminal 6) will be used as the maximum output limit
2	Analog input 1 (terminal 6) will be used as the minimum output limit
3	Analog input 1 (terminal 6) will be used as an offset value and added to the PID controller output

The basic PID block diagram shown in section 8.1 shows the limits applied when P3-09 is set to 0. When other values are set for P3-09 the limits for the PID output are defined by the methods listed in the table above.

When P3-09=0 (default) the limits are set digitally by parameters P3-07 and P3-08 and limits for the PID controller are calculated as follows.
Upper Limit = P3-07 * P1-01: (A value of 100% limits the maximum speed of the PID controller to the maximum speed limit defined in P1-01).
Lower Limit = P3-08 * P1-01

8.2.5. PID Controller Ramp Rates

The drive standard ramp rates, as defined by P1-03 and P1-04 are normally active whilst the drive operates in PID mode. P3-11 (Maximum PID error to enable ramps) can be set to define a threshold PID error level, whereby ramps are enabled or disabled based on the magnitude of the PID error. If the difference between the set-point and feedback values is less than the threshold set in P3-11 then the internal ramp times of the drive are disabled. Where a greater PID error exists, the ramp times are enabled. This allows the rate of change of motor speed on large PID errors to be limited, whilst smaller errors are reacted to quickly. Setting P3-11 to 0 means that the drive ramps are always enabled.

Caution: Care must be taken in adjusting P3-11. Disabling the ramps may cause the motor to react dramatically to larger errors in the PID control and tuning of the PID controller might be adversely effected.

8.2.6. PID Controller Gains values and Tuning

As with any PID controller, the response and behaviour of the system is controlled by the Proportional Gain (P3-01), the Integral Time Constant (P3-02) and the Differential Time Constant (P3-03). Correct setting of these parameters is essential for stable and reliable system operation. There are many methods and text books available explaining how these terms work and how they can be tuned, and so only a brief summary is given below.

P3-01 Proportional Gain: Range 0.1 to 30.0, Default Setting 1.0
Proportional gain acts as a multiplier of the difference between the Feedback and Set-point signals. The PID controller firstly determines the PID Error, assuming direct operation
PID Error = PID Set-point – PID Feedback

The proportional gain is then used to multiply this error. If the Integral and Differential Time constants are both set to zero,
PID Output = Proportional Gain x (PID Set-point – PID Feedback)

A large value of P-gain will cause a greater change in output frequency for a small difference between the Feedback and Set-point. If the value is too large, the system is likely to be unstable and motor output speed will often overshoot the set-point. Higher values are acceptable on dynamic applications requiring fast response. Lower values should be used for slower responding systems, such as fan and pump control applications. If the system tends to overshoot, reducing the P gain will have an effect of reducing the overshoot.

P3-02 Integral Time Constant: Range 0.0 to 30.0, Default Setting 1.0
The integral time constant is a time based function, which modifies the output of the PID controller based on the change in PID Error over a defined time period. The effect of the Integral Time Constant is always to try to reduce the PID Error towards zero (so that Feedback = Set-

point). For dynamic systems which respond quickly, the value will need to be shorter. Slow response systems, such as temperature control applications will require a correspondingly longer time setting.

P3-03 Differential Time Constant: Range 0.00 to 1.00, Default 0.00

The differential time constant is also a time based function, this time modifying the PID output based on changes in the Set-point. In most applications, leaving the setting of P3-03 at zero will give good results.

⚠	The user has to adjust the PID control parameters (P-gain, I-gain and D-gain) in P3-01, P3-02 and P3-03 respectively to get the best control performance. The values will vary dependent on system inertia and the time constant (rate of change) of the system being controlled**.**

8.2.7. PID Sleep and Wake Functions

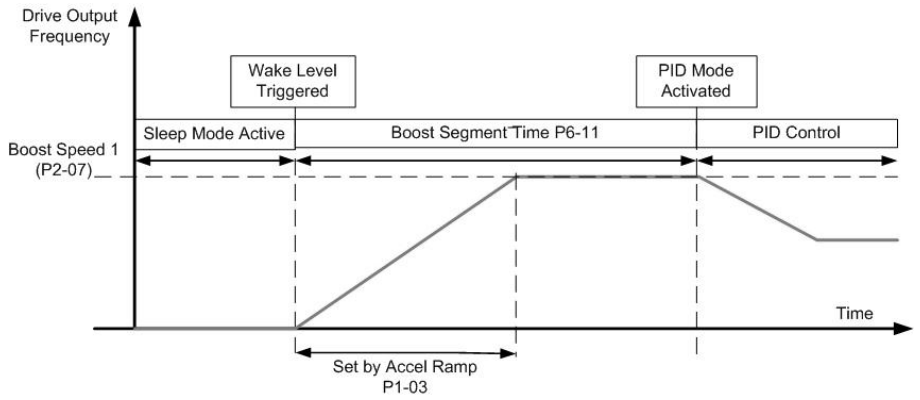
The Optidrive HVAC can be programmed to disable its output when running in PID mode when the speed output to the motor falls below a programmed value. This is referred to a Sleep or standby mode. Generally fan and pump applications perform little useful work at the lower end of the speed range and the sleep function allows the drive to save energy during periods of low system efficiency by shutting off the output to the motor. The level for sleep mode is programmed in parameter P3-14. A time period is also applied to the sleep function such that the sleep function must remain below the value set in P3-14 for the period programmed in P2-27 (standby mode timer) before the sleep function is activated. Sleep mode is disabled if P2-27 = 0.

Once the Optidrive HVAC enters into sleep mode a separate wake up mode can be applied for the drive. The wake mode level is used to trigger the drive returning out of sleep mode to normal operation. Setting different thresholds for the sleep and wake levels allows boundaries to be set that stop the drive continuous entering in and out of sleep mode and the settings to be optimised to maximise efficiency. Wake up level is set in parameter P3-13 – PID feedback wake up level and is set as a percentage of the feedback signal such that when the feedback signal reaches a specified level the drive is triggered out of sleep mode and the PID controller re-enabled.

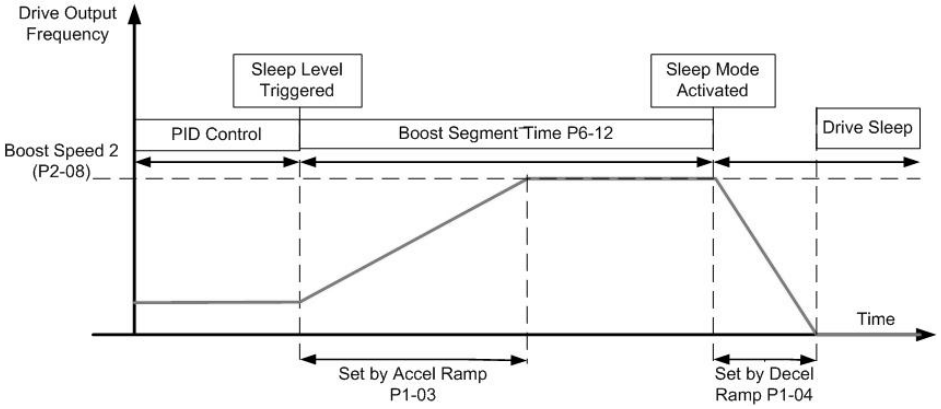
8.2.8. PID Boost Cycle on Sleep and Wake

The Optidrive HVAC can be programmed to execute a pre-defined boost cycle on entering or exiting sleep mode. This feature could be used to boost pump pressure prior to drive entering sleep mode so the drive is able to maintain sleep mode status for a greater period (prevent frequent switching in and out of switch mode. The boost on wake could be used to execute a cycle that quickly returns the system to normal operating status prior to entering back into PID control.

The pump wake up boost is enabled when the speed hold time on enable P6-11 is set to a value other than 0. P6-11 contains the time that the drive will run the boost function on wake. The speed for the boost function on wake is set in preset speed 7 (P2-07). The timing diagram below gives an example of the set-up and motion profile for the Boost on wake function.



The pump sleep boost is enabled when the speed hold time on disable P6-12 is set to a value other than 0. P6-12 contains the time that the drive will run the boost function before entering sleep mode. The speed for the boost function on sleep is set in preset speed 8 (P2-08). The timing diagram below gives an example of the set-up and motion profile for the Boost on sleep function.



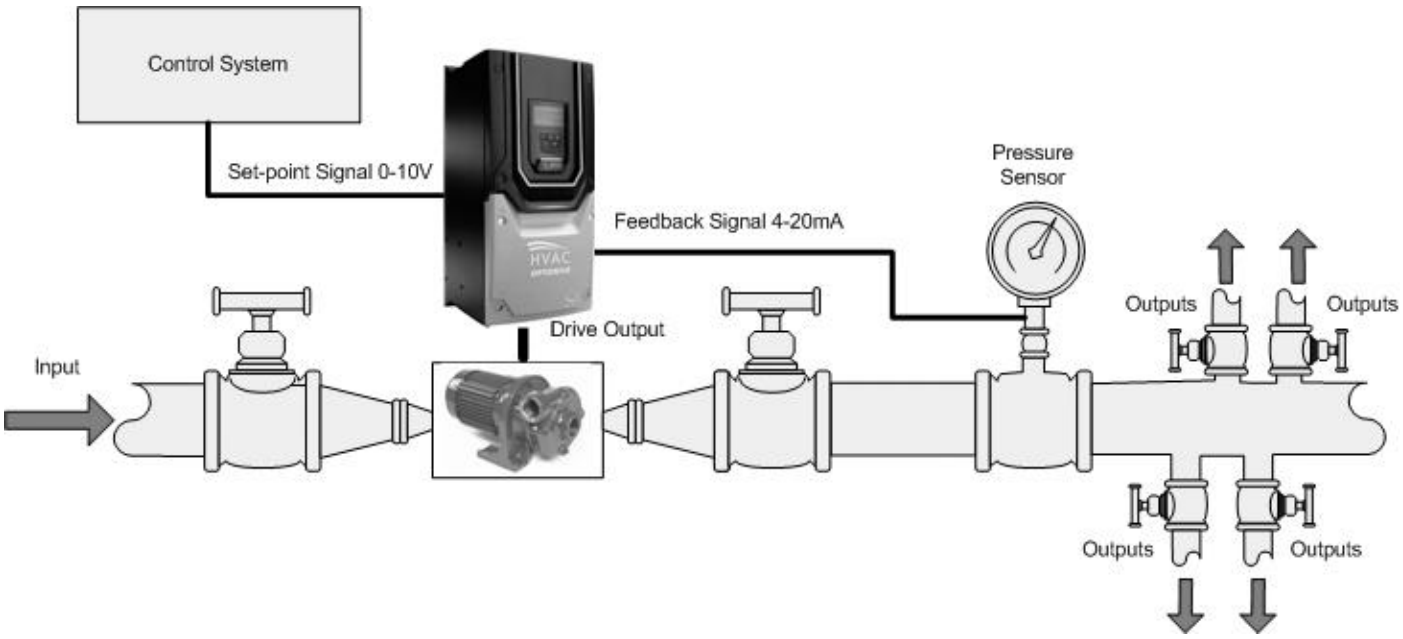
The execution time for both the sleep and wake boost functions (P6-11 and P6-12) include the time taken to accelerate to the boost speed (P2-07 and P2-08) but not the time to accelerate or decelerate once the boost function ends. This is shown in the timing diagrams.

When boost on sleep in activated the Optidrive HVAC will automatically run the boost on sleep function whenever the drive is stopped / disabled. When boost on wake is activated the boost on wake function is automatically run whenever the drive is started / enabled.

8.3. Application Example

Using an Optidrive HVAC to control pressure in a simple pump system

The diagram for the pump system is shown below.



The Optidrive HVAC is to maintain pressure at the output of the pump to the set-point value and to maintain that set-point as different output values are opened and closed.

Firstly the Pressure sensor is connected to the drive second analog input (terminal 10). The following parameter changes are made to configure the HVAC unit to accept the feedback signal from the sensor.

- P3-10 = 0 (default): Sets the PID feedback source as analog input 2
- P2-33 = t 4-20: Sets analog input 2 to accept a 4-20mA reference and to trip on loss of signal.

Next the set-point signal from the control system is connected to drive analog input 1 (terminal 6). The following parameter changes are made to configure the HVAC unit to accept the set-point signal from the control system.

- P3-05 = 1: Sets the PID set-point source as analog input 1
- P2-30 = U 0-10 (default): Sets analog input 1 to accept a 0-10V reference

Lastly active PID control on the drive, configure and tune the PID settings.

- Set P1-12 = 3: Sets the drive control to PID mode (enables the PID controller)
- Set P3-04 = 0 (default): Select Direct control mode. As the feedback signal falls (pressure drops), the speed of the pump is increases and vice versa.
- Starting from the default values suitable value for the P-gain, I-gain and D-gain are adjusted to give best performance in P3-01, P3-02 and P3-03 respectively.

Adding Sleep and Wake thresholds to the pump system

With the pump system shown above the design of the pump is such that it is performing very little useful work when run below 20Hz. The drive is required to shut off the pump if pump speed falls below 20Hz for longer than 1 minute. The pump must start up again when the feedback error increases above 10%. The following settings are made to the drive.

- P3-14 = 20Hz: Standby level. Standby function is activated when the drive goes below 20HZ for longer than the time set in P2-27
- P2-27 = 60s: Standby timer. Standby function is activated when the drive goes below P3-14 for longer than 60 seconds.
- P3-13 = 10%: Drive will wake when PID error increases beyond 10%.

8.4. PID Pipe Prime (Fill) Mode with Pipe Break Detection.

Pump prime mode allows starting of the pump in a safely controlled manner, to ensure consistent filling and pressurisation of pipe work and systems. Low pressure warnings are ignored during priming to allow the system to prime correctly, whilst a failsafe timeout prevents the pump from continuing to run in the event of a failure to prime. This helps to prevent the effects of water hammering (such as bursting water pipes) or damage to fountain / sprinkler heads.

Operational Overview:

The Pipe Fill function with Burst Pipe detection is commissioned using the following two parameters:

P3-16: Pump Prime Time

P3-17: Burst Pipe Threshold

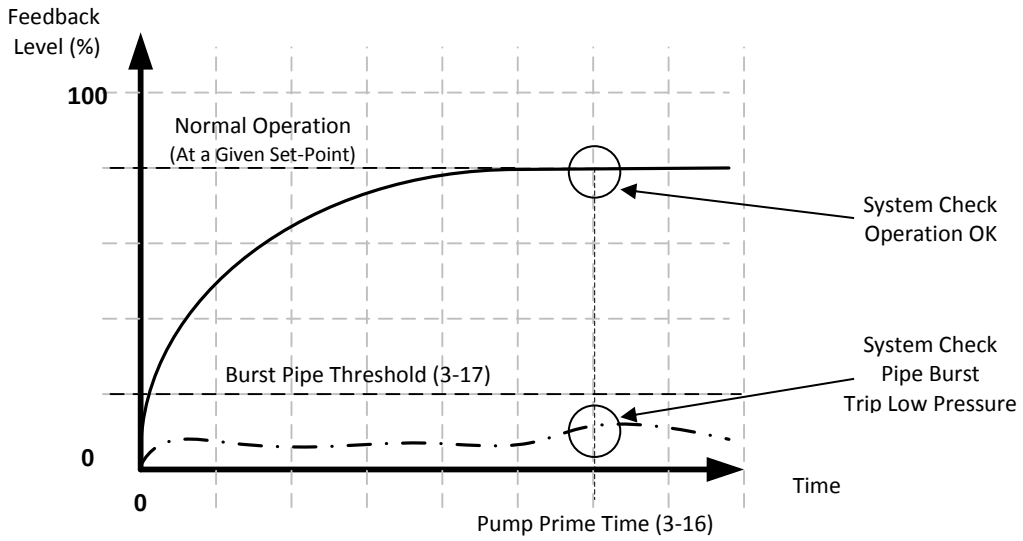
These parameters require security level 1 (P1-14 = 101 Default) to access.

The Pipe Fill function with Burst Pipe detection is available when the drive is operating in PID mode only. The PID function should be commissioned in the normal way and as described in this user guide prior to enabling the Pipe Prime function.

The Pipe Fill function with Burst Pipe detection is enabled by setting a value other than 0 in parameter P3-16 (Pump Prime Time). The time set in P3-16 should be sufficient for the PID feedback to exceed the Burst Pipe Threshold value (P3-17) under normal operating conditions. The Burst Pipe Threshold should be set to a value just below the minimum feedback level seen by the system during normal operation. Each time the drive is enabled whilst in PID control or is switched to PID control, the drive will monitor the PID feedback level for the time entered in P3-16. If the PID feedback level does not exceed the threshold entered in P3-17 before the time in P3-16 expires then the drive will trip with "Pr-Lo" (pressure low) trip.

In direct PID mode, (P3-04 = 0) PID feedback should be less than or equal to the Burst Pipe threshold before the pump prime time (P3-16) expires. In inverse PID mode (P3-04 = 1) PID feedback should be larger than or equal to the threshold before the pump prime time (P3-16) expires.

Failure of the Pump prime mode indicates a leak or burst pipe within the pump system and will result in the Optidrive HVAC shutting down the pump. During normal operation the system pressure is still continuously monitored against the Burst Pipe Threshold so that a burst pipe during normal operation will likewise result in the drive tripping ‘low pressure’ and shutting the pump down



Soft Fill mode for Pipe Fill Operation:

When the pump is first started the feedback is low or zero and this can cause the PID loop to react quickly and to ramp the drive aggressively. Good response level might be required during normal operation (once the system is primed) but could cause issues of water hammering or other mechanical damage during start up.

In order to provide a soft Fill of the system to allow the pipe filling to take place the drive can be configured to start at a preset speed and to run for a pre-defined time period at this speed before switching to PID operation. This function is enabled using the Boost of Wake function described in section 7.2.8.

P6-11 sets the Speed Hold Time on enable, or the time the soft fill mode will operate.

P2-07 sets Preset speed 7 / Boost speed 1, or the speed the motor will operate whilst in soft fill mode.

Once configured the soft fill function will operate each time the drive is enabled, or wakes from standby operation.

Quick Setup Overview:

- Set Basic parameters P1-01 to P1-10.
- Set Parameter P1-14 = 101 to allow access to advanced parameters in menu 8
- Set the PID control menu 3 parameters (see section 8)
- Set the Pump Prime Time in parameter P3-16 (Normally established through monitoring the system during normal operation)
- Set the Burst Pipe Threshold in parameter P3-17 (Normally established through monitoring the system during normal operation)
- If Soft Fill Mode is required, Set P6-11 & P2-07 (P6-11 requires security level 2 access – Default P1-14 = 201)

9. Parameters

9.1. Parameter Set Overview

The Optidrive HVAC Parameter set consists of 9 groups as follows:

- Group 1 – Basic Parameter Set
- Group 2 – Extended Parameter Set
- Group 3 – User PID Control Parameter Set
- Group 4 – Motor Control Parameters
- Group 5 – Field Bus Communications Parameter Set
- Group 8 – HVAC Specific Functions Parameter Set
- Group 0 –Monitoring and Diagnostic Parameters (Read Only)

When the Optidrive is reset to factory defaults, or is in its factory supplied state, only Group 1 Parameters can be accessed. In order to allow access to parameters from the higher level groups, P1-14 must be set to the same value as P2-40 (Default setting = 101). With this setting, parameter groups 1 – 5 and group 8 can be accessed, along with the first 39 parameters in Group 0. These parameters are listed in the tables below.
For advanced parameter access, P1-14 can be set to the same value as P6-30 (Default setting = 201), which allows access to all parameter groups and ranges. Advanced parameter descriptions are listed in the advanced user guide.

Values given in brackets () are default settings for horsepower rated drive models.

9.2. Parameter Group 1 – Basic Parameters

Par	Parameter Name	Minimum	Maximum	Default	Units
P1-01	**Maximum Speed Limit**	P1-02	120.0	50.0 (60.0)	Hz / Rpm
	Maximum output frequency or motor speed limit – Hz or rpm. If P1-10 >0, the value entered / displayed is in Rpm				
P1-02	**Minimum Speed Limit**	0.0	P1-01	0.0	Hz / Rpm
	Minimum speed limit – Hz or RPM. If P1-10 >0, the value entered / displayed is in Rpm				
P1-03	**Acceleration Ramp Time**	0.0	6000.0	30.0	Seconds
	Acceleration ramp time from 0 to base speed (P-1-09) in seconds.				
P1-04	**Deceleration Ramp Time**	0.0	6000.0	30.0	Seconds
	Deceleration ramp time from base speed (P1-09) to standstill in seconds. When set to zero, fastest possible ramp time without trip is activated				
P1-05	**Stop Mode Select**	0	1	0	-
	0 : Ramp To Stop. When the enable signal is removed, the drive will ramp to stop, with the rate controlled by P1-04 as described above. **1 : Coast to Stop**. When the enable signal is removed the motor will coast (freewheel) to stop				
P1-06	**Energy Optimiser**	0	1	0	0
	0 : Disabled **1 : Enabled**. When enabled, the Energy Optimiser attempts to reduce the overall energy consumed by the drive and motor when operating at constant speeds and light loads. The output voltage applied to the motor is reduced. The Energy Optimiser is intended for applications where the drive may operate for some periods of time with constant speed and light motor load.				
P1-07	**Motor Rated Voltage**	0	250 / 500	230 / 400 (460)	Volts
	This parameter should be set to the rated (nameplate) voltage of the motor (Volts)				
P1-08	**Motor Rated Current**	[Drive Dependent]	Drive Rated Current	100% drive rated current	Amps
	This parameter should be set to the rated (nameplate) current of the motor Parameter Range: Frame size 2, min 10% to max 100% of drive rated current Frame size 3 to 7, min 20% to max 100% of drive rated current				
P1-09	**Motor Rated Frequency**	25	120	50 (60)	Hz
	This parameter should be set to the rated (nameplate) frequency of the motor				
P1-10	**Motor Rated Speed**	0	7200	0	Rpm
	This parameter can optionally be set to the rated (nameplate) rpm of the motor. When set to the default value of zero, all speed related parameters are displayed in Hz, and the slip compensation for the motor is disabled. Entering the value from the motor nameplate enables the slip compensation function, and the Optidrive display will now show motor speed in estimated rpm. All speed related parameters, such as Minimum and Maximum Speed, Preset Speeds etc. will also be displayed in Rpm.				

P1-11	**Voltage Boost**	0	15 – 30% [Drive Dependent]	0.5 – 2.5% [Drive Dependent]	%
	Voltage boost is used to increase the applied motor voltage at low output frequencies, in order to improve low speed and starting torque. Excessive voltage boost levels may result in increased motor current and temperature, and force ventilation of the motor may be required. An automatic setting (AUto) is also possible, whereby the Optidrive will automatically adjust this parameter based on the motor parameters measured during an auto-tune (See Parameter P4-02).				
P1-12	**Control Mode Select**	0	6	0	-
	0: Terminal Control. The drive responds directly to signals applied to the control terminals. **1: Uni-directional Keypad Control**. The drive can be controlled in the forward direction only using the internal or remote Keypad **2: Bi-directional Keypad Control**. The drive can be controlled in the forward and reverse directions using the internal or remote Keypad. Pressing the keypad START button toggles between forward and reverse. **3: PID Control**. The output frequency is controlled by the internal PID controller. **4: Fieldbus Control** by the selected Fieldbus (Group 5 Parameters) – Excluded BACnet (see option 6) **5: Slave Mode**. The drive acts as a Slave to a connected Optidrive operating in Master Mode **6: BACnet Mode.** Drive communicates / responds as a slave within a BACnet network.				
P1-13	**Digital Input Function**	0	13	1	-
	Defines the function of the digital inputs. When set to 0 the inputs are user defined using group 9 parameters or the PLC software function in the OptiTools Studio software package. When set to a value other than 0 the digital input configuration is defined by digital input definition table (see section 10.1)				
P1-14	**Extended Menu Access**	0	30000	0	-
	Parameter Access Control. The following settings are applicable : P1-14 <> P2-40 and P1-14 <> P6-30: Allows access to Parameter Group 1 only P1-14 = P2-40 (101 default): Allows access to Parameter Groups 0 – 5 and group 8 P1-14 = P6-30 (201 default): Allows access to Parameter Groups 0 - 9				

10. Digital Input Functions

10.1. Digital Input Configuration Parameter P1-13

P1-13 *(2)	Local (Hand) Control Function	Digital Input 1 (Terminal 2)	Digital Input 2 (Terminal 3)	Digital Input 3 (Terminal 4)	Analog Input 1 (Terminal 6)	Analog Input 2 (Terminal 10)	Notes
0	N/A	All functions User defined in Menu 9 or configured through PLC function in OptiTools studio software suite.					
1 *(3)	Analog Input 2	O: Stop C: Run / Enable	O: Normal Operation C: Preset 1 / PI Set-point 2	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	When Input 3 is Closed: Speed Reference = Analog Input 2 Start Command = Input 1 In PI Mode, Analog Input 1 must be used for feedback
2		O: No Function C: Momentary Start	O: Stop (Disable) C: Run Permit	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	
3		O: Stop C: Run / Enable	O: Forward C: Reverse	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	
4		O: Stop C: Run / Enable	O: Fire Mode *(1) C: Normal Operation * (1)	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	
5	Preset Speeds	O: Stop C: Run / Enable	O: Preset Speed 1 C: Preset Speed 2	O: Remote Ctrl C: Local Ctrl	Analog In 1	O: Ext Trip C: Normal Operation	When Input 3 is Closed: Speed Reference = Preset Speed 1 / 2 Start Command = Input 1
6		O: No Function C: Momentary Start	O: Stop (Disable) C: Run Permit	O: Remote Ctrl C: Local Ctrl	Analog In 1	O: Preset 1 C:Preset 2l	
7		O: Stop C: Run / Enable	O: Forward C: Reverse	O: Remote Ctrl C: Local Ctrl	Analog In 1	O: Preset 1 C:Preset 2	
8		O: Stop C: Run / Enable	O: Fire Mode *(1) C: Normal Operation * (1)	O: Remote Ctrl C: Local Ctrl	Analog In 1	O: Preset 1 C:Preset 2	
9 *(3)	Keypad Speed Reference	O: Stop C: Run / Enable	O: Normal Operation C: Preset 1 / PI Set-point 2	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	When Input 3 is Closed: Speed Reference = Keypad Start Command = Determined by P2-37
10 *(3)		O: Stop C: Run / Enable	O: Normal Operation C: Preset 1 / PI Set-point 2	O: Remote Ctrl C: Local Ctrl	Analog In 1	O: Ext Trip C: Normal Operation	
11		O: No Function C: Momentary Start	O: Stop (Disable) C: Run Permit	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	
12		O: Stop C: Run Fwd	O: Forward C: Reverse	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	
13		O: Stop C: Run Fwd	O: Fire Mode *(1) C: Normal Operation * (1)	O: Remote Ctrl C: Local Ctrl	Analog In 1	Analog In 2	

Notes

*(1): Logic shown is as per the default setting. Fire mode logic can be configured through parameter P8-09.

*(2): Default setting for P1-13 = 1

*(3): When the drive is in PID control (P1-12 = 3) and digital preset reference is selected (P3-05 = 0) then P1-13 can be set to 1, 9, or 10 to allow selection between two independent digital references using digital input 2. Digital preset reference 1 and 2 are set in P3-06 and P3-15 respectively.

Note: “Motor thermistor trip” connection is via analog input 2 and is configured by parameter P2-33 (PtC-tH). The “External trip” input is no longer utilised for the thermistor input (this is different to the ODP drive and E2 drive).

11. Extended Parameters

11.1. Parameter Group 2 - Extended parameters

P2-01	**Preset Speed 1**	-P1-01	P1-01	5.0	Hz / Rpm
	Preset speed 1 is selected by configuring P1-13 to an option that permits logic selection, by using the user defined logic configuration parameters in menu 9 (P9-21 to P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-02	**Preset Speed 2**	-P1-01	P1-01	10.0	Hz / Rpm
	Preset speed 2 is selected by configuring P1-13 to an option that permits logic selection, by using the user defined logic configuration parameters in menu 9 (P9-21to P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-03	**Preset Speed 3**	-P1-01	P1-01	25.0	Hz / Rpm
	Preset speed 3 is selected using the user defined logic configuration parameters in menu 9 (P9-21 – P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-04	**Preset Speed 4**	-P1-01	P1-01	P1-01	Hz / Rpm
	Preset speed 4 is selected using the user defined logic configuration parameters in menu 9 (P9-21 – P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-05	**Preset Speed 5 (Clean Speed 1)**	-P1-01	P1-01	0.0	Hz / Rpm
	Preset speed 5 is automatically reference by the clean function when this function is enabled. See section 7.5, Pump clean function. When clean function is disabled Preset speed 5 can be selected as per normal operation and is selected using the user defined logic configuration parameters in menu 9 (P9-21 to P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-06	**Preset Speed 6 (Clean Speed 2)**	-P1-01	P1-01	0.0	Hz / Rpm
	Preset speed 6 is automatically reference by the clean function when this function is enabled. See section 7.5, Pump clean function. When clean function is disabled Preset speed 6 can be selected as per normal operation and is selected using the user defined logic configuration parameters in menu 6 (P9-21 to P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-07	**Preset Speed 7 (Boost Speed 1 / Pump Stir Speed)**	-P1-01	P1-01	0.0	Hz / Rpm
	Preset speed 7 is automatically referenced by the start / stop boost function, or the Pump Stir Function, when these functions are enabled. See section 7.6, Pump Stir function and section 8, PID control applications. When HVAC functions are disabled Preset speed 7 can be selected as per normal operation and is selected using the user defined logic configuration parameters in menu 6 (P9-21 – P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-08	**Preset Speed 8 (Boost Speed 2)**	-P1-01	P1-01	0.0	Hz / Rpm
	Preset speed 8 is automatically reference by the start / stop boost function when this function is enabled. See section 8, PID control applications. When boost function is disabled Preset speed 8 can be selected as per normal operation (and is selected using the user defined logic configuration parameters in menu 6 (P9-21 to P9-23), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-09	**Skip Frequency Centre Point**	P1-02	P1-01	0.0	Hz / Rpm
	Defines the centre point of the skip frequency band. The width of the skip frequency band is defined by: Lower limit = P2-09 - P2-10/2 Upper limit = P2-09 + P2-10/2 All skip frequency bands defined for forward speeds are mirrored for negative speeds.				
P2-10	**Skip Frequency Band**	0.0	P1-01	0.0	Units
	Defines the width of the skip frequency band. The width of the skip frequency band is defined by: Lower limit = P2-09 - P2-10/2 Upper limit = P2-09 + P2-10/2 All skip frequency bands defined for forward speeds are mirrored for negative speeds.				
P2-11	**Analog Output 1 Function (Terminal 8)**	0	11	8	-
	Digital Output Mode. Logic 1 = +24V DC **0 : Drive Enabled (Running)**. Logic 1 when the Optidrive is enabled (Running) **1: Drive Healthy**. Logic 1 When no Fault condition exists on the drive **2 : At Target Frequency (Speed)**. Logic 1 when the output frequency matches the set-point frequency **3 : Output Frequency > 0.0**. Logic 1 when the motor runs above zero speed **4 : Output Frequency >= Limit**. Logic 1 when the motor speed exceeds the adjustable limit **5 : Output Current >= Limit**. Logic 1 when the motor current exceeds the adjustable limit **6 : Reserved**. No Function **7 : Analog Input 2 Signal Level >= Limit**. Logic 1 when the signal applied to the Analog Input 2 exceeds the adjustable limit **Analog Output Mode (Format set in P2-12)** **8 : Output Frequency (Motor Speed)**. 0 to P-01 **9 : Output (Motor) Current**. 0 to 200% of P1-08 **10 : Reserved**. No Function **11 : Output (Motor) Power**. 0 to 150% of drive rated power				
Note:	When using settings 4 – 7, parameters P2-16 and P2-17 are used to control the output behaviour. The output will switch to Logic 1 when the selected signal exceeds the value programmed in P2-16, and return to Logic 0 when the signal falls below the value programmed in P2-17.				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-12	**Analog Output 1 Format (Terminal 8)**	-	-	U 0-10	-
	U 0-10 = 0 to10V, U 10-0 = 10 to 0V, A 0-20 = 0 to 20mA A 20-0 = 20to 0mA A 4-20 = 4 to 20mA A 20-4 = 20 to 4mA				
P2-13	**Analog Output 2 Function (Terminal 11)**	0	11	9	-
	Digital Output Mode. Logic 1 = +24V DC **0 : Drive Enabled (Running)**. Logic 1 when the Optidrive is enabled (Running) **1 : Drive Healthy**. Logic 1 When no Fault condition exists on the drive **2 : At Target Frequency (Speed)**. Logic 1 when the output frequency matches the set-point frequency **3 : Output Frequency > 0.0**. Logic 1 when the motor runs above zero speed **4 : Output Frequency >= Limit**. Logic 1 when the motor speed exceeds the adjustable limit **5 : Output Current >= Limit**. Logic 1 when the motor current exceeds the adjustable limit **6 : Reserved**. No Function **7 : Analog Input 2 Signal Level >= Limit**. Logic when the signal applied to the Analog Input 2 exceeds the adjustable limit **Analog Output Mode (Format set in P2-14)** **8 : Output Frequency (Motor Speed)**. 0 to P-01 **9 : Output (Motor) Current**. 0 to 200% of P1-08 **10 : Reserved**. No Function **11 : Output (Motor) Power**. 0 to 150% of drive rated power				
Note:	When using settings 4 – 7, parameters P2-19 and P2-20 are used to control the output behaviour. The output will switch to Logic 1 when the selected signal exceeds the value programmed in P2-19, and return to Logic 0 when the signal falls below the value programmed in P2-20.				
P2-14	**Analog Output 2 Format (Terminal 11)**	-	-	U 0-10	-
	U 0-10 = 0 to10V. U 10-0 = 10 to 0V, A 0-20 = 0 to 20mA A 20-0 = 20to 0mA A 4-20 = 4 to 20mA A 20-4 = 20 to 4mA				
P2-15	**Relay Output 1 Function (Terminals 14, 15 & 16)**	0	7	1	-
	Selects the function assigned to Relay Output 1. The relay has normally open and normally closed contacts. Logic 1 indicates the relay is active, and therefore the normally open contact is closed (terminals 14 and 15 will be linked together) and the normally closed contact is opened (terminals 14 and 16 will no longer be connected together). **0 : Drive Enabled (Running)**. Logic 1 when the motor is enabled **1 : Drive Healthy**. Logic 1 when power is applied to the drive and no fault exists **2 : At Target Frequency (Speed)**. Logic 1 when the output frequency matches the set-point frequency **3 : Output Frequency > 0.0 Hz**. Logic 1 when the drive output frequency to the motor is exceeds 0.0Hz **4 : Output Frequency >= Limit**. Logic 1 when the motor speed exceeds the adjustable limit **5 : Output Current >= Limit**. Logic 1 when the motor current exceeds the adjustable limit **6 : Reserved**. No Function **7 : Analog Input 2 Signal Level >= Limit**. Logic 1 when the signal applied to the Analog Input 2 exceeds the adjustable limit **8 : Reserved.** No Function **9 : Fire Mode Active.** Logic 1 when the drive in running in Fire Mode (Fire Mode input is active). **10 : Maintenance Due.** Logic 1 when Maintenance Timer expires indicating that Maintenance is now due. **11 : Drive Available.** Logic 1 when drive is in Auto-mode, no trips are present, and the safety circuit is enabled indicating that drive is ready for automatic control. **12 : Drive Tripped.** Logic one when the drive has tripped and the display shows the fault code. **13 : Hardware Inhibit Status.** Logic 1 when both Hardware Enable (STO) inputs are present and the drive is able to be operated				
Note:	When using settings 4 – 7, parameters P2-16 and P2-17 are used to control the output behaviour. The output will switch to Logic 1 when the selected signal exceeds the value programmed in P2-16, and return to Logic 0 when the signal falls below the value programmed in P2-17.				
P2-16	**Adjustable Threshold 1 Upper Limit (AO1 / RO1)**	P2-17	200	100.0	%
	Setting the upper limited value for P2-11 and P2-15, please refer to P2-11 or P2-15				
P2-17	**Adjustable Threshold 1 Lower Limit (AO1 / RO1)**	0	P2-16	0.0	%
	Setting the lower limited value for P2-11 and P2-15, please refer to P2-11 or P2-15.				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-18	**Relay Output 2 Function (Terminals 17 & 18)**	0	8	0	-
	Selects the function assigned to Relay Output 2. The relay has two output terminals, Logic 1 indicates the relay is active, and therefore terminals 17 and 18 will be linked together. **0 : Drive Enabled (Running)**. Logic 1 when the motor is enabled **1 : Drive Healthy**. Logic 1 when power is applied to the drive and no fault exists **2 : At Target Frequency (Speed)**. Logic 1 when the output frequency matches the set-point frequency **3: Output Frequency > 0.0 Hz**. Logic 1 when the drive output frequency to the motor is exceeds 0.0Hz **4 : Output Frequency >= Limit**. Logic 1 when the motor speed exceeds the adjustable limit **5 : Output Current >= Limit**. Logic 1 when the motor current exceeds the adjustable limit **6 : Reserved**. No Function **7 : Analog Input 2 Signal Level >= Limit**. Logic 1 when the signal applied to the Analog Input 2 exceeds the adjustable limit **8 : Assist Pump 1 Control (DOL1)** . See section 7.1, Pump staging –DOL Cascade. **9 : Fire Mode Active.** Logic 1 when the drive in running in Fire Mode (Fire Mode input is active). **10 : Maintenance Due.** Logic 1 when Maintenance Timer expires indicating that Maintenance is now due. **11 : Drive Available.** Logic 1 when drive is in Auto-mode, no trips are present, and the safety circuit is enabled indicating that drive is ready for automatic control. **12 : Drive Tripped.** Logic one when the drive has tripped and the display shows the fault code. **13 : Hardware Inhibit Status.** Logic 1 when both Hardware Enable (STO) inputs are present and the drive is able to be operated				
Note:	When using settings 4 – 7, parameters P2-19 and P2-20 are used to control the output behaviour. The output will switch to Logic 1 when the selected signal exceeds the value programmed in P2-19, and return to Logic 0 when the signal falls below the value programmed in P2-20.				
P2-19	**Adjustable Threshold 2 Upper Limit (AO2 / RO2)**	P2-20	200	100.0	%
	Setting the upper limited value for P2-13 and P2-18, please refer to P2-13 or P2-18.				
P2-20	**Adjustable Threshold 2 Lower Limit (AO2 / RO2)**	0	P2-19	0.0	%
	Setting the lower limited value for P2-13 and P2-18, please refer to P2-13 or P2-18.				
P2-21	**Display Scaling Factor**	-30.000	30.000	0.000	-
	Determines the factor for scaling display. The variable selected in P2-22 is scaled by the factor set in P2-21.				
P2-22	**Display Scaling Source**	0	2	0	-
	Source value used when custom units are to be shown on the drive display. **0: Motor Speed** **1: Motor Current** **2: Analog Input 2**				
Note:	P2-21 & P2-22 allow the user to program the Optidrive display to show an alternative output unit scaled from an existing parameter (for example, to display conveyer speed in metres per second based on the output frequency). This function is disabled if P2-21 is set to 0. If P2-21 is set >0, the variable selected in P2-22 is multiplied by the factor entered in P2-21, and is shown on the drive display whilst the drive is running.				
P2-23	**Zero Speed Holding Time**	0.0	60.0	0.2	Seconds
	Determines the time for which the drive output frequency is held at zero when stopping, before the drive output is disabled				
P2-24	**Switching Frequency**	4kHz	[Drive Dependent]	[Drive Dependent]	Default
	Effective power stage switching frequency. Higher frequencies reduce audible noise from the motor, and improve the output current waveform, at the expense of increased drive losses. **Note: De-rating of the drive output current may be required when increasing P2-24 beyond the minimum setting. Refer to section 13.5.3 on page 69 for further information.**				
P2-25	**Fast Decel Ramp Time**	0.0	30.0	0.0	Seconds
	This parameter allows an alternative deceleration ramp down time to be programmed into the Optidrive. Fast Deceleration ramp is selected Automatically in the case of a mains power loss if P2-38 = 2. When ramp rate in P2-25 is set to 0.0, the drive will coast to stop. Fast deceleration ramp can also be selected using the user defined logic configuration parameters in menu 9 (P9-02), or selection configured through the drive PLC function using the OptiTools Studio Suite PC software.				
P2-26	**Spin Start Enable**	0	1	1	-
	0 : Disabled **1 : Enabled**. The drive will attempt to determine if the motor is already rotating on start up and to detect rotational speed and direction. The drive will begin control of the motor from its current (detected) speed. A short delay may be observed when starting the drive whilst the spin start function is completed.				
P2-27	**Standby Mode Enable**	0.0	250.0	0.0	Seconds
	This parameter defines the time period, whereby if the drive operates at minimum speed for greater than the set time period, the Optidrive output will be disabled, and the display will show StndbY. The function is disabled if P2-27 = 0.0.				
P2-28	**Slave Speed Scaling**	0	3	0	-
	Active in Keypad mode (P1-12 = 1 or 2) and Slave mode (P1-12=4) only. The keypad reference can be multiplied by a preset scaling factor or adjusted using an analog trim or offset. **0 : Disabled**. No scaling or offset is applied. **1 : Actual Speed = Digital Speed x P2-29** **2 : Actual Speed = (Digital Speed x P2-29) + Analog Input 1 Reference** **3 : Actual Speed = (Digital Speed x P2-29) x Analog Input 1 Reference**				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-29	**Slave Speed Scaling Factor**	-500.0	500.0	%	100.0
	Slave speed scaling factor used in conjunction with P2-28.				
P2-30	**Analog Input 1 Format (Terminal 6)**	-	-	U 0- 10	-
	U 0- 10 = 0 to 10 Volt Signal (Uni-polar) U 10-0 = 10 to 0 Volt Signal (Uni-polar) - 10- 10 = -10 to +10 Volt Signal (Bi-polar) A 0-20 = 0 to 20mA Signal t 4-20 = 4 to 20mA Signal, the Optidrive will trip and show the fault code 4-20F if the signal level falls below 3mA r 4-20 = 4 to 20mA Signal, the Optidrive will ramp to preset speed 4 if the signal level falls below 3mA t 20-4 = 20 to 4mA Signal, the Optidrive will trip and show the fault code 4-20F if the signal level falls below 3mA r 20-4 = 20 to 4mA Signal, the Optidrive will ramp to preset speed 4 if the signal level falls below 3mA				
P2-31	**Analog Input 1 scaling**	0.0	500.0	100.0	%
	P2-31 is used to scale the analog input prior to being applied as a reference to the drive. For example, if P2-30 is set for 0 – 10V, and the scaling factor is set to 200.0%, a 5 volt input will result in the drive running at maximum speed (P1-01)				
P2-32	**Analog Input 1 Offset**	-500.0	500.0	0.0	%
	P2-32 defines an offset for the analog input, as a percentage of the full range of the input. A positive offset is deducted from the incoming analog signal and a negative offset is added to the signal. For example, if P2-30 is set for 0 – 10V, and the analog offset is set to 10.0%, then 1 volt (10% of 10V) will be deducted from the incoming analog reference prior to it being applied.				
P2-33	**Analog Input 2 Format (Terminal 10)**	-	-	U 0- 10	-
	U 0- 10 = 0 to 10 Volt Signal (Uni-polar) U 10-0 = 10 to 0 Volt Signal (Uni-polar) Ptc-th = Motor PTC Thermistor Input A 0-20 = 0 to 20mA Signal t 4-20 = 4 to 20mA Signal, the Optidrive will trip and show the fault code 4-20F if the signal level falls below 3mA r 4-20 = 4 to 20mA Signal, the Optidrive will ramp to preset speed 4 if the signal level falls below 3mA t 20-4 = 20 to 4mA Signal, the Optidrive will trip and show the fault code 4-20F if the signal level falls below 3mA r 20-4 = 20 to 4mA Signal, the Optidrive will ramp to preset speed 4 if the signal level falls below 3mA				
P2-34	**Analog Input 2 scaling**	0.0	500.0	100.0	%
	P2-34 is used to scale the analog input prior to being applied as a reference to the drive. For example, if P2-34 is set for 0 – 10V, and the scaling factor is set to 200.0%, a 5 volt input will result in the drive running at maximum speed (P1-01)				
P2-35	**Analog Input 2 Offset**	-500.0	500.0	0.0	%
	P2-35 defines an offset for the analog input, as a percentage of the full range of the input. A positive offset is deducted from the incoming analog signal and a negative offset is added to the signal. For example, if P2-33 is set for 0 – 10V, and the analog offset is set to 10.0%, then 1 volt (10% of 10V) will be deducted from the incoming analog reference prior to it being applied.				
P2-36	**Start Mode Select**	-	-	Auto-0	-
	Defines the behaviour of the drive relating to the enable digital input and also configures the Automatic Restart function. Ed9E-r : Following Power on or reset, the drive will not start if Digital Input 1 remains closed. The Input must be closed after a power on or reset to start the drive. Auto-0 : Following a Power On or Reset, the drive will automatically start if Digital Input 1 is closed. Auto- 1 to Auto-5 : Following a trip, the drive will make up to 5 attempts to restart at 20 second intervals. The drive must be powered down to reset the counter. The numbers of restart attempts are counted, and if the drive fails to start on the final attempt the drive will trip with the fault and will require the user to manually reset the drive. **DANGER! "Auto" modes allow the drive to Auto-start, therefore the impact on system/Personnel safety needs to be considered.**				
P2-37	**Keypad Restart Speed**	0	7	2	-
	Options 0 to 3 are only active when P1-12 = 1 or 2 (keypad Mode) **0 : Minimum Speed**. Following a stop and restart, the drive will always initially run at the minimum speed P1-02 **1 : Previous Operating Speed**. Following a stop and restart, the drive will return to the last keypad set-point speed used prior to stopping **2 : Current Running Speed**. Where the Optidrive is configured for multiple speed references (typically Hand / Auto control or Local / Remote control), when switched to keypad mode by a digital input, the drive will continue to operate at the last operating speed **3 : Preset Speed 4**. Following a stop and restart, the Optidrive will always initially run at Preset Speed 4 (P2-04) Options 4 to 7 are only active in all control modes. Drive starting in these modes is controlled by the enable digital input on the control terminals. **4 : Minimum Speed (Terminal Enable)**. Following a stop and restart, the drive will always initially run at the minimum speed P1-02 **5 : Previous Operating Speed (Terminal Enable)**. Following a stop and restart, the drive will return to the last keypad set-point speed used prior to stopping **6 : Current Running Speed (Terminal Enable)**. Where the Optidrive is configured for multiple speed references (typically Hand / Auto control or Local / Remote control), when switched to keypad mode by a digital input, the drive will continue to operate at the last operating speed **7 : Preset Speed 4 (Terminal Enable)**. Following a stop and restart, the Optidrive will always initially run at Preset Speed 4 (P2-04)				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-38	**Mains Loss Stop Mode**	0	2	0	-
	Controls the behaviour of the drive in response to a loss of mains power supply whilst the drive is enabled. **0: Mains Loss Ride Through**. The Optidrive will attempt to continue operating by recovering energy from the load motor. Providing that the mains loss period is short, and sufficient energy can be recovered before the drive control electronics power off, the drive will automatically restart on return of mains power **1: Coast To Stop**. The Optidrive will immediately disable the output to the motor, allowing the load to coast or free wheel. When using this setting with high inertia loads, the Spin Start function (P2-26) may need to be enabled **2: Fast Ramp To Stop**. The drive will ramp to stop at the rate programmed in the Fast deceleration time P2-25				
P2-39	**Parameter Access Lock**	0	1	0	-
	0 : Unlocked. All parameters can be accessed and changed **1 : Locked**. Parameter values can be displayed, but cannot be changed				
P2-40	**Extended Menu Access Code**	0	9999	101	-
	Defines the access code which must be entered in P1-14 to access parameter groups above Group 1				

11.2. Parameter Group 3 – PID Control

Par	Parameter Name	Minimum	Maximum	Default	Units
P3-01	**PID Proportional Gain**	0.1	30.0	1.0	-
	PID Controller Proportional Gain. Instantaneous error between the feedback and the set-point in the PID controller is multiplied by P3-01 to produce the output from the PID controller. Higher values of proportional gain produce a larger change in the drive output frequency in response to changes in the PID set-point or feedback signals. Too high a value can cause instability				
P3-02	**PID Integral Time**	0.0	30.0	1.0	Seconds
	PID Controller Integral Time. Accumulated error in the PID control. Uses accumulated errors between set-point and feedback signals to influence the output from the PID controller. P3-02 is the time constant for accumulating error. Larger values provide a more damped response. Lower values result is a faster system response but may result in instability.				
P3-03	**PID Differential Time**	0.00	1.00	0.0	Seconds
	PID Differential Time Constant. The Differential time constant references the rate of change of the feedback signal over time and works to slow the rate of change of the PID controller, particularly as it approached the set-point. Setting a shorter time will decrease overshoot but slow down response and may lead to instability. **Note: P3-03 is set to 0 by default which disables the differential time constant. Care must be taken when adjusting this value outside of its default value.**				
P3-04	**PID Operating Mode**	0	1	0	-
	0 : Direct Operation. Use this mode if an increase in the feedback signal should result in an decrease in the motor speed **1 : Inverse Operation**. Use this mode if an increase in the feedback signal should result in an increase in the motor speed				
P3-05	**PID Reference Select**	0	2	0	-
	Selects the source for the PID Reference / Set-point **0 : Digital Preset Set-point**. P3-06 is used **1 : Analog Input 1 Set-point** **2 : Analog Input 2 Set-point**				
P3-06	**PID Digital Reference Value**	0.0	100.0	0.0	%
	When P3-05 = 0, this parameter sets the preset digital reference (set-point) used for the PID Controller				
P3-07	**PID Output Upper Limit**	P3-08	100.0	100.0	%
	Limits the maximum value output from the PID controller				
P3-08	**PID Output Lower Limit**	0.0	P3-07	0.0	%
	Limits the minimum output from the PID controller				
P3-09	**PID Output Limit Select**	0	3	0	-
	0 : Digital Output Limits. The output range of the PID controller is limited by the values of P3-07 & P3-08 **1 : Analog Input 1 Provides a Variable Upper Limit**. The output range of the PID controller is limited by the values of P3-08 & the signal applied to Analog Input 1 **2: Analog Input 1 Provides a Variable Lower Limit**. The output range of the PID controller is limited by the signal applied to Analog Input 1 & the value of P3-07 **3: PID output Added to Analog Input 1 Value**. The output value from the PID Controller is added to the speed reference applied to the Analog Input 1				
P3-10	**PID Feedback Source Select**	0	1	0	-
	Defines the source of the PID control feedback (location of the feedback sensor) **0 : Analog Input 2** : 0 – 100.0% **1 : Analog Input 1** : 0 – 100.0% **2 : Motor current** : 0 – 100.0% of P1-08 Value **3 : DC bus voltage** : 0 – 1000 Volt = 0 – 100.0% **4 : Analog input 1 – Analog input 2** : Differential of Analog 1 – Analog 2 = 0 – 100.0% **5 : Larger value between AnIn1 and AnIn2** : The greater of Analog input 1 or Analog Input 2 is always used				

Par	Parameter Name	Minimum	Maximum	Default	Units
P3-11	**PID Error to Enable Ramp**	0.0	25.0	0.0	%
	Defines a threshold PID error level, whereby if the difference between the set-point and feedback value is less than the set threshold, the internal ramp times of the drive are disabled to allow the drive to react quickly to small errors. Where a greater PID error exists, the ramp times are enabled to limit the rate of change of motor speed. Setting to 0.0 means that the drive ramps are always enabled. This parameter is intended to allow the user to disable the drive internal ramps where a fast reaction to the PID control is required, however by only disabling the ramps when a small PID error exists, the risk of possible over current or over voltage trips being generated are reduced.				
P3-12	**Feedback Display Scaling**	0.000	50.000	0.000	-
	Applies a scaling factor to the displayed PID feedback, allowing the user to display the actual signal level from a transducer, e.g. 0 – 10 Bar etc.				
P3-13	**Feedback Wake Up Level**	0.0	100.0	0.0	%
	Sets a programmable level whereby if the drive enters standby mode whilst operating under PID control, the selected feedback signal must fall below this threshold before the drive will return to normal operation.				
P3-14	**Standby Activation Speed**	0.0	P1-01	0	Hz / Rpm
	Determines the level at which the drive will enter into standby mode. P2-27 must be set with a value (time) for standby function to be active. Drive enters standby mode if motor speed remains below the level set in P3-14 for the time period set in P2-27.				
P3-15	**2nd PID Digital Reference Value**	0.0	100.0	0.0	%
	When P3-05 = 0, and the 2nd digital reference is selected (see Digital Input Functions – Section 10.1) this parameter sets the preset digital reference (set-point) used for the PID Controller				
P3-16	**Pump Prime Time**	0	600	0	Seconds
	A value other than zero in this parameter will automatically enable burst pipe protection function. Each time the drive is enabled whilst in PID control or is switched to PID control, the drive will monitor the PID feedback level for the time entered in P3-16. If the PID feedback level does not exceed the threshold entered in P3-17 before the time in P3-16 expires then the drive will trip with "Pr-Lo" (pressure low) trip.				
P3-17	**Burst Pipe Threshold**	0.0	100.0	0.0%	%
	PID feedback threshold for the burst pump control. In direct PID mode, PID feedback should be less than or equal to this threshold before the pump prime time (P3-16) expires. In inverse PID mode, PID feedback should be larger than or equal to the threshold before the pump prime time (P3-16) expires.				
P3-18	**PID Reset Control**	0	1	0	-
	This parameter is used to control the reset behaviour of the PID loop. 0: PID loop will continue running as long as P gain (P3-01) is not zero. 1: PID loop will only run when drive is enabled. If drive is not running, PID output will reset to 0 (Including integral result)				

11.3. Parameter Group 4 – High Performance Motor Control

⚠	**Incorrect adjustment of parameters in menu group 4 can cause unexpected behaviour of the motor and any connected machinery. It is recommended that these parameters are only adjusted by experienced users.**				
Par	**Parameter Name**	**Minimum**	**Maximum**	**Default**	**Units**
P4-02	**Auto-tune Enable**	0	1	0	-
	When set to 1, the drive immediately carries out a non-rotating auto-tune to measure the motor parameters for optimum control and efficiency. Following completion of the auto-tune, the parameter automatically returns to 0.				
P4-07	**Maximum Motoring Current Limit**	20	150	150	%-
	This parameter defines the maximum current limit or reference used by the drive.				
P4-12	**Thermal Overload Value Retention**	0	1	0	-
	0 : Disabled. **1 : Enabled**. All Optidrives feature electronic thermal overload protection for the connected motor, designed to protect the motor against damage. An internal overload accumulator monitors the motor output current over time, and will trip the drive if the usage exceeds the thermal limit. When P4-12 is disabled, removing the power supply from the drive and re-applying will reset the value of the accumulator. When P4-12 is enabled, the value is retained during power off.				

11.4. Parameter Group 5 – Communication Parameters

Par	Parameter Name	Minimum	Maximum	Default	Units
P5-01	**Drive Fieldbus Address**	0	63	-	1
	Sets the Fieldbus address for the Optidrive				
P5-03	**Modbus RTU / BACnet Baud rate**	9.6	115.2	115.2	kbps
	Sets the baud rate when Modbus/BACnet communications are used 9.6kbps, 19.2kpbs, 38.4kpbs, 57.6kpbs, 115 kbps				
P5-04	**Modbus RTU / BACnet Data Format**	-	-	n-1	-
	Sets the expected Modbus or BACnet telegram data format as follows n-1 : No Parity, 1 stop bit n-2 : No parity, 2 stop bits O-1 : Odd parity, 1 stop bit E-1 : Even parity, 1 stop bit				
P5-05	**Communications Loss Timeout**	0.0	5.0	1.0	seconds
	Sets the watchdog time period for the communications channel. If a valid telegram is not received by the Optidrive within this time period, the drive will assume a loss of communications has occurred and react as selected below (P5-07)				

Par	Parameter Name	Minimum	Maximum	Default	Units
P5-06	**Communications Loss Action**	0	3	0	-
	Controls the behaviour of the drive following a loss of communications as determined by the above parameter setting (P5-06). **0: Trip & Coast To Stop** **1: Ramp to Stop Then Trip** **2: Ramp to Stop Only (No Trip)** **3: Run at Preset Speed 4**				
P5-07	**Fieldbus Ramp Control**	0	1	0	-
	Selects whether the acceleration and deceleration ramps are control directly via the Fieldbus, or by internal drive parameters P1-03 and P1-04. **0 : Disabled**. Ramps are control from internal drive parameters **1 : Enabled**. Ramps are controlled directly by the Fieldbus				
P5-08	**Fieldbus Module PDO4**	0	7	1	-
	When using an optional Fieldbus interface, this parameter configures the parameter source for the 4th process data word transferred from the drive to the network master during cyclic communications: 0 : Output Power – Output power in kW to two decimal places, e.g. 400 = 4.00kW 1 : Output Power – Output power in kW to two decimal places, e.g. 400 = 4.00kW 2 : Digital Input Status – Bit 0 indicates digital input 1 status, bit 1 indicates digital input 2 status etc. 3 : Analog Input 2 Signal Level – 0 to 1000 = 0 to 100.0% 4 : Drive Heat-sink Temperature – 0 to 100 = 0 to 100°C 5 : User Register 1 – Can be accessed by PLC program or group 9 parameters 4 : User Register 2 – Can be accessed by PLC program or group 9 parameters 7 : P0-80 Value - P0-80 value can be selected by P6-28				
P5-09	**BACnet Device Instance Number (Low)**	0	65535	1	-
	Drive instance number within the BACnet network. Combined with P5-10 the value entered must represent a unique value with the BACnet system / network. P5-09 represents the lower 16 bits of the device instance number. Device instance number 22 bit total.				
P5-10	**BACnet Device Instance Number (High)**	0	63	0	-
	Drive instance number within the BACnet network. Combined with P5-09 the value entered must represent a unique value with the BACnet system / network. P5-10 represents upper 6 bits of the device instance number. Device instance number 22 bit total.				
P5-11	**BACnet Maximum Masters**	0	127	127	-
	Parameter defines the maximum address of any BACnet masters that can exist on the current local MSTP BACnet network. When the device is polling for the next master in the network it will not poll about the value set in P5-11. For example, if the value is set to 50 then when the drive finishes communicating and needs to pass control to the next master it will poll up to address 50 looking for a response before rolling back to address 0.				
P5-12	**Fieldbus Module PDO3**	0	7	0	-
	When using an optional Fieldbus interface, this parameter configures the parameter source for the 3rd process data word transferred from the drive to the network master during cyclic communications: 0 : Motor Current – With one decimal place, e.g. 100 1 : Output Power – Output power in kW to two decimal places, e.g. 400 = 4.00kW 2 : Digital Input Status – Bit 0 indicates digital input 1 status, bit 1 indicates digital input 2 status etc. 3 : Analog Input 2 Signal Level – 0 to 1000 = 0 to 100.0% 4 : Drive Heat-sink Temperature – 0 to 100 = 0 to 100°C 5 : User Register 1 – Can be accessed by PLC program or group 9 parameters 4 : User Register 2 – Can be accessed by PLC program or group 9 parameters 7 : P0-80 Value - P0-80 value can be selected by P6-28				
P5-13	**Fieldbus Module PDI4**	0	1	0	-
	When using an optional Fieldbus interface, this parameter configures the parameter source for the 4th process data word transferred from the network master to the drive during cyclic communications: 0: User ramp time – In second with two decimal places. 1: User Register 4 – Can be accessed by PLC program or group 9 parameters				
P5-14	**Fieldbus Module PDI3**	0	2	0	-
	When using an optional Fieldbus interface, this parameter configures the parameter source for the 3rd process data word transferred from the network master to the drive during cyclic communications: 0 : Not used - No function 1 : User PID Reference - 0 to 1000 = 0% to 100.0% 2 : User Register 3 – Can be accessed by PLC program or group 9 parameters				

11.5. Parameter Group 8 – HVAC Function Specific Parameters

Par	Parameter Name	Minimum	Maximum	Default	Units
P8-01	**Stir Interval Duration**	0	60000	0	mins
	Period of inactivity (drive is standby mode) that will trigger the drive stir function.				
P8-02	**Stir Activation Time**	1	6000	10	Secs
	Set the time period that the stir function will be active once triggered (excludes time for deceleration to stop)				
Note:	For full detail of Stir function configuration see section 7.6, Pump Stir Function, or contact your local Invertek distributor				

Par	Parameter Name	Minimum	Maximum	Default	Units
P8-03	**Cleaning Function Select**	0	3	0	-
	This parameter configures the drive conditions that will cause activation of the automatic pump clean function. **0 = Disabled** **1 = Active on Start up Only.** The pump cleaning function operates every time the pump is started. **2 = Active on start up and over-torque detection.** The pump cleaning function operates every time the pump is started, and also in the event that the drive detects a possible pump blockage during normal operation. This requires the Load Profile Monitoring function to be active and commissioned for correct operation, see parameter P8-06. **3 = Active on over-torque detection only.** The pump cleaning function operates only when a possible pump blockage is detected during normal operation. This requires the Load Profile Monitoring function to be active and commissioned for correct operation, see parameter P8-06. Note: The pump clean function can also be activated by digital input configured in group 9 parameters.				
P8-04	**Cleaning Time**	0	600	0	Secs
	Sets the time period for the operation of the pump cleaning cycle. When bi-directional pump cleaning is selected, the time interval is used twice, once in each direction.				
P8-05	**Clean Function Ramp Time**	0.0	6000	30	Secs
	Independent ramp rate used only for the pump automatic cleaning function (see P8-03) when the motor is Accelerated as part of the cleaning cycle.				
Note:	For full detail of Clean function configuration see section 7.5, Pump Clean Function, or contact your local Invertek distributor				
P8-06	**Load Monitor Enable**	0	3	0	-
	This parameter enables the Load Profile Monitoring Function (load current monitoring), which can be used to detect belt failure in belt driven fan applications, or Dry Pump, Pump Blockage or broken impeller in Pump applications. **0: Disabled** **1: Low Load Detection Enabled (Belt Failure / Dry Pump / Broken Impeller)** **2: High Load Detection Enabled (Pump Blockage)** **3: Low and High Current Detection**				
	**Adjustment of parameter P8-06 (<>0) will cause the drive to automatically run the motor through its programmed frequency range upon the next drive enable (input enable). Ensure the application is in a suitable condition to allow the motor to run safely through its frequency range prior to enabling this feature.**				
P8-07	**Load Profile Bandwidth**	0.1	50.0	1.0	Amps
	Parameter sets a bandwidth around the Load profile generated by P8-06. If P8-06 has been set to an appropriate value to detect an over /under load condition and the drive operates outside of the bandwidth set in P8-07 for a period longer than that defined by P8-08 then the drive will trip. Value entered in P8-07 is the value between the normal current and the trip level, hence total bandwidth for the function is 2 x P8-07.				
P8-08	**Load Monitor Trip Delay**	0	60	0	Secs
	Parameter sets a time limit for the Load profile generated by P8-06. If P8-06 has been set to an appropriate value to detect an over /under load condition and the drive operates outside of the bandwidth set in P8-07 for a period longer than that defined by P8-08 and then the drive will trip.				
Note:	For full detail of Load Profile Monitoring function configuration see section 7.4, Load Profile Monitoring Function, or contact your local Invertek distributor				
P8-09	**Fire Mode Logic**	0	1	0	-
	When Fire mode is assigned to a digital input on the drive then the logic configuration for the input is set by P8-09 to allow normally open or normally closed activation. Default behaviour is for Input logic off (0) to activate fire mode (Open activation). Input configuration for Fire mode is set by parameter P1-13 or can be user defined by the setting of P9-32. **0 : Open Activation** **1 : Closed Activation**				
P8-10	**Fire Mode Speed**	-P1-01	P1-01	5	Hz / Rpm
	Sets the operational frequency of the drive when Fire Mode is selected. Drive will maintain operation at this frequency until the fire mode signal is removed or the drive is no longer able to sustain operation.				
Note:	For full detail on the Fire mode function see section 7.8, Fire Mode Function, or contact your local Invertek distributor				
P8-11	**Bypass Mode on Fault**	0	1	0	-
	Parameter configures the drive to switch to bypass mode automatically should a trip occur on the drive. When enabled the drive standard relays 1 and 2 are dedicated to bypass control and cannot be assigned other functions. **0 = Disabled** **1 = Enabled**				
P8-12	**Bypass mode of Fire**	0	1	0	-
	Parameter configures the drive to switch to bypass mode automatically should an input to the drive be configured for Fire Mode operation and that input becomes active. When enabled the drive standard relays 1 and 2 are dedicated to bypass control and cannot be assigned other functions. **0 = Disabled** **1 = Enabled**				
P8-13	**Bypass Contactor Changeover Time**	0	30	2	Secs
	Parameter active when Bypass function is enabled. Parameter P8-05 sets a time delay or changeover time between the switching of the drive relays controlling the bypass circuitry.				
	Care must be taken when setting P8-13 to ensure that drive and DOL contactors are not switched in circuit simultaneously. **Both Mechanical and Electrical interlocking of drive and DOL contactors to regional standards are recommended in configuring the Bypass function.**				
Note:	For full detail on the Bypass Mode function see section 7.7, Bypass Control Function, or contact your local Invertek distributor				

Par	Parameter Name	Minimum	Maximum	Default	Units
P8-14	**Pump Staging Function Select**	0	2	0	-
	Parameter enables the pump staging (cascade) function on the drive **0 = Disabled** **1 = Single VFD with DOL Cascade (max 4 DOL pumps)** **2 = Multiple Drive Cascade Master Drive (Only valid when drive set to Optibus master address, P5-01 = 1)**				
P8-15	**Number of Assist Pumps**	0	4	0	-
	Parameter valid when P8-14 is set to 1 or 2 to enable Pump Staging Function. P8-15 set the number of assist pumps (P8-14 = 1) or network slave drives (P8-14 = 2) that are available in the Pump Staging application. Setting the value to 0 disables Pump Staging.				
P8-16	**Pump Duty Switch Over Time**	0	1000	0	Hours
	In order to balance run time (duty) on each pump in the Pump staging application and to ensure periodic operation of each pump P8-16 can be set with a time limit for pump switch over. When set to a value other than 0 (disabled) the operation of each staging pump will be cycled to ensure the difference in duty between each pump does not exceed the time set in P8-16				
P8-17	**Assist Pump Start Speed**	P8-18	P1-01	0	Hz / RPM
	HVAC Optidrive upper speed Staging threshold. When the drive output increases beyond this threshold the next Staging pump is switch on. The Pump staging settle time must then expire before additional staging pumps can be brought on or off line. Priority for Staging pump switch on is always given to the pump with lowest run time accumulated.				
P8-18	**Assist Pump Stop Speed**	0	P8-17	0	Hz / RPM
	HVAC Optidrive lower speed Staging threshold. When the drive output decreases below this threshold one of the Staging pumps currently operating is switch off. The Pump staging settle time must then expire before additional staging pumps can be brought on or off line. Priority for Staging pump switch off is always given to the pump with highest run time accumulated.				
P8-19	**Pump Settling Time**	10	600	10	Secs
	Parameter sets a time delay for pump staging whereby, following switch in or switch out of a staging pump, further pumps are not permitted to be switched in or out until this time period has elapsed. This parameter should be set to allow adequate settle time between staging pump transitions.				
P8-20	**Pump Master Clock Reset**	0	1	0	-
	Master drive in pump staging monitors and maintains duty run times for all available staging pumps. All clocks are available to view in P0-20. P8-20 provides the master reset to all run time clocks used for Pump Staging Function (all clocks set to 0).				
Note:	For full detail of Pump Staging function configuration see section 7.1 and 7.2, or contact your local Invertek distributor				

11.6. Parameter Group 0 – Monitoring Parameters (Read Only)

Par	Parameter Name	Minimum	Maximum	Default	Units
P0-01	**Analog Input 1 Value**	-100.0	100.0	-	%
	Displays the signal level applied to analog input 1 (Terminal 6) after scaling and offsets have been applied.				
P0-02	**Analog Input 2 Value**	0.0	100.0	-	%
	Displays the signal level applied to analog input 2 (Terminal 10) after scaling and offsets have been applied.				
P0-03	**Digital Input Status**	00000	11111	-	Binary
	Displays the status of the drive inputs, including the extended I/O module (if fitted). 1st Entry: 00000 ... 11111. Drive digital Input status. MSB represents digital input 1 / LSB representing digital input 5. 2nd Entry: E 000 ... E 111. Drive Extended (option) Input status. MSB represents digital input 6 / LSB representing digital input 8.				
P0-04	**Speed Controller Reference**	-P1-01	P1-01	-	Hz / Rpm
	Displays the set point reference input applied to the drive internal speed controller				
P0-06	**Digital Speed Reference**	-P1-01	P1-01	-	Hz / Rpm
	Displays the value of the drive internal Motorised Pot (used for keypad) speed reference				
P0-07	**Fieldbus Speed Reference**	-P1-01	P1-01	-	Hz / Rpm
	Displays the set-point being received by the drive from the currently active Fieldbus interface.				
P0-08	**PID Reference**	0.0	100.0	-	%
	Displays the set-point input to the PID controller.				
P0-09	**PID Feedback**	0.0	100.0	-	%
	Displays the Feedback input signal to the PID controller				
P0-10	**PID Output**	0.0	100.0	-	%
	Displays the output level of the PID controller				
P0-11	**Motor Voltage**	0	-	-	V
	Displays the instantaneous output voltage from the drive to the motor				
P0-13	**Trip Log**	-	-	-	%
	Displays the last four fault codes for the drive. Refer to section 15.1 for further information				
P0-14	**Magnetising Current (Id)**	-	-	-	A
	Displays the motor magnetising Current, providing an auto tune has been successfully completed.				
P0-16	**DC Bus Voltage Ripple**	-	-	-	Vrms
	Displays the level of ripple present on the DC Bus Voltage. This parameter is used by the Optidrive for various internal protection and monitoring functions.				
P0-17	**Stator Resistance (Rs)**	-	-	-	Ohms
	Displays the measured motor stator resistance, providing an auto tune has been successfully completed.				
P0-19	**Cascade Run Time Log**	-	-	-	Hrs
	Run Time values for variable speed and DOL pumps used in cascade function. 5 entry log. 0 = Master, 1 = DOL1, 2 = DOL2, 3 = DOL3, 4 = DOL4 Clocks can be reset through P8-20, Master Clock Reset.				

Par	Parameter Name	Minimum	Maximum	Default	Units
P0-20	**DC Bus Voltage**	0	1000	-	Volts
	Displays the instantaneous DC Bus Voltage internally within the drive				
P0-21	**Drive Temperature**	0	-	-	°C
	Displays the Instantaneous Heatsink Temperature measured by the drive				
P0-22	**Time Left to Next Service**	-	-	-	Hours
	Displays the current time period remaining before the next maintenance becomes due. Maintenance interval is based on the value entered in P6-24 (Maintenance Time Interval) and the elapsed time since the maintenance interval was enabled or reset.				
P0-23	**Time Heatsink >80° C**	0	-	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the amount of time in hours and minutes that the Optidrive has operated for during its lifetime with a heatsink temperature in excess of 80°C. This parameter is used by the Optidrive for various internal protection and monitoring functions.				
P0-24	**Time Ambient >80° C**	0	-	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the amount of time in hours and minutes that the Optidrive has operated for during its lifetime with an ambient temperature in excess of 80°C. This parameter is used by the Optidrive for various internal protection and monitoring functions.				
P0-25	**Estimated Rotor Speed**	-	-	-	Hz
	Displays the estimated rotor speed of the motor.				
P0-26	**kWh Meter**	0	999.9	-	kWh
	Two entry display: First display shows user resettable meter (reset with P6-23). Second display shows none resettable value. Displays the amount of energy consumed by the drive in kWh. When the value reaches 1000, it is reset back to 0.0, and the value of P0-27 (MWh meter) is increased.				
P0-27	**MWh Meter**	0	65535	-	MWh
	Two entry display: First display shows user resettable meter (reset with P6-23). Second display shows none resettable value. Displays the amount of energy consumed by the drive in MWh.				
P0-28	**Software Version**	-	-	-	-
	Displays the software version of the drive: Four entry display: First display = IO Version, Second display = IO Checksum, Third display = DSP Version, Fourth display = DSP Checksum				
P0-29	**Drive Type**	-	-	-	-
	Displays the type details of the drive: Three entry display: First display = Frame size and input voltage level Second display = Power rating Third display = Output Phase Count				
P0-30	**Serial Number**	-	-	-	-
	Displays the unique serial number of the drive. Dual entry display: First display = Serial number (MSB), Second display = Serial number (LMSB)				
P0-31	**Run Time Since Date of Manufacturer**	0	-	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the total operating time of the drive.				
P0-32	**Run Time Since Last Trip 1**	0	99999H	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the total operating time of the drive since the last fault occurred. Run-time clock stopped by drive disable (or trip), reset on next enable only if a trip occurred. Reset also on next enable after a drive power down.				
P0-33	**Run Time Since Last Trip 2**	0	99999H	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the total operating time of the drive since the last fault occurred. Run-time clock stopped by drive disable (or trip), reset on next enable only if a trip occurred (under-volts not considered a trip) – not reset by power down / power up cycling unless a trip occurred prior to power down.				
P0-34	**Run Time Since Last Disable**	0	99999H	-	HH:MM:SS
	Two entry display: First display shows hours. Second display shows minutes and seconds Displays the total operating time of the drive since the last Run command was received.				
P0-35	**Fan Run Time**	0	99999H	-	HH:MM:SS
	Displays the total operating time of the Optidrive internal cooling fans. Two entry display: First display shows user resettable time (reset with P6-22). Second display shows none resettable time. This is used for scheduled maintenance information				
P0-36	**DC Bus Voltage Log (256ms)**	-	-	-	-
	Diagnostic log for DC bus voltage. Values logged every 256mS with 8 samples total. Logging suspended on drive trip.				
P0-37	**DC Bus Voltage Ripple Log (20ms)**	-	-	-	-
	Diagnostic log for DC bus voltage ripple. Values logged every 20mS with 8 samples total. Logging suspended on drive trip.				
P0-38	**Heatsink Temperature Log (30s)**	-	-	-	-
	Diagnostic log for heatsink temperature. Values logged every 30S with 8 samples total. Logging suspended on drive trip.				
P0-39	**Ambient Temperature Log (30s)**	-	-	-	-
	Diagnostic log for drive ambient temperature. Values logged every 30S with 8 samples total. Logging suspended on drive trip.				
P0-40	**Motor Current Log (256ms)**	-	-	-	-
	Diagnostic log for Motor Current. Values logged every 256mS with 8 samples total. Logging suspended on drive trip.				
Note:	The above parameters (P0-36 to P0-40) are used to store the history of various measured levels within the drive at various regular time intervals prior to a trip. The values are frozen when a fault occurs and can be used for diagnostic purposes.				

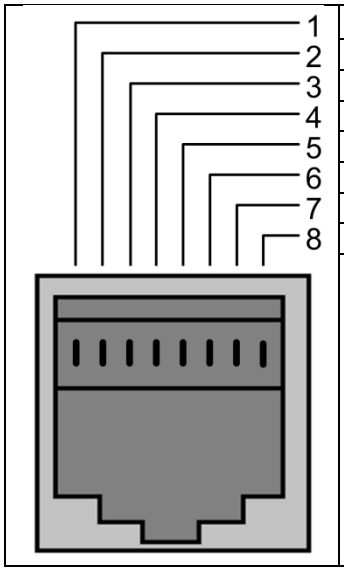
Par	Parameter Name	Minimum	Maximum	Default	Units
P0-41	**Over Current Fault Counter**	0	-	0	-
P0-42	**Over Voltage Fault Counter**	0	-	0	-
P0-43	**Under Voltage Fault Counter**	0	-	0	-
P0-44	**Heatsink Over Temperature Fault Counter**	0	-	0	-
P0-45	**Brake Chopper Short Circuit Fault Counter**	0	-	0	-
P0-46	**Ambient Over Temperature Fault Counter**	0	-	0	-
Note	These parameters (P0-41 to P0-46) contain a record of how many times certain critical faults have occurred during a drives operating lifetime. This provides useful diagnostic data				
P0-47	**I/O comms fault counter**	0	-	0	-
	Displays the number of communication errors detected by the I/O processor in messages received from the power stage processor since the last power up				
P0-48	**DSP comms fault counter**	0	-	0	-
	Displays the number of communication errors detected by the Power Stage processor in messages received from the I/O processor since the last power up				
P0-49	**Modbus RTU / BACnet Fault Counter**	0	-	0	-
	This parameter is incremented every time an error occurs on the Modbus RTU communication link. This information can be used for diagnostic purposes.				
P0-50					

12. Serial communications

12.1. RS-485 communications

Optidrive HVAC has an RJ45 connector located within the wiring enclosure of the drive. This connector allows the user to set up a drive network via a wired connection. The connector contains two independent RS485 connections, one for Invertek's Optibus Protocol and one for Modbus RTU / BACnet. Both connections can be used simultaneously.

The electrical signal arrangement of the RJ45 connector is shown as follows:



1	Not Used
2	Not Used
3	0 Volt
4	Optibus / Remote Keypad / PC Connection -
5	Optibus / Remote Keypad / PC Connection +
6	+24 Volt Remote Keypad Power Supply
7	RS 485- Modbus RTU / BACnet
8	RS 485+ Modbus RTU / BACnet

Warning:
This is not an Ethernet connection. Do not connect directly to an Ethernet port.

The Optibus data link is used for connection of Invertek peripherals and inter-drive communication. .

The Modbus interface allows connection to a Modbus RTU network as described below.

12.2. Modbus RTU Communications

12.2.1. Modbus Telegram Structure

The Optidrive HVAC2 supports Master / Slave Modbus RTU communications, using the 03 Read Holding Registers and 06 Write Single Holding Register commands. Many Master devices treat the first Register address as Register 0; therefore it may be necessary to convert the Register Numbers detail in section 12.2.2 by subtracting 1 to obtain the correct Register address. The telegram structure is as follows:-

Command 03 – Read Holding Registers						
Master Telegram	**Length**			**Slave Response**	**Length**	
Slave Address	1	Byte		Slave Address	1	Byte
Function Code (03)	1	Byte		Function Code (03)	1	Byte
1st Register Address	2	Bytes		Starting Address	1	Byte
No. Of Registers	2	Bytes		1st Register Value	2	Bytes
CRC Checksum	2	Bytes		2nd Register Value	2	Bytes
				Etc...		
				CRC Checksum	2	Bytes

Command 06 – Write Single Holding Register						
Master Telegram	**Length**			**Slave Response**	**Length**	
Slave Address	1	Byte		Slave Address	1	Byte
Function Code (06)	1	Byte		Function Code (06)	1	Byte
Register Address	2	Bytes		Register Address	2	Bytes
Value	2	Bytes		Register Value	2	Bytes
CRC Checksum	2	Bytes		CRC Checksum	2	Bytes

12.2.2. Modbus Control & Monitoring Registers

The following is a list of accessible Modbus Registers available in the Optidrive HVAC.

- When Modbus RTU is configured as the Fieldbus option, all of the listed registers can be accessed.
- Registers 1 and 2 can be used to control the drive providing that Modbus RTU is selected as the primary command source (P1-12 = 4) and no Fieldbus Option Module is installed in the drive Option Slot.
- Register 4 can be used to control the acceleration and deceleration rate of the drive providing that Fieldbus Ramp Control is enabled (P5-07 = 1)
- Registers 6 to 24 can be read regardless of the setting of P1-12

Register Number	Upper Byte	Lower Byte	Read Write	Notes
1	Command Control Word		R/W	Command control word used to control the Optidrive when operating with Modbus RTU. The Control Word bit functions are as follows :- Bit 0 : Run/Stop command. Set to 1 to enable the drive. Set to 0 to stop the drive. Bit 1 : Fast stop request. Set to 1 to enable drive to stop with 2nd deceleration ramp. Bit 2 : Reset request. Set to 1 in order to reset any active faults or trips on the drive. This bit must be reset to zero once the fault has been cleared. Bit 3 : Coast stop request. Set to 1 to issue a coast stop command.
2	Command Speed Reference		R/W	Set-point must be sent to the drive in Hz to one decimal place, e.g. 500 = 50.0Hz
3	Reserved		R/W	No Function
4	Command Ramp times		R/W	This register specifies the drive acceleration and deceleration ramp times used when Fieldbus Ramp Control is selected (P5-08 = 1) irrespective of the setting of P1-12. The input data range is from 0 to 60000 (0.00s to 600.00s)
6	Error code	Drive status	R	This register contains 2 bytes. The Lower Byte contains an 8 bit drive status word as follows :- Bit 0 : 0 = Drive Disabled (Stopped), 1 = Drive Enabled (Running) Bit 1 : 0 = Drive Healthy, 1 = Drive Tripped The Upper Byte will contain the relevant fault number in the event of a drive trip. Refer to section 15.1 for a list of fault codes and diagnostic information
7	Output Frequency		R	Output frequency of the drive to one decimal place, e.g.123 = 12.3 Hz
8	Output Current		R	Output current of the drive to one decimal place, e.g.105 = 10.5 Amps
9	Output Torque		R	Motor output torque level to one decimal place, e.g. 474 = 47.4 %
10	Output Power		R	Output power of the drive to two decimal places, e.g.1100 = 11.00 kW
11	Digital Input Status		R	Represents the status of the drive inputs where Bit 0 = Digital Input 1 etc.
20	Analog 1 Level		R	Analog Input 1 Applied Signal level in % to one decimal place, e.g. 1000 = 100.0%
21	Analog 2 Level		R	Analog Input 2 Applied Signal level in % to one decimal place, e.g. 1000 = 100.0%
22	Pre Ramp Speed Reference		R	Internal drive frequency set-point
23	DC bus voltages		R	Measured DC Bus Voltage in Volts
24	Drive temperature		R	Measured Heatsink Temperature in °C

12.2.3. Modbus Parameter Access

All User Adjustable parameters (Groups 1 to 5) are accessible by Modbus, except those that would directly affect the Modbus communications, e.g.

- P5-01 Drive Fieldbus Address
- P5-03 Modbus RTU Baud Rate
- P5-04 Modbus RTU Data Format

All parameter values can be read from the drive and written to, depending on the operating mode of the drive – some parameters cannot be changed whilst the drive is enabled for example.

When accessing a drive parameter via Modbus, the Register number for the parameter is the same as the parameter number,
E.g. Parameter P1-01 = Modbus Register 101.
Modbus RTU supports sixteen bit integer values, hence where a decimal point is used in the drive parameter, the register value will be multiplied by a factor of ten,
E.g. Read Value of P1-01 = 500, therefore this is 50.0Hz.

For further details on communicating with Optidrive using Modbus RTU, please refer to your local Invertek Sales Partner.

13. Technical Data

13.1. Environmental

Ambient temperature range	Operational	: -10 … 50°C (refer to section 13.5.1 on page 69 for derating information)
	Storage	: -40 °C … 60 °C
Max altitude for rated operation		: 1000m (refer to section 13.5.2 on page 69 for derating information)
Relative Humidity		: < 95% (no condensation permitted)

13.2. Input Voltage Ranges

Depending upon model and power rating, the drives are designed for direct connection to the following supplies:

Model Number	Supply Voltage	Phases	Frequency
ODV-2-x2xxx-1xxxx	200 – 240 Volts + 10% / -15%	1	50 – 60Hz
ODV-2-x2xxx-3xxxx		3	
ODV-2-x4xxx-3xxxx	380 – 480 Volts +10% / - 15%	3	

All Optidrive HVAC units have phase imbalance monitoring. A phase imbalance of > 3% will result in the drive tripping. For input supplies which have supply imbalance greater than 3% (typically the Indian sub- continent & parts of Asia Pacific including China) Invertek Drives recommends the installation of input line reactors. Alternatively, the drives can be operated as a single phase supply drive with 50% de-rating.

13.3. Output Power and Current ratings

The following tables provide the output current rating information for the various Optidrive HVAC models. Invertek Drives always recommend that selection of the correct Optidrive is based upon the motor full load *current* at the incoming supply voltage.

200 - 240 Volt (+ / - 10%) 1 Phase Input, 3 Phase Output

kW	HP	Nominal Input Current	Fuse or MCB (Type B)		Supply Cable Size		Nominal Output Current	Motor Cable Size		Maximum Motor Cable Length
			Non UL	UL	mm	AWG / kcmil		mm	AWG	
0.75	1	10.5	16	15	2.5	12	4.3	1.5	16	100
1.5	2	16.2	20	20	4	10	7	1.5	16	100
2.2	3	23.8	25	25	10	8	10.5	1.5	16	100

Note

- The maximum motor cable length stated applies to using a shielded motor cable. When using an unshielded cable, the maximum cable length limit may be increased by 50%. When using the Invertek Drives recommended output choke, the maximum cable length may be increased by 100%
- The PWM output switching from any inverter when used with a long motor cable length can cause an increase in the voltage at the motor terminals, depending on the motor cable length and inductance. The rise time and peak voltage can affect the service life of the motor. Invertek Drives recommend using an output choke for motor cable lengths of 50m or more to ensure good motor service life
- For UL compliant installation, use Copper wire with a minimum insulation temperature rating of 70°C, UL Class CC or Class J Fuses

200 - 240 Volt (+ / - 10%) 3 Phase Input, 3 Phase Output

kW	HP	Nominal Input Current	Fuse or MCB (Type B)		Supply Cable Size		Nominal Output Current	Motor Cable Size		Maximum Motor Cable Length
			Non UL	UL (A)	mm	AWG / kcmil		mm	AWG / kcmil	
0.75	1	5.7	10	10	1.5	14	4.3	1.5	16	100
1.5	2	8.4	10	10	2.5	14	7	1.5	16	100
2.2	3	13.1	16	15	4	12	10.5	1.5	16	100
4	5	17.3	20	20	4	10	18	2.5	16	100
5.5	7.5	25	32	30	10	8	24	4	14	100
7.5	10	32.9	40	35	16	8	30	6	12	100
11	15	54.1	63	60	25	4	46	10	8	100
15	20	69.6	80	80	35	3	61	16	6	100
18.5	25	76.9	100	100	35	1	72	25	6	100
22	30	92.3	125	125	50	2/0	90	35	4	100
30	40	116.9	160	150	70	3/0	110	50	2	100
37	50	150.2	200	175	95	4/0	150	70	1	100
45	60	176.5	200	200	120	250	180	95	2/0	100
55	75	211	250	225	185	300	202	120	3/0	100
75	120	267	315	300	2 x 95	500	248	150	4/0	100

380 - 480 Volt (+ / - 10%) 3 Phase Input, 3 Phase Output										
kW	HP	Nominal	Fuse		Supply		Nominal	Motor		Maximum
(400V)	(460V)	Input	Or		Cable		Output	Cable		Motor
		Current	MCB (Type B)		Size		Current	Size		Cable
			Non UL	UL (A)	mm	AWG / kcmil		mm	AWG / kcmil	Length
0.75	1	3.1	6	6	1.5	14	2.2	1.5	16	100
1.5	2	4.8	6	6	1.5	14	4.1	1.5	16	100
2.2	3	7.2	10	10	1.5	14	5.8	1.5	16	100
4	5	10.8	16	15	2.5	12	9.5	1.5	16	100
5.5	7.5	13.3	16	15	4	12	14	1.5	16	100
7.5	10	18.5	25	25	4	8	18	2.5	16	100
11	15	26.5	32	30	10	8	24	4	14	100
15	20	32.9	40	40	16	8	30	6	12	100
18.5	25	46.6	63	60	16	4	39	10	10	100
22	30	54.1	63	60	25	4	46	10	8	100
30	40	69.6	80	80	35	3	61	16	6	100
37	50	76.9	100	100	35	1	72	25	6	100
45	60	92.3	125	125	50	2/0	90	35	4	100
55	75	116.9	160	150	70	3/0	110	50	2	100
75	100	150.2	200	175	95	4/0	150	70	1	100
90	150	176.5	200	200	120	250	180	95	2/0	100
110	175	217.2	250	250	185	400	202	120	3/0	100
132	200	255.7	315	300	2 x 95	500	240	150	4/0	100
160	250	302.4	400	350	2 x 95	700	302	2 x 70	350	100
200	300	370	400	400	2 x 150	900	370	2 x 95	500	100
250	350	450	500	500	2 x 150	1500	450	2 x 120	700	100

Note

- The maximum motor cable length stated applies to using a screened motor cable. When using an unscreened cable, the maximum cable length limit is increased by 50%. When using the Invertek Drives recommended output choke, the maximum cable length limited can be increased by 100%
- The PWM output switching from any inverter when used with a long motor cable length can cause an increase in the voltage at the motor terminals, depending on the motor cable length and inductance. The rise time and peak voltage can affect the service life of the motor. Invertek Drives recommend using an output choke for motor cable lengths of 50m or more to ensure good motor service life
- For UL compliant installation, use Copper wir4 with a minimum insulation temperature rating of 75°C. When using fuses type should be Class CC or Class J

13.4. Additional Information for UL Approved Installations

Optidrive HVAC is designed to meet the UL requirements. In order to ensure full compliance, the following must be fully observed.

Input Power Supply Requirements				
Supply Voltage	200 – 240 RMS Volts for 230 Volt rated units, + /- 10% variation allowed. 240 Volt RMS Maximum			
	380 – 480 Volts for 400 Volt rated units, + / - 10% variation allowed, Maximum 500 Volts RMS			
Imbalance	Maximum 3% voltage variation between phase – phase voltages allowed			
	All Optidrive HVAC units have phase imbalance monitoring. A phase imbalance of > 3% will result in the drive tripping. For input supplies which have supply imbalance greater than 3% (typically the Indian sub- continent & parts of Asia Pacific including China) Invertek Drives recommends the installation of input line reactors. Alternatively, the drives can be operated as a single phase supply drive with 50% derating.			
Frequency	50 – 60Hz + / - 5% Variation			
Short Circuit Capacity	**Voltage Rating**	**Min kW (HP)**	**Max kW (HP)**	**Maximum supply short-circuit current**
	230V	0.37 (0.5)	18.5 (25)	5kA rms (AC)
	230V	22 (30)	75 (100)	10kA rms (AC)
	400 / 460V	0.75 (1)	37 (50)	5kA rms (AC)
	400 / 460V	45 (60)	132 (200)	10kA rms (AC)
	400 / 460V	160 (250)	250 (350)	18kA rms (AC)
	All the drives in the above table are suitable for use on a circuit capable of delivering not more than the above specified maximum short-circuit Amperes symmetrical with the specified maximum supply voltage.			
Incoming power supply connection must be according to section 4.3				
All Optidrive HVAC units are intended for indoor installation within controlled environments which meet the condition limits in section 13.1				
Branch circuit protection must be installed according to the relevant national codes. Fuse ratings and types are shown in section 13.4				
Suitable Power and motor cables should be selected according to the data shown in section 13.4				
Power cable connections and tightening torques are shown in section 3				
Optidrive HVAC provides motor overload protection in accordance with the National Electrical Code (US). • Where a motor thermistor is not fitted, or not utilised, Thermal Overload Memory Retention must be enabled by setting P4-12 = 1 • Where a motor thermistor is fitted and connected to the drive, connection must be carried out according to the information shown in section 4.6				

13.5. Derating Information

Derating of the drive maximum continuous output current capacity is require when

- Operating at ambient temperature in excess of 40°C / 104°F
- Operating at Altitude in excess of 1000m/ 3281 ft
- Operation with Effective Switching Frequency higher than the minimum setting

The following derating factors should be applied when operating drives outside of these conditions

13.5.1. Derating for Ambient Temperature

Enclosure Type	Maximum Temperature Without Derating	Derate by	Maximum Permissible
IP20	50°C / 122°F	N/A	50°C
IP40	40°C / 104°F	N/A	40°C
IP55	40°C / 104°F	1.5% per °C (1.8°F)	50°C
IP66	40°C / 104°F	2.5% per °C (1.8°F)	50°C

13.5.2. Derating for Altitude

Enclosure Type	Maximum Altitude Without Derating	Derate by	Maximum Perms sable (UL Approved)	Maximum Perms sable (Non-UL Approved)
IP20	1000m / 3281ft	1% per 100m / 328 ft.	2000m / 6562 ft.	4000m / 13123 ft.
IP40	1000m / 3281ft	1% per 100m / 328 ft.	2000m / 6562 ft.	4000m / 13123 ft.
IP55	1000m / 3281ft	1% per 100m / 328 ft.	2000m / 6562 ft.	4000m / 13123 ft.
IP66	1000m / 3281ft	1% per 100m / 328 ft.	2000m / 6562 ft.	4000m / 13123 ft.

13.5.3. Derating for Switching Frequency

	Switching Frequency (Where available)					
Enclosure Type	**4kHz**	**8kHz**	**12kHz**	**16kHz**	**24kHz**	**32kHz**
IP20	N/A	N/A	20%	30%	40%	50%
IP40	N/A	TBC	TBC	TBC	TBC	TBC
IP55	N/A	10%	10%	15%	25%	N/A
IP66	N/A	10%	25%	35%	50%	50%

13.5.4. Example of applying Derating Factors

A 4kW, IP66 drive is to be used at an altitude of 2000 metres above sea level, with 12 kHz switching frequency and 45°C ambient temperature.
From the table above, we can see that the rated current of the drive is 9.5 Amps at 40°C,
Firstly, apply the switching frequency derating, 12 kHz, 25% derating
9.5 Amps x 75% = 7.1 Amps
Now, apply the derating for higher ambient temperature, 2.5% per °C above 40°C = 5 x 2.5% = 12.5%
7.1 Amps x 87.5% = 6.2 Amps
Now apply the derating for altitude above 1000 metres, 1% per 100m above 1000m = 10 x 1% = 10%
7.9 Amps x 90% = 5.5 Amps continuous current available.
If the required motor current exceeds this level, it will be necessary to either

- Reduce the switching frequency selected
- Use a higher power rated drive and repeat the calculation to ensure sufficient output current is available.

14. Troubleshooting

14.1. Fault messages

Fault Code	No.	OLED Message	Description	Corrective Action
no-FLt	00	No Fault	No Fault	Displayed in P0-13 if no faults are recorded in the log
O-I	03	Over current trip	Instantaneous over current on drive output.	**Fault Occurs on Drive Enable** Check the motor and motor connection cable for phase – phase and phase – earth short circuits. Check the load mechanically for a jam, blockage or stalled condition Ensure the motor nameplate parameters are correctly entered, P1-07, P1-08, P1-09. Reduced the Boost voltage setting in P1-11 Increase the ramp up time in P1-03 If the connected motor has a holding brake, ensure the brake is correctly connected and controlled, and is releasing correctly
I.t-trP	04	Over load trip	Drive has tripped on overload after delivering >100% of value in P1-08 for a period of time.	Check to see when the decimal points are flashing (drive in overload) and either increase acceleration rate or reduce the load. Check motor cable length is within the limit specified for the relevant drive in section 13.3 Ensure the motor nameplate parameters are correctly entered in P1-07, P1-08, and P1-09 Check the load mechanically to ensure it is free, and that no jams, blockages or other mechanical faults exist
PS-trP	05	Hardware Over Current	Check the wiring to motor and the motor for phase to phase and phase to earth short circuits. Disconnect the motor and motor cable and retest. If the drive trips with no motor connected, it must be replaced and the system fully checked and retested before a replacement unit is installed.	
O-volt	06	Over voltage	Over voltage on DC bus	The value of the DC Bus Voltage can be displayed in P0-20 A historical log is stored at 256ms intervals prior to a trip in parameter P0-36 This fault is generally caused by excessive regenerative energy being transferred from the load back to the drive. When a high inertia or over hauling type load is connected. If the fault occurs on stopping or during deceleration, increase the deceleration ramp time P1-04. If operating in PID control, ensure that ramps are active by reducing P3-11
U-volt	07	Under voltage	Under voltage on DC bus	This occurs routinely when power is switched off. If it occurs during running, check the incoming supply voltage, and all connections into the drive, fuses, contactors etc.
O-t	08	Over temperature trip	Heatsink over temperature	The heatsink temperature can be displayed in P0-21. A historical log is stored at 30 second intervals prior to a trip in P0-38 Check the drive ambient temperature Ensure the drive internal cooling fan is operating Ensure that the required space around the drive as shown in section 3.8 thru 3.10 has been observed, and that the cooling airflow path to and from the drive is not restricted Reduce the effective switching frequency setting in parameter P2-24 Reduce the load on the motor / drive
U-t	09	Under temperature trip	Drive Under temperature	Trip occurs when ambient temperature is less than -10°C. The temperature must be raised over -10°C in order to start the drive.
P-dEF	10	Load default parameters	Factory Default parameters have been loaded	Press STOP key, the drive is now ready to be configured for the required application. Four button defaults – see section 5.8
E-tr iP	11	External trip	Digital Input External trip	E-trip requested on control input terminals. Some settings of P1-13 require a normally closed contact to provide an external means of tripping the drive in the event that an external device develops a fault. If a motor thermistor is connected check if the motor is too hot.
SC-Obs	12	Optibus serial comms fault	Communications Fault	Communications lost with PC or remote keypad. Check the cables and connections to external devices
FLt-dc	13	Excessive DC ripple	Excessive DC Ripple on Internal DC bus	The DC Bus Ripple Voltage level can be displayed in parameter P0-16 A historical log is stored at 20ms intervals prior to a trip in parameter P0-37 Check all three supply phases are present and within the 3% supply voltage level imbalance tolerance. Reduce the motor load If the fault persists, contact your local Invertek Drives Sales Partner
P-LoSS	14	Input phase loss	Input phase missing trip	Drive intended for use with a 3 phase supply, one input phase has been disconnected or lost.
h O-I	15	Instant over current	Instantaneous over current on drive output.	Refer to fault 3 above
th-FLt	16	Thermistor Fault	Faulty thermistor on heat-sink.	Refer to your Invertek Sales Partner.

Fault Code	No.	OLED Message	Description	Corrective Action
dAtA-F	17	I/O processor data error	Internal memory fault.	Parameters not saved, factory defaults are reloaded. If problem reoccurs, refer to your IDL Authorised Distributor.
4-20F	18	4-20mA signal out of range	4-20mA Signal Lost	The reference signal on Analog Input 1 or 2 (Terminals 6 or 10) has dropped below the minimum threshold of 3mA when signal format is set to 4-20mA. Check the signal source and wiring to the Optidrive terminals.
dAtA-E	19	M/C processor data error	Internal memory fault.	Parameters not saved, factory defaults are reloaded. If problem reoccurs, refer to your IDL Authorised Distributor.
U-dEF	20	User Parameter Default	User Parameter Defaults	User Parameter default has been loaded. Press the Stop key. Three button default – see section 5.9
F-Ptc	21	Motor PTC over heat	Motor PTC Over Temperature	The connected motor PTC device has caused the drive to trip (analog input 2 configured for PTC device).
FAn-F	22	Cooling Fan Fault	Cooling Fan Fault	Check and if necessary, replace the drive internal cooling fan
O-hEAt	23	Ambient Temperature High	Ambient Temperature too High	The measured temperature around the drive is above the operating limit. Ensure the drive internal cooling fan is operating Ensure that the required space around the drive as shown in sections 3.8 thru 3.10 has been observed, and that the cooling airflow path to and from the drive is not restricted Increase the cooling airflow to the drive Reduce the effective switching frequency setting in parameter P2-24 Reduce the load on the motor / drive
O_tor9	24	Exceed max torque	Over-Current Error	Current Monitoring Function has detected current levels above the normal operating condition for the application. Check mechanical load has not changed and that the load is not jammed or stalling. For pump application check for potential pump blockage For fan applications check airstream to and from the fan is not restricted
U_tor9	25	Output torque too low	Under-Current Error	Current Monitoring Function has detected current levels below the normal operating condition for the application. Check for mechanical breakages causing loss of load (e.g. belt break). Check motor has not become disconnected from the drive.
OUt-F	26	Drive Output Fault	Drive output fault	Drive output fault, refer to your IDL Authorised Distributor
Sto-F	29	Internal STO circuit Error	Refer to your Invertek Sales Partner	
AtF-01	40	Autotune fail 1	Autotune Failed	Measured motor stator resistance varies between phases. Ensure the motor is correctly connected and free from faults. Check the windings for correct resistance and balance.
AtF-02	41	Autotune fail 2		Measured motor stator resistance is too large. Ensure the motor is correctly connected and free from faults. Check that the power rating corresponds to the power rating of the connected drive.
AtF-03	42	Autotune fail 3		Measured motor inductance is too low. Ensure the motor is correctly connected and free from faults.
AtF-04	43	Autotune fail 4		Measured motor inductance is too large. Ensure the motor is correctly connected and free from faults. Check that the power rating corresponds to the power rating of the connected drive.
AtF-05	44	Autotune fail 5		Measured motor parameters are not convergent. Ensure the motor is correctly connected and free from faults. Check that the power rating corresponds to the power rating of the connected drive.
Pr-Lo	48	Feedback Pressure Low	Low Pressure Detected by Pipe Fill Function	Check the pump system for leaks for burst pipes. Check the Pipe fill function has been commissioned correctly (P3-16 & P3-17)
OUt-PH	49	Output Phase Loss	Output (Motor) Phase Loss	One of the motor output phases is not connected to the drive.
Sc-F01	50	Modbus Comms fault	Modbus communication error detected	
Sc-F03	52	Option Module Fault	Fitted communication Module Fault	Internal communication to the inserted Communications Option Module has been lost. Check the module is correctly inserted
Sc-F04	53	IO Card Comms fault	IO card comms trip	Internal communication to the inserted I/O Option Module has been lost. Check the module is correctly inserted
Sc-F05	54	BACnet Comms fault	BACnet comms loss trip	A valid BACnet telegram has not been received within the watchdog time limit set in P5-05 Check the network master / PLC is still operating Check the connection cables Increase the value of P5-05 to a suitable level