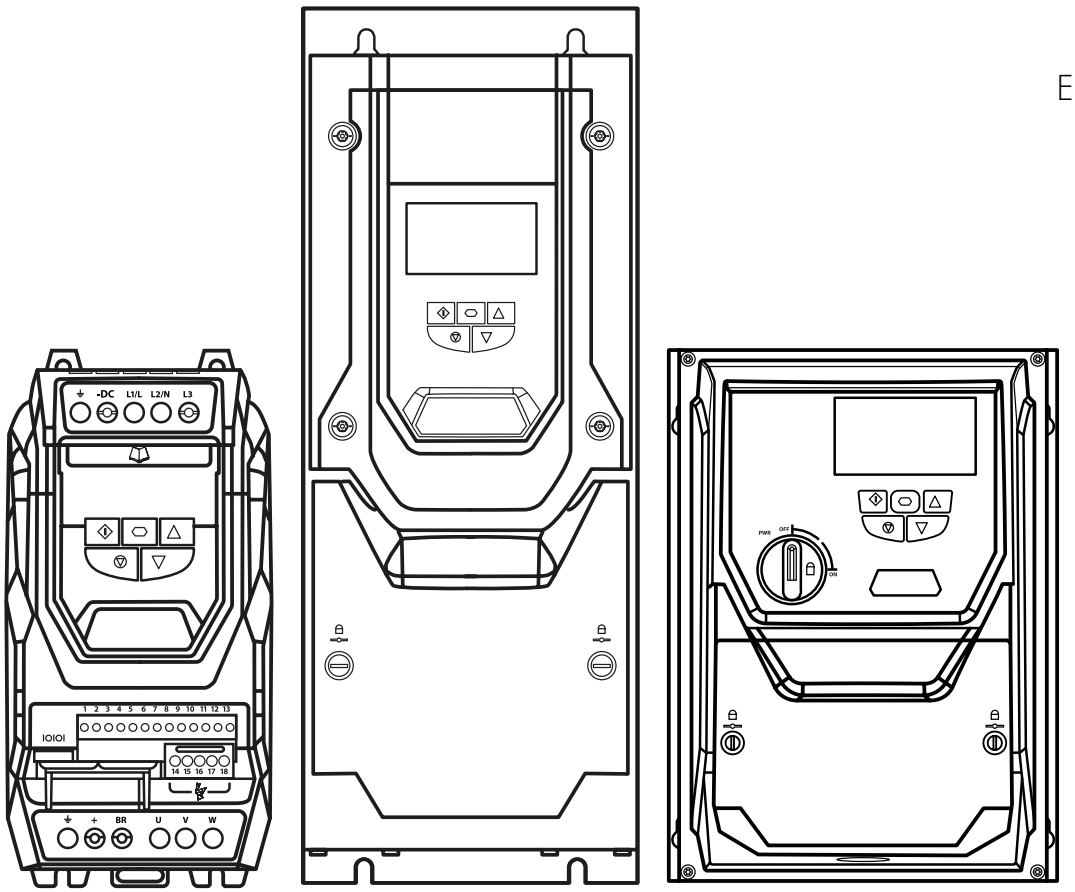
Bardac drives

iP²SOLARPUMP

AC Variable Speed Drive
for Solar Pumping Applications

0.75kW – 160kW / 1HP – 250HP
For 200 – 480 Volt 3 Phase Motors



User Guide

Declaration of Conformity

Bardac Corporation, 40 Log Canoe Circle, Stevensville, MD 21666

Bardac Corporation hereby states that the P2 product range conforms to the relevant safety provisions of the following council directives:

2004/108/EC (EMC) and 2006/95/EC (LVD) (Valid until 20.04.2016)

2014/30/EU (EMC) and 2014/35/EU (LVD) (Valid from 20.04.2016)

Design and manufacture is 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

Safe Torque OFF ("STO") Function

P2 incorporates a hardware STO (Safe Torque Off) Function, designed in accordance with the standards listed below.

Standard	Classification	Independent Approval
EN 61800-5-2:2007	Type 2	*TUV
EN ISO 13849-1:2006	PL "d"	
EN 61508 (Part 1 to 7)	SIL 2	
EN60204-1	Uncontrolled Stop "Category 0"	
EN 62061	SIL CL 2	

Electromagnetic Compatibility

All P2 drives 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 mains supply via the power cables for compliance with the above 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, and the relevant category. Within the European Union, equipment into which this product is incorporated must comply with the EMC Directive 2004/108/EC. This User Guide provides guidance to ensure that the applicable standards may be achieved.

All Bardac P2 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.

This User Guide is for use with version 2.10 Firmware User Guide Revision 1.02

Bardac Corporation 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.

	This manual is intended as a guide for proper installation. Bardac Corporation 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 P2 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.

1. Quick Start Up

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.

This variable speed drive product (P2) 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 P2 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 P2, including the specified environmental limitations.

Do not perform any flash test or voltage withstand test on the P2. Any electrical measurements required should be carried out with the P2 disconnected.

Electric shock hazard! Disconnect and ISOLATE the P2 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.

Ensure that the drive and its enclosure are connected to a suitable earth connection along with any exposed conductive material such as the structure that supports the photovoltaic modules.

Do NOT open or remove the cover of fuses whilst the pump is running, always stop the pump by disabling the P2 Solar Pump Drive and then isolate the DC power using appropriate means before working on the power wiring of the drive.

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

Open circuit voltages that are too high can cause permanent damage to the drive, ensure that the photovoltaic power source has been checked to be appropriate for the drive that it will be connected to before making the actual connections.

The "Safe Torque Off" Function does not prevent high voltages from being present at the drives power terminals.

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

Within the European Union, all machinery in which this product is used must comply with the Machinery Directive 2006/42/EC, Safety of Machinery. In particular, the machine manufacturer is responsible for ensuring that the electrical equipment complies with EN60204-1 and providing a disconnecting device which must be one of the following types:

- A switch-disconnector, utilization category AC-23B (EN 60947-3)
- A circuit breaker suitable for isolation in accordance with EN 60947-2
- A disconnector with an integrated auxiliary contact that ensures under all circumstances the switching devices break the load circuit prior to opening of the main contacts of the disconnector (EN 60947-3)

For installation in other regions, conformance with local electrical regulations and codes of practice must be adhered to.

The level of integrity offered by the P2 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.

Take care during commissioning and normal operation that you do not allow the pump to run dry as this could cause permanent damage to the pump.

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 P2 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.

P2s 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 P2 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 P2. In the case of suspected fault or malfunction, contact your local Bardac Drives Sales Partner for further assistance.

1.2. Quick Start Process

Step	Action	See Section	Page
1	Identify the Model Type and ratings of your drive from the model code on the label. In particular - **Check the voltage rating suits the incoming supply** verify the VMPP and Voc for the array - Check the output current capacity meets or exceeds the full load current for the intended motor - Check the enclosure type is suitable for the intended mounting location	2.1. Identifying the Drive by Model Number 2.3. Understanding the Rating Label 2.4. Drive model numbers – IP20 2.5. Drive model numbers – IP55 2.6. Drive model numbers – IP66 3.1. General	11 12 13 13 14 15
2	Unpack and check the drive. Notify the supplier and shipper immediately of any damage.		
3	Ensure correct ambient and environmental conditions for the drive are met by the proposed mounting location.	10.1. Environmental	62
4	Install the drive in a suitable cabinet (IP20 Units), ensuring suitable cooling air is available. Mount the drive to the wall or machine (IP55 & IP66).	3.1. General 3.2. Before Installation 3.4. Mechanical dimensions and weight 3.5. Guidelines for Enclosure mounting (IP20 Units) 3.6. Mounting the Drive – IP20 Units 3.7. Guidelines for mounting (IP55 Units) 3.8. Guidelines for mounting (IP66 Units)	15 15 16 19 20 20 21
5	Select the correct power and motor cables according to local wiring regulations or code, noting the maximum permissible sizes	10.2. Output Power and Current ratings	62
6	For IT Supply network, or any power supply type where the phase – earth voltage may exceed the phase – phase voltage (such as ungrounded supplies), disconnect the EMC filter before connecting the supply.		
7	Check the supply cable and motor cable for faults or short circuits.		
8	Route the cables		
9	Check that the intended motor is suitable for use, noting any precautions recommended by the supplier or manufacturer.	4.4. Motor Connection 8.3.2. Working with different motor types	26 49
10	Check the motor terminal box for correct Star or Delta configuration where applicable	4.5. Motor Terminal Box Connections	26
11	Ensure correct wiring protection is providing, by installing a suitable circuit breaker or fuses in the incoming supply line	4.3.3. Fuse / Circuit Breaker Selection	26
12	Connect the power cables, especially ensuring the protective earth connection is made	4.1. Connection Diagram	24
13	Connect the control cables as required for the application	4.7. Control Terminal Connections	27
14	Thoroughly check the installation and wiring		
15	Commission the drive parameters	9. Serial communications	60

1.3. Basic Commissioning Procedure

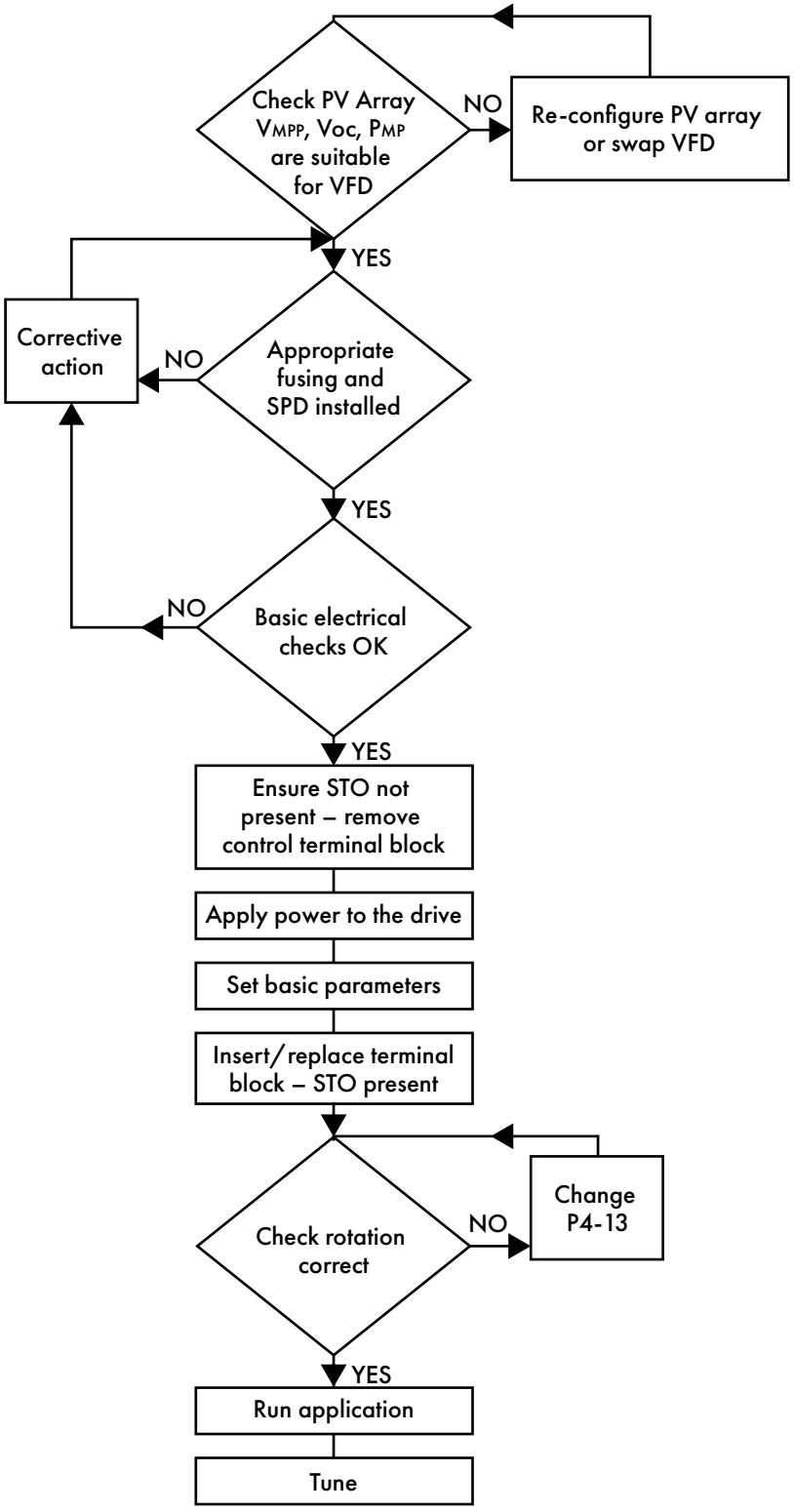
This section provides a short guide to commission the drive for a standard Photovoltaic Pumping Application. Other functions are configurable but this guide is intended to provide the user with a starting point, for further information please contact your local Bardac sales partner for detailed support.

It is the responsibility of the system integrator or the installer to ensure that the solar pump solution is suitably sized for the application requirements including the dimensioning of the Photovoltaic array. The maximum limits of the P2 solar Pump drive are given in the technical section of this User Guide and are summarised below:

Drives for use with 400V motors can be fed with DC Voltage from 345 to 800Vdc with a recommended VMPP in the area of 565Vdc

Drives for use with 200V motors can be fed with DC Voltage from 185 to 410Vdc with a recommended VMPP in the area of 325Vdc

Please note that the output voltage of the drive will be limited to the DC Voltage divided by the square root of 2 – this could limit the maximum operational speed of the pump in certain conditions.



1.3.1. Basic Parameter Setting

Par.	Description	Default	Typical
P1-01	**Maximum Frequency / Speed**	**50.0Hz**	**50.0Hz**
	Maximum output frequency/speed of the drive in Hertz (units will change to rpm if the motor rated speed has been entered into P1-10). This parameter is usually set to the rated frequency of the motor but can be adjusted above or below this value if necessary for the application. If this parameter is set above the motor rated frequency, it should be confirmed that the motor current does not exceed the motor rated current. It is also advisable to check that the power of the PV array has been dimensioned to deliver the required power at this speed.		
P1-02	**Minimum Frequency / Speed**	**20.0Hz**	**25.0Hz**
	Minimum output frequency/speed of the drive in Hertz (units will change to rpm if the motor rated speed has been entered into P1-10). This parameter is usually set to the minimum frequency that the pump can deliver the minimum flow / pressure required and when the pump and motor can still be adequately cooled.		
P1-03	**Acceleration Ramp**	**5.0s**	**15.0s**
	Acceleration ramp time from zero speed to rated motor speed. Very short ramp times can cause a response that is too fast which can collapse the array on start-up – excessively long ramps can also cause a lag in the control loop.		
P1-04	**Deceleration Ramp**	**5.0s**	**3.0s**
	Deceleration ramp time from nominal motor speed to zero speed.		
P1-07	**Motor Rated Voltage**	**400Vac**	**Motor Nameplate**
	This is the motor rated voltage (phase to phase). Set this parameter to the Motor Rated Voltage as stated on the motor name-plate. If the motor is a permanent magnet motor then this parameter becomes the back EMF (phase to phase) of the motor at the rated speed of the motor		
P1-08	**Motor Rated Current**	**x.x A**	**Motor Nameplate**
	Rated motor current (RMS), set this parameter to the value indicated on the motor nameplate. Incorrect setting of this parameter could cause poor performance of the motor but more importantly, could cause incorrect motor thermal protection.		
P1-12	**Primary Command Source**	**3 (PID)**	**3 (PID)**
	In order to operate the P2 Solar Pump Drive with the in-built MPPT algorithm, the primary command source must be set to 3 (PID). This will enable the MPPT control to be selected in the advanced parameters.		
P1-13	**Digital Input Function Select**	**1**	**1**
	This parameter selects the functionality of the different digital and analogue inputs of the drive. Set this parameter to "1" for the most common configuration which enables digital input 1 as the drive enable input.		
P1-14	**Extended Menu Access Code**	**0**	**101**
	Set this parameter to 101 in order to allow access to the extended parameter. This parameter is used to close off the extended parameters from end users that could make changes that may not be appropriate.		

1.3.2. Extended Parameter Setting:

Par.	Description	Default	Typical
P2-24	**Effective Switching Frequency**	**16Khz**	**16Khz**
	The effective switching frequency is actually twice what would ordinarily be known as the PWM frequency as we modulate both edges of the pulse. We recommend setting this parameter to 16kHz for optimum balance between performance, audible noise and losses in the system. Higher settings of this parameter can cause increased losses in the drive.		
P2-25	**Fast Deceleration Ramp Time**	**0,5s**	**0,5s**
	Rapid deceleration ramp time that the equipment uses to decelerate rapidly in the event of a sudden drop in DC bus voltage.		
P2-26	**Spin Start Enable**	**1**	**0**
	When activated (P2-26 = 1), the drive when enabled will attempt to synchronise the output to the actual speed of the motor. This function is more often used for fan application where the fan could be rotating as a result of its inertia or due to airflow, but can be used with pumps where there may be a flow of water causing the pump to rotate. In the case of most pumps, the rotation will come to a sudden stop when the drive has been disabled, this function should be disabled for these types of pump.		

Par.	Description	Default	Typical
P2-36	**Start Mode Select / Automatic Restart**	**Auto-0**	**Auto-5**
	This parameter defines the automatic re-start and automatic fault re-set of the drive. With this parameter set to 'Auto-5' the drive will automatically restart if the run command is present and make up to five attempts to automatically reset from a fault condition at 20s intervals. If after five reset attempts, the drive is unsuccessful (the fault condition remains), the drive will no longer attempt to reset and will remain in a tripped state until it is manually reset or the drive supply has been removed and restored.		
P2-38	**Main Loss Ride Through / Stop Control**	**3:DC**	**3:DC**
	Setting this parameter to 3 (DC Supply), informs the drive that it is being supplied its power from a DC source. This means that the drive is not looking to measure the supply voltage on all three input phases.		
P4-01	**Motor Control Mode**	**1:CT**	**0:VT**
	This parameter selects the motor type and control required. The most common setting for pumps would be '0' (Eco Vector mode – variable torque) which means that the drive will operate in vector mode and is configured for a centrifugal pump. If you are connecting the drive to a pump with a constant torque characteristic then set this parameter to '1'. This parameter is also used to select different motor types such as PM or BLDC.		
P4-05	**Motor Rated Power Factor (CosΦ)**	**0.81**	**See Nameplate**
	This parameter is the motor rated power factor (CosΦ), set this parameter to the value indicated on the motor nameplate.		
P4-02	**Motor Parameter Auto-tune Enable**	**0**	**1**
	Once that the previous parameters have been set, an autotune should be carried out for optimum performance. Carrying out an autotune allows the drive to measure some of the motor specific parameters. This autotune is a stationary autotune which does not rotate the motor during its measurements. It is also very important to ensure that the motor is stationary when activating this function.		
P4-13	**Inverter Output Phase Sequence**	**0:U,V,W**	**0:U,V,W**
	This parameter defines the output phase sequence of the drive and consequently the direction considered as forwards. It can be used to change the direction of rotation of the motor without having to physically swap two output phase cables. Please ensure that if using this parameter that you are not running the motor in reverse which could of course, cause damage to the pump.		

1.3.3. Solar Pumping Application Settings

Par.	Description	Default	Typical
P3-01	**PID Proportional Gain (1)**	**1.0**	**1.0**
	This parameter is the Proportional gain that the drive uses to achieve the optimum operating point when the drive is started. A reduced proportional gain will cause a slow reaction system that may cause the system to respond too slowly to the initial fluctuations of the array voltage while the pump is accelerating. By increasing the proportional gain the system will react faster. Excessively high settings can cause an unstable system.		
P3-02	**PID Integration Time (1)**	**1.0**	**1.0**
	This parameter is the Integration time that the drive uses to achieve the optimum operating point when the drive is started. The proportional gain induces steady state errors that can be corrected by this integration term. Smaller values in this setting cause a more responsive system and excessively low values can cause an unstable system. Likewise, excessively large settings in this parameter will make the system particularly slow to completely correct the error.		
P3-04	**PID Operating Mode**	**1**	**1**
	This parameter defines how the P2 SolarPump PID mode operates. Direct Mode = 0. Inverse mode = 1. The inverse mode means that as the DC Bus voltage decreases, the pump speed should also decrease. The direct mode is the opposite and is not suitable for Solar Pumping applications.		
P3-05	**PID Reference (Set-point) Source Select**	**0**	**3**
	In order to operate using the internal MPPT algorithm in the drive, this parameter should be set to 3.		
P3-08	**User PID Output Low Limit**	**0.0%**	**50.0%**
	This parameter determines the low limit of the PID output. If set to zero, it will take longer for the drive to ramp up to the MPP from a start or when recovering from standby. This will also apply an 'effective minimum frequency' given by P1-01 x P3-08.		
P3-10	**PID Feedback Source Select**	**3:DC**	**3:DC**
	This parameter selects the PID feedback source and should be set to 3 for DC Bus Voltage in order to operate with the internal MPPT selected in P3-05.		
P8-09	**PID Proportional Gain (2)**	**1.0**	**0.2**
	This parameter sets the proportional gain that the drive uses to maintain the optimum operating point once the system has stabilized after startup. A reduced proportional gain will cause a slow reaction system which can be desirable in order to keep the pump speed as stable as possible during PV Array Voltage fluctuations caused by the variation of solar irradiation and other environmental influences.		

Par.	Description	Default	Typical
P8-10	**PID Integration Time (2)**	**1.0**	**1.0**
	This parameter sets the integration time that the drive uses to maintain the optimum operating point once the equipment has stabilized after startup. The proportional gain induces steady-state errors that can be corrected by integrating the error over time and adding it to the proportional action. Very high values can cause slowness in correction and response.		
P8-12	**PID Gain Transition Band**	**0.0%**	**0.1%**
	Error band, between the set-point and DC bus voltage, in% of 1000Vdc. Once inside this band the inverter switches between PID gain (1) and PID gain (2).		
P8-13	**PID Gain 2 Transition Delay**	**0.0s**	**0.5s**
	This parameter sets a time delay from the moment that the system enters the transition band configured in P8-12, to when the drive switches from PID gain 1 settings to PID gain 2 settings.		
P8-11	**PID Error Deadband**	**0.0%**	**0.0%**
	Error band calculated in% of 1000Vdc, of the error between the set-point and real value of DC bus voltage, in which the converter will not modify the output speed and therefore will be maintained at a stable speed.		
P3-06	**MPPT Start Voltage**	**51.0%**	**xx.x%**
	Defines the Voltage that is loaded into the MPPT on start-up. This value is in % of 1000Vdc, a value of 51.0% would correlate to 510V dc.		
P8-18	**MPPT Minimum Voltage**	**264/460Vdc**	**xxxVdc**
	Defines the minimum DC bus voltage achievable by calculation of the MPPT controller. When the inverter is enabled the value loaded to the MPPT will be P3-06 The value set in P8-18 corresponds to the voltage delivered by the PV array (Vmp) at the point of maximum power with the minimum irradiation that we can expect the pump to operate.		
P8-19	**MPPT Maximum Operating Voltage**	**322/560**	**xxxVdc**
	Defines the maximum DC bus voltage achievable by calculation of the MPPT controller. When the drive is enabled the value loaded to the MPPT will be P3-06. The value set in P8-19 corresponds to the voltage delivered by the PV array (Vmp) at the point of maximum power with the maximum irradiation that we can expect the pump to operate.		
P8-20	**MPPT Voltage Variation**	**5V**	**3V**
	This parameter defines the iteration voltage of the MPPT algorithm. The MPPT system continuously tests whether it has found the maximum power point of the system. To do this we must select the resolution in Vdc for the MPPT controller.		

1.3.4. Standby / Wake-up parameter settings

Par.	Description	Default	Typical
P8-14	**Standby Mode**	**0**	**1**
	This parameter selects the variables that causes the drive to go into standby (sleep) mode. By default, this parameter is set to 0 which means that standby mode is selected based on pump speed. A setting of 1 however, configures the drive to go into standby mode and 'wake-up' from this condition based on the voltage of the DC Bus. If a solar irradiation sensor is used then this setting should be changed to 2.		
P8-15	**Standby Activation Level**	**0.0%**	**45.0%**
	With P8-14 = 1, this parameter should be set in DC Bus Voltage as a % of 1000V, below which the inverter will decelerate the pump speed and remain in Standby mode waiting for the DC bus to exceed the wake-up level. 45.0% = 450Vdc.		
P2-27	**Standby Activation Delay Time**	**0s**	**5s**
	This parameter sets the delay time in seconds that the DC Bus Voltage must remain below the activation level set in P8-15, in order for the drive to go into standby (sleep) mode.		
P8-16	**Standby Wake-Up Level**	**0.0%**	**53.0%**
	This parameter sets the DC Bus Voltage in % 1000V, above which the inverter will wake-up form standby (sleep) mode, start to run and increase the speed of the pump. 53.0% = 530Vdc		
P8-17	**Standby Wake-Up Delay Time**	**0.0s**	**30.0s**
	This parameter sets the delay time in seconds, which the standby wake-up condition must be present for before the drive will begin the wake-up sequence and exit standby (sleep) mode.		

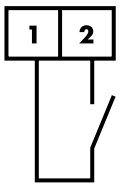
1.3.5. Optional Parameter Settings for Irradiance Sensor

Par.	Description	P2 Adjustment
P2-30	**Analogue Input Format**	**0-10V/4-20mA**
	This parameter defines the type of signal from the irradiation sensor.	
P8-14	**Standby Mode**	**2**
	This parameter selects the variables that causes the drive to go into standby (sleep) mode. By default, this parameter is set to 0 which means that standby mode is selected based on pump speed. A setting of 1 however, configures the drive to go into standby mode and 'wake-up' from this condition based on the voltage of the DC Bus. If a solar irradiation sensor is used then this setting should be changed to 2.	
P8-15	**Standby Activation Level**	**45.0%**
	This parameter sets the irradiation level in % of transducer range, below which the drive will decelerate the pump speed and enter Standby (sleep) mode.	
P8-16	**Standby Wake-Up Level**	**53.0%**
	This parameter sets the irradiation level in % of transducer range, above which the drive will exit standby (sleep) mode, start the pump and increase the speed.	
P8-17	**Standby Wake-Up Delay Time**	**30s**
	This parameter sets the delay time in seconds, which the standby wake-up condition must be present for before the drive will begin the wake-up sequence and exit standby (sleep) mode.	

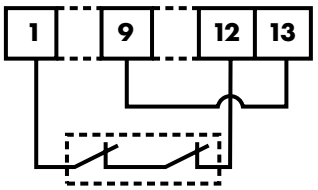
1.3.6. Minimum control wiring requirements

The P2 Solar Pump Drive is a very flexible product which can be controlled in a number of ways. In order to operate the drive as detailed in section 9. Serial communications, the drive will need the STO circuit to be closed (XREF STO section) and a drive enable provided to Digital Input 1 as shown below. Please note that if the STO function is not going to be used in the application, the wiring is still required and a link will be needed between terminals T1-T12 and T9-T13.

Control Terminals



Run/Stop
Link T1 to T2 to run and remove to stop



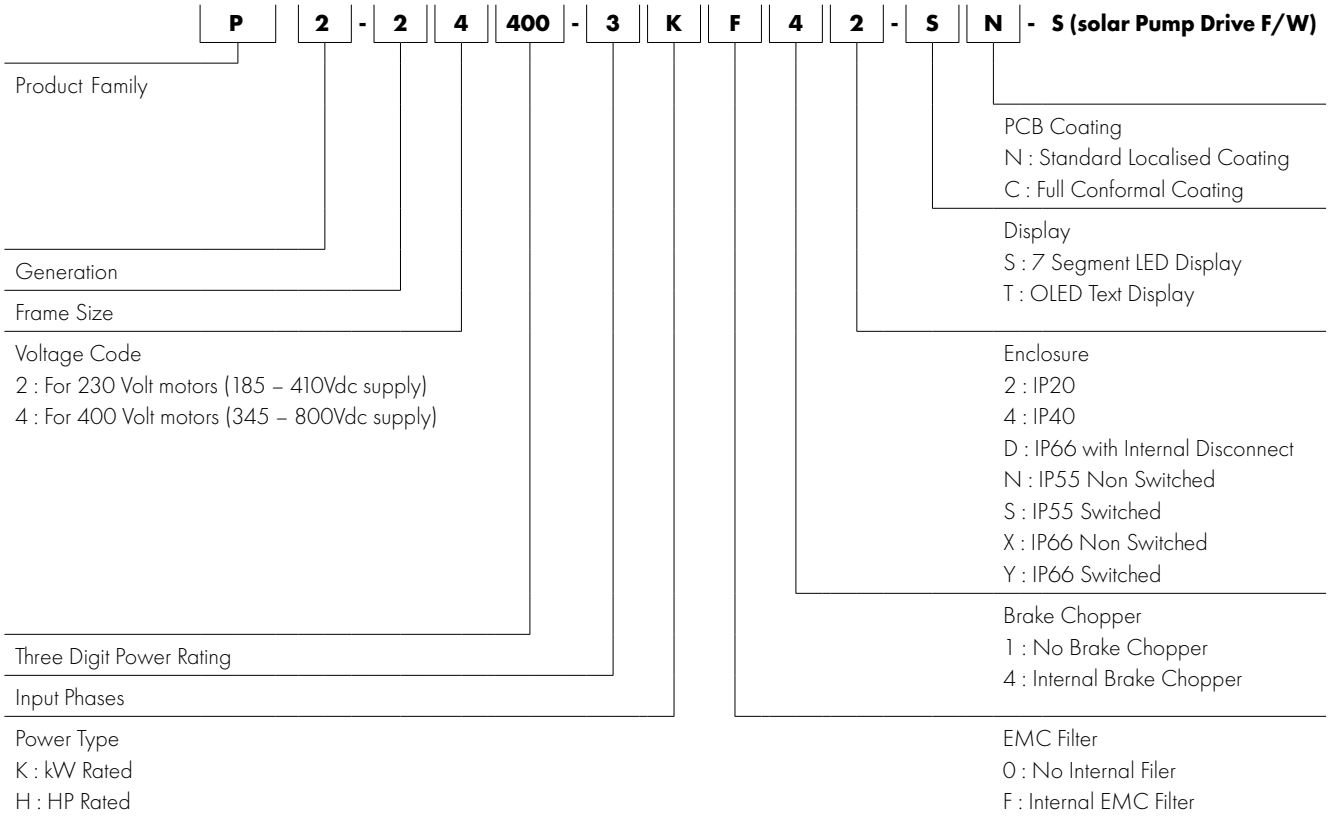
Mandatory Hardware Enable
The STO inputs can be used as a high integrity means of preventing torque being applied on the motor – section 4.11. If this function is not required, the terminals must be linked as illustrated.

2. General Information and Ratings

This chapter contains information about the P2 including how to identify the drive.

2.1. Identifying the Drive by Model Number

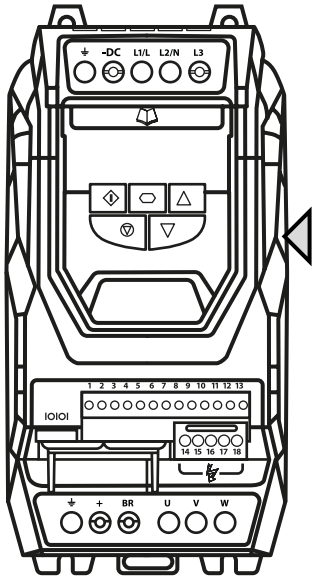
Each drive can be identified by its model number, as shown in the table below. The model number is on the shipping label and the drive nameplate. The model number includes the drive and any options.



2.2. Product Rating Label Location

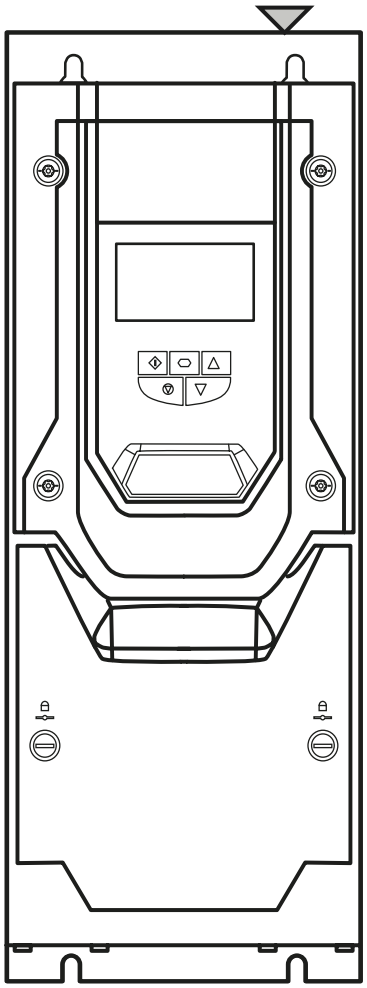
All P2 models carry a rating label, which can be located as follows:

IP20 Models



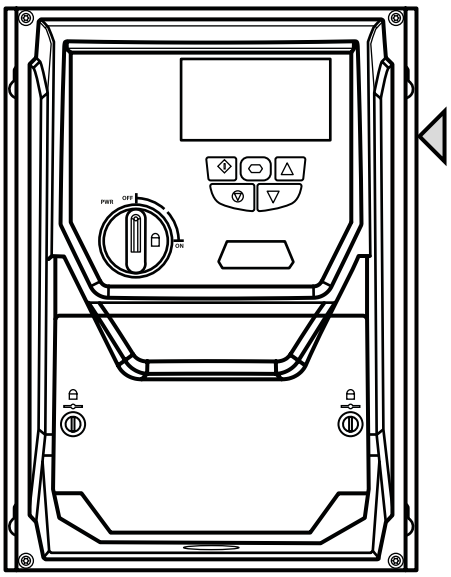
On right hand side when viewed from the front.

IP55 Models



On the top surface.

IP66 Models

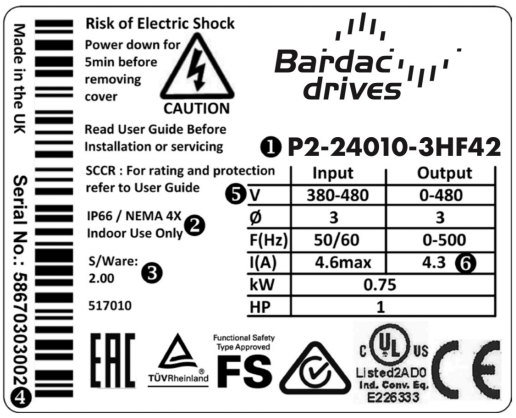


On right hand side when viewed from the front.

2.3. Understanding the Rating Label

The product rating label provides the following information.

	Key
1	Model Code
2	Enclosure Type and IP Rating
3	Firmware Version
4	Serial Number
5	Technical Data – Supply Voltage 200 – 240Vac = 185 – 410Vdc 380 – 480Vac = 345 – 800Vdc
6	Technical Data – Maximum continuous output current



2.4. Drive model numbers – IP20

Mechanical Dimensions and Mounting information are shown from section 3.4.1. IP20 Units on page 16.
Electrical Specifications are shown in section 10.2. Output Power and Current ratings on page 62.

200-240Vac motors / 185 – 410Vdc supply					
kW Model	**kW**	**HP Model**	**HP**	**Output Current (A)**	**Frame Size**
P2-22075-1KF42-S	0.75	P2-22010-1HF42-S	1	4.3	2
P2-22150-1KF42-S	1.5	P2-22020-1HF42-S	2	7	2
P2-22220-1KF42-S	2.2	P2-22030-1HF42-S	3	10.5	2
P2-22075-3KF42-S	0.75	P2-22010-3HF42-S	1	4.3	2
P2-22150-3KF42-S	1.5	P2-22020-3HF42-S	2	7	2
P2-22220-3KF42-S	2.2	P2-22030-3HF42-S	3	10.5	2
P2-32040-3KF42-S	4	P2-32050-3HF42-S	5	18	3
P2-32055-3KF42-S	5.5	P2-32075-3HF42-S	7.5	24	3
P2-42075-3KF42-S	7.5	P2-42100-3HF42-S	10	39	4
P2-42110-3KF42-S	11	P2-42150-3HF42-S	15	46	4
P2-52150-3KF42-S	15	P2-52020-3HF42-S	20	61	5
P2-52185-3KF42-S	18.5	P2-52025-3HF42-S	25	72	5
380-480Vac motors / 345 – 800Vdc supply					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
P2-24075-3KF42-S	0.75	P2-24010-3HF42-S	1	2.2	2
P2-24150-3KF42-S	1.5	P2-24020-3HF42-S	2	4.1	2
P2-24220-3KF42-S	2.2	P2-24030-3HF42-S	3	5.8	2
P2-24400-3KF42-S	4	P2-24050-3HF42-S	5	9.5	2
P2-34055-3KF42-S	5.5	P2-34075-3HF42-S	7.5	14	3
P2-34075-3KF42-S	7.5	P2-34100-3HF42-S	10	18	3
P2-34110-3KF42-S	11	P2-34150-3HF42-S	15	24	3
P2-44150-3KF42-S	15	P2-44200-3HF42-S	20	30	4
P2-44185-3KF42-S	18.5	P2-44250-3HF42-S	25	39	4
P2-44220-3KF42-S	22	P2-44300-3HF42-S	30	46	4
P2-54300-3KF42-S	30	P2-54040-3HF42-S	40	61	5
P2-54370-3KF42-S	37	P2-54050-3HF42-S	50	72	5
P2-84200-3KF42-S	200	P2-84300-3HF42-S	300	370	8
P2-84250-3KF42-S	250	P2-84350-3HF42-S	350	450	8

2.5. Drive model numbers – IP55

Mechanical dimensions and mounting information are shown from section 3.4.2. IP55 Units on page 17.
Electrical specifications are shown in section 10.2. Output Power and Current ratings on page 62.

200-240Vac motors / 185 – 410Vdc supply					
kW Model	**kW**	**HP Model**	**HP**	**Output Current (A)**	**Frame Size**
P2-42055-3KF4N-S	5.5	P2-42075-3HF4N-S	7.5	24	4
P2-42075-3KF4N-S	7.5	P2-42100-3HF4N-S	10	39	4
P2-42110-3KF4N-S	11	P2-42150-3HF4N-S	15	46	4
P2-52150-3KF4N-S	15	P2-52020-3HF4N-S	20	61	5
P2-52185-3KF4N-S	18.5	P2-52025-3HF4N-S	25	72	5
P2-62022-3KF#N-S	22	P2-62030-3HF#N-S	30	90	6
P2-62030-3KF#N-S	30	P2-62040-3HF#N-S	40	110	6
P2-62037-3KF#N-S	37	P2-62050-3HF#N-S	50	150	6
P2-62045-3KF#N-S	45	P2-62060-3HF#N-S	60	180	6
P2-72055-3KF#N-S	55	P2-72075-3HF#N-S	75	202	7
P2-72075-3KF#N-S	75	P2-72100-3HF#N-S	100	248	7

380-480Vac motors / 345 – 800Vdc supply					
kW Model Number	**kW**	**HP Model Number**	**HP**	**Output Current (A)**	**Frame Size**
P2-44110-3KF4N-S	11	P2-44150-3HF4N-S	15	24	4
P2-44150-3KF4N-S	15	P2-44200-3HF4N-S	20	30	4
P2-44185-3KF4N-S	18.5	P2-44250-3HF4N-S	25	39	4
P2-44220-3KF4N-S	22	P2-44300-3HF4N-S	30	46	4
P2-54300-3KF4N-S	30	P2-54040-3HF4N-S	40	61	5
P2-54370-3KF4N-S	37	P2-54050-3HF4N-S	50	72	5
P2-64045-3KF#N-S	45	P2-64060-3HF#N-S	60	90	6
P2-64055-3KF#N-S	55	P2-64075-3HF#N-S	75	110	6
P2-64075-3KF#N-S	75	P2-64120-3HF#N-S	120	150	6
P2-64090-3KF#N-S	90	P2-64150-3HF#N-S	150	180	6
P2-74110-3KF#N-S	110	P2-74175-3HF#N-S	175	202	7
P2-74132-3KF#N-S	132	P2-74200-3HF#N-S	200	240	7
P2-74160-3KF#N-S	160	P2-74250-3HF#N-S	250	302	7

2.6. Drive model numbers – IP66

Mechanical dimensions and mounting information are shown from section 3.4.3. IP66 Units on page 18.
Electrical specifications are shown in section 10.2. Output Power and Current ratings on page 62.

200-240Vac motors / 185 – 410Vdc supply							
kW Model Number		**kW**	**HP Model Number**		**HP**	**Output Current (A)**	**Frame Size**
Non Switched	**Switched**		**Non Switched**	**Switched**			
P2-22075-1KF4X-S	P2-22075-1KF4Y-S	0.75	P2-22010-1HF4X-S	P2-22010-1HF4Y-S	1	4.3	2
P2-22150-1KF4X-S	P2-22150-1KF4Y-S	1.5	P2-22020-1HF4X-S	P2-22020-1HF4Y-S	2	7	2
P2-22220-1KF4X-S	P2-22220-1KF4Y-S	2.2	P2-22030-1HF4X-S	P2-22030-1HF4Y-S	3	10.5	2
P2-22075-3KF4X-S	P2-22075-3KF4Y-S	0.75	P2-12010-3HF4X-S	P2-22010-3HF4Y-S	1	4.3	2
P2-22150-3KF4X-S	P2-22150-3KF4Y-S	1.5	P2-22020-3HF4X-S	P2-22020-3HF4Y-S	2	7	2
P2-22220-3KF4X-S	P2-22220-3KF4Y-S	2.2	P2-22030-3HF4X-S	P2-22030-3HF4Y-S	3	10.5	2
P2-32040-3KF4X-S	P2-32040-3KF4Y-S	4	P2-32050-3HF4X-S	P2-32050-3HF4Y-S	5	18	3

380-480Vac motors / 345 – 800Vdc supply							
kW Model Number		**kW**	**HP Model Number**		**HP**	**Output Current (A)**	**Frame Size**
Non Switched	**Switched**		**Non Switched**	**Switched**			
P2-24075-3KF4X-S	P2-24075-3KF4Y-S	0.75	P2-24010-3HF4X-S	P2-24010-3HF4Y-S	1	2.2	2
P2-24150-3KF4X-S	P2-24150-3KF4Y-S	1.5	P2-24020-3HF4X-S	P2-24020-3HF4Y-S	2	4.1	2
P2-24220-3KF4X-S	P2-24220-3KF4Y-S	2.2	P2-24030-3HF4X-S	P2-24030-3HF4Y-S	3	5.8	2
P2-24400-3KF4X-S	P2-24400-3KF4Y-S	4	P2-24050-3HF4X-S	P2-24050-3HF4Y-S	5	9.5	2
P2-34055-3KF4X-S	P2-34055-3KF4Y-S	5.5	P2-34075-3HF4X-S	P2-34075-3HF4Y-S	7.5	14	3
P2-34075-3KF4X-S	P2-34075-3KF4Y-S	7.5	P2-34100-3HF4X-S	P2-34100-3HF4Y-S	10	18	3

3. Mechanical Installation

3.1. General

- The P2 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 P2 must be installed in a pollution degree 1 or 2 environment only.
- Do not mount flammable material close to the P2.
- Ensure that the minimum cooling air gaps, as detailed in sections 3.5. Guidelines for Enclosure mounting (IP20 Units), 3.7. Guidelines for mounting (IP55 Units) and 3.8. Guidelines for mounting (IP66 Units) – are left clear.
- Ensure that the ambient temperature range does not exceed the permissible limits for the P2 given in section 10.1. Environmental
- Provide suitable clean, moisture and contaminant free cooling air sufficient to fulfill the cooling requirements of the P2.

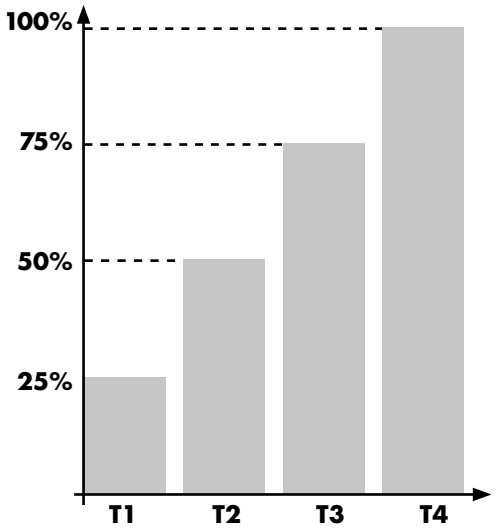
3.2. Before Installation

- Carefully Unpack the P2 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 P2 in its original box until required. Storage should be clean and dry and within the temperature range –40°C to +60°C

3.3. Installation Following a Period of Storage

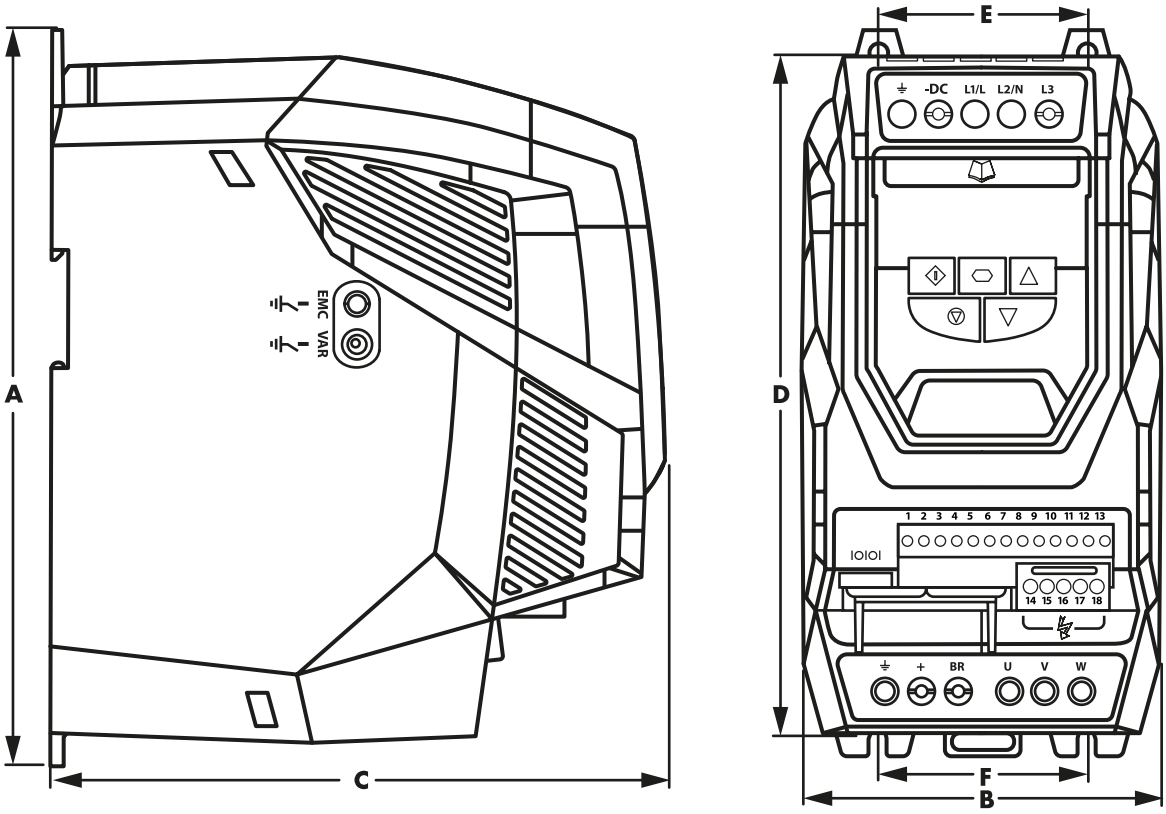
Where the drive has been stored for some time prior to installation, or has remained without the main power supply not present for an extended period of time, it is necesary to reform the DC capacitors within the drive according to the following table before operation. For drives which have not been connected to the main power supply for a period of more than 2 years, this requires a reduced mains voltage mains voltage to be applied for a time period, and gradually increased prior to oeprating the drive. The voltage levels relative to the drive rated voltage, and the time periods for which they must be applied are shown in the following table. Following completion of the procedure, the drive may be operated as normal.

Storage Period / Power-OFF Period	Initial Input Voltage Level	Time Period T1	Secondary Input Voltage Level	Time Period T2	Third Input Voltage Level	Time Period T3	Final Input Voltage Level	Time Period T4
Up to 1 Year	100%	N/A						
1 – 2 Years	100%	1 Hour	N/A					
2 – 3 Years	25%	30 Minutes	50%	30 Minutes	75%	30 Minutes	100%	30 Minutes
More than 3 Years	25%	2 Hours	50%	2 Hours	75%	2 Hours	100%	2 Hours



3.4. Mechanical dimensions and weight

3.4.1. IP20 Units

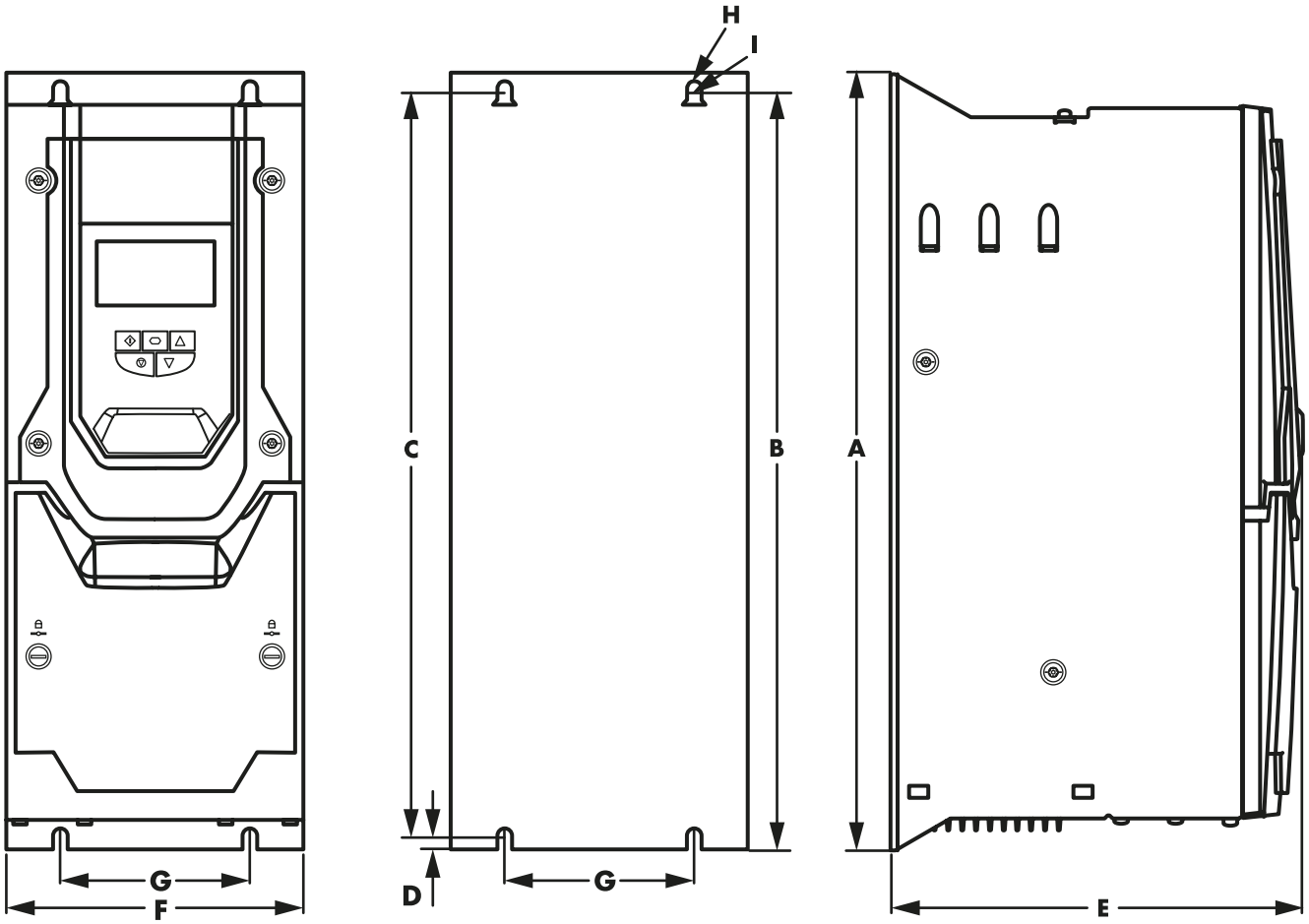


Drive Size	A		B		C		D		E		F		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	Kg	lb
2	221	8.70	110	4.33	185	7.28	209	8.23	63	2.48	63	2.48	1.8	4.0
3	261	10.28	131	5.16	205	8.07	247	9.72	80	3.15	80	3.15	3.5	7.7
4	418	16.46	160	6.30	240	9.45	400	15.75	125	4.92	125	4.92	9.2	20.3
5	486	19.13	222	8.74	260	10.24	460	18.11	175	6.89	175	6.89	18.1	39.9

Mounting Bolts		
Frame Size	Metric	UNF
2	M4	#8
3	M4	#8
4	M8	5/16
5	M8	5/16

Tightening Torques			
	Frame Size	Required Torque	
Control Terminals	All	0.5 Nm	4.5 lb-in
Power Terminals	2 & 3	1 Nm	9 lb-in
	4	2 Nm	18 lb-in
	5	4 Nm	35.5 lb-in

3.4.2. IP55 Units

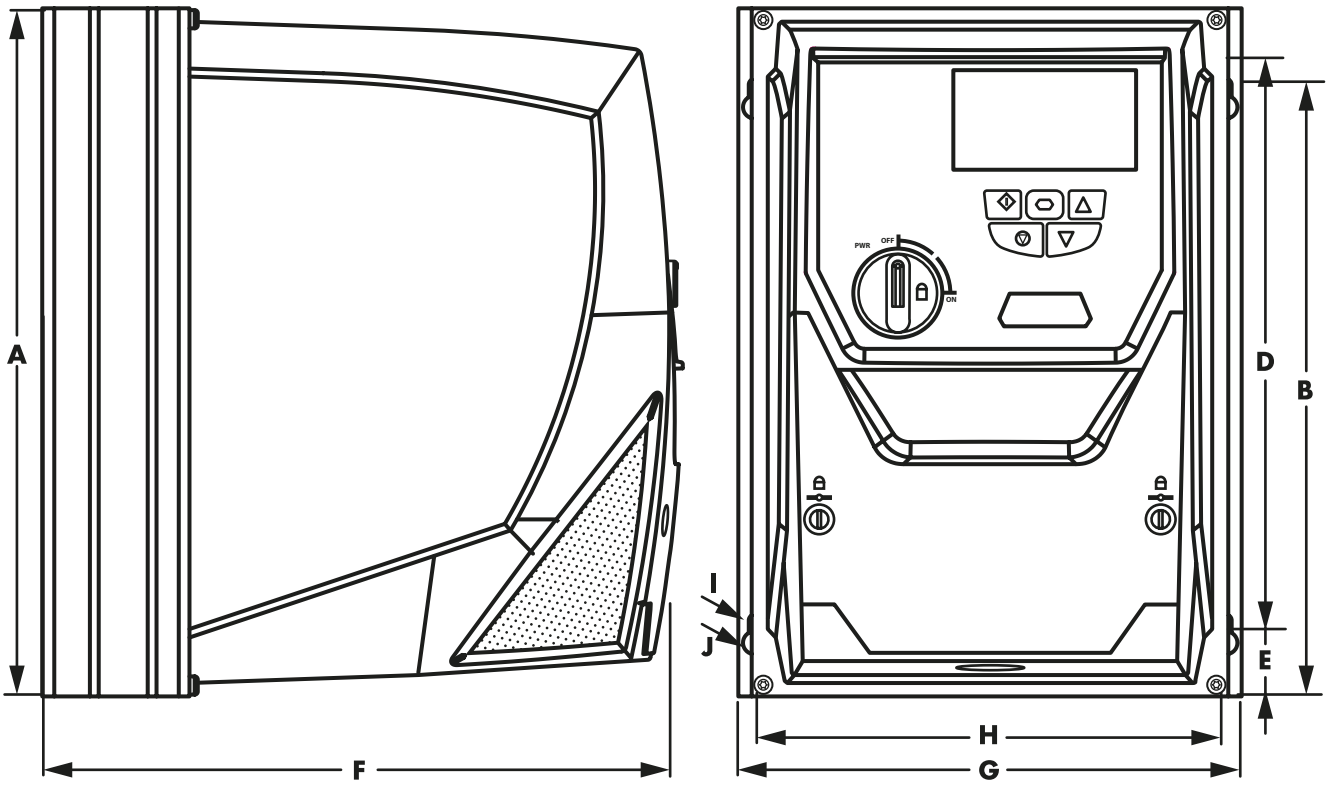


Drive Size	A		B		D		E		F		G		H		I		J		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	kg	lb
4	450	17.72	428	16.85	433	17.05	8	0.31	252	9.92	171	6.73	110	4.33	4.25	0.17	7.5	0.30	11.5	25.4
5	540	21.26	515	20.28	520	20.47	8	0.31	270	10.63	235	9.25	175	6.89	4.25	0.17	7.5	0.30	23	50.7
6	865	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	55	121.2
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	89	196.2

Mounting Bolts		
Frame Size	**Metric**	**UNF**
4	M8	#8
5	M8	#8
6	M10	5/16
7	M10	5/16

Tightening Torques			
	Frame Size	**Required Torque**	
Control Terminals	All	0.5 Nm	4.5 lb-in
Power Terminals	4	2 Nm	18 lb-in
	5	4 Nm	35.5 lb-in
	6	15 Nm	11 lb-ft
	7	15 Nm	11 lb-ft

3.4.3. IP66 Units



Drive Size	A		B		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	kg	lb
2	257	10.12	220	8.66	200	7.87	29	1.12	239	9.41	188	7.40	178	7.01	4.2	0.17	8.5	0.33	4.8	10.6
3	310	12.20	277	10.89	252	9.90	33	1.31	266	10.47	211	8.29	200	7.87	4.2	0.17	8.5	0.33	7.7	16.8

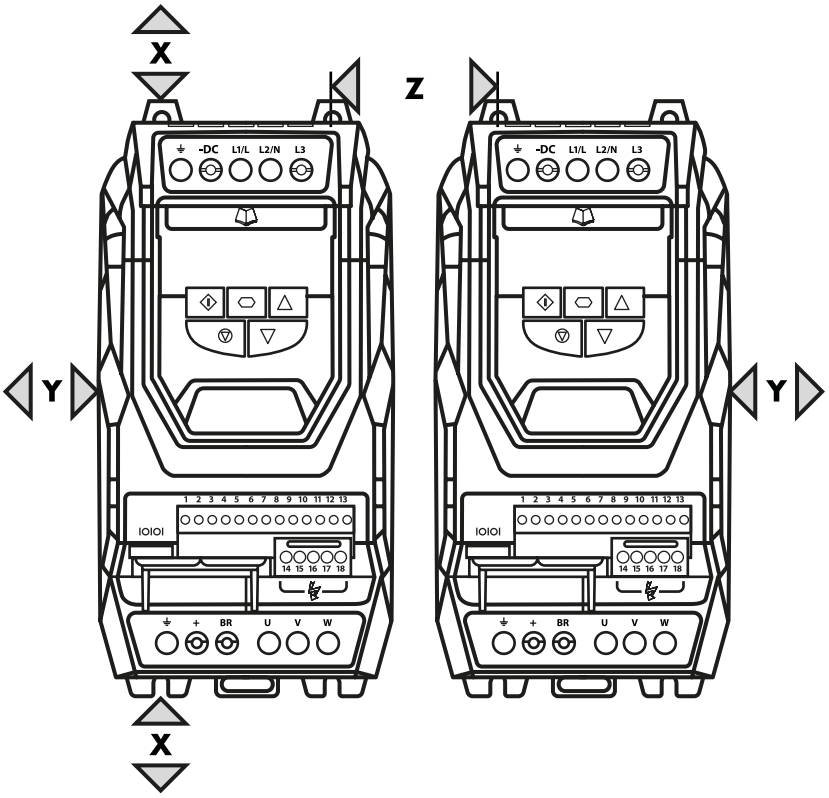
Mounting Bolts		
Frame Size	Metric	UNF
2	M4	#8
3	M4	#8

Tightening Torques			
	Frame Size	Required Torque	
Control Terminals	All	0.5 Nm	4.5 lb-in
Power Terminals	2 & 3	1 Nm	9 lb-in

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 P2 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. Bardac Drives recommends 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	m3/min	CFM
2	75	2.95	10	0.39	46	1.81	0.3	11
3	100	3.94	10	0.39	52	2.05	0.9	31
4	200	7.87	25	0.98	70	2.76	1.7	62
5	200	7.87	25	0.98	70	2.76	2.9	104
8	300	11.81	100	3.94			20	705

NOTE

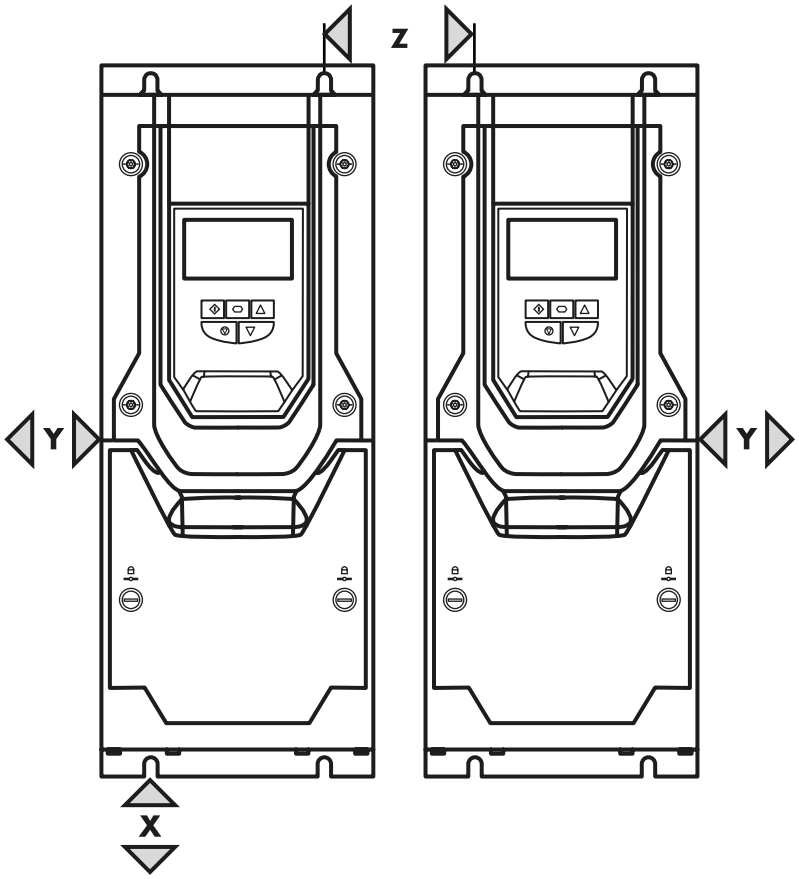
Dimension Z assumes that the drives are mounted side-by-side with no clearance.
Typical drive heat losses are <3% of operating load conditions.
Above are guidelines only and the operating ambient temperature of the drive MUST be maintained at all times.

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 10.1. Environmental on page 62.
- 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
4	200	7.87	10	0.39
5	200	7.87	10	0.39
6	200	7.87	10	0.39
7	200	7.87	10	0.39

NOTE

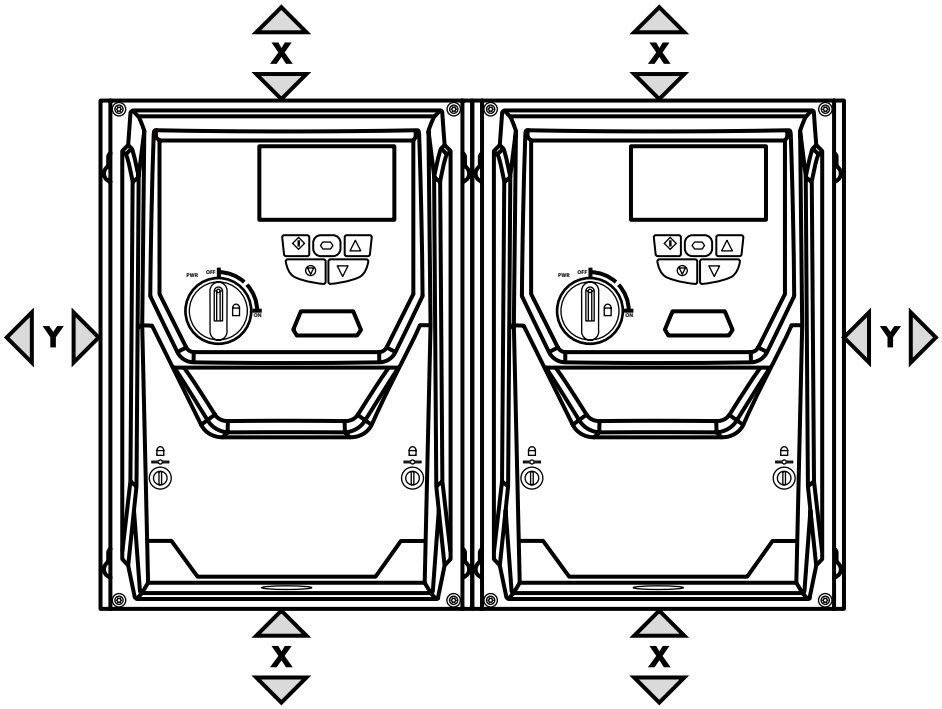
Typical drive heat losses are approximately 3% of operating load conditions.

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

- 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 10.1. Environmental
- 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
- 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.



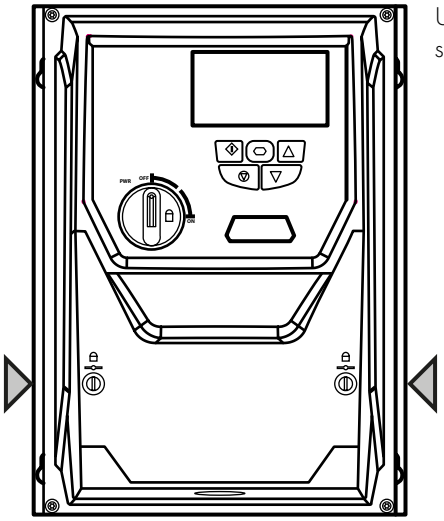
Drive Size	X Above & Below		Y Either Side	
	mm	in	mm	in
2	200	7.87	10	0.39
3	200	7.87	10	0.39

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)

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.

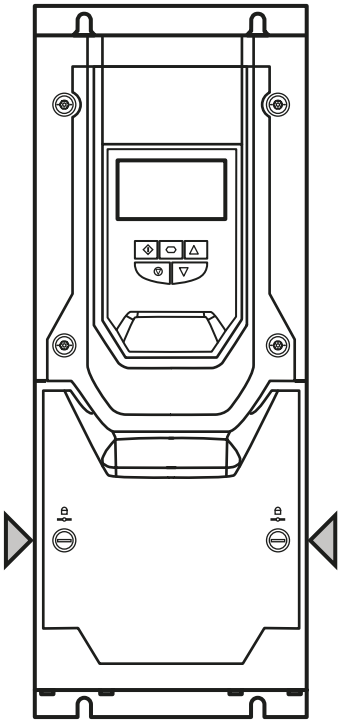
3.9. Removing the Terminal Cover

3.9.1. Frame Sizes 2 & 3



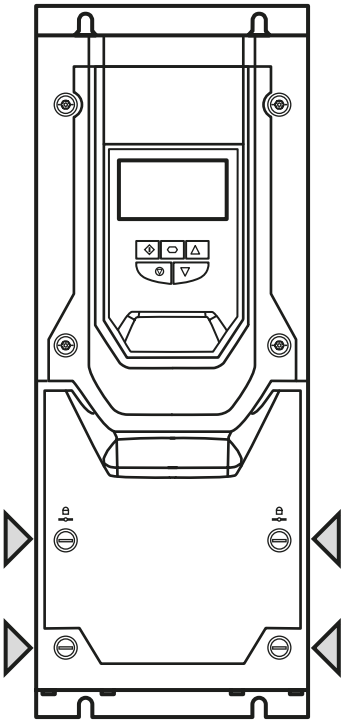
Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical.

3.9.2. Frame Size 4



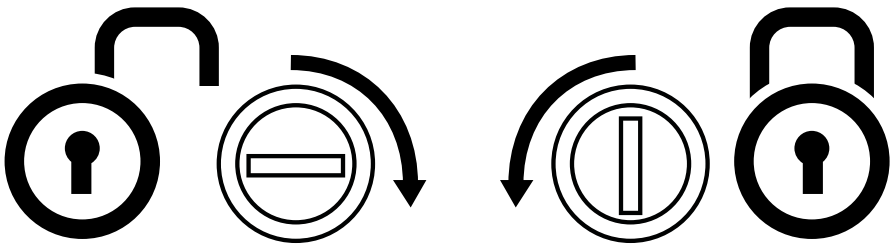
Using a suitable flat blade screwdriver, rotate the two retaining screws indicated until the screw slot is vertical.

3.9.3. Frame Size 5

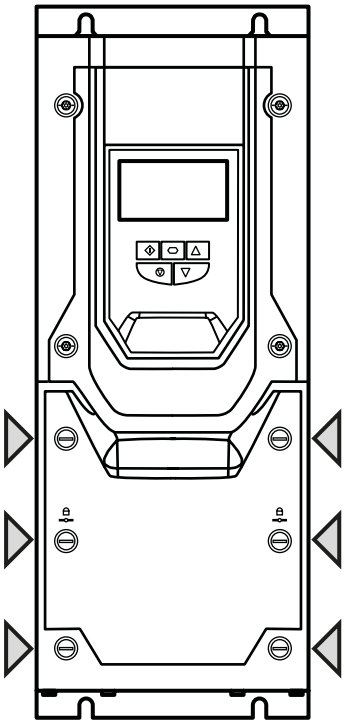


Using a suitable flat blade screwdriver, rotate the four retaining screws indicated until the screw slot is vertical.

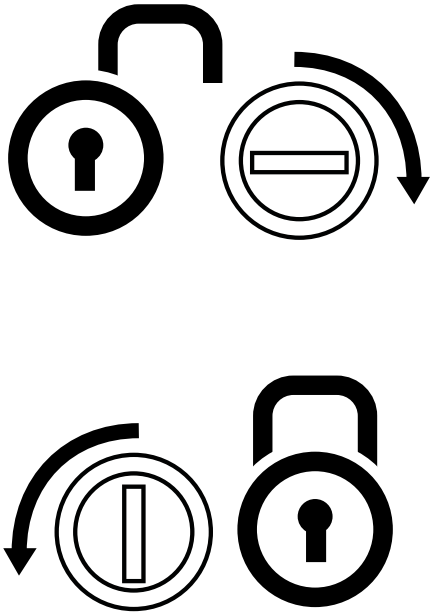
Terminal Cover Release Screws



3.9.4. Frame Sizes 6 & 7



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



3.10. 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 section 10.1. Environmental.
- 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.

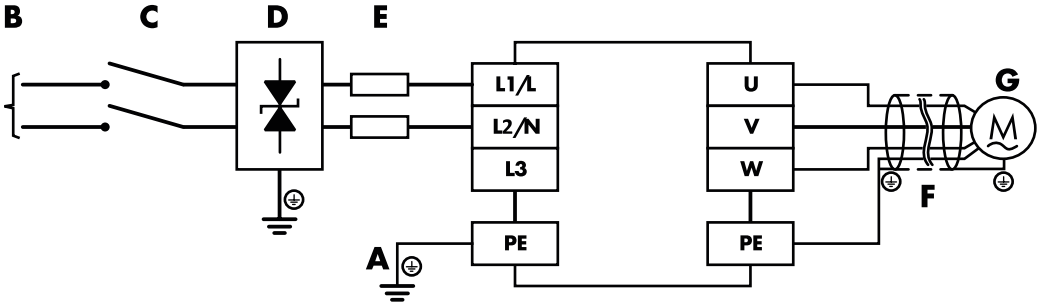
Checks should also be made on all electrical connections, ensuring screw terminals are correctly torqued; and that power cables have no signs of heat damage.

4. Electrical Installation

4.1. Connection Diagram

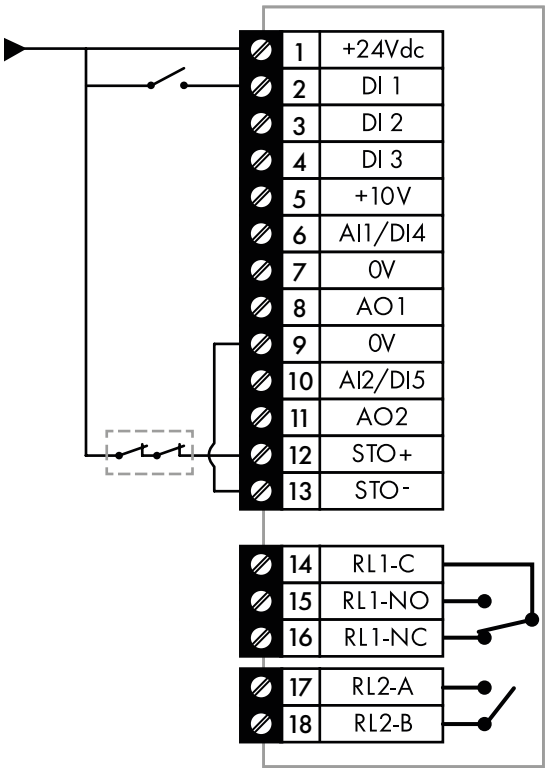
All power terminal locations are marked directly on the product. IP20 Frame Size 2 – 4 units have AC/DC power input located at the top with the motor and brake resistor connections located at the bottom. All other units have power terminals located at the bottom.

4.1.1. Electrical Power connections



Key		Page
A	4.2. Protective Earth (PE) Connection	25
B	4.3. Incoming Power Connection	25
C	4.3 DC Isolator / Disconnect	19
D	Surge Suppression Device	
E	4.3.3. Fuse / Circuit Breaker Selection	26
F	4.10. EMC Compliant Installation	29
G	4.4. Motor Connection	26

4.1.2. Control Connections



Key			Sec.	Page
1	+24V	24 Volt DC Input / Output	4.7.1	27
2	DI1	Digital Input 1 (Run Enable)	4.7.2	27
3	DI2	Digital Input 2		
4	DI3	Digital Input 3		
5	+10V	+10Volt DC Output		
6	AI1 / DI4	Analog Input 1 / Digital Input 4	4.7.3	27
7	0V	0 Volt Common		
8	AO1	Analog Output 1	4.7.4	27
9	0V	0 Volt Common		
10	AI2 / DI5	Analog Input 2 / Digital Input 5	4.7.3	27
11	AO2	Analog Output 2	4.7.4	27
12	STO+	STO + 24VDC Connection	4.11	30
13	STO-	STO 0 Volt Connection		
14	RL1-C	Relay Output 1 Common	4.7.5	27
15	RL1-NO	Relay Output 1 Normally Open		
16	RL1-NC	Relay Output 2 Normally Closed		
17	RL2-A	Relay Output 2		
18	RL2-B	Relay Output 2		

4.2. Protective Earth (PE) Connection

4.2.1. Grounding Guidelines and Lightning Protection

Adequate safety earthing must be provided in accordance with local wiring rules and codes of practice. The ground terminal of each P2 should be connected back to the common safety earth to maintain touch potentials within safe limits. The ground terminal of each P2 should be individually connected DIRECTLY to the site ground bus bar (or Ground Rod). P2 ground connections should not loop from one drive to another, or to, or from any other equipment. Ground impedance must conform to local safety regulations and/or electrical codes.

To meet UL regulations, UL approved ring crimp terminals should be used for all ground wiring connections.

The integrity of all ground connections should be checked periodically.

4.2.2. Protective Earth Conductor

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

4.2.3. Motor Ground

The driven motor must be locally connected to a suitable ground location to maintain touch potentials within safe limits. In addition, the motor ground must be connected to one of the ground terminals on the drive.

4.2.4. Ground Fault Monitoring

As with all inverters, a leakage current to earth can exist. The P2 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 P2

4.2.5. 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.

4.2.6. Lightning Protection

Surges induced by lightning are one of the most common causes of failure of the electronics associated with solar pumping systems. A direct lightning strike would be seen as a very rare event but lightning strikes occurring some distance away from the system can cause very high electrical fields which can be problematic if not addressed properly.

It is always advisable to ensure that the frames supporting the PV Panels is suitably grounded (earthed) which can provide a low impedance discharge path to ground (earth) for any induced voltages. In any dry or rocky locations, the grounding rods/cables should be placed deeper and consideration should be made to this requirement during any excavation phases when preparing the site.

It is also recommended to place a suitable PV surge suppression device for the DC-Side. These are often incorporated in the string combiner boxes (if used) but should be selected according to the inverter Max Voc Voltage.

4.3. Incoming Power Connection

4.3.1. Suitability

All P2 Solar Drive models are designed for use on a dc supply, single phase ac supply or balanced three phase ac supply depending on the model. For all models and ratings when working with an IT Supply network, or any power supply type where the phase to earth voltage may exceed the phase to phase voltage (such as ungrounded supplies), the internal EMC filter and surge protection must be disconnected before connecting the supply.

4.3.2. Cable Selection

- For 1 phase ac supply, power should be connected to L1/L, L2/N.
- For a DC Supply, the main power cables should be connected to L1/L, L2/N.
- For 3 phase ac supplies, the mains power cables should be connected to L1, L2, and L3. Phase sequence is not important. Neutral connection is not required.

For compliance with CE and C Tick EMC requirements, refer to section 4.10. EMC Compliant Installation on page 29.

- A fixed installation is required according to IEC61800-5-1 with a suitable disconnecting device installed between the P2 and the main 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 dimensioned according to any local codes or regulations. Maximum dimensions for each drive model are given in section 10.2. Output Power and Current ratings on page 62.

4.3.3. Fuse / Circuit Breaker Selection

- Suitable fuses to provide wiring protection of the input power cable should be installed in the incoming supply line, according to the data in section 10.2. Output Power and Current ratings on page 62.
- The fuses must comply with any local codes or regulations in place. In general, type gG (IEC 60269) or UL type J fuses are suitable; however in some cases type aR fuses may be required. The operating time of the fuses must be below 0.5 seconds.
- Where allowed by local regulations, suitably dimensioned type B MCB circuit breakers of equivalent rating may be utilised in place of fuses, providing that the clearing capacity is sufficient for the installation.
- The maximum permissible short circuit current at the P2 Power terminals as defined in IEC60439-1 is 100kA.
- The P2 provides thermal and short circuit protection for the connected motor and motor cable.

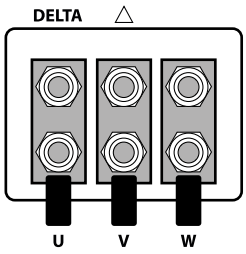
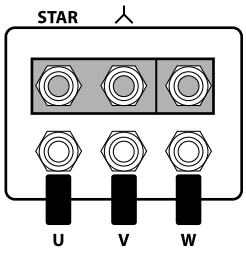
4.4. Motor Connection

- 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 P2 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 P2 earth terminals to provide a low impedance path for common mode leakage current to return to the drive. This is best achieved in practice by using a cable with suitable shielding which provides a low impedance path at high frequencies, and ensuring correct, low impedance earth bonding of the motor cable at both ends. For further information, refer to section 4.10. EMC Compliant Installation on page 29.

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. 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 – 2.5mm2 / 30 – 12 AWG.

4.7. Control Terminal Connections

Exsample connection schematics are provided in section 7.3 Example Connection Schematics on page 37.

4.7.1. +24VDC Input / Output

When the mains power is applied to the drive, terminal 1 provides a +24VDC output, maximum load 100mA. This may be used to activate digital inputs or provide power to sensors.

When no mains power is applied to the drive, the drive control electronics may be powered from an external +24VDC source. When powered in this way, all analog and digital I/O and communication functions remain operative, however the motor may not be operated, which allows safe testing and commissioning of the installation without risk of high voltage being present. When powered in this way, the drive requires up to 100mA.

4.7.2. Digital Inputs

Up to five digital inputs are available. The function of the inputs is defined by parameters P1-12 and P1-13, which are explained in section 7. Control Terminal Functions on page 40.

4.7.3. Analog Inputs

Two analog inputs are available, which may also be used as digital Inputs if required. The signal formats are selected by parameters as follows

- Analog Input 1 Format Selection Parameter P2-30
- Analog Input 2 Format Selection Parameter P2-33

These parameters are described more fully in section 8.1. Parameter Group 2 - Extended parameters on page 43.

The function of the analog input, e.g. for speed reference or PID feedback for example is defined by parameters P1-12 and P1-13. The function of these parameters and available options are described in section 7. Control Terminal Functions on page 40.

4.7.4. Analog Outputs

Two analog outputs are available, and may be used for 0 – 10 Volt Signal (max load 20mA), 0 – 20mA, 4 – 20mA or a digital +24Volt DC, 20mA output. The parameters to select function and format are as follows.

Analog Input	Function selected by	Format Selected by
Analog Input 1	P2-11	P2-12
Analog Input 2	P2-13	P2-14

These parameters are described more fully in section 8.1. Parameter Group 2 - Extended parameters on page 43.

4.7.5. Relay Outputs

Two relay outputs are available, which may be used to switch external loads up to 5A at 230 VAC or 6A at 30VDC.

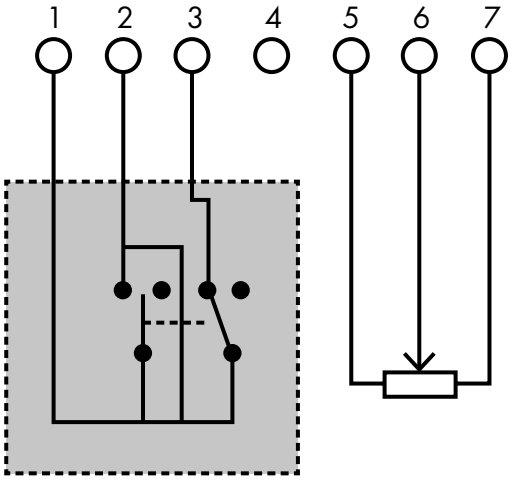
Relay 1 has both normally open and normally closed contacts available. Relay 2 provides a simple open or closed contact.

The relay output function may be configured using parameters P2-15 and P2-18, which are described in section 8.1. Parameter Group 2 - Extended parameters on page 43.

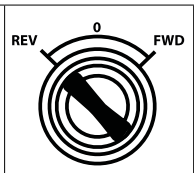
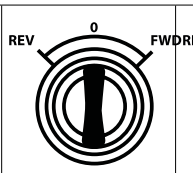
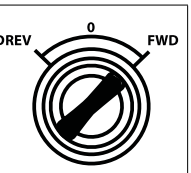
4.8. IP66 Switched Version Integrated Control Switch and Potentiometer Wiring

P2 is optionally available with an integrated mains disconnect / isolator and front mounted control switch and potentiometer. This allows the drive to be operated directly from the front control panel, whilst also providing for options such as Hand / Auto or Local / Remote Control etc.

The built in switch and pot are wired inside the terminal cover directly to the user control terminals as shown in the diagram below. These connections may be disconnected by the user if they are not required.



The control switch activates the first two digital inputs as follows:

Switch Position			
DI1	ON	OFF	ON
DI2	ON	ON	OFF

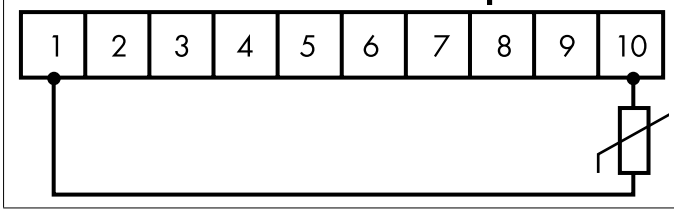
4.9. Motor Thermal overload Protection

4.9.1. 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-08 for a sustained period of time (e.g. 150% for 60 seconds).

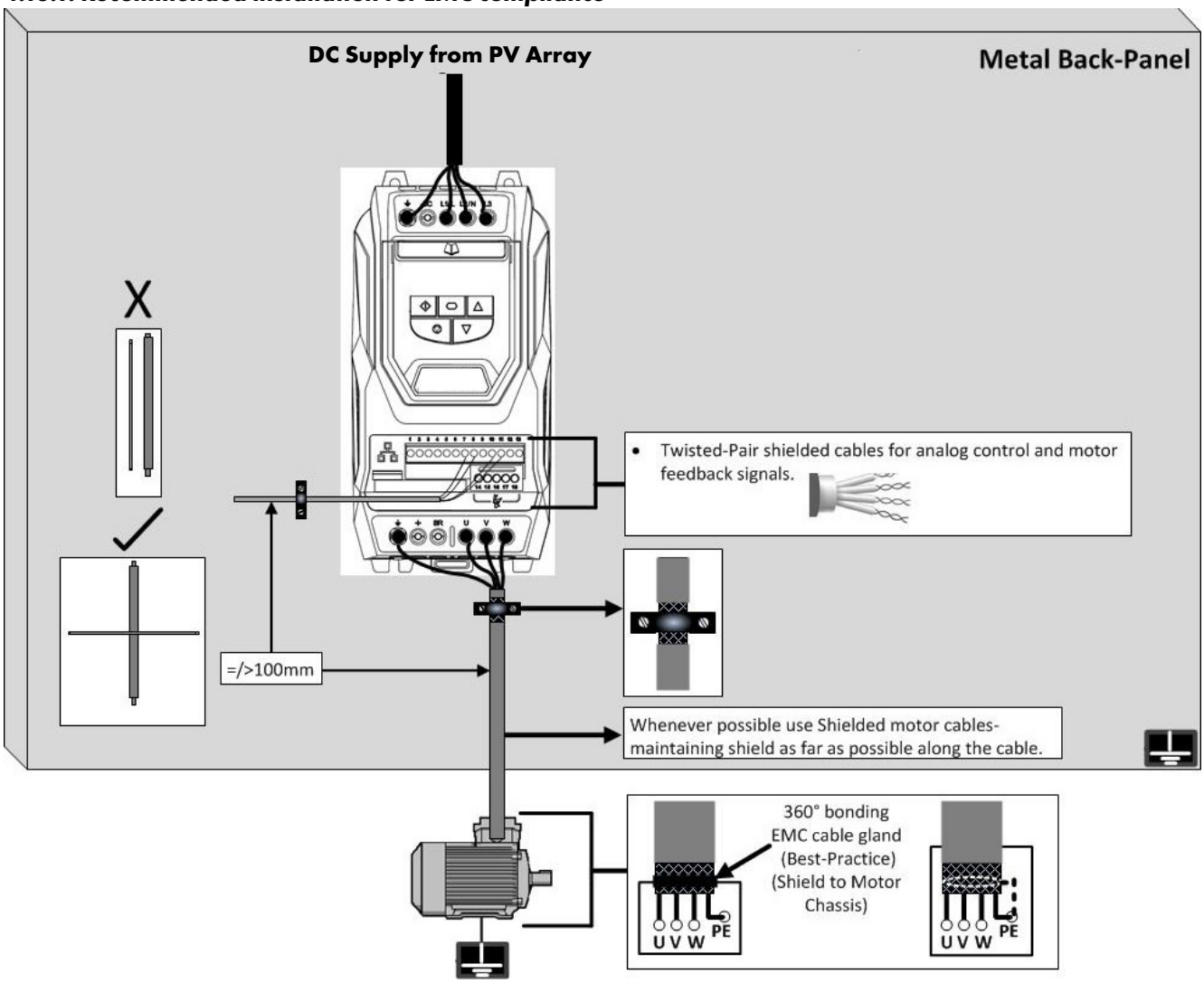
4.9.2. Motor Thermistor Connection

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

Control Motor Strip	Additional Information
Control Terminal Strip 	▪ Compatible Thermistor : PTC Type, 2.5kΩ trip level ▪ Use a setting of P1-13 that has Input 5 function as E-TRIP "External Trip", e.g. P1-13 = 6. Refer to section 7.2. Digital Input Configuration Parameter P1-13 on page 42 for further details. ▪ Enable the Motor PTC Thermistor Input function in parameter P2-33

4.10. EMC Compliant Installation

4.10.1. Recommended installation for EMC compliance



4.10.2. Recommended Cable Types by EMC Category

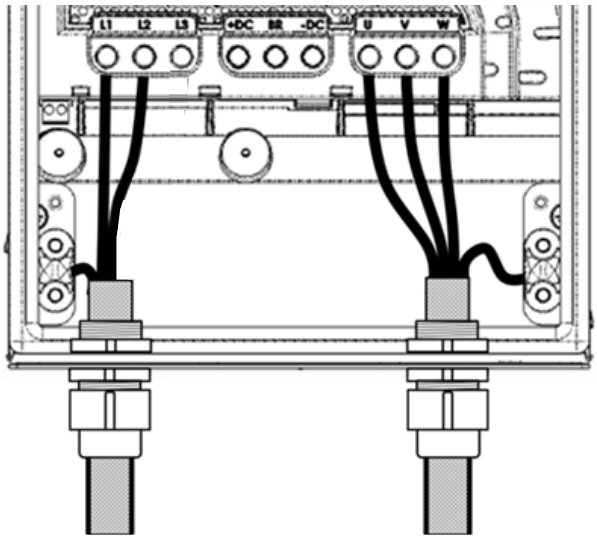
Category	Supply Cable Type	Motor Cable Type	Control Cables	Maximum Permissible Motor Cable Length
C1[6,7,8]	Shielded[1]	Shielded[1,5]	Shielded[4]	1M / 5M[9]
C2[8]	Shielded[2]	Shielded[1, 5]		5M / 25M[9]
C3[8]	Unshielded[3]	Shielded[2]		25M / 100M[9]

1. A screened (shielded) cable suitable for fixed installation with the relevant mains voltage in use. 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. Installation of a standard cable within a suitable steel or copper tube is also acceptable.
2. A cable suitable for fixed installation with relevant mains voltage with a concentric protection wire. Installation of a standard cable within a suitable steel or copper tube is also acceptable.
3. A cable suitable for fixed installation with relevant mains voltage. A shielded type cable is not necessary.
4. A shielded cable with low impedance shield. Twisted pair cable is recommended for analog signals.
5. The cable shield should be terminated at the motor end using an EMC type gland allowing connection to the motor body through the largest possible surface area. The shield must also be terminated at the drive end, as close as practically possible to the drive output terminals. Where drives are mounted in a steel control panel enclosure, the cable screen may be terminated directly to the control panel backplate using a suitable EMC clamp or gland fitted as close to the drive as possible. The drive earth terminal must also be connected directly to this point, using a suitable cable which provides low impedance to high frequency currents. For IP55 and IP66 drives, connect the motor cable shield to the gland plate or internal ground clamp.

6. 230 Volt, 1 phase input drives using internal EMC filter. Other models require external EMC filter.
7. Compliance with category C1 conducted emissions only is achieved. For compliance with category C1 radiated emissions, additional measures may be required, contact your Sales Partner for further assistance.
8. EMC categories for drives with internal filter EMC filter and rated voltage less than 480 Volts. For other drives, additional EMC filtering is required.
9. Permissible cable length with additional external EMC filter.

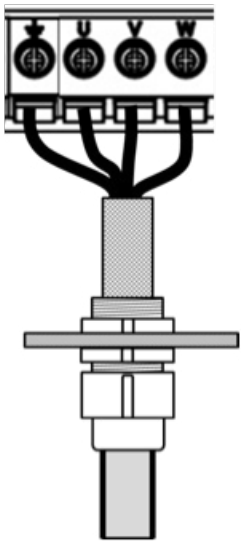
4.10.3. Enclosed Drives Recommended Cable Connections

IP55



Shield Drain Wire

IP66



4.11. Safe Torque Off

Safe Torque OFF will be referred to as "STO" through the remainder of this section.

Note: If the 'Safe Torque Off' funtion is not required, then you must link out of the terminals to enable the drive as shown in section 1.3.6. Minimum control wiring requirements.

4.11.1. Responsibilities

The overall system designer is responsible for defining the requirements of the overall "Safety Control System" within which the drive will be incorporated; furthermore the system designer is responsible for ensuring that the complete system is risk assessed and that the "Safety control System" requirements have been entirely met and that the function is fully verified, this must include confirmation testing of the "STO" function before drive commissioning.

The system designer shall determine the possible risks and hazards within the system by carrying out a thorough risk and hazard analysis, the outcome of the analysis should provide an estimate of the possible hazards, furthermore determine the risk levels and identify any needs for risk reduction. The "STO" function should be evaluated to ensure it can sufficiently meet the risk level required.

4.11.2. What STO Provides

The purpose of the "STO" function is to provide a method of preventing the drive from creating torque in the motor in the absence of the "STO" input signals (Terminal 12 with respect to Terminal 13), this allows the drive to be incorporated into a complete safety control system where "STO" requirements need to be fulfilled.[1]

The "STO" function can typically eliminate the need for electro-mechanical contactors with cross-checking auxiliary contacts as per normally required to provide safety functions.[2]

The drive has the "STO" function built-in as standard and complies with the definition of "Safe torque off" as defined by IEC 61800-5-2:2007.

The "STO" function also corresponds to an uncontrolled stop in accordance with category 0 (Emergency Off), of IEC 60204-1. This means that the motor will coast to a stop when the "STO" function is activated, this method of stopping should be confirmed as being acceptable to the system the motor is driving.

The "STO" function is recognised as a fail-safe method even in the case where the "STO" signal is absent and a single fault within the drive has occurred, the drive has been proven in respect of this by meeting the following safety standards :

	SIL (Safety Integrity Level)	PFHD (Probability of dangerous Failures per Hour)	SFF (Safe failure fraction %)	Lifetime assumed
EN 61800-5-2	2	1.23E-09 1/h (0.12 % of SIL 2)	50	20 Yrs

	PL (Performance level)	CCF (%) (Common Cause Failure)	MTTFd	Category
EN ISO 13849-1	PL d	1	4525a	3

	SILCL
EN 62061	SILCL 2

Note: The values achieved above maybe jeopardised if the drive is installed outside of the Environmental limits detailed in section 10.1. Environmental.

⚠	Disconnect and ISOLATE the drive before attempting any work on it. The "STO" function does not prevent high voltages from being present at the drive power terminals.
	[1]Note: The "STO" function does not prevent the drive from an unexpected re-start. As soon as the "STO"inputs receive the relevant signal it is possible (subject to parameter settings) to restart automatically, Based on this, the function should not be used for carrying out short-term non-electrical machinery operations (such as cleaning or maintenance work).
	[2]Note: In some applications additional measures may be required to fulfil the systems safety function needs: the "STO" function does not provide motor braking. In the case where motor braking is required a time delay safety relay and/or a mechanical brake arrangement or similar method should be adopted, consideration should be made over the required safety function when braking as the drive braking circuit alone cannot be relied upon as a fail safe method.
	When using permanent magnet motors and in the unlikely event of a multiple output power devices failing then the motor could effectively rotate the motor shaft by 180/p degrees (Where p denotes number of motor pole pairs).

4.11.4. "STO" Operation

When the "STO" inputs are energised, the "STO" function is in a standby state, if the drive is then given a "Start signal/command" (as per the start source method selected in P1-13) then the drive will start and operate normally.

When the "STO" inputs are de-energised then the STO Function is activated and stops the drive (Motor will coast), the drive is now in "Safe Torque Off" mode.

To get the drive out of "Safe Torque Off" mode then any "Fault messages" need to be reset and the drive "STO" input needs to be re-energised.

4.11.5. "STO" Status and Monitoring

There are a number of methods for monitoring the status of the "STO" input, these are detailed below:

Drive Display

In Normal drive operation (Mains AC power applied), when the drives "STO" input is de-energised ("STO" Function activated) the drive will highlight this by displaying "**InHibit**", (**Note:** If the drive is in a tripped condition then the relevant trip will be displayed and not "InHibit").

Drive Output Relay

- Drive relay 1: Setting P2-15 to a value of "13" will result in relay opening when the "STO" function is activated.
- Drive relay 2: Setting P2-18 to a value of "13" will result in relay opening when the "STO" function is activated.

"STO" Fault Codes

Fault Code	Code Number	Description	Corrective Action
"Sto-F"	29	A fault has been detected within either of the internal channels of the "STO" circuit.	Refer to your Bardac Sales Partner

4.11.6. "STO" Function response time

The total response time is the time from a safety related event occurring to the components (sum of) within the system responding and becoming safe. (Stop Category 0 in accordance with IEC 60204-1)

- The response time from the "STO" inputs being de-energised to the output of the drive being in a state that will not produce torque in the motor ("STO" active) is less than 1ms.
- The response time from the "STO" inputs being de-energised to the "STO" monitoring status changing state is less than 20ms
- The response time from the drive sensing a fault in the STO circuit to the drive displaying the fault on the display/Digital output showing drive not healthy is less than 20ms.

4.11.7. "STO" Electrical Installation

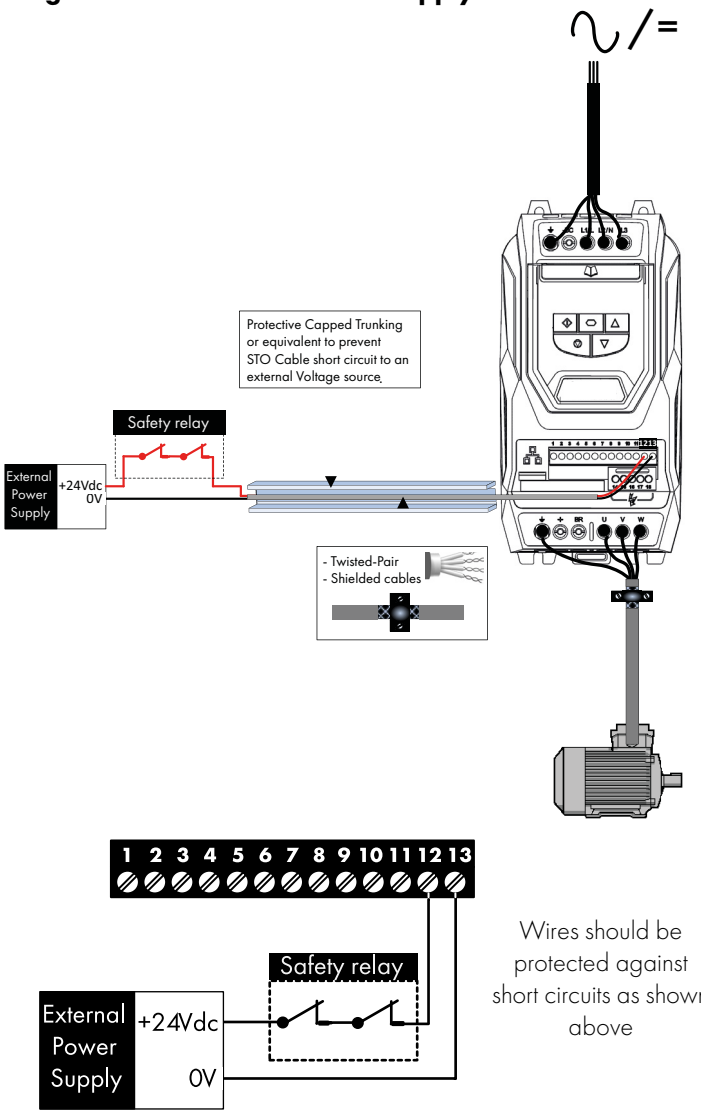
⚠	The "STO" wiring shall be protected from inadvertent short circuits or tampering which could lead to failure of the "STO" input signal, further guidance is given in the diagrams below.

In addition to the wiring guidelines for the "STO" circuit below, section 4.10.1. Recommended installation for EMC compliance on page 29 should also be followed.

The drive should be wired as illustrated below; the 24Vdc signal source applied to the "STO" input can be either from the 24Vdc on the drive or from an External 24Vdc power supply.

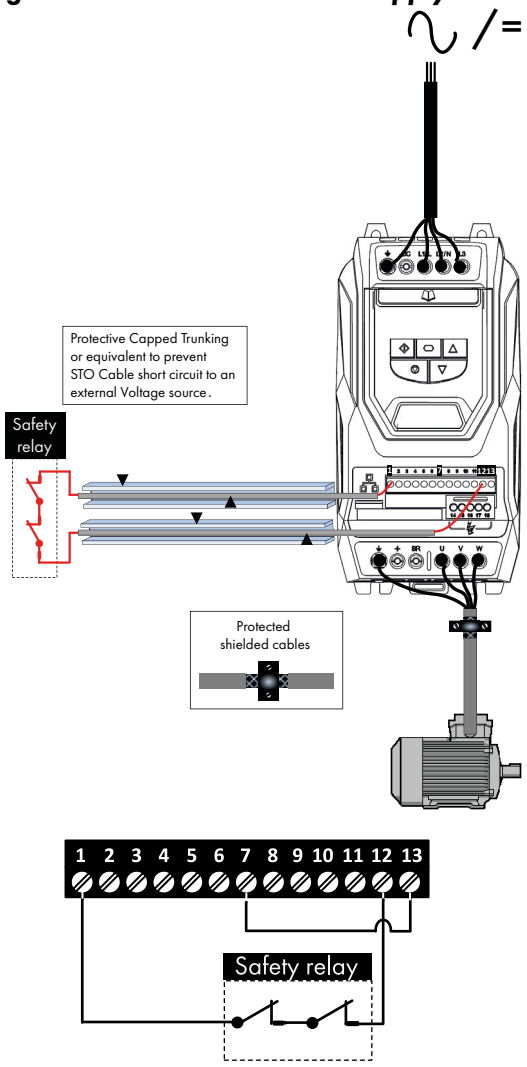
4.11.8. Recommended "STO" wiring

Using an External 24Vdc Power Supply.



Wires should be protected against short circuits as shown above

Using the drives on-board 24Vdc supply



Note: The Maximum cable length from Voltage source to the drive terminals should not exceed 25 mtrs.

4.11.9. External Power supply Specification

Voltage Rating (Nominal)	24Vdc
STO Logic High	18-30Vdc (Safe torque off in standby)
Current Consumption (Maximum)	100mA

4.11.10. Safety Relay Specification

The safety relay should be chosen so that at minimum it meets the safety standards in which the drive meets.

Standard Requirements	SIL2 or PLd SC3 or better (With Forcibly guided Contacts)
Number of Output Contacts	2 independent
Switching Voltage Rating	30Vdc
Switching Current	100mA

4.11.11. Enabling the "STO" Function

The "STO" function is always enabled in the drive regardless of operating mode or parameter changes made by the user.

4.11.12. Testing the "STO" Function

Before commissioning the system the "STO" function should always be tested for correct operation, this should include the following tests:

- With the motor at standstill, and a stop command given to the drive (as per the start source method selected in P1-13):
  - o De-energise the "STO" inputs (Drive will display ""InHibit").
  - o Give a start command (as per the start source method selected in P1-13) and check that the drive still displays "Inhibit" and that the operation is in line with the section 4.11.4. "STO" Operation and section 4.11.5. "STO" Status and Monitoring
- With the motor running normally (from the drive):
  - o De-energise the "STO" inputs
  - o Check that the drive displays "Inhibt" and that the motor stops and that the operation is in line with the section and section 4.11.4. "STO" Operation and section 4.11.5. "STO" Status and Monitoring

4.11.13. "STO" Function Maintenance

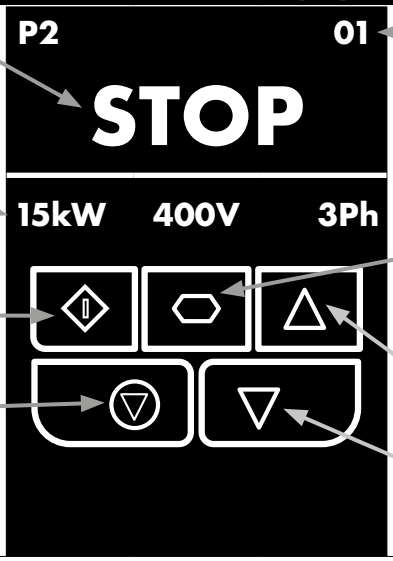
The "STO" function should be included within the control systems scheduled maintenance program so that the function is regularly tested for integrity (Minimum once per Year), furthermore the function should be integrity tested following any safety system modifications or maintenance work. If drive fault messages are observed refer to section 11.1. Fault messages on page 65 for further guidance.

5. LED Keypad and Display Operation

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

5.1. OLED Keypad and Display Layout

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 Keypad mode, used to Stop the drive.

Drive Address
Drive serial communication address set in parameter P5-01.

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

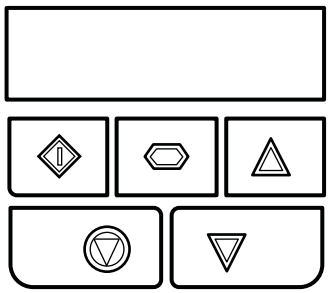
Navigate Button
Used to display real-time information, to access and exit parameter edit mode and to store parameter changes.

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

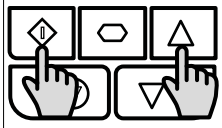
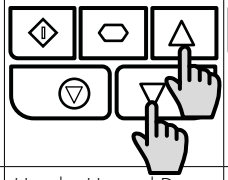
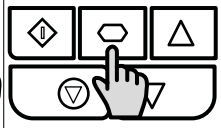
Down Button
Used to decrease speed in real-time mode or to decrease parameter values in parameter edit mode.

5.2. LED Keypad and Display Layout

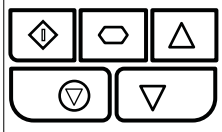
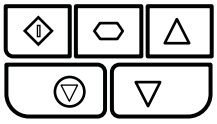
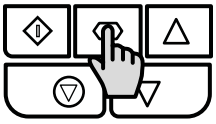
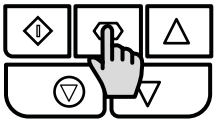
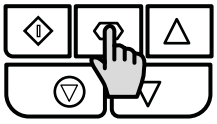
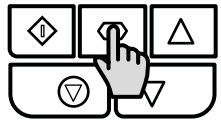
	NAVIGATE	Used to display real-time information, to access and exit parameter edit mode and to store parameter changes.
	UP	Used to increase speed in real-time mode or to increase parameter values in parameter edit mode.
	DOWN	Used to decrease speed in real-time mode or to decrease parameter values in 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.



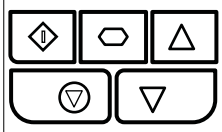
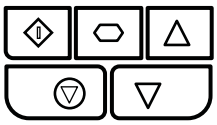
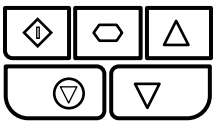
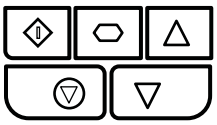
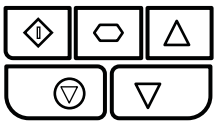
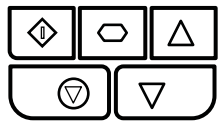
5.3. Selecting the Language on the OLED Display

P2 **01** **STOP** **15kW 400V 3Ph**	**Select Language** **Español** **Deutsch** **English**	**Select Language** **Español** **Deutsch** **English**
		
Hold down the Start and Up keys for >1s	Use the Up and Down arrows to select a language.	Press the Navigate button to select.

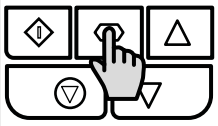
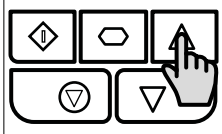
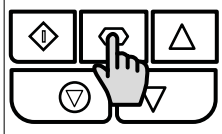
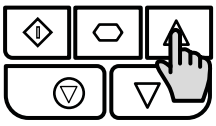
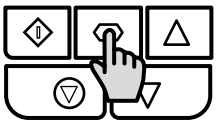
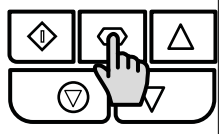
5.3.1. Operating Displays

Inhibit / STO Active	Drive Stopped	Drive Running Output Frequency Display	Drive Running Output Current Display	Drive Running Motor Power Display	Drive Running Motor Speed Display
LED Display :					
inhibt	StoP	H 50.0	A 2.3	P 1.50	1500
OLED Display :					
P2 01 **INHIBIT** 15kW 400V 3Ph	P2 01 **STOP** 15kW 400V 3Ph	Output Frequency 01 **23.7Hz** 15.3A 6.9kW	Motor Current 01 **15.3A** 6.9kW 23.7Hz	Motor Power 01 **6.9kW** 23.7Hz 15.3A	Motor Speed 01 **718rpm** 23.7Hz 15.3A
					
Drive Inhibited. The STO connections are not made. Refer to section 4.11.8. Recommended "STO" wiring on page 32	Drive Stopped / Disabled	Drive is enabled / running, display shows the output frequency (Hz). Press the Navigate key to select alternative displays.	Press the Navigate key for < 1 second. The display will show the motor current (Amps)	Press the Navigate key for < 1 second. The display will show the motor power (kW)	If P-10 > 0, pressing the Navigate key for < 1 second will display the motor speed (RPM)

5.4. Additional Display Messages

Auto Tuning in Progress	External 24VDC Supply	Overload	Switching Frequency Reduction	Mains Loss	Maintenance Time Elapsed
LED Display :					
Auto-t	Etl-24	H 500	Not Indicated	Not Indicated	Not Indicated
OLED Display :					
Auto-tuning	P2 01 **Ext 24V** External 24V mode	P2 01 **OL** **23.7Hz** 15.3A 6.9kW	P2 01 **SF↓** **23.7Hz** 15.3A 6.9kW	P2 01 **ML** **23.7Hz** 15.3A 6.9kW	P2 01 **23.7Hz** 15.3A 6.9kW
					
Auto tune in progress. See parameter P4-02 information in section 8.3. Parameter Group 4 – High Performance Motor Control on page 49.	The drive control board is powered only from an external 24 Volt source, with no mains power applied.	Indicates an Overload condition. Output current exceeds the motor rated current entered in Parameter P1-08.	Switching frequency is reduced, due to high heatsink temperature.	The incoming mains power supply has been disconnected or is missing.	The user programmable maintenance reminder time has elapsed.

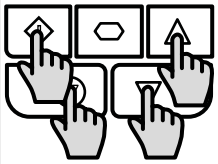
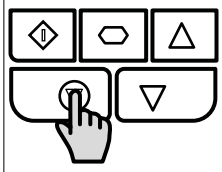
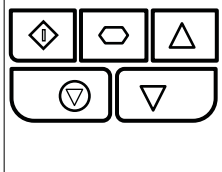
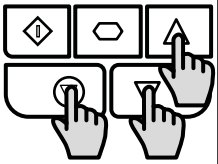
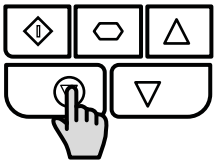
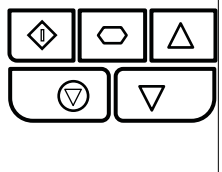
5.5. Changing Parameters

LED Display :					
StoP	P1-01	P1-08	A 2.3	P1-08	StoP
OLED Display :					
Stop	P2 01 **P1-01**	P2 01 **P1-08**	P2 01 **30.0A** ▲▼	P2 01 **P1-08**	P2 01 **Stop**
15kW 400V 3Ph	50.0Hz	30.0A	P1-08 ↑30.0 ↓3.0	30.0A	15kW 400V 3Ph
					
Press and hold the Navigate key > 2 seconds.	Use the up and down keys to select the required parameter. Drives with OLED display will show the present parameter value on the lower line of the display.	Press the Navigate key for < 1 second.	Adjust the value using the Up and Down keys. Drives with OLED display will show the maximum and minimum possible settings on the lower line of the display.	Press for < 1 second to return to the parameter menu.	Press for > 2 seconds to return to the operating display.

5.6. Parameter Factory Reset / User Reset

P2 provides a feature to allow the user to define their own default parameter set. After commissioning all required parameters, the user can save these as the defaul parameters by setting P6-29 = 1. If required, the User Default Parameters may be cleared by setting P6-29 = 2.

If the user wishes to relaod the User Default Parameters from the drive memory, the following procedure is used.

Factory Parameter Reset, LED Display :			**User Parameter Reset, LED Display :**		
StoP	P-dEF	StoP	StoP	U-dEF	StoP
Factory Parameter Reset, OLED Display :			**User Parameter Reset, OLED Display :**		
P2 01 **Stop**	P2 01 **P-Def**	P2 01 **Stop**	P2 01 **Stop**	P2 01 **U-Def**	P2 01 **Stop**
15kW 400V 3Ph	50.0Hz	15kW 400V 3Ph	P1-08 ↑30.0 ↓3.0	30.0A	15kW 400V 3Ph
					
Press and hold the Up, Down, Start and Stop keys for >2s	The display shows P-de. Briefly press the Stop key.	The display returns to Stop. All parameters are reset to Factory defaults.	Press and hold the Up, Down and Stop keys for >2s	The display shows U-def. Briefly press the Stop key.	The display returns to Stop. All parameters are reset to Factory defaults.

5.7. Resetting the drive following a trip

P2 has many protection features, designed to protect both the drive and motor from accidental damage. When any of these protection features are activated, the drive will trip, and display a fault message. The fault messages are listed in section 11.1. Fault messages on page 65.

When a trip occurs, after the cause of the trip has been investigated and rectified, the user can reset the trip in one of the following ways:

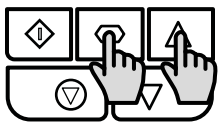
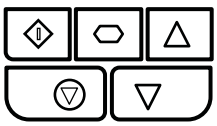
- Press the keypad Stop key
- Power off the drive completely, then power on again
- If P1-13 > 0, switch off digital input 1, then back on again
- If P1-12 = 4, reset via the fieldbus interface
- If P1-12 = 6, reset via BACnet

5.8. Keypad short cuts

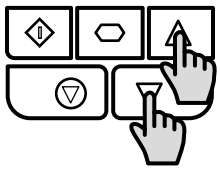
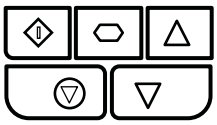
The following short cuts can be used to speed up selecting and changing parameters when using the keypad.

5.8.1. Selecting the parameter groups

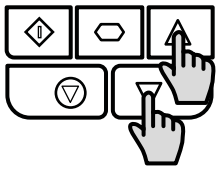
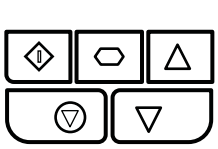
When extended or advanced parameter access is enabled (see section 8. Extended Parameters on page 43), additional parameter groups are visible, and may be selected quickly by the following method.

P1-01	P2-01
	
Whilst in the parameter selection menu, press the Navigate and Up or Navigate and Down keys simultaneously.	The next highest or lowest accessible parameter group will be selected.

5.8.2. Selecting the lowest parameter in a group

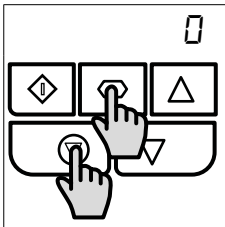
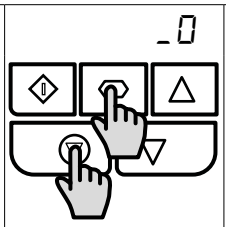
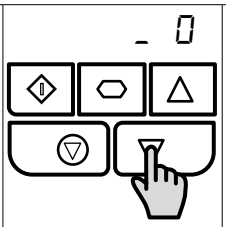
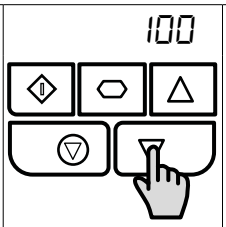
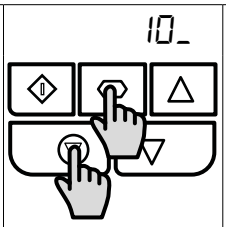
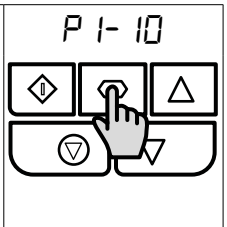
P1-08	P1-01
	
Whilst in the parameter selection menu, press the Up and Down keys simultaneously.	The next highest or lowest accessible parameter group will be selected.

5.8.3. Setting a parameter to the minimum value

1500	0
	
Whilst editing a parameter value, press the Up and Down keys simultaneously.	The parameter will be set to the lowest possible value.

5.8.4. Adjusting individual digits

When editing parameter values and making large changes, e.g. setting the motor rated speed from 0 to 1500RPM, it is possible to directly select the parameter digits using the following method.

0	_0	_ 0	100	10_	P1-10
					
Whilst editing a parameter value, press the Stop and Navigate keys simultaneously.	The cursor will step one digit to the left. Repeating the key press will move another digit to the left.	The individual digit value may be adjusted using the up and down keys.	Adjust the value using the Up and Down keys	When the cursor reaches the highest accessible digit, pressing Stop and Navigate will return the cursor to the right most digit.	Press the Navigate key to return to the parameter selection menu.

6. Parameters

6.1. Parameter Set Overview

The **P2** Parameter set consists of 10 groups as follows:

- Group 0 – Read Only Monitoring Parameters
- Group 1 – Basic Configuration Parameters
- Group 2 – Extended Parameters
- Group 3 – PID Control Parameters
- Group 4 – High Performance Motor Control Parameters
- Group 5 – Field Bus Parameters
- Group 6 – Advanced Options
- Group 7 – Advanced Motor Control
- Group 8 – Application Parameters
- Group 9 – Advanced I/O Selection

When the P2 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, the access code must be changed as follows.

P1-14 = P2-40 (Default setting = 101). With this setting, parameter groups 1 – 5 can be accessed, along with the first 50 parameters in Group 0.

P1-14 = P6-30 (Default setting = 201). With this setting, all parameters are accessible.

6.2. Parameter Group 1 – Basic Parameters

The basic parameter group allows the user to

- Enter the motor nameplate information
  - P1-07 = Motor Rated Voltage
  - P1-08 = Motor Rated Current
  - P1-09 = Motor Rated Frequency
  - P1-10 = (Optionally) Motor Rated Speed
- Define the operating speed limits
  - P1-01 = Maximum Frequency or Speed
  - P1-02 = Minimum Frequency or Speed
- Define the acceleration and deceleration times used when starting and stopping the motor, or changing speed
  - P1-03 = Acceleration Time
  - P1-04 = Deceleration Time
- Select where the drive should receive it's command signals from, and determine what functions are associated with the drive control terminal inputs
  - P1-12 Selects the control source
  - P1-13 Assigns the functions to the digital inputs

These parameters will often provide enough functions to allow the user to complete basic commissioning in simple applications. The parameters are described more fully below.

Par.	Description	Minimum	Maximum	Default	Units
P1-01	**Maximum Frequency / Speed Limit**	**P1-02**	**500.0**	**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 Frequency / Speed Limit**	**0.0**	**P1-01**	**20.0**	**Hz / Rpm**
	Minimum speed limit – Hz or rpm. If P1-10 >0, the value entered / displayed is in Rpm				
P1-03	**Acceleration Ramp Time**	**See Below**		**5.0 / 10.0**	**Seconds**
	Acceleration ramp time from 0 to base speed (P-1-09) in seconds. FS2 & FS3 : 5.0 Seconds Default Setting, 0.01 Seconds Resolution, 600.0 Seconds Maximum FS4 – FS7 : 10.0 Seconds Default Setting, 0.1 Seconds Resolution, 6000 Seconds Maximum				

Par.	Description		Minimum	Maximum	Default	Units
P1-04	**Deceleration Ramp Time**		**See Below**		**5.0 / 10.0**	**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. FS2 & FS3 : 5.0 Seconds Default Setting, 0.01 Seconds Resolution, 600.0 Seconds Maximum FS4 – FS7 : 10.0 Seconds Default Setting, 0.1 Seconds Resolution, 6000.0 Seconds Maximum					
P1-05	**Stop Mode**		**0**	**3**	**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. In this mode, the drive brake transistor (where fitted) is disabled.			
	1	Coast to Stop	When the enable signal is removed, the drive output is immediately disabled, and the motor will coast (freewheel) to stop. If the load can continue to rotate due to inertia, and the drive may possibly be re-enabled whilst the motor is still rotating, the spin start function (P2-26) should be enabled. In this mode, the drive brake transistor (where fitted) is disabled.			
	2	AC Flux Braking	As Option 0, but additionally, AC Flux braking is used to increase the available braking torque.			
P1-07	**Motor Rated Voltage**		**Drive Rating Dependent**			**Volts**
	For Induction Motors - Enter the rated (nameplate) voltage of the motor (Volts) **For PM & BLDC Motors** - Enter the back EMF at rated motor speed					
P1-08	**Motor Rated Current**		**Drive Rating Dependent**			**Amps**
	This parameter should be set to the rated (nameplate) current of the motor					
P1-09	**Motor Rated Frequency**		**10**	**500**	**50 (60)**	**Hz**
	This parameter should be set to the rated (nameplate) current of the motor					
P1-10	**Motor Rated Speed**		**0**	**30000**	**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 P2 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. **Note:** When the drive is operated with the optional Encoder Feedback Interface, this parameter must be set to the correct nameplate Rpm of the connected motor.					
P1-11	**Torque Boost**		**0.0**	**Drive Rating Dependent**		**%**
	Torque Boost is used to increase the applied motor voltage and hence current at low output frequencies. This can improve low speed and starting torque. Increasing the boost level will increase motor current at low speed, which may result in the motor temperature rising - force ventilation of the motor may then be required. In general, the lower the motor power, the higher the boost setting that may be safely used. For IM motors, a suitable setting can usually be found by operating the motor under very low or no load conditions at approximately 5Hz, and adjusting P1-11 until the motor current is approximately the magnetising current. This parameter is also effective when using alternative motor types, P4-01 = 3, 4 or 5. In this case, the boost current level is defined as 4 x P1-11 x P1-08.					
P1-12	**Primary Command Source**		**0**	**6**	**3**	**-**
	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 an external or remote Keypad.			
	2	**Uni-directional Keypad Control**	As above.			
	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 P2 operating in Master Mode.			
	6	**BACnet Control**	Control via BACnet connected to the RJ45 serial interface connector.			
P1-13	**Digital Input Source Select**		**0**	**14**	**1**	**-**
	Defines the function of the digital inputs depending on the control mode setting in P1-12. See section 7.1 Control Source Selection for more information.					
P1-14	**Extended Menu Access Code**		**0**	**30000**	**0**	**-**
	Parameter Access Control. The following settings are applicable: P1-14 = P2-40 = 101 : Allows access to Extended Parameter Groups 0 – 5 P1-14 = P6-30 = 201 = Allows access to all parameter groups (Intended for experienced users only, usage is not described in this User Guide)					

7. Control Terminal Functions

For standard applications and operation, the basic control of the drive and functions of all drive input terminals can be configured using just two parameters, P1-12 and P1-13. P1-12 is used to define the source of all control commands and the primary speed reference source. P1-13 then allows fast selection of Analog and Digital Input functions based on a selection table.

7.1 Control Source Selection

7.1.1. P1-12 Function

P1-12 is used to select the main control source of the drive and the main speed reference according to the following table:

P1-12	Function	Control Source	Main Speed Reference	Notes
0	Terminal Control	Terminals	Analog Input 1	All control signals are applied to the control terminals. Functions are determined by P-15 Macro setting.
1	Keypad Control	Keypad / Terminals	Motorised Pot / Keypad	When keypad mode is selected, the default operation of the drive requires the keypad Start & Stop buttons are used to control the drive. This can be changed using P-31 to allow the drive to be started from Digital Input 1 directly.
2	Keypad Control	Keypad / Terminals	Motorised Pot / Keypad	
3	**PID Control**	**Terminals**	**PID Output**	**Enable / Disable control of the drive is through the drive control terminal strip.** **Output frequency is set by the output of the PI Controller. This mode must be selected in order to use the MPPT algorithm in the drive.**
4	Fieldbus / Modbus RTU	Modbus RTU	Fieldbus / Modbus RTU	Control of the drive operation is through a fieldbus option module mounted in the drive option slot. If no option module is fitted, control is through the Modbus RTU interface. Digital Input 1 must be closed to allow operation.
5	Slave Mode	Master Drive	From Master	P2 provides an inbuilt Master / Slave function. A single drive acts as the Master, and connected Slave drives will mimic the starting and stopping, along with the following the output frequency, with any scaling applied. Digital Input 1 must be closed to allow operation.
6	BACnet	BACnet	BACnet	Control of the drive operation is through the BACnet Interface. Digital Input 1 must be closed to allow operation.

7.1.2. Overview

P2 uses a Macro approach to simplify the configuration of the Analog and Digital Inputs. There are two key parameters which determine the input functions and drive behaviour:-

- P1-12 – Selects the main drive control source and determines how the output frequency of the drive is primarily controlled.
- P1-13 – Assigns the Macro function to the analog and digital inputs.

Additional parameters can then be used to further adapt the settings, e.g.

- P2-30 – Used to select the format of the analog signal to be connected to analog input 1, e.g. 0 – 10 Volt, 4 – 20mA
- P2-33 – Used to select the format of the analog signal to be connected to analog input 2, e.g. 0 – 10 Volt, 4 – 20mA
- P2-36 – Determines whether the drive should automatically start following a power on if the Enable Input is present
- P2-37 – When Keypad Mode is selected, determines at what output frequency / speed the drive should start following the enable command, and also whether the keypad start key must be pressed or if the Enable input alone should start the drive.

The diagrams below provide an overview of the functions of each terminal macro function, and a simplified connection diagram for each.

7.1.3. Macro Function Guide

Function	Explanation
STOP	Latched Input, Open the contact to STOP the drive
RUN	Latched input, Close the contact to Start, the drive will operate as long as the input is maintained
FWD↻	Latched Input, selects the direction of motor rotation FORWARD
REV↺	Latched Input, selects the direction of motor rotation REVERSE
RUN FWD↻	Latched Input, Close to Run in the FORWARD direction, Open to STOP
RUN REV↺	Latched Input, Close to Run in the REVERSE direction, Open to STOP
ENABLE	Hardware Enable Input. In Keypad Mode, P2-36 determines whether the drive immediately starts, or the keypad start key must be pressed. In other modes, this input must be present before the start command is applied via the fieldbus interface.
START↥	Normally Open, Rising Edge, Close momentarily to START the drive (NC STOP Input must be maintained)
^- START -^	Simultaneously applying both inputs momentarily will START the drive (NC STOP Input must be maintained)
STOP↴	Normally Closed, Falling Edge, Open momentarily to STOP the drive
START↥FWD↻	Normally Open, Rising Edge, Close momentarily to START the drive in the forward direction (NC STOP Input must be maintained)
START↥REV↻	Normally Open, Rising Edge, Close momentarily to START the drive in the reverse direction (NC STOP Input must be maintained)
^-FAST STOP (P2-25)-^	When both inputs are momentarily active simultaneously, the drive stops using Fast Stop Ramp Time P2-25
FAST STOP↴ (P2-25)	Normally Closed, Falling Edge, Open momentarily to FAST STOP the drive using Fast Stop Ramp Time P2-25
E-TRIP	Normally Closed, External Trip input. When the input opens momentarily, the drive trips showing E-trIP or Ptc-th depending on P2-33 setting. See section 4.9.2. Motor Thermistor Connection on page 28 for further information.
Analog Input AI1	Analog Input 1, signal format selected using P2-30
Analog Input AI2	Analog Input 2, signal format selected using P2-33
AI1 REF	Analog Input 1 provides the speed reference
AI2 REF	Analog Input 2 provides the speed reference
P-xx REF	Speed reference from the selected preset speed
PR-REF	Preset speeds P2-01 – P2-08 are used for the speed reference, selected according to other digital input status
PI-REF	PI Control Speed Reference
PI FB	Analog Input used to provide a Feedback signal to the internal PI controller
KPD REF	Keypad Speed Reference selected
INC SPD↑	Normally Open, Close the input to Increase the motor speed
DEC SPD↓	Normally Open, Close input to Decrease motor speed
FB REF	Selected speed reference from Fieldbus (Modbus RTU / CAN Open / Master depending on P-12 setting)
(NO)	Input is Normally Open, Close momentarily to activate the function
(NC)	Input is Normally Closed, Open momentarily to activate the function

7.2. 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	
14		O: Stop C: Run	O: Forward C: Reverse				

Digital input 3	Analog input 1	Analog input 2	Preset Speed
Off	Off	Off	Preset Speed 1
On	Off	Off	Preset Speed 2
Off	On	Off	Preset Speed 3
On	On	Off	Preset Speed 4
Off	Off	On	Preset Speed 5
On	Off	On	Preset Speed 6
Off	On	On	Preset Speed 7
On	On	On	Preset Speed 8

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).

8. Extended Parameters

8.1. Parameter Group 2 - Extended parameters

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-01	**Preset Speed 1**	P1-02	P1-01	5.0	Hz / Rpm
P2-02	**Preset Speed 2**	P1-02	P1-01	10.0	Hz / Rpm
P2-03	**Preset Speed 3**	P1-02	P1-01	25.0	Hz / Rpm
P2-04	**Preset Speed 4**	P1-02	P1-01	0.0	Hz / Rpm
	Preset Speeds / Frequencies selected by digital inputs depending on the setting of P1-13. If P1-10 = 0, the values are entered as Hz. If P1-10 > 0, the values are entered as Rpm. Setting a negative value will reverse the direction of motor rotation.				
P2-05	**Preset Speed 5 / Clean Speed 1**	P1-02	P1-01	0.0	Hz / Rpm
	Preset speed 5 is automatically reference by the Pump Clean function when this is enabled. When the Pump Clean function is disabled, Preset speed 5 can be selected as per preset speeds 1 – 4.				
P2-06	**Preset Speed 6 / Clean Speed 2**	P1-02	P1-01	0.0	Hz / Rpm
	Preset speed 6 is automatically reference by the Pump Clean function when this is enabled. When the Pump Clean function is disabled Preset speed 6 can be selected as per as per preset speeds 1 – 4.				
P2-07	**Preset Speed 7 / Boost Speed 1 / Stir Speed**	P1-02	P1-01	0.0	Hz / Rpm
	Preset speed 7 is automatically referenced by the Start Boost function, or the Pump Stir Function, when these functions are enabled. When they are disabled, Preset speed 7 can be selected as per preset speeds 1 – 4.				
P2-08	**Preset Speed 8 / Boost Speed 2**	P1-02	P1-01	0.0	Hz / Rpm
	Preset speed 8 is automatically reference by the Stop Boost function when this function is enabled. When disabled, Preset speed 8 can be selected as per preset speeds 1 – 4.				
P2-09	**Skip Frequency Centre Point**	P1-02	P1-01	0.0	Hz / Rpm
P2-10	**Skip Frequency Band Width**	0.0	P1-01	0.0	Hz / Rpm
	The Skip Frequency function is used to avoid the P2 operating at a certain output frequency, for example at a frequency which causes mechanical resonance in a particular machine. Parameter P2-09 defines the centre point of the skip frequency band, and is used conjunction with P2-10. The P2 output frequency will ramp through the defined band at the rates set in P1-03 and P1-04 respectively, and will not hold any output frequency within the defined band. If the frequency reference applied to the drive is within the band, the P2 output frequency will remain at the upper or lower limit of the band.				
P2-11	**Analog Output 1 (Terminal 8) Function Select**	0	11	8	-
	Digital Output Mode. Logic 1 = +24V DC				
	0 : Drive Enabled (Running). Logic 1 when the P2 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 setpoint 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 : Motor Torque >= Limit.** Logic when the motor torque exceeds the adjustable limit **7 : Analog Input 2 Signal Level >= Limit.** Logic when the signal applied to the Analog Input 2 exceeds the adjustable limit **Note:** When using settings 4 – 7, parameters P2-16 and P2-17 must be used together to control the 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.				
	Analog Output Mode				
	8 : Output Frequency (Motor Speed). 0 to P-01 **9 : Output (Motor) Current.** 0 to 200% of P1-08 **10 : Motor Torque.** 0 to 200% of motor rated torque **11 : Output (Motor) Power.** 0 to 150% of drive rated power **12 : PID Output.** Output from the internal PID Controller, 0 – 100% **13: DC Bus Level.** 0 – 100.0% = 0 – 1000Vdc				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-12	**Analog Output 1 (Terminal 8) Format**	See Below		U 0-10	-
	U 0-10 = 0 to 10V. U 10-0 = 10 to 0V, A 0-20 = 0 to 20mA A 20-0 = 20 to 0mA A 4-20 = 4 to 20mA A 20-4 = 20 to 4mA				
P2-13	**Analog Output 2 (Terminal 11) Function Select**	0	11	9	-
	Digital Output Mode. Logic 1 = +24V DC				
	0 : Drive Enabled (Running). Logic 1 when the P2 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 setpoint 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 : Motor Torque >= Limit.** Logic when the motor torque exceeds the adjustable limit **7 : Analog Input 2 Signal Level >= Limit.** Logic when the signal applied to the Analog Input 2 exceeds the adjustable limit **Note:** When using settings 4 – 7, parameters P2-16 and P2-17 must be used together to control the 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.				
	Analog Output Mode				
	8 : Output Frequency (Motor Speed). 0 to P-01 **9 : Output (Motor) Current.** 0 to 200% of P1-08 **10 : Motor Torque.** 0 to 200% of motor rated torque **11 : Output (Motor) Power.** 0 to 150% of drive rated power **12 : PID Output.** Output from the internal PID Controller, 0 – 100% **13: DC Bus Level.** 0 – 100.0% = 0 – 1000Vdc				
P2-14	**Analog Output 2 (Terminal 11) Format**	See Below		U 0-10	-
	0-10 = 0 to 10V A 0-20 = 0 to 20mA A 4-20 = 4 to 20mA 0-0 = 10 to 0V A 20-0 = 20to 0mA A 20-4 = 20 to 4mA				
P2-15	**Analog Output 2 (Terminal 11) Function Select**	0	11	9	-
	Digital Output Mode. Logic 1 = +24V DC				
	0 : Drive Enabled (Running). Logic 1 when the P2 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 setpoint 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 : Motor Torque >= Limit.** Logic when the motor torque exceeds the adjustable limit **7 : Analog Input 2 Signal Level >= Limit.** Logic when the signal applied to the Analog Input 2 exceeds the adjustable limit **Note:** When using settings 4 – 7, parameters P2-16 and P2-17 must be used together to control the 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. **8 : Reserved.** No Function **9 : Reserved.** No Function **10 : Maintenance Due.** Logic 1 when the internally programmable maintenance timer has elapsed. **11 : Drive Ready.** Logic 1 when drive is not tripped, STO circuit is closed, mains supply present, hardware enable input present. **12 : Drive Tripped.** Logic one when the drive has tripped and the display shows the fault code. **13 : STO Status.** Logic 1 when both STO inputs are present and the drive is able to be operated **14 : PID Error >= Limit.** The PID Error (difference between setpoint and feedback) is greater than or equal to the programmed limit **15 : High Load Detection Alarm.** Logic 1 when the load monitoring has been enabled using P8-06 to P8-08 and a high load condition has been detected – usually used to signal pump blockage				
P2-16	**Adjustable Threshold 1 Upper Limit (Analog Output 1 / Relay Output 1)**	P2-17	200.0	100.0	%
P2-17	**Adjustable Threshold 1 Lower Limit (Analog Output 1 / Relay Output 1)**	0.0	P2-16	0.0	%
	Used in conjunction with some settings of Parameters P2-11 & P2-15.				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-18	**User Relay 2 Output (Terminals 17 & 18) Function select**	0	15	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 setpoint 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 : Output Torque >= Limit.** Logic 1 when the motor torque exceeds the adjustable limit **7 : Analog Input 2 Signal Level >= Limit.** 1 Logic when the signal applied to the Analog Input 2 exceeds the adjustable limit **8 : Hoist Brake Control.** The relay can be used to control the motor holding brake on a hoist. Contact your local Bardac Sales Partner for further information on using this feature. **Note:** When using settings 4 – *7*, parameters P2-19 and P2-20 must be used together to control the 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. **9 : Reserved.** No Function **10 : Maintenance Due.** Logic 1 when the internally programmable maintenance timer has elapsed. **11 : Drive Ready.** Logic 1 when drive is not tripped, STO circuit is closed, mains supply present, hardware enable input present. **12 : Drive Tripped.** Logic one when the drive has tripped and the display shows the fault code. **13 : STO Status.** Logic 1 when both STO inputs are present and the drive is able to be operated **14 : PID Error >= Limit.** The PID Error (difference between setpoint and feedback) is greater than or equal to the programmed limit **15 : High Load Detection Alarm.** Logic 1 when the load monitoring has been enabled using P8-06 to P8-08 and a high load condition has been detected – usually used to signal pump blockage				
P2-19	**Adjustable Threshold 1 Upper Limit (Analog Output 2 / Relay Output 2)**	P2-20	200.0	100.0	%
P2-20	**Adjustable Threshold 1 Lower Limit (Analog Output 2 / Relay Output 2)**	0.0	P2-19	0.0	%
	Used in conjunction with some settings of Parameters P2-13 & P2-18.				
P2-21	**Display Scaling Factor**	-30.000	30.000	0.000	-
P2-22	**Display Scaling Source**	0	4	4	-
	P2-21 & P2-22 allow the user to program the P2 to display an alternative output unit scaled from an existing parameter, e.g. 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 displayed whilst the drive is running, with a 'c' to indicate the customer scaled units. **P2-22 Options** **0: Motor Speed** **1: Motor Current** **2: Analog Input 2** **3: P0-80 Value** **4: Analog Input 1** **Note:** P2-21 & P2-22 allow the user to program the P2 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	**Effective Switching Frequency**	Drive Rating Dependent			kHz
	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 10.3.3. Derating for Swicthing Frequency on page 64 for further information.				
P2-25	**Fast Decel Ramp Time**	0.00	240.0	0.10	Seconds
	This parameter allows an alternative deceleration ramp down time to be programmed into the P2, which can be selected by digital inputs (dependent on the setting of P1-13) or selected automatically in the case of a mains power loss if P2-38 = 2. When set to 0.0, the drive will coast to stop.				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-26	**Spin Start Enable**	0	1	0	-
	When 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 present (detected) speed. A short delay may be observed when starting the drive whilst the spin start function is completed. **0 : Disabled** **1 : Enabled** **2 : Enabled following Trip, Brown Out or Coast Stop**				
P2-27	**Standby Mode Timer**	0.0	250.0	0.0	Seconds
	This parameter defines the time period, whereby if the drive operates at the frequency / speed set in P3-14 (Standby speed threshold) for greater than the set time period, the P2 output will be disabled, and the display will show YbdnES. The function is disabled if P2-27 = 0.0.				
P2-28	**Slave Speed Scaling Control**	0	3	0	-
	Active in Keypad mode (P1-12 = 1 or 2) and Slave mode (P1-12=5) 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**				
P2-29	**Slave Speed Scaling Factor**	-500.0	500.0	100.0	%
	Used in conjunction with P2-28.				
P2-30	**Analog Input 1 (Terminal 6) Format**	See Below		U 0-10	-
	0 1-0 U = 0 to 10 Volt Signal (Uni-polar) 0-0 1 U = 10 to 0 Volt Signal (Uni-polar) 0 1-0 1- = -10 to +10 Volt Signal (Bi-polar) 02-0 = 0 to 20mA Signal 02-4 t = 4 to 20mA Signal, the P2 will trip and show the fault code F02-4 if the signal level falls below 3mA 02-4 r = 4 to 20mA Signal, the P2 will ramp to stop if the signal level falls below 3mA 4-02 t = 20 to 4mA Signal, the P2 will trip and show the fault code F02-4 if the signal level falls below 3mA 4-02 r = 20 to 4mA Signal, the P2 will ramp to stop if the signal level falls below 3mA				
P2-31	**Analog Input 1 Scaling**	0.0	2000.0	100.0	%
	Scales the analog input by this factor, e.g. 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	%
	Sets an offset, as a percentage of the full scale range of the input, which is applied to the analog input signal				
P2-33	**Analog Input 1 (Terminal 10) Format**	See Below		U 0-10	-
	0 1-0 U = 0 to 10 Volt Signal (Uni-polar) 0-0 1 U = 10 to 0 Volt Signal (Uni-polar) 0 1-0 1- = -10 to +10 Volt Signal (Bi-polar) 02-0 = 0 to 20mA Signal 02-4 t = 4 to 20mA Signal, the P2 will trip and show the fault code F02-4 if the signal level falls below 3mA 02-4 r = 4 to 20mA Signal, the P2 will ramp to stop if the signal level falls below 3mA 4-02 t = 20 to 4mA Signal, the P2 will trip and show the fault code F02-4 if the signal level falls below 3mA 4-02 r = 20 to 4mA Signal, the P2 will ramp to stop if the signal level falls below 3mA				
P2-34	**Analog Input 2 Scaling**	0.0	2000.0	100.0	%
	Scales the analog input by this factor, e.g. 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)				
P2-35	**Analog Input 2 Offset**	-500.0	500.0	0.0	%
	Sets an offset, as a percentage of the full scale range of the input, which is applied to the analog input signal				

Par	Parameter Name	Minimum	Maximum	Default	Units
P2-36	**Start Mode Select / Automatic Restart**	See Below		AUto-0	-
	Defines the behaviour of the drive relating to the enable digital input and also configures the Automatic Restart function. EdGE-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 fault with, and will require the user to manually reset the fault. ⚠ **DANGER! "AUto" modes allow the drive to Auto-start, therefore the impact on system/Personnel safety needs to be considered.**				
P2-37	**Keypad Mode Restart Speed**	0	3	1	-
	Options 0 to 3 are only active when P1-12 = 1 or 2 (keypad Mode). With these settings, the drive waits for the keypad start button to be pressed before running. **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 P2 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 P2 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 P2 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 P2 will always initially run at Preset Speed 4 (P2-04)				
P2-38	**Mains Loss Stop Mode**	0	2	3	-
	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 P2 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 P2 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 **3: DC Bus Power Supply Mode.** This mode is intended to be used when the drive is powered directly via the +DC and –DC Bus connections. Refer to your Bardac Sales Partner for further details				
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 Parameter Access Code Definition**	0	9999	101	-
	Defines the access code which must be entered in P1-14 to access parameter groups above Group 1				

8.2. Parameter Group 3 – PID Control

8.2.1. Overview

P2 provides an internal PID controller. Parameters for configuration of the PID controller are located together in Group 3. For simple applications, the user needs to only define the setpoint source (P3-05 to select the source or P3-06 for a fixed setpoint), feedback source (P3-10) and adjust the P Gain (P3-01), I time (P3-02) and optionally the differential time (P3-03).

The PID operation is uni-directional, and all signals are treated as 0 – 100% to provide a simple, intuitive operating format.

8.2.2. *Parameter List*

Par	Parameter Name		Minimum	Maximum	Default	Units
P3-01	**PID Proportional Gain**		**0.1**	**30.0**	**1.0**	**-**
	PID Controller Proportional Gain. Higher values provide a greater change in the drive output frequency in response to small changes in the feedback signal. Too high a value can cause instability					
P3-02	**PID Integral Time Constant**		**0.0**	**30.0**	**1.0**	**s**
	PID Controller Integral Time. Larger values provide a more damped response for systems where the overall process responds slowly					
P3-03	**PID Differential Time Constant**		**0.00**	**1.00**	**0.00**	**s**
	PID Differential Time Constant					
P3-04	**PID Operating Mode**		**0**	**1**	**1**	**-**
	0	**Direct Operation**	Use this mode if an increase in the motor speed should result in an increase in the feedback signal			
	1	**Inverse Operation**	Use this mode if an increase in the motor speed should result in a decrease in the feedback signal			
P3-05	**PID Reference Source Select**		**0**	**2**	**0**	**-**
	0	**Digital Preset Setpoint**	P3-06 is used			
	1	**Analog Input 1 Setpoint**	Analog Input 1 as displayed in P0-01 is used			
	2	**Analog Input 2 Setpoint**	Analog Input 2 as displayed in P0-02 is used			
	3	**MPPT Algorithm**	Maximum Power Point Tracking algorithm for optimum operation with PV supply			
P3-06	**PID Digital Reference (Setpoint)**		**0.0**	**100.0**	**-**	**%**
	When P3-05 = 0, this parameter sets the preset digital reference (setpoint) used for the PID Controller. Where the feedback is provided from a transducer such as a pressure transducer or level measurement, this represents the percentage of the pressure range (e.g. for a 0 – 10 Bar transducer, 4 bar = 40%) or the level. When running in MPPT mode (P3-05 = 3), this value is the DC Bus Set-Point which is entered as a percentage of 1000V (29.3% = 293V)					
P3-07	**PID Controller Output Upper Limit**		**P3-08**	**100.0**	**100.0**	**%**
	Limits the maximum value output from the PID controller					
P3-08	**PID Controller Output Lower Limit**		**0.0**	**P3-07**	**0.0**	**%**
	Limits the minimum output from the PID controller					
P3-09	**PID Output Limit Control**		**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 Signal Source Select**		**0**	**1**	**3**	**-**
	0	**Analog Input 2**				
	1	**Analog Input 1**				
	2	**Output Current**				
	3	**DC Bus Voltage**				
	4	**Differential : Analog Input 1 – Analog Input 2**				
	5	**Largest Value : Analog Input 1 or Analog Input 2**				
P3-11	**Maximum PID Error to Enable Ramps**		**0.0**	**25.0**	**0.0**	**%**
	Defines a threshold PID error level, whereby if the difference between the setpoint and feedback values is less than the set threshold, the internal ramp times of the drive are disabled. Where a greater PID error exists, the ramp times are enabled to limit the rate of change of motor speed on large PID errors, and react quickly to small errors.					
P3-12	**PID Feedback Value Display Scaling Factor**		**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	**PID Error Wake Up Level**		**0.0**	**100.0**	**5.0**	**%**
	Sets a programmable level whereby if the drive enters standby motor whilst operating under PID control, the selected feedback signal must fall below this threshold before the drive will return to normal operation.					

Par	Parameter Name			Minimum	Maximum	Default	Units
P3-18	**PID Operation Control**			0	1	1	-
	0	**Continuous PID Operation**	In this operating mode, the PID controller operates continuously, regardless of whether the drive is enabled or disabled. This can result in the output of the PID controller reaching the maximum level prior to the drive enable signal being applied.				
	1	**PID operation on Drive Enable**	In this operating mode, the PID controller only operates when the drive is enabled, and hence will always start from zero when the drive is enabled.				
P3-19	**MPPT Iteration Cycle Time**			1.0	10.0	10.0	s
	This parameter defines the cycle time for each iteration of the MPPT controller. A lower value may allow the system to try to arrive at the MPPT quicker from a starting point or after recovering from cloud cover but if the value is too short, it can reduce the stability of the system.						

8.3. Parameter Group 4 – High Performance Motor Control

8.3.1. Overview

Parameters relating to the motor control are located together in Group 4. These parameters allow the user to

- Select the motor type to match the connected motor
- Carry out an autotune
- Define the torque limits and setpoint source for control methods that support this (vector control methods only).

8.3.2. Working with different motor types

P2 is compatible with the following motor types:

- IM Induction Motors
- PM Permanent Magnet AC Motors
- Brushless DC Motors
- Synchronous Reluctance Motors

The parameter set is intended to allow operation with each motor type using the same basic parameter settings. The sections below provide additional information for each motor type.

8.3.3. IM Motors

IM Motor Control Methods

IM Motors may be operated in the following modes:-

- Eco Vector Speed Control (CT) (Default Mode)
  - This mode provides the simplest control, and is suitable for a wide range of applications with constant torque
- Eco Vector Speed Control (VT)
  - This mode provides the simplest control, and is suitable for a wide range of applications with variable torque

Operating in Eco Vector Speed Control Mode

The P2 Solar Pump drive can be programmed by the user to operate in Sensorless Vector mode, which provides enhanced low speed torque, optimum motor speed regulation regardless of load and accurate control of the motor torque. In most applications, the default settings will provide adequate performance, however it is advisable to use the following procedure.

- Ensure advanced parameter access is enabled by setting P1-14 = 101
- Enter the motor nameplate details into the relevant parameters as follows
  - P1-07 Motor Rated Voltage
  - P1-08 Motor Rated Current
  - P1-09 Motor Rated Frequency
  - (Optional) P1-10 Motor Rated Speed (Rpm)
- Select the required mode VT/CT mode by setting P4-01 = 0 or 1
- Ensure that the motor is correctly connected to the drive
- Carry out a motor data Autotune by setting P4-02 = 1

⚠	The Autotune will begin immediately when P4-02 is set regardless of the status of the drive enable signal. Whilst the autotune procedure does not drive or spin the motor, the motor shaft may still turn slightly. It is not normally necessary to uncouple the load from the motor; however the user should ensure that no risk arises from the possible movement of the motor shaft.
	It is essential that the correct motor data is entered into the relevant drive parameters. Incorrect parameter settings can result in poor or even dangerous performance.

8.3.4. PM AC Permanent Magnet AC Motors

The P2 Solar Pump drive can be used to control Permanent Magnet AC motors without a feedback encoder or resolver. These motors operate synchronously, and a vector control strategy is used to maintain correct operation. In general, the motor can be operated between 10% - 100% of rated speed with a correctly selected and configured drive. In order to operate a PM motor, the following parameter settings are necessary.

- Ensure advanced parameter access is enabled by setting P1-14 = 101
- Enter the motor details into the relevant parameters as follows
  - o P1-07 Back EMF at Rated Frequency / Speed (kE)
- This is the voltage imposed by the magnets at the drive output terminals when the motor operates at rated frequency or speed. Some motors may provide a value for volts per thousand RPM, and it may be necessary to calculate the correct value for P1-07.
  - o P1-08 Motor Rated Current
  - o P1-09 Motor Rated Frequency
  - o (Optional) P1-10 Motor Rated Speed (Rpm)
- Select PM Motor Speed control mode by setting P4-01 = 3
- Ensure that the motor is correctly connected to the drive
- Carry out a motor data Autotune by setting P4-02 = 1

The autotune measures the electrical data required from the motor to ensure good control. Following the steps above, it should be possible to operate the motor. Further parameter settings are possible to further enhance the performance is required, please refer to your Bardac Drives Sales Partner for more information.

8.3.5. BLDC Brushless DC Motors

The P2 Solar Pump drive can operate with Brushless DC motors without a feedback encoder or resolver. These motors operate synchronously, and a vector control strategy is used to maintain correct operation. In general, the motor can be operated between 10% - 100% of rated speed with a correctly selected and configured drive.

Parameter setting and configuration steps for BLDC motor operation are the same as with an AC PM motor, as shown above, with the exception that P4-01 should be set to 4 for this motor type.

8.3.6. Group 4 Parameter Listing

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
P4-01	**Motor Control Mode**					0	6	1	-
	Setting	**Motor Type**	**Primary Control**	**Control Method**	**Additional Information**				
	0	IM	Speed	Vector	ECO Vector Speed Control (Variable Torque)				
	1	IM	Speed	Vector	ECO Vector Speed Control (Constant Torque)				
	2	IM	Speed	Vector	Eco Enhanced Vector Control				
	3	AC PM	Speed	Vector	For speed control of AC PM motors with Sinusoidal back EMF				
	4	BLDC	Speed	Vector	For speed control of BLDC motors with Trapezoidal back EMF				
	5	Syn RM	Speed	Vector	For speed control of Synchronous Reluctance motors				
P4-02	**Motor Parameter Auto-tune Enable**					0	1	0	-
	When set to 1, the drive immediately carries out a non-rotating autotune to measure the motor parameters for optimum control and efficiency. Following completion of the autotune, the parameter automatically returns to 0.								
P4-03	**Vector Speed Controller Proportional Gain**					0.1	400.0	50	%
	Sets the proportional gain value for the speed controller when operating in Vector Speed motor control modes (P4-01 = 0 or 1). Higher values provide better output frequency regulation and response. Too high a value can cause instability or even over current trips. For applications requiring best possible performance, the value should be adjusted to suit the connected load by gradually increasing the value and monitoring the actual output speed of the load until the required dynamic behaviour is achieved with little or no overshoot where the output speed exceeds the setpoint. In general, higher friction loads can tolerate higher values of proportional gain, and high inertia, low friction loads may require the gain to be reduced.								

Par	Parameter Name			Minimum	Maximum	Default	Units
P4-04	**Vector Speed Controller Integral Time Constant**			**0.000**	**2.000**	**0.050**	**s**
	Sets the integral time for the speed controller. Smaller values provide a faster response in reaction to motor load changes, at the risk of introducing instability. For best dynamic performance, the value should be adjusted to suit the connected load.						
P4-05	**Motor Power Factor Cos Ø**			**0.50**	**0.99**	**-**	**-**
	When operating in Vector Speed motor control modes, this parameter must be set to the motor nameplate power factor						
P4-07	**Maximum Motoring Current Limit**			**P4-08**	**500.0**	**150.0**	**%**
	This parameter defines the maximum output current the drive will provide to the motor before reducing the output frequency to attempt to limit the current.						
P4-12	**Thermal Overload Value Retention**			**0**	**1**	**0**	**-**
	0	**Disabled**					
	1	**Enabled**	All P2s 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.				
P4-13	**Output Phase Sequence**			**0**	**1**	**0**	**-**
	0	**U,V,W**	Stand motor phase sequence. Typically, this provides clockwise rotation of the motor.				
	1	**U,W,V**	Reverse motor phase sequence. Typically this provides counter-clockwise rotation of the motor.				
P4-14	**Thermal Overload Limit Reaction**			**0**	**1**	**0**	**-**
	0	**It.trp :** When the overload accumulator reaches the limit, the drive will trip on It.trp to prevent damage to the motor					
	1	**Current Limit Reduction :** When the overload accumulator reaches 90% of the limit, the current limit will be internally set to 100% of P1-08 in order to prevent an It.trp. The current limit will return to the setting in P4-07 when the overload accumulator reaches 10%.					

8.4. Parameter Group 5 – Communication Parameters

8.4.1. Overview

The P2 Solar Pump drive provides many methods to allow the user to connect to a variety of fieldbus networks. In addition, connection to options such as external keypads, PC and Optistick are possible. Parameter Group 5 provides the parameters required to configure the various fieldbus interfaces and connection points.

8.4.2. Connecting Bardac Drives Options

All Bardac Drives options which require communication with the drive, such as the Optiport and Optipad remote keypads and Optistick connect to the P2 Solar Pump drive using the built in RJ45 connection point. The pin connections on these options are already matched, such that a simple pin to pin plug in cable can be used to connect these options without any special requirements. For further information on connecting and using these optional items, refer to the specific option User guide.

8.4.3. Connecting to a PC

The P2 Solar Pump drive may be connected to a PC with Microsoft Windows operating system to allow use of the Optitools Studio PC software for commissioning and monitoring. There are two possible methods of connection as follows:-

- Wired Connection. Requires the optional PC connection kit OPT-2-USB485-OBUS which provides a USB to RS485 serial port conversion and premanufactured RJ45 connection.
- Bluetooth Wireless Connection. Requires the optional Optistick OPT-2-STICK. The PC must have Bluetooth onboard or a suitable Bluetooth dongle which can support a Bluetooth serial connection.

With either communication method, the steps to establish a connection between the PC and drive are as follows:-

- Download and install the Optitools Studio PC software to the PC
- Start the software, and select the Parameter Editor function
- If the drive address has been changed in parameter P5-01, ensure that in the Optitools Studio software the Network Scan Limit setting in the lower left corner of the screen is set to the same or higher value.
- In Optitools Studio select Tools > Communication Type
  - If using the Optistick, Select BlueTooth
  - If using the wired PC connection kit, select RS485
- In Optitools Studio select Tools > Select COM Port > Select the COM port associated with the connection
- Click the Scan Drive Network button in the lower left corner of the screen.

8.4.4. Modbus RTU Connection

P2 supports Modbus RTU communication, for further information refer to section 9.2. Modbus RTU Communications on page 60.

8.4.5. BACnet Connection

8.4.6. Other Fieldbus Networks

8.4.7. Communication Parameters

Par	Name			Minimum	Maximum	Default	Units
P5-01	**Drive Fieldbus Address**			**0**	**63**	**1**	**-**
	Sets the Fieldbus address for the P2. When using Modbus RTU, this parameter sets the Node Address. Refer to section 9.2. Modbus RTU Communications for further information. When Using BACnet MS/TP, this parameter sets the MAC ID. Refer to section 11.3 for further information.						
P5-03	**Modbus RTU / BACnet MSTP 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, 76.8kbps						
P5-04	**Modbus RTU / BACnet MSTP Data Format**			**-**	**-**	**-**	**-**
	Sets the expected Modbus 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**	**2.0**	**Seconds**
	Sets the watchdog time period for the communications channel. If a valid telegram is not received by the P2 within this time period, the drive will assume a loss of communications has occurred and react as selected below. Setting to zero disables the function.						
P5-06	**Communications Loss Action**			**0**	**3**	**0**	**-**
	0	**Trip & Coast To Stop**					
	1	**Ramp to Stop Then Trip**					
	2	**Ramp to Stop Only (No Trip)**					
	3	**Run at Preset Speed 8**					
P5-07	**Fieldbus Ramp Control**			**0**	**1**	**0**	**-**
	0	**Disabled**	Ramps are control from internal drive parameters P1-03 and P1-04.				
	1	**Enabled**	Ramps are controlled directly by the Fieldbus PDI4 Data Word				
P5-08	**Fieldbus Process Data Output Word 4 Select**			**0**	**4**	**0**	**-**
	0	**Motor Current**	0 to 2000 = 0 to 200.0%				
	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 Heatsink Temperature**	0 to 100 = 0 to 100°C				
	5	**User Register 1**	User Defined Register 1 Value				
	6	**User Register 2**	User Defined Register 2 Value				
	7	**P0-80 value**	User Selected data value				
P5-09	**BACnet Device Instance Number (Low)**			**0**	**65535**	**0**	**-**
P5-10	**BACnet Device Instance Number (High)**			**0**	**63**	**0**	**-**
	When using BACNet MS/TP, these parameter together allow a unique Device Instance Number to be programmed into the drive. For further information on using BACnet MS/TP, refer to section 11.3						
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. Refer to section 11.3 for further information. 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.						

Par	Name			Minimum	Maximum	Default	Units
P5-12	**Fieldbus Process Data Output Word 3 Select**			**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** – Output current to 1 decimal place, e.g. 100 = 10.0 Amps **1: Power (x.xx kW)** 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 Heatsink Temperature** – 0 to 100 = 0 to 100°C **5: User register 1** – User Defined Register 1 Value **6: User register 2** – User Defined Register 1 Value **7: P0-80 value** – User Selected data value.						
P5-13	**Fieldbus Ramp Control**			**0**	**1**	**0**	**-**
	0	**Fieldbus Ramp Control**	This option must be selected if the drive acceleration and deceleration ramps are to be controlled from the fieldbus. P5-07 must also be set to 1 to enable this function				
	1	**User register 4**	The value received by the drive in PDI 4 is transferred to User Register 4. This option allows the function of the process data word to be defined in Parameter Group 9. In this case, User Register 4 should not be written to within any PLC function code, although the value can be read				
P5-14	**Fieldbus Process Data Input Word 3 Select**			**0**	**2**	**0**	**-**
	0	**Torque limit/reference**	This option must be selected if the drive output torque limit / setpoint is to be controlled from the fieldbus. This also requires setting P4-06 = 3				
	1	**User PID reference register**	This option allows the setpoint to the PID controller to be received from the Fieldbus. In order for this option to be used, P9-38 must be set to 1, and the PID User setpoint must not be utilised within the PLC function				
	2	**User register 3**	The value received by the drive in PDI 3 is transferred to User Register 3. This option allows the function of the process data word to be defined in Parameter Group 9. In this case, User Register 3 should not be written to within any PLC function code, although the value can be read.				
P5-15	**Modbus Response Delay**			**0**	**16**	**0**	**Chr**
	Allows the user to configure an additional delay between the drive receiving a request via the Modbus RTU interface, and transmitting a reply. The value entered represents the delay in addition to the minimum delay permissible according to the Modbus RTU specification, and is expressed as the number of additional characters.						

8.5. Advanced Parameters

For Advanced Parameters, basic information only is provided in this guide. The parameter functions are described more fully in Optitools Studio PC software.

8.5.1. Parameter Group 6 – Advanced Configuration

Par.	Function	Setting Range		Default	Notes
P6-01	Enable Firmware Upgrade	0	Disabled	0	This parameter should not be adjusted by the user.
		1	I/O and DSP Upgrade		
		2	I/O Upgrade		
		3	DSP Upgrade		
P6-02	Automatic Thermal management Minimum Effective Switching Frequency	4 – 32kHz (Model Dependent)		4 kHz	This parameter defines the minimum effective switching frequency which the drive will use. During operation, the drive measures the power module temperature and will switch automatically to a lower switching frequency if the temperature reaches a pre-defined limit. This parameter determines the lowest frequency that can be used. In the event that the power module temperature continues to increase, the drive will trip on over temperature.
P6-03	Auto Reset Time Delay	1 – 60 Seconds		20s	Sets the delay time which will elapse between consecutive drive reset attempts when Auto Reset is enabled in P2-36
P6-04	Relay Output Hysteresis	0.0 – 25.0%		0.3%	This parameter works in conjunction with P2-11 and P2-13 = 2 or 3 to set a band around the target speed (P2-11 = 2) or zero speed (P2-11 = 3). When the speed is within this band, the drive is considered to be at target speed or Zero speed. This function is used to prevent "chatter" on the relay output if the operating speed coincides with the level at which the digital / relay output changes state. e.g. if P2-13 = 3, P1-01 = 50Hz and P6-04 = 5%, the relay contacts close above 2.5Hz

Par.	Function	Setting Range		Default	Notes
P6-08	Maximum Speed Reference Frequency	0 – 20kHz		0 kHz	When the motor speed reference is to be controlled by a frequency input signal (connected to Digital input 3), this parameter is used to define the input frequency which corresponds to the maximum motor speed (set in P1-01). This maximum frequency that can be set in this parameter must be in the range 5kHz to 20kHz. When set to 0, this function is disabled.
P6-10	Function Block Program Enable	0	Disabled	0	This parameter must be set to 1 to enable any Function Block Program loaded into the drive to operate. When set to 0, the Function Block Program will be disabled.
		1	Enabled		
P6-11	Speed Hold Time on Enable	0 – 250s		0s	Defines a time period for which the drive will run at Preset Speed 7 (P2-07) when the Enable signal is applied to the drive. The preset speed can be any value from minimum to maximum frequency and in either direction. This function can be useful in applications requiring controlled start-up behaviour regardless of the normal system operation, and allows the user to program the drive to always start at the same frequency, with the same direction of rotation for a specified time period before returning to normal operation. This function can be used with pumps to provide a reverse spin on start-up to clear any potential blockages.
P6-12	Speed Hold / DC Injection Time on Disable	0 – 250s		0s	When P6-18 = 0, defines a time period for which the drive will run at Preset Speed 8 (P2-08) following removal of the Enable signal, before ramping to stop **Note:** Setting this parameter > 0 will result in the drive continuing to operate for the set time at the preset speed after the enable signal has been removed. It is important to ensure this method of operation is safe prior to using this function
P6-18	DC Injection Current	0.0 – 100.0%		0.0%	Defines the DC current level as a percentage of motor rated current (P1-08) that is applied to the motor when a stop command is received and the DC Injection function is activated.
P6-22	Reset Fan Run Time	0	No Reset	0	Setting to 1 resets the internal Fan run-time counter to zero (as displayed in Index 1 of P0-35).
		1	Reset		
P6-23	Reset Energy Meters	0	No Reset	0	Setting to 1 resets internal kWh meter to zero (as displayed in Index 1 of P0-26 and Index 1 of P0-27).
		1	Reset		
P6-24	Maintenance Time Interval	0 – 60000 Hours		0 Hours	Allows the user to define a maintenance interval period for the application. This defines the total number of run time hours which must elapse before the service indicator is displayed. This may be viewed on the drive OLED display, may be programmed to a relay output, and also sets a bit in the drive status word. When P6-25 is set to 1, the internal service interval counter is set to this value
P6-25	Reset Maintenance Time	0	No Reset	0	When this parameter is set to 1, the internal service interval counter is set to the value defined in P6-24
		1	Reset		
P6-26	Analog Output 1 Scaling	0.0 – 500.0%		100.0%	Defines the scaling factor as a % used for Analog Output 1
P6-27	Analog Output 1 Offset	-500.0 – 500.0%		0.0%	Defines the offset as a % used for Analog Output 1
P6-28	P0-80 Display Value	0 - 200		0	This parameter defines the index of the internal variable, the value of which will be displayed in P0-80. This is usually used in conjunction with the Function Block Program. Refer to section 1.6 for further information
P6-29	Save User Parameters	0	No Function	0	Setting this parameter to 1 saves the present drive parameter settings to the User Default Parameters Memory. Following this, if the User carries out a 3-button default parameter command (UP, DOWN and STOP), the parameter saved at this time will be restored. Setting 2 clears the User Default Parameters Memory.
		1	Save Parameters		
		2	Clear Parameters		
P6-30	Advanced Access Code	0 – 9999		201	Defines the access code which must be entered into P1-14 to allow access to the Advanced Parameters.

8.5.2. Parameter Group 7 – Motor Control

Par.	Function	Setting Range	Default	Notes
P7-01	MeasuredMotor Stator Resistance	0.000 – 65.535	Drive Dependent	Motor date, measured or calculated curing the autotune. P7-04 is not used for PM & BLDC Motors P7-06 is used only for PM motors
P7-03	Motor Stator Inductance	0.0000 – 1.0000		
P7-04	Motor Magnetising Current	Drive Dependent		
P7-05	Motor Leakage Coefficient (Sigma)	0.000 – 0.250		
P7-06	Motor Q Axis Inuctance (Lsq)	0.0000 – 1.0000		
P7-09	Over Voltage Current Limit	0.0 – 100.0%	5.0%	Effective in vector speed control mode only, and will come into function once the drive DC bus voltage increases above a preset limit. This voltage limit is set internally just below the over voltage trip level. This parameter will effectively limit the output torque current in order to prevent a large current flowing back to the drive, which may cause an Over-voltage trip. A small value in this parameter will limit the motor control torque when the drive DC bus voltage exceeds the preset limit. A higher value may cause a significant distortion in the motor current, which may cause an aggressive, rough motor behaviour
P7-10	System Inertia Constant	0 - 600	10	System Load Inertia to Motor Inertia Ratio entered as H = (JTot / JMot). This value can normally be left at the default value (10) and is used by the drive control algorithms as a feed-forward control variable to provide optimum torque current to accelerate the load. Hence accurate setting of the inertia ratio will produce a better system response and dynamic behaviour.
P7-11	Pulse Width Minimum Limit	0 - 500		This parameter is used to limit the minimum output pulse width, which can be used for long motor cable applications. Increasing the value of this parameter will reduce the risk of over-current trips, but will also reduce the maximum available output motor voltage.
P7-12	Magnetising Period	0 – 5000ms	Drive Dependent	Sets the motor magnetising period in V/F Mode Sets the motor alignment time in PM modes
P7-14	Low Frequency Torque Boost Current	0.0 – 100.0%	0.0%	For PM Motors, applies a torque boost current at low frequency, % x P1-08
P7-15	Low Frequency Torque Boost Frequency Limit	0.0 – 50.0%	0.0%	For PM motors, determines the frequency, % x P1-09 when the boost current is removed
P7-18	Over-modulation Enable	0 Disable 1 Enable 2 Auto	2	When enabled, over modulation provides a small increase in the available output voltage from the drive, which can assist in applications where the supply voltage is too low to provide the required motor voltage, resulting in an increased motor current
P7-19	BLDC Light Load Optimization	0 Disable 1 Enable	0	When enabled and the drive is set in BLDC Mode (P4-01 = 4), the drive will reduce the output voltage during light load operation in order to improve motor efficiency and performance. This setting has no effect when the motor is significantly loaded.

8.5.3. Parameter Group 8 – Application Parameters

Par	Name	Minimum	Maximum	Default	Units
P8-01	**Pump Stir Interval Duration**	**0**	**60000**	**0**	**Minute**
	Sets the duration that the drive will remain in 'standby' for before it activates a stir profile. Setting this value to zero disables the pump stir function.				
P8-02	**Pump Stir Activation Time**	**1**	**6000**	**10**	**s**
	Sets the time duration for the stir cycle once activated				
P8-03	**Pump Clean Function Select**	**-**	**-**	**-**	**-**
	Determines the conditions that trigger the pump clean cycle				
	0 Disabled				
	1 Active on start-up				
	2 Active on start-up and over-torque detection				
	3 Active on over-torque detection only				

Par	Name		Minimum	Maximum	Default	Units
P8-04	**Pump Clean Duration**		**0**	**600**	**0**	**Seconds**
	Sets the time period for the operation of the pump clean cycle. If bi-directional pump cleaning is used, this duration will be used twice – once in the reverse direction and once again in the positive direction					
P8-05	**Pump Clean Function Ramp Time**		**0**	**6000**	**30**	**Seconds**
	Acceleration ramp that is used only during a pump clean cycle					
P8-06	**Load Monitor Enable**		**0**	**4**	**0**	**-**
	0	**Disable**				
	1	**Low current detection (under-torque)**				
	2	**High current detection (over-torque)**				
	3	**High and low current detection (over and under-torque)**				
	4	**High and low current detection (over and under-torque) – No Trip**				
P8-07	**Load Profile Monitoring Bandwidth**		**0**	**1**	**0**	**A**
	This 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 set in P8-08 then the drive will detect the over/under load condition. The value entered in P8-07 is the value between the 'normal' current and the over/under load condition hence the total bandwidth is 2 x P8-07.					
P8-08	**Load monitoring trip delay**		**0**	**60**	**0**	**s**
	This 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 set in P8-08 then the drive will detect the over/under load condition. The value entered in P8-07 is the value between the 'normal' current and the over/under load condition hence the total bandwidth is 2 x P8-07.					
P8-09	**User PID Proportional Gain 2**		**0.1**	**30.0**	**1.0**	**-**
	This gain is active when the error between the actual dc bus voltage and the setpoint is within the transition band set in P8-12. This can be used to have a softer response when you are closer to the set-point. Higher values provide a greater change in the drive output frequency in response to small changes in the feedback signal. Too high a value can cause instability					
P8-10	**User PID Integral Time Constant 2**		**0.0**	**30.0**	**1.0**	**s**
	This gain is active when the error between the actual dc bus voltage and the setpoint is within the transition band set in P8-12. This can be used to have a softer response when you are closer to the set-point. Lower values provide a greater change in the drive output frequency in response to small changes in the feedback signal. Too low a value can cause instability					
P8-11	**User PID Error Dead-band**		**0.0**	**20.0**	**0.2**	**%**
	This is the bandwidth (above and below the User PID Reference/Setpoint) within which the drive must not change the PID output, the speed will therefore be stable between these limits. The deadband is always related to PID reference (P3-05). This function is disabled when P8-11 is set to zero. If P8-11 > 0, the deadband is the percentage added above and subtracted below the PID reference. If the PID feedback is between these limits and after the delay time set but P8-13, the PID output is not modified and holds the last value. If P8-11 > 0, P8-12 has no effect. If the error goes beyond the bandwidth, the PID output will change immediately without delay.					
P8-12	**User PI Gains Transition Band**		**0.0**	**20.0**	**0.2**	**%**
	This is the transition band between gains 1 and 2 which is active only if P8-11 = 0 and P8-12 > 0. When the PID feedback is inside this band the 2nd PI gains (P8-09 and P8-10) are selected after the time delay set in P8-13. This allows for a slower reaction when close to the PID reference. The delay is only active when transitioning from the primary gains (P3-01 and P3-02) to the 2nd gains (P8-09 and P8-10).					
P8-13	**User PI Gains Transition Delay**		**0.0**	**20.0**	**0.2**	**%**
	This is the time delay that must elapse before either the deadband is applied (if P8-11>0) OR the PI gains transition is applied (if P8-11=0 and P8-12 >0) when operating in the deadband defined by P8-12.					
P8-14	**Standby Mode**		**0**	**2**	**0**	**-**
	This parameter selects the operation of the standby mode. P8-14 = 0 – the drive will go into standby based on the operating speed of the motor with the level set in P3-14. P8-14 = 1 – the PID feedback value will be used for standby and wake-up control with the standby and wake-up levels being set in P8-15 and P8-16 P8-14 = 2 – the analogue input 1 value will be used for standby and wake-up control. The standby and wake-up levels being set in P8-15 and P8-16 When P8-14 > 0, the speed boost functions when entering and exiting standby are automatically disabled.					

Par	Name	Minimum	Maximum	Default	Units
P8-15	**Standby Activation Level**	**0.0**	**100.0**	**0.0**	**%**
	Specifies the level for activation of the standby function. **If P8-14 = 1:** When the PID is operated in direct mode (P3-04 = 0), if the level of the PID feedback is higher than this level the drive will enter in Standby mode after the time set in P2-27. The delay timer will be reset to 0 if the feedback goes below this level before entering standby mode. When the PID is operated in inverse mode (P3-04 = 1), if the level of the PID feedback is lower than this level the drive will enter in Standby mode after the time set in P2-27. The delay timer will be reset to 0 if the feedback goes above this level before entering standby mode. **If P8-14 = 2:** If the level of analogue input 1 is lower than this level the drive will enter in standby mode after the time set in P2-27. The delay timer will be reset to 0 if the value of analogue input 1 goes above this level before entering into standby mode. If P2-27 is 0, the drive will never enter standby mode. It is very important for Solar applications using MPPT or DC Bus Voltage feedback mode (P3-05 = 3 or P3-10 = 3) and P8-14 is set to 1 or 2, the drive always starts in Standby mode after a power on cycle (start of day). This is very important for the following reason: When the solar panels start to deliver energy first time in the morning there will not yet be enough energy to run the motor. For this reason the drive must always start in Standby mode and the wake up procedure is defined in P8-16.				
P8-16	**Standby Wake-up Level**	**0.0**	**100.0**	**0.0**	**%**
	Specifies the level for the drive to wake up from a standby condition. **If P8-14 = 1:** When the PID operates in direct mode (P3-04=0), if the level of the PID feedback is lower than this level, the drive will wake up after the time set up in P8-17 has elapsed. The delay timer will reset to 0 if the feedback goes above this level in the meantime. When the PID operates in inverse mode (P3-04=1), if the level of the PID feedback is higher than this level, the drive will wake up after the time set up in P8-17 has elapsed. The delay timer will reset to 0 if the feedback goes below this level in the meantime. **If P8-14 = 2:** If the level of Analogue Input 1 is higher than this level, the drive will wake up after the time set up in P8-17 has elapsed. The delay timer will reset to 0 if Analogue Input 1 goes below this level in the meantime.				
P8-17	**Standby Wake-up Delay Time**	**0.0**	**250.0**	**0.0**	**s**
	This delay works in conjunction with P8-16 when the drive wakes up from a standby condition.				
P8-18	**MPPT Controller Minimum Voltage**	**0**	**-**	**-**	**V**
	This parameter defines the minimum DC Bus voltage at which the MPPT controller will operate at. When the DC Bus voltage is below the level set in this parameter, the MPPT will not be active.				
P8-19	**MPPT Controller Maximum Voltage**	**0**	**-**	**-**	**V**
	This parameter defines the maximum DC Bus voltage at which the MPPT controller will operate at. When the DC Bus voltage is above the level set in this parameter, the MPPT will not be active.				
P8-20	**MPPT Controller Voltage Steps**	**1**	**30**	**5**	**V**
	This parameter defines the voltage steps for the MPPT controller. Setting a high value here will make the MPPT controller respond quicker but with a lower resolution. Setting a lower value will give higher resolution but with a slower response.				

8.5.4. Parameter Group 9 – User Inputs and Output Programming

Par.	Function	Setting Range		Default	Notes
P9-01	Enable Input Source	These parameters allow the user to directly select the source of the various command points. Parameters are only adjustable if P1-13 = 0. This allows complete flexibility over the drive control functions, and interaction with the internal Function Block programming environment.			
P9-02	Fast Stop Source				
P9-03	Run Forward Source				
P9-04	Run Reverse Source				
P9-05	Latch Enable	0	Disabled	0	
		1	Enabled		
P9-06	Reverse Input Source	See above			
P9-07	Reset Source				
P9-08	External Trip Source				
P9-09	Terminal Control Overide Source				
P9-10	Speed Source 1	In combination with P9-18 – P9-20, allow selection of several speed reference sourcesfor common applications.			
P9-11	Speed Source 2				
P9-12	Speed Source 3				
P9-13	Speed Source 4				
P9-14	Speed Source 5				
P9-15	Speed Source 6				
P9-16	Speed Source 7				
P9-17	Speed Source 8				

Par.	Function	Setting Range		Default	Notes
P9-18	Speed Select Input 0	See above			
P9-19	Speed Select Input 1				
P9-20	Speed Select Input 2				
P9-21	Preset Speed Select Input 0				
P9-22	Preset Speed Select Input 1				
P9-23	Preset Speed Select Input 2				
P9-28	MOP Up Source				
P9-29	MOP Down Source				
P9-33	Analog Output 1 Control	0	P2-11	0	These parameters allow the user to overdide the normal parameter control source for the associated function, allowing interaction with the internal Function Block programming environment.
		1	Function Block Digital		
		2	Function Block Analog		
P9-34	Analog Output 2 Control	0	P2-13	0	
		1	Function Block Digital		
		2	Function Block Analog		
P9-35	Relay 1 Control	0	P2-15	0	
		1	Function Block Digital		
P9-36	Relay 2 Control	0	P2-18	0	
		1	Function Block Digital		
P9-37	Display Scaling Control	0	P2-21	0	
		1	Function Block Digital		
P9-38	PID Setpoint Control	0	P3-05	0	
		1	Function Block Digital		
P9-39	PID Feedback Control	0	P3-10	0	
		1	Function Block Digital		
P9-41	Relay 3, 4 and 5 Control	0	Default Settings	0	
		1	Function Block Digital		
P9-42	Clean Trigger Input (Edge Trigger)				
P9-44	PID 2nd Digital Reference Select Input				

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

Par.	Function	Units
P0-01	Analog Input 1 Scaled Signal Level	%
P0-02	Analog Input 2 Scaled Signal Level	%
P0-03	Digital Input Status – Bit representation (0 or 1) where the left most digit indicates the status of Digital Input 1	N/A
P0-04	Pre-Ramp Speed Reference	Hz / RPM
P0-05	Torque Reference / Limit	%
P0-06	Digital (Keypad) Speed Reference	Hz / RPM
P0-07	Fieldbus Speed Reference	Hz / RPM
P0-08	PID Reference (Setpoint)	%
P0-09	PID Feedback	%
P0-10	PID Output	%
P0-11	Applied Motor Voltage	V
P0-12	Output Torque	%
P0-13	Trip Log – Last 4 Trips	N/A
P0-14	Motor Magnetising Current Id	A
P0-15	Motor Rotor Current Iq	A
P0-16	DC Voltage Ripple	V
P0-17	Motor Stator Resistance Rs	Ω
P0-18	Motor Stator Inductance Ls	H
P0-19	Motor Rotor Resistance Rr	Ω
P0-20	DC Bus Voltage	V
P0-21	Drive Temperature	C
P0-22	Remaining Service Time	Hours
P0-23	Operating Time Heatsink > 85 C	HH:MM:SS
P0-24	Operating Time High Ambient Temperature	HH:MM:SS

Par.	Function	Units
P0-25	Rotor Speed	Hz / RPM
P0-26	Energy consumption kWh	kWh
P0-27	Energy Consumption MWh	MWh
P0-28	Drive firmware version	N/A
P0-29	Drive Type	N/A
P0-30	Drive serial number	N/A
P0-31	Drive Lifetime	HH:MM:SS
P0-32	Run time since last trip 1	HH:MM:SS
P0-33	Run time since last trip 2	HH:MM:SS
P0-34	Last operating time	HH:MM:SS
P0-35	Cooling fan operating time	Hours
P0-36	DC Bus Voltage Log : 8 samples, 256ms	V
P0-37	DC Bus Ripple Log : 8 samples 20ms	V
P0-38	Heatsink Temperature Log : 8 samples, 30s	C
P0-39	Ambient temperature log : 8 samples, 30s	C
P0-40	Motor Current Log : 8 samples 256ms	A
P0-41	Over current trip count	N/A
P0-42	Over voltage trip count	N/A
P0-43	Under voltage trip count	N/A
P0-44	Over temperature trip count	N/A
P0-45	Brake resistor over current trip count	N/A
P0-46	Ambient over temperature trip count	N/A
P0-47	I/O processor error count	N/A
P0-48	DSP error count	N/A
P0-49	Modbus RTU . BACnet MSTP error count	N/A
P0-51	PDI cyclic data	N/A
P0-52	PDO cyclic data	N/A
P0-53	U phase offset and reference	N/A
P0-54	V phase offset and reference	N/A
P0-55	Last Fire Mode Activation Time	Hours
P0-56	Fire Mode Activation Period	Minute
P0-57	Ud / Uq	N/A
P0-58	Load Torque Profile Current Values	Hz / RPM
P0-59	Frequency input reference	Hz / RPM
P0-60	Fire Mode Total Activation Time	Minute
P0-61	Relay Hysteresis value	Hz / RPM
P0-62	Fire Mode Activation Counter	N/A
P0-63	Post ramp speed reference	Hz / RPM
P0-64	Effective switching frequency	kHz
P0-65	Drive life time	HH:MM:SS
P0-66	Function block program ID	N/A
P0-67	Overload Integration Level	%
P0-68	User ramp value	S
P0-69	I2C error count	N/A
P0-70	Option module type	N/A
P0-71	Fieldbus interface type	N/A
P0-72	Ambient temperature	C
P0-73	24 hour timer	Minute
P0-74	L1 – L2 input voltage	V
P0-75	L2 – L3 input voltage	V
P0-76	L3 – L1 input voltage	V
P0-77	Test parameter 1 / 2	N/A
P0-78	Test parameter 3 / 4	N/A
P0-79	Motor control & DSP version	N/A
P0-80	User specified internal value (P6-28)	N/A

9. Serial communications

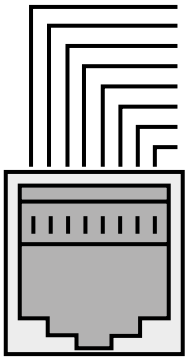
9.1. RJ45 Connector Pin Assignment

The P2 Solar Pump drive has an RJ45 connector on the front of the control panel. This connector allows the user to set up a drive network via a wired connection. The connector contains multiple interfaces for different communication protocols:-

- Bardac's Optibus Protocol - Used for PC and peripheral connection only
- Modbus RTU
- BACnet MSTP

The Optibus connection is always available, and can be used simultaneously with other interfaces, however only one other interface may be used, e.g. If Modbus RTU is in use, BACnet is disabled. If a Fieldbus Option Module (E.g. Profibus) is inserted into the drive, both Modbus and BACnet are disabled.

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



1	Not used
2	Not used
3	0 Volts
4	-RS485 (PC)
5	+RS485 (PC)
6	+24 Volt
7	-RS485 (Modbus RTU)
8	+RS485 (Modbus RTU)

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

Warning:
When using Modbus RTU or BACnet, ensure that the 0V signal (T3) is also used to avoid comms errors and potentially damaging common mode voltages

9.2. Modbus RTU Communications

9.2.1. Modbus Telegram Structure

The P2 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 0 by subtracting 1 to obtain the correct Register address. The telegram structure is as follows:

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

Slave Response	**Length**	
Slave Address	1	Byte
Function Code (03)	1	Byte
Byte Count	1	Byte
1st Register Value	2	Bytes
2nd Register Value	2	Bytes
Etc...		
CRC Checksum	2	Bytes

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

Slave Response	**Length**	
Slave Address	1	Byte
Function Code (06)	1	Byte
Register Address	2	Bytes
Register Value	2	Bytes
CRC Checksum	2	Bytes

9.2.2. Modbus Control & Monitoring Registers

The following is a list of accessible Modbus Registers available in the P2.

- 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 3 can be used to control the output torque level providing that
  - The drive is operating in Vector Speed or Vector Torque motor control modes (P4-01 = 1 or 2)
  - The torque controller reference / limit is set for 'Fieldbus' (P4-06 = 3)
- 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 P2 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	Setpoint must be sent to the drive in Hz to one decimal place, e.g. 500 = 50.0Hz
3	Command Torque Reference		R/W	Setpoint must be sent to the drive in % to one decimal place, e.g. 2000 = 200.0%
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 Bit 2 : No Function Bit 3 : Drive Ready, 1 = Drive Inhibit Bit 4 : Maintenance Time Not Reached, 1 = Maintenance Time Reached Bit 5 : 0 = Not In Standby (Sleep), 1 = Standby (Sleep) mode active Bit 6 : No function Bit 7 : 0 = Normal condition, 1 = Low or High Load condition detected The Upper Byte will contain the relevant fault number in the event of a drive trip. Refer to section 11.1. Fault messages for a list of fault codes and diagnostic information. Bit 8 : No Function The Upper Byte will contain the relevant fault number in the event of a drive trip. Refer to section 11.1. Fault messages 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 setpoint
23	DC bus voltages		R	Measured DC Bus Voltage in Volts
24	Drive temperature		R	Measured Heatsink Temperature in °C

9.2.3. 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. Some parameters are internally scaled, for further information refer to the P2 Modbus Register Map Application Note, or Advanced User Guide.

E.g. Parameter P1-03 = Modbus Holding Register 103.

Since Modbus RTU supports sixteen bit integer values only, and the parameter is adjustable to one decimal place, the register value will be multiplied by a factor of ten,

E.g. Read Value of P1-03 = 50, therefore this is 5.0 seconds.

10. Technical Data

10.1. Environmental

Ambient Temperature	Storage and Transportation	All Units	-40 ... 60°C / -40 ... 140°F	
	Operating	IP20 Units	-10 ... 50°C / 14 ... 122°F	
		IP55 Units	- 10 ... 40°C / 14 ... 104°F	UL Approved
			40 ... 50°C / 104 ... 122°F	With derating (refer to section 10.3.1. Derating for Ambient Temperature on page 64)
		IP66 Units	- 10 ... 40°C / 14 ... 104°F	UL Approved
			40 ... 50°C / 104 ... 122°F	With derating (refer to section 10.3.1. Derating for Ambient Temperature on page 64)
Altitude	Operating	All Units	=<1000m	With UL approval
			=<4000m	With derating (refer to section 10.3.2. Derating for Altitude on page 64)
Relative Humidity	Operating	All Units	< 95%	non-condensing, frost and moisture free

10.2. Output Power and Current ratings

The following tables provide the output current rating information for the various P2 models. Bardac Drives always recommend that selection of the correct P2 is based upon the motor full load current at the incoming supply voltage. The PV DC Supply Fuse rating and type can be calculated based on the drive rated output current multiplied by the rated output voltage divided by the array Vmpp. In the table below, the figure used for the Vmpp is 325Vdc for the 240Vac product and 565Vdc for the 440V product.

10.2.1. 200 – 240 Volt (+/- 10%),1 Phase Input, 3 Phase Output

Frame Size	Power Rating		Fuse or MCB (Type B)			Maximum Cable Size		Rated Output Current	Maximum Motor Cable Length	
			PV dc Supply		1-Phase AC Supply					
	kW	HP	UR	gG	gG	mm	AWG/kcmil	A	m	ft
2	0.75	1	6	15	8	8	4.3	330	100	330
2	1.5	2	6	20	8	8	7	330	50	330
2	2.2	3	10	25	8	8	10.5	330	35	330

10.2.2. 200 – 240 Volt (+/- 10%), 3 Phase Input, 3 Phase Output

Frame Size	Power Rating		Fuse or MCB (Type B)			Maximum Cable Size		Rated Output Current	Maximum Motor Cable Length	
			PV dc Supply		3-Phase AC Supply					
	kW	HP	UR	gG	gG	mm	AWG/kcmil	A	m	ft
2	0.75	1	6	10	8	8	4.3	330	100	330
2	1.5	2	6	15	8	8	7	330	50	330
2	2.2	3	10	17.5	8	8	10.5	330	35	330
3	4	5	16	30	8	8	18	330	20	330
3	5.5	7.5	20	40	8	8	24	330	20	330
4	7.5	10	25	50	16	5	30	330	22	330
4	11	15	40	70	16	5	46	330	22	330
5	15	20	50	90	35	2	61	330	12	330
5	18.5	25	63	110	35	2	72	330	12	330
6	22	30	80	150	150	300MCM	90	330	6	330
6	30	40	90	175	150	300MCM	110	330	6	330
6	37	50	125	225	150	300MCM	150	330	6	330
6	45	50	150	250	150	300MCM	180	330	6	330
7	55	50	175	300	150	300MCM	202	330	6	330
7	75	50	200	350	150	300MCM	248	330	6	330

NOTE:

- Ratings shown above apply to 40°C Ambient temperature. For derating information, refer to section 10.3.1. Derating for Ambient Temperature
- Operation with single phase supply is possible, with 50% derating of the output current capacity
- 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 Bardac 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. Bardac 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

10.2.3. 380 – 480 Volt (+ / - 10%), 3 Phase Input, 3 Phase Output

Frame Size	Power Rating		Fuse or MCB (Type B)			Maximum Cable Size		Rated Output Current	Maximum Motor Cable Length	
			PV dc Supply		3-Phase AC Supply					
	kW	HP	UR	gG	gG	mm	AWG/kcmil	A	m	ft
2	0.75	1	6	6	8	8	2.2	100	330	330
2	1.5	2	6	10	8	8	4.1	100	330	330
2	2.2	3	6	10	8	8	5.8	100	330	330
2	4	5	10	15	8	8	9.5	100	330	330
3	5.5	7.5	15	25	8	8	14	100	330	330
3	7.5	10	20	30	8	8	18	100	330	330
3	11	15	25	40	8	8	24	100	330	330
4	15	20	32	50	16	5	30	100	330	330
4	18.5	25	32	60	16	5	39	100	330	330
4	22	30	40	70	16	5	46	100	330	330
5	30	40	50	80	35	2	61	100	330	330
5	37	50	64	100	35	2	72	100	330	330
6	45	60	70	125	150	300MCM	90	100	330	330
6	55	75	90	150	150	300MCM	110	100	330	330
6	75	100	125	200	150	300MCM	150	100	330	330
6	90	150	150	250	150	300MCM	180	100	330	330
7	110	175	150	300	150	300MCM	202	100	330	330
7	132	200	200	350	150	300MCM	240	100	330	330
7	160	250	250	400	150	300MCM	302	100	330	330
8	200	300	300	500	240	450MCM	370	100	330	330
8	250	350	350	600	240	450MCM	450	100	330	330

NOTE:

- Ratings shown above apply to 40°C Ambient temperature. For derating information, refer to section 10.3.1. Derating for Ambient Temperature
- Operation with single phase supply is possible, with 50% derating of the output current capacity
- 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 Bardac 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. Bardac 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
- Data values shown in Italics are provisional

10.3. 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 for enclosed drives (non UL approved)
- 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

10.3.1. Derating for Ambient Temperature

Enclosure Type	Maximum Temperature Without Derating (UL Approved)	Derate by	Maximum Permissible Operating Ambient Temperature with Derating (Non UL Approved)
IP20	50°C / 122°F	N/A	50°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

10.3.2. Derating for Altitude

Enclosure Type	Maximum Altitude Without Derating	Derate by	Maximum Permssable (UL Approved)	Maximum Permssable (Non-UL Approved)
IP20	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

10.3.3. Derating for Swicthing Frequency

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

10.3.4. Example of applying Derating Factors

A 4kW, IP66 drive is to be used at an altitude of 2000 metres above sea level, with 12kHz 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, 12kHz, 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.

11. Troubleshooting

11.1. Fault messages

Fault Code	No.	Description	Corrective Action
no-FLt	00	No Fault	Displayed in P0-13 if no faults are recorded in the log
OI-b	01	Brake channel over current	Ensure the connected brake resistor is above the minimum permissible level for the drive – refer to the ratings shown in section 10.2. Output Power and Current ratings. Check the brake resistor and wiring for possible short circuits.
OL-br	02	Brake resistor overload	The drive software has determined that the brake resistor is overloaded, and trips to protect the resistor. Always ensure the brake resistor is being operated within its designed parameter before making any parameter or system changes. To reduce the load on the resistor, increase deceleration the time, reduce the load inertia or add further brake resistors in parallel, observing the minimum resistance value for the drive in use.
O-I	03	Instantaneous over current on drive output. Excess load on the motor.	**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. If operating in Vector mode (P4-01 – 0 or 1), also check the motor power factor in P4-05 and ensure an autotune has been successfully completed for the connected motor. 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 **Fault Occurs When Running** If operating in Vector mode (P4-01 – 0 or 1), reduce the speed loop gain in P4-03
I_t-trP	04	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 10.2. Output Power and Current ratings Ensure the motor nameplate parameters are correctly entered in P1-07, P1-08, and P1-09 If operating in Vector mode (P4-01 – 0 or 1), also check the motor power factor in P4-05 and ensure an autotune has been successfully completed for the connected motor. 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-uoLt	06	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 or connect a suitable brake resistor to the drive. If operating in Vector Mode, reduce the speed loop gain P4-03 If operating in PID control, ensure that ramps are active by reducing P3-11
U-uoLt	07	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	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 parameter 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 sections 3.5. Guidelines for Enclosure mounting (IP20 Units), 3.6. Mounting the Drive – IP20 Units, 3.7. Guidelines for mounting (IP55 Units) and 3.8. Guidelines for mounting (IP66 Units) –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 occurs when ambient temperature is less than -10°C. The temperature must be raised over -10°C in order to start the drive.

Fault Code	No.	Description	Corrective Action
P-dEF	10	Factory Default parameters have been loaded	Press STOP key, the drive is now ready to be configured for the required application
E-tr iP	11	External trip	E-trip requested on control input terminals. Some settings of P1-13 require a normally closed contactor 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-0bS	12	Communications Fault	Communications lost with PC or remote keypad. Check the cables and connections to external devices
FLt-dc	13	Excessive DC Ripple	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 Bardac Drives Sales Partner
P-LoSS	14	Input phase loss trip	Drive intended for use with a 3 phase supply, one input phase has been disconnected or lost.
h O-I	15	Instantaneous over current on drive output.	Refer to fault 3 above
th-FLt	16	Faulty thermistor on heatsink.	Refer to your Bardac Sales Partner.
dAtA-F	17	Internal memory fault.	Parameters not saved, defaults reloaded. Try again. If problem recurs, refer to your IDL Authorised Distributor.
4-20F	18	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. Check the signal source and wiring to the P2 terminals.
dAtA-E	19	Internal memory fault.	Parameters not saved, defaults reloaded. Try again. If problem recurs, refer to your IDL Authorised Distributor.
U-dEF	20	User Parameter Defaults	User Parameter defaults have been loaded. Press the Stop key.
F-Ptc	21	Motor PTC Over Temperature	The connected motor PTC device has caused the drive to trip
FAn-F	22	Cooling Fan Fault	Check and if necessary, replace the drive internal cooling fan
O-hEAt	23	Ambient Temperature too High	The measured temperature around the drive is above the operating limit of the drive. Ensure the drive internal cooling fan is operating Ensure that the required space around the drive as shown in sections 3.5. Guidelines for Enclosure mounting (IP20 Units), 3.6. Mounting the Drive – IP20 Units, 3.7. Guidelines for mounting (IP55 Units) and 3.8. Guidelines for mounting (IP66 Units) – 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	Maximum Torque Limit Exceeded	The output torque limit has exceeded the drive capacity or trip threshold Reduce the motor load, or increase the acceleration time
U-tor9	25	Output Torque Too Low	Active only when hoist brake control is enabled P2-18 = 8. The torque developed prior to releasing the motor holding brake is below the preset threshold. Contact your local Bardac Sales Partner for further information on using the P2 in hoist applications.
OUt-F	26	Drive output fault	Drive output fault
Sto-F	29	Internal STO circuit Error	Refer to your Bardac Sales Partner
Enc-01	30	Encoder Feedback Fault	Encoder communication /data loss
SP-Err	31	Speed Error	Speed Error. The error between the measured encoder feedback speed or the estimated rotor speed is greater than the pre-set limit allowed.
Enc-03	32	Encoder Feedback Fault	Incorrect Encoder PPR count set in parameters
Enc-04	33	Encoder Feedback Fault	Encoder Channel A Fault
Enc-05	34	Encoder Feedback Fault	Encoder Channel B Fault
Enc-06	35	Encoder Feedback Fault	Encoder Channels A & B Fault

Fault Code	No.	Description	Corrective Action
AtF-01	40	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		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		Measured motor inductance is too low. Ensure the motor is correctly connected and free from faults.
AtF-04	43		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		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.
Ph-SEq	45	Input phase sequence incorrect	Applies to Frame Size 8 drives only, indicates that the incoming power supply phase sequence is incorrect. Any 2 phases may be swapped.
OUt-Ph	49	Output (Motor) Phase Loss	One of the motor output phases is not connected to the drive.
Sc-F01	50	Modbus comms fault	A valid Modbus telegram has not been received within the watchdog time limit set in P5-06 Check the network master / PLC is still operating Check the connection cables Increase the value of P5-05 to a suitable level
Sc-F02	51	CAN Open comms trip	A valid CAN open telegram has not been received within the watchdog time limit set in P5-06 Check the network master / PLC is still operating Check the connection cables Increase the value of P5-06 to a suitable level
Sc-F03	52	Communications Option Module Fault	Internal communication to the inserted Communication Option Module has been lost. Check the module is correctly inserted
Sc-F04	53	IO card comms trip	Internal communication to the inserted Option Module has been lost. Check the module is correctly inserted

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