



# GCTR2PCE

## Hydrocyclone Test Rig

### Operation and Maintenance Manual



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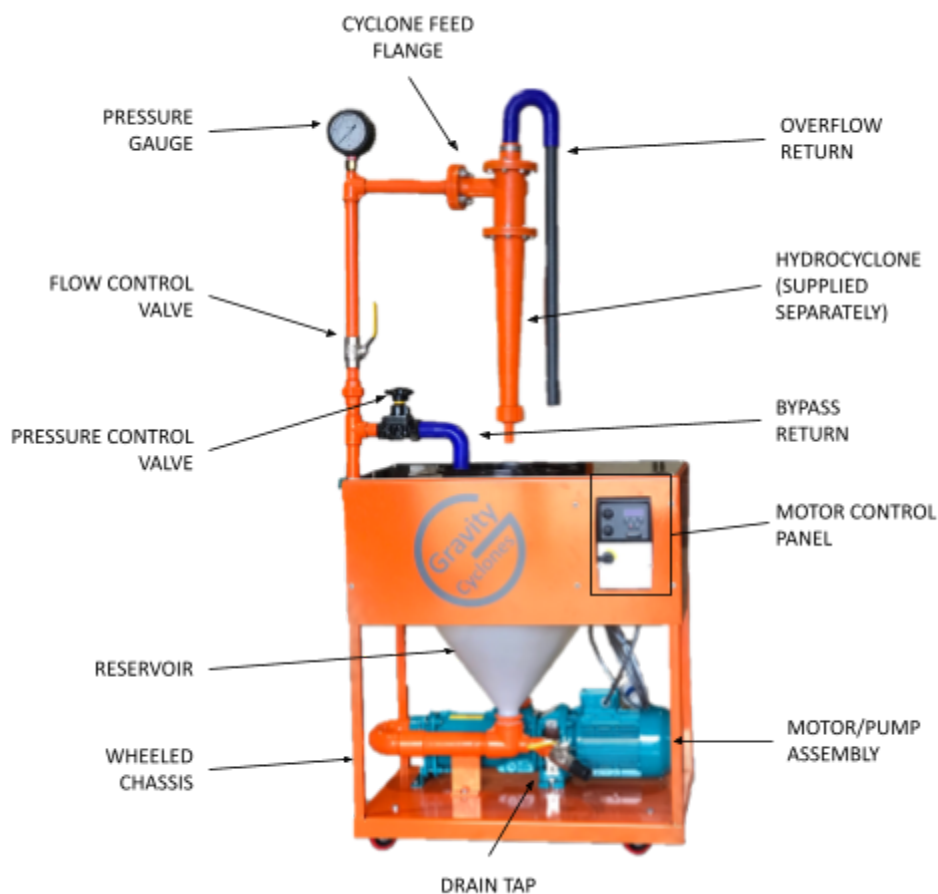
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## Overview & Location of Components

The GCTR2PCE Hydrocyclone Test Rig is designed to test hydrocyclones up to a diameter of 50mm. It employs a moving cavity pump driven by a variable speed electric motor which is powered by a controllable inverter. The feed slurry is contained in a 40L tank and is continually mixed by the bypass flow via the Pressure Control Valve. Flow to the cyclone is controlled by the Flow Control Valve with fine pressure control achieved by the Pressure Control Valve. Both the overflow and underflow from the cyclone are recycled to the reservoir tank.

## Location of Components



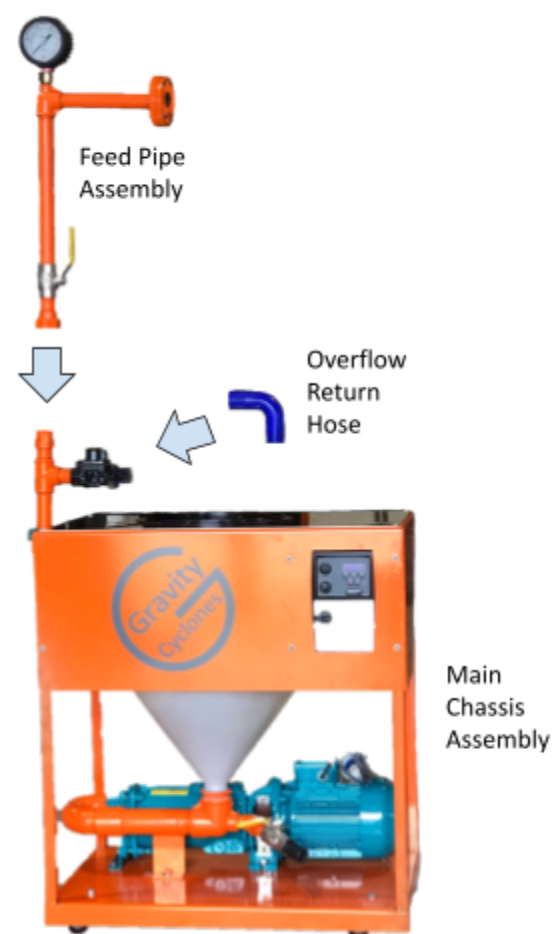
## Parts Supplied

- Main Chassis Assembly
- Feed Pipe Assembly
- Overflow Return Hose
- Reservoir Sieve
- Reservoir Cover
- Drain Hose
- Instruction Manual (electronic copy)

## Assembly

Please complete the final assembly before use.

1. Place the reservoir sieve into the bottom of the reservoir.
2. Place the Reservoir Cover onto the reservoir.
3. Attach the Feed Pipe Assembly to the Main Chassis Assembly via the feed pipe union taking care to ensure that the cyclone feed pipe is parallel to the main chassis.
4. Remove the Reservoir Cover and attach the Overflow Return Hose ensuring that flow is directed to the reservoir. Note that this can be removed to allow re-fitting of the Reservoir Cover but should always be replaced whenever the system is in use.
5. Attach the Drain Hose to the Drain Tap and direct to a suitable waste sump or drain.





## Electrical Supply Attachment

The electrical supply requirements will depend on the inverter specified.

Connection instructions are presented in Appendix 6, section 4.3.

## Care Points

- Always wear appropriate safety equipment.
- Only suitable for use on a flat hard floor.
- Disconnect electrical supply before undertaking any maintenance operation.
- The pump should not be run with an empty feed tank or with both the Flow and Pressure Control valves closed.
- Ensure the cyclone and overflow pipe is fitted before operation.
- Only suitable for use with water based slurries.
- Dispose waste slurry in a safe manner and clean after each use
- When starting the motor always ensure that the overflow valve is fully open and that the cyclone control valve is closed.
- Never exceed an inverter frequency of 60Hz.
- To prevent solids solidifying in the pump the system must be thoroughly cleaned after each use.
- Only use the power supply specified.
- Minor surface corrosion can form on the mild steel pipes and malleable iron pipe fittings used in the construction of this test rig. This is normal and does not affect the performance, however, a cleaning operation is recommended after transit or periods of extended storage.

## Hydrocyclone installation

- Always ensure that the Reservoir Cover is fitted before installing a cyclone.
- The Hydrocyclone inlet must be attached to the rig via the Cyclone Mounting Flange (EN 1092-1 DN25) with the underflow directed into the Reservoir Tank.
- An overflow return pipe should be fitted to direct overflow to the Reservoir Tank.
- For larger cyclones we recommended that a spray reducer is attached.
- Cyclone removal is the reverse of cyclone installation.



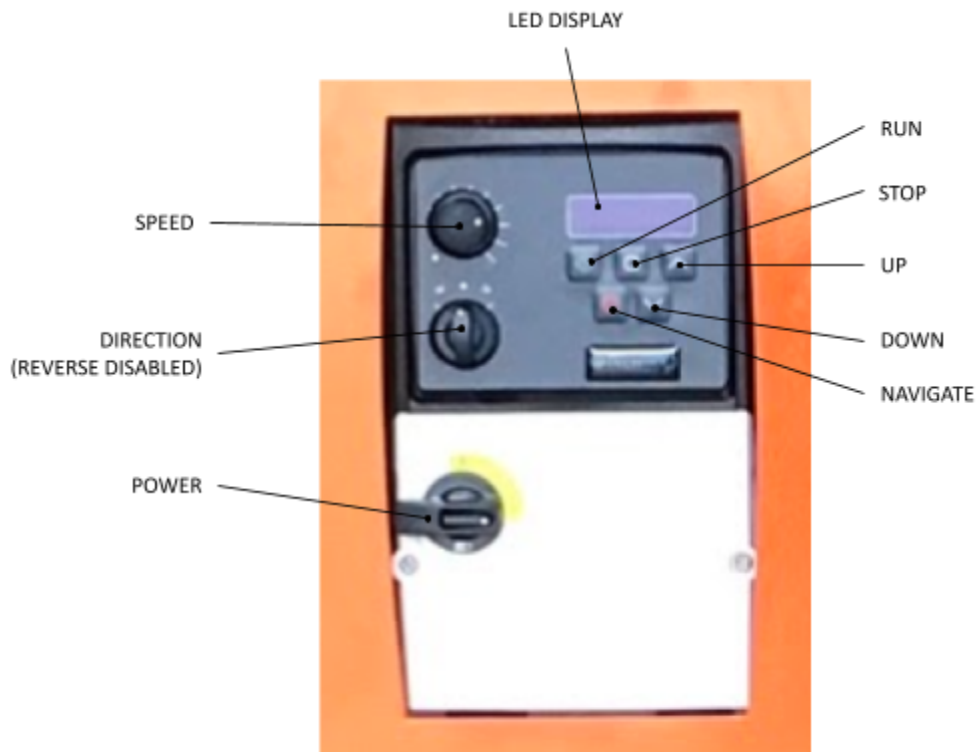
A full list of adaptor requirements can be found in Appendix 1.

## Fill the Reservoir

- Remove the Reservoir Cover and fit the Overflow Return Hose.
- Ensure that the drain valve is closed and fill the reservoir with 20 - 30L of test slurry.
- Close the Flow Control Valve and fully open the Pressure Control valve.

## Start the Pump

1. Connect to the power supply.
2. Turn the speed control to zero and ensure that the direction control is in the stop position.
3. Switch on electrical supply via the Power switch.
4. Turn the direction control to forward and adjust the motor speed until the required flow is achieved. Notes:
  - Motor speed is controlled by inverter frequency and that frequency will be presented on the LED display.
  - The reverse switch is disabled as the motor will not operate in reverse.
  - Motor inverter frequency will increase slowly.



Motor shut-down is the reverse of start-up.



## Hydrocyclone Test

- Open the Flow Control Valve and adjust the Pressure Control Valve and Speed Control until the required pressure is achieved and the flows have stabilised.
- Samples may be taken from either the underflow or overflow.
- Time sample collection to determine mass and volume flow rates.

## Shut Down & Cleaning

- Fill the tank with clean water and run the system to flush the system.
- Drain the tank and repeat as needed until the drain water is clean and free of debris.
- Remove the test cyclone.
- Disconnect the electrical supply.
- Clean all equipment with a damp cloth following.



## Appendix 1 - Cyclone Adaptor Requirements

Hydrocyclone	Maximum Feed Size	Feed	Overflow	Underflow
GCH50N	300µm	DN25 Flange	Stub Pipe 40mm ID 55mm OD	25mm OD
GCH50F	300µm	DN25 Flange	Stub Pipe 40mm ID 55mm OD	25mm OD
GCH50S	300µm	DN25 Flange	Stub Pipe 40mm ID 55mm OD	Stub Pipe 30mm ID 40mm OD
GCH25F	200µm	Stub Pipe 20mm ID 30mm OD	Stub Pipe 20mm ID 30mm OD	15mm OD
GCCA1x10F	200µm	20mm Hose Stub	Stub Pipe 10mm ID 15mm OD	Not Required

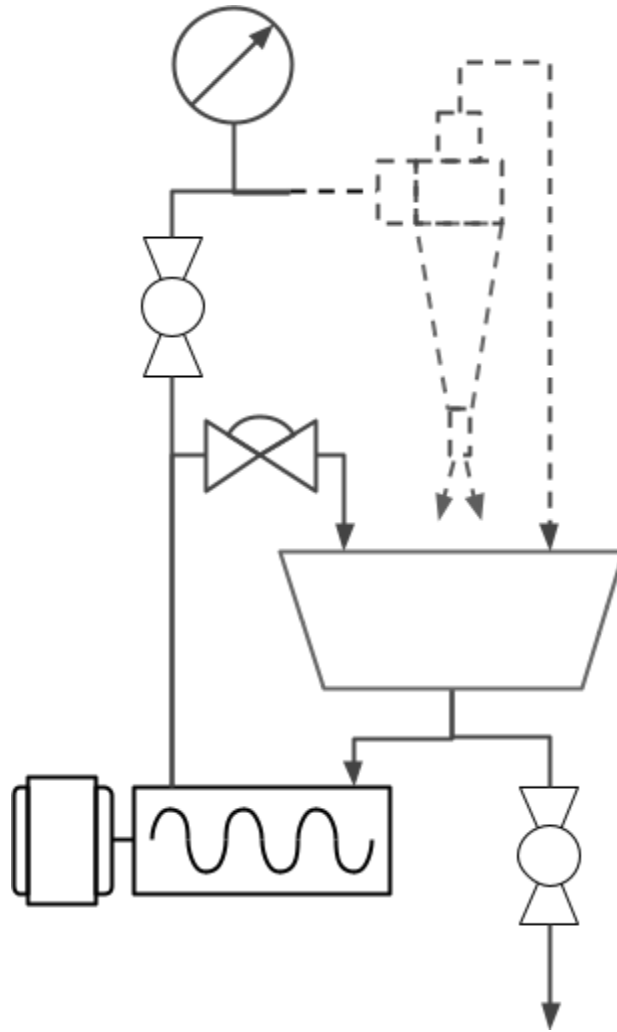
## Appendix 2 - Inverter Settings

The inverter has been pre-set to the correct settings for this system.

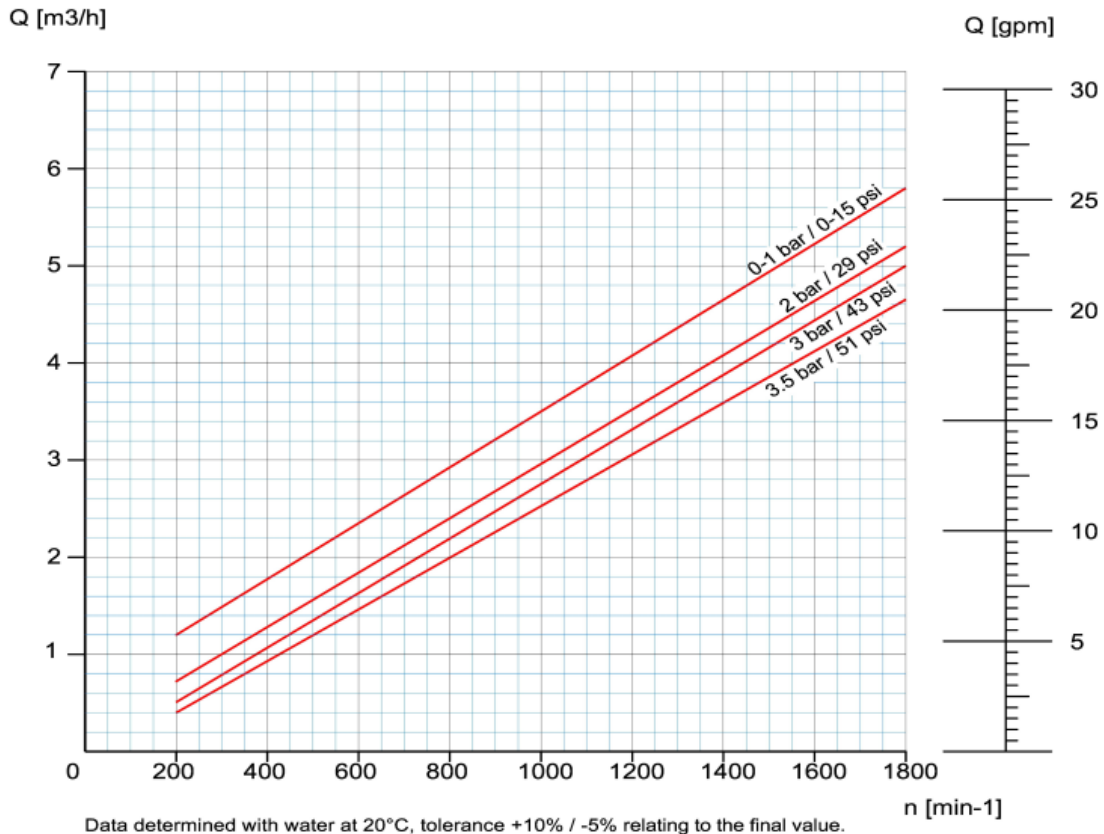
Should the settings be lost the correct settings may be re-entered by pressing and holding the Navigation key for 2 seconds and using the Up and Down keys to enter the required setting.

<b>Parameter</b>	<b>Description</b>	<b>Setting</b>
P-01	Maximum Frequency (Hz)	60
P-02	Minimum Frequency (Hz)	40
P-03	First Acceleration Time (s)	5
P-04	First Deceleration Time (s)	5
P-05	Stopping Mode	0
P-07	Motor Rated Voltage (V)	230
P-08	Motor Rated Current (A)	2.4
P-09	Motor Rated Frequency (Hz)	50
P-10	Motor Rated Speed (rpm)	1460
P-11	Low Frequency Torque Boost (%)	0
P-12	Primary Command Source	0
P-13	Operating Application Type	0
P-14	Extended Menu Access Code	0
P-15	Digital Input Function Selection	8
P-17	Switching Frequency (kHz)	8

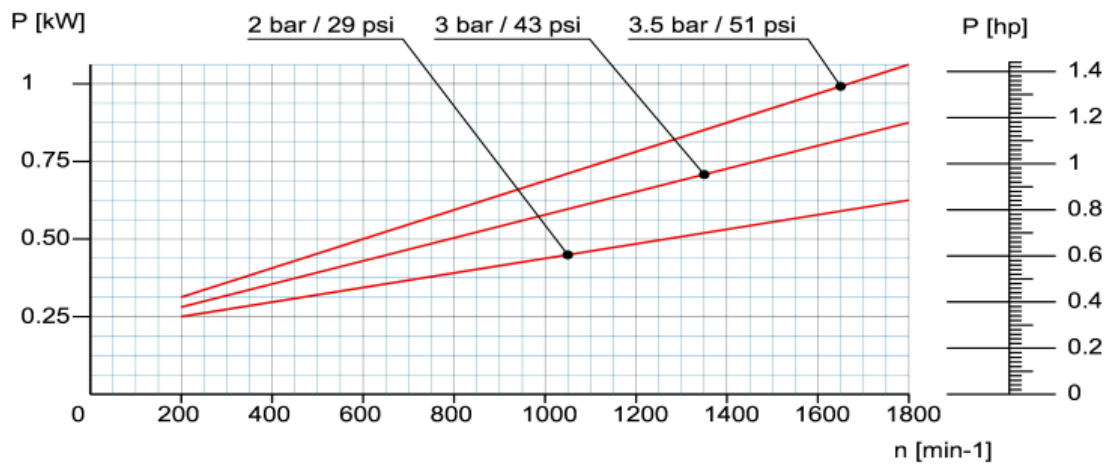
### Appendix 3 - Hydraulic Diagram



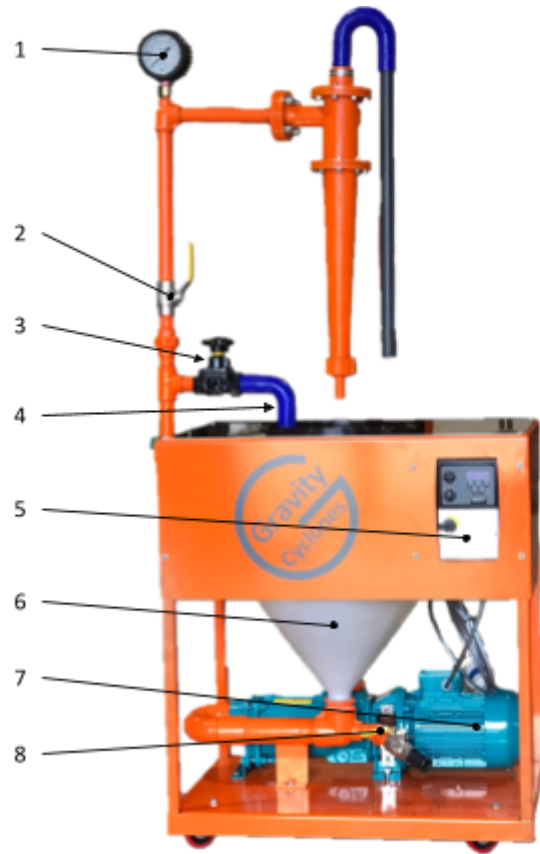
# Appendix 4 - Pump Performance Curve



Data determined with water at 20°C, tolerance +10% / -5% relating to the final value.



## Appendix 5 - Spare Parts List



Item	Part Number	Description
1	C700-030656	PRESSURE GAUGE
2	RAWM-030595	FLOW CONTROL VALVE
3	C700-030545	PRESSURE CONTROL VALVE
4	C700-030654	BYPASS RETURN HOSE
5	C700-030460	INVERTER - 2.2kW 1 ph
6	C700-030655	CONICAL RESERVOIR
7	C700-030515	MOTOR / PUMP UNIT
8	RAWM-030595	FLOW CONTROL VALVE

# Appendix 6 - Instruction Manual - TECDrive Inverter

TECDrive TEC-3 User Guide Revision 1.20

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Distributed by TEC Electric Motors

[www.tecmotors.co.uk/tecdrive](http://www.tecmotors.co.uk/tecdrive)



## TECDrive User Guide

STYLEREF "Heading 1" Technical Data

STYLEREF "Heading 1" Modbus RTU Communications






**IP20 & IP66 (NEMA 4X)  
AC Variable Speed Drive**  
0.37 – 22kW (0.5 – 30HP)  
110 – 480V

# Appendix 6 - Instruction Manual - TECDrive Inverter

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<b>Declaration of Conformity</b>	
TEC Electric Motors hereby states that the TECDrive TEC-3 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)	
Designed and manufacture is in accordance with the following harmonised European standards:	
EN 61800-5-1: 2007	Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
EN 61800-3: 2004 /A1 2012	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
<b>Electromagnetic Compatibility</b>	
All TECDrive products 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.	
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<b>Copyright Invertek Drives Ltd © 2016</b>	
All TECDrive 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.	
<b>This user guide is the "original instructions" document. All non-English versions are translations of the "original instructions".</b>	
The contents of this User Guide are believed to be correct at the time of printing. In the interest of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.	
<b>This User Guide is for use with version 3.04 Firmware. User Guide Revision 1.20</b>	
Invertek Drives Ltd adopts a policy of continuous improvement and whilst every effort has been made to provide accurate and up to date information, the information contained in this User Guide should be used for guidance purposes only and does not form the part of any contract.	
	This manual is intended as a guide for proper installation. Invertek Drives Ltd cannot assume responsibility for the compliance or the non-compliance to any code, national, local or otherwise, for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.
	This TECDrive 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.

# Appendix 6 - Instruction Manual - TECDrive Inverter

## 1. Quick Start Up

### 1.1. Important Safety Information

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

	<b>Danger:</b> Indicates a risk of electric shock, which, if not avoided, could result in damage to the equipment and possible injury or death.		<b>Danger:</b> Indicates a potentially hazardous situation other than electrical, which if not avoided, could result in damage to property.
	<p>This variable speed drive product (TECDrive) 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 TECDrive 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. <u>Only qualified electricians are allowed to install and maintain this product.</u></p> <p>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 <u>information regarding transport, storage, installation and use of the TECDrive, including the specified environmental limitations.</u></p> <p>Do not perform any flash test or voltage withstand test on the TECDrive. Any electrical measurements required should be carried out with the TECDrive disconnected.</p> <p>Electric shock hazard! Disconnect and ISOLATE the TECDrive 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 multi-meter that no voltage is present on any drive power terminals prior to commencing any work.</p> <p>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.</p> <p>Ensure correct earthing connections. 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.</p> <p>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.</p> <p>Do not carry out any work on the drive control cables whilst power is applied to the drive or to the external control circuits.</p> <p>Within the European Union, all machinery in which this product is used must comply with Directive 2006/42/EC, Safety of Machinery. In particular, the machine manufacturer is responsible for providing a main switch and ensuring the electrical equipment complies with EN60204-1.</p> <p>The level of integrity offered by the TECDrive 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.</p> <p><u>The driven motor can start at power up if the enable input signal is present.</u></p> <p>The STOP function does not remove potentially lethal high voltages. ISOLATE the drive and wait 10 minutes before starting any work on it. <u>Never carry out any work on the Drive, Motor or Motor cable whilst the input power is still applied.</u></p> <p>The TECDrive 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.</p> <p>Do not activate the automatic fault reset function on any systems whereby this may cause a potentially dangerous situation.</p> <p>IP20 drives must be installed in a pollution degree 2 environment, mounted in a cabinet with IP54 or better.</p> <p>TECDrives are intended for indoor use only.</p> <p>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.</p> <p>The entry of conductive or flammable foreign bodies should be prevented. Flammable material should not be placed close to the drive</p> <p>Relative humidity must be less than 95% (non-condensing).</p> <p>Ensure that the supply voltage, frequency and no. of phases (1 or 3 phase) correspond to the rating of the TECDrive as delivered.</p> <p>Never connect the mains power supply to the Output terminals U, V, W.</p> <p>Do not install any type of automatic switchgear between the drive and the motor</p> <p>Wherever control cabling is close to power cabling, maintain a minimum separation of 100 mm and arrange crossings at 90 degrees</p> <p>Ensure that all terminals are tightened to the appropriate torque setting</p> <p>Do not attempt to carry out any repair of the TECDrive. In the case of suspected fault or malfunction, contact your local Invertek Drives Sales Partner for further assistance.</p>		
			



# Appendix 6 - Instruction Manual - TECDrive Inverter

TECDrive TEC-3 User Guide Revision 1.20

## 1.2. Quick Start Process

Step	Action	See Section	Page
1	Identify the Enclosure Type, Model Type and ratings of your drive from the model code on the label. In particular <ul style="list-style-type: none"> <li>Check the voltage rating suits the incoming supply</li> <li>Check the output current capacity meets or exceeds the full load current for the intended motor</li> </ul>	2.1	Identifying the Drive by Model Number
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.	9.1	Environmental
4	Install the drive in a suitable cabinet (IP20 Units) ensuring suitable cooling air is available. Mount the drive to the wall or machine (IP66).	3.1 3.3 3.4 3.5 3.6	General Mechanical Dimensions and Mounting – IP20 Open Units Guidelines for Enclosure Mounting – IP20 Units Mechanical Dimensions – IP66 (Nema 4X) Enclosed Units Guidelines for mounting (IP66 Units)
5	Select the correct power and motor cables according to local wiring regulations or code, noting the maximum permissible sizes	9.2	Rating Tables
6	If the supply type is IT or corner grounded, disconnect the EMC filter before connecting the supply.	9.5	EMC Filter Disconnect
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.	4.10	EMC Compliant Installation
10	Check the motor terminal box for correct Star or Delta configuration where applicable	4.5	Motor Terminal Box Connections
11	Ensure suitable wiring protection is providing, by installing a suitable circuit breaker or fuses in the incoming supply line	4.3.2 9.2	Fuse / Circuit Breaker Selection Rating Tables
12	Connect the power cables, especially ensuring the protective earth connection is made	4.1 4.2 4.3 4.4	Connection Diagram Protective Earth (PE) Connection Incoming Power Connection Motor Connection
13	Connect the control cables as required for the application	4.6 4.10 7 7.8	Control Terminal Wiring EMC Compliant Installation Analog and Digital Input Macro Configurations Example Connection Diagrams
14	Thoroughly check the installation and wiring		
15	Commission the drive parameters	5.1 6	Managing the Keypad Parameters

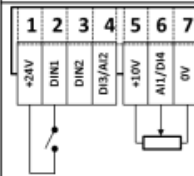
## 1.3. Installation Following a Period of Storage

If the drive has not been powered, either unused or in storage, the DC Link Capacitors require reforming before power may be connected to the drive. Refer to your local sales partner for information regarding the correct procedure.

TECDrive TEC-3 User Guide Revision 1.20

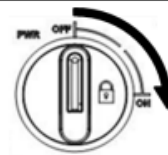
## 1.4. Quick Start Overview

### Quick Start – IP20 & IP66 Non Switched



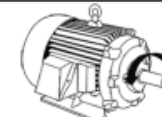
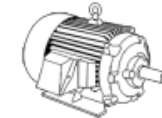
- Connect a Start / Stop switch between control terminals 1 & 2
  - Close the Switch to Start
  - Open to Stop
- Connect a potentiometer (5k – 10kΩ) between terminals 5, 6 and 7 as shown
  - Adjust the potentiometer to vary the speed from P-02 (0Hz default) to P-01 (50 / 60 Hz default)

### Quick Start – IP66 Switched



Switch the mains power on to the unit using the built in isolator switch on the front panel.

The OFF/REV/FWD will enable the output and control the direction of rotation of the motor.



The potentiometer will control the motor shaft rotational speed.

STYLEREF "Heading 1" Modbus RTU Communications

STYLEREF "Heading 1" Technical Data

# Appendix 6 - Instruction Manual - TECDrive Inverter

## 2. General Information and Ratings

This chapter contains information about the TECDrive E3 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.

Product Family	TEC	-	3	-	1	2	002	-	1	F	1	2
Generation												
Frame Size												
Input Voltage	1 = 110 - 115 2 = 200 - 240 4 = 380 - 480											
	IP Rating: 2 = IP20 X = IP66 Non Switched Y = IP66 Switched Dynamic Brake Transistor: 1 = Not Fitted 4 = Internal Transistor Filter Type: 0 = No Filter F = Internal EMC Filter No. Of Input Phases: _____ Output Current x 10: _____											

### 2.2. Drive Model Numbers

110 - 115V + / - 10% - 1Phase Input - 3 Phase 230V Output (Voltage Doubler)				
Model Number	With Filter	Without Filter	kW	HP
TEC-3-110023-1024	N/A		0.37	0.5
TEC-3-110043-1024	N/A		1	1.3
TEC-3-210058-1048	N/A		1.5	1.8
200 - 240V + / - 10% - 1Phase Input - 3 Phase Output				
Model Number	With Filter	Without Filter	kW	HP
TEC-3-120023-1F14			0.37	0.5
TEC-3-120043-1F14			0.75	1
TEC-3-120070-1F14			1.5	2
TEC-3-220070-1F48			1.5	2
TEC-3-220095-1F48			2.2	3
N/A			4.0	5
200 - 240V + / - 10% - 3Phase Input - 3 Phase Output				
Model Number	With Filter	Without Filter	kW	HP
TEC-3-120023-3024	N/A		0.37	0.5
TEC-3-120043-3024	N/A		0.75	1
TEC-3-120070-3024	N/A		1.5	2
TEC-3-220070-3F48			1.5	2
TEC-3-220095-3F48			2.2	3
TEC-3-320080-3F48			4.0	5
TEC-3-320240-3F48			5.5	7.5
TEC-3-420300-3F48			7.5	10
TEC-3-420460-3F48			11	15
380 - 480V + / - 10% - 3Phase Input - 3 Phase Output				
Model Number	With Filter	Without Filter	kW	HP
TEC-3-340023-3F14			0.75	1
TEC-3-340041-3F14			1.5	2
TEC-3-240041-3F48			1.5	2
TEC-3-240058-3F48			2.2	3
TEC-3-240095-3F48			4	5
TEC-3-340140-3F48			5.5	7.5
TEC-3-340180-3F48			7.5	10
TEC-3-340240-3F42			11	15
TEC-3-440300-3F42			15	20
TEC-3-440390-3F42			18.5	25
TEC-3-440460-3F42			22	30

For IP20 units, replace 'F' with '2'  
 For IP66 Non Switched Units, replace 'F' with 'X'  
 For IP66 Switched Units, replace 'F' with 'Y'

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## 3. Mechanical Installation

### 3.1. General

The TECDrive 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 Sizes 1 and 2 only).

IP20 TECDrives must be installed in a pollution degree 1 or 2 environment only.

Do not mount flammable material close to the TECDrive

Ensure that the minimum cooling air gaps, as detailed in section 3.5 and 3.7 are left clear

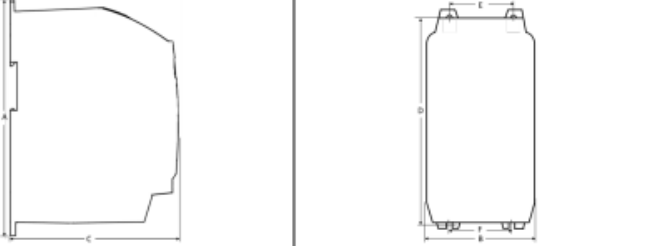
Ensure that the ambient temperature range does not exceed the permissible limits for the TECDrive given in section 9.1

Provide suitable clean, moisture and contaminant free cooling air sufficient to fulfil the cooling requirements of the TECDrive

### 3.2. UL Compliant Installation

Refer to section 9.4 on page for Additional Information for UL Compliance.

### 3.3. Mechanical Dimensions and Mounting - IP20 Open Units



Drive Size	A	B	C	D	E	F	Weight	Weight						
mm	in	mm	in	mm	in	mm	mm	mm						
1	173	6.81	83	3.27	123	4.84	162	6.38	50	1.97	50	1.97	1.0	1.0
2	221	8.70	110	4.33	150	5.91	209	8.23	63	2.48	63	2.48	1.7	1.7
3	261	10.28	131	5.16	175	6.89	247	9.72	80	3.15	80	3.15	3.2	3.2
4	420	16.54	171	6.73	212	8.35	400	15.75	125	4.92	125	4.92	9.1	9.1

Mounting Bolts	Frame Size 1 - 3		4 x M5 (R8)		Frame Size 4		4 x M8	
	Control Terminals	Power Terminals	Control Terminals	Power Terminals	Control Terminals	Power Terminals	Control Terminals	Power Terminals
Tightening Torques	0.5 Nm (4.5 lb-in)	1 Nm (9 lb-in)	0.5 Nm (4.5 lb-in)	1 Nm (9 lb-in)	0.5 Nm (4.5 lb-in)	1 Nm (9 lb-in)	0.5 Nm (4.5 lb-in)	1 Nm (9 lb-in)

### 3.4. 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.

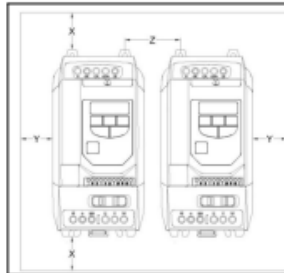
In any environments where the conditions require it, the enclosure must be designed to protect the TECDrive against ingress of airborne dust, corrosive gases or liquids, conductive contaminants (such as condensation, carbon dust, and metallic particles) and sprays or splashing water from all directions.

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. Invertex Drives recommend the following minimum sizes for drives mounted in non-ventilated metallic enclosures:-

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Drive Size	X Above & Below		Y Either Side		Z Between		Recommended airflow
	mm	in	mm	in	mm	in	
1	50	1.97	50	1.97	33	1.30	11
2	75	2.95	50	1.97	46	1.81	22
3	100	3.94	50	1.97	52	2.05	60
4	100	3.94	50	1.97	52	2.05	120

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

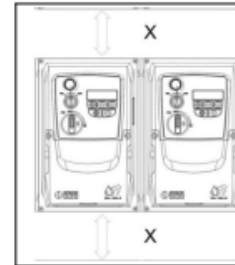
Typical drive heat losses are 3% of operating load conditions.

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

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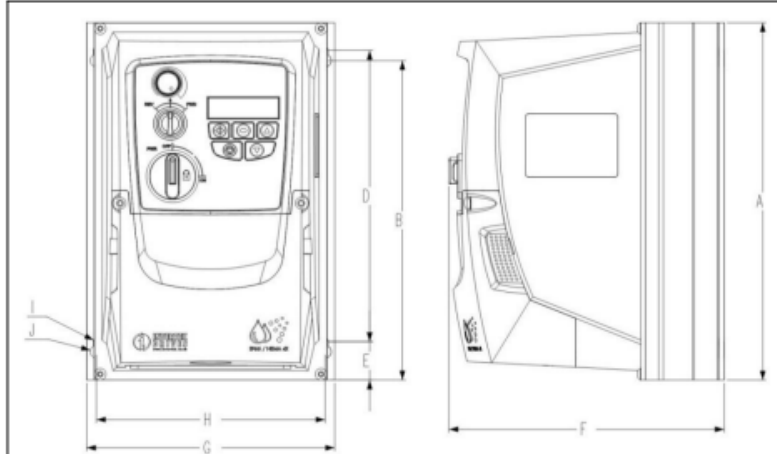
Drive Size	X Above & Below		Y Either Side	
	mm	in	mm	in
1	200	7.87	10	0.39
2	200	7.87	10	0.39
3	200	7.87	10	0.39

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.

Drive Size	Power Cable	Motor Cable	Control Cables
1	M20 (PG13.5)	M20 (PG13.5)	M20 (PG13.5)
2	M25 (PG21)	M25 (PG21)	M20 (PG13.5)
3	M25 (PG21)	M25 (PG21)	M20 (PG13.5)

### 3.5. Mechanical Dimensions – IP66 (Nema 4X) Enclosed 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
1	232.0	9.13	207.0	8.15	189.0	7.44	25.0	0.98	179.0	7.05	161.0	6.34	148.5	5.85	4.0	0.16	8.0	0.31	3.1	6.8
2	257.0	10.12	220.0	8.67	200.0	7.87	28.5	1.12	187.0	7.36	188.0	7.40	176.0	6.93	4.2	0.17	8.5	0.33	4.1	9.0
3	310.0	12.20	276.5	10.89	251.5	9.90	33.4	1.31	252	9.92	211.0	8.30	197.5	7.78	4.2	0.17	8.5	0.33	7.6	16.7

Mounting Bolts	All Frame Sizes	4 x M4 (Ø)
Tightening Torques	All Frame Sizes	Control Terminals 0.5 Nm (4.5 lb-in) Power Terminals 1 Nm (9 lb-in)

### 3.6. 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 9.1

The drive must be mounted vertically, on a suitable flat surface

The minimum mounting clearances as shown in the table below must be observed

The mounting site and chosen mountings should be sufficient to support the weight of the drives

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.

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### 3.7. Gland Plate and Lock Off

The use of a suitable gland system is required to maintain the appropriate IP / Nema rating. The gland plate has pre moulded cable entry holes for power and motor connections suitable for use with glands as shown in the following table. Where additional holes are required, these can be drilled to suitable size. Please take care when drilling to avoid leaving any particles within the product.

	Power & Motor Cables			Control & Signal Cables		
	Moulded Hole Size	Imperial Gland	Metric Gland	Knockout Size	Imperial Gland	Metric Gland
Size 1	22mm	PG13.5	M20	22mm	PG13.5	M20
Size 2 & 3	27mm	PG21	M25	22mm	PG13.5	M20

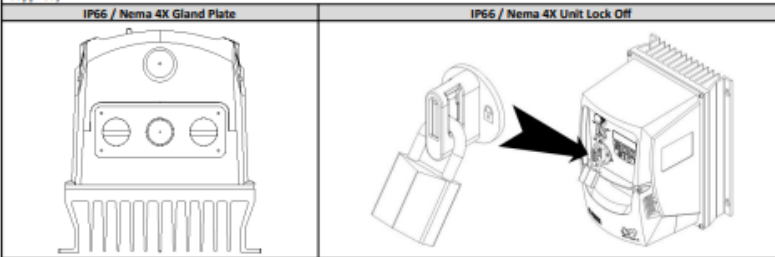
#### Flexible Conduit Hole Sizes:

	Drill Size	Trade Size	Metric
Size 1	28mm	1/2 in	21
Size 2 & 3	35mm	1 in	27

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

#### Power Isolator Lock Off

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

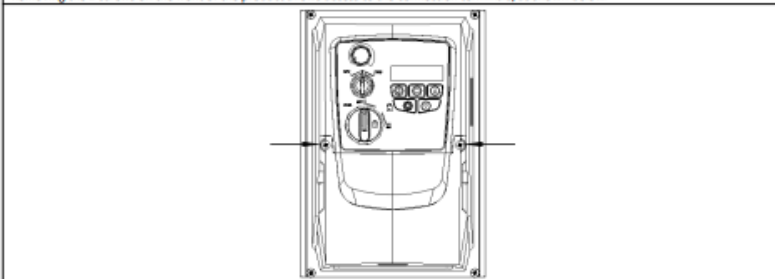


### 3.8. Removing the Terminal Cover

To access the connection terminals, the drive front cover needs to be removed as shown.

#### IP66 / Nema 4X Units

Removing the 2 screws on the front of the product allows access to the connection terminals, as shown below.



### 3.9. Routine Maintenance

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

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

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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.

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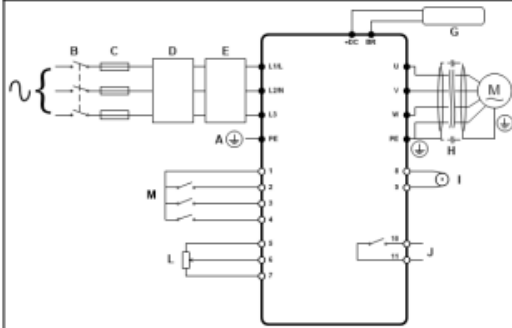
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## 4. Power & Control Wiring

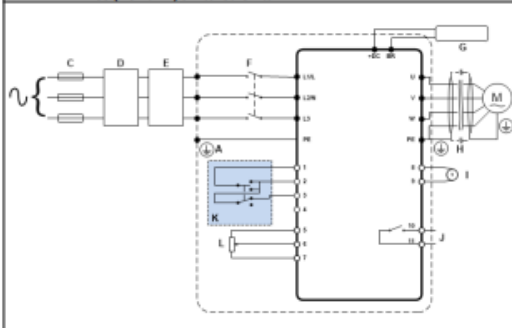
### 4.1. Connection Diagram

#### 4.1.1. IP20 & IP66 (Nema 4X) Non-Switched Units



Key	Sec.	Page
A	Protective Earth (PE) Connection	4.2
B	Incoming Power Connection	4.3
C	Fuse / Circuit Breaker Selection	4.3.2
D	Optional Input Choke	4.3.3
E	Optional External EMC Filter	4.10
F	Internal Disconnect / Isolator	4.3
G	Optional Brake Resistor	4.11
H	Motor Connection	
I	Analog Output	4.8.1
J	Relay Output	4.8.2
K	Using the REV/O/FWD Selector Switch (Switched Version Only)	4.7
L	Analog Inputs	4.8.3
M	Digital Inputs	4.8.4

#### 4.1.2. IP66 (Nema 4X) Switched Units



### 4.2. Protective Earth (PE) Connection

#### Grounding Guidelines

The ground terminal of each TECDrive should be individually connected DIRECTLY to the site ground bus bar (through the filter if installed). TECDrive ground connections should not loop from one drive to another, or to, or from any other equipment. Ground loop impedance must conform to local industrial safety regulations. To meet UL regulations, UL approved ring crimp terminals should be used for all ground wiring connections.

The drive Safety Ground must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be checked periodically.

#### Protective Earth Conductor

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

#### Safety Ground

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

#### Motor Ground

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

#### Ground Fault Monitoring

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

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- Individual ELCBs should be used for each TECDrive

#### 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.

### 4.3. Incoming Power Connection

#### 4.3.1. Cable Selection

- For 1 phase supply, the mains power cables should be connected to L1/L, L2/N.
- For 3 phase supplies, the mains power cables should be connected to L1, L2, and L3. Phase sequence is not important.
- For compliance with CE and C Tick EMC requirements, refer to section 4.10 EMC Compliant Installation on page .
- A fixed installation is required according to IEC61800-5-1 with a suitable disconnecting device installed between the TECDrive and the AC Power Source. The disconnecting device must conform to the local safety code / regulations (e.g. within Europe, EN60204-1, Safety of machinery).
- The cables should be dimensioned according to any local codes or regulations. Maximum dimensions are given in section 9.2.

#### 4.3.2. 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 9.2 Rating Tables. 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 TECDrive Power terminals as defined in IEC60439-1 is 100kA.

#### 4.3.3. Optional Input Choke

- An optional Input Choke is recommended to be installed in the supply line for drives where any of the following conditions occur:-
  - The incoming supply impedance is low or the fault level / short circuit current is high
  - The supply is prone to dips or brown outs
  - An imbalance exists on the supply (3 phase drives)
  - The power supply to the drive is via a busbar and brush gear system (typically overhead Cranes).
- In all other installations, an input choke is recommended to ensure protection of the drive against power supply faults. Part numbers are shown in the table.

230 Volt 1 Phase	1	OPT-2-L1016-20
	2	OPT-2-L1025-20
	3	N/A
400 Volt 3 Phase	2	OPT-3-L3006-20
	2	OPT-3-L3010-20
	3	OPT-3-L3036-20
	4	OPT-3-L3050-20

### 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 TECDrive 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 TECDrive earth terminals.
- Maximum permitted motor cable length for all models: 100 metres shielded, 150 metres unshielded.

### 4.5. Motor Terminal Box Connections

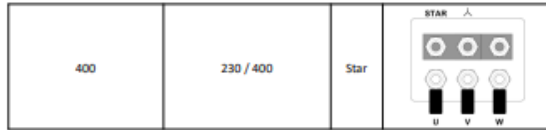
Most general purpose motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor. This operational voltage is normally selected when installing the motor by selecting either STAR or DELTA connection. STAR always gives the higher of the two voltage ratings.

230	230 / 400	Delta	
400	400 / 690		



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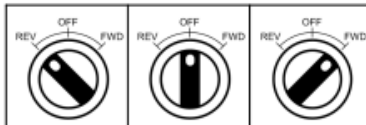


## 4.6. Control Terminal Wiring

- 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 – 2.5mm<sup>2</sup> / 30 – 12 AWG.

## 4.7. Using the REV/O/FWD Selector Switch (Switched Version Only)

By adjusting the parameter settings the TECDrive can be configured for multiple applications and not just for Forward or Reverse. This could typically be for Hand/Off/Auto applications (also known as Local/Remote) for HVAC and pumping industries.



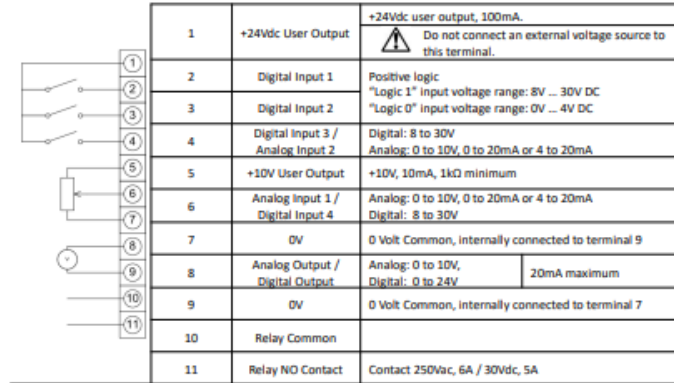
Switch Position			Parameters to Set		Notes
			P-12	P-15	
Run Reverse	STOP	Run Forward	0	0	Factory Default Configuration Run Forward or Reverse with speed controlled from the Local POT
STOP	STOP	Run Forward	0	5,7	Run Forward with speed controlled from the local POT Run Reverse - disabled
Preset Speed 1	STOP	Run Forward	0	1	Run Forward with speed controlled from the Local POT Preset Speed 1 provides a 'log' Speed set in P-20
Run Reverse	STOP	Run Forward	0	6, 8	Run Forward or Reverse with speed controlled from the Local POT
Run in Auto	STOP	Run in Hand	0	4	Run in Hand - Speed controlled from the Local POT Run in Auto 0 Speed controlled using Analog input 2 e.g. from PLC with 4-20mA signal
Run in Speed Control	STOP	Run in PI Control	5	1	In Speed Control the speed is controlled from the Local POT In PI Control, Local POT controls PI set point
Run in Preset Speed Control	STOP	Run in PI Control	5	0, 2, 4, 5, 8, 12	In Preset Speed Control, P-20 sets the Preset Speed In PI Control, POT can control the PI set point (P-44+1)
Run in Hand	STOP	Run in Auto	3	6	Hand - speed controlled from the Local POT Auto - Speed Reference from Modbus
Run in Hand	STOP	Run in Auto	3	3	Hand - Speed reference from Preset Speed 1 (P-20) Auto - Speed Reference from Modbus

**NOTE** To be able to adjust parameter P-15, extended menu access must be set in P-14 (default value is 101)

## 4.8. Control Terminal Connections

Default Connections	Control Terminal	Signal	Description

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### 4.8.1. Analog Output

The analog output function may be configured using parameter P-25, which is described in section 6.2 Extended Parameters on page . The output has two operating modes, dependent on the parameter selection.

- Analog Mode
  - The output is a 0 – 10 volt DC signal, 20mA max load current
- Digital Mode
  - The output is 24 volt DC, 20mA max load current

### 4.8.2. Relay Output

The relay output function may be configured using parameter P-18, which is described in section 6.2 Extended Parameters on page .

### 4.8.3. 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 P-16
- Analog Input 2 Format Selection Parameter P-47

These parameters are described more fully in section 6.2 Extended Parameters on page .

The function of the analog input, e.g. for speed reference or PID feedback for example is defined by parameters P-15. The function of these parameters and available options is described in section 7 Analog and Digital Input Macro Configurations on page .

### 4.8.4. Digital Inputs

Up to four digital inputs are available. The function of the inputs is defined by parameters P-12 and P-15, which are explained in section 7 Analog and Digital Input Macro Configurations on page .

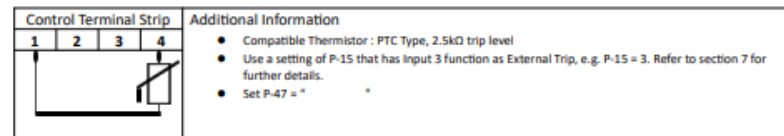
## 4.9. Motor Thermal overload Protection

### 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<sub>t</sub>-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:-



## 4.10. EMC Compliant Installation

Category	Supply Cable Type	Motor Cable Type	Control Cables	Maximum Permissible Motor Cable Length
C1 <sup>4</sup>	Shielded <sup>1</sup>	Shielded <sup>1,5</sup>	Shielded <sup>4</sup>	1M / 5M <sup>7</sup>
C2	Shielded <sup>2</sup>	Shielded <sup>1,5</sup>		5M / 25M <sup>7</sup>
C3	Unshielded <sup>3</sup>	Shielded <sup>2</sup>		25M / 100M <sup>7</sup>

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- 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 screen should be terminated at the motor end using an EMC type gland allowing connection to the motor body through the largest possible surface area. Where drives are mounted in a steel control panel enclosure, the cable screen may be terminated directly to the control panel using a suitable EMC clamp or gland, as close to the drive as possible. For IP66 drives, connect the motor cable screen to the internal ground clamp.
- 6/ 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.
- 7/ Permissible cable length with additional external EMC filter

### 4.11. Optional Brake Resistor

TECDrive E3 Frame Size 2 and above units have a built in Brake Transistor. This allows an external resistor to be connected to the drive to provide improved braking torque in applications that require this.

The brake resistor should be connected to the "r" and "BR" terminals as shown.

 The voltage level at these terminals may exceed 800VDC  
 Stored charge may be present after disconnecting the mains power  
 Allow a minimum of 5 minutes discharge after power off before attempting any connection to these terminals

Suitable resistors and guidance on selection can be obtained from your Invertek Sales Partner.







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## 5. Operation

### 5.1. Managing the Keypad

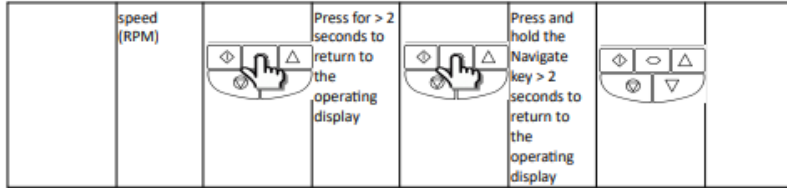
The drive is configured and its operation monitored via the keypad and display.

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

5.2. Operating Displays	5.3. Changing Parameters	5.4. Read Only Parameter Access	5.5. Resetting Parameters
 Drive Stopped / Disabled	 Press and hold the Navigate key > 2 seconds	 Press and hold the Navigate key > 2 seconds	 To reset parameter values to their factory default settings, press and hold Up, Down and Stop buttons for > 2 seconds. The display will show "
 Drive is enabled / running, display shows the output frequency (Hz)	 Use the up and down keys to select the required parameter	 Use the up and down keys to select P-00	
 Press the Navigate key for < 1 second. The display will show the motor current (Amps)	 Press the Navigate key for < 1 second	 Press the Navigate key for < 1 second	 Press the Stop key. The display will show "
 Press the Navigate key for < 1 second. The display will show the motor power (kW)	 Adjust the value using the Up and Down keys	 Use the up and down keys to select the required Read Only parameter	
 If P-10 > 0, pressing the Navigate key for < 1 second will display the motor	 Press for < 1 second to return to the parameter menu	 Press the Navigate key for < 1 second to display the value	 <b>5.6. Resetting a Fault</b> Press the Stop key. The display will show "

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## 6. Parameters

### 6.1. Standard Parameters

Par.	Description	Minimum	Maximum	Default	Units
P-01	<b>Maximum Frequency / Speed Limit</b>	P-02	500.0	50.0 (60.0)	Hz / RPM
Maximum output frequency or motor speed limit – Hz or RPM. If P-10 >0, the value entered / displayed is in RPM					
P-02	<b>Minimum Frequency / Speed Limit</b>	0.0	P-01	0.0	Hz / RPM
Minimum speed limit – Hz or RPM. If P-10 >0, the value entered / displayed is in RPM					
P-03	<b>Acceleration Ramp Time</b>	0.00	600.0	5.0	s
Acceleration ramp time from zero Hz / RPM to base frequency (P-09) in seconds.					
P-04	<b>Deceleration Ramp Time</b>	0.00	600.0	5.0	s
Deceleration ramp time from base frequency (P-09) to standstill in seconds. When set to 0.00, the value of P-24 is used.					
P-05	<b>Stopping Mode / Mains Loss Response</b>	0	3	0	-
Selects the stopping mode of the drive, and the behaviour in response to a loss of mains power supply during operation.					
	<b>Setting</b>	<b>On Disable</b>	<b>On Mains Loss</b>		
	0	Ramp to Stop (P-04)	Ride Through (Recover energy from load to maintain operation)		
	1	Coast	Coast		
	2	Ramp to Stop (P-04)	Fast Ramp to Stop (P-24), Coast if P-24 = 0		
	3	Ramp to Stop (P-04) with AC Flux Braking	Fast Ramp to Stop (P-24), Coast if P-24 = 0		
P-06	<b>Energy Optimiser</b>	0	1	0	-
0: Disabled 1: Enabled. When enabled, the Energy Optimiser attempts to reduce the overall energy consumed by the drive and motor by reducing the output voltage during constant speed, light load operation. The Energy Optimiser is intended for applications where the drive may operate for some periods of time with constant speed and light motor load, whether constant or variable torque.					
P-07	<b>Motor Rated Voltage / Back EMF at rated speed (PM / BLDC)</b>	0	250 / 500	230 / 400	V
For Induction Motors, this parameter should be set to the rated (nameplate) voltage of the motor (Volts). For Permanent Magnet or Brushless DC Motors, it should be set to the Back EMF at rated speed.					
P-08	<b>Motor Rated Current</b>	Drive Rating Dependent			A
This parameter should be set to the rated (nameplate) current of the motor					
P-09	<b>Motor Rated Frequency</b>	10	500	50 (60)	Hz
This parameter should be set to the rated (nameplate) frequency of the motor					
P-10	<b>Motor Rated Speed</b>	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 (where motor speed is maintained at a constant value regardless of applied load) for the motor is disabled. Entering the value from the motor nameplate enables the slip compensation function, and the TECDrive display will now show motor speed in RPM. All speed related parameters, such as Minimum and Maximum Speed, Preset Speeds etc. will also be displayed in RPM. If P-09 value is changed, P-10 value is reset to 0					
P-11	<b>Low Frequency Torque Boost Current</b>	0.0	Drive Dependent	Drive Dependent	%
Low frequency torque can be improved by increasing this parameter. Excessive boost levels may however result in high motor current and increased risk of tripping on Over Current or Motor Overload (refer to section 10.1) This parameter operates in conjunction with P-51 (Motor Control Mode) as follows :-					
	<b>P-51</b>	<b>P-11</b>			
	0	0	Boost is automatically calculated according to autotune data		
		>0	Voltage boost = $P-11 \times P-07$ . This voltage is applied at 0.0Hz, and linearly reduced until $P-09 / 2$		
	1	All	Voltage boost = $P-11 \times P-07$ . This voltage is applied at 0.0Hz, and linearly reduced until $P-09 / 2$		
	2, 3, 4	All	Boost current level = $4 * P-11 * P-08$		
For IM motors, when P-51 = 0 or 1, a suitable setting can usually be found by operating the motor under very low or no load conditions at approximately 5Hz, and adjusting P-11 until the motor current is approximately the magnetising current (if known) or in the range shown below. Frame Size 1 : 60 – 80% of motor rated current Frame Size 2 : 50 – 60% of motor rated current Frame Size 3 : 40 – 50% of motor rated current Frame Size 4 : 35 – 45% of motor rated current					
P-12	<b>Primary Command Source</b>	0	9	0	-
0: Terminal Control. The drive responds directly to signals applied to the control terminals. 1: Uni-directional Keypad Control. The drive can be controlled in the forward direction only using the internal keypad, or an external remote Keypad. 2: Bi-directional Keypad Control. The drive can be controlled in the forward and reverse directions using the internal keypad, or an external remote Keypad. Pressing the keypad START button toggles between forward and reverse.					

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	<p><b>3: Modbus Network Control.</b> Control via Modbus RTU (RS485) using the internal Accel / Decel ramps</p> <p><b>4: Modbus Network Control.</b> Control via Modbus RTU (RS485) interface with Accel / Decel ramps updated via Modbus</p> <p><b>5: PI Control.</b> User PI control with external feedback signal</p> <p><b>6: PI Analog Summation Control.</b> PI control with external feedback signal and summation with analog input 1</p> <p><b>7: CAN open Control.</b> Control via CAN (RS485) using the internal Accel / Decel ramps</p> <p><b>8: CAN open Control.</b> Control via CAN (RS485) interface with Accel / Decel ramps updated via CAN</p> <p><b>9: Slave Mode.</b> Control via a connected Invertek drive in Master Mode. Slave drive address must be &gt; 1.</p> <p>When P-12 = 1, 2, 3, 4, 7, 8 or 9, an enable signal must still be provided at the control terminals, digital input 1.</p>																								
P-13	<p><b>Operating Mode Select</b></p> <p>Provides a quick set up to configure key parameters according to the intended application of the drive. Parameters are preset according to the table.</p> <p><b>0: Industrial Mode.</b> Intended for general purpose applications.</p> <p><b>1: Pump Mode.</b> Intended for centrifugal pump applications.</p> <p><b>2: Fan Mode.</b> Intended for Fan applications.</p> <table border="1"> <thead> <tr> <th>Setting</th> <th>Application</th> <th>Current Limit (P-54)</th> <th>Torque Characteristic (P-28 &amp; P-29)</th> <th>Spin Start (P-33)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>General</td> <td>150%</td> <td>Constant</td> <td>0 : Off</td> </tr> <tr> <td>1</td> <td>Pump</td> <td>110%</td> <td>Variable</td> <td>0 : Off</td> </tr> <tr> <td>2</td> <td>Fan</td> <td>110%</td> <td>Variable</td> <td>2 : On</td> </tr> </tbody> </table>	Setting	Application	Current Limit (P-54)	Torque Characteristic (P-28 & P-29)	Spin Start (P-33)	0	General	150%	Constant	0 : Off	1	Pump	110%	Variable	0 : Off	2	Fan	110%	Variable	2 : On	0	2	0	-
Setting	Application	Current Limit (P-54)	Torque Characteristic (P-28 & P-29)	Spin Start (P-33)																					
0	General	150%	Constant	0 : Off																					
1	Pump	110%	Variable	0 : Off																					
2	Fan	110%	Variable	2 : On																					
P-14	<p><b>Extended Menu Access code</b></p> <p>Enables access to Extended and Advanced Parameter Groups. This parameter must be set to the value programmed in P-37 (default: 101) to view and adjust Extended Parameters and value of P-37 + 100 to view and adjust Advanced Parameters. The code may be changed by the user in P-37 if desired.</p>	0	65535	0	-																				

## 6.2. Extended Parameters

Par.	Description	Minimum	Maximum	Default	Units
P-15	<p><b>Digital Input Function Select</b></p> <p>Defines the function of the digital inputs depending on the control mode setting in P-12. See section 7 Analog and Digital Input Macro Configurations for more information.</p>	0	17	0	-
P-16	<p><b>Analog Input 1 Signal Format</b></p> <p>See Below</p> <p>UD-10</p> <p>= Uni-polar 0 to 10 Volt Signal. The drive will remain at minimum speed (P-02) if the analog reference after scaling and offset are applied is &lt;=0.0%. 100% signal means the output frequency / speed will be the value set in P-01.</p> <p>= Uni-polar 0 to 10 Volt Signal, bi-directional operation. The drive will operate the motor in the reverse direction of rotation if the analog reference after scaling and offset are applied is &lt;0.0%. E.g. for bidirectional control from a 0 – 10 volt signal, set P-35 = 200.0%, P-39 = 50.0%</p> <p>= 0 to 20mA Signal</p> <p>= 4 to 20mA Signal, the TECDrive will trip and show the fault code if the signal level falls below 3mA</p> <p>= 4 to 20mA Signal, the TECDrive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA</p> <p>= 20 to 4mA Signal, the TECDrive will trip and show the fault code if the signal level falls below 3mA</p> <p>= 20 to 4mA Signal, the TECDrive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA</p> <p>= 10 to 0 Volt Signal (Uni-polar). The drive will operate at Maximum Frequency / Speed if the analog reference after scaling and offset are applied is &lt;=0.0%</p>				
P-17	<p><b>Maximum Effective Switching Frequency</b></p> <p>Sets maximum effective switching frequency of the drive. If "rEd" is displayed when the parameter is viewed, the switching frequency has been reduced to the level in P00-32 due to excessive drive heatsink temperature.</p>	4	32	8	kHz
P-18	<p><b>Output Relay Function Select</b></p> <p>Selects the function assigned to the relay output. The relay has two output terminals, Logic 1 indicates the relay is active, and therefore terminals 10 and 11 will be connected.</p> <p><b>0: Drive Enabled (Running).</b> Logic 1 when the motor is enabled</p> <p><b>1: Drive Healthy.</b> Logic 1 when power is applied to the drive and no fault exists</p> <p><b>2: At Target Frequency (Speed).</b> Logic 1 when the output frequency matches the setpoint frequency</p> <p><b>3: Drive Tripped.</b> Logic 1 when the drive is in a fault condition</p> <p><b>4: Output Frequency &gt;= Limit.</b> Logic 1 when the output frequency exceeds the adjustable limit set in P-19</p> <p><b>5: Output Current &gt;= Limit.</b> Logic 1 when the motor current exceeds the adjustable limit set in P-19</p> <p><b>6: Output Frequency &lt; Limit.</b> Logic 1 when the output frequency is below the adjustable limit set in P-19</p> <p><b>7: Output Current &lt; Limit.</b> Logic 1 when the motor current is below the adjustable limit set in P-19</p> <p><b>8: Analog Input 2 &gt; Limit.</b> Logic 1 when the signal applied to analog input 2 exceeds the adjustable limit set in P-19</p> <p><b>9: Drive Ready to Run.</b> Logic 1 when the drive is ready to run, no trip present.</p>	0	9	1	-
P-19	<p><b>Relay Threshold Level</b></p> <p>Adjustable threshold level used in conjunction with settings 4 to 8 of P-18</p>	0.0	200.0	100.0	%
P-20	<p><b>Preset Frequency / Speed 1</b></p>	-P-01	P-01	5.0	Hz / RPM
P-21	<p><b>Preset Frequency / Speed 2</b></p>	-P-01	P-01	25.0	Hz / RPM
P-22	<p><b>Preset Frequency / Speed 3</b></p>	-P-01	P-01	40.0	Hz / RPM
P-23	<p><b>Preset Frequency / Speed 4</b></p> <p>Preset Speeds / Frequencies selected by digital inputs depending on the setting of P-15</p> <p>If P-10 = 0, the values are entered as Hz. If P-10 &gt; 0, the values are entered as RPM.</p> <p>Changing the value of P-09 will reset all values to factory default settings</p>	-P-01	P-01	P-09	Hz / RPM
P-24	<p><b>2nd Ramp Time (Fast Stop)</b></p> <p>This parameter allows a 2<sup>nd</sup> ramp time to be programmed into the drive.</p>	0.00	600.0	0.00	s

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Par.	Description	Minimum	Maximum	Default	Units
	<p>This ramp time is automatically selected in the case of a mains power loss if P-05 = 2 or 3. When set to 0.00, the drive will coast to stop.</p> <p>When using a setting of P-15 that provides a "Fast Stop" function, this ramp time is also used.</p> <p>In addition, if P-24 &gt; 0, P-02 &gt; 0, P-26=0 and P-27 = P-02, this ramp time is applied to both acceleration and deceleration when operating below minimum speed, allowing selection of an alternative ramp when operating outside of the normal speed range, which may be useful in pump and compressor applications.</p>				
P-25	<p><b>Analog Output Function Select</b></p> <p>0: Drive Enabled (Running). Logic 1 when the TECDrive is enabled (Running)</p> <p>1: Drive Healthy. Logic 1 when no Fault condition exists on the drive</p> <p>2: At Target Frequency (Speed). Logic 1 when the output frequency matches the setpoint frequency</p> <p>3: Drive Tripped. Logic 1 when the drive is in a fault condition</p> <p>4: Output Frequency &gt;= Limit. Logic 1 when the output frequency exceeds the adjustable limit set in P-19</p> <p>5: Output Current &gt;= Limit. Logic 1 when the motor current exceeds the adjustable limit set in P-19</p> <p>6: Output Frequency &lt; Limit. Logic 1 when the output frequency is below the adjustable limit set in P-19</p> <p>7: Output Current &lt; Limit. Logic 1 when the motor current is below the adjustable limit set in P-19</p> <p>8: Output Frequency (Motor Speed). 0 to P-01, resolution 0.1Hz</p> <p>9: Output (Motor) Current. 0 to 200% of P-08, resolution 0.1A</p> <p>10: Output Power. 0 – 200% of drive rated power</p> <p>11: Load Current. 0 – 200% of P-08, resolution 0.1A</p>	0	11	8	-
P-26	<p><b>Skip frequency hysteresis band</b></p>	0.0	P-01	0.0	Hz / RPM
P-27	<p><b>Skip Frequency Centre Point</b></p> <p>The Skip Frequency function is used to avoid the TECDrive operating at a certain output frequency, for example at a frequency which causes mechanical resonance in a particular machine. Parameter P-27 defines the centre point of the skip frequency band, and is used in conjunction with P-26. The TECDrive output frequency will ramp through the defined band at the rates set in P-03 and P-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 TECDrive output frequency will remain at the upper or lower limit of the band.</p>	0.0	P-01	0.0	Hz / RPM
P-28	<p><b>V/F Characteristic Adjustment Voltage</b></p>	0	P-07	0	V
P-29	<p><b>V/F Characteristic Adjustment Frequency</b></p> <p>This parameter in conjunction with P-28 sets a frequency point at which the voltage set in P-29 is applied to the motor. Care must be taken to avoid overheating and damaging the motor when using this feature.</p>	0.0	P-09	0.0	Hz
P-30	<p><b>Start Mode, Automatic Restart, Fire Mode Operation</b></p> <p><b>Index 1 : Start Mode &amp; Automatic Restart</b></p> <p>Selects whether the drive should start automatically if the enable input is present and latched during power on. Also configures the Automatic Restart function.</p> <p>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.</p> <p>Following a Power On or Reset, the drive will automatically start if Digital Input 1 is closed.</p> <p>To : Following a trip, the drive will make up to 5 attempts to restart at 20 second intervals. The numbers of restart attempts are counted, and if the drive fails to start on the final attempt, the drive will trip with a fault, and will require the user to manually reset the fault. The drive must be powered down to reset the counter.</p> <p><b>Index 2 : Fire Mode Input Logic</b></p> <p>Defines the operating logic when a setting of P-15 is used which includes Fire M, e.g. settings 15, 16 &amp; 17.</p> <p><b>0: Normally Closed (NC) Input.</b> Fire Mode active if input is open. <b>1: Normally Open (NO) Input.</b> Fire Mode active if input is closed</p> <p><b>Index 3 : Fire Mode Input Type</b></p> <p>Defines the input type when a setting of P-15 is used which includes Fire Mode, e.g. settings 15, 16 &amp; 17.</p> <p><b>0: Maintained Input.</b> The drive will remain in Fire Mode, only as long the fire mode input signal remains (Normally Open or Normally Closed operation is supported depending on Index 2 setting).</p> <p><b>1: Momentary Input.</b> Fire Mode is activated by a momentary signal on the input. Normally Open or Normally Closed operation is supported depending on Index 2 setting. The drive will remain in Fire Mode until disabled or powered off.</p>	N/A	N/A	Edge-r	-
P-31	<p><b>Keypad Start Mode Select</b></p> <p>This parameter is active only when operating in Keypad Control Mode (P-12 = 1 or 2) or Modbus Mode (P-12 = 3 or 4). When settings 0, 1, 4 or 5 are used, the Keypad Start and Stop keys are active, and control terminals 1 and 2 must be linked together. Settings 2, 3, 6 and 7 allow the drive to be started from the control terminals directly, and the keypad Start and Stop keys are ignored.</p> <p><b>0: Minimum Speed, Keypad Start</b></p> <p>1: Previous Speed, Keypad Start</p> <p>2: Minimum Speed, Terminal Enable</p> <p>3: Previous Speed, Terminal Enable</p> <p>4: Current Speed, Keypad Start</p> <p>5: Preset Speed 4, Keypad Start</p> <p>6: Current Speed, Terminal Start</p> <p>7: Preset Speed 4, Terminal Start</p>	0	7	1	-
P-32	<p><b>Index 1 : Duration</b></p> <p><b>Index 2 : DC Injection Mode</b></p>	0.0	25.0	0.0	s
		0	2	0	-

STYLEREF "Heading 1" Technical Data

STYLEREF "Heading 1" Modbus RTU Communications

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Par.	Description	Minimum	Maximum	Default	Units
	<p><b>Index 1:</b> Defines the time for which a DC current is injected into the motor. DC injection current level may be adjusted in P-59.</p> <p><b>Index 2:</b> Configures the DC Injection Function as follows &gt;</p> <p>0: DC Injection on Stop. DC is injected into the motor at the current level set in P-59 following a stop command, after the output frequency has reduced to P-58 for the time set in Index 1.</p> <p>1: If the drive is in Standby Mode prior to disable, the DC injection is disabled</p> <p>1: DC Injection on Start. DC is injected into the motor at the current level set in P-59 for the time set in Index 1 immediately after the drive is enabled, prior to the output frequency ramping up. The output stage remains active during this phase. This can be used to ensure the motor is at standstill prior to starting.</p> <p>2: DC Injection on Start &amp; Stop. DC injection applied as both settings 0 and 1 above.</p>				
P-33	<p><b>Spin Start</b></p> <p>0: Disabled</p> <p>1: Enabled. When enabled, on start up the drive will attempt to determine if the motor is already rotating, and will begin to control the motor from its current speed. A short delay may be observed when starting motors which are not turning.</p> <p>2: Enabled on Trip, Brown Out or Coast Stop. Spin start is only activated following the events listed, otherwise it is disabled.</p>	0	2	0	-
P-34	<p><b>Brake Chopper Enable (Not Size 1)</b></p> <p>0: Disabled</p> <p>1: Enabled With Software Protection. Brake chopper enabled with software protection for a 200W continuous rated resistor</p> <p>2: Enabled Without Software Protection. Enables the internal brake chopper without software protection. An external thermal protection device should be fitted.</p> <p>3: Enabled With Software Protection. As setting 1, however the Brake Chopper is only enabled during a change of the frequency setpoint, and is disabled during constant speed operation.</p> <p>4: Enabled Without Software Protection. As setting 2, however the Brake Chopper is only enabled during a change of the frequency setpoint, and is disabled during constant speed operation.</p>	0	4	0	-
P-35	<p><b>Analog Input 1 Scaling / Slave Speed Scaling</b></p> <p>0.0 2000.0 100.0 %</p> <p><b>Analog Input 1 Scaling.</b> The analog input signal level is multiplied by this factor, e.g. if P-16 is set for a 0 – 10V signal, and the scaling factor is set to 200.0%, a 5 volt input will result in the drive running at maximum frequency / speed (P-01)</p> <p><b>Slave Speed Scaling.</b> When operating in Slave Mode (P-12 = 9), the operating speed of the drive will be the Master speed multiplied by this factor, limited by the minimum and maximum speeds.</p>	0.0	2000.0	100.0	%
P-36	<p><b>Serial Communications Configuration</b></p> <p>See Below</p> <p><b>Index 1: Address</b> 0 63 1 -</p> <p><b>Index 2: Baud Rate</b> 9.6 1000 115.2 kbps</p> <p><b>Index 3: Communication loss protection</b> 0 3000 13000 ms</p> <p>This parameter has three sub settings used to configure the Modbus RTU Serial Communications. The Sub Parameters are</p> <p><b>1st Index: Drive Address:</b> Range: 0 – 63, default: 1</p> <p><b>2nd Index: Baud Rate &amp; Network type:</b> Selects the baud rate and network type for the internal RS485 communication port. For Modbus RTU: Baud rates 9.6, 19.2, 38.4, 57.6, 115.2 kbps are available. For CAN Open: Baud rates 125, 250, 500 &amp; 1000 kbps are available.</p> <p><b>3rd Index: Watchdog Timeout:</b> Defines the time for which the drive will operate without receiving a valid command telegram to Register 1 (Drive Control Word) after the drive has been enabled. Setting 0 disables the Watchdog timer. Setting a value of 30, 100, 1000, or 3000 defines the time limit in milliseconds for operation. A ' ' suffix selects trip on loss of communication. An ' ' suffix means that the drive will coast stop (output immediately disabled) but will not trip.</p>				
P-37	<p><b>Access Code Definition</b></p> <p>0 9999 101 -</p> <p>Defines the access code which must be entered in P-14 to access parameters above P-14</p>	0	9999	101	-
P-38	<p><b>Parameter Access Lock</b></p> <p>0: Unlocked. All parameters can be accessed and changed</p> <p>1: Locked. Parameter values can be displayed, but cannot be changed except P-38.</p>	0	1	0	-
P-39	<p><b>Analog Input 1 Offset</b></p> <p>-500.0 500.0 0.0 %</p> <p>Sets an offset, as a percentage of the full scale range of the input, which is applied to the analog input signal. This parameter operates in conjunction with P-35, and the resultant value can be displayed in P00-01. The resultant value is defined as a percentage, according to the following &gt;&gt;</p> $P00-01 = (\text{Applied Signal Level}(\%) - P-39) \times P-35$	-500.0	500.0	0.0	%
P-40	<p><b>Index 1: Display Scaling Factor</b> 0.000 16.000 0.000 -</p> <p><b>Index 2: Display Scaling Source</b> 0 3 0 -</p> <p>Allows the user to program the TECDrive to display an alternative output unit scaled from either output frequency (Hz), Motor Speed (RPM) or the signal level of PI feedback when operating in PI Mode.</p> <p><b>Index 1:</b> Used to set the scaling multiplier. The chosen source value is multiplied by this factor.</p> <p><b>Index 2:</b> Defines the scaling source as follows &gt;</p> <p>0: Motor Speed. Scaling is applied to the output frequency if P-10 = 0, or motor RPM if P-10 &gt; 0.</p> <p>1: Motor Current. Scaling is applied to the motor current value (Amps)</p> <p>2: Analog Input 2 Signal Level. Scaling is applied to analog input 2 signal level, internally represented as 0 – 100.0%</p> <p>3: PI Feedback. Scaling is applied to the PI feedback selected by P-46, internally represented as 0 – 100.0%</p>	0.000	16.000	0.000	-
P-41	<p><b>PI Controller Proportional Gain</b></p> <p>0.0 30.0 1.0 -</p> <p>PI 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.</p>	0.0	30.0	1.0	-
P-42	<p><b>PI Controller Integral Time</b></p> <p>0.0 30.0 1.0 s</p> <p>PI Controller Integral Time. Larger values provide a more damped response for systems where the overall process responds slowly</p>	0.0	30.0	1.0	s

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Par.	Description	Minimum	Maximum	Default	Units
P-43	<p><b>PI Controller Operating Mode</b></p> <p>0: Direct Operation. Use this mode if when the feedback signal drops, the motor speed should increase.</p> <p>1: Inverse Operation. Use this mode if when the feedback signal drops, the motor speed should decrease.</p> <p>2: Direct Operation, Wake at Full Speed. As setting 0, but on restart from Standby, PI Output is set to 100%</p> <p>3: Reverse Operation, Wake at Full Speed. As setting 0, but on restart from Standby, PI Output is set to 100%</p>	0	1	0	-
P-44	<p><b>PI Reference (Setpoint) Source Select</b></p> <p>0 1 0 -</p> <p>Selects the source for the PID Reference / Setpoint</p> <p>0: Digital Preset Setpoint. P-45 is used</p> <p>1: Analog Input 1 Setpoint. Analog input 1 signal level, readable in P00-01 is used for the setpoint.</p>	0	1	0	-
P-45	<p><b>PI Digital Setpoint</b></p> <p>0.0 100.0 0.0 %</p> <p>When P-44 = 0, this parameter sets the preset digital reference (setpoint) used for the PI Controller as a % of the feedback signal.</p>	0.0	100.0	0.0	%
P-46	<p><b>PI Feedback Source Select</b></p> <p>0 5 0 -</p> <p>Selects the source of the feedback signal to be used by the PI controller.</p> <p>0: Analog Input 2 (Terminal 4) Signal level readable in P00-02.</p> <p>1: Analog Input 1 (Terminal 6) Signal level readable in P00-01</p> <p>2: Motor Current. Scaled as % of P-08.</p> <p>3: DC Bus Voltage Scaled 0 – 1000 Volts = 0 – 100%</p> <p>4: Analog 1 – Analog 2. The value of Analog input 2 is subtracted from Analog 1 to give a differential signal. The value is limited to 0.</p> <p>5: Largest (Analog 1, Analog 2). The larger of the two analog input values is always used for PI feedback.</p>	0	5	0	-
P-47	<p><b>Analog Input 2 Signal Format</b></p> <p>- - - U0-10</p> <p>= 0 to 10 Volt Signal</p> <p>= 0 to 20mA Signal</p> <p>= 4 to 20mA Signal, the TECDrive will trip and show the fault code if the signal level falls below 3mA</p> <p>= 4 to 20mA Signal, the TECDrive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA</p> <p>= 20 to 4mA Signal, the TECDrive will trip and show the fault code if the signal level falls below 3mA</p> <p>= 20 to 4mA Signal, the TECDrive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA</p> <p>= Use for motor thermistor measurement, valid with any setting of P-15 that has Input 3 as E-Trip. Trip level: 3kΩ, reset 1kΩ</p>				U0-10
P-48	<p><b>Standby Mode Timer</b></p> <p>0.0 25.0 0.0 s</p> <p>When standby mode is enabled by setting P-48 &gt; 0.0, the drive will enter standby following a period of operating at minimum speed (P-02) for the time set in P-48. When in Standby Mode, the drive display shows and the output to the motor is disabled.</p>	0.0	25.0	0.0	s
P-49	<p><b>PI Control Wake Up Error Level</b></p> <p>0.0 100.0 5.0 %</p> <p>When the drive is operating in PI Control Mode (P-12 = 5 or 6), and Standby Mode is enabled (P-48 &gt; 0.0), P-49 can be used to define the PI Error Level (E.g. difference between the setpoint and feedback) required before the drive restarts after entering Standby Mode. This allows the drive to ignore small feedback errors and remain in Standby mode until the feedback drops sufficiently.</p>	0.0	100.0	5.0	%
P-50	<p><b>User Output Relay Hysteresis</b></p> <p>0.0 100.0 0.0 %</p> <p>Sets the hysteresis level for P-19 to prevent the output relay chattering when close to the threshold.</p>	0.0	100.0	0.0	%

## 6.3. Advanced Parameters

Par.	Description	Minimum	Maximum	Default	Units
P-51	<p><b>Motor Control Mode</b></p> <p>0: Vector speed control mode</p> <p>1: V/f mode</p> <p>2: PM motor vector speed control</p> <p>3: BLDC motor vector speed control</p> <p>4: Synchronous Reluctance motor vector speed control</p> <p>5: LSPM motor vector speed control</p>	0	5	0	-
P-52	<p><b>Motor Parameter Autotune</b></p> <p>0: Disabled</p> <p>1: Enabled. When enabled, the drive immediately measures required data from the motor for optimal operation. Ensure all motor related parameters are correctly set first before enabling this parameter. This parameter can be used to optimise the performance when P-51 = 0. Autotune is not required if P-51 = 1. For settings 2 – 5 of P-51, autotune MUST be carried out AFTER all other required motor settings are entered.</p>	0	1	0	-
P-53	<p><b>Vector Mode Gain</b></p> <p>0.0 200.0 50.0 %</p> <p>Single Parameter for Vector speed loop tuning. Affects P &amp; I terms simultaneously. Not active when P-51 = 1.</p>	0.0	200.0	50.0	%
P-54	<p><b>Maximum Current Limit</b></p> <p>0.0 175.0 150.0 %</p> <p>Defines the max current limit in vector control modes</p>	0.0	175.0	150.0	%
P-55	<p><b>Motor Stator Resistance</b></p> <p>0.00 655.35 - Ω</p> <p>Motor stator resistance in Ohms. Determined by Autotune, adjustment is not normally required.</p>	0.00	655.35	-	Ω
P-56	<p><b>Motor Stator d-axis Inductance (Lsd)</b></p> <p>0 6553.5 - mH</p> <p>Determined by Autotune, adjustment is not normally required.</p>	0	6553.5	-	mH
P-57	<p><b>Motor Stator q-axis Inductance (Lsq)</b></p> <p>0 6553.5 - mH</p> <p>Determined by Autotune, adjustment is not normally required.</p>	0	6553.5	-	mH
P-58	<p><b>DC Injection Speed</b></p> <p>0.0 P-01 0.0 Hz / RPM</p>	0.0	P-01	0.0	Hz / RPM

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	Sets the speed at which DC injection current is applied during braking to Stop, allowing DC to be injected before the drive reaches zero speed if desired.	0.0	100.0	20.0	%
P-59	<b>DC Injection Current</b>				
	Sets the level of DC injection braking current applied according to the conditions set in P-32 and P-58.				
P-60	<b>Motor Overload Management</b>	-	-	-	-
	<b>Index 1 : Thermal Overload Retention</b>	0	1	0	1
	0: Disabled 1: Enabled. When enabled, the drive calculated motor overload protection information is retained after the mains power is removed from the drive.				
	<b>Index 2 : Thermal Overload Limit Reaction</b>	0	1	0	1
	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 output current limit is internally reduced to 100% of P-08 in order to avoid an It.trp. The current limit will return to the setting in P-54 when the overload accumulator reaches 10%				

## 6.4. P-00 Read Only Status Parameters

Par.	Description	Explanation
P00-01	1 <sup>st</sup> Analog input value (%)	100% = max input voltage
P00-02	2 <sup>nd</sup> Analog input value (%)	100% = max input voltage
P00-03	Speed reference input (Hz / RPM)	Displayed in Hz if P-10 = 0, otherwise RPM
P00-04	Digital input status	Drive digital input status
P00-05	User PI output (%)	Displays value of the User PI output
P00-06	DC bus ripple (V)	Measured DC bus ripple
P00-07	Applied motor voltage (V)	Value of RMS voltage applied to motor
P00-08	DC bus voltage (V)	Internal DC bus voltage
P00-09	Heatsink temperature (°C)	Temperature of heatsink in °C
P00-10	Run time since date of manuf. (Hours)	Not affected by resetting factory default parameters
P00-11	Run time since last trip (1) (Hours)	Run-time clock stopped by drive disable (or trip), reset on next enable only if a trip occurred. Reset also on next enable after a drive power down.
P00-12	Run time since last trip (2) (Hours)	Run-time clock stopped by drive disable (or trip), reset on next enable only if a trip occurred (under-volts not considered a trip) – not reset by power down / power up cycling unless a trip occurred prior to power down
P00-13	Trip Log	Displays most recent 4 trips with time stamp
P00-14	Run time since last disable (Hours)	Run-time clock stopped on drive disable, value reset on next enable
P00-15	DC bus voltage log (V)	8 most recent values prior to trip, 256ms sample time
P00-16	Heatsink temperature log (°C)	8 most recent values prior to trip, 30s sample time
P00-17	Motor current log (A)	8 most recent values prior to trip, 256ms sample time
P00-18	DC bus ripple log (V)	8 most recent values prior to trip, 22ms sample time
P00-19	Internal drive temperature log (°C)	8 most recent values prior to trip, 30 s sample time
P00-20	Internal drive temperature (°C)	Actual internal ambient temperature in °C
P00-21	CANopen process data input	Incoming process data (RX PDO1) for CANopen: P11, P12, P13, P14
P00-22	CANopen process data output	Outgoing process data (TX PDO1) for CANopen: P01, P02, P03, P04
P00-23	Accumulated time with heatsink > 85°C (Hours)	Total accumulated hours and minutes of operation above heatsink temp of 85°C
P00-24	Accumulated time with drive internal temp > 80°C (Hours)	Total accumulated hours and minutes of operation with drive internal ambient above 80°C
P00-25	Estimated rotor speed (Hz)	In vector control modes, estimated rotor speed in Hz
P00-26	kWh meter / MWh meter	Total number of kWh / MWh consumed by the drive.
P00-27	Total run time of drive fans (Hours)	Time displayed in hh:mm:ss. First value displays time in hrs, press up to display mm:ss.
P00-28	Software version and checksum	Version number and checksum. "1" on LH side indicates I/O processor, "2" indicates power stage
P00-29	Drive type identifier	Drive rating, drive type and software version codes
P00-30	Drive serial number	Unique drive serial number
P00-31	Motor current Id / Iq	Displays the magnetising current (Id) and torque current (Iq). Press UP to show Iq
P00-32	Actual PWM switching frequency (kHz)	Actual switching frequency used by drive
P00-33	Critical fault counter – O-I	These parameters log the number of times specific faults or errors occur, and are useful for diagnostic purposes.
P00-34	Critical fault counter – O-Volts	
P00-35	Critical fault counter – U-Volts	
P00-36	Critical fault counter – O-temp (h/sink)	
P00-37	Critical fault counter – b O-I (chopper)	
P00-38	Critical fault counter – O-hEAt (control)	

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Par.	Description	Explanation
P00-39	Modbus comms error counter	
P00-40	CANbus comms error counter	
P00-41	I/O processor comms errors	
P00-42	Power stage uC comms errors	
P00-43	Drive power up time (life time) (Hours)	
P00-44	Phase U current offset & ref	Internal value
P00-45	Phase V current offset & ref	Internal value
P00-46	Phase W current offset & ref	Internal value
P00-47	Index 1 : Fire mode total active time	Total activation time of Fire Mode
	Index 2 : Fire Mode Activation Count	Displays the number of times Fire Mode has been activated
P00-48	Scope channel 1 & 2	Displays signals for first scope channels 1 & 2
P00-49	Scope channel 3 & 4	Displays signals for first scope channels 3 & 4
P00-50	Bootloader and motor control	Internal value

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## 7. Analog and Digital Input Macro Configurations

### 7.1. Overview

TECDrive E3 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:-

**P-12** – Selects the main drive control source and determines how the output frequency of the drive is primarily controlled.

**P-15** – Assigns the Macro function to the analog and digital inputs.

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

**P-16** – Used to select the format of the analog signal to be connected to analog input 1, e.g. 0 – 10 Volt, 4 – 20mA

**P-30** – Determines whether the drive should automatically start following a power on if the Enable input is present

**P-31** – 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.

**P-47** – Used to select the format of the analog signal to be connected to analog input 2, e.g. 0 – 10 Volt, 4 – 20mA

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

### 7.2. Macro Functions Guide Key

STOP / RUN	Latched input, Close to Run, Open to Stop
Forward Rotation /Reverse Rotation	Selects the direction of motor operation
AI1 REF	Analog Input 1 is the selected speed reference
P-xx REF	Speed setpoint from the selected preset speed
PR-REF	Preset speeds P-20 – P-23 are used for the speed reference, selected according to other digital input status
^FAST STOP (P-24)^	When both inputs are active simultaneously, the drive stops using Fast Stop Ramp Time P-24
E-TRIP	External Trip input, which must be Normally Closed. When the input opens, the drive trips showing or depending on P-47 setting
(NO)	Normally Open Contact, Momentarily Close to Start
(NC)	Normally Closed Contact, momentarily Open to Stop
Fire Mode	Activates Fire Mode, see section 7.7 Fire Mode
ENABLE	Hardware Enable input. In Keypad Mode, P-31 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 signal via the fieldbus interface
INC SPD	Normally Open, Close the input to Increase the motor speed
DEC SPD	Normally Open, Close input to Decrease motor speed
KPD REF	Keypad Speed Reference selected
FB REF	Selected speed reference from Fieldbus (Modbus RTU / CAN Open / Master depending on P-12 setting)

### 7.3. Macro Functions – Terminal Mode (P-12 = 0)

STOP	RUN	FWD ↴	REV ↵	AI1 REF	P-20 REF	Analog Input AI1	1
STOP	RUN	AI1 REF	PR-REF	P-20	P-21	Analog Input AI1	1
STOP	RUN	0	0	P-20	P-20 - P-23	P-01	2
		1	0	P-21			
		0	1	P-22			
		1	1	P-23			
STOP	RUN	AI1	P-20 REF	E-TRIP	OK	Analog Input AI1	3
STOP	RUN	AI1	AI2	Analog Input AI2		Analog Input AI1	4
STOP	RUN FWD ↴	STOP	RUN REV ↵	AI1	P-20 REF	Analog Input AI1	1
STOP	RUN	FAST STOP (P-24)		E-TRIP	OK	Analog Input AI1	3
		FWD ↴	REV ↵	E-TRIP	OK	Analog Input AI1	3
STOP	RUN FWD ↴	STOP	RUN REV ↵	E-TRIP	OK	Analog Input AI1	3
STOP	RUN	FWD ↴	REV ↵	0	0	P-20	2
				1	0	P-21	
				0	1	P-22	
				1	1	P-23	
				1	1	P-23	
STOP	START FWD ↴	STOP	START REV ↵	0	0	P-20	2
				1	0	P-21	
				0	1	P-22	
				1	1	P-23	
(NO)	START ↴	STOP	(NC)	AI1 REF	P-20 REF	Analog Input AI1	5

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(NO)	START FWD ↴	STOP	(NC)	(NO)	START REV ↵	Analog Input AI1	6
FAST STOP (P-24)							
STOP	RUN	FAST STOP (P-24)	OK	AI1 REF	P-20 REF	Analog Input AI1	7
(NO)	START FWD ↴	STOP	(NC)	(NO)	START REV ↵	KPD REF	P-20 REF
FAST STOP (P-24)							
STOP	RUN	DI2	E-TRIP	OK			11
					0	0	P-20
					1	0	P-21
					0	1	P-22
					1	1	P-23
STOP	RUN	P-23 REF	AI1	Fire Mode		Analog Input AI1	1
STOP	RUN	P-23 REF	P-21 REF	Fire Mode		FWD ↴	REV ↵
STOP	RUN	DI2	Fire Mode				2
					0	0	P-20
					1	0	P-21
					0	1	P-22
					1	1	P-23
STOP	RUN	FWD ↴	REV ↵	Fire Mode		Analog Input AI1	1

### 7.4. Macro Functions - Keypad Mode (P-12 = 1 or 2)

STOP	ENABLE	-	INC SPD ↑	-	DEC SPD ↓	FWD ↴	REV ↵	8
START								
STOP	ENABLE	-	PI Speed Reference			KPD REF	P-20 REF	8
STOP	ENABLE	-	INC SPD ↑	-	DEC SPD ↓			8
START								
STOP	ENABLE	-	INC SPD ↑	E-TRIP	OK	-	DEC SPD ↓	9
START								
STOP	ENABLE	-	INC SPD ↑	KPD REF	AI1 REF	AI1	10	
STOP	ENABLE	FWD ↴	REV ↵	KPD REF	AI1 REF	AI1	1	
STOP	ENABLE	FWD ↴	REV ↵	E-TRIP	OK	KPD REF	P-20 REF	11
STOP	RUN FWD ↴	STOP	RUN REV ↵	E-TRIP	OK	KPD REF	P-20 REF	11
FAST STOP (P-24)								
STOP	RUN FWD ↴	STOP	RUN REV ↵	KPD REF	AI1 REF	AI1		
STOP	RUN	-	-	E-TRIP	OK	-	-	2
STOP	RUN	PR REF	KPD REF	Fire Mode		P-23	P-21	2
STOP	RUN	P-23 REF	KPD REF	Fire Mode		FWD ↴	REV ↵	2
STOP	RUN	KPD REF	P-23 REF	Fire Mode		FWD ↴	REV ↵	2
STOP	RUN	AI1 REF	KPD REF	Fire Mode		AI1	1	

9,10,11,12,13 = 0

### 7.5. Macro Functions - Fieldbus Control Mode (P-12 = 3, 4, 7, 8 or 9)

STOP	ENABLE	FB REF (Fieldbus Speed Reference, Modbus RTU / CAN / Master-Slave defined by P-12)					14
STOP	ENABLE	PI Speed Reference					15
STOP	ENABLE	FB REF	P-20 REF	E-TRIP	OK	Analog Input AI1	3
STOP	ENABLE	FB REF	PR REF	P-20	P-21	Analog Input AI1	1
START (P-12 = 3 or 4 Only)							
STOP	ENABLE	FB REF	AI1 REF	E-TRIP	OK	Analog Input AI1	3
START (P-12 = 3 or 4 Only)							
STOP	ENABLE	FB REF	KPD REF	E-TRIP	OK	Analog Input AI1	3
START (P-12 = 3 or 4 Only)							
STOP	ENABLE	-	-	E-TRIP	OK	Analog Input AI1	16
STOP	ENABLE	PR REF	FB REF	Fire Mode		P-23	P-21
STOP	ENABLE	P-23 REF	FB REF	Fire Mode		Analog Input AI1	1
STOP	ENABLE	FB REF	P-23 REF	Fire Mode		Analog Input AI1	1
STOP	ENABLE	AI1 REF	FB REF	Fire Mode		Analog Input AI1	1

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## 7.6. Macro Functions - User PI Control Mode (P-12 = 5 or 6)

STOP	ENABLE	PI REF	P-20 REF	AI2	AI1	4
STOP	ENABLE	PI REF	AI1 REF	AI2 (PI FB)	AI1	4
STOP	ENABLE	PI REF	P-20	E-TRIP	OK	AI1 (PI FB)
(NO)	START	(NC)	STOP	AI2 (PI FB)	AI1	12
(NO)	START	(NC)	STOP	PI REF	P-20 REF	AI1 (PI FB)
(NO)	START	(NC)	STOP	E-TRIP	OK	AI1 (PI FB)
STOP	RUN	FWD	REV	AI2 (PI FB)	AI1	4
STOP	RUN	-	-	E-TRIP	OK	AI1 (PI FB)
STOP	RUN	P-23 REF	PI REF	Fire Mode	AI1 (PI FB)	1
STOP	RUN	P-23 REF	P-21 REF	Fire Mode	AI1 (PI FB)	1
STOP	RUN	P-21 REF	P-23 REF	Fire Mode	AI1 (PI FB)	1
STOP	RUN	AI1 REF	PI REF	Fire Mode	AI1 (PI FB)	1

**2,9,10,11,12,13 = 0**

## 7.7. Fire Mode

The Fire Mode function is designed to ensure continuous operation of the drive in emergency conditions until the drive is no longer capable of sustaining operation. The Fire Mode input may be a normally open (Close to Activate Fire Mode) or Normally Closed (Open to Activate Fire Mode) according to the setting of P-30 Index 2. In addition, the input may be momentary or maintained type, selected by P-30 Index 3. This input may be linked to a fire control system to allow maintained operation in emergency conditions, e.g. to clear smoke or maintain air quality within that building.

The fire mode function is enabled when P-15 = 15, 16 or 17, with Digital Input 3 assigned to activate fire mode.

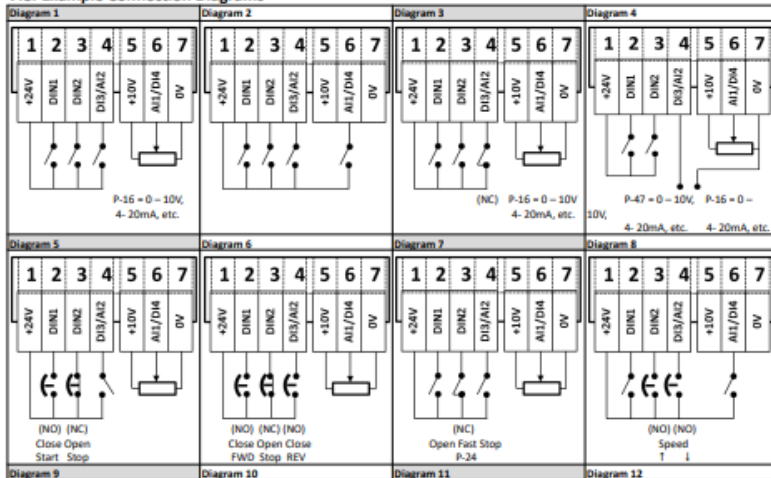
Fire Mode disables the following protection features in the drive:-

O-t (Heat-sink Over-Temperature), U-t (Drive Under Temperature), Th-Flt (Faulty Thermistor on Heat-sink), E-trip (External Trip), 4-20 F(4-20mA fault), Ph-ib (Phase Imbalance), P-Loss (Input Phase Loss Trip), SC-trip (Communications Loss Trip), I1-trip (Accumulated overload Trip)

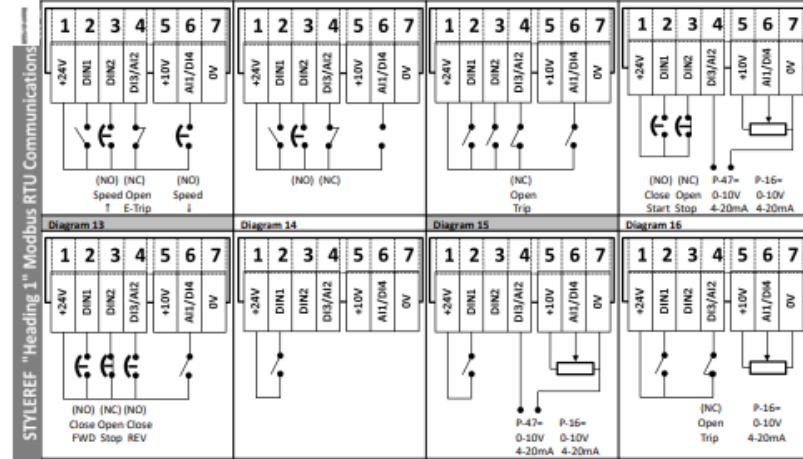
The following faults will result in a drive trip, auto reset and restart:-

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

## 7.8. Example Connection Diagrams



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## 8. Modbus RTU Communications

### 8.1. Introduction

The TECDrive E3 can be connected to a Modbus RTU network via the RJ45 connector on the front of the drive.

### 8.2. Modbus RTU Specification

Protocol	Modbus RTU
Error check	CRC
Baud rate	9600bps, 19200bps, 38400bps, 57600bps, 115200bps (default)
Data format	1 start bit, 8 data bits, 1 stop bits, no parity.
Physical signal	RS-485 (2-wire)
User interface	RJ45
Supported Function Codes	03 Read Multiple Holding Registers 06 Write Single Holding Register 16 Write Multiple Holding Registers (Supported for registers 1 - 4 only)

### 8.3. RJ45 Connector Configuration

For full MODBUS RTU register map information please refer to your Inverter Drives Sales Partner. Local contacts can be found by visiting our website [www.invertekdrives.com](http://www.invertekdrives.com)

When using MODBUS control the Analog and Digital inputs can be configured as shown in section 7.5



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

### 8.4. Modbus Register Map

Register Number	Pac.	Type	Supported Function Codes	Function		Range	Explanation
				Low Byte	High Byte		
1	-	R/W	03 06 16	✓	✓	0-3	16 Bit Word. Bit 0 : Low = Stop, High = Run Enable Bit 1 : Low = Decel Ramp 1 (P-04), High = Decel Ramp 2 (P-24) Bit 2 : Low = No Function, High = Fault Reset Bit 3 : Low = No Function, High = Coast Stop Request
2	-	R/W	✓	✓	✓	0-5000	Setpoint frequency x10, e.g. 100 = 10.0Hz

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Register	Bit	R/W	✓	✓	Parameter Name	Default Value	Description
4	-	R/W	✓	✓	Acceleration and Deceleration Time	0.60000	Ramp time in seconds x100, e.g. 250 = 2.5 seconds
5	-	R	✓	✓	Error code	Drive status	Low Byte = Drive Error Code, see section 10.1 High Byte = Drive Status as follows :- 0: Drive Stopped 1: Drive Running 2: Drive Tripped
7	-	R	✓	✓	Output Motor Frequency	0.20000	Output frequency in Hz x10, e.g. 100 = 10.0Hz
8	-	R	✓	✓	Output Motor Current	0.480	Output Motor current in Amps x10, e.g. 10 = 1.0 Amps
11	-	R	✓	✓	Digital input status	0.15	Indicates the status of the 4 digital inputs Lowest Bit = 1 Input 1
20	P00-01	R	✓	✓	Analog Input 1 value	0.1000	Analog input % of full scale x10, e.g. 1000 = 100%
21	P00-02	R	✓	✓	Analog Input 2 value	0.1000	Analog input % of full scale x10, e.g. 1000 = 100%
22	P00-03	R	✓	✓	Speed Reference Value	0.1000	Displays the setpoint frequency x10, e.g. 100 = 10.0Hz
23	P00-08	R	✓	✓	DC bus voltage	0.1000	DC Bus Voltage in Volts
24	P00-09	R	✓	✓	Drive temperature	0.100	Drive heatsink temperature in °C

All user configurable parameters are accessible as Holding Registers, and can be Read from or Written to using the appropriate Modbus command. The Register number for each parameter P-04 to P-60 is defined as 128 + Parameter number, e.g. for parameter P-15, the register number is 128 + 15 = 143. Internal scaling is used on some parameters, for further details please contact your Inverter Drives Sales Partner.

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## 9. Technical Data

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### 9.1. Environmental

Operational ambient temperature range	Open Drives	: -10 ... 50°C (frost and condensation free)
	Enclosed Drives	: -10 ... 40°C (frost and condensation free)
Storage ambient temperature range		: -40 ... 60°C
Maximum altitude		: 2000m. Derate above 1000m : 1% / 100m
Maximum humidity		: 95%, non-condensing

**NOTE** For UL compliance: the average ambient temperature over a 24 hour period for 200-240V, 2.2kW and 3HP, IP20 drives is 45°C.

### 9.2. Rating Tables

Frame Size	kW	HP	Input Current	Fuse / MCB (Type B)		Maximum Cable Size		Output Current	Recommended Brake Resistance
				Non UL	UL	mm	AWG		
<b>110 - 115 (+ / - 10%) V 1 Phase Input, 230V 3 Phase Output (Voltage Doubler)</b>									
1	0.37	0.5	7.8	10	10	8	8	2.3	-
1	0.75	1	15.8	25	20	8	8	4.3	-
2	1.1	1.5	21.9	32	30	8	8	5.8	100
<b>200 - 240 (+ / - 10%) V 1 Phase Input, 3 Phase Output</b>									
1	0.37	0.5	3.7	10	6	8	8	2.3	-
1	0.75	1	7.5	10	10	8	8	4.3	-
1	1.5	2	12.9	16	17.5	8	8	7	-
2	1.5	2	12.9	16	17.5	8	8	7	100
2	2.2	3	19.2	25	25	8	8	10.5	50
3	4	5	29.2	40	40	8	8	15.3	25
<b>200 - 240 (+ / - 10%) V 3 Phase Input, 3 Phase Output</b>									
1	0.37	0.5	3.4	6	6	8	8	2.3	-
1	0.75	1	5.6	10	10	8	8	4.3	-
1	1.5	2	9.5	16	15	8	8	7	-
2	1.5	2	8.9	16	15	8	8	7	100
2	2.2	3	12.1	16	17.5	8	8	10.5	50
3	4	5	20.9	32	30	8	8	18	25
3	5.5	7.5	26.4	40	35	8	8	24	20
4	7.5	10	33.3	40	45	16	5	30	15
4	11	15	50.1	63	70	16	5	46	10
<b>380 - 480 (+ / - 10%) V 3 Phase Input, 3 Phase Output</b>									
1	0.75	1	3.5	6	6	8	8	2.2	-
1	1.5	2	5.6	10	10	8	8	4.1	-
2	1.5	2	5.6	10	10	8	8	4.1	250
2	2.2	3	7.5	16	10	8	8	5.8	200
2	4	5	11.5	16	15	8	8	9.5	120
3	5.5	7.5	17.2	25	25	8	8	14	100
3	7.5	10	21.2	32	30	8	8	18	80
3	11	15	27.5	40	35	8	8	24	50
4	15	20	34.2	40	45	16	5	30	30
4	18.5	25	44.1	50	60	16	5	39	22
4	22	30	51.9	63	70	16	5	46	22

Cable sizes shown are the maximum possible that may be connected to the drive. Cables should be selected according to local wiring codes or regulations at the point of installation

### 9.3. Single Phase Operation of Three Phase Drives

All drive models intended for operation from three phase mains power supply (e.g. model codes TEC-3-xxxxxx-3xxx) may be operated from a single phase supply at up to 50% of maximum rated output current capacity.

In this case, the AC power supply should be connected to L1 (L) and L2 (N) power connection terminals only.

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## 1. INTRODUCTION

The following instructions contain important information on the operation, maintenance and installation of Sydex pumps. The observance of these directives is essential for the appropriate use of the machine.

### 1.1 Operating Instructions

Each pump is produced in relation to a specific order, and for this reason the serial number and the model indicated in this manual should be exactly the same as the model no. and serial no. indicated on the machine's nameplate.

### 1.2 The Company

The manufacturer of the pump is Sydex srl.

### 1.3 Range, size, year of construction and serial Number

The range, the model no., year of construction, and the serial number are indicated in this manual, and are stated on the type plate of the machine.

### 1.4 Essential information for enquiries and orders

This information is required when inquiring about spare parts parts or placing orders:

- 1) Model of the machine.
- 2) Year of construction and serial Number.

### 1.5 Acoustic level pressure

The Acoustic level pressure is measured in accordance with OSHA CFR 1910.95 to assure that our machines does not exceed 85 dB (A).

The noises emission generated by the drive and the pipes are not included in the above emission value.

In order to maintain a noise emission level under 85 dB (A), the pump must be mounted correctly and not allowed to cavitate.

### 1.6 Operating Purposes

The pump must not be operated outside of the parameters specified in the order.

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### 2 Safety Precautions

These operating instructions contain safety precautions that must be observed. This manual should be read and understood by the mechanical fitter, as well other responsible operators prior to assembly and operation. The instructions should be safely kept at the operating site where the machine is being used.

Following are symbols commonly used to indicate areas of danger:

Safety Sign  
Ranger to general Public



Safety Sign,  
Electrical Hazard.



Danger from possible Injury by Machinery.



Danger from Suspended loads.



Damage to machinery.



Eyes protection sign.



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#### 2.1 Personnel qualifications and training

The end user must ensure that the personnel responsible for the operation, maintenance, inspection and assembly are in possession of the appropriate qualifications for the tasks. Personnel lacking the appropriate skills and knowledge should receive the correct training and instruction.

#### 2.2 Non-observance of safety precautions

Failure to comply with the safety instructions may lead to hazards to life and limb, as well as dangers for the environment and for the pump.

The following are just some examples of possible dangers resulting from failure to comply with the safety instructions:

1. Failure of important machine/plant functions.
2. Premature failure of components or machine/equipment malfunction
3. Danger to the environment from leakage of dangerous materials .
4. Danger to personnel from electrical, mechanical or chemical hazards.

#### 2.3 Safety rules

During maintenance and repair work on the pump, please note the following:

- 1) Keep in mind the simple safety rules that we have included in this operating instructions
- 2) Keep in mind and adhere to applicable local and international rules and regulations.
- 3) Keep in mind and adhere to the internal safety precautions and indications.

Non observance can void product warranty.

#### 2.4 Safety instructions for the end-user.

1. Personnel should use the appropriate personal protection equipment [ppe]
2. Protective guards for moving parts (e.g. coupling) must never be removed whilst the machine is in operation.
3. Leakages (e.g. in the shaft seal) of hazardous liquids (e.g. explosive, toxic, hot) must be drained in such a way that no danger arises for persons or for environment. Always observe the relevant statutory requirements
4. The risk of exposure to electrical power must be eliminated.
5. Where appropriate risk assessments and/or methods statements should be provided prior to any work being carried out

#### 2.5 Safety Instructions for maintenance, Inspection and Assembly Work

1. The end user must ensure that all maintenance, inspection and installation work is performed by authorised and qualified personnel who understand the operating instructions and are properly trained.
2. Pumps or units which transfer dangerous substances must be decontaminated.
3. Work on a pump/machine should only be performed when it is disconnected and safely isolated from its power source, pressure has been relieved, and the complete unit has returned to room temperature. It is imperative that these procedures are adhered to before attempting work on the machine.
4. Immediately following completion of work, all safety and protective devices must be replaced in position and, where applicable, re-activated.
5. Refer to section 5 Assembly and installation.



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6. Where appropriate risk assessments and/or methods statements should be provided prior to any work being carried out

**2.6 Unauthorised use of spare parts and/or modifications to the Pump**  
Modifications to the machines and/or its components are permitted only with the manufacturer's consent. Original spare parts and accessories authorised by the manufacturer ensure safety. The use of the other components revokes any warrant and liability for consequences which may result.

**2.7 Impermissible Modes of Operation**  
The operational safety of the machines supplied is warranted only for employment in accordance with the intended use. The machine should not be operated in any way exceeds design capacities.

**2.8 Handling, storage and disposal of hazardous materials**  
The section gives information on handling, storage and disposal of materials used in the pumps which may be considered hazardous to your health.

The following table indicates what is used inside pump:

WHERE USED	LIQUID - PRODUCT	DANGER FOR
Bearings	anti-seize compounds	releases vapour
Stator - rotor	grease - Vaseline	hands and skin
Oil - general lubrication	seal - gearbox	eyes and skin
Pumps surface	Paint	releases dust and fumes if machined. Treat as fire hazardous.

All seek medical advice where appropriate



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### 3 GENERAL DESCRIPTION OF THE PUMP

The progressive cavity pump supplied, is part of the "VOLUMETRIC PUMP FAMILY". The inventor of that system was the professor René Moineau. The main components of the pump are:

- the stator - a stationary part usually an alloy tube containing an injected elastomer
- the rotor - a rotating part usually made by a metallic material

The rotor has a single helix shape and the stator is formed as a double-helix with twice the pitch of the rotor. The interference fit between the rotor and stator creates a series of sealed chambers called cavities. When the rotor turns inside the stator, the medium is gently conveyed from the inlet to the outlet of the cavities.

The Sydex progressive cavity pump utilizes many positive characteristics:

- Sydex pumps have no suction or pressure valves, but do have a stable flow rate in proportion to the number of revolutions.
- Sydex pumps have a high suction capacity.
- Sydex pumps can transport all types of media including inhomogeneous, gaseous and abrasive media, as well as those that are not of a liquid consistency, or contain solids and fibrous material.
- Sydex pumps are capable of handling high-viscosity media.

Sydex progressive cavity pumps have also the following advantages:

- Self-priming even if not containing 100% liquid.
- Gentle handling of shear-sensitive products.
- Capacity is direct proportional to the pump speed.
- No pulsation, low noise and vibration.
- No significant torque increase when reaching maximum performance.
- Compact style construction.

The Sydex pump operates according to the positive displacement principle. Operation of the pump against an excessive pressure caused by closed valves, by high pressure losses in the piping or by product sedimentation will lead to the destruction of the pump, drive, pipe work and downstream equipment. Every progressive cavity pump must therefore be protected against overpressure. Safety valves with bypass pipes oil-filled contact manometers that deactivate the pump are appropriate protective devices.

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### 4 Packing, Transportation and Storage.

#### 4.1 Packaging and transportation

To transport and store the pump it is necessary that the personnel know and employ the appropriate means, hoists and tools, always observing the safety instructions. Sydex pumps are shipped on skid-mounted wood-framed cardboard enclosures. Upon receipt, inspect the pump for any transportation damage.

Check also:

- If the pump we supplied coincides with the model you ordered.
- If inside the packaging the 'Declaration of conformity' and the complete operating instructions are included.

Claims for damages should be reported to the freight carrier immediately.



Avoid suspending the complete pump unit by the bolts of the motor or gear box. These eye bolts should be used for lifting the motor and/or the gear box only.

Due to the variety of possible pump designs and applications, only general instructions can be given here. These should be adequate for experienced assembly or transportation personnel.



Use caution when lifting top heavy pumps. The centre of gravity may be above the points where the lifting gear is attached. If this is the case, secure additionally to prevent tipping over!

When moving the pump or unit on wheels, strictly adhere to the following:

- Lock out the motor drive to protect against unintended start-up;
- Move the pump unit carefully and slowly, especially where the ground is uneven. Hazards of tipping!
- Be careful not to allow flexible piping to bend or become kinked. Obstruction of flow will cause excessive discharge pressure.
- Where necessary, secure the pump unit with additional support blocks.

#### 4.2 Storage

Pumps are packaged for transportation and short-term storage. In cases of prolonged storage, the pumps should be protected as follows until installation:

**Stator:** When stored for a long period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set). This will increase the required starting torque. For this reason, the stator should be removed and stored in a cool, dry place in an air-tight package and protected from light.

**Rotor:** Support with wooden blocks and protect against damage from mechanical impact. For tool steel rotors: coat the surfaces with protective grease to avoid rusting.



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Pump parts in : No protection necessary  
Stainless steel

Drives: Observe the instructions of the drive supplier

**Store Room:** The environment in which rubber products are being kept must be cool, dry, free of dust and well ventilated, and must not be stored in the open. Rubber products should be kept in surroundings not having less than minus 10°C and not more than plus 15°C. Store rooms should not be damp, and it must be ensured that there will be no condensation. Recommended relative humidity is < 65%. Rubber products must be protected against light, particularly direct sunlight or artificial light having a high UV portion. Rubber products should be kept in a sealed package. There must be no solvents, oil, grease, lubricants or any chemicals kept in the store room.

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### 5 ASSEMBLY AND INSTALLATION

#### 5.1 Mounting tools

No special tools are required for the assembly and installation of the pump.

#### 5.2 Space requirements

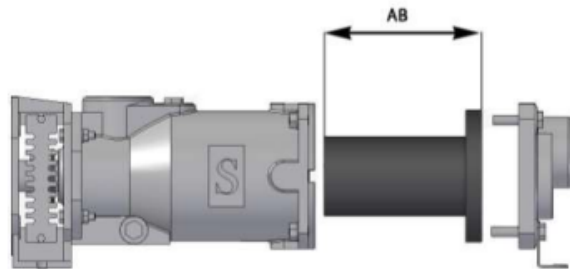
Customers are responsible for determining the space requirements. The following factors must be taken into consideration:

- Dimensions and weight of the machine.
- Required transportation and hoisting equipment.
- Possible piping layout should include an allowance for the space required to remove the rotor and stator.
- Freedom of movement to:
  - Operate the drive.
  - Speed and pressure indicators.
  - Space required for lubrication.
  - Disassembly of mechanical protective devices.
  - Space required for handling the mounting tools.



#### Space allowing disassembling of Stator and Rotor.

A specific space must be allowed for exchanging the stator. The required dimensions. See chart below for recommended disassembly dimensions:



#### 5.3 Direction of Rotation

The rotational direction of the pump determines the flow direction of the conveying medium (check the diagram below). This direction is given on the name plate of the pump.

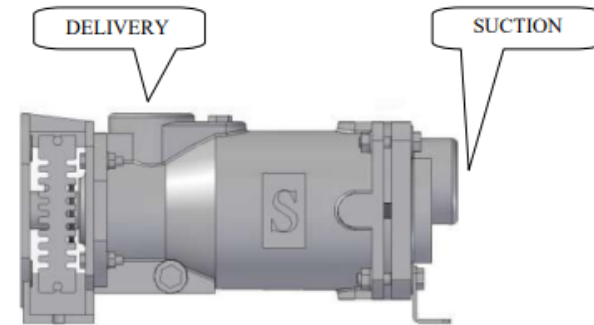
For the FM range it is NOT possible to reverse the rotation (for more info contact our technical department).



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Following the drawing below:



#### 5.5 Piping sizing

The pipe diameters on the suction and pressure sides must be dimensioned in accordance with the customer's pressure-loss calculation. The nominal size of the suction pipe should at least match that of the pump suction flange.

Prior to starting up the pump, ensure that all pipelines are free from foreign bodies. Installation residues (such as weld spatter, screws, steel chips etc) will lead to damage of the Sydex pump for which warranty claims will not be accepted.

#### 5.6 Electrical connection



The electrical connections must be established in accordance with the manufacturer's specifications, as well as the safety specifications applying at the installation site.

On the name plate of the electric motors you will find voltage/frequency and kW data. The mains voltage and frequency must match the ratings indicated on the type and rating plates.

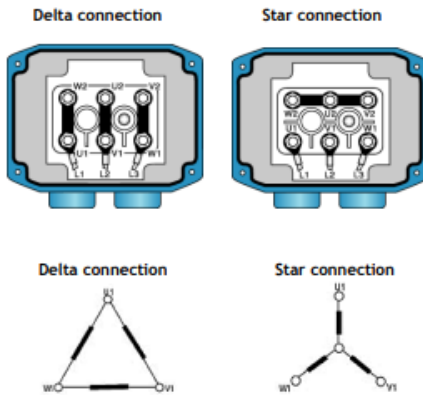
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Three-phase cage motor:



Switch on electric motor direct on line or use an adequate frequency inverter.

**attention** An increased starting torque is necessary due to the compression fit between the rotor and stator conveying elements. This means the electric motors that drive the progressive cavity pumps must always be started direct-on-line or with an adequate frequency inverter which is configured correctly for a constant torque application.

Ensure that customer-supplied frequency inverters comply with the starting torque and running power specified on the offer specifications.

Other important points to be observed:

- Always use a thermal motor safety switch.
- If possible, mount an isolating switch as close as possible to the pump.
- It is recommended to mount an earth leakage circuit breaker.



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## 6 START-UP AND TEMPORARY SHUTDOWN

### 6.1 Messa in funzione

Sydex progressing Cavity Pumps must be operated with the following precautions:

- Before initial start-up, regardless of rotation, make sure the pump housing and suction piping are filled with medium. Priming of the pump is necessary to lubricate the stator.



Never run the pump dry!  
Even a few rotations in dry condition will damage the stator.

- Turn pump motor on and off briefly to check direction of rotation.



Sydex pumps are positive displacement progressing cavity pumps and have the potential to generate very high pressure capable of bursting vessels or pipes.



Excessive pressure can overload the drive train (shaft, joints, rotor) or exceed pressure limitations of the housing and their connections, resulting in damage or breakage.

Never run the pump with an inlet or outlet valve closed. Open valves and vents before starting the pump.

### 6.2 Temporary Shutdown

Following the temporary shutdown, the pump should be emptied and rinsed when:



- The pump is installed in a location inside or outside where the medium has the potential to freeze.
- The medium has a tendency to solidify or harden.
- The medium tends to build up or become tacky on the shaft sealing area

Other suggestions:

**Stator:** When stored for an extended period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set). This will increase the required starting torque. For this reason the stator should be removed and stored in a cool, dry place in an air-tight package and protected light.

**Rotor:** After the stator has been removed. Cover the entire pump to protect from mechanical damage,



Prior to installation, thoroughly clean rotor to prevent damage caused by interaction of the grease, stator material and medium.

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#### 6.3 Stand-by pump

A stand-by pump is sometimes installed to eliminate downtime. Stand-by pumps should be operated occasionally to keep properly conditioned for use.



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## 7 MAINTENANCE

### 7.1 General Instructions

A requirement for the reliable operation of any pump is service and maintenance in compliance with instructions. Maintenance personnel must therefore have access to these operating instructions and adhere to them meticulously. Sydex will accept no liability for damages arising through non-observance of these operating instructions.



- The pumps should be regularly rinsed or cleaned if deposits of medium are likely to build up.



- If the pump needs to be disassembled, ensure that the pump and motor are switched off and cannot be turned on accidentally.

### 7.2 Lubrication

The Sydex pump does not require frequent lubrication.



- Maintenance and lubrication of the drive should be carried out according to the drive manufacturer's instructions.

### 7.3 Removal and Assembly of the Stator and the Rotor

Check that all maintenance, inspection and installation work is performed by authorised and qualified personnel who understand the operating instructions and are properly trained.

#### 7.3.1 Preventive actions



The pump with attached pipework should be empty and must be cooled off.

- Close all the valves and disconnect the pipework on the suction side and pressure side of the pump.
- Before commencing the dismantling of pumps parts, safeguard the pump against tipping over or falling down by fastening it at the lantern.
- Clean the delivery chamber.

#### 7.3.2 Removal the Stator.

- Remove the screws from the support feet (870).
- Remove the screws (936) from the suction flange (050).
- Remove the suction flange (050).  
\* For Stain Steel version: remove the ties rod (860).
- Remove the stator (305).



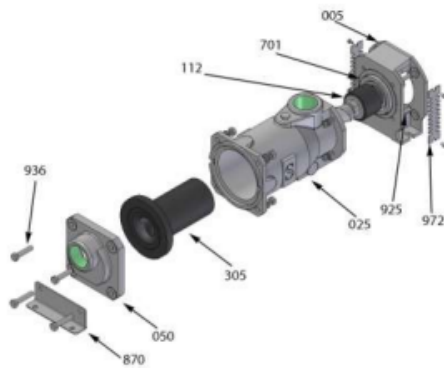
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- Remove the protections (972) from the block lantern (005).
- Remove the screws (911) from the block lantern (005).
- Remove the suction chamber (025) from the block lantern (005).
- Remove the o'ring (710) on the block lantern.



#### 7.3.3 Assembly the stator.

- Reassemble the stator in reverse order (see point 7.3.2).
- Installing the stator will be easier when using glycerine as a lubricant.

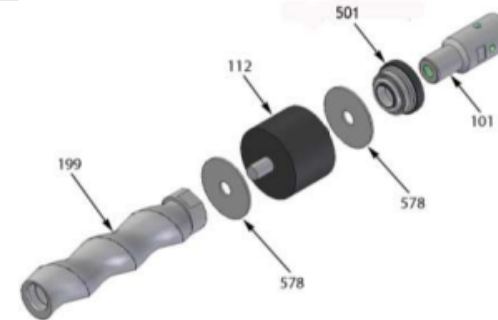
#### 7.3.4 Removal of rotor.

- Remove the stator (see point 7.3.2).
- Block the female drive shaft (101)
- Unscrew the rotor (199) from the joint (112).
- Remove the washer (578) from the joint.



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#### 7.3.5 Assembly the Rotor.

- Reassemble the rotor in reverse order (see point 7.3.4). Apply thread-locking fluid to the screw of the joint (rotor side), insert the washer and screw the joint to the rotor (199).

#### 7.4 Removal and assembly of the joint.

##### 7.4.1 Removal of the joint.

- Remove the stator (305), the suction chamber (025) and the rotor (199) - see point 7.3.2; 7.3.4) during this operations keep attention to the mechanical seal (501).
- Block the female drive shaft (101) and move the joint anticlockwise - from the drive view.

##### 7.4.2 Assembly the Joint.

- Apply Thread-locking fluid to the screw of the joint (female shaft side), insert the washer and screw the joint to the female drive shaft (101).

#### 7.5 Disassemble and assembly the mechanical seal.

##### 7.5.1 Disassemble the rotary mechanical seal faces.

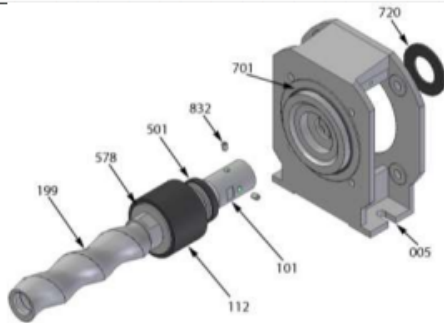
- Repeat the operations 7.3.2
- Unscrew the two grub screw (832) on the female drive shaft and remove: rotor, joint, female drive shaft and the mechanical seal rotary faces.
- Repeat the operations 7.3.4; 7.4.1.
- Remove slowly the mechanical seal rotary faces from the female drive shaft.
- When you conclude the operation 7.4.1 it's possible remove the mechanical seal counter ring faces (501) from the seal housing in the lantern (005).
- Remove the counter ring faces (501) delicately - eventually use an screwdriver.

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### 7.6.3 Mechanical seal Reassembly

- When you conclude the operation 7.5.1 clean the female drive shaft (101) and all the parts of the mechanical seal, check if the mechanical seal is damage - in this case change the mechanical seal.
- Clean the seal housing. \*
- When you conclude the cleaning, insert the flange (582) and, with care, the mechanical seal counter ring faces (501) in the seal housing.
- Remount the female drive shaft, the mechanical seal rotary faces, the joint and the rotor - see operations 7.4.2 - 7.3.5 and 7.3.3.

\* This explanation concerning a cast Iron pump. The stain steel pump has a flange seal housing.



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## 8 Trouble - Shooting

Sydex progressive cavity pumps will operate trouble-free if they are used in accordance with the offer and with this manual.  
If operating problems arise, use this chart as a guide in locating the problem.

Trouble-shooting guide										
Pump will not start	No suction capability	Discharge output low	Discharge pressure low	Discharge output fluctuates	Pump is noisy	Pump jammed	Drive overloaded	Stator and Rotor service life too short	Shaft seal leaks	Possible cause and remedies
x							x			Pump or stator is new, too much static friction. 1) Fill the pump and if possible, run the pump in one way and in the another way till unblock the pump. 2) If necessary lubricate the rotor and the stator.
x		x	x				x			Power supply incorrect. 1) Check motor nameplate data. Test voltage, phase and frequency.
		x					x	x		Discharge pressure too high. 1) Measure actual discharge pressure and compare to your specification.
x						x	x			Foreign matter or debris in pump. 1) Remove debris and correct any damage.
x						x	x	x		Temperature of pumped liquid too high, stator swells. 1) Reduce liquid temperature, if liquid temperature cannot be reduced, use an undersized rotor.
x						x	x	x		Liquid contains too many solids, causing blockages. 1) Check specification, increase liquid-to-solids ratio.
x						x	x	x		Chemical attack on the stator. 1) Check specification. If necessary change the stator with a correct one.
x						x	x	x	x	Liquid settles and hardens at pump shut-down. 1) Clean pump and rinse out after each use.
		x	x	x						Air in suction piping. 1) Check connections - If necessary increase NPSH.
	x	x	x	x						Suction pipe leaks. 1) Check seals and connections.

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Problematiche									Possibile cause and remedies
Pump will not start	No suction capability	Discharge output low	Discharge pressure low	Discharge output fluctuates	Pump is noisy	Pump jammed	Drive overloaded	Stator and Rotor service life too short	
		x	x						Pump speed too low. 1) If drive is variable speed, increase speed at pump.
		x	x	x	x			x	Discharge too high or suction head too low (cavitation). 1) Reduce suction losses; lower liquid temperature, install pump at lower elevation.
		x	x		x	x	x	x	Pump running dry. 1) Fill pump; provide dry run protection: relocate suction piping.
	x	x	x		x			x	Stator or Rotor worn out. 1) Check rotor and stator. Replace the worn out parts.
					x				Joints worn. 1) Replace the worn out pieces.
							x		Pump speed too high. 1) If drive is variable, set at lower speed.
							x		Viscosity too high. 1) Measure specific gravity and compare to specified specific gravity.
x		x				x	x	x	Pressure head too high. 1) Check pressure head with manometer. Reduce the pressure head by increasing the pressure pipe diameter or by shortening the pressure pipe.
	x							x	Wrong direction of rotation. 1) Reverse polarity of drive motor.
	x							x	Mechanical seal worn or damage. 1) Replace the mechanical seal.
					x			x	Pump bearing worn (Housing bearing version). 1) replace bearings, lubricate seal



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## 9 RECOMMENDED SPARE PARTS

In general, we have all spare parts subject to wear in stock. Our subsidiaries and exclusive representatives also hold a certain stock. We recommend to keep an amount of spare parts, corresponding to the pump, in stock on site as follows:

Description	Small Set	Large Set	Position Code
Rotor		1	199
Stator	1	1	305
Connecting rod (complete)		1	(120-401-912-708-790-951-403-447-717-435-415)
Mechanical seal		1	T..
Lantern O'ring	1	1	701

To ensure that you receive the part quickly, please provide the following information with your order:

- Specify the model number of your pump, serial number, and Year of construction (see the plate on the pump).
- Identification part code - as per the parts drawing.