Invertek Drives.com

OPTIDRIVE™ E³

AC Variable Speed Drive

0.37kW – 37kW / 0.5HP – 50HP

110 – 480 Volt 1 & 3 Phase

Advanced Technical Manual

Revision History

Issue	Note	Section	Date
01	Pre-Release		05/01/16
02	Added changes for V3.02 Firmware	N/A	04/02/16
	P-30 new functions	2.3.2	
	P00-47 New functions	2.5	
	Revised I/O table P-15 selection	2.6	
	Added parameter changes for 1 Phase Output Drive	2.4	
	Added Voltage levels for 110V drives	9.10.5	
	Revised Fire Mode Operation Description	2.8.1	
	Added CAN & Modbus info for new P-30	4.7.8	
03	Updated P-11 Max setting to “Drive Dependent”	2.3.1	01/03/16
	Updated P-18 Maximum Setting = 9	2.3.2	
	Updated P-25 Added setting 11	2.3.2	
	Updated P-30 Correcting error to Index 3	2.3.2	
	Updated P-51 adding setting 5	2.3.3	
	Updated P-52 description to add note regarding setting 5 for P-51	2.3.3	
	Updated I/O function tables to improve clarity	2.6.3	
04	Changes to include V3.03 Firmware		06/07/16
	Additional settings added to P-43	2.3.2	
	Added field Gateway usage info	5	
	Added operating display info	2.8.3	
	Added introduction section	1	
	Added note regarding changing parameters when enabled	2.2	
05	Changes to include V3.05 Firmware		01/09/17
	Corrected motor control mode selection parameter range	4.6.2	
	Added additional P-01 upper limit info	2.3.1	
	Corrected range of P-05, P-10, increased range P-09	4.6.2	
	Revised order for switching frequency derating info	0	
	Added additional info for V3.05 firmware functions		
	- Additional parameter function in P-05 and P-06, additional info for P-13	2.3.1	
	- P-36 Index 3 new options	2.3.2	
	- P-60 function updated	2.3.3	
	- Added P-15 option 18	2.6.4	
	- Added P-15 option 18	2.6.5	
	- Added P-15 option 18	2.6.6	
	- Added P-15 option 18	2.6.7	
	Added information on 4kW reduced overload below 5Hz	9.10.5	
	Additional description of Effective Switching frequency changes	2.8.3	
	Corrected P-40 listing	2.3.2	18/10/17
06	Added changes for V3.06 firmware		21/05/18
	Corrected range of P-12	2.3.1	
	P-16, P-17, P-18, P-25, P-31, P-32, P-33, P-34, P-36, P-39, P-43 description updated	2.3.2	
	Changed range of P-48	2.3.3	
	Corrected scaling for CAN object 200Eh	4.5.4	3/10/18
	Added firmware changes for V3.07		17/7/19
	- P-60 Index 1 default setting changed	2.3.3	
	- Add Modbus register 46	4.7.12	
	- Add 400V 1.2A drive rating		
	- Added IP66 Switch function options		
	- Added info for faults which require a time delay to reset		
	Added Frame Size 5 Info		
	- Switching frequency info	3.1	
	- Boost setting range	3.2	
	Added changes for V3.08 firmware	1.1	13/8/19
	Added speed step info	2.8.4	
	Revised switching frequency derating information (new simplified format)	7.2	
	Added Heartbeat Consumer to CAN Object Table	4.5.4	

1 About this Advanced Technical Manual

1.1 Compatibility

This Document is for use with version 3.08 Firmware.
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.
The information in this user guide relates to the functionality of the firmware version as stated above. Prior versions of firmware may not fully support all functions as described. If necessary, firmware updates may be carried out using Optitools Studio PC software.

1.2 Intended Audience

This Advanced Technical Manual is intended to be used in conjunction with the standard User Guide included with the product and is intended to provide additional information for more advanced product applications and usage. The reader should be familiar with the contents of the standard product User Guide, and, should observe all safety warnings and installation guidelines contained therein.

2 Optidrive E3 Parameter Set Overview

2.1 About this section

This document provides a list of the available parameters, and a description of their respective functions, for the Optidrive E3.

2.2 Parameter Structure Overview and Access

The parameter set is arranged in Groups according to the following structure: -

Parameter Group	Range	Access Level	Access Type
P00	P00-01 to P00-20	Extended	Read Only
	P00-21 to P00-50	Advanced	Read Only
Basic Parameters	P-01 to P-14	Basic	Read / Write
Extended Parameters	P-15 to P-50	Extended	Read / Write
Advanced Parameters	P-51 to P-60	Advanced	Read / Write

Access to all parameter groups is controlled by setting P-14 as follows
P-14 = P-37 (Factory setting: 101) Allows Extended Parameter Access
P-14 = P-37 + 100 (Factory Setting: 201) Allows Advanced Parameter Access

In order to prevent possible damage to the drive and connected machinery, certain parameters are locked during operation of the drive to prevent change. In the case that the drive is enabled, and the user tries to change the parameter, an “L” is shown on the left of the display.

2.3 Parameter Descriptions

2.3.1 Basic Parameters

Par.	Description	Minimum	Maximum	Default	Units
P-01	**Maximum Frequency / Speed Limit**	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 The maximum possible value is limited by the lower of the following: - - 500.0Hz maximum limit - P-09 x 5 - If P-10 >0, (500 x 120) / Motor Poles RPM - P-17 / 16 **Note** When P-10>0, slip compensation is automatically enabled, and P-01 is corrected to the synchronous speed of the motor.				
P-02	**Minimum Frequency / Speed Limit**	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	**Acceleration Ramp Time**	0.00	600.0	5.0	s
	Acceleration ramp time from zero Hz / RPM to base frequency (P-09) in seconds.				
P-04	**Deceleration Ramp Time**	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	**Stopping Mode**	0	3	0	-

Setting	Description	Behaviour on Disable (Stop)	Behaviour on Mains Loss
0	Ramp to Stop with Mains Loss Ride Through.	Ramp to stop, rate controlled by P-04.	Continue running by reducing the speed of the load to recover energy.
1	Coast to Stop	Coast (freewheel) to stop	
2	Ramp to Stop	Ramp to stop, rate controlled by P-04.	Ramp to stop using the P-24 decel ramp
3	AC Flux Braking	As setting 2, but AC flux braking is also applied, increasing the level of available braking torque.	As setting 2, but AC flux braking is also applied, increasing the level of available braking torque.
4	Mains Loss function disabled	No Action	No Action

P-06	**Energy Optimisation**	0	1	0	-

Enables / Disables the Energy Optimisation functions of the Optidrive E3 as follows.
Motor Energy Optimisation: Reduces energy losses in the motor under part load conditions by reducing motor flux. This function should not be used in applications which have large sudden load step changes, or for PI control applications, as it may cause instability in the control or over current trip.
Optidrive Energy Optimiser: Reduces the energy losses in the drive at higher output frequencies by reducing switching losses. This may lead to vibration or instability in the motor under light load conditions.

Setting	Motor Energy Optimiser	Drive Energy Optimiser
0	**Disabled**	**Disabled**
1	**Enabled**	**Disabled**
3	**Disabled**	**Enabled**
4	**Enabled**	**Enabled**

P-07	**Motor Rated Voltage / Back EMF at rated speed (PM / BLDC)**	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	**Motor Rated Current**	Drive Rating Dependent			A
	This parameter should be set to the rated (nameplate) current of the motor. This parameter cannot be adjusted greater than the continuous current rating of the drive. When the motor nameplate value is entered, thermal overload protection is enabled, as described in section 9.10.4.				
P-09	**Motor Rated Frequency**	10	500	50 (60)	Hz
	This parameter should be set to the rated (nameplate) frequency of the motor.				
P-10	**Motor Rated Speed**	0	30000	0	RPM
	This parameter can optionally be set to the rated (nameplate) RPM of the motor. When set to the default value of zero, all speed related parameters are displayed in Hz, and the slip compensation for the motor is disabled. Entering the value from the motor nameplate enables the slip compensation function, and the Optidrive display will now display the motor speed in RPM. All speed related parameters, such as Minimum and Maximum Speed, Preset Speeds etc. will also be displayed in RPM. **Note** If P-09 value is changed, P-10 value is reset to 0.				

Par.	Description	Minimum	Maximum	Default	Units
P-11	**Low Frequency Torque Boost Current**	0.0	Drive Dependent	3.0	%

Low Frequency Torque Boost is used to increase the applied motor voltage and hence current at low output frequencies. This can improve low speed and starting torque. Increasing the boost level will increase motor current at low speed, which may result in the motor temperature rising - force ventilation of the motor may then be required. In general, the lower the motor power, the higher the boost setting that may be safely used.
For IM motors, when P-51 = 0 1 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
This parameter is also effective when using alternative motor types, P-51 = 2, 3 or 4.
In this case, the boost current level is defined as 4*P-11*P-08.

Par.	Description	Minimum	Maximum	Default	Units
P-12	**Primary Command Source**	0	9	0	-

Setting	Function	Description
0	**Terminal Control**	The drive responds directly to signals applied to the control terminals.
1	**Uni-directional Keypad Control**	The drive can be controlled in the forward direction only using an external or remote Keypad
2	**Bi-directional Keypad Control**	The drive can be controlled in the forward and reverse directions using an external or remote Keypad. Pressing the keypad START button toggles between forward and reverse.
3	**Modbus Network Control**	Control via Modbus RTU (RS485) using the internal Accel / Decel ramps
4	**Modbus Network Control**	Control via Modbus RTU (RS485) interface with Accel / Decel ramps updated via Modbus
5	**PI Control**	User PI control with external feedback signal
6	**PI Analog Summation Control**	PI control with external feedback signal and summation with analog input 1
7	**CAN Control**	Control via CAN (RS485) using the internal Accel / Decel ramps
8	**CAN Control**	Control via CAN (RS485) interface with Accel / Decel ramps updated via CAN
9	**Slave Mode**	Control via a connected Invertek drive in Master Mode. Slave drive address must be > 1.

NOTE 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

Par.	Description	Minimum	Maximum	Default	Units
P-13	**Operating Mode Select**	0	2	0	-

Provides a quick set up to configure key parameters according to the intended application of the drive. Parameters are preset according to the table.
0: Industrial Mode. Intended for general purpose applications.
1: Pump Mode. Intended for centrifugal pump applications.
2: Fan Mode. Intended for Fan applications.

Setting	Application	Current Limit (P-54)	Torque Characteristic	Spin Start (P-33)	Thermal Overload Limit Reaction (P-60 Index 2)
0	General	150%	Constant	0: Off	0: Trip
1	Pump	110%	Variable	0: Off	1: Current Limit Reduction
2	Fan	110%	Variable	2: On	1: Current Limit Reduction

Par.	Description	Minimum	Maximum	Default	Units
P-14	**Extended Menu Access code**	0	65535	0	-

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.

2.3.2 Extended parameters

Par.	Description			Minimum	Maximum	Default	Units
P-15	**Digital Input Function Select**			0	18	0	-
	Defines the function of the digital inputs depending on the control mode setting in P-12. See section 2.6 Control Terminal Connections for more information.						
P-16	**Analog Input 1 Signal Format**			See Below		See Below	-
	Setting	**Function**	**Description**				
	U 0- 10	0 to 10VDC Uni-direction	Default setting for IP20 & IP66 Non-Switched drives. The drive will operate from P-02 (Minimum Frequency / Speed) to P-01 (Maximum Frequency / Speed) according to the applied signal level voltage. Signal format applied at the terminal input must uni-polar. Maximum applied signal voltage must not exceed 10VDC. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%.					
	b 0- 10	0 to 10VDC bi-directional	The drive will operate from –P-01 (Reverse Rotation, Maximum Frequency / Speed) to P-01 (Forward Rotation, Maximum Frequency / Speed) according to the applied signal level. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. The drive will operate the motor in the reverse direction of rotation if the analog reference after scaling and offset are applied is <0.0% The resultant value after scaling and offset are applied may not exceed the range -100 to 100%.					
	A 0-20	0 to 20mA	The drive will operate from P-02 (Minimum Frequency / Speed) to P-01 (Maximum Frequency / Speed) according to the applied signal level current. Signal format applied at the terminal input must uni-polar. Maximum applied signal current must not exceed 20mA. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%.					
	t 4-20	4 to 20mA	The drive will operate from P-02 (Minimum Frequency / Speed) to P-01 (Maximum Frequency / Speed) according to the applied signal level current. Signal format applied at the terminal input must uni-polar. Maximum applied signal current must not exceed 20mA. Signal level =<4mA is treated as zero. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%. The drive will trip and show the fault code 4-20F if the signal level falls below 3mA					
	r 4-20	4 to 20mA	The drive will operate from P-02 (Minimum Frequency / Speed) to P-01 (Maximum Frequency / Speed) according to the applied signal level current. Signal format applied at the terminal input must uni-polar. Maximum applied signal current must not exceed 20mA. Signal level =<4mA is treated as zero. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%. The drive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA					
	t 20-4	20 to 4mA	The drive will operate from P-01 (Maximum Frequency / Speed) to P-02 (Minimum Frequency / Speed) according to the applied signal level current. Signal format applied at the terminal input must uni-polar. Maximum applied signal current must not exceed 20mA. Signal level =<4mA is treated as zero. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%. The drive will trip and show the fault code 4-20F if the signal level falls below 3mA					

Par.	Description			Minimum	Maximum	Default	Units
	r 20-4	20 to 4mA	The drive will operate from P-01 (Maximum Frequency / Speed) to P-02 (Minimum Frequency / Speed) according to the applied signal level current. Signal format applied at the terminal input must uni-polar. Maximum applied signal current must not exceed 20mA. Signal level =<4mA is treated as zero. Note: P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%. The drive will run at Preset Speed 1 (P-20) if the signal level falls below 3mA				
	U 10-0	10 to 0V	The drive will operate at Maximum Frequency / Speed if the analog reference after scaling and offset are applied is =<0.0%				
	In-Pot	Built in Pot	**For IP66 Switched Drives Only**. Default setting for IP66 Switched drives. The built-in pot is used to provide the signal to analog input 1. P-39 Analog Input Offset and P-35 are applied to the signal. The resulting value will be displayed in P00-01. Motor rotation remains in the same direction regardless of the result after scaling an offset are applied. The resultant value after scaling and offset are applied may not exceed the range 0.0 to 100%.				
P-17	**Maximum Effective Switching Frequency**			4	32	8	kHz
	Sets the maximum effective switching frequency of the drive. The actual switching frequency used by the drive may be reduced according to the output frequency or heatsink temperature. Refer to section 2.8.3 Automatic Switching Frequency Reduction for further information. Actual switching frequency will be displayed in parameter P00-32.						
P-18	**Output Relay Function Select**			0	9	1	-
	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.						
	Setting	**Function**	**Contacts Closed Under the Following Condition(s):**				
	0	**Drive Enabled (Running)**	The motor is enabled				
	1	**Drive Healthy**	Power is applied to the drive and no fault exists				
	2	**At Target Frequency (Speed)**	The output frequency matches the setpoint frequency				
	3	**Drive Tripped**	The drive is in a fault condition				
	4	**Output Frequency >= Limit**	The output frequency exceeds the adjustable limit set in P-19				
	5	**Output Current >= Limit**	The motor current exceeds the adjustable limit set in P-19				
	6	**Output Frequency < Limit**	The output frequency is below the adjustable limit set in P-19				
	7	**Output Current < Limit**	The motor current is below the adjustable limit set in P-19				
	8	**Analog Input 2 > Limit**	The signal applied to analog input 2 exceeds the adjustable limit set in P-19				
	9	**Drive Ready to Run**	The drive is ready to run, no trip present.				
P-19	**Relay Threshold Level**			0.0	200.0	100.0	%
	Adjustable threshold level used in conjunction with settings 4 to 7 of P-18						
P-20	**Preset Frequency / Speed 1**			P-02	P-01	5.0	Hz / RPM
P-21	**Preset Frequency / Speed 2**			P-02	P-01	25.0	Hz / RPM
P-22	**Preset Frequency / Speed 3**			P-02	P-01	40.0	Hz / RPM
P-23	**Preset Frequency / Speed 4**			P-02	P-01	P-09	Hz / RPM
	Preset Speeds / Frequencies may be selected by digital inputs depending on the setting of P-15 If P-10 = 0, the values are entered as Hz. If P-10 > 0, the values are entered as RPM. **Note:** Changing the value of P-09 will reset all values to factory default settings.						
P-24	**2nd Deceleration Ramp Time (Fast Stop)**			0.00	600.0	0.00	s
	This parameter allows an alternative deceleration ramp down time to be programmed into the Optidrive, which can be selected by digital inputs (dependent on the setting of P-15) or selected automatically 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.						

Par.	Description	Minimum	Maximum	Default	Units
P-25	**Analog Output Function Select**	0	11	8	-

Digital Output Mode. Logic 1 = +24V DC

Setting	Function	Output = 24VDC under the following condition(s):
0	**Drive Enabled (Running)**	The Optidrive is enabled (Running). The output remains on even if output frequency = 0.0Hz or the drive is in standby mode.
1	**Drive Healthy**	No Fault condition exists on the drive.
2	**At Target Frequency (Speed)**	Output frequency matches the setpoint frequency.
3	**Drive Tripped**	The drive is in a trip condition.
4	**Output Frequency >= Limit**	The output frequency exceeds the adjustable limit set in P-19.
5	**Output Current >= Limit**	The motor current exceeds the adjustable limit set in P-19.
6	**Output Frequency < Limit**	The output frequency is below the adjustable limit set in P-19.
7	**Output Current < Limit**	The motor current is below the adjustable limit set in P-19.

Analog Output Mode

Setting	Description	Range
8	**Output Frequency (Motor Speed)**	0 to P-01, resolution 0.1Hz
9	**Output (Motor) Current**	0 to 200.0% of P-08, updated every 256ms
10	**Output Power**	0 – 200.0% of drive rated power
11	**Load Current (Torque)**	0 – 200.0% of P-08, updated every 64ms

P-26	**Skip frequency hysteresis band**	0.0	P-01	0.0	Hz / RPM
P-27	**Skip Frequency Centre Point**	0.0	P-01	0.0	Hz / RPM

The Skip Frequency function is used to avoid the Optidrive operating at a certain output frequency, for example at a frequency which causes mechanical resonance in some machines or applications. Parameter P-27 defines the centre point of the skip frequency band and is used in conjunction with P-26. The Optidrive 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 Optidrive output frequency will remain at the upper or lower limit of the band.

P-28	**V/F Characteristic Adjustment Voltage**	0	250 / 500	0	V
P-29	**V/F Characteristic Adjustment Frequency**	0.0	P-09	0.0	Hz

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-30 Start Mode, Automatic Restart, Fire Mode Configuration

Index 1: Start Mode & Automatic Restart

Selects whether the drive should start automatically if the enable input is present and latched during power on. Also configures the Automatic Restart function.

Setting	Start Function	Auto Restarts	Description
EdgE-r	Edge Run	0	Following Power on or reset, the drive will not start if Digital Input 1 remains closed. The Input must be closed after a power on or reset to start the drive.
AUto-0	Auto	0	Following a Power on or Reset, the drive will automatically start if Digital Input 1 is closed.
AUto-1	Auto	1	As AUto-0. In addition, 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.
AUto-2	Auto	2	
AUto-3	Auto	3	
AUto-4	Auto	4	
AUto-5	Auto	5	

	Index 2: Fire Mode Input Logic	0	1	0	-

Defines the operating logic when a setting of P-15 is used which includes Fire Mode, e.g. settings 15, 16 & 17.

Setting	Input Type	Fire Mode Active When
0	**Normally Closed (NC)**	Input is open
1	**Normally Open (NO)**	Input is closed

	Index 3: Fire Mode Input Type	0	1	0	-

Defines the input type when a setting of P-15 is used which includes Fire Mode, e.g. settings 15, 16 & 17.

Setting	Input Type	Description
0	**Maintained Input**	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).
1	**Momentary Input**	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.

Par.	Description	Minimum	Maximum	Default	Units
P-31	**Keypad Start Mode Select**	0	3	1	-

This parameter is active only when operating in Keypad Control Mode (P-12 = 1 or 2), Modbus Mode (P-12 = 3 or 4) or CAN Mode (P-12 = 7 or 8). When settings 0 or 1 are used, the Keypad Start and Stop keys are active, and control terminals 1 and 2 must be linked together. Settings 2 and 3 allow the drive to be started from the control terminals directly, and the keypad Start and Stop keys are ignored.

Setting	Start At	Enable From
0	Minimum Speed (P-02)	Keypad (Digital Input 1 must be closed)
1	Previous Speed	Keypad (Digital Input 1 must be closed)
2	Minimum Speed	Digital Input 1
3	Previous Speed	Digital Input 1
4	Present Speed	Keypad (Digital Input 1 must be closed)
5	Preset Speed 4 (P-23)	Keypad (Digital Input 1 must be closed)
6	Present Speed	Digital Input 1
7	Preset Speed 4 (P-23)	Digital Input 1

Par.	Description	Minimum	Maximum	Default	Units
P-32	**DC Injection Braking Configuration**				

DC Injection braking provides a simple method for braking the motor shaft. A DC current is injected into the motor to generate braking torque.
DC injection braking must not be used in applications where a load operates against gravity, e.g. lifting and lowering applications.
It is suitable for use in applications where a load has high inertia, and a reduced stopping time is required, or applications where it is essential that the motor shaft comes to a complete stop on disable or before starting.

Index 1: Duration	0.0	25.0	0.0	s
Index 2: DC Injection Mode	0	2	0	-

Index 1: Defines the time for which a DC current is injected into the motor. DC Injection current level may be adjusted in P-59.

Index 2: Configures the DC Injection Function as follows: -

Setting	Function	Description
0	**DC Injection on Stop**	When the drive is disabled, DC is injected into the motor at the current level set in P-59 when the output frequency is at or below the level set in P-58. No current is injected during deceleration due to a change of setpoint. The current is injected for the time set in Index 1. This can be useful to ensure the motor has reached a complete stop before the drive disables, or to provide additional braking torque during stopping.
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.
2	**DC Injection on Start & Stop**	DC injection applied as both settings 0 and 1 above.

Par.	Description	Minimum	Maximum	Default	Units
P-33	**Spin Start**	0	2	0	-

Spin start should be used in applications such as fans or flywheels where the load has high inertia and may be rotating prior to enabling the drive. The Spin Start function attempts to determine if the motor is rotating and synchronises the output frequency to the motor speed. The Spin Start function can determine the direction of motor rotation and it if necessary, reverse the direction providing that sufficient braking torque is possible.
Spin Start cannot detect the motor speed if it is changing rapidly, or it exceeds the maximum frequency / speed limit set in P-01.
If the motor is at standstill when the drive is enabled, there may be a short delay before the motor starts to rotate.

Setting	Function	Description
0	**Disabled**	
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.
2	**Enabled on Trip, Brown Out or Coast Stop**	Spin start is only activated following the events listed, otherwise it is disabled.

Par.	Description	Minimum	Maximum	Default	Units
P-34	**Brake Chopper Enable (Not Size 1)**	0	2	0	-

Frame Size 2 and above drives have an internal brake chopper, which allows connection of an external resistor to dissipate the regenerated braking energy. This parameter enables the function, and additionally configures the software protection used to prevent overloading the resistor.

Setting	Function	Description
0	**Disabled**	
1	**Enabled with Software Protection**	Enables the internal brake chopper with software protection for a 200W continuous rated resistor
2	**Enabled Without Software Protection**	Enables the internal brake chopper without software protection. An external thermal protection device should be fitted
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
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.

Par.	Description	Minimum	Maximum	Default	Units
P-35	**Analog Input 1 Scaling / Slave Speed Scaling**	0.0	2000.0	100.0	%
	Analog Input 1 Scaling. 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) **Slave Speed Scaling**. 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-36	**Serial Communications Configuration**	See Below			
	Index 1: Address	0	63	1	-
	Index 2: Baud Rate	9.6	1000	115.2	kbps
	Index 3: Communication loss protection	0	3000	300	ms
	This parameter has three sub settings used to configure the Modbus RTU and CAN Serial Communications. The Sub Parameters are				
	Index 1: Drive Address: Range: 0 – 63, default: 1				
	Index 2: Baud Rate & Network type: 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: Baud rates 125, 250, 500 & 1000 kbps are available.				
	Index 3: Watchdog Timeout: 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, 3000, 10000, 30000 or 60000 defines the time limit in milliseconds for operation. A '**t**' suffix selects trip on loss of communication. An '**r**' suffix means that the drive will coast stop (output immediately disabled) but will not trip.				
P-37	**Access Code Definition**	0	9999	101	-
	Defines the access code which must be entered in P-14 to access parameters above P-14				
P-38	**Parameter Access Lock**	0	1	0	-

Setting	Function	Description
0	**Unlocked**	All parameters can be accessed and changed
1	**Locked**	Parameter values can be displayed but cannot be changed except P-38.

P-39	**Analog Input 1 Offset**	-500.0	500.0	0.0	%
	Sets an offset, as a percentage of the full-scale range of the input, which is applied to the analog input signal. This parameter operates in conjunction with P-35, and the resultant value after scaling and offset are applied can be displayed in P00-01. The resultant value is defined as a percentage, according to the following: - P00-01 = (Applied Signal Level (%) - P-39) x P-35)				
P-40	**Index 1: Display Scaling Factor**	0.000	16.000	0.000	-
	Index 2: Display Scaling Source	0	3	0	-
	Allows the user to program the Optidrive 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.				
	Index 1: Used to set the scaling multiplier. The chosen source value is multiplied by this factor.				
	Index 2: Defines the scaling source as follows: -				

Setting	Function	Description
0	**Motor Speed**	Scaling is applied to the output frequency if P-10 = 0, or motor RPM if P-10 > 0.
1	**Motor Current**	Scaling is applied to the motor current value (Amps)
2	**Analog Input 2 Signal Level**	Scaling is applied to analog input 2 signal level, internally represented as 0 – 100.0%
3	**PI Feedback**	Scaling is applied to the PI feedback selected by P-46, internally represented as 0 – 100.0%

P-41	**PI Controller Proportional Gain**	0.0	30.0	1.0	-
	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-42	**PI Controller Integral Time**	0.0	30.0	1.0	s
	PI Controller Integral Time. Larger values provide a more damped response for systems where the overall process responds slowly				
P-43	**PI Controller Operating Mode**	0	3	0	-

Setting	Function	Description
0	**Direct Operation**	Use this mode if when the feedback signal drops, the motor speed should increase. When the drive restarts following standby, the PID controller will restart from zero.
1	**Inverse Operation**	Use this mode if when the feedback signal drops, the motor speed should decrease. When the drive restarts following standby, the PID controller will restart from zero.
2	**Direct Operation**	Use this mode if when the feedback signal drops, the motor speed should increase. When the drive restarts following standby, the PID controller will restart from maximum.
3	**Inverse Operation**	Use this mode if when the feedback signal drops, the motor speed should decrease. When the drive restarts following standby, the PID controller will restart from maximum.

P-44	**PI Reference (Setpoint) Source Select**	0	1	0	-
	Selects the source for the PID Reference / Setpoint				

Setting	Function	Description
0	**Digital Preset Setpoint**	P-45 is used
1	**Analog Input 1 Setpoint**	Analog input 1 signal level, readable in P00-01 is used for the setpoint.

P-45	**PI Digital Setpoint**	0.0	100.0	0.0	%
	When P-44 = 0, this parameter sets the preset digital reference (setpoint) used for the PI Controller as a % of the feedback signal range.				

Par.	Description			Minimum	Maximum	Default	Units
P-46	**PI Feedback Source Select**			0	5	0	-
	Selects the source of the feedback signal to be used by the PI controller.						
	Setting	**Function**	**Description**				
	0	**Analog Input 2**	(Terminal 4) Signal level readable in P00-02.				
	1	**Analog Input 1**	(Terminal 6) Signal level readable in P00-01				
	2	**Motor Current**	Scaled as % of P-08				
	3	**DC Bus Voltage**	Scaled 0 – 1000 Volts = 0 – 100%				
	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.				
	5	**Largest (Analog 1, Analog 2)**	The larger of the two analog input values is always used for PI feedback.				
P-47	**Analog Input 2 Signal Format**			-	-	-	U0-10
	Setting	**Signal Type**	**Additional Information**				
	U 0-10	0 to 10 Volt					
	A 0-20	0 to 20mA					
	t 4-20	4 to 20mA	The drive will trip and show the fault code 4-20F if the signal level falls below 3mA				
	r 4-20	4 to 20mA	The drive will ramp to stop if the signal level falls below 3mA				
	t 20-4	20 to 4mA	The drive will trip and show the fault code 4-20F if the signal level falls below 3mA				
	r 20-4	20 to 4mA	The drive will ramp to stop if the signal level falls below 3mA				
	Ptc-th	Motor Thermistor (PTC)	Valid with any setting of P-15 that has Input 3 as E-Trip.				
P-48	**Standby Mode Timer**			0.0	60.0	0.0	s
	When standby mode is enabled by setting P-48 > 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 StndbY, and the output to the motor is disabled.						
P-49	**PI Control Wake Up Error Level**			0.0	100.0	0.0	%
	When the drive is operating in PI Control Mode (P-12 = 5 or 6), and Standby Mode is enabled (P-48 > 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-50	**User Output Relay Hysteresis**			0.0	10.0	5.0	%
	Sets the hysteresis level for P-19 to prevent the output relay chattering when close to the threshold.						

2.3.3 Advanced Parameters

Par.	Description	Minimum	Maximum	Default	Units
P-51	**Motor Control Mode**	0	5	0	-
	Selects the motor type and control method used by the drive. For control of IE4 motors, the correct motor type setting must be used, and the instructions followed in section 2.7 Motor Control Methods on page 23				
	Setting / **Control Method**				
	0 / **Vector speed control mode for Induction Motors**				
	1 / **V/f mode for Induction Motors**				
	2 / **PM vector speed control for Permanent Magnet Motors**				
	3 / **BLDC vector speed control for Brushless DC Motors**				
	4 / **SR vector speed control for Synchronous Reluctance Motors**				
	5 / **LSPM vector speed control for Line Start Permanent Magnet Motors**				
P-52	**Motor Parameter Autotune**	0	1	0	-
	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.				
	Setting / **Function** / **Description**				
	0 / **Disabled**				
	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.				
P-53	**Vector Mode Gain**	0.1	200.0	50.0	%
	Single Parameter for Vector speed loop tuning. Affects P & I terms simultaneously. Not active when P-51 = 1.				
P-54	**Maximum Current Limit**	0.1	175.0	150.0	%
	Defines the max current limit in vector control modes				
P-55	**Motor Stator Resistance**	0.0	655.35	-	Ω
	Motor stator resistance in Ohms. Determined by Autotune, adjustment is not normally required.				
P-56	**Motor Stator d-axis Inductance (Lsd)**	0	6553.5	-	mH
	Determined by Autotune, adjustment is not normally required.				
P-57	**Motor Stator q-axis Inductance (Lsq)**	0	6553.5	-	mH
	Determined by Autotune, adjustment is not normally required.				
P-58	**DC Injection Speed**	0.0	P-01	0.0	Hz / RPM
	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.				
P-59	**DC Injection Current**	0.0	100.0	20.0	%
	Sets the level of DC injection braking current applied according to the conditions set in P-32 and P-58.				
P-60	**Motor Overload Management**	-	-	-	-
	Index 1: Thermal Overload Retention	0	1	1	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.				
	Index 2: Thermal Overload Limit Reaction	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%				

2.4 Alternative Parameter Functions for Single Phase Output Drives

Single phase output drives feature several changes in order to provide optimal operation with single phase motors. These changes are based around two key principles: -

- The Starting method for single phase motors requires the motor to be started at full speed in order to provide optimal starting torque. The starting boost parameters allow adjustment of this function to provide optimal motor starting.
- It is not possible to have reverse operation with a single-phase motor, thereby all reverse functions are disabled in the drive firmware.

2.4.1 Single Phase Output Drives – Alternative Parameters

Par.	Description			Minimum	Maximum	Default	Units
P-05	**Stopping Mode / Mains Loss Response**			0	2	0	-
	Selects the stopping mode of the drive, and the behaviour in response to a loss of mains power supply during operation.						
	Setting	**On Disable**	**On Mains Loss**				
	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				
	AC Flux braking is not possible with single phase motors.						
P-06	**Reserved**			-	-	-	-
	Energy optimiser feature is not suitable for Single Phase motors						
P-11	**Start Boost Voltage**			0.0	100.0	3.0	%
	This parameter sets the initial voltage applied to the motor following a start command. The inverter applied the voltage set in this parameter at the frequency set in P-32 initially, and then ramps to the motor rated voltage set in P-09 over the time period set in P-33. Excessive voltage boost levels may result in increased motor current and temperature and can result in the drive tripping during starting.						
P-13	**Reserved**			-	-	-	-
	Application Macro selection is not supported on single phase output drives.						
P-15	**Digital Input Function Select**			0	17	0	-
	This parameter has the same function as three phase output drives, however, note that for single phase output drives, all reverse functions are disabled, and the inputs assigned have no function.						
P-20	**Preset Frequency / Speed 1**			0.0	P-01	5.0	Hz / RPM
P-21	**Preset Frequency / Speed 2**			0.0	P-01	25.0	Hz / RPM
P-22	**Preset Frequency / Speed 3**			0.0	P-01	40.0	Hz / RPM
P-23	**Preset Frequency / Speed 4**			0.0	P-01	P-09	Hz / RPM
	These parameters have alternative default settings compared to three phase drives and are uni-directional only.						
P-32	**Starting Boost Frequency**			0.0	P-09	P-09	Hz
	Sets the frequency used during the starting boost phase of operation.						
P-33	**Boost Period Duration**			0.0	150	5.0	s
	Time for which the start-up boost period is applied. During this period, the output frequency is set to P-32 and the voltage increases linearly from P-11 to P-07. Setting P-33 to zero disables boost.						
P-51 To P-59	**Reserved**			-	-	-	-
	These parameters are not present in single phase output drives.						

2.5 Parameter Group 0 – Monitoring Parameters (Read Only)

Par.	Description	Explanation
P00-01	1st Analog input value (%)	100% = max input voltage
P00-02	2nd 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 (V)	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	CAN process data input	Incoming process data (RX PDO1) for CAN: PI1, PI2, PI3, PI4
P00-22	CAN process data output	outgoing process data (TX PDO1) for CAN: PO1, PO2, PO3, PO4
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 80C
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. If "rEd" is displayed, the switching frequency has been automatically reduced.
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)	
P00-39	Modbus comms error counter	
P00-40	CAN comms error counter	
P00-41	I/O processor comms errors	
P00-42	Power stage uC comms errors	
P00-43	Drive power up time (lifetime) (Hours)	Total lifetime of drive with power applied
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 Index 2: Fire Mode Activation Count	Total activation time of Fire Mode 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

2.6 Control Terminal Connections

For standard applications and operation, the basic control of the drive and functions of all drive input terminals can be configured using just two parameters, P-12 and P-15. P-12 is used to define the source of all control commands and the primary speed reference source. P-15 then allows fast selection of Analog and Digital Input functions based on a selection table.

2.6.1 P-12 Function

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

P-12	Function	Control Source	Main Speed Reference	Notes
0	Terminal Control	Terminals	Analog Input 1	All control signals are applied to the control terminals. Functions are determined by P-15 Macro setting.
1	Keypad Control	Keypad / Terminals	Motorised Pot / Keypad	When keypad mode is selected, the default operation of the drive requires the keypad Start & Stop buttons are used to control the drive. This can be changed using P-31 to allow the drive to be started from Digital Input 1 directly.
2	Keypad Control	Keypad / Terminals	Motorised Pot / Keypad	
3	Modbus RTU	Modbus RTU	Modbus RTU	Control of the drive operation is through the Modbus RTU Interface. Acceleration and Deceleration Rates are controlled by P-03 and P-04 respectively. Digital Input 1 must be closed to allow operation.
4	Modbus RTU	Modbus RTU	Modbus RTU	Control of the drive operation is through the Modbus RTU Interface. Acceleration and Deceleration Rates are also controlled by Modbus, P-03 and P-04 are disabled. Digital Input 1 must be closed to allow operation.
5	PI Control	Terminals	PI Output	Enable / Disable control of the drive is through the drive control terminal strip. Output frequency is set by the output of the PI Controller
6	PI Control with Analog Summation	Terminals	PI Output Added to AI1	Enable / Disable control of the drive is through the drive control terminal strip. Output frequency is set by the output of the PI Controller, added to the value of analog input 1.
7	CAN	CAN	CAN	Control of the drive operation is through the CAN Interface. Acceleration and Deceleration Rates are controlled by P-03 and P-04 respectively. Digital Input 1 must be closed to allow operation.
8	CAN	CAN	CAN	Control of the drive operation is through the CAN Interface. Acceleration and Deceleration Rates are also controlled by Modbus, P-03 and P-04 are disabled. Digital Input 1 must be closed to allow operation.
9	Slave Mode	Master Drive	From Master	

2.6.2 Overview

Optidrive 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.

2.6.3 Macro Function Guide

Function	Explanation
STOP	Latched Input, Open the contact to STOP the drive
RUN	Latched input, Close the contact to Start, the drive will operate as long as the input is maintained
FWD↻	Latched Input, selects the direction of motor rotation FORWARD
REV↺	Latched Input, selects the direction of motor rotation REVERSE
RUN FWD↻	Latched Input, Close to Run in the FORWARD direction, Open to STOP
RUN REV↺	Latched Input, Close to Run in the REVERSE direction, Open to STOP
ENABLE	Hardware Enable Input. In Keypad Mode, 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 command is applied via the fieldbus interface.
START↥	Normally Open, Rising Edge, Close momentarily to START the drive (NC STOP Input must be maintained)
^- START -^	Simultaneously applying both inputs momentarily will START the drive (NC STOP Input must be maintained)
STOP ↧	Normally Closed, Falling Edge, Open momentarily to STOP the drive
START↥FWD↻	Normally Open, Rising Edge, Close momentarily to START the drive in the forward direction (NC STOP Input must be maintained)
START↥REV↺	Normally Open, Rising Edge, Close momentarily to START the drive in the reverse direction (NC STOP Input must be maintained)
^-FAST STOP (P-24)-^	When both inputs are momentarily active simultaneously, the drive stops using Fast Stop Ramp Time P-24
FAST STOP↧ (P-24)	Normally Closed, Falling Edge, Open momentarily to FAST STOP the drive using Fast Stop Ramp Time P-24
E-TRIP	Normally Closed, External Trip input. When the input opens momentarily, the drive trips showing **E-tr iP** or **Ptc-th** depending on P-47 setting
Fire Mode	Activates Fire Mode, see section 2.8.1 Fire Mode
Analog Input AI1	Analog Input 1, signal format selected using P-16
Analog Input AI2	Analog Input 2, signal format selected using P-47
AI1 REF	Analog Input 1 provides the speed reference
AI2 REF	Analog Input 2 provides the speed reference
P-xx REF	Speed reference from the selected preset speed
PR-REF	Preset speeds P-20 – P-23 are used for the speed reference, selected according to other digital input status
PI-REF	PI Control Speed Reference
PI FB	Analog Input used to provide a Feedback signal to the internal PI controller
KPD REF	Keypad Speed Reference selected
INC SPD↑	Normally Open, Close the input to Increase the motor speed
DEC SPD↓	Normally Open, Close input to Decrease motor speed
FB REF	Selected speed reference from Fieldbus (Modbus RTU / CAN / Master depending on P-12 setting)
(NO)	Input is Normally Open, Close momentarily to activate the function
(NC)	Input is Normally Closed, Open momentarily to activate the function
SPD STEP↑	Increase motor speed by fixed step. See section 2.8.4
SPD STEP↓	Decrease motor speed by fixed step. See section 2.8.4

2.6.4 Macro Functions – Terminal Mode (P-12 = 0)

P-15	DI1		DI2		DI3 / AI2		DI4 / AI1		Diagram
	0	1	0	1	0	1	0	1	
0	STOP	RUN	FWD ↻	REV ↺	AI1 REF	P-20 REF	Analog Input AI1		1
1	STOP	RUN	AI1 REF	PR-REF	P-20	P-21	Analog Input AI1		1
2	STOP	RUN	**DI2**	**DI3**	**PR**		P-20 - P-23	P-01	2
			0	0	P-20				
			1	0	P-21				
			0	1	P-22				
			1	1	P-23				
3	STOP	RUN	AI1 REF	P-20 REF	E-TRIP ↴	(NC)	Analog Input AI1		3
4	STOP	RUN	AI1 REF	AI2 REF	Analog Input AI2		Analog Input AI1		4
5	STOP	RUN FWD ↻	STOP	RUN REV ↺	AI1 REF	P-20 REF	Analog Input AI1		1
		^----------FAST STOP (P-24)----------^							
6	STOP	RUN	FWD ↻	REV ↺	E-TRIP ↴	(NC)	Analog Input AI1		3
7	STOP	RUN FWD ↻	STOP	RUN REV ↺	E-TRIP ↴	(NC)	Analog Input AI1		3
		^----------FAST STOP (P-24)----------^							
8	STOP	RUN	FWD ↻	REV	**DI3**	**DI4**	**PR**		2
					0	0	P-20		
					1	0	P-21		
					0	1	P-22		
					1	1	P-23		
9	STOP	RUN↥FWD ↻	STOP	RUN↥REV↺	**DI3**	**DI4**	**PR**		2
		^----------FAST STOP (P-24)----------^			0	0	P-20		
					1	0	P-21		
					0	1	P-22		
					1	1	P-23		
10	(NO)	START ↥	STOP ↴	(NC)	AI1 REF	P-20 REF	Analog Input AI1		5
11	(NO)	START↥FWD ↻	STOP ↴	(NC)	(NO)	START↥REV↺	Analog Input AI1		6
		^----------FAST STOP (P-24)----------^							
12	STOP	RUN	FAST STOP↴ (P-24)	(NC)	AI1 REF	P-20 REF	Analog Input AI1		7
13	(NO)	START↥FWD ↻	STOP ↴	(NC)	(NO)	START↥REV↺	KPD REF	P-20 REF	13
		^----------FAST STOP (P-24)----------^							
14	STOP	RUN	DI2		E-TRIP ↴	(NC)	**DI2**	**DI4**	**PR**
							0	0	P-20
							1	0	P-21
							0	1	P-22
							1	1	P-23
15	STOP	RUN	P-23 REF	AI1	Fire Mode		Analog Input AI1		1
16	STOP	RUN	P-23 REF	P-21 REF	Fire Mode		FWD ↻	REV ↺	2
17	STOP	RUN	DI2		Fire Mode		**DI2**	**DI4**	**PR**
							0	0	P-20
							1	0	P-21
							0	1	P-22
							1	1	P-23
18	STOP	RUN	FWD ↻	REV ↺	Fire Mode		Analog Input AI1		1

2.6.5 Macro Functions - Keypad Mode (P-12 = 1 or 2)

P-15	DI1		DI2		DI3 / AI2		DI4 / AI1		Diagram
	0	1	0	1	0	1	0	1	
0	STOP	ENABLE	-	INC SPD ↑	-	DEC SPD ↓	FWD ↻	REV ↺	8
				^---------- START ----------^					
1	STOP	ENABLE	PI REF						
2	STOP	ENABLE	-	INC SPD ↑	-	DEC SPD ↓	KPD REF	P-20 REF	8
				^---------- START ----------^					
3	STOP	ENABLE	-	INC SPD ↑	E-TRIP ↴	(NC)	-	DEC SPD ↓	9
				^---------- START ----------^					
4	STOP	ENABLE	-	INC SPD ↑	KPD REF	AI1 REF	Analog Input AI1		10
5	STOP	ENABLE	FWD ↻	REV ↺	KPD REF	AI1 REF	Analog Input AI1		1
6	STOP	ENABLE	FWD ↻	REV ↺	E-TRIP ↴	(NC)	KPD REF	P-20 REF	11
7	STOP	RUN FWD ↻	STOP	RUN REV ↺	E-TRIP ↴	(NC)	KPD REF	P-20 REF	11
		^----------FAST STOP (P-24)----------^							
8	STOP	RUN FWD ↻	STOP	RUN REV ↺	KPD REF	AI1 REF	Analog Input AI1		1
14	STOP	RUN	-	SPD STEP↑	E-TRIP ↴	(NC)	-	SPD STEP↓	9
15	STOP	RUN	PR REF	KPD REF	Fire Mode		P-23	P-21	2
16	STOP	RUN	P-23 REF	KPD REF	Fire Mode		FWD ↻	REV ↺	2
17	STOP	RUN	KPD REF	P-23 REF	Fire Mode		FWD ↻	REV ↺	2
18	STOP	RUN	AI1 REF	KPD REF	Fire Mode		Analog Input AI1		1
9,10,11,12, 13 = 0									

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

P-15	DI1		DI2		DI3 / AI2		DI4 / AI1		Diagram
	0	1	0	1	0	1	0	1	
0	STOP	ENABLE	FB REF (Fieldbus Speed Reference, Modbus RTU / CAN / Master-Slave defined by P-12)						14
1	STOP	ENABLE	PI REF						15
3	STOP	ENABLE	FB REF	P-20 REF	E-TRIP ↴	(NC)	Analog Input AI1		3
5	STOP	ENABLE	FB REF	PR REF	P-20	P-21	Analog Input AI1		1
		^------START (P-12 = 3 or 4 Only)--------^							
6	STOP	ENABLE	FB REF	AI1 REF	E-TRIP ↴	(NC)	Analog Input AI1		3
		^------START (P-12 = 3 or 4 Only)--------^							
7	STOP	ENABLE	FB REF	KPD REF	E-TRIP ↴	(NC)	Analog Input AI1		3
		^------START (P-12 = 3 or 4 Only)--------^							
14	STOP	ENABLE	-	-	E-TRIP ↴	(NC)	Analog Input AI1		16
15	STOP	ENABLE	PR REF	FB REF	Fire Mode		P-23	P-21	2
16	STOP	ENABLE	P-23 REF	FB REF	Fire Mode		Analog Input AI1		1
17	STOP	ENABLE	FB REF	P-23 REF	Fire Mode		Analog Input AI1		1
18	STOP	ENABLE	AI1 REF	FB REF	Fire Mode		Analog Input AI1		1
2,4,8,9,10,11,12,13 = 0									

2.6.7 Macro Functions - User PI Control Mode (P-12 = 5 or 6)

P-15	DI1		DI2		DI3 / AI2		DI4 / AI1		Diagram
	0	1	0	1	0	1	0	1	
0	STOP	ENABLE	PI REF	P-20 REF	Analog Input AI2		Analog Input AI1		4
1	STOP	ENABLE	PI REF	AI1 REF	Analog Input AI2 (PI FB)		Analog Input AI1		4
3, 7	STOP	ENABLE	PI REF	P-20	E-TRIP ↴	(NC)	Analog Input AI1 (PI FB)		3
4	(NO)	START ↥	(NC)	STOP ↴	Analog Input AI2 (PI FB)		Analog Input AI1		12
5	(NO)	START ↥	(NC)	STOP ↴	PI REF	P-20 REF	Analog Input AI1 (PI FB)		5
6	(NO)	START ↥	(NC)	STOP ↴	E-TRIP ↴	(NC)	Analog Input AI1 (PI FB)		
8	STOP	RUN	FWD ↻	REV ↺	Analog Input AI2 (PI FB)		Analog Input AI1		4
14	STOP	RUN	-	-	E-TRIP ↴	(NC)	Analog Input AI1 (PI FB)		16
15	STOP	RUN	P-23 REF	PI REF	Fire Mode		Analog Input AI1 (PI FB)		1
16	STOP	RUN	P-23 REF	P-21 REF	Fire Mode		Analog Input AI1 (PI FB)		1
17	STOP	RUN	P-21 REF	P-23 REF	Fire Mode		Analog Input AI1 (PI FB)		1
18	STOP	RUN	AI1 REF	PI REF	Fire Mode		Analog Input AI1 (PI FB)		1
2,9,10,11,12,13 = 0									

2.6.8 Example Connection Diagrams

Diagram 1

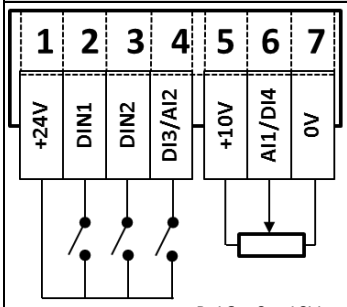


Diagram 2

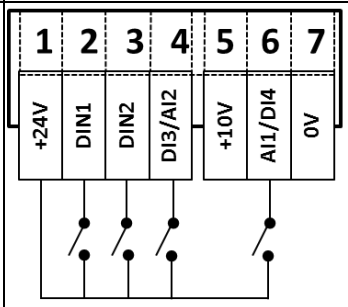


Diagram 3

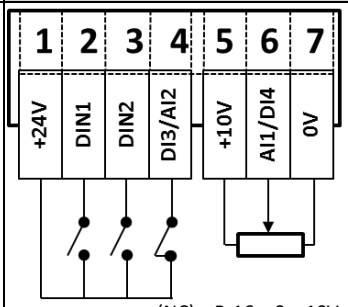


Diagram 4

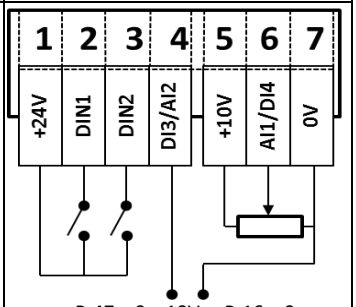


Diagram 5

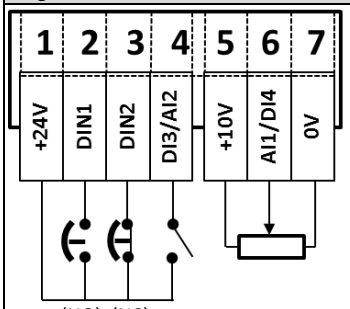


Diagram 6

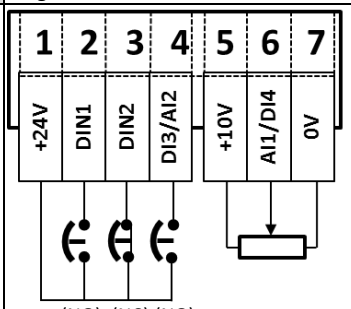


Diagram 7

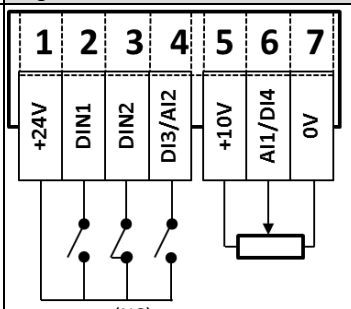


Diagram 8

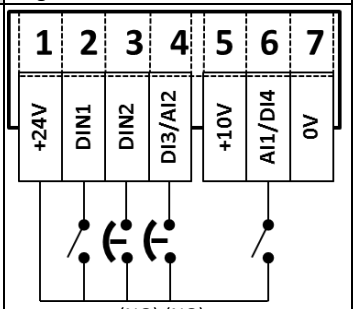


Diagram 9

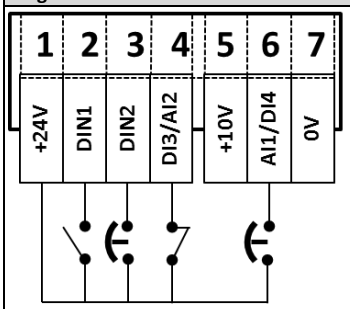


Diagram 10

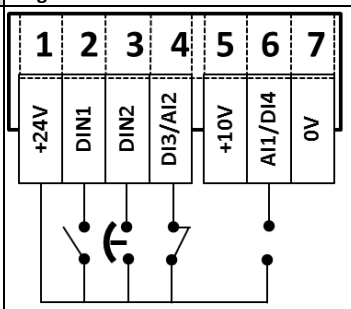


Diagram 11

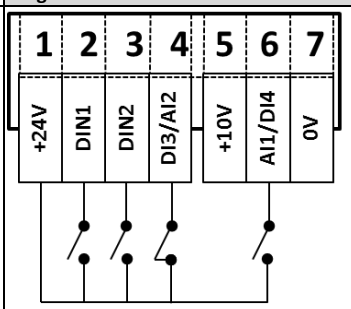


Diagram 12

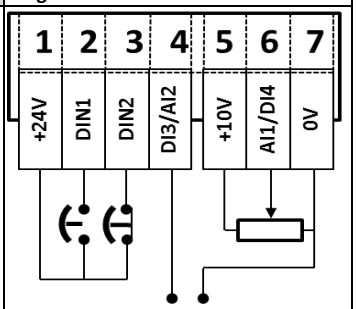


Diagram 13

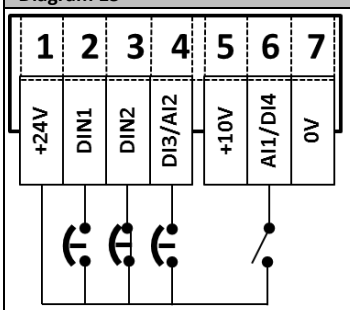


Diagram 14

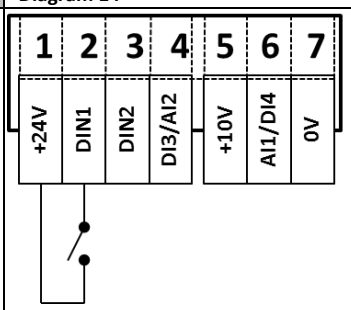


Diagram 15

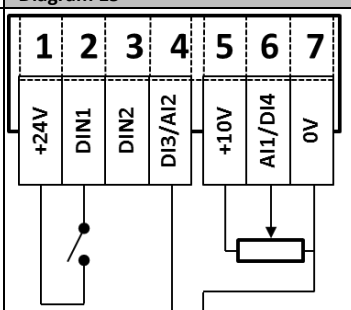
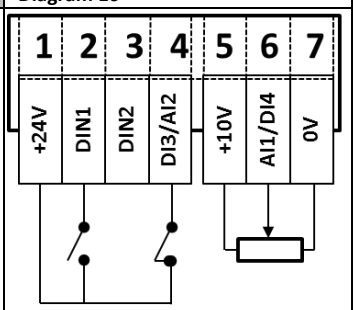


Diagram 16



2.7 Motor Control Methods

Optidrive E3 may be used with the following motor types:

- Asynchronous Induction Motors (IM)
- Synchronous Permanent Magnet AC Motors (PM)
- Brushless DC Motors (BLDC)
- Synchronous Reluctance Motors (SynRM)
- Line Start Permanent Magnet Motors (LSPM)

Each motor type requires the correct operating mode to be selected and the correct commissioning procedure to be followed as described in the following sections.

2.7.1 IM Motors

Optidrive E3 factory default parameters are intended for use with IM motors where the power rating of the motor is approximately the same or slightly less than the indicated power rating of the drive. In this case, it should be possible to operate the motor without any parameter adjustment at all for initial testing.

For optimum performance, the drive parameters should be adjusted to match the motor ratings. This will also ensure correct protection of the motor from damage due to overload.

The basic parameters that should be adjusted are:

- P-07: Motor Rated Voltage (V)
- P-08: Motor Rated Current (A)
- P-09: Motor Rated Frequency (Hz)

In addition, it is also possible to set

- P-10: Motor Rated Speed (RPM)

When this parameter is adjusted, slip compensation is activated. Slip compensation attempts to compensate the motor speed relative to the load applied, such that when operating at a constant speed with different loads, the motor shaft speed should remain approximately the same.

To further improve the performance of the motor, the following additional steps can be followed:

- Carry out an Autotune
    - This requires Advanced Parameter Access, P-14 = P-37 + 100 (Default: 201)
    - After the correct nameplate information is entered from the motor, the drive can additionally measure some electrical characteristics of the motor to further optimise the motor control to suit connected motor.
    - This is achieved by setting P-52 = 1
    - The autotune will begin IMMEDIATELY following the setting of this parameter!
    - The drive output will be enabled, and the motor shaft may move. It is important to ensure this is safe before carrying out the autotune.
    - For IM motors, the autotune takes only a few seconds, and measures only the motor stator resistance. Parameter P-55 will be updated with the new value.
- Adjust the Low Frequency Torque Boost
    - IM motors require some additional voltage at low frequency to improve the low speed operation and torque.
    - By adjusting P-11, it is possible to optimise the low speed operation.
    - If P-11 is increased too far, excessive motor heating or over current trips may result.

2.7.2 PM Motors

2.7.2.1 Suitable Motor Types

Optidrive E3 provides open loop control of permanent magnet AC motors, intended to allow the use of high efficiency motors in simple applications. Both interior and exterior magnets type motors are supported.
Operation is tested with motors under the following conditions

- The motor Back EMF is >=1 V / Hz
- Maximum motor frequency 360Hz
- Operation down to 10% of rated speed
- RMS Back EMF must not exceed the AC supply voltage during motor operation

It is possible to operate at lower speeds, or with motors with a lower Back EMF / Frequency ratio, however performance may be reduced.

2.7.2.2 Commissioning Procedure

When operating with permanent magnet motors, the commissioning steps are as follows:

- Enter the motor Back EMF at Rated Frequency / Speed in parameter P-07
    - This parameter must not be set to the rated motor voltage, but the actual Back EMF imposed by the motor magnets at the drive output terminals.
    - It is sometimes necessary to derive this information from a voltage constant and the rated operating speed, e.g.
        - If a motor has rated speed 2500RPM, back EMF constant 80V / 1000 RPM, P-07 = (2500 * 80) / 1000 = 200V
    - Alternatively, obtain the value from the motor supplier, or by direct measurement using an oscilloscope
- Enter the Motor Rated Current in P-08
    - It is possible that excessive current levels may permanently damage the motor, therefore this parameter must be set correctly to ensure this cannot occur.
    - Additionally, this current level is used by the autotune to determine the correct inductance values
- Enter the motor rated frequency in P-09
- Optionally enter the motor rated speed in P-10
- Enabled Advanced Parameter Access by setting P-14 = P-37 + 100 (Default: 201)
- Select PM motor control in by setting P-51 = 2
- Carry out an Autotune
    - For PM motor operation, an Autotune MUST be carried out
    - This is achieved by setting P-52 = 1
    - The autotune will begin IMMEDIATELY following the setting of this parameter!
    - The drive output will be enabled, and the motor shaft may move. It is important to ensure this is safe before carrying out the autotune.
    - For PM motors, the autotune measures the motor stator resistance and both Q and D axis inductance values. Parameters P-55, P-56 and P-57 will be updated following the measurements.
- It should now be possible to operate the motor.
- Low speed and starting of the motor may be further optimised by adjusting P-11
    - In PM motor control mode, P-11 adjust the additional current injected into the motor at low frequency to help maintain the rotor alignment and ensure reliable starting.

2.7.3 BLDC Motors

Optidrive E3 provides open loop control of BLDC motors, intended to allow the use of high efficiency motors in simple applications. Operation is tested with motors under the following conditions

- The motor Back EMF is >=1 V / Hz
- Maximum motor frequency 360Hz
- Operation down to 10% of rated speed
- RMS Back EMF must not exceed the AC supply voltage during motor operation

It is possible to operate at lower speeds, or with motors with a lower Back EMF / Frequency ratio, however performance may be reduced.

2.7.3.1 Commissioning Procedure

When operating with permanent magnet motors, the commissioning steps are as follows:

- Enter the motor Back EMF at Rated Frequency / Speed in parameter P-07
    - This parameter must not be set to the rated motor voltage, but the actual Back EMF imposed by the motor magnets at the drive output terminals.
    - It is sometimes necessary to derive this information from a voltage constant and the rated operating speed, e.g.
        - If a motor has rated speed 2500RPM, back EMF constant 80V / 1000 RPM, P-07 = (2500 * 80) / 1000 = 200V
    - Alternatively, obtain the value from the motor supplier, or by direct measurement using an oscilloscope
- Enter the Motor Rated Current in P-08
    - It is possible that excessive current levels may permanently damage the motor, therefore this parameter must be set correctly to ensure this cannot occur.
    - Additionally, this current level is used by the autotune to determine the correct inductance values
- Enter the motor rated frequency in P-09
- Optionally enter the motor rated speed in P-10
- Enabled Advanced Parameter Access by setting P-14 = P-37 + 100 (Default: 201)
- Select BLDC motor control in by setting P-51 = 3
- Carry out an Autotune
    - For BLDC motor operation, an Autotune MUST be carried out
    - This is achieved by setting P-52 = 1
    - The autotune will begin IMMEDIATELY following the setting of this parameter!
    - The drive output will be enabled, and the motor shaft may move. It is important to ensure this is safe before carrying out the autotune.
    - For PM motors, the autotune measures the motor stator resistance and both Q and D axis inductance values. Parameters P-55, P-56 and P-57 will be updated following the measurements.
- It should now be possible to operate the motor.
- Low speed and starting of the motor may be further optimised by adjusting P-11
    - In BLDC motor control mode, P-11 adjust the additional current injected into the motor at low frequency to help maintain the rotor alignment and ensure reliable starting.

2.7.4 SynRM Motors

2.7.4.1 Suitable Motor Types

Optidrive E3 provides open loop control of Synchronous Reluctance AC motors, intended to allow the use of high efficiency motors in simple applications.

Operation is tested with motors under the following conditions

- Rated voltage 200 – 400VAC
- 4, 6 and 8 poles
- Maximum motor frequency 100Hz
- Operation down to 10% of rated speed

2.7.4.2 Commissioning Procedure

When operating with synchronous reluctance motors, the commissioning steps are as follows:

- Enter the motor rated voltage in parameter P-07
- Enter the Motor Rated Current in P-08
    - It is possible that excessive current levels may permanently damage the motor, therefore this parameter must be set correctly to ensure this cannot occur.
    - Additionally, this current level is used by the autotune to determine the correct inductance values
- Enter the motor rated frequency in P-09
- Optionally enter the motor rated speed in P-10
- Enabled Advanced Parameter Access by setting P-14 = P-37 + 100 (Default: 201)
- Select SynRM motor control in by setting P-51 = 4
- Carry out an Autotune
    - For SynRM motor operation, an Autotune MUST be carried out
    - This is achieved by setting P-52 = 1
    - The autotune will begin IMMEDIATELY following the setting of this parameter!
    - The drive output will be enabled, and the motor shaft may move. It is important to ensure this is safe before carrying out the autotune.
    - For SynRM motors, the autotune measures the motor stator resistance and both Q and D axis inductance values. Parameters P-55, P-56 and P-57 will be updated following the measurements.
- It should now be possible to operate the motor.
- Low speed and starting of the motor may be further optimised by adjusting P-11
    - In SynRM motor control mode, P-11 adjust the additional current injected into the motor at low frequency to help maintain the rotor alignment and ensure reliable starting.

2.7.5 LSPM Motors

2.7.5.1 Suitable Motor Types

Optidrive E3 provides open loop control of Line Start Permanent Magnet AC motors, intended to allow the use of high efficiency motors in simple applications. Both interior and exterior magnets type motors are supported.
Operation is tested with motors under the following conditions

- The motor Back EMF is >=1 V / Hz
- Maximum motor frequency 100Hz
- Operation down to 10% of rated speed
- RMS Back EMF must not exceed the AC supply voltage during motor operation

It is possible to operate at lower speeds, or with motors with a lower Back EMF / Frequency ratio, however performance may be reduced.

2.7.5.2 Commissioning Procedure

When operating with LSPM motors, the commissioning steps are as follows:

- Enter the motor Back EMF at Rated Frequency / Speed in parameter P-07.
    - It is preferable to use Back EMF rather than rated voltage as this will improve performance
    - It is sometimes necessary to derive this information from a voltage constant and the rated operating speed, e.g.
        - If a motor has rated speed 2500RPM, back EMF constant 80V / 1000 RPM, P-07 = (2500 * 80) / 1000 = 200V
    - Alternatively, obtain the value from the motor supplier, or by direct measurement using an oscilloscope
- Enter the Motor Rated Current in P-08
    - It is possible that excessive current levels may permanently damage the motor, therefore this parameter must be set correctly to ensure this cannot occur.
    - Additionally, this current level is used by the autotune to determine the correct inductance values
- Enter the motor rated frequency in P-09
- Optionally enter the motor rated speed in P-10
- Enabled Advanced Parameter Access by setting P-14 = P-37 + 100 (Default: 201)
- Select LSPM motor control in by setting P-51 = 5
- Carry out an Autotune
    - For LSPM motor operation, an Autotune MUST be carried out
    - This is achieved by setting P-52 = 1
    - The autotune will begin IMMEDIATELY following the setting of this parameter!
    - The drive output will be enabled, and the motor shaft may move. It is important to ensure this is safe before carrying out the autotune.
    - For LSPM motors, the autotune measures the motor stator resistance and both Q and D axis inductance values. Parameters P-55, P-56 and P-57 will be updated following the measurements.
- It should now be possible to operate the motor.
- Low speed and starting of the motor may be further optimised by adjusting P-11
    - In LSPM motor control mode, P-11 adjust the additional current injected into the motor at low frequency to help maintain the rotor alignment and ensure reliable starting.

2.8 Software Functions

2.8.1 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-trp Communications Loss Trip
- It-trp Accumulated overload Trip
- Out-F Drive output fault, Output stage trip

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

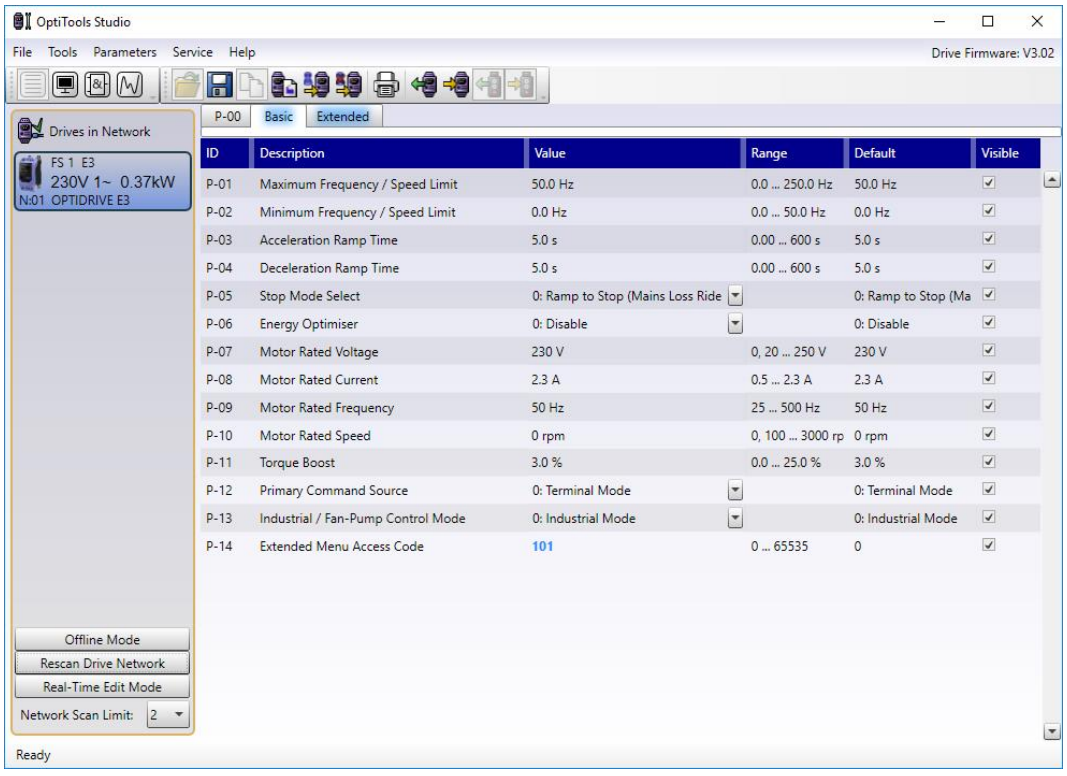
- O-Volt Over Voltage on DC Bus
- U-Volt Under Voltage on DC Bus
- h O-I Fast Over-current Trip
- O-I Instantaneous over current on drive output

2.8.2 OEM / User Default Parameters

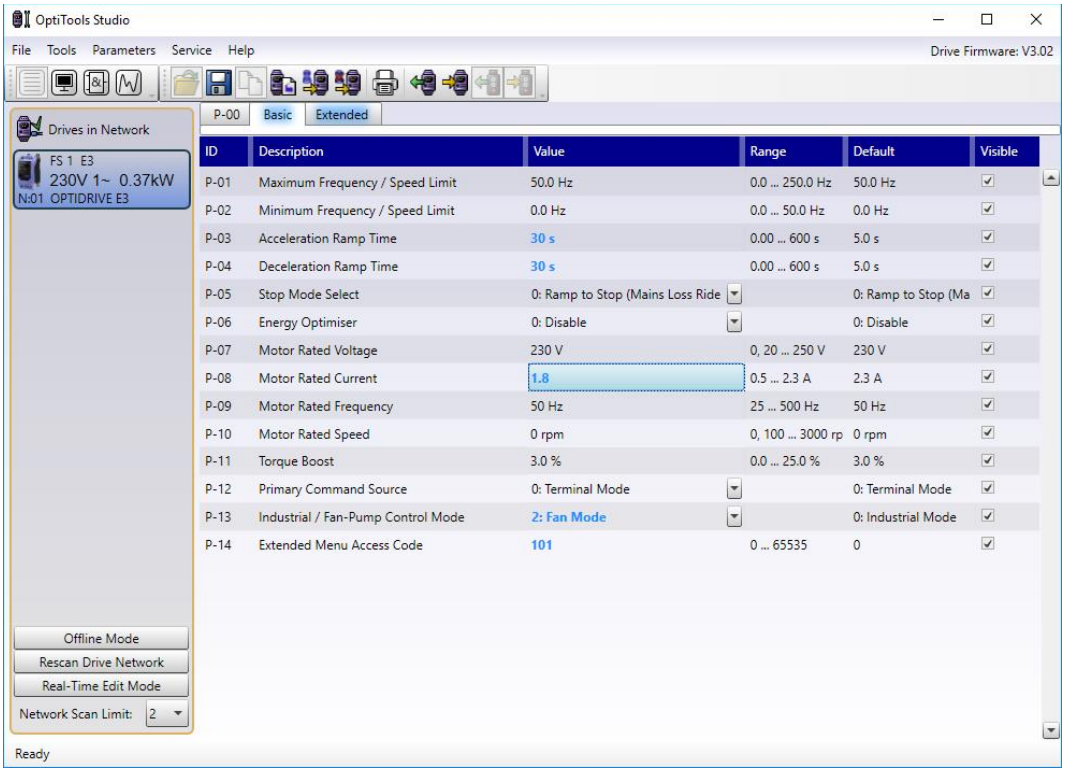
Optidrive E3 includes an embedded function to allow the user to create their own “default” parameters. This means that if a factory reset is carried out, the drive will return to these parameters, as opposed to the Invertek Drive factory default parameters.
This feature is accessed using Optitools Studio PC software only, which may be freely downloaded from the Invertek Drives website.

2.8.2.1 Creating the default parameter set

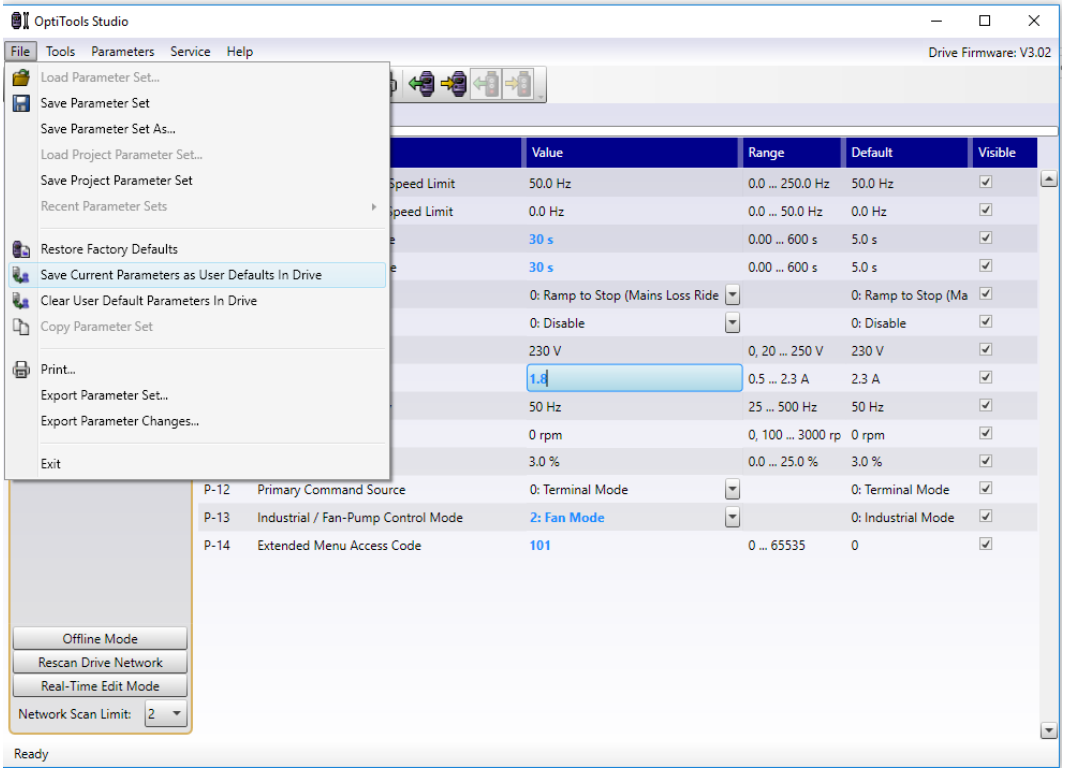
In order to create the User Default settings, the following process should be used.



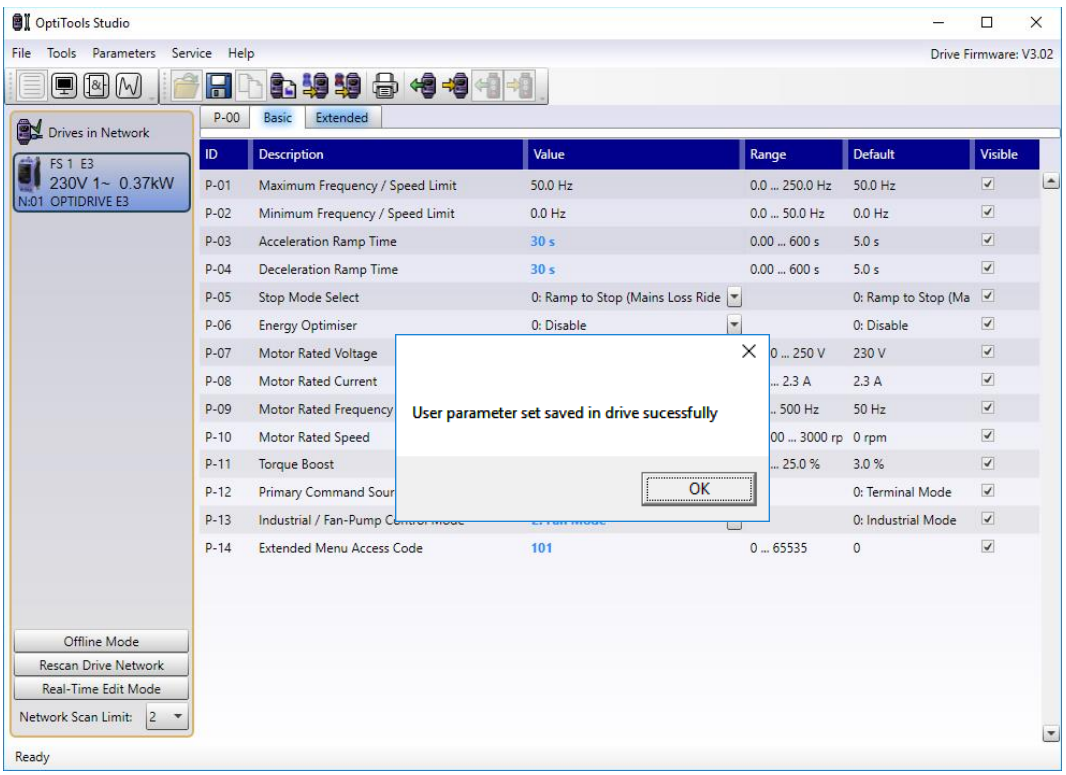
In Optitools Studio, ensure communication is established with the connected drive.



Make any changes to the parameter set as required. Changes from Invertek factory default settings are highlighted in blue.



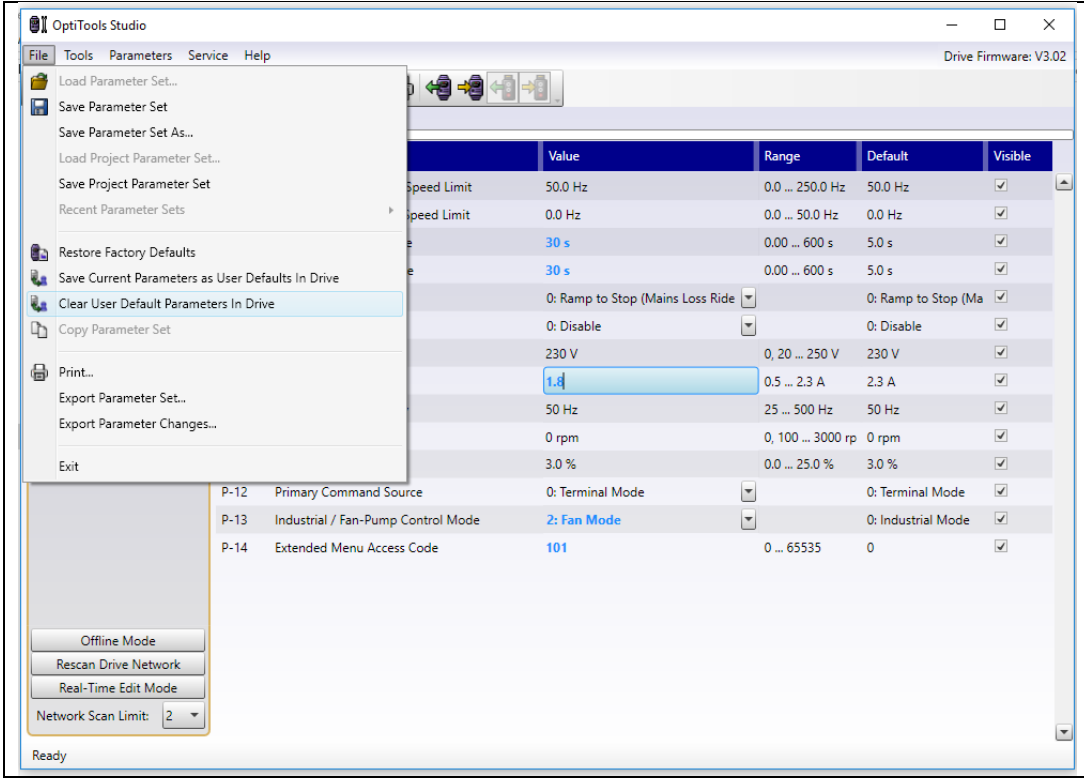
In the File menu, select “Save Current Parameters as User Defaults in Drive”



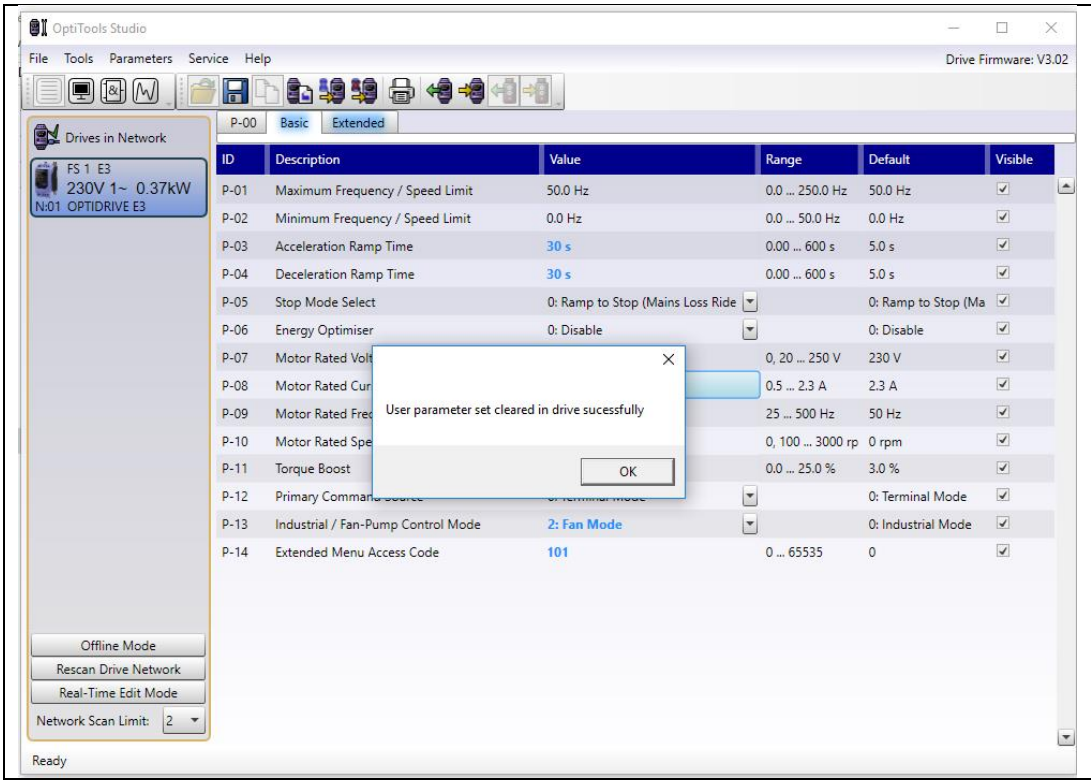
The confirmation message will appear.

2.8.2.2 Clearing User Default Parameters

In order to clear the User Default parameters, the following method is used.



From the File menu, select “Clear User Default Parameters in Drive”



The confirmation message will appear to show the user defaults are now cleared and resetting the drive will return it to Invertek Drives Factory default settings.

2.8.3 Automatic Switching Frequency Reduction

2.8.3.1 Heatsink Temperature Based Effective Switching Frequency Reduction

When the drive heatsink temperature exceeds preset threshold values, the output Effective Switching Frequency is automatically reduced below the value selected in P-17 to reduce the risk of over temperature trip. The threshold levels are shown in section 7.1 Thermal Management on page 53.

2.8.3.2 Output Frequency based Effective Switching Frequency Reduction

At low output frequency, Effective Switching Frequency is automatically reduced. Hysteresis is applied to prevent continuous switching. The operation is according to the following table:

P-17	32kHz	24kHz	16kHz	12kHz	8kHz	4kHz
Effective Switching Frequency increases when Output Frequency exceeds	9.0Hz	7.0Hz	5.0Hz	3.0Hz	N/A	N/A
Effective Switching Frequency reduces when Output Frequency reduces below	7.0Hz	5.0Hz	3.0Hz	1.0Hz	N/A	N/A

2.8.3.3 Output Current Based Effective Switching Frequency Reduction

Effective Switching Frequency is automatically reduced based on motor load current as follows:

- All ODE-3-240095-3F4**#** models:
  - If P-17 = 12kHz, 16kHz, 24kHz, Effective switching frequency is reduced to 8kHz when motor current exceeds 10.45A (110% of the drive rated current). Switching frequency will return to the value set in P-17 when motor current reduces below 7.6A (80% of drive rated current)
  - If P-17 = 32kHz, Effective switching frequency is reduced to 8kHz when motor current exceeds 10.45A (110% of drive rated current). Switching frequency changes to 24kHz when motor current reduces below 7.6A (80% of drive rated current). Switching frequency will return to the value set in P-17 when motor current reduces below 6.7A (70% of drive rated current)
- All other models:
  - Effective switching frequency is reduced to 8kHz when motor current exceeds 140% of the drive rated current. Switching frequency will return to the value set in P-17 when motor current reduces below 110% of drive rated current.

2.8.4 Output Frequency Change by Fixed Step

From firmware version 3.08 a new feature is introduced which allows the output frequency and hence motor speed to be changed by a fixed step each time an increase or decrease request is received at the digital inputs.
This speed control method is active only under the following conditions:

- P-12 = 1 or 2 (Motorised Pot Speed Reference)
- P-15 = 14

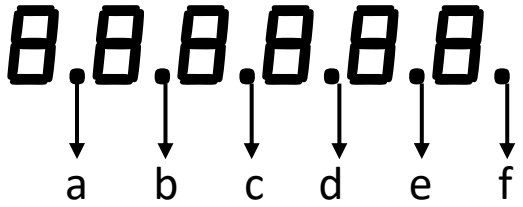
With the parameter settings, digital inputs 2 and 4 operate as follows:

- Digital Input 2: Speed Step Up
  - Each time a rising edge pulse is received at the digital input, the output frequency or motor speed is increased by the amount set in P-20 Preset Speed 1
- Digital Input 4: Speed Step Down
  - Each time a rising edge pulse is received at the digital input, the output frequency or motor speed is decreased by the amount set in P-20 Preset Speed 1
- A single speed step is applied for each rising edge at the digital input
- Minimum on time for the pulse recommended as 20ms
- If pulses are applied simultaneously to both inputs, the speed step is not applied
- Using the keypad or remote keypad Up and Down buttons has no effect
- All other operation is as per Keypad Mode.

2.9 LED Display

Optidrive E3 has a built in 6 Digit 7 Segment LED Display. In order to display certain warnings, the following methods are used: -

2.9.1 LED Display Layout



2.9.2 LED Display Meanings

LED Segments	Behaviour	Meaning
a, b, c, d, e, f	Flashing all together	Overload, motor output current exceeds P-08
a and f	Flashing alternately	Mains Loss (Incoming AC power has been removed)
a	Flashing	Fire Mode Active

3 Drive Model Specific Parameter Variations

3.1 Available Effective Switching Frequency Options

110 Volt, 1 Phase Models (Voltage Doubler)					
Frame	**kW**	**HP**	**Default**	**Minimum**	**Maximum**
1	0.37	0.5	8 kHz	4 kHz	32 kHz
1	0.75	1	8 kHz	4 kHz	32 kHz
2	1.1	1.5	8 kHz	4 kHz	32 kHz
230 Volt, 1 Phase Models					
Frame	**kW**	**HP**	**Default**	**Minimum**	**Maximum**
1	0.37	0.5	8 kHz	4 kHz	32 kHz
1	0.75	1	8 kHz	4 kHz	32 kHz
1	1.5	2	8 kHz	4 kHz	32 kHz
2	1.5	2	8 kHz	4 kHz	32 kHz
2	2.2	3	8 kHz	4 kHz	32 kHz
3	4	5	8 kHz	4 kHz	24 kHz
230 Volt, 3 Phase Models					
Frame	**kW**	**HP**	**Default**	**Minimum**	**Maximum**
1	0.37	0.5	8 kHz	4 kHz	32kHz
1	0.75	1	8 kHz	4 kHz	32 kHz
1	1.5	2	8 kHz	4 kHz	32 kHz
2	1.5	2	8 kHz	4 kHz	32 kHz
2	2.2	3	8 kHz	4 kHz	32 kHz
3	3	4	8 kHz	4 kHz	24 kHz
3	4	5	8 kHz	4 kHz	24 kHz
4	5.5	7.5	8 kHz	4 kHz	24 kHz
4	7.5	10	8 kHz	4 kHz	24 kHz
4	11	15	8 kHz	4 kHz	24 kHz
5	15	20	4 kHz	4 kHz	24 kHz
5	18.5	25	4 kHz	4 kHz	24 kHz
400 Volt, 3 Phase Models					
Frame	**kW**	**HP**	**Default**	**Minimum**	**Maximum**
1	0.37	0.5	8 kHz	4 kHz	32 kHz
1	0.75	1	8 kHz	4 kHz	32 kHz
1	1.5	2	8 kHz	4 kHz	32 kHz
2	1.5	2	8 kHz	4 kHz	32 kHz
2	2.2	3	8 kHz	4 kHz	32 kHz
2	4	5	8 kHz	4 kHz	32 kHz
3	5.5	7.5	8 kHz	4 kHz	24 kHz
3	7.5	10	8 kHz	4 kHz	24 kHz
3	11	15	8 kHz	4 kHz	24 kHz
4	15	20	8 kHz	4 kHz	24 kHz
4	18.5	25	8 kHz	4 kHz	24 kHz
4	22	30	8 kHz	4 kHz	24 kHz
5	30	40	4 kHz	4 kHz	24 kHz
5	37	50	4 kHz	4 kHz	24 kHz

3.2 V/F Mode Voltage Boost Setting Options

110 Volt, 1 Phase Input Models (Voltage Doubler)				
Frame	**kW**	**HP**	**Default**	**Maximum**
1	0.37	0.5	3.0%	25.0%
1	0.75	1	3.0%	25.0%
2	1.1	1.5	2.5%	20.0%
230 Volt, 1 Phase Input Models				
Frame	**kW**	**HP**	**Default**	**Maximum**
1	0.37	0.5	3.0%	25.0%
1	0.75	1	3.0%	25.0%
1	1.5	2	3.0%	25.0%
2	1.5	2	2.5%	20.0%
2	2.2	3	2.5%	20.0%
3	4	5	2.0%	15.0%
230 Volt, 3 Phase Input Models				
Frame	**kW**	**HP**	**Default**	**Maximum**
1	0.37	0.5	3.0%	25.0%
1	0.75	1	3.0%	25.0%
1	1.5	2	3.0%	25.0%
2	1.5	2	2.5%	20.0%
2	2.2	3	2.5%	20.0%
3	3	4	2.0%	15.0%
3	4	5	2.0%	15.0%
4	5.5	7.5	1.5%	10.0%
4	7.5	10	1.5%	10.0%
4	11	15	1.5%	10.0%
5	15	20	1.0%	10.0%
5	18.5	25		
400 Volt 3 Phase Input Models				
Frame	**kW**	**HP**	**Default**	**Maximum**
1	0.37	0.5	3.0%	25.0%
1	0.75	1	3.0%	25.0%
1	1.5	2	3.0%	25.0%
2	1.5	2	2.5%	20.0%
2	2.2	3	2.5%	20.0%
2	4	5	2.5%	20.0%
3	5.5	7.5	2.0%	15.0%
3	7.5	10	2.0%	15.0%
3	11	15	2.0%	15.0%
4	15	20	1.5%	10.0%
4	18.5	25	1.5%	10.0%
4	22	30	1.5%	10.0%
5	30	40	1.0%	10.0%
5	37	50	1.0%	10.0%

4 Fieldbus Interface Support

4.1 Fieldbus Support Overview

Optidrive E3 provides support for the following fieldbus networks and functions

Fieldbus	Interface	Drive Control	Drive Parameter Access
Modbus RTU	On-board RJ45	Yes	Access to all Writable Parameters
CAN bus	On-board RJ45	Yes	Access to all Writable Parameters

4.2 Modbus RTU

Optidrive E3 supports Modbus RTU communication, using the 03 Read Holding Registers and 06 Write Single Holding Register commands. Many Master devices treat the first Register address as Register 0; therefore it may be necessary to convert the register numbers listed below by subtracting 1 to obtain the correct Register address. The telegram structure is as follows: -

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

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

The table shows the Modbus RTU register number corresponding to each parameter value. All values are holding registers.
All User Adjustable parameters are accessible by Modbus, except those that would directly affect the Modbus communications, e.g.

- P-36 Index 1 Drive Fieldbus Address
- P-36 Index 2 Baud Rate
- P-36 Index 3 Comms Loss Timeout

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

4.3 Profibus DP

Profibus DP communication is supported through an external gateway. Operation is explained further in section 5 Fieldbus Gateways on page 44.

4.4 DeviceNet

DeviceNet communication is supported through an external gateway. Operation is explained further in section 5 Fieldbus Gateways on page 44.

4.5 CAN

The CAN communication profile in the Optidrive E3 is implemented according to the specification DS301 version 4.02 of CAN in automation (www.can-cia.de). Specific device profiles such as DS402 are not supported.
The CAN communication function is enabled by default after power up. However, in order to use any control functions through CAN, this requires P-12 = 7 or 8.
The CAN communication baud rate can be set by using parameter P-36. Available baud rates are: 125kbps, 250kbps, 500kbps, 1Mbps. (with default settings as 500kbps).
The Node ID is set up through drive address parameter P-36 as well with the default value of 1.
The tables below show the Index and Sub Index required to address each parameter. All User Adjustable parameters are accessible by CAN, except those that would directly affect the communications.
All parameter values can be read from the drive and written to, depending on the operating mode of the drive – some parameters may be changed whilst the drive is enabled for example.
Optidrive E3 provides the following default COB-ID and functions:

Type	COB-ID	Function
NMT	000h	Network management
Sync	080h	Synchronous message COB-ID can be configured to other value.
Emergency	080h + Node address	Emergency message
PDO1 (TX)	180h + Node address	Process data object. PDO1 is pre-mapped and enabled by default. COB-ID can be configured to other value. PDO2 is pre-mapped and disabled by default. Transmission mode, COB-ID and mapping can be configured.
PDO1 (RX)	200h + Node address	
PDO2 (TX)	280h + Node address	
PDO2 (RX)	300h + Node address	
SDO (TX)	580h + Node address	SDO channel can be used for drive parameter access.
SDO (RX)	600h + Node address	
Error Control	700h + Node address	Guarding and Heartbeat function are supported. COB-ID can be configured to other value.

4.5.1.1 Note

- The Optidrive E3 SDO channel only supports expedited transmission.
- The Optidrive E3 can only support up to 2 Process Data Objects (PDO). All PDOs are pre-mapped; however, PDO2 is disabled by default. The table below gives the default PDO mapping information.

- Customer configuration (mapping) will NOT be saved during power down. This means that the CAN configuration will restore to its default condition each time the drive is powered up.

4.5.2 PDO Default Mapping

	Objects No.	Mapped Object	Length	Mapped Function	Transmission Type
RX PDO1	1	2000h	Unsigned 16	Control command register*	254 Valid immediately
	2	2001h	Integer 16	Speed reference	
	3	2003h	Unsigned 16	User ramp reference	
	4	0006h	Unsigned 16	Dummy	
TX PDO1	1	200Ah	Unsigned 16	Drive status register	254 Send after receiving RX PDO 1
	2	200Bh	Integer 16	Motor speed Hz	
	3	200Dh	Unsigned 16	Motor current	
	4	2010h	Integer 16	Drive temperature	
RX PDO2	1	0006h	Unsigned 16	Dummy	254
	2	0006h	Unsigned 16	Dummy	
	3	0006h	Unsigned 16	Dummy	
	4	0006h	Unsigned 16	Dummy	
TX PDO2	1	2011h	Unsigned 16	DC bus voltage	254
	2	2012h	Unsigned 16	Digital input status	
	3	2013h	Integer 16	Analog input 1 (%)	
	4	2014h	Integer 16	Analog input 2 (%)	

***** Drive control can only be achieved when P-12=7 or 8 provided that P-31 = 0, 1, 4 or 5.

4.5.3 PDO transmission type

Various transmission modes can be selected for each PDO. For RX PDO, the following modes are supported: -

Transmission Type	Mode	Description
0 – 240	Synchronous	The received data will be transferred to the drive active control register when the next sync message is received.
254, 255	Asynchronous	The received data will be transferred to the drive active control register immediately without delay.

For TX PDO, the following modes are supported: -

Transmission Type	Mode	Description
0	Acyclic synchronous	TX PDO will only be sent out if the PDO data has changed and PDO will be transmitted on reception of SYNC object
1-240	Cyclic synchronous	TX PDO will be transmitted synchronously and cyclically. The transmission type indicates the number of SYNC object that are
254	Asynchronous	TX PDO will only be transferred once corresponding RX PDO has been received.
255	Asynchronous	TX PDO will only be transferred anytime if PDO data value has changed.

4.5.4 CAN Specific Object Table

Index	Sub Index	Function	Access	Type	PDO Map	Default Value
1000h	0	Device Type	RO	U32	N	0
1001h	0	Error Register	RO	U8	N	0
1002h	0	Manufacturer Status Register	RO	U16	N	0
1005h	0	COB-ID Sync	RW	U32	N	00000080h
1008h	0	Manufacturer Device Name	RO	String	N	ODE3
1009h	0	Manufacturer Hardware Version	RO	String	N	x.xx
100Ah	0	Manufacturer Software Version	RO	String	N	x.xx
100Ch	0	Guard Time (1ms)	RW	U16	N	0
100Dh	0	Lifetime Factor	RW	U8	N	0
1014h	0	COB-ID EMCY	RW	U32	N	00000080h+Node ID
1015h	0	Inhibit Time Emergency (100µs)	RW	U16	N	0
1016h	0	Consumer Heartbeat Time No. of entries	RO	U8	N	1
	1	Consumer Heartbeat Master Node & Time	RW	U32	N	0
1017h	0	Producer Heartbeat Time (1ms)	RW	U16	N	0
1018h	0	Identity Object No. Of entries	RO	U8	N	4
	1	Vendor ID	RO	U32	N	0x0000031A
	2	Product Code	RO	U32	N	Drive Dependent
	3	Revision Number	RO	U32	N	x.xx
	4	Serial Number	RO	U32	N	Drive Dependent
1200h	0	SDO Parameter No. Of entries	RO	U8	N	2
	1	COB-ID Client -> Server (RX)	RO	U32	N	00000600h+Node ID
	2	COB-ID Server -> Client (TX)	RO	U32	N	00000580h+Node ID
1400h	0	RX PDO1 comms param. no. of entries	RO	U8	N	2
	1	RX PDO1 COB-ID	RW	U32	N	40000200h+Node ID
	2	RX PDO transmission type	RW	U32	N	254
1401h	0	RX PDO2 comms param. no. of entries	RO	U8	N	2
	1	RX PDO2 COB-ID	RW	U32	N	C0000300h+Node ID
	2	RX PDO2 transmission type	RW	U8	N	0
1600h	0	RX PDO1 1 mapping / no. of entries	RW	U8	N	4
	1	RX PDO1 1st mapped object	RW	U32	N	20000010h
	2	RX PDO1 2nd mapped object	RW	U32	N	20010010h
	3	RX PDO1 3rd mapped object	RW	U32	N	20030010h
	4	RX PDO1 4th mapped object	RW	U32	N	00060010h
1601h	0	RX PDO2 1 mapping / no. of entries	RW	U8	N	4
	1	RX PDO2 1st mapped object	RW	U32	N	00060010h
	2	RX PDO2 2nd mapped object	RW	U32	N	00060010h
	3	RX PDO2 3rd mapped object	RW	U32	N	00060010h
	4	RX PDO2 4th mapped object	RW	U32	N	00060010h
1800h	0	TX PDO1 comms parameter number of entries	RO	U8	N	3
	1	TX PDO1 COB-ID	RW	U32	N	40000180h+Node ID
	2	TX PDO1 transmission type	RW	U8	N	254
	3	TX PDO1 Inhibit time (100µs)	RW	U16	N	0
1801h	0	TX PDO2 comms param no. of entries	RO	U8	N	3
	1	TX PDO2 COB-ID	RW	U32	N	C0000280h+Node ID
	2	TX PDO2 transmission type	RW	U8	N	0
	3	TX PDO2 Inhibit time (100µs)	RW	U16	N	0
1A00h	0	TX PDO1 mapping / no. of entries	RW	U8	N	4
	1	TX PDO1 1st mapped object	RW	U32	N	200A0010h
	2	TX PDO1 2nd mapped object	RW	U32	N	200B0010h
	3	TX PDO1 3rd mapped object	RW	U32	N	200D0010h
	4	TX PDO1 4th mapped object	RW	U32	N	20100010h
1A01h	0	TX PDO2 mapping / no. of entries	RW	U8	N	4
	1	TX PDO2 1st mapped object	RW	U32	N	20110010h
	2	TX PDO2 2nd mapped object	RW	U32	N	20120010h
	3	TX PDO2 3rd mapped object	RW	U32	N	20130010h
	4	TX PDO2 4th mapped object	RW	U32	N	20140010h

4.6 Parameter Access Overview

The accessible parameter numbers and respective scaling are listed in the following tables. The method to access the parameters depends on the fieldbus type in use as described in the following section.
The R/W column indicates whether the values are Writeable as well as readable (R/W) or Read Only (R)
The data types for the parameter are defined as follows: -
WORD Hexadecimal Word
U16 Unsigned 16 Bit Value
S16 Signed 16 Bit Value

4.6.1 Modbus RTU Register / CAN Index Data – Control & Monitoring

Modbus RTU Register	CAN Open Index	Sub Index	PDO Map	Parameter Number	Upper byte	Lower Byte	Format	Min	Max	Type	Scaling
1	2000h	0	Y	-	Control Word		WORD	-	-	R/W	See Below
2	2001h	0	Y	-	Frequency Setpoint		S16	-5000	5000	R/W	1dp, e.g. 100 = 10.0Hz
3	2002h	0	Y	-	Reserved		-	-	-	R/W	No function
4	2003h	0	Y	-	Modbus ramp control time		U16	0	60000	R/W	2dp, e.g. 500 = 5.00s
5	2004h	0	Y	-	High Resolution Frequency Setpoint		S16	-30000	30000	R	See Below
6	200Ah	0	Y	-	Error code	Drive status	WORD	-	-	R	See Below
7	200Bh	0	Y	-	Output Frequency		S16	0	5000	R	1dp, e.g. 100 = 10.0Hz
8	200Dh	0	Y	-	Motor Current		U16	0	-	R	1dp, e.g. 100 = 10.0A
9	200Eh	0	Y	-	Motor Torque		S16	0	65535	R	4096 = 100%
10	200Fh	0	Y	-	Motor Power		U16	0	-	R	2dp, e.g. 100 = 1.00kW
11	2012h	0	Y	P00-04	Digital Input Status		WORD	-	-	R	See Below
12	-	-		P00-20	Rating ID		U16	-	-	R	Internal Value
13	-	-		P00-20	Power rating		U16	-	-	R	2dp, e.g. 37 = 0.37kW / HP
14	-	-		P00-20	Voltage rating		U16	-	-	R	See Below
15	27E8h	0	N	P00-18	IO processor software version		U16	-	-	R	2dp, e.g. 300 = 3.00
16	27EAh	0	N	P00-18	Motor control processor software version		U16	-	-	R	2dp, e.g. 300 = 3.00
17	-	-		P00-20	Drive type		U16	-	-	R	Internal Value
18	201Ch	0	Y	P00-48	Scope Channel 1 Data		S16	-	-	R	Internal Format
19	201Dh	0	Y	P00-48	Scope Channel 2 Data		S16	-	-	R	Internal Format
-	201Eh	0	Y	P00-49	Scope Channel 3 Data		S16			R	Internal Format
-	201Fh	0	Y	P00-49	Scope Channel 4 Data		S16			R	Internal Format
20	2013h	0	Y	P00-01	Analog 1 input result		U16	0	1000	R	1dp, e.g. 500 = 50.0%
21	2014h	0	Y	P00-02	Analog 2 input result		U16	0	1000	R	1dp, e.g. 500 = 50.0%
-	2015h	0	Y	-	Analog Output %		U16	0	1000	R	1dp, e.g. 500 = 50.0%
22	-	-		P00-03	Pre-Ramp Speed Reference Value		S16	0	5000	R	1dp, e.g. 500 = 50.0Hz
23	2011h	0	Y	P00-08	DC Bus Voltage		U16	0	1000	R	600 = 600 Volts
24	-			P00-09	Drive Power Stage Temperature		S16	-10	150	R	50 = 50°C
-	2043h	0	Y	-	Control board temperature		S16	-10	150	R	50 = 50°C
25	-	-		P00-30	Drive Serial Number 4		U16	-	-	R	See Below
26	-	-		P00-30	Drive Serial Number 3		U16	-	-	R	
27	-	-		P00-30	Drive Serial Number 2		U16	-	-	R	
28	-	-		P00-30	Drive Serial Number 1		U16	-	-	R	
29	2017h	0	Y	-	Relay Output Status		WORD	0	1	R	Bit 0 Indicates Relay Status 1 = Relay Contacts Closed
30	-	-		-	Reserved		-	-	-	R	No Function
31	-	-		-	Reserved		-	-	-	R	No Function
32	203Ch	0	Y	P00-26	kWh Meter		U16	0	9999	R	1dp, e.g. 100 = 10.0kWh
33	203Dh	0	Y	P00-26	MWh Meter		U16	0		R	10 = 10MWh
34	203Eh	0	Y	P00-10	Running Time – Hours		U16			R	1 = 1 Hour
35	203Fh	0	Y	P00-10	Running Time – Minutes & Seconds		U16			R	100 = 100 Seconds
36	2040h	0	Y	P00-14	Run time since last enable – Hours		U16			R	1 = 1 Hour
37	2041h	0	Y	P00-14	Run time since last enable – Minutes & seconds		U16			R	100 = 100 Seconds
38	-	-		-	Reserved		U16			R	No Function
39	2010h	0	Y	P00-20	Internal Drive Temperature		S16	-10	100	R	20 = 20C
40	2044h	0	Y	-	Speed Reference (Internal Format)		U16	0	P-01	R	3000 = 50Hz
41	-	-		-	Reserved		-	-	-	R	No Function
42	2046h	0	Y		Digital Pot / Keypad Reference		U16	0	P-01	R	3000 = 50Hz
43	2048h	0	Y	P00-07	Output Voltage		U16	0	-	R	100 = 100 Volts AC RMS
44	-	-		-	Parameter Access Index		U16	1	60	R	See Below
45	-	-		-	Parameter Access Value		S16	-	-	R	See Below
46	-	-	N	-	Parameter Checksum		U16	0	65535	R	See Below
-	2049h	0	Y	P00-05	PI Output		U16	0	1000	R	1000 = 100.0%
-	23E8h	0	N	-	Scope Index 12					RW	
-	23E9h	0	N	-	Scope Index 34					RW	
-	27D0h	0	N	P00-11	Run Time Since Last Trip 1 – Hours		U16	0	65535	R	1 = 1 Hour
-	27D1h	0	N	P00-11	Run Time Since Last Trip 1 - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27D2h	0	N	P00-12	Run Time Since Last Trip 2 – Hours		U16	0	65535	R	1 = 1 Hour
-	27D3h	0	N	P00-12	Run Time Since Last Trip 2 - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27D4h	0	N	P00-13	Trip Log 2 & 1		WORD	-	-	R	

Modbus RTU Register	CAN Open Index	Sub Index	PDO Map	Parameter Number	Upper byte	Lower Byte	Format	Min	Max	Type	Scaling
-	27D5h	0	N	P00-13	Trip Log 4 & 3		WORD	-	-	R	
-	27D6h	0	N	P00-13	Trip 1 Time – Hours		U16	0	65535	R	1 = 1 Hour
-	26D7h	0	N	P00-13	Trip 1 Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27D8h	0	N	P00-13	Trip 2 Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27D9h	0	N	P00-13	Trip 2 Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27DAh	0	N	P00-13	Trip 3 Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27DBh	0	N	P00-13	Trip 3 Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27DCh	0	N	P00-13	Trip 4 Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27DDh	0	N	P00-13	Trip 4 Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27DEh	0	N	P00-23	Time Heatsink > 85°C – Hours		U16	0	65535	R	1 = 1 Hour
-	27DFh	0	N	P00-23	Time Heatsink > 85°C - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27E0h	0	N	P00-24	Time Internal > 80°C – Hours		U16	0	65535	R	1 = 1 Hour
-	27E1h	0	N	P00-24	Time Internal > 80°C - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27E2h	0	N	P00-27	Fan Run Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27E3h	0	N	P00-27	Fan Run Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27E4h	0	N	-	Fire Mode Active Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27E5h	0	N	-	Fire Mode Active Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27E6h	0	N	-	Power on Time – Hours		U16	0	65535	R	1 = 1 Hour
-	27E7h	0	N	-	Power on Time - Seconds		U16	0	3599	R	100 = 100 Seconds
-	27E9h	0	N	P00-28	IO Checksum		WORD	-	-	R	
-	27EBh	0	N	P00-28	DSP Checksum		WORD	-	-	R	
-	27ECh	0	N	P00-19	Ambient Temperature Log 1		S16	-10	150	R	50 = 50°C
-	27Edh	0	N	P00-19	Ambient Temperature Log 2		S16	-10	150	R	50 = 50°C
-	27EEh	0	N	P00-19	Ambient Temperature Log 3		S16	-10	150	R	50 = 50°C
-	27EFh	0	N	P00-19	Ambient Temperature Log 4		S16	-10	150	R	50 = 50°C
-	27F0h	0	N	P00-19	Ambient Temperature Log 5		S16	-10	150	R	50 = 50°C
-	27F1h	0	N	P00-19	Ambient Temperature Log 6		S16	-10	150	R	50 = 50°C
-	27F2h	0	N	P00-19	Ambient Temperature Log 7		S16	-10	150	R	50 = 50°C
-	27F3h	0	N	P00-19	Ambient Temperature Log 8		S16	-10	150	R	50 = 50°C
-	27F4h	0	N	P00-15	DC Bus Voltage Log 1		U16	0	1000	R	600 = 600 Volts
-	27F5h	0	N	P00-15	DC Bus Voltage Log 2		U16	0	1000	R	600 = 600 Volts
-	27F6h	0	N	P00-15	DC Bus Voltage Log 3		U16	0	1000	R	600 = 600 Volts
-	27F7h	0	N	P00-15	DC Bus Voltage Log 4		U16	0	1000	R	600 = 600 Volts
-	27F8h	0	N	P00-15	DC Bus Voltage Log 5		U16	0	1000	R	600 = 600 Volts
-	27F9h	0	N	P00-15	DC Bus Voltage Log 6		U16	0	1000	R	600 = 600 Volts
-	27FAh	0	N	P00-15	DC Bus Voltage Log 7		U16	0	1000	R	600 = 600 Volts
-	27FBh	0	N	P00-15	DC Bus Voltage Log 8		U16	0	1000	R	600 = 600 Volts
-	27FCh	0	N	P00-16	Heatsink Temperature Log 1		S16	-10	150	R	50 = 50°C
-	27FDh	0	N	P00-16	Heatsink Temperature Log 2		S16	-10	150	R	50 = 50°C
-	27FEh	0	N	P00-16	Heatsink Temperature Log 3		S16	-10	150	R	50 = 50°C
-	27FFh	0	N	P00-16	Heatsink Temperature Log 4		S16	-10	150	R	50 = 50°C
-	2800h	0	N	P00-16	Heatsink Temperature Log 5		S16	-10	150	R	50 = 50°C
-	2801h	0	N	P00-16	Heatsink Temperature Log 6		S16	-10	150	R	50 = 50°C
-	2802h	0	N	P00-16	Heatsink Temperature Log 7		S16	-10	150	R	50 = 50°C
-	2803h	0	N	P00-16	Heatsink Temperature Log 8		S16	-10	150	R	50 = 50°C
-	2804h	0	N	P00-17	Motor Current Log 1		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	2805h	0	N	P00-17	Motor Current Log 2		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	2806h	0	N	P00-17	Motor Current Log 3		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	2807h	0	N	P00-17	Motor Current Log 4		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	2808h	0	N	P00-17	Motor Current Log 5		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	2809h	0	N	P00-17	Motor Current Log 6		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	280Ah	0	N	P00-17	Motor Current Log 7		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	280Bh	0	N	P00-17	Motor Current Log 8		U16	0	-	R	1dp, e.g. 100 = 10.0A
-	280Ch	0	N	P00-18	DC Ripple Log 1		U16	0	-	R	1 = 1 Volt
-	280Dh	0	N	P00-18	DC Ripple Log 2		U16	0	-	R	1 = 1 Volt
	280Eh	0	N	P00-18	DC Ripple Log 3		U16	0	-	R	1 = 1 Volt
-	280Fh	0	N	P00-18	DC Ripple Log 4		U16	0	-	R	1 = 1 Volt
-	2810h	0	N	P00-18	DC Ripple Log 5		U16	0	-	R	1 = 1 Volt
-	2811h	0	N	P00-18	DC Ripple Log 6		U16	0	-	R	1 = 1 Volt
-	2812h	0	N	P00-18	DC Ripple Log 7		U16	0	-	R	1 = 1 Volt
-	2813h	0	N	P00-18	DC Ripple Log 8		U16	0	-	R	1 = 1 Volt
-	2814h	0	N	P00-25	Estimated Rotor Speed		S16	-	-	R	
-	2815h	0	N	P00-32	Actual PWM Frequency		U16	-	-	R	
-	2816h	0	N	P00-31	Motor Current iD		U16	0	-	R	
-	2817h	0	N	P00-31	Motor Current iQ		U16	0	-	R	
-	2818h	0	N	P00-33	O-I Trip Counter		U16	0	-	R	
-	2819h	0	N	P00-34	O-V Trip Counter		U16	0	-	R	
-	281Ah	0	N	P00-35	U-V Trip Counter		U16	0	-	R	
-	281Bh	0	N	P00-36	O-T Trip Counter		U16	0	-	R	
-	281Ch	0	N	P00-37	bO-I Trip Counter		U16	0	-	R	
-	281Dh	0	N	P00-38	O-Heat Trip Counter		U16	0	-	R	

4.6.2 Modbus RTU / CAN Index – Parameters

Modbus RTU Register	CAN Open Index	Par.	Description	Format	Min	Max	Data format / scaling
129	2065h	01	Max speed limit	U16	0	5*P-09	Internal value (3000 = 50.0Hz)
130	2066h	02	Min speed limit	U16	0	P-01	Internal value (3000 = 50.0Hz)
131	2067h	03	Accel ramp time	U16	0	60000	2dp, e.g. 300=3.00s
132	2068h	04	Decel ramp time	U16	0	60000	2dp, e.g. 300=3.00s
133	2069h	05	Stop Mode	U16	0	3	0: Ramp to stop + Mains Loss Ride Through 1: Coast to stop 2: Ramp to stop + Fast Stop 3: AC Flux Braking + Fast Stop
134	206Ah	06	Energy Optimiser	U16	0	1	0: Disabled 1: Enabled
135	206Bh	07	Motor rated voltage	U16	0	250 500	400 = 400 Volts
136	206Ch	08	Motor rated current	U16	0	Drive Rating Dependent	1dp, e.g. 100 = 10.0A
137	206Dh	09	Motor rated frequency	U16	25	500	Data unit is in Hz
138	206Eh	10	Motor rated speed	U16	0	60 * P-09	RPM
139	206Fh	11	Boost Value	U16	0	Drive Rating Dependent	1dp, e.g. 100 = 10.0%
140	2070h	12	Control mode	U16	0	6	0: Terminal Control 1: Keypad forward only 2: Keypad forward and reverse 3: Modbus control mode 4: Modbus control with ramp control 5: PID control 6: PID control with analog speed sum 7: CAN 8: CAN + Ramp Control 9: Slave Mode
141	2071h	13	Application Mode	U16	0	2	0: Industrial Mode 1: Pump Mode 2: Fan Mode
142	2072h	14	Access code	U16	0	9999	No Scaling
143	2073h	15	Digital input function	U16	0	17	See section 2.6 for function details
144	2074h	16	Analog input format	U16	0	7	0: 0…10V 1: b 0…10V 2: 0…20mA 3: t 4…20mA 4: r 4…20mA 5: t 20…4mA 6: r 20…4mA 7: 10…0V
145	2075h	17	Effective switching frequency	U16	0	5 (Drive Rating Dependent)	0 = 4KHz 1 = 8KHz 2 = 12Khz 3 =16KHz 4 = 24KHz 5 = 32KHz
146	2076h	18	Relay Output Function	U16	0	9	See parameter description for details
147	2077h	19	Digital Threshold	U16	0	1000	100 = 10.0%
148	2078h	20	Preset Speed 1	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
149	2079h	21	Preset Speed 2	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
150	207Ah	22	Preset Speed 3	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
151	207Bh	23	Preset Speed 4	U16	-P-01	P-01	Internal value (3000 = 50.0Hz)
152	207Ch	24	2nd Ramp	U16	0	60000	2dp e.g. 250 = 2.50s
153	207Dh	25	Analog Output Function	U16	0	10	See user guide for function details
154	207Eh	26	Skip Frequency Centre	U16	0	P-01	Internal value (3000 = 50.0Hz)
155	207Fh	27	Skip Frequency Band	U16	0	P-01	Internal value (3000 = 50.0Hz)
156	2080h	28	V/F Adjust Voltage	U16	0	P-07	100 = 100V
157	2081h	29	V/F Adjust Frequency	U16	0	P-09	50 = 50Hz
158	2082h	30	Start Mode Select	WORD	See Below		
159	2083h	31	Keypad restart mode	U16	0	7	See parameter description for details
160	2084h	32	DC Injection	WORD	See Below		
161	2085h	33	Spin Start Enable	U16	0	2	See parameter description for details
162	2086h	34	Brake circuit enable	U16	0	4	See parameter description for details
163	2087h	35	Analog Input / Slave Scaling	U16	0	20000	1000 = 100.0%
164	2088h	36	Communication Settings	WORD	See Below		
165	2089h	37	Access code definition	U16	0	9999	
166	208Ah	38	Parameter lock	U16	0	1	0: Unlocked 1: Locked
167	208Bh	39	Analog input offset	U16	-5000	5000	1dp, e.g. 300=30.0%
168	208Ch	40	Display Scaling Function	WORD	See Below		
169	208Dh	41	User PI P gain	U16	1	300	1dp, e.g. 10 = 1.0

Modbus RTU Register	CAN Open Index	Par.	Description	Format	Min	Max	Data format / scaling
170	208Eh	42	User PI I time constant	U16	0	300	1dp, e.g. 10 = 1.0s
171	208Fh	43	User PI mode select	U16	0	1	See parameter description for details
172	2090h	44	User PI reference select	U16	0	1	See parameter description for details
173	2091h	45	User PI digital reference	U16	0	1000	1dp, e.g. 100 =10.0%
174	2092h	46	User PI feedback select	U16	0	3	See parameter description for details
175	2093h	47	Analog Input 2 Format	U16	0	6	0: 0...10V 1: 0...20mA 2: t 4...20mA 3: r 4...20mA 4: t 20...4mA 5: r 20...4mA 6: Ptc-th
176	2094h	48	Standby Mode Timer	U16	0	250	1dp, e.g. 250 = 25.0s
177	2095h	49	PI Wake Up Error Level	U16	0	1000	1dp, e.g. 50 = 5.0%
178	2096h	50	User Relay Output Hysteresis	U16	0	1000	1dp e.g. 100 = 10.0%
179	2097h	51	Motor Control Mode	U16	0	5	0: IM Vector 1: V/F 2: PM Motor 3: BLDC Motor 4: SynRM Motor
180	2098h	52	Motor Parameter Autotune	U16	0	1	
181	2099h	53	Vector Mode Gain	U16	0	2000	1dp, e.g. 500 = 50.0%
182	209Ah	54	Maximum Current Limit	U16	0	1750	1dp, e.g. 1000 = 100.0%
183	209Bh	55	Motor Stator Resistance	U16	0	65535	2dp, e.g. 100 = 1.00R
184	209Ch	56	Motor Stator d-axis Inductance (Lsd)	U16	0	65535	1dp, e.g. 1000 = 100.0mH
185	209Dh	57	Motor Stator q-axis Inductance (Lsq)	U16	0	65535	1dp, e.g. 1000 = 100.0mH
186	209Eh	58	DC Injection Speed	U16	0	P-01	3000 = 50.0Hz
187	209Fh	59	DC Injection Current	U16	0	1000	1dp, e.g. 100 = 10.0%
188	20A0h	60	Thermal Overload Retention	U16	0	1	

4.7 Additional Information

4.7.1 Drive Control Word Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
High byte								Low byte							

Bit 0: Run/Stop command: Set to 1 to enable the drive. Set to 0 to stop the drive.

Bit 1: Fast stop request. Set to 1 to enable drive to stop with 2nd deceleration ramp.

Bit 2: Reset request. Set to 1 in order to reset the drive if drive is under trip condition.

User must clear this bit when drive is under normal condition to prevent un-expected reset.

Bit 3: Coast stop request. Set to 1 to issue a coast stop command.

For normal operation, Bit 3 has the highest priority, bit 0 has the lowest priority (bit 3>bit 1>bit 0). For example, if user set command as 0x0009, drive will do a coast stop rather than run. For normal run/start, just set this register to 1.

Note that stat/stop (bit 0), fast stop (bit 1) and coast stop (bit 3) only works if P-31= 0 or 1. Otherwise, start/stop function is controlled by drive control terminals. Reset function (bit 2) works all the time as long as the drive is operated under Modbus control mode (P-12=3 or 4).

4.7.2 Speed Reference Format (Standard resolution)

Speed reference value is transferred with one decimal place (200 = 20.0Hz). The maximum speed reference value is limited by P-01. Either register 2 or register 5 can be used for speed reference control, however only one reference should be used in any control system, otherwise unexpected behaviour can result.

4.7.3 Acceleration / Deceleration Ramp Time

Active only when P-12 = 4, this register specifies the drive acceleration and deceleration ramp time. The same value is applied simultaneously to the acceleration and deceleration ramp times. The value has two decimal places, e.g. 500 = 5.00 seconds.

4.7.4 High Resolution Speed Reference

This register allows the user to set the speed reference value in the internal format, e.g. 3000 = 50.0Hz. This allows control resolution to 1 RPM with a 2-pole motor. The maximum allowed value is limited by P-01.

Either register 2 or register 5 can be used for speed reference control, however only one reference should be used in any control system, otherwise unexpected behaviour can result.

4.7.5 Drive status and error code Word

High byte gives drive error code. (Valid when the drive is tripped, see 0 for further details)
Low byte gives drive status information as follows: -
Bit 0: 0 =Drive Stopped, 1 = Drive Running
Bit 1: 0 = OK, 1 = Drive Tripped
Bit 5: 0 = OK, 1 = In Standby Mode
Bit 6: 0 = Not Ready, 1 = Drive Ready to Run (not tripped, hardware enabled and no mains loss condition)

4.7.6 Scope Channel Data Values

These registers show the scope present data sample value for the first two scope channels. The channel data source selection is carried out through Optitools Studio.

4.7.7 Modbus RTU Registers 25 - 28: Drive Serial Number

The drive serial number may be read using these four registers. The serial number has 11 digits, stored as follows: -

Register 28		Register 27				Register 26		Register 25		
x	x	x	x	x	x	x	x	x	x	x

e.g.

Register 25	1										
Register 26	1										
Register 27	8745										
Register 28	57										
Drive Serial Number	5	7	8	7	4	5	0	1	0	0	1

4.7.8 Start Mode, Auto Restart & Fire Mode Configuration (P-30)

This parameter contains 3 values, stored as follows: -

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Input Type 0: Constant 1: Momentary Start				Input Sense 0: Normally Closed (Open Fire Mode) 1: Normally Open (Closed Fire Mode)				Start Mode / Auto Restart as: - 0: Edge-r 1: Auto-0 2: Auto-1 3: Auto-2 4: Auto-3 5: Auto-4 6: Auto-5							

4.7.9 DC Injection Configuration (P-32)

The parameter value is stored as a combined 16-bit word which is constructed as follows: -

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DC Injection Mode 0: DC Injection on Start 1: DC Injection on Stop 2: DC Injection on Start & Stop								DC Injection Duration: 1dp, e.g. 0 – 250 = 0.0 – 25.0s							

4.7.10 Communications Configuration (P-36)

This Register entry contains multiple data entries, as follows: -

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Trip Configuration				Baud Rate				Drive Address							

Data values can be interpreted as follows: -

Drive Address	1 to 63		
Baud Rate	**Setting**	**Modbus RTU**	**CAN**
	0	115k2	500
	1	115k2	500
	2	9k6	500
	3	19k2	500
	4	38k4	500
	5	57k6	500
	6	115k2	500
	7	115k2	125
	8	115k2	250
	9	115k2	500
	10	115k2	1000
Trip Time Set-up	0	Comms Loss Trip Disabled	
	1	30ms Watchdog, Trip on Comms Loss	
	2	300ms Watchdog, Trip on Comms Loss	
	3	1000ms Watchdog, Trip on Comms Loss	
	4	3000ms Watchdog, Trip on Comms Loss	
	5	30ms Watchdog, Ramp to Stop on Comms Loss	
	6	300ms Watchdog, Ramp to Stop on Comms Loss	
	7	1000ms Watchdog, Ramp to Stop on Comms Loss	
	8	3000ms Watchdog, Ramp to Stop on Comms Loss	

4.7.11 Display Scaling (P-40)

The parameter value is stored as a combined 16-bit word which is constructed as follows: -

High Byte								Low Byte							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Display Scaling Source 0: Motor Speed 1: Motor Current 2: Analog Input 2 Signal 3: PI Feedback		Display Scaling Factor: 3dp, e.g. 0 – 16000 = 0.000 – 16.000													

4.7.12 Parameter Checksum Modbus Register 46

A checksum is calculated based on the present value of all user adjustable parameters and stored in Modbus Register 46. This may be read to determine if parameter settings have been adjusted.

4.8 Modbus RTU Indirect Parameter Access

Optidrive E3 allows Read / Write access to all user adjustable parameters using a simple method as detailed below. This is achieved using the following two Modbus registers.

4.8.1.1 Register 44: Drive parameter index

This index value will be used by register 45 to carry out parameter read and write function. The valid range of this parameter is from 1 to 60 (maximum number of drive user adjustable parameters)

4.8.1.2 Register 45: Drive parameter value

When reading this register, the value represents the drive parameter value which index is specified by register 44.
When writing to this register, the value will be written to the drive parameter number specified by register 44.

4.8.2 Parameter Read Method

In order to read a parameter, firstly write the parameter number to register 44, then read the value from register 45, e.g. to Read the Value of P-01

- Write 1 to Register 44
- Read the Value of Register 45

4.8.3 Parameter Write Method

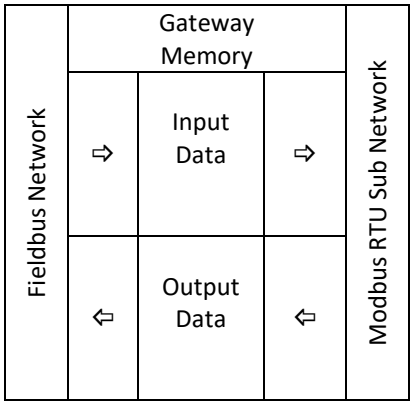
Writing parameter values can be achieved by the same method, however, register 45 is used to write the parameter value after the parameter number has been selected using Register 44, e.g. to Write a Value of 60.0Hz to parameter P-01

- Write 1 to Register 44
- Register 45 will return the present value of P-01, which can be Read if required
- Referring to the parameter table shown in 4.6.2, apply any scaling necessary
    - In this case, 60.0Hz = 3600
- Write the scaled value to Register 45. P-01 now changes to 60.0Hz, or an exception code may be returned.

5 Fieldbus Gateways

5.1 Gateway Concept

The fieldbus gateway acts as an interface between the Modbus RTU interface embedded into the Optidrive E3, and a high-level fieldbus network such as Profibus DP or DeviceNet. The gateway supports multiple drive connection up to 8 drives, providing a cost-effective method to connect Optidrive E3 units to a Profibus network.
The gateway internally consists of two segments of memory. Data transferred from the fieldbus Master System is written to the first memory area, and the fieldbus Master may Read data from the second memory area.



The fieldbus Master can normally be configured to Read and Write the entire gateway memory area in a single transaction, or separate transaction per drive may be configured. The gateway is the pre-configured by Invertek to carry out the necessary individual Modbus RTU transactions to communicate with the Sub Network of connected drives.

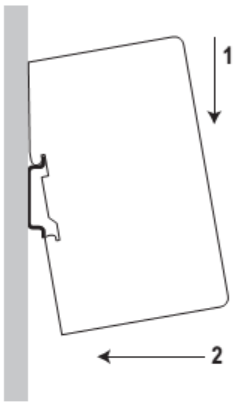
5.2 Gateway Included Components

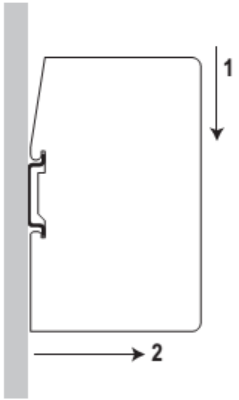
Each gateway is supplied with the following: -

- Anybus Communicator Profibus AB7000 OR Anybus Communicator DeviceNet AB7001
- Anybus Communicator Resource CD (Includes configuration software, manuals, GSD / EDS file and application notes)
- Female DB9-RJ10 Black RS232 configuration cable
- Male DB9-RJ45 Blue Subnetwork Connection Cable

Note: PROFIBUS / DeviceNet network cable and connector are not included.

5.3 Gateway Installation





- Mount the gateway on to the DIN-rail
- The DIN-rail mechanism works as follows:
- To snap the gateway on, first press it downwards (1) to compress the spring in the DIN-rail mechanism, then push it against the DIN-rail as to
- make it snap on (2)
- To snap the gateway off, push it downwards (1) and pull it out from the DIN-rail (2), as to make it snap off from the DIN-rail
- Connect the Anybus Communicator to the PROFIBUS-DP / DeviceNet network
- For Profibus, set the PROFIBUS node ID (see “Module Front” on page 49)
- Connect the gateway to the serial subnetwork using the supplied Blue Male DB9-RJ45 Subnetwork Connection Cable
- For a network with multiple drives, refer to „Multi Drive Network Example“ on page 45
- Gateways supplied by Invertek drives are pre-configured to operate with 4 connected E3 drives, unless an alternative number is specified when ordering.
- If an alternative number of slaves are required, configuration files to suit between one and 4 slaves may be downloaded from the Invertek Drives website. The user may then load the desired slave configuration to the gateway as follows: -
- Connect the gateway to the PC via the configuration cable
- Connect the power cable and apply power
- Start the Anybus Configuration Manager program on the PC
- (The Anybus Configuration Manager software attempts to detect the serial port automatically. If
- not successful, select the correct port manually in the “Port”-menu)
- Configure the gateway using the Anybus Configuration Manager and download the relevant configuration to suit the number of connected slave drives.
- Set up the PROFIBUS communication in accordance with the configuration

5.4 Subnetwork Connection

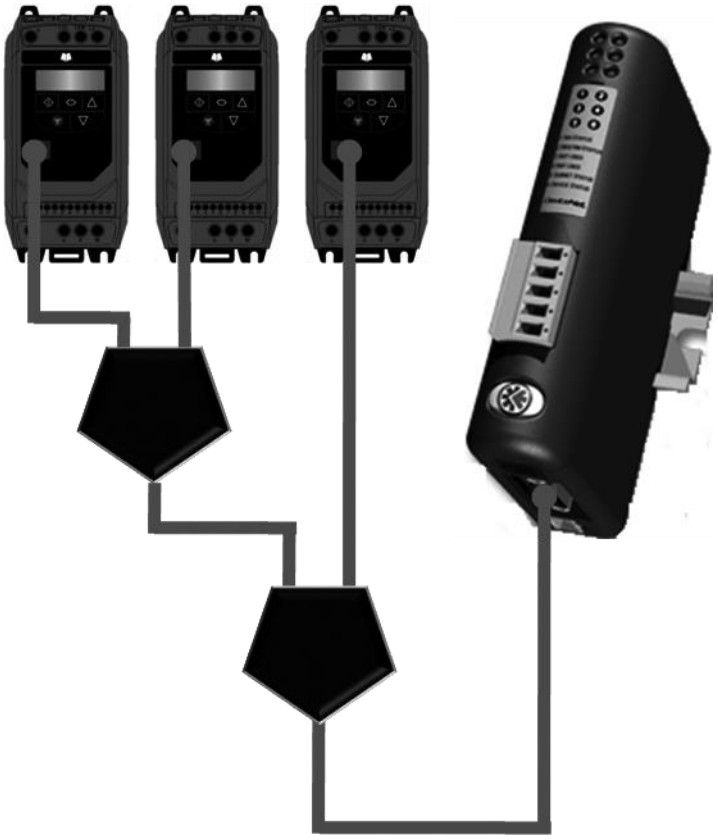
The drive sub network connects to the connector on the bottom of the gateway, using the supplied DB9-RJ45 cable. For a single drive installation, the cable can be connected directly from the gateway to the Optidrive. For a network of multiple drives, the network can be easily constructed using suitable RJ45 cables and splitters available from your Invertek Drives Sales Partner.

5.4.1 Single Drive Network Example

The gateway is connected to the drive using the supplied Blue Male DB9-RJ45 Subnetwork Connection Cable.

5.4.2 Multi Drive Network Example

The network can be constructed using firstly the supplied Blue Male DB9-RJ45 Subnetwork Connection Cable, and in addition, RJ45 Splitters (OPT-2-J45SP-IN) and RJ45 cables (0.5m – OPT-2J$505-IN, 1m – OPT-J4510-IN, 3m – OPT-2-J4530-IN). Alternative cables may be used; Invertek recommend using Cat 6 shielded twisted pair cables with pin to pin construction.



5.5 Commissioning Drive Parameter Settings

5.5.1 P-36 Communication Configuration

The Optidrive communication parameters are set using P-36, which has three indices as follows: -

P-36	**Serial Communications Configuration**
	Index 1: Address
	Range: 0 – 63, default: 1 For a single drive network, the address must be set to 1. For multiple drives, the addresses must be set sequentially starting from 1.
	Index 2: Baud Rate
	Selects the baud rate and network type for the internal RS485 communication port. When using the gateway, the baud rate must be set to 57.6kbps.
	Index 3: Communication loss protection
	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.

5.5.2 P-12 Command Source Selection

Modbus RTU is always enabled on Optidrive E3, allowing the gateway to provide remote monitoring of the drive by a remote Profibus Master device regardless of the control configuration of the drive.

If it is desired to control the drive from the Profibus network, P-12 must be set as follows: -

P-12	**Primary Command Source**	0	9	0	-
	3: Modbus Network Control. Control via the fieldbus using the internal Accel / Decel ramps (P-03 / P-04)				
	4: Modbus Network Control. Control via the fieldbus with Accel / Decel ramps updated via Modbus				

5.6 Gateway Memory Mapping

The PLC programmer can read/write the PLC memory mapping to gateway memory in order to monitor/control drives in the sub network.

5.6.1 Input memory

This part of the memory contains the real-time drive information that can be read by the PLC.

Drive	Data	Start Address	Data Length	Data Range	Unit	Description
1	Trip code	0x0000	8 bits	0 to 11		Refer to drive User Guide
	Drive status	0x0001	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x0002	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x0004	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x0006	16 bits	-	-	
2	Trip code	0x0008	8 bits	0 to 11		See error code list for further information
	Drive status	0x0009	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x000A	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x000C	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x000E	16 bits	-	-	
3	Trip code	0x0010	8 bits	0 to 11		See error code list for further information
	Drive status	0x0011	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x0012	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x0014	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x0016	16 bits	-	-	
4	Trip code	0x0018	8 bits	0 to 11		See error code list for further information
	Drive status	0x0019	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x001A	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x001C	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x001E	16 bits	-	-	
5	Trip code	0x0020	8 bits	0 to 11		See error code list for further information
	Drive status	0x0021	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x0022	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x0024	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x0026	16 bits	-	-	
6	Trip code	0x0028	8 bits	0 to 11		See error code list for further information
	Drive status	0x0029	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x002A	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x002C	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x002E	16 bits	-	-	
7	Trip code	0x0030	8 bits	0 to 11		See error code list for further information
	Drive status	0x0031	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x0032	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x0034	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x0036	16 bits	-	-	
8	Trip code	0x0038	8 bits	0 to 11		See error code list for further information
	Drive status	0x0039	8bits	0, 1, 2,		Refer to Drive Status Word on page 48
	Motor speed in Hz	0x003A	16 bits	-P-01 to P-01	Hz	One decimal place (500 = 50.0Hz)
	Motor current	0x003C	16 bits	0 to 10000	A	One decimal place (76 = 7.6A)
	Not Used	0x003E	16 bits	-	-	

5.6.2 Output memory

This part of the memory contains the control command information to allow the PLC to control the drives.

Drive	Data	Start Address	Data Length	Data Range	Unit	Description
1	Control command	0x0200	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0202	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0204	16 bits			
	Ramp Time	0x0206	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
2	Control command	0x0208	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x020A	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x020C	16 bits			
	Ramp Time	0x020E	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
3	Control command	0x0210	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0212	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0214	16 bits			
	Ramp Time	0x0216	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
4	Control command	0x0210	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0212	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0214	16 bits			
	Ramp Time	0x0216	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
5	Control command	0x0220	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0222	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0224	16 bits			
	Ramp Time	0x0226	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
6	Control command	0x0228	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x022A	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x022C	16 bits			
	Ramp Time	0x022E	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
7	Control command	0x0230	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0232	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0234	16 bits			
	Ramp Time	0x0236	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps
8	Control command	0x0230	16 bits	-		Refer to Drive Control Word on page 48
	Speed reference in HZ	0x0232	16 bits	-P-01 to P-01	Hz	Drive digital speed reference. Including one decimal place. (500 = 50.0Hz)
	No Function	0x0234	16 bits			
	Ramp Time	0x0236	16 bits	0 - 60000	s	Ramp time in seconds x 100 (250 = 2.5s) simultaneously applied to acceleration and deceleration ramps

5.6.3 Drive Control Word

The drive Control Word format is the same as used for Modbus RTU, explained in section 4.7.1 Drive Control Word Format on page 41.

5.6.4 Drive Status Word

The drive Status Word format is the same as used for Modbus RTU, explained in section 4.7.5 Drive status and error code Word on page 42.

5.7 Controlling the Optidrive(s)

The following points should be noted when attempting to control the Optidrive(s): -

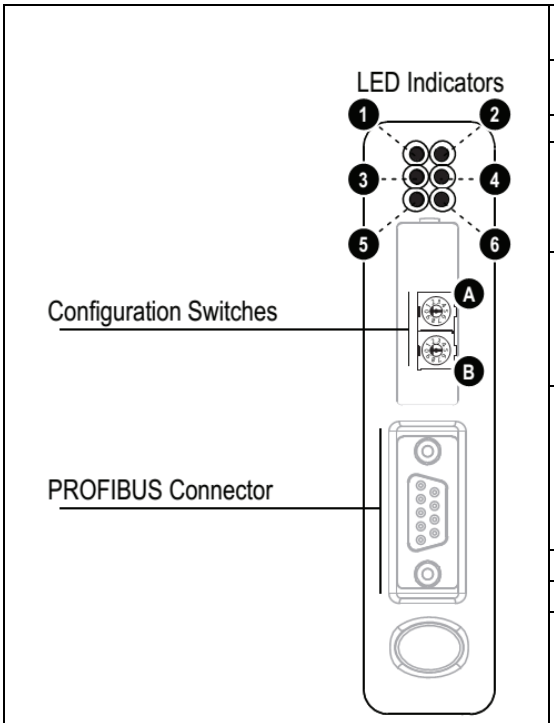
- The drive must be set for Modbus RTU control using P-12
- Digital Input, which acts as a hardware enable must be ON in order for the drive to start, otherwise the drive will not enable, and the Sub Network Status LED will illuminate Red when the user tries to start the drive.
- The Enable / Run signal is Edge triggered, and so the drive must receive a control word with Bit 0 = 0, followed by a control word with Bit 0 = 1 in order to start.
- If P-12 = 3 and the user writes any data to the Ramp Time memory area, the gateway will indicate a Sub Network Status error (red flash), as the drive rejects the data which cannot be used.

5.8 Profibus DP Gateway Features – OD-PROFB-IN

- Complete PROFIBUS-DP slave functionality according to IEC 61158
- Supports all common baud rates up to 12 Mbit (detected automatically)
- Up to 64 bytes of I/O data in each direction, allowing up to 8 Optidrives to be connected to a single gateway.
- Galvanically isolated bus electronics

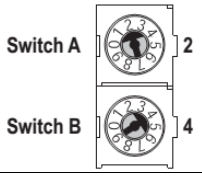
5.8.1 Installation

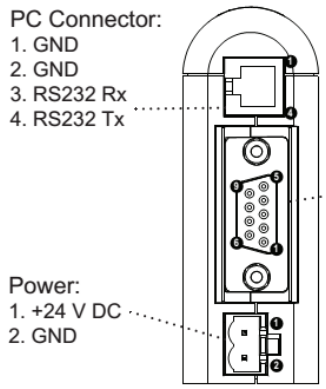
5.8.1.1 Overview - Module Front



1	Online	Green	Online
		Off	Not Online
2	Offline	Red	Offline
		Off	Not Offline
3	Not Used	-	-
4	Fieldbus Diagnostics	Off	No diagnostics present
		Red, Flashing 1Hz	Configuration Error
		Red, Flashing 2Hz	User parameter data error
		Red, Flashing 4Hz	Initialisation Error
5	Subnet Status	Flashing Green	Running, but one or more transaction errors
		Green	Running
		Red	Transaction error / subnet stopped
6	Device Status	Off	Power Off
		Alternating Red / Green	Invalid / missing configuration
		Green	Initialising
		Flashing Green	Running
		Red	Bootloader Mode
		Flashing Red	Diagnostic Code
A	Set the PROFIBUS node address by using the switches as follows: Node address = (switch B * 10) + (switch A * 1)		
B			

Example:
Setting node address 42

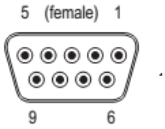




DB9	
1	+5V
2	RS232 Rx (Not Used)
3	RS232 Tx (Not Used)
4	NC
5	Signal 0V
6	RS422 Rx+ (Not Used)
7	RS422 Rx- (Not Used)
8	RS485+ Modbus RTU
9	RS485- Modbus RTU

Power	
1	+24VDC, 300mA
2	0V

PROFIBUS Connector



Pin no	Description
1	Shield
3	B-line
4	RTS
5	GND bus
6	+5V bus out
8	A-line
2, 7, 9	NC

5.8.2 Profibus Master Configuration

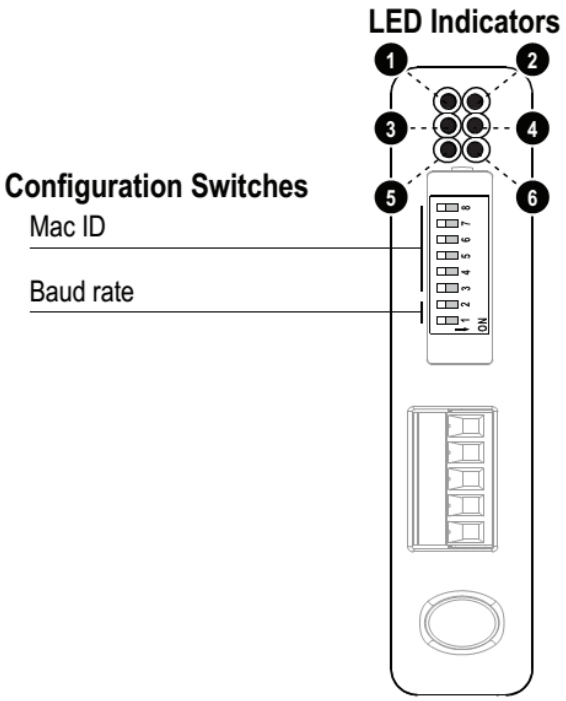
The latest applicable GSD file may be downloaded from the HMS website, www.anybus.com.
The actual configuration process will differ for different Profibus Master Systems and is not possible to explain in this document. Example configurations for Siemens PLC are provided on the HMS website.
When configuring the communication between the Master System and the gateway, 4 words of Input Process Data and 4 words of Output Process Data should be allocated per drive connected the gateway, up to a maximum of 32 Input and Output words. If necessary, a configuration may be chosen in the Profibus Master which supports more than the connected number of drives, e.g. if 3 drives are connected to the gateway, the Master System can be configured for 12, 16 or even 32 words of Input and Output process data. The additional words will simply not contain any data.

5.9 DeviceNet Gateway Features – OD-DEVNT-IN

- Communications Adapter, profile no. 12
- Group two server
- MacID and baud rate configuration via on-board switches
- Polled, Change-of-state and Bit strobed I/O

5.9.1 Installation

5.9.1.1 Overview - Module Front



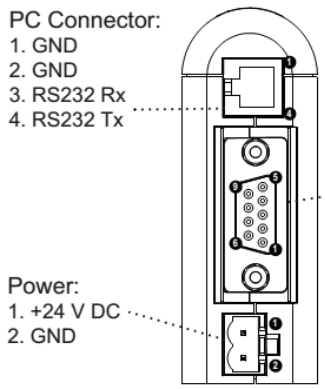
1	Network Status	Off	Not online
		Green	Link ok, online, connected
		Flashing Green	Online, not connected
		Red	Critical link failure
		Flashing Red	Connection timeout
2	Module Status	Off	No power
		Green	Device operational
		Flashing Green	Data size bigger than configured
		Red	Unrecoverable fault
		Flashing Red	Minor fault
3	Not Used	-	-
4	Not Used	-	-
5	Subnet Status	Flashing Green	Running, but one or more transaction errors
		Green	Running
		Red	Transaction error / subnet stopped
6	Device Status	Off	Power Off
		Alternating Red / Green	Invalid / missing configuration
		Green	Initialising
		Flashing Green	Running
		Red	Bootloader Mode
		Flashing Red	Diagnostic Code

5.9.1.2 Configuration Switches – Baud Rate

Switch 1	Switch 2	Baud Rate
OFF	OFF	125k
OFF	ON	250k
ON	OFF	500k
ON	ON	N/A

5.9.1.3 Configuration Switches – MAC ID

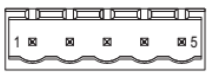
MAC ID	Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8
0	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	OFF	ON	OFF
3-62	...	...	...	...	...	...
63	ON	ON	ON	ON	ON	ON



DB9	
1	+5V
2	RS232 Rx (Not Used)
3	RS232 Tx (Not Used)
4	NC
5	Signal 0V
6	RS422 Rx+ (Not Used)
7	RS422 Rx- (Not Used)
8	RS485+ Modbus RTU
9	RS485- Modbus RTU

Power	
1	+24VDC, 300mA
2	0V

DeviceNet Connector



Pin no	Description
1	V-
2	CAN L
3	Shield
4	CAN H
5	V+

5.9.2 DeviceNet Master Configuration

The latest version of the EDS file may be downloaded from the HMS website, www.anybus.com.
The actual configuration process will differ for different DeviceNet Master Systems and is not possible to explain in this document. Example configurations for Rockwell PLC are provided on the HMS website.
When configuring the communication between the Master System and the gateway, 4 words of Input Process Data and 4 words of Output Process Data should be allocated per drive connected the gateway, up to a maximum of 32 Input and Output words. If necessary, a configuration may be chosen in the Master which supports more than the connected number of drives, e.g. if 3 drives are connected to the gateway, the Master System can be configured for 12, 16 or even 32 words of Input and Output process data. The additional words will simply not contain any data.

5.10 Diagnostics and Troubleshooting

Symptom	Suggested Actions
No Communication, Master > Gateway	Check all network cables Check correct bus termination Check correct node address on gateway Check GSD / EDS file is recognised and used by the Master Check the Status LEDs 1 and 2
Profibus Communication OK, Not possible to control the Optidrive(s)	Check the subnetwork Status LED Check all sub network connections Check correct baud rate set in drives Check drives are addressed sequentially from 1 Check that data is written to the correct memory area(s)

6 Diagnostic and Fault Messages

6.1 Fault Messages

Fault Code	No.	Description
no-Flt	00	No Fault
OI-b	01	Brake channel over current
OL-br	02	Brake resistor overload
O-I	03	Instantaneous over current
I.t-trp	04	Motor Thermal Overload (I2t)
O-Volt	06	Over voltage on DC bus
U-Volt	07	Under voltage on DC bus
O-t	08	Heatsink over temperature
U-t	09	Under temperature
P-dEF	10	Factory Default parameters have been loaded
E-trip	11	External trip
SC-ObS	12	Optibus comms loss
FLt-dc	13	DC bus ripple too high
P-LOSS	14	Input phase loss trip
h O-I	15	Instantaneous over current on drive output.
th-Flt	16	Faulty thermistor on heatsink.
dAtA-F	17	Internal memory fault. (IO)
4-20 F	18	4-20mA Signal Lost
dAtA-E	19	Internal memory fault. (DSP)
U-dEF	20	User Default Parameters Loaded
F-Ptc	21	Motor PTC thermistor trip
FAN-F	22	Cooling Fan Fault
O-hEAt	23	Environmental temperature too high
Out-F	26	Drive output fault
AtF-01	40	Measured motor stator resistance varies between phases.
AtF-02	41	Measured motor stator resistance is too large.
AtF-03	42	Measured motor inductance is too low.
AtF-04	43	Measured motor inductance is too large.
Out-Ph	44	Output (motor) phase missing
Out-Ph	49	Output (Motor) phase loss
SC-F01	50	Modbus comms loss fault
SC-F02	51	CAN comms loss trip

6.2 Resetting a Fault

When the drive trips, and a fault message is displayed, it can be reset in one of the following ways: -

- Completely remove the incoming power supply and allow the power to dissipate completely. Re-apply the power.
- Remove and reapply the enable input
- Press the stop / Reset button
- If Modbus or CAN are in use, set the reset bit in the control word from 0 to 1

In the event of O-I, hO-I or I.t-trp faults, in order to prevent damage that may occur through repeatedly enabling the drive into a fault condition, these trips cannot be reset immediately. A delay time according to the following table must be allowed before reset is possible.

First Trip	2 seconds delay before reset is possible
Second Trip	4 seconds delay before reset is possible
Third Trip	8 seconds delay before reset is possible
Fourth Trip	16 seconds delay before reset is possible
Fifth Trip	32 seconds delay before reset is possible
Subsequent Trips	64 seconds delay before reset is possible

7 Rated Temperatures and De-rating curves

7.1 Thermal Management

The Optidrive E3 product range has an integrated Thermal Management function. This function allows the drive to automatically reduce the drive output switching frequency when operating at higher heatsink temperatures to avoid the risk of an over temperature trip. The tables below show the heatsink temperature threshold points at which thermal management occurs.

NOTE

The available range of switching frequencies is subject to the drive frame size, power rating and voltage rating. Refer to section 3.1 Available Effective Switching Frequency Options for further information.

7.1.1 IP20 Drives

Temperature Threshold	Action
70 ^{O}C	Auto reduce from 32kHz to 24kHz
75 ^{O}C	Auto reduce from 24kHz to 16kHz
80 ^{O}C	Auto reduce from 16kHz to 12kHz
85 ^{O}C	Auto reduce from 12kHz to 8kHz
90 ^{O}C	Auto reduce from 8kHz to 4kHz
97 ^{O}C	Over temp trip

7.1.2 IP66 Drives

Temperature Threshold	Action
70 ^{O}C	Auto reduce from 32kHz to 24kHz
75 ^{O}C	Auto reduce from 24kHz to 16kHz
80 ^{O}C	Auto reduce from 16kHz to 12kHz
85 ^{O}C	Auto reduce from 12kHz to 8kHz
90 ^{O}C	Auto reduce from 8kHz to 4kHz
97 ^{O}C	Over temp trip

7.2 De-rating for Effective Switching Frequency and Ambient Temperature

The tables below show the maximum permissible continuous output current as a percentage of the drive rated output current for each available effective switching frequency and the ambient temperature at which it applies.

7.2.1 IP20 Drives

Permissible Load for each Effective Switching Frequency Setting at Ambient Temperature									
Frame Size	Effective Switching Frequency	Ambient Temperature							
		-10	0	10	20	30	40	50	60
1	4 kHz	100%	100%	100%	100%	100%	100%	100%	85.7%
	8 kHz	100%	100%	100%	100%	100%	100%	94.3%	80.0%
	12 kHz	100%	100%	100%	100%	97.1%	90.0%	87.0%	74.3%
	16 kHz	100%	100%	100%	100%	97.1%	90.0%	80.0%	68.6%
	24 kHz	100%	100%	100%	100%	97.1%	84.3%	71.0%	60.0%
	32 kHz	100%	100%	100%	100%	92.9%	78.6%	58.6%	54.3%
2	4 kHz	100%	100%	100%	100%	100%	100%	100%	83.8%
	8 kHz	100%	100%	100%	100%	100%	100%	89.5%	75.8%
	12 kHz	100%	100%	100%	100%	100%	88.4%	74.7%	63.2%
	16 kHz	100%	100%	100%	94.7%	84.2%	73.7%	64.2%	54.7%
	24 kHz	100%	91.6%	84.2%	77.9%	70.5%	63.2%	55.8%	N/A
	32 kHz	66.3%	66.3%	64.2%	61.1%	58.9%	55.8%	45.7%	N/A
3	4 kHz	100%	100%	100%	100%	100%	100%	100%	84.9%
	8 kHz	100%	100%	100%	100%	100%	100%	100%	54.6%
	12 kHz	100%	100%	100%	100%	100%	100%	97.5%	47.5%
	16 kHz	100%	100%	100%	100%	100%	95.4%	73.8%	43.3%
	24 kHz	100%	100%	100%	100%	88.8%	70.4%	51.7%	34.2%
4	4 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
	8 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
	12 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	83.5%	70.9%
	16 kHz	100.0%	100.0%	100.0%	100.0%	100%	83.9%	71.5%	60.7%
	24 kHz	100.0%	100.0%	100.0%	100%	80.2%	65.0%	52.0%	44.1%
5	4 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	N/A
	8 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	84.7%	N/A
	12 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	94.4%	69.4%	N/A
	16 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	90.3%	54.2%	N/A
	24 kHz	100.0%	100.0%	100.0%	100.0%	100.0%	84.7%	38.9%	N/A

7.2.2 IP66 Outdoor Drives

Permissible Load for each Effective Switching Frequency Setting at Ambient Temperature								
Frame Size	Effective Switching Frequency	Ambient Temperature						
		-10	0	10	20	30	40	50
1	4 kHz	100%	100%	100%	100%	100%	100%	85%
	8 kHz	100%	100%	100%	100%	100%	100%	85%
	12 kHz	100%	100%	100%	100%	100%	100%	85%
	16 kHz	100%	100%	100%	100%	100%	100%	85%
	24 kHz	100%	100%	100%	100%	100%	100%	85%
	32 kHz	100%	100%	100%	100%	97.6%	81.4%	58.1%
2	4 kHz	100%	100%	100%	100%	100%	100%	85%
	8 kHz	100%	100%	100%	100%	100%	100%	85%
	12 kHz	100%	100%	100%	100%	100%	100%	85%
	16 kHz	100%	100%	100%	100%	92.6%	78.9%	57.9%
	24 kHz	78.9%	78.9%	78.9%	75.6%	54.7%	47.4%	33.7%
	32 kHz	72.6%	72.6%	68.4%	54.7%	47.4%	33.7%	0%
3	4 kHz	100%	100%	100%	100%	100%	100%	85%
	8 kHz	100%	100%	100%	100%	100%	100%	85%
	12 kHz	100%	100%	100%	100%	100%	100%	85%
	16 kHz	100%	100%	100%	100%	100%	92.1%	64.2%
	24 kHz	100%	100%	100%	100%	100%	77.1%	47.1%
4	4 kHz	100%	100%	100%	100%	100%	100%	85%
	8 kHz	100%	100%	100%	100%	100%	100%	85%
	12 kHz	100%	100%	100%	100%	83.3%	86.9%	67.4%
	16 kHz	100%	100%	91.3%	78.3%	65.2%	50.0%	34.8%
	24 kHz	76.1%	76.1%	65.2%	52.2%	41.3%	29.3%	0%

8 Immunity Tests

8.1 Electrostatic Discharge (ESD)

The Optidrive E3 product range has been designed and tested to comply with the limits defined in EN 61800-3:2004+A1-2012. The test techniques used are as defined in EN 61000-4-2:2009.

Application	Test points	Test Method	Level
Direct	Control Terminals	Contact Discharge	±4kV
		Air Discharge	±8kV
	Power Terminals	Air Discharge	±8kV
Indirect	Vertical coupling plane	Contact Discharge	±4kV
	Horizontal coupling plane	Contact Discharge	±4kV

8.2 Electrical Fast Transient Burst (EFT/B)

The Optidrive E3 product range has been designed and tested to comply with the limits defined in EN 61800-3: 2004+A1-2012. The test techniques used are as defined in EN 61000-4-4:2004.

Test points	Test Method	Level
Control Terminals	Capacitive clamp	±1kV at 5kHz
Motor Power Terminals	Capacitive clamp	±2kV at 5kHz
1-PH Supply Power Terminals	Coupling Decoupling Network	±2kV at 5kHz
3-PH Supply Power Terminals	Capacitive clamp	±4kV at 5kHz

8.3 Surge

The Optidrive E3 product range has been designed and tested to comply with the limits defined in EN 61800-3: 2004+A1-2012. The test techniques used are as defined in EN 61000-4-5:2006.

Drive Type	Test Method	Level
200-240V	Line to Line/Neutral	±1kV
	Line/Neutral to Earth	±2kV
380-480V	Line to Line	±2kV
	Line to Earth	±4kV

8.4 Dielectric strength (Flash)

The Optidrive E3 product range has been designed and tested to comply with the limits defined in EN 61800-5-1: 2007. The test techniques used are as defined in EN 61800-5-1: 2007.

Drive Type	Level
200-240V	1.5kV
380-480V	2.5kV

9 General Technical and Performance Data

9.1 Electrical Data

9.1.1 Mains Supply Details	
Supply Voltage Range	110 Volt Units – 110 – 115 Volt +10% / -10% 230 Volt Units – 200 – 240 Volt +10% / -10% 400 Volt Units – 380 – 480 Volt +10% / -10%
Supply Frequency	48 – 62Hz
Inrush Current	< rated input current
Power Up Cycles	>120x /hr, evenly spaced
Single Phase Operation	Three phase drives can be operated from a single-phase supply with 50% derating of the maximum output current
9.1.2 Motor Control	
Output Frequency Range	0 to 500Hz in 0.1 Hz steps Max Output Frequency = Max Switching Frequency / 16.
Output Voltage Range	0 to Supply Voltage
Speed Regulation	Open Loop < 2% motor rated speed
Torque Control	0 – 175% of rated torque, + / -5% accuracy, Response time <10ms
Effective Switching Frequency	Refer to section 3.1
Acceleration Time	0 – 600 seconds, 0.01s resolution
Deceleration Time	Two deceleration ramps 0 – 600 seconds, 0.01s resolution
9.1.3 Overload Capacity	
Overload Capacity	150% of rated current for 60 seconds, repeat cycle every 10 minutes. 175% / 4 seconds

9.2 Input Output Current Ratings

9.2.1 110V Input

Frame Size	Supply Voltage	Power Rating (kW)	Input Current (A)	iTHD (%)	AC Line Choke	Input Current (A)	iTHD (%)	Output Current (A)
1	110V, 1 Ph.	0.37	7.8		OPT-2-L1016-20	7.1		2.3
		0.75	15.8	<60.0	OPT-2-L1016-20	15.0		4.3
2	110V, 1 Ph.	1.1	21.9		OPT-2-L1025-20	20.1		5.8

The data above is provided to show typical values. Results measured at the point of installation may vary according to the installation site and load conditions Test results are measured under the following conditions: -

- 400 Volt RMS AC Supply Voltage
- Operating IE2 motor with matching power rating according to the drive
- Operated at full rated output current capacity

9.2.2 230V Input

Frame Size	Supply Voltage	Power Rating (kW)	Input Current (A)	iTHD (%)	AC Line Choke	Input Current (A)	iTHD (%)	Output Current (A)
1	230V, 1ph	0.37	3.7	<175%	OPT-2-L1016-20	2.9		2.3
		0.75	7.5	<175%	OPT-2-L1016-20	6.6		4.3
		1.5	12.9	<175%	OPT-2-L1016-20	9.7		7.0
	230V, 3ph	0.37	3.4	<85.0	OPT-2-L3006-20	3.4		2.3
		0.75	5.6	<85.0	OPT-2-L3006-20	5.6		4.3
		1.5	9.5	<85.0	OPT-2-L3010-20	6.3		7.0
2	230V, 1ph	1.5	12.9	<125.0	OPT-2-L1016-20	11.4		7.0
		2.2	19.2	<100.0	OPT-2-L1025-20	17.0		10.5
	230V, 3ph	1.5	8.9	<85.0	OPT-2-L3006-20	7.0		7.0
		2.2	12.1	<85.0	OPT-2-L3010-20	9.9		10.5
3	230V, 1ph	4.0	29.2	<125.0	-	25.9		15.3
	230V, 3ph	4.0	20.9	<85.0	OPT-2-L3036-20	13.5		18
		5.5	26.4	<85.0	OPT-2-L3036-20	17.4		24
4	230V, 3ph	5.5	26.9	<85.0	OPT-2-L3036-20	22.0		24
		7.5	33.3	<85.0	OPT-2-L3036-20	27.7		30
		11	50.1	<85.0	OPT-2-L3050-20	41.7		46

The data above is provided to show typical values. Results measured at the point of installation may vary according to the installation site and load conditions Test results are measured under the following conditions: -

- 230 Volt RMS AC Supply Voltage
- Operating IE2 motor with matching power rating according to the drive
- Operated at full rated output current capacity

9.2.3 400 / 460 Volt Input

Frame Size	Supply Voltage	Power Rating (kW)	Input Current (A)	iTHD (%)	AC Line Choke	Input Current (A)	iTHD (%)	Output Current (A)
1	400V, 3ph	0.75	3.5	<85.0	OPT-2-L3006-20	1.5		2.2
		1.5	5.6	<85.0	OPT-2-L3006-20	2.7		4.1
2		1.5	5.6	<85.0	OPT-2-L3006-20	4.5		4.1
		2.2	7.5	<85.0	OPT-2-L3006-20	5.5		5.8
		4.0	11.5	<85.0	OPT-2-L3010-20	9.2		9.5
3		5.5	17.2	<85.0	OPT-2-L3036-20	14.5		14
		7.5	21.2	<85.0	OPT-2-L3036-20	17.2		18
		11	27.5	<85.0	OPT-2-L3036-20	21.7		24
4		15	34.2	<85.0	OPT-2-L3036-20	27.0		30
		18.5	44.1	<85.0	OPT-2-L3050-20	34.8		39
		22	51.9	<85.0	OPT-2-L3050-20	40.9		46

The data above is provided to show typical values. Results measured at the point of installation may vary according to the installation site and load conditions Test results are measured under the following conditions: -

- 400 Volt RMS AC Supply Voltage
- Operating IE2 motor with matching power rating according to the drive
- Operated at full rated output current capacity

9.3 Standby Power Consumption

The following table shows the power consumption of the drive under the following conditions.

- Drive is powered from the nominal rated mains supply voltage (e.g. 230 or 400 Volt)
- Output disabled
- Cooling fan off
- No external power drawn from the control terminals

Frame Size	Voltage	Phase	Consumption
1	230	1	3.07W
	230	3	3.07W
	400	3	4.55W
2	230	1	4.51W
	230	3	4.51W
	400	3	6.44W
3	230	1	5.16W
	230	3	5.16W
	400	3	6.42W
4	230	3	7.54W
	400	3	14.6W

9.4 DC Bus Discharge Time

DC Bus discharge times are based on maximum continuous rated DC bus voltage. In compliance with EN 61800-5-1:2007, all drives have a caution on the rating labels stating "Power down for 5 minutes before removing cover"

Frame Size	Supply Voltage	DC Bus Voltage			Time to reach 50V
		Max	after 5s	after 60s	
1	240Vac +10%	375	323	24.8	26 sec
	480Vac +10%	680	510	36	34 sec
2	240Vac +10%	375	332	27.3	42 sec
	480Vac +10%	680	564	24.5	48 sec
3	240Vac +10%	375	324	36.4	27 sec
	480Vac +10%	680	601	59.6	109 sec
4	240Vac +10%	375	301	28.6	46 sec
	480Vac +10%	680	610	40.2	58 sec

9.5 Earth Leakage Current (Touch Current)

The Optidrive E3 product range has been designed and tested to comply with the limits defined in EN 61800-5-1: 2007. The test techniques used are as defined in EN 60990:2000.
As stated in the standard 61800-5-1:2007, 5.2.3.5 the motor does not have to be loaded, however, the motor type, cable type and length can have a significant impact on the results.

Frame Size	Typical Supply Conditions		Maximum Supply Conditions	
	Supply Voltage	I_{Touch} (mA)	Supply Voltage	I_{Touch} (mA)
1	1ph 230V 50Hz	3.5	1ph 240V +10% 60Hz	4.8
	3ph 230V 50Hz	4.6	3ph 240V +10% 60Hz	7.5
	3ph 400V 50Hz	8	3ph 480V +10% 60Hz	13
2	1ph 230V 50Hz	3.5	1ph 240V +10% 60Hz	4.8
	3ph 230V 50Hz	4.7	3ph 240V +10% 60Hz	7.2
	3ph 400V 50Hz	8.1	3ph 480V +10% 60Hz	12.6
3	1ph 230V 50Hz	3.5	1ph 240V +10% 60Hz	4.7
	3ph 230V 50Hz	4.7	3ph 240V +10% 60Hz	6.8
	3ph 400V 50Hz	8.1	3ph 480V +10% 60Hz	12.7
4	3ph 230Vac 50Hz	4.8	3ph 240V +10% 60Hz	6.9
	3ph 400Vac 50Hz	8.2	3ph 480V +10% 60Hz	12.9

NOTE
The Touch Current value is based on: -

- Normal operating conditions, i.e. all phases balanced and connected correctly with the motor running
- Drive fitted with integrated EMC filter

9.6 Digital & Analog I/O

9.6.1 Digital Inputs Specification

Voltage Range	8 – 30 V dc, Internal or External supply, NPN (positive logic)
Response Time	< 8ms

9.6.2 Analog Inputs Specification

Range	Current: 0-20mA, 4-20mA. 20mA max input current
	Voltage: -10-10V (Analog Input 1 Only), 0-10V, 0-5V, 0/24V, 30V max input
Resolution	Analog Input 1: 12-bit, <16ms response time (Uni-Polar)
	Analog Input 2: 12-bit, <16ms response time (Uni-Polar)
Accuracy	better than 1% of full scale
Scaling & Offset	Parameter adjustable

9.6.3 Analog Output Specification

Range	Current: 0...20mA, 4...20mA, 20mA max
	Analog: 0...10V, 0 / 24V (digital), 20mA max
Resolution	10-bit
Accuracy	better than 1% of full scale

9.6.4 Relay Output

Maximum Switching Voltage :	250VAC, 30 VDC
Maximum Switching Current :	5A at 30 Volt DC, 6A at 250 Volt AC

9.7 Environmental Data

9.7.1 Temperature Range		
Ambient Temperature Range: Operation	IP20 Drives: -10 - +50°C (14 - 122°F) without derating IP55 & IP66 Drives: -10 - + 40°C (14 - 104°F) without derating	
Note: No frost or condensation permissible		
Ambient Temperature Range: Storage	-40 … 60 ºC. No Frost or Condensation	
9.7.2 Altitude		
Maximum Altitude (No derating)	1000m Derate above 1000m by 1% per 100m	
Maximum Altitude (UL Approved)	2000m	
Maximum Altitude	4000m	
9.7.3 Relative Humidity		
Relative Humidity Limit	95% Maximum, non-condensing	
9.7.4 Contamination Levels		
Standard	IEC 721-3-3, Non-conductive dust allowed	
Transportation	Class 1C2 (chemical gases), Class 1S2 (solid particles)	
Storage	Class 2C2 (chemical gases), Class 2S2 (solid particles)	
Operation	Class 3C2 (chemical gases), Class 3S2 (solid particles	
9.7.5 Vibration Levels		
Shock Test	Pulse Shape Peak Acceleration Duration Axes Tested Number of Shocks Configuration	Half-Sine 15g 11ms 3 Orthogonal 3 in each direction (18 in total) Non-operational throughout
Sinusoidal vibration test	Frequency Range Severity Sweep Rate Axes Tested Number of Cycles Configuration	10Hz – 150Hz 10Hz – 57.55Hz: 0.15mm peak-peak displacement 57.55Hz – 150Hz: 1g peak acceleration 1 octave/minute 3 Orthogonal 10 cycles/axis (1 cycle consists of an up and a down sweep) Non-operational throughout

9.8 Response Times

Command Source	Response Time
Digital Input	<8ms
Analog Input	<16ms
Modbus RTU Interface	<8ms from receipt of valid command
CAN Interface	<8ms from receipt of valid command
Master / Slave Function	<8ms, response, 60ms cycle
Power Stage	<10ms to enable output

9.9 Motor Control Performance

9.9.1 V/F Mode

Speed Regulation: + / - 20% of motor slip with slip compensation enabled

9.9.2 Vector Mode

Static Speed Accuracy: + / - 0.033%
Speed Regulation 0 – 100% Load Range: + / - 1%
Torque Response: 1- 8ms
Torque Linearity (10 – 90% of motor rated speed, 20 – 100% load torque range): + / - 5%

9.10 Output Current Limit

9.10.1 Overload Operation

Optidrive E3 provides the following overall limits:

- 150% Output current / 60 Seconds Maximum
- 175% Output current / 3.75 Seconds Maximum

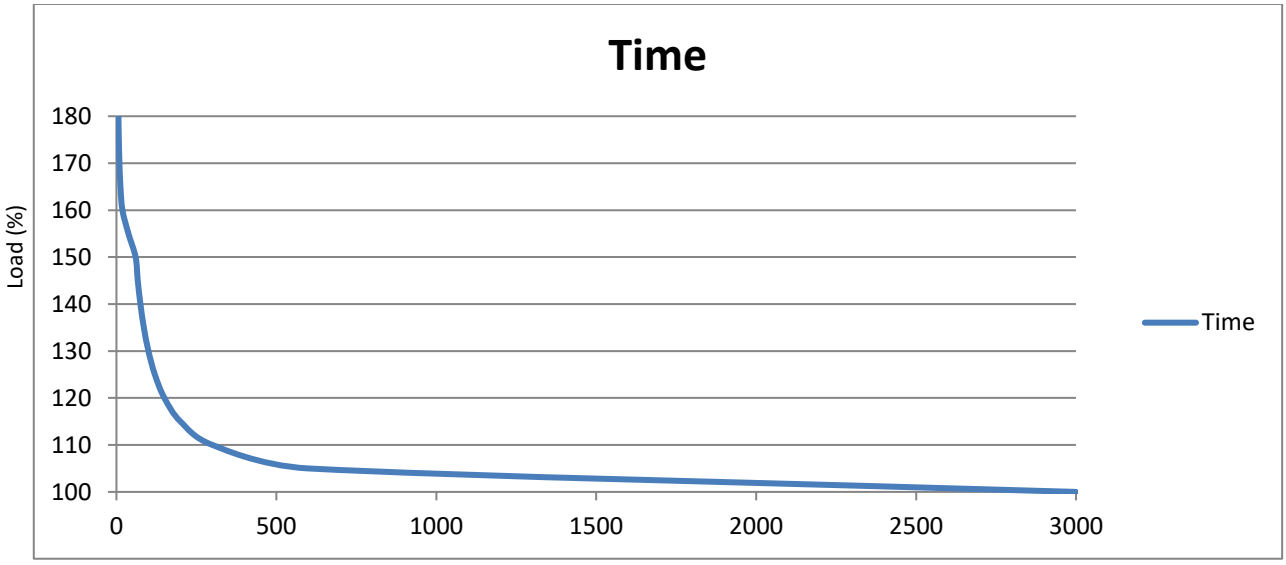
9.10.2 Overview

Optidrive E3 features both hardware and software protection of the output stage to prevent damage. In addition, an Ixt system is used to monitor motor overload condition and prevent damage to the motor due to operation for prolonged periods at high load.
I x t protection is software based, using the value for motor rated current programmed in P-08. An internal accumulator register is used to estimate the point at which damage may occur to the motor, and operates as follows
Motor Current < P-08
The accumulator value reduces towards zero. The time required depends on the actual load current as explained further below.
Motor Current = 100% P-08
The accumulator value remains static.
Motor Current > 100% P-08 < 150% P-08
The accumulator value increases at a rate proportional to the overload level, e.g. (Motor Current / Rated current) – 100%. If the overload limit is reached, the drive will trip, displaying it.trp. to protect the motor.
Motor Current > 150% P-08
For high current levels, the accumulator operates 16 times faster than for current levels below 150% of P-08.
Peak over current trip levels are shown in the table below.

9.10.3 Example Operation

Maximum overload operation is 150% of motor rated current for 60 seconds. As this represents an overload of 50%, the accumulator trip level is 3000. This means that if the drive operates with 125% load current, the time can be calculated as 3000 / (125 – 100) = 120 Seconds.
Above 150% load, accumulation is 16 times faster, hence for 160% load current, the time is 3000 / 16 / (160 – 150) = 18.75 seconds

9.10.4 Overload Curve



9.10.5 Additional Special Case Overload Operation

For ODE-3-240095-3F4# models, when output frequency <5Hz, overload accumulation is 2.5 times faster.

9.11 Under / Over Voltage Trip Levels

The following levels are not user adjustable and define the operating voltage levels of the drive and brake chopper circuit.

Drive Rated Supply Voltage	Drive Type	DC Bus Voltage Level (Volts DC)				
		Brake Chopper On	Brake Chopper Off	Under Voltage Trip	Minimum Operating (Inrush Disabled)	Over Voltage Trip
110 – 115 Volts AC	Single Phase Output	195	189	80	113	208
110 – 115 Volts AC	Voltage Doubler	390	378	160	239	418
200 – 240 Volts AC	All	390	378	160	239	418
380 – 480 Volts AC	All	780	756	320	478	835

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