

Optidrive VTC
Advanced User Guide

Revision 2.21

Revision History :

Revision	Date	Description
01.04	01.06.05	First release.
02.00	08.09.05	Parameter set modified. For drive version 2.00
02.10	17.11.05	Rating table changed. Parameter description changed. Control function flowchart added.
02.20	19.07.06	Parameter description updated. Control function flowchart added. Updated to current European standards
02.21	19.10.06	Rating table updated. Parameter description updated according to drive version 2.21. Control function flowchart modified.
02.21 - r1	20.11.06	Group zero parameter description updated.

Applicable standards :

- EN 61800-5-1 : Adjustable speed electrical power drive systems
- EN 60204-1 : Safety of machinery - Part 1 : General Requirements
- EN 61800-3 : EMC product standard for Variable speed drive systems
- EN 55011 : Limits and Methods of measurement of radio interference characteristics of Industrial Equipment
- UL 508C : Power Conversion equipment
- CE Marked for Low voltage Directive

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1. Product Overview

1.1 Technology

- Latest generation processing core for high performance / low cost
- Flash programmability for maximum flexibility
- Field upgradeable via IR interface
- Communications based on IrDA 1.0 and RS485
- PDA support for fast, easy commissioning
- Latest generation power stage for minimal component count, high reliability and lower thermal losses
- Flexible user interface which retains compatibility with existing Optidrive
- Low cost and ease of use paramount, providing the customer with a cost-competitive, rapidly commissioned drives solution

1.2 Markets and Applications

- Global market compatibility, supporting key supply voltage ranges
- Conformance with key standards and certification
- Supports HVAC applications with energy saving function
- in-built PID control
- Refrigeration system support, for both high and low pressure control
- Support for single phase supply operation (with automatic derating) across the entire drive range

2. General Specifications

2.1 Input voltage ranges

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

200V... 240V \pm 10%, 1ph or 3ph, 50...60 Hz \pm 5%
380V... 480V \pm 10%, 1ph or 3ph, 50...60 Hz \pm 5%

Note that all 230V S1 products are for connection to 1ph supplies only.
All 230V S2 products can be supplied with a 1ph or 3ph EMC filter. The 3ph filter variant is intended for connection to 230V 3ph supplies

Note that for all power ratings above 2.2kW in 230V and all power ratings in 400V, operation on a single phase supply results in a 50% derating.

All Optidrive Plus units have phase imbalance monitoring. A phase imbalance of > 3% will result in the drive tripping.

For input supplies which have supply imbalance greater than 3% (typically the Indian sub- continent & parts of Asia Pacific including China) we will recommend that input line reactors are fitted.

Alternatively, the drives can be operated as a single phase supply drive with 50% derating.

2.2 Output Power and Current ratings

The following table relates power ratings to mechanical drive sizes.

SIZE 2 (INTEGRAL RFI FILTER, INTEGRAL BRAKING TRANSISTOR)

Model	ODV-xxxx-zz ¹⁾	22150	22220
Motor output rating – VTC 110% o/l	kW	1.5	2.2
Model	ODV-xxxx-USA	22020	22030
Motor output rating – VTC 110% o/l	HP	2	3
Supply voltage / phases	V±10%	220-240 / 1Ø	
Supply fuse or MCB (type B) 2)	A	20	32
Output voltage / phases	V	0-240V / 3Ø	
Output Amps – VTC 110% overload	A	7	10.5 (* 9)
Motor cable size, Copper 75 °C	mm ²	1.5	
Max motor cable length	m	100	
Min brake resistor	Ω	33	22

Model	ODV-xxxx-zz ¹⁾	24150	24220	24400
Motor output rating – VTC 110% o/l	kW	1.5	2.2	4.0
Model	ODV-xxxx-USA	24020	24030	24050
Motor output rating – VTC 110% o/l	HP	2	3	5
Supply voltage / phases	V±10%	220-240 / 1Ø or 3Ø ³⁾		
Supply fuse or MCB (type B) 2)	A	10	10	20
Output voltage / phases	V	0-480 / 3Ø		
Output Amps – VTC 110% overload	A	4.1	5.8	9.5
Motor cable size, Copper 75 °C	mm ²	1.0	1.5	
Max motor cable length	m	100		
Min brake resistor	Ω	47	47	33

Model	ODP-xxxx-zz ¹⁾	25150	25220	25370	25550
Motor output rating – VTC 110% o/l	kW	1.5	2.2	3.7	5.5
Model	ODP-xxxx-USA	25020	25030	25050	25750
Motor output rating – VTC 110% o/l	HP	2	3	5	7.5
Supply voltage / phases	V±10%	480-575 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	10	10	10	20
Output voltage / phases	V	0-600 / 3Ø			
Output Amps – VTC 110% overload	A	3.1	4.1	5.8	9.0
Motor cable size, Copper 75 °C	mm ²	1.0	1.5		
Max motor cable length	m	100	100	100	100
Min brake resistor	Ω	47			

SIZE 3 (INTEGRAL RFI FILTER, INTEGRAL DC LINK CHOKE & BRAKING TRANSISTOR)

Model	ODV-xxxx-zz ¹⁾	32030	32040	32055
Motor output rating – VTC 110% o/l	kW	3.0	4.0	5.5
Model	ODV-xxxx-USA	32040	32050	32075
Motor output rating – VTC 110% o/l	HP	4	5	7.5
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø		
Supply fuse or MCB (type B) 2)	A	32	32	50
Output voltage / phases	V	0-240 / 3Ø		
Output Amps – VTC 110% overload	A	14	18	25 (* 24)
Motor cable size, Copper 75 °C	mm ²	2.5	2.5	4
Max motor cable length	m	100		
Min brake resistor	Ω	15		

Model	ODV-xxxx-zz ¹⁾	34055	34075	34110	34150 **
Motor output rating – VTC 110% o/l	kW	5.5	7.5	11.0	15.0
Model	ODV-xxxx-USA	34075	34100	34150	34200 **
Motor output rating – VTC 110% o/l	HP	7.5	10	15	20
Supply voltage / phases	V±10%	380-480 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	32	32	50	50
Output voltage / phases	V	0-480 / 3Ø			
Output Amps – VTC 110% overload	A	14	18	25 (* 24)	30
Motor cable size, Copper 75 °C	mm ²	2.5	2.5	4	6
Max motor cable length	m	100			
Min brake resistor	Ω	22			

* Maximum rating for UL applications

** Models not UL listed

- 1) “-zz” in the part number refers to the country variation
- 2) For cUL compliance, use fuse type Bussmann KTN-R / KTS-R or equivalent
- 3) Part number for 1-phase supply different to part number for 3-phase supply

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Model	ODP-xxxx-zz ¹⁾	35075	35110	35150 **
Motor output rating – VTC 110% o/l	kW	7.5	11.0	15.0
Model	ODP-xxxx-USA	35100	35150	35200 **
Motor output rating – VTC 110% o/l	HP	10	15	20
Supply voltage / phases	V±10%	480-575 / 1Ø (with 50% derating) or 3Ø		
Supply fuse or MCB (type B) ²⁾	A	32	32	50
Output voltage / phases	V	0-480 / 3Ø		
Output Amps – VTC 110% overload	A	14	18	24
Motor cable size, Copper 75 °C	mm ²	2.5		4
Max motor cable length	m	100		
Min brake resistor	Ω	22		

** Models not UL listed

SIZE 4 (INTEGRAL RFI FILTER, LINE CHOKE & BRAKING TRANSISTOR)

Model	ODV-xxxx-zz ¹⁾	42075	42110	42150	42185	42220
Motor output rating – VTC 110% o/l	kW	7.5	11	15	18.5	22
Model	ODV-xxxx-USA	42100	42150	42200	42250	42300
Motor output rating – VTC 110% o/l	HP	10	15	20	25	30
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø				
Supply fuse or MCB (type B) ²⁾	A	80	80-100	100	100-125	160
Output voltage / phases	V	0-240 / 3Ø				
Output Amps – VTC 110% overload	A	39	46	61	72	90
Motor cable size, Copper 75 °C	mm ²	10	10	16	16	25
Max motor cable length	m	100				
Min brake resistor	Ω	6				

Model	ODV-xxxx-zz ¹⁾	44185	44220	44300	44370	44450
Motor output rating – VTC 110% o/l	kW	18.5	22	30	37	45
Model	ODV-xxxx-USA	44250	44300	44400	44500	44600
Motor output rating – VTC 110% o/l	HP	25	30	40	50	60
Supply voltage / phases	V±10%	380-480 / 1Ø(with 50% derating) or 3Ø				
Supply fuse or MCB (type B) ²⁾	A	80	80-100	100	100-125	160
Output voltage / phases	V	0-480 / 3Ø				
Output Amps – VTC 110% overload	A	39	46	61	72	90
Motor cable size, Copper 75 °C	mm ²	10	10	16	16	25
Max motor cable length	m	100				
Min brake resistor	Ω	12				

SIZE 5 (INTEGRAL RFI FILTER, LINE CHOKE & BRAKING TRANSISTOR)

Model	ODV-xxxx-zz ¹⁾	52300	52370	52450
Motor output rating – VTC 110% o/l	kW	30	37	45
Model	ODV-xxxx-USA	52400	52500	52600
Motor output rating – VTC 110% o/l	HP	40	50	60
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø		
Supply fuse or MCB (type B) ²⁾	A	200	250-300	250-300
Output voltage / phases	V	0-240 / 3Ø		
Output Amps – VTC 110% overload	A	110	150	180
Motor cable size, Copper 75 °C	mm ²	35	55	70
Max motor cable length	m	100		
Min brake resistor	Ω	3		

Model	ODV-xxxx-zz ¹⁾	54550	54750	54900
Motor output rating – VTC 110% o/l	kW	55	75	90
Model	ODV-xxxx-USA	54750	54100	54120
Motor output rating – VTC 110% o/l	HP	75	100	120
Supply voltage / phases	V±10%	380-480 / 1Ø(with 50% derating) or 3Ø		
Supply fuse or MCB (type B) ²⁾	A	200	250-300	250-300
Output voltage / phases	V	0-480 / 3Ø		
Output Amps – VTC 110% overload	A	110	150	180
Motor cable size, Copper 75 °C	mm ²	35	55	70
Max motor cable length	m	100		
Min brake resistor	Ω	6		

1) "-zz" in the part number refers to the country variation

2) For cUL compliance, use fuse type Bussmann KTN-R / KTS-R or equivalent

SIZE 6 (EXTERNAL LINE CHOKE, INTEGRAL RFI FILTER & BRAKING TRANSISTOR)

Model	ODV-xxxxx-zz ¹⁾	64110	64132	64160**
Motor output rating – VTC 110% o/l	kW	110	132	160
Model	ODV-xxxxx-USA	64150	64175	64210**
Motor output rating – VTC 110% o/l	HP	150	175	210
Supply voltage / phases	V±10%	380-480 / 1Ø (with 50% derating) or 3Ø		
Supply fuse or MCB (type B) ²⁾	A	315	350	400
Output voltage / phases	V	0-480 / 3Ø		
Output Amps – VTC 110% overload	A	202	240	300
Motor cable size, Copper 75 °C	mm ²	90	120	170
Max motor cable length	m	100		
Min brake resistor	Ω	6		

** Models not UL listed

- 1) “-zz” in the part number refers to the country variation
- 2) For cUL compliance, use fuse type Bussmann KTN-R / KTS-R or equivalent

For more details about the drive power rating/size information, please refer to the latest Optidrive brochure.

2.3 Protection features

The range of drives can detect and shut down in the event of the following fault conditions arising :

- Phase - Phase short circuit
- Phase - Earth short circuit
- Output phase over-current trip
- Output current thermal overload (I^2t)
- Brake resistor short circuit
- Brake resistor thermal overload (I^2t)
- Heatsink thermal overload (trip > 97 °C)
- Heatsink thermal underload (trip < 0 °C)
- DC Link Over voltage
- DC Link Under voltage
- Input phase loss protection (for 3 phase input unit)
- Input phase imbalance protection (for 3 phase input unit)

2.4 Conformance

All products conform to the following international standards :

- EN 61800-5-1 Adjustable speed electrical power drive systems
- EN 61800-3 EMC product standard for Variable speed drive systems
- EN 55011 Limits and Methods of measurement of radio interference characteristics of Industrial Equipment
- UL 508C Power Conversion equipment
- Enclosure protection rating according to NEMA 250, EN 60529
- Flammability rating according to UL 94

2.5 Environmental

Ambient temperature range	- Operational	: 0 ... 50 °C
Without derating the drive	- Storage	: -40 °C ... 60 °C
Max altitude for rated operation		: 1000m
Derating above 1000m (to 4000m max)		: 1% / 100m
Relative Humidity		: < 95% (non condensing)
Protection rating		: IP20, NEMA 0

2.6 EMC

Immunity :	EN 61000-6-2, industrial level
Radiated Emissions :	EN 61000-6-3 /-4, industrial, domestic levels
Conducted Emissions :	EN 61000-6-3 /-4, Drives with 1ph supplies : domestic (class B) to 1m Drives with 3ph supplies : industrial (class A) to 1m

Conducted emissions limits apply only when optional RFI filter fitted inside drive
A range of foot mounted EMC filters will be available for sizes #1 to #3.

With the foot-mounted EMC filter fitted, the drive will meet the industrial standard with up to 25m of screened motor cable at rated switching frequency.

2.7 *Physical Dimensions*

The following dimensions apply to the standard units, as factory supplied.

Size 1 :	155 x 80 x 130	(L x W x D)	
Size 2 :	260 x 100 x 175	(L x W x D)	
Size 3 :	260 x 171 x 175	(L x W x D)	
Size 4 :	520 x 340 x 220	(L x W x D)	
Size 5 :	1045 x 340 x 220	(L x W x D)	45kW
Size 5 :	1100 x 340 x 330	(L x W x D)	55kW to 90kW
Size 6 :	1100 x 340 x 330	(L x W x D)	

3. Design Specifications

3.1 User interface

3.1.1 Keypad

Each unit will have a keypad fitted as standard, allowing drive operation and set up without any further equipment.

The keypad will consist of 5 keys with the following functions :

Start / Run	: Enable running of motor
Stop / Reset	: Stop motor / Reset trip
Navigate	: Function key to enter / exit parameter edit mode
Up	: Increase Parameter / Value
Down	: Decrease Parameter / Value

The Start/Stop buttons on the keypad can be disabled by appropriately configuring the drive, if required.

3.1.2 Display

A standard 5-digit 7-segment display is fitted to each drive to allow drive operation to be monitored and parameters to be set.

Access to parameters and modifying their values is based on the existing easy-to-use Optidrive concept, thereby minimising commissioning time.

3.1.3 IrDA communications

An optional hand-held PDA commissioning module is available which communicates with the drive via an IrDA compliant communication link. All parameters and operating modes are displayed in plain text. Parameter sets can be read into the Optiwand and transferred to other drives as required. The Optiwand will be able to store an unlimited number of parameter sets, limited only by the size of the PDA memory. Each parameter set can be given a descriptive filename for easy identification.

For more details, see section 3.4

3.2 Motor control module interface

3.2.1 Hardware requirements

The motor control core is DSP based and is referenced to minus DC bus (-Ve) potential. This motor control core handles the power stage in its entirety, from input voltage monitoring to power stage IGBT control.

The User interface is handled by a separate microcontroller, referenced to the user 0V brought out via the User terminal strip. The two microcontrollers are linked via a 2-wire, optically isolated asynchronous serial interface, operating at 230kbps.

3.2.2 Key features in implementation of motor control core

Key features are listed below :

- Motor control needs only motor nameplate data (typically rated frequency, rated speed, rated voltage, rated current) for optimum performance.
- Auto-tune function to optimise drive parameters
- Spin start onto spinning motor – both forwards & reverse
- Output frequency range from 0.1Hz to 120Hz.
- Maximum motor frequency up to 5x base frequency (F_0)
- Brake channel control
- Analog output supporting voltage (0-10V) and current (4-20mA) modes
- Optical (IrDA) communications operating at 115kbps
- RS-485 communication up to 115kbps
- Realtime display of Power, speed and current
- Run-time clock and kWh meters
- In-build automatically energy saving function for HVAC application

3.3 User terminals

3.3.1 Power terminals, earthing and screening

The full range of products will have power input at the top of the unit and motor connection at the bottom. In addition, sizes 2 and above will have connection for an external braking resistor next to the motor connections.

The earth connection will be made directly to the heatsink, thereby earthing the heatsink and forming a low impedance path between motor earth and supply earth which by-passes the PCBs.

There will be provision for an earthing bracket which connects directly to the heatsink and allows optimal, direct motor screen connections.

3.3.2 Low power control terminals

Terminal	Description
1	User 24V output, 100mA current limited. Internally connected to terminal 5.
2	Digital input (+ve logic only).
3	Digital input (+ve logic only) Second 24V digital output, current limited, max load 5mA.
4	Digital input (+ve logic only), second analog input (0..10V, 0..24V, 4..20mA), motor thermistor input.
5	User 24V output, 100mA current limited. Internally connected to terminal 1.
6	Bipolar analog input, +/- 10V or +/- 24V configurable. Resolution = 12-bit + sign. Symmetry error < 0.1%.
7	User 0V
8	Analog output. Configurable as 0..10V, 4..20mA with up to 20mA drive capability or as a 24V digital output with 20mA drive capability
9	User 0V
10	Programmable relay contact (N.O.) - can be inverted via software
11	Programmable relay contact (N.O.) - can be inverted via software

Notes :

- All digital inputs are positive logic only with logic levels defined as follows :
 "Logic 1" input voltage range 8V..30V DC.
 "Logic 0" input voltage range 0V..4V DC.

A switch between terminal 1 (+24V output) and each digital input will activate that input. The digital inputs are sampled once per 8ms.

- The 3rd digital input duals as a second analog input (unipolar) which has a 11-bit resolution (for v1.04 or later) and supports both voltage and current

formats. This input can also be configured as a motor thermistor input. The second analog input is sampled once per 16ms

- The bipolar analog input can be used as a +/-10V input or as a +/- 24V input. This supports direct connection of a potentiometer (2k2) using the Optidrive +24V output. The resolution is 12-bit + sign. The bipolar analog input is sampled at once per 16ms.
- The analog output supports voltage (0..10V) and current formats (0..20mA, 4..20mA). The output can also be configured as a 24V output. The output can source up to 20mA and is short circuit proof. The analog output has an 8-bit resolution and is updated once per 16ms.
- The relay contacts are N.O. and can be configured to close on conditions as programmed into the Optidrive. The functions can be inverted to effectively give N.C. contacts (excluding drive power down). The relay contacts are rated at 250V AC / 30V DC @ 5A.

3.4 Serial communications & optional fieldbus gateway

3.4.1 IRDA communications

A serial communications interface operating at 115kbps will be available using IrDA technology (IrDA 1.0 compliant) for communications with the Optiwand CE Plus or to a standard PC via the IR adapter.

The interface will allow access to all parameters for drive set-up and monitoring during operation.

The communication protocol will allow individual drives to be addressed, thus allowing communication with any one of an array of drives. Up to 63 drive addresses will be available.

The drive address can be set via the keypad and display.

Three levels of error detection / data verification will be implemented in the protocol to effectively eliminate the risk of erroneous data transfer. For more information about the protocol, please contact INVERTEK DRIVE LTD.

The mechanical design of the drive will make provision for an optical link to an optional external communications interface module. This will facilitate communications based on RS232 and RS485.

An external Fieldbus gateway module will provide Fieldbus support for future expansion.

A remote keypad will be supported that is powered from the Optidrive directly.

The communications protocol will support multiple master operation (up to 4 master units per network).

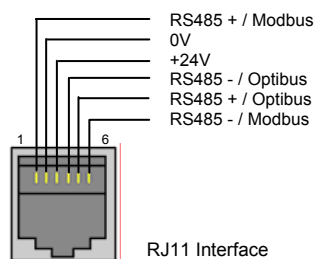
In master/Slave operation mode, the master will send out its speed and torque reference information once every 20ms. All slave drives in the network will use these two references for their operation depending on the drive configuration.

The Optibus Plus protocol enables the user to use different peripherals to communicate with the drive at the same time. For example, the user can use OptiwandCE Plus, OptistoreCE Plus and the OptiPort Plus (remote keypad) with the same drive at the same time. Communication cycle time for any external peripherals is 60ms.

3.4.2 RS-485 communications

In addition to the IrDA data link, all drives with version 2.00 or later have an extra RJ11 connector on the front of the control panel. This connector will enable the user to set up a drive network via a wired connection.

The electrical signal arrangement of the RJ11 connector shows as follows:



The Optibus data link uses the same communication protocol as is used for IrDA communication. In other words, the user can set up a drive network either using the Infrared data link or by a wire link or a combination of both.

For Master/Slave applications, the drives should be connected using the RS485 wire link. Up to 62 slaves can be connected to one master drive.

The RS485 Modbus interface can be used for Modbus network applications if the Modbus communication software has been installed inside the drive. The Modbus baud rate can be changed through parameter settings from 9600bps up to 115200bps.

The data format for both communication protocols is fixed as:
1 start bit, 8 data bits, 1 stop bit, and no parity.

The industry standard Modbus RTU protocol is used for the communication. Please contact Invertek Drives Ltd for the details about Modbus memory mapping.

3.4.3 Fieldbus gateway

An optional, external fieldbus gateway can be used to connect Optidrive Plus with other controller networks, such as Profibus or DeviceNet.

Up to 4 drives can be connected to a single DeviceNet gateway and up to 8 drives to a Profibus gateway.

For more information about the fieldbus gateway options, please contact your local distributor or visit www.invertek.co.uk

4. **Parameter definitions and access**

Accessing and changing parameters is done in an intuitive manner, as described below :

Normal (real-time) display mode (non parameter edit mode) allows the key variables listed below to be displayed in real time.

H	Frequency	0 ... ±2000	Hz
A	Motor current	0 ... 1000	A
P	Drive input power	0 ... max power	kW
*	Speed (rpm)	0 ... ±60,000	rpm
*	C	Scaled value	

* Only visible when activated

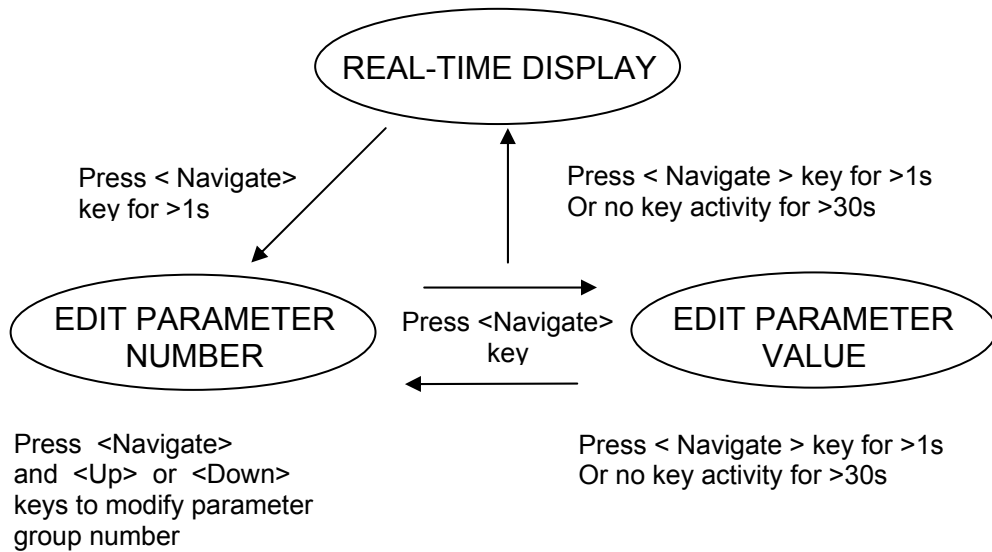
The user can scroll between these variables by pressing and releasing the <Navigate> key within 1s. The scrolling mechanism rolls over from Scaled Value back to speed.

To enter parameter access mode, press the < Navigate > button for approx 1s. The display changes from indicating operational speed to “PY-XX”, where Y represents the parameter group number and XX represents the parameter last accessed during the previous commissioning session. The value of XX can be incremented or decremented using the <up> / <down> keys. The parameter scrolling mechanism rolls over from one group to the next if extended access has been enabled using P1-14.

Pressing and releasing the <Navigate> key once more will then display the current value of the selected parameter. This can then be edited within the limits of that parameter, unless parameter lock has been enabled (P2-38).

Pressing the <Navigate> key once more toggles back to display the parameter number in case further editing is required. If the <Navigate> key is held for approx. 1 second, the display reverts to displaying the real-time values (speed/freq or current/load). The display will also revert to displaying the selected real-time value if no buttons are pressed for >60s .

The operation of the parameters is illustrated by the following diagram :



The parameters are split into standard parameters (eg max / min speed) accessible in the basic menu (Parameter Group 1) and extended parameters accessible in the extended menu (Parameter Group 2).

Parameter Group 3 is used for User PID applications

Parameter Group 4 is used for Vector Control applications.

The parameter listings with default and limiting values are shown in the following tables.

4.1 Parameter set overview

Basic parameter set

Par	Description	Range	Default
P1-01	Max speed limit (Hz or rpm)	P1-02 to 120Hz / 7,200 rpm	50Hz (60Hz)
P1-02	Min speed limit (Hz or rpm)	0 to P1-01	0Hz
P1-03	Accel ramp time (s)	0s ... 3000s	30s
P1-04	Decel ramp time (s)	0s ... 3000s	30s
P1-05	Stop mode select	0 : Ramp to stop (mains ride thro) 1 : Coast to stop 2 : Ramp to stop (Fast-Stop mode)	0
P1-06	Energy optimizer	0 : Disable 1 : Enable	0
P1-07	Motor rated voltage	0V, 20V to 250V 0V, 20V to 500V 0V, 20V to 600V	230V 400V (460V) 575V
P1-08	Motor rated current (rms)	20% to 100% of drive current rating (Amps)	Drive rating (Amps)
P1-09	Motor rated frequency	25 to 120Hz	50 Hz (60Hz)
P1-10	Motor rated speed	0 to 7,200 rpm	0
P1-11	Preset speed 1	-P1-01 (min) to P1-01 (max)	50 Hz (60Hz)
P1-12	Terminal / Keypad control of drive	0 : Terminal control 1 : Keypad control (fwd only) 2 : Keypad control (fwd / rev toggle using start button) 3 : Enable User PID control 4 : Modbus network control	0 (terminal)
P1-13	Trip log	Last four trips stored	No fault
P1-14	Extended menu access code	0 to 30000. When in default state, set to 101 to access extended menu	0

Default parameter values for Horse Power rated drives are shown in brackets

Extended parameter set

Par	Description	Range	Default
P2-01	Digital inputs function select	0 ... 23 (see table on page 24)	0
P2-02	Preset speed 2	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-03	Preset speed 3	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-04	Preset speed 4	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-05	Preset speed 5	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-06	Preset speed 6	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-07	Preset speed 7	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-08	Preset speed 8	-P1-01 (min) to P1-01 (max)	0 Hz / rpm
P2-09	Skip frequency	P1-02 (min) to P1-01 (max)	0 (inactive)
P2-10	Skip frequency band	0 (min) to P1-01 (max)	0 (inactive)
P2-11	Analog output function select	(Digital output mode) 0: Drive enabled 1: Drive healthy 2: Motor at target speed 3: Motor speed > 0 4: Motor speed > limit 5: Motor current > limit 6: 2nd analog input > limit (Analog output mode) 7: Motor speed 8: Motor current 9: Motor power (kW)	7
P2-12 (h)	Digital output control high limit	Speed : 0..100% (100% = max speed) Current : 0..200% (100% = rated current) 2nd analog input: 0..100% (100% = max 2 nd analog input)	100%
P2-12 (L)	Digital output control low limit	0 ... P2-12(h)	100%
P2-13	Relay output function	0: Drive Enabled 1: Drive healthy 2: Motor at target speed 3: Motor speed > 0 4: Motor speed > limit 5: Motor current > limit 6: 2nd analog input > limit	1
P2-14 (h)	User relay output control high limit	Speed : 0..100% (100% = max speed) Current : 0..200% (100% = rated current) 2nd analog input : 0..100% (100% = max 2 nd analog input)	100%
P2-14 (L)	User relay output control low limit	0 ... P2-14(h)	100%
P2-15	Relay output mode	0 : N.O. 1 : N.C.	0
P2-16	Standby mode wake-up speed	0...100%	0.0%
P2-17	Start mode select	Edge-r, Auto-0...Auto-5	Auto-0
P2-18	Spin start enable	0: Disable 1: Enable	0

P2-19	Keypad restart mode	0 : Minimum speed 1 : previous speed 2 : Min-speed (Auto-r) 3 : prev. speed (Auto-r)	1
P2-20	Enable standby mode	0 : Disable, 1s...250s delay	0
P2-21	Display scaling factor	0.000 to 30.000	0 (disable)
P2-22	Display scaling source	0 : 2 nd analog input 1: Speed	0
P2-23	Brake circuit enable	0 : Disable 1 : Enable + low braking power 2 : Enable + high braking power 3 : Enable + no protection	0
P2-24	Effective switching freq.	S1, S2 230V : 4..32kHz S2 400V : 4..32kHz S3 400V : 4..24kHz S4 400V : 4..24kHz S5* 400V : 4..16kHz S6* 400V : 4..16kHz *: maximum switching frequency depends on power rating	16 kHz 8 kHz 4 kHz 4 kHz 4 kHz 4 kHz
P2-25	Second Decel ramp time (s)	0s ... 3000s	30s
P2-26	Modbus RTU baudrate option (Optional item) (Not available in V1.04)	9.6kbps to 115.2kbps	115.2kbps
P2-27	Drive comms address	0 (disable), 1..63	1
P2-28	Master / Slave mode select	0 : Slave mode 1 : Master mode	0
P2-29	Digital speed reference preset scaling factor	0..500%, steps of 0.1%	100%
P2-30	Bipolar an input format	0..24V, 0..10V, -10..10V, -24..24V	0..24V
P2-31	Bipolar an input scaling	0..500.0%	100.0%
P2-32	Bipolar an input offset	-500.0%..500.0%, steps of 0.1%	0.0%
P2-33	2 nd an input format	0 / 24V, 0..10V, 4..20mA, 0..20mA	0..10V
P2-34	2 nd an input scaling	-500.0%...500.0%	100.0%
P2-35	Digital speed reference scaling control	0 : Disabled (no scaling) 1 : Scaling set by preset value in P2-29 2 : Slave speed scaled by preset value in P2-29, then bipolar analog input added as offset 3 : Slave speed scaled by preset value in P2-29 <i>and</i> by bipolar analog input	0
P2-36	Analog output format	0..10V, 4..20mA, 10..0V, 20..4mA	0..10V
P2-37	Extended Parameter access code	0 ... 9999	101
P2-38	Parameter lock	0 : Unlocked 1 : Locked	0
P2-39	Hours run meter	0h 0mins to 65535 hours	Read only
P2-40	Drive type / rating	“ 0.37”, “0 230” : 3 ^{GV} 230V 0.37kW “HP 20”, “1 460” : VTC, 460V 20HP	Read only

Advanced parameter set - PID control

Par	Description	Range	Default
P3-01	User PID Proprtional Gain	0.1 ... 30.0	2
P3-02	User PID Integral time constant	0.0s ... 30.0s	1s
P3-03	User PID Differential time constant	0.00s ... 1.00s	0,00
P3-04	User PID operating mode	0 : Direct 1 : Inverse	0
P3-05	User PID reference select	0 : Digital 1 : Analog	0
P3-06	User PID digital reference	0 ... 100%	0.0 %
P3-07	User PID controller output high limit	P3-08 to 100% of control range	100%
P3-08	User PID controller output low limit	0 to P3-07	0
P3-09	User PID output limit control	0 : Digital output limits 1 : Analog upper limit 2 : Analog lower limit 3 : PID output + Bipolar analog input	0
P3-10	User PID feedback select	0 : 2 nd Analog input 1 : Bipolar analog input	0

Vector control parameter set

Par	Description	Range	Default
P4-01	<i>Reserved</i>		0
P4-02	Motor parameter auto-tune	0 : Disable 1 : Enable	0

Motor parameters (Hidden)

Par	Description	Range	Default
P5-01	Motor Stator resistance (Rs)	Rating dependent	Rating dependent
P5-02	<i>Reserved</i>		
P5-03	<i>Reserved</i>		
P5-04	Magnetising current (Id rms)	10% to 80% of motor rated current	Rating dependent
P5-05	<i>Reserved</i>		
P5-06	<i>Reserved</i>		
P5-07	<i>Reserved</i>		
P5-08	<i>Reserved</i>		
P5-09	<i>Reserved</i>		
P5-09	<i>Reserved</i>		
P5-11	Pulse width limitation	0...500 (Time = value *16.67ns)	Drive dependent
P5-12	Magnetising period delay time	0...2000ms	Rating dependent

Application Specific parameter set (Hidden)

Par	Description	Range	Default
P6-01	Software upgrade enable	0 : Disable 1 : I/O En 2 : DSP En	0
P6-02	Thermal management enable	0 : Disable 1 : Enable	0
P6-03	Auto-reset delay time	1s...60s	20s
P6-04	Relay speed hysteresis	0.0 ... 25.0%	0.3
P6-05	<i>Reserved</i>		0
P6-06	<i>Reserved</i>		0
P6-07	<i>Reserved</i>		0
P6-08	Modbus Communication loss timer	0: disable 1..60s	2s
P6-09	<i>Reserved</i>		
P6-10	Minimum integral error	0...20.0%	0

Calibration parameters (restricted access)

<i>Par</i>	<i>Location</i>	<i>Description</i>	<i>Range</i>	<i>1st power up default</i>
P7-01	I/O uC	Error count for I/O RX comms	0 ... 255 (read only)	0
P7-02	I/O uC	Error count for IrDA comms	0 ... 255 (read only)	0
P7-03	I/O uC	Scaling factor for bipolar analog input	50 .. 200%	100.0%
P7-04	I/O uC	Offset correction for bipolar analog input	-25 .. 25	0
P7-05	I/O uC	Symmetry for bipolar analog input	50 ... 150%	100.0%
P7-06	I/O uC	Scaling factor for second analog input	50 .. 200%	103.0%
P7-07	I/O uC	Offset correction for second analog input	-125 .. 125	0
P7-08	I/O uC	Scaling factor for second analog current input	0...200.0%	102.4%
P7-09	I/O uC	Scaling factor for analog output – 0..10V	0 ... 255	235
P7-10	I/O uC	Offset correction for analog output – 0..10V	-125 .. 125	0
P7-11	I/O uC	Scaling factor for analog output – 4..20mA	0 ... 255	180
P7-12	I/O uC	Offset correction for analog output – 4..20mA	-125 .. 125	-2
P7-13	I/O uC	Scaling factor for analog output – 0 / 24V	0 ... 255	215
P7-14	I/O uC	Scaling factor for bipolar analog input 24V mode	50..200%	102.5%

These parameters are only available during drive production and are used to calibrate the drive hardware.

These parameters are unaffected by setting parameter defaults or any other parameter changes within the drive.

Drive real-time parameters (read-only watch windows)

Par	Description	Display Range	
P0-01	Bipolar an input value	-100.0 ..100.0%	
P0-02	2 nd analog input value	0...100.0%	
P0-03	Speed controller reference	-100.0 ..100.0%	
P0-04	Digital speed ref (digi pot)	- P1-01 ... P1-01 / Hz	
P0-05	<i>Reserved</i>		
P0-06	User PID ref input	0...100.0%	
P0-07	User PID feedback	0...100.0%	
P0-08	User PID error input	0...100.0%	
P0-09	User PID P-term	0...100.0%	
P0-10	User PID I-term	0...100.0%	
P0-11	User PID D-term	0...100.0%	
P0-12	User PID output	0...100.0%	
P0-13	Motor voltage	0...200.0%	
P0-14	Magnetising current (Id)	A (rms)	
P0-15	<i>Reserved</i>		
P0-16	Field strength	0..100% (100% is rated Id)	
P0-17	Stator resistance (Rs)	Ohm	
P0-18	<i>Reserved</i>		
P0-19	<i>Reserved</i>		
P0-20	DC bus voltage	V dc	
P0-21	Drive temperature	Degrees C (calculated)	
P0-22	Supply voltage L1	V rms	
P0-23	Supply voltage L2	V rms	
P0-24	Supply voltage L3	V rms	
P0-25	<i>Reserved</i>		
P0-26	kWh meter	0.0 ... 999.9 kWh	
P0-27	MWh meter	0.0 ... 65535 MWh	
P0-28	Software I.D. I/O processor	Eg " 1.00", " 4F3C"	
P0-29	Software I.D. Motor control	Eg " 1.01", " 7°4E"	
P0-30	Drive Serial number	000000 ... 000000 (SN grp 1) 000-00 ... 999-99 (SN grp 2, 3)	Fixed in prod'n
<i>P0-31</i>	<i>Drive serial number #2</i>		
<i>P0-32</i>	<i>DSP bootloader version</i>	<i>Eg " 1.00"</i>	
<i>P0-33</i>	<i>Reserved</i>		
<i>P0-34</i>	<i>Comms error count (DSP)</i>	<i>0 ... 65535</i>	
<i>P0-35</i>	<i>Configuration register value</i>	<i>Internal value</i>	
<i>P0-36</i>	<i>Digital input status</i>	<i>Internal value</i>	
<i>P0-37</i>	<i>Analog out internal value</i>	<i>Internal value</i>	
<i>P0-38</i>	<i>Current Phase U offset</i>	<i>Internal value</i>	
<i>P0-39</i>	<i>Current Phase U ref</i>	<i>Internal value</i>	
<i>P0-40</i>	<i>Current Phase V offset</i>	<i>Internal value</i>	
<i>P0-41</i>	<i>Current Phase V ref</i>	<i>Internal value</i>	
<i>P0-42</i>	<i>Brake resistor max on time</i>	<i>Time in milliseconds</i>	
<i>P0-43</i>	<i>Brake resistor duty cycle</i>	<i>Internal value</i>	
<i>P0-44</i>	<i>Uq internal ref value</i>	<i>Internal value</i>	
<i>P0-45</i>	<i>Ud internal ref value</i>	<i>Internal value</i>	
<i>P0-46</i>	<i>Measured spin start speed</i>	<i>Internal value</i>	
<i>P0-47</i>	<i>Calculated slip speed value</i>	<i>Internal value</i>	
<i>P0-48</i>	<i>Reserved</i>		
<i>P0-49</i>	<i>Rated Iq internal value</i>	<i>Internal value</i>	
<i>P0-50</i>	<i>Motor voltage</i>	<i>V ph-ph (rms)</i>	
<i>P0-51</i>	<i>Switching frequency internal</i>	<i>Internal value</i>	
<i>P0-52</i>	<i>Speed hysteresis value</i>	<i>Internal value</i>	
<i>P0-53</i>	<i>Reserved</i>		
<i>P0-54</i>	<i>Modbus comms error</i>	<i>0 ... 65535</i>	
<i>P0-55</i>	<i>Modbus speed reference</i>	<i>Internal value</i>	
<i>P0-56</i>	<i>Reserved</i>		
<i>P0-57</i>	<i>Reserved</i>		
<i>P0-58</i>	<i>Reserved</i>		
<i>P0-59</i>	<i>Modbus write command data value</i>	<i>Register dependent</i>	
<i>P0-60</i>	<i>Reserved</i>		

Digital inputs : Terminal mode

The following table defines the functions of the digital inputs when in terminal mode, depending of the value of parameter P2-01 (Digital input function select).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Analog input function	
0	O : Stop (Disable) C : Run (Enable)	O : Bipolar analog input C : Preset speed 1, 2	O : Preset speed 1 C : Preset speed 2	Bipolar analog input	
1	O : Stop (Disable) C : Run (Enable)	O : Preset speed 1 C : Preset speed 2	O : Preset speed 1, 2 C : Preset speed 3	O : Preset speed 1,2,3 C : Preset speed 4	
2	O : Stop (Disable) C : Run (Enable)	Digi input 2	Digi input 3	Analog input	Preset value
		Open	Open	Open	Preset speed 1
		Closed	Open	Open	Preset speed 2
		Open	Closed	Open	Preset speed 3
		Closed	Closed	Open	Preset speed 4
		Open	Open	Closed	Preset speed 5
		Closed	Open	Closed	Preset speed 6
		Open	Closed	Closed	Preset speed 7
Closed	Closed	Closed	Preset speed 8		
3	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	O : Bipolar analog input C : Preset speed 1	Bipolar analog input	
4	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	2 nd Analog input	O : 2 nd analog input C : Preset speed 1	
5	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	Digi input 3	Analog input	Preset value
			Open	Open	Preset speed 1
			Closed	Open	Preset speed 2
			Open	Closed	Preset speed 3
Closed	Closed	Preset speed 4			
6 ²⁾	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	External trip input : O : Trip C : OK	Bipolar analog input	
7	O : Stop (Disable) C : Run Forward	O : Stop (Disable) C : Run Reverse	O : Bipolar analog input C : Preset speed 1	Bipolar analog input	
8 ²⁾	O : Stop (Disable) C : Run Forward	O : Stop (Disable) C : Run Reverse	O : Preset speed 1 C : Bipolar analog input	Bipolar analog input	
9	O : Stop (Disable) C : Run Forward	O : Stop (Disable) C : Run Reverse	Digi input 3	Analog input	Preset value
			Open	Open	Preset speed 1
			Closed	Open	Preset speed 2
			Open	Closed	Preset speed 3
Closed	Closed	Preset speed 4			
10 ²⁾	O : Stop (Disable) C : Run Forward	O : Stop (Disable) C : Run Reverse	External trip input : O : Trip C : OK	Bipolar analog input	
11	O : Stop (Disable) C : Run (Enable)	O : Bipolar analog input C : Preset speed 1	External trip input : O : Trip C : OK	Bipolar analog input	
12 ²⁾	O : Stop (Disable) C : Run (Enable)	O : Preset speed 1 C : Bipolar analog input	External trip input : O : Trip C : OK	Bipolar analog input	
13	Normally Open (NO) Momentarily Close to Run	Normally Closed (NC) Momentarily Open to Stop	O : Bipolar analog input C : Speed Preset 1	Bipolar analog input	
14	Normally Open (NO) Momentarily Close to Run Forward	Normally Closed (NC) Momentarily Open to Stop	Normally Open (NO) Momentarily Close to Run Reverse	Bipolar analog input	
15	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	O : Decel ramp 1 C : Decel ramp 2	Bipolar analog input	
16	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	O : Decel ramp 1 C : Decel ramp 2	O : Preset speed 1 C : Preset speed 2	
17	Normally Open (NO) Momentarily Close to Run Forward	Normally Closed (NC) Momentarily Open to Stop	Normally Open (NO) Momentarily Close to Run Reverse	O : Preset speed 1 C : Keypad mode	
18	O : Stop (Disable) C : Run (Enable)	Digi input 2	Digi input 3	Preset value	O : Terminal mode C : Keypad mode
		Open	Open	Preset speed 1	
		Closed	Open	Preset speed 2	
		Open	Closed	Preset speed 3	
Closed	Closed	Preset speed 4			
19	O : Stop (Disable) C : Run (Enable)	O : Bipolar Analog input C : 2 nd Analog input	2 nd Analog input	Bipolar analog input	
20 ¹⁾	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	O : Bipolar analog input C : Preset speed 1	Bipolar analog input	
21 ¹⁾	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	O : Forward C : Reverse	Bipolar analog input	
22 ¹⁾	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK	Bipolar analog input	
23	O : Stop (Disable) C : Run (Enable)	O : Normal control C : Fire mode	O : Bipolar analog input C : Speed Preset 1	Bipolar analog input	

Notes :

- 1) When P2-01 = 20, 21 or 22, the 2nd digital input is configured as an output, which outputs +24V when the drive is healthy, otherwise 0V
- 2) When connecting a motor thermistor, connect between terminals 1 & 4, set P2-01 = 6, 10, 11, 12 or 22 (Uses external trip input)

Digital inputs : Keypad mode

The following table defines the functions of the digital inputs when in keypad mode, depending of the value of parameter P2-01 (Digital input function select).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Additional information		
0 ¹⁾	O : Stop (Disable) C : Run (Enable)	Closed : Remote pushbutton UP	Closed : Remote pushbutton DOWN	When drive is stopped, closing digital inputs 2 & 3 together starts drive. Bipolar analog input has no effect		
1	O : Stop (Disable) C : Run (Enable)	Closed : Remote pushbutton UP	External trip input : O : Trip C : OK	Closed : Remote pushbutton DOWN		
2	O : Stop (Disable) C : Run (Enable)	Closed : Remote pushbutton UP	O : Digital speed ref C : Preset speed 1	Bipolar analog input > 5V reverses rotation		
1) 3..9, 13,14, 16	O : Stop (Disable) C : Run (Enable)	Closed : Remote pushbutton UP	Closed : Remote pushbutton DOWN	When drive is stopped, closing digital inputs 2 & 3 together starts drive. Bipolar analog input > 5V reverses rotation		
10	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : Bipolar analog input	External trip input : O : Trip C : OK	Analog speed reference		
11	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : Preset speed 1	External trip input : O : Trip C : OK	Allows connection of motor thermistor. Bipolar analog input > 5V reverses rotation		
12	O : Stop (Disable) C : Run (Enable)	O : Preset speed 1 C : Digital speed ref	External trip input : O : Trip C : OK	Allows connection of motor thermistor. Bipolar analog input > 5V reverses rotation		
15	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : Preset speed 1	O : Decel ramp 1 C : Decel ramp 2	Bipolar analog input > 5V reverses rotation		
17	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : Bipolar analog input	O : Digital / Analog ref C : Preset speed 1	Analog speed reference		
18	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : Preset speed	Digi input 3	Analog input	Preset value	
			Open	Open	Preset speed 1	
			Closed	Open	Preset speed 2	
			Open	Closed	Preset speed 3	
23	O : Stop (Disable) C : Run (Enable)	O : Normal control C : Fire mode	O : Digital speed ref C : Speed Preset 1	Preset speed 4		
19	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : 2nd analog input	2 nd analog input	Bipolar analog input > 5V reverses rotation		
20,21	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	O : Digital speed ref C : Preset speed 1			
22	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK			
23	O : Stop (Disable) C : Run (Enable)	O : Normal control C : Fire mode	O : Digital speed ref C : Speed Preset 1			

Notes:

- 1) In addition to the speed being set using the pushbuttons on the front of the drive, these settings for P2-01 allow the speed to be controlled remotely using remote pushbuttons connected to digital inputs 2 and 3.
- 2) When P2-19 = 2 or 3 in keypad mode, the drive START and STOP is controlled from the hardware enable input (terminal 2). In this case, the START / STOP buttons will have no effect.
- 3) Reverse rotation control using the analog input only works in keypad mode. If P1-12=1, the rotation control only works when P2-19 = 2 or 3. If P2-35 = 2 or 3, the function is disabled.
- 4) When connecting a motor thermistor, connect between terminals 1 & 4, set P2-01 = 6, 10, 11, 12 or 22 (Uses external trip input)

Digital inputs : PID control mode

The following table defines the functions of the digital inputs when in PID control mode, depending of the value of parameter P2-01 (Digital input function select).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Additional information
0..10, 13..16,18	O : Stop (Disable) C : Run (Enable)	No effect	No effect	Digital input 1 must be closed to run the drive External trip function only works when bipolar analog input is selected as feedback signal (P3-10=1).
11	O : Stop (Disable) C : Run (Enable)	O : PID control C : Preset speed 1	External trip input : O : Trip C : OK	
12	O : Stop (Disable) C : Run (Enable)	O : Preset speed 1 C : PID control	External trip input : O : Trip C : OK	
17	O : Stop (Disable) C : Run (Enable)	O : PID control C : Bipolar analog input	No effect	
19	O : Stop (Disable) C : Run (Enable)	O : PID control C : 2 nd analog input	No effect	
20, 21	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	No effect	
22	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK	
23	O : Stop (Disable) C : Run (Enable)	O : Normal control C : Fire mode	No effect	

Digital inputs : Modbus control mode

The following table defines the digital input functionality when the drive is in Modbus control mode (P1-12 = 4).

P2-01	Digi input 1 function	Digi input 2 function	Digi input 3 function	Additional information	
0..2,4, 6..9, 13..16,18	O : Stop (Disable) C : Run (Enable)	No effect	No effect	Digital input 1 must be closed to enable the drive	
3	O : Stop (Disable) C : Run (Enable)	O : Forward C : Reverse	O : Master speed ref C : Preset speed 1		
5	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Preset speed	Digi input 3	Analog input	Preset value
			Open	Open	Preset speed 1
			Closed	Open	Preset speed 2
			Open	Closed	Preset speed 3
10	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Digital speed ref	External trip input : O : trip C : OK	Digital input 1 must be closed to enable the drive	
11	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Preset speed 1	External trip input : O : trip C : OK		
12	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Bipolar analog input	External trip input : O : trip C : OK		
17	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Bipolar input	No effect		
19	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : 2 nd Analog input	2nd analog input		
20,21	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	O : Master speed ref C : Speed Preset 1		
22	O : Stop (Disable) C : Run (Enable)	2 nd digital output : Drive healthy = +24V	External trip input : O : trip C : OK		
23	O : Stop (Disable) C : Run (Enable)	O : Normal control C : Fire mode	O : Master speed ref C : Speed Preset 1		

Notes: If P1-19 = 2 or 3, drive can only be started/stopped by closing/opening digital input 1. If P1-19 = 0 or 2, the master speed reference will be automatically reset to zero each time when drive is stopped.

4.2 *Parameter functional descriptions*

Group 1: Basic Parameter set

P1-01 Maximum Speed Limit

This parameter sets the upper limiting boundary defining the maximum frequency (speed) that can be applied to the motor in any mode of operation.

This parameter will be displayed in Hz in the factory default state or whenever the motor rated speed parameter (P1-10) is zero. If the motor rated speed in rpm has been entered into P1-10, this parameter will be displayed in rpm.

Maximum value: 120Hz
 Minimum value: value of P1-02
 Default value: 50.0 Hz

P1-02 Minimum Speed Limit

This parameter sets the lower limiting boundary defining the minimum frequency (speed) that can be applied to the motor in any mode of operation.

This parameter will be displayed in Hz in the factory default state or whenever the motor rated speed parameter (P1-10) is zero. If the motor rated speed in rpm has been entered into P1-10, this parameter will be displayed in rpm.

The speed will only drop below this level after the drive enable signal has been removed, when the drive will ramp the output frequency to zero.

Maximum value: value of P1-01
 Minimum value: 0
 Default value: 0.0 Hz

P1-03 Acceleration ramp time

This parameter defines the time taken in seconds for the output frequency (speed) to increase from zero to the rated frequency (speed), as defined in parameter P1-09.

Note that the ramp rate is unaffected by changing either the maximum or minimum speed limits (P1-01, P1-02) since the ramp time is related to P1-09 and not P1-01 / P1-02.

Too small a value in this parameter may cause the drive over current trip during motor speed acceleration.

When set to the minimum ramp time of 0s, the output will change to the requested value within 8ms of the action being requested via the digital input or 16ms via the analog input.

Maximum value: 3000s
 Minimum value: 0s
 Default value: 30.0 s

P1-04 Deceleration ramp time

This parameter defines the time taken in seconds for the output frequency (speed) to decrease from the rated frequency (value in P1-09) to zero.

Note that the ramp rate is unaffected by changing either the maximum or minimum speed limits (P1-01, P1-02) since the ramp time is related to P1-09 and not P1-01 / P1-02.

When set to the minimum ramp time of 0s and enable signal is removed, the drive control the motor to stop as fast as it can be without tripping as over voltage.

Maximum value: 3000s
 Minimum value: 0s
 Default value: 30.0 s

P1-05 Stop mode select

This parameter defines the way in which the motor comes to standstill when the drive enable signal is removed.

When P1-05 is set to 0 (factory default), the drive speed is ramped down to zero according to the setting of P1-04 (or P2-25 if the second deceleration time is in use) whenever the drive enable signal is removed. The drive will only be disabled when the drive output frequency reaches zero. (If a zero speed holding time is set in P2-16, this the drive will hold zero speed for this time before disabling). In the event of the mains supply being lost, the drive will automatically attempt to keep itself operating by braking (regenerating) a rotating motor.

When P1-05 is set to 1, coast-to-stop is selected. In this case, the drive output will be disabled as soon as the enable signal is removed, leaving the motor to coast down to zero in an uncontrolled fashion.

When P1-05 is set to 2, the motor will be ramped down to zero similarly to the case above where P1-05 = 0 whenever the drive enable signal is removed.

When the mains supply is removed, however, the drive will ramp the output down to zero at the rate defined in P2-25 if P2-25 not equal to zero. If P2-25 = 0, the output of the drive will be disabled immediately. This allows a mechanical brake to be applied immediately in the event of mains loss.

Maximum value: 2
 Minimum value: 0
 Default value: 0

P1-06 Energy optimizer

When this parameter is set to 1, the drive will automatically detect the motor load condition. If the load is very low, then the drive will automatically reduce the output power to the motor in order to save the energy, Once the load increase, the output power will also increase.

Maximum value: 1
 Minimum value: 0
 Default value: 0 (Function disabled)

P1-07 Motor rated voltage

Defines the rated voltage of the motor connected to the drive (as stamped on the motor rating plate). The parameter value will be used in V/F speed control mode to control the output voltage applied to the motor. In V/F speed control mode, the drive output voltage will be controlled so as to give the value set in P1-07 when the output speed is equal to the motor base frequency defined in P1-09.

This parameter is also used by the motor parameter auto tune function (See P4-02). An incorrect input value will cause the auto tune function to fail.

If drive runs in V/F mode, user can also set this value to 0 after a proper auto-tune, as this will help to stop the motor as fast as possible. (Note that motor rated voltage value must be in the same range of the drive rated voltage value in order to use this function.)

The value of this parameter will also affect the value in P4-09.

Maximum value: 500V / 250V
 Minimum value: 20V
 Default value: Drive rating (400V/230V)

P1-08 Motor rated current

Defines the rated current of the motor connected to the drive (as stamped on the motor rating plate).

This allows the drive to match its internal motor thermal protection (I x t protection) to the motor itself. This ensures that the drive will trip on motor overload (I.t-trP) before any thermal damage results in the motor.

This parameter is also used by the motor parameter auto tune function (See P4-02). An incorrect input value will cause the auto tune function to fail.

Maximum value: rated current of the drive
 Minimum value: 20% rated current of the drive
 Default value: rated current of the drive

P1-09 Motor rated frequency

Defines the rated frequency of the motor connected to the drive (as stamped on the motor rating plate). This is the frequency at which maximum (rated) output voltage will be applied to the motor. Above this frequency, the applied motor voltage is held constant at its maximum value.

Maximum value: 120Hz
 Minimum value: 25Hz
 Default value: 50Hz

P1-10 Motor rated speed

Defines the rated speed of the motor (in rpm) to be connected to the drive (as stamped on the motor rating plate) which should be entered into this parameter if it is required that the drive displays its speed in rpm.

When a non-zero value has been entered into this parameter, the operating speed of the motor will be available in rpm on the display. The speed related parameters (i.e. P1-01, P1-02, P2-02 etc) will also be displayed in rpm.

In vector mode, the displayed value in rpm represents the shaft speed of the motor. In V/F speed control mode, entering a non-zero value into this parameter will activate the automatic slip compensation. If the synchronous speed has been entered into P1-10, slip compensation will be disabled, but the speed display will still be in rpm.

Maximum value: 60 x value of P-09 (eg 3000 rpm when P-09 = 50Hz)
 Minimum value: Sync speed of 20-pole motor
 Default value: 0

P1-11 Preset speed 1

Parameter P1-11 permits the user to define a preset speed. The preset speed can be selected using the programmable digital inputs.

The preset speed can be set to any value within the range -P1-01 to P1-01. This parameter can only be set to a positive value when P1-12=1.

If the absolute value in these parameters is less than the minimum speed (P1-02), then the drive output speed will be limited at minimum speed.

Maximum value: P1-01
 Minimum value: -P1-01
 Default value: Base frequency of the motor (P1-09)

P1-12 Operation mode select

This parameter allows the user to define whether the Optidrive should be controlled from the user terminal connector (factory default setting), from the push buttons on the front of the keypad or to enable the internal PID controller.

When P1-12 = 0, terminal control mode is selected. In this case, the drive speed will be controlled either using switches and / or a potentiometer. The function of the digital inputs can be defined / programmed using P2-01.

When P-12 = 1, keypad mode is selected. In this case, the speed of the motor is controlled using the keys on the Optidrive keypad. The <START> and <STOP> buttons will enable and disable the Optidrive output respectively. When enabled, the speed of the drive can be ramped up and down using the <UP> and <DOWN> buttons. If remote keypad operation is required, <START>, <STOP>, <UP> and <DOWN> keys can be mounted on the front of a panel and connected electrically to the digital inputs. See Application Note ODP-AN-21 for further details.

Note that the Optidrive must have the hardware enable signal applied (digital input 1 closed) before keypad control is possible.

When P1-12 = 1, only forward (positive) speeds are possible and a reversal in direction cannot occur.

When P1-12 = 2, the same functionality as above is achieved except for the fact that reverse operation is possible. In this case, the <START> button doubles up as a reverse “toggle” button. Each press of the <START> button will cause a reversal in

direction. After having been stopped, the Optidrive will always start in the same direction as it was last running in. This is the default configuration. Additionally, the drive can be configured to start from zero speed by setting P2-19 = 0.

If preferred, the target speed can be preset whilst the drive is stopped. This is done by pressing the Stop button whilst stopped – the drive will then display the target speed which can be adjusted using the <UP> and <DOWN> buttons. The <NAVIGATE> button toggles between positive and negative speeds if P1-12 = 2.

When P1-12 = 3, PID control mode is selected. In this mode, the Optidrive Plus internal PID control algorithm will be activated. The user specified PID control parameters, which are defined in parameter group 3, will be used in the control algorithm. The output of the PID controller will be used as speed reference. The hardware enable signal must be present to enable this operation.

When P1-12=4, the Modbus control function will be enabled. Drive can only operate as a Modbus slave. And the communication baud rate can be set with parameter P2-26. The communication address can be set with parameter P2-27.

Default setting: 0 (Terminal control mode)

P1-13 Event and Trip log

This parameter holds a record of the most recent four trips and / or events that have occurred. Each trip will be displayed in abbreviated text, with the most recent trip being displayed first (displayed on entering into the value of P1-13).

Whenever a new trip occurs, this is entered at the top of the list and the other trips are shifted down. The oldest trip will then be removed from the trip log.

Note that if the most recent trip in the trip log is an “Under-voltage” trip, further Under-voltage trips will not be entered into the trip log. This ensures that the trip log does not fill up with Under-voltage trips, which naturally occur every time drive is turned off.

See section 5 for detailed descriptions of the trip codes.

P1-14 Advanced access code

This parameter allows the user to gain access to parameter groups other than the basic parameter set (parameter group 1). Access is permitted when the value entered into P1-14 is equal to the value held in P2-38. In its factory default state, P1-14 must be set to “101” in order to gain access to the extended parameter group menus.

If access to the extended menu is to be denied (for example where the parameters have been locked – see P2-38), P2-38 can be set to a user-defined value. Access to the extended menu will only be permitted when this user-defined value is entered into P1-14.

For experienced users who need to access the motor control parameters, which are located in parameter group 6, a special access code must be entered into P1-14. The value for this access code is “702”. Note that the user cannot change this code.

Maximum value: 30000
Minimum value: 0
Default value: 0

Group 2: Extended Parameter set

P2-01 Digital inputs function selection

The functionality of the digital inputs within the Optidrive Plus is user programmable. This allows the user to select the functions required by their particular application.

Options include: selection between preset speeds, analog input (voltage/current), external thermistor input, forward/reverse, external trip signal input, push-button operation.

See “Digital Inputs : Terminal mode” in section 4 for specific details.

P2-02...P2-08 Preset speed 2...8

Parameters P2-02 – P2-08 permit the user to define individual preset speeds. The preset speeds are selected using the programmable digital inputs. The preset speeds can be set to any value within the range -P1-01 to P1-01. User can only set a positive value into these parameters when P1-12=1.

If the absolute value in these parameters is less than the minimum speed (P1-02), then the drive output speed will be limited at minimum speed.

Maximum value: P1-01
 Minimum value: -P1-01
 Default value: 0 Hz

P2-09 / P2-10 Skip frequency / Skip frequency band

The skip frequency parameters are used to set up a band of frequencies through which the drive output frequency may pass, but never stop in. This is used typically to prevent continuous operation close to any frequency at which mechanical resonances may occur. Such resonances may simply cause excessive acoustic noise or in some case may cause mechanical stresses that could lead to mechanical failure.

Parameter P2-09 specifies the centre point of the skip frequency band and P2-08 the width of that band. Consider the following example :

P2-08 = 30Hz, P2-09 = 10Hz

This will give a skip frequency band between 25Hz and 35Hz, centred on 30Hz. If the analog speed reference then requests a speed within these limits, the speed will remain at the nearest limit. When the output frequency ramps between these two limits, it will do so at the ramp rates specified in P1-03 and P1-04.

In the event of the reverse output / motor running at negative speeds, the skip frequency band will have exactly the same effect as in the positive direction.

When the Skip frequencies are used in PID control mode, a hysteresis function is activated. The result of this is that the motor speed will remain at the lower skip band limit until the PID output increases beyond the upper limit. The same principle applies for a reducing speed reference. See application note ODP-AN-07 for further details.

P2-09:
Maximum value: P1-01
Minimum value: P1-02
Default value: 0

P2-10:
Maximum value: P1-01
Minimum value: 0
Default value: 0

P2-11 Analog output function

The Optidrive Plus has a dedicated analog output channel (control terminals 8 and 9). The output function can be programmed using this parameter to suit user requirements.

The format of analog output signal can be specified by P2-36 (0...10V or 4...20mA). If it is configured as a digital output, the output switches between 0V and 24V. The available options for the analog output are :

Digital output mode: (0V/24V)

- P2-11=0: 24V when drive is enabled, 0V when disabled.
- P2-11=1: 24V voltage when drive is healthy (no trip), 0V when tripped.
- P2-11=2: 24V when output frequency is within ± 0.1 Hz of target (requested) frequency, otherwise 0V.
- P2-11=3: 24V when the output frequency is greater than “zero frequency” (0.3% of base frequency), otherwise 0V.
- P2-11=4: 24V when the output frequency is greater than the speed limit value that is set in parameter P2-12h, 0V when less than the limit in P2-12L.
- P2-11=5: 24V when motor current is greater than the current limit value that is set in parameter P2-12h, 0V when less than the limit in P2-12L.
- P2-11=6: 24V when second analog input signal is greater than the limit value that is set in parameter P2-12h, 0V when less than the limit in P2-12L.

Analog output mode: (0...10V or 4...20mA)

- P2-11=7: The amplitude of the analog output signal represents the motor speed. It is scaled from zero to the maximum speed limit, as defined in P1-01.
- P2-11=8: The amplitude of the output analog signal represents the motor current. It is scaled from zero to 200% of motor rated current, as defined in P1-08.
- P2-11=9: The amplitude of the output analog signal represents the output power of the drive. And it is scaled from zero to drive rating power.

Default value: 7

P2-12 Analog output control limit

P2-12h Analog output control high limit

P2-12L Analog output control low limit

This parameter is only used when P2-11 is set to 4, 5 or 6.

Parameter P2-12 combines both the high and low limits, entered as separate values into P2-12. The first value in this parameter gives the high limit (with a character ‘h’ on the LH side of the display), and the second value in this parameter gives the low limit (with a character ‘L’ on the LH side of the drive display).

The upper limit is the level at which the output changes to a logic 1 output, the low limit is the level at which the output changes to a logic 0.

The two limits therefore define a hysteresis band.

If user sets P2-12h less than P2-12L, the value in P2-12L will be set equal to P2-12h automatically.

If the user changes the setting of P2-11, then the parameter values in P2-12 will be automatically reset to 100% (h) and 100%(L). The value of parameter P2-12 must therefore be redefined each time that Parameter P2-11 is changed.

Default setting: 100% / 100%

P2-13 Relay output function

This parameter allows the user to select under what operating conditions the output user relay contacts are closed*. The following settings are available :

- P2-13=0: Relay contacts closed when drive is enabled.
- P2-13=1: Relay contacts closed when drive is healthy (no trip).
- P2-13=2: Relay contacts closed when output frequency within ± 0.1 Hz of the target (request) frequency.
- P2-13=3: Relay contacts closed when the output frequency is greater than “Zero frequency”(0.3% of base frequency).
- P2-13=4: Relay contacts closed when output frequency is greater than the speed limit value that is set in Parameter P2-14h. And relay contacts open when less than the limit in P2-14L.
- P2-13=5: Relay contacts closed when motor current is greater than the current limit value that is set in Parameter P2-14h. And relay contacts open when less than the limit in P2-14L.
- P2-13=6: Relay contacts closed when second analog input value is greater than the limit that is set in Parameter P2-14h. And relay contacts open when less than the limit in P2-14L

For hoist applications, when P2-16 > 0 and P2-13 = 0, then P2-14 sets the motor frequency (as a percentage of maximum frequency) that is applied to the motor on enable for 350ms immediately after the zero speed holding time elapses. This function prevents the load from dropping when the drive is enabled and the mechanical brake releases. See Application Note AN ODP-34a for more details.

*: The relay is configured as normally open. See P2-15 for N.O. / N.C. configuration

Default value: 1 (drive healthy)

P2-14 Relay control limit

P2-14h Relay output control high limit

P2-14L Relay output control low limit

This parameter is only used when P2-13 is set to 4, 5 or 6.

Parameter P2-14 combines both the high and low limits, entered as separate values into P2-14. The first value in this parameter gives the high limit (with a character 'h' on the LH side of the display), and the second value in this parameter gives the low limit (with a character 'L' on the LH side of the drive display).

The upper limit is the level at which the relay output changes state, the low limit is the level at which the relay output changes back again.

The two limits therefore define a hysteresis band.

If user sets P2-14h less than P2-14L, the value in P2-14L will be set equal to P2-14h automatically.

If the user changes the setting of P2-13, then the parameter values in P2-14 will be automatically reset to 100% (h) and 100%(L). The value of parameter P2-14 must therefore be redefined each time that Parameter P2-13 is changed.

For hoist applications, when P2-16 > 0 and P2-13 = 0, then P2-14 sets the motor frequency (as a percentage of maximum frequency) that is applied to the motor on enable for 350ms immediately after the zero speed holding time elapses. This function prevents the load from dropping when the drive is enabled and the mechanical brake releases. See Application Note AN ODP-34a for more details.

Default setting: 100% / 100%

P2-15 Relay output mode

This parameter enables the user to program the mode of operation of the user relay output.

This can be configured to operate as normally open (N.O.) or normally closed (N.C.) by setting this parameter.

If P2-15 = 0, the relay function is normally open (N.O.)

If P2-15 = 1, the relay function is normally closed (N.C.)

Default value: 0 (Normally open)

P2-16 Standby mode wake up speed

Drive will wake up from standby mode if the speed reference exceeds this limit. 100% equals P1-01. However if this parameter is set to zero or the actual defined speed value less than minimum speed value in P1-02, then this parameter has no effect. In such case, drive will wake up if the speed reference exceeds P1-02.

Note that this function is only available for drive firmware version 2.21 or later.

Maximum value: 100.0%

Minimum value: 0.0%

Default value: 0.0%

P2-17 Start mode select

This parameter allows the user to define the start-up mode of the Optidrive Plus and operates in conjunction with the hardware enable signal applied between terminals 1 and 2. Possible settings are:

Edge-r:

Edge run – requires the run signal to be applied *after* a trip or a power up before the drive will run. If the enable signal is present on power up, the drive will not run.

Auto-0:

Auto-run – enables whenever a run signal is present (assuming no trip). If the run signal is present on power up, the drive will run immediately.

Auto-1 → Auto-4:

As Auto-0, except for the fact that the Optidrive Plus will attempt to auto restart after a trip. The number of re-start Attempts is given by the number after the “Auto-“. The re-start counter is reset after a power down or a reset operation that performed by user through pushbuttons.

In the factory default setting (Auto-run), the Optidrive Plus will start and run whenever terminals 1 and 2 are linked, provided there is no trip condition.

“Edge-r” may be used where the drive should not start automatically on power up should the run switch be closed. In this case, the run switch must be opened and then re-closed before the drive will start. The same rule applies after clearing / re-setting a trip condition.

If the application requires that the drive attempts to re-start after a trip condition, parameter P2-17 can be set to Auto-1 ... Auto-4, in which case the drive will attempt to clear the trip and re-start between 1 and 4 times after a trip. After this number of re-starts has been attempted, the drive will remain in a tripped state. Typically, an operator would investigate the cause of the trips at this stage. In each of these cases, a delay of 20s will elapse after a trip before the Optidrive attempts a re-start.

Default setting: Auto-0 (enables whenever a run signal is present), no attempts to restart are made after a trip.

P2-18 Spin start enable

This parameter enables the spin start function, which will identify the speed and direction of rotation of a motor when the drive is enabled. The Optidrive will then automatically jump to this speed and then start ramping to the target speed.

Do not restart the drive in a short interval. This may cause the over current trip during spin start function.

The speed detection process takes less than 1s, unless the speed is zero in which case the detection may take several seconds, but never more than 5s.

If this parameter is set to one, then the spin start function is always activated each time the drive is enabled. If this parameter is zero, the spin start detection process is disabled and there is no start delay on enabling the drive.

Default setting: 0 (Spin start disabled)

P2-19 Keypad restart mode

This parameter specifies the restart target speed used on enable when operating in keypad control mode.

P2-19=0 or 2:

Target speed is reset to minimum speed (P1-02) when drive is disabled, such that minimum speed will be the target speed next time the drive is enabled.

In this mode of operation, the user cannot preset a target speed though the keypad. The drive will always start from minimum speed.

P2-19=1 or 3:

The previous speed of operation prior to the drive last being disabled will be used as target speed next time the drive is enabled.

If P2-19 = 0 or 1, the drive must receive a START signal (eg from the START button) in addition to digital input 1 being closed to cause the drive to run. Pressing the STOP button will stop the drive.

If P2-19 = 2 or 3, the drive will be start as soon as digital input 1 is closed. A start signal is not required. Opening digital input 1 will stop the drive. In this case, the start and stop buttons on the drive control panel will not function.

Default setting: 1 (Previous speed as target speed)

P2-20 Standby mode enable

Drive provides a Standby function that will automatically disable the drive output when drive output speed has remained at minimum speed (P1-12) for greater than the specified time.

P2-20 = 0: Standby function is disabled. Drive will continue to deliver power to the motor at minimum speed as long as the drive is enabled.

P2-20 = 1 ~ 60: Drive will enter Standby mode when drive has remained at minimum speed for the time set in this parameter. When this time has elapsed, the output of the drive will be disabled automatically. As soon as the target speed reference is greater than the minimum speed limit (P1-02) or the value set in P2-16, whichever is the higher, the drive will automatically re-enable and ramp to the target speed.

Time unit for P2-20 is in second (s).

Default setting: 0 (Standby function disabled)

P2-21 Display scaling factor

P2-21 enables the user to scale the data from a selected source to provide a displayed value that better represents the controlled process. The source value to be used by the display scaling calculation is defined in P2-22.

If P2-21 has a non-zero value, then a scaled display value becomes visible on the display in addition to motor speed, motor current and motor power. Pressing the <NAVIGATE> button cycles through the real-time values. A lower case character 'c' on the left-hand side of the display indicates that the scaled display value is being displayed. The scaled display value is calculated by the following equation:

$$\text{Scaling display value} = P2-21 * \text{Scaling source value}$$

If P2-21 = 0, then the scaled display function is disabled.

Maximum value: 30.000s
 Minimum value: 0.000s
 Default setting: 0.000 (Function disabled)

P2-22 Display scaling source

This parameter determines which input data source will be used as the source value for display scaling purposes. This parameter will have no effect if the scaling factor (P2-21) is set to zero.

P2-22 = 0 : Second analog input value is used as scaling source data. In this case, the range of input data value is from 0 to 4096.
 P2-22 = 1 : Motor speed information is used as scaling source data.

Default setting : 0

P2-23 Brake circuit enable

Optidrive Plus sizes #2 to #6 have a built-in brake circuit for connection of an external braking resistor in order to dump the re-generated energy from the motor. P2-23 controls the functionality of the brake circuit.

P2-23 = 0 : brake circuit is disabled. The brake transistor inside the drive remain disabled even if the drive is in regeneration condition.
 P2-23 = 1 : brake circuit is enabled and the software overload protection is also enabled. The overload protection is assumes that Invertek's standard low power rating braking resistor is connected to the brake terminals.
 P2-23 = 2 : brake circuit is enabled and the software overload protection is also enabled. The overload protection is assumes that Invertek's standard higher power rating braking resistor is connected to the brake terminals
 P2-23 = 3 : brake circuit is enabled but without braking resistor overload protection. This is intended for use with custom / higher power brake resistors.

In version v2.21 or later, if option 1, 2 and 3 is selected and the drive is in under temperature trip condition, drive will enable brake circuit (pulse output) for heating. This function will required a braking resistor fitted on the drive. Once the drive internal temperature is over 0°C, the drive will automatically goes into normal operation. This function won't affect the normal braking function.

Default setting : 0

P2-24 Effective switching frequency

This parameter allows the user to select the drive output switching frequency to cater for different application requirements.

When operating at a particular switching frequency, there will be an associated acoustic noise produced by the motor at that particular switching frequency. In most industrial applications (400V supplies), this is of little consequence as background noise is much greater.

However, domestic (220V) applications tend to be used in quieter environments where acoustic noise is important.

Note that when Auto mode is selected, then drive will use minimum available switching frequency based on parameter P1-01. (Minimum value will be 4Khz)

The user can change the switching frequency at any time.

Default setting: Rating dependent

P2-25 Second deceleration ramp time

This parameter defines the time taken in seconds for the output frequency (speed) to decrease from the rated frequency (value in P1-09) to zero.

Note that the ramp rate is unaffected by changing either the maximum or minimum speed limits (P1-01, P1-02) since the ramp time is related to P1-09 and not P1-01 / P1-02.

When set to the minimum ramp time of 0s, the second deceleration ramp time is disabled, resulting in the main deceleration ramp time (P1-04) being used.

Maximum value: 3000s
Minimum value: 0s
Default value: 0s

P2-26 Modbus RTU baudrate

Modbus network communication baud rate.

Value can be set from 9600bps to 115200bps.

Maximum value: 115200bps
Minimum value: 9600bps
Default value: 115200bps

P2-27 Drive communications address

All communications between the Optidrive Plus and other peripheral products (eg Optiwand CE, OptiPort etc) is carried out via the optical IrDA interface. To allow multiple drive communications networks (where multiple drives are connected to the same optical link), it is necessary for each drive to have its own unique identifier i.e. drive address.

The drive address can be set to any value between 1 and 63, allowing up to 63 discrete drives to be connected on the same optical network. When any Optidrive Plus receives a valid telegram (message) via the optical interface, it will only respond to the command if that telegram contains its own drive address. In this way, any one drive from the entire group of 63 can be picked out which will then respond in the requested manner.

If P2-27 = 0, all communications are disabled.

Maximum value:	63
Minimum value:	0
Default setting:	1

P2-28 Master/Slave mode select

This parameter decides whether the drive should work as a master or as a slave in a network system.

If the drive has been set as a master drive and its address is ≥ 1 , then it will send out the status information including speed information periodically in order to synchronize the other slave drives within the same network.

P2-28=0:	Slave mode
P2-28=1:	Master mode

Default setting: 0 (Slave mode)

P2-29 Digital speed reference preset scaling factor

The digital speed reference input to the drive is scaled by this factor when P2-35 = 1. Operates on references originating from the serial data link. This parameter can be used as an electronic gearbox for Master / Slave applications.

This function is especially suitable for those applications in which all drives in the network should be synchronised but run at different speeds based on a fixed scaling factor.

For example, if a slave drive set P2-29 to 80% and the master drive of the network runs at 50Hz, then the slave drive will run at 40Hz after being enabled. See P2-35 for more information.

Maximum value:	500.0%
Minimum value:	0.0%
Default setting:	100.0%

P2-30 Bipolar analog input format

This parameter allows the user to configure the bipolar analog input to suit the format of the signal connected to the analog input control terminals. The following formats are supported:

Voltage 0...24V, 0...10V, -10...10V, -24...24V

When set to 0...24V or 0...10V, all negative input voltages will give zero speed. When set to -10...10V or -24...24V, all negative voltages will result in the drive running with a negative speed, where the speed is proportional to the magnitude of the input voltage.

Note that -24...24V option is only available to drive firmware version v2.21 or later.

Current signal formats are supported by the second analog input.

Default setting: 0...24V

P2-31 Bipolar analog input scaling factor

This parameter will scale the bipolar analog input value according to the value of this parameter. This function is usually used to ensure that full speed is reached at the maximum voltage available on the analog input terminals.

The scaled input value = P2-31 * unscaled analog input value

The scaled analog input value is internally limited to ensure that it remains within range.

Maximum value: 500.0%

Minimum value: 0.0%

Default setting: 100.0%

P2-32 Bipolar analog input offset

This parameter is only valid when the bipolar analog input signal formats are unipolar, i.e. 0...24V or 0...10V.

This parameter can be used to introduce an offset to the analog input, such that the speed remains at the minimum speed limit until the input voltage exceeds this offset.

For cases where the minimum available input voltage is > 0, the offset can also be used to ensure that speed increases linearly from minimum to maximum speed starting at the available input voltage.

For example, if the minimum value of the external input voltage signal is 1V (assume that P2-30 = 0...10V), setting P2-32 = 10.0%, will give a 0Hz output on the drive output when 1V is applied on the bipolar analog input.

Maximum value: 500.0%

Minimum value: -500.0%

Default setting: 0.0%

P2-33 2nd analog input format

This parameter allows the user to configure the 2nd analog input to suit the format of the signal connected to the 2nd analog input. The following formats are supported:

Voltage	0 / 24V(functions as a digital input), 0...10V
Current	4...20mA, 0...20mA

All input formats are unipolar.

Default setting: 0...10V

P2-34 2nd analog input scaling factor

This parameter will scale the 2nd analog input value according to the value of this parameter. This function is usually used to ensure that 100% is reached when the voltage available on the analog input terminals is at its maximum.

The scaled input value = P2-34 * unscaled 2nd analog input value

The scaled analog input value is internally limited to ensure that it remains within range.

Maximum value:	500.0%
Minimum value:	0.0%
Default setting:	100.0%

P2-35 Digital speed reference scaling control

Only active in keypad control mode and usually used in a Master/Slave network application.

When P2-35 = 1,
Actual speed = Digital speed * P2-29.

When P2-35 = 2,
Actual speed = (Digital speed x P2-29) + bipolar analog input
Max analog input is equal to P1-01

When P2-35 = 3,
Actual speed = (Digital speed x P2-29) x bipolar analog input
Analog input scales 0% ... 200%

If P2-35=0, function is disabled.

Default setting: 0

P2-36 Analog output format

This parameter determines which analog signal format should be used for the analog output function. The available formats include :

0...10V /10..0V voltage output format
4...20mA /20..4mA current output format.

The output signal format is only valid when the parameter value in P2-11 is set to 7, 8 or 9 (ie analog formats). See P2-11 for further information.

Default settings: 0...10V

P2-37 Extended Parameter access code

Parameter P2-37 can be used to allow the user to specify their own extended menu access code. Access to the extended menu (Parameter group 2,3,4,5) is only permitted when the value entered into P1-14 equals that stored in P2-37.

In this way, the user may change to code from the standard value of “101” to any desired value.

Maximum value: 9999

Minimum value: 0

Default setting: 101

P2-38 Parameter Lock

This parameter allows the user to specify whether the parameter value can be changed or not.

P2-38 = 0 All parameters can be accessed and changed. All changes will be saved in permanent memory and will apply even after a power down. The parameter save-to-memory process is automatic.

P2-38 = 1 All parameters can be accessed for read purposes but changes are not permitted. This ensures that a set of working parameters can not be changed by unauthorised users.
All parameters values that have been locked by this process will not blink – an indication that the value cannot be changed.
Any attempts to make a change to a parameter value will not be permitted and an upper case character ‘L’ will be seen in the drive display window indicating that the parameter is locked.

Default setting: 0

P2-39 Hours run indicator

This is a read-only parameter indicating the number of hours that the Optidrive Plus has been running.

It is not re-settable and therefore holds useful information on the overall run-time of the drive and / or the equipment that it is driving.

There are two different display formats for this parameter, depending on the hours that the drive has been running.

If the total running hours is less than 100 hours, the parameter display format would be for example :

33h 42 indicating 33 hours, 42 minutes

If the total running hours is greater than 100 hours, the parameter display format would be for example :

4124h indicating 4124 hours

P2-40 Drive type / rating

This read-only parameter allows the user to verify the Optidrive drive type, voltage rating and power rating. This should always correspond with the ratings on top of the drive.

A typical display indicating the voltage/power rating would be:

“ 0.37”, “0 230” : 3^{GV} 230V 0.37kW
“HP 20”, “1 460” : VTC, 460V 20HP

Group 3 : ADVANCED PARAMETER SET - USER PID

P3-01/P3-02/P3-03 User PID controller Control parameter

These three parameters are used for the Optidrive Plus integrated PID control algorithm.

The user can set up each of these parameters separately in order to get the desired PID control performance.

For many applications where the differential control is not required, P3-03 can be left set to zero.

P3-01 Proportion Gain :

Maximum value: 30
 Minimum value: 0.1
 Default setting: 2

P3-02 Integral time constant :

Maximum value: 30s
 Minimum value: 0.0s
 Default setting: 1.0s

P3-03 Differential time constant :

Maximum value: 1s
 Minimum value: 0.01s
 Default setting: 0.0s

P3-04 User PID operation mode

This parameter determines which operational mode the PID controller will function in. In all cases, P3-04 allows the user to select either direct PID control, where an increase in the speed of the drive output frequency increases the feedback value, or to select inverse mode, where an increase in the drive output frequency reduces the feedback value.

P3-04 = 0 Direct mode
 P3-04 = 1 Inverse mode

Default setting: 0 (Direct mode)

P3-05 User PID reference select

The PID controller reference can be given by an external analog signal connected to the bipolar analog input or by a digital preset value depending on the input value of P3-05.

P3-05 = 0 : PID control using the digital preset value for the reference input. The digital preset reference value is defined in Parameter P3-06, which will give a reference value that covers the range 0 to 100% of the feedback.

P3-05 = 1 : PID control using the Optidrive Plus bipolar analog input as the reference input. In PID control mode, the bipolar analog input will be automatically configured as a unipolar input, irrespective of the setting of P2-30. Negative input voltages therefore clamp to zero.

Default setting: 0 (Digital preset value as reference)

P3-06 User PID digital reference

This parameter is used to set up the digital preset PID reference value. It is expressed as a percentage, where 100% equates to the maximum (full range) feedback value.

This parameter only has an effect when P3-05 is set to 0.

Maximum value: 100%
 Minimum value: 0
 Default setting: 0

P3-07 / P3-08 User PID output high limit / Low limit

These two parameters are used to limit the PID controller output value so that operation within a specified speed band is maintained.

P3-07 : PID controller output high limit. This parameter defines the maximum output value of the PID controller. The upper limit value is calculated as :

$$\text{Upper Limit} = \text{P3-07} * \text{P1-01}$$

A value of 100% gives the maximum speed limit as is defined in P1-01

P3-08 : PID controller output low limit. This parameter defines the minimum output value of the PID controller. The lower limit value is calculated as :

$$\text{Lower Limit} = \text{P3-08} * \text{P1-01}$$

P3-07 High limit : Maximum value : 100%
 Minimum value : P3-08
 Default setting : 100%

P3-08 Low limit : Maximum value : P3-07
 Minimum value : 0
 Default setting : 0

P3-09 User PID output limit control

This parameter defines which limit source should be used for the PID output result limitation.

When set to 0, the value defined in P3-07 and P3-08 will be used to limit the PID output result.

When set to 1, the maximum output value if user PID controller will be limited by the bipolar analog input value.

When set to 2, the minimum output value if user PID controller will be limited by the bipolar analog input value.

When set to 3, the bipolar analog input value will be added to the PID output

Maximum value: 2
 Minimum value: 0
 Default setting: 0

P3-10 User PID feedback select

This parameter is used to select user PID feedback signal.

When set to 0, the 2nd analog input value will be used as PID controller feedback.

When set to 1, bipolar analog input value will be used as PID controller feedback. This option gives the possibility to use second analog input as E-trip input (Motor thermistor connection) if digital PID reference is used.

Maximum value: 1
Minimum value: 0
Default setting: 0 (2nd analog input as feedback)

Group 4 : VTC CONTROL PARAMETER SET

P4-02 Motor parameter auto measurement

The Auto-tune will measure stator resistance to ensure that best performance is achieved by all users very easily.

P4-02=0 Auto tune is disabled.

P4-02=1 Auto tune is enabled. No hardware enable signal is required. The auto-tune function will start immediately.

Before enable this auto-tune function, user must input the correct value of motor rated voltage, rated current and base frequency to the drive.

Note that no matter the auto-tune function finished correctly or failed, this parameter will always be reset to 0 automatically

During the auto-tune function, the motor may spin slightly. Extra care should be taken.

When running, the message “Auto-t” will be displayed, indicating that Auto tune is in progress. The display automatically returns to “Stop” on completion.

Default setting: 0 (Function disabled)

Group 5 : HIDDEN CONTROL PARAMETERS

P5-01 Motor stator resistance

This represents the motor stator resistance value in Ohms, as is measured across two phases of the motor.

The value in this parameter could be changed if required, although this should always be calculated by the Auto-tune function. This value is available via Parameter group zero (P0-17)

Maximum value: Drive dependent
 Minimum value: 0
 Default setting: Rating dependent

P5-04 Magnetising current

This parameter represents the motor magnetising current value in Ampere. Whenever P1-08 (motor rated current) is changed, this value is approximated to 0.6 x motor rated current, assuming a motor power factor of 0.8. When Auto-tune subsequently runs, a more accurate value will be determined automatically.

The value in this parameter could be changed if required, but will be determined by Auto-tune. The measured value is available via Parameter group zero (P0-14).

Default setting: Rating dependent

P5-11 Minimum output pulse limitation

This parameter is used to limit the minimum output pulse width, which can be used for long cable applications.

The minimum pulse is limited as:

$$\text{Length (ns)} = \text{P5-11} * 16.67$$

Default setting: Drive dependent
 Minimum value: 0
 Maximum value: 500

P5-12 V/F mode magnetising current setup delay

This parameter is used to set up a minimum delay time for the magnetising current control in V/F mode when drive is started.

Too small a value may cause drive over current trip during acceleration with a very short ramp time in P1-03.

Default setting: Drive dependent
 Minimum value: 0
 Maximum value: 2000ms

Group 6 : APPLICATION SPECIFIC PARAMETERS

P6-01 Software upgrade enable

This parameter is used to enable Optidrive Plus firmware upgrades. All upgrades are carried out via the standard IrDA interface. Upgrades require an official upgrade file, provided by the manufacturer. Each motor control upgrade file is specific to a drive type and power rating and should only be used on a drive of the correct power rating. The I/O processor upgrade file is identical for all drive types.

- P6-01 = 0 Function is disabled (normal operation)
- P6-01 = 1 IO processor upgrade function is enabled. Set this parameter to 1 to upgrade the I/O processor firmware. The display changes to a line of dashes, indicating that the drive is ready for upgrade. On completion, the display returns to STOP.
- P6-01 = 2 Motor control processor upgrade function is enabled. Set this parameter to 2 to upgrade the motor control processor software. After setting to 1, the drive must be powered down fully and then powered back up again. The display will then show “Prog...” indicating that the drive is ready for upgrade. On completion of the upgrade, the drive will display “dAtA-F” indicating that the flash upgrade is complete and that the parameters have been returned to default values. Press the <STOP> button to acknowledge after which the display returns to “StoP”

On completion of an upgrade, or after a power up, the value of P5-01 will be reset to zero automatically.

See ODP-AN-28 and ODP-AN-29 for more information.

Default setting: 0

P6-02 Thermal management

This parameter determines whether or not the thermal fold back function should engage when the drive temperature reaches a preset level. Since higher switching frequencies result in higher thermal losses, a possible over-temperature trip can be avoided by reducing switching frequency.

- P6-02=0 Automatic thermal fold back is disabled. The drive will remain operating at the specified switching frequency until an over temperature (“O-t”) trip occurs.
- P6-02=1 Automatic thermal fold back is enabled. The drive will reduce the switching frequency to a lower level automatically when the drive temperature reaches a level just below the trip level. The lower losses result in a reduction in drive temperature. The drive will not automatically increase the switching frequency if the load, hence temperature reduces.
After a disable or power down, the drive reverts to the original switching frequency set in P2-24.

Default setting: 0 (Function disabled)

Note : Only drives that have a power module or heatsink thermistor can benefit from this function.

P6-03 Auto-reset delay time

This parameter defines the auto restart time delay for the drive after a trip condition.

Maximum value: 60s
 Minimum value: 1s
 Default setting: 20s

P6-04 Relay speed hysteresis band

This parameter defines the speed control hysteresis band for analog digital output and relay output function.

This parameter will defines a speed band as a percentage value of drive maximum speed (P1-01)

Maximum value: 25.0%
 Minimum value: 0
 Default setting: 0.3%

P6-08 Modbus communication loss timer

This parameter defines the behaviour of the drive after the communication between drive and Modbus network master being loss.

When set to zero, then the drive will continue running even loses the communication with the Modbus master.

When set to a value large than zero, then the drive will trip after certain seconds that defined in this parameter.

Maximum value: 60s
 Minimum value: 0
 Default setting: 2s

P6-09 PID wake-up / restart level

This parameter works in conjunction with the PID controller and standby mode, allowing the user to specify the level at which the drive will wake from Standby mode. This level is expressed as a percentage of the feedback control signal (from the feedback transducer) and operates relative to the PID controller set-point, ie the difference (or error) between the PID controller set-point and the feedback signal.

Example : If the PID controller set point is 40% (representing 40% of the feedback transducer control range) and the PID wake-up / restart level is set to 5%, the drive will only re-wake from Standby mode when the feedback signal drops to 35% (ie 40% - 5%).

Standby mode will be entered as usual when the speed drops down to the minimum speed set in P1-02 and remains there for the period set in the standby mode parameter P2-20.

If the PID controller is operating in Inverse mode (P3-04 = 1), the drive wakes from Standby mode when the speed increases above 45% (40% + 5%) in the above example.

Since the wake-up level is expressed as a value relative to the PID set-point, the wake-up level will track any changes to the set-point (eg if the set-point comes from an analog input).

If this parameter is set to zero, this function is disabled. This function is available in firmware versions V2.21 or later.

Maximum value: 50.0%
Minimum value: 0
Default setting: 0

P6-10 Minimum integral error

This parameter defines the minimum integral error input for user PID controller. If the error value less than this limit, the integral loop will keep the output unchanged. This parameter can be used to reduce the effect of jitter or quantisation on the feedback signal.

Maximum value: 20.0%
Minimum value: 0
Default setting: 0

5. *Fault codes, drive status and diagnostics*

To enable the operational status of the drive to be determined at any time, the following information is displayed :

Drive OK, disabled : StoP
 Fault / trip : fault mnemonic as defined below.

The following list indicates which mnemonics will be displayed under fault / trip conditions, and their meaning.

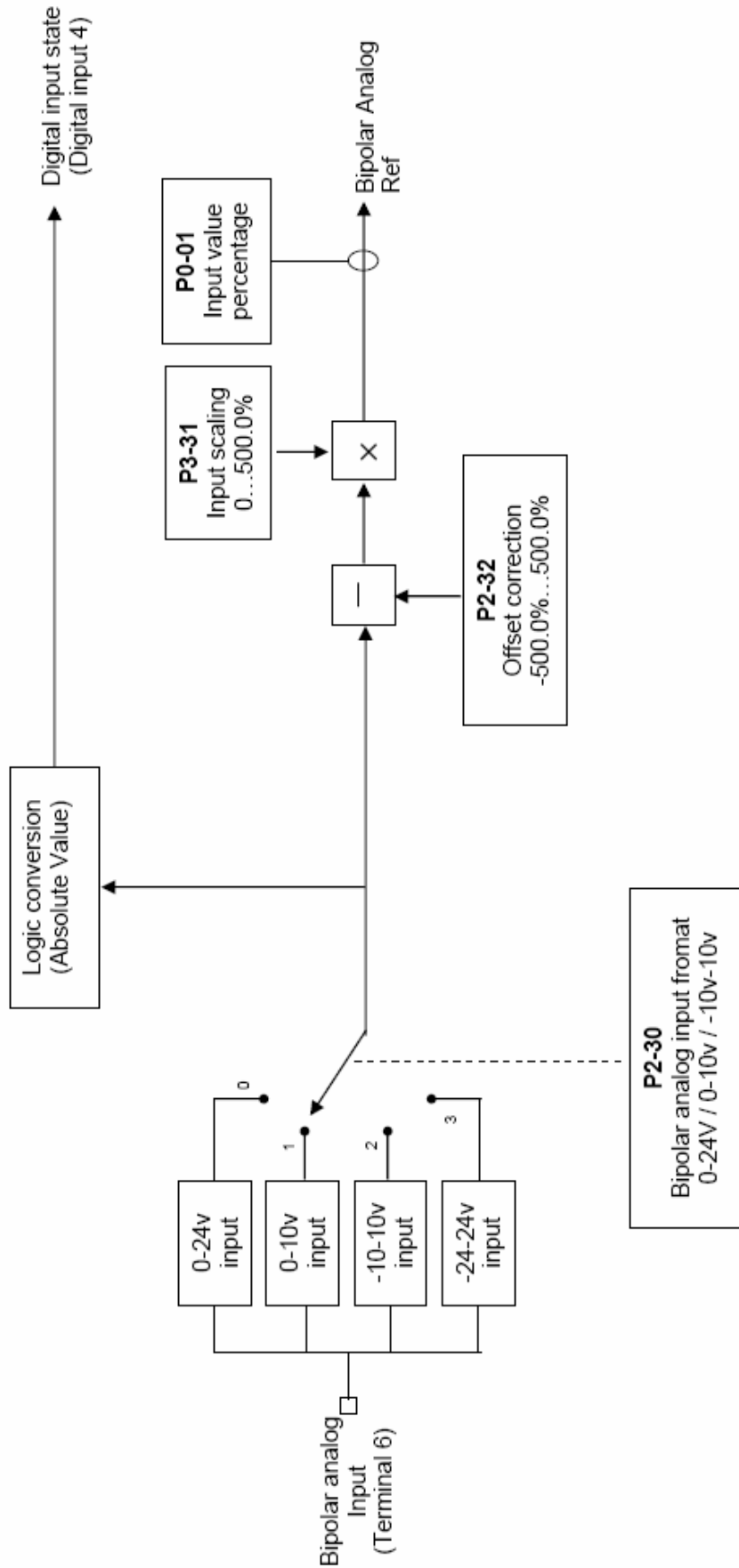
Trip message	Explanation
P-dEF	Default parameters loaded, usually after pressing STOP, UP & DOWN keys for 1s. Press STOP to reset the trip. Display then reads “StoP”
“O-I” “h O-I”	Over-current on drive output to motor. Trip on drive enable : check for wiring error or short circuit Trip on motor starting : check for stalled or jammed motor Trip during operation : check for sudden overload or malfunction If “h O-I” occurs, check for short circuit on output. If wiring correct, contact your supplier.
“I.t-trP”	Drive overload trip, occurring when the drive has been delivering >100% rated current (set in P1-08) for a period of time. The display flashes to indicate an overload condition.
“O-Uolt”	Over-voltage on DC bus. Check supply voltage is within limits. If trip occurs on deceleration, reduce deceleration time or fit braking resistor
“U-Uolt”	Under-voltage trip. Happens routinely when drive powered down. If it occurs whilst running, check supply voltage
“OI-b”	Over current in the brake resistor circuit. Check cabling to brake resistor
“OL-br”	Brake resistor overload. Increase deceleration time, reduce load inertia or add further brake resistors in parallel. Ensure minimum resistance values from ratings tables in section 7.4 are observed.
“O-t”	Over-temperature trip. Check drive cooling and possible enclosure dimensions
“U-t”	Under-temperature trip. Trip occurs if ambient is less than 0 OC. Drive ambient temperature must be raised above zero in order to start the drive.
“th-Flt”	Thermistor hardware fault. Contact your local distributor for further information.
“PS-trP”	Trip on drive enable : check for wiring error or short circuit Trip during operation : check for sudden overload or over-temperature
“dAtA-F”	Occurs routinely after Flash upgrade. Reset using the STOP button or after a power down cycle. All parameters set to default after an upgrade.
“P-LOSS”	If a drive intended for use with a 3-phase supply has one phase removed. Condition must persist for >15s before a trip occurs. Phase loss detection disabled if parameters defaulted (P-dEF) when L3 has been removed.
“Ph-Ib”	Phase imbalance. Trips if the phase imbalance exceeds 3%. Condition must persist for >30s before a trip occurs.
“SC-trP”	Check integrity of OptiLink (communication link) between drives interconnected optically. Check that each drive in a network has a unique drive address (P2-27) If Modbus function enabled, check Modbus communication link.
“E-triP”	External trip (connected to digital input 3). Check motor thermistor (if connected)
“At-Fxx”	Auto-tune failed to complete successfully. (xx = 01...07) See 6.3 for more details.
“SPIN-F”	Spin start function failed to detect motor speed. Check cable connection between drive and motor. Make sure motor speed less than maximum speed limit (P1-01). Make sure motor base frequency(P1-09) less than 100Hz

Auto tune trouble shooting

Trip message	Explanation and check point
At-F01	Measured motor stator resistance varies between phases. Ensure that all motor phases are connected to the drive. Check motor for winding imbalance.
At-F02	Measured motor stator resistance is too large. Ensure that motor is connected. Check that the motor power matches the drive power rating.

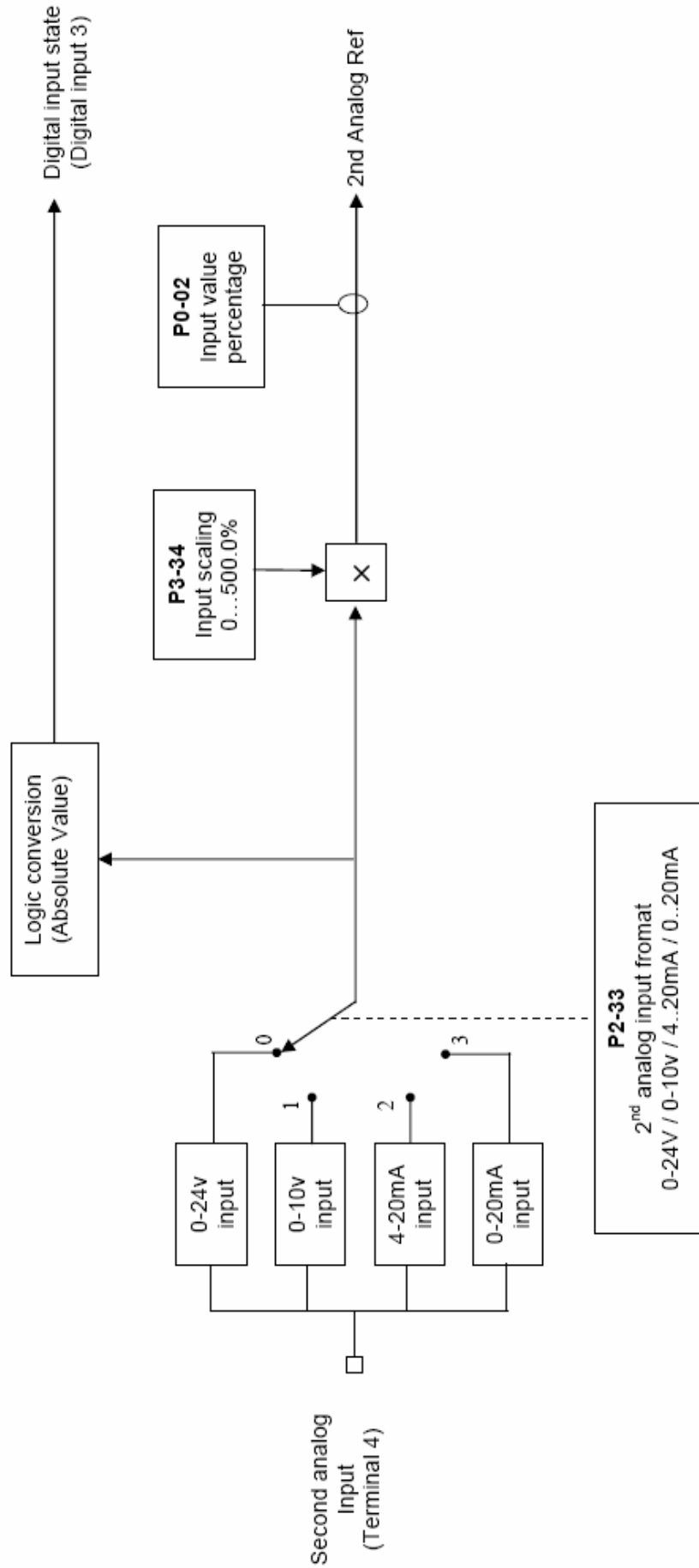
6. Control function flowchart

1. Bipolar analog input function setup flowchart

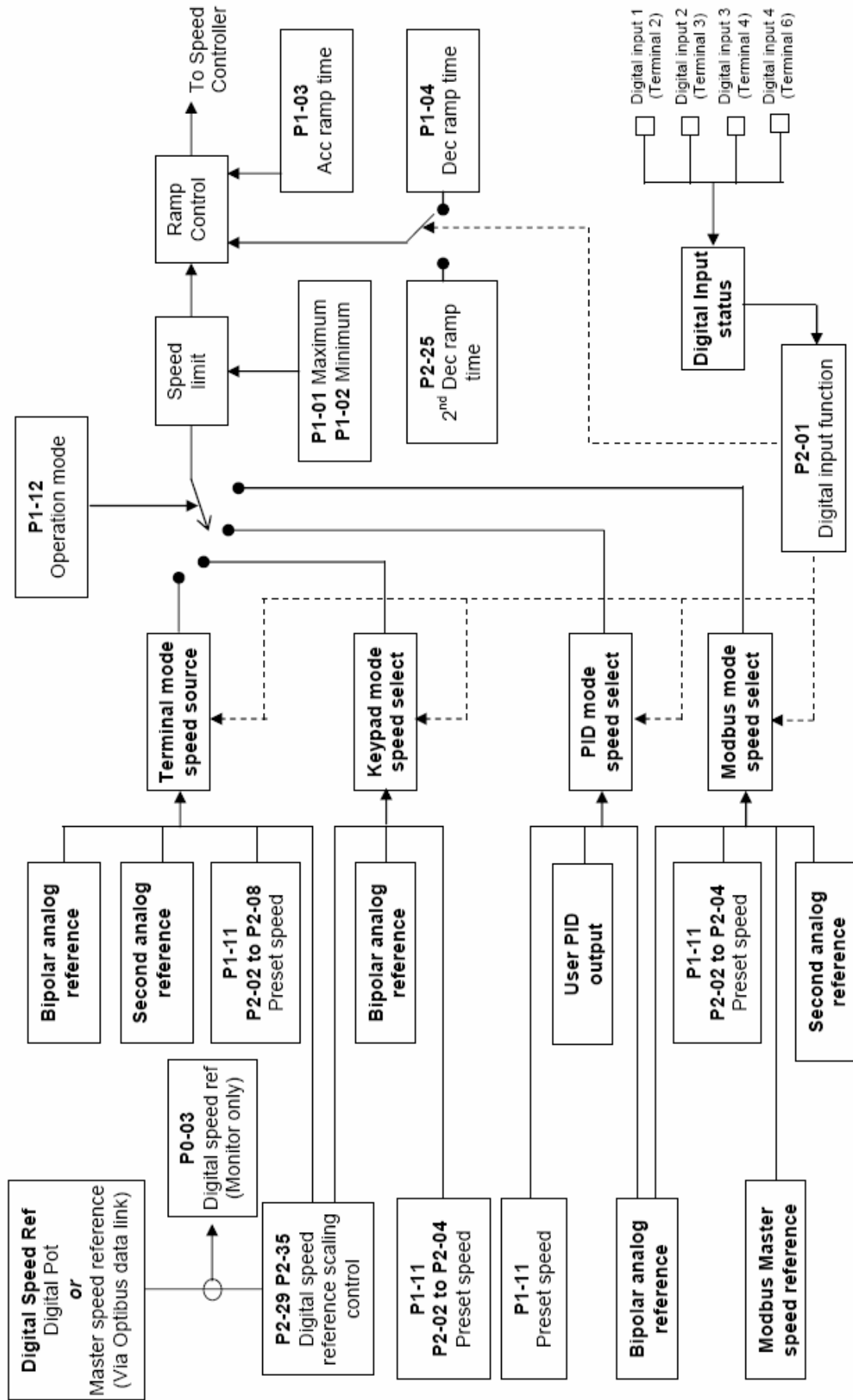


Bipolar analog input sample period is 8ms and the resolution is 12bits

2. Second analog input function setup flowchart



3. Ramp control flowchart



4. PID control flowchart

PID control Algorithm:

$$PIDoutput = Kp \times e(k) + Kp \cdot \frac{T}{Ti} \sum_{j=1}^k e(j) + Kp \cdot \frac{Td}{T} [e(k) - 2e(k-1) + e(k-2)]$$

Where, Kp = P3-01, Ti = P3-02, Td = P3-03 and T = 10ms.

