Optidrive Plus
Advanced User Guide

Revision 2.21

Revision History :

Revision	*Date*	*Description*
01.00	05.06.01	First draft release
01.01	09.03.04	Parameter set modified, user terminals enhanced
01.02	17.11.04	Parameter set modified. Add new PID terminal function
01.03	02.12.04	Parts of parameter function changed. For drive with software version 1.03.
01.04	01.06.05	Parameter set modified, Parts of parameter function changed. For drive software version 1.04.
02.00	08.09.05	Parameter set modified. For drive version 2.00
02.10	17.11.05	Rating table changed. Parameter description changed. Added control function flowchart.
02.20	19.07.06	Parameter description updated according to drive version 2.20. Control function flowchart modified. Updated to current European standards Hoist application note modified
02.21	13.10.06	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

Contents :

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 in-built filters and PID control
- Refrigeration system support, for both high and low pressure control
- Torque control for winding applications
- Full torque over entire speed range to substitute DC drives
- Max torque at zero speed for high starting torque applications
- Support for spindle motors / machine applications up to 2kHz output frequency
- Support for single phase supply operation (with automatic derating) across the entire drive range
- Support for hoist applications

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 ± 10%, 1ph or 3ph, 50…60 Hz ± 5%
380V... 480V ± 10%, 1ph or 3ph, 50…60 Hz ± 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

For all power ratings above 2.2kW in 230V and all power ratings in 400V, operation on a single phase supply will result in a 50% derating of the product.

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 1 (INTEGRAL RFI FILTER)

Model ODP-xxxxx-zz [1]		12037	12075	12150
Motor output rating – industrial 150% o/l	kW	0.37	0.75	1.5
Model ODP-xxxxx-USA		12005	12010	12020
Motor output rating – industrial 150% o/l	HP	0.5	1.0	2.0
Supply voltage / phases	V±10%	220-240 / 1Ø		
Supply fuse or MCB (type B) 2)	A	6	10	20
Output voltage / phases	V	0-240V / 3Ø		
Output Amps – industrial 150% overload	A	2.3	4.3	7
Motor cable size, Copper 75 °C	mm^2	1.0		1.5
Max motor cable length	m	25		

SIZE 2 (INTEGRAL RFI FILTER, INTEGRAL BRAKING TRANSISTOR)

Model ODP-xxxxx-zz [1]		22150	22220
Motor output rating – industrial 150% o/l	KW	1.5	2.2
Model ODP-xxxxx-USA		22020	22030
Motor output rating – industrial 150% o/l	HP	2	3
Supply voltage / phases	V±10%	220-240 / 1Ø or 3Ø [3]	
Supply fuse or MCB (type B) 2)	A	20	32
Output voltage / phases	V	0-240V / 3Ø	
Output Amps – industrial 150% 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 ODP-xxxxx-zz [1]		24075	24150	24220	24400
Motor output rating – industrial 150% o/l	KW	0.75	1.5	2.2	4.0
Model ODP-xxxxx-USA		24010	24020	24030	24050
Motor output rating – industrial 150% o/l	HP	1	2	3	5
Supply voltage / phases	V±10%	380-480 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	6	10	10	20
Output voltage / phases	V	0-480 / 3Ø			
Output Amps – industrial 150% overload	A	2.2	4.1	5.8	9.5
Motor cable size, Copper 75 °C	mm^2	1.0		1.5	
Max motor cable length	m	50	100	100	100
Min brake resistor	Ω	47	47	47	33

Model ODP-xxxxx-zz [1]		25075	25150	25220	25370	25550
Motor output rating – industrial 150% o/l	kW	0.75	1.5	2.2	3.7	5.5
Model ODP-xxxxx-USA		25010	25020	25030	25050	25750
Motor output rating – industrial 150% o/l	HP	1	2	3	5	7.5
Supply voltage / phases	V±10%	500-600 / 1Ø(with 50% derating) or 3Ø				
Supply fuse or MCB (type B) 2)	A	6	10	10	10	20
Output voltage / phases	V	0-600 / 3Ø				
Output Amps – industrial 150% overload	A	1.7	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	50	100	100	100	100
Min brake resistor	Ω	47				

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

Model ODP-xxxxx-zz [1]		32030	32040	32055	32075 **
Motor output rating – industrial 150% o/l	KW	3.0	4.0	5.5	7.5
Model ODP-xxxxx-USA		32040	32050	32075	32100 **
Motor output rating – industrial 150% o/l	HP	4	5	7.5	10
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	32	32	50	50
Output voltage / phases	V	0-240 / 3Ø			
Output Amps – industrial 150% overload	A	14	18	25 (* 24)	30
Motor cable size, Copper 75 °C	mm^2	2.5	2.5	4	4
Max motor cable length	m	100			
Min brake resistor	Ω	15			

* 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) Size 2 230V 3-phase drives are fitted with a 3-phase EMC filter and are therefore different to the 230V 1-phase version.

Model ODP-xxxxx-zz [1]		34055	34075	34110	34150 **
Motor output rating – industrial 150% o/l	KW	5.5	7.5	11.0	15.0
Model ODP-xxxxx-USA		34075	34100	34150	34200 **
Motor output rating – industrial 150% 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 – industrial 150% 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

Model ODP-xxxxx-zz [1]		35075	35110	35150 **
Motor output rating – industrial 150% o/l	kW	7.5	11.0	15.0
Model ODP-xxxxx-USA		35100	35150	35200 **
Motor output rating – industrial 150% o/l	HP	10	15	20
Supply voltage / phases	V±10%	500-600 / 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 – industrial 150% 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 ODP-xxxxx-zz [1]		42075	42110	42150	42185
Motor output rating – industrial 150% o/l	KW	7.5	11	15	18.5
Model ODP-xxxxx-USA		42100	42150	42200	42250
Motor output rating – industrial 150% o/l	HP	10	15	20	25
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	125
Output voltage / phases	V	0-240 / 3Ø			
Output Amps – industrial 150% overload	A	39	46	61	72
Motor cable size, Copper 75 °C	mm^2	10	10	16	16
Max motor cable length	m	100			
Min brake resistor	Ω	12			

Model ODP-xxxxx-zz [1]		44185	44220	44300	44370
Motor output rating – industrial 150% o/l	KW	18.5	22	30	37
Model ODP-xxxxx-USA		44250	44300	44400	44500
Motor output rating – industrial 150% o/l	HP	25	30	40	50
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	125
Output voltage / phases	V	0-480 / 3Ø			
Output Amps – industrial 150% overload	A	39	46	61	72
Motor cable size, Copper 75 °C	mm^2	10	10	16	16
Max motor cable length	m	100			
Min brake resistor	Ω	12			

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

Model ODP-xxxxx-zz [1]		52220	52300	52370	52450
Motor output rating – industrial 150% o/l	KW	22	30	37	45
Model ODP-xxxxx-USA		52300	52400	52500	52600
Motor output rating – industrial 150% o/l	HP	30	40	50	60
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	160	200	250-300	250-300
Output voltage / phases	V	0-240 / 3Ø			
Output Amps – industrial 150% overload	A	90	110	150	180
Motor cable size, Copper 75 °C	mm^2	25	35	55	70
Max motor cable length	m	100			
Min brake resistor	Ω	3			

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

Model ODP-xxxxx-zz [1]		54450	54550	54750	54900
Motor output rating – industrial 150% o/l	KW	45	55	75	90
Model ODP-xxxxx-USA		54600	54750	54100	54120
Motor output rating – industrial 150% o/l	HP	60	75	100	120
Supply voltage / phases	V±10%	380-480 / 1Ø(with 50% derating) or 3Ø			
Supply fuse or MCB (type B) 2)	A	160	200	250-300	250-300
Output voltage / phases	V	0-480 / 3Ø			
Output Amps – industrial 150% overload	A	90	110	150	180
Motor cable size, Copper 75 °C	mm^2	25	35	55	70
Max motor cable length	m	100			
Min brake resistor	Ω	6			

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

Model ODP-xxxxx-zz [1]		62055	62075	62090
Motor output rating – industrial 150% o/l	KW	55	75	90
Model ODP-xxxxx-USA		62075	62100	62120
Motor output rating – industrial 150% o/l	HP	75	100	120
Supply voltage / phases	V±10%	220-240 / 1Ø(with 50% derating) or 3Ø		
Supply fuse or MCB (type B) 2)	A	315-350	400	450-500
Output voltage / phases	V	0-240 / 3Ø		
Output Amps – industrial 150% 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	3		

Model ODP-xxxxx-zz [1]		64110	64132	64160
Motor output rating – industrial 150% o/l	KW	110	132	160
Model ODP-xxxxx-USA		64150	64175	64210
Motor output rating – industrial 150% 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	450-500
Output voltage / phases	V	0-480 / 3Ø		
Output Amps – industrial 150% 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		

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 Self 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 over temperature (trip > 97 °C)
- Heatsink thermal under temperature (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

*A*mbient 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 the optional RFI filter is fitted inside drive. A range of foot mounted EMC filters will be available for sizes #1 to #3.

With the external 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)
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

3.1.4 RS485 communications

Optidrive Plus has an integrated RS-485 communication interface, which supports both the Optibus Plus communication protocol and the Industry standard Modbus RTU communication protocol. All signals can be accessed through the RJ11 connector which is located on the front of drive above the IrDA window.

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 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 high speed 2-wire, optically isolated serial interface.

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
- On-line continuous parameter adaptation to maintain performance
- Spin start onto spinning motor – both forwards & reverse
- Torque control input (with speed limit)
- Speed control input (with torque limit)
- Output frequency range from 0.1Hz to 2kHz (assume PRF >= 8x output frequency).
- Maximum motor frequency up to 5x base frequency (F_0)
- Rated torque at zero speed
- 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
- Real-time display of Power, speed and current
- Run-time clock and kWh meters
- Internal software functions to support hoist applications

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 0..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 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 0..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 protected. 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 addressed, thus allowing communication with any one of an array of drives. Upto 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 Drives 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).

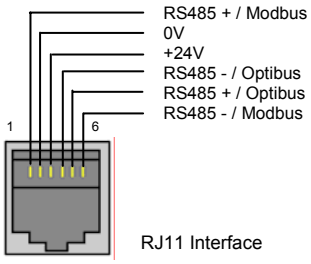
In master/Slave operation mode, the master will send out its speed and torque reference information once every 20ms. All slave drives in the network will use these two references for their operation depending on the drive configuration.

The Optibus Plus protocol enables the user to use different peripherals to communicate with the drive at 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 net work via a wired connection.

The electrical signal arrangement of the RJ11 connector is shown 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 is 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 fixes 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

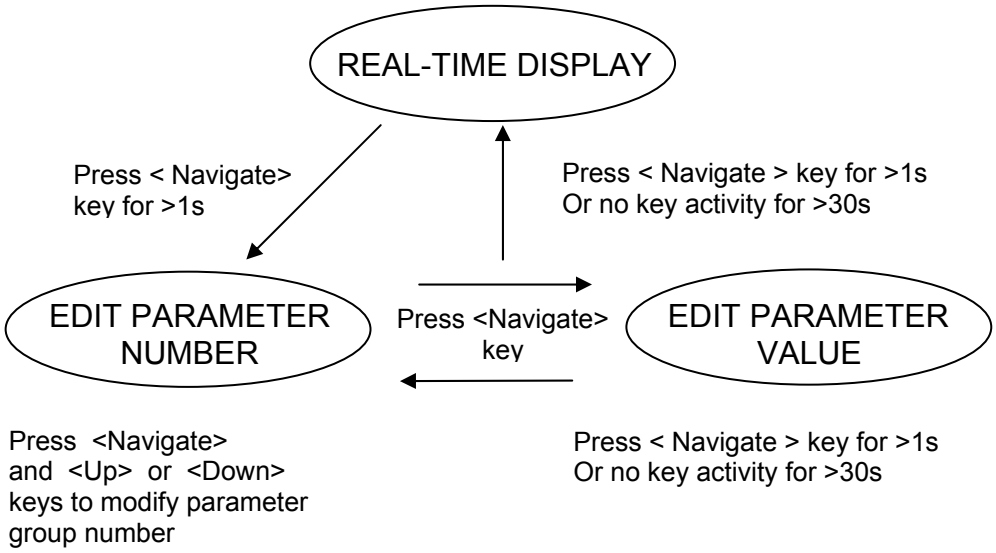
The user can scroll between these variables by pressing and releasing the <Navigate> key within 1s. The scrolling mechanism rolls over from Scaled Value back to speed.

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 P1-09 x 5. Max value 2000Hz / 60,000 rpm	50Hz (60Hz)
P1-02	Min speed limit (Hz or rpm)	0 to P1-01	0Hz
P1-03	Accel ramp time (s)	0s … 3000s	5s
P1-04	Decel ramp time (s)	0s … 3000s	5s
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 Optimisation (Reserved for 3GV-M)	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 2000Hz	50 Hz (60Hz)
P1-10	Motor rated speed	0 to 60,000 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 (Optional)	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 … 22(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 torque > limit 6: 2nd analog input > limit (Analog output mode) 7: Motor speed 8: Motor torque 9: Motor power (kW) 10: Motor current	7
P2-12 (h)	Digital output control high limit	Speed : 0..100% (100% = max speed) Torque : 0..200% (100% = rated torque) PID feedback : 0..100% (100% = max 2nd 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 torque > limit 6: 2nd Analog in > limit	1
P2-14 (h)	User relay output control high limit	Speed : 0..100% (100% = max speed) Torque : 0..200% (100% = rated torque) PID feedback : 0..100% (100% = max 2nd 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	Zero speed holding time	0, 0.1 to 9.9s, 10s to 60s	0.2s
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 : 2nd analog input 1 : Speed 2 : Motor output torque	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..32kHz 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)	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%..500%, steps of 0.1%	0%
P2-33	2nd an input format	0 / 24V, 0..10V, 4..20mA, 0..20mA	0..10V
P2-34	2nd an input scaling	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 *and* 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” : 3GV 230V 0.37kW “HP 20”, “1 460“ : VTC, 460V 20HP	Read only

Advanced parameter set - PID control

(Reserved for 3GV-M)

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 : 2nd Analog input 1 : Bipolar analog input	0

Vector control parameter set

Par	*Description*	*Range*	*Default*
P4-01	Control mode	0: Speed control (vector) 1:Torque control (vector) 2: Speed control (V/F)	2
P4-02	Motor parameter auto-tune	0 : Disable 1 : Enable	0
P4-03	Speed controller Proportional Gain	0 … 4096 (internal value)	1000
P4-04	Speed controller Integral time constant	0.000 … 1.000s	0.05s
P4-05	Cos Φ	0.50 to 0.99	Rating dependent
P4-06	Torque reference select	0 : Preset value 1 : Bipolar analog input 2 : 2nd analog input 3 : Modbus master reference (Optional for 3GV-M)	0
P4-07	Torque reference preset value	0 … 200%	200%
P4-08	Minimum torque reference limit	0…150%	0
P4-09	V/F characteristic adjustment frequency	0 … P1-09	0.0Hz
P4-10	V/F characteristic adjustment voltage	0 ... P1-07	0

Motor parameters (Hidden)

Par	*Description*	*Range*	*Default*
P5-01	Motor Stator resistance (Rs)	Drive dependent	Rating dependent
P5-02	Motor Rotor resistance (Rr)	Drive dependent	Rs
P5-03	Stator inductance (Ls)	Drive dependent	Rating dependent
P5-04	Magnetising current (Id rms)	10% to 80% of motor rated current	Rating dependent
P5-05	Leakage coefficient (sigma)	0.025 to 0.250	0.100
P5-06	Speed controller filter time constant	0.001 … 0.100s	0.005s
P5-07	Quick Rs measurement Enable	0: Disable 1: Enable	1
P5-08	Parameter adaptation	0: Disable 1: Enable	1
P5-09	Over voltage current limit	0 to 100% of motor rated current.	0 (Disabled)
P5-10	Re-generation current limit	0 to 200% of motor rated current	100%
P5-11	Pulse width limitation	0...500 (Time = value *16.67ns)	Drive dependent
P5-12	V/F mode magnetising period	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	User relay speed hysteresis band	0.0 … 25.0%	0.3
P6-05	Hoist function boost speed	0 … 10.0%	0 (Disabled)
P6-06	Boost speed holding time	0.1 … 5.0s	0.4s
P6-07	Speed zone control	0 … 20%	1.0%
P6-08	*Modbus communication loss timer (3GV-M only)*	*0: disable 1..60s*	*2s*
P6-09	Speed droop control	0 …25.0% of P1-09	0 (Disabled)
P6-10	Minimum integral error for PID control (Not for 3GV-M)	0…20.0%	0

Calibration parameters (restricted access)

Par	*Location*	*Description*	*Range*	*1st power up default*
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	2nd 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	Torque controller reference	0…100.0%	
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	Output Torque	0…200.0%	
P0-14	Magnetising current (Id)	A (rms)	
P0-15	Rotor current (Iq)	A (rms)	
P0-16	Field strength	0..100% (100% is rated Id)	
P0-17	Stator resistance (Rs)	Ohm	
P0-18	Stator inductance (Ls)	H	
P0-19	Rotor resistance (Rr)	Ohm	
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	Rotor speed	Hz	
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
P0-31	*Drive serial number #2*		
P0-32	*DSP bootloader version*	*Eg “ 1.00”*	
P0-33	*Measured Cos phi*	*Eg 0.78*	
P0-34	Comms error count (DSP)	0 … 65535	
P0-35	*Configuration register value*	*Internal value*	
P0-36	*Digital input status*	*Internal value*	
P0-37	*Analog out internal value*	*Internal value*	
P0-38	*Current Phase U offset*	*Internal value*	
P0-39	*Current Phase U ref*	*Internal value*	
P0-40	*Current Phase V offset*	*Internal value*	
P0-41	*Current Phase V ref*	*Internal value*	
P0-42	*Brake resistor max on time*	Time in milliseconds	
P0-43	*Brake resistor duty cycle*	*Internal value*	
P0-44	*Uq internal ref value*	*Internal value*	
P0-45	*Ud internal ref value*	*Internal value*	
P0-46	*Measured spin start speed*	*Internal value*	
P0-47	*Calculated slip speed value*	*Internal value (V/F mode only)*	
P0-48	*Hoist boost speed*	*Internal value*	
P0-49	*Rated Iq internal value*	*Internal value*	
P0-50	*Motor voltage*	V ph-ph (rms)	
P0-51	*Switching frequency internal*	*Internal value*	
P0-52	*Speed hysteresis value*	*Internal value*	
P0-53	*PID DC bus feedback value*	0..4096	
P0-54	*Modbus comms error*	0 … 65535	
P0-55	*Modbus speed reference*	*Internal value*	
P0-56	*Droop speed*	*Internal value*	
P0-57	*Slip speed*	*Internal value (vector mode only)*	
P0-58	*Speed jump zone*	*Internal value*	
P0-59	*Modbus write command data value*	*Register dependent*	
P0-60	*Motor control loop ID*	0 … 65535	

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	2nd Analog Input (eg varies torque limit)	Bipolar analog input
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*** Open / Open / Preset speed 1 Closed / Open / Preset speed 2 Open / Closed / Preset speed 3 Closed / Closed / Preset speed 4		O : Terminal mode C : Keypad mode
19	O : Stop (Disable) C : Run (Enable)	O : Bipolar Analog input C : 2nd Analog input	2nd Analog input	Bipolar analog input
20 [1]	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	O : Bipolar analog input C : Preset speed 1	Bipolar analog input
21 [1]	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	O : Forward C : Reverse	Bipolar analog input
22 [1]	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK	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
3..9, 13,14, 16 [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 > 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	
			Closed / Closed / Preset speed 4	
19	O : Stop (Disable) C : Run (Enable)	O : Digital speed ref C : 2nd analog input	No effect	Bipolar analog input > 5V reverses rotation
20,21	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	O : Digital speed ref C : Preset speed 1	
22	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK	

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 : 2nd analog input	No effect	
20, 21	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	No effect	
22	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	External trip input : O : Trip C : OK	

Digital inputs : Modbus control mode (for 3GV-M only)

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
			Closed	Closed	Preset speed 4
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 : Preset speed1 C : Master speed ref	External trip input : O : trip C : OK		
17	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : Bi-Analog input	No effect		
19	O : Stop (Disable) C : Run (Enable)	O : Master speed ref C : 2nd Analog input	No effect		
20,21	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	O : Master speed ref C : Speed Preset 1		
22	O : Stop (Disable) C : Run (Enable)	2nd digital output : Drive healthy = +24V	External trip input : O : trip C : OK		

Notes: If P2-19 = 2 or 3, drive can only be started / stopped by closing / opening digital input 1.
If P2-19 = 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: 5 x base frequency (i.e. 5 x P1-09) *
Minimum value: value of P1-02
Default value: 50.0 Hz

* The maximum speed is also limited by the switching frequency, which is set by P2-24. The limit is given by : Maximum output frequency to motor = P2-24 / 16.

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. too small a value will cause over current trip during motor speed acceleration.

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 output will change to the requested value within 8ms of the action being requested via the digital input or 16ms via the analog input. There will always be a minimum delay in vector mode at start up depends on motor size, which is used for build up the magnetizing current inside the motor.

Maximum value: 3000s
Minimum value: 0s
Default value: 5.0 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.

Too small a value may cause drive trip as over voltage depends on motor load situation.

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 will control the motor to stop as fast as it can be without tripping as over voltage. There is a minimum deceleration time limit depends on drive size. For size 1 to 4 the minimum ramp time is 3s, for size 5 is 12s and for size 6 is 24s.

Maximum value: 3000s
Minimum value: 0s
Default value: 5.0 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 HVAC energy reduction

Not available for 3GV-M, and this function only works in V/F mode (P4-01=2).

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: 600V / 500V / 250V
Minimum value: 20V or 0V
Default value: Drive rating (575V/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.

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: 2000Hz*
Minimum value: 25Hz
Default value: 50Hz

* The maximum speed is also limited by the switching frequency, which is set by P2-24. The limit is given by : Maximum output frequency to motor = P2-24 / 16.

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.
User can only put a positive value into this parameter if 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.
Note that this option is not available for the 3GV-M. The parameter value will be reset to 0 if user set it to 3.

For 3GV-M, there is an option of 4, which will enable the Modbus control function. 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 the Optidrive 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 menues.

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 put a positive value into these registers if 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 ±0.1Hz 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 torque (torque current/rotor current) is greater than the torque 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 load current (torque). It is scaled from zero to 200% of motor rated torque, 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.
P2-11=10: The amplitude of the output analog signal represents the output current of the drive. And it is scaled from zero to 200% of motor rated current.

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) and100%(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 ±0.1Hz 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 torque is greater than the torque 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) and100%(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 Zero speed holding time

This parameter could enable the drive stay at zero speed (0Hz) for a certain time whenever drive receives a stop command and reduces the output speed to zero before the output signal is completely shut down.

If P2-16=0, the output of the drive will be shut down immediately when output speed reach zero. If P2-16 not equal to zero, the drive will keep at zero speed for a certain period, which is specified by P2-16 in seconds, before the output of the drive shutting down.

This function usually operates in conjunction with relay output function so that the drive would give out a relay control signal before the drive output is disabled.

For hoist applications, this parameter must be set to value large than zero. See Application Note AN ODP-34(34a) for more details.

The holding time can be selected from minimum 0.1s to maximum 60s.

Maximum value:	60s
Minimum value:	0s
Default value:	0.2s

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. Note also that the base frequency settings in P1-09 must less than 100Hz.

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

Optidrive Plus provides a Standby function that will automatically disable the drive output when drive output speed has remained at minimum speed (P1-02) for greater than the specified time.

P2-20 = 0:	Standby function is disabled. Optidrive Plus will continue to deliver power to the motor at minimum speed as long as the drive is enabled.
P2-20 = 1 ~ 60:	Optidrive Plus 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 large than the minimum speed, the drive will automatically re-enable and ramp to the target speed.

If there is a non-zero value in the parameter P2-16, then the standby function will be disabled.

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:

Scaling display value = P2-21 * 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.
P2-22 = 2 : Motor output torque 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 frequecy

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 relating to the switching frequency. In most industrial applications (3-phase supplies), this is of little consequence as background noise is much greater.

However, domestic (220V 1-phase) applications tend to be used in quieter environments where acoustic noise is important.

The selected switching frequency value will also affect some other motor control parameters. For example the maximum speed limit and maximum motor base frequency are limited by the switching frequency. The maximum output frequency limit will reduce if the effective switching frequency value is reduced.

The user can change the switching frequency at any time as long as the selected maximum frequency / rated frequency is applicable.
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 following table indicates the maximum effective switching frequency as a function of drive power rating :

Drive Size	kW Rating	HP Rating	Max available switching frequency
Size 1	All ratings	All ratings	32 kHz
Size 2	All ratings	All ratings	32 kHz
Size 3 - 230V	3 4 5.5	4 5 7.5	32 kHz 32 kHz 24 kHz
Size 3 - 400V	5.5 7.5 11 15	7.5 10 15 20	32 kHz 32 kHz 24 kHz 24 kHz
Size 4	All ratings	All ratings	24 kHz
Size 5 - 230V	22 30 37 45	30 40 50 60	16 kHz 16 kHz 8 kHz 4 kHz
Size 5 - 400V	45 55 75 90	60 75 100 150	16 kHz 16 kHz 8 kHz 4 kHz
Size 6 - 230V	55 75 90	75 100 120	16 kHz 8 kHz 4 kHz
Size 6 - 400V	110 132 160	160 200 250	16 kHz 8 kHz 4 kHz

The relationship between maximum output speed / motor base frequency and the effective switching frequency is given by the following table :

Effective switching freq	Maximum speed/ Base freq
4kHz	250Hz
8kHz	500Hz
16kHz	1000Hz
24KHz	1500Hz
32KHz	2000Hz
Auto *	2000Hz

* : value depends on the maximum switching frequency of the drive.

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 will not be affected by changing either the maximum or minimum speed limits (P1-01, P1-02) since the ramp time is related to P1-09.

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 option

Modbus network communication baud rate. Value can be set from 9600bps to 115200bps. This parameter is reserved in V1.04 software release. For standard 3GV drive, this parameter is reserved.

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 an 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 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 minues

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

(This parameter group is not available for 3GV-M)

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 :

Upper Limit = P3-07 * 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 :

Lower Limit = P3-08 * 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 bi-polar analog input value.
When set to 2, the minimum output value if user PID controller will be limited by the bi-polar analog input value.
When set to 3, the bipolar analog input value will be added to the PID output

Maximum value: 3
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 intpu 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 : VECTOR CONTROL PARAMETER SET

P4-01 Control mode

This key parameter defines which motor control mode should be used for the motor control application. There are three different motor control modes available:

P4-01=0 Vector speed control mode with estimated rotor speed feedback control)
Field orientated control algorithms are used for motor speed control. Since estimated rotor speed is used to internally close the speed loop, this mode of operation effectively gives closed loop performance without a physical encoder. With a correctly tuned speed controller, steady state speed regulation is typically better then 1%. An Auto-tune (P4-02) should be carried out prior to first operation to ensure best control.

P4-01=1 Torque control mode
Instead of controlling the motor speed, the motor output torque is controlled directly. In this mode of operation, the output speed will vary dependent on load. The maximum speed is limited by P1-01. This mode is often used for winding applications, where a constant torque is required to maintain tension in a cable. An Auto-tune (P4-02) should be carried out prior to first operation to ensure best control.

P4-01=2 V/F speed control mode
This mode is effectively voltage vector control, where applied motor voltage is controlled rather than the torque producing current. The magnetising current is controlled directly, so that voltage boost is not required.
The Voltage characteristic can be selected using the HVAC parameter (P1-06). The default setting gives a linear characteristic, where voltage is proportional to frequency, noting that the magnetising current is independently controlled.
Setting HVAC mode to 1 selects a reduced voltage characteristic, where applied motor voltage is reduced at lower speeds. This is typically used for fan applications to save energy consumption. The Auto-tune function should also be called in this mode of operation. In this case, the tuning process is less complex and completes very quickly.

Note that the motor parameters are extremely important, particularly in vector control mode, if best control performance is to be achieved. Note that incorrect motor parameters may result in poor motor performance when vector mode is active. Voltage control mode (P4-01 = 2) is relatively insensitive to motor parameters.

Default Setting: 2 (V/F speed control mode)

P4-02 Motor parameter auto measurement

In order to get the best performance for the motor control applications, the motor parameters which are required by the Optidrive Plus control algorithms need to be close to their true values.
The Auto-tune will measure stator resistance, stator inductance, leakage inductance, rotor resistance and magnetising current. Since most parameters are difficult to measure by hand, the auto-tune is an essential part of the Optidrive Plus 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. Note that the auto-tune may take a couple of minutes to complete for some motors.

See application note ODP-AN-33 for further information

Default setting: 0 (Function disabled)

P4-03/P4-04 Vector mode speed controller control parameters

These three parameters are used to adjust the close loop speed PID controller performance when the drive runs in vector speed control mode (P4-01=0).

P4-03 Proportion Gain
Maximum value: 4096
Minimum value: 0
Default setting: 1000

P4-04 Integral time constant
Maximum value: 1.000s
Minimum value: 0.01s
Default setting: 0.05s

Increasing P4-03 will increase the instantaneous responsiveness to a speed error, but will cause instability if the value is too high.
Increasing the P4-04 gives a slower response to errors.

In general, set the Integral time constant to a smaller value, then increase the P-gain to give the maximum possible value without instability, then increase the Integral time constant to give the desired response.

P4-05 Motor power factor (cosΦ)

Motor power factor on the nameplate should be put into this parameter before carrying out the motor parameter auto-tune function in vector control mode.

A correct value in this parameter is very important in order to get the correctly motor auto-tune result. Usually this parameter can be found on the motor nameplate.

If this value is not available, user can take a similar value according AN-ODP-42 for the motor connected. For drive version 2.21 or later, if there is no such info available for the particular motor, user can then set this value as zero, however this won’t guarantee that drive can get correct motor parameter information during auto-tune.

Maximum value: 0.99
Minimum value: 0.50 or 0.00
Default setting: Drive dependent

P4-06 Torque reference select

This parameter is used to select the torque reference input source when Optidrive Plus runs in torque control mode. (P4-01=1)

P4-06=0	A fixed digital preset value set by P4-07 is used as torque reference.
P4-06=1	The bipolar analog input value will be used as torque reference. Note that the analog input signal should be unipolar format. If the analog input is configured as a bipolar input (-10V…+10V), then any negative input signal will limit to zero, giving a zero torque reference.
P4-06=2	The 2nd analog input value will be used as torque reference.
P4-06=3	This is only available for 3GV-M. Torque reference from network master.

Default settting: 0

P4-07 Torque limit preset value

This parameter only has an effect when P4-06 = 0 and will give a digital percentage torque reference value, where 100% equates to motor rated output torque. If the load torque on the motor is large than the value set in this parameter, then the motor speed will reduce to zero. Motor speed will not come back to the reference value until the load torque is less than the value that set in this parameter.

Maximum value:	200%
Minimum value:	0%
Default setting:	200%

P4-08 Minimum torque reference limit

This parameter defines the minimum output torque limit.

If this parameter is not set to zero in speed control mode (P4-01), then once the motor output torque less than this value, motor output speed will be increase automatically until reach maximum speed limit. Once the motor output torque is large than this value, motor speed will return to reference speed value.

Maximum value:	150%
Minimum value:	0%
Default setting:	0%

P4-09/P4-10 V/F characteristic adjustment point / voltage

The Voltage - Frequency characteristic defines the level of voltage that is applied to the motor at any given frequency.

Parameters P4-09 and P4-10 allows the user to modify the V/F characteristic should this be required.

Parameter P4-09 can be set to any frequency between 0 and the base frequency (P1-09) and represents the frequency at which the adjustment voltage set in P4-10 is applied.

This is best visualised by considering a rubber band stretched along a line representing the Voltage/Frequency characteristic. The effect on the V/F characteristic of changing P4-09/ P4-10 is the same as getting hold of the rubber band at the frequency specified in P4-09 and moving it up or down to represent the voltage adjustment level that specified in P4-10. In this way, there is a smooth change in voltage as frequency increases, thereby avoiding voltage discontinuities.

Note that the voltage at any particular frequency can be increased or decreased to suit the needs of the application. See ODP-AN-15a for further information.

When P4-09 = 0, this function is disabled.

P4-09: V/F adjustment frequency		**P4-10: V/F adjustment voltage**	
Maximum value:	P1-09	Maximum value:	P1-07
Minimum value:	0	Minimum value:	0
Default value:	0	Default value:	0

Group 5 : MOTOR CONTROL PARAMETERS (HIDDEN)

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 can be read via Parameter group zero (P0-17)

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

P5-02 Motor rotor resistance

This represents the motor stator resistance value in Ohms. This cannot be measured directly from the motor terminals.

The value in this parameter could be changed if required, although this should always be calculated by the Auto-tune function. This value can be read via Parameter group zero (P0-19)

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

P5-03 Motor stator inductance

This represents the motor stator inductance value in Henry and is equivalent to the phase inductance.

The value in this parameter could be changed if required, although this should always be calculated by the Auto-tune function. This value can be read via Parameter group zero (P0-18).

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 can be read via Parameter group zero (P0-14).

Default setting: Rating dependent

P5-05 Leakage coefficient

This parameter value represents the motor leakage inductance coefficient, calculated by the Auto-tune algorithms.

Maximum value: 0.250
Minimum value: 0.025
Default setting: 0.100

P5-06 Rotor speed filter time constant

This parameter value specifies motor control algorithm rotor speed feedback filter time constant. Too small a value may cause motor speed instability. Too large a value may cause the controller have a slow response to the speed changes on the motor shaft. This parameter is only used in vector control mode.

Maximum value: 0.100
Minimum value: 0.001
Default setting: 0.005

P5-07 Quick Rs measurement enable

Since an auto-tune is usually carried out during the commissioning process, the motor is usually cold when this happens. Temperature dependent parameters – especially stator resistance – can vary significantly during operation.

Whenever the drive is enabled from a stopped condition, the drive will normally start from the Auto-tuned (cold) parameters. To cater for the possible variance in stator resistance, the drive can carry out a quick stator resistance measurement on enable. This is carried out during the magnetisation phase and can add a delay of one magnetisation time constant (typically 100 – 200 ms) before the drive will start to ramp up in speed.

This parameter enables (1) or disables (0) the motor stator resistance quick measurement when the drive run signal is given.

This function is only active when the drive is in vector control mode.

Default setting: 1 (Quick Rs measurement enabled)

P5-08 Motor parameter adaptation

Usually the motor parameters, particularly stator resistance and rotor resistance will change if the motor temperature changes, adversely affecting the motor control performance of the drive. Optidrive Plus has built-in motor parameter adaptation, which enables the control algorithms to track the motor parameters in real time, automatically adjusting the parameter values used for the internal control algorithms.

Default setting: 0 (Parameter adaptation disabled)

P5-09 Over voltage control current limit

This parameter is only valid in vector speed control mode. This parameter will come into function once the drive DC bus voltage increase over certain limit. This voltage limit is set internally just below the over voltage trip level. This parameter will effectively limit the output torque current in order to prevent large current going back to the drive, which may cause over voltage trip.

A small value in this parameter will limit the motor control torque once drive DC bus over this control level. A higher value may cause big distortion on the motor current, which may cause an aggressive behaviour of the motor.

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

P5-10 Re-generating current limit

This parameter defines the control current limit when motor in regenerating mode.
The value in this parameter represents the percentage value of motor rated current that is defined in P1-08.

The current limit that defined in this parameter will override the normal torque producing current limit when motor goes into regeneration mode. Too high a value may cause big motor current distortion and the motor may behaviour aggressively once motor goes into regeneration mode. The output torque of the motor may reduce during regeneration if the value in this parameter is too small.

Minimum value: 0
Maximum value: 200%
Default setting: 100%

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. Increasing the value of this parameter will reduce the risk of over-current trips on long motor cables, but will also reduce the maximum available output motor voltage for a given input voltage.

The minimum pulse is defined by : Duration (ns) = P5-11 * 16.67

Default setting: Drive dependent
Minimum value: 0
Maximum value: 625

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 run signal is given.
Too small a value may cause the drive to trip on over-current if the acceleration ramp is very short.

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 Invertek Drives Ltd. Each motor control upgrade file is specific to a drive type and power rating and can only be used on a drive of the correct power rating. For a given version, 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 to1, 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 dispay “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 drive 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)

P6-03 Auto-reset delay time

This parameter defines the auto restart time delay for the drive after a trip condition. The Auto-restart function is enabled in P2-17.

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

P6-04 Speed hysteresis band for relay output control

This parameter defines the speed control hysteresis band for the digital and relay output functions and is used when P2-11 or P-13 = 2 or 3.
This parameter will define a speed band as a percentage value of drive maximum speed (P1-01) and is applied to both sides of the centre point. The total band is therefore 2x the value in this parameter. This function is used to prevent "chatter" on the output if the operating speed coincides with the level at which the digital / relay output changes state.

eg if P2-13 = 3, P1-01 = 50Hz and P6-04 = 5%, the relay contacts close above 2.5Hz

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

P6-05 Boost speed for hoist applications

This parameter defines the boost speed value for the hoist control function. This parameter will define a speed as a percentage value of drive maximum speed (P1-01). For more information regarding this parameter please see section 7.

Maximum value: 10.0%
Minimum value: 0
Default setting: 0

P6-06 Boost speed holding time for hoist applications

This parameter defines time for which the boost speed will be applied on the motor. This parameter is special designed for hoist applications and in used in conjunction parameter P6-06 to prevent the load from sagging when the mechanical brake releases. For more information regarding this parameter please see section 7.

Maximum value: 5.0s
Minimum value: 0.1s
Default setting: 0.4s

P6-07 Stator speed zone

This parameter defines a speed band that centred at 0Hz stator electrical frequency. Usually when stator frequency is around zero, the maximum output torque that produced by motor will reduced. This is not good for some application where high torque is needed when motor speed drops in this area.

This parameter defines a speed band as percentage value of motor base frequency (P1-09), it will prevent motor stator speed staying in the speed band area.

For example, we set P1-09=50Hz, and P6-07=2.0%. Then if motor stator speed reference is between 0Hz and 1Hz, the stator speed will be limited at 1Hz, if motor stator speed reference is between 0Hz and -1Hz, stator speed will be limited at -1Hz.

Maximum value: 20.0%
Minimum value: 0
Default setting: 1.0%

P6-08 Modbus communication loss timer (for Modbus versions only)

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 if communication with the Modbus master is lost.

When set to a value larger than zero, the drive will trip after the number of seconds specified in this parameter.

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

P6-09 Speed droop control

This parameter only applies when the drive is in vector speed control mode. (P4-01=0)

When set to zero, this speed droop control function is disabled.

If P6-09 > 0, this parameter effectively defines a slip speed at motor rated output torque. The droop speed is the percentage value of P1-09. Depending on the motor load condition, the reference speed will be reduced by a certain droop value before goes into speed controller. See equations below:

Droop speed = P6-09 * P1-09
Droop value = Droop speed * (Motor real torque / Motor rated torque)
Speed controller input = Speed reference – Droop value

For example, P1-09 =50 Hz, P6-09 = 10.0%. Drive has a reference speed of 40Hz, when motor output torque is about 80% of rated torque value, then the speed reference into the speed controller will be 36Hz. (-36Hz if reference speed is -40Hz)

Maximum value: 25.0%
Minimum value: 0
Default setting: 0 (Disabled)

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.

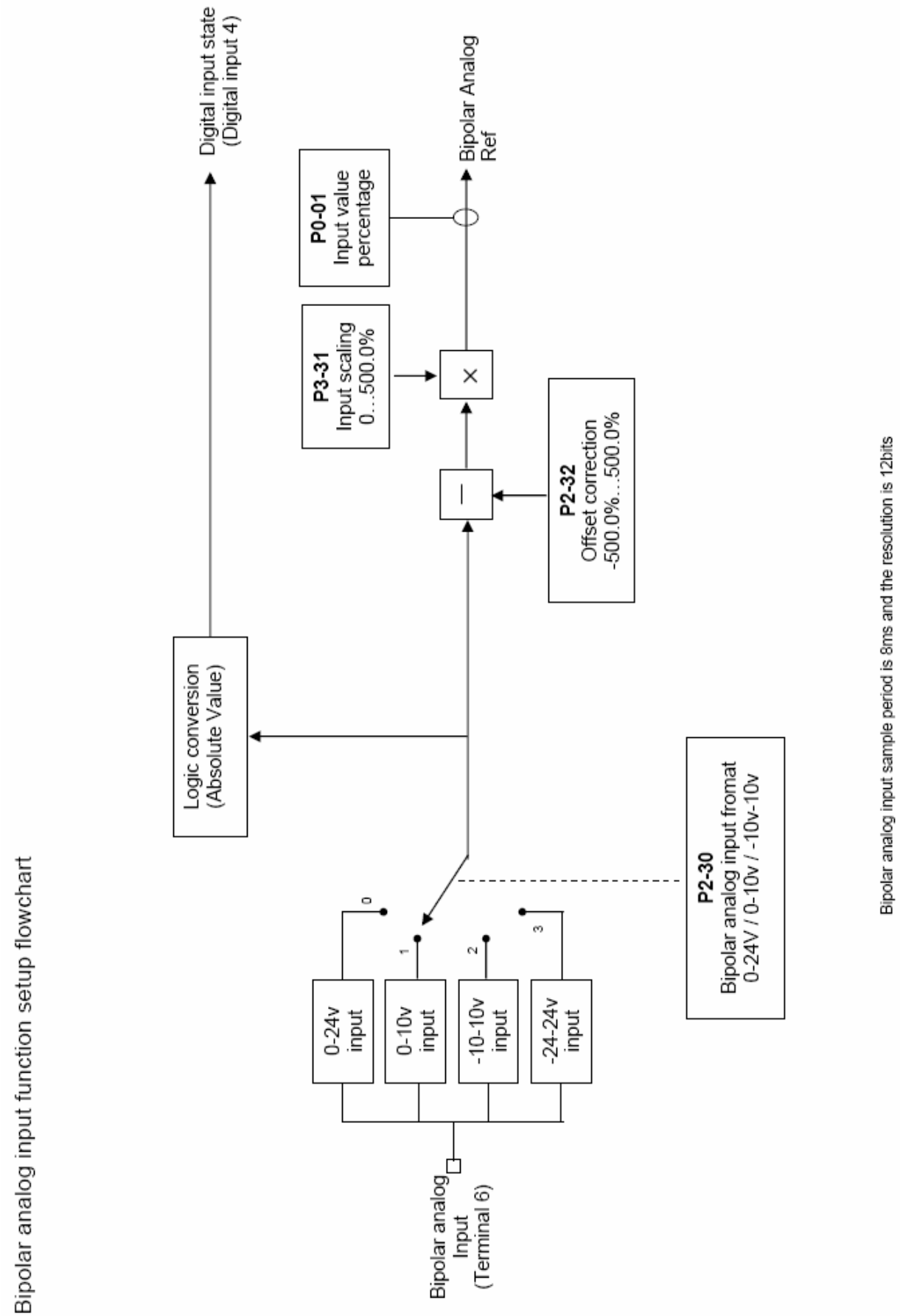
Trip message	Explanation
P-dEF	Default parameters loaded, usually after pressing STOP, UP & DOWN keys for 1s. Press STOP to reset the trip. Display then reads “StoP”
“O-I” “h O-I”	Over-current on drive output to motor. Trip on drive enable : check for wiring error or short circuit Trip on motor starting : 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

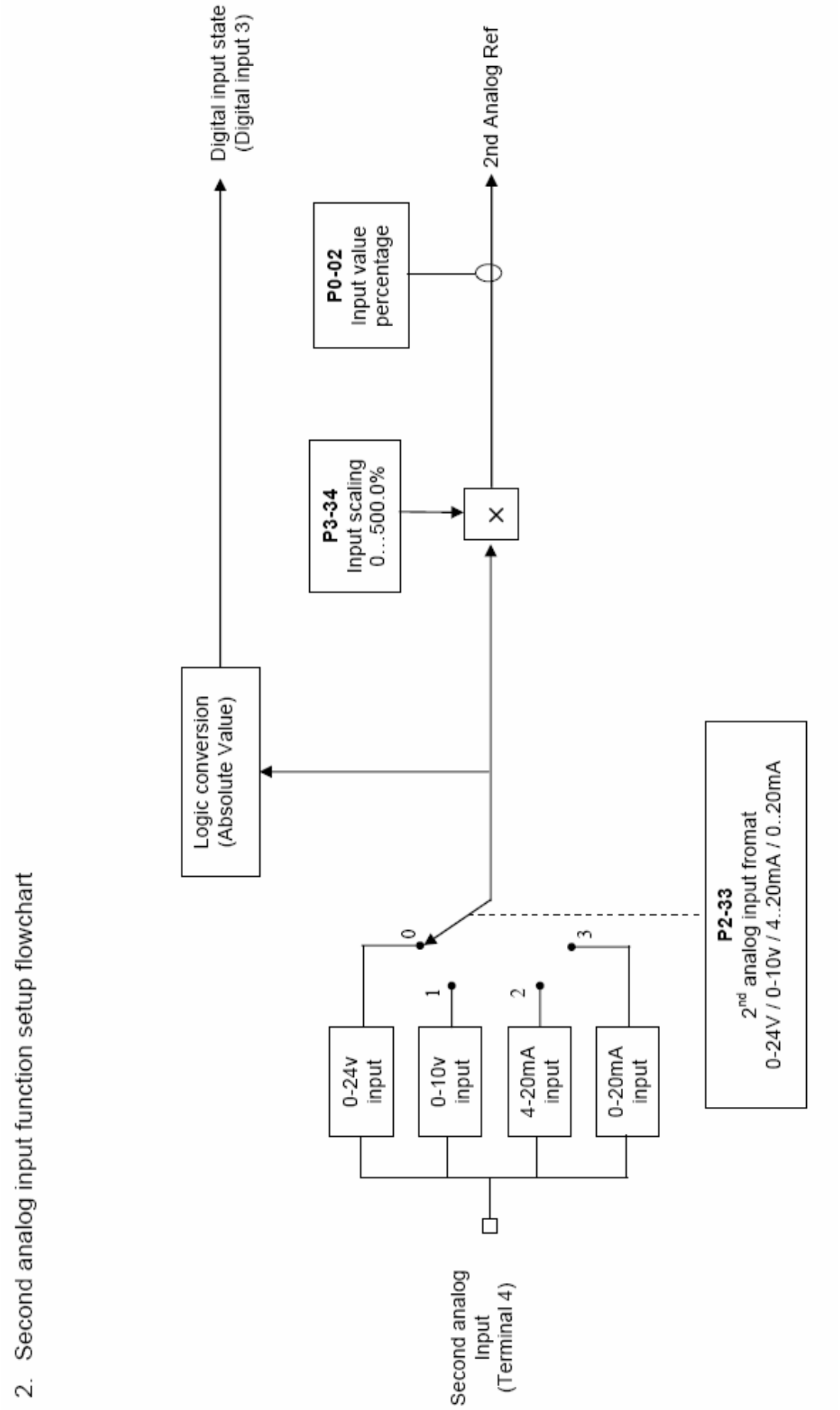
Trip message	Explanation and check point
At-F01	Measured motor stator resistance varies between phases. Ensure that all motor phases are connected to the drive. Check motor for winding imbalance.
At-F02	Measured motor stator resistance is too large. Ensure that motor is connected. Check that the motor power matches the drive power rating.
At-F03	Measured motor inductance is too low. Ensure that there is no short circuit on the motor or a winding fault. Check that the motor power matches drive power rating.
At-F04	Measured motor inductance is too high. Check for motor connection fault. Check that the motor power matches drive power rating.
At-F05…At-F07	Motor parameter measurements not convergent. Check motor windings for fault. Check that the motor power matches drive power rating.

6. Control function flowchart

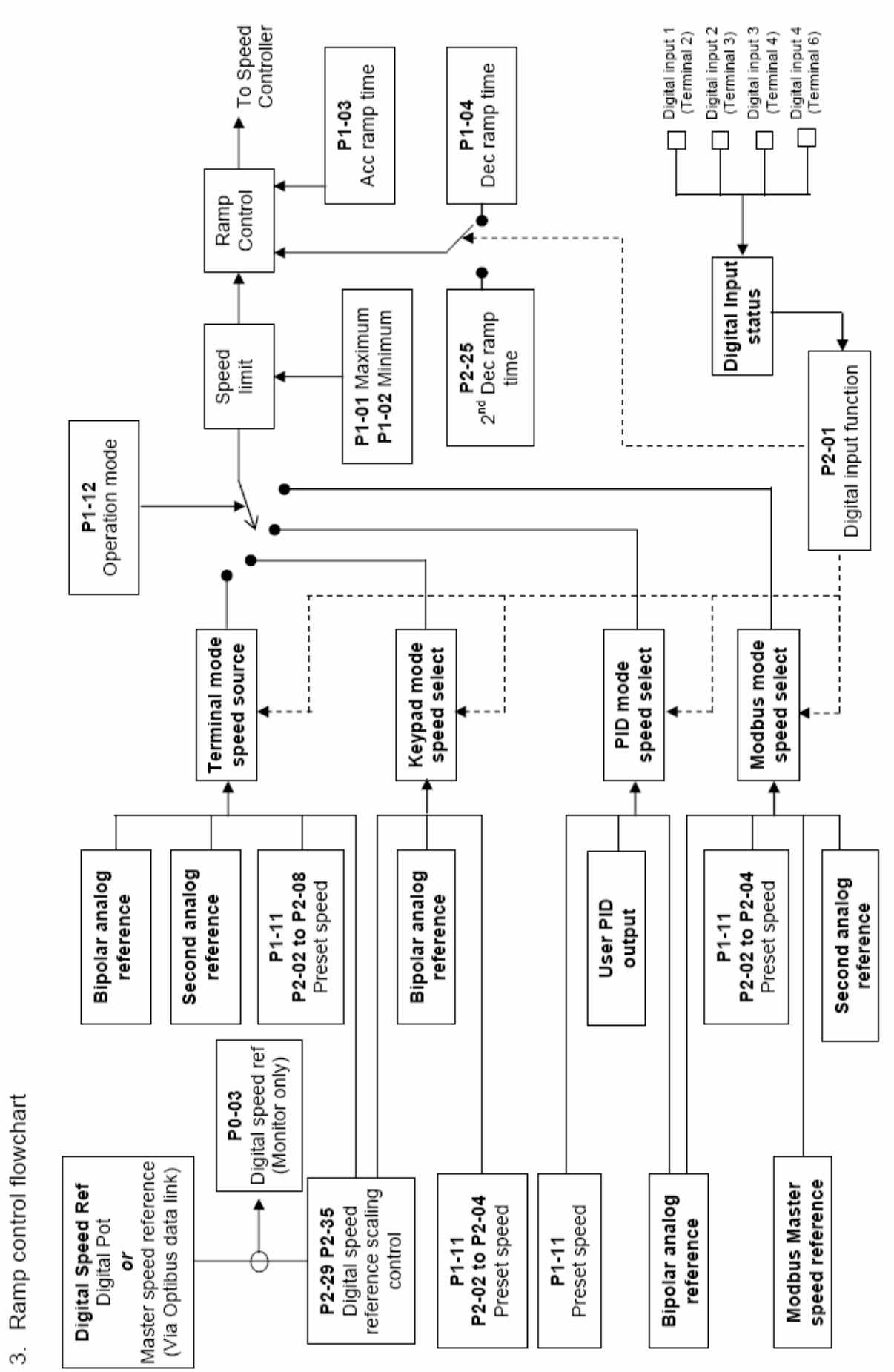
1. Bipolar analog input function setup flowchart



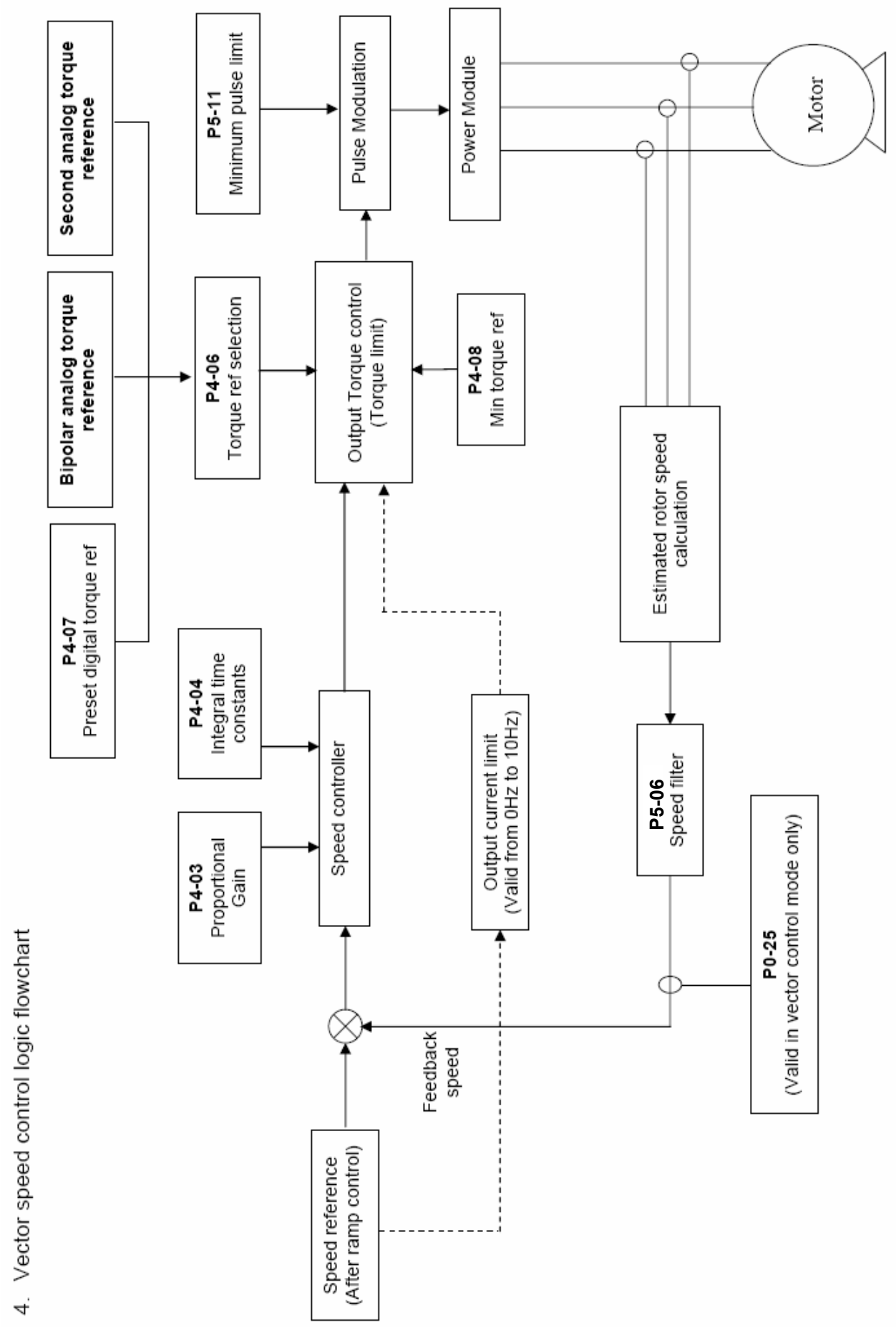
2. Second analog input function setup flowchart



3. Ramp control flowchart



4. Vector speed control logic flowchart

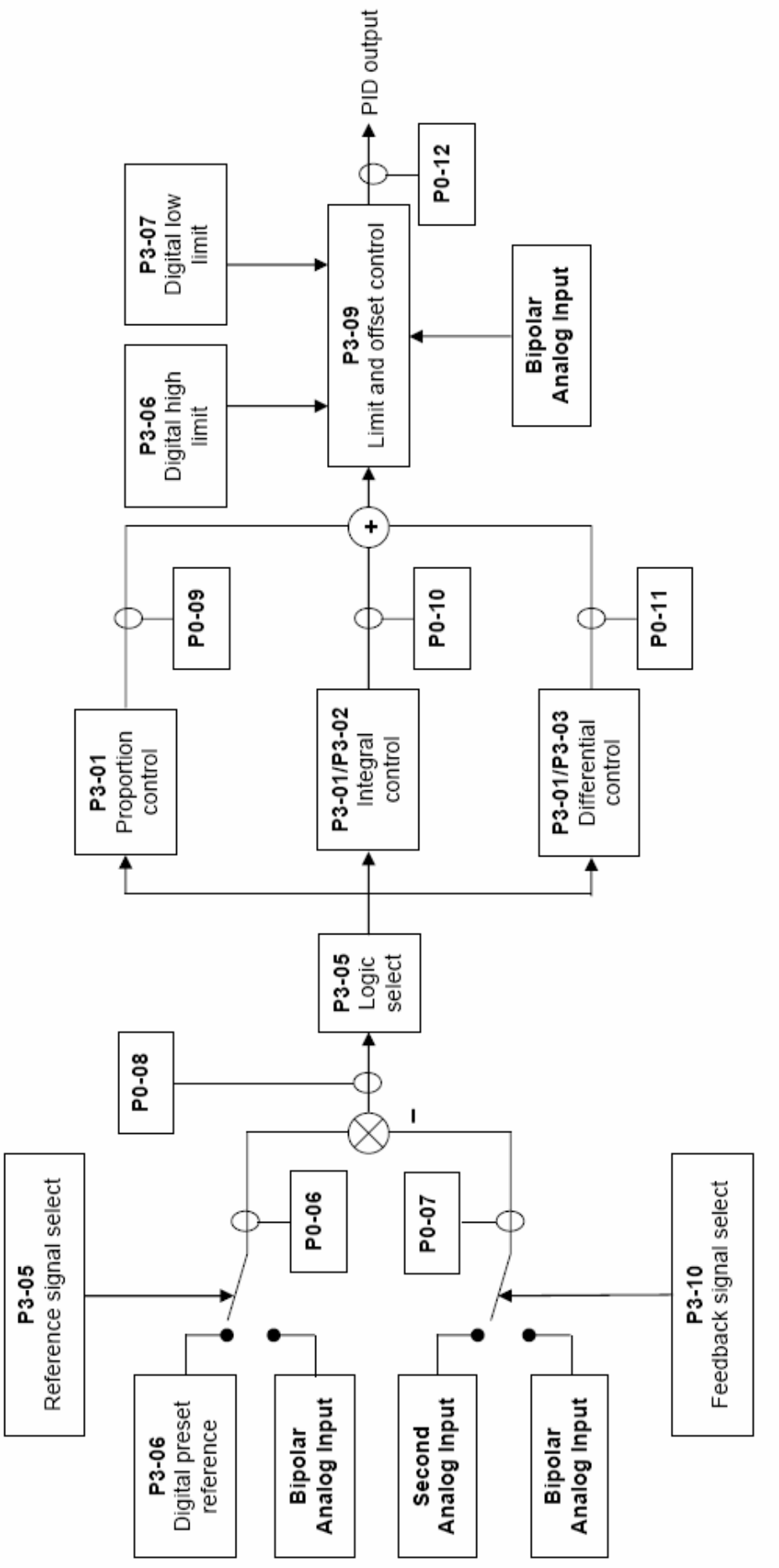


5. PID control flowchart

PID control Algorithm:

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

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



7. Special functions

7.1 Hoist function support

- ***General:***

For applications such as hoists where a high starting or holding torque must be available as soon as the drive is enabled (for example to support a weight), it is necessary to pre-magnetise the motor prior to releasing the mechanical brake. Additionally, the electrical frequency must be increased from zero prior to releasing the brake. This will effectively prevent the load from dropping down.

Optidrive Plus 3^{GV} provides a function to support these types of applications. This document describes how to enable the hoist function via parameter settings.

Important Safety Notice

Any control function provided by Optidrive Plus 3^{GV} cannot be regarded as a fail-safe solution, particularly in hoist applications. All applications where malfunction of any component in the drive, motor or otherwise could cause injury or loss of life must be subject to a risk assessment and further independent protection against dropping the load provided.

- ***Parameters:***

Note: the following guidelines apply equally to V/F and 3GV vector control modes. Ensure that Auto-tune has been carried out prior to normal operation in all cases.

P2-13: Relay output function select

This parameter should be set to 3, resulting in the relay contacts closing when the speed exceeds the value set in P6-04. For this type of application, the brake should be released between 2Hz and 3Hz. P6-04 should be adjusted accordingly.
Ensure that P2-15 = 0 (normally open – default setting).

P6-04: Speed hysteresis band for relay output

When P2-13 = 0, this parameter represents the speed hysteresis band around zero above which the relay contacts will close. This parameter is expressed as a percentage of P1-01. If P1-01 = 50Hz, setting P6-04 = 5% results in the relay closing when the speed exceeds 2.5Hz.

Further information :

For all hoist applications, a braking resistor must be used and the brake control enabled in P2-23. Please refer to the drive rating tables in the user guide for more information on recommended braking resistor values.