OptiDrive Advanced Technical Manual

Revision 1.01

Revision History :

Revision	***Date***	***Description***
01.00	08.06.00	First draft release
01.01	02.08.00	Options and Application Notes added

Contents :

1. Product Overview

1.1 Technology
1.2 Mains supply compatibility
1.3 Markets and applications

2. General Specifications

2.1 Input voltage ranges
2.2 Output Power and Current ratings
2.3 Self Protection features
2.4 Conformance
2.5 Environmental
2.6 Physical Dimensions

3. Design Specifications

3.1 User interface
- 3.1.1 Keypad
- 3.1.2 Display
- 3.1.3 Remote Wand

3.2 Terminals and I/O
- 3.2.1 Power terminals, earthing and screening
- 3.2.2 Digital inputs
- 3.2.3 Analog input
- 3.2.4 Analog output
- 3.2.5 Signal terminals overview

4. Parameter definitions and access

4.1 Standard Parameters
4.2 Standard Parameters – detailed description
4.4 Advanced Parameters
4.3 Advanced Parameters – detailed description

5. Fault codes, drive status and diagnostics

6. User options

6.1 Braking resistors
6.2 Mains input filters
6.3 PI controller module

7. Application Notes

1. Product Overview

1.1 Technology

The Optidrive range consists of a series of products in five physical sizes designed to provide cost-effective, easy-to-use drives for 3ph induction motors in the power range 0.37kW to 90kW. The Optidrive employs open loop voltage and frequency control to regulate the speed of the motor. The digital control is combined with the latest IGBT power semiconductor technology to give a compact, robust solution for general purpose drive applications. The product is designed for ease of use and ease of installation, together with simple programming and commissioning thereby minimising the overall applied cost of a drive solution.

1.2 Mains supply compatibility

The Optidrive is designed for direct on-line connection to world-wide supplies. The single phase units are designed to operate on 220V (200V … 240V) single or 3 phase supplies, whereas the 400V 3ph units are designed for a voltage supply in the range 380V … 480V. For more detailed information, see section 2.2

1.3 Markets and Applications

The Optidrive product range is aimed at a broad market where general motor speed control is required. Real benefits are offered to both low volume end users and to OEM customers where the ease of use and the innovative Optiwand significantly reduce commissioning time.

The simple but powerful features render the Optidrive suitable for a wide range of applications:

- **Fan controllers**
  - Air conditioning systems
  - Energy saving
  - Refrigeration systems
- **Compressors**
  - Refrigeration systems
  - Compressed air supply systems
- **Machine tools and metalworking**
  - Spindles, including high speed spindles
  - High speed cutters
  - Polishing
  - Rapid stop (E-stop)

- **Woodworking applications**
  - Lathe spindles
  - Saw mills - cut and traverse systems
  - High speed routers and planers
  - Rapid stop (E-stop)

- **Conveyors**
  - Quarry stone transportation
  - Aggregate mixing systems
  - Packaging industries

- **Pumps**
  - Paper industry
  - Water supply industry
  - Sewage systems

- **P-I control (using optional PI controller and suitable feedback transducer)**
  - Load controllers
  - Temperature controllers
  - Pressure controllers

- **IP40 applications (with IP40 Optidrive)**
  - Control room installations
  - Exposed wall mounting applications

- **IP65 applications (with IP65 Optidrive)**
  - Food processing
  - Outdoor / exposed installations

- **Textile industry**
  - Multiple motors (spindles) on one drive
  - Hi speed spindles

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 :

Optidrive sizes 1, 2 (220V) :
200V... 240V ± 10%, 1ph or 3ph, 50…60 Hz ± 5%
Optidrive sizes 1, 2, 3, 4, 5 (400V) :
380V... 480V ± 10%, 3ph, 50…60 Hz ± 5%

Those products used with a 3ph supply are designed for a maximum supply imbalance of 3% between phases. For input supplies which have supply imbalance greater than 3% (typically the Indian sub- continent & parts of Asia Pacific including China) we recommend that input line reactors are fitted.

2.2 Output Power and Current ratings

The following table relates power ratings to mechanical drive sizes.

Model	***Supply (nom)***	***Power rating***	***Output current***	***Size***
OD-12037	1ph/3ph, 220V	0.37 kW / 0.5HP	2.3 A	1
OD-12075	1ph/3ph, 220V	0.75 kW / 1HP	4.3 A	1
OD-12150	1ph/3ph, 220V	1.5 kW / 2HP	7.0 A	1
OD-14075	3ph, 400V	0.75 kW / 1HP	2.2 A	1
OD-14150	3ph, 400V	1.5 kW / 2HP	4.1 A	1
OD-22150	1ph/3ph, 220V	1.5 kW / 2HP	7.0 A	2
OD-22220	1ph/3ph, 220V	2.2 kW / 3HP	10.5 A	2
OD-24075	3ph, 400V	0.75 kW / 1HP	2.2A	2
OD-24150	3ph, 400V	1.5 kW / 2HP	4.1 A	2
OD-24220	3ph, 400V	2.2 kW / 3HP	5.8 A	2
OD-24400	3ph, 400V	4.0 kW / 5HP	9.5 A	2
OD-34055	3ph, 400V	5.5 kW / 7.5HP	13 A (18A hvac)	3
OD-34075	3ph, 400V	7.5 kW / 10HP	18 A (25A hvac)	3
OD-34110	3ph, 400V	11 kW / 15HP	25 A (29A hvac)	3
OD-34150	3ph, 400V	15 kW / 20HP	29.5 A	3
OD-44185	3ph, 400V	18.5 kW / 25HP	39 A (46A hvac)	4
OD-44220	3ph, 400V	22 kW / 30HP	46 A (61A hvac)	4
OD-44300	3ph, 400V	30 kW / 40HP	61 A (72A hvac)	4
OD-44370	3ph, 400V	37 kW / 50HP	72 A (88A hvac)	4
OD-54450	3ph, 400V	45 kW / 60HP	88 A (110A hvac)	5
OD-54550	3ph, 400V	55 kW / 75HP	110 A (145A hvac)	5
OD-54750	3ph, 400V	75 kW / 100HP	145 A (180A hvac)	5
OD-54900	3ph, 400V	90 kW / 120HP	180 A (215A hvac)	5

2.3 *Protection features*

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

- Phase - Phase short circuit
- Phase - Earth short circuit
- Output phase over-current trip
- Output current thermal overload (I^2t)
- Brake resistor short circuit
- Brake resistor thermal overload (I^2t)
- Heatsink thermal overload (trip @ 90 °C)
- DC Link Over voltage
- DC Link Under voltage
- External (thermistor) trip
- Serial communications trip

2.4 *Conformance*

All products conform to the following international standards :

- IEC 664-1 Insulation co-ordination within low voltage systems
- UL 840 Insulation co-ordination for electrical equipment
- EN 50081-2 EMC – Generic emissions standard (Industrial level)
- EN 50082-2 EMC – Generic immunity standard (Industrial level)

- Enclosure protection level 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		: 1% / 100m
Relative Humidity		: < 95% (non condensing)
Protection rating		: IP20, NEMA 0

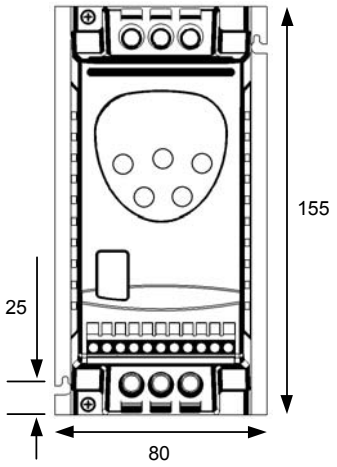
2.6 *Physical Dimensions*

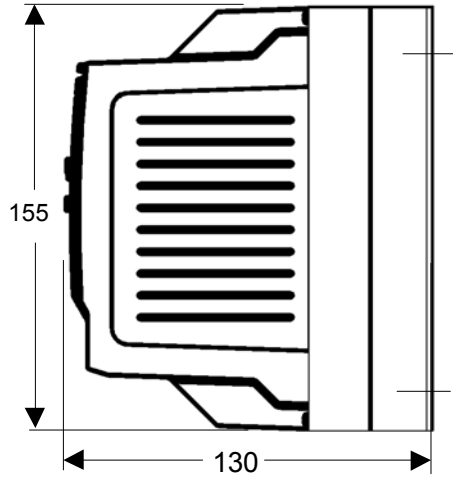
The following dimensions apply to the standard units without mains filter fitted.

Size 1 :	150 x 80 x 135	(L x W x D)
Size 2 :	260 x 100 x 150	(L x W x D)
Size 3 :	260 x 171 x 150	(L x W x D)
Size 4 :	520 x 340 x 220	(L x W x D)
Size 5 :	1040 x 340 x 220	(L x W x D)

Dimension diagrams :

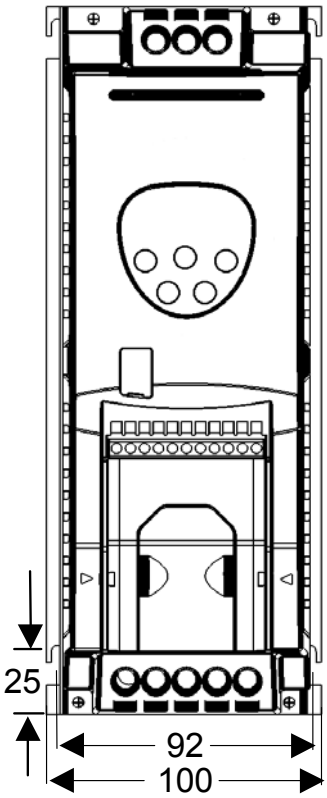
Optidrive Size #1

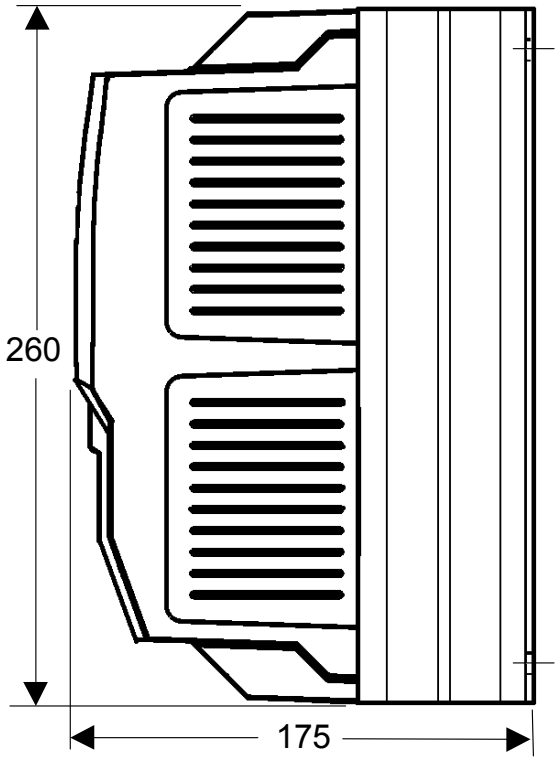




Fixing screws : 2 x M4

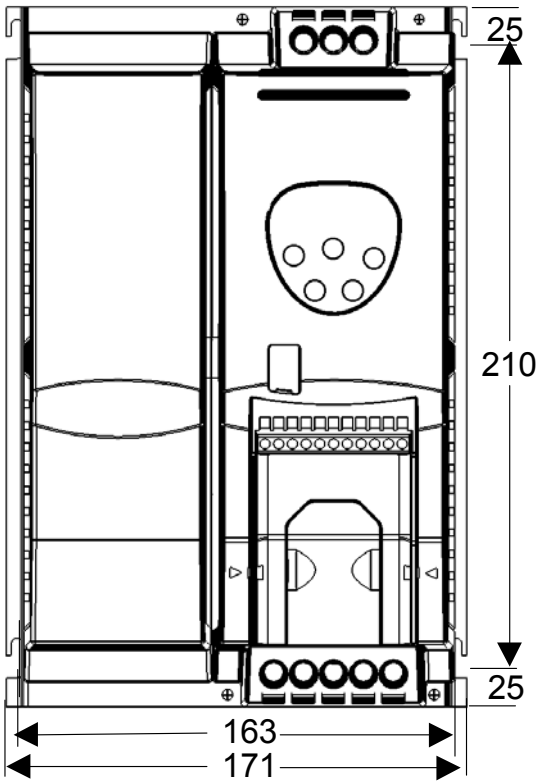
Optidrive Size #2

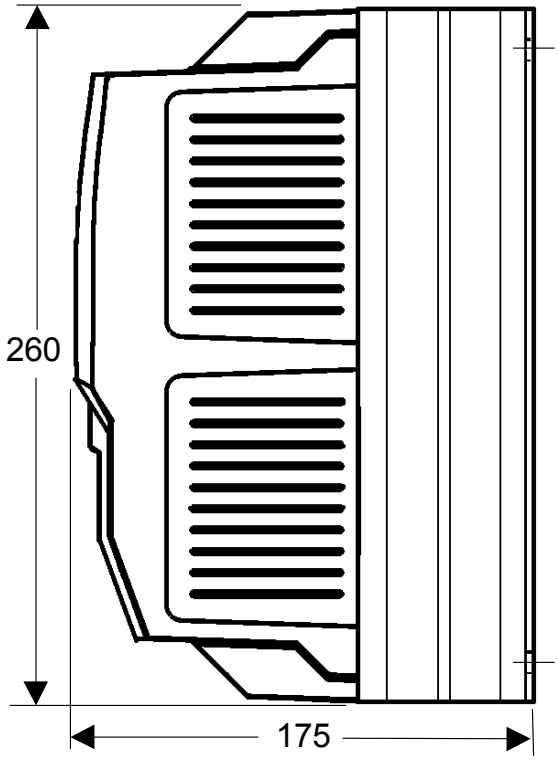




Fixing screws : 2 x M4

Optidrive Size #3





Fixing screws : 4 x M4

A range of mains input filters is available as an option for all Optidrives up to 15kW. For 18.5kW and above, the filter is built into the drive. When the filter is mounted behind the Optidrive (foot mounting), the dimensions are modified as follows :

Size #1 Optidrive : depth increased by 40mm to 170mm
Size #2 Optidrive : depth increased by 50mm to 225mm
Size #3 Optidrive : depth increased by 50mm to 225mm

In all cases, the electrical specification of the Optidrive / OptiFilter combination gives the following performance in accordance with EN50081 :

Optidrive sizes #1, #2, #3 :

Class A (industrial / EN50081-2) limits achieved for screened motor cable up to 25m

Class B (domestic / EN50081-1) limits achieved for screened motor cable up to 5m

Optidrive sizes #4, #5 (in-built filter) :

Class A (industrial / EN50081-2) limits achieved for screened motor cable up to 50m

Class B (domestic / EN50081-1) limits achieved for screened motor cable up to 5m

3. Design Specifications

3.1 User interface

3.1.1 Keypad

Each Optidrive has a keypad fitted as standard, allowing drive operation and set up without any additional equipment.

The keypad consists of 5 keys with the following functions :

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

The Start/Stop buttons on the keypad are disabled when the parameters have their factory default settings. To enable keypad operation, set P-12 to 1 or 2 (see parameter section).

The Navigate key alone is used to gain access to the parameter edit menu. Pressing and holding this key allows the user to toggle between the parameter edit menu and the real time display (where the drive operating status / running speed is displayed). This key is also used to toggle between the operating speed and operating current during drive operation.

3.1.2 Display

A standard 6-digit 7-segment display is fitted to each drive to allow drive operation to be monitored and parameters to be set.

3.1.3 Optiwand

The unique hand-held Optiwand provides a simple method of rapidly commissioning any number of Optidrives via an optical InfraRed link. The Optiwand has a large LCD graphics display allowing parameters and operating information to be displayed clearly and in any one of 12 user selectable languages. Complete Optidrive settings can be Uploaded into the Optiwand in < 1s and then transferred to other Optidrives as required. Up to 63 individual parameter sets can be stored in one Optiwand.

The Optiwand also has an edit mode which allows the user to change any parameter value and then store the change in the Optiwand. This can be done without an Optidrive being present.

The IR communications link is compatible with the IR interface on PC's, thereby allowing parameters to be transferred to / from any PC.

3.1.3 OptiStore and Optimouse

The Windows based applications program OptiStore provides the user with a means of storing complete parameter sets on a PC. These are stored as text files and can therefore be saved under any Windows compatible filename and printed out on any standard Windows printer.

Once stored in file format, parameter sets can be attached to E-mail to be sent to any E-mail destination worldwide. This facilitates a very powerful method for customer and application support.

In the event of a PC not having an optical port, the Optimouse provides a solution. The Optimouse plugs into any standard COM port on a PC, effectively providing that PC with an IrDA compatible optical port.

3.2 Terminals and I/O

3.2.1 Power terminals, earthing and screening

The full range of products have power input at the top of the unit and motor connection at the bottom. In addition, sizes 2, 3, 4 and 5 have connection for an external braking resistor next to the motor connections.

The earth connection is available on each corner of the heatsink, thereby earthing the heatsink and forming a low impedance path between motor earth and supply earth which by-passes the PCBs.

3.2.2 Digital inputs

Three digital inputs are available. All of these are programmable in terms of functionality. This functionality is defined by P-19 (see parameter descriptions).

All inputs are galvanically isolated from the drive power stage to 2.5kV. The inputs are both +ve and -ve logic activated (auto-detected by the Optidrive). Any digital input will be activated by an input voltage of <8V (-ve logic) or a voltage of >21V (positive logic). All voltages are referenced to the common 0V terminals (terminals 1, 7or 9).

All inputs will withstand up to 50V DC without damage.

3.2.3 Analog input

A bipolar 12-bit (4000 step) fully isolated analog input is available. The level of isolation is 2.5kV from the power stage. This input is used as the speed reference input, and can be configured as a voltage or current input. The max response delay of this input is < 8ms, ie within 8ms the drive will respond completely to any change on the analog input. The input is over-voltage protected up to 50V.

When used in bipolar voltage mode (-10V … 10V), the input symmetry is better than 0.2%.

The analog input format is set using P-16 (see parameter descriptions). Available settings are 0..10V, 4..20mA, 0..20mA or 20..4mA , 10..0V or -10..10V.

A 10V, 30mA voltage output is available on terminal 5 to allow the speed reference to be set using only an external potentiometer (500 Ohms or greater). The 10V output is short-circuit and over-voltage protected.

3.2.4 Analog output

A single-ended 10-bit (1000 step) analog output with a bandwidth of >100Hz is available, delivering an output voltage between 0 and 10V. This can be configured by software to represent either speed or motor current.

In motor speed mode, the output voltage is scaled linearly between 0 and 10V, representing 0 to maximum speed (as set in P-01)

In motor current mode, the output voltage is scaled linearly between 0 and 10V, where 10V represents 2x rated current, as set in P-08.

The analog output can source up to 20mA and is short circuit / over-voltage protected.

3.2.5 Signal terminals overview

The signal terminal block has the following signal connections :

- 0V common — connect digital inputs to this to activate
- Digital input 1 — active low (connect to 0V to activate)
- Digital input 2 — active low (connect to 0V to activate)
- Digital input 3 — active low (connect to 0V to activate)
- +10V ref out — 10V ref for analog input (pot supply +)
- Analog input — 0 .. 10V (4 .. 20mA when Iref enable)
- 0V common — 0V ref for analog input (pot supply -)
- Analog output — 0 .. 10V programmable analog output
- 0V common — 0V ref for analog output
- Relay common — N.O. relay contact *
- Relay N.O. — N.O. relay contact *

* The relay contacts are rated at 250V AC / 30V DC @ 10A

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.

	Speed	0 … ±60000	rpm
H	Frequency	0 … ±1000	Hz
A	Motor current	0 … 100.0	A

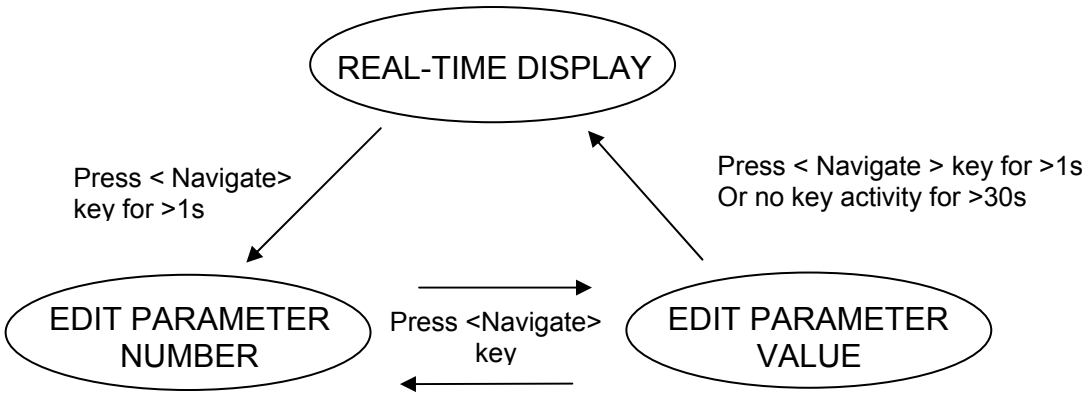
The user can scroll between these variables by pressing and releasing the <Navigate> key within 1s. The scrolling mechanism rolls over from Load back to speed.

To enter parameter access mode, press the < Navigate > button for approx. 1s. The display changes from indicating operational speed to “P-XX”, where 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 the max to min parameter number and vice versa.

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 write access has been disabled (P-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 >20s if P-01 … P-40 are being accessed, and >60s if P-00 (watch windows) is being accessed.

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 and advanced parameters accessible in the extended menu.

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

4.1 Standard parameters

The following list provides an overview of the standard parameter set :

Par	*Description*	*Range*	*Default*
P-01*	Max speed limit (Hz or rpm)	P-02 to 5*P-09 (max 1000Hz)	50Hz
P-02*	Min speed limit (Hz or rpm)	0 to P-01 (max 1000Hz)	0Hz
P-03	Accel ramp time (s)	0.0s … 3000s	5s
P-04	Decel ramp time (s)	0.0s … 3000s	5s
P-05	Stop mode select	Ramp to stop / coast to stop	Ramp to stop
P-06	V/F characteristic	Constant torque / Pump-Fan	Const. Torque
P-07	Rapid decel ramp time	0.0s … 25s (disabled when 0.0s)	0.0s
P-08	Motor rated current limit	0 to current rating of drive (Amps)	Rated I-Drive
P-09	Motor rated frequency	25 to 1000Hz	50 Hz
P-10	Motor rated speed	0 to 60,000 rpm	0
P-11	Voltage boost	0 .. 25% of max output	3%
P-12	Terminal / Keypad control of drive	0 : terminal control 1 : keypad control (fwd only) 2 : Keypad control (fwd / rev toggle using start button) 3 : terminal control (IR transmit master / slave mode enabled)	0 (terminal)
P-13	Trip log	Last four trips stored	no fault
P-14	Advanced menu access code	0 to 9999	0

* If the motor rated speed in rpm has been entered into P-10, parameters P-01, P-02, P-20 … P-23, P-27 and P-28 are in rpm.

Brief overview :

P-01, P-02 : Max / Min speed limits. Format (Hz / rpm).
P-03, P-04 : Accel / Decel time from 0 to rated frequency (ramp rate) in seconds
P-05 : Preset ramp rate to stop / Ramp to stop with DC inj / coast to stop.
P-06 : V/F characteristic – either V= K.F (linear) or V= K.F^2 (for pumps/fans).
P-07 : Fast decel ramp selected on either mains loss (P-05 = 2) or when forward AND reverse run enable are active (P-19 = 5, 7 or 9).
P-08 : Motor rated current in Amps. Defaults to max rated drive current.
P-09 : Motor rated frequency : 50 to 1000 Hz in 1Hz steps.
P-10 : Motor rated speed : when non-zero, speed related values in rpm
P-11 : Starting boost voltage: 3% default, max 25% of rated voltage
P-12 : Terminal or keypad control of motor start / stop. Setting to “2” allows keypad mode to be selected with the <Start> button toggling between forward & rev.
P-13 : Fault history log. Most recent 4 trips stored in order of occurrence
P-14 : Access to advanced menu. Default value of “101” can be changed by user by changing the value in P-37.

Parameter Zero (P-00)

Parameter zero (P-00) is a special read-only parameter which provides visibility ,a window, into the internal control functions of the drive, allowing key internal nodes to be monitored and is intended primarily as a commissioning and diagnostic aid. It is accessible in the extended parameter set. Any one of these values can be selected by scrolling between them using the <up> and <down> keys, as in the case of any other parameter. The currently selected variable is indicated by a single digit number (0 to 9) on the left hand side of the drive display.

The following internal variables can be monitored using P-00 :

1	Unscaled analog input (from user terminals)	%'age of analog input voltage
2	Speed ref from scaled (P-35) analog input	Hz,
3	Pre ramp frequency ref	Hz,
4	Post ramp frequency ref	Hz,
5	Slip frequency	Hz
6	Stator frequency	Hz
7	Applied Motor voltage	V
8	DC Bus Volts	V
9	Thermistor voltage	

Display of Slip Frequency

In its factory default state, the Optidrive has slip compensation disabled, since the rated speed of the motor will not be known to the drive. In this case, P-10 = 0 and watch window 5 above will be zero in all cases.

Once the motor rated speed in rpm has been entered into P-10, slip compensation is automatically activated and the instantaneous value of slip will be displayed in watch window 5. Slip compensation automatically attempts to maintain a constant rotor speed under varying load conditions by modifying the applied stator frequency as a function of load current.

Once P-10 has been entered, the real-time display values will also include speed in rpm in addition to applied motor frequency in Hz and motor current in A.

4.2 Standard Parameters – detailed description

P-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 (P-10) is zero. If the motor rated speed in rpm has been entered into P-10, this parameter will be displayed in rpm.

Maximum value : 5 x base frequency (ie 5 x P-09)
Minimum value : value of P-02
Default value : 50 Hz

P-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 (P-10) is zero. If the motor rated speed in rpm has been entered into P-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 P-01
Minimum value : 0
Default value : 0 Hz

P-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 P-09.

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

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

P-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 P-09) to zero.

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

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

P-05 Stop mode select

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

When set to zero (factory default), the drive speed is ramped down to zero according to the setting of P-04 whenever the drive enable signal is removed. The drive will only be disabled when the Optidrive output frequency reaches zero. (Note that DC injection braking can be used to hold zero speed if required – see parameters P-31 and P-32).
In the event of the mains supply being lost, the Optidrive will automatically attempt to keep itself operating by braking (regenerating) a rotating motor. The rate of deceleration is set also by P-04, unless P-07 has been set to a non-zero value. In this case, the deceleration ramp rate set in P-07 is used.
In general, best performance is achieved when P-07 is somewhat longer than the normal braking time and is also improved when slip compensation is activated (whenever the motor rated speed is entered into P-10).

When P-05 is set to 1, coast-to-stop is selected. In this case, the Optidrive 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 P-05 is set to 2, the motor will be ramped down to zero similarly to the case above where P-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 P-04 if P-07 = 0, otherwise at the rate defined in P-07. This allows the motor to be stopped rapidly (a form of Emergency Stop), independently of the main deceleration ramp time, in the event of the mains supply being lost.

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

P-06 V/F characteristic select

This parameter defines the rate at which the voltage is applied to the motor as the output frequency increases. For many applications the required characteristic is linear (constant torque selected when P-06 = 0), but for fan and some pump applications, a significant energy saving can be achieved at lower speeds by selecting the variable torque setting (P-06 = 1).

Maximum value : 1
Minimum value : 0

Default value : 0

P-07 Rapid deceleration ramp rate

The second deceleration ramp can be selected manually or automatically under certain conditions to effectively provide an independent, rapid stop facility that can be used in conjunction with an E-Stop. In most cases, this will be set to a lower value than the standard deceleration ramp rate in P-04

When P-07 = 0, the second deceleration ramp function is disabled.

The second deceleration ramp is activated automatically when P-06 = 0 or 2 and the mains supply is lost / removed. This ramp can also be activated manually by closing digital inputs 1 and 2 simultaneously when P-19 has been set to 5, 7 or 9. These inputs would normally be connected to a rapid stop button and could for example be linked in with an E-Stop function.

Maximum value : 25s
Minimum value : 0.0s

Default value : 0.0s

P-08 Motor rated current

The rated current of the motor to be connected to the Optidrive (as stamped on the motor rating plate) should be entered into this parameter. This allow the Optidrive 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.

Maximum value : rated current of the Optidrive
Minimum value : 0.25x rated current of the Optidrive

Default value : rated current of the Optidrive

P-09 Motor rated frequency

The rated frequency of the motor to be connected to the Optidrive (as stamped on the motor rating plate) should be entered into this parameter. This defines the frequency at which maximum (rated) output voltage is applied to the motor. Above this frequency, the voltage is held constant at this maximum value. At frequencies below the value entered in P-09, the output voltage varies in accordance with the setting of P-06 (V/F characteristic).
Note that the V/F curve can also be modified using parameters P-26 and P-29, allowing the user to adapt the V/F curve to suit non-standard motors.

Maximum value : 1000Hz
Minimum value : 25Hz

Default value : 50Hz

P-10 Motor rated speed

The rated speed of the motor (in rpm) to be connected to the Optidrive (as stamped on the motor rating plate) should be entered into this parameter if it is required that the Optidrive displays its speed in rpm. When once a value (non-zero) has been entered into this parameter, the operating speed of the motor in rpm will be available on the display. The speed related parameters (ie P-01, P-02, P-20…P-23, P-27, P-28) will also be displayed in rpm when once an rpm value has been entered into P-10.

In addition to permitting speed to be displayed in rpm, setting P-10 activates the slip compensation. In this case, the Optidrive will attempt to maintain constant rotor speed in rpm under varying load conditions. This is done by internally measuring the load current and adjusting the applied stator frequency accordingly.

It is possible also to adjust the level of slip compensation applied using the slip compensation adjustment factor (P-24).

If the user wishes to have speed displayed in rpm without any slip compensation be applied, the synchronous speed of the motor should be entered into P-10. This would be for example 3000rpm (2-pole), 1500rpm (4-pole), or 1000rpm (6-pole) for a 50Hz motor.

Maximum value : 60 x value of P-09 (eg 3000 rpm when P-09 = 50Hz)
Minimum value : 12 x value of P-09 (eg 600 rpm when P-09 = 50Hz)

Default value : 0

P-11 Voltage boost level

The voltage boost parameter sets the level of voltage that is applied to the motor at zero output frequency (DC). This is used to ensure that the motor has sufficient starting torque to accelerate cleanly away from zero.

It may be necessary to increase the level of boost if operation at low speeds is required, or if the load connected to the motor needs a particularly large starting torque. If operation at very low speed for long periods of time is required, this parameter should be used with some caution, as large values of voltage boost can cause excessive heating in the motor at low speed. This is due to the fact that the fan connected to the rotor is virtually ineffective at low speed and little or no cooling of the motor results.

The effect of the voltage boost decreases linearly from the specified value at 0Hz to zero at half rated frequency (25Hz with a 50Hz motor). This approach gives a smoother transition from maximum to zero boost as output frequency increases.

Maximum value : 25% of rated motor voltage
Minimum value : 0
Default value : 3% of motor rated voltage

P-12 Terminal / Keypad mode select

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

When P-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 using P-19.

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 Optidrive 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 AN21 for further details. If the Optidrive is stopped whilst running at a particular speed, it will return to that same speed when re-enabled (pushing the <START> button.
Note that the Optidrive must have the hardware enable signal applied (digital input 1 closed) before keypad operation is possible.
When P-12 = 1, only forward (positive) speeds are possible and a reversal in direction cannot occur.

When P-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 a positive speed direction. This ensures that there is no ambiguity as to which direction the motor will start in.

Note that when the Optidrive is to be controlled remotely from the Optiwand (or via the optical link from some other controller), the Optidrive must be in keypad mode. The keypad on the Optiwand then operates exactly like the keypad on the Optidrive.

When P-12 = 3, terminal mode is enabled exactly as when P-12 = 0. In this case, however, Master mode (for Master / Slave operation) is also enabled. The Optidrive will now transmit its speed reference signal continuously via the IR link. Any number of slave Optidrives can then be connected optically with the Master Optidrive using the OptiLink (see Application Note AN24 for details) Since the slave Optidrives receive their speed reference via the optical IR communications port, these must be in keypad mode (P-12 = 1 or 2) to function correctly. Note that the speed of each slave Optidrive can be scaled independently with respect to the Master Optidrive.

P-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 (on entering into the value of P-13).

Whenever a new trip occurs, this is entered at the top of the list and the other trips move 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 is ensure 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.

P-14 Advanced access code

This parameter allows the user to gain access to the extended parameter set (P-15 to P-40). Access is allowed when the value entered into P-14 is equal to the value held in P-37. In its factory default state, P-14 must be set to “101” in order to gain access to the extended menu.

If access to the extended menu is to be denied (for example where the parameters have been locked – see P-38), P-37 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 P-14.

Maximum value : 9999
Minimum value : 0

Default value : 0

4.3 Advanced parameters

The following list describes the advanced parameter set :

Par	***Description***	***Range***	***Default***
P-15	Motor rated voltage	220V Optidrive : 80V to 250V 400V Optidrive : 80V to 500V	0 for 220V 400V for 400V
P-16	Analog input V /mA	0-10V, 4-20mA, 0-20mA, 20-4mA, 10-0V, -10-10V	0-10V
P-17	Switching frequency	8, 16, 32 kHz for 220V units 8, 16 kHz for 400V units	16 kHz for 220V Optidrives, 8kHz for 400V units
P-18	Relay output function	0 : Optidrive Enabled 1 : Drive healthy (not tripped) 2 : Motor at set speed 3 : Motor at zero speed 4 : Motor at max speed (P-01)	0
P-19	Digital inputs function select	0 to 11, See following table	0
P-20*	Preset speed 1	P-02 (min) to P-01 (max)	50Hz / 1440 rpm
P-21*	Preset speed 2	P-02 (min) to P-01 (max)	0 Hz / rpm
P-22*	Preset speed 3	P-02 (min) to P-01 (max)	0 Hz / rpm
P-23*	Preset speed 4	P-02 (min) to P-01 (max)	0 Hz / rpm
P-24	Slip compensation correction factor	20% … 250%	100%
P-25	Analog output function select	(Analog) 0 : Motor Speed (Analog) 1 : Motor Current (Digital) 2 : Drive enabled (Digital) 3 : Motor at set speed	0
P-26	V/F characteristic adjustment factor	20% … 250%	100%
P-27*	Skip freq / speed	P-02 (min) to P-01 (max)	0 (inactive)
P-28*	Skip freq / speed band	0 to 100% of base freq (P-09)	0 Hz / rpm
P-29	V/F characteristic adjustment frequency	0 Hz to base frequency (P-09). Function disabled when set to 0.	0 Hz
P-30	Drive start mode	0 to 4	0
P-31	DC injection voltage	0.1 to 20%	10%
P-32	DC injection braking time (s)	0 to 60s	2s
P-33	DC injection on enable	0: Disable, 1: Enable	0
P-34	Brake resistor enable	0 : Disable 1, 2 : Enable	0
P-35	Analog input scaling factor	25% to 500%	100%
P-36	Drive address (s-comms)	0 to 63	0
P-37	Access code definition	0 to 9999	101
P-38	Parameter access lock	0 : All parameters can be changed and are auto-saved on power down 1 : Parameter changes not saved on power down 2 : Parameter read-only access. No changes allowed.	0 (write access and auto-save enabled)
P-39	Hours run meter	0 to 99999 hours	Read only
P-40	Software checksum	0000 to FFFF (hex)	Read only

Notes :

- To restore factory default parameters, hold <up>, <down> and <stop> keys simultaneously for >1s. This will also reset the access code, but will not affect the Hours run meter. The hours run meter cannot be reset or changed.

- Pressing the <up> and <down> keys simultaneously in parameter edit mode resets the selected parameter number / value to zero (or the minimum value as defined by the limits for that parameter).

Brief overview :

P-15 : Motor rated voltage : Enter the motor rated (nameplate) voltage into this parameter.
P-16 : Analog input format : volts or mA (0-10V, 4-20mA, 0-20mA, 20-4mA, 10-0V or –10..10V)
P-17 : Power stage switching frequency. 8kHz, 16kHz or 32kHz selectable
P-18 : Relay output function : Contacts closed if selected condition true.
P-19 : Defines function of digital inputs. (also influenced by P-16, see P-19 table)
P-20, P-21, P-22, P-23 : Define preset speeds 1, 2, 3, 4 respectively.
P-24 : Slip compensation trim factor. The internally calculated value will be scaled by the percentage value specified in this parameter. Range is 20% to 250%
P-25 : Analog output function select . Analog: 0: speed, 1: current
Digital : 2: Drive enabled, 3: Motor at set speed
P-26 : V/F adjustment level. Motor voltage adjusted by this %age value at the frequency specified in P-29
P-27, P-28 : Skip speed/frequency and band through which speed reference may pass but not stop in.
P-29 : V/F adjustment frequency. Motor voltage adjusted by the %age value specified in P-26 at the frequency specified in P-29.
P-30 : Defines how many times drive will attempt an auto-restart after a trip. The interval delay between restart attempts is 10s.
P-31, P-32 : If P-05 = 0 or 2 (ramp to zero), these parameters set the duration and level for DC braking which is applied when the ramp reaches zero.
P-33 : Activates DC injection braking on enable
P-34 : Braking resistor control. When zero, brake resistor is disabled.
P-35 : Permits analog input voltage to be scaled up / down. Range 0.2x to 5x.
P-36 : Distinct drive address for paralleled serial comms via IR link (communications disabled when P-36 = 0)
P-37 : Allows advanced menu access code (as entered in P-14) to be changed.
P-38 : Enables / disables parameter modification and whether or not parameter changes are permanently saved.
P-39 : Hours run meter. Read only parameter indicating hours of drive operation.
P-40 : Drive type identification and software checksum. Allows exact s/w version to be determined

4.4 Advanced parameters – detailed description

P-15 Motor rated voltage

This parameter allows the user to scale the applied motor voltage such that the value set in P-15 is reached when the output frequency reaches rated frequency (as set in P-09). It is therefore possible to run a 220V motor correctly when the Optidrive has a 400V supply.

In addition, when P-15 has a non-zero value, voltage compensation is activated. This ensures that the output voltage is controlled correctly independent of supply voltage and/or in internal DC bus voltage which may vary significantly during deceleration.

When this parameter is set to zero, the output voltage will vary with input voltage and during deceleration. The significant increase in motor voltage during deceleration will increase motor current and motor losses, which may mean that less (or no) braking resistors are needed.

Maximum value : 500V
Minimum value : 80V
Default value : 0 (disabled) for 230V Optidrives, 400V for 400V Optidrives

P-16 Analog input format (V / mA)

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

Voltage 0..10V, 10..0V, -10..10V
Current 4..20mA, 0..20mA, 20..4mA

When configured for one of the voltage input formats, the analog input accepts bipolar input voltages in the range -10V..10V. When set to 0..10V or 10..0V, all negative voltages will give zero speed. When set to -10..10V, all negative voltages will result in the drive running with negtive speeds, where the speed is proprtional to the magnitude of the input voltage.

All current input formats are unipolar. When 4..20mA or 20..4mA is selected, the Optidrive will automatically trip when the input current falls below 2mA. This is especially important for the inverse (20..4mA) setting where the drive would otherwise give maximum output speed if the current input was to be interrupted.

The analog input format can be switched using digital input 3 when P-19 = 0. A voltage input format will be selected when the input is open, otherwise a current input format is selected. This allows switching between a local (voltage) signal and a remote (current) signal.

P-17 Effective switching frequency

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

All 400V products are shipped with the effective output switching frequency set to 8kHz. This minimises the thermal losses in the Optidrive which therefore runs cooler. When operating at a particular switching frequency, there will be an associated acoustic noise produced by the motor at that particular switching frequency. In most industrial applications (400V supplies), this is of little consequence as backgroung noise is much greater.
However, domestic (220V) applications tend to be in quieter environments where acoustic noise is important. For this reason, all 220V Optidrives are set to 16kHz in the factory default state.

P-18 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 :

P-18 = 0 : Relay contacts closed when drive output is enabled
P-18 = 1 : Relay contacts closed when drive is healthy (no trip)
P-18 = 2 : Relay contacts closed when the output frequency is within 0.25Hz of the target (requested) frequency.
P-19 = 3 : Relay contacts closed when the output frequency is within (5% x P-09) of zero frequency.
P-19 = 4 : Relay contacts closed when the output frequency reaches the maximum (P-01) frequency.

Default value : 1 (drive healthy)

P-19 Digital inputs function select

The functionality of the digital inputs within the Optidrive is user programmable, allowing the user to select the functions required for the application.

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

The following table defines the functions of the digital inputs depending of the value of parameter P-19 (Digital input function select).

P-19	*Digi input 1 function*	*Digi input 2 function*	*Digi input 3 function*
0	Open : Stop (Disable) Closed : Run (Enable)	Open : Analog input Closed : Speed Preset 1	Volts / Current analog input
1	Open : Stop (Disable) Closed : Run (Enable)	Open : Analog input Closed : Speed Preset 1/2 (Digi input 3 selects)	Open : Speed Preset 1 Closed : Speed Preset 2
2	Open : Stop (Disable) Closed : Run (Enable)	Digital input 2 : open \ Digital input 3 : open / Digital input 3 : open \ Digital input 2 : closed / Digital input 3 : closed \ Digital input 2 : open / Digital input 3 : closed \ Digital input 2 : closed /	➔ Selects Speed Preset 1 ➔ Selects Speed Preset 2 ➔ Selects Speed Preset 3 ➔ Selects Speed Preset 4
3	Open : Stop (Disable) Closed : Run (Enable)	External trip input Open : trip, Closed : OK	Open : Analog Input Closed : Speed Preset 1
4	Open : Stop (Disable) Closed : Run (Enable)	Open : Forward Closed : Reverse	Open : Analog Input Closed : Speed Preset 1
5	Open : Stop (Disable) Closed : Fwd Enable	Open : Stop (Disable) Closed : Reverse Enable	Open : Analog Input Closed : Speed Preset 1
6	Open : Stop (Disable) Closed : Run (Enable)	Open : Forward Closed : Reverse	External trip input Open : trip, Closed : OK
7	Open : Stop (Disable) Closed : Fwd Enable	Open : Stop (Disable) Closed : Reverse Enable	External trip input Open : trip, Closed : OK
8	Open : Stop (Disable) Closed : Run (Enable)	Open : Forward Closed : Reverse	Open : Speed Preset 1 Closed : Speed Preset 2
9	Open : Stop (Disable) Closed : Fwd Enable	Open : Stop (Disable) Closed : Reverse Enable	Open : Speed Preset 1 Closed : Speed Preset 2
10	Normally Open (N.O.) Momentarily Close to run	Normally Closed (N.C.) Momentarily Open to stop	Open : Analog Input Closed : Speed Preset 1
11	Normally Open (N.O.) Push to run forwards	Normally Closed (N.C.) Momentarily Open to stop	Normally Open (N.O.) Push to run reverse

Notes :

Forward speed is defined by clockwise rotation as viewed looking towards the motor shaft.

If P-19 = 0 and digital input 3 = 0, the analog input will be in volts (0-10V) irrespective of the setting in P-16. If digital input 3 = 1, the current input format will be 4-20mA unless P-16 is set to either 0-20mA or 20..4mA. This allows the input format to be switched between voltage (local) and current (remote) formats. The dual analog input option card provides a facility for connecting the second analog input.

If P-19 <> 0, the analog input format will be defined by the setting in P-16 : (0-10V / 4-20mA / 0-20mA / 20-4mA / 10..0V / -10V..10V).

If P-19 = 5, 7 or 9 the fail-safe “wire-break” mode is supported, where either digital input 1 or 2 will be active for forward and reverse operation respectively.

In this case, a break in the wire will always result in the drive being disabled and the motor coming to zero.

Default setting : 0

P-20 … P-23 Preset / Jog speeds 1 … 4

Parameters P-20 – P-23 permit the user to define up to 4 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 P-02 (miniumum value) to P-01 (maximum value).

Maximum value : P-01
Minimum value : P-02
Default value : 50.0Hz for P-20, 0.0Hz for P-21 … P-23

P-24 Slip compensation correction factor

When the rated speed of the motor connected to the Optidrive is entered into P-10, slip compensation is automatically activated. This means that the Optidrive will attempt to maintain constant shaft speed independent of the applied mechanical load. This calculation assumes particular motor characteristics which may vary from motor to motor. This parameter allows the user to trim the level of slip compensation applied. When set to the factory default value (100%), there is no change to the slip compensation applied.

Maximum value : 250%
Minimum value : 20%
Default value : 100%

P-25 Analog output function

The function of the analog output can be controlled using this parameter. The following options are available :

Analog output mode
P-25 = 0 : Motor Speed. 0V = zero speed, +10V = max speed (P-01)
P-25 = 1 : Motor Current. +10V = 200% of the motor rated current (P-08)

Digital output mode
P-25 = 2 : +5V when drive enabled, 0V when disabled
P-25 = 3 : +5V when motor at set speed, 0V otherwise

Digital output modem can be used in conjunction with the optional 2nd relay output module. This 2nd relay is driven by the digital output and effectively adds an independent relay output to that within the Optidrive (controlled from P-18).

Default value : 0 (analog speed otuput)

P-26, P-29 V/F characteristic adjustment

The Voltage - Frequency characteristic defines the level of voltage that is applied to the motor at any given frequency. Depending on the setting of P-06, this will have either a linear characteristic (where voltage increases linearly with frequency – P-06 = 0) or a quadratic characteristic (where voltage increases in proportion to (frequency)^2 – P-06 = 1).

Firstly, the above characteristic will be modified by the setting of P-11 (voltage boost level). Parameters P-26 and P-29 then give an extra level of adaptation, allowing the user to further modify the V/F characteristic should this be required.

Parameter P-29 can be set to any frequency between 0 and the base frequency (P-09) and represents the frequency at which the percentage adjustment level set in P-26 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 P-26 / P-29 is the same as getting hold of the rubber band at the frequency specified in P-29 and moving it up or down to represent the voltage adjustment level specified in P-26. 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.

When P-29 = 0, this function is disabled.

P-26 :	P-29 :
Maximum value : 250%	Maximum value : P-09
Minimum value : 20%	Minimum value : 0 Hz
Default value : 100%	Default value : 0 Hz

P-27, P-28 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 may in some cases cause mechanical stresses that could lead to mechanical failure.

Parameter P-27 specifies the centre point of the skip frequency band and P-28 the width of that band. Consider the following example :

P-27 = 30Hz, P-28 = 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 P-03 and P-04.

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

P-27 :	P-28 :
Maximum value : P-01	Maximum value : P-01
Minimum value : 0	Minimum value : 0
Default value : 0	Default value : 0

P-30 Start mode / Auto reset select

This parameter allows the user to define the start-up mode of the Optidrive 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 power-down to start)
	Auto-0	(Auto-run – enables whenever a run signal is present (assuming no trip)
	Auto-1 → Auto-4	(As Auto-0, except for the fact that the Optidrive 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.

In the factory default setting (Auto-run), the Optidrive 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 P-30 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 have 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)

P-31, P-32, P-33 DC injection braking control

DC injection braking is typically applied just before the output of the Optidrive is disabled (when a stop command has been issued) to ensure that the motor has come to standstill. This is often used in conjunction with a mechanical brake which can be activated using the on-board relay (configured using P-18). The relay contacts will only open when the Optidrive disables its output (P-18 = 0) ie after DC injection braking has been applied.

To cater for different motors / inertias, the level of DC injection braking (voltage) can be set using P-31 and the duration in seconds in P-32.

Note that DC injection braking is only applied after a stop signal has been issued (drive enable removed) and the output has ramped to zero. If coast to stop has been selected (P-05 = 1), DC injection braking will not be applied.

In some applications (typically fans and pumps) a motor / load may freewheel when not being driven by the Optidrive (due to air / fluid flow). In these cases, it is beneficial to brake the motor to standstill before attempting to accelerate it up to the operational speed. This prevents possible over-current trips that may otherwise occur. In such cases, the motor can be also braked to zero using DC injection braking. In this case, it must be applied after an enable signal has been applied prior to the output ramping up from zero.

P-34 External braking resistor selection

If an external braking resistor is to be used with the Optidrive to enable high inertia loads to be stopped rapidly, P-34 must be set accordingly. The following options are available :

P-34 = 0 Internal braking control disabled. Braking resistor has no effect.

P-34 = 1 Internal braking control activated. In addition, the internal power dissipation monitor is activated which ensures that the thermal limit of the externally connected braking resistor is not exceeded. This monitor assumes that one or more of the Invertek Drives “Optibrake” braking resistors is connected, where the thermal limits are known.
If the power dissipation limit is exceeded, the Optidrive will trip displaying the message “OL-br” (Overload brake resistor).
In the event of other (non-Invertek) resistors being used, P-34 should be set to 2.

P-34 = 2 Internal braking control activated. The internal power dissipation monitor is disabled. This means that it is now possible to overload the external braking resistor and other protection

methods should be considered. This setting should be used if, for example, high power braking resistors are connected.

Default setting : 0 (braking resistor control disabled)

P-35 Speed reference input scaling factor

This parameter is used to scale either the analog speed reference or the digital speed reference, depending on whether the Optidrive is in terminal or keypad mode.

When the Optidrive is in terminal mode (P-12 = 0 or 3), this parameter is used to scale the analog input so that a 0...10V signal on the input controls the output speed linearly between the minimum (P-02) and maximum (P-01) speed limits. The adjustment of P-35 to match the operating range P-02 to P-01 is done automatically by the Optidrive whenever P-01 or P-02 is changed.

When the Optidrive is in keypad mode (P-12 = 1 or 2), P-35 will typically have a value of 100%, irrespective of the settings of P-01 and P-02. If the Optidrive is being controlled from its own keypad, or via keys connected to the input terminal strip (remote push-button control), there will normally be no need to change P-35.

In Master / Slave mode, all slave drives must be in keypad mode (ie P-12 = 1 or 2). If the relative speeds of the Master and various slave drives need to be set independently to suit the application (speed scaling), this can be done by setting P-35 to the required value in each of the slave drives. Any slave drive can be set to run at between 20% and 500% of the Master drive.

Note that the acceleration ramp times should be scaled by the same factor as the Master / Slave speed. For example, if a slave drive runs to 2x the speed of the Master drive, its accel / decel ramp times should be set to 0.5x those of the Master. This ensures accurate ramp rate following in addition to end speed following.

Master / Slave mode utilises OptiLink – an easy-to-use polymer fibre interconnect system that allows multiple Optidrives to communicate optically. This is described in more detail in the Application Note section.

Maximum value : 500%
Minimum value : 20%
Default setting : 100%

P-36 Serial communications drive address

All communications between the Optidrive an other peripheral products (eg Optiwand, OptiGate etc) is carried out via the optical IrDA interface. To allow multiple drive communications networks (where multiple Optidrives are

connected to the same optical link), it is necessary for each drive to have its own unique identifier ie drive address.

The drive address can be set to any value between 1 and 63, allowing upto 63 discrete drives to be connected on the same optical network. When any Optidrive 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 P-36 = 0, all communications are disabled.

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

P-37 Advanced menu access code definition

Parameter P-37 can be used to allow the user to specify their own extended menu access code. Access to the extended menu (P-15 to P-40) is only permitted when the value entered into P-14 equals that stored in P-37. In this way, the user may change to code from the standard value of “101” to any desired value. This feature is often used in conjunction with P-38 (parameter write access)

Maximum value : 9999
Minimum value : 0
Default setting : 101

P-38 Parameter access control

This parameter allows the user to specify what type of access to parameters is to be permitted and can as such be used to lock all parameter write (change) operations. The following settings are available :

P-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.

P-38 = 1 All parameters can be accessed and changed. All changes will saved in temporary memory and will be functional until the Optidrive is powered down. After the next power up, the parameter settings will be extracted from permanent memory such that all changes made with P-38 = 1 will be lost. This setting may be used to test experimental settings without risk of losing a known set of parameter settings.

P-38 = 2 All parameters can be accessed for read purposes but changes are not permitted. This ensures that a set of working parameters are not changed by unauthorised users. If P-38 has been set to 2, the user can then specify an extended access code in P-37. Only with this code can access to the extended menu be obtained and P-38 changed to 1 or 2.

Maximum value : 1
Minimum value : 0

Default setting : 0 (all changes permitted and changes automatically saved)

P-39 Hours run indicator

This is a read only parameter indicating the number of hours that the Optidrive has been running. It is not re-settable and therefore holds useful information on the lifetime of the Optidrive and / or the equipment that it is driving.

P-40 Drive type identifier / software version

This read only parameter allows the user to determine the Optidrive voltage and power rating in addition to the software version.

A typical display indicating the voltage/power rating would be H3 7.5, indicating a 400V, 3phase 7.5kW rating. Similarly, a diaply of L1 0.75 would indicate a rating of 230V, 1phase 0.75kW.

The software version (eg 1.05) will be displayed if the user presses the <UP> key on the Optidrive keypad.

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
Drive running : Output frequency / speed of drive, or motor current
Fault / trip : fault mnemonic as defined below.

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

Mnemonic	***Description***
StoP	Drive power stage disabled. This message will be displayed when drive is stopped and no are faults present. The drive is ready for normal operation.
P-deF	Default parameters loaded. This message will be displayed when the user invokes the command to load the factory default parameters.
O-I	Over-current on drive output. If this occurs during normal operation, it may indicate an excessive acceleration rate or that the kW rating of the motor is greater than that of the drive.
O-Uolt	Over-voltage on DC bus. This may occur if the deceleration rate is too rapid. Normally, this can be resolved by fitting an external braking resistor(s) to the Optidrive power terminals. Ensure that P-34 is set to 1 or 2 to enable the Optidrive internal braking circuit.
U-Uolt	Under voltage on DC bus. This indicates that the mains supply voltage is below the minimum limit. This message occurs naturally every time the supply to the drive is switched off.
OL-br	Brak resistor thermal overload. When P-34 = 1, the Optidrive monitors the power dissipation in the braking resistor(s) connected to the Optidrive. If the permitted internal limit is exceeded, the Optidrive will trip with this fault message. The deceleration ramp time must either be reduced or more braking resistors must be added. When multiple brake resistors are used, the minimum braking resistor ohmic value must be observed.
OI-b	Brake resistor short circuit. This usually indicates a low resistance or short circuit across the braking resistor.
I.t-trP	Motor thermal overload. When the motor current level exceeds 100% of the motor current value entered into P-08, the Optidrive will monitor the level and duration of the overload. Depending on the overload level, the Optidrive will trip with this message after a certain time period. Typically, the Optidrive will deliver 150% of the current in P-08 for 1 minute.
th-Flt	Faulty thermistor on heatsink. This is not a user serviceable part. The user must refer to their authorised Optidrive distributor to rectify this fault.
EE-F	EEPROM checksum failure. Parameters not saved, defaults reloaded. This is not a user serviceable part. The user must refer to their authorised Optidrive distributor to rectify this fault.
PS-Flt	Internal power stage fault, indicating an over-current or a thermal overload within the power switching module. If this fault occurs as soon as the Optidrive is enabled, it may indicate a failed power module. In this case, The user must refer to their authorised Optidrive distributor to rectify this fault.

O-t	Heatsink over temperature. This generally indicates that the Optidrive is operating at too high a switching frequency for the operating load and / or environmental temperature. Reduce the switching frequency or improve airflow / cooling to overcome this problem.
E-trP	External trip. This trip message occurs when one of the digital inputs has been configured (using P-19) to support an external trip. Depending on the setting of P-19, this may be Digital input 2 or 3. Both of these inputs are suitable for thermistor connection (type PT100). When this input is shorted to 0V (or < 2k), no trip will occur. When the resistance increases beyond 5k , the Optidrive will trip on E-trP.
SC-trP	Serial communications trip. Communication between the Master and Slave Optidrives in Master / Slave mode has been interrupted. Ensure that the OptiLink is intact.
Ain-F	The voltage present on the analog input has increased beyond 15V. The voltage on the analog input should remain in the range –10V…+10V for correct operation.
Iin-F	The current level on the analog input has fallen below 2mA when the input is configured for 4..20mA operation. The current should remain within the expected range.

Overcurrent :

If the drive is required to accelerate / decelerate at a rate that would require >150%, the increased current level will be limited to 175% drive current by hardware. This may result in the motor accel / decel rate not being achieved.

If excessive acceleration / deceleration is selected (very low ramp rates), it is possible that the drive may trip on overcurrent (O-I).

When the drive is delivering >100% motor current, an I.t integral will result in the drive tripping, should the permitted time limit be exceeded. This will occur after 1 minute at 150%.

6. User options

The easy-to-use, yet powerful features of the Optidrive are enhanced by a range of options. A further powerful feature of these options is that they can be retrofitted to the Optidrive without the user having to re-design the mechanical layout of his application.

1. Power dump resistor (applies to size #2 upwards)

All Optidrives (excluding size #1) are fitted with a power dump module as standard. In conjunction with an external braking resistor(s), the Optidrive can be configured to decelerate rapidly, where the inertial energy of the load is dumped as heat in the braking resistor. In so doing, the otherwise inevitable over-voltage trip is eliminated.

To maintain the ease-of-use concept, the brake resistor(s) are custom designed to be mounted on the side of the heatsink of the Optidrive. This provides ideal cooling for the resistors and requires no additional mounting space within the cabinet.

To protect against thermal overload, the Optidrive can be set to monitor the power dissipation within the brake resistor (applies to the standard Invertek “Optibrake” resistors only). If the thermal limit of the resistor is exceeded, the Optidrive will trip before damage to the resistor results. This feature is activated when P-34 = 1.

This monitor can be disabled (P-34 = 2), allowing braking resistors with greater power to used.

Each of the resistors is fitted with an internal fusible link. This eliminates the risk of massive overheating of the resistor should any other component fail.

One standard braking resistor (250W) has been designed for use with sizes #2 and #3 Optidrives. Each Optidrive can accommodate two braking resistors - one on either side of the Optidrive heatsink.

A larger (500W) resistor is available for Optidrives sizes #4 and #5. These have the same design features as the above resistor.

INVERTEK DRIVES LTD

OPTIBRAKE

User Guide

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SAFETY

This brake resistor is specifically designed to be used with the Optidrive variable speed drive product and is intended for professional incorporation into complete equipment or systems. If installed incorrectly it may present a safety hazard. The Optidrive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction.
System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must read carefully this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the Optibrake, including the specified environmental limitations.
Please read the IMPORTANT SAFETY INFORMATION below, and all Warning and Caution boxes elsewhere.

SAFETY NOTICES

WARNING is given where there is a hazard that could lead to injury or death of personnel.
CAUTION is given where there is a hazard that could lead to damage to equipment.

It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with 89/336/EEC, Electromagnetic Compatibility.

WARNING
Within the European Union, all machinery in which this product is used must comply with the Directive 89/392/EEC, Safety of Machinery. In particular, the equipment should comply with EN60204-1.

WARRANTY

All Invertek Drives Ltd (IDL) products carry a 2-year warranty, valid from the date of manufacture.

Complete Warranty Terms and Conditions are available upon request from your IDL Authorised Distributor.

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Part No. 82-OBMAN-UK
Rev 01, ECN0008 May 1999

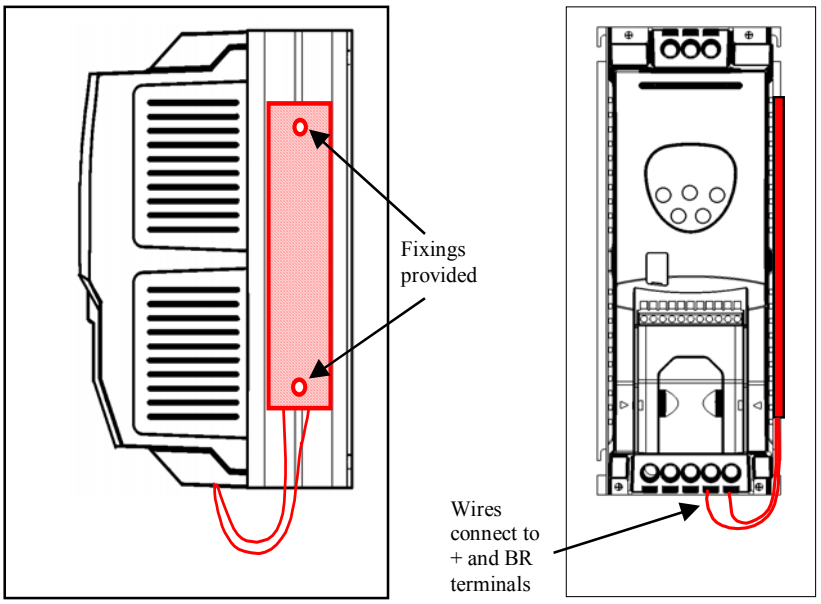
MECHANICAL AND ELECTRICAL INSTALLATION

CAUTION
- Carefully inspect the Optibrake before installation to ensure it is undamaged.
- Store the Optibrake in its box until wanted. Storage should be clean and dry. Temperature range –40°C to +60°C.
- Install the Optibrake on to the Optidrive heat-sink ensuring it mounts securely and achieves a good thermal contact. The Optidrive should then be mounted onto a flat, vertical, flame-resistant vibration-free mounting within an IP54 or equivalent enclosure (EN60529).
- Flammable materials should not be placed close to the Optibrake.

WARNING
- Optibrakes should be installed only by qualified electrical persons and in accordance with local and national regulations and codes of practice.
- ***Electric shock hazard!*** Disconnect and **ISOLATE** the Optidrive before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply.
- Where the electrical supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.
- Note in operation the surface of the Optibrake can reach temperatures in excess of 100°C.

SPECIFICATIONS

Optibrake for Optidrive Size 2 and 3	200 Watt continious	6kW peak for 0.132 S
Optibrake for Optidrive Size 4	5oo Watt continious	25kW peak for 0.132 S



EASY START UP

- Optibrake is designed to slide on to the side of the Optidrive heatsink creating a simple integrated assembly.
- Fixing screws for the Optibrake are provided along with spring washers. Ensure these are fastened securely before operation.
- The wires of the Optibrake connect to the + and BR terminals on the Optidrive, orientation is not important.
- To enable the Optibrake to work Parameter 34 of the drive needs setting to 1 *(NOT to 2 as this would disable software overload protection of the resistor)*. Note to access P34 the value of P14 may need to be set to 101, refer to the Optidrive manual for further information.
- For heavy braking applications a maximium of two resistors can be fitted in parallel, one to either side of the Optidrive.

CONFORMITY with STANDARDS

For an Optidrive fitted with an Optibrake the following standards apply:
- CE-marked for Low Voltage Directive.
- IEC 664-1 Insulation Coordination within Low Voltage Systems.
- UL 840 Insulation coordination for electrical equipment.
- EN50081-2 EMC Generic Emissions Standard, Industrial Level.
- EN50082-2 EMC Generic Immunity Standard, Industrial Level.
- Enclosure ingress protection, EN60529 IP20, NEMA 250.
- Flammability rating according to UL 94.

G O Jones, Technical Director

For use with following Optidrives	OD-BRES02-IN	22110 22150 22220	24075 24110 24150 24220 24300 24400	34055 34075 34110 34150
	OD-BRES04_IN	44185 44220 44300 44375		

2. *External filter unit*

In order to comply with the European standards on emissions (EN50081-1 and EN50081-2), a range of optional mains filters are available for use with the Optidrive.
To maintain the ease-of-use concept, the filters are custom designed to be mounted on the base of the heatsink of the Optidrive. This requires no additional “floor space” within the cabinet.

The mains filters are supplied with integral power cables that should be connected to the input of the associated Optidrive. In addition to the inherent earth connection through the mechanical mounting of the Optidrive on top of the filter, an additional earth connection ensures that the necessary earth connection is present.

The filters are available in both single and 3-phase versions for the size #1 and size #2 Optidrives and a 3-phase version for the size #3 Optidrives. Size #4 and size #5 Optidrives have an integral filter.

To obtain the desired level of conducted and radiated emissions, it is essential that the mains filter and motor cable are connected in accordance with the User Guide (see next page). The motor cable should have an earthed screen, which must be connected at both the drive and motor side.

Depending on the length of the motor cable, the mains filter allows compliance with the more stringent light industrial (domestic / class B) emissions levels. Exact details are shown in the User Guide (see next page).

INVERTEK DRIVES LTD

OPTIFILTER

User Guide

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation.
The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.

SAFETY

This filter is specifically designed to be used with the Optidrive variable speed drive product and is intended for professional incorporation into complete equipment or systems. If installed incorrectly it may present a safety hazard. The Optidrive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control mechanical plant that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction.
System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must read carefully this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the Optifilter, including the specified environmental limitations.
Please read the IMPORTANT SAFETY INFORMATION below, and all Warning and Caution boxes elsewhere.

SAFETY NOTICES

WARNING is given where there is a hazard that could lead to injury or death of personnel.
CAUTION is given where there is a hazard that could lead to damage to equipment.

It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with 89/336/EEC, Electromagnetic Compatibility.

WARNING
Within the European Union, all machinery in which this product is used must comply with the Directive 89/392/EEC, Safety of Machinery. In particular, the equipment should comply with EN60204-1.

WARRANTY

All Invertek Drives Ltd (IDL) products carry a 2-year warranty, valid from the date of manufacture. This date is clearly visible on the rating label.

Complete Warranty Terms and Conditions are available upon request from your IDL Authorised Distributor.

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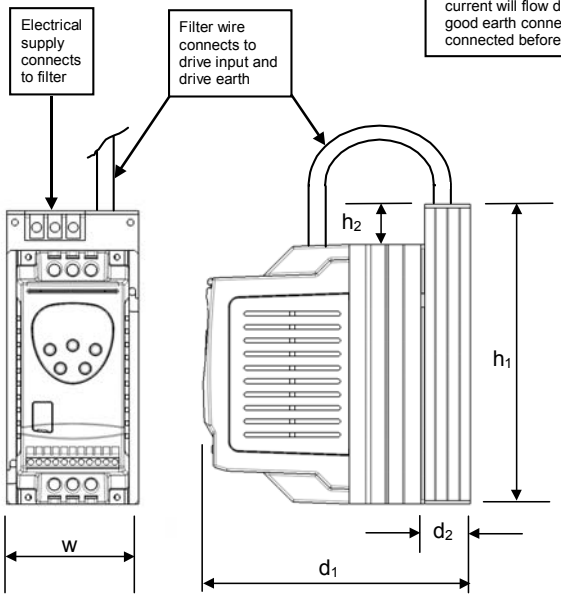
Part No. 82-OFMAN-UK
Rev 01, ECN0008 March 1999

MECHANICAL AND ELECTRICAL INSTALLATION

CAUTION
- Carefully inspect the Optifilter before installation to ensure it is undamaged.
- Store the Optifilter in its box until wanted. Storage should be clean and dry. Temperature range –40°C to +60°C.
- Install the Optifilter on a flat, vertical, flame-resistant vibration-free mounting within an IP54 or equivalent enclosure (EN60529).
- Flammable material should not be placed close to the filter.
- Wherever control cabling is close to power cabling, maintain a minimum separation of 100 mm **and** arrange crossings at 90°

WARNING
- Optifilters should be installed only by qualified electrical persons and in accordance with local and national regulations and codes of practice.
- ***Electric shock hazard!*** Disconnect and **ISOLATE** the Optidrive before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply.
- Where the electrical supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.
- These filters contain capacitors that are connected between phase and earth; a leakage current will flow during normal operation, therefore a good earth connection is essential and must be connected before applying power to the filter.



CONFORMITY with STANDARDS

- CE-marked for Low Voltage Directive.
- IEC 664-1 Insulation Coordination within Low Voltage Systems.
- UL 840 Insulation coordination for electrical equipment.
- EN50081-2 EMC Generic Emissions Standard, Industrial Level.
- EN50082-2 EMC Generic Immunity Standard, Industrial Level.
- Enclosure ingress protection, EN60529 IP20, NEMA 250.
- Flammability rating according to UL 94.

G O Jones · Technical Director

EASY START UP
- Optifilter is designed to slide on to the back of the Optidrive heatsink creating a simple integrated assembly.
- Fixing holes for the combined assembly are the same as for the standalone drive; longer screws are provided.
- The electrical supply connects to the filter; connection of the supply earth to the filter earth is essential.
- The filter wire (see diagram above) connects to the drive input and drive earth points as per the label on the wire.
- When screened motor cable is used and connected as per the Optidrive manual employing good wiring practice, the integrated Optifilter and Optidrive assembly meets the European standard for EMC for motor - drive cable lengths defined in the table below.

Size		1	1	2	2	3
Optifilter model reference	OD-xxxx-IN	F1121	F1341	F2121	F2341	F3341
Supply voltage	+/- 10%	220-240	220-480	220-240	220-480	220-480
Phases		1	3	1	3	3
Output current (max)	A	10	6	16	30	30
Earth leakage	mA	<1.6	<30	<1.6	<30	<30
Dimensions	W	90	90	105	105	105
	H1	200	200	300	300	300
	H2	30	30	20	20	20
	D1	175	175	225	225	225
	D2	45	45	50	50	50
Weight (filter only)	kg	0.5	0.5	0.9	0.9	0.9
Weight (filter + drive)	kg	1.6	1.6	3.7	3.7	6.5
Compliance to Conducted Emissions standards						
EN 50081-1 (Domestic): motor-drive cable length						
Drive Fsw (P-17) =8kHz	m	10	3	5	5	5
Drive Fsw (P-17) =16kHz	m	5	3	5	5	5
Drive Fsw (P-17) =32kHz	m	5	3	5	5	5
EN50081-2 (industrial): motor-drive cable length						
Drive Fsw (P-17) =8kHz	m	40	10	35	35	30
Drive Fsw (P-17) =16kHz	m	30	10	30	30	30
Drive Fsw (P-17) =32kHz	m	25	8	25	25	25
Compliance to Radiated Emissions standards		All Optidrives comply to EN 50081-1 with or without filter				
For use with following Optidrives	OD-xxxxx-IN	12037 12055 12075 12150	14075 14150	22110 22150 22220	24075 24110 24150 24220 24300 24400	34055 34075 34110 34150

3. PI controller module

To further extend the application areas of the Optidrive, a PI controller module is available. This is designed to plug directly into the Optidrive User control terminal strip and requires no additional external power sources.

The PI controller input will support feedback transducers with either a 0…10V (3-wire) format or a 4…20mA (2-wire) format.

The feedback transducer can also draw its supply from the PI controller card, provided that it will function correctly on a 10V supply.

Application areas include :

- Temperature control
- Pressure control
- Flow rate control
- Closed loop speed control

The PI controller is designed primarily for systems that have a response time in the range 0.1s to 10s – a typical range for many applications.

Both the Proportional and Integral gains can be set. The P-Gain is set using a 5-turn potentiometer. The integral gain can be changed to 0.1s, 1s or 10s by setting up the on-board switches. These settings are detailed in the User Guide (see next page)

In a similar fashion, the format of both the reference input and feedback inputs can be set using the on-board switches.

If the system is to be set to run at a preset level, an on-board reference potentiometer can be used to adjust the quantity being controlled to the required level. In this way, the system can be set up without the need for an external reference signal.

PI OPTION MODULE

User Guide

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SAFETY

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System design, installation, commissioning and maintenance must be carried out only by personnel who have the necessary training and experience. They must read carefully this safety information and the instructions in this Guide and follow all information regarding transport, storage, installation and use of the Option module, including the specified environmental limitations.
Please read the IMPORTANT SAFETY INFORMATION below, and all Warning and Caution boxes elsewhere.

SAFETY NOTICES

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WARNING
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WARRANTY

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Complete Warranty Terms and Conditions are available upon request from your IDL Authorised Distributor.

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Part No. 82-PICON-UK
Rev 03, ECN0018, November 1999

MECHANICAL AND ELECTRICAL INSTALLATION

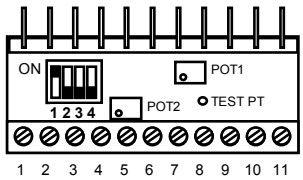
CAUTION
- Store the Optidrive Option Module in its box until required. It should be stored in a clean and dry environment. Temperature range –40°C to +60°C.
- Install the Option Module onto the Optidrive by inserting the row of 11 pins into the terminal connector of the Optidrive, ensuring that the terminals are tightened.
- If the Option Module is being used with Size#1 Optidrive, care should be taken to support the Option Module when the terminal screws of the Option Module are being tightened or loosened.

WARNING
- Optidrives and the Option Modules should be installed only by qualified electrical persons and in accordance with local and national regulations and codes of practice.
- ***Electric shock hazard!*** Disconnect and **ISOLATE** the Optidrive before attempting any work on it. High voltages are present at the terminals and within the drive for up to 10 minutes after disconnection of the electrical supply.
- Where the electrical supply to the drive is through a plug and socket connector, do not disconnect until 10 minutes have elapsed after turning off the supply.

SPECIFICATIONS

Rated reference input :	+/- 10V DC or 4…20mA	Proportional gain range :	0.2 …. 30
Rated feedback input :	+/- 10V DC or 4…20mA	Integral gain settings :	0.1s, 1s, 10s
Max input voltage :	+/- 50V DC	Conformity :	IP20, UL94V-0
Environmental :	-10ºC … +50ºC		

SWITCH SETTINGS FOR OPERATIONAL MODE SELECTION



	Switch Open (OFF)	Switch Closed (ON)
S1 *	Integral gain 0.1s	Integral gain 1s
S2 *	Integral gain 0.1s	Integral gain 10s
S3	Feedback format 0…10V	Feedback format 4…20mA
S4	Reference format 0…10V	Reference format 4…20mA

* The greater integral time will take precedence should S1 and S2 be closed at the same time.

Note :
P-16 must be set to voltage mode (0-10V) to support this option module.

POTENTIOMETER SETTINGS

POTENTIOMETER 1 : REFERENCE VOLTAGE PRESET

For those applications that require a fixed preset operating point, an on-board preset potentiometer is available to avoid having to use an external potentiometer for this type of application. To use this feature, S4 must be open (Off).
The preset voltage ranges from 0V (fully anticlockwise) to 10V (fully clockwise). Note that the preset voltage can be measured on the PI Option Module test point (see diagram above).

Important Note : If an external reference is used (either voltage or current format), this potentiometer must be turned to zero (fully anti-clockwise). If this is not done, an offset will be introduced by POT1.

POTENTIOMETER 2 : PROPORTIONAL GAIN ADJUST

The proportional gain of the PI controller is adjusted using POT2 (see above diagram). Minimum gain is achieved by turning the Potentiometer fully anti-clockwise. In general, it is best use this setting as the starting point during commissioning of this Option Module with the Optidrive in any application.

General Notes :
- **When the 4..20mA setting is used for either the feedback (pin 7) *or* reference (pin 6) input and the 0.10V setting is used for the other input (eg 0..10V ref, 4..20mA feedback), the voltages measured on pins 6 and 7 will be different under stable operating conditions. This is due to an offset of 2.5V that is introduced internally to support 4..20mA operation. Control settles with the 0..10V input nominally 2.5V *lower* than the 4..20mA input.**
- Both Potentiometers 1 and 2 are 5-turn types, ie they require 5 full turns to cover the full range. In the event of the maximum or minimum point being reached, the adjustment disengages to avoid mechanical damage.

Both POT1 and 2 are turned to their minimum values (fully anti-clockwise) when delivered from Invertek Drives Ltd.

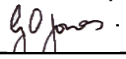
OPTION MODULE CONTROL TERMINALS

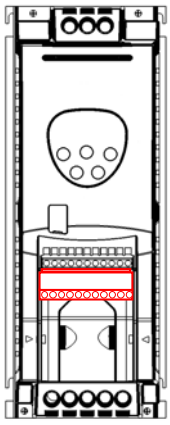
* The analog PI inputs must be connected to terminals 6 and 7.

STANDARDS CONFORMITY

An Optidrive fitted with this Option Module complies with the following standards:

- CE-marked for Low Voltage Directive.
- IEC 664-1 Insulation Coordination within Low Voltage Systems.
- UL 840 Insulation coordination for electrical equipment.
- EN50081-2 EMC Generic Emissions Standard, Industrial Level.
- EN50082-2 EMC Generic Immunity Standard, Industrial Level.
- Enclosure ingress protection, EN60529 IP20, NEMA 250.
- Flammability rating according to UL 94.





Option PCB inserted into Optidrive control terminal strip.

All 11 terminal screws on the Optidrive must be tightened to ensure good electrical contact and correct functionality.

Optidrive size 2

7. Application Notes

Ref No	*Application Note Description*
AN01	Matching the Optidrive to the motor
AN02	Selecting between Constant torque mode and fan / pump mode
AN03	Selecting the required stop mode
AN04	Locking parameters to prevent unauthorised changes
AN05	Displaying motor speed in RPM
AN06	Switching between voltage (local) and current (remote) reference inputs
AN07	Setting up skip frequency ranges
AN08	Selecting the required start / restart mode
AN09	Programming the output relay
AN10	Using the second relay output option module
AN11	Adjusting the slip compensation to maintain constant rotor speed
AN12	
AN13	
AN14	
AN15	
AN16	
AN17	Activating DC bus voltage compensation (active motor voltage control)
AN18	Adjusting the V/F characteristic
AN19	Using the Optidrive with 2 preset speeds and forward / reverse
AN20	Using the Optidrive with 4 preset speeds
AN21	Using the Optidrive with remote push-buttons for speed control
AN22	Using the Optidrive with 8 preset speeds
AN23	DC injection braking on the Optidrive
AN24	Master / Slave operation using the Optical Link
AN25	Optidrive communications protocol
AN26	PI control using the PI option module
AN27	
AN28	
AN29	
AN30	

Application Note AN 01

Matching the Optidrive to the motor

- ***General***

For the majority of industrial applications, the Optidrive will spin a motor without any parameter adjustments being made to the Optidrive. In general, the “nameplate data” taken from the rating plate of the motor should be entered into the Optidrive to ensure that the Optidrive is matched to the motor, thereby avoiding the risk of damage to the motor occurring.

- ***Rating plate parameters***

P-08 Motor rated current

The motor rated current in Amps should be entered into this parameter. Most industrial motors have a Star / Delta rating to allow operation at different voltages. Care should be taken to ensure that the current rating taken from the ratings plate corresponds to the motor voltage rating (this depends on the way in which the motor is connected (Star or Delta).
Typically, this will be displayed as 220V / 400V 3.3A / 1.9A

When this parameter has been set, the Optidrive will monitor the current and be able to determine whether or not the motor is in overload. Should the motor run in an overload condition for long periods of time (minutes), the Optidrive will trip. This provides one level of protection to prevent the motor from overheating.

The factory default value for this parameter is the rated current of the Optidrive.

P-09 Motor rated frequency

The motor rated frequency in Hertz should be entered into this parameter. In general, this value will be 50Hz so that no change is required to the factory default setting.

This parameter is changed for use with high-speed motors or with 60Hz motors.

P-10 Motor rated speed in rpm

This parameter only needs to be set if the user requires the speed to be displayed in RPM, or if the application requires that changes in load on the motor do not cause a significant change in the motor output speed.

When the rated speed has been set, all speed-related parameters (eg maximum speed, minimum speed etc) will be in RPM.
Also, the Optidrive display will show the running speed in RPM in addition to the speed in Hertz and current in Amps during normal operation.

Setting P-10 also activates the load (slip) compensation. This is a type of speed control where the Optidrive monitors the level of the load on the motor and automatically adjusts the frequency supplied to the motor to try to maintain constant rotor speed.

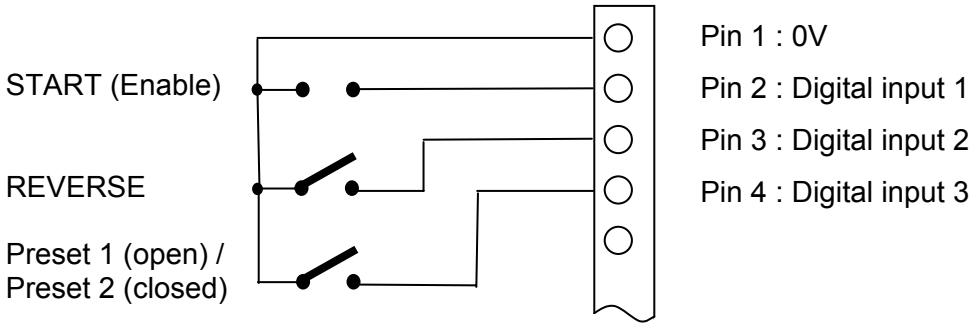
Application Note AN 19

Using the Optidrive with 2 preset speeds and forward / reverse

- ***General***

The OptiDrive provides the user with the possibility of operating with two preset speeds selected via a switch connected to terminal 4 of the user terminal strip and with forward / reverse direction selected using a second switch connected to terminal 3 of the user terminal strip. This mode of operation will be described below :

- ***Wiring details : 2 preset speeds with forwards / reverse***



11-way Optidrive
control terminal strip

- **Notes :**

1. The Optidrive must be set to terminal mode with P-12 = 0 and P-19 = 8.

2. Set the required preset speeds in P-20 and P-21. When digital input 3 is open, P-20 is selected. When digital input 3 is closed, P-21 is selected.

3. When digital input 2 is open, the preset speed set in P-20 or P-21 is selected. When digital input 2 is closed, the selected preset speed will be reversed in terms of the rotational direction of the motor.

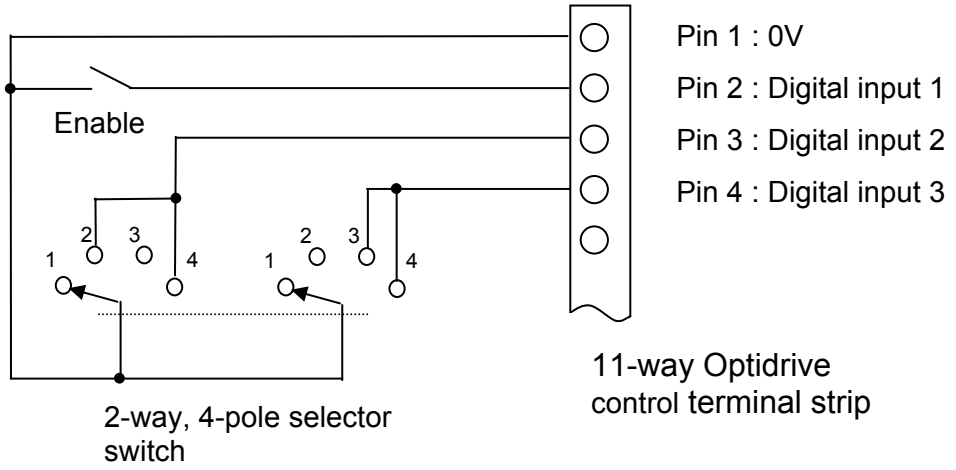
Application Note AN 20

Using the Optidrive with 4 preset speeds

- ***General***

The Optidrive can be configured to operate with any one of 4 preset speeds, selected using a 2-pole, 4-position selector switch. This application note describes how this can be implemented very simply.

- ***Wiring details :***



- **Notes :**

4. The Optidrive must be set to terminal mode with P-12 = 0 and P-19 = 2.

5. The preset speeds are set in P-20, P-21, P-22 and P-23. The preset speeds can be set to any value between minimum (P-02) and maximum speed (P-01)

   V1.05 software only : the preset speeds can also be set to independent negative speed values.

6. The selector switch must be mechanically linked such that the two poles are switched simultaneously. Each switch position selects one of the four available preset speeds.

Application Note AN 21

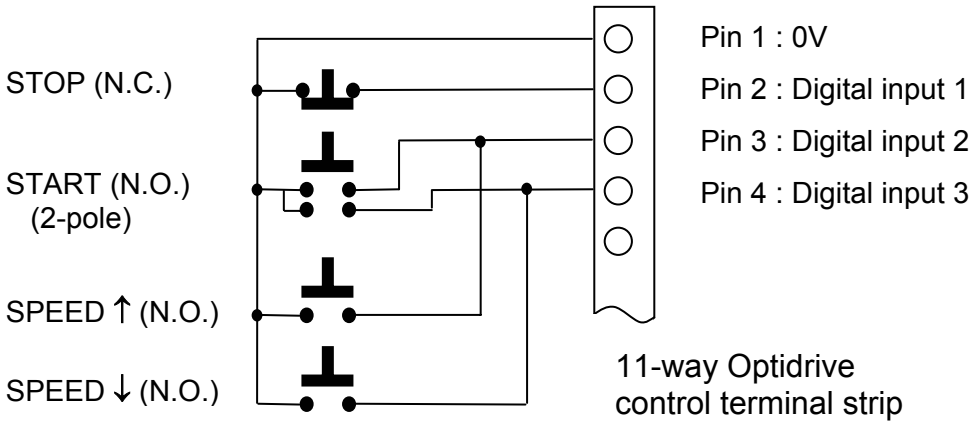
Using the Optidrive with remote push-buttons for speed control

- ***General***

Some applications, especially those where an Optidrive is build into an enclosure, require the speed of the motor to be controlled using push-buttons mounted on the front of the enclosure. This application note describes how this can be implemented very simply.

Note : Applies only to software version 1.05 and any later versions.

- ***Wiring details :***



- **Notes :**

7. The Optidrive must be set to keypad mode (P-12 = 1 or 2) to support this mode of operation. If unidirectional operation is required, set P-12 = 1.

8. If speed reversal is required set P-12 = 2. The <START> button then acts as a reverse button. Pressing this button causes the drive to run at the same speed in the opposite direction.

9. If <STOP> is pressed, the drive will ramp down to zero and stop. Pressing <START> once more causes the drive to ramp back up to the operational speed prior to the <STOP> button being pressed.

10. The <START> button must have a 2-pole N.O. action.

11. For safety critical applications, place an additional enable switch between pin 1 (0V) of the terminal strip and the push-buttons. When this switch is open, the push-buttons are inoperative.

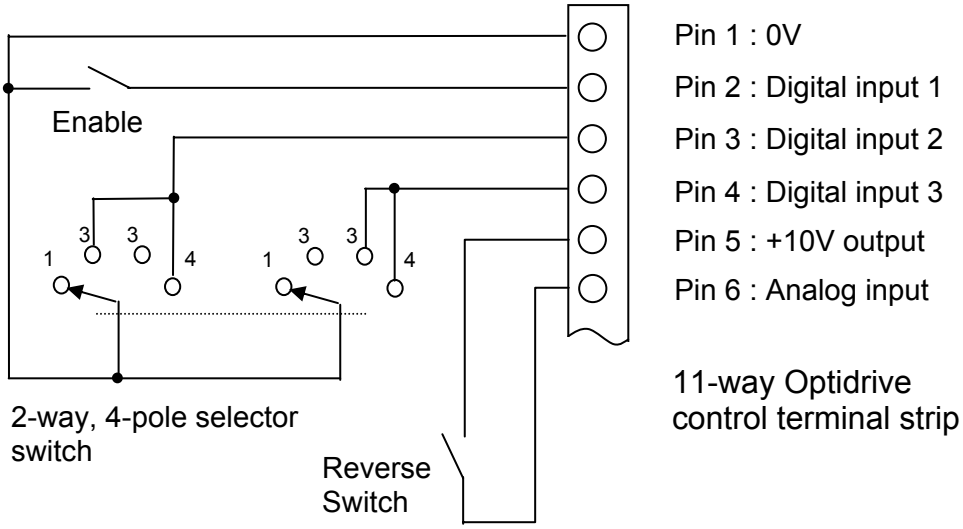
Application Note AN 22

Using the Optidrive with 8 preset speeds

- ***General***

The Optidrive can be configured to operate with any one of 8 preset speeds, 4 in a forwards direction and the same 4 in a reverse direction. These are selected using a 2-pole, 4-position selector switch for the 4 forwards preset speeds and an additional switch for the forwards / reverse selection.

- ***Wiring details :***



- **Notes :**

12. The Optidrive must be set to terminal mode with P-12 = 0 and P-19 = 2.

13. The preset speeds are set in P-20, P-21, P-22 and P-23. The preset speeds can be set to any value between minimum (P-02) and maximum speed (P-01).
    V1.05 software only : the preset speeds can also be set to independent negative speed values.

14. The selector switch must be mechanically linked such that the two poles are switched simultaneously. Each switch position selects one of the four available preset speeds.

15. Each of the 4 preset speeds can be reversed in polarity by closing a switch between terminals 5 and 6 (connecting the analog input to +10V). This effectively provides a total of 8 preset speeds. *(Applies to V1.05 software only)*.

Application Note AN 23

DC injection braking on the Optidrive

- ***General***

DC injection braking on the Optidrive can be used to ensure that a spinning motor reaches true zero speed before the Optidrive is disabled, or to ensure that a spinning motor is brought to standstill prior to the output frequency of the Optidrive being increased from zero. In the latter case, an over-current condition can be avoided.

- **Notes :**

16. DC injection braking is activated by entering a non-zero value into P-32. This specifies the time for which DC-injection braking is applied after a ramp-to-stop (disable) signal has been given by the operator, and will be applied as soon as the Optidrive output frequency reaches zero. This can be used to ensure that the motor speed has definitely reached zero before the output is disabled.

17. If a mechanical brake is being applied, this can be activated by using the Optidrive user relay (terminals 10 and 11). P-19 should be set to 0 in this case.

18. The level of DC injection braking is set using P-31. This is a percentage of motor rated voltage. Typical values lie between 5% and 20% depending on motor type.

19. In some applications (eg fans) it is possible that the motor/fan spins when the Optidrive is disabled due to airflow through the fan blades. In this case, the Optidrive will start onto a spinning motor. To avoid possible over-current trips, the motor speed should be brought to zero before the Optidrive output ramps up in frequency. This is achieved by setting P-33 = 1 (DC injection braking on drive enable).

20. When P-33 = 1, DC injection braking will be applied for the time set in P-32 with a voltage level as set in P-31 on both enable and disable (start and stop) commands to the Optidrive.

- **Typical applications**

- Ensuring that a motor has stopped prior to applying a mechanical brake.

Stopping a free-spinning motor prior to ramping up the output frequency of the Optidrive, thereby preventing a possible Optidrive over-current trip.

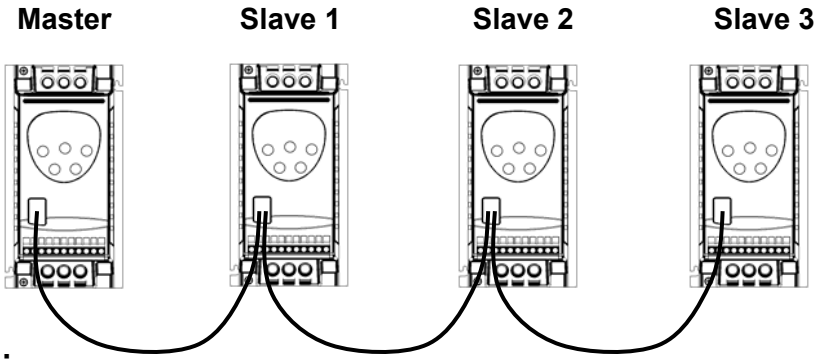
Application Note AN 24

Master / Slave operation using the Optical Link

- ***General***

For applications that require digital Master / Slave speed following, the Optidrive offers a very easy solution using optical communications. A Master / Slave system requires one Master Optidrive to which any number of slaves (unlimited) are connected using OptiLink, available from Invertek Drives as a kit of parts (OptiLink kit).
When in Master mode, the Optidrive transmits its own instantaneous speed reference to all the slaves via the OptiLink. Each slave can operate at a preset ratio of the Master Optidrive speed, using P-35 (speed reference scaling factor) to set this ratio.

- ***OptiLink connection details :***

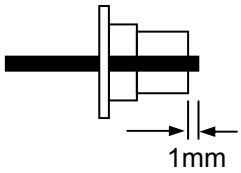


- **Notes :**

21. The standard IR window in the front of each of the Optidrives must be replaced by the optical windows supplied with the OptiLink kit. A small screwdriver can be used to remove the standard IR windows from the front of each Optidrive. The first Optidrive (Master) and the last slave Optidrive should be fitted with the single hole windows. The 2-hole windows should be used for all the slave Optidrives between the Master and last slave.

TO PREVENT THE RISK OF ELECTRIC SHOCK, THE MAINS SUPPLY MUST BE DISCONNECTED BEFORE REMOVING THE INFRA RED WINDOWS

22. The Optical fibre should be cut cleanly to the required lengths using a sharp craft knife and inserted into the small collets supplied with the OptiLink kit, so that the optical fibre just protrudes beyond the bottom of the collet. The collet with fibre inserted should then be pushed fully into the required hole in the Optidrive IR window.



23. The Master Optidrive must have P-12 set to 3 (Master terminal mode). All the slaves should have P-12 = 1 or 2, depending on whether or not negative speed is required.

24. The relative speed of each slave with respect to the Master speed can be set using P-35. This allows any speed ratio in the range 20% to 500%.

Each Slave drive requires a Drive Enable by connecting Pins 1-2 on the terminal strip. When the Master drive is enabled, all slaves will enable simultaneously (if not tripped!).

Application Note AN 25

Optidrive communications protocol

Revision record :	Description	Release Date :
Rev 1.0	Original specification	10.04.2000
Rev 1.1	Global address specification modified Drive address requires msbit set (add 128) Examples with drive address from host corrected	13.04.2000

Application Note AN 25

Optidrive communications protocol

Author : Dr David Jones, R&D Director, Invertek Drives Ltd

• *General*

All communications with the Optidrive are achieved using the optical IR port built into every Optidrive as standard. To communicate with the Optidrive, the information must be encoded according to the protocol described in this document and originate from an IrDA compliant optical tranceiver.

If the application requires the use of either an Optiwand or a communications Gateway, the users do not need to concern themselves with the details of the communication protocol. This will be handled internally by the Gateway or Optiwand.

If, however, the user would like to communicate directly with the Optidrive, either optically or by using an optical / RS485 adapter, the information in this document will be required.

When communicating between the Optidrive and a gateway or host system where line-of-sight communication (as with the Optiwand) is not possible, communication is achieved using an optical adapter, optical polymer fibre and either a gateway or host controller.

• *Communications protocol overview*

- The communications protocol ASCII based, operating at 9600 bps
- Each Optidrive acts as a slave unit any will only transmit data in response to a request from the Host / master.
- Up to 63 drive addresses are permitted, allowing 63 Optidrives to be connected to the same optical communication link.
- Global telegrams are permitted allowing simultaneous data transfer to multiple drives
- All operations that are supported by the Optiwand can also be carried out via a Gateway or external host controller.
- When data is received by an Optidrive, it will be actioned immediately. All operations can be carried out transparently whilst the Optidrive is driving a motor with the exception of a parameter set download operation. Individual parameters can be changed during drive operation.
- All transmitted bytes other than the START and STOP flags, including all commands and the data checksum are send as ASCII codes. For example, a download command (‘D’ = 0x44 (hex)) is sent as two consecutive ASCII codes ie 0x34, 0x34. Further examples will be shown in the following section.
- Any non-ASCII byte received other than the START / STOP flags will terminate the data reception and a new sequence must be started.

- ***Communications protocol details***

Master (Host controller) transmit data packet format :

All transmissions originating from a Host controller must have the following format :

FG1 [DA] [CMD] ([DATA]) [CS] FG2

Where	FG1 = Start Flag	0x7F, flags start of data transmission	
	DA = Drive Address **	valid addresses { 1 … 63 }	
	CMD = Master Command	'R' (0x52)	Run command
		'S' (0x53)	Stop command
		'A' (0x41)	Motor current request
		'Z' (0x5A)	Speed request in Hz
		'M' (0x4D)	Speed request in RPM
		'D' (0x44)	Download param set
		'U' (0x55)	Upload request
		'O' (0x4F)	Individual parameter edit
		'T' (0x54)	Drive Status request
		'V' (0x56)	Software version request
		'P' (0x50)	Set new speed in Hz
	Keypad mode only (P-12 = 1)	'I' (0x46)	Increase speed on ramp
		'L' (0x4C)	Reduce speed on ramp
	DATA = transmitted data	data will depend on command send	
	CS = data checksum	calculated at the time of transmission and is the logical NOT of the byte result of the byte addition of all transmitted ASCII bytes excluding the START and STOP flags and the checksum itself. i.e. ~(DA + CMD + ([DATA]))	
	FG2 = Stop flag	0x7E, flags end of data transmission	

*** For communication with the Optidrive from a Host controller, add the value **128** to the drive address. This distinguishes between Optiwand and Host controller communications*

Examples :

1. Send Run Command to Drive number 01 from intelligent host :

The required data transmission will be

0x7F, 0x38, 0x31, 0x35, 0x32, 0x32, 0x46 0x7E

Start Drive number Command Checksum Stop

Flag	(128 + 01)	(0x2F)	Flag

2. *Send new target speed of 40.0Hz from intelligent host to drive 05 in keypad mode :*

   The required data transmission will be

0x7F,	0x38, 0x35,	0x35, 0x30,	0x30, 0x39, 0x36, 0x30,	0x35, 0x45	0x7E
Start Flag	Drive number (128 + 05)	Command (‘P’)	Target Speed (40.0Hz) (2400 = 0x0960 sent)	Checksum (0x5E)	Stop Flag

Note that the transmitted speed in Hertz is always 60x the speed required. Therefore 40Hz is transmitted as 40.0 x 60 = 2400. The high byte is transmitted first. A word (16-bit) value is **always** transmitted.

Checksum = logical NOT $\sum$(0x30, 0x35, 0x35, 0x30, 0x30, 0x39, 0x36, 0x30) = 0x66

Note that the checksum is the least significant byte of the result.

Global commands (to multiple Optidrives)

Some applications require particular commands to be sent simultaneously to multiple Optidrives. An example of this would be a RUN command or a STOP command.

Global commands from a host controller are sent by using 0xC7 as the drive address (add 128 to the ASCII code ‘G’ ie 0x80 + 0x47 = 0xC7).
All Optidrives receiving a command following this drive address will carry out this command. There is no reply from the Optidrives to a global command.

Example :

1. *Send a Run Command to all Optidrives from intelligent host :*

   The required data transmission will be

0x7F,	0x43, 0x37,	0x35, 0x32,	0x31, 0x45	0x7E
Start Flag	Global drive Address (‘G’) + 128 = 0xC7	Command (‘R’)	Checksum (0x1E)	Stop Flag

Slave (Optidrive) reply data packet format :

Whenever a valid data packet is received by the Optidrive, the response will have a format defined by the following information.

Note that if a valid data packet is received with an incorrect (different) drive address, the Optidrive will ignore the data and no response at all will be generated.

All responses to valid commands will be the lower case equivalent to the command received. For example, if a 'R' command is received by the Optidrive, it will respond with an 'r' reply.

Format of the Optidrive response :

FG1 [DA] [REPLY] ([DATA]) [CS] FG2

Where	FG1 = Start Flag		0x7F, flags start of data transmission	
	DA = Drive Address		returns its own Drive address	
	REPLY = Slave reply	'r'	(0x72)	Run command executed
		's'	(0x73)	Stop command executed
		'a'	(0x61)	Motor current
		'z'	(0x7A)	Speed request in Hz
		'm'	(0x6D)	Speed request in RPM
		'd'	(0x64)	New Param set loaded
		'u'	(0x75)	Param set returned
		'o'	(0x6F)	Param edit successful
		't'	(0x74)	Drive Status returned
		'v'	(0x76)	Software version returned
	Keypad mode only (P-12 = 1)	'p'	(0x70)	New speed in Hz loaded
		'i'	(0x66)	Increase speed actioned
		'l'	(0x6C)	Reduce speed actioned
		'e'	(0x65)	Error – command not executed (error code gives reason why)
	DATA = requested data		data will depend on the command received	
	CS = data checksum		calculated at the time of transmission and is the logical NOT of the byte result of the byte addition of all transmitted ASCII bytes excluding the START and STOP flags and the checksum itself. i.e. ~(DA + REPLY + ([DATA]))	
	FG2 = Stop flag		0x7E, flags end of data transmission	

Examples :

1. *Run Command to Drive number 01 carried out :*

   The resulting reply data transmission will be

0x7F,	0x30, 0x31,	0x37, 0x32,	0x33, 0x31	0x7E
Start Flag	Drive number	Reply ('r')	Checksum	Stop Flag

2. *New target speed of 40.0Hz set in drive 05 :*

   The resulting reply data transmission will be

0x7F,	0x30, 0x35,	0x37, 0x30,	0x33, 0x31,	0x7E
Start Flag	Drive number	Reply ('p')	Checksum	Stop Flag

Optidrive response to a drive status request

In the event of the Optidrive status being requested, the returned data will have the following format :

[Start Flag], [Drive Addr], ['t'], [status], ([trip code]), [checksum], [stop flag]

The status byte can have the following values :

0x00	Drive stopped
0x01	Drive running
0x09 + Trip code	Drive tripped, trip code indicates fault

The possible status / trip codes are shown in the following list :

0x00	Over-current trip
0x01	Short circuit on brake resistor circuit
0x02	Internal memory chip fault
0x03	External trip
0x04	Over-voltage trip
0x05	Under-voltage trip
0x06	Over-temperature trip
0x07	Internal thermistor failure
0x08	Analog input fault – voltage mode
0x09	Default parameters loaded
0x0A	Current overload trip (I x t)
0x0B	Analog input fault – current mode
0x0C	Thermal overload in braking resistor
0x0D	Internal Power Stage trip

Example :

1. *Optidrive Status information requested for drive 12 :*

   The Optidrive returns a “drive tripped” message with an over-current fault code :

0x7F,	0x30, 0x43,	0x37, 0x34,	0x30, 0x39, 0x30, 0x36,	0x33, 0x31,	0x7E
Start Flag	Drive number (‘0x0C’)	Reply (‘t’)	Optidrive tripped	Over-temperature	Checksum	Stop Flag

Optidrive response to an error condition

Whenever the Optidrive receives a command that it either does not recognise or it cannot carry out, it will respond with an error message, indicating that an error has occurred and what the reason for the error was.

In the event of an error occurring, the message will have the following format :

[Start Flag], [Drive Addr], [‘e’], [error code], [checksum], [stop flag]

The error code will have one of the following values :

0x91	Optidrive not in keypad mode
0x92	Optidrive speed in RPM not available (P-10 = 0)
0x93	Optidrive running – command cannot be carried out
0x94	Optidrive stopped – command cannot be carried out
0x95	Invalid data – incorrect checksum
0x96	*Reserved for OptiStore*
0x97	Invalid command – data not recognised
0x98	Optidrive parameters locked – command cannot be carried out

Example :

1. *Download operation could not be carried out – Optidrive number 18 running :*

   The Optidrive returns a “drive running” message :

0x7F,	0x31, 0x32,	0x36, 0x35,	0x39, 0x33,	0x46, 0x38,	0x7E
Start Flag	Drive number (‘0x12’)	Reply (‘e’)	Optidrive running	Checksum	Stop Flag

Uploading and Downloading parameter sets / Editing parameters

The standard Optidrive communications protocol supports parameter set transfer both as a Download operation (transfer to Optidrive) and as an Upload operation (transfer from Optidrive).
In addition, individual parameters can be edited (Optidrive software V1.05 or later).

Download operations

Prior to carrying out a download operation, the Host controller must request the software version from the Optidrive. This has been implemented to ensure compatibility with possible future products.

This is achieved by sending the following data :

0x7F [DA] ['V'] [CS] 0x7E

the Optidrive will respond with the following data :

0x7F [DA] ['v'] [VERSION] [CS] 0x7E

All Optidrives with V1.05 software will respond with a value in the range 150 to 159 (decimal), where the least significant digit represents possible variants of the V1.05 software release. All of these will operate in exactly the same way from a communications viewpoint.

Note that early versions of the Optidrive (V1.04 and earlier) will not respond to the Version command. All Optidrives produced since February 2000 will be fitted with V1.05 software. If a download operation to an earlier version is needed, please contact Invertek Drives for further information. In general, this should not be required.

Once the software version has been identified, the parameter set can be downloaded to the Optidrive.

The data transfer format for a download operation is as follows :

0x7F [DA] ['D'] ([PARAM SET]) [CS] 0x7E

All the parameters within a parameter set are transferred sequentially. This sequence must be maintained at all times, otherwise data loss may occur.

As with all other data transfer, each byte of the parameter set is converted into two ASCII values prior to transmission.

The exact format of the parameter set is defined in an additional application note (AN26 – Parameter Set Data format)

If a parameter set is downloaded whilst an Optidrive is running, an error message will be generated an the parameter set will be discarded. The Optidrive must be stopped for a data set to be accepted.

Upload operations

An upload operation can take place at any time, also when the Optidrive is running. This operation is carried out by issuing the Upload (‘U’) command as follows :

0x7F [DA] [‘U’] [CS] 0x7E

The Optidrive with the correct Dive address will respond by sending its own complete parameter set formatted in exactly the same way as with a download operation. This will be as follows :

0x7F [DA] [‘u’] ([PARAM SET]) [CS] 0x7E

The format of the parameter set is detailed in application note AN26 - Parameter Set Data format.

Individual Parameter Edit

Some applications require that a host controller can change individual parameters during Optidrive operation. This can be achieved using the ‘O’ command, with the exception of parameters P-09 (motor rated frequency) and P-17 (switching frequency). Any attempt to change these parameters when the drive is running will result in an error message being returned by the Optidrive.

The individual parameter edit operation is carried out as follows :

0x7F [DA] [‘O’] [PARAM VALUE] [PARAM NUMBER] [CS] 0x7E

The parameter value is a 16-bit value with the high byte transmitted first. The parameter number is a byte value representing the number of the parameter to be edited.

Example :

1. *Change parameter P-01 to 60.0Hz in Optidrive number 02 from intelligent host :*

   The transmitted data would be as follows :

0x7F, 0x38, 0x32, 0x34, 0x46, 0x30, 0x45, 0x31, 0x30, 0x30, 0x31, 0x45, 0x34, 0x7E

Start Flag	Drive num (‘0x02’) +128	Command (‘O’)	New Param value (3600 = 0x0E10)	Param Num (0x01)	Checksum (0xE4)	Stop Flag

Note that the value transmitted representing any value in Hz is 60x that value in Hz. For 60.0Hz, the value transmitted is 3600 (0x0E10).