Control Techniques

CONTROL TECHNIQUES

Unidrive
Product Data

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Product Overview

Unidrive

The Unidrive is an advanced AC drive for use with AC induction motors and AC brushless servo motors. Every unit can operate as a V/Hz, Sensorless vector, Closed loop flux vector, Servo drive, or as a Regeneration module. The Unidrive's control mode can be easily and quickly changed from the on-board keypad, a remote keypad, or through *UniSoft*, a Windows™ based configuration software tool.

Sizes

There are five physical sizes comprising 26 different models ranging from 0.75 kW to 1 MW (1 to 1300 HP). The drive is designed for stand alone as well as coordinated systems applications. There are hundreds of configurable functions in 20 logically organised menus. All functions are factory defaulted to typical values to facilitate easy set-up.

Parameters

The Unidrive's most commonly used parameters are stored in Menu 0. This menu is defaulted with those parameters which are typically accessed, but the user may map any of the drive's other parameters to this menu for easier access. This approach means easy access for those parameters the user selects.

Simple to use

In order to simplify initial start up a number of pre-defined application examples are available. These pre-defined application examples are available for the following functions: Easy mode, Motorised potentiometer, Preset Speeds, Torque control, PID control, Axis limit control, Brake control, Digital lock.

Flexibility

In addition Unidrive has many other of embedded configurable functions which are easily adapted for virtually any application. Some of these configurable functions include items such as assignable I/O, autotune, encoder feedback, frequency and direction pulse signal input and output, open loop frequency slaving, ratio control, electronic holding brake, S-ramps, position control and many others.

Technology

Many of these important product features would not be possible without the use of advanced technology in the Unidrive. The drive employs advanced microprocessor technology which controls all drive functions including input to the inverter ASIC (Application Specific Integrated Circuit) which synthesises an adjustable carrier frequency PWM (Pulse Width Modulation) output. The ASIC output controls the IGBT (Insulated Gate Bipolar Transistor) inverter section. All printed circuit boards are manufactured using surface mount technology.

Operating modes

The Unidrive can be configured to operate in any of the following operating modes:

Open-loop

For use with standard AC induction motors.

The Drive applies power to the motor at frequencies which are varied by the user. The motor speed is a result of the output frequency of the Drive and slip due to the mechanical load.

The Drive can power a number of motors connected in parallel (each motor must be protected against overload; this is described in the Installation Guide).

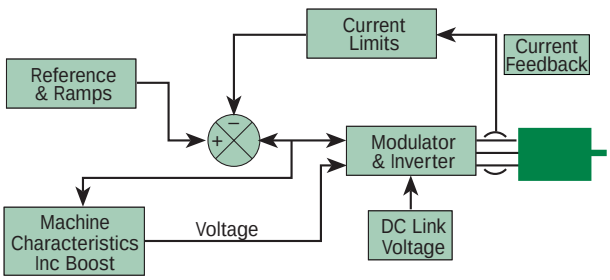
The Drive can improve the performance of the motor by applying the following:

- Slip compensation
- Fixed boost or Open-loop Vector operation

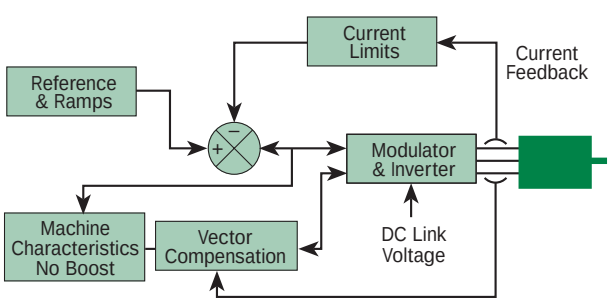
Fixed boost applies a fixed voltage boost at low frequencies.

Open-loop Vector operation maintains almost constant flux by dynamically adjusting the motor voltage according to the load on the motor.

Open Loop Mode



Open Loop Vector Mode



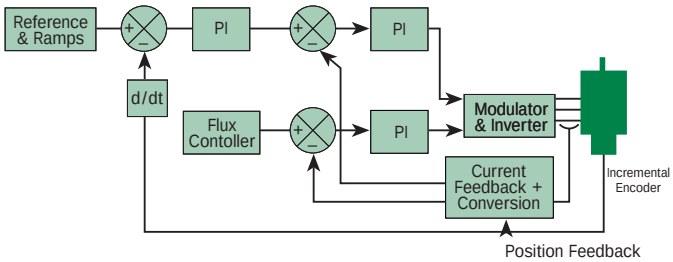
Closed-loop Vector

For use with standard AC induction motors coupled to an incremental encoder.

The Drive directly controls the speed of the motor. The Drive and motor form a closed-loop system where the encoder is used to apply feedback to the Drive.

The Drive can power only one motor.

Closed Loop Vector Mode



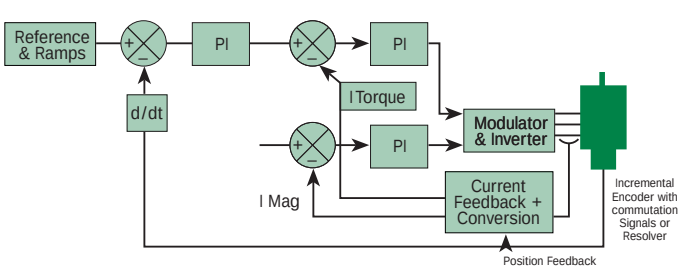
Closed-loop Servo

For use only with permanent-magnet brushless AC servo motors coupled to suitable feedback device having commutation output signals.

The Drive directly controls the speed of the motor. The Drive and motor form a closed-loop system where the feedback is used to apply feedback to the Drive.

The Drive can power only one motor.

Servo Mode



Key Features

Regeneration

Warning

Before a Drive is used in the Regeneration mode, the Drive and the accompanying motoring Drive(s) must be modified.

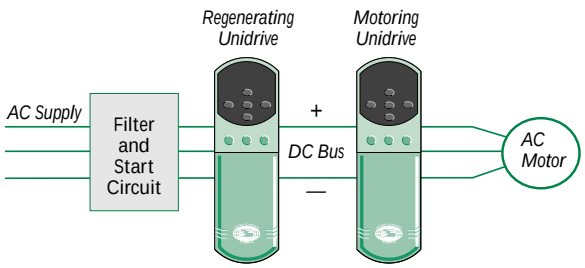
Contact the supplier of the Drive for details.

The Regeneration mode is used for four-quadrant operation. A Drive can be operated in Regeneration mode only when it is connected to other Drive(s) operating in one of the other (motoring) modes.

Regeneration mode allows the following:

- AC supply to be fed from the Regeneration Drive to the Drive(s) that are controlling the motor
- Regenerated power to be returned to the AC supply by the Regeneration Drive instead of being dissipated in braking resistors

Regeneration Module Control Mode ▼



Default configurations

The Drive is supplied in either of two default configurations to suit the continent in which it is sold. The configurations are distinguished as follows:

European voltage, 50Hz supply

USA voltage, 60Hz supply

The following details differences between Europe and USA Menu zero default parameters:

Europe

- Select positive-logic
- Current-loop PI gains

USA

- Select digital control by two or three wires
- Frequency/speed demand indication

General Features

- Coast & Ramp to Stop modes
- 8 Preset speeds & Ramps
- 3 Skip frequencies
- S Ramp
- Motorised potentiometer
- Internal braking transistor as standard
- Encoder input as standard
- Programmable security code
- Bright two line LED display

Advanced Features

- Position control
- Digital lock
- Mains dip ride through
- Frequency slaving
- Catch a spinning motor
- Programmable logic functions
- Orientation
- Dynamic V/f

Performance features

- Sensorless Vector control
- 336µs speed loop sample time
- 176µs current loop sample time
- 16 bit speed loop
- 12 bit current loop
- Voltage boost
- Dynamic injection/braking
- Fast current loop with PI control
- 0.75kW to 1MW

Flexibility features

- Speed reference selector
- Full I/O programmability
- Unisoft
- 4 drives in one
- Well structured menu system
- Encoder I/P
- Programmable logic functions
- Configurable menu zero
- Programmable thresholds
- Resolver feedback
- Sin/cos feedback
- High speed communications
- Applications module
- Servo module

Ease of use features

- Macros
- Bright two line LED display
- Cloning module
- Unisoft

Maintenance features

- Clock
- Full internal protection & diagnostics
- Last ten trips stored
- Programmable security code
- Common control board
- Pluggable terminals

Introduction to Application Macros

Unidrive operation can be simplified by using pre-configured application macros. These macros are held in the internal memory of the drive and are user selectable.

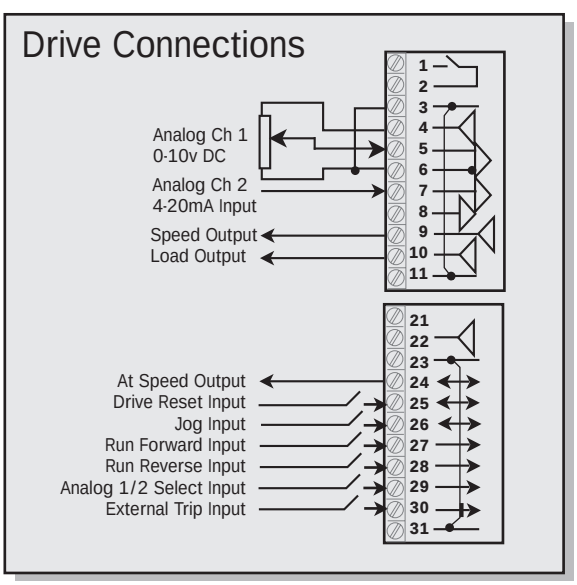
Macro summary

		Unidrive			VTC
Macro	Function	OL	CL	SERVO	VTC
0	Default mode	y	y	y	y
1	Easy mode	y	y	y	y
2	Motorised potentiometer	y	y	y	y
3	Preset speeds	y	y	y	y
4	Torque control	y	y	y	n
5	PID macro	y	y	y	y
6	Axis Limit control	y	y	y	n
7	Hoist control/brake release	y	y	y	n
8	Digital Lock	n	y	y	n

When a Macro is not enabled, the drive operates in a default configuration (EURO USA)

Macro 1 – Easy Mode

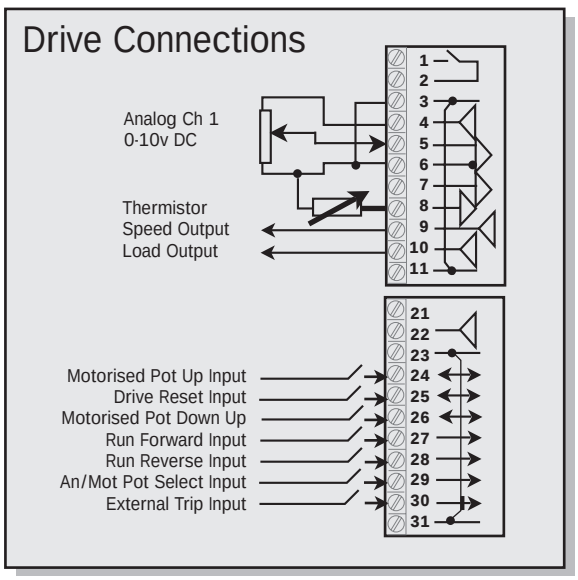
Easy mode defines the most commonly used features with only 10 parameters. These parameters are numbered 0.01 to 0.10

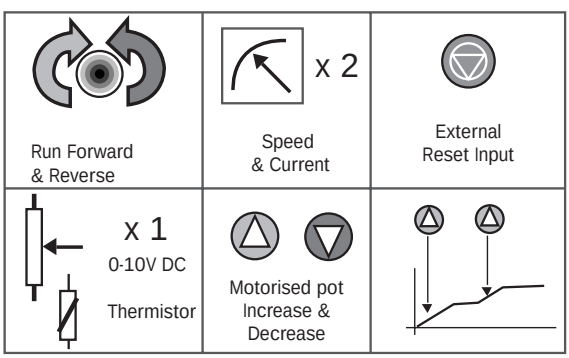


Menu 0 Parameter	Open loop & VTC		Vector and Servo	
	Param.	Description	Param.	Description
0.01	1.07	Minimum Speed	1.07	Minimum Speed
0.02	1.06	Maximum Speed	1.06	Maximum Speed
0.03	2.11	Acceleration time	2.11	Acceleration time
0.04	2.21	Deceleration time	2.21	Deceleration time
0.05	1.14	Reference select	1.14	Reference select
0.06	4.07	Current limit	4.07	Current limit
0.07	5.14	Voltage mode	3.10	Proportional gain
0.08	5.15	Voltage boost	3.11	Integral gain
0.09	5.13	Dynamic V/F	3.12	Derivation gain
0.10	5.04	Motor Speed (rpm)	3.02	Speed feedback

Macro 2 – Motorised Potentiometer

With this function it is possible to emulate a motorised potentiometer within the Unidrive by simply supplying two logic input signals to increase or decrease the “potentiometer”. The output of the “potentiometer” may be routed to control any of the drive’s non-bit parameters such as speed, torque or current limit. The function may be configured to reset upon power cycling or to memorise its value.



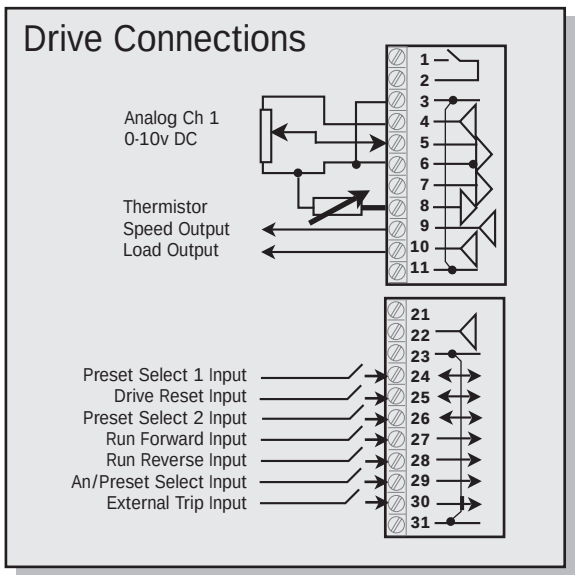


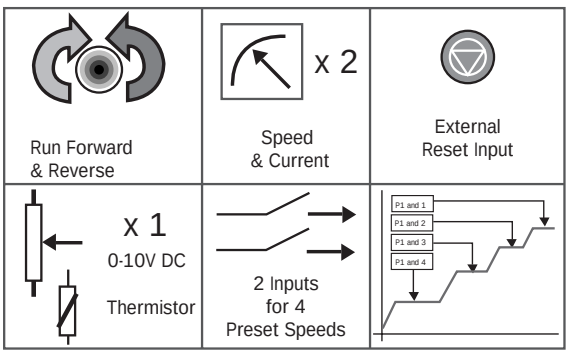
Introduction to Application Macros

Macro 3 – Preset Speeds

By using this macro up to four preset frequencies / speeds can be used. Preset values must be programmed into individual parameters. Frequency / speed selection is done by activating terminal 29 and putting a binary combination on terminals 24 and 26.

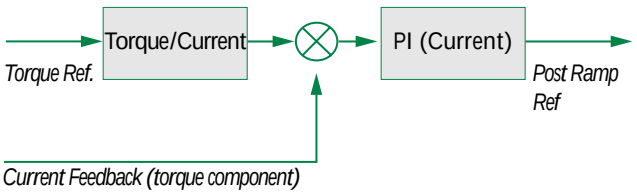
Terminal 24	Terminal 26	Speed
Open	Open	As set in Pr 0.25
Open	Closed	As set in Pr 0.26
Closed	Open	As set in Pr 0.27
Closed	Closed	As set in Pr 0.28

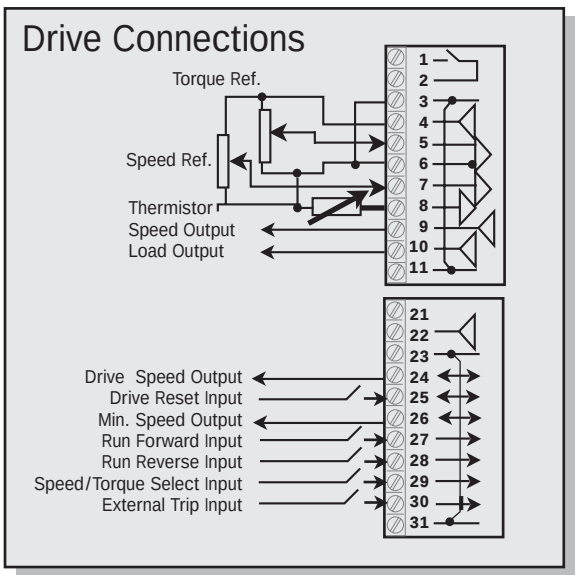


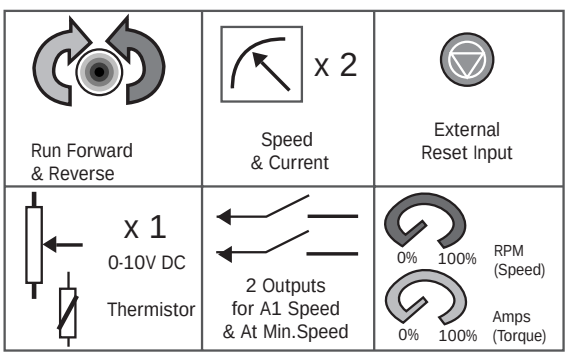


Macro 4 – Torque control

When this macro is selected a drive can be operated in Speed or Torque control by using terminal 29.
If in Speed control mode, speed is maintained independent of load within the limits of the drive. In Torque control mode the drive will attempt to reach the speed set point but only with the torque available as defined by the torque reference signal.



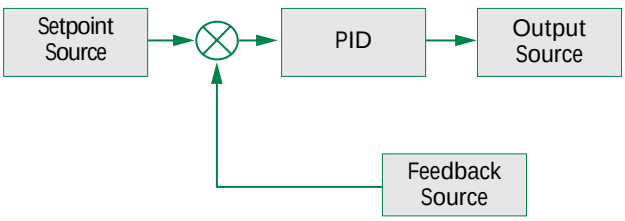


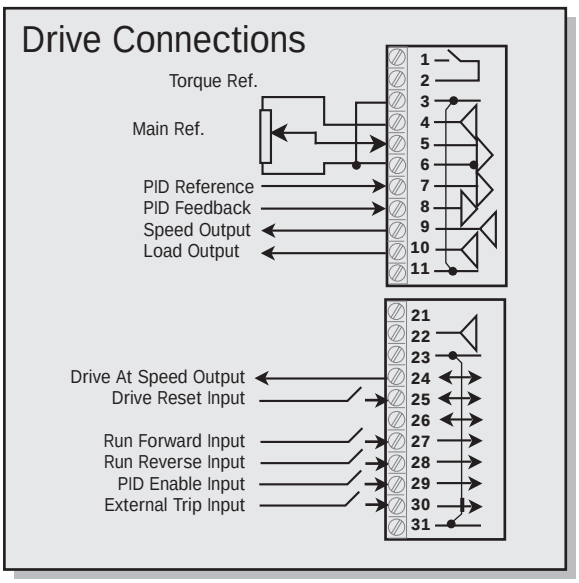


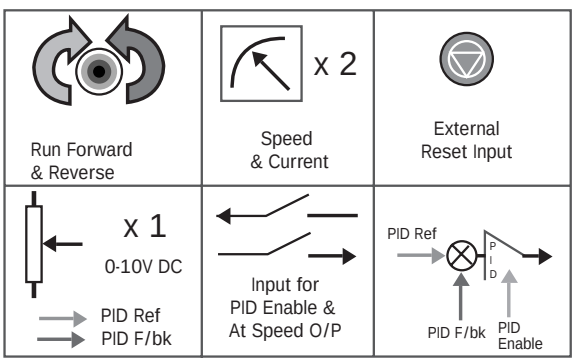
Introduction to Application Macros

Macro 5 – PID control

This macro configures the drive to control a motor with reference to PID control signal. In PID control, the error resulting from differences between the PID feedback and PID reference is passed through a limiter, a scaling stage and finally the error is added to the frequency / speed signal.

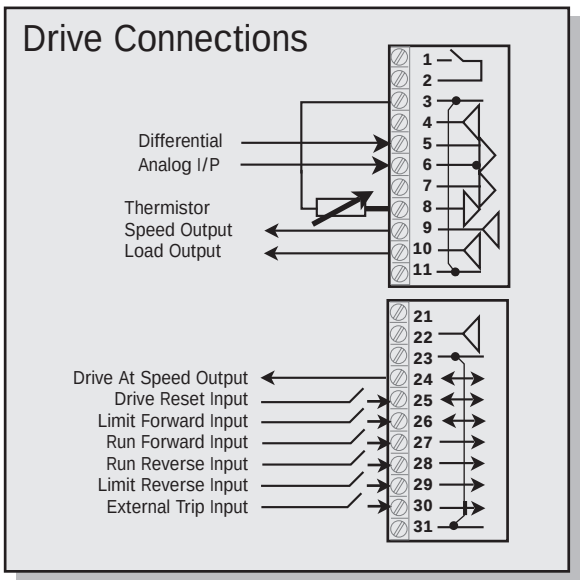


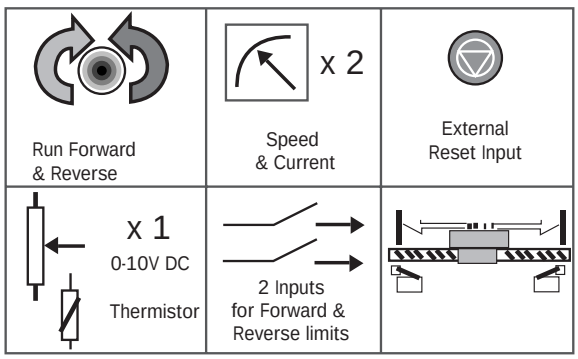




Macro 6 – Axis Limit control

Using this macro enables two digital inputs to be re-programmed so providing limit switch lockout for axis position control systems. The drive would normally be run from a +/- 10v reference and controlled forward / backwards from this. If a limit switch level is reached the drive will be forced to stop independent of the speed setting.

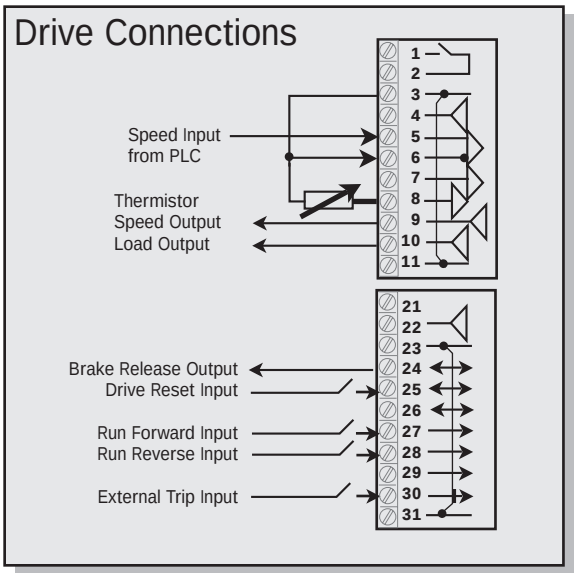


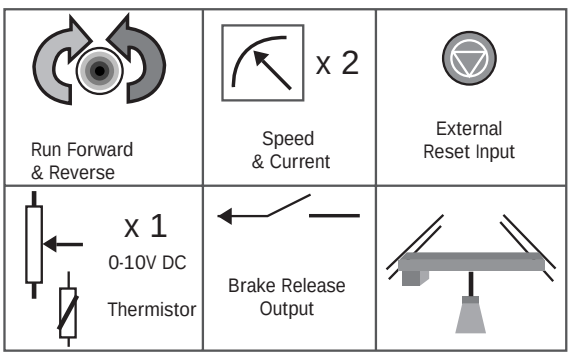


Introduction to Application Macros

Macro 7 – Brake control

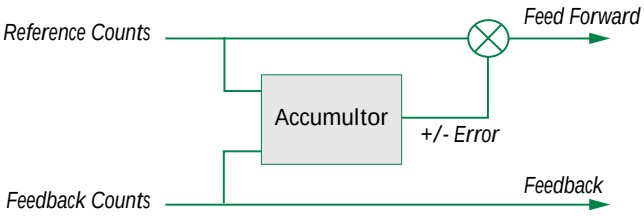
This macro essentially allows the control of an external brake. The brake is released when the drive is running and there is current in the motor.

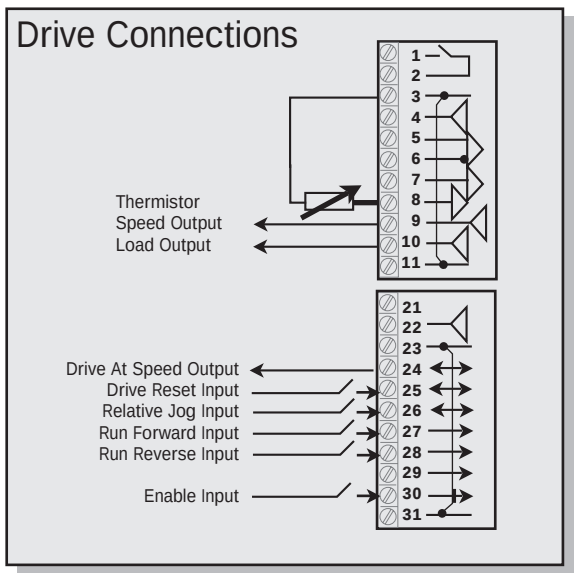


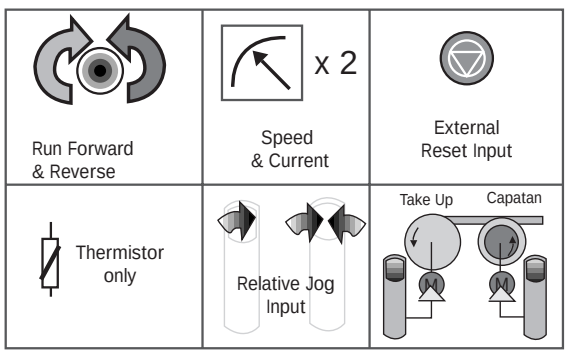


Macro 8 – Digital Lock

The digital lock macro enables a drive to be operated so that it will lock two motor shafts together pulse for pulse.







Additional Configurable Functions

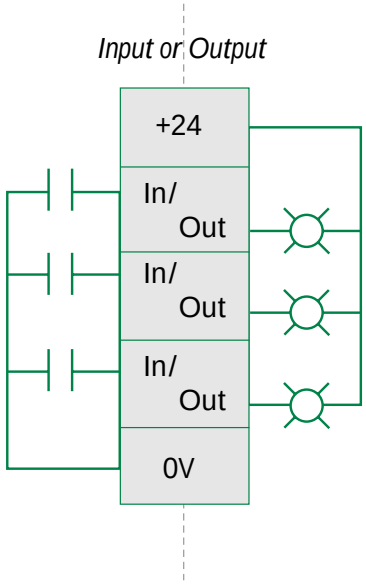
Assignable I/O

The Unidrive Inputs and Outputs are user assignable; the user defines which I/O points operate with which functions. For example, digital input 1 could be defined as a preset speed or drive reset. This capability provides optimum usage and maximum flexibility of the Unidrive's I/O and it applies to analogue as well as digital I/O.

I/O TYPE	QUANTITY	FUNCTION
Analogue In	3	Assignable
Analogue Out	2	Assignable
Digital In	3	Assignable
Digital In or Out	3	Assignable

Direction Definable Digital I/O

To further enhance the Unidrive's flexibility and optimisation of digital I/O, some of the digital points may be defined as inputs or outputs. The basic Unidrive contains six digital I/O points, three of which can be independently defined as either inputs or outputs.



Sequence Logic Control Modes

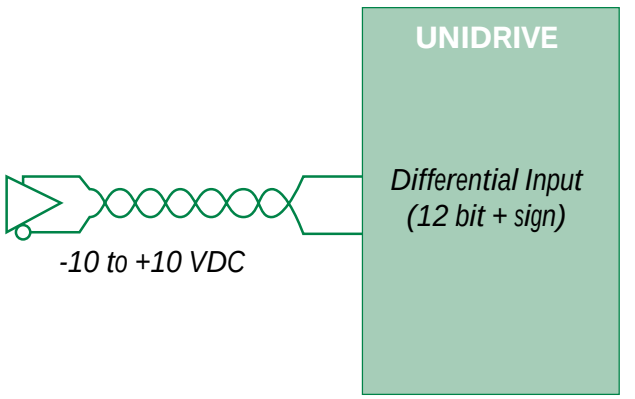
There are five logic control modes available for run/jog sequencing. Two of the modes are used with momentary run inputs (the drive provides latching in software) for three wire control. Three of the modes are used with maintained run inputs for two wire control. One of the two wire modes (wire proof) requires maintained contact closure for all commands safeguarding against any false commands as a result of a lost wire.

MACHINE LOGIC CONTROL MODE	RUN SIGNAL CONTACT TYPE
Pushbutton	Momentary
System	Momentary
Wire proof	Maintained
PLC	Maintained
Wireproof PLC	Maintained

High Resolution Differential Input

The Unidrive is equipped with one differential analogue input which has a >12 bit (+ sign) resolution. This input can receive a +10V to -10V bipolar input or it can be configured as a single ended unipolar input. This precision input is especially useful in servo and position type applications.
For higher resolution (> 16 bit) use a UD78 high performance Servo Module.

High Resolution Differential Input Illustration ▼



Additional Configurable Functions

Analogue Input Modes

There are multiple analogue signal input possibilities. All analogue inputs can be voltage or current type. If a current signal configuration is chosen, there are several choices for signal type and several choices for how the drive handles a signal loss.

ANALOGUE MODE	SIGNAL TYPE	ACTION UPON SIGNAL LOSS
0	Voltage	N/A
1	0-20mA	N/A
2	20-0mA	N/A
3	4-20mA	Trip on Loss
4	20-4mA	Trip on Loss
5	4-20mA	Min (or Low) Speed on Loss
6	20-4mA	Min (or Low) Speed on Loss
7	4-20mA	Previous Speed on Loss
8	20-4mA	Previous Speed on Loss
9	th	Thermistor (channel 3 only)

Encoder Feedback or Frequency/Direction Input/Output

Every Unidrive is equipped with an encoder interface. This interface is accessed through a 15 pin D-shell connector (female) and is used for feedback in closed loop flux vector or servo modes. If the Unidrive is configured for open loop, the interface can be used as a frequency/direction pulse signal input and output. This is useful for frequency slaving, whereby the frequency of a slave drive is locked in with a master drive.

PIN	PRIMARY FUNCTION		ALTERNATE FUNCTION	
1, 2	A, A	Quadrature Input	FIN, FXN	Frequency Input
3, 4	B, B	Quadrature Input	DIN DIN	Direction Input
5, 6	Z, Z	Marker Pulse	—	—
7, 8	U,U	Gray Scale (Servo) Commutating Signals	FOUT, FOUT	Frequency Output
9,10	V,V	Gray Scale (Servo) Commutating Signals	DOUT DOUT	Direction Output
11,12	W,W	Gray Scale (Servo) Commutating Signals	—	—

Torque Mode Selection

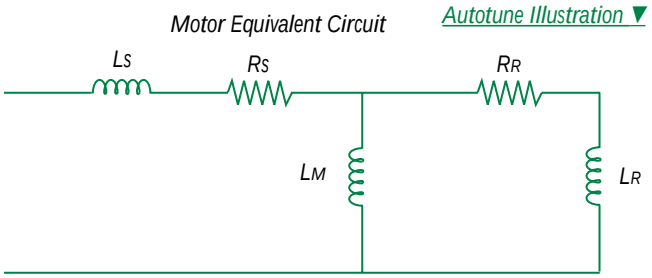
In the closed loop mode, there are three types of torque control possible: basic torque control, torque control with speed override, and winder/unwinder torque control (to safeguard against web breaks).

PARAMETER 4.11	TORQUE MODE
0	Speed Control
1	Torque Control
2	Torque Control w/ Speed Over-Ride
3	Winder / Unwinder Torque Control

Autotune

The Unidrive is capable of measuring the motor's stator resistance (Rs) and magnetising inductance (Lm). These values allow the drive to establish a mathematical model of the motor's electrical circuit for use in vector control. The magnetising inductance is measured upon command through a bit parameter, and is only performed when commanded. The Unidrive may be configured to measure the stator resistance automatically every time the drive is enabled or powered-up. Automatic measurement can also be disabled.
Automatic slip measurement can be done during normal operation.

Autotune Illustration ▼

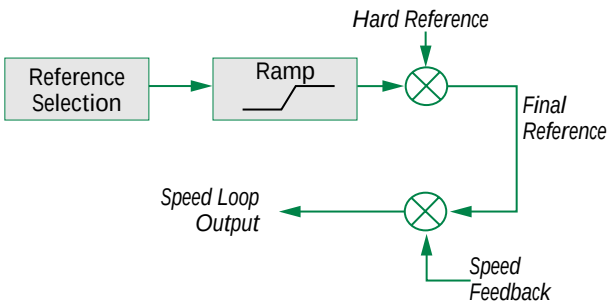


Additional Configurable Functions

Hard Reference Input (closed loop only)

This function is useful in applications requiring a dancer input. By routing the dancer feedback directly into the hard reference input, all drive ramps are ignored and the value is added to the normal post ramp speed reference.

Hard Reference Input Illustration ▼



Power Cost and Consumption Calculator

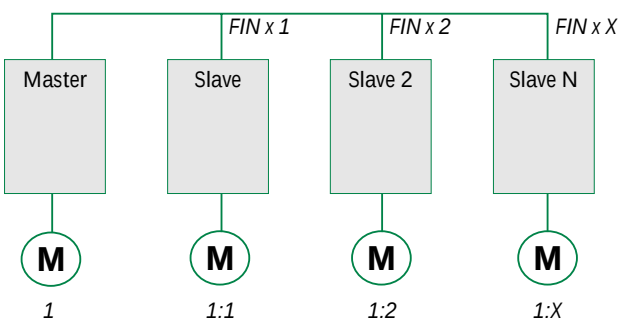
The Unidrive can calculate the instantaneous cost per hour to operate the drive based on the current power consumption rate and the electricity cost per kWatt hour. The electricity cost can be scaled to any currency so that the cost is calculated according to that currency. Additionally, there is a power meter which measures consumed power in MWhrs and kWhrs.

PARAMETER	UNITS	RANGE
6.20	Currency/ Hour	0.00 to 300.00
6.25	kWHrs	0.0 to 999.9
6.24	MWHrs	0 to 30,000

Frequency Slaving Control

Frequency slaving (open loop mode) is used to lock the frequency produced at the drive output with an external frequency applied to the drive encoder interface. This could be used to keep the shafts of two synchronous machines in lock, by feeding the frequency and direction output from the master drive into the encoder interface of the slave drive. Alternatively, the two machines could be operated so that the shafts rotate with an exact ratio, i.e as though the shafts were connected by gears.

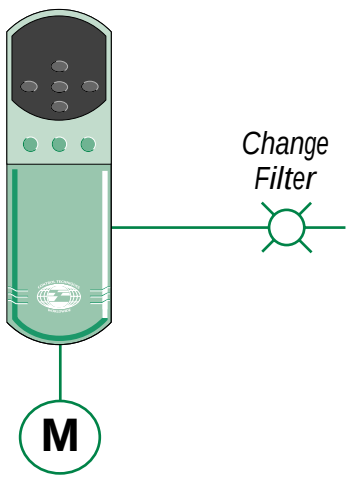
Frequency Slaving Control Illustration ▼



Filter Change Alarm

This function allows the user to program a time period between 0 and 30,000 hours which determines when the filter alarm will annunciate. The time period is based on the drive run time. The filter alarm function can be activated or deactivated based on the drive's configuration.

Filter Change Alarm Illustration ▼



Additional Configurable Functions

Run Time Log: Years, Days, Hours, Minutes

The Unidrive keeps a running log of it's total operating time. This clock begins when the unit leaves the factory and continues from there. This data is useful for maintenance purposes and allows the user to easily identify total run time down to the minute.

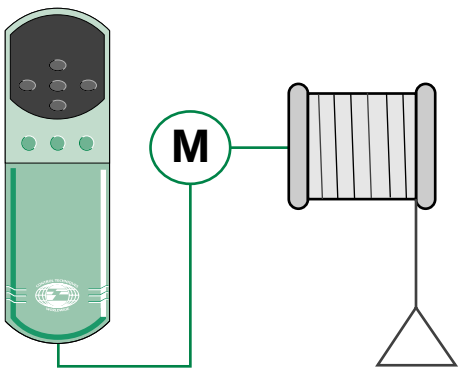
Year 2000 compliant.

PARAMETER	UNITS	RANGE
6.22	Years - Days	0.000 to 30.365
6.23	Hours - Minutes	0.00 to 23.59

Electronic Holding Brake

When this function is active the drive will hold torque at stand still following a stop command rather than disabling the output bridge. The drive status will be 'StoP' when the drive is at a standstill rather than 'rdy'. This function will operate in the open loop or closed loop modes.

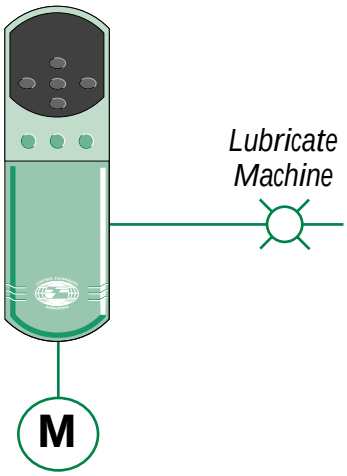
Electronic Holding Brake Illustration ▼



Machine Lubrication Alarm

This function allows the user to program a time period between 0 and 30,000 hours which determines when the lubrication alarm will annunciate. The time period is based on the drive run-time. The lubrication alarm function can be activated or deactivated based on the drive's configuration.

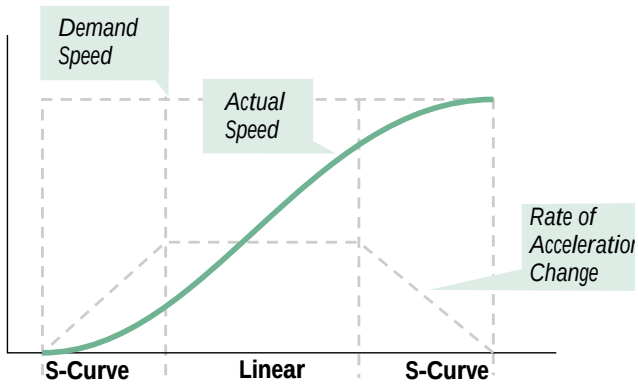
Machine Lubrication Alarm Illustration



S-Ramp

All acceleration and deceleration ramps can be configured as S-ramps. This function provides smoother starting and stopping for sensitive loads. The user can adjust the maximum rate of change of acceleration (time squared), which in effect defines the curvature of the S-ramp.

S-Ramp Illustration ▼

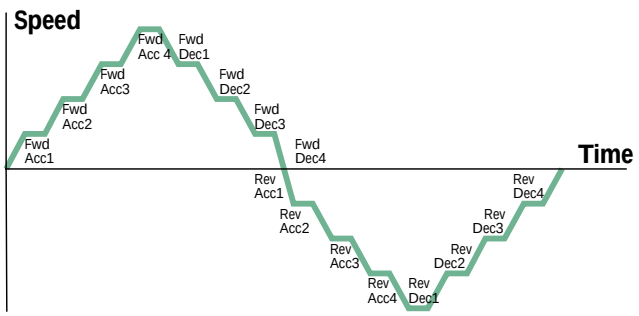


Additional Configurable Functions

Acceleration and Deceleration Ramp Selection

There are eight acceleration rates and eight deceleration rates which are selectable by logic inputs. The rates are operational in the forward and reverse directions. However, they can be split such that four of the rates operate in forward and four operate in reverse.

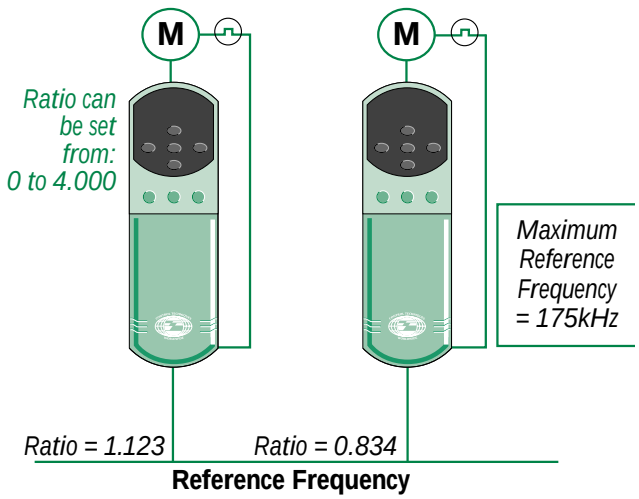
Acceleration and Deceleration Ramp Selections Illustration ▼



Ratio Control

The Unidrive has the ability to accept a frequency as reference and multiply that reference by an adjustable ratio. This function permits frequency following/slaving and digital locking. (The scenario below utilises the second encoder option.)

Ratio Control Illustration ▼



Preset Speeds

The Unidrive has eight preset speeds which can be selected by terminal inputs or by a timed function. The timed function allows the user to define an interval between 0 and 400 seconds which determines when the next preset speed is activated.

LOGIC INPUT No. 1	No. 2	No.3	PRESET SPEED SELECTED
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

* Note: Macro available.

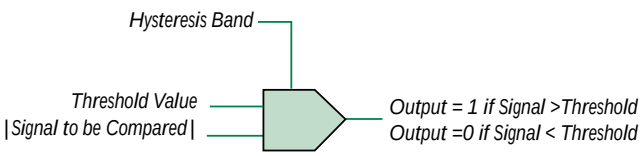
Programmable Thresholds

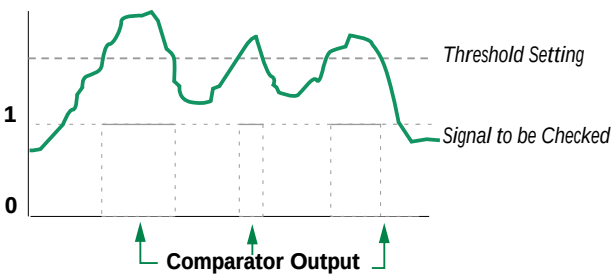
The drive software supports two software controllable 'numerical comparators'. These comparators can be used to detect when an internal or external signal exceeds a user set point threshold. These threshold comparators provide a hysteresis band to prevent erratic operation at or near the threshold point.

Applications:

Release External Brake when Torque > 50%

Turn on Motor Fan when Speed < 20%





Additional Configurable Functions

Programmable Logic

The Unidrive has several unique programmable logic functions that are built-in to the drive. This programmable logic 'soft-circuitry' can AND/OR/NAND/NOR up to 3 logic signals. These signals can be internal drive states, external user machine inputs or a combination of each. In addition, the resultant boolean logic can be sent through a 'built-in' adjustable time delay before being used by the drive or sent out through its' logic output driver circuitry.

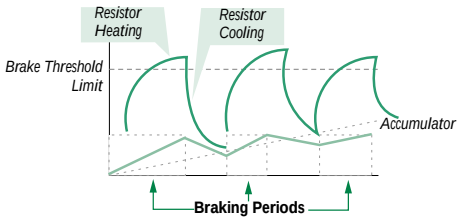
Programmable Logic Example ▼

Example: If Speed is 0 AND Motor Current >80% for >3 seconds = Motor is stalled

Dynamic Brake Alarm

The Unidrive contains an internal "Braking Energy Accumulator" that builds up as a function of brake usage. This accumulator can provide a representation of brake resistor temperature. Parameters are included that help define the braking resistor thermal time constant. Adjustment parameters are included to determine when an alarm bit is to be set which can be used to help provide electronic protection for a braking resistor.

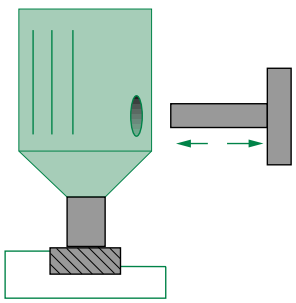
Dynamic Brake Alarm Illustration ▼



Spindle Orientation

Upon an orientation command, the Unidrive has built-in position control logic to permit a machine tool spindle for example to be stopped and held in a predetermined position for a tool change to occur. The drive would be set for closed loop control and upon an "orientation command" coming in from one of the drives programmable inputs, the drive would then decelerate to the orientation position reference setting. After arriving within a settable "orientation acceptance window", an "orientation complete" output would interface to machine logic to proceed with the tool change or other manufacturing step.

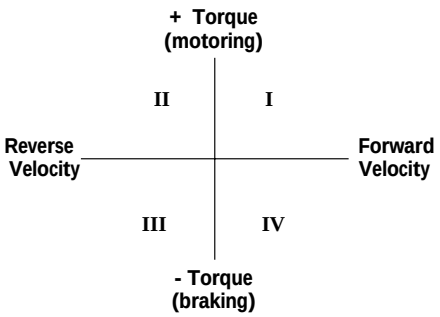
Spindle Orientation Illustration ▼



Motoring or Regenerating Current Limit

Unidrives have individual current limit control in each of the four quadrants of operation. The current limiting section also provide a symmetrical current limit that can, when introduced, override those independent settings. These extra settings provide a greater range of flexibility and overall application.

Current Limit Illustration ▼



Unidrive Menu

Introduction

The Unidrive's more than 700 parameters are organised so that similar parameters are grouped within the same menu. For example, Menu 1 holds the parameters associated with the selection of a speed reference. Menu 2 holds parameters associated with the selection of acceleration and deceleration rates etc.

Menus zero

This menu holds parameters that are quick access duplicates of the most used advanced parameters.

Categories:

0.0	Configuration
0.01 – 0.02	Speed limits
0.03 – 0.06	Ramps
	Speed reference selection
	Current limit
0.07- 0.09	Voltage boost (open loop)
	PID gains (closed loop)
0.10 – 0.13	Monitoring
0.14 – 0.17	Jog reference
	Ramp mode selector
	Stop and torque mode selectors
0.18 – 0.19	S-ramp
0.20 – 0.23	Skip bands
0.24 – 0.26	Analogue input modes
0.27 – 0.34	Miscellaneous
0.35	Keypad reference monitoring
0.36 – 0.38	Serial communications
	Parameter displayed at power up
0.39 – 0.41	Spinning motor
	Autotune
	PWM switching frequency
0.42 – 0.47	Motor parameters
0.48	Operating mode selection
0.49 – 0.50	Status information

Menu 1	*Frequency / speed reference selection*
	Frequency / speed limits
	Skip frequencies / speeds
Menu 2	*Acceleration and deceleration ramps*
	Ramp selection, enable selected
	Braking mode selection
	S-ramp
Menu 3	*Speed indications*
	Speed loop PID gain
	Speed sensing thresholds
	Frequency slaving
	Hard speed reference
	Encoder set up
Menu 4	*Current monitoring*
	Current limiting in speed control
	Current loop gains
	Torque control
	Motor protection
Menu 5	*Motor monitoring*
	Motor ratings
	Voltage boost
	Autotune
	PWM switching frequency
	Slip compensation
Menu 6	*Drive sequencer*
	Auto-start
	AC supply loss
	Jog time
	Limit switches
	Injection braking
	Synchronise to a spinning motor
	Keypad enable
	Run-time log
	Electricity cost
Menu 7	*Analogue I/O*
	Temperatures
Menu 8	*Digital I/O*
Menu 9	*Programmable logic*
	Motorised potentiometer
	Binary-sum logic
Menu 10	*Status and diagnostic information*
	Process generated trips
	UD78 power supply indicator
Menu 11	*Menu 0 assignments*
	Scale factors
	Initial parameters displayed
	Serial communications
	Drive information
Menu 12	*Programmable comparators*
Menu 13	*Position control*
Menu 14	*PID controller*
Menu 15	*Regeneration*
Menu 16	*Small Option Module*
Menu 17	*Large Option Module*
Menu 18	*User parameters LOM*
Menu 19	*User LOM*
Menu 20	*UD70 only*

Unidrive Options

Drive Communications

UD71 Serial Communications Module

- RS232 communications for easy commissioning and drive programming
- RS485 communications for industrial process control

Distributed Applications

- UD70 Modbus Module (19.2 Kbps)
- UD73 Profibus DP Module (1.5 Mbps)
- UD74 Interbus S Module (0.5 Mbps)
- UD76 Modbus+ Module (1 Mbps)
- UD77 DeviceNet (0.5 Mbps)
- UD75 CTNet Module (5 Mbps)
  - Peer to peer communications
  - Distributed control
  - Simplifies high performance industrial applications

Easy Applications

UD70 Applications Module

- 32 bit RISC processor
- 256k flash memory
- High level programming language (DPL) eliminates need for PLC
- Standard programs for axis control, coiler control, lift and position control
- Windows™ based programming “toolkit”
- ANSI communications and Modbus as standard

UD78 High Performance Servo Module

- >16 bit analogue input for precise position control
- Accurate tracking of small input signal changes with <150µV deadband
- 24V back-up tracks encoder position when mains loss is experienced
- RS485 communications

Feedback Device

UD50 Extended I/O

- Low cost external control
- 2 N/0 relays
- 3 Digital inputs
- 3 Digital I/0
- 2 Analogue inputs
- 1 Analogue output

UD51 Second Encoder

- Master/Slave capability for multiple drive control (Digital Lock)
- Quadrature or frequency and direction reference
- Freeze input
- Simulated encoder output

UD52 Sin/Cos Encoder

- High precision positioning
- 500,000 ppr
- Single or multi-turn
- Absolute position tracked
- Freeze input

UD53 Resolver Feedback

- Easy expansion of drive for use in rugged and demanding environments
- Simulated encoder output

Drive Set Up

UD55 Cloning Module

- Easy set-up of multiple drives
- Simplifies the transfer of parameters between Drives
- Stores 8 full parameter sets

Specifications

AC supply requirements

380V to 480V ±10%

3-phase

Maximum supply imbalance: 2% negative phase sequence (equivalent to 3% voltage imbalance between phases)

48 to 62 Hz

Motor requirements

Number of phases: 3

Voltage: 380V ~ 480V ±10%

Temperature, humidity and cooling method

Ambient temperature range:

–10°C to 50°C (14°F to 122°F). Output current de-rating may apply at high ambient temperatures.

Cooling method: Natural convection

Maximum humidity: 95% non-condensing at 40°C (104°F)

Storage temperature range: –40°C to 50°C (–40°F to 122°F)

Maximum storage time: 12 months

Altitude

Altitude range: 0 to 4000m (13000 ft), subject to the following conditions:

1000m to 4000m (330 feet to 13000 ft) above sea level: de-rate the maximum output current from the specified figure by 1% per 100m (330 ft)

Vibration

Maximum vibration:

≤0.5g as specified in IEC 68–2–61; 1982

Ingress protection

Gland plate(s) not fitted: IP00

Gland plate(s) fitted; cable glands not fitted: IP10

Cable-glands fitted; glands fitted: IP40, NEMA 1

Power and Current ratings

40°C (104°F) ambient	Nominal rating		Maximum permissible continuous output current					Nominal AC supply current
Model	@380V	@460V	3kHz	4.5kHz	6kHz	9kHz	12kHz	
UNI 1401	0.75 kW	1.0 HP	2.1 A	2.1 A	2.1 A	2.1 A	2.1 A	3.1 A
UNI 1402	1.1 kW	1.5 HP	2.8 A	2.8 A	2.8 A	2.8 A	2.8 A	3.2 A
UNI 1403	1.5 kW	2.0 HP	3.8 A	3.8 A	3.8 A	3.8 A	3.8 A	5.5 A
UNI 1404	2.2 kW	3.0 HP	5.6 A	5.6 A	5.6 A	5.6 A	4.5 A	8.4 A
UNI 1405	4.0 kW	5.0 HP	9.5 A	9.5 A	8.5 A	7.0 A	5.5 A	9.5 A
UNI 2401	5.5 kW	7.5 HP	12.0 A	12.0 A	12.0 A	12.0 A	11.7 A	13.7 A
UNI 2402	7.5 kW	10.0 HP	16.0 A	16.0 A	16.0 A	14.2 A	11.7 A	16.3 A
UNI 2403	11.0 kW	15.0 HP	25.0 A	21.7 A	18.2 A	14.2 A	11.7 A	24.3 A
UNI 3401	15.0 kW	25.0 HP	34.0 A	34.0 A	34.0 A	28.0 A	23.0 A	34.0 A
UNI 3402	18.5 kW	30.0 HP	40.0 A	40.0 A	37.0 A	28.0 A	23.0 A	39.0 A
UNI 3403	22.0 kW	30.0 HP	46.0 A	46.0 A	40.0 A	32.0 A	26.6 A	46.0 A
UNI 3404	30.0 kW	40.0 HP	60.0 A	47.0 A	40.0 A	32.0 A	26.7 A	59.0 A
UNI 3405	37.0 kW	50.0 HP	70.0 A	56.0 A	46.0 A	35.0 A	28.0 A	74.0 A
UNI 4401	45.0 kW	75.0 HP	96.0 A	96.0 A	88.0 A	70.0 A		96.0 A
UNI 4402	55.0 kW	100.0 HP	124.0 A	104.0 A	88.0 A	70.0 A		120.0 A
UNI 4403	75.0 kW	125.0 HP	156.0 A	124.0 A	105.0 A	80.0 A		151.0 A
UNI 4404	90.0 kW	150.0 HP	180.0 A	175.0 A	145.0 A	110.0 A		173.0 A
UNI 4405	110.0 kW	150.0 HP	202.0 A	175.0 A	145.0A	110.0 A		190.0 A
UNI 5401	160.0 kW	200.0 HP	300.0 A					240.0 A

Accuracy and Resolution

The following data applies to the Drive only; it does not include the performance of the source of the control signals.

Output-frequency accuracy:≤ ±0.1%

Output-frequency resolution:
(open-loop): ≤ ± 0.001 Hz
(closed-loop): ≤ ± 0.01 RPM

Starts per hour

By electronic control: unlimited

By interrupting the AC supply:
model sizes 1 and 2: ≤ 20
model sizes 3 and 4: ≤ 10

Specifications

Dissipation

Model	Nominal rating		Maximum total power dissipation				
	@380V	@460V	3kHz	4.5kHz	6kHz	9kHz	12kHz
UNI 1401	0.75kW	1.0HP	80 W	80 W	90 W	90 W	90 W
UNI 1402	1.1kW	1.5HP	90 W	90 W	100 W	100 W	110 W
UNI 1403	1.5kW	2.0HP	100 W	110 W	110 W	120 W	130 W
UNI 1404	2.2kW	3.0HP	130 W	130 W	140 W	150 W	150 W
UNI 1405	4.0kW	5.0HP	180 W	190 W	190 W	190 W	170 W
UNI 2401	5.5kW	7.5HP	210 W	230 W	250 W	280 W	310 W
UNI 2402	7.5kW	10HP	270 W	290 W	310 W	320 W	310 W
UNI 2403	11.0kW	15HP	400 W	380 W	360 W	330 W	310 W
UNI 3401	15.0kW	25HP	570 W	620 W	670 W	660 W	630 W
UNI 3402	18.5kW	30HP	660 W	720 W	730 W	660 W	630 W
UNI 3403	22.0kW	30HP	730 W	800 W	770 W	730 W	700 W
UNI 3404	30.0kW	40HP	950 W	830 W	790 W	740 W	710 W
UNI 3405	37.0kW	50HP	1090 W	990 W	920 W	850 W	800 W
UNI 4401	45kW	75HP	1460 W	1610 W	1630 W	1530 W	
UNI 4402	55kW	100HP	1910 W	1780 W	1670 W	1560 W	
UNI 4403	75kW	125HP	2370 W	2130 W	2030 W	1860 W	
UNI 4404	90kW	150HP	2640 W	2890 W	2700 W	2470 W	
UNI 4405	110kW	150HP	2970 W	2910 W	2720 W	2490 W	
UNI 5401	160kW	200HP	5000 W				

Frequencies and speed

PWM switching frequency:

3kHz nominal (selectable up to 12kHz)

Maximum output frequency (open-loop): 2000Hz

Maximum speed (closed-loop): 30 000 RPM

Speed regulation:
(open-loop): 1 ~ 2%
(closed-loop): 0.01%

Speed control range:
(open-loop): >50:1
(closed-loop): >1000:1

50°C (122°F) ambient	Maximum permissible continuous output current				
Model	3kHz	4.5kHz	6kHz	9kHz	12kHz
UNI 1401	2.1 A	2.1 A	2.1 A	2.1 A	2.1 A
UNI 1402	2.8 A	2.8 A	2.8 A	2.8 A	2.8 A
UNI 1403	3.8 A	3.8 A	3.8 A	3.8 A	3.3 A
UNI 1404	5.6 A	5.6 A	5.1 A	4.0 A	3.3 A
UNI 1405	6.9 A	5.9 A	5.1 A	4.0 A	3.3 A
UNI 2401	12.0 A	12.0 A	12.0 A	11.6 A	9.7 A
UNI 2402	16.0 A	16.0 A	14.7 A	11.6 A	9.7 A
UNI 2403	20.0 A	17.3 A	14.7 A	11.6 A	9.7 A
UNI 3401	34.0 A	34.0 A	28.0 A	21.0 A	17.9 A
UNI 3402	40.0 A	34.0 A	28.0 A	21.0 A	17.9 A
UNI 3403	44.0 A	36.0 A	31.0 A	24.0 A	20.6 A
UNI 3404	44.0 A	36.0 A	31.0 A	24.0 A	20.9 A
UNI 3405	50.0 A	41.0 A	34.0 A	26.0 A	23.0 A
UNI 4401	95.0 A	85.0 A	75.0 A	60.0 A	
UNI 4402	105.0 A	85.0 A	75.0 A	60.0 A	
UNI 4403	135.0 A	105.0 A	85.0 A	65.0 A	
UNI 4404	180.0 A	150.0 A	125.0 A	95.0 A	
UNI 4405	190.0 A	150.0 A	125.0 A	95.0 A	

Specifications

Overall dimensions

H Height including mounting brackets

W Width

D Projection forward of panel when surface mounted

F Projection forward of panel when through-panel mounted

R Projection rear of panel when through-panel mounted

Dimension	Model size				
	1	2	3	4	5
H	368mm 14 1/4 in	368mm 14 1/4 in	364mm 14 5/16 in	743mm 29 1/4 in	1319mm 51 15/16 in
W	95mm 3 3/4 in	190mm 7 1/2 in	375mm 14 3/4 in	500mm 19 11/16in	355mm 14 in
D	200mm 7 7/8 in	200 mm 7 7/8 in	360mm 10 1/4 in	360mm 10 1/4 in	484mm 19 in
F	120mm 4 1/4 in	120mm 4 1/4 in	120mm 4 1/4 in	120mm 4 1/4 in	340mm 13 1/6 in
R	80mm 3 1/8 in	80mm 3 1/8 in	140mm 5 1/2 in	140mm 5 1/2 in	144mm 5 11/16 in

Weights

Model size	kg	lb
1	4	8.8
2	8	17
3	22	49
4	70	154
*5	102	224

*Power Module only

Electromagnetic compatibility (EMC) conducted emission

This is a summary of the EMC performance of the Drive. For full details, refer to the Unidrive EMC Data Sheet which can be obtained from a Drive Centre or distributor listed on the back cover.

Immunity

Compliance with immunity standards does not depend on installation details. The Drive meets EN50082–2 (generic immunity standard for the industrial environment) and the following specifications from the IEC1000–4 group (derived from IEC801):

Part 2, Electrostatic discharge: Level 3

Part 3, Radio frequency field: Level 3

Part 4, Transient burst: Level 4 at the control terminals

Part 4 Transient burst:
Level 4 at the control terminals
Level 3 at the power terminals

Part 5, Surge (at the AC supply terminals):
Level 4 line-to-ground
Level 3 line-to-line (as specified by EN50082–2 informative annex)

Part 6, Conducted radio frequency:
Level 3

Emission

Compliance with emission standards depends on rigorous adherence to the installation guidelines, including the use of the specified RFI filter in the AC supply circuit. Compliance also depends on the PWM switching frequency used in the output stage of the Drive, and the length of the motor cable. For full details, refer to the Unidrive EMC Data Sheet which can be obtained from a Drive Centre or distributor listed at the end of this Product Data Guide.

Dynamic Braking

Resistor Connections

The external braking resistor should be connected to the Unidrive terminals labelled (+) and (-) on the terminal strip on Unidrive size 1 & 2 or the stud connections on Unidrive size 3 & 4. The resistor *must* be thermally protected in the unlikely event that the braking transistor fails. This thermal device must either disconnect the input AC power to the Inverter or disconnect the resistor from the circuit. Please contact the a Drive Centre for additional application information.

Custom Resistor Values

The resistor ohmic value is based on the torque required to stop the motor (and connected load) in the time dictated by the application. The first equation to be solved is the torque required knowing the required stop time.

$$T = \frac{J \times N}{t_d \times 307} \text{ (Ft - Lb) or } T = \frac{2\pi J \times N}{t_d \times 60} \text{ (Nm)}$$

Where:

J = *Total Inertia (Lb-Ft² or Kgm²)*
N = *Motor Max. Speed (RPM)*
t_d = *Decel Time (Sec.)*
T = *Torque (Ft-Lb or Nm)*

The torque required must be equal or less than 1.5 x motor/drive capability.

$$HP_{(brake)} = \frac{T \times N}{5250} \text{ or } P_{(kW)} = \frac{T \times N}{30}$$

The ohmic value of the resistor can now be calculated using the following formula:

$$R = \frac{(V_b)^2}{HP_{(brake)} \times 746} \text{ or } R = \frac{(V_b)^2}{P_{(kW)}}$$

Where:

V_b = *Bus voltage level when braking*
= *750 VDC*

Minimum Values

The calculated minimum ohmic value is limited by the braking transistor supplied in the Unidrive being used. The following is a list of the minimum values.

MODEL	MINIMUM VALUE
Unidrive Size 1	40 Ohms
Unidrive Size 2	40 Ohms
Unidrive Size 3	10 Ohms
Unidrive Size 4	5 Ohms

Average Power Dissipation

The average power dissipated in the resistor for intermittent operation is then simply the number of watts dissipated per stop times the duty cycle (D).

Where:

$$D = \frac{t_d}{t_d + t_{off}}$$

In order to use this formula for average power dissipation, the brake resistor must be off long enough for the temperature of the resistor to return to ambient temperature between braking cycles. Also, the maximum on time (or decel time) should not exceed the peak capabilities of the power resistor. Typically, a power resistor has the capability of dissipating 10 times rated wattage for 5 to 10 seconds.

Peak Power Rating

The peak power handling ability of the resistor must meet or exceed the following:

$$PPK = (Vb)^2/R$$

Accessories

RFI Filter

Apply an RFI Filter to each drive input if it is necessary to meet the Electromagnetic Emission Standards.

Specifications

Control Inputs and Outputs

TERMINAL	I/O TYPE & FUNCTION	RATING
1	Status Relay 1 Dry contact output pole 1/2 *Drive OK* (default)	Normally open contacts 5A, 240 VAC resistive
2	Status Relay 1 Dry contact output pole 2/2	
3	Circuit Common 0 VDC Analogue reference	
4	+10 VDC User supply for external analogue signal device	± 1% Voltage tolerance 10 mA output current (current limit protected)
5	Analogue Input 1 (non-inverting input) Programmable Differential Analogue Input *Analogue Speed Reference 1* (default)	Bipolar ±10 VDC 100kΩ input impedance 12-bit plus sign resolution, ≤ 2mS sampling period OL <45 Oμs C.L. Programmable Differential Analogue Input
6	Analogue Input 1 (inverting input)	
7	Analogue Input 2 Programmable Single-ended Analogue Input *Analogue Speed Reference 2* (default)	Programmable: ±10 VDC (default), 4-20mA, 20-4mA, 0-20mA inputs, 100kΩ input impedance 10-bit plus sign resolution ≤ 2mS sampling period
8	Motor Thermistor Input Programmable Single-ended Analogue Input	
9	Analogue Output 1 Programmable Single-ended Analogue Output *Output Frequency* (open loop default) *Speed Feedback* (closed loop default) Short circuit protected	Programmable: ±10 VDC @ 10mA (max) (default) 4-20mA, or 0-20mA 1kΩ minimum load resistance 10-bit plus sign resolution, 8mS update period
10	Analogue Output 2 Programmable Single-ended Analogue Output *Torque Output* (default)	
11	Circuit Common 0 VDC Analogue reference	
21	OV Common	
22	+24 VDC User Supply	Voltage Tolerance: ±10% Nominal Output: 200 mA Overload Output: 240 mA with current foldback protection
23	Circuit Common 0 VDC Digital reference	
24	Programmable Logic I/O F1 Output: *At speed* (open loop) *At zero speed* (closed loop)	Output Mode: User-defined: Negative or positive logic *Negative logic* (default) Push-pull output, 0 - +24 VDC 100mA max output, 120mA overload current Input Mode: User-defined: Positive logic (V > +15 VDC) or negative logic (V < +5 VDC) (default) Voltage range: 0 - +24 VDC 3.2 mA max load at +24 VDC
25	Programmable Logic I/O F2 Input: *Drive reset* (default)	
26	Programmable Logic I/O F3 Input: *Jog* (default)	
27	Programmable Logic Input F4 Latched *Run Forward* (default)	User-defined: Positive logic (V > +15 VDC) or negative logic (V < +5 VDC) (default) Voltage range: 0 - +24VDC, 3.2 mA max load @ +24 VDC
28	Programmable Logic Input F5 Latched *Run Reverse* (default)	
29	Programmable Logic Input F6 *Local (default)/Remote*	
30	Logic Input: *Drive Enable* (closed loop) *External Trip* (open loop)	
31	Circuit Common 0 VDC digital reference	

NOTE: There are no terminals numbered 12, 13...., 20 on the Unidrive

Protection

DC Bus Undervoltage Trip	350 VDC
DC Bus Overvoltage Trip	830 VDC
MOV Voltage Transient Protection (Line to Line & Line to Ground)	160 Joules, 1400 Volts Clamping
Drive Overload Trip	Current overload value is exceeded. Programmable to allow up to 150% of Drive Current for one minute. Open loop and 175% of Drive Current Closed loop.
Instantaneous Overcurrent Trip	215% of Drive rated current
Phase Loss Trip	DC bus ripple threshold exceeded
Overtemperature Trip	Drive heatsink temperature exceeds 95°C
Short Circuit Trip	Protects against output phase fault
Ground Fault Trip	Protects against output phase to ground fault
Motor Thermal Trip	Electronically protects the motor from overheating due to Loading conditions

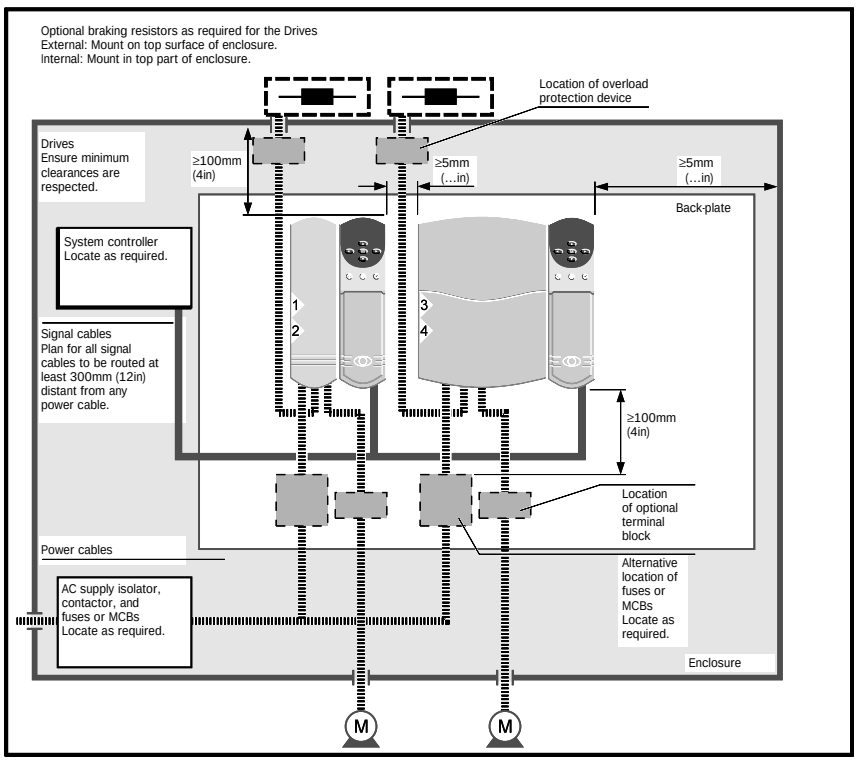
Cable & Fuse Recommendations

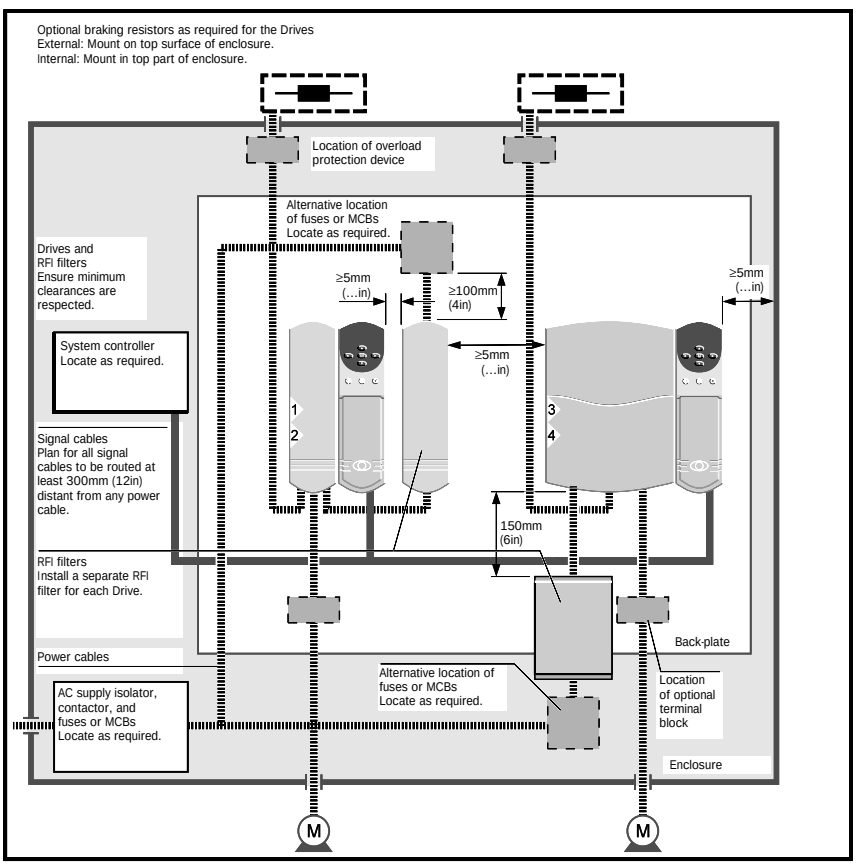
FUSES and CABLES					
CATALOGUE NUMBER	AC Supply Cables		Motor Cables		Fuse ① Rating
	mm2	AWG	mm2	AWG	Amps
UNI1401	1.5	16	1.5	16	6
UNI1402	2.5	14	2.5	14	10
UNI1403	2.5	14	2.5	14	10
UNI1404	2.5	14	2.5	14	10
UNI1405	2.5	14	2.5	14	16
UNI2401	2.5	14	2.5	14	16
UNI2402	4.0	10	4.0	10	35
UNI2403	4.0	10	4.0	10	20
UNI3401	6	8	6	8	40
UNI3402	10	6	10	6	50
UNI3403	10	6	10	6	60
UNI3404	16	4	16	4	70
UNI3405	25	4	25	4	80
UNI4401	35	2	35	2	100
UNI4402	35	2	35	2	125
UNI4403	50	2/0	50	2/0	160
UNI4404	70	2/0	70	2/0	200
UNI4405	95	3/0	95	3/0	250
① UNI5401	95	3/0	95	3/0	450

① *Use Fuse class RK1 or similar HRC fuse.*

Pre-Installation

Panel Guidelines





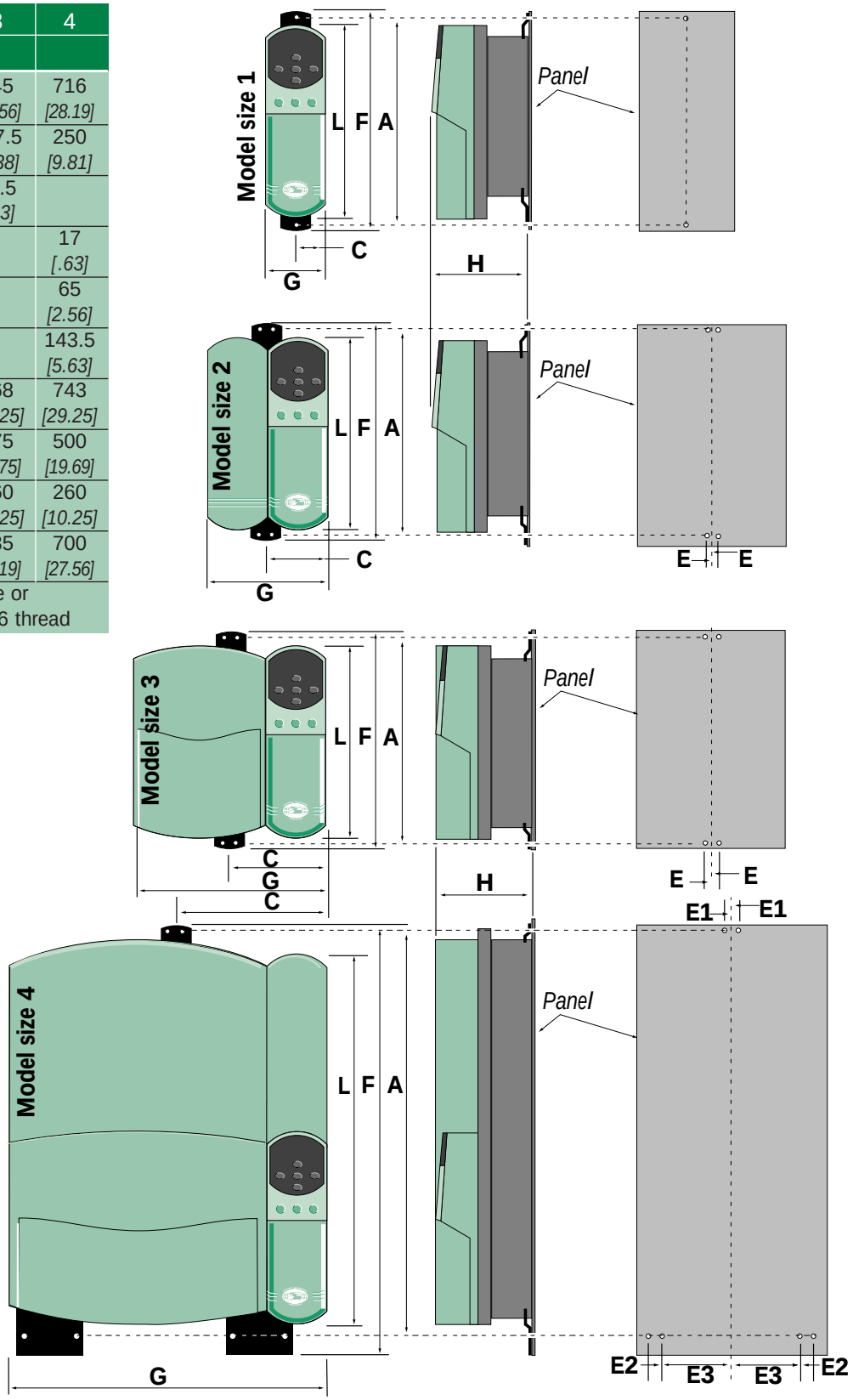
① *Consult Drive Centre for Filter details.*

Drive Mounting Dimensions

Surface Mounting

Model Size	1	2	3	4
Dimension ①				
A	345 *[13.56]*	345 *[13.56]*	345 *[13.56]*	716 *[28.19]*
C	47.5 *[1.88]*	95 *[3.75]*	187.5 *[7.38]*	250 *[9.81]*
E		16.5 *[.63]*	16.5 *[.63]*	
E1				17 *[.63]*
E2				65 *[2.56]*
E3				143.5 *[5.63]*
F	368 *[14.25]*	368 *[14.25]*	368 *[14.25]*	743 *[29.25]*
G	95 *[3.75]*	190 *[7.50]*	375 *[14.75]*	500 *[19.69]*
H	200 *[7.88]*	200 *[7.88]*	260 *[10.25]*	260 *[10.25]*
L	335 *[13.19]*	335 *[13.19]*	335 *[13.19]*	700 *[27.56]*
Mounting hole diam.	6.5 *[.16]* clearance or $^1/_4$ UNF M6 thread			

① *Dimensions in mm and [inches].*



Pre-Installation

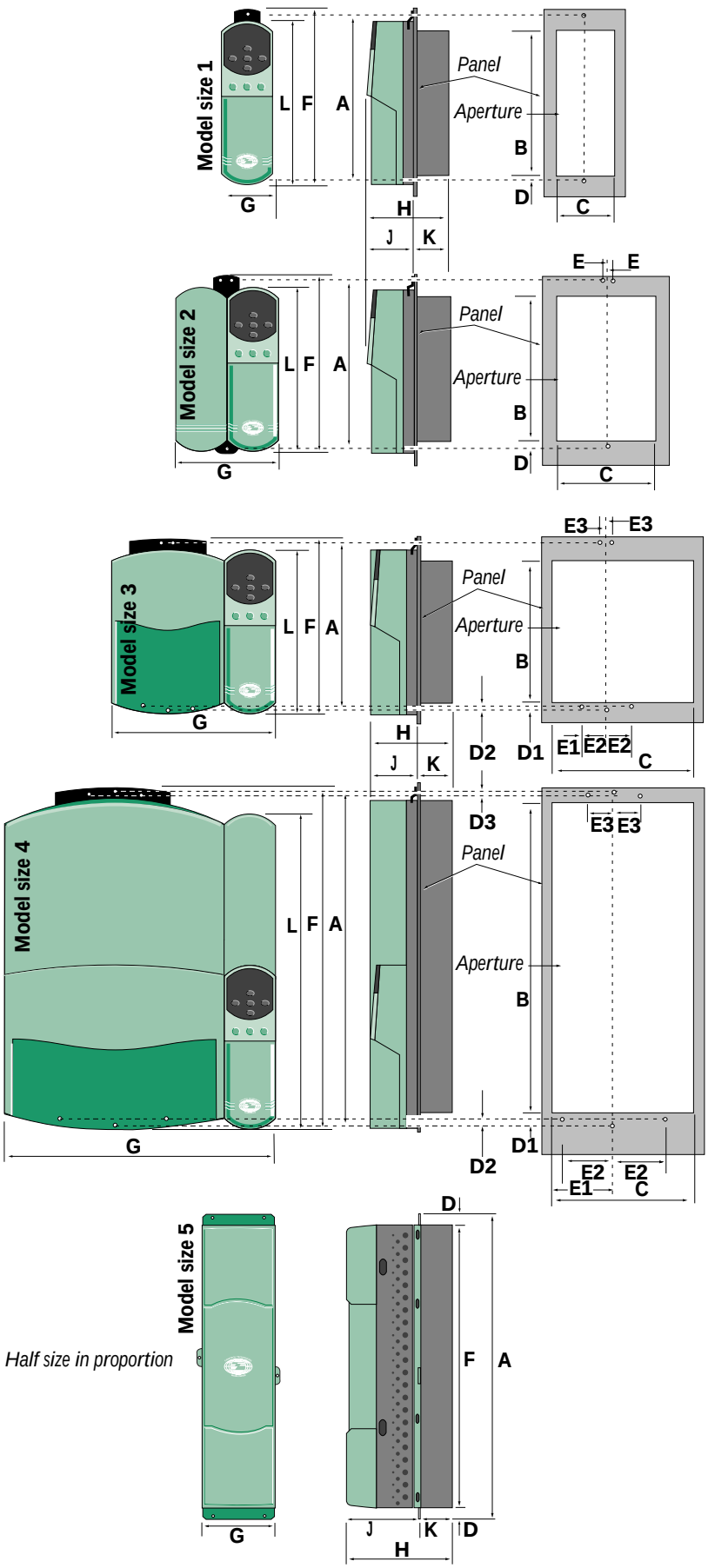
Drive Mounting Dimensions

Through-panel Mounting

Model Size	1	2	3	4
Dimension ①				
A	345 *[13.56]*	345 *[13.56]*	345 *[13.56]*	717.5 *[28.25]*
B	295 *[11.63]*	295 *[11.63]*	287 *[11.31]*	650 *[25.56]*
C	86.5 *[3.38]*	182 *[7.19]*	358 *[14.13]*	482 *[19]*
D	*13 (0.5)*	*13 (0.5)*		
D1			16 *[.63]*	17 *[.63]*
D2			7 *[.25]*	7.5 *[.31]*
D3				3.5 *[.13]*
E		16.5 *[.13]*		
E1			131.5 *[5.19]*	192 *[7.56]*
E2			69 *[2.69]*	130 *[5.13]*
E3			16.5 *[.63]*	65 *[2.56]*
F	364 *[14.31]*	364 *[14.31]*	364 *[14.31]*	743 *[29.25]*
G	95 *[3.75]*	190 *[7.50]*	375 *[14.75]*	500 *[19.69]*
H	200 *[7.88]*	200 *[7.88]*	260 *[10.25]*	260 *[10.25]*
J ②	120 *[7.88]*	120 *[7.88]*	120 *[10.25]*	120 *[10.25]*
K ③	80 *[3.13]*	80 *[3.13]*	140 *[5.50]*	140 *[5.50]*
L	335 *[13.19]*	335 *[13.19]*	335 *[13.19]*	700 *[27.56]*
Mounting hole diam.	6.5 *[.16]* clearance or M6 1/4 UNF thread			

① *Dimensions in mm and [inches].*
② *Plus thickness of gasket.*
③ *Minus thickness of gasket*

Model Size	5
Dimension ①	
A	1319 *[51 15/16]*
D	35.5 *[1 7/16]*
F	1248 *[49 1/8]*
G	315 *[12 3/8]*
H	484 *[19]*
J	340 *[13 1/16]*
K	144 *[5 11/16]*



Enclosure Guidelines

Heat Dissipation in a Sealed Enclosure

If possible, locate heat-generating equipment in the lower part of the enclosure to encourage internal convection. Otherwise, use a taller enclosure or install stirrer fans.

The enclosure must be of adequate size to maintain sufficient cooling of the drive when it is installed inside a sealed enclosure. Heat generated by all the equipment in the enclosure must be taken into account. To calculate the minimum acceptable size of an enclosure, use the following procedure:

Calculate the minimum required surface area Ae *for the enclosure from:*

$$A_e = \frac{P}{k(T_i - T_{amb})}$$

Where:

T_{amb}	*Maximum ambient temperature in °C external to the enclosure.*
A_e	*Unobstructed heat-conducting are in* mm^2.
k	*Heat transmission coefficient of the enclosure material.*
T_i	*Maximum permissible operating temperature in °C.*
P	*Power in watts dissipated by all heat sources in the enclosure.*

Example:

To calculate the size of an enclosure for model UNI 1403 (1.5kW, 2HP).

The following conditions are assumed:

The Drive is surface-mounted inside the enclosure.

Only the top, front, and two sides of the enclosure are free to dissipate heat.

The enclosure is made from painted 2mm (.079in) sheet steel.

Maximum external air temperature: 30°C (86°F).

Insert the following values:

T_i = *40°C*
T_{amb} = *30°C*
k = *5.5 (typical for painted 2mm (.079in) sheet steel)*
P = *100 at 3kHz (see pages 18 &19)*

Note:

It is essential to include any other heat sources in the value of P.

The minimum required heat conducting area is then:

$$A_e = \frac{100}{5.5(40 - 30)} = 1.81m^2$$

Estimate two of the enclosure dimensions — the height (H) and depth (D), for instance. Calculate the width (W) from:

$$W = \frac{A_e - 2HD}{H + D}$$

Inserting H = D = 0.5m, obtain the minimum width:

$$W = \frac{1.81 - (2 \times 0.5 \times 0.5)}{0.5 + 0.5} = 0.81m$$

Heat Dissipation in a Ventilated Enclosure

If a high ingress protection rating is not required, the enclosure may be smaller. A ventilating fan can be used to exchange air between the inside and outside of the enclosure.

To calculate the volume of ventilating air, use the following equation:

$$V = \frac{3.1P}{T_i - T_{amb}}$$

Where V = Air-flow in m^3 *per hour.*

Example:

P = *100*
T_i = *40°C*
T_{amb} = *30°C*

Then:

$$V = \frac{3.1 \times 73}{40 - 30} = 31m^3 / hr$$

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