DC Drives

SERIES

invensys

Eurotherm

Single & Three Phase DC Drives

Specification Sheet

- Extruders
- Pumps & Fans
- Printing press
- Paper machines
- Machine Tools
- Mixers
- Calenders
- Winders
- Unwinders
- Conveyors
- Rolling Mills
- Test Rigs
- Wire & Cable
- Rubber Mixers
- Textile Machinery
- Cranes and hoists and much more...

Eurotherm® offer a wider choice of variable speed DC drives than any other manufacturer. The range has over 50 models with power ratings up to many hundreds of kilowatts. The units are remarkably compact - providing savings in cabinet size and enabling easy machine installation and wiring.

All products are available ex-stock (UK) to assist you in minimising downtime in emergency or breakdown situations. Product manuals provide step by step guidance for start-up, with examples of typical applications, to make system design and installation quick and trouble-free.

This range consists of:

Model	Description
ER-340 **ER-680** **ER-1220**	 Single Phase, 1- and 4-quadrant, fully isolated or non isolated DC motor controllers for armature currents up to 12.2A
ER-3200i **ER-3600XRi**	 Single Phase 1- and 4-quadrant, fully isolated DC motor controller for armature currents up to 48A for 1-Quadrant or 36A for 4-Quadrant
ER-PL **ER-PLX**	 Three phase, 2- and 4-Quadrant, fully isolated digital, DC motor controllers for armature currents up to 2250A

Single Phase, 1- and 4-Quadrant

Models:
ER-340, ER-680 and ER-1220
ER-340i, ER-680i and ER-1220i
ER-340XRi, ER-680XRi and ER-1220XRi

DC motor controllers for armature currents from 3.4 Amps to 12.2 Amps

Technical Specification

1-Quadrant

Power range:	0.55-1.9 kW @ 180V dc
Non-isolated:	Models ER-340, ER-680, ER-1220 ***Warning:*** *These products are non-isolated and all terminals are at dangerous line potential. Ensure connected items are not earthed and have sufficient dielectric strength to avoid breakdown.*
Fully isolated:	Models ER-340i, ER-680i, ER-1220i.

4-Quadrant

Power range:	0.55-1,9kW @ 180V dc
Fully isolated:	Models ER-340XRi, ER-680XRi, ER-1220XRi

Power requirements

AC supply input:	110/240V ac and 30/60V ac (factory option) ±10%; 50-60Hz

Maximum output

Armature voltage:	V dc = 0.77 x ac supply voltage (nominal)
Field voltage:	V dc = 0.9 or 0.45 x ac supply voltage (maximum 1A)

Speed

Feedback:		Standard for armature voltage and analogue tachometer
Range:		0-100% dependent to the set point value
Accuracy:	Tachometer	0.1% (Speed Range 100:1)
	ARM	2% (Speed Range 20:1)

Overload

Overload:	150% of unit nominal current for 30 seconds on fully isolated units

User Adjustment

Relay driver threshold (Level*):	±0.5-100% symmetrical about zero
Maximum Speed (Max spd):	Corresponds to 40-200V or 10-50V ARM or tachometer voltage
Minimum Speed (Min spd):	0-30% of maximum speed
Up Ramp (Ramp):	1-20 seconds up ramp rate between 0 and 100% speed
Down Ramp (Ramp*):	1-20 seconds up ramp rate between 100% and 0% speed
Stability (Stab*):	1-10 Gain of speed loop
Max Current (Imax):	0-100% armature current limit
IR Compensation (IR comp):	0-25%

(* for fully isolated units only)

Inputs/Outputs

Inputs/outputs:	Dependent to the model, see manual description

External Controls

Speed Setpoint:	From external 10K Ohms potentiometer
External RUN:	Contact for electronic stop/start

Dissipation (W)

Dissipation (W):	3V x armature current (A)

Alarms

Alarms:	Stall Trip, 680 1220i fan monitoring

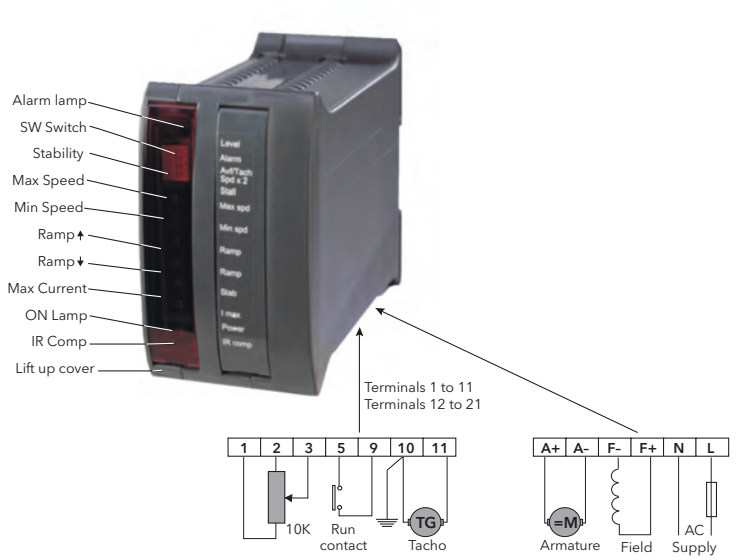
Environment

Storage and operating temperature:	-10°C to +50°C
Operating atmosphere:	Non-explosive, non-corrosive, defined by ICE 664
Humidity:	RH 5% to 85% at 40°C, non-condensing and non-streaming
Unit Protection:	IP20 in accordance with ICE 364
Thyristor Protection:	Internal MOV, RC snubber, high speed fuse 20A (fitted externally)
Approvals:	CE, UL, cUL

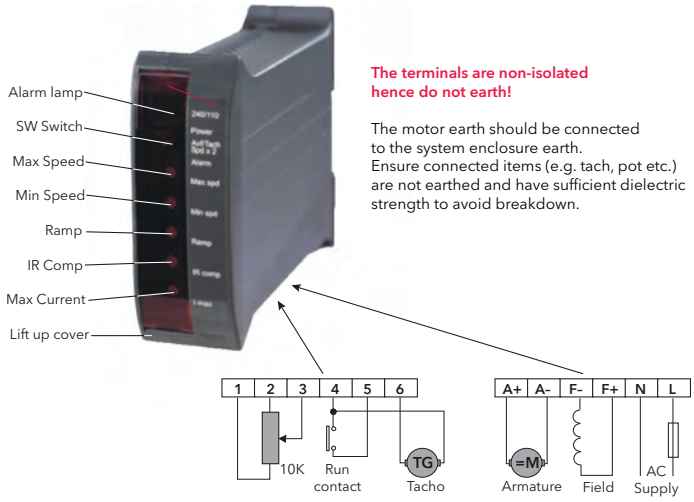
Dimensions (mm)

Model	Height	Depth	Width
ER-340	105	120	35
ER-340i	105	120	60
ER-340XRi	105	120	60
ER-680	105	120	45
ER-680i	105	120	70
ER-680XRi	105	120	70
ER-1220	105	120	45
ER-1220i	105	120	70
ER-1220XRi	105	120	70

Details for 340, 680 and 1220 units with 'i' and 'XRi' version



Details for 340, 680 and 1220 units



The terminals are non-isolated hence do not earth!

The motor earth should be connected to the system enclosure earth. Ensure connected items (e.g. tach, pot etc.) are not earthed and have sufficient dielectric strength to avoid breakdown.

Main Terminal Listing for "i" and "XRi" versions

Term	Function
A+	Motor armature +
A-	Motor armature -
F-	Motor Field -
F+	Motor Field +
N	AC supply 110V/240V or 30/60V
L	AC supply 110V/240V or 30/60V
1	Reference +10V dc 10mA max,
2	'Min-In', connected through 'Min spd.' to 0V
3	Speed input to ramp, 0 to 10V
4	Output (+/-10V), *
5	COMMON, 0V
6	Input PB +/-, *
7	Input PB +, *
8	Input PB -, *
9	RUN, electronic inhibit, open to reset
10	Com. 0V
11	TACH input, negative voltage, 1.5MOhm
12	RLOP, Relay drive output, *
13	RLIP, Relay driver input,*
14	OVLD, Overload,*
15	TRIP, Latched + 10V,*
16	ROP, Ramp output 0- ±10V
17	DEM Demand output, = the total speed dem.
18	SOP speed output, 0- ±10V
19	IOP current output, 0- + 5V
20	SPD, direct speed input fast resp., 0- ± 10V
21	TRQ, torque input. 0- + 7,5V for 0-150%

* see Application manual according to the model

Coding

Model	Regen	Terminals	Supply Vac (V)	Power (kW)*	Armature Current (A)
ER-340	No	Non-isolated		0.55	3.4
ER-340i	No	Fully isolated		0.55	3.4
ER-680	No	Non-isolated	110/240	1.1	6.8
ER-680i	No	Fully isolated	or	1.1	6.8
ER-1220	No	Non-isolated	30/60	1.8	12.2
ER-1220i	No	Fully isolated		1.8	12.2
ER-340 XRi	Yes	Fully isolated		0.55	3.4
ER-680 XRi	Yes	Fully isolated		1.1	6.8
ER-1220 XRi	Yes	Fully isolated		1.8	12.2

* at 180V dc Armature voltage

Single Phase, 1- and 4-Quadrant

Models: ER-3200i and ER-3600XRi

DC motor controllers for armature currents from 4 Amps to 48 Amps

Technical Specification

1-Quadrant

Power range:	2.2-11kW @ 320V dc ER-3200i/8, -/16, -/32, -/48

4-Quadrant

Power range:	1.1-9.5kW @ 320V dc ER-3600XRi/4, -/8, - /16, - /32, - /36

Power Requirements

AC Supply Input:	240/415V ac or 240/110V ac, 50-60Hz

Maximum Output

Armature Voltage:	(V dc) = 0.77 x ac supply voltage (nominal)
Field voltage:	(V dc) = 0.9 or 0.45 x ac supply voltage (maximum 1A)

Speed

Feedback:		Standard for Armature Voltage and
Analogue		Tachometer (select by switch)
Range:		0-100% dependent on the set point value,
Accuracy:	Tachometer	0.1% (Speed Range 100:1)
	ARM	2% (Speed Range 20:1)

Overload

Overload:	150% of unit nominal current for 30 seconds

Inputs/Outputs

Inputs/outputs:	Dependent to the model, see manual description

User Adjustment

Maximum Speed (Max spd):	Corresponds to 40-200V or 10-50V ARM or tacho voltage
Minimum Speed (Min spd):	0-30% of maximum speed
Up Ramp (Ramp):	1-30 seconds up ramp rate between 0 and 100% speed
Down Ramp (Ramp):	1-30 seconds up ramp rate between 100% and 0% speed
Stability (Stab):	1-10 Gain of speed loop
Max Current (Imax):	0-100% armature current limit, separate presets selects by switches
IR Compensation (IR comp):	0-25%

External Controls

Speed Setpoint:	From external 10K Ohms potentiometer
External RUN:	Contact for electronic STOP/START (There is a pot kit including graduated dial and knob)

Dissipation

Dissipation (W):	3V x Armature current (A), approx

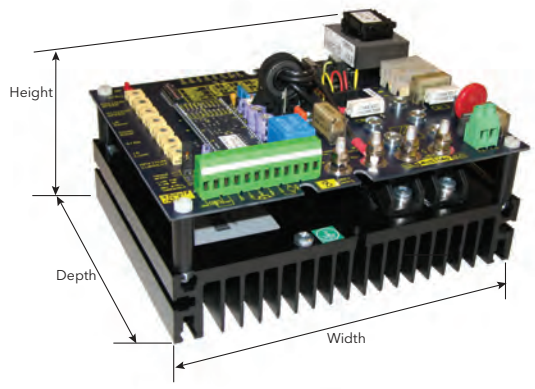
Alarms

Alarms:	Stall Trip

Environment

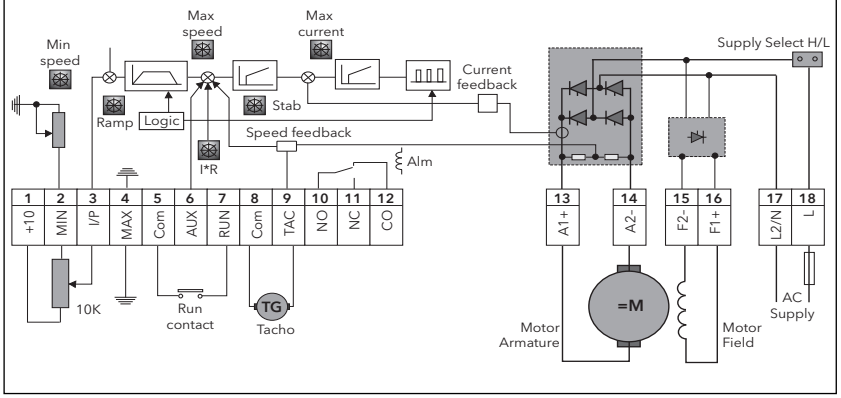
Storage and operating temperature:	-10°C to +50°C
Operating atmosphere:	Non-explosive, non-corrosive, defined by ICE 664
Humidity:	RH 5% to 85% at 40°C, non-condensing and non-streaming
Unit Protection:	IP00 in accordance with ICE 364
Thyristor Protection:	Internal MOV, RC snubber, High Speed Fuse (externally fitted)
Approvals:	CE, CSA, UL, cUL

Dimensions (mm)

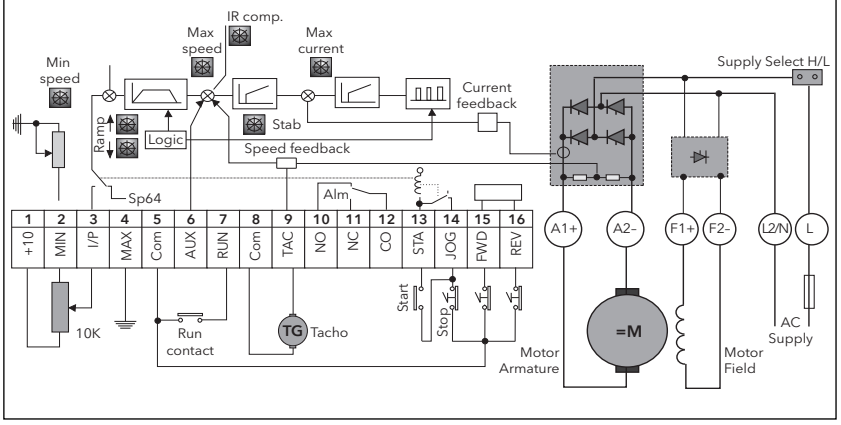


Model	Height	Depth	Width
ER-3200i /8 to 48	105	150	200
ER-3600XRi /4 to 32	70	175	200
ER-3600XRi /36	90	175	200

Details for 3200i



Details for 3600XRi version



Main Terminal Listing of 3200i

Term	Function
A+	Motor armature +
A-	Motor armature -
F-	Motor Field -
F+	Motor Field +
L2/N	AC supply 110V/240V or 30/60V
L	AC supply 110V/240V or 30/60V
1	Reference +10V dc 10mA max
2	'Min-In', connected through 'Min spd.' to 0V
3	Speed input to ramp, 0-10V
4	COMMON, 0V
5	COMMON, 0V
6	AUXILIARY Input, Speed or Torque
7	RUN, electronic inhibit
8	COMMON 0V
9	TACH input, 25-400V, + or –
10	RELAY contact NO*
11	RELAY contact NC*
12	RELAY COM
51	RELAY supply; –24V, 25mA
52	STALL Relay, 100mA
53	ZERO speed Relay, 100mA
54	Current OUTPUT, 0-5V
55	Setpoint ramp OUTPUT, 0-10V
56	Speed OUTPUT
57	Speed input to ramp, 0-10V
58	Drive Common
62	START/STOP
64	INPUT to current loop, 0-5V
65	Auxiliary inverted speed IO 0-10V
66	Auxiliary speed IO 0-10V
67	+24V dc 25mA

* For more details see Product Manual

Coding

Model	Regen	Terminals	Supply Vac (V)	Power (kW)*	Armature Current (A)
ER-3200i/8	No	Fully isolated	110/240 or 415/240	2.2	8
ER-3200i/16	No			4.4	16
ER-3200i/32	No			7.5	32
ER-3200i/48	No			11.0	48
ER-3600XRi/4	Yes			1.1	4
ER-3600XRi/8	Yes			2.2	8
ER-3600XRi/16	Yes			4.4	16
ER-3600XRi/32	Yes			7.5	32
ER-3600XRi/36	Yes			9.5	36

* at 320V dc Armature voltage

Three Phase, 2- and 4-Quadrant

Models: ER-PL and ER-PLX

DC motor controllers for armature currents from 36 Amps to 2250 Amps

The Eurotherm Digital DC-Drive, ER-PL and ER-PLX are probably the most powerful on the market today. With an extensive range of standard software blocks, they can take control of the most demanding motion tasks. All models include a 40 character alpha- numeric back-lit display, full set of centre winding blocks including diameter control and field weakening for extended speed range applications.

Available in both 2-Quadrant and 4-Quadrant versions the range comprises 5 very compact frame sizes. UL, cUL, CE and cTick approved.

Unique regenerative braking feature available on most ER-PL Models (see table) for applications using regenerative stopping (emergency stops, etc.). There is no need to use a more expensive 4-Quadrant, DC-Drive or Dynamic Braking resistors.

Technical Specification

2-Quadrant

Power range:		15kW-980kW @ 460V dc Armature Voltage
	ER-PL	15kW, 20kW, 30kW, 40kW, 50kW, 65kW, 85kW, 115kW, 145kW, 185kW, 225kW, 265kW, 275kW 315kW, 360kW, 400kW, 440kW, 520kW, 600kW, 700kW, 800kW, 900kW, 980kW Power ratings >980kW are available using external Thyristor Stack and separate Stack Driver Unit, Model: ER-PLXD

4-Quadrant

	Power range:	15kW-980kW @ 460V dc
	ER-PLX	15kW, 20kW, 30kW, 40kW, 50kW, 65kW, 85kW, 115kW, 145kW, 185kW, 225kW, 275kW, 315kW, 360kW, 400kW, 440kW, 520kW, 600kW, 700kW, 800kW, 900kW, 980kW Power ratings >980kW are available using external Thyristor Stack and separate Stack Driver Unit, Model: ER-PLXD

Power Requirements

AC Supply Input:	Armature:	3-Phase, 12V ac-480V ac, ±10%, 50Hz-60Hz (Standard Version) 3-Phase, 12V ac-690V ac, ±10%, 50Hz-60Hz (High Voltage Version, ER-PL(X)275 up to ER-PL980 only)
	Field:	3-Phase, 100V ac-480V ac, ±10%, 50Hz-60Hz (Standard Version) 3-Phase, 100V ac-690V ac, ±10%, 50Hz-60Hz (High Voltage Version, ER-PL(X)275 up to ER-PLX980 only)

Control Supply

Control supply:	1-Phase, 110V ac-240V ac, ± 10%, 50Hz-60Hz

Field Options

Field options:	Fixed current, fixed voltage, field weakening, delayed quenching, standby, economy, variable Field Voltage (Vdc) = 0 to 0.9 x AC Supply Voltage Field Current 8A, 16A, 32A, 50A or 64A depending of Armature Current rating

Speed

Feedback:	Standard for Armature Voltage, Analogue Tachometer and encoder
Range:	0-100% dependent to the setpoint value,
Accuracy: Tachometer	0.1% (Speed Range 100:1)
ARM	2% (Speed Range 20:1)

Overload

Overload:	150% of unit nominal current for 25 seconds 100% for ER-PL400 and ER-PLX400

Standard Software Functions

Functions:	Full suite of centre winding blocks	Delay timer
	Motorised potentiometer with memory	Current profiling
	2 x PIDs free programmable	Latch
	2 x Summers free programmable	Dual motor swap
	2 x Filters	Linear and S-ramps
	Jog/Crawl/Slack functions	Batch counter
	Self auto-tune for current loop	3 drive recipe pages

Inputs/Outputs (all short circuit protected)

8 x analogue inputs:	Configurable, resolution 5mV + sign, 4 voltage ranges ±5/10/20/30V, can be used as digital input
4 x analogue outputs:	Resolution 2.5mV + sign, voltage range 0- ± 11V, 3 configurable + dedicated (armature current)
17 x digital inputs:	All configurable
7 x digital outputs:	All configurable, max. 32V dc 350mA see manual description

External Controls

Speed Setpoint:	From external 10K Ohms potentiometer
External RUN:	Contact for electronic STOP/START

Dissipation

Dissipation (W):	3V x Armature current (A) (Nominal)

Alarms

Alarms (All configurable):	First fault latched and automatically displayed Fault automatically saved at power off Short circuit protected Over temp and over voltage protected

Monitoring

Monitoring:	All digital I/O states	Motor field current (A)
	All analogue I/O voltages	Motor armature volts (V)
	Tachogenerator voltage	Output power
	Motor armature current (A)	AC supply volts

Standards

Standards:	CE marked to EN50178 (low voltage directive) EN50082-2:1995 immunity industrial environment EN50082-1: 1997 immunity residential commercial and light industry EN50081-2: 1993 emissions industrial environment (EN55011 Class A) EN50081-1: 1992 emissions industrial environment (EN55022 Class B) UL and cUL listed

Communications

Communication:	Profibus DP, Option Card: AB4005, DeviceNet, Option Card: AB4004, Ethernet (Optional)

Other Features

Other features:	Friendly easy to use menu structure with English language parameter names Extremely flexible block diagram including unique configuration checker Free ER-PL Pilot configuration and monitoring software

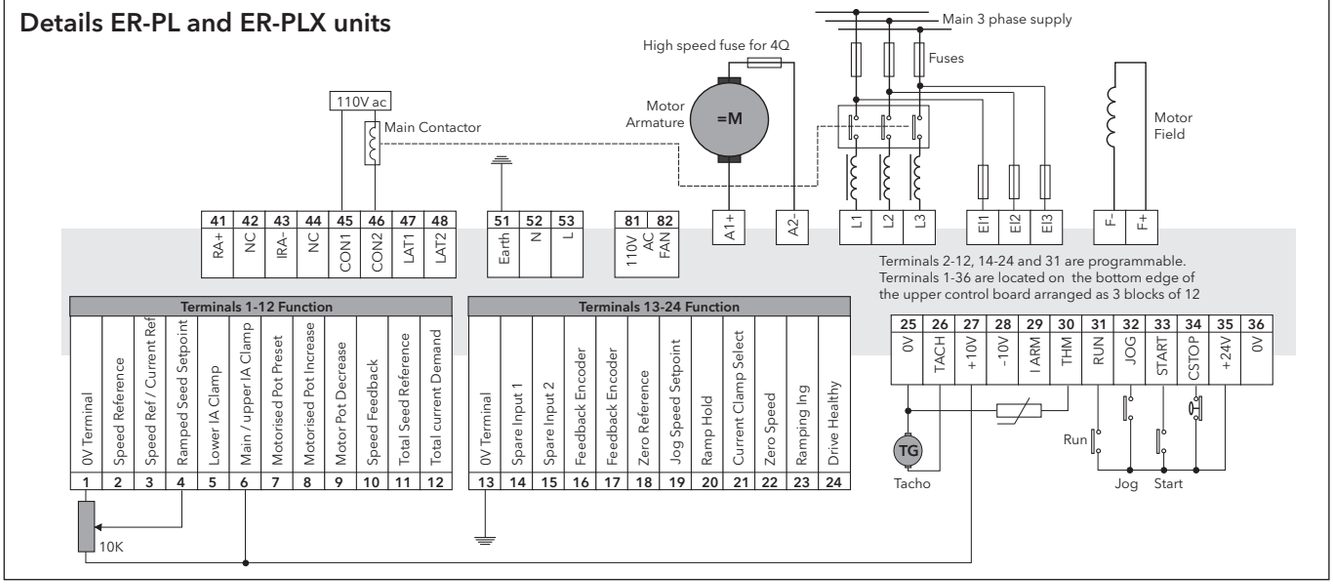
Environment

Storage temperature:	-25°C to +50°C
Operating temperature:	0°C to +50°C
Operating atmosphere:	Non-explosive, non-corrosive, defined by ICE 664
Humidity:	RH 5% to 85% at 40°C, non-condensing and non-streaming
IR Compensation (IR comp):	0-30%
Max Current (Imax):	0-100% armature current limit
Unit Protection:	IP20 in accordance with ICE 364
Thyristor Protection:	Internal MOV, RC snubber

Protection

Protection:	High energy MOV's	Mains synchronisation loss
	Interline device networks	Armature over-volts
	Instantaneous over-current	Speed feedback failure
	Field failure & over-current	Stall protection
	Motor over-temperature	Standstill logic
	Thyristor stack over-temperature	Thyristor 'trigger' failure
	Mains supply phase loss	Digital output short circuit

Details ER-PL and ER-PLX units



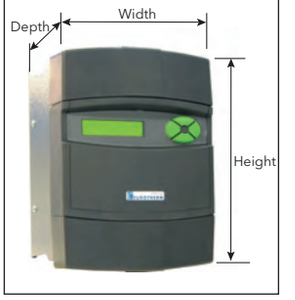
2-Quadrant Coding and Specifcation

Model Number	Armature Current	Power @460V dc	Field Current	Regenerative Braking Feature	Frame Size	Dimensions Height (mm)	Width (mm)	Depth (mm)	Weight (kg)
ER-PL15	36A	15kW	8A	YES	1	289	216	174	8
ER-PL20	51A	20kW	8A	YES	1	289	216	174	8
ER-PL30	72A	30kW	8A	YES	1	289	216	174	8
ER-PL40	99A	40kW	8A	YES	1	289	216	174	8
ER-PL50	123A	50kW	8A	YES	1	289	216	174	8
ER-PL65	155A	65kW	16A	NO	2	410	216	218	15
ER-PL85	205A	85kW	16A	NO	2	410	216	218	15
ER-PL115	270A	115kW	16A	NO	2	410	216	218	15
ER-PL145	330A	145kW	16A	YES	2	410	216	218	15
ER-PL185	430A	185kW	32A	NO	3	505	216	294	24
ER-PL225	530A	225kW	32A	YES	3	505	216	294	24
ER-PL265	630A	265kW	32A or 50A	NO	3	505	216	294	24
ER-PL275	650A	275kW	32A or 50A	NO	4	700	253	350	45
ER-PL315	750A	315kW	32A or 50A	NO	4	700	253	350	45
ER-PL360	850A	360kW	32A or 50A	NO	4	700	253	350	45
ER-PL400	950A	400kW	32A or 50A	YES	4	700	253	350	45
ER-PL440	1050A	440kW	32A or 50A	NO	4	700	253	350	45
ER-PL520	1250A	520kW	64A	NO	5	700	506	350	90
ER-PL600	1450A	600kW	64A	NO	5	700	506	350	90
ER-PL700	1650A	700kW	64A	YES	5	700	506	350	90
ER-PL800	1850A	800kW	64A	YES	5	700	506	350	90
ER-PL900	2050A	900kW	64A	YES	5	700	506	350	90
ER-PL980	2250A	980kW	64A	YES	5	700	506	350	90

4-Quadrant Coding and Specifcation

Model Number	Armature Current	Power @460V dc	Field Current	Regenerative Braking Feature	Frame Size	Dimensions Height (mm)	Width (mm)	Depth (mm)	Weight (kg)
ER-PLX15	36A	15kW	8A	YES (Full 4-Quadrant)	1	289	216	174	8
ER-PLX20	51A	20kW	8A	YES (Full 4-Quadrant)	1	289	216	174	8
ER-PLX30	72A	30kW	8A	YES (Full 4-Quadrant)	1	289	216	174	8
ER-PLX40	99A	40kW	8A	YES (Full 4-Quadrant)	1	289	216	174	8
ER-PLX50	123A	50kW	8A	YES (Full 4-Quadrant)	1	289	216	174	8
ER-PLX65	155A	65kW	16A	YES (Full 4-Quadrant)	2	410	216	218	15
ER-PLX85	205A	85kW	16A	YES (Full 4-Quadrant)	2	410	216	218	15
ER-PLX115	270A	115kW	16A	YES (Full 4-Quadrant)	2	410	216	218	15
ER-PLX145	330A	145kW	16A	YES (Full 4-Quadrant)	2	410	216	218	15
ER-PLX185	430A	185kW	32A or 50A	YES (Full 4-Quadrant)	3	505	216	294	24
ER-PLX225	530A	225kW	32A or 50A	YES (Full 4-Quadrant)	3	505	216	294	24
ER-PLX275	650A	275kW	32A or 50A	YES (Full 4-Quadrant)	4	700	253	350	45
ER-PLX315	750A	315kW	32A or 50A	YES (Full 4-Quadrant)	4	700	253	350	45
ER-PLX360	850A	360kW	32A or 50A	YES (Full 4-Quadrant)	4	700	253	350	45
ER-PLX400	950A	400kW	32A or 50A	YES (Full 4-Quadrant)	4	700	253	350	45
ER-PLX440	1050A	440kW	32A or 50A	YES (Full 4-Quadrant)	4	700	253	350	45
ER-PLX520	1250A	520kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90
ER-PLX600	1450A	600kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90
ER-PLX700	1650A	700kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90
ER-PLX800	1850A	800kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90
ER-PLX900	2050A	900kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90
ER-PLX980	2250A	980kW	64A	YES (Full 4-Quadrant)	5	700	506	350	90

Dimensions (mm)



Graphical Configurator and Diagnostic

Model: ER-PL PILOT

Configuration and Diagnostic Software

The ER-PL PILOT is a PC based graphical configuration and diagnostic tool for use with the range of ER-PL and ER-PLX digital DC drives. It greatly simplifies drive programming, installation and commissioning.

The ER-PL PILOT is included free of charge on a CDROM with every digital drive. It makes interconnecting the drive's application blocks a simple task and allows the user to tailor the drive's control strategy to exactly meet the demands of the process or application. It is these abilities which further strengthens Eurotherm's commitment to providing the user with cost effective and easy to use DC drive products.

This is a highly intuitive Windows based software package which requires no previous knowledge of any programming language. The package can be used in 2 operating modes:

- Off-line without a drive connected, the user can create recipes of drive parameters and block connections.
- On-line with a drive connected the ER-PL PILOT can also be used to monitor and adjust the drive parameters.

The PC running the ER-PL PILOT software is connected to the drive via the PC's standard serial port. The package is designed for ease of use and provides a clear, defined and understandable method for accessing all levels of the drives extensive built in functionality.

This makes complete system configurations very straightforward and quick. There are 3 levels of recipe creation and functionality available in ER-PL PILOT to suit all requirements.

They are:

- Total recipe (top level) - used to manipulate the entire range of parameters.
- Bar sub-menus (2nd level) - used to manipulate each main sub-set of parameters.
- Block pages (lowest level) - used to manipulate parameters of individual blocks within the drive.

The recipes and sections of recipes may be cut and pasted or printed out.

The Bar sub-menus (2nd level) shows the 4 main menu bars on the ER-PL PILOT entry page.

These are:

- Change parameters
- Application blocks
- Diagnostics and ancillary functions
- Control terminals

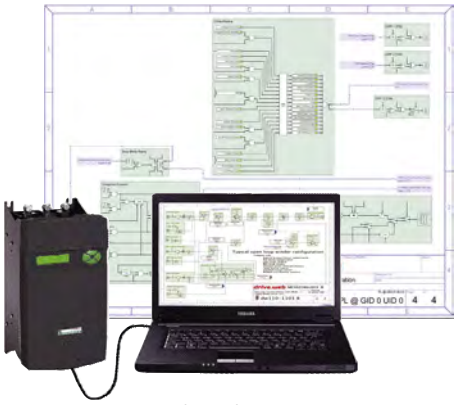
Each bar has buttons that allow access to a drive block page.

The Block pages (lowest level) Each block has its own page which details its default values (shown in blue text) and any altered values (shown in black text) with its own block diagram. In most cases this alleviates the need for a hard copy of the technical manual - an excellent plus point when commissioning on site!

Diagnostic and monitoring in engineering units (volts, amps, Kilowatts, rpm, Hz) and percentages for all terminals and block diagram outputs can be shown in bar graph or panel meter format.

Model: SAVVY

Software with Graphical Function Block Programming (SFD)



Easy, intuitive, Java based, *SAVVY* programming tools with automated software update running under Windows, MacOS, UNIX and Linux)

The graphical Signal Flow Diagram (SFD) programming option adds powerful system design and documentation features with function blocks, user wiring, monitoring and trending including:

- Full ER-PL(X), DC-Drive configuration, operation, monitoring and diagnostic functionality
- Online or Offline design of DC-Drive configurations using intuitive tools with pre-engineered function blocks
- Internet access to Drives and systems for remote configuration, monitoring and process training
- Platform independent software tools run on Windows, Mac OSX, Unix, Linux, Solaris, etc.
- "Dock" feature enables users to easily select key monitoring, control and connection points to be displayed as values or trend charts
- Drive configuration importing and exporting
- Drive configuration cloning
- Drive "phantom" configuration
- Ability to annotate drawings
- Multiple page drawing organization for complex configurations of DC-Drives

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