2. Drives

LINEARMECH product range also includes a complete Series of drives, specifically engineered and developed for Linearmech brushless servomotors BM Series and linear servoactuators SA Series. Linearmech can provide you a **full package solution** with the advantage of having a sole responsible partner from the initial phase of product selection up to the start-up operations of your applications.

2.1 General features

Drives ECO Series by LINEARMECH are full digital products, optimized to control sinusoidal motors.

The implemented control (**Field Oriented Control**) allows high accuracy in motion control, together with Torque, Speed and Positioning control.

The **integrated mechatronic functions** also allows to manage even complex movements with simple digital / serial inputs.

Drives ECO Series operating modes:

TORQUE CONTROL

- analogic reference (0 ... 10) V
- access to the internal drive registers (field networks)

SPEED CONTROL

- analogic reference ± 10V
- access to the internal drive registers (field networks)

POSITIONING CONTROL

- SAP (Stand Alone Positioning)
- MSQ (Multi Sequencer)
- Electrical Axis
- Field networks

  Ethercat (Coe)

  CANopen (DS402)

  RS 422/485 (SNET @ 19200 Baud)

  Modbus RTU (@ 19200 Baud)

The RS 422 serial port is available as standard. It enables the connection of all drives to a PC through a **serial line**.

The **“DRIVEWATCHER” application software** allows you to manage settings and debug functions. The software allows you to analyze all the data both coming from the drive unit and from the complete dynamic system, load and actuators parameters included.

Using the program utility, it is possible to save and control (graphics and diagrams allow you to have an immediate visual response) all the relevant measurements during the operations, such as speed, power, voltage. This to get the real evaluation of the required torque and finally to reach the better optimization of the system as a whole.

Following sections refer to the general information of each single operating mode; for more information, please refer to the specific manuals.

2.2 SAP (Stand Alone Positioning)

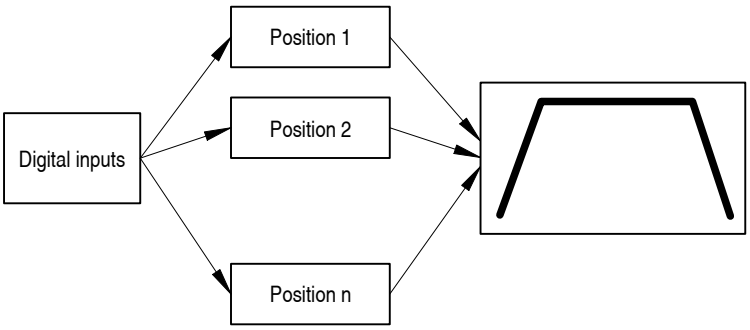
The SAP integrated mechatronic function allows to obtain a completely independent positioning, without any PLCs or PCs.

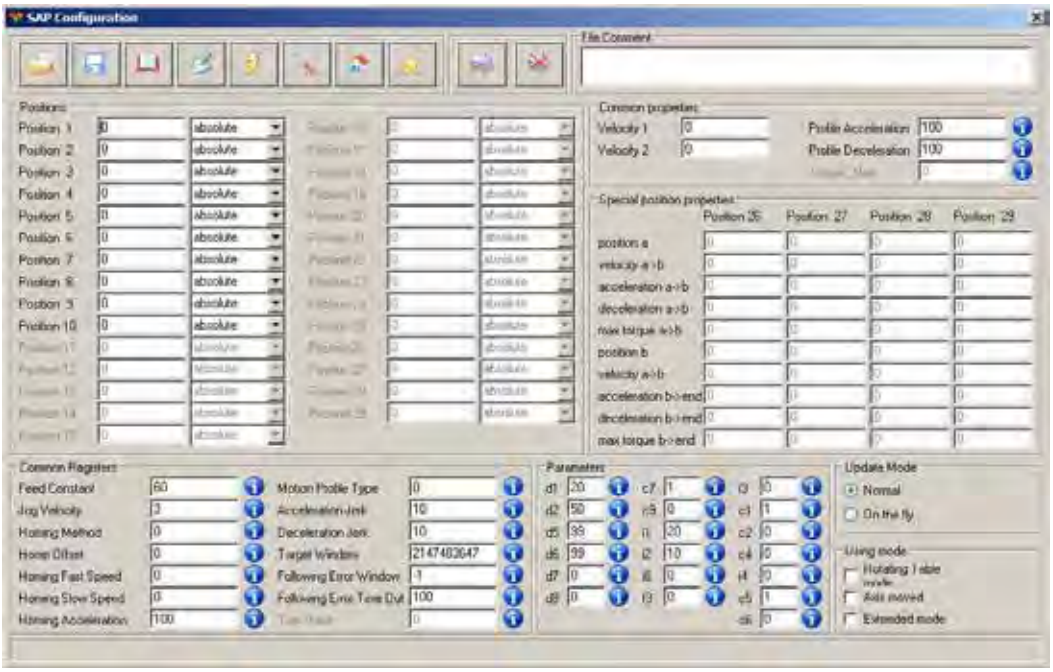
Through the selection of digital inputs, it is possible to recall TARGET positions, previously set inside the drive with DRIVE WATCHER software tool.

The system allows the following movements:

- ZERO SETTING, positioning adjustment related to the input of a sensor
- Movement with an ABSOLUTE positioning related to a reference position
- Movement with a RELATIVE positioning related to the current position

SAP operating mode





SAP Control panel

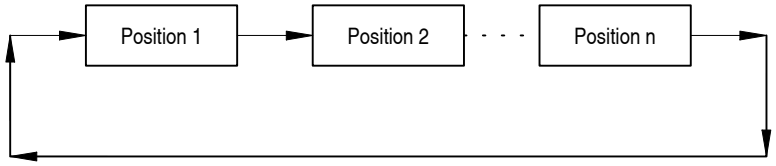
2.3 MSQ (Motion Sequencer)

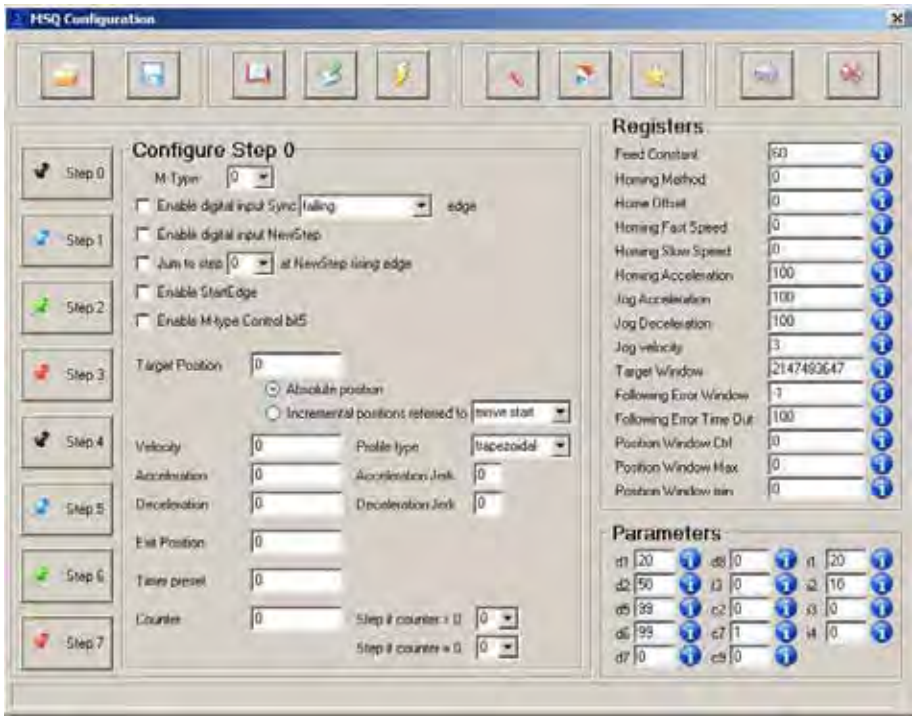
The MSQ integrated mechatronic function allows connecting a sequence of independent movements to manage even sophisticated applications, without any PLCs or PCs.

The system allows the following movements:

- ZERO SETTING, positioning adjustment related to the input of a sensor
- Movement with an ABSOLUTE positioning related to a reference position
- Movement with a RELATIVE positioning related to the current position
- Movement index
- Movement positioning after counting
- Movement positioning by external signal

MSQ operating mode



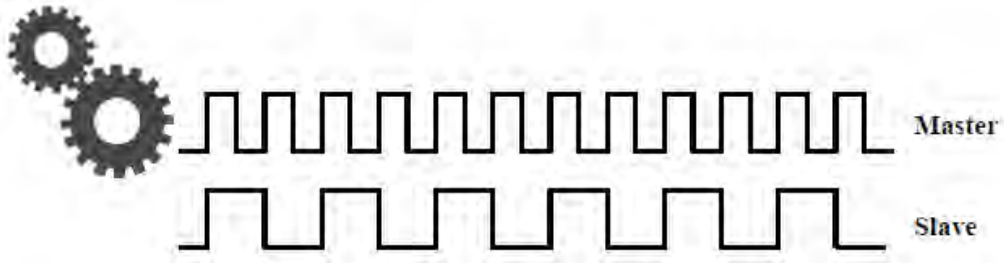


MSQ Control panel

2.4 Electrical axis

The Electrical Axis integrated mechatronic function allows relating the movement of a servomotor (SLAVE) to the action of another motor (MASTER encoder). Possibility to set a given transmission ratio trough a parameter (electric cam).

ELECTRICAL AXIS operating mode



2.5 Field Networks

Thanks to the fieldbus networks, it is possible to manage the drive by exchanging the information with a MASTER system in serial mode.

They offer great flexibility thanks to the possibility of modifying parameters, sending a speed or position setpoint or adding specific mechatronic functions.

A reduced need for wiring is possible by connecting several drives to the same serial line. Field networks differ from each other in communication speed, numbers of functions that can be managed and reference standards.

ETHERCAT

According to the new standards of industrial applications, the Ethercat fieldbus is now taking the lead.

High-speed communication bus, able to get real-time performances of drives. Specifically useful in case of application when many axes are involved with high dynamic and performance needs.

Ethercat is an industrial communication protocol with high performances, which extend the IEEE 802.3 Ethernet standard, allowing data transfer with predictable timing and an extremely precise synchronization. All datas are transferred in the standard Ethernet frame without modifying the basic structure.

For this reason the connection of the drive to an Ethercat network in made by a RJ45 connector, whose wiring respects Ethernet / IEEE 802.3 10Base-T, 100Base-TX and1000Base standards.

The Ethercat protocol applied on the Linearmech ECO Series Drives is Ethercat (CoE), this means a CANopen over EtherCAT.

CANopen

CANopen is a standard application for automation systems based on CAN (Controller Area Network) offering the following performance features:

- Transmission of critical data process according to the producer / consumer principle
- Standard description of the device (data, parameters, functions, programs) in the form of the so-called “object dictionary”
- Standard services for device monitoring, error signal (emergency messages) and network coordination (“network management”)

The implemented protocol refers to the CiA CANopen - Device Profile Drives and Motion Control - DSP 402 v1.1.

RS 422/485 - MODBUS RTU

These networks are very flexible but not really fast. Mostly used for changing parameters, positioning registers and running integrated mechatronic functions.

2.6 Models and functions

Model	ELECTRICAL CHARACTERISTICS			MECHATRONIC FUNCTIONS			
	Supply voltage [V]	Rated current [A] (RMS value)	Peak current [A] (RMS value)	Analogic	SAP MSQ	Electrical axis	Field networks
MICROECO 10-20	24 ... 48 V dc	10	20	•	•	-	• (NO Ethercat)
MINIECO 3-6	230 V ac	3	6	•	-	-	• (NO Ethercat)
MINIECO PLUS 4-8		4	8				
ECO 2D 4-10	230 V ac	4	10	•	•	•	• (Ethercat optional)
ECO 2D 6-15		6	15				
ECO 4D 4-10	400 V ac	4	10	•	•	•	• (Ethercat optional)
ECO 4D 5-13		5	13				
ECO 4D 10-20		10	20				

NOTE: Ethercat fieldbus network only available for ECO2D and ECO4D Drives Series.

2.7 Available trasducers

Model	ELECTRICAL CHARACTERISTICS			SUPPORTED FEEDBACKS		
	Supply voltage [V]	Rated current [A] (RMS value)	Peak current [A] (RMS value)	Incremental encoder 5 V LD with switching sensors E01	Resolver R01	Absolute multiturn encoder with BISS protocol A01
MICROECO 10-20	24 ... 48 V dc	10	20	•	-	-
MINIECO 3-6	230 V ac	3	6	•	-	-
MINIECO PLUS 4-8		4	8			optional
ECO 2D 4-10	230 V ac	4	10	•	optional	optional
ECO 2D 6-15		6	15			
ECO 4D 4-10	400 V ac	4	10	•	optional	optional
ECO 4D 5-13		5	13			
ECO 4D 10-20		10	20			

NOTE: in case of use of a RESOLVER or an ABSOLUTE ENCODER, please contact our Technical Dpt. for assistance in Linearmech ECO Series Drive product selection and configuration.

2.8 Recommended Servomotors - Drives matching

The table below shows the recommended matching between **Linearmech Servomotors BM Series** and **Drives ECO Series** with the related performances (standard motor wiring rated speed 3000 rpm).

WARNING: the performance diagrams shows in Chapter 1.5 refers to the maximum motor performances. Possible degrading in performances must be considered depending on the selected drive, as specified in the table below.

			BM 45 L	BM 63 S	BM 63 L	BM 82 S
MINIECO 10-20	24 V dc	$T_{0,\ 100K}$ [Nm]	0.35	0.44	0.38	
		$T_{nom,\ 100K}$ [Nm]	0.32	0.34	0.35	
		T_p [Nm]	0.86	0.82	0.76	
	48 V dc	$T_{0,\ 100K}$ [Nm]	0.35	0.70	0.89	
		$T_{nom,\ 100K}$ [Nm]	0.32	0.60	0.84	
		T_p [Nm]	1.05	1.65	1.67	
MINIECO 3-6	230 V ac	$T_{0,\ 100K}$ [Nm]	0.35	0.70	1.35	1.50
		$T_{nom,\ 100K}$ [Nm]	0.32	0.60	1.30	1.30
		T_p [Nm]	1.05	2.10	3.80	3.10
MINIECO PLUS 4-8		$T_{0,\ 100K}$ [Nm]	0.35	0.70	1.35	1.50
		$T_{nom,\ 100K}$ [Nm]	0.32	0.60	1.30	1.30
		T_p [Nm]	1.05	2.10	4.20	4.10
ECO 2D 4-10	230 V ac	$T_{0,\ 100K}$ [Nm]	0.35	0.70	1.35	1.50
		$T_{nom,\ 100K}$ [Nm]	0.32	0.60	1.30	1.30
		T_p [Nm]	1.05	2.10	4.20	4.50
ECO 2D 6-15		$T_{0,\ 100K}$ [Nm]				
		$T_{nom,\ 100K}$ [Nm]				
		T_p [Nm]				
ECO 4D 4-10	400 V ac	$T_{0,\ 100K}$ [Nm]				1.50
		$T_{nom,\ 100K}$ [Nm]				1.30
		T_p [Nm]				4.50
ECO 4D 5-13		$T_{0,\ 100K}$ [Nm]				
		$T_{nom,\ 100K}$ [Nm]				
		T_p [Nm]				
ECO 4D 10-20		$T_{0,\ 100K}$ [Nm]				
		$T_{nom,\ 100K}$ [Nm]				
		T_p [Nm]				

2.8 Recommended Servomotors - Drives matching

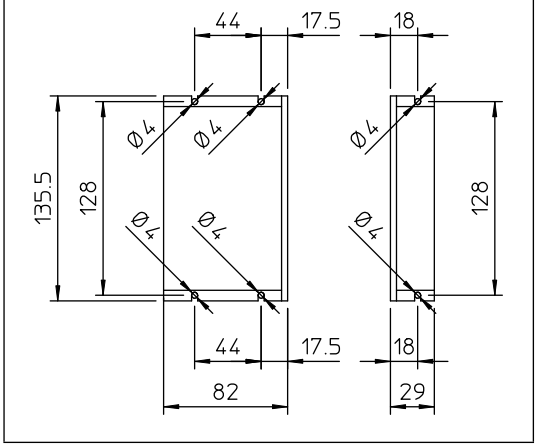
The table below shows the recommended matching between **Linearmech Servomotors BM Series** and **Drives ECO Series** with the related performances (standard motor wiring rated speed 3000 rpm).

WARNING: the performance diagrams shows in Chapter 1.5 refers to the maximum motor performances. Possible degrading in performances must be considered depending on the selected drive, as specified in the table below.

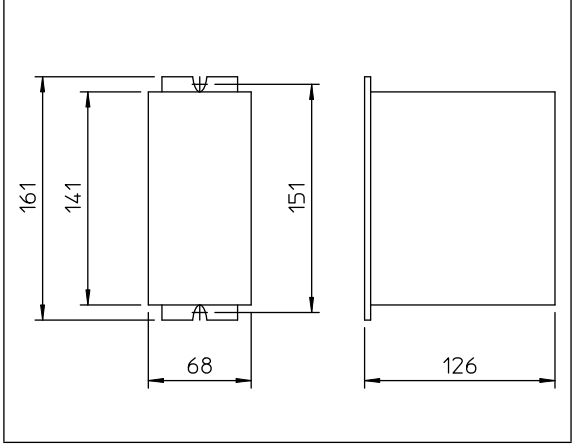
BM 82 L	BM 102 S	BM 102 L6	BM 102 L8			
				[Nm] $T_{0,\ 100K}$	24 V dc	MINIECO 10-20
				[Nm] $T_{nom,\ 100K}$		
				[Nm] T_p		
				[Nm] $T_{0,\ 100K}$	48 V dc	
				[Nm] $T_{nom,\ 100K}$		
				[Nm] T_p		
1.90				[Nm] $T_{0,\ 100K}$	230 V ac	MINIECO 3-6
1.52				[Nm] $T_{nom,\ 100K}$		
3.65				[Nm] T_p		
2.50				[Nm] $T_{0,\ 100K}$		MINIECO PLUS 4-8
2.16				[Nm] $T_{nom,\ 100K}$		
4.80				[Nm] T_p		
2.50	3.22			[Nm] $T_{0,\ 100K}$	230 V ac	ECO 2D 4-10
2.16	2.10			[Nm] $T_{nom,\ 100K}$		
6.10	6.72			[Nm] T_p		
2.90	4.82	4.50	4.70	[Nm] $T_{0,\ 100K}$		ECO 2D 6-15
2.50	3.70	3.90	2.50	[Nm] $T_{nom,\ 100K}$		
9.00	10.10	9.30	11.80	[Nm] T_p		
2.90	5.20	4.80	6.20	[Nm] $T_{0,\ 100K}$	400 V ac	ECO 4D 4-10
2.50	4.10	3.90	3.90	[Nm] $T_{nom,\ 100K}$		
9.00	10.70	10.00	13.80	[Nm] T_p		
	5.20	6.00	7.70	[Nm] $T_{0,\ 100K}$		ECO 4D 5-13
	4.10	5.10	5.45	[Nm] $T_{nom,\ 100K}$		
	13.90	13.00	17.50	[Nm] T_p		
	5.20	7.30	9.00	[Nm] $T_{0,\ 100K}$		ECO 4D 10-20
	4.10	6.40	6.70	[Nm] $T_{nom,\ 100K}$		
	15.00	20.00	24.30	[Nm] T_p		

2.9 Dimensions

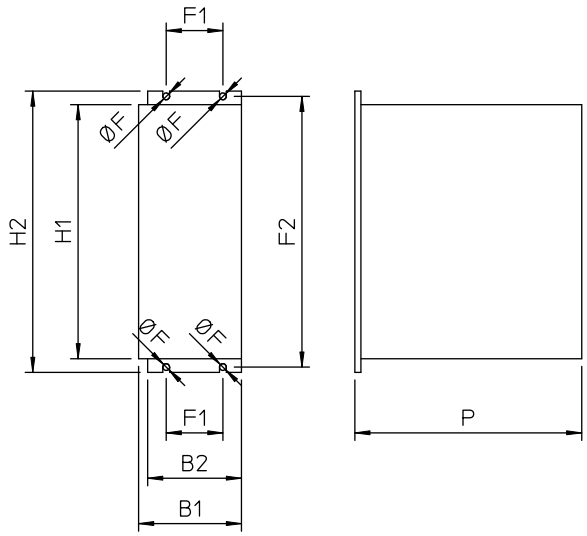
MICROECO



MINIECO, MINIECO Plus

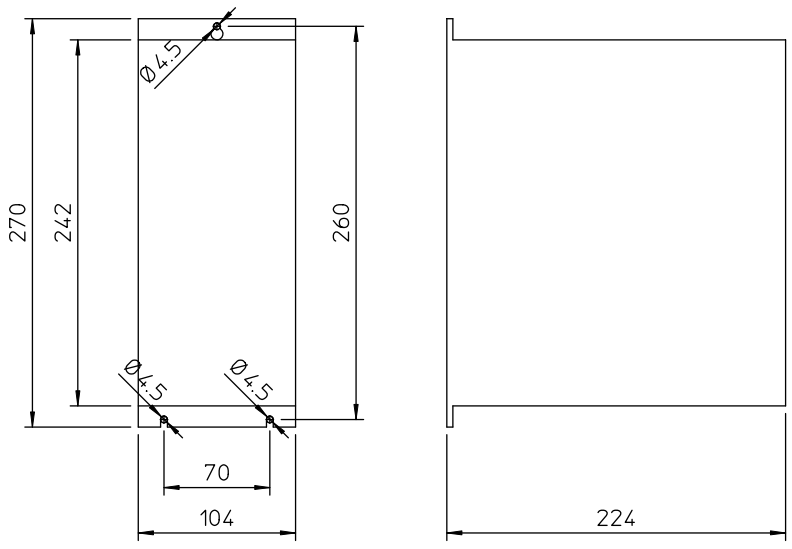


ECO2D 4-10 A 230 V, ECO2D 6-15 A 230 V, ECO4D 4-10 A 400 V, ECO4D 5-13 A 400 V



DRIVE	B1	B2	∅ F	F1	F2	H1	H2	P
ECO2D 4-10 A 230 V	68	62	4.5	37.5	179	168	186	150
ECO2D 6-15 A 230 V	82							
ECO4D 4-10 A 400 V	73	67	4.5	42.5	220	210	227	190
ECO4D 5-13 A 400 V	87							

ECO4D 10-20 A 400 V



3. Connecting cables

On request, wirings can be supplied with power and signal connectors from the servomotor to the drive. The standard cable length is 5 m.

3.1 Power supply cable

Outer jacket material:	PVC - Class 43 for UL 1581 and CSA 22.2 n°210 Colour: orange
Operating temperature:	for fixed wiring, without external mechanical stress: (- 40 ... + 80)°C for mobile laying cables: (- 10 ... + 80)°C
Minimum bending radius:	for fixed wiring: 4 × cable diameter for mobile laying cables: 7.5 × cable diameter
Max. shifting speed for trailing cables:	3 m/s
Max. acceleration/deceleration:	10 m/s^2
Fatigue life for trailing cables:	(3 ... 6) million movements
Operating voltage:	STYLE 2464: 300 V (UL) - U_0/U 450/750 V STYLE 2570: 1000 V (UL)
Reference standards:	CSA 22.2 n°210, UL 1581
Approvals:	UL recognized / CSA (or) AWM STYLE 2464 80°C 300 V - CSA AWM STYLE 2570 80°C 1000 V - CSA
Fire performance:	self-extinguishing VW-1 (UL); FT1 (CSA); IEC 60332-1, CEI 20-35 (EU)
Industrial oils resistance:	ASTM n°2, IRM 902, IEC 60811-2-1

3.2 Signal cable

Outer jacket material:	PVC - Class 43 for UL 1581 and CSA 22.2 n°210 Colour: green
Operating temperature:	for fixed wiring, without external mechanical stress: (- 40 ... + 80)°C for mobile laying cables: (- 10 ... + 80)°C
Minimum bending radius:	for fixed wiring: 4 × cable diameter for mobile laying cables: 7.5 × cable diameter
Max. shifting speed for trailing cables:	3 m/s
Max. acceleration/deceleration:	10 m/s^2
Fatigue life for trailing cables:	(3 ... 6) million movements
Operating voltage:	30 V - 300 V (UL)
Reference standards:	CSA 22.2 n°210, UL 1581
Approvals:	UL recognized / CSA (or) AWM STYLE 2464 80°C 300 V - CSA AWM STYLE 2570 80°C 1000 V - CSA
Fire performance:	self-extinguishing VW-1 (UL); FT1 (CSA); IEC 60332-1, CEI 20-35 (EU)
Industrial oils resistance:	ASTM n°2, IRM 902, IEC 60811-2-1

4. Ordering code

4.1 Servomotor ordering code

BM 45 L	-	30	24	E01	CV	01	L
1	2	3	4	5	6	7	8

1 Servomotor size — page 6-9

2 Brake — page 6-9

- = without brake

B = with holding brake 24V dc

3 Rated speed

30 = 3000 rpm (standard)

40 = 4000 rpm (1)

50 = 5000 rpm (1)

60 = 6000 rpm (2)

4 Drive supply voltage — page 35

24 = 24 V dc

48 = 48 V dc

230 = 230 V ac - 1-phase

400 = 400 V ac - 3-phase

5 Motor feedback — page 26

E01: optical encoder, LINE-DRIVER, 2000 ppr (standard)

R01: resolver, 1 pole pairs 7 V rms, 10 kHz (optional)

A01: BISS absolute multiturn encoder (option available starting from size BM 63)

- = without device

6 Electrical connections — page 28-30

CV = power and signal cable, 0.5 m long, no connectors

CN = double 90° connector

7 Thermal protection — page 27

01 = PTC (3)

02 = PTO

03 = KTY 84-130 (3)

8 Output shaft version — page 10-25

C = cylindrical shaft

L = shaft with key

(1) - available only for BM 45 and BM 63 sizes - Contact our Technical Dpt. for more information

(2) - available only for BM 45 size - Contact our Technical Dpt. for more information

(3) - not supported by ECO series drives supplied by Linearmech

4.2 Drive ordering code

ECO 2D 4-10	230 V	SAP + MSQ	E01	-
1	2	3	4	5

Linearmech ECO Series Drives complete options and coding:

Model	Supply voltage	Positioner	Feedback	Ethercat
MICROECO 10-20	24 ... 48 V dc	SAP + MSQ	E01	-
MINIECO 3-6	230 V ac	SAP + MSQ	E01	-
MINIECO PLUS 4-8	230 V ac	-	E01	-
			A01	-
ECO 2D 4-10	230 V ac	SAP + MSQ	E01	- Ethercat
			R01	- Ethercat
			A01	- Ethercat
ECO 2D 6-15	230 V ac	SAP + MSQ	E01	- Ethercat
			R01	- Ethercat
			A01	- Ethercat
ECO 4D 4-10	400 V ac	SAP + MSQ	E01	- Ethercat
			R01	- Ethercat
			A01	- Ethercat
ECO 4D 5-13	400 V ac	SAP + MSQ	E01	- Ethercat
			R01	- Ethercat
			A01	- Ethercat
ECO 4D 10-20	400 V ac	SAP + MSQ	E01	- Ethercat
			R01	- Ethercat
			A01	- Ethercat

4. Ordering code

4.3 Connecting cables ordering code

4.3.1 Signal cables

CS	R01	M17	05	1
1	2	3	4	5

1 Cable type page 39

CS = signal cable

CP = power supply cable

2 Trasducer page 26

E01: optical encoder, LINE-DRIVER, 2000 ppr

R01: resolver, 1 polar pair, 7 V rms, 10 kHz

A01: BISS absolute multiturn encoder

3 Motor side connectors page 28-30

M17 = M17 17-pole connector

M23 = M23 17-pole connector

4 Length

05 = 5 meters

10 = 10 meters

15 = 15 meters

5 Drive side connectors

1 = 26-pole HD type connector (for MINIECO-ECO2D-ECO4D drives)

2 = No connectors (for MICROECO drives)

4.3.2 Power supply cables

CP	M17	10
1	2	3

1 Cable type page 39

CS = signal cable

CP = power supply cable

2 Motor side connectors page 28-30

M17 = M17 7-pole connector

M23 = M23 6-pole connector

3 Length

05 = 5 meters

10 = 10 meters

15 = 15 meters

A. Terms and Definitions

Term	Symbol	Unit of measure	Definition
MOTOR			
Continuous rated torque	$T_{nom, 100K}$	Nm	Torque supplied by the motor for an unlimited period of time, at nominal speed (in thermal balance condition), without exceeding the thermal limits of the relevant insulation class. This condition is defined during test run at conditions described in appendix B.
Stall torque	$T_{0, 100K}$	Nm	Torque supplied by the motor for an unlimited period of time, with blocked rotor (in thermal balance condition), without exceeding the thermal limits of the relevant insulation class. This condition is defined during test run at a rotation speed closed to 0 rpm, at conditions described in appendix B.
Peak torque	T_p	Nm	Torque generated at max. current (peak). The max. torque is possible for short periods of time to have a dynamic system behaviour (abrupt variations of the operating condition). Exceeding this value causes the irreversible demagnetization of the rotor magnetic group.
Rated speed	n_{nom}	rpm	Speed performed by the motor for an unlimited period of time, without exceeding the thermal limits of the relevant insulation class, with torque as defined in the TORQUE - SPEED curve shown in the motor specific diagram.
Max. speed	n_{max}	rpm	Max. permissible rotating speed. It depends on centrifugal force of rotating masses, rotor balance grade and bearings.
Stall current	$I_{0, 100K}$	A	Current (RMS value) phase - phase supplied to the motor in order to generate the torque in conditions of blocked rotor (stall).
Peak current	I_p	A	Current (RMS value) phase - phase supplied to the motor in order to generate the max. torque (peak). This current is limited by the motor magnetic circuit: exceeding this value even for a short time causes the irreversible demagnetization of the magnets.
Voltage constant	k_E	V/1000 rpm	Voltage (RMS value) phase - phase produced by operating motor at 1 000 rpm, at 20°C ambient temperature, with average windings temperature increment of 20 K.
Torque constant	k_T	Nm/A	Ratio between torque with blocked rotor and current with blocked rotor ($T_{0, 100K}$ / $I_{0, 100K}$), with windings temperature increment of 100 K (insulation class F).
Thermal time constant	t_{th}	min	Time necessary to heat the cold motor up to a temperature increase of 0.63 × 100 K, with load $I_{0, 100K}$.
Winding resistance	R_{ph}	Ω	Electric resistance of phase - phase windings connected in Y circuit, at 20°C ambient temperature.
Winding inductance	L_D	mH	Inductance of phase - phase windings connected in Y circuit.
Electric time constant	t_{el}	ms	Ratio between winding inductance and winding resistance (L_D / R_{ph}).
Moment of inertia (without brake)	J_{motore}	kg × m^2	Moment of inertia of motor rotating elements.
Moment of inertia (with brake)	$J_{motore\ BR}$	kg × m^2	Moment of inertia of motor and brake rotating elements.
Permissible radial load on motor shaft	F_R	N	Constant load radially applied on the centre of the motor shaft, at 3 000 rpm for nominal bearing service life of 10 000 h.
Permissible axial load on motor shaft	F_N	N	Constant load axially applied on the motor shaft, at 3 000 rpm for nominal bearing service life of 10 000 h.
BRAKE			
Supply voltage	U_{BR}	V	Voltage supplied to the brake excitation coil to release the brake.
Brake power	P_{BR}	W	Power consumption of the brake excitation coil.
Rated braking torque	T_{BR}	Nm	Holding braking torque (it cannot be used to stop the motor).
Brake disengagement delay time	t_{-BR}	ms	Reacting time from the moment the rated power supply voltage is applied until the brake is completely disengaged.
Brake engagement delay time	t_{BR}	ms	Reacting time from the moment the brake power supply is interrupted until the rated braking torque T_{BR} is reached.