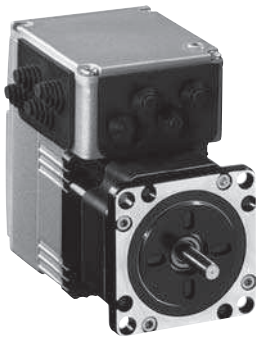
Lexium integrated drives
ILS1 with pulse/direction interface



ILS1●57 with 3-phase stepper motor

Presentation

ILS1 contain a 3-phase stepper motor and control electronics with pulse/direction interface. Pulse/direction signals of a master controller, e.g. a motion controller, or A/B signals of an encoder are converted directly into motion.

Application areas

Lexium integrated drives with 3-phase stepper motors offer high torque at low speed of rotation. These Lexium integrated drives are ideally suited as drives in velocity mode with excellent constant velocity characteristics and also or for high-resolution positioning. Commissioning the stepper motor drives is simple because it is not necessary to adjust the controller.

Special features

- High continuous stall torque
- Good constant velocity characteristics
- High positioning resolution (0.018°)
- Holding brake (option for ILS1●85)

Control

ILS1 moves the stepper motor according to a reference value. The reference value signal is generated by a controller or an encoder and is sent to the multifunction interface as a pulse signal.
The number of steps (steps per revolution) is set with a parameter switch.

Electronics

The electronic system comprises control and power electronics. They have a common power supply and are not galvanically isolated. Four 24 V signals are also available. The assignment of the signal inputs and outputs can be adjusted via parameter switches.
The electronics are thermally decoupled from the motor by a plastic element.

Connection technologies

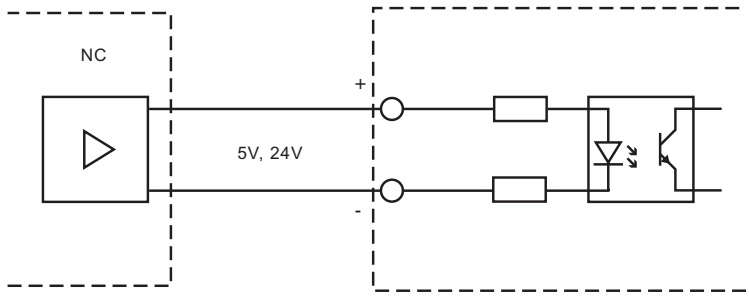
ILS1 have the following connections:
- Power supply
- Multifunction interface
- Service interface
- 24 V signal interface for four signal inputs/outputs
- Signal interface for safety function “Safe Torque Off” (“Power Removal”)

Printed circuit board connectors are used for cabling.

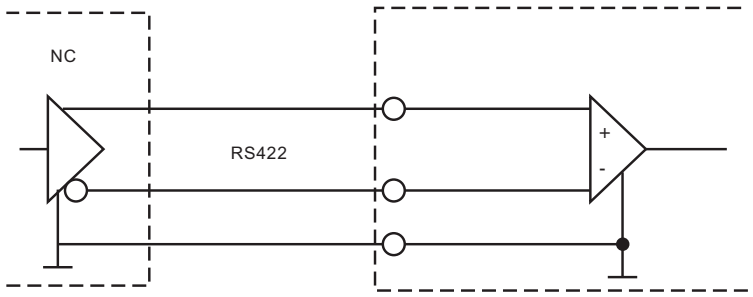
Multifunction interface

The multifunction interface operates at one of the following signal levels depending on the device model:
- 5V signals opto-isolated (ILS1V)
- 5 V differential signals without galvanic isolation (ILS1W)
- 24 V signals opto-isolated (ILS1U)

The reference pulses are supplied via two of the signal inputs, either as pulse/direction signals or as A/B signals. The other signal inputs have the functions “power amplifier enable/pulse blocking” and “step size switching/PWM motor current control".



Circuit of signal inputs of ILS1U and ILS1V



Circuit of signal inputs of ILS1W

Connection technologies (continued)

Service interface

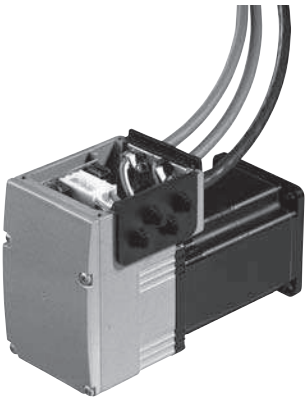
The service interface is used to connect the RS 485 bus for service purposes. A PC can be connected to the service interface via an RS 485-RS 232 converter. The “Lexium CT” commissioning software can be used for tasks such as reading the error memory or monitoring the temperature.

24 V signal interface

Two signal inputs and two signal outputs are available. The signal inputs have the functions “step size switching” and “power amplifier enable/pulse blocking". The signal outputs have the functions “power amplifier standby” and “fault output/index pulse".
The 24 V power supply to the signal outputs is internal via the supply voltage of the Integrated Drive System.

Signal interface for “Safe Torque Off” safety function (“Power Removal”)

The integrated “Safe Torque Off” safety function (“Power Removal”) enables a stop of category 0 or 1 as per IEC/EN 60204-1 without external power contactors. The supply voltage does not have to be interrupted. This reduces the system costs and response times.
The “Safe Torque Off” safety function (“Power Removal”) is activated via two redundant 24 V input signals (low active).



Integrated drive system with printed circuit board connectors

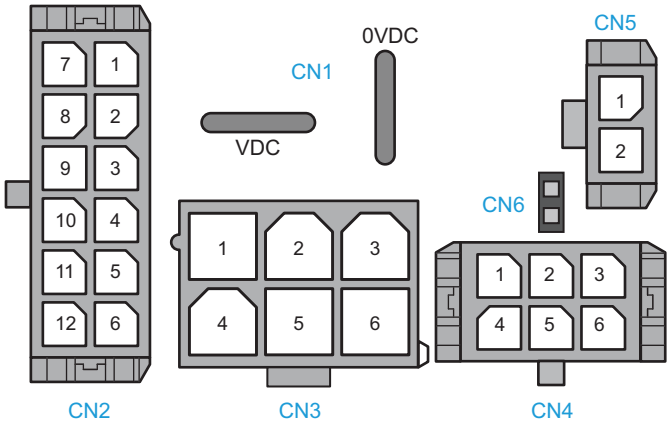
Connection technologies (continued)

Printed circuit board connector

Printed circuit board connectors are preferably used for cabling series machines with cable harnesses.

- Fieldbus and I/O signal connection with connector “Molex Micro Fit"
- Power supply connection with “AMP Positive Lock” crimp contacts

Two cable entries are required for cabling the Lexium integrated drives (see accessories, page 4/107).



Printed circuit board connector, overview of connections

Connection	Assignment
CN1	Supply voltage ⎓ V
CN2	Multifunction interface
CN3	Service interface
CN4	24 V signal interface
CN5	Interface for safety function “Safe Torque Off"
CN6	Jumper for disabling “Safe Torque Off” safety function (“Power Removal”)

Lexium integrated drives
ILS1 with pulse/direction interface

Functions

Overview

The following functions can be set on ILS1 with the parameter switches:
- ■ Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000
- ■ Motor phase current (25% ... 100% of nominal current)
- ■ Idle current reduction to 70% of specified motor phase current
- ■ Functions of signal inputs
- □ Reference pulses supplied as pulse/direction or A/B encoder signals (PULSE/DIR / A/B signal input)
- □ Enable or block power amplifier (ENABLE / GATE signal input)
- □ Enable or block reference pulse (ENABLE / GATE signal input)
- □ Control motor phase current with PWM signal (PWM / STEP2_INV signal input)
- □ Increase or reduce number of steps by a factor of 10, e. g. 200/2000 (PWM / STEP2_INV signal input)
- ■ Functions of signal outputs
- □ Output error signal (FAULT / INDEXPULSE signal output)
- □ Output index pulse signal (FAULT / INDEXPULSE signal output)
- □ The operating readiness is signalled via the ACTIVE signal output.
- ■ Activate blocking detection. If the actual position deviates more than one revolution from the reference position, an error is generated and the compact drive system is de-energised. The motor has no torque in this operating status.
- ■ Switch on RS 485 terminating resistor
- ■ Switch on/off safety function “Safe Torque Off"

Setting the number of steps

The number of steps per axis revolution can be set via the number of steps function.

Example:
At a number of steps of 1000, the Integrated Drive System executes exactly one complete motor revolution at 1000 pulses. At a pulse frequency of 1 kHz this corresponds to a speed of 1 s^{-1} = 60 rpm.
The STEP2_INV setting at the parameter switch can be inverted via the input signal STEP2_INV of the multifunction interface or the 24 V signal interface.

Settings via parameter switch
Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000 per revolution

Setting the motor phase current

The motor phase current is set with a rotary switch. A high motor phase current generates a high motor torque.

Settings via rotary switch
Motor phase current (25% ... 100% (in increments of 5%) of nominal current

Activating the motor phase reduction

If the full holding torque is not required, the motor phase current reduction can be used to reduce the holding torque.
Advantage: motor and electronics heat up less and efficiency is improved.
The motor phase current is reduced to approximately 70% of the set motor phase current value 100 ms after the last pulse edge is received.
The motor phase current is set with a rotary switch. A high motor phase current generates a high motor torque.

Settings via parameter switch
Activate/deactivate motor phase current reduction

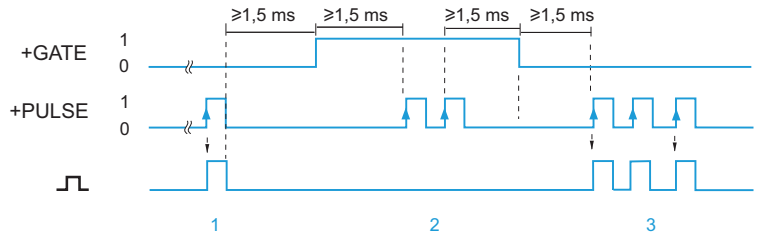
Setting the function of the ENABLE/GATE signal input

The ENABLE/GATE signal is available at the following interfaces:
- 24 V signal interface
- Multifunction interface

The ENABLE/GATE signal can have two functions:

ENABLE function: enable/block power amplifier
The ENABLE function enables the power amplifier so that the motor can be controlled.

GATE function: enable/block the pulse input
The GATE function blocks the pulses at the reference input without switching off the operating readiness. In a multi-axis system, individual axes can be selected with the GATE function.



Signal sequences when the Integrated Drive System is switched on with the GATE function

1 Motor step
2 No motor steps
3 Motor steps

The diagram shows the motor movement with activated GATE function. No pulse may be applied for 1.5 ms before and after the GATE signal changes to ensure that the Integrated Drive System can follow the preset pulse step by step. If the time interval is not kept, the LED signals a warning. The warning does not affect the operating readiness of the Integrated Drive System.

Settings via parameter switch
Set the function of the ENABLE/GATE signal input

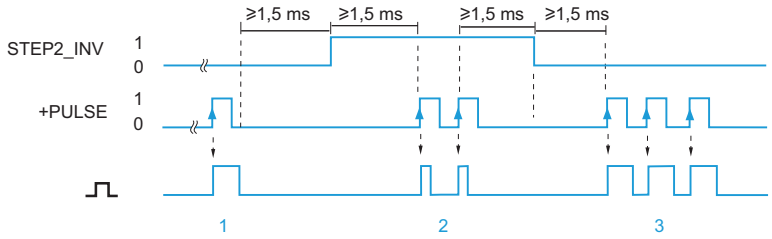
Setting the function of the STEP2_INV / PWM signal input

The STEP2_INV/PWM signal is available at the following interfaces:
- Multifunction interface
- 24 V signal interface (only STEP2_INV)

The STEP2_INV/PWM signal can have two functions:

STEP2_INV function

The STEP2_INV function can be used if a high positioning accuracy is required but the output frequency of the master controller is limited.
The number of steps can be increased or reduced by a factor of 10 with the STEP2_INV / PWM signal.
If the STEP2_INV function is activate, the setting of the parameter switch 1.1 is inverted.



Signal sequences when the STEP2_INV signal changes

1 Large motor step
2 Motor steps decreased by a factor of 10
3 Large motor steps

PWM function

The PWM (pulse width modulation) function can be used to reduce the motor phase current and, by implication, the torque to a value between 0% and 100% of the motor phase current that is set at the HEX rotary switch.
At constant level HIGH, motor phase current does not flow (current set to zero).
At constant level LOW, the motor operates with the adjusted maximum motor phase current.
If rectangular pulse signals are supplied, the motor phase current can be set using the pulse-pause ratio.

Settings via parameter switch

Set the function of the STEP2_INV / PWM signal input

Setting the function of the FAULT/INDEX PULSE signal output

The index pulse signal can be made available at the FAULT / INDEXPULSE signal output.
The FAULT/INDEX PULSE signal is available at the following interfaces:
■ 24 V signal interface
The FAULT/INDEX PULSE signal can have two functions:

FAULT function
The FAULT function displays an error status. An error can be reset by blocking and enabling the power amplifier (ENABLE: LOW → HIGH signal).

INDEXPULSE function
If the integrated Drive System is equipped with the optional internal Hall sensor at the motor shaft, the Hall sensor sends the INDEXPULSE signal per revolution.

Settings via parameter switch
Set the function of the FAULT/INDEX PULSE signal output

Activating blocking detection.

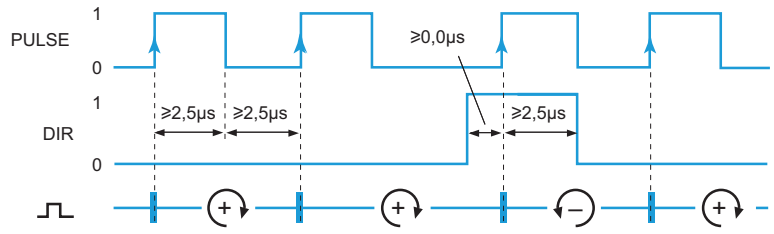
The blocking detection responds if the actual position of the axis deviates from the reference position by more than one revolution.
When the blocking detection responds, the Integrated Drive System is de-energised and the FAULT signal output is set.

Settings via parameter switch
Activate/deactivate blocking detection

Setting the function of the DIR/A and PULSE/B signal inputs

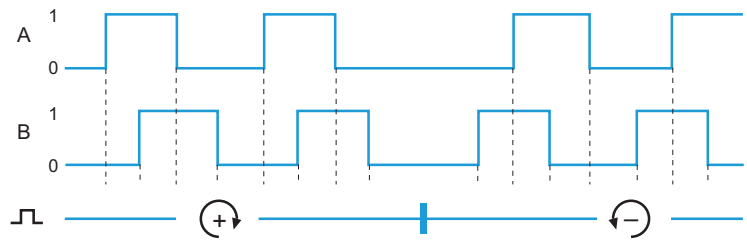
The reference position values can be supplied to the multifunction interface as pulse/direction signals or as A/B encoder signals. The Integrated Drive System converts the input signals into a motor movement.
Two interface modes are available:

PULSE/DIR interface mode
The motor executes an angle step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal.



Pulse/direction signals

A/B interface mode
In A/B interface mode, A/B encoder signals are supplied as reference values.



A/B encoder signals

Settings via parameter switch
Set the function of the DIR / A and PULSE / B signal inputs

"Safe Torque Off" ("Power Removal") safety function

The Lexium integrated drive integrates the "Safe Torque Off" ("Power Removal") safety function which prevents unintended restarting of the motor. The motor no longer produces any torque if the safety function is active.

This safety function:

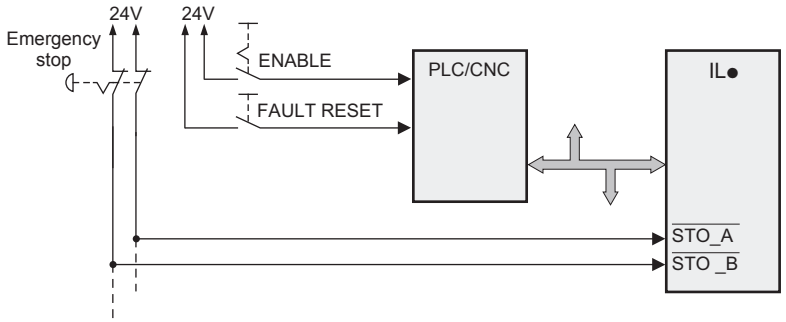
- Complies with the machine safety standard ISO 13849-1, perfomance level "d" (PL d).
- Complies with the standard for functional safety IEC/EN 61508, SIL2 capability (safety control-signalling applied to processes and systems). The SIL (Safety Integrity Level) capability depends on the connection diagram for the servo drive and for the safety function. Failure to observe the setup recommendations could inhibit the SIL capability of the "Safe Torque Off" ("Power Removal") safety function.
- Complies with product standard IEC/EN 61800-5-2 "Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional" for both stop functions:
  - Safe Torque Off ("STO") corresponds to Category 0 stop according to IEC/EN 60204-1. Standstill by immediate power shutdown to the machine drive elements (i.e. an uncontrolled stop).
  - Safe Stop 1 ("SS1") corresponds to Category 1 stop according to IEC/EN 60204-1. A controlled stop in which the machine drive elements are retained to effect the standstill. The final shutdown is ensured by an external Emergency stop module with safe time delay, e.g. Preventa XPS-AV *(1)*.

The "Safe Torque Off" ("Power Removal") safety function has a redundant electronic architecture *(2)* which is monitored continuously by a diagnostics function.

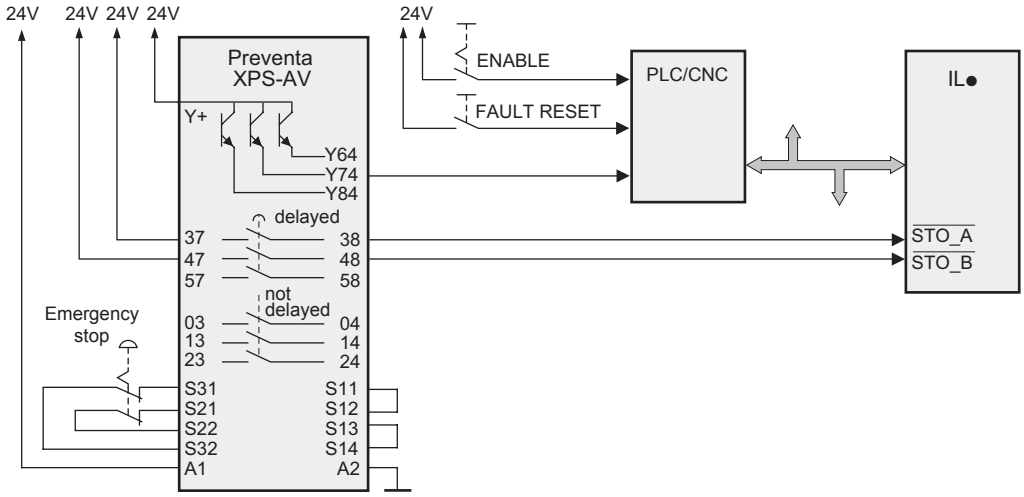
This PL d and SIL2 safety function is certified as conforming to these standards by the TÜV certification body in the context of a voluntary certification.

(1) Please refer to the "Safety functions and solutions using Preventa" catalogue.
(2) Redundant: Consists of mitigating the effects of the failure of one component by means of the correct operation of another, assuming that faults do not occur simultaneously on both.

Examples of applications of the safety function



Example of Category 0 Stop

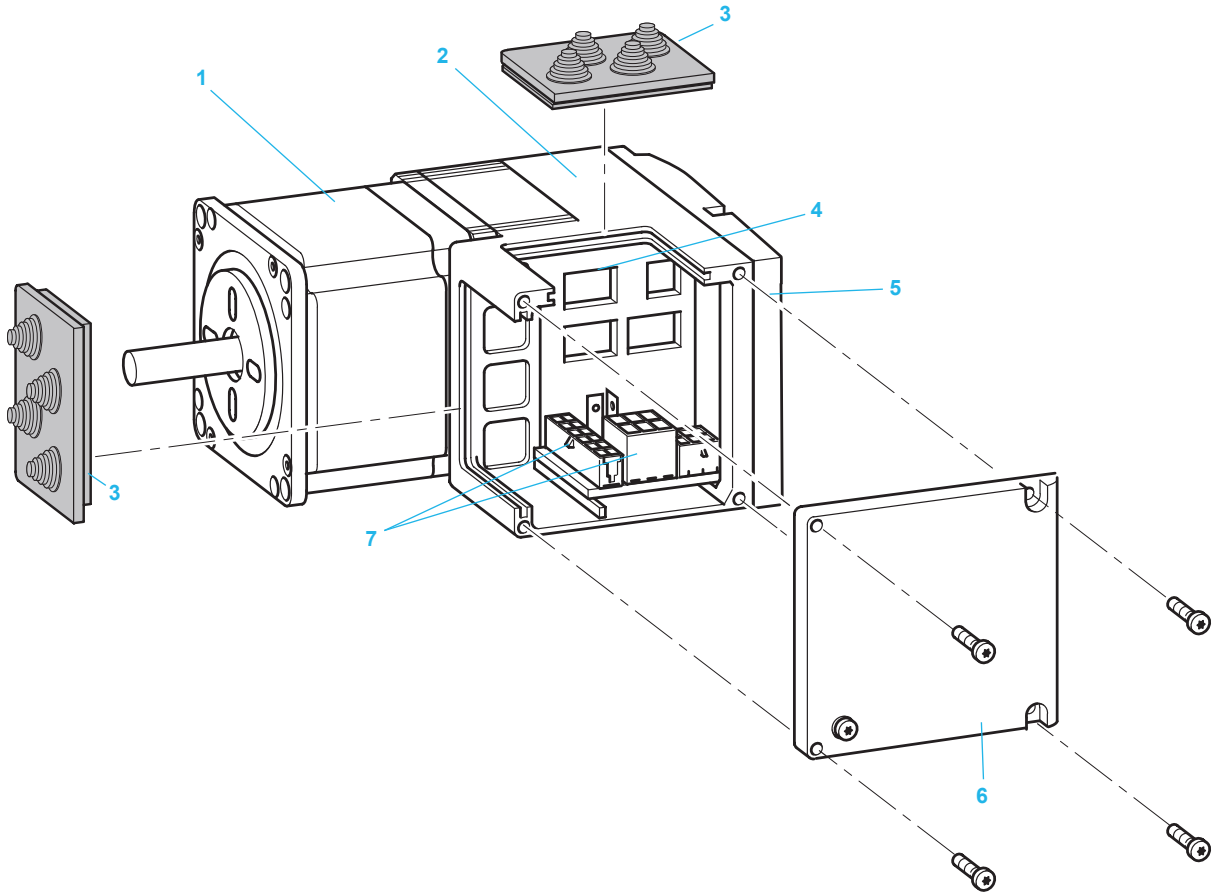


Example of Category 1 Stop

Lexium integrated drives
ILS1 with pulse/direction interface
ILS1 with 3-phase stepper motor

Description

ILS1 consist of control electronics with pulse/direction interface and a 3-phase stepper motor. ILS1 is optionally available with printed circuit board connectors or industrial connectors. A holding brake is optionally available for ILS1●85.



1 3-phase stepper motor
2 Electronics housing
3 Insert cable entry (accessory)
4 Settings via parameter switches
5 Cover for electronics housing
6 Cover for connector housing
7 Electrical interfaces

Lexium integrated drives
ILS1 with pulse/direction interface
ILS1 with 3-phase stepper motor

Certifications

Conformity to standards			Lexium integrated drives have been developed to comply with the stringent international standards and with the recommendations for adjustable speed power drive systems, specifically: IEC/EN 61800-3 (noise immunity to conducted and radiated high-frequency signals) and IEC/EN 50178 (resistance of devices to vibration).
	EMC immunity		EN 61800-3:2001, second environment
	Conducted and radiated EMC emissions		EN 61800-3:2001-02; IEC 61800-3, Ed.2 ■ Power supplies without external mains filter: □ C3 up to 10 m supply cable length ■ Power supplies with external mains filter: □ C2 up to 20 m supply cable length □ C3 up to 50 m supply cable length
CE marking			The Lexium integrated drives are CE marked in accordance with the European Machinery Directive (98/37/EEC) and the European EMC Directive (2004/108/EEC).
Product certifications			UL (USA), cUL (Canada)
			TÜV certification: Lexium integrated drives are TÜV-certified for device safety and medical devices. The certification includes: ■ Functional safety of electrical/electronic/programmable safety-related electronic systems (IEC 61508:2000; SIL 2) ■ Safety of machinery – functional safety of safety-related electrical and electronic and programmable electronic control systems (IEC 62061:2005; SILcl2) ■ Safety of machinery – safety-related parts of control systems – Part 1: General principles for design (ISO 13849-1:2006; PL d (Category 3))

Ambient conditions

Ambient temperature *(1)*		**°C**	0 ... 65; power reduction by 2%/°C at 50 ... 65
Max. permissible temperature of the power amplifier		**°C**	105
Max. permissible temperature of the motor *(2)*		**°C**	110
Transport and storage temperature		**°C**	-25 ... +70
Installation height without power reduction		**m**	< 1000 m above mean sea level
Relative humidity		**%**	15 ... 85 (not condensing)
Vibration load during operation as per DIN EN 60068-2-6	Number of cycles		10
	Acceleration amplitude:	**m/s²**	20
	Frequency range	**Hz**	10 ... 500
Continuous shocks as per DIN EN 60068-2-29	Number of shocks		1000
	Peak acceleration	**m/s²**	150
Shaft wobble and perpendicularity			According to EN 50347 (IEC 60072-1)
Degree of protection as per DIN EN 60034-5			Total except shaft bushing IP54, shaft bushing IP41

Electrical data

Power supply connection (CN1)			Corresponds to PELV according to DIN 19240, not protected against reverse polarity		
Supply voltage range		**⎓ V**	18 ... 40		
Nominal supply voltage		**⎓ V**	24 / 36		
Ripple at nominal voltage		**V_{PP}**	≤ 3.6		
Max. current consumption	ILS1●57	**A**	3.5		
	ILS1●851, ILS1●852	**A**	5		
	ILS1●853				
	■ with winding type T	**A**	6		
	■ with winding type P	**A**	5		
Inrush current			Charging current for capacitor C=1500 µF		
External fuse		**A**	10		
Multifunction interface (CN2)					
Type of integrated drive			**ILS1V (5 V)**	**ILS1W (5 V RS 422)**	**ILS1U (24 V)**
Signal inputs	Galvanically isolated		yes	no	yes
	Logic 0 (U_{low})	**V**	-5.25 ... +0.4	RS 422	-3 ... +3
	Logic 0 (U_{high})	**V**	+2.5...+5.25	RS 422	+20 ... +30
	Permissible voltage range	**V**	-5.25 ... +5.25	-2 ... +26 *(3)*	-3 ... 30
	Input resistance	**Ω**	140	5000	2000
	PULSE/DIR frequency input	**kHz**	≤ 200	≤ 200	≤ 200
	Frequency input PWM current reduction	**kHz**	6 ... 25	6 ... 25	6 ... 25
Signal outputs			Short-circuit protected, protected against reverse polarity up to 100 mA, suitable for inductive load (1000 mH / 100 mA)		
	Galvanically isolated		yes	no	yes
	Max. switching voltage	**V**	30	30	30
	Max. switching current	**mA**	100	100	100
	Internal voltage drop at 10 mA / 100 mA	**V**	≤ 1.6 / 1.9	≤ 0.2 / 0.2	≤ 1.6 / 1.9

(1) Limit values with flanged motor mounted on a steel plate 300 x 300 x 10 mm
(2) Measured at the surface
(3) Voltage relating to 0V ⎓

Electrical data		
24 V signal interface (CN4)		4 signals, can each be used as input or output GND galvanically connected to GND supply voltage, not protected against reverse polarity
24 V signal inputs		
Logic 0 (U_{low})	**V**	-3 ... +3
Logic 1 (U_{high})	**V**	+20 ... +30
Permissible voltage range	**V**	-3 ... 30
Input resistance	**Ω**	2000
Debounce time IO0..IO3	**ms**	0.1
Debounce time IO2, IO3 with capture function	**ms**	0.01
24 V signal outputs		Switching to plus, short-circuit protected, suitable for inductive load (1000 mH / 100 mA)
Supply voltage range	**⎓ V**	23 ... 25
Max. switching current (total)	**mA**	200
Max. switching current per output	**mA**	100
		The internal power supply unit is protected against: ■ Short circuit of the output voltage ■ Overload of output voltage (limited to 6 W output power)
Interface for safety function "Safe Torque Off" (CN5)		No galvanic isolation; corresponds to RS 485 standard
Logic 0 (U_{low})	**V**	-3 ... +4.5
Logic 1 (U_{high})	**V**	+15 ... +30
Input current (typical at 24 V)	**mA**	10
Debounce time	**ms**	1 ... 5
Response time (until shutdown of power amplifier)	**ms**	< 50
Max. Time offset until detection of signal differences between $\overline{\text{STO\_A}}$ and $\overline{\text{STO\_B}}$ *(1)*	**S**	< 1
Safety function "Safe Torque Off" ("Power Removal")		
Protection Of machine		"Safe Torque Off" safety function which forces stopping and/or prevents unintended restarting of the motor, conforming to standard ISO 13849-1, performance level "d" (PL d) , and standard IEC/EN 61800-5-2
Of the system process		"Safe Torque Off" safety function which forces stopping and/or prevents unintended restarting of the motor, conforming to standard IEC/EN 61508 level SIL2 and standard IEC/EN 61800-5-2

(1) Switching process must be simultaneous for both signal inputs (time offset < 1 s).

Mechanical data ILS1●57

Type of integrated drive			ILS1●571	ILS1●572	ILS1●573
Winding type			P	P	P
Max. torque	M_{max}	**Nm**	0.45	0.90	1.50
Holding torque		**Nm**	0.51	1.02	1.70
Rotor inertia		**kg·cm²**	0.1	0.22	0.38
Number of steps			200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000		
Step angle		°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036		
Systematic angle tolerance per step *(1)*		**arcmin**	±6	±6	±6
Mass		**kg**	1.3	1.6	2.0
Shaft load *(2)*	Max. radial force *(3)*	**N**	24	24	50
	Max. axial tensile force	**N**	100		
	Max. axial force pressure	**N**	8.4		
	Nominal bearing service life *(4)*	**h**	20000		

Mechanical data ILS1●85

Type of integrated drive			ILS1●851	ILS1●852	ILS1●853	
Winding type			P	P	P	T
Max. torque	M_{max}	**Nm**	2.0	4.0	6.0	4.5
Holding torque		**Nm**	2.0	4.0	6.0	4.5
Rotor inertia		**kg·cm²**	1.1	2.2	3.3	
Number of steps			200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000			
Step angle		°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036			
Systematic angle tolerance per step *(1)*		**arcmin**	±6			
Mass		**kg**	2.6	3.6	4.7	
Shaft load *(2)*	Max. radial force *(3)*	**N**	100	100	110	
	Max. axial tensile force	**N**	170			
	Max. axial force pressure	**N**	30			
	Nominal bearing service life *(4)*	**h**	20000			

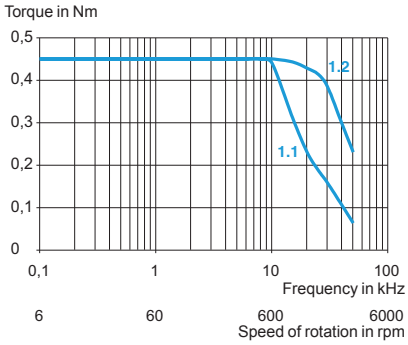
Holding brake

Holding torque	**Nm**	6
Electrical pull-in power	**W**	22
Brake release time	**ms**	40
Brake application time	**ms**	20
Moment of inertia	**kg·cm²**	0.2
Mass	**kg**	1.8

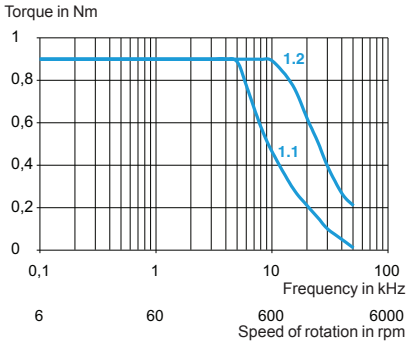
(1) Measured at 1000 steps/revolution
(2) Conditions for shaft load: speed of rotation 60 rpm, duty cycle at torque, ambient temperature 40 °C
(3) Point of application of radial force: 10.5 mm distance to flange
(4) Operating hours at a probability of failure of 10 %

Torque characteristics ILS1●57

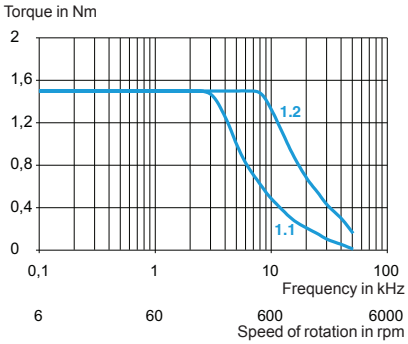
ILS1●571P (winding type P)



ILS1●572P (winding type P)

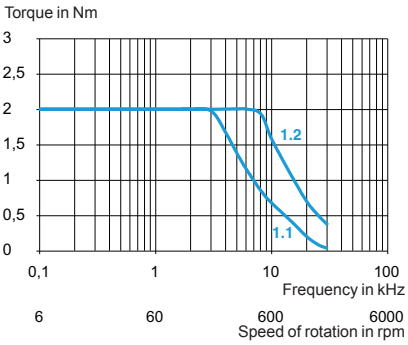


ILS1●573P (winding type P)

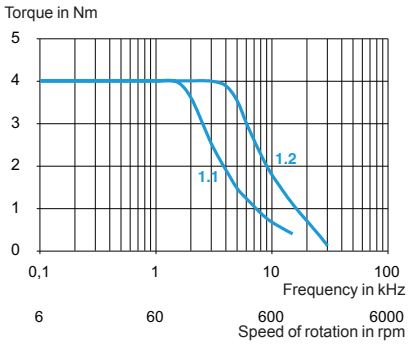


Torque characteristics ILS1●85

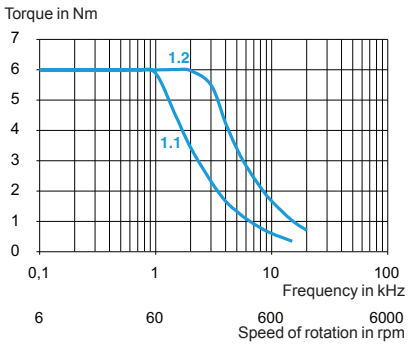
ILS1●851P (winding type P)



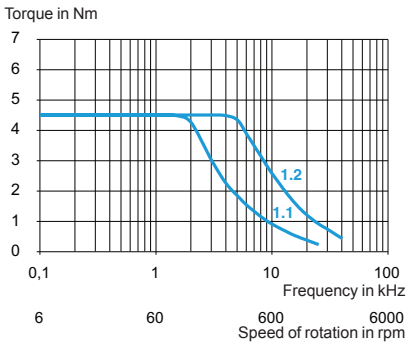
ILS1●852P (winding type P)



ILS1●853P (winding type P)



ILS1●853T (winding type T)



1.1 Max. torque at 24 V
1.2 Max. torque at 36 V

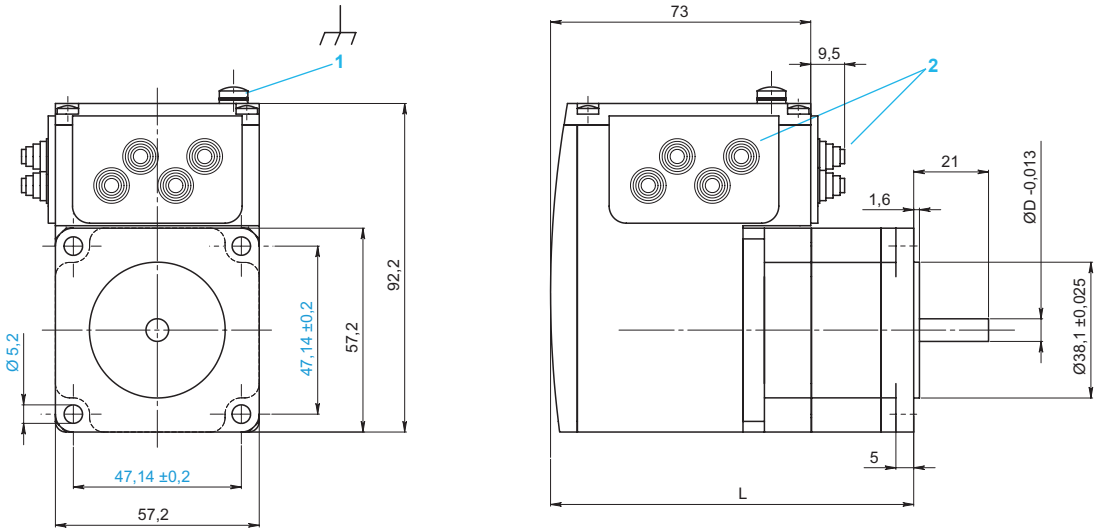
Lexium integrated drives
ILS1 with pulse/direction interface
ILS1 with 3-phase stepper motor

References

Example:	I	L	S	1	U	5	7	1	P	B	1	A
Motor type **S** = 3-phase stepper motor	I	L	**S**	1	U	5	7	1	P	B	1	A
Supply voltage **1** = 24 ... 36 V	I	L	S	**1**	U	5	7	1	P	B	1	A
Communication interface **U** = pulse/direction 24 V, opto-isolated **V** = pulse/direction 5 V, opto-isolated **W** = pulse/direction 5 V RS 422	I	L	S	1	**U**	5	7	1	P	B	1	A
Flange size **57** = 57 mm **85** = 85 mm	I	L	S	1	U	**5**	**7**	1	P	B	1	A
Motor length ("L") *(1)* **1** = motor length "L" **2** = motor length "L" **3** = motor length "L"	I	L	S	1	U	5	7	**1**	P	B	1	A
Winding type **P** = medium speed of rotation, medium torque **T** = high speed of rotation, medium torque *(2)*	I	L	S	1	U	5	7	1	**P**	B	1	A
Connection technology **B** = printed circuit board connector **C** = industrial connector	I	L	S	1	U	5	7	1	P	**B**	1	A
Measurement system **1** = index pulse	I	L	S	1	U	5	7	1	P	B	**1**	A
Holding brake **A** = no holding brake **F** = with holding brake *(3)*	I	L	S	1	U	5	7	1	P	B	1	**A**

(1) The motor length "L" depends on the mechanical characteristics, see pages 4/101, 4/104 and 4/105.
(2) Winding type T only with ILS1●853.
(3) Holding brake only with ILS1●85.

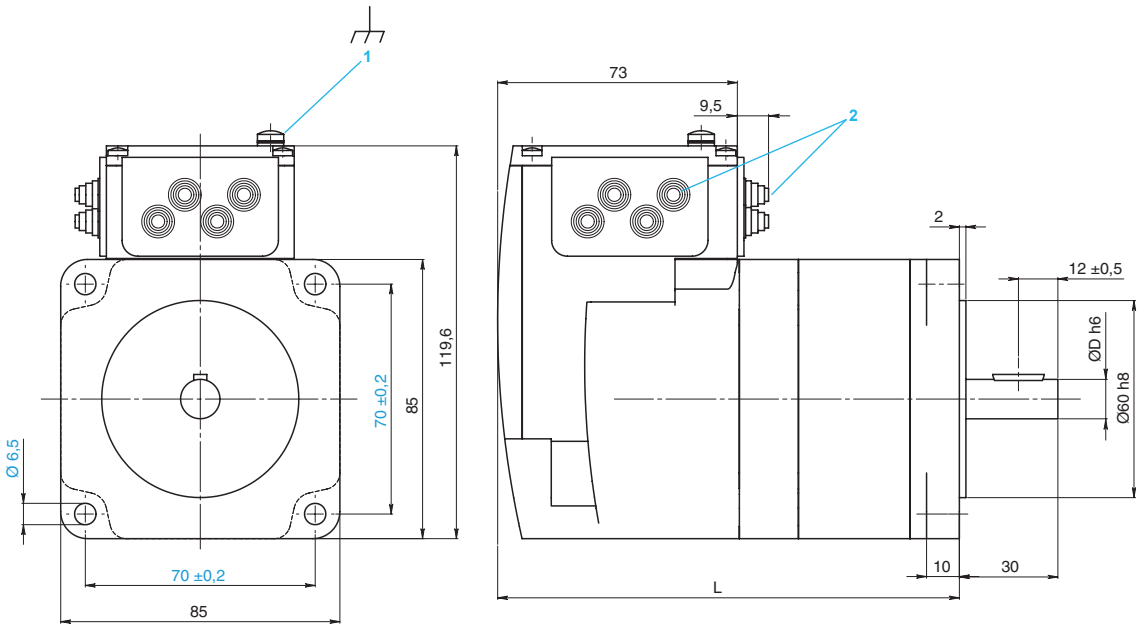
ILS1●57 integrated drives



	L	D
ILS1●571	101.9	6.35
ILS1●572	115.9	6.35
ILS1●573	138.9	8.00

1 Earth (ground) terminal
2 Accessories: cable entries Ø = 3 ... 9 mm

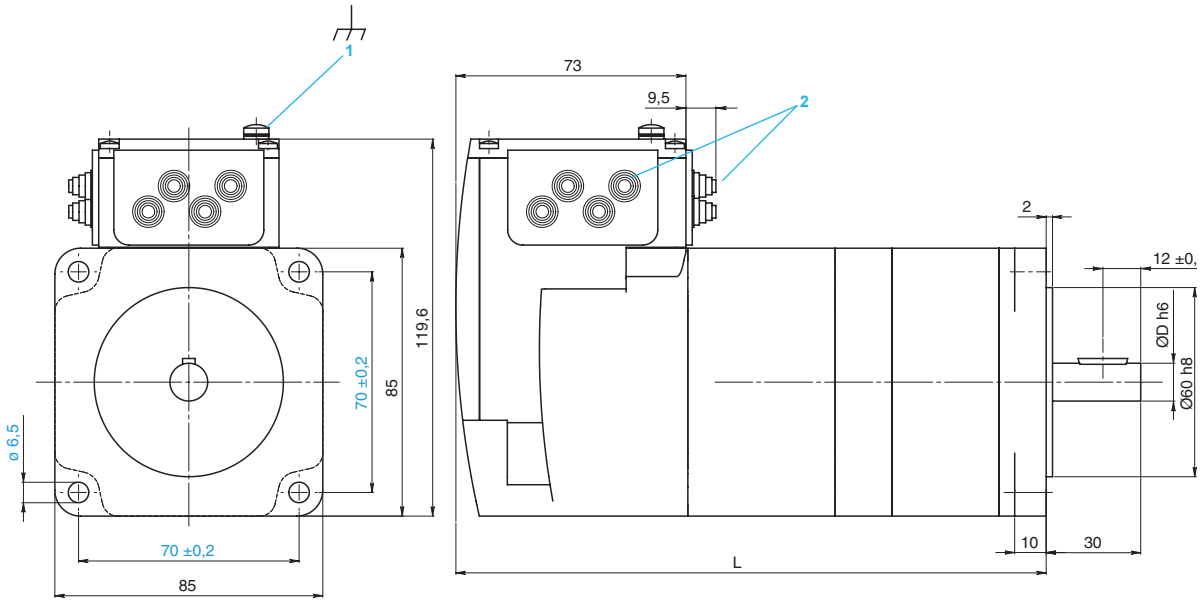
ILS1●85 integrated drives without holding brake



	L	D
ILS1●851	140.6	12
ILS1●852	170.6	12
ILS1●853	200.6	14

1 Earth (ground) terminal
2 Accessories: cable entries Ø = 3 ... 9 mm

ILS1●85 integrated drives with holding brake



	L	D
ILS1●851	187.3	12
ILS1●852	217.3	12
ILS1●853	247.3	14

1 Earth (ground) terminal
2 Accessories: cable entries Ø = 3 ... 9 mm