Technical Note

OEM-Driver for Q-Motion Stick-Slip Piezo Inertia Motors

PI

E-872 PIShift Piezomotor Drive Electronics, 1 Channel, 48 V, OEM Board

The E-872 drive electronics is designed and intended for open-loop operation of PIShift piezo inertia drives.

The E-872 must be installed in a suitable case before start-up. Only authorized and qualified personnel must install, operate, maintain and clean the E-872.

The E-872 piezo amplifier is a laboratory device as defined by DIN EN 61010-1.
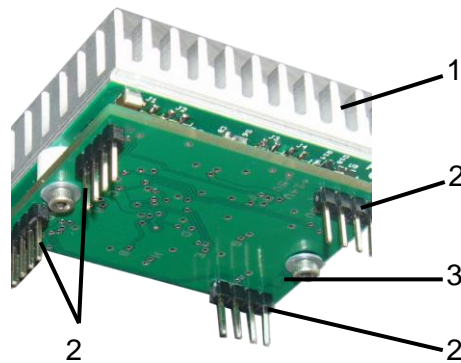
E-872 parts:

1   Heat sink

2   Connector strips

3   Bottom plate

Technical Data

	E-872.01	E-872.02
Function	Drive electronics for PIShift piezomotors, 1 channel, OEM board with solder pins, for	
	full-cycle operation	microstepping with 8-bit resolution
Amplifier		
Control input	TTL signals for step and direction	
Output voltage	0 to 48 V	0 to 48 V
Max. output current (<8 ms)	600 mA	
Max. full step frequency	20 kHz	20 kHz (corresponds to 5.1 MHz microstep frequency)
Microsteps per step	-	256
Current limitation	Short-circuit-proof	
Miscellaneous		
Contacting	4 x connector strip 4-pin RM2.54	
Overtemp protection	ADM1032 Programmable temperature sensors with digital output over SMBus	
Mass	39 g	
⚠ Operating voltage	48 V $=$	
⚠ Max. current consumption	0.62 A	
Stand-by current consumption	<20 mA	

PIEZO NANO POSITIONING

Ambient conditions and classifications	
Area of application	For indoor use only
Maximum altitude	2000 m
Relative humidity	Highest relative humidity 80% for temperatures up to 31°C
	Decreasing linearly to 50% relative humidity at 40°C
Operating temperature range	5 to 50°C
Storage temperature range	0°C to 70°C
Transport temperature range	−25°C to +85°C
Overvoltage category	II
Protection class	I
Degree of pollution	2
Measurement category	I
Degree of protection according to IEC 60529	IP20*

* The specified degree of protection corresponds to the minimum requirement for the case in which the E-872 is to be installed.

Safety

NOTICE

Electrostatic hazard!

The E-872 contains electrostatically sensitive equipment (ESD) and can be damaged if handled improperly.

➢ Avoid touching pins and PCB traces.

➢ Before touching the E-872, discharge yourself of any electric charges appropriately, e.g. by wearing an antistatic wrist strap.

➢ Only handle and store the E-872 in environments that dissipate existing static charges to earth in a controlled way and prevent electrostatic charges (ESD workplace or electrostatically protected area, in short EPA).

NOTICE

Electromagnetic disturbances!

If the E-872 is operated without a case, live parts are accessible. Electrical, magnetic and electromagnetic fields emitted by live parts can disturb the E-872 and/or the environment.

➢ Only operate the E-872 when it is installed in a shielded case that fulfills the requirements of electromagnetic compatibility.

Physik Instrumente (PI) GmbH & Co. KG_Auf der Römerstraße 1_76228 Karlsruhe/Germany
Telefon +49 721 4846-0, Telefax +49 721 4846-1019 E-Mail info@pi.ws, www.pi.ws

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⚠	**NOTICE**

Supply voltage too high or incorrectly connected!

Operating voltages that are too high or incorrectly connected can cause damage to the E-872.

➤ Do **not** exceed the supply voltage range for which the E-872 is specified (see "Operating voltage" in the Technical Data table on p. 1).

➤ Only operate the E-872 when the operating voltage is properly connected (for pin assignment, see p. 4).

Dimensions

Dimensions in millimeters, decimal places separated by commas in drawings

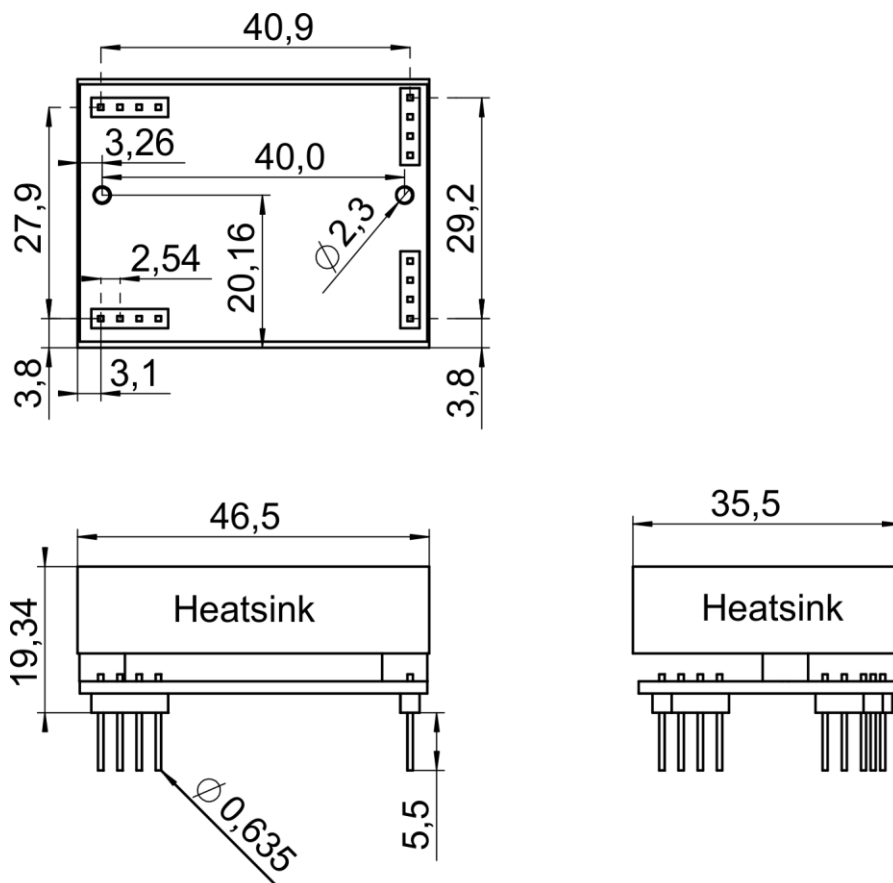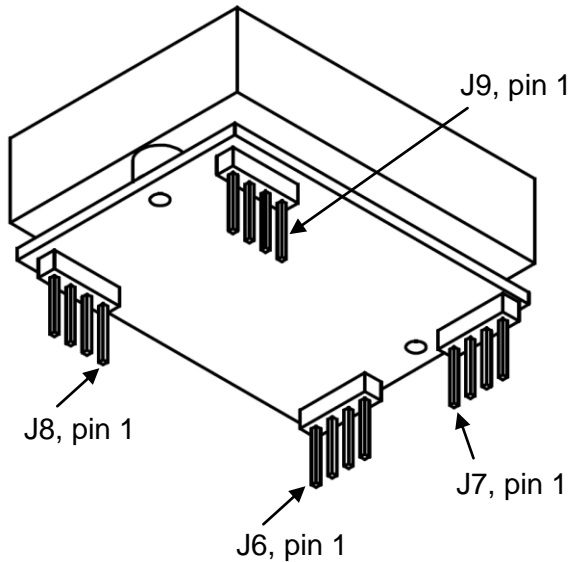Dimensions are identical for E-872.01 and E-872.02.

Figure 1: Dimensions of the E-872

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Pin Assignment

Connector	Function
J6	Control input
J7	Temperature monitor
J8	Supply power
J9	Motor output

J6 Control input

Pin	Description
1	Step (TTL)
2	/Step (TTL)
3	V/D (TTL; direction)
4	GND

J7 Temperature monitor*

Pin	Description
1	GND
2	/ALERT
3	SDATA
4	SCLK

J8 Supply power

Pin	Description
1	+48 V
2	+48 V
3	GND
4	GND

J9 Motor output

Pin	Description
1	GND
2	GND
3	Piezo out (0-48 V)
4	Piezo out (0-48 V)

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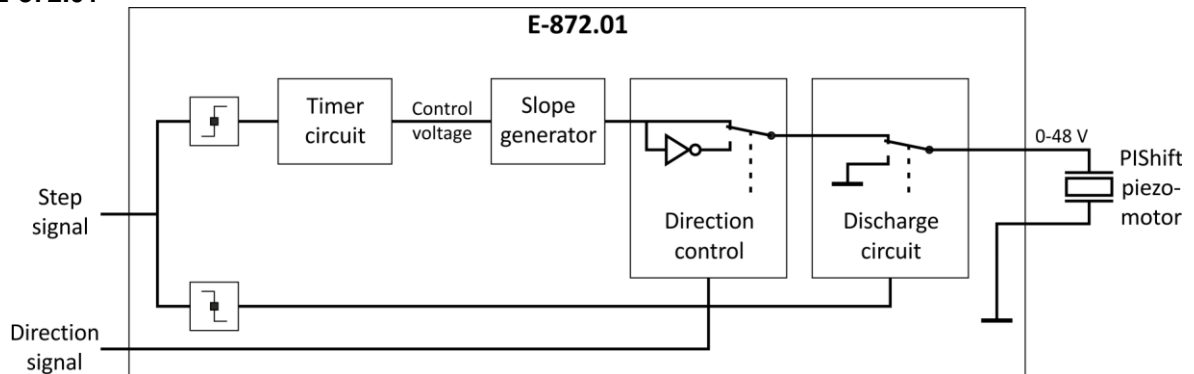
Block Diagram

E-872.01

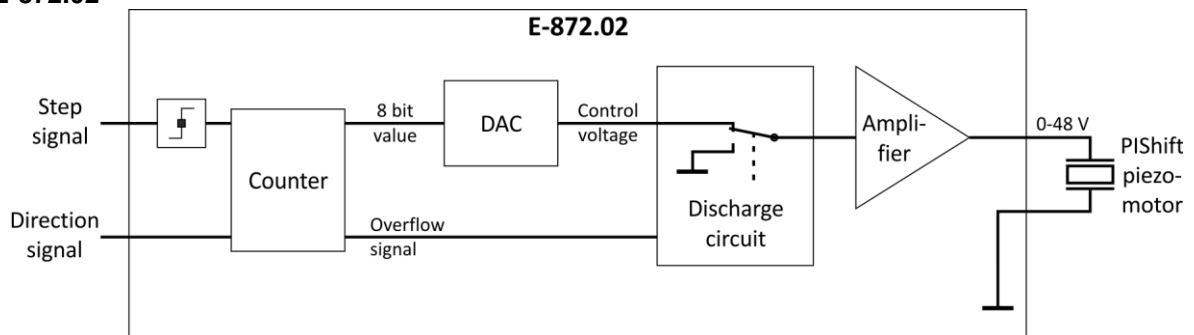Figure 2: Block diagram for E-872.01

E-872.02

Figure 3: Block diagram for E-872.02

Operation Notes

The E-872 generates a modified sawtooth signal and outputs the corresponding piezo voltage. The piezo voltage generates a cyclic alternation of static and sliding friction ("slip phase") between the moving rod and the piezo actuator of the PIShift drive and thus a continuous feed of the rod.

The output of one period of the modified sawtooth signal generates one "step cycle" of the rod. Depending on the E-872 model, the step cycle is divided into 256 microsteps. See the following sections for details.

The input signal can be noninverted (STEP) or inverted (/STEP) as required, but the unused input should be left unconnected.

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Full-cycle operation (E-872.01)

With the E-872.01 model, full-cycle operation is possible only, i.e. every pulse on the step line (J6 control input socket) will cause a complete step cycle. Full-cycle operation is intended for applications where fast motion is important.

The following description assumes noninverted input signals. If you choose to control the E-872 with inverted input signals, the evaluation of the input signal states and edges are inverted accordingly.
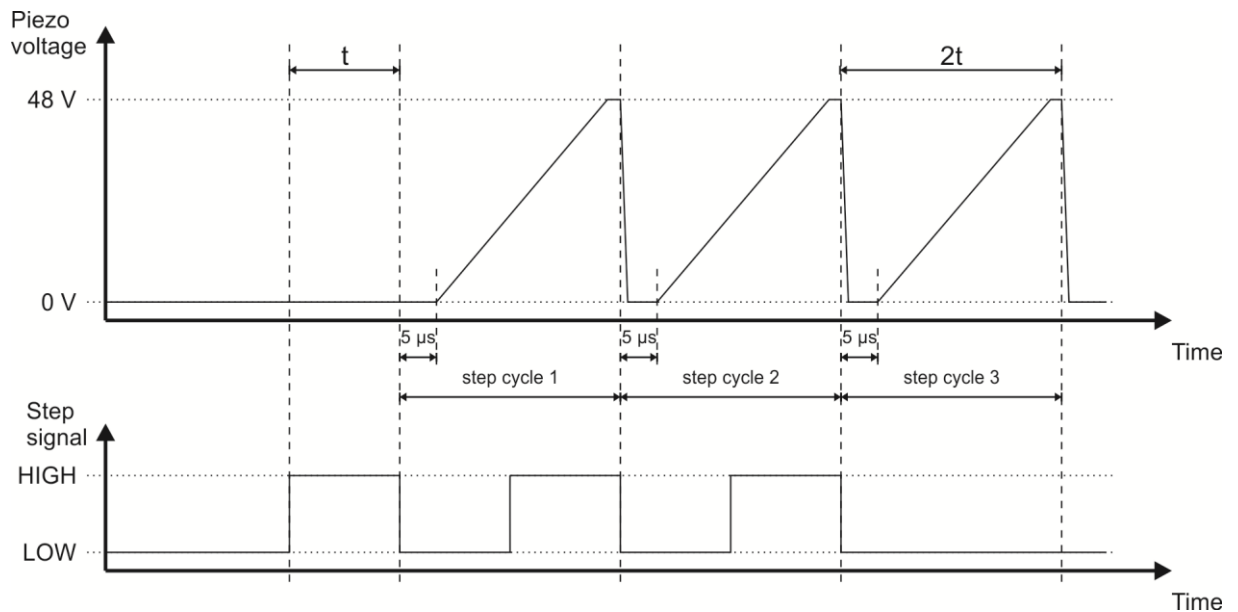

Figure 4: Step signal and piezo voltage. Diagram for positive direction of motion

The duty cycle of the step signal must be 50%. Operation with lower duty cycle values will reduce the drive efficiency and cause choppy motion. For very low step frequencies or single step pulses, the pulse width should not be longer than 2.5 ms.

The slip phase is a fixed 5 µs charge or discharge period, depending on the direction of motion. If the piezo capacitance is very high, the piezomotor may not discharge completely and run at decreased efficiency.

The slip phase of each step is triggered by the falling edge of the step signal. For single step pulses, the step cycle is completed after twice the pulse width from the falling edge of the step pulse. The output voltage is reset to 0 V after each step in any direction.

The maximum step frequency is 20 kHz. Higher step signal frequencies will not damage the driver but will stop the motion of the piezomotor.

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Microstepping operation (E-872.02)

With the E-872.02 model, microstepping operation is possible only, i.e. every pulse on the step line (J6 control input socket) will cause one microstep. The microsteps are being counted by an 8 bit counter. Microstepping operation is intended for applications where very precise motion is important.

The following description assumes noninverted input signals. If you choose to control the E-872 with inverted input signals, the evaluation of the input signal states and edges are inverted accordingly.
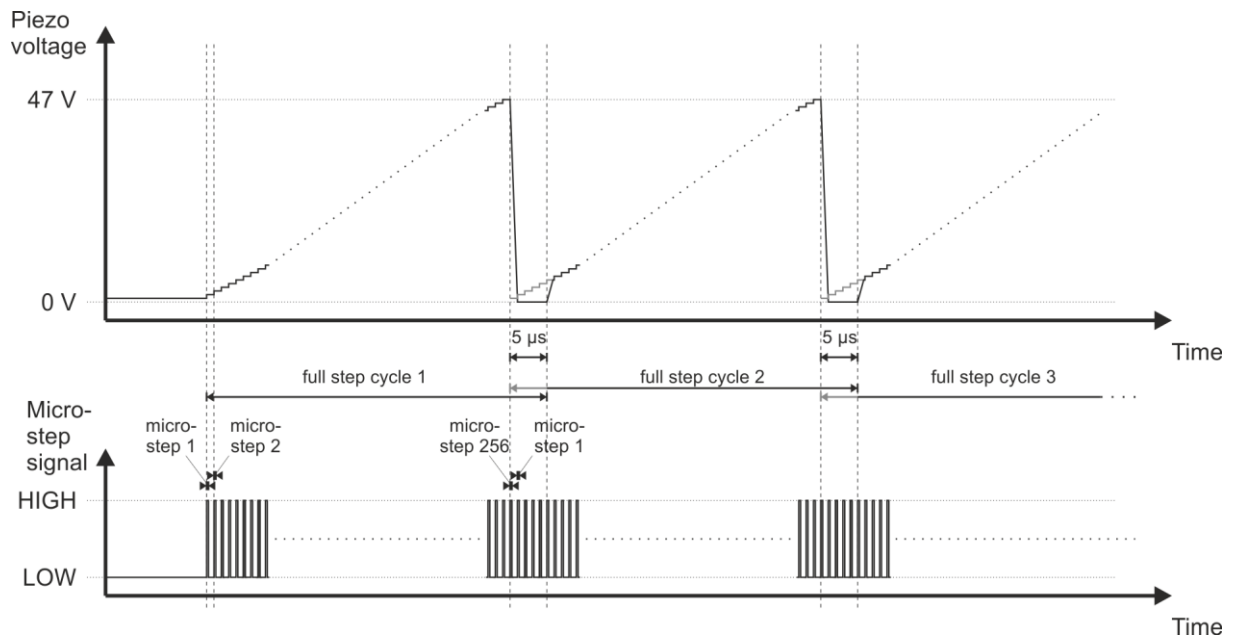

Figure 5: Microstep signal and piezo voltage. Diagram for positive direction of motion

A complete step cycle consists of 256 microsteps. Each microstep is triggered by the rising edge of the step line signal. The piezo output voltage does not reach the supply rails, but swings from approximately +1 V to +47 V and vice versa.

The slip phase of each step cycle is triggered by the overflow signal of the 8 bit counter, i.e. the 256th microstep signal. The output voltage is reset to approximately 1 V after each step cycle in any direction.

The slip phase is a fixed 5 µs charge or discharge period, depending on the direction of motion. If the piezo capacitance is very high, the piezomotor may not discharge completely and run at decreased efficiency. During this phase, the piezo output voltage reaches 0 V or 48 V respectively.

If the microstep signal continues during the slip phase, the E-872.02 will increase the piezo output voltage to the desired value after the slip phase without losing count (see Figure 5). In this case, the slope is low enough for the piezomotor to follow the motion, so the rod will not slip.

Maximum microstep frequency is approximately 5.1 MHz which corresponds to a full-step frequency of 20 kHz. Higher step signal frequencies will not damage the driver but will stop the motion of the piezomotor.

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Temperature Sensors

NOTICE

Temperature sensors use default values!

The E-872 has two integrated ADM1032 temperature sensors which are accessible via the SMBus protocol on the connector **J7**. The temperature sensors have not been preconfigured to match your application and thus will not prevent overheating of the E-872.

➢ See the ADM1032 datasheet for instructions on configuration of the temperature sensors.

NOTICE

No integrated overtemperature protection!

The E-872 does not feature on-board overtemperature protection.

➢ Use external hardware for the evaluation of the ADM1032 temperature sensors.

➢ If necessary, include an overtemperature deactivation circuit for the E-872 into your design.

Installation

The E-872 must be installed on another printed circuit board by the four pin headers **J6 – J9**.

Tools and accessories

- Suitable printed circuit board:

    – The printed circuit board has four suitable four-pin header connectors (for position and orientation, see "Dimensions" on p. 3).

    – The components on the printed circuit board do not protrude beyond the header connectors.

Installing the E-872 on a printed circuit board

1. Align the pin headers of the E-872 with the header connectors of the printed circuit board.

2. Push the pin headers into the header connectors.

3. Check that the E-872 is affixed firmly.

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