Technical Note

CBo, 2015-09-02
P876T0001, valid for P-876 and P-878

DuraAct and DuraAct Power Patch Transducers

Contents

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About this Document

This document describes the following products (hereinafter referred to as "P-87x" or "patch transducer"; x stands for the respective model):

- P-876 DuraAct Patch Transducers
- P-878 DuraAct Power Patch Transducers

This document also applies to custom products of the DuraAct and DuraAct Power product lines if nothing else is stated in their accompanying documentation. The product line is stated on the delivery note of the custom product. The properties of custom products may differ from those stated in this technical note.

Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this document:

DANGER

Imminently hazardous situation!

If not avoided, the hazardous situation will result in death or serious injury.

➢ Actions to take to avoid the situation.

NOTICE

Dangerous situation

If not avoided, the dangerous situation will result in damage to equipment.

➢ Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals. The latest versions of the user manuals are available for download on our website http://www.pi.ws.

Product	Document
E-413.D2	PZ199E user manual
E-835.00	PZ211E user manual

Safety

Intended Use

In accordance with its design, the P-87x is intended for integration into a mechanical system and for the following applications:

- Actuator engineering: Creating motion of the P-87x by applying electrical voltage
- Sensor engineering: Measuring the electrical voltage generated by deformation of the P-87x
- Power generation: Generation of electrical voltage for a load by deformation of the P-87x

Generally, integration into a mechanical system is done by gluing the patch transducer to a structure.

If an electrical operating device is designed to be integrated into another electrical operating device: The operator is responsible for standards-compliant integration of the electrical device into the overall system.

Depending on the model, the motion is performed as follows:

Model	Motion
P-876	Lateral contraction (p. 7)
P-878	Expansion in a longitudinal direction and lateral contraction (p. 8)

To operate the P-87x as piezo actuator, suitable electronics are required that supply the required operating voltages. The electronics are not included in the scope of delivery of the P-87x. We recommend the use of suitable electronics (p. 4) from PI.

General Safety Instructions

The P-87x is built according to state-of-the-art technology and recognized safety standards. Improper use of the P-87x may result in personal injury and/or damage to the P-87x.

- ➢ Only use the P-87x for its intended purpose, and only use it if it is in good working order.
- ➢ Read the documentation.
- ➢ Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for correct installation and operation of the P-87x.

Personnel Qualification

The patch transducers may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

- ➢ Follow general accident prevention rules!

Electrical Dangers

DANGER

Dangerous voltage in piezo actuators during operation!

Depending on the model, the P-87x is energized during operation as piezo actuator with voltages up to 1000 V. Touching the live parts of the P-87x can result in serious injury or death from electric shock.

- Do **not** touch the patch transducer during operation.
- Before start-up, electrically insulate the solder joints of the patch transducer to protect against direct or indirect contact with live parts. Observe the clearances and creepage distances required for the operating voltage, and observe the standards applicable to your application.

NOTICE

Operating voltage excessively high or incorrectly connected!

Operating voltages that are excessively high or incorrectly connected can cause damage to the P-87x.

- Do **not** exceed the specified operating voltage range of the P-87x (see "Specifications", p. 13).
- Only operate the P-87x when the operating voltage is properly connected (see "Electrical Contacting", p. 10).

NOTICE

Destruction of the patch transducer due to contamination!

If the patch transducer is contaminated with conductive materials (e.g., metal dust), it can be destroyed during operation.

- Avoid contact of conductive material (e.g., metal dust) with the electrodes (solder joints) of the patch transducer.

Mechanical Dangers

NOTICE

Destruction of the patch transducer due to mechanical overload!

DuraAct patch transducers are bendable (exception: patch transducers without a specified bending radius). Bending the patch transducer with an excessively low bending radius can mechanically overload the patch transducer. Mechanical overload leads to destruction of the patch transducer.

- Do **not** bend the patch transducer with a lower bending radius than stated in the specifications (p. 13).
- If a bending radius is not stated in the specifications: Avoid bending forces on the patch transducer.

NOTICE

Destruction of the patch transducer due to pull forces!

Excessive pull forces can destroy the piezo ceramic of the patch transducer.

- Avoid pull forces on the patch transducer >30 MPa.

NOTICE

Damage due to filing, grinding, and roughening!

The surface of the patch transducer consists of a polymer material that serves as electrical insulation and mechanical stabilization. Removing the surface material damages the patch transducer.

- Avoid filing, grinding, and roughening the surface of the patch transducer.

NOTICE

Damage due to moving stranded wires!

Mechanical stresses (e. g., shear forces) on the soldered or glued connections or the stranded wires can lead to damage to the patch transducer.

- Make sure that moving stranded wires are relieved of strain by using shrink tubing or fixing with adhesive.

Thermal Dangers

NOTICE

Destruction of the patch transducer due to overheating!

Overheating can destroy the patch transducer.

- Do **not** exceed the operating temperature range specified for the P-87x (see "Specifications", p. 13).

Model Overview

The P-87x is available in the following versions:

Model	Description
P-876.A11	DuraAct patch transducer, 61 mm × 35 mm × 0.4 mm
P-876.A12	DuraAct patch transducer, 61 mm × 35 mm × 0.5 mm
P-876.A15	DuraAct patch transducer, 61 mm × 35 mm × 0.8 mm
P-876.SP1	DuraAct patch transducer, 16 mm × 13 mm × 0.5 mm
P-878.A1	DuraAct Power patch transducer, 27 mm × 9.4 mm × 0.6 mm

Product View

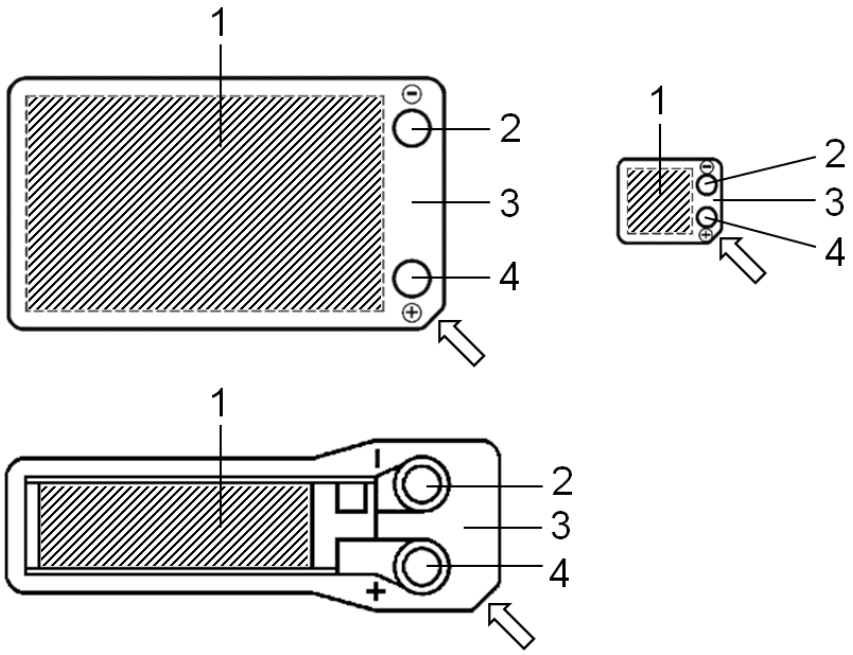


Fig. 1: P-876.A1x (top left), P-876.SP1 (top right) and P-878.A1 (bottom)
1: Active element (piezo ceramic; see hatched area)
2: Negative electrode (solder pad)
3: Base body (embedded in a polymer material)
4: Positive electrode (solder pad)
Arrow: Bevel marks the positive electrode

Directions of Motion

Direction of motion of the P-876

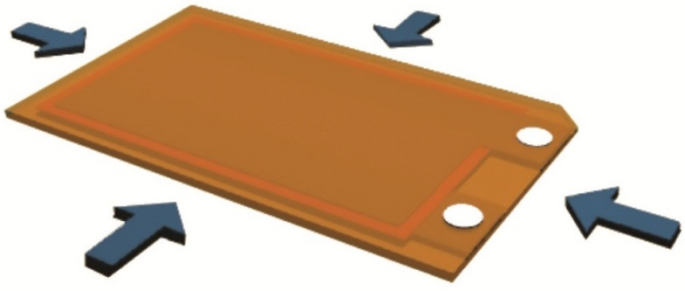


Fig. 2: Lateral contraction of the P-876 when applying electrical voltage. The patch transducer contracts evenly on the plane.

Direction of motion of the P-878

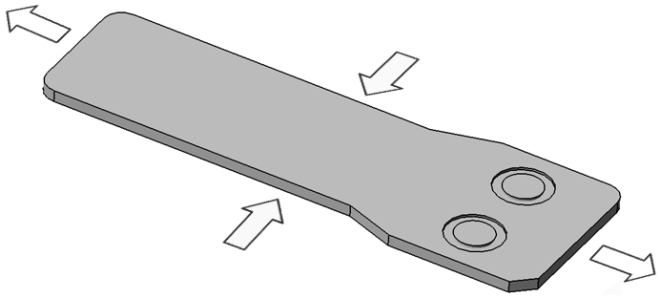


Fig. 3: Expansion in a longitudinal direction and lateral contraction of the P-878 when applying electrical voltage

Suitable Electronics

Item ID	Description
E-413.D2	Piezo amplifier for DuraAct patch transducers
E-835.00	OEM piezo amplifier for DuraAct patch transducers

➢ To order, contact the customer service department (p. 13).

General Notes on Installation

DuraAct patch transducers are provided with an adhesion primer layer optimized for epoxy resins. For gluing DuraAct patch transducers, it is possible to use epoxy resins as well as many other acrylate- and polyurethane-based glues. The choice of adhesive depends on the surface to be glued and the application.

Gluing to Surfaces Made of Hard Materials (Metal, Glass, etc.)

Basically, a hard adhesive bond is beneficial when gluing to hard surfaces where the glass transition temperature (glass point) of the adhesive used needs to be above the operating temperature. According to experience, epoxy-based glues without filler have better properties on hard surfaces than those with filler.

Gluing to Surfaces Made of Composite Materials (GRP)

Ceramic-filled glues have proved to be reliable for gluing composite materials such as glass-fiber reinforced plastic (GRP). Better sound transmission is ensured due to the fillers. It is much easier to fill cavities in uneven surfaces.

Gluing on Flexible Surfaces (Polymers)

Gluing on flexible surfaces (e.g., PVC) and other polymers is particularly critical. Due to the complex surface chemistry, it is recommended to consult a specialist for adhesives.

Gluing Patch Transducers to the Surface

NOTICE

Damage due to overheating during heat curing of the adhesive!

Continuous heating of the patch transducer above the Curie temperature, leads to depolarization of the piezo ceramic. Depolarization can damage the piezo ceramic.

- ➢ Make sure that a temperature of 180 °C is **not** exceeded during hardening of the adhesive.

Fig. 4: Gluing a DuraAct patch transducer (sectional view): Complete wetting with adhesive on one side (black arrow) and adhesive layer between the patch transducer and the surface (white arrow)

Requirements

- ✓ You have read and understood the safety instructions and hazard warnings (p. 3 et seq).
- ✓ You have read and understood the user information of the manufacturer of the adhesive.
- ✓ The surfaces of the parts to be glued are dry and free of dust and grease.

Tools and accessories

- Suitable adhesive (see "General Notes on Installation", p. 8)

Gluing patch transducers to the surface

1. If necessary, roughen the surface, on which the patch transducer is to be glued.
2. Apply the adhesive to the clean surfaces of the parts to be joined according to the instructions of the adhesive manufacturer:
   - ➢ Make sure that the adhesive is completely spread over the sides of the DuraAct patch transducer (see Fig. 4, p. 9) to ensure even force and signal input, and absorb peel and shear forces (e. g., on curved surfaces).
   - ➢ Avoid air pockets to ensure optimum performance of the glued patch transducer.
3. Glue the parts to each other according to the instructions of the adhesive manufacturer.
4. Wait until the adhesive has completely hardened.

Electrical Contacting

DuraAct patch transducers are equipped with electrodes that are accessible from the outside via solder pads with lead-free solder. The electrodes can make contact in one of the following ways:

- Soldering the stranded wires (p. 10)
- Gluing the stranded wires (p. 12)

For exact identification of the connections, it is recommended to use a red stranded wire for contacting the positive electrode and a black stranded wire for contacting the negative electrode.

Indicating the Polarity

The polarity is indicated by the plus and minus signs on the patch transducer or a bevel that marks the positive electrode (see "Product View", p. 7).

Soldering the Stranded Wires

NOTICE

Damage due to overheating of the patch transducer during soldering!

Overheating of the patch transducer leads to deformation that damages the patch transducer. Long and repeated soldering processes can cause damage to the electrode.

- ➢ The soldering temperature should not be any higher than necessary (≤350 °C).
- ➢ Make sure that the soldering time does **not** exceed 1 to 2 seconds.
- ➢ Allow the solder point to cool down before resoldering.

INFORMATION

Any residual polymer on the electrodes resulting from the manufacturing process can impede wetting with solder.

- ➢ Roughen the electrodes carefully with a glass fiber brush or steel wool.

Requirements

- ✓ You have read and understood the safety instructions and hazard warnings (p. 3 et seq).

Tools and accessories

- Suitable stranded wires that meet the applicable standards for the conditions of use
- Suitable soldering iron
- Suitable lead-free solder: Sn 95.5, Ag 3.8, Cu 0.7
- Suitable flux according to one of the following standards:
  - DIN EN 29454, part 1, paragraph 1.1.1 or 1.2.3
  - ANSI J-STD-004, flux type ROL0 / ROM0
- Suitable cable tools

Soldering the stranded wires

1. Twist and tin the stripped end of the stranded wire. Shorten the tinned end to a length of 2 mm.

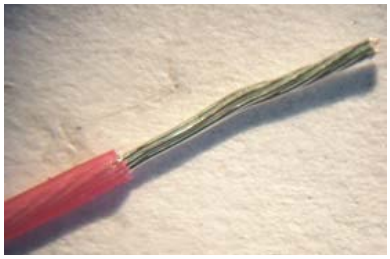
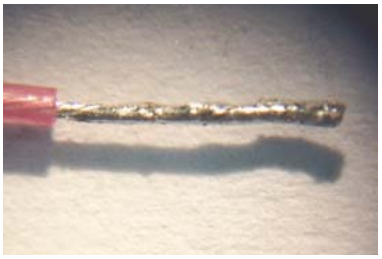
Twisting	Tinning	Shortening to 2 mm
		

Fig. 5: Preparing the stranded wire

2. Apply the flux to the tinned end of the stranded wire and the solder point provided for the electrode (solder pad).
3. Hold the stranded wire flat with the tinned end on the solder point.
4. Coat the tip of the soldering iron with a small amount of the solder.
5. Hold the tip of the soldering iron at the solder point on the tinned end of the stranded wire for a maximum of 1 to 2 seconds so that the solder flows.
   The soldered joint must be flat or punctiform.

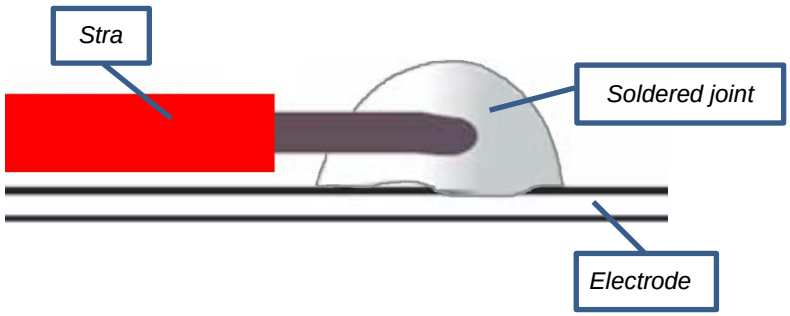


Fig. 6: Punctiform soldered joint (sectional view)

6. Repeat steps 1 to 5 for the second stranded wire.
7. Remove any residual flux with isopropanol.

Gluing the Stranded Wires

NOTICE

Damage due to overheating during heat curing of the adhesive!

Continuous heating of the patch transducer above the Curie temperature, leads to depolarization of the piezo ceramic. Depolarization can damage the piezo ceramic.

➢ Make sure that a temperature of 180 °C is **not** exceeded during hardening of the adhesive.

INFORMATION

For optimum electrical contacting, it is recommended to use silver-plated stranded wires.

Requirements

✓ You have read and understood the safety instructions and hazard warnings (p. 3 et seq).
✓ You have read and understood the user information of the manufacturer of the adhesive.

Tools and accessories

- Suitable stranded wires that meet the applicable standards for the conditions of use
- Electrically conductive, silver-filled epoxy resin adhesive
- Suitable cable tools

Gluing the stranded wires

1. If necessary, clean the bonding surfaces so that they are dry, dust-free and grease-free.
2. Remove the insulation at the end of the stranded wire to be glued and shorten the stripped end to a length of 2 mm.
3. Glue the untwisted and untinned stranded wire to the electrode (solder pad):
   a) Apply the thinnest possible layer of adhesive to the bonding surface provided on the electrode.
   b) Apply a small amount of adhesive to the stripped end of the stranded wire.
   c) Hold the stranded wire in the desired orientation on the adhesive point and fix the stranded wire.
4. Repeat steps 2 and 3 for the second stranded wire.
5. Wait until the adhesive has completely hardened.

Customer Service

For inquiries and orders, call PI Ceramic or send us an email (info@piceramic.com).

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

Specifications

P-876 Data Table

	Operating voltage range	Min. lateral contraction	Rel. lateral contraction	Blocking force	Dimensions	Min. bending radius	Piezo ceramic height	Electrical capacitance
	V	*µm/m*	*µm/m/V*	*N*		*mm*	*µm*	*nF*
P-876.A11	-50 to 200	400	1.6	90	61 mm × 35 mm × 0.4 mm	12	100	150
P-876.A12	-100 to 400	650	1.3	265	61 mm × 35 mm × 0.5 mm	20	200	90
P-876.A15	-250 to 1000	800	0.64	775	61 mm × 35 mm × 0.8 mm	70	500	45
P-876.SP1	-100 to 400	650	1.3	280	16 mm × 13 mm × 0.5 mm	–	200	8

Electrical capacitance: Tolerance ±20 %
Piezo ceramic: PIC255
Standard connections: Solder pads
Operating temperature range: -20 to 150 °C

Custom design or different specifications on request.

P-878 Data Table

	P-878.A1	Unit
Min. axial strain	1200	µm/m
Rel. axial strain	10	µm/V
Min. lateral contraction	250	µm/m
Rel. lateral contraction	1.2	µm/V
Blocking force	44	N
Dimensions	27 mm × 9.4 mm × 0.6 mm	
Min. bending radius	24	mm
Active element	15 mm × 5.4 mm	
Electrical capacitance	150	nF

Electrical capacitance: Measured at 1 V_{pp}, 1 kHz, RT, tolerance ±20 %
Piezo ceramic: PIC252
Standard connections: Solder pads
Operating voltage range: -20 to 120 V
Operating temperature range: -20 to 150 °C

Custom design or different specifications on request.

Dimensions

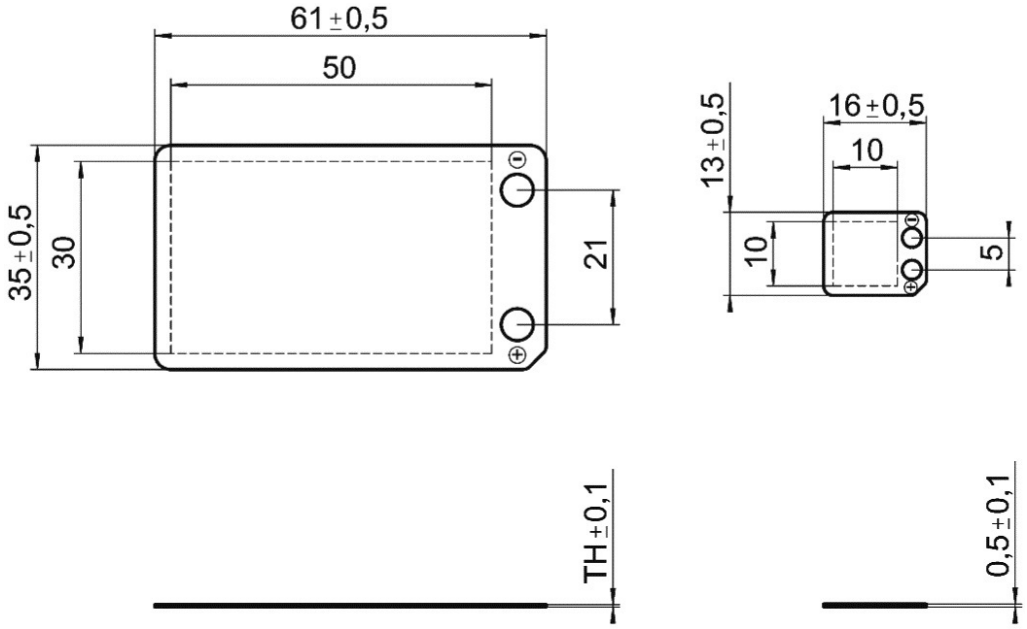


Fig. 7: P-876.A (left), P-876.SP1 (right), dimensions in mm

Model	*Height (TH)*
P-876.A11	*0.4 mm*
P-876.A12	*0.5 mm*
P-876.A15	*0.8 mm*

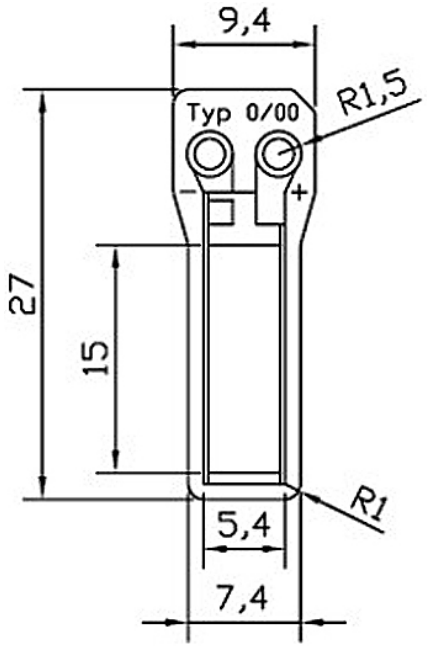


Fig. 8: P-878.A1, dimensions in mm

Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfil the responsibility as the product manufacturer, PI Ceramic GmbH undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following address:

PI Ceramic GmbH
Lindenstrasse
D-07589 Lederhose, Germany

EC Declaration of Conformity

For the P-876/P-878, an EC Declaration of Conformity has been issued in accordance with the following European directives:

2011/65/EU, RoHS Directive

The applied standards certifying the conformity are listed below.
RoHS: EN 50581:2012

If an electrical operating device is designed to be integrated into another electrical operating device: The operator is responsible for standards-compliant integration of the electrical device into the overall system.