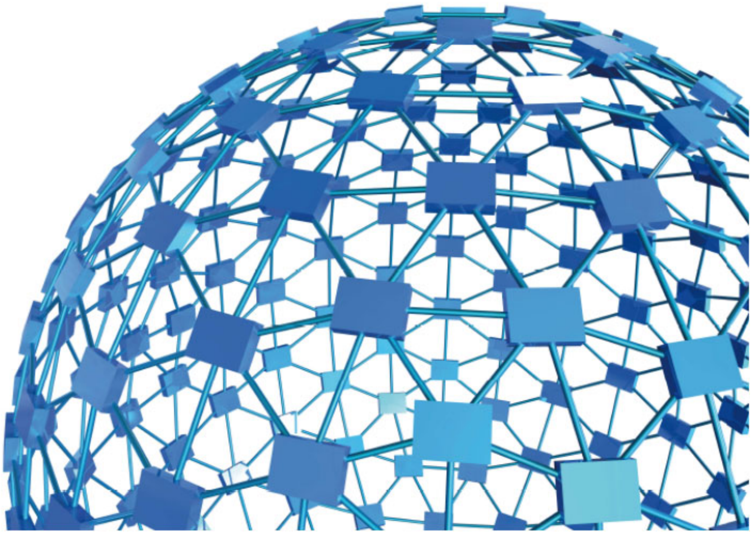
ugo basile®
TRANSFORMING IDEAS INTO INSTRUMENTS

instruction manual

ISOMETRIC TRANSDUCER
Cat. No. 7003-7004-7005-7010



UGO BASILE S.R.L.
sales@ugobasile.com / service@ugobasile.com www.ugobasile.com

UGO BASILE S.R.L.

Via Di Vittorio, 2
21036 GEMONIO, VA, ITALY
Phone: +39 0332 744574

sales@ugobasile.com / service@ugobasile.com
www.ugobasile.com

instruction manual

ISOMETRIC TRANSDUCER
Cat. No. 7003-7004-7005-7010

Serial No.

Instruction Manual
Revision 1

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Isometric Transducers

Cat. No. 7003 / 7004 / 7005 & 7010

General

The three models 7003-7004-7005 cover the range from 0 to 50 g (see table on the facing page). The high sensitivity 7010 is designed for the mg range.

The force exerted on a hollow carbon fibre beam is converted into proportional electric signal via strain-gauges, conveniently wired in Wheatstone bridge circuit.

Model Selection

Ugo Basile transducers are of robust construction and can withstand forces of up to 5-10 times the rated value.

It is possible to use 7003 which is generally used for trachea rings or artery strips, where forces of 5-10 grams are involved, by operating at minimum amplifier sensitivity; however, the cantilever will deflect with a load of the mentioned magnitude

Generally speaking, it is advisable to use a stiff transducer, operating at high amplifier sensitivity, and use the most sensitive transducer only when

The picture shows an **Isometric** Transducer (right) & an **Isotonic** Transducer (left), see separate datasheet

Also available from Ugo Basile:

- Tissue Baths, 1, 2, 4-chambers
- Digital Recorder DataCapsule-*Evo*
- Electrodes & Stimulators

Main Features

- Ugo Basile transducers have been designed for precise measurement of force in muscular preparations under isometric conditions
- An Isometric Transducer measures changes in force at constant length whereas an Isotonic Transducer is basically a displacement meter under constant load

ugo basile TRANSFORMING IDEAS INTO INSTRUMENTS	**CHECK-LIST** ☐ **CAT. 7003 ISOMETRIC FORCE TRANSDUCER DY1** ☐ **CAT. 7004 ISOMETRIC FORCE TRANSDUCER DY2** ☐ **CAT. 7005 ISOMETRIC FORCE TRANSDUCER DY3** ☐ **CAT. 7010 HIGH SENSITIVITY TRANSDUCER DY0**

CLIENTE / CUSTOMER____

No. Ordine / Order No. ___________________ Data / Date____/_____/______

UB code	*Cat.No.*	*√*	*Q.ty*	*DESCRIPTION*
			1	INSTRUCTION MANUAL
E-PC 021	A		CONNECTOR	UB (ECTA)
E-PR 001	B			UB (RTG18)
E-PC 037	C			DIN 8
E-PC 022	D			GRASS
E-PC 037	E			DIN 8 (for DataCapsule 17400)
E-PC 037	F			DIN 8 (for DataCapsule 17304)
E-PC 037	G			DIN 8 (for DataCapsule 17308)

DATE / /	Serial No.	PREPARATO DA / PACKED BY

IMPORTANT/IMPORTANTE:	
Check the shipment for completeness immediately after receipt: should you find any discrepancy, please fill in the following part and transmit it to our fax No. +39 0332 745488 Al ricevimento della merce controllate che la spedizione sia completa: in caso di discrepanza, completate il formulario di seguito riportato ed inviatelo al nostro fax No. 0332 745488	
FROM: Name	Company/Institution
DATE	REF.
NOTES	

MOD.04 REV 0

C O N T E N T S

ISOMETRIC FORCE TRANSDUCER

Cat. 7 0 0 3 / 7 0 0 4 / 7 0 0 5 / 7 0 1 0

1 GENERAL

These Transducers have been designed for precise measurement of force in muscular preparations under isometric conditions.

Force exerted on a cantilever (see picture) is converted into proportional electric signal via two bonded strain-gauges conveniently wired in a Wheatstone bridge circuit.

The three models Cat. No. 7003, 7004, 7005 cover the range from 0 to 50 gram; the high sensitivity model Cat. No. 7010 is designed for the mg range. See also paragraph 1.2- Model Specifications.

The cantilever deflects very slightly assuring almost ideal isometric conditions, plus low hysteresis and non-linearity error.

It is fabricated from thin wall titanium tubing, arranged in a lattice work which ensures stiffness and low inertia. The joints are tied with metallic wire and then locked with epoxy resin.

The titanium lattice work is practically corrosion proof and consequently withstands the daily contact with salty solutions which is unavoidable in the isolated organ work and which, in the long run, would destroy aluminium structures; stainless steel (see APPENDIX) has been excluded because of its higher specific gravity and consequent high momentum of inertia.

The lattice work is mated to a steel plate on which the strain-gauges are attached.

1.1 Compatibility

Our Isometric Transducers are normally supplied with a connector designed for UGO BASILE Unirecord 7050 or Gemini 7070.

If the customer wishes to make use of other recording apparatus, the transducers can be provided to order, together with advice on appropriate wiring alterations to make the transducer compatible with the customer's existing equipment.

IMPORTANT NOTE:

The grey plastic connector mounted on our Transducers manufactured before 1990 (RTG 18 of Cannon) has been replaced by a cylindrical all metal model of ECTA.

Before ordering, check carefully the connection compatibility of your amplifier/recording system. Adaptors are available. Ask for details.

1.2 Model Specifications

Model	7010	7003	7004	7005
Mechanical				
Force Range	**0-800 mg**	**0-2 g**	**0-10 g**	**0-50 g**
Overload Rating	5 g	20 g	50 g	200 g
Momentum of Inertia	7.5 gcm²	12.5 gcm²	17.5 gcm²	22.5 gcm²
Lever Arm Displacement	0.5 mm/g	0.3 mm/g	0.1 mm/g	0.06 mm/g
Resonant Frequency	80 Hz	115 Hz	150 Hz	200 Hz
Electrical				
Excitation Voltage (max.)	6V	6V	6V	6V
Excitation Voltage (typical)	3V	3V	3V	3V
Current Drain (typical)	18mA	18mA	18mA	18mA
Bridge Resistance (nominal)	120 Ω	120 Ω	120 Ω	120 Ω
Sensitivity (µV per g per V)	110	70	25	10
Non Linearity & Hysteresis	± 3.5%	± 3%	± 2%	± 1.5%
Physical				
Weight	200 g	200 g	200 g	200 g
Shipping Weight	900 g	900 g	900 g	900 g

1.3 Model Selection

In routine tests, 7004 or 7005 transducers will normally be sufficiently sensitive. We suggest using 7003, the most sensitive transducer, to detect the minimum quantity of active substance, when experiments are to be carried out on relatively insensitive organs or when forces exerted are very small, e.g., in the case of artery strips.

The High sensitivity transducer 7010 is available when smaller forces are involved.

The outer ring of the lattice lever arm provides approx. twice the sensitivity of the inner ring which enables the optimum sensitivity/isometry ratio to be selected, since the organ can be linked to either ring.

The transducers are of robust construction and can withstand forces of up to 10 times the rated value. It is possible to use 7003 which is generally used for trachea rings or artery strips, where forces of 1-2 grams are involved, by operating at minimum amplifier sensitivity.

However the cantilever will deflect with a load of this magnitude. Generally speaking, it is advisable to use a stiff transducer, operating at high amplifier sensitivity, and use the most sensitive transducer only when the forces involved are very small.

2 UNPACKING & PRELIMINARY CHECK

Check the contents of the shipment for completeness, packing list to hand, and visually inspect the instrument as soon you take it out of the packaging. Use the ***Check List*** supplied.

Inspect the instrument for damage such as scratches, broken or loose parts.

If the instrument is damaged or, after having tested it, fails to meet rated performances, notify the carrier and our company immediately.

Protect the environment!

Dispose of packaging properly, according to existing and applicable waste management rules and regulations.

2.1 Notes on the Instruction Manual

The Instruction Manual included in the package is necessary for the correct installation and operation of the instrument.

We recommend keeping the manual in good condition, ready to be consulted by the qualified personnel who operate the instrument.

Free of charge copies of the instruction manual are available upon request: please contact our service department (see paragraph 3.4-Customer Support) specifying the series number of your instrument.

3 MAINTENANCE

3.1 Cleaning

The instruments require practically no maintenance. For cleaning, avoid the use of chemical agents which may damage the transducer cover.

Loose dust may be removed with a soft cloth or a dry brush. Cotton wool and a mild detergent can be used.

The hinged cover (**6**) enables the operator to have the cantilever well clear when linking the organ hread and to protect it from accidental knocks when the transducer is in operatin or stored.

The hinge /7) is quite a solid component, despite its small size and is fastened to the aluminium casing by rivets. This substantial joint generally withstands even strong side knocks to the cover but obviously should not be challenged by rough handling.

3.2 Long Inactivity

The instrument does not require any particular maintenance after long inactivity, except cleaning.

3.3 Troubleshooting

In case of malfunction of the system transducer/amplifier/recorder, check first the control settings of the “channel”. Incorrect control setting can indicate a trouble that does not exist.

Then check the excitation source and make sure the colour coded leads are correctly wired to the appropriate connector pins.

If the visual check does not reveal something grossly evident as the cantilever jammed or broken, the fault may be located on the circuit which is very simple and does not contain active components.

Check, by a conventional “tester”, that the resistance of the full bridge is approx. 120 Ohm, via the output leads /clear-blue).

A fault can be caused by a damaged or defective trimmer, unsoldered connection, etc. and will generally appear as an “open” or “short” circuit.

Erratic operation and in particular base line drift and/or marked hysteresis after transient load, may be caused by a defective or detached strain-gauge element.

In case of electronic fault, the Transducers should be returned to factory for repair, see paragraph 3.4-Customer Support sotto.

3.4 Customer Support

For any further information you may desire concerning the use and/or maintenance on our transducers, please do not hesitate to get in touch with our local distributor or with our **service department** at:-

UGO BASILE
Viale G. Borghi 43
21025 COMERIO – Varese, ITALY

Phone : +39 0332 744574

Fax : +39 0332 745488

e-mail : service@ugobasile.com

Before sending any instrument to our factory for repair, we recommend you to get in touch with our service department to obtain a return authorization number (R.A.N.) and shipping/packing instructions.

We may not be held responsible for damages during transport due to poor packing. Whenever possible, please use the original packing.

4 ORDERING INFORMATION

7003 **Isometric Force Transducer, type DY1** (** see note below*)

7004 **Isometric Force Transducer, type DY2** (** see note below*)

7005 **Isometric Force Transducer, type DY3** (** see note below*)

NOTE:

Transducers can be fitted with the following connector; please specify it by adding the correspondent letter to the catalogue number:-

-A ECTA connector (round metal) to Basile Recorders

-B RTG connector (rectangular plastic) to Basile Recorders

-C connector to MacLab or PowerLab

-D connector for MacLab or PowerLab (Grass)

5 BIBLIOGRAPHY

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5.2 High Sensitivity Transducer 7010

- G.P. Sgaragli et alia: **"Calcium Antagonist and Antiperoxidant Properties of Some Hindered Phenols"** Br. J. Pharmacol. 110: 369-377, **1993**

- P. Dorigo et alia: **"Comparison Between the Cardiac Effects Induced by Muzolimine and Fusemide in Guinea-pig Atria"** Cardiovascular Drugs & Therap. Vol. 4, No. 6: 1477-1485, **1990**

- G. Fassina et alia: **"A Caffeine Analogue (1,3,7-trimethyl-6-thioxo-2-oxopurine) with a Negative Inotropic and Chronotropic Effect"** Naunyn-Schmiedeberg's Archives of Pharmacol. Vol. 330, No. 3: 222-226, **1985**

6 APPENDIX

CANTILEVER DESIGN

The design of the cantilever presents several notable dimensioning problems; the lattice work/steel plate arrangement has been selected (see GENERAL) as a good combination of an elastic element (a thin steel plate) and a stiff one (the lattice Ti tubing structure) of low momentum of inertia.

Near the fixed end (4), where the bending moment M_f is maximum, two strain gauges (5) are attached which transform the plate strain, via a Wheatstone bridge, into a voltage ΔV.

The bending moment at the joint is:-

$$M_f = F \cdot L \tag{1}$$

Where $L = l + \frac{u}{2}$ (see Fig.1)

and the consequent strain:-

$$\varepsilon = \frac{M_f}{WE} = \frac{FL}{WE} \tag{2}$$

where E is the modulus of elasticity and W the section modulus.

Being

$$\frac{\Delta R}{R} = K\varepsilon \tag{3}$$

where K is the gauge factor, the bridge output voltage (2 strain-gauge, constant voltage) is approx.

$$\Delta V = \frac{V_B}{2} \frac{\Delta R}{R} \tag{4}$$

It follows that the sensitivity of the system

$$S = \frac{\Delta V}{F} = \frac{V_B KL}{2WE} \tag{5}$$

is function of both electrical and mechanical parameters. On what concerns the excitation voltage V_B, this is limited by the corresponding I_{max} which can flow through the strain gauges without damaging them, according to the expression:-

$$V_B < 2I_{max}R \tag{6}$$

Resonant Frequency

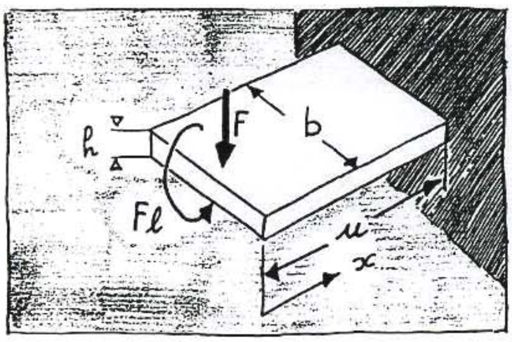
At first glance, it seems very easy to raise the sensitivity of the transducer by increasing L and decreasing W. However the cantilever resonant frequency:-

$$f = \frac{1}{2\pi}\sqrt{\frac{k_{\phi}}{J}} \qquad (7)$$

where k_{ϕ} is the angular stiffness coeff. at the joint, function of the plate shape - see (17) - and J the momentum of inertia, shows that the attempt to decrease W antagonizes the need to keep k_{ϕ} large as it is desirable to mazimize the resonant frequency. In the same way a large L and a small J are obviously conflicting requirements.

Plate Stiffness

Let us calculate the stiffness of the plate which forms the system elastic element



The equation of the elastic line is:-

$$\frac{d^2y}{dx^2} = - \frac{F(l + x)}{\frac{1}{2}\,hEW} \qquad (8)$$

where $$W = bh^2/6 \qquad (9)$$

By integrating two times:-

$$\frac{dy}{dx} = - \frac{F}{\frac{1}{2}hEW}\left[(l + \tfrac{1}{2}x)x + C_1\right] \qquad (10)$$

$$Y = \frac{F}{\frac{1}{2}hEW}\left[(1 + \frac{x}{3})\frac{x^2}{2} + C_1 x + C_2\right] \quad (11)$$

where the constants C_1 and C_2, being y = dy/dx = 0 at the joint,

$$C_1 = -(1 + \frac{1}{2}u)u \quad (12)$$

$$C_2 = (\frac{1}{2} + \frac{u}{3})u^2 \quad (13)$$

Rotation and displacement at the plate free end are therefore:-

$$\phi_0 = (\frac{dy}{dx})_0 = \frac{F}{\frac{1}{2}hEW}(1 + \frac{1}{2}u)u \quad (14)$$

$$Y_0 = -\frac{F}{\frac{1}{2}hEW}(\frac{1}{2} + \frac{u}{3})u^2 \quad (15)$$

The rigid lattice framework rotates of angle ϕ_0 around a point of abscissa:-

$$x_0 = -\frac{Y_0}{\phi_0} = \frac{\frac{1}{2} + \frac{u}{31}}{1 + \frac{u}{21}}u \quad (16)$$

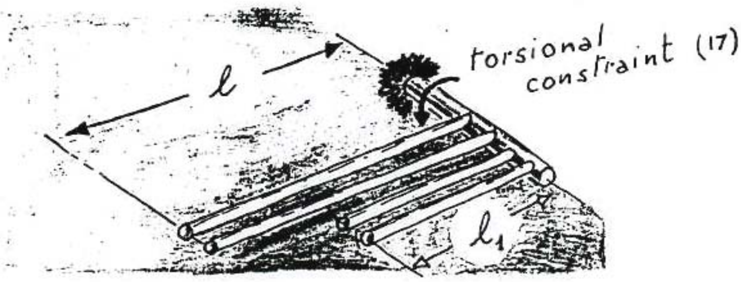
Being u/1 very small, we can consider $x_0 = \frac{1}{2}u$, which is equivalent to imagine the rigid lattice framework hinged at the centre of the plate and constrained by a torsion bar of rotational stiffness:-

$$K_\phi = \frac{F(1 + \frac{1}{2}u)}{\phi_0} = \frac{\frac{1}{2}EWh}{u} \quad (17)$$

<u>Momentum of Inertia</u>

The lattice framework can be visualized, for the approx. evaluation of

J, as made by four tube stretches, see transducer picture and sketch below,



two of which of length l and two of length $l_1 = \alpha l$, being $\alpha = 0.65$ the ratio between organ hook distances from the plate centre.

If m is the mass per length unit of the tubes, it follows that:-

$$J = \frac{2}{3} ml^3(1 + \alpha^3) = 0.85\ ml^3 \qquad (18)$$

We can reasonably assume:-

$$J = mL^3 \qquad (19)$$

taking into account the extra mass of hooks, epoxy resin, etc.

Being γ the tube specific gravity, D_0 the outer and D_i the tube inner diameter,

$$m = \frac{\gamma}{g}\pi \frac{D_0^2 - D_i^2}{4} \qquad (20)$$

Having discarded aluminium (see GENERAL) as it is likely to get easily corroded by the salty solutions, having calculated J from the (20) & (19), it follows from the (7) that the use of Ti enables to reduce the weight in the ratio 4.5/7.8 respect to steel and hence to increase the resonant frequency by 32%.

Plate Optimization

From (5) & (9), sensitivity can be denoted as:-

$$S = 3\frac{V_B KL}{Ebh^2} = A\frac{L}{bh^2} \qquad (21)$$

where, assuming V_b = 2V, K = 2, E = 2.1 · 10^9 g/cm^2,

$$A = 0.571 \cdot 10^{-3} \tag{22}$$

while, from (7), (9) and (17) the resonant frequency can be denoted as:-

$$f = \frac{1}{2\pi}\sqrt{\frac{Ebh^3}{12umL^3}} = B\sqrt{\frac{bh^3}{uL^3}} \tag{23}$$

where, for model 7005, B = 0.584 · 10^6 (0.67·10^6 for 7004, 0.78·10^6 for 7003)
To visualize the influence of small changes of L, b, h and u, let us calculate the natural logarithms of S and f :-

$$\log S = \log A + \log L - \log b - 2\log h \tag{24}$$

$$\log f = \log B + \frac{1}{2}\log b + \frac{3}{2}\log h - \frac{1}{2}\log u - \frac{3}{2}\log L \tag{25}$$

Differentiating the above expressions:-

$$\frac{dS}{S} = \frac{dL}{L} - \frac{db}{b} - 2\frac{dh}{h} \tag{26}$$

$$\frac{df}{f} = \frac{1}{2}\frac{db}{b} + \frac{3}{2}\frac{dh}{h} - \frac{1}{2}\frac{du}{u} - \frac{3}{2}\frac{dL}{L} \tag{27}$$

Considering dS, dL, db, dh, df, du small but not infinitesimal, we realize that:-

a 10% rise of L brings about {10% rise of sensitivity; 15% reduction of res. frequency

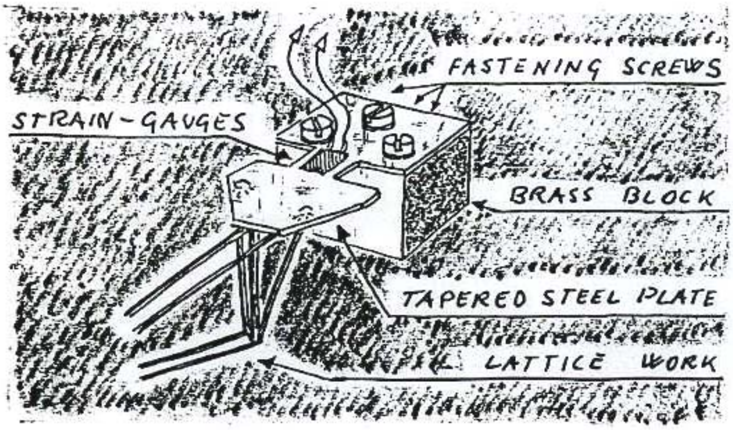
a 10% reduction of b brings about {10% rise of sensitivity; 5% reduction of res. frequency

a 10% reduction of h brings about {20% rise of sensitivity; 15% reduction of res. frequency

a reduction of u does not alter the sensitivity but increases the resonant frequency by 5%.

It is therefore convenient to reduce u and b to the minimum value compatible with the physical dimensions of the strain-gauges and at the same time to increase conveniently h.

To sum up, the plate should not be larger than the strain-gauge itself, which measures 0.3 x 0.4 cm. As this would involve a practical manufacturing impossibility, since the plate must be fastened to the transducer case and mated to the lattice lever arm, a good compromise has been attained by tapering a plate of more substantial size, according to the sketch below.



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CE CONFORMITY STATEMENT

Manufacturer	**UGO BASILE srl**
Address	Via G. di Vittorio, 2 – 21036 Gemonio, VA, ITALY
Phone n.	+39 0332 744574
Fax n.	+39 0332 745488

We hereby declare that

Instrument.	**ISOMETRIC FORCE TRANSDUCER**
Catalog number	**7003, 7004, 7005, 7010**

is manufactured in compliance with the following European Union Directives and relevant harmonized standards

- *2011/65/UE and 2015/863/UE on the restriction of the use of certain hazardous substances in electrical and electronic equipment*

Account *Manager* Mauro Uboldi

Nome / *Name*

October 2018

Date

Firma / *Signature*

MOD. 13 Rev. 0