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TRANSFORMING IDEAS INTO INSTRUMENTS

# instruction manual

## ISOTONIC TRANSDUCER
## Cat. No. 7006


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# instruction manual

## ISOTONIC TRANSDUCER
## Cat. No. 7006

**Serial No.**

Instruction Manual
Revision 1

# Isotonic Transducer

Cat. No. 7006

## General

The 7006 Isotonic Transducer basically consists of a carbonfibre lever arm which pivots on the shaft of a Hall-effect rotary motion transducer of original design.

The arm is balanced by an adjustable counter-weight of tungsten alloy.

**It is possible to carry out experiments on extremely small muscle fibres**, which can be held under a tension of as little as 100-200 mg so that minimal force and consequent displacement alterations can be recorded.

The lever arm balancing is provided by a tungsten alloy counterweight which can be shifted by turning its knurled section.

This load is monitored by the counterweight rim moving along a scale calibrated in grams.

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

## Also available from Ugo Basile:

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

## Main Features

- Ugo Basile Isotonic Transducer is specially designed for investigating isotonic contractions in isolated organs, particularly smooth muscle, amphibian hearts, etc.
- An Isotonic Transducer is basically a displacement meter under constant load, whereas an Isometric transducer measures changes in force at constant length

UGO BASILE S.R.L.

*BIOLOGICAL RESEARCH APPARATUS*

# CHECK-LIST

☐ **CAT. 7006 ISOTONIC TRANSDUCER**

CLIENTE / CUSTOMER________________________________________

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

| *UB code* | *Cat.No.* | √ | *Q.ty* | *DESCRIPTION* | | *DESCRIZIONE* | |
|---|---|---|---|---|---|---|---|
| | | | 1 | INSTRUCTION MANUAL | | MANUALE DI ISTRUZIONE | |
| | 7006 | | 1 | TRANSDUCER | | TRASDUTTORE | |
| E-PC 021 | -A | | CONNECTOR | | UB (ECTA) | CONNETTORE | UB (ECTA) |
| E-PR 001 | -B | | | | UB (RTG18) | | UB (RTG18) |
| E-PC 037 | -C | | | | DIN 8 | | DIN 8 |
| E-PC 022 | -D | | | | GRASS | | GRASS |
| E-PC 037 | -E | | | | DIN 8 (per DataCapsule) | | DIN 8 (for DataCapsule) |
| E-PC 038 | -CWE | | | | DIN 8 (per DataCapsule) | | DIN 8 (for DataCapsule) |
| WITHOUT CONNECTOR | | | | | | | |
| CU2 | | | 1 | HEX. (ALLEN) WRENCH | | CHIAVE A BRUGOLA | |

| 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<br>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 | |

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# ISOTONIC TRANSDUCER

Cat. 7 0 0 6

## 1.0 INSTRUMENT DESCRIPTION

### 1.1 General

This new Hall effect transducer, which offers performances far superior to isotonic transducers based on different principles of operation, is specially designed for investigating isotonic contractions in isolated organs, particularly smooth muscle, amphibian hearts, etc.

It is basically a displacement meter under constant load, whereas an isometric transducer measures changes in force at constant length.

The tapered tube of carbon fibre (10) (see picture and figure 1) may recall the lever arm of the UGO BASILE isometric transducers. However, instead of being mounted on a steel plate to which the strain gauges are attached, the lever arm pivots on the shaft of a Hall effect motion transducer of original design.

The shaft turns on high quality ball bearings, which fit a precision seat, machined into a thick aluminum flange (3).

The rotation of a "magnetic frame" fastened to the shaft induces a flux variation across a semiconductor Hall plate, producing a voltage output proportional to the extent of rotation and hence to the organ preparation displacement, see sketch and more details on APPENDIX 8.1.

### 1.2 The Rotating Assembly

This assembly features a very low starting torque: when the lever arm is balanced, a mere 10 mg weight attached to the tip ring is sufficient to cause the transducer shaft to rotate.

It is therefore possible to carry out experiments on extremely small muscle fibres, which can be held under a tension of 100-200 mg only.

The carbon tube, beside assuring stiffness and low inertia, is corrosion proof and consequently withstands the daily contact with salty solutions, which is unavoidable in the isolated organ work.

The lever arm assembly (9-10) is provided with a travel limit set-up (14-15) to maintain the angular displacement to +/- 15 degrees.

A lateral Perspex plate (1) prevents the carbon tube from deflecting outside its elastic deformation limits if accidentally knocked.

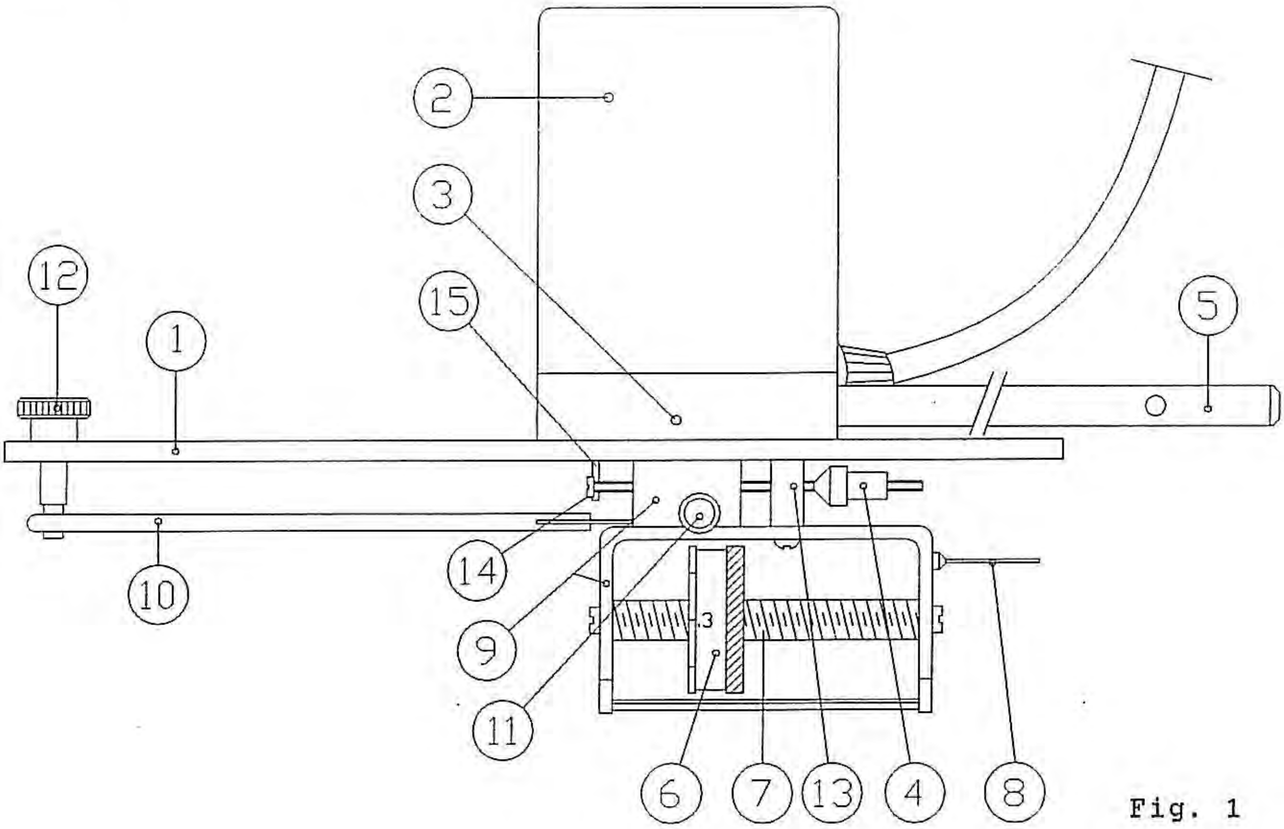



Fig. 1

## 1.3 Minimum Inertia Arrangement

The lever arm loading is provided by a cylindrical tungsten alloy counterweight which can be rotated by hand via its knurled section.

Rotation causes the counterweight to shift along its threaded shaft, thereby varying the "load" on the organ attached to the outer ring of the lever arm.

The load is monitored by the counterweight rim moving along a scale calibrated in grams. One scale division corresponds to 0.5 grams and is covered by one revolution of the counterweight. Intermediate load values can be accurately preset by aligning the counterweight rim marks with the upper edge of the scale, providing load variations in 0.1 g steps.

The counterweight is designed and mounted to enable the operation of the transducer with a substantial mass very close to the fulcrum, thus minimizing the inertia which - according to the laws of mechanics - increases with the square of the radius of gyration from the fulcrum.

**Minimum inertia means that the lever arm follows the organ displacement with negligible delay.**

Smaller counterweights attached to longer lever arms, as generally used in conventional isotonic lever arrangements, provide convenient balance in static conditions but only mediocre dynamic response when rapid contractions take place.

More details and sketch on APPENDIX 8.2.

# 2.0 OPERATION

## 2.1 Assembling, Positioning, Connecting the Transducer

Assemble the transducer supporting rod (5) and tighten it by levering the Allen wrench stem into the rod side hole. The same Allen wrench will help you to remove the lock screw (13) and its spacer, provided to protect the mechanism during transport.

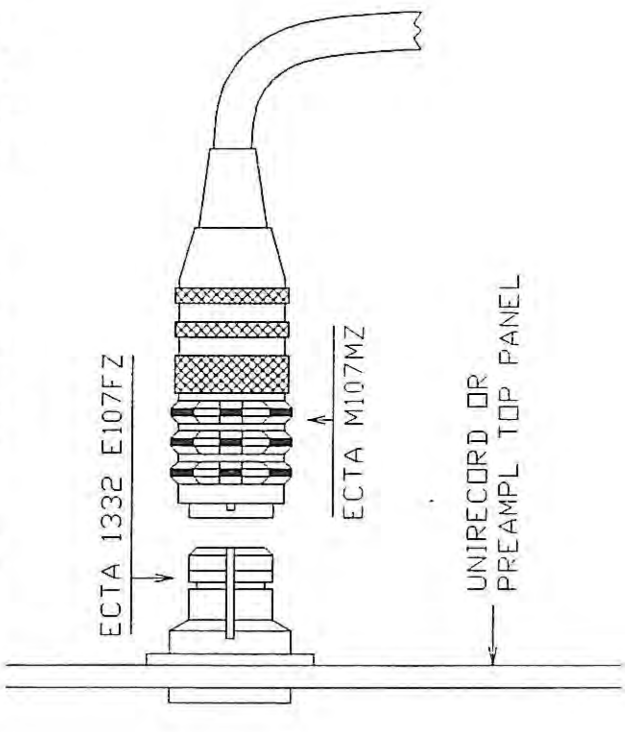
Clamp the transducer to a laboratory stand and slacken the plastic thumb screw (12) fitted to the Perspex plate (1) to hold the lever arm in horizontal position.

The isotonic transducers we supply, unless otherwise indicated by the customer, are provided with standard ECTA 1332 M107MZ 7-pin male connectors for direct coupling to the Unirecord 7050, Gemini 7070 or Quartet 9400.

To engage the transducer connector, rotate it until the bayonet fits into the groove of ECTA 1332 E107FZ (female connector) and apply pressure on its knurled nickel plated body until full insertion.

Then push in the black ring until it snaps into locked position.

To disengage the connector, first unlock the black ring: it



snaps easily out by a combined pull on it and push on the connector body. Use forefinger and thumb of both hands.

Then hold the connector (not the ring!) and gently pull until separation.

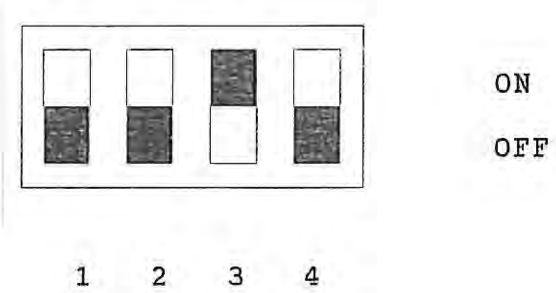
Connect the transducer to the recorder. Allow the whole system at least 15 minutes warm-up time to stabilize the electronic components.

Then make sure that the recording/displaying apparatus is properly zeroed and calibrated. See 3.0.

## 2.2 7006 Compatibility

2.2.1 When the Isotonic Transducer is connected to a Basile recorder (7050, 7070 or 9400), the dip-switch block located on the preamplifier should be set as indicated in the following sketch:

Dip-switches




2.2.2 When the Isotonic Transducer is connected to an amplifier/recording system of other makes, provide an excitation voltage between 6 and 15 Volts D.C.

## 2.3 Loading the Organ

Set a convenient base line. Start the experiment with the lever arm held in horizontal position by the thumb screw 12.

<u>Set the force acting on the preparation</u> (tone) by shifting the transducer counterweight according to the indications of the literature and your personal experience on that particular preparation. See 7.0 BIBLIOGRAPHY.

One turn of the counterweight increases the force of 0.5 grams; each division marked on the counterweight rim corresponds to 0.1

grams. Gram and half-gram marks are neatly engraved on the transducer scale. See 1.3.

The counterweight shift feature enables the operator to load the organ up to 15 grams. A hook (8) is provided on the counterweight bracket, in case higher loads are necessary in particular experiments.

It should be noted that there is a 1:2 ratio between the hook and the organ ring distance from the fulcrum. A 20 gram weight attached to the hook will therefore increase the load on the organ by 10 grams over the load monitored on the scale, if any.

Free the lever arm, by releasing the thumb screw 12.

It is convenient to wait at least 10-20 minutes before starting the experiment, to operate on a "stabilized" organ, thus avoiding the natural organ release under load to combine with the response to chemical/electrical stimulation.

Once this time has elapsed, replace the horizontal position of the lever arm by shifting the transducer along its upright (ideally via a rack-work boss-head) and balance the recorder.

See 3.1 & 3.2 on the instruction manual of Unirecord 7050 or on the instruction manual of the Preamplifiers 7080/9080 and 7082/9082 in case you are working with U.B. Recorders Gemini 7070 or Quartet 9400.

## 3.0 CALIBRATION

The term "calibration" can be misleading when you have to hand a transducer with something moving on a graduated scale, not to speak of the preamplifier controls.

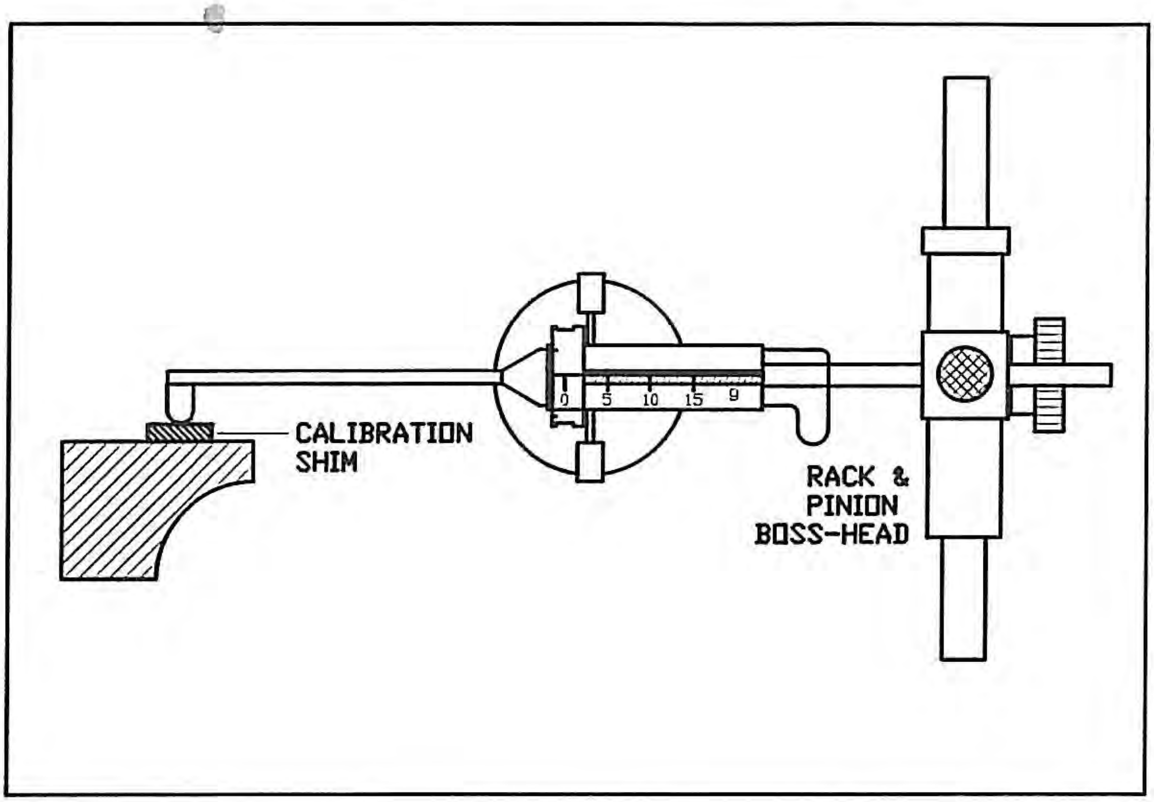
Consider that we are dealing with a <u>displacement transducer</u>: forget the "load setting" (see 2.3, 1st paragr.) for the moment.

To calibrate the isotonic transducer means to put in figures the linear correspondence between the shift of the recording stylus and the preparation displacement in a given experiment.

In simpler words, once you have "calibrated" the transducer, you know how much the organ has contracted (or released) when the stylus has shifted from the base line the amplitude you "read" on the chart, say, 3 cm.

TO CALIBRATE OPERATE AS FOLLOWS:-

3.1 The most practical way is to adjust the counterweight "below zero", i.e., shifting it leftwards to its travel limit and <u>rest</u> the tip ring on any supporting structure onto which you have placed a metal or plastic calibration shim, whose thickness, say, 2 mm (0.2 cm), you have checked with a caliper, see sketch below.




Reposition the stylus on the base line via the balance or the zero suppression knob (see 7050 or 70/9082 instruction manuals).

Remove the calibration shim. The stylus will shift, say, 3.8 cm.

Adjust the sensitivity (see paragraph 3.1) to bring the stylus on the 4 cm. The calibration factor is therefore 0.2/4 = 2/40 = 1/20.

A spike of, say, 9 cm will consequently indicate that your organ has contracted 9 x 1/20 = 9/20 = 0.45 cm (4.5 mm).

In case the Isotonic Transducer 7006 works in conjunction with a UNIRECORD 7050, a GEMINI 7070 or a QUARTET 9400, our recorders can "memorize" the calibration standard you have just determined (again, see 7050 or 70/9082 manuals).

This standard can be recalled and shown as stylus displacement <u>at any sensitivity</u>, for an immediate comparison with the displacement caused by the working preparation.

3.2 In case the transducer is mounted on a rack & pinion boss-head, provided with vernier, load the transducer 1-2 grams, to keep the thread taut, then fasten the thread end to the table surface, the rim of the organ bath or the like with putty or adhesive tape, so as to keep the lever arm approximately horizontal.

Reposition the stylus on the base line.

Shift the transducer up or down, for instance 5 mm. The stylus will shift from the base line, say, 5.3 cm. Adjust the sensitivity to obtain a round figure, which makes the computing easier. In our case, slightly decrease it to bring the stylus to the 5.0 mark on the chart.

At this point, the job is done! A 4 cm hump (or valley) in the recording pattern indicates your preparation has contracted (or released) 4 mm.

## 4.0 MAINTENANCE

### 4.1 Cleaning

Avoid the use of chemical cleaning agents which may damage Perspex parts; avoid chemicals containing benzene, toluene, xylene, acetone or similar solvents.

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

Do not lubricate the counterweight threaded shaft (7) which is designed to operate dry. In case the counterweight "sticks", apply 2-3 drops of petrol on the shaft, then shift the counterweight back and forth along its range for 2-3 times.

### 4.2 Troubleshooting

In case of malfunction of the system transducer/amplifier/recorder, check first the control setting of the "channel"; incorrect control setting can indicate a fault that does not exist.

In case the Isotonic Transducer is wired to amplifier/recording systems of other makes, check the excitation voltage and make sure the colour coded leads are correctly wired to the appropriate connector pins.

Bear in mind that highly professional engineering advice is mandatory for matching successfully transducers and recorders of different makes. Compatibility is hard to assess at first sight: a number of factors come into play and interact: impedance, excitation voltage, electromagnetic interferences, shielding, noise, ground loops, etc.

If the visual check does not reveal something grossly evident as the lever arm assembly being jammed or its shaft bent, the fault may be located in the circuit.

All its active and passive components are of professional quality and operate well within their rated limits. A fault is a very remote but not impossible event; human factor is involved in assembling and testing, not to speak of the transport which challenges even very compact and solid structures.

In case of electronic fault, the transducer should be returned to the factory for repair.

N.B. In no case it is advisable to open the transducer case (2) to attempt a repair. Besides the probable lack of appropriate spare parts, even the most skilled technician cannot carry out a professional job if not provided with precision jigs and balancing devices, suitable electronic instrumentation, etc., not to speak of a dust-free chamber on which all the handling should be carried out to avoid an immediate and marked deterioration of ball bearing smoothness.

## 4.3 Emergency Fixing

(Repairing & rebalancing the movable assembly)

The transducer movable part (lever arm assembly, shaft and magnetic rotor) is factory trimmed to compensate the unavoidable small individual weight distribution differences.

By shifting two small threaded counterweights (11-4), the center of mass of the system is brought to coincide with its fulcrum, thus providing lever arm balancing at any angle within its travel limits.

The trimming counterweights are then locked into position by a drop of varnish.

In case of an accidental fall or knock which may crack or break the carbon beam and/or distort the bracket supporting the loading counterweight (6), provided that the shaft of the transducer is not bent, a "home made" repair of the system can be successfully carried out, using epoxy resin, etc.

From the aesthetic angle the result may not be impeccable, but the transducer can work again, after the movable part has been rebalanced.

To accomplish this, shift the horizontal counterweight (4) first, left or right, until the lever arm rests horizontally. Then move the vertical counterweight (11) up or down until the lever rests at any angle without moving.

A high center of mass will cause the lver arm to "fall" left and rightwards, whilst a low center of mass will cause the lever arm to be "too stable" in the horizontal position.

A couple of retouching adjustments and a bit of patience will lead to a passable result, at least until the whole can be factory repaired and rechecked with appropriate instrumentation.

## 5.0 ORDERING INFORMATION

7006 Isotonic Transducer

7001 Transducer Handle (5, see fig. 1)
7002 Plastic Thumb Screw (12)
7013 Lever Arm Assembly

7011 D.C. Power Supply for connecting the 7006 to ampl./recording systems where excitation voltage is not available at the input connector

### 5.1 Adaptors

9123 For linking transducers manufactured before 1990 to recorders manufactured after

9124 For linking transducers manufactured after 1990 to recorders manufactured before

## 6.0 TRANSDUCER SPECIFICATIONS

### 6.1 Physical

Overall Dimensions : 16.5 x 5.5 x 11 cm
excl. removable handle

| | | |
|---|---|---|
| Weight | : | 0.35 Kg |
| Shipping Weight | : | 1.60 Kg |

## 6.2 Mechanical

| | | |
|---|---|---|
| Counterweight | : | W alloy, 50 g |
| Threaded Shaft | : | Al alloy, M6, 1 mm pitch |
| Lever Arm Length (pivot-tip ring) | : | 10 cm |
| Lever Arm Travel | : | 6 cm |
| Operating Range | : | +/-15° about the centre (zero) |
| Momentum of Inertia | : | 35 $gcm^2$ |
| Breakaway Torque | : | less than 0.1 gcm |

## 6.3 Electrical

| | | |
|---|---|---|
| Voltage Output | : | 300 uV per mm displacement of the lever arm tip |
| Linearity | : | +/-2% to +/-15 degree rotation |
| Excitation Voltage | : | 6 ÷ 15 Volt |
| Excitation Current | : | 20 mA (constant in the range 6 ÷ 15 V) |

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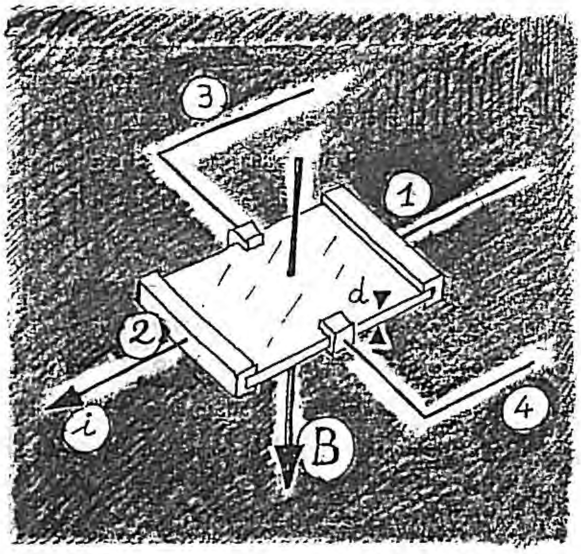
# 8.0 APPENDIX

## 8.1 The Hall Effect Circuit

The Hall effect plates are electrical components based on the effect discovered in 1897 by the American physicist Edwin H. Hall.




Main features of a Hall effect plate

A current $i_{1-2}$ (control current) flows lengthwise through an oblong plate of suitable material, in our case InAs since the effect is much larger in semiconductors than in metals.

d is the plate thickness and B a magnetic field (control field) perpendicular to its plane.

When the above control quantities are simultaneously applied, a potential difference (open circuit Hall voltage $V_H$) develops between the points 3 and 4, its magnitude being given by:-

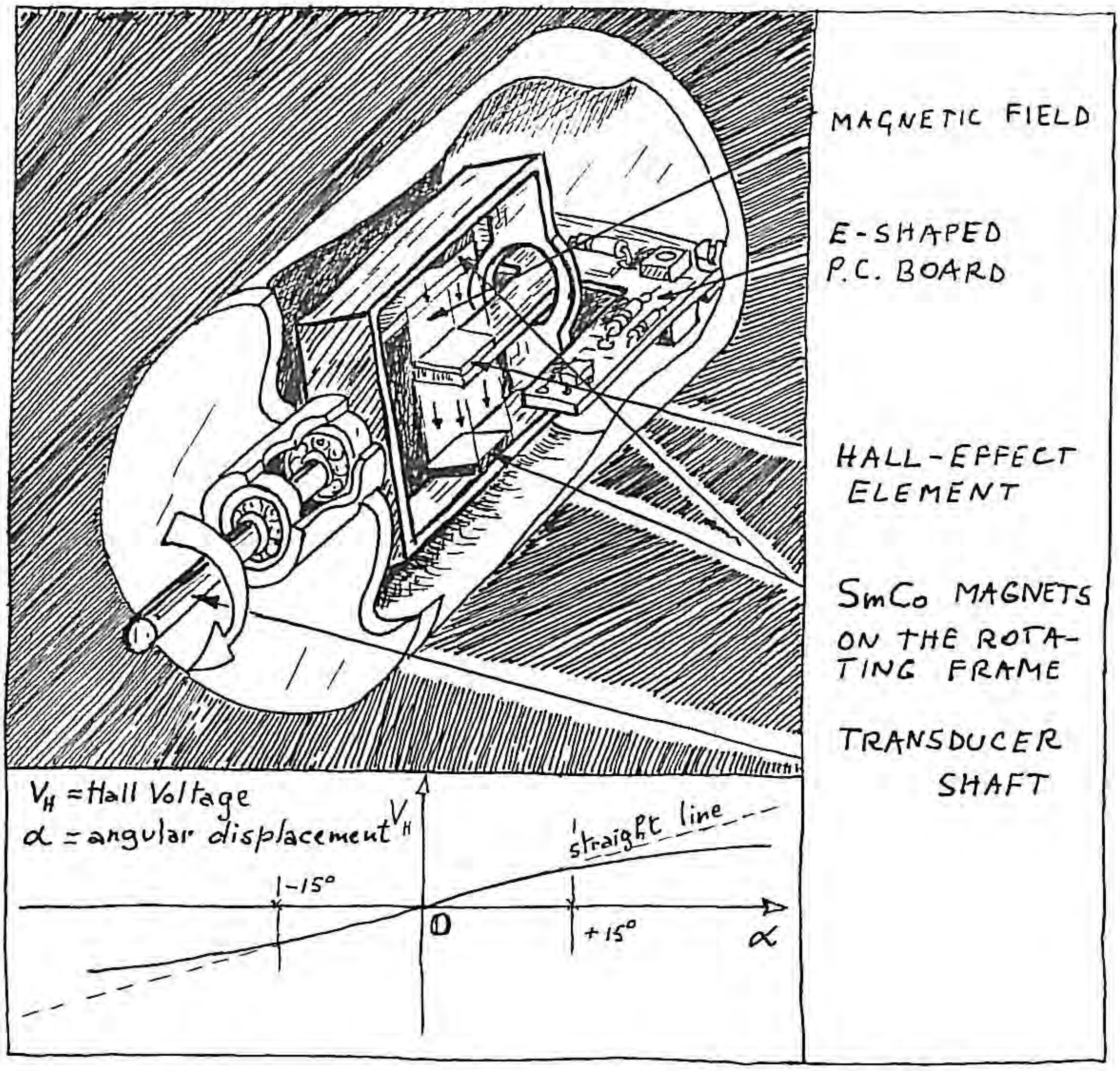
$R_h$ is material constant (Hall constant)

$$V_H = \frac{R_h}{d} \, i \, B$$

This equation shows the feature of the Hall effect which is of primary importance in the transducer application, namely the output signal (Hall voltage) being proportional to the product:

CURRENT x MAGNETIC INDUCTION

The magnetic induction flux across the stationary Hall sensor changes when the frame carrying the Sm-Co magnets rotates around it. The flux changes generate a voltage output proportional to the extent of rotation and hence to the organ preparation displacement (see sketch below)



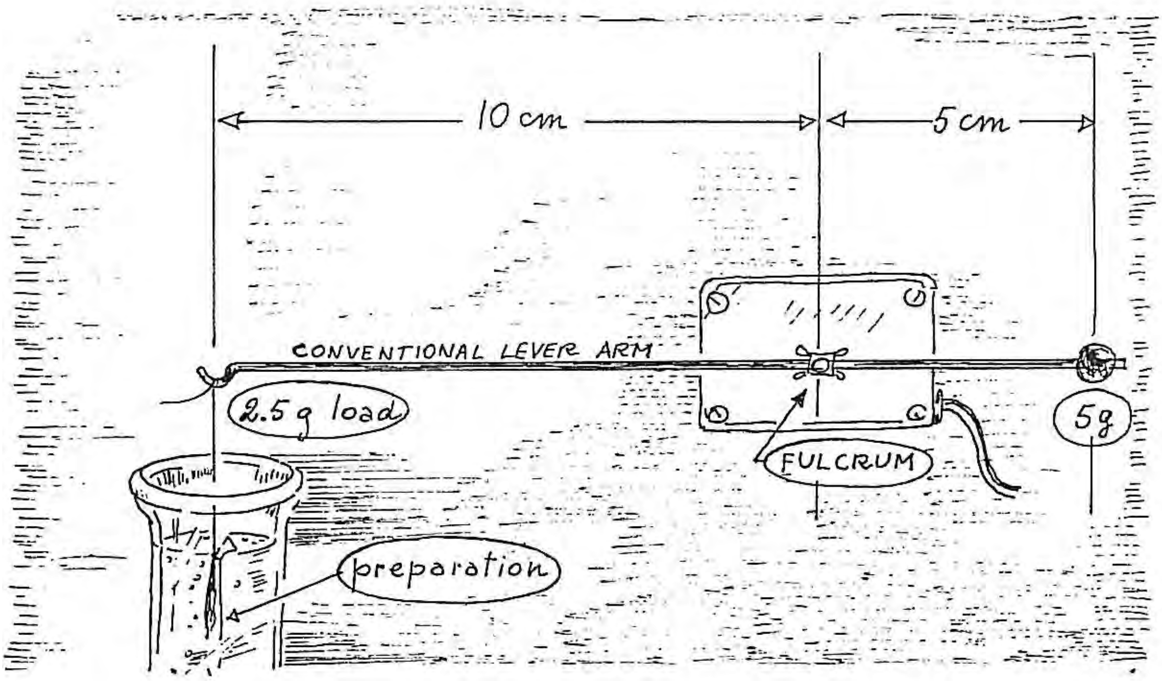

Our Hall effect sensor U1 (Sprague UGN3503U) is consolidated on a miniature P.C. Board (see drwgs. 7006-40 & 7006-42)

8.2 Minimum Inertia (following paragraph 1.2)

Bearing that in mind, it should be noted that the claimed moment of inertia of, say, 15 $gcm^2$ of other makes of "rotary motion transducers" is illusory.

In fact, this 15 $gcm^2$ is the moment of the "naked" transducer, so to speak, whilst the moment of 7006 includes the substantial 50 g counterweight.

In a conventional arrangement, to load the organ, the researcher will, for instance, stick a 5 g putty ball at, say, 5 cm from the fulcrum as in the sketch below.




In case the required force is 2.5 g, he will therefore add a moment of inertia $5 \times 5^2 = 125$ $gcm^2$, so his total will be: $125 + 15 = 140$ $gcm^2$.

In the 7006, it is sufficient to shift the 50 g counterweight of 0.5 cm to provide same organ load. The moment of the shifted counterweight alone will be : $50 \times 0.5^2 = 12.5$.

To that we should add the moment of inertia of the lever arm arrangement, shaft and the transducer rotor (without counterweight) which totals: 30 $gcm^2$.

We obtain 12.5 + 30 = 42.5 which is considerably less than 140.

| issued on |
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# Notes

# Notes

# Notes

# CE CONFORMITY STATEMENT


Manufacturer **UGO BASILE srl**

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*We hereby declare that*

Instrument. **ISOTONIC TRANSDUCER**

Catalog number *7006*

*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*