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Repair & Maintenance Manual



Transonic®

T106/T206 Flowmeters

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OF TRANSONIC SYSTEMS INC. MANAGEMENT.

AUST106 Service Manual Rev 7/92

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Excellence in Quantitative Hemodynamics
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I-a. Introduction

This maintenance and repair manual is designed to teach flowmeter users and their Biomedical Engineering Service Departments how to maintain the electronics of the Transonic® T106/T206 flowmeters and flowsensors for performance to factory specifications, and how to make elementary repairs, if necessary.

For physical care of the flowmeter, including sterilization and cleaning, the user is referred to the Operator's Manual.

In all cases of equipment malfunction, the user is advised to diagnose the symptoms and leave the repair to Transonic Systems Inc. or to its authorized agents.

CAUTION: SERVICE BY NON-AUTHORIZED PERSONNEL VOIDS THE FACTORY WARRANTY, MAY VOID THE UL RATING & MAY ADVERSELY AFFECT ACCURACY OF THE INSTRUMENT.

The company offers a liberal factory warranty on meters and probes *(see next page).*

Under no circumstance, should the user attempt to modify the electronic circuitry of the meter. The meter/probe combination delivers an extremely high degree of flow measurement precision. This is achieved through company proprietary know-how which is not apparent from the electronic circuit diagrams. For instance, in order to resolve a 1 ml/min flow with an H2R probe, the meter resolves ultrasonic transit-time differences of only a few picoseconds; circuit modifications may well alter the circuit's performance to yield unacceptably high zero flow offsets and the like. *(As a point of reference, in 3.3 picoseconds, light travels a distance of only 1 mm; the resolution of "fast" electronic circuitry is limited to a few nanoseconds.)*

A. 3 - Year Free Maintenance Agreement

Transonic Systems Inc. shall inspect and recalibrate the electronic flowmeter free of charge up to three (3) times during the first three (3) years of operation. The Buyer pays shipping charges to the Transonic Systems' plant.

B. Limited Warranty

1. Transonic Systems Inc. warrants for a period of one (1) year from date of shipment that the electronic flowmeter is free from defects which are the result of faulty material or workmanship by Transonic Systems Inc.
2. Transonic Systems Inc. warrants for a period of six (6) months from date of shipment that the sterile tubing flowsensors are free from defects which are the result of faulty material or workmanship by Transonic Systems Inc.
3. The warranty of Transonic Systems Inc. shall not apply to:
   a) Defects caused by abuse, neglect or misuse;
   b) Damage due to accident or casualty; or
   c) Unauthorized repairs, alterations.
4. No other warranty is expressed or implied. Transonic Systems Inc. is not liable for incidental or consequential damages.
5. Warranty is valid only if equipment is purchased through Transonic Systems, its duly appointed distributor or licensed representative.

C. Warranty Claim

The obligations of Transonic Systems Inc. under this warranty are limited to repairing or, at its option, replacing any goods determined to be defective. Buyer must notify Transonic Systems Inc. in writing within the warranty period of the reason Buyer believes that warranty repairs are required. Buyer is then required upon the request of Transonic Systems Inc. and at Buyer's expense, to return the goods to the Transonic Systems Inc. manufacturing plant. Freight for shipping the repaired goods from the Transonic Systems Inc. manufacturing plant to Buyer's place of business shall be paid for by the Buyer. Any goods repaired or replaced by Transonic Systems Inc. shall be warranted for the period of time remaining on the original warranty from its date of inception.

I-c. Equipment Return Instructions

Meters

(1) Contact Transonic Systems for a return material authorization (RMA) number.

(2) Please put your RMA # on the FACTORY RETURN FORM *(page 4)* & complete the form with information for repair service personnel.

(3) Please use the Transonic Systems shipping carton for returning meter equipment.

(4) Place the two foam packing pieces over the front and back ends of the flowmeter to protect front and rear panel controls. Notches in the foam correspond to protrusions on the instrument.

(5) Place the instrument with its foam padding into the box.

(6) Place between meter and box, in the space around the flowmeter,
Power cords,
Flowsensors (individually packaged with their parts).

(7) On top of the flowmeter place:
Factory Repair Return Form, with your name and phone number
Operator's Manual
SENSOR RECORD OF USE & any correspondence that would help define the problem.
Seal the cover of the box.

(8) As a carrier for return, Federal Express (FedEx) is recommended for all shipping.
Ship to our factory address:

TRANSONIC SYSTEMS INC.
34 Dutch Mill Road
Ithaca NY 14850

(9) If you have any questions, please call Customer Service at:

Tel: 800-353-3569; 607-257-5300; or Fax: 607-257- 7256.

Flowsensors

(1) Contact Transonic Systems for a return material authorization (RMA) number.

(2) Please put your RMA # on the FLOWSENSOR REPAIR RETURN FORM *(page 5)* with information for repair service personnel. Completing this form will help to assure a 2-week turnaround for your repair.

(3) Along with all parts of the flowsensor, pack
Flowsensor Repair Return Form
SENSOR RECORD OF USE
Additional correspondence that would help define the problem.

(4) As a carrier for return, Federal Express (FedEx) is recommended for all shipping.
Ship to our factory address:

TRANSONIC SYSTEMS INC.
34 Dutch Mill Road
Ithaca NY 14850

(8) If you have any questions, please call Customer Service at:

Tel: 800-353-3569; 607-257-5300; or Fax: 607-257- 7256.

I-c. Flowmeter Repair Return Form

for copy use

Transonic Systems Inc. will return the repaired meter within 2 weeks of receipt or send you a temporary replacement meter, if all the information below is supplied. Before returning a product for repair, call Transonic Cust omer Service for a RMA (return material authorization) number.

CUSTOMER NAME _____ DATE OF

address _____ RETURN _____

_____

METER SERIAL # _____

CONTACT PERSON familiar with reported problem, and available by phone:

Name _____ Fax # _____

Phone # _____ Best time to call _____

DESCRIPTION OF THE PROBLEM(S):

1. In case of 2-channel meter: problem exists in:

[ ] left channel [ ] right channel [ ] both channels.

2. Please complete the appropriate entry from the three below

[ ] Meter does not measure flow at all. Go to Section 4, below.

[ ] Meter malfunctions erratically: intermittent problem shows up:

[ ] when meter is turned on [ ] after ___ minutes of power on

[ ] All meter functions operate, but readings are suspect

3. Please describe the problem

[ ] Zero flow offset is too high with the "Lo Flo" meter button pushed in, and probe # _____ plugged directly into the meter (no extension cord) and properly liquid filled* (see below)

The zero offset was _____ [ ] ml/min; [ ] L/min; [ ] % of full scale on the:

front panel [ ] Analog Meter [ ] Digital Meter

rear panel [ ] Avg. flow Monitor BNC [ ] Pulsatile Flow monitor BNC

* *Refer to Section IV, p.12 on how to make proper zero flow measurements on the bench, and to diagnose whether the meter or the flowsensor is at fault. In case of doubt, include the flowsensor with this shipment.*

[ ] Noise in flow readings is too high as monitored on the:

front panel [ ] Analog Meter [ ] Digital Meter

rear panel [ ] Avg. flow Monitor BNC [ ] Pulsatile Flow monitor BNC

[ ] Other: Please describe:_____

_____

_____

_____

_____

4. Please add any comment that may expedite the repair

_____

_____

_____

Return the flowmeter with this form to: *Attn.* Meter Repair Dept.

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Fax: 607-257-7256; Internet: www.transonic.com

I-c. Flowsensor Repair Return Form

for copy use

Before returning a product for repair, call Transonic Customer Service for a RMA *(return material authorization)* number.

CUSTOMER NAME _____ DATE OF

address _____ RETURN _____

_____

FLOWSENSOR SERIAL # _____

CONTACT PERSON familiar with reported problem, and available by phone:

Name:_____ Fax #: _____

Phone #: _____ Best time to call: _____

DESCRIPTION OF THE PROBLEM(S)

1. With flowsensor plugged directly into the meter without extension cable and properly liquid-filled (refer to Section IV "Initial Bench-Top Operation", page 18) the meter indicates:
   - [ ] "No.Pr." - go to 3, below:
   - [ ] "Ac.Er" - go to 3, below:
   - [ ] Identifies probe: e.g. "4'Gd"
2. Please describe the problem:
   - [ ] Received signal reads below 0.5 on the ANALOG METER on T106, HT107 Series flowmeters (For T101 Series flowmeters, see respective manual)
   - [ ] Flow readings are suspect (please explain)
   - [ ] Other (please describe)

   _____

   _____
3. The defects in this flowsensor showed up:

   _____

   _____
   - [ ] upon arrival
   - [ ] after repeated uses, as a sudden gradual change in performance.

     The flowsensor was used approximately _____ times.

     The duration of each use was approximately _____ hours / days / weeks.

     Sterilization method(s) used: _____.
4. Please add any additional comments that may expedite this repair.

   _____

   _____

* For flowsensors under factory warranty: Transonic Systems Inc. will, within 2 weeks of date of receipt of flowsensor, either repair it or replace it from available stock, or notify you of a delivery date for a replacement if not available from stock. For non-warranty repairs: Transonic Systems Inc. will, within 2 weeks of date of receipt of the flowsensor, either repair the flowsensor or notify you of the cost of repair *(depending on the repair cost level authorized herewith).*

Return flowsensor and this form to:

Transonic Systems Inc.
Attn. Probe Repair Department
34 Dutch Mill Road, Ithaca, NY 14850
TEL: 800-353-3569, 607-257-5300; Fax: 607-257-7256

II. Periodic Maintenance Requirements

A. Meter

A routine maintenance check of flowmeter performance consists of exercising all meter front-and-rear-panel functions with a sampling of flowsensors connected, and verifying that all functions respond as described. See the flowmeter Operator's Manual instruction in "Initial Bench-Top Operation" for a detailed protocol.

Exterior flowmeter surfaces can be cleaned using a cloth or brush dampened with soapy water, followed by damp wiping with clear water. Alternately, the surface can be damp-wiped clean with isopropyl alcohol instead of soapy water. Do not drip liquids into the meter cabinet. A flowmeter exposed to accidental spillage should be unplugged immediately from its power source. Remove the cover. If the spilled liquid is potentially corrosive or may leave a residue, flood the area of the spill with water, using care not to disturb components or wires. Compressed air may be used to blow liquid off components, repeating the rinse and air-blowing if the spilled liquid is other than water. Remove remaining moisture with a heat gun. **Do not operate the flowmeter in a wet condition; keep it in a dry environment.**

B. Flowsensors

Flowsensor operational tests must be performed periodically to safeguard the validity of the flow measurements made with that sensor. The meter incorporates a test mode; during each probe use, test mode measurements must be made to confirm the proper operation of the probe. (See the instructions supplied with the probe, or, in the flowmeter's Operatior's Manual, the "flowmeter operation" portion of the section about "use of a flowmeter with …xxx… flowsensor.")

if the flowsensor does not perform to specification, the Operator's Manual Appendix IB "Factory-aurthorized repair of probes, cable" provides detailed instructions on diagnosis and repair of problems.

C. Record of Flowsensor Use

Enter and maintain flowsensor use performance data in the Record of Sensor Use form *(on next page)* for diagnostic reference and for inclusion with any flowsensor return to the factory for repair.

for copying

PERIVASCULAR PROBE RECORD OF USE
T106/T206

Please note: Periodic probe maintenance is necessary to assure validity of flow measurements. The received signal of the probe is normalized to 1.0 at the factory and should vary only slowly ("aging of transducers") over time. As a loss of signal is often indicative of deterioration of probe function, tracking of performance is helpful in diagnosing signal degradation before flow readings become questionable.

User/contact person _____ **phone #** _____

Perivascular probe # _____ **date received** _____

	Date	Rec'd Signal Quality	√ How Used		Notes
			Bench	Intra-operative	
Example	*12/9/97*	*Good**		√	*50 mL/min flows recorded on CABG graft*

Bench-test procedures are described Section A-IV, pages 12-17 of the Operator's manual.
When returning flowsensors for factory examination, please obtain a RMA (Return Material Authorization) by calling 1-800-353-3569 (USA) or 607-257-5300 and include the Factory Return Form along with this page.

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II. Flowsensor Record of Use

for copying

STERILE TUBING (CLAMP-ON) FLOWSENSOR RECORD OF USE
T106/T206 ANIMAL RESEARCH FLOWMETERS

Maintaining a record of probe received signal strength is an essential part of routine probe maintenance. The clamp-on flowsensor's received signal is normalized to 1.0 at the factory on the tubing for which the sensor is built and should vary only slowly over time (due to transducer "aging") when the probe is used with the tubing specified on its Transonic Flowprobe Specifications sheet. As signal degradation may indicate improper mounting of the probe or deterioration of probe function, performance tracking is helpful in diagnosing problems before flow readings become questionable.

User/contact person _____ **phone #** _____

Sterile-tubing (clamp-on) probe # _____ **date received** _____

Made for tubing material _____ **O.D.** _____ **I.D.** _____

	Date	Rec'd Signal Quality	√ How Used		Notes (Describe tubing if different)
			Bench	In Patient Circuit	
Example	*12/9/971*	*good**	√		

Bench-test procedures are described Section A-IV, pages 12-17 in the Operator's manual.
When returning flowsensors for factory examination, please obtain a RMA (Return Material Authorization) by calling 1-800-353-3569 (USA) or 607-257-5300 and include the Factory Return Form along with this page.

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II. Flowsensor Record of Use

for copying

IN-LINE FLOWPROBE RECORD OF USE
T106/T206 ANIMAL RESEARCH FLOWMETERS

Maintaining a record of probe received signal strength is an essential part of routine probe maintenance. The received signal of the probe is normalized to 1.0 at the factory and should vary only slowly over time (due to transducer "aging"). As a loss of signal is may indicate deterioration of probe function, tracking of performance is helpful in diagnosing problems before flow readings become questionable.

User/contact person _____ **phone #** _____

In-Line flowprobe # _____ **date received** _____

Made for tubing material _____ **O.D.** _____ **I.D.** _____

	Date	Rec'd Signal Quality	√ How Used		Notes (Describe tubing if different)
			Bench	In Patient Circuit	
Example	*12/9/971*	*good**	√		

Bench-test procedures are described Section A-IV, pages 12-17 in the Operator's manual.
When returning flowsensors for factory examination, please obtain a RMA (Return Material Authorization) by calling 1-800-353-3569 (USA) or 607-257-5300 and include the Factory Return Form along with this page.

Direct Quantification of Volume Flow

T106U / T206U, T106 / T206 Animal Research Flowmeters

For Acute/Chronic & Extracorporeal Flow Measurements

- Available in single or dual channel models
- Display average flow rate in ml or L/min
- Pulsatile and mean analog flow signals can be externally recorded from rear-panel BNC
- Provides at-a-glance monitoring of the quality of the ultrasound signal
- Low flow scale selection for increased sensitivity
- Proven transit-time ultrasound technology
- T106U/T206U provides low cost data acquisition and pressure recording.

Acute or Chronic *In Vivo* Animal Studies

One flowmeter to study multiple animal models with exceptional resolution and reliability.

- Measurement capability for vessels from 250 microns through 36 mm diameter
- Probes are non-constrictive and compatible for long-term implant
- New series of cardiac output flowprobes for highest accuracy in vessels with turbulent flow

Extracorporeal & *In Vitro* Flow Measurements

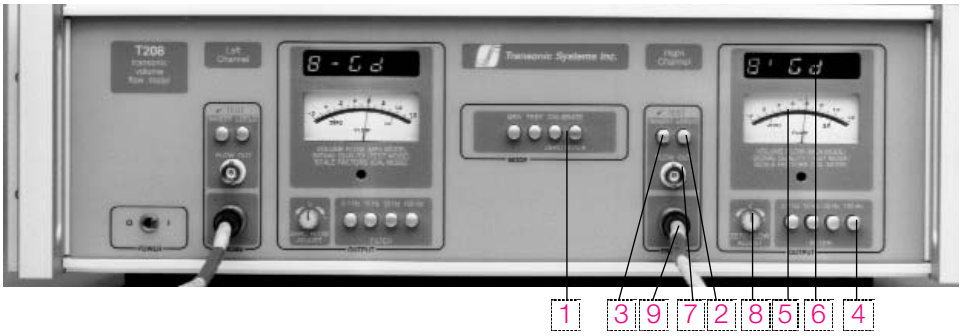
One flowmeter to measure a wide variety of liquids *(ie. blood, saline, urine, buffers)*.

- high resolution in-line flowprobes for tubing I.D. from 0.046" *(1.2 mm)* through 0.875" *(20.8 mm)*
- sterile tubing flowsensors for flexible tubing I.D. from 1.8" *(3.2 mm)* up to 3/4" *(19.0 mm)*

Probe design dependent. See Accessories for Animal Research Flowmeters *(Appendix B)* for specifications effective at date of manual publication. Contact factory for latest specifications.

T206 Dual Channel Flowmeter

(*front panel)*



T106
single channel
10 lbs (4.5 Kg), 81/2"w x 5"h x 16"d
(90-130 Volts; 50-60Hz, single phase
(30 VA, 1.0 AMP slow-blow fuse);
200-260 Volts; 50-60Hz, single phase
(30VA, 0.4 AMP slow-blow fuse)

T206
dual channel
16 lbs. (7.2 Kg), 19"w x 5"h x 16"d
90-130 Volts; 50-60Hz, single phase
(60 VA, 1.6 AMP slow-blow fuse);
200-260 Volts; 50-60Hz, single phase
(60VA, 0.8 AMP slow-blow fuse)

T106U/T206U
single channel and dual channel model with data acquisition and pressure recording capability. Includes:

- **Computer Interface circuitry,** cable, and "WINDAQ" software to connect the flowmeter to an IBM compatible computer via its serial RS232 port;
- **Pressure** sensor amplification by flowmeter A/D board for acquisition of pressure data in addition to flow. RJ11 phone input jack for pressure transducers; 1 per flow channel.

Synchronization for multi-unit operation or simultaneous use with Doppler instrument is supplied as standard circuitry on all units.

Gating (-G) Option for use during MRI unit to eliminate cross-coupling interferences.

Bubble Alarm (-B) Option with audible alarm which sounds when gas bubbles pass through a sterile tubing flowsensor.

Electrical Isolation
Flowmeter is grounded. If accidentally ungrounded, line to ground leakage current is less than 50 µA. ETL listed.

1 **Push Button Control of**
Mode of operation: selects Measure, transducer Test, Calibrate External Recording Devices for Zero / Full Scale

2 Low Flow Range: expands displayed flow sensitivity by a factor of four;

3 Polarity of Displayed Flow: inverts polarity of analog flow outputs and flow displays

4 Output filtering: 0.1, 10, 30 and 100 Hz Low pass filtering applied to analog output signals

Automatic Meter Adjustments

- Probe size and corresponding flow output ranges (see flowprobe tables)
- Volume flow calibration of the applied probe
- Dual channel flowmeters synchronously monitor two flowprobes at the maximum rate without cross coupling interference

Flowmeter Displays

5 **Analog Meter** (taut-band needle)

6 **Digital Display**

- Volume flow (in Measure mode)
- Received signal amplitude (analog meter, Test mode)
- Diagnostic Data (digital display in Test mode)
- Probe scale data (in Zero and Scale factor Calibration modes)
- Test Light: indicates when acoustic signal and flow output signals do not meet specifications.

Multi-Unit Synchronization
Rear panel master/slave control and input cable to time ultrasound signals for concurrent operation with pulsed

7 **Flow Monitor Outputs**

* Average volume flow; rear panel, BNC connector, 0.1Hz low-pass filtered
* Pulsatile/Average volume flow; front/rear panel, BNC connector, filtering controlled by front panel push buttons
  Zero calibration = 0 Volts out
  Scale factor flow = 1V ± 2%
  Output resistance = 500 Ohm
  Full range for flows = ± 5V (bi-directional flows, ± 5 times scale factor)

8 **Offset Adjustment Dial**
for Zero flow reading during occlusion or when no flow is passing through a sterile tubing flowsensor; front panel

9 **Probe Connector**
Accepts male CH10-style connector of probe or extension cable

Digital Identification
Probe identification and calibration parameters programmed into flowprobe connector.

Ultrasonic Frequency
Probe dependent (see probe tables)

Ultrasonic Transducers
R-, S-, Series: implantable (chronic/acute) perivascular flowprobes;
V-, Series: microcirculation flowprobes (T106/T206);
A-, Series: cardiac output flowprobes;
C-Series: sterile tubing (clamp-on) flowsensors for extracorporeal use with tubing.
N-Series: in-line flowprobes that splice into laboratory tubing

Extension Cable
1, 2, 3 meter cables available; supplied one per flowmeter channel purchased

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Descriptions of the functions and controls for standard Transonic Animal Research flowmeters follow.

MODE SWITCHES

Determine the mode of operation when the instrument is connected to a functioning flowprobe.

"MEA" button (or no button) pushed in:
The instrument is in its Measure Mode and provides information on volume flow passing through a connected flowprobe's sensor window:
The **digital display** presents absolute average (0.1 Hz low-pass filtered) volume flow in ml/min or L/min.
The **"AVERAGE" BNC connector** (rear panel) presents average volume flow (0.1 Hz low-pass filtered) as a fraction 1 of the scale factor (S.F.) on analog meter face.
The **analog mete**r and **"FLOW OUT"** (front panel))/ **"PULSATILE"** (rear panel) **BNC connectors** provide fractional instantaneous or average volume flow as selected by the user (0.1, 10, 30, or 100 Hz low-pass filtered).

"CALIBRATE ZERO" button pushed in:
Digital display reads "C 0" to inform user that flowmeter is in calibrate 0 mode;
Analog meter, "FLOW OUT" (front panel) / **"PULSATILE"** (rear panel) **BNC connectors** and **"AVERAGE" BNC connector** (rear panel) provide zero baseline flow signal, 0.02 Volts ± 0.12.

"CALIBRATE SCALE" button pushed in:
Digital display shows a "C" followed by scale factor for the connected flowprobe (in ml/min or L/min) to inform user:
1) that the flowmeter is in the calibrate scale factor mode and
2) the magnitude of the scale factor for the flowprobe in use.
Analog meter, "FLOW OUT" (front panel) / **"PULSATILE"** (rear panel) **BNC connectors** and **"AVERAGE" BNC connector** (rear panel) provide a 1 Volt ± 0.12 reading that corresponds to full scale flow for the flowprobe in use.

"TEST" button pushed in:
Digital display presents a diagnostic message that identifies the probe size in mm and an assessment of the level of the received signal:
"Gd" = sufficiently strong received signal;
"Lo" = marginally adequate received signal;
"No" = insufficient or no received signal.
Analog meter indicates received signal amplitude of the flowprobe in use.
"FLOW OUT" (front panel) / **"PULSATILE"** (rear panel) and **"AVERGAE" BNC connectors** provide volume flow signals as in "MEA" mode.

ANALOG METER

In "MEA" mode: Indicates fractional[1] volume flow passing through a connected flowprobe's sensing window.

In "CALIBRATE" mode(s): Indicates a reading corresponding to zero flow ("ZERO") or to full scale flow ("SCALE") for the flowprobe in use (absolute volume flow equals analog meter reading times the scale factor shown on the digital display).

In "TEST" mode: Indicates received signal amplitude of connected flowprobe in volts-peak-to-peak.

[1]Absolute volume flow equals analog meter reading times the scale factor shown on the digital display.

DIGITAL DISPLAY

In all modes

"Ac. Er" ("acoustic error") when no flowprobe is connected, or when the ultrasonic signal's pathway in the flowprobe's sensing window is blocked by air or fat; the reflector is misaligned; the probe or extension cable is malfunctioning, etc.

When the flowmeter identifies a functioning flowsensor

In "MEA" mode: Indicates absolute average (0.1 Hz low-pass filtered) volume flow in ml/min or L/min;
In "CALIBRATE SCALE" mode: Indicates scale factor multiplier by which the fractional indications of analog meter and analog outputs are multiplied to determine absolute flow of flowprobe in use (for instance, "C 25 ml/min" for a 2 mm flowprobe with the "LO FLO" push button depressed);
In "CALIBRATE ZERO" mode: Displays "C 0" when connected to flowprobe;
In "TEST" mode: Indicates diagnostic messages of probe and signal condition, i.e.:

"6-Gd" = The instrument identifies a connected 6 mm flowprobe with good acoustic signal coupling strength;

"6-Lo" = The electro-acoustic pathway of connected 6 mm flowprobe produces a marginal received signal strength;

"6-No" = The electro-acoustic pathway of a connected 6 mm flowprobe is blocked and there is no signal strength.

"√TEST" LIGHT advises operator to check readings, in TEST mode

Illuminates when no acoustic signal is received from sensor or when the amplitude of the received signal lies between the "Lo" and "Gd" signal levels. In the latter case, the **"√TEST"** light warns that the flow signals recorded by the flowmeter may not meet the flowmeter's stated accuracy specifications.

"INVERT" PUSH BUTTON

Inverts signal polarity, reversing the indicated direction of flow presented by the digital display, analog meter and "FLOW OUT" and "AVG. FLOW" BNC connectors. Push in to invert polarity; push again to restore original flow indication.

"LO FLO" PUSH BUTTON

Increases displayed flow sensitivity by decreasing flowmeter's scale factor by a factor of four.
In "CALIBRATE SCALE" mode: digital display at "LO FLO" will read 25% of its former scale factor flow level.

In "MEA" mode: digital display will continue to present absolute volume flow directly in ml/min or L/min. At the analog meter and "AVG. FLOW" and "FLOW OUT" BNC connectors, the same flow will be represented by a four times stronger electrical signal. To reset function to normal scale, push button.

"ZERO FLOW ADJUST" BUTTON

Used to adjust flowmeter to read zero flow during occlusion or when no flow is passsing through a sterile tubing flowsensor.

"OUTPUT FILTER" PUSH BUTTONS

Determine low-pass cut-off frequency of signals presented on analog meter and at the front panel "FLOW OUT" and rear panel "PULSATILE" BNC connectors.

"0.1 Hz" setting: provides average flow indication (making the "FLOW OUT" and "PULSATILE" signals equal to the signal on the "AVERAGE" connector).

Other settings (10, 30, 100 Hz): analog flow outputs represent pulsatile volume flow within the instrument's accuracy specifications if the filter cut-off frequency (in Hz) is at least ten times the animal model's pulse repetition rate in beats per second. Filter type: third order (3 pole) Butterworth in the 100 Hz setting; second order (2 pole) Butterworth in the 0.1, 10, and 30 Hz settings.

"FLOW OUT", "AVERAGE" AND "PULSATILE FLOW MONITOR CONNECTORS

BNC-type connectors: supply flow information to accessory instrumentation (strip-chart recorder, digital voltmeter, etc.):

Front panel **"FLOW OUT"** connector and rear panel **"PULSATILE"** connector: presents analog meter signal when meter is engaged in all modes of operation

(Measure, Calibrate Zero and Calibrate/Scale Factor);
- in "MEA" or "TEST" mode: provides instantaneous or average flow signal as determined by output filter (1 Volt or equal scale factor);
- in "CALIBRATE SCALE" and "CALIBRATE ZERO" modes: provides calibration signals.

Rear panel **"AVERAGE"** flow monitor connector: presents average flow signals (0.1 Hz second order Butterworth low-pass filtered). Zero flow = zero Volts nominal; Scale factor flow = 1.0 Volts nominal; Output resistance = 500 Ohms.

COMPUTER INTERFACE PORT

T106U/T206U Flowmeters are equipped with the Computer Interface port, a rear panel 25-pin D-shell connector, RS-232 format, so that the meter can be connected directly to a serial port of an IBM PC-compatible computer. Older T106/T206 Series meters are offered this Computer Interface as an option (-P Option).

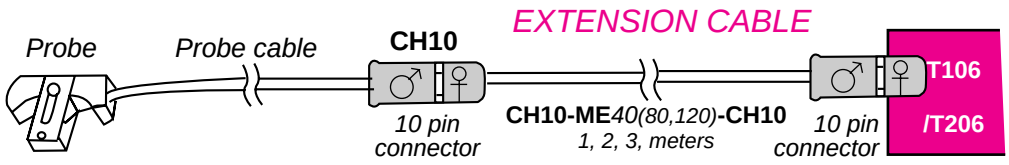
OPTIONAL CONNECTORS

Multi-Unit Synchronization Selector: Optional rear panel low frequency (LF) stereo earphone jack and high frequency (HF) BNC connector and mode dial allow operation of a connected flowprobe in close proximity to other pulsed ultrasonic devices such as distance gauges, other flowprobes. The synchronized flowmeter can either supply timing signals or derive its timing signals from other instruments.

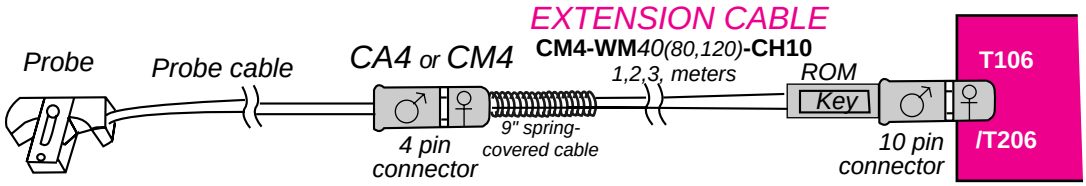
Pressure Port: When equipped with a Computer Interface or (-P) Option, the meter can also be equipped with an optional pressure transducer.

"PROBE" CONNECTOR

Accepts CH10 (10-pin) connector of probe or probe extension cable (CH10-WE80-CH10).



Accepts CM4 (4-pin) probe connectors via a CM4-WM40-CH10 extension cable.



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