ENERGO FLOW





PORTABLE ULTRASONIC FLOWMETER
ENERGOFLOW LF 2P2

Technical Specifications

2026

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Technical Specifications

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Note: All models of Flow meters of the Energoflow LF series are also available with support of Cyrillic font for the graphic display. These devices are additionally marked as "UVR-011 X-X " .

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INTRODUCTION

This document is provides the technical specifications of the single cjhannel and two-channel Portable flowmeter **Energoflow LF 2P2.**

The flowmeters can be used for technological process control in metallurgical, chemical and other branches of industry; in water supply and outflow systems; including the custody transfer, of the water, acids, alkalis, oil, oil products and other liquids discharge.

ABBREVIATIONS

ACS – automatic control system;
AGC – automatic gain control;
ADC – analog -digital converter;
EU – electronic unit;
LCD – liquid-crystal display;
MC – microcontroller;
SW – software;
EAT – electro-acoustic transducer;
PC – personal computer;
AGC – automatic gain control;

1 APPLICATION

1.1 Flowmeters are intended for measurement of the volume flow rate and volume of acoustically transparent liquids in the pressure pipelines in forward and reverse direction.

1.2 The flowmeters measure liquid flow velocity *V*, and the time intervals (by means of the built-in quartz electronic clock). Depending on the flow direction, the velocity has the sigh «+» or «–».

1.3 Flowmeters consist of an EU and 1 or 2 pairs of sensors - EAT. The sensors are mounted on the pipeline surface. The sensors are connected to the EU with the signal cables. EAT of each pair forms acoustic signal, crossing the liquid flow by chord or diameter.

1.4 In the different versions one or two measuring channels are implemented. The one-channel flowmeter is produced on the base of the two-channel one, by simplified complete set and appropriate programming.

The further description concerns the two-channel flowmeters.

1.5 The flowmeters are designed for operation in the independent (autonomous) mode, though can be controlled by the PC or the Automatic Control System.

1.6 Each channel of the flowmeter is completely independent (autonomous) and can be applied for measurements in a separate pipeline. The two-channel flowmeters provide forming of the «combinational» channel by summing, substraction or averaging the flow rate in the two channels, with further fixing the results in the memory. This allows to apply the flowmeter for measurement of the sum flow rate of two channels, or to perform measurements in one pipeline with higher accuracy (i.e. two-channel mode).

1.7 Turning the channels on/off, choosing the type of processing is provided by the configuration in the course of commissioning.

1.8 The progressive total volume for each channel including the combinational one is formed every second after erasing the archive data.. The data on the liquid volumes for the reporting period (hour, day etc.) for all channels is registered in the non-volatile memory.

1.9 The flowmeters perform the off-state time indication with up-to-second accuracy and save in the non-volatile memory information on the pauses in measurement for each channel.

1.10 The flowmeters are equipped with a built-in crystal calibrator, that allows to perform their calibration without stopping the operation.

1.11 The portable flowmeters are manufactured in common industrial version and are intended for operation in the explosion-hazard zones .

2 TECHNICAL FEATURES

2.1 The flowmeter calculates the current flow rate as a product of the measured flow velocity and the internal cross-section area of the pipeline according to the formula:

$$Q = 3600 \cdot Sg \cdot V \cdot \pi \cdot D^2/4, \quad (1)$$

where Q — current volume flow rate, m^3/h;

Sg — hydrodynamical index;

V — measured flow velocity, *m/s*;

D — internal diameter of the pipeline, *m*.

2.2 The range of measured flow velocity 0, 1 - 10 *m/s*. In the velocity range from 0 up to 0, 1 *m/s* flowmeters perform measurements with non-normalized error.

2.3 The range of the permissible values of *DN* is from 0,07 to 3,2 *m.*

2.4 Thickness of the pipeline wall - from 2 up to 30 mm.

2.5 Depending on the Dn and v, the range of the volume flow rate (m^3*h) makes from $Q_1 = 282,7 * D^2$ up to $Q_3 = 28270 * D^2$, where D - numerical value of the Dn. The flowmeter operating range within the fixed *D* – 100:1 (from 1,0 to 100 % of the maximal flow rate).

2.6 The measurement can be performed in the two-channel mode (configuration variant 5). With this purpose it is necessary to mount the EAT in the same pipeline cross section, in order the probing by the channels 1 and 2 should be performed in the perpendicular directions.

2.7 The impurities in the liquid increase the ultrasonic signal attenuation on its passing through the measuring line between EAT and complicate measurement performing.

Metrological restrictions on the amount of impurities in the liquid are not present, but the manufacturer guarantees the flowmeter normal operation within up to 0,2 % volumetric concentration of the particles suspended in the liquid.

The ability of the flowmeter application for more polluted fluids can be proved by monitoring measurements.

2.8 For the autonomous mode operation the flowmeter is equipped with the 22-button keypad and LCD situated on the EU frontal panel.

LCD allows to display up to 8 lines of alphanumeric information simultaneously. Upon the customer's it is possible to display on the LCD (or on the PC display within the ACS) as follows:

- measurement results - flow velocity and direction, current volume flow rate, volume;
- oscillogram of the signal passed through the sector of measuring;
- the flowmeter configuration and adjustment parameters;
- archive data;
- time and date.

2.9 Functional features of the flowmeter and its adjustment is changed by programming the built-in MC. The unskillful treatment may cause the flowmeter damage. To prevent the unauthorized access to the flowmeter control the password is provided. It represents sequence of figures (up to 10).

The operator's commands which do not influence the flowmeter configuration and adjustment and may not cause archive data erasing, are executed without the password.

The PC software for the flowmeter control is also protected with the password.

The consumer is able to change the password.

2.10 For outputting the measurement results into the remote external registering devices the flowmeters are equipped with pulse-frequency output. Each pulse corresponds to the liquid volume increment by a fixed value (i.e. «pulse weight»).

Upon the customer's choice there can be delivered to the mentioned output the following values: - - volume increment for any of the channels;

– volume increment for the combinational channel.

2.11 Metrological characteristics

2.11.1 The basic relative error of the flowmeters for the first and the second channel while measuring the volume flow rate and volume of the liquid is standardized in the two flow rate ranges Q:

– from minimal Q_1 to the transition Q_2;

– from the transition Q_2 to the maximal flow rate Q_3.

The values of the minimal Q_1, maximal Q_3 and transition Q_2 flow rates are shown in the table 1.

Table 1 — Normalized flow rate values, m^3/h

Flow rate	Clamp-on EAT
Q_1	$282{,}7 \cdot 10^{-6} \cdot D^2$
Q_2	$Q_1 \cdot 830/D$ for $D < 830$ *mm*; Q_1 for $D \geq 830$ *mm*
Q_3	$Q_1 \cdot 100$
D — numeral value of DN, *mm*	

2.11.2 The limits of the flowmeter permissible basic relative error in the course of measurement of flow velocity, flow rate and liquid volume (by LCD indications and pulse and digital output signals) make:

- In the flow rate range from Q_1 to Q_2 — ± 4,0 %;
- In the flow rate range from Q_2 to Q_3 — ± 1,5 %.

2.11.3 In the two-channel measurement mode of the flowmeters with clamp-on EAT (the volume flow rate in the pipeline is calculated as an average of the flowmeter two working channels, that measure the flow rate in the same pipeline cross section simultaneously) the basic relative error does not exceed:

- In the flow rate range from Q_1 to Q_2 — ± 2,5 %;
- In the flow rate range from Q_2 to Q_3 — ± 1,0 %.

2.11.4 Under condition of monthly calibration performed by means of 0,15 class measurement instruments the flowmeters with clamp-on EAT in the flow rate range 3:1 (ex., in the range of flow velocity from 3 *m/s* to 9 *m/s*) provide liquid volume measurement with relative error ± 0,5 %.

2.11.5 The flowmeter metrological characteristics indicated above are true for the distances between the flowmeter EAT and hydroacoustic resistance no less than those shown in the table 2.

2.12. Pulse-frequency output signal characteristics

2.12.1 Signal type – «dry contact» (optic relay), capacity – up to 0,5 V·A (dc voltage 50 V, current up to 0,1A).

The pulse forming is stopped if $Q \leq Q_{min}$ and if $Q \geq Q_{max}$. The values Q_{min}, Q_{max} are set in the course of the flowmeter setup.

Table 2 — minimal distance between the flowmeter EAT and hydroacoustic resistance

Hydroacoustic resistance	Straight-line sector length, in the DN			
	Clamp-on EAT		Cut-in EAT, cut-in section	
	before	after	before	after
Bend or T-bend	25	5	12	3
Two or more bends within one plane	25	5	15	5
Two or more bends within different planes	50	10	25	5
Confusor	10	5	5	3
Diffusor	25	5	10	3
Abrupt narrowing	20	5	10	2
Abrupt widening	25	5	15	5
Fully opened valve	15	5	8	2
Pump	50	10	30	10

Depending on the value *DN* the flowmeter sets automatically the pulse weight according to the table 3.

Table 3

DN, mm		Pulse weight	DN, mm		Pulse weight
from 0,07	to 0,111 (incl.)	0,2 dm^3	from 0,5	to 0,7 (incl.)	10 dm^3
from 0,111	to 0,156 (incl.)	0,5 dm^3	from 0,7	to 1,11 (incl.)	20 dm^3
from 0,156	to 0,223 (incl.)	1 dm^3	from 1,11	to 1,57 (incl.)	50 dm^3
from 0,223	to 0,35 (incl.)	2 dm^3	from 1, 57	and more	100 dm^3
from 0,35	to 0,5 (incl.)	5 dm^3			

2.12.2 The flowmeter pulse-frequency output is performed with galvanic isolation (electric strength 1,5 kV).

2.13. The flowmeter basic absolute error limits while measuring the pipeline wall thickness (for the complete set with thickness gauge) – do not exceed ± 0,2 mm.

2.14. The time of the flowmeter operating mode setup - 2 minutes after power supply enabling. The flowmeter operation mode – round-the-clock.

2.15 The flowmeter calculates by integrating instant volumes the volume of the liquid, passed through the pipeline in the course of the report interval (hour, day etc.). The volumes corresponding to the report periods are archived.

Each second the integrated volume is formed for each channel (by the progressive total from the moment of the archive erasing).

2.16 To fix the control measurement flow rate values in the archive “Hourly” the flowmeter is provided with the ability to choose the minimal report period in the range from 1 to 60 minutes.

2.17 The two-channel flowmeters automatically form and save (when the flowmeter is off) in its memory 3 archives – one for each channel including combinational one.

Each channel includes data on the volume of liquid for the preceding hours, days, months and years of operation (256 minimal report intervals, 64 days, 12 months, 16 years).

The one-channel flowmeter forms and saves one archive of the capacity indicated above.
When the archive is overflown, the new records replace the oldest ones. The fact of the achieve overflow is registered.

2.18 The power supply off, or the powering voltage below the norm, the flowmeter MC switches automatically into the «sleep mode», the timer and the memory for program and archive storage being powered from the in-built lithium accumulator. This provides setup, archive and timer saving.

When Power is restored the flowmeter starts operating without operator’s interference.

The lithium accumulator warranty period - 10 years.

2.19 For each flowmeter the time of the pause in measurement is calculated (by the progressive total):

- in the case of the power supply disabling (off time);
- when the flowmeter operates in the modes «Oscillograph», «Configuration» or «Diagnostics» (Auto conf.);
- when the measurement signal (of the acoustic link between EAT) is disabled in the channel I: No signal I (I = 1, 2, 3).

Note. 1. No changes in signal 3 , if there is no signal in the channel 1 or 2.
2. The time of disabling is registered with the accuracy up to 1 minute.

2.20 In a separate archive the flowmeters fix the on/off points. Archive volume — 256 records. For each channel the **Emergency** archive is created – fixing the points of breaking and restoring of the acoustic communication between sensors. Archive volume — 256 records. When the archive is overflown, the new records replace the old ones.

2.21 The flowmeter limits of the additional absolute error while measuring the liquid flow velocity V, caused by the temperature, equal:

$\pm$ 0,02 *m/s* – for each 10 ^{0}C change of the EU ambient temperature;

$\pm$ 0,01 *m/s* - for each 10 ^{0}C change of the pipeline temperature in the place of EAT installation.

2.22 The cable length between EAT and EU - up to 100 m.

2.23 Communication line between EU and EAT — РК-50, РК-75 coaxial cable with linear capacitance of 150 *pF/m*.

2.24 For communication with PC the flowmeter is equipped with a built-in interface unit RS-232 without galvanic isolation. The speed of data exchange with PC — 9600 *bauds*.

2.25 The PC communication line length — up to 15 *m*.

2.26 To extend the PC communication cable length up to 1200 m it is recommended to use RS-232/RS-485 and connect the PC over RS485.

2.27 The flowmeter powering is performed through the single-phase AC line of 220 ($^{+22}_{-33}$) V and frequency of (50$\pm$0,5) Hz, or through the four built-in removable DC accumulators of 5 ($^{+0,25}_{-1}$) V.

For the AC line powering the flowmeter is equipped with 5 ($^{+0,25}_{-0,25}$) V power unit.

2.28 The minimal non-stop operation time of the flowmeter with accumulator –4 hours.

To recharge the accumulators the flowmeter is equipped with a charging unit.

2.29 The maximal power consumed by the flowmeter from 220 *V* AC line equals 6 W.

In the case of the accumulator powering the current consumed by the flowmeter does not exceed 0,55 A for 5 V voltage.

2.30 The data on the flowmeter overall dimensions and weight of the units are indicated in the table 4.

Table 4

Flowmeter unit	Overall dimensions, *mm*, at most	Weight, *kg*, at most
Electronics unit	230 × 106 × 58	0,85
Electroacoustic transducer with magnetic clamp-on	80 × 60 × 50	0,7

2.31 For transportation convenience the flowmeter with the accessories is supplied in a case (rf. Appendix A).

2.32 The flowmeter units are available in the following climatic versions:

– EU — for the working temperature range from 5 to 45*°C*, humidity up to 80 *%*;

– EAT - for the working temperature range from - 20 to 100^{0}C, humidity up to 98%.

Upon special requirement the flowmeter can be equipped with EAT with working temperature range from - 60 to 250^{0}C.

2.33 Ingress protection degree : EU – IP56; EAT – IP67.

2.34 The level of the side radiation caused by the flowmeter corresponds to the requirements of the «General norms permitted for the industrial radio interference».

2.35 The flowmeter reliability indices: average operating life - 15 years, average error-free running time - 25000 h.

2.36 The flowmeter verification is performed every two years.

2.37 He manufacturer preserves the right for design and software changes intended for the technical features and metrological characteristics improvement.

3 STRUCTURE AND OPERATION PRINCIPLE

3.1. In the flowmeter the pulse-time method of the liquid flow velocity measurement is implemented.

3.2. Measurements in the two channels are performed in turns in the time sharing mode. To obtain one pair of the instant flow measurement results it takes less than 1 s.

3.3. The flowmeter setup and configuration is performed through the EU keyboard or under PC control. Upon the operator's command the built-in microcontroller of the flowmeter «fixes in the memory» all the changes.

3.4. The channels switching on/off and selection of the processing type вида in the combinational channel is provided by setting the configuration variant according to the table 5.

Table 5 — Flowmeter configuration variants

Variant	Measurements in the channels 1 and 2	Type of processing in the combinational channel
0	Not performed	Unavailable
1	In the channel 1 only	
2*	In the channel 2 only	
3*	In both 1 and 2 channels simultaneously	
4*		Total volume flow rate for two channels
5*		Average ** total volume flow rate for two channels
6*		Difference of volume flow rates for the channels (1 minus 2)
7*		Difference of volume flow rates for the channels (2 minus 1)

Notes. 1. * - unavailable for one-channel flowmeter.
2. ** - the average sum of the values A and B is calculated by the ratio (A + B)/2.

3.5. In the course of setup it is corrected the timer rate, are chosen the optimal places of EAT mounting on the pipeline, set the receiver gain, switched on/off the automatic control including automatic gain control (hereinafter AGC) and tracking (in the time) the signal passed through the liquid.

3.6. In the flowmeter mode «Oscillograph» it is possible to observe on the LCD (PC display) the form of signal passed through the liquid in each channel, to regulate the receiver gain separately for the forward and reverse flow direction, to estimate the time shift between the measurement signals, caused by the liquid flow.

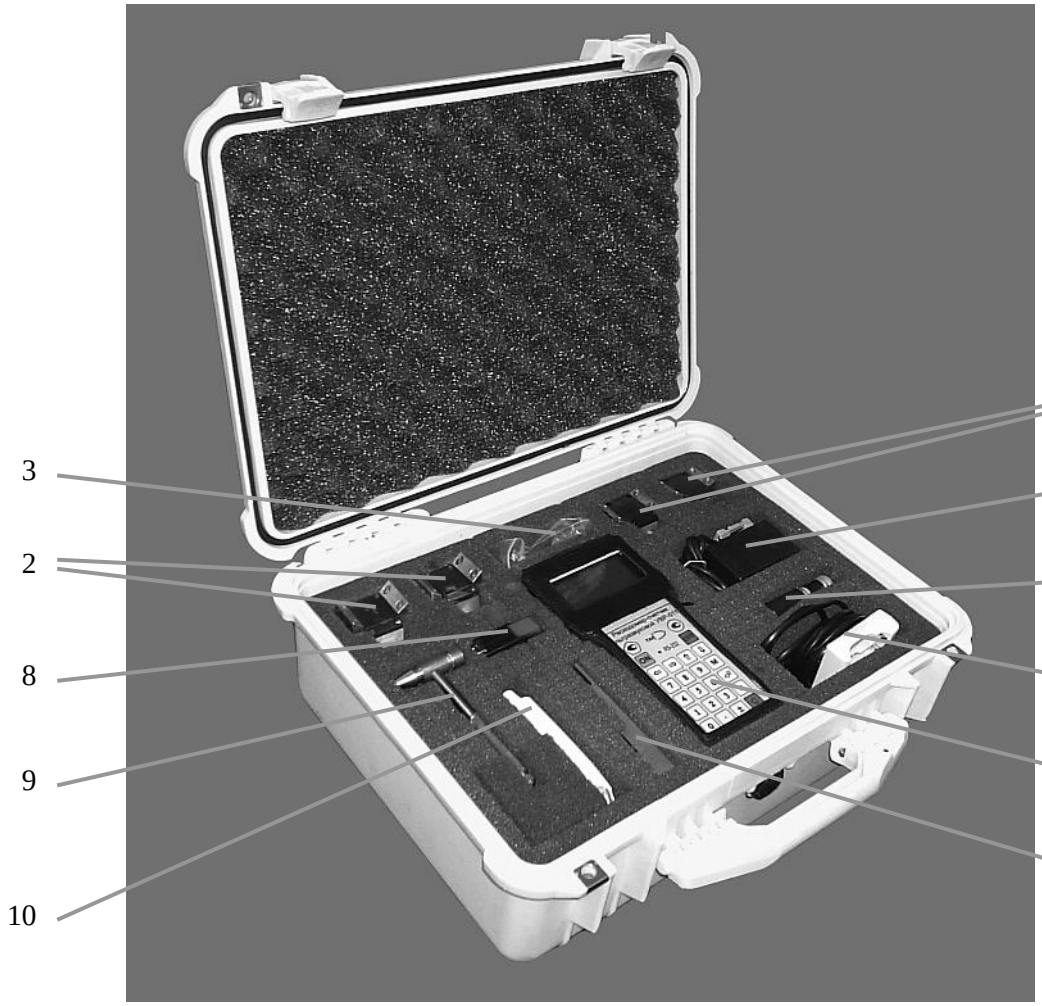
3.7. In certain periodicity the flowmeter micro-controller performs diagnostics and correction of the receiver operating modes for each channel. If the useful signal level at the receiver output is insufficient for normal operating, the "No I signal" warning appears on the LCD, where **I** is the channel number.

3.8. The flowmeter micro-controller constantly controls powering. When the power supply unit is disabled the frowmeter powering is performed by the accumulators. If the accumulators powering is off or their voltage is lower than 4 V, the measurement is stopped and the flowmeter is disabled. Though all the settings, timer rate, archives are saved. Power supply enabled the flowmeter starts operating automatically.

3.9. The thickness gauge allows to measure the pipeline wall thickness if the velocity of the ultrasound propagation in the material of the pipeline is known. And vice-versa if the thickness of the metal sample is known, it is possible to determine the velocity of the ultrasonic waves propagation in it. Before measuring the thickness it is recommended to perform the flowmeter calibration with the standard thickness sample «Step» (within the complete set).

3.10. The flowmeters are verified with the help of the built-in calibrator. In the course of verification the calibrator operation is controlled by the PC with special software SW.The calibrator brings into the signals, passing through the liquid in the pipeline, unequal (for forward and reverse direction) standard LCI delays, multiple to the entire quantity of periods of the flowmeter crystal generator. It allows to control the correctness of the liquid flow velocity measurement. The liquid flow in the pipeline should be stopped for the time of calibration.

APPENDIX A
Flowmeter exterior view



1	Energoflow LF 2P2 Electronic unit — EU	1 pc.
2	Electroacoustic clamp-on transducer with chain-clamp mounting system	4 pc.
3	Removable plates (for magnet clamp-on)	16 pc.
4	Power unit 5V, 1A	1 pc.
5	Thickness gauge	1 pc.
6	Accumulator charger	1 pc.
7	Standard thickness sample «Step»	1 pc.
8	Metal tape-measure, 5 *m*	1 pc.
9	Mounting hammer	1 pc.
10	Water-resistant grease	1 tube

Note: Depending on Customer's specification, the completeness of the flowmeter case may differ

APPENDIX B

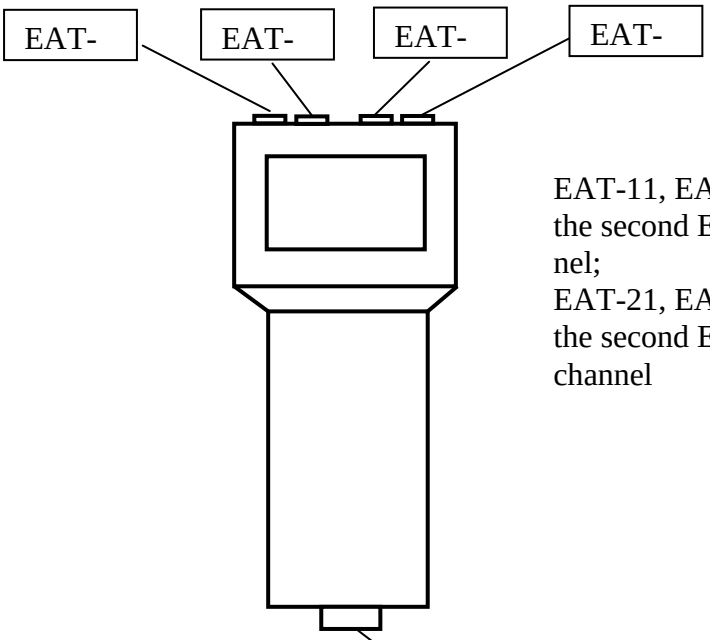
Recommendations for accumulators

1 Accumulators used in the flowmeters are supplied to consumer partially charged.
2 It is recommended to use only one type of accumulators with minimal capacity of 1,5 A*h of the same production lot.
3 In the flowmeter the automatic accumulator discharge control is provided. When the accumulator is discharged to the level of 4 V the flowmeter is disabled.
4 If after repeated turning on the flowmeter is disabled again (that signalizes the accumulators discharge), remove accumulators from the flowmeter and charge them by means of the standard charger (supplied within the complete set) during 14 – 15 hours.

Attention! The use of the unsuitable charger and charge time exceeding may cause their failure.

APPENDIX C

EU sockets application

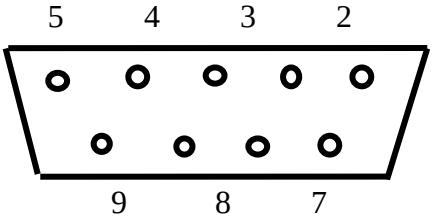


EAT-11, EAT-12 – the first and the second EAT of the first channel;
EAT-21, EAT-22 – the first and the second EAT of the second channel

XS2 socket contacts

XS2 - two-row 9-pin socket DRB-9F Variant B.

Cont. №	Signal type
8, 9	Minus 5 V (power)
6,7	Plus 5 V (power)
5	Common
3	RxD
2	TxD
1	7.6Fr. output
4	7.7Fr. output



Interface cable scheme

