100series® Ultrasonic Flowmeter

Technical Data Sheet

FNDOC-UK-DS-100/1-03, February 2016

FEATURES

- Fully electronic, no moving parts
- Cannot clog or jam
- Non-contact, non-invasive sensors
- WRAS approved wetted parts
- FDA and EU approved material for all foodstuffs, including alcoholic beverages
- Does not measure gas flow
- No reverse flow measurement (can be enabled)
- ***NEW!*** IP66 ingress protection
- Wide temperature range
- Wide flow range
- High pressure rating
- Fast response (1000 measurements per second)
- ***NEW!*** In-built temperature sensor ("T" type only)
- ***NEW!*** Streaming data output ("T" type only)
- Simple pulse output to replace mechanical meters
- Analog output option ("B" type only)
- Low pressure drop
- LED indication of no liquid and flow rate
- Automatic viscosity and temperature compensation; will operate with almost any clean, sonically conductive liquid any maintain performance
- Intelligent with data bus for more information
- High production volume, low cost
- OEM labelling for high volume customers
- 100% performance test in production
- Empty pipe condition from serial bus or factory option for logic output alarm

APPLICATIONS

- Cold drinks dispense
- Hot drinks dispense
- Dosing applications
- Water flow measurement
- Process applications
- General purpose flow measurement

Please note the important notice concerning availability, standard warranty and use in critical applications of Flownetix products and disclaimers thereto that is at the end of this data sheet.

Information is current as of publication date. Products conform to specifications per the terms of Flownetix Limited standard warranty. Production does not necessarily include testing of all parameters.

DESCRIPTION

The Flownetix 100series® are a range of smart, non-invasive ultrasonic flow meters developed for low cost applications using innovative ultrasonic technology and designed as "drop-in" replacements for mechanical meters.

The meter has no moving parts so it cannot clog or jam due to contaminants in the flow. In addition, the unit features automatic temperature and viscosity compensation and low pressure drop. The Flownetix 100series is ideal for measuring beverage delivery, heating and cooling systems.

The Flownetix 100v4 is available in two bore sizes. The Flownetix 107v4 is designed particularly for use in drinks dispense applications where the use of 3/8" pipework is common and can be connected using standard John Guest® 3/8" Speedfit® fittings(1). The meter is easily cleaned using pellets or chemicals. The 110v4 uses a 3/8" BSP threaded connection to give a larger bore for higher flows in general applications or hand pumped drinks dispense applications.

The Flownetix 100v4 replaces the popular Flownetix 100v3 range and now has ingress protection improved to IP66.

There are two electronics options available. The "T" version replaces the previous "A" versions and incorporates a NPN pulse output, a streaming data output that gives total, rate, temperature and other real time information. Used with the Flownetix RS485 bus system, data can be streamed into a customer application locally or remotely.

The "B" version has the NPN pulse output, a voltage and current output as well as a pull-up type pulse output. Both versions incorporate the same serial interface as used on the award winning Flownetix 300series® range of consumer water meters. OEM, volume and distribution customers can configure output scaling and other features allowing for larger and more flexible stock holding by using the *fnMeterTools*™ software.

[1] The brands "Speedfit" and "John Guest" are the registered trademarks of John Guest International Limited. We are in no way connected with the John Guest group of companies.

ORDERING INFORMATION

Flownetix products are made in volume to order at our dedicated production facility. In order to ensure the correct configuration of parts ordered, please order using only the following part numbering format:

FN110v4-B-OEM/FNX-C/100-P/1000-I/25-V/25
(1) (2) (3) (4) (5) (6) (7)

(1) Tube type (107 or 110)
(2) Electronics type (T or B)
(3) Branding (FNX or specific code for high volume customers requiring their own branding)
(4) Cable length in cm
(5) Pulses per litre
(6) Flow (in l/m) for full scale current output (20mA) – B type electronics only
(7) Flow (in l/m) for full scale voltage output (5V) – B type electronics only

Standard items[1] available:

PRODUCT	INTERNAL DIAMETER	FITTING	CABLE	PULSE OUTPUT	TEMP SENSOR	REAL TIME DATA	CURRENT SINK	VOLTAGE OUTPUT	ORDER CODE
107-T	7mm	3/8 pipe	1m, 8 core	1000 pulses/l	Y	Y	n/a	n/a	FN107v4-T-OEM/FNX-C/100-P/1000
110-T	10mm	3/8 BSP	1m, 8 core	1000 pulses/l	Y	Y	n/a	n/a	FN110v4-T-OEM/FNX-C/100-P/1000
107-B	7mm	3/8 pipe	1m, 8 core	1000 pulses/l	N	N	20mA @ 25l/m	5V @ 25l/m	FN107v4-B-OEM/FNX-C/100-P/1000-I/25-V/25
110-B	10mm	3/8 BSP	1m, 8 core	1000 pulses/l	N	N	20mA @ 25l/m	5V @ 25l/m	FN110v4-B-OEM/FNX-C/100-P/1000-I/25-V/25

[1] Non-standard items are subject to a minimum production quantity from the factory of 1000 units of any one type. Not all combinations and values are available. Please consult Flownetix before ordering non-standard parts.

ABSOLUTE MAXIMUM RATINGS

Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Supply voltage	26V
NPN pulse output current	50mA
NPN pulse output voltage	60V
Current sink external voltage	30V
All inputs/outputs	-0.3V
Ambient temperature	80°C
Liquid temperature	85°C to maintain WRAS approval
Storage temperature	-25°C to 85°C
Maximum torque (110v4 thread)	

SPECIFICATIONS

Using water with $T_a = T_{liquid} = 25°C$ unless otherwise stated

PARAMETER	CONDITIONS	107	110	UNIT
MECHANICAL				
Continuous operating pressure	$T_a = 25°C$	1.0	1.0	MPa
		10	10	bar
	$T_a = 60°C$			MPa
				bar
	$T_a = 85°C$			MPa
				bar
Maximum pressure (1)	$T_a = 25°C$, 1 minute	2.5	2.5	MPa
		25	25	bar
Materials (wetted parts)		EMS Grivory HT1V-4FWA Black 9225	EMS Grivory HT1V-4FWA Black 9225	
Materials (enclosure)		GE LEXAN® POLYCARBONATE	GE LEXAN® POLYCARBONATE	
WRAS listing (material)		0602501	0602501	
WRAS listing (product)		TBC	TBC	
Connection type		3/8” diameter pipe	3/8 BSP thread	
Recommended fitting		John Guest® Speedfit® PI0412S	John Guest® Speedfit® PI451613S	
Dimensions (overall)		105.9 x 45.1 x 38.0	96.8 x 45.3 x 38.0	mm
Dimensions (casing)		69.4 x 45.1 x 38.0	69.4 x 45.3 x 38.0	mm
Mass	1m cable, no connector	0.08	0.10	kg
Protection class (1)		IP66 (BS EN 60529) (9)	IP66 (BS EN 60529) (9)	
Cable length		1	1	m
Cable type				

SPECIFICATIONS (continued)

PARAMETER	CONDITIONS	107	110	UNIT
FLOW				
Maximum flow rate (Q4) [7]		8	25	l/m
Transitional flow rate (Q2)		0.4	0.5	l/m
Minimum flow rate (Q1)		0.10	0.20	l/m
Minimum registered flow rate		0.05	0.10	l/m
Accuracy [1]	T_{liquid} < 30°C, Q2 < Q < Q4	±3	±3	% of reading
	T_{liquid} >= 30°C, Q2 < Q < Q4	±3	±3	% of reading
	Q1 < Q < Q2	±5	±5	% of reading
Resolution		0.001	0.001	l/m
Reverse flow		option	option	
Response time		<0.1	<0.1	s
Ambient temperature [2]		-10 - 80	-10 - 80	°C
Liquid temperature [2]		-10 - 85	-10 - 85	°C
Pressure loss	Q = Q4	<0.05	<0.05	MPa
		<0.5	<0.5	bar
Suitable liquid sound speeds		1250 - 1750	1250 - 1750	m/s

PARAMETER	CONDITIONS	T type	B type	UNIT
ELECTRICAL				
POWER SUPPLY				
DC supply voltage		8 - 24	8 - 24	V
DC supply current	V+ = 24V, I_{sink}=0mA, LED off, pulsing	11.4	13.8	mA
PULSE OUTPUT(S) [6]				
Pulse rate [4]	Standard	1000	1000	pulses/l
Pulse edge time resolution [5]		488	488	µs
Typical NPN LOW voltage	V_{ext} = 5V, R_{ext} = 10kΩ	0.12	0.12	V
	V_{ext} = 5V, R_{ext} = 3.3kΩ	0.4	0.4	V
	V_{ext} = 5V, R_{ext} = 1kΩ	1.6	1.6	V
	V_{ext} = 24V, R_{ext} = 10kΩ	0.7	0.7	V
	V_{ext} = 24V, R_{ext} = 3.3kΩ	2	2	V
	V_{ext} = 24V, R_{ext} = 1kΩ	5.6	5.6	V
Typical NPN rise time	V_{ext} = 5V, R_{ext} = 10kΩ	5	5	µs
	V_{ext} = 5V, R_{ext} = 3.3kΩ	2	2	µs
	V_{ext} = 5V, R_{ext} = 1kΩ	<1	<1	µs
	V_{ext} = 24V, R_{ext} = 10kΩ	6	6	µs
	V_{ext} = 24V, R_{ext} = 3.3kΩ	2	2	µs
	V_{ext} = 24V, R_{ext} = 1kΩ	1	1	µs
Typical PNP HIGH voltage	V_s = 8V, R_{ext} = ∞	-	7.5	V
	V_s = 8V, R_{ext} = 100kΩ	-	7.5	V
	V_s = 8V, R_{ext} = 10kΩ	-	7.4	V
	V_s = 8V, R_{ext} = 3.3kΩ	-	7.1	V
	V_s = 8V, R_{ext} = 1kΩ	-	6.5	V
	V_s = 24V, R_{ext} = ∞	-	23.5	V
	V_s = 24V, R_{ext} = 100kΩ	-	23.5	V
	V_s = 24V, R_{ext} = 10kΩ	-	23.3	V
	V_s = 24V, R_{ext} = 3.3kΩ	-	22.9	V
	V_s = 24V, R_{ext} = 1kΩ	-	9.4	V
Typical PNP fall time	V_s = 8V, R_{ext} = ∞	-	76	µs
	V_s = 8V, R_{ext} = 100kΩ	-	76	µs
	V_s = 8V, R_{ext} = 10kΩ	-	40	µs
	V_s = 8V, R_{ext} = 3.3kΩ	-	26	µs
	V_s = 8V, R_{ext} = 1kΩ	-	16	µs
	V_s = 24V, R_{ext} = ∞	-	100	µs
	V_s = 24V, R_{ext} = 100kΩ	-	70	µs
	V_s = 24V, R_{ext} = 10kΩ	-	36	µs
	V_s = 24V, R_{ext} = 3.3kΩ	-	24	µs
	V_s = 24V, R_{ext} = 1kΩ	-	12	µs
Current limit	V_s = 24V, R_{ext} = 0	-	10	mA

SPECIFICATIONS (continued)

CURRENT SINK				
No liquid output [(1)]		-	3.98 - 4.02	mA
Zero flow output [(1)]		-	3.98 - 4.02	mA
20mA output	Vext = 24V, Rload = 0Ω	-	20.00	mA
	Vext = 24V, Rload = 1kΩ	-	20.00	mA
	Vext = 5V, Rload = 0Ω	-	20.00	mA
	Vext = 5V, Rload = 82Ω	-	19.60	mA
Accuracy			±0.02mA	mA
VOLTAGE OUPUT				
No liquid output [(1)]		-	<0.02	V
Zero flow output [(1)]		-	<0.02	V
5V output	Rload = ∞	-	4.98	V
	Rload = 100kΩ	-	4.93	V
	Rload = 10kΩ	-	4.50	V
Accuracy at 2.50V [(1)]	Rload = ∞	-	±0.02	V
TEMPERATURE SENSOR				
Sensor part		Maxim DS18B20+	-	
Sensing range [(8)]		-55 to +125	-	°C
Sensor resolution [(8)]		12	-	bits
Sensor accuracy [(8)]	-10°C < θ < +85°C	0.5	-	°C
Sensor location		Outside of flow tube	-	
REAL TIME OUTPUT				
Data rate		1024	-	bits per second
Data packet size		32	-	bytes
Data packet frequency		1	-	s

[1] 100% production tested
[2] Do not allow liquid to freeze inside the meter
[3] Adjustable
[4] Other options available, subject to minimum order quantity
[5] Pulses are designed for counting, measuring frequency is not recommended due to software interrupt time resolution
[6] On B type electronics, the PNP output is driven at the same time as the NPN output, including during communications data output
[7] Unlike mechanical meters, the maximum flow can be sustained continuously. Exceeding the maximum flow may affect output accuracy but will not damage the meter as long as maximum pressure ratings are not exceeded
[8] The temperature sensor is a digital device with calibration and specification as provided by the manufacturer. Flownetix tests, but does not calibrate or otherwise modify the temperature sensor reading
[9] The internal parts are sealed to achieve the IP66 rating. The external casing contains drainage holes that allow water and condensation to drain out of the outer enclosure. Water seen leaving the casing this way does not indicate a leaking of the flow tube

MECHANICAL INSTALLATION

For threaded parts, plastic fittings must be used to connect to the meter to avoid damaging the thread. DO NOT OVER-TIGHTEN.

Ingress protection

Internally, the meter's electronics and sensors are sealed to prevent liquid ingress and meter's are designed and tested to IP66. The external casing contains drain holes to allow spilt liquids and condensation to drain out. Liquid seen coming from the casing does not indicate leakage of the flow tube.

Installation position

The 100series® may be installed at any angle although it is recommended that it be installed such that the U-shaped measurement section remains full or completely drains of liquid should the process empty of liquid.

The meter should not be placed on the suction side of a pump, always on the outlet side. Valves should be placed on the output side. The meter is easily supported by pipework or hoses due to its low mass. A pipe inlet diameter that matches the inlet on the meter is recommended.

Liquids

The measuring tube is manufactured from a food grade plastic and so is safe to use with drinking water and other beverages. Most oils and other non-corrosive substances can also be used, but please consult Flownetix before use. Special plastics are available on request for certain order quantities subject to testing and minimum order quantities. Liquid and ambient temperatures must not be exceeded.

THE 100SERIES® IS NOT GUARANTEED SANITARY FROM THE FACTORY AND SHOULD BE FLUSHED, CLEANED OR TREATED AS REQUIRED BY LOCAL REGULATIONS BEFORE INSTALLATION.

Entrained air/solids

This meter is designed to operate on clean liquids only. Higher levels of air or solid can prevent transmission of the ultrasonic signal and the output will fall to zero, although will cause no damage to the meter.

ELECTRICAL CONNECTIONS

"T" TYPE ELECTRONICS

COLOUR	NAME	DESCRIPTION
Red	V+	Power supply
Black	GND	Ground
Blue	NPN/DATA OUT	NPN pulse output and data bus output, requires pull-up resistor
Yellow	DATA IN	Real time streaming output, requires pull-up resistor
White	REALTIME	PNP pulse output, internal 100K pull-down resistor (B type units only)
Orange (1)	NC	Do not connect, cut off at factory
Brown (1)	NC	Do not connect, cut off at factory
Green (1)	NC	Do not connect, cut off at factory

(1) Units may be fitted with a 5-core or 8-core cable. If 8 cores are used, then the 3 unused wires will be cut back by the factory. Do not connect these wires to any other connection.

"B" TYPE ELECTRONICS

COLOUR	NAME	DESCRIPTION
Red	V+	Power supply
Black	GND	Ground
Blue	NPN/DATA OUT	NPN pulse output and data bus output, requires pull-up resistor
Yellow	DATA IN	Data bus input, leave unconnected or tie to GND if not used OPTIONAL: Factory option (at time of order only) for empty pipe alarm logic signal (5)
White	PNP	PNP pulse output, internal 100K pull-down resistor (B type units only)
Orange	VOUT	0-5VDC analog voltage output (B type units only)
Brown	ISINK	4-20mA analog current sink (B type units only)
Green	GND2	Ground, internally connected to black wire

OUTPUT FUNCTIONS

OUTPUT FUNCTION	EMPTY TUBE CONDITION	NO FLOW CONDITION	FORWARD FLOW CONDITION	REVERSE FLOW CONDITION
Pulse output(s)	No pulses (1)	No pulses (1)	Pulse rate proportional to flow rate (2)	No pulses (3)
Voltage output (B only)	0V	0V	Voltage output proportional to flow rate	0V (3)
Current sink (B only)	4mA	4mA	Current sink proportional to flow rate	4mA (3)
LED	OFF (blinking ON every 4 seconds)	ON (blinking OFF every 4 seconds)	Blink speed increases with flow rate (4)	Blink speed increases with flow rate (4)

1 Pulse may stop in the LOW or HIGH condition to mimic mechanical meters
2 Pulses are designed for counting, due to software interrupt speed resolution measuring the frequency is not recommended
3 If reverse flow option is enabled, output is the same as for forward flow condition
4 Non-linear relationship for indication only due to wide flow turndown ratio
5 If empty pipe alarm output option selected, communications are only available when the pipe is empty

TECHNICAL INFORMATION

THEORY OF OPERATION

Ultrasonic flowmeters fall into two main categories:

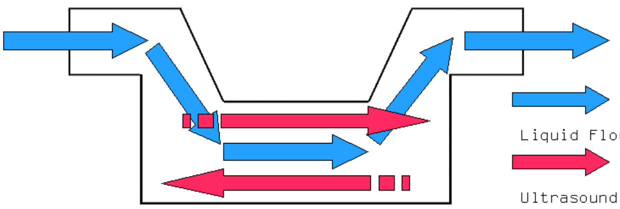
- Doppler
- Transit time

The former rely on the Doppler effect to relate the frequency shifts of acoustic waves to the flow velocity. This requires some particles, bubbles or disturbances in the flow to reflect the transmitted signal. Generally at least 25ppm of suspended solid or bubbles with diameters of 30 micron is required for a typical application.

For this reason, Doppler ultrasonic flowmeters are not suited to use on clean liquids or where conditions mean that the particles are not travelling parallel to the pipe axis.

Transit time (sometimes called time of flight or TOF) is the technique used by the majority of ultrasonic flowmeters including the Flownetix range of products.

A pair of ultrasonic transducers, acting in turn as transmitter-receiver and receiver-transmitter, is placed on the pipe wall, one on the upstream and the other on the downstream. The time for acoustic waves to travel from the upstream transducer to the downstream transducer t_d is shorter than the time it takes for the same waves to travel from the downstream to the upstream t_u. The time difference is directly proportional to the flow velocity. Zero difference means zero flow.



Transit time ultrasonic flowmeter operation

t_d and t_u are created by:

$$t_d = \frac{L}{c + V \cos\theta}$$

$$t_u = \frac{L}{c - V \cos\theta}$$

where c is the speed of sound in the fluid, V is the flow velocity, L is the distance between the transducers and θ is the angle between the flow direction and the line formed by the transducers.

The difference of t_d and t_u, the transit time difference, is:

$$\Delta t = t_d - t_u = \frac{L}{c - V \cos\theta} - \frac{L}{c + V \cos\theta}$$

$$= \frac{2VL\cos\theta}{c^2 - V^2 cos^2\theta}$$

$$= \frac{\frac{2VX}{c^2}}{1 - \left(\frac{V}{c}\right)^2 cos^2\theta}$$

where $X = L\ cos\ \theta$

To simplify this, we assume that the flow velocity V is much smaller than the speed of sound c. For example, pure water at 20°C has a sound speed of 1482m/s against a typical liquid flow of velocity of 0.01 to 4m/s. Therefore, since:

$$V \ll c \Rightarrow \left(\frac{V}{c}\right)^2 \approx 0 \ll 1$$

we then have:

$$\Delta t \approx \frac{2VX}{c^2}$$

or,

$$V = \frac{c^2 \Delta t}{2X}$$

Note that the speed of sound c in the fluid is affected by many factors such as temperature and density. However, since the measurement is only dependant on the speed of sound, this can be measured and included in the calculation. Therefore those physical factors of the fluid that varies after the time of calibration, such as temperature and density, are automatically corrected for. Since we already have t_d and t_u, the sound speed can be calculated by taking the average of these which removes the effect due to the flowing liquid.

Correction for changes in the sound speed of the fluid is required for any ultrasonic meter to maintain performance across different fluids and physical parameters as shown above. Just taking pure water as an example, a meter calibrated at 20°C (where the sound speed is 1482m/s) will read an error of +8% at 4°C (c = 1421m/s) and an error of -10% at 74°C (c = 1555m/s) without such correction. Note the square relationship to c in the equation above.

With other fluids the speed of sound can be very different. Sea water at 20°C measured by a meter calibrated on pure water at 20°C would have an error of –6.7% (c = 1531m/s) and diesel oil at 25°C an error of +29% (c = 1250m/s).

By using the ultrasonics, effects other than just a change in temperature can be corrected for the instant that the changed fluid passes through the measuring section. Many ultrasonic meters require this information to be entered directly, an ideal meter corrects automatically.

Typical values for δt should be noted to understand the challenges of producing an ultrasonic flowmeter. Assuming a small bore 15mm flow meter with axial transducers, δt may only be of the order of 50ns at 5m/s of liquid flow. Therefore, in order to achieve a meter with 100:1 turndown ratio maintaining a performance of 2% of reading at that flow, the meter must be able to resolve time differences of at least 0.01ns (10^{-11}s), the same time as it takes light to travel a distance of 30mm.

Ultrasonic liquid flowmeters do not (unless by design) measure the flow of gas, including air, which can be beneficial in many applications where mechanical meters read high or can be damaged. Substances have "acoustic impedance" which can be thought of in the same way as electrical impedance. With a close impedance match between interfaces, energy is transferred; with a large mismatch, energy is reflected back to the source. Taking some typical acoustic impedances:

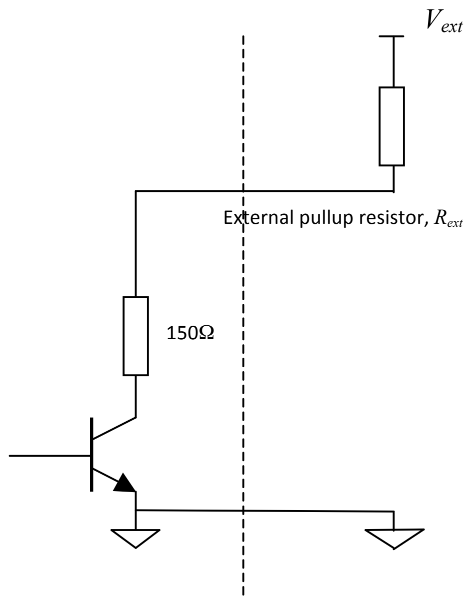
SUBSTANCE	**ACOUSTIC IMPEDANCE (Mrayl) 10^6 kg m^{-2} s^{-1}**
Lead zirconate titanate (piezo material in transducer)	30
Plastics	Typically 0.5-5
Water	1.5
Air	0.43 x 10^{-3}

It can be seen that for a typical transducer to plastic to water interface, the impedance match is good compared to the transducer to plastic to air. Therefore most of the signal entering an air filled tube is reflected back at the plastic-air interface. With no signal passing through the tube, no flow of air can be measured.

NPN PULSE OUTPUT

The NPN pulse output mimics a traditional mechanical meter's pulse output. An open collector NPN output allows interface to an output voltage that differs from the supply voltage.

A representation of this output is shown below:



For R > 3.3kΩ,

$$V_{OL} = 0.2 + \left(\frac{150}{R + 150}\right) V_{ext}$$

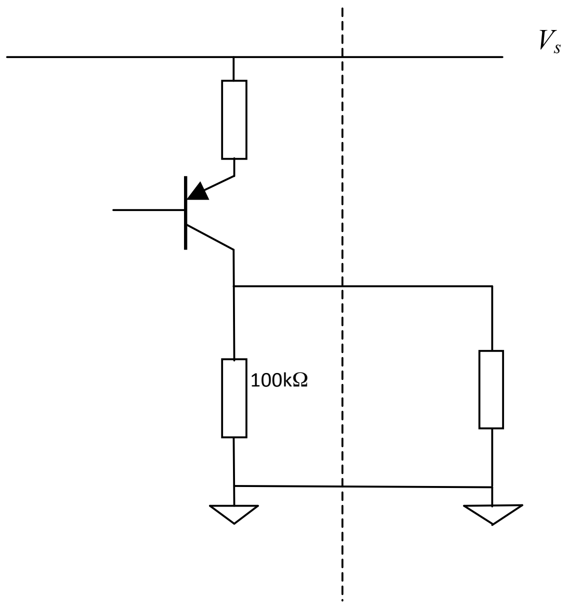
Standard products produce 1000 pulses per litre (or 1 pulse as each ml passes). The timing of the pulse edges is controlled by the 100series® firmware with a timing resolution of approximately TBC μs. For this reason, measuring the frequency of the output is not recommended to determine flow rate. The output is designed for counting.

The pulse output is used for the serial DATA OUT. Pulse transitions should not be counted during communications, although the meter will continue to measure during the communications time.

PNP PULSE OUTPUT

This output is available on the B type electronics only. It is a copy of the NPN pulse output (including DATA OUT), presented using a transistor to pull up to the supply voltage. This is connected internally and so the pull-up voltage can only be equal to the supply voltage. An internal 100K transistor gives a slow pull-down action.

A representation of this output is shown below:



This output is limited to approximately 10mA so short circuit direct to GND can be tolerated continuously.

Due to the internal design of this circuit, the circuit draws an additional 4mA in the low output state even if not connected externally.

VOLTAGE OUTPUT

The voltage output is a very simple 0-5VDC produced using a digital-to-analog converter. It provides a very simple indication of flow rate, but errors can be caused if not using short cable lengths or a high impedance meter to measure the voltage. The current output is recommended for the majority of analog connection applications.

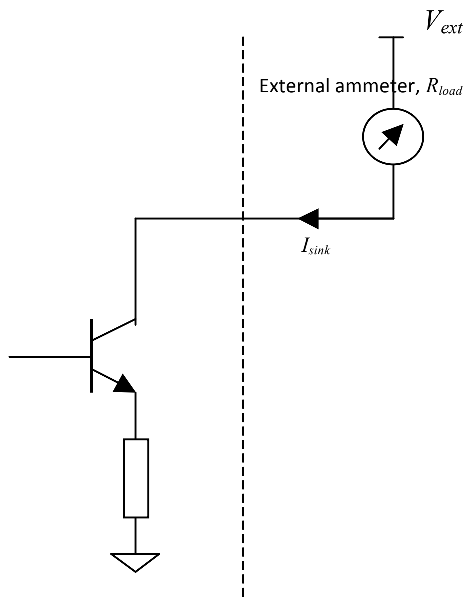
$$V_o = 5\left(\frac{Q}{Q4}\right) \quad \text{volts}$$

The output is factory set to be within ±0.02V at 2.5VDC output. Errors due to voltage offsets can be more significant at low output voltages; the pulse output is the ultimate measure of the meter's performance.

CURRENT SINK

The current sink allows interfacing to a current loop type connection. A current sink is used as the low internal voltages of the 100series® limit the ability to provide a current output to drive into high resistance loads. The current sink also allows interfacing to loop voltages that differ from the supply voltage or give the open to increase the loop voltage for long or high resistance loop connections.

A representation of this output is shown below:



$$I_{sink} = 4 + 16\left(\frac{Q}{Q4}\right) \quad \text{mA}$$

This output is factory set to be within ±0.02mA at 4.00mA, improved calibration is possible for users with the appropriate supplied Flownetix equipment and software. Errors due to small current offsets can be more significant at low sink currents; the pulse output is the ultimate measure of the meter's performance.

In order to obtain the 20mA full scale output, the load with determine the minimum external voltage required:

$$V_{ext} > \left((R_{load} + 150) * 0.02\right) + 0.4$$

For digital devices where the load is very low, there are normally no issues; moving coil meters tend to present a greater voltage drop to the current loop.

COMMUNICATIONS INTERFACE

The Flownetix 100series® and 300series® products communications interface. Initially developed to allow test and configuration of the meter during manufacture, a wide range of data is available to download from the meter to confirm its operation state and also give very useful information regarding the application conditions the meter experiences.

The information available includes:

- Model type and serial number for meter identification
- Battery status (300series only)
- Memory status
- Meter reading
- Meter readings for the past 12 months (300series only)
- Current timestamp value
- Peak flow rate and timestamp
- Number of seconds of air, reverse and forward flow conditions
- Current flow condition (air, reverse or forward flow)
- Current flow rate
- Liquid and ambient condition information
- and more…

The protocol is open to anyone wishing to interface to the meter and is non-specific to any particular manufacturer or remote reading equipment.

Flownetix does not currently manufacture any remote reading equipment so end users and utilities are free to choose the best remote solution for their own needs. If you develop a remote reading solution for Flownetix products, please contact us so we can your product to our list for consideration by our customers.

The pulse output (1000 pulses per litre as standard) is a volt free (open collector NPN) type output so needs an external pullup resistor on the interface equipment.

The serial data output pin is shared with the pulse output; do not count transitions on the pulse output pin during communications. The meter only outputs data on this pin after requested on the DATA IN connection so pulse transitions should be ignored unless communications are being initiated. Do not forget to implement a pull-up resistor in the external equipment.

The 100series' serial port uses 3.3V logic level RS232-type signalling. Typically to interface to a PC or similar serial port a driver device such as a MAX3232 must be used to convert the RS232 signal levels to TTL levels acceptable to the meter.

The serial port operates at 9600 baud with 8 data bits, 1 start bit, 2 stop bits and no parity.

To initiate communications, hold DATA IN (YELLOW) to the GND (BLACK) LOW between 1000ms and 3000ms. After the low time, release DATA IN. The unit will output an ASCII 0x3F (question mark, '?') character.

At this time, the pulse output pin becomes the data output pin so pulse transitions must not be counted until communications is completed. Within 200ms of the '?' character from the unit, send a single command character to the unit on DATA IN (YELLOW).

The unit will respond with data depending on the command sent. Throughout the communications process, the meter continues to measure flow as normal.

For full details of the commands available, please contact Flownetix.

REAL TIME OUTPUT

The 100v4-T devices are equipped with a real time output connection. Every 1 second, a stream of data that includes the flow rate, total, alarms, counts of air and reverse events, temperature, fluid sound speed (in conjunction with the temperature sensor reading this can be used to give an indication of the fluid, subject to the application) and more.

Electrically the output is the same as the pulse output. A pull-up resistor is required.

For full details, see the document *"Flownetix 100series and 300series - Interface Manual".*

TEMPERATURE SENSOR

The 100v4-T devices include a built in IC temperature sensor attached to the outside of the flow tube. The part is a Maxim DS18B20+ that is read directly by the meter's MCU.

The temperature data is available at the serial port or the real time output stream. As the temperature sensor part is digital and performance calibrated at manufacture, performance should be as given in the manufacturer's data sheet.

Comparing the temperature reading to the sound speed can help to identify the fluid, depending on the application. For example, it is simple to tell the difference between beer and water. For more information, see the document *"Flownetix 100series and 300series - Interface Manual".*

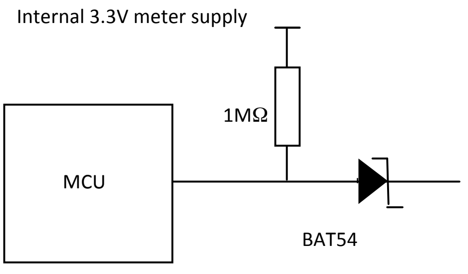
OPTIONAL EMPTY PIPE ALARM

At the time of manufacture, it is possible to request an empty pipe alarm logic signal output. Empty pipe indication can be obtained from the serial bus from standard products; a logic level output is available as an option specified during manufacture.

In the latter case, the YELLOW wire (DATA IN) indicates the tube signal status as an OUTPUT:

Condition	**Output logic**	**Output condition**
Pipe full	LOW (<0.7V)	Internally pulled down by MCU
Pipe empty	HIGH (>2.5V)	Internally pulled up through 1MΩ

Internally the circuit generates the pipe empty alarm signal using the following circuit:



The signal level on this line should be measured directly by a high impedance device (>10MΩ) and not pulled or driven high or low externally. If communications are required, first check the output condition is HIGH (i.e. pipe empty) before starting the communications event. Attempting to initiate communications with the line LOW may damage the meter or remote equipment.

FURTHER READING

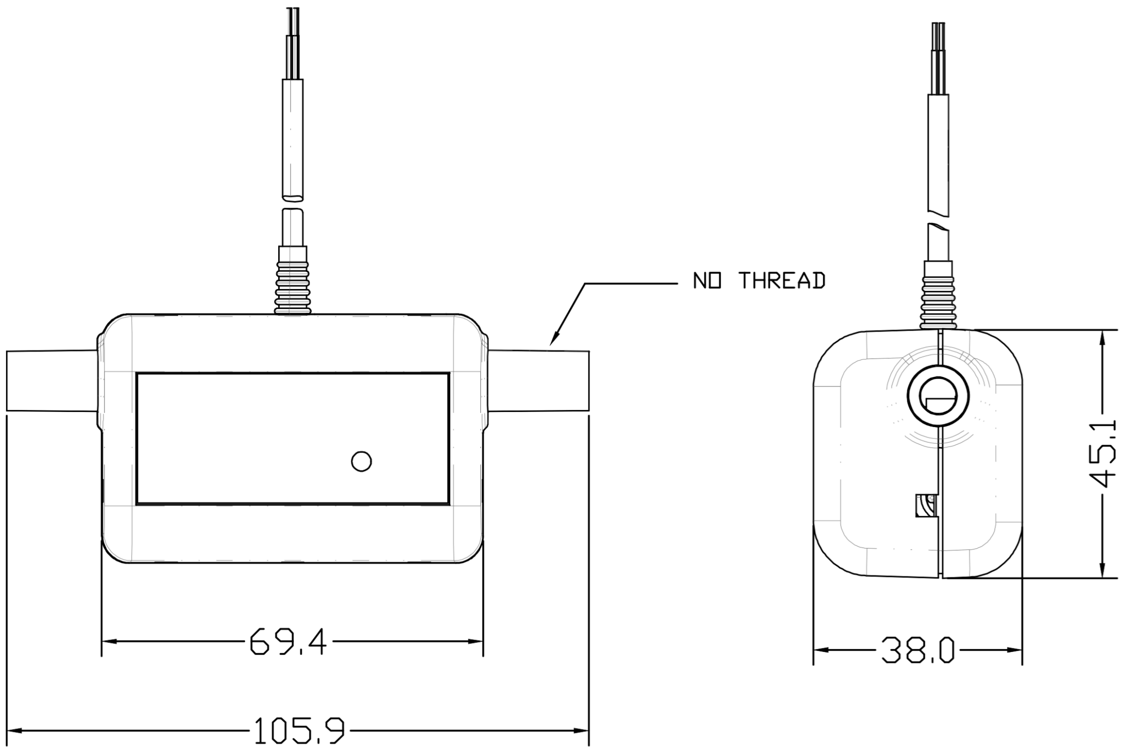
These documents and more can be downloaded from http://my.flownetix.com (registration required).

"Flownetix 100series and 300series - Interface Manual"
Detailed information for use of the pulse output, analog outputs, serial interface and real time data output

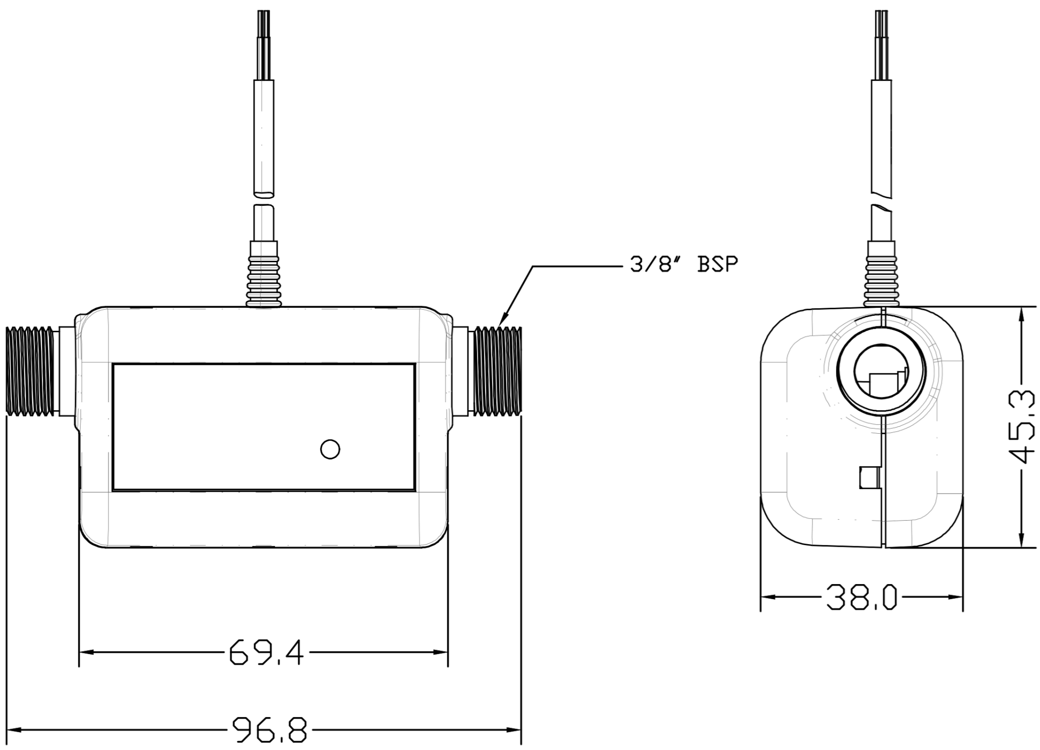
"Flownetix RS485 solution - notes for system integrators"
Introduction and communications for using the RS485 system

"Flownetix live demo usage notes"
Live demo description and instructions for use

DIMENSIONS



Flownetix 107v4 dimensions



Flownetix 110v4 dimensions

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