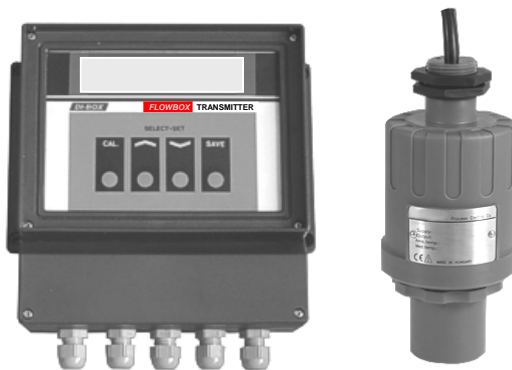**DI-BOX**

Flow meter:

ULTRASONIC FLOW METER

FLOWBOX

Rising element:

PALMER-BOWLUS FLUME

ZPB160

User's manual

Wrocław   2020

Thank you for choosing product of our firm.
The DI-BOX company guarantees the big quality
of the purchased device and its proper operation.

The guarantee period for the purchased apparatus covers: **18 months**.

The present device is manufactured in conformity with the standards required for digital tools B class.

This manual was issued only in order for information purposes. All information included can be changed. The **DI-BOX** does not bear the responsibility for any direct and indirect defects arisen as a result of using this manual.

BHP HEALTH AND SAFETY. The assembly, starting, service, maintenance and repairs can be made exclusively by the qualified personnel in accordance with the obligatory safety principles.

The device is safe and works properly, if it is properly transported, stored, installed, started up, serviced and maintained. The product should be used in accordance with the manual.

BHP HEALTH AND SAFETY. **CAUTION: The improper service may cause getting hurt or serious device damage.**

DI-BOX

Zakład Aparatury Kontrolno-Pomiarowej i Automatyki Przemysłowej

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TABLE OF CONTENTS

1. INITIAL INFORMATION

The measuring set serves as not foamed liquid intensity measure flow in the gravitation conditions and total amount of sewage flowing through the measuring channel.

In the scope of this application, the FLOWBOX flow meter determines the temporary flow on the basis of liquid accumulation in the Palmer-Bowlus flume ZPB160, in accordance with the guidelines and recommendations of the **ISO 4359:1983** standard.

! **The basic condition to apply the method is to provide free, undisturbed inflow and outflow of liquid from the measuring flume.**

Measuring set consists of:
→ Flow measuring transmitter M1600,
→ Ultrasonic level sensor SPA 380-4,
→ Palmer-Bowlus ZPB160 flume.

2. TECHNICAL DATA

2.1. Flow measuring transmitter M1600

→ **MEASURING SCOPES:**

Intensity flow measurement: for ZPB160

- in the entities m^3/h: $40\ m^3/h$

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- in the entities m^3 (summary):   0...1.000 000

→ **PROGRAMMING:** local, for Palmer-Bowlus ZPB160

→ **OUTPUTS SIGNALS:** (electroplating separation in/out)

Current output:	0/4...20mA, load 500 Ω max.
Impulse output:	every 0,1m3, type: opencolector
Digital output:	RS485/MODBUS RTU

→ **OTHER DATA:**

Power supply:	~230V, 50Hz
Power consumption:	≤ 10 VA
Mass:	~1,5 kg
Material:	ABS
Protection class:	IP65
Work temperature scope (without protective case):	-10 do 55 ^{o}C

2.2. Ultrasonic level sensor SPA 380-4

SPA 380 is the ultrasonic inlet of distance for standard current signal intended for measuring the liquid level changes.

The basic usage is situated at measuring level in industrial and municipal sewage treatment plants, batch and reserve tanks, wells, sewage wet wells, measuring instruments in open channels, etc.

The device is made in the form of measuring probe having the microprocessor measuring instrument and ultrasound sensor.

The casing of the probe is made of PVC what assures the wide scope of usages in different environment conditions.

The membrane of ultrasound sensor is situated inside the casing and communicates with frontal surface of the probe by the acoustic coupler what protects it against the influence of environment conditions (humidity, caustic fumes, etc.)

The probe has the function of automatic cleaning of frontal surface of radiator with gathering sediments by the instant increase of the ultrasound wave emitted power.

SPECIFICATION
Technical parameters:
→ Accuracy: 0.10% of the scope in the laboratory conditions
0.25% of the scope in the field conditions
→ Resolution: 0,7mm
→ Measuring scope: 0,25...4,0m.
→ Signal beam curve: 5-7° with decrease of the power of 3d
→ Temperature compensation: automatic

Output:
→ Analogue output: : 4...20mA or 20...4mA
→ Max. load: R=(Uzas.-6)24mA

Feeding: 18 to 30VDC max. 0.07A
**Protection class:** IP68
Thread diameter: 2.0" NPT

## 2.3. Palmer-Bowlus ZPB flume

Palmer-Bowlus measuring flume is one of the prefabricated measuring flumes intended for measuring the flow in gravitation wires. It is recommended to gravitation channels with circular section and pipelines working without pressure.

The channel assures exact relation between the level of its filling and liquid flow intensity in the channel or pipeline.

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! The basic condition to apply the method is to provide free, undisturbed inflow and outflow of liquid from the measuring flume.
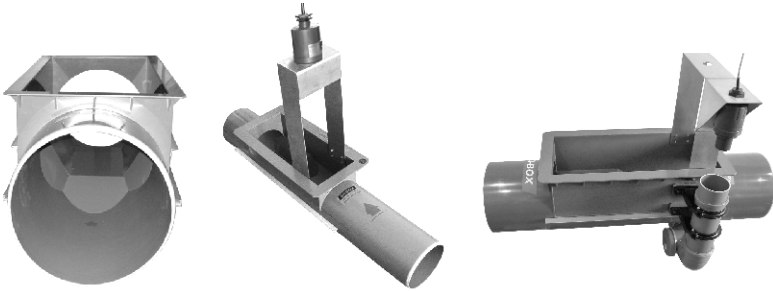
Typ koryta	DN	Q m³/h	B	L	Typ koryta	DN	Q m³/h	B	L
ZPB100	Ø 110	12	155	800	ZPB400	Ø 400	450	450	1500
ZPB160	Ø 160	40	210	800	ZPB500	Ø 500	730	550	1700
ZPB200	Ø 200	70	250	1190	ZPB600	Ø 630	980	685	2000
ZPB250	Ø 250	130	305	1190	ZPB800	Ø 800	1700	860	2600
ZPB300	Ø 315	220	368	1400	ZPB1000	Ø 1000	4380	1050	3500
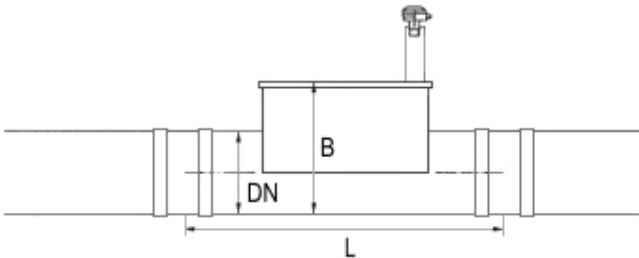
! In order to obtain the proper flow intensity, the flume must be installed horizontally without fall.

3. INSTALLATION OF MEASURING SET

## 3.1. Assembly recommendations

PALMER-BOWLUS FLUME ZPB

→ Install the flume on the pipeline by means of inserting channel in pipeline goblet or typical hydraulic muff in the way of assuring the durability and tightness of the connection, remembering about the proper flume orientation (the indicator in the channel shows the flow direction).

→ **Install the flume in the horizontal position without drops.**

→ Perform support of the flume assuring its immobilization

→ Handle must screwed to the channel in the given places by means of eight M5 screws

INLET AND OUTLET CHANNELS

→ Provide free, undisturbed inflow and outflow of liquid from the measuring flume by means of ensuring long enough straight inlet and outlet channel parts.

ULTRASONIC LEVEL SENSOR SPA 380-4

→ SPA 380-4 sensor should be installed in the durable and safe way in the given measuring handle. The handle screwed to the reducer by means of 2x4 M5 should guaranteed solid and safe placement of the sensor during work.

→ Put the measuring sensor in the handle in accordance with the drawing. Use the washers. Screw the nuts 2,0".

→ The way of ultrasonic signal should be free of any disturbances.

→ The surface of the assembly should be free of vibrations.

→ The surrounding temperature should be between -20˚C....+70˚C

→ There should not be the electric power cables or electric power converters nearby.

DI-BOX
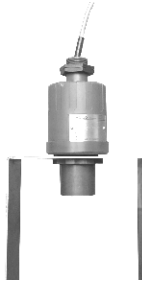
[!] In case of sensor installation outside you should cover it against the sunbeams and environment conditions.

[!] **The delivered sensor 380-4 SPA is calibrated for the determined type of flume and does not require any settings by the user. The change of factory settings will cause error of measuring transmitter M1600.**

MEASURING TRANSMITTER M1600

→ It is recommended to use the roofing of the transmitter protecting it against direct influence of the atmospheric factors (for instance: rain, snow) or installation in safety case.

→ **BHP** HEALTH AND SAFETY. In order to assure the safety of service (for instance: during the starting up, maintenance and cleaning) the transmitter should be mounted in the easy available place.

→ All connections of electric wires should be placed as to prevent from their mechanical damage.

→ [!] The installation of the device must meets with electromagnetic compatibility rules.

→ The influence of the disturbances of the other devices on the flow meter work **must be strictly eliminated!**

Rys. Dimensions of M1600 transmitter and span of holes for mounting bolts

NOTES REFERRING TO SET FUNCTIONING:

In order to assure the proper functioning of the measuring set, please to work in accordance with the manual.

3.2. Connecting the wires to the transmitter M1600

In order to connect the signal, output and power supply wires to the transmitter strip terminal in accordance electric scheme (chapter 3.3), you should:

→   Unscrew two screws visible on the frontal board,
→   Insert signal, power supply and output wires into the proper throttles,
→   Connect the wires to the terminal strip and immobilize them screwing the throttles to the end.
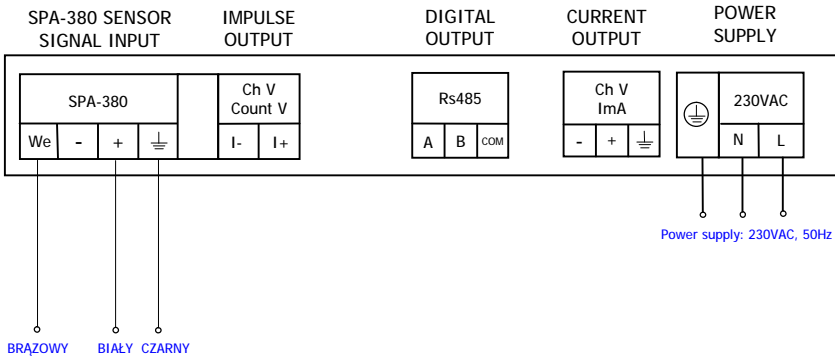
BHP **HEALTH AND SAFETY: All electric connections should be made during switched off power supply of the measuring transmitter M1600.**

Do not touch the strip joints while making the connection of the wires to the terminal strips (use the screwdrivers with the isolations, hang the wires on isolation).
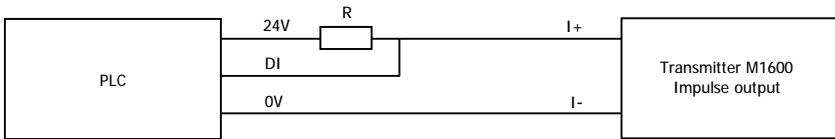

Unscrew and take off a cover

3.3. Scheme of electric connections of the transmitter M1600

SPA-380 SENSOR SIGNAL INPUT	IMPULSE OUTPUT	DIGITAL OUTPUT	CURRENT OUTPUT	POWER SUPPLY

SPA-380	Ch V Count V	Rs485	Ch V ImA	230VAC
We	-	+	⏚	I-	I+	A	B	COM	-	+	⏚	⏚	N	L

Power supply: 230VAC, 50Hz

BRĄZOWY   BIAŁY   CZARNY

Kabel czujnika SPA -380 : LiYCY 2x0,35mm ekr.

PLC	24V ——— R ——— I+	Transmitter M1600 Impulse output
	DI	
	0V ——— I-	

PLC connection to impulse output.

Resistor should limit a current to max 150mA.

For PLC R = ~ 2-3kΩ.

! Installation of the device must meets the electromagnetic compatibility rules.

! **The influence of the disturbances of the other devices on the flowmeter work must be strictly eliminated!**

4. DEVICE SERVICE

! The measuring set was configured to measurement the intensity and amount of sewages by using the measuring channel Plamer-Bowlus ZPB160 and level sensor SPA 380-4. The characteristics of measuring channel and proper measuring formula was implemented to the M1600 transmitter memory. The user should only set the parameter h0 in accordance with the point. 4.2.

In the event of change the sensor or measuring flume the M1600 transmitter **should be programmed in the company DI-BOX**.

4.1. Display of device

The four-buttons keyboard and liquid-crystal unit are to communicate with the user.

After connecting the measuring set in accordance with the electric scheme (point. 3.2.), to the factor of the transmitter there will be projected the following issues: indications of liquid flow intensity in m^3/h, summary amount flowing through the measuring flume and actual value of the liquid level in the flume.


```
V = 21.4 m3/h      9.0
Q = 20 m3
```

Flow intensity	V = 21.4 m3/h 9.0	Value of the liquid level in the flume [cm]
Summary liquid amount	Q = 20 m3	

By pressing the button ∧ or ∨ you may switch a main display for an information of unit time duration and power stoppage.

         DI-BOX

Time duration

```
duration        stopp
    1:25          11
```

Number of power stoppage

Projecting the announcement:

```
SENSOR ?   h      0.0
Q =  20 m3
```

→   means incorrect connection of ultrasonic sensor with a M1600 transmitter.

Projecting the announcement:

```
V = ! ! !           20.0
Q =  20 m3
```

→   means exceeding a flume's flow range.

When the # or * characters appear in the display, it indicates a connection to the Modbus network:

```
V = 21.4 m3/h     9.0
Q = 20 m3         **
```

The M1600 transmitter is connected to the Modbus network.

* The M1600 transmitter is connected to the Modbus network, the M1600 and Master are properly configured.

** The M1600 transmitter is connected to the Modbus network, the M1600 and the Master are correctly configured. Inquiry was received from Master and response was obtained from M1600 transmitter.

4.2. Device calibration

After proper installation of measuring set you should make the measurement of the setting of ultrasound sensor SPA 380-4 with relation to the measuring feet of ZPB 160 flume and enter into the memory of the M1600 transmitter.

It is the most effective way to do this:

→ Plug the input part of measuring channel,

→ Fill the input part with water as to overflow the water through the measuring feet and water level levels to the measuring feet,

→ Check the value of the filling indicated by the transmitter M1600 on the display at factory settings:

```
V = 0.0m3/h          -0.1
Q = 20 m3
```

If the filling value h on the display is another than "0" (on the drawing h=-0.1) in these conditions (the lack of flow) you should:

→ Press the button **CAL** through about 20-30 seconds until the announcement displays:

```
h0 = 52.4cm     ⬍ ?
         ZERO LEVEL
```

It means that the ultrasound sensor SPA 380-4 front - in accordance with factory settings - is 52.4cm from the surface of ZPB flume's measuring feet.

→ Buttons ∨ (or ∧ depends on situation) decrease (or increase) the value H0 with size h displayed by the transmitter M1600 (in the described example the value h was -0.1cm so you need to increase this value h0, so the proper value h0 is 52.4 + 0.1=52.5cm)

→ press button **SAVE**

After making these activities there should be displayed the actual value, filling (level) of the liquid.

```
V = 0.0m3/h          0.0
Q = 20 m3
```

If there is not possible to perform the above-mentioned procedure for some reasons, applying the solution with lower exactness - physically measure the distance front sensor from measuring feet. In order to change the setting the following should be performed:

→ Press the button **CAL** through about 20-30 seconds until the announcement displays:

> h0 = 56.3cm   ⬍ ?
> ZERO LEVEL

→ Buttons ∨ or ^ set the new, with reference to factory settings, proper distance - for the channel ZPB, in accordance with the below mentioned drawing:
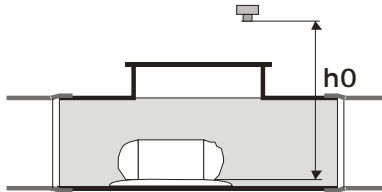
→ After measuring and setting the proper distance **h0** you should press button **SAVE**, what will be confirmed by **OK.**

4.3. Measuring scope and input electric current set

Wanting to read out or set the measuring scope or outflow current, one should:

→ Press the button **SAVE** through about 5 seconds until the announcement displays:

> 0.0 - 40.0   4mA
> measuring scope

It means that the flow intensity measuring scope within the scope **0-40 m3/h** for the current scope **4-20mA** was manufactured set. If there is a necessity to change it, you should press button **CAL** and then chose one of the scope by buttons ∨ or ^.

0-10m^3/h	0-20mA
0-20m^3/h	0-20mA
0-30m^3/h	0-20mA
0-40m^3/h	0-20mA
0-10m^3/h	4-20mA
0-20m^3/h	4-20mA
0-30m^3/h	4-20mA
0-40m^3/h	4-20mA

You should press **SAVE** what will be confirmed by **OK**.

5. MODBUS INTERFACE

MODBUS interface allows for the connection of one or more measuring transmitters to a common transmission line of the RS-485 standard with the use of Modicon-MODBUS protocol. MODBUS interface is characterized by the following capabilities:

- → reading the current measurement results,
- → reading the previously entered parameters,
- → writing new parameters,
- → examining the device status.

5.1. Technical data

1. Transmission line: in accordance with specification of the (EIA) RS-485 standard.
2. Communication protocol: in accordance with specification of the Modicon-MODBUS standard.
3. Maximum line length: 1200 m.
4. Galvanic barrier: for each transmitter.
5. Maximum number of logical units: 247.
6. Maximum number of physical units connected to the line without a repeater: 32.
7. Maximum access time to a single station: below 300 ms.
8. Format of transmission for a single character (asynchronous transmission):
   - → rate: 9600 bauds,
   - → number of bits: 8 (RTU),
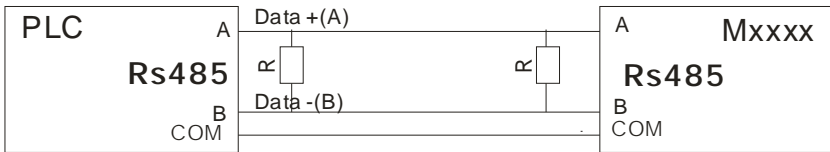   - → number of stop bits: 1,

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→ error control: no parity control (NONE PARITY).

9. Resistance to interference: in accordance with specification of the (EIA) RS-485 standard.

5.2. Installation and launch of the MODBUS interface

Connection of transmitters:

Transmitters must be connected to the existing line in accordance with the figure presented below:

Connection of M1600 transmitter to the MODBUS network

R = 100 – 150Ω 1W, depending on the wave impedance of the used cable.
Resistors can't be used in the case of short connections.

Configuration of the M1600 transmitter:

Each transmitter operating in the network must be properly configured with the use of keyboard through assignment of a unique identification number.

Determination of the number identifying transmitter in the network:

→ press and hold SAVE key for approx. 15s - after this time, the message **MODBUS NUMBER** will appear in the bottom part of the display and the current device number will be displayed in the upper part,

→ exit from the procedure occurs after pressing **SAVE** key again,

→ in order to change the current device number, press **CAL** key and then use arrow keys to set the desired device number, and press **SAVE** key,

→ pressing **CAL** key again before pressing **SAVE** key will result in cancelling the carried out settings and return to the display of the current device number.

5.3. Description of registers of the transmitter M1600

Reading of the measurement results and setting of transmitter parameters occurs through 16-bit registers available via standard functions of the MODBUS protocol.

The following reading and writing registers are distinguished **FOR MEASURING TRANSMITTERS**:
- → read with the use of function 3 (Read Holding Registers),
- → written with the use of function 6 (Write single register)
- → address range 0 - 65535

Types of variables:

UNSIGNED - 16-bit unsigned integer, represented by one register.

FLOAT - 32-bit floating point value according to the IEEE standard, represented by two registers (32 bits).

LONG INTEGER – 32-bit total value according to the IEEE standard, represented by two registers (32 bits).

Read Holding Registers

1. Address: 0, Format: FLOAT

LEVEL in [m] - for the flow transmitter,

2. Address: 0, Format: FLOAT

FLOW in [m³/h] - for the flow transmitter,

3. Address: 0, Format: FLOAT

SUMMARY in [m³] - for the flow transmitter,

4. Address: 0, Format: FLOAT

ZERO LEVEL [m] - for the flow transmitter,

Handling of errors

In the Exception Response, the device returns error codes:

1 – illegal function,

2 – illegal address of registers,

3 – illegal value of registers.

Handling of errors in the M1600 transmitter

The following messages are shown on the transmitter display:

- transmitters is connected to the Modbus network,

DI-BOX

* - transmitter is connected to the Modbus network, transmitter and Master are correctly configured,

*1 - illegal function,

*2 - illegal address of registers,

*3 - illegal value of registers,

*4 - CRC checksum error.

6. MAINTENANCE RECOMMENDATIONS

5.1. Palmer Bowlus ZPB flume and ultrasonic sensor SPA 380-4

Check the permeability and clearness of the liquid piling up elements (measuring flume) depending on needs. The maintenance of the sensor SPA 380-4 refers to the occasional check of sensor surface clearness and possible wiping the sensor frontal surface with the soft cloth.